The GALE ENCYCLOPEDIA *of* Medicine

FOURTH EDITION

The GALE ENCYCLOPEDIA *of* MEDICINE

FOURTH EDITION

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The GALE ENCYCLOPEDIA *of* MEDICINE

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LAURIE J. FUNDUKIAN, EDITOR

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Bedwetting

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Beriberi
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Chancroid

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Cystoscopy
Cytomegalovirus antibody screening test
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Debridement
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Dyspareunia
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Ear surgery
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Leprosy
Leptospirosis
Lesch-Nyhan syndrome
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Lymphocytic choriomeningitis
Lymphocytopenia
Lymphogranuloma venereum
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M

Macular degeneration
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Magnetic field therapy
Magnetic resonance imaging
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Malaria
Malignant lymphomas
Malignant melanoma
Malingering
Mallet finger
Mallory-Weiss syndrome
Malnutrition
Malocclusion
MALT lymphoma
Mammography
Mania
Marfan syndrome
Marijuana
Marriage counseling
Marshall-Marchetti-Krantz procedure
Massage therapy
Mastectomy
Mastitis
Mastocytosis
Mastoidectomy
Mastoiditis
Maternal to fetal infections
Maxillofacial trauma
Measles
Meckel's diverticulum
Mediastinoscopy
Meditation
Mediterranean diet
Medullary sponge kidney
Melioidosis
Memory loss
Ménière's disease
Meningitis
Meningococcemia
Menopause
Men's health
Menstrual disorders
Mental retardation
Mental status examination
Mercury poisoning
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Metabolic acidosis
Metabolic alkalosis
Methadone
Methamphetamine
Methemoglobinemia
Microphthalmia and anophthalmia
Mifepristone
Migraine headache
Mineral deficiency
Mineral toxicity
Minerals
Minnesota multiphasic personality inventory (MMPI-2)
Minority health
Minoxidil
Miscarriage
Mitral valve insufficiency
Mitral valve prolapse
Mitral valve stenosis
Moles
Monkeypox
Monoamine oxidase inhibitors
Mood disorders
Motion sickness
Movement disorders
Movement therapy
MRSA infections
Mucopolysaccharidoses
Mucormycosis
Multiple chemical sensitivity

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Multiple-gated acquisition (MUGA) scan
Multiple endocrine neoplasia syndromes
Multiple myeloma
Multiple personality disorder
Multiple pregnancy
Multiple sclerosis
Mumps
Munchausen syndrome
Muscle relaxants
Muscle spasms and cramps
Muscular dystrophy
Mushroom poisoning
Music therapy
Mutism
Myasthenia gravis
Mycetoma
Mycobacterial infections, atypical
Mycoplasma infections
Myelodysplastic syndrome
Myelofibrosis
Myelography
Myers-Briggs type indicator
Myocardial biopsy
Myocardial resection
Myocarditis
Myoglobin test
Myomectomy
Myopathies
Myopia
Myositis
Myotonic dystrophy
Myringotomy and ear tubes
Myxoma

N

Nail-patella syndrome
Nail removal
Narcolepsy
Narcotics
Nasal irrigation
Nasal packing
Nasal papillomas
Nasal polyps
Nasal trauma
Nasogastric suction
Nasopharyngeal culture
Naturopathic medicine
Nausea and vomiting
Near-drowning
Necrotizing enterocolitis
Neonatal jaundice
Nephrectomy
Nephritis
Nephrotic syndrome
Nephrotoxic injury
Neuralgia
Neuroblastoma
Neuroendocrine tumors
Neurofibromatosis
Neurogenic bladder
Neurolinguistic programming
Neurological exam
Neurosurgery
Neutropenia
Nicotine and related disorders
Night terrors
Nitrogen narcosis
Nocardiosis
Nongonococcal urethritis
Non-nucleoside reverse transcriptase inhibitors
Nonsteroidal anti-inflammatory drugs
Noroviruses
Nosebleed
Numbness and tingling
Nutrition
Nutrition through an intravenous line
Nutritional supplements
Nystagmus

O

Obesity
Obesity surgery
Obsessive-compulsive disorder
Obstetrical emergencies
Occupational asthma
Occupational therapy
Oil spills: health effects
Oligomenorrhea
Omega-3 fatty acids
Onychomycosis
Oophorectomy
Ophthalmoplegia
Oppositional defiant disorder
Optic atrophy
Optic neuritis
Oral contraceptives
Oral hygiene
Orbital and periorbital cellulitis
Orchitis
Organ donation
Organic food
Orthodontics
Orthopedic surgery
Orthostatic hypotension
Osteoarthritis
Osteochondroses
Osteogenesis imperfecta
Osteomyelitis
Osteopathy
Osteopetroses
Osteoporosis
Ostomy
Otitis externa
Otitis media
Otosclerosis
Ototoxicity
Ovarian cancer
Ovarian cysts
Ovarian torsion
Overactive bladder
Overhydration
Oxygen/ozone therapy

P

Pacemakers
Paget's disease of bone
Paget's disease of the breast
Pain
Pain management
Palliative care

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Palpitations
Pancreas transplantation
Pancreatectomy
Pancreatic cancer, endocrine
Pancreatic cancer, exocrine
Pancreatitis
Panic disorder
Pap test
Papilledema
Paracentesis
Paralysis
Paranoia
Parathyroid hormone test
Parathyroid scan
Parathyroidectomy
Paratyphoid fever
Parkinson's disease
Parotidectomy
Paroxysmal atrial tachycardia
Parrot fever
Partial thromboplastin time
Paruresis
Patau syndrome
Patent ductus arteriosus
Pellagra
Pelvic exam
Pelvic fracture
Pelvic inflammatory disease
Pelvic relaxation
Pelvic ultrasound
Penicillins
Penile cancer
Penile prostheses
Percutaneous transhepatic cholangiography
Perforated eardrum
Perforated septum
Pericardiocentesis
Pericarditis
Perinatal infection
Periodic paralysis
Periodontal disease
Peripheral neuropathy
Peripheral vascular disease
Peritonitis
Pernicious anemia
Peroxisomal disorders
Personality disorders
Pervasive developmental disorders
Pet therapy
Peyronie's disease
Pharmacogenetics
Phenylketonuria
Pheochromocytoma
Phimosis
Phlebotomy
Phobias
Phosphorus imbalance
Photodynamic therapy
Photorefractive keratectomy and laser-assisted in-situ keratomileusis
Photosensitivity
Phototherapy
Physical allergy
Physical examination
Physical therapy
Pica
Pickwickian syndrome
Piercing and tattoos
Pilates
Pinguecula and pterygium
Pinta
Pituitary dwarfism
Pituitary tumors
Pityriasis rosea
Placenta previa
Placental abruption
Plague
Plasma renin activity
Plasmapheresis
Plastic, reconstructive, and cosmetic surgery
Platelet aggregation test
Platelet count
Platelet function disorders
Pleural biopsy
Pleural effusion
Pleurisy
Pneumococcal pneumonia
Pneumocystis pneumonia
Pneumonectomy
Pneumonia
Pneumothorax
Poison ivy and poison oak
Poisoning
Polarity therapy
Polio
Polycystic kidney disease
Polycystic ovary syndrome
Polycythemia vera
Polydactyly and syndactyly
Polyglandular deficiency syndromes
Polyhydramnios and oligohydramnios
Polymyalgia rheumatica
Polymyositis
Polysomnography
Porphyrias
Portal vein bypass
Positron emission tomography (PET)
Post-concussion syndrome
Post-traumatic stress disorder
Postmenopausal bleeding
Postpartum depression
Postpolio syndrome
Prader-Willi syndrome
Precocious puberty
Preeclampsia and eclampsia
Pregnancy
Premature ejaculation
Premature labor
Premature menopause
Premature rupture of membranes
Prematurity
Premenstrual dysphoric disorder
Premenstrual syndrome
Prenatal surgery
Preparing for surgery
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Priapism
Prickly heat
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Proctitis
Progressive multifocal leukoencephalopathy

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Progressive supranuclear palsy
Prolactin test
Prolonged QT syndrome
Prophylaxis
Prostate biopsy
Prostate cancer
Prostate ultrasound
Prostatectomy
Prostate-specific antigen test
Prostatitis
Protease inhibitors
Protein components test
Protein electrophoresis
Protein-energy malnutrition
Prothrombin time
Proton pump inhibitors
Provenge (sipuleucel-T)
Pseudogout
Pseudomonas infections
Pseudoxanthoma elasticum
Psoriasis
Psoriatic arthritis
Psychiatric confinement
Psychoanalysis
Psychological tests
Psychosis
Psychosocial disorders
Psychosurgery
Psychotherapy
Ptosis
Puberty
Puerperal infection
Pulmonary alveolar proteinosis
Pulmonary artery catheterization
Pulmonary edema
Pulmonary embolism
Pulmonary fibrosis
Pulmonary function tests
Pulmonary hypertension
Pulmonary valve insufficiency
Pulmonary valve stenosis
Pyelonephritis
Pyloric stenosis
Pyloroplasty
Pyruvate kinase deficiency

Q

Q fever
Qigong

R

Rabies
Radial keratotomy
Radiation injuries
Radiation therapy
Radical neck dissection
Radioactive implants
Rape and sexual assault
Rashes
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Raynaud's disease
Recompression treatment
Rectal cancer
Rectal examination
Rectal polyps
Rectal prolapse
Recurrent miscarriage
Red blood cell indices
Red reflex testing
Reflex sympathetic dystrophy
Reflex tests
Reflexology
Rehabilitation
Reiki
Reiter's syndrome
Relapsing fever
Relapsing polychondritis
Renal artery occlusion
Renal artery stenosis
Renal tubular acidosis
Renal vein thrombosis
Renovascular hypertension
Respiratory acidosis
Respiratory alkalosis
Respiratory distress syndrome
Respiratory failure
Respiratory syncytial virus infection
Restless legs syndrome
Restrictive cardiomyopathy
Reticulocyte count
Retinal artery occlusion
Retinal detachment
Retinal hemorrhage
Retinal vein occlusion
Retinitis pigmentosa
Retinoblastoma
Retinopathies
Retrograde cystography
Retrograde ureteropyelography
Retrograde urethrography
Retropubic suspension
Reye's syndrome
Rheumatic fever
Rheumatoid arthritis
Rhinitis
Rhinoplasty
Riboflavin deficiency
Rickets
Rickettsialpox
Ringworm
Rocky Mountain spotted fever
Rolfing
Root canal treatment
Rosacea
Roseola
Ross River Virus
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Rotavirus infections
Roundworm infections
Rubella
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S

Sacroiliac disease
Salivary gland scan
Salivary gland tumors
Salmonella food poisoning
Salpingectomy
Salpingo-oophorectomy
Sarcoidosis
Sarcomas
Saw palmetto
Scabies

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Scarlet fever
Scars
Schistosomiasis
Schizoaffective disorder
Schizophrenia
Sciatica
Scleroderma
Sclerotherapy for esophageal varices
Scoliosis
Scrotal nuclear medicine scan
Scrotal ultrasound
Scrub typhus
Scurvy
Seasonal affective disorder
Seborrheic dermatitis
Secondary polycythemia
Sedation
Seizure disorder
Selective serotonin reuptake inhibitors
Self-mutilation
Semen analysis
Seniors' health
Sensory integration disorder
Sepsis
Septic shock
Septoplasty
Serum sickness
Severe acute respiratory syndrome (SARS)
Severe combined immunodeficiency
Sex hormones tests
Sex reassignment surgery
Sex therapy
Sexual abuse
Sexual addiction
Sexual dysfunction
Sexual perversions
Sexually transmitted diseases
Sexually transmitted diseases cultures
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Shiatsu
Shigellosis
Shin splints
Shingles
Shock
Shortness of breath
Shy-Drager syndrome
Shyness
Sick sinus syndrome
Sickle cell disease
Sideroblastic anemia
Sudden infant death syndrome
Sigmoidoscopy
Sildenafil citrate
Silicosis
Single photon emission computed tomography
Sinus endoscopy
Sinusitis
Situs inversus
Sitz bath
Sjogren's syndrome
Skin biopsy
Skin cancer, non-melanoma
Skin culture
Skin grafting
Skin lesion removal
Skin lesions
Skin pigmentation disorders
Skin resurfacing
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Small intestine biopsy
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Smoking-cessation drugs
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Somatoform disorders
Sore throat
South American blastomycosis
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Spinal cord injury
Spinal cord tumors
Spinal instrumentation
Spinal stenosis
Spirometry
Splenectomy
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Sporotrichosis
Sports injuries
Sprains and strains
Sputum culture
Squamous cell carcinoma of the skin
St. John's wort
Stanford-Binet intelligence scales
Stapedectomy
Staphylococcal infections
Staphylococcal scalded skin syndrome
Starvation
Stem cell transplantation
Steroids
Stillbirth
Stockholm syndrome
Stomach cancer
Stomach flushing
Stomachache
Stomatitis
Stool culture
Stool fat test
Stool O and P test
Strabismus
Strep throat
Streptococcal antibody tests
Streptococcal infections
Stress
Stress reduction
Stress test
Stridor
Stroke
Stuttering
Subacute sclerosing panencephalitis
Subarachnoid hemorrhage
Subdural hematoma
Substance abuse and dependence
Sudden cardiac death

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Suicide
Sulfonamides
Sunburn
Sunscreens
Superior vena cava syndrome
Surfactant
Swallowing disorders
Swollen glands
Sydenham's chorea
Sympathectomy
Syphilis
Systemic lupus erythematosus

T

Tai chi
Tanning
Tapeworm diseases
Tardive dyskinesia
Tarsorrhaphy
Tay-Sachs disease
Technetium heart scan
Teeth whitening
Teething
Temporal arteritis
Temporomandibular joint disorders
Tendinitis
Tennis elbow
Tensilon test
Tension headache
Testicular cancer
Testicular self-examination
Testicular surgery
Testicular torsion
Tetanus
Tetracyclines
Tetralogy of Fallot
Thalassemia
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Thematic apperception test
Therapeutic baths
Therapeutic touch
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Thoracic outlet syndrome
Thoracic surgery
Thoracoscopy
Threadworm infection
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Thrombocytosis
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Thyroid ultrasound
Thyroidectomy
Thyroiditis
Tilt table test
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Tonsillectomy and adenoidectomy
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Tooth decay
Tooth extraction
Tooth replacements and restorations
Toothache
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TORCH test
Torticollis
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Tourette syndrome
Toxic epidermal necrolysis
Toxic shock syndrome
Toxoplasmosis
Trabeculectomy
Tracheoesophageal fistula
Tracheotomy
Trachoma
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Traditional Chinese medicine
Trager psychophysical integration
Trans fatty acids
Transcranial Doppler ultrasonography
Transesophageal echocardiography
Transfusion
Transhepatic biliary catheterization
Transient ischemic attack
Transplant surgery
Transposition of the great arteries
Transurethral bladder resection
Transvaginal ultrasound
Transverse myelitis
Traumatic amputations
Traveler's diarrhea
Tremors
Trench fever
Trichinosis
Trichomoniasis
Tricuspid valve insufficiency
Tricuspid valve stenosis
Trigeminal neuralgia
Trigger finger
Triglycerides
Triglycerides test
Triple screen
Tropical spastic paraparesis
Troponins test
Tubal ligation
Tube compression of the esophagus and stomach
Tube feedings
Tuberculin skin test
Tuberculosis
Tularemia
Tumor markers
Tumor removal
Turner syndrome
2,3-diphosphoglycerate test
Typhoid fever
Typhus
Tzanck preparation

U

Ulcer surgery
Ulcers (digestive)
Ultraviolet light treatment
Umbilical cord blood banking
Umbilical hernia repair

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Undernutrition
Undescended testes
Upper GI exam
Ureteral stenting
Urethritis
Uric acid tests
Urinalysis
Urinary anti-infectives
Urinary catheterization
Urinary diversion surgery
Urinary incontinence
Urinary tract infection
Urine culture
Urine flow test
Uterine fibroid embolization
Uterine fibroids
Uveitis

V

Vaccination
Vaginal pain
Vaginismus
Vagotomy
Valsalva maneuver
Valvular heart disease
Varicose veins
Vascular disease
Vascular surgery
Vasculitis
Vasectomy
Vasodilators
Vegetarianism
Vegetative state
Velopharyngeal insufficiency
Vena cava filter
Venography
Venous access
Venous insufficiency
Ventricular aneurysm
Ventricular assist device
Ventricular ectopic beats
Ventricular fibrillation
Ventricular septal defect
Ventricular shunt
Ventricular tachycardia
Vesicoureteral reflux
Vibriosis
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Visual impairment
Vitamin A deficiency
Vitamin B6 deficiency
Vitamin D deficiency
Vitamin E deficiency
Vitamin K deficiency
Vitamin tests
Vitamin toxicity
Vitamins
Vitiligo
Vitrectomy
Vocal cord nodules and polyps
Vocal cord paralysis
Vomiting
Von Willebrand disease
Vulvar cancer
Vulvodynia
Vulvovaginitis

W

Waldenström's macroglobulinemia
Warts
Wechsler intelligence test
Wegener's granulomatosis
Weight loss drugs
West Nile virus
Wheezing
Whiplash
White blood cell count and differential
Whooping cough
Wilderness medicine
Wilms' tumor
Wilson disease
Wiskott-Aldrich syndrome
Withdrawal syndromes
Wolff-Parkinson-White syndrome
Women's health
Wound culture
Wound flushing
Wounds

X

X-linked agammaglobulinemia
X rays of the orbit

Y

Yaws
Yellow fever
Yersinosis
Yoga

Z

Zellweger syndrome
Zoonosis

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PLEASE READ—IMPORTANT INFORMATION

The *Gale Encyclopedia of Medicine, Fourth Edition* is a health reference product designed to inform and educate readers about a wide variety of health topics such as diseases, disorders and conditions, treatments and diagnostic tests, diets, alternative treatments, and prevention. Gale, Cengage Learning believes the product to be comprehensive, but not necessarily definitive. It is intended to supplement, not replace, consultation with a physician or other healthcare practitioners. While Gale, Cengage Learning has made substantial efforts to provide information that is accurate, comprehensive, and up-to-date, Gale, Cengage Learning makes no representations or warranties of any kind, including without limitation, warranties of merchantability or fitness for a particular purpose, nor does it guarantee the accuracy, comprehensiveness, or timeliness of the information contained in this product. Readers should be aware that the universe of medical knowledge is constantly growing and changing, and that differences of opinion exist among authorities. Readers are also advised to seek professional diagnosis and treatment for any medical condition, and to discuss information obtained from this book with their healthcare provider.

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INTRODUCTION

The *Gale Encyclopedia of Medicine 4 (GEM4)* is a one-stop source for medical information on common medical disorders, conditions, tests, treatments, drugs, and other health-related topics, including high-profile diseases such as AIDS, Alzheimer's disease, cancer, and heart disease. This encyclopedia avoids medical jargon and uses language that laypersons can understand, while still providing thorough coverage of each topic. The *Gale Encyclopedia of Medicine 4* fills a gap between basic consumer health resources, such as single-volume family medical guides, and highly technical professional materials.

Scope

More than 1,800 full-length articles are included in the *Gale Encyclopedia of Medicine 4*, including disorders/conditions, tests/procedures, and treatments/therapies. Many common drugs are also covered, with generic drug names appearing first and brand names following in parentheses—e.g., acetaminophen (Tylenol). Prominent individuals in medicine are highlighted as sidebar biographies that accompany the main topical essays. Articles follow a standardized format that provides information at a glance. Rubrics include:

Disorders/Conditions	Tests/Treatments
Definition	Definition
Demographics	Purpose
Description	Precautions
Causes and symptoms	Description
Diagnosis	Preparation
Treatment	Aftercare
Prognosis	Risks
Prevention	Normal/abnormal results
Resources	Resources
Key terms	Key terms

In recent years, there has been a resurgence of interest in holistic medicine that emphasizes the connection between mind and body. Aimed at achieving and maintaining good health rather than just eliminating disease, this approach has come to be known as alternative medicine. The *Gale Encyclopedia of Medicine 4* includes a number of essays on alternative therapies, ranging from traditional Chinese medicine to homeopathy and from meditation to aromatherapy. In addition to full essays on alternative therapies, the encyclopedia features specific **Alternative treatment** sections for diseases and conditions that may be helped by complementary therapies. The *Gale Encyclopedia of Medicine 4* also includes entries on diets, nutrition, and general wellness.

Inclusion Criteria

A preliminary list of diseases, disorders, tests, and treatments was compiled from a wide variety of sources, including professional medical guides and textbooks as well as consumer guides and encyclopedias. The general advisory board, made up of public librarians, medical librarians, and consumer health experts, evaluated the topics and made suggestions for inclusion. The list was sorted by category and sent to *GEM4* medical advisors, certified physicians with various medical specialities, for review. Final selection of topics to include was made by the medical advisors in conjunction with the Gale, Cengage Learning editor.

About the Contributors

The essays were compiled by experienced medical writers, including physicians, pharmacists, nurses, and other health care professionals. *GEM4* medical advisors reviewed the completed essays to ensure that they are appropriate, up to date, and medically accurate.

How to Use this Book

The *Gale Encyclopedia of Medicine 4* has been designed with ready reference in mind.

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- Straight **alphabetical arrangement** allows users to locate information quickly.
- Bold-faced terms function as **print hyperlinks** that point the reader to related entries in the encyclopedia.
- **Cross-references** placed throughout the encyclopedia direct readers to where information on subjects without entries can be found. Synonyms and acronyms are also cross-referenced.
- Lists of **key terms** are provided where appropriate to define unfamiliar terms or concepts. A **glossary** of key terms is also included at the back of Volume 6.
- Valuable **contact information** for organizations and support groups is included with each entry. The appendix contains an extensive list of organizations arranged in alphabetical order.
- The **resources section** directs users to additional sources of medical information on a topic.
- A comprehensive **general index** allows users to easily target detailed aspects of any topic, including Latin names.

Graphics

The *Gale Encyclopedia of Medicine 4* is enhanced with 765 images, including photos, charts, tables, and detailed illustrations.

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An advisory board comprised of medical specialists from a variety of backgrounds provided invaluable assistance in the formulation of this encyclopedia. This advisory board performed a myriad of duties, from defining the scope of coverage to reviewing individual entries for accuracy and accessibility. We would therefore like to express our sincere thanks and appreciation for all of their contributions.

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A

Abdominal aorta ultrasound *see* **Abdominal ultrasound**

Abdominal aortic aneurysm *see* **Aortic aneurysm**

Abdominal hernia *see* **Hernia**

Abdominal thrust *see* **Heimlich maneuver**

Abdominal ultrasound

Definition

Ultrasound technology allows doctors to "see" inside a patient without resorting to surgery. A transmitter sends high frequency sound waves into the body, where they bounce off the different tissues and organs to produce a distinctive pattern of echoes. A receiver "hears" the returning echo pattern and forwards it to a computer, which translates the data into an image on a television screen. Because ultrasound can distinguish subtle variations between soft, fluid-filled tissues, it is particularly useful in providing diagnostic images of the abdomen. Ultrasound can also be used in treatment.

Purpose

The potential medical applications of ultrasound were first recognized in the 1940s as an outgrowth of the sonar technology developed to detect submarines during World War II. The first useful medical images were produced in the early 1950s, and, by 1965, ultrasound quality had improved to the point that it came into general medical use. Improvements in the technology, application, and interpretation of ultrasound continue. Its low cost, versatility, safety and speed have brought it into the top drawer of medical imaging techniques.

While **pelvic ultrasound** is widely known and commonly used for fetal monitoring during **pregnancy**, ultrasound is also routinely used for general abdominal imaging. It has great advantage over x-ray imaging technologies in that it does not damage tissues with ionizing radiation. Ultrasound is also generally far better than plain x rays at distinguishing the subtle variations of soft tissue structures, and can be used in any of several modes, depending on the need at hand.

As an imaging tool, abdominal ultrasound generally is warranted for patients afflicted with: chronic or acute abdominal **pain**; abdominal trauma; an obvious or suspected abdominal mass; symptoms of **liver disease**, pancreatic disease, **gallstones**, spleen disease, **kidney disease** and urinary blockage; or symptoms of an abdominal **aortic aneurysm**. Specifically:

- Abdominal pain. Whether acute or chronic, pain can signal a serious problem—from organ malfunction or injury to the presence of malignant growths. Ultrasound scanning can help doctors quickly sort through potential causes when presented with general or ambiguous symptoms. All of the major abdominal organs can be studied for signs of disease that appear as changes in size, shape and internal structure.
- Abdominal trauma. After a serious accident, such as a car crash or a fall, internal bleeding from injured abdominal organs is often the most serious threat to survival. Neither the injuries nor the bleeding are immediately apparent. Ultrasound is very useful as an initial scan when abdominal trauma is suspected, and it can be used to pinpoint the location, cause, and severity of hemorrhaging. In the case of puncture wounds, from a bullet for example, ultrasound can locate the foreign object and provide a preliminary survey of the damage. The easy portability and versatility of ultrasound technology has brought it into common emergency room use, and even into limited ambulance service.
- Abdominal mass. Abnormal growths—tumors, cysts, abscesses, scar tissue and accessory organs—can be located and tentatively identified with ultrasound. In particular, potentially malignant solid tumors can be

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distinguished from benign fluid-filled cysts and abscesses. Masses and malformations in any organ or part of the abdomen can be found.

- Liver disease. The types and underlying causes of liver disease are numerous, though jaundice tends to be a general symptom. Ultrasound can differentiate between many of the types and causes of liver malfunction, and is particularly good at identifying obstruction of the bile ducts and cirrhosis, which is characterized by abnormal fibrous growths and reduced blood flow.
- Pancreatic disease. Inflammation and malformation of the pancreas are readily identified by ultrasound, as are pancreatic stones (calculi), which can disrupt proper functioning.
- Gallstones. Gallstones cause more hospital admissions than any other digestive malady. These calculi can cause painful inflammation of the gallbladder and also obstruct the bile ducts that carry digestive enzymes from the gallbladder and liver to the intestines. Gallstones are readily identifiable with ultrasound.
- Spleen disease. The spleen is particularly prone to injury during abdominal trauma. It may also become painfully inflamed when beset with infection or cancer. These conditions also lend themselves well to ultrasonic inspection and diagnosis.
- Kidney disease. The kidneys are also prone to traumatic injury and are the organs most likely to form calculi, which can block the flow of urine and cause blood poisoning (uremia). A variety of diseases causing distinct changes in kidney morphology can also lead to complete kidney failure. Ultrasound imaging has proven extremely useful in diagnosing kidney disorders.
- Abdominal aortic aneurysm. This is a bulging weak spot in the abdominal aorta, which supplies blood directly from the heart to the entire lower body. These aneurysms are relatively common and increase in prevalence with age. A burst aortic aneurysm is imminently life-threatening. However, they can be readily identified and monitored with ultrasound before acute complications result.

Ultrasound technology can also be used for treatment purposes, most frequently as a visual aid during surgical procedures—such as guiding needle placement to drain fluid from a cyst, or to extract tumor cells for biopsy. Increasingly, direct therapeutic applications for ultrasound are being developed.

The direct therapeutic value of ultrasonic waves lies in their mechanical nature. They are shock waves, just like audible sound, and vibrate the materials through which they pass. These vibrations are mild, virtually unnoticeable at the frequencies and intensities used for imaging. Properly focused however, high-intensity ultrasound can be used to heat and physically agitate targeted tissues.

High-intensity ultrasound is used routinely to treat soft tissue injuries, such as strains, tears and associated scarring. The heating and agitation are believed to promote rapid healing through increased circulation. Strongly focused, high-intensity, high-frequency ultrasound can also be used to physically destroy certain types of tumors, as well as gallstones and other types of calculi. Developing new treatment applications for ultrasound is an active area of medical research.

Precautions

Properly performed, ultrasound imaging is virtually without risk or side effects. Some patients report feeling a slight **tingling** and/or warmth while being scanned, but most feel nothing at all. Ultrasound waves of appropriate frequency and intensity are not known to cause or aggravate any medical condition, though any woman who thinks she might be pregnant should raise the issue with her doctor before undergoing an abdominal ultrasound.

The value of ultrasound imaging as a medical tool, however, depends greatly on the quality of the equipment used and the skill of the medical personnel operating it. Improperly performed and/or interpreted, ultrasound can be worse than useless if it indicates that a problem exists where there is none, or fails to detect a significant condition. Basic ultrasound equipment is relatively inexpensive to obtain, and any doctor with the equipment can perform the procedure whether qualified or not. Patients should not hesitate to verify the credentials of technicians and doctors performing ultrasounds, as well as the quality of the equipment used and the benefits of the proposed procedure.

In cases where ultrasound is used as a treatment tool, patients should educate themselves about the proposed procedure with the help of their doctors, as is appropriate before any surgical procedure. Also, any abdominal ultrasound procedure, diagnostic or therapeutic, may be hampered by a patient's body type or other factors, such as the presence of excessive bowel gas (which is opaque to ultrasound). In particular, very obese people are often not good candidates for abdominal ultrasound.

Description

Ultrasound includes all sound waves above the frequency of human hearing—about 20 thousand hertz, or cycles per second. Medical ultrasound generally uses frequencies between one and 10 million hertz

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KEY TERMS

Accessory organ—A lump of tissue adjacent to an organ that is similar to it, but which serves no important purpose, if functional at all. While not necessarily harmful, such organs can cause problems if they grow too large or become cancerous. In any case, their presence points to an underlying abnormality in the parent organ.

Benign—In medical usage, benign is the opposite of malignant. It describes an abnormal growth that is stable, treatable and generally not life-threatening.

Biopsy—The surgical removal and analysis of a tissue sample for diagnostic purposes. Usually, the term refers to the collection and analysis of tissue from a suspected tumor to establish malignancy.

Calculus—Any type of hard concretion (stone) in the body, but usually found in the gallbladder, pancreas and kidneys. They are formed by the accumulation of excess mineral salts and other organic material such as blood or mucous. Calculi (pl.) can cause problems by lodging in and obstructing the proper flow of fluids, such as bile to the intestines or urine to the bladder.

Cirrhosis—A chronic liver disease characterized by the invasion of connective tissue and the degeneration of proper functioning—jaundice is often an accompanying symptom. Causes of cirrhosis include alcoholism, metabolic diseases, syphilis and congestive heart disease.

Common bile duct—The branching passage through which bile—a necessary digestive enzyme—travels from the liver and gallbladder into the small intestine. Digestive enzymes from the pancreas also enter the intestines through the common bile duct.

Computed tomography scan (CT scan)—A specialized type of x-ray imaging that uses highly focused and relatively low energy radiation to produce detailed two-dimensional images of soft tissue structures, particularly the brain. CT scans are the chief competitor to ultrasound and can yield higher quality images not disrupted by bone or gas. They are, however, more cumbersome, time consuming and expensive to perform, and they use ionizing electromagnetic radiation.

Doppler—The Doppler effect refers to the apparent change in frequency of sound wave echoes returning to a stationary source from a moving target. If the object is moving toward the source, the frequency increases; if the object is moving away, the frequency decreases. The size of this frequency shift can be used to compute the object's speed—be it a car on the road or blood in an artery. The Doppler effect holds true for all types of radiation, not just sound.

Frequency—Sound, whether traveling through air or the human body, produces vibrations—molecules bouncing into each other—as the shock wave travels along. The frequency of a sound is the number of vibrations per second. Within the audible range, frequency means pitch—the higher the frequency, the higher a sound's pitch.

Ionizing radiation—Radiation that can damage living tissue by disrupting and destroying individual cells at the molecular level. All types of nuclear radiation—x rays, gamma rays and beta rays—are potentially ionizing. Sound waves physically vibrate the material through which they pass, but do not ionize it.

Jaundice—A condition that results in a yellow tint to the skin, eyes and body fluids. Bile retention in the liver, gallbladder and pancreas is the immediate cause, but the underlying cause could be as simple as obstruction of the common bile duct by a gallstone or as serious as pancreatic cancer. Ultrasound can distinguish between these conditions.

Malignant—The term literally means growing worse and resisting treatment. It is used as a synonym for cancerous and connotes a harmful condition that generally is life-threatening.

Morphology—Literally, the study of form. In medicine, morphology refers to the size, shape and structure rather than the function of a given organ. As a diagnostic imaging technique, ultrasound facilitates the recognition of abnormal morphologies as symptoms of underlying conditions.

(1–10 MHz). Higher frequency ultrasound waves produce more detailed images, but are also more readily absorbed and so cannot penetrate as deeply into the body. Abdominal ultrasound imaging is generally performed at frequencies between 2–5 MHz.

An ultrasound machine consists of two parts: the transducer and the analyzer. The transducer both produces the sound waves that penetrate the body and receives the reflected echoes. Transducers are built around piezoelectric ceramic chips. (Piezoelectric

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refers to electricity that is produced when you put pressure on certain crystals such as quartz). These ceramic chips react to electric pulses by producing sound waves (they are transmitting waves) and react to sound waves by producing electric pulses (receiving). Bursts of high frequency electric pulses supplied to the transducer causes it to produce the scanning sound waves. The transducer then receives the returning echoes, translates them back into electric pulses and sends them to the analyzer–a computer that organizes the data into an image on a television screen.

Because sound waves travel through all the body's tissues at nearly the same speed—about 3,400 miles per hour—the microseconds it takes for each echo to be received can be plotted on the screen as a distance into the body. The relative strength of each echo, a function of the specific tissue or organ boundary that produced it, can be plotted as a point of varying brightness. In this way, the echoes are translated into a picture. Tissues surrounded by bone or filled with gas (the stomach, intestines and bowel) cannot be imaged using ultrasound, because the waves are blocked or become randomly scattered.

Four different modes of ultrasound are used in medical imaging:

- A-mode. This is the simplest type of ultrasound in which a single transducer scans a line through the body with the echoes plotted on screen as a function of depth. This method is used to measure distances within the body and the size of internal organs. Therapeutic ultrasound aimed at a specific tumor or calculus is also A-mode, to allow for pinpoint accurate focus of the destructive wave energy.
- B-mode. In B-mode ultrasound, a linear array of transducers simultaneously scans a plane through the body that can be viewed as a two-dimensional image on screen. Ultrasound probes containing more than 100 transducers in sequence form the basis for these most commonly used scanners, which cost about $50,000.
- M-Mode. The M stands for motion. A rapid sequence of B-mode scans whose images follow each other in sequence on screen enables doctors to see and measure range of motion, as the organ boundaries that produce reflections move relative to the probe. M-mode ultrasound has been put to particular use in studying heart motion.
- Doppler mode. Doppler ultrasonography includes the capability of accurately measuring velocities of moving material, such as blood in arteries and veins. The principle is the same as that used in radar guns that measure the speed of a car on the highway. Doppler capability is most often combined with B-mode scanning to produce images of blood vessels from which blood flow can be directly measured. This technique is used extensively to investigate valve defects, arteriosclerosis and hypertension, particularly in the heart, but also in the abdominal aorta and the portal vein of the liver. These machines cost about $250,000.

The actual procedure for a patient undergoing an abdominal ultrasound is relatively simple, regardless of the type of scan or its purpose. **Fasting** for at least eight hours prior to the procedure ensures that the stomach is empty and as small as possible, and that the intestines and bowels are relatively inactive. Fasting also allows the gall bladder to be seen, as it contracts after eating and may not be seen if the stomach is full. In some cases, a full bladder helps to push intestinal folds out of the way so that the gas they contain does not disrupt the image. The patient's abdomen is then greased with a special gel that allows the ultrasound probe to glide easily across the skin while transmitting and receiving ultrasonic pulses.

This procedure is conducted by a doctor with the assistance of a technologist skilled in operating the equipment. The probe is moved around the abdomen to obtain different views of the target areas. The patient will likely be asked to change positions from side to side and to hold their breath as necessary to obtain the desired views. Discomfort during the procedure is minimal.

The many types and uses of ultrasound technology makes it difficult to generalize about the time and costs involved. Relatively simple imaging—scanning a suspicious abdominal mass or a suspected abdominal aortic aneurysm—will take about half an hour to perform and will cost a few hundred dollars or more, depending on the quality of the equipment, the operator and other factors. More involved techniques such as multiple M-mode and Doppler-enhanced scans, or cases where the targets not well defined in advance, generally take more time and are more expensive.

Regardless of the type of scan used and the potential difficulties encountered, ultrasound remains faster and less expensive than **computed tomography scans** (CT), its primary rival in abdominal imaging. Furthermore, as abdominal ultrasounds are generally undertaken as "medically necessary" procedures designed to detect the presence of suspected abnormalities, they are covered under most types of major medical insurance. As always, though, the patient would be wise to confirm that their coverage extends to the specific procedure proposed. For nonemergency situations, most underwriters stipulate prior approval as a condition of coverage.

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Specific conditions for which ultrasound may be selected as a treatment option—certain types of tumors, lesions, **kidney stones** and other calculi, muscle and ligament injuries, etc.—are described in detail under the appropriate entries in this encyclopedia.

Preparation

A patient undergoing abdominal ultrasound will be advised by their physician about what to expect and how to prepare. As mentioned above, preparations generally include fasting and arriving for the procedure with a full bladder, if necessary. This preparation is particularly useful if the gallbladder, ovaries or veins are to be examined.

Aftercare

In general, no aftercare related to the abdominal ultrasound procedure itself is required.

Risks

Abdominal ultrasound carries with it no recognized risks or side effects, if properly performed using appropriate frequency and intensity ranges. Sensitive tissues, particularly those of the reproductive organs, could possibly sustain damage if violently vibrated by overly intense ultrasound waves. In general though, such damage would only result from improper use of the equipment.

Any woman who thinks she might be pregnant should raise this issue with her doctor before undergoing an abdominal ultrasound, as a fetus in the early stages of development could be injured by ultrasound meant to probe deeply recessed abdominal organs.

Normal results

As a diagnostic imaging technique, a normal abdominal ultrasound is one that indicates the absence of the suspected condition that prompted the scan. For example, symptoms such as a persistent **cough**, labored breathing, and upper abdominal pain suggest the possibility of, among other things, an abdominal aortic aneurysm. An ultrasound scan that indicates the absence of an aneurysm would rule out this life-threatening condition and point to other, less serious causes.

Abnormal results

Because abdominal ultrasound imaging is generally undertaken to confirm a suspected condition, the results of a scan often will prove abnormal—that is they will confirm the diagnosis, be it kidney stones, **cirrhosis** of the liver or an aortic aneurysm. At that point, appropriate medical treatment as prescribed by a patient's doctor is in order. See the relevant disease and disorder entries in this encyclopedia for more information.

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Kurt Richard Sternlof

Abdominal wall defects

Definition

Abdominal wall defects are birth (congenital) defects that allow the stomach or intestines to protrude. It occurs when a child's abdomen does not develop fully while in the womb. This allows the intestine to develop outside the abdomen. Early in all pregnancies, the intestine develops inside the umbilical cord and then usually moves inside the abdomen a few weeks later. Occasionally, the intestine stays inside the umbilical cord and so develops outside the abdominal wall. There are various types of abdominal wall defect. If the intestine is contained inside a covering of membrane, this process is called an omphalocele, which can be either small or large. If the intestine is not inside a covering of membrane, this formation is called a gastroschisis.

Demographics

Abdominal wall defects are very rare. Omphalocele occurs in about one in every 3,500 births, and gastroschisis is even more rare. Omphalocele is often associated with other problems. An ultrasound is the best method for the detection of the condition and can occur as early as 11 to 14 weeks of gestation.

Description

Many unexpected and fascinating events occur during the development of a fetus inside the womb. The stomach and intestines begin development outside the baby's abdomen and only later does the abdominal

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KEY TERMS

Hernia—Movement of a structure into a place it does not belong.

Umbilical—Referring to the opening in the abdominal wall where the blood vessels from the placenta enter.

Viscera—Any of the body's organs located in the chest or abdomen.

wall enclose them. Occasionally, either the umbilical opening is too large, or it develops improperly, allowing the bowels or stomach to remain outside or squeeze through the abdominal wall.

Causes and symptoms

There are many causes for **birth defects** that still remain unclear. Presently, the cause(s) of abdominal wall defects is unknown, and any symptoms the mother may have to indicate that the defects are present in the fetus are nondescript.

Diagnosis

At birth, the problem is obvious, because the base of the umbilical cord at the navel bulges or, in worse cases, contain viscera (internal organs). Before birth, an ultrasound examination may detect the problem. It is always necessary in children with one birth defect to look for others, because birth defects are usually multiple.

Treatment

Abdominal wall defects are effectively treated with surgical repair. Unless there are accompanying anomalies, the surgical procedure is not overly complicated. The organs are normal, just misplaced. However, if the defect is large, it may be difficult to fit all the viscera into the small abdominal cavity.

Prognosis

If there are no other defects, the prognosis after surgical repair of this condition is relatively good. However, 10% of those with more severe or additional abnormalities die from it. The organs themselves are fully functional; the difficulty lies in fitting them inside the abdomen. The condition is, in fact, a **hernia** requiring only replacement and strengthening of the passageway through which it occurred. After surgery, increased pressure in the stretched abdomen can compromise the function of the organs inside.

Prevention

Some, but by no means all, birth defects are preventable by early and attentive prenatal care, good **nutrition**, supplemental **vitamins**, diligent avoidance of all unnecessary drugs and chemicals—especially tobacco—and other elements of a healthy lifestyle.

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Abnormal heart rhythms *see* **Arrhythmias**

ABO blood typing *see* **Blood typing and crossmatching**

ABO incompatibility *see* **Erythroblastosis fetalis**

Abortion, habitual *see* **Recurrent miscarriage**

Abortion, partial birth

Definition

Partial birth abortion, medically known as intact dilation and extraction (IDX), is a method of late-term abortion that ends a **pregnancy** and results in the **death** and intact removal of a fetus from the uterus. In the United States, the procedure is illegal.

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Purpose

Partial birth abortion, or IDX, is performed to end a pregnancy in the mid to late second trimester. It is typically performed between weeks 19 and 26 of pregnancy. IDX is highly controversial. Some physicians argue that IDX has advantages that make it preferable to other late-term abortion procedures in some circumstances. One advantage is that the fetus is removed largely intact, allowing for better evaluation and **autopsy** of the fetus in cases of fetal abnormalities. Intact removal of the fetus also may carry a lower risk of puncturing the uterus or damaging the cervix. Another perceived advantage is that IDX ends the pregnancy without requiring the woman to go through labor. This may reduce the emotional trauma of ending the pregnancy when compared to other methods of late-term abortion. In addition, IDX may offer a lower cost and shorter procedure time. Regardless of any perceived advantages, the procedure is illegal in the United States. Even before the procedure became illegal, it was performed only rarely.

Legal Controversies

Before 2003, the legality of IDX rested with each individual state. In 2003, U. S. President George W. Bush signed into law the federal Partial-Birth Abortion Ban Act banning partial birth abortions nationwide and implementing fines or jail terms for physicians who perform them. A federal judge then declared the law unconstitutional so that the government was not able to enforce it. A series of court battles over the constitutionality of the law continued until 2007. One legal issue centered on the fact that the legislation did not provide for exceptions in life-threatening cases where the procedure was needed to protect the mother's health. Another issue was the breadth and scope of the definition of partial-birth abortion. Three federal appeals courts ruled that the law was unconstitutional. Nevertheless, in April 2007, the U. S. Supreme Court upheld the law, ruling that it was constitutional, thus allowing for its enforcement.

Precautions

IDX is illegal in the United States. Women considering IDX in countries where the procedure is legal should be aware of the highly controversial nature of this procedure. One controversy common to this and all late-term abortions is determining at what point in the pregnancy the fetus is viable (able to survive outside the mother' body). In technologically advanced countries, fetuses generally are viable at 28 weeks of pregnancy; some fetuses as young as 24 weeks survive. Another area of controversy specific to IDX is that fetal death does not occur until after most of the fetus's body has exited the uterus. Because of these concerns, many physicians who perform abortions do not perform IDX; this tends to limit the availability of the procedure.

KEY TERMS

Cervix—The narrow outer end of the uterus that separates the uterus from the vaginal canal.

Footling breech—A position of the fetus while in the uterus where the feet of the fetus are nearest the cervix and will be the first part of the fetus to exit the uterus, with the head of the fetus being the last part to exit the uterus.

Laminaria—A medical product made from a certain type of seaweed that is physically placed near the cervix to cause it to dilate.

Description

IDX first involves administration of medications to cause the cervix to dilate. Dilation usually occurs over the course of several days. Next, the physician rotates the fetus to a footling breech position. The body of the fetus is then drawn out of the uterus feet first, until only the head remains inside the uterus. The physician then uses an instrument to puncture the base of the skull, which collapses the fetal head. Typically, the contents of the fetal head are then partially suctioned out, which results in the death of the fetus and reduces the size of the fetal head enough to allow it to pass through the cervix. The dead but otherwise intact fetus is then removed from the woman's body.

Preparation

Medical preparation for IDX involves an outpatient visit to administer dilation medications such as *laminaria*. Psychological preparation is desirable.

In addition, preparation may involve fulfilling local legal requirements, such as a mandatory waiting period, counseling, or an informed consent procedure reviewing stages of fetal development, **childbirth**, alternative abortion methods, and adoption.

Aftercare

IDX typically does not require an overnight hospital stay. A follow-up doctor's visit usually is scheduled to monitor the woman for any complications.

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Risks

With all abortion, the later in pregnancy an abortion is performed, the more complicated the procedure and the greater the risk of injury to the woman. In addition to associated emotional reactions, IDX carries the risk of injury to the woman, including heavy bleeding, **blood clots**, damage to the cervix or uterus, pelvic infection, and anesthesia-related complications. There also is a risk of incomplete abortion, meaning that the fetus is not dead when removed from the woman's body. Possible long-term risks include difficulty becoming pregnant or carrying a future pregnancy to term.

Normal results

The expected outcome of IDX is the termination of a pregnancy and death of the fetus.

Resources

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ORGANIZATIONS

Planned Parenthood Federation of America, Inc., 434 West 33rd St., New York, NY, 10001, (212) 541-7800, (212) 245-1845, (800) 230-7526, http://search.plannedparenthood.org.

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Abortion, selective

Definition

Selective abortion, also known as selective reduction, refers to choosing to abort a fetus, typically in a multi-fetal **pregnancy**, to decrease the health risks to the mother in carrying and giving birth to more than one or two babies, and also to decrease the risk of complications to the remaining fetus(es). The term selective abortion also refers to choosing to abort a fetus for reasons such as the woman is carrying a fetus which likely will be born with some birth defect or impairment, or because the sex of the fetus is not preferred by the individual.

KEY TERMS

Multi-fetal pregnancy—A pregnancy of two or more fetuses.

Selective reduction—Typically referred to in cases of multifetal pregnancy, when one or more fetuses are aborted to preserve the viability of the remaining fetuses and decrease health risks to the mother.

Purpose

A woman may decide to abort for health reasons, for example, if she is at higher risk for complications during pregnancy because of a disorder or disease such as diabetes. A 2004 case reported on an embryo embedded in a **cesarean section** scar. Although rare, it can be life threatening to the mother. In this care, selective abortion was successful at saving the mother and the remaining embryos.

However, selective reduction is recommended often in cases of multi-fetal pregnancy, or the presence of more than one fetus, typically, at least three or more fetuses. In the general population, multi-fetal pregnancy happens in only about 1–2% of pregnant women. But multi-fetal pregnancies occur far more often in women using fertility drugs.

Precautions

Because women or couples who use fertility drugs have made an extra effort to become pregnant, it is possible that the individuals may be unwilling or uncomfortable with the decision to abort a fetus in cases of multi-fetal pregnancy. Individuals engaging in fertility treatment should be made aware of the risk of multi-fetal pregnancy and consider the prospect of recommended reduction before undergoing fertility treatment.

Description

Selective reduction is usually performed between 9 and 12 weeks of pregnancy and is most successful when performed in early pregnancy. It is a simple procedure and can be performed on an outpatient basis. A needle is inserted into the woman's stomach or vagina and potassium chloride is injected into the fetus.

Preparation

Individuals who have chosen selective reduction to safeguard the remaining fetuses should be counseled prior to the procedure. Individuals should

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receive information regarding the risks of a multi-fetal pregnancy to both the fetuses and the mother compared with the risks after the reduction.

Individuals seeking an abortion for any reason should consider the ethical implications whether it be because the fetus is not the preferred sex or because the fetus would be born with a severe birth defect.

Aftercare

Counseling should continue after the abortion because it is a traumatic event. Individuals may feel guilty about choosing one fetus over another. Mental health professionals should be consulted throughout the process.

Risks

About 75% of women who undergo selective reduction will go into **premature labor**. About 4–5% of women undergoing selective reduction also miscarry one or more of the remaining fetuses. The risks associated with multi-fetal pregnancy are considered higher.

Normal results

In cases where a multi-fetal pregnancy of three or more fetuses is reduced to two fetuses, the remaining twin fetuses typically develop as they would if they had been conceived as twins.

Resources

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"Selective Reduction Eleiminates an Emryo Embedded in a Cesarean Scar." *Women's Health Weekly* (April 8, 2004): 117.

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The Alan Guttmacher Institute, 120 Wall Street, New York, NY, 10005, (212) 248-1111, http://www.agi-usa.org.

The American Society for Reproductive Medicine, 1209 Montgomery Highway, Birmingham, AL, 35216-2809, (205) 978-5000, http://www.asrm.org.

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Abortion, spontaneous *see* **Miscarriage**

Abortion, therapeutic

Definition

Therapeutic abortion is the intentional termination of a **pregnancy** before the fetus can live independently. Abortion has been a legal procedure in the United States since 1973.

Purpose

An abortion may be performed whenever there is some compelling reason to end a pregnancy. Women have abortions because continuing the pregnancy would cause them hardship, endanger their life or health, or because prenatal testing has shown that the fetus will be born with severe abnormalities.

Abortions are safest when performed within the first six to 10 weeks after the last menstrual period. The calculation of this date is referred to as the gestational age and is used in determining the stage of pregnancy. For example, a woman who is two weeks late having her period is said to be six weeks pregnant, because it is six weeks since she last menstruated.

About 90% of women who have abortions do so before 13 weeks and experience few complications. Abortions performed between 13–24 weeks have a higher rate of complications. Abortions after 24 weeks are extremely rare and are usually limited to situations where the life of the mother is in danger.

Precautions

Most women are able to have abortions at clinics or outpatient facilities if the procedure is performed early in pregnancy. Women who have stable diabetes, controlled **epilepsy**, mild to moderate high blood pressure, or who are HIV positive can often have abortions as outpatients if precautions are taken. Women with heart disease, previous **endocarditis**, **asthma**, lupus erythematosus, uterine fibroid tumors, blood clotting disorders, poorly controlled epilepsy, or some psychological disorders usually need to be hospitalized in order to receive special monitoring and medications during the procedure.

Description

Very early abortions

Between five and seven weeks, a pregnancy can be ended by a procedure called menstrual extraction. This procedure is also sometimes called menstrual regulation, mini-suction, or preemptive abortion. The contents of the uterus are suctioned out through

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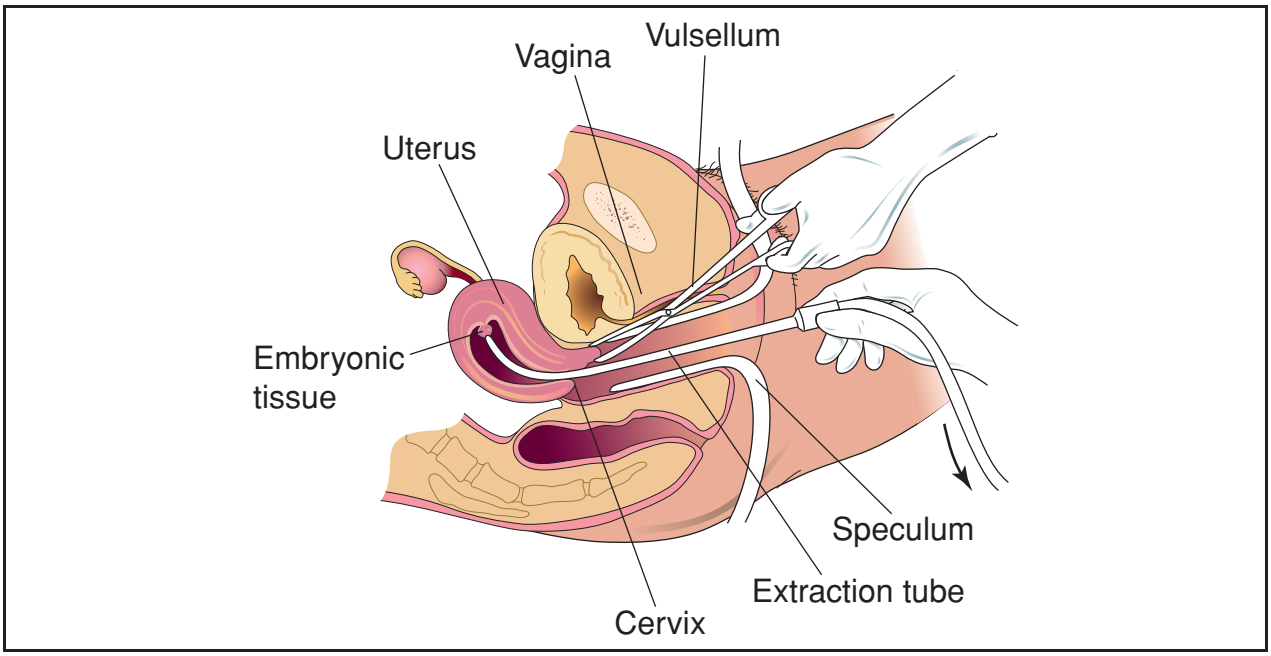

Between 5 and 7 weeks, a pregnancy can be ended by a procedure called menstrual extraction. The contents of the uterus are suctioned out through a thin extraction tube that is inserted through the undilated cervix. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

a thin (3–4 mm) plastic tube that is inserted through the undilated cervix. Suction is applied either by a bulb syringe or a small pump.

Another method is called the "morning after" pill, or **emergency contraception**. Basically, it involves taking high doses of birth control pills within 24 to 48 hours of having unprotected sex. The high doses of hormones causes the uterine lining to change so that it will not support a pregnancy. Thus, if the egg has been fertilized, it is simply expelled from the body.

There are two types of emergency **contraception**. One type is identical to ordinary birth control pills, and uses the hormones estrogen and progestin). This type is available with a prescription under the brand name Preven. But women can even use their regular birth control pills for emergency contraception, after they check with their doctor about the proper dose. About half of women who use birth control pills for emergency contraception get nauseated and 20% vomit. This method cuts the risk of pregnancy 75%.

The other type of morning-after pill contains only one hormone: progestin, and is available under the brand name Plan B. It is more effective than the first type with a lower risk of **nausea and vomiting**. It reduces the risk of pregnancy 89 percent.

Women should check with their physicians regarding the proper dose of pills to take, as it depends on the brand of birth control pill. Not all birth control pills will work for emergency contraception.

Menstrual extractions are safe, but because the amount of fetal material is so small at this stage of development, it is easy to miss. This results in an incomplete abortion that means the pregnancy continues.

First trimester abortions

The first trimester of pregnancy includes the first 13 weeks after the last menstrual period. In the United States, about 90% of abortions are performed during this period. It is the safest time in which to have an abortion, and the time in which women have the most choice of how the procedure is performed.

MEDICAL ABORTIONS. Medical abortions are brought about by taking medications that end the pregnancy. The advantages of a first trimester medical abortion are:

- The procedure is non-invasive; no surgical instruments are used.
- Anesthesia is not required.
- Drugs are administered either orally or by injection.
- The procedure resembles a natural miscarriage.

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KEY TERMS

Endocarditis—An infection of the inner membrane lining of the heart.

Fibroid tumors—Fibroid tumors are non-cancerous (benign) growths in the uterus. They occur in 30-40% of women over age 40, and do not need to be removed unless they are causing symptoms that interfere with a woman's normal activities.

Lupus erythematosus—A chronic inflammatory disease in which inappropriate immune system reactions cause abnormalities in the blood vessels and connective tissue.

Prostaglandin—Oxygenated unsaturated cyclic fatty acids responsible for various hormonal reactions such as muscle contraction.

Rh negative—Lacking the Rh factor, genetically determined antigens in red blood cells that produce immune responses. If an Rh negative woman is pregnant with an Rh positive fetus, her body will produce antibodies against the fetus's blood, causing a disease known as Rh disease. Sensitization to the disease occurs when the women's blood is exposed to the fetus's blood. Rh immune globulin (RhoGAM) is a vaccine that must be given to a woman after an abortion, miscarriage, or prenatal tests in order to prevent sensitization to Rh disease.

Disadvantages of a medical abortion are:

- The effectiveness decreases after the seventh week.
- The procedure may require multiple visits to the doctor.
- Bleeding after the abortion lasts longer than after a surgical abortion.
- The woman may see the contents of her womb as it is expelled.

Two different medications can be used to bring about an abortion. Methotrexate (Rheumatrex) works by stopping fetal cells from dividing which causes the fetus to die.

On the first visit to the doctor, the woman receives an injection of methotrexate. On the second visit, about a week later, she is given misoprostol (Cytotec), an oxygenated unsaturated cyclic fatty acid responsible for various hormonal reactions such as muscle contraction (prostaglandin), that stimulates contractions of the uterus. Within two weeks, the woman will expel the contents of her uterus, ending the pregnancy. A follow-up visit to the doctor is necessary to assure that the abortion is complete.

With this procedure, a woman will feel cramping and may feel nauseated from the misoprostol. This combination of drugs is 90–96% effective in ending pregnancy.

Mifepristone (RU-486), which goes by the brand name Mifeprex, works by blocking the action of progesterone, a hormone needed for pregnancy to continue, then stimulates ulerine contractions thus ending the pregnancy. It can be taken as much as 49 days after the first day of a woman's last period. On the first visit to the doctor, a woman takes a mifepristone pill. Two days later she returns and, if the **miscarriage** has not occurred, takes two misoprostol pills, which causes the uterus to contract. Five percent of women won't need to take misoprostol. After an observation period, she returns home.

Within four days, 90% of women have expelled the contents of their uterus and completed the abortion. Within 14 days, 95–97% of women have completed the abortion. A third follow-up visit to the doctor is necessary to confirm through observation or ultrasound that the procedure is complete. In the event that it is not, a surgical abortion is performed. Studies show that 4.5 to 8% of women need surgery or a blood **transfusion** after taking mifepristone, and the pregnancy persists in about 1% of women. In this case, surgical abortion is recommended because the fetus may be damanged. Side effects include **nausea**, vaginal bleeding and heavy cramping. The bleeding is typically heavier than a normal period and may last up to 16 days.

Mifepristone is not recommended for women with **ectopic pregnancy**, an **IUD**, who have been taking long-term steroidal therapy, have bleeding abnormalities or on blood-thinners such as Coumadin.

Surgical abortions

First trimester surgical abortions are performed using vacuum aspiration. The procedure is also called dilation and evacuation (D & E), suction dilation, vacuum curettage, or suction curettage.

Advantages of a vacuum aspiration abortion are:

- It is usually done as a one-day outpatient procedure.
- The procedure takes only 10–15 minutes.
- Bleeding after the abortion lasts five days or less.
- The woman does not see the products of her womb being removed.

Disadvantages include:

- The procedure is invasive; surgical instruments are used.
- Infection may occur.

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During a vacuum aspiration, the woman's cervix is gradually dilated by expanding rods inserted into the cervical opening. Once dilated, a tube attached to a suction pump is inserted through the cervix and the contents of the uterus are suctioned out. The procedure is 97–99% effective. The amount of discomfort a woman feels varies considerably. **Local anesthesia** is often given to numb the cervix, but it does not mask uterine cramping. After a few hours of rest, the woman may return home.

Second trimester abortions

Although it is better to have an abortion during the first trimester, some second trimester abortions may be inevitable. The results of **genetic testing** are often not available until 16 weeks. In addition, women, especially teens, may not have recognized the pregnancy or come to terms with it emotionally soon enough to have a first trimester abortion. Teens make up the largest group having second trimester abortions.

Some second trimester abortions are performed as a D & E. The procedures are similar to those used in the first trimester, but a larger suction tube must be used because more material must be removed. This increases the amount of cervical dilation necessary and increases the risk of the procedure. Many physicians are reluctant to perform a D & E this late in pregnancy, and for some women is it not a medically safe option.

The alternative to a D & E in the second trimester is an abortion by induced labor. Induced labor may require an overnight stay in a hospital. The day before the procedure, the woman visits the doctor for tests, and to either have rods inserted in her cervix to help dilate it or to receive medication that will soften the cervix and speed up labor.

On the day of the abortion, drugs, usually prostaglandins to induce contractions, and a salt water solution, are injected into the uterus. Contractions begin, and within eight to 72 hours the woman delivers the fetus.

Side effects of this procedure include nausea, **vomiting**, and **diarrhea** from the prostaglandins, and **pain** from uterine cramps. Anesthesia of the sort used in **childbirth** can be given to mask the pain. Many women are able to go home a few hours after the procedure.

Very early abortions cost between $200–$400. Later abortions cost more. The cost increases about $100 per week between the thirteenth and sixteenth week. Second trimester abortions are much more costly because they often involve more risk, more services, anesthesia, and sometimes a hospital stay. Insurance carriers and HMOs may or may not cover the procedure. Federal law prohibits federal funds including Medicaid funds, from being used to pay for an elective abortion.

Preparation

The doctor must know accurately the stage of a woman's pregnancy before an abortion is performed. The doctor will ask the woman questions about her menstrual cycle and also do a **physical examination** to confirm the stage of pregnancy. This may be done at an office visit before the abortion or on the day of the abortion. Some states require a waiting period before an abortion can be performed. Others require parental or court consent for a child under age 18 to receive an abortion.

Despite the fact that almost half of all women in the United States have had at least one abortion by the time they reach age 45, abortion is surrounded by controversy. Women often find themselves in emotional turmoil when deciding if an abortion is a procedure they wish to undergo. Pre-abortion counseling is important in helping a woman resolve any questions she may have about having the procedure.

Aftercare

Regardless of the method used to perform the abortion, a woman will be observed for a period of time to make sure her blood pressure is stable and that bleeding is controlled. The doctor may prescribe **antibiotics** to reduce the chance of infection. Women who are Rh negative (lacking genetically determined antigens in their red blood cells that produce immune responses) should be given a human Rh immune globulin (RhoGAM) after the procedure unless the father of the fetus is also Rh negative. This prevents blood incompatibility complications in future pregnancies.

Bleeding will continue for about five days in a surgical abortion and longer in a medical abortion. To decrease the risk of infection, a woman should avoid intercourse and not use tampons and douches for two weeks after the abortion.

A follow-up visit is a necessary part of the woman's aftercare. Contraception will be offered to women who wish to avoid future pregnancies, because menstrual periods normally resume within a few weeks.

Risks

Serious complications resulting from abortions performed before 13 weeks are rare. Of the 90% of

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women who have abortions in this time period, 2.5% have minor complications that can be handled without hospitalization. Less than 0.5% have complications that require a hospital stay. The rate of complications increases as the pregnancy progresses.

Complications from abortions can include:

- uncontrolled bleeding
- infection
- blood clots accumulating in the uterus
- a tear in the cervix or uterus
- missed abortion where the pregnancy continues
- incomplete abortion where some material from the pregnancy remains in the uterus

Women who experience any of the following symptoms of post-abortion complications should call the clinic or doctor who performed the abortion immediately.

- severe pain
- fever over 100.4 °F (38.2 °C)
- heavy bleeding that soaks through more than one sanitary pad per hour
- foul-smelling discharge from the vagina
- continuing symptoms of pregnancy

Normal results

Usually the pregnancy is ended without complication and without altering future fertility.

Resources

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Debra Gordon

Abrasions *see* **Wounds**

Abruptio placentae *see* **Placental abruption**

Abscess

Definition

An abscess is an enclosed collection of liquefied tissue, known as pus, somewhere in the body. It is the result of the body's defensive reaction to foreign material.

Description

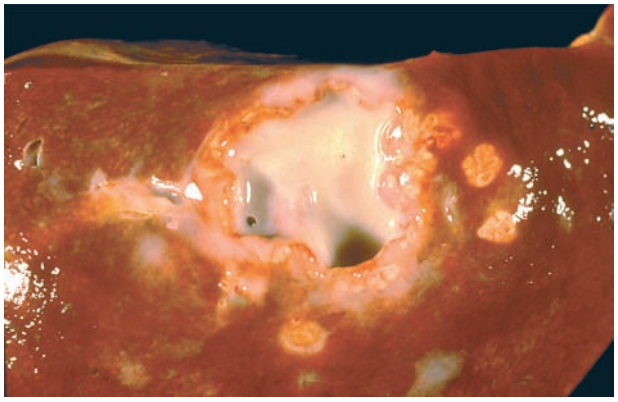
There are two types of abscesses, septic and sterile. Most abscesses are septic, which means that they are the result of an infection. Septic abscesses can occur anywhere in the body. Only a germ and the body's immune response are required. In response to the invading germ, white blood cells gather at the infected site and begin producing chemicals called enzymes that attack the germ by digesting it. These enzymes act like acid, killing the germs and breaking them down into small pieces that can be picked up by the circulation and eliminated from the body. Unfortunately, these chemicals also digest body tissues. In most cases, the germ produces similar chemicals. The result is a thick, yellow liquid–pus–containing digested germs, digested tissue, white blood cells, and enzymes.

An abscess is the last stage of a tissue infection that begins with a process called inflammation. Initially, as the invading germ activates the body's immune system, several events occur:

- Blood flow to the area increases
- The temperature of the area increases due to the increased blood supply
- The area swells due to the accumulation of water, blood, and other liquids
- It turns red
- It hurts, because of the irritation from the swelling and the chemical activity

These four signs—heat, swelling, redness, and pain—characterize inflammation

As the process progresses, the tissue begins to turn to liquid, and an abscess forms. It is the nature of an abscess to spread as the chemical digestion liquefies more and more tissue. Furthermore, the spreading follows the path of least resistance—the tissues most easily



An amoebic abscess caused by *Entameoba histolytica*. *(© Phototake. — All rights reserved.)*

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KEY TERMS

Cellulitis—Inflammation of tissue due to infection.

Enzyme—Any of a number of protein chemicals that can change other chemicals.

Fallopian tubes—Part of the internal female anatomy that carries eggs from the ovaries to the uterus.

Flora—Living inhabitants of a region or area.

Pyogenic—Capable of generating pus. *Streptococcus, Staphococococcus,* and bowel bacteria are the primary pyogenic organisms.

Sebaceous glands—Tiny structures in the skin that produce oil (sebum). If they become plugged, sebum collects inside and forms a nurturing place for germs to grow.

Septicemia—The spread of an infectious agent throughout the body by means of the blood stream.

Sinus—A tubular channel connecting one body part with another or with the outside.

digested. A good example is an abscess just beneath the skin. It most easily continues along beneath the skin rather than working its way through the skin where it could drain its toxic contents. The contents of the abscess also leak into the general circulation and produce symptoms just like any other infection. These include chills, **fever**, aching, and general discomfort.

Sterile abscesses are sometimes a milder form of the same process caused not by germs but by non-living irritants such as drugs. If an injected drug like penicillin is not absorbed, it stays where it was injected and may cause enough irritation to generate a sterile abscess–sterile because there is no infection involved. Sterile abscesses are quite likely to turn into hard, solid lumps as they scar, rather than remaining pockets of pus.

Causes and symptoms

Many different agents cause abscesses. The most common are the pus-forming (pyogenic) bacteria like *Staphylococcus aureus*, which is nearly always the cause of abscesses under the skin. Abscesses near the large bowel, particularly around the anus, may be caused by any of the numerous bacteria found within the large bowel. Brain abscesses and liver abscesses can be caused by any organism that can travel there through the circulation. Bacteria, amoeba, and certain fungi can travel in this fashion. Abscesses in other parts of the body are caused by organisms that normally inhabit nearby structures or that infect them. Some common causes of specific abscesses are:

- skin abscesses by normal skin flora
- dental and throat abscesses by mouth flora
- lung abscesses by normal airway flora, pneumonia germs, or tuberculosis
- abdominal and anal abscesses by normal bowel flora

Specific types of abscesses

Listed below are some of the more common and important abscesses.

- Carbuncles and other boils. Skin oil glands (sebaceous glands) on the back or the back of the neck are the ones usually infected. The most common germ involved is *Staphylococcus aureus*. Acne is a similar condition of sebaceous glands on the face and back.
- Pilonidal abscess. Many people have as a birth defect a tiny opening in the skin just above the anus. Fecal bacteria can enter this opening, causing an infection and subsequent abscess.
- Retropharyngeal, parapharyngeal, peritonsillar abscess. As a result of throat infections like strep throat and tonsillitis, bacteria can invade the deeper tissues of the throat and cause an abscess. These abscesses can compromise swallowing and even breathing.
- Lung abscess. During or after pneumonia, whether it's due to bacteria [common pneumonia], tuberculosis, fungi, parasites, or other germs, abscesses can develop as a complication.
- Liver abscess. Bacteria or amoeba from the intestines can spread through the blood to the liver and cause abscesses.
- Psoas abscess. Deep in the back of the abdomen on either side of the lumbar spine lie the psoas muscles. They flex the hips. An abscess can develop in one of these muscles, usually when it spreads from the appendix, the large bowel, or the fallopian tubes.

Diagnosis

The common findings of inflammation—heat, redness, swelling, and pain—easily identify superficial abscesses. Abscesses in other places may produce only generalized symptoms such as fever and discomfort. If the patient's symptoms and **physical examination** do

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not help, a physician may have to resort to a battery of tests to locate the site of an abscess, but usually something in the initial evaluation directs the search. Recent or chronic disease in an organ suggests it may be the site of an abscess. Dysfunction of an organ or system—for instance, seizures or altered bowel function—may provide the clue. **Pain** and tenderness on physical examination are common findings. Sometimes a deep abscess will eat a small channel (sinus) to the surface and begin leaking pus. A sterile abscess may cause only a painful lump deep in the buttock where a shot was given.

Treatment

Since skin is very resistant to the spread of infection, it acts as a barrier, often keeping the toxic chemicals of an abscess from escaping the body on their own. Thus, the pus must be drained from the abscess by a physician. The surgeon determines when the abscess is ready for drainage and opens a path to the outside, allowing the pus to escape. Ordinarily, the body handles the remaining infection, sometimes with the help of **antibiotics** or other drugs. The surgeon may leave a drain (a piece of cloth or rubber) in the abscess cavity to prevent it from closing before all the pus has drained out.

Alternative treatment

If an abscess is directly beneath the skin, it will be slowly working its way through the skin as it is more rapidly working its way elsewhere. Since chemicals work faster at higher temperatures, applications of hot compresses to the skin over the abscess will hasten the digestion of the skin and eventually result in its breaking down, releasing the pus spontaneously. This treatment is best reserved for smaller abscesses in relatively less dangerous areas of the body—limbs, trunk, back of the neck. It is also useful for all superficial abscesses in their very early stages. It will "ripen" them.

Contrast **hydrotherapy**, alternating hot and cold compresses, can also help assist the body in resorption of the abscess. There are two homeopathic remedies that work to rebalance the body in relation to abscess formation, *Silica* and *Hepar sulphuris*. In cases of septic abscesses, bentonite clay packs (bentonite clay and a small amount of *Hydrastis* powder) can be used to draw the infection from the area.

Prognosis

Once the abscess is properly drained, the prognosis is excellent for the condition itself. The reason for the abscess (other diseases the patient has) will determine the overall outcome. If, on the other hand, the abscess ruptures into neighboring areas or permits the infectious agent to spill into the bloodstream, serious or fatal consequences are likely. Abscesses in and around the nasal sinuses, face, ears, and scalp may work their way into the brain. Abscesses within an abdominal organ such as the liver may rupture into the abdominal cavity. In either case, the result is life threatening. Blood poisoning is a term commonly used to describe an infection that has spilled into the blood stream and spread throughout the body from a localized origin. Blood poisoning, known to physicians as septicemia, is also life threatening.

Abscesses in the hand are more serious than they might appear. Due to the intricate structure and the overriding importance of the hand, any hand infection must be treated promptly and competently.

Prevention

Infections that are treated early with heat (if superficial) or antibiotics will often resolve without the formation of an abscess. It is even better to avoid infections altogether by taking prompt care of open injuries, particularly puncture **wounds**. **Bites** are the most dangerous of all, even more so because they often occur on the hand.

Resources

BOOKS

Fauci, Anthony S., et al., editors. *Harrison's Principles of Internal Medicine*. 17th ed. New York: McGraw-Hill Professional, 2008.

J. Ricker Polsdorfer MD

Abscess drainage *see* **Abscess incision and drainage**

Abscess incision and drainage

Definition

An infected skin nodule that contains pus may need to be drained via a cut if it does not respond to **antibiotics**. This allows the pus to escape, and the infection to heal.

Purpose

An **abscess** is a pus-filled sore, usually caused by a bacterial infection. The pus is made up of both live and dead organisms and destroyed tissue from the white blood cells that were carried to the area to fight the infection. Abscesses are often found in the soft tissue

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under the skin, such as the armpit or the groin. However, they may develop in any organ, and are commonly found in the breast and gums. Abscesses are far more serious and call for more specific treatment if they are located in deep organs such as the lung, liver or brain.

Because the lining of the abscess cavity tends to interfere with the amount of the drug that can penetrate the source of infection from the blood, the cavity itself may require draining. Once an abscess has fully formed, it often does not respond to antibiotics. Even if the antibiotic does penetrate into the abscess, it doesn't function as well in that environment.

Precautions

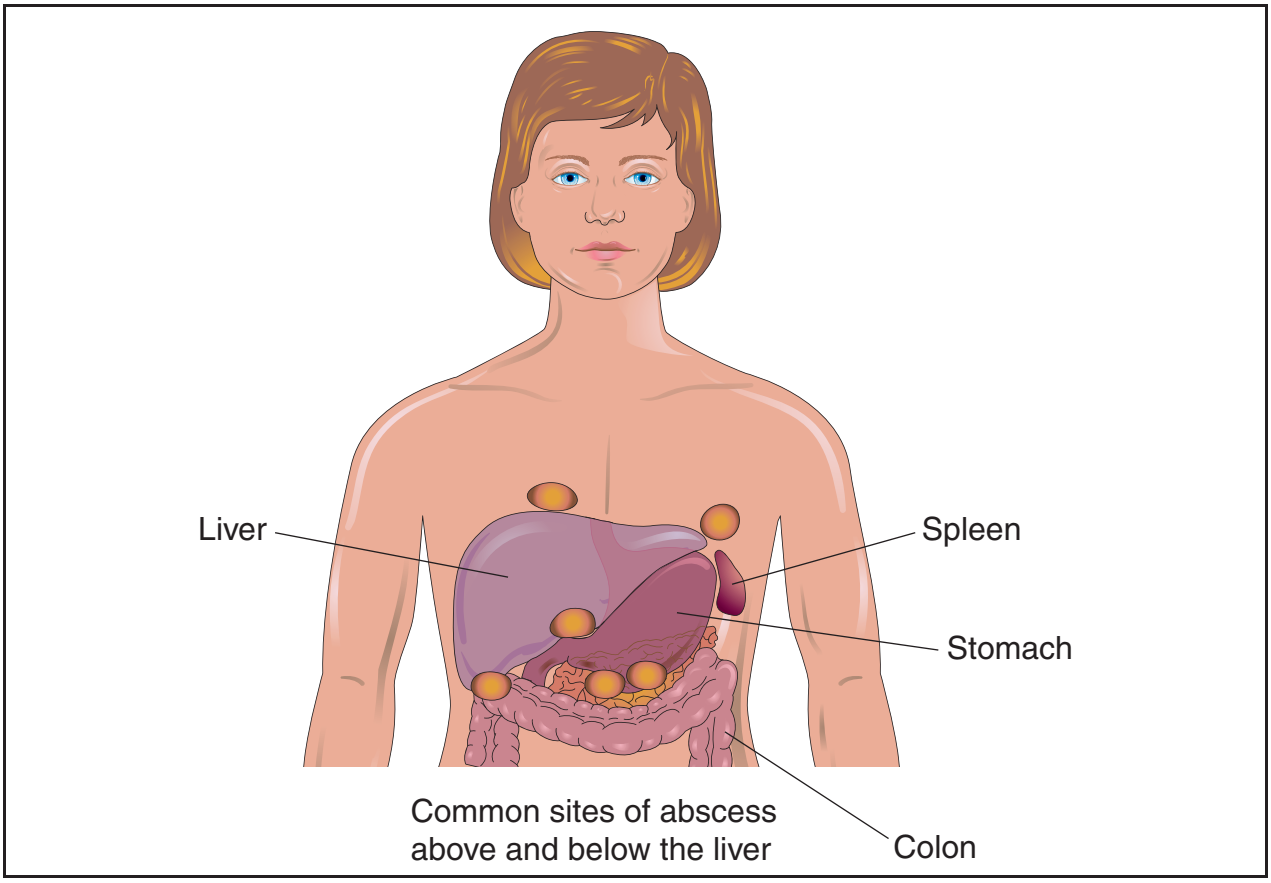
An abscess can usually be diagnosed visually, although an imaging technique such as a computed tomography scan may be used to confirm the extent of the abscess before drainage. Such procedures may also be needed to localize internal abscesses, such as those in the abdominal cavity or brain.

Description

A doctor will cut into the lining of the abscess, allowing the pus to escape either through a drainage tube or by leaving the cavity open to the skin. How big the incision is depends on how quickly the pus is encountered.

Once the abscess is opened, the doctor will clean and irrigate the wound thoroughly with saline. If it is not too large or deep, the doctor may simply pack the abscess wound with gauze for 24–48 hours to absorb the pus and discharge.

If it is a deeper abscess, the doctor may insert a drainage tube after cleaning out the wound. Once the tube is in place, the surgeon closes the incision with simple stitches, and applies a sterile dressing. Drainage is maintained for several days to help prevent the abscess from reforming.



Although abscesses are often found in the soft tissue under the skin, such as the armpit or the groin, they may develop in any organ, such as the liver. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

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KEY TERMS

White blood cells—Cells that protect the body against infection.

Preparation

The skin over the abscess will be cleansed by swabbing gently with an antiseptic solution.

Aftercare

Much of the **pain** around the abscess will be gone after the surgery. Healing is usually very fast. After the tube is taken out, antibiotics may be continued for several days. Applying heat and keeping the affected area elevated may help relieve inflammation.

Risks

If there is any scarring, it is likely to become much less noticeable as time goes on, and eventually almost invisible. Occasionally, an abscess within a vital organ (such as the brain) damages enough surrounding tissue that there is some permanent loss of normal function.

Normal results

Most abscesses heal after drainage alone; others require drainage and antibiotic drug treatment.

Resources

BOOKS

Cunningham, G., et al. *Williams Obstetrics*. 22nd ed. New York, NY: McGraw-Hill, 2005.

ORGANIZATIONS

National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS), 1 AMS Circle, Bethesda, MD, 20892-3675, (301) 495-4484, (301) 718-6366, (877) 226-4267, NIAMSinfo@mail.nih.gov, http://www.niams. nih.gov/.

Carol A. Turkington

Abuse

Definition

Abuse is defined as any action that intentionally harms or injures another person. Abuse also encompasses inappropriate use of any substance, especially those that alter consciousness (e.g., alcohol, **cocaine**, methamphetamines).

Description

There are several major types of abuse: physical abuse, **sexual abuse**, **substance abuse**, **elder abuse**, and psychological abuse. All forms of abuse in the United States are illegal and have the potential to carry serious criminal penalties.

Physical abuse

Physical abuse is the infliction of injury by another person. Physical abuse can happen to both children and adults of either gender and of any sexual orientation. The injuries can be inflicted by punching, kicking, biting, burning, beating, or use of a weapon such as a baseball bat or knife. Physical abuse can result in **bruises**, **burns**, **poisoning**, broken bones, and internal hemorrhages.

According to the United States Department of Health and Human Services Administration for Children and Families, in 2006 in the United States there were 1,530 child fatalities that resulted from **child abuse** (a rate of just over 2 deaths per 100,000 children). Of these, about three-quarters of the children were under four years old, with the largest number of deaths occurring in infants under one year old. In addition, about 905,000 children were victims of nonfatal maltreatment (a rate of about 12 children 12 per 1,000 population). Nearly three-quarters of these children were victims of repeated maltreatment. Nearly 83% of abused children were abused by a parent or a parent acting with another individual.

Physical abuse of adults primarily occurs against women. The United Nations Development Fund for Women estimates that one-third of all women in the world will be beaten, coerced into sex, or otherwise abused during their lifetime. Sixty-nine percent of women worldwide report that at some time during their life they have been abused by a spouse or man with whom they are intimate. Intimate partners also commit the majority of murders of women. Violence against women tends to increase in times of economic downturns and political or social chaos (e.g., when a country is at war). Domestic violence is also strongly linked to substance abuse among the perpetrators. The U. S. Department of Justice found that in domestic violence cases, 61% of the perpetrators and 36% of the victims had a substance abuse problem. The most common substance abused was alcohol. Males can be victims of physical abuse, especially in homosexual

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KEY TERMS

Encopresis—Abnormalities relating to bowel movements that can occur as a result of stress or fear.

relationships, but the statistics for abuse against men are more poorly documented than for abuse against women and children.

Sexual abuse

Sexual abuse of a child refers to sexual behavior between an adult and child or between two children, one of whom is forcefully dominant or significantly older. Sexual behaviors can include touching breasts, genitals, and buttocks while the victim is either dressed or undressed. Sexual abuse behavior also includes exhibitionism, cunnilingus, fellatio, or penetration of the vagina or anus with sexual organs or objects. Pornographic photography also is a form of sexual abuse of children. The U.S. Department of Justice estimates that one in six victims of a **sexual assault** are under age 12. Despite publicity surrounding cases where a child is assaulted by a stranger, almost all sexual assaults against children are perpetrated by a family member (e.g. father, stepfather, aunt, uncle, sibling, cousin) or family intimate (e.g., a live-in lover or friend of the parent).

Sexual abuse also can take the form of **rape**. The legal definition of rape includes only slight penile penetration in the victim's outer vulva area. Complete erection and ejaculation are not necessary. Rape is the perpetration of an act of sexual intercourse when:

- will is overcome by force or fear (from threats, use of weapons, or use of drugs)
- mental impairment renders the victim incapable of rational judgment
- if the victim is below the legal age established for consent

The National Coalition Against Domestic Violence (NCADV) estimates that 1 in 5 women and 1 in 33 men will be the victim of a rape or an attempted rape during their lifetime. According the U.S. Department of Justice, 54% of all rapes are of women under age 18. Rape can occur within the context of marriage. Marital rape accounts for about 25% of all rapes in the United States. Marital rape is often accompanied by physical and psychological abuse. In 90% of all rapes, the woman knows the rapist. Women who are victims of a sexual assault have a high chance of experiencing depression, **post-traumatic stress disorder**, developing substance abuse, and of becoming suicidal.

Substance abuse

Substance abuse is an abnormal pattern of substance usage leading to significant distress or impairment. Alcohol, street drugs, and prescription drugs are common substances of abuse. Substance abuse is often a contributing factor in physical and sexual abuse. Children of parents who are substance abusers are more likely to experience abuse than children living in households where there is no substance abuse. The National Committee to Prevent Child Abuse found that in the United States, 80% of child abuse cases were associated with substance abuse by the perpetrator.

The criteria for substance abuse is one or more of the following occurring within a 12-month period:

- recurrent substance use resulting in failure to fulfill obligations at home, work, or school
- using substance in situations that are physically dangerous (i.e., while driving or operating machinery)
- recurrent substance-related legal problems
- continued usage despite recurrent social and interpersonal problems (i.e., arguments and fights with significant other)

Elder abuse

Abuse of the elderly is common and occurs mostly because of caregiver burnout due to the high level of dependency and continuous care that frail, elderly individuals often require. The NCADV estimates that in 2007 there were 2.1 million cases of elder abuse in the United States but that only one out of every 14 cases was reported to authorities. Victims tend to be over age 50 and highly dependent on their caregivers because of physical or mental disabilities. In 90% of the cases, the abuser is a family member.

Elder abuse can take the form of physical abuse, psychological abuse, sexual abuse, or financial abuse. Examples of elder abuse include:

- withholding food, water, or medicines
- delaying needed medical care

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- coercing or deceiving an elderly person into signing legal documents
- wrongful use of the elderly individual's money
- removing or selling the elderly individual's property without permission
- initiating non-consensual sexual contact
- pushing, hitting or tying the individual in a bed or chair
- screaming, emotionally manipulating, intentionally humiliating, or intentionally confusing the individual

Psychological abuse

Victims of psychological abuse can be of any age or gender. This form of abuse is often difficult to prove. It includes threatening the victim with violence, harassing them when the are outside the home (e.g., at school or work), denying the victim access to others (e.g., refusing to allow the victim to see friends, preventing use of the telephone), confining the victim to home, or destroying the victim's property. A woman with a physical disability has a greatly increased likelihood of being psychologically abused. Men who are unemployed but living in a household where the woman works are most likely to be psychological abusers. Almost all men who physically abuse women also psychologically abuse them.

Causes and symptoms

Children who have been abused usually exhibit a variety of symptoms that encompass behavioral, emotional, and psychosomatic problems (body problems caused by emotional or psychological disturbance). Children who have been physically abused tend to be more aggressive, angry, hostile, depressed, and have low self-esteem. Additionally, they exhibit fear, **anxiety**, and nightmares. Severe psychological problems may result in suicidal behavior or posttraumatic stress disorder. Physically abused children may complain of physical illness even in the absence of a cause. They also may develop **eating disorders** or **encopresis**. Children who are sexually abused may exhibit abnormal sexual behavior in the form of aggressiveness and hyperarousal. Adolescents may display promiscuity, sexual acting out, and homosexual exploration. Children who are psychologically abused or who witness psychological abuse are more likely to become psychological abusers as adults.

Physical abuse directed toward adults can ultimately lead to **death**. Approximately 50% of women murdered in the United States were killed by a former or current male partner. Approximately one-third of emergency room visits by women are prompted by an incident of domestic violence. Female victims who are assaulted by an intimate partner also have a higher rate of internal injuries and loss of consciousness than victims of stranger assault (e.g., mugging, robbery). As well as showing physical signs of abuse, adults who are abused often have poor health, difficulty concentrating, suicidal thoughts, clinical depression, low self-esteem, and a high rate of substance abuse. Many victims of abuse are afraid or unwilling to admit the abuse is occurring and will go to great lengths to disguise their situation.

Diagnosis

Physical abuse should be suspected whenever children or adults have unexplained injuries, especially when these injuries occur with an unexpectedly high frequency. A report may be filed with the local family social services agency that will initiate investigations. A police report may also be made. The authorities normally will follow up the allegation of abuse.

Sexual abuse of both a child and an adult may be identified from information given by the victim. Victims can be assessed for signs of ejaculatory evidence from the perpetrator. Ejaculatory specimens can be retrieved from the mouth, rectum, and clothing. Tests for **sexually transmitted diseases** may be performed.

Elder abuse should be suspected if a dependent individual demonstrates a fear of the caregiver. Additionally, elder abuse can be suspected if there are signs indicating intentional delay of required medical care, an unexpected change in medical status, or a significant change in the elderly individual's financial status.

Substance abuse usually causes behavioral changes such as failure to perform expected tasks or inability to meet reasonable work and family responsibilities. It should be suspected in a person who continues to use their drug of choice despite recurrent negative consequences. The diagnosis can be made after administration of a comprehensive physical exam and a chemical abuse assessment by a therapist.

Treatment

Both children and adults who are victims of physical or sexual abuse typically require immediate medical attention and long-term **psychotherapy**. Many victims of abuse, especially children who are sexually abused, take years to come to terms with the

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abuse. Therapists who specialize in treating victims of physical and sexual abuse can help the individual understand has happened and suggest ways to make positive steps toward moving past the abuse. Support groups can be helpful for some victims. When children are abused by the adults they live with, they may be removed from the abuser's home and placed in foster care or a group home. Psychological counseling and anger management should also be made available to the abuser. The effects of all types of abuse can last for years even with good mental health care. Children witnessing abuse, even if they were not abused themselves, also are often adversely affected and can benefit from psychotherapy.

Substance abusers may elect treatment or be sent to a treatment facility as part of a law enforcement proceeding. Treatment for substance abusers can be at either an inpatient or outpatient facility, depending on severity of **addiction**. Psychological counseling, behavior modification strategies, and medications may be used to assist in abstinence. The individual should be encouraged to participate in community-centered support groups (e.g., Alcoholics Anonymous, **Narcotics** Anonymous). Support groups also exist for family members of substance abusers.

Toll-free telephone hotlines available 24 hours a day, 7 days a week can provide referrals and counseling for people in an abuse crisis situation. People calling these hotlines may choose to remain anonymous. A list of national hotlines in the United States can be found in the reference section of this article.

Prognosis

How an individual progresses after experiencing an abuse situation depends on the individual's personality, the type of abuse, the length of time the individual was abused, family support, and the professional support services available. Usually victims of abuse require extensive psychotherapy to deal with emotional distress associated with the incident. Perpetrators require further psychological evaluation and treatment. Victims of abuse may have a variety of emotional problems including depression, acts of **suicide**, **post-traumatic stress disorder**, and anxiety disorder. Many turn to substance abuse as a way to avoid dealing with their emotions. Children who experience sexual abuse may enter abusive relationships or have problems with intimacy as adults. Substance abusers may experience relapses since the cardinal feature of all addictive disorders is a tendency to return to symptoms. Elderly individuals may suffer from further medical problems and/or anxiety; in some cases neglect may precipitate death.

Prevention

Prevention programs are geared to education and awareness. Detection of initial symptoms or characteristic behaviors may assist in identifying some potential abuse situations. Certain professionals in the United States are required by law to report suspected child abuse. These include teachers, social workers, law officers, and some medical personnel. In some cases treatment may be sought before incident. The professional treating the abused persons must develop a clear sense of the relationship dynamics and the chances for continued harm.

ORGANIZATIONS

Childhelp National Child Abuse Hotline, 15757 N. 78th St., Suite B., Scottsdale, AZ, 85260, (480) 922-8212, (480) 922-7061, (800) 422-4453, http://www.childhelp.org. Help for children who are being abused or adults who are concerned that a child they know is being abused or neglected.

Elder Abuse Hotline, (800) 252-8966, .Assistance in reporting and counseling about elder abuse.

National Coalition Against Domestic Violence, 1120 Lincoln Street, Suite 1603, Denver, CO, 80203, (303) 839-1852, (303) 831-9251, http://ww.ncadv.org/.

National Domestic Violence Hotline, P. O. box 161810, Austin, TX, 78716, (512) 794-1133, (800) 799-SAFE (7233), http://www.thehotline.org.Help for both men and women who are victims of domestic violence.

Rape, Abuse and Incest National Network (RAINN), 2000 L Street NW, Suite 406, Washington, DC, 20036, (202) 544-1034, (202) 544-3556, (800) 656-HOPE (4673), http://www.rainn.org/get-help/national-sexual-assault-online-hotline.Online counseling and referral to local rape crisis centers using anonymous instant messaging or telephone.

Substance Abuse Treatment Referral Hotline, P.O. Box 2345, Rockville, MD, 20847-2345, (800) 662-HELP (4357), http://www.samhsa.gov.Information, support, treatment options, and referrals to local rehab centers for any drug or alcohol problem.

Laith Farid Gulli M.D.
Bilal Nasser M.Sc.
Tish Davidson A. M.

Acceleration-deceleration cervical injury *see* **Whiplash**

ACE inhibitors *see* **Angiotensin-converting enzyme inhibitors**

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Acetaminophen

Definition

Acetaminophen, paracetamol, is a medicine that is sold over the counter, and combined with stronger **pain** relievers by prescription, to relieve mild to moderate pain.

Purpose

Acetaminophen and **aspirin** are equally effective as pain relievers. But, unlike aspirin, acetaminophen does not reduce inflammation.

Description

Acetaminophen is sold under various brand names: Tylenol, Panadol, Aspirin Free Anacin, and Bayer Select Maximum Strength **Headache** Pain Relief Formula.

Over the counter acetaminophen is available as tablets, chewable tablets, capsules, oral suspension and drops, and as rectal suppositories.

Acetaminophen, in usual doses and for short periods of time, is considered safe for use during **pregnancy** and nursing.

Many multi-symptom cold, flu, and sinus medicines contain acetaminophen. The labels list acetaminophen, if present, and the amount per dose.

Recommended dosage

The usual dose for adults and children above age 12 is 650 mg three to four times a day.

The maximum safe dose for adults without **liver disease** is 4 grams (4000 mg) per 24 hours.

For children of average size, below age 12, the following can serve as a guide for maximum doses:

- Infants 3 months or less – 40mg three times a day
- Infants 4 to 12 months – 80mg three times a day
- Toddlers 1-2 years – 120mg three to four times a day
- Children 2-3 years – 160mg three to four times a day
- Children 4-5 years – 240mg three to four times a day
- Children 6-8 years – 320mg three to four times a day
- Children 9-10 years – 400mg three to four times a day
- Children 11 years – 480mg three to four times a day

Precautions

Take with food or milk to reduce the possibility of stomach upset.

Acetaminophen is combined with **narcotics** and strong non-narcotic pain relievers in prescription products. It is also combined with cold and flu products sold over the counter. Thus, caution is advised when taking prescription and over the counter products together to avoid unknowingly overdosing on the drug.

In acute conditions with pain and **fever**, acetaminophen should be used only for one to two days before seeking medical attention.

If there is a **sore throat**, fever, rash, headache, **nausea** and/or **vomiting**, immediate medical attention should be sought.

People who consume three or more alcoholic beverages a day are at greater risk of liver disease if they take acetaminophen.

Acetaminophen interferes with the results of some laboratory tests. Check with your doctor if you take acetaminophen and are scheduled for tests.

Acetaminophen does not reduce inflammation, swelling, or have anti-rheumatic effects.

Side effects

Common side effects of acetaminophen include generalized rash, **hives**, **itching** and hoarseness. If difficulty breathing develops, there may be an allergic reaction and immediate medical attention is needed.

Acute overdoses of acetaminophen may cause nausea, **vomiting**, sweating, exhaustion, upper abdominal pain and flu-like symptoms.

Overdoses of acetaminophen, more than 4000mg/day, can cause liver damage and failure. Chronic, daily use of moderate to large doses of acetaminophen and/or combining acetaminophen with moderately heavy use of alcohol can result in liver damage and failure.

Liver failure symptoms include **fatigue**, **jaundice**, and unusual bleeding or bruising.

Interactions

Acetaminophen may increase the effects of the blood thinner warfarin (Coumadin).

The toxicity and effects of acetaminophen may be increased by the anti-tuberculosis drug isoniazid and imatinib.

The toxicity and effectiveness of acetaminophen may be decreased by phenytoin (Dilantin), **barbiturates**, the cholesterol-lowering drug cholestyramine resin (Questran), and carbamazepine.

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KEY TERMS

Botulinum toxin—Any of a group of potent bacterial toxins or poisons produced by different strains of the bacterium *Clostridium botulinum*. The toxins cause muscle paralysis.

Dysphagia—Difficulty in swallowing.

Endoscopy—A test in which a viewing device and a light source are introduced into the esophagus by means of a flexible tube. Endoscopy permits visual inspection of the esophagus for abnormalities.

Esophageal manometry—A test in which a thin tube is passed into the esophagus to measure the degree of pressure exerted by the muscles of the esophageal wall.

Esophageal sphincter—A circular band of muscle that closes the last few centimeters of the esophagus and prevents the backward flow of stomach contents.

Esophagomyotomy—A surgical incision through the muscular tissue of the esophagus.

Esophagus—The muscular tube that leads from the back of the throat to the entrance of the stomach.

Peristalsis—The coordinated, rhythmic wave of smooth muscle contraction that forces food through the digestive tract.

Reflux—An abnormal backward or return flow of a fluid.

Resources

OTHER

Medline Plus: www.nlm.nih.gov/medlineplus/druginfo/meds

James Waun MD, RPh

Acetylsalicylic acid *see* **Aspirin**

Achalasia

Definition

Achalasia is a disorder of the esophagus that prevents normal swallowing.

Description

Achalasia affects the esophagus, the tube that carries swallowed food from the back of the throat down into the stomach. A ring of muscle called the lower esophageal sphincter encircles the esophagus just above the entrance to the stomach. This sphincter muscle is normally contracted to close the esophagus. When the sphincter is closed, the contents of the stomach cannot flow back into the esophagus. Backward flow of stomach contents (reflux) can irritate and inflame the esophagus, causing symptoms such as **heartburn**. The act of swallowing causes a wave of esophageal contraction called peristalsis. Peristalsis pushes food along the esophagus. Normally, peristalsis causes the esophageal sphincter to relax and allow food into the stomach. In achalasia, which means "failure to relax," the esophageal sphincter remains contracted. Normal peristalsis is interrupted and food cannot enter the stomach.

Causes and symptoms

Causes

Achalasia is caused by degeneration of the nerve cells that normally signal the brain to relax the esophageal sphincter. The ultimate cause of this degeneration is unknown. Autoimmune disease or hidden infection is suspected.

Symptoms

Dysphagia, or difficulty swallowing, is the most common symptom of achalasia. The person with achalasia usually has trouble swallowing both liquid and solid foods, often feeling that food "gets stuck" on the way down. The person has chest **pain** that is often mistaken for angina pectoris (cardiac pain). Heartburn and difficulty belching are common. Symptoms usually get steadily worse. Other symptoms may include nighttime **cough** or recurrent **pneumonia** caused by food passing into the lower airways.

Diagnosis

Diagnosis of achalasia begins with a careful medical history. The history should focus on the timing of symptoms and on eliminating other medical conditions that may cause similar symptoms. Tests used to diagnose achalasia include:

- Esophageal manometry. In this test, a thin tube is passed into the esophagus to measure the pressure exerted by the esophageal sphincter.

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- X ray of the esophagus. Barium may be swallowed to act as a contrast agent. Barium reveals the outlines of the esophagus in greater detail and makes it easier to see its constriction at the sphincter.
- Endoscopy. In this test, a tube containing a lens and a light source is passed into the esophagus. Endoscopy is used to look directly at the surface of the esophagus. This test can also detect tumors that cause symptoms like those of achalasia. Cancer of the esophagus occurs as a complication of achalasia in 2–7% of patients.

Treatment

The first-line treatment for achalasia is balloon dilation. In this procedure, an inflatable membrane or balloon is passed down the esophagus to the sphincter and inflated to force the sphincter open. Dilation is effective in about 70% of patients.

Three other treatments are used for achalasia when balloon dilation is inappropriate or unacceptable.

- Botulinum toxin injection. Injected into the sphincter, botulinum toxin paralyzes the muscle and allows it to relax. Symptoms usually return within one to two years.
- Esophagomyotomy. This surgical procedure cuts the sphincter muscle to allow the esophagus to open. Esophagomyotomy is becoming more popular with the development of techniques allowing very small abdominal incisions.
- Drug therapy. Nifedipine, a calcium-channel blocker, reduces muscle contraction. Taken daily, this drug provides relief for about two-thirds of patients for as long as two years.

Prognosis

Most patients with achalasia can be treated effectively. Achalasia does not reduce life expectancy unless esophageal carcinoma develops.

Prevention

There is no known way to prevent achalasia.

Resources

BOOKS

Greenberger, Norton, Richard Blumberg, and Robert Burakoff. *Current Diagnosis & Treatment in Gastroenterology, Hepatology, & Endoscopy*. New York: McGraw–Hill Medical, 2009.

Richard Robinson

Achondroplasia

Definition

Achondroplasia is the most common cause of dwarfism, or significantly abnormal short stature.

Description

Achondroplasia is one of a number of chondodystrophies, in which the development of cartilage, and therefore, bone is disturbed. The disorder appears in approximately one in every 10,000 births. Achondroplasia is usually diagnosed at birth, owing to the characteristic appearance of the newborn.

Normal bone growth depends on the production of cartilage (a fibrous connective tissue). Over time, **calcium** is deposited within the cartilage, causing it to harden and become bone. In achondroplasia, abnormalities of this process prevent the bones (especially those in the limbs) from growing as long as they normally should, at the same time allowing the bones to become abnormally thickened. The bones in the trunk of the body and the skull are mostly not affected, although the opening from the skull through which the spinal cord passes (foramen magnum) is often narrower than normal, and the opening (spinal canal) through which the spinal cord runs in the back

An x-ray image of an achondroplastic person's head and chest. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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KEY TERMS

Cartilage—A flexible, fibrous type of connective tissue which serves as a base on which bone is built.

Foramen magnum—The opening at the base of the skull, through which the spinal cord and the brainstem pass.

Hydrocephalus—An abnormal accumulation of fluid within the brain. This accumulation can be destructive by pressing on brain structures and damaging them.

Mutation—A new, permanent change in the structure of a gene, which can result in abnormal structure or function somewhere in the body.

Spinal canal—The opening that runs through the center of the column of spinal bones (vertebrae), and through which the spinal cord passes.

Vertebrae—The individual bones of the spinal column which are stacked on top of each other. There is a hole in the center of each bone, through which the spinal cord passes.

bones (vertebrae) becomes increasingly and abnormally small down the length of the spine.

Causes and symptoms

Achondroplasia is caused by a genetic defect. It is a dominant trait, meaning that anybody with the genetic defect will display all the symptoms of the disorder. A parent with the disorder has a 50% chance of passing it on to the offspring. Although achondroplasia can be passed on to subsequent offspring, the majority of cases occur due to a new mutation (change) in a gene. Interestingly enough, the defect seen in achondroplasia is one of only a few defects known to increase in frequency with increasing age of the father (many genetic defects are linked to increased age of the mother).

People with achondroplasia have abnormally short arms and legs. Their trunk is usually of normal size, as is their head. The appearance of short limbs and normal head size actually makes the head appear to be oversized. The bridge of the nose often has a scooped out appearance termed "saddle nose." The lower back has an abnormal curvature, or sway back. The face often displays an overly prominent forehead, and a relative lack of development of the face in the area of the upper jaw. Because the foramen magnum and spinal canal are abnormally narrowed, nerve damage may occur if the spinal cord or nerves become compressed. The narrowed foramen magnum may disrupt the normal flow of fluid between the brain and the spinal cord, resulting in the accumulation of too much fluid in the brain (**hydrocephalus**). Children with achondroplasia have a very high risk of serious and repeated middle ear infections, which can result in **hearing loss**. The disease does not affect either mental capacity, or reproductive ability.

Diagnosis

Diagnosis is often made at birth due to the characteristically short limbs, and the appearance of a large head. X-ray examination will reveal a characteristic appearance to the bones, with the bones of the limbs appearing short in length, yet broad in width. A number of measurements of the bones in x-ray images will reveal abnormal proportions.

Treatment

No treatment will reverse the defect present in achondroplasia. All patients with the disease will be short, with abnormally proportioned limbs, trunk, and head. Treatment of achondroplasia primarily addresses some of the complications of the disorder, including problems due to nerve compression, hydrocephalus, bowed legs, and abnormal curves in the spine. Children with achondroplasia who develop middle ear infections (acute **otitis media**) will require quick treatment with **antibiotics** and careful monitoring in order to avoid hearing loss.

Prognosis

Achondroplasia is a disease that causes considerable deformity. However, with careful attention paid to the development of dangerous complications (nerve compression, hydrocephalus), most people are in good health, and can live a normal lifespan.

Prevention

The only form of prevention is through **genetic counseling**, which could help parents assess their risk of having a child with achondroplasia.

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Resources

BOOKS

Achondroplasia – A Medical Dictionary, Bibliography, and Annotated Research Guide to Internet References. 2nd ed. San Diego, CA: ICON, 2009.

ORGANIZATIONS

Little People of America, Inc., 250 El Camino Real, Suite 201, Tustin, CA, 92780, (714) 368-3689, (714) 368-3367, (888) LPA-2001 (572-2001), http://www. lpaonline.org.

Rosalyn Carson-DeWitt MD

Achromatopsia *see* **Color blindness**

Acid indigestion *see* **Heartburn**

Acid phosphatase test

Definition

Acid phosphatase is an enzyme found throughout the body, but primarily in the prostate gland. Like all enzymes, it is needed to trigger specific chemical reactions. Acid phosphatase testing is done to diagnose whether **prostate cancer** has spread to other parts of the body (metastasized), and to check the effectiveness of treatment. The test has been largely supplanted by the prostate specific antigen test (PSA).

Purpose

The male prostate gland has 100 times more acid phosphatase than any other body tissue. When prostate **cancer** spreads to other parts of the body, acid phosphatase levels rise, particularly if the cancer spreads to the bone. One-half to three-fourths of persons who have metastasized prostate cancer have high acid phosphatase levels. Levels fall after the tumor is removed or reduced through treatment.

Tissues other than prostate have small amounts of acid phosphatase, including bone, liver, spleen, kidney, and red blood cells and platelets. Damage to these tissues causes a moderate increase in acid phosphatase levels.

Acid phosphatase is very concentrated in semen. **Rape** investigations will often include testing for the presence of acid phosphatase in vaginal fluid.

KEY TERMS

Enzyme—A substance needed to trigger specific chemical reactions.

Metastasize—Spread to other parts of the body; usually refers to cancer.

Prostate gland—A gland of the male reproductive system.

Precautions

This is not a screening test for prostate cancer. Acid phosphatase levels rise only after prostate cancer has metastasized.

Description

Laboratory testing measures the amount of acid phosphatase in a person's blood, and can determine from what tissue the enzyme is coming. For example, it is important to know if the increased acid phosphatase is from the prostate or red blood cells. Acid phosphatase from the prostate, called prostatic acid phosphatase (PAP), is the most medically significant type of acid phosphatase.

Subtle differences between prostatic acid phosphatase and acid phosphatases from other tissues cause them to react differently in the laboratory when mixed with certain chemicals. For example, adding the chemical tartrate to the test mixture inhibits the activity of prostatic acid phosphatase but not red blood cell acid phosphatase. Laboratory test methods based on these differences reveal how much of a person's total acid phosphatase is derived from the prostate. Results are usually available the next day.

Preparation

This test requires drawing about 5–10 mL of blood. The patient should not have a rectal exam or prostate massage for two to three days prior to the test.

Aftercare

Discomfort or bruising may occur at the puncture site, and the person may feel dizzy or faint. Applying pressure to the puncture site until the bleeding stops will reduce bruising. Warm packs on the puncture site will relieve discomfort.

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Normal results

Normal results vary based on the laboratory and the method used.

Abnormal results

The highest levels of acid phosphatase are found in metastasized prostate cancer. Diseases of the bone, such as Paget's disease or **hyperparathyroidism**; diseases of blood cells, such as **sickle cell disease** or **multiple myeloma**; or lysosomal disorders, such as Gaucher's disease, will show moderately increased levels.

Certain medications can cause temporary increases or decreases in acid phosphatase levels. Manipulation of the prostate gland through massage, biopsy, or rectal exam before a test can increase the level.

Resources

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Nancy J. Nordenson

Acid reflux *see* **Gastroesophageal reflux disease**

Acidosis *see* **Respiratory acidosis; Renal tubular acidosis; Metabolic acidosis**

Acne

Definition

Acne is a common skin condition characterized by pimples on the face, chest, and back. It occurs when the pores of the skin become clogged with oil, dead skin cells, and bacteria.

Demographics

Acne vulgaris, or common acne, is the most prevalent of all skin diseases. It affects nearly 17 million people in the United States. Nearly 85% of young people develop acne at some time between the ages of 12 and 25 years. It usually begins at **puberty** and worsens during adolescence, occurring most often between the ages of 14 and 18. However, acne can arise at any age, including in newborns and older adults. It is more common and often more severe in males than in females. Although acne usually resolves on its own during early adulthood, some people continue to have acne outbreaks well into adulthood.

Description

Acne originates in the oil or sebaceous glands that lie just beneath the surface of the skin, within the hair follicles. These glands produce an oil called sebum—the skin's natural moisturizer—which also helps preserve the flexibility of the hair. These sebaceous follicles open onto the skin through pores, allowing the sebum to reach the hair and skin surface. The most common sites of acne are the face, chest,

Acne vulgaris affecting a woman's face. Acne is the general name given to a skin disorder in which the sebaceous glands become inflamed. *(© Biophoto Associates/Photo Researchers, Inc.)*

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KEY TERMS

Androgens—Male sex hormones that are linked to the development of acne.

Anti-androgens—Drugs that inhibit the production of androgens.

Antibiotics—Medications that kill bacteria.

Comedo, comedone—A hard plug composed of sebum and dead skin cells.

Comedolytic—A drug that breaks up comedones and opens clogged pores.

Corticosteroids—A group of hormones produced by the adrenal glands with various functions, including regulation of fluid balance, androgen activity, and reaction to inflammation.

Estrogens—Hormones produced by the ovaries, the female sex glands.

Follicles—Structures in the skin containing oil glands and hair; the source of pimples.

Isotretinoin—A drug for severe acne that decreases sebum production and dries up pimples.

Papule—An inflamed pimple near the surface of the skin.

Propionibacterium acnes—Skin bacteria that infect sebaceous follicles, causing acne.

Pustule—A pus-filled pimple.

Sebaceous follicles—Structures in the skin that contain oil-producing glands and hair follicles and which give rise acne.

Sebum—An oily skin moisturizer produced by sebaceous glands.

Tretinoin—A naturally occurring retinoid, derived from vitamin A, that treats acne by increasing the turnover (death and replacement) of skin cells.

shoulders, and back since these have the most sebaceous follicles.

At puberty increased levels of androgens (male hormones) cause the sebaceous glands to overproduce sebum. The excess sebum cannot be cleared from the pores efficiently. In addition, cells lining the follicle are shed too quickly and the dead cells clump together. When the excess sebum combines with the dead, sticky skin cells, a hard plug—called a comedo—forms and blocks the pore. There are two types of comedones in mild noninflammatory acne: whiteheads and blackheads. When the plugged follicle begins to bulge as a small whitish bump mostly under the skin, it is called a whitehead. If the comedo opens up, the top surface of the plug darkens as it is exposed to the air and it is referred to as a blackhead.

Moderate and severe inflammatory acnes result from infection of plugged follicles with *Propionibacterium acnes*, bacteria that normally live on the skin. Other microorganisms can also be involved. The bacteria produce chemicals and enzymes that cause inflammation. Pimples form when infected whiteheads or blackheads weaken and burst, releasing sebum, bacteria, and skin and white blood cells into the surrounding tissues. Inflamed pimples near the skin surface are called papules. Deeper pimples that fill with pus are called pustules. The most severe type of acne occurs when the infected follicles continue to enlarge without rupturing, forming nodules and cysts. Cysts are closed sacs that form lumps under the skin. Nodules are large hard swellings deep within the skin. Cysts and nodules can be painful and scarring can occur when new skin cells are laid down to replace damaged cells.

Acne is not a serious health threat. However, it can negatively affect appearance and has the potential of causing permanent scarring. Some people, especially teenagers, become quite upset about their acne and this distress can contribute to social or psychological problems.

Risk factors

Risk factors for acne include:

- Age. Teenagers are most susceptible to acne because of hormonal changes.
- Gender. Acne is more common in boys than in girls and boys tend to have more severe cases.
- Heredity. Acne runs in families.
- Hormonal changes in females. Acne can flare up right before menstruation, when levels of estrogen (female hormones that reduce oil production) drop, and during pregnancy and menopause.
- Disease. Hormonal disorders can complicate acne in girls.

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- Personal hygiene. Abrasive soaps, hard scrubbing, or picking at pimples will worsen acne.
- Cosmetics. Oil-based makeup and sunscreen—which clog pores—and hairsprays can aggravate acne.
- Environment. Exposure to oils and grease, polluted air, and sweating in hot weather aggravate acne.
- Diet. Although foods do not cause acne, certain foods may cause flare-ups or worsen the condition.
- Drugs. Acne can be a side effect of drugs including tranquilizers, antidepressants, antibiotics, oral contraceptives, and steroid drugs, including anabolic steroids, which are chemically similar to the male hormone testosterone.
- Stress. Emotional stress may contribute to acne.
- Friction. Continual pressure or rubbing of the skin—for example by bicycle helmets, backpacks, or tight clothing—can worsen acne.

Causes and symptoms

The exact cause of most cases of acne is unknown. Contrary to popular myth, acne is not caused or aggravated by dirt, by eating greasy foods or chocolate, or by sexual activity. Many factors, including heredity, can contribute to the development of acne. The interactions between the body's hormones, skin proteins and secretions, and bacteria determine the course of acne.

Excess male hormone production in women can cause acne. Flare-ups of acne are also influenced by a woman's menstrual cycle. One study found that women over age 33 actually had a higher incidence of premenstrual acne than teenage girls.

Some alternative medical practitioners assert that acne is often related to toxicity in the intestines or liver due to:

- the presence of bacteria such as *Clostridia spp*. and *Yersinia enterocolitica*
- a low-fiber diet
- a deficiency in healthy gut flora such as *Lactobacillus spp*.
- an intestinal overgrowth of the yeast *Candida albicans*
- food allergies

In teenagers acne often occurs on the forehead, nose, and chin. As people age the condition tends to appear towards the outer part of the face. Adult women may have acne on their chins and around their mouths. The elderly often develop whiteheads and blackheads on the upper cheeks and skin around the eyes.

Although acne is usually a superficial condition, inflamed lesions may cause tenderness, **itching**, **pain**, or swelling. The most troubling aspects of these lesions are their negative effect on appearance and the potential for scarring. Some people, especially teenagers who may be particularly self-conscious, are emotionally distressed by their acne, leading to difficulties with school, employment, or relationships.

Diagnosis

Examination

Acne has a characteristic appearance and is not difficult to diagnose. The doctor takes a complete medical history, including questions about skin care, diet, factors that seem to improve or exacerbate the condition, medication use, and prior treatment. A **physical examination** includes the face, upper neck, chest, shoulders, back, and other affected areas. Under good lighting the doctor determines the number and types of blemishes, whether they are inflamed, whether they are deep or superficial, and whether there is skin discoloration or scarring.

Tests

Laboratory tests are not performed unless the acne appears to be caused by a hormonal disorder or other underlying medical problem. In these cases, blood analyses or other tests may be ordered. Stool tests can be helpful in determining whether there is a bacterial or yeast overgrowth contributing to the condition. Food-allergy testing may also be considered. Most insurance plans cover the costs of diagnosing and treating acne.

Treatment

Traditional

Acne cannot be cured, but it can be controlled. The goal of acne treatment is to reduce sebum and keratin production, remove dead skin cells to help unclog the pores, and kill bacteria with topical drugs and oral medications. Treatment choice depends upon whether the acne is mild, moderate, or severe. Severe cases are referred to a dermatologist or an endocrinologist who treats diseases of the glands and the hormones. Most dermatologists use a combination of treatments, depending on the individual. Counseling may be necessary to clear up misconceptions about the condition and to offer support regarding the negative effect of acne on physical appearance.

In addition to medications, treatments for severe acne or the resulting **scars** include:

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- Comedone extraction. The comedo is removed from the pore with a special tool.
- Chemical peels. Glycolic acid is applied to peel off the top layer of skin to reduce scarring.
- Dermabrasion. The affected skin is frozen with a chemical spray and removed by brushing or planing.
- Punch grafting. Deep scars are excised and the area repaired with small skin grafts.
- Intralesional injection. Corticosteroids are injected directly into inflamed cysts.
- Collagen injection. Shallow scars are elevated by collagen protein injections.
- Laser treatments. There are two types of laser treatments for removing acne scars.

Drugs

Mild non-inflammatory acne is usually treated with topical over-the-counter acne medications that reduce the formation of new comedones. These may contain:

- benzoyl peroxide (Clearasil, Fostex)
- salicylic acid (Stridex)
- sulfur (Therac lotion)
- resorcinol (Acnomel cream)

Treatment with stronger topical medications requires a doctor's prescription. Such medications include comedolytics, which are agents that loosen hard plugs and open pores. These include concentrated formulas of salicylic acid, resorcinol, and sulfur. They also include topical retinoids—natural or synthetic vitamin A derivatives—which increase turnover (**death** and replacement) of skin cells. Topical retinoids are considered a cornerstone of acne treatment:

- adapalene (Differin)
- tretinoin (Retin-A, Avita, Renova Emollient)
- tazarotene (Tazorac)

Topical antibiotics to kill bacteria may be added to the treatment regimen if inflammation is present. These include:

- erythromycin
- clindamycin (Cleocin-T)
- meclocycline (Meclan)
- sodium sulfacetamide

Topical medications that act as both comedolytics and **antibiotics** include:

- benzoyl peroxide
- azelaic acid (Azelex), a naturally occurring skin substance
- benzoyl peroxide plus erythromycin (Benzamycin)

Topical medications are available as creams, gels, lotions, soaps, or pads of varying strengths. The medications are applied to the entire affected skin area once or twice per day after washing with mild soap. Possible side effects include mild redness, peeling, irritation, dryness, and an increased sensitivity to sunlight that requires the use of a sunscreen. Medications may be used for months or years to control acne.

The goal of treating moderate acne is to decrease inflammation as well as prevent new comedone formation. Common treatments are topical tretinoin combined with a topical or oral antibiotic or topical benzoyl peroxide and erythromycin. The treatment is maintained for at least two to four months.

When acne is severe and the lesions are deep, oral antibiotics may be taken daily to reduce the spread of bacteria:

- tetracycline, which is the most common antibiotic for treating acne but which should not be taken while pregnant or breastfeeding
- erythromycin
- minocycline, which may have fewer side effects than other antibiotics
- doxycycline for inflammatory acne

Antibiotics must be used for up to three months to affect severe acne. They can cause side effects including:

- dizziness
- photosensitivity
- gastrointestinal upset
- skin darkening
- allergic reactions
- yeast infections
- tooth discoloration
- folliculitis

Oral isotretinoin (Accutane) reduces sebum production and cell stickiness. It is reserved for the treatment of very severe acne with cysts and nodules or if antibiotic therapy is unsuccessful. Isotretinoin is sometimes used in combination with topical or oral antibiotics. Treatment may continue for four to five months and may be repeated or replaced with topical drugs or oral antibiotics if the acne returns. Lower dosages require a longer course of therapy.

Women who might become pregnant should use isotretinoin with extreme caution, since it can cause **birth defects** and **miscarriage** up to a month after stopping the medication. Strict attention should be

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paid to **pregnancy** tests and contraceptive requirements for women of childbearing age who take this medication.

Side effects of isotretinoin are very common and may include:

- temporary worsening of the acne
- dry eyes, lips, skin, and genital mucosa
- nosebleeds
- vision disorders
- elevated liver enzymes, blood fats, and cholesterol

Monthly blood tests are necessary to ensure that the medication is not causing serious harm.

Anti-androgens—drugs that inhibit androgen production—and estrogens (female hormones) are used to treat women whose acne is unresponsive to other therapies. Certain types of **oral contraceptives**, such as norgestimate/ethinyl estradiol (Ortho-Tri-Cyclen), have been shown to improve acne. Both ultra-low-dose birth-control pills (Alesse) and those with higher doses of estrogen can be effective in treating acne.

Other drugs, such as spironolactone and oral **corticosteroids** or anti-inflammatory drugs, may be used to reduce hormone activity in the adrenal glands, thereby reducing production of sebum. This is the treatment of choice for an extremely severe but rare type of inflammatory acne called *acne fulminans*, which primarily affects adolescent males. *Acne conglobata* is a more common form of severe inflammation characterized by numerous, deep, inflammatory nodules that heal with scarring. It is treated with oral isotretinoin and corticosteroids.

Alternative

In addition to proper cleansing to keep the skin free of oil, alternative treatments for acne include:

- a well-balanced diet high in fiber, zinc, and raw foods
- intermittent fasting
- an elimination diet with the avoidance of alcohol, dairy products, caffeine, sugar, processed foods, and foods high in iodine, which appear to contribute to acne
- avoidance of smoking

Nutritional supplements for treating acne include:

- essential fatty acids
- vitamin B complex
- vitamin A or beta-carotene
- zinc
- chromium

Supplementation with herbs that are blood cleansers or blood purifiers, strengthen the action of the liver and the kidneys, and help with **detoxification** and excretion are used to treat acne. These include:

- dandelion (*Taraxacum officinale*) root tincture
- burdock root (*Arctium lappa*), also known as gobo, which can be purchased fresh at health-food grocers or in Asian markets and can be used raw or cooked in salads, stir fries, or other vegetable dishes or as a tincture
- red clover (*Trifolium pratense*), which can be consumed as a tea throughout the day
- milk thistle (*Silybum marianum*) seed which can be taken as a tincture or ground up and eaten in combination with hot cereal, granola, or other foods

Other herbs useful in the treatment of acne include:

- *Echinacea spp*.
- goldenseal (*Hydrastis canadensis*), which is particularly helpful for clearing up underlying intestinal toxicity and killing bacteria
- traditional Chinese herbal remedies such as cnidium seed (*Cnidium monnieri*) and honeysuckle flower (*Lonicera japonica*) Wholistic physicians or nutritionists can recommend the proper amounts of these herbs.

Bowel toxicity may contribute to acne flare-ups. *Lactobacillus acidophilus* and *Lactobacillus bulgaricus* can be obtained from yogurt or as capsules to maintain a healthy balance of intestinal flora. Allergic foods should be identified and removed from the diet. Dietary fiber, such as oat and wheat bran, beans, fruits and vegetables and their skins, and psyllium seed, should be increased. The fiber absorbs toxins and carries them through the colon for excretion.

Individuals with acne may want to participate in a **movement therapy**, such as **yoga** or t'ai chi, or begin an **exercise** regimen. **Stress reduction** or **meditation** can also be helpful.

Home remedies

Washing the acne-affected area with a mild germicidal soap and an abrasive sponge can help dislodge the material plugging the gland. However manipulating or squeezing acne pustules can cause deep and permanent scarring.

Prognosis

Acne is not curable, but it can be controlled by proper treatment. Improvement takes time and the

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results of specific treatments vary with the individual. Over-the-counter treatments for mild non-inflammatory acne can help prevent new blemishes, although it often takes 8–10 weeks to see improvement, as old blemishes take time heal. Inflammatory acne that is treated with a topical comedolytic in combination with an antibiotic usually improves within four to six weeks. Acne tends to reappear when treatment stops, but spontaneously improves over time. Inflammatory acne can leave scars that require further treatment.

Oral isotretinoin clears up resistant cysts and nodules in up to 90% of patients and prevents scarring. Long-term control is achieved in up to 60% of patients treated for four to five months. Another 20% of patients require a second course of isotretinoin and the final 20% may require only topical drugs or oral antibiotics. Improvement with anti-androgens may take up to four months.

Prevention

There is no sure way to prevent acne, but the following steps may help minimize flare-ups:

- washing affected areas gently with lukewarm water twice every day, using just the fingertips and a mild soap containing sulfur, *Calendula officinalis*, or other substances that are useful against acne
- washing gently after sweating
- waiting 5–15 minutes after washing to apply acne medication
- avoiding abrasive soaps, facial scrubs, toners, astringents, and masks, which can irritate the skin and cause breakouts
- limiting use of makeup and moisturizers; applying any medications before applying makeup
- using only skin and hair products that are labeled "oil-free," "nonacnegenic," or "noncomedogenic," meaning that they do not clog pores
- shampooing often and wearing hair up and away from the face
- eating a healthy well-balanced diet of fresh fruits and vegetables
- avoiding foods that trigger flare-ups
- exposing the affected skin to sunlight on a limited basis, unless otherwise advised
- avoiding the handling of affected areas or picking or squeezing pimples, as this can contribute to scarring and spread the acne
- reducing stress

Resources

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ORGANIZATIONS

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Acne rosacea *see* **Rosacea**

Acoustic neurinoma *see* **Acoustic neuroma**

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Acoustic neuroma

Definition

An acoustic neuroma is a benign tumor involving cells of the myelin sheath that surrounds the vestibulocochlear nerve (eighth cranial nerve).

Description

The vestibulocochlear nerve extends from the inner ear to the brain and is made up of a vestibular branch, often called the vestibular nerve, and a cochlear branch, called the cochlear nerve. The vestibular and cochlear nerves lie next to one another. They also run along side other cranial nerves. People possess two of each type of vestibulocochlear nerve, one that extends from the left ear and one that extends from the right ear.

The vestibular nerve transmits information concerning balance from the inner ear to the brain and the cochlear nerve transmits information about hearing. The vestibular nerve, like many nerves, is surrounded by a cover called a myelin sheath. A tumor, called a schwannoma, can sometimes develop from the cells of the myelin sheath. A tumor is an abnormal growth of tissue that results from the uncontrolled growth of cells. Acoustic neuromas are often called vestibular schwannomas because they are tumors that arise from the myelin sheath that surrounds the vestibular nerve. Acoustic neuromas are considered benign (noncancerous) tumors since they do not spread to other parts of the body. They can occur anywhere along the vestibular nerve but are most likely to occur where the vestibulocochlear nerve passes through the tiny bony canal that connects the brain and the inner ear.

An acoustic neuroma can arise from the left vestibular nerve or the right vestibular nerve. A unilateral tumor is a tumor arising from one nerve and a bilateral tumor arises from both vestibular nerves. Unilateral acoustic neuromas usually occur spontaneously (by chance). Bilateral acoustic neuromas occur as part of a hereditary condition called **Neurofibromatosis** Type 2 (NF2). A person with NF2 has inherited a predisposition for developing acoustic neuromas and other tumors of the nerve cells.

Acoustic neuromas usually grow slowly and can take years to develop. Some acoustic neuromas remain so small that they do not cause any symptoms. As the acoustic neuroma grows it can interfere with the functioning of the vestibular nerve and can cause vertigo and balance difficulties. If the acoustic nerve grows large enough to press against the cochlear nerve, then **hearing loss** and a ringing (**tinnitus**) in the affected ear will usually occur. If untreated and the acoustic neuroma continues to grow it can press against other nerves in the region and cause other symptoms. This tumor can be life threatening if it becomes large enough to press against and interfere with the functioning of the brain.

Causes and symptoms

Causes

An acoustic neuroma is caused by a change or absence of both of the NF2 tumor suppressor genes in a nerve cell. Every person possesses a pair of NF2 genes in every cell of their body including their nerve cells. One NF2 gene is inherited from the egg cell of the mother and one NF2 gene is inherited from the sperm cell of the father. The NF2 gene is responsible for helping to prevent the formation of tumors in the nerve cells. In particular the NF2 gene helps to prevent acoustic neuromas.

Only one unchanged and functioning NF2 gene is necessary to prevent the formation of an acoustic neuroma. If both NF2 genes become changed or missing in one of the myelin sheath cells of the vestibular nerve then an acoustic neuroma will usually develop. Most unilateral acoustic neuromas result when the NF2 genes become spontaneously changed or missing. Someone with a unilateral acoustic neuroma that has developed spontaneously is not at increased risk for having children with an acoustic neuroma. Some unilateral acoustic neuromas result from the hereditary condition NF2. It is also possible that some unilateral acoustic neuromas may be caused by changes in other genes responsible for preventing the formation of tumors.

Bilateral acoustic neuromas result when someone is affected with the hereditary condition NF2. A person with NF2 is typically born with one unchanged and one changed or missing NF2 gene in every cell of their body. Sometimes they inherit this change from their mother or father. Sometimes the change occurs spontaneously when the egg and sperm come together to form the first cell of the baby. The children of a person with NF2 have a 50% chance of inheriting the changed or missing NF2 gene.

A person with NF2 will develop an acoustic neuroma if the remaining unchanged NF2 gene becomes spontaneously changed or missing in one of the myelin sheath cells of their vestibular nerve. People with NF2 often develop acoustic neuromas at a younger age. The mean age of onset of acoustic neuroma in NF2 is 31 years of age versus 50 years of age for sporadic acoustic neuromas. Not all people with NF2, however, develop acoustic neuromas. People with NF2 are at

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KEY TERMS

Benign tumor—A localized overgrowth of cells that does not spread to other parts of the body.

Chromosome—A microscopic structure, made of a complex of proteins and DNA, that is found within each cell of the body.

Computed tomography (CT)—An examination that uses a computer to compile and analyze the images produced by x rays projected at a particular part of the body.

Cranial nerves—The set of twelve nerves found on each side of the head and neck that control the sensory and muscle functions of a number of organs such as the eyes, nose, tongue face and throat.

DNA testing—Testing for a change or changes in a gene or genes.

Gene— A building block of inheritance, made up of a compound called DNA (deoxyribonucleic acid) and containing the instructions for the production of a particular protein. Each gene is found on a specific location on a chromosome.

Magnetic resonance imaging (MRI)—A test that uses an external magnetic field instead of x rays to visualize different tissues of the body.

Myelin sheath—The cover that surrounds many nerve cells and helps to increase the speed by which information travels along the nerve.

Neurofibromatosis type 2 (NF2)—A hereditary condition associated with an increased risk of bilateral acoustic neuromas, other nerve cell tumors and cataracts.

Protein— A substance produced by a gene that is involved in creating the traits of the human body such as hair and eye color or is involved in controlling the basic functions of the human body.

Schwannoma—A tumor derived from the cells of the myelin sheath that surrounds many nerve cells.

Tinnitus—A ringing sound or other noise in the ear.

Vertigo—A feeling of spinning or whirling.

Vestibulocochlear nerve (Eighth cranial nerve)—Nerve that transmits information, about hearing and balance from the ear to the brain.

increased risk for developing **cataracts** and tumors in other nerve cells.

Most people with a unilateral acoustic neuroma are not affected with NF2. Some people with NF2, however, only develop a tumor in one of the vestibulocochlear nerves. Others may initially be diagnosed with a unilateral tumor but may develop a tumor in the other nerve a number of years later. NF2 should be considered in someone under the age of 40 who has a unilateral acoustic neuroma. Someone with a unilateral acoustic neuroma and other family members diagnosed with NF2 probably is affected with NF2. Someone with a unilateral acoustic neuroma and other symptoms of NF2 such as cataracts and other tumors may also be affected with NF2. On the other hand, someone over the age of 50 with a unilateral acoustic neuroma, no other tumors and no family history of NF2 is very unlikely to be affected with NF2.

Recent studies in Europe have suggested a possible connection between the widespread use of mobile phones and an increased risk of developing acoustic neuromas. Some observers, however, question whether mobile phones have been in use long enough to be an identifiable risk factor.

Symptoms

Small acoustic neuromas usually only interfere with the functioning of the vestibulocochlear nerve. The most common first symptom of an acoustic neuroma is hearing loss, which is often accompanied by a ringing sound (tinnitis). People with acoustic neuromas sometimes report difficulties in using the phone and difficulties in perceiving the tone of a musical instrument or sound even when their hearing appears to be otherwise normal. In most cases the hearing loss is initially subtle and worsens gradually over time until deafness occurs in the affected ear. In approximately 10% of cases the hearing loss is sudden and severe.

Acoustic neuromas can also affect the functioning of the vestibular branch of the vestibulocochlear nerve and can cause vertigo and dysequilibrium. Twenty percent of small tumors are associated with periodic vertigo, which is characterized by **dizziness** or a whirling sensation. Larger acoustic neuromas are less likely to cause vertigo but more likely to cause dysequilibrium. Dysequilibrium, which is characterized by minor clumsiness and a general feeling of instability, occurs in nearly 50% of people with an acoustic neuroma.

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As the tumor grows larger it can press on the surrounding cranial nerves. Compression of the fifth cranial nerve can result in facial **pain** and or **numbness**. Compression of the seventh cranial nerve can cause spasms, weakness or **paralysis** of the facial muscles. Double vision is a rare symptom but can result when the 6th cranial nerve is affected. Swallowing and/or speaking difficulties can occur if the tumor presses against the 9th, 10th, or 12th cranial nerves.

If left untreated, the tumor can become large enough to press against and affect the functioning of the brain stem. The brain stem is the stalk like portion of the brain that joins the spinal cord to the cerebrum, the thinking and reasoning part of the brain. Different parts of the brainstem have different functions such as the control of breathing and muscle coordination. Large tumors that impact the brain stem can result in headaches, walking difficulties (gait ataxia) and involuntary shaking movements of the muscles (**tremors**). In rare cases when an acoustic neuroma remains undiagnosed and untreated it can cause **nausea**, **vomiting**, lethargy and eventually **coma**, respiratory difficulties and **death**. In the vast majority of cases, however, the tumor is discovered and treated long before it is large enough to cause such serious manifestations.

Diagnosis

Anyone with symptoms of hearing loss should undergo hearing evaluations. Pure tone and speech **audiometry** are two screening tests that are often used to evaluate hearing. Pure tone audiometry tests to see how well someone can hear tones of different volume and pitch and speech audiometry tests to see how well someone can hear and recognize speech. An acoustic neuroma is suspected in someone with unilateral hearing loss or hearing loss that is less severe in one ear than the other ear (asymmetrical).

Sometimes an auditory brainstem response (ABR, BAER) test is performed to help establish whether someone is likely to have an acoustic neuroma. During the ABR examination, a harmless electrical impulse is passed from the inner ear to the brainstem. An acoustic neuroma can interfere with the passage of this electrical impulse and this interference can sometimes be identified through the ABR evaluation. A normal ABR examination does not rule out the possibility of an acoustic neuroma. An abnormal ABR examination increases the likelihood that an acoustic neuroma is present but other tests are necessary to confirm the presence of a tumor.

If an acoustic neuroma is strongly suspected then **magnetic resonance imaging** (MRI) is usually performed. The MRI is a very accurate evaluation that is able to detect nearly 100% of acoustic neuromas. Computerized tomography (CT scan, CAT scan) is unable to identify smaller tumors; but it can be used when an acoustic neuroma is suspected and an MRI evaluation cannot be performed.

Once an acoustic neuroma is diagnosed, an evaluation by genetic specialists such as a geneticist and genetic counselor may be recommended. The purpose of this evaluation is to obtain a detailed family history and check for signs of NF2. If NF2 is strongly suspected then DNA testing may be recommended. DNA testing involves checking the blood cells obtained from a routine blood draw for the common gene changes associated with NF2.

Treatment

The three treatment options for acoustic neuroma are surgery, radiation, and observation. The physician and patient should discuss the pros and cons of the different options prior to making a decision about treatment. The patient's, physical health, age, symptoms, tumor size, and tumor location should be considered.

Microsurgery

The surgical removal of the tumor or tumors is the most common treatment for acoustic neuroma. In most cases the entire tumor is removed during the surgery. If the tumor is large and causing significant symptoms, yet there is a need to preserve hearing in that ear, then only part of the tumor may be removed. During the procedure the tumor is removed under microscopic guidance and general anesthetic. Monitoring of the neighboring cranial nerves is done during the procedure so that damage to these nerves can be prevented. If preservation of hearing is a possibility, then monitoring of hearing will also take place during the surgery.

Most people stay in the hospital four to seven days following the surgery. Total recovery usually takes four to six weeks. Most people experience **fatigue** and head discomfort following the surgery. Problems with balance and head and neck stiffness are also common. The mortality rate of this type of surgery is less than 2% at most major centers. Approximately 20% of patients experience some degree of post-surgical complications. In most cases these complications can be managed successfully and do not result in long term medical problems. Surgery brings with it a risk of **stroke**, damage to the brain stem, infection, leakage of spinal fluid and damage to the cranial nerves. Hearing loss and/or tinnitis often result from the surgery. A follow-up MRI is recommended one to

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five years following the surgery because of possible regrowth of the tumor.

Stereotactic radiation therapy

During stereotactic **radiation therapy**, also called radiosurgery or radiotherapy, many small beams of radiation are aimed directly at the acoustic neuroma. The radiation is administered in a single large dose, under local anesthetic and is performed on an outpatient basis. This results in a high dose of radiation to the tumor but little radiation exposure to the surrounding area. This treatment approach is limited to small or medium tumors. The goal of the surgery is to cause tumor shrinkage or at least limit the growth of the tumor. The long-term efficacy and risks of this treatment approach are not known; however, more and more patients diagnosed with acoustic neuromas are choosing this form of therapy. Periodic MRI monitoring throughout the life of the patient is therefore recommended.

Radiation therapy can cause hearing loss, which can sometimes occur even years later. Radiation therapy can also cause damage to neighboring cranial nerves, which can result in symptoms such as numbness, pain or paralysis of the facial muscles. In many cases these symptoms are temporary. Radiation treatment can also induce the formation of other benign or malignant schwannomas. This type of treatment may therefore be contraindicated in the treatment of acoustic neuromas in those with NF2 who are predisposed to developing schwannomas and other tumors.

Observation

Acoustic neuromas are usually slow growing and in some cases they will stop growing and even become smaller or disappear entirely. It may therefore be appropriate in some cases to hold off on treatment and to periodically monitor the tumor through MRI evaluations. Long-term observation may be appropriate, for example, in an elderly person with a small acoustic neuroma and few symptoms. Periodic observation may also be indicated for someone with a small and asymptomatic acoustic neuroma that was detected through an evaluation for another medical problem. Observation may also be suggested for someone with an acoustic neuroma in the only hearing ear or in the ear that has better hearing. The danger of an observational approach is that as the tumor grows larger it can become more difficult to treat.

Prognosis

The prognosis for someone with a unilateral acoustic neuroma is usually quite good provided the tumor is diagnosed early and appropriate treatment is instituted. Long term-hearing loss and tinnitis in the affected ear are common, even if appropriate treatment is provided. Many patients also experience facial weakness, balance problems, and headaches. Regrowth of the tumor is also a possibility following surgery or radiation therapy and repeat treatment may be necessary. The prognosis can be poorer for those with NF2 who have an increased risk of bilateral acoustic neuromas and other tumors.

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ORGANIZATIONS

Acoustic Neuroma Association, 600 Peachtree Pkwy, Suite 108, Cumming, GA, (770) 205-8211, (770) 205-0239, http://anausa.org.

Acoustic Neuroma Association of Canada, 6192 Main Street, Ottawa, Canada, ON, K1S 1C2, (800) 561-2622, info@anac.ca, http://www.anac.ca.

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Acquired hypogammaglobulinemia *see* **Common variable immunodeficiency**

Acquired immunodeficiency syndrome *see* **AIDS**

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Acrocyanosis

Definition

Acrocyanosis is a decrease in the amount of oxygen delivered to the extremities. The hands and feet turn blue because of the lack of oxygen. Decreased blood supply to the affected areas is caused by constriction or spasm of small blood vessels.

Description

Acrocyanosis is a painless disorder caused by constriction or narrowing of small blood vessels in the skin of affected patients. The spasm of the blood vessels decreases the amount of blood that passes through them, resulting in less blood being delivered to the hands and feet. The hands may be the main area affected. The affected areas turn blue and become cold and sweaty. Localized swelling may also occur. Emotion and cold temperatures can worsen the symptoms, while warmth can decrease symptoms. The disease is seen mainly in women and the effect of the disorder is mainly cosmetic. People with the disease tend to be uncomfortable, with sweaty, cold, bluish colored hands and feet.

Causes and symptoms

The sympathetic nerves cause constriction or spasms in the peripheral blood vessels that supply blood to the extremities. The spasms are a contraction of the muscles in the walls of the blood vessels. The contraction decreases the internal diameter of the blood vessels, thereby decreasing the amount of blood flow through the affected area. The spasms occur on a persistent basis, resulting in long term reduction of blood supply to the hands and feet. Sufficient blood still passes through the blood vessels so that the tissue in the affected areas does not starve for oxygen or die. Mainly, blood vessels near the surface of the skin are affected.

Diagnosis

Diagnosis is made by observation of the main clinical symptoms, including persistently blue and sweaty hands and/or feet and a lack of **pain**. Cooling the hands increases the blueness, while warming the hands decreases the blue color. The acrocyanosis patient's pulse is normal, which rules out obstructive diseases. **Raynaud's disease** differs from acrocyanosis in that it causes white and red skin coloration phases, not just bluish discoloration.

KEY TERMS

Sympathetic nerve—A nerve of the autonomic nervous system that regulates involuntary and automatic reactions, especially to stress.

Treatment

Acrocyanosis usually isn't treated. Drugs that block the uptake of **calcium** (**calcium channel blockers**) and alpha-one antagonists reduce the symptoms in most cases. Drugs that dilate blood vessels are only effective some of the time. Sweating from the affected areas can be profuse and require treatment. Surgery to cut the sympathetic nerves is performed rarely.

Prognosis

Acrocyanosis is a benign and persistent disease. The main concern of patients is cosmetic. Left untreated, the disease does not worsen.

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Acromegaly and gigantism

Definition

Acromegaly is a disorder in which the abnormal release of a particular chemical from the pituitary gland in the brain causes increased growth in bone and soft tissue, as well as a variety of other disturbances throughout the body. This chemical released from the pituitary gland is called growth hormone (GH). The body's ability to process and use nutrients like fats and sugars is also altered. In children whose bony growth plates have not closed, the chemical changes of acromegaly result in exceptional growth of long bones. This variant is called gigantism, with the additional bone growth causing unusual height. When the abnormality occurs after bone growth stops, the disorder is called acromegaly.

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A comparison of the right hand of a person afflicted with acromegaly (left) and the hand of a normal-sized person. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Description

Acromegaly is a relatively rare disorder, occurring in approximately 50 out of every 1 million people (50/1,000,000). Both men and women are affected. Because the symptoms of acromegaly occur so gradually, diagnosis is often delayed. The majority of patients are not identified until they are middle aged.

Causes and symptoms

The pituitary is a small gland located at the base of the brain. A gland is a collection of cells that releases certain chemicals, or hormones, which are important to the functioning of other organs or body systems. The pituitary hormones travel throughout the body and are involved in a large number of activities, including the regulation of growth and reproductive functions. The cause of acromegaly can be traced to the pituitary's production of GH.

Under normal conditions, the pituitary receives input from another brain structure, the hypothalamus, located at the base of the brain. This input from the hypothalamus regulates the pituitary's release of hormones. For example, the hypothalamus produces growth hormone-releasing hormone (GHRH), which directs the pituitary to release GH. Input from the hypothalamus should also direct the pituitary to stop releasing hormones.

In acromegaly, the pituitary continues to release GH and ignores signals from the hypothalamus. In the liver, GH causes production of a hormone called insulin-like growth factor 1 (IGF-1), which is responsible for growth throughout the body. When the pituitary refuses to stop producing GH, the levels of IGF-1 also reach abnormal peaks. Bones, soft tissue, and organs throughout the body begin to enlarge, and the body changes its ability to process and use nutrients like sugars and fats.

Enlarged feet is one deformity caused by acromegaly. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

In acromegaly, an individual's hands and feet begin to grow, becoming thick and doughy. The jaw line, nose, and forehead also grow, and facial features are described as "coarsening." The tongue grows larger, and because the jaw is larger, the teeth become more widely spaced. Due to swelling within the structures of the throat and sinuses, the voice becomes deeper and sounds more hollow, and patients may develop loud **snoring**. Various hormonal changes cause symptoms such as:

- heavy sweating
- oily skin
- increased coarse body hair
- improper processing of sugars in the diet (and sometimes actual diabetes)
- high blood pressure

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KEY TERMS

Adenoma—A type of noncancerous (benign) tumor that often involves the overgrowth of certain cells found in glands.

Gland—A collection of cells that releases certain chemicals, or hormones, that are important to the functioning of other organs or body systems.

Hormone—A chemical produced in one part of the body that travels to another part of the body in order to exert an effect.

Hypothalamus—A structure within the brain responsible for a large number of normal functions throughout the body, including regulating sleep, temperature, eating, and sexual development. The hypothalamus also regulates the functions of the pituitary gland by directing the pituitary to stop or start production of its hormones.

Pituitary—A gland located at the base of the brain that produces a number of hormones, including those that regulate growth and reproductive functions. Overproduction of the pituitary hormone called growth hormone (GH) is responsible for the condition known as acromegaly.

- increased calcium in the urine (sometimes leading to kidney stones)
- increased risk of gallstones; and
- swelling of the thyroid gland

People with acromegaly have more skin tags, or outgrowths of tissue, than normal. This increase in skin tags is also associated with the development of growths, called polyps, within the large intestine that may eventually become cancerous. Patients with acromegaly often suffer from headaches and arthritis. The various swellings and enlargements throughout the body may press on nerves, causing sensations of local **tingling** or burning, and sometimes result in muscle weakness.

The most common cause of this disorder (in 90% of patients) is the development of a noncancerous tumor within the pituitary, called a pituitary adenoma. These tumors are the source of the abnormal release of GH. As these tumors grow, they may press on nearby structures within the brain, causing headaches and changes in vision. As the adenoma grows, it may disrupt other pituitary tissue, interfering with the release of other hormones. These disruptions may be responsible for changes in the menstrual cycle of women, decreases in the sexual drive in men and women, and the abnormal production of breast milk in women. In rare cases, acromegaly is caused by the abnormal production of GHRH, which leads to the increased production of GH. Certain tumors in the pancreas, lungs, adrenal glands, thyroid, and intestine produce GHRH, which in turn triggers production of an abnormal quantity of GH.

Diagnosis

Because acromegaly produces slow changes over time, diagnosis is often significantly delayed. In fact, the characteristic coarsening of the facial features is often not recognized by family members, friends, or long-time family physicians. Often, the diagnosis is suspected by a new physician who sees the patient for the first time and is struck by the patient's characteristic facial appearance. Comparing old photographs from a number of different time periods will often increase suspicion of the disease.

Because the quantity of GH produced varies widely under normal conditions, demonstrating high levels of GH in the blood is not sufficient to merit a diagnosis of acromegaly. Instead, laboratory tests measuring an increase of IGF-1 (3–10 times above the normal level) are useful. These results, however, must be carefully interpreted because normal laboratory values for IGF-1 vary when the patient is pregnant, undergoing **puberty**, elderly, or severely malnourished. Normal patients will show a decrease in GH production when given a large dose of sugar (glucose). Patients with acromegaly will not show this decrease, and will often show an increase in GH production. **Magnetic resonance imaging** (MRI) is useful for viewing the pituitary, and for identifying and locating an adenoma. When no adenoma can be located, the search for a GHRH-producing tumor in another location begins.

Treatment

The first step in treatment of acromegaly is removal of all or part of the pituitary adenoma. Removal requires surgery, usually performed by entering the skull through the nose. While this surgery can cause rapid improvement of many acromegaly symptoms, most patients will also require additional treatment with medication. Bromocriptine (Parlodel) is a medication that can be taken by mouth, while

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octreotide (Sandostatin) must be injected every eight hours. Both of these medications are helpful in reducing GH production, but must often be taken for life and produce their own unique side effects. Some patients who cannot undergo surgery are treated with **radiation therapy** to the pituitary in an attempt to shrink the adenoma. Radiating the pituitary may take up to 10 years, however, and may also injure/destroy other normal parts of the pituitary.

Prognosis

Without treatment, patients with acromegaly will most likely die early because of the disease's effects on the heart, lungs, brain, or due to the development of **cancer** in the large intestine. With treatment, however, a patient with acromegaly may be able to live a normal lifespan.

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Pituitary Network Association, P.O. Box 1958, Thousand Oaks, CA, 91358, (805) 499-9973, (805) 480-0633, info@pituitary.org, http://www.pituitary.org.

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ACT *see* **Alanine aminotransferase test**

ACTH test *see* **Adrenocorticotropic hormone test**

Actinomyces israelii infection *see* **Actinomycosis**

Actinomycosis

Definition

Actinomycosis is an infection primarily caused by the bacterium *Actinomyces israelii*. Infection most often occurs in the face and neck region and is characterized by the presence of a slowly enlarging, hard, red lump.

Description

Actinomycosis is a relatively rare infection occurring in one out of 300,000 (1/300,000) people per year. It is characterized by the presence of a lump or mass that often forms, draining sinus tracts to the skin surface. Fifty percent of actinomycosis cases are of the head and neck region (also called "lumpy jaw" and "cervicofacial actinomycosis"), 15% are in the chest, 20% are in the abdomen, and the rest are in the pelvis, heart, and brain. Men are three times more likely to develop actinomycosis than women.

KEY TERMS

Biopsy—The process that removes a sample of tissue for microscopic examination to aid in the diagnosis of a disease.

Sinus tract—A narrow, elongated channel in the body that allows the escape of fluid.

Causes and symptoms

Actinomycosis is usually caused by the bacterium *Actinomyces israelii*. This bacterium is normally present in the mouth but can cause disease if it enters tissues following an injury. *Actinomyces israelii* is an anaerobic bacterium which means it dislikes oxygen but grows very well in deep tissues where oxygen levels are low. **Tooth extraction**, tooth disease, **root canal treatment**, jaw surgery, or poor dental hygiene can allow *Actinomyces israelii* to cause an infection in the head and neck region.

The main symptom of cervicofacial actinomycosis is the presence of a hard lump on the face or neck. The lump may or may not be red. **Fever** occurs in some cases.

Diagnosis

Cervicofacial actinomycosis can be diagnosed by a family doctor or dentist and the patient may be referred to an oral surgeon or **infectious disease** specialist. The diagnosis of actinomycosis is based upon several things. The presence of a red lump with draining sinuses on the head or neck is strongly suggestive of cervicofacial actinomycosis. A recent history of tooth extraction or signs of **tooth decay** or poor dental hygiene aid in the diagnosis. Microscopic examination of the fluid draining from the sinuses shows the characteristic "sulfur Granules" (small yellow colored material in the fluid) produced by *Actinomyces israelii*. A biopsy may be performed to remove a sample of the infected tissue. This procedure can be performed under **local anesthesia** in the doctor's office. Occasionally the bacteria can be cultured from the sinus tract fluid or from samples of the infected tissue.

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Actinomycosis in the lungs, abdomen, pelvis, or brain can be very hard to diagnose since the symptoms often mimic those of other diseases. Actinomycosis of the lungs or abdomen can resemble **tuberculosis** or **cancer**. Diagnostic x-ray results, the presence of draining sinus tracts, and microscopic analysis and culturing of infected tissue assist in the diagnosis.

Treatment

Actinomycosis is difficult to treat because of its dense tissue location. Surgery is often required to drain the lesion and/or to remove the site of infection. To kill the bacteria, standard therapy has included large doses of penicillin given through a vein daily for two to six weeks followed by six to twelve months of penicillin taken by mouth. Tetracycline, clindamycin, or erythromycin may be used instead of penicillin. The antibiotic therapy must be completed to ensure that the infection does not return. However, a report in 2004 on several cases of actinomycosis said that therapy depends on the individual case and that many patients today will be diagnosed in earlier stages of the disease. Sometimes, shorter courses of antibiotic treatment are effective, with close diagnostic x-ray monitoring. Hyperbaric oxygen (oxygen under high pressure) therapy in combination with the antibiotic therapy has been successful.

Prognosis

Complete recovery is achieved following treatment. If left untreated, the infection may cause localized bone destruction.

Prevention

The best prevention is to maintain good dental hygiene.

Resources

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Activated charcoal *see* **Charcoal, activated**

Activated partial thromboplastin time *see* **Partial thromboplastin time**

Acupressure

Definition

Acupressure is a form of touch therapy that utilizes the principles of **acupuncture** and Chinese medicine. In acupressure, the same points on the body are used as in acupuncture, but are stimulated with finger pressure instead of with the insertion of needles. Acupressure is used to relieve a variety of symptoms and **pain**.

Purpose

Acupressure massage performed by a therapist can be very effective both as prevention and as a treatment for many health conditions, including headaches, general aches and pains, colds and flu, arthritis, **allergies**, **asthma**, nervous tension, menstrual cramps, sinus problems, sprains, **tennis elbow**, and toothaches, among others. Unlike acupuncture which requires a visit to a professional, acupressure can be performed by a layperson. Acupressure techniques are fairly easy to learn, and have been used to provide quick, cost-free, and effective relief from many symptoms. Acupressure points can also be stimulated to increase energy and feelings of well--being, reduce **stress**, stimulate the immune system, and alleviate **sexual dysfunction**.

Description

Origins

One of the oldest text of Chinese medicine is the *Huang Di*, The Yellow Emperor's Classic of Internal Medicine, which may be at least 2,000 years old. Chinese medicine has developed acupuncture, acupressure, herbal remedies, diet, **exercise**, lifestyle changes, and other remedies as part of its healing methods. Nearly all of the forms of Oriental medicine that are used in the West today, including acupuncture, acupressure, **shiatsu**, and Chinese herbal medicine, have their roots in Chinese medicine. One legend has it that acupuncture and acupressure evolved as early Chinese healers studied the puncture **wounds** of Chinese warriors, noting that certain points on the body created interesting results when stimulated. The oldest known text specifically on acupuncture points, the *Systematic Classic of Acupuncture*, dates back to 282 A.D. Acupressure is the non-invasive form of acupuncture, as Chinese physicians determined that stimulating points on the body with massage and pressure could be effective for treating certain problems.

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Therapist working acupressure points on a woman's shoulder. *(Photo Researchers, Inc.)*

Outside of Asian-American communities, Chinese medicine remained virtually unknown in the United States until the 1970s, when Richard Nixon became the first U.S. president to visit China. On Nixon's trip, journalists were amazed to observe major operations being performed on patients without the use of anesthetics. Instead, wide-awake patients were being operated on, with only acupuncture needles inserted into them to control pain. At that time, a famous columnist for the *New York Times*, James Reston, had to undergo surgery and elected to use acupuncture for anesthesia. Later, he wrote some convincing stories on its effectiveness. Despite being neglected by mainstream medicine and the American Medical Association (AMA), acupuncture and Chinese medicine became a central to alternative medicine practitioners in the United States. Today, there are millions of patients who attest to its effectiveness, and nearly 9,000 practitioners in all 50 states.

Acupressure is practiced as a treatment by Chinese medicine practitioners and acupuncturists, as well as by massage therapists. Most massage schools in the United States include acupressure techniques as part of their bodywork programs. Shiatsu massage is very closely related to acupressure, working with the same points on the body and the same general principles, although it was developed over centuries in Japan rather than in China. **Reflexology** is a form of bodywork based on acupressure concepts. Jin Shin Do is a bodywork technique with an increasing number of practitioners in America that combines acupressure and shiatsu principles with **qigong**, Reichian theory, and **meditation**.

Acupressure and Chinese medicine

Chinese medicine views the body as a small part of the universe, subject to laws and principles of harmony and balance. Chinese medicine does not make as sharp a destinction as Western medicine does between mind and body. The Chinese system believes that emotions and mental states are every bit as influential on disease as purely physical mechanisms, and considers factors like work, environment, and relationships as fundamental to a patient's health. Chinese medicine also uses very different symbols and ideas to discuss the body and health. While Western medicine typically describes

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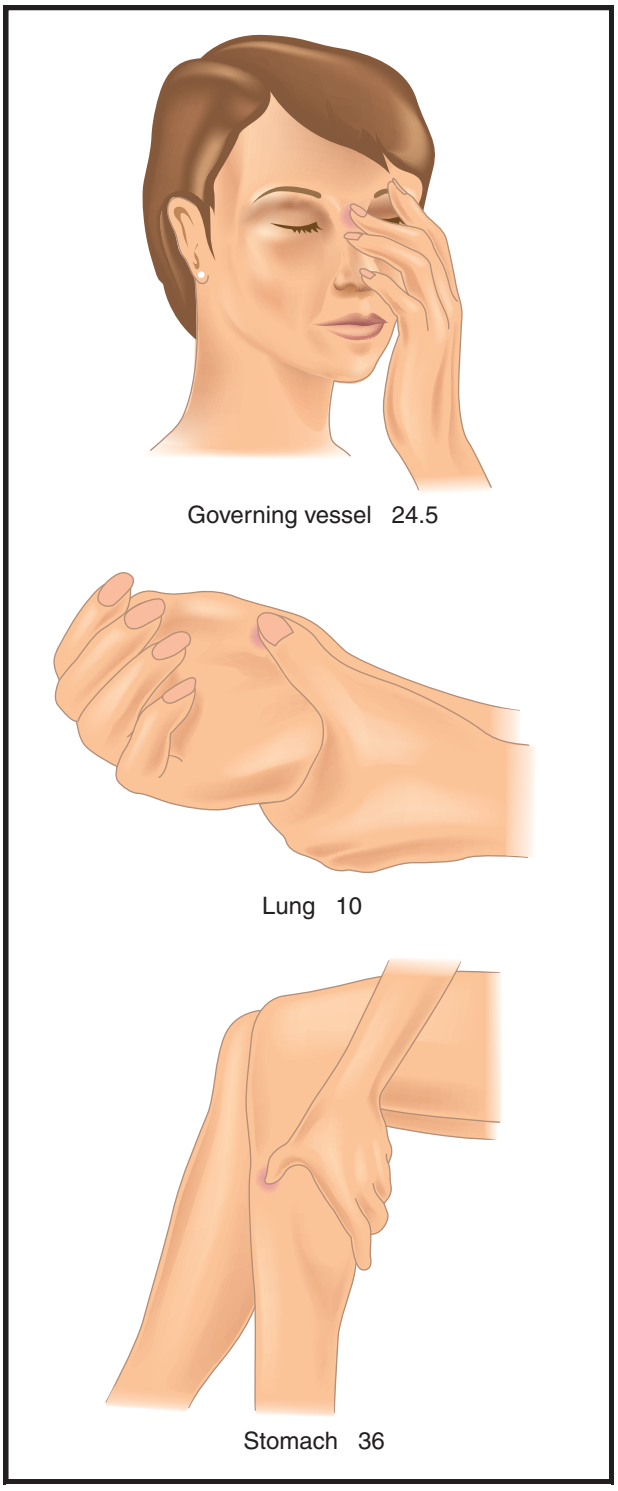

Press on point governing vessel 24.5, the top of the bridge of the nose, lightly for two minutes to relieve hay fever symptoms. Press on lung 10, the center of the thumb pad, for one minute to alleviate a sore throat. To ease heartburn, apply pressure to stomach 36, four finger-widths below the kneecap outside the shinbone. Use on both legs. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

health as mainly physical processes composed of chemical equations and reactions, the Chinese use ideas like yin and yang, chi, and the organ system to describe health and the body.

Everything in the universe has properties of yin and yang. Yin is associated with cold, female, passive, downward, inward, dark, wet. Yang can be described as hot, male, active, upward, outward, light, dry, and so on. Nothing is either completely yin or yang. These two principles always interact and affect each other, although the body and its organs can become imbalanced by having either too much or too little of either.

Chi (pronounced *chee*, also spelled *qi* or *ki* in Japanese shiatsu) is the fundamental life energy. It is found in food, air, water, and sunlight, and it travels through the body in channels called *meridians*. There are 12 major meridians in the body that transport chi, corresponding to the 12 main organs categorized by Chinese medicine.

Disease is viewed as an imbalance of the organs and chi in the body. Chinese medicine has developed intricate systems of how organs are related to physical and mental symptoms, and it has devised corresponding treatments using the meridian and pressure point networks that are classified and numbered. The goal of acupressure, and acupuncture, is to stimulate and unblock the circulation of chi, by activating very specific points, called pressure points or *acupoints*. Acupressure seeks to stimulate the points on the chi meridians that pass close to the skin, as these are easiest to unblock and manipulate with finger pressure.

Acupressure can be used as part of a Chinese physician's prescription, as a session of **massage therapy**, or as a self-treatment for common aches and illnesses. A Chinese medicine practitioner examines a patient very thoroughly, looking at physical, mental and emotional activity, taking the pulse usually at the wrists, examining the tongue and complexion, and observing the patient's demeanor and attitude, to get a complete diagnosis of which organs and meridian points are out of balance. When the imbalance is located, the physician will recommend specific pressure points for acupuncture or acupressure. If acupressure is recommended, the patient might opt for a series of treatments from a massage therapist.

In massage therapy, acupressurists will evaluate a patient's symptoms and overall health, but a massage therapist's diagnostic training isn't as extensive as a Chinese physician's. In a massage therapy treatment, a person usually lies down on a table or mat, with thin

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KEY TERMS

Acupoint—A pressure point stimulated in acupressure.

Chi—Basic life energy.

Meridian—A channel through which chi travels in the body.

Moxibustion—An acupuncture technique that burns the herb moxa or mugwort.

Shiatsu—Japanese form of acupressure massage.

Yin/yang—Universal characteristics used to describe aspects of the natural world.

clothing on. The acupressurist will gently feel and palpate the abdomen and other parts of the body to determine energy imbalances. Then, the therapist will work with different meridians throughout the body, depending on which organs are imbalanced in the abdomen. The therapist will use different types of finger movements and pressure on different acupoints, depending on whether the chi needs to be increased or dispersed at different points. The therapist observes and guides the energy flow through the patient's body throughout the session. Sometimes, special herbs (*Artemesia vulgaris* or moxa) may be placed on a point to warm it, a process called *moxibustion*. A session of acupressure is generally a very pleasant experience, and some people experience great benefit immediately. For more chronic conditions, several sessions may be necessary to relieve and improve conditions.

Acupressure massage usually costs from $30–$70 per hour session. A visit to a Chinese medicine physician or acupuncturist can be more expensive, comparable to a visit to an allopathic physician if the practitioner is an MD. Insurance reimbursement varies widely, and consumers should be aware if their policies cover alternative treatment, acupuncture, or massage therapy.

Self-treatment

Acupressure is easy to learn, and there are many good books that illustrate the position of acupoints and meridians on the body. It is also very versatile, as it can be done anywhere, and it's a good form of treatment for spouses and partners to give to each other and for parents to perform on children for minor conditions.

While giving self-treatment or performing acupressure on another, a mental attitude of calmness and attention is important, as one person's energy can be used to help another's. Loose, thin clothing is recommended. There are three general techniques for stimulating a pressure point.

- Tonifying is meant to strengthen weak chi, and is done by pressing the thumb or finger into an acupoint with a firm, steady pressure, holding it for up to two minutes.
- Dispersing is meant to move stagnant or blocked chi, and the finger or thumb is moved in a circular motion or slightly in and out of the point for two minutes.
- Calming the chi in a pressure point utilizes the palm to cover the point and gently stroke the area for about two minutes.

There are many pressure points that are easily found and memorized to treat common ailments from headaches to colds.

- For headaches, toothaches, sinus problems, and pain in the upper body, the "LI4" point is recommended. It is located in the web between the thumb and index finger, on the back of the hand. Using the thumb and index finger of the other hand, apply a pinching pressure until the point is felt, and hold it for two minutes. Pregnant women should never press this point.
- To calm the nerves and stimulate digestion, find the "CV12" point that is four thumb widths above the navel in the center of the abdomen. Calm the point with the palm, using gentle stroking for several minutes.
- To stimulate the immune system, find the "TH5" point on the back of the forearm two thumb widths above the wrist. Use a dispersing technique, or circular pressure with the thumb or finger, for two minutes on each arm.
- For headaches, sinus congestion, and tension, locate the "GB20" points at the base of the skull in the back of the head, just behind the bones in back of the ears. Disperse these points for two minutes with the fingers or thumbs. Also find the "yintang" point, which is in the middle of the forehead between the eyebrows. Disperse it with gentle pressure for two minutes to clear the mind and to relieve headaches.

Precautions

Acupressure is a safe technique, but it is not meant to replace professional health care. A physician should always be consulted when there are doubts about medical conditions. If a condition is chronic, a professional should be consulted; purely

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symptomatic treatment can exacerbate chronic conditions. Acupressure should not be applied to open wounds, or where there is swelling and inflammation. Areas of scar tissue, blisters, **boils**, **rashes**, or **varicose veins** should be avoided. Finally, certain acupressure points should not be stimulated on people with high or low blood pressure and on pregnant women.

Research and general acceptance

In general, Chinese medicine has been slow to gain acceptance in the West, mainly because it rests on ideas very foreign to the scientific model. For instance, Western scientists have trouble with the idea of chi, the invisible energy of the body, and the idea that pressing on certain points can alleviate certain conditions seems sometimes too simple for scientists to believe.

Western scientists, in trying to account for the action of acupressure, have theorized that chi is actually part of the neuroendocrine system of the body. Celebrated orthopedic surgeon Robert O. Becker, who was twice nominated for the Nobel Prize, wrote a book on the subject called *Cross Currents: The Promise of Electromedicine; The Perils of Electropollution*. By using precise electrical measuring devices, Becker and his colleagues showed that the body has a complex web of electromagnetic energy, and that traditional acupressure meridians and points contained amounts of energy that non-acupressure points did not.

The mechanisms of acupuncture and acupressure remain difficult to document in terms of the biochemical processes involved; numerous testimonials are the primary evidence backing up the effectiveness of acupressure and acupuncture. However, a body of research is growing that verifies the effectiveness in acupressure and acupuncture techniques in treating many problems and in controlling pain.

Resources

OTHER

American Association of Acupuncture and Oriental Medicine. December 28, 2000. http://www.aaaomonline.org/

National Acupuncture and Oriental Medicine Alliance. December 28, 2000. http://www.acuall.org.

Douglas Dupler MA

Acupressure, foot *see* **Reflexology**

Acupuncture

Definition

Acupuncture is one of the main forms of treatment in **traditional Chinese medicine**. It involves the use of sharp, thin needles that are inserted in the body at very specific points. This process is believed to adjust and alter the body's energy flow into healthier patterns, and is used to treat a wide variety of illnesses and health conditions.

Purpose

The World Health Organization (WHO) recommends acupuncture as an effective treatment for more than forty medical problems, including **allergies**, respiratory conditions, gastrointestinal disorders, gynecological problems, nervous conditions, and disorders of the eyes, nose and throat, and childhood illnesses, among others. Acupuncture has been used in the treatment of **alcoholism** and **substance abuse**. It is an effective and low-cost treatment for headaches and chronic **pain**, associated with problems like back injuries and arthritis. It has also been used to supplement invasive Western treatments like **chemotherapy** and surgery. Acupuncture is generally most effective when used as prevention or before a health condition becomes acute, but it has been used to help patients suffering from **cancer** and **AIDS**. Acupuncture is limited in treating conditions or traumas that require surgery or emergency care (such as for broken bones).

Description

Origins

The original text of Chinese medicine is the *Nei Ching, The Yellow Emperor's Classic of Internal Medicine*, which is estimated to be at least 2,500 years old. Thousands of books since then have been written on the subject of Chinese healing, and its basic philosophies spread long ago to other Asian civilizations. Nearly all of the forms of Oriental medicine which are used in the West today, including acupuncture, **shiatsu**, **acupressure** massage, and macrobiotics, are part of or have their roots in Chinese medicine. Legend has it that acupuncture developed when early Chinese physicians observed unpredicted effects of puncture **wounds** in Chinese warriors. The oldest known text on acupuncture, the *Systematic Classic of Acupuncture*, dates back to 282 A.D. Although acupuncture is its best known technique, Chinese medicine traditionally utilizes herbal remedies, dietary

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Woman undergoing facial acupuncture. *(© Yoav Levy/Phototake. — All rights reserved.)*

therapy, lifestyle changes and other means to treat patients.

In the early 1900s, only a few Western physicians who had visited China were fascinated by acupuncture, but outside of Asian-American communities it remained virtually unknown until the 1970s, when Richard Nixon became the first U.S. president to visit China. On Nixon's trip, journalists were amazed to observe major operations being performed on patients without the use of anesthetics. Instead, wide-awake patients were being operated on with only acupuncture needles inserted into them to control pain. During that time, a famous columnist for the *New York Times*, James Reston, had to undergo surgery and elected to use acupuncture instead of pain medication, and he wrote some convincing stories on its effectiveness.

Today, acupuncture is being practiced in all 50 states by more than 9,000 practitioners, with over 4,000 MDs including it in their practices. Acupuncture has shown notable success in treating many conditions, and more than 15 million Americans have used it as a therapy. Acupuncture, however, remains largely unsupported by the medical establishment. The American Medical Association has been resistant to researching it, as it is based on concepts very different from the Western scientific model.

Several forms of acupuncture are being used today in the United States. Japanese acupuncture uses extremely thin needles and does not incorporate herbal medicine in its practice. Auricular acupuncture uses acupuncture points only on the ear, which are believed to stimulate and balance internal organs. In France, where acupuncture is very popular and more accepted by the medical establishment, neurologist Paul Nogier developed a system of acupuncture based on neuroendocrine theory rather than on traditional Chinese concepts, which is gaining some use in America.

Basic ideas of Chinese medicine

Chinese medicine views the body as a small part of the universe, and subject to universal laws and principles of harmony and balance. Chinese medicine does

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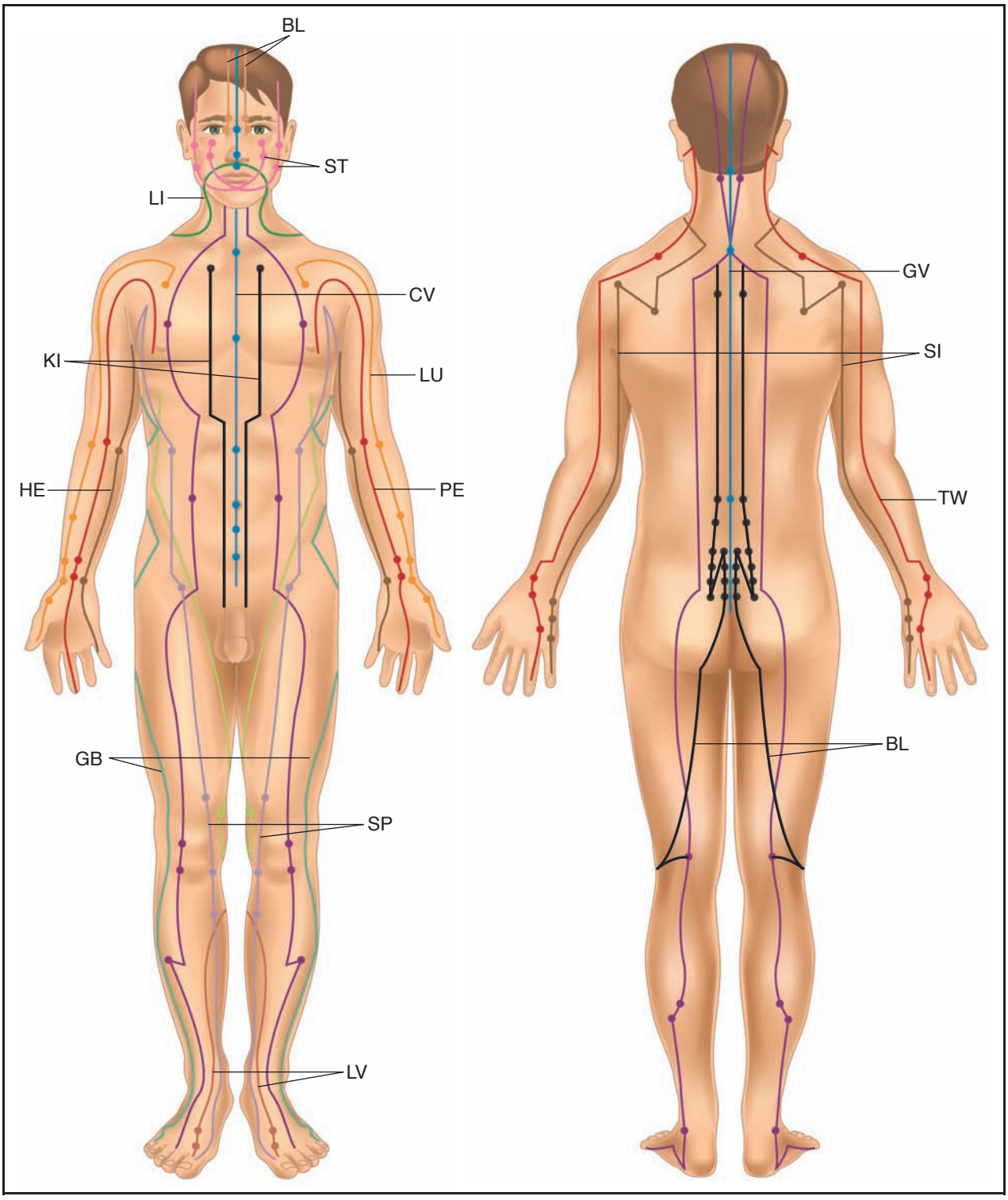

Acupuncture sites and meridians on the body. Points are shown on the bladder (BL), conception vessel (CV), gall bladder (GB), governing vessel (GV), heart (HE), kidney (KI) large intestine (LI), liver (LV), lung (LU), pericardium (PE), small intestine (SI), spleen (SP), stomach (ST), and triple warmer (TW) meridians. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

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KEY TERMS

Acupressure—Form of massage using acupuncture points.

Auricular acupuncture—Acupuncture using only points found on the ears.

Chi—Basic life energy.

Meridian—Channel through which chi travels in the body.

Moxibustion—Acupuncture technique which burns the herb moxa or mugwort.

Tonification—Acupuncture technique for strengthening the body.

Yin/Yang—Universal characteristics used to describe aspects of the natural world.

not draw a sharp line, as Western medicine does, between mind and body. The Chinese system believes that emotions and mental states are every bit as influential on disease as purely physical mechanisms, and considers factors like work, environment, lifestyle and relationships as fundamental to the overall picture of a patient's health. Chinese medicine also uses very different symbols and ideas to discuss the body and health. While Western medicine typically describes health in terms of measurable physical processes made up of chemical reactions, the Chinese use ideas like yin and yang, chi, the organ system, and the five elements to describe health and the body. To understand the ideas behind acupuncture, it is worthwhile to introduce some of these basic terms.

YIN AND YANG. According to Chinese philosophy, the universe and the body can be described by two separate but complementary principles, that of yin and yang. For example, in temperature, yin is cold and yang is hot. In gender, yin is female and yang is male. In activity, yin is passive and yang is active. In light, yin is dark and yang is bright; in direction yin is inward and downward and yang is outward and up, and so on. Nothing is ever completely yin or yang, but a combination of the two. These two principles are always interacting, opposing, and influencing each other. The goal of Chinese medicine is not to eliminate either yin or yang, but to allow the two to balance each other and exist harmoniously together. For instance, if a person suffers from symptoms of high blood pressure, the Chinese system would say that the heart organ might have too much yang, and would recommend methods either to reduce the yang or to increase the yin of the heart, depending on the other symptoms and organs in the body. Thus, acupuncture therapies seek to either increase or reduce yang, or increase or reduce yin in particular regions of the body.

CHI. Another fundamental concept of Chinese medicine is that of chi (pronounced *chee*, also spelled *qi*). Chi is the fundamental life energy of the universe. It is invisible and is found in the environment in the air, water, food and sunlight. In the body, it is the invisible vital force that creates and animates life. We are all born with inherited amounts of chi, and we also get acquired chi from the food we eat and the air we breathe. The level and quality of a person's chi also depends on the state of physical, mental and emotional balance. Chi travels through the body along channels called *meridians*.

THE ORGAN SYSTEM. In the Chinese system, there are twelve main organs: the lung, large intestine, stomach, spleen, heart, small intestine, urinary bladder, kidney, liver, gallbladder, pericardium, and the "triple warmer," which represents the entire torso region. Each organ has chi energy associated with it, and each organ interacts with particular emotions on the mental level. As there are twelve organs, there are twelve types of chi that can move through the body, and these move through twelve main channels or meridians. Chinese doctors connect symptoms to organs. That is, symptoms are caused by yin/yang imbalances in one or more organs, or by an unhealthy flow of chi to or from one organ to another. Each organ has a different profile of symptoms it can manifest.

THE FIVE ELEMENTS. Another basis of Chinese theory is that the world and body are made up of five main elements: wood, fire, earth, metal, and water. These elements are all interconnected, and each element either generates or controls another element. For instance, water controls fire and earth generates metal. Each organ is associated with one of the five elements. The Chinese system uses elements and organs to describe and treat conditions. For instance, the kidney is associated with water and the heart is associated with fire, and the two organs are related as water and fire are related. If the kidney is weak, then there might be a corresponding fire problem in the heart, so treatment might be made by acupuncture or herbs to cool the heart system and/or increase energy in the kidney system.

The Chinese have developed an intricate system of how organs and elements are related to physical and mental symptoms, and the above example is a very

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simple one. Although this system sounds suspect to Western scientists, some interesting parallels have been observed. For instance, Western medicine has observed that with severe heart problems, kidney failure often follows, but it still does not know exactly why. In Chinese medicine, this connection between the two organs has long been established.

MEDICAL PROBLEMS AND ACUPUNCTURE. In Chinese medicine, disease as seen as imbalances in the organ system or chi meridians, and the goal of any remedy or treatment is to assist the body in reestablishing its innate harmony. Disease can be caused by internal factors like emotions, external factors like the environment and weather, and other factors like injuries, trauma, diet, and germs. However, infection is seen not as primarily a problem with germs and viruses, but as a weakness in the energy of the body which is allowing a sickness to occur. In Chinese medicine, no two illnesses are ever the same, as each body has its own characteristics of symptoms and balance. Acupuncture is used to open or adjust the flow of chi throughout the organ system, which will strengthen the body and prompt it to heal itself.

A VISIT TO THE ACUPUNCTURIST. The first thing an acupuncturist will do is get a thorough idea of a patient's medical history and symptoms, both physical and emotional. This is done with a long questionnaire and interview. Then the acupuncturist will examine the patient to find further symptoms, looking closely at the tongue, the pulse at various points in the body, the complexion, general behavior, and other signs like coughs or pains. From this, the practitioner will be able to determine patterns of symptoms, which indicate which organs and areas are imbalanced. Depending on the problem, the acupuncturist will insert needles to manipulate chi on one or more of the twelve organ meridians. On these twelve meridians, there are nearly 2,000 points which can be used in acupuncture, with around 200 points being most frequently used by traditional acupuncturists. During an individual treatment, one to twenty needles may be used, depending on which meridian points are chosen.

Acupuncture needles are always sterilized and acupuncture is a very safe procedure. The depth of insertion of needles varies, depending on which chi channels are being treated. Some points barely go beyond superficial layers of skin, while some acupuncture points require a depth of 1–3 in (2.5–7.5 cm) of needle. The needles generally do not cause pain. Patients sometimes report pinching sensations and often pleasant sensations, as the body experiences healing. Depending on the problem, the acupuncturist might spin or move the needles, or even pass a slight electrical current through some of them. *Moxibustion* may be sometimes used, in which an herbal mixture (moxa or mugwort) is either burned like incense on the acupuncture point or on the end of the needle, which is believed to stimulate chi in a particular way. Also, acupuncturists sometimes use *cupping*, during which small suction cups are placed on meridian points to stimulate them.

How long the needles are inserted also varies. Some patients only require a quick in and out insertion to clear problems and provide *tonification* (strengthening of health), while some other conditions might require needles inserted up to an hour or more. The average visit to an acupuncturist takes about thirty minutes. The number of visits to the acupuncturist varies as well, with some conditions improved in one or two sessions and others requiring a series of six or more visits over the course of weeks or months.

Costs for acupuncture can vary, depending on whether the practitioner is an MD. Initial visits with non-MD acupuncturists can run from $50–$100, with follow-up visits usually costing less. Insurance reimbursement also varies widely, depending on the company and state. Regulations have been changing often. Some states authorize Medicaid to cover acupuncture for certain conditions, and some states have mandated that general coverage pay for acupuncture. Consumers should be aware of the provisions for acupuncture in their individual policies.

Precautions

Acupuncture is generally a very safe procedure. If a patient is in doubt about a medical condition, more than one physician should be consulted. Also, a patient should always feel comfortable and confident that their acupuncturist is knowledgable and properly trained.

Research and general acceptance

Mainstream medicine has been slow to accept acupuncture; although more MDs are using it, the American Medical Association does not recognize it as a specialty. The reason for this is that the mechanism of acupuncture is difficult to scientifically understand or measure, such as the invisible energy of chi in the body. Western medicine, admitting that acupuncture works in many cases, has theorized that the energy meridians are actually part of the nervous

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system and that acupuncture relieves pain by releasing endorphins, or natural pain killers, into the bloodstream. Despite the ambiguity in the biochemistry involved, acupuncture continues to show effectiveness in clinical tests, from reducing pain to alleviating the symptoms of chronic illnesses, and research in acupuncture is currently growing. The Office of Alternative Medicine of the National Institute of Health is currently funding research in the use of acupuncture for treating depression and attention-deficit disorder.

Resources

OTHER

American Association of Acupuncture and Oriental Medicine. http://www. aaaomonline.org/.

North American Society of Acupuncture and Alternative Medicine. http://www. nasa-altmed.com.

Douglas Dupler MA

Acute glomerulonephritis *see* **Acute poststreptococcal glomerulonephritis**

Acute homeopathic remedies *see* **Homeopathic remedies, acute prescribing**

Acute kidney failure

Definition

Acute kidney failure occurs when illness, infection, or injury damages the kidneys. Temporarily, the kidneys cannot adequately remove fluids and wastes from the body or maintain the proper level of certain kidney-regulated chemicals in the bloodstream.

Description

The kidneys are the body's natural filtration system. They perform the critical task of processing approximately 200 quarts of fluid in the bloodstream every 24 hours. Waste products like urea and toxins, along with excess fluids, are removed from the bloodstream in the form of urine. Kidney (or renal) failure occurs when kidney functioning becomes impaired. Fluids and toxins begin to accumulate in the bloodstream. As fluids build up in the bloodstream, the patient with acute kidney failure may become puffy and swollen (edematous) in the face, hands, and feet. Their blood pressure typically begins to rise, and they may experience **fatigue** and **nausea**.

Unlike **chronic kidney failure**, which is long term and irreversible, acute kidney failure is a temporary condition. With proper and timely treatment, it can typically be reversed. Often there is no permanent damage to the kidneys. Acute kidney failure appears most frequently as a complication of serious illness, like **heart failure**, liver failure, **dehydration**, severe **burns**, and excessive bleeding (hemorrhage). It may also be caused by an obstruction to the urinary tract or as a direct result of **kidney disease**, injury, or an adverse reaction to a medicine.

Causes and symptoms

Acute kidney failure can be caused by many different illnesses, injuries, and infections. These conditions fall into three main categories: *prerenal*, *postrenal*, and *intrarenal* conditions.

Prerenal conditions do not damage the kidney, but can cause diminished kidney function. They are the most common cause of acute renal failure, and include:

- dehydration
- hemorrhage
- septicemia, or sepsis
- heart failure
- liver failure
- burns

Postrenal conditions cause kidney failure by obstructing the urinary tract. These conditions include:

- inflammation of the prostate gland in men (prostatitis)
- enlargement of the prostate gland (benign prostatic hypertrophy)
- bladder or pelvic tumors
- kidney stones (calculi)

Intrarenal conditions involve kidney disease or direct injury to the kidneys. These conditions include:

- lack of blood supply to the kidneys (ischemia)
- use of radiocontrast agents in patients with kidney problems
- drug abuse or overdose
- long-term use of nephrotoxic medications, like certain pain medicines
- acute inflammation of the glomeruli, or filters, of the kidney (glomerulonephritis)
- kidney infections (pyelitis or pyelonephritis).

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KEY TERMS

Blood urea nitrogen (BUN)—A waste product that is formed in the liver and collects in the bloodstream; patients with kidney failure have high BUN levels.

Creatinine—A protein produced by muscle that healthy kidneys filter out.

Extracorporeal—Outside of, or unrelated to, the body.

Ischemia—A lack of blood supply to an organ or tissue.

Nephrotoxic—Toxic, or damaging, to the kidney.

Radiocontrast agents—Dyes administered to a patient for the purposes of a radiologic study.

Sepsis—A bacterial infection of the bloodstream.

Vasopressors—Medications that constrict the blood vessels.

Common symptoms of acute kidney failure include:

- anemia. The kidneys are responsible for producing erythropoietin (EPO), a hormone that stimulates red blood cell production. If kidney disease causes shrinking of the kidney, red blood cell production is reduced, leading to anemia.
- bad breath or bad taste in mouth. Urea in the saliva may cause an ammonia-like taste in the mouth.
- bone and joint problems. The kidneys produce vitamin D, which helps the body absorb calcium and keeps bones strong. For patients with kidney failure, bones may become brittle. In children, normal growth may be stunted. Joint pain may also occur as a result of high phosphate levels in the blood. Retention of uric acid may cause gout.
- edema. Puffiness or swelling in the arms, hands, feet, and around the eyes.
- frequent urination.
- foamy or bloody urine. Protein in the urine may cause it to foam significantly. Blood in the urine may indicate bleeding from diseased or obstructed kidneys, bladder, or ureters.
- headaches. High blood pressure may trigger headaches.
- hypertension, or high blood pressure. The retention of fluids and wastes causes blood volume to increase. This makes blood pressure rise.
- increased fatigue. Toxic substances in the blood and the presence of anemia may cause the patient to feel exhausted.
- itching. Phosphorus, normally eliminated in the urine, accumulates in the blood of patients with kidney failure. An increased phosphorus level may cause the skin to itch.
- lower back pain. Patients suffering from certain kidney problems (like kidney stones and other obstructions) may have pain where the kidneys are located, in the small of the back below the ribs.
- nausea. Urea in the gastric juices may cause upset stomach.

Diagnosis

Kidney failure is diagnosed by a doctor. A nephrologist, a doctor that specializes in the kidney, may be consulted to confirm the diagnosis and recommend treatment options. The patient who is suspected of having acute kidney failure will have blood and urine tests to determine the level of kidney function. A blood test will assess the levels of creatinine, blood urea nitrogen (BUN), uric acid, phosphate, **sodium**, and potassium. The kidney regulates these agents in the blood. Urine samples will also be collected, usually over a 24-hour period, to assess protein loss and/or creatinine clearance.

Determining the cause of kidney failure is critical to proper treatment. A full assessment of the kidneys is necessary to determine if the underlying disease is treatable and if the kidney failure is chronic or acute. X rays, **magnetic resonance imaging** (MRI), computed tomography scan (CT), ultrasound, renal biopsy, and/or arteriogram of the kidneys may be used to determine the cause of kidney failure and level of remaining kidney function. X rays and ultrasound of the bladder and/or ureters may also be needed.

Treatment

Treatment for acute kidney failure varies. Treatment is directed to the underlying, primary medical condition that has triggered kidney failure. Prerenal conditions may be treated with replacement fluids

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given through a vein, **diuretics**, blood **transfusion**, or medications. Postrenal conditions and intrarenal conditions may require surgery and/or medication.

Frequently, patients in acute kidney failure require *hemodialysis*, *hemofiltration*, or *peritoneal dialysis* to filter fluids and wastes from the bloodstream until the primary medical condition can be controlled.

Hemodialysis

Hemodialysis involves circulating the patient's blood outside of the body through an extracorporeal circuit (ECC), or dialysis circuit. The ECC is made up of plastic blood tubing, a filter known as a dialyzer (or artificial kidney), and a dialysis machine that monitors and maintains blood flow and administers dialysate. Dialysate is a sterile chemical solution that is used to draw waste products out of the blood. The patient's blood leaves the body through the vein and travels through the ECC and the dialyzer, where fluid removal takes place.

During dialysis, waste products in the bloodstream are carried out of the body. At the same time, electrolytes and other chemicals are added to the blood. The purified, chemically-balanced blood is then returned to the body.

A dialysis "run" typically lasts three to four hours, depending on the type of dialyzer used and the physical condition of the patient. Dialysis is used several times a week until acute kidney failure is reversed.

Blood pressure changes associated with hemodialysis may pose a risk for patients with heart problems. Peritoneal dialysis may be the preferred treatment option in these cases.

Hemofiltration

Hemofiltration, also called continuous renal replacement therapy (CRRT), is a slow, continuous blood filtration therapy used to control acute kidney failure in critically ill patients. These patients are typically very sick and may have heart problems or circulatory problems. They cannot handle the rapid filtration rates of hemodialysis. They also frequently need **antibiotics**, **nutrition**, vasopressors, and other fluids given through a vein to treat their primary condition. Because hemofiltration is continuous, prescription fluids can be given to patients in kidney failure without the risk of fluid overload.

Like hemodialysis, hemofiltration uses an ECC. A hollow fiber hemofilter is used instead of a dialyzer to remove fluids and toxins. Instead of a dialysis machine, a blood pump makes the blood flow through the ECC. The volume of blood circulating through the ECC in hemofiltration is less than that in hemodialysis. Filtration rates are slower and gentler on the circulatory system. Hemofiltration treatment will generally be used until kidney failure is reversed.

Peritoneal dialysis

Peritoneal dialysis may be used if an acute kidney failure patient is stable and not in immediate crisis. In peritoneal dialysis (PD), the lining of the patient's abdomen, the peritoneum, acts as a blood filter. A flexible tube-like instrument (catheter) is surgically inserted into the patient's abdomen. During treatment, the catheter is used to fill the abdominal cavity with dialysate. Waste products and excess fluids move from the patient's bloodstream into the dialysate solution. After a certain time period, the waste-filled dialysate is drained from the abdomen, and replaced with clean dialysate. There are three type of peritoneal dialysis, which vary according to treatment time and administration method.

Peritoneal dialysis is often the best treatment option for infants and children. Their small size can make vein access difficult to maintain. It is not recommended for patients with abdominal **adhesions** or other abdominal defects (like a **hernia**) that might reduce the efficiency of the treatment. It is also not recommended for patients who suffer frequent bouts of an inflammation of the small pouches in the intestinal tract (**diverticulitis**).

Prognosis

Because many of the illnesses and underlying conditions that often trigger acute kidney failure are critical, the prognosis for these patients many times is not good. Studies have estimated overall **death** rates for acute kidney failure at 42–88%. Many people, however, die because of the primary disease that has caused the kidney failure. These figures may also be misleading because patients who experience kidney failure as a result of less serious illnesses (like **kidney stones** or dehydration) have an excellent chance of complete recovery. Early recognition and prompt, appropriate treatment are key to patient recovery.

Up to 10% of patients who experience acute kidney failure will suffer irreversible kidney damage. They will eventually go on to develop chronic kidney

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failure or end-stage renal disease. These patients will require long-term dialysis or **kidney transplantation** to replace their lost renal functioning.

Prevention

Since acute kidney failure can be caused by many things, prevention is difficult. Medications that may impair kidney function should be given cautiously. Patients with pre-existing kidney conditions who are hospitalized for other illnesses or injuries should be carefully monitored for kidney failure complications. Treatments and procedures that may put them at risk for kidney failure (like diagnostic tests requiring radiocontrast agents or dyes) should be used with extreme caution.

ORGANIZATIONS

National Kidney Foundation, Inc. , 30 East 33rd Street, New York, NY, 10016, (212) 889-2210, (212) 689-9261, (800) 622-9010, http://www.kidney.org/

Paula Anne Ford-Martin

Acute leukemias *see* **Leukemias, acute**

Acute lymphangitis

Definition

Acute lymphangitis is a bacterial infection in the lymphatic vessels which is characterized by painful, red streaks below the skin surface. This is a potentially serious infection that can rapidly spread to the bloodstream and be fatal.

Description

Acute lymphangitis affects a critical member of the immune system—the lymphatic system. Waste materials from nearly every organ in the body drain into the lymphatic vessels and are filtered in small organs called lymph nodes. Foreign bodies, such as bacteria or viruses, are processed in the lymph nodes to generate an immune response to fight an infection.

In acute lymphangitis, bacteria enter the body through a cut, scratch, insect bite, surgical wound, or other skin injury. Once the bacteria enter the lymphatic system, they multiply rapidly and follow the lymphatic vessel like a highway. The infected lymphatic vessel becomes inflamed, causing red streaks that are visible below the skin surface. The growth of the bacteria occurs so rapidly that the immune system does not respond fast enough to stop the infection.

KEY TERMS

Biopsy—The process that removes a sample of diseased or infected tissue for microscopic examination to aid in diagnosis.

Lymphatic system—A component of the immune system consisting of vessels and nodes. Waste materials from organs drain into the lymphatic vessels and are filtered by the lymph nodes.

Septicemia—Disease caused by the presence and growth of bacteria in the bloodstream.

If left untreated, the bacteria can cause tissue destruction in the area of the infection. A pus-filled, painful lump called an **abscess** may be formed in the infected area. **Cellulitis**, a generalized infection of the lower skin layers, may also occur. In addition, the bacteria may invade the bloodstream and cause septicemia. Lay people, for that reason, often call the red streaks seen in the skin "blood poisoning." Septicemia is a very serious illness and may be fatal.

Causes and symptoms

Acute lymphangitis is most often caused by the bacterium *Streptococcus pyogenes*. This potentially dangerous bacterium also causes **strep throat**, infections of the heart, spinal cord, and lungs, and in the 1990s has been called the "flesh-eating bacterium." Staphylococci bacteria may also cause lymphangitis.

Although anyone can develop lymphangitis, some people are more at risk. People who have had radical **mastectomy** (removal of a breast and nearby lymph nodes), a leg vein removed for coronary bypass surgery, or recurrent lymphangitis caused by tinea pedis (a fungal infection on the foot) are at an increased risk for lymphangitis.

The characteristic symptoms of acute lymphangitis are the wide, red streaks which travel from the site of infection to the armpit or groin. The affected areas are red, swollen, and painful. Blistering of the affected skin may occur. The bacterial infection causes a **fever** of 100–104 °F (38–40 °C). In addition, a general ill feeling, muscle aches, **headache**, chills, and loss of appetite may be felt.

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Diagnosis

If lymphangitis is suspected, the person should call his or her doctor immediately or go to an emergency room. Acute lymphangitis could be diagnosed by the family doctor, **infectious disease** specialist, or an emergency room doctor. The painful, red streaks just below the skin surface and the high fever are diagnostic of acute lymphangitis. A sample of blood would be taken for culture to determine whether the bacteria have entered the bloodstream. A biopsy (removal of a piece of infected tissue) sample may be taken for culture to identify which type of bacteria is causing the infection. Diagnosis is immediate because it is based primarily on the symptoms. Most insurance policies should cover the expenses for the diagnosis and treatment of acute lymphangitis.

Treatment

Because of the serious nature of this infection, treatment would begin immediately even before the bacterial culture results were available. The only treatment for acute lymphangitis is to give very large doses of an antibiotic, usually penicillin, through the vein. Growing streptococcal bacteria are usually eliminated rapidly and easily by penicillin. The antibiotic clindamycin may be included in the treatment to kill any streptococci that are not growing and are in a resting state. Alternatively, a "broad spectrum" antibiotic may be used which would kill many different kinds of bacteria.

Prognosis

Complete recovery is expected if antibiotic treatment is begun at an early stage of the infection. However, if untreated, acute lymphangitis can be a very serious and even deadly disease. Acute lymphangitis that goes untreated can spread, causing tissue damage. Extensive tissue damage would need to be repaired by **plastic surgery**. Spread of the infection into the bloodstream could be fatal.

Prevention

Although acute lymphangitis can occur in anyone, good hygiene and general health may help to prevent infections.

Resources

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Belinda Rowland PhD

Acute pericarditis *see* **Pericarditis**

Acute poststreptococcal glomerulonephritis

Definition

Acute poststreptococcal **glomerulonephritis** (APSGN) is an inflammation of the kidney tubules (glomeruli) that filter waste products from the blood, following a streptococcal infection such as **strep throat**. APSGN is also called postinfectious glomerulonephritis.

Description

APSGN develops after certain streptococcal bacteria (group A beta-hemolytic streptococci) have infected the skin or throat. Antigens from the dead streptococci clump together with the antibodies that killed them. These clumps are trapped in the kidney tubules, cause the tubules to become inflamed, and impair that organs' ability to filter and eliminate body wastes. The onset of APSGN usually occurs one to six weeks (average two weeks) after the streptococcal infection.

APSGN is a relatively uncommon disease affecting about one of every 10,000 people, although four or five times that many may actually be affected by it but show no symptoms. APSGN is most prevalent among boys between the ages of 3 and 7, but it can occur at any age.

Causes and symptoms

Frequent sore throats and a history of streptococcal infection increase the risk of acquiring APSGN. Symptoms of APSGN include:

- fluid accumulation and tissue swelling (edema) initially in the face and around the eyes, later in the legs
- low urine output (oliguria)
- blood in the urine (hematuria)
- protein in the urine (proteinuria)
- high blood pressure
- joint pain or stiffness

Diagnosis

Diagnosis of APSGN is made by taking the patient's history, assessing his/her symptoms, and performing certain laboratory tests. **Urinalysis** usually shows blood and protein in the urine. Concentrations of urea and creatinine (two waste products normally filtered out of the blood by the kidneys) in the blood are often high, indicating impaired kidney function. A reliable, inexpensive blood test called the anti-streptolysin-O test can confirm that a patient has or has had a

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KEY TERMS

Streptococcus—A gram-positive, round or oval bacteria in the genus *Streptococcus*. Group A streptococci cause a number of human diseases including strep throat, impetigo, and ASPGN.

streptococcal infection. A **throat culture** may also show the presence of group A beta-hemolytic streptococci.

Treatment

Treatment of ASPGN is designed to relieve the symptoms and prevent complications. Some patients are advised to stay in bed until they feel better and to restrict fluid and salt intake. **Antibiotics** may be prescribed to kill any lingering streptococcal bacteria, if their presence is confirmed. Antihypertensives may be given to help control high blood pressure and **diuretics** may be used to reduce fluid retention and swelling. **Kidney dialysis** is rarely needed.

Prognosis

Most children (up to 95%) fully recover from APSGN in a matter of weeks or months. Most adults (up to 70%) also recover fully. In those who do not recover fully, chronic or progressive problems of kidney function may occur. Kidney failure may result in some patients.

Prevention

Receiving prompt treatment for **streptococcal infections** may prevent APSGN.

Resources

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Wessel, Michael R. "Streptococcal and Enterococcal Infections." In Fauci, Anthony S., et al., eds. *Harrison's Principles of Internal Medicine*. 17th ed. New York: McGraw-Hill Professional, 2008.

ORGANIZATIONS

American Kidney Fund (AKF), 6110 Executive Boulevard, Suite 1010, Rockville, MD, 20852, (800) 638-8299, http://www.kidneyfund.org.

National Kidney Foundation, Inc., 30 East 33rd Street, New York, NY, 10016, (212) 889-2210, (212) 689-9261, (800) 622-9010, http://www.kidney.org/.

Maureen Haggerty

Acute respiratory distress syndrome *see* **Adult respiratory distress syndrome**

Acute stress disorder

Definition

Acute **stress** disorder (ASD) is an **anxiety** disorder characterized by a cluster of dissociative and anxiety symptoms occurring within one month of a traumatic event. (Dissociation is a psychological reaction to trauma in which the mind tries to cope by "sealing off" some features of the trauma from conscious awareness).

Description

Acute stress disorder is a new diagnostic category that was introduced in 1994 to differentiate time-limited reactions to trauma from **post-traumatic stress disorder** (PTSD).

Causes and symptoms

Acute stress disorder is caused by exposure to trauma, which is defined as a stressor that causes intense fear and, usually, involves threats to life or serious injury to oneself or others. Examples are **rape**, mugging, combat, natural disasters, etc.

The symptoms of stress disorder include a combining of one or more dissociative and anxiety symptoms with the avoidance of reminders of the traumatic event. Dissociative symptoms include emotional detachment, temporary loss of memory, depersonalization, and derealization.

Anxiety symptoms connected with acute stress disorder include irritability, physical restlessness, sleep problems, inability to concentrate, and being easily startled.

Diagnosis

Diagnosis of acute stress disorder is based on a combination of the patient's history and a **physical examination** to rule out diseases that can cause anxiety. The essential feature is a traumatic event within one month of the onset of symptoms. Other diagnostic criteria include:

- The symptoms significantly interfere with normal social or vocational functioning
- The symptoms last between two days and four weeks.

Treatment

Treatment for acute stress disorder usually includes a combination of antidepressant medications and short-term **psychotherapy**.

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KEY TERMS

Depersonalization—A dissociative symptom in which the patient feels that his or her body is unreal, is changing, or is dissolving.

Derealization—A dissociative symptom in which the external environment is perceived as unreal.

Dissociation—A reaction to trauma in which the mind splits off certain aspects of the trauma from conscious awareness. Dissociation can affect the patient's memory, sense of reality, and sense of identity.

Trauma—In the context of ASD, a disastrous or life-threatening event.

Prognosis

The prognosis for recovery is influenced by the severity and duration of the trauma, the patient's closeness to it, and the patient's previous level of functioning. Favorable signs include a short time period between the trauma and onset of symptoms, immediate treatment, and appropriate social support. If the patient's symptoms are severe enough to interfere with normal life and have lasted longer than one month, the diagnosis may be changed to PTSD. If the symptoms have lasted longer than one month but are not severe enough to meet the definition of PTSD, the diagnosis may be changed to adjustment disorder.

Patients who do not receive treatment for acute stress disorder are at increased risk for **substance abuse** or major **depressive disorders**.

Prevention

Traumatic events cannot usually be foreseen and, thus, cannot be prevented. However, in theory, professional intervention soon after a major trauma might reduce the likelihood or severity of ASD. In addition, some symptoms of acute stress disorder result from biochemical changes in the central nervous system, muscles, and digestive tract that are not subject to conscious control.

Resources

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Lewis-Fernández, Roberto, et al. *Anxiety Disorders: Theory, Research and Clinical Perspectives*. Cambridge, UK: Cambridge University Press, 2010.

Rebecca J. Frey PhD

Acute stress gastritis *see* **Gastritis**

Acute transverse myelitis *see* **Transverse myelitis**

Acyclovir *see* **Antiviral drugs**

Addiction

Definition

Addiction is a disease of the brain that causes dependence upon or a persistent, compulsive need to use a habit-forming substance or an irresistible urge to engage in an activity, despite harmful consequences. Addictions are characterized by the increasing need for more of the substance or activity to obtain the same effect. Abstinence from the addiction may cause unpleasant or even life-threatening withdrawal symptoms.

Demographics

Addiction to substances and activities is very widespread in the United States, Canada, and around the world. **Substance abuse** and addiction costs Americans more than $484 billion annually in healthcare costs, lost earnings, accidents, and crime. Every year Americans suffer approximately 40 million debilitating illnesses or injuries as a result of tobacco, alcohol, and other addictive drug use. Likewise about one in ten Canadians age 15 and older are addicted to alcohol or drugs. Men are more than twice as likely as women to be addicted to a substance. However gender differences are much less pronounced among adolescents: teenage girls are almost as likely as boys to abuse a substance. Approximately 20% of people with addictions have other mental disorders as well.

Nicotine dependence is the most common type of addiction. It is estimated that worldwide tobacco use results in five million deaths annually. Cigarette **smoking** is the leading preventable cause of **death** in the United States, with 483,000 deaths annually, which is about one out of every five deaths. An additional 38,000 deaths annually are caused by exposure to secondhand smoke. As of 2007, about 19.8% of American adults smoked cigarettes. In addition about 23%

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Substance addiction and treatment

In 2009, 20.9 million people needed treatment for a substance addiction, but only 5.1% perceived this need and fewer still (1.8%) actually pursued treatment.

Dependence on specific drugs included:

Marijuana	4.2 million users
Pain relievers	1.8 million
Cocaine	1.1 million
Tranquilizers	481,000
Heroin	399,000
Stimulants	371,000
Hallucinogens	371,000
Inhalants	164,000
Sedatives	147,000

SOURCE: Substance Abuse and Mental Health Services Administration, Office of Applied Studies, *Results from the 2009 National Survey on Drug Use and Health: Volume I Summary of National Findings* (September 2010).

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of American high-school students and 8% of middle-school students smoked cigarettes.

Alcoholism is the most common addiction to a psychoactive substance. Alcohol addiction affects both sexes and all races and nationalities. In the United States 17.6 million people—about one in 12 adults—abuse or are addicted to alcohol. Alcohol addiction rates are highest among young adults aged 18–29 and lowest among those 65 and older.

An estimated four million Americans over the age of 12 use prescription **pain** relievers, sedatives, or stimulants for nonmedical reasons during any given month. In 2008, 15.4% of twelfth-graders reported using prescription drugs nonmedically. These included amphetamines, sedatives/barbiturates, tranquilizers, and opiates other than heroin.

Addictions most often first appear in adolescence. In a 2006 national survey, 14.9% of high school students reported having used an illicit drug in the previous month. Young people aged 15–24 are more likely to report addictions than those in other age groups. However the use of illegal drugs among American teenagers declined by 24% between 2001 and 2007. Cigarette smoking and alcohol use among American youth also declined significantly over the first decade of the twenty-first century.

Statistics on addictive activities are more difficult to obtain because these behaviors are less clearly defined than substance addiction. However a Harvard University study found that an estimated 15.4 million Americans suffered from a gambling addiction. More than one-half (7.9 million) were adolescents.

Description

Addiction most commonly refers to the compulsive use or abuse of or physical or psychological dependence on addictive substances, including:

- tobacco
- alcohol
- cocaine, including crack cocaine
- amphetamines, including methamphetamine or "crank," an extremely addictive substance
- heroin
- prescription medications Prescription painkillers, such as the opiates Vicodin and OxyContin, have emerged as drugs of special concern because of their widespread use by high-school students.

In recent years the term "addiction" has been used to describe a wide and complex range of behaviors. These so-called process addictions are compulsive behaviors involving activities such as:

- gambling
- eating
- working
- exercising
- shopping or otherwise spending money
- sex
- internet use, especially online gaming

Most addictions are associated with mood modification. Initially, at least, they make the addict feel better. Addicts often describe a release of tension or feelings of euphoria when using the substance or engaging in the activity. Most addictions are progressive syndromes—without treatment their severity increases over time. Furthermore many addicts are addicted to more than one substance or activity. Addictions are characterized by frequent relapse—a return to the abused substance or activity following recovery.

Some substances are more addictive than others, either because they produce a rapid and intense change in mood or because they produce painful withdrawal symptoms when stopped suddenly. Drugs that are smoked or injected, giving an immediate short-lived "high," tend to be more addictive than substances that are ingested.

The American Psychiatric Association's *Diagnostic and Statistical Manual of Mental Disorders* (*DSM-*

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IV-TR) classifies **substance abuse and dependence** as psychological disorders that are major clinical syndromes (called "Axis 1"). Over time repeated drug use changes brain structure and function in fundamental and long-lasting ways. Evidence suggests that these long-lasting brain changes are responsible for the distortions of cognitive and emotional functioning that characterize addicts, particularly the compulsion to use drugs. This explains why many addicts cannot stop using drugs by force of will alone.

Risk factors

Risk factors for addiction include:

- inherited factors
- adolescence
- addictive behavior in the home or among family members or peers
- early substance use
- early aggressive behavior
- academic failure
- lack of parental supervision
- poor social skills
- other mental disorders or illnesses
- substance abuse
- substance availability
- poverty

Causes and symptoms

For much of the twentieth century addiction was viewed as a moral failing; however today addiction is widely viewed as a disease. The disease model of alcohol and drug addiction was first introduced in the late 1940s by E. M. Jellinek and was adopted by the American Medical Association in 1956. According to the disease model, the compulsion to use alcohol and/or drugs is genetically and physiologically based and, although the disease can be arrested, it is progressive, chronic, and fatal if unchecked. However some experts argue that addiction is better understood as a learned behavior and that the negative behavior can be unlearned and replaced by learning new positive behaviors. The causes of addiction remain the subject of ongoing research and debate.

The initial positive consequences of substance use or a potentially addictive activity can "hook" a susceptible person and turn into an addiction. Addiction comes about through an array of changes in the brain and the strengthening of new memory connections. The anterior cingulated cortex in the frontal lobe of the brain is the area responsible for the long-term craving in addicts that triggers relapse.

Many experts believe that addictive substances and activities affect neurotransmitters in the brain. The primary pathway involved in the development and persistence of addiction is the brain reward or mesolimbic pathway, which operates via a neurotransmitter called dopamine. Dopamine pathways may interact with those of other neurotransmitters, including opioid pathways. These neuronal pathways have been identified as underlying both substance and process addictions.

Whatever the brain chemistry involved in addiction, it usually results from the interaction of several factors:

- Social learning. This may be the most important single factor in addiction and includes patterns of substance use and activities in the addict's family or subculture, peer pressure, and advertising or media influence.
- Availability. There are marked increases in addiction rates when tobacco, alcohol, or drugs are inexpensive or readily available.
- Individual development. Before the 1980s, addiction was blamed on an "addictive personality," which was described as escapist, impulsive, dependent, devious, manipulative, and self-centered. Although individual development may play a role in addiction, many doctors now believe that these character traits develop in addicts as a result of the addiction, rather than causing the addiction.
- Genetic factors. It is estimated that genetic factors account for 40–60% of an individual's vulnerability to addiction. Twin studies have shown that addiction has a strong inherited component. Some forms of addiction seem to run in families and some people appear to be more vulnerable to addiction because of their body chemistry.

The continued use of an addictive substance or engagement in an addictive activity causes the addict's body to adjust and develop tolerance. Increasing amounts of the substance or more frequent engagement in the activity are needed to produce the same effect. In some cases addicts routinely use amounts of a substance that would be lethal in someone who had not developed a tolerance.

The inability to hold a steady job and disruptions of social and familial relationships are common symptoms of all types of addiction. Over time the physical symptoms of an addiction increase and withdrawal

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KEY TERMS

Addictive personality—The concept that addiction is the result of pre-existing character defects.

Dopamine—A neurotransmitter in the brain.

Methamphetamine (Meth, Methadrine, "Speed")—A highly addictive medication that is used to treat attention deficit disorder and obesity, but is widely abused as a stimulant.

Neurotransmitter—A chemical that transmits impulses across a synapse between nerves.

Process addiction—Addiction to certain mood-altering behaviors, such as eating, gambling, sexual activity, overwork, and shopping.

Relapse—A recurrence of symptoms after a period of improvement or recovery.

Tolerance—The requirement for higher doses of a substance or more frequent engagement in an activity to achieve the same effect.

Withdrawal—The unpleasant, sometimes life-threatening physiological changes that occur due to the discontinuation of some drugs after prolonged regular use.

symptoms can become more severe. These symptoms vary with the individual and with the substance or activity.

According to the *DSM-IV-TR*, alcohol abuse progresses through a series of stages from social drinking to chronic alcoholism. Danger signs that indicate the probable onset of addiction to alcohol include:

- a frequent desire to drink
- increasing alcohol consumption
- memory lapses (blackouts)
- morning drinking
- hiding alcohol from family and coworkers
- drinking in secret

Alcoholic psychoses are symptoms of late-stage alcohol addiction and include:

- alcohol withdrawal delirium (delirium tremens)
- hallucinations
- Korsakoff's psychosis, an irreversible brain disorder involving severe memory loss

Symptoms of withdrawal from alcohol and some drugs may include:

- flu-like aches and pains
- digestive upset
- seizures
- hallucinatory sensations, such as the feeling of bugs crawling over one's skin
- damage to organs, including the brain and liver
- dementia

Diagnosis

Examination

Addictions are usually readily diagnosed by their symptoms and by lifestyle factors. Alcoholism is usually diagnosed when drinking impairs a person's life, personal relationships, work, and/or health. A physician, psychologist, or social worker usually makes a diagnosis of addiction based on the following criteria:

- a pattern of frequent and compulsive substance use or engagement in an activity
- preoccupation with acquiring and using an abused substance
- tolerance or escalation of the substance use or activity
- loss of willpower
- harmful consequences
- unmanageable lifestyle
- withdrawal symptoms

The examination may include probing for underlying conditions such as depression, emotional upset, **anxiety** or **stress**. A physician may also look for signs of **malnutrition** or other medical problems resulting from substance abuse.

Tests

Blood and urine tests may be ordered to check for substance use or for liver or other organ damage resulting from substance abuse.

Procedures

Imaging tests may be ordered to check for organ damage resulting from substance abuse.

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Treatment

Addictions are notoriously difficult to treat. Treatment often requires a combination of medical, psychological, and social approaches.

Traditional

Although addiction treatment may be provided by practicing clinicians such as psychiatrists, psychologists, and social workers, it is more often provided by specialized addiction treatment programs and clinics. These programs usually rely upon confrontational tactics and re-education, often employing former or recovering addicts to treat newly admitted addicts. Residential settings can be effective in helping addicted individuals to stay away from the many cues—including people and places—that form the setting for their addiction. Substance addicts may need hospital treatment to manage withdrawal symptoms.

Individual or group **psychotherapy** is often helpful for treating addictions after the substance use or addictive activity has ceased. Many of the negative behaviors and personality problems associated with addictions disappear when the substance use or activity ceases. **Family therapy** can be helpful for addressing and changing "enabling behaviors" by family members who help maintain the addiction by providing money, food, shelter, and/or emotional support.

The effectiveness of addiction treatment based on behavioral and other psychotherapeutic methods is well-documented. Specific therapies to treat addiction include:

- cognitive-behavioral approaches to prevent relapse by helping addicts recognize, avoid, and cope with situations that encourage their addictions
- motivation-enhancing strategies that utilize positive reinforcement and incentives
- motivational interviewing that uses strategies to promote behavior changes
- solution-oriented and other brief therapy techniques
- harm-reduction approaches

Drugs

Research continues into pharmacological treatments for easing withdrawal and treating various addictions. Some promising drugs boost the levels of neurotransmitters in the brain. Medications that are used to treat addiction include:

- nicotine replacement therapies including gum, patches, and inhalers
- bupropion (Zyban), an antidepressent, for tobacco addiction
- varenicline, which blocks the pleasant effects of nicotine on the brain
- disulfiram (Antabuse) and acamprosate (Campral) for treating alcoholism
- naltrexone (Depade, ReVia) for preventing relapse in alcohol and opioid addicts
- methadone, which blocks the euphoric effect of opiates
- buprenorphine (Subutex) or buprenorphine and naloxone (Suboxone) to prevent withdrawal symptoms and to treat addiction to opioids including heroin and narcotic painkillers
- sedatives for reducing anxiety and withdrawal symptoms
- antidepressants for treating underlying problems in addicts who have been "self-medicating"

Alternative

During the past several decades alternatives to the complete abstinence model have arisen. Controlled-use programs allow addicted individuals to reduce their use without committing to complete abstinence. This alternative is highly controversial and the prevailing belief is that recovery is only possible by committing to complete lifelong abstinence from all substance use.

Home remedies

Many people turn to self-help groups such as Alcoholics Anonymous (AA) and **Narcotics** Anonymous (NA) to treat their addictions. The approach of one addict helping another to stay "clean," with or without additional professional help, is widely accepted in the United States and around the world.

The most frequently recommended social outpatient treatment is the 12-step program. The number of visits to 12-step self-help groups exceeds the number of visits to all mental health professionals combined. There are 12-step groups for all major substance and process addictions.

The 12 steps consist of:

- Admit powerlessness over the addiction
- Believe that a power greater than oneself can restore sanity
- Make a decision to turn your will and your life over to the care of your higher power

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- Make a searching and fearless moral inventory of self
- Admit to your higher power, yourself, and another human being the exact nature of your wrongs
- Become willing to have your higher power remove all these defects from your character
- Humbly ask your higher power to remove your shortcomings
- Make a list of all persons harmed by your wrongs and become willing to make amends to them all
- Make direct amends to such people, whenever possible, except when to do so would injure them or others
- Continue to take personal inventory and promptly admit any future wrongdoings
- Seek to improve contact with the higher power of your understanding through meditation and prayer
- Carry the message of spiritual awakening to others and practice these principles in all your affairs

Prognosis

The prognosis for recovery from any addiction depends on the substance or process, the individual's circumstances, and the underlying personality structure. Patterns of relapse tend to be very similar regardless of the specific addiction. Two-thirds of all relapses occur within the first 90 days following treatment. Substance abusers often make repeated attempts to quit before they are successful. Physical addictions alter a person's brain chemistry in ways that make it difficult to be exposed to the addictive substance again without relapsing and cravings may persist for years. Between 40 and 60% of drug addicts relapse following treatment. Multi-drug users have the worst prognosis for recovery.

Substance abuse can damage organs, including the brain and liver, and can lead to serious and even fatal illness, as well as mental disorders such as **dementia**. Drug addiction puts the addict at risk for:

- cardiovascular disease
- stroke
- cancer
- HIV/AIDS
- hepatitis B and C
- lung disease
- obesity
- other mental disorders

Prevention

Preventive approaches are most effective when targeted at young teenagers between the ages of 11 and 13. It is during these years that most young people are likely to first experiment with drugs and alcohol. Hence reducing experimentation during this critical period holds promise for reducing the number of adults with addictions. Effective prevention programs focus on the concerns of young people with regard to the effects of tobacco, alcohol, and drugs. Training older adolescents to help younger adolescents resist peer pressure has shown considerable effectiveness in preventing experimentation.

Preventative measures against addiction include:

- fostering self-control and positive relationships
- promoting parental monitoring and support
- promoting anti-addiction policies
- educational programs for the public
- building strong communities

The most effective form of prevention appears to be a stable family that models responsible attitudes toward mood-altering substances and behaviors.

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ORGANIZATIONS

Al-Anon/Alateen, 1600 Corporate Landing Parkway, Virginia Beach, VA, 23454-5617, (757) 563-1600 (757) 563-1655wso@al-anon.org, http://www.al-anon.alateen.org.
Alcoholics Anonymous, PO Box 459, New York, NY, 10163, (212) 870-3400http://www.aa.org.
American Psychiatric Association, 1000 Wilson Blvd., Ste. 1825, Arlington, VA, 22209-3901, (703) 907-7300apa@psych.org, http://www.psych.org.
Center for Internet Addiction Recovery, P.O. Box 72, Bradford, PA, 16701, (814) 451-2405 (814) 368-9560http://www.netaddiction.com.
Centre for Addiction and Mental Health, 33 Russell St., Toronto, Ontario, Canada, M5S 2S1, (416) 535-8501 (800) 463-6273http://www.camh.net.
European Cities Against Drugs, Hantverkargatan 3D, City Hall, S-105-35, Stockholm, Sweden, 46-8-5082-9362 46-8-5082-9436ecad@ecad.net, http://www.ecad.net.
National Center on Addiction and Substance Abuse at Columbia University, 633 Third Avenue, 19th Floor, New York, NY, 10017-6706, (212) 841-5200http://www.casacolumbia.org.
National Clearinghouse for Alcohol and Drug Information, P.O. Box 2345, Rockville, MD, 20847-2345, (877) SAMHSA-7 (240) 221-4292, http://ncadi.samhsa.gov.
National Institute on Alcohol Abuse and Alcoholism (NIAAA), 5635 Fishers Lane, MSC 9304, Bethesda, MD, 20892-9304 (301) 443-3860, http://www.niaaa.nih.gov.
National Institute on Drug Abuse (NIDA), 6001 Executive Boulevard, Room 5213, Bethesda, MD, 20892-9561, (301) 443-1124information@nida.nih.gov, http://www.drugabuse.gov/NIDAHome.html.

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Addison's disease

Definition

Addison's disease is a disorder involving disrupted functioning of the part of the adrenal gland called the cortex. This results in decreased production of two important chemicals (hormones) normally released by the adrenal cortex: cortisol and aldosterone.

Description

The adrenals are two glands, each perched on the upper part of the two kidneys. The outer part of the gland is known as the cortex; the inner part is known as the medulla. Each of these parts of the adrenal gland is responsible for producing different types of hormones.

Cortisol is a very potent hormone produced by the adrenal cortex. It is involved in regulating the functioning of nearly every type of organ and tissue throughout the body, and is considered to be one of the few hormones absolutely necessary for life. Cortisol is involved in:

- the very complex processing and utilization of many nutrients, including sugars (carbohydrates), fats, and proteins
- the normal functioning of the circulatory system and the heart
- the functioning of muscles
- normal kidney function
- production of blood cells

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KEY TERMS

Gland—A collection of cells whose function is to release certain chemicals, or hormones, which are important to the functioning of other, sometimes distantly located, organs or body systems.

Hormone—A chemical produced in one part of the body, which travels to another part of the body in order to exert its effect.

- the normal processes involved in maintaining the skeletal system
- proper functioning of the brain and nerves
- the normal responses of the immune system

Aldosterone, also produced by the adrenal cortex, plays a central role in maintaining the appropriate proportions of water and salts in the body. When this balance is upset, the volume of blood circulating throughout the body will fall dangerously low, accompanied by a drop in blood pressure.

Addison's disease is also called primary adrenocortical insufficiency. In other words, some process interferes directly with the ability of the adrenal cortex to produce its hormones. Levels of both cortisol and aldosterone drop, and numerous functions throughout the body are disrupted.

Addison's disease occurs in about four in every 100,000 people. It strikes both men and women of all ages.

Causes and symptoms

The most common cause of Addison's disease is the destruction and/or shrinking (atrophy) of the adrenal cortex. In about 70% of all cases, this atrophy is believed to occur due to an autoimmune disorder. In an autoimmune disorder, the immune system of the body, responsible for identifying foreign invaders such as viruses or bacteria and killing them, accidentally begins to identify the cells of the adrenal cortex as foreign, and destroy them. In about 20% of all cases, destruction of the adrenal cortex is caused by **tuberculosis**. The remaining cases of Addison's disease may be caused by fungal infections, such as **histoplasmosis**, coccidiomycosis, and **cryptococcosis**, which affect the adrenal gland by producing destructive, tumor-like masses called granulomas; a disease called **amyloidosis**, in which a starchy substance called amyloid is deposited in abnormal places throughout the body, interfering with the function of whatever structure it is present within; or invasion of the adrenal glands by **cancer**.

In about 75% of all patients, Addison's disease tends to be a very gradual, slowly developing disease. Significant symptoms are not noted until about 90% of the adrenal cortex has been destroyed. The most common symptoms include **fatigue** and loss of energy, decreased appetite, **nausea**, **vomiting**, **diarrhea**, abdominal **pain**, weight loss, muscle weakness, **dizziness** when standing, **dehydration**, unusual areas of darkened (pigmented) skin, and dark freckling. As the disease progresses, the patient may appear to have very tanned, or bronzed skin, with darkening of the lining of the mouth, vagina, and rectum, and dark pigmentation of the area around the nipples (aereola). As dehydration becomes more severe, the blood pressure will continue to drop and the patient will feel increasingly weak and light-headed. Some patients have psychiatric symptoms, including depression and irritability. Women lose pubic and underarm hair, and stop having normal menstrual periods.

When a patient becomes ill with an infection, or stressed by an injury, the disease may suddenly and rapidly progress, becoming life-threatening. Symptoms of this "Addisonian crisis" include abnormal heart rhythms, severe pain in the back and abdomen, uncontrollable **nausea and vomiting**, a drastic drop in blood pressure, kidney failure, and unconsciousness. About 25% of all Addison's disease patients are identified due to the development of Addisonian crisis.

Diagnosis

Many patients do not recognize the slow progression of symptoms and the disease is ultimately identified when a physician notices the areas of increased pigmentation of the skin. Once suspected, a number of blood tests can lead to the diagnosis of Addison's disease. It is not sufficient to demonstrate low blood cortisol levels, as normal levels of cortisol vary quite widely. Instead, patients are given a testing dose of another hormone called corticotropin (ACTH). ACTH is produced in the body by the pituitary gland, and normally acts by promoting growth within the adrenal cortex and stimulating the production and release of cortisol. In Addison's disease, even a dose of synthetic ACTH does not increase cortisol levels.

To distinguish between primary adrenocortical insufficiency (Addison's disease) and secondary

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adrenocortical insufficiency (caused by failure of the pituitary to produce enough ACTH), levels of ACTH in the blood are examined. Normal or high levels of ACTH indicate that the pituitary is working properly, but the adrenal cortex is not responding normally to the presence of ACTH. This confirms the diagnosis of Addison's disease.

Treatment

Treatment of Addison's disease involves replacing the missing or low levels of cortisol. In the case of Addisonian crisis, this will be achieved by injecting a potent form of steroid preparation through a needle placed in a vein (intravenous or IV). Dehydration and salt loss will also be treated by administering carefully balanced solutions through the IV. Dangerously low blood pressure may require special medications to safely elevate it until the **steroids** take effect.

Patients with Addison's disease will need to take a steroid preparation (hydrocortisone) and a replacement for aldosterone (fludrocortisone) by mouth for the rest of their lives. When a patient has an illness that causes nausea and **vomiting** (such that they cannot hold down their medications), he or she will need to enter a medical facility where IV medications can be administered. When a patient has any kind of infection or injury, the normal dose of hydrocortisone will need to be doubled.

Prognosis

Prognosis for patients appropriately treated with hydrocortisone and aldosterone is excellent. These patients can expect to enjoy a normal lifespan. Without treatment, or with substandard treatment, patients are always at risk of developing Addisonian crisis.

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National Adrenal Diseases Foundation, 505 Northern Boulevard, Suite 200, Great Neck, NY, 11021, (516) 487-4992, http://www.nadf.us.

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Adenoid hyperplasia

Definition

Adenoid hyperplasia, or sometimes also commonly called adenoid hypertrophy or enlarged adenoids, is the overenlargement (or, unusual growth) of the lymph glands (lymphatic tissue) located between the nose and the back of the mouth. The tissues are similar in characteristics to the tonsils.

Demographics

The condition is one that occurs quite frequently in childhood. The adenoidal tissue is small at birth and grows until children attain adolescence. Normally, it then begins to atrophy (shrink). However, in some cases the tissue continues to grow abnormally, resulting in adenoid hyperplasia.

Description

Located at the back of the mouth above and below the soft palate are two pairs of lymph glands. The tonsils below are clearly visible behind the back teeth; the adenoids lie just above them and are hidden from view by the palate. Together these four arsenals of immune defense guard the major entrance to the body from foreign invaders—the germs humans breathe and eat. In contrast to the rest of the body's tissues, lymphoid tissue reaches its greatest size in mid-childhood (around five years of age) and recedes thereafter (generally by seven years). In this way children are best able to develop the immunities they need to survive in a world full of infectious diseases.

Beyond its normal growth pattern, lymphoid tissue grows excessively (hypertrophies) during an acute infection, as it suddenly increases its immune activity to fight off invaders. Often it does not completely return to its former size. Each subsequent infection leaves behind a larger set of tonsils and adenoids. To make matters worse, the sponge–like structure of these hypertrophied glands can produce safe havens for germs where the body cannot reach and eliminate them. Before **antibiotics** and the reduction in infectious childhood diseases over the past few generations, tonsils and adenoids caused greater health problems.

Causes and symptoms

Most tonsil and adenoid hypertrophy is simply caused by the normal growth pattern for that type of tissue. Less often, the hypertrophy is due to repeated throat infections by cold viruses, **strep throat**,

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KEY TERMS

Eustacian tube—A tube connecting the middle ear with the back of the nose, allowing air pressure to equalize within the ear whenever it opens, such as with yawning.

Hyperplastic—Overgrown.

Hypertrophy—Overgrowth.

Strep throat—An infection of the throat caused by bacteria of the *Streptococcus* family, which causes tonsillitis.

Ulcerated—Damaged so that the surface tissue is lost and/or necrotic (dead).

mononucleosis, and, in times gone by, **diphtheria**. The acute infections are usually referred to as **tonsillitis**, the adenoids getting little recognition because they cannot be seen without special instruments. Symptoms include painful, bright red, often ulcerated tonsils, enlargement of lymph nodes (glands) beneath the jaw, **fever**, and general discomfort.

After the acute infection subsides, symptoms are generated simply by the size of the glands. Extremely large tonsils can impair breathing and swallowing, although that condition is quite rare. Large adenoids can block air passages and, thus, impair nose breathing and require a child to breathe through the mouth. **Snoring** during sleep may occur, along with frequent nasal congestion/nasal discharge when both awake and asleep. **Fatigue**, uneasy and restless sleep, daytime sleepiness, lessened appetite, **bad breath**, dry and cracked lips, nasally sounding voice, and fever may also occur. Because they encircle the only connection between the middle ear and the Eustachian tube, hypertrophied adenoids can also obstruct it and cause middle ear infections. Such infections are caused by abnormally high bacterial counts and build up of fluids in the middle ear. These fluids can drip onto sensitive vocal cords, which may lead to irritations and coughing.

Diagnosis

A simple tongue blade depressing the tongue allows an adequate view of the tonsils. Enlarged tonsils may have deep pockets (crypts) containing dead tissue (necrotic debris). Viewing adenoids requires a small mirror or fiber optic endoscope. X rays of the skull, along with computed tomography (CT) and **magnetic resonance imaging** (MRI) scans, taken laterally can show the adenoids. A child with recurring middle ear infections may well have large adenoids. A **throat culture** or mononucleosis test will usually reveal the identity of the germ.

Treatment

It used to be standard practice to remove tonsils and/or adenoids after a few episodes of acute throat or ear infection. The surgery is called **tonsillectomy and adenoidectomy** (T and A). Opinion changed as it was realized that this tissue is beneficial to the development of immunity. For instance, children without tonsils and adenoids produce only half the immunity to oral **polio** vaccine. In addition, treatment of ear and throat infections with antibiotics and of recurring ear infections with surgical drainage through the eardrum (tympanostomy) has greatly reduced the incidence of surgical removal of these lymph glands. When performed today, the procedure is usually used to correct nasal obstructions and reduce chronic middle ear infections and fluids.

Alternative treatment

There are many botanical/herbal remedies that can be used alone or in formulas to locally assist the tonsils and adenoids in their immune function at the opening of the oral cavity and to tone these glands. Keeping the Eustachian tubes open is an important contribution to optimal function in the tonsils and adenoids. **Food allergies** are often the culprits for recurring ear infections, as well as tonsillitis and adenoiditis. Identification and removal of the allergic food(s) can greatly assist in alleviating the cause of the problem. Acute tonsillitis also benefits from warm saline gargles. Alternative treatments should be used with care, as the benefits of many such treatments have not been confirmed by scientific research.

Prognosis

Hypertrophied adenoids are a normal part of growing up and should be respected for their important role in the development of immunity. Only when their size causes problems by obstructing breathing or middle ear drainage do they demand intervention.

Prevention

Prevention could be concentrated toward timely evaluation and appropriate treatment of sore throats to prevent overgrowth of adenoid tissue. Avoiding other children with acute respiratory illness will also reduce the spread of these common illnesses.

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Adenoid hypertrophy *see* **Adenoid hyperplasia**

Adenoid removal *see* **Tonsillectomy and adenoidectomy**

Adenoidectomy *see* **Tonsillectomy and adenoidectomy**

Adenovirus infections

Definition

Adenoviruses are DNA viruses (small infectious agents) that cause upper respiratory tract infections, **conjunctivitis**, and several other infections in humans, They usually infect the tissue lining of the respiratory tract.

Demographics

Adenoviruses were discovered in 1953. About 47 different types have been identified since then, and about half of them are believed to cause human diseases. Infants and children are most commonly affected by adenoviruses. Adenovirus infections can occur throughout the year, but seem to be most common from fall to spring.

Adenoviruses are responsible for 3–5% of acute respiratory infections in children and 2% of respiratory illnesses in civilian adults. They are more apt to cause infection among military recruits and other young people who live in institutional environments. Outbreaks among children are frequently reported at boarding schools and summer camps. Another example includes an increased outbreak of **gastroenteritis** among cruise passengers since 2002.

Description

Adenovirus infections most often cause illness of the respiratory system; however, they may also cause various other illnesses, such as gastroenteritis, conjunctivitis, **cystitis**, and rash illness. This virus was first recognized among military recruits during World War II, and is believed to be caused by conditions of crowding and **stress**.

In one mode of adenovirus infection (called lytic infection because it destroys large numbers of cells), adenoviruses kill healthy cells and replicate up to one million new viruses per cell killed (of which 1–5% are infectious). People with this kind of infection feel sick. In chronic or latent infection, a much smaller number of viruses are released and healthy cells can multiply more rapidly than they are destroyed. People who have this kind of infection do not seem to be sick. This is probably why many adults have immunity to adenoviruses without realizing they have been infected.

Acquired immunity

Most children have been infected by at least one adenovirus by the time they reach school age. Most adults have acquired immunity to multiple adenovirus types due to infections they had as children.

Childhood infections

In children, adenoviruses most often cause acute upper respiratory infections with **fever** and runny nose. Adenovirus types 1, 2, 3, 5, and 6 are responsible for most of these infections. Occasionally more serious lower respiratory diseases, such as **pneumonia**, may occur.

Adenoviruses also cause acute pharyngoconjunctival fever in children. This disease is most often caused by types 3 and 7. Symptoms, which appear suddenly and usually disappear in less than a week, include:

- inflammation of the lining of the eyelid (conjunctivitis)
- fever
- sore throat (pharyngitis)
- runny nose
- inflammation of lymph glands in the neck (cervical adenitis)

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Adenoviruses also cause acute **diarrhea** in young children, characterized by fever and watery stools. This condition is caused by adenovirus types 40 and 41 and can last as long as two weeks.

As much as 51% of all hemorrhagic cystitis (inflammation of the bladder and of the tubes that carry urine to the bladder from the kidneys) in American and Japanese children can be attributed to adenovirus infection. A child who has hemorrhagic cystitis has bloody urine for about three days, and invisible traces of blood can be found in the urine a few days longer. The child will feel the urge to urinate frequently—but find it difficult to do so—for about the same length of time.

Adult infections

In adults, the most frequently reported adenovirus infection is acute respiratory disease (ARD, caused by types 4 and 7) in military recruits. Influenza-like symptoms including fever, **sore throat**, runny nose, and **cough** are almost always present; weakness, chills, **headache**, and swollen lymph glands in the neck also may occur. The symptoms typically last three to five days.

Epidemic keratoconjunctivitis (EKC, caused by adenovirus types 8, 19, and 37) was first seen in shipyard workers whose eyes had been slightly injured by chips of rust or paint. This inflammation of tissues lining the eyelid and covering the front of the eyeball also can be caused by using contaminated contact lens solutions or by drying the hands or face with a towel used by someone who has this infection.

The inflamed, sticky eyelids characteristic of conjunctivitis develop 4–24 days after exposure and last between one and four weeks. Only 5–8% of patients with epidemic keratoconjunctivitis experience respiratory symptoms. One or both eyes may be affected. As symptoms of conjunctivitis subside, eye **pain** and watering and blurred vision develop. These symptoms of **keratitis** may last for several months, and about 10% of these infections spread to at least one other member of the patient's household.

Other illnesses associated with adenovirus include:

- encephalitis (inflammation of the brain) and other infections of the central nervous system (CNS)
- gastroenteritis (inflammation of the stomach and intestines)
- acute mesenteric lymphadenitis (inflammation of lymph glands in the abdomen)
- chronic interstitial fibrosis (abnormal growth of connective tissue between cells)
- intussusception (a type of intestinal obstruction)
- pneumonia that does not respond to antibiotic therapy
- whooping cough syndrome when *Bordetella pertussis* (the bacterium that causes classic whooping cough) is not found

KEY TERMS

Conjunctivitis—Inflammation of the conjunctiva, the mucous membrane lining the inner surfaces of the eyelid and the front of the eyeball.

Gastroenteritis—An acute inflammation of the lining of the stomach and intestines, characterized by nausea, diarrhea, abdominal pain and weakness, which has various causes, including food poisoning due to infection with such organisms as escherichia coli, staphylococcus aureus, and salmonella species, consumption of irritating food or drink, or psychological factors such as anger, stress, and fear.

Virus—A small infectious agent consisting of a core of genetic material (DNA or RNA) surrounded by a shell of protein.

Causes and symptoms

Specific adenovirus infections can be traced to particular sources and produce distinctive symptoms. In general, however, adenovirus infection is caused by:

- inhaling airborne viruses
- getting the virus in the eyes by swimming in contaminated water, using contaminated eye solutions or instruments, wiping the eyes with contaminated towels, or rubbing the eyes with contaminated fingers.
- not washing the hands after using the bathroom, and then touching the mouth or eyes

Symptoms common to most types of adenovirus infections include:

- cough
- fever
- runny nose
- sore throat
- watery eyes

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Diagnosis

Although symptoms may suggest the presence of adenovirus, distinguishing these infections from other viruses can be difficult. A definitive diagnosis is based on culture or detection of the virus in eye secretions, sputum, urine, or stool.

The extent of infection can be estimated from the results of blood tests that measure increases in the quantity of antibodies the immune system produces to fight it. Antibody levels begin to rise about a week after infection occurs and remain elevated for about a year.

Treatment

Treatment of adenovirus infections is usually supportive and aimed at relieving symptoms of the illness. Bed rest may be recommended along with medications to reduce fever and/or pain. (**Aspirin** should not be given to children because of concerns about Reye's syndrome.) Eye infections may benefit from topical **corticosteroids** to relieve symptoms and shorten the course of the disease. Hospitalization is usually required for severe pneumonia in infants and for EKC (to prevent blindness). No effective **antiviral drugs** have been developed.

Prognosis

Adenovirus infections are rarely fatal. Most patients recover fully. Immunocompromised children have a greater chance of serious side effects and **death**, with fatality rates as high as 50–69% (depending on the cause and extent of **immunodeficiency**).

Prevention

Practicing good personal hygiene and avoiding people with infectious illnesses can reduce the risk of developing adenovirus infection. Proper handwashing can prevent the spread of the virus by oral-fecal transmission. Sterilization of instruments and solutions used in the eye can prevent the spread of EKC, as can adequate chlorination of swimming pools.

A vaccine for pertussis has been developed and is in use in combination with **diphtheria** and **tetanus** vaccines for infants. It is shown to have nearly 90% efficacy. A vaccine containing live adenovirus types 4 and 7 is used to control disease in military recruits, but it is not recommended or available for civilian use. A recent resurgence of the adenovirus was found in a military population as soon as the **vaccination** program was halted. Vaccines prepared from purified subunits of adenovirus are under investigation.

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Adhesions

Definition

Adhesions are fibrous bands of scar tissue that form between internal organs and tissues, joining them together abnormally.

Description

Adhesions are made up of blood vessels and fibroblasts—connective tissue cells. They form as a normal part of the body's healing process and help to limit the spread of infection. However when adhesions cause the wrong tissues to grow into each other, many different complex inflammatory disorders can arise. Worldwide, millions of people suffer **pain** and dysfunction due to adhesion disease.

Depending on their location, the most common types of adhesions may called:

- abdominal adhesions
- intestinal adhesions
- intraperitoneal adhesions
- pelvic adhesions
- intrauterine adhesions or Asherman's syndrome.

Adhesions can form between various tissues in the body including:

- loops of the intestines

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KEY TERMS

Asherman's syndrome—The cessation of menstruation and/or infertility caused by intrauterine adhesions.

Computed axial tomography; CT or CAT scan—A computer reconstruction of scanned x rays used to diagnose intestinal obstructions.

Endometriosis—A condition in which the endometrial tissue that lines the uterus begins to invade other parts of the body.

Endoscope—A device with a light that is used to look into a body cavity or organ.

Fibroblast—A connective-tissue cell.

Glaucoma—A group of eye diseases characterized by increased pressure within the eye that can damage the optic nerve and cause gradual loss of vision.

Hysteroscopy—A procedure in which an endoscope is inserted through the cervix to view the cervix and uterus.

Hysterosalpingography; HSG—X raying of the uterus and fallopian tubes following the injection of a contrast dye.

Irido corneal endothelial syndrome; ICE—A type of glaucoma in which cells from the back of the cornea spread over the surface of the iris and tissue that drains the eye, forming adhesions that bind the iris to the cornea.

Laparoscopic surgery; keyhole surgery—Surgery that utilizes a laparoscope with a video camera and surgical instruments inserted through small incisions.

Laparoscopy—A procedure that utilizes an endoscope to view contents of the abdominal cavity.

Pelvic inflammatory disease; PID—Inflammation of the female reproductive organs and associated structures.

Peritoneum—The membrane lining the walls of the abdominal and pelvic cavities and enclosing their organs.

Small bowel obstruction; SBO—An obstruction of the small intestine that prevents the free passage of material; sometimes caused by postoperative adhesions.

- the intestines and other abdominal organs or the abdominal wall
- abdominal organs such as the liver or bladder and the abdominal wall
- tissues of the uterus

Although adhesions can be congenital (present at birth) or result from inflammation, injury, or infection, the vast majority of adhesions form following surgery. Adhesions are a major complication of many common surgical procedures and may occur in 55% to more than 90% of patients, depending on the type of surgery.

All abdominal surgeries carry the risk of adhesion formation. Abdominal adhesions are rare in people who have not had abdominal surgery and very common in people who have had multiple abdominal surgeries. Adhesions are more common following procedures involving the intestines, colon, appendix, or uterus. They are less common following surgeries involving the stomach, gall bladder, or pancreas. Although most abdominal adhesions do not cause problems, they can be painful when stretched or pulled because the scar tissue is not elastic.

Postoperative intestinal adhesions are a major cause of intestinal or small bowel obstruction (SBO). In a small number of people the scar tissue pulls sections of the small or large intestines out of place and partially or completely blocks the passage of food and fluids. Thus SBOs can result from abdominal surgery and also are one of the most common reasons for abdominal surgery. Although intestinal obstruction is fatal in about 5% of patients, the mortality rate associated with SBO has decreased dramatically over the past century.

Intrauterine adhesions are relatively common in women and the majority of women undergoing gynecological surgery develop postoperative adhesions. Sometimes these pelvic adhesions cause chronic pelvic pain and/or **infertility**.

Adhesions can cause a rare form of glaucoma called irido corneal endothelial (ICE) syndrome. In this disorder cells from the back surface of the cornea of the eye spread over the surface of the iris and the tissue that drains the eye, forming adhesions that bind the iris to the cornea and causing further blockage of the drainage channels. This blockage increases the pressure inside the eye, which may damage the optic nerve. ICE syndrome occurs most often in light-skinned females.

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Causes and symptoms

Post-surgical adhesions

Common causes of postoperative adhesions include:

- abdominal surgery
- gynecological surgery
- thoracic surgery
- orthopedic surgery
- plastic surgery

Abdominal adhesions most often result from surgeries in which the organs are handled or temporarily moved. Intrauterine adhesions form after surgeries involving the uterus, particularly curettage—the scraping of the uterine contents. Surgery to control uterine bleeding after giving birth also can lead to intrauterine adhesions. Such adhesions can cause Asherman's syndrome, closing the uterus and preventing menstruation.

Other causes of adhesions

Any inflammation or infection of the membranes that line the abdominal and pelvic walls and enclose the organs—the peritoneum—can cause adhesions. **Peritonitis**, a severe infection that can result from **appendicitis**, may lead to adhesions. In addition to surgery or injury, pelvic adhesions can be caused by inflammation resulting from an infection such as **pelvic inflammatory disease** (PID).

Symptoms

In the majority of people adhesions do not cause symptoms or serious problems. However in some people adhesions can lead to a variety of disorders. The symptoms depend on the type of adhesion and the tissues that are involved. Adhesions may cause pain and/or **fever** in some people.

ABDOMINAL OBSTRUCTION. If a loop of intestine becomes trapped under an adhesion, the intestine may become partially or completely blocked. The symptoms of intestinal obstruction or SBOs due to adhesions depend on the degree and location of the obstruction. Partial or off-and-on intestinal obstruction due to adhesions may result in intermittent periods of painful abdominal cramping and other symptoms, including **diarrhea**.

Symptoms of significant intestinal obstruction due to adhesions include:

- severe abdominal pain and cramping
- nausea and vomiting
- abdominal distension (swelling)
- constipation and the inability to pass gas
- symptoms of dehydration

Symptoms of **dehydration** include:

- dry mouth and tongue
- severe thirst
- infrequent urination
- dry skin
- fast heart rate
- low blood pressure

In about 10% of SBOs, part of the intestine twists tightly and repeatedly around a band of adhesions, cutting off the blood supply to the intestine and resulting in strangulation and **death** of the twisted bowel. The mortality rate for strangulation of the bowel may be as high as 37%.

Symptoms of bowel strangulation due to adhesions include:

- severe abdominal pain, either cramping or constant
- abdominal distension due to the inability to pass stool and gas
- an extremely tender abdomen
- signs of systemic (body-wide) illness, including fever, fast heart rate, and low blood pressure

When a portion of the obstructed bowel begins to die from lack of blood flow, fluids and bacteria that help digest food can leak out of the intestinal wall and into the abdominal cavity causing peritonitis.

PELVIC ADHESIONS. Pelvic adhesions can interfere with the functioning of the ovaries and fallopian tubes and are among the common causes of female infertility. Adhesions on the ovaries or fallopian tubes can prevent **pregnancy** by trapping the released egg. Adhesions resulting from **endometriosis** can cause pelvic pain, particularly during menstruation, as well as fertility problems.

Diagnosis

Adhesions are diagnosed based on the symptoms, surgical history, and a **physical examination**. The physician examines the abdomen and rectum and performs a pelvic examination on women. Blood tests and chest and abdominal x rays are taken. Sometimes exploratory surgery is used to locate the adhesions and sources of pain.

Abdominal computed axial tomography—a CT or CAT scan—is the most common diagnostic tool for SBO and intestinal strangulation due to adhesions. In this procedure a computer reconstructs a portion of the abdomen from x-ray scans. Barium contrast x-ray

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studies also may be used to locate an obstruction. The ingestion of a barium solution provides better visualization of the abdominal organs. However sometimes intestinal obstruction or strangulation cannot be confirmed without abdominal surgery.

Exploratory **laparoscopy** may be used to detect either abdominal or pelvic adhesions. This procedure usually is performed in a hospital under local or **general anesthesia**. A small incision is made near the naval and carbon dioxide gas is injected to raise the abdominal wall. A tube called a trocar is inserted into the abdomen. The laparascope, equipped with a light and a small video camera, is passed through the trocar for visualization of the peritoneal cavity and the abdominal or pelvic organs.

Pelvic adhesions also may be detected by **hysteroscopy**. In this procedure a uterine endoscope is inserted through the cervix to visualize the cervix and uterine cavity. With **hysterosalpingography** (HSG) a radiopaque or contrast dye is injected through a catheter in the cervix and x rays are taken of the uterus and fallopian tubes.

Treatment

Although the symptoms of adhesion disease sometimes disappear on their own, adhesions are permanent without a surgical procedure called adhesion lysis to disrupt or remove the tissue.

Abdominal adhesions

Sometimes an adhesion-trapped intestine frees itself spontaneously. Surgery may be used to reposition the intestine to relieve symptoms. Various other techniques include using suction to decompress the intestine; however, untreated intestinal adhesions may lead to bowel obstruction.

Although dilation with an endoscope may be used to widen the region around an intestinal obstruction to relieve symptoms, SBOs caused almost always require immediate surgery. In cases of a partial obstruction or a complete obstruction without severe symptoms, surgery may be delayed for 12–24 hours so that a dehydrated patient can be treated with intravenous fluids. A small suction tube may be placed through the nose into the stomach to remove the stomach contents to relieve pain and **nausea** and prevent further bloating.

If an adhesion-related SBO disrupts the blood supply to part of the intestine, gangrene—tissue death—can occur. Strangulation of the bowel usually requires emergency abdominal surgery to remove the adhesions and restore blood flow to the intestine. Intestinal obstruction repair is performed under general anesthesia. An incision is made in the abdomen, the obstruction is located, and the adhesions are cut away, releasing the intestine. The bowel is examined for injury or tissue death. If possible, injured and dead sections are removed and the healthy ends of the intestine are stitched together (resectioned). If resectioning is not possible, the ends of the intestine are brought through an opening in the abdomen called an **ostomy**.

In some cases laparoscopic surgery can be used to removed damaged portions of the intestines. Five or six small incisions—0.2–0.4 in. (5–10 mm) in length—are made in the abdomen. The laparoscope, equipped with its light and camera, and surgical instruments are inserted through the incisions. The laparoscope guides the surgeon by projecting images of the abdominal organs on a video monitor. However the existence of multiple adhesions may preclude the use of laparoscopic surgery.

Other types of adhesions

Adhesions caused by endometriosis may be removed by either traditional open abdominal or pelvic surgery or by laparoscopic surgery. In the latter technique the laparoscope includes a laser for destroying the tissue with heat. Although untreated gynecological adhesions can lead to infertility, both types of surgeries also can result in adhesion formation.

ICE-type glaucoma caused by adhesions is difficult to treat; however untreated ICE syndrome can lead to blindness. Treatment usually includes medication and/or filtering surgery. Filtering microsurgery involves cutting a tiny hole in the white of the eye (the sclera) to allow fluid to drain, thereby lowering the pressure in the eye and preventing or reducing damage to the optic nerve.

Alternative treatment

In cases where the intestines are partially blocked by adhesions, a diet low in fiber—called a low-residue diet—may enable food to move more easily through the obstruction.

Prognosis

Intestinal obstruction surgery usually has a favorable outcome if the surgery is performed before tissue damage or death occurs. Surgery to remove adhesions and to free or reconnect the intestine often is sufficient for reducing symptoms and returning normal function to the intestine or other organ. However, the risk of new adhesion formation increases with each additional surgery. Thus abdominal adhesions can become

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a recurring problem. Adhesions reform in 11–21% of patients who have surgery to remove an adhesion-related intestinal obstruction. The risk of recurrence is particularly high among survivors of bowel strangulation.

Prevention

Abdominal and gynecological laparoscopic surgeries—also known as "keyhole" surgeries—reduce the size of the incision and the amount of contact with the organs, thereby lowering the risk of adhesion formation. Sometimes the intestines are fixed in place during surgery so as to promote benign adhesions that will not cause obstructions.

Within five days after surgery the disturbed tissue surfaces have formed a new lining of mesothelial cells that prevent adhesions from forming. Therefore biodegradable barrier membranes, films, gels, or sprays can be used to physically separate the tissues after surgery to prevent the formation of postoperative adhesions.However these gels and other barrier agents may:

- suppress the immune system
- cause infection
- impair healing

Systemic anti-inflammatory medications may be used to help prevent adhesion formation. Recent studies suggest that the common oral arthritis drug, Celebrex, an anti-inflammatory COX-2 inhibitor, taken before and immediately after surgery, may help prevent abdominal adhesions. Celebrex is known to inhibit both the formation of blood vessels and fibroblast activity, which are necessary for the formation of scar tissue.

Recent research has focused on the incorporation of anti-inflammatory and anti-proliferation drugs into polymeric films used for preventing and treating post-surgical adhesions. New types of gels to prevent post-operative adhesions also are under development.

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Margaret Alic Ph.D.

Adjustment disorders

Definition

Adjustment disorders (ADs) are a group of disorders in which a person's psychological response to a stressor elicits symptoms that warrant clinical attention. This uniting feature of the adjustment disorders can manifest as emotional distress that exceeds what is an expected norm or by notable impairment of the person's functioning in the world, socially, academically, and/or occupationally.

Ajustment disorders are considered subthreshold mental disorders, which means that they are less well defined and share some of their features with other diagnostic categories. This relative vagueness of definition allows for the classification of psychiatric conditions that are clinically significant but do not meet the full criteria for major syndromes. Another way of explaining adjustment disorders is that they are located on a continuum between normal **stress** reactions and specific psychiatric disorders.

Demographics

Even though adjustment disorders are so commonly diagnosed, there have been few large-scale epidemiological studies targeting adjustment disorders. Adjustment disorder appears to be fairly common in

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the American population; it is estimated that about 22% of adults seeking outpatient psychological treatment have one of the subtypes of this disorder. As many as 70% of children in psychiatric inpatient settings may be diagnosed with an adjustment disorder. In a questionnaire sent to child psychiatrists, 55% admitted to giving children the diagnosis of an adjustment disorder to avoid the stigma associated with other disorders.

There are no current studies of differences in the frequency of adjustment disorder in different racial or ethnic groups. There is, however, some potential for bias in diagnosis, particularly when the diagnostic criteria concern abnormal responses to stressors. The *DSM-IV-TR* specifies that clinicians must take a patient's cultural background into account when evaluating his or her responses to stressors. There is evidence that patients with average to higher-than-average incomes are more often diagnosed with AD than patients who lack socioeconomic stability or security.

Description

Often, a person experiences a stressful event as one that changes his or her world in some fundamental way. An adjustment disorder represents significant difficulty in adjusting to the new reality. Subsets of this disorder make up the most frequent psychiatric diagnoses among mentally ill populations, with features that include diagnosis of adjustment disorder. This difficulty, according to some experts, lies in the presentation of disorders in the *Diagnostic and Statistical Manual of Mental Disorders-IV, Text Revision* (also known as the DSM-IV-TR) as a dichotomy between what happens in the mind and what occurs physically in the body. Research results increasingly support that the dichotomy may not be tenable.

The category of adjustment disorder first appeared in the revised third edition of DSM (DSM-III-R) and included nine subtypes. The current edition, the DSM-IV-TR, lists six subtypes of adjustment disorder, generally based on what feature best characterizes the person's symptoms. These six subtypes are: adjustment disorder with depressed mood (thought to be the most common subtype); AD with **anxiety**; AD with mixed anxiety and depressed mood; AD with disturbance of conduct; AD with disturbance of emotions and conduct; or adjustment disorder not otherwise specified (ADNOS). This last subtype is applied when one of the other five simply does not fit the manifestations.

The criteria for these disorders also include time parameters. One of the criteria for diagnosing an adjustment disorder is that it is an acute response to stress lasting six or fewer months. In some special cases, the response can be chronic, lasting longer than six months, usually when the stressor has lasting consequences, such as divorce or **death** in the family.

The stressful events that precipitate an adjustment disorder vary widely. They may include the loss of a job; the end of a romantic relationship; a life transition such as a career change or retirement; the death of a pet; or a serious accident or sickness. Some are acute "one-time" stressors, such as relocating to a new area, while others are chronic, such as caring for a child with **mental retardation** or living in a crime-ridden neighborhood.

In spite of the disagreement among professionals about the validity of the diagnosis of adjustment disorder, many researchers consider the category useful for three reasons: (1) an adjustment disorder may be an early sign of a major mental disorder and allow for early treatment and intervention; (2) adjustment disorders are "situational" or "reactive" and do not imply that the patient has an underlying brain disease; and (3) the category does not carry the social stigma associated with such diagnostic categories as major depression; thus, it is less likely to affect the patient's employment or educational opportunities.

Risk factors

Risk factors for adjustment disorders include:

- More than one stressful life event within a relatively short time period
- History of abusive parenting, family disruption, fetal alcohol syndrome, or frequent moves in early childhood
- Concurrent mental health problems
- Exposure to war or criminal violence
- Poverty, homelessness, or other difficult life circumstances
- Being socially isolated or lacking a family or friendship network

Causes and symptoms

Causes

The processes leading to disruption of an individual patient's ability to adapt to change are not well understood. In the initial edition of the DSM-IV, the identifiable stressor was described as being "psychosocial," a category that excludes physical illnesses and natural disasters. In the *DSM-IV-TR*, the word "psychosocial" was deleted to make the point that any stressful event can lead to an adjustment disorder. It

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KEY TERMS

Cognitive-behavioral therapy—An approach to psychotherapy that emphasizes the correction of distorted thinking patterns and changing one's behaviors accordingly.

Decision tree—A decision support model used in medical and psychiatric diagnosis that consists of a tree-like chart or diagram including various symptoms, tentative diagnoses, diagnostic decisions, and their possible consequences.

Group therapy—Group interaction designed to provide support, correction through feedback, constructive criticism, and a forum for consultation and reference.

Interpersonal therapy—An approach that includes psychoeducation about the sick role, and emphasis on the present and improving interpersonal dynamics and relationships. Interpersonal therapy is effective in treating adjustment disorders related to physical illness.

Psychosocial—A term that refers to the emotional and social aspects of psychological disorders.

Solution-focused therapy—A type of therapy that involves concrete goals and an emphasis on future direction rather than past experiences.

Stressor—A stimulus or event that provokes a stress response in an organism. Stressors can be categorized as acute or chronic, and as external or internal to the organism.

Subthreshold—A term used in psychiatry to describe a condition that has significant clinical features but does not meet the full criteria of major disorders. Adjustment disorders are considered subthreshold disorders.

Support group—A group whose primary purpose is the provision of empathy and emotional support for its members. Support groups are less formal and less goal-directed than group therapy.

is important to recognize, however, that while adjustment disorders are triggered by external stressors, the symptoms result from the person's interpretation of and adaptation to the stressful event or circumstances. Beliefs, perceptions, fears, and expectations influence the development of an adjustment disorder.

People with chronic physical illnesses appear to have an increased risk of developing adjustment disorders, particularly one with depressed mood. This connection has been demonstrated among **cancer** patients. The relationship between chronic **pain** (as is commonly experienced by cancer patients) and depressive symptoms is still being studied.

Symptoms

Unlike many other disorders categorized in the DMS-IV-TR, adjustment disorders do not have an accompanying clearly delineated symptom profile, which has led to its being perceived as a "transitional" diagnosis, awaiting the manifestation of symptoms more clearly related to some other, better-defined disorder. This ambiguity arises from the difficulty in establishing what defines a reaction within the norms of a population. The *DSM-IV-TR* states that the symptoms of an adjustment disorder must appear within three months of a stressor; and that they must meet at least one of the following criteria: (1) the distress is greater than what would be expected in response to that particular stressor; or (2) the patient experiences significant impairment in social relationships or in occupational or academic settings. Moreover, the symptoms cannot represent **bereavement**, as normally experienced after the death of a loved one and cannot be an exacerbation of another, preexisting disorder and does not meet the criteria for another disorder.

Each of the six subtypes of adjustment disorder is characterized by its own predominant symptoms:

- With depressed mood: The chief manifestations are feelings of sadness and depression, with a sense of accompanying hopelessness. The patient may be tearful and have uncontrollable bouts of crying.
- With anxiety: The patient is troubled by feelings of apprehension, nervousness, and worry. He or she may also feel jittery and unable to control his or her thoughts of doom. Children with this subtype may express fears of separation from parents or other significant people, and refuse to go to sleep alone or attend school.
- With mixed anxiety and depressed mood: The patient has a combination of symptoms from the previous two subtypes.
- With disturbance of conduct: This subtype involves such noticeable behavioral changes as shoplifting, truancy, reckless driving, aggressive outbursts, or sexual promiscuity. The patient disregards the rights

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of others or previously followed rules of conduct with little concern, guilt or remorse.

- With mixed disturbance of emotions and conduct: The patient exhibits sudden changes in behavior combined with feelings of depression or anxiety. He or she may feel or express guilt about the behavior, but then repeat it shortly thereafter.
- AD not otherwise specified: This subtype covers patients who are adjusting poorly to stress but who do not fit into the other categories. These patients may complain of physical illness and pull away from social contact.

Adjustment disorders may lead to **suicide** or suicidal thinking. Researchers have also found that the suicidal process moves faster and evolves more rapidly in patients with adjustment disorders than in those with major depression. Adjustment disorders may also complicate the treatment of other diseases when, for instance, a sufferer loses interest in taking medication as prescribed or adhering to **diets** or **exercise** regimens.

An adjustment disorder can occur at any stage of life; however, the risk of an AD appears to increase during periods of life associated with major life changes, such as late adolescence, midlife, and retirement.

Diagnosis

Adjustment disorders are almost always diagnosed as the result of an interview with a psychiatrist. The psychiatrist will take a history, including identification of the stressor that has triggered the adjustment disorder, and evaluate the patient's responses to the stressor. The patient's primary physician may give him or her a thorough **physical examination** to rule out a previously undiagnosed medical illness.

The American Psychiatric Association considers adjustment disorder to be a residual category, meaning that the diagnosis is given only when an individual does not meet the criteria for a major mental disorder. For example, if a person fits the more stringent criteria for major depressive disorder, the diagnosis of adjustment disorder is not given. If the patient is diagnosed with an adjustment disorder but continues to have symptoms for more than six months after the stressor and its consequences have ceased, the diagnosis is changed to another mental disorder. The one exception to this time limit is situations in which the stressor itself is chronic or has enduring consequences. In that case, the adjustment disorder would be considered chronic and the diagnosis could stand beyond six months.

The lack of a diagnostic checklist or decision tree for adjustment disorders distinguishes these disorders from either **post-traumatic stress disorder** or **acute stress disorder**. All three require the presence of a stressor, but the latter two define the extreme stressor and specific patterns of symptoms. With adjustment disorder, the stressor may be any event that is significant to the patient, and the disorder may take very different forms in different patients.

Adjustment disorders must also be distinguished from **personality disorders**, which are caused by enduring personality traits that are inflexible and cause social, interpersonal, and occupational impairment. A personality disorder that has not yet surfaced may be made worse by a stressor and may mimic an adjustment disorder. A clinician must separate relatively stable traits in a patient's personality from passing disturbances. In some cases, however, the patient may be given both diagnoses. Again, it is important for psychiatrists to be sensitive to the role of cultural factors in the presentation of the patient's symptoms.

If the stressor is a physical illness, diagnosis is further complicated. It is important to recognize the difference between an adjustment disorder and the direct physiological effects of a general medical condition (e.g. the usual temporary functional impairment associated with **chemotherapy**). This distinction can be clarified through communication with the patient's physician or by education about the medical condition and its treatment. For some individuals, however, both may occur and reinforce each other.

Examination

An office physical examination of a patient with an adjustment disorder will not usually lead to any significant findings unless the patient is suffering from a concurrent physical illness or injury.

Tests

There are no laboratory or imaging tests that can be used to diagnose adjustment disorder.

Treatment

Traditional

There have been few research studies of significant scope to compare the efficacy of different treatments for adjustment disorder. The relative lack of outcome studies is partially due to the lack of specificity in the diagnosis itself. Because there is such variability in the types of stressors involved in adjustment disorders, it has proven difficult to design effective studies. As a

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result, there is no consensus regarding the most effective treatments for adjustment disorder.

There are, however, guidelines for effective treatment of people with adjustment disorders. Effective treatments include stress-reduction approaches; therapies that teach coping strategies for stressors that cannot be reduced or removed; and those that help patients build support networks of friends, family, and people in similar circumstances. Psychodynamic **psychotherapy** may be helpful in clarifying and interpreting the meaning of the stressor for a particular patient. For example, if the person has cancer, he or she may become more dependent on others, which may be threatening for people who place a high value on self-sufficiency. By exploring those feelings, the patient can then begin to recognize all that is not lost and regain a sense of self-worth.

Therapies that encourage the patient to express the fear, anxiety, rage, helplessness, and hopelessness of dealing with the stressful situation may be helpful. These approaches include journaling, certain types of **art therapy**, and movement or dance therapy. Support groups and **group therapy** allow patients to gain perspective on the adversity and establish relationships with others who share their problem. Psychoeducation and medical crisis counseling can assist individuals and families facing stress caused by a medical illness.

Such types of brief therapy as **family therapy**, **cognitive-behavioral therapy**, solution-focused therapy, and interpersonal therapy have all met with some success in treating adjustment disorder.

Drugs

Clinicians do not agree on the role of medications in treating adjustment disorder. Some argue that medication is not necessary for adjustment disorders because of their brief duration. In addition, they maintain that medications may be counterproductive by undercutting the patient's sense of responsibility and his or her motivation to find effective solutions. At the other end of the spectrum, other clinicians maintain that medication by itself is the best form of treatment, particularly for patients with medical conditions, those who are terminally ill, and those resistant to psychotherapy. Others advocate a middle ground of treatment that combines medication and psychotherapy.

Alternative

Spiritual and religious counseling can be helpful, particularly for people coping with existential issues related to physical illness or with moral conflicts related to difficult personal decisions (divorce, abortion, withdrawing **life support** from a dying family member, etc.) .

Some herbal remedies appear to be helpful to some patients with adjustment disorders. For adjustment disorder with anxiety, a randomized controlled trial found that the 91 patients receiving Euphytose (an herbal preparation containing a combination of plant extracts including Crataegus, Ballota, Passiflora, Valeriana, Cola, and Paullinia) showed significant improvement over the 91 patients taking a placebo. There have been no reported follow-up studies confirming these findings.

Prognosis

Most adults who are diagnosed with adjustment disorder have a favorable prognosis. For most people, an adjustment disorder is temporary and will either resolve by itself or respond to treatment. For some, however, the stressor will remain chronic and the symptoms may worsen. In addition, patients with adjustment disorders engage in deliberate self-harm at a rate that surpasses most other mental disorders. They may also be at an increased risk for future **substance abuse** disorders. Still other patients may develop a major depressive disorder even in the absence of an additional stressor.

Studies have been conducted to follow up on patients five years after their initial diagnosis. At that time, 71% of adults were completely well with no residual symptoms, while 21% had developed a major depressive disorder or **alcoholism**. For children aged 8–13, adjustment disorder did not predict future psychiatric disturbances. For adolescents, however, the prognosis is more grim. After five years, 43% had developed a major psychiatric disorder, often of far greater severity. These disorders included **schizophrenia**, **schizoaffective disorder**, major depression, substance use disorders, or personality disorders. In contrast with adults, the adolescents' behavioral symptoms and the type of adjustment disorder predicted future mental disorders.

Researchers have noted that once an adjustment disorder is diagnosed, psychotherapy, medication, or both can prevent the development of a more serious mental disorder. Effective treatment is critical, as adjustment disorder is associated with an increased risk of suicide attempts, completed suicide, substance abuse, and various unexplained physical complaints. Patients with chronic stressors may require ongoing treatment for continued symptom management. While patients may not become symptom-free,

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treatment can halt the progression toward a more serious mental disorder by enhancing the patient's ability to cope.

Prevention

In many cases, there is little possibility of preventing the stressors that trigger adjustment disorders. One preventive strategy that is helpful to many patients, however, is learning to be proactive in managing ordinary life stress, and maximizing problem-solving abilities when they are not in crisis. In addition, the general availability of counseling following a large-scale stressful event may ameliorate some stress responses.

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American Psychiatric Association, 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209-3901 703-907-7300, apa@psych.org, http://www.psych.org/.

National Alliance on Mental Illness (NAMI), 2107 Wilson Blvd., Suite 300, Arlington, VA, 22201-3042 703-524-7600 Hotline: 800-950-NAMI (6264) 703-524-9094, http://www.nami.org/Hometemplate.cfm.

National Institute of Mental Health (NIMH), 6001 Executive Boulevard, Room 8184, MSC 9663, Bethesda, MD, 20892-9663 301-443-4513 866-615-6464 301-443-4279, nimhinfo@nih.gov, http://www.nimh.nih.gov/index.shtml.

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Adrenal gland cancer

Definition

Adrenal gland cancers are rare cancers occurring in the endocrine tissue of the adrenals. They are characterized by overproduction of adrenal gland hormones. Tumors that arise from the adrenal cortex are termed adrenocortical carcinoma while tumors that develop in the adrenal medulla are known as pheochromacytomas.

Demographics

Cancers of the adrenal gland are very rare. The estimated annual incidence of adrenocortical carcinoma in the United States is 1 case in 1 million people. However, incidence of this type of **cancer** is 10 times higher in children in southern Brazil. This higher incidence rate is linked to a combination of environmental and genetic risk factors. Pheochromacytomas are also rare tumors.

Description

The adrenal gland is a hormone-producing endocrine gland with two main parts, the cortex and the medulla. The main hormone of the adrenal cortex is cortisol and the main hormone of the adrenal medulla is epinephrine. When tumors develop in the adrenal gland, they secrete excess amounts of these hormones. A cancer that arises in the adrenal cortex is called

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an adrenocortical carcinoma and can produce high blood pressure, weight gain, excess body hair, weakening of the bones and diabetes. Although rare, adrenocortical carcinomas are aggressive cancers that are typically diagnosed in later stages of advanced disease.

A cancer in the adrenal medulla is called a **pheochromocytoma** and can cause high blood pressure, **headache**, **palpitations**, and excessive perspiration.

There is a bimodal incidence pattern related to adrenocortical carcinoma with one incidence peak occurring prior to age five and a second peak manifesting between the fourth and fifth decades. The average age at diagnosis for pheochromocytoma in one report of more than 199 patients diagnosed with the disease was 47 years.

Risk factors

Although the specific causes of adrenal gland cancers are not known some cases of adrenocortical carcinomas have been linked to several hereditary cancer syndromes such as:

- Li-Fraumeni syndrome
- Beckwith-Wiedemann syndrome
- Multiple Endocrine Neoplasia type 1 (MEN1)
- SBLA (sarcoma, breast cancer, lung cancer, adrenocortical carcinoma) syndrome

Some cases of pheochromocytoma are also associated with hereditary cancer syndromes such as multiple endocrine neoplasia type 2 (MEN2) and von Hippel-Lindau disease.

Causes and symptoms

It is not known what causes most cases of adrenal gland cancer, but some cases are associated with hereditary or familial syndromes. Symptoms of adrenal cancer are related to the specific hormones produced by that tumor. An adrenocortical carcinoma typically secretes high amounts of cortisol, producing **Cushing's syndrome**. This syndrome produces progressive weight gain, rounding of the face, and increased blood pressure. These symptoms usually develop very quickly often within a span of three to six months. Women can experience menstrual cycle alterations and men can experience feminization, although this is a rare occurrence (less than 10% in men.)

The symptoms of pheochromocytoma include **hypertension**, although 5–15% of patients may have normal blood pressure; headache; generalized sweating; heart palpitations; and weakness. Because of the hormones produced by this type of tumor, **anxiety** and panic attack-type symptoms are often present as well.

KEY TERMS

Cortisol—A hormone produced by the adrenal cortex. It is partially responsible for regulating blood sugar levels.

Diabetes—A disease characterized by low blood sugar.

Epinephrine—A hormone produced by the adrenal medulla. It is important in the response to stress and partially regulates heart rate and metabolism. It is also called adrenaline.

Laparoscopy—The insertion of a tube through the abdominal wall. It can be used to visualize the inside of the abdomen and for surgical procedures.

Diagnosis

Tests

Diagnosis of adrenal cancer usually begins with blood tests to evaluate the hormone levels. Specific tests used to diagnosis adrenocortical carcinoma include evaluation of blood tests such as **fasting** blood glucose, serum potassium, fasting serum cortisol, serum estradiol, estrone, and adrenal androgens. A urine test that requires a 24-hour collection of urine, the 24-hour urinary free cortisol test, may also be ordered. Radiographic studies used to diagnose the tumor include computed tomography (CT) scans; **magnetic resonance imaging** (MRI); and, if a malignancy is suspected, **PET** scanning with fluorodeoxyglucose (FDG). Adrenocortical tumors of the adrenal gland tend to metastasize to the liver, lungs, lymph nodes and bones. These areas will be evaluated by radiographic imaging scans.

There is no consensus as to the best test to diagnosis pheochromocytoma. Some clinicians advocate the best approach to testing should be based upon the patient's clinical presentation and should include 24-hour urine collection to determine catecholamine (dopamine, norepinephrine, and epinephrine) and metanephrines (metanephrine and normetanephrine) levels and the plasma fractionated metanephrine test. Once the tumor has been confirmed using biochemical tests, radiologic tests such as CT and MRI to locate the tumor should be employed. Other radiologic tests used to support the

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biochemical evidence of pheochromocytoma include 123-I-metaiodobenzylguanidine (MIBG) scans, which can detect tumors not detected by CT or MRI, and other scans such as total body MRI and PET scanning.

Procedures

Fine-needle aspiration biopsy to obtain specimen from the suspected adrenal tumor may also be performed as part of the diagnostic evaluation.

Treatment

Traditional

When possible, total surgical removal (resection) of the adrenal gland is the recommended treatment for adrenocortical carcinoma. However, recurrent disease (nearly 80% of cases) is common even after total resection. Open laparotomy for **adrenalectomy** (removal of the adrenal gland) is the current standard of care. Removal of small tumors in which there is no evidence of metastasis may be accomplished by laparoscopic resection.

Radiation therapy may be used in patients at high risk for local recurrence and for palliative management of adrenocortical tumors that have metastasized to the bone or brain.

Drugs

The drug mitotane (Lysodren) remains the major chemotherapeutic option for the primary and adjuvant treatment of adrenocortical carcinoma. This drug is also used to treat recurrent or relapsed disease. Mitotane can be used to treat inoperable adrenocortical cancers as well. Other **chemotherapy** agents that may be used include streptozotocin, in combination with mitotane, and cisplatin-based chemotherapy when treatment with mitotane fails.

The recommended treatment of malignant pheochromocytoma also includes surgical removal. However, patients with malignant pheochromocytoma require pre-surgical medical management prior to surgery to control blood pressure and tachycardia. Typically, patients are ready for surgery 10-14 days after starting alpha- and beta-adrenergic blockade therapy. Surgery to remove this type of tumor is considered to be a high risk surgical procedure and should be attempted only by an experienced surgeon and surgical team. Surgery to remove the tumor can be accomplished by the laparoscopic approach if there is only one tumor and if the tumor is less than 8 cm in diameter. The goal of surgery is to remove as much tumor as possible. Open adrenalectomy may be required if the tumor is large or if it has metastasized.

If the pheochromocytoma is considered to be aggressive, combination chemotherapy may be initiated with the drugs cyclophosphamide, vincristine, and dacarbazine.

Prognosis

The prognosis for adrenal gland cancer is variable. For localized pheochromocytomas the five-year survival rate approaches 95%. This rate decreases with aggressive tumors that have metastasized. The overall five-year survival rate is less than 50% after surgical removal of the tumor. However, some patients have achieved prolonged survival. Disease recurrence is more likely in patients with familial pheochromocytoma.

For adrenocortical cancer, the five-year survival rate is highly dependent upon the stage of the disease at the time of diagnosis. Overall, the five-year survival estimates for adrenocortical carcinoma are 20-35%. The presence of distant metastasis significantly diminishes survival rates; about 50% of patients with metastasis die within 12 months regardless of treatment.

Prevention

Since little is known about the cause of adrenal gland cancer, it is not known if it can be prevented. Individuals at high risk because of familial or hereditary syndromes associated with the development of these cancers should speak with their physicians about recommendations related to screening for and early detection of the cancer.

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Adrenal gland removal *see* **Adrenalectomy**

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Adrenal gland scan

Definition

The adrenal gland scan is a nuclear medicine evaluation of the medulla (inner tissue) of the adrenal gland.

Purpose

The adrenal glands are a pair of small organs located just above the kidney, which contain two types of tissue. The adrenal cortex produces hormones that affect water balance and metabolism in the body. The adrenal medulla produces adrenaline and noradrenaline (also called epinepherine and norepinepherine).

An adrenal gland scan is done when too much adrenaline and noradrenaline is produced in the body and a tumor in the adrenal gland is suspected. One such situation in which a tumor might be suspected is when high blood pressure (**hypertension**) does not respond to medication. Tumors that secrete adrenaline and noradrenaline can also be found outside the adrenal gland. An adrenal gland scan usually covers the abdomen, chest, and head.

Precautions

Adrenal gland scans are not recommended for pregnant women because of the potential harm to the developing fetus. A pregnant woman should discuss with her doctor the risks of the procedure against the benefits of the information it can provide in evaluating her individual medical situation.

People who have recently undergone tests that use barium must wait until the barium has been eliminated from their system in order to obtain accurate results from the adrenal gland scan.

Description

The adrenal gland scan takes several days. On the first day, a radiopharmaceutical is injected intravenously into the patient. On the second, third, and fourth day the patient is positioned under the camera for imaging. The scanning time each day takes approximately 30 minutes. It is essential that the patient remain still during imaging.

Occasionally, the scanning process may involve fewer than three days, or it may continue several days longer. The area scanned extends from the pelvis and lower abdomen to the lower chest. Sometimes the upper legs, thighs, and head are also included.

Preparation

For two days before and ten days after the injection of the radiopharmaceutical, patients are given either Lugol's solution or potassium iodine. This prevents the thyroid from taking up radioactive iodine and interfering with the scan.

KEY TERMS

Adrenal cortex—The outer tissue of the adrenal gland. It produces a group of chemically related hormones called corticosteroids that control mineral and water balance in the body and include aldosterone and cortisol.

Adrenal medulla—The inner tissue of the adrenal gland. It produces the hormones adrenaline and noradrenaline.

Lugol's solution—A strong iodine solution.

Aftercare

The patient should not feel any adverse effects of the test and can resume normal activity immediately. Follow-up tests that might be ordered include a nuclear scan of the bones or kidney, a computed tomography scan (CT) of the adrenals, or an ultrasound of the pelvic area.

Risks

The main risk associated with this test is to the fetus of a pregnant woman.

Normal results

Normal results will show no unusual areas of hormone secretion and no tumors.

Abnormal results

Abnormal results will show evidence of a tumor where there is excessive secretion of adrenaline or noradrenaline. More than 90% of these tumors are in the abdomen.

Resources

BOOKS

Fishback, Francis, ed. *A Manual of Laboratory and Diagnostic Tests*. 8th ed. Philadelphia: Lippincott Williams & Wilkins, 2008.

Tish Davidson A.M.

Adrenal hypofunction *see* **Addison's disease**

Adrenal insufficiency *see* **Addison's disease**

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Adrenal virilism

Definition

Adrenal virilism is the development or premature development of male secondary sexual characteristics caused by male sex hormones (androgens) excessively produced by the adrenal gland. This disorder can occur before birth and can lead to sexual abnormalities in newborns. It can also occur in girls and women later in life.

Description

In the normal human body, there are two adrenal glands. They are small structures that lie on top of the kidneys. The adrenal glands produce many hormones that regulate body functions. These hormones include androgens, or male hormones. Androgens are produced in normal girls and women. Sometimes, one or both of the adrenal glands becomes enlarged or overactive, producing more than the usual amount of androgens. The excess androgens create masculine characteristics.

Causes and symptoms

In infants and children, adrenal virilism is usually the result of adrenal gland enlargement that is present at birth. This is called **congenital adrenal hyperplasia**. The cause is usually a genetic problem that leads to severe enzyme deficiencies. In rare cases, adrenal virilism is caused by an adrenal gland tumor. The tumor can be benign (adrenal adenoma) or cancerous (adrenal carcinoma). Sometimes virilism is caused by a type of tumor on a woman's ovary (arrhenoblastoma).

Newborn girls with adrenal virilism have external sex organs that seem to be a mixture of male and female organs (called female pseudohermaphrodism). Newborn boys with the disorder have enlarged external sex organs, and these organs develop at an abnormally rapid pace.

Children with congenital adrenal hyperplasia begin growing abnormally fast, but they stop growing earlier than normal. Later in childhood, they are typically shorter than normal but have well-developed trunks.

Women with adrenal virilization may develop facial hair. Typically, their menstrual cycles are infrequent or absent. They may also develop a deeper voice, a more prominent Adam's apple, and other masculine signs.

Diagnosis

Endocrinologists, doctors who specialize in the diagnosis and treatment of glandular disorders, have the most expertise to deal with adrenal virilization. Some doctors who treat disorders of the internal organs (internists) and doctors who specialize in treating the reproductive system of women (gynecologists) may also be able to help patients with this disorder.

Diagnosis involves performing many laboratory tests on blood samples from the patient. These tests measure the concentration of different hormones. Different abnormalities of the adrenal gland produce a different pattern of hormonal abnormalities. These tests can also help determine if the problem is adrenal or ovarian. If a tumor is suspected, special x rays may be done to visualize the tumor in the body. Final diagnosis may depend on obtaining a tissue sample from the tumor (biopsy), and examining it under a microscope in order to verify its characteristics.

Treatment

Adrenal virilism caused by adrenal hyperplasia is treated with daily doses of a glucocorticoid. Usually prednisone is the drug of choice, but in infants hydrocortisone is usually given. Laboratory tests are usually needed from time to time to adjust the dosage. Girls with pseudohermaphrodism may require surgery to make their external sex organs appear more normal. If a tumor is causing the disorder, the treatment will depend on the type and location of the tumor. Information about the tumor cell type and the spread of the tumor is used to decide the best kind of treatment for a particular patient. If the tumor is cancerous, the patient will require special treatment depending on how far the **cancer** has advanced. Treatment can be a combination of surgery, medications used to kill cancer cells (**chemotherapy**), and x rays or other high energy rays used to kill cancer cells (**radiation therapy**). Sometimes the doctor must remove the adrenal gland and the surrounding tissues. If the tumor is benign, then surgically removing the tumor may be the best option.

KEY TERMS

Glucocorticoid—A hormone produced by the adrenal gland; this hormone leads to an increase in blood sugar and creation of sugar molecules by the liver.

Hydrocortisone—A hormone in the group of glucocorticoid hormones.

Prednisone—A drug that functions as a glucocorticoid hormone.

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Prognosis

Ongoing glucocorticoid treatment usually controls adrenal virilism in cases of adrenal hyperplasia, but there is no cure. If a cancerous tumor has caused the disorder, patients have a better prognosis if they have an early stage of cancer that is diagnosed quickly and has not spread.

Resources

PERIODICALS

Willensy, D. "The Endocrine System." *AmericanHealth* April 1996: 92-3.

OTHER

Medline Plus: The Endocrine System. http://www.nlm.nih.gov/medlineplus/endocrinesystem.html.

Richard H. Lampert

KEY TERMS

Laparoscope—An instrument that enables the surgeon to see inside the abdominal cavity by means of a thin tube that carries an image to a television monitor.

Pancreas—An organ that secretes a number of digestive hormones and also secretes insulin to regulate blood sugar.

Pheochromocytoma—A tumor of specialized cells of the adrenal gland.

Spleen—An organ that traps and breaks down red blood cells at the end of their useful life and manufactures some key substances used by the immune system.

Vena cava—The large vein that drains directly into the heart after gathering incoming blood from the entire body.

Adrenalectomy

Definition

Adrenalectomy is the surgical removal of one or both of the adrenal glands. The adrenal glands are paired endocrine glands, one located above each kidney, that produce hormones such as epinephrine, norepinephrine, androgens, estrogens, aldosterone, and cortisol. Adrenalectomy is usually performed by conventional (open) surgery, but in selected patients surgeons may use **laparoscopy**. With laparoscopy, adrenalectomy can be accomplished through four very small incisions.

Purpose

Adrenalectomy is usually advised for patients with tumors of the adrenal glands. Adrenal gland tumors may be malignant or benign, but all typically excrete excessive amounts of one or more hormones. A successful procedure will aid in correcting hormone imbalances, and may also remove cancerous tumors that can invade other parts of the body. Occasionally, adrenalectomy may be recommended when hormones produced by the adrenal glands aggravate another condition such as **breast cancer**.

Precautions

The adrenal glands are fed by numerous blood vessels, so surgeons need to be alert to extensive bleeding during surgery. In addition, the adrenal glands lie close to one of the body's major blood vessels (the vena cava), and to the spleen and the pancreas. The surgeon needs to remove the gland(s) without damaging any of these important and delicate organs.

Description

Open adrenalectomy

The surgeon may operate from any of four directions, depending on the exact problem and the patient's body type.

In the anterior approach, the surgeon cuts into the abdominal wall. Usually the incision will be horizontal, just under the rib cage. If the surgeon intends to operate on only one of the adrenal glands, the incision will run under just the right or the left side of the rib cage. Sometimes a vertical incision in the middle of the abdomen provides a better approach, especially if both adrenal glands are involved.

In the posterior approach, the surgeon cuts into the back, just beneath the rib cage. If both glands are to be removed, an incision is made on each side of the body. This approach is the most direct route to the adrenal glands, but it does not provide quite as clear a view of the surrounding structures as the anterior approach.

In the flank approach, the surgeon cuts into the patient's side. This is particularly useful in massively obese patients. If both glands need to be removed, the surgeon must remove one gland, repair the surgical wound, turn the patient onto the other side, and repeat the entire process.

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The last approach involves an incision into the chest cavity, either with or without part of the incision into the abdominal cavity. It is used when the surgeon anticipates a very large tumor, or if the surgeon needs to examine or remove nearby structures as well.

Laparoscopic adrenalectomy

This technique does not require the surgeon to open the body cavity. Instead, four small incisions (about 1/2 in diameter each) are made into a patient's flank, just under the rib cage. A laparoscope, which enables the surgeon to visualize the inside of the abdominal cavity on a television monitor, is placed through one of the incisions. The other incisions are for tubes that carry miniaturized versions of surgical tools. These tools are designed to be operated by manipulations that the surgeon makes outside the body.

Preparation

Most aspects of preparation are the same as in other major operations. In addition, hormone imbalances are often a major challenge. Whenever possible, physicians will try to correct hormone imbalances through medication in the days or weeks before surgery. Adrenal tumors may cause other problems such as **hypertension** or inadequate potassium in the blood, and these problems also should be resolved if possible before surgery is performed. Therefore, a patient may take specific medicines for days or weeks before surgery.

Most adrenal tumors can be imaged very well with a CT scan or MRI, and benign tumors tend to look different on these tests than do cancerous tumors. Surgeons may order a CT scan, MRI, or scintigraphy (viewing of the location of a tiny amount of radioactive agent) to help locate exactly where the tumor is.

The day before surgery, patients will probably have an enema to clear the bowels. In patients with lung problems or clotting problems, physicians may advise special preparations.

Aftercare

Patients stay in the hospital for various lengths of time after adrenalectomy. The longest hospital stays are required for open surgery using an anterior approach; hospital stays of about three days are indicated for open surgery using the posterior approach or for laparoscopic adrenalectomy.

The special concern after adrenalectomy is the patient's hormone balance. There may be several sets of lab tests to define hormone problems and monitor the results of drug treatment. In addition, blood pressure problems and infections are more common after removal of certain types of adrenal tumors.

As with most open surgery, surgeons are also concerned about **blood clots** forming in the legs and traveling to the lungs (venous thromboembolism), bowel problems, and postoperative **pain**. With laparoscopic adrenalectomy, these problems are somewhat less difficult, but they are still present.

Risks

The special risks of adrenalectomy involve major hormone imbalances, caused by the underlying disease, the surgery, or both.These can include problems with wound healing itself, blood pressure fluctuations, and other metabolic problems.

Other risks are typical of many operations.These include:

- bleeding
- damage to adjacent organs (spleen, pancreas)
- loss of bowel function
- blood clots in the lungs
- lung problems
- surgical infections
- pain
- extensive scarring

Resources

BOOKS

Sippel, Rebecca S. "Endocrine Surgery" In Chen, Herbert. *Illustrative Handbook of General Surgery*. New York: Springer, 2010.

Richard H. Lampert

Adrenocortical insufficiency *see* **Addison's disease**

Adrenocorticotropic hormone test

Definition

Adrenocorticotropic hormone test (also known as an ACTH test or a corticotropin test) measures pituitary gland function.

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KEY TERMS

Adrenal glands—A pair of endocrine glands that lie on top of the kidneys.

Pituitary gland—The most important of the endocrine glands, glands that release hormones directly into the bloodstream; sometimes called the master gland.

Purpose

The pituitary gland produces the hormone ACTH, which stimulates the outer layer of the adrenal gland (the adrenal cortex). ACTH causes the release of the hormones hydrocortisone (cortisol), aldosterone, and androgen. The most important of these hormones released is cortisol. The ACTH test is used to determine if too much cortisol is being produced (**Cushing's syndrome**) or if not enough cortisol is being produced (**Addison's disease**).

Precautions

ACTH has diurnal variation, meaning that the levels of this hormone vary according to the time of day. The highest levels occur in the morning hours. Testing for normal secretion, as well as for Cushing's disease, may require multiple samples. For sequential follow-up, a blood sample analyzed for ACTH should always be drawn at the same time each day.

ACTH can be directly measured by an analyzing method (immunoassay) in many large laboratories. However, smaller laboratories are usually not equipped to perform this test and they may need to send the blood sample to a larger laboratory. Because of this delay, results may take several days to obtain.

Description

ACTH production is partly controlled by an area in the center of the brain (the hypothalamus) and partly controlled by the level of cortisol in the blood. When ACTH levels are too high, cortisol production increases to suppress ACTH release from the pituitary gland. If ACTH levels are too low, the hypothalamus produces corticotropin-releasing hormone (CRH) to stimulate the pituitary gland to make more ACTH. ACTH levels rise in response to **stress**, emotions, injury, infection, **burns**, surgery, and decreased blood pressure.

Cushing's syndrome

Cushing's syndrome is caused by an abnormally high level of circulating hydrocortisone. The high level may be the result of an adrenal gland tumor or enlargement of both adrenal glands due to a pituitary tumor. The high level of hydrocortisone may be the result of taking corticosteroid drugs for a long time. Corticosteroid drugs are widely used for inflammation in disorders like **rheumatoid arthritis**, inflammatory bowel disease, and **asthma**.

Addison's disease

Addison's disease is a rare disorder in which symptoms are caused by a deficiency of hydrocortisone and aldosterone. The most common cause of this disease is an autoimmune disorder. The immune system normally fights foreign invaders in the body like bacteria. In an autoimmune disorder, the immune systems attacks the body. In this case, the immune system produces antibodies that attack the adrenal glands. Addison's disease generally progresses slowly, with symptoms developing gradually over months or years. However, acute episodes, called Addisonian crises, are brought on by infection, injury, or other stresses. Diagnosis is generally made if the patient fails to respond to an injection of ACTH, which normally stimulates the secretion of hydrocortisone.

Preparation

A person's ACTH level is determined from a blood sample. The patient must fast from midnight until the test the next morning. This means that the patient cannot eat or drink anything after midnight except water. The patient must also avoid radioisotope scanning tests or recently administered radioisotopes prior to the blood test.

Risks

The risks associated with this test are minimal. They may include slight bleeding from the location where the blood was drawn. The patient may feel faint or lightheaded after the blood is drawn. Sometimes the patient may have an accumulation of blood under the puncture site (hematoma) after the test.

Normal results

Each laboratory will have its own set of normal values for this test. The normal values can range from: Morning (4–8 a.m.) 8–100 pg/mL or 10–80 ng/L (SI units); Evening (8–10 p.m.) less than 50 pg/mL or less than 50 ng/L (SI units).

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Abnormal results

In Cushing's syndrome, high levels of ACTH may be caused by ACTH-producing tumors. These tumors may be either in the pituitary or in another area (like tumors from lung **cancer** or **ovarian cancer**). Low ACTH levels may be caused by adrenal enlargement due to high levels of cortisol and feedback to the pituitary.

In Addison's disease, high levels of ACTH may be caused by adrenal gland diseases. These diseases decrease adrenal hormones and the pituitary attempts to increase functioning. Low levels of ACTH may occur because of decreased pituitary function.

Resources

BOOKS

Pagana, Kathleen Deska, and Timothy J. Pagana. *Mosby's Manual of Diagnostic and Laboratory Tests*. 4th ed. St. Louis: Mosby, 2009.

Janis O. Flores

Adrenogenital syndrome *see* **Adrenal virilism**

Adrenoleukodystrophy

Definition

Adrenoleukodystrophy is a rare genetic disease characterized by a loss of myelin surrounding nerve cells in the brain and progressive adrenal gland dysfunction.

Description

Adrenoleukodystrophy (ALD) is a member of a group of diseases, leukodystrophies, that cause damage to the myelin sheath of nerve cells. Approximately one in 100,000 people is affected by ALD. There are three basic forms of ALD: childhood, adult-onset, and neonatal. The childhood form of the disease is the classical form and is the most severe. Childhood ALD is progressive and usually leads to total disability or **death**. It affects only boys because the genetic defect is sex-linked (carried on the X chromosome). Onset usually occurs between ages four and ten and can include many different symptoms, not all of which appear together. The most common symptoms are behavioral problems and poor memory. Other symptoms frequently seen are loss of vision, seizures, poorly articulated speech, difficulty swallowing, deafness, problems with gait and coordination, **fatigue**, increased skin pigmentation, and progressive **dementia**.

KEY TERMS

Amniocentesis—The collection of amniotic fluid through a needle inserted through the abdomen. Used to collect fetal cells for genetic analysis.

Ataxia—Loss of coordination of muscular movement.

Hypertonia—Having excessive muscular tone.

Myelin—A layer that encloses nerve cells and some axons and is made largely of lipids and lipoproteins.

Neuropathy—A disease or abnormality of the peripheral nerves.

The adult-onset form of the disease, also called adrenomyeloneuropathy, is milder, progresses slowly, is usually associated with a normal life span, and usually appears between ages 21-35. Symptoms may include progressive stiffness, weakness, or **paralysis** of the lower limbs and loss of coordination. Brain function deterioration may also been seen. Women who are carriers of the disease occasionally experience the same symptoms, as well as others, including ataxia, hypertonia (excessive muscle tone), mild **peripheral neuropathy**, and urinary problems. The neonatal form affects both male and female infants and may produce **mental retardation**, facial abnormalities, seizures, retinal degeneration, poor muscle tone, enlarged liver, and adrenal dysfunction. Neonatal ALD usually progresses rapidly.

Causes and symptoms

The genetic defect in ALD causes a decrease in the ability to degrade very long chain fatty acids. These build up in the adrenal glands, brain, plasma, and fibroblasts. The build-up of very long chain fatty acids interferes with the ability of the adrenal gland to convert cholesterol into **steroids** and causes demyelination of nerves in the white matter of the brain. Demyelinated nerve cells are unable to function properly.

Diagnosis

Diagnosis is made based on observed symptoms, a biochemical test, and a family history. The biochemical test detects elevated levels of very long chain fatty acids in samples from **amniocentesis**, chorionic villi,

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plasma, red blood cells, or fibroblasts. A family history may indicate the likelihood of ALD because the disease is carried on the X-chromosome by the female lineage of families.

Treatment

Treatment for all forms of ALD consists of treating the symptoms and supporting the patient with **physical therapy**, psychological counseling, and special education in some cases. There is no cure for this disease, and there are no drugs that can reverse demyelination of nerve and brain cells. Dietary measures consist of reducing the intake of foods high in fat, which are a source of very long chain fatty acids. A mixture called Lorenzo's Oil has been shown to reduce the level of long chain fatty acids if used long term; however, the rate of myelin loss is unaffected. Experimental **bone marrow transplantation** has not been very effective.

Prognosis

Prognosis for childhood and neonatal ALD patients is poor because of the progressive myelin degeneration. Death usually occurs between one and ten years after onset of symptoms.

Prevention

Since ALD is a genetic disease, prevention is largely limited to **genetic counseling** and fetal monitoring through amniocentesis or **chorionic villus sampling**.

Resources

BOOKS

Beers, Mark H., Robert S. Porter, and Thomas V. Jones, eds. *The Merck Manual of Diagnosis and Therapy*. 18th ed. Whitehouse Station, NJ: Merck Research Laboratories, 2006.

John T. Lohr PhD

Adrenomyeloneuropathy *see* **Adrenoleukodystrophy**

Adult respiratory distress syndrome

Definition

Adult **respiratory distress syndrome** (ARDS), also called acute respiratory distress syndrome, is a type of lung (pulmonary) failure that may result from any disease that causes large amounts of fluid to collect in the lungs. ARDS is not itself a specific disease, but a syndrome, a group of symptoms and signs that make up one of the most important forms of lung or **respiratory failure**. It can develop quite suddenly in persons whose lungs have been perfectly normal. Very often ARDS is a true medical emergency. The basic fault is a breakdown of the barrier, or membrane, that normally keeps fluid from leaking out of the small blood vessels of the lung into the breathing sacs (the alveoli).

Description

Another name for ARDS is shock lung. Its formal name is misleading, because children, as well as adults, may be affected. In the lungs the smallest blood vessels, or capillaries, make contact with the alveoli, tiny air sacs at the tips of the smallest breathing tubes (the bronchi). This is the all-important site where oxygen passes from air that is inhaled to the blood, which carries it to all parts of the body. Any form of lung injury that damages this point of contact, called the alveolo-capillary junction, will allow blood and tissue fluid to leak into the alveoli, eventually filling them so that air cannot enter. The result is the type of breathing distress called ARDS. ARDS is one of the major causes of excess fluid in the lungs, the other being **heart failure**.

Along with fluid there is a marked increase in inflamed cells in the lungs. There also is debris left over from damaged lung cells, and fibrin, a semi-solid material derived from blood in the tissues. Typically these materials join together with large molecules in the blood (proteins), to form hyaline membranes. These membranes are very prominent in premature infants who develop respiratory distress syndrome; it is often called hyaline membrane disease. If ARDS is very severe or lasts a long time, the lungs do not heal, but rather become scarred, a process known as fibrosis. The lack of a normal amount of oxygen causes the blood vessels of the lung to become narrower, and in time they, too, may become scarred and filled with clotted blood. The lungs as a whole become very "stiff," and it becomes much harder for the patient to breathe.

Causes and symptoms

A very wide range of diseases or toxic substances, including some drugs, can cause ARDS. They include:

- Breathing in (aspiration) of the stomach contents when regurgitated, or salt water or fresh water from nearly drowning
- Inhaling smoke, as in a fire; toxic materials in the air, such as ammonia or hydrocarbons; or too much oxygen, which itself can injure the lungs

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KEY TERMS

Alveoli—The tiny air sacs at the ends of the breathing tubes of the lung where oxygen normally is taken up by the capillaries to enter the circulation.

Aspiration—The process in which solid food, liquids, or secretions that normally are swallowed are, instead, breathed into the lungs.

Capillaries—The smallest arteries which, in the lung, are located next to the alveoli so that they can pick up oxygen from inhaled air.

Face mask—The simplest way of delivering a high level of oxygen to patients with ARDS or other low-oxygen conditions.

Steroids—A class of drugs resembling normal body substances that often help control inflammation in the body tissues.

Ventilator—A mechanical device that can take over the work of breathing for a patient whose lungs are injured or are starting to heal.

- Infection by a virus or bacterium, or sepsis, a widespread infection that gets into the blood
- Massive trauma, with severe injury to any part of the body
- Shock with persistently low blood pressure may not in itself cause ARDS, but it can be an important factor
- A blood clotting disorder called disseminated intravascular coagulation, in which blood clots form in vessels throughout the body, including the lungs
- A large amount of fat entering the circulation and traveling to the lungs, where it lodges in small blood vessels, injuring the cells lining the vessel walls
- An overdose of a narcotic drug, a sedative, or, rarely, aspirin
- Inflammation of the pancreas (pancreatitis), when blood proteins, called enzymes, pass to the lungs and injure lung cells
- Severe burn injury
- Injury of the brain, or bleeding into the brain, from any cause may be a factor in ARDS for reasons that are not clear. Convulsions also may cause some cases

Usually ARDS develops within one to two days of the original illness or injury. The person begins to take rapid but shallow breaths. The doctor who listens to the patient's chest with a stethoscope may hear "crackling" or **wheezing** sounds. The low blood oxygen content may cause the skin to appear mottled or even blue. As fluid continues to fill the breathing sacs, the patient may have great trouble breathing, take very rapid breaths, and gasp for air.

Diagnosis

A simple test using a device applied to the ear will show whether the blood is carrying too little oxygen, and this can be confirmed by analyzing blood taken from an artery. The **chest x ray** may be normal in the early stages, but, in a short time, fluid will be seen where it does not belong. The two lungs are about equally affected. A heart of normal size indicates that the problem actually is ARDS and not heart failure. Another way a physician can distinguish between these two possibilities is to place a catheter into a vein and advance it into the main artery of the lung. In this way, the pressure within the pulmonary capillaries can be measured. Pressure within the pulmonary capillaries is elevated in heart failure, but normal in ARDS.

Treatment

The three main goals in treating patients with ARDS are:

- To treat whatever injury or disease has caused ARDS. Examples are: to treat septic infection with the proper antibiotics, and to reduce the level of oxygen therapy if ARDS has resulted from a toxic level of oxygen.
- To control the process in the lungs that allows fluid to leak out of the blood vessels. At present there is no certain way to achieve this. Certain steroid hormones have been tried because they can combat inflammation, but the actual results have been disappointing.
- To make sure the patient gets enough oxygen until the lung injury has had time to heal. If oxygen delivered by a face mask is not enough, the patient is placed on a ventilator, which takes over breathing, and, through a tube placed in the nose or mouth (or an incision in the windpipe), forces oxygen into the lungs. This treatment must be closely supervised, and the pressure adjusted so that too much oxygen is not delivered.

Patients with ARDS should be cared for in an intensive care unit, where experienced staff and all needed equipment are available. Enough fluid must be provided, by vein if necessary, to prevent **dehydration**. Also, the patient's nutritional state must be maintained, again by vein, if oral intake is not sufficient.

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Prognosis

If the patient's lung injury does not soon begin to heal, the lack of sufficient oxygen can injure other organs, such as the kidneys. There always is a risk that bacterial **pneumonia** will develop at some point. Without prompt treatment, as many as 90% of patients with ARDS can be expected to die. With modern treatment, however, about half of all patients will survive. Those who do live usually recover completely, with little or no long-term breathing difficulty. Lung scarring is a risk after a long period on a ventilator, but it may improve in the months after the patient is taken off ventilation. Whether a particular patient will recover depends to a great extent on whether the primary disease that caused ARDS to develop in the first place can be effectively treated.

Prevention

The only way to prevent ARDS is to avoid those diseases and harmful conditions that damage the lung. For instance, the danger of aspirating stomach contents into the lungs can be avoided by making sure a patient does not eat shortly before receiving **general anesthesia**. If a patient needs **oxygen therapy**, as low a level as possible should be given. Any form of lung infection, or infection anywhere in the body that gets into the blood, must be treated promptly to avoid the lung injury that causes ARDS.

Resources

BOOKS

Mehta, Manish. "Adult Respiratory Distress Syndrome." In Mehta, Manish, and Arun Matthews. *The Hospitalist Manual*. Shelton, CT; pmph usa, 2009.

ORGANIZATIONS

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

National Respiratory Distress Syndrome Foundation, P.O. Box 723, Montgomeryville, PA, 18936, (215) 822-3585, http://membrane.com/philanet/rds/.

David A. Cramer MD

AFP test *see* **Alpha-fetoprotein test**

African American health *see* **Minority health**

African sleeping sickness *see* **Sleeping sickness**

African trypanosomiasis *see* **Sleeping sickness**

Agammaglobulinemia *see* **Common variable immunodeficiency**

Aggression *see* **Conduct disorder**

Aging

Definition

Starting at what is commonly called middle age, operations of the human body begin to be more vulnerable to daily wear and tear; there is a general decline in physical, and possibly mental, functioning. The length of life is often into the 70s. The upward limit of the life span, however, can be as high as 120 years. During the latter half of life, an individual is more prone to having problems with the various functions of the body and to develop any number of chronic or fatal diseases. The cardiovascular, digestive, excretory, nervous, reproductive and urinary systems are particularly affected. The most common diseases of aging include Alzheimer's, arthritis, **cancer**, diabetes, depression, and heart disease.

Description

Human beings reach a peak of growth and development around the time of their mid 20s. Aging is the normal transition time after that flurry of activity. Although there are quite a few age-related changes that tax the body, disability is not necessarily a part of aging. Health and lifestyle factors together with the genetic makeup of the individual, and determines the response to these changes. Body functions that are most often affected by age include:

- Hearing, which declines especially in relation to the highest pitched tones
- The proportion of fat to muscle, which may increase by as much as 30%. Typically, the total padding of body fat directly under the skin thins out and accumulates around the stomach. The ability to excrete fats is impaired, and therefore the storage of fats increases, including cholesterol and fat-soluble nutrients
- The amount of water in the body decreases, which therefore decreases the absorption of water-soluble nutrients. Also, there is less saliva and other lubricating fluids
- The liver and the kidneys cannot function as efficiently, thus affecting the elimination of wastes

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- A decrease in the ease of digestion, with a decrease in stomach acid production
- A loss of muscle strength and coordination, with an accompanying loss of mobility, agility, and flexibility
- A decline in sexual hormones and sexual functioning
- A decrease in the sensations of taste and smell
- Changes in the cardiovascular and respiratory systems, leading to decreased oxygen and nutrients throughout the body
- Decreased functioning of the nervous system so that nerve impulses are not transmitted as efficiently, reflexes are not as sharp, and memory and learning are diminished
- A decrease in bone strength and density
- Hormone levels, which gradually decline. The thyroid and sexual hormones are particularly affected
- Declining visual abilities. Age-related changes may lead to diseases such as macular degeneration
- A compromised ability to produce vitamin D from sunlight
- A reduction in protein formation leading to shrinkage in muscle mass and decreased bone formation, possibly leading to osteoporosis

Causes and symptoms

There are several theories as to why the aging body loses functioning. It may be that several factors work together or that one particular factor is at work more than others in a given individual.

- Programmed senescence, or aging clock, theory. The aging of the cells of each individual is programmed into the genes, and there is a preset number of possible rejuvenations in the life of a given cell. When cells die at a rate faster than they are replaced, organs do not function properly, and they are soon unable to maintain the functions necessary for life.
- Genetic theory. Human cells maintain their own seed of destruction at the level of the chromosomes.
- Connective tissue, or cross-linking theory. Changes in the make-up of the connective tissue alter the stability of body structures, causing a loss of elasticity and functioning, and leading to symptoms of aging.
- Free-radical theory. The most commonly held theory of aging, it is based on the fact that ongoing chemical reactions of the cells produce free radicals. In the presence of oxygen, these free radicals cause the cells of the body to break down. As time goes on, more cells die or lose the ability to function, and the body soon ceases to function as a whole.

KEY TERMS

Antioxidants—Substances that reduce the damage of the highly reactive free radicals that are the byproducts of the cells.

Alzheimer's disease—A condition causing a decline in brain function that interferes with the ability to reason and to perform daily activities.

Senescence—Aging.

Vata—One of the three main constitutional types found under Ayurvedic principles. Keeping one's particular constitution in balance is considered important in maintaining health.

- Immunological theory. There are changes in the immune system as it begins to wear out, and the body is more prone to infections and tissue damage, which may finally cause death. Also, as the system breaks down, the body is more apt to have autoimmune reactions, in which the body's own cells are mistaken for foreign material and are destroyed or damaged by the immune system.

Diagnosis

Many problems can arise due to age-related changes in the body. Although there is no one test to be given, a thorough physical exam and a basic blood screening and blood chemistry panel can point to areas in need of further attention. When older people become ill, the first signs of disease are often nonspecific. Further exams should be conducted if any of the following occur:

- diminished or lack of desire for food
- increasing confusion
- failure to thrive
- urinary incontinence
- dizziness
- weight loss
- falling

Treatment

For the most part, doctors prescribe medications to control the symptoms and diseases of aging. In the United States, about two-thirds of people 65 and older take medications for various complaints. More women than men use these medications. The most common drugs used by the elderly are painkillers, **diuretics** or water pills, sedatives, cardiac drugs, **antibiotics**, and mental health drugs.

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Estrogen replacement therapy (ERT) is commonly prescribed to postmenopausal women for symptoms of aging. It is often used in conjunction with progesterone. ERT functions to help keep bones strong, reduce risk of heart disease, restore vaginal lubrication, and improve skin elasticity. Evidence suggests that it may also help maintain mental functions.

Expected results

Aging is unavoidable, but major physical impairment is not. People can lead a healthy, disability-free life well through their later years. A well established support system of family, friends, and health care providers, together with focus on good **nutrition** and lifestyle habits and good **stress** management, can prevent disease and lessen the impact of chronic conditions.

Alternative treatment

Nutritional supplements

Consumption of a high quality multivitamin is recommended. Common nutritional deficiencies connected with aging include B **vitamins**, vitamins A and C, **folic acid**, **calcium**, magnesium, zinc, iron, chromium, and trace **minerals**. Since stomach acids may be decreased, it is suggested that the use of a powdered multivitamin formula in gelatin capsules be used, as this form is the easiest to digest. Such formulas may also contain enzymes for further help with digestion.

Antioxidants can help to neutralize damage by the free radical actions thought to contribute to problems of aging. They are also helpful in preventing and treating cancer and in treating **cataracts** and glaucoma. Supplements that serve as antioxidants include:

- Vitamin E, 400–1,000 IUs daily. Protects cell membranes against damage. It shows promise in prevention against heart disease, and Alzheimer's and Parkinson's diseases.
- Selenium, 50 mg taken twice daily. Research suggests that selenium may play a role in reducing the risk of cancer.
- Beta-carotene, 25,000–40,000 IUs daily. May help in treating cancer, colds and flu, arthritis, and immune support.
- Vitamin C, 1,000–2,000 mg per day. It may cause diarrhea in large doses. If this occurs, however, all that is needed is a decrease in the dosage.

Other supplements that are helpful in treating age-related problems including:

- B_{12}/B-complex vitamins; studies show that B_{12} may help reduce mental symptoms, such as confusion, memory loss, and depression.
- Coenzyme Q10 may be helpful in treating heart disease, as up to three-quarters cardiac patients have been found to be lacking in this heart enzyme.

Hormones

The following hormone supplements may be taken to prevent or to treat various age-related problems. However, caution should be taken before beginning treatment, and the patient should consult his or her health care professional.

DHEA improves brain functioning and serves as a building block for many other important hormones in the body. It may be helpful in restoring declining hormone levels and in building up muscle mass, strengthening the bones, and maintaining a healthy heart.

Melatonin may be helpful for **insomnia**. It has also been used to help fight viruses and bacterial infections, reduce the risk of heart disease, improve sexual functioning, and to protect against cancer.

Human growth hormone (hGH) has been shown to regulate blood sugar levels and to stimulate bone, cartilage, and muscle growth while reducing fat.

Herbs

Garlic (*Allium sativa*) is helpful in preventing heart disease, as well as improving the tone and texture of skin. Garlic stimulates liver and digestive system functions, and also helps in dealing with heart disease and high blood pressure.

Siberian **ginseng** (*Eleutherococcus senticosus*) supports the adrenal glands and immune functions. It is believed to be helpful in treating problems related to stress. Siberian ginseng also increases mental and physical performance, and may be useful in treating **memory loss**, chronic **fatigue**, and immune dysfunction.

Proanthocyanidins, or PCO, are Pycnogenol, derived from grape seeds and skin, and from pine tree bark, and may help in the prevention of cancer and poor vision.

In **Ayurvedic medicine**, aging is described as a process of increased vata, in which there is a tendency to become thinner, drier, more nervous, more restless, and more fearful, while having a loss of appetite as well as sleep. Bananas, almonds, avocados, and coconuts are some of the foods used in correcting such conditions. One of the main herbs used for such conditions is gotu kola (*Centella asiatica*),

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which is used to revitalize the nervous system and brain cells and to fortify the immune system. Gotu kola is also used to treat memory loss, **anxiety**, and insomnia.

In Chinese medicine, most symptoms of aging are regarded as symptoms of a yin deficiency. Moistening foods such as millet, barley soup, tofu, mung beans, wheat germ, spirulina, potatoes, black sesame seeds, walnuts, and flax seeds are recommended. Jing tonics may also be used. These include deer antler, dodder seeds, processed rehmannia, longevity soup, mussels, and chicken.

Prevention

Preventive health practices such as healthy diet, daily **exercise**, stress management, and control of lifestyle habits such as **smoking** and drinking, can lengthen the life span and improve the quality of life as people age. Exercise can improve the appetite, the health of the bones, the emotional and mental outlook, and the digestion and circulation.

Drinking plenty of fluids aids in maintaining healthy skin, good digestion, and proper elimination of wastes. Up to eight glasses of water should be consumed daily, along with plenty of herbal teas, diluted fruit and vegetable juices, and fresh fruits and vegetables with high water content.

Because of a decrease in the sense of taste, older people often increase their intake of salt, which can contribute to high blood pressure and nutrient loss. Use of sugar is also increased. Seaweeds and small amounts of honey can be used as replacements.

Alcohol, nicotine, and **caffeine** all have potential damaging effects, and should be limited or completely eliminated from consumption.

A diet high in fiber and low in fat is recommended. Processed foods should be replaced by complex carbohydrates, such as whole grains. If chewing becomes a problem, there should be an increased intake of protein drinks, freshly juiced fruits and vegetables, and creamed cereals.

Resources

OTHER

"Anti-Aging-Nutritional Program." http://www.healthy.net/hwlibrarybooks/haas/ perform/antiagin.htm.

"Effects of Hormone in the Body." http://www.antiaging.org/Effects_hGH.html.

"The Elderly-Nutritional Programs." http://www.healthy.net/hwlibrarybooks/haas/ lifestage/elderly.htm.

"Evaluating the Elderly Patient: the Case for Assessment Technology." http://text.nlm.nih. gov/nih/ta/www/01.html.

"Herbal Phytotherapy and the Elderly." http://www.healthy.net/hwlibrarybooks/hoffman/ elders/elders.htm.

"Pharmacokinetics." Merck & Co., Inc. (1995-2000). http://www.merck.com/pubs/mmanual/section22/chapter304/304a.htm.

"To a Long and Healthy Life." http://www.healthy.net/hwlibraryarticles/aesoph/longandhealthy.htm.

Patience Paradox

Agoraphobia

Definition

The word agoraphobia is derived from Greek words literally meaning "fear of the marketplace." The term is used to describe an irrational and often disabling fear of being out in public.

Description

Agoraphobia is just one type of phobia, or irrational fear. People with **phobias** feel dread or panic when they face certain objects, situations, or activities. People with agoraphobia frequently also experience panic attacks, but panic attacks, or **panic disorder**, are not a requirement for a diagnosis of agoraphobia. The defining feature of agoraphobia is **anxiety** about being in places from which escape might be embarrasing or difficult, or in which help might be unavailable. The person suffering from agoraphobia usually avoids the anxiety-provoking situation and may become totally housebound.

Causes and symptoms

Agoraphobia is the most common type of phobia, and it is estimated to affect between 5–12% of Americans within their lifetime. Agoraphobia is twice as common in women as in men and usually strikes between the ages of 15-35.

The symptoms of the panic attacks that may accompany agoraphobia vary from person to person, and may include trembling, sweating, heart **palpitations** (a feeling of the heart pounding against the chest), jitters, **fatigue**, **tingling** in the hands and feet, **nausea**, a rapid pulse or breathing rate, and a sense of impending doom.

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KEY TERMS

Benzodiazepines—A group of tranquilizers often used to treat anxiety.

Desensitization—A treatment for phobias that involves exposing the phobic person to the feared situation. It is often used in conjunction with relaxation techniques.

Phobia—An intense and irrational fear of a specific object, activity, or situation.

Agoraphobia and other phobias are thought to be the result of a number of physical and environmental factors. For instance, they have been associated with biochemical imbalances, especially related to certain neurotransmitters (chemical nerve messengers) in the brain. People who have a panic attack in a given situation (e.g., a shopping mall) may begin to associate the panic with that situation and learn to avoid it. According to some theories, irrational anxiety results from unresolved emotional conflicts. All of these factors may play a role to varying extents in different cases of agoraphobia.

Diagnosis

People who suffer from panic attacks should discuss the problem with a physician. The doctor can diagnose the underlying panic or anxiety disorder and make sure the symptoms aren't related to some other underlying medical condition.

The doctor makes the diagnosis of agoraphobia based primarily on the patient's description of his or her symptoms. The person with agoraphobia experiences anxiety in situations where escape is difficult or help is unavailable–or in certain situations, such as being alone. While many people are somewhat apprehensive in these situations, the hallmark of agoraphobia is that a person's active avoidance of the feared situation impairs his or her ability to work, socialize, or otherwise function.

Treatment

Treatment for agoraphobia usually consists of both medication and **psychotherapy**. Usually, patients can benefit from certain antidepressants, such as amitriptyline (Elavil), or **selective serotonin reuptake inhibitors**, such as paroxetine (Paxil), fluoxetine (Prozac), or sertraline (Zoloft). In addition, patients may manage panic attacks in progress with certain tranquilizers called **benzodiazepines**, such as alprazolam (Xanax) or clonazepam (Klonipin).

The mainstay of treatment for agoraphobia and other phobias is cognitive behavioral therapy. A specific technique that is often employed is called desensitization. The patient is gradually exposed to the situation that usually triggers fear and avoidance, and, with the help of breathing or relaxation techniques, learns to cope with the situation. This helps break the mental connection between the situation and the fear, anxiety, or panic. Patients may also benefit from psychodynamically oriented psychotherapy, discussing underlying emotional conflicts with a therapist or support group.

Prognosis

With proper medication and psychotherapy, 90% of patients will find significant improvement in their symptoms.

ORGANIZATIONS

American Psychiatric Association (APA), 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209, (888) 357-7924, apa@psych.org, http://www.psych.org.

Anxiety Disorders Association of America, 8730 Georgia Ave. Suite 600, Silver Spring, MD, 20910, (240) 485-1001, (140) 485-1035, http://www.adaa.org.

National Institute of Mental Health (NIMH), 6001 Executive Boulevard, Room 8184, MSC 9663, Bethesda, MD 20892-9663, http://www.nimh.nih.gov/site-info/ contact-nimh.shtml.

Robert Scott Dinsmoor

Agranulocytosis *see* **Neutropenia**

AIDS

Definition

AIDS, or acquired immune deficiency syndrome, is the end stage of an **infectious disease** caused by the human **immunodeficiency** virus, or HIV. There are two variants of the HIV virus, HIV-1 and HIV-2, both of which ultimately cause AIDS. The virus damages the immune system, leaving the patient vulnerable to certain cancerous tumors and increasingly severe opportunistic infections. HIV can be transmitted whenever a body fluid containing the virus—semen, saliva, blood, or breast milk—comes into contact with a mucous membrane or the bloodstream itself.

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Risk of acquiring HIV infection by entry site

Entry site	Risk virus reaches entry site	Risk virus enters	Risk inoculated
Conjunctiva	Moderate	Moderate	Very low
Oral mucosa	Moderate	Moderate	Low
Nasal mucosa	Low	Low	Very low
Lower respiratory	Very low	Very low	Very low
Anus	Very high	Very high	Very high
Skin, intact	Very low	Very low	Very low
Skin, broken	Low	High	High
Sexual:			
Vagina	Low	Low	Moderate
Penis	High	Low	Low
Ulcers (STD)	High	High	Very high
Blood:			
Products	High	High	High
Shared needles	High	High	Very high
Accidental needle	Low	High	Low
Traumatic wound	Moderate	High	High
Perinatal	High	High	High

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A person can get AIDS through sexual intercourse, anal or oral sex, **childbirth**, **breastfeeding**, blood **transfusion**, **tattoos** or body **piercing**, or sharing hypodermic needles.

Demographics

As of 2009, about 0.6% of the world's population was infected with HIV, or about 35 million people. Ninety-five percent of these cases are in Africa or southeastern Asia. About 25 million people have died of AIDS since 1981, making the disease one of the deadliest pandemics in history. In the United States, the CDC's recently revised estimates indicate that about 945,000 people have been diagnosed with AIDS since 1981, and about 1.2 million are currently living with HIV infection. About a quarter of these people are unaware that they are infected with the virus. The CDC estimates that there are 56,300 new cases of HIV infection in the United States each year.

The CDC gives the following statistics for specific groups within the United States:

- Males account for 74% of persons with HIV infection in the United States, although worldwide, the figure for males is 50%.
- In terms of race or ethnicity, 47% of persons with HIV infection are African American, 34% are Caucasian, 17% are Hispanic, and 2% are Native American or Asian American.
- In terms of method of transmission, 50% of infected persons are men who had sex with men; 33% had high-risk heterosexual sex; 13% are injection drug users; and the remainder are people who engaged in more than one high-risk behavior.
- In terms of age group, one percent of infected persons are under 13 years of age; 15% are between the ages of 13 and 24; 26% are between the ages of 25 and 34; 32% are between the ages of 35 and 44; 20% are between the ages of 45 and 54; 8% are 55 or older.

A worrisome new trend as of 2009 is the return and increase of high-risk behaviors among men who have sex with men in Canada and the United States. This trend appears to have been triggered by the spread of **methamphetamine addiction** from the West Coast to the Eastern Seaboard since the early 2000s.

AIDS in women

Women exposed to HIV infection through heterosexual contact are the most rapidly growing risk group in the United States. The gender demographics of HIV infection within the United States are changing, with women accounting for more new cases in 2009 than was the case in 1999. The percentage of AIDS cases diagnosed in American women has risen from 7% in 1985 to about 26% in 2006, the last year for which data are available. According to the CDC, in 2006 approximately 278,400 women in the United States were living with HIV/AIDS. The rate was highest among black women, who had 23 times as many cases as Caucasian women and 4 times as many cases as Hispanic women. About 75% of these women contracted HIV through high-risk heterosexual activity; almost all of the remainder acquired the infection through needle sharing.

The prevalence of women with HIV in the United States is low, however, compared to the rate in many countries in the developing world. Worldwide, about half the people living with HIV are women. According to the United Nations, in 2005 about 59% of women living in sub-Saharan Africa are infected with HIV. The vast majority of them were infected through having unprotected sex with an infected male partner. One theory that has been proposed to explain the higher rate of AIDS in women in Africa is the prevalence of **schistosomiasis** in the region. Schistosomiasis is a parasitic disease caused by a trematode (a type of flatworm) that affects as many as 50% of women in some parts of Africa; while it is rarely fatal, schistosomiasis

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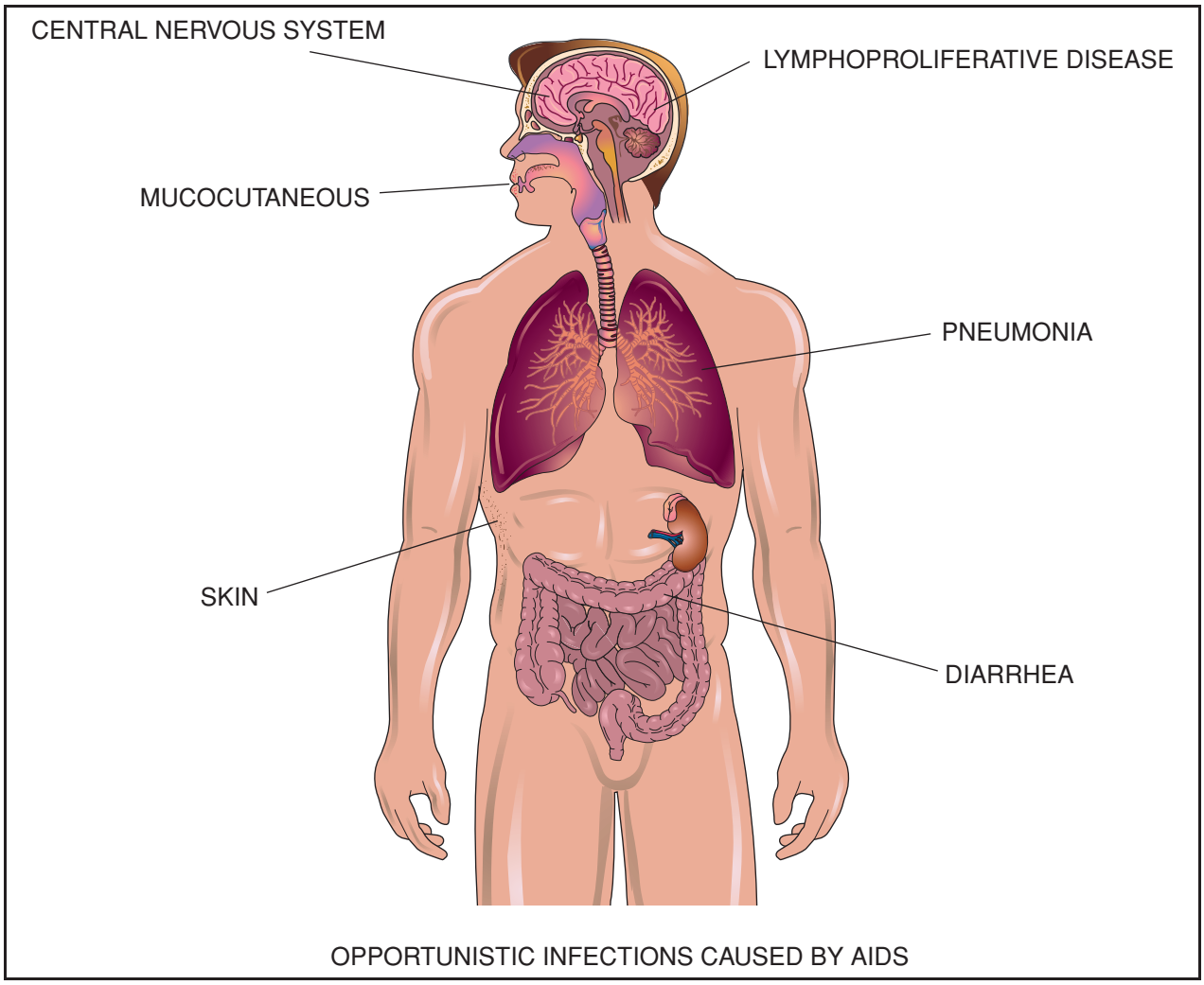

Because the immune system cells are destroyed by the AIDS virus, many different types of infections and cancers can develop, taking advantage of a person's weakened immune system. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

damages the tissues lining the vagina, making them more vulnerable to the AIDS virus.

AIDS in children

Since AIDS can be transmitted from an infected mother to a fetus during **pregnancy** or to an infant during the birth process or through breastfeeding, all infants born to HIV-positive mothers are considered a high-risk group. However, prenatal drug treatment of HIV-positive mothers in developed countries has reduced the number of children born infected with HIV. In the developing world, drug treatment is either not available or not affordable. According to the United Nations Children's Fund (UNICEF) worldwide 2.3 million children under age 13 were living with HIV in 2006. The previous year, about 380,000 children died of AIDS and more than half a million children were newly infected. UNICEF estimates that at least 15 million children have lost at least one parent to AIDS.

AIDS is the leading causes of **death** in children under age five in many parts of Africa and Southeast Asia. One reason for this tragedy is that only 1% of sexually active women in these regions get tested for HIV infection, and these women can become pregnant before they develop symptoms of the disease. The interval between exposure to HIV and the development of AIDS is shorter in children than in adults. Infants infected with HIV have a high chance of developing AIDS within one year and dying before age three. In the remainder, AIDS progresses more slowly; the average child patient survives to about seven years of age. Some survive into early adolescence.

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AIDS in older adults

The demographics of HIV infection among the elderly have changed since the early days of the AIDS epidemic. In the mid-1980s, most cases of AIDS among older adults in the United States were the result of transfusions with contaminated blood. The introduction of effective screening tests for blood products has virtually eliminated this path of HIV transmission, however; as of 2009, almost all cases of AIDS in seniors are the result of sexual activity. In the United States, about 10% of all cases of AIDS occur in people over 50, and 3% in people over 60. About 35% of seniors who develop AIDS are homosexual or bisexual men; others are heterosexual men living in urban areas who engage in high-risk sex with prostitutes. In addition, the number of older adults with HIV/AIDS is rising; the CDC estimates that by 2015, half of all persons living with HIV/AIDS in North America will be over the age of 50.

One reason that sexually active seniors are particularly at risk for HIV infection is that they are rarely concerned about **contraception**. Adults over 50 are five times more likely than younger people to have unprotected sex because they think of **condoms** as a method of birth control rather than a means of preventing disease transmission. In addition, older women have thinner and more fragile tissues lining the walls of the vagina; these tissues are more likely to be bruised or damaged during unprotected intercourse, making it easier for the virus to enter the underlying tissues. Several studies done in 2006 and 2007 reported that older women are less likely than their younger counterparts to take precautions against HIV infection, in part because they are less sexually active than older men, and partly because they do not perceive themselves as being at risk for HIV infection.

According to the *Merck Manual of Geriatrics*, "Practically no prevention information on AIDS is targeted at elderly persons, although most elderly persons are sexually active." According to statistics compiled by the Centers for Disease Control and Prevention, about 2100 men between the ages of 55 and 59 are diagnosed with HIV infection each year, and 800 over the age of 65. Since the epidemic began in 1981, 15,000 adults over age 65 have been diagnosed with HIV in the United States.

Description

Background

AIDS is now considered a pandemic because it has spread to every country in the world. According to the World Health Organization (WHO), 34 million people around the world were living with HIV infection in 2009; 2.1 million people died in 2008 from the disease, 330,000 of them children. Scientists think that the virus that causes AIDS originated somewhere in the African rainforest as an infection of chimpanzees and Old World monkeys. At some point in the twentieth century the virus jumped the species barrier from monkeys into humans, most likely somewhere in western Africa. The earliest known case of HIV infection was found in a blood sample collected from a man in Kinshasa in the Congo in 1959. AIDS was first defined as an epidemic human disease in June 1981 by the Centers for Disease Control and Prevention (CDC). The virus that causes AIDS was identified by two teams of French and American scientists in 1983–1984.

The first cases of AIDS in the United States were not diagnosed until 1981, when the CDC reported a cluster of five cases of an opportunistic lung infection among homosexual men in Los Angeles. In the first 15 years of the epidemic, there were no effective treatments for HIV infection (there is still no cure as of 2009). In 1996, a team of researchers in California introduced a form of treatment known as highly active antiretroviral therapy or HAART. While drug therapy is not a cure for AIDS, it can slow the progress of the disease and improve the patient's quality of life.

Course

HIV infection progresses in stages as the virus gradually weakens the body's immune system. It takes an average of 11 years for HIV infection to progress to AIDS, although the disease progresses faster in children and the elderly. AIDS is diagnosed when the count of certain white blood cells in the patient's blood drops to a critical level or the patient develops life-threatening tumors or opportunistic infections.

In the early stage of HIV infection, the patient may have no symptoms at all or a mild flu-like illness with **fever** and **headache** within a few days or weeks of getting infected. These symptoms usually go away without treatment and the person feels normal, even though they are a carrier and can transmit the infection to others. The infected person may continue to feel well for a period ranging from a few months to several years.

Risk factors

AIDS can be transmitted in several ways. The risk factors for HIV transmission vary according to the method of transmission.

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- Sexual contact. People at greatest risk are those who do not practice safer sex by always using a condom, those who have multiple sexual partners, those who participate in anal intercourse, and those who have sex with a partner who has HIV infection and/or other sexually transmitted diseases (STDs). In the United States and Europe, most cases of sexually transmitted HIV infection result from homosexual contact, whereas in Africa, the disease is spread primarily through sexual intercourse among heterosexuals. Most people with AIDS in the United States are between 25 and 44 years of age.
- Transmission in pregnancy. High-risk mothers include women sexually active with bisexual men, intravenous drug users, and women living in neighborhoods with a high rate of HIV infection among heterosexuals. The chances of transmitting the disease to the child are higher in women in advanced stages of the disease. Breast feeding increases the risk of HIV transmission as HIV passes into breast milk. The rate of pediatric HIV transmission in the United States had decreased substantially because of HIV testing and improved drug treatment for infected mothers, so fewer than 1% of AIDS cases now occur in children under age 15. In the developing world, mother to infant transmission remains epidemic. In 2006, AIDS was the single most common cause of death in children under age 5 in South Africa, while worldwide children account for about 10% of all AIDS cases.
- Exposure to contaminated blood. Risk of HIV transmission among intravenous drug users increases with the frequency and duration of intravenous use, frequency of needle sharing, number of people sharing a needle, and the rate of HIV infection in the local population. In 2006, about 19% of men with AIDS and 25% of women with AIDS contracted the disease through sharing needles during intravenous drug injection. With the introduction of new blood product screening in the mid-1980s, HIV transmission through blood transfusions became rare in the developed world. However, contaminated blood is still a significant source of infection in the developing world.
- Transmission via improperly sterilized tattooing or body piercing needles.
- Needle sticks or body fluid splashes among health care professionals. Transmission through theses sources accounts for fewer than 0.3% of all HIV infections in the United States. This rate reflects the emphasis on universal safety precautions (e.g., use of gloves, face shields, proper disposal of needles) among health care professionals and first responders.

Some older adults are at higher risk than others of HIV infection. In order to determine whether HIV testing should be a personal priority, an adult 55 years of age or older should use the following checklist of high-risk behaviors for 1978 and later:

- Shared needles for injecting drugs or steroids
- If a male, had unprotected sex with other males
- Had unprotected sex with someone known or suspected to be infected with HIV
- Had a blood transfusion between 1978 and 1985
- Had another sexually transmitted disease
- Had unprotected sex with anyone with any of the five previous risk factors

Causes and symptoms

Causes

The cause of AIDS is infection with human immunodeficiency virus or HIV. HIV is a retrovirus that reproduces by inserting its own genetic material into a type of white blood cell called a CD4 lymphocyte. When the virus copies break out of the infected white blood cell, they attack other CD4 cells and the cycle repeats. The virus has a short life cycle, needing as little as 1.5 days to enter a cell, replicate, and release new copies of itself to infect other cells. Eventually so many of the white blood cells have been destroyed that the body's immune system is weakened and the person can no longer fight off opportunistic infections. The patient may also develop certain cancers associated with a weakened immune system.

Symptoms

STAGES. The symptoms of HIV infection vary according to the progress of the infection. As mentioned above, about 30% of patients develop an acute syndrome resembling flu within a month of exposure to HIV. The patient typically has a fever, headache, swollen lymph nodes, and **fatigue**. This illness is called acute retroviral syndrome or ARS. The symptoms then disappear; however, the infected person is highly contagious in this early phase and can readily pass on the virus to others. The patient may or may not have developed antibodies to HIV (a process known as seroconversion) at this point; thus a test for HIV infection in this early period may not yield positive results even though the patient is in fact infected.

In the second phase, the virus may be silent, but more commonly it produces complications. Patients in

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this stage of infection may have the following symptoms:

- Swelling of the lymph nodes that lasts three months or longer
- Fevers and night sweats
- Loss of energy
- Weight loss
- Frequent yeast infections of the vagina or mouth and throat. Yeast infections of the mouth are sometimes called thrush
- Skin rashes or flaky skin that does not go away
- Short-term memory loss. This symptom helps to explain why HIV infection in seniors is often misdiagnosed as early-stage Alzheimer's

In full-blown AIDS, the person develops one or more of the following opportunistic infections. Death usually results from one of these infections or from an AIDS-related **cancer**.

- Lung infections: these include a type of pneumonia caused by an organism known as *Pneumocystis jirovecii*, a yeast-like fungus; and tuberculosis.
- Mouth infections: these include oral candidiasis, or thrush.
- Infections of the digestive tract: these include parasitic as well as bacterial infections, and are often marked by severe diarrhea.
- Infections of the central nervous system: these include meningitis and toxoplasmosis. AIDS dementia complex (ADC), which is often misdiagnosed as Alzheimer's disease, is caused by destruction of brain tissue by toxins secreted by HIV. AIDS dementia complex affects between 10 and 20% of AIDS patients in the United States and is often the first symptom of full-blown AIDS. Like Alzheimer's, ADC is characterized by memory loss, inability to concentrate, loss of motor ability, poor balance, and mood changes.

AIDS-related cancers include **Kaposi's sarcoma**, a skin cancer occasionally found in older men who do not have HIV infection; and cervical cancers in women. AIDS patients are also at increased risk of developing Hodgkin's disease, Burkitt's lymphoma, and cancers of the anus or rectum.

Diagnosis

The diagnosis of HIV infection and AIDS is complicated by the fact that many people are afraid to be tested for the disease. They may fear that a positive test will lead to the loss of housing, jobs, relationships, or the chance to complete their education. Because many infected persons put off getting tested and telling their partners, the disease continues to spread. In 2006, the CDC recommended routine HIV screening for all adults, adolescents, and pregnant women within health care settings, not just those considered to be high-risk. As of 2009, the CDC recommends that people engaging in high-risk behaviors be tested for HIV infection every year.

Examination

The patient's history is often the most important single diagnostic clue to HIV infection, particularly if he or she admits to unsafe sexual practices or intravenous drug use. If the doctor suspects HIV infection on the basis of the flu-like symptoms of acute retroviral syndrome, or if the patient requests HIV testing, the doctor will usually order appropriate blood or oral fluid tests.

AIDS-related **dementia** is the first symptom to appear in 4–15% of patients with AIDS in the United States. In those cases the doctor will include a neurologic examination and a **mental status examination** as part of the office physical. The patient may be referred to a psychiatrist for further evaluation if he or she appears to be suicidal or homicidal.

Tests

LABORATORY TESTS. Testing for HIV is a two-step process. The first test is a screening test, which usually involves taking a sample of the patient's blood. There are also newer screening tests that can use a sample of the person's urine or saliva. These rapid screening tests look for antibodies to the HIV virus and give results in about 20 minutes. If the person tests positive for HIV infection, a second test, called a Western blot test, is performed. This test uses a technique for separating out proteins in a blood sample to identify antibodies against HIV.

In 1996 the Food and Drug Administration (FDA) approved a test kit that people can use at home called the Home Access HIV-1 Test. The person pricks their finger on a special blotting card and mails it back to the company. The sample is identified only by a code number, which allows the person to remain completely anonymous. The test costs about $45 and results are available in seven days.

An important point to keep in mind is that it may take the body several weeks to three months after a person is infected to produce enough antibodies to HIV to be detected by a blood test. This period of time is called the window period. A person who tests negative for HIV infection after high-risk behaviors

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should wait three months and have another blood test to make sure they are not infected.

The doctor may also order a **complete blood count** and a stool test if the patient is suspected of having intestinal parasites.

IMAGING TESTS. The doctor may order a chest x-ray if opportunistic infections of the lung are suspected, or a **magnetic resonance imaging** (MRI) study of the brain if the patient has signs of AIDS dementia complex (ADC).

Diagnosis in children

The CDC recommends HIV testing as a part of standard prenatal care for all pregnant women. When a pregnant woman tests positive for HIV, testing of her infant ideally begins within 48 hours of birth. Testing is repeated at between one and two months of age and again at age 3–6 months. Testing of infants uses a different technique to detect the presence of HIV virus. Infants can be diagnosed by direct culture of the HIV virus, PCR testing, and p24 antigen testing. By one month of age, results are highly accurate. Diagnostic blood testing in children older than 18 months is similar to adult testing, with ELISA screening confirmed by Western blot.

In terms of symptoms, children are less likely than adults to have an early acute syndrome. They are, however, likely to have delayed growth, a history of frequent illness, recurrent ear infections, a low **white blood cell count**, failure to gain weight, and unexplained fevers. Children with AIDS are more likely to develop bacterial infections, inflammation of the lungs, and AIDS-related brain disorders than are HIV-positive adults.

Procedures

If the patient appears to have an opportunistic infection of the nervous system, the doctor may order a **lumbar puncture** in order to test a sample of spinal fluid. In some cases the doctor may take a sample of nerve, skin, or muscle tissue for a biopsy.

Treatment

Because there is no cure for AIDS, all forms of HIV/AIDS therapy are focused on improving the quality and length of life for people who are infected by slowing or halting the replication of the virus and treating or preventing infections and cancers that often develop in people with AIDS.

Traditional

Drugs

Medications are the mainstay of AIDS treatment. Drug treatment guidelines for HIV/AIDS change frequently as new drugs are approved and new drug regimens developed. Two principles currently guide doctors in developing drug regimens for AIDS patients: using combinations of drugs rather than one medication alone; and basing treatment decisions on the results of the patient's viral load tests. Current information on United States Food and Drug Administration-(FDA) approved drugs by class can be found at the United States Department of Health and Human Services Aids Info Website at http://www.aidsinfo.nih.gov/DrugsNew/Default.aspx?MenuItem=Drugs. Individuals interested in participating in a trial of new HIV/AIDS drugs under development can find a list of clinical trials currently accepting volunteers at http://www.clinicaltrial.gov. There is no cost to volunteers to participate and some medical care and testing is provided.

POST-EXPOSURE PROPHYLAXIS (PEP). Post-exposure **prophylaxis** (PEP) is a four- to eight-week course of **antiretroviral drugs** given to persons immediately after exposure (through **rape**, unprotected sex, or needlestick injuries) to HIV to prevent them from being infected by the virus. To be effective, PEP must be started within 48 hours of exposure. It has some unpleasant side effects, including severe **nausea** and headaches.

TREATMENT OF OPPORTUNISTIC INFECTIONS AND MALIGNANCIES. Most AIDS patients require complex long-term treatment with medications for infectious diseases. This treatment is often complicated further by the development of resistance in the disease organisms. AIDS-related malignancies in the central nervous system are usually treated with **radiation therapy**. Cancers elsewhere in the body are treated with **chemotherapy**.

PROPHYLACTIC TREATMENT FOR OPPORTUNISTIC INFECTIONS. Prophylactic treatment is treatment that is given to prevent disease. AIDS patients with a history of *Pneumocystis* **pneumonia**, with CD4+ counts below 200 cells/mm^3 or 14% of lymphocytes, weight loss, or thrush should be given prophylactic medications. Drugs that may be given include **antibiotics** such as trimethoprim-sulfamethoxazole (Bactrim) or pentamidine (Pentam-300, Pentacarinat) and anti-fungals such as amphotericin B (AmBisome), flucytosine (Ancobon), and clotrimazole (Lotrim AF, Mycelex, Femizole-7). All these drugs can have undesirable side effects.

ANTIVIRAL TREATMENTS. When a person tests positive for HIV infection, the doctor will measure the amount of virus in the patient's blood. This level is called the viral load. The viral load helps the doctor to

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KEY TERMS

Acquired immune deficiency syndrome (AIDS)—HIV infection that has led to certain opportunistic infections, cancers, or a CD4+ T-lymphocyte (helper cell) blood cell count lower than 200/mL.

Acute retroviral syndrome (ARS)—A syndrome that develops in about 30% of HIV patients within a few weeks of infection. ARS is characterized by nausea, vomiting, fever, headache, general tiredness, and muscle cramps.

AIDS dementia complex—A type of brain dysfunction caused by HIV infection that causes difficulty thinking, confusion, and loss of muscular coordination.

Carrier—A person who bears or carries a disease agent in or on their body and can transmit the disease to others, but is immune to the disease or has no symptoms of it.

CD4—A type of protein molecule in human blood. The HIV virus infects cells with CD4 surface proteins and, as a result, depletes the number of T cells, B cells, natural killer cells, and monocytes in the patient's blood.

Dietitian—A health care professional who specializes in individual or group nutritional planning, public education in nutrition, or research in food science. To be licensed as a registered dietitian (RD) in the United States, a person must complete a bachelor's degree in a nutrition-related field and pass a state licensing examination. Dietitians are also called nutritionists.

Highly active antiretroviral therapy (HAART)—An individualized combination of three or more antiretroviral drugs used to treat patients with HIV infection. It is sometimes called a drug cocktail.

Kaposi's sarcoma—A cancer of the connective tissue that produces painless purplish red (in people with light skin) or brown (in people with dark skin) blotches on the skin. It is a major diagnostic marker of AIDS.

Lipodystrophy—The medical term for redistribution of body fat in response to HAART, insulin injections in diabetics, or rare hereditary disorders.

Lymphoma—A cancerous tumor in the lymphatic system that is associated with a poor prognosis in AIDS patients.

Malabsorption syndrome—A condition characterized by indigestion, bloating, diarrhea, loss of appetite, and weakness, caused by poor absorption of nutrients from food as a result of HIV infection itself, giardiasis or other opportunistic infections of the

decide when to start drug treatment for HIV. The current method of treatment is called highly active antiretroviral therapy or HAART. Introduced in 1996, HAART consists of combinations of three or more different drugs from two or more of the seven classes of antiretroviral drugs presently available. HAART is not a cure for AIDS, but it reduces the viral load, improves the patient's overall quality of life, and extends life expectancy by four to 12 years.

Antiviral drugs suppress HIV replication, as distinct from treating its effects on the body. These drugs fall into several classes:

- Nucleotide reverse transcriptase inhibitors (also called nucleoside analogues). These drugs work by interfering with the action of HIV reverse transcriptase inside infected cells, thus ending the virus's replication process. These drugs include zidovudine (Retrovir), lamivudine (Epivir), and abacavir (Ziagen) and many others. They are often used in used in multi-drug combinations.
- Non-nucleoside reverse transcriptase inhibitors. This class of drugs binds to an enzyme that is necessary for the HIV virus to reproduce. Examples of drugs in this class are viramune, delavirdine (Rescriptor), and efavirenz (Sustiva) and others.
- Protease inhibitors. Protease inhibitors work by disabling protease, an enzyme necessary for HIV reproduction. Protease inhibitors include saquinavir (Invirase), ritonavir (Norvire), indinavir (Crixivan), nelfinavir (Viracept), amprenavir (Agenerase), kaletra, and many others.
- Integrase inhibitors. Integrase inhibitors prevent the virus from inserting its own genetic material into the DNA of the infected cell. This stops the virus from replicating. Integrase was the only FDA-approved drug in this class as of early 2009. Several investigational drugs in this category were in clinical trials at that time.
- Fusion inhibitors and entry inhibitors. Fusion inhibitors block specific proteins on the surface of the virus or the CD4+ cell. These proteins help the

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digestive tract, or certain surgical procedures involving the stomach or intestines.

Non-nucleoside reverse transcriptase inhibitors—The newest class of antiretroviral drugs that work by inhibiting the reverse transcriptase enzyme necessary for HIV replication.

Nucleoside analogues—The first group of effective anti-retroviral medications. They work by interfering with the AIDS virus' synthesis of DNA.

Opportunistic infection—An infection caused by an organism that does not cause disease in a person with a healthy immune system.

Pandemic—An infectious disease that spreads across a large region or even worldwide.

Post-exposure prophylaxis (PEP)—A four-week course of antiretroviral drugs given to people immediately following exposure to HIV infection from rape, unprotected sex, needlestick injuries, or sharing needles.

Protease inhibitors—The second major category of drug used to treat AIDS that works by suppressing the replication of the HIV virus.

Retrovirus—A virus that uses its RNA to produce DNA and add that DNA to the genetic material of infected cells.

Seroconversion—The development of detectable specific antibodies in a patient's blood serum as a result of infection or immunization.

T-lymphocyte—A type of white blood cell, also known as a T-helper cell, a T_h cell, an effector T cell, or a CD4+ T cell, whose numbers in a blood sample can be used to monitor the progression of HIV infection.

Viral load—A measure of the severity of HIV infection, calculated by estimating the number of copies of the virus in a milliliter of blood.

Wasting syndrome—A combination of weight loss and change in composition of body tissues that occurs in patients with HIV infection. Typically, the patient's body loses lean muscle tissue and replaces it with fat as well as losing weight overall.

Western blot—A procedure that uses electrical current passed through a gel containing a sample of tissue extract in order to break down the proteins in the sample and detect the presence of antibodies for a specific disease. The Western blot method is used in HIV testing to confirm the results of an initial screening test.

Window period—The period of time between a person's getting infected with HIV and the point at which antibodies against the virus can be detected in a blood sample.

virus gain entry into the cell. The only FDA-approved fusion inhibitor as of early 2009 was enfuvirtide (Fuzeon). Entry inhibitors block HIV from entering cells. The only FDA-approved fusion inhibitor as of early 2009 was maraviroc (Selzentry). Several drugs in this class are, in pre-approval clinical trials.

HAART has several drawbacks. First, it is a very expensive form of treatment. In addition, many of the drugs used in HAART have troublesome side effects; as a result, some AIDS patients simply stop taking their medications. Last, some patients develop resistance to the antiretroviral drugs and no longer respond to treatment. The doctor can sometimes switch one of the drugs in the patient's combination to another drug within the same class.

Another problem with HAART is the complicated dosing schedules of the different drugs prescribed for an individual patient. To encourage adherence to treatment schedules (which must be at least 98 percent complete to protect the patient from developing a strain of the virus resistant to HAART), some pharmaceutical companies have developed fixed-dose combinations—medications in which several antiretroviral drugs that are known to work well together are combined in a single pill.

STIMULATION OF BLOOD CELL PRODUCTION. Because many patients with AIDS have abnormally low levels of both red and white blood cells, they may be given medications to stimulate blood cell production. Epoetin alfa (erythropoietin) may be given to anemic patients. Patients with low white blood cell counts may be given filgrastim or sargramostim.

Alternative

AIDS patients turn to alternative medicine when conventional treatments are ineffective and to supplement conventional treatment, reduce disease symptoms, counteract drug effects, and improve quality of life. Because alternative medicines may interact with conventional medicines, it is important for patients with HIV infection to inform their doctors of all treatments being used.

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CAM treatments that have been recommended for AIDS patients include multivitamin therapy, **acupuncture**, **yoga**, **massage therapy**, and the use of relaxation techniques to improve mood and relieve depression. Some studies indicate that naturopathic treatments slow the progression of HIV infection even though they cannot cure it. Interestingly, a study published in 2007 reported that seniors with AIDS are just as likely to use complementary therapies since the introduction of HAART as they were before 1996. The study also reported that men who used CAM were more likely to be college-educated, to have contracted HIV through intravenous drug use rather than through sex with other men, and to be African American rather than Caucasian.

The National Center for Complementary and Alternative Medicine (NCCAM) announced plans in 2007 to conduct a three-year study of CAM therapies used by adults diagnosed with HIV. According to the center, between 47 and 74% of HIV-positive persons in the United States have used some type of CAM approach—most often to relieve the side effects of HAART as well as to improve overall well-being. The study is scheduled to run from 2009 through 2011.

Prognosis

There was no cure for AIDS as of 2010. Without treatment, HIV infection progresses to AIDS in an average of 11 years. After diagnosis with AIDS, the patient has a life expectancy of 9.2 months without treatment. A person diagnosed with HIV infection who begins treatment with HAART has a life expectancy of about 20 years as of 2010. Unfortunately, about half of patients who begin treatment with HAART fail to benefit from it as much as they had hoped and discontinue it.

About 37% of patients with AIDS eventually develop AIDS dementia complex, with another 30% showing milder symptoms of dementia. Women with AIDS are at slightly higher risk than men of developing ADC.

Older adults generally have a worse prognosis than younger adults diagnosed with AIDS. The earlier stages of HIV infection progress more rapidly to AIDS in seniors, the initial CD4+ T cell counts are lower, and the survival period is shorter. Whereas 80 percent of younger adults survive for a year after being diagnosed with AIDS, only 40% of seniors survive that long.

The reasons for the poorer prognosis in older adults were not fully understood as of 2010. Various explanations include delayed diagnosis due to the fact that the early symptoms of HIV infection are easily confused with those of other diseases commonly found in older persons; inadequate treatment; the high rate of other diseases and disorders in the elderly that can further weaken the immune system; a lower rate of compliance with treatment regimens; and age-related changes in the immune system itself. It is thought that the immune system in older adults is less efficient in replacing T helper cells and so is more easily overwhelmed by HIV infection.

Prevention

There was no vaccine against HIV infection as of 2010; moreover, it is unlikely that an effective vaccine will be developed in the foreseeable future because the retrovirus that causes AIDS mutates so rapidly. Although various vaccines against HIV have been tested by the National Institutes of Health since 1996, none have so far been approved for use outside clinical trials.

Researchers are, however, actively working on producing preventative and therapeutic vaccines for HIV. Preventative vaccines immunize an individual against a disease, so that he or she does not become infected. A therapeutic vaccine, also called a treatment vaccine, does not keep someone from getting a disease the way a preventative vaccine does. Instead, therapeutic vaccines are used to boost the body's immune system in order to help control infection. The potential exists to prolong life indefinitely using these and other drug therapies to boost the immune system, keep the virus from replicating, and ward off opportunistic infections and malignancies.

People can lower their risk of HIV infection by taking the following precautions recommended by the CDC:

- Limit sexual activity to a single partner who is known to be uninfected and is faithful
- Use a condom when having sex with anyone whose HIV status is unknown
- Do not share needles or inject illegal drugs
- Do not exchange sex for drugs
- Health care workers should follow guidelines for protecting against needle sticks and other accidental exposures to body fluids that may be contaminated with HIV
- Get tested for HIV infection after engaging in high-risk activities; if the test results are positive, inform all current sexual partners

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Diet and nutritional concerns

Diet and **nutrition** are a major part of managing HIV infection and AIDS. While there is no standard "HIV diet" or "AIDS diet" because patients' symptoms, medication regimens, and corresponding nutritional needs vary so widely, there are general practices followed by registered dietitians who work with doctors and other health care professionals to care for these patients.

The function of nutritional education and dietary management in patients with HIV infection and AIDS is to maintain the patient's energy level and ability to carry out normal activities of daily life; lower the risk of opportunistic infections of the digestive system; and minimize the side effects of HAART on the patient's ability to eat and enjoy food.

Dietetics consultation and follow-up

Patients with HIV infection should consult a registered dietitian (RD) as soon as possible after diagnosis, because good nutrition is essential to maintaining a normal level of activity and self-care as well as supporting the patient's immune system. RDs use several screening questionnaires to evaluate patients for potential nutritional problems. On the patient's first visit, he or she is given a quick nutrition screen or QNS to fill out. The QNS identifies such problems as unintentional weight loss, nausea, difficulty swallowing, and **diarrhea**. The dietitian then measures the patient's height, weight, skinfold thickness, and the circumference of the muscles on the patient's midarm. These last two measurements are needed in order to monitor changes in body fat distribution and muscle wasting that often accompany HIV infection.

The next step in the initial assessment is the patient's completion of a food intake record (FIR). The patient is asked to record everything he or she eats or drinks in a 24-hour period, including snacks and alcoholic beverages. If possible, the patient will fill out two FIRs, one for a working day and one for a weekend day or holiday. The FIR allows the dietitian to evaluate the patient's usual eating habits, portion sizes, food preferences, and average calorie intake. It also establishes a baseline for the individual patient, so that loss of appetite later on or other nutritional problems can be detected as quickly as possible.

Follow-up visits to the dietitian are scheduled according to the degree of the patient's nutritional risk. The American Dietetic Association and the Los Angeles County Commission on HIV Health Services use the following timelines for HIV patients at nutritional risk:

- Low risk: The patient's weight is stable, with a balanced and adequate food intake; normal blood levels of cholesterol, triglycerides, and glucose; no evidence of kidney or liver disorders; regular physical exercise; and low levels of psychosocial stress. Low-risk patients are evaluated by the RD as needed, but at least once a year.
- Moderate risk: The patient is obese or suffers from changing patterns of body fat distribution; has high blood cholesterol levels or high blood pressure; has developed an eating disorder, nausea, vomiting, or diarrhea; has been recently diagnosed with type 2 diabetes or food allergies; is in recovery from substance abuse; or is under psychosocial stress. Moderate-risk patients should be seen by the RD within a month.
- High risk: The patient is pregnant; suffers from poorly controlled diabetes; has lost 10% of body weight over the previous 4–6 months; has lost 5% of body weight in the previous 4 weeks; has dental problems, involvement of the central nervous system, severe nausea or vomiting, severe pain on swallowing, or chronic diarrhea; has one or more opportunistic infections; or is under severe psychosocial stress. These patients should be seen by an RD within one week.

In addition to assessment of the patient's nutritional needs, RDs also evaluate his or her living situation and other issues that may affect receiving adequate nutrition.

Specific issues in nutritional care of HIV patients

NAUSEA, VOMITING, AND DIARRHEA. **Nausea and vomiting** are common symptoms of HIV infection as well as side effects of HAART. They can lead to long-term damage to the esophagus and dental problems as well as weight loss and inability to take needed medications. About 30% of patients develop nausea and **vomiting** within one to four weeks following infection as part of a condition called acute retroviral syndrome or ARS, which resembles **influenza** or mononucleosis. Most patients, however, develop nausea, **vomiting**, and diarrhea later on in the course of the disease as side effects of HAART or from opportunistic infections of the gastrointestinal system. Patients with HIV infection are highly susceptible to such diseases as **giardiasis**, **cryptosporidiosis**, **listeriosis**, *Campylobacter* infections, and *Salmonella* infections.

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Treatment of nausea, vomiting, and diarrhea in patients with HIV infections may require a number of diagnostic tests and imaging studies as well as evaluation of the patient's medications in order to determine the cause(s) of the symptoms.

LIPODYSTROPHY. Lipodystrophy is the medical term for the redistribution of body fat that sometimes occurs in patients with HIV infection as a result of HAART, genetic factors, the length of time a person has been HIV-positive, and the severity of the disease. It is not completely understood why antiretroviral drugs and other factors have this effect. The patient may notice new deposits of fat at the back of the neck (sometimes called "buffalo humps") and around the abdomen. Conversely, fat may be lost under the skin of the face, resulting in sunken cheeks, or lost under the skin of the buttocks, arms, or legs. Lipodystrophy is not necessarily associated with weight loss.

Lipodystrophy may be accompanied by other changes in the patient's metabolism, particularly **insulin resistance** and higher levels of blood cholesterol and **triglycerides**. One recommendation nutritionists often give to patients with lipodystrophy and metabolic changes is to follow the **Mediterranean diet**, which is high in fiber-rich whole grains and vegetables and low in saturated fats. Another recommendation is to maintain a schedule of regular physical **exercise** (particularly weight training), which has been shown to lower insulin resistance and decrease abdominal fat deposits.

WASTING. Wasting refers to rapid unintentional weight loss (usually defined as 5% of body weight over a period of six months) combined with changes in the composition of body tissue. Specifically, the patient is losing lean muscle tissue and replacing it with fat. The patient's outward appearance may not be a reliable guide to wasting, particularly if he or she also has lipodystrophy. Weight loss associated with wasting may result from nausea and vomiting related to opportunistic infections of the digestive tract as well as from reactions to medication.

Nutrition is the first line of defense against wasting. To help the patient maintain weight, nutritionists recommend raising the daily calorie intake from 17–20 calories per pound of body weight (a guideline used for patients whose weight has been stable) to 25 calories per pound. Patients with wasting syndrome may require as much as 3500 calories per day to maintain their weight. Nutrient ratios should be 15–20% protein, 50–60% carbohydrates, and 25% fats to protect the body's muscle tissue. Patients who need more calories or protein may benefit from adding such supplements as Ensure or Instant Breakfast to their daily diet. In addition, weight training or other forms of regular exercise help to maintain muscle tissue.

Other treatments for wasting include the use of appetite stimulants to increase food intake and hormonal treatments to build lean muscle tissue, particularly in male patients.

MEDICATION INTERACTIONS. Most medications used in HAART have the potential to cause nausea and vomiting. Some antiretroviral medications should be taken with food to minimize these side effects. Digestive disturbances are the single most common reason given by patients for discontinuing antiretroviral therapy. In some cases, switching to a different combination of drugs helps to relieve nausea, vomiting, or diarrhea.

FOOD SAFETY ISSUES. Food safety is an important concern for patients with HIV infection because their immune systems have difficulty fighting off food or water-borne disease organisms. While most people can get **food poisoning** or parasitic infections of the digestive tract if they drink contaminated water or do not prepare food properly, patients with HIV infection can get severely ill as a result of these diseases. Food-borne illnesses are also much more difficult to treat in persons with AIDS or HIV infection, and may lead to **malabsorption syndrome**, a condition in which the body cannot absorb and make use of needed nutrients in food.

The CDC and NIH have brochures with detailed instructions for patients about safety issues in purchasing and preparing foods, particularly when traveling abroad. Basic safeguards include the following:

- Wash hands repeatedly in warm soapy water before and after preparing or eating food; instant hand sanitizers should be used when away from home
- Cook all meats, fish, and poultry to the well-done stage; do not eat sushi, raw oysters, or raw meat in any form
- Do not use unpasteurized milk or dairy products
- Do not eat raw, soft-boiled, or "wet" scrambled eggs, or Caesar salad made with raw egg in the dressing; hard-boiled or hard-scrambled eggs are safe
- Rinse all fruits and vegetables carefully in clean, safe water, and clean all cutting boards and knives that touch chicken and meat with soap and hot water before using these utensils with other food items
- Keep all refrigerated foods below 40°F; check expiration dates on food packaging

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- Completely reheat leftovers before eating, and do not eat leftovers that have been stored in the refrigerator for longer than 3 days
- Do not drink water that comes directly from lakes, streams, rivers, or springs, and ask for drinks without ice in restaurants

Caregiver concerns

A caregiver for an older adult with AIDS should be concerned with the following:

- Complete compliance with the senior's HAART regimen. Failure to take the medications exactly as directed can lead to resistant forms of HIV and eventual treatment failure. A handout for patients on how to take antiretroviral medications is available on the American Academy of Family Physicians website at http://www.aafp.org/afp/20030815/ 689ph.html
- Nausea, vomiting, and weight loss, or signs of lipodystrophy or wasting syndrome; the doctor may recommend a consultation with a professional dietitian
- Signs of dementia; AIDS-related dementia in seniors is often misdiagnosed as Alzheimer's disease
- Signs of drug interactions between the senior's antiretroviral therapy and medications he or she may be taking for other diseases
- Signs of upper respiratory infections, particularly pneumonia or thrush
- Skin disorders, including changes in the skin that may indicate cancer

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Public Broadcasting System (PBS) Frontline. *The Age of AIDS*. http://www.pbs.org/wgbh/pages/frontline/aids

ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333 800-232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

Food and Drug Administration (FDA), 10903 New Hampshire Ave., Silver Spring, MD, 20993 888-INFO-FDA, http://www.fda.gov/.

Gay Men's Health Crisis (GMHC), Tisch Building, 119 West 24th Street, New York, NY, 10011 212-367-1000, http://www.gmhc.org/.

Infectious Diseases Society of America (IDSA), 1300 Wilson Blvd, Suite 300, Arlington, VA, 22209 703-299-0200 703-299-0204, http://www.idsociety.org/.

National Institute of Allergy and Infectious Diseases (NIAID), 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-6612 301-496-5717 866-284-4107 301-402-3573, http://www3.niaid.nih.gov.

International AIDS Society (IAS), Ave. Louis Casaï 71, P. O. Box 28, Geneva, Switzerland, CH - 1216 Cointrin +41-(0)22-7 100 800 +41-(0)22-7 100 899, info@iasociety.org, http://www.iasociety.org/.

World Health Organization (WHO), Avenue Appia 20, 1211 Geneva 27, Switzerland + 41 22 791 21 11 + 41 22 791 31 11, info@who.int, http://www.who.int/en/.

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AIDS serology *see* **AIDS tests**

AIDS tests

Definition

AIDS tests, short for acquired **immunodeficiency** syndrome tests, cover a number of different procedures used in the diagnosis and treatment of HIV patients. These tests sometimes are called AIDS serology tests. Serology is the branch of immunology that deals with the contents and characteristics of blood serum. Serum is the clear light yellow part of blood that remains liquid when blood cells form a clot. AIDS serology evaluates the presence of human immunodeficiency virus (HIV) infection in blood serum and its effects on each patient's immune system.

Purpose

AIDS serology serves several different purposes. Some AIDS tests are used to diagnose patients or confirm a diagnosis; others are used to measure the progression of the disease or the effectiveness of specific treatment regimens. Some AIDS tests also can be used to screen blood donations for safe use in transfusions.

In order to understand the different purposes of the blood tests used with AIDS patients, it is helpful to understand how HIV infection affects human blood and the immune system. HIV is a retrovirus that enters the blood stream of a new host in the following ways:

- by sexual contact
- by contact with infected body fluids (such as blood and urine)
- by transmission during pregnancy, or
- through transfusion of infected blood products

A retrovirus is a virus that contains a unique enzyme called reverse transcriptase that allows it to replicate within new host cells. The virus binds to a protein called CD4, which is found on the surface of certain subtypes of white blood cells, including helper T cells, macrophages, and monocytes. Once HIV enters the cell, it can replicate and kill the cell in ways that are still not completely understood. In addition to killing some lymphocytes directly, the AIDS virus disrupts the functioning of the remaining CD4 cells. CD4 cells ordinarily produce a substance called interleukin-2 (IL-2), which stimulates other cells (T cells and B cells) in the human immune system to respond to infections. Without the IL-2, T cells do not reproduce as they normally would in response to the HIV virus, and B cells are not stimulated to respond to the infection.

Precautions

In some states such as New York, a signed consent form is needed in order to administer an AIDS test. As with all blood tests, healthcare professionals should always wear latex gloves and avoid being pricked by the needle used in drawing blood for the tests. It may

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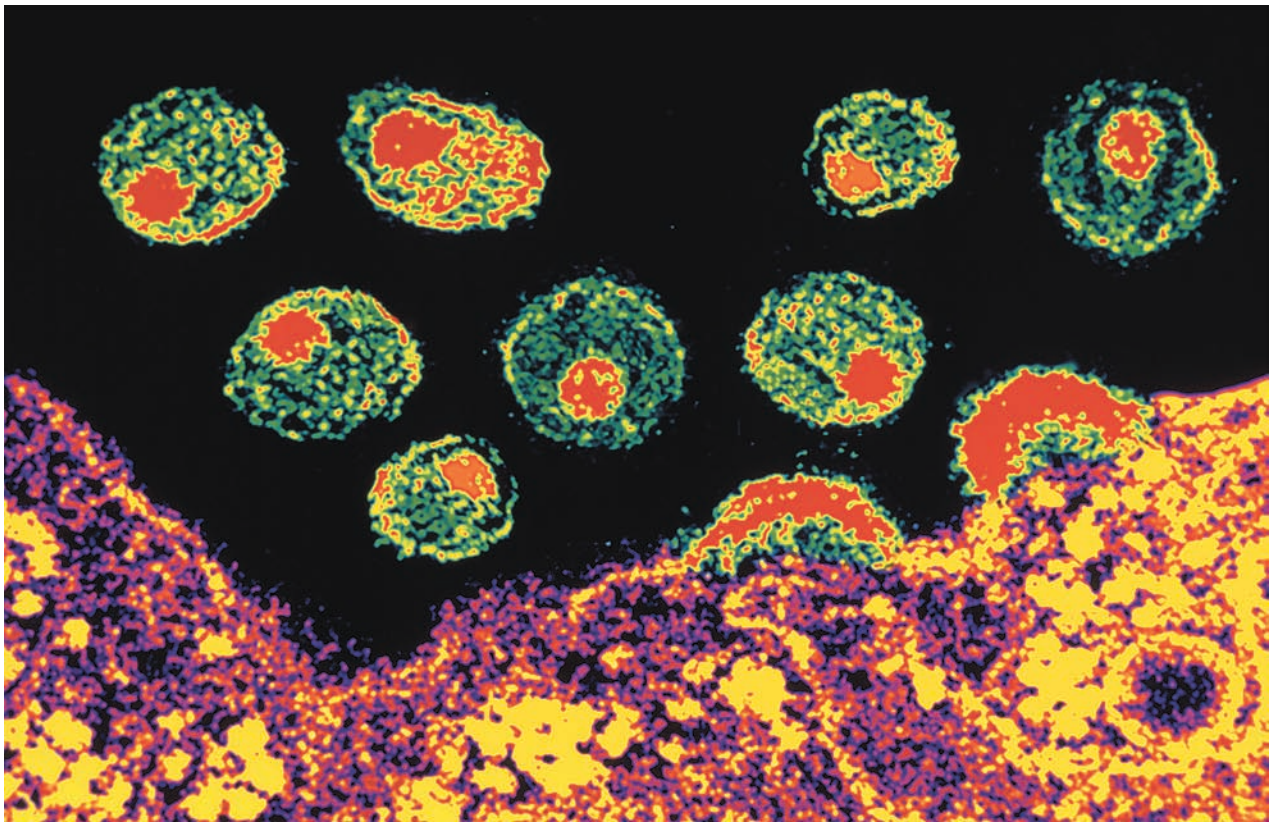

Mature HIV-1 viruses (above) and the lymphocyte from which they emerged (below). Two immature viruses can be seen budding on the surface of the lymphocyte (right of center). *(Scott Camazir/Photo Researchers, Inc.)*

be difficult to get blood from a habitual intravenous drug user due to collapsed veins.

Description

Diagnostic tests

Diagnostic blood tests for AIDS usually are given to persons in high-risk populations who may have been exposed to HIV or who have the early symptoms of AIDS. Most persons infected with HIV will develop a detectable level of antibody within three months of infection. The condition of testing positive for HIV antibody in the blood is called seroconversion, and persons who have become HIV-positive are called seroconverters.

It is possible to diagnose HIV infection by isolating the virus itself from a blood sample or by demonstrating the presence of HIV antigen in the blood. Viral culture, however, is expensive, not widely available, and slow—it takes 28 days to complete the viral culture test. More common are blood tests that work by detecting the presence of antibodies to the HIV virus. These tests are inexpensive, widely available, and accurate in detecting 99.9% of AIDS infections when used in combination to screen patients and confirm diagnoses.

ENZYME-LINKED IMMUNOSORBENT ASSAY (ELISA). This type of blood test is used to screen blood for transfusions as well as diagnose patients. An ELISA test for HIV works by attaching HIV antigens to a plastic well or beads. A sample of the patient's blood serum is added, and excess proteins are removed. A second antibody coupled to an enzyme is added, followed by addition of a substance that will cause the enzyme to react by forming a color. An instrument called a spectrophotometer can measure the color. The name of the test is derived from the use of the enzyme that is coupled or linked to the second antibody.

The latest generation of ELISA tests are 99.5% sensitive to HIV. Occasionally, the ELISA test will be positive for a patient without symptoms of AIDS from a low-risk group. Because this result is likely to be a false-positive, the ELISA must be repeated *on the same sample of the patient's blood.* If the second ELISA is positive, the result should be confirmed by the Western blot test.

WESTERN BLOT (IMMUNOBLOT). The Western blot or immunoblot test is used as a reference procedure to

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confirm the diagnosis of AIDS. In Western blot testing, HIV antigen is purified by electrophoresis (large protein molecules are suspended in a gel and separated from one another by running an electric current through the gel). The HIV antigens are attached by blotting to a nylon or nitrocellulose filter. The patient's serum is reacted against the filter, followed by treatment with developing chemicals that allow HIV antibody to show up as a colored patch or blot. A commercially produced Western blot test for HIV-1 is now available. It consists of a prefabricated strip that is incubated with a sample of the patient's blood serum and the developing chemicals. About nine different HIV-1 proteins can be detected in the blots.

When used in combination with ELISA testing, Western blot testing is 99.9% specific. It can, however, yield false negatives in patients with very early HIV infection and in those infected by HIV-2. In some patients the Western blot yields indeterminate results.

IMMUNOFLUORESCENCE ASSAY (IFA). This method is sometimes used to confirm ELISA results instead of Western blotting. An IFA test detects the presence of HIV antibody in a sample of the patient's serum by mixing HIV antigen with a fluorescent chemical, adding the blood sample, and observing the reaction under a microscope with ultraviolet light.

POLYMERASE CHAIN REACTION (PCR). This test is used to evaluate the very small number of AIDS patients with false-negative ELISA and Western blot tests. These patients are sometimes called antibody-negative asymptomatic (without symptoms) carriers, because they do not have any symptoms of AIDS and there is no detectable quantity of antibody in the blood serum. Antibody-negative asymptomatic carriers may be responsible for the very low ongoing risk of HIV infection transmitted by blood transfusions. It is estimated that the risk is between one in 10,000 and one in 100,000 units of transfused blood.

The polymerase chain reaction (PCR) test can measure the presence of viral nucleic acids in the patient's blood even when there is no detectable antibody to HIV. This test works by amplifying the presence of HIV nucleic acids in a blood sample. Numerous copies of a gene are made by separating the two strands of DNA containing the gene segment, marking its location, using DNA polymerase to make a copy, and then continuously replicating the copies. It is questionable whether PCR will replace Western blotting as the method of confirming AIDS diagnoses. Although PCR can detect the low number of persons (1%) with HIV infections that have not yet generated an antibody response to the virus, the overwhelming majority of infected persons will be detected by ELISA screening within one to three months of infection. In addition, PCR testing is based on present knowledge of the genetic sequences in HIV. Since the virus is continually generating new variants, PCR testing could yield a false negative in patients with these new variants. In 2004, researchers reported on a new test that was more sensitive to HIV, detecting the infection in as little as 12 days after infection. However, the manufacturer was still seeking FDA approval for the test, which would cost about the same as PCR testing.

In 1999, the U.S. Food and Drug Administration (FDA) approved an HIV home testing kit. The kit contained multiple components, including material for specimen collection, a mailing envelope to send the specimen to a laboratory for analysis, and provides pre- and post-test counseling. It uses a finger prick process for blood collection. Other tests have been in development that would allow patients to monitor their own therapy in the home without sending out for results.

Prognostic tests

Blood tests to evaluate patients already diagnosed with HIV infection are as important as the diagnostic tests. Because AIDS has a long latency period, some persons may be infected with the virus for 10 years or longer before they develop symptoms of AIDS. These patients are sometimes called antibody-positive asymptomatic carriers. Prognostic tests also help drug researchers evaluate the usefulness of new medications in treating AIDS.

BLOOD CELL COUNTS. Doctors can measure the number or proportion of certain types of cells in an AIDS patient's blood to see whether and how rapidly the disease is progressing, or whether certain treatments are helping the patient. These cell count tests include:

- Complete blood count (CBC). A CBC is a routine analysis performed on a sample of blood taken from the patient's vein with a needle and vacuum tube. The measurements taken in a CBC include a white blood cell count (WBC), a red blood cell count (RBC), the red cell distribution width, the hematocrit (ratio of the volume of the red blood cells to the blood volume), and the amount of hemoglobin (the blood protein that carries oxygen). Although CBCs are used on more than just AIDS patients, they can help the doctor determine if an AIDS patient has an advanced form of the disease. Specific AIDS-related signs in a CBC include a low hematocrit, a sharp decrease in the number of blood platelets, and a low level of a certain type of white blood cell called neutrophils.

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- Absolute CD4+ lymphocytes. A lymphocyte is a type of white blood cell that is important in the formation of an immune response. Because HIV targets CD4+ lymphocytes, their number in the patient's blood can be used to track the course of the infection. This blood cell count is considered the most accurate indicator for the presence of an opportunistic infection in an AIDS patient. The absolute CD4+ lymphocyte count is obtained by multiplying the patient's white blood cell count (WBC) by the percentage of lymphocytes among the white blood cells, and multiplying the result by the percentage of lymphocytes bearing the CD4+ marker. An absolute count below 200-300 CD+4 lymphocytes in 1 cubic millimeter (mm^3) of blood indicates that the patient is vulnerable to some opportunistic infections.
- CD4+ lymphocyte percentage. Some doctors think that this is a more accurate test than the absolute count because the percentage does not depend on a manual calculation of the number of types of different white blood cells. A white blood cell count that is broken down into categories in this way is called a WBC differential.

It is important for doctors treating AIDS patients to measure the lymphocyte count on a regular basis. Experts consulted by the United States Public Health Service recommend the following frequency of serum testing based on the patient's CD4+ level:

- CD4+ count more than 600 cells/mm^3: Every six months
- CD4+ count between 200-600 cells/mm^3: Every three months
- CD4+ count less than 200 cells/mm^3: Every three months

When the CD4+ count falls below 200 cells/mm^3, the doctor will put the patient on a medication regimen to protect him or her against opportunistic infections.

HIV VIRAL LOAD TESTS. Another type of blood test for monitoring AIDS patients is the viral load test. It supplements the CD4+ count, which can tell the doctor the extent of the patient's loss of immune function, but not the speed of HIV replication in the body. The viral load test is based on PCR techniques and can measure the number of copies of HIV nucleic acids. Successive test results for a given patient's viral load are calculated on a base 10 logarithmic scale.

ORAL HIV TESTS. Scientists have developed oral HIV tests that can be conducted with saliva samples. One of the unintented effects of these tests is the misperception that HIV can be transmitted through saliva. Still, they present an excellent alternative to blood sample testing.

RAPID HIV TESTS. Researchers constantly work on more rapid tests for HIV that can be done in physician offices or by less skilled people and more convenient locations in developing countries. A finger-stick test that can be read quickly from a whole blood sample had shown promising results in the fall of 2003. Another test, called the VScan test kit, requires no refrigeration or electricity and can safely be stored at room temperature. Even if the positive results must be confirmed by ELISA or Western blotting, an accurate initial rapid test can help screen populations for HIV antibodies.

In 2004, a new three-minute test for HIV was launched in the United States under FDA approval. The hope of this test is that health care providers such as family practice physician offices can quickly test a patient in the office and provide results while the patient waits, rather than sending results to a lab.

BETA$_2$-MICROGLOBULIN (BETA$_{2M}$). Beta-microglobulin is a protein found on the surface of all human cells with a nucleus. It is released into the blood when a cell dies. Although rising blood levels of β_{2M} are found in patients with **cancer** and other serious diseases, a rising β_{2M} blood level can be used to measure the progression of AIDS.

P24 ANTIGEN CAPTURE ASSAY. Found in the viral core of HIV, p24 is a protein that can be measured by the ELISA technique. Doctors can use p24 assays to measure the antiviral activity of the patient's medications. In addition, the p24 assay is sometimes useful in detecting HIV infection before seroconversion. However, p24 is consistently present in only 25% of persons infected with HIV.

GENOTYPIC DRUG RESISTANCE TEST. Genotypic testing can help determine whether specific gene mutations, common in people with HIV, are causing drug resistance and drug failure. The test looks for specific genetic mutations within the virus that are known to cause resistance to certain drugs used in HIV treatment. For example the drug 3TC, also known as lamivudine (Epivir), is not effective against strains of HIV that have a mutation at a particular position on the reverse transcriptase protein—amino acid 184—known as M184V (M→V, methionine to valine). So if the genotypic resistance test shows a mutation at position M184V, it is likely the person is resistant to 3TC and not likely to respond to 3TC treatment. Genotypic tests are only effective if the person is already taking antiviral medication and if the viral

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KEY TERMS

Antibody—A protein in the blood that identifies and helps remove disease organisms or their toxins. Antibodies are secreted by B cells. AIDS diagnostic tests work by demonstrating the presence of HIV antibody in the patient's blood.

Antigen—Any substance that stimulates the body to produce antibodies.

B cell—A type of white blood cell derived from bone marrow. B cells are sometimes called B lymphocytes. They secrete antibody and have a number of other complex functions within the human immune system.

CD4—A type of protein molecule in human blood that is present on the surface of 65% of human T cells. CD4 is a receptor for the HIV virus. When the HIV virus infects cells with CD4 surface proteins, it depletes the number of T cells, B cells, natural killer cells, and monocytes in the patient's blood. Most of the damage to an AIDS patient's immune system is done by the virus' destruction of CD4+ lymphocytes. CD4 is sometimes called the T4 antigen.

Complete blood count (CBC)—A routine analysis performed on a sample of blood taken from the patient's vein with a needle and vacuum tube. The measurements taken in a CBC include a white blood cell count, a red blood cell count, the red cell distribution width, the hematocrit (ratio of the volume of the red blood cells to the blood volume), and the amount of hemoglobin (the blood protein that carries oxygen). CBCs are a routine blood test used for many medical reasons, not only for AIDS patients. They can help the doctor determine if a patient is in advanced stages of the disease.

Electrophoresis—A method of separating complex protein molecules suspended in a gel by running an electric current through the gel.

Enzyme-linked immunosorbent assay (ELISA)—A diagnostic blood test used to screen patients for AIDS or other viruses. The patient's blood is mixed with antigen attached to a plastic tube or bead surface. A sample of the patient's blood serum is added, and excess proteins are removed. A second antibody coupled to an enzyme is added, followed by a chemical that will cause a color reaction that can be measured by a special instrument.

Human immunodeficiency virus (HIV)—A transmissible retrovirus that causes AIDS in humans. Two forms of HIV are now recognized: HIV-1, which causes most cases of AIDS in Europe, North and South America, and most parts of Africa; and HIV-2, which is chiefly found in West African patients. HIV-2, discovered in 1986, appears to be less virulent than HIV-1, but also may have a longer latency period.

Immunofluorescent assay (IFA)—A blood test sometimes used to confirm ELISA results instead of using the Western blotting. In an IFA test, HIV antigen is mixed with a fluorescent compound and then with a sample of the patient's blood. If HIV antibody

load is greater than 1,000 copies per milliliter (mL) of blood. The cost of the test, usually between $300 and $500, is now covered by many insurance plans.

PHENOTYPIC DRUG RESISTANCE TESTING. Phenotypic testing directly measures the sensitivity of a patient's HIV to particular drugs and drug combinations. To do this, it measures the concentration of a drug required to inhibit viral replication in the test tube. This is the same method used by researchers to determine whether a drug might be effective against HIV before using it in human clinical trials. Phenotypic testing is a more direct measurement of resistance than genotypic testing. Also, unlike genotypic testing, phenotypic testing does not require a high viral load but it is recommended that persons already be taking **antiretroviral drugs**. The cost is between $700 and $900 and is now covered by many insurance plans.

AIDS serology in children

Children born to HIV-infected mothers may acquire the infection through the mother's placenta or during the birth process. Public health experts recommend the testing and monitoring of all children born to mothers with HIV. Diagnostic testing in children older than 18 months is similar to adult testing, with ELISA screening confirmed by Western blot. Younger infants can be diagnosed by direct culture of the HIV virus, PCR testing, and p24 antigen testing. These techniques allow a pediatrician to identify 50% of infected children at or near birth, and 95% of cases in infants three to six months of age.

Preparation

Preparation and aftercare are important parts of AIDS diagnostic testing. Doctors are now advised to

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is present, the mixture will fluoresce when examined under ultraviolet light.

Lymphocyte—A type of white blood cell that is important in the formation of antibodies. Doctors can monitor the health of AIDS patients by measuring the number or proportion of certain types of lymphocytes in the patient's blood.

Macrophage—A large white blood cell, found primarily in the bloodstream and connective tissue, that helps the body fight off infections by ingesting the disease organism. HIV can infect and kill macrophages.

Monocyte—A large white blood cell that is formed in the bone marrow and spleen. About 4% of the white blood cells in normal adults are monocytes.

Opportunistic infection—An infection that develops only when a person's immune system is weakened, as happens to AIDS patients.

Polymerase chain reaction (PCR)—A test performed to evaluate false-negative results to the ELISA and Western blot tests. In PCR testing, numerous copies of a gene are made by separating the two strands of DNA containing the gene segment, marking its location, using DNA polymerase to make a copy, and then continuously replicating the copies. The amplification of gene sequences that are associated with HIV allows for detection of the virus by this method.

Retrovirus—A virus that contains a unique enzyme called reverse transcriptase that allows it to replicate within new host cells.

Seroconversion—The change from HIV- negative to HIV-positive status during blood testing. Persons who are HIV-positive are called seroconverters.

Serology—The analysis of the contents and properties of blood serum.

Serum—The part of human blood that remains liquid when blood cells form a clot. Human blood serum is clear light yellow in color.

T cells—Lymphocytes that originate in the thymus gland. T cells regulate the immune system's response to infections, including HIV. CD4 lymphocytes are a subset of T lymphocytes.

Viral load test—A new blood test for monitoring the speed of HIV replication in AIDS patients. The viral load test is based on PCR techniques and supplements the CD4+ cell count tests.

Western blot—A technique developed in 1979 that is used to confirm ELISA results. HIV antigen is purified by electrophoresis and attached by blotting to a nylon or nitrocellulose filter. The patient's serum is reacted against the filter, followed by treatment with developing chemicals that allow HIV antibody to show up as a colored patch or blot. If the patient is HIV-positive, there will be stripes at specific locations for two or more viral proteins. A negative result is blank.

WBC differential—A white blood cell count in which the technician classifies the different white blood cells by type as well as calculating the number of each type. A WBC differential is necessary to calculate the absolute CD4+ lymphocyte count.

take the patient's emotional, social, economic, and other circumstances into account and to provide counseling before and after testing. Patients are generally better able to cope with the results if the doctor has spent some time with them before the blood test explaining the basic facts about HIV infection and testing. Many doctors now offer this type of informational counseling before performing the tests.

Aftercare

If the test results indicate that the patient is HIV-positive, he or she will need counseling, information, referral for treatment, and support. Doctors can either counsel the patient themselves or invite an experienced HIV counselor to discuss the results of the blood tests with the patient. They also will assess the patient's emotional and psychological status, including the possibility of violent behavior and the availability of a support network.

Risks

The risks of AIDS testing are primarily related to disclosure of the patient's HIV status rather than to any physical risks connected with blood testing. Some patients are better prepared to cope with a positive diagnosis than others, depending on their age, sex, health, resources, belief system, and similar factors.

Normal results

Normal results for ELISA, Western blot, IFA, and PCR testing are negative for HIV antibody.

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Normal results for blood cell counts:

- WBC differential: Total lymphocytes 24–44% of the white blood cells
- Hematocrit: 40–54% in men; 37–47% in women
- T cell lymphocytes: 644–2200/mm^3, 60–88% of all lymphocytes
- B cell lymphocytes: 82–392/mm^3, 3–20% of all lymphocytes
- CD4+ lymphocytes: 500–1200/mm^3, 34–67% of all lymphocytes

Abnormal results

The following results in AIDS tests indicate progression of the disease:

- Percentage of CD4+ lymphocytes: less than 20% of all lymphocytes.
- CD4+ lymphocyte count: less than 200 cells/mm^3
- Viral load test: Levels more than 5000 copies/mL
- β:-2-microglobulin: Levels more than 3.5 mg/dL
- P24 antigen: Measurable amounts in blood serum

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Air embolism *see* **Gas embolism**

Alagille syndrome

Definition

Alagille syndrome (ALGS) is a rare genetic condition that affects the bile ducts of the liver primarily. It can also affect the heart, kidneys, skeleton, and other parts of the body. ALGS is usually caused by a defect in the JAG1 gene and is known as Alagille syndrome 1 or ALGS1. Rarely it is caused by a defect in the NOTCH2 gene and is known as Alagille syndrome 2 or ALGS2. Other names for ALGS include:

- Alagille's syndrome
- Alagille-Watson syndrome
- arteriohepatic dysplasia (AHD)
- cardiovertebral syndrome
- cholestasis with peripheral pulmonary stenosis
- hepatic ductular hypoplasia
- hepatofacioneurocardiovertebral syndrome
- JAG1–related Alagille syndrome
- NOTCH2–related Alagille Syndrome
- paucity of interlobular bile ducts
- syndromatic hepatic ductular hypoplasia
- syndromic bile duct paucity
- Watson-Miller syndrome

Demographics

Alagille syndrome is very rare, occurring in only one out of 70,000–100,000 live births. However since symptoms of the disorder are often extremely mild, the true incidence may be closer to one in 20,000. The condition affects males and females equally.

Description

Liver damage caused by narrowed, malformed, and a reduced number of bile ducts is a major feature of Alagille syndrome. Bile, which helps digest fats, is carried from the liver to the gallbladder and small intestine by ducts. During their first year or two, children with AGS usually lose bile ducts in the liver and have a narrowing of the ducts outside the liver. Bile builds up in the liver causing scarring, which leads to **cirrhosis** in about 30–50% of children with AGS. In addition to **liver disease** AGS can cause:

- characteristic facial features
- heart murmur or other heart defects
- ophthalmologic (eye) problems
- abnormalities in blood vessels in the brain, kidneys, and spinal cord
- an unusual "butterfly" shape in the bones of the spinal cord
- a variety of rarer symptoms

Most cases of ALGS are caused by changes or mutations in the JAG1 gene on the short arm of chromosome 20. The JAG1 gene encodes a cell-surface

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KEY TERMS

Amniocentesis—The insertion of a needle through the abdomen into the uterus at 16–18 weeks of gestation to withdraw a small sample of the amniotic fluid surrounding the fetus to test for genetic disorders and other medical conditions.

Bile—A liquid secreted by the liver and passed through ducts to the small intestine where it aids in the digestion and absorption of fats.

Bilirubin—A red-yellow pigment in the bile and blood; excessive accumulation of bilirubin results in jaundice.

Chorionic villus sampling (CVS)—The insertion of a needle through the abdomen or cervix at 10–12 weeks of gestation and the removal of cells from around the embryo to test for chromosome abnormalities or other genetic disorders.

Cirrhosis—Disruption of liver function due to damage from chronic progressive disease.

Jaundice—Yellowing of the eyes and skin due to the buildup of bilirubin in the blood.

Xanthomas—Fatty yellow patches or nodules on the skin or internal tissues.

protein that is active in many cell types. The JAG1 protein interacts with the protein encoded by the NOTCH2 gene to trigger interactions between neighboring cells called Notch signaling. This process directs cells to their proper place in the developing embryo. However ALGS is characterized by variable expressivity. This means that the symptoms and severity of ALGS vary greatly. In some cases this is probably because different mutations in the JAG1 gene result in different symptoms or manifestations. However the symptoms and severity of ALGS in family members with the same JAG1 mutation can differ considerably. In addition, ALGS is not fully penetrant, meaning that some people with an inherited JAG1 mutation have no features or symptoms of the disorder.

Risk factors

Alagille syndrome is an autosomal dominant trait, meaning that it can affect either gender and that a single copy of the defective or deleted gene is sufficient to cause the disorder. In 30–50% of cases ALGS is inherited from a parent; however it occurs sporadically as a result of random mutations in 50–70% of cases. In these cases neither parent has the gene mutation; rather the change or mutation occurs for the first time either in the egg or sperm or in the developing embryo. Regardless of whether the genetic defect is inherited or spontaneous, individuals with ALGS have a 50% chance of passing on the altered gene to each of their children. Since the disorder is dominant, passing on one copy of the gene can cause ALGS.

Causes and symptoms

More than 90% of cases of Alagille syndrome are caused by mutations in the JAG1 gene on chromosome 20. An additional seven percent of cases are caused by small deletions on chromosome 20 that include the JAG1 gene. A variety of different mutations, duplications, and deletions in the JAG1 gene can cause ALGS. Less than one percent of individuals with ALGS have mutations in the NOTCH2 gene.

Alagille syndrome is usually identified within the first months of life by symptoms of liver damage including:

- jaundice (yellowing of the skin and whites of the eyes)
- an enlarged liver
- pale, loose stools
- severe skin itching called pruritus, due to a buildup of bilirubin in the blood
- harmless fatty deposits from high cholesterol levels in the blood, appearing as yellow bumps on the skin called xanthomas
- stunted growth

Although symptoms often stabilize or improve between the ages of four and 10, complications of ALGS may persist:

- Narrowing of the pulmonary arteries carrying blood from the heart to the lungs can cause a heart murmur, the most common sign of ALGS other than liver disease. The murmur rarely affects cardiac function, although a small number of patients have more serious defects in the heart walls or valves.
- Facial features that are characteristic of ALGS include a broad, prominent forehead, deep–set eyes, and a small pointed chin.
- More than 90% of children with ALGS have an unusual eye abnormality.

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- The bones of the spinal cord may have the shape of butterfly wings, although this condition almost never affects nerve function or causes other spinal problems.
- Malabsorption of fats and fat-soluble vitamins due to a lack of bile can cause diarrhea, failure to thrive in infancy, poor growth and delayed puberty, learning delays, blood-clotting problems, and bone fractures.
- ALGS can cause undersized kidneys, cysts in the kidneys, decreased kidney function, or other kidney disease.
- Advanced liver disease can cause the spleen to enlarge.
- Abnormalities in the carotid arteries of the head and neck can lead to internal bleeding or stroke.
- Various blood vessels in the body can narrow or bulge.

Diagnosis

Examination

A diagnosis of Alagille syndrome is based on clinical features—usually a combination of liver disease and at least two other symptoms such as:

- heart abnormalities or murmurs
- skeletal abnormalities
- ophthalmologic abnormalities
- facial features typical of ALGS

A single symptom of ALGS may be sufficient for a diagnosis if a relative is also affected. However other affected family members may have such mild or variable symptoms that their condition is not apparent. Once a patient is diagnosed with ALGS, the parents or other family members may be evaluated for subtle features of the condition. Diagnosis is very important since other genetic syndromes can cause similar liver disease and heart and eye defects and are inherited differently.

Tests

In addition to blood tests to measure liver and kidney function and nutritional status, genetic tests may be performed, sometimes prenatally, to check for gene-related abnormalities. A JAG1 gene mutation may be sufficient for ALGS diagnosis even in the absence of major symptoms. Tests include:

- DNA sequence analysis of the entire JAG1 coding region
- scanning for mutations in the JAG1 coding region
- fluorescence in situ hybridization (FISH) to detect the deletion of the entire JAG1 gene
- tests for duplications of the JAG1 gene
- linkage analysis of the JAG1 gene
- sequence analysis of the entire NOTCH2 coding region
- deletion/duplication analysis of the NOTCH2 gene

Procedures

Procedures for the diagnosis of Alagille syndrome include:

- abdominal ultrasound to detect liver enlargement and to rule out other conditions
- liver biopsy or surgery for direct examination of the bile duct system
- an echocardiogram to detect heart problems
- x rays of the spine
- examinations of the blood vessels and kidneys

Treatment

Traditional

Treatment of Alagille syndrome varies greatly depending on the symptoms and severity of the disorder. However it usually requires multidisciplinary treatment including medical genetics, gastroenterology, cardiology, ophthalmology, and **nutrition**. Treatment usually focuses on increasing the flow of bile from the liver, maintaining normal growth and development, and correcting nutritional deficiencies. Infants receive special formula containing high levels of medium-chain **triglycerides** (MCTs) for improved fat absorption by the small intestine. Breastfed infants may receive supplemental MCT oil. A child may receive additional calories through a tiny tube passed through the nose into the stomach or through a **gastrostomy** tube placed directly into the stomach through a small opening in the abdomen.

Other treatments may be necessary:

- Approximately 15–20% of ALGS patients require a liver transplant
- Severe pruritus is sometimes treated by partial external biliary diversion (PEBD), in which one end of the small intestine is surgically connected to the gallbladder and the other end to an opening in the abdomen for the collection of bile outside of the body
- Heart surgery may be required to repair defects

Drugs

Drugs used to treat Alagille syndrome include:

- ursodiol (Actigall, Urso) to increase bile flow
- large oral doses or injections of fat-soluble vitamins (A, D, E, and K) to treat deficiencies

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- cholestyramine (Questran, Prevalite), rifampin (Rifadin), naltrexone (ReVia, Depade), or antihistamines to relieve pruritus

Home remedies

Infants, children, and adults with Alagille syndrome can benefit from a high-calorie diet that includes **calcium** and the fat-soluble **vitamins**. Pruritus can be treated with moisturizers to hydrate the skin. Fingernails should be trimmed to prevent damage from scratching.

Prognosis

The prognosis for Alagille syndrome varies greatly depending on the degree of liver, heart, and **kidney disease** and the presence of intracranial bleeding. About 75% of children with ALGS survive to at least 20 years of age. Although there is no way to predict which patients will reach end-stage liver disease, the survival rate for patients undergoing **liver transplantation** is 60–80%. ALGS patients most often die from liver disease, heart disease, or blood vessel abnormalities.

Prevention

Prenatal testing via **chorionic villus sampling** or **amniocentesis** is available if a parent has been diagnosed with Alagille syndrome. However the variability of clinical symptoms, even within a single family, limits the interpretation of test results, since the same genetic mutation can result in a wide range of medical problems with varying degrees of severity.

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ORGANIZATIONS

American Liver Foundation (ALF), 75 Maiden Ln., Suite 603, New York, NY, 10038 (212) 668-1000 (212) 483-8179, http://www.liverfoundation.org.

Children's Liver Association for Support Services (CLASS), 25379 Wayne Mills Pl., Suite 143, Valencia, CA, 91355 (661) 263-9099 (877) 679-9099 (661) 263-9099, admin@classkids.org, http://www.classkids.org.

Madisons Foundation (MF), PO Box 241956, Los Angeles, CA, 90024 (310) 264-0826 (310) 264–4766, getinfo@madisonsfoundation.org, http://www.madisonsfoundation.org.

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Alanine aminotransferase test

Definition

The alanine aminotransferase test, also known as ALT, is one of a group of tests known as **liver function tests** (or LFTs) and is used to monitor damage to the liver.

Purpose

ALT levels are used to detect liver abnormalities. Since the alanine aminotransferase enzyme is also found in muscle, tests indicating elevated AST levels might also indicate muscle damage. However, other tests, such as the levels of the MB fraction of creatine kinase should indicate whether the abnormal test levels are because of muscle or liver damage.

Description

The alanine aminotransferase test (ALT) can reveal liver damage. It is probably the most specific test for liver damage. However, the severity of the liver damage is not necessarily shown by the ALT test, since the amount of dead liver tissue does not correspond to higher ALT levels. Also, patients with normal, or declining, ALT levels may experience serious liver damage without an increase in ALT.

Nevertheless, ALT is widely used, and useful, because ALT levels are elevated in most patients with **liver disease**. Although ALT levels do not necessarily indicate the severity of the damage to the liver, they may indicate how much of the liver has been damaged. ALT levels, when compared to the levels of a similar enzyme, aspartate aminotransferase (AST), may provide important clues to the nature of the liver disease. For example, within a certain range of values, a ratio of 2:1 or greater

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for AST: ALT might indicate that a patient suffers from alcoholic liver disease. Other diagnostic data may be gleaned from ALT tests to indicate abnormal results.

Preparation

No special preparations are necessary for this test.

Aftercare

This test involves blood being drawn, probably from a vein in the patient's elbow. The patient should keep the wound from the needle puncture covered (with a bandage) until the bleeding stops. Patients should report any unusual symptoms to their physician.

Normal results

Normal values vary from laboratory to laboratory, and should be available to your physician at the time of the test. An informal survey of some laboratories indicates many laboratories find values from approximately seven to 50 IU/L to be normal.

Abnormal results

Low levels of ALT (generally below 300 IU/L) may indicate any kind of liver disease. Levels above 1,000 IU/L generally indicate extensive liver damage from toxins or drugs, viral hepatitis, or a lack of oxygen (usually resulting from very low blood pressure or a **heart attack**). A briefly elevated ALT above 1,000 IU/L that resolves in 24–48 hours may indicate a blockage of the bile duct. More moderate levels of ALT (300–1,000IU/L) may support a diagnosis of acute or chronic hepatitis.

It is important to note that persons with normal livers may have slightly elevated levels of ALT. This is a normal finding.

Michael V. Zuck PhD

Albers-Schönberg disease *see* **Osteopetroses**

Albinism

Definition

Albinism is an inherited condition present at birth, characterized by a lack of pigment that normally gives color to the skin, hair, and eyes. Many types of albinism exist, all of which involve lack of pigment in varying degrees. The condition, which is found in all races, may be accompanied by eye problems and may lead to skin **cancer** later in life.

A man with albinism stands with his normally pigmented father. *(Norman Lightfoot/Photo Researchers, Inc.)*

Description

Albinism is a rare disorder found in fewer than five people per 100,000 in the United States and Europe. Other parts of the world have a much higher rate; for example, albinism is found in about 20 out of every 100,000 people in southern Nigeria.

There are 10 types of the most common form of the condition, known as "oculocutaneous albinism," which affects the eyes, hair, and skin. In its most severe form, hair and skin remain pure white throughout life. People with a less severe form are born with white hair and skin, which turn slightly darker as they age. Everyone with oculocutaneous albinism experiences abnormal flickering eye movements (**nystagmus**) and sensitivity to bright light. There may be other eye problems as well, including poor vision and crossed or "lazy" eyes (**strabismus**).

The second most common type of the condition is known as "ocular" albinism, in which only the eyes lack color; skin and hair are normal. There are five forms of ocular albinism; some types cause more problems, especially eye problems, than others.

Causes and symptoms

Every cell in the body contains a matched pair of genes, one inherited from each parent. These genes act as a sort of "blueprint" that guides the development of a fetus.

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KEY TERMS

Amino acids—Natural substances that are the building blocks of protein. The body breaks down the protein in food into amino acids, and then uses these amino acids to create other proteins. The body also changes amino acids into melanin pigment.

Astigmatism—An eye condition in which the lens doesn't focus light evenly on the retina, leading to problems with visual sharpness.

Carrier—A person with one normal gene and one faulty gene, who can pass on a condition to others without actually having symptoms.

DNA—The abbreviation for "deoxyribonucleic acid," the primary carrier of genetic information found in the chromosomes of almost all organisms. The entwined double structure allows the chromosomes to be copied exactly during cell division.

DOPA—The common name for a natural chemical (3, 4-dihydroxyphenylalanine) made by the body during the process of making melanin.

Enzyme—A protein that helps the body convert one chemical substance to another.

Gene—The basic unit of genetic material carried in a particular place on a chromosome. Genes are passed on from parents to child when the sperm and egg unite during conception.

Hairbulb—The root of a strand of hair from which the color develops.

Hermansky-Pudlak Syndrome (HPS)—A rare type of albinism characterized by a problem with blood clotting and a buildup of waxy material in lungs and intestines.

Melanin—Pigment made in the hair, skin and eyes.

Nystagmus—An involuntary back-and-forth movement of the eyes that is often found in albinism.

Strabismus—Crossed or "lazy" eyes, often found in albinism.

Tyrosine—A protein building block found in a wide variety of foods that is used by the body to make melanin.

Tyrosinase—An enzyme in a pigment cell which helps change tyrosine to DOPA during the process of making melanin.

Albinism is an inherited problem caused by a flaw in one or more of the genes that are responsible for directing the eyes and skin to make melanin (pigment). As a result, little or no pigment is made, and the child's skin, eyes and hair may be colorless.

In most types of albinism, a recessive trait, the child inherits flawed genes for making melanin from both parents. Because the task of making melanin is complex, there are many different types of albinism, involving a number of different genes.

It's also possible to inherit one normal gene and one albinism gene. In this case, the one normal gene provides enough information in its cellular blueprint to make some pigment, and the child will have normal skin and eye color. They "carry" one gene for albinism. About one in 70 people are albinism carriers, with one flawed gene but no symptoms; they have a 50% chance of passing the albinism gene to their child. However, if both parents are carriers with one flawed gene each, they have a one in four chance of passing on both copies of the flawed gene to the child, who will have albinism. (There is also a type of ocular albinism that is carried on the X chromosome and occurs almost exclusively in males because they have only one X chromosome and, therefore, no other gene for the trait to override the flawed one.)

Symptoms of albinism can involve the skin, hair, and eyes. The skin, because it contains little pigment, appears very light, as does the hair.

Although people with albinism may experience a variety of eye problems, one of the myths about albinism is that it causes people to have pink or red eyes. In fact, people with albinism can have irises varying from light gray or blue to brown. (The iris is the colored portion of the eye that controls the size of the pupil, the opening that lets light into the eye.) If people with albinism seem to have reddish eyes, it's because light is being reflected from the back of the eye (retina) in much the same way as happens when people are photographed with an electronic flash.

People with albinism may have one or more of the following eye problems:

- They may be very far-sighted or near-sighted, and may have other defects in the curvature of the lens of the eye (astigmatism) that cause images to appear unfocused

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- They may have a constant, involuntary movement of the eyeball called nystagmus
- They may have problems in coordinating the eyes in fixing and tracking objects (strabismus), which may lead to an appearance of having "crossed eyes" at times. Strabismus may cause some problems with depth perception, especially at close distances
- They may be very sensitive to light (photophobia) because their irises allow "stray" light to enter their eyes. It's a common misconception that people with albinism shouldn't go out on sunny days, but wearing sunglasses can make it possible to go outside quite comfortably

In addition to the characteristically light skin and eye problems, people with a rare form of albinism called Hermansky-Pudlak Syndrome (HPS) also have a greater tendency to have bleeding disorders, inflammation of the large bowel (**colitis**), lung (pulmonary) disease, and kidney (renal) problems.

Diagnosis

It's not always easy to diagnose the exact type of albinism a person has; there are two tests available that can identify only two types of the condition. Recently, a blood test has been developed that can identify carriers of the gene for some types of albinism; a similar test during **amniocentesis** can diagnose some types of albinism in an unborn child. A **chorionic villus sampling** test during the fifth week of **pregnancy** may also reveal some types of albinism.

The specific type of albinism a person has can be determined by taking a good family history and examining the patient and several close relatives.

The "hairbulb pigmentation test" is used to identify carriers by incubating a piece of the person's hair in a solution of tyrosine, a substance in food which the body uses to make melanin. If the hair turns dark, it means the hair is making melanin (a "positive" test); light hair means there is no melanin. This test is the source of the names of two types of albinism: "ty-pos" and "ty-neg."

The tyrosinase test is more precise than the hairbulb pigmentation test. It measures the rate at which hair converts tyrosine into another chemical (DOPA), which is then made into pigment. The hair converts tyrosine with the help of a substance called "tyrosinase." In some types of albinism, tyrosinase doesn't do its job, and melanin production breaks down.

Treatment

There is no treatment that can replace the lack of melanin that causes the symptoms of albinism. Doctors can only treat, not cure, the eye problems that often accompany the lack of skin color. Glasses are usually needed and can be tinted to ease **pain** from too much sunlight. There is no cure for involuntary eye movements (nystagmus), and treatments for focusing problems (surgery or **contact lenses**) are not effective in all cases.

Crossed eyes (strabismus) can be treated during infancy, using eye patches, surgery or medicine injections. Treatment may improve the appearance of the eye, but it can do nothing to cure the underlying condition.

Patients with albinism should avoid excessive exposure to the sun, especially between 10 a.m. and 2 p.m. If exposure can't be avoided, they should use UVA-UVB sunblocks with an SPF of at least 20. Taking beta-carotene may help provide some skin color, although it doesn't protect against sun exposure.

Prognosis

In the United States, people with this condition can expect to have a normal lifespan. People with albinism may experience some social problems because of a lack of understanding on the part of others. When a member of a normally dark-skinned ethnic group has albinism, he or she may face some very complex social challenges.

One of the greatest health hazards for people with albinism is excessive exposure to sun without protection, which could lead to skin cancer. Wearing opaque clothes and sunscreen rated SPF 20, people with albinism can safely work and play outdoors safely even during the summer.

Prevention

Genetic counseling is very important to prevent further occurrences of the conditon.

Resources

BOOKS

National Organization for Albinism and Hypopigmentation (NOAH). *Raising a Child with Albinism: A Guide to the Early Years*. East Hampstead, NH: National Organization for Albinism and Hypopigmentation (NOAH), 2008.

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ORGANIZATIONS

Albinism World Alliance, PO Box 959, East Hampstead, NH, 03826-0959, (603) 887-2310, (800) 473-2310, http://www.albinism.org.

American Foundation for the Blind, 2 Penn Plaza, Suite 1102, New York, NY, 10121, (212) 502-7600, (888) 545-8381, (800) AFB-LIND (232-5463), http://www.afb.org/.

Hermansky-Pudlak Syndrome Network, Inc., One South Road, Oyster Bay, NY, 11771-1905, (516) 922-4022, (800) 780-9477, http://www.hpsnetwork.org.

National Organization for Albinism and Hypopigmentation (NOAH), PO Box 959, East Hampstead, NH, 03826-0959 , (603) 887-2310, (800) 648-2310, (800) 473-2310, http://www.albinism.org/.

Carol A. Turkington

Albuterol *see* **Bronchodilators**

Alcohol-related neurologic disease

Definition

Alcohol, or ethanol, is a poison with direct toxic effects on nerve and muscle cells. Depending on which nerve and muscle pathways are involved, alcohol can have far-reaching effects on different parts of the brain, peripheral nerves, and muscles, with symptoms of **memory loss**, incoordination, seizures, weakness, and sensory deficits. These different effects can be grouped into three main categories: (1) intoxication due to the acute effects of ethanol, (2) withdrawal syndrome from suddenly stopping drinking, and (3) disorders related to long-term or chronic alcohol abuse. Alcohol-related neurologic disease includes Wernicke-Korsakoff disease, alcoholic cerebellar degeneration, alcoholic myopathy, alcoholic neuropathy, alcohol withdrawal syndrome with seizures and **delirium** tremens, and **fetal alcohol syndrome**.

Description

Acute excess intake of alcohol can cause drunkenness (intoxication) or even **death**, and chronic or long-term abuse leads to potentially irreversible damage to virtually any level of the nervous system. Any given patient with long-term alcohol abuse may have no neurologic complications, a single alcohol-related disease, or multiple conditions, depending on the genes they have inherited, how well nourished they are, and other environmental factors, such as exposure to other drugs or toxins.

Neurologic complications of alcohol abuse may also result from nutritional deficiency, because alcoholics tend to eat poorly and may become depleted of thiamine or other **vitamins** important for nervous system function. Persons who are intoxicated are also at higher risk for **head injury** or for compression injuries of the peripheral nerves. Sudden changes in blood chemistry, especially **sodium**, related to alcohol abuse may cause central pontine myelinolysis, a condition of the brainstem in which nerves lose their myelin coating. **Liver disease** complicating alcoholic **cirrhosis** may cause **dementia**, delirium, and movement disorder.

Causes and symptoms

When a person drinks alcohol, it is absorbed by blood vessels in the stomach lining and flows rapidly throughout the body and brain, as ethanol freely crosses the blood-brain barrier that ordinarily keeps large molecules from escaping from the blood vessel to the brain tissue. Drunkenness, or intoxication, may occur at blood ethanol concentrations of as low as 50–150 mg per dL in people who don't drink. Sleepiness, stupor, **coma**, or even death from respiratory depression and low blood pressure occur at progressively higher concentrations.

Although alcohol is broken down by the liver, the toxic effects from a high dose of alcohol are most likely a direct result of alcohol itself rather than of its breakdown products. The fatal dose varies widely because people who drink heavily develop a tolerance to the effects of alcohol with repeated use. In addition, alcohol tolerance results in the need for higher levels of blood alcohol to achieve intoxicating effects, which increases the likelihood that habitual drinkers will be exposed to high and potentially toxic levels of ethanol. This is particularly true when binge drinkers fail to eat, because **fasting** decreases the rate of alcohol clearance and causes even higher blood alcohol levels.

When a chronic alcoholic suddenly stops drinking, withdrawal of alcohol leads to a syndrome of increased excitability of the central nervous system, called delirium tremens or "DTs." Symptoms begin six to eight hours after abstinence, and are most pronounced 24–72 hours after abstinence. They include body shaking (tremulousness), **insomnia**, agitation, confusion, hearing voices or seeing images that are not really there (such as crawling bugs), seizures, rapid heart beat, profuse sweating, high blood pressure, and **fever**. Alcohol-related seizures may also occur without

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KEY TERMS

Abstinence—Refraining from the use of alcoholic beverages.

Atrophy—A wasting or decrease in size of a muscle or other tissue.

Cerebellum—The part of the brain involved in coordination of movement, walking, and balance.

Degeneration—Gradual, progressive loss of nerve cells.

Delirium—Sudden confusion with decreased or fluctuating level of consciousness.

Delirium tremens— A complication that may accompany alcohol withdrawal. The symptoms include body shaking (tremulousness), insomnia, agitation, confusion, hearing voices or seeing images that are not really there (hallucinations), seizures, rapid heart beat, profuse sweating, high blood pressure, and fever.

Dementia—Loss of memory and other higher functions, such as thinking or speech, lasting six months or more.

Myoglobinuria—Reddish urine caused by excretion of myoglobin, a breakdown product of muscle.

Myopathy—A disorder that causes weakening of muscles.

Neuropathy—A condition affecting the nerves supplying the arms and legs. Typically, the feet and hands are involved first. If sensory nerves are involved, numbness, tingling, and pain are prominent, and if motor nerves are involved, the patient experiences weakness.

Thiamine—A B vitamin essential for the body to process carbohydrates and fats. Alcoholics may suffer complications (including Wernike-Korsakoff syndrome) from a deficiency of this vitamin.

Wernicke-Korsakoff syndrome—A combination of symptoms, including eye-movement problems, tremors, and confusion, that is caused by a lack of the B vitamin thiamine and may be seen in alcoholics.

withdrawal, such as during active heavy drinking or after more than a week without alcohol.

Wernicke-Korsakoff syndrome is caused by deficiency of the B-vitamin thiamine, and can also be seen in people who don't drink but have some other cause of thiamine deficiency, such as chronic **vomiting** that prevents the absorption of this vitamin. A 2004 study demonstrated that alcohol-dependent patients admitted to a **detoxification** facility had consumed significantly less thiamine than a comparison group of healthy volunteers. Patients with this condition have the sudden onset of Wernicke encephalopathy; the symptoms include marked confusion, delirium, disorientation, inattention, memory loss, and drowsiness. Examination reveals abnormalities of eye movement, including jerking of the eyes (**nystagmus**) and double vision. Problems with balance make walking difficult. People may have trouble coordinating their leg movements, but usually not their arms. If thiamine is not given promptly, Wernicke encephalopathy may progress to stupor, coma, and death.

If thiamine is given and death averted, **Korsakoff's syndrome** may develop in some patients who suffer from memory impairment that leaves them unable to remember events for a period of a few years before the onset of illness (retrograde **amnesia**) and unable to learn new information (anterograde amnesia). Most patients have very limited insight into their memory dysfunction and have a tendency to make up explanations for events they have forgotten (confabulation).

Severe **alcoholism** can cause cerebellar degeneration, a slowly progressive condition affecting portions of the brain called the anterior and superior cerebellar vermis, causing a wide-based gait, leg incoordination, and an inability to walk heel-to-toe in tightrope fashion. The gait disturbance usually develops over several weeks, but may be relatively mild for some time, and then suddenly worsen after binge drinking or an unrelated illness.

Fetal alcohol syndrome occurs in infants born to alcoholic mothers when prenatal exposure to ethanol retards fetal growth and development. Affected infants often have a distinctive appearance with a thin upper lip, flat nose and mid-face, short stature and small head size. Almost half are mentally retarded, and most others are mildly impaired intellectually or have problems with speech, learning, and behavior. Fetal alcohol syndrome is the leading cause of **mental retardation** and many physicians warn that there is no safe level of alcohol for a pregnant mother to consume.

Alcoholic myopathy, or weakness secondary to breakdown of muscle tissue, is also known as alcoholic

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rhabdomyolysis or alcoholic myoglobinuria. Males are affected by acute (sudden onset) alcoholic myopathy four times as often as females. Breakdown of muscle tissue (myonecrosis), can come on suddenly during binge drinking or in the first days of alcohol withdrawal. In its mildest form, this breakdown may cause no noticeable symptoms, but may be detected by a temporary elevation in blood levels of an enzyme found predominantly in muscle, the MM fraction of creatine kinase.

The severe form of acute alcoholic myopathy is associated with the sudden onset of muscle **pain**, swelling, and weakness; a reddish tinge in the urine caused by myoglobin, a breakdown product of muscle excreted in the urine; and a rapid rise in muscle enzymes in the blood. Symptoms usually worsen over hours to a few days, and then improve over the next week to 10 days as the patient is withdrawn from alcohol. Muscle symptoms are usually generalized, but pain and swelling may selectively involve the calves or other muscle groups. The muscle breakdown of acute alcoholic myopathy may be worsened by crush injuries, which may occur when people drink so much that they compress a muscle group with their body weight for a long time without moving, or by withdrawal seizures with generalized muscle activity.

In patients who abuse alcohol over many years, chronic alcoholic myopathy may develop. Males and females are equally affected. Symptoms include painless weakness of the limb muscles closest to the trunk and the girdle muscles, including the thighs, hips, shoulders, and upper arms. This weakness develops gradually, over weeks or months, without symptoms of acute muscle injury. Muscle atrophy, or decreased bulk, may be striking. The nerves of the extremities may also begin to break down, a condition known as alcoholic **peripheral neuropathy**, which can add to the person's difficulty in moving.

The way in which alcohol destroys muscle tissue is still not well understood. Proposed mechanisms include muscle membrane changes affecting the transport of **calcium**, potassium, or other **minerals**; impaired muscle energy metabolism; and impaired protein synthesis. Alcohol is metabolized or broken down primarily by the liver, with a series of chemical reactions in which ethanol is converted to acetate. Acetate is metabolized by skeletal muscle, and alcohol-related changes in liver function may affect skeletal muscle metabolism, decreasing the amount of blood sugar available to muscles during prolonged activity. Because not enough sugar is available to supply needed energy, muscle protein may be broken down as an alternate energy source. However, toxic effects on muscle may be a direct result of alcohol itself rather than of its breakdown products.

Although alcoholic peripheral neuropathy may contribute to muscle weakness and atrophy by injuring the motor nerves controlling muscle movement, alcoholic neuropathy more commonly affects sensory fibers. Injury to these fibers can cause **tingling** or burning pain in the feet, which may be severe enough to interfere with walking. As the condition worsens, pain decreases but **numbness** increases.

Diagnosis

The diagnosis of alcohol-related neurologic disease depends largely on finding characteristic symptoms and signs in patients who abuse alcohol. Other possible causes should be excluded by the appropriate tests, which may include blood chemistry, **thyroid function tests**, brain MRI (**magnetic resonance imaging**) or CT (computed tomography scan), and/or **cerebrospinal fluid analysis**.

Acute alcoholic myopathy can be diagnosed by finding myoglobin in the urine and increased creatine kinase and other blood enzymes released from injured muscle. The surgical removal of a small piece of muscle for microscopic analysis (muscle biopsy) shows the scattered breakdown and repair of muscle fibers. Doctors must rule out other acquired causes of muscle breakdown, which include the abuse of drugs such as heroin, **cocaine**, or amphetamines; trauma with crush injury; the depletion of phosphate or potassium; or an underlying defect in the metabolism of carbohydrates or lipids. In chronic alcoholic myopathy, serum creatine kinase often is normal, and muscle biopsy shows atrophy, or loss of muscle fibers. **Electromyography** (EMG) may show features characteristic of alcoholic myopathy or neuropathy.

Treatment

Acute management of alcohol intoxication, delirium tremens, and withdrawal is primarily supportive, to monitor and treat any cardiovascular or **respiratory failure** that may develop. In delirium tremens, fever and sweating may necessitate treatment of fluid loss and secondary low blood pressure. Agitation may be treated with **benzodiazepines** such as chlordiazepoxide, beta-adrenergic antagonists such as atenolol, or alpha 2-adrenergic agonists such as clonidine. Because Wernicke's syndrome is rapidly reversible with thiamine, and because death may intervene if thiamine is not given promptly, all patients admitted for acute complications of alcohol, as well as all patients with

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unexplained encephalopathy, should be given intravenous thiamine.

Withdrawal seizures typically resolve without specific anti-epileptic drug treatment, although status epilepticus (continual seizures occurring without specific) should be treated vigorously. Acute alcoholic myopathy with myoglobinuria requires monitoring and maintenance of kidney function, and correction of imbalances in blood chemistry including potassium, phosphate, and magnesium levels.

Chronic alcoholic myopathy and other chronic conditions are treated by correcting associated nutritional deficiencies and maintaining a diet adequate in protein and carbohydrate. The key to treating any alcohol-related disease is helping the patient overcome alcohol **addiction**. Behavioral measures and social supports may be needed in patients who develop broad problems in their thinking abilities (dementia) or remain in a state of confusion and disorientation (delirium). People with walking problems may benefit from **physical therapy** and assistive devices. Doctors may also prescribe drugs to treat the pain associated with peripheral neuropathy.

Prognosis

Complete recovery from Wernicke's syndrome may follow prompt administration of thiamine. However, repeated episodes of encephalopathy or prolonged alcohol abuse may cause persistent dementia or Korsakoff **psychosis**. Most patients recover fully from acute alcoholic myopathy within days to weeks, but severe cases may be fatal from **acute kidney failure** and disturbances in heart rhythm secondary to increased potassium levels. Recovery from chronic alcoholic myopathy may occur over weeks to months of abstinence from alcohol and correction of **malnutrition**. Cerebellar degeneration and alcoholic neuropathy may also improve to some extent with abstinence and balanced diet, depending on the severity and duration of the condition.

Prevention

Prevention requires abstinence from alcohol. Persons who consume small or moderate amounts of alcohol might theoretically help prevent nutritional complications of alcohol use with dietary supplements including B vitamins. However, proper **nutrition** cannot protect against the direct toxic effect of alcohol or of its breakdown products. Patients with any alcohol-related symptoms or conditions, pregnant women, and patients with liver or neurologic disease should abstain completely. Persons with family history of alcoholism or alcohol-related conditions may also be at increased risk for neurologic complications of alcohol use.

Resources

PERIODICALS

"Missouri Clinics Will Diagnose and Treat Fetal Alcohol Syndrome." *Mental Health Weekly Digest* (June 7, 2004): 33.

Stacey, Philip S. "Preliminary Investigation of Thiamine and Alcohol Intake in Clinical and Healthy Samples." *Psychological Reports* (June 2004): 845–849.

ORGANIZATIONS

National Institute on Alcohol Abuse and Alcoholism (NIAAA), 5635 Fishers Lane, MSC 9304, Bethesda, MD, 20892-9304, (301) 443-3860, http://www.niaaa.nih.gov/.

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Alcohol abuse *see* **Alcoholism**

Alcohol dependence *see* **Alcoholism**

Alcohol withdrawal *see* **Withdrawal syndromes**

Alcoholic cerebellar disease *see* **Alcohol-related neurologic disease**

Alcoholic hepatitis *see* **Hepatitis, alcoholic**

Alcoholic rose gardener's disease *see* **Sporotrichosis**

Alcoholism

Definition

Alcoholism is a chronic physical, psychological, and behavioral disorder characterized by excessive use of alcoholic beverages; emotional and physical dependence on them; increased tolerance over time of the effects of alcohol; and withdrawal symptoms if the person stops drinking.

Demographics

The World Health Organization (WHO) estimates that some 2 billion people worldwide consume alcoholic beverages, which can have immediate and long term consequences on health and social life. More than 76 million people are currently affected by alcohol dependence and abuse. Alcohol causes 1.8 million

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Risk factors for alcoholism

- **Age:** Beginning drinking at a young age increases the risk of alcohol dependence.
- **Family history:** Children of alcohol-dependent parents are at greater risk of developing alcoholism.
- **Gender:** Males are more likely to become alcohol dependent than females, but women are at an increased risk of developing complications associated with alcoholism, such as liver disease.
- **Length of use:** Regular binge drinking over an extended period of time may result in alcohol dependence.
- **Mental health:** Persons afflicted by mental health disorders such as depression may be more likely to misuse alcohol or other substances.
- **Social and cultural factors:** Being surrounded by friends who routinely drink may increase a person's level of alcohol use. Alcohol consumption in the media may also influence personal drinking habits.

SOURCE: Mayo Clinic, "Alcoholism." Available online at: http://www.mayoclinic.com/health/alcoholism/DS00340 (accessed August 17, 2010).

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deaths a year, which represents 3.2% of all deaths worldwide. According to a 2007 report from the Task Force on Community Preventive Services of the Centers for Disease Control, excessive alcohol consumption in the United States is responsible for approximately 75,000 deaths per year, making it the third leading cause of preventable death. Moreover, nearly 47% of homicides, 23% of suicides, and 40% of fatal motor vehicle crashes are directly caused by alcohol abuse. According to the 2009 report of the National Survey on Drug Use and Health, 7.8% of Americans aged 12 or older (an estimated 19.3 million people) needed treatment for an alcohol problem in the past year. Of those who needed alcohol treatment, 8.1% received treatment at a specialty substance use treatment facility, 4.5% did not receive treatment but felt they needed it, and 87.4% did not receive treatment and did not perceive a need for it.

According to 2008 Center for Disease Control data, the percentage of adults who drank alcohol in 2007 was 61%. The percentage of drinkers who had five or more drinks on at least one day during that year was 21%.

Alcohol use by persons under age 21 is an important public health concern. In the United States, alcohol is the most commonly used and abused drug among youth. Although drinking under the age of 21 is against the law, people aged 12 to 20 years drink nearly 20% of all alcohol consumed in the United States. More than 90% of this alcohol is consumed in the form of binge drinking.

According to the NIAAA, 60% of American women were having at least one drink a year in 2005. Among women who drank, 13% had more than seven drinks per week with an estimated 5.3 million women drinking in a way that threatened their health, safety, and general well-being. Studies of women alcoholics indicate that women are at higher risk than men for serious health problems related to alcoholism. Because women tend to metabolize alcohol more slowly, have a lower percentage of body water and a higher percentage of body fat than men, they develop higher blood alcohol levels than men at a given amount of alcohol per pound of body weight. Thus, even though women typically begin to drink heavily at a later age than men, they often become dependent on alcohol much more rapidly. This relatively speedy progression of alcoholism in women is called telescoping.

At the other end of the age distribution, alcoholism among the elderly appears to be underrecognized. One third of older alcoholic persons develop a problem with alcohol in later life, while the other two thirds grow older with the medical and psychosocial consequences of early onset alcoholism. Confusion and other signs of intoxication in an elderly person are also often misinterpreted as side effects of other medications. In addition, the effects of alcohol may be increased in elderly patients because of physiologic changes associated with **aging**. The elderly are at higher risk for becoming dependent on alcohol than younger people because their bodies do not absorb alcohol as efficiently; a 90-year-old who drinks the same amount of alcohol as a 20-year-old (of the same sex) will have a blood alcohol level 50% higher.

Description

Alcoholism is a complex behavioral as well as medical disorder. It often involves the criminal justice system as well as medicine and other helping professions. Its emergence in an individual's life is affected by a number of variables ranging from age, weight, sex, and ethnic background to his or her family history, peer group, occupation, religious preference, and many other categories. Moreover, persons diagnosed with alcoholism may demonstrate considerable variety in their drinking patterns, age at onset of the disorder, and the speed of its progression.

The *Diagnostic and Statistical Manual of Mental Disorders*, 4th edition (DSM–IV), distinguishes between Alcohol Dependence and Alcohol Abuse largely on the basis of a compulsive element in Alcohol Dependence that is not present in Alcohol Abuse. Some psychiatrists differentiate between so-called primary alcoholism, in which the patient has no other

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major psychiatric diagnosis; and secondary alcoholism, in which the problem drinking is the patient's preferred way of medicating symptoms of another psychiatric disorder, such as depression, **schizophrenia**, **post–traumatic stress disorder**, or one of the **dissociative disorders**. Experts in other branches of medicine tend to emphasize patterns of and attitudes toward drinking in order to distinguish between nonproblematic use of alcohol and alcohol abuse or dependence. Classification is typically based on the following five categories:

- Social drinkers. Individuals who use alcohol in minimal to moderate amounts to enhance meals or other social activities. They do not drink alone
- Situational drinkers. These people rarely or never drink except during periods of stress. They are far more likely to drink alone than social drinkers
- Problem drinkers. These individuals drink heavily, even when they are not under overwhelming stress. Their drinking causes some problems in their lives (e.g., DUI arrests), but they are capable of responding to warnings or advice from others
- Binge drinkers. This type of drinker uses alcohol in an out-of-control fashion at regular intervals. The binges may be planned in advance. This pattern is a growing problem on many college campuses
- Alcoholic drinkers. These are drinkers who have no control of any kind over their intake, and find that their lives are unmanageable

Other factors have complicated definitions of alcoholism in the United States, including: 1) the increasing tendency to combine alcohol with other drugs of abuse, sometimes called cross-addiction; and 2) the rising rates of alcohol abuse and dependence among children under 12 years of age.

Risk factors

According to the NIAAA, the risk for developing alcoholism seems to run in families. Genetics and lifestyle are both factors. Socializing patterns, the amount of **stress** in a person's life, and the availability of alcohol are all factors that may increase the risk for alcoholism. In general, more men than women are alcohol dependent. Alcohol problems are highest in the 18–29 age group and lowest among adults aged 65 and older. People who start drinking in their teens are also at much higher risk of developing alcohol problems compared to people who start drinking at age 21 or older.

Causes and symptoms

The symptoms of alcohol intoxication often include talkativeness and a positive mood while the drinker's blood alcohol level is rising, with depression and mental impairment when it is falling. Blood alcohol concentration (BAC) produces the following symptoms of central nervous system (CNS) depression at specific levels:

- 50 mg/dL: feelings of calm or mild drowsiness
- 50–150 mg/dL: loss of physical coordination. The legal BAC for drivers in most states is 100 mg/dL or lower.
- 150–200 mg/dL: loss of mental faculties
- 300–400 mg/dL: unconsciousness
- Over 400 mg/dL: may be fatal.

The symptoms of long-term heavy consumption of alcohol may take a variety of different forms. In spite of a long history of use for "medicinal" purposes, alcohol is increasingly recognized to be toxic to the human body. It is basically a CNS depressant that is absorbed into the bloodstream, primarily from the small intestine. Regular consumption of large amounts of alcohol can cause irreversible damage to a number of the body's organ systems, including the cardiovascular system, the digestive tract, the central nervous system, and the peripheral nervous system. Heavy drinkers are at high risk of developing stomach or duodenal ulcers, **cirrhosis** of the liver, and cancers of the digestive tract. Many alcoholics do not eat properly, and often develop nutritional deficiency diseases as well as organ damage.

In addition to physical symptoms, most alcoholics have a history of psychiatric, occupational, financial, legal, or interpersonal problems as well. Alcohol misuse is the single most important predictor of violence between domestic partners as well as intergenerational violence within families. In 1994 (the latest year for which statistics are available), 79% of drivers over age 25 involved in fatal automobile accidents were intoxicated. In the states that provided data in 1994 for arrests for driving while impaired (DWI) by alcohol, about one-third of the arrested drivers had previous DWI citations. Since the early 1990s, most states have passed stricter laws against alcohol–impaired driving. These laws include such provisions as immediate license suspension for the first DWI arrest and lowering the legal blood alcohol limit to 0.08 g/dL for adults and 0.02 g/dL for drivers under 21. Penalties for repeated DWI citations include prison sentences; house arrest with electronic monitoring; license plates that identify offending drivers; automobile confiscation; and putting a special ignition interlock on the offender's car.

Diagnosis

The diagnosis of alcoholism is usually based on the patient's drinking history, a thorough **physical**

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KEY TERMS

Acamprosate—An anti-craving medication used in Europe to reduce the craving for alcohol. It is presently undergoing tests for approval in the United States.

Alcohol Use Disorders Inventory Test (AUDIT)—A test for alcohol use developed by the World Health Organization (WHO). Its ten questions address three specific areas of drinking over a 12-month period: the amount and frequency of drinking, dependence upon alcohol, and problems that have been encountered due to drinking alcohol.

Behavioral therapy—Form of psychotherapy used to treat depression, anxiety disorders, phobias, and other forms of psychopathology.

Binge drinking—Consumption of five or more alcoholic drinks in a row on a single occasion.

CAGE—A four-question assessment for the presence of alcoholism in both adults and children.

Disulfiram—A medication that has been used since the late 1940s as part of a treatment plan for alcohol abuse. Disulfiram, which is sold under the trade name Antabuse, produces changes in the body's metabolism of alcohol that cause headaches, vomiting, and other unpleasant symptoms if the patient drinks even small amounts of alcohol.

Ethanol—The chemical name for beverage alcohol. It is also sometimes called ethyl alcohol or grain alcohol to distinguish it from isopropyl or rubbing alcohol.

Naltrexone—A medication originally developed to treat addiction to heroin or morphine that is also used to treat alcoholism. It works by reducing the craving for alcohol rather than by producing vomiting or other unpleasant reactions.

Withdrawal—The characteristic withdrawal syndrome for alcohol includes feelings of irritability or anxiety, elevated blood pressure and pulse, tremors, and clammy skin.

examination, laboratory findings, and the results of psychodiagnostic assessment.

Examination

A physician who suspects that a patient is abusing or is dependent on alcohol should give him or her a complete physical examination with appropriate laboratory tests, paying particular attention to liver function and the nervous system. Physical findings that suggest alcoholism include head injuries after age 18; broken bones after age 18; other evidence of blackouts, frequent accidents, or falls; puffy eyelids; flushed face; alcohol odor on the breath; shaky hands; slurred speech or tongue tremor; rapid involuntary eye movements (**nystagmus**); enlargement of the liver (hepatomegaly); **hypertension**; **insomnia**; and problems with **impotence** (in males). Severe **memory loss** may point to advanced alcoholic damage to the CNS.

Tests

Several laboratory tests can be used to diagnose alcohol abuse and evaluate the presence of medical problems related to drinking. These tests include:

- Full blood cell count. This test indicates the presence of anemia, which is common in alcoholics. In addition, the mean corpuscular volume (MCV) is usually high in heavy drinkers. An MCV higher than 100 fL suggests alcohol abuse.
- Liver function tests. Tests for serum glutamine oxaloacetic transaminase (SGOT) and alkaline phosphatase can indicate alcohol–related injury to the liver. A high level (30 units) of gamma–glutamyltransferase (GGT) is a useful marker because it is found in 70% of heavy drinkers
- Blood alcohol levels
- Carbohydrate deficient transferrin (CDT) tests. This test should not be used as a screener, but is useful in monitoring alcohol consumption in heavy drinkers (those who consume 60 grams of alcohol per day) When CDT is present, it indicates regular daily consumption of alcohol.

The results of these tests may not be accurate if the patient is abusing or dependent on other substances.

Procedures

Since some of the physical signs and symptoms of alcoholism can be produced by other drugs or disorders, screening tests can also help to determine the existence of a drinking problem. There are several assessment instruments for alcoholism that can be either self-administered or administered by a clinician. The so-called CAGE test is a brief screener consisting of four questions:

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- Have you ever felt the need to *cut down* on drinking?
- Have you ever felt *annoyed* by criticism of your drinking?
- Have you ever felt *guilty* about your drinking?
- Have you ever taken a morning *eye opener*? One "yes" answer should raise a suspicion of alcohol abuse; two "yes" answers are considered a positive screen.

Other brief screeners include the Alcohol Use Disorder Identification Test, or AUDIT, which also highlights some of the physical symptoms of alcohol abuse that doctors look for during a physical examination of the patient. The Michigan Alcoholism Screening Test, or MAST, is considered the diagnostic standard. It consists of 25 questions; a score of five or higher is considered to indicate alcohol dependency. A newer screener, the **Substance Abuse** Subtle Screening Inventory, or SASSI, was introduced in 1988. It can be given in either group or individual settings in a paper and pencil or computerized format. The SASSI is available in an adolescent as well as an adult version from the SASSI Institute.

According to one 1998 study, some brief screeners may be inappropriate for widespread use in some subpopulations because of ethnic and sex bias. The CAGE questionnaire often yielded inaccurate results when administered to African American men and Mexican American women. The AUDIT does not appear to be affected by ethnic or gender biases. Another study of the use of alcohol screening questionnaires in women found that the AUDIT was preferable to the CAGE questionnaire for both African American and Caucasian women.

Treatment

Because alcoholism is a complex disorder with social and occupational as well as medical implications, treatment plans usually include a mix of several different approaches. The following key issues are usually considered in determining which treatment option is appropriate:

- severity of the problem and evidence to suggest other mental health problems (e.g. depression, suicide attempts)
- staff credentials of those treating the child or teen, and what forms of therapy (e.g., family, group, medications) are to be used
- nature of family involvement
- how education is to be continued during treatment
- if an in-patient program is necessary, what length it should be
- what aftercare is to be provided following discharge
- what portion of treatment is to be covered by health insurance and what needs to be paid out of pocket

Traditional

Most alcoholics are treated with a variety of psychosocial approaches, including regular attendance at Alcoholics Anonymous (AA) meetings, **group therapy**, marital or **family therapy**, community-based approaches, social skills training, relapse prevention, and stress management techniques. Insight-oriented individual **psychotherapy** by itself is ineffective with the majority of alcoholics.

The most effective psychosocial treatments of alcohol dependence incorporate a cognitive–behavioral approach. Relapse prevention utilizes cognitive-behavioral approaches to identifying high–risk situations for each patient and restructuring his or her perceptions of the effects of alcohol as well as of the relapse process. Network therapy, which combines individual cognitive–behavioral psychotherapy with the involvement of the patient's family and peers as a group support network, is a newer approach to alcohol dependence. One recent study found that while cognitive–behavioral therapy is effective in treating alcohol dependence, the reasons that are usually offered to explain its effectiveness should be reexamined.

Drugs

Most drugs that are now being used to treat alcoholism fall into one of two groups: those that restrain the desire to drink by producing painful physical symptoms if the patient does drink; and those that appear to reduce the craving for alcohol directly. Several medications in the second category were originally developed to treat **addiction** to opioid substances (e.g., heroin and morphine).

ALCOHOL–SENSITIZING MEDICATIONS. The most commonly used alcohol-sensitizing agent is disulfiram (Antabuse), which has been used since the 1950s to deter alcoholics from drinking by the threat of a very unpleasant physical reaction if they do consume alcohol. The severity of the disulfiram/ethanol reaction, or DER, depends on the amount of alcohol and disulfiram in the blood. The symptoms of the reaction include facial flushing, rapid heart beat, **palpitations**, difficult breathing, lowered blood pressure, headaches, **nausea**, and **vomiting**.

A DER results when the drinker consumes alcohol because disulfiram inhibits the functioning of an enzyme called aldehyde dehydrogenase. This enzyme

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is needed to convert acetaldehyde, which is produced when the body begins to oxidize the alcohol. Without the aldehyde dehydrogenase, the patient's blood level of acetaldehyde rises, causing the symptoms associated with DER.

Another alcohol-sensitizing agent is **calcium** carbimide, which is marketed under the brand name Temposil. Calcium carbimide produces physiological reactions with alcohol similar to those produced by disulfiram, but the onset of action is far more rapid and the duration of action is much shorter.

ANTI-CRAVING MEDICATIONS. Another medication approved for the treatment of alcoholism is naltrexone, which appears to reduce the craving for alcohol. In addition, an injectable, long–acting form of naltrexone (Vivitrol) is also available.

An anti-craving drug that is presently approved for use in the European Community, acamprosate (calcium acetyl–homotaurinate), has no psychotropic side effects nor any potential for abuse or dependence. Acamprosate is also approved in the United States to treat alcohol dependence. It appears to reduce the frequency of drinking, but its effects on enhancing abstinence from alcohol are no greater than those of naltrexone. In addition, acamprosate does not appear to enhance the effectiveness of naltrexone if the drugs are given in combination.

Other medications are available to treat the symptoms of alcohol withdrawal, such as shakiness, nausea, and sweating that occur after someone with alcohol dependence stops drinking.

Alternative

Many clinical trials for the treatment or prevention of alcoholism are currently sponsored by the National Institutes of Health (NIH) and other agencies. In 2008, NIH reported 335 on-going or recently completed studies, including 123 in the recruitment stage.

A few examples include:

- The evaluation of whether long-term chronic alcoholism is associated with changes in emotional functioning and brain structure and function. (NCT00300638)
- The study of serotonin transporter proteins in people with alcoholism and healthy volunteers to examine how these proteins may be related to the inability of people with alcoholism to appropriately regulate their alcohol consumption. Serotonin transporters are substances that regulate levels of the brain chemical serotonin. Problems in this regulation have been implicated in alcoholism. (NCT00085865)
- The use of combined motivational enhancement therapy and cognitive behavioral therapy to test the benefits of continued/discontinued treatment with naltrexone. (NCT00115037)
- The evaluation of the safety and effectiveness of a combination of study medications (ondansetron, topiramate) in the treatment of alcohol dependence. (NCT00006205)

Clinical trial information is constantly updated by NIH and the most recent information on alcoholism trials can be found at: http://clinicaltrials.gov/ct2/results?term = alcoholism.

Prognosis

The prognosis for recovery from alcoholism varies widely. The usual course of the disorder is one of episodes of intoxication beginning in adolescence, with full-blown dependence by the mid-20s to mid-30s. The most common pattern is one of periodic attempts at abstinence alternating with relapses into uncontrolled drinking. On the other hand, it is thought that as many as 20% of persons diagnosed as alcohol-dependent achieve long-term sobriety even without medical treatment. It is difficult to compare the outcomes of the various treatment approaches to alcoholism, in part because their definitions of "success" vary. Some researchers count only total abstinence from alcohol as a successful outcome, while others regard curtailed drinking and better social adjustment as indicators of success. The role of genetic factors in the prognosis is still disputed. Available evidence suggests that such factors as the presence of a spouse, partner, or close friend in the alcoholic's life, or religious commitment, can outweigh genetic vulnerability to the disorder.

Prevention

It is widely recognized that the best prevention measure for children is strong parenting. This requires good communication between parents and their kids, so that they may be advised about the dangers of alcoholism and addiction. Prevention initiatives in schools, churches and the community have also been widely implemented. However, alcoholism prevention remains a difficult issue because the potential for a problem condition is often not recognized at its onset.

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ORGANIZATIONS

Al-Anon/Alateen, 1600 Corporate Landing Parkway, Virginia Beach, VA, 23454-5617 (757) 563-1600 (757) 563-1655, wso@al-anon.org, http://www.al-anon.alateen.org.

Alcoholics Anonymous World Services, Inc., 475 Riverside Drive at West 120th St., New York, NY, 10115 (212) 870-3400, http://www.aa.org.

National Council on Alcoholism and Drug Dependence (NCADD), 244 East 58th Street, 4th Floor, New York, NY, 10022 (212) 269-7797 (212) 269-7510, national@ncadd.org, http://www.ncadd.org.

National Institute on Alcohol Abuse and Alcoholism (NIAAA), 5635 Fishers Lane, Room 2015, Bethesda, MD, 20892-9304 (301) 443-2238 (866) 503-SKIN, http://www.niaaa.nih.gov.

Rebecca J. Frey PHD
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ALD *see* **Adrenoleukodystrophy**

Aldolase test

Definition

Aldolase is an enzyme found throughout the body, particularly in muscles. Like all enzymes, it is needed to trigger specific chemical reactions. Aldolase helps muscle turn sugar into energy. Testing for aldolase is done to diagnose and monitor skeletal muscle diseases.

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KEY TERMS

Aldolase—An enzyme, found primarily in the muscle, that helps convert sugar into energy.

Enzyme—A substance needed to trigger specific chemical reactions.

Neurologic—Having to do with the nervous system.

Skeletal muscle—Muscle connected to, and necessary for, the movement of bones.

Purpose

Skeletal muscle diseases increase the aldolase level found in a person's blood. Skeletal muscles are those muscles attached to bones and whose contractions make those bones move. When the muscles are diseased or damaged, such as in **muscular dystrophy**, the cells deteriorate and break open. The contents of the cells, including aldolase, spill into the bloodstream. Measuring the amount of aldolase in the blood indicates the degree of muscle damage.

As muscles continue to deteriorate, aldolase levels decrease and eventually fall below normal. Less muscle means fewer cells and less aldolase.

Muscle weakness may be caused by neurologic as well as muscular problems. The measurement of aldolase levels can help pinpoint the cause. Aldolase levels will be normal where muscle weakness is caused by neurological disease, such as poliomyelitis or **multiple sclerosis**, but aldolase levels will be elevated in cases of muscular disease, such as muscular dystrophy.

Aldolase is also found in the liver and cardiac muscle of the heart. Damage or disease to these organs, such as chronic hepatitis or a **heart attack**, will also increase aldolase levels in the blood, but to a lesser degree.

Description

Aldolase is measured by mixing a person's serum with a substance with which aldolase is known to trigger a reaction. The end product of this reaction is measured, and, from that measurement, the amount of aldolase in the person's serum is determined.

The test is covered by insurance when medically necessary. Results are usually available the next day.

Preparation

To collect the 5–10 mL of blood needed for this test, a healthcare worker ties a tourniquet on the patient's upper arm, locates a vein in the inner elbow region, and inserts a needle into that vein. Vacuum action draws the blood through the needle into an attached tube. Collection of the sample takes only a few minutes.

The patient should avoid strenuous **exercise** and have nothing to eat or drink, except water, for eight to ten hours before this test.

Aftercare

Discomfort or bruising may occur at the puncture site and the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops will reduce bruising. Warm packs to the puncture site will relieve discomfort.

Normal results

Newborns have the highest normal aldolase levels and adults the lowest. Normal values will vary based on the laboratory and the method used.

Abnormal results

As noted, aldolase is elevated in skeletal muscle diseases, such as muscular dystrophies. Duchenne's muscular dystrophy, the most common type of muscular dystrophy, will increase the aldolase level more than any other disease.

Nondisease conditions that affect the muscle, such as injury, **gangrene**, or an infection, can also increase the aldolase level. Also, strenuous exercise can temporarily increase a person's aldolase level.

Certain medications can increase the aldolase level, while others can decrease it. To interpret what the results of the aldolase test mean, a physician will evaluate the result, the person's clinical symptoms, and other tests that are more specific for muscle damage and disease.

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Nancy J. Nordenson

Aldosterone assay

Definition

This test measures the levels of aldosterone, a hormone produced by the outer part (cortex) of the two adrenal glands, organs which sit one on top of

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KEY TERMS

Aldosteronism—A condition in which the adrenal glands secrete excessive levels of the hormone aldosterone.

Renin—An enzyme produced in the kidneys that controls the activation of the hormone angiotensin, which stimulates the adrenal glands to produce aldosterone.

each of the kidneys. Aldosterone regulates the amounts of **sodium** and potassium in the blood. This helps maintain water balance and blood volume, which, in turn, affects blood pressure.

Purpose

Aldosterone measurement is useful in detecting a condition called aldosteronism, which is caused by excess secretion of the hormone from the adrenal glands. There are two types of aldosteronism: primary and secondary. Primary aldosteronism is most commonly caused by an adrenal tumor, as in Conn's syndrome. Idiopathic (of unknown cause) **hyperaldosteronism** is another type of primary aldosteronism. Secondary aldosteronism is more common and may occur with congestive **heart failure**, **cirrhosis** with fluid in the abdominal cavity (**ascites**), certain kidney diseases, excess potassium, sodium-depleted diet, and toxemia of **pregnancy**.

To differentiate primary aldosteronism from secondary aldosteronism, a plasma renin test should be performed at the same time as the aldosterone assay. Renin, an enzyme produced in the kidneys, is high in secondary aldosteronism and low in primary aldosteronism.

Description

Aldosterone testing can be performed on a blood sample or on a 24-hour urine specimen. Several factors, including diet, posture (upright or lying down), and time of day that the sample is obtained can cause aldosterone levels to fluctuate. Blood samples are affected by short-term fluctuations. A urine specimen collected over an entire 24-hour period lessens the effects of those interfering factors and provides a more reliable aldosterone measurement.

Preparation

Fasting is not required for either the blood sample or urine collection, but the patient should maintain a normal sodium diet (approximately 0.1 oz [3g]/day) for at least two weeks before either test. The doctor should decide if drugs that alter sodium, potassium, and fluid balance (e.g., **diuretics**, antihypertensives, **steroids**, **oral contraceptives**) should be withheld. The test will be more accurate if these are suspended at at least two weeks before the test. Renin inhibitors (e.g., propranolol) should not be taken one week before the test, unless permitted by the physician. The patient should avoid licorice for at least two weeks before the test, because of its aldosterone-like effect. Strenuous **exercise** and **stress** can increase aldosterone levels as well. Because the test is usually performed by a method called radioimmunoassay, recently administered radioactive medications will affect test results.

Since posture and body position affect aldosterone, hospitalized patients should remain in an upright position (at least sitting) for two hours before blood is drawn. Occasionally blood will be drawn again before the patient gets out of bed. Nonhospitalized patients should arrive at the laboratory in time to maintain an upright position for at least two hours.

Risks

Risks for this test are minimal, but may include slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after venipuncture, or hematoma (blood accumulating under the puncture site).

Normal results

Normal results are laboratory-specific and also vary with sodium intake, with time of day, source of specimen (e.g., peripheral vein, adrenal vein, 24-hour urine), age, sex, and posture.

Reference ranges for blood include:

- supine (lying down): 3–10 ng/dL
- upright (sitting for at least two hours): Female: 5–30ng/dL; Male: 6-22 ng/dL.

Reference ranges for urine: 2–80 mg/24 hr.

Abnormal results

Increased levels of aldosterone are found in Conn's disease (aldosterone-producing adrenal tumor), and in cases of Bartter's syndrome (a condition in which the kidneys overexcrete potassium, sodium and chloride, resulting in low blood levels of potassium and high blood levels of aldosterone and renin). Among other conditions, elevated levels are also seen in secondary aldosteronism, stress, and malignant **hypertension**.

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Decreased levels of aldosterone are found in aldosterone deficiency, steroid therapy, high-sodium **diets**, certain antihypertensive therapies, and **Addison's disease** (an autoimmune disorder).

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Janis O. Flores

Alemtuzumab

Definition

Alemtuzumab is sold as Campath in the United States. Alemtuzumab is a humanized monoclonal antibody that selectively binds to CD52, a protein found on the surface of normal and malignant B and T cells, that is used to reduce the numbers of circulating malignant cells of patients who have B-cell chronic lymphocytic leukemia (B-CLL).

Purpose

Alemtuzumab is a monoclonal antibody used to treat B-CLL, one of the most prevalent forms of adult chronic leukemia. It specifically binds CD52, a protein found on the surface of essentially all B and T cells of the immune system. By binding the CD52 protein on the malignant B cells, the antibody targets it for removal from the circulation. Scientists believe that alemtuzumab triggers antibody-mediated lysis of the B cells, a method that the immune system uses to eliminate foreign cells.

Alemtuzumab has been approved by the FDA for treatment of refractory B-CLL. For a patient's disease to be classified as refractory, both alkylating agents and fludarabine treatment must have been tried and failed. Thus, this drug gives patients who have tried all approved treatments for B-CLL another option. As most patients with B-CLL are in stage III or IV by the time both alkylating agents and fludarabine have been tried, the experience with alemtuzumab treatment are primarily with those stages of the disease. In clinical trials, about 30% of patients had a partial response to the drug, with 2% of these being complete responses.

This antibody has been tested with limited success in the treatment of non-Hodgkin's lymphoma (NHL) and for the preparation of patients with various immune cell malignancies for **bone marrow transplantation**. There is also a clinical trial ongoing to test the ability of this antibody to prevent rejection in **kidney transplantation**.

KEY TERMS

Alkylating agent—A chemical that alters the composition of the genetic material of rapidly dividing cells, such as cancer cells, causing selective cell death; used as a chemotherapeutic agent to treat B-CLL.

Antibody—A protective protein made by the immune system in response to an antigen, also called an immunoglobulin.

Autoimmune—An immune reaction of a patient against their own cells.

Humanization—Fusing the constant and variable framework region of one or more human immunoglobulins with the binding region of an animal immunoglobulin, done to reduce human reaction against the fusion antibody.

Monoclonal—Genetically engineered antibodies specific for one antigen.

Tumor lysis syndrome—A side effect of some immunotherapies, like monoclonal antibodies, that lyse the tumor cells, due to the toxicity of flooding the bloodstream with such a quantity of cellular contents.

Description

Alemtuzumab is produced in the laboratory using genetically engineered single clones of B-cells. Like all antibodies, it is a Y-shaped molecule can bind one particular substance, the antigen for that monoclonal antibody. For alemtuzumab, the antigen is CD52, a protein found on the surface of normal and malignant B and T cells as well as other cells of the immune and male reproductive systems. Alemtuzumab is a humanized antibody, meaning that the regions that bind CD52, located on the tips of the Y branches, are derived from rat antibodies, but the rest of the antibody is human sequence. The presence of the human sequences helps to reduce the immune response by the patient against the antibody itself, a problem seen when complete mouse antibodies are used for **cancer** therapies. The human sequences also help to ensure that the various cell-destroying mechanisms of the human immune

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system are properly triggered with binding of the antibody.

Alemtuzumab was approved in May of 2001 for the treatment of refractory B-CLL. It is approved for use alone but clinical trials have tested the ability of the antibody to be used in combination with the purine analogs pentostatin, fludarabine, and cladribine, and rituximab, a monoclonal antibody specific for the CD20 antigen, another protein found on the surface of B cells.

Recommended dosage

This antibody should be administered in a gradually escalating pattern at the start of treatment and any time administration is interrupted for seven or more days. The recommended beginning dosage for B-CLL patients is a daily dose of 3 mg of Campath administered as a two-hour IV infusion. Once this amount is tolerated, the dose is increased to 10 mg per day. After tolerating this dose, it can be increased to 30 mg, administered three days a week. Acetominophen and diphenhydramine hydrochoride are given thirty to sixty minutes before the infusion to help reduce side effects.

Additionally, patients generally receive anti-infective medication before treatment to help minimize the serious opportunistic infections that can result from this treatment. Specifically, trimethoprim/sulfamethoxazole (to prevent bacterial infections) and famciclovir (to prevent viral infections) were used during the clinical trial to decrease infections, although they were not eliminated.

Precautions

Blood studies should be done on a weekly basis while patients are receiving the alemtuzumab treatment. **Vaccination** during the treatment session is not recommended, given the T cell depletion that occurs during treatment. Furthermore, given that antibodies like alumtuzumab can pass through the placenta to the developing fetus and in breast milk, use during **pregnancy** and **breastfeeding** is not recommended unless clearly needed.

Side effects

A severe side effect of alemtuzumab treatment is the possible depletion of one or more types of blood cells. Because CD52 is expressed on a patient's normal B and T cells, as well as on the surface of the abnormal B cells, the treatment eliminates both normal and cancerous cells. The treatment also seems to trigger autoimmune reactions against various other blood cells. This results in severe reduction of the many circulating blood cells including red blood cells (anemia), white blood cells (**neutropenia**), and clotting cells (thrombopenia). These conditions are treated with blood transfusions. The great majority of patients treated exhibit some type of blood cell depletion.

A second serious side effect of this drug is the prevalence of opportunistic infections that occurs during the treatment. Serious, and sometimes fatal bacterial, viral, fungal, and protozoan infections have been reported. Treatments to prevent **pneumonia** and herpes infections reduce, but do not eliminate these infections.

The majority of other side effects occur after or during the first infusion of the drug. Some common side effects of this drug include **fever** and chills, **nausea and vomiting**, **diarrhea**, **shortness of breath**, skin rash, and unusual **fatigue**. This drug can also cause low blood pressure (**hypotension**).

In patients with high tumor burden (a large number of circulating malignant B cells) this drug can cause a side effect called tumor lysis syndrome. Thought to be due to the release of the lysed cells' contents into the blood stream, it can cause a misbalance of urea, uric acid, phosphate, potassium, and **calcium** in the urine and blood. Patients at risk for this side effect must keep hydrated and can be given allopurinol before infusion.

Interactions

There have been no formal drug interaction studies done for alemtuzumab.

Michelle Johnson MS, JD

Alendronate *see* **Bone disorder drugs**

Alexander technique

Definition

The Alexander technique is a somatic method for improving physical and mental functioning. Excessive tension, which Frederick Alexander, the originator, recognized as both physical and mental, restricts movement and creates pressure in the joints, the spine, the breathing mechanism, and other organs. The goal of the technique is to restore freedom and expression to the body and clear thinking to the mind.

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Purpose

Because the Alexander technique helps students improve overall functioning, both mental and physical, it offers a wide range of benefits. Nikolaas Tinbergen, in his 1973 Nobel lecture, hailed the "striking improvements in such diverse things as high blood pressure, breathing, depth of sleep, overall cheerfulness and mental alertness, resilience against outside pressures, and the refined skill of playing a musical instrument." He went on to quote a list of other conditions helped by the Alexander technique: "rheumatism, including various forms of arthritis, then respiratory troubles, and even potentially lethal **asthma**; following in their wake, circulation defects, which may lead to high blood pressure and also to some dangerous heart conditions; gastrointestinal disorders of many types, various gynecological conditions, sexual failures, migraines and depressive states."

Literature in the 1980s and 1990s went on to include improvements in back **pain**, chronic pain, postural problems, repetitive strain injury, benefits during **pregnancy** and **childbirth**, help in applying **physical therapy** and rehabilitative exercises, improvements in strain caused by computer use, improvements in the posture and performance of school children, and improvements in vocal and dramatic performance among the benefits offered by the technique.

Description

Origins

Frederick Matthias Alexander was born in 1869 in Tasmania, Australia. He became an actor and Shakespearean reciter, and early in his career he began to suffer from strain on his vocal chords. He sought medical attention for chronic hoarseness, but after treatment with a recommended prescription and extensive periods of rest, his problem persisted.

Alexander realized that his hoarseness began about an hour into a dramatic performance and reasoned that it was something he did in the process of reciting that caused him to lose his voice. Returning to his medical doctor, Alexander told him of his observation. When the doctor admitted that he didn't know what Alexander was doing to injure his vocal chords, Alexander decided to try and find out for himself.

Thus began a decade of self-observation and discovery. Using as many as three mirrors to observe himself in the act of reciting, normal speaking, and later standing, walking, and sitting, Alexander managed to improve his coordination and to overcome his vocal problems. One of his most startling discoveries was that in order to change the way he used his body he had to change the way he was thinking, redirecting his thoughts in such a way that he did not produce unnecessary tension when he attempted speech or movement. After making this discovery at the end of the nineteenth century, Alexander became a pioneer in body-mind medicine.

KEY TERMS

Direction—Bringing about the free balance of the head on the spine and the resulting release of the erector muscles of the back and legs which establish improved coordination.

Habit—Referring to the particular set of physical and mental tensions present in any individual.

Inhibition—Referring to the moment in an Alexander lesson when the student refrains from beginning a movement in order to avoid tensing of the muscles.

Sensory awareness—Bringing attention to the sensations of tension and/or release in the muscles.

At first, performers and dancers sought guidance from Alexander to overcome physical complaints and to improve the expression and spontaneity of their performances. Soon a great number of people sought help from his teaching for a variety of physical and mental disorders.

The Alexander technique is primarily taught one-on-one in private lessons. Introductory workshops or workshops for special applications of the technique (e.g.,workshops for musicians) are also common. Private lessons range from a half-hour to an hour in length, and are taught in a series. The number of lessons varies according to the severity of the student's difficulties with coordination or to the extent of the student's interest in pursuing the improvements made possible by continued study. The cost of lessons ranges from $40–80 per hour. Insurance coverage is not widely available, but discounts are available for participants in some complementary care insurance plans. Pre-tax Flexible Spending Accounts for health care cover Alexander technique lessons if they are prescribed by a physician.

In lessons teachers guide students through simple movements (while students are dressed in comfortable clothing) and use their hands to help students identify and stop destructive patterns of tension. Tensing arises from mental processes as well as physical, so discussions of personal reactions or behavior are likely to arise in the course of a lesson.

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The technique helps students move with ease and improved coordination. At the beginning of a movement (the lessons are a series of movements), most people pull back their heads, raise their shoulders toward their ears, over-arch their lower backs, tighten their legs, and otherwise produce excessive tension in their bodies. Alexander referred to this as misuse of the body.

At any point in a movement, proper use can be established. If the neck muscles are not over-tensed, the head will carry slightly forward of the spine, simply because it is heavier in the front. When the head is out of balance in the forward direction, it sets off a series of stretch reflexes in the extensor muscles of the back. It is skillful use of these reflexes, along with reflex activity in the feet and legs, the arms and hands, the breathing mechanism, and other parts of the body, that lessons in the technique aim to develop.

Alexander found that optimal functioning of the body was very hard to maintain, even for the short period of time it took to complete a single movement. People, especially adults, have very strong tension habits associated with movement. Chronic misuse of the muscles is common. It may be caused by slouching in front of televisions or video monitors, too much sitting or driving and too little walking, or by tension associated with past traumas and injuries. Stiffening the neck after a **whiplash** injury or favoring a broken or sprained leg long after it has healed are examples of habitual tension caused by injury.

The first thing a teacher of the Alexander technique does is to increase a student's sensory awareness of this excessive habitual tension, particularly that in the neck and spine. Next the student is taught to inhibit the tension. If the student prepares to sit down, for example, he will tense his muscles in his habitual way. If he is asked to put aside the intention to sit and instead to free his neck and allow less constriction in his muscles, he can begin to change his tense habitual response to sitting.

By leaving the head resting on the spine in its natural free balance, by keeping eyes open and focused, not held in a tense stare, by allowing the shoulders to release, the knees to unlock and the back to lengthen and widen, a student greatly reduces strain. In Alexander lessons students learn to direct themselves this way in activity and become skilled in fluid, coordinated movement.

Precautions

Side effects

The focus of the Alexander technique is educational. Teachers use their hands simply to gently guide students in movement. Therefore, both contraindications and potential physiological side effects are kept to a minimum. No forceful treatment of soft tissue or bony structure is attempted, so damage to tissues, even in the case of errors in teaching, is unlikely.

As students' sensory awareness develops in the course of Alexander lessons, they become more acutely aware of chronic tension patterns. As students learn to release excessive tension in their muscles and to sustain this release in daily activity, they may experience tightness or soreness in the connective tissue. This is caused by the connective tissue adapting to the lengthened and released muscles and the expanded range of movement in the joints.

Occasionally students may get light-headed during a lesson as contracted muscles release and effect the circulatory or respiratory functioning.

Forceful contraction of muscles and rigid postures often indicate suppression of emotion. As muscles release during or after an Alexander lesson, students may experience strong surges of emotion or sudden changes in mood. In some cases, somatic memories surface, bringing to consciousness past injury or trauma. This can cause extreme **anxiety**, and referrals may be made by the teacher for counseling.

Research and general acceptance

Alexander became well known among the intellectual, artistic, and medical communities in London, England, during the first half of the twentieth century. Among Alexander's supporters were John Dewey, Aldous Huxley, Bernard Shaw, and renowned scientists Raymond Dart, G.E. Coghill, Charles Sherrington, and Nikolaas Tinbergen.

Researchers continue to study the effects and applications of the technique in the fields of education, preventive medicine, and **rehabilitation**. The Alexander technique has proven an effective treatment for reducing **stress**, for improving posture and performance in schoolchildren, for relieving chronic pain, and for improving psychological functioning. The technique has been found to be as effective as beta-blocker medications in controlling stress responses in professional musicians, to enhance respiratory function in normal adults, and to mediate the effects of **scoliosis** in adolescents and adults.

Resources

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Vineyard, Missy. *How You Stand, How You Move, How You Live: Learning the Alexander Technique to Explore Your*

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Mind–Body Connection and Achieve Self–Mastery. Cambridge, MA: Da Capo, 2007.

OTHER

Alexander Technique Resource Guide. (Includes list of teachers) AmSAT Books. (800) 473-0620 or (804) 295-2840.

ORGANIZATIONS

Alexander Technique International, 1692 Massachusetts Ave., 3rd Floor, Cambridge, MA, 02138, (617) 497-5151, (617) 497-2615, (888) 668-8996, alexandertechnique@-veri zon.net, http://www.ati-net.com.

Sandra Bain Cushman

Alkali-resistant hemoglobin test *see* **Fetal hemoglobin test**

Alkaline phosphatase test

Definition

Alkaline phosphatase is an enzyme found throughout the body. Like all enzymes, it is needed, in small amounts, to trigger specific chemical reactions. When it is present in large amounts, it may signify bone or **liver disease** or a tumor.

Purpose

Medical testing of alkaline phosphatase is concerned with the enzyme that is found in liver, bone, placenta, and intestine. In a healthy liver, fluid containing alkaline phosphate and other substances is continually drained away through the bile duct. In a diseased liver, this bile duct is often blocked, keeping fluid within the liver. Alkaline phosphatase accumulates and eventually escapes into the bloodstream.

The alkaline phosphatase of the liver is produced by the cells lining the small bile ducts (ductoles) in the liver. Its origin differs from that of other enzymes called aminotransferases. If the liver disease is primarily of an obstructive nature (cholestatic), i.e. involving the biliary drainage system, the alkaline phosphatase will be the first and foremost enzyme elevation. If, on the other hand, the disease is primarily of the liver cells (hepatocytes), the aminotransferases will rise prominently. Thus, these enzymes are very useful in distinguishing the type of liver disease–cholestatic or hepatocellular.

Growing bones need alkaline phosphatase. Any condition of bone growth will cause alkaline phosphatase levels to rise. The condition may be normal, such as a childhood growth spurt or the healing of a broken bone; or the condition may be a disease, such as bone **cancer**, Paget's disease, or **rickets**.

During **pregnancy**, alkaline phosphatase is made by the placenta and leaks into the mother's bloodstream. This is normal. Some tumors, however, start production of the same kind of alkaline phosphatase produced by the placenta. These tumors are called **germ cell tumors** and include **testicular cancer** and certain brain tumors.

Alkaline phosphatase from the intestine is increased in a person with inflammatory bowel disease, such as ulcerative **colitis**.

KEY TERMS

Alkaline phosphatase—An enzyme found throughout the body, primarily in liver, bone, placenta, and intestine.

Cholestatis—Stoppage or suppression of the flow of bile.

Enzyme—A substance needed to trigger specific chemical reactions.

Hepatocellular—Of or pertaining to liver cells.

Hepatocyte—A liver cell.

Isoenzyme—A variation of an enzyme.

Description

Alkaline phosphatase is measured by combining the person's serum with specific substances with which alkaline phosphatase is known to react. The end product of this reaction is measured; and from that measurement, the amount of alkaline phosphatase in the person's serum is determined.

Each tissue-liver, bone, placenta, and intestine–produces a slightly different alkaline phosphatase. These variations are called isoenzymes. In the laboratory, alkaline phosphatase is measured as the total amount or the amount of each of the the four isoenzymes. The isoenzymes react differently to heat, certain chemicals, and other processes in the laboratory. Methods to measure them separately are based on these differences.

The test is covered by insurance when medically necessary. Results are usually available the next day.

Preparation

To collect the 5–10 mL blood needed for this test, a healthcare worker ties a tourniquet on the person's

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upper arm, locates a vein in the inner elbow region, and inserts a needle into that vein. Vacuum action draws the blood through the needle into an attached tube. Collection of the sample takes only a few minutes.

A person being tested for alkaline phosphatase should not have anything to eat or drink, except water, for eight to ten hours before the test. Some people release alkaline phosphatase from the intestine into the bloodstream after eating. This will temporarily increase the result of the test.

Aftercare

Discomfort or bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops will reduce bruising. Warm packs to the puncture site will relieve discomfort.

Normal results

Normal results vary by age and by sex. They also vary based on the laboratory and the method used.

Abnormal results

Bone and liver disease increase alkaline phosphatase more than any other disease, up to five times the normal level. Irritable bowel disease, germ cell tumors, and infections involving the liver, such as viral hepatitis and **infectious mononucleosis**, increase the enzyme also, but to a lesser degree. Healing bones, pregnancy, and normal growth in children also increase levels.

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Nancy J. Nordenson

Alkalosis *see* **Metabolic alkalosis; Respiratory alkalosis**

Allergic alveolitis *see* **Hypersensitivity pneumonitis**

Allergic bronchopulmonary aspergillosis

Definition

Allergic bronchopulmonary **aspergillosis**, or ABPA, is one of four major types of infections in humans caused by *Aspergillus* fungi. ABPA is a hypersensitivity reaction that occurs in **asthma** patients who are allergic to this specific fungus.

Description

ABPA is an allergic reaction to a species of *Aspergillus* called *Aspergillus fumigatus*. It is sometimes grouped together with other lung disorders characterized by eosinophilia–an abnormal increase of a certain type of white blood cell in the blood–under the heading of **eosinophilic pneumonia**. These disorders are also called hypersensitivity lung diseases.

ABPA appears to be increasing in frequency in the United States, although the reasons for the increase are not clear. The disorder is most likely to occur in adult asthmatics aged 20-40. It affects males and females equally.

Causes and symptoms

ABPA develops when the patient breathes air containing *Aspergillus* spores. These spores are found worldwide, especially around riverbanks, marshes, bogs, forests, and wherever there is wet or decaying vegetation. They are also found on wet paint, construction materials, and in air conditioning systems. ABPA is a nosocomial infection, which means that a patient can get it in a hospital. When *Aspergillus* spores reach the bronchi, which are the branches of the windpipe that lead into the lungs, the bronchi react by contracting spasmodically. So the patient has difficulty breathing and usually wheezes or coughs. Many patients with ABPA also run a low-grade **fever** and lose their appetites.

Complications

Patients with ABPA sometimes **cough** up large amounts of blood, a condition that is called **hemoptysis**. They may also develop a serious long-term form of **bronchiectasis**, the formation of fibrous tissue in the lungs. Bronchiectasis is a chronic bronchial disorder caused by repeated inflammation of the airway, and marked by the abnormal enlargement of, or damage to, the bronchial walls. ABPA sometimes occurs as a complication of **cystic fibrosis**.

Diagnosis

The diagnosis of ABPA is based on a combination of the patient's history and the results of blood tests, sputum tests, skin tests, and diagnostic imaging. The doctor will be concerned to distinguish between ABPA and a worsening of the patient's asthma, cystic fibrosis, or other lung disorders. There are seven major

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KEY TERMS

Antifungal—A medicine used to treat infections caused by a fungus.

Antigen—A substance that stimulates the production of antibodies.

Bronchiectasis—A disorder of the bronchial tubes marked by abnormal stretching, enlargement, or destruction of the walls. Bronchiectasis is usually caused by recurrent inflammation of the airway and is a diagnostic criterion of ABPA.

Bronchodilator— A medicine used to open up the bronchial tubes (air passages) of the lungs.

Eosinophil—A type of white blood cell containing granules that can be stained by eosin (a chemical that produces a red stain).

Eosinophilia—An abnormal increase in the number of eosinophils in the blood.

Hemoptysis—The coughing up of large amounts of blood. Hemoptysis can occur as a complication of ABPA.

Hypersensitivity—An excessive response by the body to a foreign substance.

Immunoglobulin E (IgE)—A type of protein in blood plasma that acts as an antibody to activate allergic reactions. About 50% of patients with allergic disorders have increased IgE levels in their blood serum.

Nosocomial infection—An infection that can be acquired in a hospital. ABPA is a nosocomial infection.

Precipitin—An antibody in blood that combines with an antigen to form a solid that separates from the rest of the blood.

Spirometer—An instrument used to test a patient's lung capacity.

"Wheal and flare" reaction—A rapid response to a skin allergy test characterized by the development of a red, itching spot in the area where the allergen was injected.

Wheezing—A whistling or musical sound caused by tightening of the air passages inside the patient's chest.

criteria for a diagnosis of allergic bronchopulmonary aspergillosis:

- a history of asthma
- an accumulation of fluid in the lung that is visible on a chest x-ray
- bronchiectasis (abnormal stretching, enlarging, or destruction of the walls of the bronchial tubes)
- skin reaction to *Aspergillus* antigen
- eosinophilia in the patient's blood and sputum
- *Aspergillus* precipitins in the patient's blood. Precipitins are antibodies that react with the antigen to form a solid that separates from the rest of the solution in the test tube
- a high level of IgE in the patient's blood. IgE refers to a class of antibodies in blood plasma that activate allergic reactions to foreign particles

Other criteria that may be used to support the diagnosis include the presence of *Aspergillus* in samples of the patient's sputum, the coughing up of plugs of brown mucus, or a late skin reaction to the *Aspergillus* antigen.

Laboratory tests

The laboratory tests that are done to obtain this information include a **complete blood count** (CBC), a **sputum culture**, a blood serum test of IgE levels, and a skin test for the *Aspergillus* antigen. In the skin test, a small amount of antigen is injected into the upper layer of skin on the patient's forearm about four inches below the elbow. If the patient has a high level of IgE antibodies in the tissue, he or she will develop what is called a "wheal and flare" reaction in about 15-20 minutes. A "wheal and flare" reaction is characterized by the eruption of a reddened, **itching** spot on the skin. Some patients with ABPA will develop the so-called late reaction to the skin test, in which a red, sore, swollen area develops about six to eight hours after the initial reaction.

Diagnostic imaging

Chest x-rays and CT scans are used to check for the presence of fluid accumulation in the lungs and signs of bronchiectasis.

Treatment

ABPA is usually treated with prednisone (Meticorten) or other **corticosteroids** taken by mouth, and with **bronchodilators**.

Antifungal drugs are *not* used to treat ABPA because it is caused by an allergic reaction to *Aspergillus* rather than by direct infection of tissue.

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Follow-up care

Patients with ABPA should be given periodic checkups with chest x-rays and a spirometer test. A spirometer is an instrument that evaluates the patient's lung capacity.

Prognosis

Most patients with ABPA respond well to corticosteroid treatment. Others have a chronic course with gradual improvement over time. The best indicator of a good prognosis is a long-term fall in the patient's IgE level. Patients with lung complications from ABPA may develop severe airway obstruction.

Prevention

ABPA is difficult to prevent because *Aspergillus* is a common fungus; it can be found in the saliva and sputum of most healthy individuals. Patients with ABPA can protect themselves somewhat by avoiding haystacks, compost piles, bogs, marshes, and other locations with wet or rotting vegetation; by avoiding construction sites or newly painted surfaces; and by having their air conditioners cleaned regularly. Some patients may be helped by air filtration systems for their bedrooms or offices.

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ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

National Institute of Allergies and Infectious Diseases, 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-6612, (301) 496-5717, (301) 402-3573, (866) 284-4107, ocpostoffice@niaid.nih.gov, http://www.niaid.nih.gov.

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923, (800) 999-6673, http://www.rarediseases.org.

Rebecca J. Frey PhD

Allergic purpura

Definition

Allergic purpura (AP) is an allergic reaction of unknown origin causing red patches on the skin and other symptoms. AP is also called Henoch–Schönlein purpura, named after the two German doctors who first described the condition in the 1860s.

KEY TERMS

Glomeruli—Knots of capillaries in the kidneys responsible for filtering the blood (singular, glomerulus).

Demographics

AP affects mostly children but it can occur at any age. Approximately 20 per 100,000 children each year have a reaction. Most cases are children between the ages of two and seven years. Boys are affected more often than girls.

Description

"Purpura" is a bleeding disorder that occurs when blood vessels inflame and capillaries rupture, allowing small amounts of blood to accumulate in the surrounding tissues. In AP, this occurs because the capillaries are blocked by protein complexes formed during an abnormal immune reaction. The skin is the most obvious site of reaction, but the joints, gastrointestinal tract, and kidneys are also often affected.

Causes and symptoms

Causes

AP is caused by a reaction involving antibodies, special proteins of the immune system. Antibodies are designed to bind with foreign proteins, called antigens. In some situations, antigen–antibody complexes can become too large to remain suspended in the bloodstream. When this occurs, they precipitate out and become lodged in the capillaries. This change can cause the capillary to burst, allowing a local hemorrhage.

The source of the antigen causing AP is unknown. Antigens may be introduced by bacterial or viral infection. More than 75% of patients report having had an infection of the throat, upper respiratory tract, or gastrointestinal system several weeks before the onset of AP. Medical researchers find that AP often occurs after the immune system has had an unusual reaction. Other complex molecules can act as antigens as well, including drugs such as **antibiotics** or vaccines. Otherwise harmless substances that stimulate an immune reaction are known as allergens. Drug allergens that may cause AP include penicillin, ampicillin, erythromycin, and quinine. Vaccines possibly linked to AP include those for typhoid,

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measles, **cholera**, and **yellow fever**. Cold weather can also be a contributing factor in its cause.

Symptoms

The onset of AP may be preceded by a **headache**, **fever**, and loss of appetite. Most patients first develop an itchy skin rash. The rash is red, either flat or raised, and may be small and freckle-like. The rash may also be larger, resembling a bruise. **Rashes** become purple and then rust colored over the course of a day, and fade after several weeks. Rashes are most common on the buttocks, abdomen, and lower extremities. Rashes higher on the body may also occur, especially in younger children.

Joint **pain** and swelling is common, especially in the knees and ankles. **Hives**, **nausea**, **vomiting**, and **diarrhea** can also be present. Abdominal pain occurs in almost all patients, along with blood in the body waste (feces). About half of all patients show blood in the urine, low urine volume, or other signs of kidney involvement. Kidney failure may occur due to widespread obstruction of the capillaries in the filtering structures called glomeruli. Kidney failure develops in about five percent of all patients, and in 15% of those with elevated blood or protein in the urine.

Less common symptoms include prolonged headache, fever, and pain and swelling of the scrotum. Involvement of other organ systems may lead to **heart attack** (myocardial infarction), inflammation of the pancreas (**pancreatitis**), intestinal obstruction, or bowel perforation.

Diagnosis

Diagnosis of AP is based on the symptoms and their development, a careful medical history, and blood and urine tests. A **physical examination** will indicate lesions of the skin and tenderness of joints. A **skin biopsy** may be used, along with **urinalysis**. X rays or computed tomography (CT) scans may be performed to assess complications in the bowel or other internal organs.

Treatment

Most cases of AP resolve completely without treatment, often within one month. Nonetheless, a hospital stay is required because of the possibility of serious complications, such as internal bleeding. Non–aspirin pain relievers may be given for joint pain. **Corticosteroids** (like prednisone) are sometimes used, although not all specialists agree on their utility. Kidney involvement requires monitoring and correction of blood fluids and electrolytes.

Patients with severe kidney complications may require a **kidney biopsy** so that tissue can be analyzed. Even after all other symptoms subside, elevated levels of blood or protein in the urine may persist for months and require regular monitoring. **Hypertension** or kidney failure may develop months or even years after the acute phase of the disease. Kidney failure requires dialysis or transplantation.

Prognosis

Most people who develop AP become better on their own after several weeks. About half of all patients have at least one recurrence. Cases that do not have kidney complications, or where those complications are minor, usually have the best prognosis.

Prevention

All necessary and proper action should be taken to ensure exposure of the foreign substance (source) causing allergic purpura does not occur.

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Richard Robinson

Allergic rhinitis

Definition

Allergic **rhinitis**, more commonly referred to as hay **fever**, is an inflammation of the nasal passages caused by allergic reaction to airborne substances such as dander, dust, or pollen.

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This illustration depicts excessive mucus production in the nose after inhalation of airborne pollen. *(© John Bavosi/SPL/ Photo Researchers, Inc.)*

Demographics

Allergic rhinitis affect approximately 60 million people in the United States, and its prevalence is increasing. In 2008, there were more than 12 million doctor visits because of it, which affects about 20% of all adults and as many as 40% of children in the United States, and is responsible for 2.5% of all doctor visits. Allergic rhinitis (AR) is the most common allergic condition and one of the most common of all minor afflictions. **Antihistamines** and other drugs used to treat allergic rhinitis make up a significant fraction of both prescription and over-the-counter drug sales each year.

From 2000 to 2005, the cost of treating allergic rhinitis almost doubled from $6.1 billion to $11.2 billion, with more than half the cost spent on prescription medications. Immunotherapy helps reduce hay fever symptoms in about 85% of people with allergic rhinitis.

Description

There are two types of allergic rhinitis: seasonal and perennial. Seasonal AR occurs in the spring, summer, and early fall, when airborne plant pollens are at their highest levels. In fact, the term hay fever is really a misnomer, since allergy to grass pollen is only one cause of symptoms for most people. Perennial AR occurs all year and is usually caused by home or workplace airborne pollutants. A person can be affected by one or both types. Symptoms of seasonal AR are worst after being outdoors, while symptoms of perennial AR are worst after spending time indoors.

Both types of **allergies** can develop at any age, although onset in childhood through early adulthood is most common. Although allergy to a particular substance is not inherited, increased allergic sensitivity may "run in the family." While allergies can improve on their own over time, they can also become worse over time.

Causes and symptoms

Causes

Allergic rhinitis is a type of immune reaction. Normally, the immune system responds to foreign microorganisms, or particles, like pollen or dust, by producing specific proteins, called antibodies, that are capable of binding to identifying molecules, or antigens, on the foreign particle. This reaction between antibody and antigen sets off a series of reactions designed to protect the body from infection. Sometimes, this same series of reactions is triggered by harmless, everyday substances. This is the condition known as allergy, and the offending substance is called an allergen.

Like all allergic reactions, AR involves a special set of cells in the immune system known as mast cells. Mast cells, found in the lining of the nasal passages and eyelids, display a special type of antibody, called immunoglobulin type E (IgE), on their surface. Inside, mast cells store reactive chemicals in small packets, called granules. When the antibodies encounter allergens, they trigger release of the granules, which spill out their chemicals onto neighboring cells, including blood vessels and nerve cells. One of these chemicals, histamine, binds to the surfaces of these other cells, through special proteins called histamine receptors. Interaction of histamine with receptors on blood vessels causes neighboring cells to become leaky, leading to the fluid collection, swelling, and increased redness characteristic of a runny nose and red, irritated eyes. Histamine also stimulates **pain** receptors, causing the

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KEY TERMS

Allergen—A substance that provokes an allergic response.

Anaphylaxis—Increased sensitivity caused by previous exposure to an allergen that can result in blood vessel dilation (swelling) and smooth muscle contraction. Anaphylaxis can result in sharp blood pressure drops and difficulty breathing.

Antibody—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

Antigen—A foreign protein to which the body reacts by making antibodies.

Granules—Small packets of reactive chemicals stored within cells.

Histamine—A chemical released by mast cells that activates pain receptors and causes cells to become leaky.

Mast cells—A type of immune system cell that is found in the lining of the nasal passages and eyelids, displays a type of antibody called immunoglobulin type E (IgE) on its cell surface, and participates in the allergic response by releasing histamine from intracellular granules.

itchy, scratchy nose, eyes, and throat common in allergic rhinitis.

The number of possible airborne allergens is enormous. Seasonal AR is most commonly caused by grass and tree pollens, since their pollen is produced in large amounts and is dispersed by the wind. Showy flowers, like roses or lilacs, that attract insects produce a sticky pollen that is less likely to become airborne. Different plants release their pollen at different times of the year, so seasonal AR sufferers may be most affected in spring, summer, or fall, depending on which plants provoke a response. The amount of pollen in the air is reflected in the pollen count, often broadcast on the daily news during allergy season. Pollen counts tend to be lower after a good rain that washes the pollen out of the air and higher on warm, dry, windy days.

Virtually any type of tree or grass may cause AR. A few types of weeds that tend to cause the most trouble for people include the following:

- ragweed
- sagebrush
- lamb's-quarters
- plantain
- pigweed
- dock/sorrel
- tumbleweed

Perennial AR is often triggered by house dust, a complicated mixture of airborne particles, many of which are potent allergens. House dust contains some or all of the following:

- house mite body parts. All houses contain large numbers of microscopic insects called house mites. These harmless insects feed on fibers, fur, and skin shed by the house's larger occupants. Their tiny body parts easily become airborne.
- animal dander. Animals constantly shed fur, skin flakes, and dried saliva. Carried in the air, or transferred from pet to owner by direct contact, dander can cause allergy in many sensitive people.
- mold spores. Molds live in damp spots throughout the house, including basements, bathrooms, air ducts, air conditioners, refrigerator drains, damp windowsills, mattresses, and stuffed furniture. Mildew and other molds release airborne spores that circulate throughout the house.

Other potential causes of perennial allergic rhinitis include the following:

- cigarette smoke
- perfume
- cosmetics
- cleansers
- copier chemicals
- industrial chemicals
- construction material gases

Symptoms

Inflammation of the nose, or rhinitis, is the major symptom of AR. Inflammation causes **itching**, sneezing, runny nose, redness, and tenderness. Sinus swelling can constrict the eustachian tube that connects the inner ear to the throat, causing a congested feeling and "ear popping." The drip of mucus from the sinuses down the back of the throat, combined with increased sensitivity, can also lead to throat irritation and redness. AR usually also causes redness, itching, and watery eyes. **Fatigue** and **headache** are also common.

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Diagnosis

Diagnosing seasonal AR is usually easy and can often be done without a medical specialist. When symptoms appear in spring or summer and disappear with the onset of cold weather, seasonal AR is almost certainly the culprit. Other causes of rhinitis, including infection, can usually be ruled out by a **physical examination** and a nasal smear, in which a sample of mucus is taken on a swab for examination.

Allergy tests, including skin testing and provocation testing, can help identify the precise culprit, but may not be done unless a single source is suspected and subsequent avoidance is possible. Skin testing involves placing a small amount of liquid containing a specific allergen on the skin and then either poking, scratching, or injecting it into the skin surface to observe whether redness and swellings occurs. Provocation testing involves challenging an individual with either a small amount of an inhalable or ingestable allergen to see if a response is elicited.

Perennial AR can also usually be diagnosed by careful questioning about the timing of exposure and the onset of symptoms. Specific allergens can be identified through allergy skin testing.

Treatment

Avoidance of the allergens is the best treatment, but this is often not possible. When it is not possible to avoid one or more allergens, there are two major forms of medical treatment, drugs and immunotherapy.

Drugs

ANTIHISTAMINES. Antihistamines block the histamine receptors on nasal tissue, decreasing the effect of histamine release by mast cells. They may be used after symptoms appear, though they may be even more effective when used preventively, before symptoms appear. A wide variety of antihistamines are available.

Older antihistamines often produce drowsiness as a major side effect. Such antihistamines include the following:

- diphenhydramine (Benadryl and generics)
- chlorpheniramine (Chlor-trimeton and generics)
- brompheniramine (Dimetane and generics)
- clemastine (Tavist and generics).

Newer antihistamines that do not cause drowsiness are available by prescription and include the following:

- astemizole (Hismanal)
- fexofenadine (Allegra)
- cetirizine (Zyrtec)
- azelastin HCl (Astelin)

Loratidine (Claritin) was available only by prescription but was released to over-the-counter status by the FDA.

Hismanal has the potential to cause serious heart **arrhythmias** when taken with the antibiotic erythromycin, the antifungal drugs ketoconazole and itraconazole, or the antimalarial drug quinine. Taking more than the recommended dose of Hismanal can also cause arrhythimas. Seldane (terfenadine), the original non-drowsy antihistamine, was voluntarily withdrawn from the market by its manufacturers in early 1998 because of this potential and because of the availability of an equally effective, safer alternative drug, fexofenadine.

LEUKOTRIENE RECEPTOR ANTAGONISTS. Leukotriene receptor antagonists (montelukast or Singulair and zafirlukast or Accolate) are a newer class of drugs used daily to help prevent **asthma**. They've also become approved in the United States to treat allergic rhinitis.

DECONGESTANTS. **Decongestants** constrict blood vessels to counteract the effects of histamine. This decreases the amount of blood in the nasopahryngeal and sinus mucosa and reduces swelling. Nasal sprays are available that can be applied directly to the nasal lining and oral systemic preparations are available. Decongestants are stimulants and may cause increased heart rate and blood pressure, headaches, isomnia, agitation and difficulty emptying the bladder. Use of topical decongestants for longer than several days can cause loss of effectiveness and rebound congestion, in which nasal passages become more severely swollen than before treatment.

TOPICAL CORTICOSTEROIDS. Topical **corticosteroids** reduce mucous membrane inflammation and are available by prescription. Allergies tend to become worse as the season progresses because the immune system becomes sensitized to particular antigens and can produce a faster, stronger response. Topical corticosteroids are especially effective at reducing this seasonal sensitization because they work more slowly and last longer than most other medication types. As a result, they are best started before allergy season begins. Side effects are usually mild, but may include headaches, nosebleeds, and unpleasant taste sensations.

MAST CELL STABILIZERS. Cromolyn **sodium** prevents the release of mast cell granules, thereby preventing release of histamine and the other chemicals contained in them. It acts as a preventive treatment if

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it is begun several weeks before the onset of the allergy season. It can be used for perennial AR as well.

Immunotherapy

Immunotherapy, also known as desensitization or allergy shots, alters the balance of antibody types in the body, thereby reducing the ability of IgE to cause allergic reactions. Immunotherapy is preceded by allergy testing to determine the precise allergens responsible. Injections involve very small but gradually increasing amounts of allergen, over several weeks or months, with periodic boosters. Full benefits may take up to several years to achieve and are not seen at all in about one in five patients. Individuals receiving all shots will be monitored closely following each shot because of the small risk of **anaphylaxis**, a condition that can result in difficulty breathing and a sharp drop in blood pressure.

Alternative treatment

Alternative treatments for AR often focus on modulation of the body's immune response, and frequently center around diet and lifestyle adjustments. Chinese herbal medicine can help rebalance a person's system, as can both acute and constitutional homeopathic treatment. Vitamin C in substantial amounts can help stabilize the mucous membrane response. For symptom relief, western herbal remedies including eyebright (*Euphrasia officinalis*) and nettle (*Urtica dioica*) may be helpful. Bee pollen may also be effective in alleviating or eliminating AR symptoms. A 2004 report said that **phototherapy** (treatment with a combination of ultraviolet and visible light) decreased the symptoms of allergic rhinitis in a majority of patients who did not respond well to traditional drug treatment.

Prognosis

Most people with AR can achieve adequate relief with a combination of preventive strategies and treatment. While allergies may improve over time, they may also get worse or expand to include new allergens. Early treatment can help prevent an increased sensitization to other allergens.

Prevention

Reducing exposure to pollen may improve symptoms of seasonal AR. Strategies include the following:

- stay indoors with windows closed during the morning hours, when pollen levels are highest
- keep car windows up while driving
- use a surgical face mask when outside
- avoid uncut fields
- learn which trees are producing pollen in which seasons, and avoid forests at the height of pollen season
- wash clothes and hair after being outside
- clean air conditioner filters in the home regularly
- use electrostatic filters for central air conditioning

Moving to a region with lower pollen levels is rarely effective, since new allergies often develop

Preventing perennial AR requires identification of the responsible allergens.

Mold spores:

- keep the house dry through ventilation and use of dehumidifiers
- use a disinfectant such as dilute bleach to clean surfaces such as bathroom floors and walls
- have ducts cleaned and disinfected
- clean and disinfect air conditioners and coolers
- throw out moldy or mildewed books, shoes, pillows, or furniture

House dust:

- vacuum frequently, and change the bag regularly. Use a bag with small pores to catch extra-fine particles
- clean floors and walls with a damp mop
- install electrostatic filters in heating and cooling ducts, and change all filters regularly

Animal dander:

- avoid contact if possible
- wash hands after contact
- vacuum frequently
- keep pets out of the bedroom, and off furniture, rugs, and other dander-catching surfaces
- have your pets bathed and groomed frequently

Resources

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Richard Robinson
Karl Finley

Allergies

Definition

Allergies are hypersensitive responses by the immune system to otherwise harmless foreign substances.

Demographics

Allergies are among the most common medical disorders. It is estimated that 60 million Americans, or more than one in every five, suffer from some form of allergy that is pronounced enough to cause symptoms. More than half of all Americans test positive for one or more allergens. Allergies are the third leading cause of chronic disease among American children and the single largest reason for school absences. Allergies are the fifth leading cause of chronic disease among all Americans, accounting for one in nine physician visits and a major source of lost workplace productivity. There are similar proportions of allergy sufferers throughout much of the world.

Among Americans:

- Approximately 36 million suffer from seasonal allergies, with seasonal allergic rhinitis—or hay fever—affecting 20% of all adults and up to 40% of children. Pollen allergies generally develop between the ages of 6 and 13. Other respiratory allergies, such as those to dust, animal dander, and molds, may occur in children as young as two or three.
- Approximately 12 million have food allergies, including 4% of adults and 6-8% of children four years-of-age and under. Approximately 6.9 million Americans are allergic to seafood and 0.4-0.6% are allergic to peanuts and other nuts—the most severe of food allergies.
- Allergic drug reactions account for 5-10% of all adverse drug reactions, with skin reactions being the most common. About one-fifth of all children are allergic to some type of medication, often penicillin, sulfa drugs, or aspirin.
- Although about 15% of adults have mild, localized allergic reactions to insect bites and stings, approximately 3% have serious allergies to the venom of stinging insects, such as honeybees, wasps, hornets, yellow jackets, and fire ants (which are found only in the South). Children rarely experience the severe reactions to venom that sometimes occur in adults.
- Hives affect up to 20% of the population at some point in their lives.
- Skin allergies or allergic contact dermatitis is the most common skin condition in children under age 11.
- Estimates of the prevalence of latex allergy vary from less than 1% to 6%. Healthcare workers are particularly at risk for contact dermatitis from latex gloves.

Almost nine million American children suffer from **asthma**, a chronic disease that causes inflammation of the airways, making it difficult to breathe. Many different allergens can trigger asthma attacks and it is estimated that 50% of adults and more than 80% of children with asthma have associated allergies, especially **allergic rhinitis**. It is believed that asthma is both under-diagnosed and under-treated in the elderly.

Anaphylaxis or anaphylactic shock is a rare, severe, and potentially fatal allergic reaction that causes blood pressure to drop severely and the airways to swell shut. Among Americans:

- More than 700 die each year from anaphylaxis brought on by an allergic reaction
- Approximately 150–200 die from food-induced anaphylaxis
- Penicillin in its various forms results in about 400 deaths per year in the United States. Worldwide, 32 out of every 100,000 patients exposed to penicillin have an anaphylactic reaction
- Each year 40–100 Americans die from an anaphylactic reaction to insect bites or stings
- There are about 220 cases of anaphylaxis and three deaths annually from latex allergy

The incidence of allergies and asthma is increasing in industrialized countries by about 5% per year and as many as half of all those affected are children. Some of this increase can be attributed to better diagnosis and reporting. However much of it may be due to lifestyle and environmental factors.

Description

An allergy is a type of immune response. The immune system normally responds to microorganisms, such as bacteria or viruses, or foreign particles by producing specific proteins called antibodies. These

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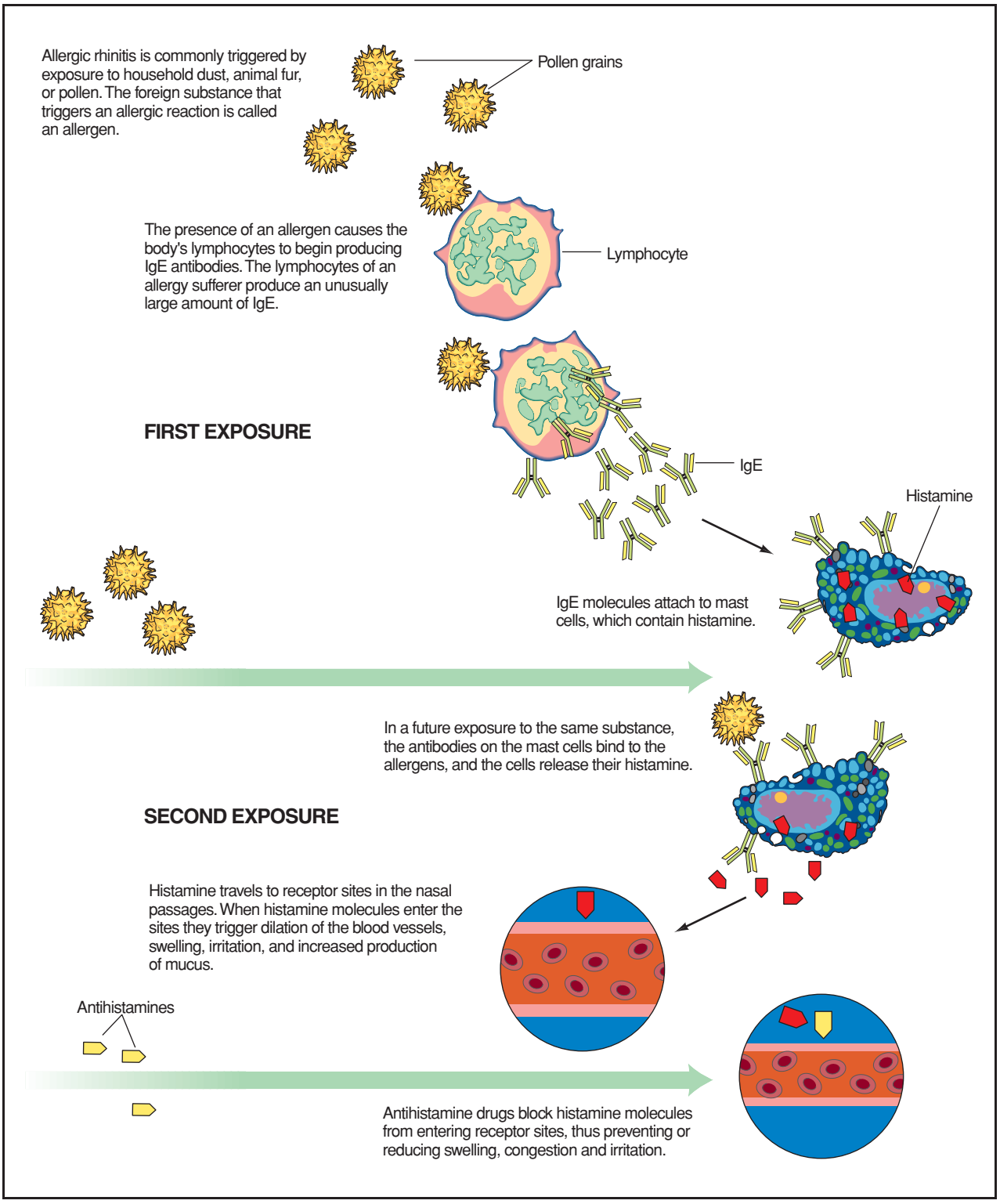

The allergic response. *(Illustration by Hans & Cassady, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

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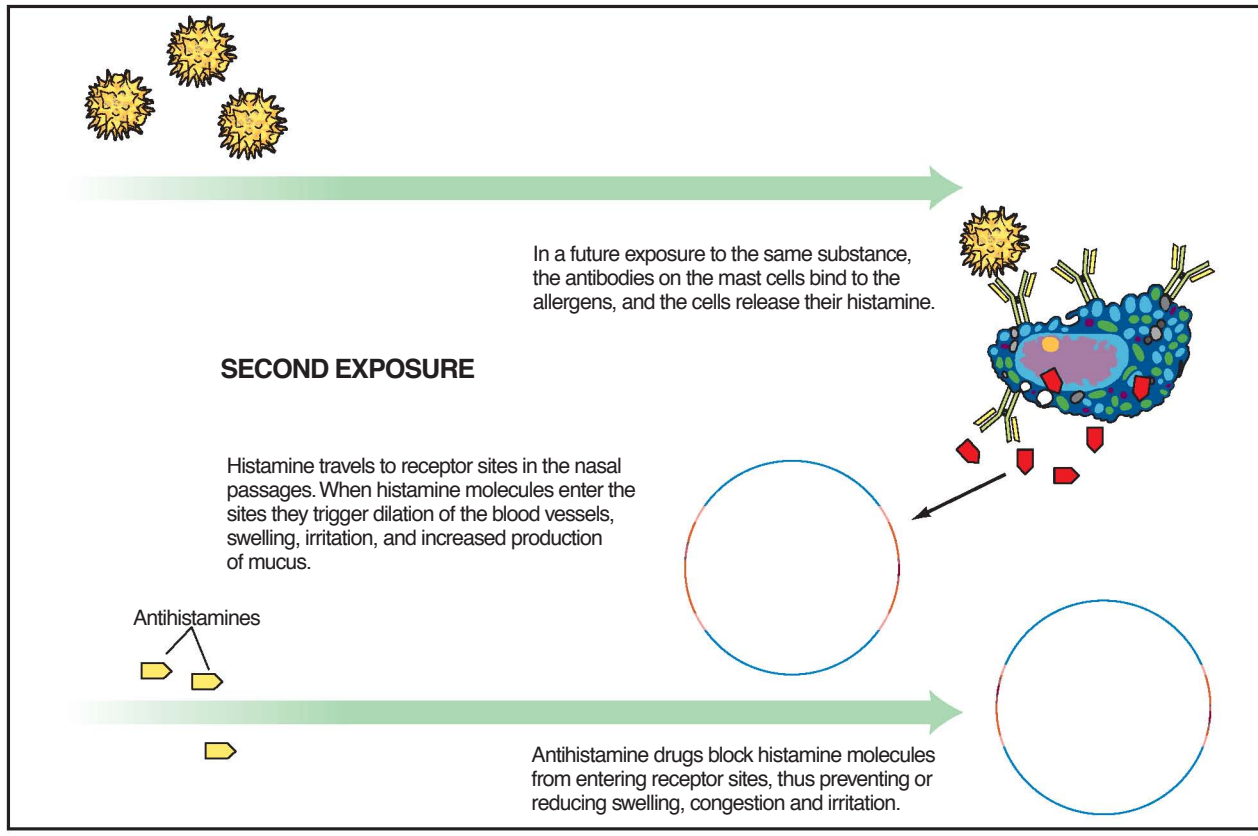

Second and subsequent exposure to allergen. *(Illustration by Hans & Cassady, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

antibodies identify and bind to a specific foreign molecule—known as the antigen. The reaction between the antibody and its antigen sets off a series of chemical reactions designed to protect the body from infection. However with allergies, this immune response is triggered by harmless common substances called allergens. Allergens may be inhaled into the lungs (pollen, dust, animal dander, mold, pollutants), swallowed (food, drugs), injected (drugs, insect venom), or touched (poisonous plants, latex).

There are two main types of allergic reactions. Immediate hypersensitivity reactions are mediated predominately by a type of immune-system cell called a mast cell and occur within minutes of contact with the allergen. Delayed hypersensitivity reactions are mediated by T cells, a type of white blood cell, and occur hours to days after exposure to the allergen.

In immediate sensitivity reactions allergens bind to a type of antibody called immunoglobulin E or IgE on the surface of mast cells. Mast cells are filled with granules that contain a variety of potent chemicals including histamine. When the IgE on a mast cell binds its specific allergen, the contents of the granules spill out onto neighboring cells. Histamine binds to proteins called histamine receptors on the surfaces of these other cells, causing a chain of reactions that lead to allergy symptoms. Histamine binding to receptors on blood vessels increases leakage, leading to the fluid accumulation, swelling, and redness. In the nasal passages histamine causes swelling, congestion, and increased mucus production. Histamine also stimulates **pain** receptors on nerve cells, causing sensitivity and irritation. These symptoms last from one to several hours following contact with the allergen.

In delayed hypersensitivity reactions roving T cells contact the allergen, setting in motion a more prolonged immune response. This type of allergic response may develop over several days following contact with the allergen and symptoms may persist for a week or more.

Allergens enter the body through four main routes: the airways, the gastrointestinal tract, the circulatory system, and the skin. Inhaled or ingested allergens usually cause immediate hypersensitivity reactions. Allergens on the skin usually cause delayed hypersensitivity reactions.

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People are sensitive to different allergens. For example, some people have severe allergic **rhinitis** but no **food allergies**, whereas others are extremely sensitive to nuts but not to any other food. Allergies may worsen over time. For example, allergic rhinitis can be either seasonal or chronic and a childhood ragweed allergy may progress to year-round dust and pollen allergies. Conversely, people can lose allergies. Infant or childhood **atopic dermatitis**, for example, almost always disappears with advancing age. However most often, an apparent loss of sensitivity is due to reduced exposure to the allergen or increased tolerance for the allergy symptoms.

Risk factors

Although allergies to specific allergens are not inherited, the propensity for developing allergies is frequently inherited.

- If neither parent has allergies, the chances of a child developing allergies are approximately 10–20%.
- A child with one allergic parent has a 30–50% chance of developing allergies.
- The likelihood of developing allergies rises to 40–75% if both parents have allergies. However children are not necessarily sensitive to the same allergens as their parents. Since people with allergies tend to produce more IgE than those without allergies, it may be that the tendency to produce more IgE is inherited. High levels of IgE also increase the likelihood of having allergies to multiple allergens.

Other risk factors for the development of childhood allergies include:

- low birth weight
- being born during a high-pollen season
- not being breastfed
- growing up in a home with tobacco smoke
- having a family pet
- having a lower socioeconomic status
- repeated exposure to an allergen or prolonged exposure to a strong allergen

Causes and symptoms

The most common airborne allergens are:

- plant pollens
- animal fur and dander
- body parts from house mites (microscopic creatures found in all houses)
- house dust
- mold spores
- feathers
- cigarette smoke
- chemicals
- solvents
- cleansers

Pollen can cause both seasonal and chronic rhinitis. Seasonal rhinitis occurs at the same time every year and is caused by the pollen of specific plants, especially grasses and trees in the spring and ragweed in the late summer and fall. Allergies tend to worsen as the season progresses because the immune system becomes sensitized to particular antigens and produces a faster, stronger response. Chronic rhinitis can be caused by food as well as airborne allergens.

Airborne allergens cause immediate hypersensitivity reactions in the upper airways and eyes. These include sneezing, runny nose, itchy, watery, and bloodshot eyes, nasal congestion, and scratchy or irritated throat due to postnasal drip. Airborne allergens can also cause inflammation of the thin membrane (conjunctiva) covering the eye, resulting in the redness, irritation, and increased tearing of allergic **conjunctivitis** or pink eye. Asthma causes **wheezing**, coughing, and **shortness of breath** and is associated with exposure to numerous allergens including cockroach allergens.

Common food allergens include:

- cow's milk
- eggs
- grains such as wheat or corn
- nuts, especially peanuts, walnuts, and Brazil nuts
- fish, mollusks, and shellfish
- soy products
- some fruits, especially raw seeded fruit
- some vegetables, especially tomatoes or legumes such as peas or beans
- chocolate
- certain spices
- food additives and preservatives

True food allergies are often confused with intolerance to certain foods. Food allergies, like other types of allergies, are caused by an antibody response, whereas intolerance is due a deficiency in the enzymes needed to digest a certain food. For example, a milk allergy is caused by sensitivity to an allergen (often the protein lactalbumin) in the milk itself. In contrast, people who lack the enzyme lactase have lactose intolerance—the inability to digest one of the sugars in milk—and suffer from gastrointestinal problems when they consume milk or certain milk products.

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Symptoms of food allergies depend on the tissues that are most sensitive to the allergen and whether the allergen has spread systemically through the circulatory system. Allergens in food can cause immediate hypersensitivity reactions that include **itching**, swelling, and/or **rashes** of the eyes, lips, mouth, and throat. Food allergies can also cause respiratory symptoms. Swelling and irritation of the intestinal lining can cause **nausea**, **vomiting**, cramping, **diarrhea**, and gas. When food allergens enter the bloodstream from the gastrointestinal tract, they can cause **hives**, atopic **dermatitis**, or more severe reactions such as angioedema. Some food allergens may cause anaphylaxis, a potentially life-threatening condition marked by tissue swelling, airway constriction, and drop in blood pressure. Reactions to peanuts and other nuts can be so dangerous that physicians recommend caution in giving these foods to infants and children with a family history of allergy. Some school systems are restricting the use of peanuts and peanut butter in lunchrooms or banning them altogether, since even smelling or touching them can cause an allergic reaction in some children.

Drugs that often cause allergic reactions include:

- penicillin and other antibiotics
- flu vaccines
- tetanus toxoid vaccine
- gamma globulin

Insects and other arthropods whose **bites** or **stings** may cause an allergic reaction include:

- bees, wasps, and hornets
- mosquitoes
- fleas
- scabies

Injected allergens from drugs or insect **bites and stings** are introduced directly into the circulation where they can cause both local reactions, such as swelling and irritation at the injection site, and system-wide (systemic) reactions, including anaphylaxis. Symptoms of an allergy to insect venom include:

- hives
- itchy eyes
- a dry cough
- constriction of the throat and chest
- nausea
- dizziness
- abdominal pain

There are three main types of allergic skin reactions:

- atopic dermatitis or eczema
- hives (urticaria)
- contact dermatitis

Atopic dermatitis and **eczema** are skin reactions to allergens introduced through the airways or gastrointestinal tract. Eczema commonly occurs in infants and children with a family history of allergies and is usually outgrown by the age of six. It generally occurs in cycles, beginning with dry, itchy skin that becomes inflamed when scratched, followed by weeping sores that subsequently crust over. In the chronic stage the affected skin becomes thickened, leathery, and scaly. Eczema appears most often on the cheeks, ears, and neck and the inner folds of elbows and knees, but it may affect other parts of the body as well.

Whole-body or systemic reactions can occur with any type of allergen, but are more common following ingestion or injection of an allergen. Hives are a systemic skin reaction characterized by raised, red, itchy blotches of varying sizes anywhere on the body, but especially on the stomach, chest, arms, hands, and face. Angioedema is a deeper, more extensive, and painful reaction in which fluid accumulation causes recurrent, non-inflammatory swelling of the skin, eyelids, lips, mucous membranes, genitals, other organs, and brain. However it most often occurs on the extremities, fingers, toes, and parts of the head, neck, and face. Hives and angioedema are usually acute conditions, although they can sometimes persist for weeks.

Skin contact with allergens can cause reddening, itching, and blistering, known as **contact dermatitis**. The dermatitis sometimes has an identifying pattern, such as the outline of an earring or latex glove. Common causes include:

- poison ivy, oak, and sumac
- nickel or nickel alloys
- chemicals
- cosmetics
- latex

Dermatitis can also be caused by non-allergic damage to skin cells arising from irritants such as cold, soap, or chemical agents.

Asthma is a chronic, reversible respiratory disorder caused by obstruction and swelling of the airways to the lungs. An asthma attack begins when the muscles surrounding the bronchial tubes spasm and the tubes narrow. This stimulates increased mucus production, further blocking the airways, and inflammation and swelling, which cause even more congestion and discomfort. Symptoms of asthma include

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coughing, wheezing, shortness of breath, **fatigue**, **anxiety**, and tightness in the chest. Asthma can be triggered by allergens—including pollen, animal dander, dust, and certain foods—and by non-allergenic irritants.

Anaphylaxis is an IgE-mediated hypersensitivity reaction brought about by mediators released by mast cells in the tissues and by immune system cells called basophils in the blood. These can cause airway constriction, blood pressure drop, widespread tissue swelling, heart rhythm abnormalities, and sometimes loss of consciousness. Other symptoms may include **dizziness**, weakness, seizures, coughing, flushing, or cramping. Symptoms can begin within five minutes after exposure to the allergen or up to an hour or more later. Anaphylaxis is most often associated with allergies to foods, medications, and insect venoms.

Genetic profile

The genetic predisposition toward the development of hypersensitivity reactions upon exposure to specific antigens is called atopy. After birth the immune system switches to become either non-allergy prone (TH1) or allergy prone (TH2), depending on an interplay of heredity and environment. TH stands for T-helper white blood cells. TH1 cells fight bacteria and viruses and protect against allergies. TH2 cells fight parasitic infections and promote the production of excessive IgE, increasing the likelihood of developing allergies. TH2 immunity is much more likely to be switched on in children with a family history of allergies.

Over the past four decades atopy has increased significantly, for reasons that are not well understood. In addition to genetic factors, it has been suggested that our environment contains more allergy-inducing substances and that protective factors may have been removed from the environment. There is also some evidence suggesting that the worldwide fight against **infectious disease** and increased personal cleanliness may be interfering with immune system function. Global warming—and the accompanying changes in natural vegetation patterns and increased pollen production—may also be affecting atopy.

Diagnosis

Examination

Allergies can often be diagnosed by a careful medical history that matches the onset of symptoms with exposure to possible allergens. Allergy is suspected if the symptoms are characteristic of an allergic reaction and occur repeatedly upon exposure to the suspected allergen, at a certain time of year, or in a particular environment. Although **allergy tests** can be used to identify potential allergens, their results must be supported by evidence of an allergic response.

Tests

With allergy skin tests a tiny dose of an aqueous extract of the suspected allergen is pricked, scratched, punctured, or patched on the skin. The initial test is usually a prick or patch test on the back, forearm, or top of the thigh. Reactions are usually evaluated about 15 minutes after exposure. An allergen may produce a classic immune wheal-and-flare response—a skin lesion with a raised, white, compressible area surrounded by a red flare. A positive skin reaction will occur even if the allergen is normally encountered in the airways or in food. Skin testing can produce false positives and, occasionally, serious allergic reactions. Intradermal skin tests involve injection of the allergen into the dermis of the skin. These are more sensitive and use smaller amounts of allergen, so they can be used with potentially fatal allergens such as **antibiotics**.

Provocation tests administer the allergen directly through its normal route under medically controlled conditions. Food allergen provocation tests involve the ingestion of a measured amount of the suspected allergen in an opaque capsule after abstinence from the suspected allergen for two weeks or more. The results are compared to the response to ingestion of a placebo. Diagnosis of delayed allergic contact dermatitis involves the application of a skin patch containing the allergen. Provocation tests are never used when a patient's medical history suggests the possibility of anaphylaxis.

Since people with allergies may have a higher level of total IgE in their serum (the portion of the blood that contains antibodies) than those without allergies, total IgE can be measured with a two-site immunometric assay. However there is considerable overlap in serum IgE levels among people with and without allergies. Furthermore other non-allergic conditions—including **smoking**, HIV/AIDS, parasitic infections, and IgE myeloma—can raise IgE levels. However a total serum IgE test is useful for diagnosing some conditions.

With allergen-specific IgE measurements, the suspected allergen is bound to a solid support, such as a cellulose sponge, microtiter plate, or paper disk. A patient's serum is incubated with the allergen. Allergen-specific IgE antibodies will bind to the solid phase and remain there when the serum is washed off. A second labeled antibody that binds to any IgE is added to determine the level of the allergen-specific

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KEY TERMS

Allergen—Any substance that provokes an allergic response.

Allergenic—Acting as an allergen or inducing an allergic response.

Allergic rhinitis—Inflammation of the mucous membranes of the nose and eyes in response to an allergen. Hay fever is seasonal allergic rhinitis.

Anaphylaxis—Severe, potentially fatal hypersensitivity caused by previous exposure to an allergen that can result in blood vessel dilation and a sharp drop in blood pressure, smooth muscle contraction, and difficulty breathing.

Angioedema—Severe non-inflammatory swelling of the skin, organs, and brain, possibly accompanied by fever and muscle pain.

Antibody—A specific immunoglobulin protein produced by the immune system in response to a specific antigen.

Antigen—A foreign protein or particle that causes the body to produce specific antibodies that bind to it.

Asthma—A lung condition, usually of allergic origin, in which the airways become narrow due to smooth muscle contraction, causing wheezing, coughing, and shortness of breath.

Atopic dermatitis—A skin condition resulting from exposure to airborne or food allergens.

Atopy—Genetic predisposition toward the development of allergies.

Conjunctivitis—Inflammation of the conjunctiva, the membrane covering the white part of the eye.

Contact dermatitis—Skin inflammation resulting from contact with an allergen or other substance.

Delayed hypersensitivity reactions—Allergic reactions mediated by T cells that occur hours to days after exposure to the antigen.

Eczema—An inflammatory skin condition characterized by redness, itching, and oozing lesions, which become crusty, scaly, or hardened.

Epinephrine—Adrenalin; a hormone released into the bloodstream in response to stress. Its many effects include stimulating the heart and increasing blood pressure, metabolic rate, and blood glucose concentration.

Granules—Small packets of reactive chemicals stored within cells.

Histamine—A chemical released by mast cells during an allergic reaction and which has a variety of effects on other cells.

Hives—A raised, itchy area of skin that is usually a sign of an allergic reaction.

Immediate hypersensitivity reactions—Allergic reactions that are mediated by mast cells and occur within minutes of allergen contact.

Immunoglobulin E (IgE)—Antibodies produced in the lungs, skin, and mucous membranes that are responsible for allergic reactions.

Mast cells—A type of immune system cell that displays immunoglobulin E (IgE) on its cell surface and participates in allergic reactions by releasing histamine and other chemicals from intracellular granules. The lining of the nasal passages and eyelids are particularly rich in mast cells.

T cells—Immune system white blood cells that have highly specific antigen receptors on their surfaces. Some T cells stimulate other immune system cells to produce and release antibodies.

IgE. The radioallergosorbent test (RAST) uses radioactive anti-IgE antibodies. A newer test called an enzyme-linked immunosorbent assay (ELISA) uses anti-IgE antibodies that are linked to an enyzme. A test called the CAP-RAST measures the amount of IgE in the blood that is specific for a given food.

Attempts are being made to directly measure immune system mediators such as histamine, eosinophil cationic protein (ECP), and mast cell tryptase.

Electrodermal testing or electro-acupuncture allergy testing has been used in Europe, but is somewhat controversial and has not been approved by the U.S. Food and Drug Administration (FDA). An electric potential is applied to the skin and changes in the electrical resistance are measured upon exposure to the suspected allergen.

Procedures

Elimination **diets** are often used to diagnose food allergies. Suspect foods may be sequentially eliminated from the diet. Alternatively, after several weeks on a diet lacking any of the suspected allergenic foods, each

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suspected food is reintroduced one at a time and the patient is observed for signs of allergic reaction.

Treatment

Traditional

The most effective allergy treatment is avoiding all allergen exposure. This is usually possible with food allergens but can be very difficult with other types of allergens. Therefore immediate hypersensitivity reactions are usually treated with drugs.

Immunotherapy, usually called allergy shots or desensitization, alters the balance of antibody types in the body. Immunotherapy is generally used when medications cannot relieve symptoms. Extracts of the allergen are injected into the skin in gradually increasing amounts over a period of weeks, months, or years, with occasional booster shots. The amounts of allergen are too small to trigger an allergic response; however patients are monitored closely after each injection because of the small risk of anaphylaxis. Immunotherapy is most effective for hay **fever** and insect sting allergies, particularly in patients who cannot avoid allergens in the environment and who do not respond to medications. It may also reduce or eliminate the need for medications. While many rhinitis sufferers have been helped by allergy shots, they are costly and time-consuming and are not always effective. It may take up to several years of treatment to fully benefit from immunotherapy and about one in five patients do not respond at all. However some experts recommend preventative immunotherapy for children who have severe reactions to insect stings.

Drugs

There are a large number of prescription and over-the-counter medications for treating immediate hypersensitivity reactions. Most of these work by decreasing the ability of histamine to provoke symptoms. Other drugs counteract the effects of histamine by stimulating other systems or by reducing the general immune response. Medications are available as pills, liquids, nasal sprays, eye drops, and skin creams. The appropriate medication depends on the symptoms and the patient's overall health. A physician may recommend trying a few different medications to determine which ones are most effective with the fewest side effects.

Antihistamines are the most common treatment for rhinitis. They block the histamine receptors in nasal tissue, thereby decreasing the effects of histamine released by mast cells. Antihistamines can be used after symptoms appear, although they may be even more effective when used preventively, before symptoms appear. They help reduce sneezing, itching, and runny nose (rhinorrhea). Antihistamines can also be used to treat other types of allergies.

There are a wide variety of antihistamines available. Older first-generation antihistamines often cause drowsiness as a major side effect. They can also cause dizziness, **dry mouth**, tachycardia, blurred vision, **constipation**, and a lowered threshold for seizures. Their effects can be similar to those of alcohol and care should be taken when operating motor vehicles, since individuals may not be aware that they are impaired. These antihistamines include:

- diphenhydramine (Benadryl and generics)
- chlorpheniramine (Chlor-trimeton and generics)
- brompheniramine (Dimetane and generics)
- clemastine (Tavist and generics)

Newer antihistamines that do not cause drowsiness or cross the blood-brain barrier include:

- loratidine (Claritin)
- cetirizine (Zyrtec)
- fexofenadine (Allegra)
- desloratadine (Clarinex)
- azelastin HCl (Astelin)
- astemizole (Hismanal)

Seldane (terfenadine), the original non-drowsy antihistamine, was voluntarily withdrawn from the market by its manufacturer in early 1998 because of its potential for causing serious heart **arrhythmias** and the availability of the equally effective but safer drug fexofenadine. Hismanal also has the potential for causing heart arrhythmias when taking more than the recommended dose or taking it along with the antibiotic erythromycin, the antifungal drugs ketoconazole or itraconazole, or the antimalarial drug quinine.

Decongestants constrict the blood vessels in the nasopharyngeal and sinus mucosa, reducing swelling and relieving nasal and sinus congestion. Both oral systemic preparations and nasal sprays—which are applied directly to the nasal lining—are available. Decongestants are stimulants and may cause increased heart rate and blood pressure, headaches, **insomnia**, agitation, and difficulty emptying the bladder. Use of nasal decongestants for longer than several days can result in loss of effectiveness and rebound congestion in which nasal passages become even more swollen.

Cromolyn **sodium** is a nonsteroidal mast cell stabilizer that prevents the release of mast cell granules and thus the release of histamine and other chemicals. It can be started several weeks before the onset of the

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allergy season as a preventive treatment. It can also be used for year-round allergy prevention. Cromolyn sodium is available as a nasal spray that coats the nasal membranes to treat allergic rhinitis and in aerosol form (a suspension of particles in gas) for asthma.

Newer types of allergy medications include:

- the IgE modifier omalizumab (Xolair), which interferes with the action of mast cells
- leukotriene modifiers or antileukotrienes, which block the action of leukotrienes—inflammatory substances released by the immune system during an allergic reaction—and include zafirlukast (Accolate), montelukast (Singulair), and zileuton (Zyflo)
- immunomodulatory topical ointments—which interfere with cell mechanisms that produce inflammatory responses—and include pimecrolimus (Elidel cream) and tacrolimus (Protopic ointment)

Corticosteroids help to prevent and treat the inflammation associated with allergic conditions by reducing the recruitment of inflammatory cells and the synthesis of immune-system chemicals called cytokines. Studies have shown that steroidal nasal sprays are more effective on an as-needed basis for seasonal allergies than antihistamines. Although hives and angioedema are usually treated with antihistamines, cromolyn, or epinephrine, intractable cases may be treated with oral cortisone; however it should be used sparingly and only as a last recourse because of its side effects. Corticosteroids are also used to prevent and control asthma attacks.

Topical corticosteroids reduce mucous membrane and skin inflammations by decreasing the amount of fluid that moves from the vascular spaces into the tissues. Topical corticosteroid creams are effective for contact dermatitis, although overuse can lead to dry and scaly skin. Moderately strong corticosteroids can be applied as a wrap for 24 hours. Short-term oral corticosteroid therapy also may be appropriate for acute contact dermatitis. Side effects are usually mild, but may include headaches, nosebleeds, and unpleasant taste sensations.

Because allergic reactions involving the lungs cause the airways or bronchial tubes to narrow, bronchodilators—which open or dilate the smooth muscle lining the airways—can be very effective for treating asthma attacks. **Bronchodilators** include:

- adrenaline (epinephrine)
- albuterol (Proventil)
- pirbuterol (Maxair)
- theophylline
- other adrenergic stimulants

Most bronchodilators are administered as aerosols. Theophylline, naturally present in coffee and tea, is usually taken orally, but in a severe asthma attack it may be administered intravenously.

Bronchodilators are often administered via metered-dose inhalers (MDIs):

- The inhaler is shaken and the patient exhales air from the lungs
- The inhaler is placed at least two fingerbreadths in front of the mouth and aimed at the back of the throat
- The inhaler is activated while breathing in slowly for three to four seconds
- The breath is held for at least ten seconds and then expelled
- There should be at least 30–60 seconds before the inhaler is used again
- The mouth should be washed out and the teeth brushed to remove residual medication

Other drugs, including **steroids**, are used in the long-term management of asthma and to prevent asthma attacks. The anticholinergics ipratropium bromide (Atrovent) and atropine sulfate are also used to treat asthma. Ipratropium is used in emergency situations with a nebulizer.

An anaphylaxis emergency is treated by injection of adrenaline, which relaxes muscles and helps open the airways. People who are susceptible to anaphylaxis because of food or insect allergies often carry an EpiPen—adrenaline in a hypodermic needle. Prompt injection into the thigh can prevent a more serious reaction. The patient should be placed in a recumbent position and vital signs—especially the airway status—determined. If the reaction is the result of an insect sting or injection, a tourniquet may need to be placed proximal to the penetrated area and released for one to two minutes at 10-minute intervals. If the individual does not respond to these interventions, emergency treatment is essential.

Alternative

Any alternative treatment for allergies starts with identifying the allergen and avoiding or eliminating it, although this is not always possible. A physician should be consulted before initiating any alternative therapy. Although alternative remedies may be derived from natural sources, they are still drugs and can have potentially harmful effects.

The following treatments may help relieve symptoms of allergic rhinitis from airborne allergens:

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- Traditional Chinese medicine treats allergic rhinitis with various herbs. The patent combination medicines Bu Zhong Yi Qi Wan (Tonify the Middle and Augment the Qi) and Yu Ping Feng San (Jade Windscreen) are used for preventing allergies. Bi Yan Pian (Rhinitis Infusion) is often prescribed for symptoms affecting the nose.
- Acupuncture may be as effective as antihistamine drugs in treating allergic rhinitis. It is also may strengthen the immune system.
- Vitamins A and E are antioxidants and help to promote normal functioning of the immune system.
- Coenzyme Q10 may help promote normal functioning of the immune system.
- Zinc may boost the immune system.
- *Echinacea* spp. may have anti-inflammatory activity and may boost the immune system.
- *Astragalus membranaceus* (milk-vetch root) may help strengthen the immune system.
- Vitamin C has antihistamine and decongestive activities.
- Stinging nettle (*Urtica dioica*) has antihistamine and anti-inflammatory properties. The usual dose is 300 milligrams (mg) four times daily.
- Grape (*Vitis vinifera*) seed extract has antihistamine and anti-inflammatory properties. The usual dose is 50 mg three times daily.
- The bioflavonoid hesperidin may act as a natural antihistamine.
- The dietary supplement N-acetylcysteine may have decongestive activity.
- The homeopathic remedies *Rhus toxicodendron*, *Apis mellifica*, *Nux vomica*, and *Ferrum phosphoricum* alternating with *Kali muriaticum* have decongestant activities when taken internally.
- Licorice (*Glycyrrhiza glabra*) has cortisone-like anti-inflammatory activity, stimulating the adrenals and relieving allergy symptoms. It can be taken as a tea or in 100–300 mg capsules. Long-term use can result in sodium retention or potassium loss.
- Chinese skullcap (*Scutellaria baicalensis*) has bronchodilating activity, is an anti-inflammatory, and can help prevent allergic reactions. It is taken in combination with other herbs.
- The herbal remedies khellin (*Ammi visnaga*) and cramp (*Viburnum opulus*) bark have bronchodilating activity.
- *Ginkgo biloba* seeds are used in Chinese medicine for relief from wheezing and coughing.
- The bioflavonoids quercetin and hesperidin may help stabilize mast cells.
- Although *Ephedra sinicia* (ma huang in traditional Chinese medicine) has anti-inflammatory activity and has proven effective in treating allergies, ephedra should not be used because it can raise blood pressure, cause rapid heartbeat, and interfere with adrenal gland function. The supplement ephedra was banned from sale in the United States in April of 2004 because of severe health risks.

The following homeopathic remedies are taken internally:

- Marsh tea (*Ledum*) for itching insect bites
- *Apis mellifica* for bee stings and hives that are relieved by cold
- Poison ivy (*Rhus toxicodendron*) for hives that are relieved with heat and for poison ivy, oak, or sumac rashes
- Stinging nettle (*Urtica urens*) for hives
- *Croton tiglium* oil for poison ivy, oak, or sumac rashes
- *Anacardium* A qualified homeopathic practitioner should be consulted to match symptoms with the correct remedy.

Various Chinese herbal remedies may be effective in treating atopic dermatitis. A poultice (crushed herbs applied directly to the affected area) made of jewelweed (*Impatiens* spp.) or chickweed (*Stellaria media*) may soothe the skin. A topical cream or wash containing *Calendula officinalis*, a natural antiseptic and anti-inflammatory agent, may help heal rash.

Home remedies

The basic home remedy for allergies is to avoid or eliminate the allergen. This may involve keeping dust under control by cleaning or using air filters, making adjustments in pet ownership, removing items such as feather pillows, and eliminating allergenic foods from the diet. Children with allergies to milk, eggs, fish, or apples who follow an oral desensitization procedure—in which they are exposed to allergenic foods in controlled, but increasing, doses—may develop resistance to the allergen.

Eczema is treated by keeping the skin lubricated with hypoallergenic lotions and gentle soaps. For extremely dry, sensitive skin, Cetaphil lotion may be used as a cleanser instead of soap.

Cold-water compresses and calamine lotion may help reduce the irritation of contact dermatitis. Hydrocortisone ointment or cream or similar preparations can help alleviate itching. Side effects of topical agents may include excessive drying of the skin.

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Prognosis

There is no cure for allergies. Although most allergy symptoms can be successfully treated with medications, these cannot prevent future allergic reactions. Some allergies improve over time, but often they worsen. Although severe asthma and anaphylaxis can be life-threatening, learning to recognize and avoid allergy-provoking situations enables most people with allergies to lead normal lives.

Some children outgrow their allergies, meaning that the allergen no longer causes obvious symptoms. Children younger than three who are in danger of anaphylaxis from foods such as milk, eggs, wheat, or soybeans often outgrow their food allergies after several years. Children who develop food sensitivities after three years-of-age are less likely to outgrow them. Allergies to foods such as tree nuts, fish, and seafood are generally lifelong.

More than half of all asthmatic children outgrow the condition completely and another 10% improve to the point where they have only occasional asthma attacks as adults.

Prevention

Avoiding allergens is the first line of defense. By identifying allergens, most people can learn to avoid allergic reactions from food, drugs, and contact allergens such as **poison ivy** or latex. Many allergenic foods, such as peanuts, eggs, and milk, are used as ingredients in other foodstuffs. Since 2006 food manufacturers in the United States have been required to clearly state if a product contains any of the eight major food allergens that are responsible for more than 90% of allergic food reactions: milk, eggs, peanuts, tree nuts, fish, shellfish, wheat, and soy.

Airborne allergens are more difficult to avoid. Recommendations include:

- avoiding environmental irritants such as tobacco smoke, perfumes, household cleaning agents, paints, glues, air fresheners, and potpourri
- controlling dust mites with allergen-impermeable covers on mattresses and pillows, frequent washing of bedding in hot water, and removal of items that collect dust such as stuffed toys
- vacuuming often
- keeping windows and doors closed to prevent pollen from entering the home
- reducing growth of mold by lowering indoor humidity, repairing foundations to reduce indoor leakage and seepage, and installing exhaust systems to ventilate areas where steam is generated, such as the bathroom and kitchen
- reducing pet dander, avoiding pet allergens including those in saliva, body excretions, pelts, urine, and feces, and restricting pets to only specific areas of the home
- repairing poorly vented gas and wood-burning stoves and artificial fireplaces because nitrogen dioxide from these has been linked to poor asthma control

Infants appear to be most sensitive to allergens during the first six months of life. Some physicians believe babies are especially vulnerable to allergies because their immune systems are still developing. **Breastfeeding** is recommended to reduce the likelihood of allergic reactions, since infants are never allergic to their mother's milk. However traces of whatever the mother consumes pass into breast milk, so it is important to be alert to possible connections between a baby's allergic symptoms and foods, medication, or even **vitamins** ingested by the mother.

Rashes in infants under one year of age are likely caused by a food or drug allergy. Physicians often recommend that solid foods be introduced gradually if there is a family history of allergies. New foods can be introduced one at a time with 7–10 days in between. The later a food item is introduced into the diet, the less likely it is to cause an allergic reaction.

Babies and young children can have allergic reactions to ingredients in lotions, soaps, detergents, and baby wipes. Dye- and fragrance-free baby products can help prevent unnecessary exposure to potential allergens.

Toddlers are old enough to become anxious about allergy symptoms, which can trigger further allergic attacks and create a frustrating cycle. Parents should try to avoid conveying their own anxieties about allergy symptoms to the child.

During the preschool years, controlling a child's diet and environment becomes more difficult. Children may feel stigmatized or left out when provided with special foods and denied others. Children also may begin encountering potential allergens, including pet dander, at school and playmates' homes.

Parents of school-age children with allergies need to educate them about their condition and inform teachers and the school nurse of any restrictions and/or emergency procedures. Children are generally not allowed to carry medication, asthma inhalers, or EpiPens in school, so arrangements must be made for the school nurse or other supervising adult to administer emergency medication.

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Health care team roles

Diagnosis and effective management of allergy symptoms involves cooperation and collaboration between the patient and an interdisciplinary team of healthcare professionals. The primary-care physician or pediatrician, allergy and immunology specialists, nurses, laboratory technologists, respiratory therapists, and health educators are involved in helping patients and families learn to prevent and effectively manage symptoms. They teach patients how to distinguish mild allergy symptoms from those requiring immediate medical attention. Pharmacists and pharmacy assistants may offer additional instruction about medication use and the importance of adhering to prescribed treatment.

Resources

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"Tips to Remember: What is an Allergic Reaction?" *AAAAI*. http://www.aaaai.org/patients/publicedmat/tips/whatisallergicreaction.stm

ORGANIZATIONS

American Academy of Allergy, Asthma & Immunology (AAAAI), 555 East Wells Street, Milwaukee, WI, 53202-3823 (414) 272-6071, http://www.aaaai.org/.

Asthma and Allergy Foundation of America, 8201 Corporate Drive, Suite 1000, Landover, MD, 20785 (800) 7-ASTHMA, Info@aafa.org, http://www.aafp.org.

Centers for Disease Control and Prevention, 1600 Clifton Road, Atlanta, GA, 30333 (888) 232-6348 (301) 563-6595, cdcinfor@cdc.gov, http://www.cdc.gov.

National Institute of Allergy and Infectious Diseases (NIAID), Office of Communications and Public Liaison, 6610 Rockledge Drive, Bethesda, MD, 20892-66123 (8660 284-4107, http://www3.niaid.nih.gov.

U.S. Food and Drug Administration, 10903 New Hampshire Ave., Silver Spring, MD, 20993-0002 (888) INFO-FDA, http://www.fda.gov.

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Allergy tests

Definition

Allergy tests indicate a person's allergic sensitivity to commonly encountered environmental substances.

Demographics

Allergy tests are very common. Skin tests are the most common, and the most common method is the

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A close-up of a patient's arm after allergy testing. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

prick test. It is estimated that 60 million Americans, or more than one in every five people, suffer from some form of allergy, with similar proportions worldwide. Allergy is the single largest reason for school absence and is a major source of lost productivity in the workplace.

Description

In prick testing, a drop of each allergen to be tested is placed on the skin, usually on the forearm or the back. A typical battery of tests may involve two dozen allergen drops, including a drop of saline solution that should not provoke a reaction (negative control) and a drop of histamine that should provoke a reaction (positive control). A small needle is inserted through the drop, and used to prick the skin below. A new needle is used for each prick. The sites are examined over the next 20 minutes for evidence of swelling and redness, indicating a positive reaction. In some instances, a tracing of the set of reactions may be made by placing paper over the tested area. Similarly, in intradermal testing, separate injections are made for each allergen tested. Observations are made over the next 20 minutes.

In RAST testing, a blood sample is taken for use in the laboratory, where the antibody- containing serum is separated from the blood cells. The serum is then exposed to allergens bound to a solid medium. If a person has antibodies to a particular allergen, those antibodies will bind to the solid medium and remain behind after a rinse. Location of allergen-antibody combinations is done by adding antibody-reactive antibodies, so called anti-antibodies, that are chemically linked with a radioactive dye. By locating radioactive spots on the solid medium, the reactive allergens are discovered.

Provocation testing may be performed to identify airborne or food allergens. Inhalation testing is performed only after a patient's lung capacity and response to the medium used to dilute the allergen has been determined. Once this has been determined, the patient inhales increasingly concentrated samples of a particular allergen, followed each time by measurement of the exhalation capacity. Only one allergen is tested per day. Testing for **food allergies** is usually done by removing the suspect food from the diet for two weeks, followed by eating a single portion of the suspect food and follow-up monitoring.

Purpose

Allergy is a reaction of the immune system. Normally, the immune system responds to foreign microorganisms and particles, like pollen or dust, by producing specific proteins called antibodies that are capable of binding to identifying molecules, or antigens, on the foreign organisms. This reaction between antibody and antigen sets off a series of reactions designed to protect the body from infection. Sometimes, this same series of reactions is triggered by harmless, everyday substances. This is the condition known as allergy, and the offending substance is called an allergen. Common inhaled allergens include pollen, dust, and insect parts from tiny house mites. Common food allergens include nuts, fish, and milk.

Allergic reactions involve a special set of cells in the immune system known as mast cells. Mast cells serve as guards in the tissues where the body meets the outside world: the skin, the mucous membranes of the eyes and other areas, and the linings of the respiratory and digestive systems. Mast cells display a special type of antibody, called immunoglobulin type E (IgE), on their surface. Inside, mast cells store reactive chemicals in small packets, called granules. When the antibodies encounter allergens, they trigger the release of granules, which spill out their chemicals onto neighboring cells, including blood vessels and nerve cells. One of these chemicals, histamine, binds to the surfaces of these other cells, through special proteins called histamine receptors. Interaction of histamine with receptors on blood vessels causes neighboring cells to become leaky, leading to the fluid collection, swelling, and increased redness characteristic of a runny nose and red, irritated eyes. Histamine also stimulates **pain** receptors, causing the itchy, scratchy nose, eyes, and throat common in **allergic rhinitis**.

The particular allergens to which a person is sensitive can be determined through allergy testing.

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KEY TERMS

Allergen—A substance that provokes an allergic response.

Anaphylaxis—Increased sensitivity caused by previous exposure to an allergen that can result in blood vessel dilation (swelling) and smooth muscle contraction. Anaphylaxis can result in sharp blood pressure drops and difficulty breathing.

Antibody—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

Antigen—A foreign protein to which the body reacts by making antibodies.

Histamine—A chemical released by mast cells that activates pain receptors and causes cells to become leaky.

Mast cells—A type of immune system cell that is found in the lining of the nasal passages and eyelids, displays a type of antibody called immunoglobulin type E (IgE) on its cell surface, and participates in the allergic response by releasing histamine from intracellular granules.

Allergy tests may be performed on the skin or using blood serum in a test tube. During skin tests, potential allergens are placed on the skin and the reaction is observed. In radio-allergosorbent allergy testing (RAST), a patient's blood serum is combined with allergen in a test tube to determine if serum antibodies react with the allergen. Provocation testing involves direct exposure to a likely allergen, either through inhalation or ingestion. Positive reactions from any of these tests may be used to narrow the candidates for the actual allergen causing the allergy.

Identification of the allergenic substance may allow the patient to avoid the substance and reduce allergic reactions. In addition, allergy testing may be done in those with **asthma** that is difficult to manage, **eczema**, or skin **rashes** to determine if an allergy is causing the condition or making it worse. Allergy tests may also be done before allergen desensitization to ensure the safety of more extensive exposure.

Skin testing is the most common type of allergy test. There are two forms: percutaneous and intradermal. In percutaneous or prick testing, allergen solutions are placed on the skin, and the skin is then pricked with a needle, allowing the allergen to enter the skin and become exposed to mast cells. Scratch testing, in which the skin is scratched instead of punctured, is used less often. Intradermal testing involves directly injecting allergen solutions into the skin. In both tests, a reddened, swollen spot develops at the injection site for each substance to which the person is sensitive. Skin reactivity is seen for allergens regardless of whether they usually affect the skin. In other words, airborne and food allergens cause skin reactions equally well.

The range of allergens used for testing is chosen to reflect possible sources in the environment and may include the following:

- pollen from a variety of trees, common grasses, and weeds
- mold and fungus spores
- house dust
- house mites
- animal skin cells (dander) and saliva
- food extracts
- antibiotics
- insect venoms

Radio-allergosorbent testing (RAST) is a laboratory test performed when a person may be too sensitive to risk skin testing or when medications or skin conditions prevent it.

Provocation testing is done to positively identify suspected allergens after preliminary skin testing. A purified preparation of the allergen is inhaled or ingested in increasing concentrations to determine if it will provoke a response. In 2004, scientists introduced an optical method to continuously measure the changes in nasal mucosa (lining) changes with an infrared light to help improve the accuracy of provocation testing. Food testing is much more tedious than inhalation testing, since full passage through the digestive system may take a day or more.

Precautions

While allergy tests are quite safe for most people, the possibility of a condition known as **anaphylaxis** exists. Anaphylaxis is a potentially dangerous condition that can result in difficulty breathing and a sharp drop in blood pressure. People with a known history of anaphylaxis should inform the testing clinician. Skin tests should never include a substance known to cause anaphylaxis in the person being tested.

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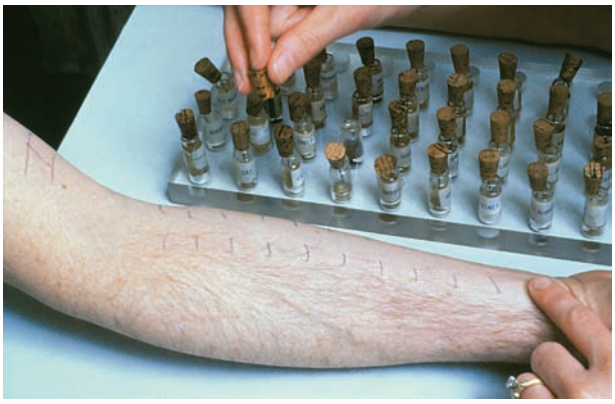

Patient is being exposed to certain allergens as part of an allergy test. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Provocation tests may cause an allergic reaction. Therefore, treatment medications should be available following the tests, to be administered, if needed.

Preparation

Skin testing is preceded by a brief examination of the skin. The patient should refrain from using anti-allergy drugs for at least 48 hours before testing. Prior to inhalation testing, patients with asthma who can tolerate it may be asked to stop any asthma medications. Testing for food **allergies** requires the person to avoid all suspect food for at least two weeks before testing.

Aftercare

Skin testing does not usually require any aftercare. A generalized redness and swelling may occur in the test area, but it will usually resolve within a day or two.

Inhalation tests may cause delayed asthma attacks, even if the antigen administered in the test initially produced no response. Severe initial reactions may justify close professional observation for at least 12 hours after testing.

Risks

Intradermal testing may inadvertently result in the injection of the allergen into the circulation, with an increased risk of adverse reactions. Inhalation tests may provoke an asthma attack. Exposure to new or unsuspected allergens in any test carries the risk of anaphylaxis. Because patients are monitored following allergy testing, an anaphylactic reaction is usually recognized and treated promptly. Occasionally, a delayed anaphylactic response can occur that will require immediate care. Proper patient education regarding how to recognize anaphylaxis is vital.

Normal results

Lack of redness or swelling on a skin test indicates no allergic response. In an inhalation test, the exhalation capacity should remain unchanged. In a food challenge, no symptoms should occur.

Abnormal results

Presence of redness or swelling, especially more than 5 mm (1/4 inch) in diameter, indicates an allergic response. This does not mean the substance actually causes the patient's symptoms, however, since he or she may have no regular exposure to the allergen. In fact, the actual allergen may not have been included in the test array.

Following allergen inhalation, reduction in exhalation capacity of more than 20%, and for at least 10–20 minutes, indicates a positive reaction to the allergen.

Gastrointestinal symptoms within 24 hours following the ingestion of a suspected food allergen indicates a positive response.

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Allogenic transplant *see* **Bone marrow transplantation**

Allopurino *see* **Gout drugs**

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Alopecia

Definition

Alopecia simply means hair loss (baldness).

Demographics

The most common type of alopecia is androgenetic alopecia, which is an inherited condition. This type of alopecia affects as many as 30-40% of men and women. Androgenetic alopecia is the most common cause of hair loss in adolescents and can begin much earlier than most people think, as early as age 12 in boys and girls. Hair loss accounts for approximately 3% of children's visits to dermatologists.

Description

Hair loss occurs for a great many reasons, from conditions that make people literally pull it out to complete hair loss caused by the toxicity of **cancer chemotherapy**. Some causes are considered natural, while others signal serious health problems. Some conditions are confined to the scalp. Others reflect disease throughout the body. Being plainly visible, the skin and its components can provide early signs of disease elsewhere in the body.

Top of balding male's head. *(Kelly A. Quin. Reproduced by permission.)*

Often, conditions affecting the skin of the scalp will result in hair loss. The first clue to the specific cause is the pattern of hair loss, whether it is complete baldness (alopecia totalis), patchy bald spots, thinning, or hair loss confined to certain areas. Another contributing factor is the condition of the hair and the scalp beneath it. Sometimes only the hair is affected; sometimes the skin is visibly diseased as well.

Causes and symptoms

Alopecia results from a number of causes ranging from hereditary to psychological.

- Male pattern baldness (androgenic alopecia) is considered normal in adult males. It is easily recognized by the distribution of hair loss over the top and front of the head and by the healthy condition of the scalp. Researchers in Taiwan in 2010 reported in the *British Journal of Dermatology* that men with androgenic alopecia are at increased risk for the development of metabolic syndrome (increased risk for the development of a spectrum of cardiovascular diseases and diabetes mellitus Type 2).
- Alopecia areata is a hair loss condition of unknown cause that can be patchy or extend to complete baldness.
- Fungal infections of the scalp usually cause patchy hair loss. The fungus, similar to the ones that cause athlete's foot and ringworm, often glows under ultraviolet light.
- Trichotillomania is the name of a mental disorder that causes a person to pull out his or her own hair.
- Complete hair loss is a common result of cancer chemotherapy, due to the toxicity of the drugs used. Cancer cells reproduce rapidly and so the drugs are designed to attack rapidly reproducing cells in the body. Hair cells also reproduce rapidly and end up being destroyed, causing hair loss.
- Systemic diseases often affect hair growth either selectively or by altering the skin of the scalp. One example is thyroid disorders. Hyperthyroidism (too much thyroid hormone) causes hair to become thin and fine. Hypothyroidism (too little thyroid hormone) thickens both hair and skin.
- Several autoimmune diseases (when protective cells begin to attack self cells within the body) affect the skin, notably lupus erythemematosus.
- Alopecia is becoming nearly epidemic among black women as a result of some hairstyles that pull too tightly on the scalp and the use of harsh chemical

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KEY TERMS

Autoimmune disease—Certain diseases caused by the body's development of an immune reaction to its own tissues.

Chemotherapy—The treatment of diseases, usually cancer, with drugs (chemicals).

Hair follicles—Tiny organs in the skin, each one of which grows a single hair.

Lupus erythematosus—An autoimmune disease that can damage skin, joints, kidneys, and other organs.

Systemic—Affecting all or most parts of the body.

treatments that damage the hair shaft and follicles, according to the American Academy of Dermatology.

Diagnosis

Dermatologists are skilled in diagnosis by sight alone. For more obscure diseases, a **skin biopsy** may be used to remove a specimen of the skin so that it can be examined under a microscope. Systemic diseases will require a complete evaluation by a physician, including specific tests to identify and characterize the problem.

Treatment

Successful treatment of underlying causes is most likely to restore hair growth, such as the completion of chemotherapy, effective cure of a scalp fungus, or control of a systemic disease.

Traditional

Over the past few decades a multitude of hair replacement methods have been performed by physicians and non-physicians. They range from simply weaving someone else's hair in with the remains of one's own to surgically transplanting thousands of hair follicles one at a time.

Hair transplantation is completed by taking tiny plugs of skin, each containing one to several hairs, from the back side of the scalp. The bald sections are then implanted with the plugs. Research has evaluated the technique of hair grafting, and found that micrografts (one or two hairs transplanted per follicle) resulted in fewer complications and the best results.

Another surgical procedure used to treat androgenic alopecia is scalp reduction. By stretching skin, the hairless scalp can be removed and the area of bald skin decreased by closing the space with hair-covered scalp. Hair-bearing skin can also be folded over an area of bald skin with a technique called a flap.

Stem cell research is generating new hope for baldness. Scientists know that a part of the hair follicle called the bulge contains stem cells that can give rise to new hair and help heal skin **wounds**. Research with mice and humans continues to show promise for identifying the genes that cause baldness and to identify drugs that can reverse the process.

Drugs

Two drugs—minoxidil (Rogaine) and **finasteride** (Proscar)—promote hair growth in a significant minority of patients, especially those with male pattern baldness and alopecia areata. Both drugs have proved to be safe when used for this purpose. **Minoxidil** is a liquid that is applied directly to the scalp and finasteride is the first and only approved treatment for hair loss available in a pill form. Only minoxidil is used in women.

Minoxidil was approved for over-the-counter sales in 1996. When used continuously for long periods of time, minoxidil produces satisfactory results in about one-fourth of patients with androgenic alopecia and as many as half the patients with alopecia areata. There is also an over-the-counter extra-strength version of minoxidil (5% concentration) approved for use by men only. The treatment often results in new hair that is thinner and lighter in color. It is important to note that new hair stops growing soon after the use of minoxidil is discontinued.

Women with androgenetic alopecia who do not respond to treatment with minoxidil may be prescribed the drug spironolactone, which blocks the action of the hormone aldosterone.

Results of a small study on 42 patients with alopecia areata reported in 2009 indicated that application of a 1% bexarotene gel applied daily to areas of alopecia areata for up to six months resulted in significant hair regrowth, even in areas of the scalp that had not been treated with the topical solution.

Researchers in 2010 reported in the *British Journal of Clinical Psychiatry* that the drug olanzapine was a safe and effective treatment for alopecia associated with the condition trichotillomania.

Prognosis

The prognosis of alopecia varies with the cause. It is generally much easier to lose hair than to regrow it. Even when it returns, it is often thin and less attractive than the original.

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ORGANIZATIONS

The American Hair Loss Council, 30 South Main, Shenandoah, PA, 17976, http://www.ahlc.org.

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Alpha-fetoprotein test

Definition

The alpha-fetoprotein (AFP) test is a blood test that is performed during **pregnancy**.

Purpose

This screening test measures the level of AFP in the mother's blood and indicates the probability that the fetus has one of several serious **birth defects**. The level of AFP can also be determined by analyzing a sample of amniotic fluid. This screening test cannot diagnose a specific condition; it only indicates increased risk for several birth defects. Outside pregnancy, the AFP test is used to detect **liver disease**, certain cancerous tumors, and to monitor the progress of **cancer** treatment.

Description

Alpha-fetoprotein is a substance produced by the liver of a fetus. The exact function of this protein is unknown. After birth, the infant's liver stops producing AFP, and an adult liver contains only trace amounts. During pregnancy, the fetus excretes AFP in urine and some of the protein crosses the fetal membranes to enter the mother's blood. The level of AFP can then be determined by analyzing a sample of the mother's blood. The AFP test is usually performed at weeks 13 to 16 of pregnancy. AFP levels peak in maternal blood at 16 to 18 weeks. Blood is drawn from the patient's (mother's) vein, usually on the inside of the elbow. AFP can also be measured in the sample of amniotic fluid taken at the time of **amniocentesis**. Test results are usually available after about one week.

By analyzing the amount of AFP found in a blood or amniotic fluid sample, doctors can determine the probability that the fetus is at risk for certain birth defects. It is very important that the doctor know precisely how old the fetus is when the test is performed since the AFP level changes over the length of the pregnancy. Alone, AFP screening cannot diagnose a birth defect. The test is used as an indicator of risk and then an appropriate line of testing (such as amniocentesis or ultrasound) follows, based on the results.

High AFP levels

Abnormally high AFP may indicate that the fetus has an increased risk of a neural tube defect, the most common and severe type of disorder associated with increased AFP. These types of defects include spinal column defects (**spina bifida**) and anencephaly (a severe and usually fatal brain abnormality). If the tube that becomes the brain and spinal cord does not close correctly during fetal development, AFP may leak through this abnormal opening and enter the amniotic fluid. This leakage creates abnormally high levels of AFP in amniotic fluid and in maternal blood. If the screening test indicates abnormally high AFP, ultrasound is used to diagnose the problem.

Other fetal conditions that can raise AFP levels above normal include:

- cysts at the end of the spine
- blockage in the esophagus or intestines
- liver disease causing liver cells to die
- defects in the abdominal wall
- kidney or urinary tract defects or disease
- brittle bone disease

Levels may also be high if there is too little fluid in the amniotic sac around the fetus, more than one developing fetus, or a pregnancy that is farther along than estimated.

Low AFP levels

For unknown reasons, abnormally low AFP may indicate that the fetus has an increased risk of **Down syndrome**. Down syndrome is a condition that includes **mental retardation** and a distinctive physical

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KEY TERMS

Amniotic fluid—Fluid within the uterine sac in which the fetus lives until born.

Fetus—The stage in human development from the second month of pregnancy until birth.

appearance linked to an abnormality of chromosome 21 (called trisomy 21). If the screening test indicates an abnormally low AFP, amniocentesis is used to diagnose the problem. Abnormally low levels of AFP can also occur when the fetus has died or when the mother is overweight.

Additional disorders

AFP is often part of a "triple check" blood test that analyzes three substances as risk indicators of possible birth defects: AFP, estriol, and human chorionic gonadotropin (HCG). When all three substances are measured in the mother's blood, the accuracy of the test results increases.

In 2004, a study showed that the risk of an infant's **death** from **sudden infant death syndrome** (SIDS) increased if levels of AFP were higher during the second trimester of the mother's pregnancy.

Although AFP in human blood gradually disappears after birth, it never disappears entirely. It may reappear in liver disease, or tumors of the liver, ovaries, or testicles. The AFP test is used to screen people at high risk for these conditions. After a cancerous tumor is removed, an AFP test can monitor the progress of treatment. Continued high AFP levels suggest the cancer is growing.

Preparation

There is no specific physical preparation for the AFP test.

Aftercare

There is no specific aftercare involved with this screening test.

Risks

The risks associated with drawing blood are minimal, but may include bleeding from the puncture site, feeling faint or lightheaded after the blood is drawn, or blood accumulating under the puncture site (hematoma).

Results

It is very important that the doctor know precisely how old the fetus is when the test is performed since the AFP level considered normal changes over the length of the pregnancy. Errors in determining the age of the fetus lead to errors when interpreting the test results. Since an AFP test is only a screening tool, more specific tests must follow to make an accurate diagnosis. An abnormal test result does not necessarily mean that the fetus has a birth defect. The test has a high rate of abnormal results (either high or low) to prevent missing a fetus that has a serious condition.

Alpha-fetoprotein is measured in nanograms per milliliter (ng/mL) and is expressed as a probability. The probability (1:100, for example) translates into the chance that the fetus has a defect (a one in 100 chance, for example).

When testing for cancer or liver diseases, AFP results are reported as nanograms per milliliter. An AFP level less than or equal to 15 ng/mL for men, nonpregnant women, and children is considered normal.

Abnormal results

The doctor will inform the woman of her specific increased risk as compared to the "normal" risk of a standard case. If the risk of Down syndrome is greater than the standard risk for women who are 35 years old or older (one in 270), amniocentesis is recommended. Again, the test has a high rate of showing an abnormal AFP level in order to prevent missing a fetus that has Down's syndrome. This screening test only predicts risk; appropriate diagnostic testing will follow after an abnormal screening result.

In tumor or liver disease testing, an AFP level greater than 15 ng/mL is considered abnormal. A difference of greater than 20% between two different measurements is considered to be medically significant.

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ORGANIZATIONS

March of Dimes, 1275 Mamaroneck Ave., White Plains, NY, 10605 (914) 997-4488, http://www.modimes.org.

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National Cancer Institute, NCI Office of Communications and Education, Public Inquiries Office, 6116 Executive Boulevard, Suite 300, Bethesda, MD, 20892-2580 (800) 422-6237, http://www.cancer.gov.

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Alpha-thalassemia *see* **Thalassemia**

Alpha$_1$-adrenergic blockers

Definition

Alpha$_1$-adrenergic blockers, called alpha blockers for short, are drugs that work by blocking the alpha$_1$-receptors in smooth muscle. When these receptor sites are blocked, **stress** hormones (catecholamines) cannot act on the smooth muscle cells. The result is relaxation (vasodilatation) and widening of the blood vessels. Blood pressure is lowered and blood flows more easily through the blood vessels.

Purpose

Alpha blockers are used for two main purposes. They treat high blood pressure (**hypertension**), and they treat benign (non-cancerous) prostatic hyperplasia (BPH), a condition that affects men and is characterized by an **enlarged prostate** gland that often causes reduced urine flow.

High blood pressure

High blood pressure puts a strain on the heart and the arteries. Over time, hypertension can damage blood vessels to the point of causing **stroke**, **heart failure**, or kidney (renal) failure. People with high blood pressure may also be at higher risk for **heart attack** (myocardial infarction). Controlling high blood pressure makes these problems less likely. Alpha blockers help lower blood pressure by causing vasodilatation, meaning that they increase the diameter of the blood vessels, which reduces the amount of work the heart must do to maintain adequate blood flow. Alpha$_1$-adrenergic blockers have also been shown to increase the amount of HDL ("good") cholesterol and reduce the level of LDL ("bad") cholesterol. They also increase the body's sensitivity to insulin and in this way may help to prevent type 2 diabetes.

Benign prostatic hyperplasia (BPH)

BPH primarily affects older men. Over time, the prostate, a donut-shaped gland below the bladder, enlarges. When this happens, it may restrict the flow of urine from the bladder out of the body. Men who are diagnosed with BPH may have to urinate more often, or they may feel that they can not completely empty their bladders. Alpha blockers inhibit the contraction of prostatic smooth muscle and thus relax the prostate and the bladder, allowing urine to flow more freely.

Other conditions

Alpha blockers also can be used to treat other problems resulting from reduced blood circulation. These include **Raynaud's disease**, a painful constriction of the blood vessels in the hands and feet, phlebitis, an inflammation of the veins that can lead to **blood clots**, diabetic **gangrene**, a condition in which tissue dies as the result of poor circulation to the legs and feet, **acrocyanosis**, a disorder of very small arteries in the hands and feet, and acute blockage of an artery.

Description

Alpha blockers are not the first choice treatment for controlling high blood pressure because of their significant side effects. **Diuretics** (water pills) and a low-salt diet are the preferred first treatment for hypertension. Commonly prescribed alpha blockers for hypertension and BPH include doxazosin (Cardura), prazosin (Minipress), terazosin (Hytrin), tamsulosin (Flomax) and alfuzosin (Uroxatral) and many others. Prazosin is also used in the treatment of heart failure. All are available only with a physician's prescription and are sold in tablet form.

Recommended dosage

The recommended dose depends on the patient and the type of alpha blocker and may change over the course of treatment. The prescribing physician will gradually increase the dosage, if necessary. Some patients may need as much as 15–20 mg per day of terazosin, 16 mg per day of doxazosin, or as much as 40 mg per day of prazosin, but most people benefit from lower dosages. As the dosage increases, so does the possibility of unwanted side effects.

Alpha blockers should be taken exactly as directed, even if the medication does not seem to be working at first. It should not be stopped even if symptoms improve. These drugs need to be taken regularly to be effective. Patients should avoid missing any doses, and should not take larger or more frequent doses to make up for missed doses.

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KEY TERMS

Adrenergic—Refers to neurons (nerve cells) that use catecholamines as neurotransmitters at a synapse.

Adrenergic receptor—There are three families of adrenergic receptors, alpha$_1$, alpha$_2$ and beta, and each family contains three distinct subtypes. Each of the nine subtypes are coded by separate genes, and display specific drug specificities and regulatory properties.

Alpha blockers—Medications that bind alpha adrenergic receptors and decrease the workload of the heart and lower blood pressure. They are commonly used to treat hypertension, peripheral vascular disease, and hyperplasia.

Arteries—Blood vessels that carry oxygenated blood away from the heart to the cells, tissues, and organs of the body.

Catecholamines—Family of neurotransmitters containing dopamine, norepinephrine and epinephrine, produced and secreted by cells of the adrenal medulla and the brain. Catecholamines have excitatory effects on smooth muscle cells of the vessels that supply blood to the skin and mucous membranes and have inhibitory effects on smooth muscle cells located in the wall of the gut, the bronchial tree of the lungs, and the vessels that supply blood to skeletal muscle. There are two different main types of receptors for these neurotransmitters, called alpha and beta adrenergic receptors. The catecholamines are therefore are also known as adrenergic neurotransmitters.

Hyperplasia—The abnormal increase in the number of normal cells in a given tissue.

Hypertension—Persistently high arterial blood pressure.

Neurotransmitter—Substance released from neurons of the peripheral nervous system that travels across the synaptic clefts (gaps) of other neurons to excite or inhibit the target cell.

Palpitation—Rapid, forceful, throbbing, or fluttering heartbeat.

Receptor—A molecular structure in a cell or on the surface of a cell that allows binding of a specific substance that causes a specific physiologic response.

Synapse—A connection between nerve cells, by which nervous excitation is transferred from one cell to the other.

Vasodilatation—The increase in the internal diameter of a blood vessel that results from relaxation of smooth muscle within the wall of the vessel thus causing an increase in blood flow.

Precautions

Alpha blockers may lower blood pressure to a greater extent than desired, especially in the elderly. This can cause **dizziness**, lightheadedness, heart **palpitations**, and **fainting**. Activities such as driving, using machinery, or doing anything else that might be dangerous should be avoided for at least 24 hours after taking the first dose. Patients should be especially careful when getting up in the middle of the night because of the increased risk of dizziness and falling. The same precautions are recommended if the dosage is increased or if the drug has been stopped and then started again. Anyone whose safety on the job could be affected by taking alpha blockers should inform his or her physician, so that the physician can take this factor into account when increasing dosage.

Some people may feel drowsy or less alert when using these drugs. They should accordingly avoid driving or performing activities that require full attention.

People diagnosed with **kidney disease** or **liver disease** may also be more sensitive to alpha blockers. They should inform their physicians about these conditions if alpha blockers are prescribed. Older people may also be more sensitive and may be more likely to have unwanted side effects, such as fainting, dizziness, and lightheadedness.

It should be noted that alpha blockers do not cure high blood pressure. They simply help to keep the condition under control. Similarly, these drugs will not shrink an enlarged prostate gland. Although they will help relieve the symptoms of prostate enlargement, the prostate may continue to grow, and it eventually may be necessary to have prostate surgery.

Alpha blockers may lower blood counts. Patients may need to have their blood checked regularly while taking this medicine.

Anyone who has had unusual reactions to alpha blockers in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

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The effects of taking alpha blockers during **pregnancy** are not fully known. Women who are pregnant or planning to become pregnant should inform their physicians. **Breastfeeding** mothers who need to take alpha blockers should also talk to their physicians. These drugs pass into breast milk and may affect nursing babies. It may be necessary to stop breastfeeding while being treated with alpha blockers. The safety of alpha blockers in children remains unproven.

Side effects

The most serious side effect of alpha blockers is an increased risk of heart attack when these drugs are taken for an extended period. The link between increased risk of heart attack and alpha blockers emerged from the 42,000-patient Antihypertensive and Lipid-Lowering Treatment to Prevent Heart Attack (ALLHAT) study. For this reason, these drugs are not usually prescribed until other treatments have failed to control symptoms.

Common side effects are dizziness, drowsiness, tiredness, **headache**, nervousness, irritability, stuffy or runny nose, **nausea**, **pain** in the arms and legs, and weakness. These problems usually appear after only a few days on the drug and gradually go away as the body adjusts to the drug. Most do not require medical treatment. If side effects do not subside or if they interfere with normal activities, the physician should be informed.

If any of the following side effects occur, the prescribing physician should be notified as soon as possible:

- fainting
- shortness of breath or difficulty breathing
- fast, pounding, or irregular heartbeat
- swollen feet, ankles, wrists

Other side effects may occur. Anyone who has unusual symptoms after taking alpha blockers should contact his or her physician. Patients who smoke, use alcohol, or **exercise** strenuously tend to have more severe side effects.

Interactions

At high doses, alpha blockers may interact with other antihypertensive (blood-pressure lowering) drugs to cause unsafe low blood pressure. Excessive low blood pressure may also occur in men taking alpha blockers and **impotence** drugs. They may also interact with drugs used to treat heart rhythm abnormalities (**arrhythmias**). People taking alpha blockers should also avoid taking over-the-counter drugs that make blood vessels constrict (narrow). Drugs that cause blood vessel constriction are often found in cold, **cough**, **asthma**, and allergy medications and in diet pills.

Other **drug interactions** are possible. Anyone taking alpha blockers should discuss with their physician and pharmacist all prescription, over-the-counter, and herbal remedies being taken to avoid unwanted side effects or dangerous interactions.

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ORGANIZATIONS

American College of Cardiology, Heart House, 2400 N Street, NW, Washington, DC, 20037 (202) 375-6000 (800) 253-4636 x8603 (202) 375-7000, resource @acc.org, http://www.acc.org.

American Heart Association, 7272 Greenville Avenue, Dallas, TX, 75231 (800) 242-8721, http://www.americanheart.org.

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Alport syndrome

Definition

Alport syndrome is a hereditary disease of the kidneys that primarily affects men, causing blood in the urine, **hearing loss**, and eye problems. Eventually, **kidney dialysis** or transplant may be necessary.

Demographics

Alport syndrome affects about one in 5,000 Americans, striking men more often and more severely than women. There are several varieties of the syndrome, some occurring in childhood and others not causing symptoms until men reach their 20s or 30s.

Description

All varieties of Alport syndrome are characterized by **kidney disease** that usually progresses to **chronic kidney failure** and by uremia (the presence of excessive amounts of urea and other waste products in the blood).

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KEY TERMS

Albumin—A protein that is important in maintaining blood volume.

Dialysis—A technique of removing waste material from the blood. It is used with patients whose kidneys have stopped functioning and can no longer cleanse the blood on their own.

Diuretic—A drug that increases the amount of urine a person produces.

Hematuria—Blood in the urine.

Pulmonary edema—Excess fluid in the air spaces of the lungs.

Uremia—The presence of excessive amounts of urea and other waste products in the blood.

Causes and symptoms

Alport syndrome, in most cases, is caused by a defect in one or more genes located on the X chromosome. It is usually inherited from the mother, who is a normal carrier. However, in up to 20% of cases there is no family history of the disorder. In these cases, there appears to be a spontaneous genetic mutation causing Alport syndrome.

Blood in the urine (hematuria) is a hallmark of Alport syndrome. Other symptoms that may appear in varying combinations include:

- protein in the urine (proteinuria)
- sensorineural hearing loss
- eye problems such as nystagmus (involuntary, rhythmic eye movements), cataracts, or cornea problems
- skin problems
- platelet disorders
- abnormal white blood cells
- smooth muscle tumors

Not all patients with Alport syndrome have hearing problems. In general, those with normal hearing have less severe cases of Alport syndrome.

Diagnosis

Alport syndrome is diagnosed with a medical evaluation and family history, together with a **kidney biopsy** that can detect changes in the kidney typical of the condition. **Urinalysis** may reveal blood or protein in the urine.

Tests

Blood tests are performed to evaluate platelet levels. Low platelet levels are another indication of Alport syndrome.

Tests for the Alport gene are now available. Although testing is fairly expensive, it is covered by many types of health insurance. DNA tests can diagnose affected children even before birth, and genetic linkage tests tracing all family members at risk for Alport syndrome are available.

Treatment

There is no specific treatment that can cure Alport syndrome. Instead, care is aimed at easing the problems related to kidney failure, such as the presence of too many waste products in the blood (uremia).

To control kidney inflammation (**nephritis**), patients should:

- restrict fluids
- control high blood pressure
- manage pulmonary edema
- control high blood levels of potassium

Rarely patients with Alport syndrome may develop **nephrotic syndrome**, a group of symptoms including too much protein in the urine, low albumin levels, and swelling. To ease these symptoms, patients should:

- drink less
- eat a salt-free diet
- use diuretics
- have albumin transfusions

The treatment for chronic kidney failure is dialysis or a kidney transplant.

Prognosis

Women with this condition can lead a normal life, although they may have slight hearing loss. An affected woman may notice blood in her urine only when under **stress** or pregnant.

Men generally have a much more serious problem with the disease. Most will experience kidney disease in their 20s or 30s, which may eventually require dialysis or transplantation, and many develop significant hearing loss. Men with Alport syndrome often die of complications by middle age.

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Prevention

Alport syndrome is a genetic disease and prevention efforts are aimed at providing affected individuals and their families with information concerning the genetic mechanisms responsible for the disease. Since it is possible to determine if a woman is a carrier, or if an unborn child has the condition, **genetic counseling** can provide helpful information and support for the decisions that affected individuals and their families may have to make.

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ORGANIZATIONS

American Association of Kidney Patients, 3505 E. Frontage Rd., Suite 315, Tampa, FL, 33607 (800) 749-2257 (813) 636-8122, info@aakp.org, http://www.aakp.org.

American Kidney Fund (AKF), Suite 1010, 6110 Executive Boulevard, Rockville, MD, 20852 (800) 638-8299, http://www.kidneyfund.org.

National Kidney and Urologic Disease Information Clearinghouse, 3 Information Way, Bethesda, MD, 20892 (301) 654-4415, http://www.niddk.nih.gov.

National Kidney Foundation, 30 East 33rd St., New York, NY, 10016 (800) 622-9010, http://www.kidney.org.

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923 (800) 999-6673, http://www.rarediseases.org.

Carol A. Turkington
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Alprazolam *see* **Benzodiazepines**

ALS *see* **Amyotrophic lateral sclerosis**

Alteplase *see* **Thrombolytic therapy**

Altitude sickness

Definition

Altitude sickness is a general term encompassing a spectrum of disorders that occur at higher altitudes. Since the severity of symptoms varies with altitude, it is important to understand the range of the different altitudes that may be involved. High altitude is defined as height greater than 8,000 feet (2,438 m); medium altitude is defined as height between 5,000 and 8,000 feet (1,524–2,438 m); and extreme altitude is defined as height greater than 19,000 feet (5,791 m). The majority of healthy individuals suffer from altitude sickness when they reach very high altitudes. In addition, about 20% of people ascending above 9,000 feet (2,743 m) in one day will develop altitude sickness. Children under six years and women in the premenstrual part of their cycles may be more vulnerable. Individuals with preexisting medical conditions—even a minor respiratory infection—may become sick at more moderate altitudes.

Description

There are three major clinical syndromes that fall under the heading of altitude sickness: acute mountain sickness (AMS), high-altitude **pulmonary edema** (HAPE), and high-altitude cerebral **edema** (HACE). These syndromes are not separate, individual syndromes as much as they are a continuum of severity, all resulting from a decrease in oxygen in the air. AMS is the mildest, and the other two represent severe, life-threatening forms of altitude sickness.

Altitude sickness occurs because the partial pressure of oxygen decreases with altitude. (Partial pressure is a term applied to gases that is similar to the way the term concentration is applied to liquid solutions.) For instance, at 18,000 feet (5,486 m) the partial pressure of oxygen drops to one-half its value at sea level and, therefore, there is a substantially lower amount of oxygen available for the individual to inhale. This is known as hypoxia. Furthermore, since there is less oxygen to inhale, less oxygen reaches the blood. This is known as hypoxemia. These two conditions are the major factors that form the basis for all the medical problems associated with altitude sickness.

As a person becomes hypoxemic, his natural response is to breathe more rapidly (hyperventilate). This is the body's attempt to bring in more oxygen at a rapid rate. This attempt at alleviating the effects of the hypoxia at higher altitudes is known as acclimatization, and it occurs during the first few days. Acclimatization is a response that occurs in individuals who travel from lower to higher altitudes. There are groups of people who have lived at high altitudes (for example, in the Himalayan and Andes mountains) for generations, and they are simply accustomed to living at such altitudes, perhaps through a genetic ability.

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KEY TERMS

Cerebral—Pertaining to the brain.

Edema—Accumulation of excess fluid in the tissues of the body.

Hypoxemia—Insufficient oxygenation of the blood.

Hypoxia—A deficiency in the amount of oxygen required for effective ventilation.

Pulmonary—Pertaining to the lungs.

Causes and symptoms

Acute mountain sickness (AMS) is a mild form of altitude sickness that results from ascent to altitudes higher greater than 8,000 feet (2,438 m)—even 6,500 feet (1,981 m) in some susceptible individuals. Although hypoxia is associated with the development of AMS, the exact mechanism by which this condition develops has yet to be confirmed. It is important to realize that some individuals acclimatize to higher altitudes more efficiently than others. As a result, under similar conditions some will suffer from AMS while others will not. At present, the susceptibility of otherwise healthy individuals to contracting AMS cannot be accurately predicted. Of those who do suffer from AMS, the condition tends to be most severe on the second or third day after reaching the high altitude, and it usually abates after three to five days if they remain at the same altitude. However, it can recur if the individuals travel to an even higher altitude. Symptoms usually appear a few hours to a few days following ascent, and they include **dizziness**, **headache**, **shortness of breath**, **nausea**, **vomiting**, loss of appetite, and **insomnia**.

High-altitude pulmonary edema (HAPE) is a life-threatening condition that afflicts a small percentage of those who suffer from AMS. In this condition, fluid leaks from within the pulmonary blood vessels into the lung tissue. As this fluid begins to accumulate within the lung tissue (pulmonary edema), the individual begins to become more and more short of breath. HAPE is known to afflict all types of individuals, regardless of their level of physical fitness.

Typically, the individual who suffers from HAPE ascends quickly to a high altitude and almost immediately develops shortness of breath, a rapid heart rate, a **cough** productive of a large amount of sometimes bloody sputum, and a rapid rate of breathing. If no medical assistance is provided by this point, the patient goes into a **coma** and dies within a few hours.

High-altitude cerebral edema (HACE), the rarest and most severe form of altitude sickness, involves cerebral edema, and its mechanism of development is also poorly understood. The symptoms often begin with those of AMS, but neurologic symptoms such as an altered level of consciousness, speech abnormalities, severe headache, loss of coordination, **hallucinations**, and even seizures. If no intervention is implemented, **death** is the result.

Diagnosis

The diagnosis for altitude sickness may be made from the observation of the individual's symptoms during travel to higher altitudes.

Treatment

Mild AMS requires no treatment other than an **aspirin** or ibuprofen for headache, and avoidance of further ascent. **Narcotics** should be avoided because they may blunt the respiratory response, making it even more difficult for the person to breathe deeply and rapidly enough to compensate for the lower levels of oxygen in the environment. Oxygen may also be used to alleviate symptoms of mild AMS.

As for HAPE and HACE, the most important course of action is descent to a lower altitude as soon as possible. Even a 1,000–2,000 foot (305–610 m) descent can dramatically improve one's symptoms. If descent is not possible, **oxygen therapy** should be started. In addition, dexamethasone (a steroid) has been suggested in order to reduce cerebral edema.

Prognosis

The prognosis for mild AMS is good, if appropriate measures are taken. As for HAPE and HACE, the prognosis depends upon the rapidity and distance of descent and the availability of medical intervention. Descent often leads to improvement of symptoms, however, recovery times vary among individuals.

Prevention

When individuals ascend from sea level, it is recommended that they spend at least one night at an intermediate altitude prior to ascending to higher elevations. In general, climbers should take at least two days to go from sea level to 8,000 feet (2,438m). After reaching that point, healthy climbers should generally allow one day for each additional 2,000 feet (610m), and one day of rest should be taken every two or three days. Should mild symptoms begin to surface, further ascent should be avoided. If the symptoms are severe,

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the individual should return to a lower altitude. Some reports indicate that acetazolamide (a diuretic) may be taken before ascent as a preventative measure for AMS.

Paying attention to diet can also help prevent altitude sickness. Water loss is a problem at higher altitudes, so climbers should drink ample water (enough to produce copious amounts of relatively light-colored or clear urine). Alcohol and large amounts of salt should be avoided. Eating frequent small, high-carbohydrate snacks (for example, fruits, jams and starchy foods) can help, especially in the first few days of climbing.

Resources

BOOKS

West, John B., Robert B. Schoene, and James S. Milledge. *High Altitude Medicine and Physiology*. 4th ed. Oxford, UK: Hodder Arnold, 2007.

Kapil Gupta MD

Aluminum hydroxide *see* **Antacids**

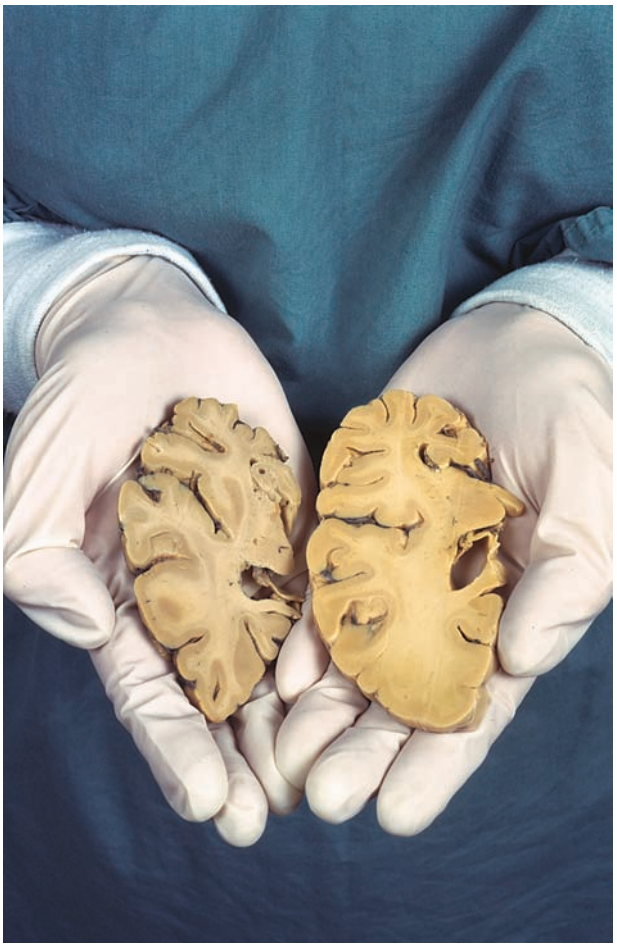
Alzheimer's disease

Definition

Alzheimer's disease (AD) is the most common form of **dementia** in those aged 65 and older. It is an irreversible and incurable progressive neurological disease caused by the degeneration and eventual **death** of a large number of neurons (nerve cells) in several areas of the brain, accompanied by diminished brain size. AD usually occurs in old age and begins with short-term **memory loss**. This is followed by the slow progressive loss of memory and cognitive and intellectual functions, leading to the deterioration of physical functioning and incapacitation.

Demographics

Alzheimer's disease is the most common degenerative brain disorder. It accounts for 50–70% of all cases of dementia in the United States and for about 75% of all dementias in people over age 65. An estimated 5.1 million Americans have AD. The exact number is difficult to determine since AD is often misdiagnosed or not diagnosed until the disease is in its later stages. About 350,000 new cases of Alzheimer's disease are diagnosed each year in the United States and approximately 65,800 people die from AD each year. It is the fourth leading cause of death in American adults after heart disease, **cancer**, and **stroke**.



A brain segment affected by Alzheimer's disease on the right compared with a healthy brain segment (left). The diseased brain appears shrunken, and the fissures are noticeably larger. *(Simon Fraser/MRC Unit, Newcastle General Hospital/ Science Photo Library/Photo Researchers, Inc.)*

Alzheimer's rarely occurs before the age of 60. Early-onset AD, affecting people in their 30s, 40s, and 50s, accounts for only about 5% of total cases. About 3–5% of men and women aged 65–74 have AD. About 19–20% of those between 75 and 84 and nearly half of those over 85 have the disease. Slightly more women than men develop AD, but this may be because women tend to live longer. About half of all nursing home patients in the United States have AD.

Alzheimer's disease appears to be more prevalent among African Americans, with estimates ranging from 14% to almost 100% higher than among Caucasian Americans. One study reported that the onset of AD in Hispanics occurs at an age that is, on average, five years younger than its onset in Caucasians.

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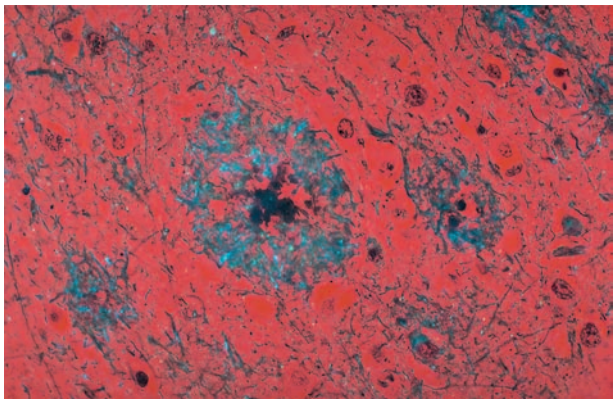

Diseased tissue from the brain of an Alzheimer's patient showing senile plaques within the brain's gray matter. *(Cecil Fox/Photo Researchers, Inc.)*

The incidence of Alzheimer's in other developed countries is about the same as in the United States. In countries such as Japan that have a rapidly **aging** population with a higher percentage of people over 65, the incidence of AD is even higher than in the United States. In developing countries the percentage of the population with AD is lower because fewer people live to age 65. However more than 50% of people with AD live in developing countries and by 2025 this is expected to be above 70%.

The number of people afflicted with Alzheimer's is expected to more than triple by 2050, as the population ages and more people live longer. The number may be even higher than predicted, since recent research suggests that mild cognitive impairment observed in many elderly people may be early-stage Alzheimer's disease.

Description

In 1906 Alois Alzheimer (1864–1915), a German psychiatrist and neuroanatomist, was studying slides prepared from the brain of a 51-year-old woman, known as Frau D., who had died after suffering from dementia for several years. Her symptoms did not fit those of any brain disorder known at the time. Alzheimer found abnormal clumps of material—now called beta-amyloid plaques—and tangled bundles of fibers—neurofibrillary tangles—in Frau D.'s brain tissue. These plaques and tangles, found upon brain **autopsy**, constitute the diagnostic signature of Alzheimer's disease. The plaques, sometimes called senile plaques, are sticky clumps or clusters of dead and dying neurons and other cellular debris surrounding insoluble deposits of beta-amyloid. The latter are fragments of a larger protein called amyloid precursor protein (APP) that was not processed properly. These plaques are located in between neurons. They are believed to interfere with normal communication between neurons, eventually causing the nerve cells to die. The tangles are accumulations of twisted fragments of tau proteins inside neurons. Tau proteins normally bind and stabilize neurons. When tau proteins are damaged by the addition of phosphorus, a process called hyperphosphorylation, they form filaments that twist around each other to form neurofibrillary tangles that can no longer stabilize the neurons. Increased beta-amyloid may cause the formation of neurofibrillary tangles. However it is not known whether the plaques and tangles cause AD or are the result of it. Plaques and tangles occur as part of the normal aging process, but are far less prevalent in normal brains than in the brains of AD patients. Because dementia had been associated with the elderly and Frau D. had been middle-aged, her disease was named presenile dementia and was thought to be a very rare disorder. It was not until the early 1950s that researchers at St. Elizabeth's Hospital in Washington, D.C. came to realize that Alzheimer's disease is the single most common cause of dementia.

Scientists have since found other changes in the brains of AD patients. Connections between nerve cells are disrupted and nerve cells die in areas of the brain that are vital for memory and learning, including the hippocampus, which is a structure deep in the brain that controls short-term memory. Later, AD affects the cerebral cortex, particularly the areas responsible for language and reasoning. Eventually many areas of the brain become involved and atrophied (shrunken and dysfunctional).

The levels of the brain neurotransmitters serotonin, norepinephrine, and acetylcholine are also lower in AD. These chemicals transmit signals across the synapses or gaps between nerve cells. Many of the behavioral and psychiatric problems associated with AD are thought to result from low levels of these neurotransmitters. Acetylcholine and norepinephrine are important for many processes in the body including digestion, blood vessel dilation and constriction, and regulation of heartbeat.

Public awareness of AD increased significantly when Ronald Reagan (1911–2004), the 40th president of the United States (1981–1989), was diagnosed with the disease in 1994. He died from complications of AD at the age of 93. Because of the growing numbers of people who are affected by AD, their increasing life expectancy, and the direct and indirect costs of their care, Alzheimer's disease is now considered to be a major public health concern.

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Alzheimer's disease places severe emotional and financial burdens on patients and their families. In 2007 the annual cost of caring for a patient with AD was estimated at $18,400 for mild or early-stage conditions and at $36,100 for a patient with severe AD. The total annual cost of caring for AD patients in the United States was estimated to be at least $100 billion, including both direct patient costs and indirect costs, such as time lost from work by caregivers. On average, Medicare pays more than three times as much for the healthcare of a beneficiary with AD compared to a beneficiary without AD.

Risk factors

The most significant risk factor for Alzheimer's disease is advancing age. The risk of developing AD begins to rise after age 65 and rises sharply after age 75. There are various other possible risk factors:

- About 25% of AD cases are considered to be familial (FAD), defined as having symptoms of Alzheimer's disease in at least three generations of a single family. About 2–5% of all AD cases are familial early-onset FAD of one of three types (AD1, AD3, and AD4), in which the disease develops before the age of 60, usually between the ages of 40 and 50, but sometimes as early as age 30. First-degree relatives of AD patients may have as much as a 20% lifetime risk of being affected by the disease. The risk to immediate relatives increases as more family members develop the disease. The remaining 75% of cases are sporadic Alzheimer's disease (SAD) with no clear family history.
- African American and Caribbean Hispanics who have mutations in a particular gene are at a higher than normal risk for AD, particularly if they have a family history of the disease.
- A family history of Parkinson's disease is a risk factor for AD.
- There is some evidence that neuronal damage from small strokes may be linked to AD.
- Studies have found a clear correlation between low educational and occupational attainment (employment in jobs that are not mentally challenging) and an increased risk for AD. Taking on less challenging rather than more challenging jobs as one grows older is also associated with a higher risk for AD.
- Studies on special breeds of genetically engineered (transgenic) mice have suggested high blood cholesterol levels may increase the rate of plaque deposition.
- Researchers suspect that a high-cholesterol, high-fat diet may increase the risk of AD. However, studies have not found cholesterol-lowering drugs to have any affect on AD onset.
- High systolic blood pressure combined with high blood cholesterol levels increases the risk of AD by three-four fold.
- Obesity is a risk factor for AD.
- Mild cognitive impairment (MCI), which is characterized primarily by memory loss while other cognitive functions remain intact, increases the risk of AD. About 12% of people with MCI develop Alzheimer's disease each year. About 40% of people diagnosed with MCI have clear symptoms of AD after four years.
- High levels of an amino acid called homocysteine may be a risk factor for late-onset AD.
- Symptoms of AD may develop faster in people who have had a head trauma or hypothyroidism.
- Down syndrome patients over the age of 40 all develop the brain cell changes that are characteristic of Alzheimer's disease. Down syndrome-associated AD accounts for less than 1% of Alzheimer's cases.

Various environmental factors have been suspected of contributing to the development of AD. However, epidemiological studies have not borne out any links between AD and factors such as pollutants in drinking water, aluminum from commercial products, and metal **dental fillings**. Although higher-than-average levels of aluminum have been found in the brains of patients with AD, it now appears that this a result rather than a cause of the disease.

Causes and symptoms

In most cases the cause of AD is unknown. It is most likely caused by a combination of genetic and environmental factors. Viral, immunological, and/or biochemical etiologies have also been proposed. Genetics almost certainly plays a role, even in sporadic AD. Brain inflammation and restriction of blood flow to the brain may play a role in the development of beta-amyloid plaques and neurofibrillary tangles. Highly reactive molecules called free radicals damage all types of cells through oxidative processes, especially brain cells, which have lower levels of protective **antioxidants**.

AD symptoms can be grouped into three categories: cognitive deficits or losses in brain function related to memory and learning; behavioral and psychiatric symptoms of dementia or BPSD; difficulties with activities of daily life or ADL. For most of the twentieth century studies of AD patients focused on cognitive symptoms. It was not until the 1980s and

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1990s that researchers began to examine behavioral and psychiatric symptoms more closely.

There are four major cognitive deficits associated with AD:

- Amnesia or memory impairment, including a loss of the sense of time.
- Aphasia or loss of language. Patients may not remember the names of objects and use words like "thing" or "it" instead. They may echo what other people say or repeat a word or phrase over and over. Sometimes patients lose all language except curses.
- Apraxia—the inability to perform voluntary movements. Patients with apraxia may have trouble putting on a hospital gown or brushing their teeth.
- Agnosia—the inability to recognize familiar people and places. *Agnosia* comes from the Greek word meaning "to not know." Patients with agnosia may even fail to recognize their own face in a mirror.

Symptoms associated with BPSD (behavioral and psychiatric symptoms of dementia) include:

- Depression. Depression in AD is believed to result, at least in part, from lowered production of serotonin.
- Delusions, or a false belief that is maintained even in the presence of evidence to the contrary. For example, AD patients may believe that someone is stealing from them when they cannot remember where they put something.
- Wandering. This behavior may result from becoming disoriented or lost, but sometimes AD patients wander for no apparent reason.
- Hallucinations, or sensory experiences that seem real. Although hallucinations can affect any of the senses, most are visual or auditory. For example, AD patients may say that they see Martians in the corner of the room or hear the voices of their long-dead parents. Like delusions, hallucinations are believed to be related to the deterioration of brain tissue. However sometimes they are caused by medications.
- Aggression—hitting, shoving, pushing, or threatening behavior.
- Agitation. Emotionally excited behavior (screaming, shouting, cursing, pacing, fidgeting, etc.) that is disruptive or unsafe may result from brain tissue damage or be a symptom of depression. It is thought that the emotional overreactions of AD patients are related to destruction of neurons in the amygdala of the brain.

ADL (activities of daily life) or personal-care symptoms include difficulties with:

- eating, including simple cooking and washing dishes
- shopping for groceries and other necessities
- bathing, showering, or shaving
- grooming and dressing in clothing appropriate for the weather and activity
- toileting
- other aspects of personal hygiene such as teeth brushing, denture cleaning, or washing hair

Although the rate of AD progression and specific symptoms vary with the individual, the general course of the progression is fairly consistent. Early-onset AD often progresses faster than the more common late-onset type. AD is generally considered to have seven stages:

- Stage 1: no decline in function yet noted. This includes individuals who may carry predictive gene mutations but have no symptoms and those who will develop AD by other mechanisms.
- Stage 2: generally normal functioning. The individual is aware of a subtle cognitive decline.
- Stage 3: early Alzheimer's disease. Patients have difficulty performing complex tasks that require cognitive skills.
- Stage 4: mild Alzheimer's disease. Patients require assistance with tasks such as paying bills or balancing a checkbook.
- Stage 5: moderate Alzheimer's disease. Patients require assistance in making everyday personal decisions such as choosing appropriate clothing or ordering from a restaurant menu.
- Stage 6: moderately severe Alzheimer's disease. Patients require assistance dressing, bathing, and using the toilet and may have urinary and/or bowel incontinence.
- Stage 7: severe Alzheimer's disease. Vocabulary shrinks to a few words, followed by little or no verbal communication. The ability to walk is lost, followed by an inability to maintain a sitting posture in a chair. Eventually the patient experiences a profound lack of purposeful muscle control, is totally dependent for care, and cannot smile or hold up his or her head.

AD usually starts slowly with a very gradual decline that is termed "insidious." Some people are unaware of any impairment, blaming their forgetfulness on old age or "senior moments." Often the earliest symptoms are recognized only in hindsight by a friend or family member. Furthermore, since the present generation at risk for AD is the first in history to understand the implications of the disease, there are very powerful emotional reasons for attributing early signs of AD to normal aging, job **stress**, adjusting to retirement, and other less troubling factors.

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However the insidious nature of AD onset is a characteristic that helps physicians to distinguish it from other causes of dementia, including vascular dementia.

Key warning signs of early-stage AD include:

- repeatedly asking the same question
- repeatedly telling the same story, word for word
- memory loss that affects job performance
- loss of initiative
- inability to pay bills or balance a checkbook
- misplacing commonly used personal or household objects
- difficulty performing familiar tasks such as cooking, making repairs, or playing games like cards or checkers
- poor or decreased judgment
- problems with abstract thinking
- getting lost in familiar surroundings
- relying on others to make decisions or answer questions
- disorientation of time and place
- problems with language
- mood or behavior changes
- personality changes
- neglecting personal hygiene—not bathing or changing clothes regularly

The first symptoms of early-stage AD usually include forgetfulness, short-term memory loss, temporary episodes of spatial disorientation, groping for words, minor problems with arithmetic, and small errors in judgment, often accompanied by some **anxiety**, agitation, mild depression, and withdrawal. The patient may light the stove under a saucepan while forgetting to add the food or water, but most ADL are unaffected. Some patients can continue to operate a motor vehicle safely, although many people with early-stage AD voluntarily give up driving.

Everyone has occasional memory lapses that do not signify any change in cognitive function. Early-stage AD may begin with routine memory lapses—forgetting where one left the car keys—but progresses to more profound or disturbing lapses, such as forgetting that one has a car. Some AD patients are unaware that their memory is failing. Other patients are keenly aware of their memory loss and may become anxious and frustrated. Becoming lost or disoriented on a walk around the neighborhood becomes more likely as the disease progresses. Individuals with AD may forget the names of family members or forget what was said at the beginning of a sentence by the time they hear the end. Although the progression of memory loss varies, it eventually begins to interfere with daily activities.

Middle-stage Alzheimer's typically begins two to three years after the initial onset. Patients begin to lose awareness of their cognitive deficits. Memory loss, especially of recent events, becomes more severe and is accompanied by moderate spatial and temporal disorientation, loss of ability to concentrate, **aphasia**, and increased anxiety. Severe language problems develop. Patients cannot understand or remember the names of things. Their speech may not flow smoothly. Because of individual variation in disease progression, some patients may still be able to carry out routine behaviors and engage in generalized conversation. However they can no longer drive a car, cook a meal, or read a newspaper. They are unable to work, plan and execute familiar tasks, and reason and exercise judgment. They may get lost easily and find simple things confusing. The loss of cognitive functioning becomes impossible to ignore. Mood and personality are affected. Some people become angry or violent. Behavioral and psychiatric symptoms include agitation, wandering, temper tantrums, depression, and disorientation. Patients begin to lose their basic sense of personal identity. They may be at high risk for falls and other accidents. A small number of AD patients have vision problems. Although they frequently deny that they cannot see, autopsies confirm destruction in areas of the brain that process visual images.

Eventually spatial and temporal disorientation becomes profound and may be accompanied by **delusions**, **hallucinations**, and **paranoia**. Patients may not recognize a family member or may accuse a spouse of infidelity. They may become uninhibited and confrontational. Some patients exhibit inappropriate sexual behaviors. AD patients may have trouble sleeping and suffer from nighttime confusion or agitation called sunsetting or sundowner's syndrome. Some patients repeat words, thoughts, or movements, a behavior known as perseveration. Eventually they are unable to feed, bathe, dress, or groom themselves and cannot be left unattended.

In end-stage Alzheimer's disease patients undergo general physical decline and lose control of many physical functions. Seizures and hypertonicity (increased muscle movements) are common. Bladder and bowel control is lost and stiffening muscles prevent walking. Patients who can walk often wander aimlessly and must be monitored for night wandering due to altered sleep patterns. Although some patients may use a wheelchair temporarily, eventually they become completely bedridden, unable even to sit up. Many patients are unable to talk. Abnormal jerking

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movements may occur for no reason or in response to touch or noises. Reflexes may be exaggerated and some patients experience whole body contractions known as generalized seizures.

Once the disease affects the brain stem, the basic processes of digestion, respiration, and excretion shut down. Patients may be unable to eat or swallow and they sleep most of the time. Their hands and feet feel cold, breathing becomes shallow, and the patient is generally unresponsive. Death often results from infection, **pneumonia**, or **malnutrition**. Otherwise breathing simply stops. From the onset of initial symptoms, disease progression can last up to 25 years, although the typical duration is eight to 10 years.

Genetic profile

Familial early-onset Alzheimer's disease accounts for fewer than 10% of AD cases. It can be caused by mutations in one of three genes. It is usually an autosomal dominant trait. Autosomal means that it affects males and females with equal frequency. Dominant means that it will affect individuals even if they inherited one copy of the mutated gene from one parent and a normal copy of the gene from the other parent. Individuals who have two copies of the mutant gene will pass on the gene to all of their children. If each parent has one copy of the mutant gene, there is a 75% that any of their children will inherit the gene. If only one parent has one copy of the gene, each of their children has a 50% of inheriting the gene.

Identification of these three genes has led to the subdivision of familial early-onset AD into three categories:

- AD1 is a genetic defect in the amyloid precursor protein (APP) gene located on chromosome 21. Mutations in the APP gene are associated with AD onset between the ages of 55 and 60.
- AD3 is a genetic defect in the presenilin 1 (PSEN1) gene located on chromosome 14. Presenilin 1 may be one of the enzymes that clips APP into beta-amyloid. It also may be important for the functioning of synaptic connections between neurons.
- AD4 is an extremely rare genetic defect in the presenilin 2 (PSEN2) gene located on chromosome 1. Presenilin 2 is also involved in processing APP. Mutations in PSEN1 and PSEN2 are associated with AD onset between the ages of 30 and 50. These three mutations result in the production of abnormal proteins and increased amounts of beta-amyloid. Together they account for approximately 50% of early-onset FAD.

AD2 is familial late-onset Alzheimer's disease, accounting for 15–25% of all AD cases. An association has also been found between AD2 and mutations in the gene encoding apolipoprotein E (APOE), located on chromosome 19. Apolipoprotein E is a major part of a lipoprotein that removes excess cholesterol from the blood. There are at least three forms or alleles of the APOE gene: e2, e3, and e4. Since each person inherits one APOE gene from each parent, it is possible to have two copies of one form of the APOE gene or two different forms of the gene. APOE e3 is the most common allele in the general population and does not appear to affect the development of AD. The relatively rare APOE e2 allele may be associated with a lower risk for AD or a later age of onset. Individuals with one copy of the e4 gene are three times more likely to develop late-onset AD than those without it. Those with two copies of APOE e4 gene are almost four times more likely to develop AD. APOE e4 can also lower the age of onset by as much as 17 years. Although APOE e4 increases the risk of developing AD, it does not cause the disease. Not everyone with e4 develops AD. However about 65% of all people with AD have at least one copy of e4. There are various theories as to why APOE e4 increases the risk of developing AD: it may facilitate beta-amyloid buildup in plaques, thereby lowering the age of AD onset, or it may interact with cholesterol levels and have effects on neuronal death that are independent of its effects on plaque buildup.

Sporadic AD is referred to as a polygenic disorder because it is believed to result from the effects of multiple genes combined with environmental factors. This view is supported by research involving identical twins. Only one-third of identical twins of those with AD develop AD themselves. This suggests that factors other than genetic predisposition affect the development of SAD.

AD researchers are also interested in the SORL1 gene, which encodes a protein that is involved regulating the transport of APP and lipoproteins in cells and may play a role in late-onset AD.

Down syndrome-associated Alzheimer's is another genetically determined form of AD. Normal individuals have two copies of each of the 22 human chromosomes, one copy from each parent. People with **Down syndrome**, also called trisomy 21, have three copies of chromosome 21, which results in brain changes that are similar to those that occur in both familial and sporadic AD. This is thought to be due to the overproduction of APP from the extra chromosome 21 APP gene.

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Diagnosis

An early and accurate diagnosis of AD is important for developing strategies for managing symptoms and helping patients and their families plan for treatment, long-term care, and financial concerns while the patient can still be involved in decision making. A diagnosis of AD also may help family members to avoid unnecessary anger and feelings of **impotence** when dealing with the progression of the disease.

A diagnosis of AD is based upon the finding of slowly progressive dementia, exclusion of other possible causes for dementia, and brain-imaging studies that show changes in the structure of the brain, usually in the form of shrinkage. Possible AD is diagnosed when AD is considered to be the primary cause of the symptoms, but the diagnosis is complicated by the presence of another disorder. Probable AD is diagnosed when physicians and psychiatrists have ruled out all other disorders that could produce similar symptoms.

Examination

Diagnosis of Alzheimer's disease can be quite complex and require consultations with various specialists. It requires a complete **physical examination** and medical and family history, including family members who have had AD and their ages of onset. The results of neurological exams are generally normal in early-stage AD. A complete evaluation of alcohol use and prescription and over-the-counter medication history, including alternative remedies, **vitamins**, herbal supplements, or illicit drugs, is necessary to rule out other causes of dementia, because more than 150 drugs can cause AD-like symptoms. Diagnosis is based upon clinical findings of otherwise unexplained slowly progressing dementia. FAD is diagnosed if there is a family history of the disease. Although AD virtually always develops in Down syndrome patients over age 40, it may be difficult to determine whether further impairment is due to the Down syndrome or the progression of AD.

Other types of dementia, including some that are reversible, can cause symptoms similar to those of AD. Approximately 20% of patients originally suspected of having AD turn out to have some other disorder, about half of which are treatable:

- Multi-infarct vascular dementia is caused by strokes (blood clots in the brain) that lead to stepwise destruction of mental capacities.
- Diffuse white matter disease is a form of vascular dementia that can be diagnosed by magnetic resonance imaging (MRI) that reveals the generalized death of large parts of the brain.
- Parkinson's disease is a neurodegenerative condition that causes movement and functional abnormalities. Most Parkinson's patients have tremors and rigidity in their arms and legs.
- Alcohol-associated dementia is caused by nutritional deficiencies in alcoholics, especially malnutrition and deficiencies in vitamins B1 (thiamine) and B12 (cobalamin) and niacin (nicotinic acid). It is potentially reversible.
- Chronic use of certain drugs such as tranquilizers, sedatives, and pain relievers, as well as drug interactions, can cause potentially reversible dementia.
- Endocrine abnormalities (hormone imbalances), especially thyroid dysfunction, are less common causes of dementia. They can be diagnosed by blood tests.
- Chronic infections of the central nervous system, tertiary syphilis, trauma or injury to the brain, brain tumors, psychiatric conditions such as depression (pseudodementia or dementia of depression), and genetic and degenerative disorders other than AD can also cause dementia.

Evaluations for depression and **delirium** (reduced consciousness or awareness of one's environment) are particularly important components of the diagnostic process because, although they may be symptoms of AD, they can also be mistaken for AD. Depression and memory loss are both common among the elderly and a combination of the two can lead to a mistaken diagnosis of AD. Depression can be treated with drugs, although some antidepressants may worsen dementia, further complicating both diagnosis and treatment.

The clinical evaluation will assess cognitive impairment other than short-term memory loss. A family member or close friend of the patient often will be questioned about the onset and duration of symptoms. A neuropsychiatric examination may be performed to determine the pattern of cognitive impairment and probe the patient's level of functioning. Patients may be asked to write a sample check, describe how they answer the telephone, interpret sample traffic signs, or pick out items on a shopping list from a display.

Tests

Blood and urine tests are used to help rule out other causes of dementia. Genetic tests are available to detect genes known to cause AD. However the APOE e4 gene is not used for diagnostic purposes, since even two copies of gene do not necessarily predict the development of AD.

Several types of oral and written tests are used to help diagnose AD and track its progression, including

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KEY TERMS

Acetylcholine—A neurotransmitter with effects that are generally opposite those of dopamine and norepinephrine. Acetylcholine dilates blood vessels, lowers blood pressure, and slows heartbeat.

Agitation—Excessive restlessness or emotional disturbance that is often associated with anxiety or psychosis; common in middle-stage AD.

Agnosia—Inability to recognize familiar people, places, and objects.

Amnesia—Partial or complete loss of memory or gaps in memory.

Amygdala—An almond-shaped brain structure of the limbic system that is activated in stressful situations and triggers fear.

Antioxidant—A substance that prevents the destructive effects of oxidative chemicals in the body.

Aphasia—Loss of language abilities.

Apolipoprotein E (APOE)—A protein that transports cholesterol throughout the body. One form of this protein, APOE e4, is associated with a 60% risk of late-onset AD.

Apraxia—An inability to perform purposeful movements that is not caused by paralysis or loss of feeling.

Autosomal dominant—A gene located on a chromosome other than the X or Y sex chromosomes, whose expression is dominant over that of a second copy of the same gene.

Beta-amyloid plaques—Senile plaques; structures in the brain, composed of dead or dying nerve cells and cell debris surrounding deposits of beta-amyloid protein, that are diagnostic of AD. Beta-amyloid forms when amyloid precursor protein (APP) is not broken down properly.

Brain stem—The part of the brain that connects to the spinal cord and controls most basic bodily functions. It is the last part of the brain to be destroyed by AD.

Cholinesterase inhibitors—Drugs that may slow the progression of AD by inhibiting the enzymes that break down acetylcholine.

Computed topography (CT) scan—A scan that used x rays and a computer to form detailed images of a part of the body.

Delirium—A disturbance of consciousness marked by confusion, inattention, delusions, hallucinations, and agitation. It is distinguished from dementia by its relatively sudden onset and variation in the severity of symptoms.

Delusion—A persistent false belief held in the face of strong contradictory evidence.

Dementia—A group of symptoms (syndrome) associated with a chronic progressive impairment of memory, reasoning ability, and other intellectual functions, personality changes, deterioration in personal grooming, and disorientation.

Donepezil hydrochloride (Aricept)—A drug that increases the levels of acetylcholine in the brain.

Down syndrome—A genetic disorder characterized by an extra chromosome 21 (trisomy 21), mental retardation, and susceptibility to early-onset AD.

Free radicals—Reactive atoms or molecules with unpaired electrons that damage cells, proteins, and DNA.

Genetic disease—A disease caused by genes inherited from one or both parents.

tests of mental status, functional abilities, memory, verbal fluency, and concentration. In early-stage AD the results of these tests are usually within the normal range. The widely used mini-mental status examination (MMSE) is a screening test. It is not particularly sensitive for detecting cognitive impairment in well-educated individuals who have previously functioned at a high level. It may also not yield accurate results for poorly educated individuals or cultural minorities. The clock test asks patients draw the face of a clock, possibly including a specific time such as 3:20. Patients with AD often put the numbers out of order, put them all in one part of the clock face instead of evenly spaced, or have difficulty drawing in the clock hands.

Occasionally the cerebrospinal fluid is tested for the levels of two proteins, Tau and a specific beta-amyloid protein fragment called A beta 42. Increased Tau protein and decreased A beta 42 in the cerebrospinal fluid are indicative of AD.

Procedures

Brain neuroimaging studies such as **positron emission tomography (PET)**, MRI, **single photon**

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Ginkgo—An herb from *Ginkgo biloba*, a shade tree native to China with fan-shaped leaves and fleshy seeds with edible kernels. Some alternative practitioners recommend ginkgo extract for preventing and treating AD.

Hallucination—False sensory perceptions; hearing sounds or seeing people or objects that are not there. Hallucinations can also affect the senses of smell, touch, and taste.

Hippocampus—A part of the brain's limbic system that is involved in memory formation and learning.

Insidious—Progressing gradually and inconspicuously, but with serious effects.

Magnetic resonance imaging (MRI)—An imaging technique that uses electromagnetic radiation and a computer to obtain detailed images of soft tissues such as the brain.

Mild cognitive impairment (MCI)—A transitional phase of memory loss in older people that precedes dementia or AD.

Neurofibrillary tangles—Accumulations of twisted protein fragments inside nerve cells in the brain that are diagnostic of AD.

Neuron—A nerve cell.

Neurotransmitters—Chemicals that carry nerve impulses from one nerve cell to another. AD causes a drop in the production of several important neurotransmitters.

Norepinephrine—A neurotransmitter and adrenal hormone and the precursor of epinephrine.

Perseveration—Continuous involuntary repetition of speech or behavior.

Polygenic—A trait or disorder that is determined by several different genes. Most human characteristics, including height, weight, and general body build, are polygenic. Schizophrenia and late-onset AD are considered polygenic disorders.

Positron emission tomography (PET)—A method of medical imaging capable of displaying the metabolic activity of organs and useful for investigating brain disorders.

Presenile dementia—The original name for Alzheimer's disease.

Presenilin (PSEN)—Presenilin 1 and presenilin 2 are proteins that are involved in processing amyloid precursor protein (APP). Mutations in the genes encoding these proteins can cause early-onset AD.

Pseudodementia—Depression with symptoms resembling those of dementia. The term "dementia of depression" is now preferred.

Serotonin—A neurotransmitter found in the brain and blood. Low levels of serotonin are associated with AD.

Sunsetting—Confusion or agitation in the evening.

Systolic—Referring to the rhythmic contraction of the heart (systole) as the blood in the chambers is forced out. Systolic blood pressure is blood pressure measured during the systolic phase.

Tau protein—A protein involved in maintaining the internal structure of nerve cells. Tau protein is damaged in AD and forms neurofibrillary tangles.

Tomography—A technique for producing a focused image of the structures at a specific depth within the body, while blurring details at other depths.

emission computed tomography (SPECT) scans, or computed topography (CT) scans may be used to detect gross cerebral cortex atrophy due to brain cell death. **PET** scans can detect the earliest changes in brain structure. MRI scans are often performed on patients who are having problems with balance or gait. MRIs can detect diffuse atrophy that is often present in the cerebrum of the brain of AD patients. PET and SPECT scans can be used to evaluate patterns of glucose (sugar) metabolism in the brain to differentiate patterns characteristic of AD from those associated with vascular dementia and Pick's disease. PET scans are more precise than SPECT scans but are more expensive. However imaging alone cannot diagnose AD. MRI and CT scans and electroencephalographs (EEGs), which measure the electrical activity in the brain, can be useful for excluding other causes of dementia such as stroke, **subdural hematoma**, and brain tumors.

Although a skilled physician can diagnose probable AD with 90% accuracy, a definitive diagnosis of Alzheimer's disease requires a brain autopsy after death and examination of the brain tissue by a histopathologist. The presence of a large number of beta-amyloid plaques and intraneuronal neurofibrillary

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tangles are considered diagnostic of AD. Antibodies that bind to the specific amyloid proteins are tagged with a fluorescent or colorimetric molecule and visualized in a microscope. In addition, the longer the disease has progressed, the smaller the brain is at death.

A study published in The Archives of Neurology in August 2010 found that spinal fluid test can be 100 percent accurate in identifying patients with significant memory loss who are on their way to developing Alzheimer's disease. The test is one of many ways the the diagnosis of AD is moving from only being positive after death. Much work lies ahead, researchers say: making sure the tests are reliable if used in doctors' offices, making sure the research findings hold up in real-life situations, getting doctors and patients comfortable with the notion of spinal taps, the method used to get spinal fluid. In addition to spinal fluid tests, new PET scans of the brain that show the telltale amyloid plaques are being developed, which are a unique feature of the disease. And researches are testing hundreds of new drugs that might change the course of the brain cell death associated with this disease. Breakthroughs in research have been rather stagnent, but as of 2010, this research field had a flurry of new studies.

Treatment

Traditional

Although there is no cure for Alzheimer's disease, early diagnosis and prompt intervention can slow its progression and enable patients to function independently for a longer period. Healthcare professionals usually assess a patient's ADL to determine what type of care is needed. The mainstay of treatment is the establishment of daily routines, good nursing care and/or home-care strategies, and providing physical and emotional support. In the initial stages, counseling by a psychologist or an AD support group is recommended. The patient and caregiver should establish a relationship with a primary-care provider so that illnesses, such as urinary or respiratory infections, can be properly diagnosed and treated rather than being simply attributed to the inevitable decline of AD. Neurological and behavioral aspects of AD, including anxiety, agitation, defiant behavior, **insomnia**, hallucinations, and seizures are treated on an as-needed basis.

Treatment of AD is a very active area of research and the National Institutes of Health (NIH) and other agencies sponsor numerous clinical trials of new drugs and therapies. A list of current clinical trials enrolling volunteers can be found at http://clinicaltrials.gov/

Drugs

The most common drugs prescribed for AD are inhibitors of acetylcholinesterase and butylcholinesterase, enzymes that break down the neurotransmitters acetylcholine and butylcholine, respectively. These medications increase levels of acetylcholine in the brain, thereby improving brain function in early-stage mild-to-moderate AD:

- galantamine (Razadyne, formerly known as Reminyl)
- rivastigmine (Exelon)
- donepezil hydrochloride (Aricept)

Memantine (Namenda) is used to treat moderate-to-severe AD. It acts on glutamate, another brain neurotransmitter. It is used alone or in combination with donepezil.

These drugs can modestly increase attention span, concentration, mental acuity, and information processing and improve the ability to perform normal ADL. They slow the progression of symptoms for about six months to one year in one-third to one-half of patients with AD. All have side effects, most often mild **diarrhea**, **nausea**, **vomiting**, **muscle cramps**, **dizziness**, **headache**, **fatigue**, and sleep disturbances. Tacrine (Cognex), the first such drug, is no longer prescribed because of the risk of liver toxicity.

The antioxidant vitamin E may delay AD onset by protecting neurons from free-radical damage. AD patients have lower blood levels of vitamin E than other adults of the same age. One large two-year study of moderately affected AD patients found that taking 2000 IU (international units) of vitamin E daily significantly delayed disease progression as compared with patients taking a placebo. However, high levels of vitamin E can put patients at higher risk for bleeding disorders. Vitamin E therapy, in combination with cholinesterase inhibitors, has become the standard treatment for AD.

Drugs previously used to treat AD—including selegiline (a drug for Parkinson's disease), prednisone, estrogen, and nonsteroidal anti-inflammatory drugs (NSAIDs)—have been found to be ineffective.

Medications can be prescribed to manage the behavioral and psychiatric symptoms of AD, which are often very stressful for caregivers. These medications are usually prescribed for specific symptoms:

- typical antipsychotics—usually haloperidol (Haldol), risperidone (Risperdal), olanzapine, or quetiapine—for anxiety, aggression, delusions, or hallucinations

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- short-term antianxiety drugs, usually lorazepam (Ativan) or buspirone (BuSpar), for agitation
- a selective serotonin reuptake inhibitor (SSRI), such as citalopram or sertraline, at half the adult dosage, for depression, which is common in early-stage AD
- acetaminophen or a very low dose of codeine for pain

Patients with AD are more susceptible to the side effects of medications, especially psychoactive drugs, and are usually given lower doses than younger adults. Physicians often recommend first trying to reduce behavioral symptoms with changes to the patient's environment.

Alternative

Antioxidants have shown some degree of effectiveness in treating AD. Antioxidants, in addition to vitamin E, include:

- vitamin C
- selenium
- green tea
- ginkgo biloba extract

Derived from the leaves of the *Gingko biloba* tree, gingko also increases blood and oxygen flow to the brain and has anti-inflammatory and neuroprotective effects. It has been used for many years in China, is widely prescribed in Europe for circulatory problems, and is the most common herbal treatment for AD. However a large-scale, well-designed 2008 study found that Ginkgo extract neither prevented nor delayed AD.

Other supplements for treating AD include:

- Huperzine A, from the club moss *Huperzia serrata*, is a natural cholinesterase inhibitor that has been reported to produce greater improvement than synthetic cholinesterase inhibitors at doses of 0.1–0.4 milligrams (mg) daily and has few side effects. Side effects may include nausea, muscle cramps, vomiting, and diarrhea. Like ginkgo biloba, it is an unregulated herb and preparations may have widely varying amounts of active ingredients.
- Thiamine (vitamin B1) in daily doses of 3 grams (g) for two to three months have been shown in small studies to improve mental function and AD assessment scores; however other studies have found no effect. Side effects can include nausea and indigestion.
- Cobalamin (vitamin B12) improved memory and mental function in AD patients in some studies but not in others.
- Acetyl L-carnitine is similar in structure to acetylcholine and some studies have indicated that 2–3 g daily slows the progression of AD in patients who developed the disease before age 66. Patients who developed AD after age 66 worsened with the treatment. Side effects include increased appetite, body odor, and rash.
- DHEA (dehydroepiandrosterone) is a steroid hormone. Although a link between decreased levels of DHEA in the elderly and AD has been suggested, no studies have been performed. Side effects include acne, hair growth, irritability, insomnia, headache, and menstrual irregularities.
- Melatonin is a hormone that helps regulate mood and sleep cycles. The usual dose is 3 mg one to two hours before bed. Side effects are drowsiness, confusion, headache, decreased sex drive, and decreased body temperature.

Naturopathic treatment for AD includes supplementation with antioxidant vitamins (A, C, and E), carotenoids, small amounts of selenium and zinc, and thiamine. Some alternative practitioners advise people with AD to also take supplements of phosphatidylcholine, gotu kola, **ginseng**, **St. John's Wort**, rosemary, saiko-keishi-to-shakuyaku (a Japanese herbal mixture), and **folic acid**. However none of these have met the safety and effectiveness standards of conventional Western medicine.

The incidence of AD is lower in countries with **diets** that are lower in calories and fats. There have been a few reports suggesting that diets rich in fish improve mental function in patients with AD or dementia and AD patients treated with essential fatty acids have shown greater improvement in mood and mental function than patients on placebos. Because of its disease-preventing properties, red wine in moderation may also benefit AD patients. Patients with AD should avoid environmental toxins such as tobacco smoke.

A variety of other therapies may be beneficial in the treatment of psychological symptoms of AD:

- Music therapy has been found to calm agitated AD patients and improve mood, reduce chronic pain, depression, agitation, wandering, and feelings of isolation, and enhance long-term memory. Old familiar songs can be particularly effective in improving recall
- Light therapy in the evening can help alleviate sleep-cycle disturbances
- Supportive therapies include touch, compliments, and displays of affection

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- Sensory stimulation through massage and aromatherapy may be beneficial
- Socio-environmental therapies include activities related to the patient's previous interests and favorite foods, as well as pleasant surroundings
- Cognitive therapy can reduce negative perceptions and teach coping strategies
- Insight-oriented psychotherapy addresses patients' awareness of their disease
- Dance therapy, validation therapy, reminiscence therapy, and reality-oriented therapy have also been used with AD patients

Home remedies

About 70% of AD patients are cared for at home, with the remainder residing in various types of institutions. Creative strategies are necessary to help the patient stay as independent as possible. Caregivers need their own support systems to minimize anger, despair, and burnout. Becoming familiar with likely future scenarios and considering financial and legal issues early on can ease the burden on both the patient and the family.

In the early stages of AD when memory loss is minimal, it is helpful for family and friends to interact with patients as much as possible, reminding them to eat, take their medication, keep their appointments, and help sustain daily living activities. Keeping records is helpful, particularly when there are several caregivers. The household should be organized so that important items can be found easily. The patient will need help in managing finances. Providing neighbors with a house key and setting up a schedule to check in on the patient are recommended. With the help of family, neighbors, and community resources, many people with early AD are able to maintain a successful lifestyle in their home environment for months or years.

Basic safety concerns for AD patients include:

- falls
- ingestion of dangerous substances
- wandering from home and becoming lost
- injuring one's self or others with sharp objects, fire, or burns
- the inability to respond rapidly to crisis situations

Often families have to modify their homes because of safety concerns:

- grab bars in bathrooms, bed rails, and clutter-free passageways
- electrical appliances that are unplugged and put away when not in use
- matches, lighters, knives, or weapons stored out of reach
- lowered hot water heater temperature to avoid accidental scalding
- a list of emergency numbers, including the poison control center and hospital emergency room, posted by the phone

Patients who have been diagnosed with AD should never be allowed to drive because of the danger of accidents or becoming disoriented. Some local chapters of the Alzheimer's Association offer help with transportation.

A calm, structured environment with simple orientation aids such as calendars and clocks can help reduce anxiety and increase safety. Labeling cabinets and drawers can help patients focus their attention. Signs can be posted reminding patients of important phone numbers and to turn off appliances and lock doors. Scheduling meals, bathing, and other activities at regular times and places provides routine and emotional security, since unfamiliar places and activities can be disorienting. Caregivers should develop a daily routine and take advantage of periods during the day when the patient is less confused and more cooperative. The most severe symptoms often occur at night. Sleep disturbances may be minimized by keeping the patient engaged in activities during the day. Daily supervised walks are a good general exercise for people with AD.

A loss of grooming skills—mismatched clothing, unkempt hair, and decreased interest in personal hygiene—is often one of the early symptoms of AD. Caregivers, especially spouses, may find these changes socially embarrassing and difficult to cope with. The caregiver will increasingly assume grooming responsibilities as the disease progresses.

Feeding may require using a colored plate to focus the patient's attention on the food. Finger foods may be preferable to the use of utensils. A nutritionist can give advice on well-balanced, easily prepared meals. Eventually the caregiver may need to feed the patient. As movement and swallowing become difficult, a feeding tube may be placed into the stomach through the abdominal wall.

Incontinence presents the most difficult problem for many caregivers and is a major reason for moving to nursing-home care. In the early stages, limiting fluid intake and increasing the frequency of toileting can help. Careful attention to hygiene is important to prevent skin irritation and infection from soiled clothing.

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Family members or other caregivers have a difficult and stressful job, which becomes harder still as the disease progresses. Caring for dementia patients is significantly more demanding and time-consuming than caring for patients with other illnesses. Each day may bring new challenges as the patient's ability levels decrease and new patterns of behavior develop. Many caregivers find the constant but unpredictable demands extremely difficult. The personality changes of AD can be heartbreaking for family members as a loved one deteriorates, seeming to become a different person. As the disease progresses, the patient's behavior may become increasingly erratic. It may be impossible to leave a patient unattended for even a few minutes because they may wander off. Neighbors should always be informed of the person's condition. However not all AD patients develop negative behaviors: some become gentle, spending increasing amounts of time in dreamlike states.

Caregivers often develop feelings of anger, resentment, guilt, and hopelessness. Depression is common and may need to be treated. Caregivers can become susceptible to illness, especially if they do not receive adequate support from family, friends, and community. Support groups can help caregivers deal with stress. The location and contact numbers for AD caregiver support groups are available from the Alzheimer's Association, local social service agencies, physicians, and pharmaceutical companies that manufacture the drugs used to treat AD.

Most families eventually need outside help to care for the AD patient. Personal-care assistants, either volunteer or paid, may be available through local social service agencies. Adult daycare facilities are becoming increasingly common. Meal delivery, shopping assistance, or respite care may also be available. Special Alzheimer's disease facilities are available for both respite daycare and permanent long-term care.

The decision to move the patient to a nursing home is often one of the most difficult for the family, who may consider that they have failed in their obligations and are abandoning their loved one. Counseling with a physician, clergy, or other trusted adviser can ease this transition. Selecting a nursing home may require a difficult balancing of costs, services, location, and availability. Keeping the entire family involved in the decision may help prevent further stress later.

Social Security Disability, Medicare, Medicaid, or Supplemental Security Income may provide financial assistance, but will not usually cover nursing home care indefinitely. Long-term care insurance, if purchased prior to diagnosis, reverse mortgages, or other financial devices may be appropriate.

Prognosis

There is no cure for Alzheimer's disease and once the symptoms develop patients do not recover. The goal is to maintain cognitive and physical function for as long as possible. Although there is considerable variation in the rate of disease progression, symptoms continue to worsen, usually over a period of years. Eventually loss of brain cells and brain damage result in the impairment of autonomic body functions, the failure of various organ systems, **coma**, and death. Most AD patients die within eight to 10 years of diagnosis, although that interval can be as short as one year or as long as 20 years. The life expectancy of AD patients is increasing because the disease is generally being diagnosed at an earlier stage.

The most common cause of death among AD patients is infection. People with AD are often in poor health and may be malnourished, which puts them at increased risk of life-threatening infections such as pneumonia. They are also susceptible to other conditions and diseases of old age. The consequences of cancer, stroke, and heart disease can be more severe in patients with AD than in otherwise healthy people.

Prevention

There is no known prevention for Alzheimer's disease. Several studies have suggested that high-fat and high-calorie diets may increase the risk of developing AD. Other possible risk factors include alcohol, salt, and refined carbohydrates. Some studies have found that fish consumption reduces the incidence of AD in Europe and North America, possibly due to the omega-3 fatty acids found in fish. It is also possible that staying physically and mentally active throughout life may lower the risk of AD.

Individuals with a history of Alzheimer's disease in their families may want to consider **genetic counseling** to clarify possible risk factors and determine the appropriateness of available genetic tests. Since the APOE e4 gene is merely a risk factor for AD, it is not considered useful for predicting whether a person will develop the disease. The National Institute on Aging does not recommend using the test to screen people because:

- it does not predict whether an individual will develop AD
- there are ethical implications to testing for a disease that is currently incurable

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- it may have adverse psychological consequences for patients and their families
- it could lead to discrimination in employment or health insurance for carriers of the gene

Research on the prevention of AD has focused on blocking the production of amyloid protein in the brain and on breaking down beta-amyloid after it is released from cells but before it has a chance to aggregate into insoluble plaques.

Health care team roles

Treatment of AD is a team effort, involving primary-care physicians, nurses, imaging and laboratory technicians, gerontology specialists, psychiatrists, psychologists, and caregivers. Educating patients and caregivers about the nature of the disease and its progression usually falls on the nursing staff. Nurses are also the first line of access for medical care and support groups. Social workers, counselors, and support group facilitators may provide emotional support, practical advice, and information about community resources. Specialized Alzheimer's disease facilities may be used for either respite daycare or permanent long-term care.

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ORGANIZATIONS

Alzheimer's Association, 225 N. Michigan Ave., Fl. 17, Chicago, IL, 60601-7633 (312) 335-8700 (800) 272-3900 (866) 699-1246, info@alz.org, http://www.alz.org.

Alzheimer's Australia, PO Box 4019, Hawker, ACT, Australia, 2614 61 (2) 6254-4233 (1800) 100-500 (Australia only), http://www.alzheimers.org.au.

Alzheimer's Disease Education and Referral Center, National Institute on Aging, PO Box 8250, Silver Spring, MD, 20907-8250 (800) 438-4380, adear@nia.nih.gov, http://www.nia.nih.gov/Alzheimers.

Alzheimer's Foundation of America, 322 Eighth Avenue, 7th Floor, New York, NY, 10001 (866) 232-8484 (646) 638-1546, info@alzfdn.org, http://www. alzfdn.org.

American Health Assistance Foundation, 22512 Gateway Center Drive, Clarksburg, MD, 20871 (800) 437-2423 (301) 948-4403, info@ahaf.org, http://www.ahaf.org.

European Alzheimer's Disease Consortium, Dept. of Internal Medicine and Clinical Gerontology, Toulouse University Hospital, 170 Avenue de Casselardit, Toulouse, France, 31300 33-5-6177-7649 33-5-6149-7109, reynish.e@chu-toulouse.fr, http://eadc.alzheimer- europe.org.

Fisher Center for Alzheimer's Research Foundation, One Intrepid Square, West 46th Street & 12th Avenue, New York, NY, 10036 (800) ALZINFO (259-4636), http://www.alzinfo.org.

National Institute of Neurological Disorders and Stroke (NINDS), NIH Neurological Institute, PO Box 5801, Bethesda, MD, 20824 (301) 496-5751 (800) 352-9424, http://www.ninds.nih.gov/index.htm.

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Ambiguous genitals *see* **Intersex states**

Amblyopia

Definition

Amblyopia is a decrease in vision in a healthy eye that is caused by problems with the eye and the brain failing to work together in correctly processing information from the "bad" or amblyopic eye. Lazy eye is a common non medical term used to describe amblyopia because the eye with poorer vision does not seem to be doing its job of seeing.

Man with a lazy eye. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Demographics

Amblyopia is the most common cause of impaired vision in children. It affects about three out of every 100 people or two to four percent of the population.

Description

Vision is a combination of the clarity of the images received from the eyes (visual acuity) and the processing of those images by the brain. If the images produced by the two eyes are substantially different, the brain may not be able to fuse the images. Instead of seeing two different images or double vision (diplopia), the brain suppresses the blurrier image. This suppression can lead to amblyopia.

The critical stage for binocular vision development occurs between the ages of five and seven months with continued development through about age eight years. Ambylopia is most likely to develop early in childhood and leads to poor visual development in the blurrier eye. Amblyopia can also occur in adults if one eye is damaged or vision is reduced by the development of a cataract.

Risk factors

Children who were premature, who are developmentally delayed, have other eye problems, or who have a family history of amblyopia are at higher risk for developing this disorder.

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Causes and symptoms

Some of the major causes of amblyopia are as follows:

- Strabismus. A misalignment of the eyes (strabismus) is the most common cause of functional amblyopia. The two eyes are looking in two different directions at the same time. The brain is sent two different images and this causes confusion. The brain turns off images from the misaligned or "crossed" eye in order to avoid double vision.
- Anisometropia. This is another type of functional amblyopia. In this case, there is a difference of refractive states between the two eyes (in other words, a difference of prescriptions between the two eyes). For example, one eye may be more nearsighted than the other eye, or one eye may be farsighted and the other eye nearsighted. Because the brain cannot fuse the two dissimilar images, it will suppress the blurrier image, causing the eye to become amblyopic.
- Cataract. Clouding of the lens of the abnormal eye will cause the image to be blurrier than the image from the normal eye. The brain "prefers" the clearer image. The eye with the cataract may become amblyopic.
- Ptosis. This is the drooping of the upper eyelid. If light cannot enter the eye because of the drooping lid, the eye is essentially not being used. This condition can lead to amblyopia.
- Nutrition. Nutritional deficiencies or chemical toxicity may result in amblyopia. Alcohol, tobacco, or a deficiency in the B vitamins may result in toxic amblyopia.
- Heredity. Amblyopia can run in families.

Barring the presence of **strabismus** or **ptosis**, children may or may not show signs of amblyopia. Children may hold their heads at an angle while trying to favor the eye with normal vision. They may have trouble seeing or reaching for things when approached from the side of the amblyopic eye. Parents may notice that one side of approach is preferred by the child or infant. If an infant's good eye is covered, the child may cry.

Diagnosis

Examination

Because children with outwardly normal eyes may have amblyopia, regular vision screenings are recommended beginning at a young age. There is some controversy regarding the age at which children should have their first vision examination. Some authorities recommend that children have their vision checked by their pediatrician, family physician, ophthalmologist, or optometrist at or before six months of age. Others recommend testing by at least the child's fourth birthday. In actuality, children's eyes can be examined at any age, even at one day of life. The earlier amblyopia is found, the better the possible outcome. Most physicians test vision as part of a child's medical examination. If there is any sign of an eye problem, the child may be referred to an eye specialist.

Generally, a difference of two lines or more (on an eye-chart test of visual acuity) between the two eyes would be defined as amblyopia. For example, if someone has 20/20 vision with the right eye and only 20/40 with the left, and the left eye cannot achieve better vision with corrective lenses, the left eye is said to be amblyopic.

Objective methods such as retinoscopy can measure the refractive status of the eyes. This can help determine anisometropia. In retinoscopy, a hand-held instrument is used to shine a light in the child's (or infant's) eyes. Using hand-held lenses, a rough prescription can be obtained. Visual acuity can be determined using a variety of methods. Many different eye charts are available (e.g., tumbling E, pictures, or letters).

In amblyopia, single letters are easier to recognize than when a whole line is shown. This is called the "crowding effect" and helps in diagnosing amblyopia. Neutral density filters also may be held over the eye to aid in the diagnosis. Sometimes visual fields to determine defects in the area of vision will be performed. Color vision testing also may be performed. Amblyopia is a diagnosis of exclusion, so many tests may be performed to rule out visual or health problems that also can cause a decrease in vision.

KEY TERMS

Anisometropia—An eye condition in which there is an inequality of vision between the two eyes. There may be unequal amounts of nearsightedness, farsightedness, or astigmatism, so that one eye will be in focus while the other is not.

Cataract—Cloudiness of the eye's natural lens.

Occlusion therapy—A type of treatment for amblyopia in which the good eye is patched for a period of time. This forces the weaker eye to be used.

Strabismus—A condition in which the eyes are misaligned and point in different directions. One eye may look straight ahead, while the other turns inward, outward, upward, or downward. This is also called crossed–eyes.

Visual acuity—Acuity is the acuteness or sharpness of vision.

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Treatment

The treatment plan should be discussed with the doctor to fully understand the purpose of the treatment, its length, and expected results.

Traditional

Treatment should be begun as early as possible in a child's life. The primary treatment is occlusion therapy, which is performed by a child's wearing a patch over the good eye. This forces the amblyopic eye to work and the brain to process information from this eye. Clinical trials sponsored by the United States National Institutes of Health (NIH) have shown that for many children, wearing a patch over the good eye for two hours daily effectively treats mild to moderate amblyopia; patching for six hours daily generally improves severe amblyopia. Limited patching time allows the child to wear the patch at home, avoiding the stigma of looking different in public. Initially it was thought that if patching were not done by age seven, it would be ineffective, but research as of 2010 has shown that the effective period for reversing or reducing amblyopia can extend through age 17 years in some individuals; information on reversing amblyopia in older adults is limited.

When patched, eye exercises may be prescribed to force the amblyopic eye to focus and work. This is called vision therapy or **vision training**. Even after vision has been improved in the weak eye, part-time patching may be recommended to maintain the improvement.

Drugs

An alternative to patching is treatment with the drug atropine. Atropine eyedrops are applied to the "good" (stronger) eye. Atropine dilates the pupil and causes vision in the good eye to become blurry. This forces the brain to process information from the "bad" or ambylopic eye.

While patching or atropine treatment is necessary to get the amblyopic eye/brain processing to work, it is just as important to correct any underlying reason for the amblyopia. Glasses may also be worn if there are errors in refraction. Surgery or vision training may be necessary in the case of strabismus. Better **nutrition** is indicated in some toxic amblyopias.

Prognosis

It is important to diagnose and treat amblyopia early because significant vision loss can occur if left untreated. The best outcomes result from early diagnosis and treatment. However, treatment may be successful in older children. Success in the treatment of amblyopia also depends upon how severe the amblyopia is, the specific type of amblyopia, and patient compliance.

Prevention

To protect their child's vision, parents must be aware of amblyopia as a potential problem. Parents should be encouraged to take young children for vision exams early on in life and certainly before they begin school. Proper nutrition is important in the avoidance of toxic amblyopia.

ORGANIZATIONS

American Academy of Ophthalmology (AAO), P. O. Box 7424, San Francisco, CA, 94120-7424, (415) 561-8500, (415) 561-8500, http://www.aao.org.

American Optometric Association, 243 North Lindbergh Blvd., St. Louis, MO, 63141, (314) 991-4100, (314) 991-4101, (800) 365-2219, http://www.aoa.org.

American Academy of Optometry, 6110 Executive Blvd., Suite 506, Rockville, MD, 20852 (301) 984–1441 (301) 984–4737, aaopt@aaopt.org, http://www.aaopt.org.

EyeCare America Foundation of the American Academy of Ophthalmology, PO Box 429098, San Francisco, CA, 94142–9098 (877) 887–6327 (800) 324–EYES (3937) (415) 561–8567, pubserv@aao.org, http://www.eyecareamerica.org.

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Amebiasis

Definition

Amebiasis is an **infectious disease** caused by a parasitic one-celled microorganism (protozoan) called *Entamoeba histolytica*. Persons with amebiasis may experience a wide range of symptoms, including **diarrhea**, **fever**, and cramps. The disease may also affect the intestines, liver, or other parts of the body.

Description

Amebiasis, also known as amebic **dysentery**, is one of the most common parasitic diseases occurring in humans, with an estimated 500 million new cases each year. It occurs most frequently in tropical and subtropical areas where living conditions are crowded, with inadequate sanitation. Although most cases of amebiasis occur in persons who carry the disease but do not exhibit any symptoms (asymptomatic), as

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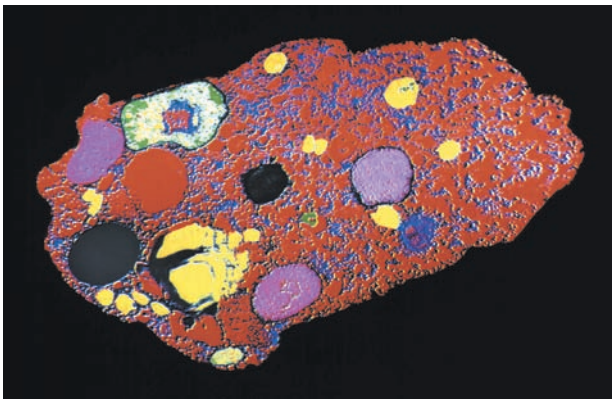

A micrograph of *Entameoba histolytica,* a parasitic amoeba that invades and destroys the tissues of the intestines, causing amebiasis and ulceration to the intestinal wall. *(Photo Researchers, Inc.)*

many as 100,000 people die of amebiasis each year. In the United States, between one and 5% of the general population will develop amebiasis in any given year, while male homosexuals, migrant workers, institutionalized people, and recent immigrants develop amebiasis at a higher rate.

Human beings are the only known host of the amebiasis organism, and all groups of people, regardless of age or sex, can become affected. Amebiasis is primarily spread in food and water that has been contaminated by human feces but is also spread by person-to-person contact. The number of cases is typically limited, but regional outbreaks can occur in areas where human feces are used as fertilizer for crops, or in cities with water supplies contaminated with human feces.

Causes and symptoms

Recently, it has been discovered that persons with symptom-causing amebiasis are infected with *Entamoeba histolytica*, and those individuals who exhibit no symptoms are actually infected with an almost identical-looking ameba called *Entamoeba dispar*. During their life cycles, the amebas exist in two very different forms: the infective cyst or capsuled form, which cannot move but can survive outside the human body because of its protective covering, and the disease-producing form, the trophozoite, which although capable of moving, cannot survive once excreted in the feces and, therefore, cannot infect others. The disease is most commonly transmitted when a person eats food or drinks water containing *E. histolytica* cysts from human feces. In the digestive tract the cysts are transported to the intestine where the walls of the cysts are broken open by digestive secretions, releasing the mobile trophozoites. Once released within the intestine, the trophozoites multiply by feeding on intestinal bacteria or by invading the lining of the large intestine.

Within the lining of the large intestine, the trophozoites secrete a substance that destroys intestinal tissue and creates a distinctive bottle-shaped sore (ulcer). The trophozoites may remain inside the intestine, in the intestinal wall, or may break through the intestinal wall and be carried by the blood to the liver, lungs, brain, or other organs. Trophozoites that remain in the intestines eventually form new cysts that are carried through the digestive tract and excreted in the feces. Under favorable temperature and humidity conditions, the cysts can survive in soil or water for weeks to months, ready to begin the cycle again.

Although 90% of cases of amebiasis in the United States are mild, pregnant women, children under two years of age, the elderly, malnourished individuals, and people whose immune systems may be compressed, such as **cancer** or **AIDS** patients and those individuals taking prescription medications that suppress the immune system, are at a greater risk for developing a severe infection.

The signs and symptoms of amebiasis vary according to the location and severity of the infection and are classified as follows:

Intestinal amebiasis

Intestinal amebiasis can be subdivided into several categories:

ASYMPTOMATIC INFECTION. Most persons with amebiasis have no noticeable symptoms. Even though these individuals may not feel ill, they are still capable of infecting others by person-to-person contact or by contaminating food or water with cysts that others may ingest, for example, by preparing food with unwashed hands.

CHRONIC NON-DYSENTERIC INFECTION. Individuals may experience symptoms over a long period of time during a chronic amebiasis infection and experience recurrent episodes of diarrhea that last from one to four weeks and recur over a period of years. These patients may also suffer from abdominal cramps, **fatigue**, and weight loss.

AMEBIC DYSENTERY. In severe cases of intestinal amebiasis, the organism invades the lining of the intestine, producing sores (ulcers), bloody diarrhea, severe abdominal cramps, **vomiting**, chills, and fevers as high as 104–105°F (40–40.6°C). In addition, a case of acute amebic dysentery may cause complications, including

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KEY TERMS

Ameboma—A mass of tissue that can develop on the wall of the colon in response to amebic infection.

Antibody—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

Appendicitis—Condition characterized by the rapid inflammation of the appendix, a part of the intestine.

Asymptomatic—Persons who carry a disease and are usually capable of transmitting the disease but who do not exhibit symptoms of the disease are said to be asymptomatic.

Dysentery—Intestinal infection marked by diarrhea containing blood and mucus.

Fulminating colitis—A potentially fatal complication of amebic dysentery marked by sudden and severe inflammation of the intestinal lining, severe bleeding or hemorrhaging, and massive shedding of dead tissue.

Inflammatory bowel disease (IBD)—Disease in which the lining of the intestine becomes inflamed.

Lumen—The inner cavity or canal of a tube-shaped organ, such as the bowel.

Protozoan—A single-celled, usually microscopic organism that is eukaryotic and, therefore, different from bacteria (prokaryotic).

inflammation of the appendix (**appendicitis**), a tear in the intestinal wall (perforation), or a sudden, severe inflammation of the colon (fulminating **colitis**).

AMEBOMA. An ameboma is a mass of tissue in the bowel that is formed by the amebiasis organism. It can result from either chronic intestinal infection or acute amebic dysentery. Amebomas may produce symptoms that mimic cancer or other intestinal diseases.

PERIANAL ULCERS. Intestinal amebiasis may produce skin infections in the area around the patient's anus (perianal). These ulcerated areas have a "punched-out" appearance and are painful to the touch.

Extraintestinal amebiasis

Extraintestinal amebiasis accounts for approximately 10% of all reported amebiasis cases and includes all forms of the disease that affect other organs.

The most common form of extraintestinal amebiasis is amebic **abscess** of the liver. In the United States, amebic liver abscesses occur most frequently in young Hispanic adults. An amebic liver abscess can result from direct infection of the liver by *E. histolytica* or as a complication of intestinal amebiasis. Patients with an amebic abscess of the liver complain of **pain** in the chest or abdomen, fever, **nausea**, and tenderness on the right side directly above the liver.

Other forms of extraintestinal amebiasis, though rare, include infections of the lungs, chest cavity, brain, or genitals. These are extremely serious and have a relatively high mortality rate.

Diagnosis

Diagnosis of amebiasis is complicated, partly because the disease can affect several areas of the body and can range from exhibiting few, if any, symptoms to being severe, or even life-threatening. In most cases, a physician will consider a diagnosis of amebiasis when a patient has a combination of symptoms, in particular, diarrhea and a possible history of recent exposure to amebiasis through travel, contact with infected persons, or anal intercourse.

It is vital to distinguish between amebiasis and another disease, inflammatory bowel disease (IBD) that produces similar symptoms because, if diagnosed incorrectly, drugs that are given to treat IBD can encourage the growth and spread of the amebiasis organism. Because of the serious consequences of misdiagnosis, potential cases of IBD must be confirmed with multiple stool samples and blood tests, and a procedure involving a visual inspection of the intestinal wall using a thin lighted, tubular instrument (**sigmoidoscopy**) to rule out amebiasis.

A diagnosis of amebiasis may be confirmed by one or more tests, depending on the location of the disease.

Stool examination

This test involves microscopically examining a stool sample for the presence of cysts and/or trophozoites of *E. histolytica* and not one of the many other intestinal amebas that are often found but that do not cause disease. A series of three stool tests is approximately 90% accurate in confirming a diagnosis of amebic dysentery. Unfortunately, however, the stool

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test is not useful in diagnosing amebomas or extraintestinal infections.

Sigmoidoscopy

Sigmoidoscopy is a useful diagnostic procedure in which a thin, flexible, lighted instrument, called a sigmoidoscope, is used to visually examine the lower part of the large intestine for amebic ulcers and take tissue or fluid samples from the intestinal lining.

Blood tests

Although tests designed to detect a specific protein produced in response to amebiasis infection (antibody) are capable of detecting only about 10% of cases of mild amebiasis, these tests are extremely useful in confirming 95% of dysentery diagnoses and 98% of liver abscess diagnoses. Blood serum will usually test positive for antibody within a week of symptom onset. Blood testing, however, cannot always distinguish between a current or past infection since the antibodies may be detectable in the blood for as long as 10 years following initial infection.

Imaging studies

A number of sophisticated imaging techniques, such as **computed tomography scans** (CT), **magnetic resonance imaging** (MRI), and ultrasound, can be used to determine whether a liver abscess is present. Once located, a physician may then use a fine needle to withdraw a sample of tissue to determine whether the abscess is indeed caused by an amebic infection.

Treatment

Asymptomatic or mild cases of amebiasis may require no treatment. However, because of the potential for disease spread, amebiasis is generally treated with a medication to kill the disease-causing amebas. More severe cases of amebic dysentery are additionally treated by replacing lost fluid and blood. Patients with an amebic liver abscess will also require hospitalization and bed rest. For those cases of extraintestinal amebiasis, treatment can be complicated because different drugs may be required to eliminate the parasite, based on the location of the infection within the body. Drugs used to treat amebiasis, called amebicides, are divided into two categories:

Luminal amebicides

These drugs get their name because they act on organisms within the inner cavity (lumen) of the bowel. They include diloxanide furoate, iodoquinol, metronidazole, and paromomycin.

Tissue amebicides

Tissue amebicides are used to treat infections in the liver and other body tissues and include emetine, dehydroemetine, metronidazole, and chloroquine. Because these drugs have potentially serious side effects, patients given emetine or dehydroemetine require bed rest and heart monitoring. Chloroquine has been found to be the most useful drug for treating amebic liver abscess. Patients taking metronidazole must avoid alcohol because the drug-alcohol combination causes nausea, **vomiting**, and **headache**.

Most patients are given a combination of luminal and tissue amebicides over a treatment period of seven to ten days. Follow-up care includes periodic stool examinations beginning two to four weeks after the end of medication treatment to check the effectiveness of drug therapy.

Prognosis

The prognosis depends on the location of the infection and the patient's general health prior to infection. The prognosis is generally good, although the mortality rate is higher for patients with ameboma, perforation of the bowel, and liver infection. Patients who develop fulminant colitis have the most serious prognosis, with over 50% mortality.

Prevention

There are no immunization procedures or medications that can be taken prior to potential exposure to prevent amebiasis. Moreover, people who have had the disease can become reinfected. Prevention requires effective personal and community hygiene.

Specific safeguards include the following:

- Purification of drinking water. Water can be purified by filtering, boiling, or treatment with iodine.
- Proper food handling. Measures include protecting food from contamination by flies, cooking food properly, washing one's hands after using the bathroom and before cooking or eating, and avoiding foods that cannot be cooked or peeled when traveling in countries with high rates of amebiasis.
- Careful disposal of human feces.
- Monitoring the contacts of amebiasis patients. The stools of family members and sexual partners of infected persons should be tested for the presence of cysts or trophozoites.

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Resources

BOOKS

Friedman, Lawrence S. "Liver, Biliary Tract, & Pancreas." In McPhee, Stephen, and Maxine Papadakis. *Current Medical Diagnosis and Treatment, 2010*, 49th ed. New York: McGraw-Hill Medical, 2009.

Rebecca J. Frey PhD

Amebic dysentery *see* **Amebiasis**

KEY TERMS

Hymen—Membrane that stretches across the opening of the vagina.

Hypothyroidism—Underactive thyroid gland.

Hysterectomy—Surgical removal of the uterus.

Turner's syndrome—A condition in which one female sex chromosome is missing.

Amenorrhea

Definition

The absence of menstrual periods is called amenorrhea. Primary amenorrhea is the failure to start having a period by the age of 16. Secondary amenorrhea is more common and refers to either the temporary or permanent ending of periods in a woman who has menstruated normally in the past. Many women miss a period occasionally. Amenorrhea occurs if a woman misses three or more periods in a row.

Description

The absence of menstrual periods is a symptom, not a disease. While the average age that menstruation begins is 12, the range varies. The incidence of primary amenorrhea in the United States is just 2.5%.

Some female athletes who participate in rowing, long distance running, and cycling, may notice a few missed periods. Women athletes at a particular risk for developing amenorrhea include ballerinas and gymnasts, who typically **exercise** strenuously and eat poorly.

Causes and symptoms

Amenorrhea can have many causes. Primary amenorrhea can be the result of hormonal imbalances, psychiatric disorders, **eating disorders**, **malnutrition**, excessive thinness or fatness, rapid weight loss, body fat content too low, and excessive physical conditioning. Intense physical training prior to **puberty** can delay menarche (the onset of menstruation). Every year of training can delay menarche for up to five months. Some medications such as anti-depressants, tranquilizers, **steroids**, and heroin can induce amenorrhea.

Primary amenorrhea

However, the main cause is a delay in the beginning of puberty either from natural reasons (such as heredity or poor **nutrition**) or because of a problem in the endocrine system, such as a pituitary tumor or **hypothyroidism**. An obstructed flow tract or inflammation in the uterus may be the presenting indications of an underlying metabolic, endocrine, congenital or gynecological disorder.

Typical causes of primary amenorrhea include:

- excessive physical activity
- drastic weight loss (such as occurs in anorexia or bulimia)
- extreme obesity
- drugs (antidepressants or tranquilizers)
- chronic illness
- Turner's syndrome (a chromosomal problem in place at birth, relevant only in cases of primary amenorrhea)
- the absence of a vagina or a uterus
- imperforate hymen (lack of an opening to allow the menstrual blood through)

Secondary amenorrhea

Some of the causes of primary amenorrhea can also cause secondary amenorrhea—strenuous physical activity, excessive weight loss, use of antidepressants or tranquilizers, in particular. In adolescents, **pregnancy** and **stress** are two major causes. Missed periods are usually caused in adolescents by stress and changes in environment. Adolescents are especially prone to irregular periods with fevers, weight loss, changes in environment, or increased physical or athletic activity. However, any cessation of periods for four months should be evaluated.

The most common cause of seconardy amenorrhea is pregnancy. Also, a woman's periods may halt temporarily after she stops taking birth control pills. This temporary halt usually lasts only for a month or two, though in some cases it can last for a year or more. Secondary amenorrhea may also be related to hormonal problems related to stress, depression,

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anorexia nervosa or drugs, or it may be caused by any condition affecting the ovaries, such as a tumor. The cessation of menstruation also occurs permanently after **menopause** or a **hysterectomy**.

Diagnosis

It may be difficult to find the cause of amenorrhea, but the exam should start with a pregnancy test; pregnancy needs to be ruled out whenever a woman's period is two to three weeks overdue. Androgen excess, estrogen deficiency, or other problems with the endocrine system need to be checked. Prolactin in the blood and the thyroid stimulating hormone (TSH) should also be checked.

The diagnosis usually includes a patient history and a physical exam (including a **pelvic exam**). If a woman has missed three or more periods in a row, a physician may recommend blood tests to measure hormone levels, a scan of the skull to rule out the possibility of a pituitary tumor, and ultrasound scans of the abdomen and pelvis to rule out a tumor of the adrenal gland or ovary.

Treatment

Treatment of amenorrhea depends on the cause. Primary amenorrhea often requires no treatment, but it's always important to discover the cause of the problem in any case. Not all conditions can be treated, but any underlying condition that is treatable should be treated.

If a hormonal imbalance is the problem, progesterone for one to two weeks every month or two may correct the problem. With **polycystic ovary syndrome**, birth control pills are often prescribed. A pituitary tumor is treated with bromocriptine, a drug that reduces certain hormone (prolactin) secretions. Weight loss may bring on a period in an obese woman. Easing up on excessive exercise and eating a proper diet may bring on periods in teen athletes. In very rare cases, surgery may be needed for women with ovarian or uterine cysts.

Prognosis

Prolonged amenorrhea can lead to **infertility** and other medical problems such as **osteoporosis** (thinning of the bones). If the halt in the normal period is caused by stress or illness, periods should begin again when the stress passes or the illness is treated. Amenorrhea that occurs with discontinuing birth control pills usually go away within six to eight weeks, although it may take up to a year.

The prognosis for polycystic ovary disease depends on the severity of the symptoms and the treatment plan. Spironolactone, a drug that blocks the production of male hormones, can help in reducing body hair. If a woman wishes to become pregnant, treatment with clomiphene may be required or, on rare occasions, surgery on the ovaries.

Prevention

Primary amenorrhea caused by a congenital condition cannot be prevented. In general, however, women should maintain a healthy diet, with plenty of exercise, rest, and not too much stress, avoiding **smoking** and **substance abuse**. Female athletes should be sure to eat a balanced diet and rest and exercise normally. However, many cases of amenorrhea cannot be prevented.

ORGANIZATIONS

American College of Obstetricians and Gynecologists (ACOG), PO Box 96920, Washington, DC, 20090-6920, (202) 638-5577, http://www.acog.org.

American College of Obstetricians and Gynecologists, PO Box 96920, Washington, DC, 20090-6920, (202) 638-5577, http://www.acog.org.

Feminist Women's Health Center, 106 East E Street, Yakima, WA, 98901, (800) 572-4223, http://www.fwhc.org.

Carol A. Turkington

Amikiacin *see* **Aminoglycosides**

Amiloride *see* **Diuretics**

Amino acid disorders screening

Definition

Amino acid disorder screening checks for inherited disorders in amino acid metabolism. Tests are most commonly done on newborns. Two tests are available, one using a blood sample and the other a urine sample.

Purpose

Amino acid disorder screening is done in newborns, and sometimes children and adults, to detect inborn errors in metabolism of amino acids. 20 of the 100 known amino acids are the main building blocks for human proteins. Proteins regulate every aspect of cellular function. Of these 20 amino acids, ten are not

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KEY TERMS

Amino acid—An organic compound composed of both an amino group and an acidic carboxyl group; amino acids are the basic building blocks of proteins.

Aminoaciduria—The abnormal presence of amino acids in the urine.

Chromatography—A family of laboratory techniques that separate mixtures of chemicals into their individual components.

Enzyme—A biological catalyst that increases the rate of a chemical reaction without being used up in the reaction.

Metabolism—The sum of all the chemical and energy reactions that take place in the human body.

made by the body and must be acquired through diet. Congenital (present at birth) enzyme deficiencies that affect amino acid metabolism or congenital abnormalities in the amino acid transport system of the kidneys creates a condition called aminoaciduria.

Screening is especially important in newborns. Some congenital amino acid metabolic defects cause **mental retardation** that can prevented with prompt treatment of the newborn. One of the best known examples of this is **phenylketonuria** (PKU). This is a genetic error in metabolism of phenylalanine, an amino acid found in milk. Individuals with PKU do not produce the enzyme necessary to break down phenylalanine.

PKU occurs in about one out of 16,000 live births in the United States, but is more prevalent in caucasians and less prevalent in Ashkenazi Jews and African Americans. Newborns in the United States are routinely screened for PKU by a blood test.

There are two types of aminoacidurias. Primary or overflow aminoaciduria results from deficiencies in the enzymes necessary to metabolize amino acids. Overflow aminoaciduria is best detected by a blood plasma test.

Secondary or renal aminoaciduria occurs because of a congenital defect in the amino acid transport system in the tubules of the kidneys. This produces increased amino acids in the urine. Blood and urine test in combination are used to determine if the aminoaciduria is of the overflow or renal type. Urine tests are also used to monitor specific amino acid disorders.

Newborns are screened for amino acid disorders. Young children with acidosis (accumulation of acid in the body), severe **vomiting** and **diarrhea**, or urine with an abnormal color or odor, are also screened with a urine test for specific amino acid levels.

Precautions

Both blood and urine tests are simple tests that can be done in a doctor's office or clinic. These tests can be done on even the youngest patients.

Description

Two types of amino acid screening tests are used together to diagnose amino acid disorders.

Blood plasma screening

In the blood test, a medical technician draws a small amount of blood from a baby's heel. The procedure is rapid and relatively painless. Total time for the test is less than ten minutes. The blood is sent to a laboratory where results will be available in about two days.

Urine test

In the urine test, the patient is asked to urinate into a collecting cup. For an infant, the urine is collected in a pediatric urine collector. The process is painless. The length of time the test takes is determined by how long it takes the patient to urinate. Results also take about two days.

Both these tests use thin layer chromatography to separate the amino acids present. Using this technique, the amino acids form a characteristic patterns on a glass plate coated with a thin layer of silica gel. This pattern is then compared to the normal pattern to determine if there are abnormalities.

Preparation

Before the blood test, the patient must not eat or drink for four hours. Failure to fast will alter the results of the test.

The patient should eat and drink normally before the urine test. Some drugs may affect the results of the urine test. The technician handling the urine sample should be informed of any medications the patient is taking. Mothers of **breastfeeding** infants should report any medications they are taking, since these can pass from mother to child in breast milk.

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Aftercare

The blood screening is normally done first. Depending on the results, it is followed by the urine test. It takes both tests to distinguish between overflow and renal aminoaciduria. Also, if the results are abnormal, a 24-hour urine test is performed along with other tests to determine the levels of specific amino acids. In the event of abnormal results, there are many other tests that will be performed to determine the specific amino acid involved in the abnormality.

Risks

There are no particular risks associated with either of these tests. Occasionally minor bruising may occur at the site where the blood was taken.

Normal results

The pattern of amino acid banding on the thin layer chromatography plates will be normal.

Abnormal results

The blood plasma amino acid pattern is abnormal in overflow aminoaciduria and is normal in renal aminoaciduria. The pattern is abnormal in the urine test, suggesting additional tests need to be done to determine which amino acids are involved. In addition to PKU, a variety of other amino acid metabolism disorders can be detected by these tests, including tyrosinosis, histidinemia, maple syrup urine disease, hypervalinemia, hyperprolinemia, and homocystinuria.

ORGANIZATIONS

Association for Neuro-Metabolic Disorders, 5223 Brookfield Lane, Sylvania, OH, 43560-1809, (419) 885-1809.

Children's PKU Network (CPN), 3790 Via De La Valle, Ste 120, Del Mar, CA, 92014, (858) 509-0767, (858) 509-0768, (800) 377-6677, pkunetwork@aol.com, http://www.pkunetwork.org/.

National Society for Phenylketonuria, PO Box 26642, London, England, N14 4ZF, 440208 364 3010, info@nspku.org, http://www.nspku.org/.

Tish Davidson A.M.

Aminoglycosides

Definition

Aminoglycosides are a group of **antibiotics** that are used alone or in combination with other antibiotics to treat bacterial infections. This group of antibiotics includes at least eight drugs: amikacin, gentamicin, kanamycin, neomycin, netilmicin, paromomycin, streptomycin, and tobramycin. All of these drugs have the same basic chemical structure.

Purpose

Aminoglycosides are primarily used to combat infections due to aerobic, Gram-negative bacteria. These bacteria can be identified by their reaction to Gram's stain. In Gram's staining, a film of material containing the possible bacteria is placed on a glass slide and dried. The slide is stained with crystal violet for one minute, cleaned off with water and then placed into a solution of Gram's iodine solution for one minute. The iodine solution is rinsed off and the slide is immersed in 95% ethyl alcohol. The slide is then stained again with reddish carbolfuchsin or safranine for 30 seconds, rinsed in water, dried and examined. Gram-positive bacteria retain the violet purple stain. Gram-negative bacteria accept the red stain. Bacteria that can successfully be combated with aminoglycosides include *Pseudomonas*, *Acinetobacter*, and *Enterobacter* species, among others. Streptomycin is also effective against mycobacteria, the bacteria responsible for **tuberculosis**.

Although the aminoglycosides can be used against certain Gram-positive bacteria, they are not typically employed as a first-line treatment because other antibiotics are more effective with fewer side effects. Aminoglycosides are relatively ineffective against anaerobic bacteria (bacteria that grow in the absence of oxygen) and fungi. Only one aminoglycoside, paromomycin, is used to treat parasitic infection. Like all other antibiotics, aminoglycosides are not effective against **influenza**, the **common cold**, or other viral infections.

Description

U.S. brand names

Aminoglycosides are manufactured under many brand names. Some U.S. brand names are as follows:

- tobramycin—AkTob, TOBI, Tobrex
- gentamycin—Gentak, Gentasol
- amikacin—Amikin
- neomycin—NeoFradin, Neo-Rx
- kanamycin—Kantrex

Canadian brand names

Some Candian brand names for aminoglycoside drugs include:

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KEY TERMS

Aerobic bacteria—Bacteria that require oxygen in order to grow and survive.

Anaerobic bacteria—Bacteria that cannot grow or reproduce in the presence of oxygen.

Eighth cranial nerve disease—A disorder affecting the eighth cranial nerve, characterized by a loss of hearing and/or balance.

Gram-negative—Referring to bacteria that take on a pink color when exposed to Gram's stain.

Gram-positive—Referring to bacteria that takes on a purplish-black color when exposed to Gram's stain.

Gram's stain—A stain used in microbiology to classify bacteria and help identify the species to which they belong. This identification aids in determining treatment.

Kidney (renal) disease—Any disorder that impairs the kidney's ability to remove waste and toxins from the body.

Myasthenis gravis—A neuromuscular disease characterized by muscle weakness in the limbs and face.

Parkinson's disease—A neurological disorder caused by deficiency of dopamine, a neurotransmitter, which is a chemical that assists in transmitting messages between the nerves within the brain. It is characterized by muscle tremor or palsy and rigid movements.

- tobramycin—PMS-Tobramycin, Sandoz-Tobramycin, TOBI, Tobrex
- gentamycin—Alomicin, Diogent, Garamycin, Garamycin Injectable
- amikacin—Amikin, Amikacin Sulfate Injectable

Streptomycin, the first aminoglycoside, was isolated from *Streptomyces griseus* in the mid-1940s. This antibiotic proved to be very effective against tuberculosis. One of the main drawbacks to streptomycin is its toxicity, especially to cells in the inner and middle ear and the kidney. Furthermore, some strains of tuberculosis are resistant to treatment with streptomycin. Therefore, medical researchers have put considerable effort into identifying other antibiotics with streptomycin's effectiveness, but without its toxicity.

Aminoglycosides are absorbed very poorly from the gastrointestinal tract; in fact, aminoglycosides taken by mouth are excreted virtually unchanged and undiminished in quantity. The route of drug administration depends on the type and location of the infection being treated. The typical routes of administration are by intramuscular (injection into a muscle) or intravenous injection (injection into a vein), irrigation, topical skin application, or inhalation. If the infection being treated involves the central nervous system, the drug can be injected directly into the fluid of the spinal canal.

The way in which aminoglycosides stop bacterial growth has not been fully explained. It is known that the drug attaches to a bacterial cell wall and is drawn into the cell via channels made up of the protein porin. Once inside the cell, the aminoglycoside attaches to the cell's ribosomes. Ribosomes are the intracellular structures responsible for manufacturing proteins. This attachment either shuts down protein production or causes the cell to produce abnormal, ineffective proteins. The bacterial cell cannot survive with this impediment.

Antibiotic treatment using aminoglycosides may pair the drug with a second type of antibiotic, usually a beta-lactam or vancomycin, administered separately. Beta-lactams disrupt the integrity of the bacteria cell wall, making it more porous. The increased porosity allows more of the aminoglycoside into the bacteria cell.

Recommended dosage

Dosage depends on the patient's age, weight, gender, and general health. Since the drug is removed from the body by the kidneys, it is important to assess any underlying problems with kidney function. Kidney function is assessed by measuring the blood levels of creatinine, a protein normally found in the body. If these levels are high, it is an indication that the kidneys may not be functioning at an optimal rate and dosage will be lowered accordingly.

Traditionally, aminoglycosides were administered at even doses given frequently throughout the day. It was thought that a steady concentration of the drug in the blood was necessary to combat infection. However, this administration schedule is time and labor intensive. Furthermore, administering doses 8-12 hours apart can be as effective.

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Precautions

All pre-existing medical conditions, especially **kidney disease**, **liver disease**, eighth cranial nerve disease, **myasthenia gravis**, and Parkinson's diseases, should be discussed with the prescribing physician before taking any aminoglycosides.

Pregnant or breastfeeding

Pregnant women are usually advised against taking aminoglycosides, because it may cause damage to the fetus's hearing, kidneys, or sense of balance. However, those risks need to be considered alongside the threat to the mother's health and life in cases of serious infection. Aminoglycosides do not pass into breast milk to any great extent, so nursing mothers may be prescribed aminoglycosides without harming their infant.

Pediatric

Children are more likely to experience side effects from aminoglycosides. These medications should only be prescribed when the benefits outweigh the risks.

Geriatric

The elderly are especially sensitive to the side effects of aminoglycosides. These patients need to pay close attention to any new symptoms and should discuss them with a physician.

Side effects

Aminoglycosides have been shown to be toxic to certain cells in the ears and in the kidneys. Approximately 5–10% of people who are treated with aminoglycosides experience some side effect impairing their hearing, sense of balance, or kidneys. In most cases the damage is minor and reversible once medication is stopped.

If cells in the inner ear are damaged or destroyed, an individual may experience a loss of balance and feelings of **dizziness**. Damage to the middle ear may result in **hearing loss** or **tinnitus**. Neomycin, kanamycin, and amikacin are the most likely to cause problems with hearing, and streptomycin and gentamicin carry the greatest risk of causing vertigo and loss of balance. Kidney damage, apparent with changes in urination frequency or urine production, is most likely precipitated by neomycin, tobramycin, and gentamicin.

Young children and the elderly are at the greatest risk of experiencing side effects. Excessive dosage or poor clearance of the drug from the body can be injurious at any age.

Less common side effects include skin **rashes** and **itching**. Very rarely, certain aminoglycosides may cause difficulty in breathing, weakness, or drowsiness. Gentamicin, when injected, may cause leg cramps, skin rash, **fever**, or seizures.

If side effects linger or become worse after medication is stopped, it is advisable to seek medical advice. Side effects that may be of concern include tinnitus or loss of hearing, dizziness or loss of balance, changes in urination frequency or urine production, increased thirst, appetite loss, and **nausea** or **vomiting**.

Interactions

Individual aminoglycoside drugs can have multiple interactions with other drugs. Patients who are prescribed aminoglycosides should ask their health care provider for a list of interactions specific to the aminoglycoside preparation they are taking.

Resources

BOOKS

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Levison, Matthew E. "Aminoglycosides." *Merck Manuals Online Medical Library*. July 2009. http://www.merck. com/mmpe/sec14/ch170/ch170b.html accessed July 22, 2010.

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Amitriptyline *see* **Antidepressant drugs, tricyclic**

Amlodipine *see* **Calcium channel blockers**

Amnesia

Definition

Amnesia refers to the loss of memory. **Memory loss** may result from two-sided (bilateral) damage to parts of the brain vital for memory storage,

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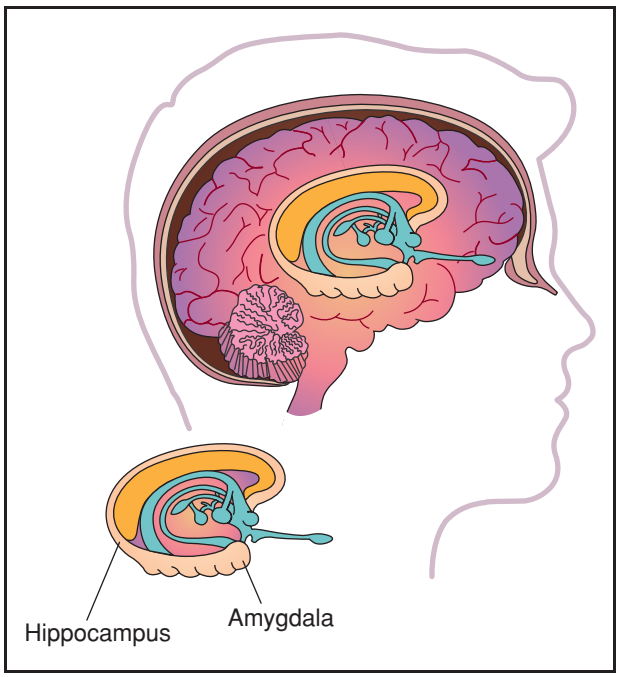
processing, or recall (the limbic system, including the hippocampus in the medial temporal lobe).

Description

Amnesia can be a symptom of several neurodegenerative diseases; however, people whose primary symptom is memory loss (amnesiacs), typically remain lucid and retain their sense of self. They may even be aware that they suffer from a memory disorder.

People who experience amnesia have been instrumental in helping brain researchers determine how the brain processes memory. Until the early 1970s, researchers viewed memory as a single entity. Memory of new experiences, motor skills, past events, and previous conditioning were grouped together in one system that relied on a specific area of the brain.

If all memory were stored in the same way, it would be reasonable to deduce that damage to the specific brain area would cause complete memory loss. However, studies of amnesiacs counter that theory. Such research demonstrates that the brain has multiple systems for processing, storing, and drawing on memory.



Memory loss may result from bilateral damage to the limbic system of the brain responsible for memory storage, processing, and recall. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Causes and symptoms

Amnesia has several root causes. Most are traceable to brain injury related to physical trauma, disease, infection, drug and alcohol **abuse**, or reduced blood flow to the brain (vascular insufficiency). In Wernicke-Korsakoff syndrome, for example, damage to the memory centers of the brain results from the use of alcohol or **malnutrition**. Infections that damage brain tissue, including **encephalitis** and herpes, can also cause amnesia. If the amnesia is thought to be of psychological origin, it is termed psychogenic.

There are at least three general types of amnesia:

- Anterograde. This form of amnesia follows brain trauma and is characterized by the inability to remember new information. Recent experiences and short-term memory disappear, but victims can recall events prior to the trauma with clarity.
- Retrograde. In some ways, this form of amnesia is the opposite of anterograde amnesia: the victim can recall events that occurred after a trauma, but cannot remember previously familiar information or the events preceding the trauma.
- Transient global amnesia. This type of amnesia has no consistently identifiable cause, but researchers have suggested that migraines or transient ischemic attacks may be the trigger. (A transient ischemic attack, sometimes called "a small stroke," occurs when a blockage in an artery temporarily blocks off blood supply to part of the brain.) A victim experiences sudden confusion and forgetfulness. Attacks can be as brief as 30–60 minutes or can last up to 24 hours. In severe attacks, a person is completely disoriented and may experience retrograde amnesia that extends back several years. While very frightening for the patient, transient global amnesia generally has an excellent prognosis for recovery.

Diagnosis

In diagnosing amnesia and its cause, doctors look at several factors. During a **physical examination**, the doctor inquires about recent traumas or illnesses, drug and medication history, and checks the patient's general health. Psychological exams may be ordered to determine the extent of amnesia and the memory system affected. The doctor may also order imaging tests such as **magnetic resonance imaging** (MRI) to reveal whether the brain has been damaged, and blood work to exclude treatable metabolic causes or chemical imbalances.

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KEY TERMS

Classical conditioning—The memory system that links perceptual information to the proper motor response. For example, Ivan Pavlov conditioned a dog to salivate when a bell was rung.

Emotional conditioning—The memory system that links perceptual information to an emotional response. For example, spotting a friend in a crowd causes a person to feel happy.

Explicit memory—Conscious recall of facts and events that is classified into episodic memory (involves time and place) and semantic memory (does not involve time and place). For example, an amnesiac may remember he has a wife (semantic memory), but cannot recall his last conversation with her (episodic memory).

Limbic system—The brain structures involved in memory.

Magnetic resonance imaging (MRI)—MRI uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

Motor skill learning—This memory system is associated with physical movement and activity. For example, learning to swim is initially difficult, but once an efficient stroke is learned, it requires little conscious effort.

Neurodegenerative disease—A disease in which the nervous system progressively and irreversibly deteriorates.

Priming memory—The memory system that joins perceptual and conceptual representations.

Transient ischemic attack—A sudden and brief blockage of blood flow in the brain.

Working memory—The memory system that relates to the task at hand and coordinates recall of memories necessary to complete it.

Treatment

Treatment depends on the root cause of amnesia and is handled on an individual basis. Regardless of cause, cognitive **rehabilitation** may be helpful in learning strategies to cope with memory impairment.

Prognosis

Some types of amnesia, such as transient global amnesia, are completely resolved and there is no permanent loss of memory. Others, such as Korsakoff syndrome, associated with prolonged alcohol abuse or amnesias caused by severe brain injury, may be permanent. Depending on the degree of amnesia and its cause, victims may be able to lead relatively normal lives. Amnesiacs can learn through therapy to rely on other memory systems to compensate for what is lost.

Prevention

Amnesia is only preventable in so far as brain injury can be prevented or minimized. Common sense approaches include wearing a helmet when bicycling or participating in potentially dangerous sports, using automobile seat belts, and avoiding excessive alcohol or drug use. Brain infections should be treated swiftly and aggressively to minimize the damage due to swelling. Victims of strokes, brain aneurysms, and transient ischemic attacks should seek immediate medical treatment.

Resources

PERIODICALS

Squire, Larry R., and Stuart M. Zola. "Amnesia, Memory and Brain Systems." *Philosophical Transactions of the Royal Society of London, Series B* 352 (1997): 1663.

Julia Barrett

Amniocentesis

Definition

Amniocentesis is a procedure used to diagnose fetal defects in the early second trimester of **pregnancy**. A sample of the amniotic fluid, which surrounds a fetus in the womb, is collected through a pregnant woman's abdomen using a needle and syringe. Tests performed on fetal cells found in the amniotic fluid can reveal the presence of many types of genetic disorders as well as the sex of the fetus. Early diagnosis allows doctors and prospective parents to make important decisions about treatment and intervention prior to birth.

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A physician uses an ultrasound monitor (left) to position the needle for insertion into the amnion when performing amniocentesis. *(Will & Deni McIntyre/Photo Researchers, Inc.)*

Purpose

Since the mid-1970s, amniocentesis has been used routinely to test for **Down syndrome**, by far the most common, nonhereditary, genetic birth defect, afflicting about one in every 1,000 babies. More than 800 different diagnostic tests are available, most of them for hereditary genetic disorders such as **Tay-Sachs disease**, **sickle cell disease**, **hemophilia**, **muscular dystrophy**, and **cystic fibrosis**. Amniocentesis also can be used to assess lung development in the fetus, detect Rh disease, and detect neural tube defects such as **spina bifida**. Although the test is not used for this purpose, the sex of the baby can be determined.

Description

Amniocentesis, often called amnio, is recommended for women who will be older than 35 on their due date. It is also recommended for women who have already borne children with **birth defects**, or when either of the parents has a family history of a birth defect for which a diagnostic test is available. Another reason for the procedure is to confirm indications of Down syndrome and certain other defects (e.g., neural tube defects) that may have shown up previously during routine maternal blood screening.

The risk of bearing a child with a nonhereditary genetic defect such as Down syndrome is directly related to a woman's age—the older the woman, the greater the risk. Thirty-five is the recommended age to begin amniocentesis testing because that is the age at which the risk of carrying a fetus with such a defect roughly equals the risk of **miscarriage** caused by the procedure, which is about one in 200. At age 25, the risk of giving birth to a child with this type of defect is about one in 1,400; by age 45, it increases to about one in 20. All pregnant women over 35 in the United States are encouraged to undergo amniocentesis, and many younger women also decide to have the procedure. Notably, some 75% of all Down syndrome infants born in the United States each year are to women younger than 35. In January 2007, the American College of Obstetricians and Gynecologists issued a

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KEY TERMS

Alpha-fetoprotein (AFP)—A protein normally produced by the liver of a fetus and detectable in maternal blood samples. AFP screening measures the amount of alpha-fetoprotein in the blood. Levels outside the norm may indicate fetal defects.

Chorionic villus sampling (CVS)—A procedure similar to amniocentesis, except that cells are taken from the chorionic membrane for testing. These cells, called chorionic villus cells, eventually become the placenta. The samples are collected either through the abdomen, as in amniocentesis, or through the vagina. CVS can be done earlier in the pregnancy than amniocentesis, but carries a somewhat higher risk.

Chromosomes—Chromosomes are the strands of genetic material in a cell that occur in nearly identical pairs. Normal human cells contain 23 chromosome pairs—one in each pair inherited from the mother, and one from the father.

Down syndrome—The most prevalent of a class of genetic defects known as trisomies, in which cells contain three copies of certain chromosomes rather than the usual two. Down syndrome, or trisomy 21, usually results from three copies of chromosome 21.

Hereditary—Something that is inherited or passed down from parents to offspring. In biology and medicine, the word pertains to inherited genetic characteristics.

Maternal blood screening—Maternal blood screening is normally done early in pregnancy to test for a variety of conditions. Abnormal amounts of certain proteins in a pregnant woman's blood raise the probability of fetal defects. Amniocentesis is recommended if such a probability occurs.

Rh disease—The Rh factor is a genetically determined antigen on red blood cells that produce immune responses. If an Rh-negative woman is pregnant with an Rh-positive fetus, her body will produce antibodies against the fetus's blood, causing a disease known as Rh disease. Sensitization to the disease occurs when the women's blood is exposed to the fetus's blood. Rh immune globulin (RhoGAM) is a vaccine that must be given to a woman after an abortion, miscarriage, or prenatal tests in order to prevent sensitization to Rh disease.

Tay-Sachs disease—An inherited disease prevalent among the Ashkenazi Jewish population of the United States. Infants with the disease are unable to process a certain type of fat that accumulates in nerve and brain cells, causing mental and physical retardation, and death by age four.

Ultrasound—A technique that uses high-frequency sound waves to create a visual image (a sonogram) of soft tissues. The technique is routinely used in prenatal care and diagnosis.

recommendation that all pregnant patients be offered the option of amniocentesis testing, regardless of maternal age.

One of the most common reasons for performing amniocentesis is an abnormal alpha-fetoprotein (AFP) test. Alpha-fetoprotein is a protein produced by the fetus and present in the mother's blood. A simple blood screening, usually conducted around the fifteenth week of pregnancy, can determine the AFP levels in the mother's blood. Levels that are too high or too low may signal possible fetal defects. Because this test has a high false-positive rate, another test such as amniocentesis is recommended whenever the AFP levels fall outside the normal range.

Amniocentesis is generally performed during the sixteenth week of pregnancy, with results usually available within three weeks. It is possible to perform amniocentesis as early as the eleventh week, but this is not usually recommended because there appears to be an increased risk of miscarriage when done at this time. The advantage of early amniocentesis and speedy results lies in the extra time for decision making if a problem is detected. Potential treatment of the fetus can begin earlier. Important, also, is the fact that elective abortions are safer and less controversial the earlier they are performed.

Precautions

As an invasive surgical procedure, amniocentesis poses a real, although small, risk to the health of a fetus. Parents must weigh the potential value of the knowledge gained, or indeed the reassurance that all is well, against the small risk of miscarriage. The serious emotional and ethical dilemmas that adverse test

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results can bring must also be considered. The decision to undergo amniocentesis is always a matter of personal choice.

Description

The word amniocentesis literally means "puncture of the amnion," the thin-walled sac of fluid in which a developing fetus is suspended during pregnancy. During the procedure, the obstetrician inserts a very fine needle through the woman's abdomen into the uterus and the amniotic sac and withdraws approximately 1 oz (28.3 g) of amniotic fluid for testing. The relatively painless procedure is performed on an outpatient basis, sometimes using **local anesthesia**.

The physician uses ultrasound images to guide needle placement and collect the sample, thereby minimizing the risk of fetal injury and the need for repeated needle insertions. Once the sample is collected, the woman can return home after a brief observation period. She may be instructed to rest for the first 24 hours and to avoid heavy lifting for two days.

The sample of amniotic fluid is sent to a laboratory where fetal cells contained in the fluid are isolated and grown in order to provide enough genetic material for testing. This takes about seven to 14 days. The material is then extracted and treated so that visual examination for defects can be made. For some disorders, like Tay-Sachs, the simple presence of a telltale chemical compound in the amniotic fluid is enough to confirm a diagnosis. Depending on the specific tests ordered, and the skill of the lab conducting them, all the results are available one to four weeks after the sample is taken.

Cost of the procedure depends on the doctor, the lab, and the tests ordered. Most insurers provide coverage for women over 35, as a follow-up to positive maternal blood screening results, and when genetic disorders run in the family.

An alternative to amniocentesis now in general use, is **chorionic villus sampling** (CVS), which can be performed as early as the eighth week of pregnancy. While this allows for the possibility of a first-trimester abortion, if warranted, CVS is apparently also riskier and is more expensive. The most promising area of new research in prenatal testing involves expanding the scope and accuracy of maternal blood screening as this poses no risk to the fetus.

Preparation

It is important for a woman to fully understand the procedure and to feel confident in the obstetrician performing it. Evidence suggests that a physician's experience with the procedure reduces the chance of mishap. Almost all obstetricians are experienced in performing amniocentesis. The patient should feel free to ask questions and seek emotional support before, during, and after amniocentesis is performed.

Aftercare

Necessary aftercare falls into two categories: physical and emotional.

Physical aftercare

During and immediately following the sampling procedure, a woman may experience **dizziness**, **nausea**, a rapid heartbeat, and cramping. Once past these immediate hurdles, the physician will send the woman home with instructions to rest and to report any complications requiring immediate treatment, including:

- Vaginal bleeding. The appearance of blood could signal a problem
- Premature labor. Unusual abdominal pain and/or cramping may indicate the onset of premature labor. Mild cramping for the first day or two following the procedure is normal
- Signs of infection. Leaking of amniotic fluid or unusual vaginal discharge, and fever could signal the onset of infection

Emotional aftercare

Once the procedure has been safely completed, the **anxiety** of waiting for the test results can prove to be the worst part of the process. A woman should seek and receive emotional support from family and friends, as well as from her obstetrician and family doctor. Professional counseling may also prove necessary, particularly if a fetal defect is detected.

Risks

Most of the risks and short-term side effects associated with amniocentesis relate to the sampling procedure. A successful amniocentesis sampling results in no long-term side effects. Risks include:

- Maternal/fetal hemorrhaging. While spotting in pregnancy is fairly common, bleeding following amniocentesis should always be investigated.
- Infection. Infection, although rare, can occur after amniocentesis. An unchecked infection can lead to severe complications.
- Fetal injury. A very slight risk of injury to the fetus resulting from contact with the amniocentesis needle does exist.

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- Miscarriage. The rate of miscarriage occurring during standard, second-trimester amniocentesis is approximately 0.5%. This compares to a miscarriage rate of 1% for CVS. Many fetuses with severe genetic defects miscarry naturally during the first trimester.
- The trauma of difficult family-planning decisions. The threat posed to parental and family mental health from the trauma accompanying an abnormal test result can not be underestimated.

Normal results

Negative results from an amniocentesis analysis indicate that everything about the fetus appears normal and the pregnancy can continue without undue concern. A negative result for Down syndrome means that it is 99% certain that the disease does not exist.

An overall "normal" result does not, however, guarantee that the pregnancy will come to term, or that the fetus does not suffer from some other defect. Laboratory tests are not 100% accurate at detecting targeted conditions, nor can is there a test for every possible fetal condition.

Abnormal results

Positive results on an amniocentesis analysis indicate the presence of a fetal defect, with an accuracy approaching 100%. With such a diagnosis, prospective parents face emotionally and ethically difficult choices regarding prenatal treatment options, the prospect of treating the defect at birth, and the option of elective abortion. At this point, the parents need expert medical advice and counseling.

Resources

OTHER

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Prenatal Testing. MedlinePlus December 22, 2009. http://www.nlm.nih.gov/medlineplus/prenataltesting.html

Routine Tests in Pregnancy. American Congress of Obstetricians and Gynecologists. January 2009. http://www.acog.org/publications/patient_education/bp133.cfm

ORGANIZATIONS

American College of Obstetricians and Gynecologists, P.O. Box 96920, Washington, DC, 20090-6920 (202) 638-5577, http://www.acog.org.

American Pregnancy Association, 431 Greenway Drive, Suite 800, Irving, TX, 75038 (972) 550-0140 (972) 550-0800, Questions@AmericanPregnancy.org, http://www.americanpregnancy.org.

March of Dimes Foundation, 1275 Mamaroneck Avenue, White Plains, NY, 10605 (914)997-4488, askus@marchofdimes.com, http://www.marchofdimes.com.

National Society of Genetic Counselors, 401 N. Michigan Avenue, Chicago, IL, 60611 (312) 321-6834 (312) 673-6972, nsgc@nsgc.org, http://www.nsgc.org.

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Amniotic fluid analysis *see* **Amniocentesis**

Amoxicillin *see* **Penicillins**

Amphetamines *see* **Central nervous system stimulants**

Amphotericin B *see* **Antifungal drugs, systemic**

Amputation

Definition

Amputation is the intentional surgical removal of a limb or body part. It is performed to remove diseased tissue or relieve **pain**.

Purpose

Arms, legs, hands, feet, fingers, and toes can be amputated. Most amputations involve small body parts such as a finger, rather than an entire limb. About 65,000 amputations are performed in the United States each year.

Amputation is performed for the following reasons:

- to remove tissue that no longer has an adequate blood supply
- to remove malignant tumors
- because of severe trauma to the body part

The blood supply to an extremity can be cut off because of injury to the blood vessel, hardening of the arteries, **arterial embolism**, impaired circulation as a complication of **diabetes mellitus**, repeated severe infection that leads to **gangrene**, severe **frostbite**, **Raynaud's disease**, or **Buerger's disease**.

More than 90% of amputations performed in the United States are due to circulatory complications of diabetes. Sixty to eighty percent of these operations involve the legs or feet. Although attempts have been

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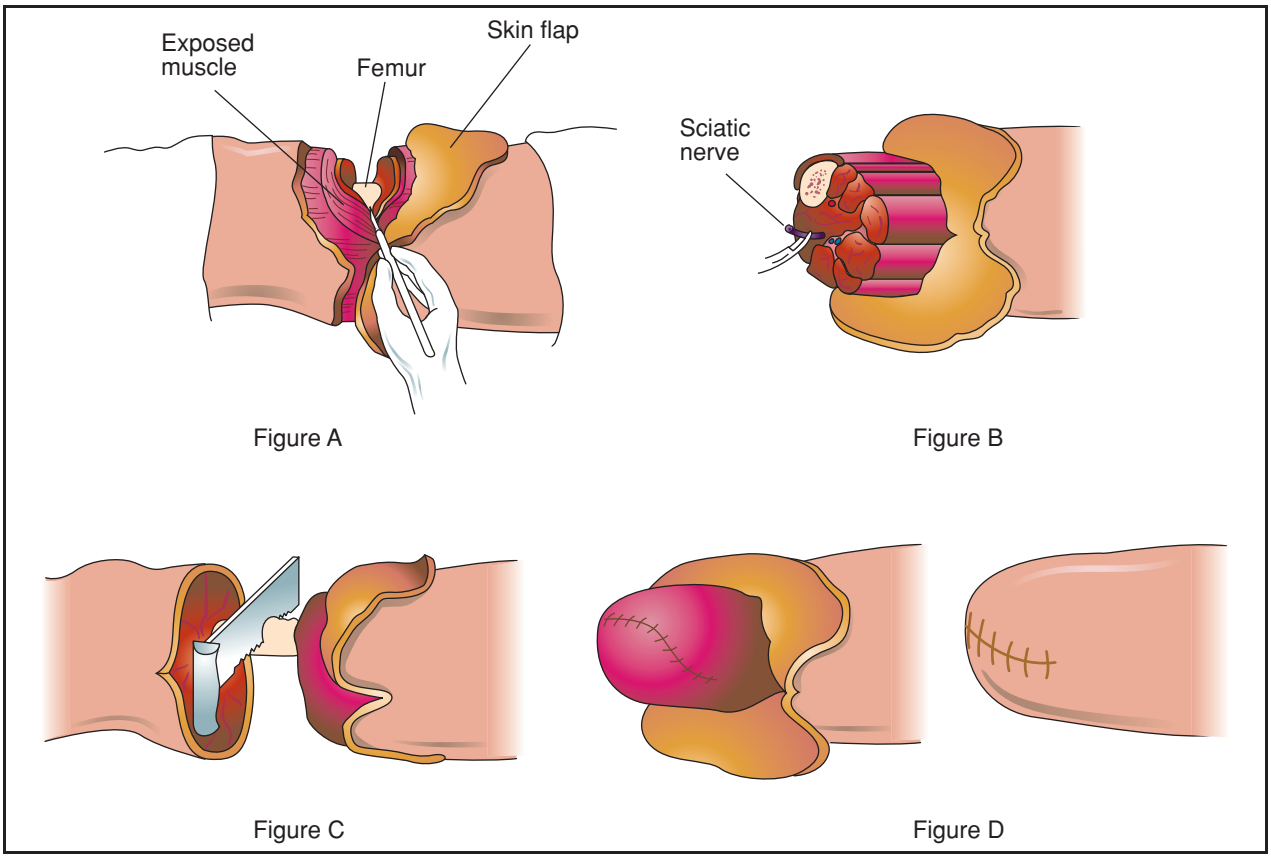

Amputation of leg. Figure A: After the surgeon creates two flaps of skin and tissue, the muscle is cut and the main artery and veins of the femur bone are exposed. Figure B: The surgeon severs the main artery and veins. New connections are formed between them, restoring blood circulation. The sciatic nerve is then pulled down, clamped and tied, and severed. Figure C: The surgeon saws through the exposed femur bone. Figure D: The muscles are closed and sutured over the bone. The remaining skin flaps are then sutured together, creating a stump. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

made in the United States to better manage diabetes and the foot ulcers that can be complications of the disease, the number of resulting amputations has not decreased.

Precautions

Amputations cannot be performed on patients with uncontrolled diabetes mellitus, **heart failure**, or infection. Patients with blood clotting disorders are also not good candidates for amputation.

Description

Amputations can be either planned or emergency procedures. Injury and arterial embolisms are the main reasons for emergency amputations. The operation is performed under regional or **general anesthesia** by a general or orthopedic surgeon in a hospital operating room.

Details of the operation vary slightly depending on what part is to be removed. The goal of all amputations is twofold: to remove diseased tissue so that the wound will heal cleanly, and to construct a stump that will allow the attachment of a prosthesis or artificial replacement part.

The surgeon makes an incision around the part to be amputated. The part is removed, and the bone is smoothed. A flap is constructed of muscle, connective tissue, and skin to cover the raw end of the bone. The flap is closed over the bone with sutures (surgical stitches) that remain in place for about one month. Often, a rigid dressing or cast is applied that stays in place for about two weeks.

Preparation

Before an amputation is performed, extensive testing is done to determine the proper level of amputation. The goal of the surgeon is to find the place

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KEY TERMS

Arterial embolism—A blood clot arising from another location that blocks an artery.

Buerger's disease—An episodic disease that causes inflammation and blockage of the veins and arteries of the limbs. It tends to be present almost exclusively on men under age 40 who smoke, and may require amputation of the hand or foot.

Diabetes mellitus—A disease in which insufficient insulin is made by the body to metabolize sugars.

Raynaud's disease—A disease found mainly in young women that causes decreased circulation to the hands and feet. Its cause is unknown.

where healing is most likely to be complete, while allowing the maximum amount of limb to remain for effective **rehabilitation**.

The greater the blood flow through an area, the more likely healing is to occur. These tests are designed to measure blood flow through the limb. Several or all of them can be done to help choose the proper level of amputation.

- measurement of blood pressure in different parts of the limb
- xenon 133 studies, which use a radiopharmaceutical to measure blood flow
- oxygen tension measurements in which an oxygen electrode is used to measure oxygen pressure under the skin. If the pressure is 0, the healing will not occur. If the pressure reads higher than 40 mm Hg (40 millimeters of mercury), healing of the area is likely to be satisfactory.
- laser Doppler measurements of the microcirculation of the skin
- skin fluorescent studies that also measure skin microcirculation
- skin perfusion measurements using a blood pressure cuff and photoelectric detector
- infrared measurements of skin temperature

No single test is highly predictive of healing, but taken together, the results give the surgeon an excellent idea of the best place to amputate.

Aftercare

After amputation, medication is prescribed for pain, and patients are treated with **antibiotics** to discourage infection. The stump is moved often to encourage good circulation. **Physical therapy** and rehabilitation are started as soon as possible, usually within 48 hours. Studies have shown that there is a positive relationship between early rehabilitation and effective functioning of the stump and prosthesis. Length of stay in the hospital depends on the severity of the amputation and the general health of the amputee, but ranges from several days to two weeks.

Rehabilitation is a long, arduous process, especially for above the knee amputees. Twice daily physical therapy is not uncommon. In addition, psychological counseling is an important part of rehabilitation. Many people feel a sense of loss and grief when they lose a body part. Others are bothered by phantom limb syndrome, where they feel as if the amputated part is still in place. They may even feel pain in the limb that does not exist. Many amputees benefit from joining self-help groups and meeting others who are also living with amputation. Addressing the emotional aspects of amputation often speeds the physical rehabilitation process.

Risks

Amputation is major surgery. All the risks associated with the administration of anesthesia exist, along with the possibility of heavy blood loss and the development of **blood clots**. Infection is of special concern to amputees. Infection rates in amputations average 15%. If the stump becomes infected, it is necessary to remove the prosthesis and sometimes to amputate a second time at a higher level.

Failure of the stump to heal is another major complication. Nonhealing is usually due to an inadequate blood supply. The rate of nonhealing varies from 5–30% depending on the facility. Centers that specialize in amputation usually have the lowest rates of complication.

Persistent pain in the stump or pain in the phantom limb is experienced by most amputees to some degree. Treatment of phantom limb pain is difficult. Finally, many amputees give up on the rehabilitation process and discard their prosthesis. Better fitting prosthetics and earlier rehabilitation have decreased the incidence of this problem. Researchers and prosthetic manufacturers continue to refine the materials and methods used to try to improve the comfort and function of prosthetic devices for amputees. For example, a 2004 study showed that a technique called the bone bridge amputation technique helped improve comfort and stability for transtibial amputees.

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Normal results

The five-year survival rate for all lower extremity amputees is less than 50%. For diabetic amputees, the rate is less than 40%. Up to 50% of people who have one leg amputated because of diabetes will lose the other within five years. Amputees who walk using a prosthesis have a less stable gait. Three to five percent of these people fall and break bones because of this instability. Although the **fractures** can be treated, about one-half of amputees who suffer them then remain wheelchair bound.

Resources

PERIODICALS

Edwards, Anthony R. "Study Helps Build Functional Bridges for Amputee Patients." *Biomechanics* (May 1, 2004): 17.

Jeffcoat, William. "Incidence of Amputation is a Poor Measure of the Quality of Ulcer Care." *The Diabetic Foot* Summer (2004): 70–74.

OTHER

Amputation Prevention Global Resource Center Page. http://www.diabetesresource.com.

ORGANIZATIONS

American Diabetes Association, 1701 North Beauregard Street, Alexandria, VA, 22311, (800) 342-2383, Ask ADA@diabetes.org, http://www.diabetes.org/.

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Amylase tests

Definition

Amylase is a digestive enzyme made primarily by the pancreas and salivary glands. Enzymes are substances made and used by the body to trigger specific chemical reactions. The primary function of the enzyme amylase is to break down starches in food so that they can be used by the body. Amylase testing is usually done to determine the cause of sudden abdominal **pain**.

Purpose

Amylase testing is performed to diagnose a number of diseases that elevate amylase levels. **Pancreatitis**, for example, is the most common reason for a high amylase level. When the pancreas is inflamed, amylase escapes from the pancreas into the blood. Within six to 48 hours after the pain begins, amylase levels in the blood start to rise. Levels will stay high for several days before gradually returning to normal.

KEY TERMS

Amylase—A digestive enzyme made primarily by the pancreas and salivary glands.

Enzyme—A substance made and used by the body to trigger specific chemical reactions.

Pancreatitis—Inflammation of the pancreas.

There are other causes of increased amylase. An ulcer that erodes tissue from the stomach and goes into the pancreas will cause amylase to spill into the blood. During a **mumps** infection, amylase from the inflamed salivary glands increases. Amylase is also found in the liver, fallopian tubes, and small intestine; inflammation of these tissues also increases levels. Gall bladder disease, tumors of the lung or ovaries, alcohol **poisoning**, ruptured **aortic aneurysm**, and intestinal strangulation or perforation can also cause unusually high amylase levels.

Precautions

This is not a screening test for future pancreatic disease.

Description

Amylase testing is done on both blood and urine. The laboratory may use any of several testing methods that involve mixing the blood or urine sample with a substance with which amylase is known to react. By measuring the end-product or the reaction time, technicians can calculate the amount of amylase present in the sample. More sophisticated methods separately measure the amylase made by the pancreas and the amylase made by the salivary glands.

Urine testing is a better long-term monitor of amylase levels. The kidneys quickly move extra amylase from the blood into the urine. Urine levels rise six to 10 hours after blood levels and stay high longer. Urine is usually collected throughout a 2- or 24-hour time period. Results are usually available the same day.

Preparation

In most cases, no special preparation is necessary for a person undergoing an amylase blood test. Patients taking longer term urine amylase tests will

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be given a container and instructions for collecting the urine at home. The urine should be refrigerated until it is brought to the laboratory.

Aftercare

Discomfort or bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Applying warm packs to the puncture site relieves discomfort.

Normal results

Normal results vary based on the laboratory and the method used.

Abnormal results

Eight out of ten persons with acute pancreatitis will have high amylase levels, up to four times the normal level. Other causes of increased amylase, such as mumps, kidney failure, **pregnancy** occurring in the abdomen but outside the uterus (**ectopic pregnancy**), certain tumors, a penetrating ulcer, certain complications of diabetes, and advanced pancreatic **cancer**, are further investigated based on the person's symptoms, medical history, and the results of other tests.

In **kidney disease**, the kidneys are not as efficient at removing amylase from the blood. Amylase rises in the blood, but stays at normal levels in the urine.

People with macroamylasia have large clumps of amylase in their blood. These clumps are too large to move through the kidney, so they stay in the blood. Amylase levels in the blood will be high; levels in the urine will be low.

Amylase levels may be low in severe **liver disease** (including hepatitis), conditions in which the pancreas fails to secrete enough enzyme for proper digestions (pancreatic insufficiency), when toxic materials build up in the blood during pregnancy (pre-eclampsia), following **burns**, in thyroid disorders, and in advanced **cystic fibrosis**. Some medications can raise or lower levels.

Resources

BOOKS

Pagana, Kathleen Deska, and Timothy J. Pagana. *Mosby's Manual of Diagnostic and Laboratory Tests*. 4th ed. St. Louis: Mosby, 2009.

Nancy J. Nordenson

Amyloidosis

Definition

Amyloidosis is a progressive, incurable, metabolic disease characterized by abnormal deposits of protein in one or more organs or body systems.

Demographics

Amyloidosis is a rare disease, occurring in about eight of every one million people. It affects males and females equally and usually develops after the age of 40.

Description

Amyloid proteins are manufactured by malfunctioning bone marrow. Amyloidosis, which occurs when accumulated amyloid deposits impair normal body function, can cause organ failure or **death**. At least 15 types of amyloidosis have been identified. Each one is associated with deposits of a different kind of protein.

Types of amyloidosis

The major forms of this disease are primary systemic, secondary, and familial or hereditary amyloidosis. Another form of amyloidosis is associated with **Alzheimer's disease**.

Primary systemic amyloidosis usually develops between the ages of 50 and 60. With about 2,000 new cases diagnosed annually, primary systemic amyloidosis is the most common form of this disease in the United States. Also known as light-chain-related amyloidosis, it may also occur in association with **multiple myeloma** (bone marrow **cancer**).

Secondary amyloidosis is a result of chronic infection or inflammatory disease. It is often associated with:

- familial Mediterranean fever (a bacterial infection characterized by chills, weakness, headache, and recurring fever)
- granulomatous ileitis (inflammation of the small intestine)
- Hodgkin's disease (cancer of the lymphatic system)
- leprosy
- osteomyelitits (bacterial infection of bone and bone marrow)
- rheumatoid arthritis

Familial or hereditary amyloidosis is the only inherited form of the disease. It occurs in members of

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KEY TERMS

Amyloid—A waxy, starch-like protein.

Peripheral nerves—Nerves that carry information to and from the spinal cord.

Stem cells—Parent cells from which other cells are made.

most ethnic groups, and each family has a distinctive pattern of symptoms and organ involvement. Hereditary amyloidosis is thought to be autosomal dominant, which means that only one copy of the defective gene is necessary to cause the disease. A child of a parent with familial amyloidosis has a 50-50 chance of developing the disease.

Amyloidosis can involve any organ or system in the body. The heart, kidneys, gastrointestinal system, and nervous system are affected most often. Other common sites of amyloid accumulation include the brain, joints, liver, spleen, pancreas, respiratory system, and skin.

Causes and symptoms

The cause of amyloidosis is unknown. Most patients have gastrointestinal abnormalities, but other symptoms vary according to the organ(s) or system(s) affected by the disease. The affected organs are rubbery, firm, and enlarged.

Heart

Because amyloid protein deposits can limit the heart's ability to fill with blood between beats, even the slightest exertion can cause **shortness of breath**. If the heart's electrical system is affected, the heart's rhythm may become erratic. The heart may also be enlarged and **heart murmurs** may be present. Congestive **heart failure** may result.

Kidneys

The feet, ankles, and calves swell when amyloidosis damages the kidneys. The kidneys become small and hard, and kidney failure may result. It is not unusual for a patient to lose 20–25 lb (9–11 kg) and develop a distaste for meat, eggs, and other protein-rich foods. Cholesterol elevations that do not respond to medication and protein in the urine (proteinuria) are common.

Nervous system

Nervous system symptoms often appear in patients with familial amyloidosis. Inflammation and degeneration of the peripheral nerves (**peripheral neuropathy**) may be present. One in four patients with amyloidosis has **carpal tunnel syndrome**, a painful disorder that causes **numbness** or **tingling** in response to pressure on nerves around the wrist. Amyloidosis that affects nerves to the feet can cause burning or numbness in the toes and soles and eventually weaken the legs. If nerves controlling bowel function are involved, bouts of **diarrhea** alternate with periods of **constipation**. If the disease affects nerves that regulate blood pressure, patients may feel dizzy or faint when they stand up suddenly.

Liver and spleen

The most common symptoms are enlargement of the liver and spleen. Liver function is not usually affected until quite late in the course of the disease. Protein accumulation in the spleen can increase the risk of rupture of this organ due to trauma.

Gastrointestinal system

When amyloidosis affects the gastrointestinal system, there may be bleeding, abdominal **pain**, constipation, and diarrhea. Intestinal movement (motility) may be reduced, and absorption of food and other nutrients may be impaired (leading to **malnutrition**). The tongue may become inflamed, enlarged, and stiff.

Skin

Skin symptoms occur in about half of all cases of primary and secondary amyloidosis and in all cases where there is inflammation or degeneration of the peripheral nerves. Waxy-looking raised bumps (papules) appear on the face and neck, in the groin, armpits, or anal area, and on the tongue or in the ear canals. Swelling, hemorrhage beneath the skin (purpura), hair loss, and **dry mouth** may occur.

Respiratory system

Airways may be obstructed by amyloid deposits in the nasal sinus, larynx and trachea (windpipe).

Diagnosis

Blood and urine tests can reveal the presence of amyloid protein, but tissue or bone-marrow biopsy is necessary to positively diagnose amyloidosis. Once the diagnosis has been confirmed, additional laboratory

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tests and imaging procedures are performed to determine:

- which type of amyloid protein is involved
- which organ(s) or system(s) have been affected
- how far the disease has progressed

Treatment

Traditional

The goal of treatment is to slow down or stop production of amyloid protein, eliminate existing amyloid deposits, alleviate underlying disorders (that give rise to secondary amyloidosis), and relieve symptoms caused by heart or kidney damage. Specialists in cardiology, hematology (the study of blood and the tissues that form it), nephrology (the study of kidney function and abnormalities), neurology (the study of the nervous system), and rheumatology (the study of disorders characterized by inflammation or degeneration of connective tissue) work together to assess a patient's medical status and evaluate the effects of amyloidosis on every part of the body.

Drugs

Colchicine (Colebenemid, Probeneaid), prednisone, (Prodium), and other anti-inflammatory drugs can slow or stop disease progression. Bone-marrow and stem-cell transplants can enable patients to tolerate higher and more effective doses of melphalan (Alkeran) and other **chemotherapy** drugs prescribed to combat this non-malignant disease.

Surgery can relieve nerve pressure and may be performed to correct other symptom-producing conditions. Localized amyloid deposits can also be removed surgically. Dialysis or **kidney transplantation** can lengthen and improve the quality of life for patients whose amyloidosis results in kidney failure. Heart transplants are rarely performed.

Home remedies

Although no link has been established between diet and development of amyloid proteins, a patient whose heart or kidneys have been affected by the disease may be advised to use a diuretic or follow a low-salt diet.

Prognosis

Most cases of amyloidosis are diagnosed after the disease has reached an advanced stage. The course of each patient's illness is unique, but death resulting from heart disease or kidney failure generally occurs within a few years. Amyloidosis associated by multiple myeloma usually has a poor prognosis. Most patients with both diseases die within one to two years.

Prevention

Genetic counseling may be helpful for patients with hereditary amyloidosis and their families. Use of Cholchicine in patients with **familial Mediterranean fever** has successfully prevented amyloidosis.

Resources

BOOKS

Bashey, Asad, and Rafat Abonour. *100 Questions and Answers About Myeloma.* 2nd ed. Sudbury, MA: Jones & Bartlett Publishers, 2008.

ORGANIZATIONS

Amyloidosis Foundation, 7151 N. Main St., Suite 2, Clarkston, MI, 48346, http://www.amyloidosis.org.

Amyloidosis Network International, 7118 Cole Creek Drive, Houston, TX, 77092-1421 (888) 269-5643.

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923 (800) 999-6673, http://www.rarediseases.org.

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Amyotrophic lateral sclerosis

Definition

Amyotrophic lateral sclerosis (ALS) is a disease that breaks down tissues in the nervous system (a neurodegenerative disease) of unknown cause that affects the nerves responsible for movement. It is also known as motor neuron disease and Lou Gehrig's disease, after the baseball player whose career it ended.

Demographics

According to the National Institute for Neurological Disorders and **Stroke**, an estimated 20,000 Americans had ALS as of 2009, with some 5,000 people diagnosed with the disease each year. Worldwide, ALS is considered one of the most common neuromuscular diseases, affecting people of all races equally. Onset of ALS most commonly occurs between ages 40 and 60, but younger and older people may also develop ALS. Men are affected more often than women.

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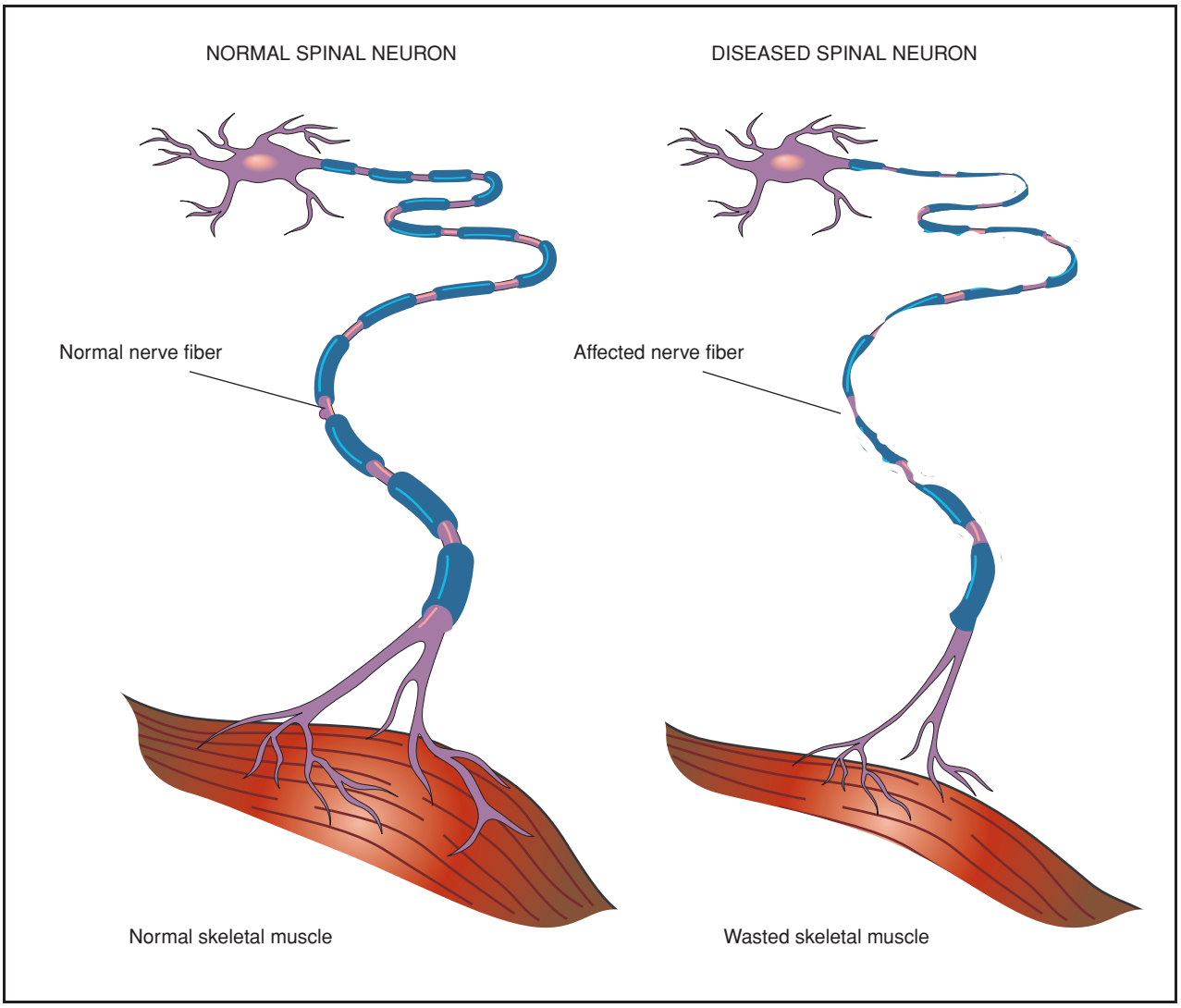

Amyotrophic lateral sclerosis (ALS) is caused by the degeneration and death of motor neurons in the spinal cord and brain. These neurons convey electrical messages from the brain to the muscles to stimulate movement in the arms, legs, trunk, neck, and head. As motor neurons degenerate, the muscles are weakened and cannot move as effectively, leading to muscle wasting. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Description

Amyotrophic lateral sclerosis is a progressive disease of the central nervous system. "A" means "no," "myo" implies muscle cells, and "trophic" refers to nourishment. The nerve cells that extend from the brain to the spinal cord (upper motor neurons), and from the spinal cord to the peripheral nerves (lower motor neurons), for unexplained reasons, degenerate and die. "Lateral" refers to the areas of the spinal cord that are affected, and "sclerosis" occurs as hard tissue replaces the previously originally healthy nerve.

The parts of the body that are not affected by ALS are those areas not involved in the use of motor neurons. The mind remains very sharp and in control of sight, hearing, smell, touch and taste. Bowel and bladder functions are generally not affected. Amyotrophic lateral sclerosis rarely causes **pain**, yet leaves patients dependent on the care of others during advanced stages.

ALS progresses rapidly and paralyzed patients are usually under the intensive care of nursing facilities or loved ones. This can have a devastating psychological effect on the family members and the patient. In most cases ALS is fatal within two to five years, although approximately 10% live eight years or more.

Risk factors

In most ALS cases, the disease occurs apparently at random with no clearly identified risk factors.

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People do not have a family history of ALS are not considered to be at risk for developing ALS.

Causes and symptoms

The cause of ALS is unknown, nor is it known why ALS strikes some people and not others. The symptoms of ALS are caused by the death of motor neurons in the spinal cord and brain. Normally, these neurons convey electrical messages from the brain to the muscles to stimulate movement in the arms, legs, trunk, neck, and head. As motor neurons die, the muscles they enervate cannot be moved as effectively, and weakness results. In addition, lack of stimulation leads to muscle wasting, or loss of bulk. Involvement of the upper motor neurons causes spasms and increased tone in the limbs, and abnormal reflexes. Involvement of the lower motor neurons causes persistent muscle wasting and twitching (fasciculations).

Although many causes of motor neuron degeneration have been suggested for ALS, none has yet been proven responsible. Results of recent research have implicated toxic molecular fragments known as free radicals. Some evidence suggests that a cascade of events leads to excess free radical production inside motor neurons, leading to their death. Why free radicals should be produced in excess amounts is unclear, as is whether this excess is the cause or the effect of other degenerative processes. Additional agents within this toxic cascade may include excessive levels of a neurotransmitter known as glutamate, which may over-stimulate motor neurons, thereby increasing free-radical production, and a faulty **detoxification** enzyme known as SOD-1, for superoxide dismutase type 1. The actual pathway of destruction is not known, however, nor is the trigger for the rapid degeneration that marks ALS. Further research may show that other pathways are involved, perhaps ones even more important than this one. Autoimmune factors or premature **aging** may play some role, as could viral agents or environmental toxins.

The disease starts slowly, affecting just one limb, such as the hands or feet, and steadily progresses to more limbs and muscles. When muscles lack the proper nourishment they require, they begin to thin and deteriorate. This condition is the hallmark of amyotrophic lateral sclerosis. Muscle wasting is due to the inability of degenerating motor neurons to elicit a signal to the muscles that allow them to function and grow. Common examples of symptoms for ALS are **muscle cramps** and twitching, weakness in the hands, feet, or ankles, speech slurring, and swallowing difficulties. Other early symptoms include arm and leg stiffness, foot drop, weight loss, **fatigue**, and difficulty making facial expressions.

KEY TERMS

Aspiration—Inhalation of food or saliva.

Bulbar muscles—Muscles that control chewing, swallowing, and speaking.

Degeneration—Nerves progressively withering.

Fasciculations—Involuntary twitching of patient's muscles.

Voluntary muscle—A muscle under conscious control, such as arm and leg muscles.

One of the earliest symptoms of ALS is weakness in the bulbar muscles. These muscles in the mouth and throat assist in chewing, swallowing, and speaking. Weakness of these muscle groups usually cause problems such as slurred speech, difficulty with conversation and hoarseness of the voice.

As the disease progresses the respiratory muscles (breathing muscles) weaken, resulting in increased difficulty with breathing, coughing and possibly inhaling food or saliva. The potential for lung infection increases and can cause death. Many patients find it more comfortable and extend their lives when assisted by ventilators at this stage of the disease. Communication becomes very difficult. One way to accomplish feedback with others is to make use of the eyes. Blinking is one mode that patients of amyotrophic lateral sclerosis will be forced to utilize, in order to continue communication.

As the disease progresses, victims gradually lose the use of their feet, hand, leg, and neck muscles, and **paralysis** results in affected muscle groups. They are able to speak and swallow only with great struggle. **Sexual dysfunction** is not affected. Breathing will become increasingly difficult and the patients of ALS may decide to prolong life with the use of assisted ventilation, which may decrease the risks of death from infections such as **pneumonia**.

Diagnosis

ALS is difficult to diagnose. There is no one set way to test for the disease. A second opinion is frequently recommended if ALS is suspected since it is a fatal neurological disease. To date, there is no one test or procedure to ultimately establish the diagnosis of ALS. It is through a clinical examination and series of

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diagnostic tests, often ruling out other diseases that mimic ALS, that a diagnosis can be established.

Examination

The diagnosis of ALS begins with a complete medical history and physical exam, plus a neurological examination to determine the distribution and extent of weakness. The examinations are repeated at regular intervals to assess whether symptoms are getting progressively worse.

Tests

A series of diagnostic tests are performed to rule out and exclude other possible causes and diseases that resemble ALS, such as tumors of the skull base or high cervical spinal cord, thyroid disease, spinal arthritis, **lead poisoning**, or severe vitamin deficiency. Other possibilities to rule out include **multiple sclerosis**, spinal cord neoplasm, polyarteritis, syringomyelia, **myasthenia gravis**, and **muscular dystrophy**. Electro diagnostic tests such as **electromyography** (EMG) and nerve conduction velocity (NCV) are used to help diagnose ALS. Blood and urine tests, spinal taps, x rays, and muscle and/or nerve biopsy are performed, as well as **magnetic resonance imaging** (MRI), myelograms of the cervical spine and CT (computed tomography) scans. ALS is rarely misdiagnosed following a careful review of all these tests.

Treatment

Currently, there is no cure for ALS and no treatment that can significantly alter its course. Management aims to control the symptoms that patients experience. Emotional, psychological and physical support, are provided to ease the difficulty associated with this disorder.

Traditional

Moderate activities are recommended in the early stages of the disease. **Physical therapy** can help muscles stay active and delay the resulting weakness. ALS patients are encouraged to maintain a healthy diet and **exercise** regularly for as long as possible. Education of ALS is very important in developing an understanding of the disease, and is vital for family members as well as patients.

A physical therapist works with an affected person and family to implement exercise and stretching programs to maintain strength and range of motion, and to promote general health. Swimming may be a good choice for people with ALS, as it provides a low–impact workout to most muscle groups. One result of chronic inactivity is contracture, or muscle shortening. **Contractures** limit a person's range of motion, and are often painful. Regular stretching can prevent contracture. Several drugs are available to reduce cramping, a common complaint in ALS.

An occupational therapist can help design solutions to movement and coordination problems, and provide advice on adaptive devices and home modifications.

Speech and swallowing difficulties can be minimized or delayed through training provided by a speech-language pathologist. This specialist can also provide advice on communication aids, including computer-assisted devices and simpler word boards.

Nutritional advice can be provided by a nutritionist. A person with ALS often needs softer foods to prevent jaw exhaustion or **choking**. Later in the disease, **nutrition** may be provided by a **gastrostomy** tube inserted into the stomach.

Mechanical ventilation may be used when breathing becomes too difficult. Modern mechanical ventilators are small and portable, allowing a person with ALS to maintain the maximum level of function and mobility. Ventilation may be administered through a mouth or nose piece, or through a tracheostomy tube. This tube is inserted through a small hole made in the windpipe. In addition to providing direct access to the airway, the tube also decreases the risk aspiration. While many people with rapidly progressing ALS choose not to use ventilators for lengthy periods, they are increasingly being used to prolong life for a short time.

The progressive nature of ALS means that most persons will eventually require full-time nursing care. This care is often provided by a spouse or other family member. While the skills involved are not difficult to learn, the physical and emotional burden of care can be overwhelming. Caregivers need to recognize and provide for their own needs as well as those of people with ALS, to prevent depression, burnout, and bitterness.

Throughout the disease, a support group can provide important psychological aid to affected persons and their caregivers as they come to terms with the losses ALS inflicts. Support groups are sponsored by both the ALS Society and the Muscular Dystrophy Association.

Drugs

Only one drug has been approved by the Food and Drug Administration (FDA) for treatment of

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ALS: riluzole (Rilutek). The drug appears to have a positive effect in that it appears to extend the life of ALS patients by about three months when taken regularly early in the disease, and shows a significant slowing of the loss of muscle strength. Riluzole acts by decreasing glutamate release from nerve terminals. Experimental trials of nerve growth factor have not demonstrated any benefit.

Another drug, Myotrophin (somatomedin C), appears to prevent neuron loss and enhance neuron generation in animal studies.

Alternative

Given the serious prognosis and absence of traditional medical treatments, it is not surprising that a large number of alternative treatments have been tried for ALS. Some studies suggested that amino–acid therapies may provide some improvement for some people with ALS. While individual reports claim benefits for megavitamin therapy, herbal medicine, and removal of **dental fillings**, for instance, no evidence suggests that these offer any more than a brief psychological boost, often followed by a more severe letdown when it becomes apparent the disease has continued unabated. However, once the causes of ALS are better understood, alternative therapies may be more intensively studied. For example, if damage by free radicals turns out to be the root of most of the symptoms, antioxidant **vitamins** and supplements may be used more routinely to slow the progression of ALS. Or, if environmental toxins are implicated, alternative therapies with the goal of detoxifying the body may be of some use.

Prognosis

Amyotrophic lateral sclerosis normally progresses rapidly and leads to death from respiratory infection within three to five years. If the person involved is young and the initial symptoms appear in the limbs, the disease tends to develop more slowly. Improved medical care prolongs the lives of ALS patients and shows promise for more effective treatments in the future.

Prevention

There is no known way to prevent ALS or to alter its course.

Resources

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ALS Association, 27001 Agoura Road, Suite 250, Calabasas Hills, CA, 91301-5104 (818) 880-9007 (800) 782-4747 (818) 880-9006, advocacy@alsa-national. org, http://www.alsa.org.

ALS Therapy Development Institute, 215 First Street, Cambridge, MA, 02142 (617) 441-7200 (617) 441-7299, info@als.net, http://www.als.net.

Muscular Dystrophy Association, 3300 East Sunrise Drive, Tucson, AZ, 85718-3208 (520) 529-2000 (800) 344-4863 (520) 529-5300, mda@mdausa.org, http://www.mda.org.

Les Turner ALS Foundation, 5550 W. Touhy Avenue, Suite 302, Skokie, IL, 60077-3254 (847) 679-3311 (800) ALS-1107 (847) 679-9109, info@lesturnerals.org, http://www.lesturnerals.org.

Project ALS, 900 Broadway, Suite 901, New York, NY, 10003 (212) 420-7382 (800) 603-0270 (212) 420-7387, info@projectals.org, http://www.projectals.org.

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Anabolic steroid use

Definition

Anabolic **steroids** are a class of man-made drugs that are chemically related to the male hormone testosterone.

Description

Anabolic steroids are more accurately called anabolic-androgenic steroids. This name defines their two principle characteristics. Anabolic means to synthesize or build up; thus anabolic steroids increase skeletal muscle mass. Androgenic means involving male sexual characteristics. Anabolic steroids are related to testosterone and affect the body the many of the same ways as testosterone. Testosterone is the main hormone responsible for male sexual characteristics. It stimulates and maintains the male reproductive organs, stimulates development of bones and muscle, promotes skin and hair growth, and can influence emotions and sex drive. In males, the testes produce testosterone with a small amount also secreted by the adrenal glands. Women have only the small amount of testosterone produced by the adrenal glands.

Several hundred different types of anabolic steroids have been synthesized in attempts to maximize their benefits and minimize side effects. As of 2009, not a single anabolic steroid had been manufactured that was free of negative side effects. In many developing countries, anabolic steroids can be purchased without a prescription. However, in the United States, they have been controlled substances since 1991. Possession of an anabolic steroid without a prescription is illegal and can result in a maximum one-year prison sentence and a minimum fine of $1,000 fine for the first offense.

Medical uses

Anabolic steroids were first developed in the 1930s in Europe in an effort to produce a drug to treat conditions where the testes did not secrete enough testosterone. Physicians tried using these drugs for many other purposes in the 1940s and 1950s with limited success. Disadvantages outweighed benefits for most purposes, and during the later decades of the twentieth century, medical use in North America and Europe was restricted to a few conditions. These include:

- Bone marrow stimulation: During the second half of the twentieth century anabolic steroids were the mainstay of therapy for hypoplastic anemia not due to nutrient deficiency, especially aplastic anemia. In the twenty-first century anabolic steroids have been replaced by synthetic protein hormones that selectively stimulate growth of blood cell precursors oth fewer side effects.
- Growth stimulation: From the 1960s through the 1980s, anabolic steroids were used heavily by pediatric endocrinologists to treat children with growth failure. The availability of synthetic growth hormone

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KEY TERMS

Adrenal gland—An endocrine gland located above each kidney. The inner part of each gland secretes epinephrine (adrenaline) and the outer part secretes steroid hormones.

Androgen—A natural or artificial steroid that acts as a male sex hormone. Androgens are responsible for the development of male sex organs and secondary sexual characteristics.

Androstenedione—Also called "andro," this hormone occurs naturally during the making of testosterone and estrogen.

Catabolic—A metabolic process in which energy is released through the breakdown of complex molecules into simpler ones.

Corticosteroids—A steroid hormone produced by the adrenal gland and involved in metabolism and immune response.

Estrogen—Any of several steroid hormones, produced mainly in the ovaries, that stimulate estrus and the development of female secondary sexual characteristics.

Hormone—A chemical messenger that is produced by one type of cell and travels through the bloodstream to change the metabolism of a different type of cell.

Hypoplastic anemia—Anemia that is characterized by defective function of the blood-forming organs (such as bone marrow) and is caused by toxic agents such as chemicals or x rays. Anemia is a blood condition in which there are too few red blood cells or the red blood cells are deficient in hemoglobin.

Progestin—Female steroid sex hormones.

Prohormones—A physiologically inactive precursor of a hormone.

Prostate gland—An O-shaped gland in males that secretes a fluid into the semen that acts to improve the movement and viability of sperm.

Testosterone—A male steroid hormone produced in the testes and responsible for the development of secondary sex characteristics.

(GH) and increasing social stigmatization of anabolic steroids has significantly reduced their use for this purpose.

- Stimulation of appetite and preservation of muscle mass: Anabolic steroids are given to treat chronic wasting syndrome in people with diseases such as cancer and HIV/AIDS.
- Induction of male puberty: Androgens sometimes are given to boys distressed about extreme delay of puberty. Testosterone is, as of 2009, nearly the only androgen used for this purpose, but synthetic anabolic steroids often were used prior to the 1980s.
- Treatment of breast cancer: Testosterone has been reported to slow the development of some, but not all, breast cancer in some women.
- Treatment of hypogonadism: The average adult male naturally produces 2.5–11 milligrams (mg) of testosterone daily. Testosterone is given as a replacement hormone if the testes either do not produce enough hormone or if the testes are damaged or removed (e.g., in testicular cancer).

Abuse of steroids

Soon after the first anabolic steroids were synthesized, experimenters realized that these compounds caused an increase in muscle mass in laboratory animals. This soon led to the abuse of these drugs by bodybuilders and weightlifters. Anabolic steroid use spread to elite athletes looking for an edge in strength and speed. By the 1950s some Olympic athletes, primarily from the Soviet Union, East Germany, and other Eastern European countries, were taking large doses of steroids that allowed them to dominate their sports. Many of the male athletes developed such **enlarged prostate** glands (a gland near that surrounds the urethra that aids in semen production) that they needed a tube inserted into their urethra in order to urinate. Some of the female athletes developed so many male physical characteristics (e.g., low voices, facial hair, male musculature) that chromosome tests were necessary to prove that they were female.

Concerns over the growing illicit market and the prevalence of abuse, combined with the possibility of harmful long-term effects of steroid use, led the United States Congress in 1991 to place anabolic steroids in Schedule III of the Controlled Substances Act (CSA). The CSA defines anabolic steroids as any drug or hormonal substance chemically and pharmacologically related to testosterone (other than estrogens, progestins, and **corticosteroids**) that promotes muscle growth.

On January 20, 2005, the Anabolic Steroid Control Act of 2004 took effect, amending and expanding

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the Controlled Substance Act by placing both anabolic steroids and prohormones (substances the body can convert into anabolic steroids) on the controlled substance list and making possession of the banned substances a federal crime. Also in 2005, Major League Baseball (MLB), amid long-time rumors of anabolic steroid abuse among players, was rocked by the publication of *Juiced* by former Oakland Athletics outfielder Jose Canseco who alleged steroid abuse was wide spread in professional baseball. In response, Congress held hearings in March 2005 on steroid abuse in the MLB, subpoenaing such baseball superstars as home run champion Mark McGwire, Sammy Sosa, and Curt Schilling to testify. MLB officials promised a crackdown on anabolic steroid use among players. Nevertheless, steroid use continued, and in 2007, Barry Bonds, baseball's all-time home run leader was indicted for illicit steroid use. In that same year, the United States Drug Enforcement Agency, in conjunction with many other federal agencies, broke up 56 illegal laboratories producing steroids and seized 11.4 million steroid dosage units and 242 kilograms of raw Chinese steroid power as part of a two-year investigation known as Operation Raw Deal.

Most illicit anabolic steroids are sold at gyms, bodybuilding competitions, and through the mail and Internet. Many of these substances or the raw materials to make them are smuggled into the United States from countries where their possession without a prescription is legal (e.g., China, Mexico). The drugs are available both as pills and injectable liquids. Anabolic steroids commonly encountered on the illicit market include: boldenone (Equipoise), ethlestrenol (Maxibolin), fluoxymesterone (Halotestin), methandriol, methandrostenolone (Dianabol), methyltestosterone, nandrolone (Durabolin, DecaDurabolin), oxandrolone (Anavar), oxymetholone (Anadrol), stanozolol (Winstrol), testosterone (including sustanon), and trenbolone (Finajet). In addition, new anabolic steroid compounds specifically designed to be undetectable by current drug tests are constantly being developed. Many of these drugs are produced in unsanitary, illicit laboratories with little or no quality control. In addition, many counterfeit products that do not contain any steroids or that are mislabeled relative to the type and dose of steroid they contain are sold over the Internet.

Steroid abuse has spread downward from elite and professional athletes to college and then high school athletes and younger. According to the a survey by the United States Centers for Disease Control and Prevention (CDC), in 2005, 850,000 high school students in the United States had used anabolic steroid pills or shots without a prescription. A more recent 2007 study found that 1.5% of eighth graders and 2.2% of twelfth graders (2.3% of boys and 0.6% of girls) had at some time used illicit steroids. Anabolic steroid users generally take extremely high doses of steroids that can add up to 100 mg a day or more through "stacking" or combining several different types or brands of steroids. Often athletes take these drugs on a schedule called "cycling," where they take steroids for a period of 12–16 weeks followed by a steroid-free period. Another approach to illicit anabolic steroids use is "pyramiding," in which doses are gradually increased to mid-cycle, then decreased to zero.

Causes and symptoms

Anabolic steroids do increase muscle mass. While this may seem desirable at first, these drugs have very serious side effects. Anabolic steroids fool the body into thinking that testosterone is being produced in large quantities. Excessive use causes a harmful disturbance of the body's normal hormone levels and body chemistry. Cardiovascular side effects are the most common. They include increased heart rate (tachycardia), **heart attack** (myocardial infarction) even in young athletes, high blood pressure (**hypertension**), an increase in low-density lipoprotein (LDL or "bad" cholesterol and a decrease in high-density lipoprotein (HDL or "good" cholesterol that increases the risk of **stroke**. Other negative side effects may include liver damage, liver tumors (usually not cancerous), and a decrease in blood clotting factors. Young people may develop severe **acne**. Males may experience shrinking testes, falling sperm count, increased risk of **infertility**, enlarged breasts, and an enlarged prostate gland and baldness. In addition, the ends of long bones fuse together and stop growing, resulting in permanently stunted growth and short stature. Women frequently show signs of masculinity including the development of facial hair, lower voice, and male-type musculature. They may stop menstruating, may be at higher risk for certain types of **cancer** and have an increased risk of **birth defects** in their children.

Anabolic steroids also affect mental health. Their use can cause drastic mood swings, inability to sleep, depression, and feelings of hostility. There is some evidence that young men may become more volatile and violent when taking these drugs, a condition know "roid rage." Steroids also may be psychologically and physically addictive to some users. Withdrawal

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symptoms may include **insomnia**, **fatigue**, restlessness, reduced sex drive, depression, and suicidal thoughts.

In addition to these physical and mental side effects, steroid abuse brings other risks, some of which are connected to the way some steroids are manufactured and distributed. The drugs are often made in motel rooms, bathrooms, and warehouses in developing countries and then smuggled into the United States. The potency, purity, and strength of the steroids produced this way are not regulated; therefore, users cannot know how much they are taking. Some users of injectable steroids share needles, increasing the risk of contracting HIV or hepatitis.

Most data on the long-term effects of anabolic steroids on humans come from case reports rather than formal scientific studies. From the case reports, the incidence of life-threatening side effects appears to be low, but serious adverse effects may be under-recognized or under-reported. Data from animal studies seem to support this possibility. One study found that exposing male mice for one-fifth of their lifespan to steroid doses comparable to those taken by human athletes caused a high percentage of premature deaths. Most effects of anabolic steroid use are reversible if the abuser stops taking the drugs, but some, such as short stature, can be permanent.

Diagnosis

Diagnosis is often difficult, since anyone using anabolic steroids without a prescription and not under the direction of a physician is considered abusing the drug. Many athletes either do not understand what they are taking or strongly resist admitting that they are using performance-enhancing substances. Sudden increase in musculature, as well as the symptoms listed above are clues that anabolic steroid abuse could be occurring. Virtually all major professional sports leagues in the United States test for steroids and other performance-enhancing drugs, as do most intercollegiate athletic leagues. Many steroids are detectable in urine samples, however new compounds are constantly being developed in a deliberate attempt to produce compounds that are undetectable by current tests.

Treatment

Few studies of treatment for anabolic steroid abuse have been conducted. Knowledge as of 2009 is based largely on the experiences of a small number of physicians who have worked with individuals undergoing steroid withdrawal. The physicians have found that supportive therapy is sufficient in some cases. Patients are educated about what they may experience during withdrawal and are evaluated for suicidal thoughts. If symptoms are severe or prolonged, medications or hospitalization may be needed. Depression needs to be monitored closely.

Sometimes medications are used to restore hormone balance after its disruption by steroid abuse. Other medications target specific withdrawal symptoms, for example, antidepressants to treat depression, and **analgesics** (**pain** killers) for headaches, muscle, and joint pains. Some individuals are psychologically addicted to steroids and benefit from behavioral therapies.

Alternative treatment

There is little data on alternative medicines or treatments for anabolic steroid abuse. However, anabolic steroid manufacturers recommend **saw palmetto** to be taken in conjunction with androstenedione as it can help reduce associated hair loss and is useful in controlling prostate enlargement.

Prognosis

Anabolic steroid abuse is a treatable condition. Abusers can overcome the problem with the help of family members, support groups, **psychotherapy**, medication, treatment programs, and family counseling. These programs are customized to help teens and adults lead productive and normal lives. However, heavy steroid use—even if it is stopped after a few years—may stunt growth and increase the risk of **liver cancer**. A steroid user who quits may experience severe depression that can lead to suicidal thoughts and **suicide** attempts or completion. The risk of depression and suicide is highest among teenage abusers.

Some physicians recommend that athletes using steroids avoid sudden discontinuance of all steroids simultaneously because their bodies may enter an immediate catabolic (metabolic breakdown of compounds) phase. This can lead to a considerable loss of strength and mass, an increase of fat and water in the body, and breast enlargement in males. Breast enlargement occurs because the suddenly low androgen level shifts the hormone balance in favor of estrogen compounds, which suddenly become the dominant hormone.

Prevention

Educating young people to the dangers of anabolic steroid abuse is the best way to prevent their misuse. The National Institute on Drug Abuse in conjunction with the Oregon Health & Science University has

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developed two programs for use with high school sports teams. The Adolescent Training and Learning to Avoid Steroids (ATLAS) program is aimed a teaching high school football players how to improve performance with training and healthy behaviors. The Athletes Targeting Healthy Exercise and **Nutrition** Alternatives (ATHENA) has similar goals but is designed for female athletes. Both programs have been shown to reduce steroid abuse and decrease other risky behaviors such as alcohol and **marijuana** use. These programs were awarded the 2006 *Sports Illustrated* magazine Champion Award for improving the safety and healthy of high school athletes.

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ORGANIZATIONS

National Center for Drug Free Sport Inc. , 2735 Madison Avenue, Kansas City, MO, 64108, (816) 474-8644, (816) 501-9287, info@drugfreesport.com, http://www.drugfreesport.com.

National Clearinghouse for Alcohol and Drug Information, P.O. Box 2345, Rockville, MD, 20847-2345, (877) 726-4727, http://store.samhsa.gov/.

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Anaerobic infections

Definition

An anaerobic infection is an infection caused by bacteria (called anaerobes) which cannot grow in the presence of oxygen. Anaerobic bacteria can infect deep **wounds**, deep tissues, and internal organs where there is little oxygen. These infections are characterized by **abscess** formation, foul-smelling pus, and tissue destruction.

KEY TERMS

Abscess—A lump filled with pus resulting from an infection.

Anaerobic—Living and growing in the absence of oxygen.

Necrosis—Tissue death and destruction resulting from infection or disease.

Description

Anaerobic means "life without air." Anaerobic bacteria grow in places which completely, or almost completely, lack oxygen. They are normally found in the mouth, gastrointestinal tract, and vagina, and on the skin. Commonly known diseases caused by anaerobic bacteria include gas **gangrene**, **tetanus**, and **botulism**. Nearly all dental infections are caused by anaerobic bacteria.

Anaerobic bacteria can cause an infection when a normal barrier (such as skin, gums, or intestinal wall) is damaged due to surgery, injury, or disease. Usually, the immune system kills any invading bacteria, but sometimes the bacteria are able to grow and cause an infection. Body sites that have tissue destruction (necrosis) or a poor blood supply are low in oxygen and favor the growth of anaerobic bacteria. The low oxygen condition can result from blood vessel disease, **shock**, injury, and surgery.

Anaerobic bacteria can cause infection practically anywhere in the body. For example:

- Mouth, head, and neck. Infections can occur in the root canals, gums (gingivitis), jaw, tonsils, throat, sinuses, and ears.
- Lung. Anaerobic bacteria can cause pneumonia, lung abscesses, infecton of the lining of the lung (empyema), and dilated lung bronchi (bronchiectasis).
- Intraabdominal. Anaerobic infections within the abdomen include abscess formation, peritonitis, and appendicitis.
- Female genital tract. Anaerobic bacteria can cause pelvic abscesses, pelvic inflammatory disease, inflammation of the uterine lining (endometritis), and pelvic infections following abortion, childbirth, and surgery.

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- Skin and soft tissue. Anaerobic bacteria are common causes of diabetic skin ulcers, gangrene, destructive infection of the deep skin and tissues (necrotizing fascitis), and bite wound infections.
- Central nervous system. Anaerobic bacteria can cause brain and spinal cord abscesses.
- Bloodstream. Anaerobic bacteria can be found in the bloodstream of ill patients (a condition called bacteremia).

Causes and symptoms

People who have experienced shock, injury, or surgery, and those with blood vessel disease or tumors are at an increased risk for infection by anaerobic bacteria. There are many different kinds of anaerobic bacteria which can cause an infection. Indeed, most anaerobic infections are "mixed infections" which means that there is a mixture of different bacteria growing. The anaerobic bacteria that most frequently cause infections are *Bacteroides fragilis*, *Peptostreptococcus*, and *Clostridium* species.

The signs and symptoms of anaerobic infection can vary depending on the location of the infection. In general, anaerobic infections result in tissue destruction, an abscess which drains foul-smelling pus, and possibly **fever**. Symptoms for specific infections are as follows:

- Tooth and gum infections. Swollen, tender bleeding gums, bad breath, and pain. Severe infections may produce oozing sores.
- Throat infection. An extremely sore throat, bad breath, a bad taste in the mouth, fever, and a sense of choking.
- Lung infection. Chest pain, coughing, difficulty breathing, fever, foul-smelling sputum, and weight loss.
- Intraabdominal infection. Pain, fever, and possibly, if following surgery, foul- smelling drainage from the wound.
- Pelvic infection. Foul-smelling pus or blood draining from the uterus, general or localized pelvic pain, fever, and chills.
- Skin and soft tissue infection. Infected wounds are red, painful, swollen, and may drain a foul-smelling pus. Skin infection causes localized swelling, pain, redness, and possibly a painful, open sore (ulcer) which drains foul-smelling pus. Severe skin infections may cause extensive tissue destruction (necrosis).
- Bloodstream. Bloodstream invasion causes high fever (up to 105°F [40.6°C]), chills, a general ill feeling, and is potentially fatal.

Diagnosis

The diagnosis of anaerobic infection is based primarily on symptoms, the patient's medical history, and location of the infection. A foul-smelling infection or drainage from an abscess is diagnostic of anaerobic infection. This foul smell is produced by anaerobic bacteria and occurs in one third to one half of patients late in the infection. Other clues to anaerobic infection include tissue necrosis and gas production at the infection site. A sample from the infected site may be obtained, using a swab or a needle and syringe, to determine which bacteria is (are) causing the infection. Because these bacteria can be easily killed by oxygen, they rarely grow in the laboratory cultures of tissue or pus samples.

The recent medical history of the patient is helpful in diagnosing anaerobic infection. A patient who has or recently had surgery, dental work, tumors, blood vessel disease, or injury are susceptible to this infection. The failure to improve following treatment with **antibiotics** that aren't able to kill anaerobes is another clue that the infection is caused by anaerobes. The location and type of infection also help in the diagnosis.

Diagnostic tests may include blood tests to see if bacteria are in the bloodstream and x rays to look at internal infections.

Treatment

Serious infections may require hospitalization for treatment. Immediate antibiotic treatment of anaerobic infections is necessary. Laboratory testing may identify the bacteria causing the infection and also which antibiotic will work best. Every antibiotic does not work against all anaerobic bacteria but nearly all anaerobes are killed by chloramphenicol (Chloromycetin), metronidazole (Flagyl or Protostat), and imipenem (Primaxin). Other antibiotics which may be used are clindamycin (Cleocin) or cefoxitin (Mefoxin).

Surgical removal or drainage of the abscess is almost always required. This may involve drainage by needle and syringe to remove the pus from a skin abscess (called "aspiration"). The area would be numbed prior to the aspiration procedure. Also, some internal abscesses can be drained using this procedure with the help of ultrasound (a device which uses sound waves to visualize internal organs). This type of abscess drainage may be performed in the doctor's office.

Prognosis

Complete recovery should be achieved with the appropriate surgery and antibiotic treatment.

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Untreated or uncontrolled infections can cause severe tissue and bone destruction, which would require **plastic surgery** to repair. Serious infections can be life threatening.

Prevention

Although anaerobic infections can occur in anyone, good hygiene and general health may help to prevent infections.

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Belinda Rowland PhD

Anaerobic myositis *see* **Gangrene**

Anal atresia

Definition

The anus is either not present or it is in the wrong place.

Description

There are basically two kinds of anal atresia. In boys with high anal atresia, there may be a channel (**fistula**) connecting the large intestine to either the urethra (which delivers urine from the bladder) or the bladder itself. In girls, the channel may connect with the vagina. Sixty percent of children with high anal atresia have other defects, including problems with the esophagus, urinary tract, and bones. In low anal atresia, the channel may open in front of the circular mass of muscles that constrict to close the anal opening (anal sphincter) or, in boys, below the scrotum. Occasionally, the intestine ends just under the skin. It is estimated that overall abnormalities of the anus and rectum occur in about one in every 5,000 births and are slightly more common among boys. A mother who has one child with these kind of conditions has a 1% chance of having another child who suffers from this ailment.

KEY TERMS

Anus—The canal at the end of the large intestine through which waste is excreted to the outside of the body.

Bowel obstruction—Anything that prevents waste from moving normally to the anal opening.

Colostomy—An operation where the large intestine is diverted through an opening in the abdomen and waste is excreted.

Feces—Bodily waste material that normally passes through the anus.

Fistula—An abnormal channel that connects two organs or connects an organ to the skin.

Causes and symptoms

Anal atresia is a defect in the development of the fetus. The cause is unknown, but genetics seem to play a minor role.

Diagnosis

Usually a physician can make an obvious visual diagnosis of anal atesia right after birth. Occasionally, however, anal atresia is missed until the baby is fed and signs of intestinal obstruction appear. At the end of the first or second day, the abdomen swells and there is **vomiting** of fecal material. To determine the type of anal atresia and the exact position, x rays will be taken which include injecting opaque dye into the opening. **Magnetic resonance imaging** (MRI) or **computed tomography scans** (CT), as well as ultrasound, are the imaging techniques used to determine the type and size of the anal atresia. Ultrasound uses sound waves, CT scans pass x rays through the body at different angles, and an MRI uses a magnetic field and radio waves.

Treatment

Surgery is the only treatment for anal atresia. For high anal atresia, immediately after the diagnosis is made, a surgical incision is made in the large intestine to make a temporary opening (**colostomy**) in the abdomen where waste is excreted. Several months later, the intestine is moved into the ring of muscle (sphincter) that is part of the anus and a hole is made in the skin. The colostomy is closed several weeks later. In low anal atresia, immediately after diagnosis, a hole is made in the skin to open the area where the anus should be. If the channel is in the wrong place, the

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intestine is moved into the correct position sometime during the child's first year. After surgery, the pediatric surgeon uses an instrument to dilate or widen the rectum and teaches the parents how to do this daily at home to prevent scar tissue from contracting.

Prognosis

With high anal atresia, many children have problems controlling bowel function. Most also become constipated. With low anal atresia, children generally have good bowel control, but they may still become constipated.

Prevention

There is no known way to prevent anal atresia.

Resources

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Anal cancer

Definition

Anal **cancer** is an uncommon form of cancer affecting the anus. The anus is the inch-and-a-half-long end portion of the large intestine, which opens to allow solid wastes to exit the body. Other parts of the large intestine include the colon and the rectum.

Demographics

Approximately 5,000 Americans were diagnosed with anal cancer in 2009, and an estimated 700 individuals died of the disease during this same interval, according to the American Cancer Society. Anal cancers are fairly rare: they make up only 1% to 2% of cancers affecting the digestive system. This type of cancer is diagnosed much less frequently than cancers of the colon and rectum. The disease affects women somewhat more often than men. As the average age of the general population increases, the incidence of anal cancer is also increasing. The average age at diagnosis for most anal cancers is 60 years and older.

Description

Different cancers can develop in different parts of the anus, part of which is inside the body and part of which is outside. Sometimes abnormal changes of the anus are harmless in their early stages but may later develop into cancer. Some **anal warts**, for example, contain precancerous areas and can develop into cancer. Types of anal cancer include:

- Squamous cell carcinomas—Most anal cancers diagnosed in the United States are squamous cell carcinomas, which arise from the cells lining the anal margin and the anal canal. The anal margin is the part of the anus that is half inside and half outside the body, and the anal canal is the part of the anus that is inside the body. The earliest form of squamous cell carcinoma is known as carcinoma in situ, or Bowen's disease.
- Cloacogenic carcinomas—Often listed as a subclass of squamous cell cancer of the anus, these tumors develop in the transitional zone, or cloaca, which is a ring of tissue between the anal canal and the rectum. Other terms for this type of tumor are basaloid or transitional cell carcinoma of the anus.
- Adenocarcinomas—A small percentage of anal cancers are classified as adenocarcinomas, which affect glands in the anal area.
- Basal cell carcinoma or malignant melanoma—A very small percentage of anal cancers are either basal cell carcinomas, or malignant melanomas, two types of skin cancer. Malignant melanomas, which develop from skin cells that produce the brown pigment called melanin, are far more common on areas of the body exposed to the sun.

Two other very rare types of anal cancers are Paget's disease (not the same as Paget's disease of the bone) and gastrointestinal stromal tumors.

Risk factors

Most cases of squamous cell carcinoma of the anus appear to be linked to infection by the **human papilloma virus** (HPV). This same virus causes most cases of **cervical cancer**. Therefore, women who have been diagnosed with cervical cancer are considered to be at high risk for the development of anal cancer. HPV can be spread during vaginal, anal, and oral intercourse. The HPV subtype most likely to cause anal cancer is HPV-16. HPV subtypes HPV-6 and HPV-11 cause most cases of genital and anal **warts**.

Individuals infected with the human **immunodeficiency** virus (HIV) are also at increased risk for the development of anal cancer. A history of multiple sexual partners increases risk for HIV and HPV infection and also increases risk for anal cancer. Anal intercourse, especially in individuals younger than age 30, increases the risk for anal cancer in both men and women.

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KEY TERMS

Biopsy—A procedure in which a small piece of body tissue is removed and examined under a microscope for cancer.

Chemotherapy—A cancer treatment in which drugs delivered into the bloodstream kill cancer cells or make them more vulnerable to radiation therapy.

Human immunodeficiency virus (HIV)—The virus that causes acquired immune deficiency syndrome (AIDS).

Human papillomavirus (HPV)—A virus with many subtypes, some of which cause cell changes that increase the risk of certain cancers.

Lymph nodes—Bean-shaped structures found throughout the body that produce and store infection-fighting cells.

Radiation therapy—A cancer treatment that uses high-energy rays to kill or weaken cancer cells. Radiation may be delivered externally or internally via surgically implanted pellets.

Smokers are at higher risk, as are individuals with weakened immune systems, such as transplant patients taking **immunosuppressant drugs**.

Causes and symptoms

The exact cause of most anal cancers is unknown. Symptoms of anal cancer resemble those found in other harmless conditions. They include **pain**, **itching** and bleeding, straining during a bowel movement, change in bowel habits, change in the diameter of the stool, discharge from the anus, and swollen lymph nodes in the anal or groin area.

Diagnosis

Examination

Anal cancer is sometimes diagnosed during routine physicals, or during minor procedures such as hemorrhoid removal. It may also be diagnosed during a **digital rectal examination** (DRE), when a physician inserts a gloved, lubricated finger into the anus to feel for unusual growths. Digital rectal exams are typically done to check for **prostate cancer** and are sometimes part of routine pelvic exams in women.

Tests

Radiologic tests used to aid diagnosis include x ray, computed tomography (CT) scans, **magnetic resonance imaging** (MRI) and positron emission testing (**PET**) scans.

Procedures

Other diagnostic procedures for anal cancer include: **anoscopy**, which is a procedure that involves use of a special device to examine the anus; proctoscopy, a procedure that involves use of a lighted scope to see the anal canal; and transrectal ultrasound, which uses sound waves to create an image of the anus and nearby tissues.

A biopsy is performed on any suspicious growths; that is, a tiny specimen of the growth is removed and examined under a microscope for cancer cells. A procedure called a fine needle aspiration biopsy, in which a needle is used to withdraw fluid from lymph nodes located near the growth, may also be performed to make sure the cancer has not spread to these nodes.

Treatment

Traditional

Anal cancer is treated using three methods, used either in concert or individually: surgery, **radiation therapy**, and **chemotherapy**.

Two types of surgery may be performed. A local resection, performed if the cancer is small and has not spread, removes the tumor and an area of tissue around the tumor. A more extensive procedure, an abdominoperineal (AP) resection, is a more complex procedure in which the anus and the lower rectum are removed, and an opening called a **colostomy** is created for body wastes to exit. This procedure is fairly uncommon because radiation and chemotherapy are just as effective. AP resection may be used however, if radiation and chemotherapy are not effective or if the cancer recurs after treatment with radiation and chemotherapy.

Drugs

Chemotherapy fights cancer using drugs, which may be delivered via pill or needle. Some chemotherapy types kill cancer cells directly, while others act indirectly by making cancer cells more vulnerable to radiation. The main drugs used to treat anal cancer are 5-fluorouracil (5-FU) and mitomycin or

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5-FU and cisplatin. Side effects of chemotherapy, which damages normal cells in addition to cancer cells, may include **nausea and vomiting**, hair loss, loss of appetite, **diarrhea**, mouth sores, **fatigue**, **shortness of breath**, and a weakened immune system.

Prognosis

Anal cancer is often curable. The chance of recovery depends on the stage of the cancer at the time of diagnosis and the patient's general health.

The overall five year survival rate for anal cancer is 60% in men and 78% in women. Five year relative survival rates for anal cancer diagnosed in localized stages is 89%, 61% for cancer diagnosed with regional spread, and 30% for individuals diagnosed with anal cancers that have already metastasized to distant sites in the body.

Prevention

Reducing the risks of the **sexually transmitted diseases** HPV and HIV also reduces the risk of anal cancer. Results of recent research indicate that as many as 80% of anal cancers could be prevented by **vaccination** against HPV subtypes 16 and 18. In addition, quitting **smoking** lowers the risk of anal cancer. In adults considered to be at low risk for anal cancer over the age of 50, screening as part of exams for **colon cancer**, prostate cancer, and during pelvic exams for women may lead to earlier detection if an anal tumor is present. Screening procedures specific to anal cancer may be recommended for members of high risk groups.

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ORGANIZATIONS

American Cancer Society, 1599 Clifton Road, NE, Atlanta, GA, 30329 (800) ACS-2345 (404) 329-7530, http://www.cancer.org.

American College of Gastroenterology, P.O. Box 342260, Bethesda, MD, 20827-2260 (301) 263-9000, http://www.acg.gi.org.

American Gastroenterological Association, 4930 Del Ray Avenue, Bethesda, MD, 20814 (301) 654-2055, http://www.gastro.org.

American Society of Colon and Rectal Surgeons, 85 W. Algonquin Road, Suite 550, Arlington Heights, IL, 60005 (847) 290-9184, http://www.fascrs.org.

National Cancer Institute (National Institutes of Health), NCI Office of Communications and Education, Public Inquiries Office, 6116 Executive Boulevard, Suite 300, Bethesda, MD, 20892-8322 (800) 422-6237, http://www.cancer.gov.

United Ostomy Association of America, P.O. Box 66, Fairview, TN, 37062-0066 (800) 826-0826, http://www.uoaa.org.

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Anal fissure *see* **Anorectal disorders**

Anal warts

Definition

Anal **warts**, also known as condyloma acuminata, are small warts that can occur in the rectum.

Description

Initially appear as tiny blemishes that can be as small as the head of a pin or grow into larger cauliflower-like protuberances. They can be yellow, pink, or light brown in color, and only rarely are painful or uncomfortable. In fact, infected individuals often are unaware that they exist. Most cases are caused by sexual transmission.

Most individuals have between one to 10 **genital warts** thtat range in size from roughly 0.5-1.9 cm^2. Some will complain of painless bumps or **itching**, but often, these warts can remain completely unnoticed.

Causes and symptoms

Condyloma acuminatum is one of the most common sexually transmitted disease (STD) in the United States. Young adults aged 17 to 33 years are at greatest risk. Risk factors include **smoking**, using **oral contraceptives**, having multiple sexual partners, and an early

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KEY TERMS

Electrocoagulation—A technique using electrical energy to destroy the warts. Usually done for warts within the anus with a local anesthesia, electrocoagulation is most painful form of therapy, and can cause both bleeding and discharge from the anus.

coital age. In addition, individuals who have a history of immunosuppression or anal intercourse are also at risk.

Roughly 90% of all anal warts are caused by the **human papilloma virus** (HPV) types 6 and 11, which are the least likely of over 60 types of HPV to become cancerous. Anal warts are usually transmitted through direct sexual contact with someone who is infected with condyloma acuminata anywhere in the genital area, including the penis and vagina. Studies have shown that roughly 75% of those who engage in sexual contact with someone infected with condyloma acuminata will develop these warts within three months.

Treatment

According to guidelines from the Centers for Disease Control (CDC), the treatment of all genital warts, including anal warts, should be conducted according to the methods preferred by the patient, the medications or procedures most readily available, and the experience of the patient's physician in removing anal warts.

Treatment options include electrical cautery, surgical removal, or both. Warts that appear inside the anal canal will almost always be treated with cauterization or surgical removal. Surgical removal, also known as excision, has the highest success rates and lowest recurrence rates. Indeed, studies have shown that initial cure rates range from 63—91%.

Unfortunately, most cases require numerous treatments because the virus that causes the warts can live in the surrounding tissue. The area may seem normal and wart-free for six months or longer before another wart develops.

Electrocoagulation, a technique that uses electrical energy to destroy the warts, is usually the most painful of the procedures done to eliminate condyloma acuminata of the anus, and is usually reserved for larger warts. It is done with **local anesthesia**, and may cause discharge or bleeding from the anus.

Follow-up visits to the physician are necessary to make sure that the warts have not recurred. It is recommended that these patients see their physicians every three to six months for up to 1.5 years, which is how long the incubation period is for the HPV virus.

Carbon dioxide laser treatment and electrodesiccation are other options, but these are usually reserved for extensive warts or those that continue to recur despite numerous treatments. However, because HPV virus can be transmitted via the smoke caused by these procedures, they are usually reserved for the worst infections.

For small warts that affect only the skin around the anus, several medications are available, which can be applied directly to the surface of the warts by a physician or by the patients themselves.

Such medications include podophyllum resin (Podocon-25, Pod-Ben-25), a substance made from the cytotoxic extracts of several plants. This agent offers a cure rate of 20–50% when used alone, and is applied by the physician weekly and then washed off 6 hours later by the patient.

Podofilox (Condylox) is another agent, and is available for patients to use at home. It can be applied twice daily for up to four weeks. Podofilox offers a slightly higher cure rate than podophyllin, and can also be used to prevent warts.

Trichloroacetic and bichloroacetic acids are available in several concentrations up to 80% for the treatment of condyloma acuminata. These acids work to cauterize the skin, and are quite caustic. Nevertheless, they cause less irritation and overall body effects than the other agents mentioned above. Recurrence, however, is higher with these acids.

Bleomycin (Blenoxane) is another treatment option, but it has several drawbacks. First, it must be administered by a physician into each lesion via injection, but is can have a host of side effects, and patients must be followed carefully by their physician.

Imiquimod 5% cream is also available for patients to apply themselves. It is to be applied three times weekly, for up to 16 weeks, and has been shown to clear warts within eight to 10 weeks.

Finally, the interferon drugs, which are naturally occurring proteins that have antiviral and antitumor effects, are available. These include interferon alfa 2a and 2b (Roferon, Intron A), which are to be injected into each lesion twice a week for up to eight weeks.

Prognosis

Once a diagnosis of anal warts has been made, further outbreaks can be controlled or sometimes prevented with proper care. Unfortunately, many cases of

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anal warts either fail to respond to treatment or recur. Patients have to undergo roughly six to nine treatments over several months to assure that the warts are completely eradicated.

Recurrence rates have been estimated to be over 50% after one year and may be due to the long incubation of HPV (up to 1.5 years), deep lesions, undetected lesions, virus present in surrounding skin that is not treated.

Prevention

Sexual abstinence and monogamous relationships can be the most effective form of prevention, and **condoms** may also decrease the chances of transmission of condyloma acuminata. Abstinence from sexual relations with people who have anal or genital warts can prevent infection. Unfortunately, since many people may not be aware that they have this condition, this is not always possible.

Individuals infected with anal warts should have follow-up checkups every few weeks after their initial treatment, after which self-exams can be done.

Sexual partners of people who have anal warts should also be examined, as a precautionary preventive measure.

Finally, 5-flourouracil (Adrucil, Efudex, Fluoroplex) may be useful to prevent recurrence once the warts have been removed. Treatment must, however, be initiated within one month of wart removal.

Resources

OTHER

http://www.emedicine.com.
http://www.mayohealth.org.

ORGANIZATIONS

Centers for Disease Control and Prevention. Sexually Transmitted Diseases, 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov/STD/.

Liz Meszaros

Analgesics

Definition

Analgesics are medicines that relieve **pain**.

Purpose

Analgesics are those drugs that mainly provide pain relief. The primary classes of analgesics are the **narcotics**, including additional agents that are chemically based on the morphine molecule but have minimal **abuse** potential; **nonsteroidal anti-inflammatory drugs** (NSAIDs) including the salicylates; and **acetaminophen**. Other drugs, notably the **tricyclic antidepressants** and anti-epileptic agents such as gabapentin, have been used to relieve pain, particularly neurologic pain, but are not routinely classified as analgesics. Analgesics provide symptomatic relief, but generally have no effect on the cause, although NSAIDs, by virtue of their anti-inflammatory and pain relief activity, may be beneficial in both regards.

KEY TERMS

Acute pain—Pain that is usually temporary and results from something specific, such as a surgery, an injury, or an infection.

Analgesic—Medicine used to relieve pain.

Chronic pain—Pain that lasts more than three months and threatens to disrupt daily life.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Osteoarthritis—Joint pain resulting from damage to the cartilage.

Peripheral nervous system—Nerves that are not found in the brain of spinal cord.

Description

Pain has been classified as "productive" pain and "non-productive" pain. While this distinction has no physiologic meaning, it may serve as a guide to treatment. "Productive" pain has been described as a warning of injury, and so may be both an indication of need for treatment and a guide to diagnosis. "Non-productive" pain by definition serves no purpose either as a warning or diagnostic tool.

Although pain syndromes may be dissimilar, the common factor is a sensory pathway from the affected organ to the brain. Analgesics work at the level of the nerves, either by blocking the signal traveling from the peripheral nervous system so that it does not reach the brain, or by altering the interpretation of the signal by the brain. There is a high degree of variation in both an individual's tolerance for pain and in the way an individual responds to various analgesics. Selection of an appropriate analgesic is based on consideration of the risk-benefit factors of

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each class of drugs, based on type of pain, severity of pain, risk of adverse effects, and response of the individual to treatment.

Traditionally, pain has been divided into two classes: acute pain and chronic pain.

Acute pain

Acute pain is self limiting in duration, and includes post-operative pain, pain of injury, and **childbirth**. Because acute pain is expected to be short term, the long-term side effects of analgesic therapy generally may be ignored. Thus, these patients may safely be treated with narcotic analgesics without concern about possible **addiction**, or NSAIDs with only limited concern for the risk of ulcers. Drugs and doses should be adjusted based on observation of healing rate, switching patients from high to low doses, and from narcotic analgesics to non-narcotics when circumstances permit.

An important consideration in the management of severe pain is that patients should not be subject to the return of pain. Analgesics should be dosed adequately to ensure that the pain is at least tolerable. Drug administration should be frequent enough to avoid the **anxiety** that accompanies the anticipated return of pain.

Chronic pain

Chronic pain is pain lasting more than three months and severe enough to impair function. It is more difficult to treat than acute pain, since the anticipated side effects of the analgesics are more difficult to manage. In the case of narcotic analgesics this means considering the addiction potential, as well as respiratory depression and **constipation**. For the NSAIDs, the risk of gastric ulcers limit dose. Generally, chronic **pain management** requires a combination of drug therapy, life-style modification, and other treatment modalities.

While some classes of drugs, such as the narcotic agonist/antagonist drugs bupronophine, nalbuphine, and pentazocine, and the selective COX-2 inhibitor celecoxib (Celebrex) represent an advance in reduction of adverse effects, they are still not fully suitable for long-term management of severe pain. In 2004, the COX-2 inhibitor rofecoxib (Vioxx) was withdrawn from the market in the United States followed by valdecoxib (Bextra) in 2005 because of an increased risk of **heart attack** and **stroke** and severe skin toxicity. Celecoxib (Celebrex) remains the only COX-2 inhibitor available in the United States. It does not carry the same increased cardiovascular risks as the withdrawn drugs.

Narcotic analgesics

The narcotic analgesics, also termed opioids, are all derived from opium. The class includes morphine, codeine, and a number of semi-synthetics including meperidine (Demerol), oxycodone (OxyContin), oxymorphone (Opana), fentanyl (Duragesic, Fentanyl patch), and others. The narcotic analgesics vary in potency, but all are effective in treatment of pain when used in adequate doses. Adverse effects are dose related. Because these drugs are all addictive, they are controlled under federal and state laws. A variety of dosage forms are available, including oral solids, liquids, intravenous, intrathecal injections (injections into the fluid surrounding the spinal cord and brain), and transcutaneous (skin) patches.

NSAID analgesics

NSAIDs are effective analgesics even at doses too low to have any anti-inflammatory effects. There are a number of chemical classes, but all have similar therapeutic effects and side effects. Common NSAIDs available without prescription include naproxen (Aleve), ibuprofen (Advil, Motrin, Pamprin, Nuprin) and **aspirin**. Ibuprofen and aspirin act more rapidly but for a shorter duration than naproxen. Over-the-counter NSAIDs are appropriate only for oral administration. Other oral NSAIDs are available only by prescription. In addition prescription ketorolac (Toradol) is appropriate for injection and may be used in moderate to severe pain for short periods.

Acetaminophen (Tylenol) is a non-narcotic analgesic with no anti-inflammatory properties. It is appropriate for mild to moderate pain. Although the drug is well tolerated in normal doses, it may have significant liver toxicity at high doses. Because acetaminophen is largely free of side effects at therapeutic doses, it has been considered the first choice for mild pain, including that of **osteoarthritis**.

Topical analgesics (topical being those that are applied on the skin) have become much more popular in recent years. Those applied for local effect include capsaicin, methylsalicylate, and transdermal lidocaine. Transdermal fentanyl may be applied for systemic (the entire body in general) effect. In some cases, these topical agents reduce the need for drug therapy. Sales of pain relief patches have increased substantially in recent years. They are particularly useful

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for elderly patients who may not want to take a lot of tablets.

Recommended dosage

Appropriate dosage varies by drug, and should be determined by the type of pain, as well as other risks associated with patient's age and condition. For example, narcotic analgesics should usually be avoided in patients with a history of **substance abuse**, but may be fully appropriate in patients with **cancer** pain. Similarly, because narcotics are more rapidly metabolized in patients who have used these drugs for a long period, higher than normal doses may be needed to provide adequate pain management. NSAIDs, although comparatively safe in adults, represent an increased risk of gastrointestinal bleeding in patients over the age of 60.

Precautions

Narcotic analgesics may be contraindicated in patients with respiratory depression. NSAIDS may be hazardous to patients with ulcers or an ulcer history. They should be used with care in patients with renal (kidney) disease or blood **coagulation disorders**. NSAIDs should not be given to patients who are allergic to aspirin.

Side effects

Each drug's adverse effects should be reviewed individually. Drugs within a class may vary in their frequency and severity of adverse effects.

The primary adverse effects of the narcotic analgesics are addiction, constipation, and respiratory depression. Because narcotic analgesics stimulate the production of enzymes that cause the metabolism of these drugs, patients on narcotics for a prolonged period may require increasing doses. This is not the same thing as addiction, and is not a reason for withholding medication from patients in severe pain.

NSAIDs can lead to ulcers and may cause kidney problems. Gastrointestinal discomfort is common especially with prolonged high doses, although in some cases, these drugs may cause ulcers without the warning of gastrointestinal distress. Platelet aggregation (blood clotting) problems may occur, although not to the same extent as is seen with aspirin.

Interactions

Interactions depend on the specific type of analgesic. Information on specific interactions can be found by reading the packaging information of by asking the pharmacist or prescribing physician.

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ORGANIZATIONS

American Pain Foundation, 201 North Charles Street, Suite 710, Baltimore, MD, (888) 615-7246, info@painfoundation.org, http://www.painfoundation.org.

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Analgesics, opioid

Definition

Opioid **analgesics**, also known as narcotic analgesics, are **pain** relievers that act on the central nervous system. Like all **narcotics**, they may become habit-forming if used over long periods.

Purpose

Opioid analgesics are used to relieve pain from a variety of conditions. Some are used before or during surgery (including dental surgery) both to relieve pain and to make anesthetics work more effectively. They may also be used for the same purposes during labor and delivery.

Opioids are also given to relieve the pain of terminal **cancer**, **diabetic neuropathy**, lower back pain, and other chronic diseases or disorders. The World Health Organization (WHO) has established a three-stage "ladder" for the use of opioids in managing cancer pain.

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Opioid analgesics

Drug	Route of administration	Onset of action (min)	Time to peak effect (min)	Duration of action (h)
Strong agonists				
Fentanyl (Sublimaze)	IM	7–15	20–30	1–2
	IV	1–2	3–5	0.5–1
Hydromorphone (Dilaudid)	Oral	30	90–120	4
	IM	15		
	IV	10–15	30–60	2–3
	Sub-Q	30		15–30
Levorphanol (Levo-Dromoran)	Oral	10–60	90–120	4–5
	IM			
	IV	—	60	4–5
	Sub-Q	10–60	within 20	
Meperidine (Demerol)	Oral	15	60–90	2–4
	IM	10–15		
	IV	30–50	2–4	
	Sub-Q	1		
Methadone (Dolophine)	Oral	30–60	90–120	4–6
	IM			
	IV	10–20	60–120	4–5
Morphine (many trade names)	Oral	—	60–120	4–5
	IM	10–30		
	IV		30–60	4–5
	Sub-Q	—		
	Epidural	10–30	20	4–5
Oxycodone, extended release (Oxycontin)	Oral	—	—	8–12
Oxymorphone (Numorphan)	IM	10–15	30–90	3–6
	IV			
	Sub-Q	5–10	15–30	3–4
	Rectal			
Mild-to-moderate agonists				
Butorphanol	IM	10–30	30–60	3–4
	IV	2–3	30	2–4
Codeine (many trade names)	Oral	30–40	60–120	4
	IM	10–30	30–60	4
	Sub-Q	10–30		4
Hydrocodone (Hycodan)	Oral	10–30	30–60	4–6
Nalbuphine (Nubain)	IM	within 15	60	3–6
	IV	2–3	30	3–4
	Sub-Q	within 15	—	3–6
Oxycodone, immediate release (Percodan)	Oral	—	60	3–4
Pentazocine (Talwin)	Oral	15–30	60–90	3
	IM	15–20	30–60	2–3
	IV	2–3	15–30	2–3
Propoxyphene (Darvon, Dolene)	Oral	15–60	120	4–6
	Sub-Q	15–20	30–60	2–3

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Description

Opioid analgesics relieve pain by acting directly on the central nervous system. However, this can also lead to unwanted side effects, such as drowsiness, **dizziness**, breathing problems, **nausea**, and physical or mental dependence.

U.S. brand names

U.S. brand names for some drugs in this category include:

- codeine
- propoxyphene (Darvon) (taken off the market in November 2010)

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KEY TERMS

Analgesic—Medicine used to relieve pain.

Central nervous system—The brain and spinal cord.

Colitis—Inflammation of the colon (large bowel).

Hallucination—A false or distorted perception of objects, sounds, or events that seems real. Hallucinations usually result from drugs or mental disorders.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Narcotic—A drug derived from opium or compounds similar to opium. Such drugs are potent pain relievers and can affect mood and behavior. Long-term use of narcotics can lead to dependence and tolerance.

Tolerance—A decrease in sensitivity to a drug. When tolerance occurs, a person must take more and more of the drug to get the same effect.

Withdrawal symptoms—A group of physical or mental symptoms that may occur when a person suddenly stops using a drug to which he or she has become dependent.

- propoxyphene and acetaminophen (Darvocet N, taken off the market in November 2010)
- meperidine (Demerol)
- hydromorphone (Dilaudid)
- morphine (Astamorph PF, Avinza, Depo-Dur, Duramorph, Infumorph, Kadian, MS Contin, MSIR, Oramorph SR, RMS, Roxanol
- oxycodone (OxyContin)
- oxycodone combined with acetaminophen (Percocet, Roxicet)
- hydrocodone combined with acetaminophen (Lortab, Anexsia, Vicodin)
- fentanyl (Duragesic), oxymorphone (Opana)
- methadone (Methadose)

These drugs come in many forms—tablets, syrups, suppositories, and injections, and are sold only by prescription. For some, a new prescription is required for each new supply—refills are prohibited according to federal regulations. Some of these drugs also require that a tamper-proof physical prescription be brought to the pharmacy rather than having the prescription called or faxed in by the physician.

Canadian brand names

Canadian brand names for some drugs in this category include:

- codeine (Paveral)
- morphine (Epimorph, Statex)
- merperidine (Pethadol, Pethidine Hydrochloride)

Recommended dosage

Recommended doses vary depending on the type of opioid analgesic and the form in which it is being used. Doses may be different for different patients depending on their size, age, and physical condition. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for correct dosages, and make sure to understand how to take the drug. Do not stop taking the drug suddenly without checking with the physician or dentist who prescribed it. Gradually tapering (lowering) the dose may reduce the chance of withdrawal symptoms.

Precautions

Anyone who uses opioid analgesics—or any narcotic—over a long time may become physically or mentally dependent on the drug. Physical dependence may lead to withdrawal symptoms when the person stops taking the medicine. Building tolerance to these drugs is also possible when they are used for a long period. Over time, the body needs larger and larger doses achieve the same level of pain relief.

Opioid analgesics should always be taken exactly as directed. Never take larger or more frequent doses, and do not take the drug for longer than directed. If the drugs do not seem to be working, consult a physician. Do not share these or any other prescription drugs with others because the drug may have a completely different effect on the person for whom it was not prescribed.

The effects of alcohol are increased by opioid analgesics. Anyone taking these drugs should not drink alcoholic beverages.

Some of these drugs may also contain **aspirin**, **caffeine**, or **acetaminophen**.

Pediatric

Children are especially sensitive to opioid analgesics and may have serious breathing problems after

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taking them. Children may also become unusually restless or agitated when given these drugs.

Geriatric

Like children, geriatric patients are highly sensitive to opioid analgesics and may experience serious breathing problems after taking them.

Pregnant or breastfeeding

It is generally best to avoid taking opioid analgesics during **pregnancy**. Women who are pregnant or plan to become pregnant while taking opioid analgesics should let their physicians know. No evidence exists that these drugs cause **birth defects** in people, but some do cause birth defects and other problems when given to pregnant animals in experiments. Babies can become dependent on opioid analgesics if their mothers use too much during pregnancy. This can cause the baby to go through withdrawal symptoms after birth. If taken just before delivery, some opioid analgesics may cause serious breathing problems in the newborn.

Some opioid analgesics can pass into breast milk and may affect the nursing baby. Women who are breast feeding should check with their physicians about the safety of taking these drugs.

Other conditions and allergies

The effects of opioid analgesics may be altered in the presence of these conditions:

- Head injury
- History of convulsions
- Asthma, emphysema, or any chronic lung disease
- Heart disease
- Kidney disease
- Liver disease
- HIV infection
- Underactive thyroid—the chance of side effects may be greater
- Addison's disease (a disease of the adrenal glands)
- Colitis
- Gallbladder disease or gallstones
- Enlarged prostate or other urinary problems
- Current or past alcohol abuse
- Current or past drug abuse, especially narcotic abuse
- Current or past emotional problems—The chance of side effects may be greater

Let the prescriber know about any **allergies** to food, dyes, preservatives, or other substances and about any previous reactions to opioid analgesics.

Side effects

Some people experience drowsiness, dizziness, lightheadedness, or a false sense of well-being after taking opioid analgesics. Anyone who takes these drugs should not drive, use machinery, or do anything else that might be dangerous until they know how the drug affects them. **Nausea and vomiting** are common side effects, especially when beginning to take the medicine. If these symptoms do not go away after the first few doses, check with the physician or dentist who prescribed the medicine.

Dry mouth is another common side effect. Dry mouth can be relieved by sucking on sugarless hard candy or ice chips or by chewing sugarless gum. Saliva substitutes, which come in liquid or tablet forms, also may help. Patients who must use opioid analgesics over long periods and who have dry mouth should see their dentists, as the problem can lead to **tooth decay** and other dental problems.

These side effects may be serious and require quick medical attention. These symptoms could be signs of an overdose. Get emergency medical care immediately.

- cold, clammy skin
- bluish discoloration of the skin
- extremely small pupils
- serious difficulty breathing or extremely slow breathing
- extreme sleepiness or unresponsiveness
- severe weakness
- confusion
- severe dizziness
- severe drowsiness
- slow heartbeat
- low blood pressure
- severe nervousness or restlessness

These less common side effects do not require emergency medical care, but should have medical attention as soon as possible:

- hallucinations or a sense of unreality
- depression or other mood changes
- ringing or buzzing in the ears
- pounding or unusually fast heartbeat
- itching, hives, or rash
- facial swelling

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- trembling or twitching
- dark urine, pale stools, or yellow eyes or skin (after taking propoxyphene)
- increased sweating, red or flushed face (more common after taking hydrocodone and meperidine)

The following side effects usually do not need medical attention and disappear after the first few doses. If they continue or interfere with normal activity, check with the physician who prescribed the medicine.

- headache
- loss of appetite
- restlessness or nervousness
- nightmares, unusual dreams, or problems sleeping
- weakness or fatigue
- mental sluggishness
- stomach pain or cramps
- blurred or double vision or other vision problems
- problems urinating, such as pain, difficulty urinating, frequent urge to urinate, or decreased amount of urine
- constipation

Interactions

Anyone taking the following drugs should notify his or her physician before taking opioid analgesics:

- Central nervous system (CNS) depressants, such as antihistamines and other medicines for allergies, hay fever, or colds; tranquilizers; some other prescription pain relievers; seizure medicines; muscle relaxants; sleeping pills; some anesthetics (including dental anesthetics).
- Monoamine oxidase (MAO) inhibitors, such as phenelzine (Nardil) and tranylcypromine (Parnate). The combination of the opioid analgesic meperidine (Demerol) and MAO inhibitors is especially dangerous.
- Tricyclic antidepressants, such as amitriptyline (Elavil).
- Anti-seizure medicines, such as carbamazepine (Tegretol). May lead to serious side effects, including coma, when combined with propoxyphene and acetaminophen (Darvocet-N) or propoxyphene (Darvon). Note: Darvon and Darvacet were taken off the market in November 2010 due to adverse and dangerous side effects.
- Muscle relaxants, such as cyclobenzaprine (Flexeril).
- Sleeping pills, such as triazolam (Halcion).
- Blood-thinning drugs, such as warfarin (Coumadin).
- Naltrexone (Trexan, Revia). Cancels the effects of opioid analgesics.
- Rifampin (Rifadin).
- Zidovudine (AZT, Retrovir). Serious side effects when combined with morphine.

Opioids may also interact with certain herbal preparations sold as dietary supplements. Among the herbs known to interact with opioids are valerian (*Valeriana officinalis*), **ginseng** (*Panax ginseng*), kava kava (*Piper methysticum*), and chamomile (*Matricaria chamomilla*). It is just as important for patients to inform their doctor of herbal remedies that they take on a regular basis as it is to give the doctor a list of their other prescription medications.

Resources

PERIODICALS

Manchikanti, K.N., et al. "Increasing Deaths from Opioid Analgesics in the United States: An Evaluation of an Interventional Pain Management Practice." *Journal of Opioid Management* 4, no. 5 (September-October 2008): 271-83.

Manchikanti, K.N., L. Manchikanti, V. Pampati, and V.A. Cash. "Prevalance of Side Effects of Prolonged Low or Moderate Dose Opioid Therapy with Concomitant Benzodiazepine and/or Antidepressant Therapy in Chronic Non-cancer Pain." *Pain Physician* 12, no. 1 (January-February 2009): 259-67.

Stanos, S.P., D.A. Fishbain, and S.M. Fishman. "Pain Management with Opioid Analgesics: Balancing Risk and Benefit." *American Journal of Physical Medicine & Rehabilitation* 88, supplement 2 (2009): S69–S99.

Trescot, A.M., et al. "Opioids in the Management of Chronic Non-cancer Pain: An Update of the American Society of Interventional Pain Physicians (ASIPP) Guidelines." *Pain Physician* 11, supplement 2 (Mar 2008): S5–S62.

OTHER

"Pain PDQ." *National Cancer Institute*. April 20, 2010. http://www.cancer.gov/cancertopics/pdq/supportivecare/pain/Patient accessed July 21, 2010.

ORGANIZATIONS

The National Pain Foundation, 300 E Hampden Avenue, Suite 100, Englewood, CO, 80113, http://www.nationalpainfoundation.org.

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Anaphylactic shock *see* **Anaphylaxis**

Anaphylactoid purpura *see* **Allergic purpura**

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Anaphylaxis

Definition

Anaphylaxis is a rapidly progressing, life-threatening allergic reaction.

Description

Anaphylaxis is a type of allergic reaction, in which the immune system responds to otherwise harmless substances from the environment. Unlike other allergic reactions, however, anaphylaxis can kill. Reaction may begin within minutes or even seconds of exposure, and rapidly progress to cause airway constriction, skin and intestinal irritation, and altered heart rhythms. In severe cases, it can result in complete airway obstruction, shock, and **death**.

Causes and symptoms

Causes

Like the majority of other allergic reactions, anaphylaxis is caused by the release of histamine and other chemicals from mast cells. Mast cells are a type of white blood cell and they are found in large numbers in the tissues that regulate exchange with the environment: the airways, digestive system, and skin.

On their surfaces, mast cells display antibodies called IgE (immunoglobulin type E). These antibodies are designed to detect environmental substances to which the immune system is sensitive. Substances from a genuinely threatening source, such as bacteria or viruses, are called antigens. A substance that most people tolerate well, but to which others have an allergic response, is called an allergen. When IgE antibodies bind with allergens, they cause the mast cell to release histamine and other chemicals, which spill out onto neighboring cells.

The interaction of these chemicals with receptors on the surface of blood vessels causes the vessels to leak fluid into surrounding tissues, causing fluid accumulation, redness, and swelling. On the smooth muscle cells of the airways and digestive system, they cause constriction. On nerve endings, they increase sensitivity and cause **itching**.

In anaphylaxis, the dramatic response is due both to extreme hypersensivity to the allergen and its usually systemic distribution. Allergens are more likely to cause anaphylaxis if they are introduced directly into the circulatory system by injection. However, exposure by ingestion, inhalation, or skin contact can also cause anaphylaxis. In some cases, anaphylaxis may develop over time from less severe **allergies**.

KEY TERMS

ACTH—Adrenocorticotropic hormone, a hormone normally produced by the pituitary gland, sometimes taken as a treatment for arthritis and other disorders.

Antibody—An immune system protein which binds to a substance from the environment.

NSAIDs—Non-steroidal antiinflammatory drugs, including aspirin and ibuprofen.

Tracheostomy tube—A tube which is inserted into an incision in the trachea (tracheostomy) to relieve upper airway obstruction.

Anaphylaxis is most often due to allergens in foods, drugs, and insect venom. Specific causes include:

- Fish, shellfish, and mollusks
- Nuts and seeds
- Stings of bees, wasps, or hornets
- Papain from meat tenderizers
- Vaccines, including flu and measles vaccines
- Penicillin
- Cephalosporins
- Streptomycin
- Gamma globulin
- Insulin
- Hormones (ACTH, thyroid-stimulating hormone)
- Aspirin and other NSAIDs
- Latex, from exam gloves or condoms, for example.

Exposure to cold or **exercise** can trigger anaphylaxis in some individuals.

Symptoms

Symptoms may include:

- Urticaria (hives)
- Swelling and irritation of the tongue or mouth
- Swelling of the sinuses
- Difficulty breathing
- Wheezing
- Cramping, vomiting, or diarrhea
- Anxiety or confusion
- Strong, very rapid heartbeat (palpitations)
- Loss of consciousness

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Diagnosis

Anaphylaxis is diagnosed based on the rapid development of symptoms in response to a suspect allergen. Identification of the culprit may be done with RAST testing, a blood test that identifies IgE reactions to specific allergens. Skin testing may be done for less severe anaphylactic reactions.

Treatment

Emergency treatment of anaphylaxis involves injection of adrenaline (epinephrine) which constricts blood vessels and counteracts the effects of histamine. Oxygen may be given, as well as intravenous replacement fluids. **Antihistamines** may be used for skin rash, and aminophylline for bronchial constriction. If the upper airway is obstructed, placement of a breathing tube or tracheostomy tube may be needed.

Prognosis

The rapidity of symptom development is an indication of the likely severity of reaction: the faster symptoms develop, the more severe the ultimate reaction. Prompt emergency medical attention and close monitoring reduces the likelihood of death. Nonetheless, death is possible from severe anaphylaxis. For most people who receive rapid treatment, recovery is complete.

Prevention

Avoidance of the allergic trigger is the only reliable method of preventing anaphylaxis. For insect allergies, this requires recognizing likely nest sites. Preventing **food allergies** requires knowledge of the prepared foods or dishes in which the allergen is likely to occur, and careful questioning about ingredients when dining out. Use of a Medic-Alert tag detailing drug allergies is vital to prevent inadvertent administration during a medical emergency.

People prone to anaphylaxis should carry an "Epi-pen" or "Ana-kit," which contain an adrenaline dose ready for injection.

Resources

OTHER

The Merck Page. http://www.merck.com.

Richard Robinson

Anemias

Definition

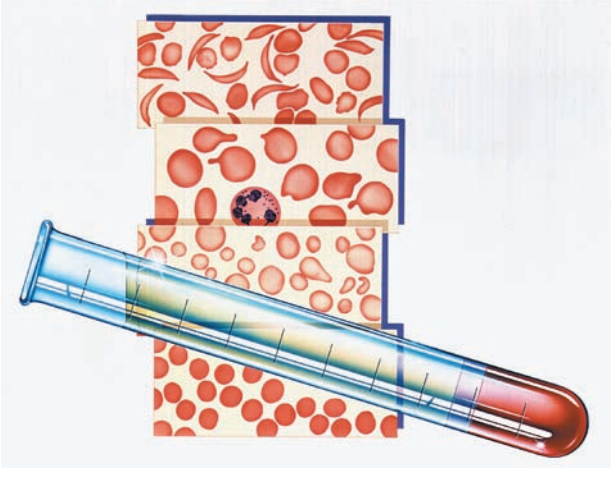
Anemia is a condition characterized by abnormally low levels of healthy red blood cells or hemoglobin (the component of red blood cells that delivers oxygen to tissues throughout the body). It is sometimes referred to as iron-poor blood or "tired blood."

Demographics

The exact number of people in any country with anemia is difficult to determine because the disorder often goes undiagnosed. According to the National Heart, Lung, and Blood Institute (NHLBI), anemia affects more than 3 million Americans. Other sources estimate that 4% of men and 8% of women in the general populations of Canada, the United States, and Western Europe have mild anemia. It is thought that the rates of anemia are 2-5 times higher in the developing countries.

According to the World Health Organization (WHO), iron deficiency is the most important nutritional disorder in the world. WHO estimates that 80% of the world's population may be iron deficient. The prevalence of vitamin B_{12} deficiency among the geriatric population is estimated at 5-15%.

Although the prevalence of anemia is greater in women than men aged less than 75, by age 75, male prevalence surpasses female prevalence by about 5%.



An illustration of normal red blood cells (left) and those in three different types of anemia (from left), iron-deficiency anemia, megaloblastic anemia, and sickle cell anemia. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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Description

WHO defines anemia as a hemoglobin level lower than 13 g/dL in men and lower than 12 g/dL in women. Hemoglobin is a protein found in red blood cells (RBCs). It has an active site called a heme that contains iron. The heme iron binds oxygen in the lungs for transport to the rest of the body where it releases the oxygen. A decrease of RBCs means a decrease of hemoglobin and a decrease of iron levels. Iron is essential to most life forms and to human health. A deficiency of iron impairs oxygen delivery to cells, resulting in **fatigue**, poor physical performance, and decreased immunity.

The tissues of the human body need a regular supply of oxygen to stay healthy. Red blood cells live for only about 120 days. When they die, the iron they contain is returned to the bone marrow and used to create new red blood cells. Anemia develops when heavy bleeding causes significant iron loss; when something happens to slow down the production of red blood cells; or to increase the rate at which they are destroyed.

Types of anemia

Anemia can be mild, moderate, or severe enough to lead to life-threatening complications. More than 400 different types of anemia have been identified, many of which are rare.

IRON DEFICIENCY ANEMIA. The onset of **iron deficiency anemia** is gradual and, at first, there may not be any symptoms. The deficiency begins when the body loses more iron than it derives from food and other sources. Because depleted iron stores cannot meet the red blood cell's needs, fewer red blood cells develop. In this early stage of anemia, the red blood cells look normal but they are reduced in number. Then the body tries to compensate for the iron deficiency by producing more red blood cells, which are characteristically small in size. Symptoms of anemia develop at this stage.

FOLIC ACID DEFICIENCY ANEMIA. **Folic acid** anemia is especially common in infants and teenagers. Although this condition usually results from a dietary deficiency, it is sometimes due to inability to absorb enough folic acid from such foods as:

- cheese
- eggs
- fish
- green vegetables
- meat
- milk
- mushrooms
- yeast

Smoking raises the risk of developing this condition by interfering with the absorption of vitamin C, which the body needs to absorb folic acid. Folic acid anemia can be a complication of **pregnancy**, when a woman's body needs eight times more folic acid than it does otherwise.

VITAMIN B_{12} DEFICIENCY ANEMIA. Less common in the United States and Canada than folic acid anemia, vitamin B_{12} deficiency anemia is another type of megaloblastic anemia that develops when the body fails to absorb enough of this nutrient. Necessary for the creation of red blood cells, B_{12} is found in meat and vegetables.

Large amounts of B_{12} are stored in the body, so this condition may not become apparent until as much as four years after B_{12} absorption stops or slows down. The resulting drop in red blood cell production can cause:

- loss of muscle control
- loss of sensation in the legs, hands, and feet
- soreness or burning of the tongue
- weight loss
- yellow-blue color blindness

The most common form of B_{12} deficiency is **pernicious anemia**. Since most people who eat meat or eggs get enough B_{12} in their **diets**, a deficiency of this vitamin usually means that the body is not absorbing it properly. This problem can occur among people who have had intestinal surgery or among those who do not produce adequate amounts of intrinsic factor, a chemical secreted by the stomach lining that combines with B_{12} to help its absorption in the small intestine.

Pernicious anemia usually strikes between the ages of 50 and 60. **Eating disorders** or an unbalanced diet increase the risk of developing pernicious anemia. So do:

- diabetes mellitus
- gastritis, stomach cancer, or stomach surgery
- thyroid disease
- family history of pernicious anemia

VITAMIN C DEFICIENCY ANEMIA. A rare disorder that causes the bone marrow to manufacture abnormally small red blood cells, vitamin C deficiency anemia results from a severe and long-standing dietary deficiency.

HEMOLYTIC ANEMIA. Some people are born with **hemolytic anemia**. Some acquire this condition, in

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which infection or antibodies destroy red blood cells more rapidly than bone marrow can replace them.

Hemolytic anemia can enlarge the spleen, accelerating the destruction of red blood cells (hemolysis). Other complications of hemolytic anemia include:

- pain
- shock
- gallstones and other serious health problems

THALASSEMIA. An inherited form of hemolytic anemia caused by mutations on either chromosome 11 or chromosome 16, **thalassemia** stems from the body's inability to manufacture as much normal hemoglobin as it needs. There are two categories of thalassemia, depending on which of the amino acid chains is affected (hemoglobin is composed of four chains of amino acids). In alpha-thalassemia, there is an imbalance in the production of the alpha chain of amino acids; in beta-thalassemia, there is an imbalance in the beta chain. Alpha-thalassemias most commonly affect people of African descent (25% have at least one gene for the disorder); beta-thalassemias most commonly affect people of Mediterranean ancestry and Southeast Asians. The most severe form of beta-thalassemia is also known as Cooley's anemia, named for the American pediatrician who first identified it.

Characterized by production of red blood cells that are unusually small and fragile, thalassemia affects only people who inherit the gene for it from both parents. This pattern is called autosomal recessive inheritance.

AUTOIMMUNE HEMOLYTIC ANEMIAS. Warm antibody hemolytic anemia is the most common type of this disorder. This condition occurs when the body produces autoantibodies that coat red blood cells. The coated cells are destroyed by the spleen, liver, or bone marrow.

Warm antibody hemolytic anemia is more common in women than in men. About one-third of patients who have warm antibody hemolytic anemia also have lymphoma, leukemia, lupus, or connective tissue disease.

In cold antibody hemolytic anemia, the body attacks red blood cells at or below normal body temperature. The acute form of this condition frequently develops in people who have had **pneumonia**, mononeucleosis, or other acute infections. It tends to be mild and short-lived, and disappears without treatment.

Chronic cold antibody hemolytic anemia is most common in women and most often affects those who are over 40 and who have arthritis. This condition usually lasts for a lifetime, generally causing few symptoms. However, exposure to cold temperatures can accelerate red blood cell destruction, causing fatigue, joint aches, and discoloration of the arms and hands.

SICKLE CELL ANEMIA. Sickle cell anemia is a chronic, incurable condition that causes the body to produce defective hemoglobin, which forces red blood cells to assume an abnormal crescent shape. Unlike normal oval cells, fragile sickle cells can't hold enough hemoglobin to nourish body tissues. The deformed shape makes it hard for sickle cells to pass through narrow blood vessels. When capillaries become obstructed, a life-threatening condition called sickle cell crisis is likely to occur.

Sickle cell anemia is hereditary. It almost always affects blacks and people of Mediterranean descent. A child who inherits the sickle cell gene from each parent will have the disease. A child who inherits the sickle cell gene from only one parent carries the sickle cell trait, but does not have the disease.

APLASTIC ANEMIA. Sometimes curable by bone marrow transplant, but potentially fatal, **aplastic anemia** is characterized by decreased production of red and white blood cells and platelets (disc-shaped cells that allow the blood to clot). This disorder may be inherited or acquired as a result of:

- recent severe illness
- long-term exposure to industrial chemicals
- use of anticancer drugs and certain other medications

ANEMIA OF CHRONIC DISEASE. **Cancer**, chronic infection or inflammation, and kidney and **liver disease** often cause mild or moderate anemia. Chronic liver failure generally produces the most severe symptoms. People infected with the Human **immunodeficiency** virus (HIV) that causes **AIDS** often face severe fatigue.

Risk factors

Risk factors for anemia include a variety of medical, genetic, environmental, and lifestyle factors:

- Female sex. Menstruation and pregnancy increase the risk of anemia during a woman's childbearing years.
- Race. African Americans and people of Saudi Arabian ancestry are at increased risk of sickle cell anemia, while people of Mediterranean ancestry are at increased risk of thalassemia.
- Family history of anemia.
- Intestinal disorders that affect the body's ability to absorb nutrients. These include parasitic infections

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KEY TERMS

Anemia of chronic disease (ACD)—A blood disorder that results from a medical condition that affects the production and lifespan of red blood cells.

Aplastic—Exhibiting incomplete or faulty development.

Cooley's anemia—Another name for the most severe form of beta-thalassemia. It is named for Thomas Benton Cooley (1871–1945), an American pediatrician who first described it in the children of Italian immigrants.

Erythropoietin—A hormone that stimulates production of red blood cells.

Hematocrit—A laboratory test that determines the percentage of packed red blood cells in a given volume of blood.

Hematology—The medical specialty that deals with the blood and the organs that form blood.

Hemoglobin—An iron-containing pigment of red blood cells composed of four amino acid chains (alpha, beta, gamma, delta) that delivers oxygen from the lungs to the tissues of the body.

Immunosuppressant—A medicine that blocks the body's immune response.

Megaloblast—A large erythroblast (a red marrow cell that synthesizes hemoglobin).

Pica—A medical disorder characterized by cravings for dirt, ice cubes, paper, starch, clay, or other non-nutritive items. It is often a sign of iron deficiency or hemolytic anemia.

Red blood cell (RBC)—A cell found in blood that contains haemoglobin to bind oxygen and carry it to all parts of the body.

Sickle cell anemia—A blood disorder in which the body produces abnormally shaped red blood cells that look like a crescent or sickle and also contain an abnormal form of hemoglobin, which interferes with oxygen delivery to tissues.

Sideroblastic anemia—A disorder in which the body has adequate iron but is unable to incorporate it into hemoglobin.

Thalassemia—An inherited blood disorder characterized by abnormal red blood cells that are unable to carry enough oxygen throughout the body.

like hookworm as well as disorders like Crohn's disease.

- Chronic diseases like diabetes, kidney failure, liver disease, or cancer.
- Workplace exposure to toxic chemicals.
- Malnutrition.
- Alcoholism.
- Adherence to a strict vegetarian or vegan diet.
- Age below 2 years. Infants who drink a lot of cow's milk may not get enough iron in their diet.
- High levels of athletic activity. Such vigorous sports as jogging, long-distance running, and basketball can cause red blood cells to break down more rapidly in the bloodstream.

Causes and symptoms

Causes

Anemia is caused by bleeding, decreased red blood cell production, or increased red blood cell destruction. Poor diet can contribute to vitamin deficiency and iron deficiency anemias in which fewer red blood cells are produced. Hereditary disorders and certain diseases can cause increased blood cell destruction. However, excessive bleeding is the most common cause of anemia, and the speed with which blood loss occurs has a significant effect on the severity of symptoms. Chronic blood loss is usually a consequence of:

- cancer
- gastrointestinal tumors
- diverticulosis
- polyposis
- heavy menstrual flow
- hemorrhoids
- nosebleeds
- stomach ulcers
- long-standing alcohol abuse

Acute blood loss is usually the result of:

- childbirth
- injury
- a ruptured blood vessel
- surgery

When a large amount of blood is lost within a short time, blood pressure and the amount of oxygen

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in the body drop suddenly. **Heart failure** and **death** can follow.

Loss of even one-third of the body's blood volume in the space of several hours can be fatal. More gradual blood loss is less serious, because the body has time to create new red blood cells to replace those that have been lost.

Symptoms

Weakness, fatigue, and a run-down feeling may be signs of mild anemia. Skin that is pasty or sallow, or lack of color in the creases of the palm, gums, nail beds, or lining of the eyelids are other signs of anemia. Someone who is weak, tires easily, is often out of breath, and feels faint or dizzy may be severely anemic.

Other symptoms of anemia are:

- angina pectoris (chest pain, often accompanied by a choking sensation that provokes severe anxiety)
- pica (cravings for ice, paint chips, starch, clay, dirt, or other nonfood items)
- headache
- inability to concentrate, memory loss
- inflammation of the mouth (stomatitis) or tongue (glossitis)
- insomnia
- irregular heartbeat
- loss of appetite
- nails that are dry, brittle, or ridged
- rapid breathing
- sores in the mouth, throat, or rectum
- sweating
- swelling of the hands and feet
- thirst
- tinnitus (ringing in the ears)
- unexplained bleeding or bruising

In pernicious anemia, the tongue feels unusually slick. A patient with pernicious anemia may have:

- problems with movement or balance
- tingling in the hands and feet
- confusion, depression, and memory loss

Pernicious anemia can damage the spinal cord. A doctor should be notified whenever symptoms of this condition occur.

A doctor should also be notified if a patient who has been taking iron supplements develops:

- diarrhea
- cramps
- vomiting

Diagnosis

Personal and family health history may suggest the presence of certain types of anemia. Anemia does not always have noticeable symptoms, however, and is sometimes diagnosed in the course of an examination for another disease or disorder.

Examination

An office examination can yield some clues to anemia. The doctor may discover that the patient's heartbeat is irregular, that breathing is uneven or unusually rapid, or that the liver and spleen are enlarged. In some cases a **pelvic exam** (in women) or a rectal exam will indicate that the patient is losing blood.

Tests

Laboratory tests that measure the percentage of red blood cells or the amount of hemoglobin in the blood are used to confirm diagnosis and determine which type of anemia is responsible for a patient's symptoms. X rays and examinations of bone marrow may be used to identify the source of bleeding.

Other tests that may be done include tests of the types of hemoglobin as well as the total amount of hemoglobin present in the patient's blood; measurement of the number of reticulocytes (young blood cells) in the blood; tests that measure the level of iron in the body; tests for vitamin deficiencies; and tests for signs of kidney failure. Children may be tested for signs of **lead poisoning**.

Procedures

The doctor may send the patient to a gastroenterologist for an **endoscopy** if blood is found in the patient's stool. An endoscopy is a diagnostic procedure in which a tube is inserted into the patient's body to pinpoint the location of bleeding, tumors, or other problems.

Treatment

Traditional

Treatment for anemia depends on what is causing the anemia:

- Iron deficiency anemia is usually treated with iron supplements, prescribed for several months or longer.
- A lifelong regimen of B_{12} shots is necessary to control symptoms of pernicious anemia. The patient may be

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advised to limit physical activity until treatment restores strength and balance.

- Folate deficiency anemia is treated with folic acid supplements.
- ACD can be treated with epoetin, a synthetic erythropoietin that stimulates the production of RBCs, but the focus is on treating the underlying disease.
- Aplastic anemia may be treated with blood transfusions to increase levels of red blood cells, or bone marrow transplants if the bone marrow cannot produce healthy blood cells.
- Anemia of chronic disease can be treated with erythropoietin, a hormone that stimulates production of red blood cells. It is sometimes used to treat anemia from kidney disease or cancer chemotherapy.
- Hemolytic anemia is treated by managing related infections and drugs that suppress the immune system (immunosuppressants). There is no specific treatment for cold-antibody hemolytic anemia. About one-third of patients with warm-antibody hemolytic anemia respond well to large doses of intravenous and oral corticosteroids, which are gradually discontinued as the patient's condition improves. Patients with this condition who don't respond to medical therapy must have the spleen surgically removed. This operation controls anemia in about one-half of the patients on whom it's performed. Immune-system suppressants are prescribed for patients whose surgery is not successful.
- Sickle cell anemia treatment may include the administration of oxygen, pain-relieving drugs, and fluids to reduce pain and prevent complications. Psychotherapy or counseling may help patients deal with the emotional impact of this condition.

In addition to iron, **vitamins**, and medicines prescribed to treat the underlying causes of anemia or to increase the production of RBCs, blood transfusions may be prescribed in some cases, as well as surgery to stop serious or life-threatening bleeding when it is causing anemia, for example, to control chronic bleeding from a stomach ulcer.

Medication or surgery may also be necessary to control heavy menstrual flow, repair a bleeding ulcer, or remove polyps (growths or nodules) from the bowels.

Patients with thalassemia usually do not require treatment. However, people with Cooley's anemia may require periodic hospitalization for blood transfusions and/or **bone marrow transplantation**.

Drugs

Patients with sickle cell anemia may require **pain** relievers to treat periodic crises caused by the disease. Children with sickle cell anemia are usually given penicillin from 2 months to 5 years of age to prevent infections. Another drug that helps some patients with sickle cell anemia is hydroxyurea, a drug developed to treat cancer. Hydroxyurea stimulates the production of fetal hemoglobin, a type of hemoglobin usually found only in newborns. It can reduce the need for blood transfusions and the frequency of sickle cell crises.

Alternative

Home remedies

Anyone who has anemia caused by poor **nutrition** should modify his or her diet to include more vitamins, **minerals**, and iron. Vitamin C can stimulate iron absorption. The following foods are also good sources of iron:

- almonds
- broccoli
- dried beans
- dried fruits
- enriched breads and cereals
- lean red meat
- liver
- potatoes
- poultry
- rice
- shellfish
- tomatoes

Because light and heat destroy folic acid, fruits and vegetables should be eaten raw or cooked as little as possible.

Alternative treatment

As is the case in standard medical treatment, the cause of the specific anemia will determine the alternative treatment recommended. If the cause is a deficiency, for example iron deficiency, folic acid deficiency, B_{12} deficiency, or vitamin C deficiency, supplementation is the treatment. For extensive blood loss, the cause should be identified and corrected. Other types of anemias should be addressed on a deep healing level with crisis intervention when necessary.

Many alternative therapies for iron-deficiency anemia focus on adding iron-rich foods to the diet or

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on techniques to improve circulation and digestion. Iron supplementation, especially with iron citrate (less likely to cause **constipation**), is used by alternative practitioners. This supplement can be given in combination with herbs that are rich in iron. Some examples of iron-rich herbs are dandelion (*Taraxacum officinale*), parsley (*Petroselinum crispum*), and nettle (*Urtica dioica*). The homeopathic remedy ferrum phosphoricum can also be helpful.

An iron-rich herbal tonic can also me made using the following recipe:

- soak 1/2 oz of yellow dock root and 1/2 oz dandelion root in 1 qt of boiled water for four to 8 hours
- strain and simmer until the amount of liquid is reduced to 1 cup
- remove from heat and add 1/2 cup black strap molasses, mixing well
- store in refrigerator; take 1 tsp-2 Tbsp daily

Other herbal remedies used to treat iron-deficiency anemia aim to improve the digestion. Gentian (*Gentiana lutea*) is widely used in Europe to treat anemia and other nutritionally based disorders. The bitter qualities of gentian help stimulate the digestive system, making iron and other nutrients more available for absorption. This bitter herb can be brewed into tea or purchased as an alcoholic extract (tincture).

Other herbs recommended to promote digestion include:

- anise (*Pimpinella anisum*)
- caraway (*Carum carvi*)
- cumin (*Cuminum cyminum*)
- linden (*Tilia* spp.)
- licorice (*Glycyrrhiza glabra*)

Traditional Chinese treatments for anemia include:

- acupuncture to stimulate a weakened spleen
- asian ginseng (*Panax ginseng*) to restore energy
- dong quai (*Angelica sinensis*) to control heavy menstrual bleeding
- a mixture of dong quai and Chinese foxglove (*Rehmannia glutinosa*) to clear a sallow complexion

Prognosis

The prognosis of anemia depends on its cause.

Folic acid and iron deficiency anemias

It usually takes three to six weeks to correct folic acid or iron deficiency anemia. Patients should continue taking supplements for another six months to replenish iron reserves. They should have periodic blood tests to make sure the bleeding has stopped and the anemia has not recurred.

Pernicious anemia

Although pernicious anemia is considered incurable, regular B_{12} shots will alleviate symptoms and reverse complications. Some symptoms will disappear almost as soon as treatment begins.

Aplastic anemia

Aplastic anemia can sometimes be cured by bone marrow transplantation. If the condition is due to immunosuppressive drugs, symptoms may disappear after the drugs are discontinued.

Sickle cell anemia

The prognosis for sickle cell anemia is still relatively poor. With the exception of children who benefit from bone marrow transplantation, most people with sickle cell anemia have shortened life expectancies. As recently as the 1990s, the average life span for patients with the disease was 42 years for males and 48 years for females. About half of patients diagnosed with the disease live into their early fifties

Thalassemia

Patients with mild beta thalassemia have a normal life expectancy with generally good health, although like patients with alpha thalassemia, they should be informed about the hereditary nature of their condition. The prognosis for patients with Cooley's anemia depends on their compliance with therapy. Untreated Cooley's anemia usually leads to death from heart failure or infection before age 20.

Hemolytic anemia

Acquired hemolytic anemia can generally be cured when the cause is removed.

Prevention

Inherited anemias cannot be prevented although they can be diagnosed before birth by **amniocentesis**. **Genetic counseling** can help parents cope with questions and concerns about transmitting disease-causing genes to their children.

Avoiding excessive use of alcohol, quitting smoking, eating a balanced diet that contains plenty of iron-rich foods, and taking a daily multivitamin can help prevent anemia.

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Methods of preventing specific types of anemia include:

- avoiding lengthy exposure to industrial chemicals and drugs known to cause aplastic anemia
- not taking medication that has triggered hemolytic anemia and not eating foods that have caused hemolysis (breakdown of red blood cells)
- receiving regular B_{12} shots to prevent pernicious anemia resulting from gastritis or stomach surgery

Nutrition/Dietetic concerns

Iron deficiency anemia has been associated with a low dietary intake of iron. There are two forms of dietary iron: heme and nonheme. Heme iron is the best source of iron and is found in animal foods such as red meats, fish, and poultry. Nonheme iron is found in plant foods such as lentils and beans, and is also the form of iron added to iron-enriched foods. Folate is found in citrus juices and fruits, dark green leafy vegetables, legumes and fortified breakfast cereals. Vitamin B_{12} requirements are met by eating meat and dairy products.

Health care team roles

Anemia is often overlooked as a priority associated with quality patient care. Identifying the underlying causes of anemia in patients is critical to positive care outcomes and requires early assessment and intervention. The entire health care team plays a critical role in the well-being and quality of life of patients with anemia by understanding the disease and appropriate treatments, and by providing patients with any materials and education needed to understand the disease and its treatment.

Caregiver concerns

Anemia can have a significant impact on the quality of life of older adults. Anemia from iron deficiency often results from poor nutrition in this age group. Caregivers need to focus on the age-related physiologic changes underlying this condition and whether anemia correction can improve quality of life. The prevalence of blood loss/iron deficiency as a cause of anemia in the elderly points to the importance of recognizing this diagnosis in these patients.

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ORGANIZATIONS

American Society of Hematology (ASH), 1900 M Street, NW, Suite 200, Washington, DC, 20036 202-776-0544 202-776-0545, ash@hematology.org, http://www.hematology.org/.

Cooley's Anemia Foundation, 330 Seventh Avenue, #900, New York, NY, 10001 800-522-7222 212-279-5999, http://www.thalassemia.org.

National Heart, Lung, and Blood Institute (NHLBI), Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105 301-592-8573 240-629-3246, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi.nih.gov/.

Sickle Cell Disease Association of America (SCDAA), 231 East Baltimore Street, Suite 800, Baltimore, MD, 21202 410-528-1555 800-421-8453 410-528-1495, scdaa@-sicklecelldisease.org, http://www.sicklecell disease.org/index.phtml.

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Anencephaly *see* **Congenital brain defects**

Anesthesia, general

Definition

General anesthesia is the induction of a state of unconsciousness with the absence of **pain** sensation over the entire body, through the administration of anesthetic drugs. It is used during certain medical and surgical procedures.

Types of anesthetics

Type	Names	Route(s) of administration	Effect
General	Enflurane, halothane, isoflurane, ketamine, nitrous oxide, propofol, thiopental	Intravenously, inhalation	Produces total unconsciousness affecting the entire body
Regional	Chloroprocaine, lidocaine, mepivacaine	Intravenously, nerve block	Temporarily interrupts transmission of nerve impulses (temperature, touch, pain) and motor functions in a large area to be treated; does not produce unconsciousness
Local	Bupivacaine, lidocaine, procaine, tetracaine	Local infiltration	Temporarily blocks transmission of nerve impulses and motor functions in a specific area; does not produce unconsciousness
Topical	Benzocaine, butamben, dibucaine, lidocaine, pramoxine, tetracaine	Dermal (sprays, ointments, creams, gels)	Temporarily blocks nerve endings in skin and mucous membranes; does not produce unconsciousness

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Purpose

General anesthesia has many purposes including:

- pain relief
- blocking memory of the procedure
- producing unconsciousness
- inhibiting normal body reflexes to make surgery safe and easier to perform
- relaxing the muscles of the body

Description

Anesthesia performed with general anesthetics occurs in four stages which may or may not be observable because they can occur very rapidly:

- Stage One: Analgesia. The patient experiences analgesia or a loss of pain sensation but remains conscious and can carry on a conversation.
- Stage Two: Excitement. The patient may experience delirium or become violent. Blood pressure rises and becomes irregular, and breathing rate increases. This stage is typically bypassed by administering a

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KEY TERMS

Amnesia—The loss of memory.

Analgesia—A state of insensitivity to pain even though the person remains fully conscious.

Anesthesiologist—A medical specialist who administers an anesthetic to a patient before he is treated.

Anesthetic—A drug that causes unconsciousness or a loss of general sensation.

Arrhythmia—Abnormal heart beat.

Barbiturate—A drug with hypnotic and sedative effects.

Catatonia—Psychomotor disturbance characterized by muscular rigidity, excitement or stupor.

Hypnotic agent—A drug capable of inducing a hypnotic state.

Hypnotic state—A state of heightened awareness that can be used to modulate the perception of pain.

Hypoxia—Reduction of oxygen supply to the tissues.

Malignant hyperthermia—A type of reaction (probably with a genetic origin) that can occur during general anesthesia and in which the patient experiences a high fever, muscle rigidity, and irregular heart rate and blood pressure.

Medulla oblongata—The lowest section of the brainstem, located next to the spinal cord. The medulla is the site of important cardiac and respiratory regulatory centers.

Neurotransmitter—One of a group of chemicals secreted by a nerve cell (neuron) to carry a chemical message to another nerve cell, often as a way of transmitting a nerve impulse. Examples of neurotransmitters include acetylcholine, dopamine, serotonin, and norepinephrine.

Opioid—Any morphine-like synthetic narcotic that produces the same effects as drugs derived from the opium poppy (opiates), such as pain relief, sedation, constipation and respiratory depression.

Pneumothorax—A collapse of the lung.

Stenosis—A narrowing or constriction of the diameter of a passage or orifice, such as a blood vessel.

barbiturate, such as sodium pentothal, before the anesthesia.

- Stage Three: Surgical Anesthesia. During this stage, the skeletal muscles relax, and the patient's breathing becomes regular. Eye movements slow, then stop, and surgery can begin.
- Stage Four: Medullary Paralysis. This stage occurs if the respiratory centers in the medulla oblongata of the brain that control breathing and other vital functions cease to function. Death can result if the patient cannot be revived quickly. This stage should never be reached. Careful control of the amounts of anesthetics administered prevent this occurrence.

Agents used for general anesthesia may be either gases or volatile liquids that are vaporized and inhaled with oxygen, or drugs delivered intravenously. A combination of inhaled anesthetic gases and intravenous drugs are usually delivered during general anesthesia; this practice is called balanced anesthesia and is used because it takes advantage of the beneficial effects of each anesthetic agent to reach surgical anesthesia. If necessary, the extent of the anesthesia produced by inhaling a general anesthetic can be rapidly modified by adjusting the concentration of the anesthetic in the oxygen that is breathed by the patient. The degree of anesthesia produced by an intravenously injected anesthetic is fixed and cannot be changed as rapidly. Most commonly, intravenous anesthetic agents are used for induction of anesthesia and then followed by inhaled anesthetic agents.

General anesthesia works by altering the flow of **sodium** ions into nerve cells (neurons) through the cell membrane. Exactly how the anesthetic does this is not understood since the drug apparently does not bind to any receptor on the cell surface and does not seem to affect the release of chemicals that transmit nerve impulses (neurotransmitters) from the nerve cells. It is known, however, that when the sodium ions do not get into the neurons, nerve impulses are not generated and the brain becomes unconscious, does not store memories, does not register pain impulses from other areas of the body, and does not control involuntary reflexes. Although anesthesia may feel like deep sleep, it is not the same as sleep. In sleep, some parts of the brain speed up while others slow down. Under anesthesia, the loss of consciousness is more widespread.

When general anesthesia was first introduced in medical practice, ether and chloroform were inhaled with the physician manually covering the patient's mouth. Since then, general anesthesia has become much more sophisticated. During most surgical procedures, anesthetic agents are now delivered and controlled

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by computerized equipment that includes anesthetic gas monitoring as well as patient monitoring equipment. Anesthesiologists are the physicians that specialize in the delivery of anesthetic agents. Currently used inhaled general anesthetics include halothane, enflurane, isoflurane, desfluorane, sevofluorane, and nitrous oxide.

- Halothane (Fluothane) is a powerful anesthetic and can easily be overadministered. This drug causes unconsciousness but little pain relief so it is often used with other agents to control pain. Very rarely, it can be toxic to the liver in adults, causing death. It also has the potential for causing serious cardiac arrhythmias. Halothane has a pleasant odor, and was frequently the anesthetic of choice for use with children, but since the introduction of sevofluorane in the 1990s, halothane use has declined.
- Enflurane (Ethrane) is less potent and results in a more rapid onset of anesthesia and faster awakening than halothane. In addition, it acts as an enhancer of paralyzing agents. Enflurane has been found to increase intracranial pressure and the risk of seizures; therefore, it should not be used in patients with seizure disorders.
- Isoflurane (Forane) is not toxic to the liver but can cause some cardiac irregularities. Isofluorane is often used in combination with intravenous anesthetics for anesthesia induction. Awakening from anesthesia is faster than it is with halothane and enfluorane.
- Desfluorane (Suprane) may increase the heart rate and should not be used in patients with aortic valve stenosis; however, it does not usually cause heart arrhythmias. Desflurane may cause coughing and excitation during induction and is therefore is used intravenously. Desflurane is rapidly eliminated and awakening is therefore faster than with other inhaled agents.
- Sevofluorane (Ultane) may also cause increased heart rate and should not be used in patients with narrowed aortic valve (stenosis); however, it does not usually cause heart arrhythmias. Unlike desfluorane, sevofluorane does not cause any coughing or other related side effects, and can therefore be used without intravenous agents for rapid induction. For this reason, sevofluorane is replacing halothane for induction in pediatric patients. Like desfluorane, this agent is rapidly eliminated and allows rapid awakening.
- Nitrous oxide (laughing gas) is a weak anesthetic and is used with other agents, such as thiopental, to produce surgical anesthesia. It has the fastest induction and recovery and is the safest because it does not slow breathing or blood flow to the brain. However, it diffuses rapidly into air-containing cavities and can result in a collapsed lung (pneumothorax) or lower the oxygen contents of tissues (hypoxia).

Commonly administered intravenous anesthetic agents include ketamine, thiopental, opioids, and propofol.

- Ketamine (Ketalar) affects the senses, and produces a dissociative anesthesia (catatonia, amnesia, analgesia) in which the patient may appear awake and reactive, but cannot respond to sensory stimuli. These properties make it especially useful for use in developing countries and during warfare medical treatment. Ketamine is frequently used in pediatric patients because anesthesia and analgesia can be achieved with an intramuscular injection. It is also used in high-risk geriatric patients and in shock cases, because it also provides cardiac stimulation.
- Thiopental (Pentothal) is a barbiturate that induces a rapid hypnotic state of short duration. Because thiopental is slowly metabolized by the liver, toxic accumulation can occur; therefore, it should not be continuously infused. Side effects include nausea and vomiting upon awakening.
- Opioids include fentanyl, sufentanil, and alfentanil, and are frequently used before anesthesia and surgery as a sedative and analgesic, as well as a continuous infusion for primary anesthesia. Because opioids rarely affect the cardiovascular system, they are particularly useful for cardiac surgery and other high-risk cases. Opioids act directly on spinal cord receptors, and are frequently used in epidurals for spinal anesthesia. Side effects may include nausea and vomiting, itching, and respiratory depression.
- Propofol (Diprivan) is a nonbarbiturate hypnotic agent and the most recently developed intravenous anesthetic. Its rapid induction and short duration of action are identical to thiopental, but recovery occurs more quickly and with much less nausea and vomiting. Also, propofol is rapidly metabolized in the liver and excreted in the urine, so it can be used for long durations of anesthesia, unlike thiopental. Hence, propofol is rapidly replacing thiopental as an intravenous induction agent. It is used for general surgery, cardiac surgery, neurosurgery, and pediatric surgery.

General anesthetics are given only by anesthesiologists, the medical professionals trained to use them. These specialists consider many factors, including a patient's age, weight, medication **allergies**, medical history, and general health, when deciding which anesthetic or combination of anesthetics to use. General anesthetics are usually inhaled through a mask or a breathing tube or injected into a vein, but are also sometimes given rectally.

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General anesthesia is much safer today than it was in the past. This progress is due to faster-acting anesthetics, improved safety standards in the equipment used to deliver the drugs, and better devices to monitor breathing, heart rate, blood pressure, and brain activity during surgery. Unpleasant side effects are also less common.

Recommended dosage

The dosage depends on the type of anesthetic, the patient's age and physical condition, the type of surgery or medical procedure being done, and other medication the patient takes before, during, or after surgery.

Precautions

Although the risks of serious complications from general anesthesia are very low, they can include **heart attack**, **stroke**, brain damage, and **death**. Anyone scheduled to undergo general anesthesia should thoroughly discuss the benefits and risks with a physician. The risks of complications depend, in part, on a patient's age, sex, weight, allergies, general health, current medications, and history of **smoking**, drinking alcohol, and illicit drug use. Some of these risks can be minimized by ensuring that the physician and anesthesiologist are fully informed of the detailed health condition of the patient, including any drugs that he or she may be using. Older people are especially sensitive to the effects of certain anesthetics and may be more likely to experience side effects from these drugs.

Patients who have had general anesthesia should not drink alcoholic beverages or take medications that slow the central nervous system (e.g., **antihistamines**, sedatives, tranquilizers, sleep aids, certain pain relievers, **muscle relaxants**, and anti-seizure medication) for at least 24 hours, except under a doctor's care.

Special conditions

People with certain medical conditions are at greater risk of developing problems with anesthetics. Before undergoing general anesthesia, anyone with the following conditions should absolutely inform their doctor.

ALLERGIES. Anyone who has had allergic or other unusual reactions to **barbiturates** or general anesthetics in the past should notify the doctor before having general anesthesia. In particular, people who have had malignant hyperthermia or whose family members have had malignant hyperthermia during or after being given an anesthetic should inform the physician. Signs of malignant hyperthermia include rapid, irregular heartbeat, breathing problems, very high **fever**, and muscle tightness or spasms. These symptoms can occur following the administration of general anesthesia using inhaled agents, especially halothane. In addition, the doctor should also be told about any allergies to foods, dyes, preservatives, or other substances.

PREGNANCY. The effects of anesthetics on pregnant women and fetuses vary, depending on the type of drug. In general, giving large amounts of general anesthetics to the mother during labor and delivery may make the baby sluggish after delivery. Pregnant women should discuss the use of anesthetics during labor and delivery with their doctors. Pregnant women who may be given general anesthesia for other medical procedures should ensure that the treating physician is informed about the **pregnancy**.

BREASTFEEDING. Some general anesthetics pass into breast milk, but they have not been reported to cause problems in nursing babies whose mothers were given the drugs.

OTHER MEDICAL CONDITIONS. Before being given a general anesthetic, a patient who has any of the following conditions should inform his or her doctor:

- neurological conditions, such as epilepsy or stroke
- problems with the stomach or esophagus, such as ulcers or heartburn
- eating disorders
- loose teeth, dentures, bridgework
- heart disease or family history of heart problems
- lung diseases, such as emphysema or asthma
- history of smoking
- immune system diseases
- arthritis or any other conditions that affect movement
- diseases of the endocrine system, such as diabetes or thyroid problems

Side effects

Because general anesthetics affect the central nervous system, patients may feel drowsy, weak, or tired for as long as a few days after having general anesthesia. Fuzzy thinking, blurred vision, and coordination problems are also possible. For these reasons, anyone who has had general anesthesia should not drive, operate machinery, or perform other activities that could endanger themselves or others for at least 24 hours, or longer if necessary.

Most side effects usually disappear as the anesthetic wears off. A nurse or doctor should be notified if these or other side effects persist or cause problems, such as:

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- headache
- vision problems, including blurred or double vision
- shivering or trembling
- muscle pain
- dizziness, lightheadedness, or faintness
- drowsiness
- mood or mental changes
- nausea or vomiting
- sore throat
- nightmares or unusual dreams

A doctor should be notified as soon as possible if any of the following side effects occur within two weeks of having general anesthesia:

- severe headache
- pain in the stomach or abdomen
- back or leg pain
- severe nausea
- black or bloody vomit
- unusual tiredness or weakness
- weakness in the wrist and fingers
- weight loss or loss of appetite
- increase or decrease in amount of urine
- pale skin
- yellow eyes or skin

Interactions

General anesthetics may interact with other medicines. When this happens, the effects of one or both of the drugs may be altered or the risk of side effects may be greater. Anyone scheduled to undergo general anesthesia should inform the doctor about all other medication that he or she is taking. This includes prescription drugs, nonprescription medicines, herbal remedies, and street drugs. Serious and possibly life-threatening reactions may occur when general anesthetics are given to people who use street drugs, such as **cocaine**, **marijuana**, phencyclidine (PCP or angel dust), amphetamines (uppers), barbiturates (downers), heroin, or other **narcotics**. Anyone who uses these drugs should make sure their doctor or dentist knows what they have taken.

Resources

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ORGANIZATIONS

American Academy of Anesthesiologist Assistants, 2209 Dickens Road, Richmond, VA, 23230-2005, (804) 565-6353, (888) 443-6353, http://www.anesthetist.org.

American Society of Anesthesiologists, 520 N. Northwest Highway, Park Ridge, IL, 60068-2573, (847) 825-5586, (847) 825-1692, http://www.asahq.org.

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Anesthesia, local

Definition

Local or regional anesthesia involves the injection or application of an anesthetic drug to a specific area of the body, as opposed to the entire body and brain as occurs during **general anesthesia**.

Purpose

Local anesthetics are used to prevent patients from feeling **pain** during medical, surgical, or dental procedures. Over-the-counter local anesthetics are also available to provide temporary relief from pain, irritation, and **itching** caused by various conditions, such as **cold sores**, **canker sores**, sore throats, **sunburn**, insect **bites**, **poison ivy**, and minor cuts and scratches.

Types of surgery or medical procedures that regularly make use of local or regional anesthesia include the following:

- biopsies in which skin or tissue samples are taken for diagnostic procedures
- childbirth
- surgeries on the arms, hands, legs, or feet
- eye surgery
- surgeries involving the urinary tract or sexual organs

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KEY TERMS

Canker sore—A painful sore inside the mouth.

Cold sore—A small blister on the lips or face, caused by a virus. Also called a fever blister.

Epidural space—The space surrounding the spinal fluid sac.

Malignant hyperthermia—A type of reaction (probably with a genetic basis) that can occur during general anesthesia in which the patient experiences a high fever, the muscles become rigid, and the heart rate and blood pressure fluctuate.

Subarachnoid space—The space surrounding the spinal cord that is filled with cerebrospinal fluid.

Topical—Not ingested; applied to the outside of the body, for example to the skin, eye, or mouth.

Surgeries involving the chest and abdomen are usually performed under general anesthesia.

Local and regional anesthesia have advantages over general anesthesia in that patients can avoid some unpleasant side effects, can receive longer lasting pain relief, have reduced blood loss, and maintain a sense of psychological comfort by not losing consciousness.

Description

Regional anesthesia typically affects a larger area than local anesthesia, for example, everything below the waist. As a result, regional anesthesia may be used for more involved or complicated surgical or medical procedures. Regional anesthetics are injected. Local anesthesia involves the injection into the skin or muscle or application to the skin of an anesthetic directly where pain will occur. Local anesthesia can be divided into four groups: injectable, topical, dental (non-injectable), and ophthalmic.

Local and regional anesthesia work by altering the flow of **sodium** molecules into nerve cells or neurons through the cell membrane. Exactly how the anesthetic does this is not understood, since the drug apparently does not bind to any receptor on the cell surface and does not seem to affect the release of chemicals that transmit nerve impulses (neurotransmitters) from the nerve cells. It is known, however, that when the sodium molecules do not get into the neurons, nerve impulses are not generated and pain impulses are not transmitted to the brain. The duration of action of an anesthetic depends on the type and amount of anesthetic administered.

Regional anesthesia

Types of regional anesthesia include:

- Spinal anesthesia. Spinal anesthesia involves the injection of a small amount of local anesthetic directly into the cerebrospinal fluid surrounding the spinal cord (the subarachnoid space). Blood pressure drops are common but are easily treated.
- Epidural anesthesia. Epidural anesthesia involves the injection of a large volume of local anesthetic directly into the space surrounding the spinal fluid sac (the epidural space), not into the spinal fluid. Pain relief occurs more slowly but is less likely to produce blood pressure drops. Also, the block can be maintained for long periods, even days.
- Nerve blocks. Nerve blocks involve the injection of an anesthetic into the area around a nerve that supplies a particular region of the body, preventing the nerve from carrying nerve impulses to the brain.

Anesthetics may be administered with another drug, such as epinephrine (adrenaline), which decreases bleeding, and sodium bicarbonate to decrease the acidity of a drug so that it will work faster. In addition, drugs may be administered to help a patient remain calm and more comfortable or to make them sleepy.

Local anesthesia

INJECTABLE LOCAL ANESTHETICS. These medicines are given by injection to numb and provide pain relief to some part of the body during surgery, dental procedures, or other medical procedures. They are given only by a trained health care professional and only in a doctor's office or a hospital. Some commonly used injectable local anesthetics are procaine (Novocain), lidocaine (Dalcaine, Dilocaine, L-Caine, Nervocaine, Xylocaine, and other brands), and tetracaine (Pontocaine).

TOPICAL ANESTHETICS. Topical anesthetics, such as benzocaine, lidocaine, dibucaine, pramoxine, butamben, and tetracaine, relieve pain and itching by deadening the nerve endings in the skin. They are ingredients in a variety of nonprescription products that are applied to the skin to relieve the discomfort of sunburn, insect bites or **stings**, poison ivy, and minor cuts, scratches, and **burns**. These products are sold as creams, ointments, sprays, lotions, and gels.

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DENTAL ANESTHETICS (NON-INJECTABLE). Some local anesthetics are intended for pain relief in the mouth or throat. They may be used to relieve throat pain, **teething** pain, painful canker sores, toothaches, or discomfort from dentures, braces, or bridgework. Some dental anesthetics are available only with a doctor's prescription. Others may be purchased without a prescription, including products such as Num-Zit, Orajel, Chloraseptic lozenges, and Xylocaine.

OPHTHALMIC ANESTHETICS. Other local anesthetics are designed for use in the eye. The ophthalmic anesthetics proparacaine and tetracaine are used to numb the eye before certain eye examinations. Eye doctors may also use these medicines before measuring eye pressure or removing stitches or **foreign objects** from the eye. These drugs are to be given only by a trained health care professional.

Recommended dosage

The recommended dosage depends on the type of local anesthetic and the purpose for which it is being used. When using a nonprescription local anesthetic, follow the directions on the package. Questions concerning how to use a product should be referred to a medical doctor, dentist, or pharmacist.

Precautions

People who strongly feel that they cannot psychologically cope with being awake and alert during certain procedures may not be good candidates for local or regional anesthesia. Other medications may be given in conjunction with the anesthetic, however, to relieve **anxiety** and help the patient relax.

Local anesthetics should be used only for the conditions for which they are intended. For example, a topical anesthetic meant to relieve sunburn pain should not be used on cold sores. Anyone who has had an unusual reaction to any local anesthetic in the past should check with a doctor before using any type of local anesthetic again. The doctor should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

Older people may be more sensitive to the effects of local anesthetics, especially lidocaine. This increased sensitivity may increase the risk of side effects. Older people who use nonprescription local anesthetics should be especially careful not to use more than the recommended amount. Children also may be especially sensitive to the effects of some local anesthetics, which may increase the chance of side effects. Anyone using these medicines on a child should be careful not to use more than the amount that is recommended for children. Certain types of local anesthetics should not be used at all young children. Follow package directions carefully and check with a doctor of pharmacist if there are any questions.

Regional anesthetics

Serious, possibly life-threatening, side effects may occur when anesthetics are given to people who use street drugs. Anyone who uses **cocaine**, **marijuana**, amphetamines, **barbiturates**, phencyclidine (PCP, or angel dust), heroin, or other street drugs should make sure their doctor or dentist knows what they have used.

Patients who have had a particular kind of reaction called malignant hyperthermia (or who have one or more family members who have had this problem) during or just after receiving a general anesthetic should inform their doctors before receiving any kind of anesthetic. Signs of malignant hyperthermia include fast and irregular heartbeat, very high **fever**, breathing problems, and **muscle spasms** or tightness.

Although problems are rare, some unwanted side effects may occur when regional anesthetics are used during labor and delivery. These anesthetics can prolong labor and increase the risk of **Cesarean section**. Pregnant women should discuss with their doctors the risks and benefits of being given these drugs.

Patients should not drive or operate other machinery immediately following a procedure involving regional anesthesia, due to **numbness** and weakness, or if local anesthesia also included drugs to make the patient sleep or strong pain medications. Injection sites should be kept clean, dry, and uncovered to prevent infection.

Injectable local anesthetics

Until the anesthetic wears off, patients should be careful not to injure the numbed area. If the anesthetic was used in the mouth, do not eat or chew gum until feeling returns.

Topical anesthetics

Unless advised by a doctor, topical anesthetics should not be used on or near any part of the body with large sores, broken or scraped skin, severe injury, or infection. They should also not be used on large areas of skin. Some topical anesthetics contain alcohol and should not be used near an open flame, or while **smoking**.

Anyone using a topical anesthetic should be careful not to get this medication in the eyes, nose, or

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mouth. When using a spray form of this medication, do not spray it directly on the face, but apply it to the face with a cotton swab or sterile gauze pad. After using a topical anesthetic on a child, make sure the child does not get the medicine in his or her mouth.

Topical anesthetics are intended for the temporary relief of pain and itching. They should not be used for more than a few days at a time. Check with a doctor if:

- the discomfort continues for more than seven days
- the problem gets worse
- the treated area becomes infected
- new signs of irritation, such as skin rash, burning, stinging, or swelling appear

Dental anesthetics (non-injectable)

Dental anesthetics should not be used if certain kinds of infections are present. Check package directions or check with a dentist or medical doctor if uncertain. Dental anesthetics should be used only for temporary pain relief. If problems such as **toothache**, mouth sores, or pain from dentures or braces continue, check with a dentist. Check with a doctor if **sore throat** pain is severe, lasts more than two days, or is accompanied by other symptoms such as fever, **headache**, skin rash, swelling, **nausea**, or **vomiting**.

Patients should not eat or chew gum while the mouth is numb from a dental anesthetic. There is a risk of accidently biting the tongue or the inside of the mouth. Also nothing should be eaten or drunk for one hour after applying a dental anesthetic to the back of the mouth or throat, since the medicine may interfere with swallowing and may cause **choking**. If normal feeling does not return to the mouth within a few hours after receiving a dental anesthetic or if it is difficult to open the mouth, check with a dentist.

Ophthalmic anesthetics

When anesthetics are used in the eye, it is important not to rub or wipe the eye until the effect of the anesthetic has worn off and feeling has returned. Rubbing the eye while it is numb could cause injury.

Side effects

Side effects of regional or local anesthetics vary depending on the type of anesthetic used and the way it is administered. Anyone who has unusual symptoms following the use of an anesthetic should get in touch with his or her doctor immediately.

There is a small risk of developing a severe headache called a spinal headache following a spinal or epidural block. This headache is severe when the patient is upright and hardly felt when the patient lies down. Though rare, it can occur and can be treated by performing a blood patch, in which a small amount of the patient's own blood is injected into the area in the back where the anesthetic was injected. The **blood clots** and closes up any area that may have been leaking spinal fluid. Relief is almost immediate. Finally, blood clots or **abscess** can form in the back, but these are also readily treatable and so pose little risk.

A physician should be notified immediately if any of these symptoms occur:

- large swellings that look like hives on the skin, in the mouth, or in the throat
- severe headache
- blurred or double vision
- dizziness or lightheadedness
- drowsiness
- confusion
- anxiety, excitement, nervousness, or restlessness
- convulsions (seizures)
- feeling hot, cold, or numb
- ringing or buzzing in the ears
- shivering or trembling
- sweating
- pale skin
- slow or irregular heartbeat
- breathing problems
- nusual weakness or tiredness

Interactions

Some anesthetic drugs may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who receives a regional or local anesthetic should let the doctor know all other drugs he or she is taking including prescription drugs, nonprescription drugs, and street drugs (such as cocaine, marijuana, and heroin).

Resources

BOOKS

Harvey, Richard A., and Pamela C. Champe. *Lippincott's Illustrated Reviews: Pharmacology*. 4th ed. Philadelphia: Lippincott Williams &Wilkins, 2008.

Nancy Ross-Flanigan

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Aneurysmectomy

Definition

Aneurysmectomy is a surgical procedure performed to repair a weak area in the aorta. The aorta is the largest artery in the body and the main blood vessel leading away from the heart.

Purpose

The purpose of aneurysmectomy is to repair an **aortic aneurysm** that is likely to rupture if left in place. Aneurysmectomy is indicated for an aortic aneurysm that grows to at least 2 in(5 cm) or for an aortic aneurysm of any size that is symptomatic, tender, or enlarging rapidly.

Precautions

Aneurysmectomy may not be appropriate for patients with severely debilitating diseases such as **cancer**, **emphysema**, and **heart failure**.

Description

An aortic aneurysm is a bulge in the wall of the aorta that is usually due to arteriosclerosis or **atherosclerosis**. People who are 50-80 years old are most likely to develop an aortic aneurysm, with men four times more likely to develop one than women.

An aortic aneurysm develops and grows slowly. It rarely produces symptoms and is usually only diagnosed by accident during a routine physical exam or on an x ray or ultrasound done for another reason. As the aneurysm grows larger, the risk of bursting with no warning, which causes catastrophic bleeding, rises. A ruptured aortic aneurysm can cause sudden loss of a fatal amount of blood within minutes or it can leak in a series of small bleeds that lead within hours or days to massive bleeding. A leaking aortic aneurysm that is not treated is always fatal.

Aneurysmectomy is performed to repair the two most common types of aortic aneurysms: abdominal aortic aneurysms that occur in the abdomen below the kidneys, and thoracic aortic aneurysms that occur in the chest. It is major surgery performed in a hospital under **general anesthesia** and involves removing debris and then implanting a flexible tube (graft) to replace the enlarged artery. Aneurysmectomy for an aneurysm of the ascending aorta (the first part of the aorta that travels upward from the heart) requires the use of a heart-lung machine that temporarily stops the heart while the aneurysm is repaired. Aneurysmectomy requires a one-week hospital stay; the recovery period is five weeks.

KEY TERMS

Aneurysm—A weakening in the muscular walls of a part of the artery which causes the damaged section to enlarge or sag, giving it a balloon-like appearance.

Aorta—The main blood vessel that leads away from the heart and the body's largest artery. The aorta carries blood from the heart through the chest and abdomen, providing major branches to all of the organs in the body.

Arteriosclerosis—Hardening of the arteries that occurs as part of the aging process.

Artery—A blood vessel that carries blood from the heart to the body's tissues.

Atherosclerosis—A form of arteriosclerosis in which cholesterol-containing fatty deposits accumulate in the inner most walls of the heart's arteries.

Thoracic—Relating to the chest.

During surgery, the site of the aneurysm (either the abdomen or the chest) is opened with an incision to expose the aneurysm. The aorta is clamped above and below the aneurysm to stop the flow of blood. Then, an incision is made in the aneurysm. An artificial Dacron tube is sewn in place above and below the opened aneurysm, but the aneurysm is not removed. Plaque or clotted blood are cleaned from the diseased tissue. The clamps are removed and blood flow is re-established through the graft. The wall of the aneurysm is wrapped around the graft to protect it and the skin of the abdomen or chest is sewn up.

Aneurysmectomy can be performed as elective or emergency surgery. Elective aneurysmectomy takes about an hour and is far safer than emergency aneurysmectomy, with a mortality rate of 3-5% for elective abdominal aneurysmectomy and 5-10% for elective thoracic aneurysmectomy. When an aneurysm ruptures, 62% of patients die before they reach the hospital. Of those who make it into emergency aneurysmectromy, 50% die. After a successful aneurysmectomy, the patient has nearly the same life expectancy as other people of the same age.

Preparation

Before elective aneurysmectomy, blood studies, a **chest x ray**, cardiac catherization, electrocardiogram (ECG), and ultrasound are performed.

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Aftercare

After aneurysmectomy, the patient is monitored in an Intensive Care Unit for the first 24–48 hours. Follow-up tests include ECG, chest x ray, and ultrasound.

Risks

Elective aneurysmectomy has a 5-10% rate of complications, such as bleeding, kidney failure, respiratory complications, **heart attack**, **stroke**, infection, limb loss, bowel **ischemia**, and **impotence**. These complications are many times more common in emergency aneurysmectomy.

Resources

PERIODICALS

Donaldson, M. C., M. Belkin, and A. D. Whittemore. "Mesenteric Revascularization During Aneurysmectomy." *Surgery Clinic of North America* 77 (April 1997): 443-459.

ORGANIZATIONS

American Heart Association, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, http://www.americanheart.org.

National Heart, Lung, and Blood Institute (NHLBI), Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105 (301) 592-8573 TTY: (240) 629-3255, (240) 629-3246, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi. nih.gov/.

Lori De Milto

Aneurysms *see* **Aneurysmectomy; Cerebral aneurysm; Ventricular aneurysm**

Angina

Definition

Angina is **pain**, "discomfort," or pressure localized in the chest that is caused by an insufficient supply of blood (**ischemia**) to the heart muscle. It is also sometimes characterized by a feeling of **choking**, suffocation, or crushing heaviness. This condition is also called angina pectoris.

Description

Often described as a muscle spasm and choking sensation, the term "angina" is used primarily to describe chest (thoracic) pain originating from insufficient oxygen to the heart muscle. An episode of angina is not an actual **heart attack**, but rather pain that results from the heart muscle temporarily receiving too little blood. This temporary condition may be the result of demanding activities such as **exercise** and does not necessarily indicate that the heart muscle is experiencing permanent damage. In fact, episodes of angina seldom cause permanent damage to heart muscle.

KEY TERMS

Ischemia—Decreased blood supply to an organ or body part, often resulting in pain.

Myocardial infarction—A blockage of a coronary artery that cuts off the blood supply to part of the heart. In most cases, the blockage is caused by fatty deposits.

Myocardium—The thick middle layer of the heart that forms the bulk of the heart wall and contracts as the organ beats.

Angina can be subdivided further into two categories: angina of effort and variant angina.

Angina of effort

Angina of effort is a common disorder caused by the narrowing of the arteries (**atherosclerosis**) that supply oxygen-rich blood to the heart muscle. In the case of angina of effort, the heart (coronary) arteries can provide the heart muscle (myocardium) adequate blood during rest but not during periods of exercise, **stress**, or excitement–any of which may precipitate pain. The pain is relieved by resting or by administering nitroglycerin, a medication that reduces ischemia of the heart. Patients with angina of effort have an increased risk of heart attack (myocardial infarction).

Variant angina

Variant angina is uncommon and occurs independently of atherosclerosis which may, however, be present as an incidental finding. Variant angina occurs at rest and is not related to excessive work by the heart muscle. Research indicates that variant angina is caused by coronary artery muscle spasm of insufficient duration or intensity to cause an actual heart attack.

Causes and symptoms

Angina causes a pressing pain or sensation of heaviness, usually in the chest area under the breast bone (sternum). It occasionally is experienced in the shoulder, arm, neck, or jaw regions. Because episodes of angina occur when the heart's need for oxygen increases beyond

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the oxygen available from the blood nourishing the heart, the condition is often precipitated by physical exertion. In most cases, the symptoms are relieved within a few minutes by resting or by taking prescribed angina medications. Emotional stress, extreme temperatures, heavy meals, cigarette **smoking**, and alcohol can also cause or contribute to an episode of angina.

Diagnosis

Physicians can usually diagnose angina based on the patient's symptoms and the precipitating factors. However, other diagnostic testing is often required to confirm or rule out angina, or to determine the severity of the underlying heart disease.

Electrocardiogram (ECG)

An electrocardiogram is a test that records electrical impulses from the heart. The resulting graph of electrical activity can show if the heart muscle isn't functioning properly as a result of a lack of oxygen. Electrocardiograms are also useful in investigating other possible abnormal features of the heart.

Stress test

For many individuals with angina, the results of an electrocardiogram while at rest will not show any abnormalities. Because the symptoms of angina occur during stress, the functioning of the heart may need to be evaluated under the physical stress of exercise. The **stress test** records information from the electrocardiogram before, during, and after exercise in search of stress-related abnormalities. Blood pressure is also measured during the stress test and symptoms are noted. A more involved and complex stress test (for example, thallium scanning) may be used in some cases to picture the blood flow in the heart muscle during the most intense time of exercise and after rest.

Angiogram

The angiogram, which is basically an x ray of the coronary artery, has been noted to be the most accurate diagnostic test to indicate the presence and extent of coronary disease. In this procedure, a long, thin, flexible tube (catheter) is maneuvered into an artery located in the forearm or groin. This catheter is passed further through the artery into one of the two major coronary arteries. A dye is injected at that time to help the x rays "see" the heart and arteries more clearly. Many brief x rays are made to create a "movie" of blood flowing through the coronary arteries, which will reveal any possible narrowing that causes a decrease in blood flow to the heart muscle and associated symptoms of angina.

Treatment

Conservative treatment

Artery disease causing angina is addressed initially by controlling existing factors placing the individual at risk. These risk factors include cigarette smoking, high blood pressure, high cholesterol levels, and **obesity**. Angina is often controlled by medication, most commonly with nitroglycerin. This drug relieves symptoms of angina by increasing the diameter of the blood vessels carrying blood to the heart muscle. Nitroglycerin is taken whenever discomfort occurs or is expected. It may be taken by mouth by placing the tablet under the tongue or transdermally by placing a medicated patch directly on the skin. In addition, **beta blockers** or **calcium channel blockers** may be prescribed to also decrease the demand on the heart by decreasing the rate and workload of the heart.

Surgical treatment

When conservative treatments are not effective in the reduction of angina pain and the risk of heart attack remains high, physicians may recommend **angioplasty** or surgery. Coronary artery bypass surgery is an operation in which a blood vessel (often a long vein surgically removed from the leg) is grafted onto the blocked artery to bypass the blocked portion. This newly formed pathway allows blood to flow adequately to the heart muscle.

Another procedure used to improve blood flow to the heart is balloon angioplasty. In this procedure, the physician inserts a catheter with a tiny balloon at the end into a forearm or groin artery. The catheter is then threaded up into the coronary arteries and the balloon is inflated to open the vessel in narrowed sections. Other techniques using laser and mechanical devices are being developed and applied, also by means of catheters.

Alternative treatment

During an angina episode, relief has been noted by applying massage or kinesiological methods, but these techniques are not standard recommendations by physicians. For example, one technique places the palm and fingers of either hand on the forehead while simultaneously firmly massaging the sternum (breast bone) up and down its entire length using the other hand. This is followed by additional massaging by the fingertip and thumb next to the sternum, on each side.

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Once the angina has subsided, the cause should be determined and treated. Atherosclerosis, a major associated cause, requires diet and lifestyle adjustments, primarily including regular exercise, reduction of dietary sugar and saturated fats, and increase of dietary fiber. Both conventional and alternative medicine agree that increasing exercise and improving diet are important steps to reduce high cholesterol levels. Alternative medicine has proposed specific cholesterol-lowering treatments, with several gaining the attention and interest of the public. One of the most recent popular treatments is garlic (*Allium sativum*). Some studies have shown that adequate dosages of garlic can reduce total cholesterol by about 10%, LDL (bad) cholesterol by 15%, and raise HDL (good) cholesterol by 10%. Other studies have not shown significant benefit. Although its effect on cholesterol is not as great as that achieved by medications, garlic may possibly be of benefit in relatively mild cases of high cholesterol, without causing the side effects associated with **cholesterol-reducing drugs**. Other herbal remedies that may help lower cholesterol include alfalfa (*Medicago sativa*), fenugreek (*Trigonella foenum-graecum*), Asian **ginseng** (*Panax ginseng*), and tumeric (*Curcuma longa*).

Antioxidants, including vitamin A (beta carotene), vitamin C, vitamin E, and selenium, can limit the oxidative damage to the walls of blood vessels that may be a precursor of atherosclerotic plaque formation.

Prognosis

The prognosis for a patient with angina depends on its origin, type, severity, and the general health of the individual. A person who has angina has the best prognosis if he or she seeks prompt medical attention and learns the pattern of his or her angina, such as what causes the attacks, what they feel like, how long episodes usually last, and whether medication relieves the attacks. If patterns of the symptoms change significantly, or if symptoms resemble those of a heart attack, medical help should be sought immediately.

Prevention

In most cases, the best prevention involves changing one's habits to avoid bringing on attacks of angina. If blood pressure medication has been prescribed, compliance is a necessity and should be a priority as well. Many healthcare professionals–including physicians, dietitians, and nurses–can provide valuable advice on proper diet, weight control, blood cholesterol levels, and blood pressure. These professionals also offer suggestions about current treatments and information to help stop smoking. In general, the majority of those with angina adjust their lives to minimize episodes of angina, by taking necessary precautions and using medications if recommended and necessary. **Coronary artery disease** is the underlying problem that should be addressed.

ORGANIZATIONS

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www. nhlbi.nih.gov.

American Heart Association, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, http:// www.americanheart.org.

Jeffrey P. Larson RPT

Angioedema *see* **Hives**

Angiogram *see* **Angiography**

Angiography

Definition

Angiography is the x-ray (radiographic) study of the blood vessels. An angiogram uses a radiopaque substance, or contrast medium, to make the blood vessels visible under x ray. The key ingredient in most radiographic contrast media is iodine. Arteriography is a type of radiographic examination that involves the study of the arteries.

Purpose

Angiography is used to detect abnormalities, including narrowing (stenosis) or blockages in the blood vessels (called occlusions) throughout the circulatory system and in some organs. The procedure is commonly used to:

- identify atherosclerosis
- diagnose heart disease
- evaluate kidney function
- detect kidney cysts or tumors
- map renal anatomy in transplant donors
- detect an aneurysm
- detect a tumor, blood clot, or arteriovenous malformations in the brain
- diagnose problems with the retina of the eye

Angiography also is used to provide surgeons with an accurate vascular "map" of the heart before open-

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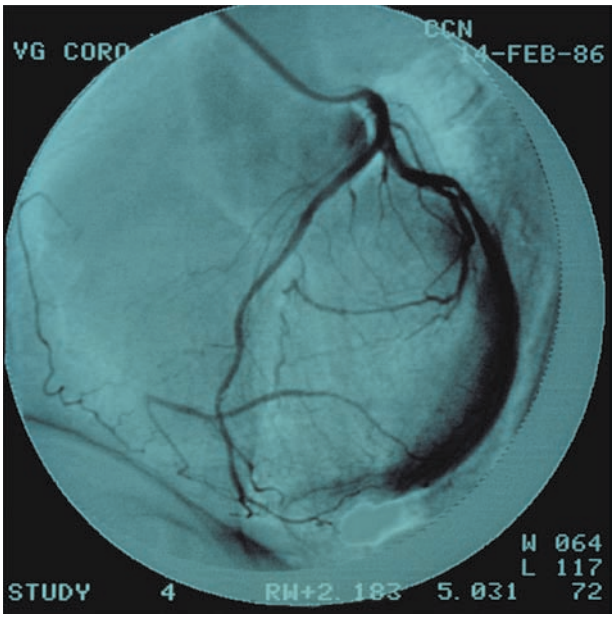

An angiogram of a coronary artery. *(© CNRI/Phototake. — All rights reserved.)*

heart surgery, or of the brain before **neurosurgery**. Angiography may be used after penetrating trauma, like a gunshot or knife wound, to detect blood vessel injury; it may be used to check the position of shunts and stents placed by physicians into blood vessels.

Precautions

Patients with **kidney disease** or injury may suffer further kidney damage from the contrast media used for angiography. Patients who have blood-clotting problems, have a known allergy to contrast media, or are allergic to iodine may also not be suitable candidates for an angiography procedure. Newer types of contrast media classified as non-ionic are less toxic and cause fewer side effects than traditional ionic agents. Because x rays carry risks of ionizing radiation exposure to the fetus, pregnant women are also advised to avoid this procedure.

Description

Before the angiographic procedure, patients are briefed on the details of the test, the benefits and risks, and the possible complications involved, and asked to sign an informed consent form. Most angiographic procedures are paid for by major medical insurance. Patients should check with their individual insurance plans to determine their coverage.

Angiography requires the injection of a contrast medium that makes the blood vessels visible to x ray. The contrast medium is injected through a procedure known as arterial puncture. The puncture is usually made in the groin area, armpit, inside elbow, or neck.

Patients undergoing an angiogram are advised to stop eating and drinking eight hours before the procedure. They must remove all jewelry before the procedure and change into a hospital gown. If the arterial puncture is to be made in the armpit or groin area, shaving may be required. A sedative may be administered to relax the patient for the procedure. An intravenous (IV) line is also inserted into a vein in the patient's arm before the procedure begins in case medication or blood products are required during the angiogram or complications arise.

The site is cleaned with an antiseptic agent and injected with a local anesthetic. Then, a small incision is made in the skin to help the needle pass. A needle containing a solid inner core called a stylet is inserted through the incision and into the artery. When the radiologist has punctured the artery with the needle, the stylet is removed and replaced with another long wire called a guide wire. It is normal for blood to spurt out of the needle before the guide wire is inserted.

The guide wire is fed through the outer needle into the artery to the area that requires angiographic study. A fluoroscope displays a view of the patient's vascular system and is used to direct the guide wire to the correct location. Once it is in position, the needle is then removed, and a catheter is threaded over the length of the guide wire until it to reaches the area of study. The guide wire is then removed, and the catheter is left in place in preparation for the injection of the contrast medium.

Depending on the type of angiographic procedure being performed, the contrast medium is either injected by hand with a syringe or is mechanically injected with an automatic injector, sometimes called a power injector, connected to the catheter. An automatic injector is used frequently because it is able to deliver a large volume of contrast medium very quickly to the angiographic site. Usually a small test injection is made by hand to confirm that the catheter is in the correct position.

The patient is told that the injection will start, and is instructed to remain very still. The injection causes some mild to moderate discomfort. Possible side effects or reactions include **headache**, **dizziness**, irregular heartbeat, **nausea**, warmth, burning sensation, and chest **pain**, but they usually last only momentarily. To view the area of study from different angles or perspectives, the patient may be asked to change positions several times, and subsequent contrast medium

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KEY TERMS

Aneurysm—An abnormal bulge of an artery that can rupture leading to hemorrhage.

Arteriovenous malformation—An abnormal tangle of arteries and veins.

Arteriosclerosis—A chronic condition characterized by thickening and hardening of the arteries and the build-up of plaque on the arterial walls. Arteriosclerosis can slow or impair blood circulation.

Carotid artery—An artery located in the neck.

Catheter—A long, thin, flexible tube used in angiography to inject contrast material into the arteries.

Cirrhosis—A condition characterized by the destruction of healthy liver tissue. A cirrhotic liver is scarred and cannot break down the proteins in the bloodstream. Cirrhosis is associated with portal hypertension.

Embolism—A blood clot, air bubble, or clot of foreign material that travels and blocks the flow of blood in an artery. When blood supply to a tissue or organ is blocked by an embolism, infarction (death of the tissue the artery feeds) occurs. Without immediate and appropriate treatment, an embolism can be fatal.

Femoral artery—An artery located in the groin area that is the most frequently accessed site for arterial puncture in angiography.

Fluorescein dye—An orange dye used to illuminate the blood vessels of the retina in fluorescein angiography.

Fluoroscope—An imaging device that displays "moving x rays" of the body. Fluoroscopy allows the radiologist to visualize the guide wire and catheter he or she is moving through the patient's artery.

Guide wire—A wire that is inserted into an artery to guide a catheter to a certain location in the body.

Ischemia—A lack of normal blood supply to a organ or body part because of blockages or constriction of the blood vessels.

Necrosis—Cellular or tissue death; skin necrosis may be caused by multiple, consecutive doses of radiation from fluoroscopic or x-ray procedures.

Plaque—Fatty material that is deposited on the inside of the arterial wall.

Portal hypertension—A condition caused by cirrhosis of the liver. It is characterized by impaired or reversed blood flow from the portal vein to the liver, an enlarged spleen, and dilated veins in the esophagus and stomach.

Portal vein thrombosis—The development of a blood clot in the vein that brings blood into the liver. Untreated portal vein thrombosis causes portal hypertension.

Retina—Light-sensitive tissue on the back of the eye that receives images and converts them into nerve impulses to be sent to the brain by way of the optic nerve.

injections may be administered. During any injection, the patient or the imaging equipment may move.

Throughout the injection procedure, radiographs (x-ray pictures) or fluoroscopic images are obtained. Because of the high pressure of arterial blood flow, the contrast medium dissipates through the patient's system quickly and becomes diluted, so images must be obtained in rapid succession. One or more automatic film changers may be used to capture the required radiographic images. In many imaging departments, angiographic images are captured digitally, obviating the need for film changers. The ability to capture digital images also makes it possible to manipulate the information electronically allowing for a procedure known as digital subtraction angiography (DSA). Because every image captured is comprised of tiny picture elements called pixels, computers can be used to manipulate the information in ways that enhance diagnostic information. One common approach is to electronically remove or (subtract) bony structures that otherwise would be superimposed over the vessels being studied, hence the name digital subtraction angiography.

Once the x rays are complete, the catheter is slowly and carefully removed from the patient. Manual pressure is applied to the site with a sandbag or other weight for 10–20 minutes to allow for clotting to take place and the arterial puncture to reseal itself. A pressure bandage is then applied.

Computerized tomography angiography (CTA)

Computerized tomography angiography (CTA), a newer technique, is used in the evaluation of blood vessel narrowing and blockage. It is less invasive than catheter angiography described above. Instead of injecting contrast material through a catheter, the material is administered intravenously through a vein in the arm. This causes less discomfort. Patients who are unable to

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undergo catheter angiography may be candidates for CTA or MRI angiography described below.

CTA is especially useful in screening for arterial disease and in patients with intracranial aneurysms. CTA is particularly useful in delineating the relationship of vascular lesions with bony anatomy close to the skull base. While such lesions can be demonstrated with standard angiography, it often requires studying several projections of the two-dimensional films rendered with standard angiography. CTA is ideal for more anatomically complex skull-base lesions because it clearly demonstrates the exact relationship of the bony anatomy with the vascular pathology. This is not possible using standard angiographic techniques.

Once the information from a CTA scan has been captured, a computer is used to process and reconstruct images. The approach yields shaded surface displays of the actual vascular anatomy that are three dimensional and clearly show the relationship of the bony anatomy with the vascular pathology.

The CTA procedure takes about an hour. During actual scanning, the patient must remain still for 10–30 minutes. Individuals who experience claustrophobia may be distressed by this procedure.

Magnetic resonance angiography (MRA)

Angiography can also be performed using MRI (**magnetic resonance imaging**) scanners. The technique is called MRA (magnetic resonance angiography). A contrast medium is not usually used, but may be used in some body applications. The active ingredient in the contrast medium used for MRA is one of the rare earth elements, gadolinium. Some MRI angiograms do not require the use of contrast material. When needed, the contrast agent is injected into an arm vein, and images are acquired with careful attention being paid to the timing of the injection and selection of MRI specific imaging parameters. Once the information has been captured, a workstation is used to process and reconstruct the images. The post-processing capabilities associated with CTA and MRA yield three-dimensional representations of the vascular pathology being studied and can also be used to either enhance or subtract adjacent anatomical structures.

Individuals who have any artificial metal implanted parts (e.g., implanted defibrillator, cardiac pacemaker, cochlear implant, screws, plates, surgical staples, shrapnel, artificial joints, intrauterine device [IUD]) should tell their physician and the MRA technologist before the procedure. In some cases, the metal inside the body may heat up during the procedure making it unsafe to perform an MRA.

Most angiograms follow the general procedures outlined above, but vary slightly depending on the area of the vascular system being studied. A variety of common angiographic procedures are outlined below.

Cerebral angiography

Cerebral angiography is used to detect aneurysms, stenosis, **blood clots**, and other vascular irregularities in the brain. The catheter is inserted into the femoral or carotid artery, and the injected contrast medium travels through the blood vessels in the brain. Patients frequently experience headache, warmth, or a burning sensation in the head or neck during the injection portion of the procedure. A cerebral angiogram takes two to four hours to complete.

Coronary angiography

Coronary angiography is administered by a cardiologist with training in radiology or, occasionally, by a radiologist. The arterial puncture is typically made in the femoral artery, and the cardiologist uses a guide wire and catheter to perform a contrast injection and x-ray series on the coronary arteries. The catheter may also be placed in the left ventricle to examine the mitral and aortic valves of the heart. If the cardiologist requires a view of the right ventricle of the heart or of the tricuspid or pulmonic valves, the catheter is inserted through a large vein and guided into the right ventricle. The catheter also serves the purpose of monitoring blood pressures in these different locations inside the heart. The angiographic procedure takes several hours, depending on the complexity of the procedure.

Pulmonary angiography

Pulmonary, or lung, angiography is performed to evaluate blood circulation to the lungs. It is also considered the most accurate diagnostic test for detecting a **pulmonary embolism**. The procedure differs from cerebral and coronary angiography in that the guide wire and catheter are inserted into a vein instead of an artery, and are guided up through the chambers of the heart and into the pulmonary artery. Throughout the procedure, the patient's vital signs are monitored to ensure that the catheter does not cause **arrhythmias**, or irregular heartbeats. The contrast medium is then injected into the pulmonary artery where it circulates through the lungs' capillaries. The test typically takes up to 90 minutes and carries more risk than other angiography procedures.

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Kidney (renal) angiography

Patients with chronic renal disease or injury can suffer further damage to their kidneys from the contrast medium used in a renal angiogram, yet they often require the test to evaluate kidney function. These patients should be well hydrated with an intravenous saline drip before the procedure, and may benefit from available medications (e.g., dopamine) that help to protect the kidney from further injury associated with contrast agents. During a renal angiogram, the guide wire and catheter are inserted into the femoral artery in the groin area and advanced through the abdominal aorta, the main artery in the abdomen, and into the renal arteries. The procedure takes approximately one hour.

Fluorescein angiography

Fluorescein angiography is used to diagnose retinal problems and circulatory disorders. It is typically conducted as an outpatient procedure. The patient's pupils are dilated with eye drops, and he or she rests the chin and forehead against a bracing apparatus to keep it still. Sodium fluorescein dye is then injected with a syringe into a vein in the patient's arm. The dye travels through the patient's body and into the blood vessels of the eye. The procedure does not require x rays. Instead, a rapid series of close-up photographs of the patient's eyes are taken, one set immediately after the dye is injected, and a second set approximately 20 minutes later once the dye has moved through the patient's vascular system. The entire procedure takes up to one hour.

Celiac and mesenteric angiography

Celiac and mesenteric angiography involves radiographic exploration of the celiac and mesenteric arteries, arterial branches of the abdominal aorta that supply blood to the abdomen and digestive system. The test is commonly used to detect aneurysm, thrombosis, and signs of **ischemia** in the celiac and mesenteric arteries, and to locate the source of gastrointestinal bleeding. It is also used in the diagnosis of a number of conditions, including portal **hypertension** and **cirrhosis**. The procedure can take up to three hours, depending on the number of blood vessels studied.

Splenoportography

A splenoportograph is a variation of an angiogram that involves the injection of contrast medium directly into the spleen to view the splenic and portal veins. It is used to diagnose blockages in the splenic vein and portal-vein thrombosis and to assess the patency and location of the vascular system prior to **liver transplantation**.

Most angiographic procedures are paid for by major medical insurance. Patients should check with their individual insurance plans to determine their coverage.

Aftercare

Because life-threatening internal bleeding is a possible complication of an arterial puncture, an overnight stay in the hospital is sometimes recommended following an angiographic procedure, particularly with cerebral and coronary angiography. If the procedure is performed on an outpatient basis, the patient is typically kept under close observation for a period of at six to 12 hours before being released. If the arterial puncture was performed in the femoral artery, the patient is instructed to keep his or her leg straight and relatively immobile during the observation period. The patient's blood pressure and vital signs are monitored, and the puncture site observed closely. Pain medication may be prescribed if the patient is experiencing discomfort from the puncture, and a cold pack is often applied to the site to reduce swelling. It is normal for the puncture site to be sore and bruised for several weeks. The patient may also develop a hematoma at the puncture site, a hard mass created by the blood vessels broken during the procedure. Hematomas should be watched carefully, as they may indicate continued bleeding of the arterial puncture site.

Angiography patients are also advised to have two to three days of rest after the procedure in order to avoid placing any undue **stress** on the arterial puncture site. Patients who experience continued bleeding or abnormal swelling of the puncture site, sudden dizziness, or chest pain in the days following an angiographic procedure should seek medical attention immediately.

Patients undergoing a fluorescein angiography should not drive or expose their eyes to direct sunlight for 12 hours following the procedure.

Risks

Because angiography involves puncturing an artery, internal bleeding, or hemorrhage are possible complications of the test. As with any invasive procedure, infection of the puncture site or bloodstream is also a risk, but this is rare.

A **stroke** or **heart attack** may be triggered by an angiogram if blood clots or plaque on the inside of the arterial wall are dislodged by the catheter and form a blockage in the blood vessels, or if the vessel undergoes temporary narrowing or spasm from irritation by the catheter. The heart may also become irritated by the movement of the catheter through its chambers during pulmonary and coronary angiographic procedures, and arrhythmias may develop.

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Patients who develop an allergic reaction to the contrast medium used in angiography may experience a variety of symptoms, including swelling, difficulty breathing, **heart failure**, or a sudden drop in blood pressure. If the patient is aware of the allergy before the test is administered, certain medications can be administered at that time to counteract the reaction.

Angiography involves minor exposure to radiation through the x rays and fluoroscopic guidance used in the procedure. Unless the patient is pregnant, or multiple radiological or fluoroscopic studies are required, the dose of radiation incurred during a single procedure poses little risk. However, multiple studies requiring fluoroscopic exposure that are conducted in a short time period have been known to cause skin necrosis in some individuals. This risk can be minimized by careful monitoring and documentation of cumulative radiation doses administered to these patients, particularly in those who have therapeutic procedures performed along with the diagnostic angiography.

Normal results

The results of an angiogram or arteriogram depend on the artery or organ system being examined. Generally, test results should display a normal and unimpeded flow of blood through the vascular system. Fluorescein angiography should result in no leakage of fluorescein dye through the retinal blood vessels.

Abnormal results of an angiogram may display a narrowed blood vessel with decreased arterial blood flow (ischemia) or an irregular arrangement or location of blood vessels. The results of an angiogram vary widely by the type of procedure performed, and should be interpreted by and explained to the patient by a trained radiologist.

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ORGANIZATIONS

American College of Radiology, 1891 Preston White Drive, Reston, VA, 20191 (703) 648-8900, http://www.acr.org.

Radiological Society of North America (RSNA), 820 Jorie Blvd, Oak Brook, Il, 60523-2251 (800) 381-6660 (630) 571-7837, http://www.rsna.org.

Society of Interventional Radiology, 3975 Fair Ridge Drive, Suite 400 North, Fairfax, VA, 22033 (703) 691-1805 (800) 488-7284 (703) 691-1855, http://www.sirweb.org.

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Angiomas *see* **Birthmarks**

Angioplasty

Definition

Angioplasty is a procedure used to widen narrowed or partially blocked (occluded) blood vessels. There are various types of angioplasty. The specific names of these procedures are derived from the type of equipment used and the path of entry into the blood vessel. For example, percutaneous transluminal angioplasty (PTA) means that the vessel is entered through the skin (percutaneous) and that the catheter is moved into the blood vessel of interest through the same vessel or one that communicates with it (transluminal). In the case of an angioplasty involving the coronary arteries, the point of entry might be the femoral artery in the groin, with the catheter/guidewire system passed through the aorta to the heart and the origin of the coronary arteries at the base of the aorta just outside the aortic valve.

Purpose

An angioplasty is done to reopen a partially blocked blood vessel so that blood can flow through it again at a normal rate. In patients with an occlusive **vascular disease** such as **atherosclerosis**, the flow of blood to other organs or remote parts of the body is limited by the narrowing (stenosis) of the vessel's lumen due to fatty deposits or patches known as plaque. Once the vessel has been widened, an adequate blood flow is restored, but the vessel may narrow again over time (restenosis) at the same location and the procedure may need to be repeated.

Description

Angioplasties were originally performed by dilating the blood vessel with the introduction of larger and

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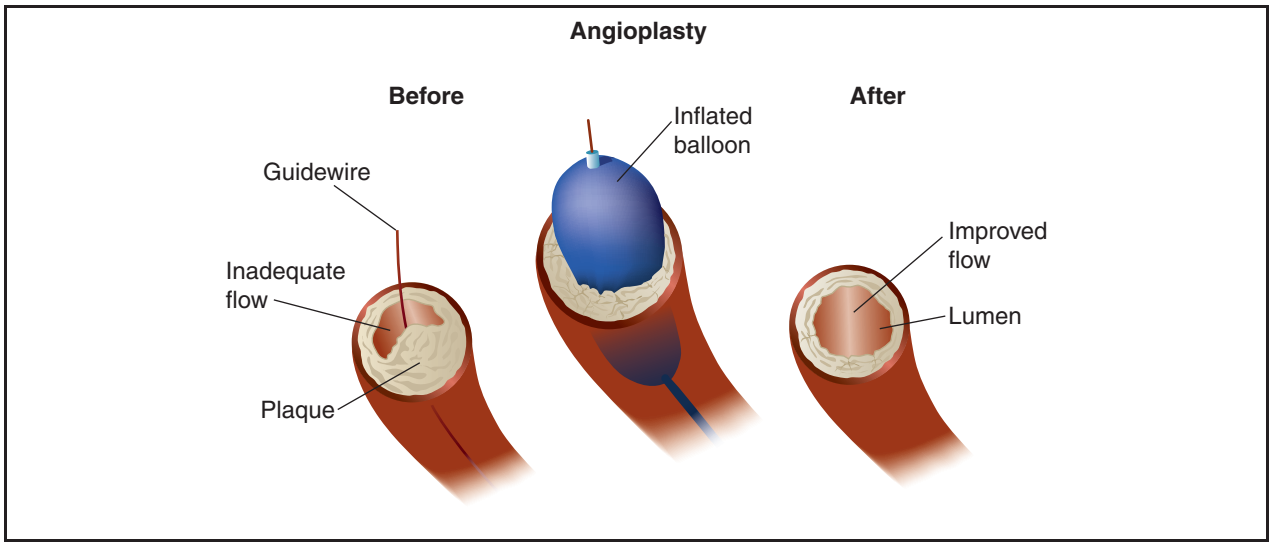

In balloon angioplasty, plaque is pushed out of the clogged artery by the inflation of the balloon device. *(Illustration by Argosy, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

larger stiff catheters through the narrowed space. The complications that resulted from this approach led researchers to develop other ways to open the vessel with smaller devices. An alternative approach was developed in which the catheters used to perform angioplasties contain balloons that are gradually inflated to widen the vessel. Stents, which are thin collapsed tubes made of wire mesh sometimes coated with drugs that help prevent the blood vessel from re-closing can be inserted to provide structural support for the vessel. Lasers may be used to help break up the plaque or fat deposits lining the vessel. Some catheters are equipped with spinning wires or drill tips to clean out the plaque.

Angioplasty may be performed while the patient is either sedated or anesthetized, depending on which vessels are involved. If a percutaneous transluminal coronary angioplasty (PTCA) is to be performed, the patient is sedated so that he or she can report discomfort and **cough** if asked to do so. PTCA procedures are performed in **cardiac catheterization** laboratories with sophisticated monitoring devices. If angioplasty is performed in the radiology department's angiographic suite, the patient may be sedated for the procedure while a nurse monitors the patient's vital signs. Angioplasties performed by vascular surgeons are done in an operating room or specially designed vascular procedure suite.

Typically, patients are given an anticoagulant (blood thinning medication) before the procedure to assist in the prevention of thromboses (**blood clots**), even though these drugs may slow down the sealing of the entry point of the catheter into the vein. Patients also may be given **calcium channel blockers** and nitrates to reduce the risk of vascular spasm. The angioplasty is performed using fluoroscopic guidance and contrast media. Since the decision to perform angioplasty may have been made following a diagnostic angiogram, the patient's sensitivity to contrast media containing iodine is likely to be known. The procedure may then require the use of an alternative contrast agent.

The patient's skin is cleansed with an antiseptic solution at the site where the surgeon will insert the catheter and other equipment, and the area is protected with a sterile drape. Although many angioplasties are performed by puncturing the vessel through the skin, others are done by surgically exposing the site of entry. Direct view of the vessel's puncture site aids in monitoring damage to the vessel or excessive bleeding at the site. After the vessel has been punctured and the guidewire introduced, a fluoroscope is used to monitor small amounts of contrast media that have been injected. This technique allows the surgeon to see the guidewire's movement through the vessel. If the fluoroscope has a feature called "roadmap," the amount of contrast media injected is greater in order to define the full route the guidewire will take. The fluoroscopy system then superimposes subsequent images over the roadmap while the physician moves the guidewire along the mapped route to the destination.

When the surgeon reaches the location of the stenosis, he or she inflates the balloon on the catheter that has been passed along the guidewire. The size of

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KEY TERMS

Anticoagulant—A type of medication given to prevent the formation of blood clots. Anticoagulants are also known as blood thinners.

Atherosclerosis—In this disease, deposits of fatty materials build up on the walls of arterial blood vessels, causing them to narrow or become obstructed. Blood pressure increases, leading to heart disease.

Calcium channel blocker—A drug that lowers blood pressure by regulating calcium-related electrical activity in the heart.

Cardiac catheterization—A procedure to pass a catheter to the heart and its vessels for the purpose of diagnosing coronary artery disease, assessing injury or disease of the aorta, or evaluating cardiac function.

Contrast medium—A substance that is swallowed or injected into the body to create clearer images in radiographic studies of internal structures.

Electrocardiogram (EKG)—A graphic tracing of the electrical activity of the heart. By looking at the graph, some heart abnormalities can be diagnosed.

Embolus (plural emboli)—A gas or air bubble, bit of tissue, blood clot, or foreign object that circulates in the bloodstream until it lodges in a vessel. A large embolus can narrow or block the vessel, which leads to decreased blood flow in the organ supplied by that vessel.

Fluoroscopy—A radiologic technique that creates x-ray images of internal body structures for immediate projection on a fluorescent screen.

Hematoma—A localized collection of blood in an organ or tissue due to broken blood vessels.

Lumen—The cavity or channel inside a blood vessel or tube-shaped organ.

Occlusion—An obstruction or blockage in a blood vessel.

Patency—Being widely open. A blood vessel that has been widened or reopened is said to be patent.

Plaque—In atherosclerosis, a swollen area in the lining of an artery formed by fatty deposits.

Stenosis (plural, stenoses)—The narrowing or constriction of an opening or passageway in the body.

Stent—A thin rod-like or tube-like device made of wire mesh, inserted into a vein or artery to keep the vessel open.

the balloon and the duration of its inflation depend on the size and location of the vessel. In some cases, the surgeon also may use a stent, which is opened or expanded inside the blood vessel after it has been guided to the proper location. The blood vessel may be widened before, during, or after the stent has been opened up. In cases where the vessel is tortuous (twisted) or at intersections of vessels, a graft may be necessary to strengthen the walls of the blood vessel. Stents, grafts, and balloon dilation may all be used together or separately. Sometimes radiation is used when a stent is placed.

After the surgeon has widened the blood vessel, he or she verifies its patency by using fluoroscopy and contrast media to produce an angiogram, by using intravascular ultrasound, or by using both techniques. After the imaging studies have been completed, the surgeon removes the equipment from the blood vessel and closes the puncture site.

Risks

There is a danger of puncturing the vessel with the guidewire during an angioplasty, although the risk is very small. Patients must be monitored for hematoma or hemorrhage at the puncture site. There is also a small risk of **heart attack**, **stroke**, and, although unlikely, death—all related to vessel spasm (transient vessel narrowing from irritation by the catheter), or from emboli (as plaque can be dislodged by the catheter or and travel to the heart or brain). Abrupt closure of the coronary artery occurs in about 4% of patients.

Recurrence of stenosis, known as restenosis, is an additional potential complication. The risk of recurrence is highest in the first six months after angioplasty, with rates as high as 35% reported in some studies.

The length of the patient's hospital stay following an angioplasty depends on his or her overall health, the occurrence of complications, and the availability of home care.

Alternatives

For some patients, **thrombolytic therapy** (treatment with drugs that dissolve blood clots) coupled with lifestyle changes is an alternative to angioplasty. Many medical centers, in fact, restrict the use of angioplasty to patients who cannot be treated with thrombolytic therapy.

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Health care team roles

Physicians often have specially trained assistants for vascular procedures. These assistants may be nurses, surgical technicians, or X-ray specialists. Cardiac catheterization laboratories will include someone specially trained in monitoring EKG equipment and vital signs. Either a nurse, nurse anesthetist, or anesthesiologist will administer **sedation** or anesthesia for the procedure.

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National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573; TTY: (240) 629-3255, (240) 629-3246, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi.nih.gov.

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Angiotensin-converting enzyme inhibitors

Definition

Angiotensin-converting enzyme inhibitors, often called ACE inhibitors, are drugs that block the conversion of the chemical angiotensin I into angiotensin II. Angiotensin II increases blood pressure by causing blood vessels to constrict (narrow) and increasing salt and water retention in the body. Thus, ACE inhibitors lower blood pressure by blocking the formation of angiotensin II.

Purpose

ACE inhibitors are commonly used to treatment high blood pressure. Treating high blood pressure is important because the condition puts a burden on the heart and the arteries that will lead to permanent damage over time. If left untreated, high blood pressure increases the risk of heart attacks, **heart failure**, **stroke**, and kidney failure. ACE inhibitors are also used to treat other cardiac conditions such **coronary artery disease** and congestive heart failure (CHF), and they are given after heart attacks (myocardial infarctions). A **heart attack** damages and weakens the heart muscle. The damage continues to progress even after a person recovers from the attack. ACE inhibitor drugs help slow further damage to the heart. ACE inhibitors have also been found effective in treating certain chronic kidney diseases, including helping to slow or prevent kidney damage in people with diabetes. Occasionally they also are used to treat sclerodema and migraines.

ACE inhibitors may be used alone or in combination with other drugs. They work by preventing a naturally occurring chemical in the blood, angiotensin I, from being converted into angiotensin II. People who have high blood pressure and other cardiac problems often have high blood levels of angiotensin II. This means that their blood vessels are constricted more than normal and that excess **sodium** (salt) and water are retained in the body. These conditions force the heart to work harder. By blocking the formation of angiotensin II, ACE inhibitors help reverse these conditions so that the heart must do less work to keep blood flowing through the body.

Description

ACE inhibitors are available only with a physician's prescription and come in tablet, capsule, and injectable forms. Some commonly used ACE inhibitors are benazepril (Lotensin), captopril (Capoten), enalapril (Vasotec), fosinopril (Monopril), lisinopril (Prinivil, Zestril), moexipril (Univasc), perindopril (Aceon, Coversy), quinapril (Accupril), ramipril (Altace, Tritace, Ramace, Ramiwin), and trandolapril (Mavik).

Recommended dosage

The recommended dosage depends on the type of ACE inhibitor and the medical condition for which it

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KEY TERMS

Arteries—Blood vessels that carry blood away from the heart to the cells, tissues, and organs of the body.

Chronic—A word used to describe a long-lasting condition. Chronic conditions often develop gradually and involve slow changes.

Enzyme—A type of protein, produced in the body, that brings about or speeds up chemical reactions.

Fetus—A developing baby inside the womb.

Scleroderma—A disease that first affects the skin and later affects certain internal organs. The first symptoms are the hardening, thickening, and shrinking of the skin.

Systemic lupus erythematosus (SLE)—A chronic, inflammatory, autoimmune disorder in which the individual's immune system attacks, injures, and destroys the body's own organs and tissues. It may affect many organ systems including the skin, joints, lungs, heart, and kidneys.

Venom—A poisonous substance secreted by an animal, usually delivered through a bite or a sting.

is being taken. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

This medicine may work slowly and take several weeks to noticeably lower blood pressure.

Do not stop taking this medicine without checking with the physician who prescribed it.

Precautions

A person taking an ACE inhibitor should see a physician regularly. The physician will check the blood pressure to make sure the medicine is working as it should and will note any unwanted side effects. People who have high blood pressure often feel perfectly fine. However, they should continue to see their physicians even when they feel well, so that the physician can keep a close watch on their condition. It is also important for patients to keep taking their medicine even when they feel fine.

ACE inhibitors will not cure high blood pressure, but they will help control the condition. To avoid the serious health problems that high blood pressure can cause, individuals may need to take ACE inhibitors or other blood pressure drugs for the rest of their lives. Furthermore, medication alone may not be enough. Patients with high blood pressure may also need to avoid certain foods, such as salty snacks, and keep their weight under control. The health care professional who is treating the condition can offer advice on what measures may be necessary. Patients being treated for high blood pressure should not change their **diets** without consulting their health care provider.

Anyone taking ACE inhibitors should not take any other prescription, over-the-counter (OTC), or herbal medicine without first checking with his or her physician. Some medicines, such as certain cold remedies, may increase blood pressure.

Some people feel dizzy or lightheaded after taking the first dose of an ACE inhibitor, especially if they have been taking a diuretic (water pill). Anyone who begins an ACE inhibitor should not drive, use machines, or do anything else that might be dangerous until they have found out how the drug affects them. Such symptoms should be reported to the physician or pharmacist if they do not subside within a day or so. For the first one or two days of taking an ACE inhibitor, patients may become lightheaded when arising from bed in the morning. Patients should rise slowly to a sitting position before standing up to reduce the risk of falling.

To prevent the blood pressure from getting too low, observe these precautions:

- Do not drink alcohol without checking with the physician who prescribed this medicine.
- Certain ACE inhibitors should be taken one hour before meals. Other ACE inhibitors may be taken with or without meals Check with a pharmacist or physician about when the drug should be taken.
- Avoid overheating when exercising or in hot weather. The loss of water from the body through heavy sweating can cause low blood pressure.
- Check with a physician if illness occurs while taking an ACE inhibitor. This is especially true if the illness involves severe nausea, vomiting, or diarrhea. Vomiting and diarrhea can cause the loss of too much water from the body, which can lead to low blood pressure.

Anyone who is taking ACE inhibitors should tell the health care professional in charge before having any surgical or dental procedures or receiving emergency treatment.

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Some ACE inhibitors may change the results of certain medical tests, such as blood or urine tests. Before having medical tests, anyone taking an ACE inhibitor should alert the health care professional in charge.

Do not use a potassium supplement or a salt substitute that contains potassium without first checking with the physician who prescribed the ACE inhibitor. These drugs cause the body to retain potassium. Ingesting additional potassium may result in unsafe levels.

Patients who are being treated with bee or wasp venom to prevent allergic reactions to **stings** may have a severe allergic reaction to certain ACE inhibitors.

Special conditions

People who are being treated for medical conditions with other drugs may have problems if they take ACE inhibitors. Before taking these drugs, be sure to let the physician know about all medical conditions and app prescription drugs, over-the counter drugs, herbal remedies, and dietary supplements being taken.

ALLERGIES. Anyone who has had unusual reactions to an ACE inhibitor in the past should let his or her physician know before taking this type of medicine again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. The use of ACE inhibitors in **pregnancy** can cause serious problems in the fetus or newborn. These drugs should not be used during pregnancy. Women who are pregnant or who may become pregnant should check with their physicians before using this medicine. Women who become pregnant while taking this medicine should check with their physicians immediately.

BREASTFEEDING. Some ACE inhibitors pass into breast milk. Women who are **breastfeeding** should check with their physicians before using ACE inhibitors.

OTHER MEDICAL CONDITIONS. Before using ACE inhibitors, people with any of these medical problems should make sure their physician is aware of their conditions:

- diabetes
- heart or blood vessel disease
- recent heart attack or stroke
- liver disease
- kidney disease
- kidney transplant
- scleroderma
- systemic lupus erythematosus (SLE)

Side effects

The most common side effect of ACE inhibitors is a dry, continuing **cough** which occurs in about 10–30% of people using these drugs. The cough usually does not subside unless the medication is stopped. Ask the physician if the cough can be treated. Less common side effects, such as **headache**, loss of taste, unusual tiredness, **nausea**, or **diarrhea** also may occur and do not need medical attention unless they are severe or they interfere with normal activities.

More serious side effects are rare, but may occur. If any of the following side effects occur, check with a physician immediately:

- swelling of the face, lips, tongue, throat, arms, legs, hands, or feet. This is considered a medical emergency and immediate medical care should be sought. If the throat swells shut, death can result.
- itchy skin
- sudden breathing or swallowing problems
- chest pain
- hoarseness
- sore throat
- fever and chills
- stomach pain
- yellow eyes or skin

In addition, anyone who has any of the following symptoms while taking an ACE inhibitor should check with his or her physician as soon as possible:

- dizziness, lightheadedness, fainting
- confusion
- nervousness
- fever
- joint pain
- numbness or tingling in hands, feet, or lips
- weak or heavy feeling in the legs
- skin rash
- irregular heartbeat
- shortness of breath or other breathing problems

Other side effects may occur. Anyone who has unusual symptoms after taking an ACE inhibitor should get in touch with his or her physician.

Interactions

ACE inhibitors may interact with certain foods, herbal medicines, dietary supplements, and other drugs. For example, captopril (Capoten) interacts with food and should be taken one hour before meals. Anyone who takes ACE inhibitors should let

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the physician know all other medicines he or she is taking and should ask about foods that should be avoided. Among the foods and drugs that may interact with ACE inhibitors are:

- water pills (diuretics)
- lithium, used to treat bipolar disorder
- tetracycline, an antibiotic
- medicines or supplements that contain potassium
- salt substitutes that contain potassium

The list above does not include everything that interacts with ACE inhibitors. Be sure to check with a physician or pharmacist before combining ACE inhibitors with any other prescription, nonprescription (over-the-counter) medicine, dietary supplement, or herbal remedy.

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Angiotensin-converting enzyme test

Definition

This test measures blood levels of angiotensin-converting enzyme (ACE), also known as Serum Angiotensin-Converting Enzyme (SASE). The primary function of ACE is to help regulate arterial pressure by converting angiotensin I to angiotensin II.

KEY TERMS

Sarcoidosis—Sarcoidosis is a rare disease of unknown cause in which inflammation occurs in lymph nodes and other tissues throughout the body, usually the lungs, skin, liver, and eyes.

Purpose

The ACE test is used primarily to detect and monitor the clinical course of **sarcoidosis** (a disease that affects many organs, especially the lungs), to differentiate between sarcoidosis and similar diseases, and to delineate between active and inactive sarcoid disease. Elevated ACE levels are also found in a number of other conditions, including Gaucher's disease (a rare familial disorder of fat metabolism) and **leprosy**.

Precautions

It should be noted that people under 20 years of age normally have very high ACE levels. Decreased levels may be seen in the condition of excess fat in the blood (hyperlipidemia). Drugs that may cause decreased ACE levels include ACE inhibitor antihypertensives and **steroids**.

Description

ACE plays an important role in the renin/aldosterone mechanism which controls blood pressure by converting angiotensin I to angiotensin II, two proteins involved in regulating blood pressure. Angiotensin I by itself is inactive, but when converted by ACE to the active form, angiotensin II, it causes narrowing of the small blood vessels in tissues, resulting in an increase in blood pressure. Angiotensin II also stimulates the hormone aldosterone, which causes an increase in blood pressure. Certain kidney disorders increase the production of angiotensin II, another cause of **hypertension**. Despite the action of ACE on blood pressure regulation, determination of this enzyme is not very helpful in the evaluation of hypertension (high blood pressure).

Preparation

Determination of ACE levels requires a blood sample. The patient need not be **fasting**.

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Risks

Risks for this test are minimal, but may include slight bleeding from the puncture site, **fainting** or feeling lightheaded after venipuncture, or hematoma (blood accumulating under the puncture site).

Normal results

Normal ranges for this test are laboratory-specific but can range from 8–57 U/mL for patients over 20 years of age.

Abnormal results

Serum ACE levels are elevated in approximately 80–90% of patients with active sarcoidosis. Thyroid hormone may have an effect on ACE activity, as hypothyroid (low thyroid) patients, as well as patients with **anorexia nervosa** with associated findings of **hypothyroidism**, may have low serum ACE activity. ACE can also be decreased in lung **cancer** (bronchogenic carcinoma).

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Janis O. Flores

Hand laceration from a dog bite. *(© Scott Camazine/Alamy.)*

Animal bite infections

Definition

The most common problem following an animal bite is simple infection. The saliva of dogs, cats, ferrets, and rabbits is known to contain a wide variety of bacteria. According to one recent study, bacteria or other pathogens show up in about 85% of **bites**. When an animal bites, it can then transmit pathogens into the wound. These microorganisms may grow within the wound and cause an infection. The consequences of infection range from mild discomfort to life-threatening complications.

Description

Two to 4.5 million animal bites occur each year in the United States; about 1% of these bites require hospitalization. Animal bites result in 334,000 emergency room visits per year, which represents approximately 1% of all emergency hospital visits, at an annual cost of $100 million dollars in health care expenses and lost income. Children are the most frequent victims of dog bites, with 5–9 year-old boys having the highest incidence. Men are more often bitten by dogs than are women (3:1), whereas women are more often bitten by cats (3:1).

Dog bites make up 80–85% of all reported incidents. Cats account for about 10% of reported bites, and other animals (including hamsters, ferrets, rabbits, horses, raccoons, bats, skunks, and monkeys) make up the remaining 5–10%. Cat bites become infected more frequently than dog bites. A dog's mouth is rich in bacteria, but only 15–20% of dog bites become infected. In contrast, approximately 30–50% of cat bites become infected.

Many factors contribute to the infection rates, including the type of wound inflicted, the location of the wound, pre-existing health conditions in the bitten person, the extent of delay before treatment, patient compliance and the presence of a foreign body in the wound. Dogs usually inflict crush injuries because

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KEY TERMS

Anaerobic—Referring to an organism that can live in the absence of air or oxygen. About two-thirds of animal bites are found to contain anaerobic disease-producing organisms.

Canines—The two sharp teeth located next to the front incisor teeth in mammals that are used to grip and tear.

Carnassials—The last upper premolar teeth in the mouths of cats and other carnivores, adapted to shear or puncture food. Carnassial teeth often cause puncture wounds when a cat bites a human.

Culture—A laboratory procedure in which a sample from a wound, the blood or other body fluid is taken from an infected person. The sample is placed in conditions under which bacteria can grow. If bacteria grow, identification tests are done to determine the bacteria species causing the infection.

Immunocompetence—An individual's ability to fight off infection.

Microorganisms—Microscopic organisms, such as bacteria, viruses, algae and fungi.

Pasteurellosis—A bacterial infection caused by *Pasteurella multocida*. Pasteurellosis is characterized by inflammation around the wound site and may be accompanied by bacteria in the bloodstream and infection in tissues and organs.

Pathogen—Any disease-producing microorganism.

Postexposure prophylaxis (PEP)—Any treatment given after exposure to a disease to try to prevent the disease from occurring. In the case of rabies, PEP involves a series of vaccines given to an individual who has been bitten by an unknown animal or one that is potentially infected with the rabies virus.

Tenosynovitis—Inflammation of the sheath of tissue that surrounds a tendon. Tenosynovitis is a common complication of animal bites containing anaerobic bacteria.

Zoonosis (plural, zoonoses)—Any disease of animals that can be transmitted to humans. Rabies is an example of a zoonosis.

they have rounded teeth and strong jaws; thus, the bite of an adult dog can exert up to 200 pounds per square inch of pressure. This pressure usually results in a crushing injury, causing damage to such deep structures as bones, blood vessels, tendons, muscles, and nerves. The canine teeth in a dog's mouth are also sharp and strong, often inflicting lacerations. Cats, with their needle-like incisors and carnassial teeth, typically cause puncture **wounds**. Puncture wounds appear innocuous on the surface, but the underlying injury goes deep. Cat teeth essentially inject bacteria into the bite, and the deep, narrow wound is difficult to clean. Persons with impaired immunocompetence—for example, individuals with HIV infection—are especially vulnerable to infection from cat bites. Lastly, bites or **stings** from marine creatures (sharks, rays, eels, etc.) require immediate medical attention as these bites may contain disease organisms unique to the ocean environment as well as causing severe loss of blood.

The bacterial species most commonly found in bite wounds include *Pasteurella multocida*, *Staphylococcus aureus*, *Pseudomonas sp*, and *Streptococcus sp*. *P. multocida*, the root cause of pasteurellosis, is especially prominent in cat bite infections. Other infectious diseases from animal bites include **cat-scratch disease**, **tetanus** and **rabies**.

Doctors are increasingly aware of the importance of checking animal bite wounds for anaerobic organisms, which are microbes that can live and multiply in the absence of air or oxygen. A study published in 2003 reported that about two-thirds of animal bite wounds contain anaerobes. These organisms can produce such complications as septic arthritis, tenosynovitis, **meningitis**, and infections of the lymphatic system.

With regard to the most common types of domestic pets, it is useful to note that biting and other aggressive behavior has different causes in dogs and cats. To some extent these differences are rooted in divergent evolutionary pathways, but they have also been influenced by human interference through selective breeding. Dogs were first domesticated by humans as early as 10,000 B.C. for hunting and as guard or attack dogs. Many species travel in packs or groups in the wild, and many human fatalities resulting from dog bites involve a large group of dogs attacking one or two persons. In addition, dogs typically relate to humans according to a hierarchical model of dominance and submission, and many of the techniques of dog training are intended to teach the dog to respect human authority. Certain breeds of dogs are much more likely to attack humans than others; those most often involved in fatal attacks are pit bulls, Rottweilers, German shepherds, huskies, and mastiffs.

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According to the Centers for Disease Control (CDC), there are between 15 and 20 fatal dog attacks on humans in the United States each year. There are several assessment or evaluation scales that veterinarians or animal trainers can use to score individual or mixed-breed dogs for dominant or aggressive behavior.

Unlike dogs, cats were not domesticated until about 3000 B.C., and were important to ancient civilizations as rodent catchers and household companions rather than as protectors or hunters of wild game. Biologists classify cats as solitary predators rather than as pack or herd animals; as a result, cats do not relate to humans as authority figures in the same way that dogs do, and they do not form groups that attack humans when threatened or provoked. In addition, domestic cats have been selectively bred for appearance rather than for fierceness or aggression. Most cat bites are the result of fear on the cat's part (as when being placed in a carrier for a trip to the vet) or a phenomenon known as petting-induced aggression. Petting-induced aggression is a behavior in which a cat that has been apparently enjoying contact with a human suddenly turns on the human and bites. This behavior appears to be more common in cats that had no contact with humans during their first seven weeks of life. In other cats, this type of aggression appears to be related to a hypersensitive nervous system; petting or cuddling that was pleasurable to the cat for a few seconds or minutes becomes irritating, and the cat bites as a way of indicating that it has had enough. In older cats, petting-induced aggression is often a sign that the cat feels **pain** from touching or pressure on arthritic joints in its neck or back.

Causes and symptoms

The most common sign of infection from an animal bite is inflammation. The skin around the wound is red and feels warm, and the wound may exude pus. Nearby lymph glands may be swollen. Complications can arise if the infection is not treated and spreads into deeper structures or into the bloodstream. If the bite is deep or occurs on the hand or at a joint, complications are more likely.

Live disease-causing bacteria within the bloodstream and tissues cause complications far from the wound site. Such complications include meningitis, brain abscesses, **pneumonia** and lung abscesses, and heart infections, among others. These complications can be fatal. Deep bites or bites near joints can damage joints and bones, causing inflammation of the bone and bone marrow or septic arthritis.

Cat-scratch disease is caused by *Bartonella henselae*, a bacterium that is carried in cat saliva; infection may be transmitted by a bite or scratch. Approximately 22,000 cases are reported each year in the United States; worldwide, nine out of every 100,000 individuals become infected. More than 80% of reported cases occur in persons under the age of 21. The disease is not normally severe in individuals with healthy immune systems. Symptoms may become serious, however, in immunocompromised individuals, such as those with acquired immune deficiency syndrome (**AIDS**) or those undergoing **chemotherapy**. Common symptoms include an inflamed sore in the area of the bite or scratch, swollen lymph nodes, **fever**, **fatigue**, and rash.

Rabies is caused by a virus that is transmitted through the bite of an animal that is already infected. It is classified as a **zoonosis**, which is a term that refers to any disease of animals that can be transmitted to humans. More than 90% of animal rabies cases occur in such wild animals as skunks, bats, and raccoons, with such domestic animals as dogs and cats accounting for fewer than 10% of cases. The World Health Organization (WHO) estimates that more than 55,000 individuals worldwide die each year as a result of rabies. The highest incidence of rabies deaths, more than 95%, occurs in Asia and Africa. Rabies is nowadays rare in the United States, as a result of good animal control practices. Onset is delayed, usually weeks to months after the person has been bitten. Early symptoms of rabies include fever, **headache**, and flu-like symptoms. These progress to **anxiety**, **hallucinations**, **muscle spasms**, partial **paralysis**, fear of water (hydrophobia), and other neurological symptoms as the virus spreads to the central nervous system. Medical treatment must be sought soon after exposure because **death** invariably follows once the infection becomes established.

Diagnosis

A medical examination involves taking the history of the injury and assessing the wound type and damage. Tetanus immunization and general health status are checked. An x ray may be ordered to assess bone damage and to check for **foreign objects** in the wound. Wound cultures are done for infected bites if the victim is at high risk for complications or if the infection does not respond to treatment. Evaluation of possible exposure to rabies is also important. A biting animal suspected of having rabies is usually apprehended, tested, and observed for a period of time for evidence of pre-existing infection.

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Treatment

Treatment depends on the wound type, its site, and risk factors for infection. All wounds are cleaned and disinfected as thoroughly as possible. Bites to the head and face usually receive sutures, as do severe lacerations elsewhere. Puncture wounds are left open. If **abscess** formation occurs, the physician may perform an incision so as to drain the abscess.

If infection occurs, **antibiotics** are prescribed. Antibiotics may also be used for infection prevention. Since a single bite wound may contain many different types of bacteria, no single antibiotic is always effective. Commonly prescribed antibiotics are penicillin or a combination of amoxicillin and clavulanate potassium. Aztreonam has been reported to be effective in treating infections caused by *P. multocida*.

Because rabies is caused by a virus, antibiotics are not effective. In addition, there is no known cure for the disease once symptoms become apparent. It is therefore recommended that individuals with a high risk of contracting the disease (veterinarians, animal handlers, some laboratory workers) receive preexposure **vaccination**. Individuals bitten by an unknown or potentially rapid animal should receive postexposure vaccination, also called postexposure **prophylaxis** (PEP). The PEP regimen consists of one dose of vaccine given at the initial visit as well as one dose of human immune globulin. Additional doses of vaccine are given on days 3, 7, 14, and 28.

Prognosis

Once a bacterial infection is halted, the bite victim usually recovers fully. There is no known cure for rabies once symptoms become evident and death is almost certain. Prognosis improves greatly with postexposure prophylaxis.

Prevention

Preventing bites obviously prevents subsequent infections. With regard to domestic pets, parents should inform themselves about the aggression level and other characteristics of a particular breed before bringing a purebred pet dog into the family, and consider having a specific dog evaluated by a veterinarian or animal behaviorist before adopting it. In addition, parents should make sure that the dog has been neutered or spayed, since intact dogs of either sex are more likely to bite than those that have been altered. Cat bites can often be prevented by learning about a cat's body language and recognizing the signs of petting-induced aggression. These include dilating pupils, a low growl, stiffening of the body, twitching of the tail, and flattening the ears backward against the head.

Children under 12 years of age are at a higher risk for bites due to their small size and their inexperience with animals; therefore, they should be supervised with animals and taught to act appropriately around them. In particular, children should be taught not to tease a dog by pulling its fur or tail; to leave a dog alone while it is eating; and to avoid running or screaming in the presence of a dog, as the animal is more likely to chase a moving object. Direct eye contact with a threatening dog should be avoided, as the dog may interpret that as aggression. It is best to stand still if at all possible, with feet together and arms against the chest; most dogs will lose interest in an object that is not moving, and will eventually go away.

A wild animal that is unusually aggressive or behaving strangely (e.g. a raccoon or bat that is active during the daytime or is physically uncoordinated) should be avoided and reported to the local animal control authorities; it may be infected with the rabies virus. Wild animals should not be taken in as pets, and garbage or pet food that might attract wild animals should not be left outside the home or camp site. People should also avoid trying to break up fights between animals and should as a rule approach unknown cats and dogs very cautiously, especially on their territory. Finally, animals should not be trained to fight.

Domestic pets should be vaccinated against rabies; people should consult a veterinarian for advice about the frequency of booster vaccinations for the area in which they live. In addition, people who are traveling to countries where rabies is endemic should consider vaccination before leaving the United States.

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ORGANIZATIONS

American Academy of Emergency Medicine (AAEM), 555 East Wells Street, Suite 1100, Milwaukee, WI, 53202, (414) 276-3349, (800) 884-2235, http://www.aaem.org.
American Veterinary Medical Association (AVMA), 1931 North Meacham Road, Suite 100, Schaumburg, IL, 60173-4360, (847) 925-1329, (800) 248-2862, http://www.avma.org.
Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

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Ankylosing spondylitis

Definition

Ankylosing spondylitis (AS) refers to inflammation of the joints in the spine. AS is also known as rheumatoid spondylitis or Marie-Strümpell disease.

KEY TERMS

Ankylosing—When bones of a joint are fused, stiff, or rigid.

HLA-B27—An antigen or protein marker on cells that may indicate ankylosing spondylitis.

Immune suppressing—Anything that reduces the activity of the immune system.

Inflammation—A reaction of tissues to disease or injury, often associated with pain and swelling.

Spondylitis—An inflammation of the spine.

Description

A form of arthritis, AS is characterized by chronic inflammation, causing **pain** and stiffness of the back, progressing to the chest and neck. Eventually, the whole back may become curved and inflexible if the bones fuse (this is known as "bamboo spine"). AS is a systemic disorder that may involve multiple organs, such as the:

- eye (causing an inflammation of the iris, or iritis)
- heart (causing aortic valve disease)
- lungs
- skin (causing a scaly skin condition, or psoriasis)
- gastrointestinal tract (causing inflammation within the small intestine, called ileitis, or inflammation of the large intestine, called colitis)

Less than 1% of the population has AS; however, 20% of AS sufferers have a relative with the disorder.

Causes and symptoms

Genetics play an important role in the disease, but the cause of AS is still unknown. More than 90% of patients have a gene called HLA-B27, but only 10-15% of those who inherit the gene develop the disease. Symptoms of AS include:

- low back and hip pain and stiffness
- difficulty expanding the chest
- pain in the neck, shoulders, knees, and ankles
- low-grade fever
- fatigue
- weight loss

AS is seen most commonly in males 30 years old and older. Initial symptoms are uncommon after the age of 30, although the diagnosis may not be

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established until after that age. The incidence of AS in Afro-Americans is about 25% of the incidence in Caucasians.

Diagnosis

Doctors usually diagnose the disease simply by the patient's report of pain and stiffness. Doctors also review spinal and pelvic x rays since involvement of the hip and pelvic joints is common and may be the first abnormality seen on the x ray. The doctor may also order a blood test to determine the presence of HLA-B27 antigen. When a diagnosis is made, patients may be referred to a rheumatologist, a doctor who specializes in treating arthritis. Patients may also be referred to an orthopedic surgeon, a doctor who can surgically correct joint or bone disorders.

Treatment

Physical therapists prescribe exercises to prevent a stooped posture and breathing problems when the spine starts to fuse and ribs are affected. Back braces may be used to prevent continued deformity of the spine and ribs. Only in severe cases of deformity is surgery performed to straighten and realign the spine, or to replace knee, shoulder, or hip joints.

Alternative treatment

To reduce inflammation various herbal remedies, including white willow (*Salix alba*), yarrow (*Achillea millefolium*), and lobelia (*Lobelia inflata*), may be helpful. **Acupuncture**, performed by a trained professional, has helped some patients manage their pain. Homeopathic practitioners may prescribe such remedies as *Bryonia* and *Rhus toxicodendron* for pain relief.

Prognosis

There is no cure for AS, and the course of the disease is unpredictable. Generally, AS progresses for about 10 years and then its progression levels off. Most patients can lead normal lives with treatment to control symptoms.

Prevention

There is no known way to prevent AS.

Resources

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Arthritis Foundation, P.O. Box 7669, Atlanta, GA, 30357-0669, (404) 872-7100, http://www.arthritis.org.

National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS), 1 AMS Circle, Bethesda, MD, 20892-3675, (301) 495-4484, (301) 718-6366, (877) 226-4267, NIAMSinfo@mail.nih.gov, http://www.niams.nih.gov.

Spondylitis Association of America, P.O. Box 5872, Sherman Oaks, CA, 91413, (818) 892-1616, (818) 892-1611, http://www.spondylitis.org.

Jeanine Barone Physiologist

Anorectal abscess *see* **Anorectal disorders**

Anorectal disorders

Definition

Anorectal disorders are a group of medical disorders that occur at the junction of the anal canal and the rectum.

Description

The anal canal, also called the anus, is the opening at the bottom end of the digestive tract and is a combination of external skin and tissue from the digestive tract. It has many sensory nerves and is sensitive to **pain**. The rectum is the last section of the digestive tract and has a mucus layer as its inside surface. It has very few sensory nerves and is, therefore, relatively insensitive to pain. The anal canal has a ring of muscle, called the anal sphincter, which keeps the anus closed. There are a number of different anorectal disorders.

Causes and symptoms

An anal fissure is a tear in the lining of the anus that is usually caused by a hard bowel movement. Fissures are painful and bleed when the tissue is stressed during bowel movements.

Anorectal abscesses are characterized by pus-forming infections in the anorectal region. Painful abscesses form under the skin.

An anorectal **fistula** is an abnormal opening or channel from the anorectal area to another part of the body. Typically, the channel leads to pockets of skin near the anus. When seen in infants, anorectal fistulas

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are considered **birth defects**. These are seen more frequently in boys than in girls. Fistulas are also seen more frequently in people who have other diseases, including **Crohn's disease**, **tuberculosis**, **cancer**, and **diverticulitis**. Anorectal fistulas also occur following anorectal abscesses or other injury to the anal area. Fistulas are usually painful and discharge pus.

Diagnosis

Diagnosis is made by visual inspection of the skin around the anus. Also, the doctor may probe the rectum with a gloved finger. An anoscope is a short instrument that allows the physician to view the inside of the anus. A proctoscope is a longer, rigid viewing tube of approximately six to ten inches in length, which may be used to look for anorectal disorders. A sigmoidoscope is a longer, flexible tube, that allows the physician to view up to about two feet of the inside of the large intestine. Tissue samples and material for microbial culture may be obtained during the examination.

Treatment

Treatment usually isn't required for **hemorrhoids**. Most hemorrhoids will heal if the patient takes stool softeners to relieve the **constipation**. Enlarged blood vessels can be eliminated by surgery if they are considered a severe problem. In the case of fissures, treatment involves stool softeners that eliminate **stress** on the fissure during bowel movements, which allows the fissure to heal. If the fissure doesn't heal, surgery is required. Treatment for anorectal abscesses consists of cutting the **abscess** and draining the pus. Fistulas are treated by surgery.The usual treatment for **proctitis** is **antibiotics**.

Resources

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John T. Lohr PhD

Anorectal fistula *see* **Anorectal disorders**

Anorexia nervosa

Definition

Anorexia nervosa is a psychiatric disorder characterized by an unrealistic fear of weight gain, self-starvation, and conspicuous distortion of body image. The individual is obsessed with becoming increasingly thinner and limits food intake to the point where health is compromised. The disorder can be fatal. The name comes from two Latin words that mean nervous inability to eat.

Demographics

Anorexia is a disorder of industrialized countries where food is abundant and the culture values a thin appearance. About 1% of Americans are anorectic and female anorectics outnumber males 10:1. In men the disorder is more often diagnosed in homosexuals than in heterosexuals. Some experts believe that number of diagnosed anorectics represents only the most severe cases, and that many more people have anorexic tendencies, but their symptoms do not rise to the level needed for a medical diagnosis.

Anorexia has been characterized as a "rich white girl" disorder. Most anorectics are white, and about three-quarters of them come from households at the middle income level or above. However, in the 2000s, the number of blacks and Hispanics diagnosed with anorexia has increased.

Anorexia can occur in people as young as age 7. However, the disorder most often begins during adolescence. It is most likely to start at one of two times, either age 14 or 18. Interestingly, this corresponds with the age of transitioning into and out of high school. There is a secondary peak of individuals who become anorexic in their 40s. The younger the age at which anorexic behavior starts, the more difficult it is to cure. Preteens who develop anorexia often show signs of compulsive behavior and depression in addition to anorexia.

Description

Anorexia is often thought of as a modern problem, but the English physician Richard Morton first described it in 1689. In the twenty-first century anorexia nervosa is recognized as a psychiatric disorder in the *Diagnostic and Statistical Manual for Mental Disorders Fourth Edition (DSM-IV-TR)* published by the American Psychiatric Association.

Individuals with anorexia are on an irrational, unrelenting quest to lose weight, and no matter how much they lose and how much their health is compromised, they want to lose more weight. Recognizing the development of anorexia can be difficult, especially in a society that values and glamorizes thinness. Dieting is often the trigger that starts a person down the road to anorexia. The future anorectic may begin by skipping meals or taking only tiny portions. She (most

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anorectics are female) always has an excuse for why she does not want to eat, whether it is not feeling hungry, feeling ill, having just eaten with someone else, or not liking the food served. She also begins to read food labels and knows exactly how many calories and how much fat are in everything she eats. Many anorectics practically eliminate fat and sugar from their **diets** and seem to live on diet soda and lettuce. Some future anorectics begin to **exercise** compulsively to burn extra calories. Eventually these practices have serious health consequences. At some point, the line between problem eating and an eating disorder is crossed.

Anorectics spend a lot of time looking in the mirror, obsessing about clothing size, and practicing negative self-talk about their bodies. Some are secretive about eating and will avoid eating in front of other people. They may develop strange eating habits such as chewing their food and then spitting it out, or they may have rigid ideas about "good" and "bad" food. Anorectics will lie about their eating habits and their weight to friends, family, and healthcare providers. Many anorectics experience depression and **anxiety disorders**.

There are two major subtypes of anorectics. Restrictive anorectics control their weight by rigorously limiting the amount of calories they eat or by **fasting**. They may exercise excessively or abuse drugs or herbal remedies claim to increase the rate at which the body burns calories. Purge-type anorectics eat and then get rid of the calories and weight by self-induced **vomiting**, excessive laxative use, and abuse of **diuretics** or **enemas**.

Risk factors

Competitive athletes of all races have an increased risk of developing anorexia nervosa, especially in sports where weight it tied to performance. Jockeys, wrestlers, figure skaters, cross-country runners, and gymnasts (especially female gymnasts) have higher than average rates of anorexia. People such as actors, models, cheerleaders, and dancers (especially ballet dancers) who are judged mainly on their appearance are also at high risk of developing the disorder.

Causes and symptoms

Causes

Anorexia is a complex disorder that does not have a single cause but appears to result from the interaction of cultural and biological factors. Research suggests that some people have a predisposition toward anorexic and that something then triggers the behavior, which then becomes self-reinforcing. Hereditary, biological, psychological and social factors all appear to play a role.

While the precise cause of the disorder is not known, it has been linked to the following:

- Heredity. Twin studies show that if one twin has anorexia nervosa, the other has a greater likelihood of developing the disorder. Having a close relative, usually a mother or a sister, with anorexia nervosa also increases the likelihood of other (usually female) family members developing the disorder. However, when compared to many other diseases, the inherited component of anorexia nervosa appears to be fairly small.
- Biological factors. There is some evidence that anorexia nervosa is linked to abnormal neurotransmitter activity in the part of the brain that controls pleasure and appetite. Neurotransmitters are also involved in other mental disorders such as depression. Research in this area is relatively new and the findings are unclear. People with anorexia tend to feel full sooner than other people. Some researchers believe that this is related to the fact that stomach of people with anorexia tends to empty more slowly than normal; others think it may be related to the appetite control mechanism of the brain.
- Psychological factors. Certain personality types appear to be more vulnerable to developing anorexia nervosa. Anorectics tend to be perfectionists who have unrealistic expectations about how they "should" look and perform. They tend to have a black-or-white, right-or-wrong, all-or-nothing way of seeing situations. Many anorectics lack a strong sense of identity and instead take their identity from pleasing others. Virtually all anorectics have low-self worth. Many experience depression and anxiety disorders, although researchers do not know if this is a cause or a result of the eating disorder.
- Social factors. Anorectics are more likely to come either from overprotective families or disordered families where there is a lot of conflict and inconsistency. Either way, the anorectic feels a need to be in control of something, and that something becomes body weight. The family often has high, sometimes unrealistic and rigid, expectations. Often something stressful or upsetting triggers the start of anorexic behaviors. This may be as simple as a family member teasing about the person's weight, nagging about eating junk food, commenting on how clothes fit, or comparing the person unfavorably to someone who is thin. Life events such as moving, starting a new school, breaking up with a boyfriend, or even

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KEY TERMS

Amenorrhea—Absence of the menses in a female who has begun to have menstrual periods.

Body dysmorphic disorder—A psychiatric disorder marked by preoccupation with an imagined physical defect.

Diuretic—A substance that removes water from the body by increasing urine production.

Electrolyte—Ions in the body that participate in metabolic reactions. The major human electrolytes are sodium (Na+), potassium (K+), calcium (Ca 2+), magnesium (Mg2+), chloride (Cl-), phosphate (HPO4 2-), bicarbonate (HCO3-), and sulfate (SO4 2-).

Hyperalimentation—A method of re-feeding anorectics by infusing liquid nutrients and electrolytes directly into central veins through a catheter.

Lanugo—A soft, downy body hair that develops on the chest and arms of anorexic women.

Neurotransmitter—One of a group of chemicals secreted by a nerve cell (neuron) to carry a chemical message to another nerve cell, often as a way of transmitting a nerve impulse. Examples of neurotransmitters include acetylcholine, dopamine, serotonin, and norepinephrine.

Purging—The use of vomiting, diuretics, or laxatives to clear the stomach and intestines after a binge.

Russell's sign—Scraped or raw areas on the patient's knuckles, caused by self-induced vomiting.

Superior mesenteric artery syndrome—A condition in which a person vomits after meals due to blockage of the blood supply to the intestine.

entering puberty and feeling awkward about one's changing body can trigger anorexic behavior. Overlaying the family situation is the unrelenting media message that thin is good and fat is bad; thin people are successful, glamorous, and happy, fat people are stupid, lazy, and failures.

Although anorexia nervosa is still considered a disorder that largely affects women, its incidence in the male population is rising. Less is known about the causes of anorexia in males, but some risk factors are the same as for females. These include certain occupational goals (e.g., jockey) and increasing media emphasis on external appearance in men. Moreover, homosexual males are under pressure to conform to an ideal body weight that is about 20 pounds lighter than the standard "attractive" weight for heterosexual males.

Signs and Symptoms

Anorexic behavior has physical and psychological consequences. These include:

- excessive weight loss; loss of muscle
- stunted growth and delayed sexual maturation in preteens
- gastrointestinal complications: liver damage, diarrhea, constipation, bloating, stomach pain
- cardiovascular complications: irregular heartbeat, low pulse rate, cardiac arrest
- urinary system complications: kidney damage, kidney failure, incontinence, urinary tract infections
- skeletal system complications: loss of bone mass, increased risk of fractures, teeth eroded by stomach acid from repeat vomiting
- reproductive system complications (women): irregular menstrual periods, amenorhhea, infertility
- reproductive system complications (men): loss of sex drive, infertility
- fatigue, irritation, headaches, depression, anxiety, impaired judgment and thinking
- fainting, seizures, low blood sugar
- chronically cold hands and feet
- weakened immune system, swollen glands, increased susceptibility to infections
- development of fine hair called lanugo on the shoulders, back, arms, and face, head hair loss, blotchy, dry skin
- potentially life-threatening electrolyte imbalances
- coma
- increased risk of self-mutilation (cutting)
- increased risk of suicide
- death

Diagnosis

Diagnosis of anorexia nervosa is made when the individual meets the criteria for the disorder outlined in the *DSM IV-TR*.

Anorexia is diagnosed when most of the following conditions are present:

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- an overriding obsession with food and thinness that controls activities and eating patterns every hour of every day
- the individual weighs less than 85% of the average weight for his or her age and height group and willfully and intentionally refuses to maintain an appropriate body weight
- extreme fear of gaining weight or becoming fat, even when the individual is significantly underweight
- a distorted self-image that fuels a refusal to admit to being underweight, even when this is demonstrably true
- refusal to admit that being severely underweight is dangerous to health
- for women, three missed menstrual periods in a row after menstruation has been established

Diagnosis is based on several factors including a patient history, **physical examination**, laboratory tests, and a mental status evaluation. A patient history is less helpful in diagnosing anorexia than in diagnosing many diseases because many people with anorexia lie repeatedly about how much they eat and their use of **laxatives**, enemas, and medications. The patient may, however, complain about related symptoms such as **fatigue**, headaches, **dizziness**, **constipation**, or frequent infections.

Tests

A physical examination begins with weight and blood pressure and moves through all the signs listed above. Based on the physical exam, the physician will order laboratory tests. In general these tests will include a **complete blood count** (CBC), **urinalysis**, blood chemistries (to determine electrolyte levels), and **liver function tests**. The physician may also order an electrocardiogram to look for heart abnormalities. Other conditions including metabolic disorders, brain tumors (especially hypothalamus and pituitary gland lesions), diseases of the digestive tract, and a condition called superior mesenteric artery syndrome can cause weight loss or **vomiting** after eating. People with this condition sometimes vomit after meals because the blood supply to the intestine is blocked. The physician may perform tests needed to rule out the presence of these disorders and assess the patient's nutritional status.

The individual may be referred to a psychiatrist for a mental status evaluation. The physician will evaluate things such as whether the person is oriented in time and space, appearance, observable state of emotion (affect), attitude toward food and weight, delusional thinking, and thoughts of self-harm or **suicide**. This evaluation helps to distinguish between anorexia and other psychiatric disorders, including depression, **schizophrenia**, social phobia, **obsessive-compulsive disorder**, and **body dysmorphic disorder**. Two diagnostic tests that are often used are the Eating Attitudes Test (EAT) and the Eating Disorder Inventory (EDI).

Treatment

Treatment choices depend on the degree to which anorexic behavior has resulted in physical damage and whether the person is a danger to him or herself. Medical treatment should be supplemented with psychiatric treatment. Patients are frequently uncooperative and resist treatment, denying that their life may be endangered and insisting that the doctor only wants to "make them get fat."

Traditional

Hospitalization is recommended for anorexics with any of the following characteristics:

- weight of 40% or more below normal; or weight loss over a three-month period of more than 30 pounds
- severely disturbed metabolism
- severe binging and purging
- signs of psychosis
- severe depression or risk of suicide
- family in crisis

Hospital impatient care is first geared toward correcting problems that present as immediate medical crises, such as severe **malnutrition**, severe electrolyte imbalance, irregular heart beat, pulse below 45 beats per minute, or low body temperature. Patients are hospitalized if they are a high suicide risk, have severe clinical depression, or exhibit signs of an altered mental state. They may also need to be hospitalized to interrupt weight loss, stop the cycle of vomiting, exercising and/or laxative abuse, treat substance disorders, or for additional medical evaluation.

Day treatment or partial hospitalization where the patient goes every day to an extensive treatment program provides structured mealtimes, **nutrition** education, intensive therapy, medical monitoring, and supervision. If day treatment fails, the patient may need to be hospitalized or enter a full-time residential treatment facility.

Anorexia nervosa is a chronic disease and relapses are common and to be expected. Outpatient treatment provides medical supervision, nutrition counseling, self-help strategies, and therapy after the patient has reached some weight goals and shows stability.

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A nutrition consultant or dietitian is an essential part of the team needed to successfully treat anorexia. The first treatment concern is to get the individual medically stable by increasing calorie intake and balancing electrolytes. After that, nutritional therapy is needed support the long process of recovery and stable weight gain. This is an intensive process involving of nutrition education, meal planning, nutrition monitoring, and helping the anorectic develop a healthy relationship with food.

Therapy

Medical intervention helps alleviate the immediate physical problems associated with anorexia, but by itself, it rarely changes behavior. **Psychotherapy** plays a major role in the helping the anorectic understand and recover from anorexia. Several different types of psychotherapy are used depending on the individual's situation. Generally, the goal of psychotherapy is help the individual develop a healthy attitude toward their body and food. This may involve addressing at the root causes of anorexic behavior as well as addressing the behavior itself.

Some types of psychotherapy that have been successful in treating anorectics are listed below.

- Cognitive behavior therapy (CBT) is designed to change the individual's thoughts and feelings about his or her body and behaviors toward food, but it does not address why those thoughts or feelings exist. This therapy is relatively short-term
- Psychodynamic therapy, also called psychoanalytic therapy, attempts to help the individual gain insight into the cause of the emotions that trigger their anorexic behavior. This therapy tends to be longer term that CBT.
- Interpersonal therapy is short-term therapy that helps the individual identify issues and problems in relationships. The individual may be asked to look back at his or her family history to try to recognize problem areas and work toward resolving them.
- Family and couples therapy is helpful in dealing with conflict or disorder that may be a factor in perpetuating anorexic behavior. Family therapy is especially useful in helping parents who are anorectics avoid passing on their attitudes and behaviors on to their children.

Drugs

Anorectics are treated with a variety of medications to address physical problems brought about by their eating disorder and to treat additional psychiatric problems such as depression, **anxiety**, and suicidal thoughts. The medications used will vary depending on the individual, however, depression is common among anorectics and is treated often treated with **antidepressant drugs**.

Alternative

Alternative treatments should serve as complementary to a conventional treatment program. Alternative therapies for anorexia nervosa include diet and nutrition counseling, herbal therapy, **hydrotherapy**, **aromatherapy**, **Ayurvedic medicine**, and mind/body medicine.

The following herbs may help reduce anxiety and depression which are often associated with this disorder:

- chamomile (*Matricaria recutita*)
- lemon balm (*Melissa officinalis*)
- linden (*Tilia* spp.) flowers

Essential oils of herbs such as bergamot, basil, chamomile, sage, and lavender may help stimulate appetite, relax the body, and fight depression. They can be diffused into the air, inhaled, massaged, or put in bath water.

Relaxation techniques such as **yoga**, **meditation**, and t'ai chi can relax the body and release **stress**, anxiety, and depression.

Hypnotherapy may help resolve unconscious issues that contribute to anorexic behavior.

Other alternative treatments that may be helpful include hydrotherapy, **magnetic field therapy**, **acupuncture**, **biofeedback**, Ayurvedic medicine, and **traditional Chinese medicine**.

Prognosis

Anorexia nervosa is difficult to treat successfully. Medical stabilization, nutrition therapy, continued medical monitoring, and substantial psychiatric treatment give a person with anorexia the best chance of recovery. Estimates suggest that between 20% and 30% of people in treatment drop out too soon and have major relapses. Even those who stay in treatment relapse occasionally. Treating anorexia is often a long, slow, frustrating process that can cost many thousands of dollars. The earlier in life that the disorder starts and the longer the disorder continues untreated, the more difficult it is bring about recovery. Many individuals with anorexia are willfully uncooperative and do not want to recover.

About half the people treated for anorexia nervosa recover completely and are able (sometimes with

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difficulty) to maintain a normal weight. Of the remaining 50% between 6% and 20% die. The most frequent causes of **death** associated with anorexia are **starvation**, electrolyte imbalance, **heart failure**, and suicide. About 20% remain dangerously underweight, and the rest remain thin. Long-term health complications are common.

Prevention

Short of major long-term changes in the larger society, the best strategy for prevention of anorexia is the cultivation of healthy attitudes toward food, weight control, and beauty (or body image) within families. Some ways to prevent anorexia nervosa from developing are as follows:

- If you are a parent, do not obsess about your own weight and appearance in front of your children.
- Do not tease your children about their body shapes or compare them to others.
- Make it clear that you love and accept your children as they are.
- Try to eat meals together as a family whenever possible.
- Remind children that the models they see on television and in fashion magazines have extreme, not normal or healthy bodies.
- Do not put your child on a diet unless advised to by your pediatrician.
- Block your child from visiting pro-anorexia Web sites. These are sites where people with anorexia give advice on extreme weight loss techniques and support each other's distorted body image.
- If your child is a competitive athlete, get to know the coach and the coach's attitude toward weight.
- If you think your child has an eating disorder, do not wait to intervene and the professional help. The sooner the disorder is treated, the easier it is to cure.

Relapses happen to many people with anorexia. People who are recovering from anorexia can help prevent themselves from relapsing by:

- never dieting; instead plan healthy meals
- staying in treatment
- monitoring negative self-talk; practicing positive self-talk
- spending time doing something enjoyable every day
- staying busy, but not overly busy; getting at least seven hours of sleep each night
- spending time each day with people you care about and who care about you

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ORGANIZATIONS

American Psychological Association, 750 First Street, NE, Washington, DC, 20002-4242 (202) 336-5500; TDD/TTY: (202)336-6123 (800) 374-2721, apa@psych.org, http://www.apa.org.

National Association of Anorexia Nervosa and Related Eating Disorders (ANAD), P.O. Box 7, Highland Park, IL, 60035 (847) 831-3438 (847) 433-3996, http://www.anad.org.

National Eating Disorders Association, 603 Stewart Street, Suite 803, Seattle, WA, 98101 (206) 382-3587 Help and Referral Line: (800) 931-2237. (206) 829-8501, info@NationalEatingDisorder.org, http://www.nationaleatingdisorders.org.

Tish Davidson A.M.

Anoscopy

Definition

An anoscopy is an examination of the rectum in which a small tube is inserted into the anus to screen, diagnose, and evaluate problems of the anus and anal canal.

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KEY TERMS

Anal fissure—An ulcer on the margin of the anus.

Digital rectal examination—An examination where a gloved, lubricated index finger is inserted into the rectum to check for any abnormalities.

Polyps—A tumor with a small flap that attaches itself to the wall of various vascular organs such as the nose, uterus and rectum. Polyps bleed easily, and if they are suspected to be cancerous they should be surgically removed.

Vasovagal reaction—Regarding the action of stimuli from the vagus nerve on blood vessels.

Purpose

This test may be ordered for the evaluation of perianal or anal **pain**, **hemorrhoids**, **rectal prolapse**, **digital rectal examination** that shows a mass, perianal **abscess** and condyloma (a wart-like growth). An anascopy may be performed to check for abnormal openings between the anus and the skin, or anal fissures. The test is also used to diagnose **rectal cancer**.

Precautions

Anoscopy should not be performed on patients with acute cardiovascular problems due to the vasovagal reaction it may cause. This test is also not recommended for patients with acute abdominal problems and those with a constricted or narrowed anal canal.

Description

Anoscopy views the anus and anal canal by using an anoscope. An anoscope is a plastic, tube-shaped speculum that is a smaller version of a sigmoidscope. Before the anoscope is used, the doctor completes a digital **rectal examination** with a lubricated, gloved index finger. The anoscope is then lubricated and gently inserted a few inches into the rectum. This procedure enlarges the rectum to allow the doctor to view the entire anal canal with a light. If any suspicious areas are noticed, a piece of tissue can be biopsied.

During the anoscopy procedure there may be a feeling of pressure or the need to go to the bathroom. If a biopsy is taken, the patient may feel a slight pinch. The procedure is performed on an out-patient basis, and takes approximately an hour to complete.

Preparation

The patient will be instructed to clear their rectum of stool before the procedure. This may be done by taking a laxative, enema, or other preparation that may help with the evacuation.

Aftercare

If a biopsy is needed during an anoscopy, there may be slight anal bleeding for less than two days following the procedure. The patient may be instructed to sit in a bathtub of warm water for 10 to 15 minutes, three times a day, to help decrease the pain and swelling.

Risks

A simple anoscopy procedure offers minimal risks. There is a limited risk of bleeding and mild pain is a biopsy is performed.

Normal results

Normal values to look for during an anoscopy include an anal canal that appears healthy in size, color, and shape. The test also looks for no evidence of bleeding, polyps, hemorrhoids or other abnormalities.

Abnormal results

While an anoscopy is typically performed to determine is hemorrhoids are present, other abnormal finding could include polyps, abscesses, inflammation, fissures, colorectal polyps, or **cancer**.

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Anosmia

Definition

The term anosmia means lack of the sense of smell. It may also refer to a decreased sense of smell. Ageusia, a companion word, refers to a lack of taste

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KEY TERMS

Allergen—Any substance that irritates only those who are sensitive (allergic) to it.

Corticosteroids—Cortisone, prednisone, and related drugs that reduce inflammation.

Rhinitis—Inflammation and swelling of the nasal membranes.

Nasal polyps—Drop-shaped overgrowths of the nasal membranes.

sensation. Patients who actually have anosmia may complain wrongly of ageusia, although they retain the ability to distinguish salt, sweet, sour, and bitter–humans' only taste sensations.

Description

Of the five senses, smell ranks fourth in importance for humans, although it is much more pronounced in other animals. Bloodhounds, for example, can smell an odor a thousand times weaker than humans. Taste, considered the fifth sense, is mostly the smell of food in the mouth. The sense of smell originates from the first cranial nerves (the olfactory nerves), which sit at the base of the brain's frontal lobes, right behind the eyes and above the nose. Inhaled airborne chemicals stimulate these nerves.

There are other aberrations of smell beside a decrease. Smells can be distorted, intensified, or hallucinated. These changes usually indicate a malfunction of the brain.

Causes and symptoms

The most common cause of anosmia is nasal occlusion caused by **rhinitis** (inflammation of the nasal membranes). If no air gets to the olfactory nerves, smell will not happen. In turn, rhinitis and **nasal polyps** (growths on nasal membranes) are caused by irritants such as allergens, infections, cigarette smoke, and other air pollutants. Tumors such as nasal polyps can also block the nasal passages and the olfactory nerves and cause anosmia. **Head injury** or, rarely, certain viral infections can damage or destroy the olfactory nerves.

Diagnosis

It is difficult to measure a loss of smell, and no one complains of loss of smell in just one nostril. So a physician usually begins by testing each nostril separately with a common, non-irritating odor such as perfume, lemon, vanilla, or coffee. Polyps and rhinitis are obvious causal agents a physician looks for. Imaging studies of the head may be necessary in order to detect brain injury, sinus infection, or tumor.

Treatment

Cessation of **smoking** is the first step. Many smokers who quit discover new tastes so enthusiastically that they immediately gain weight. Attention to reducing exposure to other nasal irritants and treatment of respiratory **allergies** or chronic upper respiratory infections will be beneficial. **Corticosteroids** are particularly helpful.

Alternative treatment

Finding and treating the cause of the loss of smell is the first approach in **naturopathic medicine**. If rhinitis is the cause, treating acute rhinitis with herbal mast cell stabilizers and herbal **decongestants** can offer some relief as the body heals. If chronic rhinitis is present, this is often related to an environmental irritant or to **food allergies**. Removal of the causative factors is the first step to healing. Nasal steams with essential oils offer relief of the blockage and tonification of the membranes. Blockages can sometimes be resolved through naso-specific therapy–a way of realigning the nasal cavities. Polyp blockage can be addressed through botanical medicine treatment as well as **hydrotherapy**. Olfactory nerve damage may not be regenerable. Some olfactory aberrations, like intensified sense of smell, can be resolved using **homeopathic medicine**.

Prognosis

If nasal inflammation is the cause of anosmia, the chances of recovery are excellent. However, if nerve damage is the cause of the problem, the recovery of smell is much more difficult.

Resources

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J. Ricker Polsdorfer MD

Anoxemia *see* **Anoxia**

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Anoxia

Definition

Anoxia is a condition characterized by an absence of oxygen supply to an organ or a tissue.

Description

Anoxia results when oxygen is not being delivered to a part of the body. If the condition does not involve total oxygen deprivation, it is often called hypoxia, although the two terms have been used interchangeably. A related condition, anoxemia, occurs when the blood circulates but contains a below normal amount of oxygen.

The five types of anoxia or hypoxia include hypoxemic, anemic, affinity, stagnant, and histotoxic. Hypoxemic anoxia happens when the oxygen pressure outside the body is so low that the hemoglobin, the chemical which carries oxygen in the red blood cells (RBCs), is unable to become fully loaded with the gas. This results in too little oxygen reaching the tissues and can occur in suffocation when a person is at high altitude, where the pressure of oxygen in the air is much less than at sea level.

Anemic anoxia results from a decrease in the amount of hemoglobin or RBCs in the blood, which reduces the ability to get oxygen to the tissues. Anemia may result from lack of production of red blood cells (iron deficiency), blood loss (hemorrhage), or shortened lifespan of red blood cells (autoimmune disease).

Affinity anoxia involves a defect in the chemistry of the blood such that the hemoglobin can no longer pick up as much oxygen from the air, even though the quantities are normal, reducing how much is delivered to the tissues.

Stagnant anoxia occurs when there is interference with the blood flow, although the blood and its oxygen-carrying abilities are normal. A common cause of general stagnant anoxia is heart disease or interference with the return of blood flow through the veins. Examples of local stagnant anoxia include exposure to cold, diseases that restrict circulation to the extremities, and ergot **poisoning**. When the tissue or organ itself has a reduced ability to accept and use the oxygen, it is called histotoxic anoxia. The classic example is cyanide poisoning, where the chemical inactivates a cellular enzyme necessary for the cell to use oxygen. Thus, tissue exposed to cyanide cannot use the oxygen even though it is in normal amounts in the bloodstream. Histotoxic anoxia can also be caused by exposure to **narcotics**, alcohol, formaldehyde, acetone, toluene, and certain anesthetic agents.

KEY TERMS

Amnesia—Loss of memory often traceable to brain tissue damage.

Anoxemia—An extreme lack of oxygen in the blood.

Hemoglobin—A chemical found in red blood cells that transports oxygen.

Myoclonus—Involuntary contractions of a muscle or group of muscles.

Causes and symptoms

Anoxia and hypoxia can be caused by any number of disease states of the blood, lungs, heart and circulation including **heart attack**, severe **asthma**, or **emphysema**. It can also result from smoke or carbon monoxide inhalation, improper exposure to anesthesia, poisoning, strangulation, **near-drowning**, or high altitude exposure through mountain climbing or travel in an insufficiently pressurized airplane. Anoxia, and the resultant brain damage, is a particular problem with newborns during difficult births.

No matter what the cause of anoxia, the symptoms are similar. In severe cases, the patient is often confused and commonly stuperous or comatose (in a state of unconsciousness). Depending on the severity of the injury to the brain, the organ most sensitive to reduced oxygen intake, this condition can persist for hours, days, weeks, or even months or years. Seizures, myoclonic jerks (involuntary **muscle spasms** or twitches), and neck stiffness are some other symptoms of the anoxic condition.

Symptoms of more localized or less complete oxygen deprivation (hypoxia) include increased breathing rate, lightheadedness, **dizziness**, **tingling** or warm sensation, sweating, reduced field of vision, sleepiness, a bluish tint to skin, particularly the fingertips and lips, and behavior changes, often an inappropriate sense of euphoria.

Diagnosis

Diagnosis of anoxia and hypoxia is commonly made through the appearance of clinical symptoms. However, suspected reduction in oxygen reaching the tissues can be confirmed using laboratory tests. The exact test that is performed is dependent on the

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suspected cause of the anoxia. One systemic measure of tissue anoxia is the serum lactate (lactic acid) test. When cells are forced to produce energy without oxygen, as would happen during anoxia, lactic acid is one of the byproducts. Thus, an increase in lactic acid in the blood would indicate that tissues were starved for oxygen and are using non-oxygen pathways to produce energy. Normally, the blood contains less than 2mmol/L of lactic acid. However, some forms of anoxia do not increase lactic acid concentrations in the blood and some increases in lactic acid levels are not associated with anoxia, so an elevated value for this test is only suggestive of an anoxic or hypoxic condition.

Treatment

The exact treatment for anoxia is dependent on the cause of the reduced oxygen reaching the tissues. However, immediate restoration of tissue oxygen levels through supplementing the patient's air supply with 100% oxygen is a common first step. Secondary steps often include support of the cardiovascular system through drugs or other treatment, treatment of lung disease, transfusions, or administration of anecdotes for poisoning, as appropriate.

Prognosis

A good prognosis is dependent on the ability to treat the underlying cause of the low oxygen levels. If cardiovascular and respiratory systems can be supported adequately, recovery from the injury to the tissue is possible, although extent of injury to the brain can be difficult to assess. The exact amount of recovery varies with the amount of injury sustained, where significant injury brings a poorer prognosis. As recovery occurs, both psychological and neurological abnormalities may appear, persist, and can improve. Some problems seen after anoxia include mental confusion, personality changes, **amnesia** or other types of **memory loss**, **hallucinations**, and persistent myoclonus (involuntary contractions of the muscles).

Prevention

Hypoxemic anoxia can be avoided by utilizing supplemental oxygen when in high altitudes and being aware of the early symptoms of **altitude sickness** and reducing altitude once recognized. Iron supplements can avoid anemic hypoxia, although more severe anemic states are usually caused by disease or bleeding. Maintaining good cardiovascular health through proper diet and **exercise** is a good first step to avoiding the most common cause of stagnant anoxia. Avoiding exposure to the toxic chemicals that cause the condition can prevent histotoxic anoxia.

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ORGANIZATIONS

Brain Injury Association of America, 1608 Spring Hill Road, Suite 110, Vienna, VA, 22182, (703) 761-0750, (703) 761-0755, http://www.biausa.org.

Coma/Traumatic Brain Injury Recovery Association, 8300 Republic Airport Suite 106, Farmingdale, NY, 11735, (631) 756-1826, http://www.comarecovery.org.

Michelle Johnson MS, JD

Antacids

Definition

Antacids are medicines that neutralize stomach acid.

Purpose

Antacids are used to relieve acid **indigestion**, upset stomach, sour stomach, and **heartburn**. Some formulations also contain dimethicone to reduce gas pains, or alginic acid, which, in combination with antacids, may help manage **gastroesophageal reflux disease** (GERD). Antacids should not be confused with gastric acid inhibitors, such as the H-2 receptor blockers (cimetidine (Tagamet), rantidine (Zantac), and others) or **proton pump inhibitors** (lansoprazole (Prevacid), omeprazole (Prilosec and others). Although all three classes of drugs act to reduce the levels of gastric acid, their mechanisms are different, and this affects the appropriate use of the drugs. Antacids have a rapid onset and short duration of action. They are most appropriately used for rapid relief of gastric discomfort for a short period of time.

Antacids may be divided into two classes, those that work by chemical neutralization of gastric acid, most notably **sodium** bicarbonate, and those that act

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KEY TERMS

Acid indigestion—Stomach discomfort that results from too much acid in the stomach.

Adsorption—A process that occurs when molecules of a liquid or gas cling to the surface of a solid.

Chronic—A word used to describe a long-lasting condition. Chronic conditions often develop gradually and involve slow changes.

Heartburn—A burning sensation, usually in the center of the chest, near the breastbone resulting from the presence of excess stomach acid.

Indigestion—A feeling of discomfort or illness that results from the inability to properly digest food.

Inflamed bowel—Irritation of the intestinal tract.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Pregnancy safety categories—A system for reporting the known safety issues of drugs for use during pregnancy, The ratings range from A, proven safe by well controlled studies, to X, proven harmful.

by adsorption of the acid (non-absorbable antacids), such as **calcium** and magnesium salts.

The chemical antacids generally have the most rapid onset, but may cause acid rebound. Acid rebound is a condition in which the gastric acid returns in greater concentration after the drug effect has stopped. Also, since these antacids often contain high concentrations of sodium, they may be inappropriate in people with **hypertension** who must limit their salt intake.

Calcium and magnesium salts act by adsorption of the acid and are less prone to the rebound effect. Nevertheless, they may have other significant disadvantages. These antacids are particularly prone to **drug interactions**, and individuals taking other medications must often avoid taking this type of antacid and certain other drugs together. These antacids are more effective in liquid formulations than in tablet or capsule form, and so may be inconvenient for routine dosing.

The non-absorbable antacids may have additional uses beyond control of hyperacidity. Calcium salts may be used as diet supplements to help prevent **osteoporosis**. Aluminum carbonate is useful for binding phosphate and has been found to be effective in treatment and control of hyperphosphatemia or for use with a low phosphate diet to prevent formation of phosphate urinary stones. This application is particularly valuable in patients with **chronic kidney failure**.

Antacids with aluminum and magnesium hydroxides or aluminum hydroxide alone effectively prevent significant stress ulcer bleeding in post-operative patients and those with severe **burns**.

Recommended dosage

The dose depends on the type of antacid. The individual should consult the packaging of the particular product and his or her physician or pharmacist to determine the correct dose.

When using antacids in chewable tablet form, the tablet should be chewed thoroughly before it is swallowed. A glass of water should be drunk after taking chewable aluminum hydroxide. Lozenges should be allowed to dissolve completely in the mouth. Liquid antacids should be shaken well before using.

Precautions

Antacids should be avoided if any signs of **appendicitis** or inflamed bowel are present. These signs include cramping, **pain**, soreness in the lower abdomen, bloating, **nausea and vomiting**.

Antacids may affect the results of some medical tests, such as those that measure how much acid the stomach produces. Healthcare providers and patients should keep this in mind when scheduling a medical test.

Antacids that contain magnesium may cause **diarrhea**. Other types of antacids may cause **constipation**.

Individuals should avoid taking antacids containing sodium bicarbonate when the stomach is uncomfortably full from eating or drinking.

Antacids should not be given to children under six years of age.

Antacids that contain calcium or sodium bicarbonate may cause side effects, such as **dizziness**, **nausea**, and **vomiting**, in people who consume large amounts of calcium (from dairy products or calcium supplements). In some cases, this can lead to permanent kidney damage. Individuals who consume large amounts of calcium should check with a physician before taking antacids containing additional calcium.

Some antacids contain large amounts of sodium, particularly sodium bicarbonate (baking soda). Anyone on a low-sodium diet should check the list of ingredients or talk to their physician or pharmacist before taking an antacid product.

Excessive use of antacids may cause or increase the severity or kidney problems. Calcium-based antacids may lead to the formation of **kidney stones**.

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PREGNANCY. Antacids are not classified under the **pregnancy** safety categories A, B, C, D and X. Occasional use of antacids in small amounts during pregnancy is considered safe. However, pregnant women should check with their physicians before using antacids or any other medicines. Pregnant women who are consuming extra calcium should be aware that using antacids that contain sodium bicarbonate or calcium can lead to serious side effects.

BREASTFEEDING. Some antacids may pass into breast milk. However, no evidence exists thtforat the ingestion of antacids through breast milk causes problems for nursing babies whose mothers use antacids occasionally.

Side effects

Side effects are very rare when antacids are taken as directed. They are more likely when these drugs are taken in large doses or over a long time. Minor side effects include a chalky taste, mild constipation or diarrhea, thirst, stomach cramps, and whitish or speckled stools. These symptoms do not need medical attention unless they are severe, long-lasting, or interfere with normal activities.

Other uncommon side effects may occur. Anyone who has unusual symptoms after taking antacids should get in touch with a healthcare provider.

Interactions

Antacids have multiple drug interactions, usually due to inhibition of absorption of other medications. In rare cases, the absorbable antacids may alter the acidity of the stomach contents or urine sufficiently to alter drug absorption or excretion. Individuals should talk to their doctor or pharmacist before beginning to take a new medication.

Resources

BOOKS

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ORGANIZATIONS

American College of Gastroenterology, P. O. Box 342260, Bethesda, MD, 20827-2260, (301) 263-9000, http://www.acg.gi.org.

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Antegrade pyelography *see* **Intravenous urography**

Antenatal testing

Definition

Antenatal testing includes any diagnostic procedures performed before the birth of a baby.

Purpose

These tests and exams are essential for protecting the health of a pregnant woman and her developing child.

Precautions

Some tests, such as amniocentisis, carry a small risk of a **miscarriage** or other complications that could harm the mother or baby.

Description

Women who become pregnant undergo a wide variety of tests throughout the nine months before delivery. In the early stages, physicians order blood tests to screen for possible disorders or infections, such as human **immunodeficiency** virus (HIV), which can pass from the mother to the fetus. Later, the focus shifts to checking on fetal well-being with a variety of technological tools such as ultrasound scans. Descriptions of the most common tests and procedures used during **pregnancy** are listed below.

When a woman first learns she is pregnant, her physician will run a series of routine urine and blood tests to determine her blood type, check for anemia and **gestational diabetes**, make sure she is immune to **rubella** (German measles) and check for infectious diseases like HIV, hepatitis, chlamydia or **syphilis**.

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KEY TERMS

Alpha fetoprotein screen—A test that measures the level of alpha fetoprotein, a substance produced by a fetus with birth defects, in the mother's blood.

Amniocentesis—An invasive procedure that allows physicians to check for birth defects by collecting a sample of fetal cells from inside the amniotic sac.

Breech position—When a child is oriented feet first in the mother's uterus just before delivery.

GBS—Group B streptococci are a type of bacteria that, if passed to an infant, can cause inflammation of the brain, spinal cord, blood or lungs. In some cases, it can result in infant death.

Ultrasound—A device that records sound waves as they bounce off a developing fetus to create an image, which is projected onto a large computer screen.

Physicians also usually do **pelvic exam** to screen for **cervical cancer** and check the patient's blood pressure. As the pregnancy progresses, more tests will follow.

Ultrasound

Ultrasound is a device that records sound waves as they bounce off the developing fetus to create an image, which is projected onto a large computer screen. Physicians order an ultrasound scan to listen for a fetal heartbeat, determine a woman's precise due date, check for twins, and perform other measurements of the fetus. An ultrasound scan also is known as a sonogram. The procedure takes a few minutes, is painless and usually is covered by health insurance.

The ultrasound technician will ask the pregnant woman to remove her clothes and change into a gown. The technician may rub gel on the woman's stomach, which helps the hand-held device pick up sound waves. In certain cases, the technician may insert a plastic probe into the woman's vaginal canal to get a clearer picture of the fetus. Early in pregnancy, the test may need to be done with a full bladder.

Unlike x rays, ultrasound is safe to use during pregnancy. It does not cause any known side-effects that would harm the mother or baby.

Pregnant women usually will have their first ultrasound anytime between 8 and 12 weeks of gestation. In normal cases, the technician is able to identify a fetal heartbeat, which appears as a flashing light on the screen. Closer to the due date, physicians use ultrasound to make sure the fetus is in the correct position to exit the birth canal head first.

Sometimes an ultrasound will show that a fetus has stopped growing, or a gestational sac has formed without a fetus, and a miscarriage has occurred. Later in pregnancy, it also may show that the child is in a breech position, oriented feet first, which can cause a difficult labor.

Tests for birth defects

Most obstetricians offer parents a variety of ways to find out if their developing child might have **birth defects** such as **spina bifida** and **Down Syndrome**. An alpha fetoprotein screen can be done through a simple blood test in the doctor's office between the 16th and 18th week of gestation. It tells the odds that their child will have a severe congenital anomaly. The test works by measuring the level of alpha fetoprotein, a substance produced by a fetus with birth defects. Low levels of alpha fetoprotein in the mother's blood may indicate Down's Syndrome. In that case, the next step for most couples is **amniocentesis** because the alpha fetoprotein test can give false-positive results. Amniocentesis is a more accurate test, but it also has higher risks of complications.

This procedure typically is used to diagnose Down Syndrome while a developing child is still in the womb, at 15-28 weeks.

During amniocentesis, a doctor inserts a needle through a woman's vaginal canal and inside her cervix. Using ultrasound as a guide, the doctor pierces the uterus to withdraw a sample of fluid from the amniotic sac. Afterwards, tiny cells shed by the fetus can be studied in the laboratory. Scientists can analyze DNA samples to determine if the fetus has Down syndrome or other genetic conditions. Amniocentesis also can determine the sex of the fetus.

Women who have a history of recurring miscarriages may not want to have this procedure.

Amniocentesis is usually performed in a doctor's office on an outpatient basis.

Common side effects include cramping and bleeding.

In about one out of every 1,000 cases, amniocentesis causes a needle to puncture the uterine wall, which could result in miscarriage.

In most cases, couples find out their baby does not have a birth defect.

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If the results come back positive for Down's Syndrome or other serious conditions, the couple must decide if they want to end the pregnancy. Others use the knowledge to plan and prepare any special care needed for their future child.

Group B Strep

This test is for Group B streptococci (GBS) infection.

By testing for GBS, physicians can determine if a woman is at risk of passing this infection along to her child.

Women who have had a prior child with GBS, or who have a **fever** or prolonged or premature rupture of the amniotic sac may be at higher risk for this type of infection.

GBS is a type of bacteria commonly found in the vagina and rectum. Unlike regular **strep throat**, GBS can be present in a person's body without causing any symptoms, so many women do not realize they are infected with it.

To test for the presence of GBS, doctors may take a urine sample. They also may collect samples from the vagina or rectum, which are then analyzed in a lab. This test is usually performed late in pregnancy, at 35-37 weeks of gestation.

This is a routine urine test or pelvic exam with no side effects.

In many cases, doctors do not find any evidence of this type of infection.

If a woman is found to be infected with Group B strep, physicians usually wait to treat it until just before labor begins. At that time, they may give the mother **antibiotics** so the baby is not born with the infection. Newborns who are exposed to Group B strep can have inflammation of the brain, spinal cord, blood or lungs. In some cases, this serious complication can result in infant **death**.

Resources

BOOKS

Your Pregnancy & Birth: Information You Can Trust from the Leading Experts in Women's Health Care. Washington, DC: The American College of Obstetricians and Gynecologists, 2005.

ORGANIZATIONS

American College of Obstetricians and Gynecologists (ACOG), PO Box 96920, Washington, DC, 20090-6920, (202) 638-5577, http://www.acog.org.

March of Dimes Birth Defects Foundation, 1275 Mamaroneck Ave., White Plains, NY, 10605, (914) 997-4488, http://www.modimes.org.

Melissa Knopper

Antepartum testing

Definition

Antepartum testing consists of a variety of tests performed late in **pregnancy** to verify fetal well-being, as judged by the baby's heart rate and other characteristics. Antepartum tests include the nonstress test (NST), biophysical profile, and contraction **stress test** (CST).

Purpose

Antepartum testing is performed after 32 weeks of pregnancy so that the couple and the doctor can be warned of any problems that may necessitate further testing or immediate delivery. The results reflect the adequacy of blood flow (and oxygen delivery) to the fetus from the placenta.

Antepartum tests are usually done in pregnancies at high risk for fetal complications. Various reasons include:

- any chronic illness in the mother, such as high blood pressure or diabetes
- problems with previous pregnancies, such as stillbirth
- fetal complications, such as intrauterine growth retardation (a slowing of growth of the fetus) or birth defects
- problems in the current pregnancy, including preeclampsia (serious pregnancy-induced high blood pressure), gestational (pregnancy-related) diabetes, premature rupture of the membranes, excessive amniotic fluid (the liquid that surrounds the fetus), vaginal bleeding, or placenta previa (a condition in which the placenta is positioned over the cervix instead of near the top of the uterus)
- twins or other multiple fetuses

One of the most common indications for antepartum testing is post-term pregnancy. A pregnancy should not be allowed to continue past 42 weeks. (The usual pregnancy is 40 weeks in duration). Babies should be monitored with antepartum testing starting at 41 weeks. After 41 weeks, there is an increasing risk that the placenta cannot meet the growing baby's

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KEY TERMS

Amniotic fluid—The liquid that surrounds the baby within the amniotic sac. Because it is composed mostly of fetal urine, a low amount of fluid can indicate inadequate placental blood flow to the fetus.

Deceleration—A decrease in the fetal heart rate that can indicate inadequate blood flow through the placenta.

Oxytocin—A natural hormone that produces uterine contractions.

Ultrasound—A procedure in which high-frequency sound waves are used to create a picture of the baby, used alone or with antepartum tests.

Vibroacoustic stimulation—In the biophysical profile, use of an artificial larynx to produce a loud noise to "awaken" the fetus.

needs for oxygen and **nutrition**. This may be reflected in decreased movements of the baby, decreased amniotic fluid, and changes in the heart rate pattern of the baby.

Description

Technology

The NST and CST use a technique called **electronic fetal monitoring** to evaluate the heartbeat of the fetus. The biophysical profile is an ultrasound examination.

NST

The NST is usually the first antepartum test used to verify fetal well-being. It is based on the principle that when the fetus moves, its heartbeat normally speeds up. The NST assesses fetal health through monitoring accelerations of the heart rate in response to the baby's own movements, i.e., in the absence of **stress**.

The mother lays down or sits, and an electronic fetal monitor is placed on her abdomen to monitor the fetal heart rate. The doctor records the baby's heartbeat on a graph or "tracing" to determine whether it demonstrates correct reactivity, or acceleration of the heart rate. To record fetal movements on the tracing, the mother presses a button every time she feels the baby move. If the baby is inactive, the mother may be asked to rub her abdomen to "awaken" it. Sometimes an instrument is used to produce a loud noise to arouse the fetus (vibroacoustic stimulation). The test usually takes between 20–45 minutes.

A baby who is receiving enough oxygen should move at least twice in a 20 minute period. The baby's heart rate should increase at least 20 beats per minute for at least 20 seconds during these movements. The NST is the simplest and cheapest antepartum test.

Biophysical profile

The biophysical profile is an ultrasound exam that can add additional information to the NST. During the biophysical profile, the examiner checks for various characteristics of the baby to evaluate its overall health. These include: fetal movement, fetal tone, breathing movements, and the amniotic fluid volume. Amniotic fluid volume is important because a decreased amount raises the possibility that the baby may be under stress. The five components of the test (NST is also included) are each given a score of 2 for normal (or present), 1 if decreased, and 0 for abnormal. The highest possible score is 10. The "modified" biophysical profile is another option; this includes only the NST and amniotic fluid volume.

CST

The CST is like the NST, except that the fetus is evaluated in response to contractions of the mother's uterus. Because it is a more complicated test, it is often used after an abnormal NST to confirm the results. Uterine contractions produce "stress" in the fetus because they temporarily stop the flow of blood and oxygen. The CST is used to confirm that the fetus does not respond to this stress by a decrease in the heart rate.

The CST is performed with the same equipment as the NST. Maternal blood pressure and fetal heart rate are recorded along with the onset, relative intensity, and duration of any spontaneous contractions. For an accurate test, the contractions should be of sufficient duration and frequency. If uterine activity does not occur naturally, a drug called oxytocin may be given to the mother intravenously (hence the test's alternate name, the oxytocin challenge test) to provoke contractions. Another option is self-stimulation of the mother's nipples, because this releases natural oxytocin. The fetal heart rate is observed until, ideally, three moderate contractions occur within 10 minutes.

Preparation

The mother should eat just before the antepartum tests to help stimulate fetal activity.

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Risks

There are no appreciable risks from the NST or the biophysical profile. Ultrasound used for the biophysical profile is painless and safe because it uses no harmful radiation, and no evidence has been found that sound waves cause any adverse effects on the mother or fetus.

The frequency of antepartum testing depends on the reason for its use. All of the tests occasionally give incorrect results, which may prompt an unnecessary early delivery or cesarean. Repeat testing is important to double-check any abnormal findings.

Normal results

In general, "negative" or normal results on antepartum testing provide reassurance that the baby is healthy and should remain so with no need for immediate delivery. While unusual, false normal results can occur.

The NST is normal ("reactive") if two or more distinct fetal movements occur in association with appropriate accelerations of the fetal heart rate within 20 minutes. A biophysical profile score of 8-10 is considered reassuring. The CST is normal if the fetus shows no decelerations in heart rate in response to three uterine contractions within 10 minutes.

Abnormal results

A "positive" result suggests that the baby is not receiving enough oxygen for some reason. However, it is quite possible that the test result was falsely abnormal. To confirm or monitor a suspected disorder, follow-up testing with the same or an alternate test will probably be performed at least weekly.

The NST is abnormal ("nonreactive") if the fetal heart rate fails to speed up by at least 20 beats per minute at least two times during a 20-minute period. Abnormal decreases in the heart rate (decelerations) are also a cause for concern.

A biophysical profile score of 6 is considered a cause for concern and should be followed by further testing. Scores of 4 or less may require immediate delivery of the fetus.

Abnormal results on the CST include late decelerations, or abnormal slowing of the fetal heart rate after the uterine contractions. This can suggest that the baby is not receiving enough oxygen and may have difficulty withstanding the stress of labor and vaginal delivery. **Cesarean section** might be necessary to spare the baby the stress of labor. With either NST or CST, a severe deceleration (a period of very slow heartbeat) can also suggest fetal distress.

The ultimate outcome will depend on the woman's individual situation. In some cases, delivery can be postponed while medication is given to the mother or the fetus. Depending upon the readiness of the mother's cervix, the doctor may decide to induce labor. The large fetus of a diabetic woman may require cesarean delivery; severe **preeclampsia** also may necessitate **induction of labor** or cesarean section. The doctor will determine the most prudent course of action.

ORGANIZATIONS

American College of Obstetricians and Gynecologists (ACOG), PO Box 96920, Washington, DC, 20090-6920, (202) 638-5577, http://www.acog.org.

National Institute of Child Health and Human Development, Bldg 31, Room 2A32, MSC 2425, 31 Center Drive, Bethesda, MD, 20892-2425, (8666) 760-5947, (800) 370-2943, http://www.nichd.nih.gov.

Laura J. Ninger

Anthrax

Definition

Anthrax is an infection caused by the bacterium *Bacillus anthracis* that primarily affects livestock but that can occasionally spread to humans, affecting either the skin, intestines, or lungs. In humans, the infection can often be treated, but it is almost always fatal in animals.

Humans suffering from anthrax often develop ulcerating nodules on the body. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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KEY TERMS

Antibody—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

Antitoxin—An antibody that neutralizes a toxin.

Bronchitis—Inflammation of the mucous membrane of the bronchial tubes of the lung that can make it difficult to breathe.

Cutaneous—Pertaining to the skin

Meningitis—Inflammation of the membranes covering the brain and spinal cord called the meninges.

Pulmonary—Having to do with the lungs or respiratory system.

Spore—A dormant form assumed by some bacteria, such as anthrax, that enable the bacterium to survive high temperatures, dryness, and lack of nourishment for long periods of time. Under proper conditions, the spore may revert to the actively multiplying form of the bacteria.

Description

Anthrax is most often found in the agricultural areas of South and Central America, southern and eastern Europe, Asia, Africa, the Caribbean, and the Middle East. In the United States, anthrax is rarely reported; however, cases of animal infection with anthrax are most often reported in Texas, Louisiana, Mississippi, Oklahoma, and South Dakota. The bacterium and its associated disease get their name from the Greek word meaning "coal" because of the characteristic coal-black sore that is the hallmark of the most common form of the disease.

During the 1800s, in England and Germany, anthrax was known either as "wool-sorter's" or "rag-picker's" disease because workers contracted the disease from bacterial spores present on hides and in wool or fabric fibers. Spores are the small, thick-walled dormant stage of some bacteria that enable them to survive for long periods of time under adverse conditions. The first anthrax vaccine was perfected in 1881 by Louis Pasteur.

The largest outbreak ever recorded in the United States occurred in 1957 when nine employees of a goat hair processing plant became ill after handling a contaminated shipment from Pakistan. Four of the five patients with the pulmonary form of the disease died. Other cases appeared in the 1970s when contaminated goatskin drumheads from Haiti were brought into the U.S. as souvenirs.

Today, anthrax is rare, even among cattle, largely because of widespread animal **vaccination**. However, some serious epidemics continue to occur among animal herds and in human settlements in developing countries due to ineffective control programs. In humans, the disease is almost always an occupational hazard, contracted by those who handle animal hides (farmers, butchers, and veterinarians) or sort wool. There are no reports of the disease spreading from one person to another.

Anthrax as a weapon

There has been a great deal of recent concern that the bacteria that cause anthrax may be used as a type of biological warfare, since it is possible to become infected simply by inhaling the spores, and inhaled anthrax is the most serious form of the disease. The bacteria can be grown in laboratories, and with a great deal of expertise and special equipment, the bacteria can be altered to be usable as a weapon.

The largest-ever documented outbreak of human anthrax contracted through spore inhalation occurred in Russia in 1979, when anthrax spores were accidentally released from a military laboratory, causing a regional epidemic that killed 69 of its 77 victims. In the United States in 2001, terrorists converted anthrax spores into a powder that could be inhaled and mailed it to intended targets, including news agencies and prominent individuals in the federal government. Because the United States government considers anthrax to be of potential risk to soldiers, the Department of Defense has begun systematic vaccination of all military personnel against anthrax. For civilians in the United States, the government has instituted a program called the National Pharmaceutical Stockpile program in which **antibiotics** and other medical materials to treat two million people are located so that they could be received anywhere in the country within twelve hours following a disaster or terrorist attack.

Causes and symptoms

The naturally occurring bacterium *Bacillus anthracis* produces spores that can remain dormant for years in soil and on animal products, such as hides, wool, hair, or bones. The disease is often fatal to cattle, sheep, and goats, and their hides, wool, and bones are often heavily contaminated.

The bacteria are found in many types of soil, all over the world, and usually do not pose a problem for

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humans because the spores stay in the ground. In order to infect a human, the spores have to be released from the soil and must enter the body. They can enter the body through a cut in the skin, through consuming contaminated meat, or through inhaling the spores. Once the spores are in the body, and if antibiotics are not administered, the spores become bacteria that multiply and release a toxin that affects the immune system. In the inhaled form of the infection, the immune system can become overwhelmed and the body can go into **shock**.

Symptoms vary depending on how the disease was contracted, but the symptoms usually appear within one week of exposure.

Cutaneous anthrax

In humans, anthrax usually occurs when the spores enter a cut or abrasion, causing a skin (cutaneous) infection at the site. Cutaneous anthrax, as this infection is called, is the mildest and most common form of the disease. At first, the bacteria cause an itchy, raised area like an insect bite. Within one to two days, inflammation occurs around the raised area, and a blister forms around an area of dying tissue that becomes black in the center. Other symptoms may include shivering and chills. In most cases, the bacteria remain within the sore. If, however, they spread to the nearest lymph node (or, in rare cases, escape into the bloodstream), the bacteria can cause a form of blood poisoning that rapidly proves fatal.

Inhalation anthrax

Inhaling the bacterial spores can lead to a rare, often-fatal form of anthrax known as pulmonary or inhalation anthrax that attacks the lungs and sometimes spreads to the brain. Inhalation anthrax begins with flu-like symptoms, namely **fever**, **fatigue**, **headache**, muscle aches, and **shortness of breath**. As early as one day after these initial symptoms appear, and as long as two weeks later, the symptoms suddenly worsen and progress to **bronchitis**. The patient experiences difficulty breathing, and finally, the patient enters a state of shock. This rare form of anthrax is often fatal, even if treated within one or two days after the symptoms appear.

Intestinal anthrax

Intestinal anthrax is a rare, often-fatal form of the disease, caused by eating meat from an animal that died of anthrax. Intestinal anthrax causes stomach and intestinal inflammation and sores or lesions (ulcers), much like the sores that appear on the skin in the cutaneous form of anthrax. The first signs of the disease are **nausea and vomiting**, loss of appetite, and fever, followed by abdominal **pain**, **vomiting** of blood, and severe bloody **diarrhea**.

Diagnosis

Anthrax is diagnosed by detecting *B. anthracis* in samples taken from blood, spinal fluid, **skin lesions**, or respiratory secretions. The bacteria may be positively identified using biochemical methods or using a technique whereby, if present in the sample, the anthrax bacterium is made to fluoresce. Blood samples will also indicate elevated antibody levels or increased amounts of a protein produced directly in response to infection with the anthrax bacterium. Polymerase chain reaction (PCR) tests amplify trace amounts of DNA to show that the anthrax bacteria are present. Additional DNA-based tests are also currently being perfected.

Treatment

In the early stages, anthrax is curable by administering high doses of antibiotics, but in the advanced stages, it can be fatal. If anthrax is suspected, health care professionals may begin to treat the patient with antibiotics even before the diagnosis is confirmed because early intervention is essential. The antibiotics used include penicillin, doxycycline, and ciprofloxacin. Because inhaled spores can remain in the body for a long time, antibiotic treatment for inhalation anthrax should continue for 60 days. In the case of cutaneous anthrax, the infection may be cured following a single dose of antibiotic, but it is important to continue treatment so as to avoid potential serious complications, such as inflammation of the membranes covering the brain and spinal cord (**meningitis**). In the setting of potential bioterrorism, cutaneous anthrax should be treated with a 60-day dose of antibiotics.

Research is ongoing to develop new antibiotics and antitoxins that would work against the anthrax bacteria and the toxins they produce. One Harvard professor, Dr. R. John Collier, and his team have been testing two possible antitoxins on rats. A Stanford microbiologist and a Penn State chemist have also been testing their new antibiotic against the bacteria that cause **brucellosis** and **tularemia**, as well as the bacteria that cause anthrax. All of these drugs are still in early investigational stages, however, and it is still unknown how these drugs would affect humans.

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Prognosis

Untreated anthrax is often fatal, but **death** is far less likely with appropriate care. Ten to twenty percent of patients will die from anthrax of the skin (cutaneous anthrax) if it is not properly treated. All patients with inhalation (pulmonary) anthrax will die if untreated. Intestinal anthrax is fatal 25-75% of the time.

Prevention

Anthrax is relatively rare in the United States because of widespread animal vaccination and practices used to disinfect hides or other animal products. Anyone visiting a country where anthrax is common or where herd animals are not often vaccinated should avoid contact with livestock or animal products and avoid eating meat that has not been properly prepared and cooked.

Other means of preventing the spread of infection include carefully handling dead animals suspected of having the disease, burning (instead of burying) contaminated carcasses, and providing good ventilation when processing hides, fur, wool, or hair.

In the event that exposure to anthrax spores is known, such as in the aftermath of a terrorist attack, a course of antibiotics can prevent the disease from occurring.

In the case of contaminated mail, as was the case in the 2001 attacks, the U.S. postal service recommends certain precautions. These precautions include inspecting mail from an unknown sender for excessive tape, powder, uneven weight or lumpy spots, restrictive endorsements such as "Personal," or "Confidential," a postmark different from the sender's address, or a sender's address that seems false or that cannot be verified. Handwashing is also recommended after handling mail. In order to decontaminate batches of mail before being opened, machines that use bacteria-killing radiation could be used to sterilize the mail. These machines are similar to systems already in place on assembly lines for sterile products, such as **bandages** and medical devices, but this technique would not be practical for large quantities of mail. In addition, the radiation could damage some of the mail's contents, such as undeveloped photographic film. Microwave radiation or the heat from a clothes iron is not powerful enough to kill the anthrax bacteria.

For those in high-risk professions, an anthrax vaccine is available that is 93% effective in protecting against infection. To provide this immunity, an individual should be given an initial course of three injections, given two weeks apart, followed by booster injections at six, 12, and 18 months and an annual immunization thereafter.

Approximately 30% of those who have been vaccinated against anthrax may notice mild local reactions, such as tenderness at the injection site. Infrequently, there may be a severe local reaction with extensive swelling of the forearm, and a few vaccine recipients may have a more general flu-like reaction to the shot, including muscle and joint aches, headache, and fatigue. Reactions requiring hospitalization are very rare. However, this vaccine is only available to people who are at high risk, including veterinary and laboratory workers, livestock handlers, and military personnel. The vaccine is not recommended for people who have previously recovered from an anthrax infection or for pregnant women. Whether this vaccine would protect against anthrax used as a biological weapon is, as yet, unclear.

Resources

OTHER

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National Institute of Allergies and Infectious Diseases, 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-6612, (301) 496-5717, (301) 402-3573, (866) 284-4107, ocpostoffice@niaid.nih.gov, http://www.niaid.nih.gov.

World Health Organization (WHO), Avenue Appia 201211, Geneva, Switzerland, 27, 4122 791-2111, info@who.int, http://www.who.int.

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Antiacne drugs

Definition

Antiacne drugs are medicines that help clear up pimples, blackheads, whiteheads, pustules, cysts and more severe forms of **acne**.

Purpose

Acne is a skin condition that occurs when pores or hair follicles become blocked. This blockage allows a waxy material called sebum to collect inside the pores or follicles. Normally, sebum flows out onto the skin and hair to form a protective coating, but when it cannot get out, small swellings develop on the skin surface. Bacteria and dead skin cells can also collect and can cause inflammation. Swellings that are small and not inflamed are whiteheads or blackheads. Together these are known as comedones. When comedones become inflamed, they turn into pimples. Pimples that fill with pus are called pustules.

The severity of acne is often influenced by seasonal changes; it is typically less severe in summer than in winter. In addition, acne in girls is often affected by the menstrual cycle.

Different types of antiacne drugs are used for different purposes. For example, lotions, soaps, gels, and creams containing benzoyl peroxide or tretinoin may be used to clear up mild to moderately severe acne. Isotretinoin (Accutane) is prescribed only for very severe, disfiguring acne.

Acne cannot be cured, but acne drugs can help clear the skin. Benzoyl peroxide and tretinoin work by mildly irritating the skin. This encourages skin cells to slough off, which helps open blocked pores. Benzoyl peroxide also kills bacteria, which helps prevent whiteheads and blackheads from turning into pimples. Isotretinoin shrinks the glands that produce sebum.

Description

Benzoyl peroxide is found in many over-the-counter acne products that are applied to the skin, such as Benoxyl, Clear By Design, Neutrogena Acne, PanOxyl, and some formulations of Clean & Clear, Clearasil, and Oxy. Some benzoyl peroxide products are available without a physician's prescription; others require a prescription. Azelaic acid, an acid that occurs naturally in the skin, is also used in products that treat mild-to-moderate acne.

Tretinoin (Avita, Retin-A, Renova) is available only with a physician's prescription and comes in liquid, cream, and gel forms, which are applied to the skin. Other topical (applied to the skin) antiacne medications are adapalene (Differin) and tazarotene (Avage, Tazorac, Zorac). These are synthetic retinoids whose action is similar to that of tretinoin.

Some newer antiacne preparations combine benzoyl peroxide with **antibiotics**. One combination of benzoyl peroxide with clindamycin is sold under the trade name BenzaClin.

Isotretinoin (Accutane), which is taken by mouth in capsule form, is available only with a physician's prescription. This is a powerful drug with significant side effects. Only physicians who have experience in diagnosing and treating severe acne, such as dermatologists, should prescribe isotretinoin.

Many antiacne preparations contain compounds derived from plants that have anti-inflammatory properties. One group of researchers listed thirty-eight different plants that are beneficial in treating acne and other inflammatory skin conditions.

Antiacne drugs

Brand name (generic name)	Possible side effects
Accutane (isotretinoin)	Conjunctivitis, dry mouth, dry skin*
Benzamycin (erythromycin and benzoyl peroxide)	Dry and itchy skin
Cleocin T (clindamycin phosphate)	Dry skin
Desquam-E (benzoyl peroxide)	Itching, red and peeling skin
Erycette (erythromycin topical)	Burning, dry skin, hives, red and peeling skin
Minocin (minocycline hydrochloride)	Diarrhea, headache, hives, peeling skin, vomiting
Retin-A (tretinoin)	Blistering, crusted, or puffy skin; darkening of the skin
Sumycin (tetracycline)	Changes in skin color, sore mouth, upset stomach

*Note: Accutane has also been associated with more severe side effects, including depression, psychosis, and birth defects (when taken by pregnant women). For more information, visit the U.S. Food and Drug Administration Web site at: http://www.fda.gov.

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Recommended dosage

The recommended dosage depends on the type of antiacne drug. These drugs come with written directions for patients and should be used only as directed. Patients who have questions about how to use the medicine should check with a physician or pharmacist.

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KEY TERMS

Triglycerides—A type of fat found in the blood. High levels of triglycerides can increase the risk of coronary artery disease.

Patients who use isotretinoin usually take the medicine for a few months, and then stop for at least two months. Their acne may continue to improve even after they stop taking the drug. If the condition is still severe after several months of treatment and a two-month break, the physician may prescribe a second course of treatment.

Precautions

Isotretinoin

Isotretinoin can cause serious **birth defects**, including **mental retardation** and physical deformities. This medicine should not be used during **pregnancy**. Women who are able to bear children should not use isotretinoin unless they have very severe acne that has not cleared up with the use of other antiacne drugs. In that case, a woman who uses this drug must have a pregnancy test two weeks before beginning treatment and each month they are taking the drug. Another pregnancy test must be done one month after treatment ends. The woman must use an effective birth control method for one month before treatment begins and must continue using it throughout treatment and for one month after treatment ends. Women who are able to bear children and who want to use this medicine should discuss this information with their health care providers. Before using the medicine, they will be asked to sign a consent form stating that they understand the danger of taking isotretinoin during pregnancy and that they agree to use effective birth control.

Do not donate blood to a blood bank while taking isotretinoin or for 30 days after treatment with the drug ends. This will help reduce the chance of a pregnant woman receiving blood containing isotretinoin, which could cause birth defects.

Isotretinoin may cause a sudden decrease in night vision. If this happens, do not drive or do anything else that could be dangerous until vision returns to normal. Let the physician know about the problem promptly.

This drug may also make the eyes, nose, and mouth dry. Ask the physician about using special eye drops to relieve eye dryness. To temporarily relieve the **dry mouth**, chew sugarless gum, suck on sugarless candy or ice chips, or use saliva substitutes, which come in liquid and tablet forms and are available without a prescription. If the problem continues for more than two weeks, check with a physician or dentist. Mouth dryness that continues over a long time may contribute to **tooth decay** and other dental problems.

Isotretinoin may increase sensitivity to sunlight. Patients being treated with this drug should avoid exposure to the sun and should not use **tanning** beds, tanning booths, or sunlamps until they know how the drug affects them.

In the early stages of treatment with isotretinoin, some people's acne seems to get worse before it starts to improve. If the condition becomes much worse or if the skin is very irritated, check with the physician who prescribed the medicine.

Benzoyl peroxide and retinol-based antiacne medications

When applying antiacne drugs to the skin, be careful not to get the medicine in the eyes, mouth, or inside of the nose. Do not put the medicine on skin that is wind burned, sunburned, or irritated, and do not apply it to open **wounds**.

Because such antiacne drugs as benzoyl peroxide and retinol-based drugs irritate the skin slightly, avoid doing anything that might cause further irritation. Wash the face with mild soap and water only two or three times a day, unless the physician says to wash it more often. Avoid using abrasive soaps or cleansers and products that might dry the skin or make it peel, such as medicated cosmetics, cleansers that contain alcohol, or other acne products that contain resorcinol, sulfur or salicylic acid.

If benzoyl peroxide, tretinoin, adapalene, or tazarotene make the skin too red or too dry or cause too much peeling, check with a physician. Using the medicine less often or using a weaker strength may be necessary.

Tretinoin may increase sensitivity to sunlight. While being treated with this medicine, avoid exposure to the sun and do not use tanning beds, tanning booths, or sunlamps. If it is not possible to avoid being in the sun, use a sunscreen with a skin protection factor (SPF) of at least 15 or wear protective clothing over the treated areas. The skin may also become more sensitive to cold and wind. People who use this medicine should protect their skin from cold and wind until they know how the medicine affects them.

Benzoyl peroxide may discolor hair or colored fabrics.

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Special conditions

People who have other medical conditions and who are taking certain other drugs may have problems if they use antiacne drugs. Before using these products, be sure to let the physician know about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to etretinate, isotretinoin, tretinoin, vitamin A preparations, or benzoyl peroxide in the past should let his or her physician know before using an antiacne drug. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. Women who are pregnant or who may become pregnant should check with a physician before using tretinoin or benzoyl peroxide. *Isotretinoin causes birth defects in humans and must not be used during pregnancy*.

BREASTFEEDING. No problems have been reported in nursing babies whose mothers used tretinoin or benzoyl peroxide. Women who are **breastfeeding** babies should not take isotretinoin, however, as it may cause development problems in nursing babies.

OTHER MEDICAL CONDITIONS. Before using antiacne drugs applied to the skin, people with any of these medical problems should make sure their physicians are aware of their conditions:

- eczema. Antiacne drugs that are applied to the skin may make this condition worse.
- sunburn or raw skin. Antiacne drugs that are applied to the skin may increase the pain and irritation of these conditions.

In people with certain medical conditions, isotretinoin may increase the amount of triglyceride (a fatty-substance) in the blood. This may lead to heart or blood vessel problems. Before using isotretinoin, people with any of these medical problems should make sure their physicians are aware of their conditions:

- alcoholism or heavy drinking, now or in the past
- diabetes (or family history of diabetes). Isotretinoin may also change blood sugar levels.
- family history of high triglyceride levels in the blood
- severe weight problems.

Side effects

Isotretinoin

Minor discomforts such as dry mouth or nose, dry eyes, dry skin, or **itching** usually go away as the body adjusts to the drug and do not require medical attention unless they continue or are bothersome.

Other side effects should be brought to a physician's attention. These include:

- burning, redness, or itching of the eyes
- nosebleeds
- signs of inflammation of the lips, such as peeling, burning, redness or pain

Bowel inflammation is not a common side effect, but it may occur. If any of the following signs of bowel inflammation occur, stop taking isotretinoin immediately and check with a physician:

- pain in the abdomen
- bleeding from the rectum
- severe diarrhea

Benzoyl peroxide and retinol-based medicines

The most common side effects of antiacne drugs applied to the skin are slight redness, dryness, peeling, and stinging, and a warm feeling to the skin. These problems usually go away as the body adjusts to the drug and do not require medical treatment.

Other side effects should be brought to a physician's attention. Check with a physician as soon as possible if any of the following side effects occur:

- blistering, crusting or swelling of the skin
- severe burning or redness of the skin
- darkening or lightening of the skin. (This effect will eventually go away after treatment with an antiacne drug ends.)
- skin rash

Other side effects are possible with any type of antiacne drug. Anyone who has unusual symptoms while using antiacne drugs should get in touch with his or her physician.

Interactions

Using antiacne drugs with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Patients using antiacne drugs on their skin should tell their physicians if they are using any other prescription or nonprescription (over-the-counter) medicine that they apply to the skin in the same area.

Isotretinoin may interact with other medicines. When this happens, the effects of one or both drugs may change or the risk of side effects may be greater. Anyone who takes isotretinoin should let the physician

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know about all other prescription and non-prescription drugs, herbal remedies, and dietary supplements he or she is taking and should ask whether the possible interactions can interfere with drug therapy. Among the drugs that may interact with isotretinoin are:

- etretinate (Tegison), used to treat severe psoriasis. Using this medicine with isotretinoin increases side effects.
- tretinoin (Retin-A, Renova). Using this medicine with isotretinoin increases side effects.
- vitamin A or any medicine containing vitamin A. Using any vitamin A preparations with isotretinoin increases side effects. Do not take vitamin supplements containing vitamin A while taking isotretinoin.
- tetracyclines (used to treat infections). Using these medicines with isotretinoin increases the chance of swelling of the brain. Make sure the physician knows if tetracycline is being used to treat acne or another infection.

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ORGANIZATIONS

American Academy of Dermatology, PO Box 4014, Schaumburg, IL, 60168-4014, (847) 240-1859, (866) 503-SKIN (7546), http://www.aad.org.

American Society of Health-System Pharmacists (ASHP), 7272 Wisconsin Avenue, Bethesda, MD, 20814, (301) 657-3000, (866) 279-0681, http://www.ashp.org.

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Anti-aging diet

Definition

The anti-aging diet is one that restricts calorie intake by 30–50% of normal or recommended intake with the goal of increasing human lifespan by at least 30%. People on the diet also have improved health providing they consume adequate **vitamins**, **minerals**, and other essential nutrients.

Origins

The idea that a calorie-restrictive diet can significantly increase lifespan has been around since the 1930s. In 1935, Cornell University food researchers Clive McCay and Leonard Maynard published their first in a series of studies of experiments in which laboratory rats were fed a diet that contained one-third less calories (compared to a control group of rats) but still contained adequate amounts of vitamins, minerals, protein, and other essential nutrients. This calorie-restrictive diet provided much less energy than researchers had previously thought rats needed to maintain growth and normal activities. The rats on the lower calorie diet lived 30–40% longer than the rats on a normal calorie diet. Since then, more than 2,000 studies have been done, mostly on animals, about the connection between calorie restriction and increased longevity.

A reduced calorie diet was taken a step further by the University of California, Los Angeles, pathologist Roy Walford who studied the biology of **aging**. In 1986 he published *The 120-Year Diet* and a follow-up in 2000, *Beyond the 120-Year Diet* in which he argued that human longevity can be significantly increased by adhering to a strict diet that contains all the nutrients needed by humans but with about one-third the calories. In 1994 he co-authored *The Anti-Aging Plan: Strategies and Recipes for Extending Your Healthy Years*. His anti-aging plan is based on his own research and that of other scientists. Included is his study of diet and aging conducted as chief physician of the Biosphere 2 project in Arizona in the early 1990s. Walford was one of eight people sealed in Biosphere 2 from 1991 to 1993 in an attempt to prove that an artificial closed ecological system could sustain human life. He also co-founded the Calorie Restriction Society in 1994.

Description

Anti-aging **diets** are regimes that reduce the number of calories consumed by 30–50% while allowing

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KEY TERMS

Alzheimer's disease—A degenerative disorder that effects the brain, causing dementia and loss of memory usually late in life.

Antioxidant—Substance that inhibits the destructive effects of oxidation in the body.

Body mass index (BMI)—A scale that expresses a person's weight in relation to height.

Calorie reduction—A decrease in the number of calories that a person consumes.

Deoxyribonucleic acid (DNA)—A nucleic acid molecule in a twisted double strand, called a double helix, that is the major component of chromosomes. DNA carries genetic information and is the basis of life.

Free radicals—Highly reactive atoms or molecules that can damage DNA.

Osteoporosis—A disease that causes bones to become porous, break easily, and heal slowly.

Parkinson's disease—An incurable nervous disorder marked by symptoms of trembling hands and a slow, shuffling walk.

Testosterone—A male sex hormone responsible for secondary sex characteristics.

the necessary amounts of vitamins, minerals, and other nutrients the body needs to sustain itself and grow. This calorie restriction has been shown to increase the lifespan of various animals, including rats, fish, fruit flies, dogs, and monkeys, by 30–50%. Some human studies have also been done—and long-term studies are underway— but evidence of its impact on humans is very limited compared to results available from the animal studies. The completed studies indicate that calorie restriction can increase the maximum human lifespan by about 30%. The problem preventing scientists from offering substantive proof that humans can greatly increase their lifespan by restricting calories is that the current maximum human lifespan is 110–120 years and full compliance with the diet is difficult. A 30% increase would extend the human lifespan to 143–156. This is an exceptionally long time for a scientific study and requires involvement of several generations of scientists. Only several hundred people have ever been documented to lived past age 110 and there are only two people with confirmed documentation who have lived to at least age 120: Jeanne Louise Calmet (1875–1997) of France who lived 122 years and 164 days; and Shigechiyo Izumi (1865–1986) of Japan who lived 120 years and 237 days, according to *Guinness World Records*.

Since 1980, dozens of books have been published offering specific calorie reduction diets aimed at increasing lifespan. The most popular diets include the Okinawa Diet, Anti-Inflammation Diet, Longevity Diet, Blood Type Diet, Anti-Aging Plan, and the 120-Year Diet.

Calorie restriction is a lifelong approach to eating by significantly lowering daily calorie intake while still getting all the body's required nutrients. People who experience **starvation** or famine receive no longevity benefits since their low calorie intake contains little **nutrition**. The diet is believed to most benefit people who start in their mid-20s, with the beneficial effects decreasing proportionately with the age one begins the diet.

Although there are variations between anti-aging diets, most reduced calorie diets recommend a core set of foods. These include vegetables, fruits, fish, soy, low-fat or non-fat dairy products, nuts, avocados, and olive oil. The primary beverages recommended are water and green or black tea.

Guidelines on calorie reduction vary from diet to diet, ranging from a 10% reduction to a 50% reduction of normal intake. Roy L. Walford (1924–2004), author of several books on anti-aging diets, says a reasonable goal is to achieve a 10–25% reduction in a person's normal weight based on age, height, and body frame. The Anti-Aging Plan diet recommends men of normal weight lose up to 18% of their weight in the first six months of the diet. For a six-foot male weighing 175 lb, that means a loss of about 31 pounds. For a small-framed woman who is five-foot, six-inches tall and weighs 120 pounds, the plan recommends losing 10% of her weight in the first six months, a loss of 12 lb.

Walford's Anti-Aging Plan is a diet based on decades of animal experimentation. It consists of computer generated food combinations and meal menus containing all of the U.S. Department of Agriculture's Recommended Daily Allowances of vitamins and other essential nutrients using foods low in calories. On the diet, the maximum number of calories allowed is 1,800 per day. There are two methods for starting the diet: rapid orientation and gradual orientation.

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The rapid orientation method allows people to eat low calorie meals rich in nutrients. This is a radical change for most people and requires a good deal of willpower. All foods low in nutrients are eliminated from the diet. The nutritional value and calories in foods and meals is determined by a software program available for purchase from Walford's Calorie Restriction Society.

The gradual orientation method allows people to adopt the diet over time. The first week, people eat a high-nutrient meal on one day. This increases by one meal a week until participants are eating one meal high in nutrients every day at the end of seven weeks. Other meals during the day are low-calorie, healthy foods but there is no limit on the amount a person can eat. After two months, participants switch to eating low-calorie, high-nutrition foods for all meals.

On his Web site Walford states: "Going for longevity on the Anti-Aging Plan requires caloric limitation. We advise, however, that you view this as a lifestyle change and not a quick-fix program or a diet. Any person can physiologically adapt to this level of limitation and experience no physical hunger provided that nearly every calorie eaten is a nutrient-rich calorie."

A sample one-day low-calorie, high-nutrition menu developed by Walford is:

- Breakfast: One cup of orange juice, one poached egg, one slice of mixed whole-grain bread, and one cup of brewed coffee or tea.
- Lunch: One-half a cup of low-fat cottage cheese mixed with one-half a cup of non-fat yogurt and one tablespoon of toasted wheat germ, an apple, and one whole wheat English muffin.
- Dinner: Three ounces of roasted chicken breast without the skin, a baked potato, and one cup of steamed spinach.
- Snack: Five dates, an oat bran muffin, and one cup of low-fat milk.

The three meals and snack contain 1,472 calories, 92 g protein, 24 g fat, 234 g carbohydrates, 27 g fiber, and 310 g cholesterol.

Function

The goal of the anti-aging diet is to slow the aging process, thereby extending the human lifespan. Even though it is not a weight loss diet, people taking in significantly fewer calories than what is considered normal by nutritionists are likely to lose weight. **Exercise** is not part of calorie reduction diets. Researchers suggest people gradually transition to a reduced calorie diet over one or two years since a sudden calorie reduction can be unhealthy and even shorten the lifespan.

There is no clear answer as to why severely reducing calorie intake results in a longer and healthier life. Researchers have various explanations and many suggest it may be due to a combination of factors. One theory is that calorie restriction protects DNA from damage, increases the enzyme repair of damaged DNA, and reduces the potential of genes being altered to become cancerous. Other calorie reduction (CR) theories suggest:

- CR helps reduce the production of free radicals; unstable molecules that attack healthy, stable molecules. Damage caused by free radicals increases as people age.
- CR delays the age-related decline of the human immune system and improved immune function may slow aging.
- CR slows metabolism, the body's use of energy. Some scientists propose that the higher a person's metabolism, the faster they age.

Benefits

The primary benefits of the anti-aging diet are improved health and prevention or forestalling diseases such as heart disease, **cancer**, **stroke**, diabetes, **osteoporosis**, Alzheimer's, and Parkinson's. Studies show that most physiologic functions and mental abilities of animals on reduced calorie diets correspond to those of much younger animals. The diet has also demonstrated extension of the maximum lifespan for most life forms on which it has been tested.

Precautions

A reduced calorie diet is not recommended for people under the age of 21 since it may impair physical growth. This impairment has been seen in research on young laboratory animals. In humans, mental development and physical changes to the brain occur in teenagers and people in their early 20s that may be negatively affected by a low-calorie diet.

Other individuals advised against starting a calorie-restricted diet include women who plan on getting pregnant, women who are pregnant, and those who are nursing babies. A low body mass index (BMI), which occurs with a low-calorie diet, is a risk factor in **pregnancy** and can result in dysfunctional ovaries and **infertility**. A low BMI also can cause premature birth and low birth weights in newborns. People with existing medical conditions or diseases are discouraged from

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reduced calorie diets. They should be especially cautious and consult with their physician before starting.

It is imperative that participants ensure that they continue to consume adequate levels of essential nutrients. **Nutritional supplements** and other forms of nutritional help may be necessary.

Risks

There are a wide range of risks associated with an anti-aging, reduced calorie diet. These risks include physical, mental, social, and lifestyle issues.

- Hunger, food cravings, and obsession with food.
- Loss of strength or stamina and loss of muscle mass, which can affect physical activities, such as sports.
- Decreased levels of testosterone, which can be compensated with testosterone supplementation.
- Rapid weight loss (more than two pounds a week), which can negatively impact health
- Slower wound healing
- Reduced bone mass, which increases the risk of fracture
- Increased sensitivity to cold
- Reduced energy reserves and fatigue
- Menstrual irregularity
- Headaches
- Drastic appearance changes from loss of fat and muscle, causing people to look thin or anorexic

Social issues can arise over family meals, since not all family members may be on a reduced calorie diet. Conflict related to the types of food served, the amount of food served and the number of meals in a day, and **fasting** may develop. Other social issues involve eating in restaurants, workplace food, parties, and holidays. The long-term psychological effects of a reduced calorie diet are unknown. However, since a low calorie diet represents a major change in a person's life, psychological problems can be expected, including anorexia, binging, and obsessive thoughts about food and eating.

Research and general acceptance

An anti-aging diet that restricts calories may slow the aging of the heart and lengthen lifespan, according to a study by Washington University School of Medicine in St. Louis, Missouri. The small study, released in 2006, followed 25 people aged 41–65 who consumed only 1,400–2,000 calories a day for six years. Results of the study showed participants had heart functions that resembled people 15 years younger and their blood pressure was significantly lower than a control group who had a calorie intake of 2,000–3,000 per day, the amount of a normal Western diet.

A calorie-restrictive diet may reverse early stages of Parkinson's disease, according to a study released in 2005 by the Oregon Health and Science University and the Portland Veterans Affairs Medical Center in Portland, Oregon. Researchers said mice in the early stages of Parkinson's disease who had their calorie intake reduced by 50% had elevated levels of glutamate, an essential brain chemical that is lost due to Parkinson's disease. Results of this study are optimistic, but further research is necessary to prove any level of effectiveness in humans.

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American Aging Association, The Sally Balin Medical Center, 110 Chesley Drive, Media, PA, 19063, (610) 627-2626, http://www.americanaging.org.
American Dietetic Association, 120 South Riverside Plaza, Suite 2000, Chicago, IL, 60606-6995, (800) 877-1600, http://www.eatright.org.
Calorie Restriction Society, 187 Ocean Drive, Newport, NC, 28570, (800) 929-6511, http://www.calorierestriction.org.
National Institute on Aging, 31 Center Drive, MSC 2292, Building 31, Room 5C27, Bethesda, MD, 20892, (800) 222-2225, http://www.nia.nih.gov.

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Antiandrogen drugs

Definition

Androgens are male sex hormones. Antiandrogen drugs are a diverse group of drugs given to counteract the effects of androgens on various body organs and tissues. Some medications in this category work by lowering the body's production of androgens, while others work by blocking the body's ability to make use of the androgens that are produced. Antiandrogen drugs that reduce the body's ability to produce androgens include such medications as leuprolide (Lupron, Viadur, or Eligard), goserelin (Zoladex), triptorelin (Trelstar Depot), and abarelix (Plenaxis). Antiandrogen drugs that block the body's ability to use androgens include flutamide (Eulexin), nilutamide (Nilandron), cyproterone acetate (Cyprostat, Androcur, Cyproterone), and bicalutamide (Casodex). Flutamide, nilutamide, and bicalutamide are nonsteroidal antiandrogen drugs while cyproterone acetate is a steroidal medication.

Some drugs that were originally developed to treat other conditions are sometimes categorized as antiandrogens because of their off-label uses. These drugs include medroxyprogesterone (**Depo-Provera**), a derivative of the female sex hormone progesterone that is used as a contraceptive and treatment for abnormal uterine bleeding; ketoconazole (Nizoral), an antifungal drug; and spironolactone (Aldactone), a diuretic.

Purpose

Antiandrogen drugs may be given for any of several conditions or disorders, ranging from skin problems to mental disorders:

- Prostate cancer. Antiandrogen medications may be used to treat both early-stage and advanced prostate cancer by lowering or blocking the supply of male sex hormones that encourage the growth and spread of the cancer.
- Androgenetic alopecia. Androgenetic alopecia is a type of hair loss that is genetically determined and affects both men and women. It is sometimes called male pattern baldness.
- Acne. Acne is the result of several factors, one of which is excessive production of sebum, a whitish semi-liquid greasy substance produced by certain glands in the skin. Antiandrogens may help to clear acne by slowing down the secretion of sebum, which depends on androgen production.
- Amenorrhea. Amenorrhea, or the absence of menstrual periods in females of childbearing age, is sometimes caused by excessively high levels of androgens in the blood. Antiandrogen medications may help to restore normal menstrual periods.
- Hirsutism. Hirsutism is a condition in which women develop excessive facial and body hair in a distribution pattern usually associated with adult males. It results from abnormally high levels of androgens in the bloodstream or from increased sensitivity of the hair follicles to normal levels of androgens. Hirsutism may be a sign of polycystic ovary syndrome (PCOS), a condition in which the ovaries develop multiple large cysts and produce too much androgen.
- Gender reassignment. Antiandrogen drugs are often prescribed for male-to-female (MTF) transsexuals as part of the hormonal treatment that precedes gender reassignment surgery.
- Paraphilias. Paraphilias are a group of mental disorders characterized by intense and recurrent sexual urges or behaviors involving nonhuman objects, children, nonconsenting adults, and/or pain and humiliation. Antiandrogen drugs have been prescribed for men diagnosed with paraphilias in order to lower blood serum levels of testosterone and help them control their sexual urges.
- Virilization. Virilization is an extreme form of excessive androgen production (hyperandrogenism) in females, marked by such changes as development of male pattern baldness, voice changes, and overdevelopment of the skeletal muscles. Antiandrogens may be given to correct this condition.

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Description

Androgens affect many different tissues in the body so antiandrogen drugs are prescribed to treat diverse conditions. Antiandrogen drugs are not interchangeable. A specific antiandrogen may work well to treat one type of androgen-related medical condition while working poorly to treat another.

U.S. brand names

In the United States there are several commonly prescribed antiandrogens:

- Leuprolide (Lupron, Eligard) is classified as a luteinizing hormone-releasing hormone (LHRH) agonist, which means that it resembles a chemical produced by the hypothalamus (a gland located in the brain) that lowers the level of testosterone in the bloodstream. It also reduces levels of estrogen in girls and women and may be used to treat endometriosis or tumors in the uterus. It has shown promise as a treatment for the paraphilias in juveniles and young adults.
- Goserelin (Zoladex) is also an LHRH agonist, and works in the same way as leuprolide.
- Triptorelin (Decapeptyl, Gonapeptyl) is an LHRH agonist, and works in the same way as leuprolide. It is not usually given to women.
- Abarelix (Plenaxis) works by blocking hormone receptors in the pituitary gland. It is recommended for the treatment of prostate cancer in men with advanced disease who refuse surgery, cannot take other hormonal treatments, or are poor candidates for surgery.
- Ketoconazole (Nizoral) is an antifungal drug available in tablets to be taken by mouth. Its use in treating hirsutism is off-label.
- Flutamide (Eulexin) is a nonsteroidal antiandrogen medication that blocks the use of androgen by the body.
- Nilutamide (Nilsnfton) is another nonsteroidal antiandrogen drug that works by blocking the body's use of androgens.
- Bicalutamide (Casodex) is a nonsteroidal antiandrogen medication that works in the same way as flutamide. It is used to treat prostate cancer.
- Cyproterone acetate (Androcur, Climen, Diane 35, Ginette 35) is a steroidal antiandrogen drug that works by lowering testosterone production as well as blocking the body's use of androgens.
- Medroxyprogesterone (Provera, Farlutal Provera, Cycrin, Amen) is a synthetic derivative of progesterone that prevents ovulation and keeps the lining of the uterus from breaking down, thus preventing uterine bleeding.
- Spironolactone (Aldactone, Spiritone) is a potassium-sparing diuretic that may be given to treat androgen excess in women.

KEY TERMS

Off-label use—Drugs in the United States are approved by the Food and Drug Administration (FDA) for specific uses based on the results of clinical trials. However, it is legal for physicians to administer these drugs for other uses. It is not legal for pharmaceutical companies to advertise drugs for off-label uses.

Prostate—A gland found only in men that surrounds the neck of the bladder and secretes fluid that when mixed with sperm becomes semen.

Canadian brand names

Canadian brand names for some antiandrogen drugs include:

- leuprolide—C-Eligard, Lupron, Lupron Depot
- ketoconazole—Apo-Ketoconazole, Ketoderm, Novo-Ketoconazole, Xolegel
- flutamide—Apo-Flutamide, Euflex, Nona-Flutamide, Eulexin
- nilutamide—Anadron
- bicalutamide—Apo-Bicalutamide, Casodex, Dom-Bicalutamide, Gen-Bicalutamide, Mylan-Bicalutamide, Novo-Bicalutamide, PHL-Bicalutamide, PMS-Bicalutamide, Pro-Bicalutamide, ratio-Bicalutamide, Sandoz-Bicalutamide, Zym-Bicalutamide
- medroxyprogesterone—Alti-MPA, Apo-Medroxy, Depo-Prevara, Depo-Provera, Gen-Medroxy, Novo-Medrone, Provera

Recommended dosage

Dosage recommendations are typically individualized and should be taken as prescribed by the physician.

- Leuprolide. Leuprolide is available in an injectable form and as an implant. The implant form, used to treat prostate cancer, contains 22.5 mg of leuprolide and is inserted under the skin every three months. This type of slow-release medication is called depot form. A longer-acting implant that lasts 12 months is also available. Injectable leuprolide is injected once a

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day in a 1-mg dose to treat prostate cancer. The dosage for endometriosis or uterine tumors is 3.75 mg injected into a muscle once a month for three to six months.

- Goserelin. Goserelin is implanted under the skin of the upper abdomen. The dosage for treating cancer of the prostate is one 3.6-mg implant every 28 days or one 10.8-mg implant every 12 weeks. For treating endometriosis, the dosage is one 3.6-mg implant every 28 days for six months.
- Triptorelin. Triptorelin is given as a long-lasting injection for treatment of prostate cancer or paraphilias. The usual dose for either condition is 3.75 mg, injected into a muscle once a month.
- Abarelix. Abarelix is given in 100-mg doses by deep injection into the muscles of the buttocks. It is given on days 1, 15, and 29 of treatment, then every four weeks for a total treatment duration of 12 weeks.
- Ketoconazole. For treatment of hirsutism, 400 mg by mouth once per day.
- Flutamide. Flutamide is available in capsule and tablet form. For treatment of prostate cancer, 250 mg by mouth three times a day. For virilization or hyperandrogenism in women, 250 mg by mouth three times a day. It should be used in women only when other treatments have proved ineffective.
- Nilutamide. To treat prostate cancer, nilutamide is taken in a single 300-mg daily dose by mouth for the first 30 days of therapy, then a single daily dose of 150 mg.
- Bicalutamide. Bicalutamide is taken by mouth in a single daily dose of 50 mg to treat prostate cancer.
- Cyproterone acetate. Cyproterone is taken by mouth three times a day in 100-mg doses to treat prostate cancer. The dose for treating hyperandrogenism or virilization in women is one 50-mg tablet by mouth each day for the first ten days of the menstrual cycle. Cyproterone acetate given to treat acne is usually given in the form of an oral contraceptive (Diane-35) that combines the drug (2 mg) with ethinyl estradiol (35 mg). Diane-35 is also taken as hormonal therapy by MTF transsexuals. The dose for treating paraphilias is 200–400 mg by injection in depot form every 1–2 weeks, or 50–200 mg by mouth daily.
- Medroxyprogesterone. For the treatment of paraphilias, given as an intramuscular 150-mg injection daily, weekly, or monthly, depending on the patient's serum testosterone levels, or as an oral dose of 100–400 mg daily. As hormonal therapy for MTF transsexuals, 10–40 mg per day. For polycystic ovary syndrome, 10 mg daily for 10 days.
- Spironolactone. For hyperandrogenism in women, 100–200 mg per day by mouth; for polycystic ovary syndrome, 50–200 mg per day. For the treatment of acne, 200 mg per day. For hormonal therapy for MTF transsexuals, 200–400 mg per day. A topical form of spironolactone is available for the treatment of androgenetic alopecia.

Precautions

Individuals being prescribed an antiandrogen drug should review all prescription, over-the-counter, and herbal medicines with the prescribing physician.

Pediatric

It is not recommended that children use antiandrogen drugs because they may interfere with proper growth and development. They should be prescribed only when other options are unavailable and the benefits would outweigh the associated side effects. Abarelix should definitely not be given to children because of the severity of this drug's possible side effects.

Pregnant or breastfeeding

Women who are or expect to become pregnant should not take antiandrogen drugs, as they can interfere with the development of the fetus. Women who must take antiandrogens should use methods of birth control that do not contain hormones.

Several of these medications are especially risky during **pregnancy**, including leuprolide, goserelin, flutamide, spironolactone, and cyproterone acetate, which has not been approved by the FDA for use in the United States, but is approved for use in Canada and the United Kingdom.

Other conditions and allergies

- Leuprolide. Leuprolide should not be used by patients diagnosed with spinal compression, or by patients allergic to the drug.
- Goserelin. Goserelin should not be used by patients known to be allergic to it. As with leuprolide, women taking goserelin should use methods of contraception that do not contain hormones.
- Triptorelin. Patients using triptorelin should see their doctor at regular intervals for monitoring of side effects.
- Abarelix. Abarelix should not be given to women. Because of the severity of this drug's possible side effects, doctors who prescribe it for men must be certified following successful completion of a safety program for its proper use.

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- Ketoconazole. Ketoconazole should not be given to alcoholic patients or those allergic to the drug. In addition, patients using ketoconazole should have their liver function monitored by their doctor.
- Flutamide. Patients taking flutamide should have their liver function monitored carefully. They should notify their doctor at once if they have pain in the upper right side of the abdomen or a yellowish discoloration of the eyes and skin, as these are signs of liver damage. In addition, patients using this drug should not discontinue taking it without telling their doctor.
- Nilutamide. This drug should not be given to patients who are allergic to it, have severe respiratory problems, or have been diagnosed with a liver disorder. Patients taking this drug should discontinue using alcoholic beverages while they are being treated with it.
- Bicalutamide. The precautions while using this drug are the same as those for flutamide.
- Cyproterone acetate. This drug has not been approved by the Food and Drug Administration (FDA) for use in the United States, but is approved for use in Canada and the United Kingdom. It should not be used during pregnancy or lactation, or by patients with liver disease. Men who are taking this drug for treatment of paraphilias should not use alcohol.
- Medroxyprogesterone. This drug should not be given to patients with a history of blood clot formation in their blood vessels. It should be used with caution in patients with asthma, seizure disorders, migraine headaches, liver or kidney disorders, or heart disease.
- Spironolactone. This drug should not be given to patients with overly high levels of potassium in the blood or to patients with liver disease or kidney failure. It should also not be given to pregnant or lactating women.

Side effects

Leuprolide and goserelin

When taking leuprolide or goserelin, men have reported side effects including pains in the chest, groin, or legs; hot flashes, loss of interest in sex, or **impotence**; bone **pain**; sleep disturbances; and mood changes. Women have reported **amenorrhea** or light and irregular menstrual periods; loss of bone density; mood changes; burning or **itching** sensations in the vagina; or pelvic pain. The side effects of goserelin may also include **nausea and vomiting**.

Triptorelin

Side effects of triptorelin include pain in the bladder, difficulty urinating, or bloody or cloudy urine; pain in the side or lower back; hot flashes or **headache**; loss of interest in sex or impotence; **vomiting** or **diarrhea**; unusual bleeding or bruising; pain at the injection site; unusual tiredness or sleep disturbances; and depression or rapid mood changes. It may also cause a temporary enlargement of the tumor. This is known as tumor flare.

Abarelix

Abarelix may cause immediate life-threatening allergic reactions following any dose. It may also cause a loss of bone mineral density, irregular heartbeat, hot flashes, sleep disturbances, or pain in the breasts and nipples. **Gynecomastia** has been reported in men.

Ketoconazole

The side effects of ketoconazole include nausea and vomiting, loss of appetite, abdominal pain, skin rash or itching, uterine bleeding, breast pain, hair loss, and loss of interest in sex. Men may experience gynecomastia and a decline in sperm production.

Flutamide, bicalutamide, nilutamide

Flutamide, bicalutamide, and nilutamide share the same side effects. These drugs have been reported to cause breast tenderness and gynecomastia in men. Other side effects include **fatigue**, nausea, flu-like symptoms, and runny nose; darkened urine; **indigestion**, **constipation**, diarrhea, or gas; bluish-colored or dry skin; **dizziness**; and liver damage. These side effects may be intensified in patients who smoke.

In addition, nilutamide may affect the ability of the eyes to adjust to sudden changes in light intensity or may make the eyes unusually sensitive to light. Another potential side effect is difficulty breathing; this is more likely to occur in Asian patients taking this drug than in Caucasians.

Cyproterone acetate

Cyproterone has been reported to cause gynecomastia and impotence in men as well as loss of interest in sex. Deep venous thrombosis, and possible damage to the cardiovascular system are also possible side effects.

Medroxyprogesterone

Side effects associated with medroxyprogesterone include high blood pressure, headache, nausea and

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vomiting, puffy skin (**edema**), and weight gain. Changes in menstrual flow, breakthrough bleeding, and sore or swollen breasts may also occur.

Spironolactone

Spironolactone may cause fatigue, headache, and drowsiness; abdominal cramps, nausea, vomiting, diarrhea, or loss of appetite; and skin **rashes** or itching. Gynecomastia and impotence have been reported in men.

Interactions

The effect of antiandrogen drugs may be increased or diminished when taken with other drugs and herbal remedies. A complete review of all medications (prescription, non-prescription, and herbal) should be done with a pharmacist or physician at the time the antiandrogen is prescribed.

The antiandrogens that have reported interactions with other medications are:

- abarelix: May interact with other medications that affect heart rhythm, including procainamide, amiodarone, sotalol, and dofetilde.
- ketoconazole: Interacts with a number of drugs, including rifampin, warfarin, phenytoin, antacids, cyclosporine, terfenadine, and astemizole. It may cause a sunburn-like skin reaction if used together with alcohol.
- flutamide: Intensifies the effects of warfarin (Coumadin) and other blood-thinning medications. It has also been reported to intensify the effects of phenytoin (Dilantin), a drug given to control seizures.
- nilutamide: reported interactions are the same as for flutamide; in addition, nilutamide has been reported to intensify the effects of theophylline (Theo-Dur), a drug given to treat asthma.
- bicalutamide: reported interactions are the same as for flutamide.
- cyproterone acetate: patients taking oral medications to control diabetes may require dosage adjustments while taking this drug.
- medroxyprogesterone: patients taking phenobarbital, phenothiazine tranquilizers (chlorpromazine, perphenazine, fluphenazine, etc.), or oral medications to control diabetes should consult their doctor about dosage adjustments.
- spironolactone: Decreases the effectiveness of aspirin and anticoagulants (blood thinners). It may also interact with potassium supplements to increase the patient's blood potassium level.

Resources

PERIODICALS

Rathnayake, D., and R. Sinclair. "Innovative Use of Spironolactone as an Antiandrogen in the Treatment of Female Pattern Hair Loss." *Dermatologic Clinics* 28, no. 3 (July 2010): 611–8.

Sharifi, N. "New Agents and Strategies for the Hormonal Treatment of Castration-Resistant Prostate Cancer." *Expert Opinion on Investigational Drugs* 19, no. 7 (July 2010): 837–47.

Thibeau, F., et al. "The World Federation of Societies of Biological Psychiatry (WFSBP) Guidelines for the Biological Treatment of Papaphilias." *World Journal of Biological Psychiatry* (June 2010): 604–55.

ORGANIZATIONS

American Academy of Dermatology (AAD), P.O. Box 4014, Schaumburg, IL, 60168 (866) 503-SKIN (7546) (847) 240-1859, http://www.aad.org.

American Association of Clinical Endocrinologists (AACE), 245 Riverside Ave, Suite 200, Jacksonville, FL, 32202 (904) 353-7878, http://www.aace.com.

National Cancer Institute Public Inquiries Office, 6116 Executive Boulevard, Room 3036A, Bethesda, MD, 20892-8322 (800) 4-CANCER, http://www. cancer.gov.

World Professional Association for Transgender Health (WPATH), 1300 South Second Street, Suite 180, Minneapolis, MN, 55454 (612) 624-9397 (612) 624-9541, http://www.wpath.org.

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Antianemia drugs

Definition

Antianemia drugs are therapeutic agents that increase either the number of red cells or the amount of hemoglobin in the blood.

Purpose

Anemia is a general term for a large number of conditions marked by a reduction in the amount of oxygen the blood can carry. Red blood cells carry oxygen in hemoglobin, so that anemia may be caused by a deficiency of blood or red blood cells or of hemoglobin. These conditions may be caused by a variety of other conditions.

- Injury can cause significant blood loss, which in turn can cause anemia.

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- Nutritional deficiency resulting in inadequate amounts of the vitamins and minerals such as iron that are needed for hemoglobin production.
- Infections and kidney disease, in which there is a deficiency of erythropoietin, a material produced in the kidneys that is essential for the production of red blood cells.
- Certain genetic conditions affect the absorption of nutrients and may lead to anemia. In sickle cell anemia, a genetic condition in which the red cells are curved rather than flat, the red cells have reduced ability to carry oxygen.

The *Merck Manual* reduces all types of anemia to three classes:

- blood loss
- inadequate production of blood
- excessive breakdown of blood cells

Anemia may be caused by one or a combination of these three factors. Drug therapy is available for many types of anemia; however, the selection of the drug depends on proper diagnosis of the cause of the anemia.

Description

U.S. brand names

Brand names for some antianemia drugs sold in the United States include:

- ferrous sulfate: Feosol, Fer-In-Sol, Fer-Iron, Slow-Fe
- ferrous gluconate: Fergon, Simron
- folic acid: Folacin
- cyanocobalamin: Nascobal
- hydroxocobalamin: Hydrobexan, Hydroxo-12, LA-12
- oxymetholone: Anadrol-50
- epoetin alfa: Epogen, Procrit
- darbepoetin alfa: Aranesp

Canadian brand names

Brand names for some antianemia drugs sold in Canada include:

- ferrous sulfate: Novoferrosulfa
- ferrous gluconate: Fertinic, Novoferrogluc
- folic acid: Apo-Folic, Novofolacid
- cyancobalamin: Anacobin, Bedoz, Rubion
- epoetin alfa: Eprex

Anemia caused by blood loss is normally treated with either blood volume expanders such as plasma or with related blood products. More severe blood loss may require transfusions of red blood cells.

In some cases, blood loss may be due to ulcers of the stomach or intestines. In these cases, treatment of the underlying cause will normally correct the anemia.

Iron deficiency

The most common cause of anemia in adults is iron deficiency. Although the typical American diet contains enough iron to meet normal needs, individuals who are less able to absorb and store iron may not make enough hemoglobin. Although the best way to meet daily iron requirements is through improved diet, iron supplements are widely available.

Iron is normally taken in the form of ferrous sulfate. Other iron salts are commercially available and make claims of fewer or less severe side effects, but these benefits may be related to the fact that other preparations contain less iron by weight. Ferrous sulfate contains about 37% iron, while ferrous gluconate contains only about 13% iron. People who have trouble with the side effects of ferrous sulfate may benefit from specialty preparations available; however, ferrous sulfate normally offers the greatest amount of iron of all commercial products.

Folic acid

Folic acid is found in many common foods, including liver, dried peas, lentils, oranges, wholewheat products, asparagus, beets, broccoli, Brussels sprouts, and spinach. Some people have difficulty absorbing folic acid or in converting it from the form found in foods to the form that is active in blood formation. In these cases, folic acid tablets are appropriate for use. Folic acid supplements are routinely given to pregnant women because it is necessary for the proper development of the fetus's nervous system.

Vitamin B_{12}

Vitamin B_{12} is also known as cyanocobalamine and hydroxocobalamine. Cyanocobalamine may be given by mouth, while hydroxocobalamine must be injected. The vitamin has many functions in the body, including maintaining the nervous system. In treatment of anemia B_{12} is needed for the metabolism of folic acid. Lack of B_{12} causes **pernicious anemia**, a type of anemia marked by a low red cell count and lack of hemoglobin. There are many other symptoms of pernicious anemia, including a feeling of **tingling** or **numbness**, **shortness of breath**, muscle weakness, faintness, and a smooth tongue. If pernicious anemia

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KEY TERMS

Anabolic steroid—Drugs derived from the male sex hormones that increase the rate of tissue growth. They are best known for increasing the rate of muscle development.

Anemia—Any condition in which the amount of hemoglobin in red cells, the number of red cells, or the size of the red cells in blood is reduced from the normal amount.

Crohn's disease—Chronic inflammation of the intestine.

Hemochromatosis—A disorder of iron metabolism characterized by excessive absorption of iron from food.

Hemoglobin—The iron-containing protein in the blood that transports oxygen from the lungs to all parts of the body.

Hemolytic anemia—A type of anemia marked by the breakdown of red blood cells causing the release of hemoglobin.

Off-label use—Drugs in the United States are approved by the Food and Drug Administration (FDA) for specific uses based on the results of clinical trials. However, it is legal for physicians to administer these drugs for other uses not specified. It is not legal for pharmaceutical companies to advertise drugs for off-label uses.

Sickle cell anemia—An inherited condition, marked by crescent-shaped red blood cells and red cell breakdown.

is left untreated for more than three months, permanent damage to the nerves of the spinal cord may result.

Anabolic steroids

The anabolic **steroids** (nandrolone, oxymetholone, oxandrolone, and stanzolol) are the same drugs that are used improperly by body builders and other athletes to increase muscle mass. Two of these drugs, nandrolone and oxymetholone, are approved for use in treatment of anemia. Nandrolone is indicated for treatment of anemia caused by kidney failure, while oxymetholone may be used to treat anemia caused by insufficient red cell production, such as **aplastic anemia**.

All anabolic steroids are considered to be drugs of abuse under U.S. federal law.

Erythropoiesis-stimulating agents

Erythropoiesis-stimulating agents (ESAs) are synthetic versions of the naturally occurring protein erythropoietin, which is made in the kidney. This protein stimulates the bone marrow to produce more red blood cells. This process takes about two weeks. ESAs include epoetin alfa (Epogen, Procrit) and darbepoetin alfa (Aranesp). Darbepoetin alpha has the same properties, but it remains active longer and requires fewer injections each week. These drugs have significant negative cardiovascular side effects and should be used only under very limited conditions. In 2007, the U.S. Food and Drug Administration (FDA) reviewed these side effects and required changes in the labeling of all ESAs to reflect these side effects and warned against off-label use.

ESAs are approved by the FDA for the following uses:

- anemia associated with chronic kidney (renal) failure
- anemia related to zidovudine (AZT) therapy in HIV-infected patients
- anemia in some cancer patients with metastatic disease who are receiving treatment with chemotherapy
- prior to surgery for certain patients who are expected to need blood transfusions and who do not want to make a presurgical donation of their blood

ESAs have been abused by athletes due to the theory that increasing the red blood cell count improves athletic performance. The potential benefits of misuse of the drug are limited, and the risks are significant. The United States and International Olympic Committees (IOC) and the National Collegiate Athletic Association (NCAA) consider the use of ESAs, sometimes called blood doping, to enhance athletic potential inappropriate and unacceptable because its use by athletes is contrary to the rules and ethical principles of athletic competition. Reliable tests are available to detect ESA use by athletes.

Recommended dosage

Iron supplements

Dosage should be calculated by iron needs based on the results of laboratory tests. Manufacturers recommend one tablet a day, containing 65 mg of iron, as a supplement for patients over the age of 12 years.

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Folic acid

For treatment of anemia, a daily dose of 1 mg is generally used. Patients who have trouble absorbing folic acid may require higher doses.

Maintenance doses are:

- infants: 0.1 mg/day
- children (under 4 years of age): up to 0.3 mg/day
- children (over 4 years of age) and adults: 0.4 mg/day
- pregnant and lactating women: 0.8 mg/day

Vitamin B_{12}

While vitamin B_{12} can be given by mouth for mild vitamin deficiency states, pernicious anemia should always be treated with injections, either under the skin (subcutaneous) or into muscle (intramuscular). Hydroxocobalamine should only be injected into muscle. Intravenous injections are not used because the vitamin is eliminated from the body too quickly when given this way. Elderly patients, whose ability to absorb vitamin B_{12} through the stomach may be impaired, should also be treated with injections only.

The normal dose of cyanocobalamine is 100 mcg (micrograms) daily for six to seven days. If improvement is seen, the dose may be reduced to 100 mcg every other day for seven doses and then 100 mcg every three to four days for two to three weeks. After that, monthly injections may be required for life.

Anabolic steroids

The dosage of oxymetholone must be individualized. The most common dose is 1–2 mg per kilogram of body weight per day, although doses as high as 5 mg/kg per day have been used. The response to these drugs is slow, and it may take several months to notice any benefit.

Erythropoiesis-stimulating agents

Dosing schedules of ESAs vary with the cause of the anemia. All doses should be individualized and the minimum amount of drug should be used to achieve the desired results. The dose should be reduced if the hemoglobin level reaches 10–12 g/dL or if the hemoglobin level increases by more than 1 g/dL in any two-week period. The drug should be temporarily stopped if hemoglobin levels exceed 12 g/dL.

Maintenance doses, if required, should be individualized to keep the hemoglobin levels within the range of 10 to 12 g/dL.

Precautions

Iron can lead to fatal **poisoning** in children. All iron supplements should be kept carefully out of reach of children.

Iron supplements

Some types of anemia do not respond to iron therapy, and the use of iron should be avoided in these cases. People with acquired **hemolytic anemia**, autoimmune hemolytic anemia, **hemochromatosis**, hemolytic anemia, and hemosiderosis should not take iron supplements. Hemolytic anemia is caused by the increased breakdown of red blood cells. Hemochromatosis and hemosiderosis are conditions in which there is too much, rather than too little, absorption of iron.

Iron supplements should also be avoided by people who have gastric or intestinal ulcers, ulcerative **colitis**, or **Crohn's disease**. These conditions are marked by inflammation of the digestive tract and are made worse by use of iron.

Folic acid

Before treating an anemia with folic acid, diagnostic tests must be performed to verify the cause of the anemia. Pernicious anemia caused by lack of vitamin B_{12} shows symptoms that are very similar to those of folic acid deficiency but also causes nerve damage that shows up as a tingling sensation and feelings of numbness. Giving folic acid to patients with B_{12} deficiency anemia improves the blood cell count, but the nerve damage continues to progress.

Vitamin B_{12}

Although vitamin B_{12} has a very high level of safety, commercial preparations may contain preservatives that may cause allergic responses.

In patients with pernicious anemia, treatment with vitamin B_{12} may lead to loss of potassium. Patients should be monitored for their potassium levels.

Anabolic steroids

All anabolic steroids are dangerous. The following warnings represent the most significant hazards of these drugs. For a complete list, patients should consult the manufacturer's package insert.

- Peliosis hepatitis, a condition in which liver and sometimes spleen tissue is replaced with blood-filled cysts, has occurred in patients receiving androgenic anabolic steroids. Although this condition is usually

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reversible by discontinuing the drug, if it is left undetected and untreated, it may lead to life-threatening liver failure or bleeding.

- Liver tumors may develop. Although most of these tumors are benign and will go away when the drug is discontinued, liver cancers may result.
- Anabolic steroids may cause changes in blood lipids, leading to atherosclerosis with greatly increased risk of heart attack.
- Masculinization may occur when used by women because anabolic steroids are derived from male sex hormones.
- Elderly men who use these drugs may be at increased risk of prostate enlargement and prostate cancer.
- Increased water retention due to anabolic steroids may lead to heart failure.
- Anabolic steroids should not be used during pregnancy, since this may cause masculinization of the fetus.
- Anabolic steroids should be used in children only if there is no possible alternative. These drugs may cause the long bones of the legs to stop growing prematurely, leading to reduction in adult height. Regular monitoring is essential.
- In patients with epilepsy, the frequency of seizures may be increased.
- In patients with diabetes, glucose tolerance may be altered. Careful monitoring is essential.

Erythropoiesis-stimulating agents

ESAs should be used only when the benefits clearly outweigh the risks. Risks include an increased likelihood of fatal and nonfatal **heart attack**, **stroke**, **heart failure**, and **blood clots**. In **cancer** patients, tumors have been found to grow faster and survival times to be shortened in people receiving ESAs. Anyone who may need an ESA should check with their physician for the latest information concerning the risks and benefits of using these drugs.

Side effects

Iron supplements

The most common side effects of iron consumption are stomach and intestinal problems, including stomach upset with cramps, **constipation**, **diarrhea**, **nausea**, and **vomiting**. At least 25% of patients have one or more of these side effects. The frequency and severity of the side effects increases with the dose of iron. Less frequent side effects include **heartburn** and urine discoloration.

Folic acid

Folic acid is considered extremely safe, and there are no predictable side effects. Where side effects have been reported, they have been among patients taking many times more than the normal therapeutic dose of the drug.

On rare occasions allergic reactions to folic acid have been reported.

Vitamin B_{12}

Diarrhea and **itching** of the skin have been reported on rare occasions. Moreover, there have been reports of severe allergic reactions to cyanocobalamine.

Anabolic steroids

The list of side effects associated with anabolic steroids is extremely long. The following list covers only the most commonly observed effects:

- acne
- increased urinary frequency
- breast growth in males
- breast pain
- persistent, painful erections
- masculinization in women

Erythropoiesis-stimulating agents

In addition to the serious cardiovascular and tumor-enhancing side effects, other common adverse effects of ESAs are:

- joint pain
- chest pain
- diarrhea
- swelling
- fatigue
- fever
- weakness
- headache
- high blood pressure
- irritation at injection site
- nausea
- vomiting
- rapid heartbeat

A large number of additional adverse effects have been reported. Patients should consult the manufacturer's package insert for the full list.

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Interactions

Iron supplements

Iron supplements should not be taken at the same time as **antibiotics** of either the tetracycline or quinolone types. The iron will reduce the effectiveness of the antibiotic. Iron supplements also reduce the effectiveness of levodopa, which is used in treatment of Parkinson's disease.

Iron supplements should not be used with magnesium trisilicate, an antacid, or with penicillamine, which is used for some types of arthritis.

Taking iron with vitamin C increases the absorption of iron, with no increase in side effects.

Folic acid

Phenytoins, used to treat seizure disorders, interact with folic acid to reduce the effectiveness of phenytoin and increase the risk of seizures. If the two drugs must be used together, phenytoin blood levels should be monitored, and the dose may have to be increased.

Trimethoprim (an antibacterial) and methotrexate (originally an anti-cancer drug, which is also used for arthritis and **psoriasis**) act by reducing the metabolism of folic acid. Regular blood monitoring is required, and dose adjustments may be needed.

Vitamin B_{12}

Aminosalicylic acid, used to treat **tuberculosis**, may reduce the effectiveness of vitamin B_{12}. Also, colchicine, a drug used for **gout**, may reduce the effectiveness of vitamin B_{12}. Other infrequently used drugs or excessive use of alcohol may affect the efficacy of vitamin B_{12}. Patients being treated for anemia should discuss with their physician or pharmacist all medications (prescription and nonprescription) and herbal or dietary supplements they are using.

Anabolic steroids

Anabolic steroids should not be used in combination with anticoagulants such as warfarin (Coumadin). Anabolic steroids increase the effects of the anticoagulant, possibly leading to bleeding. If the combination cannot be avoided, careful monitoring is essential.

Erythropoiesis-stimulating agents

According to the manufacturer, ESAs have no significant interaction potential with other drugs.

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ORGANIZATIONS

American Society of Hematology, 2021 L St. NW, Suite 900, Washington, DC, 20036, (202) 776-0544, (202) 776-0545, http://www.hematology.org.

Iron Disorders Institute, P.O. Box 675, Taylors, SC, 29687, (864) 292-1175, (864) 292-1878, (888) 565-IRON (4766), http://www.irondisorders.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

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National Anemia Action Council, 555 E. Wells St., Suite 100, Milwaukee, WI, 53202 (414) 225-0318 (414) 276-3349, http://www.anemia.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105 (301) 592 8573, http://www.nhlbi.nih.gov.

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Antiangina drugs

Definition

Antiangina drugs are medicines that relieve the symptoms of **angina** pectoris (severe chest **pain**).

Purpose

The dull, tight chest pain of angina occurs when the heart's muscular wall is not getting enough oxygen. By relaxing the blood vessels, antiangina drugs reduce the heart's work load and increase the amount of oxygen-rich blood that reaches the heart. These drugs come in different forms, and are used in three main ways. They can be:

- taken regularly over a long period to reduce the number of angina attacks.
- taken just before some activity that usually brings on an attack, such as climbing stairs, to help prevent attacks.
- taken when an attack begins in order to relieve the pain and pressure.

Not every form of antiangina drug can be used in every way. Some work too slowly to prevent attacks that are about to begin or to relieve attacks that have already started. These forms can be used only to reduce the number of attacks. Sometimes two antiangina drugs are combined into one tablet. Be sure to understand how and when to use the type of antiangina drug that has been prescribed.

Description

Antiangina drugs, also known as nitrates, come in many different forms: tablets and capsules that are swallowed; tablets that are held under the tongue, inside the lip, or in the cheek until they dissolve; stick-on patches; ointment; and in-the-mouth sprays. Commonly used antiangina drugs include isosorbide dinitrate (Isordil, Sorbitrate, and other brands) and nitroglycerin (Nitro-Bid, Nitro-Dur, Nitrolingual Spray, Nitrostat Tablets, Transderm-Nitro, and other brands).

In 2006 the United States Food and Drug Administration (FDA) approved Randex (ranolazine) as the first new drug in ten years to treat chronic angina in patients who do not respond to other drugs. Ranexa affects electrical conduction in the heart. Its mechanism of action is different from that of other antiangian drugs All antiangina drugs are available only with a physician's prescription.

Antiangina drugs

Brand name (generic name)	Possible side effects
Adalat, Nifedical, Procardia (nifedipine)	Constipation, dizziness, heartburn, low blood pressure, moodiness, nausea, swelling
Aspirin (many brands available)	Increased bleeding risk when taken with anticoagulants, nausea, ulcers
Calan/Calan SR, Isoptin/Isoptin SR, Verelan (verapamil)	Constipation, dizziness, fatigue, fluid retention, headache, low blood pressure, nausea
Cardene/Cardene SR (nicardipine hydrochloride)	Dizziness, drowsiness, flushing, headache, indigestion, nausea, rapid heartbeat, swelling of feet
Cardizem, Cartia XT, Dilacor XR, Diltia XT, Tiazac (diltiazem)	Dizziness, fluid retention, headache, nausea, rash
Corgard, Corzide (nadolol)	Behavioral changes, dizziness, drowsiness, fatigue
Nitrocot, Nitrolingual, NitroMist, Nitroquick, Nitrostat, Nitrotab, Nitro-Time (nitroglycerin)	Dizziness, flushing, headache, lightheadedness
Imdur, Ismo, Monoket (isosorbide mononitrate)	Dizziness, headache, rash
Isordil (isosorbide dinitrate)	Dizziness, headache, low blood pressure
Lopressor, Toprol XL (metoprolol tartrate)	Depression, diarrhea, fatigue, heartburn, rash
Norvasc (amlodipine besylate)	Dizziness, fatigue, fluid retention, headache, palpitations
Ranexa (ranolazine)	Constipation, dizziness, dry mouth, nausea, seizures, swelling of the extremities, trembling, vomiting, weakness
Tenormin (atenolol)	Dizziness, fatigue, nausea, slowed heartbeat

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Recommended dosage

The recommended dosage depends on the type and form of antiangina drug and may be different for different patients. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

Always take antiangina drugs exactly as directed. The medicine will not work if it is not taken correctly.

Do not stop taking this medicine suddenly after taking it for several weeks or more, as this could cause angina attacks to return. If it is necessary to stop taking the drug, check with the physician who prescribed it for instructions on how to reduce the dosage gradually.

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KEY TERMS

Angina pectoris—A feeling of tightness, heaviness, or pain in the chest, caused by a lack of oxygen in the muscular wall of the heart.

Precautions

Remember that some forms of antiangina drugs work too slowly to relieve attacks that have already started. Check with the physician who prescribed the medicine for instructions on how to use the type that has been prescribed. Patients who are using slower-acting forms to make attacks less frequent may want to ask their physicians to prescribe a fast-acting type to relieve attacks. Another method of treating the frequency of attacks is to increase the dosage of the long-acting antiangina drug. Do this only with the approval of a physician.

These medicines make some people feel lightheaded, dizzy, or faint when they get up after sitting or lying down. To lessen the problem, get up gradually and hold onto something for support if possible. Antiangina drugs may also cause **dizziness**, lightheadedness, or **fainting** in hot weather or when people stand for a long time or **exercise**. Use caution in all these situations. Drinking alcohol while taking antiangina drugs may cause the same problems. Anyone who takes this medicine should limit the amount of alcohol consumed.

Because these drugs may cause dizziness, be careful when driving, using machines, or doing anything else that could be dangerous.

If the person is taking the form of nitroglycerin that is placed under the tongue and symptoms are not relieved within three doses taken about 5 minutes apart, the person should go to the hospital emergency room as soon as possible. A **heart attack** may be in progress.

Some people develop tolerance to antiangina drugs over time; that is, the prescribed dose of the drug no longer produces the desired effects. Anyone who seems to be developing a tolerance to this medicine should check with his or her physician.

Anyone who has had unusual reactions to antiangina drugs in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

Women who are pregnant or **breastfeeding** or who may become pregnant should check with their physicians before using antiangina drugs.

Older people may be especially sensitive to the effects of antiangina drugs and thus more likely to have side effects such as dizziness and lightheadedness.

Before using antiangina drugs, people with any of these medical problems should make sure their physicians are aware of their conditions:

- recent heart attack or stroke
- kidney disease
- liver disease
- severe anemia
- overactive thyroid
- glaucoma
- recent head injury

Side effects

A common side effect is a **headache** just after taking a dose of the medicine. These headaches usually become less noticeable as the body adjusts to the drug. Check with a physician if they are severe or they continue even after taking the medicine for a few weeks. Unless a physician says to do so, do not change the dose to avoid headaches. Other common side effects include dizziness, lightheadedness, fast pulse, flushed face and neck, **nausea** or **vomiting**, and restlessness. These problems do not need medical attention unless they do not go away or they interfere with normal activities.

Other side effects, including stomach upset and **constipation** may occur. Anyone who has unusual symptoms after taking an antiangina drug should get in touch with his or her physician.

Ranexa is used only when other **antianxiety drugs** do not control symptoms of chronic angina. This drug can have rare but serious side effects. Anyone taking the drug who experiences convulsions, swelling of the hands and feet, shaking or **tremors**, **shortness of breath**, or blood in the urine should seek medical care immediately as these are signs of an allergic reaction.

Interactions

Antiangina drugs may interact with other medicines. This may increase the risk of side effects or change the effects of one or both drugs. Anyone who takes antiangina drugs should let the physician know all other prescription and over-the counter medicines, herbal remedies, and dietary supplements that he or she is taking. Among the drugs that may interact with antiangina drugs are:

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- other heart medicines
- blood pressure medicines
- heart antiarrhythmia medications
- aspirin
- drugs for treating HIV infection
- alcohol
- ergot alkaloids used in migraine headaches
- certain antibiotics in the myocin family (Ranexa)

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American College of Cardiology, Heart House, 2400 N Street NW, Washington, DC, 20037, (202) 375-6000, http://www.acc.org.

American Heart Association, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, http://www.americanheart.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592 8573, http://www.nhlbi.nih.gov.

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Antiangiogenic therapy

Definition

Antiangiogenesis therapy is one of two classifications of drugs that restores health by controlling blood vessel growth. The other type of therapy is called proangiogenic therapy.

Purpose

Antiangiogenic therapy inhibits the growth of new blood vessels. New blood vessel growth plays a critical role in many disease conditions, including disorders that cause blindness, arthritis, and **cancer**. The beneficial effects of antiangiogenic drugs are exerted in a number of ways: by disabling the agents that activate and promote cell growth, or by directly blocking the growing blood vessel cells. The inhibitory properties of angiogenesis have been discovered in more than 300 substances, ranging from molecules produced naturally in animals and plants, such as green tea extract, to new chemicals synthesized in the laboratory. A number of medicines already approved by the U.S. Food and Drug Administration (FDA) have also been found to possess antiangiogenic properties.

There are several diseases that may benefit from antiangiogenic therapy:

- Eye disease—Excessive new blood vessels growing in the eye can cause vision loss and lead to blindness. Antiangiogenic treatments may prevent progressive loss of vision or even improve eyesight in patients.
- Arthritis—Blood vessels that invade the joint release enzymes that destroy cartilage and other tissues in arthritis. Antiangiogenic drugs may relieve the arthritic pain and prevent bone joint destruction caused by these pathological and destructive blood vessels.
- Cancer—Tumors develop a blood supply to obtain oxygen and nourishment for cancer cells. By cutting off tumor vasculature (the arrangement of blood vessels in the body or in a particular organ or tissue), antiangiogenesis therapies may literally starve tumors and prevent their growth and spread. Antiangiogenesis may also prove to be useful when combined with conventional chemotherapy or radiation therapy as part of a multimodal therapeutic approach to attack cancer using different strategies simultaneously.

Description

U.S. brand names

Brand names of drugs with antiangiogenic activity approved for use in the United States include:

- bevacizumab (Avastin)
- sorafenib (Nexavar)
- sunitinib (Sutent)
- thalidomide (Thalomid)
- erlotinib (Tarceva)

Canadian brand names

Drugs with antiangiogenic activity approved for use in Canada are the same as those used in the United States.

In the late 1990s, many medical researchers believed that antiangiogenesis was an incredible breakthrough in cancer treatment. It was safe and at first, apparently effective. But the clinical results soon

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KEY TERMS

Angiogenesis—The formation of new blood vessels, for example, as a result of a tumor.

Chemotherapy—The use of chemical agents to treat diseases, infections, or other disorders, especially cancer.

Endothelial—A layer of cells that lines the inside of certain body cavities, for example, blood vessels.

Epidermal—Referring to the thin outermost layer of the skin, itself made up of several layers, that covers and protects the underlying dermis (skin).

Fibroblast—A large flat cell that secretes the proteins that form collagen and elastic fibers and the substance between the cells of connective tissue.

Ischemic—An inadequate supply of blood to a part of the body, caused by partial or total blockage of an artery.

Ocular neovascularization—Abnormal or excessive formation of blood vessels in the eye.

Peripheral vascular disease—A disease affecting blood vessels, especially in the arms, legs, hands, and feet.

Vascular—Relating to blood vessels.

fell short of expectations. The tumors, it seemed, had found a way to circumvent even this most ingenious of treatment approaches. Despite the setbacks, angiogenesis remains a very tempting target, and researchers are exploring new agents and approaches to maximize the effects of antiangiogenic therapies.

Newer studies have demonstrated that in addition to differences in the regulation of new blood vessel formation in cancer compared with normal tissues, the actual blood vessels created in cancers are different from those created in normal tissues. These differences have allowed a number of antiangiogenic drugs to be developed that specifically damage tumor-associated blood vessels and not normal vessels. The goal of these drugs is to attack cancers by damaging their blood supply. Many antiangiogenic agents also appear to hasten the of tumor-associated blood vessels.

With the success of targeted agents such the antiangiogenic drug, Avastin, efforts are underway to widen and optimize the field of antiangiogenic agents. As oncology (the study of cancer) drug development accelerates, new indications are beginning to emerge for diseases such as ocular neovascularization and even **obesity**.

Antiangiogenic therapy offers a number of advantages over traditional therapies for cancer:

- Tumor cells often mutate and become resistant to chemotherapy. Because antiangiogenic drugs only target normal endothelial cells (a layer of cells that lines the inside of certain body cavities, such as blood vessels), these cells are less likely to develop acquired drug resistance.
- All tumors rely upon host vessels. Antiangiogenic agents are, therefore, theoretically effective against a broad range of cancers.
- Conventional chemotherapy and radiotherapy indiscriminately attacks all dividing cells in the body leading to side effects such as diarrhea, mouth ulcers, hair loss, and weakened immunity. Antiangiogenic drugs selectively target dividing blood vessels and cause fewer side effects.
- Antiangiogenic drugs are relatively nontoxic and work at levels well below the maximum tolerated dose, so may be given in lower doses over longer periods of time.
- Antiangiogenic treatment may take weeks or even months to exhibit its full beneficial effect, but this allows for continuous, chronic control of disease.
- Antiangiogenic drugs may also serve as a powerful supplement to traditional chemotherapy or radiation therapy.

Recommended dosage

The recommended dosage of bevacizumab varies with the type of cancer being treated. When used in the treatment of colorectal cancer, a typical dose is 5–10 mg per kilogram of body weight every two weeks administered intravenously in combination with a fluorouracil (5-FU) based **chemotherapy** regimen.

Precautions

Pregnant or breastfeeding

There have been no studies conducted related to the effects of angiogenesis inhibitors on pregnant women. However, these agents have been found to cause **birth defects** in animals. The development of blood vessels is critical to fetal development; therefore, angiogenesis inhibitors should not be taken during **pregnancy**. Women of child-bearing age who are prescribed these drugs should be counseled to use

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adequate contraceptive methods during their treatments and to delay pregnancy for at least six months after cessation of therapy since the drug may take as long as 100 days to be fully removed from the body. **Breastfeeding** is also not recommended for patients taking angiogenesis inhibitors. Breastfeeding should also be delayed for at least six months after the patient has stopped taking the drug.

The effects of angiogenesis inhibitors on the fertility of humans is not known. These drugs are known to disrupt the menstrual cycle and impair fertility in animals.

Other conditions and allergies

The use of the angiogenesis inhibitor bevacizumab (Avastin) can result in intestinal perforation and can cause **wounds** that have been sutured to break open, sometimes causing death. Intestinal perforation, sometimes associated with abscesses inside the abdomen, occurred throughout treatment in clinical trials with Avastin. Symptoms included abdominal **pain** associated with **constipation** and **vomiting**. Avastin therapy should be permanently discontinued in patients with intestinal perforation or wound breaks requiring medical intervention. Serious, and in some cases fatal, **hemoptysis** (coughing up of blood or mucus containing blood) has occurred in patients with **non-small cell lung cancer** treated with chemotherapy and Avastin.

Side effects

In general, research has found the side effects of antiangiogenesis agents to be mostly minimal. The side effects most likely to be associated with bevacizumab include:

- hypertension
- thromboembolic events
- venous thrombus/embolus
- delayed wound healing
- dizziness
- pain
- headache
- abdominal pain
- vomiting, anorexia, constipation, diarrhea, stomatitis
- weakness
- upper respiratory tract infection
- increased protein in the urine

Interactions

The manufacturer of bevacizumab is not reporting any significant interactions associated with the drug as of July 2010. There is the potential for bevacizumab to interact unfavorably with other drugs used to treat cancer. For example, bevacizumab may increase the cardiac toxicities associated with anthracyline chemotherapy agents. It may also increase the adverse/toxic effects of the drug irinotecan (Camptosar). Bevacizumab may interact with the drug sorafenib (Nexavar) to increase the likelihood of hand-foot skin reaction. Bevacizumab given concurrently with sunitinib (Sutent) increases the risk for microangiopathic **hemolytic anemia** and may increase the hypertensive effect of sunitinib.

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ORGANIZATIONS

The Angiogenesis Foundation, P.O. Box 382111, Cambridge, MA, 02238 (617) 576-5708 (617) 401-3782, patienthelp@angio.org, http://www.angio.org.

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Antianxiety drugs

Definition

Antianxiety drugs are medicines that calm and relax people with excessive **anxiety**, nervousness, or tension, or for short-term control of social phobia

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Antianxiety drugs

Brand name (generic name)	Possible side effects*
Atarax (hydroxyzine hydrochloride)	Chest congestion, headache, skin reddening
Ativan (lorazepam)	Diarrhea, restlessness, weakness
BuSpar, Buspirone (buspirone hydrochloride)	Constipation, insomnia, nervousness, numbness, vomiting
Librium, Libritabs (chlordiazepoxide)	Constipation, diarrhea, restlessness, weakness
Serax (oxazepam)	Decreased coordination, fainting, headache, liver problems, swelling, vertigo
Stelazine (trifluoperazine hydrochloride)	Abnormal glucose in urine, allergic reactions, blurred vision, constipation, eye spasms, fluid retention, swelling
Tranxene, Tranxene-SD (clorazepate dipotassium)	Confusion, decreased coordination, headache, nervousness, tremors
Valium (diazepam)	Blurred vision, constipation, restlessness, weakness
Xanax (alprazolam)	Change in libido, difficulty urinating, increased salivation, irritability, weight fluctuation

*Common side effects of all of these medications include changes in appetite, dizziness, drowsiness, dry mouth, fatigue, and upset stomach or nausea. Most of these drugs also share the other possible side effects listed.

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disorder, longer-term control of general anxiety disorder or another specific phobia.

Purpose

Antianxiety agents, also called anxiolytics, may be used to treat mild transient bouts of anxiety as well as more pronounced episodes of social phobia, general anxiety disorder, or another specific phobia. Many drugs that treat anxiety disorder are also used to treat **panic disorder** and post-traumatic stress syndrome. Some are also used to treat depression. Clinically significant anxiety, or general anxiety disorder, is marked by several symptoms such as marked or persistent fear of one or more social or performance situations in which he or she is exposed to unfamiliar people or possible scrutiny by others and may react in a humiliating or embarrassing way. The exposure to the feared situation produces an anxiety attack. Fear of these episodes of anxiety leads to avoidance behavior that interferes with normal social functioning, including working or attending classes. The patient is aware that these fears are unjustified.

Description

In psychiatric practice, treatment of anxiety has largely turned from traditional antianxiety agents to antidepressant therapies. In current use, the **benzodiazepines**, the best-known class of antianxiety drugs, have been largely supplanted by or supplemented by **selective serotonin reuptake inhibitors** (SSRIs), which are also used to treat major depression. Among the preferred SSRIs for **generalized anxiety disorder** are paroxetine (Paxil, Seroxat, Aropax, Deroxat, Rextin, Xetanor, Paroxat), escitalopram (Lexapro, Cipralex, Esertia), and venlafaxine (Effexor), which is not an SSRI, but is closely related to that class of drugs. Other SSRIs are fluoxetine (Prozac, Fontex, Seromex, Seronil, Fluctin, Fluox) and sertraline (Zoloft, Lustral, Serlan). Venlafaxine and paroxetine have been shown particularly effective in relieving symptoms of social anxiety.

Nevertheless, traditional antianxiety drugs remain useful for patients who need a rapid onset of action or whose frequency of exposure to anxiety provoking stimuli is low enough to eliminate the need for continued treatment. While SSRIs may require three to five weeks to show any effects and must be taken continuously, benzodiazepines such as Ativan, Centrax, Dalamane, Klonopin, Librium, Paxipan, Restoril, Serax, Tranxene, Valium, and Xanax, may produce a response within 30 minutes. These may be taken on an as-needed basis rather than continuously.

The intermediate action benzodiazepines, alprazolam (Xanax), and lorazepam (Ativan) often are the appropriate choice for treatment of mild anxiety and social phobia. Diazepam (Valium) is still widely used for anxiety, but its active metabolite, desmethyldiazepam, which has a long half-life, may make this a poorer choice than other drugs in its class. There is considerable variation among individuals in the metabolism of benzodiazepines, so patient response may not be predictable. As a class, benzodiazepines are used not only as to treat anxiety, but also as sedatives, **muscle relaxants**, and in treatment of **epilepsy** and **alcoholism**. The distinctions between these uses are largely determined by onset and duration of action and route of administration.

Buspirone (BuSpar), which is not chemically related to other classes of central nervous system (CNS) drugs, is also a traditional antianxiety drug, although it is now used most often either after the patient has failed to respond to treatment with SSRIs and benzodiazepines. It can also be used in conjunction with other antianxiety drugs. It is appropriate for

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KEY TERMS

Anxiety—Worry or tension in response to real or imagined stress, danger, or dreaded situations. Physical reactions, such as fast pulse, sweating, trembling, fatigue, and weakness may accompany anxiety.

Epilepsy—A brain disorder with symptoms that include seizures.

Glaucoma—An eye disorder caused by damage to the optic nerve resulting in vision loss. Glaucoma is usually accompanied by inflammation and increased pressure in the eye (intraocular pressure). There are several types that may develop suddenly or gradually.

Panic disorder—An disorder in which people have sudden and intense attacks of anxiety in certain situations. Symptoms such as shortness of breath, sweating, dizziness, chest pain, and extreme fear often accompany the attacks.

Phobia—An intense, abnormal, or illogical fear of something specific, such as heights or open spaces.

Pregnancy category B—Animal studies indicate no fetal risk, but no human studies, or adverse effects in animals, but not in well-controlled human studies.

Pregnancy category C—No adequate human or animal studies, or adverse fetal effects in animal studies, but no available human data.

Seizure—A sudden attack, spasm, or convulsion.

use in patients who have either failed trials of other treatments or who should not receive benzodiazepines because of a history of **substance abuse** problems. Buspirone, in common with antidepressants, requires a two to three week period before there is clinical evidence of improvement, and must be continuously dosed to maintain its effects. Benzodiazepines are controlled drugs under federal law and are subject to frequent abuse. Buspirone is not a controlled substance and has no established abuse potential.

Recommended dosage

Benzodiazepines should be administered 30 to 60 minutes before exposure to the anticipated stress. Dosage should be individualized to minimize **sedation**. The normal dose of alprazolam is 0.25–0.5 mg. The usual dose of lorazepam is 2–3 mg. Doses may be repeated if necessary.

Buspirone is initially dosed at 5 mg three times a day. Patients may be directed to increase the dosage 5 mg/day, at intervals of two to three days, as needed and should not exceed 60 mg/day. Two to three weeks may be required before a satisfactory response is seen.

Precautions

Benzodiazepines should not be used in patients with **psychosis**, acute narrow angle glaucoma, or **liver disease**. The drugs can act as respiratory depressants and should be avoided in patients with respiratory conditions. Benzodiazepines are potentially addictive and should not be administered to patients with substance abuse disorders. Because benzodiazepines are sedative, they should be avoided in patients who must remain alert. Their use for periods over four months has not been documented. These drugs should not be used during the second and third trimester of **pregnancy**, although use during the first trimester appears to be safe. They should not be taken while **breastfeeding**. Physicians and pharmacists should be consulted about use in children.

Buspirone is metabolized by the liver and excreted by the kidney, and should be used with care in patients with hepatic or renal disease. The drug is classified as schedule B during pregnancy, but should not be taken during breastfeeding. Its use in children under the age of 18 years has not been studied.

In October 2004, the United States Food and Drug Administration (FDA) issued a warning that treating children and adolescents with SSRIs increased the risk of suicidal thoughts and behaviors. In a review of 2,200 children treated with SSRIs, the FDA found no completed suicides, but did find a 4% increase in suicidal thinking or behavior, including **suicide** attempts. In 2006, this warning was extended to include all people under age 25. However, in April 2007, a comprehensive review of SSRI treatment in children, adolescents, and adults under age 25 that was published in the *Journal of the American Medical Society* indicated that the benefits of treating these patients with SSRIs generally outweighed the risks. To reduce the risks of suicide, SSRIs should only be prescribed by a psychiatrist, not a family physician, and parents and caregivers should be alert for any of the signs of potential suicidal behavior found below.

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Side effects

The most common side effects of benzodiazepines are secondary to their CNS effects and include sedation and sleepiness, depression, lethargy, apathy, **fatigue**, hypoactivity, lightheadedness, memory impairment, disorientation, anterograde **amnesia**, restlessness, confusion, crying or sobbing, **delirium**, **headache**, slurred speech, aphonia, dysarthria, stupor, seizures, **coma**, syncope, rigidity, tremor, dystonia, vertigo, **dizziness**, euphoria, nervousness, irritability, difficulty in concentration, agitation, inability to perform complex mental functions, akathisia, hemiparesis, hypotonia, unsteadiness, ataxia, incoordination, weakness, vivid dreams, psychomotor retardation, "glassy-eyed" appearance, extrapyramidal symptoms, paradoxical reactions. Other reactions include changes in heart rate and blood pressure, changes in bowel function, severe skin rash and changes in genitourinary function. Other adverse effects have been reported.

Buspirone has a low incidence of side effects. Dizziness and drowsiness are the most commonly reported adverse effects. Other CNS effects include dream disturbances, depersonalization, dysphoria, noise intolerance, euphoria, akathisia, fearfulness, loss of interest, disassociative reaction, **hallucinations**, suicidal ideation, seizures, feelings of claustrophobia, cold intolerance, stupor and slurred speech, psychosis. Rarely, heart problems, including congestive **heart failure** and myocardial infarction, have been reported. Other adverse effects have been reported.

The most common side effects of SSRIs include:

- dry mouth
- dizziness
- sour or acid stomach or gas
- heartburn
- decreased appetite
- stomach upset
- nausea
- diarrhea
- sweating
- headache
- weakness or fatigue
- drowsiness
- insomnia
- nervousness or anxiety
- tremors
- sexual problems

For additional information on less common side effects and side effects of SSRIs on children, see the entry on **antidepressant drugs, SSRI**.

Interactions

The metabolism of alprazolam may be increased by: cimetidine, **oral contraceptives**, disulfiram, fluoxetine, isoniazid, ketoconazole, metoprolol, propoxyphene, propranolol and valproic acid. The absorption of all benzodiazepines is inhibited by concomitant use of **antacids**. Benzodiazepines may increase blood levels of **digoxin**, and reduce the efficacy of levodopa. Other **drug interactions** have been reported.

Buspirone levels will be increased by concomitant use of erythromycin, itraconazole, and nefazadone. Doses should be adjusted based on clinical response. Use of buspirone at the same time as monoamine oxidase inhibitors (MAOIs, phenelzine, tranycypromine) may cause severe blood pressure elevations. Use of buspirone with monoamine odixase inhibitors (MAOIs) should be avoided.

SSRIs interact with many other drugs and herbal remedies especially other drugs that affect mood. Alcohol may increase SSRI-induced drowsiness and should not be used when taking some SSRIs.

The interaction of SSRIs with **monoamine oxidase inhibitors** (MAOIs), an older class of antidepressants, can be fatal. In addition to antidepressant MAOIs, the antibiotic linezolid (Zyvox) is an MAOI. There must be at minimum a two-week interval between stopping one drug and starting the other drug. There should be at least a three-week interval between an MAOI and either paroxetine hydrochloride or sertraline, if either type of antidepressant was taken for more than three months. Because of its long half-life in the body, it is necessary to wait five to six weeks after stopping fluoxetine before starting on an MAOI. For a more extensive list of SSRI drug interactions, please see the entry on antidepressant drugs, SSRI.

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American Academy of Child and Adolescent Psychiatry (AACAP), 3615 Wisconsin Ave. NW, Washington, DC, 20013-3007, (202) 966-7300, (202) 966-2891, communications@aacap.org, http://www.aacap.org/.
American Psychiatric Association (APA), 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209, (888) 357-7924, apa@psych.org, http://www.psych.org.
National Institute of Mental Health (NIMH), 6001 Executive Boulevard, Room 8184, MSC 9663, Bethesda, MD, 20892-9663 http://www.nimh.nih.gov/site-info/contact-nimh.shtml.

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Antiarrhythmic drugs

Definition

Antiarrhythmic drugs are medicines that correct irregular heartbeats and slow down hearts that beat too fast.

Purpose

Normally, the heart beats at a steady, even pace. The pace is controlled by electrical signals that begin near the top of the heart and quickly spread through the whole heart. If something goes wrong with this control system, the result may be an irregular heartbeat, or arrhythmia. Antiarrhythmic drugs correct irregular heartbeats and restore the normal rhythm. If the heart is beating too fast, these drugs will slow it down. By correcting these problems, antiarrhythmic drugs reduce stress on the heart and help it work more efficiently.

Description

Antiarrhythmic drugs are available only with a physician's prescription and are sold in capsule (regular and extended release), tablet (regular and extended-release), and injectable forms. Commonly used antiarrhythmic drugs are disopyramide (Norpace, Norpace CR), procainamide (Procan SR, Pronestyl, Pronestyl-SR), and quinidine (Cardioquin, Duraquin, Quinidex, and other brands). *Do not confuse quinidine with quinine, which is a related medicine with different uses, such as relieving leg cramps*. Anticoagulant (blood thinning) drugs such as warfarin (Coumadin) are often given at the same time as antiarrhythmic drugs because irregular heart rhythms increase the chance of developing **blood clots**.

Recommended dosage

The recommended dosage depends on the type of antiarrhythmic drug and other factors. Doses may be different for different patients. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

Always take antiarrhythmic drugs exactly as directed. Never take larger or more frequent doses.

Do not stop taking this medicine without checking with the physician who prescribed it. Stopping it suddenly could lead to a serious change in heart function.

Antiarrhythmic drugs work best when they are at constant levels in the blood. To help keep levels constant, take the medicine in doses spaced evenly through the day and night. Do not miss any doses. If taking medicine at night interferes with sleep, or if it is difficult to remember to take the medicine during the day, check with a health care professional for suggestions.

Precautions

Persons who take these drugs should see their physician regularly. The physician will check to make sure the medicine is working as it should and will note any unwanted side effects.

Some people feel dizzy, lightheaded, or faint when using these drugs, especially when they get up after sitting or lying down. To lessen the problem, get up gradually and hold onto something for support if possible.

This medicine may cause blurred vision or other vision problems. Because of these possible problems, anyone who takes these drugs should not drive, use

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KEY TERMS

Anxiety—Worry or tension in response to real or imagined stress, danger, or dreaded situations. Physical reactions, such as fast pulse, sweating, trembling, fatigue, and weakness may accompany anxiety.

Arrhythmia—Abnormal heart rhythm.

Asthma—A disease in which the air passages of the lungs become inflamed and narrowed.

Emphysema—A lung disease in which breathing becomes difficult.

Glaucoma—A condition in which pressure in the eye is abnormally high. If not treated, glaucoma may lead to blindness.

Hallucination—A false or distorted perception of objects, sounds, or events that seems real. Hallucinations usually result from drugs or mental disorders.

Heat stroke—A severe condition caused by prolonged exposure to high heat. Heat stroke interferes with the body's temperature regulating abilities and can lead to collapse and coma.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Myasthenia gravis—A chronic disease with symptoms that include muscle weakness and sometimes paralysis.

Palpitation—Rapid, forceful, throbbing, or fluttering heartbeat.

Prostate—A donut-shaped gland below the bladder in men that contributes to the production of semen.

Psoriasis—A skin disease in which people have itchy, scaly, red patches on the skin.

Systemic lupus erythematosus (SLE)—A chronic disease that affects the skin, joints, and certain internal organs.

Tourette syndrome—A condition in which a person has tics and other involuntary behavior, such as barking, sniffing, swearing, grunting, and making uncontrollable movements.

Tremor—Shakiness or trembling.

machines, or do anything else that might be dangerous until they have found out how the drugs affect them. If the medicine does cause vision problems, wait until vision is clear before driving or engaging in other activities that require normal vision.

Antiarrhythmic drugs make some people feel lightheaded, dizzy, or faint.

Anyone taking this medicine should not drink alcohol without his or her physician's approval.

Some antiarrhythmic drugs may change the results of certain medical tests. Before having medical tests, anyone taking this medicine should alert the health care professional in charge.

Anyone who is taking antiarrhythmic drugs should be sure to tell the health care professional in charge before having any surgical or dental procedures or receiving emergency treatment.

Antiarrhythmic drugs may cause low blood sugar in some people. Anyone who experiences symptoms of low blood sugar should eat or drink a food that contains sugar and call a physician immediately. Signs of low blood sugar are:

- anxiety
- confusion
- nervousness
- shakiness
- unsteady walk
- extreme hunger
- headache
- nausea
- drowsiness
- unusual tiredness or weakness
- fast heartbeat
- pale, cool skin
- chills
- cold sweats

Antiarrhythmic drugs may cause **dry mouth**. To temporarily relieve the discomfort, chew sugarless gum, suck on sugarless candy or ice chips, or use saliva substitutes, which come in liquid and tablet forms and are available without a prescription. If the problem continues for more than 2 weeks, check with a physician or dentist. Mouth dryness that continues over a long time may contribute to **tooth decay** and other dental problems.

People taking antiarrhythmic drugs may sweat less, which can cause the body temperature to rise. Anyone who takes this medicine should be careful

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not to become overheated during **exercise** or hot weather and should avoid hot baths, hot tubs, and saunas. Overheating could lead to heat stroke.

Older people may be especially sensitive to the effects of antiarrhythmic drugs. This may increase the risk of certain side effects, such as dry mouth, difficult urination, and **dizziness** or lightheadedness.

The antiarrhythmic drug procainamide can cause serious blood disorders. Anyone taking this medicine should have regular blood counts and should check with a physician if any of the following symptoms occur:

- joint or muscle pain
- muscle weakness
- pain in the chest or abdomen
- tremors
- wheezing
- cough
- palpitations
- rash, sores, or pain in the mouth
- sore throat
- fever and chills
- loss of appetite
- diarrhea
- dark urine
- yellow skin or eyes
- unusual bleeding or bruising
- dizziness
- hallucinations
- depression

Special conditions

People with certain medical conditions or who are taking certain other medicines may have problems if they take antiarrhythmic drugs. Before taking these drugs, be sure to let the physician know about any other medical conditions.

ALLERGIES. Anyone who has had unusual reactions to an antiarrhythmic drug in the past should let his or her physician know before taking this type of medicine again. Patients taking procainamide should let their physicians know if they have ever had an unusual or allergic reaction to procaine or any other "caine-type" medicine, such as xylocaine or lidocaine. Patients taking quinidine should mention any previous reactions to quinine. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

CONGESTIVE HEART DISEASE. Antiarrhythmic drugs may cause low blood sugar, which can be a particular problem for people with congestive heart disease. Anyone with congestive heart disease should be familiar with the signs of low blood sugar (listed above) and should check with his or her physician about what to do if such symptoms occur.

DIABETES. Antiarrhythmic drugs may cause low blood sugar, which can be a particular problem for people with diabetes. Anyone with diabetes should be familiar with the signs of low blood sugar (listed above) and should check with his or her physician about what to do if such symptoms occur.

PREGNANCY. The effects of taking antiarrhythmic drugs in **pregnancy** have not been studied in humans. In studies of laboratory animals, this medicine increased the risk of **miscarriage**. In addition, some women who have taken these drugs while pregnant have had contractions of the uterus (womb). Women who are pregnant or who may become pregnant should check with their physicians before taking this medicine. Women who become pregnant while taking this medicine should let their physicians know right away.

BREASTFEEDING. Antiarrhythmic drugs pass into breast milk. Women who are **breastfeeding** should check with their physicians before taking this medicine.

OTHER MEDICAL CONDITIONS. Before using antiarrhythmic drugs, people with any of these medical problems should make sure their physicians are aware of their conditions:

- heart disorders such as structural heart disease or inflammation of the heart muscle
- congestive heart failure
- kidney disease
- liver disease
- diseases of the blood
- asthma or emphysema
- enlarged prostate or difficulty urinating
- overactive thyroid
- low blood sugar
- psoriasis
- glaucoma
- myasthenia gravis
- systemic lupus erythematosus

Side effects

The most common side effects are dry mouth and throat, **diarrhea**, and loss of appetite. These problems usually go away as the body adjusts to the drug and do not require medical treatment. Less common side

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effects, such as dizziness, lightheadedness, blurred vision, dry eyes and nose, frequent urge to urinate, bloating, **constipation**, stomach **pain**, and decreased sexual ability, also may occur and do not need medical attention unless they do not go away or they interfere with normal activities.

More serious side effects are not common, but may occur. If any of the following side effects occur, check with the physician who prescribed the medicine as soon as possible:

- fever and chills
- difficult urination
- swollen or painful joints
- pain when breathing
- skin rash or itching

People who are especially sensitive to quinidine may have a reaction to the first dose or doses. If any of these side effects occur after taking quinidine, check with a physician immediately:

- dizziness
- ringing in the ears
- breathing problems
- vision changes
- fever
- headache
- skin rash

Other rare side effects may occur with any antiarrhythmic drug. Anyone who has unusual symptoms after taking antiarrhythmic drugs should get in touch with his or her physician.

Interactions

Antiarrhythmic drugs may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes antiarrhythmic drugs should let the physician know all other medicines he or she is taking. Among the drugs that may interact with antiarrhythmic drugs are:

- other heart medicines, including other antiarrhythmic drugs
- blood pressure medicine
- blood thinners
- pimozide (Orap), used to treat Tourette syndrome

The list above does not include every drug that may interact with antiarrhythmic drugs. Be sure to check with a physician or pharmacist before combining antiarrhythmic drugs with any other prescription or nonprescription (over-the-counter) medicine.

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American College of Cardiology, Heart House, 2400 N Street NW, Washington, DC, 20037, (202) 375-6000, ext 5603, (202) 375-7000, (800) 223-4636, ext. 5603, resource@acc.org, http://www.acc.org.

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org .

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

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Antiasthmatic drugs

Definition

Antiasthmatic drugs are medicines that treat or prevent **asthma** attacks.

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KEY TERMS

Asthma—A disease in which the air passages of the lungs become inflamed and narrowed.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Inhalant—Medicine that is breathed into the lungs.

Mucus—Thick fluid produced by the moist membranes that line many body cavities and structures.

Purpose

For people with asthma, the simple act of breathing can be a struggle. Their airways become inflamed and blocked with mucus during asthma attacks, narrowing the opening through which air passes. This is not such a problem when the person breathes in, because the airways naturally expand when a person takes a breath. The real problem arises when the person with asthma tries to breathe out. The air cannot get out through the blocked airways, so it stays trapped in the lungs. With each new breath, the person can take in only a little more air, so breathing becomes shallow and takes more and more effort.

Asthma attacks can be caused by **allergies** to pollen, dust, pets, or other things, but people without known allergies may also have asthma. **Exercise**, **stress**, intense emotions, exposure to cold, certain medicines, and some medical conditions can bring on attacks.

The two main approaches to dealing with asthma are avoiding substances and situations that trigger attacks and using medicines that treat or prevent the symptoms. With a combination of the two, most people with asthma can find relief and live normal lives.

Description

Three types of drugs are used in treating and preventing asthma attacks:

- Bronchodilators relax the smooth muscles that line the airway. This makes the airways open wider, letting more air pass through them. These drugs are used mainly to relieve sudden asthma attacks or to prevent attacks that might come on after exercise. They may be taken by mouth, injected, or inhaled. Bronchodilators can be taken in pill or liquid form, but normally are used as inhalers. The drug is breathed in metered doses and goes directly into the airways. This results in prompt response and fewer side effects. Albuterol (Accuneb, Proair, Proventil, Ventolin) is a common short-acting bronchiodilator Salmeterol (Serevent), another inhaled drug, is only prescribed when other drugs fail to control asthma, as it has a higher percentage of fatal complications than other antiasthmaic drugs.
- Corticosteroids block the inflammation that narrows the airways. Used regularly, these drugs will help prevent asthma attacks. Those attacks that do occur will be less severe. However, corticosteroids cannot stop an attack that is already underway. These drugs may be taken by mouth, injected, or inhaled. Examples of common corticosteroids used in the treatment of asthma include beclomethasone (Beconase), budesonide (Entocort, Pulmicort), flunisolide (Nasalide), fluticasone (Flonase), and triamcinolone (Azmacort, Kenalog).
- Leukotriene modifiers are a newer type of drug that can be used in place of steroids for older children or adults who have a mild degree of asthma that persists. They work by counteracting leukotrienes, which are substances released by white blood cells in the lung that cause the air passages to constrict and promote mucus secretion. Leukotriene modifiers also fight off some forms of rhinitis, an added bonus for people with asthma. However, they are not proven effective in fighting seasonal allergies. Leukotrine modifiers include montelukast (Singulair), zafirlukast (Accolate), and zileuton (Zyflo, Filmtab). However, in March 2008, the United States Food and Drug Administration (FDA) began investigating a link between montelukast (Singulair) and changes in mood and behavior, increased suicidal thinking, and increased the risk of suicide. Check with a physician or pharmacist for the most recent information on this investigation.
- Cromolyn (Intal) and nedocromil (Tilade) are mast cell inhibitors. Mast cells are cells that are involved in the production of allergy symptoms. These drugs may be taken regularly to help prevent asthma attacks and may be used alone or with other asthma medicines. They cannot stop an attack that already has started. These drugs work by preventing certain mast cells from releasing substances that cause allergic reactions or asthma symptoms.

Precautions

Using antiasthmatic drugs properly is important. Because **bronchodilators** provide quick relief, some people may be tempted to overuse them. However, with some kinds of bronchodilators, this can lead to serious and possibly life-threatening complications. Patients benefit most by using bronchodilators only as directed and also routinely using other drugs that over time will reduce their need for bronchodilators. Research has also shown that people with asthma who

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work closely with their physicians to self-manage their asthma have fewer attacks and less need for bronchodilators. Carefully managing asthma also reduces visits to the emergency department and hospitalizations.

As noted above, people using Salmeterol (Serevent) have an increased risk of fatal asthma attacks. This drug should be used only when asthma cannot be controlled by other means.

Corticosteroids are powerful drugs that may cause serious side effects when used over a long time. However, these problems are much less likely with the inhalant forms than with the oral and injected forms. While the oral and injected forms generally should be used only for one to two weeks, the inhalant forms may be used for longer periods.

It is important to remember that leukotriene modifiers are used to prevent and manage asthma, not to stop an attack. A physician or pharmacist can advise patients on possible interactions with other drugs. Note that as of 2008 an investigation was underway to examine a suspected connection between montelukast (Singulair) and increased suicidal thoughts and behavior.

Patients who are using their antiasthmatic drugs correctly but feel their asthma is not under control should see their physicians. The physician can either increase the dose, switch to another drug or add another drug to the regimen. A 2004 survey showed that 70% of people with mild to moderate asthma were not taking the correct dose of asthma medication.

When used to prevent asthma attacks, cromolyn must be taken as directed every day. The drug may take as long as four weeks to start working. Unless told to do so by a physician, patients should not stop taking the drug just because it does not seem to be working. When symptoms do begin to improve, patients should continue taking all medicines that have been prescribed, unless a physician directs otherwise.

Side effects

Inhalant forms of antiasthmatic drugs may cause dryness or irritation in the throat, **dry mouth**, or an unpleasant taste in the mouth. To help prevent these problems, gargling and rinsing the mouth or taking a sip of water after each dose is recommended.

More serious side effects are not common when these medicines are used properly. However, anyone who has unusual or bothersome symptoms after taking an antiasthmatic drug should get in touch with a physician and discuss altering the medication regimen.

Interactions

A physician or pharmacist should be consulted before combining antiasthmatic drugs with any other prescription, nonprescription (over-the-counter) medicine, or herbal remedy.

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ORGANIZATIONS

Asthma and Allergy Foundation of America, 8201 Corporate Drive, Suite 1000, Landover, MD, 20785, (800) 727-8462, info@aafa.org, http://www.aafa.org/.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

National Institute of Allergies and Infectious Diseases, 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-6612, (301) 496-5717, (301) 402-3573, (866) 284-4107, ocpostoffice@niaid.nih.gov, http://www.niaid.nih.gov.

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Antibacterial bath *see* **Therapeutic baths**

Antibiotic-associated colitis

Definition

Antibiotic-associated **colitis** is an inflammation of the intestines that sometimes occurs following antibiotic treatment and is caused by toxins produced by the bacterium *Clostridium difficile*.

Description

Antibiotic-associated colitis, also called antibiotic-associated enterocolitis, can occur following antibiotic treatment. The bacteria *Clostridia difficile* are normally found in the intestines of 5% of healthy adults, but people can also pick up the bacteria while they are in a hospital or nursing home. In a healthy

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KEY TERMS

Colitis—Inflammation of the colon.

Edema—Fluid accumulation in a tissue.

Endoscopy—A procedure in which a thin, lighted instrument is inserted into the interior of a hollow organ, such as the rectum and used to visually inspect the inner intestinal lining.

Fibrin—A fibrous blood protein vital to coagulation and blood clot formation.

Rectum—The last part of the intestine. Stool passes through the rectum and out through the anal opening.

Toxic megacolon—Acute enlargement or dilation of the large intestine.

person, harmless resident intestinal bacteria compete with each other for food and places to "sit" along the inner intestinal wall. When **antibiotics** are given, most of the resident bacteria are killed. With fewer bacteria to compete with, the normally harmless *Clostridia difficile* grow rapidly and produce toxins. These toxins damage the inner wall of the intestines and cause inflammation and **diarrhea**.

Although all antibiotics can cause this disease, it is most commonly caused by clindamycin (Cleocin), ampicillin (Omnipen), amoxicillin (Amoxil, Augmentin, or Wymox), and any in the cephalosporin class (such as cefazolin or cephalexin). Symptoms of the condition can occur during antibiotic treatment or within four weeks after the treatment has stopped.

In approximately half of cases of antibiotic-associated colitis, the condition progresses to a more severe form of colitis called pseudomembranous enterocolitis in which pseudomembranes are excreted in the stools. Pseudomembranes are membrane-like collections of white blood cells, mucus, and the protein that causes blood to clot (fibrin) that are released by the damaged intestinal wall.

Causes and symptoms

Antibiotic-associated colitis is caused by toxins produced by the bacterium *Clostridium difficile* after treatment with antibiotics. When most of the other intestinal bacteria have been killed, *Clostridium difficile* grows rapidly and releases toxins that damage the intestinal wall. The disease and symptoms are caused by these toxins, not by the bacterium itself.

Symptoms of antibiotic-associated colitis usually begin four to ten days after antibiotic treatment has begun. The early signs and symptoms of this disease include lower abdominal cramps, an increased need to pass stool, and watery diarrhea. As the disease progresses, the patient may experience a general ill feeling, **fatigue**, abdominal **pain**, and **fever**. If the disease proceeds to pseudomembranous enterocolitis, the patient may also experience **nausea**, **vomiting**, large amounts of watery diarrhea, and a very high fever (104-105 °F/40-40.5 °C). Complications of antibiotic-associated colitis include severe **dehydration**, imbalances in blood **minerals**, low blood pressure, fluid accumulation in deep skin (**edema**), enlargement of the large intestine (toxic megacolon), and the formation of a tear (perforation) in the wall of the large intestine.

The *Clostridium difficile* toxin is found in the stools of persons older than 60 years of age 20-100 times more frequently than in the stools of persons who are 10-20 years old. As a result, the elderly are much more prone to developing antibiotic-associated colitis than younger individuals.

Diagnosis

Antibiotic-associated colitis can be diagnosed by the symptoms and recent medical history of the patient, by a laboratory test for the bacterial toxin, and/or by using a procedure called **endoscopy**.

If the diarrhea and related symptoms occurred after the patient received antibiotics, antibiotic-associated colitis may be suspected. A stool sample may be analyzed for the presence of the *Clostridium difficile* toxin. This toxin test is the preferred diagnostic test for antibiotic-associated colitis. One frequently used test for the toxin involves adding the processed stool sample to a human cell culture. If the toxin is present in the stool sample, the cells die. It may take up to two days to get the results from this test. A simpler test, which provides results in two to three hours, is also available. Symptoms and toxin test results are usually enough to diagnose the disease.

Another tool that may be useful in the diagnosis of antibiotic-associated colitis, however, is a procedure called an endoscopy that involves inserting a thin, lighted tube into the rectum to visually inspect the intestinal lining. Two different types of endoscopy procedures, the **sigmoidoscopy** and the **colonoscopy**, are used to view different parts of the large intestine. These procedures are performed in a hospital or doctor's office. Patients are sedated during the procedure to make them more comfortable and are allowed to go home after recovering from the **sedation**.

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Treatment

Diarrhea, regardless of the cause, is always treated by encouraging the individual to replace lost fluids and prevent dehydration. One method to treat antibiotic-associated colitis is to simply stop taking the antibiotic that caused the disease. This allows the normal intestinal bacteria to repopulate the intestines and inhibits the overgrowth of *Clostridium difficile*. Many patients with mild disease respond well to this and are free from diarrhea within two weeks. It is important, however, to make sure that the original disease for which the antibiotics were prescribed is treated.

Because of the potential seriousness of this disease, most patients are given another antibiotic to control the growth of the *Clostridium difficile*, usually vancomycin (Vancocin) or metronidazole (Flagyl or Protostat). Both are designed to be taken orally four times a day for 10-14 days. Upon finishing antibiotic treatment, approximately 15-20% of patients will experience a relapse of diarrhea within one to five weeks. Mild relapses can go untreated with great success, however, severe relapses of diarrhea require another round of antibiotic treatment. Instead of further antibiotic treatment, a cholestyramine resin (Questran or Prevalite) may be given. The bacterial toxins produced in the intestine stick to the resin and are passed out with the resin in the stool. Unfortunately, however, vancomycin also sticks to the resin, so these two drugs cannot be taken at the same time. Serious disease may require hospitalization so that the patient can be monitored, treated, and rehydrated.

Alternative treatment

The goal of alternative treatment for antibiotic-associated enterocolitis is to repopulate the intestinal environment with microorganisms that are normal and healthy for the intestinal tract. These microorgansisms then compete for space and keep the *Clostridium difficile* from over-populating.

Several types of supplements can be used. Supplements containing *Lactobacillus acidophilus*, the bacteria commonly found in yogurt and some types of milk, *Lactobacillus bifidus*, and *Streptococcus faecium*, are available in many stores in powder, capsule, tablet, and liquid form. *Acidophilus* also acts as a mild antibiotic, which helps it to reestablish itself in the intestine, and all may aid in the production of some B **vitamins** and vitamin K. These supplements can be taken individually and alternated weekly or together following one or more courses of antibiotics.

Prognosis

With appropriate treatment and replenishment of fluids, the prognosis is generally excellent. One or more relapses can occur. Very severe colitis can cause a tear (perforation) in the wall of the large intestine that would require major surgery. Perforation of the intestine can cause a serious abdominal infection. Antibiotic-associated colitis can be fatal in people who are elderly and/or have a serious underlying illness, such as **cancer**.

Prevention

There are no specific preventative measures for this disease. Good general health can reduce the chance of developing a bacterial infection that would require antibiotic treatment and the chance of picking up the *Clostridia* bacteria. Maintaining good general health can also reduce the seriousness and length of the condition, should it develop following antibiotic therapy.

Resources

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ORGANIZATIONS

Crohn's & Colitis Foundation of America, 386 Park Ave. S, 17th Fl., New York, NY, 10016, (800) 932-2423, info@ccfa.org, http://ccfa.org.

Antibiotic prophylaxis *see* **Prophylaxis**

Antibiotics

Definition

Antibiotics are drugs that treat infections caused by bacteria. Some antibiotics may have secondary uses, such as the use of demeclocycline (Declomycin, a tetracycline derivative) to treat the syndrome of inappropriate antidiuretic hormone (SIADH) secretion. Other antibiotics may be useful in treating protozoal (another type of single-celled organism) infections.

Purpose

Antibiotics are used for treatment or prevention of bacterial infection. Different antibiotics are effective in killing different species of bacteria.

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Antibiotics

Brand name	Generic name
Aminoglycosides	
Amikin	amikacin
AK-Tob, Tobi, Tobrex	tobramycin
Capastat Sulfate	capreomycin sulfate
Garamycin, Gentak, Pred-G	gentamicin
Kantrex	kanamycin
Netromycin	netilmicin
Cephalosporins	
Ancef	cefazolin
Ceclor	cefaclor
Cedax	ceftibuten
Ceftin, Zinacef	cefuroxime
Cefzil	cefprozil
Duricef	cefadroxil
Fortaz, Tazicef	ceftazidime
Keflex	cephalexin
Mefoxin	cefoxitin
Omnicef	cefdinir
Rocephin	ceftriaxone
Spectracef	cefditoren
Suprax	cefixime
Vantin	cefpodoxime
Macrolides	
Biaxin, Biaxin XL	clarithromycin
ERYC, Ery-Tab, EryDerm, EryGel, PCE	erythromycin
Zithromax	azithromycin
Penicillins	
Amoxil, Trimox	amoxicillin
Bactocill	oxacillin
Dicloxacillin Sodium	dicloxacillin sodium
Pfizerpen	penicillin G
Principen	ampicillin
Timentin	ticarcillin (and clavulanate)
Unipen	nafcillin
V-Cillin K, Veetids	penicillin V
Zosyn	piperacillin (and tazobactam)
Tetracyclines	
Declomycin	demeclocycline
Doryx, Monodox, Vibramycin, Vibra-Tabs	doxycycline hyclate
Dynacin, Minocin	minocycline hydrochloride
Sumycin	tetracycline hydrochloride
Terramycin	oxytetracycline
Miscellaneous	
Chloramphenicol	chloramphenicol
Cleocin, Cleocin T, Clinda-Derm, Clindagel, Clindets, Clindesse	clindamycin
Coly-Mycin M	colistimethate
Flagyl, Flagyl ER, Flagyl I.V., Noritate, Metrogel	metronidazole
Furadantin, Macrobid	nitrofurantoin
Monurol	fosfomycin tromethamine
Myambutol	ethambutol
Nydrazid	isoniazid
Pyrazinamide	pyrazinamide
Synercid	quinupristin/dalfopristin
Trobicin	spectinomycin hydrochloride
Vancocin	vancomycin hydrochloride

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Description

There are a very large number of antibiotics approved for use in the United States and Canada sold under a variety of brand names.

There are several classification schemes for antibiotics. The most useful is based on chemical structure. Antibiotics within a structural class will generally show similar patterns of effectiveness, toxicity, and allergic potential. Additional classification schemes are based on:

- bacterial spectrum—broad spectrum can kill many types of bacteria, whereas narrow spectrum antibiotics specifically target a single class of bacteria
- route of administration—injectable, oral, or topical
- type of activity—bactericidal drugs kill bacteria outright whereas bacteriostatic drugs inhibit bacterial growth

Penicillins

The **penicillins** are the oldest class of antibiotics. They have a common chemical structure that they share with the cephalopsorins. The two groups are classed as beta-lactam antibiotics, and are generally bacteriocidal—that is, they kill bacteria rather than inhibiting growth. Penicillins are sold under a variety of generic and brand names.

The penicillins can be further subdivided. Natural penicillins are based on the original penicillin G structure; penicillinase-resistant penicillins, notably methicillin and oxacillin, are active even in the presence of the bacterial enzyme that inactivates most natural penicillins. Aminopenicillins such as ampicillin and amoxicillin have an extended spectrum of action compared with natural penicillins. Extended spectrum penicillins are effective against a wider range of bacteria. These generally include coverage for *Pseudomonas aeruginaosa*. The penicillin may be used in combination with a penicillinase inhibitor.

Cephalosporins

Cephalosporins and the closely related cephamycins and carbapenems are the most widely prescribed class of antibiotics in the United States. They were discovered in Italy in 1948 and were first manufactured commercially in the United States in 1964. Like the penicillins, cephalosporins contain a beta-lactam chemical structure. Consequently, bacteria resistant to penicillins are also likely to be resistant to cephalosporins, and people allergic to penicillins are likely to be allergic to cephalosporins.

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A penicillin culture. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

The "cepha" drugs are among the most diverse class of antibiotics and are themselves subgrouped into first, second, third, and fourth generation drugs. Each generation has a broader spectrum of activity than the one before. In addition, cefoxitin, a cephamycin, is highly active against anaerobic bacteria, which makes them a good choice in the treatment of abdominal infections. The fourth generation cephalosporins (cefepime, cefluprenam, cefozopran, cefpirome, cefquinome) cross the blood-brain barrier and may be used to treat **meningitis** and **encephalitis**.

Fluoroquinolones

The **fluoroquinolones** are synthetic antibacterial agents, and not derived from bacteria. A related class of antibacterial agents developed earlier, the quinolones, were not well absorbed and could be used only to treat urinary tract infections. The fluoroquinolones, which are based on the older group, are broad-spectrum bactericidal drugs that are chemically unrelated to the penicillins or the cephalosporins. They are well distributed into bone tissue, and so well absorbed that in general they are as effective when given by mouth as by intravenous infusion. Cipro is the brand name of the best-known fluoroquinolone sold in the United States.

Tetracyclines

Tetracyclines got their name because they share a chemical structure that has four rings. They are derived from a species of *Streptomyces* bacteria. As broad-spectrum bacteriostatic agents, the tetracyclines may be effective against a wide variety of microorganisms, including rickettsia and amoebic parasites.

Macrolides

The **macrolide antibiotics** are derived from *Streptomyces* bacteria, and got their name because they all have a macrocyclic lactone chemical structure. Erythromycin, the prototype of this class, has a spectrum and use similar to penicillin. Newer members of the group, azithromycin (Zithromax) and clarithyromycin (Biaxin), are particularly useful for their high level of lung penetration. Clarithromycin has been widely used to treat *Helicobacter pylori* infections that cause stomach ulcers.

Others

Other classes of antibiotics include the **aminoglycosides**, which are particularly useful for their effectiveness in treating *Pseudomonas aeruginosa* infections. Gentamycin (garamycin), polymyxin B sulfate/trimethoprim (Polytrim), and tobramycin (Tobrex) fall into this category. The lincosamindes include clindamycin (Cleocin) and lincomycin (Lincocin), which are highly active against anaerobic pathogens. The **sulfonamides** include co-trimoxazole (Bactrim) and trimethoprim (Proloprim). There are other individual drugs that have also been useful in treating specific infections.

Recommended dosage

Dosage varies with drug, route of administration, pathogen, site of infection, and severity. Additional considerations include renal function, age of patient, and other factors. Consult manufacturers' recommendations for dose and route.

Precautions

To minimize risk of adverse reactions and development of resistant strains of bacteria, antibiotics should be restricted to use in cases where there is either known or a reasonable presumption of bacterial infection. The use of antibiotics in viral infections such as the **common cold** is to be avoided. Avoid use of fluoroquinolones for trivial infections. Use antibiotics as often as directed and for as long as directed. Although the symptoms may have disappeared, the infection may not clear up completely if the drug is stopped too soon.

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KEY TERMS

Anaerobic bacteria—Bacteria that grow and reproduce in an oxygen-free environment, such as the bacterium that causes tetanus.

Bacteria—Tiny, one-celled forms of life that cause many diseases and infections.

Blood-brain barrier—A specialized, semi-permeable layer of cells around the blood vessels in the brain that controls which substances can leave the circulatory system and enter the brain.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Meningitis—Inflammation of tissues that surround the brain and spinal cord.

Microorganism—An organism that is too small to be seen with the naked eye.

Myasthenia gravis—A muscle weakness that occurs because the body makes antibodies to the natural chemical that facilitates transmission of impulses between the nerve and the muscle.

Pregnancy category—A system of classifying drugs according to their established risks for use during pregnancy. Category A: Controlled human studies have demonstrated no fetal risk. Category B: Animal studies indicate no fetal risk, but no human studies; or adverse effects in animals, but not in well-controlled human studies. Category C: No adequate human or animal studies; or adverse fetal effects in animal studies, but no available human data. Category D: Evidence of fetal risk, but benefits outweigh risks. Category X: Evidence of fetal risk. Risks outweigh any benefits.

In severe infections, therapy with a broad-spectrum antibiotic such as a third or fourth generation cephalosporin may be appropriate. Treatment should be changed to a narrow spectrum agent as soon as the disease-causing bacterium has been identified. After 48 hours of treatment, if there is clinical improvement, an oral antibiotic should be considered.

Side effects

Due to the various types of antibiotics available, there are a variety of side effects possible. The most common problems associated with each type are:

- Penicillins: Allergic reactions may be common, and cross allergenicity with cephalosporins has been reported. Penicillins are classed as category B during pregnancy.
- Cephalopsorins: Several cephalopsorins and related compounds have been associated with seizures. Cefoperazone (Cefobid), cefotetan (Cefotan), and ceftriaxone (Rocephin) may be associated with a decrease in the ability of the blood to clot and other coagulation abnormalities. Some forms of colitis (a serious infection of the large intestine) have been reported with cephalosporins and other broad-spectrum antibiotic use. Some drugs in this class may cause kidney damage. Pregnancy category B.
- Fluoroquinolones: Lomefloxacin (Maxaquin) has been associated with increased photosensitivity. All drugs in this class have been associated with convulsions. Pregnancy category C.
- Tetracyclines: Demeclocycline (Declomycin) may cause increased photosensitivity. Minocycline (Dynacin) may cause dizziness. Oral tetracyclines bind to anions such as calcium and iron. Although doxycycline and minocycline may be taken with meals, patients should take other tetracycline antibiotics on an empty stomach, and should not take the drugs with milk or other calcium-rich foods. Expired tetracycline should never be administered. Pregnancy category D.
- Macrolides: Erythromycin may aggravate the weakness of patients with myasthenia gravis. Azithromycin has rarely been associated with allergic reactions, including angioedema, anaphylaxis (life-threatening shock), and skin reactions, including Stevens-Johnson syndrome and toxic epidermal necrolysis. Oral erythromycin may be highly irritating to the stomach and when given by injection may cause severe phlebitis. These drugs should be used with caution in patients with liver dysfunction. Pregnancy category B: Azithromycin, erythromycin. Pregnancy category C: Clarithromycin, dirithromycin, troleandomycin.
- Aminoglycosides: This class of drugs causes kidney damage and damage to the organs of the inner ear. These problems can occur even with normal doses. Dosing should be based on kidney (renal) function, with periodic testing of both kidney function and hearing. Pregnancy category D.

Pediatric

Tetracyclines should not be prescribed for children under the age of eight. They should specifically

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be avoided during periods of tooth development. In children, these drugs can cause permanent tooth discoloration.

Geriatric

Older patients are more sensitive to the side effects of antibiotics. Since these patients often take multiple medications, their use and possible **drug interactions** should be carefully monitored by a physician and pharmacist.

Pregnant or breastfeeding

Several antibiotics may impair fetal development. Their use during **pregnancy** should be discussed with a physician and closely monitored. Generally, **breastfeeding** is not recommended while taking antibiotics due to the risk of upsetting the balance of the infant's intestinal bacteria and risk of masking infection in the infant.

The use of tetracyclines should be avoided during pregnancy as it may cause alterations in bone development.

Other conditions and allergies

All antibiotics cause risk of overgrowth by non-susceptible bacteria. Manufacturers list other major hazards by class; however, the health care provider should review each drug individually to assess the degree of risk.

Excessive or inappropriate use of any antibiotic may lead to the development of antibiotic resistant strains of bacteria. This has become an increasing concern as antibiotics are routinely added to animal feed and some household cleaning products. A strain that is considered resistant is one that can no longer be treated effectively using the antibiotics commonly prescribed for that type of infection.

Methicillin-resistant *Staphylococcus aureus* (MRSA) is a strain of staphylococcal bacteria that is resistant to the antibiotic methicillin and other common antibiotics that normally control staph infections. Although this strain of staph has existed in hospitals for years, in the 1990s, MRSA began appearing in places other than hospitals. By 2007, two forms of MRSA were recognized, hospital-acquired MRSA (HA-MRSA) and community-acquired MRSA (CA-MRSA). Symptoms of a MRSA infection are similar to other staph infection symptoms, only MRSA is much more dangerous and has a much higher mortality rate because treatment with common antibiotics does not kill the bacterium.

Interactions

The potential for interactions with other drugs and with foods is pronounced with the antibiotic drug group as a whole. Patients should request verbal and written information about the potential of these interactions for every antibiotic they are prescribed.

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ORGANIZATIONS

Alliance for the Prudent Use of Antibiotics (APUA), 75 Kneeland Street, Boston, MA, 02111-1901 (617) 636-0966 (617) 636-3999, http://www.tufts.edu/med/apua.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333 (800) 232-4636, http://www.cdc.gov.

United States Food and Drug Administration, 10903 New Hampshire Avenue, Silver Spring, MD, 20993 (888) INFO-FDA (463-6332), http://www.fda.gov.

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Antibiotics, ophthalmic

Definition

Ophthalmic **antibiotics** are medicines used in the eye that kill bacteria that cause eye infections. However, not all eye inflammation is caused by bacteria, and these drugs do not treat viruses.

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KEY TERMS

Bacteria—Tiny, one-celled forms of life that cause many diseases and infections.

Inflammation—The body's response to tissue damage. Includes warmth, swelling, redness, and pain in the affected part.

Ointment—A thick, spreadable substance that contains medicine and is meant to be used on the skin, or, if it is specifically an ophthalmic, or "eye" ointment, in the eye

Purpose

Ophthalmic antibiotics are applied to the eye or under the eyelid to treat eye infections caused by bacteria.

Description

Ophthalmic antibiotics come in the form of eye drops or ointment. Tobramycin (Tobrex), gatifloxacin ophthalmic (Zymar), and polymyxin B sulfate/trimethoprim (Polytrim) come as eye drops. Triple ophthalmic antibiotic ointment is sold under about a dozen brand names including Ak-Spore, Neocidin Ophthalimc Ointment, Ocusporin, Spectro-Sporin, and Triple Antibiotic. It is a combination of three antibiotics: neomycin, polymyxin B, and bacitracin. All ophthalmic antibiotics are available only with a physician's prescription.

Recommended dosage

The dosages given here are typical. Physicians may adjust the number of doses per day, the time between doses, and the length of treatment with the medicine, depending on the patient's particular medical problem. If the physician's directions are different from those given here, follow the physician's directions.

Adults

EYE DROPS. For mild to moderate infections, use one to two drops in the affected eye or eyes every four hours.

For severe infections, use two drops in the affected eye or eyes every two hours until the condition improves. At that time, the physician will determine how much to use until the infection is completely cleared up.

OINTMENT. For mild to moderate infections, squeeze a half-inch ribbon of ointment into the affected eye or eyes two or three times a day. Do not let the tip of the ointment tube touch the eye.

For severe infections, squeeze a half-inch ribbon of ointment into the affected eye or eyes every three to four hours until the condition improves. At that time, the physician will determine how much to use until the infection is completely cleared up.

Children

The child's physician should determine the proper dose.

Precautions

Use these drugs as often as directed, for as long as directed. Although the symptoms may have disappeared, the infection may not clear up completely if the drug is stopped too soon. Therefore, the medication may be prescribed for several days after the infection appears to have cleared. However, it is just as important to use the drug for *only* as long as directed. Using it for too long may lead to the growth of bacteria that do not respond to the drug. These bacteria may then cause infections that can be very difficult to treat. Make sure the physician or pharmacist specifies how long the medication is to be used.

Anyone who has had an allergic reaction the prescribed drug or to any of the ingredients in it should not use the medicine. If an apparent allergic reaction occurs, the individual should stop using the medicine immediately and call his or her physician.

Women who are pregnant or **breastfeeding** or who plan to become pregnant should check with their physicians before using ophthalmic antibiotics. Generally, these drugs are not known to cause problems for the developing fetus or infant.

Side effects

The main side effects of these drugs are **itching**, redness, and swelling of the eye or eyelid. Allergic reactions also are possible. If any of these symptoms occur, call the physician who prescribed the medicine.

Interactions

Patients who are using any other prescription or nonprescription (over-the-counter) medicines in their eyes should check with their physicians before using any ophthalmic antibiotic.

Resources

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ORGANIZATIONS

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Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

EyeCare America The Foundation of the American Academy of Ophthalmology, P. O. Box 429098, San Francisco, CA, 94142-9098, (415) 561-8567, (877) 887-6327, http://www.eyecareamerica.org.

United States Food and Drug Administration (FDA), 10903 New Hampshire Ave., Silver Spring, MD, 02993-0002, (888) 463-6332, http://www.fda.gov.

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Antibiotics, topical

Definition

Topical **antibiotics** are medicines applied to the skin to kill bacteria.

Purpose

Topical antibiotics help to prevent infections caused by bacteria that get into minor cuts, scrapes, and **burns**. Treating minor **wounds** with antibiotics allows quicker healing. If the wounds are left untreated, the bacteria will multiply, causing **pain**, redness, swelling, **itching**, and oozing. Untreated infections can eventually spread and become much more serious. Occasionally topical antibiotics are also used to treat **eczema** or other skin conditions that have become infected. Some newer antiacne preparations combine benzoyl peroxide with antibiotics.

KEY TERMS

Bacteria—Tiny, one-celled forms of life that cause many diseases and infections.

Eczema—A disease in which the skin becomes dry, red, itchy, and thickened.

Fungus—A member of a group of simple organisms that are related to yeast and molds.

Incontinence—The inability to control the bladder or bowel.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

One topical combination of benzoyl peroxide with clindamycin is sold under the trade name BenzaClin.

When treating a wound, it is not enough to simply apply a topical antibiotic. The wound must first be cleaned with soap and water and patted dry. After the antibiotic is applied, the wound should be covered with a dressing, such as a bandage or a protective gel or spray. For many years, it was thought that wounds heal best when exposed to the air. But now most experts say it is best to keep wounds clean and moist while they heal. The covering should still allow some air to reach the wound, however.

Description

Different kinds of topical antibiotics kill different kinds of bacteria. Many antibiotic first-aid products contain combinations of antibiotics to make them effective against a broad range of bacteria. The most common antibiotics found in topical antibiotics are mupirocin, bacitracin, polymyxin B, and neomycin. Triple antibiotic ointment (TAO) is sold under about a dozen brand names including Ak-Spore, Spectro-Sporin, and Triple Antibiotic. It contains three antibiotics: neomycin, polymyxin B, and bacitracin. Some antibacterial ointments (e.g., Neosporin, Polysporin) are available without a prescription, while others are prescription drugs.

Recommended dosage

The recommended dosage depends on the type of topical antibiotic. Follow the directions on the package label or ask a pharmacist for directions.

In general, topical antibiotics should be applied within four hours after injury. Do not use more than the recommended amount and do not apply it more

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often than three times a day. Do not apply the medicine over large areas of skin or on open wounds.

Precautions

Excessive or inappropriate use of any antibiotic may lead to the development of antibiotic resistant strains of bacteria. This has become of increasing concern as antibiotics are routinely added to animal feed and some household cleaning products. A strain that is considered resistant is one that can no longer be treated effectively using the antibiotics that are commonly prescribed for that type of infection.

Although use of topical antibiotics are of less concern than widespread and indiscriminate use of systemic antibiotics, to help control the development of antibiotic resistant bacteria, many public health experts advise people to use topical antibiotics only for short periods, that is, until the wound heals, and only as directed. For the topical antibiotic to work best, it should be used only to prevent infection in a fresh wound, not to treat an infection that has already started. Wounds that are not fresh may need the attention of a physician to prevent complications such as blood poisoning.

Topical antibiotics are meant to be used only on the skin and only for only a few days at a time. If the wound has not healed in five days, stop using the antibiotic and call a doctor.

Do not use topical antibiotics on large areas of skin or on open wounds. These products should not be used to treat **diaper rash** in infants or incontinence rash in adults.

Only minor cuts, scrapes, and burns should be treated with topical antibiotics. Certain kinds of injuries may need medical care and should not be self-treated with topical antibiotics. These include:

- large wounds
- deep cuts
- cuts that continue bleeding
- cuts that may need stitches
- burns any larger than a few inches in diameter
- scrapes imbedded with particles that will not wash away
- animal bites
- deep puncture wounds
- eye injuries

Never use regular topical antibiotics in the eyes. Special antibiotic products are available for treating eye infections. (See entry on **antibiotics, ophthalmic** for additional information.)

Although topical antibiotics control infections caused by bacteria, they may allow fungal infections to develop. The use of other, different drugs to treat the fungal infections may be necessary. Check with the physician or pharmacist.

Some people may be allergic to one or more ingredients in a topical antibiotic product. If an allergic reaction develops, stop using the product immediately and call a physician.

No harmful or abnormal effects have been reported in babies whose mothers used topical antibiotics while pregnant or nursing. However, pregnant or **breastfeeding** women are advised not to use any prescription, nonprescription or herbal drugs or remedies without first checking with her physician.

Unless a physician says to do so, do not use topical antibiotics on children under two years of age.

Side effects

The most common minor side effects are itching or burning. These problems usually do not require medical treatment unless they do not go away or they interfere with normal activities.

If any of the following side effects occur, check with a doctor as soon as possible:

- rash
- swelling of the lips and face
- sweating
- tightness or discomfort in the chest
- breathing problems
- fainting or dizziness
- low blood pressure
- nausea
- diarrhea
- hearing loss or ringing in the ears

Other rare side effects may occur. Anyone who has unusual symptoms after using a topical antibiotic should get in touch with the physician who prescribed or the pharmacist who recommended the medication.

Interactions

Using certain topical antibiotics at the same time as hydrocortisone (a topical corticosteroid used to treat inflammation) may hide signs of infection or allergic reaction. Do not use these two medicines at the same time unless told to do so by a health care provider.

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Anyone who is using any other type of prescription or nonprescription (over-the-counter) medicine or herbal treatment on the skin should check with a doctor before using a topical antibiotic.

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American Academy of Dermatology, PO Box 4014, Schaumburg, IL, 60168-4014, (847) 240-1859, (866) 503-SKIN (7546), http://www.aad.org.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

United States Food and Drug Administration (FDA), 10903 New Hampshire Ave., Silver Spring, MD, 02993-0002, (888) 463-6332, http://www.fda.gov.

Nancy Ross-Flanigan
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Antibody screening *see* **Blood typing and crossmatching**

Anti-cancer diet

Definition

The phrase *cancer diet* can be used to refer to several different approaches to the associations between **cancer** and **nutrition**. Some people think of a cancer diet as a preventive approach to cancer or a way to lower one's risk of cancer by avoiding foods associated with specific types of cancer. *Cancer diet* may also refer to the special **diets** or nutritional therapy prescribed for cancer patients to prevent them from developing **malnutrition** as a side effect of their cancer therapy. Last, *cancer diet* is sometimes used to refer to complementary and alternative (CAM) approaches to cancer that involve the use of special diets and **nutritional supplements**. The best-known of these are the macrobiotic diet, a largely vegetarian diet that originated in Japan; and the Gonzalez regimen, an alternative therapy for pancreatic cancer. The Gonzalez regimen includes a special diet, nutritional supplements, pancreatic enzymes in capsule form, and coffee **enemas**.

Purpose

The purpose of preventive cancer diets is to lower an individual's risk of cancer, particularly cancers of the digestive system. The purpose of nutritional therapy for cancer is to minimize loss of appetite, tissue wasting, and other symptoms of the disease or side effects of treatment; to help the patient tolerate cancer treatment; to protect the functioning of his or her immune system; and to maintain or improve the patient's quality of life. The purpose of the Gonzalez regimen and other CAM dietary therapies for cancer is to treat the disease itself rather than its symptoms or the side effects of mainstream cancer therapies.

Demographics

As of 2009, the evidence indicates that diet is second only to tobacco as a preventable cause of cancer. The World Health Organization (WHO) and the National Cancer Institute (NCI) both estimate that between 30% and 40% of all cancers in developed countries and 20% of all cancers in the developing countries are related to dietary factors. Diet has been linked not only to cancers of the mouth, esophagus, stomach, intestines, and rectum, but also to cancers of the prostate, breast, kidney, liver, and pancreas.

Cancer accounts for 7.1 million deaths worldwide each year, or 12.5% of the global total. About 20 million people around the world are presently living with cancer; this figure is expected to rise to 30 million by 2020. More than half of all new cancers occur in the developing countries. The greatest single risk factor for cancers related to diet is not race or sex but socioeconomic status (SES); cancer risk factors are highest and survival rates are lowest in groups with the least education.

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Cancer-fighting foods

Foods	Effects on cancer
Avocados	May attack free radicals in the body by blocking intestinal absorption of certain fats; may be useful in treating viral hepatitis (a cause of liver cancer)
Beans	May prevent or slow genetic damage to cells, prevent prostate cancer, and lower the risk of digestive cancers
Berries	May help prevent skin, bladder, lung, and breast cancers and slow the reproduction of cancer cells
Cabbage and cauliflower	May slow cancer growth and development and help to reduce the risk of lung, prostate, and bladder cancers
Broccoli	May prevent some types of cancer, including stomach, colon and rectal
Carrots	May reduce a wide range of cancers including lung, mouth, throat, stomach, intestine, bladder, prostate and breast
Chili peppers and jalapeños	May prevent cancers such as stomach cancer
Cruciferous vegetables (broccoli, cauliflower, kale, Brussels sprouts, and cabbage)	May help decrease prostate and other cancers
Dark green leafy vegetables	May reduce the risk of lung and breast cancer
Figs	May shrink tumors
Flax	May reduce the risk of breast, skin, and lung cancer
Garlic	May increase the activity of immune cells that fight cancer and indirectly help break down cancer causing substances. May help block carcinogens from entering cells and slow tumor development. May render carcinogens in the liver inactive May lower risk of a variety of cancers including stomach, colon, lung and skin
Grapefruits	May prevent cancer by sweeping carcinogens out of the body and inhibit the proliferation of breast-cancer cells in vitro
Grapes	May inhibit the enzymes that can stimulate cancer-cell growth and suppress immune response
Kale	May help stop the conversion of certain lesions to cancerous cells in estrogen-sensitive tissues, suppress tumor growth, and block cancer-causing substances from reaching their targets
Licorice root	May prevent the growth of prostate cancer
Mushrooms	May help the body fight cancer and build the immune system
Nuts	May suppress the growth of cancers
Oranges and lemons	May stimulate cancer-killing immune cells like lymphocytes that may function in breaking down cancer-causing substances
Papayas	May reduce absorption of cancer-causing nitrosamines from the soil or processed foods. May minimize cervical dysplasia and certain cancers
Red wine	May inhibit cell proliferation and help prevent cancer
Rosemary	May inhibit the development of breast and skin tumors
Seaweed and other sea vegetables	May help in the fight against breast cancer
Soy products like tofu	May help to prevent breast and prostate cancer by blocking and suppressing cancerous changes
Sweet potatoes	May prevent cancer cells from dividing, reduce the risk of cancer of the stomach, lung, colon, rectum, liver and pancreas, and protect against various types of cancer
Tomatoes	May combat prostate cancer and protect against breast, lung, mouth, stomach, and pancreatic cancer. May reduce risk of breast, prostate, pancreas and colorectal cancer. May prevent cellular damage that leads to cancer.
Tumeric	May inhibit the production of the inflammation-related enzyme cyclo-oxygenase 2 (COX-2), which reaches abnormally high levels in certain inflammatory diseases and cancers, especially bowel and colon cancer
Whole grains	May help decrease the risk of developing most types of cancer

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Precautions

People concerned to lower their individual risk of cancer by changing their diet should consult their primary care physician, or a reliable source like the American Cancer Society (ACS), the National Cancer Institute (NCI), or the World Health Organization (WHO) to be sure that they have up-to-date information about the relationships between cancer and nutrition. Patients being treated with nutritional therapy as part of cancer treatment should follow the recommendations of their doctors and dietitians. People considering CAM therapies for cancer should find out as much as they can about these approaches and talk to their primary care doctor before using them. They should not use CAM therapies as substitutes for mainstream cancer treatments.

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Description

Diet as a cancer preventive

Dietary changes as a preventive measure for lowering an individual's risk of cancer are sometimes called an anticancer diet, although this term does not have a precise definition. Most recommendations for lowering one's risk of cancer through changing one's eating patterns include the following:

- Eat less total fat and avoid hydrogenated fats—the type of fats often used to prepare fast foods.
- Choose foods that are high in fiber, such as wheat bran, kidney beans, garbanzo beans, navy beans, whole wheat, whole grains, legumes, whole-grain bread, and prunes.
- Eat large amounts of fresh fruits and vegetables, particularly the cruciferous vegetables (broccoli, cabbage, Brussels sprouts, mustard greens, kale, and cauliflower).
- Switch from red meat to fish; if possible, move from a meat-based to a vegetarian diet.
- Use olive oil rather than oils containing saturated fats when cooking.
- Choose foods that are high in calcium.
- Drink less alcohol.
- Consider using dietary supplements or foods reported to reduce cancer risk. These include vitamin D, selenium, green tea, and garlic.

One mainstream approach to diet that is often recommended as a way to lower cancer risk is the **Mediterranean diet**. The Mediterranean diet is better described as a nutritional model or pattern of food consumption rather than a diet in the usual sense of the word. There is more than one Mediterranean diet, if the phrase is understood to refer to the traditional foods and eating patterns found in the countries bordering the Mediterranean Sea. In general, however, Mediterranean diets have five major characteristics:

- High levels of fruits and vegetables, breads and other cereals, potatoes, beans, nuts, and seeds.
- Olive oil as the principal or only source of fat in the diet.
- Low to moderate amounts of dairy products, fish, and poultry; little use of red meat.
- Eggs used no more than 4 times weekly.
- Wine consumed in moderate amounts—two glasses per day for men, one glass for women.

These characteristics are in line with most of the recommendations of so-called anticancer diets.

It is important to remember, however, that diet is not the only risk factor for certain types of cancer. Occupation, environmental factors, and heredity also influence a given individual's risk of developing cancer. Thus changing one's diet to reduce the intake of high-risk foods and eating more foods associated with lowering one's cancer risk is not a guarantee that one will never develop cancer.

Nutritional therapy for cancer

Nutritional therapy for cancer patients is intended to help them maintain normal energy levels and avoid malnutrition. Appetite, taste, smell, and the ability to eat enough food or absorb the nutrients from food may be affected by the symptoms of the disease itself or by the side effects of treatment. Cancer patients frequently experience such symptoms as loss of appetite, **nausea and vomiting**, **constipation**, **diarrhea**, sore mouth, trouble swallowing, and depression. The most common nutritional problems in cancer patients are failure to eat enough high-protein foods and failure to take in enough overall calories.

The most common cause of malnutrition in cancer patients is anorexia, or loss of appetite, It may appear together with cachexia, a wasting syndrome in which the person loses weight, muscle, and fat tissue. Cachexia is not the same as **starvation**. A healthy person's body can adjust to starvation by slowing down its use of nutrients, but the body cannot adjust in this fashion in cancer patients with cachexia.

Nutrition therapy for cancer patients may be very different from standard guidelines for healthful eating. It is tailored to each patient's individual nutritional needs, response to cancer treatment, and personal food preferences. Patients who cannot take foods by mouth may require enteral nutrition (tube feeding) or parenteral nutrition (nutrients infused directly into the bloodstream through a catheter). Those who can take foods by mouth may need to change their eating habits by having several small meals a day rather than one large one; by taking medications for such problems as **nausea**, **vomiting**, constipation, or diarrhea; by drinking extra fluids to cope with such problems as **dry mouth** or changes in the sense of taste; and by adding as many high-protein, high-calorie foods to the diet as possible. Good choices include cheese and crackers, puddings, muffins, nutritional supplements, milk shakes, yogurt, ice cream, and chocolate.

CAM dietary therapies

GONZALEZ REGIMEN. The Gonzalez regimen is an alternative dietary therapy for pancreatic cancer

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developed by Nicholas Gonzalez, a physician in New York City. It is a complex combination of dietary changes, various nutritional supplements, and **detoxification** procedures.

- Diet. In general, the diet in the Gonzalez regimen requires the patient to consume mostly organic foods, and avoid such synthetic and refined foods as white flour and white sugar. The diet is, however, tailored to each patient. There are ten basic diets with 90 variations, ranging from nearly vegetarian diets to diets high in meat and fat.
- Supplements. These may include vitamins, minerals, trace elements, antioxidants, animal glandular concentrates and other food concentrates. Like the diet, the combination of supplements is also customized for the individual patient.
- Proteolytic enzymes made from pig pancreas. The basic theory underlying the Gonzalez regimen is that toxins from processed foods and environmental sources are responsible for cancers in humans, and that the pancreas is the organ primarily responsible for detoxifying the body. Gonzalez maintains that these pancreatic enzymes, taken in capsule form, enter the bloodstream and help the body eliminate and destroy malignant cells, waste material, and abnormal proteins that are toxic to the body. Overall, a cancer patient on the Gonzalez regimen will take between 150 and 175 capsules per day of nutrient supplements and pancreatic enzymes.
- Coffee enemas, taken twice daily. Gonzalez maintains that these enemas serve to detoxify the body by improving liver function and stimulate the gallbladder to empty, thereby speeding up the elimination of toxins and waste products.

MACROBIOTIC DIET. The macrobiotic diet is a diet based on heavy consumption of whole grains, vegetables, soy products, seaweed, beans and bean products, mild flavorings, fruit, fish, nuts, and seeds. All products used should be locally grown whenever possible and processed as little as possible. The specific foods are selected according to the time of year, the climate, the person's sex, age, and activity level, and their overall health status. The macrobiotic diet developed in Japan from traditional folk medicine. It was given the name "macrobiotic" in the 1950s by George Ohsawa (1893–1966) and brought to the West in the late 1950s.

The macrobiotic diet was first touted as a cure for cancer by one of Ohsawa's disciples, Michio Kushi (1926–). Kushi wrote a book about the macrobiotic diet as a cancer preventive and treatment, titled *The Cancer Prevention Diet: The Macrobiotic Approach to Preventing and Relieving Cancer* and first published in 1993. The website of the Kushi Institute includes personal testimonials from people who maintain that their cancers, ranging from uterine and pancreatic cancers to leukemia and brain tumors, were cured by following the macrobiotic diet.

KEY TERMS

Aflatoxins—A group of naturally occurring toxins produced by fungi of the genus *Aspergillus*.

Cachexia—Unintentional loss of body weight and muscle mass, and weakness that may occur in patients with cancer, AIDS, or other chronic diseases.

Enteral nutrition—The medical term for tube feeding.

Gonzalez regimen—An alternative therapy for pancreatic cancer that includes a special diet, nutritional supplements, pancreatic enzymes, and coffee enemas.

Macrobiotic diet—A diet based primarily on whole grains, vegetables, and beans, and avoiding refined or processed foods. It is sometimes recommended by practitioners of alternative medicine as a preventive for cancer.

Parenteral nutrition—Providing a person with necessary nutrients through intravenous feeding.

Origins

The Gonzalez regimen is based on the theories of William Donald Kelley (1925–2005), an orthodontist who developed pancreatic cancer in 1962 and claimed to have cured himself by a combination of dietary changes along with pancreatic enzymes, an individualized diet of **vitamins**, **minerals**, and other nutrients, and detoxification by means of coffee enemas. Kelley's theories were rejected by mainstream physicians, and his dental license was revoked in 1976.

The origins of the macrobiotic diet have been outlined in the previous section.

Risks

There are no known risks to eating a healthful diet in order to reduce one's risk of cancer nor in following the nutritional recommendations of one's treatment team if one is being treated for cancer.

Gonzalez notes that patients on his dietary regimen frequently experience muscle aches and pains,

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low-grade fevers, skin **rashes**, and other flu-like symptoms. He attributes these to the body's reaction to detoxification. Other reported side effects include bloating, gassiness, and **indigestion**.

The primary risk of following the macrobiotic diet is using it as a therapy for cancer instead of mainstream cancer treatment. Other people who have used it as a preventive diet to lower their risk of cancer have developed mild forms of malnutrition by failing to supplement the diet with vitamin D and vitamin B_{12}, which are not available in sufficient amounts in the foods that are the mainstays of the macrobiotic diet.

Health care team roles

Dietary changes as a cancer preventive for individual patients should be overseen and monitored by a primary care physician and a dietitian. Dietary therapy for cancer patients is usually designed and modified by a treatment team that includes a dietitian as well as doctors and nurses.

Patients with pancreatic cancer who are interested in the Gonzalez regimen should consult their present treatment team before contacting Dr. Gonzalez. Similarly, patients already diagnosed with cancer should consult their treatment team before using a macrobiotic diet as cancer therapy. The ACS "strongly urges individuals with cancer not to use a dietary program as an exclusive or primary means of treatment."

Research & general acceptance

The World Health Organization (WHO) has summarized recent findings about the relationship between lifestyle and dietary factors and cancer as follows:

- Convincing evidence for lowering cancer risk: Regular physical activity.
- Convincing evidence for increasing cancer risk: Overweight and obesity.
- Probable evidence for lowering cancer risk: High consumption of fresh fruits and vegetables.
- Probable evidence for increasing cancer risk: Excessive alcohol consumption; salted and preserved meats; highly cooked rather than rare or raw meats; fermented fish; very hot (temperature) drinks and food; and aflatoxins (toxins produced by fungi sometimes found in peanuts, grains, and tree nuts).
- Possible or insufficient evidence for lowering cancer risk: Plant fiber, soya, fish, omega-3 fatty acids, carotenoids, vitamins B_2, B_6, folate, B_{12}, C, D, E, calcium, zinc, selenium, and non-nutrient plant constituents.
- Possible or insufficient evidence for increasing cancer risk: Animal fats, heterocyclic amines (chemicals found in well-cooked meat), polycyclic aromatic hydrocarbons, and nitrosamines.

Evidence for CAM dietary therapies for cancer is considerably lower than that for preventive dietary modifications. The NCI's summary of the Gonzalez regimen states that "Existing clinical data concerning the effectiveness of the Gonzalez regimen as a treatment for cancer are limited and inconclusive," primarily because of the small size of the subject groups and the lack of a control group. In August 2009 a group of researchers in New York and Boston reported that patients following the Gonzalez regimen survived only a third as long as those receiving conventional **chemotherapy** and had a lower quality of life. There are no data as of 2009 regarding the effectiveness of the Gonzalez regimen in treating other types of cancer. There is one clinical trial of the Gonzalez regimen underway as of early 2010.

The macrobiotic diet is generally considered ineffective as a treatment for cancer. The ACS states, "After studying the literature and other available information, the American Cancer Society has found no evidence that macrobiotic diet is useful as a cure for cancer in humans." This position was reinforced by the fact that the wife and daughter of Michio Kushi both died of cancer (as did two physicians who claimed to have cured themselves of cancer by following the macrobiotic diet) and that Kushi himself had a cancerous tumor removed from his intestines in 2004. There are no clinical trials of the macrobiotic diet as cancer therapy as of 2009.

Caregiver concerns

Caregiver concerns include making sure that a cancer patient receiving nutritional therapy at home is following his or her dietary guidelines, and consulting the patient's doctor if the patient expresses interest in CAM dietary therapies.

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ORGANIZATIONS

American Cancer Society, 250 Williams Street NW, Atlanta, GA, 30303 800-ACS-2345 (227-2345), www.cancer.org.

American Dietetic Association, 120 South Riverside Plaza, Suite 2000, Chicago, IL, 60606-6995 800-877-1600, http://www.eatright.org/cps/rde/xchg/ada/hs.xsl/index.html.

Dr. Gonzalez.com: Individualized Nutritional Protocols, 36A East 36th Street, Suite 204, New York, NY, 10016 212-213-3337 212-213-3414, http://www.dr-gonzalez.com/index.htm.

Kushi Institute, 198 Leland Road, Becket, MA, 01223 413-623-5741 800-975-8744 413-623-8827, http://www.kushiinstitute.org.

National Cancer Institute, 6116 Executive Blvd., Room 3036A, Bethesda, MD, 20892-8322 800-422-6237, cancergovstaff@mail.nih.gov, www.cancer.gov.

National Center for Complementary and Alternative Medicine (NCCAM), 9000 Rockville Pike, Bethesda, MD, 20892, info@nccam.nih.gov, http://nccam.nih.gov.

World Health Organization (WHO), Avenue Appia 20, 1211 Geneva 27, Switzerland + 41 22 791 21 11 + 41 22 791 31 11, info@who.int, http://www.who.int/en.

Rebecca J. Frey PhD

Anticancer drugs

Definition

Anticancer drugs, also called antineoplastic drugs, are used to treat malignancies, or cancerous growths. Drug therapy may be used alone, or in combination with other treatments such as surgery or **radiation therapy**.

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Anticancer drugs*

Generic (brand name)	Clinical uses	Possible side effects**
Altretamine (Hexalen)	Treatment of advanced ovarian cancer	Bone marrow depression, nausea and vomiting
Bevacizumab (Avastin)	Colon or rectal cancer	Bleeding gums, dizziness, mouth sores, nosebleeds
Bleomycin (Blenoxane)	Hodgkin's lymphoma, squamous cell carcinoma, testicular cancer	Hair loss, hyperpigmentation of skin, pulmonary toxicity, stomatitis
Capecitabine (Xeloda)	Metastatic breast or colorectal cancer	Dehydration, dry skin, insomnia, nausea and vomiting, weakness
Carboplatin (Paraplatin)	Palliation of ovarian cancer	Bone marrow depression, nausea and vomiting
Cisplatin (Platinol)	Treatment of bladder, head and neck, ovarian, testicular, and uterine cancers	Renal toxicity and ototoxicity
Cyclophosphamide (Cytoxan)	Breast and ovarian cancer, leukemias, lymphomas, multiple myeloma, neuroblastoma, retinoblastoma	Bladder inflammation, bone marrow depression, hair loss, nausea and vomiting
Cytarabine (Cytosar-U)	Leukemias	Bone marrow depression, diarrhea, nausea and vomiting, stomatitis
Dacarbazine (DTIC-Dome)	Hodgkin's lymphoma, malignant melanoma	Bone marrow depression, nausea and vomiting
Docetaxel (Taxotere)	Certain types of breast, head and neck, lung, prostate, and stomach cancers	Mouth sores, muscle or joint pain, nausea and vomiting, sensitivity at injection site
Doxorubicin HCL (Adriamycin)	Many cancers, including breast, ovarian, and thyroid cancer; leukemias; lymphomas; and Wilms' tumor	Bone marrow depression, nausea and vomiting, swelling or pain on palms or soles of feet, thinning hair, trouble swallowing
Etoposide (VePesid)	Acute leukemias, lymphomas, testicular cancer	Bone marrow depression, hair loss, nausea and vomiting
Gemcitabine (Gemzar)	Pancreatic cancer	Diarrhea, loss of appetite, nausea and vomiting, thinning hair
Imatinib mesylate (Gleevec)	Leukemias	Anxiety or depression, joint pain, night sweats, stomach upset
Lapatinib (Tykerb)	Advanced breast cancer	Decreased appetite, difficulty sleeping, nausea and vomiting, pain

continued

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Anticancer drugs* [CONTINUED]

Generic (brand name)	Clinical uses	Possible side effects**
Oxaliplatin (Eloxatin)	Colorectal cancer	Hair loss, increased sensitivity to cold, numbness or tingling in extremities and mouth and throat
Paclitaxel (Taxol)	Advanced ovarian cancer	Bone marrow depression, hair loss, hypotension, muscle and joint pain, nausea and vomiting
Procarbazine (Matulane)	Hodgkin's lymphoma	Bone marrow depression, nausea and vomiting
Rituximab (Rituxan)	Non-Hodgkin's lymphoma	Back pain, flushing, heartburn, weight gain
Sipuleucel-T (Provenge)	Metastatic prostate cancer	Chills, fatigue, fever, headache, nausea, pain
Thalidomide (Thalomid)	Multiple myeloma	Birth defects (in pregnant women), blood clots, confusion, depression, joint pain, swelling of extremities
Topotecan (Hycamtin)	Small cell lung cancer	Bone marrow depression, diarrhea, hair loss, nausea and vomiting
Trastuzumab (Herceptin)	HER2-positive breast cancer	Acne, depression, hot flashes, joint pain, upset stomach
Tretinoin (ATRA)	Acute promyelocytic leukemia	Birth defects (in pregnant women), bone pain, hallucinations, increase in white blood cells, shivers
Vinblastine (Velban)	Breast cancer, Hodgkin's lymphoma, metastatic testicular cancer	Bone marrow depression, neurotoxicity
Vincristine (Oncovin)	Acute leukemia, Hodgkin's lymphoma	Constipation, neurotoxicity, possible tissue necrosis
Vinorelbine (Navelbine)	Non-small cell lung cancer	Bone marrow depression, fatigue, nausea and vomiting, thinning hair

*Includes antineoplastic drugs as well as newer drug classes, such as antimetabolites, monoclonal antibodies [immunotherapy drugs], topoisomerase inhibitors, and alkylating agents.
**While this chart lists some common side effects or risks, all of the drugs listed are also associated with additional and more severe side effects, so be sure to contact your doctor right away if these or any other symptoms occur.

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Purpose

Cancers are malignant growths. **Cancer** is commonly defined as the uncontrolled growth of cells with loss of differentiation and commonly with metastasis.

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Anticancer drugs are used to kill cancer cells or limit their growth in order to prolong life or relieve symptoms so that the quality of life is improved. In contrast, benign growths remain encapsulated and grow within a well-defined area. Although benign tumors may be fatal if untreated, due to pressure on essential organs, as in the case of a benign **brain tumor**, surgery or radiation are the preferred methods of treating growths which have a well defined location. Drug therapy is used when the tumor has spread, or may spread, to other areas of the body.

Several classes of drugs may be used in cancer treatment, depending on the nature of the cancer involved. Often two or more drugs are used together to most effectively control the cancer. Classes of cancer drugs include:

- alkylating agents. These agents cause direct damage to DNA (deoxyribonucleic acid, the genetic material in the nucleus of the cell) and prevent cells from reproducing. Alkylating agents include the following: nitrogen mustards (for example, mechlorethamine, chlorambucil, cyclophosphamide, isfofamide, melphalan); nitrosoureas (streptozocin, carmustine, lomustine); alkyl sulfonates (busulfan); triazines (dacarbazine, temozolomide; and ethylenimines (thiotepa, altretamine). The most serious side effect of these drugs is that they can cause damage to the bone marrow that results in leukemia often 5–10 years after treatment.
- platinium drugs (for example, cisplatin, carboplatin, and oxalaplatin). These drugs also damage DNA but have less chance of causing leukemia than alkylating agents.
- antimetabolites (5-fluorouacil, capecitabine, 6-mercaptopurine, methotrexate, gemcitabine, cytarabine, fludarabine, pemetrexed). These drugs damage DNA and RNA (ribonucleic acid, used in protein synthesis) by substituting incorrect compounds into the DNA and RNA when they reproduce. They are used most often to treat leukemias, breast cancer, ovarian cancer and intestinal cancer.
- antitumor antibiotics. Anthracyclines (daunorubicin, doxorubicin, epirubicin, idarubicin) are antibiotics that interfere with the synthesis of enzymes needed to duplicate DNA. These drugs are used to treat many types of cancer but have the potential to damage the heart if given in high doses. Other antitumor antibiotics include actinomycin-D, bleomycin, mitomycin-C and mitoxantrone.
- topoisomerase inhibitors (topotecan, irinotecan). These drugs also interfere with enzymes that control the reproduction of DNA.
- mitotic inhibitors (paclitaxel, docetaxel, ixabepilone, vinblastine, vincristine, vinorelbine, estramustine). Mitosis is the process of cell division. These drugs prevent cells from dividing.
- corticosteroids (prednisone, methylprednisone, dexamethasone). These drugs are related to sex hormones. They have many uses outside of cancer treatment, but when used in patients with cancer they slow cell growth and prevent nausea and vomiting caused by other anticancer drugs.
- hormone therapy drugs include several categories including: anti-estrogen drugs (ulvestrant, tamoxifen, toremifene); aromatase inhibitors (anastrozole, exemestane, letrozole); progestins (megestrol acetate); estrogens; anti-androgens (calutamide, flutamide, nilutamde); LHRH agonists (leuprolide, goserelin). These drugs work against hormones that stimulate the growth of cancer cells. For example, breast cancers are commonly stimulated by estrogens, and may be treated with drugs that inactivate the female sex hormones. Similarly, prostate cancer may be treated with drugs that inactivate androgens, the male sex hormone.
- immunotherapy drugs. These drugs enhance or stimulate the body's immune system. They include monoclonal antibody therapy (for example rituximab, alemtuzumab), where laboratory-made antibodies are injected into the body, immunostimulating drugs (interleukin -2, interferon-alpha) that nonspecifically stimulate the body's immune response, and immunomodulating drugs (thalidomide, lenalidomide) that alter the immune response

The majority of antineoplastic drugs act by interfering with cell growth. Since cancerous cells grow more rapidly than most other cells, the drugs are most effective in stopping cancer cell growth. Nevertheless, antineoplastic drugs affect not only the cancerous cells, but others cells that reproduce quickly, including cells in the hair follicles, ovaries, testes, and the blood-forming organs.

Newer methods of antineoplastic drug therapy have taken different approaches, including angiogenesis—the inhibition of formation of blood vessels feeding the tumor and contributing to tumor growth. The idea behind this approach is that if a tumor is deprived of blood, an the oxygen and food carried in blood, it will be unable to grow larger.

Many new cancer drugs are being explored on an experimental basis. Individuals who are interested in participating in a clinical trial of a new cancer drug can find a list of current trials at http://www.clinicaltrials.

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KEY TERMS

Cataract—Clouding of the lens of the eye, leading to poor vision or blindness.

Enzyme—a protein that changes the rate of a chemical reaction within the body without themselves being used up in the reaction

Impotent—Unable to achieve or maintain an erection of the penis.

Leukemia—A cancer of the blood.

Metastasis—The spread of cancer from its initial site to another part of the body.

gov. There is no charge to the patient to participate in a clinical trial.

Precautions

Because antineoplastic agents target all cells and not just cancer cells, they have a number of common adverse side effects. Hair loss is common due to the effects of these drugs on hair follicles, and anemia, immune system impairment, and blood-clotting problems are caused by destruction of the blood-forming organs, leading to a reduction in the number of red cells, white cells, and platelets. Because of the frequency and severity of these side effects, it is common to administer anticancer drugs in cycles, allowing time for recovery from the drug effects before administering the next dose. Doses are often calculated, not on the basis of weight, but rather based on blood counts, in order to avoid dangerous levels of anemia (red cell depletion), **neutropenia** (white cell deficiency), or **thrombocytopenia** (platelet deficiency.)

The health professional has many responsibilities in dealing with patients undergoing **chemotherapy**. The patient must be well informed of the risks and benefits of chemotherapy, and must be emotionally prepared for the side effects. These may be permanent, and younger patients should be aware of the high risk of sterility after chemotherapy.

The patient must also know which side effects should be reported to the practitioner, since many adverse effects do not appear until several days after a dose of chemotherapy. When chemotherapy is self-administered, the patient must be familiar with proper use of the drugs, including dose scheduling and avoidance of drug-drug and food-drug interactions.

Appropriate steps should be taken to minimize side effects. These may include administration of antinausea medications to reduce **nausea and vomiting**, maintaining fluid levels to reduce drug toxicity, particularly to the kidneys, or application of a scalp tourniquet to reduce blood flow to the scalp and minimize hair loss due to drug therapy.

Patients receiving chemotherapy also are at risk of infections due to reduced white blood counts. While prophylactic **antibiotics** may be useful, the health care professional should also be sure to use standard precautions, including gowns and gloves when appropriate. Patients should be alerted to avoid risks of viral contamination, and live virus immunizations are contraindicated until the patient has fully recovered from the effects of chemotherapy. Similarly, the patient should avoid contact with other people who have recently had live virus immunizations.

Other precautions that should be emphasized are the risks to pregnant or nursing women. Because antineoplastic drugs are commonly harmful to the fetus, women of childbearing potential should be cautioned to use two effective methods of birth control while receiving cancer chemotherapy. This also applies if the woman's male partner is receiving chemotherapy. **Breastfeeding** should be avoided while the mother is being treated.

Before prescribing or administering anticancer drugs, health care providers should inquire whether the patient has any of the following conditions:

- chickenpox or recent exposure to someone with chickenpox
- shingles (Herpes zoster)
- mouth sores
- current or past seizures
- head injury
- nerve or muscle disease
- hearing problems
- infection of any kind
- gout
- colitis
- intestine blockage
- stomach ulcer
- kidney stones
- kidney disease
- liver disease
- current or past alcohol abuse
- immune system disease
- cataracts or other eye problems
- high cholesterol

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The anticancer drug methotrexate has additional precautions. Patients should be given advice on the effects of sun exposure and the use of alcohol and **pain** relievers.

Side effects

Tamoxifen

The anticancer drug tamoxifen (Nolvadex) increases the risk of cancer of the uterus in some women. It also causes **cataracts** and other eye problems. Women taking this drug may have hot flashes, menstrual changes, genital **itching**, vaginal discharge, and weight gain. Men who take tamoxifen may lose interest in sex or become impotent. Health care providers should keep in close contact with patients to assess the individual risks associated with taking this powerful drug.

Other anticancer drugs

These side effects are not common, but could be a sign of a serious problem. Health care providers should immediately be consulted if any of the following occur:

- black, tarry, or bloody stools
- blood in the urine
- diarrhea
- fever or chills
- cough or hoarseness
- wheezing or shortness of breath
- sores in the mouth or on the lips
- unusual bleeding or bruising
- swelling of the face
- red "pinpoint" spots on the skin
- redness, pain, or swelling at the point where an injectable anticancer drug is given
- pain in the side or lower back
- problems urinating or painful urination
- dizziness or faintness
- fast or irregular heartbeat

Other side effects do not need immediate care, but should have medical attention. They are:

- joint pain
- skin rash
- hearing problems or ringing in the ears
- numbness or tingling in the fingers or toes
- trouble walking or balance problems
- swelling of the feet or lower legs
- unusual tiredness or weakness
- loss of taste
- seizures
- dizziness
- confusion
- agitation
- headache
- dark urine
- yellow eyes or skin
- flushing of the face

In addition, there are other possible side effects that do not need medical attention unless they persist or interfere with normal activities. These include changes in menstrual period, itchy skin, **nausea** and **vomiting**, and loss of appetite.

Other rare side effects may occur. Anyone who has unusual symptoms after taking anticancer drugs should contact the physician who prescribed the medication.

Interactions

Anticancer drugs may interact with a number of other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. The health care provider should be aware of all other prescription or nonprescription (over-the-counter) medicines and herbal remedies a patient is taking. The primary care provider should also be told if the patient has been treated with radiation or has taken other anticancer drugs.

Resources

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ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (800) 227-2345, http://www.cancer.org.

National Cancer Institute (National Institutes of Health), NCI Office of Communications and Education, 6116 Executive Blvd. Suite 300, Bethesda, MD, 20892-8322, (800) 4-CANCER (422-6237), cancergovstaff@mail.nih.gov, http://www.cancer.gov/.

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Anticholinergic drugs *see* **Antiparkinson drugs**

Anticlotting drugs *see* **Anticoagulant and antiplatelet drugs**

Anticoagulant and antiplatelet drugs

Definition

Anticoagulants, also called anticlotting drugs or blood thinners, are drugs used to prevent blood clot formation or to prevent a clot that has formed from enlarging. They inhibit clot formation by blocking the action of clotting factors or platelets. Anticoagulant drugs fall into three categories: inhibitors of clotting factor synthesis, inhibitors of thrombin, and antiplatelet drugs.

Purpose

Anticoagulant drugs reduce the ability of the blood to form clots. Although blood clotting is essential to prevent serious bleeding in the case of skin cuts, clots inside the blood vessels block the flow of blood to major organs and cause heart attacks and strokes. Although these drugs are sometimes called blood thinners, they do not actually thin the blood. Furthermore, this type of medication will not dissolve clots that already have formed, although the drug stops an existing clot from worsening. However, another type of drug, used in **thrombolytic therapy**, will dissolve existing clots.

Anticoagulant drugs are used for a number of conditions. For example, they may be given to prevent **blood clots** from forming after the replacement of a heart valve or to reduce the risk of a **stroke** or another **heart attack** after a first heart attack. They are also used to reduce the chance of blood clots forming during open-heart surgery or bypass surgery. Low doses of these drugs may be given to prevent blood clots in patients who have heart **arrhythmias**, as well as those who must stay in bed for a long time after certain types of surgery.

Because anticoagulants affect the blood's ability to clot, they can increase the risk of severe bleeding and heavy blood loss. It is thus essential to take these drugs exactly as directed and to see a physician regularly as long as they are prescribed.

Description

Anticoagulant drugs are available only with a physician's prescription. They come in tablet and injectable forms. They fall into three groups:

- Inhibitors of clotting factor synthesis. These anticoagulants inhibit the production of certain clotting factors in the liver. One example is warfarin (Coumadin).
- Inhibitors of thrombin. Thrombin inhibitors interfere with blood clotting by blocking the activity of thrombin, a protein needed for blood clotting. They include heparin, enoxaparin (Lovenox), dalteparin (Fragmin), ardeparin (Normiflo), and lepirudin (Refludan).
- Antiplatelet drugs. Antiplatelet drugs interact with platelets, which is a type of blood cell, to block platelets from aggregating into harmful clots. They include: aspirin, ticlopidine (Ticlid), clopidogrel (Plavix), tirofiban (Aggrastat), eptifibatide (Integrilin) dipyridamole (Persantine), and abciximag (ReoPro).

Recommended dosage

The recommended dosage depends on the type of anticoagulant drug and the medical condition for which it is prescribed. The prescribing physician or the pharmacist who filled the prescription can provide information concerning the correct dosage. Usually, the physician will adjust the dose after checking the patient's clotting time.

Anticoagulant and antiplatelet drugs must be taken exactly as directed by the physician. Larger or more frequent doses should not be taken, and the drug should not be taken for longer than prescribed. Taking

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KEY TERMS

Anticoagulant—Drug used to prevent clot formation or to prevent a clot that has formed from enlarging. Anticoagulant drugs inhibit clot formation by blocking the action of clotting factors or platelets. Anticoagulant drugs fall into three groups: inhibitors of clotting factor synthesis, inhibitors of thrombin and antiplatelet drugs.

Antiplatelet drug—Drug that inhibits platelets from aggregating to form a plug. They are used to prevent clotting and alter the natural course of atherosclerosis.

Arrhythmia—An abnormal heart rhythm.

Atherosclerosis—Condition characterized by deposits of fatty plaque in the arteries.

Clot—A soft, semi-solid mass that forms when blood gels.

Platelet—A small, disk-shaped body in the blood that has an important role in blood clotting: they form the initial plug at the rupture site of a blood vessel.

Thrombin—Thrombin is a protein produced by the body. It is a specific clotting factor that plays an important role in the blood clotting process.

Thrombin inhibitor—Thrombin inhibitors are one type of anticoagulant medication, used to help prevent formation of harmful blood clots in the body by blocking the activity of thrombin.

too much of this medication can cause severe bleeding. Anticoagulants should also be taken on schedule. A record of each dose should be kept as it is taken. If a dose is missed, it should be taken as soon as possible followed by the regular dose schedule. However, a patient who forgets to take a missed dose until the next day should not take the missed dose at all and should not double the next dose, as this could lead to bleeding. A record of all missed doses should be kept for the prescribing physician who should be informed at the scheduled visits.

Precautions

People who take anticoagulants should see a physician regularly while taking these drugs, particularly at the beginning of therapy. The physician will order periodic blood tests to check the blood's clotting ability. The results of these tests will help the physician determine the proper amount of medication to be taken each day.

Time is required for normal clotting ability to return after anticoagulant treatment. During this period, patients must observe the same precautions they observed while taking the drug. The length of time needed for the blood to return to normal depends on the type of anticoagulant drug that was taken. The prescribing physician will advise as to how long the precautions should be observed.

People who are taking anticoagulant drugs should tell all physicians, dentists, pharmacists, and other medical professionals who provide medical treatments or services to them that they are taking such a medication. They should also carry identification stating that they are using an anticoagulant drug.

Other prescription drugs, over-the-counter medicines, especially **aspirin**, should be not be taken without the prescribing physician being informed. Certain herbal remedies can enhance or diminish the effect of these drugs. Be sure to tell the prescribing physician about any herbal medicines or dietary supplements being taken.

Because of the risk of heavy bleeding, anyone who takes an anticoagulant drug must take care to avoid injuries. Sports and other potentially hazardous activities should be avoided. Any falls, blows to the body or head, or other injuries should be reported to a physician, as internal bleeding may occur without any obvious symptoms. Special care should be taken in shaving and in brushing and flossing the teeth. Soft toothbrushes should be used and the flossing should be very gentle. Electric razors should be used instead of a blade.

Alcohol can change the way anticoagulant drugs affect the body. Anyone who takes this medicine should not have more than one to two drinks at any time and should not drink alcohol every day.

Special conditions

People with specific medical conditions or who are taking certain other medicines can have problems if they take anticoagulant drugs. Before taking these drugs, the prescribing physician should be informed about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to anticoagulants in the past should let his or

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her physician know before taking the drugs again. The physician should also be told about any **allergies** to beef, pork, or other foods; dyes; preservatives; or other substances.

PREGNANCY. Anticoagulants may cause many serious problems if taken during **pregnancy**. **Birth defects**, severe bleeding in the fetus, and other problems that affect the physical or mental development of the fetus or newborn are possible. The mother may also experience severe bleeding if she takes anticoagulants during pregnancy, during delivery, or even shortly after delivery. Women should not take start taking anticoagulants during pregnancy and should not become pregnant while taking it. Any woman who becomes pregnant or suspects that she has become pregnant while taking an anticoagulant should check with her physician immediately.

BREASTFEEDING. Some anticoagulant drugs may pass into breast milk. Blood tests can be done on nursing babies to see whether the drug is causing any problems. If it is, other medication may be prescribed to counteract the effects of the anticoagulant drug.

OTHER MEDICAL CONDITIONS. Before using anticoagulant drugs, people should inform their physician about *any* medical problems they have. They should also let the physician who prescribed the medicine know if they are being treated by any other medical physician or dentist. In addition, people who will be taking anticoagulant drugs should let their physician know if they have recently had any of the following:

- fever lasting more than one to two days
- severe or continuing diarrhea
- childbirth
- heavy or unusual menstrual bleeding
- insertion of an intrauterine contraceptive device (IUD)
- falls, injuries, or blows to the body or head
- any type of surgery, including dental surgery
- spinal anesthesia
- radiation treatment

USE OF CERTAIN FOODS AND MEDICINES. Many foods and drugs may affect the way the anticoagulant drugs work or may increase the risk of side effects. Leafy green vegetables, in particular, interact with some of these drugs. The prescribing physician should provide a list of foods that interact with anticoagulant drugs. These foods do not necessarily need to be avoided, but should be eaten in reasonably consistent amounts so that their effects can be compensated for in the prescribed dosage.

Side effects

The most common minor side effects are bloating or gas. These problems usually go away as the body adjusts to the drug and do not require medical treatment.

More serious side effects may occur, especially if excessive anticoagulant is taken. If any of the following side effects occur, a physician should be notified immediately:

- bleeding gums
- sores or white spots in the mouth or throat
- unusual bruises or purplish areas on the skin
- unexplained nosebleeds
- unusually heavy bleeding or oozing from wounds
- unexpected or unusual menstrual bleeding
- blood in the urine
- cloudy or dark urine
- painful or difficult urination or sudden decrease in amount of urine
- black, tarry, or bloody stools
- coughing up blood
- vomiting blood or something that looks like coffee grounds
- constipation
- pain or swelling in the stomach or abdomen
- back pain
- stiff, swollen, or painful joints
- painful, bluish or purplish fingers or toes
- puffy or swollen eyelids, face, feet, or lower legs
- changes in the color of the face
- skin rash, itching, or hives
- yellow eyes or skin
- severe or continuing headache
- sore throat and fever, with or without chills
- breathing problems or wheezing
- tightness in the chest
- dizziness
- unusual tiredness or weakness
- weight gain.

In addition, patients taking anticoagulant drugs should check with their physicians as soon as possible if any of these side effects occur:

- nausea or vomiting
- diarrhea
- stomach pain or cramps.

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Other side effects may occur. Anyone who has unusual symptoms while taking anticoagulant drugs should get in touch with his or her physician.

Interactions

Anticoagulants may interact with many other medications. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be increased. Anyone who takes anticoagulants should inform the prescribing physician about other prescription or nonprescription (over-the-counter medicines) he or she is taking, even aspirin, **laxatives**, **vitamins**, herbals, or **antacids**.

Diet also affects the way anticoagulant drugs work in the body. A normal, balanced diet should be followed every day while taking such medication. No dietary changes should be made without informing first the prescribing physician, who should also be told of any illness or other condition interfering with the ability to eat normally. Diet is a very important consideration because the amount of vitamin K in the body affects how anticoagulant drugs work.

Dicoumarol and warfarin act by reducing the effects of vitamin K. Vitamin K is found in meats, dairy products, leafy, green vegetables, and some multiple vitamins and **nutritional supplements**. For the drugs to work properly, it is best to have the same amount of vitamin K in the body all the time. Foods containing vitamin K in the diet should not be increased or decreased without consulting with the prescribing physician. If the patient takes vitamin supplements, he or she should check the label to see if it contains vitamin K. Because vitamin K is also produced by intestinal bacteria, a severe case of **diarrhea** or the use of laxatives may also alter a person's vitamin K levels.

Resources

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ORGANIZATIONS

American College of Cardiology, Heart House, 2400 N Street NW, Washington, DC, 20037, (202) 375-6000, ext 5603, (202) 375-7000, (800) 223-4636, ext. 5603, resource@acc.org, http://www.acc.org.

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

American Society of Hematology, 2021 L St. NW, Suite 900, Washington, DC, 20036, (202) 776-0544, (202) 776-0545, http://www.hematology.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

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Anticonvulsant drugs

Definition

Anticonvulsant drugs are medicines used to prevent or treat convulsions (seizures).

Purpose

Anticonvulsant drugs are used to control seizures in people with **epilepsy**. Epilepsy is not a single disease—it is a set of symptoms that may have different causes in different people. The common thread is an imbalance in the brain's electrical activity. This imbalance causes seizures that may affect part or all of the body and may or may not cause a loss of consciousness. Anticonvulsant drugs act on the brain to reduce the frequency and severity of seizures.

Some cases of epilepsy are brought on by head injuries, brain tumors or infections, or metabolic problems such as low blood sugar. But in some people with epilepsy, the cause is not clear.

Anticonvulsant drugs are an important part of the treatment program for epilepsy. Different kinds of drugs may be prescribed for different types of seizures. In addition to taking medicine, patients with epilepsy should get enough rest, avoid **stress**, and practice good health habits.

Some physicians believe that giving the drugs to children with epilepsy may prevent the condition from getting worse in later life. However, others say the

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KEY TERMS

Chronic—A word used to describe a long-lasting condition. Chronic conditions often develop gradually and involve slow changes.

Epilepsy—A brain disorder with symptoms that include seizures.

Glaucoma—A condition in which pressure in the eye is abnormally high. If not treated, glaucoma may lead to blindness.

Porphyria—A disorder in which porphyrins build up in the blood and urine.

Porphyrin—A type of pigment found in living things, such as chlorophyll which makes plants green or hemoglobin which makes blood red.

Seizure—A sudden attack, spasm, or convulsion.

Systemic lupus erythematosus (SLE)—A chronic disease with many symptoms, including weakness, fatigue, joint pain, sores on the skin, and problems with the kidneys, spleen, and other organs.

Withdrawal symptoms—A group of physical or mental symptoms that may occur when a person suddenly stops using a drug to which he or she has become dependent.

effects are the same, whether treatment is started early or later in life. Determining when treatment begins depends on the physician and his assessment of the patient's symptoms.

Physicians also prescribe certain anticonvulsant drugs for other conditions, including **bipolar disorder** and migraine headaches.

Description

Anticonvulsant drugs may be divided into several classes. The hydantoins include pheytoin (Dilantin) and mephenytoin (Mesantoin.) Ther succimides include ethosuximide (Zarontin) and methsuccimide (Celontin.) The **benzodiazepines**, which are better known for their use as tranquilizers and sedatives, include clonazepam (Klonopin), clorazepate (Tranxene) and diazepam (Valium.) There are also a large number of other drugs which are not related to larger groups. These include carbamazepine (Tegretol), valproic acid (Depakote, Depakene) gabapentin (Neurontin), topiramate (Topamax), felbamate (Felbatol) and several others. Phenobarbital has been used as an anticonvulsant, and is still useful for some patients. The drugs are available only with a physician's prescription and come in tablet, capsule, liquid, and "sprinkle" forms.

Recommended dosage

The recommended dosage depends on the type of anticonvulsant, its strength, and the type of seizures for which it is being taken. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

Do not stop taking this medicine suddenly after taking it for several weeks or more. Gradually tapering the dose may reduce the chance of withdrawal effects.

Do not change brands or dosage forms of this medicine without checking with a pharmacist or physician. If a prescription refill does not look like the original medicine, check with the pharmacist who filled the prescription.

Precautions

Patients on anticonvulsant drugs should see a physician regularly while on therapy, especially during the first few months. The physician will check to make sure the medicine is working as it should and will note unwanted side effects. The physician may also need to adjust the dosage during this period.

Valproic acid can cause serious liver damage, especially in the first 6 months of treatment. Children are particularly at risk, but anyone taking this medicine should see their physician regularly for tests of liver function and should be alert to symptoms of liver damage, such as yellow skin and eyes, facial swelling, loss of appetite, general feeling of illness, loss of appetite, and **vomiting**. If liver problems are suspected, call a physician immediately.

Felbatol has caused serious liver damage and **aplastic anemia**, a condition in which the bone marrow stops producing blood cells. Patients taking this drug should have regular blood counts, and should stop taking the drug if there are too few red blood cells.

While taking anticonvulsant drugs, do not start or stop taking any other medicines without checking with a physician. The other medicines may affect the way the anticonvulsant medicine works.

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Because anticonvulsant drugs work on the central nervous system, they may add to the effects of alcohol and other drugs that slow down the central nervous system, such as **antihistamines**, cold medicine, allergy medicine, sleep aids, other medicine for seizures, tranquilizers, some **pain** relievers, and **muscle relaxants**. Anyone taking anticonvulsant drugs should check with his or her physician before drinking alcohol or taking any medicines that slow the central nervous system.

Anticonvulsant drugs may interact with medicines used during surgery, dental procedures, or emergency treatment. These interactions could increase the chance of side effects. Anyone who is taking anticonvulsant drugs should be sure to tell the health care professional in charge before having any surgical or dental procedures or receiving emergency treatment.

Some people feel drowsy, dizzy, lightheaded, or less alert when using these drugs, especially when they first begin taking them or when their dosage is increased. Anyone who takes anticonvulsant drugs should not drive, use machines or do anything else that might be dangerous until they have found out how the drugs affect them.

Anticonvulsant drugs may affect the results of certain medical tests. Before having medical tests, people who take anticonvulsant drugs should make sure that the medical professional in charge knows what they are taking.

Children may be more likely to have certain side effects from anticonvulsant drugs, such as behavior changes; tender, bleeding, or swollen gums; enlarged facial features; and excessive hair growth. Problems with the gums may be prevented by regularly brushing and flossing, massaging the gums, and having the teeth cleaned every 3 months whether the patient is a child or an adult.

Children who take high doses of this medicine for a long time may have problems in school.

Older people may be more sensitive to the effects of anticonvulsant drugs. This may increase the chance of side effects and overdoses.

Special conditions

People with certain medical conditions or who are taking certain other medicines can have problems if they take anticonvulsant drugs. Before taking these drugs, be sure to let the physician know about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to anticonvulsant drugs or to **tricyclic antidepressants** such as imipramine (Tofranil) or desipramine (Norpramin) in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. Some anticonvulsant drugs taken during **pregnancy** may cause bleeding problems in the mother during delivery and in the baby after delivery. This problem can be avoided by giving vitamin K to the mother during delivery and to the baby after birth.

Pregnancy may affect the way the body absorbs anticonvulsant drugs. Women who are prone to seizures may have more seizures during pregnancy, even though they are taking their medicine regularly. If this happens, they should check with their physicians about whether the dose needs to be increased.

BREASTFEEDING. Some anticonvulsant drugs pass into breast milk and may cause unwanted effects in babies whose mothers take the medicine. Women who are **breastfeeding** should check with their physicians about the benefits and risks of using anticonvulsant drugs.

DIABETES. Anticonvulsant drugs may affect blood sugar levels. Patients with diabetes who notice changes in the results of their urine or blood tests should check with their physicians.

OTHER MEDICAL CONDITIONS. Before using anticonvulsant drugs, people with any of these medical problems should make sure their physicians are aware of their conditions:

- liver disease
- kidney disease
- thyroid disease
- heart or blood vessel disease
- blood disease
- brain disease
- problems with urination
- current or past alcohol abuse
- behavior problems
- diabetes mellitus
- glaucoma
- porphyria
- systemic lupus erythematosus
- fever higher than 101 °F (38.3 °C) for more than 24 hours

USE OF CERTAIN MEDICINES. Taking anticonvulsant drugs with certain other drugs may affect the

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way the drugs work or may increase the chance of side effects.

Side effects

The most common side effects are **constipation**, mild **nausea** or **vomiting**, and mild **dizziness**, drowsiness, or lightheadedness. These problems usually go away as the body adjusts to the drug and do not require medical treatment. Less common side effects, such as **diarrhea**, sleep problems, aching joints or muscles, increased sensitivity to sunlight, increased sweating, hair loss, enlargement of facial features, excessive hair growth, muscle twitching, and breast enlargement in males also may occur and do not need medical attention unless they persist or are troublesome.

Other side effects may need medical attention. If any of these side effects occur, check with a physician as soon as possible:

- clumsiness or unsteadiness
- slurred speech or stuttering
- trembling
- unusual excitement, irritability, or nervousness
- uncontrolled eye movements
- blurred or double vision
- mood or mental changes
- confusion
- increase in seizures
- bleeding, tender, or swollen gums
- skin rash or itching
- enlarged glands in neck or armpits
- muscle weakness or pain
- fever

Other side effects are possible. Anyone who has unusual symptoms after taking anticonvulsant drugs should get in touch with his or her physician.

Interactions

Some anticonvulsant drugs should not be taken within two to three hours of taking **antacids** or medicine for diarrhea. These medicines may make the anticonvulsant drugs less effective. Ask the pharmacist or physician for more information.

Birth control pills may not work properly when anticonvulsant drugs are being taken. To prevent pregnancy, ask the physician or pharmacist if additional methods of birth control should be used while taking anticonvulsant drugs.

Anticonvulsant drugs may interact with many other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes anticonvulsant drugs should let the physician know all other medicines he or she is taking. Among the drugs that may interact with certain anticonvulsant drugs are:

- airway opening drugs (bronchodilators) such as aminophylline, theophylline (Theo-Dur and other brands), and oxtriphylline (Choledyl and other brands)
- medicines that contain calcium, such as antacids and calcium supplements
- blood thinning drugs
- caffeine
- antibiotics such as clarithromycin (Biaxin), erythromycins, and sulfonamides (sulfa drugs)
- disulfiram (Antabuse), used to treat alcohol abuse
- fluoxetine (Prozac)
- monoamine oxidase inhibitors (MAO inhibitors) such as phenelzine (Nardil) or tranylcypromine (Parnate), used to treat conditions including depression and Parkinson's disease
- tricyclic antidepressants such as imipramine (Tofranil) or desipramine (Norpramin)
- corticosteroids
- acetaminophen (Tylenol)
- aspirin
- female hormones (estrogens)
- male hormones (androgens)
- cimetidine (Tagamet)
- central nervous system (CNS) depressants such as medicine for allergies, colds, hay fever, and asthma; sedatives; tranquilizers; prescription pain medicine; muscle relaxants; medicine for seizures; sleep aids; barbiturates; and anesthetics
- alcohol
- other anticonvulsant drugs

The list above does not include every drug that may interact with anticonvulsant drugs. Be sure to check with a physician or pharmacist before combining anticonvulsant drugs with any other prescription or nonprescription (over-the-counter) medicine.

ORGANIZATIONS

American Epilepsy Society (AES), 342 North Main Street, West Hartford, CT, 06117-2507, (860) 586-7505, (860) 586-7550, http://www.aesnet.org/.

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Epilepsy Foundation of America, 8301 Professional Place, Landover, MD, 20785-7223, (301) 577-2684, (800) 332-1000, info@efa.org, http://www.efa.org.

National Institute of Neurological Disorders and Stroke (NINDS), NIH Neurological Institute, P. O. Box 5801, Bethesda, MD, 20824, (301) 496-5751, (800) 352-9424, http://www.ninds.nih.gov/.

Nancy Ross-Flanigan

Antidepressant drugs

Definition

Antidepressant drugs are medicines that reduce symptoms such as extreme sadness, hopelessness, and lack of energy that characterize **depressive disorders**.

Purpose

Depressive disorders may either be unipolar (depression alone) or bipolar (depression alternating with periods of extreme excitation or **mania**). The formal diagnosis requires a cluster of symptoms, lasting at least two weeks. These symptoms include, but are not limited to, mood changes, **insomnia** or hypersomnia (excessive sleeping), and diminished interest in daily activities formerly found enjoyable. The symptoms are not caused by any medical condition, drug side effect, or adverse life event. The condition is severe enough to cause clinically significant distress or impairment in social, occupational, or other important areas of functioning.

Secondary depression, or depression caused by unfavorable life events such as the **death** of a loved one is normally self limiting, and may best be treated with cognitive/behavioral therapy rather than drugs.

Description

Antidepressant agents act by increasing the levels of excitatory neurotransmitters, or nerve cell chemicals that act as messengers in the brain's nervous system. The neurotransmitters most commonly affected by antidepressant drugs are serotonin, dopamine, and norepinephrine. Antidepressant drugs may be prescribed as a first-line treatment for depression, or in conjunction with other methods of controlling depression, such as behavioral therapy and **exercise**.

The main types of antidepressant drugs in use today are listed below.

- tricyclic antidepressants, such as amitriptyline (Elavil), desipramine (Norpramin), doxepin (Sinequan), imipramine (Tofranil), nortriptyline (Pamelor), protriptyline (Vivactil), and trimpramine (Surmontil)
- selective serotonin reuptake inhibitors (SSRIs), such as citalopram hydrobromide (Celexa, Emocal, Sepram, Seropram), escitalopram oxalate (Lexapro, Cipralex, Esertia), fluvoxamine (Luvox, Faverin, Dumyrox), paroxetine hydrochloride (Paxil, Seroxat, Aropax, Deroxat, Rextin, Xetanor, Paroxat), fluoxetine (Prozac, Fontex, Seromex, Seronil, Fluctin, Fluox), and sertraline (Zoloft, Lustral, Serlan).
- monoamine oxidase inhibitors (MAO inhibitors), such as phenelzine (Nardil), and tranylcypromine (Parnate)
- tetracyclic compounds and atypical antidepressants that do not fall into any of the above categories

Selective serotonin reuptake inhibitors maintain levels of the excitatory neurohormone serotonin in the brain. They do not alter levels of norepinephrine. These have become the drugs of choice for a variety of psychiatric disorders, primarily because of their low incidence of severe side effects as compared with other drugs in this therapeutic class. SSRIs show similar actions and side effect profiles, but may vary in individual response and duration of action.

Tricyclic compounds, identified by their chemical structure containing three carbon rings, are an older class of antidepressants. Although generally effective, they have a high incidence certain side effects, notably **dry mouth** and dry eyes, which can cause discomfort. They also cause cardiac **arrhythmias**. Because tricyclics act on both serotonin and norepinephrine, they may have some value in treatment of patients who fail to respond to SSRIs. Drugs in this class often are available at low prices, which may be significant when cost is a major factor in treatment. They also have been found useful in control of some neurologic **pain** syndromes.

Tricyclic antidepressants are similar, but may vary in severity of side effects, most notably the degree of **sedation** and the extent of the anticholinergic effects.

Tetracyclic compounds and atypical antidepressants are chemically distinct from both the major groups and each other. Although maprotilene (no brand name, marketed in generic form only) and mirtazepine (Remeron) are similar in chemical structures, they differ in their balance of activity on serotonin and norepinephrine levels. Bupropion (Wellbutrin, Zyban) is another atypical antidepressant. It inhibits norepinephrine and dopamine uptake.

Monoamine oxidase inhibitors (phenelzine [Nardil], tranylcypromine [Parnate]) have largely been supplanted in therapy because of their high risk of severe

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KEY TERMS

Cognitive behavioral therapy—A type of psychotherapy in which people learn to recognize and change negative and self-defeating patterns of thinking and behavior.

Depression—A mental condition in which people feel extremely sad and lose interest in life. People with depression also may have sleep problems and loss of appetite and may have trouble concentrating and carrying out everyday activities.

Dopamine—A neurotransmitter and the precursor of norepinephrine.

Neurotransmitter—One of a group of chemicals secreted by a nerve cell (neuron) to carry a chemical message to another nerve cell, often as a way of transmitting a nerve impulse. Examples of neurotransmitters include acetylcholine, dopamine, serotonin, and norepinephrine.

Norepinephrine—A hormone released by nerve cells and the adrenal medulla that causes constriction of blood vessels. Norepinephrine also functions as a neurotransmitter.

Serotonin—5-Hydroxytryptamine; a substance that occurs throughout the body with numerous effects including neurotransmission. Inadequate amounts of serotonin are implicated in some forms of depression.

adverse effects, most notably severe **hypertension**. They act by inhibiting the enzyme monoamine oxidase, which is responsible for the metabolism of the stimulatory neurohormones norepinephrine, epinephrine, dopamine, and serotonin. The MAOIs are normally reserved for patients who are resistant to safer drugs. Two drugs, eldepryl (Carbex, used in treatment of **Parkinson's disease**) and the herb, **St. John's wort**, have some action against monoamine oxidase B, and have shown some value as antidepressants. They do not share the same risks as the non-selective MAO inhibitors.

All antidepressant agents, regardless of their structure, have a slow onset of action, typically three to five weeks. Although adverse effects may be seen as early as the first dose, significant therapeutic improvement is always delayed. Similarly, the effects of antidepressants will continue for a period after the drugs have been discontinued.

Recommended dosage

Dose varies with the specific drug and patient. Specialized references or a physician should be consulted.

Precautions

Antidepressants have many significant cautions and adverse effects. Although a few are listed here, specific references should be consulted for more complete information.

In October 2004, the FDA issued a warning that treating children and adolescents with SSRIs increased the risk of suicidal thoughts and behaviors. In a review of 2,200 children treated with SSRIs, the FDA found no completed suicides, but did find a 4% increase in suicidal thinking or behavior, including **suicide** attempts. In 2006, this warning was extended to include all people under age 25. However, in April 2007, a comprehensive review of SSRI treatment in children, adolescents, and adults under age 25 that was published in the *Journal of the American Medical Society* indicated that the benefits of treating these patients with SSRIs generally outweighed the risks. To reduce the risks of suicide, SSRIs should only be prescribed by a psychiatrist, not a family physician, and parents and caregivers should be alert for any of the signs of potential suicidal or self-harm behaviors.

SSRI use during **pregnancy** may not be safe, particularly during the third trimester. Exposure of fetuses to citalopram hydrobromide and other SSRIs during the late third trimester have led to very serious complications, including serotonin syndrome—a condition in which high serotonin levels cause severe problems. Symptoms in a newborn may be the result of a direct toxic effect of the SSRI or withdrawal from the drug. SSRIs pass into breast milk and may negatively affect a baby.

The most common side effects of SSRIs include:

- dry mouth
- dizziness
- sour or acid stomach or gas
- heartburn
- decreased appetite
- stomach upset
- nausea

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- diarrhea
- sweating
- headache
- weakness or fatigue
- drowsiness
- insomnia
- nervousness or anxiety
- tremors
- sexual problems

Additional information on precautions and side effects of SSRIs can be found in the entry, **antidepressant drugs, SSRI**.

Tricyclic antidepressants. Amoxepine (not marketed by brand, generic available), although a tricyclic antidepressant rather than a neuroleptic (major tranquilizer), displays some of the more serious effects of the neuroleptics, including tardive dyskinesias (drug induced involuntary movements) and neuroleptic malignant syndrome, a potentially fatal syndrome with symptoms including high **fever**, altered mental status, irregular pulse or blood pressure, and changes in heart rate. These adverse effects have not been reported with other tricyclic antidepressants.

The most common side effects are **dizziness**, drowsiness, dry mouth, unpleasant taste, **headache**, **nausea**, mild tiredness or weakness, increased appetite or craving for sweets, and weight gain. These problems usually go away as the body adjusts to the drug and do not require medical treatment. Less common side effects, such as **diarrhea**, **vomiting**, sleep problems, sweating, and **heartburn** also may occur and do not need medical attention unless they do not go away or they interfere with normal activities.

More serious side effects are not common, but may occur. If any of the following side effects occur, check with the physician who prescribed the medicine as soon as possible:

- blurred vision
- eye pain
- confusion
- hallucinations
- fainting
- loss of balance
- swallowing problems
- difficulty speaking
- mask-like face
- shakiness or trembling
- nervousness or restlessness
- movement problems, such as shuffling walk, stiff arms and legs, or slow movement
- decreased sexual ability
- fast or irregular heartbeat
- constipation
- problems urinating

Problems have been reported in babies whose mothers took tricyclic antidepressants just before delivery. Women who are pregnant or who may become pregnant should check with their physicians about the safety of using tricyclic antidepressants.

Tricyclic antidepressants pass into breast milk and may cause drowsiness in nursing babies whose mothers take the drugs. Women who are **breastfeeding** should check with their physicians before using tricyclic antidepressants.

Because tricyclic antidepressants work on the central nervous system, they may add to the effects of alcohol and other drugs that cause drowsiness, such as **antihistamines**, cold medicine, allergy medicine, sleep aids, medicine for seizures, tranquilizers, some pain relievers, and **muscle relaxants**. Anyone taking tricyclic antidepressants should check with his or her physician before drinking alcohol or taking any drugs that cause drowsiness.

These drugs may also change the results of medical tests. Before having medical tests, anyone taking this medicine should alert the health care professional in charge.

For additional information on precautions and side effects of tricyclic antidepressants, see the entry **antidepressant drugs, tricyclic**.

Monoamine oxidase inhibitors (MAOIs). The greatest risk associated with these drugs is a hypertensive (high blood pressure) crisis that may be fatal and most often occurs when the drugs are taken with interacting foods or drugs. More common adverse reactions may include low blood pressure and slowing of heartbeat. Sedation and gastrointestinal disturbances also are common. MAOIs are in pregnancy category C. Safety in breast feedinghas not been established.

Tetracyclics and atypicals. Because these drugs are individual, there are no group patterns of adverse reactions. Specific references should be consulted.

Interactions

Antidepressants have many **drug interactions**, some severe. Although a few are listed here, specific references should be consulted for more complete

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information. Before beginning any antidepressant, the patient should review with his or her physician and pharmacist all prescription, nonprescription, and herbal medicines being taken as well as any dietary supplements.

The interaction of SSRIs or tricyclic antidepressants with MAOIs can be fatal. In addition to antidepressant MAOIs, the antibiotic linezolid (Zyvox) is an MAOI. There must be at minimum a two-week interval between stopping one drug and starting the other drug. There should be at least a three-week interval between an MAOI and either paroxetine hydrochloride or sertraline, if either type of antidepressant was taken for more than three months. Because of its long half-life in the body, it is necessary to wait five to six weeks after stopping fluoxetine before starting on an MAOI.

Tricyclic compounds have many interactions, and specialized references should be consulted. Specifically, it is best to avoid other drugs with anticholinergic (drying) effects. Tricyclics should not be taken with the **antibiotics** grepafloxacin and sparfloxacin, since the combination may cause serious heart arrhythmias.

Tricyclic compounds should not be taken with the gastric acid inhibitor cimetidine (Tagamet), since this increases the blood levels of the tricyclic compound. Other acid inhibiting drugs do not share this interaction.

SSRIs interact with a number of other drugs that act on the central nervous system. Care should be used in combining these drugs with major or minor tranquilizers, or with anti-epileptic agents such as phenytoin (Dilantin) or carbamazepine (Tegretol).

ORGANIZATIONS

American Academy of Child and Adolescent Psychiatry (AACAP), 3615 Wisconsin Ave. NW, Washington, DC, 20013-3007, (202) 966-7300, (202) 966-2891, communications@aacap.org, http://www.aacap.org/.

American Psychiatric Association (APA), 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209, (888) 357-7924, apa@psych.org, http://www.psych.org.

National Institute of Mental Health (NIMH), 6001 Executive Boulevard, Room 8184, MSC 9shtml663, Bethesda, MD, 20892-9663, http://www.nimh.nih.gov/site-info/contact-nimh.stml.

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Antidepressant drugs, SSRI

Definition

SSRI or selective serotonin reuptake inhibitor drugs are prescribed primarily to treat mental depression. In people with depression, these drugs slow the reabsorption of the neurotransmitter serotonin into nerve cells in the brain, making more serotonin available.

Purpose

Because they are as effective as other types of antidepressants and have less serious side effects, SSRIs have become some of the most commonly prescribed antidepressants. In addition to treating depression, some SSRIs have been approved by the United States Food and Drug Administration (FDA) for the treatment of other psychiatric disorders including:

- obsessive-compulsive disorder (OCD)
- generalized anxiety disorder
- panic disorder
- social anxiety disorder or social phobia
- premenstrual dysphoric disorder (PMDD) or premenstrual syndrome (PMS)
- post-traumatic stress disorder (PTSD)
- bulimia nervosa, an eating disorder.

SSRIs often are prescribed for other off-label uses including:

- various mental disorders including schizophrenia
- mania
- menopause-related symptoms such as hot flashes
- geriatric depression
- loss of mental abilities in the elderly
- nicotine withdrawal
- alcoholism
- premature ejaculation
- irritable bowel syndrome

The advantages of SSRIs over other types of antidepressants include:

- Most SSRIs can be taken in one daily dose as compared with multiple daily pills.
- Because they lessen cravings for carbohydrates, SSRIs are less likely to cause weight gain.
- Since SSRIs do not appear to affect the cardiovascular system, they can be prescribed for people with high blood pressure or heart conditions.

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KEY TERMS

Citalopram hydrobromide—An SSRI that is highly specific for serotonin reuptake.

Dopamine—A neurotransmitter and the precursor of norepinephrine.

Escitalopram oxalate—An SSRI that is very similar to citalopram hydrobromide.

Fluoxetine—The first SSRI; marketed as Sarafem for treating PMDD.

Fluvoxamine—An SSRI that is used to treat obsessive-compulsive disorder as well as other conditions.

Monoamine oxidase inhibitor (MAOI)—An older class of antidepressants.

Neurotransmitter—One of a group of chemicals secreted by a nerve cell (neuron) to carry a chemical message to another nerve cell, often as a way of transmitting a nerve impulse. Examples of neurotransmitters include acetylcholine, dopamine, serotonin, and norepinephrine.

Norepinephrine—A hormone released by nerve cells and the adrenal medulla that causes constriction of blood vessels. Norepinephrine also functions as a neurotransmitter.

Obsessive-compulsive disorder (OCD)—An anxiety disorder characterized by obsessions, such as recurring thoughts or impulses, and compulsions, such as repetitive behaviors.

Off-label use—Drugs in the United States are approved by the Food and Drug Administration (FDA) for specific uses, periods of time, or dosages based on the results of clinical trials. However, it is legal for physicians to administer these drugs for other "off-label" or non-approved uses. It is not legal for pharmaceutical companies to advertise drugs for off-label uses.

Paroxetine hydrochloride—An SSRI that is used to treat mental depression, OCD, anxiety, and various other disorders.

Premenstrual dysphoric disorder (PMDD)—Premenstrual syndrome (PMS); symptoms including back and abdominal pain, nervousness and irritability, headache, and breast tenderness that occur the week before menstruation.

Serotonin—5-Hydroxytryptamine; a substance that occurs throughout the body with numerous effects including neurotransmission. Inadequate amounts of serotonin are implicated in some forms of depression.

Serotonin syndrome—A group of symptoms caused by severely elevated serotonin levels in the body.

Sertraline—An SSRI that is used to treat mental depression and a variety of other disorders.

- Since SSRIs are not particularly dangerous even in high doses and are unlikely to cause permanent damage if misused.

SSRIs are mood enhancers only in depressed individuals. They have little effect on people who are not clinically depressed. However some experts believe that SSRIs are over-prescribed and should be reserved for those with major disabling depression, especially in children and adolescents.

In October 2004, the FDA issued a warning that treating children and adolescents with SSRIs increased the risk of suicidal thoughts and behaviors. In a review of 2,200 children treated with SSRIs, the FDA found no completed suicides, but did find a 4% increase in suicidal thinking or behavior, including **suicide** attempts. In 2006, this warning was extended to include all people under age 25. However, in April 2007, a comprehensive review of SSRI treatment in children, adolescents, and adults under age 25 that was published in the *Journal of the American Medical Society* indicated that the benefits of treating these patients with SSRIs generally outweighed the risks. To reduce the risks of suicide, SSRIs should only be prescribed by a psychiatrist, not a family physician, and parents and caregivers should be alert for any of the signs of potential suicidal behavior found below.

Description

Types of SSRIs

Many brand-name SSRIs and their generic equivalents are available. Some are preferred over others for treating certain disorder, although individual response varies. Some of the more widely used include:

- citalopram hydrobromide (Celexa, Emocal, Sepram, Seropram) for treating depression
- escitalopram oxalate (Lexapro, Cipralex, Esertia) for treating depression and generalized anxiety disorder
- fluvoxamine (Luvox, Faverin, Dumyrox) for treating OCD
- paroxetine hydrochloride (Paxil, Seroxat, Aropax, Deroxat, Rextin, Xetanor, Paroxat) for treating

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depression, generalized anxiety disorder, OCD, panic disorder, social anxiety disorder, PMDD, and PTSD

- fluoxetine (Prozac, Fontex, Seromex, Seronil, Fluctin, Fluox) for treating depression, OCD, and bulimia nervosa; marketed as Sarafem for treating PMDD
- sertraline (Zoloft, Lustral, Serlan) for treating depression, OCD, panic disorder, social anxiety disorder, PMDD, and PTSD

When fluoxetine first became available in 1988, it was hailed as a new wonder drug and quickly became the most popular antidepressant ever prescribed. Many millions of Americans have taken fluoxetine and more than 70% of them claim to have benefited from it.

Citalopram hydrobromide and escitalopram oxalate are very similar, with chemical structures unrelated to other SSRIs. Citalopram hydrobromide is a mixture of two isomers—forms of the same chemical—whereas escitalopram oxalate is the active isomer alone. They appear to be highly selective for serotonin, only minimally inhibiting the reuptake of the neurotransmitters norepinephrine and dopamine.

Paroxetine hydrochloride is structurally unrelated to other SSRIs and is more selective for serotonin than fluvoxamine, fluoxetine, or sertraline, but less selective than citalopram hydrobromide and escitalopram oxalate. Paroxetine hydrochloride becomes distributed widely throughout body tissues and the central nervous system with only 1% remaining in the circulatory system.

Mode of action

Mental depression is believed to be related to the low activity of one or more neurotransmitters in the brain. Neurotransmitters are chemical messengers that cross the gap or synapse between nerve cells. Although it is not understood exactly how most SSRIs work, they are designed to increase the level of serotonin in the brain. This can reduce the symptoms of depression and other psychological disorders.

Serotonin is released by nerve cells and then, in a process called reuptake, is reabsorbed by the cells to be used again. SSRIs interfere with reuptake by blocking the serotonin reabsorption sites on the surfaces of nerve cells, thereby making more serotonin available for brain activity. Paroxetine hydrochloride inhibits the transporter molecule that moves serotonin back into the cell. SSRIs are said to selectively interfere with the reuptake of serotonin, without affecting the uptake or activities of other neurotransmitters. In contrast, older antidepressants, such as **tricyclic antidepressants** and **monoamine oxidase inhibitors** (MAOIs), affect many different neurotransmitters, brain cell receptors, and brain processes, thus increasing the likelihood of serious side effects.

Nevertheless, it is becoming clear that the serotonin neurotransmitter system is far more complex and widespread throughout the body than was originally thought. Although serotonin receptors are particularly common in areas of the brain that control emotion, it is now known that there are at least six different types of serotonin receptors that send different signals to different parts of the brain. Serotonin also appears to affect other neurotransmitter systems to some extent. As a result, increasing the levels of serotonin may not be the only reason why SSRIs relieve depression.

Effectiveness

SSRIs are not effective for treating **anxiety** or depression in 20–40% of patients. Other **antidepressant drugs** may be effective in people who do not respond to SSRIs. However, some research suggests that the use of SSRIs in the early stages of depression can prevent major **depressive disorders**.

Individuals respond differently to different SSRIs, and side effects may vary. Finding the best SSRI for an individual may be a matter of trial-and-error. It usually takes two to four weeks after starting an SSRI before symptoms begin to improve. Fluvoxamine may take one to two months for noticeable improvement. Paroxetine hydrochloride may take as long as several months, although sleep often improves within one or two weeks of beginning the medication. If there is no response after a few weeks or if side effects occur, the patient may be switched to another SSRI.

Although fluvoxamine approved for treating OCD in children and fluoxetine is the only SSRI that is FDA-approved for treating depression in children over age 8, thousands of young people have been treated by off-label use of a variety of SSRIs for:

- depression
- anxiety
- OCD
- panic
- attention deficit/hyperactivity disorder (ADHD)

SSRIs sometimes are prescribed to relieve depression accompanying **alcoholism**. A recent study found that, although type A alcoholics responded to Sertraline in conjunction with a 12-step individual therapy program, type B alcoholics (those with the most severe

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drinking problems) did not benefit from sertraline and, in some cases, increased their alcohol intake.

Recommended dosage

Usually SSRIs are started with a low dosage that may be gradually increased. In older adults, SSRIs remain in the body longer than in younger adults. The blood levels of paroxetine hydrochloride can be 70–80% higher in the elderly as compared with younger patients. Therefore, lower doses usually are prescribed for older people. Older patients with other medical conditions or who are taking many different drugs also may need smaller or less frequent doses. The dosage of an SSRI also varies according to the individual and the condition that is being treated. SSRIs may be taken with or without food, on a full or empty stomach. However taking SSRIs with food or drink may lessen side effects such as stomach upset or **nausea**.

Citalopram hydrobromide is supplied as tablets or as an oral solution equivalent to 2 mg per mL (0.03 oz.), taken once per day in the morning or evening:

- adults: 20 mg per day, increasing to 40 mg if necessary, to a maximum of 60 mg per day
- older adults: 20 mg per day to a maximum of 40 mg

Escitalopram oxalate is supplied as 5-, 10-, or 20-mg tablets or as a 1 mg per mL (0.03 oz.) liquid. The recommended dose is 10 mg per day, with a possible increase to 20 mg per day after at least one week.

Average dosages of fluvoxamine for treating OCD and depression are:

- adults: one 50-mg tablet at bedtime; may be increased up to a maximum of 300 mg daily; dosages of more than 100 mg per day should be divided into two doses, one taken in the evening and one in the morning
- children aged 8–17: initially one 25-mg tablet at bedtime; may be gradually increased by 25 mg per day every four to seven days, up to a maximum of 200 mg per day; daily dosages of more than 50 mg should be divided into two daily doses.

Average doses of paroxetine hydrochloride for treating depression are:

- adults: 20 mg (10 mL, 0.3 oz.) of oral suspension, one 20-mg tablet, or one 25-mg extended-release tablet, once a day in the morning, increased by 10 mg per week to a maximum of 50 mg—25 mL (0.75 oz.) of oral suspension—or a 62.5-mg extended-release tablet
- older adults: 10 mg (5 mL, 0.15 oz.) of oral suspension or a 10-mg tablet daily, increased to a maximum of 40 mg (20 mL, 0.6 oz.); one 12.5-mg extended-release tablet daily, increased to a maximum of 50 mg

Because of its sedating effect, paroxetine hydrochloride may be taken in the evening rather than in the morning as usually recommended. Oral suspensions need to be shaken well before measuring with a small measuring cup or measuring spoon. Extended-release tablets should be swallowed whole, not broken or chewed. Dosages may be different for treating disorders other than depression.

Typical dosages of fluoxetine are:

- one 10–20-mg daily capsule or solution taken in the morning; increased up to as much as 40 mg daily if there is no improvement in one month, up to an 80-mg maximum
- one 20-mg capsule of Sarafem per day, taken in the morning, every day or for only 14 days of a menstrual cycle; maximum of 80 mg per day; Sarafem is supplied in seven-day blister packs to help keep track of the days
- children: initially one 5–10-mg capsule or solution per day.

Sertraline is available as capsules, oral solutions, or tablets:

- adults: 50 mg daily, taken in the morning or evening, up to a maximum of 200 mg daily for severely depressed individuals
- older adults: 12.5–25 mg per day, taken in the morning or evening; may be increased gradually
- for treating OCD in children aged 6–12: 25 mg per day, taken in the morning or evening; may be increased gradually to a maximum of 200 mg per day
- children aged 13–17: initially 50 mg per day, in the morning or evening, may be increased gradually to a maximum of 200 mg per day.

Sertraline oral concentrate should be mixed with 4 oz (133 mL) of water, ginger ale, lemon-lime soda, lemonade, or orange juice and taken immediately.

Missed doses of SSRIs are handled differently depending on the SSRI and the number of doses per day. An effective SSRI may be prescribed for six months or more. Some experts recommend continuing on the SSRI indefinitely to prevent the recurrence of depression.

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Precautions

Medical conditions

Medical conditions that may affect the use or dosage of at least some SSRIs include:

- drug allergies or allergies to other substances in medications
- mania
- manic-depressive (bipolar) disorder
- brain disease or mental retardation
- seizures or epilepsy
- Parkinson s disease
- liver or severe kidney disease
- abnormal bleeding problems
- diabetes mellitus
- heart disease
- a recent heart attack
- glaucoma

SSRI use during **pregnancy** may not be safe, particularly during the third trimester. Exposure of fetuses to citalopram hydrobromide and other SSRIs during the late third trimester have led to very serious complications, including serotonin syndrome—a condition in which high serotonin levels cause severe problems. Symptoms in a newborn may be the result of a direct toxic effect of the SSRI or withdrawal from the drug. SSRIs pass into breast milk and may negatively affect a baby.

Suicidal tendencies

As discussed above, concern about a link between SSRIs and suicidal thoughts and behaviors, including suicide attempts in depressed children has led to warnings about prescribing these drugs for people under age 25. A link between SSRIs and suicidal thoughts and behaviors in adults over age 25 remains controversial as studies have produced mixed or inconclusive results.

Symptoms that may indicate suicidal tendencies can develop very suddenly in children and adolescents taking SSRIs. Parents and caregivers should be alert to the following changes:

- new or worsening depression
- severe worrying
- irritability
- agitation
- extreme restlessness
- frenzied excitement
- panic attacks
- insomnia
- impulsive behavior
- aggressive behavior
- thinking about, planning, or attempting to harm one's self

Withdrawal

SSRIs remain in the body for some time after the medication is stopped:

- Citalopram hydrobromide for at least three days
- Fluvoxamine for at least 32 hours
- Paroxetine hydrochloride for at least 42 hours
- Fluoxetine for up to five weeks
- Sertraline for at least three to five days

SSRIs can cause what the manufacturers refer to as "discontinuation syndrome" when the medication is stopped. Since this occurs most often when the drug is stopped abruptly, the normal method of stopping the drug is to gradually decrease the dose before stopping the drug completely. The occurrence of discontinuation syndrome depends on the SSRI, the dosage, and the length of time that the drug was used and the individual's body chemistry. Paroxetine hydrochloride appears to induce more serious withdrawal symptoms than other SSRIs. Symptoms of Paroxetine hydrochloride withdrawal appear within 1–10 days of stopping the drug. Because of its long half-life in the body, fluoxetine rarely causes withdrawal symptoms, although symptoms have been known to appear within 5 to 42 days of stopping Fluoxetine.

Withdrawal symptoms may include:

- generally feeling sick
- dry mouth
- runny nose
- dizziness or lightheadedness
- nausea and vomiting
- diarrhea
- headache
- sweating
- muscle pain
- weakness or fatigue
- nervousness or anxiety
- restlessness or agitation
- trembling or shaking
- insomnia
- fast heart rate
- breathing difficulties
- chest pain
- confusion

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Although withdrawal symptoms usually disappear after a short time, in some patients some symptoms appear to continue indefinitely.

Other precautions

Other precautions concerning SSRIs include:

- a 50% chance that an episode of depression will recur at some point after stopping the drug
- a 90% risk of recurrence following two episodes of depression
- reports of patients developing tolerance to an SSRI, requiring increased dosages for effectiveness
- the long-term effects of SSRIs are unknown
- SSRIs are expensive and some insurance plans to not cover mental health medications.

Side effects

Common side effects

The most common side effects of SSRIs include:

- dry mouth
- dizziness
- sour or acid stomach or gas
- heartburn
- decreased appetite
- stomach upset
- nausea
- diarrhea
- sweating
- headache
- weakness or fatigue
- drowsiness
- insomnia
- nervousness or anxiety
- tremors
- sexual problems

Most common side effects disappear as the body adjusts to the drug. Nausea may be relieved by taking the medication with meals or temporarily dividing the dose in half.

Certain side effects occur more frequently depending on the SSRI:

- Side effects of citalopram hydrobromide usually are mild and disappear as the body adjusts.
- Fluvoxamine and sertraline are more likely to cause gastrointestinal upset, including stomach irritation, nausea, and diarrhea.
- Paroxetine hydrochloride is more likely to cause dry mouth, constipation, and drowsiness. Paroxetine hydrochloride is significantly more sedating than other SSRIs, which may benefit patients with insomnia.
- The most common side effect of fluoxetine is nausea during the first two weeks on the drug; nervousness and anxiety also are common with fluoxetine.
- Paroxetine hydrochloride, fluoxetine, and sertraline often reduce appetite.
- Up to 30% of those people taking sertraline experience headaches and 20% experience insomnia.

Studies with fluvoxamine have found that children may experience different side effects than adults, the most common being:

- dry mouth
- a stuffy or bloody nose
- sweating
- drowsiness
- restlessness
- muscle twitching or tics
- tremors
- thinning hair
- abnormal thinking

Sexual side effects

Any SSRI can affect sexual interest or performance. Side effects include increased or, more often, decreased sexual interest, difficulty reaching orgasm or ejaculation, and **impotence**.

Although manufacturers initially reported that sexual problems were very rare side effects of SSRIs, most patients in clinical trials were never asked specifically about sex and were reluctant to raise the issue. After a few years it became apparent that sexual problems were commonplace among SSRI users, affecting as many as 70%. Among men taking Paroxetine hydrochloride, 23% report problems with ejaculation. Between 40% and 70% of those taking Fluoxetine report negative sexual side effects, especially loss of interest.

Less common or rare side effects

Less common—but potentially serious—side effects of at least some SSRIs may include:

- flu-like symptoms
- sneezing
- nasal congestion or a runny nose
- sore throat

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- skin rash
- itching or tingling, burning, or prickling of the skin
- fever
- chills
- body aches or pain
- muscle or joint pain
- abdominal cramps or pain
- vomiting
- decreased or increased appetite
- weight loss
- weight gain, especially after a year on an SSRI
- mouth watering
- increased frequency or amount of urination
- constipation
- menstrual changes or pain
- chest congestion or pain
- difficulty breathing
- taste changes, including a metallic taste in the mouth
- blurred vision or other visual changes
- loss of voice
- teeth grinding
- trembling or shaking
- hair loss
- sensitivity to sunlight
- anxiety or agitation
- abnormal dreams
- confusion
- lack of emotion, apathy
- memory loss

Rare side effects that may occur with some SSRIs include:

- symptoms of low blood sugar or sodium
- bleeding gums or nosebleeds
- unusual bruising
- irregular or slow heartbeat (less than 50 beats per minute)
- fainting
- painful urination or other difficulties with urination
- purple or red spots on the skin
- skin conditions
- red or irritated eyes
- inability to move the eyes
- swelling of the face, ankles, or hands
- increased or decreased body movements
- clumsiness
- tics or other sudden or unusual body or facial movements or postures
- changes in the breasts, including leakage of milk
- seizures
- irritability
- increased depression
- mood or mental changes
- abnormal behaviors
- difficulty concentrating
- lethargy or stupor
- hallucinations
- suicidal thoughts or tendencies

Various other SSRI side effects have been observed in clinical practice although their incidence is not known.

Symptoms of overdose

Although SSRIs are generally safe and overdose rarely occurs, symptoms of overdose include two or more severe side effects occurring together. More common symptoms of SSRI overdose include:

- flushing of the face
- enlarged pupils
- fast heart rate
- upset stomach
- nausea and vomiting
- sweating
- dizziness
- irritability
- drowsiness
- insomnia
- trembling or shaking

Rare symptoms of SSRI overdose include:

- deep or fast breathing with dizziness
- fainting
- muscle pain
- weakness
- difficulty urinating
- bluish skin or lips
- fast, slow, or irregular heartbeat
- low blood pressure
- confusion
- memory loss
- seizures
- coma

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Interactions

SSRIs interact with many other drugs and herbal remedies especially other drugs that affect mood. Alcohol may increase SSRI-induced drowsiness and should not be used when taking some SSRIs. Fluvoxamine appears to cause the most serious **drug interactions**, whereas citalopram hydrobromide has relatively few interactions. A combination of fluvoxamine and clozapine (Clozaril) can cause low blood pressure and seizures.

The interaction of SSRIs with MAOIs can be fatal. In addition to antidepressant MAOIs, the antibiotic linezolid (Zyvox) is an MAOI. There must be at minimum a two-week interval between stopping one drug and starting the other drug. There should be at least a three-week interval between an MAOI and either paroxetine hydrochloride or sertraline, if either type of antidepressant was taken for more than three months. Because of its long half-life in the body, it is necessary to wait five to six weeks after stopping fluoxetine before starting on an MAOI.

Some of the drugs and herbal remedies that can interact negatively with SSRIs include:

- other antidepressants
- antihistamines
- various medications for anxiety, mental illness, or seizures
- sedatives and tranquilizers
- sleeping pills
- St. John's wort

Drugs that may cause severe heart problems if taken in conjunction with some SSRIs include:

- astemizole (Hismanal)
- cisapride (Propulsid)
- terfenadine (Seldane)
- thioridazine (Mellaril), which should not be taken for at least five weeks after stopping fluoxetine

Drugs that may affect the blood levels of an SSRI or the length of time that an SSRI remains in the body include:

- antifungal drugs
- cimetidine (Tagamet)
- erythromycin
- tricyclic antidepressants
- Dilantin and phenobarbitol, which may decrease the blood levels of Paroxetine hydrochloride

Some SSRIs may cause higher blood levels of other medications including:

- alprazolam (Xanax and others)
- anticoagulants or blood-thinners such as warfarin (Coumadin)—SSRIs can increase warfarin blood levels dramatically
- aspirin and other nonsteroidal anti-inflammatory drugs (NSAIDs) including ibuprofen and naproxen
- caffeine
- carbamazepine (Tegretol)
- diazepam (Valium)
- digitalis glycosides (heart medicines)
- lithium
- methadone
- phenytoin (Dilantin and others)
- propanolol (Ineral and others)
- theophylline or theophylline-containing drugs
- triazolam (Halcion and others)
- tricyclic antidepressants

This list is not complete. Before taking any antidepressant, patients should review all their medications—prescription, nonprescription, and herbal—with the prescribing physician and their pharmacist.

Serotonin syndrome

Rarely, some drugs may interact with an SSRI to cause excessively high levels of serotonin, a condition known as serotonin syndrome. Drug interactions most likely to cause serotonin syndrome include:

- buspirone (BuSpar)
- bromocriptine (Parlodel)
- dextromethorphan (cough medicine such as Robitussin DM)
- levodopa (Sinemet)
- lithium (Eskalith)
- meperidine (Demerol)
- moclobemide (Manerex)
- nefazodone (Serzone)
- pentazocine (Talwin)
- other SSRIs
- street drugs
- sumatriptan (Imitrex)
- tramadol (Ultram)
- trazodone (Desyrel)
- tryptophan
- venlafaxine (Effexor)

Serotonin syndrome may occur shortly after the dose of a drug is increased, when symptoms have not been present at a lower dosage.

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Serotonin syndrome may be suspected when at least three of the following symptoms occur together:

- diarrhea
- fever
- shivering
- sweating
- restlessness
- agitation
- uncontrollable excitement
- poor coordination
- twitching
- trembling or shaking
- rigidity
- confusion
- mental changes
- fluctuating vital signs

Combined treatments

Increasingly physicians are combining an SSRI with other medications, either to increase effectiveness or to counteract side effects. Certain SSRIs are sometimes prescribed along with:

- an anti-anxiety drug such as diazepam (Valium)
- trazodone (Desyrel, Molipaxin, Trittico, Thombran, Trialodine), a different type of antidepressant, for patients with insomnia
- lithium

Resources

OTHER

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ORGANIZATIONS

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Antidepressant drugs, tricyclic

Definition

Tricyclic antidepressants are medicines that relieve mental depression.

Purpose

Since their discovery in the 1950s, tricyclic antidepressants have been used to treat mental depression. The name tricyclic refers to their molecular structure. Like other **antidepressant drugs**, they reduce symptoms such as extreme sadness, hopelessness, and lack of energy. Some tricyclic antidepressants are also used to treat bulimia, **cocaine** withdrawal, **panic disorder**, obsessive-compulsive disorders, certain types of chronic **pain**, and bed-wetting in children. Newer antidepressant drugs called **selective serotonin reuptake inhibitors** (SSRIs) are often used in place of the older tricyclic antidepressants because SSRIs generally have fewer side effects.

Description

Named for their three-ring chemical structure, tricyclic antidepressants work by correcting chemical imbalances in the brain. But because they also affect other chemicals throughout the body, these drugs may produce many unwanted side effects.

Tricyclic antidepressants are available only with a physician's prescription and are sold in tablet, capsule, liquid, and injectable forms. Some commonly used tricyclic antidepressants are amitriptyline (Elavil), desipramine (Norpramin), doxepin (Sinequan), imipramine (Tofranil), nortriptyline (Pamelor), protriptyline (Vivactil), and trimpramine (Surmontil). Different drugs in this family have different effects, and physicians can choose the drug that best fits the patient's symptoms. For example, a physician might prescribe Elavil for a person with depression who has trouble sleeping, because this drug is more likely to make people feel calm and sleepy. Other tricyclic antidepressants might be more appropriate for depressed people with low energy.

Recommended dosage

The recommended dosage depends on many factors, including the patient's age, weight, general health, and symptoms. The type of tricyclic antidepressant and its strength also must be considered, as well as whether the antidepressant will interact with other drugs the patient is taking. Check with the

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KEY TERMS

Asthma—A disease in which the air passages of the lungs become inflamed and narrowed.

Bulimia—An eating disorder in which a person binges on food and then induces vomiting, uses laxatives, or goes without food for some time.

Chronic—A word used to describe a long-lasting condition. Chronic conditions often develop gradually and involve slow changes.

Delusion—An abnormal mental state characterized by the acceptance of something as true that is actually false or unreal, such as the belief that one is Jesus Christ.

Depression—A mental condition in which a person feels extremely sad and loses interest in life. A person with depression may also have sleep problems and loss of appetite and may have trouble concentrating and carrying out everyday activities.

Glaucoma—A condition in which pressure in the eye is abnormally high. If not treated, glaucoma may lead to blindness.

Hallucination—A false or distorted perception of objects, sounds, or events that seems real. Hallucinations usually result from drugs or mental disorders.

Obsessive-compulsive disorder—An anxiety disorder in which a person cannot prevent himself or herself from dwelling on unwanted thoughts, acting on urges, or performing repetitious rituals, such as washing his hands or checking to make sure he or she turned off the lights.

Panic disorder—An disorder in which a person has sudden and intense attacks of anxiety in certain situations. Symptoms such as shortness of breath, sweating, dizziness, chest pain, and extreme fear often accompany the attacks.

Prostate—A donut-shaped gland in males below the bladder that contributes to the production of semen.

Schizophrenia—A severe mental disorder in which a person loses touch with reality and may have illogical thoughts, delusions, hallucinations, behavioral problems and other disturbances.

Seizure—A sudden attack, spasm, or convulsion.

Serotonin—A natural chemical found in the brain and other parts of the body, that carries signals between nerve cells.

Withdrawal symptoms—A group of physical or mental symptoms that may occur when a person suddenly stops using a drug to which he or she has become dependent.

physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

Always take tricyclic antidepressants exactly as directed. Never take larger or more frequent doses, and do not take the drug for longer than directed. Do not stop taking the medicine just because it does not seem to be working. Several weeks may be needed for its effects to be felt. Visit the physician as often as recommended so that the physician can check to see if the drug is working and to note for side effects.

Do not stop taking this medicine suddenly after taking it for several weeks or more. Gradually tapering the dose may be necessary to reduce the chance of withdrawal symptoms.

Taking this medicine with food may prevent upset stomach.

Precautions

The effects of this medicine may continue for three to seven days after patients stop taking it. All precautions should be observed during this period, as well as throughout treatment with tricyclic antidepressants.

Some people feel drowsy, dizzy, lightheaded, or sleepy, when taking these drugs. This is a special problem when getting up after sitting or lying down. To lessen the problem, gradually and hold onto something for support if possible. The drugs may also cause blurred vision. Anyone who takes these drugs should not drive, use machines or do anything else that might be dangerous until they have found out how the drugs affect them.

Because tricyclic antidepressants work on the central nervous system, they may add to the effects of alcohol and other drugs that cause drowsiness, such as **antihistamines**, cold medicine, allergy medicine, sleep aids, medicine for seizures, tranquilizers, some pain relievers, and **muscle relaxants**. Anyone taking tricyclic antidepressants should check with his or her physician before drinking alcohol or taking any drugs that cause drowsiness.

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Tricyclic antidepressants may interact with medicines used during surgery, dental procedures, or emergency treatment. These interactions could increase the chance of side effects. Anyone who is taking tricyclic antidepressants should be sure to tell the health care professional in charge before having any surgical or dental procedures or receiving emergency treatment.

These drugs may also change the results of medical tests. Before having medical tests, anyone taking this medicine should alert the health care professional in charge.

This medicine may increase sensitivity to sunlight. Even brief exposure to sun can cause a severe **sunburn** or a rash. While being treated with this tricyclic antidepressants, avoid being in direct sunlight, especially between 10 in the morning and 3 in the afternoon. Wear a hat and tightly woven clothing that covers the arms and legs, use a sunscreen with a skin protection factor (SPF) of at least 15, protect the lips with a sun block lipstick, and do not use **tanning** beds, tanning booths, or sunlamps while taking these drugs.

Tricyclic antidepressants may cause **dry mouth**. To temporarily relieve the discomfort, chew sugarless gum, suck on sugarless candy or ice chips, or use saliva substitutes, which come in liquid and tablet forms and are available without a prescription.

Children and older people are especially sensitive to the effects of tricyclic antidepressants. This increased sensitivity may increase the chance of side effects.

Special conditions

People with certain medical conditions or who are taking certain other medicines can have problems if they take tricyclic antidepressants. Before taking these drugs, be sure to let the physician know about any of the following these conditions.

ALLERGIES. Anyone who has had unusual reactions to tricyclic antidepressants or to carbamazepine (Tegretol), maprotiline (Ludiomil), or trazodone (Desyrel) in the past should let his or her physician know before taking tricyclic antidepressants. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. Problems have been reported in babies whose mothers took tricyclic antidepressants just before delivery. Women who are pregnant or who may become pregnant should check with their physicians about the safety of using tricyclic antidepressants.

BREASTFEEDING. Tricyclic antidepressants pass into breast milk and may cause drowsiness in nursing babies whose mothers take the drugs. Women who are **breastfeeding** should check with their physicians before using tricyclic antidepressants.

DIABETES. Tricyclic antidepressants may affect blood sugar levels. Diabetic patients who notice changes in blood or urine test results while taking this medicine should check with their physicians.

OTHER MEDICAL CONDITIONS. Before using tricyclic antidepressants, people with any of these medical problems should make sure their physicians are aware of their conditions:

- current or past alcohol or drug abuse
- bipolar disorder (manic-depressive illness)
- schizophrenia
- seizures (convulsions)
- heart disease
- high blood pressure
- kidney disease
- liver disease
- overactive thyroid
- stomach or intestinal problems
- enlarged prostate
- problems urinating
- glaucoma
- asthma

USE OF CERTAIN MEDICINES. Taking tricyclic antidepressants with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Side effects

The most common side effects are **dizziness**, drowsiness, dry mouth, unpleasant taste, **headache**, **nausea**, mild tiredness or weakness, increased appetite or craving for sweets, and weight gain. These problems usually go away as the body adjusts to the drug and do not require medical treatment. Less common side effects, such as **diarrhea**, **vomiting**, sleep problems, sweating, and **heartburn** also may occur and do not need medical attention unless they do not go away or they interfere with normal activities.

More serious side effects are not common, but may occur. If any of the following side effects occur, check with the physician who prescribed the medicine as soon as possible:

- blurred vision
- eye pain

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- confusion
- hallucinations
- fainting
- loss of balance
- swallowing problems
- difficulty speaking
- mask-like face
- shakiness or trembling
- nervousness or restlessness
- movement problems, such as shuffling walk, stiff arms and legs, or slow movement
- decreased sexual ability
- fast or irregular heartbeat
- constipation
- problems urinating

Some side effects may continue after treatment with tricyclic antidepressants has ended. Check with a physician if these symptoms occur:

- headache
- nausea, vomiting, or diarrhea
- sleep problems, including vivid dreams
- unusual excitement, restlessness, or irritability

Interactions

Life-threatening reactions, such as extremely high blood pressure, may occur when tricyclic antidepressants are taken with other antidepressants called monoamine oxidase (MAO) inhibitors (for example, Nardil or Parnate). Do not take tricyclic antidepressants within 2 weeks of taking a MAO inhibitor.

Tricyclic antidepressants may interact with many other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes tricyclic antidepressants should let the physician know all other medicines he or she is taking. Among the drugs that may interact with tricyclic antidepressants are:

- Central nervous system (CNS) depressants such as medicine for allergies, colds, hay fever, and asthma; sedatives; tranquilizers; prescription pain medicine; muscle relaxants; medicine for seizures; sleep aids; barbiturates; and anesthetics.
- diet pills
- amphetamines
- blood thinning drugs
- medicine for overactive thyroid
- cimetidine (Tagamet)
- other antidepressant drugs, including MAO inhibitors (such as Nardil and Parnate) and antidepressants that raise serotonin levels (such as Prozac and Zoloft)
- blood pressure medicines such as clonidine (Catapres) and guanethidine monosulfate (Ismelin)
- disulfiram (Antabuse), used to treat alcohol abuse
- major tranquilizers such as thioridazine (Mellaril) and chlorpromazine (Thorazine)
- antianxiety drugs such as chlordiazepoxide (Librium) and alprazolam (Xanax)
- antiseizure medicines such as carbamazaepine (Tegretol) and phenytoin (Dilantin)

The list above does not include every drug that may interact with tricyclic antidepressants. Be sure to check with a physician or pharmacist before combining tricyclic antidepressants with any other prescription or nonprescription (over-the-counter) medicine, or herbal remedy.

ORGANIZATIONS

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Antidiabetic drugs

Definition

Antidiabetic drugs are medicines that help control blood sugar (glucose) levels in people with **diabetes mellitus**.

Purpose

Diabetes mellitus is a disease in which the body is unable to properly use sugar (glucose). There are two types of diabetes. In type 1 diabetes (formerly called insulin-dependent, juvenile, or childhood-onset diabetes), the pancreas, a digestive organ, does not produce enough of the hormone insulin to allow the body use glucose. Type 2 diabetes (formerly called noninsulin

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KEY TERMS

Blood sugar—The concentration of glucose in the blood.

Glucose—A simple sugar that serves as the body's main source of energy.

Hormone—A substance that is produced in one part of the body, then travels through the bloodstream to another part of the body where it has its effect.

Metabolism—All the physical and chemical changes that occur in cells to allow growth and maintain body functions. These include processes that break down substances to yield energy and processes that build up other substances necessary for life.

Placebo—A pill or liquid given during the study of a drug or dietary supplement that contains no medication or active ingredient. Usually study participants do not know if they are receiving a pill containing the drug or an identical-appearing placebo.

Pregnancy category— A system of classifying drugs according to their established risks for use during pregnancy. Category A: Controlled human studies have demonstrated no fetal risk. Category B: Animal studies indicate no fetal risk, but no human studies; or adverse effects in animals, but not in well-controlled human studies. Category C: No adequate human or animal studies; or adverse fetal effects in animal studies, but no available human data. Category D: Evidence of fetal risk, but benefits outweigh risks. Category X: Evidence of fetal risk. Risks outweigh any benefits.

Salicylates—A group of drugs that includes aspirin and related compounds. Salicylates are used to relieve pain, reduce inflammation, and lower fever.

Seizure—A sudden attack, spasm, or convulsion.

dependent or adult-onset diabetes) occurs when the pancreas produces insulin, but cells in the body stop responding to the hormone. In either case, the result is that glucose builds up in the blood because the body cannot use it. **Gestational diabetes** is transient diabetes that occurs during **pregnancy** and resolves after pregnancy is over.

There is no cure for diabetes. Treatment of diabetes focuses on two goals: keeping blood glucose within the normal range and preventing the development of long-term complications. Diet, **exercise**, medication, and careful monitoring of blood glucose levels are the keys to managing diabetes so that patients can live healthier lives.

In addition to monitoring diet and exercise, type 1 diabetes is always treated by giving replacement insulin, usually several times a day. Type 2 diabetes is treatable by a number of therapeutic approaches. Drug therapy may be directed toward increasing insulin secretion, increasing insulin sensitivity, or increasing insulin penetration of the cells.

Description

Antidiabetic drugs can be subdivided into seven groups: insulin, sufonylureas, alpha-glucosidase inhibitors, biguanides, meglitinides, thiazolidinediones, and dipeptidyl peptinase IV (DPP-IV) inhibitors. Some of these drugs may be given in combination.

Insulin (Humulin, Novolin, and many others) is the hormone responsible for glucose utilization. It is effective in both types of diabetes, since, even in **insulin resistance**, some sensitivity remains and the condition can be treated with larger doses of insulin. Most insulins are now produced by recombinant DNA techniques, and are chemically identical to natural human insulin. Alternately, insulin from pigs can be chemically treated to convert it into human insulin.

Insulin is always given to people with type 1 diabetes. Some patients with type 2 diabetes may need to use insulin injections if their diabetes cannot be controlled. Injections are given subcutaneously—just under the skin, using a small needle and syringe several times daily. Insulin can also be given more continuously using an insulin pump. Insulin comes in many forms including rapid-acting, short-acting, intermediate-acting, long-acting, and pre-mixed (several types in a specific ratio) insulin. These vary in concentration, speed at which they react, and length of time for which they are effective. These types of insulin are not interchangeable. The individual and his or her physician will determine which type of insulin is best based on lifestyle and disease characteristics.

Sulfonylureas, such as chlorpropamide (Diabinese), tolazamide (Tolinase), glipizide (Glucotrol), glyburide (DiaBeta), and others, act by stimulating the beta cells of the pancreas to release more insulin. Glimepiride (Amaryl), a member of this class, appears

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to have a useful secondary action in increasing insulin sensitivity in peripheral cells.

Alpha-glucosidase inhibitors, such as acarbose (Precose) and miglitol (Glyset) do not increase insulin secretion. Instead, they slow the conversion of disaccharides and complex carbohydrates to glucose. This allows glucose to enter the bloodstream more slowly and reduces peak blood glucose levels. Alpha-glucosidase inhibitors are useful for either alone or in combination therapy with other antidiabetic drugs.

Metformin (Glucophage, Glyset, Riomet, Fortamet, and Glumetza) is the only available member of the biguanide class. Metformin decreases glucose production in the liver, decreases intestinal absorption of glucose, and increases peripheral glucose uptake and use. Metformin may be used alone or in combination therapy with other antidiabetic drugs.

There are two members of the meglitinide class: repaglinide (Prandin) and nateglitinide (Starlix). The mechanism of action of the meglitinides is to stimulate insulin production. This activity is both dose dependent and dependent on the presence of glucose, so that the drugs have reduced effectiveness in the presence of low blood glucose levels. The meglitinides may be used alone, or in combination with metformin. The manufacturer warns that nateglitinide should not be used in combination with other drugs that enhance insulin secretion.

Rosiglitazone (Avandia) and pioglitazone (Actos) are members of the thiazolidinedione class. They act by making muscle cells more responsive to insulin (decreased insulin resistance) and by reducing the amount of glucose released by the liver. Patients may need to take these drugs for several weeks before results are seen. These drugs may be used in combination with metformin or a sulfonylurea.

Dipeptidyl peptidase IV (DPP-IV) inhibitors work to lower glucose levels by increasing insulin production and decreasing the amount of glucose produced by the liver. In 2008, sitagliptin (Januvia) was the only drug in this category approved for use in the United States. It can be used with metformin.

Pramlintide (Symlin) is a new injectable antidiabetic drug that can be used by people with either type 1 or type 2 diabetes. This drug helps control glucose level fluctuations and increases the feeling of fullness, helping diabetic individuals lose weight. Exenatide injection (Byetta) is a new type of drug called incretin mimetics. It slows the release of glucose from the liver and slows stomach emptying thus reducing fluctuations in blood glucose levels. It is used to treat people with type 2 diabetes, usually in combination with other antidiabetic drugs and is given by injection.

Recommended dosage

Dosage must be highly individualized for all antidiabetic agents and is based on blood glucose levels, which must be taken regularly, often several times daily. Patients should review specific literature that comes with antidiabetic medications for complete dosage information and receive diabetes education from a healthcare provider.

Precautions

Insulin. The greatest short-term risk of insulin is **hypoglycemia** (low blood sugar), which may be the result of either a direct overdose or an imbalance between insulin injection and level of exercise and diet. This also may occur in the presence of other conditions that reduce the amount of glucose in the blood, such as illness with **vomiting** and **diarrhea**. Treatment is with glucose in the form of glucose tablets or liquid, although severe cases may require intravenous therapy. Allergic reactions and skin reactions also may occur.

Insulin is classified as category B in pregnancy, and is considered the drug of choice for glucose control during pregnancy. It is recommended that women with insulin-dependent diabetes not breastfeed because either low or high doses of insulin may inhibit milk production.

Sulfonylureas. All sulfonylurea drugs may cause hypoglycemia. Most patients become resistant to these drugs over time, and may require either dose adjustments or a switch to insulin. The list of adverse reactions is extensive, and includes central nervous system problems and skin reactions, among others. Hematologic reactions, although rare, may be severe and include **aplastic anemia** and **hemolytic anemia**. The administration of oral hypoglycemic drugs has been associated with increased cardiovascular mortality as compared with treatment with diet alone or diet plus insulin.

The sulfonylureas are classified as category C during pregnancy, based on animal studies, although glyburide has not shown any harm to the fetus and is classified as category B. Because there may be significant alterations in blood glucose levels during pregnancy, it is recommended that patients be switched to insulin. These drugs have not been fully studied during **breastfeeding,** but it is recommended that because their presence in breast milk might cause

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hypoglycemia in the newborn, breast feeding be avoided while taking sulfonylureas.

Alpha-glucosidase inhibitors are generally well tolerated, and do not cause hypoglycemia. The most common adverse effects are gastrointestinal problems, including flatulence (gas), diarrhea, and abdominal **pain**. These drugs are classified as category B in pregnancy. Although there is no evidence that the drugs are harmful to the fetus, it is important that rigid blood glucose control be maintained during pregnancy, and pregnant women most often should be switched to insulin. Alpha-glucosidase inhibitors may be excreted in small amounts in breast milk, and it is recommended that the drugs not be administered to nursing mothers.

Metformin causes gastrointestinal (stomach and digestive) reactions in about a third of patients. A rare, but very serious, reaction to metformin is lactic acidosis, which is fatal in about 50% of cases. Lactic acidosis occurs in patients with multiple medical problems, including renal (kidney-related) insufficiency. The risk may be reduced with careful renal monitoring, and careful dose adjustments to metformin.

Metformin is category B during pregnancy. There have been no carefully controlled studies of the drug during pregnancy, but there is no evidence of fetal harm from animal studies. It is important that rigid blood glucose control be maintained during pregnancy, and pregnant women should be switched to insulin. Animal studies show that metformin is excreted in milk. It is recommended that metformin not be administered to nursing mothers.

Meglitinides. These drugs are generally well tolerated, with an adverse event profile similar to placebo. The drugs are classified as category C during pregnancy, based on fetal abnormalities in rabbits given about 40 times the normal human dose. It is important that rigid blood glucose control be maintained during pregnancy, and pregnant women should be switched to insulin. It is not known whether the meglitinides are excreted in human milk, but it is recommended that these drugs not be given to nursing mothers.

Thiazolidinediones. These drugs were generally well tolerated in early trials, but they are structurally related to an earlier drug, troglitazone, which was associated with liver function problems. However, in extensive testing, these drugs have not been shown to cause any liver problems. These drugs should not be used in patients with any type of **liver disease** or **heart failure** because they tend to increase the amount of fluid the individual retains.

It is recommended that all patients treated with pioglitazone or rosiglitazone have regular liver function monitoring. The drugs are classified as pregnancy category C, based on evidence of inhibition of fetal growth in rats given more than four times the normal human dose. It is important that rigid blood glucose control be maintained during pregnancy, and pregnant women should be switched to insulin. It is not known whether the thiazolidinediones are excreted in human milk, however they have been identified in the milk of lactating rats. It is recommended that these drugs not be administered to nursing mothers.

The DPP-IV drug Januvia can cause severe allergic reaction. Other mild side effects include **headache**, **nausea**, and **sore throat**. Symlin and Byetta can cause hypoglycemia, although the most common side effect is nausea. Nausea can be controlled by slowly increasing the dosage.

Interactions

The sulfonylureas have a particularly long list of **drug interactions**, several of which may be severe. Patients should review specific literature for these drugs.

The actions of oral hypoglycemic agents may be strengthened by highly protein bound drugs, including **nonsteroidal anti-inflammatory drugs** (NSAIDs), salicylates, **sulfonamides**, chloramphenicol, coumarins, probenecid, monamine oxidase inhibitors (MAOIs), and **beta blockers**.

The literature that accompanies each medication should list possible drug-drug or food-drug interactions. The patient should review all prescription and non-prescription medicines being taken as well as all herbal remedies and dietary supplements with their physician and pharmacist before starting to take any antidiabetic agent.

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American Diabetes Association, 1701 North Beauregard Street, Alexandria, VA, 22311, (800) 342-2383, Ask ADA@diabetes.org, http://www.diabetes.org/.
Juvenile Diabetes Research Foundation International, 26 Broadway, 14th Floor, New York, NY, 10004, (212) 785-9595, (800) 533-2873, info@jdrf.org, http://www.jdf.org.
National Diabetes Education Program, One Diabetes Way, Bethesda, MD, 20814-9692, (301) 496-3583, (888) 693-6337, http://www.ndep.nih.gov/.
National Diabetes Information Clearinghouse (NDIC), 1 Information Way, Bethesda, MD, 20892-3560, (703) 738-4929, (800) 860-8747, ndic@info.niddk.nih.gov, http://diabetes.niddk.nih.gov/.
National Institute of Diabetes and Digestive and Kidney Diseases, NIDDK, NIH Bldg 31, Rm 9A06 31 Center Drive, MSC 2560, Bethesda, MD, 20892-2560, (301) 496-3583, http://www2.niddk.nih.gov/.

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KEY TERMS

Colitis—Inflammation of the colon (large bowel).

Dehydration—Excessive loss of water from the body.

Enzyme—A type of protein, produced in the body, that brings about or speeds up chemical reactions.

Nutrient—A food substance that provides energy or is necessary for growth and repair. Examples of nutrients are vitamins, minerals, carbohydrates, fats, and proteins.

Antidiarrheal drugs

Definition

Antidiarrheal drugs are medicines that relieve loose bowels or **diarrhea**.

Purpose

Antidiarrheal drugs help control diarrhea and some of the symptoms that go along with it. An average, healthy person has anywhere from three bowel movements a day to three a week. Normally the stool (the material that is passed in a bowel movement) has a texture something like clay. With diarrhea, bowel movements may be more frequent, and the texture of the stool is thin and sometimes watery.

Diarrhea is not a disease, but a symptom of some other problem. Eating or drinking food or water that is contaminated with bacteria, viruses, or parasites, or eating something that is difficult to digest may cause the symptoms. People who have trouble digesting lactose (milk sugar), for example, may get diarrhea if they eat dairy products. Diarrhea can also be caused by **stress** or may be a side effect of taking certain medicines.

Description

Antidiarrheal drugs work in several ways. The drug loperamide, found in Imodium A-D, for example, slows the passage of stools through the intestines. This allows more time for water and salts in the stools to be absorbed back into the body. Adsorbents, such as attapulgite (found in Kaopectate) pull diarrhea-causing substances from the digestive tract. However, they may also pull out substances that the body needs, such as enzymes and nutrients. Bismuth subsalicylate, the ingredient in Pepto-Bismol, decreases the secretion of fluid into the intestine and inhibits the activity of bacteria. It not only controls diarrhea, but relieves the cramps that often accompany diarrhea.

Antidiarrheal medicines come in liquid, tablet, caplet, and chewable tablet forms and can be bought without a physician's prescription.

Recommended dosage

The dose depends on the type of antidiarrheal drug. Individuals should carefully read and follow the directions on the product label. For questions about dosage, individuals should consult a physician or pharmacist. Antidiarrheal drugs should never be taken in larger or more frequent doses than the directions indicate, and they should not be taken for longer than directed.

Precautions

Diarrhea usually improves within 24–48 hours. If the symptoms last longer or if they keep coming back, this could be a sign of a more serious health problem. Anyone who has any of the symptoms listed below should get medical attention as soon as possible:

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- diarrhea that lasts more than two days or gets worse
- fever
- blood in the stool
- vomiting
- cramps or tenderness in the abdomen
- signs of dehydration, such as decreased urination, dizziness or lightheadedness, dry mouth, extreme thirst, or wrinkled skin

Individuals should not use antidiarrheal drugs for more than two days unless told to do so by a physician.

Severe, long-lasting diarrhea can lead to **dehydration**. Dehydration occurs especially rapidly in young children who have fewer fluid reserves. In such cases, lost fluids and salts, such as **calcium**, **sodium**, and potassium, must be replaced.

People over age 60 should not use attapulgite (Kaopectate, Donnagel, Parepectolin), but may use other kinds of antidiarrheal drugs. However, people in this age group may be more likely to have side effects, such as severe **constipation**, from bismuth subsalicylate.

Bismuth subsalicylate may cause the tongue or the stool to temporarily darken. This is harmless. However, this harmless darkening of the stool should not be confused with the black, tarry stools that are a sign of bleeding in the intestinal tract.

Children with **influenza** or **chickenpox** should not be given bismuth subsalicylate. It can lead to **Reye's syndrome**, a life-threatening condition that affects the liver and central nervous system. To be safe, never give bismuth subsalicylate to a child under age 16 without consulting a physician. Children may have unpredictable reactions to other antidiarrheal drugs. Loperamide should not be given to children under 6 years and attapulgite should not be given to children under 3 years unless directed by a physician.

Individuals who have a history of **liver disease** or who have been taking **antibiotics** should check with their physician before taking the antidiarrheal drug loperamide. A physician should also be consulted before anyone with acute ulcerative **colitis** or anyone who has been advised to avoid constipation uses the drug.

People whose diarrhea is caused by certain infections, such as salmonella or shigella bacteria, should not use loperamide. To be safe, check with a physician before using this drug.

Anyone who has a medical condition that causes weakness should check with a physician about the best way to treat diarrhea.

Special conditions

Before taking antidiarrheal drugs, be sure to let the physician know about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to **aspirin** or other drugs containing salicylates should check with a physician before taking bismuth subsalicylate. Anyone who has developed a rash or other unusual reactions after taking loperamide should not take that drug again without checking with a physician. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY AND BREASTFEEDING. Women who are pregnant or **breastfeeding** should check with their physicians before using antidiarrheal drugs. They should also ask advice on how to replace lost fluids and salts.

OTHER MEDICAL CONDITIONS. Before using antidiarrheal drugs, people with any of these medical problems should make sure their physicians are aware of their conditions:

- dysentery
- gout
- hemophilia or other bleeding problems
- kidney disease
- stomach ulcer
- severe colitis
- liver disease

USE OF OTHER DRUGS. Taking antidiarrheal drugs with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Side effects

The most common side effects of attapulgite are constipation, bloating, and fullness. Bismuth subsalicylate may cause ringing in the ears, but that side effect is rare. It may also cause harmless darkening of the tongue or stool. Possible side effects from loperamide include skin rash, constipation, drowsiness, **dizziness**, tiredness, **dry mouth**, **nausea**, **vomiting**, and swelling, **pain**, and discomfort in the abdomen. Some of these symptoms are the same as those that occur with diarrhea, so it may be difficult to tell if the antidiarrheal medicine is causing the problems. Children may be more sensitive than adults to certain side effects of loperamide, such as drowsiness and dizziness.

Other rare side effects may occur with any antidiarrheal medicine. Anyone who has unusual symptoms after taking an antidiarrheal drug should call his or her physician.

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Interactions

Attapulgite can decrease the effectiveness of other medicines taken at the same time. Changing the scheduling of these other medicines so that they are not taken at the same time may be necessary. Check with a physician or pharmacist to work out the proper dose schedule.

Bismuth subsalicylate should not be taken with aspirin or any other medicine that contains salicylate. This drug may also interact with other drugs, such as blood thinners such as warfarin (Coumadin), methotrexate (Trexall and others), the antigout medicine probenecid (Benemid), some drugs used to treat arthritis, and some drugs used to treat diabetes. In addition, bismuth subsalicylate may interact with any drug that interacts with aspirin. Anyone taking these drugs should check with a physician or pharmacist before taking bismuth subsalicylate.

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ORGANIZATIONS

American College of Gastroenterology, P. O. Box 342260, Bethesda, MD, 20827-2260, (301) 263-9000, http://www.acg.gi.org.

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Antidiuretic hormone (ADH) test

Definition

The antidiuretic hormone (ADH) test measures the level of antidiuretic hormone in the blood. ADH, or vasopressin, is produced by the hypothalamus and stored in the posterior pituitary gland, from where it is released into the bloodstream. ADH signals the kidneys to conserve water by concentrating the urine and reabsorbing water into the blood. ADH can also be given as a medication. The ADH test is also called the vasopressin test, the arginine vasopressin (AVP) test, or simply ADH.

Purpose

An ADH test is used alone or in combination with other tests to detect and diagnose ADH deficiency or excess. It also can help determine the cause of an ADH abnormality. In particular, the ADH test is used to help diagnosis central **diabetes insipidus**, nephrogenic diabetes insipidus, and the syndrome of inappropriate ADH (SIADH) secretion:

- Central diabetes insipidus is due either to insufficient ADH production by the hypothalamus or failure of the pituitary gland to release ADH into the bloodstream.
- Nephrogenic diabetes insipidus is caused by the failure of the kidneys to respond to ADH, resulting in the production of large volumes of dilute urine.
- SIADH is an abnormal secretion of ADH and is a common hormonal complication of traumatic brain injury (TBI).

An ADH test may be used to investigate the cause of excessive thirst and frequent urination or low blood **sodium** levels (**hyponatremia**). An ADH test is often used in conjunction with a water–loading ADH suppression test or a water–restriction or water–deprivation ADH stimulation test.

Description

Water is continually taken into the body with food and fluids and is produced from chemical reactions within the cells of the body. Water is continually lost in urine, feces, sweat, and as water vapor in exhaled breath. ADH controls the amount of water that is reabsorbed by the kidneys and excreted in the urine. When the concentration of blood serum increases or blood volume decreases, ADH is released by the pituitary gland in the brain to signal the kidneys to retain water in the body. This message dilutes the blood, increases blood volume and blood pressure, concentrates the urine, and decreases urine volume. ADH is also released in response to **anxiety** or physical **stress**, such as an injury or surgery. Receptors in the hypothalamus respond to the concentration of dissolved particles in the blood and signal the pituitary to release more or less ADH. Receptors in the heart respond to

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KEY TERMS

Antidiuretic hormone (ADH); vasopressin—A polypeptide hormone that is secreted by the pituitary gland along with oxytocin, or is chemically synthesized, and which suppresses water loss and increases blood pressure.

Diabetes insipidus—A metabolic disorder in which the pituitary gland produces inadequate amounts of antidiuretic hormone (ADH) or the kidneys are unable to respond adequately to ADH. Primary symptoms are excessive urination and constant thirst.

Hyponatremia—A deficiency of sodium in the blood.

Hypothalamus—A regulatory center in the brain.

Pituitary gland—The most important or "master" endocrine gland, which regulates and controls many body processes as well as the release of hormones by other endocrine glands.

Syndrome of inappropriate antidiuretic hormone (SIADH)—A potentially fatal condition of excessive secretion of ADH, leading to concentrated urine and blood sodium deficiency.

blood volume and pressure and signal the pituitary to release more or less ADH.

Various factors can affect ADH production and secretion, thereby disturbing the body's water balance. Medications such as lithium can block the action of ADH. ADH activity can also be partially blocked by high levels of **calcium** or low levels of potassium in the blood.

Factors that can reduce ADH levels include:

- lying down
- alcohol consumption, which reduces ADH production by direct action on the brain, resulting in a temporary increase in urine production
- high blood pressure
- over–hydration
- hypervolemia—increased blood volume

Drugs that decrease ADH levels include:

- alcohol
- beta–adrenergic agents
- morphine antagonists
- phenytoin (Dilantin)

Factors that can increase ADH levels and cause water retention include:

- nighttime
- standing or exercising
- dehydration
- infection
- pneumonia
- hypovolemia—a decrease in blood volume
- major surgery or serious injury
- severe physical stress from pain, trauma, or prolonged mechanical ventilation
- central nervous system tumors
- ectopic ADH secretion by certain lung cancers and some head and neck tumors

Drugs that increase ADH levels include:

- barbiturates
- cholinergic agents
- estrogen
- nicotine
- histamine
- oral hypoglycemia agents such as chlorpropamide
- some diuretics such as thiazides
- cyclophosphamide
- narcotics such as morphine
- tricyclic antidepressants such as desipramine and amitriptyline
- carbamazepine, an anticonvulsant
- clofibrate, a cholesterol–lowering agent

Drugs that promote ADH action include:

- acetaminophen
- aspirin
- non steroidal anti–inflammatory drugs (NSAIDs)
- metformin and tolbutamide—drugs used to treat type 2 diabetes
- theophylline

Other drugs that can affect the results of an ADH test include:

- clonidine
- haloperidol
- insulin
- steroids

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Preparation

No preparation is needed for an ADH test unless it is being performed as part of a water–deprivation ADH stimulation test or a water–loading ADH suppression test. A water–deprivation ADH stimulation test—which is sometimes used to distinguish between the different types of diabetes insipidus—requires fluid restriction prior to the ADH test, followed by the administration of ADH. A water–loading ADH suppression test—which is sometimes performed to diagnose SIADH—requires **fasting** and drinking specific amounts of water prior to the ADH test.

Blood for an ADH test is withdrawn with a needle from a vein—usually from the inside of the elbow or the back of the hand—and collected in a syringe. With infants or young children, the skin may be punctured with a lancet and the blood collected with a pipette or on a slide or test strip.

Aftercare

The only aftercare for an ADH test is the possible bandaging of the puncture site where the blood was withdrawn.

Risks

There are only minimal risks from an ADH test, but these can include:

- difficulty obtaining a blood sample
- a prick, sting, or slight pain with the puncture for blood drawing
- throbbing after the blood is drawn
- slight bleeding from the site where blood is drawn
- faintness or lightheadedness after blood drawing
- hematoma—an accumulation of blood under the puncture site
- infection

A water–deprivation ADH stimulation test or a water–loading ADH suppression test must be performed under close medical supervision. The water–deprivation test can potentially cause severe **dehydration**. The water–loading test can potentially cause severe hyponatremia and may be risky for patients with **kidney disease**.

Results

Normal ADH levels in the blood depend on the laboratory but range from zero to five picograms per milliliter (pg/mL). ADH test results do not indicate any specific conditions, but must be evaluated within the context of other diagnostic tools. High or low ADH levels can be temporary or chronic and can be due to various underlying conditions, diseases, infections, trauma or surgery, or excessive water intake.

A high ADH level may indicate:

- SIADH
- central nervous system infection
- central nervous system tumor
- lung infection
- lung tumor
- post–surgical fluid imbalance
- very rarely, acute porphyria—an inherited blood disorder

A low ADH level may indicate:

- diabetes insipidus
- primary polydipsia—excessive or abnormal thirst
- damage to the pituitary gland

Resources

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ORGANIZATIONS

National Institute of Diabetes and Digestive and Kidney Diseases (NIDDKD), Building 31, Room 9A06, 31 Center Dr., MSC 2560, Bethesda, MD, 20892–2560 (301) 496–3583, http://www2.niddk.nih.gov.

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Antiemetic drugs *see* **Antinausea drugs**

Antiepileptic drugs *see* **Anticonvulsant drugs**

Antifungal drugs, systemic

Definition

Systemic antifungal drugs are medicines taken by mouth or by injection to treat internal infections caused by fungi.

Purpose

Systemic antifungal drugs are used to treat infections in various parts of the body that are caused by a

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fungus. A fungus is an organism that can be either one-celled or filamentous. Unlike a plant, which makes its own food, or an animal, which eats plants or other animals, a fungus survives by invading and living off other living things. Fungi thrive in moist, dark places, including some parts of the body.

Fungal infections can either be internal, meaning that the infection occurs within the body, or topical (outside the body), meaning that the infection is superficial and occurs on the skin or nails. Additionally, yeast infections can affect the mucous membranes of the body. Fungal infections on the skin are usually treated with creams or ointments (**topical antifungal drugs**). However, internal infections, many yeast infections, or topical infections that do not clear up after treatment with creams or ointments may need to be treated with systemic antifungal drugs. These drugs are used, for example, to treat common fungal infections such **candidiasis** (a yeast infection, also known as thrush) that can occur in the throat, in the vagina, or in other parts of the body. They are also used to treat deep fungal infections such as **histoplasmosis**, **blastomycosis**, and **aspergillosis** that can affect the lungs and other organs. They are sometimes used to prevent or treat fungal infections in people whose immune systems are weakened, such as bone marrow or organ transplant patients, individuals undergoing **chemotherapy** or radiation treatment, and individuals with HIV/AIDS.

Description

Antifungal medications work by utilizing several different mechanisms of action at the cellular level. Some of these medications cause fungal cell death by inhibiting DNA synthesis and protein synthesis in the fungal cell leading to the cell's destruction. Other drugs in this class work by inhibiting ergosterol synthesis in the fungal cell. This leads to increased permeability of the cell wall that results in leakage of cellular content, a precursor to fungal cell death.

Antifungal drugs are categorized depending on their route or site of action, their mechanism of action, and their chemical nature. They come in tablet, capsule, liquid, and injectable forms.

U.S. brand names

Brand names of some antifungal drugs available only by prescription that are approved for use in the United States include:

- amphotericin B (Amphocin, Fungizone)
- capsofungin (Cancidas)
- flucytosine (Ancobon)
- fluconazole (Diflucan)
- itraconazole (Sporanox)
- ketoconazole (Nizoral)
- miconazole (Monistat I.V.)
- posaconazole (Noxafil)
- voriconazole (Vfend)

Canadian brand names

Flucytosine is available in Canada under the brand name Ancotil.

KEY TERMS

Elixir—Liquid that contains alcohol, water, and a therapeutic agent.

Fetus—A developing baby inside the womb.

Fungus—A unicellular or filamentous organism that causes parasitic infections.

Ointment—A thick substance that contains medicine and is meant to be spread on the skin, or if an ophthalmic ointment, in the eye.

Systemic—A term used to describe a medicine that has effects throughout the body as opposed to topical drugs that work on the skin. Most medicines that are taken by mouth or by injection are systemic drugs.

Recommended dosage

The recommended dosage depends on the type of antifungal drug and the nature and extent of fungal infection being treated. Doses may also be different for different patients. The prescribing physician or the pharmacist can provide dosage information. Systemic antifungal drugs must be taken exactly as directed. Itraconazole and ketoconazole should be taken with food.

Fungal infections can take a long time to clear up, so it may be necessary to take the medication for several months, or even for a year or longer. Individuals with **AIDS** may need to continue taking the drugs indefinitely to help prevent re-infection. It is important to keep taking the drug for as long as it is prescribed, even if symptoms seem to improve. If the drug is stopped too soon, the symptoms may return.

Systemic antifungal drugs work best when their amount is kept constant in the body, meaning that they have to be taken regularly at the same time every day without missing any doses.

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Patients taking the liquid form of ketoconazole should use a specially marked medicine spoon or other medicine-measuring device to make sure they take the correct amount. A regular household teaspoon may not hold the right amount of medicine. The individual should ask a health care provider about ways to accurately measure the dose of these drugs.

Precautions

If symptoms do not improve within a few weeks, the individual should inform the physician who prescribed the drug.

While taking this medicine, regular medical visits should be scheduled. The physician needs to check for side effects throughout the period of antifungal therapy.

Some people feel drowsy or dizzy while taking systemic antifungal drugs. Anyone who takes these drugs should not drive, use machines, or do anything else that might be dangerous until they determine how the drugs affect them.

Liver problems, stomach problems, and other problems may occur, especially in people who drink alcohol while taking systemic antifungal drugs. Alcohol and prescription or nonprescription (over-the-counter) drugs or herbal remedies that contain alcohol should be avoided while taking antifungal drugs. (Medicines that may contain alcohol include some **cough** syrups, tonics, and elixirs.) Alcohol should be avoided for at least one day after ending antifungal drug therapy.

The antifungal drug ketoconazole may make the eyes unusually sensitive to light. Wearing sunglasses and avoiding exposure to bright light may help.

Pregnancy and breastfeeding

In laboratory studies of animals, systemic antifungal drugs have caused **birth defects** and other problems in the mother and fetus. Studies have not been done on pregnant women, so it is not known whether these drugs cause similar effects in people. Women who are pregnant or who plan to become pregnant should check with their physicians before taking systemic antifungal drugs. Any woman who becomes pregnant while taking these drugs should let her physician know immediately.

Systemic antifungal drugs pass into breast milk. This means that they can be passed to a **breastfeeding** infant. Women who are breastfeeding should check with their physicians before using systemic antifungal drugs.

OTHER CONDITIONS AND ALLERGIES. People who have medical conditions that deplete stomach acid (achlorhydria) or decrease stomach acid (hypochlorhydria) should inform their physicians about the condition before they use a systemic antifungal drug. These drugs are not active in their natural form, but must be converted to the active form by an acid. If there is not enough stomach acid, the drugs will be ineffective. For people with insufficient stomach acid, it may help to take the medicine with an acidic drink, such as a cola. The patient's health care provider can suggest the best way to take the medicine.

Before using systemic antifungal drugs, people with any of these medical problems should make sure their physicians are aware of their conditions:

- current or past alcohol abuse
- liver disease
- kidney disease

Unusual reactions to systemic antifungal drugs in the past should be discussed with a physician before taking the drugs again. The physician should also be told about **allergies** to any other medications, foods, dyes, preservatives, or other substances.

Side effects

Fluconazole

Although rare, severe allergic reactions to fluconazole have been reported. Seek immediate medical attention if any of these symptoms develop after taking fluconazole (Diflucan):

- hives, itching, or swelling
- breathing or swallowing problems
- sudden drop in blood pressure
- diarrhea
- abdominal pain

Ketoconazole

Ketoconazole has caused **anaphylaxis** (a life-threatening allergic reaction) in some people after their first dose. This is a rare reaction.

Systemic antifungal drugs in general

Systemic antifungal drugs may cause serious and possibly life-threatening liver damage. Patients who take these drugs should have **liver function tests** before they start taking the medicine and as often as their physician recommends while they are taking it. The physician should be notified immediately if any of these symptoms develop:

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- loss of appetite
- nausea or vomiting
- yellow skin or eyes
- unusual fatigue
- dark urine
- pale stools

The most common minor side effects of systemic antifungal drugs are **constipation**, **diarrhea**, **nausea**, **vomiting**, **headache**, drowsiness, **dizziness**, and flushing of the face or skin. These problems usually go away as the body adjusts to the drug and do not require medical treatment. Less common side effects, such as menstrual problems in women, breast enlargement in men, and decreased sexual ability in men also may occur and do not need medical attention unless they do not improve in a reasonable amount of time.

More serious side effects are uncommon, but can occur. If any of the following side effects occur, the individual should check with the physician who prescribed the medicine immediately:

- fever and chills
- skin rash or itching
- high blood pressure
- pain, redness, or swelling at site of injection (for injectable miconazole)

Anyone who has unusual symptoms after taking systemic antifungal drugs should contact his or her physician.

Interactions

Serious and possibly life-threatening side effects can result if the oral forms of itraconazole or ketoconazole or the injectable form of miconazole are taken with certain drugs. Do not use them with any of the following drugs unless the physician approves of the therapy:

- astemizole (Hismanal)
- antacids
- theophylline-containing anti-wheezing medications

Taking an acid blocker such as cimetidine (Tagamet), esomeprazole (Nexium), famotidine (Pepcid), nizatidine (Axid), omeprazole (Prilosec), or ranitidine (Zantac) at the same time as a systemic antifungal drug may prevent the antifungal drug from working properly. For best results, take the acid blocker at least two hours after taking the antifungal drug.

Systemic antifungal drugs may interact with many other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone taking systemic antifungal drugs should inform the prescribing physician about all other prescription and nonprescription medicines he or she is taking. Among the drugs that may interact with systemic antifungal drugs are:

- acetaminophen (Tylenol)
- birth control pills
- male hormones (androgens)
- female hormones (estrogens)
- antibiotics for other types of infections
- antidepressants
- antihistamines
- muscle relaxants
- medicine for diabetes, such as tolbutamide (Orinase), glyburide (DiaBeta), and glipizide (Glucotrol)
- blood-thinning medicine, such as warfarin (Coumadin)

Other drugs, herbal drugs, or dietary supplements may interact with systemic antifungal drugs. The individual should be sure to check with a physician or pharmacist before combining systemic antifungal drugs with any other medicine.

Resources

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ORGANIZATIONS

American Academy of Dermatology (AAD), P.O. Box 4014, Schaumburg, IL, 60168 (866) 503-SKIN (7546) (847) 240-1859, http://www.aad.org.

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Antifungal drugs, topical

Definition

Topical antifungal drugs are medicines applied to the skin to treat skin infections caused by a fungus.

Purpose

Dermatologic fungal infections are usually described by their location on the body. *Tinea pedis,* often called athlete's foot is an infection of the skin of the foot, *tinea unguium* is an infection of the nails, *tinea capitis* is an infection of the scalp, and tinea corporis is an infection of the skin on the body such as the chest, arms, or legs. Some fungal infections are called "ringworm" because the way the fungus grows leaves a red, raised circle around normal skin, making it appear as if there is a worm under the skin. Three types of fungus are involved in most skin infections: *Trichophyton, Epidermophyton,* and *Microsporum*. Mild infections can usually be treated successfully with topical medicines; however, severe or resistant infections may require systemic treatment such as antifungal drugs taken by mouth. (See **Antifungal drugs, systemic**.)

Description

Many drugs currently are available in topical form for fungal infections. The imidazole family of drugs includes miconazole (Micatin, Miconazole), clotrimazole (Lotrimin), econazole (Spectazole), ketoconazole (Nizoral), oxiconazole (Oxistat), sulconazole (Exelderm). The allylamine derivatives include butenafine (Mentax), naftifine (Naftin), and terbinafine (Lamisil). The drugs in this therapeutic class are chemically distinct from each other. All drugs when applied topically have a good margin of safety, and most show a high degree of effectiveness. Although some of the topical antifungals are available without a prescription (over-the-counter), they may not be as effective as prescription drugs for treating all fungal infections.

Traditional antifungal drugs such as undecylinic acid (Cruex, Desenex) and gentian violet (also known as crystal violet) remain available, but have a lower success rate in completely eradicating the fungus than the newer agents and are not recommended. Tolnaftate (Tinactin) has a lower cure rate than the newer drugs, but may be used successfully to prevent rather than cure fungal infection.

KEY TERMS

Cream—A spreadable substance, similar to an ointment, but not as thick. Creams may be more appropriate than ointments for application to exposed skin areas such as the face and hands.

Ointment—A thick, spreadable substance that contains medicine and is meant to be used on the skin, or if a vaginal preparation, in the vagina.

Ophthalmic—Pertaining to the eye.

Otic—Pertaining to the ear.

Topical—Not ingested; applied to the outside of the body, for example to the skin, eye, or mouth.

Recommended dosage

All drugs are applied topically. The individual should consult his or her doctor or pharmacist for specific application instructions.

As with all topical products, the selection of the dosage form may be as important as proper drug selection. Factors that the physician may consider include the presence or absence of hair on the affected area and type of skin to which the medication is to be applied. Thin liquids may be recommended for application to hairy areas, creams for the hands and face, and ointments may recommended for the trunk and legs. Topical antifungal drugs are also available in shampoos and sprays. Ciclopirox and triacetin are available in formulations for topical treatment of nail fungus as well as skin infections (ciclopirox as Penlac Nail Lacquer and triacetin as Ony-Clear Nail).

Most topical antifungal drugs require at least four weeks of treatment. Infections in some areas, particularly the spaces between toes, may take six weeks or longer to treat successfully. In some cases treatment with oral (taken by mouth) antifungal drugs may be required if the topical antifungal treatment is not effective.

Precautions

Most topical antifungal agents are well tolerated. The most common adverse effects are local irritation. This may include redness, **itching**, blistering, or a burning sensation. Allergic reactions are possible but rare.

Topical antifungal drugs should only be applied in accordance with labeled uses. They are not intended for ophthalmic (eye) or otic (ear) use. Only drugs

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specifically intended for application to mucous membranes (such as the interior of the mouth) should be applied to mucous membranes.

Antifungal drugs have not been evaluated for safety in **pregnancy** and while **breastfeeding**. Although absorption of the drugs is probably low, women who are pregnant or breastfeeding should consult their physicians before using any new medication, even an over-the-counter topical treatment. Gentian violet should not be used by pregnant or breastfeeding women.

Interactions

Topical antifungal drugs are generally believed to have no negative interactions with foods or other medications. However, individuals should check with their doctor or pharmacist before beginning any new drug treatment.

Resources

BOOKS

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ORGANIZATIONS

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Antigas agents

Definition

Antigas agents are medicines that relieve the uncomfortable symptoms of too much gas (flatulence) in the stomach and intestines.

Purpose

On average adults pass 1–3 pints of gas daily. Foods that cause gas in one person may not cause them in another. Excess gas can build up in the stomach and intestines for a number of reasons. Eating high-fiber foods, such as beans, grains, and fibrous vegetables is one cause. Some people unconsciously swallow air when they eat, drink, chew gum, or smoke cigarettes. This can lead to uncomfortable amounts of gas in the digestive system. Surgery and certain medical conditions, such as irritable bowel disease, peptic ulcer, and **diverticulosis**, can also lead to gas build-up. Some intestinal parasites also can contribute to the production of severe gas. These parasites need to be treated separately with special drugs that go beyond treating the gas and treat the parasitic infestation. Abdominal **pain**, pressure, bloating, and flatulence are signs of too much gas. Antigas agents help relieve the symptoms by preventing the formation of gas pockets and breaking up gas that already is trapped in the stomach and intestines.

KEY TERMS

Digestive tract—The stomach, intestines, and other parts of the body through which food passes.

Diverticulosis—A condition in which the colon (large intestine) develops a number of outpouchings or sacs.

Flatulence—Excess gas in the digestive tract.

Irritable bowel disease—An intestinal disorder often accompanied by abdominal pain and diarrhea.

Description

Antigas agents are sold as capsules, liquids, and tablets (regular and chewable) and can be bought without a physician's prescription. Some common American brands are Gas-X, Flatulex, Mylanta Gas Relief, Di-Gel, Bean-O, and Phazyme. The ingredient that helps relieve excess gas is simethicone. Simethicone does not relieve acid **indigestion**, but some products contain a combination of simethicone and **antacids** to relieve both gas and acid indigestion. Check the label of the product or ask the pharmacist for more information.

Recommended dosage

Check the product container for dosing information. Typically, the doses should be taken after meals and at bedtime. Chewable forms should be chewed thoroughly.

Check with a physician before giving this medicine to children under age 12 years.

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Precautions

Some anti gas medicines may contain sugar, **sodium**, or other ingredients. Anyone who is on a special diet or who is allergic to any foods, dyes, preservatives, or other substances should check with his or her physician or pharmacist before using any of these products.

Anyone who has had unusual reactions to simethicone, the active ingredient in antigas medicines, should check with his or her physician before taking these drugs.

Side effects

No common or serious side effects have been reported in people who use this medicine. However, anyone who has unusual symptoms after taking an antigas agent should get in touch with his or her physician.

Interactions

Antigas agents are not known to interact with any other drugs.

Resources

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ORGANIZATIONS

National Digestive Diseases Information Clearinghouse (NDDIC), 2 Information Way, Bethesda, MD, 20892-3570, (703) 738-4929, (800) 891-5389, http://digestive.niddk.nih.gov.

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Antigastroesophageal reflux drugs

Definition

These drugs are used to treat gastroesophageal reflux, the backward flow of stomach contents into the esophagus.

KEY TERMS

Esophagus—The part of the digestive tract between the pharynx and the stomach. (The pharynx is the space just behind the mouth.)

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Purpose

The drug discussed here, cisapride (Propulsid), is used to treat nighttime **heartburn** resulting from **gastroesophageal reflux disease** (GERD). In this condition, food and stomach juices flow backward from the stomach into the esophagus, the part of the digestive tract through which food passes on its way from the mouth to the stomach. Normally, a muscular ring called the lower esophageal sphincter (LES) opens to allow food into the stomach and then closes to prevent the stomach's contents from flowing back into the esophagus. In people with GERD, this muscular ring is either weak or it relaxes at the wrong times. The main symptom is heartburn – a burning sensation centered behind the breastbone and spreading upward toward the neck and throat.

Cisapride works by strengthening the lower esophageal sphincter and making the stomach empty more quickly. This shortens the amount of time that the esophagus comes in contact with the stomach contents. Other drugs, such as H2-blockers are sometimes prescribed to reduce the amount of acid in the stomach.

Description

Cisapride is available only with a physician's prescription. Cisapride is sold in tablet and liquid forms.

Recommended dosage

The dose depends on the patient. The average dose for adults and children age 12 and over is 5-20 mg taken two to four times a day. The medicine should be taken 15 minutes before meals and at bedtime. For children under 12, the dose is based on body weight and should be determined by the child's physician.

Precautions

This medicine is effective in treating only nighttime heartburn, not daytime heartburn.

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Cisapride may increase the effects of alcohol and tranquilizers.

Cisapride has caused dangerous irregular heartbeats in a few people who took it with other medicines. Anyone who takes this drug should let the physician know all other medicines he or she is taking. Patients with heart problems should check with their physicians before taking cisapride.

Anyone who has bleeding, blockage, or leakage in the stomach or intestines should not take cisapride. Cisapride should not be used by anyone who has had an unusual reaction to the drug in the past. In addition, people with any of the following medical problems should make sure their physicians are aware of their conditions:

- Epilepsy or history of seizures
- Kidney disease
- Liver disease.

The effects of taking cisapride during **pregnancy** have not been fully studied. Women who are pregnant or plan to become pregnant should check with their physicians before taking Cisapride. The drug passes into breast milk and may affect nursing babies. Women who are **breastfeeding** and need to take this medicine should check with their physicians. Avoiding breastfeeding while taking the drug may be necessary.

Side effects

The most common side effects are abdominal **pain**, bloating, gas, **diarrhea**, **constipation**, **nausea**, upper respiratory infections, inflammation of the nasal passages and sinuses, **headache**, and viral infections. Other side effects may occur. Anyone who has unusual or troublesome symptoms after taking this drug should get in touch with his or her physician.

Interactions

Cisapride may interact with a variety of other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes Cisapride should let the physician know all other medicines he or she is taking. Among the drugs that may interact with cisapride are:

- Antifungal drugs such as ketoconazole (Nizoral), miconazole (Monistat), and fluconazole (Diflucan)
- Antibiotics such as clarithromycin (Biaxin) and erythromycin (E-Mycin, ERYC)
- Blood-thinners such as warfarin (Coumadin)
- H2-blockers such as cimetidine (Tagamet) and ranitidine (Zantac)
- Tranquilizers such as chlordiazepoxide (Librium), diazepam (Valium), and alprazolam (Xanax).

The list above does not include every drug that may interact with cisapride. Be sure to check with a physician or pharmacist before combining cisapride with any other prescription or nonprescription (over-the-counter) medicine.

ORGANIZATIONS

National Digestive Diseases Information Clearinghouse (NDDIC), 2 Information Way, Bethesda, MD, 20892-3570, (703) 738-4929, (800) 891-5389, http://digestive.niddk.nih.gov.

Pediatric/Adolescent Gastroesophageal Reflux Association, PO Box 7728, Silver Spring, MD, 20907, (301) 601-9541, gergroup@aol.com, http://www.reflux.org.

Nancy Ross-Flanigan

Antihelminthic drugs

Definition

Antihelminthic drugs are used to treat parasitic infestations.

Purpose

Parasitic infestations are caused by protozoa or worms gaining entry into the body. Most of these organisms cause infections by being ingested in the form of eggs or larvae, usually present on contaminated food or clothing. Others gain entry through breaks in the skin. Common parasitic infestations include **amebiasis**, **malaria**, **giardiasis**, hookworm, pinworm, threadworm, whipworm, and tapeworm infestations. Once in the body, parasitic worms may go unnoticed if they cause no severe symptoms. However, if they multiply rapidly and spread to a major organ, they can cause serious and even life-threatening conditions. Antihelminthic drugs are prescribed to treat these infestations. They function either by destroying the worms on contact, by paralyzing them, or by altering the permeability of their plasma membranes. The dead worms then pass out of the body in the feces.

Description

Antihelminthic drugs are available only with a prescription and are available as liquids, tablets or capsules. Some commonly used antihelminthics include: albendazole (Albenza), diethylcarbamazine

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KEY TERMS

Amebiasis—Parasitic infestation caused by amebas, especially by *Entamoeba histolytica*.

Colitis—Inflammation of the colon (large intestine).

Feces—The solid waste that is left after digestion. Feces form in the intestines and leave the body through the anus.

Flukes—Parasite worms that look like leeches. They usually have one or more suckers for attaching to the digestive mucosa of the host. Liver flukes infest the liver, destroying liver tissue and impairing bile production and drainage.

Giardiasis—Parasitic infestation caused by a flagellate protozoan of the genus Giardia, especially by *Giardia lamblia* .

Hallucination—A false or distorted perception of objective reality. Imaginary objects, sounds, and events are perceived as real.

Hookworm—Parasitic intestinal infestation caused by any of several parasitic nematode worms of the family Ancylostomatidae. These worms have strong buccal hooks that attach to the host's intestinal lining.

Larva—The immature, early form of an organism that at birth or hatching is not like its parent and has to undergo metamorphosis before assuming adult features.

Malaria—Disease caused by the presence of sporozoan parasites of the genus Plasmodium in the red blood cells, transmitted by the bite of anopheline mosquitoes, and characterized by severe and recurring attacks of chills and fever.

Microtubules—Slender, elongated anatomical channels in worms.

Nematode—Roundworm.

Onchocerciasis—Parasitic infestation caused by filamentous worms of the genus Onchocerca, especially *Onchocerca volvulus*, that is found in tropical America and is transmitted by several types of blackflies.

Organism—A single, independent life form, such as a bacterium, a plant or an animal.

Parasite—An organism that lives in or with another organism, called the host, in parasitism, a type of association characterized by the parasite obtaining benefits from the host, such as food, and the host being injured as a result.

Parasitic—Of, or relating to a parasite.

Pinworm—Enterobiusital vermicularisital, a nematode worm of the family Oxyuridae that causes parasitic infestation of the intestines and cecum. Pinworm is endemic in both temperate and tropical regions and common especially in school age children.

Protozoan—Any unicellular or multicellular organism containing nuclei and organelles (eukaryotic) of the subkingdom Protozoa.

Roundworm—Any round-bodied unsegmented worm as distinguished from a flatworm. Also called a nematode, they look similar to the common earthworm.

Tapeworm—Flat and very long (up to 30 meters) intestinal parasitic worms, similar to a long piece of tape. Common tapeworms include: *T. saginata* (beef tapeworm), *T. solium* (pork tapeworm), *D. latum* (fish tapeworm), *H. Nana* (dwarf tapeworm), and *E. granulosus* (dog tapeworm). General symptoms are vague abdominal discomfort, nausea, vomiting, diarrhea and weight loss.

Threadworm—Any long, thin nematode worm.

Trematode—Any parasitic flatworm of the class Trematoda, as the liver fluke.

Whipworm—A nematode worm of the family Trichuridae with a body that is thick at one end and very long and slender at the other end.

(Hetrazan), ivermectin (Stromectol), mebendazole (Vermox), metronidazole (Flagyl), niclosamide (Niclocide), nifurtimox (Lampit, Bayer 2502), oxamniquine (Vansil), pentamidine (Pentam), praziquantel (Biltricide), pyrantel (Antiminth), pyantel pamoate (Antiminth) and thiabendazole (Mintezol). Some types of parasitic infestations are rarely seen in the United States, thus, the corresponding antihelminthic drugs are not widely distributed and need to be obtained from the United States Centers for Disease Control and Prevention (CDC) when required.

Most antihelminthic drugs are only active against specific parasites, some are also toxic. Before treatment, the parasites must therefore be identified using tests that look for parasites, eggs, or larvae in feces, urine, blood, sputum, or tissues. Thus, niclosamide is used against tapeworms, but will not be effective for the treatment of pinworm or roundworm infestations,

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because it acts by inhibiting ATP production in tapeworm cells. Thiabendazole (Mintezole) is the drug usually prescribed for treatment of threadworm, but a similar drug, mebendazole (Vermox) works better on whipworm by disrupting the microtubules of this worm. Praziquantel is another drug that acts by altering the membrane permeability of the worms.

Preparation

Dosage is established depending on the patient's general health status and age, the type of antihelminthic drug used, and the type of parasitic infestation being treated. The number of doses per day, the time between doses, and the length of treatment will also depend on these factors.

Antihelminthic drugs must be taken exactly as directed to completely rid the body of the parasitic infestation, and for as long as directed. A second round of treatment may be required to ensure that the infection has completely cleared.

Precautions

Some antihelminthic drugs work best when ingested along with fatty foods, such as milk or ice cream. Oral drugs should be taken with water during or after meals. The prescribing physician should be informed if the patient has a low-fat or other special diet.

Some antihelminthic drugs, such as praziquantel, come in chewable form. These tablets should not be chewed or kept in the mouth, but should swallowed whole because their bitter taste may cause gagging or **vomiting**.

Antihelminthic drugs sometimes need to be taken with other medications. For example, **steroids** such as prednisone are also prescribed together with the antihelminthic drug for tapeworm to reduce the inflammation that the worm may cause.

When required, pre- or post-treatment purges are also performed with magnesium or sodium sulfate.

Regular medical visits are recommended for people affected by parasitic infestations. The physician monitors whether the infection is clearing or not and also keeps track of unwanted side effects. The prescribing physician should be informed if symptoms do not disappear or if they get worse.

Hookworm or whipworm infections are also treated with iron supplements along with the antihelminthic prescription.

Some types of parasitic infestations (e.g. pinworms) can be passed from one person to another. It is then often recommended that everyone in the household of an infected person be asked to also take the prescribed antihelminthic drug.

Risks

People with the following medical conditions may have adverse reactions to antihelminthic drugs. The prescribing physician should accordingly be informed if any of these conditions are present:

- Allergies. Anyone who has had adverse reactions to antihelminthic drugs should inform the prescribing physician before taking the drugs again. The physician should also be informed about any other pre-existing allergies.
- Ulcers. Antihelminthic drugs are also contraindicated for persons diagnosed with ulcers of the digestive tract, especially ulcerative colitis.
- Pregnancy. There is research evidence reporting that some antihelminthic drugs cause birth defects or miscarriage in animal studies. Women who are pregnant or expect to become pregnant should generally avoid these drugs. Pregnant women should accordingly inform the prescribing physician.
- Breastfeeding. Some antihelminthic drugs can pass into breast milk. Breastfeeding may have to be discontinued until the antihelminthic treatment has ended and breastfeeding mothers must also inform the prescribing physician.
- Other risk conditions. Any of the following medical conditions should also be reported to the prescribing physician: Crohn's disease, liver disease, kidney disease and worm cysts in the eyes.

Common side effects of antihelminthic drugs include **dizziness**, drowsiness, **headache**, sweating, dryness of the mouth and eyes, and ringing in the ears. Anyone taking these drugs should accordingly avoid driving, operating machines or other activities that may be dangerous until they know how they are affected by the drugs. Side effects usually wear off as the body adjusts to the drug and do not usually require medical treatment. Thiabendazole may cause the urine to have an unusual odor that can last for a day after the last dose. Other side effects of antihelminthic drugs, such as loss of appetite, **diarrhea**, **nausea**, **vomiting**, or abdominal cramps are less common. If they occur, they are usually mild and do not require medical attention.

More serious side effects, such as **fever**, chills, confusion, extreme weakness, **hallucinations**, severe diarrhea, nausea or vomiting, skin **rashes**, **low back**

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pain, dark urine, blurred vision, seizures, and **jaundice** have been reported in some cases. The patient's physician should be informed immediately if any should develop. As a rule, anyone who has unusual symptoms after starting treatment with antihelminthic drugs should notify the prescribing physician.

Antihelminthic drugs may interact with each other or with other drugs, whether prescribed or not. For example, it has been reported that use of the antihelminthic drugs pyrantel and piperazine together lowers the efficiency of pyrantel. Similarly, combining a given antihelminthic drug with another medication may increase the risk of side effects from either drug.

ORGANIZATIONS

American Society of Parasitologists, P.O. Box 1897, Lawrence, KS, 66044, (785) 843-6153, (800) 627-0326, http://asp.unl.edu/.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

World Health Organization (WHO), Avenue Appia 201211, Geneva, Switzerland, 27, 4122 791-2111, info @who.int, http://www.who.int.

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Antihemorrhoid drugs

Definition

Antihemorrhoid drugs are medicines that reduce the swelling and relieve the discomfort of **hemorrhoids** (swellings in the area around the anus).

Purpose

Hemorrhoids are bulges in the veins that supply blood to the skin and membranes of the area around the anus. They may form for various reasons. Frequent heavy lifting, sitting for long periods or straining to have bowel movements may put stress on anal tissues, which can lead to hemorrhoids. Some women develop hemorrhoids during **pregnancy** as the expanding uterus puts pressure on the anal tissues. The strain of labor and delivery can also cause hemorrhoids or make existing hemorrhoids worse. Hemorrhoids sometimes result from certain medical problems, such as tumors pressing on the lower bowel.

The main symptoms of hemorrhoids are bleeding from the rectum, especially after a bowel movement, and **itching**, burning, **pain**, and general discomfort in the anal area. Over-the-counter antihemorrhoid products can relieve many of these symptoms. The products contain combinations of four main types of ingredients:

- Local anesthetics, such as benzocaine, lidocaine, and tetracaine to temporarily relieve the pain
- Vasoconstrictors, such as epinephrine base, epinephrine hydrochloride, ephedrine sulfate and phenylephrine hydrochloride that reduce swelling and relieve itching and discomfort by tightening blood vessels
- Astringents (drying agents), such as witch hazel, calamine, and zinc oxide. These help shrink hemorrhoids by pulling water out of the swollen tissue. This, in turn, helps relieve itching, burning, and irritation.
- Protectants, such as cocoa butter, lanolin, glycerin, mineral oil, and shark liver oil which soothe irritated tissues and form a protective barrier to prevent further irritation.

KEY TERMS

Anus—The opening at the end of the intestine through which solid waste (stool) passes as it leaves the body.

Rectum—The end of the intestine closest to the anus.

Uterus—A hollow organ in a female in which a fetus develops until birth.

Description

Antihemorrhoid drugs are available as creams, ointments and suppositories. Most can be bought without a physician's prescription.

Recommended dosage

Follow package instructions for using these products. Do not use more than the recommended amount of this medicine every day. For explanations or further information about how to use antihemorrhoid drugs, check with a physician or pharmacist.

Precautions

Do not use antihemorrhoid drugs for more than seven days in a row. If the problem gets worse or does not improve, check with a physician.

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If rectal bleeding continues, check with a physician. This could be a sign of a more serious condition that needs medical attention.

Side effects

Side effects are rare, however, if a rash or any other sign of an allergic reaction occurs, stop using the medicine.

Interactions

Some antihemorrhoid drugs should not be used by people who are taking or have recently taken **monoamine oxidase inhibitors** (MAO inhibitors), such as phenelzine (Nardil) or tranylcypromine (Parnate), used to treat conditions including depression and Parkinson's disease. Anyone who is not sure if he or she has taken this type of drug should check with a physician or pharmacist before using an antihemorrhoid drug. People who are taking antidepressants or medicine for high blood pressure also should not use certain antihemorrhoid drugs. Check with a pharmacist for a list of drugs that may interact with specific antihemorrhoid drugs.

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Antihistamines

Definition

Antihistamines are drugs that block the action of histamine, a compound released in allergic inflammatory reactions. These drugs block the H_1 receptor sites that are responsible for immediate hypersensitivity reactions such as sneezing and **itching**. Members of this class of drugs may also be used for their side effects, including **sedation** and the prevention of **nausea and vomiting** (antiemesis).

Antihistamines

Brand name (generic name)	Possible side effects
*Atarax (hydroxyzine hydrochloride)	Drowsiness, dry mouth, headache
Benadryl (diphenhydramine hydrochloride)	Dizziness, drowsiness, muscle weakness, nausea, upset stomach
Claritin (loratadine)	Drowsiness, headache, mouth sores, nosebleeds, sore throat
PBZ-SR (tripelennamine hydrochloride)	Chest congestion, decreased coordination, dizziness, drowsiness, dry mouth and throat, upset stomach
Periactin (cyproheptadine hydrochloride)	Chest congestion, dizziness, drowsiness, fluttery heartbeat, hives, loss of appetite, sleepiness, vision problems
Polaramine (dexchlorpheniramine maleate)	Difficulty urinating, drowsiness, dry mouth, headache
Tavist (clemastine fumarate)	Decreased coordination, dizziness, drowsiness, upset stomach
Zyrtec (cetirizine)	Drowsiness, stomach pain, vomiting

*Also used in the treatment of anxiety

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Purpose

Antihistamines block the action of histamine H_1 at its receptor sites. These drugs have no effect on rate of histamine release, nor do they inactivate histamine. By inhibiting the activity of histamine, they can reduce capillary fragility, which produces the erythema, or redness, associated with allergic reactions. They also reduce histamine-induced secretions, including excessive tears and salivation. Additional effects vary with the individual drug used. Several of the older drugs, called first-generation antihistamines, bind nonselectively to H_1 receptors in the central nervous system as well as to peripheral receptors, and can produce sedation, inhibition of nausea and vomiting, and reduction of **motion sickness**. The second-generation antihistamines bind only to peripheral H_1 receptors and reduce allergic response with little or no sedation. Below are listed some common antihistamines and their side effects.

The first-generation antihistamines may be divided into several chemical classes. The side effect profile, which also determines the uses of the drugs, will vary by chemical class. The alkylamines include brompheniramine (Dimetapp) and chlorpheniramine (Chlor-Trimeton). These agents cause relatively little

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KEY TERMS

Allergen—A substance that causes an allergy.

Anaphylaxis—A sudden, life-threatening allergic reaction.

Hallucination—A false or distorted perception of objects, sounds, or events that seems real. Hallucinations usually result from drugs or mental disorders.

Histamine—A chemical released from cells in the immune system as part of an allergic reaction.

Pregnancy category—A system of classifying drugs according to their established risks for use during pregnancy. Category A: Controlled human studies have demonstrated no fetal risk. Category B: Animal studies indicate no fetal risk, but no human studies; or adverse effects in animals, but not in well-controlled human studies. Category C: No adequate human or animal studies; or adverse fetal effects in animal studies, but no available human data. Category D: Evidence of fetal risk, but benefits outweigh risks. Category X: Evidence of fetal risk. Risks outweigh any benefits.

sedation, and are used primarily for treatment of allergic reactions. Promethazine (Phenergan), in contrast, is a phenothiazine, chemically related to the major tranquilizers, and while it is used for treatment of **allergies**, may also be used as a sedative, to relieve **anxiety** prior to surgery, as an anti-nauseant, and for control of motion sickness. Diphenhydramine (Benadryl) is chemically an ethanolamine, and in addition to its role in reducing allergic reactions, may be used as a nighttime sedative, for control of drug-induced Parkinsonism, and, in liquid form, for control of coughs.

The second generation antihistamines have no central action, and are used only for treatment of allergic reactions. These are divided into two chemical classes. Cetirizine (Zyrtec) is a piperazine derivative, and has a slight sedative effect. Loratidine (Claritin) and fexofenadine (Allegra) are members of the piperadine class and are essentially non-sedating.

Recommended dosage

Dosage varies with drug, patient, and intended use. Consult a physician, or a pharmacist for further information.

When used for control of allergic reactions, antihistamines should be taken on a regular schedule, rather than on an as-needed basis, since they have no effect on histamine itself, nor on histamine already bound to the receptor site.

The effectiveness of different antihistamine drugs varies a great deal from patient to patient. If an antihistamine fails to provide adequate relief, the individual should switch to a drug from a different chemical class. Individual drugs may be effective in no more than 40% of patients, and provide 50% relief of allergic symptoms.

Side effects

The frequency and severity of adverse effects varies depending on the specific drug. Not all adverse reactions will apply to every member of this class.

Central nervous system reactions include drowsiness, sedation, **dizziness**, faintness, disturbed coordination, lassitude, confusion, restlessness, excitation, tremor, seizures, **headache**, **insomnia**, euphoria, blurred vision, **hallucinations**, disorientation, disturbing dreams/nightmares, schizophrenic-like reactions, weakness, vertigo, **hysteria**, nerve **pain**, and convulsions. Overdoses may cause involuntary movements. Other problems have been reported.

Gastrointestinal problems include increased appetite, decreased appetite, nausea, **vomiting**, **diarrhea**, and **constipation**.

Hematologic reactions are rare, but may be severe. These include anemia, or breakdown of red blood cells, reduced platelets, reduced white cells, and bone marrow failure.

A large number of additional reactions have been reported. Not all apply to every drug, and some reactions may not be drug related. Some of the other adverse effects are chest tightness, **wheezing**, nasal stuffiness, **dry mouth**, nose and throat, **sore throat**, respiratory depression, sneezing, and a burning sensation in the nose.

Antihistamines, including over-the-counter cold and **cough** medicines, should not be given to children under age two. Children are much more susceptible to developing serious side effects including convulsions. Some young children also respond to antihistamines by becoming restless, nervous, and irritable.

The elderly are also more likely to have side effects from antihistamine drugs. The most common are confusion, dizziness, drowsiness, dry mouth, and difficult or painful urination. Like children, they too may become excessively restless or irritable.

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DANIELE BOVET (1907–1992)

A gifted researcher in therapeutic chemistry, Daniele Bovet was born in Neuchatel, Switzerland, one of four children of a professor of experimental education. Bovet studied zoology and comparative anatomy at the University of Geneva, receiving his doctor of science degree in 1929. He then joined the Pasteur Institute in Paris, becoming director of the Laboratory of Therapeutic Chemistry in 1936.

Bovet investigated histamine, thought to cause allergy symptoms. No antagonist of histamine was known, so Bovet—with his research student Anne-Marie Staub—began studying substances that blocked hormones similar to histamine. By 1937 he had produced the first antihistamine, thymoxydiethylamine. Since this substance was too toxic for human use, Bovet and Staub performed thousands more experiments seeking less toxic antihistamines. This work formed the basis for the development of subsequent clinically useful antihistamines.

Hydroxyzine (Atarax) is thought to cause **birth defects** if used early in **pregnancy** and should be avoided. Less is known about other antihistamine drugs. Chlorpheniramine (Chlor-Trimeton), dexchlorpheniramine (Polaramine), diphenhydramine (Benadryl), brompheniramine (Dimetapp), cetirizine (Zyrtec), cyproheptadine (Periactin), clemastine (Tavist), azatadine (Optimine), loratadine (Claritin) are all listed as category B. Azelastine (Astelin), promethazine (Phenergan) are pregnancy category C drugs.

Regardless of chemical class of the drug, it is recommended that mothers not breastfeed while taking antihistamines.

Contraindications

The following are absolute or relative contraindications to use of antihistamines. The significance of the contraindication will vary with the drug and dose.

- glaucoma
- hyperthyroidism (overactive thyroid)
- high blood pressure
- enlarged prostate
- heart disease
- ulcers or other stomach problems
- stomach or intestinal blockage
- liver disease
- kidney disease
- bladder obstruction
- diabetes

Interactions

Antihistamines interact with a very long list of other drugs. To avoid **drug interactions**, before taking antihistamines, the individual should review with a physician or pharmacist all prescription and nonprescription drugs, all herbal remedies and dietary supplements that are being taken.

Monoamine oxidase inhibitor antidepressants (phenelzine [Nardil], tranylcypromine [Parnate]) may prolong and increase the effects of some antihistamines. When used with promethazine (Phenergan) this may cause reduced blood pressure and involuntary movements.

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ORGANIZATIONS

Allergy and Asthma Network: Mothers of Asthmatics (AANMA), 8201 Greensboro Drive, Suite 300, McLean, VA, 22102, (703) 288-5271, (800) 878-4403, http://www.aanma.org.

American Academy of Allergy, Asthma & Immunology, 555 East Wells Street, Suite 1100, Milwaukee, WI, 53202-3823, (414) 272-6071, http://www.aaaai.org.

Asthma and Allergy Foundation of America, 8201 Corporate Drive, Suite 1000, Landover, MD, 20785, (800) 727-8462, info@aafa.org, http://www.aafa.org/.

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Antihyperlipidemic drugs *see* **Cholesterol-reducing drugs**

Antihypertensive drugs

Definition

Antihypertensive drugs are medicines that help to lower blood pressure (**hypertension**).

Purpose

High blood pressure is often called the "silent killer" because the individual rarely sees any obvious

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signs that something is wrong until damage to the cardiovascular system has been done. Overall, antihypertensive agents lower blood pressure, although the mechanisms of action vary greatly. Within this therapeutic class, there are several subgroups of drugs. In 2003, a Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure report concluded that antihypertensive treatment can reduce incidence of **stroke** by 35–40%, **heart attack** by 20–25%, and onset of new **heart failure** by 50%. Some of the drugs used to control hypertension listed below are representative, but they are not the only antihypertensive drugs available.

There are several classes of antihypertensive drugs, each with a different mechanism of action to lower blood pressure. Calcium channel blocking agents, also called **calcium channel blockers** or calcium antagonists, inhibit the movement of calcium ions across the cell membrane. This reduces the force of contraction of muscles of the heart and arteries. Although the calcium channel blockers are treated as a group, there are four different chemical classes, leading to significant variations in the activity of individual drugs. Nifedipine (Adalat, Procardia) has the greatest effect on the blood vessels, while verapamil (Calan, Isoptin), and diltiazem (Cardizem) have a greater effect on the heart muscle itself.

Peripheral **vasodilators** such as hydralazine (Apresoline), isoxuprine (Vasodilan), and **minoxidil** (Loniten) act by relaxing blood vessels. When the blood vessels are relaxed they open more widely, and the heart has to work less hard to pump blood. This results in lower blood pressure.

Several groups of drugs act by reducing adrenergic nerve stimulation. This type of excitatory nerve stimulation causes contraction of the muscles in the arteries, veins, and heart. These drugs include the beta-adrenergic blockers and alpha/beta adrenergic blockers. There are also non-specific adrenergic blocking agents.

Beta-adrenergic blocking agents, usually just called beta blockers, include propranolol (Inderal), atenolol (Tenormin), acebutolol (Sectral), metoprolol (Lopressor), nadolol (Corgard), and pindolol (Visken). Propranolol acts on the beta-adrenergic receptors anywhere in the body, and has been used as a treatment for emotional **anxiety** and rapid heart beat. Atenolol and acebutolol act specifically on the nerves of the heart and blood vessels.

There are two alpha/beta adrenergic blockers, labetolol (Normodyne, Trandate) and carvedilol (Coreg). These work similarly to the **beta blockers**.

Antihypertensive drugs

Brand name (generic name)	Possible side effects
Accupril (quinapril hydrochloride)	Cough, dizziness, headache
Aldactazide (spironolactone and hydrochlorothiazide)	Decreased coordination, diarrhea, fever, headache, upset stomach
Altace (ramipril)	Cough, fatigue, headache
Capoten (captopril)	Decreased sense of taste, itching, rash
Cardizem (diltiazem hydrochloride)	Dizziness, fluid retention, headache, nausea, skin rash
Catapres (clonidine)	Constipation, dizziness, drowsiness, dry mouth
Corgard (nadolol)	Behavioral changes, decreased heartbeat, dizziness, tiredness
Diuril (chlorothiazide)	Constipation or diarrhea, cramps, dizziness, fever, increased glucose level in urine
Dyazide, Maxzide (triamterene and hydrochlorothiazide)	Blurred vision, fatigue, muscle and abdominal pain
DynaCirc (isradipine)	Chest pain, fluid retention, headache, fatigue
HydroDIURIL (hydrochlorothiazide; also used in combination with other drugs, such as fosinopril [brand name Monopril] and metoprolol [Lopressor])	Cramps, diarrhea, hair loss, headache, loss of appetite, nausea and vomiting
Inderal, Inderide (propranolol hydrochloride)	Constipation or diarrhea, nausea and vomiting, tingling sensation
Lasix (furosemide)	Back and muscle pain, indigestion, nausea
Prinivil, Zestril (lisinopril)	Dizziness, fatigue, headache, rash
Lotensin (benazepril hydrochloride)	Dizziness, fatigue, headache, nausea
Lozol (indapamide)	Anxiety, headache, loss of energy, muscle cramps
Minipress (prazosin hydrochloride)	Headache, nausea, weakness
Moduretic (amiloride and hydrochlorothiazide)	Diarrhea, fatigue, itching, loss of appetite
Normodyne (labetalol hydrochloride)	Fatigue, nausea, stuffy nose
Procardia, Procardia XL (nifedipine)	Constipation, fatigue, nausea, swelling
Sectral (acebutolol hydrochloride)	Chest and joint pain, constipation, gas
Tenormin, Tenoretic (atenolol, atenolol and chlorthalidone)	Dizziness, fatigue, nausea
Vaseretic (enalapril and hydrochlorothiazide)	Diarrhea, muscle cramps, rash
Zestoretic (lisinopril hydrochlorothiazide)	Dizziness, fatigue, headache

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Angiotensin-converting enzyme inhibitors, called ACE inhibitors, are drugs that block the conversion of the chemical angiotensin I into angiotensin II.

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KEY TERMS

Adrenergic—Activated by adrenalin (norepinephrine), loosely applied to the sympathetic nervous system responses.

Angioedema—An allergic skin disease characterized by patches of confined swelling involving the skin the layers beneath the skin, the mucous membranes, and sometimes the viscera—called also angioneurotic edema, giant urticaria, Quincke's disease, or Quincke's edema.

Arteries—Blood vessels that carry blood away from the heart to the cells, tissues, and organs of the body.

Diuretic—A substance that removes water from the body by increasing urine production

Ion—An atom or molecule that has an electric charge. In the body ions are collectively referred to as electrolytes.

Laryngospasm—Spasmodic closure of the larynx.

Pregnancy category—A system of classifying drugs according to their established risks for use during pregnancy. Category A: Controlled human studies have demonstrated no fetal risk. Category B: Animal studies indicate no fetal risk, but no human studies; or adverse effects in animals, but not in well-controlled human studies. Category C: No adequate human or animal studies; or adverse fetal effects in animal studies, but no available human data. Category D: Evidence of fetal risk, but benefits outweigh risks. Category X: Evidence of fetal risk. Risks outweigh any benefits.

Sympathetic nervous system—The part of the autonomic nervous system that is concerned especially with preparing the body to react to situations of stress or emergency; it contains chiefly adrenergic fibers and tends to depress secretion, decrease the tone and contractility of smooth muscle, and increase heart rate.

Angiotensin II increases blood pressure by causing blood vessels to constrict (narrow) and increases salt and water retention in the body. Thus, ACE inhibitors lower blood pressure by blocking the formation of angiotensin II. ACE inhibitors include captopril (Capoten), enalapril (Vasotec), and lisinopril (Zestril, Prinivil).

Angiotensin-2 (AT-2) receptor agonists directly inhibit the effects of ACE II rather than blocking its production. Their effect is similar to that of the ACE inhibitors, AT-2 receptor agonists have a less intrusive side effects. ACE II inhibitors include candesartan (Atacand), eprosartan (Teveten), irbesartan (Avapro), telmisartan (Micardis), and valsartan (Diovan).

In addition to these drugs, other drugs are used to lower blood pressure, most notably the **diuretics** (water pills). Diuretics include amiloride (Midamor), bumetanide (Bumex), chlorothiazide (Diuril), furosemide (Lasix), hydrochlorothiazide (Hydrodiuril, Esidrex), indapamide (Lozol), and soironolactone (Aldactone). The drugs in this class appear to lower blood pressure through several mechanisms. By promoting **sodium** (salt) loss, they increase urine production and lower blood volume. At the same time, the pressure of the walls of blood vessels (peripheral vascular resistance) is lowered. Diuretics are commonly the first choice for reduction of mild hypertension, and may be used in combination with other antihypertensive drugs.

Many medicines used to treat high blood pressure combine two different drugs from the groups listed above. The correct choice of an antihypertensive drug depends on how high the individual's blood pressure is, other medical problems present (e.g., diabetes, previous heart attack), and willingness to make lifestyle changes (e.g., diet and **exercise** adjustments). Physicians may try several different antihypertensive drugs before finding a good fit the patient.

Recommended dosage

Recommended dosage varies with patient, drug, severity of hypertension, and whether the drug is being used alone or in combination with other drugs. Individuals who want more information on how to take their antihypertensive drugs should consult the prescribing physician or the pharmacist who fills the prescription.

Precautions

The side effects of calcium channel blockers vary a great deal from drug to drug, Possible side effects include heart **palpitations**, fluid retention, swollen ankles, **constipation**, **headache**, and **dizziness**.

Beta blockers may cause a large number of adverse reactions including dangerous heart rate abnormalities. **Pregnancy** risk factor is category B (acebutolol, pindolol, sotalol) or category C (atenolol, labetalol, esmolol, metoprolol, nadolol, timolol,

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propranolol, penbutolol, carteolol, bisoprolol). **Breastfeeding** is not recommended.

Peripheral vasodilators may cause dizziness and orthostatic hypotension—a rapid lowering of blood pressure when the patient stands up. Patients taking these drugs must be instructed to rise from bed slowly. Pregnancy risk factors for this group are generally category C. Hydralazine has been shown to cause **cleft palate** in animal studies, but insufficient human data is available. Breastfeeding while taking these drugs is not recommended.

ACE inhibitors generally are well tolerated but rarely may cause dangerous reactions including laryngospasm and angioedema. Persistent **cough** is a common side effect. ACE inhibitors should not be used during pregnancy. When used in pregnancy during the second and third trimesters, angiotension-converting inhibitors (ACEIs) can cause injury to and even **death** in the developing fetus. When pregnancy is detected, discontinue the ACE inhibitor as soon as possible. Breastfeeding while taking these drugs should be avoided.

AT-II receptor inhibitors are generally well tolerated and do not cause cough. Pregnancy risk factor is category C during the first trimester and category D during the second and third trimesters. Drugs that act directly on the renin-angiotensin system can cause fetal and neonatal damage and death when administered to pregnant women. When pregnancy is detected, these drugs should be discontinued as soon as possible. Breastfeeding while taking these drugs is not recommended.

Diuretics commonly cause potassium depletion. At the direction of their physician, patients should have potassium supplementation either through diet (bananas are a good source of potassium) or potassium supplements . Pregnancy risk factor is category B or category C, depending on which diuretic is used. Routine use during normal pregnancy is inappropriate. Diuretics are found in breast milk. Breastfeeding is not recommended.

Because of the large number of classes and individual drugs in this group, specialized references offer more complete information. Physicians should review potential side effects and precautions with the patient at the time the drug is prescribed. Additional questions should be addressed to the prescribing physician or a pharmacist.

Interactions

These drugs may interact with a with a wide range of other drugs and herbal supplements. Patients should review with the prescribing physician all medications—prescription, nonprescription, herbal, and dietary supplements—before starting to take an antihypertensive drug. Specific drug references should be consulted, since interactions vary for antihypertensive drugs.

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ORGANIZATIONS

American College of Cardiology, Heart House, 2400 N Street NW, Washington, DC, 20037, (202) 375-6000, ext 5603, (202) 375-7000, (800) 223-4636, ext. 5603, resource@acc.org, http://www.acc.org.

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

Heart Failure Society of America, Inc., Court International-Suite 240 S, 2550 University Avenue West, St. Paul, MN, 55114, (651) 642-1633, (651) 642-1502, http://www.hfsa.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

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Anti-hyperuricemic drugs

Definition

Hyperuricemia is a condition in which there is too much uric acid in the blood. Anti-hyperuricemic drugs are used to treat hyperuricemia and lower the amount of uric acid in the blood.

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KEY TERMS

Gout—A condition that may develop in people with high uric acid levels. Characterized by attacks of painful, reddened joints.

Hyperuricemia—High uric acid levels in the blood.

Purpose

Anti-hyperuricemic drugs decrease the levels of uric acid in the blood, either by increasing the rate at which uric acid is excreted in the urine or by preventing the formation of excess uric acid.

Description

U.S. brand names

- allopurinol (Aloprim, Zyloprim)
- probenicid (Benemid)
- febuxostat (Uloric)

Canadian brand names

- allopurinol (Alloprim, Apo-Allopurinol, Novo-Purol, and Zyloprim)
- probenicid (Benuryl)

Uric acid is a waste product produced by cellular metabolism that is removed from the blood by the kidneys and eliminated from the body in urine. Purines are compounds that are the building blocks of uric acid. Foods high in purines include organ meat (e.g. liver, heart), yeast and yeast extracts (including alcoholic beverages because they are fermented with yeast), asparagus, spinach, beans, peas, lentils, oatmeal, cauliflower, and mushrooms.

Hyperuricemia can be caused by **kidney disease** that prevents the kidneys from removing enough uric acid or by certain **chemotherapy** drugs that cause high levels of cell **death** and the release of excess purines into the blood. Certain drugs can also cause hyperuricemia.

Gout and hyperuricemia

People with high levels of uric acid may develop **gout**. Commonly, gout occurs in males in their 40s and 50s. Gout is defined by the attacks of arthritic painful, reddened joints, and is often accompanied by hard lumps in the painful joints. The most common joint affected is the big toe. **Kidney stones**, and/or poor kidney function may also be associated with hyperuricemia, but are not considered gout if the patient does not have painful joints. In people with gout, uric acid forms crystals, which then cause the aforementioned painful symptoms. Although uric acid levels must be high in order for crystals to form, most people with high uric acid levels do not ever have these symptoms.

Acute gout attacks

When patients experience acute attacks of gout, drugs that lower the levels of uric acid can cause an attack to become more severe. Thus, drugs that lower uric acid levels and are used to treat gout in the long term are not used in the short term. Medications used in acute gout attacks include indomethacin (Indochron E-R, Indocin), colchicine, and **corticosteroids**. Colchicine causes side effects, most often **diarrhea**, in many people. The most important factor in the effective treatment of gout may be how quickly treatment is administered after an acute attack has begun. Rasburicase (Elitek) is used to treat severe hyperuricemia caused by chemotherapy. It has potentially serious side effects.

Long-term treatment

Long-term treatment of gout or hyperuricemia usually involves one or more of the following drugs: allopurinol (Zyloprim), probenicid (Benemid), acetazolamide (Diamox), prednisone (Deltasone, Orasone, Meticorten), and potassium citrate (Citra K, Polycitra K). Allopurinol decreases the amount of uric acid that the body produces. Other drugs increase the rate at which uric acid is excreted in the urine.

A newer drug to be approved by the FDA for the treatment of gout is febuxostat (Uloric). This drug is more easily tolerated by people with impaired kidney function.

Recommended dosage

Patients taking anti-hyperuricemics should have the dose slowly increased (and uric acid levels slowly lowered) to prevent acute attacks of gout. Patients may also be treated with colchicine or non-steroidal anti-inflammatory drugs to prevent acute attacks of gout.

The recommended initial dosage of allopurinol is 100 mg by mouth taken once daily. This dosage can be increased to as much as 800 mg once a day unless the patient has renal insufficiency. The most common daily dose of allopurinol is 300 mg once per day.

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The recommended starting dose of probenecid is 250 mg orally two times a day. This dose can be increased if needed to a maximum of 1,000 mg by mouth three times a day.

The recommended starting dose of febuxostat is 40 mg orally one time per day. The dose can be increased to 80 mg once per day if uric acid levels have not decreased to less than 6 mg per dL after two weeks of the 40 mg per day dose.

Precautions

Before taking any medication, patients should notify their physician of all other prescription, non-prescription medicine, herbal remedies, and dietary supplements that they are taking. Patients should also tell their physician about any health problems they are experiencing, especially any kidney (renal) problems, since this might affect the type of drug administered. **Allergies** to any of the medications used to treat acute or long-term gout should also be made known.

Pregnant or breastfeeding

Pregnant women should not use colchicine, as it may cause **birth defects**. Other anti-hyperuricemic drugs cross the placenta. The safety of these drugs to the fetus has not been established, and they should not be taken by pregnant women.

Side effects

Side effects associated with allopurinol include allergic and hypersensitivity reactions. The drug is to be discontinued at the first sign of a rash, bone marrow suppression, or hepatoxicity.

Probenicid use may cause flushing, **dizziness**, **fever**, **headache**, **dermatitis**, pruritus, and **anaphylaxis** in individuals with sensitivity to the drug.

Patients taking febuxostat may experience an increase in cardiovascular events such as myocardial infarction, **stroke**, and possibly death. Other adverse events noted in clinical trials with this drug included liver function abnormalities, **nausea**, arthralgia, and rash.

Interactions

The drugs allopurinol and probenicid have the potential for many drug-to-drug interactions. Patients must inform their health care providers of all of the drugs they are taking including non-prescription drugs which may interact with the antihyperuricemic drugs. For example, taking large amounts of vitamin C with allopurinol may result in increased kidney stone formation. Allopurinol taken in combination with iron supplements can lead to increased iron uptake by the liver.

Like allopurinol, probenicid has multiple drug-to-drug interactions. Non-prescription drugs may also interact with probenicid. Salicylates, such as **aspirin**, may decrease the effectiveness of probenicid when taken with probenicid.

Febuxostat interacts with the drugs azothioprine (Imuran, Azasan), mercaptopurine (Purinethol, 6MP), and theophylline (Theophylline). These drugs should not be taken with febuxostat.

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ORGANIZATIONS

National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), Office of Communications & Public Liaison NIDDK, NIH, Building 31. Rm 9A06, 31 Center Drive, MSC 2560, Bethesda, MD, 20892-2560 (301) 496-3583, http://www2.niddk.nih.gov.

National Kidney Foundation, Inc., 30 East 33rd Street, New York, NY, 10016 (800) 622-9010, http://www.kidney.org.

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Anti-insomnia drugs

Definition

Anti-insomnia drugs are medicines that help people fall asleep or stay asleep.

Purpose

Physicians prescribe anti-insomnia drugs for short-term treatment of insomnia—a condition in

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Anti-insomnia drugs

Brand name (generic name)	Possible side effects
Ambien (zolpidem tartrate)	Daytime drowsiness, dizziness, headache, muscle or joint pain, tremors
Dalmane (flurazepam hydrochloride)	Decreased coordination, irritability, lightheadedness, pain
Doral (quazepam)	Daytime drowsiness, dizziness, dry mouth, headache
Halcion (triazolam)	Chest pain, decreased coordination, memory impairment
Lunesta (eszopiclone)	Daytime drowsiness, decreased libido, heartburn, nausea, pain
ProSom (estazolam)	Dizziness, headache, nausea, sleep inertia (grogginess), weakness
Restoril (temazepam)	Dizziness, fatigue, headache, nausea, sleep inertia
Sonata (zaleplon)	Change in vision, decreased coordination, loss of appetite, numbness or tingling

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which people have trouble falling asleep, staying asleep, or waking up too early and failing to go back to sleep. These drugs are generally used only for occasional treatment of temporary sleep problems and should not be taken for more than a week or two at a time. People whose sleep problems do not improve during this time should return to a physician. Their sleep problems could be a sign of another underlying medical problem.

Description

The anti-insomnia drug drugs fall into two main categories: drugs that primarily help people fall asleep and drugs that primarily help people stay asleep. **Antidepressant drugs** are also sometimes used to treat **insomnia**, as sleep disturbances often accompany depression, but this is an off-label use. See the entries on antidepressants for more information.

Drugs that help people fall asleep include the sedative-hypnotics eszopiclone (Lunesta), zaleplon (Sonata), and zolpidem (Ambien). These are central nervous system (CNS) depressant. CNS depressants are medicines that slow or "damp down" the nervous system. Ramelteon (Rozerem) is another drug that helps people fall asleep more easily. It is not a CNS depressant but is thought to treat insomnia by affecting melatonin, a hormone that helps to regulate the sleep-wake cycle. Ramelteon is not habit-forming. Triazolam (Halcion) is related to **benzodiazepines** (discussed below) and also primarily helps people fall asleep.

KEY TERMS

Off-label use—Drugs in the United States are approved by the Food and Drug Administration (FDA) for specific uses, periods of time, or dosages based on the results of clinical trials. However, it is legal for physicians to administer these drugs for other "off-label" or non-approved uses. It is not legal for pharmaceutical companies to advertise drugs for off-label uses.

Physicians also prescribe medicines in the benzodiazepine family, such as flurazepam (Dalmane), quazepam (Doral), estazolam (ProSom), and temazepam (Restoril), for insomnia. Benzodiazepine drugs are described more extensively in the essay on **antianxiety drugs**. The effects of these drugs tends to be more long lasting, thus they may help people fall asleep, but also help them stay asleep. A negative consequence of these drugs is that they may leave people feeling sluggish in the morning. Ambien CR (controlled release) is an extended-release formula that can help people both fall and stay asleep. Lunesta also may help people stay asleep. Unlike drugs in the benzodiazepine family, these two drugs generally leave people feeling alert in the morning.

For people with mild insomnia, some **antihistamines**, such as diphenhydramine (Benadryl) or hydroxyzine (Atarax) may be used, since these also cause sleepiness. These drugs are discussed extensively in the entry on antihistamines.

The **barbiturates**, such as pentobarbital (Nembutal) and secobarbital (Seconal) are no longer commonly used to treat insomnia because they are too dangerous if they are taken in overdoses and the increased likelihood that they will cause dependence.

Recommended dosage

The recommended dose varies depending on the type of drug prescribed. Drugs intended to help people fall asleep tend to work quickly, often within 20 minutes, so they should be taken right before going to bed. Drugs that help people stay asleep tend to work more slowly.

For older people and others who may be more sensitive to the drug's effects, the recommended starting dosage is usually reduced.

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Zolpidem may be taken with food or on an empty stomach, but it may work faster when taken on an empty stomach. Check with a physician or pharmacists for instructions on how to take the medicine.

Precautions

Zolpidem and zaleplon are meant only for short-term treatment of insomnia. If sleep problems last more than 7–10 days, check with a physician. The controlled release form on zolpidem (Ambien CR) may safely be used longer for longer periods. Nevertheless, sleep problems lasting more than a week or two could be a sign of another medical problem. Also, many of these drugs tend to lose its effectiveness when taken every night for more than a few weeks.

Some people feel drowsy, dizzy, confused, lightheaded, or less alert the morning after they have taken any of these anti-insomnia drugs. This effect is more pronounced with drugs in the benzodiazepine family and usually does not occur with ramelteon. These drugs may also cause clumsiness, unsteadiness, double vision, or other vision problems the next day. For these reasons, anyone who takes these drugs should not drive, use machines or do anything else that might be dangerous until they have found out how zolpidem affects them.

These drugs may cause behavior changes in some people. The changes are similar to those seen in people whose behavior changes when they drink alcohol. Examples include giddiness and rage. More extreme changes, such as confusion, agitation, and **hallucinations**, also are possible. Anyone who starts having strange or unusual thoughts or behavior while taking these or any drug or herbal remedy should get in touch with his or her physician immediately.

Some sleep medicines may cause a special type of temporary **memory loss**, in which the person does not remember what happens between the time they take the medicine and the time its effects wear off. This is usually not a problem, because people normally go to sleep right after taking the medicine and stay asleep until its effects wear off. Nevertheless, it could be a problem for anyone who has to wake up before getting a full night's sleep (seven to eight hours). In particular, travelers should not take sleep medicine on airplane flights of less than seven to eight hours.

The drugs that are **central nervous system depressants** may add to the effects of alcohol and other drugs that slow the central nervous system, such as antihistamines, cold medicine, allergy medicine, medicine for seizures, tranquilizers, some **pain** relievers, and **muscle relaxants**. They may also add to the effects of anesthetics, including those used for dental procedures. The combining these drugs and alcohol or other CNS depressants can be dangerous, leading to unconsciousness or even **death**. People who take anti-insomnia drugs should not drink alcohol and should check with their physicians before taking any other medications. Anyone who shows signs of an overdose or of the effects of combining these drugs with alcohol or other drugs should have immediate emergency help. Warning signs include severe drowsiness, severe **nausea** or **vomiting**, breathing problems, and staggering.

Anyone who takes anti-insomnia drugs for more than 1–2 weeks should not stop taking it without first checking with a physician. Stopping the drug abruptly may cause rebound insomnia; increased difficulty falling asleep for the first one of two nights after the drug has been discontinued. In rare cases, withdrawal symptoms, such as **vomiting**, cramps, and unpleasant feelings may occur. Gradual tapering may be necessary.

Older people may be more sensitive to the effects of these drugs. This may increase the chance of side effects, such as confusion, and may also increase the risk of falling.

In people with breathing problems, these drugs may worsen the symptoms.

Special conditions

People with certain other medical conditions or who are taking certain other medicines can have problems if they take anti-insomnia drugs. Before taking this medicine, be sure to let the physician know about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to any sleep medicine in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. Most of these drugs are unsafe for women who are or may become pregnant. Women should check with their physicians about the safety of using anti-insomnia drugs or any other drugs or herbal remedies during **pregnancy**.

BREASTFEEDING. Women who are **breastfeeding** not take anti-insomnia medicines without first should checking with their physicians. Many of these drugs pass into breast milk and may have damaging effects on the infant.

OTHER MEDICAL CONDITIONS. Before using anti-insomnia drugs, people with any of these medical

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problems should make sure their physicians are aware of their conditions:

- chronic lung diseases (emphysema, asthma, or chronic bronchitis)
- liver disease
- kidney disease
- current or past alcohol or drug abuse
- depression
- sleep apnea
- history of substance abuse

Side effects

The most common minor side effects are daytime drowsiness or a sluggish, unfocused feeling, vision problems, memory problems, nightmares or unusual dreams, vomiting, nausea, abdominal or stomach pain, **diarrhea**, **dry mouth**, **headache**, and general feeling of discomfort or illness. These problems usually go away as the body adjusts to the drug and do not require medical treatment.

More serious side effects are not common, but may occur. If any of the following side effects occur, check with the physician who prescribed the medicine as soon as possible:

- confusion
- depression
- clumsiness or unsteadiness

Patients who take anti-insomnia drugs may notice additional side effects for a period after they stop taking the drug. They should check with their physicians if these or other troublesome symptoms occur:

- agitation, nervousness, feelings of panic
- uncontrolled crying
- worsening of mental or emotional problems
- seizures
- tremors
- lightheadedness
- sweating
- flushing
- nausea or abdominal or stomach cramps
- muscle cramps
- unusual tiredness or weakness

Other rare side effects may occur. Anyone who has unusual symptoms after taking zolpidem should get in touch with his or her physician.

Interactions

Anti-insomnia drugs may interact with many other medicines, street drugs, alcohol, and herbal remedies. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes an anti-insomnia drug should review with his or her physician all other medicines, both prescription and nonprescription, herbal remedies, dietary supplements, and street drugs he or she is taking. Among the drugs that may interact with anti-insomnia drugs are:

- other central nervous system (CNS) depressants such as medicine for allergies, colds, hay fever, and asthma, sedatives, tranquilizers, prescription pain medicine, muscle relaxants, medicine for seizures, barbiturates, and anesthetics.
- the major tranquilizer chlorpromazine (Thorazine).
- tricyclic antidepressants such as imipramine (Tofranil) and amitriptyline (Elavil).

This list is not complete. Check with a physician or pharmacist about additional **drug interactions**.

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ORGANIZATIONS

American Academy of Sleep Medicine (AASM), 2510 N. Frontage Road, Darien, IL, 60561, (630) 737-9700, (630) 737-9790, inquiries@aasmnet.org, http://wwww.aasmnet.org.

National Center on Sleep Disorders Research, National Heart, Lung, and Blood Institute, National Institutes of Health, P.O. Box 30105, Bethesda, MD, 30105, (301) 592-8573, (240) 629-3246, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi.nih.gov/about/ncsdr.

National Sleep Foundation, 1522 K St. NW, Suite 500, Washington, DC, 20005, (202) 347-3471, (202) 347-2472, http://www.sleepfoundation.org.

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Anti-itch drugs

Definition

Anti-itch drugs are medicines taken by mouth or by injection to relieve **itching**.

Purpose

The medicine described here, hydroxyzine, is a type of antihistamine used to relieve itching caused by allergic reactions. An allergic reaction occurs when the body is unusually sensitive to some substance, such as pollen, dust, mold, or certain foods or medicine. The body reacts by releasing a chemical called histamine that causes itching and other symptoms, such as sneezing and watery eyes. **Antihistamines** reduce the symptoms by blocking the effects of histamine.

Hydroxyzine is also prescribed for **anxiety** and to help people relax before or after having **general anesthesia**.

Description

Anti-itch drugs, also called antipruritic drugs, are available only with a physician's prescription and come in tablet and injectable forms. Some commonly used brands of the anti-itch drug hydroxyzine are Atarax and Vistaril.

Recommended dosage

When prescribed for itching, the usual dosage for adults is 25 mg, three to four times a day. For children over six years of age the usual dosage is 50-100 mg per day, divided into several small doses. The usual dosage for children under six years of age is 50 mg per day, divided into several small doses.

The dosage may be different for different people. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage, and take the medicine exactly as directed.

Precautions

This medicine should not be used for more than four months at a time because its effects can wear off. See a physician regularly while taking the medicine to determine whether it is still needed.

Hydroxyzine may add to the effects of alcohol and other drugs that slow down the central nervous system, such as other antihistamines, cold medicine, allergy medicine, sleep aids, medicine for seizures, tranquilizers, some **pain** relievers, and **muscle relaxants**. Anyone taking hydroxyzine should not drink alcohol and should check with his or her physician before taking any of the above.

Some people feel drowsy or less alert when using this medicine. Anyone who takes it should not drive, use machines, or do anything else that might be dangerous until they have found out how the drugs affect them.

Anyone who has had unusual reactions to hydroxyzine in the past should let his or her physician know before taking the medicine again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

A woman who is pregnant or who may become pregnant should check with her physician before taking this medicine. In studies of laboratory animals, hydroxyzine has caused **birth defects** when taken during **pregnancy**. Although the drug's effects on pregnant women have not been fully studied, physicians advise against taking it in early pregnancy.

BREASTFEEDING. Women who are **breastfeeding** should also check with their physicians before using hydroxyzine. The medicine may pass into breast milk and may cause problems in nursing babies.

Side effects

The most common side effect, drowsiness, usually goes away as the body adjusts to the drug. If it does not, reducing the dosage may be necessary. Other side effects, such as **dry mouth**, may occur and do not need medical attention unless they continue.

More serious side effects are not common, but may occur. If any of the following side effects occur, check with the physician who prescribed the medicine as soon as possible:

- Twitches or tremors
- Convulsions (seizures)

Interactions

Hydroxyzine may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes hydroxyzine should let the physician know all other medicines he or she is taking. Among the drugs that may interact with hydroxyzine are:

- Barbiturates such as phenobarbital and secobarbital (Seconal)
- Opioid (narcotic) pain medicines such as meperidine (Demerol) and oxycodone (Percocet)
- Non-narcotic pain medicines such as acetaminophen (Tylenol) and ibuprofen (Motrin, Advil).

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The list above may not include every drug that interacts with hydroxyzine. Be sure to check with a physician or pharmacist before combining hydroxyzine with any other prescription or nonprescription (over-the-counter) medicine

ORGANIZATIONS

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KEY TERMS

Glucose—A simple sugar that serves as the body's main source of energy.

Hypoglycemia—Abnormally low levels of glucose in the blood.

Parasite—An organism that lives and feeds in or on another organism (the host) and does nothing to benefit the host.

Protozoa—Animal-like, one-celled organisms, some of which cause diseases in people.

Psoriasis—A skin disease in which people have itchy, scaly, red patches on the skin.

Purpura—A spotty or patchy purplish rash caused by bleeding under the surface of the skin.

Antimalarial drugs

Definition

Antimalarial drugs are medicines that prevent or treat **malaria**.

Purpose

Antimalarial drugs treat or prevent malaria, a disease that occurs in tropical, subtropical, and some temperate regions of the world. The disease is caused by a parasite, *Plasmodium*, which belongs to a group of one-celled organisms known as protozoa. The only way to get malaria is to be bitten by a certain type of mosquito that has bitten someone who has the disease.

Thanks to mosquito control programs, malaria has been eliminated in the United States, almost all of Europe, and large parts of Central and South America. However, mosquito control has not worked well in other parts of the world, and malaria continues to be a major health problem in parts of Africa, the Middle East, Southeast Asia, Latin America, Haiti, the Dominican Republic, and some Pacific Islands at elevations below about 6,000 feet (2,000 m). In 2005, as many as 30,000 people from North American and Europe who traveled to these areas contracted malaria. People planning to travel to the tropics are often advised to take antimalarial drugs before, during, and after their trips, to help them avoid getting the disease and bringing it home with them. These drugs kill *Plasmodium* or prevent its growth. In recent years, some strains of *Plasmodium* have become resistant to antimalarial drugs, and medical researchers have stepped up efforts to develop new treatments for malaria including new combination drug such as Artesunate-Amodiaquine Winthrop (ASAQ), which became available in 2007.

Description

Antimalarial drugs are available only with a physician's prescription. They come in tablet, capsule, and injectable forms. Different drugs are used to prevent malaria or to treat different stages of the disease. Among the commonly used antimalarial drugs are chloroquine (Aralen), quinine sulfate (Formula Q), mefloquine (Lariam, Mephaquine), halofantrine (Halfan), atovaquone (Mepron), proguanil (Paludrine), atovaquone-proguanil (Malarone), sulfadoxine-pyrimethamine (Fansidar), clindamycin (Cleocin HCl, Cleocin T), doxycycline (Vibramycin, Doryx), and primaquine.

Recommended dosage

Recommended dosage depends on the type of antimalarial drug, its strength, and the form in which it is being administered (i.e., oral or by injection). The dosage may also be different for different people. The physician who prescribes the drug will determine the correct dosage. Antimalarial drugs should be taken exactly as directed and for the full time of treatment. If the drug is being taken to treat malaria, it should not be stopped just because symptoms begin to improve. Symptoms may return if the drug is stopped too soon. Larger or more frequent doses than the physician has ordered should never be taken nor should the drug be taken for longer than directed.

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Travelers taking antimalarial drugs to prevent malaria may be told to take it for one to two weeks before their trip and for four weeks afterward, as well as for the whole time they are away. It is important to follow these directions exactly.

Antimalarial drugs work best when they are taken on a regular schedule. When taken once a week to prevent malaria, they should be taken on the same day of the week. When taken daily or several times a day to treat malaria, they should be taken at the same time every day. Doses should not be missed or skipped.

Some antimalarial drugs should be taken with meals or with milk to prevent upset stomach. Others must be taken with a full glass of water. It is important to follow directions along with the prescription.

Precautions

Antimalarial drugs may cause lightheadedness, **dizziness**, blurred vision, and other vision changes. Anyone who takes these drugs should not drive, use machines or do anything else that might be dangerous until they have found out how the drugs affect them.

The antimalarial drug mefloquine (Lariam) has received attention because of reports that it causes panic attacks, **hallucinations**, **anxiety**, depression, **paranoia**, and other mental and mood changes, sometimes lasting for months after the last dose in a few patients. The U.S. Food and Drug Administration (FDA) began requiring warnings with Lariam beginning in July 2003 because of serious psychiatric effects caused by the drug. Pharmacists are required to include a 2,000-word medication guide detailing the warnings. Psychiatric side effects are uncommon, but anyone who has unexplained anxiety, depression, restlessness, confusion, or other troubling mental or mood changes after taking mefloquine should call a physician immediately.

Anyone taking antimalarial drugs to prevent malaria who develops a **fever** or flu-like symptoms while taking the medicine or within 2–3 months after traveling to an area where malaria is common should call a physician immediately.

If the drug is being taken to treat malaria and symptoms stay the same or get worse, The patient should check with the physician who prescribed the medicine.

Patients who take this medicine over a long period of time need to have a physician check them periodically for unwanted side effects.

Babies and children are especially sensitive to the antimalarial drug chloroquine. Not only are they more likely to have side effects from the medicine, but they are also at greater risk of being harmed by an overdose. A single 300-mg tablet could kill a small child. *This medicine should be kept out of the reach of children and safety vials should be used.*

Special conditions

People with certain medical conditions or who are taking certain other medicines can have problems if they take antimalarial drugs. Before taking these drugs, the physician should know about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to antimalarial drugs or related medicines in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. In laboratory animal studies, some antimalarial drugs cause **birth defects**, but it is also risky for a pregnant woman to get malaria. Untreated malaria can cause premature birth, **stillbirth**, and **miscarriage**. Some antimalarial drugs are known to be unsafe during **pregnancy**, while the safety of others has not been established. If possible, pregnant women should avoid traveling to areas where they could get malaria. If travel is necessary, women who are pregnant or who may become pregnant should check with their physicians about the use of antimalarial drugs.

BREASTFEEDING. Some antimalarial drugs pass into breast milk. Babies and young children are particularly sensitive to some of these drugs, so **breastfeeding** may not be desirable. Women who what to breastfeed should check with their physicians before using antimalarial drugs.

OTHER MEDICAL CONDITIONS. Before using antimalarial drugs, people who have any of these medical problems (or have had them in the past) should make sure their physicians are aware of their conditions:

- blood disease
- liver disease
- nerve or brain disease or disorder, including seizures (convulsions)
- past or current mental disorder
- stomach or intestinal disease
- deficiency of the enzyme glucose-6-phosphate dehydrogenase (G6PD), which is important in the breakdown of sugar in the body

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- deficiency of the enzyme nicotinamide adenine dinucleotide (NADH) methemoglobin reductase
- psoriasis
- heart disease
- family or personal history of the genetic condition favism (a hereditary allergic condition)
- family or personal history of hemolytic anemia, a condition in which red blood cells are destroyed
- purpura
- hypoglycemia (low blood sugar)
- blackwater fever (a serious complication of one type of malaria)
- myasthenia gravis (a disease of the nerves and muscles).

USE OF CERTAIN MEDICINES. Taking antimalarial drugs with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Side effects

The most common side effects of antimalarial drugs are **diarrhea**, **nausea** or **vomiting**, stomach cramps or **pain**, loss of appetite, **headache**, **itching**, difficulty concentrating, dizziness, lightheadedness, and sleep problems. These problems usually go away as the body adjusts to the drug and do not require medical treatment. Less common side effects, such as hair loss or loss of color in the hair; skin rash; or blue-black discoloration of the skin, fingernails, or inside of the mouth also may occur and do not need medical attention unless they are long-lasting.

More serious side effects are not common, but may occur. If any of the following side effects occur, the physician who prescribed the medicine should be contacted immediately:

- blurred vision or any other vision changes
- convulsions (seizures)
- mood or mental changes
- hallucinations
- anxiety
- confusion
- weakness or unusual tiredness
- unusual bruising or bleeding
- hearing loss or ringing or buzzing in the ears
- fever, with or without sore throat
- slow heartbeat
- pain in the back or legs
- dark urine
- pale skin
- taste changes
- soreness, swelling, or burning sensation in the tongue.

High doses of the antimalarial drug pyrimethamine may cause blood problems that can interfere with healing and increase the risk of infection. People taking this drug should be careful not to injure their gums when brushing or flossing their teeth or using toothpicks. If possible, dental work should be postponed until treatment is complete and the blood has returned to normal.

Other rare side effects may occur. Anyone who has unusual symptoms after taking an antimalarial drug should get in touch with his or her physician.

Interactions

Some antimalarial drugs may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes antimalarial drugs should let the physician know all other medicines he or she is taking. Among the drugs that interact with some antimalarial drugs are:

- beta blockers such as atenolol (Tenormin), propranolol (Inderal), and metoprolol (Lopressor)
- calcium channel blockers such as diltiazem (Cardizem), nicardipene (Cardene), and nifedipine (Procardia)
- other antimalarial drugs
- quinidine, used to treat abnormal heart rhythms
- antiseizure medicines such as vaproic acid derivatives (Depakote or Depakene)
- oral typhoid vaccine
- diabetes medicines taken by mouth
- sulfonamides (sulfa drugs)
- vitamin K
- anticancer drugs
- drugs used to treat overactive thyroid
- antiviral drugs such as zidovudine (Retrovir).

The list above does not include every medicine that may interact with every antimalarial drug. It is advised to check with a physician or pharmacist before combining an antimalarial drug with any other prescription or nonprescription (over-the-counter) medicine, herbal remedy, or dietary supplement.

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ORGANIZATIONS

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Antimicrobial agents *see* **Antibiotics**

Antimigraine drugs

Definition

Antimigraine drugs are medicines used to prevent or reduce the severity of migraine headaches.

Purpose

Migraine headaches usually cause an intense throbbing **pain** on one side of the head. **Nausea**, **vomiting**, **dizziness**, increased sensitivity to light and sound, and other symptoms may accompany the pain. The attacks may last for several hours or for a day or more and may develop as often as several times a week. Some people who get migraine headaches have warning signals before the headaches begin. These include restlessness, **tingling** in an arm or leg, or seeing patterns of flashing lights. This set of signals is called an aura.

The antimigraine drugs discussed in this section are meant to be taken as soon as the pain begins to relieve the pain and other symptoms. Other types of drugs are sometimes prescribed to prevent attacks in people with very severe or frequent migraines. These include antiseizure medicines (e.g., divalproex sodium/valproate [Depakote, Depacon, Depakene], topiramate [Topamax], gabapentin {Neurontin]); **tricyclic antidepressants** (e.g., amitriptyline [Elavil], doxepin [Adapin], nortriptyline [Aventyl], protriptyline [Vivactil]); selective seritonin reuptake inhibitors (e.g., fluoxetine [Prozac], sertraline [Zoloft], paroxetine [Paxil]); **calcium channel blockers** (e.g., verapamil [Calan, Covera]); and **beta blockers** (e.g., propranolol [Inderal], timolol [Blocadren], nadolol [Corgard], atenolol [Tenormin]).

Antimigraine drugs

Brand name (generic name)	Possible side effects
Cafergot (ergotamine and caffeine)	Fluid retention, increased blood pressure, increased heart rate, nausea, numbness, tingling sensation
Imitrex (sumatriptan succinate)	Burning, flushing, inflammation at injection site, neck pain, sore throat, tingling sensation
Inderal (propranolol hydrochloride)	Constipation or diarrhea, headache, nausea, rash
Midrin (acetaminophen, isomethepteneand dichloralphenazone)	Dizziness, rash

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Description

Migraine is thought to be caused by electrical and chemical imbalances in certain parts of the brain. These imbalances affect the blood vessels in the brain, first narrowing them and then widening them. As the blood vessels widen, they stimulate the release of chemicals that increase sensitivity to pain and cause inflammation and swelling. Antimigraine drugs are believed to work by correcting the imbalances and possibly by constricting blood vessels.

There are five classes of drugs given to relieve the symptoms of migraine. These drugs are used to treat headaches once they have started. They should not be taken to prevent headaches. Most of these drugs are available only with a doctor's prescription. Each class of drugs works in a different way. The five drug classes are:

- selective serotonin reuptake agonists such as Sumatriptan (Imitrex); naratriptan (Amerge, Naramig); zolmitriptan (Zomig, Zomig-ZMT); rizatriptan

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KEY TERMS

Analgesic—Medicine used to relieve pain.

Anticonvulsant—A type of drug given to prevent seizures. Some patients with migraines can be treated effectively with an anticonvulsant.

Antiemetic—A drug that helps stop nausea and vomiting.

Aura—A set of warning symptoms, such as seeing flashing lights, that some people have 10–30 minutes before a migraine attack.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Pregnancy category—A system of classifying drugs according to their established risks for use during pregnancy. Category A: Controlled human studies have demonstrated no fetal risk. Category B: Animal studies indicate no fetal risk, but no human studies; or adverse effects in animals, but not in well-controlled human studies. Category C: No adequate human or animal studies; or adverse fetal effects in animal studies, but no available human data. Category D: Evidence of fetal risk, but benefits outweigh risks. Category X: Evidence of fetal risk. Risks outweigh any benefits.

Status migrainosus—The medical term for an acute migraine headache that lasts 72 hours or longer.

(Maxalt, Maxalt-MLT); almotriptan (Axert); frovatriptan (Frova).

- ergot alkaloids such as Ergotamine tartrate (Cafatine, Cafergot, Cafetrate), Dihydroergotamine (DHE-45).
- analgesics such as Acetaminophen (Tylenol), propoxyphene (Darvon), oxycodone (OxyContin), morphine (Duramorph, MS Contin), meperidine (Demerol), hydromorphone (Dilaudid), butorphanol (Stadol).
- nonsteroidal anti-inflammatory drugs such as aspirin (Bayer Aspirin, Anacin), ibuprofen (Motrin, Ibuprin), naproxen (Naprosyn, Naprelan), ketorolac (Toradol).
- antiemetics such as Droperidol (Inapsine), chlorpromazine (Thorazine), metoclopramide (Reglan).

Recommended dosage

Recommended dosage depends on the type of drug. Typical recommended adult dosages of some common antimigraine drugs are given below. However, patients should follow exactly the specific dosage instructions given by their physician and pharmacist.

Ergotamine

Take at the first sign of a migraine attack. Patients who get warning signals (aura) may take the drug as soon as they know a **headache** is coming.

TABLETS. No more than 6 tablets for any single attack.

No more than 10 tablets per week.

SUPPOSITORIES. No more than 2 suppositories for any single attack.

No more than 5 suppositories per week.

Naratriptan

Take as soon as pain or other migraine symptoms begin. Also effective if taken any time during an attack. Do not take the drug until the pain actually starts as not all auras result in a migraine.

TABLETS. Usual dose is one 1-mg tablet taken with water or other liquid.

Doses of 2.5-mg may be used, but they may cause more side effects.

If the headache returns or if there is only partial response, the dose may be repeated once after 4 hours, for a maximum dose of 5 mg in a 24-hour period. Larger doses do not seem to offer any benefit.

Sumatriptan

Take as soon as pain or other migraine symptoms begin. Also effective if taken any time during an attack. Do not take the drug until the pain actually starts as not all auras result in a migraine.

TABLETS. Usual dose is one 25-mg tablet, taken with water or other liquid.

Doses should be spaced at least 2 hours apart.

Anyone with **liver disease** should consult with a physician for proper dosing.

INJECTIONS. No more than 6 mg per dose, injected under the skin.

No more than two 6-mg injections per day. These doses should be taken at least 1 hour apart.

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Zolmitriptan

Take as soon as symptoms begin.

TABLETS. Usual dose is 1–5 mg. Additional doses may be taken at 2-hour intervals.

No more than 10 mg per 24 hour period.

General dosage advice

Always take antimigraine drugs exactly as directed. Never take larger or more frequent doses, and do not take the drug for longer than directed.

If possible, lie down and relax in a dark, quiet room for a few hours after taking the medicine.

Precautions

These drugs should be used only to treat the type of headache for which they were prescribed. Patients should not use them for other headaches, such as those caused by **stress** or too much alcohol, unless directed to do so by a physician.

Anyone whose headache is unlike any previous headache should check with a physician before taking these drugs. If the headache is far worse than any other, emergency medical treatment should be sought immediately.

Taking too much of the antimigraine drug ergotamine class of drugs (Ergotamine tartrate [Cafatine, Cafergot, Cafetrate], Dihydroergotamine [DHE-45]), can lead to ergot **poisoning**. Symptoms include headache, muscle pain, **numbness**, coldness, and unusually pale fingers and toes. If not treated, the condition can lead to **gangrene** (tissue death).

Sumatriptan (Imitrex), naratriptan (Amerge), rizatriptan (Maxalt) and zolmitriptan (Zomig) may interact with ergotamine. These drugs should not be taken within 24 hours of taking any drug containing ergotamine.

Some antimigraine drugs work by constricting blood vessels in the brain. Because these drugs also affect blood vessels in other parts of the body, people with coronary heart disease, circulatory problems, or high blood pressure should not take these medicines unless directed to do so by their physicians.

Many migraine attacks do not respond to treatment. If the headache lasts longer than 72 hours—a condition known as status migrainosus—the patient may be given narcotic medications to bring on sleep and stop the attack. Patients with status migrainosus are often hospitalized because they are likely to be dehydrated from severe **nausea and vomiting**.

Special conditions

People with certain other medical conditions or who are taking certain other medicines can have problems if they take antimigraine drugs. Before taking these drugs, be sure to let the physician know about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to ergotamine, **caffeine**, sumatriptan, zolmitriptan, or other antimigraine drugs in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. Women who are pregnant should not take any antimigraine drugs in the ergotamine class. Risks to the fetus outweigh any benefits to the mother (**Pregnancy** category X). Other classes of drugs have not been well studied in humans and are classified as pregnancy category C.

BREASTFEEDING. Some antimigraine drugs can pass into breast milk and may cause serious health problems in nursing babies. Women who are **breastfeeding** should check with their physicians about whether to stop breastfeeding while taking the medicine.

OTHER MEDICAL CONDITIONS. Before using antimigraine drugs, people with any of these medical problems should make sure their physicians know about their conditions:

- coronary heart disease
- angina (crushing chest pain)
- circulatory problems or blood vessel disease
- high blood pressure
- liver problems
- kidney (renal) problems
- any infections
- eye problems.

Side effects

The most common side effects are fluid retention, flushing, high blood pressure, unusually fast or slow heart rate, numbness, tingling, **itching**, nausea, **vomiting**, weakness, neck or jaw pain and stiffness, feelings of tightness, heaviness, warmth, or coldness, **sore throat**, and discomfort of the mouth and tongue.

More serious side effects are not common, but they may occur. If any of the following side effects occur, call a physician immediately:

- tightness in the chest
- bluish tinge to the skin

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- cold arms and legs
- signs of gangrene, such as coldness, dryness, and a shriveled or black appearance of a body part
- dizziness
- drowsiness
- shortness of breath or wheezing
- skin rash
- swelling of the eyelids or face.

Other side effects may occur with any antimigraine drug. Anyone who has unusual symptoms after taking this medicine should get in touch with his or her physician.

Alternative treatments

Two herbal remedies are reported to be effective as alternative treatments for migraine. One is feverfew (*Tanacetum parthenium*), an herb related to the daisy that is traditionally used in England to prevent migraines. Published studies indicate that feverfew can reduce the frequency and intensity of migraines. It does not, however, relieve pain once the headache has begun. The other herbal remedy is butterbur root (*Petasites hybridus*). Petadolex is a natural preparation made from butterbur root that has been sold in Germany since the 1970s as a migraine preventive. Petadolex has been available in the United States since December 1998.

Interactions

Antimigraine drugs may interact with other medicines. When this happens, the effects of one or both of the drugs may change, or the risk of side effects may be greater. Anyone who takes these drugs should let the physician know all other medicines he or she is taking. Among the drugs that may interact with antimigraine drugs are:

- beta blockers such as atenolol (Tenormin) and propranolol (Inderal)
- drugs that tighten blood vessels such as epinephrine (EpiPen) and pseudoephedrine (Sudafed)
- nicotine such as cigarettes or Nicoderm, Habitrol, and other smoking-cessation drugs
- certain antibiotics, such as erythromycin and clarithromycin (Biaxin)
- monoamine oxidase inhibitors (MAOIs) such as phenelzine (Nardil) and tranylcypromine (Parnate)
- certain antidepressants, such as sertraline (Zoloft), fluoxetine (Prozac), and paroxetine (Paxil)
- fluvoxamine (Luvox), prescribed for obsessive compulsive disorder or chronic pain.

Naratriptan, sumatriptan, rizatriptan and zolmitriptan may interact with ergotamine. These drugs should not be taken within 24 hours of taking any drug containing ergotamine.

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ORGANIZATIONS

American Headache Society, 19 Mantua Road, Mount Royal, NJ, 08061, (856) 423-0043, (856) 423-0082, ahshq@talley.com, http://www.AmericanHeadacheSociety.org.

American Pain Foundation, 201 North Charles Street, Suite 710, Baltimore, MD, (888) 615-7246, info@painfoundation.org, http://www.painfoundation.org.

National Institute of Neurological Disorders and Stroke (NINDS), NIH Neurological Institute, P. O. Box 5801, Bethesda, MD, 20824, (301) 496-5751, (800) 352-9424, http://www.ninds.nih.gov/.

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Antimyocardial antibody test

Definition

Testing for antimyocardial antibodies is done when evaluating a person for heart damage or heart disease.

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KEY TERMS

Antibody—A special protein built by the body as a defense against foreign material entering the body.

Antimyocardial antibody—An autoantibody that attacks a person's own heart muscle, or myocardium.

Autoantibody—An antibody that attacks the body's own cells or tissues.

Myocardial infarction—A block in the blood supply to the heart, resulting in what is commonly called a heart attack.

Myocardium—The muscular middle layer of the heart.

Titer—A dilution of a substance with an exact known amount of fluid. For example, one part of serum diluted with four parts of saline is a titer of 1:4.

Purpose

Antimyocardial antibodies are autoantibodies. Normal antibodies are special proteins built by the body as a defense against foreign material entering the body. Autoantibodies are also proteins built by the body, but instead of attacking foreign material, they inappropriately attack the body's own cells. Antimyocardial antibodies attack a person's heart muscle, or myocardium.

This test may be done on a person who recently had trauma to the heart, such as heart surgery or a myocardial infarction (**heart attack**). It also may be done on someone with heart disease, such as **cardiomyopathy** or **rheumatic fever**.

Although the presence of antimyocardial antibodies does not diagnose heart damage or disease, there is a connection between the presence of these antibodies and damage to the heart. The amount of damage, however, cannot be predicted by the amount of antibodies.

These antibodies usually appear after heart surgery or the beginning of disease, but they may be present before surgery or the onset of disease. In 30% of people with myocardial infarction and 70% of people having heart surgery, antimyocardial antibodies will appear within two to three weeks and stay for three to eight weeks.

Description

A 5-10 mL sample of venous blood is drawn from the patient's arm in the region of the inner elbow. Antimyocardial antibodies are detected by combining a patient's serum (clear, thin, sticky fluid in blood) with cells from animal heart tissue, usually that of a monkey. Antimyocardial antibodies in the serum bind to the heart tissue cells. A fluorescent dye is then added to the mixture. This dye will attach to any antibodies and heart tissue cells bound together. The final mixture is studied under a microscope that is designed to show fluorescence. If fluorescent cells are seen under the microscope, the test is positive.

When the test is positive, the next step is to find out how much antibody is present. The patient's serum is diluted, or titered, and the test is done again. The serum is then further diluted and the test repeated until the serum is so dilute that fluorescence is no longer seen. The last dilution that showed fluorescence is the titer reported.

Preparation

No **fasting** or special prepartion is needed. Before the test is done it should be explained to the patient.

Aftercare

Discomfort or bruising may occur at the puncture site after the blood is drawn or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Warm packs on the puncture site relieve discomfort.

Normal results

Antimyocardial antibodies are not normally seen in healthy individuals.

Abnormal results

A positive result means that antimyocardial antibodies are present and that heart disease or damage is likely. Further testing may be needed as other autoantibodies could also be present, causing a false abnormal test.

Resources

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Antinausea drugs

Definition

Antinausea drugs are medicines that control nausea—a feeling of sickness or queasiness in the stomach with an urge to vomit. These drugs also prevent or stop **vomiting**. Drugs that control vomiting are called antiemetic drugs.

Purpose

Antinausea drugs such as prochlorperazine (Compazine), usually control both **nausea and vomiting**. Prochlorperazine is also sometimes prescribed for symptoms of mental disorders, such as **schizophrenia**.

Another commonly prescribed antinausea drug is promethazine (Phenergan). Promethazine also may be prescribed to relieve allergy symptoms and apprehension, as well as **motion sickness**.

Description

Prochlorperazine is available only with a physician's prescription. It is sold in syrup, capsule, tablet, injection, and suppository forms.

Recommended dosage

To control nausea and vomiting in adults, the usual dose is:

- Tablets—one 5-mg or 10-mg tablet three to four times a day
- Extended-release capsules—one 15-mg capsule first thing in the morning or one 10-mg capsule every 12 hours
- Suppository—25 mg, twice a day
- Syrup—5-10 mg three to four times a day
- Injection—5-10 mg injected into a muscle three to four times a day.

Doses for children must be determined by a physician.

Promethazine may be administered in pill, syrup, chewable tablet, or extended release capsule form by prescription only. For severe nausea, it may be administered by injection or via a suppository. The physician recommends dose depending on the patient's condition.

Antinausea drugs

Brand name (generic name)	Possible side effects
Compazine, Compro (prochlorperazine)	Dizziness, involuntary muscle spasms, jitteriness, puckering of the mouth
Phenergan (promethazine hydrochloride)	Dizziness, dry mouth, nausea and vomiting, rash
Reglan (metoclopramide hydrochloride)	Drowsiness, fatigue, restlessness
Tigan (trimethobenzamide hydrochloride)	Blurred vision, cramps, diarrhea, headache
Zofan (ondansetron hydrochloride)	Abdominal pain, constipation, fatigue, headache

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KEY TERMS

Anesthetic—Medicine that causes a loss of feeling, especially pain. Some anesthetics also cause a loss of consciousness.

Antihistamine—Medicine that prevents or relieves allergy symptoms.

Central nervous system—The brain and spinal cord.

Spasm—Sudden, involuntary tensing of a muscle or a group of muscles.

Tranquilizer—Medicine that has a calming effect and is used to treat anxiety and mental tension.

Precautions

Prochlorperazine may cause a movement disorder called **tardive dyskinesia**. Signs of this disorder are involuntary twitches and **muscle spasms** in the face and body and jutting or rolling movements of the tongue. The condition may be permanent. Older people, especially women, are particularly at risk of developing this problem when they take prochlorperazine.

Some people feel drowsy, dizzy, lightheaded, or less alert when using this medicine. The drug may also cause blurred vision, and movement problems. For these reasons, anyone who takes this drug should not drive, use machines or do anything else that might be dangerous until they have found out how the drug affects them.

Prochlorperazine makes some people sweat less, which can allow the body to overheat. The drug may also make the skin and eyes more sensitive to the sun.

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People who are taking prochlorperazine should try to avoid extreme heat and exposure to the sun. When going outdoors, they should wear protective clothing, a hat, a sunscreen with a skin protection factor (SPF) of at least 15, and sunglasses that block ultraviolet (UV) light. Saunas, sunlamps, **tanning** booths, tanning beds, hot baths, and hot tubs should be avoided while taking this medicine. Anyone who must be exposed to extreme heat while taking the drug should check with his or her physician.

This medicine adds to the effects of alcohol and other drugs that slow down the central nervous system, such as **antihistamines**, cold and flu medicines, tranquilizers, sleep aids, anesthetics, some **pain** medicines, and **muscle relaxants**. Drinking alcohol while taking prochlorperazine is not advised and patients should check with the physician who prescribed the drug before combining it with any other medicines.

Do not stop taking this medicine without checking with the physician who prescribed it. Stopping the drug suddenly can cause **dizziness**, nausea, vomiting, **tremors**, and other side effects. When stopping the medicine, it may be necessary to taper down the dose gradually.

Prochlorperazine may cause false **pregnancy** tests.

Women who are pregnant (or planning to become pregnant) or **breastfeeding** should check with their physicians before using antinausea medicines.

Before using prochlorperazine, people with any of the medical problems should make sure their physicians are aware of their conditions:

- Previous sensitivity or allergic reaction to prochlorperazine
- Heart disease
- Glaucoma
- Brain tumor
- Intestinal blockage
- Abnormal blood conditions, such as leukemia
- Exposure to pesticides.

Some people may experience side effects from promethazine including:

- dry mouth
- drowsiness
- confusion
- fatigue
- difficulty coordinating movements
- stuffy nose.

A physician should be contacted immediately if a patient experiences the following effects while taking promethazine:

- vision problems
- ringing in the ears
- tremors
- insomnia
- excitement
- restlessness
- yellowing of the skin or eyes
- skin rash.

Side effects

Many side effects are possible with prochlorperazine, including, but not limited to, **constipation**, dizziness, drowsiness, decreased sweating, **dry mouth**, stuffy nose, movement problems, changes in menstrual period, increased sensitivity to sun, and swelling or pain in breasts. Anyone who has unusual or troublesome symptoms after taking prochlorperazine should get in touch with his or her physician.

Side effects associated with promethazine include those listed above and interactions with various medications that may cause complications or lessen the effects of the drug. A physician should be notified of other medications the patient is on when taking promethazine.

Interactions

Prochlorperazine may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Among the drugs that may interact with prochlorperazine are antiseizure drugs such as phenytoin (Dilantin) and carbamazepine (Tegretol), anticoagulants such as warfarin (Coumadin), and drugs that slow the central nervous system such as alprazolam (Xanax), diazepam (Valium), and secobarbital (Seconal). Not every drug that interacts with prochlorperazine is listed here. A physician or pharmacist can advise patients about prescription or nonprescription (over-the-counter) drugs that might interact with Prochlorperazine.

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Antinuclear antibody test

Definition

The antinuclear antibody (ANA) test is a test done early in the evaluation of a person for autoimmune or rheumatic disease, particularly **systemic lupus erythematosus** (SLE).

Purpose

In autoimmune diseases, the body makes antibodies that work against its own cells or tissues. Rheumatic diseases (diseases that affect connective tissue, including the joints, bone, and muscle) are also associated with these antibodies. Autoantibodies are proteins built by the body, but instead of guarding against foreign material (including bacteria, viruses, and fungi) as normal antibodies do, they attack the body's own cells.

Autoimmune and rheumatic diseases can be difficult to diagnose. People with the same disease can have very different symptoms. A helpful strategy in the diagnosis of these diseases is to find and identify an autoantibody in the person's blood.

The antinuclear antibody test looks for a group of autoantibodies that attack substances found in the center (nucleus) of all cells. It is useful as a screen for many autoantibodies associated with diseases that affect the entire body (systemic diseases).

This test is particularly useful when diagnosing a person with symptoms of SLE, an illness that affects many body organs and tissues. If the test is negative, it is unlikely that the person has SLE; if the test is positive, more tests are done to confirm whether the person has SLE or another related disease. Other diseases, such as **scleroderma**, **Sjögren's syndrome**, **Raynaud's disease**, **rheumatoid arthritis**, and **autoimmune hepatitis**, often have a positive test for antinuclear antibodies.

Description

Five to 10 mL of blood is needed for this test. The antinuclear antibody test is done by adding a person's serum to commercial cells mounted on a microscope slide. If antinuclear antibodies are in the serum, they bind to the nuclei of cells on the slide. Next, a second antibody is added to the mixture. This antibody is "tagged" with a fluorescent dye so that it can be seen. The second antibody attaches to any antibodies and cells bound together and, because of the fluorescent "tag," the areas with antinuclear antibodies seem to glow, or fluoresce, when the slide is viewed under an ultraviolet microscope.

If fluorescent cells are seen, the test is positive. When positive, the serum is diluted, or titered, and the test done again. These steps are repeated until the serum is so dilute it no longer gives a positive result. The last dilution that shows fluorescence is the titer reported.

The pattern of fluorescence within the cells gives the physician clues as to what the disease might be. The test result includes the titer and the pattern.

This test is also called the fluorescent antinuclear antibody test or FANA. Results are available within one to three days.

KEY TERMS

Antibody—A special protein built by the immune system as a defense against foreign material entering the body.

Autoantibody—An antibody that attacks the body's own cells or tissues.

Antinuclear antibodies—Autoantibodies that attack substances found in the center, or nucleus, of all cells.

Autoimmune disease—Disease in which the body makes antibodies against its own cells or tissues.

Titer—A dilution of a substance with an exact known amount of fluid. For example, one part of serum diluted with four parts of saline is a titer of 1:4.

Preparation

No special preparations or diet changes are required before a person undergoes an antinuclear antibody test.

Aftercare

Discomfort or bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Warm packs relieve discomfort.

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Normal results

Normal results will be negative, showing no antinuclear antibodies.

Abnormal results

A positive test in a person with symptoms of an autoimmune or rheumatic disease helps the physician make a diagnosis. More than 95% of people with SLE have a positive ANA test. Scleroderma has a 60-71% positive rate; Sjögren's disease, 50-60%, and rheumatoid arthritis, 25-30%.

Several factors must be considered when interpreting a positive test. Diseases other than autoimmune diseases can cause autoantibodies. Some healthy people have a positive test. More testing is done after a positive test to identify individual autoantibodies associated with the various diseases.

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Antioxidants

Definition

Antioxidants are molecules that prevent oxygen molecules from interacting with other molecules in a process called oxidation. In the body, antioxidants combine with potentially damaging molecules called free radicals to prevent the free radicals from causing damage to cell membranes, DNA, and proteins in the cell. Common antioxidants important to human health are **vitamins** A, C, E, beta-carotene, and selenium. In the mid-2000s, about 20% of North Americans and Europeans were taking at least one antioxidant dietary supplement.

Purpose

The role of antioxidants in the body is complex and not completely understood. Antioxidants combine with free radicals so that the free radicals cannot react with, or oxidize, other molecules. In this way, antioxidants help slow or prevent damage to cells. Damage caused by free radicals is thought to cause or contribute to cardiovascular disease, **cancer**, **Alzheimer's disease**, age-related changes in vision, and other signs of **aging**. However, no direct cause and effect relationship between antioxidant intake and disease prevention has been proven. Antioxidants unrelated to those of importance in the body have commercial uses in the preservation of processed food and in many industrial processes.

Description

Oxygen is essential to many reactions that occur within cells. Free radicals form mainly as a result of normal cellular metabolism involving oxygen. They can also form in abnormally large amounts when the body is exposed to radiation, ultraviolet light, and toxins such as cigarette smoke or certain chemicals.

Health benefits of antioxidants and their food sources

Antioxidant	Health benefits	Food sources
Selenium	Helps maintain healthy hair and nails, enhances immunity, works with vitamin E to protect cells from damage. Reduces the risk of cancer, particularly lung, prostate, and colorectal.	Garlic, seeds, Brazil nuts, meat, eggs, poultry, seafood, whole grains. The amount in plant sources varies according to the content of the soil.
Beta-carotene	Keeps skin healthy, helps prevent night blindness and infections, promotes growth and bone development.	Red, yellow-orange, and leafy green vegetables and fruits, including carrots, apricots, cantaloupe, peppers, tomatoes, spinach, broccoli, sweet potatoes, and pumpkin.
Vitamin E	Acts as the protector of essential fats in cell membranes and red blood cells. Reduces risk of cancer, heart disease, and other age-associated diseases.	Peanut butter, nuts, seeds, vegetable oils and margarine, wheat germ, avocado, whole grains, salad dressings.
Vitamin C	Destroys free radicals inside and outside cells. Helps in the formation of connective tissue, the healing of wounds, and iron absorption, and also helps to prevent bruising and keep gums healthy. May reduce risk of cataracts, heart disease, and cancer.	Peppers, tomatoes, citrus fruits and juices, berries, broccoli, spinach, cabbage, potatoes, mango, papaya.

SOURCE: The American Dietetic Association

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The common feature of free radicals is that their molecular structure contains and unpaired electron. Free radical molecules with an unpaired electron are unstable and have a strong tendency to react with other molecules by "stealing" an electron from them to form a more stable electron pair. This reaction is called oxidation (even when it happens with molecules other than oxygen). In the body, free radicals cause damage when they react with deoxyribonucleic acid (DNA—genetic material), proteins, and lipids (fats). Antioxidants are molecules that react with free radicals in ways that neutralize them so they no longer are able to "steal" electrons and cause damage.

Some important human antioxidants must be acquired through diet, while others can be made by the body. Vitamin C (ascorbic acid), vitamin E (alpha-tocopherol), vitamin A (retinol), and beta-carotene are the most important antioxidants the body must obtain from food sources. Flavonoids found in tea, chocolate, grapes, berries, onions, and wine also appear to have antioxidant activity, although their role in health is unclear. Selenium is sometimes classified as an antioxidant, although strictly, it is not. Selenium is a mineral that must be acquired through diet. Plants grown in geographic locations with selenium rich soil provide a rich source of this mineral. Brazil nuts and tuna also have high levels of selenium. It is a necessary part of enzymes involved in antioxidant reactions. Glutathione and coenzyme Q (ubiquinone) are the most important antioxidants the body can make for itself.

Antioxidants and health

When free radicals build up faster than antioxidants can neutralize them, the body develops a condition called oxidative stress. Oxidative stress reduces the body's ability to deal with damage to cells and is thought to play a role in the development of chronic diseases such as cardiovascular disease, cancer, and Alzheimer's disease. Researchers know that a diet high in fruits and vegetables containing antioxidants promotes health and decreases the risk of developing some chronic diseases such as **atherosclerosis** (hardening of the arteries). In the early 2000s, dietary supplements containing antioxidants were popularized as a way to reduce oxidative stress, prevent health problems such as cancer, **stroke**, **heart attack**, and **dementia**, and live longer. Research has since shown that although there are relationships between antioxidant levels and health, antioxidant dietary supplements are not magic bullets to prevent age-related diseases.

One problem in determining whether there is a cause and effect relationship between oxidative stress and disease is that often it is not possible to tell if oxidative stress causes a disease or if the disease brings about oxidative stress as a result of biochemical changes in diseased cells. Also, everyone develops oxidative stress as they age, but not everyone develops the same diseases. The interactions between an individual's diet, environment, genetic make-up, and health are complex and still not well understood. Antioxidants remain of great interest to researchers seeking ways to prevent and cure chronic disease. Many clinical trials are underway to determine safety and effectiveness of different antioxidants, both alone and in combination with other drugs and supplements.

CARDIOVASCULAR DISEASE. The strongest link between antioxidant levels and health is related to the development of cardiovascular disease. Low-density lipoprotein cholesterol (LDL or "bad cholesterol") appears to react with free radicals. This changes the LDL cholesterol in a way that allows it to accumulate in cells lining the blood vessels. These cholesterol-loaded cells are precursors to the development of plaque, hard deposits that line blood vessels and cause cardiovascular disease, heart attack, and stroke.

Researchers thought increasing the amount of antioxidants in the blood by taking supplements would decrease the number of free radicals available to interact with LDL cholesterol and thus lower the risk of developing cardiovascular disease. This theory has not been proved. In fact, a paper published in the *Journal of the American Medical Association* on February 28, 2007, analyzed 68 trials of antioxidant supplements involving about 232,600 patients. The authors concluded that antioxidant supplements did not prolong life. In fact, when only rigorous, well-controlled studies were analyzed, the risk of dying increased 5%. This analysis is quite controversial, with some experts questioning the analytical methods used. However, the American Heart Association and similar organizations in other countries advocate cardiovascular disease prevention through consumption of fruits, vegetables, whole grains and nuts high in antioxidants and other heart-protecting nutrients instead of antioxidant supplements.

CANCER. Free radicals damage DNA, and sometimes this damage leads to development of cancer. In laboratory cell cultures and animal studies, antioxidants appear to slow the development of cancer. The results have been mixed in studies where humans took antioxidant dietary supplements. A large study of 29,000 men showed that when a beta-carotene dietary

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KEY TERMS

Coenzyme—Also called a cofactor; a small non-protein molecule that binds to an enzyme and catalyzes (stimulates) enzyme-mediated reactions.

Dietary supplement—A product, such as a vitamin, mineral, herb, amino acid, or enzyme, intended to be consumed in addition to an individual's diet with the expectation that it will improve health.

Enzyme—A protein that changes the rate of a chemical reaction within the body without themselves being used up in the reaction.

Free radical—A molecule with an unpaired electron that has a strong tendency to react with other molecules in deoxyribonucleic acid (DNA), proteins, and lipids (fats), resulting in damage to cells. Free radicals are neutralized by antioxidants.

Mineral—An inorganic substance found in the earth that is necessary in small quantities for the body to maintain a health. Examples: zinc, copper, iron.

Oxidation—Interaction in which one molecule removes an electron from another molecule to stabilize itself.

Retina—The layer of light-sensitive cells on the back of the eyeball that function in converting light into nerve impulses.

Vitamin—An essential nutrient the body needs in small amounts to remain healthy but that the body cannot manufacture for itself and must acquire through diet.

supplement was taken by men who smoked, they developed lung cancer at a rate 18% higher and died at a rate 8% higher than men who did not receive the supplement. Another study that gave men dietary supplements of beta-carotene and vitamin A was stopped when researchers found the men receiving the beta-carotene had a 46% greater chance of dying from lung cancer than those who did not receive the supplement. Other large studies have shown either no or only slight protective effects against cancer. The position of the American Cancer Society, the National Cancer Institute, and several international health organizations is that antioxidants should come from a healthy diet high in fruits and vegetables and low in fat and not from dietary supplements.

AGE-RELATED VISION IMPAIRMENT. **Cataracts** and age-related **macular degeneration** are two types of vision impairment common in older individuals. Cataracts develop because of changes in the protein in the lens of the eye. These changes cause the lens to become cloudy and limit vision. The changes may be due to damage by free radicals. Age-related macular degeneration is an irreversible disease of the retina that causes blindness. Two carotenoid antioxidants, zeaxanthin and lutein, are found in the retina and are essential to vision. However, study participants who took antioxidant supplements over several years did not have a reduced risk of developing these diseases.

Precautions

The mixed results obtained in human studies of antioxidant supplements suggests that all antioxidants should come from foods and not from dietary supplements. There is also little information on the safety of antioxidant supplements in children and women who are pregnant or **breastfeeding**.

Interactions

The interaction among various antioxidants, enzymes, coenzymes, drugs, herbal and dietary supplements is complex and incompletely understood. Specific antioxidants may have known interactions and should be discussed with a physician.

Complications

Antioxidants acquired by eating fruits and vegetables promote health. No complications are expected from antioxidants in food. Antioxidant dietary supplements may interact with other supplements, prescription drugs, over-the-counter drugs, and herbal supplements in ways that cause undesirable side effects. Consult a physician prior to taking an antioxidant supplement.

Parental concerns

Parents should encourage their children to eat a healthy and varied diet high in fruits, vegetables, and whole grains. There is no need to give children antioxidant dietary supplements. The safety of these supplements in children has not been studied.

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ORGANIZATIONS

American Cancer Society, 1599 Clifton Road NE, Atlanta, GA, 30329-4251, (800) ACS-2345, http://www.cancer.org.

American Dietetic Association, 120 South Riverside Plaza, Suite 2000, Chicago, IL, 60606-6995, (800) 877-1600, http://www.eatright.org.

American Heart Association, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, http://www.americanheart.org.

Linus Pauling Institute, Oregon State University, 571 Weniger Hall, Corvallis, OR, 97331-6512, (541) 717-5075, (541) 737-5077, http://lpi.oregonstate.edu.

Office of Dietary Supplements, National Institutes of Health, 6100 Executive Blvd., Room 3B01, MSC 7517, Bethesda, MD, 20892-7517, (301) 435-2920, (301) 480-1845, http://dietary-supplements.info.nih.gov.

Tish Davidson A.M.

Antiparkinson drugs

Definition

Antiparkinson drugs are medicines that relieve the symptoms of **Parkinson's disease** and other forms of parkinsonism.

Purpose

Antiparkinson drugs are used to treat symptoms of parkinsonism, a group of disorders that share four main symptoms: tremor or trembling in the hands, arms, legs, jaw, and face; stiffness or rigidity of the arms, legs, and trunk; slowness of movement (bradykinesia); and poor

Antiparkinson drugs

Brand name (generic name)	Possible side effects
Artane (trihexyphenidyl hydrochloride)	Blurred vision, dry mouth, nausea, nervousness
Benadryl (diphenhydramine hydrochloride)	Dizziness, drowsiness, loss of balance, upset stomach
Cogentin (benztropine mesylate)	Constipation, dry mouth, nausea and vomiting, rash
Eldepryl (selegiline hydrochloride)	Abdominal and back pain, decreased coordination, depression, drowsiness
Parlodel (bromocriptine mesylate)	Abdominal cramps, constipation, decreased blood pressure, heartburn
Sinemet CR (carbidopa and levodopa)	Confusion, hallucinations, involuntary body movements, nausea

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KEY TERMS

Anorexia—Lack or loss of appetite.

Anticholigerginc—An agent that blocks the parasympathetic nerves and their actions.

Bradykinesia—Extremely slow movement.

Bruxism—Compulsive grinding or clenching of the teeth, especially at night.

Carbon monoxide—A colorless, odorless, highly poisonous gas.

Central nervous system—The brain and spinal cord.

Chronic—A word used to describe a long-lasting condition. Chronic conditions often develop gradually and involve slow changes.

Hallucination—A false or distorted perception of objects, sounds, or events that seems real. Hallucinations usually result from drugs or mental disorders.

Heat stroke—A severe condition caused by prolonged exposure to high heat. Heat stroke interferes with the body's temperature regulating abilities and can lead to collapse and coma.

Parkinsonism—A group of conditions that all have these typical symptoms in common: tremor, rigidity, slow movement, and poor balance and coordination.

Pregnancy category— A system of classifying drugs according to their established risks for use during pregnancy. Category A: Controlled human studies have demonstrated no fetal risk. Category B: Animal studies indicate no fetal risk, but no human studies; or adverse effects in animals, but not in well-controlled human studies. Category C: No adequate human or animal studies; or adverse fetal effects in animal studies, but no available human data. Category D: Evidence of fetal risk, but benefits outweigh risks. Category X: Evidence of fetal risk. Risks outweigh any benefits.

Seizure—A sudden attack, spasm, or convulsion.

Spasm—Sudden, involuntary tensing of a muscle or a group of muscles.

Tremor—Shakiness or trembling.

balance and coordination. Parkinson's disease is the most common form of parkinsonism and is seen more frequently with advancing age. Other forms of the disorder may result from viral infections, environmental toxins, **carbon monoxide poisoning**, and the effects of treatment with **antipsychotic drugs**.

The immediate cause of Parkinson's disease or Parkinsonian-like syndrome is the lack of the neurotransmitter dopamine in the brain. Drug therapy may take several forms, including replacement of dopamine, inhibition of dopamine metabolism to increase the effects of the dopamine already present, or sensitization of dopamine receptors. Drugs may be used singly or in combination.

Description

Levodopa (Larodopa) is the mainstay of Parkinson's treatment. The drug crosses the blood-brain barrier, and is converted to dopamine. The drug may be administered alone, or in combination with carbidopa (Lodosyn) which inhibits the enzyme responsible for the destruction of levodopa. The limitation of levodopa or levodopa-carbidopa therapy is that after approximately two years of treatment, the drugs cease to work reliably. This has been termed the "on-off phenomenon." Additional treatment strategies have been developed to retard the progression of Parkinsonism, or to find alternative approaches to treatment.

Anticholinergic drugs reduce some of the symptoms of Parkinsonism, and reduce the reuptake of dopamine, thereby sustaining the activity of the natural neurohormone. They may be effective in all stages of the disease. All drugs with anticholinergic properties, the naturally occurring belladonna alkaloids (atropine, scopolamine, hyoscyamine), some **antihistamines** with anticholinergic properties, and synthetics such as benztropin (Cogentin), procyclidine (Kemadrin) and biperiden (Akineton) are members of this group. Although the anticholinergic drugs have only limited activity against Parkinson's disease, they are useful in the early stages, and may be adjuncts to levodopa as the disease progresses.

Amantadine (Symmetrel), was developed for prevention of **influenza** virus infection, but has anti-Parkinsonian properties. Its mechanism of action is not known.

Bromocriptine (Parlodel) is a prolactin inhibitor, which is used for a variety of indications including amenorrhea/galactorrhea, female **infertility**, and acromegaly. It appears to work by direct stimulation of the dopamine receptors. Bromocriptine is used as a late adjunct to levodopa therapy, and may permit reduction in levodopa dosage. Pergolide (Permax) is similar

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to bromocriptine, but has not been studied as extensively in Parkinson's disease.

Entacapone (Comtan) appears to act by maintaining levels of dopamine through enzyme inhibition. It is used as an adjunct to levodopa was the patient is beginning to experience the on-off effect. Tolcapone (Tasmar) is a similar agent, but has demonstrated the potential for inducing severe liver failure. As such, tolcapone is reserved for cases where all other adjunctive therapies have failed or are contraindicated.

Selegeline (Carbex, Eldepryl) is a selective monoamine oxidase B (MAO-B) inhibitor, however its mechanism of action in Parkinsonism is unclear, since other drugs with MAO-B inhibition have failed to show similar anti-Parkinsonian effects. Selegeline is used primarily as an adjunct to levodopa, although some studies have indicated that the drug may be useful in the early stages of Parkinsonism, and may delay the progression of the disease.

Pramipexole (Mirapex) and ropinirole (Requip) are believed to act by direct stimulation of the dopamine receptors in the brain. They may be used alone in early Parkinson's disease, or as adjuncts to levodopa in advanced stages.

Recommended dosage

Dosages of anti-Parkinsonian medications must be highly individualized. All doses must be carefully titrated. Specific drug references should be consulted.

Precautions

There are a large number of drugs and drug classes used to treat Parkinson's disease, and individual references for each drug should be consulted.

The anticholinergics have a large number of adverse effects, all related to their primary mode of activity. Their cardiovascular effects include tachycardia, **palpitations**, **hypotension**, postural hypotension, and mild bradycardia. They may also cause a wide range of central nervous system effects, including disorientation, confusion, **memory loss**, **hallucinations**, psychoses, agitation, nervousness, **delusions**, **delirium**, **paranoia**, euphoria, excitement, lightheadedness, **dizziness**, **headache**, listlessness, depression, drowsiness, weakness, and giddiness. **Dry mouth**, dry eyes and gastrointestinal distress are common problems. **Sedation** has been reported with some drugs in this group, but this may be beneficial in patients who suffer from **insomnia**. **Pregnancy** risk factor is C. Because anticholinergic drugs may inhibit milk production, their use during **breastfeeding** is not recommended. Patients should be warned that anticholinergic medications will inhibit perspiration, and so **exercise** during periods of high temperature should be avoided.

Levodopa has a large number of adverse effects. Anorexia and/or, loss of appetite occurs in roughly half the patients using this drug. Symptoms of gastrointestinal upset, such as **nausea and vomiting**, have been reported in 80% of cases. Other reported effects include increased hand tremor; headache; dizziness; **numbness**; weakness and faintness; **bruxism**; confusion; insomnia; nightmares; hallucinations and delusions; agitation and **anxiety**; malaise; **fatigue** and euphoria. Levodopa has not been listed under the pregnancy risk factor schedules, but should be used with caution. Breastfeeding is not recommended.

Amantadine is generally well tolerated, but may cause dizziness and **nausea**. It is classified as pregnancy schedule C. Since amantadine is excreted in breast milk, breastfeeding while taking amantidine is not recommended.

Pergolide and bromocriptine have been generally well tolerated. **Orthostatic hypotension** are common problems, and patients must be instructed to rise slowly from bed. This problem can be minimized by low initial doses with small dose increments. Hallucinations may be a problem. Bromocriptine has not been evaluated for pregnancy risk, while pergolide is category B. Since both drugs may inhibit **lactation**, breastfeeding while taking these drugs is not recommended.

Pramipexole and ropinirole cause orthostatic hypotension, hallucinations and dizziness. The two drugs are in pregnancy category C. In animals, ropinirole has been shown to have adverse effects on embryo-fetal development, including teratogenic effects, decreased fetal body weight, increased fetal **death** and digital malformation. Because these drugs inhibit prolactin secretion, they should not be taken while breastfeeding.

Side effects

The most common side effects are associated with the central nervous system, and include dizziness, lightheadedness, mood changes and hallucinations. Gastrointestinal problems, including nausea and **vomiting**, are also common.

Interactions

All anti-Parkinsonian regimens should be carefully reviewed for possible **drug interactions**. Note that combination therapy with anti-Parkinsonian

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drugs is, in itself, use of additive and potentiating interactions between drugs, and so careful dose adjustment is needed whenever a drug is added or withdrawn.

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Antiplatelet drugs *see* **Anticoagulant and antiplatelet drugs**

Antiprotozoal drugs

Definition

Antiprotozoal drugs are medicines that treat infections caused by protozoa.

Purpose

Antiprotozoal drugs are used to treat a variety of diseases caused by protozoa. Protozoa are animal-like, one-celled animals, such as amoebas. Some are parasites that cause infections in the body. African **sleeping sickness**, **giardiasis**, **amebiasis**, *Pneumocystis carinii* **pneumonia** (PCP), and **malaria** are examples of diseases caused by protozoa.

Description

Antiprotozoal drugs come in liquid, tablet, and injectable forms and are available only with a doctor's prescription.

The antiprotozoal drugs work by exerting several mechanisms of action on the protozoal organism. Some of the drugs kill the organisms by damaging DNA synthesis in the organism's cells. Other mechanisms of action that lead to protozoal cell death include disruption of nucleic acid synthesis, altering cellular protein function, and disrupting microtubule function at the cellular level. All of these actions lead to cell death and result in the death of the organism.

U.S. brand names

Brand names of antiprotozoal drugs approved for use in the United States include:

- metronidazole (Flagyl)
- eflornithine (Ornidyl)
- furazolidone (Furoxone)
- iodoquinol (Diquinol, Yodoquinol, Yodoxin)
- pentamidine (Pentam 300)

Recommended dosage

The recommended dosage depends on the type of antiprotozoal drug, its strength, and the medical problem for which it is being used. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage. Always take antiprotozoal drugs exactly as directed.

Precautions

Dizziness, confusion, lightheadedness, or poor alertness may occur when using these drugs. They may also cause blurred vision and other vision problems. Anyone taking antiprotozoal drugs should not drive, use machines, or do anything else that might be dangerous until they determine how the drugs affect them.

The antiprotozoal drug furazolidone may cause very dangerous side effects when taken with certain foods or beverages. Likewise, metronidazole (Flagyl) can cause serious liver damage if taken with alcohol. The physician who prescribed the drug or the pharmacist who filled the prescription can provide a list of products to avoid while taking these medicines.

Previous unusual reactions to antiprotozoal drugs or related medicines should be made known to the physician before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

Some antiprotozoal drugs may cause problems with the blood. This can increase the risk of infection or excessive bleeding. Patients taking these drugs should be careful not to injure their gums when brushing or flossing their teeth or using a toothpick. Patients should check with their physician before having any dental work done. Care should also be taken to avoid cuts from razors, nail clippers, or kitchen knives, or household tools.

Other conditions

People with any of the following medical conditions should discuss the use of antiprotozoal drugs with their physician to prevent potentially harmful interactions:

- anemia or other blood problems
- kidney disease
- heart disease
- low blood pressure
- diabetes
- hypoglycemia (low blood sugar)
- liver disease
- stomach or intestinal disease

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KEY TERMS

Amebiasis—An infection caused by an ameba, which is a type of protozoan.

Fetus—A developing baby inside the womb.

Giardiasis—A condition in which the intestines are infected with *Giardia lamblia*, a type of protozoan.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Parasite—An organism that lives and feeds in or on another organism (the host) and does nothing to benefit the host.

***Pneumocystis carinii* pneumonia**—A severe lung infection caused by a parasitic protozoan. The disease mainly affects people with weakened immune systems, such as people with AIDS.

- nerve or brain disease or disorder, including convulsions (seizures)
- psoriasis (a skin condition)
- hearing loss
- deficiency of the enzyme glucose-6-phosphate dehydrogenase (G6PD)
- eye or vision problems
- thyroid disease

Side effects

The most common side effects are **diarrhea**, **nausea**, **vomiting**, and stomach **pain**. These problems usually go away as the body adjusts to the drug and do not require medical treatment.

Other rare side effects may occur. Anyone who has unusual symptoms after taking an antiprotozoal drug should get in touch with his or her physician.

A physician should be contacted immediately if any of the following symptoms occur while taking antiprotozoal drugs:

- fever or chills
- signs of cold or flu
- signs of infection, such as redness, swelling, or inflammation
- unusual bruising or bleeding
- black, tarry stools
- blood in urine or stools
- pinpoint red spots on the skin
- unusual tiredness or weakness
- blurred vision or other vision changes
- skin rash, hives, or itching
- swelling of the neck
- clumsiness or unsteadiness
- numbness, tingling, pain, or weakness in the hands or feet
- decrease in urination output

Pediatric

Children are especially sensitive to the effects of some antiprotozoal drugs and should never be given this medicine unless directed to do so by a physician. This medicine should be kept out of the reach of children and stored in safety vials.

Pregnant or breastfeeding

The effects of antiprotozoal drugs on pregnant women have not been studied. In experiments with pregnant laboratory animals, some antiprotozoal drugs cause **birth defects** or death of the fetus. Women who are pregnant or who plan to become pregnant should check with their physicians before taking antiprotozoal drugs. Mothers who are **breastfeeding** should also check with their physicians about the safety of taking these drugs.

Interactions

Antiprotozoal drugs may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Before using antiprotozoal drugs, a patient should notify the physician of other medicines currently being used. Among the drugs that may interact with antiprotozoal drugs are:

- alcohol
- anticancer drugs
- medicine for overactive thyroid
- antiviral drugs such as zidovudine (Retrovir)
- antibiotics
- medicine used to relieve pain or inflammation
- amphetamine
- diet pills (appetite suppressants)
- monoamine oxidase inhibitors (MAO inhibitors) such as phenelzine (Nardil) and tranylcypromine

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(Parnate), used to treat conditions including depression and Parkinson's disease
- tricyclic antidepressants such as amitriptyline (Elavil) and imipramine (Tofranil)
- decongestants such as phenylephrine (Neo-Synephrine) and pseudoephedrine (Sudafed)
- other antiprotozoal drugs

Be sure to check with a physician or pharmacist before combining antifungal drugs with any other prescription or nonprescription (over-the-counter) medicine.

Resources

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Nancy Ross-Flanigan
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Antipruritic drugs *see* **Anti-itch drugs**

Antipsychotic drugs

Brand name (generic name)	Possible side effects
Clozaril (clozapine)	Dizziness, fainting, myocarditis, seizures
Compro, Compazine (prochlorperazine)	Dizziness, drooling, jitteriness, lactation, puckering of the mouth, tremors
Haldol (haloperidol)	Blurred vision, dehydration, headache, insomnia, involuntary muscle spasms
Mellaril (thioridazine)	Constipation and diarrhea, drowsiness, irregular heartbeat, sensitivity to light, weight fluctuation
Navane (thiothixene)	Dry mouth, excessive thirst, hives, rash, swelling, weakness
Risperdal (risperidone)	Abdominal and chest pain, fever, headache, involuntary muscle spasms, irritability
Stelazine (trifluoperazine hydrochloride)	Agitation, change in pupil size, drowsiness, fatigue, missed menstrual periods in women or decreased sexual function in men
Thorazine (chlorpromazine)	Fever, involuntary muscle spasms, labored breathing, restlessness

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Antipsychotic drugs

Definition

Antipsychotic drugs are a class of medicines used to treat **psychosis** and other mental and emotional conditions.

Purpose

Psychosis is defined as "a serious mental disorder (as **schizophrenia**) characterized by defective or lost contact with reality often with **hallucinations** or delusions." Psychosis is an end-stage condition arising from a variety of possible causes. Anti-psychotic drugs control the symptoms of psychosis, and in many cases are effective in controlling the symptoms of other disorders that may lead to psychosis, including bipolar mood disorder (formerly termed manic-depressive), in which the patient cycles from severe depression to feelings of extreme excitation. This class of drugs is primarily composed of the major tranquilizers; however, lithium carbonate, a drug that is largely specific to bipolar mood disorder, is commonly classified among the antipsychotic agents.

Description

The antipsychotic agents may be divided by chemical class. The phenothiazines are the oldest group, and include chlorpromazine (Thorazine), mesoridazine (Serentil), prochlorperazine (Compazine), and thioridazine (Mellaril). These drugs are essentially similar in action and adverse effects. They may also be used as anti-emetics, although prochlorperazine is the drug most often used for this indication.

The phenylbutylpiperadines are haloperidol (Haldol) and pimozide (Orap). They find primary use in control of Tourette's syndrome. Haloperidol has been extremely useful in controlling aggressive behavior.

The debenzapine derivatives, clozapine (Clozaril), loxapine (Loxitane), olanzapine (Zyprexa) and quetiapine (Seroquel), have been effective in controlling psychotic symptoms that have not been responsive to other classes of drugs.

The benzisoxidil group is composed of resperidone (Resperidal) and ziprasidone (Geodon). Resperidone

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KEY TERMS

Agranulocytosis—An acute condition marked by severe depression of the bone marrow, which produces white blood cells, and by prostration, chills, swollen neck, and sore throat sometimes with local ulceration. Aalso called agranulocytic angina or granulocytopenia.

Anticholinergic—Blocking the action of the neurohormone acetylcholine. The most obvious effects include dry mouth and dry eyes.

Anticonvulsants—A class of drugs given to control seizures.

Pregnancy category—A system of classifying drugs according to their established risks for use during pregnancy. Category A: Controlled human studies have demonstrated no fetal risk. Category B: Animal studies indicate no fetal risk, but no human studies, or adverse effects in animals, but not in well-controlled human studies. Category C: No adequate human or animal studies, or adverse fetal effects in animal studies, but no available human data. Category D: Evidence of fetal risk, but benefits outweigh risks. Category X: Evidence of fetal risk. Risks outweigh any benefits.

has been found useful for controlling bipolar mood disorder, while ziprasidone is used primarily as second-line treatment for schizophrenia.

In addition to these drugs, the class of antipsychotic agents includes lithium carbonate (Eskalith, Lithonate), which is used for control of bipolar mood disorder, and thiothixene (Navane), which is used in the treatment of psychosis.

Newer agents

Some newer antipsychotic drugs have been approved by the Food and Drug administration (FDA) in the early 2000s. These drugs are sometimes called second-generation antipsychotics or SGAs. Aripiprazole (Abilify), which is classified as a partial dopaminergic agonist, received FDA approval in August 2003. Two drugs that are still under investigation, a neurokinin antagonist and a serotonin 2A/2C antagonist respectively, show promise in the treatment of schizophrenia and **schizoaffective disorder**.

Recommended dosage

Dose varies with the drug, condition being treated, and patient response. Specific drug references should be consulted.

Precautions

Neuroleptic malignant syndrome (NMS). NMS is a rare, idiosyncratic combination of extra-pyramidal symptoms (EPS), hyperthermia, and autonomic disturbance. Onset may be hours to months after drug initiation, but once started, proceeds rapidly over 24 to 72 hours. It is most commonly associated with haloperidol, long-acting fluphenazine, but has occurred with thiothixene, thioridazine, and clozapine, and may occur with other agents. NMS is potentially fatal, and requires intensive symptomatic treatment and immediate discontinuation of neuroleptic treatment. There is no established treatment. Most patients who develop NMS will have the same problem if the drug is restarted.

Agranulocytosis has been associated with clozapine. This is a potentially fatal reaction, but can be prevented with careful monitoring of the white blood count. There are no well-established risk factors for developing agranulocytosis, and so all patients treated with this drug must follow the clozapine Patient Management System. For more information, the reader should call 1-800-448-5938.

Anticholinergic effects, particularly **dry mouth**, have been reported with all of the phenothiazines, and can be severe enough to cause patients to discontinue their medication.

Photosensitization is a common reaction to chlorpromazine. Patients must be instructed to use precautions when exposed to sunlight.

Lithium carbonate commonly causes increased frequency of urination.

The so-called atypical antipsychotics are associated with a substantial increase in the risk of developing **diabetes mellitus**. A study done at the University of Rochester (New York) reported in 2004 that 15.2% of patients receiving atypical antipsychotics developed diabetes, compared with 6.3% of patients taking other antipsychotic medications.

Antipsychotic drugs are **pregnancy** category C. (Clozapine is category B.) The drugs in this class appear to be generally safe for occasional use at low doses during pregnancy, but should be avoided near time of delivery. Although the drugs do not appear to be teratogenic, when used near term, they may cross

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the placenta and have adverse effects on the newborn infant, including causing involuntary movements. There is no information about safety in **breastfeeding**.

As a class, the antipsychotic drugs have a large number of potential side effects, many of them serious. Because of the potential severity of side effects, these drugs must be used with special caution in children. Specific drug references should be consulted.

Interactions

Because the phenothiazines have anticholinergic effects, they should not be used in combination with other drugs that may have similar effects.

Because the drugs in this group may cause **hypotension**, or low blood pressure, they should be used with extreme care in combination with blood pressure-lowering drugs.

The antipsychotic drugs have a large number of **drug interactions**. Specific drug references should be consulted.

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ORGANIZATIONS

American Society of Health-System Pharmacists (ASHP), 7272 Wisconsin Avenue, Bethesda, MD, 20814, (301) 657-3000, (866) 279-0681, http://www.ashp.org.

United States Food and Drug Administration (FDA), 10903 New Hampshire Ave, Silver Spring, MD, 02993-0002, (888) 463-6332, http://www.fda.gov.

Samuel D. Uretsky PharmD
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Antipsychotic drugs, atypical

Definition

The atypical antipsychotic agents, sometimes called the "novel" antipsychotic agents are a group of drugs which are different chemically from the older drugs used to treat **psychosis**. The "conventional" **antipsychotic drugs** are classified by their chemical structures as the phenothiazines, thioxanthines (which are chemically very similar to the phenothiazines), butyrophenones, diphenylbutylpiperadines and the indolones. All of the atypical antipsychotic agents are chemically classified as dibenzepines. They are considered *atypical* or *novel* because they have different side effects from the conventional antipsychotic agents. The atypical drugs are far less likely to cause extra-pyrammidal side-effects (EPS), drug induced involuntary movements, than are the older drugs. The atypical antipsychotic drugs may also be effective in some cases that are resistant to older drugs.

The drugs in this group are clozapine (Clozaril), loxapine (Loxitane), olanzapine (Zyprexa), and quetiapine (Seroquel).

Purpose

The antipsychotic drugs are used to treat severe emotional disorders.

Recommended dosage

The recommended dose depends on the drug, the patient, and the condition being treated. The normal practice is to start each patient at a low dose, and gradually increase the dose until a satisfactory response is achieved. The dose should be held at the lowest level that gives satisfactory results.

Clozapine usually requires doses between 300 and 600 milligrams a day, but some people require as much

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KEY TERMS

Anxiety—An abnormal and overwhelming sense of apprehension and fear often marked by physiological signs (as sweating, tension, and increased pulse), by doubt concerning the reality and nature of the threat, and by self-doubt about one's capacity to cope with it.

Delusions—A false belief regarding the self or persons or objects outside the self that persists despite the facts.

Depression—A state of being depressed marked especially by sadness, inactivity, difficulty with thinking and concentration, a significant increase or decrease in appetite and time spent sleeping, feelings of dejection and hopelessness, and sometimes suicidal thoughts or an attempt to commit suicide.

Glucocorticoid—Any of a group of corticosteroids (as hydrocortisone or dexamethasone) that are anti-inflammatory and immunosuppressive, and that are used widely in medicine (as in the alleviation of the symptoms of rheumatoid arthritis).

Psychosis—A serious mental disorder characterized by defective or lost contact with reality often with hallucinations or delusions.

as 900 milligrams/day. Doses higher than 900 milligrams/day are not recommended.

Loxapine is usually effective at doses of 60-100 milligrams/day, but may be used in doses as high as 250 mg/day if needed.

Olanzapine doses vary with the condition being treated. The usual maximum dose is 20 milligrams/day.

Quetiapine may be dosed anywhere from 150-750 milligrams/day, depending on how well the patient responds.

Precautions

Although the atypical antipsychotics are generally safe, clozapine has been associated with severe agranulocytosis, a shortage of white blood cells. For this reason, people who may be treated with clozapine should have blood counts before starting the drug, blood counts every week for as long as they are using clozapine, and blood counts every week for the first 4 weeks after they stop taking clozapine. If there is any evidence of a drop in the white blood count while using clozapine, the drug should be stopped.

Atypical antipsychotics should not be used in patients with liver damage, brain or circulatory problems, or some types of blood problems.

Allergies

People who have had an allergic reaction to one of the atypical antipsychotics should not use that medication again. However, sometimes it is possible to use a different drug from the same group safely.

Pregnancy

The atypical antipsychotics have not been proved safe in **pregnancy**. They should be used only when clearly needed and when potential benefits outweigh potential hazards to the fetus. These drugs have not been reported in human milk.

Side effects

Although the atypical antipsychotics are less likely to cause involuntary movements than the older antipsychotic drugs, they still have a large number of adverse effects. Review each drug individually for a full list of possible adverse effects.

Interactions

Taking atypical antipsychotic medications with certain other drugs may affect the way the drugs work or may increase the chance of side effects. While taking antipsychotic drugs, do not take any other prescription or nonprescription (over-the-counter) drugs without first checking with a physician.

Because the atypical antipsychotics may cause lowering of blood pressure, care should be used when these drugs are taken at the same time as other drugs which lower blood pressure.

Quetiapine has many interactions. Doses should be carefully adjusted when quetiapine is used with ketoconazole, itraconazole, fluconazole, erythromycin, carbamazepine, **barbiturates**, rifampin or glucocorticoids including prednisone, dexamethasone and methylprednisolone.

These drugs will also require dose adjustments when used with anti-Parkinson medications.

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Samuel D. Uretsky PharmD

Anti-rejection drugs

Definition

Anti-rejection drugs are daily medications taken by organ transplant patient's to prevent organ rejection.

Purpose

Anti-rejection drugs, which are also called immunosuppressants, help to suppress the immune system's response to a new organ. When a new organ is placed inside a patient's body, the patient's immune system recognizes the organ as foreign tissue and tries to reject it.

Description

When a physician prescribes anti-rejection drugs, the patient's risk of rejection and susceptibility to side effects are considered. The most common drugs prescribed to prevent organ rejection are cyclosporine, prednisone, azathioprine, tacrolimus or FK506, mycophenolate mofetil, sirolimus, and OKT3, as well as ATGAM and Thymoglobulin. As is true with all medications, each of these drugs has benefits and drawbacks. Cyclosporine, which is one of the most frequently used anti-rejection drugs, is usually combined with prednisone. An extremely powerful medicine, cyclosporine is usually taken by a patient over the course of his or her lifetime. Cortisol, which is the naturally produced form of prednisone in a person's body, helps the body manage **stress**, such as infections or organ rejection. Taking prednisone results in less cortisol production in a person's body, thus minimizing the risk of rejection. Azathioprine, which needs to be taken with food to avoid stomach upset, is frequently combined with cyclosporine, prednisone, or tacrolimus. Mycophenolate mofetil is a relatively new immunosuppressant that is similar to azathioprine; therefore, the two drugs should not be taken together. It is preferable to take mycophenolate mofetil on an empty stomach; however, like azathioprine, it can be taken with food because it, too, can cause stomach problems, such as **heartburn** and **nausea**. Like azathioprine, mycophenolate mofetil is not a stand-alone drug; instead, it must be used in combination with other medications. This is also the case with regard to sirolimus.

Physicians prescribe either mycophenolate mofetil or azathioprine (in combination with other **immunosuppressant drugs**) to help patients cope with acute bouts of organ rejection. The medications work by interfering with the multiplication process of white blood cells, which is part of the body's natural defense system when foreign invaders, such as a new organ, are detected. However, researchers at Duke University and the University of Florida found that mycophenolate mofetil doesn't work any better than azathioprine, but costs significantly more. Aside from cost, another consideration also needs to be the type of organ transplanted, because acute rejection rates differ. For example, six months after surgery, approximately 15% of kidney recipients will have an acute rejection episode as compared to approximately 60% of lung recipients. And because study results vary depending on the organ transplanted, more research is needed with regard to the success of mycophenolate mofetil as compared to azathioprine.

OKT3 prevents is prescribed to prevent organ rejection immediately after surgery and is also used to treat acute rejection episodes; ATGAM and Thymoglobulin, which are similar to OKT3, are used for the same reasons. All three drugs are given intravenously.

Tacrolimus, which is also known as FK506, is a fairly new drug that is considered by many experts to be as effective as cyclosporine. An alternative drug choice for patients that cannot tolerate cyclosporine, tacrolimus has been the subject of much research in recent years. Used to treat rejection episodes that are acute or chronic in nature, tacrolimus is being studied to see if using it will allow patients to reduce their dosage of prednisone without organ rejection.

In a presentation at the 2003 American Transplant Congress, surgeons from the University of Pittsburgh reported that an innovative clinical protocol developed by Dr. Thomas E. Starzl was implemented, which reduced the dosage of tacrolimus needed by lung transplant patients with excellent success. Patients required lower doses of prednisone as well. In fact, in some cases, patients were taking tacrolimus only once a day (rather than twice a day) or only four times a week. Over the long term, physicians hope that there will be less risk of lung recipients developing the kinds of complications normally associated with high levels of immunosuppressants, such as kidney dysfunction, which is a common problem faced by lung transplant patients.

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Dr. Thomas E. Strazl, the renowned physician often referred to as the modern-day father of transplantation, developed the protocol based on the knowledge that some of his patients had stopped taking their daily pills with no ill effects. Starzl theorized that giving several drugs to a patient immediately after surgery, which was the normal practice, might inhibit the immune system from developing a tolerance for the new organ. Therefore, his new protocol embraced a different approach. Shortly before the transplantation, patients were given a drug that killed their T-cells and after the operation, patients received only one anti-rejection medicine rather than the multi-pill cocktail normally prescribed. In an article published by *Lancet* in 2003, Starzl and colleagues reported the results of their pilot study involving 82 kidney, liver, pancreas or small bowel transplant patients treated according to the new drug protocol. Out of the 72 patients with successful transplants after one year, over half the patients were taking anti-rejection medication either every other day, three times per week or twice per week. Amazingly, 11 of the patients were taking only one pill a week and they exhibited no signs of organ rejection or complications. Certainly more research needs to be conducted, but these results are very promising.

Recommended dosage

The dosages vary depending on the drug or drug combination being taken by the patient. In general, cyclosporine is taken every 12 hours in liquid or capsule form. Tacrolimus is generally taken every 12 hours as well. The level of either drug in a patient's blood is monitored carefully and doses are adjusted accordingly in order to not only prevent reject, but also unpleasant side effects. Azathioprine is taken once a day in tablet form, whereas mycophenolate mofetil is generally taken every 12 hours. High doses of prednisone are usually given at first and then tapered down slowly.

Precautions

Patients should discuss proper storage methods with regard to their medications. Sirolimus, for example, should be stored at room temperature with special care taken to keep it out of excessive heat and humidity.

Although pregnant women taking anti-rejection drugs have delivered healthy babies, women planning on becoming pregnant while taking anti-rejection drugs should talk with their physicians regarding any possible complications. For example, the safety of taking mycophenolate mofetil during **pregnancy** or while **breastfeeding** is questionable and not advised.

Side effects

Side effects vary depending on the individual and the drug therapy chosen. Patients should talk with their doctors regarding the various side effects they can expect and under what conditions emergency medical care needs to be sought.

Interactions

It is essential that patients talk with their pharmacist and transplant team before taking any medications, regardless of whether they are prescription or over-the-counter drugs to ensure that the combinations will not interact. For example, **antacids** can diminish the effectiveness of mycophenolate mofetil and drugs used to treat high cholesterol may increase the potency of sirolimus. In addition, certain food products can also alter the potency of some anti-rejection drugs. For example, grapefruit and grapefruit juice can cause cyclosporine blood levels to increase.

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Lee Ann Paradise

Antiretroviral drugs

Definition

Antiretroviral drugs inhibit the reproduction of retroviruses, which are viruses whose genetic code is made up of ribonucleic acid (RNA) instead of deoxynucleic acid (DNA). Although the genetic material of these viruses is RNA, the viruses contain enzymes that

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KEY TERMS

CD4—A type of protein molecule in human blood, sometimes called the T4 antigen, that is present on the surface of 65% of immune cells. The HIV virus infects cells with CD4 surface proteins (CD4+ cells), and as a result, depletes the number of immune system cells in the individual's blood. Most of the damage to an the immune system of an HIV-infected individual is done by viral destruction of CD4+ T cells.

Hypoxemia—Lower than normal oxygenation of arterial blood.

Immune system—Mechanism that protects the body from foreign substances, foreign cells, and pathogens. The thymus, spleen, lymph nodes, white blood cells, including the B cells and T cells, and antibodies are involved in the immune response, which aims to destroy these foreign bodies.

Mutate—Undergo a spontaneous change in the make-up of genes or chromosomes.

Opportunistic infection—An infection by organisms that usually do not cause infection in people whose immune systems are working normally.

Pregnancy category— A system of classifying drugs according to their established risks for use during pregnancy. Category A: Controlled human studies have demonstrated no fetal risk. Category B: Animal studies indicate no fetal risk, but no human studies; or adverse effects in animals, but not in well-controlled human studies. Category C: No adequate human or animal studies; or adverse fetal effects in animal studies, but no available human data. Category D: Evidence of fetal risk, but benefits outweigh risks. Category X: Evidence of fetal risk. Risks outweigh any benefits.

Retrovirus—A virus composed of ribonucleic acid (RNA) instead of deoxynucleic acid (DNA).

Virus—A tiny, disease-causing particle that can reproduce only inside living cells.

transcribe this RNA into DNA, which then can be used to infect host cells. The best known of this type of virus is HIV, human **immunodeficiency** virus, the causative agent of **AIDS**.

Purpose

Antiretroviral drugs do not kill viruses outright. Instead, they block specific steps in the replication of the virus. As a result, the drugs do not cure viral infections; however continued use of antiretroviral drugs, particularly in multi-drug regimens, significantly slows and controls disease progression. The development of new antiretroviral drugs in the 2000s has allowed many patients with HIV infection to live longer and with a better quality of life. Zidovudine (AZT) was the first antiretroviral drug approved by the United States Food and Drug Administration (FDA) for the treatment of HIV.

Description

Antiretroviral drugs are classified based on the steps in virus replication that they disrupt. Medications may combine two or more drugs from different classes to boost effectiveness. Classes are as follows:

- Nucleoside and nucleotide reverse transcriptase inhibitors (NRTIs) insert material into newly synthesized viral DNA that prevents it from being completely assembled. This was the first class of antiretroviral drugs to be developed. Drugs in this class include zidovudine (AZT, Retrovir, ZDV), didanosine (ddl, Videx), stavudine (d4T, Zerit), lamivudine (Epivir, 3TC), abacavir (ABC, Ziagen), emtricitabine (Emtirva, FTC), and tenofovir (Viread, TDF).
- Non-nucleoside reverse transcriptase inhibitors (NNRTIs) interfere directly with the enzyme reverse transcriptase needed to transcribe RNA of the virus into DNA. Drugs in this class include efavirenz (Sustiva, EFV), etravirine (Intelence, ETR), and nevirapine (Viramune, NVP).
- Protease inhibitors prevent the assembly of new virus particles (virons). Drugs in this class include atzanavir (Reyataz, ATV), darunavir (Prezista, DRV), fosamprenavir (Lexiva, f-APV), indinavir (Crixivan, IDV), lopinavir/ritonavir (Kaletra, LPV/r), nelfinavir (Viracept, NVF), ritonavir (Norvir, RTV), saquinavir (Fortovase, Invirase), and tipranavir (Aptivus, TPV).
- Integrase inhibitors prevent viral DNA from being incorporated into host cells the virus infects. As of early 2010, the only FDA-approved drug in this class is raltegravir (Isentress, RAL). Other drugs of this type are under active development or in clinical trials.
- Entry inhibitors, also called fusion inhibitors, prevent the entry of the virus into a host cell. Drugs in

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this class include maraviroc (Selzentry, MVC) and enfuvirtide (Fuzeon, T-20).

- Maturation inhibitors prevent the maturing of new virons in a way that makes them non-infectious. As of January 2010, the United States Food and Drug Administration (FDA) had approved no drugs in this category. However, clinical trials of two drugs, bevirimat and vivecon were underway and second-generation maturation inhibitors were in development.

Because HIV exists in several different genetic variations (called clades) and mutates readily, the virus can develop resistance to single drug therapy. However, treatment with drug combinations appears to produce a durable response. Using antiretroviral drugs in combination helps lower risk of developing viral resistance. About half of patients who fail antiretroviral therapy are resistant to one class of drug. Research into optimal multiple drug combinations is ongoing.

Proper antiretroviral treatment can slow the progression of HIV infections and reduce the frequency of opportunistic infections. One of the most notable advances in recent years has been the success of highly active antiretroviral therapy (HAART). In most infected individuals, this multi-drug approach reduces the risk of opportunistic infections in persons with HIV/AIDS and slows the progression of the disease and **death**. Good adherence to HAART also reduces healthcare costs over the life of the HIV-infected individual.

The scientific community continues to make advancements in developing and evaluating antiretroviral drug therapy. Information on current clinical trials of antiretroviral drugs and other treatments or vaccines in development for the treatment of HIV infection is available at http://www.clinicaltrials.gov. There is no fee charged to participate in a clinical trial and participants may be compensated for their time and travel expenses.

Recommended dosage

Dosage must be individualized based on the patient and use of interacting drugs. The optimum combinations of antiretroviral drugs have not been determined, and likely vary from patient to patient. The decision to start antiretroviral therapy is based on many factors including the patient's clinical picture, ability to comply with the drug regimen, and other treatment options. Early treatment with antiretroviral drugs has been shown to offer little or no benefit to the patient and has led to unwanted side effects in some patients. Starting treatment with antiretroviral drugs is based on the level of CD4+ lymphocytes, which falls as HIV disease progresses, and the general health status of the individual.

Precautions

Although the antiretroviral drugs fall into several classes, each drug has a unique pattern of adverse effects and **drug interactions**. Since the drugs are used in various combinations, the frequency and severity of adverse effects will vary with the combination. Although most drug combinations show a higher rate of adverse events than single drug therapy, some patterns are not predictable.

The most severe adverse effects associated with the **protease inhibitors** are kidney and liver toxicity. Patients also have reported a syndrome of abdominal distention (swelling and expansion) and increased body odor, which may be socially limiting. Hemophilic patients have reported increased bleeding tendencies while taking protease inhibitors.

The nucleoside reverse transcriptase inhibitors have significant levels of toxicity. Lactic acidosis (build up of lactic acid in the blood) in the absence of hypoxemia and severe liver enlargement with fatty degeneration have been reported with zidovudine and zalcitabine, and are potentially fatal. Rare cases of liver failure, considered possibly related to underlying **hepatitis B** and zalcitabine monotherapy, have been reported.

Abacavir has been associated with fatal hypersensitivity reactions. Didanosine has been associated with severe **pancreatitis**. Nucleoside reverse transcriptase inhibitors are **pregnancy** category C. There is limited information regarding safety during pregnancy, however, zidovudine has been used during pregnancy to reduce the risk of HIV infection to the infant.

Efavirenz has been associated with a high frequency of skin rash. Nevirapine has been associated with severe liver damage and skin reactions. All of the **non-nucleoside reverse transcriptase inhibitors** are pregnancy category C, based on animal studies.

The safety of antiretroviral drugs during pregnancy has not been established. HIV-infected women who are pregnant should discuss the benefits and risks with their physician. HIV-infected mothers are advised not to breastfeed in order to prevent transmission of the virus to the newborn.

Interactions

Because of the high frequency of drug interactions associated with AIDS therapy, specialized references should be consulted. Use of recreational drugs while on antiretroviral therapy can trigger potentially lethal side effects or negate the positive effects of the therapy. Patients should discuss both potential side effects and

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drug interactions with a specialist in HIV/AIDS treatment.

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AIDS Education and Training Centers (AETC) National Resource Center, 65 Bergen Street, 8th floor, Newark, NJ, 07101, info@aidsetc.org, http://www.aidsetc.org.
AIDS.gov, U.S. Department of Health and Human Services, 200 Independence Avenue, S.W., Washington, DC, 20201, http://www.aids.gov.
United States Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333 (404) 639-3534 800-CDC-INFO (800-232-4636). TTY: (888) 232-6348, inquiry@cdc.gov, http://www.cdc.gov.
World Health Organization (WHO), Avenue Appia 20, 1211 Geneva 27, Switzerland +22 41 791 21 11 +22 41 791 31 11, info@who.int, http://www.who.int.

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Antirheumatic drugs

Definition

Antirheumatic drugs are drugs used to treat **rheumatoid arthritis**.

Purpose

Rheumatoid arthritis is a progressive form of arthritis that has devastating effects on joints and general health. It is classified as an auto immune disease, because the disease is caused by the body's own immune system acting against the body itself. Symptoms include painful, stiff, swollen joints, **fever**, **fatigue**, and loss of appetite.

In recent years, there has been a change in attitude concerning the treatment of rheumatoid arthritis. Physicians now use Disease Modifying Anti-Rheumatic Drugs (DMARDs) early in the history of the disease and are less inclined to wait for crippling stages before resorting to the more potent drugs. Fuller understanding of the side-effects of non steroidal anti-inflammatory drugs (NSAIDs) has also stimulated reliance on other types of antirheumatic drugs.

Description

The major classes of antirheumatic drugs include:

- Nonsteroidal Anti-Inflammatory Drugs (NSAIDs). Drugs belonging to this class bring symptomatic relief of both inflammation and pain, but have a limited effect on the progressive bone and cartilage loss associated with rheumatoid arthritis. They act by slowing the body's production of prostaglandins. Common NSAIDs include: ibuprofen (Motrin, Nuprin or Advil), naproxen (Naprosyn, Aleve) and indomethacin (Indocin).
- Corticosteroids. These drugs are very powerful anti-inflammatory agents. They are the synthetic analogs of cortisone, produced by the body. Corticosteroids are used to reduce inflammation and suppress activity of the immune system. The most commonly prescribed are prednisone and dexamethasone.
- Disease Modifying Anti-Rheumatic Drugs (DMARDs). DMARDs influence the disease process itself and do not only treat symptoms, hence their name. DMARDs also have anti-inflammatory effects, and most were borrowed from the treatment of other diseases, such as cancer and malaria. Anti-malarials DMARDs include chloroquine (Aralen) and hydroxychloroquine (Plaquenil). Powerful DMARDs include: methotrexate (Rheumatrex), sulfasalazine, cyclosporine, azathioprine (Imuran) and cyclophosphamide (Cytoxan), azathioprine, sulfasalazine, penicillamine, and organic gold compounds such as aurothioglucose (Solganol), gold sodium thiomalate (Aurolate) and auranofin (Ridaura).
- Slow-Acting Antirheumatic Drugs (SAARDs). SAARDs are a special class of DMARDs and the effect of these drugs is slow acting and not so quickly apparent as that of the NSAIDs. Examples are hydroxychloroquine and aurothioglucose.
- Immunosuppresive cytotoxic drugs. This class of drugs is used if treatment with NSAIDs and

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KEY TERMS

Anti-inflammatory drugs—A class of drugs that lower inflammation and that includes NSAIDs and corticosteroids.

Arthritis—A painful condition that involves inflammation of one or more joints.

Conception—The union of egg and sperm to form a fetus.

Corticosteroids—A class of drugs that are synthetic versions of the cortisone produced by the body. They rank among the most powerful anti-inflammatory agents.

Cortisone—Glucocorticoid produced by the adrenal cortex in response to stress. Cortisone is a steroid and has anti-inflammatory and immunosuppressive properties.

Cytotoxic drugs—Drugs that function by destroying cells.

Disease Modifying Anti-Rheumatic Drugs (DMARDs)—A class of antirheumatic drugs, including chloroquine, methotrexate, cyclosporine, and gold compounds, that influence the disease process itself and do not only treat its symptoms.

Inflammation—A process occurring in body tissues, characterized by increased circulation and the accumulation of white blood cells. Inflammation also occurs in disorders such as arthritis and causes harmful effects.

Inflammatory—Pertaining to inflammation.

Immune response—Physiological response of the body controlled by the immune system that involves the production of antibodies to fight off specific foreign substances or agents (antigens).

Immune system—The sum of the defense mechanisms of the body that protects it against foreign substances and organisms causing infection.

Immunosuppressive—Any agent that suppresses the immune response of an individual.

Immunosuppresive cytotoxic drugs—A class of drugs that function by destroying cells and suppressing the immune response.

Methotrexate—A drug that interferes with cell growth and is used to treat rheumatoid arthritis as well as various types of cancer. Side-effects may include mouth sores, digestive upsets, skin rashes, and hair loss.

Non steroidal—Not containing steroids or cortisone. Usually refers to a class of drugs called Nonsteroidal Anti-Inflammatory Drugs (NSAIDs).

Nonsteroidal Anti-Inflammatory Drugs (NSAIDs)—A class of drugs that is used to relieve pain, and symptoms of inflammation, such as ibuprofen and ketoprofen.

Osteoarthritis—A form of arthritis that occurs mainly in older people and involves the gradual degeneration of the cartilage of the joints.

Prostaglandins—Prostaglandins are produced by the body and are responsible for inflammation features, such as swelling, pain, stiffness, redness and warmth.

SAARDs have no effect. Immunosuppresive drugs have a stabilizing effect on the immune system. Since the inflammation associated with chronic arthritis is due to malfunctions of the immune system, use of this class of drugs has been shown to be beneficial for the treatment of rheumatoid arthritis as well. Examples are: methotrexate, mechlorethamine, cyclophosphamide, chlorambucil, and azathioprine.

Recommended dosage

Recommended dosage depends on the type of drug. The prescribing physician or the pharmacist provides information for the correct dosage. The drugs must be taken exactly as directed.

When taking methotrexate for rheumatoid arthritis, it should be taken only *once or twice a week as prescribed,* not every day. Taking it every day can lead to a fatal overdose.

Precautions

Many antirheumatic drugs such as azathioprine (Imuran) and methotrexate (Rheumatrex) are very powerful drugs. They are usually prescribed in severe cases, when all other treatments have failed. Thus, they may have serious side effects, so it is important to be monitored closely by a physician while taking any of these drugs.

Side effects

Hydroxychloroquine (Plaquenil) may cause vision problems. Anyone taking it should see an

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ophthalmologist (a physician who specializes in treating eyes) for a thorough **eye examination** every six months.

Methotrexate and penicillamine may cause **birth defects**. Women taking these drugs must stop taking them during **pregnancy** and for several months before a planned pregnancy. Methotrexate may also cause lung damage or fertility problems and should not be taken by anyone with serious kidney or **liver disease** or by anyone who drinks alcohol.

Azathioprine may cause birth defects if either the man or woman is using it at the time of conception. Anyone who uses this drug and is sexually active should consult with a physician about an effective birth control method.

Other common side effects of antirheumatic drugs include abdominal cramps, **diarrhea**, **dizziness**, loss of appetite, **headache**, **nausea**, **vomiting**, fever and chills, and mouth sores. A variety of other side effects may occur. Anyone who has unusual symptoms while taking antirheumatic drugs should notify the treating physician.

The gold compounds may cause serious blood problems by reducing the ability of the blood forming organs to produce blood cells. These drugs may decrease the number of white blood cells, red blood cells, or both. Patients taking these drugs should have regular blood counts.

Entanercept (Enbrel) may also cause blood problems, and some patients who received this drug have developed eye problems and **multiple sclerosis**. It is not certain whether these reactions were caused by entanercept, but multiple sclerosis has been seen in patients taking other drugs which act against tumor necrosis factor.

Interactions

Antirheumatic drugs may interact with a variety of other medicines or other antirheumatic drugs. When this happens, the effects of one or both of the drugs may change, or the risk of side effects may be greater. Anyone who takes this type of drug should inform the prescribing physician about any other medication he or she is taking. Among the drugs that may interact with antirheumatic drugs are phenytoin (Dilantin), **aspirin**, sulfa drugs such as Bactrim and Gantrisin, tetracycline and some other **antibiotics** and cimetidine (Tagamet). NSAIDs such as ibuprofen (Motrin, Advil) are also known to interact with other classes of antirheumatic drugs.

Nancy Ross-Flanigan

Antiseptics

Definition

An antiseptic is a substance which inhibits the growth and development of microorganisms. For practical purposes, antiseptics are routinely thought of as topical agents, for application to skin, mucous membranes, and inanimate objects, although a formal definition includes agents which are used internally, such as the urinary tract antiseptics.

Purpose

Antiseptics are a diverse class of drugs which are applied to skin surfaces or mucous membranes for their anti-infective effects. This may be either bacteriocidal or bacteriostatic. Their uses include cleansing of skin and wound surfaces after injury, preparation of skin surfaces prior to injections or surgical procedures, and routine disinfection of the oral cavity as part of a program of **oral hygiene**. Antiseptics are also used for disinfection of inanimate objects, including instruments and furniture surfaces.

Commonly used antiseptics for skin cleaning include benzalkonium chloride, chlorhexidine, hexachlorophine, iodine compounds, mercury compounds, alcohol and hydrogen peroxide. Other agents which have been used for this purpose, but have largely been supplanted by more effective or safer agents, include boric acid and volatile oils such as methyl salicylate (oil of wintergreen.)

Chlorhexidine shows a high margin of safety when applied to mucous membranes, and has been used in oral rinses and preoperative total body washes.

Benzalkonium chloride and hexachlorophine are used primarily as hand scrubs or face washes. Benzalkonium may also find application is a disinfecting agent for instruments, and in low concentration as a preservative for drugs including ophthalmic solutions. Benzalkonium chloride is inactivated by organic compounds, including soap, and must not be applied to areas which have not been fully rinsed.

Iodine compounds include tincture of iodine and povidone iodine compounds. Iodine compounds have the broadest spectrum of all topical anti-infectives, with action against bacteria, fungi, viruses, spores, protozoa, and yeasts. Iodine tincture is highly effective, but its alcoholic component is drying and extremely irritating when applied to abraided (scraped or rubbed) skin. Povidone iodine, an organic compound, is less irritating and less toxic, but not as effective. Povidone iodine has been used for hand

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KEY TERMS

Antibiotic—A medicine used to treat infections.

Bacteria—Tiny, one-celled forms of life that cause many diseases and infections.

Mucous membrane—The moist lining of a body cavity or structure, such as the mouth or nose.

Residue—Traces that remain after most of the rest of the material is gone.

scrubs and disinfection of surgical sites. Aqueous solutions of iodine have also been used as antiseptic agents, but are less effective than alcoholic solutions and less convenient to use that the povidone iodine compounds.

Hydrogen peroxide acts through the liberation of oxygen gas. Although the antibacterial activity of hydrogen peroxide is relatively weak, the liberation of oxygen bubbles produces an effervescent action, which may be useful for wound cleansing through removal of tissue debris. The activity of hydrogen peroxide may be reduced by the presence of blood and pus. The appropriate concentration of hydrogen peroxide for antiseptic use is 3%, although higher concentrations are available.

Thimerosol (Mersol) is a mercury compound with activity against bacteria and yeasts. Prolonged use may result in mercury toxicity.

Recommended dosage

Dosage varies with product and intended use.

Precautions

Precautions vary with individual product and use.

Hypersensitivity reactions should be considered with organic compounds such as chlorhexidine, benzalkonium and hexachlorophine.

Skin dryness and irritation should be considered with all products, but particularly with those containing alcohol.

Systemic toxicity may result from ingestion of iodine containing compounds or mercury compounds.

Chlorhexidine should not be instilled into the ear. There is one anecdotal report of deafness following use of chlorhexidine in a patient with a **perforated eardrum**. Safety in **pregnancy** and **breastfeeding** have not been reported, however there is one anecdotal report of an infant developing slowed heartbeat apparently related to maternal use of chlorhexidine.

Iodine compounds should be used sparingly during pregnancy and **lactation** due to risk of infant absorption of iodine with alterations in thyroid function.

Interactions

Antiseptics are not known to interact with any other medicines. However, they should not be used together with any other topical cream, solution, or ointment.

Resources

PERIODICALS

Farley, Dixie. "Help for Cuts, Scrapes and Burns." *FDA Consumer* May 1996: 12.

Samuel D. Uretsky PharmD

Antispasmodic drugs

Definition

Antispasmodic drugs relieve cramps or spasms of the stomach, intestines, and bladder.

Purpose

Antispasmodic drugs have been used to treat stomach cramps. Traditionally, they were used to treat stomach ulcers, but for this purpose they have largely been replaced by the acid inhibiting compounds, the H-2 receptor blockers such as cimetidine and ranitidine and the proton pump inhibtors such as omeprazole, lansoprazole and rabetazole.

Most of the drugs are used as "anti-cholinergics." Since they counteract the effects of the neurohormone acetylcholine. Some of these drugs are derived from the plant belladonna, also known as Deadly Nightshade. There is also a group of drugs with similar activity, but not taken from plant sources. The anticholingergics decrease both the movements of the stomach and intestine, and also the secretions of stomach acid and digestive enzymes. They may be used for other purposes including treatment of Parkinson's **disease**, and bladder urgency. These drugs inhibit secretions and cause **dry mouth** and dry eyes because of reduced salivation and tearing. Dicyclomine is an antispasmodic with very lettle

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KEY TERMS

Heat stroke—A serious condition that results from exposure to extreme heat. The body loses its ability to cool itself. Severe headache, high fever, and hot, dry skin may result. In severe cases, a person with heat stroke may collapse or go into a coma.

Hiatal hernia—A condition in which part of the stomach protrudes through the diaphragm.

Hyperthyroidism—Secretion of excess thyroid hormones by the thyroid gland.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Myasthenia gravis—A condition in which certain muscles weaken and may become paralyzed.

Reflux esophagitis—Inflammation of the lower esophagus caused by the backflow of stomach contents.

Spasm—Sudden, involuntary tensing of a muscle or a group of muscles

Ulcerative colitis—Long-lasting and repeated inflammation of the colon with the development of sores.

effect on secretions. It is used to treat **irritable bowel syndrome**.

Description

Dicyclomine is available only with a prescription and is sold as capsules, tablets (regular and extended-release forms), and syrup.

Recommended dosage

The usual dosage for adults is 20 mg, four times a day. However, the physician may recommend starting at a lower dosage and gradually increasing the dose to reduce the chance of unwanted side effects.

The dosage for children depends on the child's age. Check with the child's physician for the correct dosage.

Precautions

Dicyclomine makes some people sweat less, which allows the body to overheat and may lead to heat prostration (**fever** and heat stroke). Anyone taking this drug should try to avoid extreme heat. If that is not possible, check with the physician who prescribed the drug. If heat prostration occurs, stop taking the medicine and call a physician immediately.

This medicine can cause drowsiness and blurred or double vision. People who take this drug should not drive, use machines, or do anything else that might be dangerous until they have found out how the medicine affects them.

Dicyclomine should not be given to infants or children unless the physician decides the use of this drug is necessary. Diclyclomine should not be used by women who are **breastfeeding**. Women who are pregnant or plan to become pregnant should check with their physicians before using this drug.

Anyone with the following medical conditions should not take dicyclomine unless directed to do so by a physician:

- Previous sensitivity or allergic reaction to dicyclomine
- Glaucoma
- Myasthenia gravis
- Blockage of the urinary tract, stomach, or intestines
- Severe ulcerative colitis
- Reflux esophagitis.

In addition, patients with these conditions should check with their physicians before using dicyclomine:

- Liver disease
- Kidney disease
- High blood pressure
- Heart problems
- Enlarged prostate gland
- Hiatal hernia
- Autonomic neuropathy (a nerve disorder)
- Hyperthyroidism.

Side effects

The most common side effects are **dizziness**, drowsiness, lightheadedness, **nausea**, nervousness, blurred vision, dry mouth, and weakness. Other side effects may occur. Anyone who has unusual symptoms after taking dicyclomine should get in touch with his or her physician.

Interactions

Dicyclomine may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Among the drugs that may interact with Dicyclomine are:

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- Antacids such as Maalox
- Antihistamines such as clemastine fumarate (Tavist)
- Bronchodilators (airway opening drugs) such as albuterol (Proventil, Ventolin)
- Corticosteroids such as prednisone (Deltasone)
- Monoamine oxidase inhibitors (MAO inhibitors) such as phenelzine (Nardil) and tranylcypromine (Parnate)
- Tranquilizers such as diazepam (Valium) and alprazolam (Xanax).

The list above does not include every drug that may interact with dicyclomine. Be sure to check with a physician or pharmacist before combining dicyclomine with any other prescription or nonprescription (over-the-counter) medicine.

Nancy Ross-Flanigan

Antistreptolysin O titer (ASO) *see* **Streptococcal antibody tests**

Antithrombin III deficiency *see* **Hypercoagulation disorders**

Antituberculosis drugs

Definition

Antituberculosis drugs are medicines used to treat **tuberculosis**, an **infectious disease** that can affect the lungs and other organs.

Purpose

Tuberculosis is a disease caused by *Mycobacterium tuberculae*, a bacteria that is passed between people through the air. The disease can be cured with proper drug therapy, but because the bacteria may become resistant to any single drug, combinations of antituberculosis drugs are used to treat tuberculosis (TB) and are normally required for effective treatment. At the start of the 20th Century, tuberculosis was the most common cause of **death** in the United States, but was largely eliminated with better living conditions. It is most common in areas of crowding and poor ventilation, such as crowded urban areas and prisons. In some areas, the **AIDS** epidemic has been accompanied by an increase in the prevalence of tuberculosis.

Some antituberculosis drugs also are used to treat or prevent other infections such as *Mycobacterium avium* complex (MAC), which causes disease throughout the bodies of people with AIDS or other diseases of the immune system.

Description

Antituberculosis drugs are available only with a physician's prescription and come in tablet, capsule, liquid and injectable forms. Some commonly used antituberculosis drugs are cycloserine (Seromycin), ethambutol (Myambutol), ethionamide (Trecator-SC), isoniazid (Nydrazid, Laniazid), pyrazinamide, rifabutin (Mycobutin), and rifampin (Rifadin, Rimactane).

Recommended dosage

The recommended dosage depends on the type of antituberculosis drug and may be different for different patients. Check with the physician who prescribed the medicine or the pharmacist who filled the prescription for the proper dosage. The physician may gradually increase the dosage during treatment. Be sure to follow the physician's orders. Patients who are infected with HIV must usually take larger combinations of drugs for a longer period of time than is needed for patients with an unimpaired immune system.

Some antituberculosis drugs must be taken with other drugs. If they are taken alone, they may encourage the bacteria that cause tuberculosis to become resistant to drugs used to treat the disease. When the bacteria become resistant, treating the disease becomes more difficult.

To clear up tuberculosis completely, antituberculosis drugs must be taken for as long as directed. This may mean taking the medicine every day for a year or two or even longer. Symptoms may improve very quickly after treatment with this medicine begins. However, they may come back if the medicine is stopped too quickly. Do not stop taking the medicine just because symptoms improve.

Because people may neglect to take their medication for tuberculosis, it is common to have tuberculosis centers develop a program of Directly Observed Therapy (DOT). In these programs, patients come to the hospital or clinic, and take their medication in front of an observer. These programs may be annoying to the patients, but are justified by the risks to public health if tuberculosis germs that have become resistant to drugs were to be spread.

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KEY TERMS

Bacteria—Tiny, one-celled forms of life that cause many diseases and infections.

Feces—(Also called stool.) The solid waste that is left after food is digested. Feces form in the intestines and pass out of the body through the anus.

Fetus—A developing baby inside the womb.

Gout—A disease in which uric acid, a waste product that normally passes out of the body in urine, collects in the joints and the kidneys. This causes arthritis and kidney stones.

Immune system—The body's natural defenses against disease and infection.

Microorganism—An organism (life form) that is too small to be seen with the naked eye.

Platelets—Disk-shaped bodies in the blood that are important in clotting.

Seizure—A sudden attack, spasm, or convulsion.

Cycloserine works best when it is at constant levels in the blood. To help keep levels constant, take the medicine in doses spaced evenly through the day and night. Do not miss any doses. If taking medicine at night interferes with sleep, or if it is difficult to remember to take the medicine during the day, check with a health care professional for suggestions.

Do not take **antacids** that contain aluminum, such as Maalox, within 1 hour of taking isoniazid, as this may keep the medicine from working.

Precautions

Seeing a physician regularly while taking antituberculosis drugs is important. The physician will check to make sure the medicine is working as it should and will watch for unwanted side effects. These visits also will help the physician know if the dosage needs to be changed.

Symptoms should begin to improve within a few weeks after treatment begins with antituberculosis drugs. If they do not, or if they become worse, check with a physician.

Some people feel drowsy, dizzy, confused, or less alert when using these drugs. Some may also cause vision changes, clumsiness, or unsteadiness. Because of these possible problems, anyone who takes antituberculosis drugs should not drive, use machines, or do anything else that might be dangerous until they have found out how the medicine affects them.

Daily doses of pyridoxine (vitamin B_6) may lessen or prevent some side effects of ethionamide or isoniazid. If the physician who prescribed the medicine recommends this, be sure to take the pyridoxine every day.

Certain kinds of cheese (such as Swiss and Cheshire) and fish (such as tuna and skipjack) may cause an unusual reaction in people taking isoniazid. Symptoms of this reaction include fast or pounding heartbeat, sweating or a hot feeling, chills or a clammy feeling, **headache**, lightheadedness, and red or itchy skin. This reaction is very rare. However, if any of these symptoms occur, check with a physician as soon as possible.

Rifabutin and rifampin will make saliva, sweat, tears, urine, feces, and skin turn reddish orange to reddish brown. This is nothing to worry about. However, the discolored tears may permanently stain soft **contact lenses** (but not hard contact lenses). To avoid ruining contact lenses, do not wear soft contacts while taking these medicines.

Rifampin may temporarily lower the number of white blood cells. Because the white blood cells are important in fighting infection, this effect increases the chance of getting an infection. This drug also may lower the number of platelets that play an important role in clotting. To reduce the risk of bleeding and infection in the mouth while taking this medicine, be especially careful when brushing and flossing the teeth. Check with a physician or dentist for suggestions on how to keep the teeth and mouth clean without causing injuries. Put off any dental work until blood counts return to normal.

Rifampin may affect the results of some medical tests. Before having medical tests, anyone taking this medicine should alert the health care professional in charge.

People who have certain medical conditions may have problems if they take antituberculosis drugs. For example:

- cycloserine or isoniazid may increase the risk of seizures (convulsions) in people with a history of seizures.

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- the dosage of cycloserine may need to be adjusted for people with kidney disease.
- ethambutol or pyrazinamide may cause or worsen attacks of gout in people who are prone to having them.
- ethambutol may cause or worsen eye damage.
- diabetes may be harder to control in patients who take ethionamide.
- isoniazid may cause false results on some urine sugar tests, and pyrazinamide may cause false results on urine ketone tests. Diabetic patients who use either of these medicines should discuss the possibility of false test results with their physicians.
- people with liver disease or a history of alcohol abuse may be more likely to develop hepatitis when taking isoniazid and are more likely to have side effects that affect the liver when taking rifampin.
- in people with kidney disease, ethambutol, ethionamide, or isoniazid may be more likely to cause side effects.
- side effects are also more likely in people with liver disease who take pyrazinamide.

Before taking antituberculosis drugs, be sure to let the physician know about these or any other medical problems.

In laboratory tests of pregnant animals, high doses of some antituberculosis drugs have caused **birth defects** and other problems in the fetus or newborn. However, pregnant women with tuberculosis need to take antituberculosis drugs to clear up their disease. Knowing that many women have had healthy babies after taking these drugs during **pregnancy** may be reassuring. Pregnant women who need to take this medicine and are worried about birth defects or other problems should talk to their physicians.

Anyone who has had unusual reactions to antituberculosis drugs or to niacin should let his or her physician know before taking any antituberculosis drug. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

Patients who are on special **diets**, such as low-sodium or low-sugar diets, should make sure their physicians know. Some antituberculosis medicines may contain **sodium**, sugar, or alcohol.

Side effects

Cycloserine

In some people, this medicine causes depression and thoughts of **suicide**. If this happens, check with a physician immediately. Switching to another medicine will usually stop these troubling thoughts and feelings. Also let the physician know immediately about any other mood or mental changes; such as nervousness, nightmares, **anxiety**, confusion, or irritability; and about symptoms such as muscle twitches, convulsions, or speech problems.

Headache is a common side effect that usually goes away as the body adjusts to this medicine. This problem does not need medical attention unless it continues or it interferes with everyday life.

Ethambutol

This medicine may cause eye **pain** or vision changes, including loss of vision or changes in color vision. Check with a physician immediately if any of these problems develop.

In addition, anyone who has any of these symptoms while taking ethambutol should check with a physician immediately:

- painful or swollen joints, especially in the knee, ankle, or big toe
- a tight, hot sensation in the skin over painful or swollen joints
- chills.

Other side effects may occur but do not need medical attention unless they are bothersome or they do not go away as the body adjusts to the medicine. These include: headache, confusion, **nausea and vomiting**, stomach pain, and loss of appetite.

Ethionamide

Check with a physician immediately if eye pain, blurred vision, or other vision changes occur while taking this medicine.

Symptoms such as unsteadiness, clumsiness and pain, **numbness**, **tingling**, or burning in the hands or feet could be the first signs of nerve problems that may become more serious. If any of these symptoms occur, check with a physician immediately. Other side effects that should be brought to a physician's attention immediately include yellow eyes or skin and mood or mental changes such as depression or confusion.

Less serious side effects such as **dizziness**, nausea or vomiting, appetite loss, sore mouth, or metallic taste may also occur. These problems usually go away as the body adjusts to the medicine. They do not need medical attention unless they continue or they interfere with normal activities.

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Isoniazid

This medicine may cause serious liver damage, especially in people over 40 years of age. However, taking medicine for tuberculosis is very important for people with the disease. Anyone who has tuberculosis and has been advised to take this drug should thoroughly discuss treatment options with his or her physician.

Recognizing the early signs of liver and nerve damage can help prevent the problems from getting worse. If any of these symptoms occur, check with a physician immediately:

- unusual tiredness or weakness
- clumsiness or unsteadiness
- pain, numbness, tingling, or burning in the hands and feet
- loss of appetite
- vomiting

This medicine may also cause less serious side effects such as **diarrhea** and stomach pain. These usually go away as the body adjusts to the medicine and do not need medical attention unless they continue.

If eye pain, blurred vision, or other vision changes occur while taking this medicine, check with a physician immediately.

Pyrazinamide

Check with a physician immediately if pain in the joints occurs.

Rifabutin

Check with a physician immediately if a skin rash occurs.

Rifampin

Stop taking rifampin and check with a physician immediately if any of the following symptoms occur. These symptoms could be early signs of problems that may become more serious. Getting prompt medical attention could prevent them from getting worse.

- unusual tiredness or weakness
- nausea or vomiting
- loss of appetite

In addition, anyone who has any of these symptoms while taking rifampin should check with a physician immediately:

- breathing problems
- fever
- chills
- shivering
- headache
- dizziness
- itching
- skin rash or redness
- muscle and bone pain

Other side effects, such as diarrhea and stomach pain, may occur with this medicine, but should go away as the body adjusts to the drug. Medical treatment is not necessary unless these problems continue.

Other side effects may occur with any antituberculosis drug. Anyone who has unusual symptoms while taking an antituberculosis drug should get in touch with his or her physician.

Interactions

Taking cycloserine and ethionamide together may increase the risk of seizures and other nervous system problems. These and other side effects also are more likely in people who drink alcohol while taking cycloserine. To avoid these problems, *do not drink alcohol while taking cycloserine* and check with a physician before combining cycloserine and ethionamide.

Drinking alcohol regularly may prevent isoniazid from working properly and may increase the chance of liver damage. Anyone taking this medicine should strictly limit the use of alcohol. Check with a health care professional for advice on the amount of alcohol that may safely be used.

Many drugs may interact with isoniazid or rifampin, increasing the chance of liver damage or other side effects. Among these drugs are **acetaminophen** (Tylenol), birth control pills and other drugs that contain female hormones, and the antiseizure drugs divalproex (Depakote) and valproic acid (Depakene). For a complete list of drugs that may have this effect, check with a pharmacist.

Isoniazid may also decrease the effects of the antifungal drug ketoconazole (Nizoral) and the antituberculosis drug rifampin (Rifadin).

Rifampin may make many drugs less effective. Among the drugs that may be affected are diabetes medicines taken by mouth (oral hypoglycemics), digitalis heart drugs, many antifungal drugs, and birth control pills. Because it makes birth control pills less effective, taking rifampin may increase the chance of becoming pregnant. Women who take this medicine along with birth control pills should use an

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additional form of birth control. For a complete list of drugs that may be affected by rifampin, check with a pharmacist.

Using rifabutin with the antiretroviral drug zidovudine (AZT, Retrovir) may make the zidovudine less effective. Consult with a physician if both drugs are prescribed.

Not every drug that may interact with an antituberculosis drug is listed here. Be sure to check with a physician or pharmacist before combining an antituberculosis drug with any other prescription or nonprescription (over-the-counter) medicine.

Resources

PERIODICALS

Arbex MA, Varella MD, Siqueira HR, et al. "Antituberculosis drugs: drug interactions, adverse effects, and use in special situations - part 1: first-line drugs." *J Bras Pneumol* 36, no. 5 (October 2010): 626–640.

Arbex MA, Varella MD, Siqueira HR, et al. "Antituberculosis drugs: drug interactions, adverse effects, and use in special situations - part 2: second-line drugs." *J Bras Pneumol* 36, no. 5 (October 2010): 641–656.

Nancy Ross-Flanigan

Antiulcer drugs

Brand name (generic name)	Possible side effects
Axid (nizatidine)	Diarrhea, headache, nausea and vomiting, sore throat
Carafate (sucralfate)	Constipation, hives, insomnia, upset stomach, vomiting
Cytotec (misoprostol)	Cramps, diarrhea, gas, headache, menstrual disorders (including heavy bleeding), nausea
Pepcid (famotidine)	Constipation or diarrhea, dizziness, fatigue, fever
Prilosec (omeprazole)	Abdominal pain, diarrhea, headache, nausea and vomiting
Tagamet (cimetidine)	Breast development in men, depression and disorientation, headache
Zantac (ranitidine hydrochloride)	Constipation or diarrhea, headache, joint pain

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Antiulcer drugs

Definition

Antiulcer drugs are a class of drugs, exclusive of antibacterial agents, used to treat ulcers in the stomach and the upper part of the small intestine.

Purpose

Recurrent gastric and duodenal ulcers are caused by *Helicobacter pylori* infections, and are treated with combination treatments that incorporate antibiotic therapy with gastric acid suppression. Additionally, bismuth compounds have been used. The primary class of drugs used for gastric acid suppression are the **proton pump inhibitors**, omeprazole, lansoprazole, pantoprazole and rabeprazole. The H-2 receptor blocking agents, cimetidine, famotidine, nizatidine, and ranitidine have been used for this purpose, but are now more widely used for maintenance therapy after treatment with the proton pump inhibitors. Sucralfate, which acts by forming a protective coating over the ulcerate lesion, is also used in ulcer treatment and may be appropriate for patients in whom other classes of drugs are not indicated, or those whose gastric ulcers are caused by **nonsteroidal anti-inflammatory drugs** (NSAIDs) rather than *H. pylori* infections.

Description

The proton pump inhibitors block the secretion of gastric acid by the gastric parietal cells. The extent of inhibition of acid secretion is dose related. In some cases, gastric acid secretion is completely blocked for over 24 hours on a single dose. In addition to their role in treatment of gastric ulcers, the proton pump inhibitors are used to treat syndromes of excessive acid secretion (Zollinger-Ellison Syndrome) and **gastroesophageal reflux disease** (GERD).

Histamine H-2 receptor blockers stop the action of histamine on the gastric parietal cells, inhibiting the secretion of gastric acid. These drugs are less effective than the proton pump inhibitors, but may achieve a 75–79% reduction in acid secretion. Higher rates of acid inhibition may be achieved when the drug is administered by the intravenous route. The H-2 receptor blockers may also be used to treat **heartburn** and hypersecretory syndromes. When given before surgery, the H-2 receptor blockers are useful in prevention of aspiration **pneumonia**.

Sucralfate (Carafate), a substituted sugar molecule with no nutritional value, does not inhibit gastric acid, but rather, reacts with existing stomach acid to form a thick coating that covers the surface of an ulcer,

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KEY TERMS

Antibiotic—Medicine used to treat infections.

Enzyme—A type of protein, produced in the body, that brings about or speeds up chemical reactions.

Gastrointestinal tract—The stomach, small intestine and large intestine.

Hypersecretory—Excessive production of a bodily secretion. The most common hypersecretory syndrome of the stomach is Zollinger-Ellison Syndrome, a syndrome consisting of fulminating intractable peptic ulcers, gastric hypersecretion and hyperacidity, and the occurrence of gastrinomas of the pancreatic cells of the islets of Langerhans.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Mucous—Thick fluid produced by the moist membranes that line many body cavities and structures.

Nonsteroidal anti-inflammatory drug (NSAID)—A type of medicine used to relieve pain, swelling, and other symptoms of inflammation, such as ibuprofen or ketoprofen.

protecting the open area from further damage. A secondary effect is to act as an inhibitor of the digestive enzyme pepsin. Sucralfate does not bind to the normal stomach lining. The drug has been used for prevention of stress ulcers, the type seen in patients exposed to physical stress such as **burns** and surgery. It has no systemic effects.

Recommended dosage

The doses of the proton pump inhibitors and H-2 receptor blockers vary depending on the drug and condition being treated. Consult individual references.

The dose of sucralfate for acute ulcer therapy is 1 gram four times a day. After the ulcer has healed, maintenance treatment may continue at 1 gram two times daily.

Precautions

The proton pump inhibitors are generally well tolerated, and the most common adverse effects are **diarrhea**, **itching**, skin rash, **dizziness** and **headache**. Muscle aches and a higher than normal rate of respiratory infections are among the other adverse reactions reported. Omeprazole has an increased rate of fetal deaths in animal studies. It is not known if these drugs are excreted in human milk, but because of reported adverse effects to infants in animal studies, it is recommended that proton pump inhibitors not be used by nursing mothers.

The H-2 receptor blockers vary widely in their adverse effects. Although they are generally well tolerated, cimetidine may cause confusion in elderly patients, and has an antiandrogenic effect that may cause **sexual dysfunction** in males. Famotidine has been reported to cause headache in 4.7% of patients. It is advisable that mothers not take H-2 receptor blockers while nursing.

Sucralfate is well tolerated. It is poorly absorbed, and its most common side effect is **constipation** in 2% of patients. Diarrhea, **nausea**, **vomiting**, gastric discomfort, **indigestion**, flatulence, **dry mouth**, rash, pruritus (itching), back **pain**, headache, dizziness, sleepiness, and vertigo have been reported, as well as rare allergic responses. Because sucralfate releases small amounts of aluminum into the system, it should be used with caution in patients with renal insufficiency. There is no information available about sucralfate's safety in **breastfeeding**.

Interactions

Proton pump inhibitors may increase the pH of the stomach. This will inactivate some antifungal drugs that require an acid medium for effectiveness, notable itraconazole and ketoconazole.

H-2 receptor blocking agents have a large number of **drug interactions**.

Sucralfate should not be used with aluminum containing **antacids**, because of the risk of increased aluminum absorption. Sucralfate may inhibit absorption and reduce blood levels of anticoagulants, **digoxin**, quinidine, ketoconazole, quinolones and phenytoin.

Resources

OTHER

National Institute of Diabetes and Digestive and Kidney Diseases. http://www.niddk.nih.gov.

Stomach Ulcer (Gastric Ulcer). Fact sheet. Johns Hopkins Health Information Adult Health Advisor. http://csi.intelihealth.com.

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ORGANIZATIONS

Digestive Disease National Coalition, 507 Capitol Court NE, Suite 200, Washington, DC, 20002, (202) 544-7497, (202) 546-7105, ddnc@hmcw.org, http://www.ddnc.org.

National Digestive Diseases Information Clearinghouse (NDDIC), 2 Information Way, Bethesda, MD, 20892-3570, (703) 738-4929, (800) 891-5389, http://digestive.niddk.nih.gov.

Samuel D. Uretsky PharmD

Antiviral drugs

Definition

Antiviral drugs are medicines that cure or control virus infections.

Purpose

Antivirals are used to treat infections caused by viruses. Unlike antibacterial drugs, which may cover a wide range of pathogens, antiviral agents tend to be narrow in spectrum, and have limited efficacy.

Description

Exclusive of the antiretroviral agents used in HIV (**AIDS**) therapy, there are currently only 11 antiviral drugs available, covering four types of virus. Acyclovir (Zovirax), famciclovir (Famvir), and valacyclovir (Valtrex) are effective against herpes virus, including herpes zoster and herpes genitalis. They may also be of value in either conditions caused by herpes, such as **chickenpox** and **shingles**. These drugs are not curative, but may reduce the **pain** of a herpes outbreak and shorten the period of viral shedding.

Amantadine (Symmetrel), oseltamivir (Tamiflu), rimantidine (Flumadine), and zanamivir (Relenza) are useful in treatment of **influenza** virus. Amantadine, rimantadine, and oseltamivir may be administered throughout the flu season as preventatives for patients who cannot take influenza virus vaccine.

Cidofovir (Vistide), foscarnet (Foscavir), and ganciclovir (Cytovene) have been beneficial in treatment of cytomegalovirus in immunosupressed patients, primarily HIV-positive patients and transplant recipients. Ribavirin (Virazole) is used to treat respiratory syncytial virus. In combination with interferons, ribavirin has shown some efficacy against **hepatitis C**, and there have been anecdotal reports of utility against other types of viral infections.

As a class, the antivirals are not curative, and must be used either prophylactically or early in the development of an infection. Their mechanism of action is typically to inactivate the enzymes needed for viral replication. This will reduce the rate of viral growth, but will not inactive the virus already present. Antiviral therapy must normally be initiated within 48 hours of the onset of an infection to provide any benefit. Drugs used for influenza may be used throughout the influenza season in high risk patients, or within 48 hours of exposure to a known carrier. Antiherpetic agents should be used at the first signs of an outbreak. Anti-cytomegaloviral drugs must routinely be used as part of a program of secondary **prophylaxis** (maintenance therapy following an initial response) in order to prevent reinfection in immunocompromised patients.

Recommended dosage

Dosage varies with the drug, patient age and condition, route of administration, and other factors. Specific drug references should be consulted.

Precautions

Ganciclovir is available in intravenous injection, oral capsules, and intraoccular inserts. The capsules should be reserved for prophylactic use in organ transplant patients, or for HIV infected patients who cannot be treated with the intravenous drug. The toxicity profile of this drug when administered systemically includes granulocytopenia, anemia and **thrombocytopenia**. The drug is in **pregnancy** category C, but has caused significant fetal abnormalities in animal studies including **cleft palate** and organ defects. **Breastfeeding** is not recommended.

Cidofovir causes renal toxicity in 53% of patients. Patients should be well hydrated, and renal function should be checked regularly. Other common adverse effects are **nausea and vomiting** in 65% or patients, asthenia in 46% and **headache** and **diarrhea**, both reported in 27% of cases. The drug is category C in pregnancy, due to fetal abnormalities in animal studies. Breast feeding is not recommended.

Foscarnet is used in treatment of immunocompromised patients with cytomegalovirus infections and in acyclovir-resistant herpes simples virus. The primary hazard is renal toxicity. Alterations in electrolyte levels may cause seizures. Foscarnet is category C during pregnancy. The drug has caused skeletal abnormalities in developing fetuses. It is not known

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KEY TERMS

Asthenia—Muscle weakness.

Cytomegalovirus (CMV)—A type of virus that attacks and enlarges certain cells in the body. The virus also causes a disease in infants.

Herpes simplex—A virus that causes sores on the lips (cold sores) or on the genitals (genital herpes).

HIV—Acronym for human immunodeficiency virus, the virus that causes AIDS.

Parkinsonism—A group of conditions that all have these typical symptoms in common: tremor, rigidity, slow movement, and poor balance and coordination.

Pregnancy category—A system of classifying drugs according to their established risks for use during pregnancy. Category A: Controlled human studies have demonstrated no fetal risk. Category B: Animal studies indicate no fetal risk, but no human studies, or adverse effects in animals, but not in well-controlled human studies. Category C: No adequate human or animal studies, or adverse fetal effects in animal studies, but no available human data. Category D: Evidence of fetal risk, but benefits outweigh risks. Category X: Evidence of fetal risk. Risks outweigh any benefits.

Prophylactic—Guarding from or preventing the spread or occurrence of disease or infection.

Retrovirus—A group of viruses that contain RNA and the enzyme reverse transcriptase. Many viruses in this family cause tumors. The virus that causes AIDS is a retrovirus.

Shingles—An disease caused by an infection with the Herpes zoster virus, the same virus that causes chickenpox. Symptoms of shingles include pain and blisters along one nerve, usually on the face, chest, stomach, or back.

Virus—A tiny, disease-causing structure that can reproduce only in living cells and causes a variety of infectious diseases.

whether foscarnet is excreted in breast milk, however the drug does appear in breast milk in animal studies.

Valaciclovir is metabolized to acyclovir, so that the hazards of the two drugs are very similar. They are generally well tolerated, but nausea and headache are common adverse effects. They are both pregnancy category B. Although there have been no reports of fetal abnormalities attributable to either drug, the small number of reported cases makes it impossible to draw conclusions regarding safety in pregnancy. Acyclovir is found in breast milk, but no adverse effects have been reported in the newborn. Famciclovir is similar in actions and adverse effects.

Ribavirin is used by aerosol for treatment of hospitalized infants and young children with severe lower respiratory tract infections due to respiratory syncytial virus (RSV). When administered orally, the drug has been used in adults to treat other viral diseases including acute and chronic hepatitis, herpes genitalis, **measles**, and Lassa **fever**, however there is relatively little information about these uses. In rare cases, initiation of ribavirin therapy has led to deterioration of respiratory function in infants. Careful monitoring is essential for safe use.

The anti-influenza drugs are generally well tolerated. Amantadine, which is also used for treatment of Parkinsonism, may show more frequent CNS effects, including **sedation** and **dizziness**. Rapid discontinuation of amantidine may cause an increase in Parkinsonian symptoms in patients using the drug for that purpose. All are schedule C for pregnancy. In animal studies, they have caused fetal malformations in doses several times higher than the normal human dose. Use caution in breast feeding.

Interactions

Consult your physician or pharmacist for information on **drug interactions**.

Use particular caution in HIV-positive patients, since these patients are commonly on multi-drug regimens with a high frequency of interactions. Ganciclovir should not be used with other drugs which cause hematologic toxicity, and cidofovir should not be used with other drugs that may cause kidney damage.

Resources

PERIODICALS

Antiviral Drugs. Merck Manual Online. http://www.merckmanuals.com/home/index/ind_an.html [accessed November 23, 2010].

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Anxiety

Definition

Anxiety is a multisystem response to a perceived threat or danger. It reflects a combination of biochemical changes in the body, the patient's personal history and memory, and the social situation. It is important to distinguish between anxiety as a feeling or experience, and an anxiety disorder as a psychiatric diagnosis. A person may feel anxious without having an anxiety disorder. In addition, a person facing a clear and present danger or a realistic fear is not usually considered to be in a state of anxiety. Anxiety frequently occurs as a symptom in other categories of psychiatric disturbance.

Description

Although anxiety is a commonplace experience that everyone has from time to time, it is difficult to describe concretely because it has so many different potential causes and degrees of intensity. Doctors sometimes categorize anxiety as an emotion or an affect depending on whether it is being described by the person having it (emotion) or by an outside observer (affect). The word *emotion* is generally used for the biochemical changes and feeling state that underlie a person's internal sense of anxiety. *Affect* is used to describe the person's emotional state from an observer's perspective. If a doctor says that a patient has an anxious affect, he or she means that the patient appears nervous or anxious, or responds to others in an anxious way (for example, the individual is shaky, tremulous, etc.).

Although anxiety is related to fear, it is not the same thing. Fear is a direct, focused response to a specific event or object, and the person is consciously aware of it. Most people will feel fear if someone points a loaded gun at them or if they see a tornado forming on the horizon. They also will recognize that they are afraid. Anxiety, on the other hand, is often unfocused, vague, and hard to pin down to a specific cause. In this form it is called free-floating anxiety. Sometimes anxiety being experienced in the present may stem from an event or person that produced **pain** and fear in the past, but the anxious individual is not consciously aware of the original source of the feeling. It is anxiety's aspect of remoteness that makes it hard for people to compare their experiences of it. Whereas most people will be fearful in physically dangerous situations, and can agree that fear is an appropriate response in the presence of danger, anxiety is often triggered by objects or events that are unique and specific to an individual. An individual might be anxious because of a unique meaning or memory being stimulated by present circumstances, not because of some immediate danger. Another individual looking at the anxious person from the outside may not be aware of the reason for the person's anxiety.

Causes and symptoms

Anxiety can have a number of different causes. It can be a response to stimuli in the person's environment, such as a bridge, or a response to a stimulus within the individual, such as a hypochondriac's reaction to a stomach rumbling.

Physical

In some cases, anxiety is produced by physical responses to **stress**, or by certain disease processes or medications.

THE AUTONOMIC NERVOUS SYSTEM (ANS). The nervous system of human beings is "hard-wired" to respond to dangers or threats. These responses are not subject to conscious control, and are the same in humans as in many lower animals. They represent an evolutionary adaptation to the predators and other dangers with which all animals, including primitive humans, had to cope. The most familiar reaction of this type is often referred to as the "fight-or-flight" response. This response is the human's automatic response in a life-threatening situation. It is a state of physiological and emotional hyperarousal marked by high muscle tension and strong feelings of fear or anger. When a person has a fight-or-flight reaction, the level of stress hormones in the blood rises. He or she becomes more alert and attentive, the eyes dilate, the heartbeat increases, the breathing rate increases, and the digestion slows down, allowing more energy to be available to the muscles.

This emergency reaction is regulated by a part of the nervous system called the autonomic nervous system (ANS). The ANS is controlled by the hypothalamus, a specialized part of the brainstem that is among a group of structures called the limbic system. The limbic system controls human emotions through its connections to glands and muscles; it also connects to the ANS and "higher" brain centers, such as parts of the cerebral cortex. The limbic system cannot tell the difference between a realistic physical threat and an anxiety-producing thought or idea. The hypothalamus may trigger the release of stress hormones by the

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KEY TERMS

Affect—An observed emotional expression or response.

Anxiolytic—A type of medication that helps to relieve anxiety.

Autonomic nervous system (ANS)—The part of the nervous system that supplies nerve endings in the blood vessels, heart, intestines, glands, and smooth muscles, and governs their involuntary functioning. The autonomic nervous system is responsible for the biochemical changes involved in experiences of anxiety.

Endocrine gland—A ductless gland, such as the pituitary, thyroid, or adrenal gland, that secretes its products directly into the blood or lymph.

Free-floating anxiety—Anxiety that lacks a definite focus or content.

Hyperarousal—A state or condition of muscular and emotional tension produced by hormones released during the fight-or-flight response to a stimuli.

Hypothalamus—A portion of the brain that regulates the autonomic nervous system, the release of hormones from the pituitary gland, sleep cycles, and body temperature.

Limbic system—A group of structures in the brain that includes the hypothalamus, amygdala, and hippocampus. The limbic system plays an important part in regulation of human moods and emotions. Many psychiatric disorders are related to malfunctioning of the limbic system.

Phobia—A fear of a specific situation, object, or type of object. Phobias are often considered illogical or irrational, as the situation or object does not pose any significant danger for the individual experiencing the phobia.

pituitary gland, even when there is no objective danger.

A problem may be caused by the biochemical side effects of too many "false alarms" in the ANS. When a person responds to a real danger, his or her body is aided by the stress hormones released. The hormones allow the individual to run faster, or fight harder, than normal. However if the individual does not make use of the stress hormones released, the body has to absorb all the biochemical changes of hyperarousal, rather than release them. These biochemical changes can produce anxious feelings, as well as muscle tension and other physical symptoms associated with anxiety. They may even produce permanent changes in the brain, if the process occurs repeatedly. Some chronic physical disorders, such as **coronary artery disease**, may be worsened by anxiety, as chronic hyperarousal can put stress on the heart, stomach, and other organs.

DISEASES AND DISORDERS. Anxiety can be a symptom of certain medical conditions. Some of these diseases are disorders of the endocrine system, such as **Cushing's syndrome** (overproduction of cortisol by the adrenal cortex), and include over- or underactivity of the thyroid gland. Other medical conditions that can produce anxiety include **respiratory distress syndrome**, **mitral valve prolapse**, porphyria, and chest pain caused by inadequate blood supply to the heart (**angina** pectoris).

MEDICATIONS AND SUBSTANCE USE. Numerous medications may cause anxiety-like symptoms as a side effect. They include birth control pills; some thyroid or **asthma** drugs; some psychotropic agents; occasionally, local anesthetics; **corticosteroids**; **antihypertensive drugs**; and **nonsteroidal anti-inflammatory drugs** (like flurbiprofen and ibuprofen).

Caffeine can cause anxiety-like symptoms when consumed in sufficient quantities. Individuals who consume caffeine rich foods and beverages, such as chocolate, cocoa, coffee, tea, or carbonated soft drinks (especially cola beverages), can sometimes lower their anxiety symptoms simply by reducing their intake of these substances.

Withdrawal from certain prescription drugs, primarily **beta blockers** and corticosteroids, can cause anxiety. Withdrawal from drugs of abuse, including **LSD**, **cocaine**, alcohol, and opiates, can also cause anxiety.

CHILDHOOD DEVELOPMENT AND ANXIETY. Some researchers in early childhood believe that there may be a link between anxiety and childhood memories of dependency. Humans survival during the first years of life depends on the care of others. It is thought that this early experience of helplessness underlies the most common anxieties of adult life, including fear of powerlessness and fear of being unloved. Thus, adults may be made anxious by symbolic threats to their

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sense of competence and/or significant relationships, even though they are no longer helpless children.

SYMBOLIZATION. The psychoanalytic model gives considerable weight to the symbolic aspect of human anxiety; examples include phobic disorders, obsessions, compulsions, and other forms of anxiety that are highly individualized. The length of the human maturation process allows many opportunities for children and adolescents to connect their experiences with certain objects or events that can bring back feelings in later life. For example, a person who was frightened as a child by a tall man wearing glasses may feel panicky years later by something that reminds him of that person or experience without consciously knowing why.

Freud thought that anxiety results from a person's internal conflicts. According to his theory, people feel anxious when they feel torn between desires or urges toward certain actions, on the one hand, and moral restrictions, on the other. In some cases, the person's anxiety may attach itself to an object that represents the inner conflict. For example, someone who feels anxious around money may be pulled between a desire to steal and the belief that stealing is wrong. Money becomes a symbol for the inner conflict between doing what is considered right and doing what one wants.

PHOBIAS. **Phobias** are a type of anxiety reaction in which the person's anxiety is concentrated on a specific object, type of object, or situation. The object or situation causes fear out of proportion to any possible threat that it poses. Prior to the *Diagnostic and Statistical Manual of Mental Disorders,* 4th edition *(DSM-IV),* these specific phobias were called simple phobias. It is estimated that specific phobias affect about 9% of the population. Men and women are believed to be equally likely to develop specific phobias. Some phobias are more common than others. Common phobias include **agoraphobia** (fear of open spaces), claustrophobia (fear of small or confined spaces), and social phobia. Others phobias are less common or may be unique to the individual.

Social and environmental stressors

Anxiety often has a social dimension. People frequently report feelings of high anxiety when they anticipate and, therefore, fear the loss of social approval or love. Social phobia is a specific anxiety disorder that is marked by high levels of anxiety or fear of embarrassment in social situations.

Another social stressor is prejudice. People who belong to groups that are targets of bias are at higher risk for developing **anxiety disorders**. Some experts think, for example, that the higher rates **panic disorder** among women reflects their greater social and economic vulnerability.

Some controversial studies indicate that the increase in violent or upsetting pictures and stories in news reports and entertainment may raise the anxiety level of many people. Stress and anxiety management programs often suggest that patients cut down their exposure to upsetting stimuli.

Anxiety may also be caused by environmental or occupational factors. People who must live or work around sudden or loud noises, bright or flashing lights, chemical vapors, or similar nuisances, which they cannot avoid or control, may develop heightened anxiety levels.

Another factor that shapes human experiences of anxiety is knowledge of personal mortality. Humans are the only animals that appear to be aware of their limited life span. Some researchers think that awareness of **death** influences experiences of anxiety from the time that a person is old enough to understand death.

Symptoms of anxiety

SOMATIC. The somatic or physical symptoms of anxiety include headaches, **dizziness** or lightheadedness, **nausea** and/or **vomiting**, **diarrhea**, **tingling**, pale complexion, sweating, **numbness**, difficulty in breathing, and sensations of tightness in the chest, neck, shoulders, or hands. These symptoms are produced by the hormonal, muscular, and cardiovascular reactions involved in the fight-or-flight reaction. Children and adolescents with **generalized anxiety disorder** show a high percentage of physical complaints.

BEHAVIORAL. Behavioral symptoms of anxiety include pacing, trembling, general restlessness, hyperventilation, pressured speech, hand wringing, and finger tapping.

COGNITIVE. Cognitive symptoms of anxiety include recurrent or obsessive thoughts, feelings of doom, morbid or fear-inducing thoughts or ideas, and confusion, or inability to concentrate.

EMOTIONAL. Feeling states associated with anxiety include tension or nervousness, feeling "hyper" or "keyed up," and feelings of unreality, panic, or terror.

DEFENSE MECHANISMS. When anxiety is untreated, the individual my use, consciously or unconsciously, a number of coping strategies. These psychological defenses include:

- Repression. The person pushes anxious thoughts or ideas out of conscious awareness.
- Displacement. Anxiety from one source is attached to a different object or event. Phobias are an example of the mechanism of displacement in psychoanalytic theory.

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- Rationalization. The person justifies the anxious feelings by saying that any normal person would feel anxious in their situation.
- Somatization. The anxiety emerges in the form of physical complaints and illnesses, such as recurrent headaches, stomach upsets, or muscle and joint pain.
- Delusion formation. The person converts anxious feelings into conspiracy theories or similar ideas without reality testing. Delusion formation can involve groups as well as individuals.

Some instances of alcohol or drug use, abuse, or **addiction** may stem from attempts to self-medicate for anxiety. In these cases treating underlying anxiety along with issues of dependence may help the treatment be successful in the long run.

Diagnosis

The diagnosis of anxiety is difficult and complex because of the variety of its causes and the highly personalized and individualized nature of its symptoms. There are no medical tests that can be used to diagnose anxiety by itself. When a doctor examines an anxious patient, he or she will first rule out physical conditions and diseases that have anxiety as a symptom. Apart from these exclusions, the **physical examination** is usually inconclusive. Some anxious patients may have their blood pressure or pulse rate affected by anxiety, or may look pale or perspire heavily, but others may appear physically completely normal. The doctor will then take the patient's medication, dietary, and occupational history to see if they are taking prescription drugs that might cause anxiety, if they are abusing alcohol or mood-altering drugs, if they are consuming large amounts of caffeine, or if their workplace is noisy or dangerous. In most cases, the most important source of diagnostic information is the patient's psychological and social history. The doctor may administer a brief psychological test to help evaluate the intensity of the patient's anxiety and some of its features. Tests that may be used for this purpose are the Hamilton Anxiety Scale and the Anxiety Disorders Interview Schedule (ADIS). Many doctors will check a number of chemical factors in the blood, such as the level of thyroid hormone and blood sugar.

Treatment

Because anxiety often has more than one cause and is experienced in highly individual ways, individuals may benefit from more than one type of therapy. In addition, there is no way to tell in advance how patients will respond to a specific drug or therapy. Sometimes the doctor will need to try different medications or methods of treatment before finding the best combination for a particular patient. Many treatments for anxiety take time to be fully effective, which may require waiting six or more weeks before determining if another treatment option may be more effective.

Medications

Medications are often prescribed to relieve the physical and psychological symptoms of anxiety. Most agents work by counteracting the biochemical and muscular changes involved in the fight-or-flight reaction. Some work directly on the chemicals in the brain that are thought to underlie the anxiety.

ANXIOLYTICS. Anxiolytics are sometimes called tranquilizers. Most anxiolytic drugs are either **benzodiazepines** or **barbiturates**. Barbiturates, once commonly used, are now rarely used in clinical practice. Barbiturates work by slowing down the transmission of nerve impulses from the brain to other parts of the body. They include such drugs as phenobarbital (Luminal) and pentobarbital (Nembutal). Benzodiazepines work by relaxing the skeletal muscles and calming the limbic system. They include such drugs as chlordiazepoxide (Librium) and diazepam (Valium). Both barbiturates and benzodiazepines are potentially habit-forming and may cause withdrawal symptoms when stopped, but benzodiazepines are less likely than barbiturates to cause physical dependency. Both drugs also increase the effects of alcohol.

Two other types of anxiolytic medications include meprobamate (Equanil), which is now rarely used, and buspirone (BuSpar), a type of anxiolytic that works by increasing the efficiency of the body's own emotion-regulating brain chemicals. Buspirone has several advantages over other anxiolytics. It does not cause dependence problems, does not interact with alcohol, and does not affect the patient's ability to drive or operate machinery. However, buspirone is not effective against certain types of anxiety, such as panic disorder.

ANTIDEPRESSANTS AND BETA BLOCKERS. For some anxiety disorders, such as **obsessive-compulsive disorder** and panic type anxiety, a type of drugs used to treat depression, **selective serotonin reuptake inhibitors** (SSRIs; such as Prozac and Paxil), are the treatment of choice. A newer drug that has been shown as effective as Paxil is called escitalopram oxalate (Lexapro). Because anxiety often coexists with symptoms of depression, many doctors prescribe antidepressant medications for patients with anxiety to help treat both problems. While SSRIs are more common, antidepressants are sometimes prescribed, including **tricyclic antidepressants** such as imipramine (Tofranil) or

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monoamine oxidase inhibitors (MAO inhibitors) such as phenelzine (Nardil).

Beta blockers are medications that work by blocking the body's reaction to the stress hormones that are released during the fight-or-flight reaction. They include drugs like propranolol (Inderal) or atenolol (Tenormin). Beta blockers are sometimes given to patients with post-traumatic anxiety symptoms. More commonly, the beta blockers are given to patients with a mild form of social phobic anxiety, such as fear of public speaking.

Psychotherapy

Most patients with anxiety are treated using some form of **psychotherapy** along with medications. Two approaches that may work well for anxious patients are **cognitive-behavioral therapy** (CBT), and relaxation training. In CBT, the patient is taught to identify the thoughts and situations that stimulate his or her anxiety, and works with the therapist to develop strategies for overcoming his or her anxiety. In the behavioral part of the program, the patient is exposed to the anxiety-provoking object, situation, or internal stimulus (like a rapid heart beat) in gradual stages until he or she is desensitized to it. Relaxation training, which is sometimes called anxiety management training, includes breathing exercises and similar techniques intended to help the patient prevent hyperventilation and relieve the muscle tension associated with the fight-or-flight reaction. Both CBT and relaxation training can be used in **group therapy** as well as individual treatment. In addition to CBT, support groups are often helpful to anxious patients, because they provide a social network and can help lessen the embarrassment that often accompanies anxiety symptoms.

Psychosurgery

Surgery on the brain is very rarely recommended for patients with anxiety; however, some patients with severe cases of obsessive-compulsive disorder (OCD) have been helped by an operation on a part of the brain that is involved in OCD. Normally, this operation is attempted after all other treatments have failed, and the OCD is severe enough to prevent normal functioning.

Alternative treatment

Alternative treatments for anxiety cover a variety of approaches. **Meditation** and mindfulness training are thought beneficial to patients with phobias and panic disorder. **Hydrotherapy** is useful to some anxious patients because it promotes general relaxation of the nervous system. **Yoga**, aikido, t'ai chi, and dance therapy help patients work with the physical, as well as the emotional, tensions that either promote anxiety or are created by the anxiety.

Homeopathy and **traditional Chinese medicine** approach anxiety as a symptom of a systemic disorder. Homeopathic practitioners select a remedy based on other associated symptoms and the patient's general constitution. Chinese medicine regards anxiety as a blockage of *qi*, or vital force, inside the patient's body that is most likely to affect the lung and large intestine meridian flow. The practitioner of Chinese medicine chooses **acupuncture** point locations and/or herbal therapy to move the *qi* and rebalance the entire system in relation to the lung and large intestine.

Prognosis

The prognosis for resolution of anxiety depends on the specific disorder and a wide variety of factors, including the patient's age, sex, general health, living situation, belief system, social support network, and responses to different medications and forms of therapy.

Prevention

Because it is possible for individuals to exercise significant control over their thoughts, it may be possible for an individual to learn ways of preventing anxiety by changing though patterns. Individuals may also be able to exercise some control over anxiety arising from social and environmental conditions. Feelings of anxiousness arising occasionally from situations generally expected to cause anxiety generally cannot, and do not need to be, prevented.

Resources

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ORGANIZATIONS

Anxiety Disorders Association of America, 8730 Georgia Ave., Suite 600, Silver Spring, MD, 20910, (240) 485-1001.

American Psychiatric Association, 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209, (703) 907-7300.

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Anxiety disorders

Definition

Anxiety disorders are a group of mental disturbances characterized by anxiety as a central or core symptom. Although anxiety is a commonplace experience, not everyone who experiences it has an anxiety disorder. Anxiety is associated with a wide range of physical illnesses, medication side effects, and other psychiatric disorders.

The revisions of the *Diagnostic and Statistical Manual of Mental Disorders (DSM)* that took place after 1980 brought major changes in the classification of the anxiety disorders. Prior to 1980, psychiatrists classified patients on the basis of a theory that defined anxiety as the outcome of unconscious conflicts in the patient's mind. *DSM-III* (1980), *DSM-III-R* (1987), and *DSM-IV* (1994) introduced and refined a new classification that considered recent discoveries about the biochemical and post-traumatic origins of some types of anxiety. The present definitions are based on the external and reported symptom patterns of the disorders rather than on theories about their origins.

Demographics

The anxiety disorders vary widely in their frequency of occurrence in the general population, age of onset, family patterns, and gender distribution. The **stress** disorders and anxiety disorders caused by medical conditions or **substance abuse** are less age- and gender-specific. Whereas **obsessive-compulsive disorder** (OCD) affects males and females equally, **generalized anxiety disorder** (GAD), **panic disorder**, and specific **phobias** all affect women more frequently than men. GAD and panic disorders are more likely to develop in young adults, while phobias and OCD often begin in childhood.

Anxiety disorders in children and adolescents

DSM-IV defines one anxiety disorder as specific to children, namely, separation anxiety disorder. This disorder is defined as anxiety regarding separation from home or family that is excessive or inappropriate for the child's age. In some children, separation anxiety takes the form of school avoidance.

Children and adolescents can also be diagnosed with panic disorder, phobias, generalized anxiety disorder, and the post-traumatic stress syndromes.

Description

Anxiety disorders are the most common form of mental disturbance in the United States population. According to the Anxiety Disorders Association of America, as many as 40 million American adults are affected by anxiety disorders. These disorders are a serious problem for society because they can interfere with work, schooling, and family life. They also contribute to the high rates of alcohol and substance abuse in the United States. Anxiety disorders are an additional problem for health professionals because the physical symptoms of anxiety frequently bring people to primary care doctors or emergency rooms.

DSM-IV defines 12 types of anxiety disorders in the adult population. They can be grouped under seven headings:

- Panic disorders with or without agoraphobia. The chief characteristic of panic disorder is the occurrence of panic attacks coupled with fear of their recurrence. In clinical settings, agoraphobia is usually not a disorder by itself, but is typically associated with some form of panic disorder. Patients with agoraphobia are afraid of places or situations in which they might have a panic attack and be unable to leave or to find help. Panic disorder affects approximately 2.7% of adults.
- Phobias. These include specific phobias and social phobia. A phobia is an intense irrational fear of a specific object or situation that compels the individual to avoid it. Some phobias concern activities or objects that involve some risk (for example, flying or driving) but many are focused on harmless animals or other objects. Social phobia involves a fear of being humiliated, judged, or scrutinized. It manifests itself as a fear of performing certain functions in the presence of others, such as public speaking or using public lavatories.
- Obsessive-compulsive disorder (OCD). This disorder is marked by unwanted, intrusive, persistent thoughts or repetitive behaviors that reflect the patient's anxiety or attempts to control it. It affects about 1% of the population. About 6% of individuals who have OCD also have panic disorders.
- Stress disorders. These include post-traumatic stress disorder (PTSD) and acute stress disorder. Stress disorders are symptomatic reactions to traumatic events in the patient's life.
- Generalized anxiety disorder (GAD). GAD is the most commonly diagnosed anxiety disorder and occurs most frequently in young adults.
- Anxiety disorders due to known physical causes. These include general medical conditions or substance abuse.

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KEY TERMS

Agoraphobia—Abnormal anxiety regarding public places or situations from which the patient may wish to flee or in which he or she would be helpless in the event of a panic attack.

Compulsion—A repetitive or ritualistic behavior that a person performs to reduce anxiety. Compulsions often develop as a way of controlling or undoing obsessive thoughts.

Obsession—A repetitive or persistent thought, idea, or impulse that is perceived as inappropriate and distressing.

Panic attack—A time-limited period of intense fear accompanied by physical and cognitive symptoms. Panic attacks may be unexpected or triggered by specific internal or external cues.

- Anxiety disorder not otherwise specified. This last category is not a separate type of disorder, but is included to cover symptoms that do not meet the specific *DSM-IV* criteria for other anxiety disorders.

All *DSM-IV* anxiety disorder diagnoses include a criterion of severity. The anxiety must be severe enough to interfere significantly with the patient's occupational or educational functioning, social activities or close relationships, and other customary activities.

Causes and symptoms

The causes of anxiety include a variety of individual and general social factors, and may produce physical, cognitive, emotional, or behavioral symptoms. The patient's ethnic or cultural background may also influence his or her vulnerability to certain forms of anxiety. Genetic factors that lead to biochemical abnormalities may also play a role.

Anxiety in children may be caused by suffering from abuse, as well as by the factors that cause anxiety in adults.

Diagnosis

The diagnosis of anxiety disorders is complicated by the variety of causes of anxiety and the range of disorders that may include anxiety as a symptom. Many patients who have anxiety disorders have features or symptoms of more than one disorder. Patients whose anxiety is accounted for by another psychic disorder, such as **schizophrenia** or major depression, are not diagnosed with an anxiety disorder.

Examination

A doctor examining an anxious patient will usually begin by ruling out diseases that are known to cause anxiety and then proceed to take the patient's medication history, in order to exclude side effects of prescription drugs. Most doctors ask about **caffeine** consumption to see if the patient's dietary habits are a factor. The patient's work and family situation will also be discussed. Often, primary care physicians exhaust resources looking for medical causes for general patient complaints, which may indicate a physical illness. The Anxiety Disorders Association of American has published guidelines to aid physicians in diagnosing and managing generalized anxiety disorder.

Tests

There are no laboratory tests that can diagnose anxiety, although the doctor may order some specific tests to rule out diseases and conditions, such as laboratory tests for blood sugar and thyroid function. Although there is no psychiatric test that can provide definite diagnoses of anxiety disorders, there are several short-answer interviews or symptom inventories that doctors can use to evaluate the intensity of a patient's anxiety and some of its associated features. These measures include the Hamilton Anxiety Scale and the Anxiety Disorders Interview Schedule (ADIS).

Treatment

Traditional

For relatively mild anxiety disorders, **psychotherapy** alone may be sufficient. In general, doctors prefer to use a combination of medications and psychotherapy with more severely anxious patients. Most patients respond better to a combination of treatment methods than to either medications or psychotherapy in isolation.

Drugs

Because of the variety of medications and treatment approaches that are used to treat anxiety disorders, the doctor cannot predict in advance which combination will be most helpful to a specific patient. In many cases the doctor will need to try a new medication or treatment over a six- to eight-week period in order to assess its effectiveness. Trying a few different treatment options does not necessarily mean that the patient cannot be helped or that the doctor is incompetent.

Although anxiety disorders are not always easy to diagnose, there are several reasons why it is important for patients with severe anxiety symptoms to get help. Anxiety does not always go away by itself; it often

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progresses to panic attacks, phobias, and episodes of depression. Untreated anxiety disorders may eventually lead to a diagnosis of major depression, or interfere with the patient's education or ability to keep a job. In addition, many anxious patients develop addictions to drugs or alcohol when they try to "medicate" their symptoms. Moreover, since children learn ways of coping with anxiety from their parents, adults who get help for anxiety disorders are in a better position to help their families cope with factors that lead to anxiety than those who remain untreated.

Alternative

Alternative treatments for anxiety cover a variety of approaches. **Meditation** and mindfulness training are thought beneficial to patients with phobias and panic disorder. **Hydrotherapy** is useful to some anxious patients because it promotes general relaxation of the nervous system. **Yoga**, aikido, t'ai chi, and dance therapy help patients work with the physical, as well as the emotional, tensions that either promote anxiety or are created by the anxiety.

Homeopathy and **traditional Chinese medicine** approach anxiety as a symptom of a systemic disorder. Homeopathic practitioners select a remedy based on other associated symptoms and the patient's general constitution. Chinese medicine regards anxiety as a blockage of *qi*, or vital force, inside the patient's body that is most likely to affect the lung and large intestine meridian flow. The practitioner of Chinese medicine chooses **acupuncture** point locations and/or herbal therapy to move the *qi* and rebalance the entire system in relation to the lung and large intestine.

Prognosis

The prognosis for recovery depends on the specific disorder, the severity of the patient's symptoms, the specific causes of the anxiety, and the patient's degree of control over these causes.

Prevention

Anxiety is an unavoidable feature of human existence. However, humans have some power over their reactions to anxiety-provoking events and situations. Cognitive therapy and meditation or mindfulness training appear to be beneficial in helping people lower their long-term anxiety levels.

Resources

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ORGANIZATIONS

American Psychiatric Association, 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209 (703) 907-7300, apa@psych.org, http://www.psych.org.

Anxiety Disorders Association of America, 8730 Georgia Ave., Suite 600, Silver Spring, MD, 20910 (240) 485-1001, http://www.adaa.org.

National Alliance on Mental Illness (NAMI), Colonial Place Three, 2107 Wilson Blvd., Suite 300, Arlington, VA, 22201 (703) 524-7600 (800) 950-NAMI (6264) (703) 524-9094, http://www.nami.org.

National Institute of Mental Health (NIMH), 6001 Executive Boulevard, Room 8184, MSC 9663, Bethesda, MD, 20892 (301) 443-4513 (866) 615-6464 (301) 443-4279, nimhinfo@nih.gov, http://www.nimh.nih.gov.

National Mental Health Association (NMHA), 2000 N. Beauregard Street, 6th Floor, Alexandria, VA, 22311 (703) 684-7722 (800) 969-NMHA (703) 684-5968, http://www1.nmha.org.

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Anxiolytics *see* **Antianxiety drugs**

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Aortic aneurysm

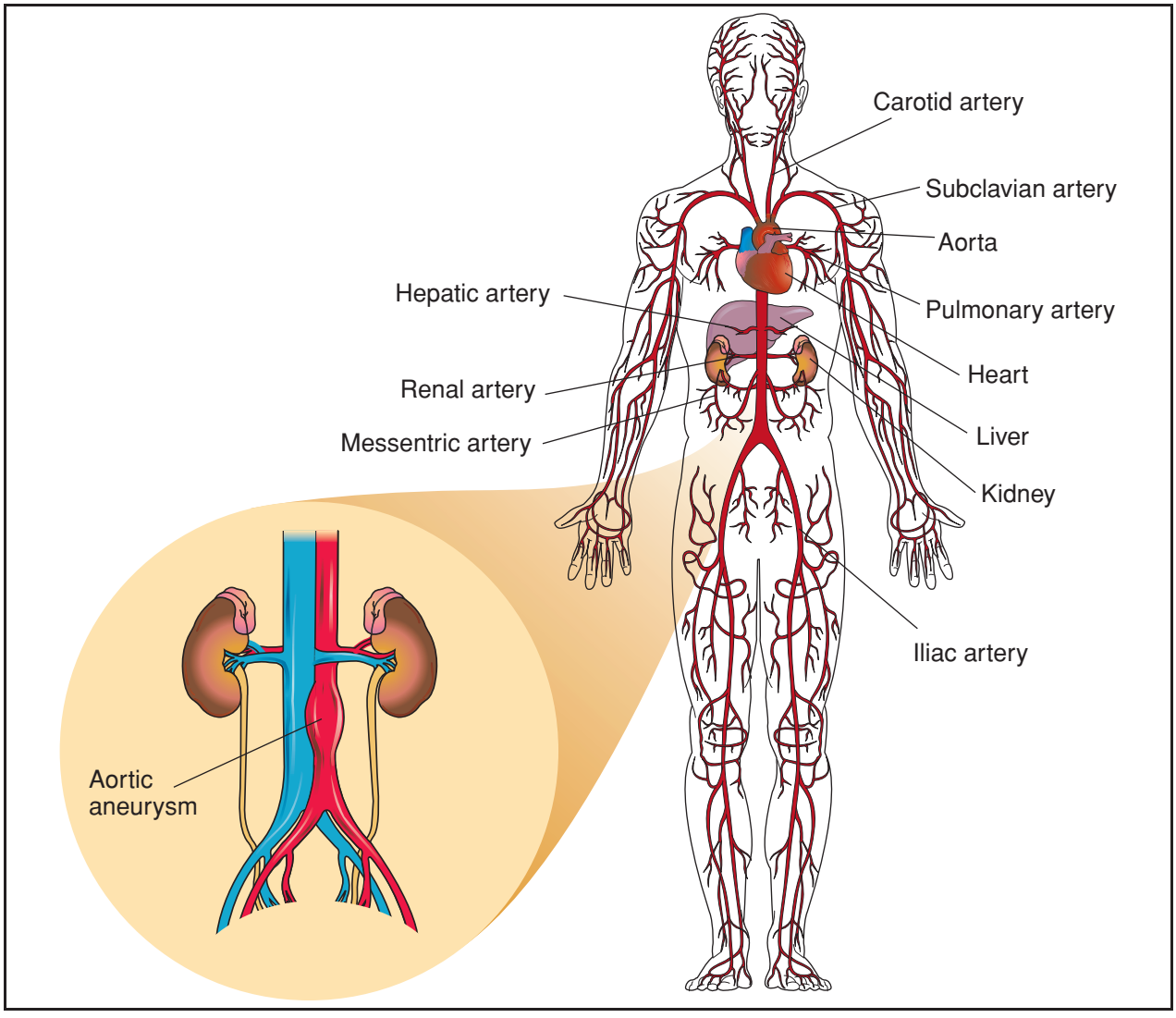
Definition

An aneurysm is an abnormal bulging or swelling of a portion of a blood vessel. The aorta, which can develop these abnormal bulges, is the large blood vessel that carries oxygen-rich blood away from the heart to the rest of the body.

Description

The aorta carries oxygen-rich blood to the body, and is therefore called an artery. Because the aorta is an artery, its walls are made of up three layers; a thin inner layer, a muscular middle layer (that gives the vessel its flexibility under pressure from the filling blood), and a fiber-like outer layer that gives the vessel strength to not burst when the heart pumps blood to the body.

Aortic aneurysms occur when a weakness develops in part of the wall of the aorta; three basic types are usually found. If all three layers of the vessel are affected and weakness develops along an extended area of the vessel, the weakened area will appear as a large, bulging region of blood vessel; this is called a fusiform aneurysm. If weakness develops between the inner and outer layers of the aortic wall, a bulge results



Aortic aneurysms occur when a weakness develops in a part of the wall of the aorta. The aorta is the large blood vessel that carries oxygen-rich blood away from the heart to the rest of the body. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

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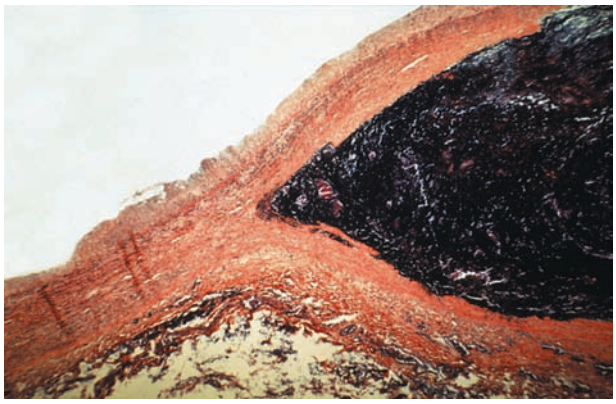
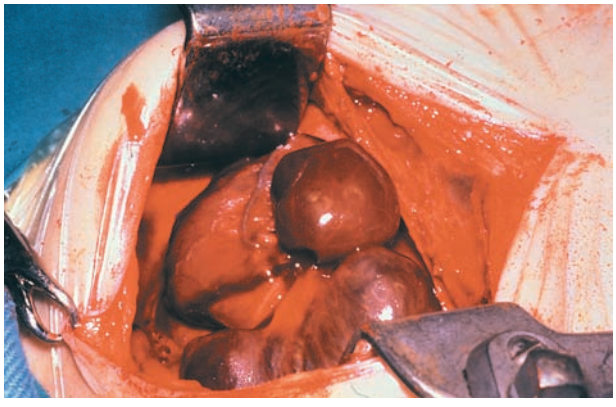


An aneurysm in progress. An aneurysm is an abnormal bulging or swelling of a portion of a blood vessel. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*



Surgery being performed to correct aortic aneurysm. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

as blood from the interior of the vessel is pushed around the damaged region in the wall and collects between these layers. This is called a dissecting aneurysm because one layer is "dissected" or separated from another. If damage occurs to only the middle (muscular) layer of the vessel, a sack-like bulge can form; therefore, this is a saccular aneurysm.

Causes and symptoms

Aortic aneurysms occur in different portions of the aorta, which begins in the chest (at the heart) and travels downward through the abdomen. Aneurysms found in the region of the aorta within the chest are called thoracic aortic aneurysms. Aneurysms that occur in the part of the aorta within the abdomen are called abdominal aortic aneurysms.

Thoracic aortic aneurysms do not usually produce any noticeable symptoms. However, as the aneurysm becomes larger, chest, shoulder, neck, lower back, or abdominal **pain** can result. Abdominal aortic aneurysms occur more often in men, and these aneurysms can cause pain in the lower back, hips, and abdomen. A painful abdominal aortic aneurysm usually means that the aneurysm could burst very soon.

KEY TERMS

Atherosclerosis—The accumulation of fat on the inner wall of an artery. This fat is largely made up of cholesterol being carried in the blood.

Dacron—A synthetic polyester fiber used to surgically repair damaged sections of blood vessel walls.

Most abdominal aortic aneurysms are caused by **atherosclerosis**, a condition caused when fat (mostly cholesterol) carried in the blood builds up in the inner wall of the aorta. As more and more fat attaches to the aortic wall, the wall itself becomes abnormally weak and often results in an aneurysm or bulge.

Aortic aneurysms are also caused by a breakdown of the muscular middle layer of the artery wall, by high blood pressure, by direct injury to the chest, and although rare, by bacteria that can infect the aorta.

Diagnosis

Silent, stable aneurysms are often detected when a person has an x ray as part of a routine examination or for other medical reasons. Otherwise, when chest, abdominal, or back pain is severe, aortic aneurysm is suspected and x-ray (radiographic) studies can confirm or rule out that condition.

Treatment

Aortic aneurysms are potentially life-threatening conditions. Small aneurysms should be monitored for their rate of growth and large aneurysms require consideration for a surgical repair. The most common method of surgical repair is to cut out the bulging section of artery wall and sew a Dacron fiber material into its place in the vessel wall.

Prognosis

Only 1-2% of people die from having surgical repair of an aortic aneurysm. However, if the

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aneurysm is untreated and eventually ruptures, less than half of the people with ruptured aneurysms will survive. The challenge for the physician is to decide when or if to do the preventive surgery.

Prevention

Aneuryms can develop in people with atherosclerosis. High blood pressure can also lead to this condition. Although no definite prevention exists, lifestyle and dietary changes that help lower blood pressure and the amount of fat in the blood stream may slow the development of aneurysms.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www. nhlbi.nih.gov.

Dominic De Bellis PhD

Aortic dissection

Definition

Aortic dissection is a rare, but potentially fatal, condition in which blood passes through the inner lining and between the layers of the aorta. The dissecting aorta usually does not burst, but has an abnormal second channel within it.

Description

A defect in the inner lining of the aorta allows an opening or tear to develop. The aorta is the main artery of the body and is an area of high blood pressure. When a defect develops, blood pressure can force the tear to open and allow blood to pass through. Since the blood is under pressure, it eventually splits (dissecting) the middle layer of the blood vessel, creating a new channel for blood. The length of the channel grows over time and can result in the closing off of connection points to other arteries. This can lead to **heart attack**, strokes, abdominal **pain**, and nerve damage. Blood may leak from the dissection and collect in the chest an around the heart.

A second mechanism leading to aortic dissection is medial hemorrhage. A medial hemorrhage occurs in the middle layer of the blood vessel and spills through the inner lining of the aorta wall. This opening then allows blood from the aorta to enter the vessel wall and begin a dissection. Approximately 2,000 cases of aortic dissection occur yearly in the United States.

KEY TERMS

Dissection—A cut or divide.

Hemorrhage—A large discharge of blood, profuse bleeding.

Causes and symptoms

Aortic dissection is caused by a deterioration of the inner lining of the aorta. There are a number of conditions that predispose a person to develop defects of the inner lining, including high blood pressure, Marfan's disease, **Ehlers-Danlos syndrome**, connective tissue diseases, and defects of heart development which begin during fetal development. A dissection can also occur accidentally following insertion of a catheter, trauma, or surgery. The main symptom is sudden, intense pain. The pain can be so intense as to immobilize the patient and cause him to fall to the ground. The pain is frequently felt in both the chest and in the back, between the shoulder blades. The extent of the pain is proportional to the length of the dissection.

Diagnosis

The pain experienced by the patient is the first symptom of aortic dissection and is unique. The pain is usually described by the patient as "tearing, ripping, or stabbing." This is in contrast to the pain associated with heart attacks. The patient frequently has a reduced or absent pulse in the extremities. A murmur may be heard if the dissection is close to the heart. An enlarged aorta will usually appear in the chest x rays and ultrasound exams of most patients. The use of a blood dye in angiograms and/or CT scans (**computed tomography scans**) will aid in diagnosing and visualizing the dissection.

Treatment

Because of the potentially fatal nature of aortic dissection, patients are treated immediately. Drugs are administered to reduce the blood pressure and heart rate. If the dissection is small, drug therapy alone may be used. In other cases, surgery is performed. In surgery, damaged sections of the aorta are removed and a synthetic graft is often used to reconstruct the damaged vessel.

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Prognosis

Depending on the nature and extent of the dissection, **death** can occur within a few hours of the start of a dissection. Approximately 75% of untreated people die within two weeks of the start of a dissection. Of those who are treated, 40% survive more than 10 years. Patients are usually given long-term treatment with drugs to reduce their blood pressure, even if they have had surgery.

Resources

BOOKS

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John T. Lohr PhD

Aortic incompetence *see* **Aortic valve insufficiency**

Aortic regurgitation *see* **Aortic valve insufficiency**

Aortic stenosis *see* **Aortic valve stenosis**

Aortic valve insufficiency

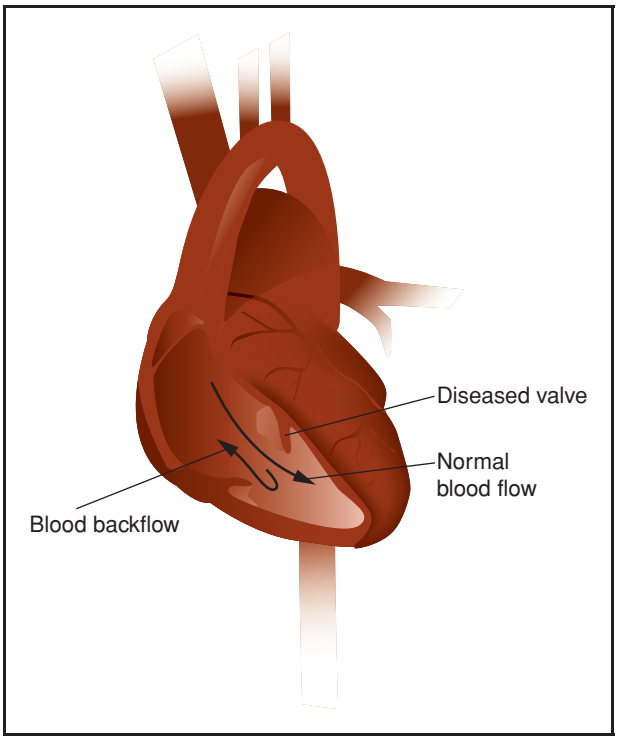
Definition

The aortic valve separates the left ventricle of the heart (the heart's largest pumping chamber) from the aorta, the large artery that carries oxygen-rich blood out of the left ventricle to the rest of the body. In aortic valve insufficiency, the aortic valve becomes leaky, causing blood to flow backwards into the left ventricle.

Description

Aortic valve insufficiency occurs when this valve cannot properly close after blood that is leaving the heart's left ventricle enters the aorta. With each contraction of the heart more and more blood flows back into the left ventricle, causing the ventricle to become overfilled. This larger-than-normal amount of blood that collects in the left ventricle puts pressure on the walls of the heart, causing the heart muscle to increase in thickness (hypertrophy). If this thickening continues, the heart can be permanently damaged.

Aortic valve insufficiency is also know as aortic valve regurgitation because of the abnormal reversed flow of blood leaking through the poorly functioning valve.



A human heart with a diseased valve that doesn't open and close properly, allowing blood to backflow to the heart. *(Illustration by Argosy, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

Causes and symptoms

The faulty working of the aortic valve can be caused by a birth defect; by abnormal widening of the aorta (which can be caused by very high blood pressure and a variety of other less common conditions); by various diseases that cause large amounts of swelling (inflammation) in different areas of the body, like **rheumatic fever**; and, although rarely, by the sexually transmitted disease, **syphilis**.

About 75% of people with aortic valve insufficiency are men. Rheumatic (inflammatory) diseases have been the main cause of this condition in both men and women.

Aortic valve insufficiency can remain unnoticed for 10 to 15 years. In cases of severe insufficiency a person may notice a variety of symptoms, including an uncomfortable pounding of the heart when lying down, a very rapid or hard heart beat (**palpitations**), **shortness of breath**, chest **pain**, and if untreated for very long times, swelling of the liver, ankles, and belly.

Diagnosis

A poorly functioning or insufficient aortic valve can be identified when a doctor listens to the heart during a

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KEY TERMS

Rheumatic fever—A disease believed to be caused by a bacterium named group A streptococcus. This bacterium causes a sore "strep throat" and can also result in fever. Infection by this bacterium can also damage the heart and its valves, but how this takes place is not clearly understood.

physical examination. A **chest x ray**, an electrocardiogram (ECG, an electrical printout of the heart beats), as well as an echocardiogram (a test that uses sound waves to create an image of the heart and its valves), can further evaluate or confirm the condition.

Treatment

Aortic insufficiency is usually corrected by having the defective valve surgically replaced. However, such an operation is done in severe cases. Before the condition worsens, certain drugs can be used to help manage this condition.

Drugs that remove water from the body, drugs that lower blood pressure, and drugs that help the heart beat more effectively can each be used for this condition. Reducing the amount of salt in the diet also helps lower the amount of fluid the body holds and can help the heart to work more efficiently as well.

In cases of a severely malfunctioning valve that has been untreated for a long time, surgery is the treatment of choice, especially if the heart is not functioning normally. Human heart valves can be replaced with man-made valves or with valves taken from pig hearts.

Prognosis

Although drug treatment can help put off the need for surgical valve replacement, it is important to replace the faulty valve before the heart muscle itself is damaged beyond recovery.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

Dominic De Bellis PhD

Aortic valve replacement

Definition

Aortic valve replacement is the insertion of a mechanical or tissue valve in place of the diseased biological aortic valve.

Purpose

Aortic valve replacement is necessary when the aortic valve has become diseased. The aortic valve can suffer from insufficiency (inability to perform adequately) or stenosis (narrowing). An insufficient valve is leaky and allows blood to flow backward from the aorta to the left ventricle during diastole, which occurs when the ventricles fill with blood. A stenotic valve prevents the forward-moving flow of blood from the left ventricle to the aorta, during systole, which is the time period when the heart is contracting.

Either situation can result in **heart failure** and an enlarged left ventricle. With aortic stenosis, the symptoms of **angina** pectoris, **fainting**, and congestive heart failure will develop with the severity of the narrowing. There is an increased rate of sudden **death** of patients with aortic stenosis. Dyspnea (labored breathing), **fatigue**, and **palpitations** are late symptoms of aortic insufficiency. Angina pectoris is associated with the latest stages of aortic insufficiency.

Demographics

Congenital **birth defects** involving a bicuspid aortic valve can develop stenosis. These patients may become symptomatic in mid-teen years through age 65. Patients with a history of **rheumatic fever** have a disposition for aortic stenosis, but may live symptom free for more than four decades. Calcification of the aortic valve tends to effect an older population with 30% of patients over age 85 having stenosis at **autopsy**.

Patients with aortic stenosis who have angina, dyspnea, or fainting are candidates for aortic valve replacement. Asymptomatic patients undergoing coronary artery bypass grafting should be treated with aortic valve replacement, but otherwise are not candidates for preventive aortic valve replacement.

Patients with a history of rheumatic fever or syphilitic aortitis (inflammation of the aorta) face the possibility of developing aortic insufficiency. Successful treatment has decreased this causative relationship. Primary causes of aortic valve disease include bacterial

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KEY TERMS

Antithrombic—Preventing clot formation.

Biological tissue valve—A replacement heart valve that is harvested from the patient (autograft), a human cadaver (homograft or allograft), or other animal, such as a pig (heterograft).

Diastole—Period between contractions of the heart.

Hemolysis—Separation of hemoglobin from the red blood cells.

Mechanical valve—An artificial device used to replace the patient's heart valve. They include three types: ball valve, disk valve, and bileaflet valve.

Systole—Period while the heart is contracting.

endocarditis, trauma, **aortic dissection**, and congenital diseases.

Patients showing acute symptoms, including **pulmonary edema**, heart rhythm problems, or circulatory collapse, are candidates for aortic valve replacement. Chronic pathologies are recommended for surgery when patients appear symptomatic, demonstrating angina and dyspnea. Asymptomatic patients also must be monitored for heart dysfunction. Left ventricular dimensions greater than 2 in (50 mm) at diastole or 3 in (70 mm) at systole are indications for replacement when aortic insufficiency is diagnosed.

Description

While receiving **general anesthesia** in preparation for the surgery, the patient's cardiac function will be monitored. A sternotomy (incision into the sternum) or thoracotomy may be used to expose the heart, with the thoracotomy providing a smaller incision through the ribs. Minimally invasive techniques may also be used, utilizing a partial sternotomy or a lateral minithoracotomy. These approaches seem to decrease patient recovery time, as well as decreasing potential complications. Anticoagulant is administered in preparation for cardiopulmonary bypass. Cardiopulmonary bypass is instituted by exposing and cannulating (putting tubes into) the great blood vessels of the heart, or by cannulating the femoral artery and vein. A combination of cannulation sites may also be used. The heart is stopped after the aorta is clamped. The base of the aorta root is opened, and the diseased valve is removed. Sutures are placed in the aortic rim and into the replacement valve. The replacement valve can be either mechanical or biological tissue. The replacement valve will be sized prior to implant to ensure that it fits the patient based on the size of the aortic valve annulus. Once seated, the valve is secured by tying the individual sutures. The heart is then deaired. The cross clamp is removed and the heart is allowed to beat as deairing continues by manipulation of the left ventricle. Cardiopulmonary bypass is terminated, the tubes are removed, and drugs to reverse anticoagulation are administered.

A heart valve prevents the flow of blood backward during heartbeats. Replacement heart valves can be mechanical or biological tissue valves. For patients younger than 65 years of age, the mechanical valve offers superior longevity. Anticoagulant medication is required for the life of the patient implanted with a mechanical valve. The biological tissue valve does not require anticoagulation but suffers from deterioration, leading to reoperation, particularly in those under age 50. Women considering bearing children should be treated with biological tissue valves because the anticoagulant of choice with mechanical valves, warfarin, is associated with developmental effects in the fetus. **Aspirin** can be substituted in certain circumstances.

Diagnosis/Preparation

Initial diagnosis by auscultation (listening) is done with a stethoscope. Additional procedures associated with diagnosis to judge severity of the lesion include **chest x ray**, **echocardiography**, and **angiography** with **cardiac catheterization**. In the absence of angiography, **magnetic resonance imaging** (MRI) or computed tomographic (CT) imaging may be used.

Aftercare

The patient will have continuous cardiac monitoring performed in the intensive care unit (ICU) postoperatively. Medications or mechanical circulatory assist may be instituted during the surgery or postoperatively to help the heart provide the necessary cardiac output to sustain the pulmonary and systemic circulations. These will be discontinued as cardiac function improves. As the patient is able to breathe without assistance, ventilatory support will be discontinued. Drainage tubes allow blood to be collected from the chest cavity during healing and are removed as blood flow decreases. Prophylactic **antibiotics** are given. Anticoagulation (warfarin, aspirin, or a combination) therapy is instituted and continued for patients who have received a mechanical valve. The ICU stay is approximately three days with a final

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hospital discharge occurring within a week after the procedure.

The patient receive wound care instructions prior to leaving the hospital. The instructions include how to recognize such adverse conditions as infection or valve malfunction, contact information for the surgeon, and guidelines on when to return to the emergency room.

Risks

There are unassociated risks with general anesthetic and cardiopulmonary bypass. Risks associated with aortic valve replacement include **embolism**, bleeding, and operative valvular endocarditis. Hemolysis is associated with certain types of mechanical valves, but is not a contraindication for implantation.

Normal results

Myocardial function typically improves rapidly, with decrease in left ventricle enlargement and size of the inner chamber over several months, allowing the heart to return to normal dimensions. Anticoagulation therapy will be continued, depending on the type of mechanical valve implanted. Implantation of biological tissue valves are associated with the formation of **blood clots**. If non-cardiac surgery or dental care is needed, the anticoagulant medication will be adjusted to prevent bleeding complications.

Morbidity and mortality rates

There is a 3–5% hospital mortality associated with aortic valve replacement. The average survival rate after five years is 85% for patients suffering from aortic stenosis who undergo aortic valve replacement. Structural valve deterioration can occur and is higher in mechanical valves during the first five years; however, biological tissue and mechanical valves have the same failure incidence at 10 years, with a 60% probability of death at 11 years as a result of valve-related complications. Patients with a mechanical valve are more likely to experience bleeding complications. Reoperation is more likely for patients treated with a biological tissue valve, but not significantly different when compared to their mechanical valve counterparts. This combines to an average rate of significant complications of 2–3% per year, with death rate of approximately 1% per year associated directly with the prosthesis.

Alternatives

Balloon valvotomy may provide short-term relief of aortic stenosis, but is considered a temporary treatment until valve replacement can be accomplished. Aortic valve repair by direct commissurotomy may also be successful for some cases of aortic stenosis. Medical treatment for inoperable patients with severe aortic stenosis is used to relieve pulmonary congestion and prevent **atrial fibrillation**.

Severe aortic insufficiency can be treated with medical therapy. Pharmaceuticals to decrease blood pressure, along with **diuretics** and **vasodilators**, are helpful in patients with aortic insufficiency.

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Aortic valve stenosis

Definition

When aortic valve stenosis occurs, the aortic valve, located between the aorta and left ventricle of the heart, is narrower than normal size.

Description

A normal aortic valve, when open, allows the free flow of blood from the left ventricle to the aorta. When the valve narrows, as it does with stenosis, blood flow is impeded. Because it is more difficult for blood to flow through the valve, there is increased strain on the heart. This can cause the left ventricle to enlarge and malfunction, resulting in reduced blood supply to the heart muscle and body, as well as fluid build up in the lungs.

Cause and symptoms

Aortic valve stenosis can occur because of a birth defect in the formation of the valve. Calcium deposits may form on the valve with **aging**, causing the valve to become stiff and narrow. Stenosis can also occur as a

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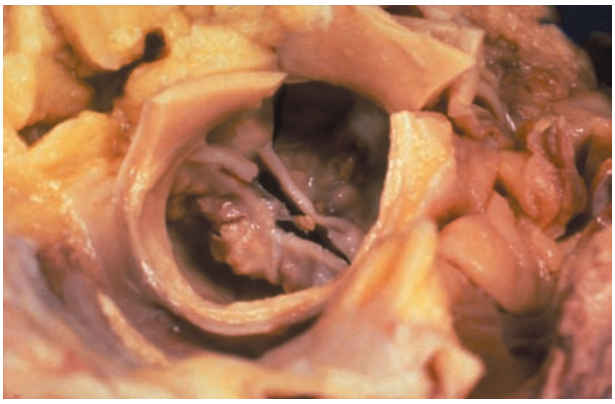

A close-up view of a calcified stenosis of the aortic valve. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

result of **rheumatic fever**. Mild aortic stenosis may produce no symptoms at all. The most common symptoms, depending on the severity of the disease, are chest **pain**, blackouts, and difficulty breathing.

Diagnosis

Using a stethoscope, a physician may hear a murmur and other abnormal heart sounds. An ECG, also called an electrocardiogram, records the electrical activity of the heart. This technique and **chest x ray** can show evidence that the left ventricle is enlarged. An x ray can also reveal calcium deposits on the valve, as well as congestion in the lungs. **Echocardiography** can pick up thickening of the valve, heart size, and whether or not the valve is working properly. This is a procedure in which high frequency sound waves harmlessly bounce off organs in the body. **Cardiac catheterization**, in which a contrast dye is injected in an artery using a catheter, is the key tool to confirm stenosis and gauge its severity.

Treatment

Treatment depends on the symptoms and how the heart's function is affected. The valve can be opened without surgery by using a balloon catheter, but this is often a temporary solution. The procedure involves inserting a deflated balloon at the end of a catheter through the arteries to the valve. Inflating the balloon should widen the valve. In severe stenosis, **heart valve replacement** is recommended, most often involving open-heart surgery. The valve can be replaced with a mechanical valve, a valve from a pig, or by moving the patient's other heart valve (pulmonary) into the position of the aortic valve and then replacing the pulmonary valve with an mechanical one. Anyone with aortic stenosis needs to take **antibiotics** (amoxicillin, erythromycin, or clindamycin) before dental and some other surgical procedures, to prevent a heart valve infection.

KEY TERMS

Aorta—The largest artery in the body, which moves blood from the left ventricle to the rest of the body.

ECG—Also called an electrocardiogram, it records the electrical activity of the heart.

Echocardiogram—A procedure in which high frequency sound waves harmlessly bounce off organs in the body providing an image so one can determine their structure and function.

Cardiac catheterization—A procedure in which dye is injected through a tube or catheter into an artery to more easily observe valves or blood vessels seen on an x ray.

Left ventricle—One of the lower chambers of the heart, which pumps blood to the aorta.

Murmur—An abnormal heart sound that can reflect a valve dysfunction.

Rheumatic fever—A bacterial infection that often causes heart inflammation.

Pulmonary valve—The valve located between the pulmonary artery and the right ventricle, which brings blood to the lungs.

Prognosis

The prognosis for aortic valve stenosis depends on the severity of the disease. With surgical repair, the disease is curable. Patients suffering mild stenosis can usually lead a normal life; a minority of the patients progress to severe disease. Anyone with moderate stenosis should avoid vigorous physical activity. Most of these patients end up suffering some kind of coronary heart disease over a 10 year period. Because it is a progressive disease, moderate and severe stenosis will be treated ultimately with surgery. Severe disease, if left untreated, leads to **death** within 2 to 4 years once the symptoms start.

Prevention

There is no way to prevent aortic stenosis.

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Jeanine Barone Physiologist

Apgar testing

Definition

Apgar testing is an assessment of the newborn by rating color, heart rate, stimulus response, muscle tone, and respirations on a scale of zero to two in each category, for a maximum possible score of 10. It is performed twice, first at one minute and then again at five minutes after birth.

Description

The five areas (color, heart rate, stimulus response, muscle tone, and respirations) are scored as follows:

- Color or appearance: 2 if the skin is pink all over; 1 for acrocyanosis, where the trunk and head are pink, but the arms and legs are blue; and 0 if the whole body is blue. Newborns with naturally darker skin color will not be pink. However, pallor is still noticeable, especially in the soles and palms. Color is related to the neonate's ability to oxygenate its body and extremities and is dependent on heart rate and respirations. A perfectly healthy newborn will often receive a score of 9 because of some blueness in the hands and feet.
- heart rate (pulse): 2 for a pulse of 100+ beats per minute (bpm); 1 for a pulse below 100 bpm; 0 for no pulse. Heart rate is assessed by listening with a stethoscope to the newborn's heart and counting the number of beats.
- Stimulus response (grimace, or reflex irritability): 2 if the neonate coughs, sneezes, or vigorously cries in response to a stimulus (such as the use of nasal suctioning, stroking the back to assess for spinal abnormalities, or having the foot tapped); 1 for a slight cry or grimace in response to the stimulus; 0 for no response.
- Muscle tone (activity): 2 for vigorous movements of arms and legs; 1 for some movement; 0 for no movement, limpness.
- Respirations: 2 for visible breathing and crying; 1 for slow, weak, irregular breathing; 0 for apnea, or no breathing. A crying newborn can adequately oxygenate its lungs. Respirations are best assessed by watching the rise and fall of the neonate's abdomen, as infants are diaphragmatic breathers.

The combined first letters of appearance, pulse, grimace, activity, and respirations spell Apgar.

Purpose

Apgar scoring was originally developed in the 1950s by the anesthesiologist Virginia Apgar to assist practitioners attending a birth in deciding whether a newborn was in need of resuscitation. Using a scoring method fosters consistency and standardization among different practitioners. A February 2001 study published in the *New England Journal of Medicine* investigated whether Apgar scoring continues to be relevant. Researchers concluded that "The Apgar scoring system remains as relevant for the prediction of neonatal survival today as it was almost 50 years ago." However, a 2006 study published in the *Journal of Pediatrics* found that there was a wide variability of Apgar scores among observers.

Benefits

The Apgar test is a quick determination of a newborn's health and alerts medical caregivers to whether the baby needs immediate medical intervention.

Preparation

No preparation is needed to perform the test. However, while being born the neonate may receive nasal and oral suctioning to remove mucus and amniotic fluid. This may be done when the head of the newborn is safely out, while the mother rests before she continues to push.

Aftercare

Since the test is primarily observational in nature, no aftercare is needed. However, the test may flag the need for immediate intervention or prolonged observation.

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DR. VIRGINIA APGAR (1909–1974)

(AP Images.)

As one of very few female medical students at Columbia University College of Physicians and Surgeons in New York during the early 1930s and one of the first women to graduate from its medical school, Apgar knew that her goal of becoming a surgeon would not be achieved easily in a male-dominated profession. Reluctantly, she switched her medical specialty to anesthesiology, she embraced her new field with typical intelligence and energy. At this time, anesthesiology was a relatively new field, having been left by the doctors mostly to the attention of nurses. Apgar realized immediately how much in need of scientifically trained personnel was this significant part of surgery, and she set out to make anesthesiology a separate medical discipline. By 1937, she had become the fiftieth physician to be certified as an anesthesiologist in the United States. The following year she was appointed director of anesthesiology at the Columbia-Presbyterian Medical Center, becoming the first woman to head a department at that institution.

As the attending anesthesiologist who assisted in the delivery of thousands of babies during these years, Apgar realized that infants had died from respiratory or circulatory complications that early treatment could have prevented. Apgar decided to bring her considerable research skills to this childbirth dilemma, and her careful study resulted in her publication of the Apgar Score System in 1952.

Normal results

The maximum possible score is 10, the minimum is zero. It is rare to receive a true 10, as some **acrocyanosis** in the newborn is considered normal, and therefore not a cause for concern. Most infants score between 7 and 10. These infants are expected to have an excellent outcome. A score of 4, 5, or 6 requires immediate intervention, usually in the form of oxygen and respiratory assistance, or perhaps just suctioning if breathing has been obstructed by mucus. While suctioning is being done, a source of oxygen may be placed near, but not over the newborn's nose and mouth. This form of oxygen is referred to as *blow-by*. A score in the 4–6 range indicates that the neonate is having some difficulty adapting to extrauterine life. This may be due to medications given to the mother during a difficult labor, or at the very end of labor, when these medications have an exaggerated effect on the neonate.

Abnormal results

With a score of 0–3, the newborn is unresponsive, apneic, pale, limp, and may not have a pulse. Interventions to resuscitate will begin immediately. The test is repeated at five minutes after birth and both scores are documented. Should the resuscitation effort continue into the five-minute time period, interventions would not stop in order to perform the test. The one-minute score indicates the need for intervention at birth. It addresses survival and prevention of birth-related complications resulting from inadequate oxygen supply. Poor oxygenation may be due to inadequate neurological and/or chemical control of respiration. The five-minute score appears to have a more predictive value for morbidity and normal development, although research studies on this are inconsistent in their conclusions.

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KEY TERMS

Acrocyanosis—A slight cyanosis, or blueness of the hands and feet of the neonate is considered normal. This impaired ability to fully oxygenate the extremities is due to an immature circulatory system which is still in flux.

Amniotic fluid—The protective bag of fluid that surrounds the fetus while growing in the uterus.

Neonate—A term referring to the newborn infant, from birth until one month of age.

Neonatologist—A physician who specializes in problems of newborn infants.

Pallor—Extreme paleness in the color of the skin.

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What is the Apgar Score? Kidshealth.org February 2008. http://kidshealth.org/parent/newborn/first_days/apgar.html#

ORGANIZATIONS

American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, IL, 60007-1098 (847) 434-4000 (847) 434-8000, http://www.aap.org.

American Pregnancy Association, 431 Greenway Drive, Suite 800, Irving, TX, 75038 (972) 550-0140 (972) 550-0800, Questions@AmericanPregnancy.org, http://www.americanpregnancy.org.

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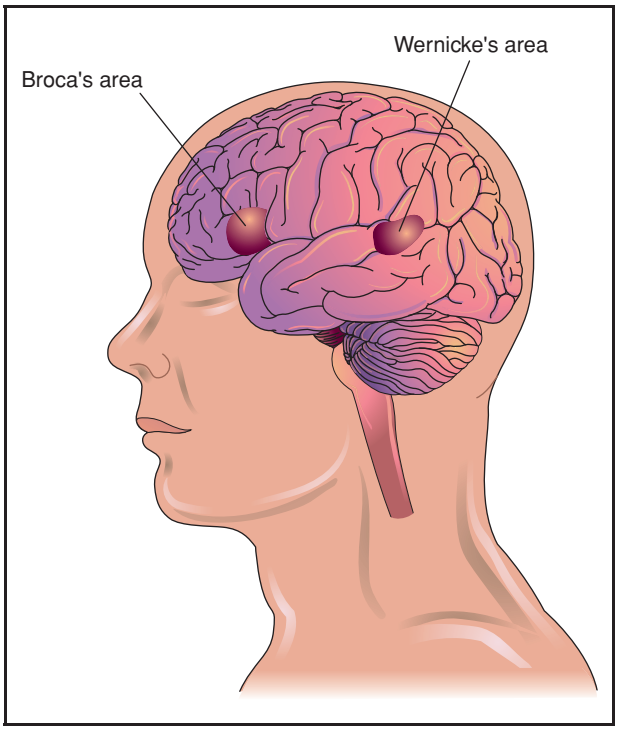
Aphasia

Definition

Aphasia is condition characterized by either partial or total loss of the ability to communicate verbally or using written words. A person with aphasia may have difficulty speaking, reading, writing, recognizing the names of objects, or understanding what other people have said. Aphasia is caused by a brain injury, as may occur during a traumatic accident or when the brain is deprived of oxygen during a **stroke**. It may also be caused by a **brain tumor**, a disease such as Alzheimer's, or an infection, like **encephalitis**. Aphasia may be temporary or permanent. Aphasia does not include speech impediments caused by loss of muscle control.



Broca's aphasia results from damage to the frontal lobe of the language-dominant area of the brain. Individuals with Broca's aphasia may become mute or may be able to use single-word statements or full sentences, although it may require great effort. Wernicke's aphasia is caused by damage to the temporal lobe of the language-dominant area of the brain. People with this condition speak in long, uninterrupted sentences, but the words used are often unnecessary and unintelligible. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Description

To understand and use language effectively, an individual draws upon word memory–stored information on what certain words mean, how to put them together, and how and when to use them properly. For a majority of people, these and other language functions are located in the left side (hemisphere) of the brain. Damage to this side of the brain is most commonly linked to the development of aphasia. Interestingly, however, left-handed people appear to have

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KEY TERMS

Anomic aphasia—A condition characterized by either partial or total loss of the ability to recall the names of persons or things as a result of a stroke, head injury, brain tumor, or infection.

Broca's aphasia—A condition characterized by either partial or total loss of the ability to express oneself, either through speech or writing. Hearing comprehension is not affected. This condition may result from a stroke, head injury, brain tumor, or infection.

Computed tomography (CT)—An imaging technique that uses cross-sectional x rays of the body to create a three-dimensional image of the body's internal structures.

Conduction aphasia—A condition characterized by the inability to repeat words, sentences, or phrases as a result of a stroke, head injury, brain tumor, or infection.

Frontal lobe—The largest, most forward-facing part of each side or hemisphere of the brain.

Global aphasia—A condition characterized by either partial or total loss of the ability to communicate verbally or using written words as a result of widespread injury to the language areas of the brain. This condition may be caused by a stroke, head injury, brain tumor, or infection. The exact language abilities affected vary depending on the location and extent of injury.

Hemisphere—One of the two halves or sides—the left and the right—of the brain.

Magnetic resonance imaging (MRI)—An imaging technique that uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

Subcortical aphasia—A condition characterized by either partial or total loss of the ability to communicate verbally or using written words as a result of damage to non-language-dominated areas of the brain. This condition may be caused by a stroke, head injury, brain tumor, or infection.

Temporal lobe—The part of each side or hemisphere of the brain that is on the side of the head, nearest the ears.

Transcortical aphasia—A condition characterized by either partial or total loss of the ability to communicate verbally or using written words that does not affect an individual's ability to repeat words, phrases, and sentences.

Wernicke's aphasia—A condition characterized by either partial or total loss of the ability to understand what is being said or read. The individual maintains the ability to speak, but speech may contain unnecessary or made-up words.

language areas in both the left and right hemispheres of the brain and, as a result, may develop aphasia from damage to either side of the brain.

Stroke is the most common cause of aphasia in the United States. Approximately 500,000 individuals suffer strokes each year, and 20% of these individuals develop some type of aphasia. Other causes of brain damage include head injuries, brain tumors, and infection. About half of the people who show signs of aphasia have what is called temporary or transient aphasia and recover completely within a few days. An estimated one million Americans suffer from some form of permanent aphasia. As yet, no connection between aphasia and age, gender, or race has been found.

Aphasia is sometimes confused with other conditions that affect speech, such as dysarthria and **apraxia**. These condition affect the muscles used in speaking rather than language function itself. Dysarthria is a speech disturbance caused by lack of control over the muscles used in speaking, perhaps due to nerve damage. Speech apraxia is a speech disturbance in which language comprehension and muscle control are retained, but the memory of how to use the muscles to form words is not.

Causes and symptoms

Aphasia can develop after an individual sustains a brain injury from a stroke, head trauma, tumor, or infection, such as herpes encephalitis. As a result of this injury, the pathways for language comprehension or production are disrupted or destroyed. For most people, this means damage to the left hemisphere of the brain. (In 95 to 99% of right-handed people, language centers are in the left hemisphere, and up to 70% of left-handed people also have left-hemisphere language dominance.) According to the traditional classification scheme, each form of aphasia is caused by damage to a different part of the left hemisphere of the brain. This damage affects one or more of the basic

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language functions: speech, naming (the ability to identify an object, color, or other item with an appropriate word or term), repetition (the ability to repeat words, phrases, and sentences), hearing comprehension (the ability to understand spoken language), reading (the ability to understand written words and their meaning), and writing (the ability to communicate and record events with text).

The traditional classification scheme includes eight types of aphasia:

- Broca's aphasia, also called motor aphasia, results from damage to the front portion or frontal lobe of the language-dominant area of the brain. Individuals with Broca's aphasia may be completely unable to use speech (mutism) or may be able to use single-word statements or even full sentences, though these sentences may require a great deal of effort to construct. Small words, such as conjunctions (and, or, but) and articles (the, an, a), may be omitted, leading to a "telegraph" quality in their speech. Hearing comprehension is usually not affected, so they are able to understand other people's speech and conversation and can follow commands. Often, they may experience weakness on the right side of their bodies, which can make it difficult to write. Reading ability is impaired, and they may have difficulty finding the right word when speaking. Individuals with Broca's aphasia may become frustrated and depressed because they are aware of their language difficulties.
- Wernicke's aphasia is caused by damage to the side portion or temporal lobe of the language-dominant area of the brain. Individuals with Wernicke's aphasia speak in long, uninterrupted sentences; however, the words used are frequently unnecessary or even made-up. They have a great deal of difficulty understanding other people's speech, sometimes to the point of being unable to understand spoken language at all. Reading ability is diminished, and although writing ability is retained, what is written may be abnormal. No physical symptoms, such as the right-sided weakness seen with Broca's aphasia, are typically observed. Also, in contrast to Broca's aphasia, individuals with Wernicke's aphasia are not aware of their language errors.
- Global aphasia is caused by widespread damage to the language areas of the left hemisphere. As a result, all basic language functions are affected, but some areas may be more affected than others. For example, an individual may have difficulty speaking but may be able to write well. The individual may experience weakness and loss of feeling on the right side of their body.
- Conduction aphasia, also called associative aphasia, is rather uncommon. Individuals with conduction aphasia are unable to repeat words, sentences, and phrases. Speech is fairly unbroken, although individuals may frequently correct themselves and words may be skipped or repeated. Although able to understand spoken language, it may also be difficult for the individual with conduction aphasia to find the right word to describe a person or object. The impact of this condition on reading and writing ability varies. As with other types of aphasia, right-sided weakness or sensory loss may be present.
- Anomic or nominal aphasia primarily influences an individual's ability to find the right name for a person or object. As a result, an object may be described rather than named. Hearing comprehension, repetition, reading, and writing are not affected, other than by this inability to find the right name. Speech is fluent, except for pauses as the individual tries to recall the right name. Physical symptoms are variable, and some individuals have no symptoms of one-sided weakness or sensory loss.
- Transcortical aphasia is caused by damage to the language areas of the left hemisphere outside the primary language areas. There are three types of aphasia: transcortical motor aphasia, transcortical sensory aphasia, and mixed transcortical aphasia. All of the transcortical aphasias are distinguished from other types by the individual's ability to repeat words, phrases, or sentences. Other language functions may also be impaired to varying degrees, depending on the extent and particular location of brain damage.

As researchers continue to learn more about the brain's structure and function, new types of aphasia are being recognized. One newly recognized type of aphasia, subcortical aphasia, mimics the symptoms of other traditional types of aphasia but involves language disorders that are not typical. This type of aphasia is associated with injuries to areas of the brain typically not identified with language and language processing.

Diagnosis

Following brain injury, an initial bedside assessment is made to determine whether language function has been affected. If the individual experiences difficulty communicating, attempts are made to determine whether this difficulty arises from impaired language comprehension or an impaired ability to speak. A typical examination involves listening to spontaneous speech and evaluating the individual's ability to recognize and name objects, comprehend what is heard,

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and repeat sample words and phrases. The individual may also be asked to read text aloud and explain what the passage means. In addition, writing ability is evaluated by having the individual copy text, transcribe dictated text, and write something without prompting.

A speech pathologist or neuropsychologist may be asked to conduct more extensive examinations using in-depth, standardized tests. Commonly used tests include the Boston Diagnostic Aphasia Examination, the Western Aphasia Battery, and possibly, the Porch Index of Speech Ability.

The results of these tests indicate the severity of the aphasia and may also provide information regarding the exact location of the brain damage. This more extensive testing is also designed to provide the information necessary to design an individualized **speech therapy** program. Further information about the location of the damage is gained through the use of imaging technology, such as **magnetic resonance imaging** (MRI) and **computed tomography scans** (CT).

Treatment

Initially, the underlying cause of aphasia must be treated or stabilized. To regain language function, therapy must begin as soon as possible following the injury. Although there are no medical or surgical procedures currently available to treat this condition, aphasia resulting from stroke or **head injury** may improve through the use of speech therapy. For most individuals, however, the primary emphasis is placed on making the most of retained language abilities and learning to use other means of communication to compensate for lost language abilities.

Speech therapy is tailored to meet individual needs, but activities and tools that are frequently used include the following:

- Exercise and practice. Weakened muscles are exercised by repetitively speaking certain words or making facial expressions, such as smiling.
- Picture cards. Pictures of everyday objects are used to improve word recall and increase vocabulary. The names of the objects may also be repetitively spoken aloud as part of an exercise and practice routine.
- Picture boards. Pictures of everyday objects and activities are placed together, and the individual points to certain pictures to convey ideas and communicate with others.
- Workbooks. Reading and writing exercises are used to sharpen word recall and regain reading and writing abilities. Hearing comprehension is also redeveloped using these exercises.
- Computers. Computer software can be used to improve speech, reading, recall, and hearing comprehension by, for example, displaying pictures and having the individual find the right word.

Prognosis

The degree to which an individual can recover language abilities is highly dependent on how much brain damage occurred and the location and cause of the original brain injury. Other factors include the individual's age, general health, motivation and willingness to participate in speech therapy, and whether the individual is left or right handed. Language areas may be located in both the left and right hemispheres in left-handed individuals. Left-handed individuals are, therefore, more likely to develop aphasia following brain injury, but because they have two language centers, may recover more fully because language abilities can be recovered from either side of the brain. The intensity of therapy and the time between diagnosis and the start of therapy may also affect the eventual outcome.

Prevention

Because there is no way of knowing when a stroke, traumatic head injury, or disease will occur, very little can be done to prevent aphasia. The extent of recovery, however, in some cases, can be affected by an individual's willingness to cooperate and participate in speech therapy directly following the injury.

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ORGANIZATIONS

National Aphasia Association, 350 Seventh Avenue, Suite 902, New York, NY, 10001, (800) 922-4622, responsecenter@aphasia.org, http://www.aphasia.org.

Julia Barrett

Apheres *see* **Transfusion**

Aplastic anemia

Definition

Aplastic anemia is a disorder in which the bone marrow significantly decreases or stops production of blood cells.

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KEY TERMS

Autoimmune disease—A disease that occurs when the body's tissues and cells are attacked by the person's own immune system.

Bone marrow—A substance found in the cavities of bones, especially the long bones and the sternum (breast bone). The bone marrow contains those cells that are responsible for the production of the blood cells (red blood cells, white blood cells, and platelets).

Bone marrow transplant—A procedure in which a quantity of bone marrow is extracted through a needle from a donor, and then passed into a patient to replace the patient's diseased or absent bone marrow.

Hematopoietic cells—Those cells that are lodged within the bone marrow and are responsible for producing the cells that circulate in the blood (red blood cells, white blood cells, and platelets).

Immunosuppressive therapy—Treatment that suppresses the immune system's functioning.

Demographics

Yearly, aplastic anemia is diagnosed in about six out of every million people in the United States. Incidence of this disorder in Europe is similar to the U.S. incidence rate. More cases of aplastic anemia are observed in Asian countries, particularly in Japan, where the disorder is diagnosed in 14 people out of every million. This increased incidence rate is thought to be from environmental causes such as increased exposure to toxic chemicals rather than to genetics or heredity because Americans of Asian heritage do not have higher incidence rates than the general U.S. population

Aplastic anemia affects both males and females of all ages. There are two age groups that have an increased risk. Both young adults (between 20-25 years of age) and the elderly (over the age of 60) have higher rates of aplastic anemia than the general population.

Description

The bone marrow (soft tissue located within the hard outer shell of the bones) is responsible for the production of all types of blood cells. The mature forms of these cells include red blood cells, which carry oxygen throughout the body; white blood cells, which fight infection; and platelets, which are involved in clotting. In aplastic anemia, the basic structure of the marrow becomes abnormal, and those cells responsible for generating blood cells (hematopoietic cells) are greatly decreased in number or absent. These hematopoietic cells are replaced by large quantities of fat.

Risk factors

Eighty percent of cases of aplastic anemia are termed "acquired" cases because the cause can often be traced to a non-genetic or non-inherited cause such as:

- previous infection with viruses and bacteria such as a hepatitis virus, the Epstein-Barr virus, HIV, parovirus and mycobacteria
- exposure to toxic chemicals such as benzene
- radiation exposure
- exposure to the drugs chloramphenicol and phenylbutazone
- exposure to the element gold
- history of transfusional graft-versus-host disease (GVHD)
- history of liver transplant for fulminant hepatitis
- pregnancy in rare instances

Hereditary aplastic anemia is relatively rare (20% of cases), but occurs in Fanconi's anemia, Shwachman-Diamond syndrome, congenital dyskeratosis, and other rare congenital or inherited diseases.

Causes and symptoms

Aplastic anemia falls into three basic categories based on the origin of its cause: idiopathic, acquired, and hereditary.

Acquired aplastic anemia refers to cases where certain environmental factors and physical conditions seem to be associated with development of the disease. However, it is sometimes difficult to pinpoint the exact cause. About 80% of cases of aplastic anemia are considered to be acquired. Many clinicians believe aplastic anemia is an autoimmune disorder.

Symptoms of aplastic anemia tend to be the same as those of other **anemias**, including **fatigue**, weakness, tiny reddish-purple marks (petechiae) on the skin (evidence of pinpoint hemorrhages into the skin), evidence of abnormal bruising, and bleeding from the gums, nose, intestine, or vagina. The patient is likely to appear pale. If the anemia progresses,

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decreased oxygen circulating in the blood may lead to an increase in heart rate and the sudden appearance of a new heart murmur.

Diagnosis

Examination

During an office visit, a physician may suspect a form of anemia based on the patient's physical appearance and symptoms. A patient history is taken and exposure to any environmental toxins is noted. In order to confirm aplastic anemia, a blood draw is normally performed and additional testing is recommended as needed.

Tests

A complete blood cell count (CBC) is performed on patients suspected of having anemia. This involves a simple blood draw, usually from the patient's arm. The blood is then analyzed at a lab. The blood count in aplastic anemia reveals low numbers of all formed blood cells. Red blood cells appear normal in size and coloration, but are greatly decreased in number. Cells called reticulocytes—very young red blood cells, which are usually produced in great numbers by the bone marrow in order to compensate for a severe anemia—are very low in number. Platelets and white blood cells are also decreased in number, though normal in structure.

Blood tests to determine histocompatibility with potential related donors for bone marrow transplant should be conducted early in the diagnostic process.

Radiographic imaging studies of the skeleton may be performed if there is suspicion of an inherited form of aplastic anemia since these conditions often cause skeletal abnormalities.

Procedures

A sample of the patient's bone marrow may need to be removed by needle (usually from the hip bone) and examined under a microscope. If aplastic anemia is present, this examination reveals very few or no hematopoietic cells, and replacement with fat.

Treatment

Traditional

The first step in the treatment of aplastic anemia involves discontinuing exposure to any substance that may be causing the disorder. Although it would seem that blood transfusions would be helpful in this disease, in fact, they only serve as a temporary help and may complicate future attempts at **bone marrow transplantation**.

The most successful treatment for aplastic anemia is bone marrow transplantation. To do this, a marrow donor, preferably a human leukocyte antigen (HLA)-matched sibling, must be identified. There are a number of tissue markers that must be examined to determine whether a bone marrow donation is likely to be compatible with the patient's immune system. Compatibility is necessary to avoid complications, including the destruction of the donor marrow by the patient's own immune system.

Drugs

Infections are a great cause of concern in patients with aplastic anemia. The patient should be started on a course of broad spectrum **antibiotics** as soon as an infection is suspected. Patients with persistent **fever** may also be treated with antifungal medications.

Patients who cannot undergo bone marrow transplant can be treated with a number of agents, including antithymocyte globulin (ATG), cyclophosphamide, **steroids**, and cyclosporine. These agents all have the potential to cause a number of troublesome side-effects and may have a success rate of only 60–80%. Still, even among those patients who have a good response, many later have a relapse (return) of aplastic anemia. Researchers are trying to identify the molecules in certain stem cells that the immune system targets in aplastic anemia.

Prognosis

Aplastic anemia is a life-threatening illness. Without treatment, the condition is likely to be fatal. Survival depends on how severe the disease is at diagnosis, the type of treatment a patient is eligible for, and what kind of response their body has to that treatment.

Patients with a very low number of a particular type of white blood cell have a poor prognosis. They have an increased chance of dying from overwhelming bacterial infections. However, the estimated five-year survival rate for patients with aplastic anemia who have been treated with immunosuppressive therapy is 75%. Patients who undergo bone marrow transplantation using an HLA-matched sibling donor have a five-year survival rate greater than 90%.

Prevention

Since most cases of aplastic anemia can be linked to an identifiable cause, minimizing or eliminating

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exposure to the known causes of aplastic anemia should be strongly considered.

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Teresa G. Odle
Melinda Granger Oberleitner RN, DNS, APRN, CNS

Aplastic crisis *see* **Fifth disease**

Appendectomy

Definition

Appendectomy is the surgical removal of the appendix. The appendix is a worm-shaped hollow pouch attached to the cecum, the beginning of the large intestine.

Purpose

Appendectomies are performed to treat **appendicitis**, an inflamed and infected appendix.

Precautions

Since appendicitis occurs most commonly in males between the ages of 10-14 and in females between the ages of 15-19, appendectomy is most often performed during this time. The diagnosis of appendicitis is most difficult in the very young (less than two years of age) and in the elderly.

Description

Appendectomy is considered a major surgical operation. Therefore, a general surgeon must perform this operation in the operating room of a hospital. An anesthesiologist is also present during the operation to administer an anesthetic. Most often the anesthesiologist uses a general anesthetic technique whereby patients are put to sleep and made **pain** free by administering drugs in the vein or by agents inhaled through a tube placed in the windpipe. Occasionally a spinal anesthetic may be used.

After the patient is anesthetized, the general surgeon can remove the appendix either by using the traditional open procedure (in which a 2-3 in. [5-7.6 cm] incision is made in the abdomen) or via **laparoscopy** (in which four 1 in. [2.5cm] incisions are made in the abdomen).

Traditional open appendectomy

When the surgeon uses the open approach, he or she makes an incision in the lower right section of the abdomen. Most incisions are less than 3 in. (7.6 cm) in length. The surgeon then identifies all of the organs in the abdomen and examines them for other disease or abnormalities. The appendix is located and brought up into the **wounds**. The surgeon separates the appendix from all the surrounding tissue and its attachment to the cecum and then removes it. The site where the appendix was previously attached, the cecum, is closed and returned to the abdomen. The muscle layers and then the skin are sewn together.

Laproscopic appendectomy

When the surgeon conducts a laproscopic appendectomy, four incisions, each about 1 in. (2.5 cm) in length, are made. One incision is near the umbilicus, or navel, and one is between the umbilicus and the pubis. Two other incisions are smaller and are in the right side of the lower abdomen. The surgeon then passes a camera and special instruments through these incisions. With the aid of this equipment, the surgeon visually examines the abdominal organs and identifies the appendix. Similarly, the appendix is freed from all of its attachments and removed. The place where the appendix was formerly attached, the cecum, is stitched. The appendix is removed through one of the incisions. The instruments are removed and then all of the incisions are closed.

Studies and opinions about the relative advantages and disadvantages of each method are divided. A skilled surgeon can perform either one of these procedures in less than one hour. However, laproscopic

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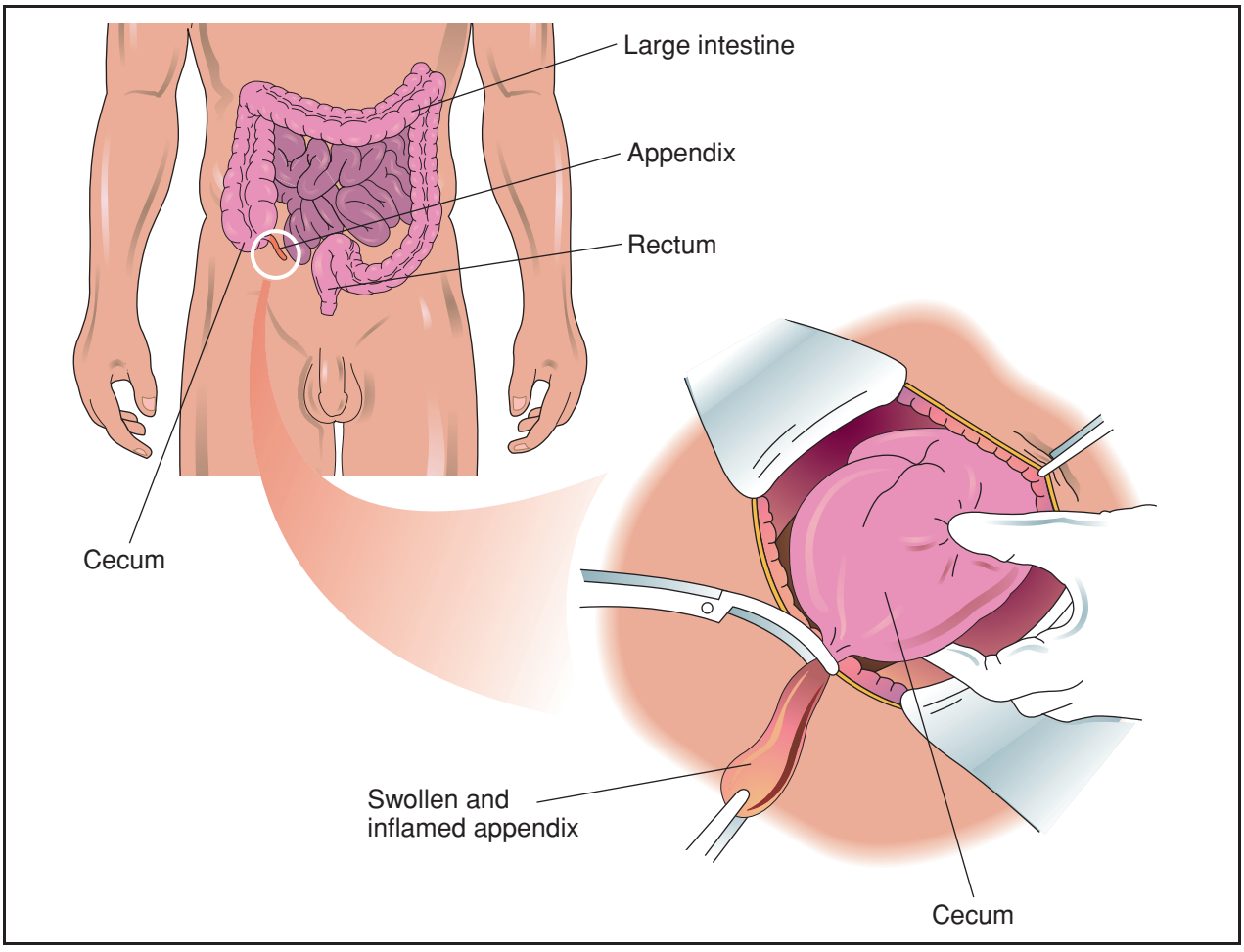

A traditional open appendectomy. After the surgeon makes an incision in the lower right section of the abdomen, he/she pulls the appendix up, separates it from the surrounding tissue and its attachment to the cecum, and then removes it. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

appendectomy (LA) always takes longer than traditional appendectomy (TA). The increased time required to do a LA increases the patient's exposure to anesthetics, which increases the risk of complications. The increased time requirement also escalates fees charged by the hospital for operating room time and by the anesthesiologist. Since LA also requires specialized equipment, the fees for its use also increases the hospital charges. Patients with either operation have similar pain medication needs, begin eating **diets** at comparable times, and stay in the hospital equivalent amounts of time. LA is of special benefit in women in whom the diagnosis is difficult and gynecological disease (such as **endometriosis**, **pelvic inflammatory disease**, ruptured ovarian follicles, ruptured **ovarian cysts**, and tubal pregnancies) may be the source of pain and not appendicitis. If LA is done in these patients, the pelvic organs can be more thoroughly examined and a definitive diagnosis made prior to removal of the appendix. Most surgeons select either TA or LA based on the individual needs and circumstances of the patient.

Insurance plans do cover the costs of appendectomy. Fees are charged independently by the hospital and the physicians. Hospital charges include fees for operating and recovery room use, diagnostic and laboratory testing, as well as the normal hospital room charges. Surgical fees vary from region to region and range between $250-$750. The anesthesiologist's fee depends upon the health of the patient and the length of the operation.

Preparation

Once the diagnosis of appendicitis is made and the decision has been made to perform an appendectomy, the patient undergoes the standard preparation for an

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KEY TERMS

Abscess—A collection of pus buried deep in the tissues or in a body cavity.

Anesthesiologist—A physician who has special training and expertise in the delivery of anesthetics.

Anesthetics—Drugs or methodologies used to make a body area free of sensation or pain.

Cecum—The beginning of the large intestine and the place where the appendix attaches to the intestinal tract.

General surgeon—A physician who has special training and expertise in performing a variety of operations.

Pelvic organs— The organs inside of the body that are located within the confines of the pelvis. This includes the bladder and rectum in both sexes and the uterus, ovaries, and fallopian tubes in females.

Pubis—The anterior portion of the pelvis located in the anterior abdomen.

Thrombophlebitis—Inflammation of the veins, usually in the legs, which causes swelling and tenderness in the affected area.

Umbilicus—The navel.

operation. This usually takes only one to two hours and includes signing the operative consents, patient identification procedures, evaluation by the anesthesiologist, and moving the patient to the operating suites of the hospital. Occasionally, if the patient has been ill for a prolonged period of time or has had protracted **vomiting**, a delay of few to several hours may be necessary to give the patient fluids and **antibiotics**.

Aftercare

Recovery from an appendectomy is similar to other operations. Patients are allowed to eat when the stomach and intestines begin to function again. Usually the first meal is a clear liquid diet—broth, juice, soda pop, and gelatin. If patients tolerate this meal, the next meal usually is a regular diet. Patients are asked to walk and resume their normal physical activities as soon as possible. If TA was done, work and physical education classes may be restricted for a full three weeks after the operation. If a LA was done, most patients are able to return to work and strenuous activity within one to three weeks after the operation.

Risks

Certain risks are present when any operation requires a general anesthetic and the abdominal cavity is opened. **Pneumonia** and collapse of the small airways (**atelectasis**) often occurs. Patients who smoke are at a greater risk for developing these complications. **Thrombophlebitis**, or inflammation of the veins, is rare but can occur if the patient requires prolonged bed rest. Bleeding can occur but rarely is a blood **transfusion** required. **Adhesions** (abnormal connections to abdominal organs by thin fibrous tissue) is a known complication of any abdominal procedure such as appendectomy. These adhesions can lead to intestinal obstruction which prevents the normal flow of intestinal contents. **Hernia** is a complication of any incision, However, they are rarely seen after appendectomy because the abdominal wall is very strong in the area of the standard appendectomy incision.

The overall complication rate of appendectomy depends upon the status of the appendix at the time it is removed. If the appendix has not ruptured the complication rate is only about 3%. However, if the appendix has ruptured the complication rate rises to almost 59%. Wound infections do occur and are more common if the appendicitis was severe, far advanced, or ruptured. An **abscess** may form in the abdomen as a complication of appendicitis.

Occasionally, an appendix will rupture prior to its removal, spilling its contents into the abdominal cavity. **Peritonitis** or a generalized infection in the abdomen will occur. Treatment of peritonitis as a result of a ruptured appendix includes removal of what remains of the appendix, insertion of drains (rubber tubes that promote the flow of infection inside the abdomen to outside of the body), and antibiotics. **Fistula** formation (an abnormal connection between the cecum and the skin) rarely occurs. It is only seen if the appendix has a broad attachment to the cecum and the appendicitis is far advanced causing destruction of the cecum itself.

Normal results

Most patients feel better immediately after an operation for appendicitis. Many patients are discharged from the hospital within 24 hours after the appendectomy. Others may require a longer stay–

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three to five days. Almost all patients are back to their normal activities within three weeks.

The mortality rate of appendicitis has dramatically decreased over time. Currently, the mortality rate is estimated at one to two per 1,000,000 cases of appendicitis. **Death** is usually due to peritonitis, intra abdominal abscess or severe infection following rupture.

The complications associated with undiagnosed, misdiagnosed, or delayed diagnosis of appendectomy are very significant. The diagnosis is of appendicitis is difficult and never certain. This has led surgeons to perform an appendectomy any time that they feel appendicitis is the diagnosis. Most surgeons feel that in approximately 20% of their patients, a normal appendix will be removed. Rates much lower than this would seem to indicate that the diagnosis of appendicitis was being frequently missed.

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Mary Jeanne Krob MD, FACS

An extracted appendix. *(© Lester V. Bergman/Corbis.)*

Appendicitis

Definition

Appendicitis is an inflammation of the appendix, which is the worm- or finger-shaped pouch attached to the cecum, the beginning of the large intestine. The appendix has no known function in the human body, but it can become diseased. Appendicitis is a medical emergency, and if it is left untreated the appendix may rupture and cause a potentially fatal infection.

Demographics

Appendicitis is the most common abdominal emergency in children and young adults in Canada and the United States as of 2010. The National Institutes of Health (NIH) estimates that about 7 percent of the general population will develop appendicitis at some point in life. There are on average about 1.1 cases per 1000 people each year in North America. The disorder is most common in people between the ages of 10 and 30, but it can develop at any age. The incidence is highest among males aged 10–14, and among females aged 15–19. It is rare in the elderly and in children under the age of two. In a few cases, appendicitis has been diagnosed in newborn babies.

Appendicitis is equally common in persons of all races and ethnic groups. It is more common in men than in women, however; the male/female ratio is about 1.7:1. Although appendicitis is not hereditary, it does appear to be more common in some families; in 2009, a team of Australian researchers reported a possible link to chromosome 1p37.3.

About 1 person in every 100,000 is born without an appendix; there are a few rare cases of persons born with two.

Description

The average human appendix ranges in size from about 3 inches in length to 4 or 5 inches, but appendices as long as 11 inches have been recorded. The appendix is longer in children than in adults, and shrinks still further in older adults. Appendicitis develops when the lumen (inner cavity) of the appendix is blocked. This blockage can be caused by a number of different objects ranging from intestinal parasites to thick mucus or fecal matter,

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KEY TERMS

Alvarado score—A ten-point scoring system used by doctors to evaluate the likelihood that a patient has acute appendicitis.

Antiemetic—A type of medication given to prevent or reduce nausea and vomiting.

Appendectomy—Surgical removal of the appendix.

Appendix (plural: appendices)—The finger-shaped pouch attached to the cecum, the beginning of the large intestine.

Laparotomy—A surgical incision into the abdomen, made between the ribs and the pelvis, that offers surgeons a view inside the abdominal cavity.

Lumen—The hollow interior of a tube-shaped organ such as the appendix.

Peritonitis—Inflammation of the peritoneum, membranes lining the abdominal pelvic wall.

Pus—A whitish-yellow material produced by the body in response to a bacterial infection. It consists of tissue fluid and dead white blood cells.

Ulceration—An abnormal change in tissue accompanied by the death of cells.

or an infection. As the blockage progresses, the tissues of the appendix begin to die from lack of blood flow. They are then invaded by bacteria and form pus. If the condition is not treated, the appendix swells and eventually bursts, spreading the infection throughout the abdomen. This spread of infection and inflammation to the tissues lining the abdomen is called **peritonitis** and is a very dangerous condition.

The **pain** of appendicitis usually starts two to three days before the appendix gets to the point of bursting. The person typically notices a vague discomfort in the area underneath the navel (belly button). Over the next day the pain gets worse and moves downward toward the lower right portion of the abdomen near the right hip. The "classic" symptoms of appendicitis at this point are **nausea**, **vomiting**, low-grade **fever** (below 100.3°F), **constipation** or **diarrhea**, swelling of the abdomen, pain that is worsened by coughing or walking, and loss of appetite. Fewer than 50 percent of patients with appendicitis, however, have the full set of classic symptoms. Children and the elderly are often misdiagnosed because they have fewer of these symptoms; in particular, very young children may be misdiagnosed because they cannot explain or describe their symptoms. As a result, their treatment is often delayed. The appendix ruptures before surgery in about 270 out of every 1,000 cases; the risk of rupture is higher in children, pregnant women, and older adults.

Risk factors

There are no significant risk factors for appendicitis; it can develop in persons of either sex, in all age groups, and in all racial or ethnic groups. Some doctors, however, think that people with a history of intestinal parasites, those whose **diets** are very low in fiber, and those with Coxsackievirus B infection may have a slightly increased risk of developing appendicitis over their lifetimes.

Causes and symptoms

Causes

The basic cause of appendicitis is inflammation of the appendix resulting from an obstruction of some kind or an infection. The appendix can be blocked by an overgrowth of lymphoid tissue, food wastes, small pieces of hardened stool, worms or other parasites, **foreign objects**, or a cancerous tumor. It may also become inflamed as a result of trauma or infection, or as a complication of Crohn's disease.

The blocked appendix swells up with pus and mucus, shutting down the blood vessels that supply it with blood. As the tissues of the appendix die, bacteria from the intestine grow rapidly within it. If the infection is not stopped by surgical removal of the organ, the appendix will eventually burst and the bacteria inside it will spread to other parts of the abdomen. Signs of rupture include the presence of symptoms for more than 24 hours, a fever, a high **white blood cell count**, and a fast heart rate. Very rarely, the inflammation and symptoms of appendicitis may disappear but recur again later.

Symptoms

There is no single symptom that is unique to appendicitis, nor is there a "typical" group of symptoms that all patients experience. The following are the most common symptoms and the percentages of patients who report having them:

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- Pain in the abdomen moving from the navel to the right lower part of the abdomen: 80%
- Nausea: 85%
- Fever: 60%
- Loss of appetite: 74%
- Diarrhea or constipation: 18%
- Symptoms lasting less than 48 hours: 80% (About 2 percent of patients, however, report pain in the abdomen lasting as long as 2 weeks.)
- A previous history of pain in the abdomen: 23%

The location of the pain may vary depending on the location of the appendix. In about half the population, the appendix is located behind the cecum rather than at its beginning, and in some people, it is located on the left side of the body.

Diagnosis

A careful history-taking and **physical examination** is the best way to diagnose appendicitis. It is often difficult even for experienced physicians to distinguish the symptoms of appendicitis from those of other abdominal disorders. A physician should ask such questions as where the pain is centered, whether the pain has shifted, and where the pain began. The physician should press on the abdomen to judge the location of the pain and the degree of tenderness.

The diagnosis of appendicitis can be tricky and complicated. The typical sequence of symptoms is present in only 50% of cases. In the other half of cases, less typical patterns may be seen, especially in pregnant women, older people, and infants. In pregnant women, appendicitis is easily masked by the frequent occurrence of mild abdominal pain and nausea from other causes. Elderly people may feel less pain and tenderness than most individuals, thereby delaying diagnosis and treatment, and leading to rupture in 30% of cases. Infants and young children often have diarrhea, vomiting, and fever in addition to pain. Another factor that complicates diagnosis is the variation in size and location of the appendix in different people. In some patients the appendix is located on the left side of the body rather than the right, and in others the appendix is unusually long and extends from the right side toward the left side of the body.

Some doctors use a scoring system called the Alvarado score to assess the patient's likelihood of having appendicitis. The score is based on six clinical signs (fever, rebound tenderness, abdominal pain migrating to the lower right quadrant, nausea or vomiting, loss of appetite, and pain on pressure in the lower right quadrant) and two laboratory measurements of white blood cells (number and type of WBCs) in the patient's blood serum. Two factors are assigned two points each and the remaining six one point each, for a maximum total score of ten points. A score below 5 generally indicates that the patient does not have appendicitis, while a score of 7 or higher is considered strongly predictive of acute appendicitis.

Examination

In addition to taking the patient's temperature and asking about recent nausea or loss of appetite, the doctor may perform certain maneuvers during the physical examination when appendicitis is suspected. Patients with appendicitis typically feel what is called rebound tenderness (soreness) when the doctor first presses on the abdomen and then releases the pressure. The patient may also stiffen the muscles of the abdomen in response to pressure; this reaction is called guarding. In addition, the doctor may be able to feel that the abdomen itself is rigid. The doctor may move or rotate the patient's right leg or hip in order to test for unusual pain during this maneuver. This is called the psoas sign, named for two muscles involved in bending or rotating the hip. Rectal exams for both men and women may be performed in order to rule out other possible diagnoses.

Tests

Several different types of laboratory and imaging tests may be performed as part of the diagnostic workup:

- Blood test. A high white blood cell count indicates the presence of infection, and the presence of a large number of white blood cells called neutrophils is one of the signs evaluated in the Alvarado score.
- Imaging tests. These may include x rays, ultrasound, or computed tomography (CT) scans. The CT scan is the most commonly used imaging test to diagnose appendicitis, but x-ray studies can be useful for detecting foreign bodies or hardened stools that may be blocking the appendix. The use of imaging studies to diagnose appendicitis is increasingly controversial as of 2010, however, as many surgeons maintain that they increase the risk of perforation by delaying surgery, add to the total cost of the procedure, and have a low rate of accuracy in distinguishing between healthy and infected appendices.
- Urine test. This test may be done to rule out kidney stones or a urinary tract infection.
- Pregnancy test. Women of childbearing age are tested for pregnancy to rule out the possibility of an ectopic pregnancy (one in which the fetus is growing

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in the Fallopian tubes, cervix, or abdomen rather than the uterus). The pain caused by an ectopic pregnancy resembles that of acute appendicitis, and the consequences of a missed diagnosis are potentially life-threatening.

In early 2010 a group of researchers in Colorado reported on a new possible diagnostic test for appendicitis that measures the levels of a protein called S100A8/A9 in the patient's blood serum. The biomarker appears to be more sensitive than WBC measurements in diagnosing acute appendicitis.

Procedures

Persons with a diagnosis of appendicitis are usually taken immediately to surgery, where a laparotomy (surgical exploration of the abdomen) is done to confirm the diagnosis. Often, the diagnosis is not certain until an operation is completed. To avoid a ruptured appendix, surgery may be recommended without delay if the symptoms point clearly to appendicitis. If the symptoms are not clear, surgery may be postponed until they progress enough to confirm a diagnosis.

When appendicitis is strongly suspected in a woman of child-bearing age, a diagnostic **laparoscopy** is sometimes recommended even after a **pregnancy** test to be sure that a gynecological problem such as a ruptured ovarian cyst is not causing the pain. In this procedure, a lighted viewing tube is inserted into the abdomen through a small incision around the navel.

A normal appendix is discovered in about 10–20% of patients who undergo laparotomy for suspected appendicitis. Sometimes the surgeon will remove a normal appendix as a safeguard against appendicitis in the future. During the surgery, another specific cause for the pain and symptoms of appendicitis is found for about 30% of these patients.

Treatment

The standard treatment for acute (sudden, severe) appendicitis is an **appendectomy**, surgery to remove the appendix. Because of the potential for a life-threatening ruptured appendix, persons suspected of having appendicitis are often taken to surgery before the diagnosis is certain.

Traditional

The surgeon can perform an appendectomy (surgical removal of the appendix) in several different ways. The oldest procedure is called an open appendectomy. The surgeon makes an incision (cut) between 2 and 4 inches in length on the lower right side of the abdomen. The appendix is removed from its location and the area is rinsed with sterile fluid to prevent further infection.

A newer and more commonly used technique is called a laparoscopic appendectomy. It requires much smaller incisions, only an inch or so long. The surgeon inserts a laparoscope, which is an instrument that allows the surgeon to see inside the abdomen, through one incision, and surgical instruments to remove the appendix through another small incision. If the surgeon finds that the infection has spread or that there are other complications, the operation may have to be completed as an open appendectomy; according to the American College of Surgeons, about 110 in every 1,000 laparoscopic procedures have to be completed as open appendectomies.

In March 2008, surgeons at a medical center in California successfully removed a woman's appendix through her vagina. The procedure is still considered experimental but allows female patients to recover more rapidly.

Drugs

In a few cases, if the doctor is not certain of the diagnosis, he or she may prescribe a course of **antibiotics** to see whether the patient's symptoms are caused by something other than an inflamed appendix and may not require surgery. Antibiotics are also given intravenously during and after surgery to reduce the risk of infection. Treatment with antibiotics is essential if the appendix has ruptured before surgery.

Patients who have not yet been evaluated by a surgeon should not be given pain relievers, as they may mask the underlying symptoms. After surgery, however, patients are given pain relievers and antiemetics (drugs to prevent **nausea and vomiting**) as needed. Patients may be given **narcotics** (opioids, most often morphine or oxycodone) for severe pain but are encouraged to use NSAIDs (naproxen or ibuprofen) as soon as possible, as narcotic pain relievers often cause constipation. Patients should not drive or drink alcohol for at least two days after returning home because drowsiness is another common side effect of opioids.

Prognosis

Most people do very well after an appendectomy if their appendix was removed before it ruptured; about 10 percent will have complications after surgery. The average hospital stay is between 1 and 3 days after the operation but full recovery at home may take 2–6 weeks before the patient can return to vigorous **exercise** or lifting heavy objects. Patients are usually

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advised to eat a light diet and drink plenty of fluids (8–10 glasses per day) during recovery at home.

The mortality rate for appendicitis in the United States is very low, between 0.2 and 0.8 percent of patients; most of these deaths are caused by complications of peritonitis rather than by the appendectomy itself. The rate of complications in appendicitis increases tenfold if the appendix bursts before surgery. There are higher rates of perforation and mortality among children and elderly persons.

Prevention

There is some evidence that people from cultures whose diets have a high level of fiber (the part of plants that is not digested) are less likely to develop appendicitis than those whose diets are low in fiber. It is thought that higher levels of fiber in the diet help the intestines push food along more efficiently, thus lowering the likelihood that the appendix will become blocked by fecal matter. Apart from increasing the amount of fiber in one's diet through eating more vegetables, however, there is no definitive way to predict or prevent appendicitis.

Health care team roles

A physician, physician assistant, or nurse practitioner usually makes an initial diagnosis of appendicitis based on history, physical findings, and laboratory results. A laboratory technician may provide a test that confirms a diagnosis. A surgeon removes an appendix. Nurses assist by collecting data from the patient and family, monitoring vital signs and status of pain, and providing patient education about the diagnosis, surgery, and recovery.

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American College of Gastroenterology (ACG), P.O. Box 342260, Bethesda, MD, 20827-2260 301-263-9000, http://www.acg.gi.org/.

American College of Surgeons (ACS), 633 North Saint Clair Street, Chicago, IL, 60611-3211 312-202-5000 800-621-4111 312-202-5001, postmaster@facs.org, http://www.facs.org/.

National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), Building 31. Rm 9A06, 31 Center Drive, MSC 2560, Bethesda, MD, 20892-2560 301-496-3583, http://www2.niddk.nih.gov.

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Appendix removal *see* **Appendectomy**

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Appetite-stimulant drugs

Definition

Appetite stimulant drugs are medicines used to increase the desire to eat.

Purpose

These drugs are sometimes used to treat people who are very elderly or have chronic, debilitating diseases like **cancer** or HIV/AIDS to stimulate them eat enough food to preserve their strength and keep from losing weight.

Description

Two drugs, megesterol (Megace) and dronabinol (Marinol) are FDA approved as appetite stimulants for people with **AIDS**. None are approved, but are sometimes used, to increase appetites in the elderly or those suffering from cancer or other chronic, debilitating conditions.

Megace is available in capsule and liquid form. Marinol is available as capsules.

Recommended dosage

Doses depend on the conditions being treated and the condition of patients at the time of treatment.

Precautions

Megestrol (Megace)

Megace is a hazardous agent with precautions for appropriate handling and disposal.

With prolonged use, this drug may lower the ability of the body to respond to **stress**. It may produce or worsen existing diabetes.

This drug should be used with caution by people who have had **blood clots** or emboli.

Dronabinol (Marinol)

This drug should be used with caution in patients with seizure disorders or liver diseases.

Marinol may increase the effects of sedative or tranquiling drugs.

Side effects

Megestrol (Megace)

Adverse effects include high blood pressure, chest **pain**, swelling of the feet and legs, **headache**, mood changes, lethargy, skin rash, **nausea**, **diarrhea**, abdominal pain, **constipation**, weakness, and **shortness of breath**.

Drabinol (Marinol)

This drug may cause flushing and **palpitations**, **dizziness**, giddiness, distorted thinking, confusion, lack of muscle coordination, nausea, **vomiting**, abdominal pain, and weakness.

Interactions

Megestrol (Megace)

This drug should not be used with dofetilide (Tikosyn), as fatal heart **arrhythmias** may occur.

Dronabinol (Marinol)

Alcohol will increase the effects of this drug on the mind and muscle coordination.

James Waun MD, RPh

Applied kinesiology *see* **Kinesiology, applied**

Apraxia

Definition

Apraxia is neurological condition characterized by loss of the ability to perform activities that a person is physically able and willing to do.

Description

Apraxia is caused by brain damage related to conditions such as **head injury**, **stroke**, **brain tumor**, and **Alzheimer's disease**. The damage affects the brain's ability to correctly signal instructions to the body. Forms of apraxia include the inability to say some words or make gestures.

Various conditions cause apraxia, and it can affect people of all ages. A baby might be born with the condition. A car accident or fall that resulted in head trauma could lead to apraxia.

From 500,000 to 750,000 people need to be hospitalized each year for head injuries according to the American Medical Association (AMA). Men between the ages of 18 and 24 form the largest group of people with head injuries. While not all severe injuries result in apraxia, men in that age group are at risk.

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KEY TERMS

CT scanning—Computer tomography scanning is a diagnostic imaging tool that uses x rays sent through the body at different angles.

MRI—Magnetic resonance imaging is a diagnostic imaging tool that utilizes an electromagnetic field and radio waves.

Risk factors for strokes include high blood pressure, diabetes, and heart disease. Cigarette **smoking** also puts a person at risk for a stroke. Brain tumors are abnormal tissue growths in the skull. They may be secondary tumors caused by the spread of **cancer** through the body.

There is more than one type of apraxia, and a person may have one or more form of this condition. A milder form of apraxia is called dyspraxia.

Causes and symptoms

Apraxia is caused by conditions that affect parts of the brain that control movements. Apraxia is a result of damage to the brain's cerebral hemispheres. These are the two halves of the cerebrum and are the location of brain activities such as voluntary movements.

Apraxia causes a lapse in carrying out movements that a person knows how to do, is physically able to perform, and wants to do. A person may be willing and able to do something like bathe. However, the brain does not send the signals that allow the person to perform the necessary sequence of activities to do this correctly.

Types of apraxia

There are several types of apraxia, and a patient could be diagnosed with one or more forms of this condition. The types of apraxia include:

- Buccofacial or orofacial apraxia is the inability of a person to follow through on commands involving face and lip motions. These activities include coughing, licking the lips, whistling, and winking. Also known as facial-oral apraxia, it is the most common form of apraxia, according to the National Institute of Neurological Disorders and Stroke (NINDS).
- Limb-kinetic apraxia is the inability to make precise movements with an arm or leg.
- Ideomotor apraxia is the inability to make the proper movement in response to a command to pantomime an activity like waving.
- Constructional apraxia is the inability to copy, draw, or build simple figures.
- Ideational apraxia is the inability to do an activity that involves performing a series of movements in a sequence. A person with this condition could have trouble dressing, eating, or bathing. It is also known as conceptual apraxia.
- Oculomotor apraxia is characterized by difficulty moving the eyes.
- Verbal apraxia is a condition involving difficulty coordinating mouth and speech movements. It is referred to as apraxia of speech by organizations including the American Speech Language Hearing Association (ASHA).

A baby who does not coo or babble may display a symptom of apraxia of speech, according to ASHA. A young child may only say a few consonant sounds, and an older child may have difficulty imitating speech. An adult also has this difficulty. Other symptoms include saying the wrong words. A person wants to say "kitchen," but says "bipem" instead, according to an ASHA report.

A person diagnosed with apraxia may also have **aphasia**, a condition caused by damage to the brain's speech centers. This results in difficulty reading, witting, speaking, and understanding when others speak.

Post-apraxia changes

A person with apraxia could experience frustration about difficulty communicating or trouble performing tasks. In some cases, the condition could affect the person's ability to live independently.

Diagnosis

Diagnosis of apraxia could begin with testing of its underlying cause. Testing for conditions like a stroke or cancer includes the MRI (**magnetic resonance imaging**) and CT scanning (computer tomography scanning). A **brain biopsy** is used to measure changes caused by Alzheimer's disease. In all cases, the physician takes a family history. Head trauma that could cause apraxia is first treated in the emergency room.

Other diagnostic treatment is related to identifying the type of apraxia. For example, the physician may ask the patient to demonstrate how to blow out a candle, wave, use a fork, or use a toothbrush.

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Assessment for speech apraxia in children includes a hearing evaluation to determine if difficulty in speaking is related to a **hearing loss**. If the condition appears related to apraxia, a speech-language pathologist examines muscle development in the jaw, lips, and tongue. The examination of adults and children includes an evaluation of how words are pronounced individually and in conversation. The pathologist observes how the patient breathes when speaking and the ability to perform actions like smiling.

The costs of diagnosis vary because the process could include examinations and diagnostic screening related to the underlying cost of the apraxia. Insurance generally covers part of these costs.

Treatment

The treatment for apraxia usually involves **rehabilitation** through speech-language therapy, **physical therapy**, or **occupational therapy**. In addition, treatment such as **chemotherapy** is administered for the condition that caused the apraxia.

Family education is an important component of apraxia treatment. The rehabilitation process takes time, and relatives can offer encouragement and support to the patient. They may be asked to help the patient with in-home exercises. Furthermore, family members sometimes need to take on the role of caregivers.

Speech-language therapy

Speech-language therapy focuses on helping the patients learn or regain communication skills. Therapists teach exercises to strengthen facial muscles used in speech. Other exercises concentrate on patients learning to correctly pronounce sounds and then turn those sounds into words.

In cases where apraxia limits the ability to speak, therapists help patients develop alternate means of communication. These alternatives range from gesturing to using a portable computer that writes and produces speech, according to ASHA.

Occupational and physical therapies

Occupational and physical therapies focus on helping patients regain the skills impaired by apraxia. Physical therapy exercises concentrate on areas such as mobility and balance. Occupational therapy helps patients relearn daily living skills.

Treatment costs

The costs of therapy vary by the type of treatment, regional location, and where the therapy is offered. Fees can range for $40 per hour for in-office **speech therapy** for a child to $85 per hour for in-home physical or occupational therapy for a senior citizen. Part of therapy costs may be covered by insurance.

Alternative treatment

Most alternative treatments target Alzheimer's disease and other conditions that cause apraxia. Herbal remedies thought to help people with Alzheimer's include **ginkgo biloba**, a plant extract. However, organizations including the Alzheimer's Association caution that the effectiveness and safety of this herbal remedy has not been evaluated by the U.S. Food and Drug Administration. The government does not require a review of supplements like ginkgo. Furthermore, there is a risk of internal bleeding if ginkgo is taken in combination with **aspirin** and blood-thinning medications.

Prognosis

The prognosis for apraxia depends on factors such as what caused the condition. While Alzheimer's is a degenerative condition, a child with verbal apraxia or a stroke patient could make progress.

In some cases, treatment helps a person to relearn or acquire skills needed to function. A caregiver may be required, and some people with **dementia** require supervised, long-term care.

Prevention

The methods of preventing apraxia focus on preventing the underlying causes of this condition. This may not be entirely possible when there is a family history of conditions such as stroke, dementia, and cancer. However, a person at risk by not smoking, exercising, and eating a diet based on the American Heart Association guidelines.

Head injury can be prevented by wearing a helmet when participating in activities like sports and bicycling. Wearing a seatbelt when in a vehicle also helps reduce the risk of head injury.

Resources

OTHER

"Apraxia in Adults." American Speech Language Hearing Association. 2005. [cited March 29, 2005]. http://www. asha.org/public/speech/disorders/apraxia_adults.htm.

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Jacobs, Daniel H., M.D. "Apraxia and Related Syndromes." e-medicine. October 27, 2004 [cited March 29, 2005]. http://www.emedicine.com/neuro/topic438.htm.
"NINDS Apraxia Information Page." National Institute of Neurological Disorders and Stroke. February 09, 2005 [cited March 29, 2005]. http://www.ninds.nih.gov/disorders/apraxia/apraxia.htm.

ORGANIZATIONS

Alzheimer's Association, 225 N. Michigan Ave., Fl. 17, Chicago, IL, 60601-7633, (312) 335-8700, (866) 699-1246, (800) 272-3900, info@alz.org, http://www.alz.org.This website is an excellent resource for anyone with a loved one suffering from Alzheimer's or another dementing illness.
American Speech Language Hearing Association, 2200 Research Boulevard , Rockville, MD, 20850-3289, (301) 296-5700, (301) 296-8580, (800) 638-8255, actioncenter@asha.org, http://asha.org/.
National Institute of Neurological Disorders and Stroke (NINDS), NIH Neurological Institute, P. O. Box 5801, Bethesda, MD, 20824, (301) 496-5751, (800) 352-9424, http://www.ninds.nih.gov/.
National Rehabilitation Information Center, 8201 Corporate Drive, Suite 600, Landover, MD, 20785, (800) 346-2742, naricinfo@heitechservices.com, http://www.naric.com.
National Stroke Association, 9707 E Easter Lane Building B, Centennial, CO, 80112, (303) 649-1328, (800) 787-6537, Info@stroke.org, http://www.stroke.org.

Liz Swain

APSGN *see* **Acute poststreptococcal glomerulonephritis**

APTT *see* **Partial thromboplastin time**

Arachnodactyly *see* **Marfan syndrome**

Arbovirus encephalitis

Definition

Encephalitis is a serious inflammation of the brain, Arbovirus encephalitis is caused by a virus from the Arbovirus group. The term *arbovirus* stands for *Arthro-pod-borne virus* because these viruses are passed to humans by members of the phylum Arthropoda (which includes insects and spiders).

KEY TERMS

Arthropods—A phylum name referring to certain insects (including mosquitoes and ticks) and spiders.

Encephalitis—A condition in which the brain swells.

Description

Of the huge number of arboviruses known to exist, about 80 types are responsible for human disease. In addition to the virus, there are usually two other types of living creatures involved in the cycle leading to human disease. When large quantities of virus are present in an arthropod (often a tick or mosquito), the viruses are passed to a bird or small mammal when the arthropod attempts to feed on the blood of that creature. The virus thrives within the new host, sometimes causing illness, sometimes not. More ticks or mosquitoes are infected with the virus when they feed on the host's blood. Eventually, a tick or mosquito **bites** a human, and the virus is passed along. Just a few types of arboviruses cycle only between arthropods and humans, with no intermediate stop in a bird or small mammal.

Because the arboviruses require an arthropod to pass them along to humans, the most common times of year for these illnesses include summer and fall, when mosquitoes and ticks are most prevalent. Damp environments favor large populations of mosquitoes, and thus also increase the risk of arbovirus infections.

The major causes of arbovirus encephalitis include the members of the viral families alphavirus (causing Eastern equine encephalitis, Western equine encephalitis, and Venezuelan equine encephalitis), flavivirus (responsible for St. Louis encephalitis, **Japanese encephalitis**, Tick-borne encephalitis, Murray Valley encephalitis, Russian spring-summer encephalitis, and Powassan), and bunyavirus (causing California encephalitis).

In the United States, the most important types of arbovirus encephalitis include Western equine encephalitis (WEE), Eastern equine encephalitis (EEE), St. Louis encephalitis, and California encephalitis. WEE strikes young infants in particular, with a 5% chance of **death** from the illness. Of those who survive, about 60% suffer permanent brain damage. EEE strikes infants and children, with a 20% chance of death, and a high rate of permanent brain damage among survivors. St. Louis encephalitis tends to strike

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adults older than 40 years of age, and older patients tend to have higher rates of death and long-term disability from the infection. California virus primarily strikes 5-18 year olds, with a lower degree of permanent brain damage.

Causes and symptoms

Encephalitis occurs because specific arboviruses have biochemical characteristics which cause them to be particularly attracted to the cells of the brain and the nerves. The virus causes cell death and inflammation, with **fever** and swelling within the brain and nerves. The membranous coverings of the brain and spinal cord (the meninges) may also become inflamed, a condition called **meningitis**. The brain is swollen, and patches of bleeding occur throughout the brain and spinal cord.

Patients with encephalitis suffer from headaches, fever, **nausea and vomiting**, stiff neck, and sleepiness. As the disease progresses, more severe symptoms develop, including **tremors**, confusion, seizures, **coma**, and **paralysis**. Loss of function occurs when specific nerve areas are damaged and/or killed.

Diagnosis

Early in the disease, laboratory testing of blood may reveal the presence of the arbovirus. The usual technique used to verify the presence of arbovirus involves injecting the patient's blood into the brain of a newborn mouse, then waiting to see if the mouse develops encephalitis. Diagnosis is usually based on the patient's symptoms, history of tick or mosquito bites, and knowledge that the patient has been in an area known to harbor the arbovirus.

Treatment

Treatment is mostly supportive, meaning it is directed at improving the symptoms, but does not shorten the course of the illness. The main concerns of treatment involve lowering fever, treating **pain**, avoiding **dehydration** or other chemical imbalances, and decreasing swelling in the brain with **steroids**.

Prognosis

Prognosis depends on the particular type of arbovirus causing disease, and on the age and prior health status of the patient. Death rates range all the way up to 20% for arbovirus encephalitis, and the rates of lifelong effects due to brain damage reach 60% for some types of arboviruses.

Prevention

Prevention involves avoiding contact with arthropods which carry these viruses. This means wearing appropriate insect repellents, and dressing properly in areas known to be infested. Insecticides and the avoidance of collections of standing water (which are good breeding ground for arthropods) is also effective at decreasing arthropod populations.

There are immunizations available against EEE and WEE. These have primarily been used to safeguard laboratory workers who have regular exposure to these viruses.

Resources

BOOKS

Stoffman, Phyllis, and Susan Champion. *Is It Catching? Visiting Nurse Service of New York Family Guide to Preventing & Treating 100 Infectious Diseases*. 2nd ed. New York: New York Visiting Nurse Service, 2006.

Rosalyn Carson-DeWitt MD

ARDS *see* **Adult respiratory distress syndrome**

Aromatherapy

Definition

Aromatherapy is the therapeutic use of plant-derived, aromatic essential oils to promote physical and psychological well-being. It is sometimes used in combination with massage and other therapeutic techniques as part of a holistic treatment approach.

Purpose

Aromatherapy offers diverse physical and psychological benefits, depending on the essential oil or oil combination and method of application used. Some common medicinal properties of essential oils used in aromatherapy include: analgesic, antimicrobial, antiseptic, anti-inflammatory, astringent, antispasmodic, expectorant, diuretic, and sedative. Essential oils are used to treat a wide range of symptoms and conditions, including, but not limited to, gastrointestinal discomfort, skin conditions, menstrual **pain** and irregularities, stress-related conditions, **mood disorders**, circulatory problems, respiratory infections, and **wounds**.

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Examples of aromatherapy oils

Name	Description	Conditions treated
Bay laurel	Antiseptic, diuretic, sedative, etc.	Bronchitis, common cold, digestive problems, influenza, and scabies and lice (CAUTION: Don't use if pregnant.)
Chamomile	Anti-inflammatory, antiseptic, pain reliever, and sedative	Acne, arthritis, burns, digestive problems, hay fever, menstrual and menopausal symptoms, and sunburn.
Clary sage	Anticonvulsive, anti-inflammatory, antiseptic, and relaxant	Anxiety, burns, eczema, and menstrual and menopausal symptoms (CAUTION: Don't use if pregnant.)
Eucalyptus	Analgesic, antibacterial, antiseptic, astringent, and expectorant	Boils, breakouts, common cold, cough, influenza, and sinusitis (CAUTION: Not to be taken orally.)
Lavender	Analgesic, antiseptic, calming/soothing	Depression, headache, insomnia, nausea, sprains, and stress
Peppermint	Pain reliever	Headache, indigestion, motion sickness, muscle pain, and nausea
Rosemary	Antiseptic, diuretic, and stimulant	Bronchitis, fluid retention, gas, indigestion, and influenza (CAUTION: Don't use if pregnant or have epilepsy or hypertension.)
Tarragon	Antispasmodic, diuretic, laxative, and stimulant	Gas, indigestion, and menstrual and menopausal symptoms (CAUTION: Don't use if pregnant.)
Tea tree	Antiseptic and soothing	Abscesses, acne, bronchitis, burns, common cold, and vaginitis
Thyme	Antibacterial, antiseptic, antispasmodic, and stimulant	Cough, diarrhea, gas, intestinal worms, laryngitis (CAUTION: Don't use if pregnant or have hypertension.)

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Description

Origins

Aromatic plants have been employed for their healing, preservative, and pleasurable qualities throughout recorded history in both the East and West. As early as 1500 B.C. the ancient Egyptians used waters, oils, incense, resins, and ointments scented with botanicals for their religious ceremonies.

There is evidence that the Chinese may have recognized the benefits of herbal and aromatic remedies much earlier than this. The oldest known herbal text, Shen Nung's *Pen Ts'ao* (c. 2700-3000 B.C.) catalogs over 200 botanicals. Ayurveda, a practice of traditional Indian medicine that dates back over 2,500 years, also used aromatic herbs for treatment.

The Romans were well-known for their use of fragrances. They bathed with botanicals and integrated them into their state and religious rituals. So did the Greeks, with a growing awareness of the medicinal properties of herbs, as well. Greek physician and surgeon Pedanios Dioscorides, whose renown herbal text *De Materia Medica* (60 A.D.) was the standard textbook for Western medicine for 1,500 years, wrote extensively on the medicinal value of botanical aromatics. The *Medica* contained detailed information on over 500 plants and 4,740 separate medicinal uses for them, including an entire section on aromatics.

Written records of herbal distillation are found as early as the first century A.D., and around 1000 A.D., the noted Arab physician and naturalist Avicenna described the distillation of rose oil from rose petals, and the medicinal properties of essential oils in his writings. However, it wasn't until 1937, when French chemist René-Maurice Gattefossé published *Aromatherapie: Les Huiles essentielles, hormones végé tales*, that aromatherapie, or aromatherapy, was introduced in Europe as a medical discipline. Gattefossé, who was employed by a French perfumeur, discovered the healing properties of lavender oil quite by accident when he suffered a severe burn while working and used the closest available liquid, lavender oil, to soak it in.

In the late 20th century, French physician Jean Valnet used botanical aromatics as a front line treatment for wounded soldiers in World War II. He wrote about his use of essential oils and their healing and antiseptic properties, in his 1964 book *Aromatherapie, traitement des maladies par les essences des plantes*, which popularized the use of essential oils for medical and psychiatric treatment throughout France. Later, French biochemist Mauguerite Maury popularized the cosmetic benefits of essential oils, and in 1977 Robert Tisserand wrote the first English language book on the subject, *The Art of Aromatherapy*, which introduced massage as an adjunct treatment to aromatherapy and sparked its popularity in the United Kingdom.

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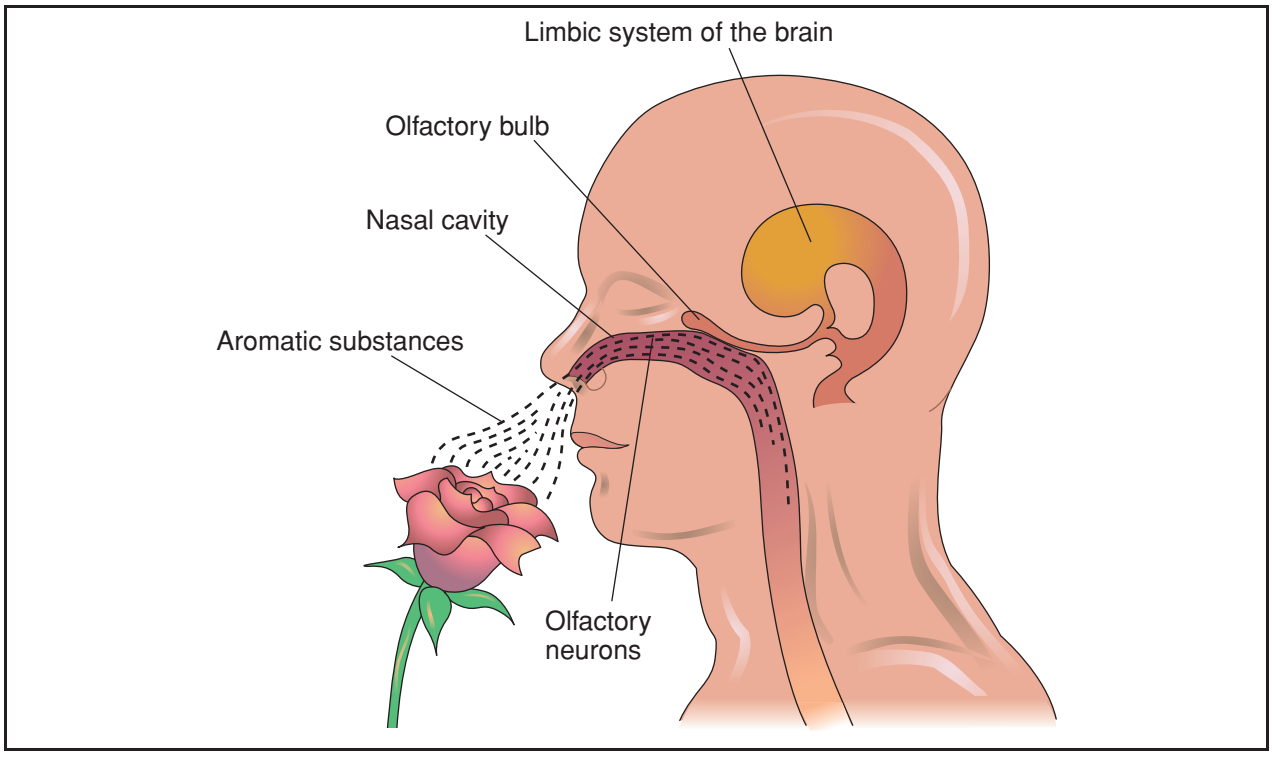

As a holistic therapy, aromatherapy is believed to benefit both the mind and body. Here, the aromatic substances from a flower stimulates the olfactory bulb and neurons. The desired emotional response (such as relaxation) is activated from the limbic system of the brain. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

In aromatherapy, essential oils are carefully selected for their medicinal properties. As essential oils are absorbed into the bloodstream through application to the skin or inhalation, their active components trigger certain pharmalogical effects (e.g., pain relief).

In addition to physical benefits, aromatherapy has strong psychological benefits. The volatility of an oil, or the speed at which it evaporates in open air, is thought to be linked to the specific psychological effect of an oil. As a rule of thumb, oils that evaporate quickly are considered emotionally uplifting, while slowly-evaporating oils are thought to have a calming effect.

Essential oils commonly used in aromatherapy treatment include:

- Roman chamomile (*Chamaemelum nobilis*). An anti-inflammatory and analgesic. Useful in treating otitis media (earache), skin conditions, menstrual pains, and depression.
- Clary sage (*Salvia sclarea*). This natural astringent is not only used to treat oily hair and skin, but is also said to be useful in regulating the menstrual cycle, improving mood, and controlling high blood pressure. Clary sage should not be used by pregnant women.
- Lavender (*Lavandula officinalis*). A popular aromatherapy oil which mixes well with most essential oils, lavender has a wide range of medicinal and cosmetic applications, including treatment of insect bites, burns, respiratory infections, intestinal discomfort, nausea, migraine, insomnia, depression, and stress.
- Myrtle (*Myrtus communis*). Myrtle is a fungicide, disinfectant, and antibacterial. It is often used in steam aromatherapy treatments to alleviate the symptoms of whooping cough, bronchitis, and other respiratory infections.
- Neroli (bitter orange), (*Citrus aurantium*). Citrus oil extracted from bitter orange flower and peel and used to treat sore throat, insomnia, and stress and anxiety-related conditions.
- Sweet orange (*Citrus sinensis*). An essential oil used to treat stomach complaints and known for its reported ability to lift the mood while relieving stress.

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KEY TERMS

Antiseptic—Inhibits the growth of microorganisms.

Bactericidal—An agent that destroys bacteria (e.g., *Staphylococci aureus, Streptococci pneumoniae, Escherichia coli, Salmonella enteritidis*).

Carrier oil—An oil used to dilute essential oils for use in massage and other skin care applications.

Contact dermatitis—Skin irritation as a result of contact with a foreign substance.

Essential oil—A volatile oil extracted from the leaves, fruit, flowers, roots, or other components of a plant and used in aromatherapy, perfumes, and foods and beverages.

Holistic—A practice of medicine that focuses on the whole patient, and addresses the social, emotional, and spiritual needs of a patient as well as their physical treatment.

Phototoxic—Causes a harmful skin reaction when exposed to sunlight.

Remedy antidote—Certain foods, beverages, prescription medications, aromatic compounds, and other environmental elements that counteract the efficacy of homeopathic remedies.

Steam distillation—A process of extracting essential oils from plant products through a heating and evaporation process.

Volatile—Something that vaporizes or evaporates quickly when exposed to air.

- Peppermint (*Mentha piperita*). Relaxes and soothes the stomach muscles and gastrointestinal tract. Peppermint's actions as an anti-inflammatory, antiseptic, and antimicrobial also make it an effective skin treatment, and useful in fighting cold and flu symptoms.
- Rosemary (*Rosmarinus officinalis*). Stimulating essential oil used to treat muscular and rheumatic complaints, as well as low blood pressure, gastrointestinal problems, and headaches.
- Tea tree (*Melaleuca alternifolia*). Has bactericidal, virucidal, fungicidal, and anti-inflammatory properties that make it a good choice for fighting infection. Recommended for treating sore throat and respiratory infections, vaginal and bladder infections, wounds, and a variety of skin conditions.
- Ylang ylang (*Cananga odorata*). A sedative essential oil sometimes used to treat hypertension and tachycardia.

Essential oils contain active agents that can have potent physical effects. While some basic aromatherapy home treatments can be self-administered, medical aromatherapy should always be performed under the guidance of an aromatherapist, herbalist, massage therapist, nurse, or physician.

Inhalation

The most basic method of administering aromatherapy is direct or indirect inhalation of essential oils. Several drops of an essential oil can be applied to a tissue or handkerchief and gently inhaled. A small amount of essential oil can also be added to a bowl of hot water and used as a steam treatment. This technique is recommended when aromatherapy is used to treat respiratory and/or skin conditions. Aromatherapy steam devices are also available commercially. A warm bath containing essential oils can have the same effect as steam aromatherapy, with the added benefit of promoting relaxation. When used in a bath, water should be lukewarm rather than hot to slow the evaporation of the oil.

Essential oil diffusers, vaporizers, and light bulb rings can be used to disperse essential oils over a large area. These devices can be particularly effective in aromatherapy that uses essential oils to promote a healthier home environment. For example, eucalyptus and tea tree oil are known for their antiseptic qualities and are frequently used to disinfect sickrooms, and citronella and geranium can be useful in repelling insects.

Direct application

Because of their potency, essential oils are diluted in a carrier oil or lotion before being applied to the skin to prevent an allergic skin reaction. The carrier oil can be a vegetable or olive based one, such as wheat germ or avocado. Light oils, such as safflower, sweet almond, grapeseed, hazelnut, apricot seed, or peach kernel, may be absorbed more easily by the skin. Standard dilutions of essential oils in carrier oils range from 2–10%. However, some oils can be used at higher concentrations, and others should be diluted further for safe and effective use. The type of carrier oil used and the therapeutic use of the application may also influence how the essential oil is mixed.

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Individuals should seek guidance from a healthcare professional and/or aromatherapist when diluting essential oils.

Massage is a common therapeutic technique used in conjunction with aromatherapy to both relax the body and thoroughly administer the essential oil treatment. Essential oils can also be used in hot or cold compresses and soaks to treat muscle aches and pains (e.g., lavender and ginger). As a **sore throat** remedy, antiseptic and soothing essential oils (e.g., tea tree and sage) can be thoroughly mixed with water and used as a gargle or mouthwash.

Internal use

Some essential oils can be administered internally in tincture, infusion, or suppository form to treat certain symptoms or conditions; however, this treatment should never be self-administered. Essential oils should only be taken internally under the supervision of a qualified healthcare professional.

As non-prescription botanical preparations, the essential oils used in aromatherapy are typically not paid for by health insurance. The self-administered nature of the therapy controls costs to some degree. Aromatherapy treatment sessions from a professional aromatherapist are not covered by health insurance in most cases, although aromatherapy performed in conjunction with **physical therapy**, nursing, therapeutic massage, or other covered medical services may be. Individuals should check with their insurance provider to find out about their specific coverage.

The adage "You get what you pay for" usually applies when purchasing essential oils, as bargain oils are often adulterated, diluted, or synthetic. Pure essential oils can be expensive; and the cost of an oil will vary depending on its quality and availability.

Preparations

The method of extracting an essential oil varies by plant type. Common methods include water or steam distillation and cold pressing. Quality essential oils should be unadulterated and extracted from pure botanicals. Many aromatherapy oils on the market are synthetic and/or diluted, contain solvents, or are extracted from botanicals grown with pesticides or herbicides. To ensure best results, essential oils should be made from pure organic botanicals and labeled by their full botanical name. Oils should always be stored dark bottles out of direct light.

Before using essential oils on the skin, individuals should perform a skin patch test by applying a small amount of the diluted oil behind the wrist and covering it with a bandage or cloth for up to 12 hours. If redness or irritation occurs, the oil should be diluted further and a second skin test performed, or it should be avoided altogether. Individuals should never apply undiluted essential oils to the skin unless advised to do so by a trained healthcare professional.

Precautions

Individuals should only take essential oils internally under the guidance and close supervision of a health-care professional. Some oils, such as eucalyptus, wormwood, and sage, should never be taken internally. Many essential oils are highly toxic and should never be used at all in aromatherapy. These include (but are not limited to) bitter almond, pennyroyal, mustard, sassafras, rue, and mugwort.

Citrus-based essential oils, including bitter and sweet orange, lime, lemon, grapefruit, and tangerine, are phototoxic, and exposure to direct sunlight should be avoided for at least four hours after their application.

Other essential oils, such as cinnamon leaf, black pepper, juniper, lemon, white camphor, eucalyptus blue gum, ginger, peppermint, pine needle, and thyme can be extremely irritating to the skin if applied in high enough concentration or without a carrier oil or lotion. Caution should always be exercised when applying essential oils topically. Individuals should never apply undiluted essential oils to the skin unless directed to do so by a trained healthcare professional and/or aromatherapist.

Individuals taking homeopathic remedies should avoid black pepper, camphor, eucalyptus, and peppermint essential oils. These oils may act as a remedy antidote to the homeopathic treatment.

Children should only receive aromatherapy treatment under the guidance of a trained aromatherapist or healthcare professional. Some essential oils may not be appropriate for treating children, or may require additional dilution before use on children.

Certain essential oils should not be used by pregnant or nursing women or by people with specific illnesses or physical conditions. Individuals suffering from any chronic or acute health condition should inform their healthcare provider before starting treatment with any essential oil.

Asthmatic individuals should not use steam inhalation for aromatherapy, as it can aggravate their condition.

Essential oils are flammable, and should be kept away from heat sources.

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Side effects

Side effects vary by the type of essential oil used. Citrus-based essential oils can cause heightened sensitivity to sunlight. Essential oils may also cause **contact dermatitis**, an allergic reaction characterized by redness and irritation. Anyone experiencing an allergic reaction to an essential oil should discontinue its use and contact their healthcare professional for further guidance. Individuals should do a small skin patch test with new essential oils before using them extensively (see "Preparations" above).

Research and general acceptance

The antiseptic and bactericidal qualities of some essential oils (such as tea tree and peppermint) and their value in fighting infection has been detailed extensively in both ancient and modern medical literature.

Recent research in mainstream medical literature has also shown that aromatherapy has a positive psychological impact on patients, as well. Several clinical studies involving both post-operative and chronically ill subjects showed that massage with essential oils can be helpful in improving emotional well-being, and consequently, promoting the healing process.

Today, the use of holistic aromatherapy is widely accepted in Europe, particularly in Great Britain, where it is commonly used in conjunction with massage as both a psychological and physiological healing tool. In the United States, where aromatherapy is often misunderstood as solely a cosmetic treatment, the mainstream medical community has been slower to accept it.

Resources

BOOKS

Price, Shirley, and Len Price. *Aromatherapy for Health Professionals*. 3rd ed. New York: Churchill Livingstone, 2006.

ORGANIZATIONS

National Association of Holistic Aromatherapy, PO Box 1868, Banner Elk, NC, 28604, (828) 898-6161, (828) 898-1965, info@naha.org, http://www.naha.org.

Paula Anne Ford-Martin

Arrhythmias

Definition

An arrhythmia is an abnormality in the heart's rhythm, or heartbeat pattern. The heartbeat can be too slow, too fast, have extra beats, skip a beat, or otherwise beat irregularly.

Description

Arrhythmias are deviations from the normal cadence of the heartbeat, which cause the heart to pump improperly. The normal heartbeat starts in the right atrium, where the heart's natural pacemaker (the sinus node) sends an electrical signal to the center of the heart to the atrioventricular node. The atrioventricular node then sends signals into the main pumping chamber to make the ventricle contract. Arrhythmias occur when the heartbeat starts in a part of the heart other than the sinus node, an abnormal rate or rhythm develops in the sinus node, or a heart conduction "block" prevents the electrical signal from traveling down the normal pathway.

More than four million Americans have arrhythmias, most of which are harmless. Middle-aged adults commonly experience arrhythmias. As people age, the probability of experiencing an arrhythmia increases. Arrhythmias often occur in people who do not have heart disease. In people with heart disease, it is usually the heart disease which is dangerous, not the arrhythmia. Arrhythmias often occur during and after heart attacks. Some types of arrhythmias, such as **ventricular tachycardia**, are serious and even life threatening. In the United States, arrhythmias are the primary cause of **sudden cardiac death**, accounting for more than 350,000 deaths each year.

Slow heart rates (less than 60 beats per minute) are called bradycardias, while fast heart rates (more than 100 beats per minute) are called tachycardias. Bradycardia can result in poor circulation of blood, and, hence, a lack of oxygen throughout the body, especially the brain. Tachycardias also can compromise the heart's ability to pump effectively because the ventricles do not have enough time to completely fill.

Arrhythmias are characterized by their site of origin: the atria or the ventricles. Supraventricular arrhythmias occur in the upper areas of the heart and are less serious than ventricular arrhythmias. **Ventricular fibrillation** is the most serious arrhythmia and is fatal unless medical help is immediate.

Causes and symptoms

In many cases, the cause of an arrhythmia is unknown. Known causes of arrhythmias include heart disease, **stress**, **caffeine**, tobacco, alcohol, diet pills, and **decongestants** in **cough** and cold medicines.

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KEY TERMS

Bradycardia—A slow heart rate. Bradycardia is one of the two types of arrhythmia

Electrocardiogram—A test which uses electric sensors placed on the body to monitor the heartbeat.

Electrophysiology study—A test using cardiac catheterization to stimulate an electrical current to provoke an arrhythmia. The test identifies the origin of arrhythmias and is used to test the effectiveness of antiarrhythmic drugs.

Tachycardia—A fast heart rate. Tachycardia is one of the two types of arrhythmia.

Symptoms of an arrhythmia include a fast heartbeat, pounding or fluttering chest sensations, skipping a heartbeat, "flip-flops," **dizziness**, faintness, **shortness of breath**, and chest pains.

Diagnosis

Examination with a stethoscope, electrocardiograms, and electrophysiologic studies is used to diagnose arrhythmias. Sometimes arrhythmias can be identified by listening to the patient's heart through a stethoscope, but, since arrhythmias are not always present, they may not occur during the physical exam.

An electrocardiogram (ECG) shows the heart's activity and may reveal a lack of oxygen from poor circulation (**ischemia**). Electrodes covered with conducting jelly are placed on the patient's chest, arms, and legs. They send impulses of the heart's activity through an electrical activity monitor (oscilloscope) to a recorder that traces them on paper. The test takes about 10 minutes and is performed in a physician's office. Another type of ECG, commonly known as the exercise **stress test**, measures how the heart and blood vessels respond to exertion while the patient is exercising on a treadmill or a stationary bike. This test is performed in a physician's office or an exercise laboratory and takes 15-30 minutes. Other types of ECGs include 24-hour ECG monitoring and transtelephonic monitoring. In 24-hour ECG (Holter) monitoring, the patient wears a small, portable tape recorder connected to disks on his/her chest that record the heart's rhythm during daily activities. Transtelephonic monitoring can identify arrhythmias that occur infrequently. Similar to **Holter monitoring**, transtelephonic monitoring can continue for days or weeks, and it enables patients to send the ECG via telephone to a monitoring station when an arrhythmia is felt, or the patient can store the information in the recorder and transmit it later.

Electrophysiologic studies are invasive procedures performed in a hospital to identify the origin of serious arrhythmias and responses to various treatments. They involve **cardiac catheterization**, in which catheters tipped with electrodes are passed from a vein in the arm or leg through the blood vessels into the heart. The electrodes record impulses in the heart, highlighting where the arrhythmia starts. During the procedure, physicians can test the effects of various drugs by provoking an arrhythmia through the electrodes and trying different drugs. The procedure takes one to three hours, during which the patient is awake but mildly sedated. Local anesthetic is injected at the catheter insertion sites.

Treatment

Many arrhythmias do not require any treatment. For serious arrhythmias, treating the underlying heart disease sometimes controls the arrhythmia. In some cases, the arrhythmia itself is treated with drugs, electrical shock (**cardioversion**), automatic implantable defibrillators, artificial **pacemakers**, **catheter ablation**, or surgery. Supraventricular arrhythmias often can be treated with drug therapy. Ventricular arrhythmias are more complex to treat.

Drug therapy can manage many arrhythmias, but finding the right drug and dose requires care and can take some time. Common drugs for suppressing arrhythmias include beta blockers, **calcium channel blockers**, quinidine, digitalis preparations, and procainamide. Because of their potential serious side effects, stronger, desensitizing drugs are used only to treat life-threatening arrhythmias. All of the drugs used to treat arrhythmias have possible side effects, ranging from mild complications with beta blockers and calcium channel blockers to more serious effects of desensitizing drugs that can, paradoxically, cause arrhythmias or make them worse. Response to drugs is usually measured by ECG, Holter monitor, or electrophysiologic study.

In emergency situations, cardioversion or **defibrillation** (the application of an electrical shock to the chest wall) is used. Cardioversion restores the heart to its normal rhythm. It is followed by drug therapy to prevent recurrence of the arrhythmia.

Artificial pacemakers that send electrical signals to make the heart beat properly can be implanted under the skin during a simple operation. Leads from the pacemaker are anchored to the right side of the heart. Pacemakers are used to correct bradycardia and are sometimes used after surgical or catheter ablation.

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Automatic implantable defibrillators correct life-threatening ventricular arrhythmias by recognizing them and then restoring a normal heart rhythm by pacing the heart or giving it an electric shock. They are implanted within the chest wall without major surgery and store information for future evaluation by physicians. Automatic implantable defibrillators have proven to be more effective in saving lives than drugs alone. They often are used in conjunction with drug therapy.

Ablation, a procedure to alter or remove the heart tissue causing the arrhythmia in order to prevent a recurrence, can be performed through a catheter or surgery. Supraventricular tachycardia can be treated successfully with ablation. Catheter ablation is performed in a catheterization laboratory with the patient under **sedation**. A catheter equipped with a device that maps the heart's electrical pathways is inserted into a vein and is threaded into the heart. High-frequency radio waves are then used to remove the pathway(s) causing the arrhythmia. Surgical ablation is similar in principle but it is performed in a hospital, using a cold probe instead of radio waves to destroy tissue. Ablation treatments are used when medications fail.

Maze surgery treats **atrial fibrillation** by making multiple incisions through the atrium to allow electrical impulses to move effectively. This is often recommended for patients who have not responded to drugs or cardioversion.

Alternative treatment

Since some arrhythmias can be life threatening, a conventional medical doctor should always be consulted first. **Acupuncture** can correct an insignificant number (1.5%) of atrial fibrillation cases. For new, minor arrhythmias, acupuncture may be effective in up to 70% of cases, but this figure may not differ much from placebo therapy. Both western and Chinese herbal remedies are also used in the treatment of arrhythmias. Since hawthorn (*Crataegus laevigata*) dilates the blood vessels and stimulates the heart muscle, it may help to stabilize arrhythmias. It is gentle and appropriate for home use, unlike foxglove (*Digitalis purpurea*), an herb whose action on the heart is too potent for use without supervision by a qualified practitioner. Homeopathic practitioners may prescribe remedies such as *Lachesis* and aconite or monkshood (*Aconitum napellus*) to treat mild arrhythmias.

Prognosis

Advances in diagnostic techniques, new drugs, and medical technology have extended the lives of many patients with serious arrhythmias. Diagnostic techniques enable physicians to accurately identify arrhythmias, while new drugs, advances in pacemaker technology, the development of implantable defibrillators, and progress in ablative techniques offer effective treatments for many types of arrhythmia.

Prevention

Some arrhythmias can be prevented by managing stress, controlling **anxiety**, and avoiding caffeine, alcohol, decongestants, **cocaine**, and cigarettes.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review. personal.info@heart.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

Texas Heart Institute. Heart Information Service, MC 3-116, PO Box 20345, Houston, TX, 77225, (832) 355-4011, (800) 292-2221, http://www.texasheart.org.

Lori De Milto

Art therapy

Definition

Art therapy, sometimes called creative arts therapy or expressive arts therapy, encourages people to express and understand emotions through artistic expression and through the creative process.

Purpose

Art therapy provides the client-artist with critical insight into emotions, thoughts, and feelings. Key benefits of the art therapy process include:

- Self-discovery. At its most successful, art therapy triggers an emotional catharsis.
- Personal fulfillment. The creation of a tangible reward can build confidence and nurture feelings of self-worth. Personal fulfillment comes from both the creative and the analytical components of the artistic process.
- Empowerment. Art therapy can help people visually express emotions and fears that they cannot express through conventional means, and can give them some sense of control over these feelings.
- Relaxation and stress relief. Chronic stress can be harmful to both mind and body. Stress can weaken and damage the immune system, can cause insomnia

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A cancer patient applies papier-mâché to an intravenous drip stand during an art therapy session. *(Ronen Zvulun/Reuters/Landov.)*

KEY TERMS

Catharsis—Therapeutic discharge of emotional tension by recalling past events.

Mandala—A design, usually circular, that appears in religion and art. In Buddhism and Hinduism, the mandala has religious ritual purposes and serves as a yantra (a geometric emblem or instrument of contemplation).

Organic illness—A physically, biologically based illness.

and depression, and can trigger circulatory problems (like high blood pressure and irregular heartbeats). When used alone or in combination with other relaxation techniques such as guided imagery, art therapy can effectively relieve stress.

- Symptom relief and physical rehabilitation. Art therapy can also help patients cope with pain. This therapy can promote physiological healing when patients identify and work through anger, resentment, and other emotional stressors. It is often prescribed to accompany pain control therapy for chronically and terminally ill patients.

Description

Origins

Humans have expressed themselves with symbols throughout history. Masks, ritual pottery, costumes, other objects used in rituals, cave drawings, Egyptian hieroglyphics, and Celtic art and symbols are all visual records of self-expression and communication through art. Art has also been associated spiritual power, and artistic forms such as the Hindu and Buddhist mandala and Native American sand painting are considered powerful healing tools.

In the late nineteenth century, French psychiatrists Ambrose Tardieu and Paul-Max Simon both published studies on the similar characteristics of and symbolism in the artwork of the mentally ill. Tardieu and Simon viewed art therapy as an effective diagnostic tool to identify specific types of mental illness or traumatic events. Later, psychologists would use this diagnostic aspect to develop psychological drawing tests (the Draw-A-Man test, the Draw-A-Person Questionnaire [DAP.Q]) and projective personality tests involving visual symbol recognition (e.g., the Rorschach Inkblot Test, the **Thematic Apperception Test** [TAT], and the Holtzman Inkblot Test [HIT]).

The growing popularity of milieu therapies at psychiatric institutions in the twentieth century was an important factor in the development of art therapy in the United States. Milieu therapies (or environmental therapy) focus on putting the patient in a controlled therapeutic social setting that provides the patient with opportunities to gain self-confidence and interact with peers in a positive way. Activities that encourage self-discovery and empowerment such as art, music, dance, and writing are important components of this approach.

Educator and therapist Margaret Naumburg was a follower of both Freud and Jung, and incorporated art into **psychotherapy** as a means for her patients to visualize and recognize the unconscious. She founded the Walden School in 1915, where she used students' artworks in psychological counseling. She published extensively on the subject and taught seminars on the technique at New York University in the 1950s. Today, she is considered the founder of art therapy in the United States.

In the 1930s, Karl, William, and Charles Menninger introduced an art therapy program at their Kansas-based psychiatric hospital, the Menninger Clinic. The Menninger Clinic employed a number of artists in residence in the following years, and the facility was also considered a leader in the art therapy movement through the 1950s and 60s. Other noted art therapy pioneers who emerged in the 50s and 60s include Edith Kramer, Hanna Yaxa Kwiatkowska (National Institute of Mental Health), and Janie Rhyne.

Art therapy, sometimes called expressive art or art psychology, encourages self-discovery and emotional growth. It is a two part process, involving both the

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creation of art and the discovery of its meaning. Rooted in Freud and Jung's theories of the subconscious and unconscious, art therapy is based on the assumption that visual symbols and images are the most accessible and natural form of communication to the human experience. Patients are encouraged to visualize, and then create, the thoughts and emotions that they cannot talk about. The resulting artwork is then reviewed and its meaning interpreted by the patient.

The "analysis" of the artwork produced in art therapy typically allows patients to gain some level of insight into their feelings and lets them to work through these issues in a constructive manner. Art therapy is typically practiced with individual, group, or family psychotherapy (talk therapy). While a therapist may provide critical guidance for these activities, a key feature of effective art therapy is that the patient/artist, not the therapist, directs the interpretation of the artwork.

Art therapy can be a particularly useful treatment tool for children, who frequently have limited language skills. By drawing or using other visual means to express troublesome feelings, younger patients can begin to address these issues, even if they cannot identify or label these emotions with words. Art therapy is also valuable for adolescents and adults who are unable or unwilling to talk about thoughts and feelings.

Beyond its use in mental health treatment, art therapy is also used with traditional medicine to treat organic diseases and conditions. The connection between mental and physical health is well documented, and art therapy can promote healing by relieving **stress** and allowing the patient to develop coping skills.

Art therapy has traditionally centered on visual mediums, like paintings, sculptures, and drawings. Some mental healthcare providers have now broadened the definition to include music, film, dance, writing, and other types of artistic expression.

Art therapy is often one part of a psychiatric inpatient or outpatient treatment program, and can take place in individual or **group therapy** sessions. Group art therapy sessions often take place in hospital, clinic, shelter, and community program settings. These group therapy sessions can have the added benefits of positive social interaction, empathy, and support from peers. The client-artist can learn that others have similar concerns and issues.

Preparations

Before starting art therapy, the therapist may have an introductory session with the client-artist to discuss art therapy techniques and give the client the opportunity to ask questions about the process. The client-artist's comfort with the artistic process is critical to successful art therapy.

The therapist ensures that appropriate materials and space are available for the client-artist, as well as an adequate amount of time for the session. If the individual artist is exploring art as therapy without the guidance of a trained therapist, adequate materials, space, and time are still important factors in a successful creative experience.

The supplies used in art therapy are limited only by the artist's (and/or therapist's) imagination. Some of the materials often used include paper, canvas, poster board, assorted paints, inks, markers, pencils, charcoals, chalks, fabrics, string, adhesives, clay, wood, glazes, wire, bendable metals, and natural items (like shells, leaves, etc.). Providing artists with a variety of materials in assorted colors and textures can enhance their interest in the process and may result in a richer, more diverse exploration of their emotions in the resulting artwork. Appropriate tools such as scissors, brushes, erasers, easels, supply trays, glue guns, smocks or aprons, and cleaning materials are also essential.

An appropriate workspace should be available for the creation of art. Ideally, this should be a bright, quiet, comfortable place, with large tables, counters, or other suitable surfaces. The space can be as simple as a kitchen or office table, or as fancy as a specialized artist's studio.

The artist should have adequate time to become comfortable with and explore the creative process. This is especially true for people who do not consider themselves "artists" and may be uncomfortable with the concept. If performed in a therapy group or one-on-one session, the art therapist should be available to answer general questions about materials and/or the creative process. However, the therapist should be careful not to influence the creation or interpretation of the work.

Precautions

Art materials and techniques should match the age and ability of the client. People with impairments, such as traumatic brain injury or an organic neurological condition, may have difficulties with the self-discovery portion of the art therapy process depending on their level of functioning. However, they may still benefit from art therapy through the sensory stimulation it provides and the pleasure they get from artistic creation.

While art is accessible to all (with or without a therapist to guide the process), it may be difficult to tap the full potential of the interpretive part of art

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therapy without a therapist to guide the process. When art therapy is chosen as a therapeutic tool to cope with a physical condition, it should be treated as a supplemental therapy and not as a substitute for conventional medical treatments.

Research and general acceptance

A wide body of literature supports the use of art therapy in a mental health capacity. And as the mind-body connection between psychological well-being and physical health is further documented by studies in the field, art therapy gains greater acceptance by mainstream medicine as a therapeutic technique for organic illness.

Resources

BOOKS

Soneff, Sharon. *Art Journals and Creative Healing: Restoring the Spirit Through Self–Expression*. Minneapolis, MN: Quarry Books, 2008.

ORGANIZATIONS

American Art Therapy Association, 225 N. Fairfax St., Alexandria, VA, 22314, (703) 548-5860, (703) 783-8468, (888) 290-0878, info@arttherapy.org, http://www.arttherapy.org.

Paula Anne Ford-Martin

Arterial blood gas analysis *see* **Blood gas analysis**

Arterial embolism

Definition

An embolus is a blood clot, bit of tissue or tumor, gas bubble, or other foreign body that circulates in the blood stream until it becomes stuck in a blood vessel.

Description

When a blood clot develops in an artery and remains in place, it is called a thrombosis. If all or part of the blockage breaks away and lodges in another part of the artery, it is called an **embolism**. Blockage of an artery in this manner can be the result of a blood clot, fat cells, or an air bubble.

When an embolus blocks the flow of blood in an artery, the tissues beyond the plug are deprived of normal blood flow and oxygen. This can cause severe damage and even death of the tissues involved.

KEY TERMS

Atrial fibrillation—An arrhythmia; chaotic quivering of the arteries.

Thrombosis—A blockage in a blood vessel that builds and remains in one place.

Emboli can affect any part of the body. The most common sites are the legs and feet. When the brain is affected, it is called a **stroke**. When the heart is involved, it is called a **heart attack** or myocardial infarction (MI).

Causes and symptoms

A common cause of embolus is when an artery whose lining has become thickened or damaged, usually with age, allows cholesterol to build up more easily than normal on the artery wall. If some of the cholesterol breaks off, it forms an embolus. Emboli also commonly form from **blood clots** in a heart that has been damaged from heart attack or when the heart contracts abnormally from **atrial fibrillation**.

Other known causes are fat cells that enter the blood after a major bone fracture, infected blood cells, **cancer** cells that enter the blood stream, and small gas bubbles.

Symptoms of an embolus can begin suddenly or build slowly over time, depending on the amount of blocked blood flow.

If the embolus is in an arm or leg, there will be muscle **pain**, **numbness** or **tingling**, pale skin color, lower temperature in the limb, and weakness or loss of muscle function. If it occurs in an internal organ, there is usually pain and/or loss of the organ's function.

Diagnosis

The following tests can be used to confirm the presence of an arterial embolism:

- Electrocardiogram, also known as an EKG or ECG. For this test, patches that detect electrical impulses from the heart are attached to the chest and extremities. The information is displayed on a monitor screen or a paper tape in the form of waves. Reduced blood and oxygen supply to the heart shows as a change in the shape of the waves.
- Noninvasive vascular tests. These involve measuring blood pressure in various parts of the body and comparing the results from each location. When there is a decrease in blood pressure beyond what is

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normal between two points, a blockage is presumed to be present.

- Angiography. In this procedure, a colored liquid material (a dye, or contrast material) that can be seen with x rays is injected into the blood stream through a small tube called a catheter. As the dye fills the arteries, they are easily seen on x-ray motion pictures. If there is a blockage in the artery, it shows up as a sudden cut off in the movement of contrast material. Angiography is an expensive procedure and does carry some risk. The catheter may cause a blood clot to form, blocking blood flow. There is also the risk of poking the catheter through the artery or heart muscle. Some people may be allergic to the dye. The risk of any of these injuries occurring is small.

Treatment

Arterial embolism can be treated with medication or surgery, depending on the extent and location of the blockage.

Medication to dissolve the clot is usually given through a catheter directly into the affected artery. If the embolus was caused by a blood clot, medications that thin the blood will help reduce the risk of another embolism.

A surgeon can remove an embolus by making an incision in the artery above the blockage and, using a catheter inserted past the embolus, drag it out through the incision.

If the condition is severe, a surgeon may elect to bypass the blocked vessel by grafting a new vessel in its place.

Prognosis

An arterial embolism is serious and should be treated promptly to avoid permanent damage to the affected area. The outcome of any treatment depends on the location and seriousness of the embolism. New arterial emboli can form even after successful treatment of the first event.

Prevention

Prevention may include diet changes to reduce cholesterol levels, medications to thin the blood, and practicing an active, healthy lifestyle.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

Dorothy Elinor Stonely

Arteriogram *see* **Angiography**

Arteriography *see* **Angiography**

Arteriosclerosis *see* **Atherosclerosis**

Arteriovenous fistula

Definition

An arteriovenous **fistula** (AV fistula) is an abnormal connection between a vein and an artery. The connection can be congenital (present at birth). Occasionally the connection can develop because of trauma such as a knife or bullet wound. Most often, the AV fistula is created surgically to allow access to the vascular system for hemodialysis. When created surgically, the connection of a vein and an artery is usually done in the forearm. The fistula develops over a period of months after the surgery.

Purpose

Hemodialysis is the process of mechanically cleansing the blood when the kidneys have failed. The surgical creation of an AV fistula provides a long-lasting site through which blood can be removed and returned during hemodialysis. The fistula, which allows the person to be connected to a dialysis machine, must be prepared by a surgeon weeks or months before dialysis is started. When the vein and artery are joined, blood flow increases and the vein gradually becomes larger and stronger, creating a site that provides vascular access years longer than other types of access and with fewer complications. AV fistulas are for people who will need dialysis for long periods—either until a kidney becomes available for transplantation or for the rest of their life. Short-term access to the vascular system for dialysis can be had by the insertion of a venous catheter.

Demographics

According to the National Kidney Foundation, at the end of 2008, 485,000 people were being treated for kidney failure or end-stage renal (kidney) disease. They are of varying ages and backgrounds and typically suffer from another condition or disease that has led to kidney shutdown, and most (about 341,000 annually) will require dialysis. Among dialysis patients, over half will have an AV fistula as vascular access. In the United States, kidney failure is disproportionately high among minority populations with

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KEY TERMS

Access—The point where a needle or catheter is inserted for dialysis.

Acute renal (kidney) failure—Abrupt loss of kidney function, possibly temporary.

Artery—Blood vessel that carries blood away from the heart to the body.

Chronic renal (kidney) failure—Progressive loss of kidney function over several years that can result in permanent kidney failure requiring dialysis.

Electrolyte—Ions in the body that participate in metabolic reactions. The major human electrolytes are sodium (Na^+), potassium (K^+), calcium (Ca^{2+}), magnesium (Mg^{2+}), chloride (Cl^-), phosphate (HPO_4^{2-}), bicarbonate (HCO_3^-), and sulfate (SO_4^{2-}).

Hypertension—High blood pressure.

the highest rate being found among African Americans, Hispanic Americans, and Native Americans.

Description

The kidneys are paired organs in the mid-abdomen, one on each side of the lower back. Their function is to clean the blood of wastes and to regulate fluid and electrolyte balance in the body. Dialysis performs these functions in place of the failing kidneys. Dialysis cannot restore kidney function, but it can prolong life, often for years, by preventing the build-up of waste products in the body.

Acute kidney failure usually happens in circumstances where an extra burden is placed on the renal system. For example, acute kidney failure can occur in advanced **liver disease**, rapidly progressing terminal illnesses such as **cancer** and certain severe **anemias**, after severe allergic reactions, as a reaction to drugs or poisons, in heart and lung diseases, during the formation of **blood clots** (**embolism**), and following heart bypass surgery. Diabetes and vascular diseases, especially those with **hypertension**, are the two most common underlying diseases contributing to **chronic kidney failure**.

Many advances in the treatment of kidney failure have been made since the first attempts at dialysis treatments in the 1920s. At one time, dialysis was thought of only as a way to keep people alive until kidney function could be restored. Often the treatment for kidney failure had to be discontinued within several days because patients' veins could not endure the trauma that occurred with frequent withdrawing and replacing of blood. The first breakthrough came in 1960 with the introduction of an implantable Teflon tube, called a shunt, that became the first effective vascular access device. Since then, the development of the AV fistula has marked another important advance, allowing effective treatment for longer periods.

Hemodialysis

Dialysis is performed as critical **life support** when a person experiences acute or chronic kidney failure. It is a mechanical way to cleanse the blood and balance body fluids when the kidneys are not able to perform these essential functions. Kidney failure can, in some cases, be reversible, and dialysis can provide temporary support until renal function is restored. Dialysis may also be used in irreversible or chronic kidney shutdown when transplantation is the medical goal and the patient is waiting for a donated kidney. Some critically ill patients with life-threatening illnesses such as cancer or severe heart disease are not candidates for transplantation and dialysis for them is the only option for treating permanent kidney failure, also called end-stage renal disease (ESRD).

There are two types of dialysis, hemodialysis and peritoneal dialysis. In hemodialysis, the blood circulates through a machine outside the body and is filtered as it circulates. In peritoneal dialysis, the blood is filtered through a membrane that has been placed in the abdomen. Blood remains in the body and waste material is filtered into an exchange fluid through an opening in the abdomen called a port. Only hemodialysis requires an AV fistula or other vascular access.

Hemodialysis circulates blood through a dialysis machine that contains a filter membrane. The blood is slowly pumped out of the body and into the machine for cleansing. After being filtered, the blood is returned to the body through the same vascular access. About one cup (235 mL) of blood is outside the body at any given moment during the continuous circulation process.

Hemodialysis is usually done three times a week, taking between three and five hours each time. Healthcare professionals perform the procedure either at independent dialysis centers or in hospitals or medical centers. Dialysis patients must go to the hemodialysis center where they will sit to receive the treatment. Although they cannot walk around, they can watch television, read, or talk to other patients. Dialysis centers offer patient education, including videos and

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brochures that describe treatment options and self-care. Patients can also receive advice and information about paying for this ongoing treatment through nationally sponsored programs that are available especially for those who need long-term dialysis. Often the dialysis center offers emotional support as well, letting people meet and talk with others who have kidney problems. Some people prefer to perform their own dialysis by having a home dialysis machine. This requires that the dialysis patient and another person, usually a family member, take a three- to six-week training program to learn how to do the treatment.

Vascular access

An access or entry to the vascular system is needed to perform the blood-cleansing role of the kidneys through hemodialysis. There are three types of vascular access: AV fistula, grafts, and catheters.

ARTERIOVENOUS FISTULA. An AV fistula has proven to be the best kind of vascular access for people whose veins are large enough, not only because it lasts longer, but also because it is less likely than other types of access to form clots or become infected. If the veins are not large enough or there is no time to wait for a fistula to develop, a graft or a catheter must be used.

GRAFT. Grafts are often the access of choice when a hemodialysis patient has small veins that will not likely develop properly into a fistula. This type of access uses a synthetic tube implanted under the skin of the arm that can be used repeatedly for needle placement. Unlike a fistula, which requires time to develop, a graft can be used as soon as two to three weeks after placement. Grafts are known to have more problems than fistulas, such as clots and infection, and will likely need replacement sooner.

CATHETER A catheter is used to provide temporary vascular access. When **kidney disease** has progressed quickly, there may not be time to prepare a permanent vascular access site before dialysis treatments are started. The catheter is a tube that is inserted into a vein in the neck, chest, or in the leg near the groin. Two chambers in the tube allow blood to flow in and out. Once the catheter is in place, needle insertion is not necessary. Catheters are effective for dialysis for several weeks or months while surgery is performed and an AV fistula develops. They are not selected for permanent access because they can clog, become infected, or cause the veins to narrow. Long-term catheter access must be used in patients for whom AV fistula or graft surgery has not been successful. If more than three weeks' use is expected, catheters can be made to tunnel under the skin, which increases comfort and reduces complications

Diagnosis/Preparation

Diagnosis

The diagnosis of kidney disease and its progression to kidney failure is typically made by a nephrologist, a specialist in kidney structure and function. The nephrologist will determine whether the patient has acute or chronic kidney failure and if dialysis is appropriate for the patient. If dialysis is recommended, the nephrologist will determine if an AV fistula is the ideal vascular access for the patient. To make these determinations, the nephrologist will need to evaluate the patient's general health, especially the presence of any underlying disease. Kidney function must be evaluated and determined to be seriously impaired before dialysis is recommended. It is typically started when kidney function is down to about 10% of its normal level. Among other tests that will be performed, such as **urinalysis** with microscopic examination of the urine, several blood and urine tests can be used to measure a person's kidney function when chronic or acute kidney failure is suspected. Some of the tests measure electrolytes and other metabolites produced by the body that are normally excreted by the kidneys and passed through urine. The tests can measure effectively if the kidney is filtering out these materials, and how much remains in the blood. These tests include, but are not limited to:

- serum creatinine—found in higher levels in the blood if kidneys fail;
- urinary creatinine—readings are lower in kidney failure;
- urinary output—measuring both fluid intake and all urine produced;
- urinary osmolality—measures the concentration of the urine, an indicator of kidney filtering ability;
- blood urea nitrogen (BUN)—harmful nitrogen waste increases in the blood as kidney function decreases; and
- electrolytes in blood and urine—ions in the blood such as sodium, potassium, magnesium, and chloride are often out of balance when kidneys fail. Potassium, for example, increases in the blood during kidney failure and can cause heart irregularities.

Description

Surgery to create an AV fistula is usually done using a local anesthetic that is injected into the forearm at the site of the proposed fistula. The procedure

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is performed in a hospital or at an outpatient surgery if the patient is not already hospitalized and has no serious underlying disease.

After cleaning and sterilizing the site, the surgeon makes a small incision in the forearm sufficient to allow the permanent uniting of a vein and an artery. The blood vessels will be appropriately blocked to stop blood flow while incisions are made to join them. Silk sutures, just as those used in other types of surgical incisions, are used to close incised areas as needed after the vein and artery have been joined. Once joined, blood flow increases. The vein will become thicker, and over a period of months the connection will become strong and develop into the fistula that will allow permanent vascular access.

Aftercare

The hemodialysis patient should expect needle insertion in the AV fistula at every dialysis session. Patients who prefer to insert their own needles or who perform dialysis at home will need training, and all patients have to learn how to avoid infection and to protect the vascular access. Because vascular access problems can lead to treatment failure, the AV fistula requires regular care to make dialysis easier and to help avoid clots, infection, and other complications.

Patients can help protect the access by:

- making sure the access is checked before each treatment;
- not allowing blood pressure to be taken on the access arm;
- checking the pulse in the access every day;
- keeping the access clean at all times;
- using the access site only for dialysis;
- taking care not to bump or cut the access;
- avoiding wearing tight jewelry or clothing near or over the access site;
- avoiding lifting heavy objects or putting pressure on the access arm; and
- sleeping with the access arm free, not under the head or body.

Risks

The most frequent complications in hemodialysis relate to the vascular access site where needles are inserted. Complications include infection around the access area and formation of clots in the fistula. Usually, because they are in the fistula itself, these clots are not life threatening. The greatest danger is that clots may block the fistula and have to be removed surgically. Frequent clotting may require creating a back-up fistula at another site, to allow dialysis when one access is blocked.

Other complications from dialysis are not directly related to the vascular access. For example, when the kidneys have shut down, they produce very little urine. Because dialysis is the only way people with kidney failure can balance fluid levels in their bodies, hemodialysis can cause bloating and fluid overload, indicating that too much fluid remains in the body. If fluid overload occurs, patients develop swollen ankles, puffy eyes, weight gain, and **shortness of breath**. Fluid overload can cause heart and circulatory problems and fluctuations in blood pressure. Medications may be prescribed and changes in fluid intake or diet may be made to help balance fluids safely in conjunction with dialysis.

Other problems that can occur during or after hemodialysis include:

- low blood pressure when fluid and wastes are removed from the blood too quickly;
- nausea due to changes in blood pressure;
- muscle cramps from the removal of too much fluid from the blood;
- headaches near the end of a dialysis session resulting from changes in the concentration of fluid and waste in the blood; or
- fatigue after treatment, lasting sometimes into the next day.

Normal results

An AV fistula can usually be created and can function well with no adverse affects in a person whose veins are large enough. The amount of time it takes to develop the fistula after surgery (usually months) depends upon the size and strength of the patient's blood vessels and on the person's health and nutritional status. When the fistula develops, the thickened vein that has been joined to an artery can be seen in the arm and a pulse can be felt in it. The early development of an AV fistula as access for long-term dialysis has been shown to improve the survival of patients with chronic renal failure and to reduce the chances of being hospitalized with complications. It also gives patients a better opportunity to choose self-dialysis as their treatment.

With good **nutrition** and a fully functioning AV fistula, dialysis patients can be relatively comfortable and free of complications. People may become tired and uncomfortable when it is close to the time for their next dialysis session. This is to be expected because

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wastes are building up in the blood, and the body senses that it is time to remove them.

Morbidity and mortality rates

Earlier use of dialysis, especially with AV fistula access, has been shown to increase survival in patients with renal failure. The AV fistula is designed to improve the effectiveness of dialysis and is reported to present fewer risks and complications, reduced incidence of clotting and infection, and longer use than other types of vascular access.

Kidney failure is reported to account for 1% of hospital admissions in the United States. It occurs in 2–5% of patients hospitalized for other conditions, surgeries, or diseases. In patients undergoing cardiac bypass surgery, 15% are reported to require dialysis for kidney failure. Overall, deaths in people undergoing dialysis are reported to be about 50% because of the multi-organ dysfunction that has influenced kidney failure.

Resources

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"Vascular Access for Hemodialysis." *Texas Heart Institute*. July 2007. http://www.texasheartinstitute.org/HIC/Topics/Proced/vascular_access_surgery.cfm (accessed June 20, 2010).

ORGANIZATIONS

National Kidney and Urologic Diseases, 3 Information Way, Bethesda, MD, 20892-3580 (800) 891-5390, http://kidney.niddk.nih.gov.

National Kidney Foundation, 30 East 33rd Street, New York, NY, 10016 (800) 622-9010, http://www.kidney.org.

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Arteriovenous malformations

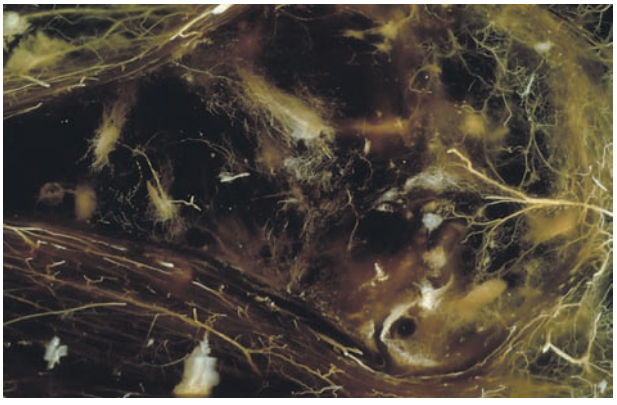
Definition

Arteriovenous malformations are blood vessel defects that occur before birth when the fetus is growing in the uterus (prenatal development). The blood vessels appear as a tangled mass of arteries and veins. They do not possess the capillary (very fine blood vessels) bed which normally exists in the common area where the arteries and veins lie in close proximity (artery-vein interface). An arteriovenous malformation (AVM) may hemorrhage, or bleed, leading to serious complications that can be life-threatening.

Description

AVMs represent an abnormal interface between arteries and veins. Normally, arteries carry oxygenated blood to the body's tissues through progressively smaller blood vessels. The smallest are capillaries, which form a web of blood vessels (the capillary bed) through the body's tissues. The arterial blood moves through tissues by these tiny pathways, exchanging its load of oxygen and nutrients for carbon dioxide and other waste products produced by the body cells (cellular wastes). The blood is carried away by progressively larger blood vessels, the veins. AVMs lack a capillary bed and arterial blood is moved (shunted) directly from the arteries into the veins.

AVMs can occur anywhere in the body and have been found in the arms, hands, legs, feet, lungs, heart, liver, and kidneys. However, 50% of these malformations are located in the brain, brainstem, and spinal cord. Owing to the possibility of hemorrhaging, such



Arteriovenous malformations. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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KEY TERMS

Aneurysm—A weak point in a blood vessel where the pressure of the blood causes the vessel wall to bulge outwards.

Angiography—A mapping of the brain's blood vessels, using x-ray imaging.

Capillary bed—A dense network of tiny blood vessels that enables blood to fill a tissue or organ.

Hydrocephalus—Swelling of the brain caused by an accumulation of fluid.

Lumbar puncture—A diagnostic procedure in which a needle is inserted into the lower spine to withdraw a small amount of cerebrospinal fluid. This fluid is examined to assess trauma to the brain.

Saccular aneurysm—A type of aneurysm that resembles a small sack of blood attached to the outer surface of a blood vessel by a thin neck.

AVMs carry the risk of **stroke**, **paralysis**, and the loss of speech, memory, or vision. An AVM that hemorrhages can be fatal.

Approximately three of every 100,000 people have a cerebral AVM and roughly 40-80% of them will experience some bleeding from the abnormal blood vessels at some point. The annual risk of an AVM bleeding is estimated at about 1-4%. After age 55, the risk of bleeding decreases. Pre-existing high blood pressure or intense physical activity do not seem to be associated with AVM hemorrhage, but **pregnancy** and labor could cause a rupture or breaking open of a blood vessel. An AVM hemorrhage is not as dangerous as an aneurysmal rupture. (An aneurysm is a swollen, blood filled vessel where the pressure of the blood causes the wall to bulge outward.) There is an approximate 10% fatality rate associated with AVM hemorrhage, compared to a 50% fatality rate for ruptured aneurysms.

Although AVMs are congenital defects, meaning a person is born with them, they are rarely discovered before age 20. A genetic link has been proposed for some AVMs, but studies are only suggestive, not positive. The majority of AVMs are discovered in people age 20-40. Medical researchers estimate that the malformations are created during days 45-60 of fetal development. A second theory suggests that AVMs are primitive structures that are left over from the period when fetal blood circulating systems began to develop.

However they form, AVMs have blood vessels that are abnormally fragile. The arteries that feed into the malformation are unusually swollen and thin walled. They lack the usual amount of smooth muscle tissue and elastin, a fibrous connective tissue. These blood vessels commonly accumulate deposits of calcium salts and hyalin. The venous part of the malformation receives blood directly from the artery. Without the intervening capillary bed, the veins receive blood at a higher pressure than they were designed to handle. This part of the malformation is also swollen (dilated) and thin walled. There is a measurable risk of an aneurysm forming near an AVM, increasing the threat of hemorrhage, brain damage, and **death**. Approximately 10-15% of AVMs are accompanied by saccular aneurysms, a type of aneurysm that looks like a small sac attached to the outer wall of the blood vessel.

Although the malformation itself lacks capillaries, there is often an abnormal proliferation of capillaries next to the defect. These blood vessels feed into the malformation, causing it to grow larger in some cases. As the AVM receives more blood through this "steal," adjacent brain tissue does not receive enough. These areas show abnormal nerve cell growth, cell death, and deposits of calcium in that area (calcification). Nerve cells within the malformation may demonstrate abnormal growth and are believed to be nonfunctional.

Causes and symptoms

Most people do not realize that they have an AVM unless it hemorrhages enough to produce symptoms. Small AVMs are more likely to hemorrhage. If a hemorrhage occurs, it produces a sudden, severe **headache**. The headache may be focused in one specific area or it may be more general. It can be mistaken for a migraine in some cases. The headache is accompanied by other symptoms, such as **vomiting**, a stiff neck, sleepiness, lethargy, confusion, irritability, or weakness anywhere in the body. Seizures occur in about a quarter of AVM cases. A person may experience decreased, double, or blurred vision. Hemorrhaging from an AVM is generally less dangerous than hemorrhaging from an aneurysm, with a survival rate of 80-90%.

Other symptoms occur less frequently, but sometimes appear alongside major symptoms such as the sudden severe headache. Additional warning signs of a bleeding AVM are impaired speech or smell, **fainting**,

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facial paralysis, a drooping eyelid, **dizziness**, and ringing or buzzing in the ears.

Although large AVMs are less likely to hemorrhage, they can induce symptoms based on their mass alone. Large AVMs exert pressure against brain tissue, cause abnormal development in the surrounding brain tissue, and slow down or block blood flow. **Hydrocephalus**, a swelling of brain tissue caused by accumulated fluids, may develop. The warning signs associated with a large non-bleeding AVM are similar to the symptoms of a small malformation that is bleeding. Unexplained headaches, seizures, dizziness, and neurological symptoms, such as sensory changes, are signals that demand medical attention.

Diagnosis

Based on the clinical symptoms such as severe headache and neurological problems, and after a complete neurologic exam, a computed tomography scan (CT) of the head will be done. In some cases, a whooshing sound from arteries in the neck or over the eye or jaw (called a bruit), can be heard with a stethoscope. The CT scan will reveal whether there has been bleeding in the brain and can identify AVMs larger than 1 inch (2.5 cm). **Magnetic resonance imaging** (MRI) is also used to identify an AVM. A **lumbar puncture**, or spinal tap, may follow the MRI or CT scan. A lumbar puncture involves removing a small amount of cerebrospinal fluid from the lower part of the spine. Blood cells or blood breakdown products in the cerebrospinal fluid indicate bleeding.

To pinpoint where the blood is coming from, a cerebral **angiography** is done. This procedure uses x rays to map out the blood vessels in the brain, including the vessels that feed into the malformation. The information gained from angiography complements the MRI and helps distinguish the precise location of the AVM.

Treatment

Neurosurgeons consider several factors before deciding on a treatment option. There is some debate over whether or not to treat AVMs that have not ruptured and are not causing any symptoms. The risks and benefits of proceeding with treatment need to be measured on an individual basis, taking into account factors such as the person's age and general health, as well as the AVM's size and location. Several treatment options are available, both for symptomatic or asymptomatic AVMs. These treatment options may be used alone or in combination.

Surgery

Removing the AVM is the surest way of preventing it from causing future problems. Both small and large AVMs can be handled in surgery. Surgery is recommended for superficial AVMs, but may be too dangerous for deep or very large AVMs. Unless it is an emergency situation, an AVM that has hemorrhaged is treated conservatively for several weeks. Conservative treatment consists of managing the immediate symptoms and allowing the patient's condition to stabilize. Surgery requires **general anesthesia** and a longer period of recuperation than any other treatment option.

Radiation

Radiation is particularly useful to treat small (under 1 in.) malformations that are deep within the brain. Ionizing radiation is directed at the malformation, destroying the AVM without damaging the surrounding tissue. Radiation treatment is accomplished in a single session and it is not necessary to open the skull. However, success can only be measured over the course of the following two years. A year after the procedure, 50-75% of treated AVMs are completely blocked; two years after radiation treatment, the percentage increases to 85-95%.

Embolization

Embolization involves plugging up access to the malformation. This technique does not require opening the skull to expose the brain and can be used to treat deep AVMs. Using x-ray images as a guide, a catheter is threaded through the artery in the thigh (femoral artery) to the affected area. The patient remains awake during the procedure and medications can be administered to prevent discomfort. The blood vessel leading into the AVM is assessed for its importance to the rest of the brain before a balloon or other blocking agent is inserted via the catheter. The block chokes off the blood supply to the malformation. There may be a mild headache or **nausea** associated with the procedure, but patients may resume normal activities after leaving the hospital. At least two to three embolization procedures are usually necessary at intervals of two to six weeks. At least a three-day hospital stay is associated with each embolization.

Prognosis

Approximately 10% of AVM cases are fatal. Seizures and neurological changes may be permanent in another 10-30% cases of AVM rupture. If an AVM bleeds once, it is about 20% likely to bleed again in the

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next year. As time passes from the initial hemorrhage, the risk for further bleeding drops to about 3-4%. If the AVM has not bled, it is possible, but not guaranteed, that it never will. Untreated AVMs can grow larger over time and rarely go away by themselves. Once an AVM is removed and a person has recovered from the procedure, there should be no further symptoms associated with that malformation.

ORGANIZATIONS

American Chronic Pain Association, PO Box 850, Rocklin, CA, 95677, (916) 632-3208, (800) 533-3231, APA @pacbell.net, http://www.theacpa.org.

Americna Pain Society, 4700 W. Lake Ave., Glenview, IL, 60025, (847) 375-4715, (866) 574-2654, info@ampainsoc.org, http://www.ampainsoc.org.

AVM Survivors Network, http://www.avmsurvivors.org/.

Julia Barrett

Arthritis *see* **Juvenile arthritis; Osteoarthritis; Psoriatic arthritis; Rheumatoid arthritis**

Arthrocentesis *see* **Joint fluid analysis**

Arthrogram *see* **Arthrography**

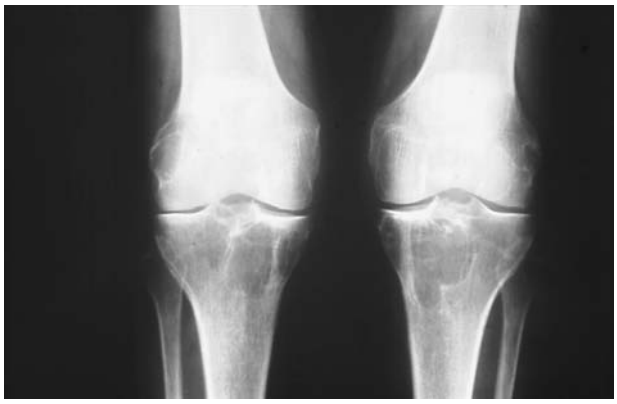
Arthrography

Definition

Arthrograpy is a procedure involving multiple x rays of a joint using a fluoroscope, or a special piece of x-ray equipment, which shows an immediate x-ray image. A contrast medium (in this case, a an iodine solution) injected into the joint area helps highlight structures of the joint.

Purpose

Frequently, arthrography is ordered to determine the cause of unexplained joint **pain**. This fluoroscopic procedure can show the internal workings of specific joints and outline soft tissue structures. The procedure may also be conducted to identify problems with the ligaments, cartilage, tendons, or the joint capsule of the hip, shoulder, knee, ankle or wrist. An arthrography procedure may locate cysts in the joint area, evaluate problems with the joint's arrangement and function, or indicate the need for **joint replacement** (prostheses). The most commonly studied joints are the knee and shoulder.



An x-ray image of the knees of a patient with cysts caused by rheumatoid arthritis. The cysts appear as dark areas just below the knee joints. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Precautions

Patients who are pregnant or may be pregnant should not have this procedure unless the benefits of the findings outweigh the risk of radiation exposure. Patients who are known to be allergic to iodine need to discuss this complication with their physician. Patients who have a known allergy to shellfish are more likely to be allergic to iodine contrast.

Description

Arthrograpy may be referred to as "joint radiography" or "x rays of the joint." The term arthrogram may be used interchangeably with arthrography. The joint area will be cleaned and a local anesthetic will be injected into the tissues around the joint to reduce pain. Next, if fluids are present in the joint, the physician may suction them out (aspirate) with a needle. These fluids may be sent to a laboratory for further study. Contrast agents are then injected into the joint through the same location by attaching the aspirating needle to a syringe containing the contrast medium. The purpose of contrast agents in x-ray procedures is to help highlight details of areas under study by making them opaque. Agents for arthrography are generally air and water-soluble dyes, the most common containing iodine. Air and iodine may be used together or independently. After the contrast agent is administered, the site of injection will be sealed and the patient may be asked to move the joint around to distribute the contrast.

Before the contrast medium can be absorbed by the joint itself, several films will be quickly taken under the guidance of the fluoroscope. The patient will be asked to move the joint into a series of positions,

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KEY TERMS

Aspirate—Remove fluids by suction, often through a needle.

Contrast (agent, medium)—A substance injected into the body that illuminates certain structures that would otherwise be hard to see on the radiograph (film).

Fluoroscope—A device used in some radiology procedures that provides immediate images and motion on a screen much like those seen at airport baggage security stations.

Radiologist—A medical doctor specially trained in radiology (x ray) interpretation and its use in the diagnosis of diseases and injuries.

X ray—A form of electromagnetic radiation with shorter wavelengths than normal light. X rays can penetrate most structures.

keeping still between positioning. Sometimes, the patient will experience some **tingling** or discomfort during the procedure, which is normal and due to the contrast. Following fluoroscopic tracking of the contrast, standard x rays of the area may also be taken. The entire procedure will last about one hour.

Preparation

It is important to discuss any known sensitivity to local anesthetics or iodine prior to this procedure. A physician should explain the procedure and the risks associated with contrast agents and ask the patient to sign an informed consent. If iodine contrast will be administered, the patient may be instructed not to eat before the exam. The timeframe of **fasting** may extend from only 90 minutes prior to the exam up to the night before. There is no other preparation necessary.

Aftercare

The affected joint should be rested for approximately 12 hours following the procedure. The joint may be wrapped in an elastic bandage and the patient should receive instructions on the care and changing of the bandage. Noises in the joint such as cracking or clicking are normal for a few days following arthrography. These noises are the result of liquid in the joints. Swelling may also occur and can be treated with application of ice or cold packs. A mild pain reliever can be used to lessen pain in the first few days. However, if any of these symptoms persist for more than a few days, patients are advised to contact their physician.

Risks

In some patients iodine can cause allergic reactions, ranging from mild **nausea** to severe cardiovascular or nervous system complications. Since the contrast dye is put into a joint, rather than into a vein, allergic reactions are rare. Facilities licensed to perform contrast exams should meet requirements for equipment, supplies and staff training to handle a possible severe reaction. Infection or joint damage are possible, although not frequent, complications of arthrography.

Normal results

A normal arthrography exam will show proper placement of the dye or contrast medium throughout the joint structures, joint space, cartilage and ligaments.

Abnormal results

The abnormal placement of dye may indicate **rheumatoid arthritis**, cysts, joint dislocation, rupture of the rotator cuff, tears in the ligament and other conditions. The entire lining of the joint becomes opaque from the technique, which allows the radiologist to see abnormalities in the intricate workings of the joint. In the case of recurrent shoulder **dislocations**, arthrography results can be used to evaluate damage. Patients with hip prostheses may receive arthrography to evaluate proper placement or function of their prostheses.

ORGANIZATIONS

American College of Radiology, 1891 Preston White Drive, Reston, VA, 20191, (703) 648-8900, (800) 227-5463, info@acr.org, http://www.acr.org.

Arthritis Foundation, P.O. Box 7669, Atlanta, GA, 30357-0669, (404) 872-7100, http://www.arthritis.org.

Teresa G. Odle

Arthroplasty

Definition

Arthroplasty is surgery to relieve **pain** and restore range of motion by realigning or reconstructing a joint.

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KEY TERMS

Fascia—Thin connective tissue covering or separating the muscles and internal organs of the body.

Rheumatoid arthritis—A joint disease of unknown origins that may begin at an early age, causing deformity and loss of function in the joints.

Purpose

The goal of arthroplasty is to restore the function of a stiffened joint and relieve pain. Two types of arthroplastic surgery exist. Joint resection involves removing a portion of the bone from a stiffened joint, creating a gap between the bone and the socket, to improve the range of motion. Scar tissue eventually fills the gap. Pain is relieved and motion is restored, but the joint is less stable.

Interpositional reconstruction is surgery to reshape the joint and add a prosthetic disk between the two bones forming the joint. The prosthesis can be made of plastic and metal or from body tissue such as fascia and skin. When interpositional reconstruction fails, total **joint replacement** may be necessary. Joint replacement is also called total joint arthroplasty.

In recent years, joint replacement has become the operation of choice for most knee and hip problems. Elbow, shoulder, ankle, and finger joints are more likely to be treated with joint resection or interpositional reconstruction.

Arthroplasty is performed on people suffering from severe pain and disabling joint stiffness that result from **osteoarthritis** or **rheumatoid arthritis**. Joint resection, rather than joint replacement, is more likely to be performed on people with rheumatoid arthritis, especially when the elbow joint is involved. Total joint replacement is usually reserved for people over the age of 60.

Precautions

If both the bone and socket of a joint are damaged, joint replacement is usually the preferred treatment.

Description

Arthroplasty is performed under general or regional anesthesia in a hospital, by an orthopedic surgeon. Certain medical centers specialize in joint surgery and tend to have higher success rates than less specialized centers.

In joint resection, the surgeon makes an incision at the joint, then carefully removes minimum amount of bone necessary to allow free motion. The more bone that remains, the more stable the joint. Ligament attachments are preserved as much as possible. In interpositional reconstruction, both bones of the joint are reshaped, and a disk of material is placed between the bones to prevent their rubbing together. Length of hospital stay depends on which joint is treated, but is normally only a few days.

Preparation

Prior to arthroplasty, all the standard preoperative blood and urine tests are performed. The patient meets with the anesthesiologist to discuss any special conditions that affect the administration of anesthesia.

Aftercare

Patients who have undergone arthroplasty must be careful not to over stress or destabilize the joint. **Physical therapy** is begun immediately. **Antibiotics** are given to prevent infection.

Risks

Joint resection and interpositional reconstruction do not always produce successful results, especially in patients with rheumatoid arthritis. Repeat surgery or total joint replacement may be necessary. As with any major surgery, there is always a risk of an allergic reaction to anesthesia or that **blood clots** will break loose and obstruct the arteries.

Normal results

Most patients recover with improved range of motion in the joint and relief from pain.

Resources

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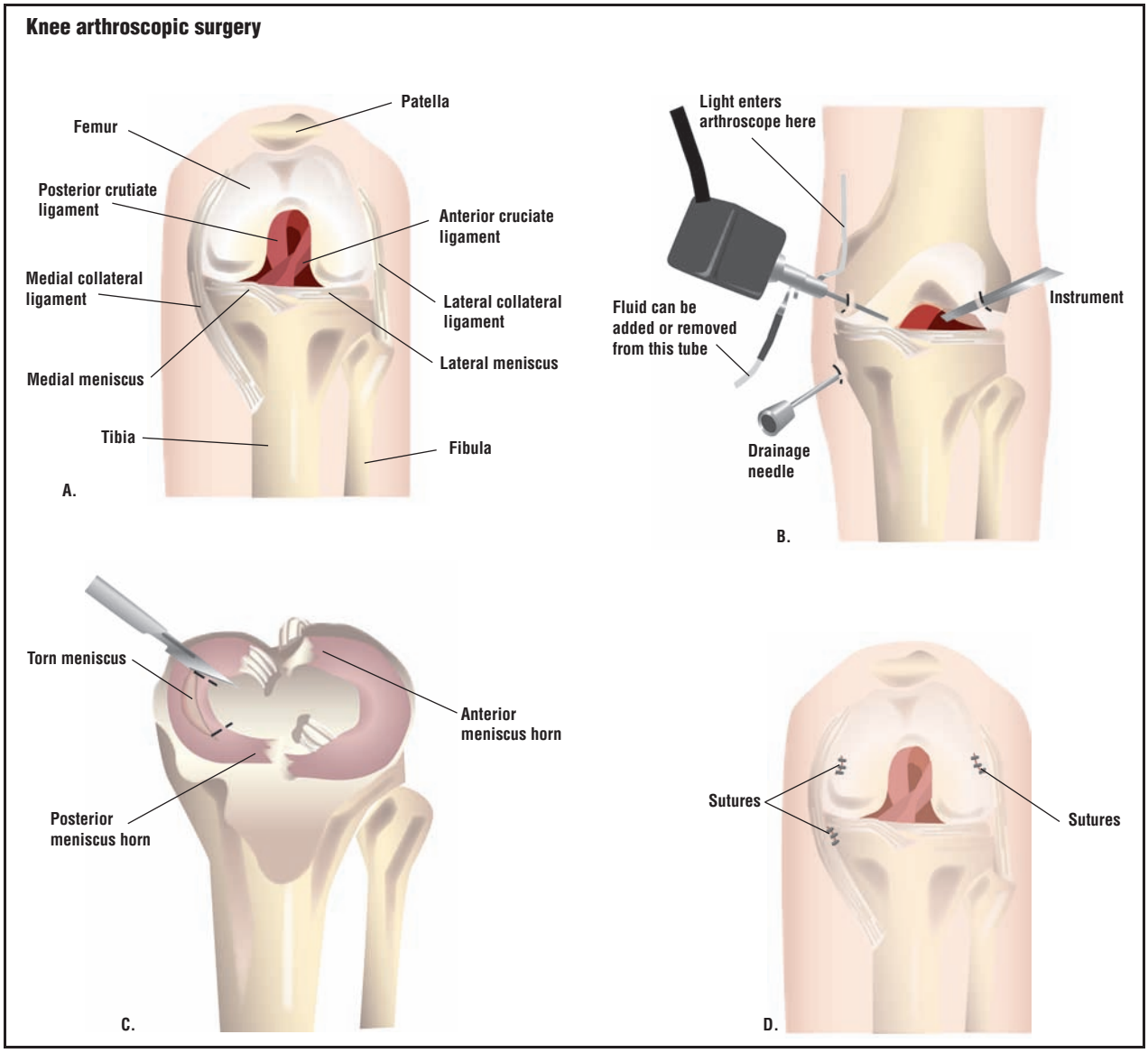
Arthroscopic surgery

Definition

Arthroscopic surgery is a procedure to visualize, diagnose, and treat joint problems. The name is derived from the Greek words *arthron,* which means *joint,* and *skopein,* which means *to look at*.

Purpose

Arthroscopic surgery is used to identify, monitor, and diagnose joint injuries and disease; or to remove bone or cartilage or repair tendons or ligaments. Diagnostic arthroscopic surgery is performed when medical history, physical exam, x rays, and other tests such as **magnetic resonance imaging** (MRI) or **computed tomographic scans** (CT) don't provide a definitive diagnosis.



Step A shows the anatomy of the knee from the front with the leg bent. To repair a torn meniscus, three small incisions are made into the knee to admit laparoscopic instruments (B). Fluid is injected into the joint to aid in the operation. The injury is visualized via the instruments, and the torn area is removed (C). *(Illustration by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)*

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KEY TERMS

Joint—The point where bones meet. Arthroscopic surgery is used on joint problems.

Laser—A device that concentrates electromagnetic radiation into a narrow beam and treats tissue quickly without heating surrounding areas.

Orthopedics—The medical specialty that deals with preserving, restoring, and developing form and function in the extremities, spine, and other structures using medical, surgical, and physical methods. Arthroscopic surgery is performed by orthopedic surgeons.

Precautions

Diagnostic arthroscopic surgery should not be performed unless conservative treatment does not fix the problem.

Description

In arthroscopic surgery, an orthopedic surgeon uses an arthroscope, a fiber-optic instrument, to see the inside of a joint. After making an incision about the size of a buttonhole in the patient's skin, a sterile sodium chloride solution is injected to distend the joint. The arthroscope, an instrument the size of a pencil, is then inserted into the joint. The arthroscope has a lens and a lighting system through which the structures inside the joint are transmitted to a miniature television camera attached to the end of the arthroscope. The surgeon uses irrigation and suction to remove blood and debris from the joint before examining it. Other incisions may be made in order to see other parts of the joint or to insert additional instruments. Looking at the interior of the joint on the television screen, the surgeon can then determine the amount or type of injury and, if necessary, take a biopsy specimen or repair or correct the problem. Arthroscopic surgery can be used to remove floating bits of cartilage and treat minor tears and other disorders. When the procedure is finished, the arthroscope is removed and the joint is irrigated. The site of the incision is bandaged.

Arthroscopic surgery is used to diagnose and treat joint problems, most commonly in the knee, but also in the shoulder, elbow, ankle, wrist, and hip. Some of the most common joint problems seen with an arthroscope are:

- inflammation in the knee, shoulder, elbow, wrist, or ankle
- injuries to the shoulder (rotator cuff tendon tears, impingement syndrome, and recurrent dislocations), knee (cartilage tears, wearing down of or injury to the cartilage cushion, and anterior cruciate ligament tears with instability), and wrist (carpal tunnel syndrome)
- loose bodies of bone and/or cartilage in the knee, shoulder, elbow, ankle, or wrist

Corrective arthroscopic surgery is performed with instruments that are inserted through additional incisions. Arthritis can sometimes be treated with arthroscopic surgery. Some problems are treated with a combination of arthroscopic and standard surgery.

Also called **arthroscopy**, the procedure is performed in a hospital or outpatient surgical facility. The type of anesthesia (local, spinal, or general) and the length of the procedure depends on the joint operated on and the complexity of the suspected problem. Arthroscopic surgery rarely takes more than an hour. Most patients who have arthroscopic surgery are released that same day; some patients stay in the hospital overnight.

Considered the most important orthopedic development in the 20th century, arthroscopic surgery is widely used. The use of arthroscopic surgery on famous athletes has been well publicized. It is estimated that 80% of orthopedic surgeons practice arthroscopic surgery. Arthroscopic surgery was initially a diagnostic tool used prior to open surgery, but as better instruments and techniques were developed, it began to be used to actually treat a variety of joint problems. New techniques currently under development are likely to lead to other joints being treated with arthroscopic surgery in the future. Recently, lasers were introduced in arthroscopic surgery and other new energy sources are being explored. Lasers and electromagnetic radiation can repair rather than resect injuries and may be more cost effective than instruments.

Preparation

Before the procedure, blood and urine studies and x rays of the joint will be conducted.

Aftercare

Immediately after the procedure, the patient will spend several hours in the recovery room. An ice pack will be put on the joint that was operated on for up to 48 hours after the procedure. **Pain** medicine,

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prescription or non-prescription, will be given. The morning after the surgery, the dressing can be removed and replaced by adhesive strips. The patient should call his/her doctor upon experiencing an increase in pain, swelling, redness, drainage or bleeding at the site of the surgery, signs of infection (**headache**, muscle aches, **dizziness**, **fever**), or **nausea** or **vomiting**.

It takes several days for the puncture **wounds** to heal, and several weeks for the joint to fully recover. Many patients can resume their daily activities, including going back to work, within a few days of the procedure. A **rehabilitation** program, including **physical therapy**, may be suggested to speed recovery and improve the future functioning of the joint.

Risks

Complications are rare in arthroscopic surgery, occurring in less than 1% of patients. These include infection and inflammation, blood vessel clots, damage to blood vessels or nerves, and instrument breakage.

Resources

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Lori De Milto

Arthroscopy

Definition

Arthroscopy is the examination of a joint, specifically, the inside structures. The procedure is performed by inserting a specifically designed illuminated device into the joint through a small incision. This instrument is called an arthroscope. The procedure of arthroscopy is primarily associated with the process of diagnosis. However, when actual repair is performed, the procedure is called **arthroscopic surgery**.

Purpose

Arthroscopy is used primarily by doctors who specialize in treating disorders of the bones and related structures (orthopedics) to help diagnose joint problems. Once described as essential for those who primarily care for athletic injuries, arthroscopy is now a technique commonly used by orthopedic surgeons for the treatment of patients of all ages. This procedure is most commonly used to diagnose knee and shoulder problems, although the elbow, hip, wrist, and ankle may also be examined with an arthroscope.

A joint is a complex system. Within a joint, ligaments attach bones to other bones, tendons attach muscles to bones, cartilage lines and helps protect the ends of bones, and a special fluid (synovial fluid) cushions and lubricates the structures. Looking inside the joint allows the doctors to see exactly which structures are damaged. Arthroscopy also permits earlier diagnosis of many types of joint problems, which had been difficult to detect in previous years.

Precautions

Most arthroscopic procedures today are performed in same-day surgery centers where the patient is admitted just before surgery. A few hours following the procedure, the patient is allowed to return home, although usually someone else must drive. Depending on the type of anesthesia used, the patient may be told not to eat for several hours before arriving. Before the procedure, the anesthesiologist will ask if the patient has any known **allergies** to local or general anesthetics. Airway obstruction is always possible in any patient who receives a **general anesthesia**. Because of this, oxygen, suction, and monitoring equipment must be available. The patient's cardiac status should always be monitored in the event that any cardiac abnormalities arise during the arthroscopy.

Description

The arthroscope is an instrument used to look directly into the joint. It contains magnifying lenses and glass-coated fibers that send concentrated light into the joint. A camera attached to the arthroscope allows the surgeon to see a clear image of the joint. This image is then transferred to a monitor located in the operating room at the time of the arthroscopy. This video technology is also important for documentation of the arthroscopic procedure. For example, if the surgeon decides after the arthroscopic examination that a conventional approach to surgically expose or "open" the joint (arthrotomy) must be used, a good photographic record will be useful when the surgeon returns to execute the final surgical plan.

The procedure requires the surgeon to make several small incisions (portals) through the skin's surface into the joint. Through one or two of the portals, a large-bore needle, called a cannula, is attached to tubing and inserted into the joint. The joint is inflated with a sterile saline solution to expand the joint and ensure

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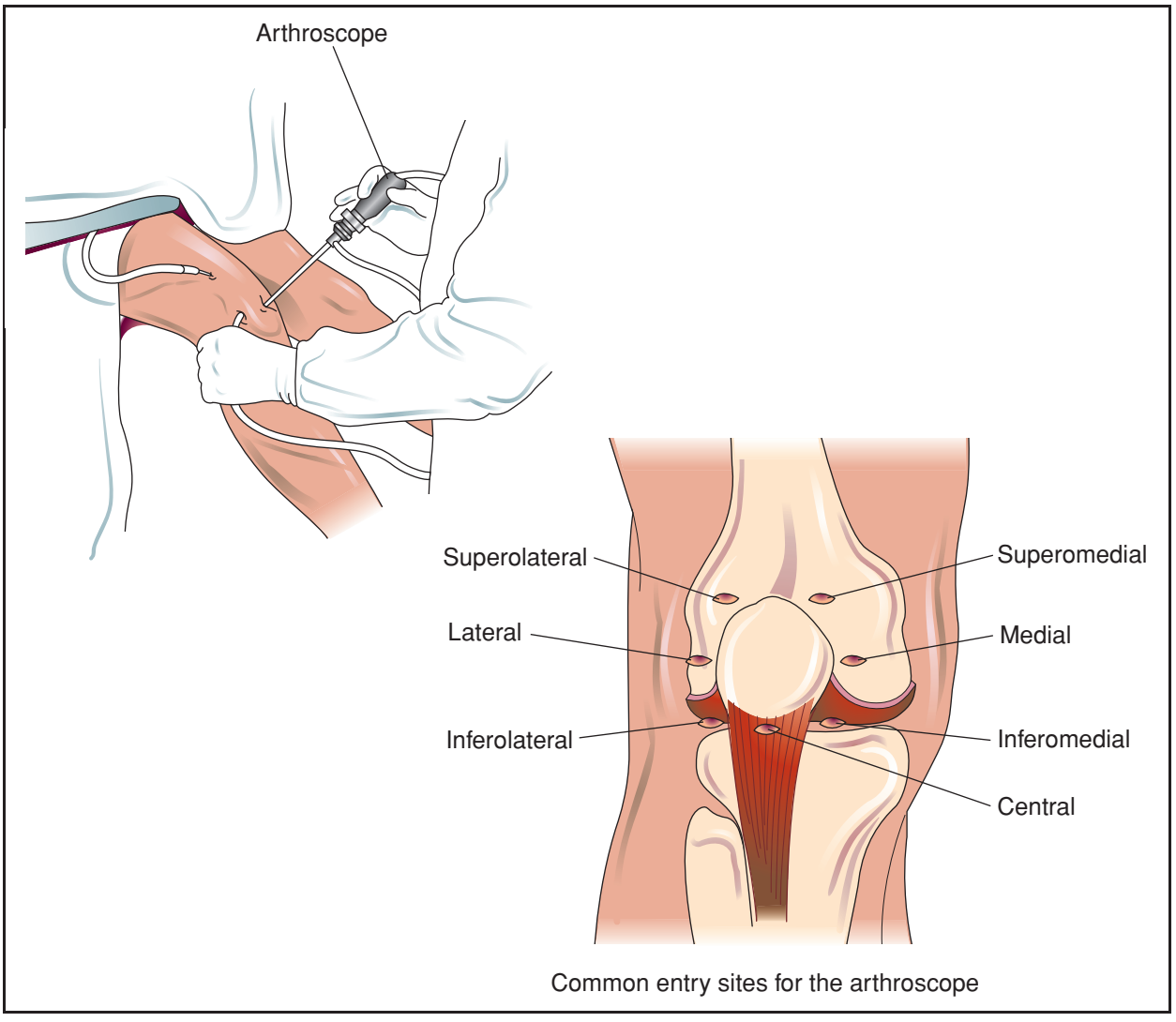

Arthroscopy is primarily used to help diagnose joint problems. This procedure, most commonly associated with knee and shoulder problems, allows accurate examination and diagnosis of damaged joint ligaments, surfaces, and other related joint structures. The illustration above indicates the most common entry sites, or portals, in knee arthroscopy. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

clear arthroscopic viewing. Often, following a recent traumatic injury to a joint, the joint's natural fluid may be cloudy, making interior viewing of the joint difficult. In this condition, a constant flow of the saline solution is necessary. This inflow of saline solution may be through the cannula with the outflow through the arthroscope, or the positions may be reversed. The arthroscope is placed through one of the portals to view and evaluate the condition of the joint.

Preparation

Before an arthroscopy can take place, the surgeon completes a thorough medical history and evaluation. Important for the accuracy of this diagnostic procedure, a medical history and evaluation may discover other disorders of the joint or body parts, proving the procedure unnecessary. This is always an important preliminary step, because **pain** can often be referred to a joint from another area of the body. Anatomical models and pictures are useful aids to explain to the patient the proposed arthroscopy and what the surgeon may be looking at specifically.

Proper draping of the body part is important to prevent contamination from instruments used in arthroscopy, such as the camera, light cords, and inflow and outflow drains placed in the portals. Draping packs used

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KEY TERMS

Hemarthrosis—A condition of blood within a joint.

Pulmonary embolus—Blockage of an artery of the lung by foreign matter such as fat, tumor, tissue, or a clot originating from a vein.

Thrombophlebitis—Inflamation of a vein with the formation of a thrombus or clot.

in arthroscopy include disposable paper gowns and drapes with adhesive backing. The surgeon may also place a tourniquet above the joint to temporarily block blood flow to the area during the arthroscopic exam.

General or **local anesthesia** may be used during arthroscopy. Local anesthesia is usually used because it reduces the risk of lung and heart complications and allows the patient to go home sooner. The local anesthetic may be injected in small amounts in multiple locations in skin and joint tissues in a process called infiltration. In other cases, the anesthetic is injected into the spinal cord or a main nerve supplying the area. This process is called a "block," and it blocks all sensation below the main trunk of the nerve. For example, a femoral block anesthetizes the leg from the thigh down (its name comes from femur, the thighbone). Most patients are comfortable once the skin, muscles, and other tissues around the joint are numbed by the anesthetic; however, some patients are also given a sedative if they express **anxiety** about the procedure. (It's important for the patient to remain still during the arthroscopic examination.)

General anesthesia, in which the patient becomes unconcious, may be used if the procedure may be unusually complicated or painful. For example, people who have relatively "tight" joints may be candidates for general anesthesia because the procedure may take longer and cause more discomfort.

Aftercare

The portals are closed by small tape strips or stitches and covered with **dressings** and a bandage. The patient spends a short amount of time in the recovery room after arthroscopy. Most patients can go home after about an hour in the recovery room. Pain medication may be prescribed for a short period; however, many patients find various over-the-counter pain relievers sufficient.

Following the surgical procedure, the patient needs to be aware of the signs of infection, which include redness, warmth, excessive pain, and swelling. The risk of infection increases if the incisions become wet too early following surgery. Because of this, it is good practice to cover the joint with plastic (for example, a plastic bag) while showering after arthroscopy.

The use of crutches is commonplace after arthroscopy, with progression to independent walking on an "as tolerated" basis by the patient. Generally, a **rehabilitation** program, supervised by a physical therapist, follows shortly after the arthroscopy to help the patient regain mobility and strength of the affected joint and limb.

Risks

The incidence of complications is low compared to the high number of arthroscopic procedures performed every year. Possible complications include infection, swelling, damage to the tissues in the joint, **blood clots** in the leg veins (**thrombophlebitis**), leakage of blood into the joint (hemarthrosis), blood clots that move to the lung (pulmonary embolus), and injury to the nerves around the joint.

Normal results

The goal of arthroscopy is to diagnose a joint problem causing pain and/or restrictions in normal joint function. For example, arthroscopy can be a useful tool in locating a tear in the joint surface of the knee or locating a torn ligament of the shoulder. Arthroscopic examination is often followed by arthroscopic surgery performed to repair the problem with appropriate arthroscopic tools. The final result is to decrease pain, increase joint mobility, and thereby improve the overall quality of the patient's activities of daily living.

Abnormal results

Less optimal results that may require further treatment include adhesive capsulitis. In this condition, the joint capsule that naturally forms around the joint becomes thickened, forming **adhesions**. This results in a stiff and less mobile joint. This problem is frequently corrected by manipulation and mobilization of the joint with the patient placed under general anesthesia.

Resources

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Jeffrey P. Larson RPT

Artificial insemination *see* **Infertility therapies**

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Asbestosis

Definition

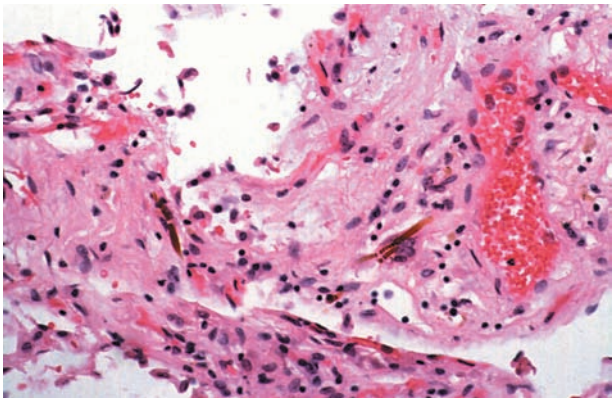
Asbestosis is chronic, progressive inflammation of the lung. It is not contagious.

Description

Asbestosis is a consequence of prolonged exposure to large quantities of asbestos, a material once widely used in construction, insulation, and manufacturing. When asbestos is inhaled, fibers penetrate the breathing passages and irritate, fill, inflame, and scar lung tissue. In advanced asbestosis, the lungs shrink, stiffen, and become honeycombed (riddled with tiny holes).

Legislation has reduced use of asbestos in the United States, but workers who handle automobile brake shoe linings, boiler insulation, ceiling acoustic tiles, electrical equipment, and fire-resistant materials are still exposed to the substance. Asbestos is used in the production of paints and plastics. Significant amounts can be released into the atmosphere when old buildings or boats are razed or remodeled.

Asbestosis is most common in men over 40 who have worked in asbestos-related occupations. Smokers or heavy drinkers have the greatest risk of developing this disease. According to the Centers for Disease Control and Prevention, between 1999 and 2005, more than 18,000 Americans over the age of 25 died as a result of asbestosis. The death rate increased from 2,482 deaths in 1999 to 2,704 in 2005, an increase of 222 deaths. Men are diagnosed with mesothelioma more often than women, and males comprised 80.8 percent of mesothelioma deaths during this timeframe (a total of 14,591). White people comprised 95.1 percent of mesothelioma deaths, totaling 17,180. Age influenced the mortality rate, as those 75 years old and older comprised the majority of the patients who passed away from mesothelioma (8,858 total deaths). Deaths in patients age 44 or younger totaled 311, or 1.7 percent.



Micrograph of asbestos fibers embedded in lung tissue. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

KEY TERMS

Asbestos—A silicate (containing silica) mineral that occurs in a variety of forms; it is characterized by a fibrous structure and resistance to fire.

Causes and symptoms

Occupational exposure is the most common cause of asbestosis, but the condition also strikes people who inhale asbestos fiber or who are exposed to waste products from plants near their homes. Family members can develop the disease as a result of inhaling particles of asbestos dust that cling to workers' clothes.

It is rare for asbestosis to develop in anyone who hasn't been exposed to large amounts of asbestos on a regular basis for at least 10 years. Symptoms of the disease do not usually appear until 15–20 years after initial exposure to asbestos.

The first symptom of asbestosis is usually **shortness of breath** following **exercise** or other physical activity. The early stages of the disease are also characterized by a dry **cough** and a generalized feeling of illness.

As the disease progresses and lung damage increases, shortness of breath occurs even when the patient is at rest. Recurrent respiratory infections and coughing up blood are common. So is swelling of the feet, ankles, or hands. Other symptoms of advanced asbestosis include chest **pain**, hoarseness, and restless sleep. Patients who have asbestosis often have clubbed (widened and thickened) fingers. Other potential complications include **heart failure**, collapsed (deflated) lung, and **pleurisy** (inflammation of the membrane that protects the lung).

Diagnosis

Screening of at-risk workers can reveal lung inflammation and lesions characteristic of asbestosis. Patients' medical histories can identify occupations, hobbies, or other situations likely to involve exposure to asbestos fibers.

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X rays can show shadows or spots on the lungs or an indistinct or shaggy outline of the heart that suggests the presence of asbestosis. Blood tests are used to measure concentrations of oxygen and carbon dioxide. **Pulmonary function tests** can be used to assess a patient's ability to inhale and exhale, and a computed tomography scan (CT) of the lungs can show flat, raised patches associated with advanced asbestosis.

Treatment

The goal of treatment is to help patients breathe more easily, prevent colds and other respiratory infections, and control complications associated with advanced disease. Ultrasonic, cool-mist humidifiers or controlled coughing can loosen bronchial secretions.

Regular exercise helps maintain and improve lung capacity. Although temporary bed rest may be recommended, patients are encouraged to resume their regular activities as soon as they can.

Anyone who develops symptoms of asbestosis should see a family physician or lung disease specialist. A doctor should be notified if someone who has been diagnosed with asbestosis:

- coughs up blood
- continues to lose weight
- is short of breath
- has chest pain
- develops a sudden fever of 101°F (38.3°C) or higher
- develops unfamiliar, unexplained symptoms

Prognosis

Asbestosis can't be cured, but its symptoms can be controlled. Doctors don't know why the health of some patients deteriorates and the condition of others remain the same, but believe the difference may be due to varying exposures of asbestos. People with asbestosis who smoke, particularly those who smoke more than one pack of cigarettes each day, are at increased risk for developing lung **cancer** and should be strongly advised to quit **smoking**.

Prevention

Workers in asbestosis-related industries should have regular x rays to determine whether their lungs are healthy. A person whose lung x ray shows a shadow should eliminate asbestos exposure even if no symptoms of the condition have appeared.

Anyone who works with asbestos should wear a protective mask or a hood with a clean-air supply and obey recommended procedures to control asbestos dust. Anyone who is at risk of developing asbestosis should:

- not smoke
- be vaccinated against influenza and pneumonia
- exercise regularly to maintain cardiopulmonary fitness
- avoid crowds and people who have respiratory infections

A person who has asbestosis should exercise regularly, relax, and conserve energy whenever necessary.

Resources

BOOKS

Craighead, John E., and A. R. Gibbs. *Asbestos and its Diseases*, New York: Oxford, 2008.

ORGANIZATIONS

American Lung Association, 1301 Pennsylvania Ave. NW, Suite 800, Washington, DC, 20001, (202) 758-3355, (202) 452-1805, (800) 548-8252, info@lungusa.org, http://www.lungusa.org/.

Maureen Haggerty

Ascariasis *see* **Roundworm infections**

Ascending cholangitis *see* **Cholangitis**

Ascending contrast phlebography *see* **Venography**

Ascites

Definition

Ascites is an abnormal accumulation of fluid in the abdomen.

Description

Rapidly developing (acute) ascites can occur as a complication of trauma, perforated ulcer, **appendicitis**, or inflammation of the colon or other tube-shaped organ (**diverticulitis**). This condition can also develop when intestinal fluids, bile, pancreatic juices, or bacteria invade or inflame the smooth, transparent membrane that lines the inside of the abdomen (peritoneum). However, ascites is more often associated with **liver disease** and other long-lasting (chronic) conditions.

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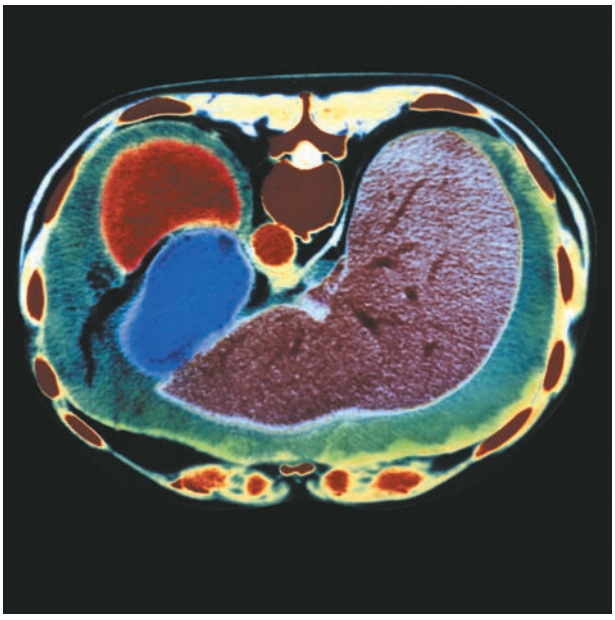

A computed tomography (CT) scan of an axial section through the abdomen, showing ascites. At right is the liver occupying much of the abdomen; the stomach and spleen are also seen. Around these organs is fluid giving rise to this condition. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

KEY TERMS

Computed tomography scan (CT)—An imaging technique in which cross-sectional x rays of the body are compiled to create a three-dimensional image of the body's internal structures.

Interferon—A protein formed when cells are exposed to a virus. Interferon causes other noninfected cells to develop translation inhibitory protein (TIP). TIP blocks viruses from infecting new cells.

Paracentesis—A procedure in which fluid is drained from a body cavity by means of a catheter placed through an incision in the skin.

Systemic lupus erythematosus—An inflammatory disease that affects many body systems, including the skin, blood vessels, kidneys, and nervous system. It is characterized, in part, by arthritis, skin rash, weakness, and fatigue.

Ultrasonography—A test using sound waves to measure blood flow. Gel is applied to a hand-held transducer that is pressed against the patient's body. Images are displayed on a monitor.

Types of ascites

Cirrhosis, which is responsible for 80% of all instances of ascities in the United States, triggers a series of disease-producing changes that weaken the kidney's ability to excrete **sodium** in the urine.

Pancreatic ascites develops when a cyst that has thick, fibrous walls (pseudocyst) bursts and permits pancreatic juices to enter the abdominal cavity.

Chylous ascites has a milky appearance caused by lymph that has leaked into the abdominal cavity. Although chylous ascites is sometimes caused by trauma, abdominal surgery, **tuberculosis**, or another peritoneal infection, it is usually a symptom of lymphoma or some other **cancer**.

Cancer causes 10% of all instances of ascites in the United States. It is most commonly a consequence of disease that originates in the peritoneum (peritoneal carcinomatosis) or of cancer that spreads (metastasizes) from another part of the body.

Endocrine and renal ascites are rare disorders. Endocrine ascites, sometimes a symptom of an endocrine system disorder, also affects women who are taking fertility drugs. Renal ascites develops when blood levels of albumin dip below normal. Albumin is the major protein in blood plasma. It functions to keep fluid inside the blood vessels.

Causes and symptoms

Causes

The two most important factors in the production of ascites due to chronic liver disease are:

- Low levels of albumin in the blood that cause a change in the pressure necessary to prevent fluid exchange (osmotic pressure). This change in pressure allows fluid to seep out of the blood vessels.
- An increase in the pressure within the branches of the portal vein that run through liver (portal hypertension). Portal hypertension is caused by the scarring that occurs in cirrhosis. Blood that cannot flow through the liver because of the increased pressure leaks into the abdomen and causes ascites.

Other conditions that contribute to ascites development include:

- hepatitis
- heart or kidney failure
- inflammation and fibrous hardening of the sac that contains the heart (constrictive pericarditis)

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Persons who have **systemic lupus erythematosus** but do not have liver disease or portal **hypertension** occasionally develop ascites. Depressed thyroid activity sometimes causes pronounced ascites. Inflammation of the pancreas (**pancreatitis**) rarely causes significant accumulations of fluid.

Symptoms

Small amounts of fluid in the abdomen do not usually produce symptoms. Massive accumulations may cause:

- rapid weight gain
- abdominal discomfort and distention
- shortness of breath
- swollen ankles

Diagnosis

Skin stretches tightly across an abdomen that contains large amounts of fluid. The navel bulges or lies flat, and the fluid makes a dull sound when the doctor taps the abdomen. Ascitic fluid may cause the flanks to bulge.

Physical examination generally enables doctors to distinguish ascities from **pregnancy**, intestinal gas, **obesity**, or ovarian tumors. Ultrasound or **computed tomography scans** (CT) can detect even small amounts of fluid. Laboratory analysis of fluid extracted by inserting a needle through the abdominal wall (diagnostic **paracentesis**) can help identify the cause of the accumulation.

Treatment

Reclining minimizes the amount of salt the kidneys absorb, so treatment generally starts with bed rest and a low-salt diet. Urine-producing drugs (**diuretics**) may be prescribed if initial treatment is ineffective. The weight and urinary output of patients using diuretics must be carefully monitored for signs of :

- hypovolemia (massive loss of blood or fluid)
- azotemia (abnormally high blood levels of nitrogen-bearing materials)
- potassium imbalance
- high sodium concentration. If the patient consumes more salt than the kidneys excrete, increased doses of diuretics should be prescribed

Moderate-to-severe accumulations of fluid are treated by draining large amounts of fluid (large-volume paracentesis) from the patient's abdomen. This procedure is safer than diuretic therapy. It causes fewer complications and requires a shorter hospital stay.

Large-volume paracentesis is also the preferred treatment for massive ascites. Diuretics are sometimes used to prevent new fluid accumulations, and the procedure may be repeated periodically.

Alternative treatment

Dietary alterations, focused on reducing salt intake, should be a part of the treatment. In less severe cases, herbal diuretics like dandelion (*Taraxacum officinale*) can help eliminate excess fluid and provide potassium. Potassium-rich foods like low-fat yogurt, mackerel, cantaloupe, and baked potatoes help balance excess sodium intake.

Prognosis

The prognosis depends upon the condition that is causing the ascites. Carcinomatous ascites has a very bad prognosis. However, salt restriction and diuretics can control ascites caused by liver disease in many cases.

Therapy should also be directed towards the underlying disease that produces the ascites. Cirrhosis should be treated by abstinence from alcohol and appropriate diet. The new interferon agents maybe helpful in treating chronic hepatitis.

Prevention

Modifying or restricting use of salt can prevent most cases of recurrent ascites.

Resources

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"Hepatic and Liver Disorders." *The Meck Page*. April 20, 1998. http://www.merck.com.

ORGANIZATIONS

American Liver Foundation, 75 Maiden Lane, Suite 603, New York, NY, 10038, (212) 668-1000, (212) 483-8179, http://www.liverfoundation.org/.

Maureen Haggerty

Ascorbic acid deficiency *see* **Scurvy**

ASD *see* **Atrial septal defect**

Asian American health *see* **Minority health**

Asian flu *see* **Influenza**

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Aspartate aminotransferase test

Definition

The Aspartate aminotransferase (AST) test measures levels of AST, an enzyme released into the blood when certain organs or tissues, particularly the liver and heart, are injured. Aspartate aminotransferase is also known as serum glutamic oxaloacetic transaminase (SGOT).

Purpose

The determination of AST levels aids primarily in the diagnosis of **liver disease**. In the past, the AST test was used to diagnose **heart attack** (myocardial infarction or MI) but more accurate blood tests have largely replaced it for cardiac purposes.

Description

AST is determined by analysis of a blood sample, usually from taken from a venipuncture site at the bend of the elbow.

AST is found in the heart, liver, skeletal muscle, kidney, pancreas, spleen, lung, red blood cells, and brain tissue. When disease or injury affects these tissues, the cells are destroyed and AST is released into the bloodstream. The amount of AST is directly related to the number of cells affected by the disease or injury, but the level of elevation depends on the length of time that the blood is tested after the injury. Serum AST levels become elevated eight hours after cell injury, peak at 24-36 hours, and return to normal in three to seven days. If the cellular injury is chronic (ongoing), AST levels will remain elevated.

One of the most important uses for AST determination has formerly been in the diagnosis of a heart attack, or MI. AST can assist in determining the timing and extent of a recent MI, although it is less specific than creatine phosphokinase (CPK), CK-MB, myglobin, troponins, and lactic dehydrogenase (LDH). Assuming no further cardiac injury occurs, the AST level rises within 6-10 hours after an acute attack, peaks at 12-48 hours, and returns to normal in three to four days. Myocardial injuries such as **angina** (chest **pain**) or **pericarditis** (inflammation of the pericardium, the membrane around the heart) do not increase AST levels.

AST is also a valuable aid in the diagnosis of liver disease. Although not specific for liver disease, it can be used in combination with other enzymes to monitor the course of various liver disorders. Chronic, silent hepatitis (**hepatitis C**) is sometimes the cause of elevated AST. In **alcoholic hepatitis**, caused by excessive alcohol ingestion, AST values are usually moderately elevated; in acute viral hepatitis, AST levels can rise to over 20 times normal. Acute extrahepatic (outside the liver) obstruction (e.g. gallstone), produces AST levels that can quickly rise to 10 times normal, and then rapidly fall. In cases of **cirrhosis**, the AST level is related to the amount of active inflammation of the liver. Determination of AST also assists in early recognition of toxic hepatitis that results from exposure to drugs toxic to the liver, like **acetaminophen** and cholesterol lowering medications.

Other disorders or diseases in which the AST determination can be valuable include acute **pancreatitis**, muscle disease, trauma, severe burn, and **infectious mononucleosis**.

KEY TERMS

Cirrhosis—Disease of the liver caused by chronic damage to its cells.

Myocardial infarction—Commonly known as a heart attack. Sudden death of part of the heart muscle, characterized, in most cases, by severe, unremitting chest pain.

Preparation

The physician may require discontinuation of any drugs that might affect the test. These types include such drugs as antihypertensives (for treatment of high blood pressure), coumarin-type anticoagulants (blood-thinning drugs), digitalis, erythromycin (an antibiotic), **oral contraceptives**, and opiates, among others. The patient may also need to cut back on strenuous activities temporarily, because **exercise** can also elevate AST for a day or two.

Risks

Risks for this test are minimal, but may include slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after venipuncture, or hematoma (blood accumulating under the puncture site).

Normal results

Normal ranges for the AST are laboratory-specific, but can range from 3-45 units/L (units per liter).

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Abnormal results

Striking elevations of AST (400-4000 units/L) are found in almost all forms of acute hepatic necrosis, such as viral hepatitis and carbon tetrachloride **poisoning**. In alcoholics, even moderate doses of the analgesic acetaminophen have caused extreme elevations (1, 960-29, 700 units/L). Moderate rises of AST are seen in **jaundice**, cirrhosis, and metastatic carcinoma. Approximately 80% of patients with infectious mononucleosis show elevations in the range of 100-600 units/L.

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Janis O. Flores

Asperger syndrome

Definition

Asperger syndrome (AS), which is also called Asperger disorder or autistic psychopathy, belongs to a group of childhood disorders known as **pervasive developmental disorders** (PDDs) or autistic spectrum disorders. AS was first described by Hans Asperger, an Austrian psychiatrist, in 1944. Asperger's work was unavailable in English before the mid–1970s; as a result, AS was often unrecognized in English–speaking countries until the late 1980s. Before the American Psychiatric Association's *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (DSM–IV 1994), there was no official definition of AS.

Demographics

According to the National Institute of Neurological Disorders and Stroke (NINDS), the rate of occurrence of AS is not well established. A conservative estimate is that two out of every 10,000 children have the disorder. In France, the INSERM (French National Health and Medical Research Institute) reports a prevalence of three children in 10,000. However further research is required to obtain precise AS prevalence data. In addition, no research has been done on the populations of developing countries, and no information is available about the incidence of the disorder in different racial or ethnic groups.

As for gender differences, AS appears to be three to four times more common in boys.

Description

Children with AS learn to talk at the usual age and often have above–average verbal skills. They have normal or above–normal intelligence and the ability to take care of themselves. The distinguishing features of AS are problems with social interaction, particularly reciprocating and empathizing with the feelings of others; difficulties with nonverbal communication (e.g., facial expressions); peculiar speech habits that include repeated words or phrases and a flat, emotionless vocal tone; an apparent lack of "common sense," a fascination with obscure or limited subjects (e.g., doorknobs, railroad schedules, astronomical data, etc.) often to the exclusion of other interests; clumsy and awkward physical movements; and odd or eccentric behaviors (hand wringing or finger flapping; swaying or other repetitious whole–body movements; watching spinning objects for long periods of time).

Risk factors

There is some indication that AS runs in families, particularly in families with histories of depression and **bipolar disorder**. Asperger noted that his initial group of patients had fathers with AS symptoms. Knowledge of the genetic profile as a risk factor continues to be limited, however.

Causes and symptoms

About 50% of patients with Asperger syndrome have a history of oxygen deprivation during the birth process, which has led to the hypothesis that the syndrome is caused by damage to brain tissue before or during **childbirth**. Another cause that has been suggested is an organic defect in the functioning of the brain. Research studies have made no connection between Asperger's disorder and childhood trauma, **abuse** or neglect.

In young children, the symptoms of AS typically include problems picking up social cues and understanding the basics of interacting with other children. The child may want friendships but find him-or herself unable to make friends. Most children with Asperger's are diagnosed during the elementary school years because the symptoms of the disorder become more apparent at this point. They include:

- Poor pragmatic language skills. This phrase means that the child does not use the right tone or volume of voice for a specific context, and does not understand

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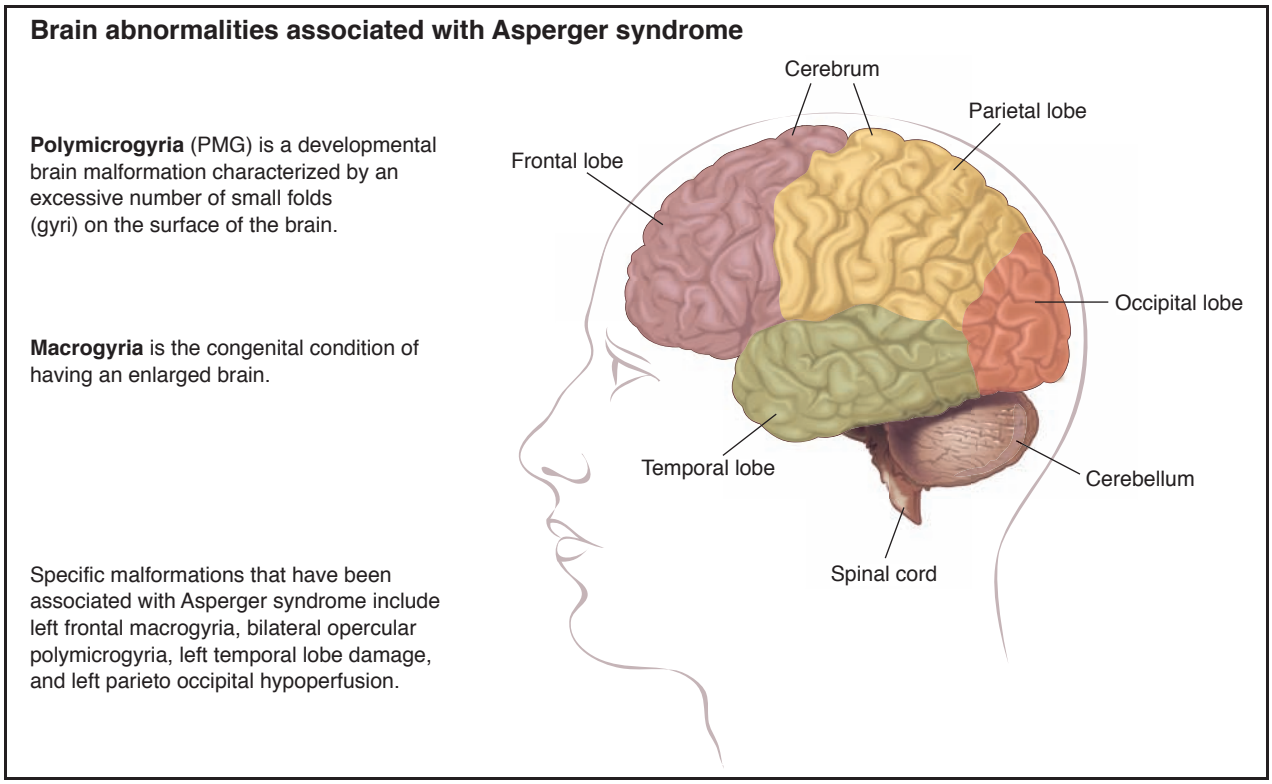

Possible brain malformations associated with Asperger syndrome. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

that using humorous or slang expressions also depends on social context.

- Problems with hand–eye coordination and other visual skills
- Problems making eye contact with others
- Learning difficulties, which may range from mild to severe
- Tendency to become absorbed in a particular topic and not know when others are bored with conversation about it. At this stage in their education, children with AS are likely to be labeled as "nerds. "
- Repetitive behaviors. These include such behaviors as counting a group of coins or marbles over and over; reciting the same song or poem several times; buttoning and unbuttoning a jacket repeatedly; etc.

Adolescence is one of the most painful periods of life for young people with Asperger's, because social interactions are more complex in this age group and require more subtle social skills. Some boys with AS become frustrated trying to relate to their peers and may become aggressive. Both boys and girls with the disorder are often quite naive for their age and easily manipulated by "street–wise" classmates. They are also more vulnerable than most youngsters to peer pressure.

Little research has been done regarding adults with AS. Some have serious difficulties with social and occupational functioning, but others are able to finish their schooling, join the workforce, and marry and have families.

Diagnosis

As of 2009, there are no blood tests or brain scans that can be used to diagnose AS. Until DSM–IV (1994), there was no "official" list of symptoms for the disorder, which made its diagnosis both difficult and inexact. Although most children with AS are diagnosed between five and nine years of age, many are not diagnosed until adulthood. Misdiagnoses are common; AS has been confused with such other neurological disorders as **Tourette syndrome**, or with Attention Deficit Disorder (ADD), **Oppositional Defiant Disorder** (ODD), or **Obsessive–Compulsive Disorder** (OCD). Some researchers think that AS overlaps with some types of learning disability, such

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KEY TERMS

Autistic psychopathy—Hans Asperger's original name for Asperger syndrome. It is still used occasionally as a synonym for the disorder.

Gillberg's criteria—A six–item checklist for Asperger syndrome developed by Christopher Gillberg, a Swedish researcher. It is widely used as a diagnostic tool.

High–functioning autism (HFA)—A subcategory of autistic disorder consisting of children diagnosed with IQs of 70 or higher.

Nonverbal Learning Disability (NLD)—A learning disability syndrome identified in 1989 that may overlap with some of the symptoms of Asperger syndrome.

Pervasive developmental disorder (PDD)—The term used by the American Psychiatric Association for individuals who meet some but not all of the criteria for autism.

as the Nonverbal Learning Disability (NLD) syndrome identified in 1989.

The inclusion of AS as a separate diagnostic category in DSM–IV was justified on the basis of a large international field trial of over a thousand children and adolescents. Nevertheless, the diagnosis of AS is also complicated by confusion with such other diagnostic categories as "high–functioning (IQ 70) autism," or HFA, and "schizoid personality disorder of childhood." With regard to the latter, AS is not an unchanging set of personality traits but has a developmental dimension. AS is distinguished from HFA by the following characteristics:

- later onset of symptoms (usually around three years of age)
- early development of grammatical speech; the AS child's verbal IQ is usually higher than performance IQ (the reverse being the case in autistic children)
- less severe deficiencies in social and communication skills
- presence of intense interest in one or two topics
- physical clumsiness and lack of coordination
- family is more likely to have a history of the disorder
- lower frequency of neurological disorders
- more positive outcome in later life

DSM–IV criteria for Asperger syndrome

DSM–IV specifies six diagnostic criteria for AS:

- The child's social interactions are impaired in at least two of the following ways: markedly limited use of nonverbal communication; lack of age–appropriate peer relationships; failure to share enjoyment, interests, or accomplishment with others; lack of reciprocity in social interactions.
- The child's behavior, interests, and activities are characterized by repetitive or rigid patterns, such as an abnormal preoccupation with one or two topics, or with parts of objects; repetitive physical movements; or rigid insistence on certain routines and rituals.
- The patient's social, occupational, or educational functioning is significantly impaired.
- The child has normal age–appropriate language skills.
- The child has normal age–appropriate cognitive skills, self–help abilities, and curiosity about the environment.
- The child does not meet criteria for another specific PDD or schizophrenia.

Other diagnostic scales and checklists

Other instruments that have been used to identify children with AS include Gillberg's criteria, a six–item list compiled by a Swedish researcher that specifies problems in social interaction, a preoccupying narrow interest, forcing routines and interests on the self or others, speech and language problems, nonverbal communication problems, and physical clumsiness; and the Australian Scale for Asperger Syndrome, a detailed multi–item questionnaire developed in 1996.

Brain imaging findings

As of 2009, only a few structural abnormalities of the brain have been linked to AS. Findings include abnormally large folds in the brain tissue in the left frontal region, abnormally small folds in the operculum (a lid–like structure composed of portions of three adjoining brain lobes), and damage to the left temporal lobe. The first single photon emission tomography (SPECT) study of patient with AS found lower than normal blood supply in the left parietal area of the brain. Brain imaging studies on a larger sample of patients is the next stage of research.

Treatment

As of 2009, there is no cure for AS and no prescribed regimen for all affected patients. Specific treatments are based on the individual's symptom pattern.

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Traditional

Individuals with Asperger syndrome often benefit from **psychotherapy**, particularly during adolescence, in order to cope with depression and other painful feelings related to their social difficulties. Treatment aims to help patients manage the major issues associated with the condition: lack of communication skills, obsessive routines, and physical clumsiness.

Drugs

The drugs that are recommended most often for children with AS include psychostimulants (methylphenidate, pemoline), clonidine, or one of the **tricyclic antidepressants** (TCAs) for hyperactivity or inattention; **beta blockers**, neuroleptics, or lithium for anger or aggression; **selective serotonin reuptake inhibitors** (SSRIs) or TCAs for rituals and preoccupations; and SSRIs or TCAs for **anxiety** symptoms. One alternative herbal remedy that has been tried with AS patients is **St. John's wort**.

Alternative

As of 2009, 26 clinical trials for the treatment of Asperger syndrome were being sponsored by the National Institutes of Health (NIH) and other agencies.

One study (NCT00464477) was recruiting parents of children with a pervasive developmental disorder (including **autism**, autistic spectrum disorder, PDD–NOS, Asperger syndrome, childhood disintegrative disorder, and Rett syndrome) to participate in a study seeking to determine potential causes of these disorders. Other trials are evaluating drugs for treatment. For example, N–acetylcysteine is being tested for the improvement of the behavior problems often associated with autism spectrum disorders (NCT00453180). The potential beneficial effect of DMSA, an oral chelating agent that removes mercury and other metals from the body, is also being investigated (NCT00376194), as well as the efficacy of risperidone in normalizing symptoms (NCT00352196). Other drugs being tested include aripiprazole (NCT00198055) and citalopram (NCT00086645). A cognitive behavioral therapy (CBT) program is also being evaluated for treating anxiety symptoms, social problems, and adaptive behavior deficits in children with Asperger syndrome (NCT00280670).

Clinical trial information is constantly updated by NIH and the most recent information on Asperger trials can be found at: http://clinicaltrials.gov/ct2/results?term=Asperger+syndrome+.

Prognosis

AS is a lifelong but stable condition. The prognosis for children with AS is generally good as far as intellectual development is concerned, although few school districts are equipped to meet their special social needs. In addition, some researchers think that people with AS have an increased risk of becoming psychotic in adolescence or adult life.

Prevention

Effective prevention of Asperger's disorder awaits further genetic mapping together with ongoing research in the structures and functioning of the brain.

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ORGANIZATIONS

Autism Network International (ANI), P.O. Box 35448, Syracuse, NY, 13235-5448, jisincla@syr.edu, http://www.ani.ac.

Autism Society of America, 7910 Woodmont Avenue, Suite 300, Bethesda, MD, 20814-3067 (301) 657-0881 (800) 3AUTISM (301) 657-0869, http://www.autism-society.org.

Global and Regional Asperger's Syndrome Partnership, 135 East 15th Street, New York, NY, 10003 (646) 242-4003, info@grasp.org, http://www.grasp.org.

MAAP Services for Autism, Asperger Syndrome, and PDD, P.O. Box 524, Crown Point, IN, 46308 (219) 662-1311 (219) 662-0638, info@maapservices.org, http://www.maapservices.org.

National Institute of Mental Health (NIMH), 6001 Executive Blvd., Room 8184, MSC 9663, Bethesda, MD, 20892-9663 (301) 443-4513 (866) 415-8051 (301) 443-4279, nimhinfo@nih.gov, http://www.nimh.nih.gov.

National Organization for Rare Disorders (NORD), 55 Kenosia Avenue, Danbury, CT, 06813-1968 (203) 744-0100 (800) 999-NORD (203) 798-2291, orphan@rarediseases.org, http://www.rarediseases.org.

Rebecca J. Frey PhD

Aspergilloma *see* **Aspergillosis**

Aspergillosis

Definition

Aspergillosis refers to several forms of disease caused by a fungus in the genus *Aspergillus*. Aspergillosis fungal infections can occur in the ear canal, eyes, nose, sinus cavities, and lungs. In some individuals, the infection can even invade bone and the membranes that enclose the brain and spinal cord (**meningitis**).

Description

Aspergillosis is primarily an infection of the lungs caused by the inhalation of airborne spores of the fungus *Aspergillus*. Spores are the small particles that most fungi use to reproduce. Although virtually everyone is exposed to this fungus in their daily environment, it rarely causes disease. When *Aspergillus* does cause disease, however, it usually occurs in those individuals with weakened immune systems (immunocompromised) or who have a history of respiratory ailments. Because it does not present distinctive symptoms, aspergillosis is generally thought to be underdiagnosed and underreported. Furthermore, many patients with the more severe forms of aspergillosis tend to have multiple, complex health problems, such as **AIDS** or a blood disorder like leukemia, which can further complicate diagnosis and treatment.

Once considered particularly rare, the incidence of reported aspergillosis has risen somewhat with the development of more sophisticated methods of diagnosis and advances made in other areas of medicine, such as with

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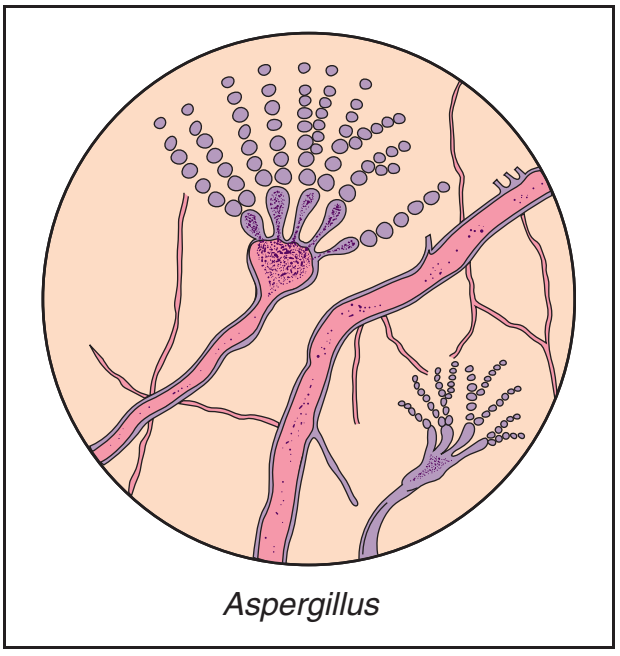

Aspergillosis is an infection of the lungs caused by inhalation of airborne spores of the fungus *Aspergillus*. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

the increased use of certain chemotherapeutic and corticosteroid drugs that are extremely useful in treating various types of **cancer** but that decrease the individual's immune response, making them more susceptible to other diseases like aspergillosis.

Our advanced ability to perform tissue and organ transplants has also increased the number of people vulnerable to fungal infections. Transplant recipients, particularly those receiving bone marrow or heart transplants, are highly susceptible to *Aspergillus*, which may be circulating in the hospital air.

Aspergillosis can be a serious, potentially deadly threat for two primary reasons:

- Aspergillosis usually occurs in those individuals who are already ill or have weakened immune systems, such as patients who have undergone chemotherapy for cancer.
- None of the currently available antifungal drugs are reliably effective against *Aspergillus*.

Causes and symptoms

Airborne *Aspergillus* spores enter the body primarily through inhalation but can also lodge in the ear or eye. Normally functioning immune systems are generally able to cope without consequent development of aspergillosis.

It is important to make distinctions between the various forms of aspergillosis, as the treatment and prognosis varies considerably among types. Aspergillosis as a diagnosis refers to three general forms:

- Allergic bronchopulmonary aspergillosis (ABPA) is seen in patients with long-standing asthma, particularly in patients taking oral corticosteroids for a long period of time. This is usually the least serious and most treatable form.
- Aspergilloma refers to the mass formed when fungal spores settle into or colonize areas of the lung that have been pitted and scarred as a result of tuberculosis or prior pneumonia. There are several available treatments, although the success rate varies with each treatment.
- Invasive fungal infection refers to rare cases in which the fungus spreads throughout the body via the blood stream and invades other organ systems. Once established, invasive fungal infections are extremely difficult to cure and, as a result, the associated death rate is extremely high.

Diagnosis

Aspergillosis can be quite difficult to diagnose because the symptoms, such as coughing and **wheezing**, if present at all, are common to many respiratory disorders. Furthermore, blood and sputum cultures are not very helpful. The presence of *Aspergillus* is so common, even in asthmatics, that a positive culture alone is insufficient for a diagnosis. Other, potentially more useful, screening tools include examining the sample obtained after repeatedly washing the bronchial tubes of the lung with water (bronchial lavage), but examining a tissue sample (biopsy) is the most reliable diagnostic tool. Researchers are currently attempting to develop a practical, specific, and rapid blood test that would confirm *Aspergillus* infection.

Signs of ABPA include a worsening of bronchial **asthma** accompanied by a low-grade **fever**. Brown flecks or clumps may be seen in the sputum. **Pulmonary function tests** may show decreased blood flow, suggesting an obstruction within the lungs. Elevated blood levels of an antibody produced in response to *Aspergillus* and of certain immune system cells may indicate a specific allergic-type immune system response.

A fungal mass (aspergilloma) in the lung usually does not produce clear symptoms and is generally diagnosed when seen on chest x rays. However, 70% or more of patients spit up blood from the lungs (**hemoptysis**) at least once, and this may become repetitive and serious. Hemoptysis, then, is another indication that the patient may be suffering from an aspergilloma.

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KEY TERMS

Antibody—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

Aspergilloma—A ball or mass made of *Aspergillus* fungi that can form in the lungs of patients with suppressed immune systems.

Bronchial lavage—A procedure that involves repeatedly washing the inside of the bronchial tubes of the lung.

Hemoptysis—Spitting up blood from the lungs or sputum stained with blood.

Immunocompromised—A state in which the immune system is suppressed or not functioning properly.

Meningitis—Inflammation of the membranes covering the brain and spinal cord, called the meninges.

Nebulizer—A device that produces an extremely fine mist that is readily inhalable.

Spores—The small, thick-walled reproductive structures of fungi.

Sputum—Mucus and other matter coughed up from the airways.

In patients with lowered immune systems who are at risk for developing invasive aspergillosis, the physician may use a combination of **blood culture** with visual diagnostic techniques, such as **computed tomography scans** (CT) and radiography, to arrive at a likely diagnosis.

Treatment

The treatment method selected depends on the form of aspergillosis. ABPA can usually be treated with many of the same drugs used to treat asthma, such as systemic **steroids**. Long-term therapy may be required, however, to prevent recurrence. Antifungal agents are not recommended in the treatment of ABPA. In cases of aspergilloma, it may become necessary to surgically remove or reduce the size of a fungal mass, especially if the patient continues to spit up blood. In aspergillosis cases affecting the nose and nasal sinuses, surgery may also be required.

In non-ABPA cases, the use of antifungal drugs may be indicated. In such cases, amphotericin B (Fungizone) is the first-line therapy. The prescribed dose will depend on the patient's condition but usually begins with a small test dose and then escalates. Less than one-third of patients are likely to respond to amphotericin B, and its side effects often limit its use. For patients who do not respond to oral amphotericin B, another option is a different formulation of the same drug called liposomal amphotericin B.

For patients who fail to respond or who cannot tolerate amphotericin B, another drug called itraconazole (Sporanox), given 400-600 mg daily, has also been approved. Treatment generally lasts about 3 months. Giving itraconazole can produce adverse reactions if prescribed in combination with certain other drugs by increasing the concentrations of both drugs in the blood and creating a potentially life-threatening situation. Even **antacids** can significantly affect itraconazole levels. As a result, drug levels must be continually monitored to ensure that absorption is occurring at acceptable levels.

Two other methods of treatment are being studied: direct instillation of an antifungal agent into the lungs and administration of antifungals using a nebulizer. Instilling or injecting amphotericin B or itraconazole directly into the lung cavity or into the fungal ball (aspergilloma) itself has been helpful in stopping episodes of hemoptysis, but not in preventing future recurrences. Furthermore, many patients with aspergillomas are poor risks for surgery because their lung function is already compromised. As a result, instillation of a fungal agent should only be considered in those who have significant hempotysis.

A popular method of treating some respiratory disorders is to add a liquid drug to another carrier liquid and aerosolize or produce a fine mist that can be inhaled into the lungs through a device called a nebulizer. However, this has not yet been shown to improve the patient's condition in cases of aspergillosis, possibly because the drug is not reaching the aspergilloma.

At this point, preventative therapy for aspergillosis is not suggested for susceptible individuals, primarily because overuse of the drugs used to fight fungal infections may lead to the development of drug-resistant aspergillosis against which current antifungal drugs are no longer effective.

Prognosis

The likelihood of recovery from aspergillosis depends on any underlying medical conditions, the

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patient's general health, and the specific type of aspergillosis. If the problem is based on an allergic response, as in ABPA, the patient will likely respond well to systemic steroids.

Patients who require **lung surgery**, especially those who have problems with coughing up blood, have a mortality rate of about 7-14%, and complications or recurrence may result in a higher overall **death** rate. However, by treating aspergilloma with other, non-surgical methods, that risk rises to 26%, making surgery a better option in some cases.

Unfortunately, the prognosis for the most serious form, invasive aspergillosis, is quite poor, largely because these patients have little resilience due to their underlying disorders. Death rates have ranged from about 50% in some studies to as high as 95% for bone-marrow recipients and patients with AIDS. The course of the illness can be rapid, resulting in death within a few months of diagnosis.

Prevention

Fungal infection by *Aspergillus* presents a major challenge, particularly in the patient with a suppressed immune system (immunocompromised). Hospitals and government health agencies continually seek ways to minimize exposure for hospitalized patients. Practical suggestions are minimal but include moving leaf piles away from the house. Unfortunately, overall avoidance of this fungus is all but impossible because it is present in the environment virtually everywhere. Research efforts are being directed at enhancing patients' resistance to *Aspergillus* rather than trying to eliminate exposure to the fungus. Given the growing number of people with immune disorders or whose immune systems have been suppressed in the course of treating another disease, research and clinical trials for new antifungal agents will be increasingly important in the future.

Resources

OTHER

"Lung, Allergic and Immune Diseases: Mold Allergy: Prevention Techniques." National Jewish Medical and Research. http://nationaljewish.org/main.html.

Office of Rare Diseases (ORD) at National Institutes of Health, Bldg. 31,1BO3, Bethesda, MD 20892-2082. (301) 402-4336, http://rarediseases.org.

ORGANIZATIONS

American College of Allergy, Asthma & Immunology, 85 West Algonquin Road, Suite 550, Arlington Heights, IL, 60005, (847) 427-1200, (847) 427-1294, mail @acaai.org, http://acaai.org.

Jill S. Lasker

Aspirin

Definition

Aspirin is a medicine that relieves **pain** and reduces **fever**.

Purpose

Aspirin is used to relieve many kinds of minor aches and pains–headaches, toothaches, muscle pain, menstrual cramps, the joint pain from arthritis, and aches associated with colds and flu. Some people take aspirin daily to reduce the risk of **stroke**, **heart attack**, or other heart problems.

Description

Aspirin, also known as acetylsalicylic acid–is sold over the counter and comes in many forms, from the familiar white tablets to chewing gum and rectal suppositories. Coated, chewable, buffered, and extended release forms are available. Many other over-the-counter medicine contain aspirin. Alka-Seltzer Original Effervescent Antacid Pain Reliever, for example, contains aspirin for pain relief and sodium bicarbonate to relieve acid **indigestion**, **heartburn**, and sour stomach.

Aspirin belongs to a group of drugs called salicylates. Other members of this group include sodium salicylate, choline salicylate, and magnesium salicylate. These drugs are more expensive and no more effective than aspirin. However, they are a little easier on the stomach. Aspirin is quickly absorbed into the bloodstream and provides quick and relatively long-lasting pain relief. Aspirin also reduces inflammation. Researchers believe these effects come about because aspirin blocks the production of pain-producing chemicals called prostaglandins.

In addition to relieving pain and reducing inflammation, aspirin also lowers fever by acting on the part of the brain that regulates temperature. The brain then signals the blood vessels to widen, which allows heat to leave the body more quickly.

Recommended dosage

Adults

TO RELIEVE PAIN OR REDUCE FEVER. One to two tablets every three to four hours, up to six times per day.

TO REDUCE THE RISK OF STROKE. One tablet four times a day or two tablets twice a day.

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KEY TERMS

Diuretic—Medicine that increases the amount of urine produced and relieves excess fluid buildup in body tissues. Diuretics may be used in treating high blood pressure, lung disease, premenstrual syndrome, and other conditions.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

NSAIDs—Nonsteroidal anti-inflammatory drugs. Drugs such as ketoprofen and ibuprofen which relieve pain and reduce inflammation.

Polyp—A lump of tissue protruding from the lining of an organ, such as the nose, bladder, or intestine. Polyps can sometimes block the passages in which they are found.

Prostaglandin—A hormonelike chemical produced in the body. Prostaglandins have a wide variety of effects, and may be responsible for the production of some types of pain and inflammation.

Reye's syndrome—A life-threatening disease that affects the liver and the brain and sometimes occurs after a viral infection, such as flu or chickenpox. Children or teenagers who are given aspirin for flu or chickenpox are at increased risk of developing Reye's syndrome.

Rhinitis—Inflammation of the membranes inside the nose.

Salicylates—A group of drugs that includes aspirin and related compounds. Salicylates are used to relieve pain, reduce inflammation, and lower fever.

TO REDUCE THE RISK OF HEART ATTACK. Check with a physician for the proper dose and number of times per week aspirin should, if at all, be taken.

Children

Check with a physician.

Precautions

Aspirin, even children's aspirin, should never be given to children or teenagers with flu-like symptoms or **chickenpox**. Aspirin can cause **Reye's syndrome**, a life-threatening condition that affects the nervous system and liver. As many as 30% of children and teenagers who develop Reye's syndrome die. Those who survive may have permanent brain damage.

Check with a physician before giving aspirin to a child under 12 years for arthritis, rheumatism, or any condition that requires long-term use of the drug.

No one should take aspirin for more than 10 days in a row unless told to do so by a physician. Anyone with fever should not take aspirin for more than 3 days without a physician's consent. Do not to take more than the recommended daily dosage.

People in the following categories should not use aspirin without first checking with their physician:

- Pregnant women. Aspirin can cause bleeding problems in both the mother and the developing fetus. Aspirin can also cause the infant's weight to be too low at birth.
- Women who are breastfeeding. Aspirin can pass into breast milk and may affect the baby.
- People with a history of bleeding problems.
- People who are taking blood-thinning drugs, such as warfarin (Coumadin).
- People with a history of ulcers.
- People with a history of asthma, nasal polyps, or both. These people are more likely to be allergic to aspirin.
- People who are allergic to fenoprofen, ibuprofen, indomethacin, ketoprofen, meclofenamate sodium, naproxen, sulindac, tolmetin, or the orange food-coloring tartrazine. They may also be allergic to aspirin.
- People with AIDS or AIDS-related complex who are taking AZT (zidovudine). Aspirin can increase the risk of bleeding in these patients.
- People taking certain other drugs (discussed in Interactions).
- People with liver damage or severe kidney failure.

Aspirin should not be taken before surgery, as it can increase the risk of excessive bleeding. Anyone who is scheduled for surgery should check with his or her surgeon to find out how long before surgery to avoid taking aspirin.

Aspirin can cause stomach irritation. To reduce the likelihood of that problem, take aspirin with food or milk or drink a full 8-oz glass of water with it. Taking coated or buffered aspirin can also help. Be aware that drinking alcohol can make the stomach irritation worse.

Stop taking aspirin immediately and call a physician if any of these symptoms develop:

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- ringing or buzzing in the ears
- hearing loss
- dizziness
- stomach pain that does not go away

Do not take aspirin that has a vinegary smell. That is a sign that the aspirin is too old and ineffective.

Because aspirin can increase the risk of excessive bleeding, do not take aspirin daily over long periods—to reduce the risk of stroke or heart attack, for example—unless advised to do so by a physician.

Side effects

The most common side effects include **stomachache**, heartburn, loss of appetite, and small amounts of blood in stools. Less common side effects are **rashes**, **hives**, fever, vision problems, liver damage, thirst, stomach ulcers, and bleeding. People who are allergic to aspirin or those who have **asthma**, **rhinitis**, or polyps in the nose may have trouble breathing after taking aspirin.

Interactions

Aspirin may increase, decrease, or change the effects of many drugs. Aspirin can make drugs such as methotrexate (Rheumatrex) and valproic acid (Depakote, Depakene) more toxic. If taken with blood-thinning drugs, such as warfarin (Coumadin) and dicumarol, aspirin can increase the risk of excessive bleeding. Aspirin counteracts the effects of other drugs, such as angiotensin-converting enzyme (ACE) inhibitors and **beta blockers**, which lower blood pressure, and medicines used to treat **gout** (probenecid and sulfinpyrazone). Blood pressure may drop unexpectedly and cause **fainting** or **dizziness** if aspirin is taken along with nitroglycerin tablets. Aspirin may also interact with **diuretics**, diabetes medicines, other **nonsteroidal anti-inflammatory drugs** (NSAIDs), seizure medications, and **steroids**. Anyone who is taking these drugs should ask his or her physician whether they can safely take aspirin.

Resources

OTHER

Aspirin. PubMed Health, National Library of Medicine. http://www.ncbi.nlm.nih.gov/pubmedhealth/PMH0000802 (accessed November 23, 2010).

Nancy Ross-Flanigan

AST *see* **Aspartate aminotransferase test**

Astemizole *see* **Antihistamines**

Asthma

Definition

Asthma is a chronic (long-lasting) inflammatory disease of the airways. In those susceptible to asthma, this inflammation causes the airways to spasm and swell periodically so that the airways narrow. The individual then must wheeze or gasp for air. Obstruction to air flow either resolves spontaneously or responds to a wide range of treatments, but continuing inflammation makes the airways hyper-responsive to stimuli such as cold air, **exercise**, dust mites, pollutants in the air, and even **stress** and **anxiety**.

Demographics

Asthma is common in industrialized countries. In the United States, it is estimated to affect between 10% and 15% of the population. This number appears to be both increasing, especially among children under age 6, while at the same time the disease is becoming more severe. Asthma is estimated to cause between 3,500 and 5,000 deaths annually in the United States. In 2007, it was responsible for 217,000 emergency room visits and 10.4 million office visits. Its estimated cost to the United States economy is about $20 billion. Worldwide, asthma is estimated to affect 300 million people.

About two-thirds of all cases of asthma are diagnosed in people under age 18, but asthma also may first appear during adult years. More women than men are diagnosed with adult-onset asthma. While the symptoms may be similar, certain important aspects of asthma differ in children and adults.

Description

The changes that take place in the lungs of people with asthma makes the airways (the "breathing tubes," or bronchi and the smaller bronchioles) hyper-reactive to many different types of stimuli that do not affect healthy lungs. In an asthma attack, the muscle tissue in the walls of bronchi go into spasm, and the cells lining the airways swell and secrete mucus into the airways. Both these actions cause the bronchi to become narrowed (bronchoconstriction). As a result, an asthmatic person has to make a much greater effort to breathe in air and to expel it.

Cells in the bronchial walls, called mast cells, release certain substances that cause the bronchial muscle to contract and stimulate mucus formation. These substances, which include histamine and a group of chemicals called leukotrienes, also bring white blood cells into the area, which is a key part of the inflammatory response.

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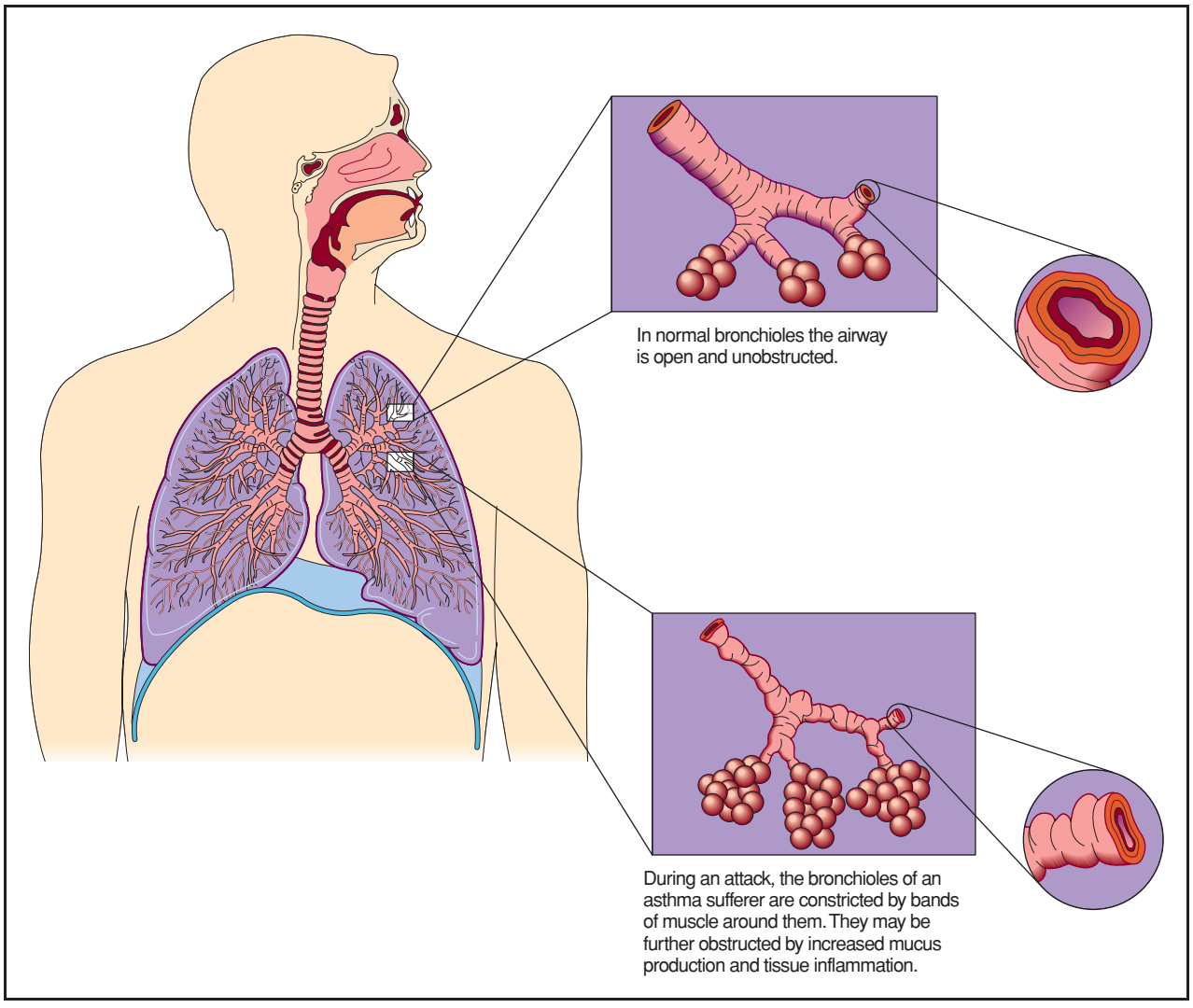

A comparison of normal bronchioles and those of an asthma sufferer. *(Illustration by Hans & Cassady, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

Many individuals with asthma are sensitized to react to such "foreign" substances as pollen, house dust mites, or animal dander; these substances are called allergens. On the other hand, asthma affects many individuals who are not allergic in this way.

Risk factors

Asthma is closely linked to **allergies**; about 75% of people with asthma also have allergies.

Child-onset asthma

About 9 million American children have been diagnosed with asthma. Approximately 20% of cases begin in the first year of life. When asthma begins in childhood, it often does so in a child who is likely, for genetic reasons, to become sensitized to common allergens in the environment (an atopic person). When these children are exposed to dust mites, animal proteins (i.e., animal hair, dander), mold, or other potential allergens, they produce a type of antibody that is intended to engulf and destroy the foreign materials. This has the effect of making the airway cells sensitive to particular materials. Further exposure can lead rapidly to an asthmatic response. This condition, called atopy, is present in at least one-third and as many as one-half of the general population.

Adult-onset asthma

Allergies also may play a role when adults become asthmatic. Adults who develop asthma may be exposed

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KEY TERMS

Allergen—A foreign substance, such as mites in house dust or animal dander which, when inhaled, causes the airways to narrow and produces symptoms of asthma.

Atopy—A state that makes persons more likely to develop allergic reactions of any type, including the inflammation and airway narrowing typical of asthma.

Beta blockers—Drugs used to treat high blood pressure (hypertension) that limit the activity of epinephrine, a hormone that increases blood pressure.

Hypersensitivity—The state where even a tiny amount of allergen can cause the airways to constrict and bring on an asthmatic attack.

Spirometry—A test using an instrument called a spirometer that shows how difficult it is for an asthmatic individual to breathe. It is used to determine the severity of asthma and to see how well it is responding to treatment.

to allergens in the workplace, such as certain forms of plastic, solvents, and wood dust. Other adults may be sensitive to **aspirin**, **nonsteroidal anti-inflammatory drugs** (NSAIDs, such as ibuprofen), or other drugs. Compared to childhood-onset asthma, adult-onset asthma tends to be more continuous, while childhood asthma often is marked by asthmatic episodes followed by asthma-free periods.

Exercise-induced asthma

People who do not have allergies can still develop a form of asthma that is brought on by aerobic exercise. These episodes can last for several minutes and leave the individual gasping for breath. Some estimates suggest that 12–15% of Americans who do not have allergies are susceptible to exercise-induced asthma; rates of 40–90% have been reported in individuals who do have allergies. Inhaling cold air, aerobic exercise lasting more than 10 minutes, or shorter periods of very heavy aerobic exercise, tend to trigger an exercise-induced asthma attack in susceptible individuals. Polluted air and certain chemicals (e.g., chlorine in pools, herbicides on a playing field) appear to increase the likelihood of an asthma episodes in sensitive individuals.

Causes and symptoms

In most cases, asthma is caused by inhaling an allergen to which the individual is hypersensitized. This sets off the chain of biochemical and tissue changes leading to airway inflammation, bronchoconstriction, and **wheezing**. Avoiding or at least minimizing exposure to asthma triggers is the most effective way of treating asthma, so it is helpful to identify which specific allergen or irritant is causing symptoms in a particular individual. Once asthma is present, symptoms may be triggered or aggravated if the individual also has **rhinitis** (inflammation of the lining of the nose as from allergies) or **sinusitis** (sinus inflammation). When stomach acid passes back up the esophagus (acid reflux), this also may worsen asthma symptoms. A viral infection of the respiratory tract (e.g., a cold) also may trigger or worsen an asthmatic reaction. Aspirin, NSAIDs, and beta-blocker drugs also may worsen the symptoms of asthma.

The most common inhaled allergens that trigger asthma attacks are:

- animal dander
- mites in house dust
- fungi (molds) that grow indoors
- cockroach allergens
- pollen
- chemicals, fumes, or airborne industrial pollutants
- smoke

Inhaling tobacco smoke, either by **smoking** or being around people who are smoking, can irritate the airways and trigger an asthmatic attack. Air pollutants such as wood smoke can have a similar effect. In addition, three factors that regularly produce attacks in certain asthmatic individuals, and may sometimes be the sole cause of symptoms are:

- inhaling cold air (cold-induced asthma)
- exercise-induced asthma
- stress or a high level of anxiety

Wheezing is often obvious, but mild asthma attacks may be confirmed only when the physician listens to the individual's chest with a stethoscope. Besides wheezing and being short of breath, the individual may **cough** and/or may report a feeling of "tightness" in the chest. Wheezing is often loudest when the individual breathes out (exhales) in an attempt to expel air through the narrowed airways.

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Some people with asthma are free of symptoms most of the time but occasionally may have episodes of **shortness of breath**. Others spend much of their time wheezing or have frequent bouts of shortness of breath until properly treated. Crying or laughing may bring on an attack. Severe episodes often develop when the individual has a viral respiratory tract infection or is exposed to a heavy load of an allergen or irritant (e.g., breathing in smoke from a campfire). Asthma attacks may last only a few minutes or can continue for hours or even days (a condition called status asthmaticus).

Being short of breath may cause an individual to become visibly anxious, sit upright, lean forward, and use the muscles of the neck and chest wall to help move air in and out of the lungs. The individual may be able to say only a few words at a time before stopping to take a breath. Confusion and a bluish tint to the skin are clues that the oxygen supply is seriously low and that emergency treatment is needed. In a severe attack that lasts for an extended period, some of the air sacs in the lung may rupture so that air collects within the chest. This makes it even harder for the lungs to exchange enough air.

Diagnosis

The physician will ask about a family history of asthma or allergies. A diagnosis of asthma may be strongly suggested when typical signs and symptoms are present. Apart from listening to the individual's chest, the examiner should look for maximum chest expansion while taking in air. Hunched shoulders and contracted neck muscles are other signs of narrowed airways. **Nasal polyps** or increased amounts of nasal secretions often are noted in asthmatic individuals. Skin changes, such as **atopic dermatitis** or **eczema**, are indications that the individual is likely to allergies.

Tests

A test called **spirometry** measures how rapidly air is exhaled and how much air is retained in the lungs. Repeating the test after the individual inhales a bronchodilator drug that widens the airways will show whether the airway narrowing is reversible, which is a very typical finding in asthma. Often individuals use a related instrument, called a peak flow meter, to keep track of asthma severity when at home.

It often is difficult to determine what is triggering asthma attacks. Allergy skin testing may be used, although an allergic skin response does not always mean that the allergen being tested is causing the asthma. The body's immune system produces specific antibody to fight off each allergen. Measuring the amount of a specific antibody in the blood may indicate how sensitive the individual is to a particular allergen. If the diagnosis is still in doubt, the individual can inhale a suspect allergen while using a spirometer to detect airway narrowing. Spirometry also can be repeated after a bout of exercise when exercise-induced asthma is suspected. A **chest x ray** may be done to help rule out other lung disorders.

Treatment

The goals of asthma treatment are to prevent troublesome symptoms, maintain lung function as close to normal as possible, and allow individuals to pursue their normal activities including those requiring exertion. Individuals should periodically be examined and have their lung function measured by spirometry to make sure that treatment goals are being met. The best drug therapy is that which controls asthmatic symptoms while causing few or no side effects. Many people with asthma are treated with a combination of long-acting drugs taken on a regular basis to help prevent asthma attacks and short-acting (quick relief) drugs given by inhaler to reduce the immediate symptoms of an attack.

Drugs

The choice of initial drug treatment often depends on whether the asthma is classified as intermittent, mildly persistent, moderately persistent, or severely persistent, the age of the individual, other medical conditions that may be present, and other drugs the patient may be taking. It make take several attempts to find the best combination of drugs to control the asthma.

BETA-RECEPTOR AGONISTS (BRONCHODILATORS). These drugs, which relax the airways, often are the best choice for relieving sudden attacks of asthma and for preventing attacks of exercise-induced asthma. Some **bronchodilators**, such as albuterol (Ventolin, Proventil) and levalbuterol (Xopenex), act mainly in lung cells and have little effect on other organs. Bronchodilators occasionally may be taken orally (i.e., pills or liquid), but normally they are administered through inhalers. The inhaled drugs go directly into the lungs and cause fewer side effects. These drugs generally start acting within minutes, but their effects last only four to six hours.

Long-acting beta agonists (LABAs) have been developed that can last up to 12 hours. These include salmeterol (Severent Diskus), fluticasone/salmeterol (Advair Diskus), arformoterol (Brovana), formoterol (Perforomist, Foradil), and budesonide/formoterol

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(Symbacort). In December 2008, the United States Food and Drug Administration (FDA) issued a warning that LABAs may increase the chance of severe asthma episodes and asthma-caused **death**, but was divided on whether these drugs should be banned for use in children. As of early 2009, LABAs were not recommended as a first-line treatment for asthma or for use alone (i.e., without inhaled **steroids**) as an asthma treatment. The FDA strongly recommends that people taking LABAs discuss the risks and benefits with their physician in light of emerging information about their safety.

LEUKOTRIENE RECEPTOR ANTAGONISTS. The leukotriene receptor antagonists such as montelukast (Singulair), zafirlukast (Accolate), and Zyflo (zileuton) control inflammation of the airways by blocking the action of leukotrienes, which are chemicals involved in producing inflammation. These drugs are tablets taken by mouth on a regular basis to treat or prevent symptoms of asthma and exercise-induced asthma. In March 2008, the FDA released a preliminary warning that Singulair might cause behavior and mood changes, suicidal thinking and behavior, and **suicide**. The warning was preliminary, meaning a cause and effect relationship between these adverse reactions and the drug had not been definitely established, and that more information was needed. The FDA recommended that individuals taking Singulair or any other leukotriene receptor antagonist drug should be alert to these behavioral side effects but not stop taking these drugs until they had discussed their condition with a physician.

CORTICOSTEROIDS. These drugs, which resemble natural body hormones, block inflammation and are often effective in relieving symptoms of chronic asthma and preventing asthma episodes, but they generally are not used to treat asthma attacks once they have begun. Examples include fluticasone (Flovent), triamcinolone (Azmacort), and beclomethasone (Vanceril, Beclovent, QVAR) all of which are taken by inhalation. When **corticosteroids** are taken by inhalation over a long time, asthma attacks become less frequent as the airways become less sensitive to allergens. Prendisone (Deltasone, Orasone, Meticorten) is given by mouth (i.e., pills) to speed recovery after treatment of initial symptoms of an asthma attack and sometimes to treat chronic asthma.

Corticosteroids are strong drugs and usually can control even severe cases of asthma over the long term and maintain good lung function. Corticosteroids may cause numerous side effects, however, including bleeding from the stomach, loss of **calcium** from bones, **cataracts** in the eye, and a diabetes-like state. Individuals using corticosteroids for lengthy periods also may have problems with wound healing, may gain weight, and may experience psychological problems. In children, growth may be slowed.

OTHER DRUGS. Cromolyn (Intal) and nedocromil (Tilade) are anti-inflammatory drugs that affect mast cells. They may be used as initial treatment to prevent asthmatic attacks. They may also prevent attacks when given before exercise or when exposure to an allergen cannot be avoided. To be effective, these drugs must be taken regularly even if there are no asthma symptoms. Anticholinergic drugs, such as atropine, may be useful in controlling severe attacks when added to an inhaled beta-receptor agonist. They help widen the airways and suppress mucus production.

Managing asthmatic attacks

A severe asthma attack should be treated as quickly as possible; professional emergency medical assistance may be needed, as an individual experiencing an acute attack may need to be given extra oxygen. Rarely is it necessary to use a mechanical ventilator to help the individual breathe. An inhaler, usually containing a beta-receptor agonist, is inhaled repeatedly or continuously. If the individual does not respond promptly and completely, a corticosteroid may be given. A course of corticosteroid therapy, given after the attack is over, may make a recurrence less likely.

Many asthma experts recommend a device called a "spacer" to be used along with metered-dose inhalers. The spacer is a tube or bellows-like device held in or around the mouth into which the metered-dose inhaler is puffed. This device enables more medication from a metered-dose inhaler to reach the lungs.

Maintaining control

Long-term asthma treatment is based on inhaling appropriate drugs using a special inhaler that meters the dose. Individuals must be instructed in proper use of an inhaler to be sure that it will deliver the right amount of drug. Once asthma has been controlled for several weeks or months, a physician may recommend that the patient gradually cut down on drug treatment. The last drug added usually is the first to be reduced. Individuals should be seen by their physician every one to six months, or as needed, depending on the frequency of asthma episodes.

School-age and older children may also be prescribed peak flow meters, simple devices which measure how easy or difficult it is for a person to exhale.

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With home peak-flow monitoring, it is possible for many children with asthma to discern at an early stage that a flare-up is just beginning and adjust their medications appropriately.

Individuals with asthma do best when they have a written action plan to follow if symptoms suddenly become worse. This plan should address how to adjust their medication and when to seek medical help. A 2004 report found that individuals with self-management written action plans had fewer hospitalizations, fewer emergency department visits, and improved lung function. They also had a 70% lower mortality rate.

Referral to an asthma specialist should be considered if:

- a life-threatening asthma attack has occurred or if asthma is severe and persistent
- treatment for three to six months has not met its goals
- some other condition, such as nasal polyps or chronic lung disease, is complicating asthma treatment
- special tests, such as allergy skin testing or an allergen challenge, are needed
- intensive long-term corticosteroid therapy has been needed to control asthma.

Special populations

INFANTS AND YOUNG CHILDREN. It is especially important to closely watch the course of asthma in young individuals. Treatment is cut down when possible, and if there is no clear improvement, treatment should be modified. Asthmatic children often need medication at school to control acute symptoms or to prevent exercise-induced attacks. Parents or guardians of these children should consult the school district on their drug policy in order to assure that a procedure is in place to permit their child to carry an inhaler. The health care provider should write an asthma treatment plan for the child's school. Proper management will usually allow a child to take part in play activities. Only as a last resort should activities be limited.

THE ELDERLY. Older persons often have other types of lung disease, such as chronic **bronchitis** or **emphysema**. These must be taken into account when treating asthma symptoms. Side effects from beta-receptor agonist drugs (including a speeding heart and tremor) may be more common in older individuals.

Alternative Treatments

Alternative medicine tends to view asthma as the body's protective reaction to environmental agents and pollutants. As such, the treatment goal is often to restore balance to and strengthen the entire body and provide specific support to the lungs and to the immune and hormonal systems. Individuals with asthma can help by keeping a diary of asthma attacks in order to determine environmental and emotional factors that may be contributing to their condition.

Alternative treatments have minimal side effects, are generally inexpensive, and are convenient forms of self-treatment. They also can be used alongside allopathic (traditional drug treatments) treatments to improve their effectiveness and lessen their negative side effects.

DIETARY AND NUTRITIONAL THERAPIES. Some alternative practitioners recommend cutting down on or eliminating dairy products from the diet, as these increase mucus secretion in the lungs and are sources of **food allergies**. Other recommendations include avoiding processed foods, refined starches and sugars, and foods with artificial additives and sulfites. Beneficial **diets** should be high in fresh fruits, vegetables, and whole grains, and low in salt. Individuals with asthma should experiment with their diets to determine if food allergies are playing a role in their asthma. Some studies have shown that a sustained vegan diet can be effective in controlling asthma.

Individuals with asthma also should stay well hydrated by drinking plenty of water, as water helps to keep the passages of the lungs moist. Onions and garlic contain quercetin, a flavonoid (a chemical compound/biological response modifier) that inhibits the release of histamine, and should be a part of an asthmatic's diet. Quercetin is also available as a supplement and should be taken with a digestive enzyme to increase its absorption.

As nutritional therapy, **vitamins** A, C, and E have been touted as important treatments for asthma. Also, the B complex vitamins, particularly B_6 and B_{12}, may be helpful for individuals with asthma, as well as magnesium, selenium, and an omega-3 fatty acid supplement such as flaxseed oil. A good multivitamin supplement also is recommended.

Herbal remedies

Chinese medicine has traditionally used *ma huang* for asthma attacks. Ma huang contains ephedrine, a bronchodilator that was once used in many drugs. However, the FDA issued a ban on the sale of ephedra that took effect in April 2004 because it was shown to

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raise blood pressure and stress the circulatory system, resulting in heart attacks and strokes for some users. Manufacturers of ephedra raised legal challenges to this decision. When the U. S. Supreme Court refused to hear these challenges in 2007, however, the ban on ephedra became permanent.

Another herbal product, ginkgo, has been shown to reduce the frequency of asthma attacks, and licorice is used in **traditional Chinese medicine** as a natural decongestant and expectorant. There are many formulas used in traditional Chinese medicine to prevent or ease asthma attacks, depending on the specific Chinese diagnosis given by the practitioner.

Other herbs used for asthma include lobelia, also called Indian tobacco; nettle, which contains a natural antihistamine; thyme, mullein, feverfew, passionflower, **saw palmetto** and Asian **ginseng**. Coffee and tea have been shown to reduce the severity of asthma attacks because **caffeine** works as a bronchodilator. Tea also contains minute amounts of theophylline, a drug used to treat asthma. Ayurvedic (traditional East Indian) medicine recommends the herb *Tylophora asthmatica.*

Mind/body approaches

Mind/body medicine has demonstrated that psychological factors play a complex role in asthma. Emotional stress can trigger asthma attacks. Mind/body techniques strive to reduce stress and help asthma sufferers manage the psychological component of their condition. **Biofeedback** is a treatment method that uses monitors to reveal physiological information to patients, to teach relaxation and deep breathing methods that may help people with asthma. Some other mind/body techniques used for asthma include relaxation methods, **meditation**, **hypnotherapy**, mental imaging, **psychotherapy**, and visualization.

Yoga and breathing methods

Some studies have shown that **yoga** significantly helps people with asthma by teaching exercises specifically designed to expand the lungs, promote deep breathing, and reduce stress. Pranayama is the yogic science of breathing, which includes hundreds of deep breathing techniques. These breathing exercises may be done daily as part of any treatment program for asthma, as they are an effective and inexpensive measure.

Controlled exercise

Many people believe that people with asthma should not exercise. This belief is especially common among parents of children with asthma. In a 2004 study, researchers reported that 20% of children with asthma do not get enough exercise. Many parents believe it is dangerous for their children with asthma to exercise, but physical activity benefits all children, including those with asthma. Parents should work with their children's healthcare providers and any coach or organized sport leader to carefully monitor the children's activities.

Acupuncture

Acupuncture can be an effective treatment for asthma. It is used in traditional Chinese medicine along with dietary changes. **Acupressure** also can be used as a self-treatment for asthma attacks and prevention. The Lung 1 points, used to stimulate breathing, can be easily found on the chest. These are sensitive, often knotted spots on the muscles that run horizontally about an inch below the collarbone, and about two inches from the center of the chest. The points can be pressed in a circular manner with the thumbs, while the head is allowed to hang forward and the individual takes slow, deep breaths. **Reflexology** also uses particular acupressure points on the hands and feet that are believed to stimulate the lungs.

Other treatments

Aromatherapists recommend eucalyptus, lavender, rosemary, and chamomile as fragrances that promote free breathing. In Japan, a common treatment for asthma is administering cold baths. This form of **hydrotherapy** has been demonstrated to open constricted air passages. Massage therapies such as **Rolfing** can help individuals with asthma as well, as they strive to open and increase circulation in the chest area. Homeopathy uses the remedies *Arsenicum album, Kali carbonicum, Natrum sulphuricum,* and *Aconite*.

Prognosis

More than half of all asthma cases in children resolve by young adulthood, but chronic infection, pollution, cigarette smoke, and chronic allergen exposure are factors which make resolution less likely. Infants and toddlers who have persistent wheezing even without viral infections and those who have a family history of allergies are most likely to continue to have asthma into the school-age years.

Most individuals with asthma respond well once the proper drug or combination of drugs is found, and most asthmatics are able to lead relatively normal, active lives. A few individuals will have progressively more trouble breathing and run a risk of going into **respiratory failure**, for which they must receive intensive treatment. Asthma causes between 3,500 and 5,000 deaths in the United States each year.

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Prevention

Exposure to the common allergens and irritants that provoke asthmatic attacks often can be reduced or avoided by implementing the following:

- If the individual is sensitive to a family pet, remove the animal from the home. If this is not acceptable, keep the pet out of the bedroom (with the bedroom door closed), remove carpeting, and keep the animal away from upholstered furniture.
- To reduce exposure to dust mites, remove wall-to-wall carpeting, keep humidity low, and use special covers for pillows and mattresses. Reduce the number of stuffed toys and wash them weekly in hot water.
- If cockroach allergen is causing asthma attacks, killing the roaches using poison, traps, or boric acid is preferable to using sprayed pesticides. Avoid leaving food or garbage exposed to discourage re-infestation.
- Keep indoor air clean by vacuuming carpets once or twice a week (with the asthmatic individual absent). Avoid using humidifiers and use air conditioning during warm weather so that windows can be kept closed. Change heating and air conditioning filters regularly. High-efficiency particulate air (HEPA) filters are available that are very effective in removing allergens from household air.
- Avoid exposure to tobacco or wood smoke.
- Do not exercise outdoors when air pollution levels are high or when air is extremely cold.
- When asthma is related to exposure at work, take all precautions, including wearing a mask and, if necessary, arranging to work in a safer area. Occupational safety and health (OSHA) regulations limit exposure to certain pollutants and potential allergens in the workplace.

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ORGANIZATIONS

Allergy and Asthma Network: Mothers of Asthmatics (AANMA), 2751 Prosperity Ave., Suite 150, Fairfax, VA, 22031 (800) 878-4403 (703) 573-7794, http://www.aanma.org.

American Academy of Allergy, Asthma, and Immunology (AAAAI), 555 East Wells Street, Suite 1100, Milwaukee, WI, 53202-3823 (414) 272-6071, http://www. aaaai.org.

American College of Allergy, Asthma, and Immunology, 85 West Algonquin Road, Suite 550, Arlington Heights, IL, 60005 (847) 427-1200, mail@acaai.org, http://www.acaai.org.

Asthma and Allergy Foundation of America, 1233 20th Street, NW, Suite 402, Washington, DC, 20036 (800) 7-ASTHMA or (800) 727-8462, info@aafa.org, http://www.aafa.org.

National Institute of Allergy and Infectious Diseases Office of Communications and Government Relations, 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-6612 (301) 496-5717 (866) 284-4107 or TDD: (800)877-8339 (for hearing impaired) (301) 402-3573, http://www3.niaid.nih.gov.

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Astigmatism

Definition

Astigmatism is the result of an inability of the cornea to properly focus an image onto the retina. The result is a blurred image.

Description

The cornea is the outermost part of the eye. It is a transparent layer that covers the colored part of the eye (iris), pupil, and lens. The cornea bends light and helps to focus it onto the retina where specialized cells (photo receptors) detect light and transmit nerve impulses via the optic nerve to the brain where the image is formed. The cornea is dome shaped. Any incorrect shaping of the cornea results in an incorrect focusing of the light that passes through that part of the cornea. The bending of light is called refraction and focusing problems with the cornea are called diseases of refraction or refractive disorders. Astigmatism is an image distortion that results from an improperly shaped cornea. Usually the cornea is spherically shaped, like a baseball. However, in astigmatism the cornea is elliptically shaped, more like a football. There is a long meridian and a short meridian. These two meridians generally have a constant curvature and are generally perpendicular to each

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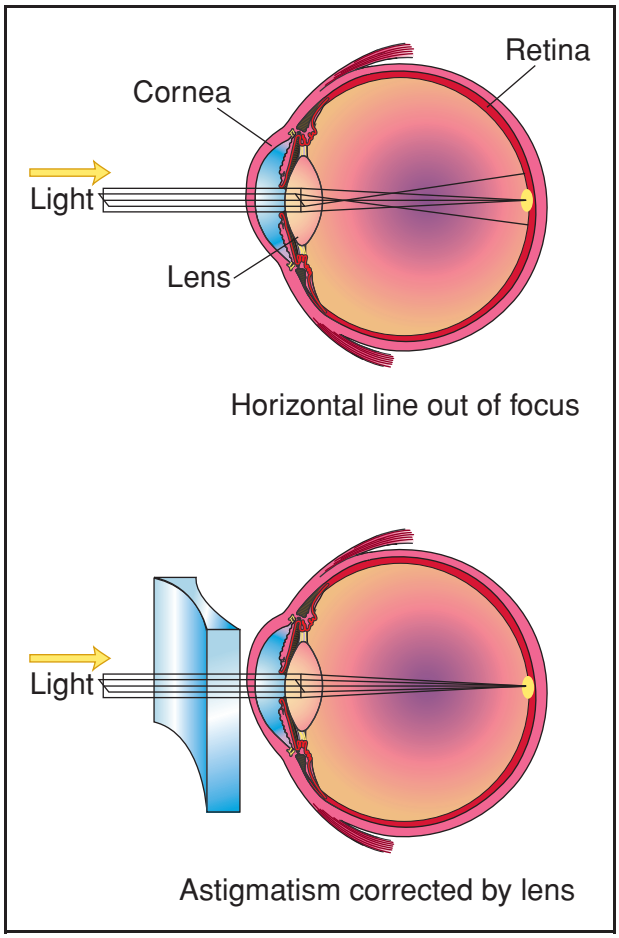

Astigmatism can be treated by the use of cylindrical lenses. The lenses are shaped to counteract the shape of the sections of the cornea that are causing the difficulty. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

other (regular astigmatism). Irregular astigmatism may have more than two meridians of focus and they may not be 90° apart. A point of light, therefore, going through an astigmatic cornea will have two points of focus, instead of one nice sharp image on the retina. This will cause the person to have blurry vision. What the blur looks like will depend upon the amount and the direction of the astigmatism. A person with nearsightedness (**myopia**) or farsightedness (**hyperopia**) may see a dot as a blurred circle. A person with astigmatism may see the same dot as a blurred oval or frankfurter-shaped blur.

Some cases of astigmatism are caused by problems in the lens of the eye. Minor variations in the curvature of the lens can produce minor degrees of astigmatism (lenticular astigmatism). In these patients, the cornea is usually normal in shape. Infants, as a group, have the least amount of astigmatism. Astigmatism may increase during childhood, as the eye is developing.

KEY TERMS

Meridian—A section of a sphere. For example, longitude or latitude on the globe. Or, on a clock, a section going through 12:00-6:00 or 3:00-9:00, etc.

Refraction—The turning or bending of light waves as the light passes from one medium or layer to another. In the eye it means the ability of the eye to bend light so that an image is focused onto the retina.

Causes and symptoms

The main symptom of astigmatism is blurring. People can also experience headaches and eyestrain. Parents can notice that a child may have astigmatism when the child can see some part of a pattern or picture more clearly than others. For example, lines going across may seem clearer than lines going up and down.

Regular astigmatism can be caused by the weight of the upper eyelid resting on the eyeball creating distortion, surgical incisions in the cornea, trauma or scarring to the cornea, the presence of tumors in the eyelid, or a developmental factor. Irregular astigmatism can be caused by scarring or keratoconus. Keratoconus is a condition in which the cornea thins and becomes cone shaped. It usually occurs around **puberty** and is more common in women. Although the causes of keratoconus are unknown, it may be hereditary or a result of chronic eye rubbing, as in people with **allergies**. The center of the cone may not be in line with the center of the cornea. Diabetes can play a role in the development of astigmatism. High blood sugar levels can cause shape changes in the lens of the eye. This process usually occurs slowly and, often, is only noticed when the diabetic has started treatment to control their blood sugar. The return to a more normal blood sugar allows the lens to return to normal and this change is sometimes noticed by the patient as farsightedness. Because of this, diabetics should wait until their blood sugar is under control for at least one month to allow vision to stabilize before being measured for eyeglasses.

Diagnosis

Patients seek treatment because of blurred vision. A variety of tests can be used to detect astigmatism

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during the eye exam. The patient may be asked to describe the astigmatic dial, a series of lines that radiate outward from a center. People with astigmatism will see some of the lines more clearly than others. One diagnostic instrument used is the keratometer. This measures the curvature of the central cornea. It measures the amount and direction of the curvature. A corneal topographer can measure a larger area of the cornea. It can measure the central area and mid-periphery of the cornea. A keratoscope projects a series of concentric light rings onto the cornea. Misshapen areas of the cornea are revealed by noting areas of the light pattern that do not appear concentric on the cornea. Because these instruments are measuring the cornea, it is also important to have a refraction in case the lens is also contributing to the astigmatism. The refraction measures the optics or visual status of the eye and the result is the eyeglass prescription. The refraction is when the patient is looking at an eye chart and the doctor is putting different lenses in front of the patient's eyes and asks which one looks better.

Treatment

Astigmatism can be treated by the use of cylindrical lenses. They can be in eyeglasses or **contact lenses**. The unit of measure describing the power of the lens system or lens is called the diopter (D). The lenses are shaped to counteract the shape of the sections of cornea that are causing the difficulty. Because the correction is in one direction, it is written in terms of the axis the correction is in. On a prescription, for example, it may say $-1.00 \times 180^{\circ}$. Cylinders correct astigmatism, minus spheres correct myopia, and plus spheres correct hyperopia.

There is some debate as to whether people with very small amounts of astigmatism should be treated. Generally, if visual acuity is good and the patient experiences no overt symptoms, treatment is not necessary. When treating larger amounts of astigmatism, or astigmatism for the first time, the doctor may not totally correct the astigmatism. The cylindrical correction in the eyeglasses may make the floor appear to tilt, thus making it difficult for the patient at first. Generally, the doctor will place lenses in a trial frame to allow the patient to try the prescription at the exam. It may take a week or so to get used to the glasses, however, if the patient is having a problem they should contact their doctor, who might want to recheck the prescription.

Contact lenses that are used to correct astigmatism are called toric lenses. When a person blinks, the contact lens rotates. In toric lenses, it is important for the lens to return to the same position each time. Lenses have thin zones, or cut-off areas (truncated), or have other ways to rotate and return to the correct position. Soft toric lenses are available in a variety of prescriptions, materials, and even in tints. Patients should ask their doctors about the possibility of toric lenses.

In 1997, the Food and Drug Administration (FDA) approved laser treatment of astigmatism. Patients considering this should make sure the surgeon has a lot of experience in the procedure and discuss the possible side effects or risks with the doctor. In the case of keratoconus, a corneal transplant is performed if the astigmatism cannot be corrected with hard contact lenses.

Prognosis

Astigmatism is a condition that may be present at birth. It may also be acquired if something is distorting the cornea. Vision can generally be corrected with eyeglasses or contact lenses. The major risks of surgery (aside from the surgical risks) are over and under correction of the astigmatism. There is no cure for over correction. Under correction can be solved by repeating the operation.

Resources

OTHER

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John T. Lohr PhD

Aston-Patterning

Definition

Aston-Patterning is an integrated system of movement education, bodywork, ergonomic adjustments, and fitness training that recognizes the relationship between the body and mind for well being. It helps people who seek a remedy from acute or chronic **pain** by teaching them to improve postural and movement patterns.

Purpose

Aston-Patterning assists people in finding more efficient and less stressful ways of performing the simple movements of everyday life to dissipate tension in the body. This is done through massage, alteration of the environment, and fitness training.

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JUDITH ASTON

Judith Aston was born in Long Beach, California. She graduated from University of California at Los Angeles with a B.A. and a M.F.A. in dance. Her interest in movement arose from working as a dancer. In 1963 Aston established her first movement education program for dancers, actors, and athletes at Long Beach City College.

Five years later, while recovering from injuries sustained during two consecutive automobile accidents, Aston met Ida Rolf, the developer of Rolfing. Aston began working for Rolf, teaching a movement education program called Rolf-Aston Structural Patterning that emphasized using the body with minimum effort and maximum precision.

In time, Rolf and Aston's views on movement diverged, and the partnership was dissolved in 1977. Aston formed her own company called the Aston Paradigm Corporation in Lake Tahoe, California. This company provides training and certification for Aston practitioners. She also began exploring how environmental conditions affect body movement, foreshadowing the ergonomic movement in the workplace that developed in the 1990s. Over time, Aston has expanded her movement work to include a fitness program for older adults. Today, Judith Aston serves as director of Aston Paradigm Corporation. She is the author of the books *Moving Beyond Posture–In Your Body on the Earth*, the *Aston Postural Assessment Workbook*, and the DVD *Aston's Walking the New Body*. More information on her current work can be found at http://www.astonkinetics.com/

KEY TERMS

Rolfing—Developed by Dr. Ida Rolf (1896–1979); a systematic approach to relieving stress patterns and dysfunctions in the body's structure through the manipulation of the highly pliant myofacial (connective) tissue. It assists the body in reorganizing its major segments into vertical alignment.

Description

Seeking to solve movement problems, Aston-Patterning helps individuals make the most of their own unique body types rather than trying to force them to conform to an ideal. Unlike **Rolfing**, it does not strive for linear symmetry. Rather, it works with asymmetry in the human body to develop patterns of alignment and movement that feel right to the individual. Aston introduced the idea of working in a three-dimensional spinal pattern. Aston-Patterning sessions have four general components:

- A personal history that helps the practitioner assess the client's needs.
- Pre-testing, in which the practitioner and the client explore patterns of movement and potential for improvement.
- Movement education and bodywork, including massage, myofacial release, and arthrokinetics to help release tension and make new movement patterns easier.
- Post-testing, when pre-testing movements are repeated, allowing the client to feel the changes that have taken place and integrate them into daily life.

Aston-Patterning requires more participation from the client than many bodywork techniques. The massage aspect of Aston-Patterning is designed around a three-dimensional, non-compressive touch that releases patterns of tension in the body. It is gentler than Rolfing. Myokinetics uses touch to release tension in the face and neck. Arthrokinetics addresses tension at bones and joints. This massage is accompanied by education about how new movement patterns may be established.

In addition to Aston-Patterning sessions, clients are helped to examine their environment for factors, such as seating or sleeping arrangements, that may limit their body function and introduce tension. Finally, they may choose to participate in the Aston fitness training program that includes loosening techniques based on self-massage, toning, stretching, and cardiovascular fitness.

Preparations

No special preparation need be taken.

Precautions

No special precautions are necessary when participating.

Side effects

No undesirable side effects are reported. Usually, clients report a diminution of tension, improved body movement, and an enhanced feeling of well being.

Research and general acceptance

Aston-Patterning is an outgrowth of Rolfing, which has been shown to be of benefit in a limited number of controlled studies. Little controlled research has been done on the either benefits or limitations of Aston-Patterning. Its claims have been neither proven nor disproved, although anecdotally

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many clients report relief from pain and tension and improved body movement.

Resources

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Davis, Martha. *The Relaxation & Stress Reduction Workbook* 6th ed. Sydney, Australia: ReadHowYouWant, 2009.

Stewart, Nicola. *The Complete Body Massage Course: An Introduction to the Most Popular Massage Therapies*. London: Collins & Brown, 2010.

Weintraub, Michael I., Ravinder Mamtani, and Marc S. Micozzi, eds. *Complementary and Integrative Medicine in Pain Management*. New York: Springer, 2008.

ORGANIZATIONS

Aston Kinetics, P.O. Box 3568, Incline Village, NV, 89450 (775) 831-8228, Astonpat@aol.com, http://www.astonkinetics.com.

Benson-Henry Institute for Mind Body Medicine at Massachusetts General Hospital, 151 Merrimac Street, 4th Floor, Boston, MA, 02114 (617) 643-6090, http://www.massgeneral.org/bhi.

The Center for Mindfulness in Medicine, Health Care and Society. Stress Reduction Clinic. University of Massachusetts Memorial Health Care., 55 Lake Ave. North, Worcester, MA, 01655 (508) 856-2656 (508) 856-1977, http://www.umassmed.edu/cfm/.

Tish Davidson AM
Laura Jean Cataldo RN, EdD

Astrocytoma *see* **Brain tumor**

Ataxia *see* **Movement disorders**

Ataxia-telangiectasia

Definition

Ataxia-telangiectasia (A-T), also called Louis-Bar syndrome, is a rare, genetic neurological disorder of childhood that progressively destroys part of the motor control area of the brain, leading to a lack of balance and coordination. A-T also affects the immune system and increases the risk of leukemia and lymphoma in affected individuals.

Description

The disorder first appeared in the medical literature in the mid-1920s, but was not named specifically until 1957. The name is a combination of two recognized abnormalities: ataxia (lack of muscle control) and telangiectasia (abnormal dilatation of capillary vessels that often result in tumors and red **skin lesions**). However, A-T involves more than just the sum of these two findings. Other associated A-T problems include immune system deficiencies, extreme sensitivity to radiation, and blood cancers.

Medical researchers initially suspected that multiple genes (the units responsible for inherited features) were involved. However, in 1995, mutations in a single large gene were identified as causing A-T. Researchers named the gene ATM for A-T, mutated. Subsequent research revealed that ATM has a significant role in regulating cell division. The symptoms associated with A-T reflect the main role of the AT gene, which is to induce several cellular responses to DNA damage, such as preventing damaged DNA from being reproduced. When the AT gene is mutated into ATM, the signaling networks are affected and the cell no longer responds correctly to minimize the damage.

A-T is very rare, but it occurs in every population world wide, with an estimated frequency of between 1/40,000 and 1/100,000 live births. But it is believed that many A-T cases, particularly those who die at a young age, are never properly diagnosed. Therefore, this disease may actually be much more prevalent. According to the A-T Project Foundation, an estimated 1% (2.5 million in the United States) of the general population carries defective A-T genes. Carriers of one copy of this gene do not develop A-T, but have a significantly increased risk of **cancer**. This makes the A-T gene one of the most important cancer-related genes identified to date.

Causes and symptoms

The ATM gene is autosomal recessive, meaning the disease occurs only if a defective gene is inherited from both parents. Infants with A-T initially often appear very healthy. At around age two, ataxia and nervous system abnormalities becomes apparent. The root cause of A-T-associated ataxia is cell death in the brain, specifically the large branching cells of the nervous system (Purkinje's cells) which are located in the cerebellum. A toddler becomes clumsy, loses balance easily and lacks muscle control. Speech becomes slurred and more difficult, and the symptoms progressively worsen. Between ages two and eight, telangiectases, or tiny, red "spider" veins, appear on the cheeks and ears and in the eyes.

By age 10-12, children with A-T can no longer control their muscles. Immune system deficiencies become common, and affected individuals are extremely sensitive to radiation. Immune system deficiencies vary between individuals but include lower-than-normal levels of proteins that function as antibodies

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KEY TERMS

Angioma—A tumor (such as a hemangioma or lymphangioma) that mainly consists of blood vessels or lymphatic vessels.

Antibody—Any of a large number of proteins produced by specialized blood cells after stimulation by an antigen and that act specifically against the antigen in an immune response.

Antigen—Any substance (such as a toxin or enzyme) capable of stimulating an immune response in the body.

Ataxia—The inability to control voluntary muscle movement, most frequently resulting from disorders in the brain or spinal cord.

Autosomal—Relating to any of the chromosomes except for X and Y, the sex chromosomes.

Cerebellum—The part of the brain responsible for coordination of voluntary movements.

Gamma-globulin—An extract of human blood that contains antibodies.

Immune response—A response from the body to an antigen that occurs when the antigen is identified as foreign and that induces the production of antibodies and lymphocytes capable of destroying the antigen or making it harmless.

Immunoglobulin—A protein in the blood that is the component part of an antibody.

Leukemia—A cancer of blood cells characterized by the abnormal increase in the number of white blood cells in the tissues. There are many types of leukemias and they are classified according to the type of white blood cell involved.

Lymphoma—A blood cancer in which lymphocytes, a variety of white blood cells, grow at an unusually rapid rate.

Mutation—Any change in the hereditary material of genes.

Purkinje's cells—Large branching cells of the nervous system.

Recessive—Producing little or no phenotypic effect when occurring in heterozygous condition with a contrasting allele.

Telangiectases—Spidery red skin lesions caused by dilated blood vessels.

Telangiectasia—Abnormal dilation of capillary blood vessels leading to the formation of telangiectases or angiomas.

Thymus—A gland located in the front of the neck that coordinates the development of the immune system.

(immunoglobulins) and white blood cells (blood cells not containing "iron" proteins). The thymus gland, which aids in development of the body's immune system, is either missing or has developed abnormally. Intelligence is normal, but growth may be retarded owing to immune system or hormonal deficiencies. Individuals with A-T are also sometimes afflicted with diabetes, prematurely graying hair, and difficulty swallowing. As the children grow older, the immune system becomes weaker and less capable of fighting infection. In the later stages, recurrent respiratory infections and blood cancers, such as leukemia or lymphoma, are common.

Diagnosis

Diagnosis relies on recognizing the hallmarks of A-T: progressive ataxia and telangiectasia. However, this may be difficult as ataxia symptoms do appear prior to telangiectasia symptoms by several years. Other symptoms can vary between individuals; for example, 70% of individuals with A-T have a high incidence of respiratory infection, 30% do not. The identification of the ATM gene raises hopes that screening, and perhaps treatment, may be possible.

Treatment

There is currently no cure for A-T, and treatment focuses on managing the individual's multiple symptoms. **Physical therapy** and **speech therapy** can help the patient adjust to ataxia. Injections of **gamma globulin**, or extracts of human blood that contain antibodies, are used to strengthen the weakened immune system. High-dose vitamin administrations may also be prescribed. Research continues in many countries to find effective treatments. Individuals and families living with this disorder may benefit from attending support groups.

Prognosis

A-T is a fatal condition. Children with A-T become physically disabled by their early teens and typically die by their early 20s, usually from the

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associated blood cancers and malignancies. In very rare cases, individuals with A-T may experience slower progression and a slightly longer life span, surviving into their 30s. A-T carriers have a five-fold higher risk than non-carriers of developing certain cancers, especially **breast cancer**.

Prevention

Medical researchers are investigating methods for screening individuals who may be carriers of the defective gene. Prenatal testing for A-T is possible but not done routinely, because commercial screening tests have yet to be developed.

Resources

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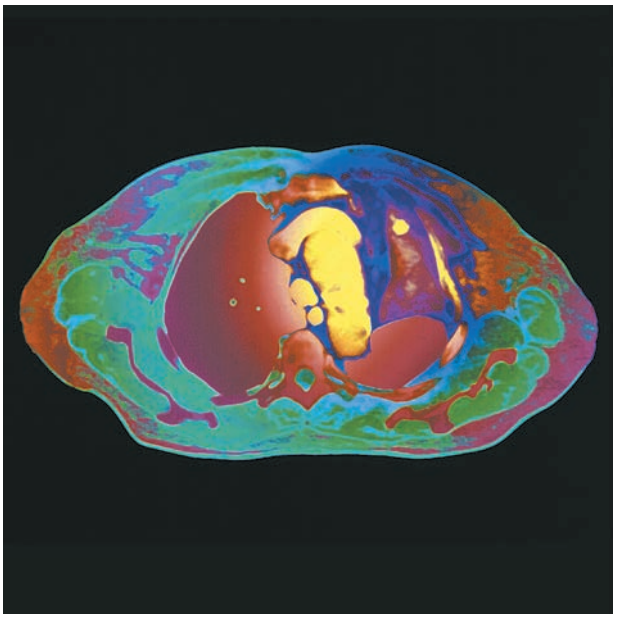

A computed tomography (CT) scan through a patient's chest. The collapsed lung appears at the right of the image. *(Photo Researchers, Inc.)*

Atelectasis

Definition

Atelectasis is a collapse of lung tissue affecting part or all of one lung. This condition prevents normal oxygen absoption to healthy tissues.

Description

Atelectasis can result from an obstruction (blockage) of the airways that affects tiny air sacs called alveoli. Alveoli are very thin-walled and contain a rich blood supply. They are important for lung function, since their purpose is the exchange of oxygen and carbon dioxide. When the airways are blocked by a mucous "plug," foreign object, or tumor, the alveoli are unable to fill with air and collapse of lung tissue can occur in the affected area. Atelectasis is a potential complication following surgery, especially in individuals who have undergone chest or abdominal operations resulting in associated abdominal or chest **pain** during breathing. Congenital atelectasis can result from a failure of the lungs to expand at birth. This congenital condition may be localized or may affect all of both lungs.

Causes and symptoms

Causes of atelectasis include insufficient attemps at respiration by the newborn, bronchial obstruction, or absence of **surfactant** (a substance secreted by alveoli that maintains the stability of lung tissue by reducing the surface tension of fluids that coat the lung). This lack of surfactant reduces the surface area available for effective gas exchange causing it to collapse if severe. Pressure on the lung from fluid or air can cause atelectasis as well as obstruction of lung air passages by thick mucus resulting from various infections and lung diseases. Tumors and inhaled objects can also cause obstruction of the airway, leading to atelectasis.

Anyone undergoing chest or abdominal surgery using **general anesthesia** is at risk to develop atelectasis, since breathing is often shallow after surgery to avoid pain from the surgical incision. Any significant decrease in airflow to the alveoli contributes to pooling of secretions, which in turn can cause infection. Chest injuries causing shallow breathing, including fractured ribs, can cause atelectasis. Common symptoms of atelectasis include **shortness of breath** and decreased chest wall expansion. If atelectasis only affects a small area of the lung, symptoms are usually minimal. If the condition affects a large area of the lung and develops quickly, the individual may turn blue (cyanotic) or pale, have extreme shortness of breath, and feel a stabbing pain

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KEY TERMS

Alveoli—Tiny air sacs in the lungs where gas exchange takes place between alveolar air and pulmonary blood within the capillaries

Bronchial—Relating to the air passages to and from the lungs including the bronchi and the bronchioles.

Bronchoscopy—A procedure in which a hollow, flexible tube is inserted into the airway to allow visual examination of the larynx, trachea, bronchi, and bronchioles. It is also used to collect specimens for biopsy or culturing and to remove airway obstructions.

Incentive spirometer—A breathing device that provides feedback on performance to encourage deep breathing.

Mucus—A thin, slippery film secreted by the mucous membranes and glands.

Postural drainage—Techniques to help expel excess mucus by specific positions of the body (that decrease the effects of gravity) combined with manual percussion and vibration over various parts of the lung.

Surfactant—A substance secreted by the alveoli in the lungs that reduces the surface tension of lung fluids, allowing gas exchange and helping maintain the elasticity of lung tissue.

Tumor—An abnormal growth of tissue resulting from uncontrolled, progressive multiplication of cells.

on the affected side. **Fever** and increased heart rate may be present if infection accompanies atelectasis.

Diagnosis

To diagnose atelectasis, a doctor starts by recording the patient's symptoms and performing a thorough **physical examination**. When the doctor listens to the lungs through a stethoscope (ausculation), diminished or bronchial breath sounds may be heard. By tapping on the chest (percussion) while listening through the stethoscope, the doctor can often tell if the lung is collapsed. A **chest x ray** that shows an airless area in the lung confirms the diagnosis of atelectasis. If an obstruction of the airways is suspected, a computed tomography scan (CT) or **bronchoscopy** may be performed to locate the cause of the blockage.

Treatment

If atelectasis is due to obstruction of the airway, the first step in treatment is to remove the cause of the blockage. This may be done by coughing, suctioning, or bronchoscopy. If a tumor is the cause of atelectasis, surgery may be necessary to remove it. **Antibiotics** are commonly used to fight the infection that often accompanies atelectasis. In cases where recurrent or long-lasting infection is disabling or where significant bleeding occurs, the affected section of the lung may be surgically removed.

Prognosis

If atelectasis is caused by a thick mucus "plug" or inhaled foreign object, the patient usually recovers completely when the blockage is removed. If it is caused by a tumor, the outcome depends on the nature of the tumor involved. If atelectasis is a result of surgery, other post-operative conditions and/or complications affect the prognosis.

Prevention

When recovering from surgery, frequent repositioning in bed along with coughing and deep breathing are important. Coughing and breathing deeply every one to two hours after any surgical operation with general anesthesia is recommended. Breathing exercises and the use of breathing devices, such as an incentive spirometer, may also help prevent atelectasis. Although smokers have a higher risk of developing atelectasis following surgery, stopping **smoking** six to eight weeks before surgery can help reduce the risk. Increasing fluid intake during respiratory illness or after surgery (by mouth or intravenously) helps lung secretions to remain loose. Increasing humidity may also be beneficial.

Postural drainage techniques can be learned from a respiratory therapist or physical therapist and are a useful tool for anyone affected with a respiratiory illness that could cause atelectasis. Because **foreign objects** blocking the airway can cause atelectasis, it is very important to keep small objects that might be inhaled away from young children.

ORGANIZATIONS

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-

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0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

Jeffrey P. Larson RPT

Atenolol *see* **Beta blockers**

Atherectomy

Definition

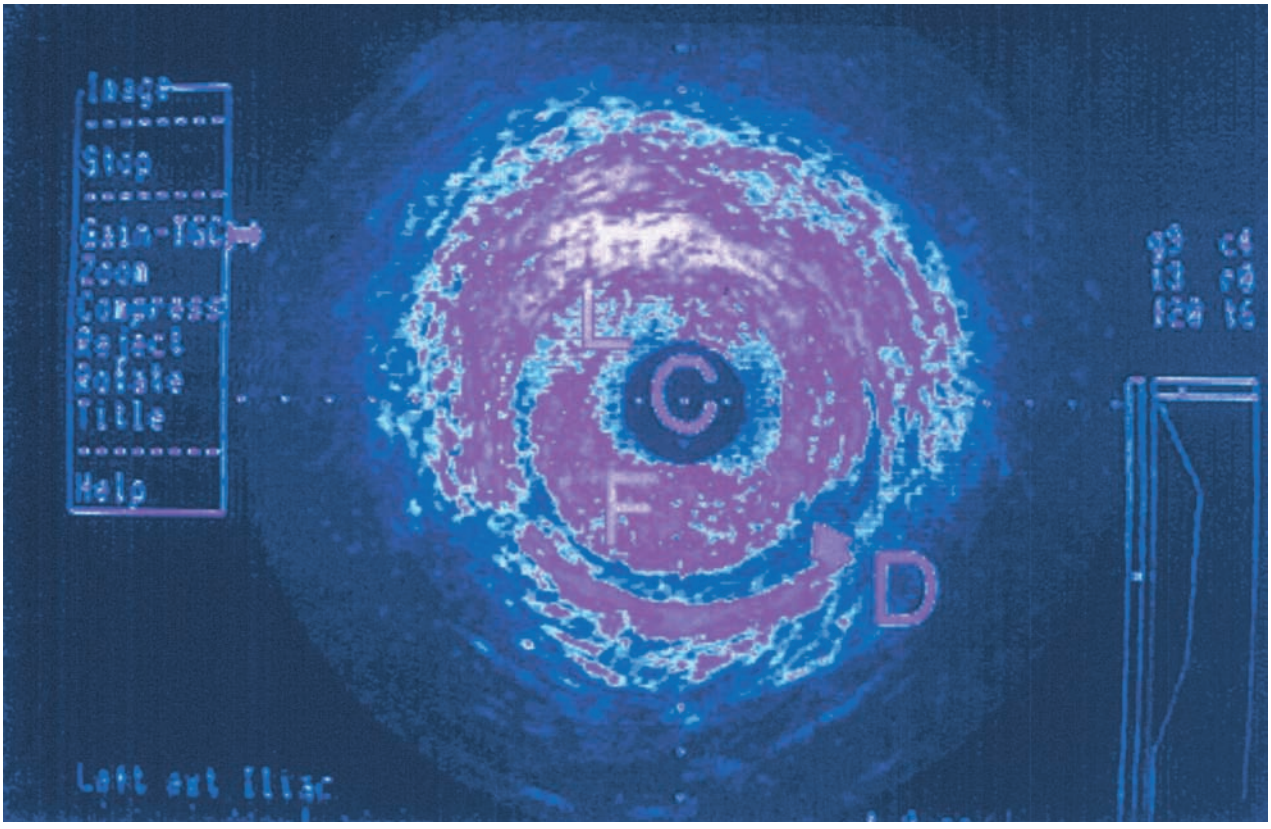
Atherectomy is a procedure to open blocked arteries or vein grafts by using a device on the end of a catheter to cut or shave away atherosclerotic plaque blocking the flow of blood.

Purpose

Atherectomy is performed on the coronary arteries to restore the flow of oxygen-rich blood to the heart, to relieve chest **pain**, and to prevent heart attacks. It may be done on patients with chest pain who have not responded to other medical therapy and on some individuals who are candidates for balloon **angioplasty** or **coronary artery bypass graft surgery**. It is sometimes performed to remove plaque that has built up after a coronary artery bypass graft surgery. Artherectomy may also be performed on the carotid arteries leading to the brain or on certain vertebral arteries.

Description

Atherectomy uses a catheter inserted into the artery that has at its tip either a rotating device that reams out the artery, a device that shaves the plaque away, or a laser that vaporizes the plaque. At the beginning of the procedure, medications are administered to control blood pressure, dilate the coronary arteries, and prevent **blood clots**. The patient is awake but sedated. The catheter is inserted into an artery in the groin, leg, or arm, and threaded through the blood vessels into the blocked artery. The cutting head or laser is positioned against the plaque and activated, and the plaque is ground up and suctioned out or vaporized.



In this digitized ultrasound of a blood vessel, C is the catheter, D is the dissection, and F is the artherosclerotic flap. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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KEY TERMS

Atherosclerotic plaque—A deposit of fat and other substances that accumulate in the lining of the artery wall.

Balloon angioplasty—A surgical procedure in which a balloon catheter is used to flatten plaque against an artery wall.

Catheter—A long, thin, flexible tube that can be inserted into a vein and moved through the cardiovascular system.

Carotid artery—An artery located in the neck.

Coronary arteries—These are the first arteries to branch off the aorta (the large artery leaving the heart). The coronary arteries surround the heart like a crown, coming out of the aorta, arching down over the top of the heart, dividing into two branches, and taking oxygen-rich blood to the heart muscle. Blockage of these arteries can cause atherosclerosis and heart attack.

Electrocardiogram (ECG, EKG)—A test that records the electrical activity of the heart using small electrode patches attached to the skin on the chest.

Plaque—Fatty material that is deposited on the inside of the arterial wall.

Stent—A device made of expandable, metal mesh that is placed (by using a balloon catheter) at the site of a narrowing artery; the stent stays in place to keep the artery open.

In some patients, artherectomy can be an alternative to coronary bypass surgery. It is significantly less painful, less costly, and has a much shorter recovery time than bypass surgery. The location(s), degree of blockage, and general health status of the individual are all factors in deciding whether artherectomy is the most appropriate procedure.

The types of atherectomy are directional, rotational, transluminal extraction and laser artherectomy extraction. Directional atherectomy was the first type approved, but is no longer commonly used; it scrapes plaque into an opening in one side of the catheter. Rotational atherectomy uses a high-speed rotating shaver to grind up plaque. Transluminal extraction uses a device that cuts plaque off vessel walls and vacuums it into a bottle. It is used to clear bypass grafts. Laser artherectomy uses a laser to break up and vaporize the plaque. In some patients, a balloon angioplasty may be done and a stent inserted after successful artherectomy.

Performed in a **cardiac catheterization** lab, atherectomy can be used instead of, or along with, balloon angioplasty. Atherectomy is successful about 95% of the time; however, plaque forms again in 20–30% of patients.

Precautions

Atherectomy should not be performed when the plaque is located where blood vessels divide into branches, when plaque is angular or inside an angle of a blood vessel, on patients with weak vessel walls, on ulcerated or calcium-hardened lesions, or on blockages through which a guide wire will not pass. Laser artherectomy has less successful outcomes in individuals with diabetes or renal failure, and usually is not the procedure of choice for these patients.

Preparation

The day before atherectomy, the patient takes medication to prevent blood clots and may be asked to bathe and shampoo with an antiseptic skin cleaner.

Aftercare

After the procedure, the patient spends several days in the hospital's cardiac monitoring area. For at least 20 minutes, pressure is applied to a dressing on the insertion site. For the first hour, an electrocardiogram (ECG) and close monitoring are conducted; vital signs are checked every 15 minutes. Pain medication is then administered. The puncture site is checked once an hour or more. For most of the first 24 hours, the patient remains in bed.

Risks

Chest pain is the most common complication of atherectomy. Other common complications are injury to the blood vessel lining, plaque that re-forms, the development of blood clots, and bleeding at the site of catheter insertion. More serious but less frequent complications are blood vessel holes, blood vessel wall tears, or reduced blood flow through the artery.

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ORGANIZATIONS

American Heart Association, 7272 Greenville Avenue, Dallas, TX, 75231 (800) 242-8721, http://www.americanheart.org.
National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105 (301) 592-8573; TTY: (240) 629-3255 (240) 629-3246, nhlbiinfo@nhlbi.nih.gov, http://www. nhlbi. nih.gov.

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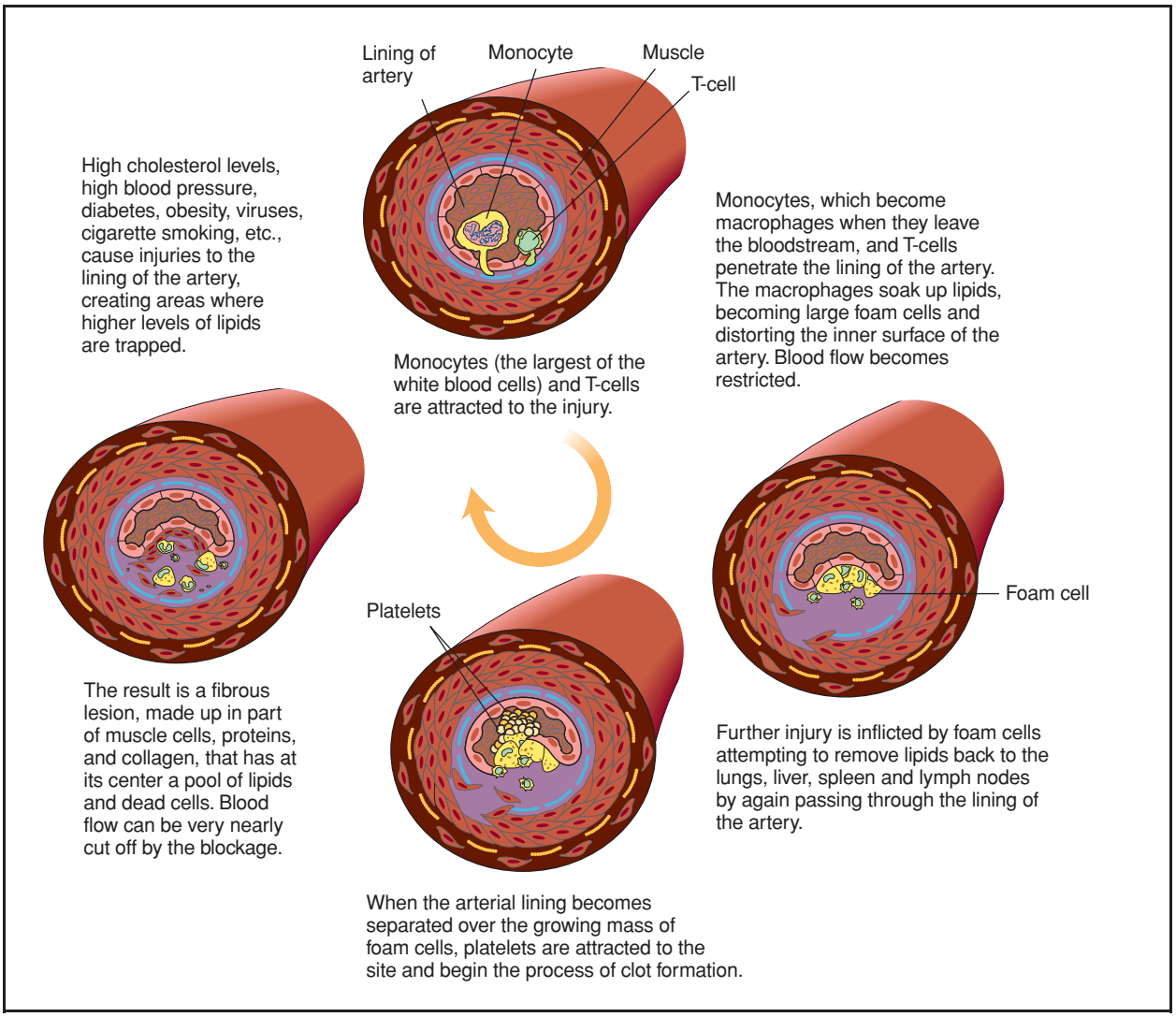
Atherosclerosis

Definition

Atherosclerosis is the buildup of a waxy plaque on the inside of blood vessels. In Greek, *athere* means *gruel*, and *skleros* means *hard*. Atherosclerosis is often called arteriosclerosis. Arteriosclerosis (from the Greek *arteria,* meaning *artery*) is a general term for hardening of the arteries. Arteriosclerosis can occur in several forms, including atherosclerosis.

Demographics

Atherosclerosis is a slow, progressive condition that may occur anywhere in the body but it usually



The progression of atherosclerosis. *(Illustration by Hans & Cassady, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

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KEY TERMS

Arteriosclerosis—Hardening of the arteries. It includes atherosclerosis, but the two terms are often used synonymously.

Cholesterol—A fat-like substance that is made by the human body and eaten in animal products. Cholesterol is used to form cell membranes and process hormones and vitamin D. High cholesterol levels contribute to the development of atherosclerosis.

HDL Cholesterol—About one-third or one-fourth of all cholesterol is high-density lipoprotein cholesterol. High levels of HDL, nicknamed "good" cholesterol, decrease the risk of atherosclerosis.

LDL Cholesterol—Low-density lipoprotein cholesterol is the primary cholesterol molecule. High levels of LDL, nicknamed "bad" cholesterol, increase the risk of atherosclerosis

Plaque—A deposit of fatty and other substances that accumulates in the lining of the artery wall.

Triglyceride—A fat that comes from food or is made from other energy sources in the body. Elevated triglyceride levels contribute to the development of atherosclerosis.

affects large and medium sized arteries. It can begin in the late teens, but it usually takes decades to cause symptoms. Some people experience rapidly progressing atherosclerosis during their thirties, others during their fifties or sixties. Over time, the buildup of the waxy plaque can cause narrowing of coronary arteries in the heart. Atherosclerosis, (the narrowing of coronary arteries due to this plaque buildup), causes more than 90% of heart attacks.

Due to the slow, progressive, and often times asymptomatic nature of the condition, it is difficult to accurately determine the frequency of atherosclerosis, but the estimated prevalence is that approximately 4.6 million people in the United States are managing various clinical manifestations of this disease.

Description

Atherosclerosis, a progressive process largely responsible for heart disease, is a type of arteriosclerosis or hardening of the arteries. An artery is made up of several layers: an inner lining called the endothelium, an elastic membrane that allows the artery to expand and contract, a layer of smooth muscle, and a layer of connective tissue. Arteriosclerosis is a broad term that includes a hardening of the inner and middle layers of the artery. It can be caused by normal **aging**, by high blood pressure, and by diseases such as diabetes. Atherosclerosis is a type of arteriosclerosis that affects only the inner lining of an artery. It is characterized by plaque deposits that block the flow of blood.

Plaque is made of fatty substances, cholesterol, waste products from the cells, **calcium**, and fibrin, a stringy material that helps clot blood. The plaque formation process stimulates the cells of the artery wall to produce substances that accumulate in the inner layer. Fat builds up within these cells and around them, and they form connective tissue and calcium. The inner layer of the artery wall thickens, the artery's diameter is reduced, and blood flow and oxygen delivery are decreased. Plaques can rupture or crack open, causing the sudden formation of a blood clot (thrombosis). Atherosclerosis can cause a **heart attack** if it completely blocks the blood flow in the heart (coronary) arteries. It can cause a **stroke** if it completely blocks the brain (carotid) arteries. Atherosclerosis can also occur in the arteries of the neck, kidneys, thighs, and arms, causing kidney failure or **gangrene** and amputation.

Causes and symptoms

Atherosclerosis is complex. Its exact cause is still unknown. It is thought that atherosclerosis is caused by a response to damage to the endothelium from high cholesterol, high blood pressure, and cigarette **smoking**. A person who has all three of these risk factors is eight times more likely to develop atherosclerosis than is a person who has none. Physical inactivity, diabetes, and **obesity** are also risk factors for atherosclerosis. High levels of the amino acid **homocysteine** and abnormal levels of protein-coated fats called lipoproteins also raise the risk of **coronary artery disease**. These substances are the targets of much current research. The role of **triglycerides**, another fat that circulates in the blood, in forming atherosclerotic plaques is unclear. High levels of triglycerides are often associated with diabetes, obesity, and low levels of high-density lipoproteins (HDL cholesterol). The more HDL ("good") cholesterol, in the blood, the less likely is coronary artery disease. These risk factors

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are all modifiable. Non-modifiable risk factors are heredity, sex, and age.

Risk factors that can be changed:

- Cigarette/tobacco smoke–Smoking increases both the chance of developing atherosclerosis and the chance of dying from coronary heart disease. Second hand smoke may also increase risk.
- High blood cholesterol–Cholesterol, a soft, waxy substance, comes from foods such as meat, eggs, and other animal products and is produced in the liver. Age, sex, heredity, and diet affect cholesterol. Total blood cholesterol is considered high at levels above 240 mg/dL and borderline at 200-239 mg/dL. High-risk levels of low-density lipoprotein (LDL cholesterol) begin at 130-159 mg/dL.
- High triglycerides–Most fat in food and in the body takes the form of triglycerides. Blood triglyceride levels above 400 mg/dL have been linked to coronary artery disease in some people. Triglycerides, however, are not nearly as harmful as LDL cholesterol.
- High blood pressure–Blood pressure of 140 over 90 or higher makes the heart work harder, and over time, both weakens the heart and harms the arteries.
- Physical inactivity–Lack of exercise increases the risk of atherosclerosis.
- Diabetes mellitus–The risk of developing atherosclerosis is seriously increased for diabetics and can be lowered by keeping diabetes under control. Most diabetics die from heart attacks caused by atherosclerosis.
- Obesity–Excess weight increases the strain on the heart and increases the risk of developing atherosclerosis even if no other risk factors are present.

Risk factors that cannot be changed:

- Heredity–People whose parents have coronary artery disease, atherosclerosis, or stroke at an early age are at increased risk. The high rate of severe hypertension among African-Americans puts them at increased risk.
- Sex–Before age 60, men are more likely to have heart attacks than women. After age 60, the risk is equal among men and women.
- Age–Risk is higher in men who are 45 years of age and older and women who are 55 years of age and older.

Symptoms differ depending upon the location of the atherosclerosis.

- In the coronary (heart) arteries: Chest pain, heart attack, or sudden death.
- In the carotid (brain) arteries: Sudden dizziness, weakness, loss of speech, or blindness.
- In the femoral (leg) arteries: Disease of the blood vessels in the outer parts of the body (peripheral vascular disease) causes cramping and fatigue in the calves when walking.
- In the renal (kidney) arteries: High blood pressure that is difficult to treat.

Diagnosis

Physicians may be able to make a diagnosis of atherosclerosis during a physical exam by means of a stethoscope and gentle probing of the arteries with the hand (palpation). More definite tests are **electrocardiography**, **echocardiography** or ultrasonography of the arteries (for example, the carotids), radionuclide scans, and **angiography**.

An electrocardiogram shows the heart's activity. Electrodes covered with conducting jelly are placed on the patient's body. They send impulses of the heart to a recorder. The test takes about 10 minutes and is performed in a physician's office. Exercise electrocardiography (**stress test**) is conducted while the patient exercises on a treadmill or a stationary bike. It is performed in a physician's office or an exercise laboratory and takes 15-30 minutes.

Echocardiography, cardiac ultrasound, uses sound waves to create an image of the heart's chambers and valves. A technician applies gel to a handheld transducer, presses it against the patient's chest, and images are displayed on a monitor. This technique cannot evaluate the coronary arteries directly. They are too small and are in motion with the heart. Severe coronary artery disease, however, may cause abnormal heart motion that is detected by echocardiography. Performed in a cardiology outpatient diagnostic laboratory, the test takes 30-60 minutes. Ultrasonography is also used to assess arteries of the neck and thighs.

Radionuclide angiography and thallium (or sestamibi) scanning enable physicians to see the blood flow through the coronary arteries and the heart chambers. Radioactive material is injected into the bloodstream. A device that uses gamma rays to produce an image of the radioactive material (gamma camera) records pictures of the heart. Radionuclide angiography is usually performed in a hospital's nuclear medicine department and takes 30-60 minutes. Thallium scanning is usually done after an exercise stress test or after injection of a vasodilator, a drug to enlarge the blood vessels, like dipyridamole (Persantine). Thallium is injected, and the scan is done then and again four

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hours (and possibly 24 hours) later. Thallium scanning is usually performed in a hospital's nuclear medicine department. Each scan takes 30-60 minutes.

Coronary angiography is the most accurate diagnostic method and the only one that requires entering the body (invasive procedure). A cardiologist inserts a catheter equipped with a viewing device into a blood vessel in the leg or arm and guides it into the heart. The patient has been given a contrast dye that makes the heart visible to x rays. Motion pictures are taken of the contrast dye flowing though the arteries. Plaques and blockages, if present, are well defined. The patient is awake but has been given a sedative. Coronary angiography is performed in a **cardiac catheterization** laboratory and takes from 30 minutes to two hours.

Treatment

Treatment includes lifestyle changes, lipid-lowering drugs, percutaneous transluminal coronary **angioplasty**, and coronary artery bypass surgery. Atherosclerosis requires lifelong care.

Patients who have less severe atherosclerosis may achieve adequate control through lifestyle changes and drug therapy. Many of the lifestyle changes that prevent disease progression–a low-fat, low-cholesterol diet, losing weight (if necessary), exercise, controlling blood pressure, and not smoking–also help prevent the disease.

Most of the drugs prescribed for atherosclerosis seek to lower cholesterol. Many popular lipid-lowering drugs can reduce LDL-cholesterol by an average of 25-30% when combined with a low-fat, low-cholesterol diet. Lipid-lowering drugs include bile acid resins, "statins" (drugs that effect HMG-CoA reductase, an enzyme that controls the processing of cholesterol), niacin, and fibric acid derivatives such as gemfibrozil (Lobid). **Aspirin** helps prevent thrombosis and a variety of other medications can be used to treat the effects of atherosclerosis.

Percutaneous transluminal coronary angioplasty and bypass surgery are invasive procedures that improve blood flow in the coronary arteries. Percutaneous transluminal coronary angioplasty (coronary angioplasty) is a non-surgical procedure in which a catheter tipped with a balloon is threaded from a blood vessel in the thigh into the blocked artery. The balloon is inflated, compresses the plaque to enlarge the blood vessel, and opens the blocked artery. Coronary angioplasty is performed by a cardiologist in a hospital and generally requires a hospital stay of one or two days. It is successful about 90% of the time, but for one-third of patients the artery narrows again within six months. It can be repeated and a "stent" may be placed in the artery to help keep it open (see below).

In coronary artery bypass surgery (bypass surgery), a detour is built around the blockage with a healthy vein or artery, which then supplies oxygen-rich blood to the heart. It is major surgery appropriate for patients with blockages in two or three major coronary arteries or severely narrowed left main coronary arteries, and for those who have not responded to other treatments. It is performed in a hospital under **general anesthesia** and uses a heart-lung machine. About 70% of patients experience full relief; about 20% partial relief.

Three other semi-experimental surgical procedures may be used to treat atherosclerosis. In **atherectomy**, a cardiologist shaves off and removes strips of plaque from the blocked artery. In laser angioplasty, a catheter with a laser tip is inserted to burn or break down the plaque. A metal coil called a stent may be permanently implanted to keep a blocked artery open.

Alternative treatment

Alternative therapies that focus on diet and lifestyle can help prevent, retard, or reverse atherosclerosis. Herbal therapies that may be helpful include: hawthorn (*Crataegus laevigata*), notoginseng root (*Panax notoginseng*), garlic (*Allium sativum*), ginger (*Zingiber officinale*), hot red or chili peppers, yarrow (*Achillea millefolium*), and alfalfa (*Medicago sativum*). Relaxation techniques including **yoga**, **meditation**, **guided imagery**, **biofeedback**, and counseling and other "talking" therapies may also be useful to prevent or slow the progress of the disease. Dietary modifications focus on eating foods that are low in fats (especially saturated fats), cholesterol, sugar, and animal proteins and high in fiber and **antioxidants** (found in fresh fruits and vegetables). Liberal use of onions and garlic is recommended, as is eating raw and cooked fish, especially cold-water fish like salmon. Smoking, alcohol, and stimulants like coffee should be avoided. **Chelation therapy**, which uses **anticoagulant drugs** and nutrients to dissolve plaque and flush it through the kidneys, is controversial. Long-term remedies can be prescribed by specialists in **ayurvedic medicine**, which combines diet, herbal remedies, relaxation and exercise, and homeopathy.

Prognosis

Atherosclerosis can be successfully treated but not cured. Recent clinical studies have shown that atherosclerosis can be delayed, stopped, and even reversed by aggressively lowering LDL cholesterol. New diagnostic techniques enable physicians to identify and treat

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atherosclerosis in its earliest stages. New technologies and surgical procedures have extended the lives of many patients who would otherwise have died.

Prevention

A healthy lifestyle–eating right, regular exercise, maintaining a healthy weight, not smoking, and controlling hypertension–can reduce the risk of developing atherosclerosis, help keep the disease from progressing, and sometimes cause it to regress.

- Eat right-A healthy diet reduces excess levels of LDL cholesterol and triglycerides. It includes a variety of foods that are low in fat and cholesterol and high in fiber; plenty of fruits and vegetables; and limited sodium. Fat should comprise no more than 30%, and saturated fat no more than 8-10%, of total daily calories according to the American Heart Association. Cholesterol should be limited to about 300 milligrams per day and sodium to about 2,400 milligrams. The "Food Guide" Pyramid developed by the U.S. Departments of Agriculture and Health and Human Services provides daily guidelines: 6-11 servings of bread, cereal, rice, and pasta; 3-5 servings of vegetables; 2-4 servings of fruit; 2-3 servings of milk, yogurt, and cheese; and 2-3 servings of meat, poultry, fish, dry beans, eggs, and nuts. Fats, oils, and sweets should be used sparingly. Mono-unsaturated oils, like olive and rapeseed (Canola) are good alternatives to use for cooking.
- Exercise regularly–Aerobic exercise can lower blood pressure, help control weight, and increase HDL ("good") cholesterol. It may keep the blood vessels more flexible. Moderate to intense aerobic exercise lasting about 30 minutes (or three 10-minute exercise periods) four or more times per week is recommended, according to the Centers for Disease Control and Prevention and the American College of Sports Medicine. Aerobic exercise includes walking, jogging, and cycling, active gardening, climbing stairs, or brisk housework. A physician should be consulted before exercise if a person has atherosclerosis or is at increased risk for it.
- Maintain a desirable body weight–Losing weight can help reduce total and LDL cholesterol, reduce triglycerides, and boost HDL cholesterol. It may also reduce blood pressure. Eating right and exercising are two key components in maintaining a desirable body weight.
- Do not smoke or use tobacco–Smoking has many adverse effects on the heart but quitting can repair damage. Ex-smokers face the same risk of heart disease as non-smokers within five to 10 years of quitting. Smoking is the worst thing a person can do to their heart and lungs.
- Seek treatment for hypertension–High blood pressure can be controlled through lifestyle changes–reducing sodium and fat, exercising, managing stress, quitting smoking, and drinking alcohol in moderation–and medication. Drugs that provide effective treatment are: diuretics, beta blockers, sympathetic nerve inhibitors, vasodilators, angiotensin converting enzyme (ACE) inhibitors, and calcium antagonists. Hypertension usually has no symptoms so it must be checked to be known. Like cholesterol, hypertension is called a "silent killer."

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ORGANIZATIONS

American Heart Association (National Center), 7272 Greenville Avenue, Dallas, TX, 75231 (800) 242-872, http://www.americanheart.org.

Centers for Disease Control and Prevention (CDC), Division for Heart

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Disease and Stroke Prevention, 4770 Buford Hwy NE, Atlanta, GA, 30341-3717, (770) 488-2424, www.cdc.gov/cholesterol/faqs.htm.

Council for Responsible Nutrition, 1828 L Street, NW, Suite 900, Washington, DC, 20036-5114 (202) 776-7929 (202) 204-7980http://www.crnusa.org.

National Heart Lung and Blood Institute (NHLBI), P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, www.nhlbi.nih.gov.

USDA National Agricultural Library, Food and Nutrition Information Center, Nutrition.gov, 10301 Baltimore Avenue, Beltsville, MD, 20705-2351, http://www.nutrition.gov.

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Athetosis *see* **Movement disorders**

Athlete's foot fungus on bottom of patient's foot. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Athlete's foot

Definition

A common fungus infection between the toes in which the skin becomes itchy and sore, cracking and peeling away. Athlete's foot (also known as *tinea pedis* or foot **ringworm**) can be treated, but it can be tenacious and difficult to clear up completely.

Description

Athlete's foot is a very common condition of itchy, peeling skin on the feet. In fact, it's so common that most people will have at least one episode at least once in their lives. It's less often found in women and children under age 12. (Symptoms that look like athlete's foot in young children most probably are caused by some other skin condition.)

Athlete's foot fungus on toes of patient. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Because the fungi grow well in warm, damp areas, they flourish in and around swimming pools, showers, and locker rooms. *Tinea pedis* got its common name because the infection was common among athletes who often used these areas.

Causes and symptoms

Athlete's foot is caused by a fungal infection that most often affects the fourth and fifth toe webs. *Trichophyton rubrum*, *T. mentagrophytes*, and *Epidermophyton floccosum*, the fungi that cause athlete's foot, are unusual in that they live exclusively on dead body tissue (hair, the outer layer of skin, and nails). The fungus grows best in moist, damp, dark places with poor ventilation. The problem doesn't occur among people who usually go barefoot.

Many people carry the fungus on their skin. However, it will only flourish to the point of causing athlete's foot if conditions are right. Many people believe athlete's foot is highly contagious, especially in public swimming pools and shower rooms. Research has shown, however, that it is difficult to pick up the infection simply by walking barefoot over a contaminated damp floor. Exactly why some people develop the condition and others don't is not well understood.

Sweaty feet, tight shoes, synthetic socks that don't absorb moisture well, a warm climate, and not drying the feet well after swimming or bathing, all contribute to the overgrowth of the fungus.

Symptoms of athlete's foot include itchy, sore skin on the toes, with scaling, cracking, inflammation, and blisters. Blisters that break, exposing raw patches of

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tissue, can cause **pain** and swelling. As the infection spreads, **itching** and burning may get worse.

If it's not treated, athlete's foot can spread to the soles of the feet and toenails. Stubborn toenail infections may appear at the same time, with crumbling, scaling and thickened nails, and nail loss. The infection can spread further if patients scratch and then touch themselves elsewhere (especially in the groin or under the arms). It's also possible to spread the infection to other parts of the body via contaminated bed sheets or clothing.

Diagnosis

Not all foot **rashes** are athlete's foot, which is why a physician should diagnose the condition before any remedies are used. Using nonprescription products on a rash that is not athlete's foot could make the rash worse.

A dermatologist can diagnose the condition by **physical examination** and by examining a preparation of skin scrapings under a microscope. This test, called a KOH preparation, treats a sample of tissue scraped from the infected area with heat and potassium hydroxide (KOH). This treatment dissolves certain substances in the tissue sample, making it possible to see the fungi under the microscope.

Treatment

Athlete's foot may be resistant to medication and should not be ignored. Simple cases usually respond well to antifungal creams or sprays (clotrimazole, ketoconazole, miconazole nitrate, sulconazole nitrate, or tolnaftate). If the infection is resistant to topical treatment, the doctor may prescribe an oral antifungal drug.

Untreated athlete's foot may lead to a secondary bacterial infection in the skin cracks.

Alternative treatment

A footbath containing cinnamon has been shown to slow down the growth of certain molds and fungi, and is said to be very effective in clearing up athlete's foot. To make the bath:

- heat four cups of water to a boil
- add eight to 10 broken cinnamon sticks
- reduce heat and simmer five minutes
- remove and let the mixture steep for 45 minutes until lukewarm
- soak feet

Other herbal remedies used externally to treat athlete's foot include: a foot soak or powder containing goldenseal (*Hydrastis canadensis*); tea tree oil (*Melaleuca* spp.); or calendula (*Calendula officinalis*) cream to help heal cracked skin.

Prognosis

Athlete's foot usually responds well to treatment, but it is important to take all medication as directed by a dermatologist, even if the skin appears to be free of fungus. Otherwise, the infection could return. The toenail infections that may accompany athlete's foot, however, are typically very hard to treat effectively.

Prevention

Good personal hygiene and a few simple precautions can help prevent athlete's foot. To prevent spread of athlete's foot:

- wash feet daily
- dry feet thoroughly (especially between toes)
- avoid tight shoes (especially in summer)
- wear sandals during warm weather
- wear cotton socks and change them often if they get damp
- don't wear socks made of synthetic material
- go barefoot outdoors when possible
- wear bathing shoes in public bathing or showering areas
- use a good quality foot powder
- don't wear sneakers without socks
- wash towels, contaminated floors, and shower stalls well with hot soapy water if anyone in the family has athlete's foot.

Resources

BOOKS

Williams, Hywel C., et al. *Evidence–based Dermatology*. Malden, MA: Oxford; Blackwell/BMJ Books, 2008.

ORGANIZATIONS

American Podiatric Medical Association, 9312 Old Georgetown Road, Bethesda, MD, 20814-1621, (301) 581-9200, http://www.apma.org.

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Athletic heart syndrome

Definition

Athletic heart syndrome is the adaptation of an athlete's heart in response the physiologic stresses of strenuous physical training. It can be difficult to

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distinguish a significant medical condition from an athletic heart.

Description

The heart adapts to physical demands by enlarging, especially the left ventricle. Enlargement increases the cardiac output, the amount of blood pumped with each beat of the heart. The exact type of adaptation depends on the nature of the physical demand. There are two types of demand, static and dynamic. Static demand involves smaller groups of muscles under extreme resistance for brief period. An example is weight lifting. Dynamic training involves larger groups of muscles at lower resistance for extended periods of time. Examples are aerobic training and tennis. Cardiac enlargement is associated with dynamic training. The heart's response to static training is hypertrophy, thickening of the muscle walls of the heart. As the wall of the heart adapts, there are changes in the electrical conducting system of the heart. Because of the larger volume of blood being pumped with each heart beat, the heart rate when at rest decreases below the normal level for nonathletes.

Sudden unexpected **death** (SUD) is the death of an athlete, usually during or shortly after physical activity. Often, there is no warning that the person will experience SUD, although in some cases, warning signs appear which cause the person to seek medical advice. Importantly, cases of death occurring during physical activity are not caused by athletic heart syndrome, but by undiagnosed heart disorders.

Causes and symptoms

Athletic heart syndrome is the consequence of a normal adaptation by the heart to increased physical activity. The changes in the electrical conduction system of the heart may be pronounced and diagnostic, but should not cause problems. In the case of SUD, other heart problems are involved. In 85-97% of the cases of SUD, an underlying structural defect of the heart has been noted.

Diagnosis

The changes in the heart beat caused by the electrical conduction system of the heart are detectable on an electrocardiogram. Many of the changes seen in athletic heart syndrome mimic those of various heart diseases. Careful examination must be made to distinguish heart disease from athletic heart syndrome.

Prognosis

The yearly rate for occurrence of SUD in people less than 35 years of age is less than 7 incidents per 100,000. Of all SUD cases, only about 8% are **exercise** related. On a national basis, this means that each year approximately 25 athletes experience SUD. In persons over age 35, the incidence of SUD is approximately 55 in 100,000, with only 3% of the cases occurring during exercise.

Resources

BOOKS

Fuster, Valentin, et al. *Hurst's the Heart*. 12th ed. New York: Mc–Graw Hill Professional, 2007.

John T. Lohr PhD

Atkins diet

Definition

The Atkins diet is a high-protein, high-fat, and very low-carbohydrate regimen. It emphasizes meat, cheese, and eggs, while discouraging foods such as bread, pasta, fruit, and sugar. It is a form of ketogenic diet.

Purpose

The primary benefit of the diet is rapid and substantial weight loss. By restricting carbohydrate intake, the body will burn more fat stored in the body. Since there are no limits on the amount of calories or quantities of foods allowed on the diet, there is little hunger between meals. According to Atkins, the diet can alleviate symptoms of conditions such as **fatigue**, irritability, headaches, depression, and some types of joint and muscle **pain**.

Description

The regimen is a low-carbohydrate, or ketogenic diet, characterized by initial rapid weight loss, usually due to water loss. Drastically reducing the amount of carbohydrate intake causes liver and muscle glycogen loss, which has a strong but temporary diuretic effect. Long-term weight loss occurs because with a low amount of carbohydrate intake, the body burns stored fat for energy.

The four-step diet starts with a two-week induction program designed to rebalance an individual's metabolism. Unlimited amounts of fat and protein are allowed

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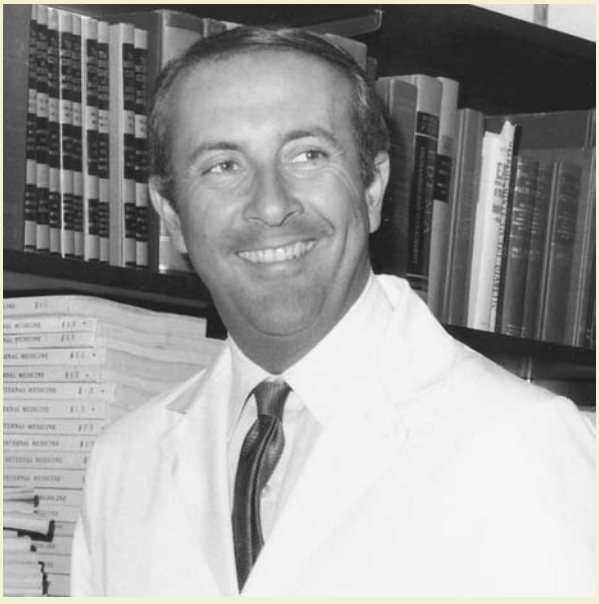
DR. ROBERT C. ATKINS (1930–2003)



(AP Images.)

Dr. Robert C. Atkins graduated from the University of Michigan in 1951 and received his medical degree from Cornell University Medical School in 1955 with a specialty in cardiology. As an internist and cardiologist he developed the Atkins Diet in the early 1970s. The diet is a ketogenic diet—a high protein, high fat, and very low carbohydrate regimen resulting in ketosis. It emphasizes meat, cheese, and eggs, while discouraging foods such as bread, pasta, fruit, and sugar. It first came to public attention in 1972 with the publication of *Dr. Atkins' Diet Revolution*. The book quickly became a bestseller but unlike most other fad diet books, this one has remained popular. At last count, it had been reprinted 28 times and sold more than 10 million copies worldwide. Atkins authored a number of other books on his diet theme, including *Dr. Atkins' New Diet Revolution* (1992), *Dr. Atkins' Quick and Easy New Diet Cookbook* (1997), and *The Vita-Nutrient Solution: Nature's Answer to Drugs* (1998).

Atkins saw about 60,000 patients in his more than 30 years of practice. He also appeared on numerous radio and television talk shows, had his own syndicated radio program, *Your Health Choices*, and authored the monthly newsletter *Dr. Atkins' Health Revelations*. Atkins received the World Organization of Alternative Medicine's Recognition of Achievement Award and was named the National Health Federation's Man of the Year. He was the director of the Atkins Center for Complementary Medicine, which he founded in the early 1980s, until his death in 2003. The company bearing his name continues to develop books and products that support his ideas on nutrition and dieting.

but carbohydrate intake is restricted to 20 grams per day. Foods allowed include butter, oil, meat, poultry, fish, eggs, cheese, and cream. The daily amount of carbohydrates allowed equals about three cups of salad vegetables, such as lettuce, cucumbers, and celery.

The second stage is for ongoing weight loss. It allows 20-40 grams of carbohydrates a day. When the individual is about 10 pounds from their desired weight, they begin the pre-maintenance phase. This gradually adds one to three servings a week of high carbohydrate foods, such as a piece of fruit or slice of whole-wheat bread. When the desired weight is reached, the maintenance stage begins. It allows 40-60 grams of carbohydrates per day.

Opinion from the general medical community remains mixed on the Atkins diet. There have been no significant long-term scientific studies on the diet. A number of leading medical and health organizations, including the American Medical Association, American Dietetic Association (ADA), and the American Heart Association oppose it. It is drastically different than the dietary intakes recommended by the U.S. Department of Agriculture and the National Institutes of Health. Much of the opposition is because the diet is lacking in some **vitamins** and nutrients, and because it is high in fat. In a hearing before the U.S. Congress on February 24, 2000, an ADA representative called the Atkins diet "hazardous" and said it lacked scientific credibility.

Preparations

No advance preparation is needed to go on the diet. However, as with most **diets**, it is generally considered appropriate to consult with a physician and to have a physical evaluation before starting such a nutritional regimen. The evaluation should include blood tests to determine levels of cholesterol, **triglycerides**, glucose, insulin, and uric acid. A glucose tolerance test is also recommended.

Precautions

Adherence to the Atkins diet can result in vitamin and mineral deficiencies. In his books, Atkins

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KEY TERMS

Biotin—A B complex vitamin, found naturally in yeast, liver, and egg yolks.

Carbohydrates—Neutral compounds of carbon, hydrogen, and oxygen found in sugar, starches, and cellulose.

Hypertension—Abnormally high arterial blood pressure, which if left untreated can lead to heart disease and stroke.

Ketogenic diet—A diet that supplies an abnormally high amount of fat, and small amounts of carbohydrates and protein.

Ketosis—An abnormal increase in ketones in the body, usually found in people with uncontrolled diabetes mellitus.

Pantetheine—A growth factor substance essential in humans, and a constituent of coenzyme A.

Triglycerides—A blood fat lipid that increases the risk for heart disease.

recommends a wide-range of **nutritional supplements**, including a multi-vitamin. Among his recommendations, Atkins suggests the following daily dosages: 300-600 micrograms (mcg) of chromium picolinate, 100-400 milligrams (mg) of pantetheine, 200 mcg of selenium, and 450-675 mcg of biotin.

The diet is not recommended for lacto-ovo vegetarians, since it cannot be done as successfully without protein derived from animal products. Also, vegans cannot follow this diet, since a vegan diet is too high in carbohydrates, according to Atkins. Instead, he recommends vegetarians with a serious weight problem give up **vegetarianism**, or at least include fish in their diet.

Side effects

According to Atkins, the diet causes no adverse side effects. Many health care professionals disagree. In a fact sheet for the Healthcare Reality Check Web site (www.hcrc.org), Ellen Coleman, a registered dietician and author, said the diet may have serious side effects for some people. She said complications associated with the diet include ketosis, **dehydration**, electrolyte loss, **calcium** depletion, weakness, **nausea**, and kidney problems. "It is certainly riskier for overweight individuals with medical problems such as heart disease, **hypertension**, **kidney disease**, and diabetes than it is for overweight people with no health problems," she said.

People with diabetes taking insulin are at risk of becoming hypoglycemic if they do not eat appropriate carbohydrates. Also, persons who **exercise** regularly may experience low energy levels and muscle fatigue from low carbohydrate intake.

Resources

BOOKS

Westman, Eric C., Stephen D. Phinney, and Jeff Volek *The New Atkins for a New You: The Ultimate Diet for Shedding Weight and Feeling Great Forever*. New York: Simon & Schuster, 2010.

Ken R. Wells

Atopic dermatitis

Definition

Eczema is a general term used to describe a variety of conditions that cause an itchy, inflamed skin rash. Atopic **dermatitis**, a form of eczema, is a non-contagious disorder characterized by chronically inflamed skin and sometimes intolerable **itching**.

Description

Atopic dermatitis refers to a wide range of diseases that are often associated with **stress** and allergic disorders that involve the respiratory system, like **asthma** and hay fever. Although atopic dermatitis can appear at any age, it is most common in children and young adults. Symptoms usually abate before the age of 25 and do not affect the patient's general health.

About one in ten babies develop a form of atopic dermatitis called infantile eczema. Characterized by skin that oozes and becomes encrusted, infantile eczema most often occurs on the face and scalp. The condition usually improves before the child's second birthday, and medical attention can keep symptoms in check until that time.

When atopic dermatitis develops after infancy, inflammation, blistering, oozing, and crusting are less pronounced. The patient's sores become dry, turn from red to brownish-gray, and skin may thicken and become scaly. In dark-skinned individuals, this condition can cause the complexion to lighten or darken. Itching associated with this condition is usually worst at night. It can be so intense that patients scratch until their sores bleed, sometimes causing scarring and infection.

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A close-up view of atopic dermatitis in the crook of the elbow of a 12-year-old patient. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Atopic dermatitis affects about 3% of the population of the United States, and about 80% of the people who have the condition have one or more relatives with the same condition or a similar one. Symptoms tend to be most severe in females. Atopic dermatitis can erupt on any part of the skin, and crusted, thickened patches on the fingers, palms, or the soles of the feet can last for years. In teenagers and young adults, atopic dermatitis often appears on one or more of the following areas:

- elbow creases
- backs of the knees
- ankles
- wrists
- face
- neck
- upper chest
- palms and between the fingers

KEY TERMS

Corticosteroid—A steroid hormone produced by the adrenal gland or as a synthetic compound that reduces inflammation, redness, rashes, and irritation.

Dermatitis—Inflammation of the skin.

Causes and symptoms

While allergic reactions often trigger atopic dermatitis, the condition is thought to be the result of an inherited over-active immune system or a genetic defect that causes the skin to lose abnormally large amounts of moisture. The condition can be aggravated by a cycle that develops in which the skin itches, the patient scratches, the condition worsens, the itching worsens, the patient scratches, etc. This cycle must be broken by relieving the itching to allow the skin time to heal. If the skin becomes broken, there is also a risk of developing skin infections which, if not recognized and treated promptly, can become more serious.

Symptoms of atopic dermatitis include the following:

- an itchy rash and dry, thickened skin on areas of the body where moisture can be trapped
- continual scratching
- chronic fatigue, caused when itching disrupts sleep

An individual is more at-risk for developing the condition if there is a personal or family history of atopic dermatitis, hay fever, asthma, or other **allergies**. Exposure to any of the following can cause a flare-up:

- hot or cold temperatures
- wool and synthetic fabrics
- detergents, fabric softeners, and chemicals
- use of drugs that suppress immune-system activity

Certain foods, such as peanuts, cow's milk, eggs, and fish, can trigger symptoms of atopic dermatitis. A small percentage of patients with atopic dermatitis find that their symptoms worsen after having been exposed to dust, feather pillows, rough-textured fabrics, or other materials to which dust adheres.

Diagnosis

Diagnosis of atopic dermatitis is usually based on the patient's symptoms and personal and family health history. Skin tests do not generally provide reliable information about this condition.

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Treatment

Atopic dermatitis cannot be cured, but the severity and duration of symptoms can be controlled. A dermatologist should be consulted when symptoms first appear, and is likely to recommend warm baths to loosen encrusted skin, followed by applications of petroleum jelly or vegetable shortening to prevent the skin's natural moisture from escaping.

Externally applied (topical) **steroids** or preparations containing coal tar can relieve minor itching, but coal tar has an unpleasant odor, stains clothes, and may increase skin-cancer risk. Excessive use of steroid creams in young children can alter growth. Pregnant women should not use products that contain coal tar. Topical steroids can cause itching, burning, **acne**, permanent stretch marks, and thinning and spotting of the skin. Applying topical steroids to the area around the eyes can cause glaucoma.

Oral **antihistamines**, such as diphenhydramine (Benadryl), can relieve symptoms of allergy-related atopic dermatitis. More concentrated topical steroids are recommended for persistent symptoms. A mild tranquilizer may be prescribed to reduce stress and help the patient sleep, and **antibiotics** are used to treat secondary infections.

Cortisone ointments should be used sparingly, and strong preparations should never be applied to the face, groin, armpits, or rectal area. Regular medical monitoring is recommended for patients who use cortisone salves or lotions to control wide-spread symptoms. Oral cortisone may be prescribed if the patient does not respond to other treatments, but patients who take the medication for more than two weeks have a greater-than-average risk of developing severe symptoms when the treatment is discontinued.

Allergy shots rarely improve atopic dermatitis and sometimes aggravate the symptoms. Since **food allergies** may trigger atopic dermatitis, the doctor may suggest eliminating certain foods from the diet if other treatments prove ineffective.

If symptoms are extremely severe, ultraviolet **light therapy** may be prescribed, and a wet body wrap recommended to help the skin retain moisture. This technique, used most often with children, involves sleeping in a warm room while wearing wet pajamas under dry clothing, rain gear, or a nylon sweatsuit. The patient's face may be covered with wet gauze covered by elastic **bandages**, and his or her hands encased in wet socks covered by dry ones.

A physician should be notified if the condition is widespread or resists treatment, or the skin oozes, becomes encrusted, or smells, as this may indicate an infection.

Alternative treatment

Alternative therapies can sometimes bring relief or resolution of atopic dermatitis when conventional therapies are not helping. If the condition becomes increasingly widespread or infected, a physician should be consulted.

Helpful alternative treatments for atopic dermatitis may include:

- Taking regular brisk walks, followed by bathing in warm water sprinkled with essential oil of lavender (*Lavandula officinalis*); lavender oil acts as a nerve relaxant for the whole body including the skin
- Supplementing the diet daily with zinc, fish oils, vitamin A, vitamin E, and evening primrose oil (*Oenothera biennis*)–all good sources of nutrients for the skin
- Reducing or eliminating red meat from the diet
- Eliminating or rotating potentially allergic foods such as cow's milk, peanuts, wheat, eggs, and soy
- Implementing stress reduction techniques in daily life.

Herbal therapies also can be helpful in treating atopic dermatitis. Western herbal remedies used in the treatment of this condition include burdock (*Arctium lappa*) and *Ruta* (*Ruta graveolens*). Long-term herbal therapy requires monitoring and should be guided by an experienced practitioner.

Other alternative techniques that may be useful in the treatment of atopic dermatitis include:

- Acupressure (acupuncture without needles) to relieve tension that may trigger a flare
- Aromatherapy, using essential oils like lavender, thyme (*Thymus vulgaris*), jasmine (*Jasminum officinale*) and chamomile (*Matricaria recutita*) in hot water, to add a soothing fragrance to the air
- Shiatsu massage and reflexology, performed by licensed practitioners, to alleviate symptoms by restoring the body's natural balance
- Homeopathy, which may temporarily worsen symptoms before relieving them, should be supervised by a trained alternative healthcare professional
- Hydrotherapy, which uses water, ice, liquid, and steam, to stimulate the immune system
- Juice therapy to purify the liver and relieve bowel congestion
- Yoga to induce a sense of serenity.

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Prognosis

Atopic dermatitis is unpredictable. Although symptoms occur less often with age and sometimes disappear altogether, they can recur without warning. Atopic dermatitis lowers resistance to infection and increases the risk of developing **cataracts**. Sixty percent of patients with atopic dermatitis will experience flares and remissions throughout their lives.

Prevention

Research has shown that babies weaned from breast milk before they are four months old are almost three times more likely than other babies to develop recurrent eczema. Feeding eggs or fish to a baby less than one year old can activate symptoms, and babies should be shielded from such irritants as mites, molds, pet hair, and smoke.

Possible ways to prevent flare-ups include the following:

- eliminate activities that cause sweating
- lubricate the skin frequently
- avoid wool, perfumes, fabric softeners, soaps that dry the skin, and other irritants
- avoid sudden temperature changes

A doctor should be notified whenever any of the following occurs:

- fever or relentless itching develop during a flare
- an unexplained rash develops in someone who has a personal or family history of eczema or asthma
- inflammation does not decrease after seven days of treatment with an over-the-counter preparation containing coal tar or steroids
- a yellow, tan, or brown crust or pus-filled blisters appear on top of an existing rash
- a person with active atopic dermatitis comes into contact with someone who has cold sores, genital herpes, or another viral skin disease

ORGANIZATIONS

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Maureen Haggerty

Atrial ectopic beats

Definition

Atrial ectopic beats (AEB) refers to a contraction of the upper heart chamber which occurs before it would be expected. Atrial ectopic beats are also known as premature atrial beats, premature atrial complex (PAC), or atrial extrasystole.

Description

An AEB is usually a harmless disturbance in the normal rhythm of the heart. It can occur only occasionally, in a regular pattern, or several may occur in sequence and then disappear. Most often, the person is unaware of the event.

Causes and symptoms

As people age, extra beats tend to happen more frequently even in perfectly healthy individuals. AEB may be triggered or increased by **stress**, **caffeine**, **smoking**, and some medicines. Cold remedies containing ephedrine or pseudoephedrine have been known to increase the incidence of atrial ectopic beats. AEB may also be the result of an enlarged atria, lung disease, or the result of reduced blood supply to that area of the heart.

If a person is aware of the event, the first symptom of AEB is usually a feeling that the heart has skipped or missed a beat. This is often accompanied by a feeling that the heart is thumping or pounding in the chest. The thumping or pounding is caused by the fact that when there is an AEB, the pause before the next beat is usually longer than normal. The next beat must be stronger than usual to pump the accumulated blood out of the chamber.

Diagnosis

Diagnosis of AEB is often suspected on the basis of the patient's description of the occurrence. An electrocardiogram (ECG) can confirm the diagnosis. An ECG shows the heart beat as three wave forms. The first wave is called P, the second is called QRS, and the last is T. An atrial ectopic beat will show up on the ECG as a P wave that occurs closer than usual to the preceding T wave.

Treatment

Atrial ectopic beats do not usually require treatment. If treatment is necessary because the beats occur

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frequently and cause intolerable discomfort, the doctor may prescribe medication.

Prognosis

Occasional AEB usually have no significance. If they increase in frequency, they can lead to atrial tachycardia or fibrillation and to a decrease in cardiac output.

Prevention

AEB cannot usually be prevented. Aggravating factors can be addressed, like excessive stimulants and uncontrolled pulmonary disorders.

ORGANIZATIONS

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Dorothy Elinor Stonely

Atrial extrasystole *see* **Atrial ectopic beats**

Atrial fibrillation and flutter

Definition

Atrial fibrillation and flutter are abnormal heart rhythms in which the atria, or upper chambers of the heart, are out of sync with the ventricles, or lower chambers of the heart. In atrial fibrillation, the atria "quiver" chaotically and the ventricles beat irregularly. In atrial flutter, the atria beat regularly and faster than the ventricles.

Description

Atrial fibrillation and flutter are two types of cardiac **arrhythmias**, irregularities in the heart's rhythm. Nearly 2 million Americans have atrial fibrillation, according to the American Heart Association. It is the most common chronic arrhythmia. Atrial flutter is less common, but both of these arrhythmias can cause a blood clot to form in the heart. This can lead to a **stroke** or a blockage carried by the blood flow (an **embolism**) anywhere in the body's arteries. Atrial fibrillation is responsible for about 15% of strokes.

The atria are the heart's two small upper chambers. In atrial fibrillation, the heart beat is completely irregular. The atrial muscles contract very quickly and irregularly; the ventricles, the heart's two large lower chambers, beat irregularly but not as fast as the atria. When the atria fibrillate, blood that is not completely pumped out can pool and form a clot. In atrial flutter, the heart beat is usually very fast but steady. The atria beat faster than the ventricles.

KEY TERMS

Arrhythmia—A variation in the normal rhythm of the heart beat. Atrial fibrillation and flutter are two types of arrhythmia.

Atria—The two small upper chambers of the heart that receive blood from the lungs and the body.

Stroke—A brain attack caused by a sudden disruption of blood flow to the brain, in this case because of a blood clot.

Ventricles—The two large lower chambers of the heart that pump blood to the lungs and to the rest of the body.

Atrial fibrillation often occurs in people with various types of heart disease. Atrial fibrillation may also result from an inflammation of the heart's covering (**pericarditis**), chest trauma or surgery, pulmonary disease, and certain medications. Atrial fibrillation is more common in older people; about 10% of people over the age of 75 have it. Atrial flutter and fibrillation usually occur in people with hypertensive or coronary heart disease and other types of heart disorders.

Causes and symptoms

In most cases, the cause of atrial fibrillation and flutter can be found, but often it cannot. Causes of these heart beat abnormalities include:

- many types of heart disease
- stress and anxiety
- caffeine
- alcohol
- tobacco
- diet pills
- some prescription and over-the-counter medications
- open heart surgery

Symptoms, when present, include:

- a fluttering feeling in the chest
- a pulse that feels like the heart is skipping, racing, jumping, or is irregular
- low energy

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- a faint or dizzy feeling
- pressure or discomfort in the chest
- shortness of breath
- anxiety

Diagnosis

A doctor can sometimes hear these arrhythmias using an instrument (a stethoscope) to listen to the sounds within the chest. Atrial fibrillation and flutter are usually diagnosed through **electrocardiography** (EKGs), an exercise-stress test, a 24-hour Holter EKG monitor, or a telephone cardiac monitor. An EKG shows the heart's activity and may reveal a lack of oxygen (**ischemia**). Electrodes covered with conducting jelly are placed on the patient's chest, arms, and legs. The electrodes send impulses of the heart's activity through a monitor (called an oscilloscope) to a recorder that traces the pattern of the impulses onto paper. The test takes about 10 minutes and is performed in a doctor's office. The **exercise-stress test** measures how the heart and blood vessels respond to work when the patient is exercising on a treadmill or a stationary bike. This test is performed in a doctor's office within an exercise laboratory and takes 15-30 minutes.

In 24-hour EKG (Holter) monitoring, the patient wears a small, portable tape recorder connected to disks on his/her chest that record the heart's rhythm during normal activities. An EKG called transtelephonic monitoring identifies arrhythmias that occur infrequently. Like **Holter monitoring**, transtelephonic monitoring continues for days or weeks and enables patients to send the EKG via telephone to a monitoring station when an arrhythmia is felt, or to store the information in the recorder and transmit it later. Doctors can also use high-frequency sound waves (**echocardiography**) to determine the structure and function of the heart. This diagnostic method is often helpful to evaluate for underlying heart disease.

Treatment

Atrial fibrillation and flutter are usually treated with medications and/or electrical shock (**cardioversion**). In some cases, removal of a small portion of the heart (ablation), implantation of a pacemaker or a cardioverter defibrillator, or maze surgery is needed.

If the heart rate cannot be quickly controlled, electrical cardioversion may be used. Cardioversion, the electric shock to the chest wall, is usually performed emergencies. This device briefly suspends the heart's activity and allows it to return to a normal rhythm.

Ablation destroys the heart tissue that causes the arrhythmia. The tissue can be destroyed by catheterization or surgery. Radiofrequency **catheter ablation**, performed in a **cardiac catheterization** laboratory, can cure atrial flutter and control the heart rate in atrial fibrillation. The patient is awake but sedated. A thin tube called a catheter is inserted into a vein and is threaded into the heart. At the end of the catheter, a device maps the electrical pathways of the heart. A cardiologist, a doctor specializing in the heart, uses this map to identify the pathway(s) causing the arrhythmia, and then eliminates it (them) with bursts of high-frequency radio waves. Surgical ablation is performed in an operating room under **general anesthesia**. Computerized mapping techniques are combined with a cold probe to destroy arrhythmia-causing tissue. Ablation is generally successful. When ablation is used for atrial fibrillation, it is usually followed by implantation of a pacemaker as well as drug therapy.

A pacemaker is a battery-powered device about the size of a matchbox that is surgically implanted near the collarbone to regulate the heart beat. Lead wires threaded to the right side of the heart supply electrical energy to pace the atria and ventricles. The implantable cardioverter defibrillator is a treatment for serious arrhythmias. The battery-powered device senses an abnormal heart rhythm and automatically provides electrical shock(s). The shock(s) suspends heart activity and then allows the heart to initiate a normal rhythm. Wire electrodes on the device are attached to the heart. Some of the electrodes are attached to the outside of the heart and some are attached to the inside of the heart through veins. The newest implantable cardioverter defibrillators can be implanted in the chest wall and do not require open chest surgery. These devices weigh less than 10 oz. and generally last seven or eight years. An implantable cardioverter defibrillator is usually used with drug therapy, but the amount medication is reduced. In maze surgery, often the last resort, surgeons create a maze of stitches (sutures) that help the heart's electrical impulses travel effectively.

Most of the drugs used for treatment have potential side effects and should be carefully monitored by a doctor. The goal of treatment is to control the rate and rhythm of the heart and to prevent the formation of **blood clots**. If the arrhythmia is caused by heart disease, the heart disease will also be treated. The American Heart Association recommends aggressive treatment.

A digitalis drug, most commonly **digoxin**, is usually prescribed to control the heart rate. Digitalis

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drugs slow the heart's electrical impulses, helping to restore the normal rate and rhythm. These drugs also increase the ability of the heart's muscular layer to contract and pump properly. Beta blockers and **calcium channel blockers** can also be used for this purpose. Beta blockers slow the speed of electrical impulses through the heart. Some calcium channel blockers dampen the heart's response to erratic electrical impulses.

To prevent blood clots, **aspirin** or warfarin (Coumadin) is administered. Warfarin, however, has potential bleeding side effects, especially in older patients. Amiodarone is fairly efffective for atrial flutter. This drug is often able to maintain the heart's proper rhythm and can also help control the heart rate when the flutter occurs.

Prognosis

Patients with atrial fibrillation and flutter can live a normal life for many years as long as the arrhythmia is controlled and serious blood clots are prevented.

Prevention

Atrial fibrillation and flutter can sometimes be prevented when the cause can be identified and controlled. Depending on the cause, prevention could include:

- treating the underlying heart disease
- reducing stress and anxiety
- reducing or stopping consumption of caffeine, alcohol, or tobacco
- discontinuing diet pills or other medications (over-the-counter or prescription)

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

Texas Heart Institute. Heart Information Service, MC 3-116, PO Box 20345, Houston, TX, 77225, (832) 355-4011, (800) 292-2221, http://www.texasheart.org.

Lori De Milto

Atrial flutter *see* **Atrial fibrillation and flutter**

Atrial septal defect

Definition

An atrial septal defect is an abnormal opening in the wall separating the left and right upper chambers (atria) of the heart.

Description

During the normal development of the fetal heart, there is an opening in the wall (the septum) separating the left and right upper chambers of the heart. Normally, this opening closes before birth, but if it does not, the child is born with a hole between the left and right atria. This abnormal opening is called an atrial septal defect and causes blood from the left atrium to flow into the right atrium.

Different types of atrial septal defects can occur, and they are classified according to where in the separating wall they are found. The most commonly found atrial septal defect occurs in the middle of the atrial septum and accounts for about 70% of all atrial septal defects. Abnormal openings can form in the upper and lower parts of the atrial septum as well.

Causes and symptoms

Abnormal openings in the atrial septum occur during fetal development and are twice as common in females as in males. These abnormalities can go unnoticed if the opening is small, producing no abnormal symptoms. If the defect is big, large amounts of blood flowing from the left to the right atrium will cause the right atrium to swell to hold the extra blood.

People born with an atrial septal defect can have no symptoms through their twenties, but by age 40, most people with this condition have symptoms that can include **shortness of breath**, rapid abnormal beating of the atria (**atrial fibrillation**), and eventually **heart failure**.

Diagnosis

Atrial septal defects can be identified by various methods. Abnormal changes in the sound of the heart beats can be heard when a doctor listens to the heart with a stethoscope. In addition, a **chest x ray**, an electrocardiogram (ECG, an electrical printout of the heartbeats), and an echocardiogram (a test that uses sound waves to form a detailed image of the heart) can also be used to identify this condition.

An atrial septal defect can also be diagnosed by using a test called **cardiac catheterization**. This test involves inserting a very thin tube (catheter) into the

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KEY TERMS

Cardiac catheterization—A test that involves having a tiny tube inserted into the heart through a blood vessel.

Dacron—A synthetic polyester fiber used to surgically repair damaged sections of heart muscle and blood vessel walls.

Echocardiogram—A test that uses sound waves to generate an image of the heart, its valves, and chambers.

heart's chambers to measure the amount of oxygen present in the blood within the heart. If the heart has an opening between the atria, oxygen-rich blood from the left atrium enters the right atrium. Through cardiac catheterization, doctors can detect the higher-than-normal amount of oxygen in the heart's right atrium, right ventricle, and the large blood vessels that carry blood to the lungs, where the blood would normally subsequently get its oxygen.

Treatment

Atrial septal defects often correct themselves without medical treatments by the age of two. If this dose not happen, surgery is done by sewing the hole closed, or by sewing a patch of Dacron material or a piece of the sac that surrounds the heart (the pericardium), over the opening.

Some patients can have the defect fixed by having an clam-shaped plug placed over the opening. This plug is a man-made device that is put in place through a catheter inserted into the heart.

Prognosis

Individuals with small defects can live a normal life, but larger defects require surgical correction. Less than 1% of people younger than 45 years of age die from corrective surgery. Five to ten percent of patients can die from the surgery if they are older than 40 and have other heart-related problems. When an atrial septal defect is corrected within the first 20 years of life, there is an excellent chance for the individual to live normally.

ORGANIZATIONS

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Dominic De Bellis PhD

Atrioventricular block *see* **Heart block**

Attapulgite *see* **Antidiarrheal drugs**

Attention deficit hyperactivity disorder (ADHD)

Definition

Attention deficit hyperactivity disorder (ADHD) is a developmental disorder characterized by distractibility, hyperactivity, impulsive behaviors, and the inability to remain focused on tasks or activities.

Description

ADHD, also called hyperkinetic disorder (HKD) outside of the United States, is the most commonly diagnosed neurological disorder in children. It is estimated to affect 3–7% of school-age children in the United States and is 3–5 times more common in boys than in girls, although in adults, the ratio of males to females is closer to 2 to 1. Worldwide, diagnosed rates of ADHD range from less than 1% in Great Britain (which has stringent standards for diagnosis) to 12%. ADHD is a disorder of childhood; symptoms must begin before age 7, although they may continue into adulthood. Although childhood ADHD has been studied extensively, less information is available on adult ADHD. Studies on adults have produced a wide range of sometimes conflicting results. These studies report that anywhere from 30–80% of children with ADHD continue to have symptoms into adulthood. One reason for the wide range of findings is that the hyperactive component of the disorder often becomes less noticeable as individuals mature and develop more self-control.

Three types of ADHD are recognized by the American Psychiatric Association and outlined in the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revised (DSM-IV-TR)*:

- predominately hyperactive. This is characterized by excessive physical activity (e.g., constant fidgeting, inability to stay seated, inability to engage in quiet play) and impulsive behaviors (e.g., interrupting, difficulty waiting in line).
- predominately inattentive. This is characterized by inability to pay close attention to detail, stay on task, and organize tasks. This form of ADHD

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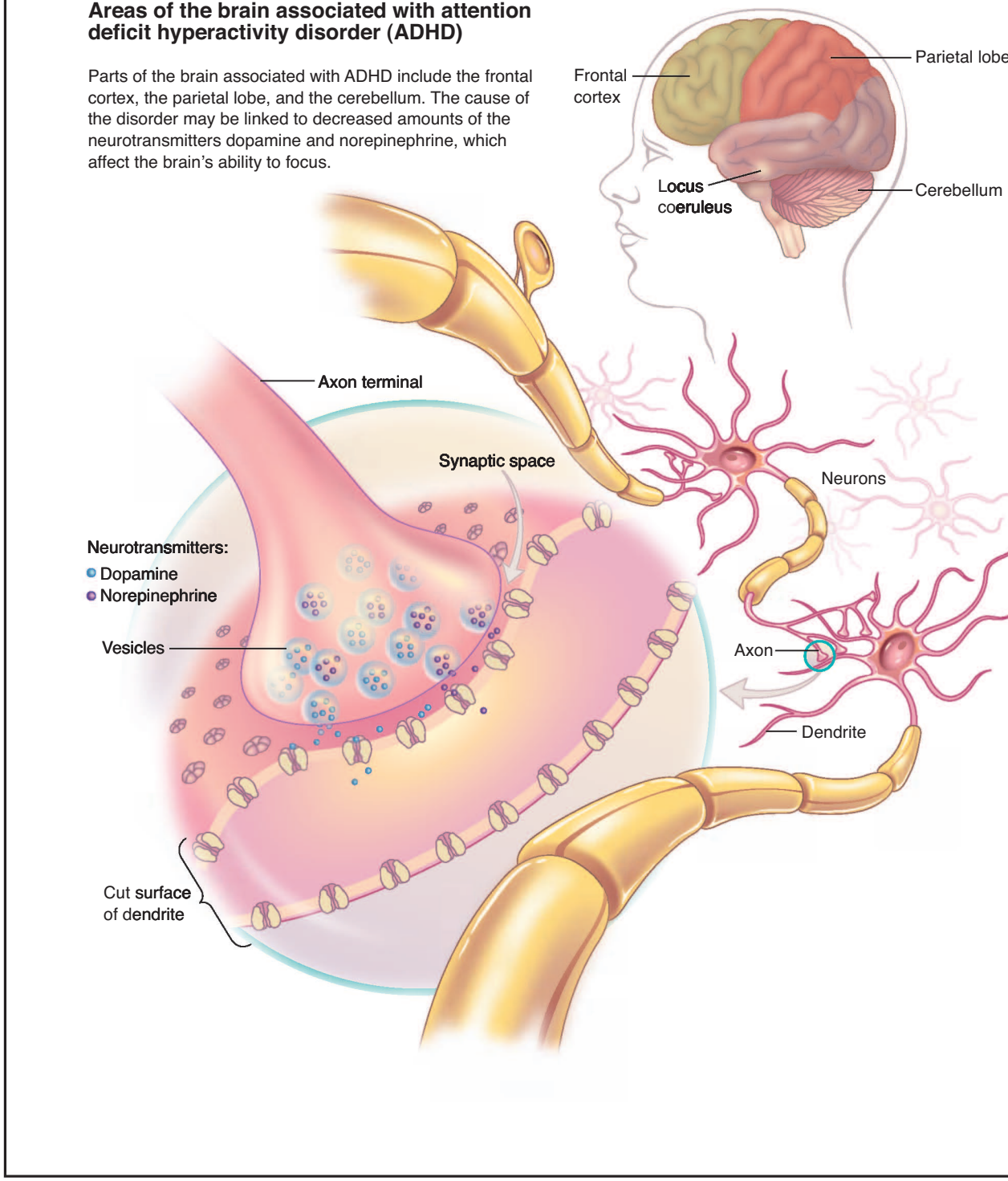
Areas of the brain associated with attention deficit hyperactivity disorder (ADHD)

Parts of the brain associated with ADHD include the frontal cortex, the parietal lobe, and the cerebellum. The cause of the disorder may be linked to decreased amounts of the neurotransmitters dopamine and norepinephrine, which affect the brain's ability to focus.



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Drugs used to treat ADHD

Brand name (generic name)	Possible side effects
Adderall (amphetamine and dextroamphetamine)	Dizziness, loss of appetite, nervousness, restlessness
Dexedrine (dextroamphetamine sulfate)	Excessive stimulation, restlessness
Ritalin (methylphenidate hydrochloride)	Insomnia, loss of appetite, nervousness

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sometimes is referred to as attention deficit disorder (ADD).

- combined hyperactive and inattentive. This combines an inappropriately high activity level with a high level of distractibility.

Causes and symptoms

Although the exact causes of ADHD are not known, it is clear that specific parts of the brain are involved including the frontal cortex, parietal lobe, and possibly the cerebellum. Functional magnetic resonance imaging (fMRI) studies comparing the brains of children with ADHD and those without the disorder show that children with ADHD have weaker brain activation of the frontal area when responding to tasks that require inhibition. Researchers believe that this is related to an imbalance in certain neurotransmitters (the chemicals in the brain that carry messages between nerve cells). Deficits in the neurotransmitters dopamine and norepinephrine are strongly suggested. One characteristic of drugs used to treat ADHD is that they make dopamine and/or norepinephrine more available in the brain. ADHD also appears to have a hereditary component. Children with a parent or sibling with ADHD are 2–8 times more likely to develop the disorder. Scientists have suggested at least 20 genes that may make a person more vulnerable to ADHD or contribute to the disorder in some way.

A widely publicized study conducted by Dr. Ben Feingold in the early 1970s suggested that **allergies** to certain foods and food additives caused the characteristic hyperactivity of ADHD children. Although some children may have adverse reactions to certain foods that can affect their behavior (for example, a rash might temporarily cause a child to be distracted from other tasks), carefully controlled follow-up studies have uncovered no link between **food allergies** and ADHD. Another popularly held misconception about food and ADHD is that the consumption of sugar causes hyperactive behavior. Again, studies have shown no link between sugar intake and ADHD. It is important to note, however, that a nutritionally balanced diet is important for normal development in all children.

Children with ADHD have short attention spans, becoming easily distracted or frustrated with tasks. Although they may be quite intelligent, their lack of focus frequently results in poor grades and difficulties in school. ADHD children act impulsively, taking action first and thinking later. They are constantly moving, running, climbing, squirming, and fidgeting, but often have trouble with motor skills and, as a result, may be physically clumsy and awkward. Their clumsiness may extend to the social arena, where they are sometimes shunned due to their impulsive and intrusive behavior.

Diagnosis

There is no single test for ADHD. Psychiatrists and other mental health professionals use the criteria listed in the *DSM-IV-TR* as a guideline for determining the presence of the disorder. A diagnosis of ADHD requires the presence of at least six of the following symptoms of inattention or six or more symptoms of hyperactivity and impulsivity combined. These symptoms must occur before age 7, be present in at least two different environments (e.g., home and school) for at least 6 months, and not be attributable to any other developmental or mental health disorder.

Inattention:

- Often fails to pay close attention to detail or makes careless mistakes in schoolwork or other activities
- Often has difficulty sustaining attention in tasks or activities
- Often does not appear to listen when spoken to
- Often does not follow through on instructions and does not finish tasks
- Often has difficulty organizing tasks and activities
- Often avoids or dislikes tasks that require sustained mental effort (e.g., homework)
- Often loses things necessary for tasks (e.g., books, tools).
- Often is easily distracted
- Often is forgetful in daily activities

Hyperactivity:

- Fidgets with hands or feet or squirms in seat
- Does not remain seated when expected to

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KEY TERMS

Conduct disorder—A behavioral and emotional disorder of childhood and adolescence. Children with a conduct disorder act inappropriately, infringe on the rights of others, and violate societal norms.

Dopamine—A neurotransmitter and the precursor of norepinephrine.

Nervous tic—A repetitive, involuntary action, such as the twitching of a muscle or repeated blinking.

Neurotransmitter—One of a group of chemicals secreted by a nerve cell (neuron) to carry a chemical message to another nerve cell, often as a way of transmitting a nerve impulse. Examples of neurotransmitters include acetylcholine, dopamine, serotonin, and norepinephrine.

Norepinephrine—A hormone released by nerve cells and the adrenal medulla that causes constriction of blood vessels. Norepinephrine also functions as a neurotransmitter.

Oppositional defiant disorder—A disorder characterized by hostile, deliberately argumentative, and defiant behavior toward authority figures.

- Runs or climbs excessively when inappropriate (in adolescents and adults, feelings of restlessness)
- Has difficulty playing quietly

Impulsivity:

- Blurts out answers before the question has been completed
- Has difficulty waiting (e.g., to take turns, to stand in line)
- Interrupts and/or intrudes on others

The first step in determining if a child has ADHD is to consult with a pediatrician. The pediatrician can make an initial evaluation of the child's developmental maturity compared to other children in his or her age group. The physician also can perform a comprehensive **physical examination** to rule out any organic causes of ADHD symptoms, such as an overactive thyroid, vision problems, or hearing problems.

If no organic problem is found, a psychologist, psychiatrist, neurologist, neuropsychologist, or learning specialist typically is consulted to perform a comprehensive ADHD assessment. A complete medical, family, social, psychiatric, and educational history is compiled from existing medical and school records and from interviews with parents and teachers. Interviews may also be conducted with the child, depending on his or her age. Along with these interviews, several clinical inventories may also be used, such as the Conners Rating Scales (Teacher's Questionnaire and Parent's Questionnaire), Child Behavior Checklist (CBCL), and the Barkley Home Situation Questionnaire. These inventories provide valuable information on the child's behavior in different settings and situations. In addition, the Wender Utah Rating Scale has been adapted for use in diagnosing ADHD in adults. Continuous Performance Tests, which involve tasks performed on a computer, may support a diagnosis of attention deficit type ADHD but by themselves are not diagnostic.

As many as 50–60% of people diagnosed with ADHD also meet the diagnostic criteria for another major psychiatric disorder such as **anxiety disorders**, depression, antisocial personality disorder, **substance abuse** disorder, or **conduct disorder**. These individuals also have a high likelihood of having a learning disorder. A complete and comprehensive psychiatric assessment is critical to differentiate ADHD from other mood and behavioral disorders.

In the United States, public schools are required by federal law to offer free ADHD testing upon request. A pediatrician also can provide a referral to a psychologist or pediatric psychiatrist for ADHD assessment. Parents should check with their insurance plans to see if these services are covered.

Treatment

The use of stimulant drugs has proved to be the most effective treatment for ADHD. These drugs generally increase the availability of neurotransmitters in the brain. Drug therapy must be highly individualized with the benefits balanced against the risk of undesirable side effects. Dextroamphetamine (Dexedrine), dextroamphetamine/amphetamine mixture (Adderall), methylphenidate (Ritalin, Metadate), and dexmethylphenidate (Focalin) are common stimulant drug treatments. These drugs are available in both immediate release and extended release forms. Atomoxetine (Strattera) is a nonstimulant norepinephrine reuptake inhibitor. Its effect is to make the norepinephrine the brain produces remain in the brain longer, thus increasing the amount of norepinephrine available.

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The use of pemoline (Cylert) to treat ADHD was stopped in 2005 because the United States Food and Drug Administration (FDA) ruled that the risk of liver damage outweigh the benefits of this drug.

Stimulant drugs may have adverse side effects in some children and that may make them inappropriate choices. These side effects include loss of appetite, **insomnia**, mood disturbance, **headache**, and gastrointestinal distress. Tics may also appear and should be monitored carefully. Psychotic reactions are among the more severe side effects. There is some evidence that long-term use of stimulant medication may interfere with physical growth and weight gain. Some experts feel that these effects are ameliorated by "medication breaks" over school vacations or weekends. Increasingly, there is concern about use of long-term stimulant medications in very young children.

In the past children who did not respond well to stimulant therapy often were given **tricyclic antidepressants** such as desipramine (Norpramin, Pertofane) and imipramine (Tofranil). By 2009, these drugs were rarely used because they have a much higher risk of causing serious side effects including and cardiac arrhythmia (irregular heartbeat that can be life threatening). Other medications prescribed for ADHD therapy include buproprion (Wellbutrin) and venlafaxine (Effexor), both atypical, non-tricyclic antidepressants. Clonidine (Catapres) and guanfacine (Tenex), both systemic antihypertensive (blood pressure lowering) medications, also have been used to control aggression and hyperactivity in some ADHD children, although these drugs can have serious side effects if taken with methylphenidate (Ritalin). A child's response to medication will change with age and maturation, so ADHD symptoms should be monitored and prescriptions adjusted accordingly.

It is important that drug treatment be carefully monitored and not be used exclusively in the management of ADHD. Behavior modification is often used in conjunction with drug therapy. Behavior modification uses a reward system to reinforce good behavior and task completion and can be implemented both in the classroom and at home. A tangible reward such as a sticker may be given to the child every time he or she completes a task or behaves in an acceptable manner. A chart system may be used to display the stickers and visually illustrate the child's progress. When a certain number of stickers are collected, the child may trade them in for a bigger reward such as a trip to the zoo or a day at the beach. The reward system stays in place until the good behavior becomes ingrained.

A variation of this technique, **cognitive-behavioral therapy**, works to decrease impulsive behavior by getting the child to recognize the connection between thoughts and behavior. Behavior is changed by changing negative thinking patterns.

Individual **psychotherapy** may help ADHD children build self-esteem, give them a place to discuss their worries and anxieties, and help them gain insight into their behavior and feelings. **Family therapy** also may be beneficial in helping family members develop coping skills and in working through feelings of guilt or anger parents may be experiencing.

Alternative treatment

A number of alternative treatments exist for ADHD. Although there is a lack of controlled studies to prove their efficacy, proponents report that they are successful in controlling symptoms in some ADHD patients. Nevertheless, none of these treatments meet the standards of safety and effectiveness required by conventional medicine. Some of the more popular alternative treatments include:

- EEG (electroencephalograph) biofeedback. By measuring brainwave activity and teaching the ADHD patient which type of brainwave is associated with attention, EEG biofeedback attempts to train patients to generate the desired brainwave activity.
- Dietary therapy. Based in part on the Feingold food allergy diet, dietary therapy focuses on a nutritional plan that is high in protein and complex carbohydrates and free of white sugar and salicylate-containing foods such as strawberries, tomatoes, and grapes.
- Herbal therapy. Herbal therapy uses a variety of natural remedies to address the symptoms of ADHD, such as ginkgo (*Gingko biloba*) for memory and mental sharpness and chamomile (*Matricaria recutita*) extract for calming. The safety of herbal remedies has not been demonstrated in controlled studies. For example, it is known that gingko may affect blood coagulation, but controlled studies have not yet evaluated the risk of the effect.
- Homeopathic medicine. The theory of homeopathic medicine is to treat the whole person at a core level. Constitutional homeopathic care requires consulting with a well-trained homeopath who has experience working with ADD and ADHD individuals.

Prognosis

Approximately 70–80% of ADHD patients treated with stimulant medication experience significant relief from symptoms at least in the short term. About half of all ADHD children seem to "outgrow"

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symptoms of the disorder in adolescence or early adulthood; the other half retain some or all symptoms of ADHD as adults. Some children diagnosed with ADHD also develop a conduct disorder. For those adolescents who have both ADHD and a conduct disorder, as many as 25% go on to develop antisocial personality disorder and the criminal behavior, substance **abuse**, and high rate of **suicide** attempts that frequently accompany this psychiatric disorder.

Untreated, ADHD negatively affects a child's social and educational performance and can seriously damage his or her sense of self-esteem. ADHD children have impaired relationships with their peers, and may be looked upon as social outcasts. They may be perceived as slow learners or troublemakers in the classroom. Siblings and even parents may develop resentful feelings towards the ADHD child.

Each child should have an individual educational plan that outlines modifications to the regular mode of instruction that will facilitate the child's academic performance. Teachers need to consider the needs of the ADHD child when giving instructions, making sure that they are well paced with cues to remind the child of each one. They must also understand the origins of impulsive behavior—that the child is not deliberately trying to ruin a lesson or activity by acting unruly. Teachers should be structured, comfortable with the remedial services the child may need, and able to maintain good lines of communication with the parent.

Specialists should devise a series of compensatory strategies that will enable the child to cope with his or her attentional or activity challenges. These strategies might include simple things like checklists of things to do before handing in assignments (name on top, check spelling, etc.), putting a clock on the child's desk to help structure time for activities, or covering the pictures on a page until the child has read the words so that he is not distracted.

Special assistance may not be limited to educational settings. Families frequently need help in coping with the demands and challenges of the ADHD child. Inattention, shifting activities every five minutes, difficulty completing homework and household tasks, losing things, interrupting, not listening, breaking rules, constant talking, boredom, and irritability can take a toll on any family.

Parents may not understand how attention regulation or impulsivity affect daily functioning, and they might not be trained in the kind of techniques that help ADHD children manage their behavior. Siblings may be resentful of what the ADHD child seems to "get away with" or the inordinate amount of attention he or she receives. The ADHD child may be resentful of the younger sibling who is more accomplished at school or never seems to get in any trouble. Family interaction patterns may set up vicious cycles that become destructive and difficult to break.

Support groups for families with any ADHD member are increasingly available through school districts and health care providers. Community colleges frequently offer courses in discipline and behavior management. Counseling services are available to complement any type of pharmacological treatment that the family obtains for its member. There are also a number of popular books that are informative and helpful. Some of these are listed below.

Resources

BOOKS

Alexander-Roberts, Colleen. *The AD/HD Parenting Handbook: Practical Advice for Parents From Parents, 2nd ed.* Lanham: Taylor Trade Pub., 2006.

Brynie, Faith Hickman. *ADHD: Attention-Deficit Hyperactivity Disorder*. Minneapolis: Twenty-First Century Books, 2008.

Conners, Keith, C. *Attention Deficit Hyperactivity Disorder in Children and Adolescents: The Latest Assessment and Treatment Strategies,* 4th ed. Kansas City, MO: Compact Clinicals, 2008.

McBurnett, Keith, and Linda Pfiffner, eds. *Attention Deficit Hyperactivity Disorder: Concepts, Controversies, New Directions*. New York: Informa Healthcare, 2008.

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"Attention Deficit Hyperactivity Disorder." *National Institute of Mental Health*. January 9, 2009 [cited November 20, 2009]. http://www.nimh.nih.gov/health/publications/adhd/summary.shtml.

Soreff, Stephen and Kiki D. Chang. "Attention Deficit Hyperactivity Disorder." *eMedicine.com*. August 12, 2008 [cited November 20, 2009]. http://emedicine.medscape.com/article/289350-overview.

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ORGANIZATIONS

Attention Deficit Disorder Association (ADDA), P.O. Box 7557, Wilmington, DE, 19803-9997, (800) 939-1019, adda@jmoadmin.com, http://www.add.org.

Children and Adults with Attention Deficit Disorder (CHADD), 8181 Professional Place, Suite 150, Landover, MD, 20785, (301) 306-7070, (800) 233-4050, Conference@chadd.org, http://www.chadd.org.

Tish Davidson AM
Teresa G. Odle
Laura Jean Cataldo RN, Ed.D.

Attention deficit disorder *see* **Attention deficit hyperactivity disorder (ADHD)**

Atypical mycobacterial infections *see* **Mycobacterial infections, atypical**

Atypical pneumonia *see* **Mycoplasma infections**

Audiometry

Definition

Audiometry is the testing of a person's ability to hear various sound frequencies. The test is performed with the use of electronic equipment called an audiometer. This testing is usually administered by a trained technician called an audiologist.

Purpose

Audiometry testing is used to identify and diagnose **hearing loss**. The equipment is used in health screening programs, for example in grade schools, to detect hearing problems in children. It is also used in the doctor's office or hospital audiology department to diagnose hearing problems in children, adults, and the elderly. With correct diagnosis of a person's specific pattern of hearing impairment, the right type of therapy, which might include **hearing aids**, corrective surgery, or **speech therapy**, can be prescribed.

An audiologist conducts a hearing test on a young girl. *(© iStockPhoto/Barbara Sauder.)*

Precautions

Testing with audiometry equipment is simple and painless. No special precautions are required.

Description

A trained audiologist (a specialist in detecting hearing loss) uses an audiometer to conduct audiometry testing. This equipment emits sounds or tones, like musical notes, at various frequencies, or pitches, and at differing volumes or levels of loudness. Testing is usually done in a soundproof testing room.

The person being tested wears a set of headphones that blocks out other distracting sounds and delivers a test tone to one ear at a time. At the sound of a tone, the patient holds up a hand or finger to indicate that the sound is detected. The audiologist lowers the volume and repeats the sound until the patient can no longer detect it. This process is repeated over a wide range of tones or frequencies from very deep, low sounds, like the lowest note played on a tuba, to very high sounds, like the pinging of a triangle. Each ear is tested separately. It is not unusual for levels of sensitivity to sound to differ from one ear to the other.

A second type of audiometry testing uses a headband rather than headphones. The headband is worn with small plastic rectangles that fit behind the ears to conduct sound through the bones of the skull. The patient being tested senses the tones that are transmitted as vibrations through the bones to the inner ear. As with the headphones, the tones are repeated at various frequencies and volumes.

The results of the audiometry test may be recorded on a grid or graph called an audiogram. This graph is generally set up with low frequencies or tones at one end and high ones at the other end, much like a piano keyboard. Low notes are graphed on the left and high notes on the right. The graph also charts the volume of the tones used; from soft, quiet sounds at the top of the chart to loud sounds at the bottom. Hearing is measured in units called decibels. Most of the sounds associated with normal speech patterns are generally spoken in the range of 20-50 decibels. An

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KEY TERMS

Audiogram—A chart or graph of the results of a hearing test conducted with audiographic equipment. The chart reflects the softest (lowest volume) sounds that can be heard at various frequencies or pitches.

Decibel—A unit of measure for expressing the loudness of a sound. Normal speech is typically spoken in the range of about 20-50 decibels.

Otoscope—A hand-held instrument with a tiny light and a funnel-shaped attachment called an ear speculum, which is used to examine the ear canal and eardrum.

adult with normal hearing can detect tones between 0-20 decibels.

Speech audiometry is another type of testing that uses a series of simple recorded words spoken at various volumes into headphones worn by the patient being tested. The patient repeats each word back to the audiologist as it is heard. An adult with normal hearing will be able to recognize and repeat 90-100% of the words.

Preparation

The ears may be examined with an otoscope prior to audiometry testing to determine if there are any blockages in the ear canal due to ear wax or other material.

Normal results

A person with normal hearing will be able to recognize and respond to all of the tone frequencies administered at various volumes in both ears by the audiometry test. An adult with normal hearing can detect a range of low and high pitched sounds that are played as softly as between nearly 0-20 decibels. Normal speech is generally spoken in the range of 20-50 decibels.

Abnormal results

Audiometry test results are considered abnormal if there is a significant or unexplained difference between the levels of sound heard between the two ears, or if the person being tested is unable to hear in the normal range of frequencies and volume. The pattern of responses displayed on the audiogram can be used by the audiologist to identify if a significant hearing loss is present and if the patient might benefit from hearing aids or corrective surgery.

Resources

OTHER

"How to Read Your Hearing Test." *Hearing Alliance of America*. http://www.earinfo.com.

"Understanding Your Audiogram." *The League for the Hard of Hearing*. http://www.lhh.org.

ORGANIZATIONS

American Academy of Audiology, 11730 Plaza America Drive, Suite 300, Reston, VA, 20190, (703) 790-8631, (800) 222-2336, http://www.audiology.org/.

Audiology Awareness Campaign, 1 Windsor Cove, Suite 305 , Columbia, SC, 29223, (803) 765-0680, (800) 445-8629, info@audiologyawareness.com, http://www.audiologyawareness.com.

Altha Roberts Edgren

Auditory integration training

Definition

Auditory integration training, or AIT, is one specific type of music/auditory therapy based upon the work of French otolaryngologists Dr. Alfred Tomatis and Dr. Guy Berard.

Origins

The premise upon which most auditory integration programs are based is that distortion in how things are heard contributes to commonly seen behavioral or **learning disorders** in children. Some of these disorders include attention deficit/hyperactive disorder (**ADHD**), **autism**, **dyslexia**, and central auditory processing disorders (CAPD). Training the patient to listen can stimulate central and cortical organization.

Auditory integration is one facet of what audiologists call central auditory processing. The simplest definition of central auditory processing, or CAP, is University of Buffalo Professor of Audiology Jack Katz's, which is: "What we do with what we hear." Central auditory integration is actually the perception of sound, including the ability to attend to sound, to remember it, retaining it in both the long- and short-term memory, to be able to listen to sound selectively, and to localize it.

Guy Berard developed one of the programs commonly used. Berard's auditory integration training consists of twenty half-hour sessions spent listening

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to musical sounds via a stereophonic system. The music is random, with filtered frequencies, and the person listens through earphones. These sound waves vibrate and exercise structures in the middle ear. This is normally done in sessions twice a day for 10 days.

Alfred Tomatis is also the inventor of the Electronic Ear. This device operates through a series of filters, and reestablishes the dominance of the right ear in hearing. The basis of Tomatis' work is a series of principles that follow:

- The most important purpose of the ear is to adapt sound waves into signals that charge the brain.
- Sound is conducted via both air and bone. It can be considered something that nourishes the nervous system, either stimulating or destimulating it.
- Just as seeing is not the same as looking, hearing is not the same as listening. Hearing is passive. Listening is active.
- A person's ability to listen affects all language development for that person. This process influences every aspect of self-image and social development.
- The capacity to listen can be changed or improved through auditory stimulation using musical and vocal sounds at high frequencies.
- Communication begins in the womb. As early as the beginning of the second trimester, fetuses can hear sounds. These sounds literally cause the brain and nervous system of the baby to develop.

Description

A quartet of CAP defects have been identified that can unfavorably alter how each person processes sound. Among these are:

- Phonetic decoding, a problem that occurs when the brain incorrectly decodes what is being heard. Sounds are unrecognizable, often because the person speaking talks too fast.
- Tolerance-fading memory, a condition with little or poor tolerance for background sounds.
- Auditory integration involves a person's ability to put together things heard with things seen. Characteristically there are long response delays and trouble with phonics, or recognizing the symbols for sounds.
- The fourth problem area, often called auditory organization, overlaps the previous three. It is characterized by disorganization in handling auditory and other information.

Certain audiological tests are carried out to see if the person has a CAP problem, and if so, how severe it is. Other tests give more specific information regarding the nature of the CAP problem. They include:

- Puretone air-conduction threshold testing, which measures peripheral hearing loss. If loss is found, then bone-conduction testing, or evaluation of the vibration of small bones in the inner ear, is also carried out.
- Word discrimination scores (WDS) determines a person's clarity in hearing ideal speech. This is done by presenting 25–50 words at 40 decibels above the person's average sound threshold in each ear. Test scores equal the percentage of words heard correctly.
- Immittance testing is made up of two parts, assessing the status of, and the protective mechanisms of the middle ear.
- Staggered sporadic word (SSW) testing delivers 40 compound words in an overlapping way at 50 decibels above threshold to each ear of the person being

ALFRED TOMATIS (1920–2001)

Internationally renowned French otolaryngologist, psychologist, educator and inventor Alfred Tomatis perceived the importance of sound and hearing early in his career. He took his degree as a Doctor of Medicine from the University of Paris and specialized in ear, nose and throat medicine. The son of two opera singers, Tomatis early in his career treated some of his parents' fellow opera singers. From these experiences with the sound of music, he developed the principle that has come to be known as the Tomatis Effect, i.e. that the human voice can only sing what it hears.

Tomatis has been called the Einstein of the ear. It was his research that made the world aware that the ears of an infant in utero are already functioning at four and half months of age. Just as the umbilical cord provides nourishment to the unborn infant's body, Tomatis postulated that the sound of the mother's voice is also a nutrient heard by the fetus. This sound literally charges and stimulates the growth of the brain.

Tomatis took this further, into the realm of language. Tomatis concluded that the need to communicate and to be understood are among our most basic needs. He was a pioneer in perceiving that language problems convert into social problems for people. "Language is what characterizes man and makes him different from other creatures," Tomatis is quoted as saying. The techniques he developed to teach people how to listen effectively are internationally respected tools used in the treatment of autism, attention-deficit disorder, and other learning disabilities.

His listening program, the invention of the Electronic Ear, and his work with the therapeutic use of sound and music for the past fifty years have made Tomatis arguably the best known and most successful ear specialist in the world. There are more than two hundred Tomatis Centers worldwide, treating a vast variety of problems related to the ability to hear. Tomatis died in December of 2001.

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tested. This test provides expanded information that makes it possible to break down CAP problems into the four basic types.

- Speech in noise discrimination (SN) testing is similar to Staggered Sporadic Word testing except that other noise is also added and the percentage correct in quiet is compared with that correct when there is added noise.
- Phonemic synthesis (PS) determines serious learning problems. The types of errors made in sounding out written words or associating written letters with the sounds they represent help in determining the type and severity of CAP problems.

Purpose

Upon completion of an auditory integration training program, the person's hearing should be capable of perceiving all frequencies at, or near, the same level. Total improvement from this therapy, in both hearing and behavior, can take up to one year.

Research and general acceptance

Auditory integration training is based upon newly learned information about the brain. Though brain structures and connections are predetermined, probably by heredity, another factor called *plasticity* also comes into play. Learning, we now know, continues from birth to **death**. Plasticity is the ability of the brain to actually change its structuring and connections through the process of learning.

Problems with auditory processing are now viewed as having a wide–reaching ripple effect on our society. It is estimated that 30–40% of children starting school have language-learning skills that can be described as poor. CAP difficulties are a factor in several different learning disabilities. They affect not only academic success, but also nearly every aspect of societal difficulties. One example to illustrate this is a 1989 University of Buffalo study where CAP problems were found to be present in a surprising 97% of youth inmates in an upstate New York corrections facility.

Resources

OTHER

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Joan Schonbeck

Australia antigen-associated hepatitis *see* **Hepatitis B**

Autism

Definition

Autism is a complex developmental disorder distinguished by difficulties with social interaction, verbal and nonverbal communication, and behavioral problems, including repetitive behaviors and narrow focus of interest.

Demographics

Estimates suggest that about 1 of every 110 children in the United States are affected by autism. Autism is almost four times more likely to be diagnosed in males. Autism is a disorder that is found worldwide. In the United Kingdom, one out of every 100 children have autism, with over half a million total diagnosed in the United Kingdom as of 2007. In China, one in every 1,000 children is diagnosed with autism. In India, the rate of incidence is 1 in

An autistic student draws a picture while sitting at a table at his school. *(BURGER/PHANIE/Photo Researchers, Inc.)*

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Prevalence of Autism Spectrum Disorders

- On average, an estimated 1 in 110 children in the United States have an Autism Spectrum Disorder (ASD).
- Of the roughly 4 million babies born in the United States each year, approximately 36,500 of those children will eventually be diagnosed with an ASD. If the prevalence rate has stayed constant during the past 20 years, then 730,000 individuals between the ages of 0 to 21 born in the United States currently have an ASD.
- ASDs occur in all racial, ethnic, and socioeconomic groups, but are on average 4 to 5 times more likely to occur in boys than in girls.
- Studies in Asia, Europe, and North America have identified a prevalence of ASDs in 0.6% to more than 1% of individuals.
- Approximately 13% of children have a developmental disability, ranging from mild speech and language impairments to more severe disorders such as cerebral palsy and autism.

SOURCE: Centers for Disease Control and Prevention, "Autism Spectrum Disorders (ASDs): Data & Statistics." Available online at: http://www.cdc.gov/ncbddd/autism/data.html (accessed August 18, 2010).

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every 250 children. In Mexico, two to six in every 1,000 children are autistic. Autism is not specific to any one socio-economic, ethnic, or racial group.

Description

Classic autism is one of several disorders categorized as autism spectrum disorders (ASD). Other ASDs include **Asperger syndrome**, Rett syndrome, childhood disintegrative disorder, and pervasive developmental disorder. As of 2010, the classification of autism and autism spectrum disorders is being re-evaluated by the American Psychiatric Association for revision in the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM*). It has been proposed that Asperger syndrome be eliminated as a diagnosis and pervasive developmental disorder not otherwise specified (PPD-NOS) be classified as autism spectrum disorder. This proposal is controversial and as of 2010 remained unresolved. *DSM-V* will be published in 2012.

Autism usually manifests before a child is three years old and it continues throughout his/her lifetime. The severity of the condition varies between individuals, ranging from the most severe (extremely unusual, repetitive, self-injurious, and aggressive behavior) to very mild. No one autistic child is alike in the manifestation of their symptoms so treatment options must be devised to treat each autistic child individually. Autism cannot be cured but is treatable. With early diagnosis and intensive therapy, autistic children may be able to lead healthy, full lives.

Risk factors

There appears to be a strong genetic basis for autism. Family studies have shown that identical twins are more likely to both be diagnosed with autism than twins who are fraternal (not genetically identical). In a family with one autistic child, the chance of having another child with autism is about one in 20 or approximately 5%, much higher than in the general population.

Other risk factors associated with autism include:

- Gender. Boys are almost four times more likely to be diagnosed with autism than girls.
- Paternal age. Children born of fathers over age 40 have a greater chance of developing autism than children born to younger fathers. The age of the mother appears to have no effect on autism.
- Certain disorders and diseases. Children who have fragile X syndrome, tuberous sclerosis, Tourette syndrome, and epilepsy are more likely to have autism.

Causes and symptoms

Researchers know that autism is a complex brain disorder that affects the way the brain uses or transmits information. Studies have implicated several causes for the disorder including genetic errors and possible environmental triggers, but more investigation is needed. Studies have found abnormalities in several parts of the brain that are believed to have occurred during fetal development. The problem may be centered in the parts of the brain responsible for processing language and information from the senses.

Profound problems with social interaction are the most common symptoms of autism and the most visible. Autistic children have different ways of learning and experiencing the world around them. Often autistic children have more acute reactions to sensory stimulation such as sound and touch. This results in avoidance of eye contact, physical contact, and oftentimes an aversion to music and other sounds. It is perhaps the way autistic children experience their world that causes difficulties with social interaction, language, and nonverbal communication.

Human beings are social and social interaction is present from birth onward. Children with autism have difficulty making social connections. A developmental milestone is when an infant can follow an object or person with his/her gaze. Autistic children tend to

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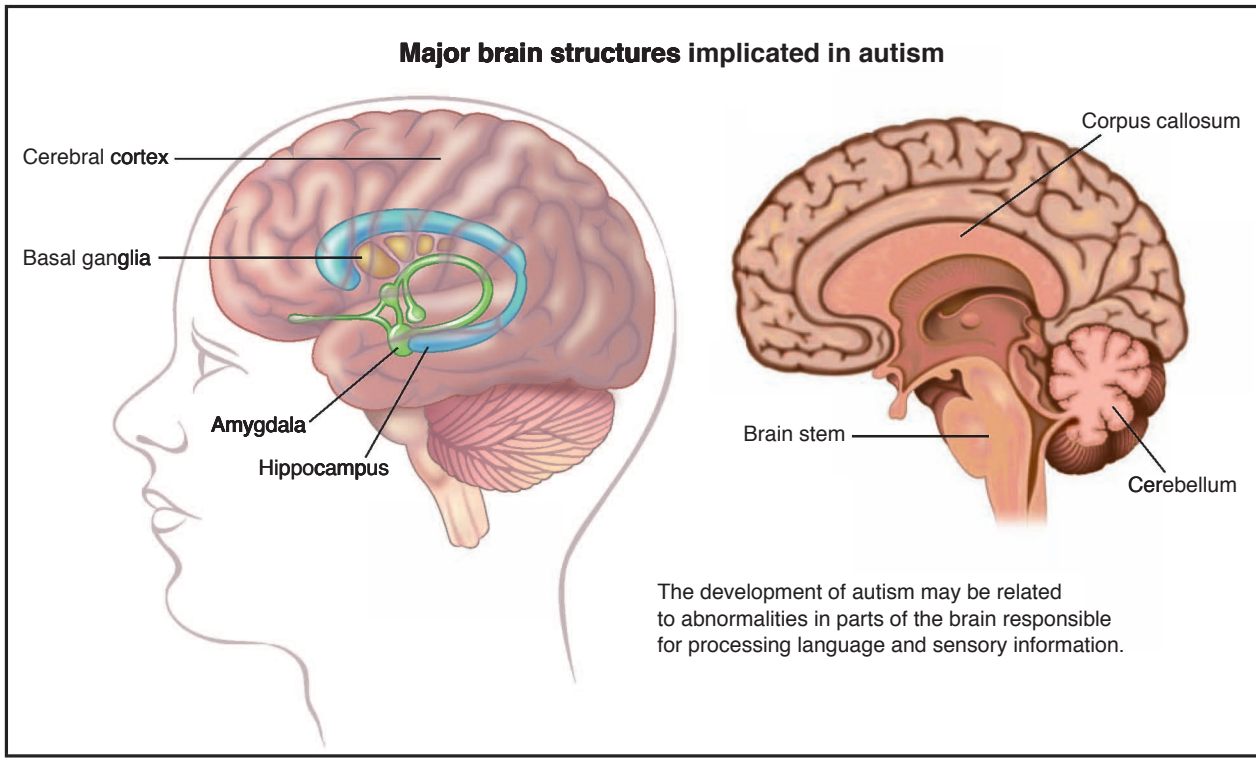

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avoid eye contact altogether. They do not actively cuddle or hug but rather they passively accept physical contact or they shy away from it. They may become rigid or flaccid when they are held, cry when picked up, and show little interest in human contact. Such a child does not lift his/her arms in anticipation of being picked up. The child may appear to have formed no attachment to his/her parents, and does not learn typical childhood games, such as "peek-a-boo."

Autistic children do not readily learn social cues. They do not know when or how to react to specific social situations or exchanges. Because of this, autistic children tend to look at and respond to different situations similarly. They do not understand that others have different perspectives and, therefore, autistic children seem to lack empathy.

Because of their problems socially and the inability to translate social interactions appropriately, autistic children seem to have uncontrolled emotional outbursts, expressing themselves in a manner that does not suit the specific social situation of the moment.

Language problems

Verbal communication problems vary greatly for autistic children. Some children do not speak at all. Some will only use one or two words at a time. Some autistic children may develop vocabulary only to lose it. Other autistic children may develop an extensive vocabulary; however, they have difficulty sustaining a natural, "back-and-forth" conversation. Autistic children tend to talk in a sing-song voice or more robotically without emotional inflections. Often autistic children do not take body language into consideration and they take what is being said quite literally. Because of their impinged language skills and the inability to express their needs, autistic children seem to act inappropriately to get what they need. They may grab something without asking or blurt out statements.

Restricted interests and activity

Language and social problems inhibit social play for autistic children. Autistic children do not engage in imaginative play and role playing. They focus on repetition, some focusing on a subject of interest very intensely.

Autistic children often stick to a rigid daily routine. Any variance to the routine may be upsetting to them and result in an extreme emotional response. Repetitive physical behaviors such as rocking, spinning, and arm flapping are also characteristic of

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KEY TERMS

Antidepressants—A type of medication that is used to treat depression; it is also sometimes used to treat autism.

Asperger syndrome—Children who have autistic behavior but no problems with language and no clinically significant cognitive delay.

Fragile X syndrome—A genetic condition related to the X chromosome that affects mental, physical and sensory development.

Major tranquilizers—The family of drugs that includes the psychotropic or neuroleptic drugs, sometimes used to help autistic people. They carry significant risk of side effects, including Parkinsonism and movement disorders, and should be prescribed with caution.

Opiate blockers—A type of drug that blocks the effects of natural opiates in the system. This makes some people, including some people with autism, appear more responsive to their environment.

Phenylketonuria (PKU)—An enzyme deficiency present at birth that disrupts metabolism and causes brain damage. This rare inherited defect may be linked to the development of autism.

Rubella—Also known as German measles. When a woman contracts rubella during pregnancy, her developing infant may be damaged. One of the problems that may result is autism.

Stimulants—A class of drugs, including Ritalin, used to treat people with autism. They may make children calmer and better able to concentrate, but they also may limit growth or have other side effects.

Tuberous sclerosis—A genetic disease that causes skin problems, seizures, and mental retardation. Autism occurs more often in individuals with tuberous sclerosis.

autism. The repetitive behaviors are often self-soothing responses to sensory stimulation from the outside world.

Sensory problems

The sensory world poses a real problem to many autistic children, who seem overwhelmed by their own senses. A child with autism may ignore objects or become obsessed with them, continually watching the object or the movement of his or her fingers over it. Some children with autism may react to sounds by banging their head or flapping their fingers. Some high-functioning autistic adults who have written books about their childhood experiences report that sounds were often excruciatingly painful to them, forcing them to withdraw from their environment or try to cope by withdrawing into their own world of sensation and movement.

Diagnosis

There is no medical test for diagnosing autism. Diagnosis is made after careful observation and screening by parents, caregivers, and physicians. Early diagnosis is beneficial in treating the symptoms of autism. Some early warning signs are:

- avoiding eye contact
- avoiding physical contact such as hugs
- inability to play make-believe
- not pointing out interesting objects
- not responding to conversation directed at him/her
- practicing excessively repetitive behaviors
- repeating words or phrases
- losing skills and/or language after learning them

Once parents feel there is a problem or their pediatrician has identified developmental problems during well-baby check-ups, they can seek out a developmental pediatrician for further diagnosis. There are several screening tests used. They are:

- Childhood Autism Rating Scale (CARS)—a test based on a 15 point scale where specific behaviors are observed by the physician.
- Checklist for Autism in Toddlers (CHAT)—a test to detect autism in 18-month olds that utilizes questionnaires filled out by both the parents and the pediatrician.
- Autism Screening Questionnaire—a 40-item questionnaire for diagnosing children four and older.
- Screening Test for Autism in Two-Year-Olds—a direct observation of three skill areas including play, motor imitation, and joint attention.

Some children have a few of the symptoms of autism, but not enough to be diagnosed with the "classical" form of the condition. Children who have autistic behavior but no problems with language may be diagnosed with Asperger syndrome by using the

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Autism Spectrum Screening Questionnaire, the Australian Scale for Asperger syndrome, or the Childhood Asperger Syndrome Test. The American Psychiatric Association may eliminate the diagnosis of Asperger syndrome in 2012. Children who have no initial symptoms but who begin to show autistic behavior as they get older might be diagnosed with childhood disintegrative disorder (CDD), another autistic spectrum disorder. It is also important to rule out other problems that seem similar to autism.

Treatment

Because the symptoms of autism can vary greatly from one person to the next, there is not a single treatment that works for every person. A spectrum of interventions including behavioral and educational training, diet and **nutrition**, alternative medicine and therapies, and medication should be utilized and fine-tuned to treat the individual. The most strongly recommended treatment option is behavioral and educational training. Early intervention and treatment is key to helping autistic children grow into productive adults.

Educational and behavioral treatment

Several educational and behavioral treatments are:

- Applied Behavior Analysis (ABA)
- speech therapy
- occupational therapy, including sensory integration therapy
- social skills therapy, including play therapy

Typically, behavioral techniques are used to help the child respond and decrease symptoms. This might include positive reinforcement to boost language and social skills. This training includes structured, skill-oriented instruction designed to improve social and language abilities. Training needs to begin as early as possible, since early intervention appears to positively influence brain development.

Most autistic children respond to intervention at home as well as at school. Schools focus on areas where the child may be delayed, such as in speech or socialization. As autistic children grow and move to different phases of childhood and adolescence, parents in collaboration with educators and physicians need to adapt the treatment to best suit the needs of their autistic child.

Medication

No single medication treats symptoms of autism; however, some medications have been used to combat specific needs in autistic children. Drugs can control **epilepsy**, which affects up to 20% of people with autism. Medication can also treat **anxiety**, depression, and hyperactivity. Medication must be individualized and adjusted as the child develops.

Five types of drugs are sometimes prescribed to help the behavior problems of people with autism are:

- stimulants, such as methylphenidate (Ritalin)
- antidepressants, such as fluvoxamine (Luvox)
- opiate blockers, such as naltrexone (ReVia)
- antipsychotics
- tranquilizers

In 2010, news of use of the drug memantine (used in Alzheimer's patients for nearly a decade in the U.S.) being used in a study conducted by Dr. Michael Amen at Ohio State University involving children with autism was reported. The wisdom is, that given their similarities (a malfunction in the brain involving a chemical called glutamate which impacts the patient's speech and interaction) the drug may help in autism, too. Most drugs for autism only focus on lessening symptoms like hyperactivity or repetitive actions. The study was designed to try and help communication, one of the core issues of autism.

Alternative treatment

Some parents report success with megavitamin therapy. Some studies have shown that vitamin B_6 with magnesium improves eye contact and speech and lessens tantrum behavior. Vitamin B_6 causes fewer side effects than other medications and is considered safe when used in appropriate doses. However, not many health practitioners advocate its use in the treatment of autism, citing that the studies showing its benefit were flawed.

DMG (dimethylglycine)

This compound, available in many health food stores, is legally classified as a food, not a vitamin or drug. Some researchers claim that it improves speech in children with autism. Those who respond to this treatment will usually do so within a week. Again, many doctors do not feel that the studies are adequate to promote this treatment.

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Diet

Many parents have seen beneficial affects from a gluten-free and casein-free diet. Gluten is a substance found in the seeds of cereal plants such as wheat, barley, oats, and rye. Casein is a protein found in milk. Often people have sensitivities to these substances without realizing it. Many foods contain these substances as an ingredient; however, there are growing numbers of gluten-free and casein-free foods available for people that would like to eliminate them from their **diets**. Parents interested in using diet as a treatment should discuss with their child's doctor how to initiate an elimination diet.

Exercise

One researcher found that vigorous **exercise** (20 minutes or longer, three or four days a week) seems to decrease hyperactivity, aggression, self-injury and other autistic symptoms.

Prognosis

Autism is treatable but not curable. With appropriate treatments adjusted to suit the autistic child as he/she grows up, the symptoms of autism improve. Today, parents and caregivers are focused on providing the best therapies possible in order for autistic children to develop to their highest potential. Because the incidence of autism seems to be increasing at a rapid rate worldwide, enough so that the CDC has voiced concern about its prevalence, there is more awareness of autism and more ongoing research efforts. People with autism have a normal life expectancy and with proper intervention they can lead full lives.

Prevention

Until the cause of autism is discovered, prevention is not possible.

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ORGANIZATIONS

Autism Research Institute/Autism Resource Center, 4182 Adams Avenue, San Diego, CA, 92116 English: (866) 366-3361; Spanish: (877) 644-1184 ext. 5 (619) 563-6840, http://www.autism.com.

Autism Society of America, 4340 East-West Hwy, Suite 350, Bethesda, MD (301) 657-0881 (800) 3-AUTISM [(800) 328-8476], http://www.autismsource.org.

Autism Speaks, 2 Park Avenue, 11th Floor, New York, NY, 10016 (212) 252-8584 (212) 252-8676, contactus@autismspeaks.org, http://www.autismspeaks.org.

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Autograft *see* **Skin grafting**

Autoimmune disorders

Definition

Autoimmune disorders are conditions in which a person's immune system attacks the body's own cells, causing tissue destruction.

Description

Autoimmunity is accepted as the cause of a wide range of disorders, and it is suspected to be responsible for many more. Autoimmune diseases are classified as either general (systemic), in which the autoimmune reaction takes place simultaneously in a number of tissues, or organ specific, in which the autoimmune reaction targets a single organ. According to the American Autoimmune Related Diseases Association, 50 million Americans have an autoimmune disease. Individuals may, and often do, have more than one autoimmune disorder. Autoimmune diseases are more common in women than in men.

Autoimmune disorders include the following:

- Systemic lupus erythematosus. A general autoimmune disease is one in which antibodies attack a number of different tissues. The disease recurs

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KEY TERMS

Antibody—A protein normally produced by the immune system to fight infection or rid the body of foreign material. The material that stimulates the production of antibodies is called an antigen. Specific antibodies are produced in response to each different antigen and can only inactivate that particular antigen.

Paresthesia— A prickly, tingling, or burning sensation on the skin.

periodically and is seen mainly in young and middle-aged women.

- Rheumatoid arthritis. Occurs when the immune system attacks and destroys the tissues that line bone joints and cartilage. The disease occurs throughout the body, although some joints may be more affected than others.
- Goodpasture's syndrome. Occurs when antibodies are deposited in the membranes of both the lung and kidneys, causing both inflammation of kidney glomerulus (glomerulonephritis) and lung bleeding. It is typically a disease of young males.
- Grave's disease. Caused by an antibody that binds to specific cells in the thyroid gland, causing them to produce excessive amounts of thyroid hormone.
- Hashimoto's thyroiditis. Caused by an antibody that binds to cells in the thyroid gland. Unlike in Grave's disease, however, this antibody's action results in less thyroid hormone being producing.
- Pemphigus vulgaris. A group of autoimmune disorders that affect the skin.
- Myasthenia gravis. A condition in which the immune system attacks a receptor on the surface of muscle cells, preventing the muscle from receiving nerve impulses and resulting in severe muscle weakness.
- Scleroderma. Also called CREST syndrome or progressive systemic sclerosis, scleroderma affects the connective tissue.
- Autoimmune hemolytic anemia. Occurs when the body produces antibodies that target red blood cells.
- Autoimmune thrombocytopenic purpura. Disorder in which the immune system targets and destroys blood platelets.
- Polymyositis and dermatomyositis. Immune disorders that affect the neuromuscular system.
- Pernicious anemia. Disorder in which the immune system attacks the lining of the stomach in such a way that the body cannot metabolize vitamin B_{12}.
- Sjögren's syndrome. Occurs when the exocrine glands are attacked by the immune system, resulting in excessive dryness.
- Ankylosing spondylitis. Immune system induced degeneration of the joints and soft tissue of the spine.
- Vasculitis. A group of autoimmune disorders in which the immune system attacks and destroys blood vessels.
- Type I diabetes mellitus. Appears to be caused by an antibody that attacks and destroys the islet cells of the pancreas, which produce insulin.
- Amyotrophic lateral sclerosis. Also called Lou Gehrig's disease. An immune disorder that causes the death of neurons, which leads to progressive loss of muscular control.
- Guillain-Barre syndrome. Also called infectious polyneuritis. A rare disorder that sometimes occurs after an infection or an immunization, Guillain-Barre syndrome affects the myelin sheath that covers nerve cells. It causes progressive muscle weakness and paralysis.
- Multiple sclerosis. An autoimmune disorder that may involve a virus, it affects the central nervous system, causing loss of coordination and muscle control.
- Celiac disease (sprue). A disease in which the body's reaction to gluten (most commonly found in wheat) causes damage to the intestines that results in poor absorption of nutrients.

Causes and symptoms

To further understand autoimmune disorders, it is helpful to understand the workings of the immune system. The purpose of the immune system is to defend the body against attack by infectious microbes (e.g., bacteria, viruses, fungi) and foreign materials (e.g., chemicals, poisons). When the immune system attacks a foreign invader, it is very specific—a particular immune system cell will only recognize and target one type of invader. To function properly, the immune system must not only develop this specialized knowledge of individual invaders, but it must also learn how to recognize and not destroy cells that belong to the body itself.

Every cell carries protein markers on its surface that identify it in one of two ways: what kind of cell it is (e.g. nerve cell, muscle cell, blood cell, etc.) and to whom that cell belongs. These markers are called major histocompatability complexes (MHCs). When

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functioning properly, cells of the immune system will not attack any cell with markers identifying it as belonging to the body. Conversely, if the immune system cells do not recognize a cell as "self," they attach themselves to it and put out a signal that the body has been invaded. This in turn stimulates the production of substances such as antibodies that disable and destroy the foreign particles. In case of autoimmune disorders, the immune system cannot distinguish between "self" cells and invader cells. As a result, the same destructive operation is carried out on the body's own cells that would normally be carried out on bacteria, viruses, and other such harmful foreign material.

The reasons why immune systems become dysfunctional and fail to recognize the body's own cells is not well understood. However, most researchers agree that a combination of genetic susceptibility, environmental, and hormonal factors play a role in developing autoimmunity. Researchers also hypothesize that autoimmunity may be triggered by several different mechanisms as follows:

- A substance that is normally sequestered in one part of the body, and therefore not usually exposed to the immune system, is released into the bloodstream where it is attacked.
- The immune system may mistake a component of the body for a similar foreign component.
- Cells of the body may be altered in some way, either by drugs, infection, or other environmental factors, so that they are no longer recognizable as "self" to the immune system.
- The immune system itself may be damaged, such as by a genetic mutation, and therefore becomes dysfunctional.

The symptoms of autoimmune disorders vary. See specific disorder topics for more complete information. A short summary of symptoms is as follows: include:

- Systemic lupus erythematosus. Symptoms include fever, chills, fatigue, weight loss, skin rashes (particularly the classic "butterfly" rash on the face), vasculitis, polyarthralgia, patchy hair loss, sores in the mouth or nose, lymph-node enlargement, gastric problems, and, in women, irregular periods. About half of those who experience lupus develop cardiopulmonary problems, and some may develop urinary problems. Lupus can also effect the central nervous system, causing seizures, depression, and psychosis.
- Rheumatoid arthritis. Initially this disorder may be characterized by a low-grade fever, loss of appetite, weight loss, and generalized pain in the joints. The joint pain then becomes more specific, usually beginning in the fingers, then spreading to other areas, such as the wrists, elbows, knees, and ankles. As the disease progresses, joint function diminishes sharply and deformities occur, particularly the characteristic "swan's neck" curling of the fingers.
- Goodpasture's syndrome. Symptoms are similar to that of iron deficiency anemia, including fatigue and pallor. Symptoms involving the lungs may range from a cough that produces bloody sputum to outright hemorrhaging. Symptoms involving the urinary system include blood in the urine and/or swelling.
- Grave's disease. This disease is characterized by an enlarged thyroid gland, weight loss without loss of appetite, sweating, heart palpitations, nervousness, and an inability to tolerate heat.
- Hashimoto's thyroiditis. This disorder generally displays few symptoms.
- Pemphigus vulgaris. This disease is characterized by blisters and deep lesions on the skin.
- Myasthenia gravis. Characterized by fatigue and muscle weakness that at first may be confined to certain muscle groups, but then may progress to the point of paralysis, myasthenia gravis patients often have expressionless faces as well as difficulty chewing and swallowing. If the disease progresses to the respiratory system, artificial respiration may be required.
- Scleroderma. This disorder usually is preceded by Raynaud's phenomenon. Symptoms that follow include pain, swelling, and stiffness of the joints, and the skin takes on a tight, shiny appearance. The digestive system also becomes involved, resulting in weight loss, appetite loss, diarrhea, constipation, and distention of the abdomen. As the disease progresses, the heart, lungs, and kidneys become involved, and malignant hypertension (high blood pressure) causes death in approximately 30% of cases.
- Autoimmune hemolytic anemia. May be acute or chronic. Symptoms include fatigue and abdominal tenderness due to an enlarged spleen.
- Autoimmune thrombocytopenic purpura. Characterized by pinhead-size red dots on the skin, unexplained bruises, bleeding from the nose and gums, and blood in the stool.
- Polymyositis and dermatomyositis. In polymyositis, symptoms include muscle weakness, particularly in the shoulders or pelvis, which prevents the patient from performing everyday activities. In dermatomyositis, the same muscle weakness is accompanied by a rash that appears on the upper body, arms, and

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fingertips. A rash may also appear on the eyelids, and the area around the eyes may become swollen.

- Pernicious anemia. Signs of pernicious anemia include weakness, sore tongue, bleeding gums, and tingling in the extremities. Because the disease causes a decrease in stomach acid, nausea, vomiting, loss of appetite, weight loss, diarrhea, and constipation are possible. Also, because vitamin B_{12} is essential for the nervous system function, its deficiency brought about by the disease can result in a host of neurological problems, including weakness, lack of coordination, blurred vision, loss of fine motor skills, loss of the sense of taste, ringing in the ears, and loss of bladder control.
- Sjögren's syndrome. Characterized by excessive dryness of the mouth and eyes.
- Ankylosing spondylitis. Generally begins with lower back pain that progresses up the spine. The pain may eventually become crippling.
- Vasculitis. Symptoms depend upon the group of veins affected and can vary greatly.
- Type I diabetes mellitus. Characterized by fatigue and an the inability to break down glucose, resulting in abnormally high level of glucose in the blood (hyperglycemia).
- Amyotrophic lateral sclerosis. First signs are stumbling and difficulty climbing stairs. Later, muscle cramps and twitching may be observed as well as weakness in the hands making fastening buttons or turning a key difficult. Speech may become slowed or slurred. There may also be difficulty swallowing. As respiratory muscles atrophy, there is increased danger of aspiration or lung infection.
- Guillain-Barre syndrome. Muscle weakness in the legs occurs first, then the arms and face. Paresthesia is often present. This disorder affects both sides of the body and may involve paralysis of the muscles that control breathing.
- Multiple sclerosis. Like Amyotrophic lateral sclerosis, the first symptom may be clumsiness. Weakness or exhaustion is often reported, as well as blurry or double vision. The individual may experience dizziness, depression, loss of bladder control, and muscle weakness so severe that the patient is confined to a wheelchair.
- Celiac disease. Damage to the lining of the small intestine causes immediate difficulties in digesting food that result in diarrhea, gas, and cramps, and long-term symptoms of vitamin and mineral deficiencies, anemia, osteoporosis, and weight loss.

Diagnosis

A variety of tests are involved in the diagnosis of autoimmune disorders, depending on the particular disease such as blood tests, **cerebrospinal fluid analysis**, electromyogram (measures muscle function), and **magnetic resonance imaging** of the brain. Usually, these tests determine the location and extent of damage or involvement. They also are useful in charting progress of the disease and as baselines for treatment.

The principle tool, however, for authenticating autoimmune disease is antibody testing. Such tests involve measuring the level of antibodies found in the blood and determining if they react with specific antigens (protein triggers) that would give rise to an autoimmune reaction. An elevated amount of antibodies indicates that a general immune reaction is occurring. Since elevated antibody levels also are seen in common infections, infections must be ruled out as the cause for the increased antibody levels.

Antibodies can also be typed by class. There are five classes of antibodies, and they can be separated in the laboratory. The class IgG is usually associated with autoimmune diseases. Unfortunately, IgG class antibodies are also the main class of antibody seen in normal immune responses.

The most useful antibody tests involve introducing the patient's antibodies to samples of his or her own tissue, usually thyroid, stomach, liver, and kidney tissue. If antibodies bind to the "self" tissue, this is diagnostic for an autoimmune disorder. Antibodies from a person without an autoimmune disorder would not react to "self" tissue.

Treatment

Treatment of autoimmune diseases is specific to the disease, and usually focuses on alleviating or preventing symptoms rather than correcting the underlying cause. For example, if a gland involved in an autoimmune reaction is not producing a hormone, for example insulin, administration of that hormone is required. Administration of a hormone, however, will not restore the function of the gland damaged by the autoimmune disease.

The other aspect of treatment is controlling the inflammatory and proliferative nature of the immune response. This generally is accomplished with two types of drugs. Corticosteroid compounds (e.g., prednisone) are used to control inflammation. There are

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many different **corticosteroids**, each having undesirable side effects, especially with long-term use.

The proliferative nature of the immune response is controlled with immunosuppressive drugs (e.g., azathioprine, chlorambucil, cyclophosphamide, methotrexate). These drugs work by inhibiting the replication of cells and, therefore also suppress non-immune cells, leading to side effects such as anemia (too few red blood cells). In addition, other drugs may be used to treat symptoms of specific disorders.

Another approach is the use of drugs such as entanercept (Enbrel), imflixmab (Remicade), and adalimumab (Humira) that block the action of tumor necrosis factor (TNF). TNF is a substance that can cause inflammation in the body. These drugs have proved very effective in relieving symptoms in people with **rheumatoid arthritis**. However, in June 2008, the United States Food and Drug Administration (FDA) began investigating whether these drugs, especially when administered long term to younger patients, caused an increase in **cancer**, especially lymphoma (cancer of the lymph tissue). As of 2009, the data on potential cancer risks related to these drugs was confusing and difficult to assess because many patients who developed cancer were taking other drugs in addition to TNFs.

Prognosis

Prognosis depends upon the pathology of each autoimmune disease.

Prevention

Though the mechanisms involved in how these diseases affect the body are known, it is still unclear why the body turns on itself, thus most autoimmune disorders cannot be prevented. Since more women than men are affected by some of these disorders (e.g., lupus), some researchers are looking into hormones as a factor that may be controlled to prevent or slow certain autoimmune disorders. This, **gene therapy**, and drugs that target specific immune system cells may help prevent or treat autoimmune disorders in the future.

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ORGANIZATIONS

American Autoimmune Related Diseases Association, Inc., 22100 Gratiot Avenue, East Detroit, MI, 48021, (586) 776-3900, (586) 776-3903, http://www.aarda.org.

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Autoimmune hepatitis *see* **Hepatitis, autoimmune**

Autologous transfusion *see* **Transfusion**

Autologous transplant *see* **Bone marrow transplantation**

Automatic implantable cardioverter-defibrillator *see* **Implantable cardioverter-defibrillator**

Autopsy

Definition

An autopsy is a postmortem assessment or examination of a body to determine the cause of **death**. An autopsy is performed by a physician trained in pathology.

Purpose

Most autopsies advance medical knowledge and provide evidence for legal action. Medically, autopsies determine the exact cause and circumstances of death, discover the pathway of a disease, and provide valuable information to be used in the care of the living. When foul play is suspected, a government coroner or medical examiner performs autopsies for legal use. This branch of medical study is called forensic medicine. Forensic specialists investigate deaths resulting from violence or occurring under suspicious circumstances.

Benefits of research from autopsies include the production of new medical information on diseases such as **toxic shock syndrome**, acquired **immunodeficiency** syndrome (**AIDS**). **Organ donation**, which can potentially save the lives of other patients, is also another benefit of autopsies.

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KEY TERMS

Acquired immunodeficiency syndrome (AIDS)—A group of diseases resulting from infection with the human immunodeficiency virus (HIV). A person infected with HIV gradually loses immune function, becoming less able to resist aliments and cancers, resulting in eventual death.

Computed tomography scan (CT scan)—The technique used in diagnostic studies of internal bodily structures in the detection of tumors or brain aneurysms. This diagnostic test consists of a computer analysis of a series of cross-sectional scans made along a single axis of a bodily structure or tissue that is used to construct a three-dimensional image of that structure.

Creutzfeld-Jakob disease—A rare, often fatal disease of the brain, characterized by gradual dementia and loss of muscle control that occurs most often in middle age and is caused by a slow virus.

Hepatitis—Inflammation of the liver, caused by infectious or toxic agents and characterized by jaundice, fever, liver enlargement, and abdominal pain.

Magnetic resonance imaging (MRI)—A diagnostic tool that utilizes nuclear magnetic energy in the production of images of specific atoms and molecular structures in solids, especially human cells, tissues, and organs.

Postmortem—After death.

Precautions

When performed for medical reasons, autopsies require formal permission from family members or the legal guardian. (Autopsies required for legal reasons when foul play is suspected do not need the consent of next of kin.) During the autopsy, very concise notes and documentation must be made for both medical and legal reasons. Some religious groups prohibit autopsies.

Description

An autopsy can be described as the examination of a deceased human body with a detailed exam of the person's remains. This procedure dates back to the Roman era when few human dissections were performed; autopsies were utilized, however, to determine the cause of death in criminal cases. At the beginning of the procedure the exterior body is examined and then the internal organs are removed and studied. Some pathologists argue that more autopsies are performed than necessary. However, recent studies show that autopsies can detect major findings about a person's condition that were not suspected when the person was alive. And the growing awareness of the influence of genetic factors in disease has also emphasized the importance of autopsies.

Despite the usefulness of autopsies, fewer autopsies have been performed in the United States during the past 10-20 years. A possible reason for this decline is concern about malpractice suits on the part of the treating physician. Other possible reasons are that hospitals are performing fewer autopsies because of the expense or because modern technology, such as CT scans and **magnetic resonance imaging**, can often provide sufficient diagnostic information. Nonetheless, federal regulators and pathology groups have begun to establish new guidelines designed to increase the number and quality of autopsies being performed.

Many experts are concerned that if the number of autopsies increases, hospitals may be forced to charge families a fee for the procedure as autopies are not normally covered by insurance companies or Medicare. Yet, according to several pathologists, the benefit of the procedure for families and doctors does justify the cost. In medical autopsies, physicians remain cautious to examine only as much of the body as permitted according to the wishes of the family. It is important to note that autopsies can also provide peace of mind for the bereaved family in certain situations.

Preparation

If a medical autopsy is being performed, written permission is secured from the family of the deceased

Aftercare

Once the autopsy has been completed, the body is prepared for final arrangements according to the family's wishes

Risks

There are some risks of disease transmission from the deceased. In fact, some physicans may refuse to do autopsies on specific patients because of a fear of

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contracting diseases such as AIDS, hepatitis, or Creutzfeld-Jakob disease.

Normal results

In most situations the cause of death is determined from the procedure of an autopsy without any transmission of disease.

Abnormal results

Abnormal results would include inconclusive results from the autopsy and transmission of **infectious disease** during the autopsy.

ORGANIZATIONS

American Medical Association, 515 N. State St., Chicago, IL, 60654, (800) 621-8335, http://www.ama-assn.org/.

Jeffrey P. Larson RPT

Avian flu

Definition

Avian **influenza**, known more casually as bird flu, is an **infectious disease** caused by a family of viruses that normally infect birds. Beginning in 1997, a subtype of avian influenza known as Avian influenza A (H5N1), has infected and caused a small number of deaths in humans.

Demographics

The avian H5N1 influenza virus was first isolated in terns (migratory shore birds) in South Africa in 1961. The virus is highly contagious and sometimes fatal in birds; it did not appear to cause disease in humans until 1997. In that year in Hong Kong, H5N1 bird flu caused 18 confirmed cases of severe respiratory disease in humans, of which six were fatal. All but one of the individuals diagnosed with bird flu in Hong Kong had close contact with infected poultry. The exception was a case in which the disease was transmitted from child to parent but spread no further.

As of May 2009, there have been 421 laboratory-confirmed cases of H1N1 avian influenza in humans. Of these, 257 (about 60%) were fatal. The disease can affect people of all ages, genders, and ethnicities. Almost all individuals who have developed avian flu were in close contact with infected birds; only a few contracted the disease from extended contact with a sick family member. As of May 2009, all confirmed cases of avian flu in humans had occurred in Asia or Africa.

Description

There are three types of influenza viruses called types A, B, and C. Only influenza A viruses causes serious, widespread illness in humans. Several different strains or subtypes of influenza A virus cause infection in humans. Other subtypes of influenza A cause disease in birds, pigs, horses, ferrets, whales, and seals. In most cases, the subtypes that cause disease in one species do not spread the disease to other species.

Bird flu was first identified in Italy more than 100 years ago. Avian influenza viruses can infect both domestic and wild birds including chickens, ducks, geese, turkeys, swans, pheasants, and quail. Although the disease is often fatal in domestic birds (e.g., chickens, turkeys), it often causes less severe illness in wild birds; wild ducks are natural reservoirs of infection. Infected wild birds shed large quantities of virus in their feces, but often appear to be relatively unaffected by flu symptoms. During migration, infected wild birds encounter other wild and domestic birds, such as chickens, and spread the disease to them. The virus then kills a large percentage of domestic birds, along with some species of wild birds. There are several subtypes of avian influenza virus, but the one of most concern to human health is called H5N1. Under most circumstances avian influenza viruses do not infect humans.

Understanding the avian influenza virus

Influenza viruses are protein sacks with a core of eight loosely connected genes. Two proteins spike up from the surface of the virus. The most plentiful protein is called haemagglutinin (H). The other surface protein is neuraminidase (N). The job of these proteins is to hook the influenza virus on to the surface of a cell in the animal it has infected and then help get the virus's genes inside that cell. Once inside, the virus genes take over the host cell and reprogram it to make thousands of copies of the virus.

There are many subtypes of influenza A viruses. These are identified by a series of letters and numbers that refer to two surface proteins, H and N. There are 16 known types of H proteins and nine known types of N proteins of influenza The structure of the genes in the influenza virus allows these viruses to mutate (change) very rapidly. Many combinations of the two proteins can result from these mutations, each representing a new subtype of influenza A.

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According to the United States Centers for Disease Control and Prevention (CDC) 15 different Influenza A subtypes can infect birds. Normally the subtypes of influenza that infect birds do not harm human, although some can infect pigs. However, the avian influenza virus called H5N1 has mutated in such a way that it is able to infect humans.

Humans and bird flu

When H5N1 avian flu was first discovered to infect humans in Hong Kong in 1997, it was feared that the disease, now called bird flu, would sweep through the community and kill thousands the way another subtype of influenza had swept across the world in 1918 and 1919. That influenza pandemic killed between 20 and 100 million people on six continents. To prevent this, Hong Kong health authorities had ordered all poultry be killed. Within three days, about 1.5 million birds in Hong Kong were destroyed to prevent further spread of the disease. Hong Kong, a relatively small island, was able to contain the infection.

The next outbreak of avian flu in humans was reported in Asia. From November 2003 through March 2004, a handful of human cases of bird flu were found in China, Vietnam, and Thailand. Meanwhile avian flu was epidemic among the bird populations in Japan, Thailand, Lao People's Democratic Republic (formerly Laos), China, and Indonesia. Millions of birds died from avian flu as the disease spread throughout Southeast Asia, and many of these countries reported a small number of human infections. By 2009, the disease had spread to some parts of the Middle East and Northern Africa, where Egypt and Djibouti reported some human cases. As of mid-2009, more than three-quarters of all laboratory-confirmed cases of avian flu in humans had occurred in Southeast Asia; none had been reported in North or South America, or Australia.

Risk factors

People at greatest risk of contracting avian flu are those who live or work closely with poultry. Potentially vulnerable people included those working on poultry on farms, in poultry processing plants, and live bird markets. Individuals living with a family member who has avian flu are also at risk of developing the disease. Avian flu does not spread easily to humans, and many people who are exposed to infected birds do not get sick.

KEY TERMS

Pandemic—The occurrence of a disease that in a short time infects a large percentage of the population over a wide geographical area.

Secondary or opportunistic infection—An infection by a microbe that occurs because the body is weakened by a primary infection caused by a different kind of microbe.

Causes and symptoms

An influenza virus that birds carry in their intestines causes Avian flu. The virus spreads as infected birds excrete saliva, nasal secretions, and feces. Birds vulnerable to the flu become infected when they come into contact with the excretions or surfaces contaminated by the viruses.

Birds that survive the H5N1 infection can excrete the virus for at least 10 days. This allows the H5N1 strain to spread through bird-to-bird contact from wild birds to domestic birds on farms and in live bird markets. The virus can also spread in surfaces including manure, bird feed, equipment, vehicles, egg flats, and crates, and the clothing and shoes of people who are exposed to the virus. Influenza is a respiratory disease. People must inhale the virus or carry it on their hands to their nose, eyes, or mouth to become sick. People cannot get the disease by eating properly cooked poultry.

In general, people who contract bird flu have symptoms similar to seasonal human influenza including **fever**, **cough**, **sore throat**, and aching muscles. Other symptoms included eye infections (**conjunctivitis**), **pneumonia**, acute respiratory distress, and viral pneumonia. Influenza weakens the respiratory system and leaves the lungs more vulnerable to infection. Many people with flu die from pneumonia caused by a secondary bacterial infection. Bacteria are able to grow in the lungs because the body's defenses have been weakened by the flu virus.

Diagnosis

The symptoms of avian flu and human flu are very similar. A physician may suspect avian influenza if an individual showing flu-like symptoms has been in close contact with poultry in an infected area. Nevertheless, laboratory testing is needed to confirm a diagnosis of avian influenza. Symptoms normally develop within 7 days of infection.

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Tests

Diagnostic tests for human flu are rapid and reliable, according to the World Health Organization (WHO). International laboratories within WHO's global network have high-security facilities and experienced staff to test samples of suspected avian flu sent from around the world. Test methods include a viral culture that analyzes a blood sample and swabbings from the nose or throat. Other testing can be done on respiratory secretions.

In April 2009, the United States Food and Drug Administration (FDA) approved a rapid detection test for the H5N1 strain of bird flu. The test is manufactured by Arbor Vita Corporation of California. All it requires is a swab from the nose or throat of an ill individual. This new test produces results in about 40 minutes. Previous bird flu tests took at minimum four hours to complete.

Treatment

Drugs

Some anti-viral drugs appear to be partially effective against avian flu viruses if they are administered promptly, usually within 48 hours after the start of symptoms. These drugs do not cure flu, but lessen its symptoms and duration. In the United States, four drugs have been approved by the U.S. Food and Drug Administration (FDA) for the treatment of influenza A viruses in otherwise healthy adults. These are amantadine (Symmetrel), rimantadine (Flumadine), oseltamivir (Tamiflu), and zanamivir (Relenza). Research indicates that the avian H5N1 virus is resistant to amantadine and rimantadine, therefore, the drugs of choice for treating bird flu are oseltamivir and zanamivir.

Antibiotics may be needed to treat secondary bacterial infections. **Acetaminophen** may be used to control fever and reduce aches.

Alternative

In March of 2005, people in South Korea began eating more kimchi to ward off avian flu infection, according to the reports from the British Broadcasting Company and other news organizations. The public turned to the spicy vegetable dish after scientists at Seoul National University announced that kimchi aided in the recovery of 11 out of 13 infected chickens. The scientists fed the birds an extract of kimchi, a dish made by fermenting cabbage with red peppers, radishes, and large amounts of garlic and ginger. A week later, all but two birds showed signs of recovery. The researchers acknowledged that their study was unscientific. At that time, they were not sure how or why kimchi was related to the recovery. However, the announcement led people to again regard kimchi as a health remedy.

Home remedies

Much of the treatment for influenza is supportive and consists bed rest, drinking plenty of fluids to stay hydrated, and using a humidifier to relieve nasal congestion and ease breathing.

Prognosis

About 60% of individuals who develop avian influenza die. The rest normally recover completely.

Prevention

Although avian influenza has been confirmed in fewer than 500 individuals worldwide, scientists at WHO, the CDC, and public health agencies of many other countries are concerned about the deadly consequences that could occur if H5N1 mutated into a virus subtype that could spread easily from one human to another. A strain of bird flu spread by human-to-human contact could cause an influenza pandemic and sicken millions. WHO and CDC experts believe that the question is not if another influenza epidemic will occur, but when it will happen and how severe it will be. For this reason, prevention strategies and pandemic planning are extremely important.

In the United States, the CDC is among the organizations preparing for a possible outbreak of bird flu in humans. In addition to laboratories equipped to test for bird flu, the CDC recommends precautions to prevent the spread of flu and other respiratory infections. Precautionary measures include restricting bird from coming into the United States from infected countries, testing poultry for avian flu viruses, and euthanizing infected birds. People with symptoms of respiratory infection are advised to cover their mouths or use facial tissues when coughing or sneezing. After coughing or sneezing, individuals should wash their hands well with soap and water, alcohol-based hand rub, or antiseptic handwash.

As of 2009, bird flu was primarily a risk for people in infected areas who work with poultry. People working with birds in locations such as commercial poultry facilities, veterinary offices, and live bird markets should wear protective clothing. That equipment includes boots, coveralls, face masks, gloves, and headgear, according to the United States Department of Agriculture (USDA).

Furthermore, poultry producers should implement security measures to prevent the outbreak of a highly pathogenic virus. Those actions include

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keeping flocks away from wild or migratory birds and providing clothing and disinfectant facilities for employees. Plastic crates are recommended for use at live bird markets because they are easier to clean than wood crates. Cleaning and disinfecting areas are also important for preventing an outbreak. Infected birds must be quarantined or destroyed.

In July 2007, The United States Food and Drug Administration approved the first vaccine for use against H5N1 bird flu. In addition, many governments around the world have stockpiled antiviral medications that can rapidly be made available should a serious influenza outbreak occur.

Resources

BOOKS

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OTHER

Centers for Disease Control and Prevention. Avian Influenza (Bird Flu): What You Should Know. [May 4, 2009], http://www.cdc. gov/flu/avian

Medline Plus. Bird Flu. Continuously updated [May 4, 2009], http://www.nlm.nih.gov/medlineplus/birdflu.html

ORGANIZATIONS

National Institute of Allergy and Infectious Diseases Office of Communications and Government Relations, 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-6612 (301) 496-5717 (866) 284-4107 or TDD: (800)877-8339 (for hearing impaired) (301) 402-3573, http://www3.niaid.nih.gov.

United States Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333 (404) 639-3534 800-CDC-INFO (800-232-4636). TTY: (888) 232-6348, inquiry@cdc.gov, http://www.cdc.gov.

World Health Organization, Avenue Appia 20, 1211 Geneva 27, Switzerland +22 41 791 21 11 +22 41 791 31 11, info@who.int, http://www.who.int.

Tish Davidson A.M.

Aviation medicine

Definition

Also known as aerospace medicine, flight medicine, or space medicine, aviation medicine is a medical specialty that focuses on the physical and psychological conditions associated with flying and space travel.

Purpose

Since flying airplanes and spacecraft involves great risk and physical demands, such as changes in gravity and oxygen, pilots and astronauts need medical experts to protect their safety and the public's safety.

Description

Pressure changes

In the United States, the Federal Aviation Administration (FAA) requires all pilots who fly above 14,500 ft (4,420 m) to be prepared for pressure changes caused by lower oxygen levels at high altitude. Pilots must either have a pressurized cabin or access to an oxygen mask. Without these protections, they could experience hypoxia, or **altitude sickness**. Hypoxia reduces the amount of oxygen in the brain, causing such symptoms as **dizziness**, **shortness of breath**, and mental confusion. These symptoms could cause the pilot to lose control of the plane. Hypoxia can be treated with **oxygen therapy**.

Rapid altitude increases and decreases can cause **pain** because there is an air pocket in the middle portion of the ear. To equalize pressure in the ear, physicians typically advise pilots and passengers to clear their sinuses by plugging their nose and blowing until the eardrums "pop." Other options include yawning, swallowing or chewing gum. For people with a cold or a severely blocked middle ear, the use of **decongestants**, **antihistamines**, or nasal sprays may help. Without taking steps to equalize pressure, the tympanic membrane could rupture, causing **hearing loss**, vertigo, dizziness, and **nausea**.

Gravity's impact

Fighter pilots who fly high-performance jets can experience health problems during rapid acceleration and when executing tight turns at high speed. During these moves, a pilot experiences extreme gravity conditions that can pull blood away from the brain and heart and into the lower body. This can cause the pilot to have tunnel vision or pass out. To prevent these potentially deadly situations, the military requires fighter pilots to wear special flight suits, or G suits, which have compartments that fill with air or fluid to keep blood from pooling in the lower body.

Some pilots, like the Blue Angels, use a technique called the **Valsalva Maneuver** instead of G suits to

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KEY TERMS

G suits—Special flight suits, worn by fighter pilots, which have compartments that fill with air or fluid to keep blood from pooling in the lower body during rapid acceleration and tight turns.

Hypoxia—Hypoxia, or altitude sickness, reduces the amount of oxygen in the brain causing such symptoms as dizziness, shortness of breath, and mental confusion.

Tympanic membrane—A structure in the middle ear that can rupture if pressure in the ear is not equalized during airplane ascents and descents.

Valsalva Maneuver—Pilots grunt and tighten their abdominal muscles to prevent black outs during high-performance flying.

prevent black outs during high-performance flying. The Valsalva Maneuver involves grunting and tightening the abdominal muscles to stop blood from collecting in the wrong parts of the body.

PREVENTIVE CARE. Since any routine health problem that affects a pilot could mean the loss of hundreds of lives, aviation medicine specialists who work for commercial airlines and the military take special care to educate pilots about proper diet, **exercise** and preventive health tools. For example, physicians may frequently screen pilots for vision changes caused by **glaucoma** or **cataracts**. They also will check for hearing loss and encourage the pilot to wear earplugs or headphones to buffer engine noise. To monitor for heart disease, physicians will check blood pressure and may order diagnostic tests such as an ECG or **stress test**.

Motion sickness

Many people experience nausea, vertigo, and disorientation when they first arrive in space. This is caused by changes in the fluid in the inner ear, which is sensitive to gravity and affects our sense of spatial orientation. The symptoms typically ease after several days, but often recur when the astronaut returns to Earth. To treat this condition, physicians give astronauts **motion sickness** medication, such as lorazepam.

Bone and muscle loss

In zero-gravity conditions, astronauts lose bone and muscle mass. On earth, the natural resistance of gravity helps build stronger muscles and bones during normal weight-bearing activities like walking or even sitting at a desk. In space, however, astronauts must work harder to prevent bone and muscle loss. Exercise is an important treatment. Crew members may use an exercise cycle or resistive rubber bands to stay in shape. Physicians also may give them medication to prevent bone loss and prescribe **nutritional supplements**, such as a mixture of essential amino acids and carbohydrates, to limit muscle atrophy.

Radiation

Another health threat to space travelers is radiation. Harmful rays can alter the DNA in human cells and cause **cancer**. Excess radiation also can weaken the immune system. To prevent these problems, physicians may give astronauts nutritional supplements. For example, research has show that n-3 fatty acids found in fish oil reduce DNA damage.

Cardiovascular issues

When astronauts return to earth after a long mission, they tend to feel dizzy and black out. Scientists are concerned about this dilemma because it could be dangerous if the crew members need to make an emergency exit. One way to prevent this problem, which is caused by a drop in blood pressure, is to have the astronauts drink extra fluids and increase salt intake to increase blood volume. Physicians also may prescribe medication that causes blood vessels to contract. As another precaution, astronauts also put on protective flight suits, or G suits, before they re-enter the earth's atmosphere.

Resources

OTHER

Federal Aviation Administration Office of Aerospace Medicine. http://www.faa.gov/about/office_org/headquarters_offices/avs/offices/aam/cami/.

National Aeronautics and Space Administration Aerospace Medicine. http://spacelink.msfc.nasa.gov.

Society of USAF Flight Surgeons Online Catalog. http://www.sousaffs.org/default.php.

ORGANIZATIONS

Aerospace Medical Association, 320 South Henry Street, Alexandria, VA, 22314-3579, (703) 739-2240, (703) 739-9652, inquiries@asma.org, http://www.asma.org.

National Space Biomedical Research Institute, One Baylor Plaza, NA-425, Houston, TX, 77030, (713) 798-7412, (713) 798-7413, info@nsbri.org, http://www.nsbri.org.

Wright State University, Division of Aerospace Medicine, 3640 Col. Glenn Highway , Dayton, OH, 45435, (937)

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7751400, (937) 775-1403, betty.somers@wright.edu, http://www.med.wright.edu/asm.

Melissa Knopper

AVM *see* **Arteriovenous malformations**

Avoidant personality disorder *see* **Personality disorders**

Avulsions *see* **Wounds**

Ayurvedic medicine

Definition

Ayurvedic medicine is a system of healing that originated in ancient India. In Sanskrit, *ayur* means life or living, and *veda* means knowledge, so Ayurveda has been defined as the "knowledge of living" or the "science of longevity." Ayurvedic medicine utilizes diet, **detoxification** and purification techniques, herbal and mineral remedies, **yoga**, breathing exercises, **meditation**, and **massage therapy** as holistic healing methods. Ayurvedic medicine is widely practiced in modern India and has been steadily gaining followers in the West.

Purpose

According to the original texts, the goal of Ayurveda is prevention as well as promotion of the body's own capacity for maintenance and balance. Ayurvedic treatment is non-invasive and non-toxic, so it can be used safely as an alternative therapy or alongside conventional therapies. Ayurvedic physicians claim that their methods can also help stress-related, metabolic, and chronic conditions. Ayurveda has been used to treat **acne**, **allergies**, **asthma**, **anxiety**, arthritis, **chronic fatigue syndrome**, colds, **colitis**, **constipation**, depression, diabetes, flu, heart disease, **hypertension**, immune problems, inflammation, **insomnia**, nervous disorders, **obesity**, skin problems, and ulcers.

Ayurvedic physicians seek to discover the roots of a disease before it gets so advanced that more radical treatments are necessary. Thus, Ayurveda seems to be limited in treating severely advanced conditions, traumatic injuries, acute **pain**, and conditions and injuries requiring invasive surgery. Ayurvedic techniques have also been used alongside **chemotherapy** and surgery to assist patients in recovery and healing.

Description

Origins

Ayurvedic medicine originated in the early civilizations of India some 3,000-5,000 years ago. It is mentioned in the *Vedas*, the ancient religious and philosophical texts that are the oldest surviving literature in the world, which makes Ayurvedic medicine the oldest surviving healing system. According to the texts, Ayurveda was conceived by enlightened wise men as a system of living harmoniously and maintaining the body so that mental and spiritual awareness could be possible. Medical historians believe that Ayurvedic ideas were transported from ancient India to China and were instrumental in the development of Chinese medicine.

Today, Ayurvedic medicine is used by 80% of the population in India. Aided by the efforts of Deepak Chopra and the Maharishi, it has become an increasingly accepted alternative medical treatment in America during the last two decades. Chopra is an M.D. who has written several bestsellers based on Ayurvedic ideas. He also helped develop the Center for Mind/Body Medicine in La Jolla, California, a major Ayurvedic center that trains physicians in Ayurvedic principles, produces herbal remedies, and conducts research and documentation of its healing techniques.

Key ideas

To understand Ayurvedic treatment, it is necessary to have an idea how the Ayurvedic system views the body. The basic life force in the body is *prana*, which is also found in the elements and is similar to the Chinese notion of *chi*. As Swami Vishnudevananda, a yogi and expert, put it, "Prana is in the air, but is not the oxygen, nor any of its chemical constituents. It is in food, water, and in the sunlight, yet it is not vitamin, heat, or light-rays. Food, water, air, etc., are only the media through which the prana is carried."

In Ayurveda, there are five basic elements that contain prana: earth, water, fire, air, and ether. These elements interact and are further organized in the human body as three main categories or basic physiological principles in the body that govern all bodily functions known as the *doshas*. The three doshas are *vata, pitta, and kapha*. Each person has a unique blend of the three doshas, known as the person's *prakriti*, which is why Ayurvedic treatment is always individualized. In Ayurveda, disease is viewed as a state of imbalance in one or more of a person's doshas, and an Ayurvedic physician strives

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DEEPAK CHOPRA (1946–)

(AP Images.)

Deepak Chopra was born in India and studied medicine at the All India Institute of Medical Science. He left his home for the United States in 1970 and completed residencies in internal medicine and endocrinology. He went on to teaching posts at major medical institutions—Tufts University and Boston University schools of medicine—while establishing a very successful private practice. By the time he was thirty-five, Chopra had become chief of staff at New England Memorial Hospital.

Disturbed by Western medicine's reliance on medication, he began a search for alternatives and discovered one in the teachings of the Maharishi Mahesh Yogi, an Indian spiritualist who had gained a cult following in the late sixties teaching Transcendental Meditation (TM). Chopra began practicing TM fervently and eventually met the Maharishi. In 1985 Chopra established the Ayurvedic Health Center for Stress Management and Behavioral Medicine in Lancaster, Massachusetts, where he began his practice of integrating the best aspects of Eastern and Western medicine.

In 1993, he published *Creating Affluence: Wealth Consciousness in the Field of All Possibilities*, and the enormously successful best seller, *Ageless Body, Timeless Mind*. In the latter he presents his most radical thesis: that aging is not the inevitable deterioration of organs and mind that we have been traditionally taught to think of it as. It is a process that can be influenced, slowed down, and even reversed with the correct kinds of therapies, almost all of which are self-administered or self-taught. He teaches that applying a regimen of nutritional balance, meditation, and emotional clarity characterized by such factors as learning to easily and quickly express anger, for instance, can lead to increased lifespans of up to 120 years.

Chopra, along with David Simon, M.D., opened the Chopra Center for Wellbeing in 1996, offering people experiences in physical healing, emotional freedom, and higher states of consciousness. Located in Carlsbad, California, the center offers a wide variety of programs, retreats, and teacher training programs that integrate the healing arts of the East with modern Western medicine. http://www.chopra.com/

to adjust and balance them, using a variety of techniques.

The vata dosha is associated with air and ether, and in the body promotes movement and lightness. Vata people are generally thin and light physically, dry-skinned, and very energetic and mentally restless. When vata is out of balance, there are often nervous problems, hyperactivity, sleeplessness, lower back pains, and headaches.

Pitta is associated with fire and water. In the body, it is responsible for metabolism and digestion. Pitta characteristics are medium-built bodies, fair skin, strong digestion, and good mental concentration. Pitta imbalances show up as anger and aggression and stress-related conditions like **gastritis**, ulcers, liver problems, and hypertension.

The kapha dosha is associated with water and earth. People characterized as kapha are generally large or heavy with more oily complexions. They tend to be slow, calm, and peaceful. Kapha disorders manifest emotionally as greed and possessiveness, and physically as obesity, **fatigue**, **bronchitis**, and sinus problems.

Diagnosis

In Ayurvedic medicine, disease is always seen as an imbalance in the dosha system, so the diagnostic process strives to determine which doshas are underactive or overactive in a body. Diagnosis is often taken over a course of days in order for the Ayurvedic physician to most accurately determine what parts of the body are being affected. To diagnose problems, Ayurvedic physicians often use long questionnaires

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Ayurvedic body types (doshas)

	Vata	Pitta	Kapha
Physical characteristics	Thin Prominent features Cool, dry skin Constipation Cramps	Average build Fair, thin hair Warm, moist skin Ulcers, heartburn, and hemorrhoids Acne	Large build Wavy, thick hair Pale, cool, oily skin Obesity, allergies, and sinus problems High cholesterol
Emotional characteristics	Moody Vivacious Imaginative Enthusiastic Intuitive	Intense Quick tempered Intelligent Loving Articulate	Relaxed Not easily angered Affectionate Tolerant Compassionate
Behavioral characteristics	Unscheduled sleep and meal times Nervous disorders Anxious	Orderly Structured sleep and meal times Perfectionist	Slow, graceful Long sleeper and slow eater Procrastinator

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and interviews to determine a person's dosha patterns and physical and psychological histories. Ayurvedic physicians also intricately observe the pulse, tongue, face, lips, eyes, and fingernails for abnormalities or patterns that they believe can indicate deeper problems in the internal systems. Some Ayurvedic physicians also use laboratory tests to assist in diagnosis.

Treatment

Ayurvedic treatment seeks to re-establish balance and harmony in the body's systems. Usually the first method of treatment involves some sort of detoxification and cleansing of the body, in the belief that accumulated toxins must be removed before any other methods of treatment will be effective. Methods of detoxification include therapeutic **vomiting**, **laxatives**, medicated **enemas**, **fasting**, and cleansing of the sinuses. Many Ayurvedic clinics combine all of these cleansing methods into intensive sessions known as *panchakarma*. Panchakarma can take several days or even weeks and they are more than elimination therapies. They also include herbalized oil massage and herbalized **heat treatments**. After purification, Ayurvedic physicians use herbal and mineral remedies to balance the body as well. Ayurvedic medicine contains a vast knowledge of the use of herbs for specific health problems.

Ayurvedic medicine also emphasizes how people live their lives from day to day, believing that proper lifestyles and routines accentuate balance, rest, diet, and prevention. Ayurveda recommends yoga as a form of **exercise** to build strength and health, and also advises massage therapy and self-massage as ways of increasing circulation and reducing **stress**. Yogic breathing techniques and meditation are also part of a healthy Ayurvedic regimen, to reduce stress and improve mental energy.

Of all treatments, though, diet is one of the most basic and widely used therapy in the Ayurvedic system. An Ayurvedic diet can be a very well planned and individualized regimen. According to Ayurveda, there are six basic tastes: sweet, sour, salty, pungent, bitter, and astringent. Certain tastes and foods can either calm or aggravate a particular dosha. For instance, sweet, sour, and salty decrease vata problems and increase kapha. Sour, salty, and pungent can increase pitta. After an Ayurvedic physician determines a person's dosha profile, they will recommend a specific diet to correct imbalances and increase health. The Ayurvedic diet emphasizes primarily vegetarian foods of high quality and freshness, tailored to the season and time of day. Cooling foods are eaten in the summer and heating ones in the winter, always within a person's dosha requirements. In daily routine, the heaviest meal of the day should be lunch, and dinner should eaten well before bedtime, to allow for complete digestion. Also, eating meals in a calm manner with proper chewing and state of mind is important, as is combining foods properly and avoiding overeating.

Cost

Costs of Ayurvedic treatments can vary, with initial consultations running anywhere from $40 to over $100, with follow-up visits costing less. Herbal treatments may cost from $10 to $50 per month, and are often available from health food or bulk herb stores.

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KEY TERMS

Dosha—One of three constitutional types, either vata, pitta, or kapha, found in Ayurvedic medicine.

Meditation—Technique of calming the mind.

Panchakarma—Intensive Ayurvedic cleansing and detoxification program.

Prakriti—An individual's unique dosha pattern.

Prana—Basic life energy found in the elements.

Yoga—System of body and breathing exercises.

Some clinics offer panchakarma, the intensive Ayurvedic detoxification treatment, which can include overnight stays for up to several weeks. The prices for these programs can vary significantly, depending on the services and length of stay. Insurance reimbursement may depend on whether the primary physician is a licensed M.D.

Preparations

Ayurveda is a mind/body system of health that contains some ideas foreign to the Western scientific model. Those people considering Ayurveda should approach it with an open mind and willingness to experiment. Also, because Ayurveda is a whole-body system of healing and health, patience and discipline are helpful, as some conditions and diseases are believed to be brought on by years of bad health habits and require time and effort to correct. Finally, the Ayurvedic philosophy believes that each person has the ability to heal themselves, so those considering Ayurveda should be prepared to bring responsibility and participation into the treatment.

Precautions

An Ayurvedic practitioner should always be consulted.

Side effects

During Ayurvedic detoxification programs, some people report fatigue, muscle soreness, and general sickness. Also, as Ayurveda seeks to release mental stresses and psychological problems from the patient, some people can experience mental disturbances and depression during treatment, and psychological counseling may be part of a sound program.

Research and general acceptance

Because Ayurveda had been outside the Western scientific system for years, research in the United States is new. Another difficulty in documentation arises because Ayurvedic treatment is very individualized; two people with the same disease but different dosha patterns might be treated differently. Much more scientific research has been conducted over the past several decades in India. Much research in the United States is being supported by the Maharishi Ayur-Ved organization, which studies the Ayurvedic products it sells and its clinical practices.

Some Ayurvedic herbal mixtures have been proven to have high antioxidant properties, much stronger than **vitamins** A, C, and E, and some have also been shown in laboratory tests to reduce or eliminate tumors in mice and to inhibit **cancer** growth in human lung tumor cells. In a 1987 study at MIT, an Ayurvedic herbal remedy was shown to significantly reduce **colon cancer** in rats. Another study was performed in the Netherlands with Maharishi Ayur-Ved products. A group of patients with chronic illnesses, including asthma, chronic bronchitis, hypertension, **eczema**, **psoriasis**, constipation, **rheumatoid arthritis**, headaches, and non-insulin dependent **diabetes mellitus**, were given Ayurvedic treatment. Strong results were observed, with nearly 80% of the patients improving and some chronic conditions being completely cured.

Other studies have shown that Ayurvedic therapies can significantly lower cholesterol and blood pressure in stress-related problems. Diabetes, acne, and allergies have also been successfully treated with Ayurvedic remedies. Ayurvedic products have been shown to increase short-term memory and reduce headaches. Also, Ayurvedic remedies have been used successfully to support the healing process of patients undergoing chemotherapy, as these remedies have been demonstrated to increase immune system activity.

Resources

BOOKS

Lad, Vasant. *The Complete Book of Ayurvedic Home Remedies*. London: Piatkus, 2006.

OTHER

"Inside Ayurveda: An Independent Journal of Ayurvedic Health Care." P.O. Box 3021, Quincy, CA 95971. http://www.insideayurveda.com.

ORGANIZATIONS

American Institute of Vedic Studies, P.O. Box 8357, Santa Fe, NM, 87504-8357, pvshastri@aol.com, http://www.vedanet.com/.

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Ayurveda Holistic Center, Bayville, Long Island, New York, NY, (516) 759-7731, http://www.Ayurvedahc.com.

Ayurvedic and Naturopathic Medical Clinic., 2115 112th Ave NE, Bellevue, WA, 98004-2946, (425) 453-8022, (425) 453-1408, http://www.ayurvedicscience.com.

Ayurvedic Institute, 11311 Menaul, NE, Albuquerque, NM, 87112, (505) 291-9698, (505) 294-7572, http://www.ayurveda.com.

Bastyr University of Natural Health Sciences, 14500 Juanita Dr. N.E., Kenmore, WA, 98028, http://www.bastyr.edu/.

Center for Mind/Body Medicine, 5225 Conneticut Ave. NW, Suite 145, Washington, DC, 20015, (202) 966-7338, (202) 966-2589, center@cmbm.org, http://www.cmbm.org.

National Institute of Ayurvedic Medicine, 584 Milltown Road, Brewster, NY, 10509, (845) 278-8700, (845) 278-8215, ayurveda@niam.com.

Rocky Mountain Institute of Yoga and Ayurveda, P.O. Box 1091, Boulder, CO, 80306, (303) 443-6923, info@rmiya.org, http://www.rmiya.org.

Douglas Dupler MA

Azithromycin *see* **Erythromycins**

AZT *see* **Antiretroviral drugs**

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B

B-cell count *see* **Lymphocyte typing**

Babesiosis

Definition

Babesiosis is an infection of red blood cells caused by the single-celled parasite, *Babesia microti*, which is spread to humans by a tick bite.

Description

Babesiosis is a rare, tick-transmitted disease that is caused most often by the single-celled parasite *Babesia microti*. By 1995, fewer than 500 cases of babesiosis had been reported in the United States. The disease occurs primarily in New England and New York, especially on the coastal islands. However, cases have occurred in other parts of the United States. Because of tick activity, the risk for babesiosis is highest during June and July.

Ticks are small, blood-sucking arachnids. Although some ticks carry disease-causing organisms, most do not. *Babesia microti* is spread to humans through the bite of the tick *Ixodes scapularis* (also called *Ixodes dammini*). *Ixodes scapularis*, called the "blacklegged deer tick," usually feeds on deer and mice. A tick picks up the parasites by feeding on an infected mouse and then passes them on by biting a new host, possibly a human. To pass on the parasites, the tick must be attached to the skin for 36–48 hours. Once in the bloodstream, *Babesia microti* enters a red blood cell, reproduces by cell division, and destroys the cell, causing anemia. Humans infected with *Babesia microti* produce antibodies that can be helpful in diagnosing the infection.

Causes and symptoms

Babesia microti live and divide within red blood cells, destroying the cells and causing anemia. The majority of people who are infected have no visible symptoms. In those who become ill, symptoms appear one to six weeks following the tick bite. Because the ticks are small, many patients have no recollection of a tick bite. The symptoms are flu-like and include tiredness, loss of appetite, **fever**, drenching sweats, and muscle **pain**. **Nausea**, **vomiting**, **headache**, shaking chills, blood in the urine, and depression can occur.

Persons who are over 40 years old, have had their spleen removed (splenectomized), and/or have a serious disease (**cancer**, **AIDS**, etc.) are at a greater risk for severe babesiosis. In severe cases of babesiosis, up to 85% of the blood cells can be infected. This causes a serious, possibly fatal, blood deficiency.

Diagnosis

Babesiosis can be diagnosed by examining a blood sample microscopically and detecting the presence of *Babesia microti* within the blood cells. The blood can also be checked for the presence of antibodies to the parasite.

Treatment

In serious cases, babesiosis is treated with a combination of clindamycin (Cleocin) and quinine. Clindamycin is given by injection and quinine is given orally three to four times a day for four to seven days. To reduce the number of parasites in the blood, severely ill patients have been treated with blood transfusions.

Prognosis

Otherwise healthy patients will recover completely. Babesiosis may last several months without treatment and is a severe, potentially fatal disease in splenectomized patients.

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KEY TERMS

Anemia—A below normal number of red blood cells in the bloodstream.

Parasite—An organism that lives upon or within another organism.

Prevention

The only prevention for babesiosis is to minimize exposure to ticks by staying on trails when walking through the woods, avoiding tall grasses, wearing long sleeves and tucking pant legs into socks, wearing insect repellent, and checking for ticks after an outing. Remove a tick as soon as possible by grasping the tick with tweezers and gently pulling. Splenectomized people should avoid northeastern coastal regions during the tick season.

Resources

OTHER

Mayo Clinic Online. http://www.mayoclinic.com (accessed November 18, 2010).

Belinda Rowland, PhD

Bach flower remedies *see* **Flower remedies**

Bacillary angiomatosis

Definition

A life-threatening but curable infection that causes an eruption of purple lesions on or under the skin that resemble **Kaposi's sarcoma**. The infection, which occurs almost exclusively in patients with **AIDS**, can be a complication of **cat-scratch disease**.

Description

Bacillary angiomatosis is a re-emerging bacterial infection that is identical or closely related to one that commonly afflicted thousands of soldiers during World War I. Today, the disease, caused by two versions of the same bacteria, is linked to homeless AIDS patients and to those afflicted with cat-scratch disease.

The infection is rarely seen today in patients who don't have HIV. According to the U.S. Centers for Disease Control and Prevention (CDC), an HIV patient diagnosed with bacillary angiomatosis is considered to have progressed to full-blown AIDS.

Causes and symptoms

Scientists have recently isolated two varieties of the Bartonella bacteria as the cause of bacillary angiomatosis: *Bartonella* (formerly *Rochalimaeaquintana*) and *B. henselae* (cause of cat-scratch disease).

B. quintana infection is known popularly as **trench fever** and is the infection associated with body lice that sickened European troops during World War I. Lice carry the bacteria, and can transmit the infection to humans. The incidence of trench **fever** was believed to have faded away with the end of World War I. It was not diagnosed in the United States until 1992, when 10 cases were reported among homeless Seattle men.

The related bacteria *B. henselae* was first identified several years ago as the cause of cat-scratch fever. It also can lead to bacillary angiomatosis in AIDS patients. Bacillary angiomatosis caused by this bacteria is transmitted to AIDS patients from cat fleas.

These two different types of bacteria both cause bacillary angiomatosis, a disease that is characterized by wildly proliferating blood vessels that form tumor-like masses in the skin and organs. The nodules that appear in bacillary angiomatosis are firm and don't turn white when pressed. The lesions can occur anywhere on the body, in numbers ranging from one to 100. They are rarely found on palms of the hands, soles of the feet, or in the mouth. As the number of lesions increase, the patient may develop a high fever, sweats, chills, poor appetite, **vomiting**, and weight loss. If untreated, the infection may be fatal.

In addition to the basic disease process, the two different types of bacteria cause some slightly different symptoms. Patients infected with *B. henselae* also experience blood-filled cysts within the liver and abnormal liver function, whereas *B. quintana* patients may have tumor growths in the bone.

Diagnosis

This life-threatening but curable infection is often misdiagnosed, because it may be mistaken for other conditions (such as Kaposi's sarcoma). A blood test developed in 1992 by the CDC detects antibodies to the bacteria. It can be confirmed by reviewing symptoms, history and negative tests for other diseases that cause swollen lymph glands. It isn't necessary to biopsy a small sample of the lymph node unless there is a question of **cancer** of the lymph node or some other disease.

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KEY TERMS

Cat-scratch disease—An infectious disease caused by bacteria transmitted by the common cat flea that causes a self-limiting, mild infection in healthy people.

Kaposi's sarcoma—A malignant condition that begins as soft brown or purple lesions on the skin and occurs most often in men with AIDS.

Treatment

Recent research indicates that **antibiotics** used to treat other HIV opportunistic infections can both prevent and treat bacillary angiomatosis. Treatment is usually given until the lesions disappear, which typically takes three or four weeks. A severely affected lymph node or blister may have to be drained, and a heating pad may help swollen, tender lymph glands. **Acetaminophen** (Tylenol) may relieve **pain**, aches, and fever over 101 °F (38.3 °C).

Prognosis

In most cases, prompt antibiotic treatment in patients with AIDS cured the infection caused by either variety of the bacteria, and patients may resume normal life. Early diagnosis is crucial to a cure.

Prevention

Studies suggest that antibiotics may prevent the disease. Patients also should be sure to treat cats for fleas.

Resources

PERIODICALS

Koehler, J. E. "Zoonoses: Cats, Fleas and Bacteria." *Journal of the American Medical Association* 271 (1994): 531-535.

Carol A. Turkington

Bacillary dysentery *see* **Shigellosis**

Bacitracin *see* **Antibiotics, topical**

Bacteremia

Definition

Bacteremia is an invasion of the bloodstream by bacteria.

Description

Bacteremia occurs when bacteria enter the bloodstream. This may occur through a wound or infection, or through a surgical procedure or injection. Bacteremia may cause no symptoms and resolve without treatment, or it may produce **fever** and other symptoms of infection. In some cases, bacteremia leads to **septic shock**, a potentially life-threatening condition.

Risk factors

Any opening through the skin and/or body orifices that allows for the entrance of bacteria into the body places an individual, particularly those with a compromised immune system, at increased risk for the development of bacteremia.

Conditions that increase the chances of developing bacteremia include:

- immune suppression, either due to HIV infection or drug therapy that suppresses the immune system
- antibiotic therapy, which changes the balance of bacterial types in the body
- prolonged or severe illness
- alcoholism or other drug abuse
- malnutrition
- diseases or drug therapy that cause ulcers in the intestines, e.g., chemotherapy for cancer

Causes and symptoms

Causes

Several types of bacteria live on the surface of the skin or colonize the moist linings of the urinary tract, lower digestive tract, and other internal surfaces. These bacteria are normally harmless as long as they are kept in check by the body's natural barriers and the immune system. People in good health with strong immune systems rarely develop bacteremia. However, when bacteria are introduced directly into the circulatory system, especially in a person who is ill or undergoing aggressive medical treatment, the immune system may not be able to cope with the invasion, and symptoms of bacteremia may develop. For this reason, bacteremia is most common in people who are already affected by or being treated for some other medical problem. In addition, medical treatment may bring a person in contact with new types of bacteria that are more invasive than those already residing in that person's body, further increasing the likelihood of bacterial infection.

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KEY TERMS

Colostomy—Surgical creation of an artificial anus on the abdominal wall by cutting into the colon and bringing it up to the surface.

Gastrostomy—Surgical creation of an artificial opening into the stomach through the abdominal wall to allow tube feeding.

Jejunostomy—Surgical creation of an opening to the middle portion of the small intestine (jejunum), through the abdominal wall.

Septic shock—A life-threatening drop in blood pressure caused by bacterial infection.

Common immediate causes of bacteremia include:

- drainage of an abscess, including an abscessed tooth
- urinary tract infection, especially in the presence of a bladder catheter
- decubitus ulcers (pressure sores)
- intravenous procedures using unsterilized needles, including IV drug use
- prolonged IV needle placement
- use of ostomy tubes, including gastrostomy (surgically making a new opening into the stomach), jejunostomy (surgically making an opening from the abdominal wall into the jejunum), and colostomy (surgically creating an artificial opening into the colon)

The bacteria most likely to cause bacteremia include members of the *Staphylococcus*, *Streptococcus*, *Pseudomonas*, *Haemophilus,* and *Esherichia* (*E. coli*) genera.

Symptoms

Symptoms of bacteremia may include:

- fever over 101°F (38.3°C)
- chills
- malaise
- abdominal pain
- nausea
- vomiting
- diarrhea
- anxiety
- shortness of breath
- confusion

Not all of these symptoms may be present. In the elderly, confusion may be the only prominent symptom. Bacteremia may lead to septic shock, whose symptoms include decreased consciousness, rapid heart and breathing rates, and multiple organ failures.

Diagnosis

Tests

Bacteremia is diagnosed by culturing the blood for bacteria. Samples may need to be tested several times over several hours. Blood analysis may also reveal an elevated number of white blood cells.

Treatment

Bacteremia may cause no symptoms, but may be discovered through a blood test for another condition. In this situation, it may not need to be treated, except in patients especially at risk for infection, such as those with heart valve defects or whose immune systems are suppressed.

Drugs

Prompt antibiotic therapy usually succeeds in clearing bacteria from the bloodstream. Recurrence may indicate an undiscovered site of infection. Untreated bacteria in the blood may spread, causing infection of the heart (**endocarditis** or **pericarditis**) or infection of the covering of the central nervous system (**meningitis**).

Blood pressure is monitored closely; a decline in blood pressure may indicate the onset of septic shock.

Prognosis

If detected and treated promptly, most individuals recover from bacteremia. However, in individuals whose immune systems are compromised, it is critical that the condition be treated promptly and aggressively so that it does not progress to **sepsis** or septic shock, which can lead to **death** even if treatment is initiated.

Prevention

Bacteremia can be prevented by preventing the infections that often precede it. Good personal hygiene such as effective hand-washing, especially during viral illness, may reduce the risk of developing bacterial infection. Treating bacterial infections quickly and thoroughly can minimize the risk of spreading infection. During medical procedures, the burden falls on medical professionals to minimize the number and duration of invasive procedures, to reduce patients' exposure to

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sources of bacteria when being treated, and to use scrupulous technique.

Resources

PERIODICALS

Lee, A., S. Mirrett, L.B. Reller, and M.P. Weinstein. "Detection of Bloodstream Infections in Adults. How Many Blood Cultures Are Needed?" *Journal of Clinical Microbiology* 45, no. 11 (2007): 3546–48.

Richard Robinson
Melinda Granger Oberleitner
RN, DNS, APRN, CNS

Bacterial meningitis *see* **Meningitis**

Bacterial vaginosis

Definition

Bacterial vaginosis (BV) is a type of vaginal infection in which the normal balance of bacteria in the vagina is disrupted, allowing the overgrowth of harmful anaerobic bacteria at the expense of protective bacteria.

Description

BV is the most common and the most serious type of vaginal infection in women of childbearing age. As many as 10 to 26 percent of pregnant women in the United States have BV; BV has been found in 12 to 25 percent of women in routine clinic populations, and in 32 to 64 percent of women in clinics for **sexually transmitted diseases** (STDs). BV is different than vaginal yeast infections and requires different methods of treatment.

In most cases, BV does not have lasting effects on women. However, there can be risks associated with BV:

Causes and symptoms

Bacteria that dominate the vaginal flora in a BV infection include *Gardnerella vaginalis* or *Mobiluncus*, although other bacteria, such as ***Escherichia coli*** from the rectum have also been shown to cause the disease. The overgrowth of these harmful bacteria are at the expense of the protective bacteria lactobacilli, which secrete a natural disinfectant, hydrogen peroxide, that maintains the healthy, normal balance of vaginal microorganisms. The factors that upset the normal balance of bacteria in the vagina are not well understood; however, the following activities or behaviors that have been associated with BV include:

KEY TERMS

Anaerobic bacteria—Bacteria that do not require oxgyen, found in low concentrations in the vagina.

Vaginal discharge—Discharge of secretions from the cervical glands of the vagina; normally clear or white.

- having a new sex partner or multiple sex partners
- stress
- douching
- using an intrauterine device (IUD) for contraception

BV is not transmitted through toilet seats, bedding, swimming pools, or touching of objects. Women who have not had sexual intercourse rarely have BV. BV is not considered an STD, although it does appear to act like an STD in women who have sex with women.

The main symptom of BV is a thin, watery or foamy, white (milky) or gray vaginal discharge with an unpleasant, foul, fish-like or musty odor. The odor is sometimes stronger after a woman has sex, when the semen mixes with the vaginal secretions. Burning or **pain** during urination can also be present with BV. **Itching** on the outside of the vagina and redness can also occur, but are seen less frequently. However, many women with BV do not exhibit any symptoms.

Diagnosis

BV is diagnosed through an examination of the vagina by a health care provider. A woman who suspects that she may have BV should not douche or use a feminine hygiene spray before the appointment with the health care provider. Laboratory tests are conducted on a sample of the vaginal fluid to see if the bacteria present are those associated with BV. The health care provider may also check to see if there is decreased vaginal acidity. Potassium hydroxide, when added to a vaginal discharge sample, enhances vaginal odors and allows the health care provider to determine if the odor is fishy or foul.

Treatment

In a few cases, BV might clear up without treatment. However, all women with symptoms of BV should be treated to relieve symptoms and to avoid the development of complications such as **pelvic inflammatory disease** (PID). In most cases, male partners are not

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treated, but female sexual partners should be examined to see if they have BV and require treatment.

BV is treated with prescription **antibiotics** such as metronidazole or clindamycin creams or oral metronidazole (both are antibiotics that can also be used by pregnant women, although at different doses). Metronidazole kills anaerobic bacteria but does not harm the protective lactobacilli. Drinking alcohol should be avoided when taking metronidazole, for this medicine can cause severe **nausea and vomiting** when combined with alcohol.

For postmenopausal women, in addition to the use of antibiotics, the health care provider may also prescribe estrogen suppositories or topical cream to thicken and lubricate vaginal tissues. Sexual activity should be avoided during treatment; a condom should be used if the woman does have sexual intercourse. The woman should be tested after treatment to ensure that the infection has been cured.

Alternative treatment

Supplement therapies are available in addition to the use of prescription medicines to ease recovery.

Herbal therapies

Fresh garlic (*Allium sativum*) has antibacterial properties and can be added to a woman's diet. A fresh, peeled garlic wrapped in gauze can also be inserted into the vagina to help treat BV. The insert should be changed twice daily.

To soothe itching or irritation of the vaginal tissues, a woman can bathe the tissues in an infusion of fresh chickweed (*Stellaria media*). The infusion is made by pouring one cup of boiling water on one to two teaspoons of the herb, steeping for five minutes, and allowing the mixture to cool before use.

Prognosis

- Pregnant women with BV often have babies of low birth weight (less than 5.5 pounds) or who are premature.
- Bacteria that cause BV may also cause pelvic inflammatory disease (PID), an infection of the uterus and fallopian tubes. The risk of a woman with BV developing PID is higher after the woman undergoes surgical procedures such as a hysterectomy or an abortion. PID can result in infertility and can also increase the risk of an ectopic pregnancy.
- BV may increase the risk of a woman becoming infected with HIV, the virus that causes AIDS.
- A woman with BV and HIV is more likely to pass HIV to her sexual partner.
- BV increases the chance that a woman will contract other STDs, such as chlamydia and gonorrhea.

BV can be successfully treated with antibiotics.

Prevention

Since the development of BV often appears to be associated with sexual activities, recommended ways to avoid BV include:

- practicing abstinence
- delaying having sex for the first time, as younger people who have sex are more likely to contract BV and STDs
- limiting the number of sexual partners
- having a sexual relationship with only one partner who does not have an STD
- practicing safer sex, which means using a condom every time when having sex

Other ways to prevent BV include:

- discontinuing the use of tampons for six months
- practicing good hygiene by wiping from front to back (away from the vagina) after bowel movements to avoid spreading bacteria from the rectum to the vagina
- wearing cotton panties and panty hose with a cotton crotch and avoiding tight or latex clothing to keep the vagina cool and dry
- avoiding the use of perfumed soaps and feminine sprays
- lowering stress levels
- avoiding douching, as douching removes some of the normal bacteria in the vagina that protects women from infection
- finishing the course of antibiotic treatment, even if the symptoms are relieved, to prevent reoccurrence of the disease
- routinely being tested for BV during regular gynecological examinations

Some physicians recommend that all women who have a **hysterectomy** or an abortion be treated for BV, to reduce the risk of developing PID.

Resources

BOOKS

Hollier, Lisa M., and George D. Wendel. *Infectious Diseases in Women*. Philadelphia: Saunders, 2008.

Introduction to Bacterial Vaginosis: A Roundtable Discussion. Woodcliff Lake, NJ: Advanstar Communications, 2007.

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3M National Vaginitis Association. *Women's Guide to Vaginal Infections*. Brochure available for download: www3.3m. com/pdas-nva/cons_addresources.html

ORGANIZATIONS

American College of Obstetricians and Gynecologists, PO Box 96920, Washington, DC, 20090-6920, (202) 638-5577, http://www.acog.org.

American Social Health Association, P.O. Box 13827, Research Triangle Park, NC, 27709, (919) 361-8400, (919) 361-8425, http://www.ashastd.org.

Judith Sims

Bacteroides infection *see* **Anaerobic infections**

Bad breath

Definition

Bad breath, sometimes called halitosis, is an unpleasant odor of the breath.

Description

Bad breath is likely to be experienced by most adults at least occasionally. Bad breath, either real or imagined, can have a significant impact on a person's social and professional life.

Causes and symptoms

Bad breath can be caused by a number of problems. Oral diseases, fermentation of food particles in the mouth, sinus infections, and unclean dentures can all contribute to mouth odor. Many non-oral diseases, such as lung infections, kidney failure, or severe **liver disease**, can also cause bad breath, though rarely. Many people think that bad breath can originate in the stomach or intestines; this is extremely rare. The esophagus is usually collapsed and closed, and, although a belch may carry odor up from the stomach, the chance of bad breath being caused from air continually escaping from the stomach is remote. Cigarette smoke can cause bad breath, not only in the cigarette smoker, but also in one who is constantly exposed to secondhand smoke.

Diagnosis

The easiest way to determine if one has bad breath is to ask someone who is trustworthy and discrete. This is usually not too difficult. Another, more private, method of determining if one has bad breath is to lick one's wrist, wait until it dries, then smell the area. Scraping the rear area of the tongue with a plastic spoon, then smelling the spoon, is another method one can use to assess bad breath.

KEY TERMS

Halitosis—The medical term for bad breath.

Treatment

The most effective treatment of bad breath is to treat the cause. Poor **oral hygiene** can be improved by regular brushing and flossing, as well as regular dental checkups. Gentle brushing of the tongue should be part of daily oral hygiene. In addition to good oral hygiene, the judicious use of mouthwash is helpful. Mouth dryness, experienced at night or during **fasting**, or due to certain medications and medical conditions, can contribute to bad breath. Dryness can be avoided by drinking adequate amounts of water. Chewing gum may be beneficial.

As mentioned, some medications, such as some high blood pressure medications, can cause **dry mouth**. If this problem is significant, a medication change, under the supervision of one's health care provider, may improve the dry-mouth condition. Oral or sinus infections, once diagnosed, can be treated medically, usually with **antibiotics**. Lung infections and kidney or liver problems will, of course, need medical treatment.

Alternative treatment

Depending on the cause, a multitude of alternative therapeutic remedies can be used. For example, **sinusitis** can be treated with steam inhalation of essential oils and/or herbs.

Prognosis

Most bad breath can be treated successfully with good oral hygiene and/or medical care. Occasionally, for patients who feel that these therapies are unsuccessful, some delusional or obsessive behavior pattern might pertain, and mental health counseling may be appropriate.

ORGANIZATIONS

American Dental Association, 211 E. Chicago Ave., Chicago, IL, 60611-2678, (312) 440-2500, http://www.ada.org.

American Medical Association, 515 N. State St., Chicago, IL, 60654, (800) 621-8335, http://www.ama-assn.org/.

Joseph Knight, PA

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Balance and coordination tests

Definition

Balance is the ability to maintain a position. Coordination is the capacity to move through a complex set of movements. Balance and coordination depend on the interaction of multiple body organs and systems including the eyes, ears, brain and nervous system, cardiovascular system, and muscles. Tests or examination of any or all of these organs or systems may be necessary to determine the causes of loss of balance, **dizziness**, or the inability to coordinate movement or activities.

Purpose

Tests of balance and coordination, and the examination of the organs and systems that influence balance and coordination, can help to identify causes of dizziness, **fainting**, falling, or incoordination.

A patient sits on a ball, working on his balance. He wears a belt so that the physical therapist can catch him if he loses balance. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

KEY TERMS

Meniere's disease—An abnormality of the inner ear that causes dizziness, ringing in the ears, and hearing loss.

Precautions

Tests for balance and coordination should be conducted in a safe and controlled area where patients will not experience injury if they become dizzy or fall.

Description

Assessment of balance and coordination can include discussion of the patient's medical history and a complete **physical examination** including evaluation of the heart, head, eyes, and ears. A slow pulse or heart rate, or very low blood pressure may indicate a circulatory system problem, which can cause dizziness or fainting. During the examination, the patient may be asked to rotate the head from side to side while sitting up or while lying down with the head and neck extended over the edge of the examination table. If these tests produce dizziness or a rapid twitching of the eyeballs (**nystagmus**), the patient may have a disorder of the inner ear, which is responsible for maintaining balance.

An examination of the eyes and ears may also give clues to episodes of dizziness or incoordination. The patient may be asked to focus on a light or on a distant point or object, and to look up, down, left, and right moving only the eyes while the eyes are examined. Problems with vision may, in themselves, contribute to balance and coordination disturbances, or may indicate more serious problems of the nervous system or brain function. **Hearing loss**, fluid in the inner ear, or ear infection might indicate the cause of balance and coordination problems.

Various physical tests may also be used. A patient may be asked to walk a straight line, stand on one foot, or touch a finger to the nose to help assess balance. The patient may be asked to squeeze or push against the doctor's hands, to squat down, to bend over, stand on tiptoes or stand on their heels. Important aspects of these tests include holding positions for a certain number of seconds, successfully repeating movements a certain number of times, and repeating the test accurately with eyes closed. The patient's reflexes may also

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be tested. For example, the doctor may tap on the knees, ankles, and elbows with a small rubber mallet to test nervous system functioning. These tests may reveal muscle weakness or nervous system problems that could contribute to incoordination.

Preparation

No special preparation is required prior to administration of balance and coordination tests. The patient may be asked to disrobe and put on an examination gown to make it easier for the doctor to observe muscles and reflex responses.

Aftercare

No special aftercare is generally required, however, some of the tests may cause episodes of dizziness or incoordination. Patients may need to use caution in returning to normal activities if they are experiencing any symptoms of dizziness, lightheadedness, or weakness.

Risks

These simple tests of balance and coordination are generally harmless.

Normal results

Under normal conditions, these tests will not cause dizziness, loss of balance, or incoordination.

Abnormal results

The presence of dizziness, lightheadedness, loss of coordination, unusual eye movements, muscle weakness, or impaired reflexes are abnormal results and may indicate the problem causing the loss of balance or incoordination. In some cases, additional testing may be needed to diagnose the cause of balance or coordination problems.

ORGANIZATIONS

EAR Foundation of Arizona, 668 North 44th Street, Suite 300, Phoenix, AZ, 85008, (602) 685-1050, (602) 239-5117, melissa@earfoundationaz.com, http://www.earfoundationaz.com.

Vestibular Disorders Association (VEDA), P.O. Box 4467, Portland, OR, 97208-4467, (503) 229-8064, (800) 837-8428, http://www.vestibular.org.

Altha Roberts Edgren

Balanitis

Definition

Balanitis is an inflammation of the head and foreskin of the penis.

Description

Balanitis generally affects uncircumcised males. These are men who have a foreskin, which is the "hood" of soft skin that partially covers the head of the penis. In balanitis, the head and foreskin become red and inflamed. (In circumcised men, who lack a foreskin, these symptoms only affect the tip of the penis.) The condition often occurs due to the fungus *Candida albicans*, the same organism that causes vaginal yeast infections in women. Balanitis (which is also referred to as balanoposthitis) can be caused by a variety of other fungal or bacterial infections, or may occur due to a sensitivity reaction to common chemical agents.

Uncircumcised men are more at risk for balanitis due to the presence of the foreskin. The snug fit of the foreskin around the top of the penis tends to create a damp, warm environment that encourages the growth of microorganisms. Most of the organisms associated with balanitis are already present on the penis, but in very small numbers. However, if the area between the head and foreskin is not cleansed thoroughly on a regular basis, these organisms can multiply and lead to infection.

Diabetes can increase the risk of developing the condition.

Causes and symptoms

Balanitis is usually a result of poor hygiene—for example, neglecting to bathe for several days. A failure to properly wash (or rinse) the area between the head and foreskin can lead to the development of fungal or bacterial infections that cause the condition. In other cases, balanitis may occur due to an allergic reaction: some men may be sensitive to chemicals found in harsh soaps, laundry detergents, or contraceptive creams. Men who contract a sexually transmitted disease (STD) such as trichimoniasis may also develop symptoms.

The symptoms of balanitis are limited to the foreskin and head of the penis (in circumcised men, only the head is affected). These include redness, inflammation, **pain**, discharge, sore or itchy skin, and difficulty retracting the foreskin.

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KEY TERMS

Acidophilus—A bacteria believed to combat yeast infections.

Circumcision—The surgical removal of the foreskin.

Urethral stricture—A narrowing of the urethra (urine tube).

Diagnosis

Balanitis is usually diagnosed based on a brief **physical examination**. This may be conducted by your regular health care provider or by a urologist, the type of doctor who specializes in such disorders. The doctor may take a sample of the discharge (if any) to determine the nature of the possible infection. A urine test may be recommended to evaluate glucose (sugar) levels in the urine. Balanitis treatment is typically covered by medical insurance.

Treatment

The treatment of balanitis depends on the specific cause, which can vary from case to case. **Antibiotics** are used to treat bacterial infections, while topical antifungals such as clotrimazole can combat balanitis caused by *Candida*. If an allergic reaction is causing symptoms, the goal is to identify the chemical agent responsible. Ointments or creams may be used to ease skin irritation.

No matter what the cause, it is important to thoroughly clean the penis on a daily basis in order to alleviate symptoms. If the condition keeps occurring, or if the inflammation is interfering with urination, **circumcision** may be advised.

Alternative treatment

According to practitioners of alternative medicine, certain herbs may be effective in controlling or preventing yeast infections—a common cause of balanitis. These remedies include garlic, calendula, and goldenseal. Eating yogurt that contains acidophilus may also help to clear up a *Candida* infection.

Prognosis

Most cases go away quickly once the cause is identified and treated. However, regular bouts of balanitis can result in urethral stricture.

Prevention

Proper hygiene is the best way to avoid balanitis. Circumcision is sometimes performed to prevent repeated cases.

Resources

BOOKS

Tanagho, Emil A., Jack W McAninch, and Donald Ridgeway Smith. *Smith's General Urology*. New York: McGraw-Hill Medical, 2008.

ORGANIZATIONS

U.S. National Library of Medicine, 8600 Rockville Pike, Bethesda, MD, 20894, (888) 346-3656, http://www.nlm.nih.gov.

Greg Annussek

Balantidiasis

Definition

Balantidiasis is an **infectious disease** produced by a single-celled microorganism (protozoan) called *Balantidium coli* that infects the digestive tract. It is primarily a disease of the tropics, although it is also found in cooler, temperate climates. Most persons with balantidiasis do not exhibit any noticeable symptoms (asymptomatic), but a few individuals will develop **diarrhea** with blood and mucus and an inflamed colon (**colitis**).

Description

Balantidiasis is caused by *Balantidium coli*, a parasitic protozoan that infects the large intestine. *B. coli* is the largest and only protozoan, having cilia or hair-like structures, that is capable of causing disease in humans. Balantidiasis occurs most commonly in areas with poor sanitation and in settings where humans live in close contact with pigs, sheep, or goats.

Causes and symptoms

Balantidiasis is transmitted primarily by eating food or drinking water that has been contaminated by human or animal feces containing *B. coli* cysts. During its life cycle, this organism exists in two very different forms: the infective cyst or capsuled form, which cannot move but can survive outside the human body because of its thick, protective covering; and the disease-producing form, the trophozoite, which although capable of moving, cannot survive once excreted in the feces and, therefore, cannot infect others. In the digestive tract, the

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KEY TERMS

Asymptomatic—Persons who carry a disease and are usually capable of transmitting the disease but who do not exhibit symptoms of the disease are said to be asymptomatic.

Biopsy—The removal of a tissue sample for diagnostic purposes.

Ciliated—Covered with short, hair-like protrusions, like *B. coli* and certain other protozoa. The cilia or hairs help the organism to move.

Colitis—An inflammation of the large intestine that occurs in some cases of balantidiasis. It is marked by cramping pain and the passing of bloody mucus.

Protozoan—A single-celled, usually microscopic organism, such as *B. coli*, that is eukaryotic and, therefore, different from bacteria (prokaryotic).

Sigmoidoscopy—A procedure in which a thin, flexible, lighted instrument, called a sigmoidoscope, is used to visually examine the lower part of the large intestine.

cysts are transported to the intestine where the walls of the cysts are broken open by digestive secretions, releasing the mobile trophozoites. Once released within the intestine, the trophozoites multiply by feeding on intestinal bacteria or by invading the lining of the large intestine. Within the lining of the large intestine, the trophozoites secrete a substance that destroys intestinal tissue and creates sores (ulcers) or abscesses. Trophozoites eventually form new cysts that are carried through the digestive tract and excreted in the feces. Under favorable temperature and humidity conditions, the cysts can survive in soil or water for weeks to months, ready to begin the cycle again.

Most individuals with balantidiasis have no noticeable symptoms. Even though these individuals may not feel ill, they are still capable of infecting others by person-to-person contact or by contaminating food or water with cysts that others may ingest, for example, by preparing food with unwashed hands.

The most common symptoms of balantidiasis are chronic diarrhea or severe colitis with abdominal cramps, **pain**, and bloody stools. Complications may include intestinal perforation in which the intestinal wall becomes torn, but the organisms do not spread to other parts of the body in the blood stream.

Diagnosis

Diagnosis of balantidiasis, as with other similar diseases, can be complicated, partly because symptoms may or may not be present. A diagnosis of balantidiasis may be considered when a patient has diarrhea combined with a possible history of recent exposure to **amebiasis** through travel, contact with infected persons, or anal intercourse.

Specifically, a diagnosis of balantidiasis is made by finding *B. coli* cysts or trophozoites in the patient's stools or by finding trophozoites in tissue samples (biopsy) taken from the large bowel. A diagnostic blood test has not yet been developed.

Stool examination

This test involves microscopically examining a stool sample for the presence of cysts and/or trophozoites of *B. coli*.

Sigmoidoscopy

To take a tissue sample from the large intestine, a procedure called a **sigmoidoscopy** is performed. During a sigmoidoscopy, a thin, flexible instrument is used to visually examine the intestinal lining and obtain small tissue specimens.

Treatment

Patients with balantidiasis are treated with prescription medication, typically consisting of a ten-day course of either tetracycline or metronidazole. Alternative drugs that have proven effective in treating balantidiasis include iodoquinol or paromomycin.

Prognosis

Although somewhat dependent on the patient's overall health, in general, the prognosis for most patients with balantidiasis is good. Severely infected patients occasionally die as a result of a tear in the intestinal wall (intestinal perforation) and consequent loss of blood.

Prevention

There are no immunization procedures or medications that can be taken prior to potential exposure to prevent balantidiasis. Moreover, people who have had the disease can become reinfected. Prevention requires

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effective personal and community hygiene. Specific safeguards include the following:

- Purification of drinking water. Water can be purified by filtering, boiling, or treatment with iodine.
- Proper food handling. Measures include protecting food from contamination by flies, cooking food properly, washing one's hands after using the bathroom and before cooking or eating, and avoiding foods that cannot be cooked or peeled when traveling in countries with high rates of balantidiasis.
- Careful disposal of human feces.
- Monitoring the contacts of balantidiasis patients. The stools of family members and sexual partners of infected persons should be tested for the presence of cysts or trophozoites.

Resources

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Rebecca J. Frey, PhD

Baldness *see* **Alopecia**

Balloon angioplasty *see* **Angioplasty**

Balloon valvuloplasty

Definition

Balloon valvuloplasty is a procedure in which a narrowed heart valve is stretched open using a procedure that does not require open heart surgery.

Purpose

There are four valves in the heart, which are located at the exit of each of the four chambers of the heart. They are called aortic valve, pulmonary valve, mitral valve, and tricuspid valve. The valves open and close to regulate the blood flow from one chamber to the next. They are vital to the efficient functioning of the heart.

In some people the valves are too narrow (a condition called stenosis). Balloon valvuloplasty is performed on children and adults to improve valve function and blood flow by enlarging the valve opening. It is a treatment for aortic, mitral, and pulmonary stenosis. Balloon valvuloplasty has the best results as a treatment for narrowed pulmonary valves. Results in treating narrowing of the mitral valve are generally good. It is more difficult to perform and less successful in treating narrowing of the aortic valve.

KEY TERMS

Cardiac catheterization—A technique used to evaluate the heart and fix certain problems. Catheterization is far less invasive than traditional surgery.

Stenosis—The narrowing of any valve, especially one of the heart valves or the opening into the pulmonary artery from the right ventricle.

Valve—Tissue in the passageways between the heart's upper and lower chambers that controls passage of blood and prevents regurgitation.

Description

Balloon valvuloplasty is a procedure in which a thin tube (catheter) that has a small deflated balloon at the tip is inserted through the skin in the groin area into a blood vessel, and then is threaded up to the opening of the narrowed heart valve. The balloon is inflated, which stretches the valve open. This procedure cures many valve obstructions. It is also called balloon enlargement of a narrowed heart valve.

The procedure is performed in a **cardiac catheterization** laboratory and takes up to four hours. The patient is usually awake, but is given **local anesthesia** to make the area where the catheter is inserted numb. After the site where the catheter will be inserted is prepared and anesthetized, the cardiologist inserts a catheter into the appropriate blood vessel, then passes a balloon-tipped catheter through the first catheter. Guided by a video monitor and an x ray, the physician slowly threads the catheter into the heart. The deflated balloon is positioned in the valve opening, then is inflated repeatedly. The inflated balloon widens the valve's opening by splitting the valve leaflets apart. Once the valve is widened, the balloon-tipped catheter is removed. The other catheter remains in place for 6 to 12 hours because in some cases the procedure must be repeated.

Preparation

For at least six hours before balloon valvuloplasty, the patient will have to avoid eating or drinking anything. An intravenous line is inserted so that medications can be administered. The patient's groin area is shaved and cleaned with an antiseptic. About an hour before the procedure, the patient is given an oral sedative such as diazepam (Valium).

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Aftercare

After balloon valvuloplasty, the patient is sent to the recovery room for several hours, where he or she is monitored for vital signs (such as pulse and breathing) and heart sounds. An electrocardiogram, which is a record of the electrical impulses in the heart, is done. The leg in which the catheter was inserted is temporarily prevented from moving. The skin condition is monitored. The insertion site, which will be covered by a sandbag, is observed for bleeding until the catheter is removed. Intravenous fluids will be given to help eliminate the x-ray dye; intravenous blood thinners or other medications to dilate the coronary arteries may be given. **Pain** medication is available.

For at least 30 minutes after removal of the catheter, direct pressure is applied to the site of insertion; after this a pressure dressing will be applied. Following discharge from the hospital, the patient can usually resume normal activities. After balloon valvuloplasty lifelong follow-up is necessary because valves sometimes degenerate or narrowing recurs, making surgery necessary.

Risks

Balloon valvuloplasty can have serious complications. For example, the valve can become misshapen so that it doesn't close completely, which makes the condition worse. **Embolism**, where pieces of the valve break off and travel to the brain or the lungs, is another possible risk. If the procedure causes severe damage to the valve leaflets, immediate surgery is required. Less frequent complications are bleeding and hematoma (a local collection of clotted blood) at the puncture site, abnormal heart rhythms, reduced blood flow, **heart attack**, heart puncture, infection, and circulatory problems.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

Lori De Milto

Bancroftian filariasis *see* **Elephantiasis**

Bandages and dressings

Definition

Bandages and dressings are both used in wound management. A bandage is a piece of cloth or other material used to bind or wrap a diseased or injured part of the body. Usually shaped as a strip or pad, bandages are either placed directly against the wound or used to bind a dressing to the wound. A dressing can consist of a wide range of materials, sometimes containing medication, placed directly against the wound.

Purpose

The purposes served by dressings include protecting **wounds**; promoting healing; and providing, retaining, or removing moisture. Bandages can be used to hold dressings in place, to relieve **pain**, and generally to make the patient comfortable. Elastic bandages are useful to provide ongoing pressure on wounds such as **varicose veins**, fractured ribs, and swollen joints.

Description

In recent years, there have been tremendous advances in the design and composition of bandages and dressings. The field is becoming increasingly complex, and there are numerous reports of health care workers applying inappropriate products. Wound-care materials come in a wide variety of product classes, including the following:

- Alginate dressings. These are derived from brown seaweed and contain calcium alginate, which turns into a sodium alginate gel when it comes in contact with wound fluid. They are available as pads or ropes.
- Biosynthetic dressings. These are composites of biological (often animal-derived) and synthetic materials such as polymers.
- Collagen dressings. These are made from collagen, a protein obtained from cowhide, cattle tendons, or birds. They are available as particles or gels.
- Composite dressings. These are similar to plastic adhesive strips and include an adhesive border, a non-adhesive or semi-adhesive surface that is applied to the wound, an absorbent layer, and a bacterial barrier.
- Contact layers. A low-adherent layer of perforated or woven polymer material designed to stop a secondary absorbent dressing from sticking to the surface of a wound.
- Gauze. This woven fabric of absorbent cotton is available in a number of formats and materials, including cotton or synthetic, non-impregnated, and impregnated with water, saline, or other substances. Gauze is sold as surgical swabs, sheets, rolls, pads, sponges, and ribbon.
- Growth factors. These short-chain proteins affect specific target cells. They exist naturally in humans,

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and can be transplanted from one part of the body to another or manufactured outside the body.

- Hydrocolloid dressings. Used for leg ulcers, minor burns, pressure sores and traumatic injuries, these self-adhesive dressings form a gel as they absorb fluid from the wound. They consist of materials such as sodium carboxymethylcellulose (an absorbent), pectin, and gelatin that are attached to a foam sheet or a thin polyurethane film.
- Hydrofibers. Similar in appearance to cotton, carboxymethylcellulose fibers turn into a gel when they come into contact with wound fluid. They are available as ribbons or pads and are highly absorbent.
- Hydrogels. These are sold as sheets and in gel form, and are primarily used to supply moisture to wounds. Depending on the state of the tissue, they can either absorb fluid or moisten the wound. An electrically conductive aloe vera gel is available to provide electrotherapy to wounds.
- Hydropolymers. These foamed-gel products consist of multiple layers. The surface layer is designed to expand to fill the contours of a wound and, at the same time, draw away fluids.
- Leg compression/wrapping products. These are designed to apply external pressure to improve blood flow and resolve chronic edema in the feet and legs. They are available in a broad range of formats, including stockings, compression bandages, or pneumatic pump.
- Polyurethane foam dressings. These are sheets of foamed polymer solutions with small open chambers that draw fluids away from the wound. Some of these foam products offer adhesive surfaces. They are available as sheets and rolls, as well as in various other formats suitable for packing wounds.
- Skin substitutes. Also known as allografts or skin equivalents, these are obtained from human cells cultured and expanded in vitro from neonatal foreskins.
- Superabsorbents. These are particles, hydropolymers, or foams that act like the material inside diapers, with a high capacity for rapid absorption.
- Transparent films. These consist of a thin, clear polyurethane sheet that, on one side, has a special adhesive that does not stick to moist surfaces like those found on a wound. They prevent bacteria and fluids from entering the wound through the dressing, but allow limited circulation of oxygen.
- Wound fillers. These can be bought as powders or pastes, or in strands or beads. They are used to fill wounds and also absorb wound fluid.
- Wound pouches. Equipped with a special collection system for wounds that have a high flow of secretion, they are designed to contain odors and to be easily drained.
- Other assorted wound-care products. These include adhesive bandages, surgical tapes, adhesive skin closures, surgical swabs, paste bandages, specialty absorptive dressings, support bandages, retention bandages, elasticized tubular bandages, lightweight elasticized tubular bandages, foam-padded elasticized tubular bandages, and plain stockinettes.

Just as there is a large selection of bandage and dressing products to choose from, there is also a broad range of applications for these products:

- Alginate dressings are used on wounds that exude moderate to heavy amounts of fluid. They are useful for packing wounds, although strip-packing gauze may be preferable for deeper wounds because it is easier to retrieve. Common applications of alginate dressings include treatment of acute surgical wounds, leg ulcers, sinuses, and pressure sores. These dressings should not be used on third-degree burns. Neither are they advisable for wounds that are dry or are secreting only small amounts of fluid, because their powerful absorbing capability may dry out the wound. These are primary dressings that need be covered by a secondary dressing.
- Biosynthetic dressings are used on burns and other wounds. Another application is as a temporary dressing for skin autograft sites. Some persons may be allergic to these dressing materials.
- Collagen dressings are believed to hasten wound repair and are often used on stubborn wounds. They are most effective on wounds that contain no dead tissue. Collagen dressings should not be used in dry wounds, third-degree burns, or on any patient who is sensitive to bovine (cow) products.
- Composite dressings are sometimes used alone, sometimes in combination with other dressings. Deep wounds should first be packed with wound-filler material. These dressings should not be cut, and are not recommended for use on third-degree burns.
- Contact layers are designed for use in clean wounds that contain no dead tissue. They are not recommended for infected, shallow, or dry wounds, or on third-degree burns.
- Gauze is used to pack wounds, and also for debridement and wicking. It is especially desirable for packing deep wounds. When using gauze to pack wounds, a loose packing technique is preferred.
- Growth factors. These have highly specific applications against such conditions as diabetic foot ulcers involving disease of the peripheral nerves. Growth factors are heat sensitive and often require

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refrigeration. These are not recommended for persons with benign or malignant tumors.

- Hydrocolloid dressings are used for leg ulcers, minor burns, pressure sores, and traumatic injuries. Because they are not painful to remove, hydrocolloid dressings are often employed in pediatric wound management. Because of their absorbent capabilities, they are used on wounds that are secreting light to moderate amounts of fluid.
- Hydrofibers are highly absorbent, so they are particularly useful for wounds that are draining heavily. For this reason, they are not recommended for dry wounds or wounds with little secretion, because they may result in dehydration. Hydrofibers should not be used as surgical sponges or on third-degree burns.
- Hydrogels are often used on wounds that contain dead tissue, on infected surgical wounds, and on painful wounds. They should not be used on wounds with moderate to heavy secretions. As with all dressings, it is important to check and follow the directions of the manufacturer. In the case of hydrogels, directions on some products indicate they are not to be used on third-degree burns.
- Hydropolymers are typically used on wounds with minimal to moderate drainage. They are not indicated for dry wounds or third-degree burns.
- Leg compression/wrapping products are used to increase blood flow and reduce edema in the lower extremities of the body. A medical doctor should be consulted before using these products on people with edema. In many cases, topical dressings are used under these products.
- Polyurethane foam dressings are very absorbent and are typically used on wounds with moderate to heavy secretions. They should not be used on third-degree burns or on wounds that are not draining or that have sinuses or tunneling.
- Skin substitutes are a relatively new product category, approved for treating venous leg ulcers. It is often advisable to cut slits in the artificial skin, so that wound secretions underneath do not lift the newly applied skin.
- Superabsorbents are employed on wounds that are secreting heavily, or in applications requiring extended wear. A packing material is commonly employed under this product. Superabsorbents should not be used on third-degree burns or wounds that are either dry or have minimal secretions.
- Transparent films are often employed as a secondary cover for another, primary dressing. They are used on superficial wounds and on intact skin at risk of infection. It is important to remove transparent films very carefully to avoid damaging fragile skin.
- Wound fillers are primary dressings that are usually used in conjunction with other, secondary dressings. Wound fillers are considered appropriate for shallow wounds with little or moderate secretions. They are not appropriate for use in third-degree burns or in dry wounds. They are similarly not recommended for wounds with tunnels or sinuses.
- Wound pouches are useful in treating wounds with high volumes of secretion. They are not suitable for dry wounds.

Recommended intervals between dressing changes vary widely among product classes. The materials used in some dressings require that they be changed several times a day. Others can remain in place for one week. Manufacturer's directions should be consulted and followed.

KEY TERMS

Debridement—Removing dead or nonviable tissue from a wound.

Edema—Swelling of body tissues, caused by collection of excess fluid.

Electrotherapy—The treatment of body tissues by passing electrical currents through them, stimulating the nerves and muscles.

Sinus—In the context of wound management, a narrow hollow in the body extending from an infected area to the surface of the skin.

Stockinette—A soft elastic material used for bandages and clothing for infants.

Preparation

Wounds require appropriate cleaning, **debridement**, closure, and medication before bandages and dressings are applied.

Determining the cause of wounds is often very important, especially the cause of chronic wounds such as skin ulcers. A physician should be advised of any signs of infection or other changes in a wound. Signs of infection may include redness around the wound site, **fever**, red streaks extending from the wound, yellow drainage from the wound, or a mal odor noted at the wound site.

Wound-care nursing is a rapidly advancing field that requires considerable training, clinical experience, and

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judgment, causing some observers to predict that it will eventually develop into an advanced practice nursing or a specialty-based practice. Increasingly, the demands on wound-care nurses are expected to require that they undertake graduate studies. For all nurses working in the field, ongoing education is a must to keep up with new knowledge, technologies, and techniques. Numerous organizations and institutions offer continuing education courses in wound care management.

Results

Wounds that receive appropriate and timely care are most likely to heal in an acceptable manner.

Resources

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National Library of Medicine. http://www.nlm.nih.gov/medlineplus/firstaidemergencies.html.

Woundcare.com. http://www.woundcare.com/.

ORGANIZATIONS

American Academy of Family Physicians, 11400 Tomahawk Creek Parkway, Leawood, KS, 66211-2672, (913) 906-6000, fp@aafp.org, http://www.aafp.org.

American College of Physicians, 190 N. Independence Mall West, Philadelphia, PA, 19106-1572, (215) 351-2600, (800) 523-1546, x2600, http://www.acponline.org.

American Medical Association, 515 N. State Street, Chicago, IL, 60610, (312) 464-5000, http://www.ama-assn.org.

American Nurses Association, 600 Maryland Avenue, SW, Suite 100 West, Washington, DC, 20024, (800) 274-4262, http://www.nursingworld.org.

American Red Cross National Headquarters, 2025 E St. NW, Washington, DC, 20006, (202) 303-4498, http://www.redcross.org.

Wound, Ostomy, and Continence Nurses Society, 1550 South Coast Highway, Suite #201, Laguna Beach, CA, 92651, (888) 224-9626, http://www.wocn.org.

L. Fleming Fallon, Jr., MD, DrPH
Laura Jean Cataldo, RN, Ed.D.

Bang's disease *see* **Brucellosis**

Barbiturate-induced coma

Definition

A barbiturate-induced **coma**, or barb coma, is a temporary state of unconsciousness brought on by a controlled dose of a barbiturate drug, usually pentobarbital or thiopental.

Purpose

Barbiturate comas are used to protect the brain during major brain surgery, such as the removal of **arteriovenous malformations** or aneurysms. Coma may also be induced to control intracranial **hypertension** caused by brain injury.

Precautions

Barbiturate-induced comas are used when conventional therapy to reduce intracranial hypertension has failed. Barbiturate dosing is geared toward burst suppression—that is, reducing brain activity as measured by **electroencephalography**. This reduction in brain activity has to be balanced against the potential side effects of **barbiturates**, which include allergic reactions and effects on the cardiovascular system.

Description

One of the greatest hazards associated with brain injury is intracranial hypertension. Brain injury may be caused by an accidental **head injury** or a medical condition, such as **stroke**, tumor, or infection. When the brain is injured, fluids accumulate in the brain, causing

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KEY TERMS

Aneurysm—A bulge or sack-like projection from a blood vessel.

Arteriovenous malformation—An abnormal tangle of arteries and veins in which the arteries feed directly into the veins without a normal intervening capillary bed.

Diuretic agent—A drug that increases urine output.

Electroencephalography—The recording of electrical potentials produced by the brain. These potentials indicate brain activity.

Hyperventilation—A respiratory therapy involving deeper and/or faster breathing to keep the carbon dioxide pressure in the blood below normal.

Intracranial hypertension—Abnormally high blood pressure within the skull.

Osmotherapy—Intravenous injection or oral administration of an agent that induces dehydration. The goal of dehydration is to reduce the amount of accumulated fluid in the brain.

Steroid—A type of drug used to reduce swelling.

it to swell. The skull does not allow for the expansion of the brain; in effect, the brain becomes compressed.

If the pressure does not abate, oxygenated blood may not reach all areas of the brain. Also, the brain tissue may be forced against hard, bony edges on the interior of the skull. In either case, the brain tissue may die, causing permanent brain damage or **death**.

Barbiturates reduce the metabolic rate of brain tissue, as well as the cerebral blood flow. With these reductions, the blood vessels in the brain narrow, decreasing the amount of swelling in the brain. With the swelling relieved, the pressure decreases and some or all brain damage may be averted.

Controversy exists, however, over the benefits of using barbiturates to control intracranial hypertension. Some studies have shown that barbiturate-induced coma can reduce intracranial hypertension but does not necessarily prevent brain damage. Furthermore, the reduction in intracranial hypertension may not be sustained.

Preparation

Inducing a barbiturate coma is usually kept in reserve for cases in which conventional treatments for controlling intracranial hypertension have failed. Before coma is induced, intracranial hypertension may be treated by hyperventilation; by facilitation of blood flow from the brain; by decompressive surgical procedures, such as draining excess fluids from under the skull or from the chambers within the brain (ventricles); or by drug therapy, including osmotherapy, diuretic agents, or **steroids**.

Risks

An estimated 25% of barbiturate-induced comas are accompanied by severe side effects. The side effects of barbiturates, especially the depressive effect on the cardiovascular system, can be too risky for some patients. Other side effects include impaired gastrointestinal motility and impaired immune response and infection. Since barbiturates depress activity in the brain, measurements of brain activity may be unreliable. Careful monitoring of the patient is required to ensure nutritional needs are being met and to guard against complications, such as lung infection, fevers, or deep vein **blood clots**.

Normal results

In many patients who do not respond to conventional therapy, barbiturate-induced coma can achieve the necessary control of intracranial hypertension.

Resources

PERIODICALS

Schwab, Stefan, et al. "Barbiturate Coma in Severe Hemispheric Stroke: Useful or Obsolete?" *Neurology* 48 (1997): 1608.

Julia Barrett

Barbiturate withdrawal *see* **Withdrawal syndromes**

Barbiturates

Definition

Barbiturates are mood-altering, central nervous system depressant medicines.

Purpose

Also known as sedative-hypnotic drugs, barbiturates make people relaxed, calm, and sleepy. They are sometimes used to control seizures (convulsions) and to produce **coma** following **head injury** or brain surgery.

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KEY TERMS

Adrenal glands—Two glands located next to the kidneys. The adrenal glands produce the hormones epinephrine and norepinephrine and the corticosteroid (cortisone-like) hormones.

Anemia—A lack of hemoglobin, the compound in blood that carries oxygen from the lungs throughout the body and brings waste carbon dioxide from the cells to the lungs, where it is released.

Central nervous system—The brain and spinal cord.

Hallucination—A false or distorted perception of objects, sounds, or events that seems real. Hallucinations usually result from drugs or mental disorders.

Hypnotic—A medicine that causes sleep.

Porphyria—A disorder in which porphyrins build up in the blood and urine.

Porphyrin—A type of pigment found in living things, such as chlorophyll, which makes plants green, and hemoglobin, which makes blood red.

Sedative—Medicine that has a calming effect and may be used to treat nervousness or restlessness.

Seizure—A sudden attack, spasm, or convulsion.

Withdrawal symptoms—A group of physical or mental symptoms that may occur when a person suddenly stops using a drug to which he or she has become dependent.

These medicines are habit forming and should be used for only short periods of time to treat **anxiety** or sleeplessness.

Description

Barbiturates are available only with a physician's prescription and are sold in capsule, tablet, liquid, and injectable forms. Some commonly used barbiturates are phenobarbital, secobarbital (Seconal), pentobarbital (Nembutal), and amobarbital (Amytal).

Recommended dosage

Recommended dosage depends on the barbiturate used and other factors such as the patient's age and the condition for which the medicine is being taken. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

Precautions

Always take barbiturates as directed. Never take larger or more frequent doses.

Barbiturates may add to the effects of alcohol and other drugs that produce drowsiness or depress the central nervous system, like **antihistamines**, cold medicines, over-the-counter sleep aids, medicine for seizures or convulsions, tranquilizers, **pain** relievers, and **muscle relaxants**.

People who have been taking barbiturates for long periods of time should not stop taking them suddenly, as they may develop withdrawal symptoms like nervousness, or even convulsions. These medicines should be discontinued gradually.

Taking an overdose of barbiturates or combining barbiturates with alcohol or other **central nervous system depressants** can cause unconsciousness and even **death**. Anyone who shows signs of an overdose or a reaction to combining barbiturates with alcohol or other drugs should get emergency medical help. Signs of overdose include:

- severe drowsiness
- shallow or slow breathing
- slurred speech
- loss of balance or staggering gait
- slow heartbeat and low blood pressure
- confusion
- generalized weakness

Barbiturates may change the results of certain medical tests. Before having medical tests, anyone taking these drugs should alert the health care professional in charge.

Drowsiness, lightheadedness or lack of muscular coordination from barbiturates can last many hours. Anyone who takes these drugs should not drive or use potentially dangerous machines until they find out how the drugs affect them.

Barbiturates may cause physical or mental dependence when taken over long periods of time. Signs of dependence include:

- the need to take increasing doses of the medicine to get the same effect
- a strong desire to keep taking the medicine
- withdrawal symptoms, such as anxiety, nausea or vomiting, convulsions, trembling, or sleep problems when the medicine is stopped

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Children, older adults, or people who are seriously ill may be especially sensitive to the effects of barbiturates, increasing the risks of confusion, drowsiness, or even excitement.

ALLERGIES. Anyone who has had unusual reactions to barbiturates in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. Taking barbiturates during **pregnancy** increases the chance of **birth defects** and may cause other problems such as prolonged labor and withdrawal effects in babies following birth. Pregnant women who must take barbiturates for serious or life-threatening conditions should thoroughly discuss with their physicians the benefits and risks of taking this medicine.

BREASTFEEDING. Barbiturates pass into breast milk and may cause problems such as drowsiness, breathing problems, or slow heartbeat in nursing babies whose mothers take the medicine.

OTHER MEDICAL CONDITIONS. Before using barbiturates, people with any of these medical problems should make sure their physicians are aware of their conditions:

- alcohol or drug abuse
- depression
- hyperactivity (in children)
- pain
- kidney disease
- liver disease
- diabetes
- overactive thyroid
- underactive adrenal gland
- chronic lung diseases such as asthma or emphysema
- severe anemia
- acute, intermittent porphyria

USE OF CERTAIN MEDICINES. Taking barbiturates with certain other drugs may affect the way the drugs work or may increase the chance of side effects from either or both drugs.

Side effects

The most common side effects are **dizziness**, lightheadedness, drowsiness, and clumsiness or unsteadiness. These problems usually go away as the body adjusts to the drug and do not require medical treatment unless they persist or interfere with normal activities.

More serious side effects are not common, but may occur. If any of the following side effects occur, check with the physician who prescribed the medicine immediately:

- slow pulse or low blood pressure
- fainting
- fever
- muscle or joint pain
- sore throat
- tightness in the chest or chest pain
- wheezing
- skin problems such as rash, hives, or red, thickened, or scaly skin
- bleeding sores on the lips
- sores or painful white spots in the mouth
- swollen eyelids, face, or lips

In addition, check with a physician as soon as possible if confusion, depression, or unusual excitement occur after taking barbiturates.

Patients who take barbiturates for a long time or at high doses may notice side effects for some time after they stop taking the drug. These effects usually appear within 8–16 hours after the patient stops taking the medicine. Check with a physician if these or other troublesome symptoms occur after stopping treatment with barbiturates:

- dizziness, lightheadedness, or faintness
- anxiety or restlessness
- hallucinations
- vision problems
- nausea and vomiting
- seizures (convulsions)
- muscle twitches or trembling hands
- weakness
- sleep problems, nightmares, or increased dreaming

Other side effects may occur. Anyone who has unusual symptoms during or after treatment with barbiturates should get in touch with his or her physician.

Interactions

Birth control pills may not work properly when taken while barbiturates are being taken. To prevent pregnancy, use additional methods of birth control while taking barbiturates.

The drugs that may interact with barbiturates include:

- Medicines that depress the central nervous system, such as those used for treating allergies, colds, or hay fever,

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as well as sedatives, tranquilizers, pain medicines, muscle relaxants, and over-the-counter sleep aids.

- Barbiturates reduce the effects of warfarin (Coumadin).
- The effects of beta-adrenergic blocking drugs like metaprolol (Lopressor) and propanalol (Inderal) are reduced by barbiturates.
- Barbiturates reduce the effects of antipsychosis drugs like clozapine (Clozaril).
- The effects of adrenocorticoid steroid medications, like cortisone, are reduced by barbiturates.
- Antiseizure medicines such as valproic acid (Depakote and Depakene) and carbamazepine (Tegretol) may increase the effects of barbiturates.
- Barbiturates may reduce the effectiveness of tetracycline antibiotics.
- The effects of felodipine (Plendil) may be decreased by barbiturates.
- Phenobarbital may decrease the effectiveness of drugs taken internally to treat fungal infections, like griseofulvin (Grifulvin). Separating the time of administering the drugs may help reduce this effect.
- Barbiturates may reduce the effectiveness of nifedipine (Procardia).
- Barbiturates may reduce the effectiveness of quinidine.
- Barbiturates may reduce the effectiveness of aminophylline used to treat asthma.

Barbiturates may also interact with other medicines. When this happens, the effects of one or both drugs may change or the risk of side effects may be increased. Anyone who takes barbiturates should let the physician know all other medicines he or she is taking.

The list above does not include every drug that may interact with barbiturates. Be sure to check with a physician or pharmacist before combining barbiturates with any other prescription or nonprescription (over-the-counter) medicine.

Resources

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Bariatric surgery

Definition

Bariatric surgeries are surgical weight-loss procedures that reduce or bypass the stomach or small intestine so that severely overweight people can achieve significant and permanent weight loss.

Purpose

Obesity is the second leading cause of preventable **death** in the United States. It is linked to an increased likelihood of developing over twenty different diseases and disorders including high blood pressure (**hypertension**), type 2 diabetes, heart disease, **stroke**, deep vein **blood clots**, fatty **liver disease**, **sleep apnea**, **heartburn**, **gastroesophageal reflux disease** (GERD), gallstone disease, arthritis, **colon cancer**, breathing problems, and depression. According to the National Institutes of Health, in 2008 32.7% of Americans were overweight, 34% were obese and just under 6% were severely or morbidly obese.

Obesity is defined by the body mass index (BMI). This calculation compares weight to height. Adults age 20 and older are evaluated as follows:

- BMI below 18.5: Underweight
- BMI 18.5–24.9: Normal weight
- BMI 25.0–29.9: Overweight
- BMI 30 and above: Obese
- BMI 40 and above: Morbidly or severely obese

Bariatric surgery is performed only on severely overweight people who have a BMI greater than 40 or are at least 100 pounds over their ideal weight. This level of obesity often is referred to as morbid obesity since it can result in many serious, and potentially deadly, health problems. Bariatric surgery is performed only on people whose risk of complications from surgery is outweighed by the need to lose weight to prevent health complications and for whom supervised weight-loss and **exercise** programs have repeatedly failed. Bariatric surgery, however, does not make people thin. Most people lose about 60% of their excess weight through this treatment. Changes in diet and exercise still are required to maintain a normal weight.

Description

Weight loss through surgery can be achieved either by operations that restrict the amount of food the stomach can hold (restrictive surgery), reduce the amount of nutrients that are absorbed (malabsorptive surgery), or some combination of the two. Both approaches are

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used in the United States, each with its advantages and disadvantages.

Bariatric surgery usually is performed in a hospital by a surgeon who has experience with **obesity surgery** or at a center that specializes in the procedure. **General anesthesia** is used, and the operation takes 2–3 hours. The hospital stay lasts about a week. In all weight-loss surgeries, the experience and skill of the surgeon affects the success of the procedure. Individuals should select a surgeon and hospital with this in mind.

Insurers may consider bariatric surgery elective surgery and not cover it under their policies. If they do cover weight-loss surgery, extensive documentation of the necessity for surgery may be required. Approval from the insurer should be sought before this operation is performed.

Restriction Surgery

Restriction surgery is the most common type of bariatric surgery performed in the United States. The normal, unrestricted stomach can hold about 6 cups (48 oz or 1.5 L) of food. With restriction surgery, the capacity of the stomach is reduced to about 1–3 oz (30–90 mL). Adjustable gastric band, or Lap-Band surgery, achieves restriction by placing a saline (salt water) filled bag around the stomach, pinching off a portion of it, and leaving only a small pouch at the top. The exit to the pouch is narrowed so that the rate at which the pouch empties is slowed. Because the pouch is so small, the individual can only eat about half a cup of food at a time without feeling nauseated.

Advantages of the adjustable gastric band are:

- This is the safest surgical weight-loss procedure.
- Recovery time is rapid compared to other weight-loss surgeries.
- A port in the skin allows access to the saline bag. The size of the stomach pouch opening can be adjusted without additional surgery by adjusting the pressure in the saline band.
- No part of the digestive system is removed; digestion continues normally just with much smaller amounts of food.
- People having this surgery do not feel hungry because stretch sensors in the wall of the stomach tell the brain that the stomach is full.
- Weight loss averages 50–65% of the excess body weight during the first two years.
- Obesity-related health problems are substantially reduced as weight is lost.
- The band can be removed. The surgery is reversible because no part of the digestive system was changed.
- The procedure is often covered by Medicare.

Disadvantages of the adjustable gastric band are:

- Individuals must relearn how to eat. The band requires that they eat five or six very small meals a day. They will vomit if too much food is consumed at once.
- The individual must learn to chew food well, eat slowly, and drink liquids between rather than with meals.
- There is a small risk that the band will slip and surgery will be required to fix or remove it.
- The individual must commit to eating a healthy diet in order to maintain weight loss. High-calorie foods such as milkshakes can cause weight gain; weight loss is less than with malabsorptive surgeries.
- This surgery was approved by the United States Food and Drug Administration (FDA) in 2001. Long-term effects are being studied.

A second type of restrictive surgery is vertical banded gastroplasty (VBG), also known as stomach stapling. This surgery is performed less often than Lap-Band surgery. With VBG, part of the stomach is stapled and banded shut making it smaller, so that individuals feel full sooner. The advantage of VBG is that the procedure is quick and has few complications. Disadvantages are that average weight loss is less than with other weight-loss surgeries, and staples can pull out allowing small leaks between the stomach and the abdomen to develop. Infection is possible, but rare (less than 1%). This procedure is usually not covered by Medicare.

A third restrictive surgery is vertical sleeve **gastrectomy** (VSG), also called sleeve gastrectomy, vertical gastrectomy, greater curvature gastrectomy, parietal gastrectomy, and longitudinal gastrectomy. In this procedure, a portion of the stomach is surgically removed, and the remainder of the stomach remains attached to the small intestine.

This procedure may be considered as an alternative for morbidly obese individuals whose health does not permit them to safely undergo Roux-en-Y malabsorption surgery. Advantages of this surgery are that it permanently removes a portion of the stomach that produces ghrelin, an appetite-stimulating hormone. In addition, the capacity of the stomach is reduced to about one ounce, and nutrient absorption problems do not occur because the stomach continues to be normally connected to the small intestine; no part of the intestine is bypassed. Disadvantages of this surgery are that few surgeons perform it, some insurers consider it experimental and will not cover its costs, and the part of the stomach that remains can stretch, allowing greater food capacity with the risk of weight gain.

Intragastric balloon placement is a fourth type of restriction technique, although it technically is not bariatric surgery. The procedure is available in Europe,

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KEY TERMS

Fat-soluble vitamin—A vitamin that dissolves in and can be stored in body fat or the liver.

Gastroesophageal reflux disease (GERD)—A condition where gastric juice from the stomach backs up into the bottom of the esophagus and causes irritation, inflammation, or erosion of the cells lining the esophagus.

Heartburn—A pain in the center of the chest behind the breastbone caused by the contents of the stomach backflowing (refluxing) into the lower end of the esophagus and causing irritation.

Mineral—An inorganic substance found in the earth that is necessary in small quantities for the body to maintain health. Examples: zinc, copper, iron.

Morbidly obese—Defines a person who is 100 lb (45 kg) (or more than 50%) overweight and has a body mass index above 40.

Osteoporosis—A condition found in older individuals in which bones decrease in density and become fragile and more likely to break. It can be caused by lack of vitamin D and/or calcium in the diet.

Sleep apnea—A sleep disorder in which breathing stops briefly then resumes on its own. These pauses can occur many times each night, resulting in poor quality of sleep.

Type 2 diabetes—Sometimes called adult-onset diabetes, this disease prevents the body from properly using glucose (sugar), but can often be controlled with diet and exercise.

Vitamin—A nutrient that the body needs in small amounts to remain healthy but that the body cannot manufacture for itself and must acquire through diet.

South America, Mexico, Canada, and Australia. It is in clinical trials in the United States. This procedure involves placing a silicon balloon in the stomach and inflating it to fill up part of the stomach so that the individual feels full sooner. An advantage of the intragastric balloon is that it can be placed in the stomach and removed without surgery. Intragastric balloons are intended for temporary use (about 6 months) and are for use in conjunction with a managed program of weight control. Approval for this type of restriction weight loss in the United States, which is not technically bariatric surgery, is not expected before 2010.

Malabsorptive surgery

Malabsorptive surgery, also called **gastric bypass** surgery, creates an alternate route for food through the digestive system so that the food bypasses part of the intestine and fewer nutrients are absorbed. In practice, malabsorptive surgery is combined with some type of restrictive surgery so that less food is also moving through the digestive tract.

The most common type of gastric bypass surgery is Roux-en-Y gastric bypass. In this surgery, a small stomach pouch is created by stapling and banding the stomach. Next, a Y-shaped piece of intestine is attached to the pouch on one end, and the jejunum, or second part of the small intestine, on the other. This allows food to bypass the duodenum, or first part of the intestine where many calories and nutrients are absorbed. The food then continues normally through the rest of the small intestine and the large intestine.

The great advantage of Roux-en Y gastric bypass is that individuals lose on average 60–70% of their excess weight and are able to maintain the weight loss for 10 years or more. As a result, most obesity-related health problems are substantially reduced or cured when weight is lost and weight loss maintained. In the United States Medicare often will pay for this surgery.

Roux-en-Y surgery has some serious disadvantages. These are:

- This surgery is more difficult for the surgeon than restrictive surgeries and involves permanently altering the digestive system.
- Many vitamins and minerals are absorbed in the part of the small intestine bypassed by this surgery. The individual must commit to a lifetime of taking nutritional supplements to prevent serious vitamin and mineral deficiencies.
- Tearing, bleeding, and infection at the sites where the cuts and reconnections were made are potentially fatal complications.
- Dumping syndrome may occur in response to meals high in sugar. Dumping occurs when food moves too fast through the intestine and causes symptoms of nausea, bloating, weakness, sweating, fainting, and diarrhea.

Billopancreatic diversion (BPD), another type of malabsorptive surgery, bypasses an even longer section

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of the small intestine. In BPD, about two-thirds of the stomach is surgically removed, leaving a pouch that can hold about 3 cups of food. A bypass is then created to the ileum, or final portion of the small intestine. In all, about 9 ft (3 m) of intestine are bypassed. As a result, many fewer calories and nutrients are absorbed. The main advantage of BPD is the large amount of excess weight—between 75% and 80%—that is lost over the first two years and the health benefits that this loss brings. In the United States, Medicare often will pay for this surgery.

Disadvantages are the same as for Roux-en Y-surgery, but nutrient deficiencies are greater. Because fat is poorly digested as a result of this surgery, bowel movements are frequent and stools are especially foul smelling.

Precautions

Bariatric surgery should not be performed unless a patient meets the following criteria:

- has a BMI of 40 or above or BMI of 35 and is at high risk for serious obesity-related health problems
- has been unsuccessful in serious attempts lose weight
- well-informed and has realistically considered the risks and benefits of the procedure
- has made a commitment to the lifelong changes in eating habits that are required after surgery
- will keep follow-up and nutritional counseling appointments; understands that lifelong medical follow-up is likely to be necessary
- has met with a psychologist or psychiatrist and is emotionally stable

Bariatric surgery is not appropriate for people who have substance addictions or who have psychological disorders. Other considerations in choosing candidates for obesity surgery include the general health of the person and his or her willingness to comply with follow-up treatment.

Preparation

After patients are carefully selected as appropriate for obesity surgery, they receive standard preoperative blood and urine tests and meet with an anesthesiologist to discuss how their health may affect the administration of anesthesia. Pre-surgery counseling is required to help patients anticipate what to expect after the operation.

Aftercare

Immediately after the operation, most patients are restricted to a liquid diet for 2–3 weeks; however, some may remain on it for up to 12 weeks. Patients then move on to a diet of pureed food for about a month, and after about two months most can tolerate solid food.

Restrictive surgeries pose few special nutritional concerns, but malabsorptive surgeries require both a specialized diet for several months after surgery and a lifelong commitment to taking **nutritional supplements**. Individuals having bariatric surgery receive both psychological and nutritional counseling before and after surgery.

Post-surgical recovery diet

After gastric bypass or BPD, the individual does not eat anything for one or two days, giving the bowel time to rest. During this time, all **nutrition** is given intravenously. Once the individual begins eating, he or she will follow a schedule similar to the one below:

- Liquids such as juice, broth, milk, or diluted cooked cereal for two or three days.
- Pureed foods that have the texture of baby food for two or three weeks while the stomach heals. These foods must be smooth and contain no chunks.
- Soft foods such as ground meat and soft-cooked fruits and vegetables for about eight weeks.
- Regular food can be eaten in very small amounts. Most people begin by eating six tiny meals a day. These meals should be high in protein. Food must be chewed thoroughly. Liquids are drunk between meals, not with them. Vitamin and mineral supplements are essential.

Lifelong nutritional supplementation

People who have gastric bypass surgery or BPD need extensive nutritional counseling and must take vitamin and mineral supplements for the rest of their lives. Most iron and **calcium** is absorbed in the duodenum, the first part of the intestine that is bypassed by these operations. Calcium deficiency can lead to **osteoporosis**, and iron deficiency can cause anemia.

In BPD, only 25% of the fat in food is absorbed because so much of the small intestine is bypassed. The fat-soluble **vitamins** A, D, E, and K are absorbed along with fat. When the body absorbs too little fat, inadequate amounts of these fat-soluble vitamins are absorbed, so dietary supplements containing these vitamins must be taken. Other vitamins that may not be absorbed in adequate amounts are vitamin B12, **folic acid**, and vitamin B1 (thiamine). Research published in the journal *Neurology* in March 2007 found that a very small number of people developed a brain disorder called Wernicke encephalopathy 4–12 weeks after bariatric surgery. This disorder is caused by a deficiency of

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vitamin B1. Most of the people who developed the disorder had failed to take their vitamin supplements as prescribed after surgery.

Patients are expected to work on changing their eating and exercise habits to assist in weight loss. Most people eat 3–4 small meals a day once they return to solid food. Eating too quickly or too much after obesity surgery can cause **nausea and vomiting** as well as intestinal "dumping," a condition in which undigested food is shunted too quickly into the small intestine, causing **pain**, **diarrhea**, weakness, and **dizziness**.

Risks

As in any abdominal surgery, there is always a risk of excessive bleeding, infection, and allergic reaction to anesthesia. Specific risks associated with obesity surgery include leaking or stretching of the pouch and loosening of the gastric staples. Although the average death rate associated with this procedure is less than 1%, the rate varies from center to center, ranging from 0–4%. Long-term failure rates can reach 50%, sometimes making additional surgery necessary. Other complications of obesity surgery include an intolerance to foods high in fats, **lactose intolerance**, bouts of **vomiting**, diarrhea, and intestinal discomfort

Studies suggest that gastric bypass surgery complications increase with age, weight, and male gender. Patients age 55 and older experienced more complications than younger patients, and male patients are more likely to have life-threatening complications than female patients, particularly those who were more severely obese.

Normal results

Most people who have surgery for obesity lose anywhere from 50–80% of their excess weight. However, quite a few put pounds back on beginning several years after surgery. The main reason for weight gain is noncompliance with their nutrition and exercise plan. Also, over time the size of the stomach pouch in restrictive surgeries tends to stretch, allowing people to eat more and still feel comfortable. On the positive side, people who lose weight through surgery almost always see great improvement in any obesity-related diseases they have.

Weight-loss surgery does have some serious risks. Complications include slipping of the band in Lap-Band surgery, failure of the staples in VBG, infection, dumping syndrome in malabsorptive surgery, and an increased risk of **gallstones** and abdominal hernias. The risk of death is less than 1% in gastric bypass surgery and 2.5–5% in BPD. About 20% of people who have VBG surgery need a second operation to correct problems arising from the procedure. **Pregnancy**, although possible, also presents some special nutritional risks to women who have had weight loss surgery. Bariatric surgery is not a magic weight-loss operation, and success also depends on the patient's willingness to exercise and eat low-calorie foods. When deciding whether to have a surgical weight-loss procedure, the expected benefits must outweigh the risks of continued obesity.

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ORGANIZATIONS

American Society for Metabolic and Bariatric Surgery, 100 SW 75th Street, Gainesville, FL, 32607, (352) 331-4900, (352) 331-4975info@asmbs.org, http://www.asmbs.org.

The Obesity Society, 8630 Fenton Street, Suite 814, Silver Spring, MD, 20910, (301) 563-6526, (301) 563-6595, http://www.obesity.org.

Weight-Control Information Network (WIN), 1 WIN Way, Bethesda, MD, 20892-3665, (202) 828-1025 (877) 946-4627 Fax: (202) 828-1028win@info.niddk.nih.gov, http://win.niddk.nih.gov.

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Barium enema

Definition

A barium enema, also known as a lower GI (gastrointestinal) exam, is a test that uses x-ray examination to view the large intestine. There are two types of tests: the

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single-contrast technique, where barium sulfate is injected into the rectum to gain a profile view of the large intestine, and the double-contrast (or "air contrast") technique, where air and barium are inserted into the rectum.

Purpose

A barium enema may be performed for a variety of reasons. One reason may be to help in screening for or diagnosing colon and **rectal cancer** (colorectal **cancer**). Detection of polyps (benign growths in the tissue lining the colon and rectum), diverticula (pouches pushing out from the colon), and structural changes in the large intestine can be confirmed by the barium enema. The double-contrast barium enema is an effective method for detecting small tumors, early inflammatory disease, and bleeding caused by ulcers. **Colonoscopy**, which uses a thin, flexible, fiber-optic device to visualize the colon and rectum, has largely replaced the barium enema in diagnosing these diseases in many countries; however, colonoscopy is more expensive to perform.

A doctor's decision to perform a barium enema is based on a patient's history of altered bowel habits. These can include **diarrhea**, **constipation**, lower abdominal **pain**, or patient reports of blood, mucus, or pus in the stool. Colorectal cancer screening is recommended for healthy people over age 50 every five to 10 years. In 2010, colorectal cancer was the second leading cause of cancer-related **death** in the United States. Those who have a close relative with colorectal cancer, or who have had a precancerous polyp, are considered to be at an increased risk for the disease and should be screened more frequently by their doctor for possible abnormalities. In the United States, this screening is most often done by a colonoscopy, although it can also be done by using a barium enema.

Description

Twenty-four hours before the barium enema, the patient will begin following a bowel-cleansing regimen that involves restricted diet and administration of **laxatives**. To begin a barium enema, the doctor will have the patient lie on their back facing upward (supine) on a tilting radiographic table so that x rays of the abdomen can be taken. The film is then reviewed by a radiologist, who assesses if the colon has been adequately cleansed of stool during the pre-procedure prep process. After being assisted into a different position, a well-lubricated rectal tube is inserted through the anus. This tube allows the physician or the assisting health care provider to slowly administer the barium into the intestine. While this filling process is closely monitored, the patient must keep the anus tightly contracted against the rectal tube so that the position is maintained and the barium is prevented from leaking out. This step is emphasized to the patient because inaccuracy may occur if the barium leaks. A rectal balloon also may be inflated to help the patient retain the barium. The table may be tilted or the patient may be moved to different positions to aid in the filling process. The patient may experience cramping pains or the urge to defecate. The patient will be instructed to take slow, deep breaths through the mouth to ease any discomfort.

As the barium fills the colon, x rays of the abdomen are taken to distinguish significant findings. There are several ways to perform a barium enema. In one method, shortly after filling, the rectal tube is removed and the patient expels as much of the barium as possible. In another method, the tube will remain in place, and the barium will move through that tube. A thin

KEY TERMS

Barium sulfate—A barium compound used during a barium enema to block the passage of x rays during the exam.

Bowel lumen—The space within the intestine.

Colonoscopy—A procedure in which the colon is cleansed and a lighted fiber optic instrument is inserted through the anus to allow the physician to view the entire length of the colon and detect abnormalities in the colon lining including polyps and ulcers.

Diverticula—A diverticulum of the colon is a sac or pouch in the colon wall that is usually asymptomatic (without symptoms) but may cause difficulty if it becomes inflamed. Diverticula is the plural of diverticulum.

Diverticulitis—A condition of the diverticulum of the intestinal tract, especially in the colon, where inflammation may cause distended sacs and pain.

Diverticulosis—A condition in which the colon (large intestine) develops a number of outpouchings or sacs.

Megacolon—Abnormally large colon associated with some chronic intestine disorders.

Sigmoidoscopy—A visual examination of the rectum and sigmoid (lower) colon using a sigmoidoscope, also known as proctosigmoidoscopy.

Ulcerative colitis— A type of inflammatory bowel disease in which ulceration or erosion of the lining of the colon occur.

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film of barium remains in the intestine, and then, in a double contrast enema, air is slowly injected through the rectum to expand the bowel lumen. Usually no x-ray films will be taken until after the air is injected. Multiple films generally are obtained by a radiologist; then, additional films are made by a technologist.

Preparation

To conduct the most accurate barium enema test, the patient must follow a prescribed diet and **bowel preparation** instructions before the test. This preparation commonly includes restricted intake of dairy products and a liquid diet for 24 hours before the test, in addition to drinking large amounts of water or clear liquids 12–24 hours before the test. Patients may also be given laxatives to help empty the bowel and be asked to give themselves a cleansing enema.

Aftercare

Patients should follow several steps immediately after undergoing a barium enema, including:

- Drinking plenty of fluids to help counteract the dehydrating effects of bowel preparation and the test.
- Taking time to rest. A barium enema and the bowel preparation taken before it can be exhausting.
- Administering a cleansing enema, if directed, to eliminate any remaining barium. Lightly colored stools will be prevalent for the next 24–72 hours following the test.

Risks

While a barium enema is considered a safe screening and diagnostic test, it can cause complications in certain people. The following indications should be kept in mind before a barium enema is performed:

- Those who have a rapid heart rate, severe ulcerative colitis, toxic megacolon, or a presumed perforation in the intestine should not undergo a barium enema.
- The test should be performed very cautiously if the patient has a blocked intestine, ulcerative colitis, diverticulitis, or severe bloody diarrhea.
- Complications that may be caused by the test include perforation of the colon, water intoxication, barium granulomas (inflamed nodules), and allergic reaction. However, these conditions are all very rare.

Normal results

When patients undergo single-contrast **enemas**, their intestines are steadily filled with barium to differentiate markings of the colon. Normal results display uniform filling of the colon. As the barium is expelled, the intestinal walls collapse. A normal result on the x ray after defecation will show the intestinal lining as having a standard, feathery appearance.

The double-contrast enema expands the intestine, which is already lined with a thin layer of barium, using air to display a detailed image of the mucosal pattern. Varying positions taken by the patient allow the barium to collect on the dependent walls of the intestine by way of gravity. In a healthy patient, the walls will have a uniform, standard appearance.

Abnormal results

A barium enema will show abnormalities on an x ray that may aid in the diagnosis of several different conditions. Most colon cancers occur in the rectosigmoid region, or on the upper part of the rectum and adjoining portion of the sigmoid colon. However, they can also be detected with a **sigmoidoscopy**. Further, an enema can identify other early signs of cancer.

Identification of polyps, **diverticulosis**, and inflammatory disease such as **diverticulitis** and ulcerative **colitis** may be made through a barium x ray. Some cases of acute **appendicitis** also may be apparent by viewing this x ray, although acute appendicitis is usually diagnosed clinically, or by computed tomography (CT) scan.

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ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (404) 320-3333, (800) ACS-2345, http://www.cancer.org.

Colon Cancer Alliance, 1200 G Street NW, Ste 800, Washington, DC, 20005, (202) 434-8980 (877) 422-2030 (866) 304-9075, http://www.ccalliance.org.

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Barium swallow *see* **Upper GI exam**

Barlow's syndrome *see* **Mitral valve prolapse**

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Bartholin's gland cyst

Definition

A Bartholin's gland cyst is a swollen fluid-filled lump that develops from a blockage of one of the Bartholin's glands, which are small glands located on each side of the opening to the vagina. Bartholin's gland cysts and abscesses are commonly found in women of reproductive age, developing in approximately 2% of all women.

Description

The Bartholin's glands are located in the lips of the labia that cover the vaginal opening. The glands (normally the size of a pea) provide moisture for the vulva area. A Bartholin's gland cyst may form in the gland itself or in the duct draining the gland. A cyst normally does not cause **pain**, grows slowly, and may go away without treatment. It usually ranges in size from 0.4-1.2 in. (1–3 cm), although some may grow much larger.

If infected, a Bartholin's gland cyst can form an **abscess** that will increase in size over several days and is very painful. In order to heal, a Bartholin's gland cyst usually must be drained.

Causes and symptoms

A Bartholin's gland cyst occurs if the duct becomes blocked for any reason, such as infection, injury, or chronic inflammation. Very rarely a cyst is caused by **cancer**, which usually occurs only in women over the age of 40. In many cases, the cause of a Bartholin's gland cyst is unknown.

Symptoms of an uninfected Bartholin's gland cyst include a painless jump on one side of the vulva area (most common symptom) and redness or swelling in the vulva area.

Symptoms of an abscessed Bartholin's gland include:

- pain that occurs with walking, sitting, physical activity, or sexual intercourse
- fever and chills
- increased swelling in the vulva area over a two- to four-day period
- drainage from the cyst, normally occurring four to five days after the swelling starts

Abscesses may be caused by sexually transmitted bacteria, such as those causing chlamydial or gonococcal infections, while others are caused by bacteria normally occurring in the vagina. Over 60 types of bacteria have been found in Bartholin's gland abscesses.

Diagnosis

A Bartholin's gland cyst or abscess is diagnosed by a gynecological **pelvic exam**. If the cyst appears to be infected, a culture is often performed to identify the type of bacteria causing the abscess.

Treatment

Treatment for this condition depends on the size of the cyst, whether it is painful, and whether the cyst is infected.

If the cyst is not infected, treatment options include:

- watchful waiting by the woman and her health care professional
- soaking of the genital area with warm towel compresses
- soaking of the genital area in a sitz bath
- use of nonprescription pain medication to relieve mild discomfort

If the Bartholin's gland is infected, there are several treatments available to treat the abscess, including:

- soaking of the genital area in a sitz bath
- treatment with antibiotics
- use of prescription or nonprescription pain medication
- incision and drainage; i.e., cutting into the cyst and draining the fluid (not usually successful, as the cyst often reoccurs)
- placement of a drain (Word catheter) in the cyst for two to four weeks so fluid can drain and prevent reoccurrence of the cyst
- marsupialization
- window operation
- use of a carbon dioxide laser to open the cyst and heat the cyst wall tissue so that the cyst cannot form a sac and reoccur
- incision and drainage, followed by treatment with silver nitrate to burn the cyst wall so the cyst cannot form a sac and reoccur
- removal of the entire Bartholin's gland cyst, if the cyst has reoccurred several times after use of other treatment methods

During surgical treatment, the area will be numbed with a local anesthetic to reduce pain. **General anesthesia** may be used for treatment of an abscess, as the procedure can be painful.

In a pregnant woman, surgical treatment of cysts that are asymptomatic should be delayed until after delivery to avoid the possibility of excessive bleeding.

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KEY TERMS

Marsupialization—Cutting out a wedge of the cyst wall and putting in stitches so the cyst cannot reoccur.

Sitz bath—A warm bath in which just the buttocks and genital area soak in water; used to reduce pain and aid healing in the genital area.

Window operation—Cutting out a large oval-shaped piece of the cyst wall and putting in stitches to create a window so the cyst cannot reoccur.

Word catheter—A small rubber catheter with an inflatable balloon tip that is inserted into a stab incision in the cyst, after the contents of the cyst have been drained.

However, if the Bartholin's gland is infected and must be drained, **antibiotics** and **local anesthesia** are generally considered safe.

If the cyst is caused by cancer, the gland must be excised, and the woman should be under the care of a gynecologist familiar with the treatment of this type of cancer.

Alternative treatment

If a Bartholin's gland cyst has no or mild symptoms, or has opened on its own to drain, a woman may decide to use watchful waiting, warm sitz baths, and nonprescription pain medication. If symptoms become worse or do not improve, a health care professional should then be consulted.

Infected Bartholin's glands should be evaluated and treated by a health care professional.

Prognosis

A Bartholin's gland cyst should respond to treatment in a few days. If an abscess requires surgery, healing may take days to weeks, depending on the size of the abscess and the type of surgical procedure used. Most of the surgical procedures, except for incision and drainage, should be effective in preventing recurring infections.

Prevention

There are few ways to prevent the formation of Bartholin's gland cysts or abscesses. However, as a Bartholin's gland abscess may be caused by a sexually transmitted disease, the practice of safe sex is recommended. Using good hygiene (e.g., wiping front to back after a bowel movement) is also recommended to prevent bacteria from the bowels from contaminating the vaginal area.

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Judith Sims

Bartonella bacilliformis infection *see* **Bartonellosis**

Bartonellosis

Definition

Bartonellosis is an infectious bacterial disease with an acute form (which has a sudden onset and short course) and a chronic form (which has more gradual onset and longer duration). The disease is transmitted by sandflies and occurs in western South America. Characterized by a form of red blood cell deficiency (**hemolytic anemia**) and **fever**, the potentially fatal acute form is called Oroya fever or Carrion's disease. The chronic form is identified by painful **skin lesions**.

Description

The acute form of the disease gets its name from an outbreak that occurred in 1871 near La Oroya, Peru. More than 7,000 people perished. Some survivors later developed a skin disease, called verruga peruana (Peruvian **warts**). These skin lesions were observed prior to the 1871 outbreak—perhaps as far back as the pre-Columbian era—but a connection to Oroya fever was unknown. In 1885, a young medical researcher, Daniel Carrion, inoculated himself with blood from a lesion to study the course of the skin disease. When he became ill with Oroya fever, the connection became apparent.

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KEY TERMS

Acute—Referring to the course of a disease, or a phase of a disease, the short-term experience of prominent symptoms.

Chronic—Referring to the course of a disease, or a phase of a disease, the long-term experience of prominent symptoms.

Erythrocytes—Red blood cells.

Hemolytic anemia—A form of erythrocyte deficiency caused by the destruction of the red blood cells.

Host—The organism that harbors or nourishes another organism (parasite). In bartonellosis, the person infected with *Bartonella basilliformis*.

Vector—An organism, such as insects or rodents, that can transmit disease to humans.

Oroya fever is often called Carrion's disease in honor of his fatal experiment.

The bacteria, *Bartonella bacilliformis*, was isolated by Alberto Barton in 1909, but wasn't identified as the cause of the fever until 1940. The *Bartonella* genus includes at least 11 bacteria species, four of which cause human diseases, including **cat-scratch disease** and **bacillary angiomatosis**. However, bartonellosis refers exclusively to the disease caused by *B. bacilliformis*. The disease is limited to a small area of the Andes Mountains in western South America; nearly all cases have been in Peru, Colombia, and Ecuador. A large outbreak involving thousands of people occurred in 1940–41, but bartonellosis has since occurred sporadically. Control of sandflies, the only known disease carrier (vector), has been credited with managing the disease.

Causes and symptoms

Bartonellosis is transmitted by the nocturnal sandfly and arises from infection with *B. bacilliformis*. The sandfly, *Lutzomyia verrucarum*, dines on human blood and, in so doing, can inject bacteria into the bloodstream. The sandfly is found only in certain areas of the Peruvian Andes; other, as-yet-unidentified vectors are suspected in Ecuador and Colombia.

Once in the bloodstream, the bacteria latch onto red blood cells (erythrocytes), burrow into the cells, and reproduce. In the process, up to 90% of the host's erythrocytes are destroyed, causing severe hemolytic anemia. The anemia is accompanied by high fever, muscle and joint **pain**, **delirium**, and possibly **coma**.

Two to eight weeks after the acute phase, an infected individual develops verruga peruana. However, individuals may exhibit the characteristic lesions without ever experiencing the acute phase. Left untreated, the lesions may last months or years. These lesions resemble blood-filled blisters, up to 1.6 in (4 cm) in diameter, and appear primarily on the head and limbs. They can be painful to the touch and may bleed or ulcerate.

Diagnosis

Bartonellosis is identified by symptoms and the patient's history, such as recent travel in areas where bartonellosis occurs. Isolation of *B. bacilliformis* from the bloodstream or lesions can confirm the diagnosis.

Treatment

Antibiotics are the mainstay of bartonellosis treatment. The bacteria are susceptible to several antibiotics, including chloramphenicol, **penicillins**, and **aminoglycosides**. Blood transfusions may be necessary to treat the anemia caused by bartonellosis.

Prognosis

Antibiotics have dramatically decreased the fatality associated with bartonellosis. Prior to the development of antibiotics, the fever was fatal in 40% of cases. With antibiotic treatment, that rate has dropped to 8%. Fatalities can result from complications associated with severe anemia and secondary infections. Once the infection is halted, an individual can recover fully.

Prevention

Avoiding sandfly **bites** is the primary means of prevention. Sandfly eradication programs have been helpful in decreasing the sandfly population, and insect repellant can be effective in preventing sandfly bites.

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Julia Barrett

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Basal cell carcinoma

Definition

A basal cell carcinoma is a skin **cancer** that originates from basal keratinocytes in the top layer of the skin, the epidermis. Sometimes these tumors are called "rodent ulcers."

Demographics

Basal cell carcinomas are most common from middle age until old age. They are more frequent in men than women. These cancers seem to be associated with exposure to ultraviolet light; they tend to develop on sun-exposed areas and are more common in people living near the equator. Those who have lighter skin are more susceptible; fair-haired blonds are more likely to develop tumors than people with darker complexions. In the United States, Caucasians have a 23% to 39% chance of developing a basal cell carcinoma over a lifetime.

Weakened immunity may also play a role. Those who have had an organ transplanted or who have contracted acquired immune deficiency syndrome (**AIDS**) are more likely to develop one of these cancers.

Basal cell carcinomas are particularly common among individuals with a rare genetic disease called nevoid basal cell carcinoma syndrome (Gorlin's syndrome). Individuals with this disease can be born with basal cell carcinomas or begin to develop them in childhood. Some have few or no cancers; others have more than 250. These tumors seldom grow much before **puberty**, but during and after adolescence they can spread rapidly. Other symptoms include small pits in the palms and soles, cysts in the jaw, and other abnormalities in the bones.

Description

Basal keratinocytes are unpigmented skin cells found deep in the epidermis, hair follicles, and sweat glands. When they become cancerous, these cells invade the dermis (the layer of skin just below the epidermis) and spread out into the normal skin. They become visible as a small growth or area of change in the skin's appearance. These tumors can appear anywhere on the body, but most become evident on the face and neck.

Most basal cell carcinomas are small tumors that can be cured with simple surgeries. They usually grow quite slowly. However, neglected or aggressive tumors can invade vast amounts of skin. These cancers can also spread along bones, cartilage, muscles, and, more rarely, nerves. Some tumors may eventually reach the eye or brain or become large enough to significantly disfigure the face. These serious consequences are more likely if the tumor lies close to bone and cartilage—for instance, at the corner of the eye. Very few basal cell carcinomas spread to more distant organs; the incidence of metastatic basal cell carcinoma is less than 0.1%. Most that do are very large, deep cancers that have been visible for years.

Causes and symptoms

Basal cell carcinomas are caused by genetic damage to a skin cell. Exposure to ultraviolet light and x rays, suppression of the immune system, and genetic factors seem to increase the risk that this will happen. Frequent or severe sunburns during childhood, frequent sunbathing or exposure through **tanning** beds, occupational exposure to sunlight due to outdoor employment (farming, construction, fishing), treatment of **acne** using x rays, or exposure to arsenic through drinking well water may all increase a person's risk of developing basal cell carcinoma.

Several types of basal cell carcinomas exist. Nodular basal cell carcinomas are the most common form. These tumors begin as a tiny red or clear bump on the skin. Over time, they develop into a growth with clear or white "pearly" raised edges and, often, a depressed area in the middle. A network of tiny blood vessels usually crisscrosses the surface, and the tumor may bleed repeatedly or crust over. Morpheaform (sclerosing, morpheic) basal cell carcinomas are more difficult to detect. These tumors are usually pale, firm, flat growths that can blend into the normal skin around them. Many look just like a scar. Superficial basal cell carcinomas are flat, red, scaly plaques that can look like **psoriasis** or **eczema**. Unlike other basal cell carcinomas, they are usually found on the arms, legs, and torso. Pigmented basal cell carcinomas are brown, black, or blue; they are usually of the nodular type and can look like a melanoma.

Some general characteristics of skin cancers include:

- irregular or ragged borders
- non-symmetrical shape
- a change in color
- a size greater than 0.2 inches (6 mm)

Diagnosis

Basal cell carcinomas are usually diagnosed with a **skin biopsy** taken in the doctor's office. This is generally a brief and simple procedure. Biopsy may or may not require numbing of the skin with injection of local anesthetic. A shave biopsy removes a tiny bit of superficial tissue; a punch biopsy removes a slightly larger, deeper sample. The skin biopsy must be sent to

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a trained pathologist to be analyzed. It may take up to a week for the biopsy results to come back. Sometimes the tumor is removed immediately after the biopsy, before the results are known.

Clinical staging, treatments, and prognosis

Basal cell carcinomas rarely spread into the lymph nodes and internal organs. For this reason, doctors tend not to stage them. If staging is needed, the TNM (tumor, lymph node, and metastases) system is usually used. For basal cell carcinomas, this can be simplified into the following five categories:

- Stage 0: The cancer is very small and has not yet spread from the epidermis to the dermis.
- Stage 1: The cancer is less than 2 cm (0.8 inches) in diameter. No cancer cells can be found in lymph nodes or other internal organs.
- Stage 2: The cancer is more than 2 cm (0.8 inches) in diameter. No cancer cells can be found in lymph nodes or other internal organs.
- Stage 3: Cancer cells have been found either in nearby lymph nodes or in the bone, muscle, or cartilage beneath the skin (or in both locations).
- Stage 4: Cancer cells have been discovered in internal organs, most often the lungs or lymph nodes, that are distant from the skin. A stage four cancer can be any size.

Treatment

Treatment options for non-metastatic, non-staged tumors

For most non-metastatic, non-staged cancers, there may be several treatment options. The recommended treatment depends on the size and type of tumor, its location, and cosmetic considerations. The cure rates for most of the following techniques are approximately 85% to 95%, but vary with tumor size and other factors. Moh's micrographic surgery has a five-year cure rate of 96%. Success rates for recurrent tumors are approximately 50% with most techniques and 90% with Moh's surgery.

In conventional surgery, the doctor numbs the area with an injection of local anesthetic, then cuts out the tumor and a small margin of normal skin around it. The wound is closed with a few stitches. One advantage to conventional surgery is that the wound usually heals quickly. Another benefit is that the complete cancer can be sent to a pathologist for evaluation. If the skin around the tumor is not completely free of cancer cells, the tumor can be treated again immediately.

Moh's micrographic surgery is a variation of conventional surgery. In this procedure, the surgeon examines each piece of skin under the microscope as it is removed. If any cancer cells remain, another slice is taken from that area and checked. These steps are repeated until the edges of the wound are clear of tumor cells, then the wound is closed. The advantage to this technique is that all of the visible cancer cells are removed but as much normal skin as possible is spared. Moh's surgery is often used for larger or higher risk tumors and when cosmetic considerations are important. The main disadvantage is that it takes much longer than conventional surgery and requires a specially trained surgeon.

A laser is sometimes used as a cutting instrument instead of a scalpel. Laser light can also destroy some cancer cells directly. A disadvantage to **laser surgery** is that the **wounds** from some lasers heal more slowly than cuts from a scalpel. The advantage is that bleeding is minimal.

In electrodessication and curettage, the physician scoops out the cancer cells with a spoon-shaped instrument called a curette. After most of the tumor is gone, the remaining cancerous tissue is destroyed with heat from an electrical current. The wound is left open to heal like an abrasion. It leaks fluid, crusts over, and heals during the next two to six weeks. This is a safe and easy method for removing many basal cell carcinomas. One disadvantage is that there is no skin sample to confirm that the tumor is completely gone. The electrical current used during this surgery can interfere with some **pacemakers** and larger tumors may heal with a noticeable scar.

In cryosurgery, liquid nitrogen is used to freeze the tumor and destroy it. This treatment is another type of blind destruction; there is no skin sample to make sure the cancer cells have all been killed. Patients report swelling and **pain** after cryosurgery, and a wound appears a few days later where the cells were destroyed. When the site heals, it has usually lost its normal pigment. There is a risk of nerve damage with this technique.

Radiation therapy is an uncommon treatment for basal cell carcinoma. One disadvantage is the inconvenience: multiple treatments, over a period of weeks, are necessary. Tumors that return after radiation also tend to grow more quickly than the original cancer. In addition, x rays may promote new skin cancers. Radiation therapy may be an option for patients who cannot undergo even minor surgery. It is also used occasionally as an adjunct to surgery. One advantage is that the cosmetic results can be very good.

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KEY TERMS

Albinism—A genetic disease characterized by the absence of the normal skin pigment, melanin.

Biopsy—A sample of an organ taken to look for abnormalities. Also, the technique used to take such samples.

Dermis—A layer of skin sandwiched between the epidermis and the fat under the skin. It contains the blood vessels, nerves, sweat glands, and hair follicles.

Epidermis—The thin layer of skin cells at the surface of the skin.

Fluorouracil—A cancer drug.

Hair follicles—The structures in the skin that make each hair.

Imiquimod—A drug, approved by the FDA to treat warts, that may destroy basal cell carcinomas by stimulating the immune system. Also known by its trade name Aldara.

Interferon alpha—A chemical made naturally by the immune system and also manufactured as a drug.

Local anesthetic—A liquid used to numb a small area of the skin.

Lymph node—A small structure located throughout the body (part of the lymphatic system) designed to filter the flow of lymph, a usually clear fluid that originates from stem cells.

Nonsteroidal anti-inflammatory drugs (NSAIDS)—A class of drugs that suppresses inflammation. Includes a wide variety of drugs, such as aspirin.

Oncologist—A doctor who specializes in the treatment of cancer.

Pathologist—A doctor who specializes in examining cells and other parts of the body for abnormalities.

Premalignant skin lesion—An abnormal change in the skin that has a good chance of turning into skin cancer but is not yet cancerous.

Selenium—A mineral needed in extremely small quantities by the body. Large amounts can be very toxic.

Squamous cell carcinoma—A type of skin cancer.

Sweat glands—Tiny glands scattered throughout the skin that produce sweat.

TNM system—A commonly used staging system that examines the main tumor (T), the lymph nodes (N), and metastases (M).

Xeroderma pigmentosum—A genetic disease characterized by the inability to repair damaged DNA. Individuals with this disease develop an excessive number of skin cancers.

Occasionally a lotion containing fluorouracil is applied to the tumor. This drug cannot penetrate very far and cancer cells in the deeper parts of the tumor may not be destroyed. The main advantage to this treatment is its simplicity.

Treatment options for metastatic cancers

Cancers that have spread to internal organs are treated with a combination of surgery, radiation, and **chemotherapy**.

Special concerns

Because many basal cell carcinomas are found on the face and neck, cosmetic concerns are a priority for many patients. If there is a risk of noticeable scarring or damage, a patient may wish to ask about alternative types of removal or inquire about the services of a plastic surgeon.

After treatment, it is important to return to the doctor periodically to check for regrowth or new skin cancers. Approximately 36% of all patients find a new basal cell or squamous cell carcinoma within the next five years. Having a basal cell carcinoma before the age of 60 may also increase the chance of developing other cancers in internal organs.

Prognosis

The prognosis for small, uncomplicated basal cell carcinomas is very good. The vast majority of these tumors can be successfully removed. However, cancers that were not completely destroyed may regrow. If the edges of the removed skin contain cancer cells, the chance that the tumor will return within the next five years is about 40%. Regrowth is more likely with cancers larger than 0.8 inches (2 cm), those on the face (particularly around the nose, eye, and ear), and higher-risk types such as morpheaform tumors. Tumors can redevelop in the scar from the surgery, on the edges of the surgery site, or deep in the skin. These cancers may not look like the original tumor. Patients should be particularly watchful for minor changes in the appearance of the scar or sores that appear nearby.

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Cancers that metastasize spread most often to the lymph nodes and lungs. The prognosis for metastatic cancers is poor, even with treatment. Survival after spread of the cancer to internal organs is eight months on the average and seldom more than a year and a half.

Prevention

The risk factors for basal cell carcinoma include:

- ethnic background
- complexion
- geographic location
- increasing age
- exposure to x rays and ultraviolet light (both UVA and UVB)
- a history of premalignant skin lesions or skin cancer
- genetic disorders such as nevoid basal cell carcinoma syndrome, xeroderma pigmentosum, and albinism
- suppression of the immune system by AIDS or an organ transplant

Some important preventive steps include wearing protective clothing and hats in the sun, using a sunscreen, avoiding the sun between 10 a.m. and 4 p.m., and staying away from suntanning booths. Checking the skin for early signs of cancer also is critical.

Drugs related to vitamin A (including beta-carotene, retinol, and isotretinoin), vitamin E, **nonsteroidal anti-inflammatory drugs** (NSAIDS), and selenium have been suggested as possibly preventing basal cell carcinoma. A 2003 study reported that selenium is not effective in preventing basal cell carcinoma and may even increase risk of squamous cell carcinoma.

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ORGANIZATIONS

Nevoid Basal Cell Carcinoma Syndrome Support Network, 162 Clover Hill Street, Marlboro, MA, 01752, (800) 815-4447, souldansur@aol.com.

Skin Cancer Foundation, 245 Fifth Ave., Suite 2402, New York, NY, 10016, (212) 725-5176, http://www.skincancer.org.

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Basal gastric secretion test *see* **Gastric acid determination**

Battered child syndrome

Definition

Battered child syndrome refers to injuries sustained by a child as a result of physical **abuse**, usually inflicted by an adult caregiver. Alternative terms include: shaken baby; **shaken baby syndrome**; **child abuse**; and non-accidental trauma (NAT).

Description

Internal injuries, cuts, **burns**, **bruises**, and broken or fractured bones are all possible signs of battered child syndrome. Psychological damage to a child is also often the by-product of child abuse and can result in serious behavioral problems such as **substance abuse** or the physical abuse of others. According to the U.S. Department of Health and Human Services Administration for Children and Families, in 2008, 1,740 child fatalities resulted from child abuse. Of these, more than three-quarters of the children were under four years old, with the largest number of deaths occurring in infants under one year old. In addition, about 772,000 children were documented victims of nonfatal maltreatment, a term that includes neglect and psychological abuse, as well as physical and **sexual abuse**. About 80% of abused children were abused by a parent or a parent acting with another individual.

Causes and symptoms

Battered child syndrome (BCS) is found at every level of society, although the incidence may be higher in low-income households where adult caregivers experience greater financial **stress** and social difficulties, have less education and understanding of child development, and may have less access to social services. In addition, children of parents who are substance abusers are more likely to experience abuse

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KEY TERMS

Fontanel—Soft spot on top of an infant's skull.

Retinal hemorrhage—Bleeding in the back of the eye.

than children living in households where there is no substance abuse. Many child abusers were also themselves abused as children.

The child batterer most often injures a child in the heat of anger. The incessant crying of an infant or child, refusal to follow directions, or the child creating a mess or breaking an object may trigger abuse. Symptoms may include a delayed visit to the emergency room with an injured child, an implausible explanation of the cause of a child's injuries, bruises that match the shape of a hand, fist or belt, cigarette burns, scald marks, bite marks, black eyes, unconsciousness, bruises around the neck, and a bulging fontanel in infants.

Diagnosis

Battered child syndrome is most often diagnosed by an emergency room physicians, pediatricians, teachers, or social workers. **Physical examination** detects bruises, burns, swelling, or **retinal hemorrhage**. X rays, MRI, CT, or other imaging techniques may confirm bone **fractures** or internal soft tissue injuries. The presence of injuries at different stages of healing (i.e., having occurred at different times) is nearly always indicative of BCS. Establishing the diagnosis is often hindered by the caregiver's intentional concealment of the true origin of the child's injuries, as a result of fear, shame, avoidance, or denial mechanisms.

Treatment

Medical treatment for battered child syndrome varies according to the type of injury incurred. Counseling and the implementation of an intervention plan for the child's parent(s) or guardian(s) is necessary. The child abuser may be incarcerated, and/or the abused child removed from the home to prevent further harm. Reporting child abuse to authorities is mandatory for doctors, teachers, and childcare workers in most states as a way to prevent continued abuse. Both physical and psychological therapy are often recommended as treatment for the abused child.

Prognosis

The prognosis for battered child syndrome depends on the severity of injury, actions taken by the authorities to ensure the future safety of the injured child, and the willingness of parents or guardians to seek counseling for themselves as well as for the child.

Prevention

Recognizing the potential for child abuse in a situation, and the seeking or offering of intervention and counseling before battered child syndrome occurs is the best way to prevent it. Signs that a child may be at risk for physical abuse include parental alcohol or substance abuse, previous abuse of the child or the child's siblings, history of mental or psychological problems in parents, parents abused as children, absence of visible parental love or concern for the child, and the child's hygiene neglected.

Resources

OTHER

"Child Abuse." *MedlinePlus, National Institutes of Health*. December 4, 2008 [cited December 17, 2008]. http://www.nlm.nih.gov/medlineplus/childabuse.html

"Child Welfare Information Gateway." *United States Department of Health and Human Services*. December 1, 2008 [cited December 17, 2008]. http://www.childwelfare.gov

ORGANIZATIONS

Childhelp National Child Abuse Hotline, 15757 N. 78th St., Suite B., Scottsdale, AZ, 85260, (480) 922-8212, (480) 922-7061, (800) 422-4453, http://www.childhelp.org.

Prevent Child Abuse America, 228 South Wabash Avenue, 10th Floor, Chicago, IL, 60604, (312) 663-3520, (312) 939-8962, mailbox@preventchildabuse.org, http://www.preventchildabuse.org.

Rape, Abuse and Incest National Network (RAINN), 2000 L Street NW, Suite 406, Washington, DC, 20036, (202) 544-1034, (202) 544-3556, (800) 656-HOPE (4673), http://www.rainn.org/get-help/national-sexual-assault-online-hotline.

Mary Jane Tenerelli, M. S.
Tish Davidson, A. M.

Becker muscular dystrophy *see* **Muscular dystrophy**

Beclomethasone *see* **Corticosteroids**

Bedbug infestation

Definition

Bedbug infestation is the contamination of bedding, clothing, and household furnishings with the insect *Cimex lectularius* or *C. hemipterus*, commonly known as bedbugs.

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Magnified image of a bedbug, which can often be found clinging to mattresses. *(© Dennis Kunkel Microscopy, Inc./Visuals Unlimited/Corbis.)*

Demographics

Before 1950, bedbugs were common worldwide. The development of the pesticide DDT eliminated bedbugs from most developed countries. However, since DDT use has been banned because of its harmful effects on the environment, bedbugs have made a comeback. Bedbug infestation is relatively common in developed countries and very common in underdeveloped countries. They spread easily, often through international travelers and are difficult to exterminate. Bedbugs are equal opportunity pests, showing no preference in the age, gender, or race of their victims.

Description

Bedbugs are small (5–8 mm long), oval, reddish-brown insects that feed on blood of birds and mammals. They are primarily nocturnal, feeding at night. During the day, they hide in mattress seams, cracks in bed frames or other furniture, behind loose wallpaper, and in bedding and clothing. Females lay large numbers of eggs that hatch in 4–5 days. Adults can live for months without feeding.

Bedbug **bites** are painless, but the bites cause an allergic reaction in most people resulting in an itchy, red rash. Although bedbug bites are rarely medically dangerous, they can become infected through scratching.

Risk factors

People often associate bedbugs with poor or dirty living conditions, but bedbugs can be found in pristinely clean environments. In recent years, complaints about bedbugs in both budget and first-class hotels have increased.

The risk of exposure to bedbugs increases with certain activities including:

- international travel
- frequent overnight stays in hotels and motels
- living in refugee camps or homeless shelters
- living in apartment buildings (bedbugs are efficient crawlers and can move through cracks from apartment to apartment)
- living in military barracks or dormitories

Causes and symptoms

The bite of a bedbug causes an allergic reaction in most people that can be difficult to differentiate from skin reactions caused by other bites or **allergies**. The rash caused by bedbugs is a red, itchy rash that is typically darker in the center of the bite. Often, but not always, bites form lines or groups of three, sometimes called "breakfast," "lunch," and "dinner." Although bedbugs will bite any exposed skin, bites are most often found on the face, neck, arms, and hands.

The time it takes a bedbug rash to appear is variable, ranging from as long as 10 days to less than one minute. Generally, the more frequently a person is exposed to bedbugs, the shorter the time it takes for the rash to appear. In rare cases, some individuals can have an extreme, life-threatening allergic reaction to bedbug bites called **anaphylaxis** or anaphylactic shock.

Bedbugs can be infected with the **hepatitis B** virus and with the parasite that causes Chagas disease.

Diagnosis

Medical diagnosis is not always necessary; the individual can make the diagnosis based on their past experience with bedbugs and recent history of travel or examination of their bedding for signs of infestation. When a medical diagnosis is sought, it is made based on the appearance of the rash along with a detailed history of recent travel and hotel stays. The doctor may also inquire about any drugs, herbs, or supplements being taken to help eliminate other possible causes of the rash. There are no tests to diagnose bedbug bites.

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KEY TERMS

Anaphylaxis—Also called anaphylactic shock; a severe allergic reaction characterized by airway constriction, tissue swelling, and lowered blood pressure.

Chagas disease—A parasitic disease that causes mild early swelling at the site of the infection, then becomes asymptomatic for many years, but later may cause serious heart and digestive system problems. Parasites causing this disease are most common in rural Central and South America.

Hepatitis B—A disease that causes inflammation of the liver and serious liver damage.

Treatment

Treatment of the individual

The symptoms and rash associated with bedbug bites go away on their own, usually within a week to 10 days. An over-the-counter skin cream containing hydrocortisone may be applied to reduce **itching**. An over-the-counter antihistamine containing diphenhydramine (e.g., Benadryl) may also help reduce itching. Parents of affected infants and children, or pregnant and **breast-feeding** women should consult an appropriate healthcare professional before using these medications.

Treatment of the infested environment

Ridding an infested environment of bedbugs is considerably more difficult than treatment of the individual. A professional exterminator experienced with bedbug elimination may be required. Because bedbugs can hide in small cracks in furniture, mattresses, and box springs, vacuuming will not remove all of them. Special mattress covers can be purchased to lock out bedbugs, but it may be more effective to purchase a new mattress and box springs. Bedbugs can live for 9–12 months without feeding.

Bedbugs can be killed by heat. Bedding and clothing should be washed in hot water and dried at very hot temperatures. The temperature must reach at least 120°F (49°C). Items that cannot be washed can be put in sealed plastic bags and placed in a car with the windows rolled up in the summer when the temperature will reach 120 degrees or more inside the car. Freezing is less effective. Items must be left at temperatures below 32°F (0°C) for several days to kill bedbugs.

Insecticides effective against bedbugs include pemethrin and diethyltoulamide. Pemethrin spray can be used on clothing. Diethyltoluamide in high concentrations can be toxic to infants and children. Consult a physician before using. A professional exterminator is the safest way to rid the environment of bedbugs.

Room foggers and sprays against mosquitoes and ticks are ineffective against bedbugs. Many treatments for the elimination or prevention of bedbugs are sold over the Internet. These vary considerably in cost and effectiveness, so it is important to research products before buying.

Prognosis

Almost everyone recovers from bedbug bites within two weeks. Complications may arise from scratching the bites so that they become infected. If infection occurs, then an antibiotic may be prescribed. Very rarely do bedbug bites transmit hepatitis B or Chagas disease to humans.

Prevention

Prevention is difficult. Avoiding secondhand bed frames, mattresses, and beds is helpful. Birds and bats can carry bedbugs, so they should be eliminated from attics and eaves. Checking the seams of mattresses for dark specks of bedbug excrement in hotels is helpful but not foolproof.

Resources

OTHER

Bed Bug Guide (A Resource Site). 2010. http://www.bedbugguide.com (accessed August 18, 2010).

"Bedbugs." *Foundation for Medical Research and Education*. MayoClinic.com. December 19, 2009. http://www.mayoclinic.com/health/bedbugs/ds00663 (accessed August 18, 2010).

"Insect Bites and Stings." MedlinePlus. March 1, 2010. http://www.nlm.nih.gov/medlineplus/insectbitesandstings. html (accessed August 18, 2010).

Schwartz, Robert A. "Bedbug Bites." eMedicine.com. March 24, 2010. http://emedicine.medscape.com/article/1088931-overview (accessed August 18, 2010).

ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (404) 639-3534, (800) CDC-INFO (800-232-4636). TTY: (888) 232-6348inquiry@cdc.gov, http://www.cdc.gov.

National Institute of Allergy and Infectious Diseases, Office of Communications and Government Relations, 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-

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6612, (301) 496-5717, (866) 284-4107 or TDD: (800)877-8339 (for hearing impaired), (301) 402-3573, http://www3.niaid.nih.gov.

Tish Davidson, AM

Bedsores

Definition

Bedsores are also called decubitus ulcers, pressure ulcers, or pressure sores. These tender or inflamed patches develop when skin covering a weight-bearing part of the body is squeezed between bone and another body part, or a bed, chair, splint, or other hard object.

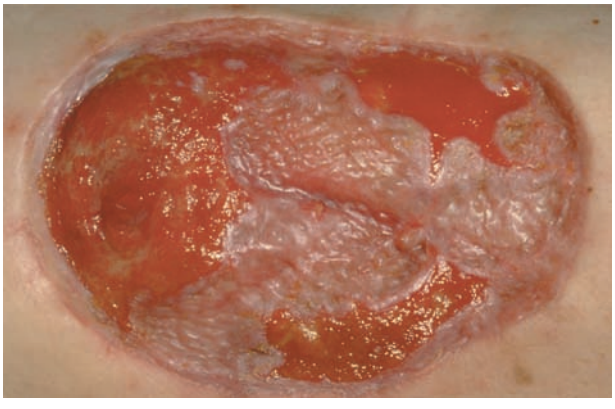
Description

Each year, about one million people in the United States develop bedsores ranging from mild inflammation to deep **wounds** that involve muscle and bone. This often painful condition usually starts with shiny red skin that quickly blisters and deteriorates into open sores that can harbor life-threatening infection.

Bedsores are not cancerous or contagious. They are most likely to occur in people who must use wheelchairs or who are confined to bed, such as quadriplegics or long-term hospital patients.

Bedsores are most apt to develop on the:

- ankles
- back of the head
- heels
- hips



Bedsore. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

- knees
- lower back
- shoulder blades
- spine

People over the age of 60 are more likely than younger people to develop bedsores. Risk is also increased by:

- atherosclerosis (hardening of arteries)
- diabetes or other conditions that make skin more susceptible to infection
- diminished sensation or lack of feeling
- heart problems
- incontinence (inability to control bladder or bowel movements)
- malnutrition
- obesity
- paralysis or immobility
- poor circulation
- prolonged bed rest, especially in unsanitary conditions or with wet or wrinkled sheets
- spinal cord injury

Causes and symptoms

Bedsores most often develop when constant pressure pinches tiny blood vessels that deliver oxygen and nutrients to the skin. When skin is deprived of oxygen and nutrients for as little as an hour, areas of tissue can die and bedsores can form.

Slight rubbing or friction against the skin can cause minor pressure ulcers. They can also develop when a patient stretches or bends blood vessels by slipping into a different position in a bed or chair.

Urine, feces, or other moisture increases the risk of skin infection, and people who are unable to move or recognize internal cues to shift position have a greater than average risk of developing bedsores.

Other risk factors include:

- malnutrition
- anemia (lack of red blood cells)
- diuse atrophy (muscle loss or weakness from lack of use)
- infection

Diagnosis

Bedsores usually follow six stages:

- redness of skin
- redness, swelling, and possible peeling of outer layer of skin

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- dead skin, draining wound, and exposed layer of fat
- tissue death through skin and fat, to muscle
- inner fat and muscle death
- destruction of bone, bone infection, fracture, and blood infection

Treatment

Prompt medical attention can prevent surface pressure sores from deepening into more serious infections. For mild bedsores, treatment involves relieving pressure, keeping the wound clean and moist, and keeping the area around the ulcer clean and dry. **Antiseptics**, harsh soaps, and other skin cleansers can damage new tissue, so a saline solution should be used to cleanse the wound whenever a fresh nonstick dressing is applied.

The patient's doctor may prescribe infection-fighting **antibiotics**, special **dressings** or drying agents, or lotions or ointments to be applied to the wound in a thin film three or four times a day. Warm whirlpool treatments are sometimes recommended for sores on the arm, hand, foot, or leg.

In a procedure called debriding, a scalpel may be used to remove dead tissue or other debris from the wound. Deep, ulcerated sores that don't respond to other therapy may require skin grafts or **plastic surgery**.

A doctor should be notified whenever a person:

- will be bedridden or immobilized for an extended time
- is very weak or unable to move
- develops bedsores

Immediate medical attention is required whenever:

- skin turns black or becomes inflamed, tender, swollen, or warm to the touch.
- the patient develops a fever during treatment.
- the sore contains pus or has a foul-smelling discharge.

With proper treatment, bedsores should begin to heal two to four weeks after treatment begins.

Alternative treatment

Zinc and **vitamins** A, C, E, and B complex help skin repair injuries and stay healthy, but large doses of vitamins or **minerals** should never be used without a doctor's approval.

A poultice made of equal parts of powdered slippery elm (*Ulmus fulva*), marsh mallow (*Althaea officinalis*), and **echinacea** (*Echinacea* spp.) blended with a small amount of hot water can relieve minor inflammation. An infection-fighting rinse can be made by diluting two drops of essential tea tree oil (*Melaleuca* spp.) in eight ounces of water. An herbal tea made from the calendula (*Calendula officinalis*) can act as an antiseptic and wound healing agent. Calendula cream can also be used.

Contrasting hot and cold local applications can increase circulation to the area and help flush out waste products, speeding the healing process. The temperatures should be extreme (hot hot and ice cold), yet tolerable to the skin. Hot compresses should be applied for three minutes, followed by 30 seconds of cold compress application, repeating the cycle three times. The cycle should always end with the cold compress.

Prevention

It is usually possible to prevent bedsores from developing or worsening. The patient should be inspected regularly; should bathe or shower every day, using warm water and mild soap; and should avoid cold or dry air. A bedridden patient should be repositioned at least once every two hours while awake. A person who uses a wheelchair should shift his weight every 10 or 15 minutes, or be helped to reposition himself at least once an hour. It is important to lift, rather than drag, a person being repositioned. Bony parts of the body should not be massaged. Even slight friction can remove the top layer of skin and damage blood vessels beneath it.

If the patient is bedridden, sensitive body parts can be protected by:

- sheepskin pads
- special cushions placed on top of a mattress
- a water-filled mattress
- a variable-pressure mattress whose sections can be individually inflated or deflated to redistribute pressure.

Pillows or foam wedges can prevent a bedridden patient's ankles from irritating each other, and pillows placed under the legs from mid-calf to ankle can raise the heels off the bed. Raising the head of the bed slightly and briefly can provide relief, but raising the head of the bed more than 30 degrees can cause the patient to slide, thereby causing damage to skin and tiny blood vessels.

A person who uses a wheelchair should be encouraged to sit up as straight as possible. Pillows behind the head and between the legs can help prevent bedsores, as can a special cushion placed on the chair seat. Donut-shaped cushions should not be used because they restrict blood flow and cause tissues to swell.

Prognosis

Bedsores can usually be cured, but about 60,000 deaths a year are attributed to complications caused

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by bedsores. Bedsores can be slow to heal. Without proper treatment, they can lead to:

- gangrene (tissue death)
- osteomyelitis (infection of the bone beneath the bedsore)
- sepsis (tissue-destroying bacterial infection)
- other localized or systemic infections that slow the healing process, increase the cost of treatment, lengthen hospital or nursing home stays, or cause death

ORGANIZATIONS

National Pressure Ulcer Advisory Panel, 1025 Thomas Jefferson St. NW, Suite 500 East, Washington, DC, 20007, (202) 521-6789, (202) 833-3636, npuap@npuap.org, http://www.npuap.org.

Wound, Ostomy and Continence Nurses Society, 15000 Commerce Parkway, Suite C, Mt. Laurel, NJ, 08054, (888) 224-WOCN (9626).

Maureen Haggerty

Bedwetting

Definition

Bedwetting, or nocturnal enuresis, is a condition of passing urine in bed during sleep after the age at which bladder control normally occurs. It is sometimes called **urinary incontinence**. It is a chronic condition that often resolves by itself before the teenage years. Bedwetting can be classified as either primary nocturnal enuresis (PNE), which means that the child has not yet had a prolonged period of staying dry at night; and secondary nocturnal enuresis (SNE), which occurs after a child has achieved nighttime dryness.

The *Diagnostic and Statistical Manual of Mental Disorders*, fourth edition (DSM-IV), classifies enuresis under the heading of disorders usually first classified in infancy, childhood, or adolescence, and defines it as "repeated voiding of urine during the day or at night into bed or clothes." The voiding of urine must occur at least twice per week for at least three months and not be caused by a medical condition. Even if the bedwetting does not meet the criterion of frequency, the manual allows the condition to be diagnosed if it causes the child significant emotional distress or impairs his or her social or academic functioning.

Demographics

Bedwetting is the single most common urologic complaint in children but is a developmental issue in most children rather than a psychological or medical disorder. Only 5–10% of cases of bedwetting are caused by medical conditions. The number of children with nocturnal enuresis decreases sharply after five years of age. According to the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), about 10% of five-year-olds, 5% of 10-year-olds, and 1% of 18-year-olds experience episodes of bedwetting. Bedwetting at all ages is twice as common in boys as in girls; males make up 60% of bedwetters overall and make up more than 90% of those who wet the bed every night. Various studies place adult bedwetting rates somewhere between 0.5% and 2.3%.

Bedwetting is known to run in families. A family history of bedwetting is found in 50% of children with secondary nocturnal enuresis. One study reported bedwetting in 43% of children whose fathers had a childhood history of bedwetting; 44% of children of enuretic mothers; and 77% of children whose father and mother had histories of bedwetting.

Bedwetting has recently been linked to specific loci on four different chromosomes. A locus on chromosome 13 was identified in 1995 as associated with bedwetting. Since then, other genetic loci have been identified on chromosomes 8, 12, and 16. It should be noted that the genes in these loci do not govern bedwetting by itself; rather, they control such factors associated with bedwetting as the ability to wake up when the bladder feels full or the capacity of the bladder to hold urine.

Description

One of the major tasks of toddlerhood is to learn how to achieve conscious control over the timing of urination. Most children do not become fully toilet trained until they are about two to four years old. Before then, the parts of the nervous system in charge of bladder control are not fully developed and functional. In general, boys take longer to learn to control their bladders than girls; most girls are dry at night by age six, but most boys do not achieve nighttime dryness until age seven. In addition, daytime bladder control is easier for a child than overnight bladder control. As of 2010, researchers do not yet fully understand why it is easier for young children to stay dry during the day than during sleep.

Risk factors

There are only three known risk factors for bedwetting as of 2010:

- family history of bedwetting
- gender—boys are more likely to have problems with bedwetting than girls

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KEY TERMS

Antidiuretic hormone (ADH)—A substance stored in the pituitary gland and released at night to diminish the formation of urine. It is also known as vasopressin.

Behavior modification—Therapy aimed at changing behavior by substituting problem behaviors with more useful activities.

Continence—The ability to control one's bladder and bowel functions.

Culture test—A laboratory test to grow samples of an infecting organism from discharge or samples of affected tissue.

Diuretic—A substance that stimulates the formation and excretion of urine.

Incontinence—Loss of bowel or bladder control.

Nocturnal enuresis—The medical term for bedwetting.

Rapid eye movement sleep—A stage of sleep during which dreams occur. This stage usually alternates with a heavier, more restful stage of sleep.

Sitz bath—A hydrotherapy treatment for soaking the pelvic or genital areas.

Urethra—The tube that drains urine from the bladder.

Urologist—A physician who specializes in treating problems of the urinary tract.

- Attention deficit hyperactivity disorder (ADHD)—bedwetting is more common in children diagnosed with ADHD

Race or ethnicity do not appear to be risk factors for bedwetting.

Causes and symptoms

Bedwetting is in most cases due to the normal immaturity of the nervous system and the urinary system. For instance, up to age six, bedwetting is often due to nothing more than the bladder having a small capacity. In addition, the muscles that control the opening and closing of the urethra may not be sufficiently developed. Often it takes a while for a child to learn recognition of bladder fullness, waking up, and going to the toilet. Sometimes chronic **constipation** causes bedwetting because the fullness of the child's large intestine reduces bladder capacity. Still another factor may be insufficient production of antidiuretic hormone (ADH), a hormone stored in the pituitary gland and released at night to slow down urine production. In most cases, urinary capacity and control increase over time, and the bedwetting problem will eventually be outgrown.

One major cause of bedwetting is lack of sleep. If a child is not sleeping enough hours, then there will be less of the light, rapid eye movement (REM) sleep, and more periods of heavy, deep sleep. During the periods of deep sleep some children have difficulty becoming aware of the urge to urinate and awakening to go to the toilet.

Bedwetting may be a sign of allergic reactions, which end up irritating sphincter muscles around the urethra. This contributes to a loss of bladder control during sleep. Heavy **snoring**, mouth breathing, and night sweats may all be indications of the presence of **allergies**.

In some cases, bedwetting is an early symptom of diabetes. Other signs and symptoms of this metabolic disease may include passing large amounts of urine all at once, increased thirst, unusual tiredness, and weight loss in spite of a good appetite.

Bedwetting can sometimes be due to emotional and psychological **stress**, including such major life changes as moving, starting school, the birth of a sibling, or the parents' divorce. This stress usually leads to the type of bedwetting called secondary nocturnal enuresis (SNE), in which a previous level of accomplishment with bladder control is lost. In other words, a child who has been dry at night will suddenly start wetting the bed again. This may indicate an underlying problem such as constipation, diabetes, physical defects in the urinary tract, sacral nerve disorders, a pelvic growth, urinary stasis, infection, **kidney stones**, or kidney damage. Secondary enuresis also frequently occurs in children who are being physically or sexually abused. A pediatrician should be consulted if the condition persists.

About 5% of cases of bedwetting are caused by a serious underlying medical problem. If the following symptoms are present, a pediatrician or a pediatric urologist should be consulted:

- straining during urination
- a burning feeling or other discomfort during urination

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- constant or recurrent dribbling of urine
- cloudy or pink urine
- bloodstains or other discharge on underpants or nightclothes
- an unpleasant urine odor
- onset of abdominal pain, backache, or fever
- constant thirst, especially at night
- sudden loss of bladder control previously mastered
- a child over the age of two who still shows no signs of being ready to learn bladder control

Diagnosis

Examination

When bedwetting in a child is resistant to home treatments or when more serious symptoms are present, a visit should be made to a healthcare provider. This is especially warranted if the child is older than six. A thorough history and physical exam should be taken along with a urine sample. Analysis and culture tests can be done on the urine to determine if an infection is present.

Tests

Further evaluations may be made using ultrasound, an x ray of the kidney, or a consultation with a urologist. If the bedwetting appears to be connected with issues of stress or family problems, a mental health consultation may be recommended.

Bedwetting in adults is rare and should be promptly evaluated, as it is often a sign of a serious medical condition or disorder. Causes may include **bladder cancer**, obstructive **sleep apnea**, diabetes, disorders of the central nervous system, urinary tract enlargement, or stones in the urinary tract. Bedwetting in an adult male may be a symptom of prostate enlargement or **prostate cancer**. It is rare for **anxiety disorders** or other psychiatric disturbances to cause bedwetting in adults, but emotional stress has been known to cause occasional SNE in a small number of adults.

Treatment

Traditional

One option for treatment of bedwetting in children is simple watchful waiting. If the child does not seem to be emotionally upset by bedwetting episodes and there is no other major stress in the family, a reassuring talk with the pediatrician may be all that is needed. As children grow, their bladder capacity increases, the natural body signals to get up and urinate become more efficient, the production of ADH increases, and the child learns to respond to the body's signal to wake up and go to the bathroom.

Another option is mechanical bedwetting alarms. These are devices that consist of a moisture-sensitive pad worn inside the child's pajamas, a wire connected to a battery-operated control mechanism, and an alarm that sounds when the pad detects wetness. Ideally, the child will be awakened by the alarm in time to get to the bathroom before all of the urine has been voided. If the child is a very heavy sleeper, a parent or older sibling may need to sleep in the child's bedroom in order to awaken him or her when the alarm sounds. Some researchers have found that alarms are more effective with older children than with younger ones.

Behavior modification therapy may also be tried. A widely used program for bedwetters involves reminding the child to urinate before going to bed, recording wet and dry nights, changing wet clothing and bedding, and discussing progress. Positive reinforcements, such as gold stars on a chart and other rewards, are given for nights that the child does not urinate in bed. The International Children's Continence Society recommends a behavioral modification approach to bedwetting as well as age-appropriate explanations for children about other types of treatment for bedwetting.

Drugs

Medications may be useful in treating some cases of bedwetting, although doctors do not usually prescribe them for children younger than seven. The three drugs used most often are desmopressin (DDAVP), oxybutynin (Ditropan), and imipramine (Tofranil). Desmopressin, given as a pill or nasal spray, works by raising the levels of ADH in the body. Oxybutynin is a drug that works to relax the muscles in the bladder, preventing premature contractions. Imipramine is a tricyclic antidepressant that works on both the brain and the urinary bladder.

Medications are effective in about 70% of children with bedwetting problems. However, it is not unusual for children to relapse once the drugs are discontinued. In addition, all three drugs have side effects: desmopressin may cause seizures; oxybutynin may cause **dry mouth** and flushing; and imipramine can cause mood changes. Because an overdose of imipramine is potentially fatal in children, the antidepressant is usually prescribed only when other treatments fail.

Alternative

HANDS-ON THERAPIES. **Acupressure**, **reflexology**, and **shiatsu** can be used to relax the child, counteract stress, and improve the actions of the nervous system.

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Hypnotherapy can also be helpful in improving bedwetting. Among other things, the child will be given positive goal affirmations to say before going to bed. This should help make the urge to urinate during the night more conscious, and encourage the child to awaken and go to the toilet.

HOMEOPATHY. The best way to use homeopathy is to see a homeopath for individual prescribing. *Equisetum* 6c may be useful, especially if there are dreams or nightmares connected with the bedwetting. For bedwetting in very excitable, outgoing children, which occurs soon after falling asleep, *Causticum* 6c may be recommended. The remedies should be given once per day at bedtime for up to two weeks. A practitioner should be consulted for more specific remedies.

HERBAL MEDICINE. A strong tea can also be made using equal parts of horsetail, *Equisetum arvense;* **St. John's wort**; cornsilk, *Zea mays;* and lemon balm, *Melissa offinalis*. Two to three handfuls of the mixture should be placed in a quart or liter jar and then covered with boiling water. The tea should be allowed to steep overnight. The child should be given half a cup of the tea three times per day, with the last dose being given at least two hours before bedtime.

Nettles, *Urtica dioica,* can be made into a pleasant tea and consumed throughout the day as a tonic for the kidneys. The tea can be mixed with equal parts of fruit juice as a pleasant drink for the child.

AROMATHERAPY. Aromatherapy uses the essential oil of cypress, *Cupressus sempervirens* to treat chronic bedwetting. Several drops of cypress oil should be put in olive oil for massage. The oil should be rubbed onto the child's stomach right before bedtime.

Home remedies

Sitting in a cool **sitz bath** (with only the child's pelvic area immersed) for about five minutes daily can tone up the urethral sphincter. The sitz bath can be set up by using a bathtub filled with 2–3 in (4.5–6.6 cm) of water; having the child sit in a large basin of water; or purchasing a sitz basin (available from drugstores and medical supply stores).

Prognosis

Most children outgrow bedwetting at some point. Underlying disease conditions may have to be assessed and treated. The prognosis of bedwetting in adults depends on the underlying cause.

Prevention

Episodes of bedwetting cannot always be prevented, but the following measures are recommended to reduce their frequency:

- Limit the child's fluid intake in the evening.
- Avoid foods or drinks containing caffeine, which is a diuretic. Caffeine is contained not only in tea and coffee, but also in energy drinks, cola, hot chocolate, and foods containing chocolate.
- Encourage the child to urinate regularly throughout the day as well as just before bedtime. A common suggestion is to ask the child to urinate every two hours during the day.
- Make sure that constipation is treated if the child has problems with it.

Resources

BOOKS

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ORGANIZATIONS

American Academy of Child and Adolescent Psychiatry (AACAP), 3615 Wisconsin Avenue, N.W., Washington, DC, 20016-3007, (202) 966-7300 (202) 966-2891http://www.aacap.org.
American Academy of Pediatrics (AAP), 141 Northwest Point Boulevard, Elk Grove Village, IL, 60007, (847) 434-4000 (847) 434-8000http://www.aap.org.
International Children's Continence Society (ICCS), c/o Tryggve Neveus, Uppsala University Children's Hospital, Nephrology Unit, Uppsala, Sweden, 751 85 Uppsala, +46-18-6110000 +46-18-6115853Tryggve. Neveus@kbh.uu.se, http://www.i-c-c-s.org.
National Association for Continence (NAFC), P.O. Box 1019, Charleston, SC, 29402, (843) 377-0900 (800) BLADDER (843) 377-0905memberservices@nafc. org, http://www.nafc.org.
National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), Building 31. Rm 9A06, 31 Center Drive, MSC 2560, Bethesda, MD, 20892-2560, (301) 496-3583http://www2.niddk.nih.gov.

Patience Paradox
Rebecca J. Frey, PhD

Beef tapeworm infection *see* **Tapeworm diseases**
Behavior therapy *see* **Cognitive-behavioral therapy**

Behcet's syndrome

KEY TERMS

Remission—When active symptoms of a chronic disease are absent.

Uveitis—Inflammation of the area of the eye around the pupil.

Definition

A group of symptoms that affect a variety of body systems, including musculoskeletal, gastrointestinal, and the central nervous system. These symptoms include ulceration of the mouth or the genital area, **skin lesions**, and inflammation of the uvea (an area around the pupil of the eye).

Description

Behcet's syndrome is a chronic disease that involves multiple body systems. The disease is named for a Turkish dermatologist, Hulusi Behcet, who first reported a patient with recurrent mouth and genital ulcers along with **uveitis** in 1937. The disease occurs worldwide, but is most prevalent in Japan, the Middle East, and in the Mediterranean region. There is a wider prevalence among males than females in a ratio of two to one.

Causes and symptoms

The cause of Behcet's syndrome is unknown. Symptoms include recurring ulcers in the mouth or the genital area, skin lesions, arthritis that affects mainly the knees and ankles, **pain** and irritation in the eyes, and **fever**. The mouth and genital ulcers tend to occur in multiples and can be quite painful. In the mouth, these ulcers are generally found on the tongue, gums, and the inside of the lips or jaws. In the genital area, the ulcers usually occur on the penis and scrotum in males and on the vulva of women. The eye inflammation can lead to blindness.

Diagnosis

Because Behcet's syndrome is a multisystem disease, it is difficult to diagnose. International criteria have been proposed to assist in classifying this disease. There is no one diagnostic feature of this disease, so diagnosis depends on grouping together enough symptoms in order to identify the disease. Symptoms of Behcet's syndrome also occur in other diseases, so it is often necessary to rule out the other diseases before a definitive diagnosis can be reached.

Treatment

Some of the current drugs used to treat Behcet's syndrome include **corticosteroids**, cyclosporine,

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azathioprine, chlorambucil, interferon alpha, thalidomide, levamisole, and pulse cyclophosphamide.

Prognosis

The prognosis for Behcet's syndrome is generally poor. There has been a documented case of Behcet's lasting for 17 years. Although the disease is considered painful but not fatal, when the central nervous system is involved there is usually severe disability and **death** often occurs. The condition is usually chronic, although there can be remissions during the course of the disease. There is no predictable method to determine which patients will progress into the more serious symptoms, and which might move into remission.

Prevention

There is no known prevention for Behcet's syndrome.

Resources

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McPhee, Stephen, and Maxine Papadakis. *Current Medical Diagnosis and Treatment, 2010*, 49th ed. New York: McGraw-Hill Medical, 2009.

ORGANIZATIONS

American Behcet's Disease Association, PO Box 869, Smithtown, NY, 11787-0869, (631) 656-0537, (480) 247-5377, (800) 723-423-4238, http://www.behcets.com.

Behcet's Organization Worldwide, Head Office. P.O. Box 27, Watchet, United Kingdom, Somerset TA23 OYJ, http://www.behcets.org.

National Eye Institue, 2020 Vision Place, Bethesda, MD, (301) 496-5248, http://www.nei.nih.gov/.

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923, (800) 999-6673, http://www.rarediseases.org.

Kim A. Sharp, M.Ln.

Bejel

Definition

Bejel, also known as endemic **syphilis**, is a chronic but curable disease, seen mostly in children in arid regions. Unlike the better-known venereal syphilis, endemic syphilis is not a sexually transmitted disease.

Description

Bejel has many other names depending on the locality: siti, dichuchwa, njovera, belesh, and skerljevo are some of the names. It is most commonly found in the Middle East (Syria, Saudi Arabia, Iraq), Africa, central Asia, and Australia. Bejel is related to **yaws** and **pinta**, but has different symptoms.

Causes and symptoms

Treponema pallidum, the bacteria that causes bejel, is very closely related to the one that causes the sexually transmitted form of syphilis, but transmission is very different. In bejel, transmission is by direct contact, with broken skin or contaminated hands, or indirectly by sharing drinking vessels and eating utensils. *T. pallidum* is passed on mostly between children living in poverty in very unsanitary environments and with poor hygiene.

The skin, bones, and mucous membranes are affected by bejel. Patches and ulcerated sores are common in the mouth, throat, and nasal passages. Gummy lesions may form, even breaking through the palate. Other findings may include a region of swollen lymph nodes and deep bone **pain** in the legs. Eventually, bones may become deformed.

Diagnosis

T. pallidum can be detected by microscopic study of samples taken from the sores or lymph fluid. However, since antibody tests don't distinguish between the types of syphilis, specific diagnosis of the type of syphilis depends on the patient's history, symptoms, and environment.

Treatment

Large doses of benzathine penicillin G given by injection into the muscle can cure this disease in any stage, although it may take longer and require additional doses in later stages. If penicillin cannot be given, the alternative is tetracycline. Since tetracycline can permanently discolor new teeth still forming, it is usually not prescribed for children unless no viable alternative is available.

Prognosis

Bejel is completely curable with antibiotic treatment.

Prevention

The World Health Organization (WHO) has worked with many countries to prevent this and other diseases, and the number of cases has been reduced somewhat. Widespread use of penicillin has been responsible for reducing the number of existing cases, but the only way to eliminate bejel is by improving living and sanitation conditions.

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KEY TERMS

Endemic disease—An infectious disease that occurs frequently in a specific geographical locale. The disease often occurs in cycles. Influenza is an example of an endemic disease.

Lymph—This is a clear, colorless fluid found in lymph vessels and nodes. The lymph nodes contain organisms that destroy bacteria and other disease causing organisms (also called pathogens).

Syphilis—This disease occurs in two forms. One is a sexually transmitted disease caused by a bacteria. The second form is not sexually transmitted, but passed on by direct contact with the patient or through use of shared food dishes and utensils.

Resources

BOOKS

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Jill S. Lasker

Benazepril *see* **Angiotensin-converting enzyme inhibitors**

Bence Jones protein test

Definition

Bence Jones proteins are small proteins (light chains of immunoblobulin) found in the urine. Testing for these proteins is done to diagnose and monitor **multiple myeloma** and other similar diseases.

Purpose

Bence Jones proteins are considered the first tumor marker. A tumor marker is a substance, made by the body, that is linked to a certain **cancer**, or malignancy. Bence Jones proteins are made by plasma cells, a type of white blood cell. The presence of these proteins in a person's urine is associated with a malignancy of plasma cells.

Multiple myeloma, a tumor of plasma cells, is the disease most often linked with Bence Jones proteins. The amount of Bence Jones proteins in the urine indicates how much tumor is present. Physicians use Bence Jones proteins testing to diagnose the disease as well as to check how well the disease is responding to treatment.

Other diseases involving cancerous or excessive growth of plasma cells or cells similar to plasma cells can cause Bence Jones proteins in the urine. These diseases include: **Waldenström's macroglobulinemia**, some lymphomas and leukemias, osteogenic sarcoma, cryoglobulinemia, malignant B-cell disease, **amyloidosis**, light chain disease, and cancer that has spread to bone.

Description

Urine is the best specimen in which to look for Bence Jones proteins. Proteins are usually too large to move through a healthy kidney, from the blood into the urine. Bence Jones proteins are an exception. They are small enough to move quickly and easily through the kidney into the urine.

A routine **urinalysis** will not detect Bence Jones proteins. There are several methods used by laboratories to detect and measure these proteins. The classic Bence Jones reaction involves heating urine to 140 °F (60°C). At this temperature, the Bence Jones proteins will clump. The clumping disappears if the urine is further heated to boiling and reappears when the urine is cooled. Other clumping procedures using salts, acids, and other chemicals are also used to detect these proteins. These types of test will reveal whether or not Bence Jones proteins are present, but not how much is present.

A more complex procedure is done to measure the exact amount of Bence Jones proteins. This procedure—immunoelectrophoresis—is usually done on urine that has been collected for 24 hours.

The test is covered by insurance when medically necessary. Results are usually available within several days.

Preparation

Urine is usually collected throughout a 24-hour time period. A person is given a large container in which to collect the urine. The urine should be

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KEY TERMS

Bence Jones protein—Small protein, composed of a light chain of immunoglobulin, made by plasma cells.

Multiple myeloma—A tumor of the plasma cells.

Plasma cells—A type of white blood cell.

refrigerated until it is brought to the laboratory or physician's office.

Normal results

Bence Jones proteins normally are not present in the urine.

Abnormal results

Bence Jones proteins are present in 50–80% of people with multiple myeloma. People with other malignancies also can have a positive Bence Jones protein test, but less frequently.

Certain nonmalignant diseases, such as **rheumatoid arthritis**, **systemic lupus erythematosus**, and chronic renal insufficiency, can have Bence Jones proteins in the urine. High doses of penicillin or **aspirin** before collecting the urine can give a false positive result.

Resources

BOOKS

Pagana, Kathleen Deska, and Timothy J. Pagana. *Mosby's Manual of Diagnostic and Laboratory Tests*. 4th ed. St. Louis: Mosby, 2009.

Nancy J. Nordenson

Bender-Gestalt test

Definition

The Bender Visual Motor Gestalt test (or Bender-Gestalt test) is a psychological assessment used to evaluate visual-motor functioning, visual-perceptual skills, neurological impairment, and emotional disturbances in children and adults ages three and older.

Purpose

The Bender-Gestalt is used to evaluate visual-motor maturity and to screen children for developmental delays. The test is also used to assess brain damage and neurological deficits. Individuals who have suffered a traumatic brain injury may be given the Bender-Gestalt as part of a battery of neuropsychological measures, or tests.

The Bender-Gestalt is sometimes used in conjunction with other personality tests to determine the presence of emotional and psychiatric disturbances such as **schizophrenia**.

Precautions

Psychometric testing requires a clinically trained examiner. The Bender Visual Motor Gestalt Test should be administered and interpreted by a trained psychologist or psychiatrist. The Bender-Gestalt should always be employed as only one element of a complete battery of psychological or developmental tests, and should never be used alone as the sole basis for a diagnosis.

Description

The original Bender Visual Motor Gestalt test was developed in 1938 by psychiatrist Lauretta Bender. There are several different versions of the Bender-Gestalt available today (i.e., the Bender-Gestalt test; Modified Version of the Bender-Gestalt test for Preschool and Primary School Children; the Hutt Adaptation of the Bender-Gestalt test; the Bender Visual Motor Gestalt test for Children; the Bender-Gestalt test for Young Children; the Watkins Bender-Gestalt Scoring System; the Canter Background Interference Procedure for the Bender-Gestalt test). All use the same basic test materials, but vary in their scoring and interpretation methods.

The standard Bender Visual Motor Gestalt test consists of nine figures, each on its own 3 × 5 card. An examiner presents each figure to the test subject one at a time and asks the subject to copy it onto a single piece of blank paper. The only instruction given to the subject is that he or she should make the best reproduction of the figure possible. The test is not timed, although standard administration time is typically 10-20 minutes. After testing is complete, the results are scored based on accuracy and organization. Interpretation depends on the form of the test in use. Common features considered in evaluating the drawings are rotation, distortion, symmetry, and perseveration. As an example, a patient with frontal lobe injury may reproduce the same pattern over and over (perseveration).

The Bender-Gestalt can also be administered in a group setting. In group testing, the figures are shown to test subjects with a slide projector, in a test booklet, or on larger versions of the individual test cards. Both the individual and group-administered Bender-Gestalt

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KEY TERMS

Neuropsychological test—A test or assessment given to diagnose a brain disorder or disease.

Perseveration—The persistence of a repetitive response after the cause of the response has been removed, or the response continues to different stimuli.

Visual-motor skills—Hand-eye coordination; in the Bender-Gestalt test, visual-motor skills are measured by the subject's ability to accurately perceive and then reproduce figures.

Visual-perceptual skills—The capacity of the mind and the eye to "see" something as it objectively exists.

evaluation may take place in either an outpatient or hospital setting. Patients should check with their insurance plans to determine if these or other mental health services are covered.

Normal results

Children normally improve in this test as they age, but, because of the complexity of the scoring process, results for the Bender-Gestalt should only be interpreted by a clinically trained psychologist or psychiatrist.

ORGANIZATIONS

American Psychological Association (APA), 750 First St. NE, Washington, DC, 20002-4242, (202) 336-5500, (800) 374-2721, http://www.apa.org/.

ERIC Clearinghouse on Assessment and Evaluation, 1131 Shriver Laboratory (Bldg 075), University of Maryland, College Park, MD, 20742, (800) 464-3742, feedback3@ericae.net, http://www.ericae.net.

Paula Anne Ford-Martin

Bends *see* **Decompression sickness**

Benign prostatic hyperplasia *see* **Enlarged prostate**

Benign prostatic hypertrophy *see* **Enlarged prostate**

Benzocaine *see* **Antiseptics**

Benzodiazepines

Definition

Benzodiazepines are medicines that help relieve nervousness, tension, and other symptoms by slowing the central nervous system.

Purpose

Benzodiazepines are a class of **antianxiety drugs**. While anxiety is a normal response to stressful situations, some people have unusually high levels of anxiety that can interfere with everyday life. For these people, benzodiazepines can help bring their feelings under control. The medicine can also relieve troubling symptoms of anxiety, such as pounding heartbeat, breathing problems, irritability, **nausea**, and faintness.

Physicians may sometimes prescribe these drugs for other conditions, such as **muscle spasms**, **epilepsy** and other seizure disorders, **phobias**, **panic disorder**, withdrawal from alcohol, and sleeping problems. However, this medicine should not be used every day for sleep problems that last more than a few days. If used this way, the drug loses its effectiveness within a few weeks.

Description

The family of antianxiety drugs known as benzodiazepines includes alprazolam (Xanax), chlordiazepoxide (Librium), diazepam (Valium), and lorazepam (Ativan). These medicines take effect fairly quickly, starting to work within an hour after they are taken. Benzodiazepines are available only with a physician's prescription and are available in tablet, capsule, liquid, or injectable forms.

Recommended dosage

The recommended dosage depends on the type of benzodiazepine, its strength, and the condition for which it is being taken. Doses may be different for different people. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

Always take benzodiazepines exactly as directed. Never take larger or more frequent doses, and do not take the drug for longer than directed. If the medicine does not seem to be working, check with the physician who prescribed it. *Do not increase the dose or stop*

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KEY TERMS

Anxiety—Worry or tension in response to real or imagined stress, danger, or dreaded situations. Physical reactions, such as fast pulse, sweating, trembling, fatigue, and weakness may accompany anxiety.

Asthma—A disease in which the air passages of the lungs become inflamed and narrowed.

Bronchitis—Inflammation of the air passages of the lungs.

Central nervous system—The brain and spinal cord.

Chronic—A word used to describe a long-lasting condition. Chronic conditions often develop gradually and involve slow changes.

Emphysema—An irreversible lung disease in which breathing becomes increasingly difficult.

Epilepsy—A brain disorder with symptoms that include seizures.

Glaucoma—A condition in which pressure in the eye is abnormally high. If not treated, glaucoma may lead to blindness.

Myasthenia gravis—A chronic disease with symptoms that include muscle weakness and sometimes paralysis.

Panic disorder—A disorder in which people have sudden and intense attacks of anxiety in certain situations. Symptoms such as shortness of breath, sweating, dizziness, chest pain, and extreme fear often accompany the attacks.

Phobia—An intense, abnormal, or illogical fear of something specific, such as heights or open spaces.

Porphyria—A disorder in which porphyrins build up in the blood and urine.

Porphyrin—A type of pigment found in living things.

Seizure—A sudden attack, spasm, or convulsion.

Sleep apnea—A condition in which a person temporarily stops breathing during sleep.

Withdrawal symptoms—A group of physical or mental symptoms that may occur when a person suddenly stops using a drug to which he or she has become dependent.

taking the medicine unless the physician says to do so. Stopping the drug suddenly may cause withdrawal symptoms, especially if it has been taken in large doses or over a long period. People who are taking the medicine for seizure disorders may have seizures if they stop taking it suddenly. If it is necessary to stop taking the medicine, check with a physician for directions on how to stop. The physician may recommend tapering down gradually to reduce the chance of withdrawal symptoms or other problems.

Precautions

Seeing a physician regularly while taking benzodiazepines is important, especially during the first few months of treatment. The physician will check to make sure the medicine is working as it should and will note unwanted side effects.

People who take benzodiazepines to relieve nervousness, tension, or symptoms of panic disorder should check with their physicians every two to three months to make sure they still need to keep taking the medicine.

Patients who are taking benzodiazepines for sleep problems should check with their physicians if they are not sleeping better within 7–10 days. Sleep problems that last longer than this may be a sign of another medical problem.

People who take this medicine to help them sleep may have trouble sleeping when they stop taking the medicine. This effect should last only a few nights.

Some people, especially older people, feel drowsy, dizzy, lightheaded, or less alert when using benzodiazepines. The drugs may also cause clumsiness or unsteadiness. When the medicine is taken at bedtime, these effects may even occur the next morning. Anyone who takes these drugs should not drive, use machines or do anything else that might be dangerous until they have found out how the drugs affect them.

Benzodiazepines may also cause behavior changes in some people, similar to those seen in people who act differently when they drink alcohol. More extreme changes, such as confusion, agitation, and **hallucinations**, also are possible. Anyone who starts having strange or unusual thoughts or behavior while taking this medicine should get in touch with his or her physician.

Because benzodiazepines work on the central nervous system, they may add to the effects of alcohol and other drugs that slow down the central nervous system, such as **antihistamines**, cold medicine, allergy medicine, sleep aids, medicine for seizures, tranquilizers, some **pain**

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relievers, and **muscle relaxants**. They may also add to the effects of anesthetics, including those used for dental procedures. These effects may last several days after treatment with benzodiazepines ends. *The combined effects of benzodiazepines and alcohol or other CNS depressants (drugs that slow the central nervous system) can be very dangerous, leading to unconsciousness or, rarely, even death.* Anyone taking benzodiazepines should not drink alcohol and should check with his or her physician before using any CNS depressants. *Taking an overdose of benzodiazepines can also cause unconsciousness and possibly death. Anyone who shows signs of an overdose or of the effects of combining benzodiazepines with alcohol or other drugs should get immediate emergency help.* Warning signs include slurred speech or confusion, severe drowsiness, staggering, and profound weakness.

Some benzodiazepines may change the results of certain medical tests. Before having medical tests, anyone taking this medicine should alert the health care professional in charge.

Children are generally more sensitive than adults to the effects of benzodiazepines. This sensitivity may increase the chance of side effects.

Older people are more sensitive than younger adults to the effects of this medicine and may be at greater risk for side effects. Older people who take these drugs to help them sleep may be drowsy during the day. Older people also increase their risk of falling and injuring themselves when they take these drugs.

Special conditions

People with certain medical conditions or who are taking certain other medicines can have problems if they take benzodiazepines. Before taking these drugs, be sure to let the physician know about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to benzodiazepines or other mood-altering drugs in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. Some benzodiazepines increase the likelihood of **birth defects**. Using these medicines during **pregnancy** may also cause the baby to become dependent on them and to have withdrawal symptoms after birth. When taken late in pregnancy or around the time of labor and delivery, these drugs can cause other problems in the newborn baby, such as weakness, breathing problems, slow heartbeat, and body temperature problems.

BREASTFEEDING. Benzodiazepines may pass into breast milk and cause problems in babies whose mothers taken the medicine. These problems include drowsiness, breathing problems, and slow heartbeat. Women who are **breastfeeding** their babies should not use this medicine without checking with their physicians.

OTHER MEDICAL CONDITIONS. Before using benzodiazepines, people with any of these medical problems should make sure their physicians are aware of their conditions:

- current or past drug or alcohol abuse
- depression
- severe mental illness
- epilepsy or other seizure disorders
- swallowing problems
- chronic lung disease such as emphysema, asthma, or chronic bronchitis
- kidney disease
- liver disease
- brain disease
- glaucoma
- hyperactivity
- myasthenia gravis
- porphyria
- sleep apnea

USE OF CERTAIN MEDICINES. Taking benzodiazepines with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Side effects

The most common side effects are **dizziness**, lightheadedness, drowsiness, clumsiness, unsteadiness, and slurred speech. These problems usually go away as the body adjusts to the drug and do not require medical treatment unless they persist or they interfere with normal activities.

More serious side effects are not common, but may occur. If any of the following side effects occur, check with the physician who prescribed the medicine as soon as possible:

- behavior changes
- memory problems
- difficulty concentrating
- confusion
- depression
- seizures (convulsions)
- hallucinations
- sleep problems

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- increased nervousness, excitability, or irritability
- involuntary movements of the body, including the eyes
- low blood pressure
- unusual weakness or tiredness
- skin rash or itching
- unusual bleeding or bruising
- yellow skin or eyes
- sore throat
- sores in the mouth or throat
- fever and chills

Patients who take benzodiazepines for a long time or at high doses may notice side effects for several weeks after they stop taking the drug. They should check with their physicians if these or other troublesome symptoms occur:

- irritability
- nervousness
- sleep problems

Other rare side effects may occur. Anyone who has unusual symptoms during or after treatment with benzodiazepines should get in touch with his or her physician.

Interactions

Benzodiazepines may interact with a variety of other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes benzodiazepines should let the physician know all other medicines he or she is taking. Among the drugs that may interact with benzodiazepines are:

- Central nervous system (CNS) depressants such as medicine for allergies, colds, hay fever, and asthma; sedatives; tranquilizers; prescription pain medicine; muscle relaxants; medicine for seizures; sleep aids; barbiturates; and anesthetics.

Medicines other than those listed above may interact with benzodiazepines. Be sure to check with a physician or pharmacist before combining benzodiazepines with any other prescription or nonprescription (over-the-counter) medicine.

Resources

OTHER

"Medicines." MedlinePlus. http://www.nlm.nih.gov/medlineplus/medicines.html (accessed November 24, 2010)

Nancy Ross-Flanigan

Benzoyl peroxide *see* **Antiacne drugs**
Benztropine *see* **Antiparkinson drugs**

Bereavement

Definition

Bereavement refers to the period of mourning and grief following the **death** of a beloved person or animal. The English word *bereavement* comes from an ancient Germanic root word meaning "to rob" or "to seize by violence." *Mourning* is the word that is used to describe the public rituals or symbols of bereavement, such as holding funeral services, wearing black clothing, closing a place of business temporarily, or lowering a flag to half mast. *Grief* refers to one's personal experience of loss; it includes physical symptoms as well as emotional and spiritual reactions to the loss. While public expressions of mourning are usually time-limited, grief is a process that takes most people several months or years to work through.

Students gathered around a memorial on a college campus, honoring and grieving slain students. *(Scott Olson/Getty Images News/Getty Images.)*

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KEY TERMS

Bibliotherapy—The use of books (usually self-help or problem-solving works) to improve one's understanding of personal problems and/or to heal painful feelings.

Biofield healing—A general term for a group of alternative therapies based on the belief that the human body is surrounded by an energy field (or aura) that reflects the condition of the person's body and spirit. Rebalancing or repairing the energy field is thought to bring about healing in mind and body. Reiki, therapeutic touch, polarity balancing, Shen therapy, and certain forms of color therapy are considered forms of biofield healing.

Complicated grief—An abnormal response to bereavement that includes unrelieved yearning for the dead person, the complete loss of previous positive beliefs or worldviews, and a general inability to function.

Disenfranchised grief—Grief that cannot be openly expressed because the death or other loss cannot be publicly acknowledged.

Euthanasia—The act of putting a person or animal to death painlessly or allowing them to die by withholding medical services, usually because of a painful and incurable disease.

Mourning—The public expression of bereavement; it may include funerals and other rituals, special clothing, and symbolic gestures.

Regression—A return to earlier, particularly infantile, patterns of thought and behavior.

Thanatology—The medical, psychological, or legal study of death and dying.

Traumatic grief—Grief resulting from the loss of a loved one in a traumatic situation (natural or transportation disaster, act of terrorism or mass murder, etc.)

Description

Bereavement is a highly individual as well as a complex experience. It is increasingly recognized that no two people respond the same way to the losses associated with the death of a loved one. People's reactions to a death are influenced by such factors as ethnic or religious traditions; personal beliefs about life after death; the type of relationship ended by death (relative, friend, colleague, etc.); the cause of death; the person's age at death; whether the death was sudden or expected; and many others. In addition, the death of a loved one inevitably confronts adults (and older adolescents) with the fact that they too will die. As a result of this complexity, most doctors and other counselors advise people to trust their own feelings about bereavement and grieve in the way that seems most helpful to them.

It is also increasingly understood that people can experience bereavement with regard to other losses. Some examples of these so-called "silent losses" include miscarriages in early **pregnancy**, the death of a child in the womb shortly before birth, or the news that a loved one has **Alzheimer's disease** or another illness that slowly destroys their personality. In addition, many counselors recognize that bereavement has two dimensions, the actual loss and the symbolic losses. For example, a person whose teenage son or daughter is killed in an accident suffers a series of symbolic losses—knowing that their child will never graduate from high school, get married, or have children—as well as the actual loss of the adolescent to death.

Causes and symptoms

Causes

The immediate cause of bereavement is usually the death of a loved friend or relative. There are a number of situations, however, that can affect or prolong the grief process:

- The relationship with the dead person was a source of pain rather than love and support. Examples would include an abusive parent or spouse.
- The person died in military service or in a natural, transportation, or workplace disaster. Bereavement in these cases is often made more difficult by intrusive news reporters as well as anxiety over the loved one's possible physical or mental suffering prior to death.
- The person was murdered. Survivors of homicide victims often find the criminal justice system as well as the media frustrating and upsetting.
- The person is missing and presumed dead but their death has not been verified. As a result, friends and relatives may alternate between grief and hope that the person is still alive.

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- The person committed suicide. Survivors may feel guilt over their inability to foresee or prevent the suicide, shame that the death was self-inflicted, or anger at the person who committed suicide.
- The relationship with the dead person cannot be openly acknowledged. This situation often leads to what is called disenfranchised grief. The most common instances are sexual relationships that have been kept secret for the sake of spouses or other family members.
- The loved one was an animal rather than a human being. Western societies are only beginning to accept that adults as well as children can grieve for a dead animal; many adults still feel that there is "something wrong" about grieving for their pet. The question of euthanasia may be an additional source of sorrow; even when the pet is terminally ill, many people are very uneasy about making the decision to end its life.

Symptoms

Bereavement typically affects a person's physical well-being as well as emotions. Common symptoms of grief include changes in appetite and weight, **fatigue**, **insomnia** and other sleep disturbances, loss of interest in sex, low energy levels, **nausea and vomiting**, chest or throat **pain**, and **headache**. People who have lost a loved one in traumatic circumstances may have symptoms of **post-traumatic stress disorder**, such as an exaggerated startle response, visual or auditory **hallucinations**, or high levels of muscular tension.

Doctors and other counselors have identified four stages or phases in uncomplicated bereavement:

- Shock, disbelief, feelings of numbness. This initial phase lasts about two weeks, during which the bereaved person finally accepts the reality of the loved one's death.
- Suffering the pain of grief. This phase typically lasts for several months. Some people undergo a mild temporary depression about six months after the loved one's death.
- Adjusting to life without the loved one. In this phase of bereavement, survivors may find themselves taking on the loved one's roles and responsibilities as well as redefining their own identities.
- Moving forward with life, forming new relationships, and having positive expectations of the future. Most people reach this stage within one to two years after the loved one's death.

BEREAVEMENT IN CHILDREN. Children do not experience bereavement in the same way as adolescents and adults. Preschool children usually do not understand death as final and irreversible, and may talk or act as if the dead pet or family member will wake up or come back. Children between the ages of five and nine are better able to understand the finality of death, but they tend to assume it will not affect them or their family. They are likely to be shocked and severely upset by a death in their immediate family. In addition to the physical disturbances that bereaved adults often experience, children sometimes begin to act like infants again (wanting bottle feeding, using baby talk, etc.) This pattern of returning to behaviors characteristic of an earlier life stage is called regression.

TRAUMATIC AND COMPLICATED GRIEF. Since the early 1990s, thanatologists (doctors and other counselors who specialize in issues related to death and dying) have identified two types of grief that do not resolve normally with the passage of time. Traumatic grief is defined as grief resulting from a sudden traumatic event that involves violent suffering, mutilation, and/or multiple deaths; appears to be random or preventable; and often involves the survivor's own brush with death. The symptoms of traumatic grief are similar to those of post-traumatic stress disorder (PTSD). Such events as the terrorist attacks of September 11, 2001; the East Asian tsunami of December 2004; and airplane crashes or other transportation disasters may produce traumatic grief in survivors.

In contrast to traumatic grief, complicated grief does not necessarily result from a specific type of event but rather refers to an abnormally intense and prolonged response to bereavement. While most people are able to move through a period of bereavement and recover a sense of purpose and meaning in life, people with complicated grief feel as if their entire worldview has been shattered. They cannot stop thinking of the dead person, long to be with him or her, and may feel that part of them died along with the loved one. They sometimes start acting like the deceased person, mimicking the symptoms of his or her illness, behaving in reckless ways, talking about "joining" the loved one, or refusing to accept the reality of the death. In general they are unable to function normally. Complicated grief should not be regarded as simply a subtype of clinical depression; the two conditions may coexist or overlap in some patients but are nonetheless distinct entities.

Diagnosis

Bereavement is considered a normal response to a death or other loss. A doctor who suspects that a patient is suffering from traumatic or complicated grief, however, may use various psychological inventories or questionnaires to see whether the patient meets the criteria for PTSD, major depression, or **acute stress**

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disorder. In addition, there are several specific questionnaires to help diagnose complicated grief.

Treatment

Most people do not require formal treatment for bereavement. However, many people choose to participate in support groups for recently bereaved people or hospice follow-up programs for relatives of patients who died in that hospice. Bereavement support groups are particularly helpful in guiding members through such common but painful problems as disposing of the dead person's possessions, celebrating holidays without the loved one, coping with anniversaries, etc.

Traumatic grief is usually treated in the same way as post-traumatic stress, with temporary use of medications to control sleep disturbances and **anxiety** symptoms along with long-term **psychotherapy**. Those suffering from traumatic grief may also be referred to support groups of people dealing with the same type of sudden and violent loss. Complicated grief is usually managed with a combination of group and individual psychotherapy.

Alternative treatment

Alternative therapies that have been reported to help with the sleep disturbances and other physical symptoms of bereavement include prayer and **meditation**; such movement therapies as **yoga** and **tai chi**; **therapeutic touch**, **Reiki**, and other forms of biofield healing; bibliotherapy and journaling; **music therapy**; **art therapy**; **hydrotherapy**; and **massage therapy**.

Prognosis

Most people move through the stages of the normal grief process within several months to two years, depending on the length and closeness of the relationship. Traumatic grief and complicated grief, however, may take three years or longer to resolve, even with appropriate treatment.

Prevention

Bereavement is considered a normal response to death and loss, which are universal human experiences. It should ordinarily be allowed to run its course; most counselors maintain that trying to stifle or cut short the grief process is more likely to cause emotional problems later on than to prevent them.

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ORGANIZATIONS

Alzheimer's Association, 225 N. Michigan Ave., Fl. 17, Chicago, IL, 60601-7633, (312) 335-8700, (866) 699-1246, (800) 272-3900, info@alz.org, http://www.alz.org.

American Academy of Child and Adolescent Psychiatry (AACAP), 3615 Wisconsin Ave. NW, Washington, DC, 20013-3007, (202) 966-7300, (202) 966-2891, communications@aacap.org, http://www.aacap.org/.

American Veterinary Medical Association (AVMA), 1931 North Meacham Road, Suite 100, Schaumburg, IL, 60173-4360, (847) 925-1329, (800) 248-2862, http://www. avma.org/.

Dougy Center for Grieving Children and Families, PO Box 86852, Portland, OR, 97286, (503) 775-5683, (503) 777-3097, (866) 775-5683, http://www.dougy.org.

National Air Disaster Alliance/Foundation (NADA), 2020 Pennsylvania Avenue NW #315, Washington, DC, 20006-1846, (336) 643-1394, (888) 444-NADA (6232), http://www.planesafe.org.

National Hospice and Palliative Care Organization, 700 Diagonal Road, Suite 625, Alexandria, VA, 22314, (703) 837-1500, (703) 837-1233, http://www.nhpco.org.

National Institute of Mental Health (NIMH), 6001 Executive Boulevard, Bethesda, MD, 20892, (301) 443-4513, (301) 443-4279, (866) 615-6464, nimhinfo@nih.gov, http://www.nimh.nih.gov.

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Tragedy Assistance Program for Survivors, Inc. (TAPS), National Headquarters, 1777 F Street NW, Suite 600, Washington, DC, 20006, (202) 588-TAPS (8277), (202) 509-8282, (800) 959-TAPS (8277), info@taps.org, http://ww.taps.org.

Rebecca Frey, PhD

Berger's disease *see* **Idiopathic primary renal hematuric/proteinuric syndrome**

Beriberi

Definition

Beriberi is a disease caused by a deficiency of thiamine (vitamin B_1) that affects many systems of the body, including the muscles, heart, nerves, and digestive system. Beriberi literally means "I can't, I can't" in Singhalese, which reflects the crippling effect it has on its victims. It is common in parts of southeast Asia, where white rice is the main food. In the United States, beriberi is primarily seen in people with chronic **alcoholism**.

Description

Beriberi puzzled medical experts for years as it ravaged people of all ages in Asia. Doctors thought it was caused by something in food. Not until the early 1900s did scientists discover that rice bran, the outer covering that was removed to create the polished white rice preferred by Asians, actually contained something that prevented the disease. Thiamine was the first vitamin identified. In the 1920s, extracts of rice polishings were used to treat the disease.

In adults, there are different forms of beriberi, classified according to the body systems most affected. Dry beriberi involves the nervous system; wet beriberi affects the heart and circulation. Both types usually occur in the same patient, with one set of symptoms predominating.

A less common form of cardiovascular, or wet beriberi, is known as "shoshin." This condition involves a rapid appearance of symptoms and acute **heart failure**. It is highly fatal and is known to cause sudden **death** in young migrant laborers in Asia whose diet consists of white rice.

Cerebral beriberi, also known as Wernicke-Korsakoff syndrome, usually occurs in chronic alcoholics and affects the central nervous system (brain and spinal cord). It can be caused by a situation that aggravates a chronic thiamine deficiency, like an alcoholic binge or severe **vomiting**.

Infantile beriberi is seen in breastfed infants of thiamine-deficient mothers, who live in developing nations.

Although severe beriberi is uncommon in the United States, less severe thiamine deficiencies do occur. About 25% of all alcoholics admitted to a hospital in the United States show some evidence of thiamine deficiency.

Causes and symptoms

Thiamine is one of the B **vitamins** and plays an important role in energy metabolism and tissue building. It combines with phosphate to form the coenzyme *thiamine pyrophosphate (TPP),* which is essential in reactions that produce energy from glucose or that convert glucose to fat for storage in the tissues. When there is not enough thiamine in the diet, these basic energy functions are disturbed, leading to problems throughout the body.

Special situations, such as an over active metabolism, prolonged **fever**, **pregnancy**, and **breastfeeding**, can increase the body's thiamine requirements and lead to symptoms of deficiency. Extended periods of **diarrhea** or chronic **liver disease** can result in the body's inability to maintain normal levels of many nutrients, including thiamine. Other persons at risk are patients with kidney failure on dialysis and those with severe digestive problems who are unable to absorb nutrients. Alcoholics are susceptible because they may substitute alcohol for food and their frequent intake of alcohol decreases the body's ability to absorb thiamine.

The following systems are most affected by beriberi:

- Gastrointestinal system. When the cells of the smooth muscles in the digestive system and glands do not get enough energy from glucose, they are unable to produce more glucose from the normal digestion of food. There is a loss of appetite, indigestion, severe constipation, and a lack of hydrochloric acid in the stomach.
- Nervous system. Glucose is essential for the central nervous system to function normally. Early deficiency symptoms are fatigue, irritability, and poor memory. If the deficiency continues, there is damage to the peripheral nerves that causes loss of sensation and muscle weakness, which is called peripheral neuropathy. The legs are most affected. The toes feel numb and the feet have a burning sensation; the leg

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KEY TERMS

B vitamins—This family of vitamins consists of thiamine (B_1), riboflavin (B_2), niacin (B_3), pantothenic acid (B_5), pyridoxine (B_6), biotin, folic acid (B_9), and cobalamin (B_{12}). They are interdependent and involved in converting glucose to energy.

Coenzyme—A substance needed by enzymes to produce many of the reactions in energy and protein metabolism in the body.

Edema—An excess accumulation of fluid in the cells and tissues.

Enzyme—A protein that acts as a catalyst to produce chemical changes in other substances without being changed themselves.

Metabolism—All the physical and chemical changes that take place within an organism.

Peripheral neuropathy—A disease affecting the portion of the nervous system outside the brain and spinal chord. One or more nerves can be involved, causing sensory loss, muscle weakness and shrinkage, and decreased reflexes.

Thiamine pyrophosphate (TPP)—The coenzyme containing thiamine that is essential in converting glucose to energy.

muscles become sore and the calf muscles cramp. The individual walks unsteadily and has difficulty getting up from a squatting position. Eventually, the muscles shrink (atrophy) and there is a loss of reflexes in the knees and feet; the feet may hang limp (footdrop).

- Cardiovascular system. There is a rapid heartbeat and sweating. Eventually the heart muscle weakens. Because the smooth muscle in the blood vessels is affected, the arteries and veins relax, causing swelling, known as edema, in the legs.
- Musculoskeletal system. There is widespread muscle pain caused by the lack of TPP in the muscle tissue.

Infants who are breastfed by a thiamine-deficient mother usually develop symptoms of deficiency between the second and fourth month of life. They are pale, restless, unable to sleep, prone to diarrhea, and have muscle wasting and **edema** in their arms and legs. They have a characteristic, sometimes silent, cry and develop heart failure and nerve damage.

Diagnosis

A **physical examination** will reveal many of the early symptoms of beriberi, such as **fatigue**, irritation, **nausea**, **constipation**, and poor memory, but the deficiency may be difficult to identify. Information about the individual's diet and general health is also needed.

There are many biochemical tests based on thiamine metabolism or the functions of TPP that can detect a thiamine deficiency. Levels of thiamine can be measured in the blood and urine and will be reduced if there is a deficiency. The urine can be collected for 24 hours to measure the level of thiamine excreted. Another reliable test measures the effect of TPP on red blood cell activity since all forms of beriberi affect the metabolism of red blood cells.

An electroencephalogram (EEG), which measures electrical activity in the brain, may be done to rule out other causes of neurologic changes. Observing improvements in the patient after giving thiamine supplements will also confirm the diagnosis.

Treatment

Treatment with thiamine reverses the deficiency in the body and relieves most of the symptoms. Severe thiamine deficiency is treated with high doses of thiamine given by injection into a muscle (intramuscular) or in a solution that goes into a vein (intravenously) for several days. Then smaller doses can be given either by injection or in pill form until the patient recovers. Usually there are other deficiencies in the B vitamins that will also need treatment.

The cardiovascular symptoms of wet beriberi can respond to treatment within a few hours if they are not too severe. Heart failure may require additional treatment with **diuretics** that help eliminate excess fluid and with heart-strengthening drugs like digitalis.

Recovery from **peripheral neuropathy** and other symptoms of dry beriberi may take longer and patients frequently become discouraged. They should stay active; **physical therapy** will also help in recovery.

Infantile beriberi is treated by giving thiamine to both the infant and the breast-feeding mother until levels are normal.

In Wernicke-Korsakoff syndrome, thiamine should be given intravenously or by injection at first because the intestinal absorption of thiamine is probably impaired

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and the patient is very ill. Most of the symptoms will be relieved by treatment, though there may be residual **memory loss**.

Excess thiamine is excreted by the body in the urine, and negative reactions to too much thiamine are rare. Thiamine is unstable in alkali solutions, so it should not be taken with **antacids** or **barbiturates**.

Alternative treatment

Alternative treatments for beriberi deal first with correcting the thiamine deficiency. As in conventional treatments, alternative treatments for beriberi stress a diet rich in foods that provide thiamine and other B vitamins, such as brown rice, whole grains, raw fruits and vegetables, legumes, seeds, nuts, and yogurt. Drinking more than one glass of liquid with a meal should be avoided, since this may wash out the vitamins before they can be absorbed by the body. Thiamine should be taken daily, with the dose depending on the severity of the disease. Additional supplements of B vitamins, a multivitamin and mineral complex, and Vitamin C are also recommended. Other alternative therapies may help relieve the person's symptoms after the thiamine deficiency is corrected.

Prognosis

Beriberi is fatal if not treated and the longer the deficiency exists, the sicker the person becomes. Most of the symptoms can be reversed and full recovery is possible when thiamine levels are returned to normal and maintained with a balanced diet and vitamin supplements as needed.

Prevention

A balanced diet containing all essential nutrients will prevent a thiamine deficiency and the development of beriberi. People who consume large quantities of junk food like soda, pretzels, chips, candy, and high carbohydrate foods made with unenriched flours may be deficient in thiamine and other vital nutrients. They may need to take vitamin supplements and should improve their **diets**.

Dietary requirements

The body's requirements for thiamine are tied to carbohydrate metabolism and expressed in terms of total intake of calories. The current recommended dietary allowances (RDA) are 0.5 mg for every 1000 calories, with a minimum daily intake of 1 mg even for those who eat fewer than 2,000 calories in a day. The RDA for children and teenagers is the same as for adults: 1.4 mg daily for males over age eleven, and 1.1 mg for females. During pregnancy, an increase to 1.5 mg daily is needed. Because of increased energy needs and the secretion of thiamine in breast milk, breast-feeding mothers need 1.5 mg every day. In infants, 0.4 mg is advised.

Food sources

The best food sources of thiamine are lean pork, beef, liver, brewer's yeast, peas and beans, whole or enriched grains, and breads. The more refined the food, as in white rice, white breads, and some cereals, the lower the thiamine. Many food products are enriched with thiamine, along with riboflavin, niacin, and iron, to prevent dietary deficiency.

During the milling process, rice is polished and all the vitamins in the exterior coating of bran are lost. Boiling the rice before husking preserves the vitamins by distributing them throughout the kernel. Food enrichment programs have eliminated beriberi in Japan and the Phillipines.

Like all B vitamins, thiamine is water soluble, which means it is easily dissolved in water. It will leach out during cooking in water and is destroyed by high heat and overcooking.

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Karen Ericson, RN

Berry aneurysm *see* **Cerebral aneurysm**

Beryllosis

Definition

Berylliosis is lung inflammation caused by inhaling dust or fumes that contain the metallic element beryllium. Found in rocks, coal, soil, and volcanic dust, beryllium is used in the aerospace industry and in many types of manufacturing. Berylliosis occurs in both acute and chronic forms. In some cases, appearance of the disease may be delayed as much as 20 years after exposure to beryllium.

Description

In the 1930s, scientists discovered that beryllium could make fluorescent light bulbs last longer. During the following decade, the hard, grayish metal was

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KEY TERMS

Beryllium—A steel-grey, metallic mineral used in the aerospace and nuclear industries and in a variety of manufacturing processes.

Chelation therapy—A treatment using chelating agents, compounds that surround and bind to target substances allowing them to be excreted from the body.

Corticosteroids—A group of anti-inflammatory drugs.

identified as the cause of a potentially debilitating, sometimes deadly disease characterized by **shortness of breath** and inflammation, swelling, and scarring of the lungs.

The manufacture of fluorescent light bulbs is no longer a source of beryllium exposure, but serious health hazards are associated with any work environment or process in which beryllium fumes or particles become airborne. Working with pure beryllium, beryllium compounds (e.g., beryllium oxide), or beryllium alloys causes occupational exposure. So do jobs involving:

- electronics
- fiber optics
- manufacturing ceramics, bicycle frames, golf clubs, mirrors, and microwave ovens
- mining
- nuclear weapons and reactors
- reclaiming scrap metal
- space and atomic engineering
- dental and laboratory technology

Beryllium dust and fumes are classified as toxic air pollutants by the Environmental Protection Agency (EPA). It is estimated that 2–6% of workers exposed to these contaminants eventually develop berylliosis.

Causes and symptoms

Coughing, shortness of breath, and weight loss that begin abruptly can be a symptom of acute berylliosis. This condition is caused by beryllium air pollution that inflames the lungs making them rigid; it can affect the eyes and skin as well. People who have acute berylliosis are usually very ill. Most recover, but some die of the disease.

Chronic berylliosis is an allergic reaction to long-term exposure to even low levels of beryllium dust or fumes. A systemic disease that causes formation of abnormal lung tissue and enlargement of the lymph nodes, chronic berylliosis also may affect other parts of the body. The symptoms of chronic berylliosis are largely the same as those seen in acute berylliosis, but they develop more slowly.

Diagnosis

Berylliosis is initially suspected if a patient with symptoms of the disease has a history of beryllium exposure. A **chest x ray** shows characteristic changes in the lungs. However, since these changes can resemble those caused by other lung diseases, further testing may be necessary.

The beryllium lymphocyte proliferation test (BeLPT), a blood test that can detect beryllium sensitivity (i.e., an allergic reaction to beryllium), is used to screen individuals at risk of developing berylliosis. When screening results reveal a high level of sensitivity, BeLPT is performed on cells washed from the lungs. This test is now considered the most definitive diagnostic test for berylliosis.

Treatment

Individuals with beryllium sensitivity or early-stage berylliosis should be transferred from tasks that involve beryllium exposure and regularly examined to determine whether the disease has progressed.

Acute berylliosis is a serious disease that occasionally may be fatal. Ventilators can help patients with acute berylliosis breathe. Prompt corticosteroid therapy is required to lessen lung inflammation.

Chronic beryllium disease is incurable. Corticosteroid therapy is often prescribed, but it is not certain that **steroids** can alter the progression of the disease, and they have no effect on scarring of lung tissue. Cleansing the lungs of beryllium is a slow process, so long-term therapy may be required. **Chelation therapy** is currently under investigation as a treatment for the disease.

Prognosis

Most patients with acute berylliosis recover fully 7–10 days after treatment begins, and the disease usually causes no after effects.

Patients whose lungs are severely damaged by chronic berylliosis may experience fatal **heart failure** because of the strain placed on the heart.

Prevention

Eliminating exposure to beryllium is the surest way to prevent berylliosis. Screening workers who are exposed to beryllium fumes or dust or who develop an

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allergic reaction to these substances is an effective way to control symptoms and prevent disease progression.

ORGANIZATIONS

American Lung Association, 1301 Pennsylvania Ave. NW, Suite 800, Washington, DC, 20001, (202) 758-3355, (202) 452-1805, (800) 548-8252, info@lungusa.org, http://www.lungusa.org/.

Beryllium Support Group, P.O. Box 2021, Broomfield, CO, 80038–2021, (303) 412–7065, http://www.chronicberylliumdisease.com/tools/tl_support.htm.

National Center for Environmental Health, 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov/nceh.

Maureen Haggerty

Beryllium pneumonosis *see* **Berylliosis**
Beryllium poisoning *see* **Berylliosis**
Beta-adrenergic blockers *see* **Beta blockers**
Beta-thalassemia *see* **Thalassemia**

Beta$_2$-microglobulin test

Definition

Beta$_2$-microglobulin is a protein found on the surface of many cells. Testing is done primarily when evaluating a person for certain kinds of **cancer** affecting white blood cells including chronic lymphocytic leukemia, non-Hodgkin's lymphoma, and **multiple myeloma** or **kidney disease**.

Purpose

Beta$_2$-microglobulin is plentiful on the surface of white blood cells. Increased production or destruction of these cells causes Beta$_2$-microglobulin levels in the blood to increase. This increase is seen in people with cancers involving white blood cells, but it is particularly meaningful in people newly diagnosed with multiple myeloma. Multiple myeloma is a malignancy (cancer) of a certain kind of white blood cell, called a plasma cell. At the time of diagnosis, the Beta$_2$-microglobulin levels reflect how advanced the disease is and the likely prognosis for that person.

When kidney disease is suspected, comparing blood and urine levels helps identify where the kidney is damaged. Beta$_2$-microglobulin normally is filtered out of the blood by the kidney's glomeruli (a round mass of capillary loops leading to each kidney tubule), only to be partially reabsorbed back into the blood when it reaches the kidney's tubules. In glomerular kidney disease, the glomeruli can't filter it out of the blood, so levels increase in the blood and decrease in the urine. In tubular kidney disease, the tubules can't reabsorb it back into the blood, so urine levels rise and blood levels fall. After a kidney transplant, increased blood levels may be an early sign of rejection.

Increased urinary levels are found in people with kidney damage caused by high exposure to the heavy metals cadmium and mercury. Periodic testing of workers exposed to these metals helps to detect beginning kidney damage.

Beta$_2$-microglobulin levels also rise during infection with some viruses, including cytomegalovirus and human **immunodeficiency** virus (HIV). Studies show that as HIV disease advances, beta$_2$-microglobulin levels rise.

Description

Testing methods vary, but most involve adding the person's serum—the yellow, liquid part of blood—or urine to one or more substances that bind to beta$_2$-microglobulin in the serum or urine. The amount of the substance(s) bound to beta$_2$-microglobulin is measured and the original amount of beta$_2$-microglobulin is determined.

The test is covered by insurance when medically necessary. Results are usually available the next day.

Preparation

The blood test requires 5 mL of blood. A healthcare worker ties a tourniquet on the person's upper arm, locates a vein in the inner elbow region, and inserts a needle into that vein. Vacuum action draws the blood through the needle into an attached tube. Collection of the sample takes only a few minutes.

Urine may be a single collection or collected throughout a 24-hour time period. The urine should be refrigerated until it is brought to the laboratory and must not become acidic.

Aftercare

Discomfort or bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Warm packs on the puncture site relieve discomfort.

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KEY TERMS

Beta$_2$-microglobulin—A protein found on the surface of many cells, particularly white blood cells.

Chronic lymphocytic leukemia—A cancer of the blood cells characterized by large numbers of cancerous, mature white blood cells and enlarged lymph nodes.

Glomerular kidney disease—Disease of the kidney that affects the glomeruli, the part of the kidney that filters certain substances out of the blood.

Multiple myeloma—A malignancy (cancer) of a certain kind of white blood cell, called a plasma cell.

Non-Hodgkin's lymphoma—Cancer that originates in the lymphatic system and typically spreads throughout the body.

Tubular kidney disease—Disease of the kidney that affect the tubules, the part of the kidney that allows certain substances to be reabsorbed back into the blood.

Normal results

- Serum: less than or equal to 2.7 g/mL
- Urine: less than 1 mg/24 hours or 0–160 g/L

Abnormal results

The meaning of an abnormal result varies with the clinical condition of the person tested. In a person with multiple myeloma, a higher level means a poorer prognosis than a lower level. In a person with kidney disease, an increased blood level means the problem is tubular, not glomerular. In a kidney transplant patient, an increase may be a sign of rejection, toxic amounts of antirejection medication, or a viral infection. An increased level in a worker exposed to cadmium or mercury may signal beginning kidney damage, and in a person with HIV, advancing disease.

Resources

BOOKS

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Nancy J. Nordenson

Beta blockers

Definition

Beta blockers are medicines that reduce the body's response to **stress** hormones, including adrenalin.

Purpose

Beta blockers lower heart rate and reduce the force of heart contractions. Beta blockers are used to help treat the following conditions:

- congestive heart failure
- chest pain (angina)
- high blood pressure
- irregular heart beat (arrhythmia)
- maintaining normal heart rhythm after treating rhythm disturbance
- heart attack
- acute migraine headaches, and preventing future ones in some patients
- essential tremors
- some types of glaucoma
- performance anxiety (off-label)

Description

Beta blockers are available as capsules, tablets, liquids, eye drops, and injections.

Examples of beta blockers include atenolol (Tenormin), metoprolol (Lopressor), nadolol (Corgard), propranolol (Inderal), and timolol (Blocadren).

Recommended dosage

The recommended dose depends on the type and strength of drug used and the condition for which it is prescribed.

Beta blockers should be taken as directed and not stopped without consulting with a physician.

This medicine may take several weeks to noticeably lower blood pressure. It is important to take the medication exactly as directed.

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Beta blockers

Brand name (generic name)	Possible side effects
Betapace (sotalol)	Diarrhea, excessive tiredness, headache, muscle aches
Blocadren (timolol)	Coldness in hands and feet, dizziness, fatigue, headache, heartburn
Cartrol (carteolol)	Blurred vision, burning or stinging in eyes, sensitivity to light
Corgard (nadolol)	Excessive tiredness, lightheadedness
Inderal (propranolol)	Constipation, dizziness, fatigue, insomnia, upset stomach
Kerlone (betaxolol)	Diarrhea, heartburn, insomnia, joint pain, nausea, rash, strange dreams
Lopressor, Toprol XL (metoprolol)	Depression, dizziness, dry mouth, fatigue, nausea and vomiting, rash
Sectral (acebutolol)	Constipation, dizziness, fatigue, headache, muscle aches
Tenormin (atenolol)	Blurred vision, difficulty breathing, fainting, pallor, swelling of extremities, weight gain
Zebeta (bisoprolol)	Diarrhea, muscle aches, runny nose, vomiting
Ziac (bisoprolol/ hydrochlorothiazide)	Cough, fatigue, headache, lightheadedness

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Physicians may recommend that patients check their pulse before and after taking this medicine. If the pulse rate becomes too slow, circulation problems may result.

Precautions

Discontinuing beta blockers without medical advice may increase the risk of **heart attack**

Beta blockers antagonize the effects of **bronchodilators** used to treat **asthma** and **emphysema** and may interfere with treating those conditions.

These drugs may mask the effects of low blood sugar, like rapid heart rate, in diabetic patients.

Anyone taking beta blockers should seek advice from a pharmacist or physician before taking other prescription or over-the-counter medicine.

Anyone taking beta blockers should inform their health care professionals before having surgical or dental procedures or receiving emergency treatment.

People may feel drowsy, dizzy, or lightheaded when they start taking these drugs. They should not drive or use dangerous machines until they find how the drugs affect them.

Beta blockers may increase sensitivity to cold, especially in older people or people who have poor circulation. Anyone who takes these medicines should dress warmly in cold weather.

People with chest **pain** on exertion may not experience the same kinds of pain while taking these medications. They should seek advice from their physicians regarding safe levels of physical activity while taking these drugs.

Older people may be unusually sensitive to the effects of beta blockers.

Before starting to take beta blockers, treating physicians need to know what other medications and medical conditions their patients have.

Beta blockers may affect the way patients respond to their **allergies**.

DIABETES. Beta blockers may make blood sugar levels rise and may hide some symptoms of low blood sugar. Diabetic patients should discuss these possible problems with their physicians.

PREGNANCY. Atenolol, and possibly other beta blockers, crosses the placenta; babies born of pregnant women taking these drugs may be briefly affected.

BREASTFEEDING. Some beta blockers pass into breast milk and may cause low blood pressure and low pulse rates in nursing babies whose mothers take the drugs. Women who need to take beta blockers and who want to breastfeed should seek medical advice.

OTHER MEDICAL CONDITIONS. Patients with asthma and/or emphysema may be adversely affected by beta blocker medications and should monitor themselves carefully.

Beta blockers may reduce symptoms, especially rapid pulse, of an overactive thyroid.

Liver and kidney diseases may increase or prolong the effects of these drugs.

Beta blockers may also make the following medical conditions worse:

- normally slow heartbeat (bradycardia)
- Myasthenia gravis (chronic disease causing muscle weakness and possibly paralysis)
- psoriasis (itchy, scaly, red patches of skin)
- depression

Side effects

The most common side effects include:

- fatigue
- dizziness

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- drowsiness
- lightheadedness
- decreased sexual desire
- cold hands
- trouble sleeping
- trouble breathing
- depression

Interactions

Beta blockers may interact with a number of medicines. Reactions may be minor or severe and affect the risks or side effects of either drug. Patients should discuss drugs they take with health providers before starting to take beta blockers.

Possible interactions include:

- The effects of both beta blockers and calcium channel blockers (Cardizem and Calan) increase when they are taken together.
- Phenothiazines (Thorazine and Mellaril) and beta blockers have a probable delayed interaction that may increase the effects of either or both drugs. This is particularly dangerous in elderly people.
- Barbiturates may reduce the effectiveness of beta blockers.
- Cimetidine (Tagamet) may reduce the effectiveness of beta blockers.
- Benadryl increases the effects of these drugs on the heart.
- If orange juice is drunk at the same time that beta blockers are taken, their effects may be reduced.
- Hydralazine (Apresoline) and beta blockers interact to increase the effects of both drugs.
- Haloperidol (Haldol) and beta blockers interact to increase the effects of both drugs.
- NSAIDs, non-steroidal anti inflammatory drugs (ibuprofen, naproxen, indomethacin), may decrease the effectiveness of beta blockers.
- Penicillins (Ampicillin) may reduce the effects of beta blockers.
- Salicylates (aspirin) may reduce the effects of beta blockers.

Resources

BOOKS

Drug Facts and Comparisons. St. Louis: Wolters Kluwer, 2008.

James Waun, MD, RPh

Betamethasone *see* **Corticosteroids**
Bile duct atresia *see* **Biliary atresia**

Bile duct cancer

Definition

Bile duct **cancer**, or cholangiocarcinoma, is a malignant tumor of the bile ducts within the liver (intrahepatic), or leading from the liver to the small intestine (extrahepatic). It is a rare tumor with poor outcome for most patients.

Description

Bile is a substance manufactured by the liver that aids in the digestion of food. Bile ducts are channels that carry the bile from the liver to the small intestine. Like the tributaries of a river, the small bile ducts in the liver converge into two large bile ducts called the left and right hepatic ducts. These exit the liver and join to form the common hepatic duct. The gallbladder, which concentrates and stores the bile, empties into the common hepatic duct to form the common bile duct. Finally, this large duct connects to the small intestine where the bile can help digest food. Collectively, this network of bile ducts is called the biliary tract.

Bile duct cancer originates from the cells that line the inner surface of the bile ducts. A tumor may arise anywhere along the biliary tract, either within or outside of the liver. Bile duct tumors are typically slow-growing tumors that spread by local invasion of neighboring structures and by way of lymphatic channels.

Bile duct cancer is an uncommon malignancy. In the United States, approximately one case arises per 100,000 people per year, but it is more common in Southeast Asia. It occurs in men only slightly more often than in women and it is most commonly diagnosed in people in their 50s and 60s. In fact, about 65% of patients with bile duct cancer are over age 65.

Causes and symptoms

A number of risk factors are associated with the development of bile duct cancer:

- Primary sclerosing cholangitis. This disease is characterized by extensive scarring of the biliary tract, sometimes associated with inflammatory bowel disease.
- Choledochal cysts. These are abnormal dilatations of the biliary tract that usually form during fetal development. There is evidence that these cysts may rarely arise during adulthood.
- Hepatolithiasis. This is the condition of stone formation within the liver (not including gallbladder stones).

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- Liver flukes. Parasitic infection with certain worms is thought to be at least partially responsible for the higher prevalence of bile duct cancer in Southeast Asia.
- Thorotrast. This is a chemical that was previously injected intravenously during certain types of x rays. It is not in use anymore. Exposure to Thorotrast has been implicated in the development of cancer of the liver as well as the bile ducts.

Symptoms

Jaundice is the first symptom in 90% of patients. This occurs when the bile duct tumor causes an obstruction in the normal flow of bile from the liver to the small intestine. Bilirubin, a component of bile, builds up within the liver and is absorbed into the bloodstream in excess amounts. This can be detected in a blood test, but it can also manifest as yellowish discoloring of the skin and eyes. The bilirubin in the bloodstream also makes the urine appear dark. Additionally, the patient may experience generalized **itching** due to the deposition of bile components in the skin. Normally, a portion of the bile is excreted in stool; bile actually gives stool its brown color. But when the biliary tract is obstructed by tumor, the stools may appear pale.

Abdominal **pain**, **fatigue**, weight loss, and poor appetite are less common symptoms. Occasionally, if obstruction of the biliary tract causes the gallbladder to swell enormously yet without causing pain, the physician may be able to feel the gallbladder during a **physical examination**. Sometimes the biliary tract can become infected, but this is normally a rare consequence of invasive tests. Infection causes **fever**, chills, and pain in the right upper portion of the abdomen.

Diagnosis

Certain laboratory tests of the blood may aid in the diagnosis. The most important one is the test for elevated bilirubin levels in the bloodstream. Levels of alkaline phosphatase and CA 19-9 may also be elevated.

When symptoms, physical signs, and blood tests point toward an abnormality of the biliary tract, the next step involves radiographic exams. Ultrasound, computed tomography (CT scan), and **magnetic resonance imaging** (MRI) are noninvasive and rapid. In recent years, MRI has become the favored imaging choice for initial diagnosis of cholangiocarcinoma when the exam is available and affordable or covered by insurance. These tests can often detect the actual tumor as well as dilatation of the obstructed biliary tract. If these tests indicate the presence of a tumor, cholangiography is required. This procedure involves injecting dye into the biliary tract to obtain anatomic images of the bile ducts and the tumor. The specialist that performs this test can also insert small tubes, or stents, into a partially obstructed portion of the bile duct to prevent further obstruction by growth of the tumor. This is vitally important since it may be the only intervention that is possible in certain patients. Cholangiography is an invasive test that carries a small risk of infection of the biliary tract. The objective of these radiological tests is to determine the size and location of the tumor, as well as the extent of spread to nearby structures.

The treatment of bile duct tumors is usually not affected by the specific type of cancer cells that comprise the tumor. For this reason, some physicians forego biopsy of the tumor.

Treatment

The treatment is with surgical resection (removal) of the tumor and all involved structures. Unfortunately, sometimes the cancer has already spread too far when the diagnosis is made. Thus, in the treatment of bile duct cancer, the first question to answer is if the tumor may be safely resected by surgery with reasonable benefit to the patient. If the cancer involves certain blood vessels or has spread widely throughout the liver, resection may not be possible. Sometimes further invasive testing is required.

Angiography can determine if the blood vessels are involved. **Laparoscopy** is a surgical procedure that allows the surgeon to directly assess the tumor and nearby lymph nodes without making a large incision in the abdomen. Only about 45% of bile duct cancers are ultimately resectable.

If the tumor is resectable, and the patient is healthy enough to tolerate the operation, the specific type of surgery performed depends on the location of the tumor. For tumors within the liver or high up in the biliary tract, resection of part of the liver may be required. Tumors in the middle portion of the biliary tract can be removed alone. Tumors of the lower end of the biliary tract may require extensive resection of part of the pancreas, small intestine, and stomach to ensure complete resection.

Unfortunately, sometimes the cancer appears resectable by all the radiological and invasive tests, but is found to be unresectable during surgery. In this scenario, a bypass operation can relieve the biliary tract obstruction, but does not remove the tumor itself. This does not produce a cure but it can offer a better quality of life for the patient.

Prognosis

Prognosis depends on the stage and resectability of the tumor. If the patient cannot undergo surgical

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resection, the survival rate is commonly less than one year. If the tumor is resected, the survival rate improves, with 20% of these patients surviving past five years.

Clinical trials

Studies of new treatments in patients are known as clinical trials. These trials seek to compare the standard method of care with a new method, or the trials may be trying to establish whether one treatment is more beneficial for certain patients than others. Sometimes, a new treatment that is not being offered on a wide scale may be available to patients participating in clinical trials, but participating in the trials may involve some risk. To learn more about clinical trials, patients can call the National Cancer Institute (NCI) at 1-800-4-CANCER or visit the NCI website for patients at www.cancertrials.nci.nih.gov.

Prevention

Other than the avoidance of infections caused by liver flukes, there are no known preventions for this cancer.

Resources

BOOKS

Abeloff, Martin D., et al.*Clinical Oncology*. 4th ed. New York: Churchill Livingstone/Elsevier, 2008.

Sabiston, David C., et al. *Sabiston Textbook of Surgery: The Biological Basis of Modern Surgical Practice*. Philadelphia: Saunders/Elsevier, 2008.

PERIODICALS

"COX–2 Promoter Enhances the Efficacy of Cholangiosarcoma Gene Therapy." *Cancer Weekly* (May 20, 2003): 167.

Khan, S.A., et al. "Guidelines for the Diagnosis and Treatment of Cholangiosarcoma: Consensus Document." *Gut* (November 2002): vi1–9.

ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (800) 227-2345, http://www.cancer.org.

American Liver Foundation, 75 Maiden Lane, Suite 603, New York, NY, 10038, (212) 668-1000, (212) 483-8179, http://www.liverfoundation.org/.

National Cancer Institute (National Institutes of Health), NCI Office of Communications and Education, 6116 Executive Blvd. Suite 300, Bethesda, MD, 20892-8322, (800) 4-CANCER (422-6237), cancergovstaff@mail.nih.gov, http://www.cancer.gov/.

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Bile duct infection *see* **Cholangitis**

Bile flow obstruction *see* **Cholestasis**

Bilharziasis *see* **Schistosomiasis**

Biliary atresia

Definition

Biliary atresia is the failure of a fetus to develop an adequate pathway for bile to drain from the liver to the intestine.

Description

Biliary atresia is the most common lethal **liver disease** in children, occurring once every 10,000–15,000 live births. Half of all liver transplants are done for this reason.

The normal anatomy of the bile system begins within the liver, where thousands of tiny bile ducts collect bile from liver cells. These ducts merge into larger and larger channels, like streams flowing into rivers, until they all pour into a single duct that empties into the duodenum (first part of the small intestine). Between the liver and the duodenum this duct has a side channel connected to the gall bladder. The gall bladder stores bile and concentrates it, removing much of its water content. Then, when a meal hits the stomach, the gall bladder contracts and empties its contents.

Bile is a mixture of waste chemicals that the liver removes from the circulation and excretes through the biliary system into the intestine. On its way out, bile assists in the digestion of certain nutrients. If bile cannot get out because the channels are absent or blocked, it backs up into the liver and eventually into the rest of the body. The major pigment in bile is a chemical called bilirubin, which is yellow. Bilirubin is a breakdown product of hemoglobin (the red chemical in blood that carries oxygen). If the body accumulates an excess of bilirubin, it turns yellow (jaundiced). Bile also turns the stool brown. Without it, stools are the color of clay.

Causes and symptoms

It is possible that a viral infection is responsible for this disease, but evidence is not yet convincing. The cause remains unknown.

The affected infant will appear normal at birth and during the newborn period. After two weeks the normal **jaundice** of the newborn will not disappear, and the stools will probably be clay colored. At this point, the condition will come to the attention of a physician. If not, the child's abdomen will begin to swell, and the infant will get progressively more ill.

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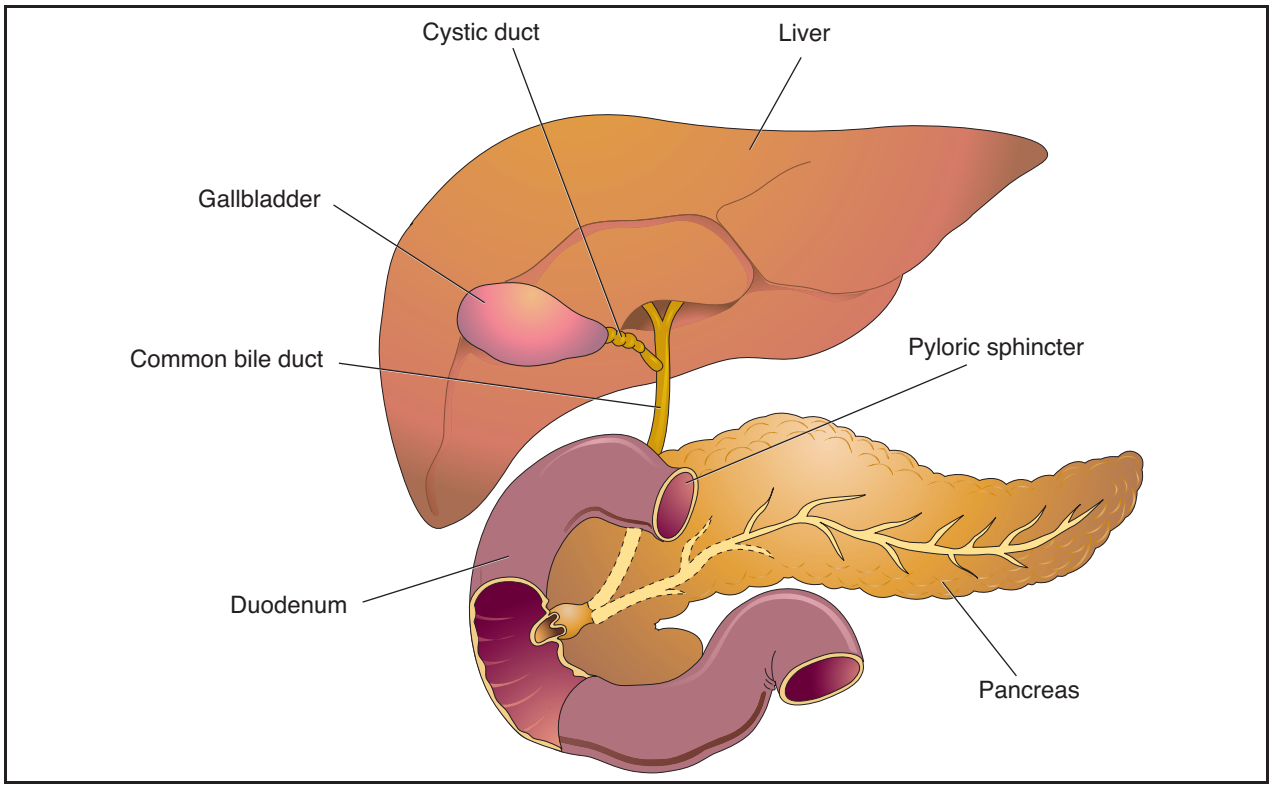

Biliary atresia is a congenital condition in which the pathway for bile to drain from the liver to the intestine is undeveloped. It is the most common lethal liver disease in children. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Nearly all untreated children will die of liver failure within two years.

Diagnosis

The persistence of jaundice beyond the second week in a newborn with clay-colored stools is a sure sign of obstruction to the flow of bile. An immediate evaluation that includes blood tests and imaging of the biliary system will confirm the diagnosis.

Treatment

Surgery is the only treatment. Somehow the surgeon must create an adequate pathway for bile to escape the liver into the intestine. The altered anatomy of the biliary system is different in every case, calling upon the surgeon's skill and experience to select and execute the most effective among several options. If the obstruction is only between the gall bladder and the intestine, it is possible to attach a piece of intestine directly to the gall bladder. More likely, the upper biliary system will also be inadequate, and the surgeon will attach a piece of intestine directly to the liver—the Kasai procedure. In its wisdom, the body will discover that the tiny bile ducts in that part of the liver are discharging their bile directly into the intestine. Bile will begin to flow in that direction, and the channels will gradually enlarge. Survival rates for the Kasai procedure are commonly 50% at five years and 15% at 10 years. Persistent disease in the liver gradually destroys the organ.

Prognosis

Before liver transplants became available, even prompt and effective surgery did not cure the whole problem. Biliary drainage can usually be established, but the patients still have a defective biliary system that develops progressive disease and commonly leads to an early **death**. Transplantation now achieves up to 90% one-year survival rates and promises to prevent the chronic disease that used to accompany earlier procedures.

Prevention

The specific cause of this birth defect is unknown, so all that women can do is to practice the many general preventive measures, even before they conceive.

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Resources

BOOKS

Sleisenger, Marvin H., et al. *Sleisenger & Fordtran's Gastrointestinal and Liver Disease: Pathophysiology, Diagnosis, Management*. St. Louis, Mo.: MD Consult, 2009.

J. Ricker Polsdorfer, MD

Biliary duct cancer *see* **Gallbladder cancer**
Biliary tract cancer *see* **Bile duct cancer**
Bilirubin test *see* **Liver function tests**

Binge eating

Definition

Binge eating is an abnormal pattern and loss of control in which an individual eats a significant amount of food in a limited time. The timeframe for a binge is usually 1–2 hours. A binge eater differs from a bulimic, in that they do not purge after such an episode.

Demographics

Estimates of the number of Americans who have binge-eating disorder range from less than 1% to 4%, with 2% being the most commonly cited figure. Although women with binge-eating disorder outnumber men three to two, binge eating is the most common male eating disorder. The disorder affects blacks and whites equally; little research as been done on other racial or ethnic groups. Unlike the **eating disorders anorexia nervosa** or **bulimia nervosa** that start in the teenage or young adult years, binge-eating disorder is more likely to occur in middle-aged adults between the ages of 46 and 55. Although binge eaters may be of normal weight, binge eating is a common disorder among people who are obese. Some estimates suggest that up to half the obese people in formal weight loss programs have problems with binge eating.

Description

Everyone eats too much occasionally, but people who are binge eaters have an abnormal eating pattern that occurs frequently. Many eating disorder specialists define binge-eating disorder as binge-eating behavior that occurs at least twice a week for three months and has a negative effect on the individual's relationships and daily activities.

The eating disorders anorexia nervosa and bulimia nervosa are considered psychiatric disorders and have formal diagnostic criteria that are defined in the *Diagnostic and Statistical Manual for Mental Disorders Fourth Edition, Text Revision (DSM-IV-TR)* published by the American Psychiatric Association (APA). Binge eating is an acknowledged problem, but it has not risen to the level of a separate psychiatric disorder as defined by the APA. The *DSM-IV-TR* classifies binge eating under the diagnosis of eating disorders not otherwise specified. Binge-eating disorder is, however, under consideration as a separate diagnostic category, pending further study. Some experts believe binge eating is a subtype of bulimia, an eating disorder characterized by episodes of binge eating followed by purging the body of calories. Other experts believe that binge eating should be classified as an obesity-related behavior. Although the way a healthcare professional views binge eating does not change the behavior, it may influence the type of therapy recommended and affect the degree to which treatment is covered by heath insurance providers.

Binge eaters exhibit many of the following behaviors:

- They eat abnormally large amounts of food at one sitting, often consuming 3,000–10,000 calories in a short period.
- They gobble their food, eating much faster than normal.
- During a binge, they feel out of control and unable to stop eating, even though they may want to.
- Despite feeling full or even painfully uncomfortable, they continue to eat.
- Binge eaters tend to diet constantly but never lose weight.
- Then often eat alone and hide empty food containers to disguise from others how much they eat.
- They are ashamed and embarrassed about their bingeing.
- Food hoarding is common.
- After a binge, they feel guilty, upset, disgusted, and/or depressed about how much they have eaten.
- They vow to themselves never to binge again but cannot keep this promise.
- People who binge eat are far more likely to describe themselves as experiencing personal problems and work difficulties and to be hypersensitive to the thoughts and opinions of others.

Binge-eating disorder is different from bulimia. The two disorders are similar in their bingeing behavior, but people with bulimia follow a binge by purging the body of calories. They do this by some combination of self-induced **vomiting**; laxative, diuretic, or enema **abuse**; **fasting**; and compulsive exercising

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KEY TERMS

Anorexia nervosa—An eating disorder that involves self-imposed starvation.

Electrolyte—Ions in the body that participate in metabolic reactions. The major human electrolytes are sodium (Na+), potassium (K+), calcium (Ca 2+), magnesium (Mg2+), chloride (Cl-), phosphate (HPO4 2-), bicarbonate (HCO3-), and sulfate (SO4 2-).

Neurotransmitter—One of a group of chemicals secreted by a nerve cell (neuron) to carry a chemical message to another nerve cell, often as a way of transmitting a nerve impulse. Examples of neurotransmitters include acetylcholine, dopamine, serotonin, and norepinephrine.

Selective serotonin reuptake inhibitors (SSRIs)—A class of antidepressants that work by blocking the reabsorption of serotonin in brain cells, raising the level of the chemical in the brain. SSRIs include Prozac, Zoloft, Luvox, and Paxil.

Serotonin—5-Hydroxytryptamine; a substance that occurs throughout the body with numerous effects including neurotransmission. Inadequate amounts of serotonin are implicated in some forms of depression and obsessive-compulsive disorder.

Triglycerides—A type of fat found in the blood. High levels of triglycerides can increase the risk of coronary artery disease.

beyond reasonable levels. People with binge-eating disorder do nothing to purge the body of the extra calories they have eaten, although they often try to diet between binges. Many people who are bulimic also have anorexic behaviors. There is no overlap between binge-eating disorder and anorexia. Most people who have binge-eating disorder are obese, but not all obese people have binge-eating behaviors.

Risk factors

People at higher risk of developing binge-eating disorder share certain characteristics. These include:

- Frequent dieting. People who go on rigorous diets or who frequently gain and lose large amounts of weight (weight cycling) are more likely to become binge eaters.
- Impulsiveness. Binge eaters, like bulimics, have problems with impulse control.
- Low self-worth and negative self-talk. This occurs almost universally among people with all types of eating disorders.
- Difficulty managing anger and appropriately expressing feelings.
- Preoccupation with body image and weight.
- History of sexual abuse. Some, but by no means all, people with binge eating disorder report being sexually abused as children. This is an area of ongoing research.
- Depression. It is not clear whether depression causes binge eating or if binge eating causes depression, but the two are often found together.

Causes and symptoms

Binge eating is a relatively new area of research. Like all eating disorders, binge eating appears to have multiple causes. Some people seem to be genetically predisposed to become binge eaters. Researchers think this may be related to abnormalities in neurotransmitters in the brain that help to regulate appetite. Research continues actively in this area.

For many binge eaters, **stress** is the factor that triggers a binge. Stress can be caused by very restrictive dieting, but it is often caused by social and cultural factors, such as family conflict, job-related stress, dysfunctional relationships, and the repeated message from the media that a thin body is favorable.

Symptoms of binge eating may be difficult to detect. Binge eating is different from continuously snacking. Binge eaters are often secretive about food and their bingeing is often done in private. **Obesity** and obesity-related diseases such as **hypertension** (high blood pressure), type 2 diabetes, and joint **pain** are signs that binge-eating disorder could be present, but not all obese people are binge eaters. Behaviors such as secretive eating, constant dieting without losing weight, obsessive concern about weight, depression, **anxiety**, and **substance abuse** are all clues, but none of these signs are definitive. The individual may complain about symptoms related to obesity, such as **fatigue** and **shortness of breath**, or mention unsuccessful dieting, but again, these signs are not definitive.

Diagnosis

Binge-eating disorder is often diagnosed and treated by a psychiatrist and/or a psychologist.

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Diagnosis can be difficult. Binge eaters often go out of their way to hide how much they eat. They may, for example, buy snack food at the grocery store and eat it in the car before they go home, or they may buy food in secret and hoard it, so that people close to them will not know they are bingeing. Normally healthcare professionals begin diagnosis with a family and personal history. However, people with binge-eating disorder often lie about their eating habits.

Tests

A physician will begin with a **physical examination** and usually order standard laboratory tests such as a **complete blood count** (CBC), **urinalysis**, and blood tests to check the level of cholesterol, **triglycerides**, and electrolytes. Additional tests, such as a thyroid function test, may be ordered to rule out other disorders. If the individual is obese, tests may be done check for obesity-related diseases such as diabetes, cardiovascular disease, and **sleep apnea**.

Several different personality and behavioral inventories, such as the **Minnesota Multiphasic Personality Inventory** (MMPI), may be administered as part of the assessment process. One of several clinical inventories, or scales, may also be used to assess depressive symptoms, including the Hamilton Depression Scale (HAM-D) or Beck Depression Inventory (BDI). These tests are usually administered in an office setting.

Treatment

Traditional treatment

The medical community does not completely agree on the best treatment for binge eating. Medical specialists are more likely first to treat weight control issues with drugs, diet, and **nutrition** counseling in order to reduce the health risks of obesity-related diseases. Although there are no drugs specifically approved by the United States Food and Drug Administration for treating binge-eating disorder, the FDA has approved **selective serotonin reuptake inhibitors** (SSRIs) such as fluoxetine (Prozac) and sertraline (Zoloft) for the treatment of bulimia. Bulimia also involves binge-eating behavior. These medications increase serotonin levels in the brain and are thought to affect the body's sense of fullness. They are used whether or not the patient shows signs of depression. SSRIs are often prescribed for people with binge-eating disorder. Appetitive suppressants are also sometimes prescribed to help control binge eating. Treatment is most successful when **group therapy** occurs in conjunction with **psychotherapy**.

Psychotherapy

Psychologists are more likely to approach the problem of binge eating by using therapy that helps the individual change his or her behavior and by treating emotional and psychological problems that cause it. For them, treating obesity is secondary to treating the behavior and the thought patterns that cause it. Psychologists tend to think that once the individual understands and can control bingeing behavior, obesity will be easier to treat.

Some types of psychotherapy that have been successful in treating people with binge-eating disorder are:

- Cognitive behavior therapy (CBT) is designed to confront and then change the individual's thoughts and feelings about his or her body and behaviors toward food, but it does not address why those thoughts or feelings exist. Strategies to maintain self-control may be explored. This therapy is relatively short term.
- Interpersonal therapy is short-term therapy that helps the individual identify specific issues and problems in relationships. The individual may be asked to look at his or her family and personal history to try to recognize problem areas and to work toward resolving them.
- Dialectical behavior therapy consists of structured private and group sessions in which the therapist and patient(s) work at reducing behaviors that interfere with quality of life, finding alternate solutions to current problem situations, and learning to regulate emotions.
- Family therapy is helpful in treating children who are binge eaters. It teaches strategies to reduce conflict, disorder, and stress that may be factors in triggering binge eating.
- Some people with binge-eating disorder find self-help groups and structured weight-loss programs useful, while others do not.

Nutrition and dietetic counseling

People with binge-eating disorder understand that their eating pattern is abnormal and unhealthy. Nutrition counseling and meal planning can help bring weight under control, but they do not address the inability to control the impulse to binge. Nutrition counseling needs to be part of a broader treatment program that includes psychotherapy and possibly drug therapy.

Alternative and complementary therapy

Alternative treatment may focus on curbing the depression that is common in individuals who binge

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eat. Herbal remedies that may ease the symptoms of depression include damiana (*Turnera diffusa*), **ginseng** (*Panax ginseng*), kola (*Cola nitida*), lady's slipper (*Cypripedium calceolus*), lavender (*Lavandula angustifolia*), lime blossom (*Tilia x vulgaris*), oats (*Avena sativa*), rosemary (*Rosmarinus officinalis*), skullcap (*Scutellaria lateriifolia*), **St. John's wort** (*Hypericum perforatum*), valerian (*Valeriana officinalis*), and vervain (*Verbena officinalis*).

Binge-eating episodes that appear to be triggered by stress may be reduced by educating the individual in relaxation exercises and techniques, including aromatherapy, breathing exercises, **biofeedback**, **music therapy**, **yoga**, and massage. Herbs known as adaptogens may also be prescribed by an herbalist or holistic healthcare professional. These herbs are thought to promote adaptability to stress, and include Siberian ginseng (*Eleutherococcus senticosus*), ginseng (*Panax ginseng*), wild yam (*Dioscorea villosa*), borage (*Borago officinalis*), licorice (*Glycyrrhiza glabra*), chamomile (*Chamaemelum nobile*), and nettles (*Urtica dioica*). Tonics of skullcap (*Scutellaria lateriafolia*), and oats (*Avena sativa*), may also be recommended to ease anxiety.

Prognosis

There is no clear prognosis for binge-eating disorder. Since stress often triggers bingeing, relapses are apt to occur in response to stressful life events. Some individuals find that simply seeking help improves their control over binge eating. For example, some studies have found that receiving a placebo is as effective as receiving medication. This is one reason why some parts of the medical community refuse to accept binge eating as a genuine disorder. Many studies are underway to test different approaches to treating binge eating. Individuals interested in participating in a clinical trial at no cost can find a list of studies currently enrolling volunteers at http://www.clinicaltrials.gov.

Prevention

Since binge eating is difficult to detect, it is also difficult to prevent. Some prevention strategies are:

- Parents should not obsess about their weight, appearance, or diet in front of their children.
- Do not tease people about their body shapes or compare them to others.
- Make it clear that family members are loved and accepted as they are.
- Try to eat meals with others whenever possible; avoid eating alone.
- Avoid using food for comfort in times of stress.
- Monitor negative self-talk; practice positive self-talk.
- Spend time doing something enjoyable every day.
- Become aware of the situations that trigger a binge and look for ways to avoid or defuse them. Do not go on extreme diets.
- Be alert to signs of low self-worth, anxiety, depression, and drug or alcohol abuse and seek help as soon as these signs appear.

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Medline Plus. "Eating Disorders." U. S. National Library of Medicine, May 15, 2009 [June 2, 2009] http://www.nlm.nih.gov/medlineplus/eatingdisorders.html

ORGANIZATIONS

American Psychological Association, 750 First Street, NE, Washington, DC, 20002-4242, (202) 336-5500; TDD/TTY: (202) 336-6123, (800) 374-2721, apa@psych.org, http://www.apa.org.

National Association of Anorexia Nervosa and Related Eating Disorders (ANAD), P.O. Box 7, Highland Park, IL, 60035, (847) 831-3438, (847) 433-3996, http://www.anad. org.

National Eating Disorders Association, 603 Stewart Street, Suite 803, Seattle, WA, 98101, (206) 382-3587 Help and Referral Line: (800) 931-2237, (206) 829-8501info@NationalEatingDisorders.org, http://www.nationaleating disorders.org.

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Biofeedback

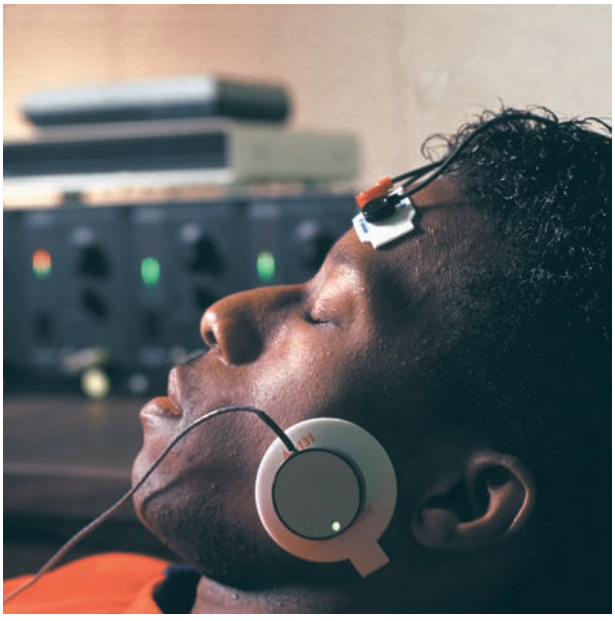
Definition

Biofeedback, or applied psychophysiological feedback, is a patient-guided treatment that teaches an individual to control muscle tension, **pain**, body temperature, brain waves, and other bodily functions and processes through relaxation, visualization, and other cognitive control techniques. The name biofeedback refers to the biological signals that are fed back, or returned, to the patient in order for the patient to develop techniques of manipulating them.

Purpose

Biofeedback has been used to successfully treat a number of disorders and their symptoms, including temporomandibular joint disorder (TMJ), chronic pain, **irritable bowel syndrome** (IBS), Raynaud's syndrome, **epilepsy**, attention-deficit hyperactivity disorder (**ADHD**), migraine headaches, **anxiety**, depression, traumatic brain injury, and **sleep disorders**.

Illnesses that may be triggered at least in part by **stress** are also targeted by biofeedback therapy. Certain types of headaches, high blood pressure, **bruxism** (teeth grinding), **post-traumatic stress disorder**, **eating disorders**, **substance abuse**, and some **anxiety disorders** may be treated successfully by teaching patients the ability to relax and release both muscle and mental tension. Biofeedback is often just one part of a comprehensive treatment program for some of these disorders.



A patient undergoing biofeedback therapy. *(Photo Researchers, Inc.)*

NASA has used biofeedback techniques to treat astronauts who suffer from severe space sickness, during which the autonomic nervous system is disrupted. Scientists at the University of Tennessee have adapted these techniques to treat individuals suffering from severe **nausea and vomiting** that is also rooted in autonomic nervous system dysfunction.

Recent research also indicates that biofeedback may be a useful tool in helping patients with **urinary incontinence** regain bladder control. Individuals learning pelvic-floor muscle strengthening exercises can gain better control over these muscles by using biofeedback. Sensors are placed on the muscles to train the patient where they are and when proper contractions are taking place.

Description

Origins

In 1961, Neal Miller, an experimental psychologist, suggested that autonomic nervous system responses (for instance, heart rate, blood pressure, gastrointestinal activity, regional blood flow) could be under voluntary control. As a result of his experiments, he showed that such autonomic processes were controllable. This work led to the creation of biofeedback therapy. Willer's work was expanded by other researchers. Thereafter, research performed in the 1970s by UCLA researcher Dr. Barry Sterman established that both cats and monkeys could be trained to control their brain wave patterns. Sterman then used his research techniques on human patients with epilepsy, where he was able to reduce seizures by 60% with the use of biofeedback techniques. Throughout the 1970s, other researchers published reports of their use of biofeedback in the treatment of cardiac **arrhythmias**, headaches, Raynaud's syndrome, and excess stomach acid, and as a tool for teaching deep relaxation. Since the early work of Miller and Sterman, biofeedback has developed into a frontline behavioral treatment for an even wider range of disorders and symptoms.

During biofeedback, special sensors are placed on the body. These sensors measure the bodily function that is causing the patient problem symptoms, such as heart rate, blood pressure, muscle tension (EMG or electromyographic feedback), brain waves (EEC or electroencephalographic feedback), respiration, and body temperature (thermal feedback), and translates the information into a visual and/or audible readout, such as a paper tracing, a light display, or a series of beeps.

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While the patient views the instantaneous feedback from the biofeedback monitors, he or she begins to recognize what thoughts, fears, and mental images influence his or her physical reactions. By monitoring this relationship between mind and body, the patient can then use these same thoughts and mental images as subtle cues, as these act as reminders to become deeply relaxed, instead of anxious. These reminders also work to manipulate heartbeat, brain wave patterns, body temperature, and other bodily functions. This is achieved through relaxation exercises, mental imagery, and other cognitive therapy techniques.

As the biofeedback response takes place, patients can actually see or hear the results of their efforts instantly through the sensor readout on the biofeedback equipment. Once these techniques are learned and the patient is able to recognize the state of relaxation or visualization necessary to alleviate symptoms, the biofeedback equipment itself is no longer needed. The patient then has a powerful, portable, and self-administered treatment tool to deal with problem symptoms.

Biofeedback that specializes in reading and altering brain waves is sometimes called *neurofeedback*. The brain produces four distinct types of brain waves—delta, theta, alpha, and beta—that all operate at a different frequency. Delta, the slowest frequency wave, is the brain wave pattern associated with sleep. Beta waves, which occur in a normal, waking state, can range from 12–35 Hz. Problems begin to develop when beta wave averages fall in the low end (underarousal) or the high end (overarousal) of that spectrum. Underarousal might be present in conditions such as depression or attention-deficit disorder, and overarousal may be indicative of an anxiety disorder, obsessive-compulsive disorder, or excessive stress. Beta wave neurofeedback focuses on normalizing that beta wave pattern to an optimum value of around 14 Hz. A second type of neurofeedback, alpha-theta, focuses on developing the more relaxing alpha (8-13 Hz) and theta waves (4-9 Hz) that are usually associated with deep, meditative states, and has been used with some success in substance abuse treatment.

Through brain wave manipulation, neurofeedback can be useful in treating a variety of disorders that are suspected or proven to impact brain wave patterns, such as epilepsy, attention-deficit disorder, migraine headaches, anxiety, depression, traumatic brain injury, and sleep disorders. The equipment used for neurofeedback usually uses a monitor as an output device. The monitor displays specific patterns that the patient attempts to change by producing the appropriate type of brain wave. Or, the monitor may reward the patient for producing the appropriate brain wave by producing a positive reinforcer, or reward. For example, children may be rewarded with a series of successful moves in a displayed video game.

Depending on the type of biofeedback, individuals may need up to 30 sessions with a trained professional to learn the techniques required to control their symptoms on a long-term basis. Therapists usually recommend that their patients practice both biofeedback and relaxation techniques on their own at home.

Preparations

Before initiating biofeedback treatment, the therapist and patient will have an initial consultation to record the patient's medical history and treatment background and discuss goals for therapy.

Before a neurofeedback session, an EEG is taken from the patient to determine his or her baseline brainwave pattern.

Biofeedback typically is performed in a quiet and relaxed atmosphere with comfortable seating for the patient. Depending on the type and goals of biofeedback being performed, one or more sensors will be attached to the patient's body with conductive gel and/or adhesives. These may include:

- Electromyographic (EMG) sensors. EMG sensors measure electrical activity in the muscles, specifically muscle tension. In treating TMJ or bruxism, these sensors would be placed along the muscles of the jaw. Chronic pain might be treated by monitoring electrical energy in other muscle groups.
- Galvanic skin response (GSR) sensors. These are electrodes placed on the fingers that monitor perspiration, or sweat gland, activity.
- Temperature sensors. Temperature, or thermal, sensors measure body temperature and changes in blood flow.
- Electroencephalography (EEG) sensors. These electrodes are applied to the scalp to measure the electrical activity of the brain, or brain waves.
- Heart rate sensors. A pulse monitor placed on the finger tip can monitor pulse rate.
- Respiratory sensors. Respiratory sensors monitor oxygen intake and carbon dioxide output.

Precautions

Individuals who use a pacemaker or other implantable electrical devices should inform their biofeedback therapist before starting treatments, as certain types of biofeedback sensors have the potential to interfere with these devices.

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Biofeedback may not be suitable for some patients. Patients must be willing to take a very active role in the treatment process. And because biofeedback focuses strictly on behavioral change, those patients who wish to gain insight into their symptoms by examining their past might be better served by psychodynamic therapy.

Biofeedback may also be inappropriate for cognitively impaired individuals, such as those patients with organic brain disease or a traumatic brain injury, depending on their levels of functioning.

Patients with specific pain symptoms of unknown origin should undergo a thorough medical examination before starting biofeedback treatments to rule out any serious underlying disease. Once a diagnosis has been made, biofeedback can be used concurrently with conventional treatment.

Biofeedback may only be one component of a comprehensive treatment plan. For illnesses and symptoms that are manifested from an organic disease process, such as **cancer** or diabetes, biofeedback should be an adjunct to (complementary to), and not a replacement for, conventional medical treatment.

Side effects

There are no known side effects to properly administered biofeedback or neurofeedback sessions.

Research and general acceptance

Preliminary research indicates that neurofeedback may be a promising new tool in the treatment of **schizophrenia**. Researchers reported that schizophrenic patients had used neurofeedback to simulate brain wave patterns that antipsychotic medications produce in the brain. Further research is needed to determine what impact this may have on treatment for schizophrenia.

The use of biofeedback techniques to treat an array of disorders has been extensively described in the medical literature. Controlled studies for some applications are limited, such as for the treatment of menopausal symptoms and premenstrual disorder (PMS). There is also some debate over the effectiveness of biofeedback in ADHD treatment, and the lack of controlled studies on that application. While many therapists, counselors, and mental health professionals have reported great success with treating their ADHD patients with neurofeedback techniques, some critics attribute this positive therapeutic impact to a placebo effect.

There may also be some debate among mental health professionals as to whether biofeedback should be considered a first line treatment for some mental illnesses, and to what degree other treatments, such as medication, should be employed as an adjunct therapy.

Resources

BOOKS

Field, Tiffany. *Complementary and Alternative Therapies Research*. Washington, DC: American Psychological Association, 2009.

ORGANIZATIONS

Association for Applied Psychophysiology and Biofeedback, 10200 W. 44th Avenue, Suite 304, Wheat Ridge, CO, 80033, (303) 422-8436, (800) 477-8892, aapb@resourcecenter.com, http://www.aapb.org.

Biofeedback Certification Institute of America, 10200 W. 44th Avenue, Suite 310, Wheat Ridge, CO, 80033-2840, (303) 420-2902, (303) 422-8894, (866) 908-8713, info@bcia.org, http://www.bcia.org/.

Paula Anne Ford-Martin

Biopsy *see* **Bone biopsy; Bone marrow aspiration and biopsy; Brain biopsy; Breast biopsy; Cervical conization; CT-guided biopsy; Endometrial biopsy; Joint biopsy; Kidney biopsy; Liver biopsy; Lung biopsy; Lymph node biopsy; Myocardial biopsy; Pleural biopsy; Prostate biopsy; Skin biopsy; Small intestine biopsy; Thyroid biopsy**

Bipolar disorder

Definition

Bipolar disorder, formerly known as manic depression, is a psychiatric disorder characterized by severe and unusual changes in energy level, mood, and interactions with others. The mood swings associated with bipolar disorder are unpredictable and range from **mania** (elevated or irritable mood) to depression (a mood characterized by loss of interest and sadness). Bipolar disorder causes significant impairment in social, occupational, and general functioning.

Demographics

According to the National Institutes of Mental Health (NIMH), in 2008 the lifetime prevalence rate of bipolar disorder in the United States was 1–1.6%. Other statistics suggest that 1.0% of the population has bipolar disorder type I, and 1.1% of the population has bipolar disorder type II. About another 2.4–4.7% of

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the population has subthreshold bipolar disorder, meaning that they show characteristics of the disorder that do not rise to the level of formal diagnosis. Internationally the lifetime prevalence of reported bipolar disorder ranges from 0.3–1.5%.

No racial differences in distribution exist. While bipolar type I occurs equally in both sexes, bipolar II and rapid-cycling bipolar disorder are more common in females than in males. The average age of onset of bipolar disorder is 25; however, about 1% of adolescents and between 0.2% and 0.4% of children have been diagnosed with the bipolar disorder. Controversy exists about diagnosing the disorder in these groups. Because of the complexity of the disorder, a correct diagnosis can be delayed, and between 20% and 30% of adults with bipolar disorder report having undiagnosed symptoms in childhood or adolescence.

Description

Bipolar disorder is characterized by alternating manic episodes in which the individual feels abnormally euphoric, optimistic, and energetic, and depressive periods in which the individual feels sad, hopeless, guilty, and sometimes suicidal. Manic or depressive periods may last for days, weeks, or months and run the spectrum from mild to severe. These episodes may be separated by periods of emotional stability in which the individual functions normally.

Bipolar I disorder is characterized by at least one manic episode without a major depressive episode. Manic episodes are the "high" of the manic-depressive cycle. A person experiencing a manic episode often has feelings of self-importance, elation, talkativeness, increased sociability, and a desire to embark on goal-oriented activities, coupled with the characteristics of irritability, impatience, impulsiveness, hyperactivity, and a decreased need for sleep. Usually this manic period is followed by a period of severe depression, although a few individuals may not experience a major depressive episode. Mixed states, where both manic or hypomanic symptoms and depressive symptoms occur at the same time, also may occur (e.g., racing thoughts of mania with the listlessness of depression). Also, dysphoric mania is common particularly in adolescents. This is mania characterized by anger and irritability.

Bipolar II disorder is characterized by major depressive episodes alternating with episodes of hypomania, a milder form of mania. A bipolar depressive episode may be difficult to distinguish from a unipolar major depressive episode. Patients with bipolar depression tend to have extremely low energy, slowed mental and physical processes, and more profound **fatigue** (for example, hypersomnia, a sleep disorder marked by a need for excessive sleep or sleepiness when awake) than people with unipolar depression.

Cyclothymia refers to the cycling of hypomanic episodes with less severe depression that does not reach major depressive proportions. Some people with cyclothymia develop bipolar I or II disorder later in life.

A phenomenon known as rapid cycling occurs in up to 20% of bipolar individuals. In rapid cycling, at least four manic and depressive mood swings must occur within 12 months. In some cases of ultra-rapid cycling, the individual may bounce between manic and depressive states several times within a 24-hour period. This condition is very hard to distinguish from mixed states.

Risk factors

According to the Mayo Clinic, 60% of bipolar cases have a family history of the disease. The Child and Adolescent Bipolar Foundation (CABF) reports that the risk for a child of one bipolar parent to develop the disorder is 15%–30%. If both parents have bipolar disorder, the risk for each child increases to 50%–75%. The risk in siblings and fraternal twins is 15%–25%. The risk in identical twins, who share the same genes, is approximately 70%. Research in identical twins indicates that both genes and other factors play a role in developing bipolar disorder.

Women who have given birth may also be at increased risk of developing subsequent episodes in the immediate period after giving birth.

Causes and symptoms

Possible causes

Although the source of bipolar disorder has not been clearly identified, a number of genetic and environmental factors appear to be involved in triggering episodes. Bipolar disorder has an inherited component. As noted above, children who have at least one parent with bipolar disorder are more likely to develop the disorder. They are also more likely to be diagnosed with other psychiatric disorders such as attention deficit/hyperactivity disorder (**ADHD**). Several studies have uncovered possible genetic connections to the predisposition for bipolar disorder. A large study done in Sweden reported in 2009 that **schizophrenia** and bipolar disorder appeared to share similar genetic causes.

No specific gene mutations have been identified that consistently show up in bipolar patients. However, there appears to be a potential genetic correlation between bipolar disorder and mutations in specific regions of chromosomes 13, 18, and 21. The building blocks of

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genes, called nucleotides, are normally arranged in a specific order and quantity. If these nucleotides are repeated in a redundant fashion, a genetic abnormality often results. Some evidence exists for an abnormal type of nucleotide sequence (CAG/CTG repeats) on chromosome 18 in patients with bipolar II disorder. However, not all bipolar patients have this mutation, and the presence of this sequence does not worsen the disorder or change the age of onset.

People with bipolar disorder tend to have other psychiatric disorders. **Oppositional defiant disorder** (ODD) and ADHD are among the most common. Over half of patients diagnosed with bipolar disorder have a history of **substance abuse**. A high rate of association exists between **cocaine** abuse and bipolar disorder. The emotional and physical highs and lows of cocaine use correspond to the manic depression cycle of the bipolar patient, making the disorder difficult to diagnoses.

For some bipolar patients, manic and depressive episodes coincide with seasonal changes. Depressive episodes are typical during winter and fall, and manic episodes are more probable in the spring and summer months.

Brain imaging studies suggest that there are physical changes in the brains of people with bipolar disorder. It is hypothesized that dopamine and other neurotransmitters involved in mood may be involved. The possible role of hormonal imbalances in bipolar disorder is another area of investigation. Further research is needed to determine which genes are involved in bipolar disorder. It is likely that both genetic and environmental factors contribute to the disease.

Symptoms

Bipolar disorder causes recurrent dramatic mood swings that range from a manic high to a depressive low. There are often periods of normal mood in between episodes of mania and depression. Severe changes in energy and behavior accompany the swings in mood.

Manic episode symptoms include:

- increased energy, activity, and restlessness
- excessively high, euphoric mood
- extreme irritability and reactivity
- racing thoughts and fast speech that jump from one topic to another, known as flight of ideas
- distractibility due to unimportant events and the inability to concentrate
- reduced perceived need for sleep
- unrealistic beliefs in one's abilities, powers, or importance
- poor judgment and impulsive behaviors
- increased sexual drive
- provocative, intrusive, or aggressive behavior
- denial that anything is wrong

Depressive episode symptoms include:

- persistent sad, anxious, or empty mood
- feelings of irritability, hopelessness, or negative mood
- feelings of guilt, worthlessness, or helplessness
- inability to take pleasure in activities
- fatigue
- inability to concentrate
- extreme sleep patterns
- extreme appetite changes that result in weight change
- chronic pain or physical discomfort in the absence of physical illness or injury
- thoughts of or attempts at suicide

Some people with bipolar II disorder have depressive episodes concurrent with mood reactivity (mood improves with positive event), and can switch from depression to hypomania. Hypomania is characterized by a mild or moderate level of mania. Because hypomania is less severe, it may be associated with increased functioning and enhanced productivity. However, hypomania is not a normal state of mind. Without proper treatment, hypomania may eventually progress into severe mania or switch into depression. Severe episodes of mania or depression may also include symptoms of **psychosis**. Psychotic symptoms include visual or auditory **hallucinations** and **delusions** (illogical, false, but strongly held beliefs). Psychotic symptoms in bipolar disorder tend to reflect the current extreme mood episode. During mania, psychotic delusions may include grandiosity, such as believing one has special powers of flight or extreme financial wealth or power. During depressive episodes, delusions may include paranoid fears of being poisoned or the belief that one has committed a terrible crime. Because of these psychotic symptoms, bipolar disorder is sometimes mistaken for schizophrenia.

Some people with bipolar disorder present with a mixed state of symptoms. A mixed bipolar state is characterized by symptoms of agitation, sleeplessness, appetite changes, psychosis, and suicidal tendencies. A depressed and hopeless mood may occur in conjunction with extreme energy. Signs of bipolar disorder may also be demonstrated outside of mental illness symptoms in behaviors such as alcohol or drug abuse, poor work performance, strained interpersonal

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KEY TERMS

Cyclothymia—A milder form of bipolar disorder characterized by alternating hypomania and less severe depressive episodes.

Dopamine—A neurotransmitter and the precursor of norepinephrine.

Neuroprotective—Conveying some form of protection to the nervous system from injury.

Neurotransmitter—One of a group of chemicals secreted by a nerve cell (neuron) to carry a chemical message to another nerve cell, often as a way of transmitting a nerve impulse. Examples of neurotransmitters include acetylcholine, dopamine, serotonin, and norepinephrine.

Nucleotides—Building blocks of genes, which are arranged in specific order and quantity.

Off-label use—Drugs in the United States are approved by the Food and Drug Administration (FDA) for specific uses, periods of time, or dosages based on the results of clinical trials. However, it is legal for physicians to administer these drugs for other "off label" or non-approved uses. It is not legal for pharmaceutical companies to advertise drugs for off-label uses.

Rapid cycling—Four or more manic, hypomanic, mixed, or depressive episodes within a 12-month period.

Schizophrenia—A severe mental disorder in which a person loses touch with reality and may have illogical thoughts, delusions, hallucinations, behavioral problems and other disturbances.

Selective serotonin reuptake inhibitors (SSRIs)—A class of antidepressants that work by blocking the reabsorption of serotonin in brain cells, raising the level of the chemical in the brain. SSRIs include Prozac, Zoloft, Luvox, and Paxil.

relationships, or excessive promiscuity. Symptoms of bipolar disorder with postpartum onset usually occur within four weeks after **childbirth**. Bipolar disorder with a seasonal pattern displays symptoms related to seasonal change and latitude. The prevalence of the season-specific bipolar symptoms increases with higher latitudes and winter months.

Bipolar symptoms often present differently in children and adolescents. Manic episodes in these age groups are typically characterized by more psychotic features than in adults, which may lead to a misdiagnosis of schizophrenia. Children and adolescents also tend toward irritability and aggressiveness instead of elation. Further, symptoms tend to be chronic (ongoing), rather than acute (episodic). Bipolar children are easily distracted, impulsive, and hyperactive, which can lead to a misdiagnosis of ADHD. Furthermore, their aggression often leads to violence, which may be misdiagnosed as a **conduct disorder**. Complicating the picture is that ADHD and conduct disorders are often present concurrently in children with bipolar disorder.

Diagnosis

Bipolar disorder usually is diagnosed and treated by a psychiatrist and/or a psychologist with medical assistance. In addition to an interview, several clinical inventories or scales may be used to assess the patient's mental status and determine the presence of bipolar symptoms. These include the Millon Clinical Multiaxial Inventory III (MCMI-III), **Minnesota Multiphasic Personality Inventory** II (**MMPI-2**), the Internal State Scale (ISS), the Self-Report Manic Inventory (SRMI), and the Young Mania Rating Scale (YMRS). The tests are verbal and/or written and are administered in both hospital and outpatient settings. Laboratory tests for drug and alcohol may be done to rule out other causes of the behavior.

Psychologists and psychiatrists typically use the criteria listed in the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition Text Revision* (*DSM-IV-TR*) published by the American Psychiatric Association to definitively diagnose bipolar disorder. The *DSM-IV-TR* describes a manic episode as an abnormally elevated or irritable mood lasting a period of at least one week that is distinguished by at least three of the mania symptoms: inflated self-esteem, decreased need for sleep, talkativeness, racing thoughts, distractibility, increase in goal-directed activity, or excessive involvement in pleasurable activities that have a high potential for painful consequences. If the mood of the patient is irritable and not elevated, four of the symptoms are required.

Although some clinicians find the criteria too rigid, a hypomanic diagnosis requires a duration of at least four days with at least three of the symptoms indicated for manic episodes (four if mood is irritable and not elevated). The *DSM-IV-TR* notes that unlike

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manic episodes, hypomanic episodes do not cause a marked impairment in social or occupational functioning, do not require hospitalization, and do not have psychotic features. In addition, because hypomanic episodes are characterized by high energy and goal-directed activities, often result in a positive outcome, and are perceived in a positive manner by the patient (e.g., as a time of heightened creativity or work output), bipolar II disorder can go undiagnosed.

Substance abuse, thyroid disease, and use of prescription or over-the-counter medication can mask or mimic the presence of bipolar disorder. In cases of substance abuse, the patient must undergo a period of **detoxification** and abstinence before a mood disorder is diagnosed and treatment begins.

Treatment

Drugs

Medication is the most effective treatment for bipolar disorder. A combination of mood stabilizing agents with antidepressants, antipsychotics, and anticonvulsants may be used for long-term regulation of manic and depressive episodes. In the acute phase, the choice of medication for bipolar disorder is dependent on the stage or type of current episode. Many drugs are used to treat an acute manic episode, primarily the antipsychotics and **benzodiazepines** (e.g., lorazepam, clonazepam). In the presence of psychotic symptoms, atypical antipsychotics may be used to treat psychotic symptoms and acute mania, and may contribute to mood stabilization. For depressive episodes, antidepressants may be used. Medications may be added temporarily, to treat episodes of mania or depression that break through despite mood-stabilizer treatment.

Mood stabilizing drugs dampen the extremes of manic and depressive episodes. Lithium (Cibalith-S, Eskalith, Lithane, Lithobid, Lithonate, Lithotabs) was the first mood stabilizer approved by the United States Food and Drug Administration (FDA) for the treatment of mania and the prevention of both manic and depressive episodes. Lithium is a first-line medication used in the long-term preventative treatment of extreme mood episodes in bipolar disorder. It has been demonstrated to play a neuroprotective role in brain function. Because lithium takes up to ten days to reach a therapeutic level in the bloodstream, it sometimes is prescribed in conjunction with neuroleptics and/or benzodiazepines to provide more immediate relief of a manic episode. Lithium also has been shown to be effective in regulating bipolar depression, but it is not recommended for mixed mania. Lithium may not be an effective long-term treatment option for rapid cyclers, who typically develop a tolerance for it or may not respond to it. Possible side effects of the drug include weight gain, thirst, **nausea**, and hand **tremors**. Prolonged lithium use also may cause **hyperthyroidism** (a disorder in which the thyroid is overactive, which may cause heart **palpitations**, nervousness, the presence of **goiter**, sweating, and a wide array of other symptoms) and abnormalities in liver function.

In addition to lithium, the following drugs are commonly used to treat bipolar disorders:

- Carbamazepine (Tegretol, Atretol) is an anticonvulsant drug often prescribed in conjunction with other mood stabilizing agents. The drug may be used to treat bipolar patients who have not responded well to lithium therapy. Blurred vision and abnormal eye movement are two possible side effects of carbamazepine therapy.
- Valproate (divalproex sodium, or Depakote; valproic acid, or Depakene) is one of the few drugs available that has been proven effective in treating rapid cycling bipolar and mixed states patients. Valproate is prescribed alone or in combination with carbamazepine and/or lithium. Stomach cramps, indigestion, diarrhea, hair loss, appetite loss, nausea, and unusual weight loss or gain are some of the common side effects of valproate.
- Risperidone (Risperdal) may be used for short-term (usually no more than 3 weeks) treatment of acute mania associated with bipolar disorder. It may be given in conjunction with lithium or valproate. Side effects include weight gain, sedation, and abnormally low blood pressure upon rising from lying down (orthostatic hypotension).
- Quetiapine (Seroquel) is a newer antipsychotic that acts on neurotransmitters in the brain. It appears to have fewer side effects than some of the older antipsychotics.
- Olanzapine (Zyprexa, Zydis) may be used to treat acute manic episodes in individuals with bipolar I. Its mechanism of action is not clear. Side effects include orthostatic hypotension (low blood pressure when rising to a standing position).
- Symbyax, a combination of olanzipine and fluoxetine, was approved by the FDA in 2004 as the first drug to specifically treat bipolar disorder.

Because antidepressants may stimulate manic episodes in some bipolar patients, their use in bipolar disorder, once common, is now controversial. They are typically used as short-term treatment. Antidepressants are not specifically approved for treating depression associated with bipolar disorder but may be prescribed off-label. **Selective serotonin reuptake inhibitors**

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(SSRIs) or, less often, **monoamine oxidase inhibitors** (MAO inhibitors) may be prescribed for episodes of bipolar depression. **Tricyclic antidepressants** used to treat unipolar depression may trigger rapid cycling in bipolar patients and are, therefore, not a preferred treatment option for bipolar depression. Antidepressants commonly prescribed for bipolar disorder include:

- SSRIs such as fluoxetine (Prozac), sertraline (Zoloft), and paroxetine (Paxil) regulate depression by regulating levels of serotonin, a neurotransmitter. Anxiety, diarrhea, drowsiness, headache, sweating, nausea, sexual problems, and insomnia are all possible side effects of SSRIs.
- MAOIs such as tranylcypromine (Parnate) and phenelzine (Nardil) block the action of monoamine oxidase (MAO), an enzyme in the central nervous system. Patients taking MAOIs must cut foods high in tyramine (found in aged cheeses and meats) out of their diet to avoid hypotensive side effects.
- Bupropion (Wellbutrin) is a heterocyclic antidepressant. The exact neurochemical mechanism of the drug is not known, but it has been effective in regulating bipolar depression in some patients. Side effects of bupropion include agitation, anxiety, confusion, tremor, dry mouth, fast or irregular heartbeat, headache, and insomnia.

Other drugs may be used in conjunction with a long-term pharmaceutical treatment plan.

- Long-acting benzodiazepines such as clonazepam (Klonapin) and alprazolam (Xanax) may be used for rapid treatment of manic symptoms to calm and sedate patients until mania or hypomania have waned and mood-stabilizing agents can take effect. Sedation is a common effect, and clumsiness, lightheadedness, and slurred speech are other possible side effects of benzodiazepines.
- Neuroleptics such as chlorpromazine (Thorazine) and haloperidol (Haldol) also may be used to control mania while a mood stabilizer such as lithium or valproate takes effect. Because neuroleptic side effects can be severe (difficulty in speaking or swallowing, paralysis of the eyes, loss of balance control, muscle spasms, severe restlessness, stiffness of arms and legs, tremors in fingers and hands, twisting movements of body, and weakness of arms and legs), benzodiazepines are generally preferred over neuroleptics.
- Clozapine (Clozaril) is an atypical antipsychotic medication used to control manic episodes in patients who have not responded to typical mood stabilizing agents. The drug has also been a useful prophylactic, or preventative treatment, in some bipolar patients. Common side effects of clozapine include tachycardia (rapid heart rate), hypotension, constipation, and weight gain. Agranulocytosis, a potentially serious but reversible condition in which the white blood cells that typically fight infection in the body are destroyed, is a possible side effect of clozapine. Patients treated with the drug should undergo weekly blood tests to monitor white blood cell counts.

Electroconvulsive therapy

Electroconvulsive therapy (ECT) has been successful in treating both unipolar and bipolar depression and mania. However, ECT usually is employed after all pharmaceutical treatment options have been explored in patients with severe depression and suicidal thoughts. ECT is given under anesthesia and patients are given a muscle relaxant medication to prevent convulsions. The treatment consists of a series of electrical pulses that move into the brain through electrodes on the patient's head. Although the exact mechanisms behind the success of ECT therapy are not known, it is believed that this electrical current alters the electrochemical processes of the brain, consequently relieving depression. Headaches, muscle soreness, nausea, and confusion are possible side effects immediately following an ECT procedure. Temporary **memory loss** has also been reported in ECT patients. In bipolar patients, ECT is often used in conjunction with drug therapy.

Psychosocial interventions

Psychosocial interventions include both patient education and **psychotherapy**. It is important for patients to receive social support and illness management skills. Family and friends must be aware of the high rates of social dysfunction and marital discord. Involvement in national support groups is advisable (i.e., National Depressive and Manic-Depressive Association).

Psychoeducation usually focuses on all of the following:

- assessment of what parameters will have an impact on the outcome of patient's disease
- implementing the boundaries and requirements of treatment
- implementation of a personal cost-benefit analysis concerning specific treatment directions
- implementing a follow-up program
- implementing future directions, which may include adjustment or change interventions

Genetic counseling should be included in family education programs since the predisposition for this

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disorder has been genetically proven to increase among first-degree relatives.

Alternative and complementary treatment

Alternative treatments for bipolar disorder generally are complementary treatments to conventional therapies. General recommendations for controlling bipolar symptoms include maintaining a calm environment, avoiding overstimulation, getting plenty of rest, regular **exercise**, and eating a healthy diet.

Chinese herbs may help to soften mood swings. **Traditional Chinese medicine** (TCM) remedies are prescribed based on the patient's overall constitution and the presentation of symptoms. These remedies can help to stabilize moods, not just treat swings in mood. A TCM practitioner might recommend a mixture called the Iron Filings Combination, which includes the Chinese herbs asparagus, ophiopogon, fritillaria, arisaema, orange peel, polygala, acorus, forsythia, hoelen, fu-shen, scrophularia, uncaria stem, salvia, and iron filings, to treat certain types of mania in the bipolar patient. There are other formulas for depression. A trained practitioner should guide all of these remedies.

Acupuncture can be used for treatment to help maintain a more even temperament.

Biofeedback is effective in helping some patients control symptoms such as irritability, poor self-control, racing thoughts, and sleep problems.

A diet low in vanadium, a mineral found in meats and other foods, and high in vitamin C may be helpful in reducing depression.

Individuals using herbal remedies in addition to traditional pharmaceuticals should tell their physician, as some herbal remedies interact with conventional drugs, either heightening or depressing their effect. Recommended herbal remedies to ease depressive episodes may include damania (*Turnera diffusa*), **ginseng** (*Panax ginseng*), kola (*Cola nitida*), lady's slipper (*Cypripedium calceolus*), lavender (*Lavandula angustifolia*), lime blossom (*Tilia x vulgaris*), oats (*Avena sativa*), rosemary (*Rosmarinus officinalis*), skullcap (*Scutellaria laterifolia*), **St. John's wort** (*Hypericum perforatum*), valerian (*Valeriana officinalis*), and vervain (*Verbena officinalis*).

Prognosis

While most patients will show some positive response to treatment, response varies widely, from full recovery to a complete lack of response to all drug and/or ECT therapy. Drug therapies frequently need adjustment to achieve the maximum benefit for the patient. Bipolar disorder is a chronic, recurrent illness in over 90% of people with the disorder. The disorder requires lifelong observation and treatment after diagnosis. According to the World Health Organization, bipolar disorder is the sixth leading cause of disability worldwide

Suicide is the major complication of bipolar disorder, and is related to the duration of the depressive episode. Between 25% and 50% of individuals with bipolar disorder attempt suicide, and 11% complete the suicide attempt. The longer the depressive episode lasts, the higher the risk of suicidal tendencies. Alcoholics and patients with other chronic medical diseases are particularly prone to planning and implementing a suicide attempt.

The four main groups that are likely to carry out a suicide attempt include the following:

- Individuals who are overwhelmed by life problems. Suicide attempts in this group tend to be related to aggression and impulsive behaviors, not significant depressive episodes.
- Individuals who are attempting to control others.
- Individuals who are chronically ill with another medical disease.
- Individuals with other severe types of psychotic illness, delusions, and paranoia.

Prevention

The ongoing medical management of bipolar disorder is critical to preventing relapse, or recurrence, of manic episodes. Even in carefully controlled treatment programs, bipolar patients may experience recurring episodes of the disorder. Patient education in the form of psychotherapy or self-help groups is crucial for training bipolar patients to recognize signs of mania and depression and to take an active part in their treatment program.

Resources

BOOKS

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"Bipolar Disorder." *National Institute of Mental Health*. April 2, 2008 [cited January 28, 2009]. http://www.nimh.nih.gov/health/topics/bipolar-disorder/index.shtml

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ORGANIZATIONS

American Academy of Child and Adolescent Psychiatry (AACAP), 3615 Wisconsin Ave. NW, Washington, DC, 20013-3007, (202) 966-7300, (202) 966-2891, communi cations@aacap.org, http://www.aacap.org/.

American Psychiatric Association (APA), 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209, (888) 357-7924, apa@psych.org, http://www.psych.org.

Depression and Bipolar Support Alliance, 730 N. Franklin Street, Suite 501, Chicago, IL, 60654-7225, (312) 642-7243, (800) 826-3632, info@dbsalliance.org, http://www.dbsalliance.org.

Mental Health America, 2000 N. Beauregard Street, 6th Floor, Alexandria, VA, 22311, (703) 684-7722, (703) 684-5968, (800) 969-6642, infoctr@mentalhealth america.net, http://www.mentalhealthamerica.net.

National Institute of Mental Health, 6001 Executive Boulevard, Room 8184, MSC 9663, Bethesda, MD, 20892-9663, (301) 443-4513, TTY (301) 443-8431, (866) 615-6464, TTY (866) 415-8051, (301) 443-4279, http://www. nimh.nih.gov.

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Bird flu *see* **Avian flu**

Birth control *see* **Diaphragm (birth control); Condom; Contraception**

Birth control pills *see* **Oral contraceptives**

Birth defects

Definition

Birth defects are physical abnormalities that are present at birth; they also are called congenital abnormalities. More than 3,000 have been identified.

Description

Birth defects are found in 2–3% of all newborn infants. This rate doubles in the first year, and reaches 10% by age five, as more defects become evident and can be diagnosed. Almost 20% of deaths in newborns are caused by birth defects.

Abnormalities can occur in any major organ or part of the body. Major defects are structural abnormalities that affect the way a person looks and require medical and/or surgical treatment. Minor defects are abnormalities that do not cause serious health or social problems. When multiple birth defects occur together and have a similar cause, they are called syndromes. If two or more defects tend to appear together but do not share the same cause, they are called associations.

Congenital absence of three fingers. Deformities such as this are usually caused by damage to the developing fetus *in utero*. *(Dr. P. Marazzi/Photo Researchers, Inc.)*

Causes and symptoms

The specific cause of many congenital abnormalities is unknown, but several factors associated with **pregnancy** and delivery can increase the risk of birth defects.

Teratogens

Any substance that can cause abnormal development of the egg in the mother's womb is called a teratogen. In the first two months after conception, the developing organism is called an embryo; developmental stages from two months to birth are called fetal. Growth is rapid, and each body organ has a critical period in which it is especially sensitive to outside influences. About 7% of all congenital defects are caused by exposure to teratogens.

DRUGS. Only a few drugs are known to cause birth defects, but all have the potential to cause harm. For example, in 2003, a study found that use of topical (local) **corticosteroids** in the first trimester of pregnancy may be associated with **cleft lip**. Thalidomide is known to cause defects of the arms and legs; several other types also cause problems, such as:

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Prevalence of common birth defects

Type of defect	Number of infants affected worldwide
Congenital heart defects	1 in 100–200
Down syndrome	1 in 800
Neural tube defects (e.g., spina bifida, anencephaly)	1 in 1,000
Orofacial clefts (e.g., cleft lip, cleft palate)	1 in 700–1,000

SOURCE: Centers for Disease Control and Prevention, "Birth Defects: Frequently Asked Questions." Available online at: http://www.cdc.gov/ncbddd/bd/faq1.htm (accessed September 23, 2010).

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- Alcohol. Drinking large amounts of alcohol while pregnant causes a cluster of defects called fetal alcohol syndrome, which includes mental retardation, heart problems, and growth deficiency. Binge drinking early in pregnancy is dangerous even if the woman quits drinking later.
- Antibiotics. Certain antibiotics are known tetratogens. Tetracycline affects bone growth and discolors the teeth. Drugs used to treat tuberculosis can lead to hearing problems and damage to a nerve in the head (cranial damage).
- Anticonvulsants. Drugs given to prevent seizures can cause serious problems in the developing fetus, including mental retardation and slow growth. Studies in the United Kingdom and Australia have tracked the percentage of birth defects caused by certain antiepileptic drugs.
- Antipsychotic and antianxiety agents. Several drugs given for anxiety and mental illness are known to cause specific defects.
- Antineoplastic agents. Drugs given to treat cancer can cause major congenital malformations, especially central nervous system defects. They also may be harmful to the health care worker who is giving them while pregnant.
- Hormones. Male hormones may cause masculinization of a female fetus. A synthetic estrogen (DES) given in the 1940s and 1950s caused an increased risk of cancer in the adult female children of the mothers who received the drug.
- Recreational drugs. Drugs such as LSD have been associated with arm and leg abnormalities and central nervous system problems in infants. Crack cocaine also has been associated with birth defects. Since drug abusers tend to use many drugs and have poor nutrition and prenatal care, it is hard to determine the effects of individual drugs.

CHEMICALS. Environmental chemicals such as fungicides, food additives, and pollutants are suspected of causing birth defects, though this is difficult to prove.

RADIATION. Exposure of the mother to high levels of radiation can cause small skull size (microcephaly), blindness, **spina bifida**, and **cleft palate**. How severe the defect is depends on the duration and timing of the exposure.

INFECTIONS. Three viruses are known to harm a developing baby: **rubella**, cytomegalovirus (CMV), and herpes simplex. *Toxoplasma gondii,* a parasite that can be contracted from undercooked meat, from dirt, or from handling the feces of infected cats, causes serious problems. Untreated **syphilis** in the mother also is harmful.

Genetic factors

A gene is a tiny, invisible unit containing information (DNA) that guides how the body forms and functions. Each individual inherits tens of thousands of genes from each parent, arranged on 46 chromosomes. Genes control all aspects of the body, how it works, and all its unique characteristics, including eye color and body size. Genes are influenced by chemicals and radiation, but sometimes changes in the genes are unexplained accidents. Each child gets half of its genes from each parent. In each pair of genes one will take precedence (dominant) over the other (recessive) in determining each trait, or characteristic. Birth defects caused by dominant inheritance include a form of dwarfism called **achondroplasia**; high cholesterol; Huntington's disease, a progressive nervous system disorder; **Marfan syndrome**, which affects connective tissue; some forms of glaucoma, and **polydactyly** (extra fingers or toes).

If both parents carry the same recessive gene, they have a one-in-four chance that the child will inherit the disease. Recessive diseases are severe and may lead to an early **death**. They include sickle cell anemia, a blood disorder that commonly affects persons of African descent, and **Tay-Sachs disease**, which causes **mental retardation** in people of eastern European Jewish heritage. Two recessive disorders more common in Caucasians are **cystic fibrosis**, a lung and digestive disorder, and **phenylketonuria** (PKU), a metabolic disorder. If only one parent passes along the genes for the disorder, the normal gene received from the other parent will prevent the disease, but the child will be a carrier. Having the gene is not harmful

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to the carrier, but there is the 25% chance of the genetic disease showing up in the child of two carriers.

Some disorders are linked to the sex-determining chromosomes passed along by parents. **Hemophilia**, a condition that prevents blood from clotting, and Duchenne **muscular dystrophy**, which causes muscle weakness, are carried on the X chromosome. Genetic defects also can take place when the egg or sperm are forming if the mother or father passes along some faulty gene material. This is more common in older mothers. The most common defect of this kind is **Down syndrome**, a pattern of mental retardation and physical abnormalities, often including heart defects, caused by inheriting three copies of a chromosome rather than the normal pair.

A less understood cause of birth defects results from the interaction of genes from one or both parents plus environmental influences. These defects are thought to include:

- Cleft lip and palate, which are malformations of the mouth.
- Clubfoot, ankle or foot deformities.
- Spina bifida, an open spine caused when the tube that forms the brain and spinal chord does not close properly.
- Water on the brain (hydrocephalus), which causes brain damage.
- Diabetes mellitus, an abnormality in sugar metabolism that appears later in life.
- Heart defects.
- Some forms of cancer.

A serious illness in the mother, such as an underactive thyroid, or **diabetes mellitus**, in which her body cannot process sugar, also can cause birth defects in the child. In fact, in 2003, it was shown that babies of diabetic mothers are five times as likely to have structural heart defects as other babies. An abnormal amount of amniotic fluid may indicate or cause birth defects. Amniotic fluid is the liquid that surrounds and protects the unborn child in the uterus. Too little of this fluid can interfere with lung or limb development. Too much amniotic fluid can accumulate if the fetus has a disorder that interferes with swallowing. In 2003, a study linked the mother's weight to risk of birth defects. Obese women were about three times more likely to have an infant with spina bifida or omphalocele (protrusion of part of the intestine through the abdominal wall) than women of average weight. Women who were overweight or classified as obese also were twice as likely to have an infant with a heart defect or multiple birth defects than women classified as average weight.

Diagnosis

If there is a family history of birth defects or if the mother is over 35 years old, then screening tests can be done during pregnancy to gain information about the health of the baby.

- Alpha-fetoprotein test. This is a simple blood test that measures the level of a substance called alpha-fetoprotein that is associated with some major birth defects. An abnormally high or low level may indicate the need for further testing.
- Ultrasound. The use of sound waves to examine the shape, function, and age of the fetus is a common procedure. It also can detect many malformations, such as spina bifida, limb defects, and heart and kidney problems. In 2003, researchers in England announced a new combination of blood tests and ultrasound to detect Down syndrome sooner and more accurately than with the usual blood screenings done at 20 weeks of pregnancy.
- Amniocentesis. This test usually is done between the 13th and 15th weeks of pregnancy. A small sample of amniotic fluid is withdrawn through a thin needle inserted into the mother's abdomen. Chromosomal analysis can rule out Down syndrome and other genetic conditions.
- Chorionic villus sampling (CVS). This test can be done as early as the ninth week of pregnancy to identify chromosome disorders and some genetic conditions. A thin needle is inserted through the abdomen or a slim tube is inserted through the vagina that takes a tiny tissue sample for testing.

If a birth defect is suspected after a baby is born, then confirmation of the diagnosis is very important. The patient's medical records and medical history may hold essential information. A careful **physical examination** and laboratory tests should be done. Special diagnostic tests also can provide genetic information in some cases. The March of Dimes, a nonprofit organization, recommends that every baby born in the United States receives, at minimum, screening for the same core group of birth defects including phenylketonuria, **congenital adrenal hyperplasia**, congenital hypothyroidism, biotinidase deficiency, and others. The goal of the recommendations is to unify screening procedures across the United States.

Treatment

Treatment depends on the type of birth defect and how serious it is. When an abnormality has been identified before birth, delivery can be planned at a health care facility that is prepared to offer any special care

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needed. Some abnormalities can be corrected with surgery. Experimental procedures have been used successfully in correcting some defects, like excessive fluid in the brain (**hydrocephalus**), even before the baby is born. Early reports have shown success with fetal surgery on spina bifida patients. By operating on these fetuses while still in the womb, surgeons have prevented the need for shunts and improved outcomes at birth for many newborns. However, long-term studies still are needed. Patients with complicated conditions usually need the help of experienced medical and educational specialists with an understanding of the disorder.

Prognosis

The prognosis for a disorder varies with the specific condition.

Prevention

Pregnant women should eat a nutritious diet. Taking **folic acid** supplements before and during pregnancy reduces the risk of having a baby with serious problems of the brain or spinal chord (neural tube defects). It is important to avoid any teratogen that can harm the developing baby, including alcohol and drugs. When there is a family history of congenital defects in either parent, **genetic counseling** and testing can help parents plan for future children. Often, counselors can determine the risk of a genetic condition occurring and the availability of tests for it. Talking to a genetic counselor after a child is born with a defect can provide parents with information about medical management and available community resources.

Resources

PERIODICALS

"Babies of Diabetic Mothers Have Fivefold Increase in Structural Heart Defects." *Diabetes Week* (October 6, 2003): 8.

Bauer, Jeff. "Researchers Link Mom's Weight to Baby's Risk of Birth Defects." *RN* (August 2003): 97–102.

"Fetal Alcohol Syndrome Is Still a Threat, Says Publication." *Science Letter* (September 28, 2004): 448.

"Fetal Diagnostic Test Combo Shows Promise." *Health & Medicine Week* (October 27, 2003): 224.

"Fetal Surgery for Spina Bifida Shows Benefits in Leg Function, Fewer Shunts." *Health & Medicine Week* (October 20, 2003): 608.

"March of Dimes Pushes Newborn Screening." *Diagnostics & Imaging Week* (July 31, 2003): 10–11.

"Studies Reveal Risk of Birth Defects from AEDs." *Pharma Marketletter* (September 13, 2004).

"Topical Corticosteroids Use During Pregnancy May Associate With Cleft Lip." *Biotech Week* (September 24, 2003): 190.

OTHER

March of Dimes. *Public Health Education Information Sheets*.

ORGANIZATIONS

March of Dimes Birth Defects Foundation, 1275 Mamaroneck Ave., White Plains, NY, 10605, (914) 997-4488, http://www.modimes.org.

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Birthmarks

Definition

Birthmarks, including angiomas and vascular malformations, are benign (noncancerous) skin growths composed of rapidly growing or poorly formed blood vessels or lymph vessels. Found at birth (congenital) or developing later in life (acquired) anywhere on the body, they range from faint spots to dark swellings covering wide areas.

Description

Skin angiomas, also called vascular (pertaining to vessel) nevi (marks), are composed of blood vessels (hemangiomas) or lymph vessels (lymphangiomas), that lie beneath the skin's surface. Hemangiomas, composed of clusters of cells that line the capillaries, the body's smallest blood vessels, are found on the face and neck (60%), trunk (25%), or the arms and legs (15%). Congenital hemangiomas, 90% of which appear at birth or within the first month of life, grow quickly, and disappear over time. They are found in 1–10% of

A fading capillary hemangioma on the nose of a child. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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full-term infants, and 25% of premature infants. About 65% are capillary hemangiomas (strawberry marks), 15% are cavernous (deep) hemangiomas, and the rest are mixtures. Hemangiomas are three times more common in girls. Usually, only one hemangioma is found; in 20% two are found, while fewer than 5% of affected infants have three or more. Lymphangiomas are skin bumps caused by enlarged lymph vessels anywhere on the body.

Vascular malformations are poorly formed blood or lymph vessels that appear at birth or later in life. One type, the salmon patch (nevus simplex), a pink mark composed of dilated capillaries, is found on the back of the neck (also called a stork bite) in 40% of newborns, and on the forehead and eyelids (also called an angel's kiss) in 20%. Stork bites are found in 70% of white and 60% of black newborns.

Found in fewer than 1% of newborns, port-wine stains (nevus flammeus), are vascular malformations composed of dilated capillaries in the upper and lower layers of the skin of the face, neck, arms, and legs. Often permanent, these flat pink-to-red marks develop into dark purple bumpy areas in later life; 85% appear on only one side of the body.

Acquired hemangiomas include spider angiomas (nevus araneus), commonly known as spider veins, and cherry angiomas (senile angiomas or Campbell de Morgan spots). Found around the eyes, cheekbones, arms, and legs, spider angiomas are red marks formed from dilated blood vessels. They occur during **pregnancy** in 70% of white women and 10% of black women, in alcoholics and **liver disease** patients, and in 50% of children. Cherry angiomas, dilated capillaries found mainly on the trunk, appear in the 30s, and multiply with **aging**.

Causes and symptoms

There are no known causes for congenital skin angiomas; they may be related to an inherited weakness of vessel walls. Exposure to estrogen causes spider angiomas in pregnant women or those taking **oral contraceptives**. Spider angiomas tend to run in families, and may be associated with liver disease, sun exposure, and trauma.

Hemangiomas

Hemangiomas first appear as single or multiple, white or pale pink marks, ranging from 2–20 cm (average 2–5 cm) in size. Some are symptomless while others cause **pain** or bleeding, or interfere with normal functioning when they are numerous, enlarged, infected, or ulcerated. Vision is affected by large marks on the eyelids. Spider and cherry angiomas are unsightly but symptomless.

Each type of hemangioma has a characteristic appearance:

- Capillary hemangiomas (strawberry marks). These round, raised marks are bright red and bumpy like a strawberry, and become white or gray when fading.
- Cavernous hemangiomas. These slightly raised, dome-shaped, blue or purple swellings are sometimes associated with lymphangiomas or involve the soft tissues, bone, or digestive tract.
- Spider angiomas. These are symptomless, reddish blue marks formed from blood-filled capillaries radiating around a central arteriole (small artery) in the shape of a spider web.
- Cherry angiomas. These harmless, dilated capillaries appear as tiny, bright red-to-violet colored bumps.
- Lymphangiomas. These dilated lymph vessels form light pink or yellow cysts (fluid-filled sacs) or swellings.

Vascular malformations

These are faint, flat, pink stains that grow as the child grows into larger dark red or purple marks. Some are symptomless but others bleed if enlarged or injured. Disfiguring port-wine stains can cause emotional and social problems. About 5% of port-wine stains on the forehead and eyelids increase eye pressure due to involvement of the eye and surrounding nerves. Abnormalities of the spinal cord, soft tissues, or bone may be associated with severe port-wine stains.

Each type has a characteristic appearance:

- Salmon patches. These symptomless, light red-to-pink marks usually fade with time.
- Port-wine stains. These flat, pink marks progress to raised, dark red-to-purple grape-like lumps distorting the facial features, arms, or legs.

Diagnosis

Patients are treated by pediatricians (doctors who specialize in the care of children), dermatologists (skin disease specialists), plastic surgeons (doctors who specialize in correcting abnormalities of the appearance), and ophthalmologists (eye disease specialists).

Angiomas and vascular malformations are not difficult to diagnose. The doctor takes a complete medical history and performs a **physical examination** including inspection and palpation of the marks. The skin is examined for discoloration, scarring, bleeding, infection, or ulceration. The type, location, size, number, and severity of the marks are recorded. The

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doctor may empty the mark of blood by gentle pressure. Biopsies or specialized x rays or scans of the abnormal vessels and their surrounding areas may be performed. Patients with port-wine stains near the eye may require **skull x rays**, **computed tomography scans**, and vision and central nervous system tests. Most insurance plans pay for diagnosis and treatment of these conditions.

Treatment

Treatment choices for skin angiomas and vascular malformations depend on their type, location, and severity, and whether they cause symptoms, pain, or disfigurement.

Watchful waiting

No treatment is given, but the mark is regularly examined. This continues until the mark disappears, or requires treatment. This approach is particularly appropriate for the treatment of hemangiomas, which often do not require treatment, since they eventually shrink by themselves.

Drugs

CORTICOSTEROIDS. Daily doses of the anti-inflammatory drugs prednisone or prednisolone are given for up to 2 months with gradual reduction of the dose. The marks begin to subside within 7–10 days, but may take up to 2 months to fully disappear. If no response is seen in 2 weeks, the drug is discontinued. Treatment may be repeated. Side effects include growth retardation, increased blood pressure and blood sugar, **cataracts**, glandular disorders, and infection. The **corticosteroids** triamcinolone acetate and betamethasone **sodium** phosphate or acetate are injected directly into the marks with a response usually achieved within a week; additional injections are given in 4–6 weeks. Side effects include tissue damage at the injection site.

INTERFERON ALPHA-2A. This drug reduces cell growth, and is used for vascular marks that affect vision and that are unresponsive to corticosteroids. Given in daily injections under the skin, a response rate of 50% is achieved after about 7 months. Side effects include **fever**, chills, muscle and joint pain, vision disorders, low white and red blood cell counts, **fatigue**, elevated liver enzymes, **nausea**, blood clotting problems, and nerve damage.

ANTIBIOTICS. Oral or topical (applied to the skin) **antibiotics** are prescribed for infected marks.

Surgery

LASER SURGERY. Lasers create intense heat that destroys abnormal blood vessels beneath the skin, without damaging normal skin. Two types of lasers are used: the flashlamp-pulsed dye laser (FPDL) and the neodymium:YAG (Nd:YAG) laser. The FPDL, used mainly for strawberry marks and port-wine stains, penetrates to a depth of 1.8 mm and causes little scarring, while the Nd:YAG laser penetrates to a depth of 6 mm, and is used to treat deep hemangiomas. **Laser surgery** is not usually painful, but can be uncomfortable. Anesthetic cream is used for FPDL treatment. Treatment with the Nd:YAG laser requires local or **general anesthesia**. Children are usually sedated or anesthetized. Healing occurs within 2 weeks. Side effects include bruising, skin discoloration, swelling, crusting, and minor bleeding.

SURGICAL EXCISION. Under local or general anesthesia, the skin is cut with a surgical instrument, and vascular marks or their **scars** are removed. The cut is repaired with stitches or skin clips.

CRYOSURGERY. Vascular marks are frozen with an extremely cold substance sprayed onto the skin. **Wounds** heal with minimal scarring.

ELECTRODESICCATION. Affected vessels are destroyed with the current from an electric needle.

Other treatments

These include:

- Sclerotherapy. Injection of a special solution causes blood clotting and shrinkage with little scarring. Side effects include stinging, swelling, bruising, scarring, muscle cramping, and allergic reactions. This treatment is used most commonly for spider angiomas.
- Embolization. Material injected into the vessel blocks blood flow, which helps control blood loss during surgery or reduces the size of inoperable growths. A serious side effect, stroke, can occur if a major blood vessel becomes blocked.
- Make-up. Special brands are designed to cover birthmarks (Covermark or Dermablend).
- Cleaning and compression. Bleeding marks are cleaned with soap and water or hydrogen peroxide, and compressed with a sterile bandage for 5-10 minutes.

Alternative treatment

Alternative treatments for strengthening weak blood vessels include eating high-fiber foods and foods containing bioflavonoids, including citrus fruit, blueberries, and cherries; supplementing the diet with vitamin C; and taking the herbs ginkgo (*Ginkgo biloba*) and bilberry (*Vaccinium myrtillus*.)

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Prognosis

The various types of birthmarks have different prognoses:

- Capillary hemangiomas. Fewer than 10% require treatment. Without treatment, 50% disappear by age 5, 70% by age 7, and 90% by age 9. No skin changes are found in half while others have some discoloration, scarring, or wrinkling. Thirty to 90% respond to oral corticosteroids, and 45% respond to injected corticosteroids; 50% respond to interferon Alpha-2a. About 60% improve after laser surgery.
- Cavernous hemangiomas. Some do not disappear and some are complicated by ulceration or infection. About 75% respond to Nd:YAG laser surgery but have scarring. Severe marks respond to oral corticosteroids, but some require excision.
- Spider angiomas. These fade following childbirth and in children, but may recur. About 90% respond to sclerotherapy, electrodesiccation, or laser therapy.
- Cherry angiomas. These are easily removed by electrodesiccation.
- Lymphangiomas. These require surgery.
- Salmon patches. Eyelid marks disappear by 6–12 months of age, and forehead marks fade by age 6; however, 50% of stork bites on the neck persist into adulthood.
- Port-wine stains. Some flat birthmarks are easily covered with make-up. Treatment during infancy or childhood improves results. About 95% of the stains respond to FPDL surgery with minimal scarring; 25% will completely and 70% will partially disappear. For unknown reasons, 5% show no improvement.

Prevention

Congenital hemangiomas or vascular malformations cannot be prevented, but spider angiomas may be prevented by **exercise**, weight control, and a high-fiber diet, as well as avoidance of sun exposure, alcohol drinking, or wearing tight hosiery.

ORGANIZATIONS

American Academy of Dermatology, PO Box 4014, Schaumburg, IL, 60168-4014, (847) 240-1859, (866) 503-SKIN (7546), http://www.aad.org.

American Academy of Pediatrics (AAP), 141 Northwest Point Boulevard, Elk Grove Village, IL, 60007-1098, (847) 434-4000, (847) 424-8000, kidsdocs@aap.org, http://www.aap.org.

Congenital Nevus Support Group, P.O. Box 305, West Salem, OH, 44287, (419) 853-4525, info@nevusnetwork.org, http://www.nevusnetwork.org/.

Vascular Birthmarks Foundation, PO Box 106, Latham, NY, 12110, (877) VBF-4646, hvbf@aol.com, http://www.birthmark.org.

Mercedes McLaughlin

Bismuth subsalicylate *see* **Antidiarrheal drugs**

Bites and stings

Definition

Bites and stings are puncture injuries inflicted by an animal that penetrate the skin.

Demographics

The majority of animal bites in the United States come from dogs and cats. Many animal bites are never reported and never become infected. The Centers for Disease Control and Prevention (CDC) estimates that between three and six million animal bites occur annually in the United States. Dog bites account for 80%–90% of animal bites. In 2008 in the United States, about 885,000 dog bites required medical attention and 31,000 required **reconstructive surgery**. Cats account for only 5%–15% of animal bites, but 6% of cat bites require hospitalization compared to 1% of dog bites. The remainder of bites in the United States are caused mainly by small rodents (e.g., rabbits, rats and mice, ferrets).

Women are bitten by cats three times more often than men, while men are bitten by dogs three times more often than women. Children ages 5–9 have the highest incidence of animal bites. Animal bites account for about 1% of all emergency room visits. Dog bites kill between 10 and 20 people (most often children) annually in the United States.

Description

Humans can be injured by the bites or stings of many kinds of animals, including mammals such as dogs, cats, and fellow humans; arthropods such as spiders, bees, and wasps; snakes; and marine animals such as jellyfish and stingrays.

Mammals

DOGS. In the United States, where the dog population exceeds 75 million, dogs surpass all other mammals in the number of bites inflicted on humans; however, most dog-bite injuries are minor. Studies

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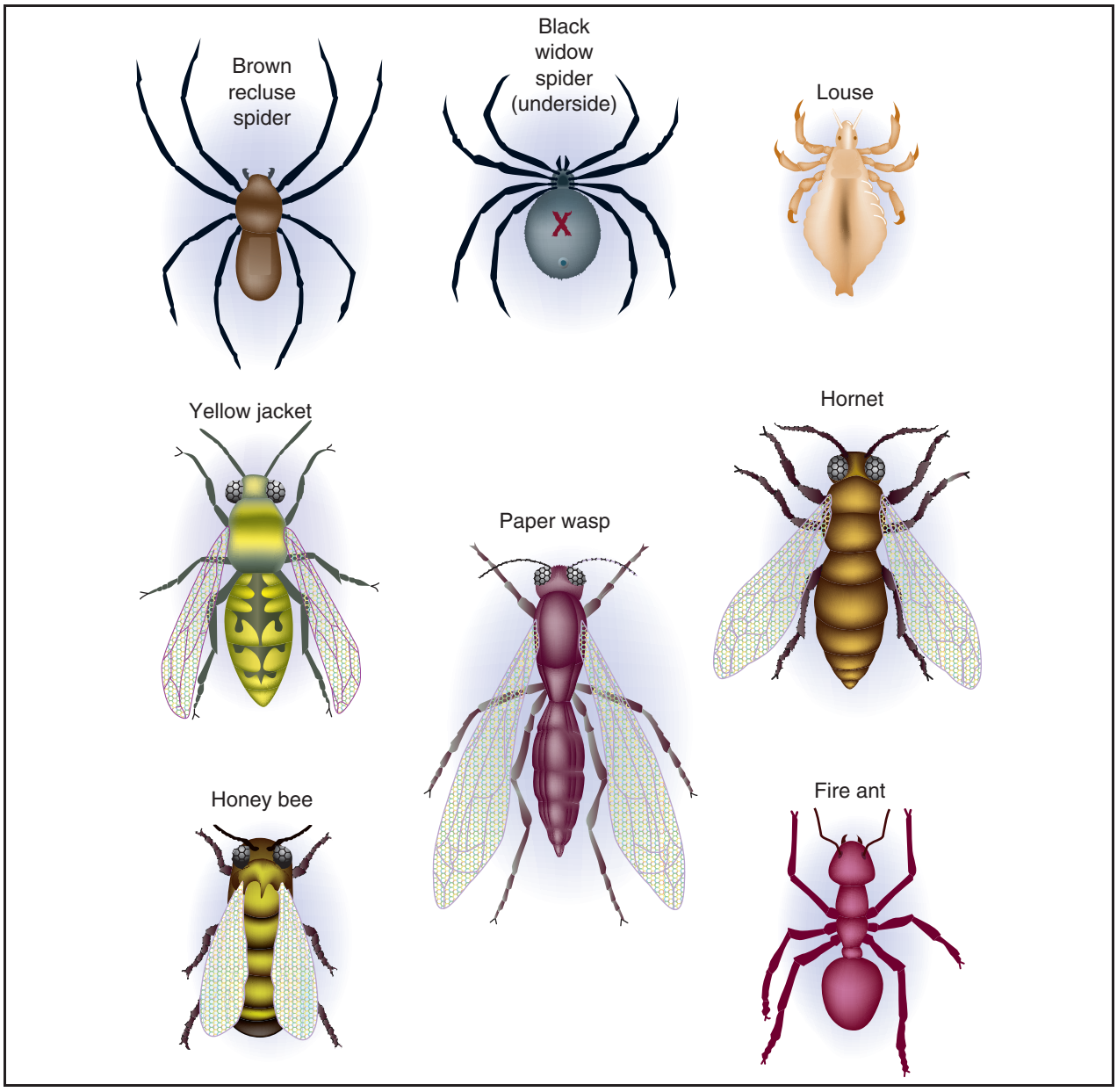

Types of spiders and insects that bite and sting. *(Illustration by Argosy, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

show that most dog bites are from pets or other dogs known to the bitten person. Nearly all of the injuries had by people seeking treatment in emergency rooms are of low severity, and most people are treated and released without being admitted to the hospital or sent to another facility. Many of the bites resulted from people attempting to break up fights between animals.

CATS. Although cats are found in nearly one-third of U.S. households, cat bites are far less common than dog bites. The tissue damage caused by cat bites is usually limited, but cat bites carry a high risk of infection. Whereas the infection rate for dog bite injuries is 15–20%, the infection rate for cat bites is 30–40%.

HUMANS. Bites from mammals other than dogs and cats are uncommon, with one exception—human bites. There are at least 70,000 human bites each year in the United States. Because the human mouth contains a multitude of potentially harmful microorganisms, human bites are more infectious than those of most other animals.

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A close-up view of lacerations on the shin of an adult woman inflicted by a Rottweiler dog. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Arthropods

Arthropods are invertebrates belonging to the phylum Arthropoda, which includes insects, arachnids, crustaceans, and other subgroups. There are more than 700,000 species in all. The list of arthropods that bite or sting humans is extensive and includes lice, bedbugs, fleas, mosquitoes, black flies, ants, chiggers, ticks, centipedes, scorpions, and other species. Spiders, bees, and wasps are the three kinds of arthropod that most often bite people.

SPIDERS. In the United States, only two kinds of venomous spider are truly dangerous: widow spiders and brown (violin or fiddle) spiders. The black widow, which is found in every state except Alaska, is probably the most notorious widow spider. It prefers dark, dry places such as barns, garages, and outhouses, and also lives under rocks and logs. Disturbing a female black widow or its web may provoke a bite. Brown spiders also prefer sheltered places, including clothing, and may bite if disturbed.

BEES AND WASPS. Bees and wasps will sting to defend their nests or if they are disturbed. Species common to the United States include honeybees, bumblebees, yellow jackets, bald-faced hornets, brown hornets, and paper wasps. Of note are also Africanized bee species, also called "killer bees," that have been found in the United States since 1990. More than 50 Americans die each year after being stung by a bee, wasp, or ant. Almost all of those deaths are the result of allergic reactions, and not of exposure to the venom itself.

Snakes

There are 20 species of venomous snakes in the United States. These snakes are found in every state except Maine, Alaska, and Hawaii. Each year about 8,000 Americans receive a snakebite; only four or five die, mostly from rattlesnake bites.

The venomous snakes of the United States are divided into two families, the Crotalidae (pit vipers) and the Elapidae. Pit vipers, named after the small heat-sensing pit that lies between each eye and nostril, are responsible for about 99% of the venomous snakebites experienced by Americans. Rattlesnakes, copperheads, and cottonmouths (also called water moccasins) are pit vipers. This family of snakes delivers its venom through two long, hinged fangs in the upper jaw. Some pit vipers carry potent venom that can threaten the brain and spinal cord. The venom of others, such as the copperheads, is less harmful.

The Elapidae family includes two kinds of venomous coral snakes indigenous to the southern and western states. Because coral snakes are bashful creatures that come out only at night, they almost never bite humans, and are responsible for approximately 25 bites a year in the United States. Coral snakes have short fangs and a small mouth, which lowers the risk of a bite actually forcing venom into a person's body. However, their venom is quite poisonous.

Marine animals

Several varieties of marine animal may bite or sting. Jellyfish and stingrays are two kinds that pose a threat to people who live or vacation in coastal communities.

Causes and symptoms

Dogs

A typical dog bite results in a laceration, tear, puncture, or crush injury. Bites from large, powerful dogs may cause **fractures** and dangerous internal injuries. Dogs trained to attack may bite repeatedly during a single episode. Infected bites usually cause **pain**, **cellulitis** (inflammation of the connective tissues), and a pus-filled discharge at the wound site within 8–24 hours. Many infections are confined to the wound site, but some of the microorganisms in the mouths of dogs can cause systemic and possibly life-threatening infections. Examples are **bacteremia** and meningitis—especially severe in people diagnosed with acquired **immunodeficiency** syndrome (**AIDS**) or other health conditions that increase their susceptibility to infection. **Rabies** is rare among pet dogs in the United States, most of which have been vaccinated against the disease. **Tetanus** is also rare but can be transmitted by a dog bite if the victim is not immunized.

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An insect bite caused this person's lower lip to swell. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Cats

The mouths of cats and dogs contain many of the same microorganisms. Cat scratches and bites are also capable of transmitting the *Bartonella henselae* bacterium, which can lead to **cat-scratch disease**, an unpleasant but usually not life-threatening illness.

Cat bites are mostly found on the arms and hands. Sharp cat teeth typically leave behind a deep puncture wound that can reach muscles, tendons, and bones, which are vulnerable to infection because of their comparatively poor blood supply. This is why cat bites are much more likely to become infected than dog bites. Also, people are less inclined to view cat bites as dangerous and requiring immediate attention; the risk that infection has set in by the time a medical professional is consulted is thus greater.

Humans

Humans bites result from fights, sexual activity, medical and dental treatment, and seizures. Bites raise the possibility of spousal or **child abuse**. Children often bite other children, but those bites are hardly ever severe. Human bites are capable of transmitting a wide range of dangerous diseases, including **hepatitis B**, **syphilis**, and **tuberculosis**.

Human bites fall into two categories: occlusional (true) bites and clenched-fist injuries. Occlusional bites present a lower risk of infection. Clenched-fist injuries, which are very infectious and can permanently damage the hand, usually result from a fist hitting teeth during a fight. People often wait before seeking treatment for a clenched-fist injury, with the result that about half of such injuries are infected by the time they are seen by a medical professional.

Spiders

As a rule, people rarely see a black widow bite, nor do they feel the bite as it occurs. The first (and possibly only) evidence that a person has been bitten may be a mild swelling of the injured area and two red puncture marks. Within a short time, some victims begin to experience severe **muscle cramps** and rigidity of the abdominal muscles. Other possible symptoms include excessive sweating, **nausea**, **vomiting**, headaches, and vertigo, as well as breathing, vision, and speech problems.

A brown spider's bite can lead to necrotic arachnidism, in which the tissue in an area of up to several inches around the bite becomes necrotic (dies), producing an open sore that can take months or years to disappear. In most cases, the bite simply produces a hard, painful, itchy, and discolored area that heals without treatment in 2–3 days. The bite may be accompanied by a **fever**, chills, **edema** (an accumulation of excess tissue fluid), **nausea and vomiting**, **dizziness**, muscle and joint pain, and a rash.

Bees and wasps

The familiar symptoms of bee and wasp stings include pain, redness, swelling, and itchiness in the area of the sting. Multiple stings can have much more severe consequences, such as **anaphylaxis**, a life-threatening allergic reaction that occurs in hypersensitive persons.

Snakes

Venomous pit viper bites usually begin to swell within 10 minutes and sometimes are painful. Other symptoms include skin blisters and discoloration, weakness, sweating, nausea, faintness, dizziness, bruising, and tender lymph nodes. Severe **poisoning** can lead to **tingling** in the scalp, fingers, and toes; muscle contractions; an elevated heart rate; rapid breathing; large drops in body temperature and blood pressure; **vomiting** of blood; and **coma**.

Many pit viper and coral snake bites (20–60%) fail to poison (envenomate) their victim, or introduce only a small amount of venom into the victim's body. The **wounds**, however, can still become infected by the harmful microorganisms that snakes carry in their mouths.

Coral snake bites are painful but may be hard to see. One to seven hours after the bite, a bitten person begins to experience the effects of the venom, which include tingling at the wound site, weakness, nausea, vomiting, excessive salivation, and irrational behavior. Major nerves of the body can become paralyzed for 6–14 days, causing double vision, difficulty swallowing and speaking, **respiratory failure**, and other

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KEY TERMS

Anaphylaxis—Also called anaphylactic shock; a severe allergic reaction characterized by airway constriction, tissue swelling, and lowered blood pressure.

Debridement—Removal of dead and damaged tissue.

Hepatitis—A disease that causes inflammation of the liver and serious liver damage.

problems. Six to eight weeks may be needed before normal muscular strength is regained.

Jellyfish

Jellyfish venom is delivered by barbs called nematocysts, which are located on the creature's tentacles and penetrate the skin of people who brush up against them. Instantly, painful and itchy red lesions usually result. The pain can continue up to 48 hours. Severe cases may lead to skin necrosis, **muscle spasms and cramps**, vomiting, nausea, **diarrhea**, headaches, excessive sweating, and other symptoms. In rare instances, cardiorespiratory failure may occur.

Stingrays

Tail spines are the delivery mechanism for stingray venom. Deep puncture wounds result that can cause an infection if pieces of spine become embedded in the wound. A typical stingray injury scenario involves a person who inadvertently steps on a resting stingray and is lashed in the ankle by its tail. Stingray venom produces immediate, excruciating pain that lasts several hours. Sometimes the victim has a severe reaction, including vomiting, diarrhea, hemorrhage (bleeding), a drop in blood pressure, and cardiac arrhythmia (disordered heart beat).

Diagnosis

Dogs

Gathering information on the circumstances of a dog attack is a crucial part of treatment. Medical professionals need to know when the attack occurred (the chances of infection increase dramatically if the wound has been left untreated more than eight hours) and what led to the attack (unprovoked attacks are more likely to be associated with rabies). A person's general health must also be assessed, including the tetanus immunization history (if any), as well as information concerning possible **allergies** to medication and pre-existing health problems that may increase the risk of infection.

A **physical examination** requires careful scrutiny of the wound, with special attention to possible bone, joint, ligament, muscle, tendon, nerve, or blood vessel damage caused by deep punctures or severe crush injuries. Serious hand injuries should be evaluated by a specialized surgeon. Laboratory tests for identifying the microorganisms in bite wounds are performed if infection is present. X rays and other diagnostic procedures may be necessary.

Cats

The diagnostic procedures used for dog bites also apply to cat bites.

Humans

Testing the blood of a person who has been bitten for immunity to hepatitis B and other diseases is always necessary after a human bite. Ideally, the biter should be tested for the presence of transmissible disease. Clenched-fist injuries often require evaluation by a hand surgeon or orthopedist. Because many people deny having been in a fight, medical professionals usually consider lacerations over the fourth and fifth knuckles—the typical result of a clenched-fist injury—to be evidence of a bite wound. Medical professionals also look for indications of spousal or child **abuse** when evaluating human bites.

Spiders

Because bites from widow spiders and brown spiders require different treatments, capturing and identifying the spider helps to establish diagnosis.

Snakes

Diagnosis relies on a physical examination of the victim, information about the circumstances of the bite, and a look at the snake itself (if it can safely be killed and brought in for identification). Blood tests and **urinalysis** supply important data on the victim's condition. Chest x rays and **electrocardiography** (a procedure for measuring heart activity) may also be necessary.

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Treatment

Dogs

Minor dog bites can be treated at home. The American Academy of Family Physicians recommends gently washing the wound with soap and water and then applying pressure to the injured area with a clean towel to stop the bleeding. The next step is to apply antibiotic ointment and a sterile bandage to the wound. To reduce swelling and fend off infection, ice should be applied and the injured area kept elevated above the level of the heart. The wound should be cleaned and covered with ointment twice a day until it heals.

Any dog bite that does not stop bleeding after 15 minutes of pressure must be seen by a medical professional. The same is true for bites that are deep or gaping; bites to the head, hands, or feet; and bites that may have broken a bone, damaged nerves, or caused a major injury of another kind. Bite victims must watch for infection. A fever is one sign of infection, as are redness, swelling, warmth, increased tenderness, and pus at the wound site. People who are diabetic, who have AIDS or **cancer**, individuals who have not had a tetanus shot in five years, and anyone else who has a medical problem that can increase susceptibility to infection should seek medical treatment no matter how minor the bite appears.

Medical treatment of dog bites involves washing (irrigating) the wound with an anti-infective solution. Removal of dead and damaged tissue (debridement) under local, regional, or general anesthetic may be required after the wound has been washed, and any person whose tetanus shots are not up to date should receive a booster injection. Some wounds are left open and allowed to heal on their own, while others require stitches (stitching may be delayed a few days if infection is a concern). Many emergency departments prescribe **antibiotics** for all people with dog bites, but some researchers suggest that antibiotics usually are unnecessary and should be limited to those whose injuries or other health problems make them likely candidates for infection. A follow-up visit after one or two days is generally required for anyone who has received bite treatment.

Cats

Because of the high risk of infection, people who are bitten by a cat should always see a doctor. Cat scratches do not require professional medical treatment unless the wound appears infected or the scratched person has a weakened immune system.

Medical treatment for cat bites generally follows the procedures used for dog bites. Experts advise that cat-bite wounds should be left open to prevent infection. Persons who have been bitten by cats usually receive antibiotics as a preventive measure.

Humans

Human bites should always be examined by a doctor. Such bites are normally treated with antibiotics and left open because of the high risk of infection. Routine use of antibiotics for human bites may not be necessary, as physicians try to minimize overuse of antibiotics. Superficial wounds in low-risk areas may no longer need antibiotic treatment, but more serious human bites to high-risk areas such as the hands should be treated with antibiotics to prevent serious infection. A person who has been bitten may require immunization against hepatitis B and other diseases. Persons who are being treated for a clenched-fist injury require a daily follow-up examination for 3–5 days.

Spiders

No spider bite should be ignored. The antidote for severe widow spider bites is a substance called antivenin, which contains antibodies taken from the blood serum of horses injected with spider venom. Doctors exercise caution in using antivenin because it can trigger anaphylactic shock, a potentially deadly allergic reaction, and **serum sickness**, an inflammatory response that can give rise to joint pain, a fever, **rashes**, and other unpleasant, though rarely serious, consequences.

An antivenin for brown spider bites exists as well, but it is in limited distribution. The drug dapsone, used to treat **leprosy**, can sometimes stop the tissue **death** associated with a brown spider bite. Necrotic areas may need **debridement** and skin grafts. Pain medications, **antihistamines**, antibiotics, and tetanus shots are a few of the other treatments that are sometimes necessary after a bite from a brown spider or widow spider.

Bees and wasps

Most stings can be treated at home. A stinger that is stuck in the skin can be scraped off with a blade, fingernail, credit card, or piece of paper (using tweezers may push more venom out of the venom sac and into the wound). The area should be cleaned and covered with an ice pack. **Aspirin** and other pain medications, oral antihistamines, and calamine lotion are good for treating minor symptoms. Putting meat tenderizer on the wound has no effect.

People who have been stung and experience an allergic reaction, or who are at risk due to their medical history, require immediate medical attention. The

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danger signs, which usually begin 10 minutes after an individual is stung (although possibly not for several hours), include nausea, faintness, chest pain, abdominal cramps, diarrhea, and difficulty swallowing or breathing.

Snakes

Although most snakes are not venomous, any snakebite should immediately be examined at a hospital. While waiting for emergency help to arrive, the victim should wash the wound site with soap and water, and then keep the injured area still and at a level lower than the heart. Ice should never be used on the wound site nor should attempts be made to suck out the venom. Making a cut at the wound site is also dangerous. It is important to stay calm and wait for emergency medical aid if it can arrive quickly. Otherwise, the victim should proceed directly to a hospital.

When the victim arrives at a hospital, the medical staff must determine whether the bite was inflicted by a venomous snake and, if so, whether envenomation occurred and how much venom the person has received. Patients may develop low blood pressure, abnormal blood clotting, or severe pain, all of which require aggressive treatment. Fortunately, the effects of some snakebites can be counteracted with antivenin. Minor rattlesnake envenomations can be successfully treated without antivenin, as can copperhead and water moccasin bites. Coral snake envenomations and the more dangerous rattlesnake envenomations require antivenin, sometimes in large amounts. Other treatment measures include antibiotics to prevent infection and a tetanus booster injection.

Jellyfish

Vinegar and other acidic substances are used to neutralize jellyfish nematocysts still clinging to the skin, which are then scraped off. Anesthetic ointments, antihistamine creams, and steroid lotions applied to the skin are sometimes beneficial. Other measures may be necessary to counter the many harmful effects of jellyfish stings, which, if severe, require emergency medical care.

Stingrays

Stingray wounds should be washed with saltwater and then soaked in very hot water for 30–90 minutes to neutralize the venom. Afterwards, the wound should be examined by a doctor to ensure that no pieces of spine remain.

Alternative treatment

Arthropods

Several alternative self-care approaches are used to treat minor bee, wasp, and other arthropod stings, including **aromatherapy**, **Ayurvedic medicine**, **flower remedies**, herbs, homeopathy, and nutritional therapy.

Prognosis

Mammals

Prompt treatment and recognizing that even apparently minor bites can have serious consequences are the keys to a good outcome after a mammal bite. Infected bites can be fatal if neglected. Surgery and hospitalization may be needed for severe bites.

Spiders

Even without treatment, adults usually recover from black widow bites after 2–3 days. Those most at risk of dying are very young children, the elderly, and people with high blood pressure. In the case of brown spider bites, the risk of death is greatest for children, although rare.

Bees and wasps

The pain and other symptoms of a bee or wasp sting normally fade away after a few hours. People who are allergic to such stings can experience severe and occasionally fatal anaphylaxis.

Snakes

A snakebite victim's chances of survival are excellent if medical aid is obtained in time. Some bites result in **amputation**, permanent deformity, or loss of function in the injured area.

Stingrays

Stingray venom rarely leads to death in humans.

Prevention

Dogs

The risk of a dog bite injury can be reduced by avoiding sick or stray dogs, staying away from dogfights (people often get bitten when they try to separate the animals), and not behaving in ways that might provoke or upset dogs, such as wrestling with them or bothering them while they are sleeping, eating, or looking after their puppies. Special precautions need to be taken around infants and young children, who must never be left alone with a dog. Pit bulls,

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Rottweilers, and German shepherds are responsible for nearly half of all fatal dog attacks in the United States and are potentially dangerous pets in households where children live or visit. For all breeds of dog, obedience training and spaying or neutering lessen the chances of aggressive behavior.

Cats

Prevention involves warning children to stay away from strange cats and to avoid rough play and other behavior that can anger cats and cause them to bite.

Spiders

Common-sense precautions include clearing webs out of garages, outhouses, and other places favored by venomous spiders; keeping one's hands away from places where spiders may be lurking; and checking clothing, shoes, and sleeping areas when camping or vacationing.

Bees and wasps

When possible, it is advised to avoid the nests of bees and wasps and to not eat sweet food or wear bright clothing, perfumes, or cosmetics that attract bees and wasps.

Emergency medical kits containing self-administrable epinephrine (Epi-pen) to counter anaphylactic shock are available for people allergic to bee or wasp stings and should be carried by them at all times. People who suspect they are allergic should consult an allergist about shots that can reduce reactions to bee and wasp venom.

Snakes

Snakes should not be kept as pets. Measures such as mowing the lawn, keeping hedges trimmed, and removing brush from the yard discourages snakes from living close to human dwellings. Tongs should be used to move brush, lumber, and firewood, to avoid exposing one's hands to snakes that might be lying underneath. Similarly, golfers should never use their hands to retrieve golf balls from a water hole, since snakes can be hiding in the rocks and weeds. Caution is also necessary when walking through weedy or grassy areas. Children should be prevented from playing in weedy, vacant lots and other places where snakes may live. Leather boots and long pants offer hikers and campers some protection from bites. Approaching a snake, even a dead one, can be dangerous, for the venom of recently killed snakes may still be active.

Jellyfish

Prevention of jellyfish stings includes obeying posted warning signs at the beach. Jellyfish tentacles may be transparent and up to 120 ft (36.5 m) long; therefore, great caution must be exercised whenever a jellyfish is sighted nearby. An over-the-counter cream tested at the Stanford University in 2004 was shown to prevent jellyfish stings.

Stingrays

Shuffling while walking through shallow areas that may be inhabited by stingrays will disturb the water, causing the animal to move before it can be stepped on.

Resources

OTHER

Garth, Alisha P., and M. Stuart Harris. "Animal Bites." June 25, 2009. http://emedicine.medscape.com/article/768875-overview (accessed September 18, 2010).

"What You Should Know about Animal Bites." Louisiana State University School of Veterinary Medicine. 2009. http://www.vetmed.lsu.edu/animal_bites.htm (accessed September 18, 2010).

ORGANIZATIONS

American Academy of Family Physicians, P.O. Box 11210, Shawnee Mission, KS, 66207, (913)906-6000 (800) 274-2237 (913) 906-6075http://familydoctor.org.

American Veterinary Medical Association (AVMA), 1931 North Meacham Road, Suite 100, Schaumburg, IL, 60173, (800) 248-2862, (847) 925-1329, avmainfo@avma. org, http://www.avma.org.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (404) 639-3534, 800-CDC-INFO (800-232-4636), TTY: (888) 232-6348, inquiry@cdc.gov, http://www.cdc.gov.

World Health Organization, Avenue Appia 20, 1211 Geneva 27, Switzerland, +22 41 791 21 11, +22 41 791 31 11, info@who.int, http://www.who.int.

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Black death *see* **Plague**

Black lung disease

Definition

Black lung disease is the common name for coal workers' pneumoconiosis (CWP) or anthracosis, a lung disease of older workers in the coal industry caused

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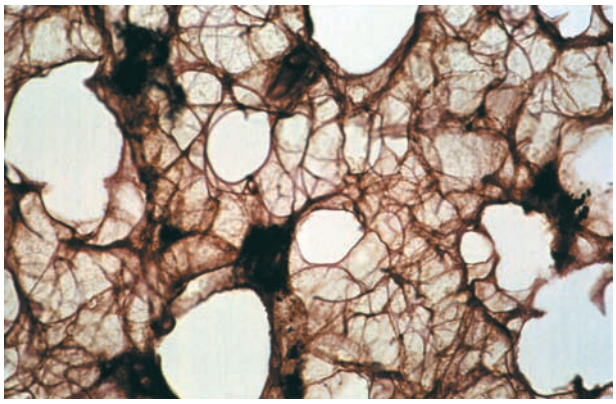

A light micrograph of a human lung containing particles of inspired coal dust (anthracosis). The black masses shown are groups of coal dust particles. *(Astrid & Hanns-Frieder Michler/Photo Researchers, Inc.)*

by inhalation, over many years, of small amounts of coal dust.

Description

The risk of having black lung disease is directly related to the amount of dust inhaled over the years; the disease typically affects workers over age 50. Its common name comes from the fact that the inhalation of heavy deposits of coal dust makes miners lungs look black instead of a healthy pink. Although people who live in cities often have some black deposits in their lungs from polluted air, coal miners have much more extensive deposits.

In the years since the federal government has regulated dust levels in coal mines, the number of cases of black lung disease has fallen sharply. Since the Federal Coal Mine Health and Safety Act of 1969, average dust levels have fallen from 8.0 mg per cubic meter to the current standard of 2.0 mg per cubic meter. The 1969 law also set up a black lung disability benefits program to compensate coal miners who have been disabled by on-the-job dust exposure.

Despite the technology available to control the hazard, however, miners still run the risk of developing this lung disease. The risk is much lower today, however; fewer than 10% of coal miners have any x ray evidence of coal dust deposits. When there is such evidence, it often shows up as only small black spots less than 0.4 in. (1 cm) in diameter, and may have been caused by **smoking** rather than coal dust. This condition is called "simple CWP" and does not lead to symptoms or disability.

Causes and symptoms

Since the particles of fine coal dust, which a miner breathes when he is in the mines, cannot be destroyed within the lungs or removed from them, they build up. Eventually, this build up causes thickening and scarring, making the lungs less efficient in supplying oxygen to the blood.

The primary symptom of the disease is **shortness of breath**, which gradually gets worse as the disease progresses. In severe cases, the patient may develop **cor pulmonale**, an enlargement and strain of the right side of the heart caused by chronic lung disease. This may eventually cause right-sided **heart failure**.

Some patients develop **emphysema** (a disease in which the tiny air sacs in the lungs become damaged, leading to shortness of breath, and respiratory and heart failure) as a complication of black lung disease. Others develop a severe type of black lung disease called progressive massive fibrosis, in which damage continues in the upper parts of the lungs even after exposure to the dust has ended. Scientists aren't sure what causes this serious complication. Some think that it may be due to the breathing of a mixture of coal and silica dust that is found in certain mines. Silica is far more likely to lead to scarring than coal dust alone.

Diagnosis

Black lung disease can be diagnosed by checking a patient's history for exposure to coal dust, followed by a chest x ray to discover if the characteristic spots in the lungs caused by coal dust are present. A pulmonary function test may aid in diagnosis.

X rays can detect black lung disease before it causes any symptoms. If exposure to the dust is stopped at that point, progression of the disease may be prevented.

Treatment

There is no treatment or cure for this condition, although it is possible to treat complications such as lung infections and cor pulmonale. Further exposure to coal dust must be stopped.

Prognosis

Those miners with simple CWP can lead a normal life. However, patients who develop black lung disease at an early age, or who have progressive massive fibrosis, have a higher risk of premature **death**.

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Prevention

The only way to prevent black lung disease is to avoid long-term exposure to coal dust. Coal mines may help prevent the condition by lowering coal dust levels and providing protective clothes to coal miners.

A light micrograph of a human lung containing particles of inspired coal dust (anthracosis). The black masses shown are groups of coal dust particles.

ORGANIZATIONS

Mine Safety and Health Administration, 4015 Wilson Blvd, Arlington, VA, 22203, (877) 778-6055, MSHAhelpdesk@dol.gov, http://www.msha.gov.

Carol A. Turkington

Bladder calculi *see* **Bladder stones**

Bladder cancer

Definition

Bladder **cancer** is a disease in which the cells lining the urinary bladder lose the ability to regulate their growth and start dividing uncontrollably. This abnormal growth results in a mass of cells that form a tumor. The most common type of bladder cancer diagnosed in the United States is urothelial bladder cancer, which in the past was classified as transitional cell carcinoma of the bladder.

Demographics

Bladder cancer is the fourth most commonly diagnosed cancer in men and the tenth most common cancer diagnosed in women in the United States. In 2009, the American Cancer Society (ACS) estimated that approximately 70,980 new cases of bladder cancer would be diagnosed (about 52,810 men and 18,170 women), causing approximately 14,330 deaths. The mortality rate for bladder cancer has declined since the 1990s. Greater than 90% of cases are diagnosed in individuals 55 years of age and older.

The rates for bladder cancer in men of African descent and Hispanic men are similar and are approximately one-half of the rate among white non-Hispanic men. The lowest rate of bladder cancer occurs in the Asian population. Among women, the highest rates also occur in white non-Hispanic females and are approximately twice the rate for Hispanics. Women of African descent have higher rates of bladder cancer than Hispanic women. Although blacks are diagnosed with bladder cancer less frequently than whites, their cancers are often diagnosed in later stages resulting in a poorer overall prognosis.

Approximately 75% of patients are diagnosed with bladder cancer that is confined to the bladder. Only 3% are diagnosed with bladder cancer that has spread to distant sites in the body at the time of diagnosis.

Description

The urinary bladder is a hollow muscular organ that stores urine from the kidneys until it is excreted out of the body. Two tubes called the ureters bring the urine from the kidneys to the bladder. The urethra carries the urine from the bladder to the outside of the body.

Bladder cancer has a very high rate of recurrence. Even after superficial tumors are completely removed, there is a 75% chance new tumors will develop in other areas of the bladder. Hence, patients need frequent and thorough follow-up care.

Risk factors

Smoking is considered the greatest risk factor for this type of cancer and by some estimates accounts for about 50% of all bladder cancers. Workers who are exposed to certain chemicals used in the dye industry and in the rubber, leather, textile, and paint industries are believed to be at a higher risk for bladder cancer. The disease also is three times more common in men than in women; Caucasians also are at an increased risk. The risk of bladder cancer increases with age. Most cases are found in people who are 50–70 years old.

Frequent urinary infections, kidney and **bladder stones**, and other conditions that cause long-term irritation to the bladder may increase the risk of getting bladder cancer. For example, individuals with spinal cord injuries requiring in-dwelling urinary catheters have a 16 to 20 times increased risk of developing bladder cancer. A past history of tumors in the bladder also could increase one's risk of getting other tumors.

Patients who have been previously treated with the cancer **chemotherapy** drug cyclophosphamide are at increased risk as are those who have been previously treated with radiation to the pelvis.

Several genetic mutations are associated with bladder cancer. Although heredity is not typically linked

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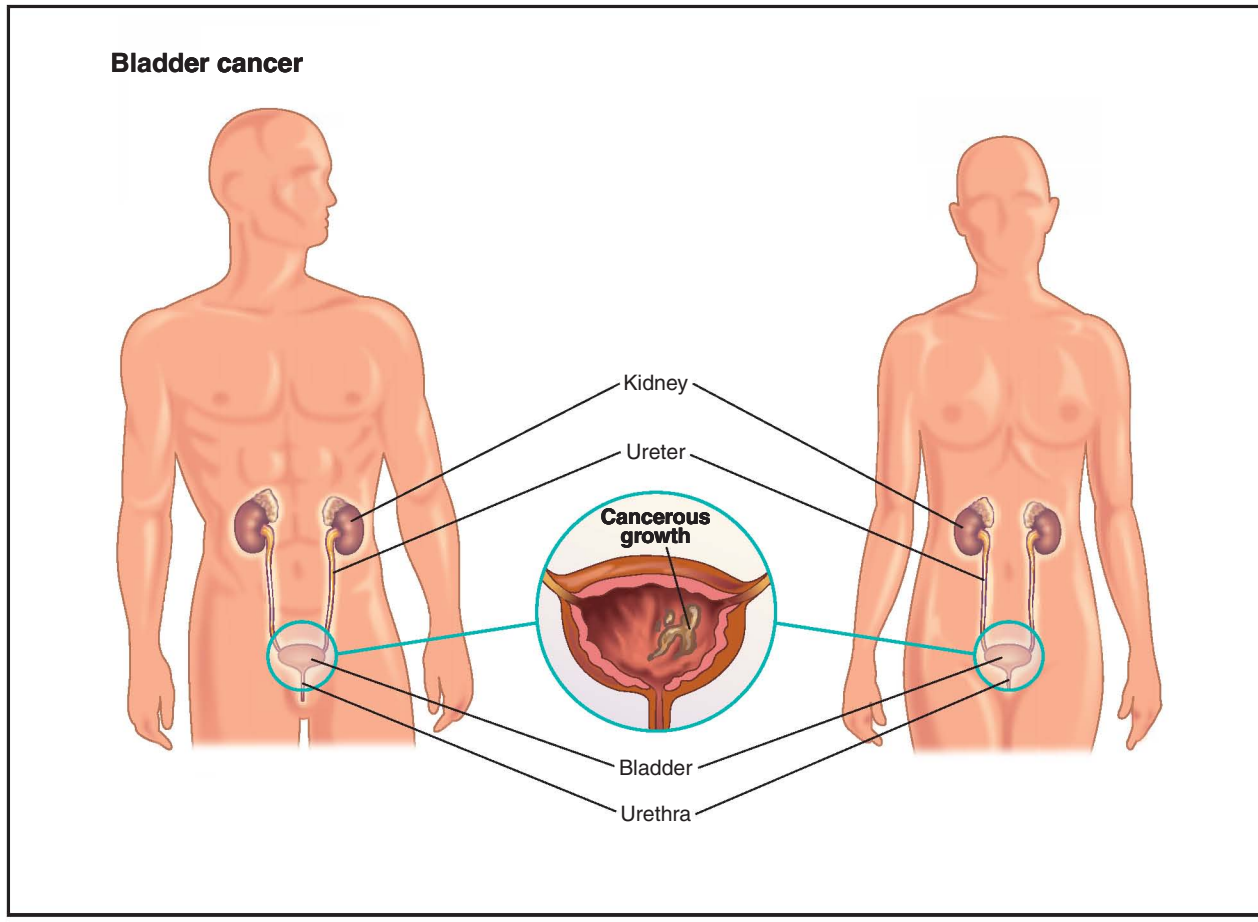

The urinary systems of a man and a woman, illustrating bladder cancer on the inner lining of the bladder. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

with the development of this type of cancer, familial clusters of bladder cancer have been identified.

Causes and symptoms

The exact cause of bladder cancer is not known, but smokers are twice as likely as nonsmokers to get the disease.

One of the first warning signals of bladder cancer is blood in the urine, which is reported by 80% of patients. This change in the urine is not typically associated with any **pain**. Sometimes, there is enough blood to change the color of the urine to a yellow-red or a dark red. At other times, the color of the urine appears normal but chemical testing of the urine reveals the presence of blood cells. A change in bladder habits such as painful urination, increased frequency of urination and a feeling of needing to urinate but not being able to do so are some of the signs of possible bladder cancer. All of these symptoms may be caused by conditions other than cancer, but it is important to see a doctor and have the symptoms evaluated. When detected early and treated appropriately, patients have a very good chance of being cured completely.

Symptoms associated with advanced bladder cancer may include flank, back, and/or pelvic pain and **edema** in the lower extremities.

Diagnosis

Examination

If a doctor has any reason to suspect bladder cancer, several tests can help find out if the disease is present. As a first step, a complete medical history will be taken to check for any risk factors. A thorough **physical examination** will be conducted to assess all the signs and symptoms.

Tests

Laboratory testing of a urine sample helps to rule out the presence of a bacterial infection. In a urine

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KEY TERMS

Cystectomy—Surgical removal of the bladder.

Cystoscopy—A diagnostic procedure that uses a cystoscope to look inside the bladder and to collect samples of urine and tissue.

Immunotherapy—A form of treatment that targets specific cells in the body's immune system to disrupt the growth of a cancer.

Urostomy—A surgical opening (a stoma) created to divert urine to the outside of the body for collection once the bladder has been removed.

cytology test, the urine is examined under a microscope to look for any abnormal or cancerous cells.

Procedures

A catheter (tube) is sometimes advanced into the bladder through the urethra, and a salt solution is passed through it to wash the bladder. The solution is collected and examined under a microscope to check for the presence of cancerous cells.

Another procedure, known as the intravenous pyelogram (IVP), is an x-ray examination that is done after a dye is injected into the bloodstream through a vein in the arm. The dye travels through the bloodstream and then reaches the kidneys to be excreted. It clearly outlines the kidneys, ureters, bladder, and urethra. Multiple x rays are taken to detect any abnormality in the lining of these organs. In addition to the IVP, a renal ultrasound may be used in the diagnosis of bladder cancer.

A procedure known as a **cystoscopy** may be used to view the inside of the bladder. A thin, hollow, lighted tube is introduced into the bladder through the urethra. If any suspicious looking masses are seen, a small piece of the tissue can be removed from it using a pair of biopsy forceps. The tissue is then examined microscopically to verify if cancer is present, and if so, to identify the type of cancer.

If cancer is detected and there is evidence to indicate that it has metastasized (spread) to distant sites in the body, imaging tests such as chest x rays, **computed tomography scans** (CT), and **magnetic resonance imaging** (MRI) may be done to determine which organs are affected. Bladder cancer generally tends to spread to the lungs, liver, and bone.

Treatment

Treatment for bladder cancer depends on the stage of the tumor; specifically, whether the tumor has invaded the muscle wall of the bladder. The patient's medical history, overall health status, and personal preferences are taken into account when deciding on an appropriate treatment plan.

Traditional

Cystectomy, surgical removal of the bladder, may be used to treat cases of non-invasive and muscle-wall invasive cancers. In non-muscle invasive disease cystectomy may be performed if the tumor is an aggressive type that tends to recur despite treatment with BCG. A 90% survival rate can be attained in this group of patients if the cystectomy is done prior to progression of the tumor to the muscle wall. The 5-year survival rate after cystectomy drops by 30–40% once the muscle wall has been invaded by tumor. Surgery may also be recommended for patients with large superficial tumors that cannot be surgically removed, those with prostatic urethral involvement, and for patients who did not respond to BCG therapy.

In patients with muscle-invasive disease, surgery is done to remove the bladder, prostate, and pelvic lymph nodes in men. In women, the bladder, urethra, uterus, ovaries, anterior vaginal wall, and pelvic lymph nodes may be removed.

If the entire urinary bladder is removed, an alternate place must be created for the urine to be stored before it is excreted out of the body. To do this, a piece of intestine is converted into a small bag and attached to the ureters. This is then connected to an opening (stoma) that is made in the abdominal wall. The procedure is called a urostomy or a urinary diversion. In some urostomy procedures, the urine from the intestinal sac is routed into a bag that is placed over the stoma in the abdominal wall. The bag is hidden by the clothing and has to be emptied occasionally by the patient. In a different procedure, the urine is collected in the intestinal sac, but there is no bag on the outside of the abdomen. The intestinal sac has to be emptied by the patient, by placing a drainage tube through the stoma.

External beam **radiation therapy** as a primary therapy is not as effective as cystectomy in the treatment of bladder cancer. For disease confined to the bladder, the 5-year survival rate after cystectomy is 90% compared to a 5-year survival rate of 20–40% for patients treated with external beam radiation.

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Drugs

Modalities used to treat non-muscle invasive bladder cancer include instilling Bacillus Calmette-Guerin (BCG) immunotherapy directly into the bladder and/or instilling chemotherapy agents such as Thiotepa, mitomycin-C, doxorubicin, and/or epirubicin directly into the bladder. Recommendations for the treatment of muscle-invasive bladder cancer include administration of adjuvant and neoadjuvant chemotherapy. Common chemotherapy agents used are methotrexate, vinblastine, doxorubicin, and cisplatin (MVAC regimen). Metastatic bladder cancer can also be treated with the MVAC chemotherapy regimen. A newer regimen that uses the chemotherapy drugs gemcitabine and cisplatin (GC) has proved to be just as effective as the MVAC regimen in the treatment of metastatic bladder cancer and is now considered a first-line treatment option.

Prognosis

When detected in early stages, the prognosis for those with bladder cancer is excellent. At least 90% of people diagnosed with non-muscle invasive bladder cancer survive five years or more after initial diagnosis. However, if the disease has spread to the nearby tissues, the survival rate drops. Once the cancer has metastasized to distant organs such as the lung and liver, only 5% of patients survive two years or more. As newer treatment methods are developed, some prognoses improve.

Non-muscle invasive bladder cancers have a high rate of recurrence and progression. Careful follow-up and surveillance is of critical importance and includes cystoscopy and bladder wash cytology every three months for two years, then every six months for two years, followed by a minimum of once yearly.

Prevention

Since the exact causes of bladder cancer are not known, there is no certain way to prevent it. Avoiding risk factors whenever possible is the best alternative.

Since smoking doubles one's risk of getting bladder cancer, avoiding tobacco may prevent at least half the deaths that result from bladder cancer. Taking appropriate safety precautions when working with organic cancer-causing chemicals is another way of preventing the disease.

If a person has had a history of bladder cancer, or has been exposed to cancer-causing chemicals, he or she is considered to be at an increased risk of getting bladder cancer. Similarly, **kidney stones**, frequent urinary infections, and other conditions that cause long-term irritation to the bladder also increase the chance of getting the disease.

Resources

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ORGANIZATIONS

American Cancer Society, 250 Williams Street, Suite 400, Atlanta, GA, 30303, (800) 227-2345, http://www.cancer.org.

American Urological Association Foundation, 1000 Corporate Boulevard, Linthium, MD, 21090, (800) 828-7866, (410) 689-3700.

Cancer Research Institute, One Exchange Plaza 55 Broadway, Suite 1802, New York, NY, 10006, (800) 992-2623, http://www.cancerresearch.org.

National Cancer Institute, NCI Office of Communications and Education, Public Inquiries Office, 6116 Executive Boulevard, Suite 300, Bethesda, MD, 20892-8322, (800) 422-6237, http://www.cancer.gov.

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Bladder removal *see* **Cystectomy**

Bladder resection *see* **Transurethral bladder resection**

Bladder stones

Definition

Bladder stones are crystalline masses that form from the **minerals** and proteins that naturally occur in urine. These types of stones are much less common than **kidney stones**.

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Description

Bladder stones can form anywhere in the urinary tract before depositing in the bladder. They begin as tiny granules about the size of a grain of sand, but they can grow to more than an inch in diameter. These stones can block the flow of urine causing **pain** and difficulty with urination. They can also scratch the bladder wall, which may lead to bleeding or infection.

Causes and symptoms

While the exact causes of the formation of bladder stones are not completely understood, bladder stones usually occur because of **urinary tract infection** (UTI), obstruction of the urinary tract, enlargement of the prostate gland in men, or the presence of foreign bodies in the urinary tract. Diet and the amount of fluid intake also appear to be important factors in the development of bladder stones.

Ninety-five percent of all bladder stones occur in men, most of whom have an **enlarged prostate** gland or a UTI. These stones are rarely seen in children or in African Americans. People with **gout** may develop bladder stones composed almost entirely of uric acid.

The symptoms of bladder stones may become evident when the wall of the bladder is scratched or when the urinary tract becomes obstructed by the stone. These symptoms include:

- abnormally dark colored urine
- blood in the urine
- difficulty urinating
- frequent urge to urinate
- lower abdominal pain
- pain or discomfort in the penis

Some people with bladder stones also may experience an inability to control urination (**urinary incontinence**).

Diagnosis

The diagnosis of bladder stones is usually made after a **physical examination**, which may include a **rectal examination** to check for enlargement of the prostate gland. Urine tests are then used to determine if there is blood or indications of an UTI in the urine. If bladder stones are suspected, bladder or pelvic x rays may be ordered. Stones that are large enough to cause problems with urinary function are almost always detectable by x ray.

Treatment

Many bladder stones can be passed out of the body in the urine. People with small bladder stones will be asked to increase their fluid intakes to at least six to eight eight-ounce glasses of water per day to increase urinary output. If the stones do not pass after two weeks, or if the patient's symptoms become worse, further medical treatment may be required.

A large bladder stone, or small stone that the patient cannot pass in the urine, may be broken up into smaller stones using ultrasound (shock waves). These smaller stones may then pass in the urine. Stones that cannot be broken into pieces by these methods, or that the patient cannot pass, may have to be surgically removed.

Alternative treatment

Traditional herbal remedies for bladder stones include celery seed and horsetail. Also, because incomplete bladder emptying may cause bladder stones, many patients may benefit from methods and remedies aimed at improving overall bladder function. These include Kegel exercises, which are used to strengthen the muscles involved in urination; herbal supplements (cornsilk, hydrangea, juniper berries, parsley, and uva ursi) used to increase urine flow and flush out sediment from the bladder; and the consumption of cranberry juice and/or fresh, unsweetened lemon juice. Cranberry juice helps to control urinary tract infection and contains a chemical that coats the walls of the bladder, making them more resistant to infection. Lemon juice helps to flush out the urinary system.

Prognosis

Most bladder stones can be, and are, passed out of the body in the urine without any permanent damage to the bladder or the rest of the urinary tract. However, most bladder stones arise from an underlying medical condition. Therefore, if this medical condition is not corrected approximately half of all patients will experience a recurrence of bladder stones within five years.

Prevention

Bladder stones may, in some cases, be prevented by the patient receiving prompt medical treatment for an enlarged prostate gland or UTI. The consumption of at least six to eight eight-ounce glasses of water per day and/or the regular consumption of cranberry juice may help to prevent recurrences of bladder stones.

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Resources

OTHER

"Bladder Stones." MedlinePlus. http://www.nlm.nih.gov/medlineplus/ency/article/001275.htm (accessed November 22, 2010).

ORGANIZATIONS

American Urological Association Foundation, 1000 Corporate Blvd., Linthicum, MD, 21090, (410) 689-3700, (410) 689-3800, (866) 746-4282, auafoundation@auafoundation.org, http://www.urologyhealth.org/.

Paul A. Johnson, Ed.M.

Bladder training

Definition

Bladder training is a behavioral modification treatment technique for **urinary incontinence** that involves placing a patient on a toileting schedule. The time interval between urination is gradually increased in order to train the patient to remain continent.

Purpose

Bladder training is used to treat urinary urge incontinence. Urge incontinence occurs when an individual feels a sudden need to urinate and cannot control the urge to do so and, as a consequence, involuntarily loses urine before making it to the toilet.

Precautions

Incontinence may be controlled through a number of invasive and non-invasive treatment options, including Kegel exercises, **biofeedback**, bladder training, medication, insertable incontinence devices, and surgery. Each patient should undergo a full diagnostic work-up to determine the type and cause of the incontinence in order to determine the best course of treatment.

Description

Bladder training may be prescribed and implemented by a general physician, urologist, or urogynecologist. A urination schedule is created for the patient. The schedule typically starts out with fairly short intervals between bathroom breaks (e.g., an hour). As soon as the patient is able to consistently remain continent for several days at a certain toileting time interval, the time span is increased. Bladder training continues until the patient regularly achieves continence at a time interval he/she feels comfortable with.

Preparation

A complete evaluation to determine the cause of urinary incontinence is critical to proper treatment. A thorough medical history and **physical examination** should be performed on patients considering bladder training. Diagnostic testing may include x rays, ultrasound, urine tests, and a physical examination of the pelvis. It may include a series of exams called urodynamic testing that measure bladder pressure and capacity and the urinary flow. The patient may also be asked to keep a diary of their urination output and frequency and episodes of incontinence over a period of several days or a week.

Risks

Bladder training may not be successful in all patients with urge incontinence. Patients who demonstrate a strong desire to control their continence and are committed to sticking with a training program tend to have the most success with bladder training.

Normal results

Patients who undergo successful bladder training gain complete or improved control over their urination. In some cases, additional alternate treatment such as biofeedback or pelvic muscle exercises may be recommended to supplement the progress made with bladder training.

ORGANIZATIONS

American Urological Association Foundation, 1000 Corporate Blvd., Linthicum, MD, 21090, (410) 689-3700, (410) 689-3800, (866) 746-4282, auafoundation@auafoundation.org, http://www.urologyhealth.org/.

National Association for Continence, P.O. Box 1019, Charleston, SC, 29402-1019, (843) 377-0900, (843) 377-0905, (800) 252-3337, memberservices@nafc.org, http://www.nafc.org.

Paula Anne Ford-Martin

Blastomyces dermatitidis see **Blastomycosis**

Blastomycosis

Definition

Blastomycosis is an infection caused by inhaling microscopic particles (spores) produced by the fungus *Blastomyces dermatitidis*. Blastomycosis may be limited to the lungs or also involve the skin and bones. In its

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Blastomycosis is usually attributed to contact with yeast-like fungi. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

most severe form, the infection can spread throughout the body and involve many organ systems (systemic).

Description

Blastomycosis is a fungal infection caused by *Blastomyces dermatitidis*. Although primarily an airborne disease, farmers and gardeners may become infected from contact with spores in the soil through cuts and scrapes. The fungus that causes the disease is found in moist soil and wood in the southeastern United States, the Mississippi River valley, southern Canada, and Central America. Blastomycosis is also called Gilchrist's disease, Chicago disease, or North American blastomycosis. Another South and Central American disease, paracoccidioidomycosis, is sometimes called **South American blastomycosis**, but despite the similar name, this disease is substantially different from North American blastomycosis. Canine blastomycosis, a common dog disease, is caused by the same fungus that infects humans. However, people do not get this disease from their dogs except only very rarely through dog **bites**.

Blastomycosis is a rare disease infecting only about 4 in every 100,000 people. It is at least six times more common in men than in women and tends to more often infect children and individuals in the 30–50-year-old age group. People who have **diabetes mellitus** or who are taking drugs that suppress the immune system (immunocompromised) are more likely to develop blastomycosis. Although people with **AIDS** can get blastomycosis because of their weakened immune system, blastomycosis has not been one of the more common fungal infections associated with AIDS.

Causes and symptoms

Once inhaled, the spores of *B. dermatitidis* can lodge in the lungs and cause a localized inflammation. This is known as primary pulmonary blastomycosis. The disease does not spread from one person to another. In the early stages, symptoms may include a dry **cough**, **fever**, heavy sweating, **fatigue**, and a general feeling of ill health. In approximately 25% of blastomycosis cases, only the lungs are affected. As the disease progresses, small lesions form in the lungs causing the air sacs deep within the lungs (alveoli) to break down and form small cavities.

In another 35%, the disease involves both the lungs and the skin. Bumps develop on the skin, gradually becoming small, white, crusted blisters filled with pus. The blisters break open, creating abscesses that do not heal. Approximately 19% of infected people have skin sores without infection in the lungs.

The remaining approximately 20% of the infected population has blastomycosis that has spread or disseminated to other systems of the body. Symptoms may include **pain** and lesions on one or more bones, the male genitalia, and/or parts of the central nervous system. The liver, spleen, lymph nodes, heart, adrenal glands, and digestive system may also be infected.

Diagnosis

A positive diagnosis of blastomycosis is made when the fungus *B. dermatitidis* is identified by direct microscopic examination of body fluids such as sputum and prostate fluid or in tissue samples (biopsies) from the lung or skin. Another way to diagnose blastomycosis is to culture and isolate the fungus from a sample of sputum. Chest x rays are used to assess lung damage, but alone cannot lead to a definitive diagnosis of blastomycosis because any damage caused by other diseases, such as by **pneumonia** or **tuberculosis**, may appear on the x ray. Because its symptoms vary widely, blastomycosis is often misdiagnosed.

Treatment

Blastomycosis must be treated or it will gradually lead to **death**. Treatment with the fungicidal drug ketoconazole (Nizoral) taken orally is effective in about 75% of patients. Amphotericin B (Fungizone) given intravenously is also very effective, but it has more toxic side effects than ketoconazole. Treatment with amphotericin B usually requires hospitalization, and the patient may also receive other drugs to minimize its side effects.

Alternative treatment

Alternative treatment for fungal infections focuses on creating an internal environment where the fungus cannot survive. This is accomplished by eating a diet low

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in dairy products; sugars, including honey and fruit juice; and foods like beer that contain yeast. This is complemented by a diet consisting, in large part, of uncooked and unprocessed foods. Supplements of **vitamins** C, E, A-plus, and B complex may also be useful. *Lactobacillus acidophilus* and *Bifidobacterium* will replenish the good bacteria in the intestines. Some antifungal herbs, like garlic (*Allium sativum*), can be consumed in relatively large doses and for an extended period of time in order to increase effectiveness. A variety of antifungal herbs such as myrrh (*Commiphora molmol*), tea tree oil (*Melaleuca* spp.), citrus seed extract, pau d'arco tea (*Tabebuia impetiginosa*), and garlic may also be applied directly to the infected skin.

Prognosis

Left untreated, blastomycosis gradually leads to death. When treated, however, patients begin to improve within one week and, with intensive treatment, may be cured within several weeks. The highest rate of recovery is among patients who only have **skin lesions**. People with the disseminated form of the disease are least likely to be cured and most likely to suffer a relapse.

Prevention

Because the fungus that causes blastomycosis is airborne and microscopic, the only form of prevention is to avoid visiting areas where it is found in the soil. For many people this is impractical. Since the disease is rare, people who maintain general good health do not need to worry much about infection.

ORGANIZATIONS

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923, (800) 999-6673, http://www.rarediseases.org.

Tish Davidson, A.M.

Bleeding disorders *see* **Coagulation disorders**

Bleeding time

Definition

Bleeding time is a crude test of hemostasis (the arrest or stopping of bleeding). It indicates how well platelets interact with blood vessel walls to form **blood clots**.

Purpose

Bleeding time is used most often to detect qualitative defects of platelets, such as Von Willebrand's disease. The test helps identify people who have defects in their platelet function. This is the ability of blood to clot following a wound or trauma. Normally, platelets interact with the walls of blood vessels to cause a blood clot. There are many factors in the clotting mechanism, and they are initiated by platelets. The bleeding time test is usually used on patients who have a history of prolonged bleeding after cuts, or who have a family history of bleeding disorders. Also, the bleeding time test is sometimes performed as a preoperative test to determine a patient's likely bleeding response during and after surgery. However, in patients with no history of bleeding problems, or who are not taking anti-inflammatory drugs, the bleeding time test is not usually necessary.

Precautions

Before administering the test, patients should be questioned about what medications they may be taking. Some medications will adversely affect the results of the bleeding time test. These medications include anticoagulants, **diuretics**, **anticancer drugs**, **sulfonamides**, thiazide, **aspirin** and aspirin-containing preparations, and **nonsteroidal anti-inflammatory drugs**. The test may also be affected by anemia (a deficiency in red blood cells). Since the taking of aspirin or related drugs are the most common cause of prolonged bleeding time, no aspirin should be taken two weeks prior to the test.

Description

There are four methods to perform the bleeding test. The Ivy method is the traditional format for this test. In the Ivy method, a blood pressure cuff is placed on the upper arm and inflated to 40 mM Hg. A lancet or scalpel blade is used to make a stab wound on the underside of the forearm. An automatic, spring-loaded blade device is most commonly used to make a standard-sized cut. The area stabbed is selected so that no superficial or visible veins are cut. These veins, because of their size, may have longer bleeding times, especially in people with bleeding defects. The time from when the stab wound is made until all bleeding has stopped is measured and is called the bleeding time. Every 30 seconds, filter paper or a paper towel is used to draw off the blood. The test is finished when bleeding has stopped completely.

The three other methods of performing the bleeding test are the template, modified template, and Duke methods. The template and modified template methods

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are variations of the Ivy method. A blood pressure cuff is used and the skin on the forearm prepared as in the Ivy method. A template is placed over the area to be stabbed and two incisions are made in the forearm using the template as a location guide. The main difference between the template and the modified method is the length of the cut made.

For the Duke method, a nick is made in an ear lobe or a fingertip is pricked to cause bleeding. As in the Ivy method, the test is timed from the start of bleeding until bleeding is completely stopped. The disadvantage to the Duke method is that the pressure on the blood veins in the stab area is not constant and the results achieved are less reliable. The advantage to the Duke method is that no scar remains after the test. The other methods may result in a tiny, hairline scar where the wound was made. However, this is largely a cosmetic concern.

Preparation

There is no special preparation required of the patient for this test. The area to be stabbed should be wiped clean with an alcohol pad. The alcohol should be left on the skin long enough for it to kill bacteria at the wound site. The alcohol must be removed before stabbing the arm because alcohol will adversely affect the tests results by inhibiting clotting.

Aftercare

If a prolonged bleeding time is caused by unknown factors or diseases, further testing is required to identify the exact cause of the bleeding problem.

Normal results

A normal bleeding time for the Ivy method is less than five minutes from the time of the stab until all bleeding from the wound stops. Some texts extend the normal range to eight minutes. Normal values for the template method range up to eight minutes, while for the modified template methods, up to 10 minutes is considered normal. Normal for the Duke method is three minutes.

Abnormal results

A bleeding time that is longer than normal is an abnormal result. The test should be stopped if the patient hasn't stopped bleeding by 20–30 minutes. Bleeding time is longer when the normal function of platelets is impaired, or there is a lower-than-normal number of platelets in the blood.

A longer-than-normal bleeding time can indicate that one of several defects in hemostasis is present, including severe **thrombocytopenia**, platelet dysfunction, vascular defects, Von Willebrand's disease, or other abnormalities.

Resources

BOOKS

McPherson, Richard A., Matthew R. Pincus, and John Bernard Henry. *Henry's Clinical Diagnosis and Management by Laboratory Methods*. Philadelphia: Saunders/Elsevier, 2007.

John T. Lohr, PhD

Bleeding varices

Definition

Bleeding varices are bleeding, dilated (swollen) veins in the esophagus (gullet), or the upper part of the stomach, caused by **liver disease**.

Description

Engorged veins are called varices (plural of varix). Varices may occur in the lining of the esophagus (the tube that connects the mouth to the stomach) or in the upper part of the stomach. Such varices are called esophageal varices. These varices are fragile and can bleed easily because veins are not designed to handle high internal pressures.

Causes and symptoms

Liver disease often causes an increase in the blood pressure in the main veins that carry blood from the stomach and intestines to the liver (portal veins). As the pressure in the portal veins increases, the veins of the stomach and esophagus swell, until they eventually become varices. Bleeding varices are a life-threatening complication of this increase in blood pressure (portal **hypertension**). The most common cause of bleeding varices is **cirrhosis** of the liver caused by chronic alcohol abuse or hepatitis. Bleeding varices occur in approximately one in every 10,000 people.

Symptoms of bleeding varices include:

- vomiting blood, sometimes in massive amounts
- black, tarry stools
- decreased urine output
- excessive thirst
- nausea
- vomiting

If bleeding from the varices is severe, a patient may go into **shock** from the loss of blood, characterized by pallor, a rapid and weak pulse, rapid and shallow respiration, and lowered systemic blood pressure.

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Diagnosis

Bleeding varices may be suspected in a patient who has any of the above-mentioned symptoms, and who has either been diagnosed with cirrhosis of the liver or who has a history of prolonged alcohol abuse. The definitive diagnosis is established via a specialized type of **endoscopy**, namely, **esophagogastroduodenoscopy** (EGD), a procedure that involves the visual examination of the lining of the esophagus, stomach, and upper duodenum with a flexible fiberoptic endoscope.

Treatment

The objective during treatment of bleeding varices is to stop and/or prevent bleeding and to restore/maintain normal blood circulation throughout the body. Patients with severe bleeding should be treated in intensive care since uncontrolled bleeding can lead to **death**.

Initial treatment of bleeding varices begins with standard resuscitation, including intravenous fluids and blood transfusions as needed. Definitive treatment is usually endoscopic, with the endoscope used to locate the sites of the bleeding. An instrument, inserted along with the endoscope, is used either to inject these sites with a clotting agent or to tie off the bleeding sites with tiny rubber bands.

Repeated endoscopic treatments (usually four to six) are generally required to eliminate the varices and to prevent the recurrence of bleeding. These endoscopic techniques are successful in about 90 percent of cases.

Patients who cannot be treated endoscopically may be considered for an alternative procedure called TIPS (transjugular intrahepatic portosystemic shunt). This procedure involves placing a hollow metal tube (shunt) in the liver connecting the portal veins with the hepatic veins (veins that leave the liver and drain to the heart). This shunt lowers the pressure in the portal veins and prevents bleeding and portal hypertension. The TIPS procedure is performed by a radiologist and has become an accepted method for reducing portal vein pressure since 1992. Although the procedure continues to evolve, TIPS can routinely be created in more than 93% of patients.

Medications aimed at controlling bleeding may also be prescribed. These include propanolol, vasopressin, octreotide acetate, and isosorbide mononitrate.

Alternative treatment

Some alternative treatments are aimed at preventing the cirrhosis of the liver that often causes bleeding varices, and most are effective. However, once a patient has reached the bleeding varice stage, standard intervention to stop the bleeding is required or the patient may die.

Prognosis

Bleeding varices represent one of the most feared complications of portal hypertension. They contribute to the estimated 32,000 deaths per year attributed to cirrhosis. Half or more of patients who survive episodes of bleeding varices are at risk of renewed esophageal bleeding during the first one to two years. The risk of recurrence can be lowered by endoscopic and drug treatment. Prognosis is usually more related to the underlying liver disease. Approximately 30 to 50 percent of people with bleeding varices will die from this condition within the six weeks of the first bleeding episode.

Prevention

The best way to possibly prevent the development or recurrence of bleeding varices is to eliminate the risk factors for cirrhosis of the liver. The most common cause of cirrhosis is prolonged alcohol abuse, and alcohol consumption must be completely eliminated. People with **hepatitis B** or **hepatitis C** also have an increased risk of developing cirrhosis of the liver. **Vaccination** against hepatitis B and avoidance of intravenous drug usage reduce the risk of contracting hepatitis.

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ORGANIZATIONS

American Liver Foundation, 75 Maiden Lane, Suite 603, New York, NY, 10038, (212) 668-1000, (212) 483-8179, http://www.liverfoundation.org/.

Paul A. Johnson, Ed.M.

Blepharitis *see* **Eyelid disorders**

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Blepharoplasty

Definition

Blepharoplasty is a cosmetic surgical procedure that removes fat deposits, excess tissue, or muscle from the eyelids to improve the appearance of the eyes.

Purpose

The primary use of blepharoplasty is for improving the cosmetic appearance of the eyes. In some older patients, however, sagging and excess skin surrounding the eyes can be so extensive that it limits the range of vision. In those cases, blepharoplasty serves a more functional purpose.

Precautions

Before performing blepharoplasty, the surgeon will assess whether the patient is a good candidate for the treatment. A good medical history is important. The surgeon will want to know about any history of thyroid disease, **hypertension**, or eye problems, which may increase the risk of complications.

Description

Blepharoplasty can be performed on the upper or lower eyelid; it can involve the removal of excess skin and fat deposits and the tightening of selected muscles surrounding the eyelids. The goal is to provide a more youthful appearance.

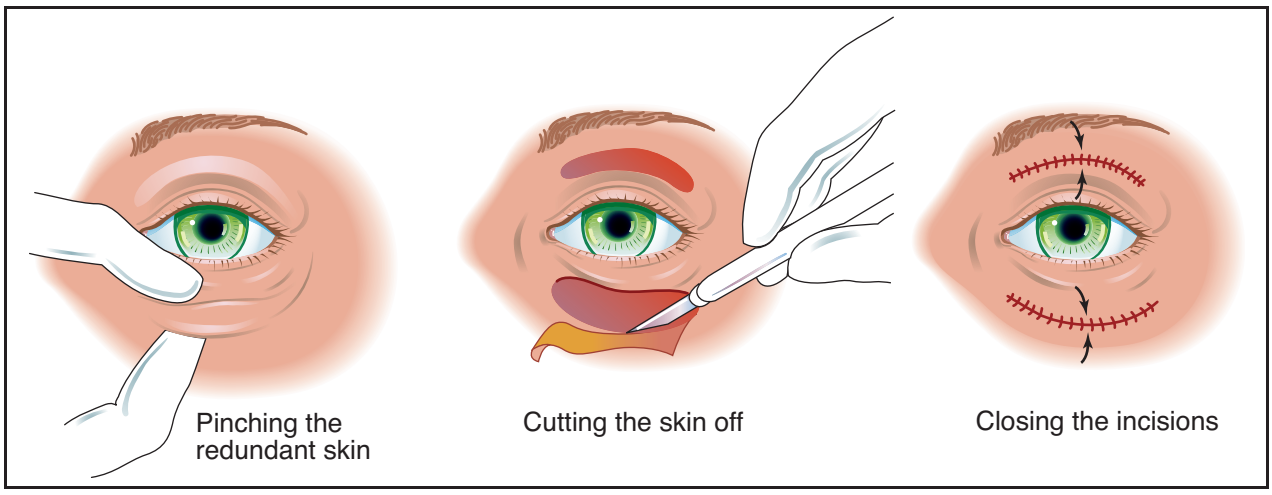
The surgeon will begin by deciding whether excess skin, fat deposits, or muscle looseness are at fault. While the patient is sitting upright, the surgeon will mark on the skin where incisions will be made. Care will be taken to hide the incision lines in the natural skin folds above and below the eye. The patient then receives injections of a local anesthetic to numb the **pain**. Many surgeons also give the patient a sedative intravenously during the procedure.

After a small, crescent-shaped section of eyelid skin is removed, the surgeon will work to tease out small pockets of fat that have collected in the lids. If muscle looseness is also a problem, the surgeon may trim tissue or add a stitch to pull it tighter. Then the incision is closed with stitches.

In some patients, fat deposits in the lower eyelid may be the only or primary problem. Such patients may be good candidates for transconjunctival blepharoplasty. In this procedure the surgeon makes no incision on the surface of the eyelid, but instead enters from behind to tease out the fat deposits from a small incision. The advantage of this procedure is that there is no visible scar.

Preparation

Prior to surgery, patients meet with their surgeon to discuss the procedure, clarify the results that can be achieved, and discuss the potential problems that might occur. Having realistic expectations is important in any cosmetic procedure. Patients will learn, for example, that although blepharoplasty can improve the



Blepharoplasty is one of the most common cosmetic surgical procedures. The illustration above depicts a procedure to eliminate dermochalasia, or baggy skin around the eyes. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

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appearance of the eyelid, other procedures, such as a chemical peel, will be necessary to reduce the appearance of wrinkles around the eye. Some surgeons prescribe vitamin C and vitamin K for 10 days prior to surgery in the belief that this helps the healing process. Patients are also told to stop **smoking** in the weeks before and after the procedure, and to refrain from alcohol and **aspirin**.

Aftercare

An antibiotic ointment is applied to the line of stitches for several days after surgery. Patients also take an antibiotic several times a day to prevent infection. Ice-cold compresses are applied to the eyes continuously for the first day following surgery, and several times a day for the next week or so, to reduce swelling. Some swelling and discoloration around the eyes is expected with the procedure. Patients should avoid aspirin or alcoholic beverages for one week and should limit their activities, including bending, straining, and lifting. The stitches are removed a few days after surgery. Patients can generally return to their usual activities within a week to 10 days.

Risks

As with any surgical procedure, blepharoplasty can lead to infection and scarring. Good care of the wound following surgery can minimize these risks. In cases where too much skin is removed from the eyelids, the patient may have difficulty closing his eyes. Dry eye syndrome may develop, requiring the use of artificial tears to lubricate the eye. In a rare complication, called retrobulbar hematoma, a pocket of blood forms behind the eyeball.

Normal results

Most patients can expect good results from blepharoplasty, with the removal of excess eyelid skin and fat producing a more youthful appearance. Some swelling and discoloration is expected immediately following the procedure, but this clears in time. Small **scars** will be left where the surgeon has made incisions, but these generally lighten in appearance over several months, and, if placed correctly, will not be readily noticeable.

Abnormal results

As noted, if too much excess skin is removed from the upper eyelid, the patient may be unable to close his eyes completely; another surgery to correct the defect may be required. Similarly, too much skin can be removed from the lower eyelid, allowing too much of the white of the eye (the sclera) to show. In extreme cases, the lower lid may be pulled down too far, revealing the underlying tissue. Called an ectropion, this too may require a second, corrective surgery. The eye's ability to make tears may also be compromised, leading to dry eye syndrome. Dry eye syndrome is potentially dangerous; in rare cases it leads to damage to the cornea of the eye and vision loss.

ORGANIZATIONS

American Society for Dermatologic Surgery, 5550 Meadowbrook Dr., Suite 120, Rolling Meadows, IL, 60008, (847) 956-0900, (847) 956-0999, http://www.asds.net/.

American Society of Plastic Surgeons, 444 E. Algonquin Rd, Arlington Heights, IL, 60005, (847) 228-9900, http://www.plasticsurgery.org/.

Richard H. Camer

Blindness *see* **Visual impairment**

Blood-viscosity reducing drugs

Definition

Blood-viscosity reducing drugs thin blood, making it less sticky and improving blood flow.

Purpose

By improving blood flow, these drugs help relieve cramps in arms, hands, and legs caused by narrowed arteries that reduce circulation and oxygen supply. Cramps caused by periodic spasms in small arteries are called **intermittent claudication**.

These drugs are sometimes used for off-label purposes like treating **stroke**; nerve, circulation and **impotence** problems caused by diabetes; **gangrene**; **septic shock**; complications of **sickle cell disease**; and leg ulcers.

Description

Pentoxiphylline (Trental, Pentoxil) is the main blood-viscosity reducing drug. It is available only by prescription. This drug comes in extended-release tablet form.

Dried Ginko biloba extract reduces blood viscosity. It is available without prescription, but there are special precautions that need to be observed when using herbal medications.

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Recommended dosage

The usual dosage of Trental and Pentoxil for adults is 400 mg, two to three times a day, with meals. Safety of this drug has not been established in children.

Precautions

This medicine may relieve cramps caused by poor circulation, but is not a substitute for specific treatments for underlying conditions.

This medicine may take several weeks to produce noticeable results. Be sure to keep taking it as directed, even if it doesn't seem to be helping.

Smoking may worsen the conditions for which the medicine is prescribed.

Older people may be especially sensitive to the effects of this medicine, which may increase the chance of side effects.

Side effects

The most common adverse effects from this drug are **nausea and vomiting**. Other, rare side effects include allergic reactions like skin rash, swelling around the lips and mouth, and headaches.

Interactions

This drug may increase the effects of theophylline (Theo-Dur).

James Waun, MD, RPh

Blood clots

Definition

A blood clot is a thickened mass in the blood formed by tiny substances called platelets. Clots form to stop bleeding, such as at the site of a cut. Clots should not form when blood is moving through the body; when clots form inside blood vessels or when blood has a tendency to clot too much, serious health problems can occur.

Demographics

The formation of a clot in a blood vessel may result in **thrombophlebitis**. The term refers to swelling of one or more veins caused by a blood clot. Although some clots occur in the arms or small, surface blood vessels, most occur in the lower legs. When the blood clot occurs in a deep vein, it is called **deep vein thrombosis**, or DVT.

As many as 350,000 to 600,000 venous blood clots per year occur in the United States. The danger of DVT comes when pieces of the clot, known as emboli or an embolus, break off and travel through the bloodstream to the lungs. About 1 in 3 blood clots to the lungs (**pulmonary embolism**) are fatal.

Description

As soon as a blood vessel wall is damaged—by a cut or similar trauma—a series of reactions normally takes place to activate platelets to stop the bleeding. Platelets are the tiny particles in the blood released into the bone marrow that gather together and form a barrier to further bleeding. Several proteins in the body are involved in the platelets clotting process. Chief among these proteins are collagen, thrombin, and von Willebrand factor. Collagen and thrombin help platelets stick together. As platelets gather at the site of injury, they change in shape from round to spiny, releasing proteins and other substances that help catch more platelets and clotting proteins. This enlarges the plug that becomes a blood clot. Formation of blood clots also is called "coagulation."

The series of reactions that cause proteins and platelets to create blood clots also are balanced by other reactions that stop the clotting process and dissolve clots after the blood vessel has healed. If this control system fails, minor blood vessel injuries can trigger clotting throughout the body. The tendency to clot too much is called "hypercoagulation." Anytime clots form inside blood vessels, they can lead to serious complications.

A blood clot that blocks an artery to the brain can cause a **stroke**. If the clot blocks blood flow to the lungs, pulmonary **embolism** can occur. A blood clot that blocks a coronary artery can cause a **heart attack**. Certain people are at higher risk for blood clots than others; surgery, some injuries, **childbirth** and lying or sitting still for extended periods of time put people at higher risk, as do inherited disorders. Once a person has a blood clot, he or she may have to take blood-thinning drugs to prevent clots from recurring. Men and women are at similar risk for blood clots. A recent study in Austria found that men run a higher risk of recurring blood clots than women, though the reason is unknown.

Causes and symptoms

Many causes can lead to blood clots, some genetic and some environmental. An environmental cause of

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DVT is prolonged inactivity. For instance, having to sit in a car or airplane for a long period of time decreases blood flow in the lower legs. Recent studies have shown that 1% of air travelers develop blood clots, usually on long flights of five hours or more. However, one study in 2004 found that air travelers developed clots on flights as short as three hours, though they often dissolved naturally and did not lead to complications. Other environmental causes of blood clots include use of **hormone replacement therapy** to ease menopausal symptoms, **oral contraceptives** for birth control, **pregnancy** (and a childbirth within the past six weeks), recent surgery or procedures involving use of a central **venous access** catheter, and **cancer**. **Smoking** also is an important and preventable environmental risk for blood clots.

Some people are born with a higher risk for blood clots. **Hypercoagulation disorders** are genetic conditions. Usually the body doesn't produce enough of the proteins involved in the clotting process, so they cannot do their job to stop the clotting; in other cases, there is an extra protein that causes too much clotting.

There may be no symptoms of blood clots until they grow so large that they block the flow of blood through the vein. Then, symptoms may develop suddenly around the area and include:

- Pain or tenderness in the affected area.
- Warmth or redness of the skin in the affected area.
- Sudden swelling in the affected limb.

Additional symptoms may indicate serious complications of blood clots such as pulmonary embolism, stroke, and heart attack. If vein swelling or **pain** are accompanied by high **fever** or **shortness of breath**, rapid pulse, or chest pain, or other symptoms that may indicate stroke, heart attack, or pulmonary embolism, it is advised to go to an emergency room immediately.

Diagnosis

A physician will diagnose blood clots based on patient history and one of several diagnostic imaging exams. The patient's history will help determine possible risk factors that may lead to suspected blood clots. In addition to family history or known genetic disorders, the patient may mention an environmental factor such as recent air travel or use of high-risk medications.

To help get a picture of suspected clots inside the blood vessels, usually the first test of choice is an ultrasound. Doppler or duplex ultrasound uses sound waves that travel through tissue and reflect back to create images. A computer transforms the sound waves into moving images on the screen that may show the clot, as well as blood flow near the clot and any abnormalities. Ultrasound does not use x rays and is a noninvasive method. Computed tomography (CT) scans also might be used to image the blood vessels. CT scans are similar to x rays, except the images are much like cross-section slices with greater detail that can be computerized and even viewed three-dimensionally. A special dye called a contrast agent may be injected before the exam to help highlight the veins. Magnetic resonance **angiography** uses **magnetic resonance imaging** (MRI) to image the blood vessels. It also may involve injection of a contrast dye. **Venography** is less commonly used, and involves injecting a contrast and using x rays to image the veins.

Treatment

Medicines can help thin blood, making it less likely to clot. The two most common blood thinners are heparin and warfarin. Heparin works right away, keeping blood clots from growing. It usually is injected. In recent years, more physicians have been prescribing low-molecular weight heparin, purified versions of the drug that can be given with less monitoring. Warfarin (coumadin) often is used for long-term treatment of blood clots and is taken orally. Patients must work closely with their physicians to constantly monitor its effects and adjust dose if necessary. Too little warfarin can lead to clotting, but too much can thin the blood so much that causing life-threatening bleeding can occur. The same can be true of low-molecular weight heparin when used on a long-term, at-home basis.

Other treatments for blood clots include injecting clot-busting drugs directly into the clot through a catheter, or in rare instances, installation of a filter to block a clot from lodging in the lungs. Sometimes, surgery also is needed to remove a clot blocking a pelvic or abdominal vein or one that is chronic and disabling. A cardiovascular surgeon or interventional radiologist may perform balloon **angioplasty** or insert a stent to open a narrowed or damaged vessel. In an emergency situation, a drug called tissue plasminogen activator, or tPA, may be given to immediately dissolve a life-threatening blood clot to the brain or heart. In 2004, the U.S. Food and Drug Administration (FDA) approved a new, small, corklike device (called a Merci Retriever) that can be used to remove blood clots from the brains of patients who cannot receive clot-busting drugs. More recently, the FDA approved a suction device that works in much the same way, called the Penumbra device.

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KEY TERMS

Coronary arteries—The main arteries that provide blood to the heart. The coronary arteries surround the heart like a crown, coming out of the aorta, arching down over the top of the heart, and dividing into various branches. These are the arteries in which heart disease occurs.

Coronary artery disease—Also called atherosclerosis, it is a buildup of fatty matter and debris in the coronary artery wall that causes narrowing of the artery.

Embolus—An embolus is a clot that has formed in a blood vessel somewhere in the body, often in the heart. It can break away from the wall of the vessel where it was formed, travel through the circulatory system, and become wedged in the brain, causing an embolic stroke. Ischemic strokes also can be caused by the formation of a blood clot in one of the cerebral arteries (arteries supplying blood to the brain). If the clot grows large enough it will block blood flow.

Ischemia—Ischemia (is-KEY-me-a) is the term used to describe the loss of oxygen and nutrients when there is inadequate blood flow. If ischemia is left untreated, it can lead to infarction (in-FARK-shun), or cell death and tissue death in the surrounding area.

Alternative treatment

Garlic is thought to lower blood clotting potential. Less evidence suggests onions and cayenne pepper may help keep blood thin. New research from Australia adds tomato juice to the list of potential blood thinners. Subjects who drank a glass of tomato juice a day reduced their risk for DVT, stroke, and cardiovascular disease. Research has shown that a natural soy and pine product called pinokinase has been effective in controlling DVT in air travelers. Patients seeking alternative treatments for blood clots should work with certified practitioners and should inform their allopathic provider about their alternative care.

Prognosis

If detected and controlled with medications, blood clots can be safely managed. However, if the clots become dislodged and travel to an artery, they can cause nearly instant **death**. For instance, more than 600,000 people have a pulmonary embolism each year and more than 10% of them die from the embolism, most within 30 to 60 minutes after symptoms start.

Prevention

Clots may be avoided by not smoking, and by not using medications that add to the risk. Clotting can be prevented by following physician recommendations concerning medications. Sometimes, physicians will prescribe special support stockings that prevent swelling and reduce chances of DVT. When taking an air flight of six hours or longer, drinking plenty of fluids to avoid **dehydration**, avoiding tight clothing around the waist, and stretching calves every hour can help prevent DVT. It is advised that those on long flights get up and move about once an hour during the flight. If not possible, moving the legs regularly while seated by flexing the ankles, then pressing the feet against the seat in the row ahead or on the floor can help stretch the calves. A physician may advise those at high risk of DVT wear support stockings during the flight or take low-molecular weight heparin two to four hours before departure.

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ORGANIZATIONS

American Heart Association, 7272 Greenville Ave., Dallas, TX, 75231, (301) 223-2307, (800) 242-8721, http://www.americanheart.org.

Centers for Disease Control and Prevention (CDC), Division for Heart Disease and Stroke Prevention, 4770 Buford Hwy NE, Atlanta, GA, 30341-3717, http://www.cdc.gov/cholesterol/faqs.htm.

National Blood Clot Alliance, 120 White Plains Road, Suite 100, Tarrytown, NY, 10591, http://www.stoptheclot.org/contact.htm.

National Heart, Lung, and Blood Institute, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (204) 629-3246, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi.nih.gov.

Teresa G. Odle

Blood crossmatching *see* **Blood typing and crossmatching**

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Blood culture

Definition

A blood culture is done when a person has symptoms of a blood infection, also called **bacteremia**. Blood is drawn from the person one or more times and is tested in a laboratory to find and identify any microorganism present and growing in the blood. If a microorganism is found, more testing is done to determine the **antibiotics** that will be effective in treating the infection.

Purpose

Bacteremia is a serious clinical condition and can lead to **death**. To give the best chance for effective treatment and survival, a blood culture is done as soon as an infection is suspected.

Symptoms of bacteremia are **fever**, chills, mental confusion, **anxiety**, rapid heartbeat, hyperventilation, blood clotting problems, and **shock**. These symptoms are especially significant in a person who already has another illness or infection, is hospitalized, or has trouble fighting infections because of a weak immune system. Often, the blood infection results from an infection somewhere else in the body that has now spread.

Additionally, blood cultures are done to find the causes of other infections. These include bacterial **pneumonia** (an infection of the lung) and infectious **endocarditis** (an infection of the inner layer of the heart). Both of these infections leak bacteria into the blood.

After a blood infection has been diagnosed, confirmed by culture, and treated, an additional blood culture may be done to make sure the infection is gone.

Description

Culture strategies

There are many variables involved in performing a blood culture. Before the person's blood is drawn, the physician must make several decisions based on a knowledge of infections and the person's clinical condition and medical history.

Several groups of microorganisms, including bacteria, viruses, mold, and yeast, can cause blood infections. The bacteria group can be further broken down into aerobes and anaerobes. Most aerobes do not need oxygen to live. They can grow with oxygen (aerobic microbes) or without oxygen (anaerobic microbes).

Based on the clinical condition of the patient, the physician determines what group of microorganisms is likely to be causing the infection and then orders one or more specific types of blood culture, including aerobic, anaerobic, viral, or fungal (for yeasts and molds). Each specific type of culture is handled differently by the laboratory. Most blood cultures test for both aerobic and anaerobic microbes. Fungal, viral, and mycobacterial blood cultures can also be done, but are less common.

The physician must also decide how many blood cultures should be done. One culture is rarely enough, but two to three are usually adequate. Four cultures are occasionally required. Some factors influencing this decision are the specific microorganisms the physician expects to find based on the person's symptoms or previous culture results, and whether or not the person has had recent antibiotic therapy.

The time at which the cultures are to be drawn is another decision made by the physician. During most blood infections (called intermittent bacteremia) microorganisms enter the blood at various time intervals. Blood drawn randomly may miss the microorganisms. Since microorganisms enter the blood 30–90 minutes before the person's fever spikes, collecting the culture just after the fever spike offers the best likelihood of finding the microorganism. The second and third cultures may be collected at the same time, but from different places on the person, or spaced at 30-minute or one-hour intervals, as the physician chooses. During continuous bacteremia, such as infective endocarditis, microorganisms are always in the blood and the timing of culture collection is less important. Blood cultures should always be collected before antibiotic treatment has begun.

Laboratory analysis

Bacteria are the most common microorganisms found in blood infections. Laboratory analysis of a bacterial blood culture differs slightly from that of a fungal culture and significantly from that of a viral culture.

Blood is drawn from a person and put directly into a blood culture bottle containing a nutritional broth. After the laboratory receives the blood culture bottle, several processes must be completed:

- provide an environment for the bacteria to grow
- detect the growth when it occurs
- identify the bacteria that grow
- test the bacteria against certain antibiotics to determine which antibiotic will be effective

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There are several types of systems, both manual and automated, available to laboratories to carry out these processes.

The broth in the blood culture bottle is the first step in creating an environment in which bacteria will grow. It contains all the nutrients that bacteria need to grow. If the physician expects anaerobic bacteria to grow, oxygen will be kept out of the blood culture bottle; if aerobes are expected, oxygen will be allowed in the bottle.

The bottles are placed in an incubator and kept at body temperature. They are watched daily for signs of growth, including cloudiness or a color change in the broth, gas bubbles, or clumps of bacteria. When there is evidence of growth, the laboratory does a gram stain and a subculture. To do the gram stain, a drop of blood is removed from the bottle and placed on a microscope slide. The blood is allowed to dry and then is stained with purple and red stains and examined under the microscope. If bacteria are seen, the color of stain they picked up (purple or red), their shape (such as round or rectangular), and their size provide valuable clues as to what type of microorganism they are and what antibiotics might work best. To do the subculture, a drop of blood is placed on a culture plate, spread over the surface, and placed in an incubator.

If there is no immediate visible evidence of growth in the bottles, the laboratory looks for bacteria by doing gram stains and subcultures. These steps are repeated daily for the first several days and periodically after that.

When bacteria grows, the laboratory identifies it using biochemical tests and the gram stain. Sensitivity testing, also called antibiotic susceptibility testing, is also done. The bacteria are tested against many different antibiotics to see which antibiotics can effectively kill it.

All information is passed on to the physician as soon as it is known. An early report, known as a preliminary report, is usually available after one day. This report will tell if any bacteria have been found yet, and if so, the results of the gram stain. The next preliminary report may include a description of the bacteria growing on the subculture. The laboratory notifies the physician immediately when an organism is found and as soon as sensitivity tests are complete. Sensitivity tests may be complete before the bacteria is completely identified. The final report may not be available for five to seven days. If bacteria was found, the report will include its complete identification and a list of the antibiotics to which the bacteria is sensitive.

One automated system is considered one of the most important recent technical advances in blood cultures. It is called continuous-monitoring blood culture systems (CMCCS). The instruments automatically monitor the bottles containing the patient blood for evidence of microorganisms, usually every 10 minutes. Many data points are collected daily for each bottle, and fed into a computer for analysis. Sophisticated mathematical calculations can determine when microorganisms have grown. This, combined with more frequent blood tests, make it possible to detect microbial growth earlier. In addition, all CMBCS instruments have the detection system, incubator, and agitation unit in one unit.

Preparation

Ten mL (milliliters) of blood is usually needed for each blood culture bottle. First a healthcare worker locates a vein in the inner elbow region. The area of skin where the blood will be drawn must be disinfected to prevent any microorganisms on a person's skin from entering the blood culture bottle and contaminating it. The area is disinfected by wiping the area with alcohol in a circular fashion, starting with tiny circles at the spot where the needle will puncture the skin and enlarging the size of the circles while wiping away from the puncture site. The same pattern of wiping is repeated using an iodine or iodophor solution. The top of the bottle is disinfected using alcohol. After the person's skin has been disinfected, the healthcare worker draws the blood and about 10 mL of blood is injected into each blood culture bottle. The type of bottles used will vary based on whether the physician is looking for bacteria (aerobes or anaerobes), yeast, mold, or viruses.

Aftercare

Discomfort or bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Warm packs relieve discomfort.

Normal results

Normal results will be negative. A single negative culture does not rule out a blood infection. False negatives can occur if the person was started on antibiotics before the blood was drawn, the environment for growth was not right, the timing was off, or for some unknown reason the microorganism just didn't grow. Three negative cultures may be enough to rule out bacteremia in the case of endocarditis.

Abnormal results

The physician's skill in interpreting the culture results and assessing the person's clinical condition is

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essential in distinguishing a blood culture that is positive because of a true infection from a culture that is positive because it became contaminated. In true bacteremia, the patient's clinical condition should be consistent with a blood infection caused by the microorganism that was found. The microorganism is usually found in more than one culture, grows soon after the bottles are incubated, and is often the cause of an infection somewhere else in the person's body.

When the culture is positive because of contamination, the patient's clinical condition usually is not consistent with an infection from the identified microorganism. In addition, the microorganism is often one commonly found on skin, rarely causes infection, is found in only one bottle, and may appear after several days of incubation. More than one microorganism often grow in contaminated cultures.

ORGANIZATIONS

American Society of Microbiology, 1752 N Street N.W., Washington, DC, 20036-2904, (202) 737-3600, http://www.asm.org/.

Nancy J. Nordenson

Blood donation and registry

Definition

Blood donation refers to the process of collecting, testing, preparing, and storing blood and blood components. Donors are most commonly unpaid volunteers, but they may also be paid by commercial enterprises. Blood registry refers to the collection and sharing of data about donated blood and ineligible donors.

Purpose

The purpose of the blood collection and distribution system is to help ensure an adequate supply of blood for accident victims, people needing surgery, and people suffering from certain diseases, as well as for medical research.

Sometimes, donors give blood specifically to benefit a particular person. People preparing for elective surgery may donate their own blood to be held and then returned to them during surgery. This is known as autologous blood donation. Directed donor blood has been donated by someone known to the intended recipient, such as a family member or friend.

Each year, more than four million Americans receive blood transfusions involving more than 26 million units of blood (one unit equals 450 milliliters, or about one pint), or an average of about 32,000 units per day. All of that blood must be collected, tested, prepared, stored, and delivered to the appropriate sites. Roughly eight million people in the United States donate blood each year; about half of the total amount needed is provided by the 36 regional blood centers of the American Red Cross.

Whole blood and the various blood components have many uses. Red blood cells, which carry oxygen, are used to treat anemia. Platelets, which play a role in controlling bleeding, are commonly used in the treatment of leukemia and other cancers. Fresh frozen plasma is also used to control bleeding in people deficient in certain clotting factors. Cryoprecipitated AHF, made from fresh frozen plasma, contains a few specific clotting factors.

Precautions

To ensure the safety of the blood supply, a multitiered process of donor screening and deferral is employed. This involves donor education, taking a detailed health history of each prospective donor, and giving potential donors a simple **physical examination** (which includes taking a few drops of blood to test for anemia). At any point in the process, a potential donor may be "deferred," or judged ineligible to donate blood. This deferral may be temporary or permanent, depending on the reason. Potential donors are also encouraged to "self-defer," or voluntarily decline to donate, rather than put future blood recipients at risk.

All donated blood is extensively tested before being used. The first step is determining the blood type, which indicates who can receive the blood. Receiving the wrong type of blood can cause **death**. Blood is also screened for any antibodies that could cause complications for recipients. In addition, blood is tested to screen out donors infected with the following diseases: **Hepatitis B** surface antigen ADD, hepatitis B core antibody, **hepatitis C** virus antibody, HIV-1 and HIV-2 antibody, HIV p24 antigen, HTLV-I and HTLV-II antibodies, and **syphilis**. Nucleic Acid Amplification testing is also performed, and other tests may be done if a doctor requests them.

In order to detect the greatest possible number of infections, these screening tests are extremely sensitive. For this reason, however, donors sometimes receive false positive test results. In these cases, more specific confirmatory tests are performed, to help rule out false positive results. Blood found to be abnormal is discarded, and all items coming into direct contact with donors are used only once and then discarded. Donors of infected blood are entered into the Donor Deferral

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Register, a confidential national data base used to prevent deferred people from donating blood.

In general, blood donors must be at least 17 years old (some states allow younger people to donate blood with their parents' consent), must weigh at least 110 pounds (50 kg), and must be in good health.

Many factors can temporarily or permanently disqualify potential donors. Most of them have to do with experiences that put them at risk of infection or having spent time in certain specified areas. Among these factors are having had a tattoo, having had sex with people in high-risk groups, having had certain diseases, and having been raped.

Description

There are eight different blood types in all—four ABO groups, each of which may be either Rh positive or Rh negative. These types, and their approximate distribution in the U.S. population, are as follows: O+ (38%), O- (7%), A+ (34%), A- (6%), B+ (9%), B- (2%), AB+ (3%), AB- (1%). In an emergency, anyone can safely receive type O red blood cells, and people with this blood type are known as "universal donors." People with type AB blood, known as "universal recipients," can receive any type of red blood cells and can give plasma to all blood types.

Blood donations can be made in community blood centers, at hospitals, or in bloodmobiles, which visit schools, churches and workplaces. The actual process of donating whole blood takes about 20 minutes. A sterile needle is inserted into a vein in the donor's arm. The blood flows through plastic tubing into a blood bag. Donors may be asked to clench their fist to encourage blood to flow. Usually, one unit of blood is collected. Afterward, donors are escorted to an observation area, given light refreshments, and allowed to rest.

Plasma, the liquid portion of the blood in which red blood cells, platelets, and other elements are suspended, is also collected, often by commercial enterprises that sell it to companies manufacturing clotting factors and other blood products. This is done using a process known as apheresis, in which whole blood is collected, the desired blood component is removed, and the remainder is returned to the donor. Collecting plasma generally takes one to two hours. Apheresis may also be used to collect other blood components, such as platelets and granulocytes.

Preparation

Once whole blood has been collected, it is sent to a lab for testing and processing. Most donated blood is separated into its constituent components, such as red blood cells, platelets, and cryoprecipitate. This enables more than one person to benefit from the same unit of donated blood.

Different blood components vary in how long they can be stored. Red blood cells can be refrigerated for up to 42 days or frozen for as long as 10 years. Platelets, stored at room temperature, may be kept for up to five days. Fresh frozen plasma and cryoprecipitated AHF can be kept for up to one year.

Aftercare

It generally takes about 24 hours for the donor's body to replenish the lost fluid. Replacing the lost red blood cells, however, may take as much as two months. Whole blood donors must wait a minimum of eight weeks before donating again. Some states place further limits on the frequency and/or total number of times an individual may donate blood within a 12-month period.

Risks

Thanks to the use of a multi-tiered screening system and advances in the effectiveness of screening tests, the transmission of infectious diseases via **transfusion** has been significantly diminished. Nonetheless, there is still a minuscule risk that blood recipients could contract HIV, Hepatitis C, or other infections via transfusion. Other diseases that could conceivably be contracted in this way, or that are of particular concern to blood-collection agencies, include **babesiosis**, Chagas disease, HTLV-I and -II, **Creutzfeldt-Jakob disease**, cytomegalovirus, **Lyme disease**, **malaria**, and new variant Creutzfeldt-Jakob disease.

Autologous blood donors run a tiny risk of having the wrong blood returned to them due to clerical error. There is also a faint possibility of bacterial contamination of the autologous blood.

Normal results

For most donors, the process is quick and painless and they leave feeling fine. They may also find satisfaction in knowing that they have contributed to the nation's blood supply and may even have helped save lives.

Abnormal results

Most blood donors suffer no significant aftereffects. Occasionally, however, donors feel faint or dizzy, nauseous, and/or have **pain**, redness, or a bruise where the blood was taken. More serious complications, which rarely occur, include **fainting**, **muscle spasms**, and nerve damage.

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ORGANIZATIONS

American Association of Blood Banks, 8101 Glenbrook Road, Bethesda, MD, 20814-2749, (301) 907-6977, (301) 907-6895, http://www.aabb.org.

American Red Cross, 2025 E Street NW, Washington, DC, 20006, (202) 303-5000, (800) 733-2767, http://www.redcross.org.

Peter Gregutt

Blood fluke infection *see* **Schistosomiasis**

Blood gas analysis

Definition

Blood gas analysis, also called arterial blood gas (ABG) analysis, is a test that measures the amounts of oxygen and carbon dioxide in the blood, as well as the acidity (pH) of the blood.

Purpose

An ABG analysis evaluates how effectively the lungs are delivering oxygen to the blood and how efficiently they are eliminating carbon dioxide from it. The test also indicates how well the lungs and kidneys are interacting to maintain normal blood pH (acid-base balance). Blood gas studies are usually done to assess respiratory disease and other conditions that may affect the lungs, and to manage patients receiving **oxygen therapy** (respiratory therapy). In addition, the acid-base component of the test provides information on kidney function.

Description

Blood gas analysis is performed on blood from an artery. It measures the partial pressures of oxygen and carbon dioxide in the blood, as well as oxygen content, oxygen saturation, bicarbonate content, and blood pH.

Oxygen in the lungs is carried to the tissues through the bloodstream, but only a small amount of this oxygen can actually dissolve in arterial blood. How much dissolves depends on the partial pressure of the oxygen (the pressure that the gas exerts on the walls of the arteries). Therefore, testing the partial pressure of oxygen is actually measuring how much oxygen the lungs are delivering to the blood. Carbon dioxide is released into the blood as a by-product of cell metabolism. The partial carbon dioxide pressure indicates how well the lungs are eliminating this carbon dioxide.

A blood gas analyzer from Corning Corporation. *(Hank Morgan/Photo Researchers, Inc.)*

The remainder of oxygen that is not dissolved in the blood combines with hemoglobin, a protein-iron compound found in the red blood cells. The oxygen content measurement in an ABG analysis indicates how much oxygen is combined with the hemoglobin. A related value is the oxygen saturation, which compares the amount of oxygen actually combined with hemoglobin to the total amount of oxygen that the hemoglobin is capable of combining with.

Carbon dioxide dissolves more readily in the blood than oxygen does, primarily forming bicarbonate and smaller amounts of carbonic acid. When present in normal amounts, the ratio of carbonic acid to bicarbonate creates an acid-base balance in the blood, helping to keep the pH at a level where the body's cellular functions are most efficient. The lungs

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KEY TERMS

Acid-base balance—The condition that exists when the body's carbonic acid-bicarbonate buffer system is in equilibrium, helping to maintain the blood pH at a normal level of 7.35–7.45.

Hemoglobin—A protein-iron compound in red blood cells that functions primarily in carrying oxygen from the lungs to the tissues of the body.

pH—A measure of the acidity of a solution. Normal blood pH ranges from 7.35–7.45.

and kidneys both participate in maintaining the carbonic acid-bicarbonate balance. The lungs control the carbonic acid level and the kidneys regulate the bicarbonate. If either organ is not functioning properly, an acid-base imbalance can result. Determination of bicarbonate and pH levels, then, aids in diagnosing the cause of abnormal blood gas values.

The procedure

The blood sample is obtained by arterial puncture (usually in the wrist, although it could be in the groin or arm) or from an arterial line already in place. If a puncture is needed, the skin over the artery is cleaned with an antiseptic. A technician then collects the blood with a small sterile needle attached to a disposable syringe. The patient may feel a brief throbbing or cramping at the site of the puncture. After the blood is drawn, the sample must be transported to the laboratory as soon as possible for analysis.

Preparation

There are no special preparations. Patients have no restrictions on drinking or eating before the test. If the patient is receiving oxygen, the oxygen concentration must remain the same for 20 minutes before the test; if the test is to be taken without oxygen, the gas must be turned off for 20 minutes before the test is taken. The patient should breathe normally during the test.

Aftercare

After the blood has been taken, the technician or the patient applies pressure to the puncture site for 10–15 minutes to stop the bleeding, and then places a dressing over the puncture. The patient should rest quietly while applying the pressure to the puncture site. Health care workers will observe the patient for signs of bleeding or circulation problems

Risks

Risks are very low when the test is done correctly. Risks include bleeding or bruising at the site, or delayed bleeding from the site. Very rarely, there may be a problem with circulation in the puncture area.

Normal results

Normal blood gas values are as follows:

- partial pressure of oxygen (PaO_2): 75–100 mm Hg
- partial pressure of carbon dioxide ($PaCO_2$): 35–45 mm Hg
- oxygen content (O_2CT): 15–23%
- oxygen saturation (SaO_2): 94–100%
- bicarbonate (HCO_3): 22–26 mEq/liter
- pH: 7.35–7.45

Abnormal results

Values that differ from those listed above may indicate respiratory, metabolic, or **kidney disease**. These results also may be abnormal if the patient has experienced trauma that may affect breathing (especially head and neck injuries). Disorders, such as anemia, that affect the oxygen-carrying capacity of blood, can produce an abnormally low oxygen content value.

Resources

BOOKS

Lynn, Pamela Barbara. *Taylor's Handbook of Clinical Nursing Skills*. Philadelphia, PA; London: Lippincott Williams & Wilkins, 2010.

Carol A. Turkington

Blood poisoning *see* **Acute lymphangitis**

Blood registry *see* **Blood donation and registry**

Blood removal *see* **Phlebotomy**

Blood sugar tests

Definition

Blood sugar tests include several different tests that measure the amount of sugar (glucose) in a person's blood. These tests are performed either on an empty stomach, or after consuming a meal or premeasured glucose drink. Blood sugar tests are done primarily to diagnose and evaluate a person with **diabetes mellitus**.

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Purpose

The body uses sugar, also called glucose, to supply the energy it needs to function. People get sugar from their diet and from their body tissues. Insulin is made by the pancreas and affects the outer membrane of cells, making it easy for glucose to move from the blood into the cells. When insulin is active, blood glucose levels fall. Sugar from body tissues is stored in the form of glycogen. When glycogen is active, blood glucose levels rise.

After a meal, blood glucose levels rise sharply. The pancreas responds by releasing enough insulin to take care of all the newly added sugar found in the body. The insulin moves the sugar out of the blood and into the cells. Only then does the blood sugar start to level off and begin to fall. A person with diabetes mellitus either does not make enough insulin, or makes insulin that does not work properly. The result is blood sugar that remains high, a condition called hyperglycemia.

Diabetes must be diagnosed as early as possible. If left untreated, it can damage or cause failure of the eyes, kidneys, nerves, heart, blood vessels, and other body organs. **Hypoglycemia**, or low blood sugar, also may be discovered through blood sugar testing. Hypoglycemia is caused by various hormone disorders and **liver disease**, as well as by too much insulin.

Description

There are a variety of ways to measure a person's blood sugar.

Whole blood glucose test

Whole blood glucose testing can be performed by a person in his or her home, and kits are available for this purpose. The person pricks his or her finger (a finger stick) with a sterile sharp blade from the kit. A single drop of blood is placed on a strip in a portable instrument called a glucometer. The glucometer quickly determines the blood sugar and shows the results on a small screen in usually a few seconds.

New technologies for monitoring glucose levels will help diabetics better control their glucose levels. These tests are particularly important for children and adolescents. In mid-2002, the U.S. Food and Drug Administration (FDA) approved a new home test for use by children and adolescents (it had already been approved for adults) called the Cygnus GlucoWatch biographer that helped better detect hypoglycemia. Studies show that more frequent checks are better; new monitors such as this allow for simpler frequent testing. Continuous monitoring was in development in early 2004, as a company called TheraSense Inc. received preapproval from the FDA for clinical trials on its home continuous glucose monitor. The monitor was designed to provide users with real-time glucose data, alarms for hypoglycemia and hyperglycemia and to show trends in their blood sugar levels.

Fasting plasma glucose test

The **fasting** plasma glucose test is done on an empty stomach. For the eight hours before the test, the person must fast (nothing to eat or drink, except water). The person's blood is drawn from a vein by a health care worker. The blood sample is collected into a tube containing an anticoagulant. Anticoagulants stop the blood from clotting. In the laboratory, the tube of blood spins at high speed within a machine called a centrifuge. The blood cells sink to the bottom and the liquid stays on the top. This straw-colored liquid on the top is the plasma. To measure the glucose, a person's plasma is combined with other substances. From the resulting reaction, the amount of glucose in the plasma is determined.

Oral glucose tolerance test

The oral glucose tolerance test is conducted to see how well the body handles a standard amount of glucose. This test measures the amount of glucose in a person's plasma before and two hours after drinking a large premeasured beverage containing glucose. The person must eat a consistent diet, containing at least 5.25 oz. (150g) of carbohydrates each day, for three days before this test. For eight hours before the test, the person must fast. A health care provider draws the first sample of blood at the end of the fast to determine the glucose level at the start of the test. The health care provider then gives the person a beverage containing 2.6 oz. (75g) of glucose. Two hours later, the person's blood is drawn again. These blood samples are centrifuged and processed in the laboratory. A doctor can then compare the before and after glucose levels to see how well the patient's body processed the sugar.

Two-hour postprandial blood glucose test

The two-hour postprandial blood glucose test measures the amount of glucose in plasma after a person eats a specific meal containing a certain amount of sugar. Although the meal follows a predetermined menu, it is difficult to control many factors associated with this testing method.

Blood sugar tests can be used in a variety of situations including:

- Testing people suspected for diabetes. The American Diabetic Association (ADA) recommends that either a fasting plasma glucose test or an oral glucose

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tolerance test be used to diagnose diabetes. If the person already has symptoms of diabetes, a blood glucose test without fasting (called a casual plasma glucose test) may be done. If the test result is abnormal, it must be confirmed with another test performed on another day. The two tests can be different or they can be the same, but they must be done on different days. If the second test also is abnormal, the person has diabetes. A two-hour postprandial test is not recommended by the ADA as a test to use for the diagnosis of diabetes. A doctor may order this test, and follow it with the oral glucose tolerance test or the fasting plasma glucose test if the results are abnormal.

- Testing pregnant women. Diabetes that occurs during pregnancy (gestational diabetes) is dangerous for both the mother and the baby. Women who may be at risk are screened when they are 24–28 weeks pregnant. A woman is considered at risk if she is older than 25 years, is not at her normal body weight, has a parent or sibling with diabetes, or if she is in an ethnic group that has a high rate of diabetes (Hispanics, Native Americans, Asians, African Americans). The blood sugar test to screen for gestational diabetes is a variation of the oral glucose tolerance test. Fasting is not required. If the result is abnormal, a more complete test is done on another day.
- Testing healthy people. Healthy people without symptoms of diabetes should be screened for diabetes when they are 45 years old and again every three years. Either the fasting plasma glucose or oral glucose tolerance test is used for screening. People in high risk groups should be tested before the age of 45 and tested more frequently.
- Testing of people already diagnosed with diabetes. The ADA recommends that a person with diabetes keep the amount of glucose in the blood at a normal level as much as possible. This can be done by the diabetic person testing his or her own blood at home one or more times a day.

Preparation

Each blood sugar test that uses plasma requires a 5 mL blood sample. A healthcare worker ties a tight band (tourniquet) on the person's upper arm, locates a vein in the inner elbow region, and inserts a needle into the vein. Vacuum action draws the blood through the needle into an attached tube. Collection of the sample takes only a few minutes.

When fasting is required, the person should have nothing to eat or drink (except water) for eight hours before the test and until the test or series of tests is completed. The person should not smoke before or during the testing period because this can temporarily increase the amount of glucose in the blood. Other factors that can cause inaccurate results are a change in diet before the test, illness or surgery two weeks before the test, certain drugs, and extended bed rest. The doctor may tell a person on insulin or taking pills for diabetes to stop the medication until after the test.

Aftercare

After the test or series of tests is completed (and with the approval of his or her doctor), the person should eat, drink, and take any medications that were stopped for the test.

The patient may feel discomfort when blood is drawn from a vein. Bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops will reduce bruising. Warm packs to the puncture site will relieve discomfort.

Risks

If the person experiences weakness, **fainting**, sweating, or any other unusual reaction while fasting or during the test, he or she should immediately tell the person giving the test.

Normal results

Normal results are:

- fasting plasma glucose test less than 120 mg/dL
- oral glucose tolerance test, 2 hours less than 140 mg/dL

For the diabetic person, the ADA recommends an ongoing blood sugar goal of less than or equal to 120 mg/dL.

Abnormal results

These abnormal results indicate diabetes and must be confirmed with repeat testing:

- fasting plasma glucose test less than or equal to 126 mg/dL
- oral glucose tolerance test, 2 hours less than or equal to 200 mg/dL
- casual plasma glucose test (nonfasting, with symptoms) less than or equal to 200 mg/dL
- gestational oral glucose tolerance test, 1 hour less than or equal to 140 mg/dL

Brain damage can occur from glucose levels below 40 mg/dL and **coma** from levels above 470 mg/dL.

A condition known as prediabetes or impaired glucose tolerance, which may lead to type 2 diabetes, usually is indicated with a reading of 100 mg/dL.

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Other hormone disorders can cause both hyperglycemia and hypoglycemia. Abnormal results must be interpreted by a doctor who is aware of the person's medical condition and medical history.

Resources

PERIODICALS

"New Guidelines Set Lower Threshold for Precursor to Diabetes." *RN* (January 2004): 17.

Plotnick, Leslie P. "The Next Step in Blood Glucose Monitoring?" *Pediatrics* (April 2003): 885.

"Premarket Approval Application Filed for Continuous Glucose Monitor." *Medical Letter on the CDC & FDA* (January 4, 2004): 26.

ORGANIZATIONS

American Diabetes Association, 1701 North Beauregard Street, Alexandria, VA, 22311, (800) 342-2383, Ask ADA@diabetes.org, http://www.diabetes.org/.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

National Diabetes Information Clearinghouse (NDIC), 1 Information Way, Bethesda, MD, 20892-3560, (703) 738-4929, (800) 860-8747, ndic@info.niddk.nih.gov, http://diabetes.niddk.nih.gov/.

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Blood thinners *see* **Anticoagulant and antiplatelet drugs**

Blood transfusion *see* **Transfusion**

Prevalence of blood types in the United States, by ethnicity

O positive is the most common blood type in the United States. The prevalence of different blood types in the U.S. population is as follows:

	Caucasian	African American	Hispanic	Asian
A+	33.0%	24.0%	29.0%	27.0%
A−	7.0%	2.0%	2.0%	0.5%
B+	9.0%	18.0%	9.0%	25.0%
B−	2.0%	1.0%	1.0%	0.4%
AB+	3.0%	4.0%	2.0%	7.0%
AB−	1.0%	0.3%	0.2%	0.1%
O+	**37.0%**	**47.0%**	**53.0%**	**39.0%**
O−	8.0%	4.0%	4.0%	1.0%

SOURCE: The American Red Cross, "Learn about Blood: Blood Types." Available online at: http://www.redcrossblood.org/learn-about-blood/blood-types (accessed August 12, 2010).

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Blood typing and crossmatching

Definition

Blood typing is a laboratory test done to determine a person's blood type. If the person needs a blood **transfusion**, another test called crossmatching is done after the blood is typed to find blood from a donor that the person's body will accept.

Purpose

Blood typing and crossmatching are most commonly done to make certain that a person who needs a transfusion will receive blood that matches (is compatible with) his own. People must receive blood of the same blood type; otherwise, a serious, even fatal, transfusion reaction can occur.

Parents who are expecting a baby have their blood typed to diagnose and prevent hemolytic disease of the newborn (HDN), a type of anemia also known as **erythroblastosis fetalis**. Babies who have a blood type different from their mothers are at risk for developing this disease. The disease is serious with certain blood type differences, but is milder with others.

A child inherits factors or genes from each parent that determine his blood type. This fact makes blood typing useful in paternity testing. To determine whether or not the alleged father could be the true father, the blood types of the child, mother, and alleged father are compared.

Legal investigations may require typing of blood or other body fluids, such as semen or saliva, to identify persons involved in crimes or other legal matters.

Description

Blood typing and crossmatching tests are performed in a blood bank laboratory by technologists trained in blood bank and transfusion services. The tests are done on blood after it has separated into cells and serum (serum is the yellow liquid left after the blood clots.) Costs for both tests are covered by insurance when the tests are determined to be medically necessary.

Blood bank laboratories are usually located in facilities, such as those operated by the American Red Cross, that collect, process, and supply blood that is donated, as well as in facilities, such as most hospitals, that prepare blood for transfusion. These laboratories are regulated by the United States Food and Drug

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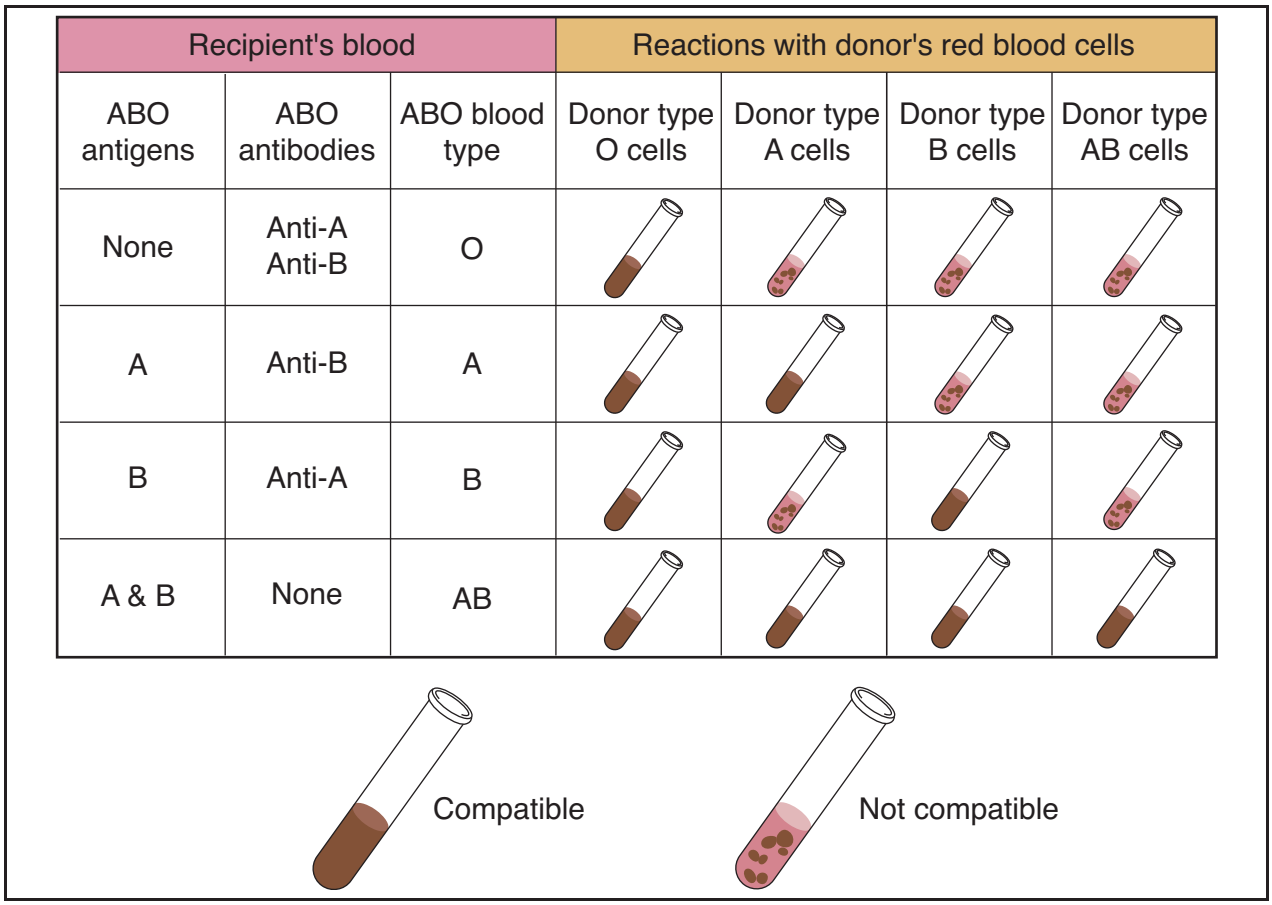

Blood typing is a laboratory test done to discover a person's blood type. If the person needs a blood transfusion, crossmatching is done following blood typing to locate donor blood that the person's body will accept. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Administration (FDA) and are often inspected and accredited by a professional association such as the American Association of Blood Banks (AABB).

Blood typing and crossmatching tests are based on the reaction between antigens and antibodies. An antigen can be anything that causes the body to launch an attack, known as an immune response, against it. The attack begins when the body builds a special protein, called an antibody, that is uniquely designed to attack and make ineffective (neutralize) the specific antigen that caused the attack. A person's body normally doesn't make antibodies against its own antigens, only against antigens that are foreign to it.

A person's body contains many antigens. The antigens found on the surface of red blood cells are important because they determine a person's blood type. When red blood cells having a certain blood type antigen are mixed with serum containing antibodies against that antigen, the antibodies attack and stick to the antigen. In a test tube, this reaction is observed as the formation of clumps of cells (clumping).

When blood is typed, a person's cells and serum are mixed in a test tube with commercially-prepared serum and cells. Clumping tells which antigens or antibodies are present and reveals the person's blood type. When blood is crossmatched, patient serum is mixed with cells from donated blood that might be used for transfusion. Clumping or lack of clumping in the test tube tells whether or not the blood is compatible.

Although there are over 600 known red blood cell antigens, organized into 22 blood group systems, routine blood typing and crossmatching is usually concerned with only two systems: the ABO and Rh blood group systems.

Blood typing

ABO BLOOD GROUP SYSTEM. In 1901, Karl Landsteiner, an Austrian pathologist, randomly combined

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KEY TERMS

ABO blood type—Blood type based on the presence or absence of the A and B antigens on the red blood cells.

Antibody—A special protein made by the body as a defense against foreign material that enters the body. It is uniquely designed to attack and neutralize the specific antigen that triggered the immune response.

Antigen—Anything that causes the body to launch an immune response against that antigen through the production of antibodies.

Blood bank—A laboratory that specializes in blood typing, antibody identification, and transfusion services.

Blood type—Blood categories based on the presence or absence of certain antigens on the red blood cells.

Crossmatch—A laboratory test done to confirm that blood from a donor and blood from the recipient are compatible.

Gene—A piece of DNA, located on a chromosome, that determines how traits such as blood type are inherited and expressed.

Immune response—The body's attack against an antigen that it considers foreign to itself. The attack begins with the production of antibodies against the antigen.

Rh blood type—Blood type based on the presence or absence of the D antigen on the red blood cells.

Transfusion—The therapeutic introduction of blood or a blood component into a patient's bloodstream.

the serum and red blood cells of his colleagues. From the reactions he observed in test tubes, he discovered the ABO blood group system. This discovery earned him the 1930 Nobel Prize in Medicine.

A person's ABO blood type—A, B, AB, or O—is based on the presence or absence of the A and B antigens on his red blood cells. The A blood type has only the A antigen and the B blood type has only the B antigen. The AB blood type has both A and B antigens, and the O blood type has neither A nor B antigens.

By the time a person is six months old, he naturally will have developed antibodies against the antigens his red blood cells lack. That is, a person with A blood type will have anti-B antibodies, and a person with B blood type will have anti-A antibodies. A person with AB blood type will have neither antibody, but a person with O blood type will have both anti-A and anti-B antibodies. Although the distribution of each of the four ABO blood types varies among racial groups, O is the most common and AB is the least common.

ABO typing is the first test done on blood when it is tested for transfusion. A person must receive ABO-matched blood. ABO incompatibilities are the major cause of fatal transfusion reactions. ABO antigens are also found on most body organs, so ABO compatibility is also important for organ transplants.

An ABO incompatibility between a pregnant woman and her baby is a minor cause of HDN and usually causes no problem for the baby. The structure of ABO antibodies makes it unlikely they will cross the placenta to attack the baby's red blood cells.

Paternity testing compares the ABO blood types of the child, mother, and alleged father. The alleged father can't be the true father if the child's blood type requires a gene that neither he nor the mother have. For example, a child with blood type B whose mother has blood type O, requires a father with either AB or B blood type; a man with blood type O cannot be the true father.

In some people, ABO antigens can be found in body fluids other than blood, such as saliva and semen. ABO typing of these fluids provides clues in legal investigations.

RH BLOOD GROUP SYSTEM. The Rh, or Rhesus, system was first detected in 1940 by Landsteiner and his colleague Alexander Wiener when they injected blood from rhesus monkeys into guinea pigs and rabbits. More than 50 antigens have since been discovered belonging to this system, making it the most complex red blood cell antigen system.

In routine blood typing and crossmatching tests, only one of these 50 antigens, the D antigen, also known as the Rh factor or Rh_o[D], is tested for. If the D antigen is present, that person is Rh-positive; if the D antigen is absent, that person is Rh-negative.

Other important antigens in the Rh system are C, c, E, and e. These antigens are not usually tested for in routine blood typing tests. However, testing for the presence of these antigens is useful in paternity testing, and when a technologist tries to identify unexpected Rh antibodies or find matching blood for a person with antibodies to one or more of these antigens.

Unlike the ABO system, antibodies to Rh antigens don't develop naturally. They develop only as an immune response after a transfusion or during **pregnancy**.

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The incidence of the Rh blood types varies between racial groups, but not as widely as the ABO blood types: 85% of whites and 90% of blacks are Rh-positive; 15% of whites and 10% of blacks are Rh-negative.

In transfusions, the Rh system is next in importance after the ABO system. Most Rh-negative people who receive Rh-positive blood will develop anti-D antibodies. A later transfusion of Rh-positive blood could result in a severe or fatal transfusion reaction.

Rh incompatibility is the most common and severe cause of HDN. This incompatibility can happen when an Rh-negative woman and an Rh-positive man produce an Rh-positive baby. Cells from the baby can cross the placenta and enter the mother's bloodstream, causing the mother to make anti-D antibodies. Unlike ABO antibodies, the structure of anti-D antibodies makes it likely that they will cross the placenta and enter the baby's bloodstream. There, they can destroy the baby's red blood cells, causing severe or fatal anemia.

The first step in preventing HDN is to find out the Rh types of the expectant parents. If the mother is Rh-negative and the father is Rh-positive, the baby is at risk for developing HDN. The next step is to test the mother's serum to make sure she doesn't already have anti-D antibodies from a previous pregnancy or transfusion. This procedure is similar to blood typing. Finally, the Rh-negative mother is given an injection of Rh Immunoglobulin (RhIg) at 28 weeks of gestation and again after delivery, if the baby is Rh positive. The RhIg attaches to any Rh-positive cells from the baby in the mother's bloodstream, preventing them from triggering anti-D antibody production in the mother. An Rh-negative woman should also receive RhIg following a **miscarriage**, abortion, or **ectopic pregnancy**.

OTHER BLOOD GROUP SYSTEMS. Several other blood group systems may be involved in HDN and transfusion reactions, although they are much less frequent than ABO and Rh. They are the Duffy, Kell, Kidd, MNS, and P systems. Tests for antigens from these systems are not included in routine blood typing, but they are commonly used in paternity testing.

Like Rh antibodies, antibodies in these systems do not develop naturally, but as an immune response after transfusion or during pregnancy. An antibody screening test is done before a crossmatch to check for unexpected antibodies to antigens in these systems. A person's serum is mixed in a test tube with commercially-prepared cells containing antigens from these systems. If clumping occurs, the antibody is identified.

Crossmatching

Crossmatching is the final step in pretransfusion testing. It is commonly referred to as compatibility testing, or "Type and Cross."

Before blood from a donor and the recipient are crossmatched, both are ABO and Rh typed. In addition, antibody screening is done to look for antibodies to certain Rh, Duffy, MNS, Kell, Kidd, and P system antigens. If an antibody to one of these antigens is found, only blood without that antigen will be compatible in a crossmatch. This sequence must be repeated before each transfusion a person receives.

To begin the crossmatch, blood from a donor with the same ABO and Rh type as the rcipient is selected. In a test tube, serum from the patient is mixed with red blood cells from the donor. If clumping occurs, the blood is not compatible; if clumping does not occur, the blood is compatible. If an unexpected antibody is found in either the patient or the donor, the blood bank does further testing to make sure the blood is compatible.

In an emergency, when there is not enough time for blood typing and crossmatching, O red blood cells may be given, preferably Rh-negative. O blood type is called the universal donor because it has no ABO antigens for a patient's antibodies to attack. In contrast, AB blood type is called the universal recipient because it has no ABO antibodies to attack the antigens on transfused red blood cells. If there is time for blood typing, red blood cells of the recipient type (type specific cells) are given. In either case, the crossmatch is continued, even though the transfusion has begun.

Preparation

To collect the 10 mL blood needed for these tests, a healthcare worker ties a tourniquet above the patient's elbow, locates a vein in the inner elbow region, and inserts a needle into that vein. Vacuum action draws the blood through the needle into an attached tube. Collection of the sample takes only a few minutes.

Blood typing and crossmatching must be done three days or less before a transfusion. A person doesn't need to change diet, medications, or activities before these tests. He should tell his healthcare provider if, during the last three months, he has received a blood transfusion or a plasma substitute, or has had a radiology procedure using intravenous contrast

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media. These can give false clumping reactions in both typing and crossmatching tests.

Aftercare

The possible side effects of any blood collection are discomfort or bruising at the site where the needle punctured the skin, as well as **dizziness** or **fainting**. Bruising is reduced if pressure is applied with a finger to the puncture site until the bleeding stops. Discomfort is treated with warm packs to the puncture site.

Risks

There are no risks from the blood collection or test procedures. Blood transfusions always have the risk of an unexpected transfusion reaction. A nurse watches a patient for signs of a reaction during the entire transfusion.

Normal results

There is no normal blood type. The desired result of a crossmatch is that compatible donor blood is found. Compatibility testing procedures are designed to provide the safest blood product possible for the recipient, but a compatible crossmatch is no guarantee that an unexpected adverse reaction will not appear during the transfusion.

Abnormal results

Except in an emergency, a person cannot receive a transfusion without a compatible crossmatch result.

ORGANIZATIONS

American Association of Blood Banks, 8101 Glenbrook Road, Bethesda, MD, 20814-2749, (301) 907-6977, (301) 907-6895, http://www.aabb.org.

Nancy J. Nordenson

Blood urea nitrogen test

Definition

The blood urea nitrogen (BUN) test measures the level of urea nitrogen in a sample of the patient's blood. Urea is a substance that is formed in the liver when the body breaks down protein. Urea then circulates in the blood in the form of urea nitrogen. In healthy people, most urea nitrogen is filtered out by the kidneys and leaves the body in the urine. If the patient's kidneys are not functioning properly or if the body is using large amounts of protein, the BUN level will rise. If the patient has severe **liver disease**, the BUN will drop.

KEY TERMS

Urea—A compound containing nitrogen that occurs in the urine and other body fluids as a result of protein metabolism.

Purpose

The BUN level may be checked in order to assess or monitor:

- the presence or progression of kidney or liver disease
- blockage of urine flow
- mental confusion (patients with kidney failure are sometimes disoriented and confused)
- abnormal loss of water from the body (dehydration)
- recovery from severe burns (the body uses larger than normal amounts of protein following serious burns)

Description

The BUN test is performed on a sample of the patient's blood, withdrawn from a vein into a vacuum tube. The procedure, which is called a venipuncture, takes about five minutes.

Preparation

The doctor should check to make sure that the patient is not taking any medications that can affect BUN results. These drugs include the **antibiotics** chloramphenicol, streptomycin, amphotericin B, methicillin, gentamicin, tobramycin, and kanamycin, as well as **diuretics** and **corticosteroids**.

The patient should be advised not to eat large amounts of meat the day before the test.

Aftercare

Aftercare consists of routine care of the area around the venipuncture.

Risks

The primary risk is the possibility of a bruise or swelling in the area of the venipuncture. The patient can apply moist warm compresses.

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Normal results

Normal BUN levels are 5–18 mg/dL for children, 7–18 mg/dL for adults, and 8–20 mg/dL in the elderly.

Abnormal results

Abnormally low BUN

Low levels of BUN may indicate **overhydration**, **malnutrition**, **celiac disease** (a disease characterized by the inability to tolerate foods containing wheat protein [gluten]), liver damage or disease, or use of corticosteroids. Low BUN may also occur in early **pregnancy**.

Abnormally high BUN

High levels of BUN may indicate **kidney disease** or failure; blockage of the urinary tract by a kidney stone or tumor; a **heart attack** or congestive **heart failure**; **dehydration**; **fever**; **shock**; or bleeding in the digestive tract. High BUN levels can sometimes occur during late pregnancy or result from eating large amounts of protein-rich foods. A BUN level higher than 100 mg/dL points to severe kidney damage.

Resources

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Rebecca J. Frey, PhD

Blood vessel scan *see* **Doppler ultrasonography**

Body dysmorphic disorder

Definition

Body dysmorphic disorder (BDD) is defined by the American Psychiatric Association in the *Diagnostic and Statistical Manual of Mental Disorders, 4th Edition, Text Revision (DSM-IV-TR)* as a condition marked by excessive preoccupation with an imaginary or minor defect in a facial feature or localized part of the body.

Demographics

BDD is thought to affect 1–2% of the general population in the United States and Canada, although some doctors think that it is underdiagnosed because it coexists so often with depression and other disorders. Estimates suggest that between 2% and 7% of people who have **cosmetic surgery** have the disorder. Reported rates of BDD among dermatology patients range between 6% and 15%. In addition, individuals are often ashamed of grooming rituals and other behaviors associated with BDD, and may avoid telling their doctor about them.

The usual age of onset of BDD is late childhood or early adolescence; the average age of individuals diagnosed with the disorder is 17, although the disorder may develop in older individuals who become preoccupied with the physical effects of **aging**. The disorder affects men and women equally, but there are no reliable data regarding racial or ethnic differences in the incidence of the disorder. BDD has a high rate of comorbidity, which means that people diagnosed with the disorder are highly likely to also be diagnosed with another psychiatric disorder, most commonly major depression, social phobia, or **obsessive-compulsive disorder** (OCD). About half of all men (but not women) diagnosed with BDD also have a **substance abuse** disorder. About 29% of individuals with BDD eventually try to commit **suicide**.

Description

The earliest known case of BDD in the medical literature was reported by an Italian physician named Enrique Morselli in 1886, but the disorder was not defined as a formal diagnostic category in the United States until 1987. The World Health Organization (WHO) did not add BDD to the International Classification of Diseases (ICD) until 1992. The word *dysmorphic* comes from two Greek words that mean "bad" or "ugly" and "shape" or "form." BDD was previously known as dysmorphophobia.

BDD is characterized by an unusual degree of worry or concern about a specific part of the face or body rather than concern about the general size or shape of the body. It is distinguished from **anorexia nervosa** and **bulimia nervosa** in that individuals with **eating disorders** are preoccupied with their overall weight and body shape. As many as 50% of individuals diagnosed with BDD undergo **plastic surgery** to correct their perceived physical defects.

The diagnostic criteria specify that the condition must be sufficiently severe to cause a decline in the individual's social, occupational, or educational functioning. The most common cause of this decline is the time lost in obsessing about the "defect." One study found that 68% of individuals in a sample of adolescents diagnosed with

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KEY TERMS

Body image—A term that refers to a person's inner picture of his or her outward appearance. It has two components: perceptions of the appearance of one's body, and emotional responses to those perceptions.

Delusion—A false belief that is resistant to reason or contrary to fact. Common delusions include delusions of persecution, delusions about one's importance (sometimes called delusions of grandeur), or delusions of being controlled by others. In BDD, the delusion is related to the individual's perception of his or her body.

Displacement—A psychological process in which repressed feelings of discontent are expressed outwardly as the concern or preoccupation with an issue or problem that the individual considers more acceptable. In some BDD individuals, obsession about the body includes displaced feelings, often related to a history of childhood abuse.

Muscle dysmorphia—A subtype of BDD, described as excessive preoccupation with muscularity and body building to the point of interference with social, educational, or occupational functioning.

Neurotransmitter—One of a group of chemicals secreted by a nerve cell (neuron) to carry a chemical message to another nerve cell, often as a way of transmitting a nerve impulse. Examples of neurotransmitters include acetylcholine, dopamine, serotonin, and norepinephrine.

Obsessive-compulsive disorder (OCD)—An anxiety disorder in which a person cannot prevent himself from dwelling on unwanted thoughts, acting on urges, or performing repetitious rituals, such as washing his hands or checking to make sure he turned off the lights.

Off-label use—Drugs in the United States are approved by the Food and Drug Administration (FDA) for specific uses over periods of time or in dosages based on the results of clinical trials. However, it is legal for physicians to administer these drugs for other "off-label" or non-approved uses. It is not legal for pharmaceutical companies to advertise drugs for off-label uses.

Selective serotonin reuptake inhibitors (SSRIs)—A class of antidepressants that work by blocking the reabsorption of serotonin in brain cells, raising the level of the chemical in the brain. SSRIs include Prozac, Zoloft, Luvox, and Paxil.

Serotonin—A chemical produced by the brain that functions as a neurotransmitter. Low serotonin levels are associated with mood disorders, particularly depression and obsessive-compulsive disorder. Medications known as selective serotonin reuptake inhibitors (SSRIs) are used to treat BDD and other disorders characterized by depressed mood.

Somatoform disorders—A group of psychiatric disorders in the DSM-IV-TR classification that are characterized by external physical symptoms or complaints. BDD is classified as a somatoform disorder.

BDD spent three or more hours every day thinking about the body part or facial feature of concern. BDD is part of the larger category of **somatoform disorders**, which are disorders characterized by physical complaints that appear to be medical in origin but that cannot be explained in terms of a physical disease, the results of substance **abuse**, or by another mental disorder.

Some psychiatrists have suggested that there is a subtype of BDD, known as muscle dysmorphia. Muscle dysmorphia is marked by excessive concern with one's muscularity and/or fitness. Persons with muscle dysmorphia spend unusual amounts of time working out in gyms or exercising rather than dieting obsessively or seeking plastic surgery.

BDD and muscle dysmorphia can both be described as disorders resulting from the individual's distorted body image. Body image refers to a person's mental picture of his or her outward appearance, including size, shape, and form. It has two major components: how the person perceives his or her physical appearance and how he or she feels about his or her body. Significant distortions in self-perception can lead to intense dissatisfaction with one's body and dysfunctional behaviors aimed at improving one's appearance. Some individuals with BDD are aware that their concerns are excessive, but others do not have this degree of insight; about 50% of individuals diagnosed with BDD also meet the criteria for a delusional disorder.

Causes and symptoms

The causes of BDD are not clearly understood; however, they are thought to involve neurobiological and psychosocial factors.

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Neurobiological causes

Research indicates that individuals diagnosed with BDD have serotonin levels that are lower than normal. Serotonin is a neurotransmitter and low levels also are associated with depression and other **mood disorders**. Research released in 2010 also suggests a strong relationship between BDD and OCD in that both disorders show somewhat similar defects in memory processing. Furthermore, studies indicate that people who have a family member with BDD are more likely to develop the disorder, suggesting there is an inherited component to the disorder.

Psychosocial causes

Another factor in the development of BDD is one's experience with body image messages. Impressionable children and adolescents absorb the message from advertising and mass media that anything short of physical perfection is unacceptable. They may then develop distorted perceptions of their own faces and bodies.

A young person's family of origin also has a powerful influence on his or her vulnerability to BDD. Children whose parents are themselves obsessed with appearance, dieting, and/or bodybuilding, or who are highly critical of their children's looks, are at greater risk of developing BDD.

An additional factor in some young people is a history of childhood trauma or abuse. Buried feelings about the abuse or traumatic incident may emerge in the form of obsession about a part of the face or body. This "reassignment" of emotions from the unacknowledged true cause to another issue is called displacement. For example, an adolescent who frequently felt overwhelmed in childhood by physically abusive parents may develop a preoccupation at the high school level with muscular strength and power.

Symptoms

The central symptom of BDD is excessive concern with a specific facial feature or body part. Research indicates that the features most likely to be the focus of the individual's attention are (in order of frequency): complexion flaws (**acne**, blemishes, **scars**, wrinkles), hair (on the head or the body, too much or too little), and facial features (size, shape, or lack of symmetry). The individual's concerns may, however, involve other body parts, and may shift over time from one feature to another. Women often become obsessed with their breasts or legs.

Other symptoms of body dysmorphic disorder include:

- Ritualistic behavior. Ritualistic behavior refers to actions that the individual performs to manage anxiety and that take up excessive amounts of his or her time. Individuals are typically upset if someone or something interferes with or interrupts their ritual. Ritualistic behaviors in BDD may include exercise or makeup routines, assuming specific poses or postures in front of a mirror, etc. In this way, BDD appears to be related to OCD.
- Camouflaging the "problem" feature or body part with makeup, hats, or clothing. Camouflaging appears to be the single most common symptom among individuals with BDD. It is reported by 94% of individuals with BDD.
- Abnormal behavior around mirrors, car bumpers, large windows, or similar reflecting surfaces. A majority of individuals diagnosed with BDD frequently check their appearance in mirrors or spend long periods doing so. A minority, however, react in the opposite fashion and avoid mirrors whenever possible.
- Frequent requests for reassurance from others about their appearance.
- Frequently comparing one's appearance to others.
- Avoiding activities outside the home, including school and social events.

Diagnosis

Physicians in family practice often make the diagnosis of BDD in children or adolescents because they are more likely to have developed long-term relationships of trust with young people. At the adult level, it is often specialists in dermatology, **cosmetic dentistry**, or plastic surgery who may suspect that the individual suffers from BDD because of frequent requests for repeated or unnecessary procedures.

The diagnosis is made on the basis of the individual's history together with the physician's observations of the individual's overall mood and conversation patterns. People with BDD often come across to others as generally anxious and worried. In addition, the individual's dress or clothing styles may suggest a diagnosis of BDD. It is not unusual, however, for individuals with BDD to take offense if their primary care doctor suggests referral to a psychiatrist.

Diagnosis begins with a complete **physical examination**. A **complete blood count** (CBC), substance abuse screen, and measurement of thyroid hormone may be ordered to rule out other conditions. A mental status evaluation is made, and some physicians use a self-report questionnaire, such as the Multidimensional Body-Self Relations Questionnaire (MBSRQ) or the short form of

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the Situational Inventory of Body-Image Dysphoria (SIBID), to evaluate individuals during an office visit.

Treatment

The standard course of treatment for body dysmorphic disorder is a combination of medications and **psychotherapy**. Surgical, dental, or dermatologic treatments have been found to be ineffective.

Drugs

The medications most frequently prescribed for individuals with BDD are the **selective serotonin reuptake inhibitors** (SSRIs), most commonly fluoxetine (Prozac) or sertraline (Zoloft). Other SSRIs that have been used with this group of individuals include fluvoxamine (Luvox) and paroxetine (Paxil). These drugs are not approved by the United States Food and Drug Administration (FDA) for use in treating BDD (i.e., this is an off-label use). Individuals with BDD require higher dosages of SSRI medications than patients who are being treated for depression with these drugs; however, treatment of BDD with SSRIs results in a relatively high rate of positive responses.

Psychotherapy

The most effective approach to psychotherapy with BDD individuals is cognitive-behavioral restructuring. Since the disorder is related to **delusions** about one's appearance, cognitive-oriented therapy that challenges inaccurate self-perceptions is more effective than purely supportive approaches. Thought-stopping and relaxation techniques also work well with BDD individuals when they are combined with cognitive restructuring.

Some doctors recommend couples therapy or **family therapy** in order to involve the individual's parents, spouse, or partner in his or her treatment. This approach may be particularly helpful if family members are critical of the individual's looks or are reinforcing his or her unrealistic body image.

Alternative treatment

Although no alternative or complementary form of treatment has been recommended specifically for BDD, such herbal remedies for depression as **St. John's wort** have been reported as helping some BDD individuals. **Aromatherapy** appears to be a useful aid to relaxation techniques as well as a pleasurable physical experience for BDD individuals. **Yoga** has helped some persons with BDD acquire more realistic perceptions of their bodies and to replace obsessions about external appearance with new respect for their body's inner structure and functioning.

Home remedies

Individuals with BDD may find the following actions helpful in reducing symptoms of BDD when used in conjunction with medication and psychotherapy:

- Exercising regularly
- Avoiding recreational drugs and alcohol
- Writing about emotions in a journal
- Joining a support group for people with BDD
- Practicing stress control techniques
- Learning what situations are personal triggers for body image anxiety

Prognosis

BDD is a chronic disease with few symptom-free intervals, although the intensity of symptoms may have periods of improvement and periods of worsening. The disorder requires ongoing treatment. Just over half of patients with BDD who have improved relapse within 6 months of discontinuing treatment.

Prevention

Given the pervasive influence of the mass media in contemporary Western societies, the best preventive strategy involves challenging the media's unrealistic portrayal of "attractive" people. Parents, teachers, primary health care professionals, and other adults who work with young people can point out and discuss the pitfalls of trying to look "perfect." However, given the apparent biochemical component to BDD, this is of limited preventative value. Parents and other adults who work with young people can educate themselves about BDD and its symptoms and pay attention to any warning signs in children's dress or behavior so that treatment can be begun as early as possible.

Resources

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"Body Dysmorphic Disorder." MedicineNet.com. March 6, 2008. http://www.medicinenet.com/body_dysmorphic_disorder/article.htm

ORGANIZATIONS

American Academy of Child and Adolescent Psychiatry, 3615 Wisconsin Avenue, NW, Washington, DC, 20016-3007, (202) 966-7300, (202) 966-2891, http://www.aacap.org.
American Psychiatric Association, 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209-3901, (703) 907-7300, apa@psych.org, http://www.psych.org.
Mental Health America, 2000 North Beauregard Street, 6th Floor, Alexandria, VA, 22311, (703) 684-7722, (800) 969-6642, TTY (800) 433-5959, (703) 684-5968, http://www.nmha.org.
National Institute of Mental Health, 6001 Executive Boulevard, Room 8184, MSC 9663, Bethesda, MD, 20892-9663, (301) 443-4513, TTY (301) 443-8431, (866) 615-6464, TTY (866) 415-8051 , (301) 443-4279, nimhinfo@nimh.gov, http://www.nih.nih.gov.

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Body image

Definition

Body image is a person's mental opinion or description of his or her own physical appearance. It also involves the reactions of others toward that person's physical body based on what is perceived by that person. The concept of body image slowly develops over time, generally beginning in infancy. Perception of body image among people can widely range from very negative to very positive. Depending on age and other factors, the degree of concern with body image can also widely vary among an individual.

A person who has a poor body image perceives their body as unattractive to others, while someone with a good body image views their body as being attractive to others. Body image is studied within the area of **psychoanalysis**, which is a psychological theory that involves mental functions of humans both consciously and unconsciously.

Generally, within psychoanalytic study, body image is not related to any objective measure (based on facts) but is subjective (based on opinions and feelings) in nature. Consequently, one's opinion of their own body image may or may not parallel how others judge that person's body image. For instance, people judging a person may view that person as attractive, whereas that person may judge themselves as having an unattractive body image.

Body image involves the perception of one's own body, based chiefly on comparison to socially constructed standards or ideals. Humans have the unique ability to form abstract conceptions about themselves. This can cause conflict when a person places unrealistic demands on him- or herself, especially on his or her own body. As the advertising and film industries bombard the industrialized world with images of idealized beauty, more and more adolescents are forming negative body images and engaging in self-destructive behaviors to fit an unrealistic ideal.

Body image, especially with young people going through **puberty** (a stage of physical and mental development that allows for sexual reproduction), can become a problem especially when: parents are overly concerned with their children's weights and appearances; parents, especially mothers, are very self-aware with their own weights and appearance; other children use excess pressure on their peers (fellow children) to look or act a particular way; and mass media advertisements and other such means that idealize a certain body type. Body image is also closely associated with self-esteem, which is defined as the amount of value and worthiness a person inwardly feels.

Older children and young adults are more concerned about how other people view them than other age groups, and so are much more sensitive in regards to body image and vulnerable to external pressures. This can affect their self-esteem as their bodies go through dramatic changes from adolescence to adulthood (puberty). Boys may be overly concerned with height when seeing girls of their same age growing faster. Girls may feel sensitive about their height, weight, or other noticeable changes happening within their body.

Statistically, according to the National Eating Disorders Association, 91% of young college women report having been on at least one diet. Seventy percent of young college men report being unhappy with their body image—with 32% of all college men stating that they have been on one or more **diets**. Other studies show similar percentages in older children and young adults, which help to support the contention that young people are very concerned with body image—a body image where the ideal is to be very slim.

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School-age children

Children begin to recognize themselves in mirrors in meaningful ways at about 18 months and begin perceiving themselves as physical beings in toddlerhood. School-age children are aware of how their bodies look, although relatively few focus an inappropriate amount of attention on them. Ideally, children learn that their physical appearance is in many ways beyond their control and learn to accept their bodies without judgment. However, children living in the industrialized world are immersed in a culture that creates standards of idealized beauty and then connects those standards to personal worth. Consequently, school-age children can become convinced that they are only worthwhile if they live up to an idealized standard of physical appearance.

Even without the pernicious effects of the media, children face prejudices based on their appearances. Children spend much of their early lives in schools, which are highly social and competitive, with notoriously rigid social hierarchies that are often based on physical appearance. Studies have found that teachers are also drawn to the most attractive children, which can further compound a child's poor body image. In a school-age child, a poor body image usually results in social withdrawal and poor self-esteem.

Adolescence

As puberty nears, children become increasingly focused on the appearance of their bodies. An adolescent may mature more quickly or slowly than his or her peers or in a way that is unattractive or makes the adolescent stand out in the crowd. Any deviation from the ideal can result in a negative body image, and adolescents may diet, **exercise**, or use **steroids**, stimulants, or **laxatives** to counter their own negative self-concept and achieve the body image they desire. In the mid-2000s, teenage girls are increasingly having **plastic surgery** (with parental permission) to "correct" what they perceive as flaws in their appearance.

Distorted body images in adolescence can lead to a number of disorders, such as **anorexia nervosa**, bulimia, or **body dysmorphic disorder**, a severe, clinically recognized illusory body image. The behaviors that accompany these psychiatric disorders create physical disorders that can be life-threatening. Body image disorders are often accompanied by additional psychological problems, such as depression or **anxiety** and thoughts of **suicide**. Eventually body image becomes an all-consuming preoccupation.

Purpose

Scientists have found that body image is first formed as an infant during contact, or lack of contact, with people such as parents and family members. Physical contact in the form of hugs, kisses, and other forms of affection can help develop an early positive body image. Lack of such contact can have the opposite effect, forming an early negative body image.

The purpose of body image is generally used as a way for individuals to compare themselves against a model (ideal) image and for people to compare others through physical traits and characteristics. It is usually measured against an ideal body shape with respect to various physical characterizations such as facial features and overall body weight of the human body, including fatness and muscle mass.

Within the field of psychoanalysis, a person's body image is often measured by asking a person to rate parts of his/her current body (such as face, stomach, and buttocks) with respect to a series of pictures representing an ideal body image. The difference in the rating between a person's current body image and a perceived idea body image is generally considered the amount a person is dissatisfied with their body.

Description

Concern with body image is generally more important with women than it is with men. Women usually are more critical of their overall body and individual parts of their body than are men. However, the gap between the two genders has been narrowing over recent years as men become more concerned with their body image.

A perception of a poor body image often relates with a feeling of being overweight, especially with women. Men, on the other hand, desire more muscle mass when considering their body image. Their feeling to be more masculine parallels this desire to add additional muscle mass and to produce more definition in their current muscles.

Generally, a poor body image can lead to constant and fad dieting, **obesity**, and eating disorders, along with low self-esteem, depression, anxiety, and overall emotional distress. However, for the most part, people with good exercise habits, positive personal and sexual experiences, and excellent emotional and mental states have better and more accurate perceptions of their body image than people without those characteristics and experiences. These people also have fewer problems associated with a poor body image.

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Precautions

Exaggerated and distorted concerns with body image have been linked in medical studies with decreases in self-esteem and increases in dieting and eating disorders, including anorexia nervosa, **binge eating** disorder, and bulimia. Bulimia is an eating disorder marked by episodes of binge eating followed by one or more behaviors to control weight, most commonly self-induced **vomiting**, laxative **abuse**, **fasting**, or excessive exercise. The disorder is rare in children under age 14. It is estimated to occur in between 1% and 3% of high school- and college-aged women in the United States.

People with extreme body image problems may have body dysmorphic disorder (BDD), which involves a distorted body image without any eating disorders. Body dysmorphic disorder was formally recognized as a psychiatric disorder in 1997, although its symptoms have been described in patients for more than 100 years. The disorder involves obsession and complete preoccupation with an imagined or mild physical flaw. It is known to occur in 1–2% of Americans, but is thought to be underdiagnosed because it often occurs in conjunction with other psychiatric disorders such as major depression and **obsessive-compulsive disorder**. Excessive preoccupation with body image and an exaggerated obsession on positive body image has also been associated with the personality disorder narcissism (self-admiration, or an overestimation about one's appearance).

Interactions

Body image can be affected by outside influences. Media sources, such as television, the Internet, and magazines, often portray people closer to the commonly accepted ideal body type than the average body image in order to sell their products and services. Consequently, people—especially older children and young adults—are overly influenced and swayed by such depictions of body image. For instance, according to the Association of Body Image and Disordered Eating (ABIDE), the average U.S. citizen was exposed to about 5,000 advertising messages each and every day. Studies of network television commercials have shown that attractiveness is a desirable trait that advertisers regularly use to convince viewers to purchase their products.

Family life can also affect a person's perception of their body image. Parents that criticize their children, such as in the way they look, talk, or act, often may have a negative effect on the development of self-esteem in their offspring.

Young people may also be affected by the comments of classmates and peers when it comes to their body image. Teasing is often a method used by young people to convey negative comments and hurtful words. Racial, sexual, and other types of teasing can have a negative impact on body image and self-esteem. Children often try to pressure their peers to conform to what is currently popular in clothing styles, language, and other characteristics, all of which can potentially hurt one's perception of their body image.

Complications

Without a healthy regard for one's self, people can often become very self-conscious of their body image. Feelings of depression, anxiety, and isolation may occur. With low self-esteem and body image problems, some people use alcohol or drugs to offset those negative feelings. Others turn away from their regular activities and their usual friends—becoming withdrawn and showing lack of interest in themselves and the world around them.

A person may recover from such feelings by attempting to accept things that cannot be changed and working on things that realistically could be improved. In some cases, outside help is needed in the form of a guidance counselor, parent, coach, religious leader, or someone else that is trusted and accepting of personal feelings. Crisis hotlines are also available to help with such problems.

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ORGANIZATIONS

Academy for Eating Disorders, 60 Revere Drive, Suite 500, Northbrook, IL, 60062-1577, (206) 382-3587, (800) 931-2237, http://www.nationaleatingdisorders.org.
National Association of Anorexia Nervosa and Associated Disorders (ANAD), P.O. Box 7, Highland Park, IL, 60035, (847) 831-3438.
National Eating Disorders Association, 603 Stewart Street, Suite 803, Seattle, WA, 98101, (206) 382-3587, (206) 829-8501, info@NationalEatingDisorders.org, http://www.edap.org.

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Body lice *see* **Lice infestation**

Boils

Definition

Boils and carbuncles are bacterial infections of hair follicles and surrounding skin that form pustules (small blister-like swellings containing pus) around the follicle. Boils are sometimes called furuncles. A carbuncle is formed when several furuncles merge to form a single deep **abscess** with several heads or drainage points.

Boils often occur from a bacterial infection in a hair follicle or skin gland. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

A close-up view of a carbuncle on person's back. *(John Watney/Photo Researchers, Inc.)*

Description

Boils and carbuncles are firm reddish swellings about 0.2–0.4 in. (5-10 mm) across that are slightly raised above the skin surface. They are sore to the touch. A boil usually has a visible central core of pus; a carbuncle is larger and has several visible heads. Boils occur most commonly on the face, back of the neck, buttocks, upper legs and groin area, armpits, and upper torso. Carbuncles are less common than single boils; they are most likely to form at the back of the neck. Males are more likely to develop carbuncles.

Boils and carbuncles are common problems in the general population, particularly among adolescents and adults. People who are more likely to develop these skin infections include those with:

- diabetes, especially when treated by injected insulin
- alcoholism or drug abuse
- poor personal hygiene
- crowded living arrangements
- jobs or hobbies that expose them to greasy or oily substances, especially petroleum products
- allergies or immune system disorders, including HIV infection.
- family members with recurrent skin infections

Causes and symptoms

Boils and carbuncles are caused by *Staphylococcus aureus*, a bacterium that causes an infection in an oil gland or hair follicle. Although the surface of human skin is usually resistant to bacterial infection, *S. aureus* can enter through a break in the skin surface—including breaks caused by needle punctures for insulin or drug injections. Hair follicles that are blocked by greasy creams, petroleum jelly, or similar

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KEY TERMS

Abscess—A localized collection of pus in the skin or other body tissue.

Carbuncle—A large, deep skin abscess formed by a group or cluster of boils.

Follicle—The small sac at the base of a hair shaft. The follicle lies below the skin surface.

Furunculosis—A condition in which the patient suffers from recurrent episodes of boils.

Pustule—A small raised pimple or blister-like swelling of the skin that contains pus.

products are more vulnerable to infection. Bacterial skin infections can be spread by shared cosmetics or washcloths, close human contact, or by contact with pus from a boil or carbuncle.

As the infection develops, an area of inflamed tissue gradually forms a pus-filled swelling or pimple that is painful to touch. As the boil matures, it forms a yellowish head or point. It may either continue to swell until the point bursts open and allows the pus to drain, or it may be gradually reabsorbed into the skin. It takes between one and two weeks for a boil to heal completely after it comes to a head and discharges pus. The bacteria that cause the boil can spread into other areas of the skin or even into the bloodstream if the skin around the boil is injured by squeezing. If the infection spreads, the patient will usually develop chills and **fever**, swollen lymph nodes (**lymphadenitis**), and red lines in the skin running outward from the boil.

Furunculosis is a word that is sometimes used to refer to recurrent boils. Many patients have repeated episodes of furunculosis that are difficult to treat because their nasal passages carry colonies of *S. aureus*. These bacterial colonies make it easy for the patient's skin to be reinfected. They are most likely to develop in patients with diabetes, HIV infection, or other immune system disorders.

Carbuncles are formed when the bacteria infect several hair follicles that are close together. Carbunculosis is a word that is sometimes used to refer to the development of carbuncles. The abscesses spread until they merge with each other to form a single large area of infected skin with several pus-filled heads. Patients with carbuncles may also have a low-grade fever or feel generally unwell.

Diagnosis

The diagnosis of boils and carbuncles is usually made by the patient's primary care doctor on the basis of visual examination of the skin. In some cases involving recurrent boils on the face, the doctor may need to consider **acne** as a possible diagnosis, but for the most part boils and carbuncles are not difficult to distinguish from other skin disorders.

Treatment

Patient and family education

Patient education is an important part of the treatment of boils and carbuncles. Patients need to be warned against picking at or squeezing boils because of the danger of spreading the infection into other parts of the skin or bloodstream. It is especially important to avoid squeezing boils around the mouth or nose because infections in these areas can be carried to the brain. Patients should also be advised about keeping the skin clean, washing their hands carefully before and after touching the boil or carbuncle, avoiding the use of greasy cosmetics or creams, and keeping their towels and washcloths separate from those of other family members. Some doctors may recommend an antiseptic soap or gel for washing the infected areas.

If the patient has had several episodes of furunculosis, the doctor may examine family members or close contacts to see if they are carriers of *S. aureus*. In many cases they also need treatment for boils or carbuncles. Skin infections and reinfections involving small groups or clusters of people are being reported more frequently in the United States.

Medications

Boils are usually treated with application of antibiotic creams—usually clindamycin or polymyxin—following the application of hot compresses. The compresses help the infection to come to a head and drain.

Carbuncles and furunculosis are usually treated with oral **antibiotics** as well as antibiotic creams or ointments. The specific medications that are given are usually dicloxacillin (Dynapen) or cephalexin (Keflex). Erythromycin may be given to patients who are allergic to penicillin. The usual course of oral antibiotics is 5–10 days; however, patients with recurrent furunculosis may be given oral antibiotics for longer periods. Furunculosis is treated with a combination of dicloxacillin and rifampin (Rifadin).

Patients with bacterial colonies in their nasal passages are often given mupirocin (Bactroban) to apply directly to the lining of the nose.

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Surgical treatment

Boils and carbuncles that are very large, or that are not draining, may be opened with a sterile needle or surgical knife to allow the pus to drain. The doctor will usually give the patient a local anesthetic if a knife is used; surgical treatment of boils is painful and usually leaves noticeable **scars**.

Alternative treatment

Naturopathic therapy

Naturopathic practitioners usually recommend changes in the patient's diet as well as applying herbal poultices to the infected area. The addition of zinc supplements and vitamin A to the diet is reported to be effective in treating boils. The application of a paste or poultice containing goldenseal (*Hydrastis canadensis*) root is recommended by naturopaths on the grounds that goldenseal helps to kill bacteria and reduce inflammation.

Homeopathy

Homeopaths maintain that taking the proper homeopathic medication in the first stages of a boil or carbuncle will bring about early resolution of the infection and prevent pus formation. The most likely choices are *Belladonna* or *Hepar sulphuris*. If the boil has already formed, *Mercurius vivus* or *Silica* may be recommended to bring the pus to a head.

Western herbal therapies

A variety of herbal remedies can be applied topically to boils to fight infection. These include essential oils of bergamot (*Citrus bergamia*), chamomile (*Matricaria recutita*), lavender (*Lavandula officinalis*), and sage (*Salvia officinalis*), as well as tea tree oil (*Melaleuca* spp.). Herbalists also recommend washing the skin with a mixture of goldenseal and witch hazel. To fight the inflammation associated with boils, herbalists suggest marsh mallow (*Althaea officinalis*) ointment, tinctures (herbal solutions made with alcohol) of blue flag (*Iris versicolor*) or myrrh (*Commiphora molmol*), and slippery elm (*Ulmus fulva*) made into a poultice.

Prognosis

The prognosis for most boils is excellent. Some patients, however, suffer from recurrent carbuncles or furunculosis. In addition, although the spread of infection from boils is relatively unusual, there have been deaths reported from brain infections caused by squeezing boils on the upper lip or in the tissue folds at the base of the nose.

Prevention

There are some precautions that people can take to minimize the risk of developing bacterial skin infections:

- cleanse skin properly with soap and water, and take showers rather than tub baths
- do not share washcloths, towels, or facial cosmetics with others
- cut down on greasy or fatty foods and snacks
- always wash hands before touching the face
- consider using antiseptic soaps and shower gels
- consult a doctor if furunculosis is a persistent problem—it may indicate an underlying disease such as diabetes

Resources

BOOKS

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Rebecca J. Frey, PhD

Bone biopsy

Definition

Bone biopsy is the removal of a piece of bone for laboratory examination and analysis.

Purpose

Bone biopsy is used to distinguish between malignant tumors and benign bone disease such as **osteoporosis** and **osteomyelitis**. This test may be ordered to determine why a patient's bones ache or feel sore, or when a mass or deformity is found on an x ray, CT scan, **bone scan**, or other diagnostic imaging procedure.

Precautions

The patient's doctor and the surgeon who performs the bone biopsy must be told about any prescription and over-the-counter medications the patient is taking, and about **allergies** or reactions the patient has had to anesthetics or **pain** relievers. Special care must be taken with patients who have experienced bleeding problems.

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KEY TERMS

Biopsy—Removal and examination of tissue to determine if cancer is present.

Osteomyelitis—An infection of the bone that is usually treated with antibiotics but sometimes requires surgery.

Osteoporosis—Thinning and loss of bone tissue.

Description

A bone biopsy involves using a special drill or other surgical instruments to remove bone from the patient's body. The procedure usually lasts about 30 minutes and may be performed in the hospital, a doctor's office, or a surgical center.

A drill biopsy is generally used to obtain a small specimen. After the skin covering the bone has been cleansed with an antiseptic and shaved, the patient is given a local anesthetic. The doctor will not begin the procedure until the anesthetic has numbed the area from which the bone is to be removed, but the patient may feel pressure or mild pain when the needle pierces the bone. The surgeon turns the needle in a half-circle to extract a sample from the core, or innermost part, of the bone. The sample is drawn into the hollow stem of the biopsy needle. The sample is then sent to a laboratory where it is examined under a microscope.

An open biopsy is used when a larger specimen is needed. After the area covering the bone has been cleansed with an antiseptic and shaved, the patient is administered a general anesthetic. After the anesthetic takes effect and the patient is unconscious, the surgeon makes an incision and removes a bone specimen. The specimen is sent to the laboratory for immediate analysis. Results of that analysis may indicate that additional surgery should be performed right away.

Preparation

No special preparation is needed for a drill biopsy, but a patient must fast for at least 12 hours before an open biopsy.

Some patients who are taking anticoagulants, **aspirin** and/or other products containing salicylates, some herbs, and **nutritional supplements** may be asked by their health care provider to discontinue taking the medications/products for a specified number of days prior to the procedure.

Aftercare

Pain medication is prescribed after a biopsy, and vital signs are monitored until they return to normal. Most patients can go home in about an hour. If bone was removed from the spine, the patient may stay in the hospital overnight. Sutures may be necessary to close the biopsy site. The surgical site must be kept clean and dry for 48 hours, and the patient's doctor should be notified if any of these symptoms appear:

- fever
- headache
- pain on movement
- inflammation or pus near the biopsy site
- bleeding through the bandage at the biopsy site

Some patients may be prescribed a course of **antibiotics** after discharge from the health care facility. Antibiotics should be taken as prescribed and the entire course of antibiotic therapy should be completed by the patient.

Risks

Risks include bone fracture, injury to nearby tissue, and infection. Bleeding is a rare complication. Factors that increase risk include:

- stress
- obesity
- poor nutrition
- chronic illness
- some medications
- mind-altering drugs

Results

Normal bone is made up of collagen fibers and bone tissue.

Abnormal results

Bone biopsy can reveal the presence of benign disease, infection, or malignant tumors that have spread to the bone from other parts of the body.

Results of this test are considered reliable, but may be affected by a failure to obtain an adequate specimen or delayed microscopic examination or laboratory analysis.

ORGANIZATIONS

National Institute of Arthritis and Musculoskeletal and Skin Diseases Information Clearinghouse, National Institutes

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of Health, 1 AMS Circle, Bethesda, MD, 20892-3675, (301) 495-4484 (877) 336-4267http://www.niams.nih.gov.

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Bone break fever *see* **Dengue fever**
Bone cancer *see* **Sarcomas**
Bone densitometry *see* **Bone density test**

Bone density test

Definition

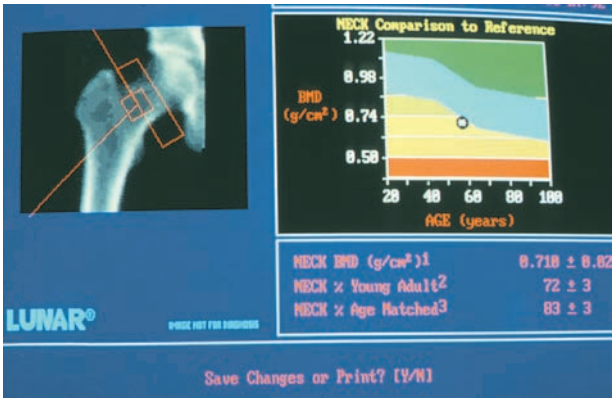
A bone density test, or bone density scan, is designed to check for **osteoporosis**, a disease that occurs when the bones become thin and weak. Osteoporosis occurs when the bones lose **calcium** and other **minerals** that keep them strong.

Purpose

A bone density scan measures the strength of an individual's bones and determines the risk of fracture. An observation of any osteoporosis present can be made.

Demographics

In 2008, the National Osteoporosis Foundation estimated that 10 million people in the United States over age 50 had osteoporosis, and another 34 million were at risk for developing the disease. Women are four to five times more likely than men to develop osteoporosis between ages 50 and 65. They have smaller, thinner bones than men to begin with, and they lose bone mass more rapidly after **menopause** (usually around age 50) when they stop producing the female reproductive hormone estrogen, which has a bone-protecting effect. In the five to seven years following menopause, women can lose about 20% of their bone mass. By age 65, however, men and women lose bone mass at about the same rate. About half of all of men and women over the age of 75 have osteoporosis. As an increasing number of men live to an older age, there is more awareness that osteoporosis is an important health issue for them as well as for women. Although people of any ethnic background can develop osteoporosis, it is especially common among white and Asian women over age 50.



Computer read-out of a bone density scan. *(Photo Researchers, Inc.)*

Patient undergoing a bone density scan. *(Photo Researchers, Inc.)*

Description

Many people are not aware that they have osteoporosis until they fracture (break) a bone. Typically, this happens in a fall that would not have caused a fracture in a young adult. Osteoporosis is estimated to be responsible for 2 million **fractures** annually. The National Institutes of Health (NIH) estimates that after age 50, half of all women and one out of every eight men will experience an osteoporosis-related fracture. These fractures can occur in any bone, but the most common locations are the hip, spine, and wrist. Breaks in the hip and spine are of special concern because they require hospitalization and often surgery and commonly cause a decrease in mobility or a permanent disability. Hip fractures are a leading cause of nursing home admissions in the elderly. Only about 15% of people who fracture a hip are able to walk across a room unaided six months

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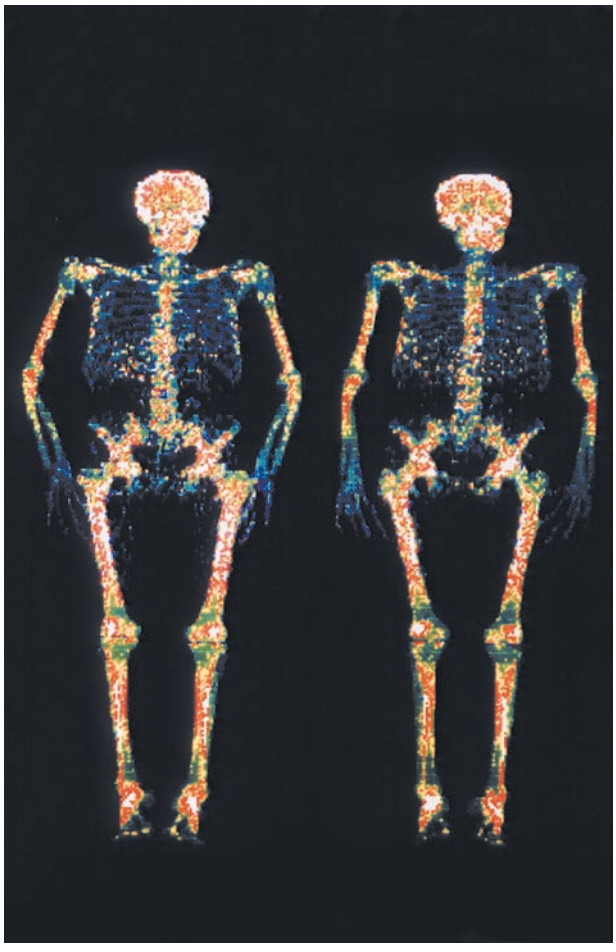

A bone densitometry scan of identical twins. Their bone density is normal and identical to one another. *(Photo Researchers, Inc.)*

KEY TERMS

Calcium—A mineral that helps build bone. After menopause, when women start making less of the bone-protecting hormone estrogen, they may need to increase their intake of calcium.

DEXA bone density scan—A bone density scan that uses a rotating x-ray beam to measure the strength of an individual's bones and his or her fracture risk.

Osteoporosis—A condition found in older individuals in which bones decrease in density and become fragile and more likely to break. It can be caused by lack of vitamin D and/or calcium in the diet.

later, and about one-fourth of people over age 50 who have a hip fracture die within one year.

Most bone density scans are done with a machine that uses a technology called Dual Energy X-ray Absorptiometry (DEXA). This machine takes a picture of the bones in the spine, hip, total body, and wrist and calculates the density of these bones. If a DEXA machine is not available, bone density scans can also be done with dual photon absorptiometry (measuring the spine, hip, and total body) and quantitative **computed tomography scans** (measuring the spine). Bone density scanners that use DEXA technology to just measure bone density in the wrist (called pDEXA scans) provide scans at some drugstores. These wrist scan tests are not as accurate as those that measure density in the total body, spine or hip.

Not all doctors routinely schedule this test. If the following factors apply to an individual, they may need a bone density scan and can discuss this with their doctor. Factors include if the individual:

- is at risk for osteoporosis
- is near menopause
- has broken a bone after a modest trauma
- has a family history of osteoporosis
- uses steroid or antiseizure medications
- has had a period of restricted mobility for more than six months

To take a DEXA bone density scan, the individual lies on a bed underneath the scanner, which has a curving plastic arm that emits x rays. These low-dose x rays form a fan beam that rotates around the body. During the test, the scanner moves to capture images of the individual's spine, hip, or entire body. A computer then compares the individual's bone strength and risk of fracture to that of other people in the United States of the same age and to young people at peak bone density. Bones reach peak density at about age 30 and then start to lose mass. The test takes about 20 minutes and is painless. Some insurance companies and Medicare cover the cost. pDEXA wrist bone scans in drugstores are available at little cost.

Preparation

Minimal preparation is needed. The individual will be asked to undress and put on a hospital gown.

Aftercare

No special aftercare is needed. The individual should be able to go home immediately without assistance after the test.

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Risks

The DEXA **bone scan** exposes the individual to only a small amount of radiation—about one-fiftieth that of a **chest x ray**, or about the amount a person is exposed to from taking a cross-country airplane flight.

Normal results

The individual, when compared with people at "young normal bone density" (called the T-score), has the same (or higher) bone density as a healthy 30-year-old. T scores above 1 mean that an individual has a healthy bone mass. Scores from 0 to −1 mean that the individual has borderline bone mass and should repeat the test in two to five years.

Abnormal results

The individual has two to four times the risk of a broken bone as other people in the United States at the same age and those at peak bone density. If an individual's T score ranges from −1 to −2.5 they have low bone mass and are at risk for osteoporosis. A T score below −2.5 means osteoporosis is already evident. These individuals should have a repeat bone density scan every year or two.

Resources

OTHER

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Cole, Adam. "How to Read Bone Density Test Results." LiveStrong.com. January 8, 2010. http://www.livestrong.com/article/23559-read-bone-density-test-results

ORGANIZATIONS

Center, 2 AMS Circle, Bethesda, MD, 20892-3676, (202) 223-0344, TTY: (202) 466-4315, (800) 624-2663(BONE), (202) 293-235, NIAMSBoneInfo@mail.nih.gov, http://www. niams.nih.gov/Health_Info/Bone.

National Osteoporosis Foundation, 1150 17th Street NW, Suite 850, Washington, DC, 20036, (202) 223-2226, (800) 231-4222, http://www.nof.org.

Barbara Boughton
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Bone disorder drugs

Definition

Bone disorder drugs are medicines used to treat weakened, brittle bones.

KEY TERMS

Fracture—A break or crack in a bone.

Menopause—The stage in a woman's life when menstruation stops.

Osteoporosis—A condition commonly found with aging, inadequate exercise, chronic illness, or taking corticosteroids such as prednisone long term. People with osteoporosis have advanced bone loss and brittle bones that are more easily fractured.

Purpose

These drugs are used to treat or prevent **osteoporosis** (brittle bones) in postmenopausal women and elderly men; to treat Paget's disease, a painful, probably genetic condition associated with weak, deformed bones; and to treat both men and women who have osteoporosis from taking **corticosteroids** (prednisone) for prolonged periods of time.

Like other living tissues, bone is constantly being reabsorbed and replaced by new bone. There is normally a balance between newly forming and older bone. **Exercise** and adequate intake of **calcium** and Vitamin D are crucial in maintaining this balance. When bone is lost more rapidly than it is formed, the condition is initially called osteopenia. Osteoporosis is advanced bone loss.

Description

Bone disorder drugs are available only with a physician's prescription and come in tablet, nasal spray, and injectable forms.

Commonly used bone disorder drugs include bisphosphonates alendronate (Fosamax) and risedronate (Actonel); the hormone calcitonin (Miacalcin, Calcimar); and raloxifene (Evista)

Recommended dosage

Doses depend on the dosage forms and conditions being treated. Consult the prescriber or pharmacist for details.

Precautions

Aldendronate (Fosamax, Actonel)

People with low blood levels of calcium should not take this medicine. When taking the drug, it is

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important to have adequate amounts of calcium and Vitamin D in the diet or as dietary supplements.

People with **kidney disease** should have their renal function carefully monitored while taking this medicine.

This medicine may worsen digestive and swallowing problems. It is important to take the medicine with a full glass of water and not lie down for at least 45 minutes afterward. If digestive problems worsen, the medicine may need to be discontinued.

Some patients with **cancer** have developed necrosis (**death**) of bone, mostly in the jaw, after taking the drug. Regular dental exams are strongly recommended.

Some patients taking this drug experience severe bone, joint, and/or muscle **pain**.

Calcitonin (Miacalcin)

Skin tests for sensitivity are frequently used before beginning treatment with this medication.

When used as a nasal spray, this drug may cause irritation and/or small sores in the nose. If this happens, it may need to be temporarily discontinued.

The injectable form of this drug has caused serious allergic reactions in some people. The nasal spray is not known to cause such reactions.

Raloxifene (Evista)

This drug increases the risk for **blood clots** and emboli to the lungs and brain. The drug should not be used in women who have a history of heart disease or **stroke** and should be discontinued at least three days before surgery or prolonged bed rest.

This drug has not been proven either safe or effective for postmenopausal women.

General precautions for bone disorder drugs

To keep bones strong, the body needs calcium and vitamin D. Dairy products and fatty fish such as salmon, sardines, and tuna are good sources of both calcium and vitamin D. People who are taking bone disorder drugs who do not get enough of these nutrients in their **diets** may need to take **nutritional supplements**.

It is important to have lifelong habits of performing regular weight-bearing exercises, such as walking, to develop and maintain strong bones.

The use of tobacco and alcohol is not recommended for people with osteopenia or osteoporosis.

Very high blood levels of calcium may interfere with the actions of these drugs.

Anyone who has had unusual reactions to bone disorder drugs in the past should let his or her physician know before taking the drugs again. The physician also should be told about any **allergies** to foods, dyes, preservatives, or other substances.

Women who are pregnant, may become pregnant, or are **breastfeeding** should check with their physicians before using these drugs.

Side effects

Aldendronate (Fosamax, Actonel)

Common side effects include **constipation**, **diarrhea**, **indigestion**, **nausea**, and abdominal, bone, or muscle pain. If these symptoms do not go away, the drug may need to be discontinued.

Calcitonin (Miacalcin)

The most common side effects of Miacalcin nasal spray are nasal dryness, redness, **itching**, sores, bleeding, and general discomfort. These problems should go away as the body adjusts to the medicine. But if they do not, or if they are very uncomfortable, check with a physician. Other side effects include skin rash, **headache**, **dizziness**, **fatigue**, and back and joint pain.

Injectable calcitonin may cause minor side effects such as nausea or **vomiting**; diarrhea; stomach pain; loss of appetite; flushing of the face, ears, hands, or feet; and discomfort or redness at the injection site.

Anyone who has a skin rash or **hives** after receiving a calcitonin injection should check with a physician.

Raloxifene (Evista)

Common side effects include swelling of the feet or legs, hot flashes, leg cramps, **nausea and vomiting**, headache, and skin rash.

Interactions

Aldendronate (Fosamax or Actonel)

Taking **aspirin** with these drugs may increase the chance of upset stomach. **Acetaminophen** (Tylenol) or buffered aspirin may reduce that possibility.

All foods and beverages interfere with the absorption of these drugs.

Calcitonin (Miacalcin)

Calcitonin may keep certain other drugs used to treat Paget's disease from working properly.

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Raloxifene (Evista)

Raloxifene may affect blood clotting. Patients who are taking warfarin (Coumadin) should check with their physicians before taking Evista.

ORGANIZATIONS

Foundation for Osteoporosis Research & Education, 1814 Franklin Street, Suite 620, Oakland, CA, 94612, (510) 832-2663, (510) 208-7174, (888) 266-3015, info@fore.org, http://www.fore.org.

National Association for the Relief of Paget's Disease, 323 Manchester Road, Walkden, Worsley, Manchester, England, M28 3HH, 44 (161) 799-4646, director@paget.org.uk, http://www.paget.org.uk.

National Osteoporosis Foundation (NOF), 1150 17th Street NW, Suite 850, Washington, DC, 20036-4603, (202) 223-2226, (202) 223-2237, (800) 231-4222, http://www.nof.org.

Nancy Ross-Flanigan
James Waun, MD, RPh

Bone grafting

Definition

Bone grafting is a surgical procedure by which new bone or a replacement material is placed into spaces between or around broken bone (**fractures**) or holes in bone (defects) to aid in healing.

Purpose

Bone grafting is used to repair bone fractures that are extremely complex, pose a significant risk to the patient, or fail to heal properly. Bone graft is also used to help fusion between vertebrae, to correct deformities, or to provide structural support for fractures of the spine. In addition to **fracture repair**, bone graft is used to repair defects in bone caused by **birth defects**, traumatic injury, or surgery for bone **cancer**.

Description

Bone is composed of a matrix mainly made up of a protein called collagen. It is strengthened by deposits of

Surgeons harvesting a sample of material for bone grafting. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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KEY TERMS

Allograft—Tissue for transplantation that is taken from another person.

Autograft—Tissue for transplantation that is taken from the patient.

Hydroxyapatite—A calcium phosphate complex that is the primary mineral component of bone.

Osteoblasts—Bone cells that build new bone tissue.

Osteoclasts—Bone cells that break down and remove bone tissue.

Osteoconduction—Provision of a scaffold for the growth of new bone.

Osteocytes—Bone cells that maintain bone tissue.

Osteogenesis—Growth of new bone.

Osteoinduction—Acceleration of new bone formation by chemical means.

calcium and phosphate salts, called hydroxyapatite. Within and around this matrix are located four types of bone cells. Osteoblasts produce the bone matrix. Osteocytes are mature osteoblasts that serve to maintain the bone. Osteoclasts break down and remove bone tissue. Bone lining cells cover bone surfaces. Together, these four types of cells are responsible for building the bone matrix, maintaining it, and remodeling the bone as needed.

There are three ways in which a bone graft can help repair a defect. The first is called osteogenesis, the formation of new bone by the cells contained within the graft. The second is osteoinduction, a chemical process in which molecules contained within the graft (bone morphogenetic proteins) convert the patient's cells into cells that are capable of forming bone. The third is osteoconduction, a physical effect by which the matrix of the graft forms a scaffold on which cells in the recipient are able to form new bone.

New bone for grafting can be obtained from other bones in the patient's own body (e.g., hip bones or ribs), called autograft, or from bone taken from other people that is frozen and stored in tissue banks, called allograft. A variety of natural and synthetic replacement materials are also used instead of bone, including collagen, the protein substance of the white fibers of the skin, bone, and connective tissues; polymers, such as silicone and some acrylics; hydroxyapatite; calcium sulfate; and ceramics. A new material, called resorbable polymeric grafts, is also being studied. These resorbable grafts provide a structure for new bone to grow on; the grafts then slowly dissolve, leaving only the new bone behind.

To place the graft, the surgeon makes an incision in the skin over the bone defect and shapes the bone graft or replacement material to fit into the defect. After the graft is placed into the defect, it is held in place with pins, plates, or screws. The incision is closed with stitches and a splint or cast is used to prevent movement of the bones while healing.

The costs associated with a bone graft vary. These costs include: the surgeon's fee (variable); anesthesiologist's fees (averaging $350 to $400 per hour); hospital charges (averaging $1,500 to $1,800 per day, more for intensive care or private rooms); medication charges ($200 to $400); and additional charges, including an assisting surgeon, treatment of complications, diagnostic procedures (e.g., blood work or x rays), medical supplies, and equipment use. The cost for the graft itself can range from $250 to $900.

This procedure is covered by many third-party insurers; insurance coverage should be explored for each individual case.

Aftercare

The time required for convalescence for fractures or spinal fusion may vary from one to 10 days, and vigorous **exercise** may be limited for up to three months.

Most bone grafts are successful in helping the bone defect to heal. The extent of recovery will depend on the size of the defect and the condition of the bone surrounding the graft at the time of surgery. Severe defects may take some time to heal and may require further attention after the initial graft. In one study of over 1,000 patients who received very large allografts after surgery for bone cancer, researchers found that approximately 85% of the patients were able to return to work or normal physical activities without using crutches. However, about 25% of these patients required a second operation, because the first did not heal properly. Less severe bone defects, though, should heal completely without serious complications.

Risks

The risks for any surgical procedure requiring anesthesia include reactions to the medications and

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breathing problems. The risks for any surgical procedure include bleeding and infection.

The drawbacks of autografts include: the additional surgical and anesthesia time (typically 30 minutes per procedure) to obtain, or harvest, the bone for grafting; added costs of the additional surgery; **pain** and infection that might occur at the site from which the graft is taken; and the relatively small amount of bone that is available for grafting.

The drawbacks of allografts include: variability between lots, since the bone is harvested from a variety of donors; the bone may take longer to incorporate with the host bone than an autograft would; the graft may be less effective than an autograft; and there is the possibility of transferring diseases to the patient. Other complications may result from the immune response mounted by the patient's immune system against the grafted bone tissue. With the use of anti-rejection agents (drugs to combat rejection of grafted bone tissue), immune rejection is less of a problem.

ORGANIZATIONS

American Association of Tissue Banks, 1320 Old Chain Bridge Road, Suite 450, McLean, VA, 22101, (703) 827-9582, (703) 356-2198, aatb@aatb.org, http://www.aatb.org.

Lisa Christenson, PhD

Bone growth stimulation

Definition

Bone growth stimulation is the technique of promoting bone growth in difficult-to-heal **fractures** by applying a low electrical current or ultrasound to the fracture.

Purpose

Bone growth stimulation is done when satisfactory healing is not occurring naturally or when the pace of healing is too slow. This condition is called fracture nonunion, and it occurs more frequently among adults than children, in people with severe or complex fractures, and in people who smoke.

The theory behind applying an electric current to fractures to stimulate healing is based on the fact that the concave side of the bone becomes negatively charged and the convex side is positively charged. It is believed that artificially encouraging this charging with an electric current will speed healing. In 1996, the Food and Drug Administration (FDA) also approved the application of low-intensity ultrasound pulses as a treatment for fracture nonunion.

Ultrasound and electromagnetic stimulation are expensive and are used only when healing problems exist for a substantial length of time. Each method must be used for at least three to six months to be effective.

KEY TERMS

Anode—The positive electrode to which an electromagnetic current flows.

Cathode—The negative electrode from which an electromagnetic current flows.

Precautions

Bone growth stimulation cannot be used if the gap between the ends of the fracture is too large.

Description

Electric stimulation can be applied either from the inside of the body (invasively) or from the outside the body (noninvasively). Ultrasound is a noninvasive procedure. The type of stimulation selected depends on the doctor's preference, the type and location of the fracture, and the patient's motivation to comply with the treatment schedule. Treatment can take anywhere from three to six months.

Invasive stimulators

Invasive electric stimulators are either fully or partially implantable. The advantage of these devices is that they apply a direct electric current to the fracture 24 hours a day. The fully implantable stimulator requires little daily attention from the patient. Patients using a semi-implanted stimulator must regulate their own treatment schedule and have to care for the external power pack. The disadvantage of implantable and semi-implantable stimulators is that their implantation is a surgical procedure.

Fully implantable direct current stimulators are installed in a hospital under general or regional anesthesia. Both the stimulator and the power source are implanted. The surgeon makes an incision and places a spiral-shaped cathode inside the bone. A wire leads to the power source and a small anode. The power source

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is a battery pack that is implanted in the nearby muscle. The body transmits electrical current to close the circuit. The incision is then closed. Once in place, the device provides continuous direct electric current for bone growth stimulation.

Partially implanted stimulators use cathode pins that are implanted at the edge of each bone that is fractured. Wires lead to the surface of the skin where a power source and the anode are located. Wires complete the circuit. The external portion of the device is held in place by a cast. This source of stimulation also runs continuously.

Noninvasive stimulators

In the noninvasive stimulator, external electromagnetic coils are placed on either side of the fracture and are held in place by a strap or cuff. Locating the coils correctly is important, and their location relative to the fracture is usually confirmed by x rays.

The coils produce a pulsating electromagnetic field. It is up to the patient to maintain the prescribed treatment schedule. Effective treatment requires stimulation anywhere from three to ten hours each day in periods of no less than one hour.

Ultrasound stimulation is the most recent treatment for stimulating bone growth. A device that generates low intensity pulses of sound is applied to the skin over the fracture. The advantage of this technique is that it is noninvasive and the period of application of the sound pulses can be as short as 20–30 minutes each day. The results of this treatment have been studied less than the effect of electromagnetic stimulation.

Preparation

Bone growth stimulation is done only when healing has failed to occur for many months. Before it is started, x rays are done of the fracture area. If the device is to be implanted, standard preoperative blood and urine tests are done. The patient may meet with an anesthesiologist to discuss any conditions that might affect the administration of anesthesia.

Aftercare

If a noninvasive, pulsating, electromagnetic field device is used, the patient must not put any stress or weight on the fracture until it is healed, which is a matter of months in most cases. In all lower limb fractures, regardless of the stimulation method used, the patient can not bear weight on the limb with the fracture until healing is complete. This limits the patient's mobility for many months. Patients have the responsibility of regularly making sure that the unit works and caring for external devices and the casts that hold them in place.

Risks

Noninvasive devices have few risks associated with them. The main risk associated with implantable devices is the development of infection at the site of implantation.

Normal results

Success in healing a fracture nonunion using bone growth stimulation depends on the type, location, and severity of the fracture and the age and general health of the patient.

Resources

OTHER

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Tish Davidson, A.M.

Bone infection *see* **Osteomyelitis**

Bone marrow aspiration and biopsy

Definition

Bone marrow aspiration, also called bone marrow sampling, is the removal by suction of the soft, spongy semisolid tissue (marrow) that fills the inside of the body's long and flat bones. Bone marrow biopsy, or needle core biopsy, is the removal of a small piece (about 0.75 x 0.06 in. [2 x 0.16 cm]) of intact bone marrow. The bone marrow is where blood cells are made.

Purpose

Examination of the bone marrow may be the next step that follows an irregular clinical finding, such as an abnormal **complete blood count** (CBC), and/or an abnormal peripheral blood smear. It also may be performed following an abnormal bone image, such as the finding of a lesion on x rays.

A biopsy of bone marrow shows the intact tissue, so that the structure of the fat cells, lymphocytes, plasma cells, fibrous connective tissue cells, and other cells—and

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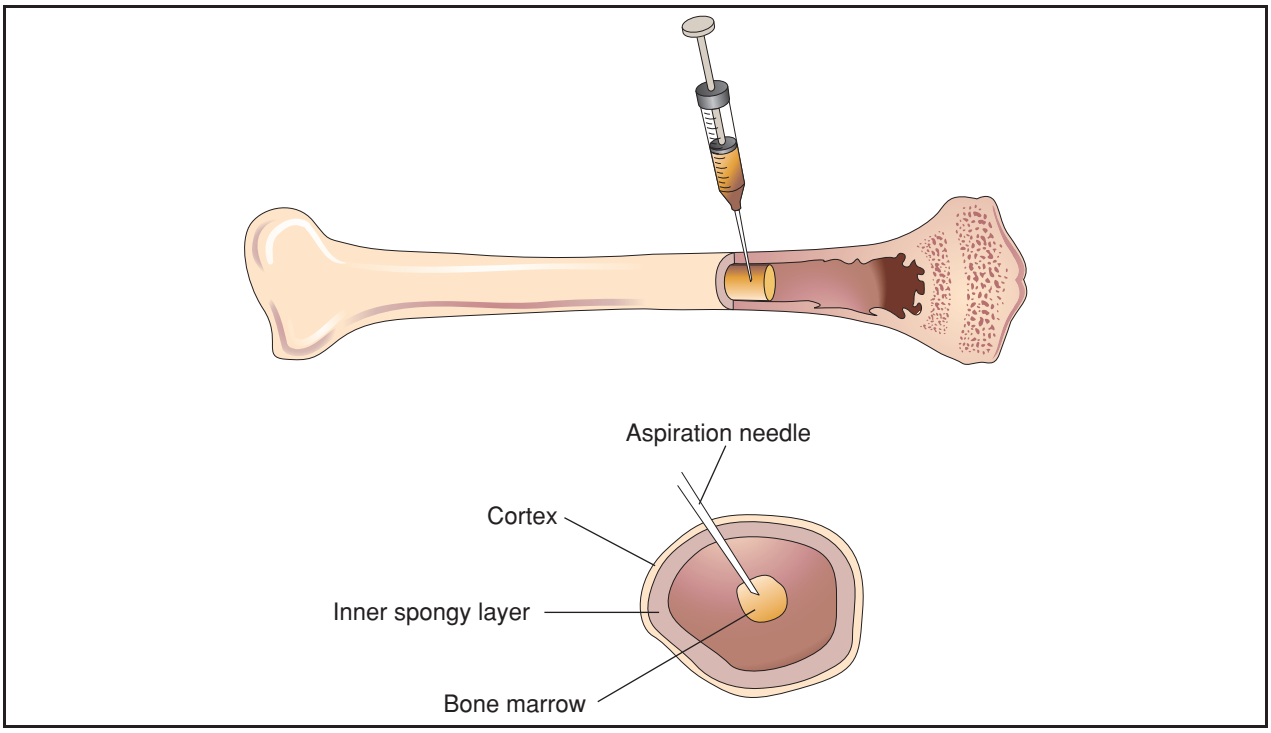

In a bone marrow aspiration, a needle is inserted beneath the skin and rotated until it penetrates the cortex, or outer covering of the bone. A small amount of marrow is suctioned out of the bone by a syringe attached to the needle. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

their relationships to each other—can be seen. A bone marrow biopsy is used to:

- diagnose and manage any form of leukemia or other myeloproliferative condition such as multiple myeloma
- rule out or confirm bone marrow infiltration by malignancies such as Hodgkin's disease, non-Hodgkin's lymphoma, and metastatic carcinoma
- monitor the effects of chemotherapy and the response or lack of response to treatment of blood disease
- evaluate the success of bone marrow transplantation
- diagnose certain genetic diseases (e.g., lipid storage disease)
- investigate pancytopenia (a decrease of all blood cells in peripheral blood), neutropenia (decreased phagocytic white blood cells), or thrombocytopenia (decreased platelets)
- diagnose an infection of unknown origin
- investigate rare anemias for which a cause cannot be found or which do not respond to treatment as anticipated
- diagnose some types of cancer, anemia, and other blood disorders
- identify the source of an unexplained fever (e.g., granulomatous lesions)
- diagnose fibrosis of bone marrow and myeloma when bone marrow aspiration has failed to provide an appropriate specimen

A combination of aspiration and biopsy procedures are commonly used to ensure the availability of the best possible bone marrow specimen. The aspirate is collected at the same time as the bone core biopsy by attaching a syringe to the bone marrow needle and withdrawing the sample before the cutting blades are inserted and the bone core is removed. The aspirate is the sample of choice for studying and classifying the nucleated blood cells of the bone marrow (e.g., determining the ratio of immature white blood cells to red blood cells, which is called the M:E ratio). The biopsy is the only sample that shows the blood-forming cells in relation to the structural and connective tissue elements (i.e., the microarchitecture) of the bone marrow. It provides the best sample for evaluating the cellularity of the bone marrow (the percentage of blood-forming tissue versus fat).

Description

A physician requests or orders the procedure. A pathologist, hematologist, or oncologist with special

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KEY TERMS

Antibodies—Proteins that are produced normally by specialized white blood cells after stimulation by a foreign substance (antigen) and that act specifically against the antigen in an immune response.

Aspiration—A procedure to withdraw fluid and cells from the body.

Connective tissue—Cells such as fibroblasts, and material such as collagen and reticulin, that unite one part of the body with another.

Fibrosis—A condition characterized by the presence of scar tissue, or reticulin and collagen proliferation in tissues to the extent that it replaces normal tissues.

Hematologist—A specialist who treats diseases and disorders of the blood and blood-forming organs.

Hematoma—Blood that collects under the skin, forms a blood clot, and causes swelling.

Hemorrhage—Heavy bleeding.

Immune system—Mechanism that protects the body from foreign substances, foreign cells, and pathogens. The thymus, spleen, lymph nodes, white blood cells (including the B cells and T cells), and antibodies are involved in the immune response, which aims to destroy these foreign bodies.

Lymphocytes—Type of white blood cells that are part of the immune system. The lymphocytes are composed of three main cell lines: B lymphocytes, T lymphocytes, and natural killer (NK) cells.

Megakaryocyte—A large bone marrow cell that is responsible for the production of platelets, which are active in blood clotting.

Myeloma (multiple myeloma)—A tumor of plasma cells that originates in bone marrow and usually spreads to more than one bone.

Needle biopsy—The procedure of using a large hollow needle to obtain a sample of intact tissue.

Pathologist—A medical doctor that specializes in identifying diseases by studying cells and tissues under a microscope.

Plasma cells—Cells in the blood and bone marrow that are formed from B lymphocytes and that produce antibodies.

White blood cell (leukocyte; WBC)—A blood cell that is responsible for fighting infection.

training in this procedure most often performs the aspirate and biopsy in a hospital or clinic. Bone marrow aspiration and biopsy are performed by a pathologist, hematologist, or oncologist with special training in this procedure. The procedure may be performed on an outpatient basis. In adults, the specimen is usually taken from the posterior superior iliac crest (top rear part of the hip). The sternum (breastbone) may be used for aspiration, but is less desirable because it carries the risk of cardiac puncture. Other sites that are rarely used are the anterior (front) superior iliac crest or a spinal column bone. When the patient is a child, the biopsy site is generally the anterior tibia, the larger of the two bones in the lower leg. A vertebra may also be used.

The skin covering the biopsy site is cleansed with an antiseptic, and the patient may be given a mild sedative. A local anesthetic such as lidocaine is administered, first under the skin with a fine needle and then around the bone at the intended puncture site with a somewhat larger-gauge needle. When the area is numb, a small incision is made in the skin and the biopsy needle is inserted. Pressure is applied to force the needle through the outer bone, and a decrease in resistance signals entry into the marrow cavity. The needle most often used for bone marrow biopsy is a Jamshidi trephine needle or a Westerman-Jensen trephine needle. A syringe is placed on the top of the needle and 1–2 mL of the bone marrow is aspirated into the syringe. In some instances, the marrow cannot be aspirated because it is fibrosed or packed with neoplastic cells. The syringe is removed, and the medical technologist uses this sample to prepare several smears containing small pieces of bone (spicules). Another syringe is fitted onto the needle hub and another sample of 3 mL is removed and transferred to a tube containing ethylenediaminetetraacetic acid (EDTA) for analysis by flow cytometry, cytogenetic testing, or other special laboratory procedures. Following aspiration, the cutting blades are inserted into the hollow of the needle until they protrude into the marrow. The needle is then forced over the tips of the cutting blades and the needle is rotated as it is withdrawn from the bone. This process captures the core sample inside the needle. A wire probe is inserted at the cutting end, and the bone marrow sample is pushed through the hub of the needle onto sterile gauze. The specimen is used to make several preparations on glass slides or cover glasses and is transferred to a fixative solution.

In the laboratory, the aspirate slides are stained with Wright stain or Wright-Giemsa stain. The biopsy

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material is sectioned onto glass slides and stained with hematoxylin-eosin, Giemsa, and Prussian blue stains. Prussian blue stain is used to evaluate the amount of bone marrow iron, and the other stains are used to contrast cell structures under the microscope. In addition, special stains may be used that aid in the classification of malignant white blood cells.

The analysis of the bone marrow is done by a pathologist, and a written report is added to the patient's medical record. A histologic technician performs special stains for bone marrow. Clinical laboratory scientists/medical technologists perform smear reviews and analysis of bone marrow cells by flow cytometry. Cytogenetic technologists may perform chromosomal analysis of bone marrow white blood cells.

Preparation

The physician should be informed of any medication the patient is using and of any heart surgery that the patient may have undergone.

Adults require no special preparation for this test. As for infants and children, they need physical and psychological preparation, depending on their age, previous medical experiences, and level of trust.

Infant preparation

Before the test, parents should know that their child will probably cry and that restraints might be used. To provide comfort and to help their child through this procedure, parents commonly are asked to be present during the procedure. Crying is a normal infant response to an unfamiliar environment, strangers, restraints, and separation from the parent. Infants cry more for these reasons than because they hurt. An infant will be restrained by hand or with devices because they have not yet developed the physical control, coordination, and ability to follow commands as adults have. The restraints used thus aim to ensure the infant's safety.

Toddler preparation

Parents should prepare a toddler for bone marrow aspiration directly before the procedure because toddlers have a very short attention span. Some general guidelines for parents include the following:

- Explain the procedure in a simple language, using concrete terms and avoiding abstract terminology.
- Make sure that the child understands where on the body the procedure will be performed and that it will be limited to that area.
- Allow the child to yell, cry, or express anything, especially pain, verbally.
- Describe how the test will feel.
- Stress the benefits of the procedure and anything that the child may find enjoyable afterwards, such as feeling better or going home.

Preschooler preparation

Parents should prepare a preschooler for bone marrow aspiration directly before the procedure so that the child does not worry about it for days in advance. Parents should ensure that the child understands that the procedure is not a punishment. Some general guidelines for parents include the following:

- Explain the procedure in a simple language, using concrete terms and avoiding abstract terminology.
- Make sure that the child understands where on the body the procedure will be performed and that it will be limited to that area.
- Allow the child to yell, cry, or express anything, especially pain, verbally.
- Describe how the test will feel and be honest about any pain that may be felt.
- Allow the child to practice different positions or movements that will be required for the procedure.
- Stress the benefits of the procedure and anything that the child may find enjoyable afterwards, such as feeling better or going for a treat on the way home.
- Practice deep breathing and other relaxation exercises. Practice also to have the child hold your hand and tell him or her to squeeze it when he or she feels pain during the procedure.

School-age child preparation

Explanations should be limited to 20 minutes, and repeated if required. The older the child, the earlier a parent can start preparation. Guidelines for parents include the ones provided for preschoolers, as well as the following:

- Suggest ways for maintaining control during the procedure; for example, counting, deep breathing, and relaxation (thinking pleasant thoughts).
- Include the child in the decision-making process; for example, the time of day or the body site where the procedure will be performed. These of course depend on the scheduling constraints of the physician and the type of procedure being performed.
- Encourage the child to participate in the procedure; for example, by holding an instrument, if allowed by the attending hospital staff.

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- Encourage the child to hold your hand or the hand of a nurse. Physical contact does help reduce pain and anxiety.

Adolescent preparation

An adolescent is best prepared by being provided with detailed information and reasons for the procedure. Adolescents should be encouraged to make as many decisions as possible. An adolescent may or may not wish a parent to be present during the procedure, and such wishes should be respected, since privacy is important during adolescence. Other guidelines include the following:

- Explain the procedure in correct medical terminology, and provide the reason for it.
- As clearly as possible, describe the equipment that will be involved in concrete terms.
- Discuss potential risks honestly and openly.

Aftercare

After the needle is removed, the biopsy site is covered with a clean, dry pressure bandage. The patient must remain lying down and is observed for bleeding for one hour. The patient's pulse, breathing, blood pressure, and temperature are monitored until they return to normal. The biopsy site should be kept covered and dry for several hours.

The patient should be able to leave the clinic and resume most normal activities immediately. Patients who have received a sedative often feel sleepy for the rest of the day, so driving, cooking, and other activities that require clear thinking and quick reactions should be avoided. Walking or prescribed **pain** medications usually ease any discomfort felt at the biopsy site, and ice can be used to reduce swelling.

A doctor should be notified if the patient:

- feels severe pain for more than 24 hours after the procedure
- experiences persistent bleeding or notices more than a few drops of blood on the wound dressing
- has a temperature above 101°F (38.3°C)
- has inflammation and pus at the biopsy site and other signs of infection

Risks

A small amount of bleeding and moderate discomfort often occur at the biopsy site. Rarely, reactions to anesthetic agents, infection, and hematoma (blood clot) or hemorrhage (excessive bleeding) also may develop. In rare instances, the heart or a major blood vessel is pierced when marrow is extracted from the sternum during bone marrow biopsy. This can lead to severe hemorrhage.

Normal results

Healthy adult bone marrow contains yellow fat cells, connective tissue, and red marrow that produces blood. Bone marrow is evaluated for cellularity; megakaryocyte production; M:E ratio; differential (classification of blood-forming cells); iron content; lymphoid, bone, and connective tissue cells; and bone and blood vessel abnormalities. The bone marrow of a healthy infant is primarily red (75–100% cellularity), and the distribution of blood-forming cells is very different from adult marrow. Consequently, age-related normal values must be used.

Abnormal results

Microscopic examination of bone marrow can reveal leukemia, granulomas, **myelofibrosis**, myeloma, lymphoma, or metastatic cancers; bone marrow infection; and bone disease. Bone marrow evaluation usually is not needed to diagnose anemia, but may be useful in cases that cannot be classified by other means.

Resources

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Falck, Tony C. and Darilyn C. Falck. "Bone Marrow Biopsy." emedicinehealth.com. January 11, 2006. http://www. emedicinehealth.com/bone_marrow_-biopsy/article_ em.htm

ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd., NE, Atlanta, GA, 30329, (404) 320-3333, (800) ACS-2345, http://www.cancer.org.

Leukemia & Lymphoma Society, 1311 Mamaroneck Avenue, Suite 310, White Plains, NY, 10605, (914) 949-5213, (800) 955-4572, http://www.leukemia-lymphoma.org.

National Cancer Institute Public Inquires Office, 6116 Executive Boulevard, Room 3036A, Bethesda, MD, 20892-8322, (800) 4-CANCER, TTY (800) 332-8615, http://www.cancer.gov.

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National Marrow Donor Program, 3001 Broadway Street NE, Suite 100, Minneapolis, MN, 55413-1753, (800) MARROW-2 (627-7692), patientinfo@nmdp. org, http://www.marrow.org.

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Bone marrow transplantation

Definition

Bone marrow transplantation involves extracting bone marrow containing normal stem cells or peripheral stem cells from a healthy donor and transferring it to a recipient whose body cannot manufacture proper quantities of normal blood cells. The goal of the transplant is to rebuild the recipient's blood cells and immune system and hopefully cure the underlying disease.

Purpose

The bone marrow—the sponge-like tissue found in the center of certain bones—contains stem cells that are the precursors of white blood cells, red blood cells, and platelets. These blood cells are vital for normal body functions, such as oxygen transport, defense against infection and disease, and clotting. Blood cells have a limited life span and are constantly being replaced; therefore, the production of healthy stem cells is vital.

In association with certain diseases, stem cells may produce too many, too few, or abnormal blood cells. Also, medical treatments may destroy stem cells or alter blood cell production. Blood cell abnormalities can be life threatening.

A person's red blood cells, white blood cells, and platelets may be destroyed or may be abnormal due to disease. Also, certain medical therapies, particularly **chemotherapy** or **radiation therapy**, may destroy a person's stem cells. The consequence to an individual's health is severe. Under normal circumstances, red blood cells carry oxygen throughout the body and remove carbon dioxide from the body's tissues. White blood cells form the cornerstone of the body's immune system and defend it against infection. Platelets limit bleeding by enabling the blood to clot if a blood vessel is damaged.

A bone marrow transplant is used to rebuild the body's capacity to produce these blood cells and bring their numbers to normal levels. Illnesses that may be treated with a bone marrow transplant include both cancers and noncancerous diseases.

Cancerous diseases may or may not specifically involve blood cells, but **cancer** treatment can destroy the body's ability to manufacture new blood cells. Bone marrow transplantation may be used in conjunction with additional treatments, such as chemotherapy, for various types of leukemia, Hodgkin's disease, lymphoma, breast and **ovarian cancer**, renal cell carcinoma, myelodysplasia, **myelofibrosis**, germ cell cancer, and other cancers. Noncancerous diseases for which bone marrow transplantation can be a treatment option include **aplastic anemia**, **sickle cell disease**, **thalassemia**, and severe **immunodeficiency**.

Demographics

The decision to prescribe a bone marrow transplant is based on the patient's age, general health status, diagnosis, and stage of the disease. A person's age or state of health may prohibit use of a bone marrow transplant. The typical cut-off age for a transplant ranges from 40–55 years; however, a person's health usually is the more important factor. Before undergoing a bone marrow transplant, the bone marrow transplant team will ensure that the patient understands the potential benefits and risks of the procedure.

Description

The first successful bone marrow transplant took place in 1968 at the University of Minnesota. The recipient was a child with **severe combined immunodeficiency** disease and the donor was a sibling. In 1973, the first unrelated bone marrow transplant was performed at Memorial Sloan-Kettering Cancer Center in New York City on a five-year-old patient with severe combined immunodeficiency disease. In 1984, Congress passed the National Organ Transplant Act, which included language to evaluate unrelated marrow transplantation and determine if a national donor registry was feasible. The National Bone Marrow Donor Registry (NBMDR), now called the National Marrow Donor Program (NMDP), was established in 1986. In 2010, the NMDP had more than 8 million volunteer donors and 100,000 cord blood units. It facilitates about 4,800 BMTs each year.

Transplant physicians specially trained in bone marrow transplantation should perform this procedure. Bone marrow transplant physicians have

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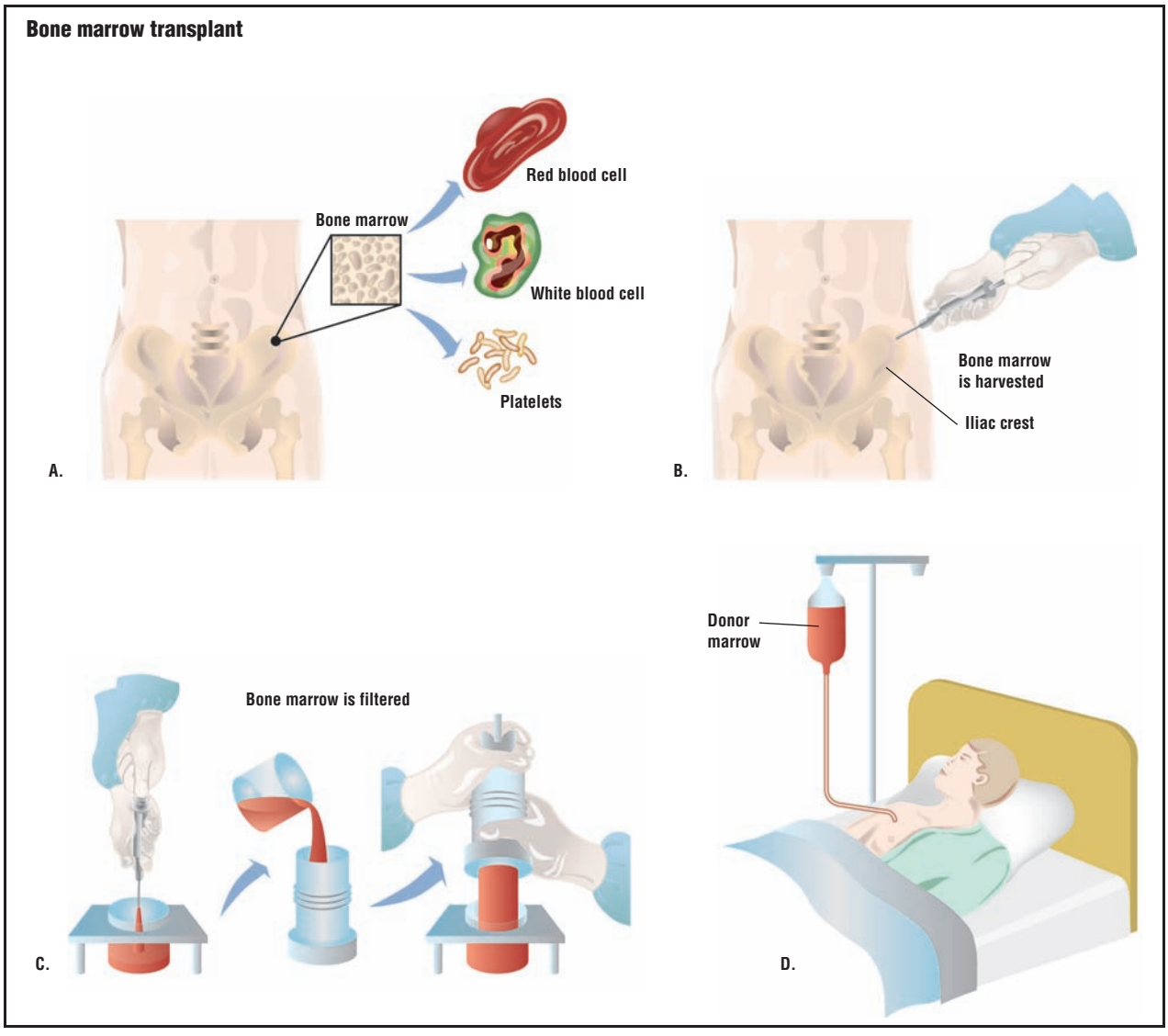

In a bone marrow transplant, bone marrow is harvested from the donor's pelvic bone at the iliac crest (B). The marrow is filtered (C) before being introduced into a large vein in the recipient's chest via a catheter (D). *(Illustration by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)*

extensive experience in hematology/oncology and bone marrow transplant.

Selecting a transplant center that has a multidisciplinary team of specialists is important. The bone marrow transplant team should include transplant physicians, **infectious disease** specialists, pharmacologists, registered nurses, and transplant coordinators. Other transplant team members may include registered dietitians, social workers, and financial counselors.

When selecting a transplant center, the patient should find out where the center is accredited. Some examples of accrediting organizations include the Foundation for the Accreditation of Cellular Therapy, the American Association of Blood Banking, the National Marrow Donor Program, and other state-level accreditation organizations.

Autologous and allogeneic transplants

Two important requirements for a bone marrow transplant are a donor and a recipient. Sometimes, the donor and the recipient may be the same person. This type of transplant is called an autologous transplant. It typically is used in cases in which a person's bone marrow generally is healthy but will be destroyed due

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KEY TERMS

ABO antigen—Protein molecules located on the surfaces of red blood cells that determine a person's blood type: A, B, or O.

Allogeneic—Referring to bone marrow transplants between two different, genetically dissimilar people.

Anemia—Decreased red cell production that results in a deficiency in oxygen-carrying capacity of the blood.

Antigen—A molecule that is capable of provoking an immune response.

Aplastic anemia—A disorder in which the body produces inadequate amounts of red blood cells and hemoglobin due to underdeveloped or missing bone marrow.

Autologous—Referring to bone marrow transplants in which recipients serve as their own donors.

Bone marrow—A spongy tissue located within flat bones, including the hip and breast bones and the skull. This tissue contains stem cells, which are the precursors of platelets, red blood cells, and white blood cells.

Bone marrow biopsy—A test involving the insertion of a thin needle into the breastbone or, more commonly, the hip, in order to aspirate (remove) a sample of the marrow. A small piece of cortical bone may also be obtained for biopsy.

Bone marrow transplant—Healthy marrow is infused into people who have had high-dose chemotherapy for one of the many forms of leukemias, immunodeficiencies, lymphomas, anemias, metabolic disorders, and sometimes solid tumors.

Chemotherapy—Medical treatment of a disease, particularly cancer, with drugs or other chemicals.

Chest x ray—A diagnostic procedure in which a very small amount of radiation is used to produce an image of the structures of the chest (heart, lungs, and bones) on film.

Chronic myelogenous leukemia (CML)—Also called chronic myelocytic leukemia, a malignant disorder that involves abnormal accumulation of white cells in the marrow and bloodstream.

Computed tomography scan (CT or CAT)—Computed axial tomography uses x rays and computers to produce an image of a cross-section of the body.

Conditioning—Process of preparing a patient to receive marrow donation, often through the use of chemotherapy and radiation therapy.

Echocardiogram—An imaging procedure used to create a picture of the heart's movement, valves and chambers. The test uses high-frequency sound waves that come from a hand wand placed on the chest. Echocardiogram may be used in combination with Doppler ultrasound to evaluate the blood flow across the heart's valves.

Electrocardiogram (ECG, EKG)—A test that records the electrical activity of the heart using small electrode patches attached to the skin on the chest.

Graft versus host disease—A life-threatening complication of bone marrow transplants in which the donated marrow causes an immune reaction against the recipient's body.

Histocompatibility—The major histocompatibility determinants are the human leukocyte antigens (HLA), which characterize how well the patient and donor are matched.

Hodgkin disease—A type of cancer involving the lymph nodes and potentially affecting non-lymphatic organs in the later stage.

Human leukocyte antigen (HLA)—A group of protein molecules located on bone marrow cells that can provoke an immune response. A donor's and a recipient's HLA types should match as closely as possible to prevent the recipient's immune system from attacking the donor's marrow as a foreign material that does not belong in the body.

Immunodeficiency—A disorder in which the immune system is ineffective or disabled due either to acquired or inherited disease.

Leukemia—A type of cancer that affects leukocytes, a particular type of white blood cell. A characteristic symptom is excessive production of immature or otherwise abnormal leukocytes.

Lymphoma—A type of cancer that affects lymph cells and tissues, including certain white blood cells (T cells and B cells), lymph nodes, bone marrow, and the spleen. Abnormal cells (lymphocyte/leukocyte) multiply uncontrollably.

Match—How similar the HLA typing, out of a possible six antigens, is between the donor and the recipient.

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Myelodysplasia—Also called myelodysplastic syndrome, it is a condition in which the bone marrow does not function normally and can affect the various types of blood cells produced in the bone marrow. Often referred to as a preleukemia and may progress and become acute leukemia.

Myelofibrosis—An anemic condition in which bone marrow cells are abnormal or defective and become fibrotic.

Non-myeloablative allogeneic bone marrow transplant—Also called "mini" bone marrow transplants. This type of bone marrow transplant involves receiving low doses of chemotherapy and radiation therapy, followed by the infusion of a donor's bone marrow or peripheral stem cells. The goal is to suppress the patient's own bone marrow with low-dose chemotherapy and radiation therapy to allow the donor's cells to engraft.

Peripheral stem cells—Stem cells that are taken directly from the circulating blood and used for transplantation. Stem cells are more concentrated in the bone marrow, but they can also be extracted from the bloodstream.

Peripheral stem cell transplant—The process of transplanting peripheral stem cells instead of using bone marrow. The stem cells in the circulating blood that are similar to those in the bone marrow are given to the patient after treatment to help the bone marrow recover and continue producing healthy blood cells. A peripheral stem cell transplant may also be used to supplement a bone marrow transplant.

Platelets—Fragments of a large precursor cell, a megakaryocyte found in the bone marrow. These fragments adhere to areas of blood vessel damage and release chemical signals that direct the formation of a blood clot.

Pulmonary function test—A test that measures the capacity and function of the lungs, as well as the blood's ability to carry oxygen.

Radiation therapy—The use of high-energy radiation from x rays, cobalt, radium, and other sources to kill cancer cells and shrink tumors. Radiation may come from a machine outside the body (external beam radiation therapy) or from materials called radioisotopes. Radioisotopes produce radiation and are placed in or near the tumor or in the area near the cancer cells. This type of radiation treatment is called internal radiation therapy, implant radiation, interstitial radiation, or brachytherapy. Systemic radiation therapy uses a radioactive substance, such as a radio-labeled monoclonal antibody that circulates throughout the body.

Red blood cell (RBC)—Cell that contains hemoglobin (the molecule that transports oxygen) and helps remove wastes from tissues throughout the body.

Remission—Disappearance of the signs and symptoms of cancer. When this happens, the disease is said to be "in remission." A remission can be temporary or permanent.

Sickle cell disease—An inherited disorder characterized by a genetic flaw in hemoglobin production. (Hemoglobin is the substance within red blood cells that enables them to transport oxygen.) The hemoglobin that is produced has a kink in its structure that forces the red blood cells to take on a sickle shape, inhibiting their circulation and causing pain. This disorder primarily affects people of African descent.

Stem cells—Unspecialized cells, or "immature" blood cells, that serve as the precursors of white blood cells, red blood cells, and platelets.

Syngeneic—Referring to a bone marrow transplant from one identical twin to the other.

Thalassemia—A group of inherited disorders that affects hemoglobin production. Because hemoglobin production is impaired, a person with this disorder may suffer mild to severe anemia. Certain types of thalassemia can be fatal.

Umbilical cord blood transplant—A procedure in which the blood from a newborn's umbilical cord, which is rich in stem cells, is used as the donor source for bone marrow transplants. Currently, umbilical cord blood transplants are mainly used for sibling bone marrow transplants or to store blood for an anonymous donation. In most cases, umbilical cord blood does not contain enough stem cells to safely use for adult bone marrow transplants.

White blood cells—A group of several cell types that occur in the bloodstream and are essential for a properly functioning immune system.

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to medical treatment for diseases such as **breast cancer** and Hodgkin's disease. Autologous transplants also are possible if the disease affecting the bone marrow is in remission. If a person's bone marrow is unsuitable for an autologous transplant, the bone marrow must be derived from another person in an allogeneic transplant.

An allogeneic bone marrow donor may be a family member or an unrelated donor. The donated bone marrow/peripheral stem cells must perfectly match the patient's bone marrow. The matching process matches human leukocyte antigens (HLA). Antigens are markers in cells that stimulate antibody production. HLA antigens are proteins on the surface of bone marrow cells. HLA testing is a series of blood tests that evaluate the closeness of tissue between the donor and the recipient. If the donor and the recipient have very dissimilar antigens, the recipient's immune system regards the donor's bone marrow cells as foreign invaders and launches a destructive attack against them. Such an attack negates any benefits offered by the transplant.

Non-myeloablative ("mini") allogeneic transplants

A "mini" transplant, also called a reduced intensity transplant or adoptive immunotherapy, involves receiving low doses of chemotherapy and radiation therapy, followed by the infusion of a donor's bone marrow or peripheral stem cells. The goal is to suppress the patient's own bone marrow with low-dose chemotherapy and radiation therapy to allow the donor's cells to engraft (settle into the bone marrow and begin reproducing). If cancer cells remain in the patient's body, the donated cells are able to identify the cancer cells as foreign and trigger an immune response, killing the cancer cells. This is called the graft-versus-tumor effect.

Peripheral blood stem cell transplants

In **stem cell transplantation**, peripheral blood stem cells are used instead of cells from the bone marrow. Peripheral blood stem cells (PBSCs) are obtained from circulating blood rather than from bone marrow, but the amount of stem cells found in the peripheral blood is much smaller than the amount of stem cells found in the bone marrow. Peripheral blood stem cells can be used in either autologous or allogeneic transplants. The majority of PBSC transplants are autologous. However, clinical studies indicate that PBSCs are being used more frequently than bone marrow for allogeneic bone marrow transplantation.

The advantages of PBSC transplants when compared to bone marrow transplants are that, in allogeneic transplantation, hematopoietic (the ability to form blood cells) and immune recovery are faster with PBSCs. In autologous transplantation, the use of PBSCs can result in faster blood count recovery. Also, some medical conditions exist in which the recipient cannot accept bone marrow transplants but can accept PBSC transplants. A possible disadvantage to PBSC transplant versus bone marrow transplantation is that so much more fluid volume is necessary to collect enough PBSCs that, at the time that the new stem cells are infused into the recipient, the fluid can collect in the lungs. Also, the time commitment for the donor for a PBSC transplant is considerable. When the PBSCs are being collected, several outpatient sessions are needed and each session lasts approximately between two and four hours.

UMBILICAL CORD BLOOD TRANSPLANT. Umbilical cord blood transplant is a procedure in which umbilical cord blood from a newborn is used as the donor source. Umbilical cord blood is rich in stem cells, the cells that are needed for transplantation, and these cells are theoretically "immunologically naïve," reducing chances of rejection and making it a good source for donation. The matching criteria are the same as for bone marrow. Most programs use this procedure for a sibling or store cord blood for anonymous donation. Umbilical cord blood can be an excellent source for children. One potential problem with umbilical cord blood transplantation is the low volume of stem cells contained in the umbilical cord. In many instances, there is inadequate volume to safely use for a transplant in an adult recipient.

The transplant procedure

HLA MATCHING. There are only five major HLA classes or types—designated HLA-A, -B, -C, -D, and class III, but much variation exists within each group. For example, HLA-A from one individual may be similar to, but not the same as, HLA-A in another individual; such a situation can render a transplant from one to the other impossible.

HLA matching is more likely if the donor and recipient are related, particularly if they are siblings; however, an unrelated donor may be a potential match. The only case in which matching HLA types between two people is not an issue is if the recipient has an identical twin. Identical twins carry the same genes, and, therefore, the same antigens. A bone marrow transplant between identical twins is called a syngeneic transplant.

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BONE MARROW TRANSPLANTATION. The bone marrow extraction, or harvest, is the same for autologous and allogeneic transplants. Harvesting is done under **general anesthesia**, and discomfort is usually minimal afterwards. Bone marrow is drawn from the iliac crest (the part of the hip bone on either side of the lower back) with a special needle and a syringe. Several punctures usually are necessary to collect the needed amount of bone marrow, approximately 1–2 quarts. (This amount is only a small percentage of the total bone marrow and is typically replaced within four weeks.) The donor remains at the hospital for 24–48 hours and can resume normal activities within a few days.

If the bone marrow is meant for an autologous transplant, it is stored at -112– -320°F (-80– -196°C) until it is needed. If a patient's own bone marrow can be used for transplantation or if a donor is not found, peripheral stem cells may be harvested from the patient's circulating blood. Bone marrow for an allogeneic transplant sometimes is treated to remove the donor's T cells (a type of white blood cell) or to remove ABO (blood type) antigens; otherwise, it is transplanted without modification.

The bone marrow or peripheral stem cells are administered to the recipient via a catheter (a narrow, flexible tube) inserted into a large vein in the chest. The donor cells look like a bag of blood and are infused for about 20–30 minutes. During the infusion, the patient's blood pressure, pulse, and breathing are monitored. From the bloodstream, the marrow migrates to the cavities within the bones where bone marrow is normally stored. If the transplant is successful, the bone marrow begins to produce normal blood cells once it is in place (engrafted).

PERIPHERAL BLOOD STEM CELL TRANSPLANTATION. Before collection for a PBSC transplant, donors receive four injections daily of the drug G-CSF, or filgrastim. (Patients can give it to themselves at home, if necessary.) These pretreatments stimulate the body to release stem cells into the blood. After these pretreatments, the donors' experience is similar to that of a whole blood donor's experience—PBSC donors' blood is collected at a clinic or hospital as an outpatient procedure. The differences are that several sessions will be needed over days or weeks, and the blood is collected in a process called apheresis. The blood travels from one arm into a blood cell separator that removes only the stem cells, and the rest of the blood is returned back to the donor in the other arm. The cells are then frozen for later use.

The PBSCs are administered to the recipient using the same methods as those used in bone marrow transplantation. As stated, the amount of fluid with PBSCs infused into the recipient's body can be an issue.

Costs

Bone marrow transplantation is an expensive procedure. (Bone marrow donors are volunteers and do not pay for any part of the procedure.) Insurance companies and health maintenance organizations (HMOs) may not cover the costs. Many insurance companies require precertification letters of medical necessity. As soon as bone marrow transplantation is discussed as a treatment option, it is important for the patient to contact his or her insurance provider to determine what costs will be covered.

Preparation

Several tests are performed before the bone marrow transplant to identify any potential problems ahead of time. Tests include:

- tissue typing and a variety of blood tests
- chest x ray
- pulmonary function tests
- computed tomography scan (CT or CAT)
- heart function tests, including an electrocardiogram and echocardiogram
- bone marrow biopsy
- skeletal survey

In addition, a complete dental exam is needed before the bone marrow transplant to reduce the risk of infection. Other precautions will be taken before the transplant to reduce the patient's risk of infection.

A triple lumen, central venous catheter (a slender, hollow flexible tube) is surgically inserted into a large vein in the chest during a simple outpatient procedure. The catheter is used to draw blood and infuse chemotherapy and other medications, as well as donor cells, blood product, fluids, and sometimes nutritional solutions. The central venous catheter usually stays in place for about six months after the bone marrow transplant.

Hormone-like medications called colony-stimulating factors may be given before the transplant to stimulate the patient's white blood cells. These medications stimulate the white blood cells to multiply, mature, and function. These medications also help the patient's white blood cells recover from chemotherapy and reduce the risk of infection.

In preparation for receiving the transplant, the recipient undergoes "conditioning," a preparative

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regimen (also called marrow ablation) in which the bone marrow and abnormal cells are destroyed. Conditioning rids the body of diseased cells and makes room for the marrow or peripheral stem cells to be transplanted. It typically involves chemotherapy and/or radiation treatment, depending on the disease being treated. Unfortunately, this treatment also destroys healthy cells and has many side effects such as extreme weakness, **nausea**, **vomiting**, and **diarrhea**. These side effects may continue for several weeks.

Aftercare

A bone marrow transplant recipient can expect to spend three to four weeks in the hospital, depending on the rate of recovery. A two- to four-week waiting period follows the marrow transplant before its success can begin to be evaluated. The marrow recipient is kept in **isolation** during this time to minimize potential infections. The recipient also receives intravenous antibiotic, antiviral, and antifungal medications, as well as blood and platelet transfusions to help fight infection and prevent excessive bleeding. Blood tests are performed daily to monitor the patient's kidney and liver function, as well as nutritional status. Other tests are performed as necessary. Further side effects, such as **nausea and vomiting**, can be treated with other medications. Once blood counts are normal and the side effects of the transplant abate, the recipient is taken off **antibiotics** and usually no longer needs blood and platelet transfusions.

Following discharge from the hospital, the recipient is monitored through home visits by nurses or outpatient visits for up to a year. For the first several months out of the hospital, the recipient needs to be careful in avoiding potential infections. For example, contact with other people who may be ill should be avoided or kept to a minimum. Further blood transfusions and medications may be necessary, but barring complications, the recipient can return to normal activities about six to eight months after the transplant.

Risks

The procedure has a lower success rate the greater the recipient's age. Complications are exacerbated for people whose health is already seriously impaired, as in late-stage cancers.

Bone marrow transplants are accompanied by serious and life-threatening risks. Furthermore, they are not always an absolute assurance of a cure for the underlying ailment; a disease may recur in the future.

Even in the absence of complications, the transplant and associated treatments are hard on the recipient. Bone marrow transplants are debilitating. A person's ability to withstand the rigors of the transplant is a key consideration in deciding to use this treatment.

In the short term, there is the danger of **pneumonia** or other infectious disease, excessive bleeding, or liver disorder caused by blocked blood vessels. The transplant may be rejected by the recipient's immune system, or the donor bone marrow may launch an immune-mediated attack against the recipient's tissues. This complication is called acute graft-versus-host disease, and it can be a life-threatening condition. Characteristic signs of the disease include **fever**, rash, diarrhea, liver problems, and a compromised immune system.

Approximately 25%–50% of bone marrow transplant recipients develop long-term complications. Chronic graft-versus-host disease symptoms include skin changes, such as dryness, altered pigmentation, and thickening; abnormal **liver function tests**; **dry mouth** and eyes; infections; and weight loss. Other long-term complications include **cataracts** (due to radiation treatment), abnormal lung function, hormonal abnormalities resulting in reduced growth or **hypothyroidism**, secondary cancers, and **infertility**.

Morbidity and mortality rates

Approximately 30% of people receiving allogeneic transplants do not survive. Autologous transplants have a much better survival rate—nearly 90%—but are not appropriate for all types of ailments requiring a bone marrow transplant. Furthermore, autologous transplants have a higher failure rate with certain diseases, specifically leukemia. At two years, the survival rate for patients with chronic myelogenous leukemia is 52% if they received a transplant in a chronic phase of their disease, 30% for patients in an accelerated phase, and 15% for patients in the blast phase.

Normal results

In a successful bone marrow transplant, the donor's marrow migrates to the cavities in the recipient's bones and produces normal numbers of healthy blood cells. Bone marrow transplants can extend a person's life, improve quality of life, and may aid in curing the underlying ailment.

Alternatives

Complementary therapies are used along with standard cancer treatments. These treatments are aimed at bringing about some overall improvement in general health and well being. Complementary therapies can be helpful in managing symptoms and improving quality of life. They can be used to help alleviate

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pain; reduce nausea; strengthen muscles; and decrease depression, **anxiety**, and **stress**. It is important to distinguish between alternative therapies (unproven methods promoted for use instead of mainstream treatment) and complementary therapies, which are used along with, rather than instead of, standard treatment. Complementary therapies are noninvasive and soothing. However, before trying them, patients should check with their oncologist to make sure the complementary therapy will not interfere with standard cancer therapy or cause harm. Examples of complementary therapies are **massage therapy**, **aromatherapy**, **meditation**, **yoga**, **biofeedback**, music, art and dance therapies, and group and individual therapy or counseling.

Hormone therapy is the treatment of cancer by removing, blocking, or adding hormones. Hormones are chemical substances produced by glands in the body that enter the bloodstream and cause effects in other tissues. Hormone therapies may be used to treat breast and prostate cancers. Hormone therapy may also be used in some situations for other cancers.

Immunotherapy, also called biological therapy, is a type of treatment that uses the body's immune system to fight cancer. The therapy mainly consists of stimulating the immune system with highly purified proteins that help it do its job more effectively.

Radiation therapy is the use of high-energy x rays, electron beams, or radioactive isotopes to attack cancer. Radiation therapy causes cancer cell **death** by ionization or by damaging the chromosomes in the cancer cells so they cannot multiply. Radiation therapy is a local treatment aimed directly at the cancer. Even though the radiation is aimed only at the cancer, it must often pass through skin and other organs to reach the tumor. Thus, some healthy cells may become damaged, too. The body, however, is able to repair the healthy cells that have been damaged and restore them to their proper function. Aside from its use as a single treatment, radiation therapy has been shown to enhance the effects of chemotherapy. It can be used in combination with chemotherapy to shrink a tumor. Successful radiation therapy depends on delivering the proper amount of radiation to the cancer in the best, and most effective way.

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ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd., NE, Atlanta, GA, 30329, (404) 320-3333, (800) ACS-2345 http://www.cancer.org.

BMT Infonet (Blood and Marrow Transplant Information Network), 2900 Skokie Valley Road, Suite 104, Highland Park, IL, 60035, (847) 433-3313, (888) 597-7674, (847) 433-4599 help@bmtinfonet.org, http://www.bmtinfonet.org.

Leukemia & Lymphoma Society, 1311 Mamaroneck Avenue, Suite 310, White Plains, NY, 10605, (914) 949-5213, (800) 955-4572 http://www.leukemia-lymphoma.org.

National Cancer Institute Public Inquires Office, 6116 Executive Boulevard, Room 3036A, Bethesda, MD, 20892-8322, (800) 4-CANCER, TTY (800) 332-8615, http://www.cancer.gov.

National Marrow Donor Program, 3001 Broadway Street NE, Suite 100, Minneapolis, MN, 55413-1753, (800) MARROW-2 (627-7692) patientinfo@nmdp.org, http://www.marrow.org.

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Bone scan

Definition

A bone scan is a diagnostic procedure used to evaluate abnormalities involving bones and joints. A radioactive substance is injected intravenously, and the image of its distribution in the skeletal system is analyzed to detect certain diseases or conditions.

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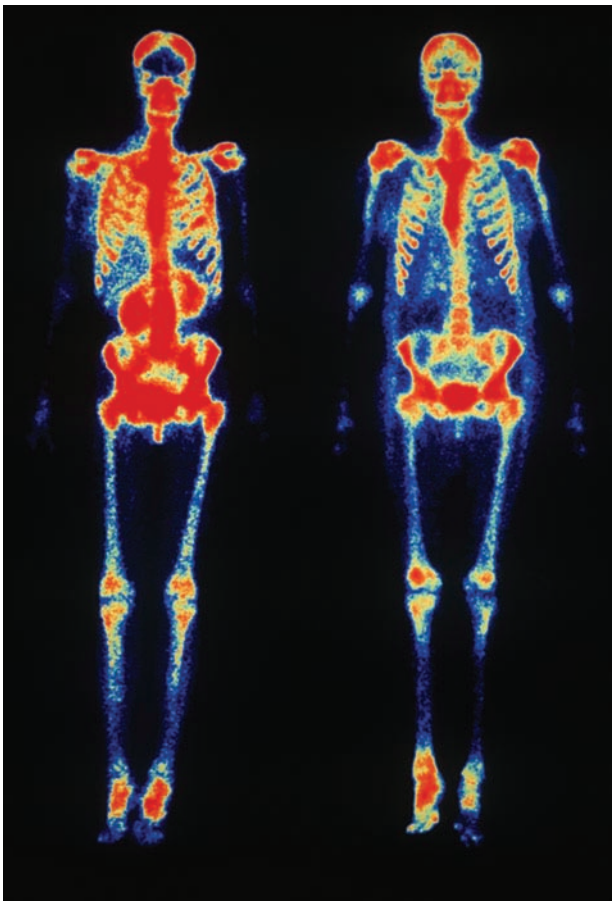

Full body bone scan revealing cancer metastases. *(Scott Camazine & Sue Trainor/Science Source/Photo Researchers, Inc.)*

KEY TERMS

Osteoarthritis—A form of arthritis that occurs mainly in older people and involves the gradual degeneration of the cartilage of the joints.

Osteomalacia—A softening of bones caused by lack of vitamin D and/or calcium in the diet.

Osteoporosis—A condition found in older individuals in which bones decrease in density and become fragile and more likely to break. It can be caused by lack of vitamin D and/or calcium in the diet.

Radioisotope—A radioactive, or radiation-emitting form, of an element.

Radiologist—A medical doctor specially trained in radiology (x ray) interpretation and its use in the diagnosis of diseases and injuries.

Radionuclide—A substance that emits radiation as it disintegrates.

Purpose

Bone scans are most frequently ordered to check whether a **cancer** that originated elsewhere has spread to the bones. Cancers that begin in the breasts, kidneys, lungs, prostate, thyroid, or urinary bladder are most likely to spread, or metastasize, to the bones. If metastases are found, periodic bone scans may be ordered to see if therapy is effective against a cancer.

Some cancers arise in bone. These are called primary bone cancers. When an abnormality is found on an x ray of a bone, a bone scan may be helpful in deciding if it is a primary bone cancer, or a noncancerous (benign) condition.

Infection in the bone (**osteomyelitis**) can be detected or confirmed by a bone scan, often days or weeks before an x ray would reveal it. Bone scans are useful in diagnosing early arthritic changes, and monitoring both the progression of the disease and the effectiveness of treatment. Unexplained **pain** may be evaluated with a bone scan, because it can demonstrate **fractures** that are difficult to detect on x ray. Bone scans can be used to see if artificial joints have loosened or become infected. Suspected **child abuse** may be evaluated with a bone scan, due to its ability to show an overall pattern of repeated trauma. Abnormalities caused by altered circulation to the bone may be diagnosed with a bone scan.

Precautions

Women who are pregnant or **breastfeeding** should not have this test. A patient who is unable to remain still for an extended period of time may require **sedation** for a bone scan.

Description

This test is performed in a radiology facility, either in a hospital department or an outpatient x-ray center. The patient usually sits or lies down while a radioactive substance is injected through a vein in the arm. For a bone scan, the radionuclide used is specifically chosen to accumulate in the bone. The patient then waits from three to four hours for the substance to collect within the skeletal system. During this time, he or she will be instructed to drink several glasses of water. Patients are free to get up and move around as they desire during this waiting time, and should urinate frequently. Just before the scanning begins, the patient should empty his or her bladder again. This

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ensures that a lot of radioactive material is not concentrated in the urinary bladder, which could obscure part of the pelvic bones.

During the scan, the patient lies on his or her back on a table, but may be repositioned to the stomach or side during the study. It is important for the patient not to move, except when directed to by the technologist.

The radionuclide scanner, sometimes called a gamma camera, or scintillation camera, is positioned against the body part to be examined. Either the camera, the table, or both, may change position during the study. For a total body bone scan, the patient is scanned from head to foot, over a period of 30–60 minutes. Patients should experience no discomfort from this examination.

A special kind of bone scan, called a SPECT (**single photon emission computed tomography**) scan, may be added to study a particular part of the body in more detail. Suspected diseases of the hips, lower back, or jaw are often evaluated using this study. It usually takes an additional 30–45 minutes. The camera circles completely around the area in question or multiple cameras are used to create a cross-sectional image. This helps pinpoint the location of the abnormality being evaluated.

The bone scan might be done in phases. The procedure is the same, except the scanning takes place immediately after the radioactive substance is injected, then again at set intervals to image how the radioactive tracer pools and distributes in the body and bone. For example, a two-phase bone scan for osteomyelitis may involve a scan about five minutes after injection, then about three hours later.

Preparation

Some specialized blood studies should be drawn before this study is begun. Jewelry or metallic objects need to be removed. No other special physical preparation is required.

The patient should understand that there is no danger of radioactive exposure to themselves or others, as only small amounts of the radioisotope are used. The total dose of radiation absorbed is minimal, often less than the amount received from ordinary x rays. The radionuclide scanner does not emit any radiation at all, but detects and records it from the patient.

Aftercare

Fluids are encouraged after the scan to aid in the excretion of the radioisotope. It is almost completely eliminated from the body within 24 hours. However, since increased airport security methods resulting from the September 11, 2001, attacks, isolated cases of people who have had recent diagnostic nuclear medicine procedures setting off airport security systems have occurred. One state's Homeland Security Department has warned people having nuclear medicine procedures and flying soon afterward to bring adequate documentation of the procedure along to the airport.

Normal results

The normal appearance of the scan will vary according to the patient's age. In general, a uniform concentration of radionuclide uptake is present in all bones in a normal scan.

Abnormal results

A high concentration of radionuclide occurs in areas of increased bone activity. These regions appear brighter and may be referred to as "hot spots." They may indicate healing fractures, tumors, infections, or other processes that trigger new bone formation. Lower concentrations of radionuclide may be called "cold spots." Poor blood flow to an area of bone or bone destruction from a tumor may produce a cold spot.

The bone scan is a very sensitive test and can detect subtle conditions more readily than other studies. However, it is not a very specific examination, and often cannot distinguish exactly what disease process is causing an abnormality. Results need to be correlated with the patient's medical history and other radiologic and laboratory studies to make a definite diagnosis.

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ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd., NE, Atlanta, GA, 30329, (404) 320-3333, (800) ACS-2345 http://www.cancer.org.

American College of Radiology, 1891 Preston White Drive, Reston, VA, 20191, (703) 648-8900 http://www.acr.org.

Radiological Society of North America (RSNA), 820 Jorie Blvd, Oak Brook, Il, 60523-2251, (630) 571-2670, (800) 381-6660, (630) 571-7837 http://www.rsna.org.

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Bone tumor *see* **Sarcomas**

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Bone x rays

Definition

Bone x rays are a diagnostic test in which ionizing radiation passing through the bones being examined enables an image to be produced on film.

Purpose

Bone x rays are ordered to detect disease or injury to the bone such as broken bones, tumors, and other problems. They can determine bone density, texture, erosion, and changes in bone relationships. Bone x rays also evaluate the joints for diseases such as **osteoarthritis**.

Precautions

Precautions should be taken to protect patients from unnecessary exposure to radiation. Patients should be shielded with lead aprons as much as possible. Women of childbearing age who could be pregnant should not have x rays of their trunk or pelvic regions. The fetus is especially at risk during the first trimester of **pregnancy**. Women who are pregnant should not have x rays of their pelvic region, lumbar spine, and abdomen unless absolutely necessary. If other types of x rays are necessary, a lead apron should be used to shield the abdominal and pelvic regions.

Description

X rays are a common diagnostic test in which a form of energy called x-ray radiation penetrates the patient's body. In bone x rays, electrical current passes through an x-ray tube and produces a beam of ionizing radiation that passes through the bone(s) being examined. This produces a picture of the inside of the body on film. The physician reads the developed x ray on a wall-mounted light box.

Digital x rays are a new type of x ray in which conventional equipment is used to take the x ray but the image is produced via computer. In a digital x ray, the image is created on a reusable plate. After being read by a laser reader, the information is sent in digital form to a storage unit connected to a computer network from which the radiologist reads the image. An electronic report can then be sent to the patient's physician.

Problems with bones that x rays can detect result from injury or from disease caused by a malfunction in the patient's bone chemistry. Bone injuries, especially broken bones (**fractures**), are common and can be accurately diagnosed by bone x rays. X rays are especially helpful in diagnosing simple and incomplete fractures that can't be detected during a **physical examination**. X rays can also be used to check for bone position in a fracture. Some bone diseases can be definitively diagnosed with bone x rays while others require additional tests.

Osteoporosis, a common bone disease, can be detected in bone x rays but other tests are then ordered to determine the extent of the disease. For osteomalacia and **rickets**, a blood test and x rays of the affected bone are usually definitive; in some cases a **bone biopsy** (microscopic analysis of a small amount of tissue) is also done. In a rare bone disease called Paget's disease, x rays may be used in conjunction with bone, blood, and urine tests to make a diagnosis. In another rare bone disease, fibrous dysplasia, bone x rays or a bone biopsy (microscopic analysis of a small amount of tissue) are used to confirm the diagnosis. Bone x rays are definitive in diagnosing **osteogenesis imperfecta**. For **osteomyelitis**, bone x rays are used in conjunction with a blood test, **bone scan**, or needle biopsy to make the diagnosis. For arthritis, x rays of the bone are occasionally used in conjunction with blood tests. For bone tumors, bone x rays are helpful but they may not be definitive.

Bone x rays are performed by a technologist and interpreted by a radiologist. They are taken in a physician's office, radiology department, outpatient clinic, or diagnostic clinic. Bone x rays generally take less

KEY TERMS

Arthritis—A disease of the joints that arises from wear and tear, age, and, less often, from inflammation.

Osteogenesis imperfecta—Also called brittle bones, this is a condition present at birth in which bones are abnormally fragile, brittle, and break easily.

Osteomalacia—A disease in which bones gradually soften and bend.

Osteomyelitis—An infection of the bone marrow and the bone.

Osteoporosis—A disease that occurs primarily in postmenopausal women in which the amount of bone is reduced or skeletal tissue wastes away.

Paget's disease—A disease, whose cause is unknown, that is generally found in older people. Symptoms include bone pain, bowed legs, curved spine, and broken bones. Another name for this disease is osteitis deformans.

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than 10 minutes. There is no **pain** or discomfort associated with the test, but some people find it difficult to remain still. The results are often available in minutes.

During the test, the patient lies on a table. The technologist taking the x ray will check the patient's positioning and place the x-ray machine over the part of the body being examined. After asking the patient to remain motionless, the technologist steps out of the area and presses a button to take the picture.

Preparation

The patient is asked to remove clothing, jewelry, and any other metal objects from the area being x rayed. If appropriate, a lead shield will be placed over other body parts to minimize exposure to radiation.

Aftercare

The patient can immediately resume normal activities.

Risks

The human body contains some natural radiation and is also exposed to radiation in the environment. There is a slight risk from exposure to radiation during bone x rays; however, the amount of radiation is small and the risk of harm is very low. If reproductive organs are exposed to radiation, genetic alterations may occur. Excessive or repeated doses of radiation can cause changes in other types of body tissue. No radiation remains in the body after the x ray.

Normal results

Normal bones show no fractures, **dislocations**, or other abnormalities.

Abnormal results

Results that indicate the presence of bone injury or disease differ in appearance according to the nature of the injury/disease. For example, fractures show up as clear breaks in the bones, while osteoporotic bone has the same shape as a normal bone on an x ray but is less dense. Even though a bone x ray may not show definite results, it often is the first imaging choice, to be followed up by another imaging technique such as **magnetic resonance imaging** (MRI). Bone x rays are still the easiest way to show a typical bone fracture and to check on healing of broken bones.

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Borderline personality disorder

Definition

Borderline personality disorder (BPD) is a mental disorder characterized by disturbed and unstable interpersonal relationships and self-image, along with impulsive behavior, unstable mood, and suicidal behavior.

Demographics

Borderline personality disorder accounts for 30%–60% of all **personality disorders** and is present in approximately 2% of Americans. About 20% of all psychiatric hospitalizations are due to the disorder. Women are affected more frequently than men; as many as 80% of patients are female. Young women are the most frequently affected group. BPD usually is initially diagnosed in young adults, and is rarely first diagnosed in individuals over age 40.

Description

Individuals with BPD have a history of unstable interpersonal relationships. They have difficulty interpreting reality and view significant people in their lives as either completely flawless or extremely unfair and uncaring, a phenomenon known as "splitting." These alternating feelings of idealization and devaluation are one major feature of borderline personality disorder. Because borderline patients set up excessive and unrealistic expectations for others, they are inevitably disappointed when their expectations are not realized.

The term "borderline" was originally used by psychologist Adolf Stern in the 1930s to describe patients whose condition bordered somewhere between **psychosis** and neurosis, although today, the term "borderline" used in this sense is considered a misnomer. The term is better used in describing the borderline states of consciousness these patients sometimes feel when they experience dissociative symptoms (a feeling of disconnection from oneself). The syndrome itself is considered a complex disorder, rather than one lying on a border between psychosis and neurosis.

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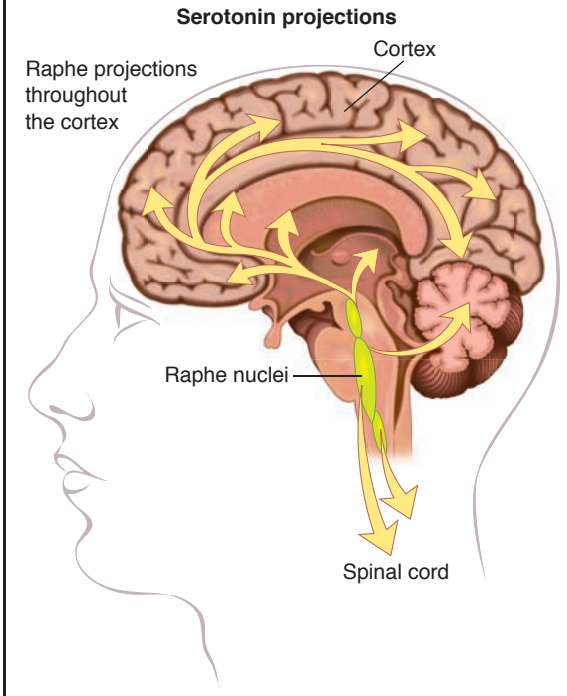

Borderline personality disorder

Diagnostic criteria for borderline personality disorder

Affective (mood-related) symptoms
1. Unstable mood caused by brief but intense episodes of depression, irritability, or anxiety
2. Chronic feelings of emptiness
3. Inappropriate and intense anger or difficulty controlling anger

Impulsive symptoms
4. Impulsive behavior in at least two areas (e.g., spending money, substance abuse, binge eating)
5. Recurrent suicidal behavior, gestures, or threats, or recurring acts of self-mutilation
6. Pattern of unstable and intense interpersonal relationships

Interpersonal symptoms
7. Extreme, persistently unstable perception of self
8. Frantic efforts to avoid abandonment

Cognitive symptoms
9. Stress-related paranoia and/or feeling disconnected from oneself

The Diagnostic and Statistical Manual of Mental Disorders states that the presence of five or more symptoms is necessary to diagnose BPD.

Diagnostic criteria for borderline personality disorder according to the *Diagnostic and Statistical Manual of Mental Disorders (DSM IV).* *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Risk factors

The National Institute of Mental Health reports that studies have found between 40% and 71% of individuals diagnosed with BPD report being sexually abused as children, most often by an individual who was not their primary caregiver. Many individuals with BPD report some kind of traumatic event in childhood such as **abuse**, separation, or abandonment. This, of course, is not true of every individual with BPD, and many individuals who experience traumatic childhood events will not develop the disorder. Abuse is considered a risk factor, but it is an environmental contributor thought to interact with inherited traits. Twin studies suggest that at least some features of this disorder are highly heritable. Mood instability and impulsivity are about 50% heritable, and studies of BPD specifically suggest a similar level of heritability. The root biological cause may be disruptions in signaling pathways involving serotonin, a nerve-signaling molecule, but more studies are necessary to confirm the biological basis of BPD. BPD has not been found to be related to race; it is believed to occur about as commonly in all races and ethnicities.

Causes and symptoms

The feelings of inadequacy and self-loathing that arise from situations of abuse or neglect may contribute to the development of a borderline personality. It has also been theorized that these patients try to compensate for the care they were denied in childhood through the idealized demands they now make on themselves and on others as adults.

The handbook used by mental health professionals to diagnose mental disorders is the *Diagnostic and Statistical Manual of Mental Disorders* fourth edition, text revised (*DSM-IV-TR*). Published by the American Psychiatric Association, it contains diagnostic criteria, research findings, and treatment information for mental disorders. It is the primary reference for mental health professionals in the United States. BPD was first listed as a disorder in the third edition *DSM-III,* which was published in 1980.

The *DSM-IV-TR* requires that at least five of the following symptoms be present in an individual for a diagnosis of BPD, although some researchers suggest

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KEY TERMS

Bipolar disorder—Formerly called manic depressive disorder. A mood disorder characterized by alternating periods of overconfidence and activity (manic highs) and depressive lows.

Cognitive-behavioral therapy—A type of psychotherapy in which people learn to recognize and change negative and self-defeating patterns of thinking and behavior.

Depression—A mental condition in which a person feels extremely sad and loses interest in life. A person with depression may also have sleep problems and loss of appetite and may have trouble concentrating and carrying out everyday activities. Severe depression may instigate a suicide attempt.

Dialectical behavior therapy—A type of cognitive-behavioral therapy designed specifically to treat borderline personality disorder.

that criteria from each of three dimensions (groupings) should actually be met.

DIMENSION: AFFECTIVE (MOOD-RELATED) SYMPTOMS.

- Unstable mood caused by brief but intense episodes of depression, irritability, or anxiety. These episodes generally are much briefer than the highs and lows of bipolar disorder. The strongest tendency is to have outbursts of anger. The level of mood instability can be a strong predictor of whether suicide will be attempted.
- Chronic feelings of emptiness.
- Inappropriate and intense anger or difficulty controlling anger displayed through temper outbursts, physical fights, and/or sarcasm.

DIMENSION: IMPULSIVE SYMPTOMS.

- Impulsive behavior in at least two areas (e.g., spending, sex, substance abuse, reckless driving, binge eating).
- Recurrent suicidal behavior, gestures, or threats, or recurring acts of self-mutilation (e.g., cutting or burning oneself). This behavior results from the combination of impulsivity and rapidly and intensely changeable mood.
- Pattern of unstable and intense interpersonal relationships, characterized by alternating between idealization and devaluation ("love-hate" relationships).

DIMENSION: INTERPERSONAL SYMPTOMS.

- Extreme, persistently unstable self-image and sense of self.
- Frantic efforts to avoid real or perceived abandonment.

In addition, there is a cognitive criterion for diagnosis that includes stress-related **paranoia** that passes fairly quickly and/or severe dissociative symptoms—feeling disconnected from oneself, as if one is an observer of one's own actions. Studies have found that as many as 40% of patients with BPD reported having semi-psychotic thoughts, and that the presence of psychotic symptoms can be a predictor of self-harm in patients who have personality disorders.

Some patients with BPD are mistakenly diagnosed with **bipolar disorder** or with **schizophrenia**. BPD can be distinguished from bipolar disorder based on the brevity of the extreme mood swings, which typically last only hours rather than days or weeks. In spite of the fact that auditory **hallucinations** can occur in people with BPD, it is distinguished from schizophrenia because the patient with BPD knows the hallucinations are not real, whereas the patient with schizophrenia does not.

Diagnosis

Borderline personality disorder typically first appears in early adulthood, with the usual age of onset around 18 years. Although the disorder may occur in adolescence, it may be difficult to diagnose, since borderline symptoms such as impulsive and experimental behaviors, insecurity, and mood swings are common—even developmentally appropriate—occurrences at this age.

Assessment is based first on determination of whether the person meets at least five of the nine *DSM-IV-TR* criteria. The next step typically involves completion of a personality assessment, which involves interviewing the patient but also can involve talking with the patient's family members or friends, with the patient's agreement. Last, the symptoms of BPD that suggest the diagnosis must have been present consistently over time.

Borderline symptoms also may be the result of chronic **substance abuse** and/or medical conditions (specifically, disorders of the central nervous system). These should be ruled out before making the diagnosis of borderline personality disorder.

BPD commonly occurs with **mood disorders** (e.g., depression, **anxiety**), **post-traumatic stress disorder** (PTSD), **eating disorders**, and attention deficit/hyperactivity disorder (ADHD). Another accompanying health problem may be a substance abuse disorder. It has also been suggested by some researchers that borderline personality disorder is not a true pathological condition in and of itself, but rather a number of overlapping personality disorders; it is, however,

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commonly recognized as a separate and distinct disorder by the American Psychiatric Association and by most mental health professionals.

Treatment

Individuals with borderline personality disorder seek psychiatric help and hospitalization at a much higher rate than people with other personality disorders, probably because of their fear of abandonment and their need to seek idealized interpersonal relationships. These patients represent the highest percentage of diagnosed personality disorders.

Traditional

Providing effective therapy for the borderline personality patient is a necessary, but difficult, challenge. The therapist-patient relationship is subject to the same inappropriate and unrealistic demands that borderline personalities place on all their significant interpersonal relationships. Individuals with BPD often are chronic treatment seekers who become easily frustrated with their therapist if they feel they are not receiving adequate attention or empathy, and symptomatic anger, impulsivity, and self-destructive behavior can impede the therapist-patient relationship. However, their fear of abandonment and of ending the therapy relationship may cause them to discontinue treatment as soon as progress is made.

Psychotherapy, typically in the form of **cognitive-behavioral therapy**, usually is the treatment of choice for borderline personalities. Dialectical behavior therapy (DBT), a cognitive-behavioral technique, has emerged as an effective therapy for borderline personalities with suicidal tendencies. The treatment focuses on giving the borderline patient self-confidence and coping tools for life outside of treatment through a combination of social skills training, mood-awareness, meditative exercises, and education about the disorder. **Group therapy** also is an option for some borderline patients, although some may feel threatened by the idea of "sharing" a therapist with others.

Drugs

Medication is not considered a first-line treatment choice but may be useful in treating some symptoms of the disorder and/or the mood disorders that often are diagnosed in conjunction with BPD. Some patients with BPD may find themselves taking several different medications, each designed to address one of the main manifestations of BPD, but there are no data from clinical trials supporting such a regimen.

Prognosis

The disorder usually peaks in young adulthood and frequently stabilizes after age 30. In many cases symptoms improve by later adulthood, especially by around age 40. Individuals with BPD are at a very high risk of attempting **suicide**. Estimates vary widely, but some studies have found that as many as 80% of individuals with BPD attempt suicide at least once, and as many as 10% of individuals with BPD complete a suicide attempt. Managing this highly prevalent suicidality is one of the greatest therapeutic challenges in BPD. The behavior usually peaks when the patient is in the mid-20s, but most of the completed suicides actually occur among patients older than 30 years, most often in patients who have experienced no recovery after many treatment attempts. If the borderline patient also has been diagnosed with a depressive disorder, the risk of suicide is much higher. For this reason, swift diagnosis and appropriate interventions are critical. Self-harming behaviors are generally not considered to be attempted suicide but instead serve as a relief from an extreme emotional state.

Prevention

There is no known way to successfully prevent borderline personality disorder. It is believed to have a complex set of causes, all of which are likely required to be present for the disorder to develop. Prompt treatment can help in preventing serious symptoms of the disorder from getting worse. Prompt, appropriate treatment also is crucial in helping to prevent suicide and suicide attempts.

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ORGANIZATIONS

Mental Health America, 2000 N. Beauregard St., 6th Floor, Alexandria, VA, 22311, (703) 684-7722, (800) 969-6642, (703) 684-5968 http://www.nmha.org.

National Education Alliance for Borderline Personality Disorder, PO Box 974, Rye, NY, 10580, info@borderlinepersonalitydisorder.com, http://www.borderlinepersonalitydisorder.com.

Treatment and Research Advancements, National Association for Personality Disorder, 23 Greene Street, New York, NY, 10013, (212) 966-6514, http://www.tara4bpd.org.

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Bordetella pertussis infection *see* **Whooping cough**

Borrelia burgdorferi infection *see* **Lyme disease**

Botanical medicine *see* **Herbalism, western**

Botox injections *see* **Botulinum toxin injections**

KEY TERMS

Antibodies—A protein developed in response to the presence of a foreign substance.

Antigen—A foreign substance inducing an antibody response within the body.

Immunoresistance—The presence of circulating antibodies.

Neuromuscular junction—Interface between motor nerve ending and muscle tissue.

Serotype—Microorganisms differing in the type of surface antigens.

Botulinum toxin injections

Definition

Botulinum is a bacterium (*Clostridium botulinum*) that produces seven different toxins that can cause **botulism** and is also medically used to block muscle contractions.

Purpose

Botulinum toxin (Botox) injection is used in conditions of excessive and inappropriate muscle contraction, spasticity (persistent states of muscle contraction), sphincter contraction, eye-movement disorders, tics and **tremors**, and cosmetically to treat facial lines and wrinkles. The U.S. Food and Drug Administration (FDA) approved Botox for treating excessive underarm sweating in 2004.

Botox has also been used in the treatment of chronic muscle tension and migraine headaches. The relief is likely due to the decrease in localized **muscle spasms**, as no direct effect of Botox on the sensory nerves has been established. Botox may be prescribed off-label to help improve movement in children with **cerebral palsy** , but this use has not been approved by the FDA. The application of the therapy seems to be growing continuously beyond its more popularly known cosmetic uses.

Precautions

Botulinum toxin is produced from the bacterium that causes **food poisoning** in humans. High doses of the toxin can be fatal; however, doses administered therapeutically are so small that harmful effects are uncommon.

Description

The number of potential applications for botulinum toxin extends to every muscle group. The first therapeutic use of Botox was in the treatment of **strabismus** (eyes are unable to direct toward the same object) and since then it has been used to treat a variety of involuntary muscle contractions or disorders. Its cosmetic use is the result of treatment for facial spasms where smoothing of facial lines was reported by patients. In general, 90% of injections for facial spasms are resolved satisfactorily.

Toxin type A has a duration of effect that lasts approximately three months and is the therapeutic agent of choice for most conditions.

Preparation

The dosage of Botox must be monitored and adjusted, with multiple injections showing a lower incidence of complications versus administration by one larger dose.

Risks

In over 30 years of therapeutic use in humans, botulinum toxin has proven to be remarkably safe. Some difficulties associated with administration of

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toxin are that different patients may experience different effects at the same dose, patients new to the treatment may experience exaggerated effects at subsequent visits, and neighboring muscles may become activated at subsequent treatments. Patients should ask about their provider's experience with injecting Botox before receiving the procedure.

Additional side effects may include excessive muscle weakness at the injection site or adjacent muscles. These effects typically resolve quickly. Occasionally, patients report flu-like symptoms but they are usually self-limited.

A certain percentage of patients may also experience resistance to the toxin. The presence of circulating antibodies to the toxin is presumed to be the primary reason for resistance to Botox injections. Patients who have little reaction to Botox A may benefit from injections using one of the other six serotypes. Using the smallest effective dose limits the likelihood of immunoresistance in unresponsive patients.

Normal results

The anticipated outcome of Botox injections is relaxation of the target muscle tissue. The pharmacological effects of botulinum toxin are typically isolated to local areas and do not result in tissue destruction or prolonged **paralysis**. Varying the dose can deliver a precise amount of toxin to achieve graded degrees of paralysis for the desired level of response.

Abnormal results

Most side effects, such as weakness in the injected muscle or overall muscle soreness, will go away quickly. Some patients have received too much of the substance when having Botox for cosmetic purposes and have been unhappy with the results. Physicians and patients should discuss the procedure and the amount to be used. Many clinicians believe that it is best to err on the side of low dosage with a return trip for more, rather than too high a dosage that might result in unwanted cosmetic effects.

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Botulism

Definition

Botulism is caused by botulinum toxin, a natural poison produced by certain bacteria in the *Clostridium* genus. Exposure to the botulinum toxin occurs mostly from eating contaminated food, or in infants, from certain clostridia growing in the intestine. Botulinum toxin blocks the motor nerves' ability to release acetylcholine, the neurotransmitter that relays nerve signals to muscles, and flaccid **paralysis**occurs. As botulism progresses, the muscles that control the airway and breathing fail.

Description

Botulism occurs rarely, but it causes concern because of its high fatality rate. Clinical descriptions of botulism possibly reach as far back in history as ancient Rome and Greece. However, the relationship between contaminated food and botulism wasn't defined until the late 1700s. In 1793 the German physician Justinius Kerner deduced that a substance in spoiled sausages, which he called *wurstgift* (German for sausage poison), caused botulism. The toxin's origin and identity remained elusive until Emile von Ermengem, a Belgian professor, isolated *Clostridium botulinum* in 1895 and identified it as the poison source.

Three types of botulism have been identified: food-borne, wound, and infant botulism. The main difference between types hinges on the route of exposure to the toxin. In the United States, there are approximately 110 cases of botulism reported annually. Food-borne botulism accounts for 25% of all botulism cases and usually can be traced to eating contaminated home-preserved food. Infant botulism accounts for 72% of all cases, but the recovery rate is good (about 98%) with proper treatment. From 1990

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KEY TERMS

Acetylcholine—A chemical released by nerve cells to signal other cells.

Antitoxin—A substance that inactivates a poison (e.g., toxin) and protects the body from being injured by it.

CT scan—The abbreviated term for computed or computerized axial tomography. The test may involve injecting a radioactive contrast into the body. Computers are used to scan for radiation and create cross-sectional images of internal organs.

Electromyograpy test—A medical test that determines a muscle's response to electrical stimuli. The test results allow medical personnel to assess how nerves to the muscle are functioning.

Flaccid paralysis—Paralysis characterized by limp, unresponsive muscles.

Lumbar puncture—A procedure in which a small amount of cerebrospinal fluid is removed from the lower spine. Examination of this fluid helps diagnose certain illnesses.

MRI—The abbreviated term for magnetic resonance imaging. MRI uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

Neurotransmitter—A chemical found in nerves that relays nerve signals to other cells. Acetylcholine is a neurotransmitter.

Sepsis—The presence of infection-causing organisms or associated toxins in the blood or within body tissues.

Spores—A state of "suspended animation" that some bacteria can adopt when conditions are not ideal for growth. Spores are analogous to plant seeds and can germinate into growing bacteria when conditions are right.

Toxin—A poisonous substance produced by a microorganism, plant, or animal.

Tracheostomy—The procedure used to open a hole in the neck to the trachea, or windpipe. It is sometimes used in conjunction with a respirator.

to 2000, 263 cases of food-borne cases were reported in the United States, most of them in Alaska. Though most were related to home canning, two restaurant-associated outbreaks affected 25 people.

Though domestic **food poisoning** is a problem worldwide, there has been a growing concern regarding the use of botulism toxin in biological warfare and terrorist acts. The Iraqi government admitted in 1995 that it had loaded 11,200 liters of botulinum toxin into SCUD missiles during the Gulf War. Luckily, these special missiles were never used. There are 17 countries known to be developing biological weapons, including the culture of botulism toxins.

Causes and symptoms

Toxin produced by the bacterium *Clostridium botulinum* is the main culprit in botulism. Other members of the *clostridium* genus can produce botulinum toxin, namely *C. argentinense*, *C. butyricum*, and *C. baratii*, but they are minor sources. To grow, these bacteria require a low-acid, oxygen-free environment that is warm (40–120°F or 4.4–48.8°C) and moist. Lacking these conditions, the bacteria transform themselves into spores that, like plant seeds, can remain dormant for years. Clostridia and their spores exist all over the world, especially in soil and aquatic sediments. They do not threaten human or animal health until the spores encounter an environment that favors growth. The spores then germinate, and the growing bacteria produce the deadly botulism toxin.

Scientists have discovered that clostridia can produce at least seven types of botulism toxin, identified as A, B, C, D, E, F, and G. Humans are usually affected by A, B, E, and very rarely F. Domesticated animals such as dogs, cattle, and mink are affected by botulism C toxin, which also affects birds and has caused massive die-offs in domestic bird flocks and wild waterfowl. Botulism D toxin can cause illness in cattle, and horses succumb to botulism A, B, and C toxin. There have been no confirmed human or animal botulism cases linked to the G toxin.

In humans, botulinum toxin latches onto specific proteins in nerve endings and irreversibly destroys them. These proteins control the release of acetylcholine, a neurotransmitter that stimulates muscle cells. With acetylcholine release blocked, nerves are not able to stimulate muscles. Ironically, botulinum toxin has found a beneficial niche in the world of medicine due to this action. Certain medical disorders are characterized by involuntary and uncontrollable muscle contractions.

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Medical researchers have discovered that injecting a strictly controlled dose of botulinum toxin into affected muscles inhibits excessive muscle contractions. The muscle is partially paralyzed and normal movement is retained. This is commonly referred to as Botox injection.

The three types of human botulism include the following symptoms:

- Food-borne. Food that has been improperly preserved or stored can harbor botulinum toxin–producing clostridia. Botulism symptoms typically appear within 18–36 hours of eating contaminated food, with extremes of four hours to eight days. Initial symptoms include blurred or double vision and difficulty swallowing and speaking. Possible gastrointestinal problems include constipation, nausea, and vomiting. As botulism progresses, the victim experiences weakness or paralysis, starting with the head muscles and progressing down the body. Breathing becomes increasingly difficult. Without medical care, respiratory failure and **death** are very likely.
- Infant. Infant botulism was first described in 1976. Unlike adults, infants younger than 12 months are vulnerable to *C. botulinum* colonizing the intestine. Infants ingest spores in honey or simply by swallowing spore-containing dust. The spores germinate in the large intestine and, as the bacteria grow, they produce botulinum toxin that is absorbed into the infant's body. The first symptoms include constipation, lethargy, and poor feeding. As infant botulism progresses, sucking and swallowing (thus eating) become difficult. A nursing mother will often notice breast engorgement as the first sign of her infant's illness. The baby suffers overall weakness and cannot control head movements. Because of the flaccid paralysis of the muscles, the baby appears "floppy." Breathing is impaired, and death from respiratory failure is a very real danger.
- Wound. Confirmed cases of wound botulism have been linked to trauma such as severe crush injuries to the extremities, surgery, and illegal drug use. Wound botulism occurs when clostridia colonize an infected wound and produce botulinum toxin. The symptoms usually appear four to 18 days after an injury occurs and are similar to food-borne botulism, although gastrointestinal symptoms may be absent.

Diagnosis

Diagnosis of botulism can be tricky because symptoms mimic those presented by other diseases. Botulism may be confused with Guillain-Barre syndrome, **myasthenia gravis**, drug reactions, **stroke**, or nervous system infection, intoxications (e.g. carbon monoxide or atropine), or shellfish poisoning. **Sepsis** is the most common initial diagnosis for infant botulism. **Failure to thrive** may also be suspected. Some reports have linked infant botulism to 5–15% of **sudden infant death syndrome** (SIDS, crib death) cases. Laboratory tests are used for definitive diagnosis, but if botulism seems likely, treatment starts immediately.

While waiting for laboratory results, doctors ask about recently consumed food and work to dismiss other disease possibilities. A **physical examination** is done with an emphasis on the nervous system. As part of this examination, CT scans, MRIs, electromyographic tests, or lumbar punctures may be ordered. Laboratory tests involve testing a suspected food and/or the patient's serum, feces, or other specimens for traces of botulinum toxin or clostridia.

Treatment

Drugs

Adults with botulism are treated with an antitoxin derived from horse serum that is distributed by the Centers for Disease Control and Prevention. The antitoxin (effective against toxin types A, B, and E) inactivates only the botulinum toxin that is unattached to nerve endings. Early injection of antitoxin (usually within 24 hours of onset of symptoms) can preserve nerve endings, prevent progression of the disease, and reduce mortality.

Infants, however, cannot receive the antitoxin used for adults. For them, human botulism immune globulin (BIG) is available in the United States through the Infant Botulism Treatment and Prevention Program in Berkeley, California. BIG neutralizes toxin types A, B, C, D, and E before they can bind to nerves. This antitoxin can provide protection against A and B toxins for approximately four months. Though many infants recover with supportive care, BIG cuts hospital stay in half, and therefore reduces hospital costs by 50% as well.

Aside from antitoxin, no drugs are used to treat botulism. **Antibiotics** are not effective for preventing or treating botulism. In fact, antibiotic use is discouraged for infants because dying bacteria could potentially release more toxin into a baby's system. Antibiotics can be used, however, to treat secondary respiratory tract and other infections.

Respiratory support

Treatment for infants usually involves intensive respiratory support and tube feeding for weeks or even months. Once an infant can breathe unaided, **physical therapy** is initiated to help the child relearn

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how to suck and swallow. A respirator is often required to help adult patients breathe, and a tracheostomy may also be necessary.

Surgery

Surgery may be necessary to clean an infected wound and remove the source of the bacteria that is producing the toxin. Antimicrobial therapy may be necessary.

Gastric lavage

When botulism is caused by food, it often is necessary to flush the gastrointestinal tract (gastric lavage). Often cathartic agents or **enemas** are used. It is important to avoid products that contain magnesium, since magnesium enhances the effect of the toxin.

Prognosis

With medical intervention, botulism victims can recover completely, though slowly. It takes weeks to months to recover from botulism, and severe cases can take years before a total recovery is attained. Recovery depends on the nerve endings building new proteins to replace those destroyed by botulinum toxin.

Prevention

Vaccines against botulism do not exist to prevent infant botulism or other forms of the disease. However, scientists announced in 2004 that they had successfully vaccinated mice and ducks against type C and D, which may help lead to vaccines for humans. Food safety is the surest prevention for botulism. Botulinum toxin cannot be seen, smelled, or tasted, so the wisest course is to discard any food that seems spoiled *without tasting it*. Home canners must be diligent about using sterile equipment and following U.S. Department of Agriculture canning guidelines. If any part of a canned food container is rusty or bulging, the food should not be eaten. Infant botulism is difficult to prevent, because controlling what goes into an infant's mouth is often beyond control, especially in regard to spores in the air. One concrete preventive is to never feed honey to infants younger than 12 months since it is one known source of botulism spores. As infants begin eating solid foods, the same food precautions should be followed as for adults.

Resources

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Sobel, Jeremy, et al. "Foodborne Botulism in the United States, 1990–2000." *Emerging Infectious Diseases* (September 2004): 1606–1612.

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Janie F. Franz
Teresa G. Odle

Bovine spongiform encephalopathy *see* **Creutzfeldt-Jakob disease**

Bowel incontinence *see* **Fecal incontinence**

Bowel preparation

Definition

Bowel preparation is a procedure usually undertaken before a diagnostic procedure or treatment can be initiated for certain colorectal diseases. Bowel preparation is a cleansing of the intestines from fecal matter and secretions.

Purpose

The ultimate goal of bowel preparation is to empty and cleanse the bowel for a diagnostic procedure (using x rays to detect a disease process in the intestines) or for surgical intervention (such as removal of polyps, **cancer**, or narrowing of the intestinal diameter). **Colonoscopy** is an effective treatment procedure for polyps (a growing mass of tissue). This procedure enables the doctor to visualize the entire large bowel. During a colonoscopy, polyps can be cauterized (applying an electric current that incinerates the polyp). The procedure can be both diagnostic and therapeutic. A **sigmoidoscopy** scope is a flexible tube that allows clinicians to view the sigmoid colon (the part of the large intestine before the rectum). This procedure is important for detection of colorectal cancer. It is safe, quick to perform (usually 30–45 minutes in about 90% of cases), and an effective diagnostic tool for evaluation of:

- rectal bleeding
- other abnormalities detected by imaging studies
- removal of polyps
- biopsy
- evaluation of chronic diarrhea or inflammatory bowel disease
- recurrences of colorectal cancer or polyps
- relieving a twisted bowel

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KEY TERMS

Lesion—An abnormal change in tissues.

Polyp—A growing mass of tissue.

- foreign body removal
- treating bleeding lesions
- preventive surveillance of cancer in patients with a positive family history of colon cancer

Precautions

Antibiotic **prophylaxis** is not routinely recommended. In some cases of prosthetic heart valves, **antibiotics** can be prescribed. Evidence exists that evacuation of intestinal waste products in conjunction with antibiotics before (prophylactic) the procedure reduces the possibility of **sepsis** (infection which spreads from the primary site to blood).

Description

The bowel is emptied of any contents for such procedures as **barium enema** (introducing a compound containing barium to promote better visualization of intestines during x rays) or colonoscopy. Preparation of the bowel distally—from the rectum—is necessary for such diagnostic procedures as sigmoidoscopy. Bowel emptying is done through taking oral laxative solutions that speed up the excretion of the contents of the lower bowel together with restrictions on solid food intake.

A newer type of imaging study may eventually make current laxative methods of bowel preparation obsolete. According to a group of researchers in the United Kingdom, computed tomography (CT) colonography (sometimes called virtual colonoscopy) has shown itself to be as accurate in diagnosing colorectal tumors as optical colonoscopy. CT colonography allows a radiologist to examine the colon and nearby organs in less than 30 seconds.

Preparation

Bowel preparation for visualization of the colon is performed to ensure the procedure will be accurate and complete. There are several effective cleansing preparations including polyethylene glycol solution (Colyte), **sodium** phosphate solution (Phospho-Soda), magnesium citrate with bisacodyl tablets, and castor oil with bisacodyl tablets. One of these preparations should be administered starting at 4:00 p.m. the day before the procedure. Patients are usually asked to avoid solid foods for about 36 hours before diagnostic procedures. Such clear liquids as vegetable or beef broth, apple or white grape juice, soda pop, or fruit-flavored gelatin are permitted, although some doctors ask patients to avoid red-colored beverages or gelatin flavors on the grounds that the red food coloring in these products may make bleeding more difficult to detect.

In most cases, patients may continue to take other prescription medications at the usual times while they are restricted to clear liquids. It is a good idea, however, to check with the doctor beforehand.

Aftercare

Patients should have a friend or relative to drive them home after the procedure, as the combination of a period of dietary restriction, frequent bowel movements, and the procedure itself leaves most people feeling tired and slightly weak. Many doctors advise patients to postpone vigorous physical activity or work requiring mental concentration until the day after the procedure. Patients can resume eating solid foods as soon as they get home.

Some patients may notice a small amount of blood on toilet tissue or underwear following a colonoscopy or other examination of the lower digestive tract. Spotting is not cause for concern; however, patients who have steady or heavy bleeding from the rectum should call their doctor as soon as possible.

Risks

The current standard of care dictates that patients receive antibiotic prophylaxis if they are at increased risk of developing an infection. High-risk patients include those with cardiac diseases or patients with prostheses.

Bowel preparation can be stressful for some patients, particularly those with pre-existing nutritional problems associated with cancer treatment or malabsorption. In addition, many patients find the various oral solutions unpleasant to the taste and difficult to swallow for that reason. According to one British study, oral solutions flavored with lemon are more acceptable to patients than unflavored forms. Both Colyte and Phospho-Soda are available with flavoring added; patients may wish to ask their pharmacist for these specific products. Mild **nausea**, **vomiting**, stomach cramps, intestinal gas, **dry mouth**, and increased thirst are common side effects of these products. Some patients are helped by taking an electrolyte supplement along with oral sodium phosphate solution to lower the risk of **dehydration**.

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Some people may have severe allergic reactions to commonly used oral **laxatives** used for bowel preparation. Patients who develop **hives**, swelling of the face or hands, swelling or **tingling** in the throat or mouth, difficulty breathing, or tightness in the chest should call their doctor *at once*. This type of reaction is a medical emergency.

Normal results

Absence of anatomical changes or abnormalities in the intestines would result in normal diagnosis.

Abnormal results

Polyps can be treated with electrocautery. A biopsy is taken of any suspicious polyps and further analyzed. Sigmoidoscopy can detect masses, bleeding, and ulcerative disease.

Resources

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ORGANIZATIONS

American College of Gastroenterology, P. O. Box 342260, Bethesda, MD, 20827-2260, (301) 263-9000, http://www.acg.gi.org.

American Society of Health-System Pharmacists (ASHP), 7272 Wisconsin Avenue, Bethesda, MD, 20814, (301) 657-3000, (866) 279-0681, http://www.ashp.org.

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Bowel resection

Definition

A bowel resection is a surgical procedure in which a part of the large or small intestine is removed.

Purpose

Bowel resection may be performed to treat various disorders of the intestine, including **cancer**, obstruction, inflammatory bowel disease, ruptured diverticulum, **ischemia** (compromised blood supply), or traumatic injury.

Description

The preferred type of bowel resection involves removal of the diseased portion of intestine, and surgically rejoining the remaining ends. In this procedure, the continuity of the bowel is maintained and normal passage of stool is preserved. When deemed necessary by the surgeon, the diseased portion of the bowel may be removed, and the functioning end of the intestine may be brought out onto the surface of the abdomen, forming a temporary or permanent **ostomy**. Use of the large intestine to form the ostomy results in a **colostomy**; use of small intestine to form the ostomy results in an ileostomy.

Preparation

As with any surgical procedure, the patient will be required to sign a consent form after the procedure is explained thoroughly. Blood and urine studies, along with various x rays and an electrocardiogram (EKG) may be ordered as the doctor deems necessary. In order to empty and cleanse the bowel, the patient may be placed on a low-residue diet for several days prior to surgery. A liquid diet may be ordered for at least the day before surgery, with nothing taken by mouth after midnight. A series of **enemas** and/or oral preparations (GoLytely or Colyte) may be ordered to empty the bowel of stool. Oral anti-infectives (neomycin, erythromycin, or kanamycin sulfate) may be ordered to decrease bacteria in the intestine and help prevent post-operative infection. A nasogastric tube is inserted through the nose into the stomach on the day of surgery or during surgery. This removes the gastric secretions and prevents **nausea and vomiting**. A urinary catheter (thin tube inserted into the bladder) may also be inserted to keep the bladder empty during surgery, giving more space in the surgical field and decreasing chances of accidental injury.

Aftercare

Post-operative care for the patient who has had a bowel resection, as with those who have had any major surgery, involves monitoring of blood pressure, pulse, respirations, and temperature. Breathing tends to be shallow because of the effect of anesthesia and the patient's reluctance to breathe deeply and experience

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KEY TERMS

Diverticulum—Small tubes or pouches that project off the wall of the intestine, visible as opaque on an x ray after the patient has swallowed a contrast (dye) substance.

Embolism—Blockage of a blood vessel by any small piece of material traveling in the blood. The emboli may be caused by germs, air, blood clots, or fat.

Ischemia—A compromise in blood supply to body tissues that causes tissue damage or death.

Ostomy—A surgically created opening in the abdomen for elimination of waste products (urine or stool).

pain that is caused by the abdominal incision. The patient is instructed how to support the operative site during deep breathing and coughing, and is given pain medication as necessary. Fluid intake and output is measured, and the operative site is observed for color and amount of wound drainage. The nasogastric tube will remain in place, attached to low intermittent suction until bowel activity resumes. Fluids and electrolytes are infused intravenously until the patient's diet can gradually be resumed, beginning with liquids and advancing to a regular diet as tolerated. The patient is generally out of bed approximately eight to 24 hours after surgery. Postoperative weight loss follows almost all bowel resections. Weight and strength are slowly regained over a period of months.

Risks

Potential complications of this abdominal surgery include:

- excessive bleeding
- surgical wound infection
- incisional hernia (an organ projects through the muscle wall that surrounds it, and the hernia occurs through the surgical scar)
- thrombophlebitis (inflammation and blood clot in veins in the legs)
- pneumonia
- pulmonary embolism (blood clot in the lungs)

Normal results

Complete healing is expected without complications after bowel resection. The period of time required for recovery from the surgery may vary depending on the patient's overall health status prior to surgery.

Abnormal results

The doctor should be made aware of any of the following problems after surgery:

- increased pain, swelling, redness, drainage, or bleeding in the surgical area
- headache, muscle aches, dizziness, fever
- increased abdominal pain or swelling, constipation, nausea or vomiting, rectal bleeding, or black, tarry stools

ORGANIZATIONS

United Ostomy Association, Inc. (UOA), PO Box 512, Northfield, MN, 55057-0512, (800) 826-0826, info@ostomy.org, http://www.ostomy.org.

Wound Ostomy and Continence Nurses Society, 15000 Commerce Parkway, Suite C, Mt. Laurel, NJ, 08054, (888) 224-9626, http://www.wocn.org.

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Bowel surgery with ostomy *see* **Colostomy**

Bowel training

Definition

Bowel training helps to reestablish normal bowel movements in persons who suffer from **constipation**, **diarrhea**, incontinence, or irregularity. Healthy bowel activity is considered one or two movements of moderate size every day.

Purpose

Many people for many reasons have irregular bowel function. In some cases, the irregularity lasts beyond the condition that caused it. The bowels by themselves develop bad habits that can be retrained with suitable exercises and education. Normal bowel habits not only improve the quality of life, they help prevent several common diseases—for example, **diverticulitis** and fecal impaction. Gall stones, **appendicitis**, **colon cancer**, **hiatal hernia**, diabetes, and heart

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KEY TERMS

Defecate—To pass feces (stool) out of the rectum through the anus.

Diverticulitis—Infection of outpouchings in the large bowel.

Fecal impaction—Obstruction of the rectum by a large mass of feces (stool).

Hiatal hernia—Part of the stomach displaced through the diaphragm into the chest.

disease have also been related to the quality of bowel movements and the foods that affect them.

- One of the most common causes of constipation is the laxative habit. Repeated artificial stimulation of the bowels destroys their natural emptying reflex, so that they will no longer move without artificial stimulants. The laxative habit begins innocently enough with the correct belief that bowels should move every day; however, laxatives will cause the evacuation of several days worth of stool in a single movement. Impatient for stool to reaccumulate for the necessary few days, the patient takes another laxative, and the cycle begins.
- The other major cause of constipation is a diet with insufficient bulk or roughage. The bowel works more smoothly the more contents it has. Western diets of highly refined foods have eliminated most of the residue from food. The result is that most food is absorbed, leaving little to pass through and be excreted as feces.
- Constipation occurs acutely with impaction—the presence in the rectum of a mass of feces too large to pass. Fecal impaction is usually the result of poor bowel habits, a diet with too little liquid and roughage, and inadequate physical activity.
- Diarrhea, whether acute or chronic, can disrupt the bowel's normal rhythm and lead to irregularity.
- Several diseases of the nervous system affect bowel reflexes.

Description

Bowel training reestablishes the bowel's normal reflexes by repeating a routine until it becomes a habit. Naturally the patient must be able and willing to cooperate. Some patients are so convinced they need daily **laxatives** that they are afraid to do without them. It takes time for a changed diet to affect the bowels and for the bowel to regain its normal rhythm. Trust and patience are necessary.

After gaining the patient's cooperation, the next step is to optimize the diet. Healthy bowel movements require ingestion of a large amount of liquids and bulk foods. The patient should drink two to three quarts of liquids every day, with liberal inclusion of prune juice and perhaps coffee for their natural laxative effects. Bulk comes from unrefined foods. Oat bran, wheat bran, brown rice, green vegetables, apples, and pears are a few examples of high residue foods. Many patients will benefit from adding bulk preparations of psyllium. Constipating foods like bananas and cheese should be avoided until a natural rhythm is well established.

To assure that stools are soft enough to pass easily, it is a good idea to add a pure stool softener like DOSS (dioctyl **sodium** sulfosuccinate), two to four per day as needed. DOSS also helps prevent impaction.

There is usually a time of day when bowel movements are more likely to occur. In anticipation of this time, the patient should participate in activities that stimulate a normal bowel movement. Walking, eating unrefined foods, and drinking prune juice or coffee encourage natural evacuation. It is acceptable to use lubricants such as glycerine suppositories or oil **enemas** at this time. For severe constipation, water enemas may be needed to initiate a movement.

It is also important for the patient to recognize the urge to defecate and to respond right away to that urge. The longer stool sits in the rectum, the more water the rectum will absorb from it, making it harder and more difficult to pass.

Normal results

With patience and diligence, normal bowel habits and the health that comes with them will return in most patients.

Resources

BOOKS

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J. Ricker Polsdorfer, MD

Braces *see* **Immobilization**

Braces, orthodontic *see* **Orthodontics**

Brachytherapy *see* **Radioactive implants**

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Brain abscess

Definition

Brain **abscess** is a bacterial infection within the brain.

Description

The brain is usually well insulated from infection by bacteria, protected by the skull, the meninges (tissue layers surrounding the brain), the immune system, and the highly regulated barrier between the bloodstream and the brain. Under certain circumstances, however, bacteria can invade the brain and cause a localized infection called an abscess. Brain abscess is relatively rare, accounting for 1 in 10,000 hospital admissions. Single abscess occurs in 75% of cases, and the remainder of cases involve multiple abscesses. If not treated, brain abscess is almost always fatal.

Causes and symptoms

One-half of all brain abscesses are caused by the spread of bacteria from a nearby infection. Sources of bacteria include:

- middle ear infections (otitis media) or infections in the bony spaces in front of the middle ear (mastoiditis)
- sinus infections
- an abscessed tooth

Other sources of bacteria include lung infections, abdominal infection, infection of the heart's lining (**endocarditis**), penetrating heart **wounds**, and **neurosurgery**.

Acquired immune deficiency syndrome (**AIDS**) or the presence of another immune deficiency greatly increases the risk of brain abscess. Approximately 25% of cases have no detectable cause of infection.

Brain abscess can be caused by a variety of organisms, many of them related to ear and sinus infections. Many times brain abscess cases are caused by two or more bacteria. In 30%–60% of cases, the bacteria combination includes streptococci, microorganisms that can live without oxygen (anaerobes), and enterobacteria. A small number of cases are caused by yeast, fungi, and single-cell organisms (protozoa).

The symptoms of brain abscess often develop slowly, usually within a period of about two weeks. The most common symptoms are:

- headache
- neurologic symptoms related to the specific part of the brain that is infected
- altered mental status
- seizures

KEY TERMS

Aspiration—Removal of fluid from a closed space through a needle.

Biopsy—The removal of a tissue sample for examination.

Diagnosis

Diagnosis of brain abscess is performed by using a computed tomography scan (CT) or a **magnetic resonance imaging** (MRI) scan to determine the site of infection. Tissue removal (biopsy) is usually performed as well. A biopsy is performed to determine the type of bacterium involved. Biopsies can also be used to rule out tumor or other noninfectious localized lesions, which may look the same on the scans.

Other tests are performed to determine the source of the infection. These tests include blood cultures, x rays of the chest, and a physical exam of the ears, sinuses, and teeth. A test for human **immunodeficiency** virus (HIV) is usually also performed.

Treatment

Treatment for brain abscess begins with intravenous **antibiotics**, chosen to match the infecting bacterium if known, or to cover a wide spectrum of possibilities if not. Treatment usually continues for six to eight weeks.

Aspiration surgery is almost always done to drain the abscess. In this procedure, a needle is guided to the infected site by CT scan, and fluid is removed (aspirated) from the abscess. Aspiration may be repeated several times until the bacteria are completely killed or removed. Surgical removal of infected or dead tissue may be needed in some cases. For patients with many sites of infection, aspiration or surgical removal is not done because of the increased difficulty and risk of the procedure. For these patients, antibiotic therapy alone is used. Steroid treatment is controversial, but may be indicated in some cases.

Prognosis

Even with prompt treatment, brain abscess is fatal in about 20% of cases. About half of those who survive have some residual neurological problems, including seizures in many patients.

There are several reasons why patients with brain abscess can have a poor prognosis. The illness may not be diagnosed correctly or an accurate diagnosis may take additional time. The patient may receive an

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antibiotic that does not match the infecting organism. Sometimes the infection may not be limited to a definite area in the brain, making diagnosis and treatment difficult. The small number of cases caused by fungal infection may take additional time to diagnose. A patient may also have a poor prognosis because there is more than one abscess, the location of the abscess is deep within the brain, or the infection has moved into many locations within the brain. Severe complications can result from brain abscess, including comma and brain rupture. In 80%–100% of cases involving brain rupture, the patient dies.

Prevention

Brain abscess may be preventable by prompt and aggressive treatment of the infections that give rise to it, especially sinus and ear infections.

Resources

BOOKS

Fauci, Anthony S., et al., eds. *Harrison's Principles of Internal Medicine*. 17th ed. New York: McGraw-Hill Professional, 2008.

Richard Robinson

Brain aneurysm *see* **Cerebral aneurysm**

Brain biopsy

Definition

A brain biopsy is the removal of a small piece of brain tissue for the diagnosis of abnormalities of the brain, such as **Alzheimer's disease**, tumors, infection, or inflammation.

Purpose

By examining the tissue sample under a microscope, the biopsy sample provides doctors with the information necessary to guide diagnosis and treatment.

Precautions

Imaging of the brain is performed to determine the precise positioning of the needle to enter the brain.

Description

When an abnormality of the brain is suspected, stereotactic (probing in three dimensions) brain needle biopsy is performed and guided precisely by a computer system to avoid serious complications. A small hole is drilled into the skull, and a needle is inserted into the brain tissue guided by computer-assisted imaging techniques (CT or MRI scans). Historically, the patient's head was held in a rigid frame to direct the probe into the brain; however, since the early 1990s it has been possible to perform these biopsies without the frame. Since the frame was attached to the skull with screws, this advancement is less invasive and better tolerated by the patient. The doctor (pathologist) prepares the sample for analysis and studies it further under a microscope.

KEY TERMS

Alzheimer's disease—A progressive, neurodegenerative disease characterized by loss of function and death of nerve cells in several areas of the brain, leading to loss of mental functions such as memory and learning.

Computed axial tomography (CT)—An x-ray technique that has the ability to image soft tissue, bone, and blood vessels.

Cortex—The thin, convoluted surface of the brain comprised primarily of cell bodies of neurons.

Magnetic resonance imaging (MRI)—An imaging technique that uses radiowaves, magnetic fields, and computer analysis to visualize body tissue and structures.

Stereotactic brain needle biopsy—In this procedure a computer uses information from a CT or MRI to create a three-dimensional map of the operation site to better guide the needle to perform the biopsy.

Preparation

A CT or MRI brain scan is done to find the position where the biopsy will be performed. Prior to the biopsy, the patient is placed under **general anesthesia**.

Aftercare

The patient is monitored in the recovery room for several hours and is usually required to spend a few days in the hospital since general anesthesia is required.

Risks

The procedure is invasive and includes risks associated with anesthesia and surgery. Brain injury may

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occur due to removal of brain tissue. The resulting scar left on the brain has the potential to trigger seizures.

Normal results

After examining the brain tissue directly, no abnormalities are detected.

Abnormal results

Various brain abnormalities can be diagnosed by microscopic analysis of the tissue sample. The pathologist (a physician trained in how disease affects the body's tissues) looks for abnormal growth, changes in cell membranes, and/or abnormal collections of cells. In Alzheimer's disease, the cortex of the brain contains abnormal collections of plaques. If infection is suspected, the infectious organism can be cultured from the tissue and identified. Classification of tumors is also possible after biopsy.

ORGANIZATIONS

Alzheimer's Association, 225 N. Michigan Ave., Fl. 17, Chicago, IL, 60601-7633, (312) 335-8700, (866) 699-1246, (800) 272-3900, info@alz.org, http://www.alz. org.

American Brain Tumor Association, 2720 River Road, Des Plaines, IL, 60018, (847) 827-9910, (847) 827-9918, (800) 886-2282, info@abta.org, http://www.abta.org/.

National Institute of Neurological Disorders and Stroke (NINDS), NIH Neurological Institute, P. O. Box 5801, Bethesda, MD, 20824, (301) 496-5751, (800) 352-9424, http://www.ninds.nih.gov/.

Bonny McClain, MS

Brain circulation scan *see* **Transcranial Doppler ultrasonography**

Brain infection *see* **Encephalitis**

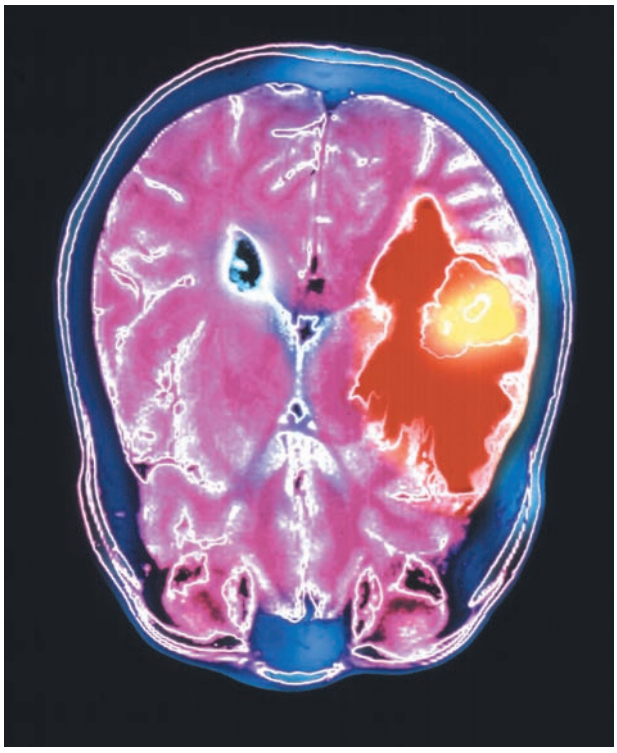
Brain injury *see* **Head injury**

Brain surgery *see* **Craniotomy**

Brain tumor

Definition

A brain tumor is an abnormal growth of tissue in the brain. Unlike other tumors, brain tumors spread by local extension and rarely metastasize (spread) outside the brain. A benign brain tumor is composed of noncancerous cells and does not metastasize beyond the part of the brain where it originates. A brain tumor is considered malignant if it contains **cancer** cells, or if it is composed of harmless cells located in an area where it suppresses one or more vital functions.



Magnetic resonance imaging (MRI) scan of axial section of human brain showing a metastatic tumor (yellow in image). *(© Simon Fraser/Science Photo Library/Photo Researchers, Inc.)*

Demographics

Each year, more than 22,000 malignant brain tumors are diagnosed in adults and children in the United States, according to the American Cancer Society. An estimated 13,000 people died from brain tumors in the United States in 2009. Brain tumors can develop at any age but are most commonly diagnosed in children between the ages of 3–12 and in adults aged 55–65. The overall risk for developing a malignant brain tumor is less than 1%.

Description

Risk factors

Primary tumors of the brain and central nervous system are often associated with HIV infection. Men and Caucasians tend to have a higher risk of developing brain tumors. Individuals considered at high risk for the development of brain cancer include children with a history of previous radiation treatment to the head for cancer and patients with certain cancers (nervous

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system, salivary gland, colon). Other risk factors include having an older father; occupational exposure to vinyl chloride, lead, and pesticides; history of **epilepsy**; and a history of certain genetic conditions (tuberous sclerosis, **neurofibromatosis**, von Hippel Lindau, **familial polyposis**, Osler-Weber-Rendu, Li-Fraumeni).

About half of all primary brain tumors are benign but in life-threatening locations. The rest are malignant and invasive.

Benign brain tumors

Benign brain tumors, composed of harmless cells, have clearly defined borders, can usually be completely removed, and are unlikely to recur. Benign brain tumors do not infiltrate nearby tissues but can cause severe **pain**, permanent brain damage, and **death**. Benign brain tumors sometimes become malignant.

Malignant brain tumors

Malignant brain tumors do not have distinct borders. They tend to grow rapidly, increasing pressure within the brain (IICP) and can spread in the brain or spinal cord beyond the point where they originate. It is highly unusual for malignant brain tumors to spread beyond the central nervous system (CNS).

Primary brain tumors

Primary brain tumors originate in the brain. They represent about 1% of all cancers and 2.5% of all cancer deaths.

Metastatic or secondary brain tumors

Metastatic brain tumors are much more common than primary brain tumors with more than 100,000 patients per year in the United States dying from the effects of metastatic brain tumors. As many as 25% of all cancer patients develop secondary or metastatic brain tumors when cancer cells spread from another part of the body to the brain. Secondary brain tumors are most apt to occur in patients who have:

- breast cancer
- colon cancer
- kidney cancer
- lung cancer
- melanoma (cancer) of the skin; these metastatic brain tumors can develop on any part of the brain or spinal cord
- cancer within the nasal passages and/or throat, which could follow the nerve pathways into the skull and metastasize to the brain

Naming and grading brain tumors

The name of a brain tumor describes where it originates, how it grows, and what kind of cells it contains. A tumor in an adult is also graded or staged according to:

- how malignant it is
- how rapidly it is growing and how likely it is to invade other tissues
- how closely its cells resemble normal cells (the more abnormal a tumor cell looks, the faster it is likely to grow)

Low-grade brain tumors usually have well-defined borders. Some low-grade brain tumors form or are enclosed (encapsulated) in cysts. Low-grade brain tumors grow slowly, if at all. They may spread throughout the brain, but rarely metastasize to other parts of the body.

Mid-grade and high-grade tumors grow more rapidly than low-grade tumors. Described as "truly malignant," these tumors usually infiltrate healthy tissue. The growth pattern makes it difficult to remove the entire tumor, and these tumors recur more often than low-grade tumors.

A single brain tumor can contain several different types of cells. The tumor's grade is determined by the highest-grade (most malignant) cell detected under a microscope, even if most of the cells in the tumor are less malignant. An infiltrating tumor is a tumor of any grade that grows into surrounding tissue.

Types of brain tumors

Glioma is the term used to refer to the most prevalent primary brain tumors. Gliomas arise from glial tissue, which supports and nourishes cells that send messages from the brain to other parts of the body. These tumors may be either malignant or benign. Astrocytomas, ependymomas, and mixed gliomas are three of the most common gliomas.

ASTROCYTOMAS. Named for the star-like shape of their cells, astrocytomas can develop on any part of the brain or spinal cord. Non-infiltrating astrocytomas grow slowly, and rarely spread to nearby tissue. Mild-to-moderately anaplastic astrocytomas with well-differentiated borders do not grow as slowly as non-infiltrating astrocytomas, and they do spread to surrounding tissues.

Anaplastic astrocytomas, which are also called Grade III astrocytomas, look more abnormal and grow more rapidly than non-infiltrating or mild-to-moderately anaplastic tumors.

Grade IV astrocytomas are also called glioblastoma multiforme (GBM) tumors. Accounting for 30%

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of all primary brain tumors, GBMs are the most common brain tumors in middle-aged adults. GBMs are the most malignant of all brain tumors. They contain a greater mixture of cells than any other brain tumors making them the most difficult to treat.

EPENDYMOMAS. Also called ependymal tumors, ependymomas account for 9% of all gliomas, and 5% of all intracranial tumors. These tumors, which are most common in children and adolescents, begin in the very thin membranes that help form cerebrospinal fluid (CSF) and line the brain cavities (ventricles) that contain it.

Ependymomas are usually benign, have well-differentiated borders, resemble normal cells, and grow very slowly. The cells of anaplastic (malignant) ependymomas look abnormal and grow more rapidly than the cells of benign tumors.

MIXED GLIOMAS. Heterogeneous tumors containing elements of astrocytomas and ependymomas and/or oligodendrogliomas are called mixed gliomas. These are rare tumors that usually occur in middle-aged adults, grow slowly, and do not usually spread beyond the part of the brain where they originate. Mixed gliomas behave like tumors composed of the highest-grade cells they contain.

Non-glial brain tumors

The most common brain tumors that do not develop from glial cells are medulloblastomas, meningiomas, and Schwannomas.

MEDULLOBLASTOMAS. Scientists once thought medulloblastomas (MDLs) developed from glial cells. These fast-growing, malignant tumors are now believed to originate in developing cells not normally present in the body after birth. They are sometimes called primitive neurodectal tumors (PNET).

MDL tumors are most common in children and are more common in boys than in girls. Only 30% of MDL tumors occur in adults. MDL tumors usually originate in the cerebellum (the part of the brain that controls coordination and some muscle activity) and are often carried to other parts of the brain by cerebrospinal fluid. MDL tumors rarely metastasize beyond the brain and spinal cord.

MENINGIOMAS. Meningiomas, which represent more than 20% of all primary brain tumors, originate in the membranes that enclose the brain and spinal cord (meninges). These tumors are usually benign and most often occur in women aged 30–50 years old. Meningiomas grow so slowly that the brain can sometimes become accustomed to their presence. Meningiomas compress, rather than invade, brain tissue and may grow to be quite large before any symptoms appear.

SCHWANNOMAS. Schwannomas originate in the Schwann cells. These cells produce myelin, the material that protects the acoustic nerve, which controls hearing. These benign tumors are twice as common in women as in men, and are most often diagnosed in patients between the ages 30–60.

Schwannomas grow very slowly, and many people adapt to the slight **hearing loss** and balance problems that are the tumors' earliest symptoms. A pear-shaped Schwannoma can cause sudden or gradual loss of hearing in an ear. As the tumor progresses, it can press on the nerves that control movement and feeling in the face and cause headaches and facial **numbness** or **tingling**. The patient may have trouble walking, swallowing, or controlling eye movements, and the sense of taste can be affected. A Schwannoma that grows large enough to press on the brain stem can be deadly.

Gliomas, meningiomas, pituitary adenomas, acoustic neuromas, and metastatic brain tumors constitute about 95% of all brain tumors.

CHILDHOOD BRAIN TUMORS. Brain tumors that occur in children are described as supratentorial (in the upper part of the brain) or infratentorial (in the lowest part of the brain). Astrocytomas and ependymomas are common supratentorial tumors. Infratentorial tumors include medulloblastomas, astrocytomas, and ependymomas.

Causes and symptoms

The cause of primary brain tumors is unknown, but people who work with rubber and certain chemicals have a greater-than-average risk of developing them. There is no evidence that **head injury** causes brain tumors, but researchers are trying to determine the relationship, if any, between brain tumors and viruses, family history, and long-term exposure to electromagnetic fields.

Results of an international study released in 2010 concluded there was no increased risk of developing glioma or meningioma in people who use mobile phones. However, the researchers cautioned that additional research in this area is needed, particularly as it relates to heavy users of mobile phones.

Symptoms do not usually appear until the tumor grows large enough to displace, damage, or destroy delicate brain tissue. When that happens, the patient may experience:

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KEY TERMS

Central nervous system (CNS)—The division of the nervous system that consists of the brain and spinal cord.

Cerebrospinal fluid (CSF)—Clear liquid that fills brain cavities and protects the brain and spinal cord.

Gamma knife—High-dose radiation treatment for intracranial tumors.

Intracranial—Located within or on the surface of the brain.

- headaches that become increasingly painful and are most painful when lying down
- nausea and vomiting or sudden attacks of vomiting not accompanied by nausea
- seizures
- dizziness or loss of coordination or balance
- personality changes
- sudden loss of vision
- memory loss
- speech problems
- sensory changes
- mental impairment
- weakness or paralysis on one side of the body

A doctor should be notified whenever a patient experiences one or more of these symptoms.

Diagnosis

Although brain tumor symptoms resemble those of many other illnesses, the presence of a brain tumor may be indicated by:

- persistent headaches with vomiting or convulsions
- progressive deterioration of sight, speech, hearing, or touch, or deterioration in the ability to use an arm, hand, foot, or leg

Examination

When a patient experiences one or more symptoms, a primary care physician will perform a complete **physical examination**, take a detailed medical history, and conduct a basic neurologic examination to evaluate:

- balance and coordination
- abstract thinking and memory
- eye movements
- hearing, touch, and sense of smell
- reflexes
- control of facial muscles and movements of the head and tongue
- awareness

Tests

If the results of the examination suggest a patient may have a brain tumor, a neurologist will recommend some or all of these additional diagnostic tests:

- computed tomography scan (CT scan) to reveal brain abnormalities
- magnetic resonance imaging (MRI) to detect tumors beneath the bones of the skull
- perfusion MRI to detect the pattern of blood flow in the brain
- complex imaging techniques such as positron emission tomography (PET scan) or single photon emission computed tomography (SPECT scan)
- electroencephalography (EEG) to measure electrical activity in the brain
- x rays to reveal any distortion in the bones of the skull
- angiography to outline a tumor and the blood vessels that lead to it
- a brain scan to identify and record the location of abnormal cells in the brain
- radionuclide brain scintigraphy to view the capillaries feeding the tumor after highlighting them with a radioactive substance
- myelography (x ray of the spine) to detect a spinal cord tumor
- a lumbar puncture (spinal tap) to obtain spinal fluid, which may contain tumor cells

Procedures

Interpreting these images and results of laboratory analysis allows neurologists to determine whether a tumor is present, but microscopic examination of tumor tissue (biopsy) is the only way to identify the kind of cells it contains.

Treatment

Brain tumors are treated by multidisciplinary teams of highly skilled specialists whose decisions are based on:

- results of diagnostic tests
- tumor size, position, and growth pattern

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- the patient's health history and current medical status
- the wishes of the patient and his family

Traditional

SURGERY. Surgery is the treatment of choice for accessible brain tumors that can be removed without causing serious neurologic damage. The procedure most often performed is a **craniotomy**, but the goals of any type of brain tumor surgery include:

- removing as much of the tumor as possible (called debulking the tumor)
- removing tumor tissue for microscopic analysis
- allowing neurosurgeons to see exactly how the tumor is situated and how it is growing
- creating an entry channel for chemotherapy drugs and forms of radiation that are implanted in the brain

Depending on the type of brain tumor, its location, and its size, a number of different techniques may be used to surgically remove it. Surgical techniques include:

- classic operation
- laser microsurgery (uses high temperatures to vaporize tumor cells
- ultrasonic aspiration (uses ultrasound waves to break up the tumor into smaller bits that can be "vacuumed" out

Before undergoing brain surgery, patients are often given **steroids** to reduce swelling of brain tissue and/or undergo radiation treatments to reduce tumor size. Anticonvulsant medications may be prescribed to prevent or control seizures.

Patients whose benign brain tumors can be completely removed may not require any additional treatment, but periodic physical and neurologic examinations and CT or MRI scans are sometimes recommended to determine whether the tumor has returned. Because surgeons cannot be sure that every bit of an infiltrating or metastasizing tumor has been removed, radiation and **chemotherapy** are used to eradicate cells that may have escaped the scalpel.

If a tumor cannot be completely removed, removing a portion of it (debulking) can alleviate the patient's symptoms, enhance the sense of well-being, and increase the effectiveness of other treatments.

RADIATION THERAPY. External radiotherapy, generally delivered on an outpatient basis, directs radiation to the tumor and the area around it. Newer techniques are used to ensure that radiation is targeted as precisely as possible to the tumor. These techniques include three-dimensional conformal **radiation therapy** (3D-CRT), intensity modulated radiation therapy (IMRT), and conformal proton beam radiation therapy.

Implant radiation therapy involves placing tiny pieces of radioactive material in the brain. Left in place permanently, or for a short time, these radioactive pellets release measured doses of radiation each day. This technique is called brachytherapy.

Brachytherapy and external beam radiation therapy may be used concurrently to treat the tumor.

Stereoactic radiosurgery involves fitting the patient with a frame to stabilize the head, using imaging techniques to determine the exact location of tumor cells, and using a sophisticated instrument to administer radiation precisely to that point. Methodologies used for delivery of radiation by this technique include particle beam therapy, photon-based therapy (Gamma Knife), and the movable linear accelerator (X-Knife, Cyberknife, and Clinac).

A variety of drugs may also be given during radiation therapy to protect brain cells from the effects of radiation (radioprotective drugs), to increase the sensitivity of tumor cells to radiation (radiosensitizers), or to boost radiation's effects (radioenhancers).

Drugs

CHEMOTHERAPY. One or more cancer-killing drugs may be taken by mouth or injected into a blood vessel or the cerebrospinal fluid. Chemotherapy may be used with radiation and surgery as part of a patient's initial treatment, or used alone to treat tumors that recur in the same place or in another part of the body. The usual chemotherapy regimen for a brain tumor is a combination approach. Chemotherapy drugs commonly used in the treatment of brain cancers include procarbazine, lomustine (CCNU), carmustine (BCNU), temozolomide, carboplatin, cisplatin, etoposide, irinotecan, methotrexate, and vincristine.

New methods of delivering chemotherapy are being used as well. These include:

- intrathecal chemotherapy, which instills the medications right into the spinal fluid;
- intra-arterial chemotherapy, which uses tiny catheter tubes to delivery high-dose chemotherapy directly into the arteries of the brain;
- interstitial chemotherapy, which is performed at the time of surgery. A chemotherapy-soaked wafer, carmustine (Gliadel), is placed in the cavity left after tumor removal.

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Potentially toxic chemotherapy drugs can be wrapped in special biologic envelopes called liposomes, to allow the drugs to be delivered to the tumor without adversely affecting other healthy tissues along the way.

When a young child has a brain tumor, chemotherapy is often used to eliminate or delay the need for radiation.

Targeted therapy

Therapies are being developed that target specific proteins on tumor cells. A type of targeted therapy used in the treatment of glioblastoma is the monoclonal antibody bevacizumab (Avastin).

Other treatments

If a brain tumor cannot be cured, treatment is designed to make the patient as comfortable as possible and preserve as much of his neurologic functioning as possible. The patient's doctor may prescribe:

- analgesics to relieve pain
- anticancer drugs to limit tumor growth
- anticonvulsants to control seizures
- steroids to reduce swelling of brain tissue

Alternative treatment

Alternative treatments have not been shown to cure brain tumors and should never be substituted for conventional therapy. However, complementary therapies (used with, not instead of, standard treatments) can help some patients cope with the **stress** of their illness and side effects of their treatment.

Massage, **meditation**, and **reflexology** help some patients relax, while **yoga** is said to soothe the body, spirit, and mind. **Hydrotherapy** uses ice, liquid, and steam to improve circulation and relieve pain. **Therapeutic touch** practitioners say they can relieve pain and other symptoms by moving their hands in slow, rhythmic motions several inches above the patient's body.

Botanical therapies, homeopathic treatment, **traditional Chinese medicine** treatments, nutritional focuses on diet and supplements, and **detoxification** can also be incorporated as complementary therapies.

Prognosis

The patient's prognosis depends on where the tumor is located, what type of cells it contains, the size of the tumor, and the effect it has already had on adjacent brain structures. A patient whose tumor is discovered early and removed completely may make a full recovery, but the surgery itself can harm or destroy normal brain tissue, causing:

- problems with thought, speech, and coordination
- seizures
- weakness
- personality changes

Although these post-operative problems may initially be more severe than the symptoms produced by the tumor, they can potentially diminish or disappear in time.

Occupational therapy can teach patients and their families new ways to approach daily tasks. **Physical therapy** can benefit patients who have difficulty keeping their balance, expressing their thoughts, speaking, or swallowing. Children may need special tutors before and after returning to school. For patients who have incurable brain tumors, hospice care may be available. Hospices provide a supportive environment and help patients manage pain and remain comfortable.

Inoperable tumors

Brain tumors that cannot be removed may cause irreversible brain damage and death.

Prevention

The cause of primary brain tumors has not been determined, so there is no known way to prevent them.

The best way to prevent secondary or metastatic brain tumors is to eliminate such risk factors as:

- poor nutrition and a low-fiber diet, since these contribute to development of intestinal cancers that can metastasize to the brain
- smoking, which causes lung cancer
- excessive use of alcohol, which is associated with liver cancer
- excessive exposure to the sun, which can cause melanoma (a deadly form of skin cancer)

Monthly self-examinations of the breasts and testicles can detect breast and **testicular cancer** at their earliest, most curable stages.

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American Cancer Society. "Brain and Spinal Cord Tumors in Children." May 13, 2009. http://www.cancer.org/Cancer/BrainCNST umorsinChildren/DetailedGuide/index (accessed July 31, 2010).

ORGANIZATIONS

American Brain Tumor Association, 2720 River Road, Des Plaines, IL, 60018, (847) 827-9910, (800) 886-2289, http://www.abta.org.
Brain Tumor Foundation for Children, Inc., 6065 Roswell Rd, Suite 505, Atlanta, GA, 30328-4015, (404) 452-4107http://www.braintumorkids.org.
Brain Tumor Information Services, Box 405, Room J341, University of Chicago Hospitals, 5841 S. Maryland Avenue, Chicago, IL, 60637, (312) 684-1400.
National Brain Tumor Society, 124 Watertown St., Suite 2 D, Watertown, MA, 02472, (800) 934-2873, http://www.braintumor.org.

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Breast biopsy

Definition

A breast biopsy is removal of breast tissue for examination by a pathologist. This can be accomplished surgically, or by withdrawing tissue through a needle.

Purpose

A biopsy is recommended when a significant abnormality is found, either on **physical examination** and/or by an imaging test. Examples of abnormality can include a breast lump felt during physical self-examination or tissue changes noticed from a mammogram test. Before a biopsy is performed, it is important to make sure that the threat of **cancer** cannot be disproved or ruled out by a simpler, less invasive examination. A lump may be obviously harmless when examined by ultrasound. If this is not decisive, the presence of cancer or a variety of benign breast conditions can be determined using a biopsy.

Precautions

The type of biopsy recommended should be considered. This will depend on whether the area can be felt, how well it can be seen on mammogram or ultrasound, and how suspicious it feels or appears. Specialized equipment is needed for different types of biopsy and availability may vary. Generally, needle biopsy is less invasive than surgical biopsy. It is appropriate for most, but not all, situations. However, some surgeons feel it is far less accurate.

Description

Surgical biopsy

If an abnormality is not felt during a self-examination, there are signs that indicate the need for medical attention. These include:

- severe breast pain
- changes in the size of a breast or the nipple
- changes in the shape of both breast or nipple
- pitting, dumpling, or redness of the breast skin
- nipple redness, irritation, or inversion
- changes in the pattern of veins visible on the surface of the breast
- some types of nipple discharge

If the abnormality is not felt, a needle localization must be done before the actual surgery. After local anesthetic is administered, a fine wire is placed in the area of concern. Either x ray or ultrasound guidance is used. The patient is awake and usually sitting up.

There are two types of breast biopsy considered here, excisional and incisional. An excisional biopsy is a surgical procedure, where the entire area of concern and some surrounding tissue is removed. It is usually done as an outpatient procedure in a hospital or free-standing surgery center. The patient may be awake, and is sometimes given medication to induce drowsiness. The area to be operated on is numbed with local anesthetic. Infrequently, **general anesthesia** is used.

An excisional biopsy itself usually takes under one hour. The total amount of time spent at the facility

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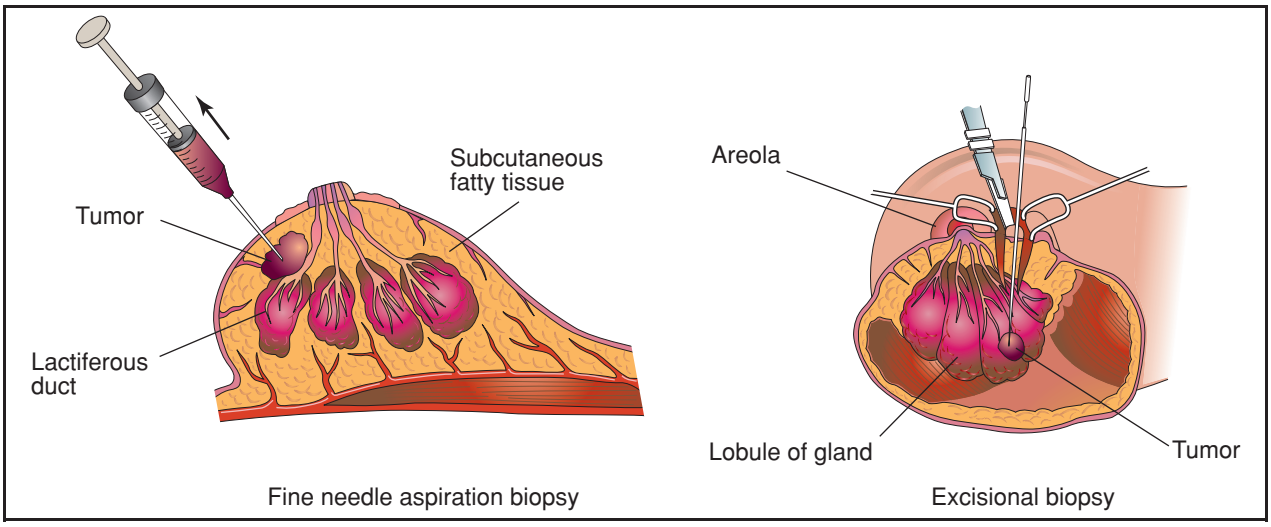

A fine needle aspiration biopsy uses a very thin needle to withdraw fluid and cells from the breast to be examined. An excisional biopsy is a surgical procedure in which the entire area of concern and some surrounding tissue is removed for analysis.
(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)

depends on the type of anesthesia used, whether a needle localization was done, and the extent of the surgery.

If a mass is very large, an incisional biopsy may be performed. In this case only a portion of the area is removed and sent for analysis. The procedure is the same as an excisional biopsy in other respects.

Needle biopsy

A needle biopsy removes part of the suspicious area for examination. There are two types, aspiration biopsy (using a fine needle), and large core needle biopsy. Either of these may be called a percutaneous needle biopsy. Percutaneous refers to a procedure done through the skin.

A fine needle aspiration biopsy uses a very thin needle to withdraw fluid and cells that can be studied. It can be done in a doctor's office, clinic, or hospital. Local anesthetic may be used but is sometimes withheld, as it may be more painful than the biopsy needle. The area to place the needle may be located by touch. No specialized equipment is needed. However, using ultrasound guidance enables the physician to feel and see the lesion at the same time. The actual withdrawing of fluid and cells can be visualized as it occurs. This helps ensure that the specimen is taken from the right place.

A large core needle biopsy uses a larger diameter needle to remove small pieces of tissue, about the size of a grain of rice. It can be done in a clinic or hospital that has the appropriate facilities. Local anesthetic is routinely used. Ultrasound or x ray is used for guidance of a large core needle biopsy.

If the suspicious area is seen best with x ray, a stereotactic device is used. This means that x rays are taken from several angles. This information is fed into a computer, which analyzes the data and guides the needle to the correct place. The patient may be sitting up, or she may be lying on her stomach, with her breast positioned through an opening in the table. The breast is held firmly but comfortably between a plastic paddle and a metal plate, similar to those used for mammograms (a set of x rays taken of the front and side of the breast). X rays may be taken before, during, and after the tissue is drawn into the needle, to confirm that the correct spot is biopsied. This procedure may also be referred to as a stereotactic core biopsy, or a mammotomy.

Ultrasound is used to guide needle placement for some lesions. The patient lies on her back or side. After the area is numbed, sterile gel is applied. The physician places a transducer, an instrument about the size of an electric shaver, over the skin. This produces an image from the reflection of sound waves. A special needle, usually in a spring-loaded device, is used to obtain the tissue. The procedure is observed on a monitor as it is happening.

Preparation

A surgical breast biopsy may require the patient to have nothing to eat or drink for a period of time before the operation. This will typically be from midnight the

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KEY TERMS

Fine needle aspiration biopsy—A procedure using a thin needle to remove fluid and cells from a lump in the breast.

Large core needle biopsy—A procedure using a thicker needle to remove a core of tissue, about the size of a grain of rice, from the breast.

night before, if general anesthesia is planned. No food restrictions are necessary for needle biopsy. It is advisable to eat lightly before the procedure. This is especially important if the patient will be lying on her stomach for a stereotactic biopsy.

Aftercare

After a surgical biopsy, the incision will be closed with stitches and covered with a bandage. The bandage can usually be removed in one or two days. Stitches are taken out approximately one week afterward. Depending on the extent of the operation, normal activities can be resumed in approximately one to three days. Vigorous **exercise** may be limited for one to three weeks.

The skin opening for a needle biopsy is minimal. It may be closed with thin, clear tape, called a steri strip, or covered with a bandaid and a small gauze bandage. The patient can return to her usual routine immediately after the biopsy. Strenuous activity or heavy lifting is not recommended for 24 hours. Any **bandages** can be removed one or two days after the biopsy.

Risks

Infection is always a possibility when the skin is broken, although this rarely occurs. Redness, swelling, or severe **pain** at the biopsy site would indicate a possible infection. Another possible consequence of a breast biopsy is a hematoma. This is a collection of blood at the biopsy site. It is usually absorbed naturally by the body. If it is very large and uncomfortable, it may need to be drained. A surgical breast biopsy may produce a visible scar on the breast. Sometimes this may make future mammograms harder to interpret accurately.

A false negative pathology report is another risk. This means that no cancer was found when a cancer was present. The incidence of this varies with the biopsy technique. In general, fine needle aspiration biopsies have the highest rate of false negative results, but there may be variation in results between facilities.

Normal results

A normal pathology report indicates no malignancy is present. The tissue sample may be further classified as a benign breast condition, such as tumor of the breast (**fibroadenoma**) or connective tissue that resembles fiber (fibrosis). Studies have demonstrated that approximately 80% of all breast biopsies result in a benign pathology report.

Abnormal results

An abnormal pathology report indicates a cancer is present. If a fine needle aspiration biopsy was performed, the pathologist has viewed individual cells under a microscope to see if they appear cancerous. Large core needle biopsy and surgical biopsy will be able to give more information. This includes the type of cancer, whether it has invaded surrounding tissue, and how likely it is to spread quickly. There are some conditions that are not malignant but indicate high risk for future development of **breast cancer**. If these are identified, more frequent monitoring of the area may be recommended.

ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (800) 227-2345, http://www.cancer.org.

National Cancer Institute (National Institutes of Health), NCI Office of Communications and Education, 6116 Executive Blvd. Suite 300, Bethesda, MD, 20892-8322, (800) 4-CANCER (422-6237), cancergovstaff@mail.nih.gov, http://www.cancer.gov/.

Ellen S. Weber, MSN

Breast cancer

Definition

Breast **cancer** is caused by the development of abnormal cells in the breast. The abnormal cells originate in the lining of either the milk glands or the ducts of the breast (ductal epithelium), defining this malignancy as a cancer. Cancer cells are characterized by uncontrolled division leading to abnormal growth and the ability of these cells to invade normal tissue locally or to spread throughout the body, a process called metastasis.

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Breast cancer

- An estimated 207,090 **female** breast cancer cases were diagnosed in 2010.
- An estimated 1,970 **male** breast cancer cases were diagnosed in 2010.
- The lifetime risk of developing invasive breast cancer is 1 in 8 in females and 1 in 1,000 in males.
- In 2010, there were more than **2.5 million** breast cancer survivors living in the United States.

SOURCE: American Cancer Society, "What are the key statistics about breast cancer?" and "What are the key statistics about breast cancer in men?" Available online at http://www.cancer.org/index (accessed August 23, 2010).

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Demographics

The American Cancer Society estimated that about 207,090 new cases of breast cancer and 54,010 cases of cancer *in situ* would be diagnosed in the United States in 2010. About 40,000 American women die of breast cancer each year; breast cancer is the second leading cause of cancer **death** in women. However, in the United States, there are 2.5 million breast cancer survivors. Both deaths from breast cancer and the number of newly diagnosed cases have declined in recent years in the United States. This is thought to be the result of earlier diagnosis from screening mammograms, improving therapies, and a dramatic decrease in the use of **hormone replacement therapy** (HRT) in postmenopausal women.

Male breast cancer is rare and accounts for less than 1% of all breast cancers. The American Cancer Society estimated that in 2010 1,970 new cases of invasive breast cancer would be diagnosed in men and about 390 men would die from the disease.

Description

Breast cancer often arises in the milk-producing glands of the breast tissue. Groups of glands in normal breast tissue are called lobules. The products of these glands are secreted into a ductal system that leads to the nipple. Depending on where in the glandular or ductal unit of the breast the cancer arises, it will develop certain characteristics that are used to subclassify breast cancer into types. Ductal carcinoma begins in the ducts, and lobular carcinoma has a pattern involving the lobules or glands. The pathologist will note the subtype at the time of evaluation with the microscope. The more important classification is related to the evaluated tumor's capability to invade, as this characteristic defines the disease as a true cancer. The stage before invasive cancer is called *in situ,* meaning that the early malignancy has not yet become capable of invasion. Thus, ductal carcinoma *in situ* is considered a minimal breast cancer.

Mammogram indicating a tumor in the center of the breast. *(Chris Bjornberg/Photo Researchers, Inc.)*

How breast cancer spreads

The primary tumor begins in the breast itself, but once it becomes invasive, it may progress beyond the breast to the regional lymph nodes or travel (metastasize) to other organ systems in the body and become systemic in nature. Lymph is the clear, protein-rich fluid that bathes the cells throughout the body. Lymph works its way back to the bloodstream via small channels known as lymphatics. Along the way, the lymph is filtered through cellular stations known as lymph nodes. Nearly all organs in the body have a primary lymph node group filtering fluid that comes from that organ. In the breast, the primary lymph nodes are under the armpit, or axilla. Classically, the

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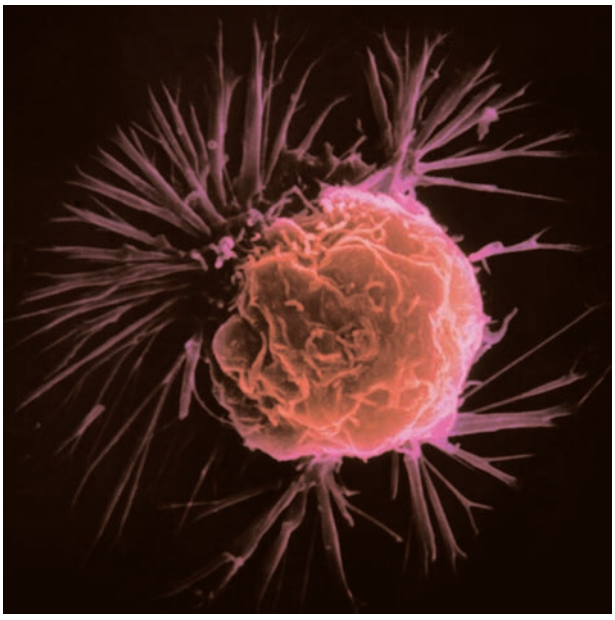

A breast cancer cell. *(© NIH/Phototake. — All rights reserved.)*

primary tumor begins in the breast and the first place to which it is likely to spread is the regional lymph nodes. Cancer, as it invades in its place of origin, may also work its way into blood vessels. If cancer gets into the blood vessels, the blood vessels provide yet another route for the cancer cells to spread to other organs of the body.

Breast cancer follows this classic progression, although it often becomes systemic or widespread early in the course of the disease. By the time one can feel a lump in the breast it is often 0.4 inches (1 cm) in size and contains roughly one million cells. Research suggests that a tumor of this size may take one to five years to develop. During that time, the cancer may metastasize, or spread by lymphatics or blood to areas elsewhere in the body.

When primary breast cancer spreads, it may first go to the axillary nodes. If this occurs, regional metastasis exists. If it proceeds elsewhere either by lymphatic or blood-borne spread, the patient develops systemic metastasis that may involve a number of other organs in the body. Favorite sites of systemic involvement for breast cancer are the lung, bones, liver, skin, and soft tissue. As it turns out, the presence and actual number of regional lymph nodes containing cancer remains the single best indicator of whether or not the cancer has become widely metastatic. Because tests to discover metastasis in other organs may not be sensitive enough to reveal minute deposits of cancer cells, the evaluation of the lymph nodes under the armpit for regional metastasis becomes very important in making treatment decisions for this disease.

If breast cancer spreads to other major organs of the body, its presence will compromise the function of those organs. Death is the result of extreme compromise of vital organ function.

Risk factors

Every woman is at risk for breast cancer. If she lives to be 85, there is a one in eight chance (12%) that she will develop breast cancer sometime during her life. The rate is slightly higher for white women and slightly lower for black women. As a woman ages, her risk of developing breast cancer rises dramatically regardless of her ethnicity or family history. The breast cancer risk of a 25-year-old woman is only one out of 19,608; by age 45, it is one in 93. In fact, fewer than 5% of cases are discovered before age 35 and the majority of all breast cancers are found in women over age 50.

There are a number of other risk factors for the development of breast cancer; however, among experts there is some disagreement about how important each of these factors is. Risk factors include:

- a family history of breast cancer in mother or sister
- carrying the BRCA1 and BRCA2 genes; women with these genes account for 5–10% of breast cancer cases and have an 80% chance of developing breast cancer at some time during their life.
- history of abnormal breast biopsies or previous history of breast cancer
- having first menstruation before age 12 or entering menopause after age 55
- having no children or having a first child after age 30
- daily alcohol consumption of two drinks or more
- obesity and a high fat diet
- breast exposure to radiation (e.g., in treatment of other cancers)
- postmenopausal hormone replacement therapy (HRT) with a combination estrogen/progesterone drug; estrogen alone does not appear to increase risk, but the longer a woman uses HRT, the more her risk increases.

HRT provides significant relief of menopausal symptoms, prevention of **osteoporosis**, and possibly protection from cardiovascular disease and **stroke**. While physicians have long known a small increased risk for breast cancer was linked to use of HRT, a landmark study released in 2003 proved the risk was greater than thought. The Women's Health Initiative found that even relatively short-term use of estrogen

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KEY TERMS

Adjuvant therapy—Treatment involving radiation, chemotherapy (drug treatment), or hormone therapy, or a combination of all three given after the primary treatment for the possibility of residual microscopic disease.

Aneuploid—An abnormal number of chromosomes in a cell.

Benign—Not malignant, noncancerous.

Biopsy—A procedure in which suspicious tissue is removed and examined by a pathologist for cancer or other disease. For breast biopsies, the tissue may be obtained by open surgery, or through a needle.

Hormone—Chemical produced by glands in the body that circulates in the blood and controls the actions of cells and organs. Estrogens are hormones that affect breast cancer growth.

Hormone therapy—Treating cancers by changing the hormone balance of the body, instead of by using cell-killing drugs.

Lumpectomy—A surgical procedure in which only the cancerous tumor in the breast is removed, together with a rim of normal tissue.

Lymph nodes—Small, bean-shaped masses of tissue scattered along the lymphatic system that act as filters and immune monitors, removing fluids, bacteria, or cancer cells that travel through the lymph system. Breast cancer cells in the lymph nodes under the arm or in the chest are a sign that the cancer has spread, and that it might recur.

Malignant—Cancerous.

Mammography—X-ray imaging of the breast that can often detect lesions in the tissue too small or too deep to be felt.

plus progestin is associated with increased risk of breast cancer, diagnosis at a more advanced stage of the disease, and a higher number of abnormal mammograms.

Causes and symptoms

All cancer is thought to occur because of small changes (mutations) in genes. A gene is a small packet of deoxyribonucleic acid (DNA), the genetic master molecule of all cells that is inherited from each parent. Genes control all aspects of development and metabolism. Small changes in the structure of genes can cause changes in proteins that regulate metabolic functions. In healthy cells, cell division is controlled by proteins regulated by genes. Specific genes make proteins that signal healthy cells when to stop dividing. In cancer, the controlling gene(s) is damaged or mutated and does not produce the proteins necessary to signal cells to stop dividing. The mutations that cause breast cancer do not have a single cause. Genetic, environmental, and lifestyle factors all play a role in determining who gets breast cancer.

Of all the risk factors listed above, family history appears to be the most important. Some studies have found that about half of all familial breast cancer cases (families in which there is a high breast cancer frequency) have mutations affecting the genes BRCA1 or BRCA2. Other genes (e.g., ATM, CHEK2, p53, PTEN) have been identified that may influence the development of breast cancer, but their impact is much less than the BRCA genes. Nevertheless, breast cancer due to heredity accounts for only a small proportion of breast cancer cases; only 5%–10% of all breast cancer cases will be women who inherited a high susceptibility through their genes.

Although there are many recognized risk factors, it is important to note that more than 70% of women who get breast cancer have no known risk factors. Having several risk factors may increase a woman's chance of developing breast cancer, but the interplay of predisposing factors is complex. In addition to those accepted factors listed above, some studies suggest that high-fat **diets**, **obesity**, or the use of alcohol can contribute to the risk profile.

Not all lumps detected in the breast are cancerous. Fibrocystic changes in the breast are extremely common. Also known as **fibrocystic condition of the breast**, fibrocystic changes are a leading cause of noncancerous lumps in the breast. Fibrocystic changes also cause symptoms of **pain**, swelling, or discharge and may become evident to the patient or physician as a lump that is either solid or filled with fluid. Complete diagnostic evaluation of any significant breast abnormality is mandatory because, although women commonly develop fibrocystic changes, breast cancer also is common, and the signs and symptoms of fibrocystic changes overlap with those of breast cancer. Certain benign changes in the breast also may be linked to increased risk for breast cancer.

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Diagnosis

The diagnosis of breast cancer is accomplished by the biopsy of any suspicious lump or mammographic abnormality that has been identified. (A biopsy is the removal of tissue for examination by a pathologist. A mammogram is a low-dose, 2-view, x-ray examination of the breast.) The patient may be prompted to visit her doctor upon finding a lump in a breast, or she may have noticed skin dimpling, nipple retraction, or discharge from the nipple. A patient may not have noticed a symptom or abnormality before a lump was detected by a screening mammogram.

When a patient has no signs or symptoms

Screening involves the evaluation of women who have no symptoms or signs of a breast problem. **Mammography** has been helpful in detecting breast cancer that cannot be identified on **physical examination**. More than 90% of all breast cancers are detected by mammogram screening. However, about 10% of breast cancer does not show up on mammography, and a similar number of patients with breast cancer have an abnormal mammogram and a normal physical examination. These figures emphasize the need for regular examination as part of the screening process.

Screening

All women are encouraged to do regular, monthly breast self-examinations. This involves feeling the breasts for any abnormal lumps or pain. If an uncertainty or a lump is found, evaluation by an experienced physician and a mammogram is recommended. The American Cancer Society (ACS) has made recommendations for the use of mammography on a screening basis. In 2009, the ACS guidelines recommended that women should begin annual screening at age 40. For women at high risk for breast cancer, the ACS recommends beginning screenings at an earlier age, having screening at more frequent intervals, and having **magnetic resonance imaging** (MRI) screening in addition to a standard mammogram. A list of conditions considered to put women at high risk for breast cancer can be found on the ACS Web site.

Because of the greater awareness of breast cancer in recent years, screening evaluations by examinations and mammography are performed much more frequently than in the past and is likely to be paid for by health insurance. As a result, the number of breast cancers diagnosed has increased, but the disease is being diagnosed at an earlier stage than previously. The earlier the stage of disease at the time it is discovered, the better the long-term outcome (prognosis) becomes.

When a patient has physical signs or symptoms

A common finding that leads to diagnosis is the presence of a lump within the breast. Skin dimpling, nipple retraction, or discharge from the nipple are less frequent initial findings prompting biopsy. Though bloody nipple discharge is distressing, it is most often caused by benign disease. Skin dimpling or nipple retraction in the presence of an underlying breast mass on examination is a more advanced finding. Actual skin involvement, with swelling (**edema**) or ulceration of the skin, are late findings.

The presence of a breast lump is a common sign of breast cancer. If the lump is suspicious and the patient has not had a mammogram by this point, a study should be done on both breasts before anything else so that the original characteristics of the lesion can be studied. The opposite breast should also be evaluated mammographically to determine if other problems exist that were undetected by physical examination.

Whether an abnormal screening mammogram or one of the signs mentioned above followed by a mammogram prompted suspicion, the definitive diagnosis is established by obtaining tissue by biopsy of the area. There are different types of biopsies, each used with its own indication. If signs of widespread metastasis are already present, biopsy of the metastasis itself may establish diagnosis.

Biopsy

Depending on the situation, different types of biopsy may be performed. The types include incisional and excisional biopsies. In an incisional biopsy, the physician takes a sample of tissue, and in excisional biopsy, the mass is removed. Fine needle aspiration biopsy and core needle biopsy are kinds of incisional biopsies.

FINE NEEDLE ASPIRATION BIOPSY. In a fine needle aspiration biopsy, a fine-gauge needle may be passed into the lesion and cells from the area suctioned into the needle can be quickly prepared for microscopic evaluation (cytology). (The patient experiencing nipple discharge also can have a sample taken of the discharge for cytological evaluation.) Fine needle aspiration is a simple procedure that can be done under **local anesthesia**, and will tell if the lesion is a fluid-filled cyst or whether it is solid. The sample obtained will yield much diagnostic information. Fine needle aspiration biopsy is an excellent technique when the lump is palpable and the physician can easily hit the target with the needle. If the lesion is a simple cyst, the fluid will be evacuated and the mass will disappear. If it is solid, the diagnosis may be obtained. Care must

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be taken, however, because if the mass is solid and the specimen is nonmalignant, a complete removal of the lesion may be appropriate to be sure.

CORE NEEDLE BIOPSY. Core needle biopsies also are obtained simply under local anesthesia. The larger piece of tissue obtained with its preserved architecture may be helpful in confirming the diagnosis short of open surgical removal. An open surgical incisional biopsy is rarely needed for diagnosis because of the needle techniques. If there remains question as to diagnosis, a complete open surgical biopsy may be required.

EXCISIONAL BIOPSY. When performed, the excisional (complete removal) biopsy is a minimal outpatient procedure often done under local anesthesia.

NON-PALPABLE LESIONS. As screening increases, non-palpable lesions (abnormalities that cannot be felt by hand examination) demonstrated only by mammography are becoming more common. The use of x rays and computers to guide the needle for biopsy or to place markers for the surgeon performing the excisional biopsy are commonly employed. Some benign lesions can be fully removed by multiple directed core biopsies. These techniques are very appealing because they are minimally invasive; however, the physician needs to be careful to obtain a good sample.

Other tests

If a lesion is not palpable and has simple cystic characteristics on mammography, ultrasound may be used both to determine that it is a cyst and to guide its evacuation. Ultrasound may also be used in some cases to guide fine needle or core biopsies of the breast.

Computed tomography (CT) scans are used only rarely in the evaluation of breast lesions. MRI is recommended for high-risk women and to follow up on suspicious findings from mammograms or for certain patients.

Staging

Once diagnosis is established and before treatment is begun, more tests are done to determine if the cancer has spread beyond the breast. These tests include a **chest x ray** and blood count with **liver function tests**. Along with the liver function measured by the blood sample, the level of alkaline phosphatase, an enzyme from bone, is also determined. A radionuclear **bone scan** may be ordered. This test looks at the places in the body to which breast cancer usually metastasizes. A CT scan also may be ordered. The physician will do a careful examination of the axillae to assess likelihood of regional metastasis. Sometimes, the physician will remove all of the axillary lymph nodes to assess breast cancer stage. However, recent studies show great success with sentinel **lymph node biopsy**. This technique removes the sentinel lymph node, or that lymph node that receives fluid drainage first from the area where the cancer is located. If this node is free of cancer, staging can be assigned accordingly. This method saves women the discomfort and side effects associated with removing additional lymph nodes in her armpit.

Using the results of these studies, the stage of cancer is defined for the patient. This helps establish a treatment protocol and prognosis. In the United States, formal staging is done using the TNM system. This system considers the tumor size and how much it has grown (T), whether the cancer has spread to the lymph nodes (N), and whether it has metastasized (M) to distant sites in the body. Stages are summarized below.

- Stage I. The cancer is no larger than 2 cm and no cancer cells are found in the lymph nodes.
- Stage II. The cancer is no larger than 2 cm but has spread to the lymph nodes or is larger than 2 cm but has not spread to the lymph nodes.
- Stage IIIA. Tumor is larger than 5 cm and has spread to the lymph nodes or is smaller than 5 cm and has spread to the lymph nodes, which have grown into each other.
- Stage IIIB. Cancer has spread to tissues near the breast or to lymph nodes inside the chest wall, along the breastbone.
- Stage IV. Cancer has spread to skin and lymph nodes near the collarbone or to other organs of the body.

Treatment

Surgery, radiation, and **chemotherapy** all may be used in the treatment of breast cancer. Depending on the stage, they will be used in different combinations or sequences to effect an appropriate strategy for the type and stage of the disease being treated.

Surgery

Historically, surgical removal of the entire breast and axillary lymph nodes, along with the muscles down to the chest wall (radical **mastectomy**), was performed as the preferred therapy for breast cancer. In the past 30 years, surgery remains a primary option, but other therapies have risen in importance. Recent studies have suggested that breast conserving treatment (as opposed to radical mastectomy) improves the quality of life for women without compromising survival. Ultimately, the extent of surgery depends on the type of breast cancer, whether the disease has spread, and the patient's age and health.

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If the tumor is less than 1.5 in. (4 cm) in size and located so that it can be removed without destroying the reasonable cosmetic appearance of the residual breast, just the primary tumor and a rim of normal tissue will be removed. The axillary nodes will still be removed for staging purposes, usually through a separate incision. Because of the risk of recurrence in the remaining breast tissue, **radiation therapy** is used to lessen the chance of local recurrence. This type of primary therapy is known as **lumpectomy** (or segmental mastectomy) and axillary dissection.

Sentinel lymph node biopsy, a technique for identifying which nodes in the axilla drain the tumor, has been developed to provide selective sampling and further lessen the degree of surgical trauma the patient experiences.

When patients are selected appropriately based on the preoperative clinical stage, all of these surgical approaches have been shown to produce similar results. In planning primary surgical therapy, it is imperative that the operation is tailored to fit the clinical circumstance of the patient.

The pathologic stage of the cancer is evaluated after surgical treatment and defines additional treatment. In addition to stage, other tests may be necessary to aid in decisions regarding additional adjuvant therapies. Adjuvant therapies are treatments used after the primary treatment to help ensure that no microscopic disease exists and to help prolong patients' survival time or reduce pain.

Radiation therapy

Like surgical therapy, radiation therapy is a local modality—it treats only the specific tissue exposed to radiation and not the rest of the body. Radiation is usually given post-operatively after surgical **wounds** have healed. The pathologic stage of the primary tumor is now known and this aids in treatment planning. The extent of the local surgery also influences the planning. Radiation may not be needed at all after modified radical mastectomy for stage I disease but is usually used when breast-preserving surgery is performed. If the tumor was extensive or if multiple nodes were involved, the field of tissue exposed will vary accordingly. Radiation is used as an adjunct to surgical therapy and is considered important to gaining local control of the tumor. In the past, radiation was used as an alternative to surgery on occasion. However, now that breast-preserving surgical protocols have been developed, primary radiation treatment of the tumor is no longer performed. Radiation also has an important role in the treatment of the patient with widespread (disseminated) disease, particularly if it involves the skeleton. Radiation therapy can affect pain control and prevention of fracture in this circumstance.

Chemotherapy

Survival after breast cancer surgery is improved by the addition of postoperative chemotherapy. Post-surgical chemotherapy therapy in patients who have no evidence of residual disease is now performed on the basis that some patients have metastases that are too small to be detectable. This occurs because it is unlikely that the surgeon has removed every single cancerous cell. Loose cancer cells, if not killed by chemotherapy, may travel through the circulatory system and form new tumors elsewhere. Chemotherapy may also be given in some circumstances before surgery. Chemotherapy is administered either orally or by injection into a blood vessel and usually involves multiple drugs. It is given in cycles, followed by a period of time for recovery, followed by another course of drugs.

Chemotherapy can produce significant side effects, including **nausea and vomiting**, temporary hair loss, mouth or vaginal sores, **fatigue**, weakened immune system, and **infertility**. Complementary therapies are often helpful in reducing some of these side effects.

Hormone therapy

Many breast cancers, particularly those originating in postmenopausal women, are responsive to hormones. These cancers have receptors on their cells for the hormone estrogen. Part of the post-surgery primary tumor assessment is evaluation for the presence of estrogen and progesterone receptors. If they are present on the cancer cells, altering the hormone status of the patient will slow tumor growth and have a positive impact on survival. Hormonal status may be changed with drug therapy. The drug tamoxifen binds to estrogen receptors on the cancer cells, so that hormones cannot interact with the cells and stimulate their growth. If the patient has these receptors present, tamoxifen is commonly prescribed for five years as an adjunct to primary treatment. In women whose cancer cells have estrogen receptors, tamoxifen reduces the chance of breast cancer reoccurring by about 50%.

Toremifene (Fareston) and fulvestrant (Faslodex) are drugs similar to tamoxifen in that they target hormone receptors on cancer cells. They are often used when cancer cells are unresponsive to tamoxifen. In addition, a new group of drugs called aromatase inhibitors, which block the enzymes that produce estrogen

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in postmenopausal (but not premenopausal) women, have been used to treat both early and late advanced breast cancer. These drugs include letrozole (Femara), anastrozole (Arimidex), and exemestane (Aromasin). Because of these agents, there is rarely any need for surgical removal of hormone-producing glands, such as the ovary or adrenal, that was sometimes necessary in the past.

Biotherapeutics

Biotherapeutics are a type of targeted therapy. Large amounts of antibodies of a single type (called monoclonal antibodies) that react with specific receptors on cancer cells are made in the laboratory. When given to the patient, they inactivate or destroy those cells containing that specific receptor, but do not react with other cells. Trastuzumab (Herceptin) and Lapatinib (Tykerb) target cells that contain a growth protein known as HER/2. Between 15% and 25% of women have breast cancer that responds to these drugs. Bevacizumab (Avastin) is a biotherapeutic used to treat breast cancer that has metastasized. It helps prevent tumors from becoming established by interfering with the growth of blood vessels into the tumor. Without access to nutrients in the blood, the tumors cannot increase in size. Biotherapeutics are normally used in addition to chemotherapy drugs.

Complementary treatments

Complementary treatments are alternative therapies used along with conventional medicine. They often are successful in moderating side effects of conventional treatment and improving the patient's quality of life. For example, **acupuncture** and **guided imagery** may be useful tools in treating pain symptoms and side effects of chemotherapy associated with breast cancer. Acupuncture involves the placement of a series of thin needles into the skin at targeted locations on the body, known as acupoints, in order to harmonize the energy flow within the human body. Guided imagery involves creating a visual mental image of pain. Once the pain can be visualized, the patient can adjust the image to make it more pleasing, and thus more manageable.

Many herbal remedies are available to lessen pain symptoms and chemotherapy side effects such as **nausea**, and to promote relaxation and healing. However, breast cancer patients should consult with their healthcare professional before taking any herbal treatments. Depending on the preparation and the type of herb, these remedies may interact with and enhance or diminish the effects of other prescribed medications. One herb that is generally regarded as helpful in relieving the nausea that accompanies chemotherapy is ginger (*Zingiber officinale*).

Prognosis

The prognosis for breast cancer depends on the type and stage of cancer. Lymph node involvement is one of the best indicators of breast cancer survival rates. According to the American Cancer Society, As of 2010, the five-year survival rate for American women with carcinoma *in situ* and stage I breast cancer was 88%–93%. The five-year survival rate for women with stage II breast cancer was 74%–81% Forty-one percent to 67% of stage III patients survive five years, and about 15% of stage IV patients do so.

Prevention

Breast cancer cannot be prevented, but making lifestyle choices that eliminate the risk factors listed above is both prudent and promotes general health and well being. While regular breast exams and screening mammograms will not prevent breast cancer, they significantly aid in its early detection and treatment, thus increasing the chances of survival.

Resources

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Lewis, Shelley. *Five Lessons I Didn't Learn From Breast Cancer (And One Big One I Did)*. New York: Penguin Books, 2008.

Link, John S. *Breast Cancer Survival Manual: A Step-by-Step Guide for the Woman With Newly Diagnosed Breast Cancer,* 4th ed. New York: H. Holt, 2007

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"Breast Cancer." Centers for Disease Control and Prevention. July 6, 2009 [September 22, 2009]. http://www.cdc.gov/cancer/breast.

"Breast Cancer." MedlinePlus. September 22, 2009 [September 23, 2009]. http://www.nlm.nih.gov/medlineplus/breastcancer.html.

"What You Need to Know About Breast Cancer." National Cancer Institute. November 1, 2007 [September 22, 2009]. http://www.cancer.gov/cancertopics/wyntk/breast.

ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd., NE, Atlanta, GA, 30329, (404) 320-3333, (800) ACS-2345 http://www.cancer.org.

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Breast Cancer Network of Strength Headquarters, 135 S. LaSalle Street, Ste 2000, Chicago, IL, 60603, (312) 986-8338, (800) 221-2141 (English); (800) 986-9505 (Español), (312) 294-8597, http://www.networkofstrength.org.

Cancer Research and Prevention Foundation, 1600 Duke Street, Suite 500, Alexandria, VA, 22314, (703) 836-4412, (800) 227-2732 info@preventcancer.org, http://www.preventcancer.org.

National Cancer Institute Public Inquires Office., 6116 Executive Boulevard, Room 3036A, Bethesda, MD, 20892-8322, (800) 4-CANCER, TTY (800) 332-8615, http://www.cancer.gov.

Richard A. McCartney, MD
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Breast enlargement *see* **Breast implants**

Breast implants

Definition

Breast implantation is a surgical procedure for enlarging the breast. Breast-shaped sacks made of a silicone outer shell and filled with silicone gel or saline (salt water), called implants, are used.

Purpose

Breast implantation is usually performed to make normal breasts larger for cosmetic purposes. Sometimes a woman having a **breast reconstruction** after a **mastectomy** will need the opposite breast enlarged to make the breasts more symmetric. Breasts that are very unequal in size due to trauma or congenital deformity may also be corrected with an enlargement procedure.

A silicone breast implant. *(AP Images.)*

Precautions

A woman in poor health or with a severe chronic disease is not a good candidate for this procedure.

A cosmetic breast enlargement is usually an outpatient procedure. It may be done under local or **general anesthesia**, depending on patient and physician preference. The incision is made through the armpit, under the breast, or around the areola (the darkened area around the nipple). These techniques create the most inconspicuous **scars**. The implant is placed between the breast tissue and underlying chest muscle, or under the chest muscle. The operation takes approximately one to two hours. The cost of a cosmetic procedure is rarely covered by insurance. However, if enlargement is part of breast reconstruction after a mastectomy, health plans may pay for some or all of it. The surgeon's fee ranges from $2,700–$4,200 and up. The procedure may also be called breast augmentation or augmentation mammaplasty.

Preparation

Before the surgery is performed, the woman should have a clear understanding of what her new breasts will look like. She and her physician should agree about the desired final result. Many surgeons find it helpful to have the patient review before and after pictures, to clarify expectations.

Aftercare

Driving and normal activities may be restricted for up to one week. Stitches are usually removed in seven to ten days. Typically, a woman can resume all routines, including vigorous **exercise**, in about three weeks. The scars will be red for approximately one month, but will fade to their final appearance within one or two years.

Risks

Risks that are common to any surgical procedure include bleeding, infection, anesthesia reaction, or unexpected scarring. A breast enlargement may also result in decreased sensation in the breast or may interfere with **breastfeeding.** Implants can make it more difficult to read and interpret mammograms, possibly delaying **breast cancer** detection. The implant itself can rupture and leak, or become displaced. A thick scar that normally forms around the implant, called a capsule, can become very hard. This

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is called capsular contracture, and may result in **pain** and/or an altered appearance of the breast. The older the implant, the greater the chances that these problems will occur.

There has been intermittent publicity about possible health risks from breast implants. Most concerns have focused on silicone gel-filled implants. The Food and Drug Administration (FDA) previously restricted the use of this type of implant but reapproved the use of silicone implants in 2006. Recent studies have shown no evidence of long-term health risks from silicone implants. However, research on the possible links between these implants and autoimmune or connective tissue diseases is continuing.

Normal results

Breasts of expected size and appearance would be the normal results of this surgery.

ORGANIZATIONS

American Society of Plastic Surgeons, 444 E. Algonquin Rd, Arlington Heights, IL, 60005, (847) 228-9900, http://www.plasticsurgery.org/.

Ellen S. Weber, MSN

Breast infection *see* **Mastitis**

Breast radiography *see* **Mammography**

Breast reconstruction

Definition

Breast reconstruction is a series of surgical procedures performed to recreate a breast. Reconstructions are commonly done after one or both breasts are removed as a treatment for **breast cancer**. Also, a breast may need to be refashioned for other reasons, such as trauma or abnormalities that occur during breast development.

Purpose

Many authorities consider reconstruction an integral part of the therapy for breast **cancer**. A breast that appears natural offers a sense of wholeness and normalcy, which can aid in the psychological recovery from breast cancer. It eliminates the need for an external prosthesis (false breast), which many women find physically uncomfortable as well as inconvenient.

Precautions

Not all women are good candidates for breast reconstruction. Overall poor physical health, or specific problems such as cigarette **smoking**, **obesity**, high blood pressure, or diabetes, will increase the chance of complications. Also, a difficult and/or prolonged recovery period or failure of the reconstruction may occur. A woman's physical ability to cope with major surgery and recuperation also need to be considered.

Description

Breast reconstruction is done in two stages, with the ultimate goal of creating a breast that looks and feels as natural as possible. It is important to remember that while a good result may mimic a normal breast closely, there will inevitably be **scars** and loss of sensation. The reconstructed breast cannot be exactly like the original.

The first step is to form a structure called a breast mound. This can be accomplished using artificial materials called **breast implants**, or by using tissues from other parts of the woman's body. The second step involves creating a balance between the newly constructed breast and the breast on the opposite side. The nipple and areolar complex (darker area around the nipple) are recreated. This is usually done several months after the mound is created, to allow swelling to go down. Other procedures may be necessary, such as lifting the opposite breast (mastopexy), or making it larger or smaller to match the reconstructed breast.

Timing, immediate or delayed reconstruction

While immediate reconstruction (IR) is not recommended for women with breast cancer who need to undergo other, more important treatments, breast reconstruction can be done almost anytime. It even can be done during the same procedure as the **mastectomy**, or it can be delayed. There are psychological benefits to IR. The ability to return to normal activities and routines is often enhanced when reconstruction follows immediately after mastectomy. A better appearance may result from IR. There is less skin removal, often resulting in a shorter scar. The surgeon is better able to preserve the normal boundaries of the breast, so it is easier to match the opposite breast more closely.

The cost of IR is generally lower than the cost of delayed reconstruction (DR). There is one fewer operation and hospital stay. Surgeon's fees may be lower for a combined procedure than for two separate surgeries.

There are disadvantages of IR as well. The surgery itself is longer, causing more time under anesthesia.

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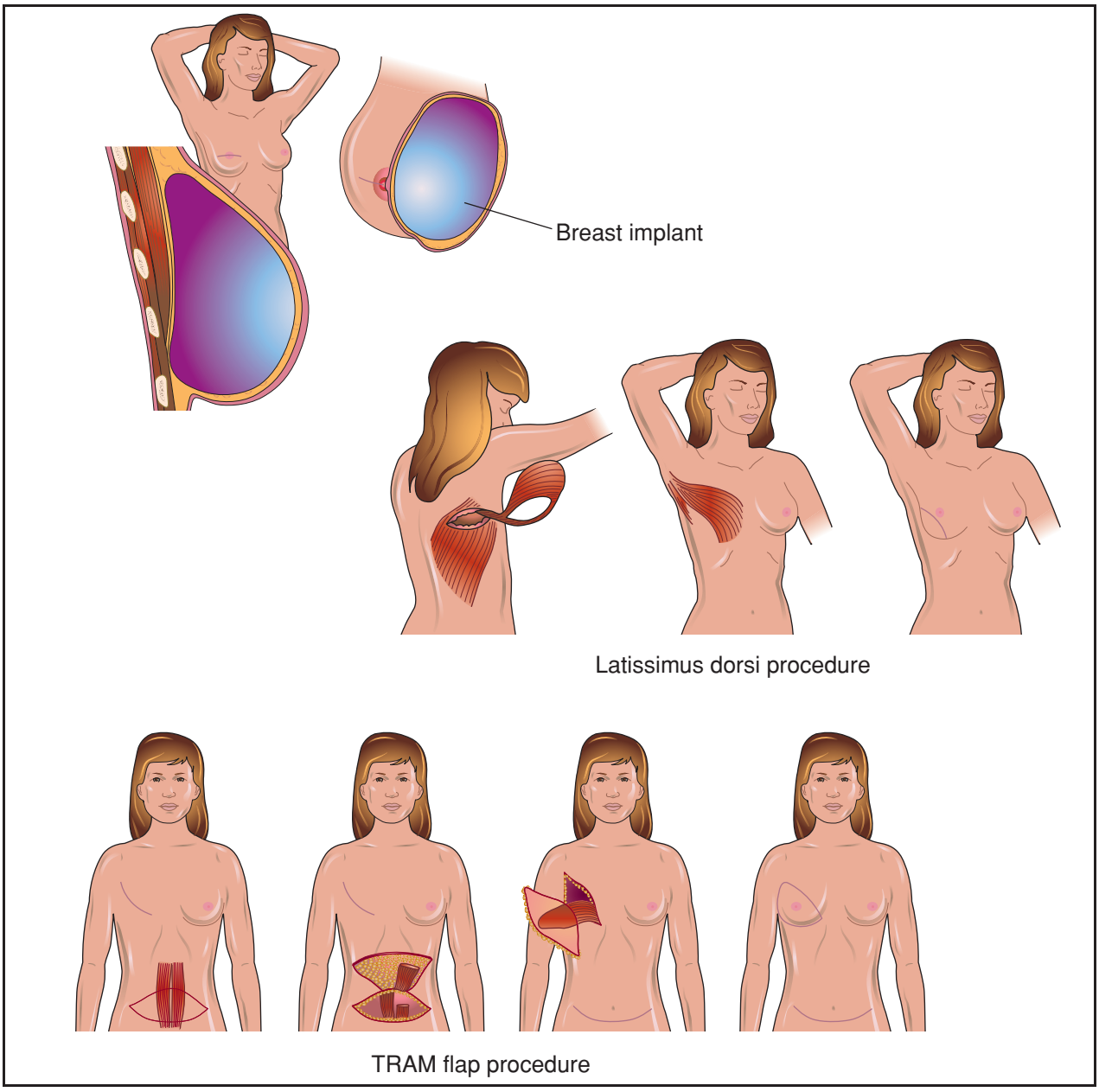

Breast reconstruction surgery may be performed by inserting an artificial substance, or implant, to replace breast tissue. Autologous reconstruction, in which a woman's own tissues are used, includes the latissimus dorsi flap, where skin and muscle taken from the back are rotated around to the breast area, and the TRAM flap, in which abdominal fat and muscle are tunneled under the skin to the breast area. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Post-operative **pain** and recovery time will be greater than for mastectomy alone.

Other authorities contend that delayed reconstruction (DR) offers different physical and psychological advantages. The initial mastectomy procedure alone takes less time, and has a shorter recovery period and less pain than mastectomy and IR. The patient has more time to adjust to her diagnosis and recover from additional therapy. She is better able to research her options, and to formulate realistic goals for reconstruction. Some **reconstructive surgery** requires blood transfusions. With DR, the patient can donate her own blood ahead of time (autologous **transfusion**), and/or arrange to have family and friends donate blood for her use (directed donation).

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KEY TERMS

Autologous—From the same person. An autologous breast reconstruction uses the woman's own tissues. An autologous blood transfusion is blood removed then transfused back to the same person at a later time.

Capsular contracture—Thick scar tissue around a breast implant, which may tighten and cause discomfort and/or firmness.

Flap—A section of tissue moved from one area of the body to another.

Free flap—A section of tissue detached from its blood supply, moved to another part of the body, and reattached by microsurgery to a new blood supply.

Mastopexy—Surgical procedure to lift up a breast. May be used on opposite breast to achieve symmetrical appearance with a reconstructed breast.

Pedicle flap—Also called an attached flap. A section of tissue with its blood supply intact, which is maneuvered to another part of the body.

The psychological **stress** of living without a breast is a disadvantage of DR. The extra procedure DR entails results in higher costs. Although initial recovery is faster, an additional recuperation period is required after the delayed operation.

Type of reconstruction

There are two basic choices for breast reconstruction. The breast tissue can be replaced with an implant or the breast is created using some of the woman's own tissues (autologous reconstruction).

ARTIFICIAL IMPLANTS. In general, implant procedures take less time and are less expensive than autologous ones. Implants are breast-shaped pouches. They are made of silicone outer shells, which may be smooth or textured. The inside may contain silicone gel, saline (salt water), or a combination of both.

An implant may be a fixed-volume type, which cannot change its size. Implants that have the capacity to be filled after insertion are called tissue expanders. These may be temporary or permanent.

The initial procedure for any implant insertion uses the mastectomy incision to make a pocket of tissue, usually underneath the chest wall muscle. In DR, the mastectomy scar may be re-opened and used for this purpose, or a more cosmetic incision may be made. The implant is inserted into the pocket, and the skin is stretched as needed and stitched closed.

If there is inadequate tissue to achieve the desired size, or a naturally sagging breast is desired, a tissue expander is used. It resembles a partially deflated balloon, with an attached valve or port through which saline can be injected. After the initial surgical incision is healed, the woman returns to the doctor's office, on a weekly or biweekly basis, to have small amounts of saline injected. Injections can continue for about six to eight weeks, until the preferred size is obtained. In some cases it may be overfilled, and later partially deflated to allow for a more pliable, natural result. A temporary tissue expander will be removed after several months and replaced with a permanent implant.

IR surgery using an implant takes approximately two to three hours, and usually requires up to a three-day hospital stay. Implant insertion surgery, as part of DR, takes one to two hours and can sometimes be done as an outpatient, or it may entail overnight hospitalization.

AUTOLOGUS RECONSTRUCTION. Attached flap and free flap are two types of surgery where a woman's tissue is used in reconstruction. An attached flap uses skin, muscle, and fat, leaving blood vessels attached to their original source of blood. The flap is maneuvered to the reconstruction site, keeping its original blood supply for nourishment. This may also be known as a pedicle flap. The second kind of surgery is called a free flap. This also uses skin, muscle, and fat, but severs the blood vessels, and attaches them to other vessels where the new breast is to be created. The surgeon uses a microscope to accomplish this delicate task of sewing blood vessels together. Sometimes the term microsurgery is used to refer to free flap procedures. Either type of surgery may also be called a myocutaneous flap, referring to the skin and muscle used.

The skin and muscle used in autologous reconstruction can come from one of several possible places on the body, including the abdomen (TRAM flap or "tummy tuck"), the back (latissimus dorsi flap), or the buttocks (gluteus maximus free flap).

Finishing the reconstruction

Other procedures may be necessary to achieve the goal of symmetrical breasts. It may be necessary

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to make the opposite breast larger (augmentation), smaller (reduction), or higher (mastopexy). These or any other refinements should be completed before the creation of a nipple and areola. Tissue to form the new nipple may come from the reconstructed breast itself, the opposite breast, or a more distant donor site, such as the inner thigh or behind the ear. The nipple and areolar construction is usually an outpatient procedure. A final step, often done in the doctor's office, is tattooing the new nipple and areola to match the color of the opposite nipple and areola as closely as possible.

Insurance

Insurance coverage for breast reconstruction varies widely. Some policies will allow procedures on the affected breast, but refuse to pay for alterations to the opposite breast. Other plans may cover the cost of an external prosthesis, or reconstructive surgery, but not both.

Implants may pose additional insurance concerns. Some companies will withdraw coverage for women with implants, or add a disclaimer for future implant-related problems. Careful reading of insurance policies, including checking on the need for pre-approval and/or a second opinion, is strongly recommended.

Preparation

Routine preoperative preparations, such as taking nothing to eat or drink the night before surgery, are needed for reconstructive procedures. If blood transfusion is required, the patient or family and friends will donate several weeks before the surgery.

Emotional preparation is also important. Breast reconstruction will not resolve a psychological problem the woman had before mastectomy, nor make an unstable relationship strong. An expectation of physical perfection is unrealistic. A woman who cites any of these reasons for reconstruction shows that she has not been adequately informed or prepared. Complete understanding of the benefits and limitations of this surgery is necessary for a satisfactory result.

Aftercare

The length of the hospital stay, recovery period, and frequency of visits to the doctor after surgery vary considerably with the different kinds of reconstruction. In general, autologous procedures require longer hospitalization and recovery time than implant procedures. **Bandages** and drainage tubes remain in place for at least a day for all surgeries. Microsurgical or free flaps are most closely monitored in the first day or two after surgery. The circulation to the breast may be checked as often as every hour. Complete breast reconstruction requires at least one additional surgery to create a nipple and areola. Scars may remain red and raised for a month or longer. The true, final appearance of the breasts will not be visible for at least one year.

Risks

Some women have reported various types of autoimmune-related connective tissue disorders, which they attribute to their implants—usually involving silicone gel implants. Food and Drug Administration (FDA) guidelines issued in 1992 limited their use, but these restrictions were removed in 2006 due to a lack of evidence. However, the use of silicone gel–filled implants will continue to be closely monitored, and manufacturers of these implants are required to conduct 10-year consumer studies. Saline-filled implants are permitted for all uses, although manufacturers must also collect data on possible risks.

There are a number of risks common to any surgical procedure such as bleeding, infection, anesthesia reaction, or unexpected scarring. Hematoma (accumulation of blood at the surgical site) or seroma (collection of fluid at the surgical site) can delay healing if not drained. Any breast reconstruction also poses a risk of asymmetry and/or the need for unplanned surgical revision. Persistent pain is another potential complication possible with all types of breast reconstruction.

Implants have some unique problems that may develop. A thick scar, also called a capsule, forms around the implant, as part of the body's normal reaction to a foreign substance. Capsular contracture occurs when the scar becomes firm or hardened. This may cause pain and/or change the texture and appearance of the breast. Implants can rupture and leak, deflate, or become displaced. The chances of capsular contracture or rupture increase with the age of the implant. These complications can usually be remedied with outpatient surgery to loosen the capsule or remove and/or replace the implant as needed. There is some evidence that using implants with textured surfaces may decrease the incidence of these problems. An implant tends to remain firm indefinitely. It will not grow larger or smaller as the woman's weight changes. Asymmetry can develop if a woman gains or loses a large amount of weight.

The autologous procedures all carry a risk of flap failure—loss of blood supply to the tissue forming the new breast. If a large portion of the flap develops inadequate blood supply, another reconstructive technique may be necessary. TRAM flap procedures can result in decreased muscle tone and weakness in the

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abdomen and/or abdominal **hernia**. Arm weakness may occur after latissimus dorsi flap surgery.

Normal results

A normal result of breast reconstruction depends on the woman's goals and expectations. It will not be the same as the breast it replaces. In general, it should be similar in size and shape to the opposite breast, but will have less sensation and be less mobile than a natural breast. A reconstruction using implants will usually be firmer and rounder than the other breast. It may feel cooler to touch, depending on the amount of tissue over it. Scars are unavoidable, but should be as unobtrusive as possible.

Breast reconstruction surgery may be performed by inserting an artificial substance, or implant, to replace breast tissue. Autologous reconstruction, in which a woman's own tissues are used, includes the latissimus dorsi flap, where skin and muscle taken from the back is rotated around to the breast area, and the TRAM flap, in which abdominal fat and muscle are tunneled under the skin to the breast area.

ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (800) 227-2345, http://www.cancer.org.

American Society of Plastic Surgeons, 444 E. Algonquin Rd, Arlington Heights, IL, 60005, (847) 228-9900, http://www.plasticsurgery.org/.

Ellen S. Weber, MSN

Breast reduction

Definition

Breast reduction is a surgical procedure performed in order to decrease the size of the breasts.

Purpose

Women with very large breasts (macromastia or mammary hyperplasia) seek breast reduction for relief of **pain** in the back, shoulder, and neck. They may also feel uncomfortable about their breast size and have difficulty finding clothing that will fit properly. Additionally, breast reduction may be needed after **reconstructive surgery** following the surgical removal of cancerous breast tissue (**mastectomy**), to make the breasts more symmetric.

KEY TERMS

Gynecomastia—Overly developed or enlarged breasts in a male.

Macromastia—Excessive size of the breasts.

Mammary hyperplasia—Increased size of the breast.

Men who have enlarged breasts (**gynecomastia**) may also be candidates for breast reduction. However, excessive alcohol intake, smoking marijuana, or using anabolic **steroids** may cause gynecomastia, and surgery is not recommended for men who continue to use these products.

Precautions

Breast reduction is not recommended for women whose breasts are not fully developed or who plan to breast feed.

Description

Breast reduction may also be called reduction mammaplasty. It is most often done in the hospital, under general anesthetic. However, studies have suggested that an outpatient procedure using local anesthetic and mild **sedation** may be appropriate for some patients. The operation takes approximately two to four hours. The most commonly made incision encircles the areola (darkened area around the nipple) and extends downward and around the underside of the breast. This produces the least conspicuous scar. The excess tissue, fat, and skin are removed, and the nipple and areola are repositioned. In certain cases, **liposuction** (fat suctioning) is used to remove extra fat from the armpit area. A hospital stay of up to three days may be needed for recovery.

If deemed medically necessary, breast reduction is covered by some insurance plans. However, a specified amount of breast tissue may need to be removed in order to qualify for coverage. Surgeon's fees range from $4,800–$6,500 and up.

Preparation

Consultation between surgeon and patient is important to ensure that the woman understands and agrees with the expected final results of the procedure. Measurements and photographs may be taken. Many doctors also recommend a mammogram before the operation, to make sure there is no **cancer**.

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Aftercare

After the surgery, an elastic bandage or special supportive bra is placed over gauze **bandages** and drainage tubes. The bandages and tubes are removed in a day or two. The bra will need to be worn around the clock for several weeks. Stitches are removed one to three weeks after the operation. Normal activities, including sexual relations, may be restricted for several weeks. **Scars** will typically remain red and perhaps lumpy for up to several months, but will gradually fade and become less noticeable. It may take up to a year before the breasts achieve their final position and size.

Risks

Risks common to any operation include bleeding, infection, anesthesia reactions, or unexpected scarring. Breast reduction may result in decreased feeling in the breasts or nipples and/or impaired ability to breastfeed. When healing is complete, the breasts may be slightly uneven, or the nipples may be asymmetric.

Normal results

Smaller breast size should be achieved, and with that, the accompanying pain and discomfort should be alleviated.

ORGANIZATIONS

American Society of Plastic Surgeons, 444 E. Algonquin Rd, Arlington Heights, IL, 60005, (847) 228-9900, http://www.plasticsurgery.org/.

Ellen S. Weber, MSN

Breast self-examination

Definition

A breast self-examination (BSE) is an inspection by a woman of her breasts to detect **breast cancer**.

Purpose

A BSE is one of three tests the American Cancer Society recommends to help detect breast cancer in its earliest stages. By regularly examining her own breasts, a woman is more likely to find any changes that may have occurred. The best time to perform a BSE is about a week after a woman's period ends, when her breasts are not tender or swollen. If her periods are not regular, a BSE should be completed on the same day every month. A BSE should also be regularly completed by women who are pregnant, **breastfeeding**, or have **breast implants**. By combining a BSE with a **mammography** and clinical breast examination, a woman is offered the best opportunity for reducing chances of **death** from breast cancer through early detection. Close to 90% of breast cancers are found through a BSE. The American Cancer Society recommends that beginning at the age of 20, women complete a BSE each month by feeling for lumps or anything suspicious, as well as looking at their breasts carefully in a mirror for any changes in contour, swelling, dimpling, puckering of the skin, or changes in the nipple.

Description

To complete a monthly BSE:

- When lying down, place a pillow under the right shoulder and position the right arm behind the head. Using the finger pads of the three middle fingers on the left hand, check the entire breast area. Use small circles and follow an up-and-down pattern while pressing firmly enough to know how the breast feels from month to month. This exam should then be repeated on the left breast using the finger pads of the right hand with the pillow under the left shoulder.
- When standing before a mirror, any changes in the shape or look of the breasts should be checked. In order to look for any skin or nipple changes such as dimpling or nipple discharge, the arms should first be placed at the sides and then overhead. Hands are then placed firmly on hips to flex chest muscles, and then the body should be bent forward.
- When taking a shower, the right arm should be raised. By using soapy hands and flat fingers the right breast and outer part of the breast can be examined. The same small circles and up-and-down pattern used when lying down should be used in an upright position. Repeat on the left breast.

Preparation

Before beginning a monthly BSE, a woman's breasts should be completely exposed.

Normal results

Each woman's breasts have their own normal look and feel. By completing a BSE each month, a woman can determine what is normal for her and check for changes that may arise. A regular pattern of lumpiness in the breasts is normal.

Abnormal results

If any changes are noticed during a monthly BSE, such as a new, hard lump in the breast or underarms, a doctor should examine the area immediately. Other trouble signs that should not be ignored include:

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- change in breast size or shape
- dimpling or puckering of the skin
- redness, swelling, or warmth that does not go away
- a pain in one area that does not vary with a woman's monthly cycle
- a nipple that pulls in
- discharge from the nipple that begins suddenly and appears only in one breast
- one nipple that has an itchy, sore, or scaling area

Resources

BOOKS

Sarg. Michael J., and Ann D. Gross. *The Cancer Dictionary*. 3rd ed. New York: Checkmark Books, 2007.

OTHER

"How to do a Breast Self-Exam." Women.com. May 5, 2001. http://www.women.com.

ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (800) 227-2345, http://www.cancer.org.

Komen Foundation, 5005 LBJ Freeway, Suite 250, Dallas, TX, 75244, (877) GO KOMEN, http://www.komen.org/.

Beth A. Kapes

Breast sonogram *see* **Breast ultrasound**

Breast ultrasound

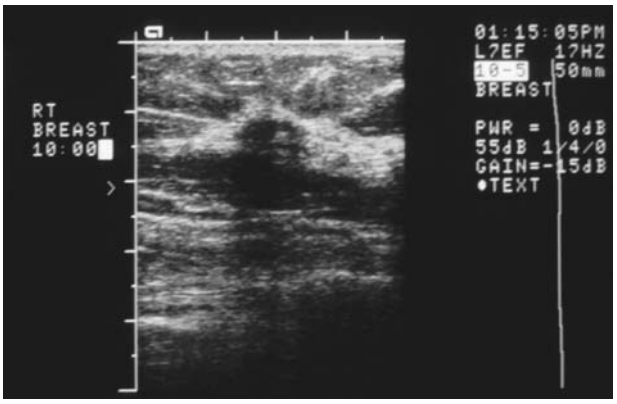
Definition

Breast ultrasound (or sonography) is an imaging technique for diagnosing breast disease, such as **cancer**. It uses harmless, high frequency sound waves to form an image (sonogram). The sound waves pass through the breast and bounce back or echo from various tissues to form a picture of the internal structures. It is not invasive and involves no radiation.

Purpose

Breast ultrasound may be used in several ways. The most common application is to investigate a specific area of the breast where a problem is suspected. A palpable lump and/or a lump or density discovered by x-ray imaging (mammogram) can be further evaluated by ultrasound. It is especially helpful in distinguishing between a fluid-filled cyst and a solid mass. It also can identify small lesions that are too tiny to be felt.

Breast ultrasound is often the first study performed to evaluate masses in women under 35 whose mammograms can be difficult to interpret due to the density of their breast tissue. In 2003, a new study found that ultrasound was more accurate than **mammography** at diagnosing **breast cancer** in women under age 45. However, mammography still works as a screening tool, with breast ultrasound as the follow-up examination. Another study in that year found that combining ultrasound with **magnetic resonance imaging** (MRI) direction greatly improved diagnostic decisions about breast cancer lesions. The lesions detected by MRI could also be localized using ultrasound needle guidance for follow-up biopsy.



A breast ultrasound image. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

The lack of radiation used with ultrasound makes it ideal for studying breast abnormalities in women who are pregnant. Assessing **breast implants** for leakage or rupture is another use for ultrasound. Breast inflammation, where pockets of infection or abscesses may form, can be diagnosed and monitored by ultrasound.

Thickened and swollen breast skin may be a sign of inflammatory breast cancer. Ultrasound can sometimes identify a cancerous growth within the breast causing the thickened skin. These cases are usually followed by a core biopsy guided by ultrasound.

Breast ultrasound is employed to observe and guide a needle for several interventional procedures. These include cyst aspiration, fine needle aspiration, large core needle biopsy (as a first step in determining treatment for a lesion that is likely to be cancerous), and needle localization in surgical **breast biopsy**. Biopsies guided by ultrasound have distinct advantages. Patients usually find that the procedure is less traumatic and more comfortable than surgical biopsies. Ultrasound is known for its accuracy in determining how far a cancerous growth extends into the surrounding tissue in lesions that cannot be felt. Biopsies guided

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KEY TERMS

Cyst—A thin-walled, fluid-filled benign structure in the breast.

Ductal carcinoma—A type of cancer that accounts for as much as 80% of breast cancers. These tumors feel bigger than they look on ultrasound or mammogram.

Fibroadenoma—A benign breast growth made up of fibrous tissue. It is the most common mass in women under 35 years of age, and is found in both breasts in 3% of cases.

Infiltrating lobular carcinoma—A type of cancer that accounts for 8% to 10% of breast cancers. In breasts that are especially dense, ultrasound can be useful in identifying these masses.

Microcalcifications—Tiny flecks that are too small to be felt. They are important markers of cancer that show up on ultrasound and mammogram.

Mucinous (colloid) carcinoma—A type of cancer that accounts for 1% to 2% of breast cancers. Resembles medullary carcinoma in ultrasound and mammogram, but usually affects older women.

Nonpalpable—Cannot be felt by hand. In cancer, growths that are nonpalpable are too small to be felt, but may be seen on ultrasound or mammogram.

Papillary carcinoma—A type of breast cancer that primarily occurs in older women. On ultrasound, this type of tumor may look like a solid or complex mass, or it may show up as solid tissue protruding into a cyst.

Tubular carcinoma—A type of cancer that accounts for approximately 1% to 2% of breast cancers. Can appear small on ultrasound or mammogram.

by ultrasound are generally less costly than surgical biopsies. Additionally, if the abnormality that requires biopsy can be seen on both a mammogram and ultrasound, an ultrasound-guided biopsy is often more comfortable for the patient as no compression is necessary.

Description

Ultrasound can be done in a doctor's office or another outpatient setting, such as a hospital or imaging center.

The patient removes her clothing from the waist up and puts on a hospital gown, open in the front. She lies on her back or side on an examining table. A gel that enhances sound transmission is spread over the area to be examined. The technologist then places a transducer, an instrument about the size of an electric shaver, against the skin. The images from reflected sound waves appear on a monitor screen.

A physician called a radiologist interprets the images obtained from ultrasound imaging. In 2003, it was reported that new computer-aided diagnosis (CAD) technology that had recently been widely added to mammography may help improve ultrasound as well. The CAD system uses computer algorithms applied to a three-dimensional ultrasound image to assign scores to mass characteristics. Though the technology will not replace human observation and judgment, it may soon be added to support the radiologist's interpretation.

A good ultrasound study is difficult to obtain if the patient is unable to remain quietly in one position. **Obesity** may hinder clear viewing of internal structures, and the accuracy of an ultrasound study is highly dependent on the skill of the person performing the examination. The images recorded vary with the angle and pressure of the transducer and the equipment settings. The examination may take from 30 to 45 minutes. Most insurance plans cover the cost of an ultrasound examination.

Normal results

An ultrasound examination may reveal either normal tissue or a benign condition such as a cyst. Ultrasound can confidently diagnose a benign structure that has certain characteristics of a simple cyst. In the case of a simple cyst with no symptoms, additional treatment beyond continued observation is usually not needed.

Abnormal results

A potentially malignant mass can be identified by breast ultrasound. Abnormal results fall into the following categories: benign fibrous nodule, complex cyst, suspicious lesion, and lesion highly suggestive of cancer. In cases where ultrasound shows the presence of a complex cyst or fibrous nodule, a biopsy is justified because 10% to 15% of these growths are malignant. Lesions falling into the last two categories (suspicious or highly suggestive of cancer) have a higher chance of

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being cancerous and should be investigated further, either by biopsy or surgery.

Breast cancers such as the following may be identified on ultrasound: ductal carcinoma, infiltrating lobular carcinoma, medullary carcinoma, mucinous (colloid) carcinoma, tubular carcinoma, and papillary carcinoma. On ultrasound, the shape of a lesion and the type of edges it has can sometimes indicate if it is benign or cancerous, but there are exceptions. For example, benign fibroadenomas are usually oval, and some cancers can be similarly shaped. Cancerous tumors usually have jagged edges, but some benign growths can have these edges as well. Ultrasound is not a definitive test. Tissue diagnosis is often required.

Resources

PERIODICALS

"CAD Software Improves Breast Ultrasound, Digital Mammograms." *Cancer Weekly* (December 23, 2003): 13.

Rubin, Eva, et al. "Reducing the Cost of Diagnosis of Breast Carcinoma: Impact of Ultrasound and Imaging–Guided Biopsies on a Clinical Breast Practice." *Cancer* 91 (January 2001): 324–31.

Trevino, Merlino. "MR-directed US Provides Economical Breast Diagnosis — Ultrasound Characterizes Indeterminate Lesions Already Found by MRI." *Diagnostic Imaging* (April 1, 2003): 59.

Ellen S. Weber, MSN
Teresa G. Odle

Breast x ray *see* **Mammography**

Breastfeeding

Definition

Breastfeeding is the practice of feeding an infant milk through the mother's breast. According to La Leche League International (LLLI), human milk is "a living fluid that protects babies from disease and actively contributes to the development of every system in baby's body." Breastfeeding stimulates the immune systems of babies and helps to protect against **diarrhea** and infection.

Purpose

The purpose of breastfeeding is to provide healthy **nutrition** for a newborn infant at low cost.

Breastfeeding and medication interactions

Drug name	Use or condition treated
Safe to take in prescribed or standard doses:	
Acetaminophen (e.g., Tylenol)	Pain relief
Antacids (e.g., Maalox, Tums)	Heartburn, upset stomach
Caffeine	Stimulant
Clotrimazole (Lotrimin, Mycelex)	Antifungal
Decongestant nasal sprays (e.g., Afrin)	Nasal congestion
Fexofenadine (Allegra)	Antihistamine
Ibuprofen (e.g., Advil, Motrin)	Pain relief
Inhalers, bronchodilators, and corticosteroids	Asthma
Insulin	Diabetes
Loratadine (Claritin)	Antihistamine
Metoprolol (Lopressor, Toprol)	Hypertension
Penicillins	Bacterial infection
Propranolol (Inderal)	Hypertension
Warfarin (Coumadin)	Anticoagulant
Not safe to take in any dose:	
Amantadine	Influenza or Parkinson's disease
Antilipemics (excluding resins) or lipid-lowering drugs	High cholesterol
Antineoplastic agents	Cancer
Aspirin (large doses)	Arthritis
Clozapine	Schizophrenia
Salicylates, large doses	Arthritis

SOURCE: BabyCenter, "Drug safety during breastfeeding." Available online at: http://www.babycenter.com/0_drug-safety-during-breastfeeding_8790.bc (accessed September 20, 2010). Information derived from the U.S. National Library of Medicine's Drugs and Lactation Database (LactMed), available online at: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?LACT.

(Table by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)

Description

The mother's body prepares for breastfeeding while she is pregnant. The fatty tissue of the breast is replaced by glandular tissue that is necessary to produce milk. When baby suckles the breast the hormone oxytocin is released. This causes the muscle cells of the breast to squeeze milk from the milk ducts to the nipple.

History

Since the advent of humans, mothers have breastfed their babies. During ancient times mothers breastfed their babies for 12–18 months or until the mother's menstrual cycle returned.

For thousands of years breastfeeding was the only source of nutrition for the first part of a baby's life. Before the invention of infant formula, few alternatives were available. If a mother could not breastfeed, a wet

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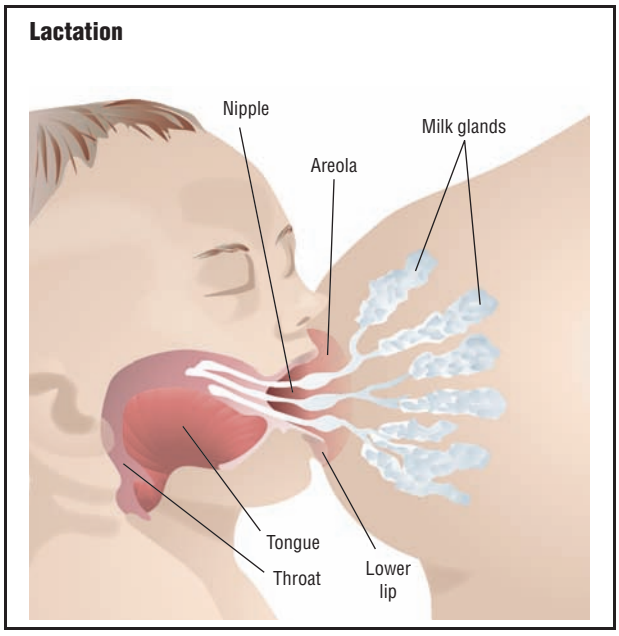

When an infant is properly latched onto the breast, the baby's nose touches (or nearly touches) the breast. He or she takes the entire areola into the mouth, facilitating the intake of milk far back into the throat. *(Illustration by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)*

nurse was found or the baby was fed animal milk or "pap," a mixture of flour, rice, and water. In the early 1900s, most babies in America were still breastfed, and over half of them were breastfed for one year or longer. However, as more women entered the workforce and supplemental methods of feeding were introduced, breastfeeding rates in America decreased. According to a survey from Ross Labs, by 1971 only 24.7% of American babies were breastfed at birth, and of these babies, only 5.4% of them were still breastfed at 6 months. Beginning in the mid 1980s, breastfeeding began to be strongly encouraged in the United States. Breast milk is today considered the best nutrition for an infant, although infants can still grow and thrive on infant formula.

Demographics

In 1982, the United States experienced resurgence in breastfeeding and rates have continued to increase. The National Immunization Survey conducted by the Centers for Disease Control and Prevention (CDC) in 2005 revealed that 72% of American babies were breastfed at birth and 39% were still breastfed at 6 months.

The developing world has experienced a decline in breastfeeding rates as well due to urbanization, social change, and the promotion of formula. Mothers who choose to feed their babies formula often encounter unsafe hygienic conditions in which to prepare the bottles, or they cannot afford to purchase the fuel needed to heat the water to sterilize the bottle and preparation equipment. Two of the major causes of infant mortality in developing countries are diarrhea and acute respiratory infections. Both are conditions that breastfeeding can protect against.

The World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) are working together to bring about a change in the global breastfeeding culture. In 2002, they developed "The Global Strategy for Infant and Young Child Feeding," which recommends that all babies are exclusively breastfed for the first 6 months of life with continued breastfeeding up to 2 years or beyond. Exclusive breastfeeding means that breast milk is the child's only source of nutrition for the first 6 months of life and that no other solids or liquids, such as formula or water, are introduced at this time, with the exception of liquid **vitamins** or medicines. Despite this recommendation, only one-third of all babies in the developing world were exclusively breastfed for 6 months in 2004. The highest rates of exclusive breastfeeding were in the East Asia/Pacific region (43%) and the lowest rates were in the Western/Central Africa region (20%).

Composition of breast milk

Breast milk is the perfect food for an infant. It contains all the nutrients a baby needs to grow and stay healthy, such as:

- Fats. Breast milk contains omega-3 fatty acids essential for the growth and development of the brain and nerve tissue. The amount of fat a baby receives depends on the length of the feeding. The milk at the beginning of the feeding is called the foremilk. It is the low-fat milk. The hindmilk that comes at the end of the feeding contains higher concentrations of fat. Therefore, the longer the baby nurses the higher the fat content.
- Proteins. The whey proteins found in breast milk are easier to digest than formula. Taurine, an amino acid that is important in the development of brain tissue, is found in breast milk but not in cow's milk.
- Sugars. Breast milk contains lactose, a milk sugar that provides energy. Breast milk contains 20%–30% more lactose than cow's milk.
- Vitamins and minerals. Breast milk provides the most balanced source of vitamins and minerals for an infant.
- Immune system boosters. White blood cells and immunoglobulins are responsible for fighting and destroying infection.

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KEY TERMS

Celiac disease—A condition in children and adults where the body is unable to tolerate wheat protein (gluten).

Eczema—A disease in which the skin becomes dry, red, itchy, and thickened.

Foremilk—Thin watery milk found at the beginning of breast feeding.

Galactosemia—A rare genetic disorder where an infant cannot metabolize the sugar in breast milk, and therefore cannot breastfeed.

Immunoglobulin (Ig)—A substance made by B cells that neutralizes specific disease–causing substances and organisms. Also called "antibody." Immunoglobulins are divided into five classes: IgA, IgD, IgE, IgG, and IgM.

Lactose—A sugar found in milk that provides energy.

Omega-3 fatty acids—A class of fatty acids which lowers the level of cholesterol in the blood. Omega-3 fatty acids are also essential for the growth and development of the brain and nerve tissue.

Osteoporosis—A condition found in older individuals in which bones decrease in density and become fragile and more likely to break. It can be caused by lack of vitamin D and/or calcium in the diet.

Oxytocin—A hormone that stimulates contractions during child labor and the production of breast milk.

Taurine—An amino acid that is important in the development of brain tissue. Taurine is a key component of bile which is needed to digest fats.

Type 1 diabetes—A chronic immune system disorder in which the pancreas does not produce sufficient amounts of insulin, a hormone that enables cells to use glucose for energy. Also called juvenile diabetes, it must be treated with insulin injections.

Type 2 diabetes—Formerly called adult-onset diabetes. In this form of diabetes, the pancreas either does not make enough insulin or cells become insulin resistant and do not use insulin efficiently.

The content of breast milk varies from feeding to feeding, at different times of day, and as the baby grows.

Benefits

Benefits for baby

There are many benefits for the breastfeeding baby, including:

- Increased immunity. Breast milk contains antibodies that are relayed by the mother and help to protect the baby from bacteria and viruses. These immunoboosters are not found in formula.
- Lower incidence of ear infections and respiratory infections.
- Potentially higher intelligence. Several studies have found higher levels of brain-boosting Docosahexaenoic acid (DHA) in the blood levels of breastfed babies than in formula-fed babies.
- Improved digestion and less constipation.
- Decreased risk of diarrhea, pneumonia, urinary tract infections, and certain types of spinal meningitis.
- Decrease in food allergies and eczema.
- More normal weight gain. Breastfed babies are less likely to be overweight than formula-fed babies.
- Reduced risk of type 1 (juvenile) and type 2 (adult onset) diabetes, celiac disease, cancer, rheumatoid arthritis, multiple sclerosis, liver disease, and acute appendicitis.
- Lower risk of sudden infant death syndrome (SIDS).
- Reduced risk of breast cancer (in daughters who have been nursed).
- Better development of jaw and facial structure
- Strong bonding between mother and child.

Benefits for mother

Breastfeeding women also enjoy many benefits:

- Reduced risk of breast, ovarian, and uterine cancers.
- Natural contraceptive. Many women who breastfeed exclusively for six months experience a delay of fertility.
- Faster postpartum recovery. Breastfeeding uses up extra calories so it is easier for moms to lose their pregnancy weight. Nursing also helps the uterus shrink back to its normal size faster.
- Relaxation. When a mother is breastfeeding her body produces oxytocin, a hormone that induces a calm, content feeling.
- Protection from osteoporosis.

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- Savings in time and money. Breast milk is cheaper than formula and the mother does not have to spend time preparing bottles.
- Better stewardship of the environment, as there are no bottles to wash or cans to dispose of.

Maternal nutrition

The ideal diet of a breastfeeding woman is comprised of healthy and nutritious foods from the five basic food groups. Foods high in carbohydrate such as pastas, grains, and fruits should make up about half of the daily food intake. Healthy fats, such as fatty fish and avocados, should be 30%, and proteins should equal 15%–20%. Breastfeeding women should make sure to eat foods that contain a lot of **calcium**, such as dairy products, broccoli, and beans, and make sure they eat plenty of iron-rich foods like lean red meat, fish, and poultry.

In order to compensate for the energy they expend breastfeeding their babies, breastfeeding women should add 300–500 extra nutritious calories to their diet each day and drink extra fluids. Breastfeeding mothers should also continue to take a prenatal vitamin.

Precautions

Almost every substance that a breastfeeding mother puts into her body has the potential to pass to her baby through her breast milk. This includes food, medicine, alcohol, and cigarettes.

- Foods: Foods such as dairy products, caffeine, grains and nuts, gassy foods, and spicy foods may cause the baby to fuss if the food upsets the baby's stomach. If this occurs, the mother should eliminate the suspect food from her diet for 10–14 days to see if the trouble stops.
- Medications: Any medication taken while breastfeeding should be approved by a doctor.
- Birth control pills: The high estrogen type of birth control pills may decrease a breastfeeding mother's milk supply and are not recommended. A progestin-only pill such as the "mini-pill" is the least likely to cause milk supply issues.
- Alcohol: Infants have a hard time detoxifying from the alcohol that passes through their mother's breast milk to them. It is recommended to limit alcohol consumption while breastfeeding.
- Cigarettes: Cigarettes contain toxins that can pass through to the baby and are not recommended for breastfeeding women.

When breastfeeding is not an option

Although breastfeeding is the optimal way to feed an infant, sometimes it is not possible or feasible. A small percentage of women have conditions that prevent breast milk production, such as insufficient development of milk production glands, and cannot breastfeed. Women with HIV infection are advised against breastfeeding, as the virus may be passed to their babies. Women who are newly diagnosed with infectious **tuberculosis** should not breastfeed unless they are on medication. Other health conditions may require that the woman take medication that prevents them from breastfeeding. Babies with **galactosemia**, a rare genetic disorder that prevents them from metabolizing the sugar in breast milk, cannot breastfeed.

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ORGANIZATIONS

American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, IL, 60007-1098, (847) 434-4000, (847) 434-8000 http://www.aap.org.

La Leche League International, PO Box 4079, Schaumburg, IL, 60168-4079, 1-800-525-3243, 1-847-519-9585 http://www.llli.org/.

United Nations Children Fund (UNICEF), 3 United Nations Plaza, New York, NY, 10017, (212) 326-7000, (212) 887-7465, http://www.llli.org/.

United States Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (404) 639-3534, (800) CDC-INFO (800-232-4636), TTY: (888) 232-6348, inquiry@cdc.gov, http://www.cdc.gov.

World Health Organization, Avenue Appia 20, 1211 Geneva 27, Switzerland, +22 41 791 21 11, +22 41 791 31 11, info@who.int, http://www.who.int.

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Breast-feeding problems

Definition

Breast-feeding problems are a variety of physical, behavioral, and emotional difficulties with nursing an infant.

Description

Breastfeeding, or nursing, is the practice of nourishing an infant with milk from the human breast. Full-term babies have a natural suckling instinct, and breastfeeding comes naturally to most as soon as they leave the womb. After delivery, levels of prolactin, the hormone that triggers milk product, begin to rise in the body. At first, babies feed on a nutrient-rich substance known as colostrum, which is produced by the breast before regular milk production begins. New mothers will experience engorgement in the days following the birth of their babies when breast milk "comes in" and engorges the breasts. After this time, regular feedings and proper breastfeeding techniques usually ensure a healthy milk supply for most babies until it is time to wean. However, breastfeeding can be a complex process and sometimes there is a problem with the infant's suckling technique, the mother's milk supply, or other factors.

Causes and symptoms

Inadequate weight gain and a **failure to thrive** in nursing infants is the most obvious sign that there is a breastfeeding problem.

Many factors may interfere with successful breastfeeding. These include:

- Milk supply problems. A variety of factors can cause an inadequate supply in new mothers. Milk production is largely a supply and demand process. If the baby does not nurse frequently enough or eat enough at each feeding, milk production will adjust itself and decrease accordingly.
- Latching problems. Some babies, particularly preterm infants, have difficulty suckling. This can be due to an abnormality of the mouth or simply to a lack of coordination of the jaw muscles. In addition, the mother may not be placing her breast into the infant's mouth properly.
- Scheduling problems. Very young infants need to be breastfed very frequently, about every 2 to 3 hours during the first month of life. As the baby gets older he or she will eat more at each feeding and need to feed less frequently. Newborns should not go more than 4 hours between feedings, even during the night. Scheduling may become a problem for women who work outside the home, as they often find that their milk flow diminishes after they return to work.
- Nipple and breast problems. Infants may have difficulty latching on to inverted or flat nipples. Other structural problems, such as insufficient mammary glandular tissue, may result in reduced milk production. In addition, cracked and sore nipples and breast infection (mastitis) can make nursing painful.
- Retained placenta. If a woman's milk has not come in, and she continues to experience abnormal bleeding after delivery, she may still be retaining pieces of the placenta within her uterus.
- Stomach sleeping. A nursing mother who sleeps on her stomach may experience decreased milk production due to the extended pressure on her breasts.
- Stress and fatigue. New mothers need proper rest in order to produce an adequate milk supply. The ability to relax is also fundamental to proper breastfeeding. Women who are stressed can have difficulty achieving milk "let-down," the sensation of the mammary glands releasing milk.
- Psychological issues. Some women are unable to breastfeed because of preconceived notions about the practice, or ideas instilled by their parents and peers that have put up a psychological barrier for them. Many women are uncomfortable breastfeeding in public and may even abandon the practice because they do not want to be shut off from others or feel squeamish about feeding their babies even in front of friends and family members.

Diagnosis

Breastfeeding problems are usually first suspected when an infant is not gaining weight as expected. Most babies lose some weight in the first few days of life. However, they should regain the weight quickly and be back at their birth weight at two weeks of age. An average weight gain of 6–8 ounces per week should be maintained through the second or third month. After that, growth charts can demonstrate whether the child is gaining adequate weight.

Failure to gain weight regularly can be a sign of many different problems with a newborn, some very serious. The baby's pediatrician can do a variety of tests and take a complete history of the baby including regularity of soiling diapers, frequency of feeding, fussiness, and other factors. The tests and history can help the pediatrician determine if a problem with breastfeeding is causing the lack of weight gain.

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KEY TERMS

Areola—The pigmented, circular area surrounding the nipple of each breast.

Lactation—Secretion of milk from the breasts; the act of breastfeeding.

Latch-on—The process whereby the baby opens the mouth widely and first exerts negative pressure on the mother's nipple and then positive pressure. Good latch-on will result in adequate transfer of milk into the baby's mouth and prevent sore nipples from occurring.

Postpartum—Refers to the six-week period after childbirth.

Prolactin—A hormone secreted after delivery that stimulates the production of milk.

Once a breastfeeding problem has been established, a healthcare practitioner will ask questions about the baby's feeding schedule and may observe the mother's breastfeeding technique to determine if an improper latching-on technique or inadequate suckling is causing the difficulty. **Lactation** counselors may be helpful in diagnosing these problems. Further **physical examination** and tests may be necessary to determine if structural breast problems or placental fragments are the root of the problem.

Treatment

Proper treatment for breastfeeding difficulties depends on the cause of the problem.

Inadequate milk production

Milk production can be boosted in several ways. The easiest way is for the mother to encourage more frequent feedings at the breast. If this is impractical or the baby does not cooperate, milk production often can be increased through intermittent use of a breast pump, a device that expresses milk from the breast. Breast pumps are available in manual and electric models and can be purchased or rented. Pumped breast milk can be bottled or frozen and fed by bottle to the baby at a later time, although if milk production is a problem the mother will probably want to put the baby to the breast at every opportunity.

Milk thistle, or *Silybum marianum*, is sometimes prescribed to promote increased breast milk secretion. Although the herb is considered safe for nursing mothers, it should be acquired from a reputable source and prescribed by an herbalist, naturopathic physician, or other healthcare professional familiar with its use.

Each breast contains both foremilk and the richer, fat-laden hindmilk. Infants need the nutrients and fat of the hindmilk, but must get through the foremilk to reach it. This can be encouraged by the mother completely emptying one breast before starting the baby on the other one. If the baby does not completely empty a breast, the job can be finished with the aid of a breast pump. The next time the mother nurses, she should start the child on the opposite breast.

Latching problems

To ensure proper breastfeeding, the mother should encourage the baby to latch on to the entire nipple, with his or her lips past the outside perimeter of the areola, before starting to suck. The mother will likely have to guide the breast into the baby's mouth, and repositioning may be required.

Practice makes perfect, and sometimes all an infant needs to improve his latching and suckling technique is time. If the baby has a structural problem in the mouth, such as a **cleft palate**, a breast pump may be required to keep milk production going. In some cases where suckling does not improve, feeding with a supplementary **nutrition** system may be required. The system consists of a feeding bottle containing the mother's own breast-pumped milk, and two tubes that run down from the bottle and attach to the nipples. Milk flows easily from the tubes with a weak sucking action from the baby. Both baby and mother can still maintain closeness while providing the baby with adequate milk flow.

Scheduling problems

Nursing newborns who are sleeping through the night without a feeding are probably not getting enough milk. They should go no longer than four hours at night without feeding, and may require waking to ensure they get enough to eat.

Women who have returned to work can use a portable breast pump at least once during the workday to encourage sustained milk flow and to store milk for their babies to eat during their time away from home.

Nipple and breast problems

Liquid vitamin E applied regularly to sore or cracked nipples can soothe the **pain** and help the healing process. Women who think they have a breast infection should see their healthcare provider immediately, as they will probably require a course of **antibiotics**.

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Women with inverted nipples may find that the baby has a hard time latching on. Inverted nipples do not usually preclude breastfeeding, but may require extra time and effort to help the baby learn to feed effectively. A lactation consultant can help the woman find a technique that works for her and her baby.

Retained placenta

Minor surgery known as a **dilatation and curettage** (D and C) usually is required to remove pieces of placenta that have been retained by the uterus. Once the placenta has been removed, prolactin levels normally rise, stimulating milk production.

Stress and fatigue

Relaxation exercises, **yoga**, **meditation**, massage, and **aromatherapy** can all be useful tools for relieving **stress**. Women should establish a quiet, restful environment for nursing. Warm compresses to the breast may also assist in milk let down. If it is feasible, taking naps when the baby is sleeping can help to ease the **fatigue** caused by nighttime feedings.

Psychological issues

Support from family and friends is necessary for any new mother, especially one that chooses to nurse her child. If no familiar support network exists, women may seek help from groups for nursing mothers such as the La Leche League.

Many hospitals offer mothers and their spouses classes on breastfeeding techniques and nursing issues. Women who have negative feelings about breastfeeding may find classes helpful in overcoming these issues.

Expected results

In most cases, treatment for breastfeeding problems is successful and mother and baby do well. Other women may be able to breastfeed in limited amounts, but require supplementing their child's diet with formula to ensure proper weight gain and adequate nutrition. For a small percentage of women, physical problems or psychological issues may prevent successful nursing altogether.

Prevention

The best way for a new mother to prevent nursing problems is to take care of herself by eating right, drinking plenty of fluids, and staying rested and relaxed. It is important, because breastfeeding incidence and duration are both believed to be associated with reduced risk of some female cancers and possibly with improved bone health later in life.

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International Board of Lactation Consultant Examiners, 6402 Arlington Boulevard, Suite 350, Falls Church, VA, 22042, (703) 560-7330, (703) 560-7332, iblce@ibcle.org, www.iblce.org.

La Leche League International, PO Box 4079, Schaumburg, IL, 60168-4079, (800) 525-3243, (847) 519-9585, http://www.llli.org.

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Breech birth

Definition

In a breech birth, the presenting part of the fetus, or the part that enters the woman's birth canal first, is the buttocks or leg(s).

Demographics

In almost 97% of vaginal births, the head is the part of the baby to be born first (i.e., vertex presentation). During a woman's **pregnancy**, the fetus moves

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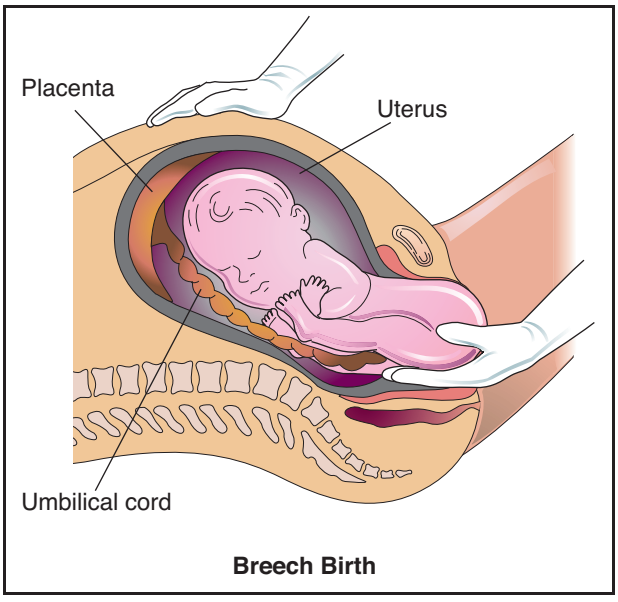

Approximately 4 in 100 babies will start labor in the breech (buttocks first) position. While this is a potentially dangerous situation, many full-term babies can be safely delivered from the breech position. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

freely inside the uterus, cushioned by the amniotic fluid. At 20 weeks of gestation, the midway point in the pregnancy, about 24% of fetuses are in a breech position. By 34 weeks, only about 7% are in a breech position. As the pregnancy progresses toward term (37–42 weeks), the growing fetus has less room in which to turn around, and usually remains more in an inverted (head down) position. However, in about 3–4% of births, the buttocks or feet present first.

Description

There are three types of breech presentations:

- Complete breech, in which the buttocks present first, the baby's thighs are tight against the abdomen, the legs are crossed, and the feet are flexed. In this position, the fetus is curled up tightly in a ball.
- Frank breech, in which the knees are straight (i.e., not bent), and the legs are held tightly against the abdomen and head. This breech position comes closest to filling the pelvic inlet, as would the fetus's head.
- Footling breech, in which one or both legs enter the birth canal first. The fetus appears to be standing in an upright position.

Risk factors

Risks of a vaginal breech delivery include:

- Prolapse of the umbilical cord. This is especially true in a footling presentation, where the feet and legs are small and provide room for the umbilical cord to slip alongside and into the birth canal. Any pressure on the cord compresses the sides of the cord, decreasing blood flow and oxygen to the fetus. This may result in anoxia.
- Entrapment of the head. This occurs when the body passes through the cervix, but the head, which is the largest part of the body, cannot fit through the cervical opening. This may occur because the cervix was incompletely dilated at the time of the birth, or when the head is larger than the pelvic opening.
- Trauma to the head or neck of the neonate during delivery. This could result in permanent brain damage or paralysis of the infant.
- Trauma to the spine or an arm resulting in fracture of a bone.
- Meconium aspiration. The breech position may cause an early rupture of the amniotic fluid membranes, and meconium (the infant's first stool) may be released. If the neonate breathes in any of the meconium, he or she risks obstruction of the airway by the meconium, and pneumonia.
- Dysfunctional labor. A fetal breech position can cause labor to be drawn out, exhausting the mother, and diminishing her ability to push as the time of delivery approaches.
- Higher level of perinatal morbidity and mortality.

Accurate imaging of the fetus *in utero* has decreased the number of breech births by alerting obstetricians and midwives to this presentation before delivery. A technique called external version may be used to encourage the fetus to rotate into a vertex position. However, as the practice of external version has increased, practitioners have had less experience delivering a breech baby vaginally. A successful vaginal delivery of a breech presentation depends to a great extent on the skill and experience of the practitioner.

Twins present a special challenge and take one of several possible birth positions:

- Vertex-vertex. In this, the safest of positions for delivery, the twins both present in the vertex, or head-down position. It occurs in about 40%–45% of twin births.
- Vertex-breech or breech-vertex. This position offers the most efficient use of the uterine space, but is not the best presentation for delivery. Vertex-breech and vertex-transverse positions occur in about 35%–40% of twin births. Breech-vertex positioning occurs in about 15%–20% of births.

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KEY TERMS

Anoxia—An absence of oxygen.

Cephalopelvic disproportion—Occurs when the fetus's head is larger than the mother's pelvic inlet.

Meconium—The first feces passed by the newborn. If passed before birth, the fetus can inhale this material, causing medical complications.

Nuchal cord—The term used when the umbilical cord is looped around the fetus's neck in utero.

Presentation—The part of the fetus's body that enters into the birth canal first.

Prolapsed umbilical cord—Occurs when the cord falls into the birth canal, and may even hang out of the mother's vagina. This can cause compression of the cord and lead to decreased oxygen and blood flow to the fetus.

Transverse—A position in which the fetus lies sideways against the birth canal, with a shoulder or arm possibly entering the canal.

- Breech-breech presentation occurs in about 15%–20% of twin births, and almost always results in cesarean-section birth.

If the second twin entering the birth canal is the larger, there will be a concern that he or she may become stuck because the smaller, first twin did not adequately enlarge the cervical opening. Twins are often born prematurely, and are smaller than a full-term infant. The more premature the infant, the greater the chance it will have a smaller body-to-head proportion than the full-term infant. This creates a greater hazard for breech birth, because the small body can come through a less-dilated cervix, and there is a greater chance that the head will get trapped. Accurate imaging of twin positions will play a major role in determining the safest delivery method. An external version of the second twin may be proposed. Version of the first twin is unlikely, as the procedure poses a threat to both twins.

Causes and symptoms

The specific cause of a particular breech presentation may not be understood about 80% of the time. Causes of breech presentation may include:

- an inability of the fetus to have full movement inside the uterus
- the position of the placenta, such as a low-lying placenta previa, and a short umbilical cord
- decreased muscle tone of the fetus
- a congenital disorder of the fetus, especially neuromuscular in nature
- a space-related problem for the fetus, such as with uterine fibroids
- fetal anomaly, such as hydrocephalus
- uterine structural anomaly, such as a septum trapping the fetus in a breech position
- gestation of less than 40 weeks
- multiple gestation
- hydramnios, a condition in which excess amniotic fluid is produced and the fetus has too much room in which to move

Diagnosis

There are three primary ways in which a breech position is discovered, including imaging, position of the fetal heartbeat, and external palpation on the mother's abdomen.

Examination

Leopold's maneuvers consist of a series of four external palpations of the mother's abdomen to determine fetal position in the uterus. The fetal head is hard and can move separately from the rest of the body. The buttocks feel soft and move with the body. As the time for delivery draws near, a vaginal examination may be required, as Leopold's maneuvers can sometimes be misleading. In a vaginal examination, the baby's fontanelles are palpated.

Procedures

There are a variety of imaging technologies, varying in safety, cost, and ease of access. **Magnetic resonance imaging** (MRI) is very accurate, but is extremely expensive, not as readily available, and would rarely provide more information than an ultrasound to justify its use. Ultrasound is the most widely used method of imaging during pregnancy, as it uses sound waves instead of radiation, is readily available, and is cost efficient. Ultrasound is considered safe to use at all stages in pregnancy.

Treatment

When dealing with a breech presentation, there are three choices for delivery: attempt to rotate the fetus into a vertex presentation prior to delivery; attempt a trial of vaginal delivery in the breech position; or deliver by **cesarean section**. Some hospitals may not have the mother attempt a vaginal delivery and instead opt for cesarean section.

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Traditional

The traditional and commonly used treatment within Western medical standards is external version. In external version, the fetus is rotated manually by the physician, who exerts pressure on the mother's abdomen to cause the fetus to somersault into the vertex position. Medication may be given to the mother to relax the uterine muscles before the procedure. The vertex position allows the fetus more mobility and decreases the chance of uterine contractions, which lead to early labor. Before attempting version, an ultrasound is performed to confirm the position of the fetus. The timing of version is important. Done too early, the fetus may rotate back into a breech position if too much space is still available. Performed at 35–37 weeks gestation, the success rate has shown to be up to 65%. In approximately 1–2% of cases, complications arise following version, leading to the need for immediate delivery via cesarean section.

Version should always be done in a hospital, where there are facilities for immediate cesarean delivery available in the cases of cord compression or **placental abruption**. Some research has indicated that giving the mother an epidural for the version procedure increases its success rate. The version can be accomplished by two health care professionals. Mineral oil may be applied to the mother's abdomen so that the obstetrician's hands can smoothly slide over the surface. The fetal heart rate should be monitored closely for any signs of fetal distress, and should be continued for about an hour after the procedure to assure fetal stability. Mothers who are Rh-negative may be given Rh immune globulin, which would prevent incompatibility should fetal-to-mother **transfusion** occur during the version. About 90% of babies turned by version remain in this position for delivery.

Version has risks and is contraindicated in the following situations:

- uterine structural anomalies
- third-trimester bleeding
- hydramnios, excess amniotic fluid production
- nuchal cord, or the cord around the baby's neck (not always seen on ultrasound)
- previous uterine surgery, such as cesarean section, that has weakened the uterine walls
- cephalopelvic disproportion (CPD), a condition in which the baby's head is too big for the mother's pelvic inlet, as evidenced on ultrasound or other imaging tools

Surgery

In a cesarean birth, an incision is made through the mother's abdominal wall into the uterus. The amniotic fluid membranes are broken and the neonate is extracted. A vertical incision in the uterus along the mother's abdominal midline is called a classical cut. This provides the fastest access to the infant and may be chosen in the event of an emergency delivery. The fetus can be removed from the uterus in minutes. If a woman has had the classical uterine incision, she will not be allowed to attempt a vaginal delivery in the future, because the uterine wall can rupture during the next labor. When time permits, the preferred incision is a transverse one, just above the pubic bone. This incision is sometimes referred to as a bikini cut. Healing time is decreased and may allow a woman to successfully deliver vaginally in the future.

Alternative

The preferred mode of delivery is a vaginal birth with the fetus in vertex presentation. Attempts are made to rotate the fetus from a breech into a vertex position. One method has been to have the mother assume different positions (e.g., knee-chest) in the hope that this would cause the fetus to move into a more favorable position. Research studies have not shown this to be very successful, although periodic anecdotal accounts of success have been reported. In the November 11, 1998, issue of the *Journal of the American Medical Association,* researchers reported on the use of **traditional Chinese medicine** to cause the fetus to rotate. In this study, moxa, a combustible Chinese herb, was used over a two-week period to stimulate an **acupuncture** point on the toe. Stimulation of this point is believed to increase fetal activity, during which the fetus then moves into the vertex position. After two weeks of treatment with moxa, 75% of the 130 fetuses studied rotated into the vertex position. Only 48% of the control (no intervention, just routine obstetrical care) fetuses rotated. However, the results of this study have not been replicated.

Attempted vaginal delivery

During a breech birth more nursing personnel may be needed to assist the obstetrician and provide support for the mother. A neonate that has been in a breech position *in utero* may maintain an unusual position for a few days after birth. An explanation by the nurse can greatly reduce the mother's concern that there is something wrong with her baby.

When a vaginal breech birth is attempted, the pace of the delivery is very important. Fetal heart

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rate and uterine contractions need to be closely monitored. During a vertex vaginal delivery, the head is molded coming down the birth canal, and the labor process slows the pace of the delivery. In a breech vaginal birth, the smaller body may slip more quickly through the canal. If the head becomes caught, fetal **anoxia** (lack of oxygen) can occur. The head does not mold during a rapid breech birth, and if the neonate is allowed to deliver quickly, perhaps due to a detected prolapsed cord, the rapid change in pressure can result in intracranial hemorrhage. To assist the breech delivery, the mother may be asked to assume a squatting position, as this increases the birth canal volume by about 28%. (This position is not popular in the United States.) Forceps may be used to protect the neonate's neck and head from trauma and to assist in the delivery. If the vaginal birth attempt causes fetal distress, an emergency cesarean delivery may be required.

Prognosis

About half the attempts of a vaginal breech delivery result in a cesarean birth. Discovery of breech presentation before the time of delivery allows attempts to be made to rotate the fetus. If these attempts prove unsuccessful, a cesarean birth can then be scheduled. A scheduled cesarean allows the mother and her partner to be informed and participate, to some degree, in the process. Anesthesia can be chosen that allows the mother to be awake during the birth of her child. If emergency cesarean delivery is required, the mother is given a **general anesthesia** to shorten the time required to extract the fetus in distress. If complications do not occur, the prognosis is excellent.

Prevention

None of the known causes of breech presentation are preventable, and in many breech presentations, there is no known cause. While it is not possible to prevent this presentation, attempts such as version are made to prevent a breech delivery, or to minimize its inherent risks.

Resources

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ORGANIZATIONS

American College of Obstetricians and Gynecologists, P.O. Box 96920, Washington, DC, 20090-6920, (202) 638-5577, http://www.acog.org.

Association of Women's Health, Obstetric, and Neonatal Nurses, 2000 L St., NW, Suite 740, Washington, DC, 20036, (202) 261-2400, (800) 673-8499, Toll free in Canada (800) 245-0231, (202) 728-0575, customerservice@ awhonn.org, http://www.awhonn.org.

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Breech presentation *see* **Breech birth**

Brill-Zinsser disease *see* **Typhus**

Brittle bone disease *see* **Osteogenesis imperfecta**

Broken nose *see* **Nasal trauma**

Bronchiectasis

Definition

Bronchiectasis is a condition in which an area of the bronchial tubes is permanently and abnormally widened (dilated), with accompanying infection.

Description

The bronchial tubes are the networks of branching tubes that deliver air to the tiny sacs of the lungs (alveoli). In bronchiectasis, the diameter of the bronchi is unusually large. Examination of the walls of the bronchial tubes reveals destruction of the normal structural elements, with replacement by scar tissue.

Colorized bronchogram of lungs—right tree has almost no structure, caused by chronic inflammation. *(Mehau Kulyk/Photo Researchers, Inc.)*

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Pus collects within the bronchi, and the normal flow of oxygen into the lungs, and carbon dioxide out of the lungs (air exchange) is impaired. The bronchi show signs of inflammation, with swelling and invasion by a variety of immune cells. The inflamed areas show signs of increased growth of blood vessels. The area of the lung that should be served by a diseased bronchial tube is also prone to inflammation and infection.

Causes and symptoms

Prior to the widespread use of immunizations, bronchiectasis was often the result of a serious infection with either **measles** or **whooping cough**. Currently, viruses that cause **influenza** (flu) or influenza-like syndromes, as well as a number of bacteria may precede the development of bronchiectasis. Patients who have been infected with **tuberculosis** or the virus that causes **AIDS** (HIV or human **immunodeficiency** virus) also have an increased chance of bronchiectasis.

A number of pre-existing conditions may cause an individual to be more susceptible than normal to infection, with increased risk of bronchiectasis developing. These conditions include disorders of cilia and immune disorders.

Cilia are the tiny hairs that usually line the bronchial tubes. Cilia wave constantly, sweeping the bronchial tubes clean of bacterial or viral invaders and cleaning away excess secretions (mucus, sputum) that may be produced by the bronchi. When these cilia are abnormal or absent at birth, various bacterial or viral invaders may remain in the respiratory tract, multiply, and cause serious infections.

Immune disorders include decreased production of certain immune chemicals (immunoglobulins) that usually serve to fight off infection by bacterial or viral invasion. When these immunoglobulins are not produced in large enough quantity, bacterial and viral invaders are not effectively killed off, and infection occurs.

Other causes of bronchiectasis include an abnormally blocked (obstructed) airway. This can be due to tumor growth within the bronchial tube, or due to a child accidentally inhaling a small object, which then blocks off the bronchial tube. People with the disease called **cystic fibrosis** (CF) often have their bronchial tubes obstructed by the thick, sticky mucus that is a hallmark of CF. Toxic exposures (breathing ammonia, for example) can harm the bronchi and lead to bronchiectasis. An extreme allergic response of the immune system to the presence of certain fungi (especially one called *Aspergillus*) can also damage the bronchial tubes enough to result in bronchiectasis.

KEY TERMS

Bronchi—The network of tubular passages that carry air to the lung and allow air to be expelled from the lungs.

Cilia—Hair-like projections that line the bronchial tubes (also present in other areas of the body). Normal cilia beat consistently, sweeping the bronchi clean of bacteria, viruses, and mucus.

Symptoms of bronchiectasis include constant **cough** and the production of infected sputum (sputum is a mixture of mucus and pus), which may be bloody. In some cases, there may be **wheezing** and **shortness of breath**. The constant, low level of infection may flare, resulting in increased production of sputum, worsening of the cough, and **fever**. The area of the lung served by the affected bronchial tube may become severely infected, resulting in **pneumonia**.

Diagnosis

Chest x ray may reveal evidence of bronchiectasis, and CT scans are particularly good at revealing the thick, dilated bronchial walls of bronchiectasis. Sputum will need to be collected and cultured (grown in a laboratory dish) in order to examine it microscopically for the specific type of organism responsible for infection. A careful search for other underlying diseases is important, looking in particular for ciliary abnormalities, cystic fibrosis, or immunoglobulin deficiencies.

Treatment

Treatment should involve efforts to resolve any underlying disorder. Infections will require **antibiotics**; obstruction may require the removal of a foreign object or tumor. Medications are available to help thin the sputum, so that it can be more effectively coughed up. Rhythmic clapping on the chest and back while the patient assumes a number of positions (head down, primarily) may help the lungs to drain more effectively. This is called **chest physical therapy**, or percussion and postural drainage.

When a particular area of the lung is constantly and severely infected, surgery may be needed to remove it. When bleeding occurs from irritated bronchial tubes and overgrown bronchial blood vessels, surgery may be required either to remove an area of the bronchial tube,

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or to inject the bleeding blood vessel with a material to stop the bleeding.

In some patients, bronchiectasis eventually leads to a constantly low level of blood oxygen, despite other treatments. These patients usually have an associated increase in the size of the right side of their hearts, along with a decrease in the heart's ability to pump blood through the lungs. Some patients with extremely severe symptoms and disability have been treated with **lung transplantation**.

Prognosis

Prognosis varies widely, depending on how widespread or focal the bronchiectasis, and on the presence of other underlying disorders.

ORGANIZATIONS

American Lung Association, 1301 Pennsylvania Ave. NW, Suite 800, Washington, DC, 20001, (202) 758-3355, (202) 452-1805, (800) 548-8252, info@lungusa.org, http://www.lungusa.org/.

Rosalyn Carson-DeWitt, MD

Bronchiolitis

Definition

Bronchiolitis is an acute viral infection of the small air passages of the lungs called the bronchioles.

Demographics

Bronchiolitis is extremely common. It occurs most often in children between the ages of two and 24 months, with peak infection occurring between three and six months of age. About 25% of infants have bronchiolitis during their first year, and 95% have had the disease by their second birthday. Bronchiolitis occurs more often in boys than girls, with boys being hospitalized at 1.5 times the rate of girls. In temperate climates, bronchiolitis peaks from winter to late spring. In subtropical climates, the disease peaks from October to February.

Description

Bronchiolitis is an acute inflammation of the upper and lower respiratory tract. In children with bronchiolitis, the small airways (bronchioles) can become blocked. Infants, especially those born prematurely, and toddlers are at risk because their airways are so small and easily obstructed. Bronchiolitis makes it difficult to breathe. The child coughs and wheezes. The danger in bronchiolitis arises from an inability to get enough oxygen in and out of the lungs. Bronchiolitis can be fatal to the very young.

Risk factors

Children who attend daycare or who live in crowded conditions and those who are exposed to secondhand smoke at home are more likely to develop bronchiolitis. Premature infants and children born with heart and lung defects or HIV/AIDS are more likely to have severe, life-threatening infections. Bronchiolitis is a significant cause of respiratory disease worldwide. The World Health Organization (WHO) has funded research to develop a vaccine against the disease, but attempts have been unsuccessful.

Causes and symptoms

Bronchiolitis is caused by several different viruses. The most common of these is respiratory syncytial virus (RVS), which is responsible for about 100,000 hospitalizations of children under age four each year. Two subtypes of RSV have been identified, one of which causes most of the severe bronchiolitis infections. In addition, bronchiolitis can be caused by **influenza**, parainfluenza, and adenoviruses, all of which are common from fall through spring. These viruses are spread in tiny drops of fluid from an infected person's nose and mouth through direct contact, such as shaking hands or kissing. The viruses can also live several hours on countertops, toys, or used tissues and easily infect people who handle contaminated items. The time from infection to the appearance of symptoms varies from two to seven days.

Bronchiolitis affects individuals differently depending on their age. In adults, older children, and some infants, bronchiolitis viruses cause symptoms similar to a mild cold—runny nose, stuffy head, and mild **cough**. The lungs are not involved, and these symptoms clear up without any medical treatment. In some children under age two, the cold-like upper respiratory symptoms worsen after a day or two. The lung tissue begins to swell and produce mucus, and the cells lining the bronchioles begin to slough off into the air passages. As the airways narrow from swelling and mucus accumulation, breathing becomes difficult, and the child makes a **wheezing** or whistling sound with each breath. Lung involvement can occur quite rapidly.

The most common signs of bronchiolitis involve the infant's struggle to breathe. The child may take 50–60 breaths per minute and may develop brief periods

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KEY TERMS

Bronchiole—A thin air passage in the lung that branches off a larger airway.

Congenital—A condition that is present at birth.

when they stop breathing (apnea) and begin to turn blue (**cyanosis**). This occurs most often in babies who were born very prematurely or who are under six weeks of age and babies with congenital heart and lung problems and compromised immune systems. Babies may also stop eating, because it is becomes difficult for them to swallow and breathe at the same time. They may have a low **fever**, cough, and **vomiting**.

Diagnosis

Examination

Bronchiolitis is usually diagnosed through a **physical examination** by a pediatrician or family physician. The physician often finds an increased heart rate; rapid, labored breathing; and crackles in the lungs when the child inhales. Signs of ear infection (**otitis media**) and throat infection (pharyngitis) are sometimes present.

Tests

Although laboratory tests are available that can within in a few hours confirm the presence of RSV, these tests are not routinely necessary. The oxygen level in the blood may be measured through pulse oximetry in babies who are having difficulty breathing. Inadequate oxygen in the blood is an indication that hospitalization is necessary. Chest x rays may be done on severely ill children to rule out other conditions.

Procedures

More invasive procedures are not usually necessary unless required for further diagnosis or treatment of an accompanying illness or complication.

Treatment

Traditional

The degree of respiratory distress determines treatment. Individuals with mild symptoms are treated as if they have a cold with rest, fluids, and a cool air humidifier. Babies who are struggling to breathe may be hospitalized and given supplemental humidified oxygen. Their breathing is monitored and, if necessary, fluids are given intravenously to prevent **dehydration**. Occasionally, infants need mechanical ventilation to fill and empty the lungs until the airways open.

Drugs

As of 2010, there were no drugs that were substantially effective in treating bronchiolitis.

Children with compromised immune systems from diseases such as congenital HIV/AIDS and transplant patients are at highest risk for severe infections, serious complications, and **death**. Children with congenital heart and lung disorders are also at higher risk, as are infants under six weeks old. These high-risk children may be admitted to pediatric intensive care units and treated with ribvarin (Virazole), a drug that keeps the virus from reproducing. This drug is reserved for the most critical cases.

Alternative

Although there are alternative treatments for cold symptoms, such as **echinacea** and zinc, parents should consult their health practitioner about the appropriateness of using these treatments in very young children.

Prognosis

The majority of children who get bronchiolitis, even severe infections, recover without complications in one to two weeks, although **fatigue** and a light cough may linger longer. About 60% of people develop only cold-like symptoms without lung involvement. However, the disease accounts for about 100,000 pediatric hospitalizations and 4,500 deaths each year. Deaths usually occur because medical care is not sought soon enough.

While many viral illnesses, such as **chickenpox**, can be contracted only once, after which individuals develop immunity, people can get bronchiolitis multiple times. However, after the first infection, the symptoms are usually mild.

Prevention

The viruses that cause bronchiolitis spread very easily, making prevention difficult. Common sense measures such as frequent hand washing and keeping children away from crowds and sick individuals are only partially effective. Certain very high-risk babies can be treated during the peak virus season with monthly injections of antiviral immunoglobulins to

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protect against RSV infection. These injections cost several thousand dollars per child per season and are reserved for children whose life could be at risk if they became infected. Antiviral immunoglobulins are used only for prevention and are not effective as a treatment once the infection has been acquired.

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ORGANIZATIONS

American Academy of Family Physicians, P.O. Box 11210, Shawnee Mission, KS, 66207, (913) 906-6000, (800) 274-2237, (913) 906-6075, http://familydoctor.org.

American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, IL, 60007-1098, (847) 434-4000, (847) 434-8000, http://www.aap.org.

Tish Davidson, AM

Bronchitis

Definition

Bronchitis is an inflammation of the air passages between the nose and the lungs, including the windpipe or trachea and the larger air tubes of the lung that bring air in from the trachea (bronchi). Bronchitis can either be of brief duration (acute) or have a long course (chronic). Acute bronchitis usually is caused by a viral infection, but also can be caused by a bacterial infection; it can heal without complications. Chronic bronchitis is a sign of serious lung disease that may be slowed but cannot be cured.

Demographics

Acute bronchitis is extremely common. Worldwide, it is one of the top five reasons for a child to see a doctor. The National Center for Health Statistics estimates that about 9% of Americans develop bronchitis each year. In European studies, as many as 20% of school-age children developed bronchitis.

Anyone can get acute bronchitis, but infants, young children, and the elderly are more likely to get the disease because people in these age groups generally have weaker immune systems. Smokers and people with heart or other lung diseases are also at higher risk of developing acute bronchitis. Individuals exposed to chemical fumes or high levels of air pollution also have a greater chance of developing acute bronchitis.

Chronic bronchitis is a major cause of disability and **death** in the United States. The American Lung Association estimates that about 14 million Americans have the disease. Like acute bronchitis, chronic bronchitis is an inflammation of airways accompanied by coughing and spitting up of phlegm. In chronic bronchitis, these symptoms are present for at least three months in each of two consecutive years.

Description

Although acute and chronic bronchitis are both inflammations of the air passages, their causes and treatments are different. Acute bronchitis is most prevalent in winter. It usually follows a viral infection, such as a cold or the flu, and can be accompanied by a secondary bacterial infection. Acute bronchitis resolves within two weeks, although the **cough** may persist longer. Acute bronchitis, like any upper airway inflammatory process, can increase a person's likelihood of developing **pneumonia**.

Chronic bronchitis is caused by inhaling bronchial irritants, especially cigarette smoke. Until recently, more men than women developed chronic bronchitis, but as the number of women who smoke has increased, so has their rate of chronic bronchitis. Because this disease progresses slowly, middle-aged and older people are more likely to be diagnosed with chronic bronchitis.

Chronic bronchitis is one of a group of diseases that fall under the name **chronic obstructive pulmonary disease** (COPD). Other diseases in this category include **emphysema** and chronic asthmatic bronchitis. Chronic bronchitis may progress to emphysema, or both diseases may be present together.

Risk factors

Smoking, heart or lung disease, and exposure to chemical fumes or high levels of air pollution increase

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KEY TERMS

Acute—Disease or condition characterized by the rapid onset of severe symptoms.

Bronchi—The larger air tubes of the lung that bring air in from the trachea.

Chronic—Disease or condition characterized by slow onset over a long period of time.

Chronic obstructive pulmonary disease (COPD)—A term used to describe chronic lung diseases, like chronic bronchitis, emphysema, and asthma.

Emphysema—A chronic obstructive pulmonary disease in which the destruction of air sac walls form abnormally large air sacs that have reduced gas exchange ability and tend to retain air within the lungs. Symptoms include labored breathing, the inability to forcefully blow air out of the lungs, and an increased susceptibility to respiratory tract infections.

an individual's risk for bronchitis. Infants, young children, and the elderly are also at greater risk because they are more likely to have a weak immune system.

Causes and symptoms

Acute bronchitis

Acute bronchitis usually begins with the symptoms of a cold, such as a runny nose, sneezing, and dry cough. However, the cough soon becomes deep and painful. Coughing brings up a greenish-yellow phlegm or sputum. These symptoms may be accompanied by a **fever** of up to 102°F (38.8°C). **Wheezing** after coughing is common.

In uncomplicated acute bronchitis, the fever and most other symptoms, except the cough, disappear after three to five days. Coughing may continue for several weeks. Acute bronchitis is often complicated by a bacterial infection, in which case the fever and a general feeling of illness persist. To be cured, the bacterial infection should be treated with **antibiotics**.

Chronic bronchitis

Chronic bronchitis is caused by inhaling respiratory tract irritants. The most common irritant is cigarette smoke. The American Lung Association estimates that 80%–90% of COPD cases are caused by smoking. Other irritants include chemical fumes, air pollution, and environmental irritants, such as mold or dust.

Chronic bronchitis develops slowly over time. The cells that line the respiratory system contain fine, hair-like outgrowths from the cell called cilia. Normally, the cilia of many cells beat rhythmically to move mucus along the airways. When smoke or other irritants are inhaled, the cilia become paralyzed or snap off. When this occurs, the cilia are no longer able to move mucus, and the airways become inflamed, narrowed, and clogged. This leads to difficulty breathing and can progress to the life-threatening disease emphysema.

A mild cough, sometimes called smokers' cough, is often the first visible sign of chronic bronchitis. Coughing brings up phlegm, although the amount varies considerably from person to person. Wheezing and **shortness of breath** may accompany the cough. Diagnostic tests show a decrease in lung function. As the disease advances, breathing becomes difficult and activity decreases. The body does not get enough oxygen, leading to changes in the composition of the blood.

Diagnosis

Examination

Initial diagnosis of bronchitis is based on observing the patient's symptoms and health history. The physician listens to the patient's chest with a stethoscope for specific sounds that indicate lung inflammation, such as moist rales and crackling, and wheezing, which indicates airway narrowing. Moist rales consist of a bubbling sound heard with a stethoscope. The sound is caused by fluid secretion in the bronchial tubes.

Tests

A **sputum culture** may be performed, particularly if the sputum is green or has blood in it, to determine whether a bacterial infection is present and to identify the disease-causing organism so that an appropriate antibiotic can be selected. Normally, the patient is asked to cough deeply, then spit the material that comes up from the lungs (sputum) into a cup. This sample is then grown in the laboratory to determine which organisms are present. The results are available in two to three days, except for tests for **tuberculosis**, which can take as long as two months.

Procedures

Occasionally, in diagnosing a chronic lung disorder, the sample of sputum is collected using a procedure called a **bronchoscopy**. In this procedure, the patient is given a local anesthetic, and a tube is passed into the airways to collect a sputum sample.

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A pulmonary function test is important in diagnosing chronic bronchitis and other variations of COPD. This test uses an instrument called a spirometer to measure the volume of air entering and leaving the lungs. The test is done in the doctor's office and is painless. It involves breathing into the spirometer mouthpiece either normally or forcefully. Volumes less than 80% of the normal values indicate an obstructive lung disease.

To better determine what type of obstructive lung disease a patient has, the doctor may do a chest x ray, electrocardiogram (ECG), and blood tests. An electrocardiogram is an instrument used to measure the electrical activity of the heart and is useful in the diagnosis of heart conditions. Other tests may be used to measure how effectively oxygen and carbon dioxide are exchanged in the lungs.

Treatment

Acute bronchitis

When no secondary infection is present, acute bronchitis is treated in the same way as the **common cold**. Home care includes drinking plenty of fluids, resting, not smoking, increasing moisture in the air with a cool mist humidifier, and taking **acetaminophen** (Datril, Tylenol, Panadol) for fever and **pain**. **Aspirin** should not be given to children because of its association with the serious illness **Reye's syndrome**.

Expectorant cough medicines, unlike **cough suppressants**, do not stop the cough. Instead they are used to thin the mucus in the lungs, making it easier to cough up. This type of cough medicine may be helpful to individuals suffering from bronchitis. People who are unsure about what type of medications are in over-the-counter cough syrups should ask their pharmacist for an explanation.

If a secondary bacterial infection is present, the infection is treated with an antibiotic. Patients need to take the entire amount of antibiotic prescribed. Stopping the antibiotic early can lead to a return of the infection. Tetracycline or ampicillin is often used to treat adults. Other possibilities include trimethoprim/sulfamethoxazole (Bactrim or Septra) and the newer erythromycin-like drugs, such as azithromycin (Zithromax) and clarithromycin (Biaxin). Children under age eight are usually given amoxicillin (Amoxil, Pentamox, Sumox, Trimox), because tetracycline discolors permanent teeth that have not yet come in.

Chronic bronchitis

The treatment of chronic bronchitis is complex and depends on the stage of chronic bronchitis and whether other health problems are present. Lifestyle changes, such as quitting smoking and avoiding secondhand smoke or polluted air, are an important first step. Controlled **exercise** performed on a regular basis is also important.

Drugs

Drug therapy begins with **bronchodilators**. These drugs relax the muscles of the bronchial tubes and allow increased airflow. They can be taken by mouth or inhaled using a nebulizer. A nebulizer is a device that delivers a regulated flow of medication into the airways. Common bronchodilators include albuterol (Ventolin, Proventil, Apo-Salvent) and metaproterenol (Alupent, Orciprenaline, Metaprel, Dey-Dose).

Anti-inflammatory medications are added to reduce swelling of the airway tissue. **Corticosteroids**, such as prednisone, can be taken orally or intravenously. Other **steroids** are inhaled. Long-term steroid use can have serious side effects. Other drugs, such as ipratropium (Atrovent), are given to reduce the quantity of mucus produced.

As the disease progresses, the patient may need supplemental oxygen. Complications of COPD are many and often require hospitalization in the latter stages of the disease.

Alternative treatment

Alternative practitioners focus on prevention by eating a healthy diet that strengthens the immune system and practicing **stress** management. Bronchitis can become serious if it progresses to pneumonia; therefore, antibiotics may be required. In addition, there are a multitude of botanical and herbal medicines that can be formulated to treat bronchitis. Some examples include inhaling eucalyptus or other essential oils in warm steam. Herbalists recommend a tea made of mullein (*Verbascum thapsus*), coltsfoot (*Tussilago farfara*), and anise seed (*Pimpinella anisum*). **Homeopathic medicine** and **traditional Chinese medicine** may also be useful for bronchitis, and **hydrotherapy** can contribute to cleaning the chest and stimulating immune response.

Prognosis

When treated, acute bronchitis normally resolves in one to two weeks without complications, although a cough may continue for several more weeks. The progression of chronic bronchitis, on the other hand, may be slowed, and an initial improvement in symptoms may be achieved. Unfortunately, there is no cure for chronic bronchitis, and the disease can often lead to or coexist with emphysema.

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Prevention

The best way to prevent bronchitis is to not begin smoking or to stop smoking. Smokers are ten times more likely to die of COPD than nonsmokers. Smokers who stop show improvement in lung function. Other preventative steps include avoiding chemical and environmental irritants, such as air pollution, and maintaining good overall health. Immunizations against certain types of pneumonia, as well as **influenza**, are an important preventative measure for anyone with lung or immune system diseases.

Resources

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ORGANIZATIONS

American Lung Association, 1301 Pennsylvania Ave., NW Suite 800, Washington, DC, 20004, (212) 315-8700, (800)LUNG-USA (548-8252), http://www.lungusa.org.

Global Alliance Against Chronic Respiratory Diseases (GARD), World Health Organization, Department of Chronic Diseases and Health Promotion, 20, Avenue Appia, CH-1211 27, Geneva, Switzerland, http://www.who.int/gard/en/index.html.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105 (301) 592-8573; TTY: (240) 629-3255, (240) 629-3246, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi.nih.gov.

Tish Davidson, AM

Bronchodilators

Definition

Bronchodilators are medicines that help open the bronchial tubes (airways) of the lungs, allowing more air to flow through them.

Purpose

People with **asthma** have trouble breathing because their airways are inflamed and become narrowed. Normally, air moves smoothly from the mouth and nose through the airways and into the tiny air sacs of the lungs as a person breathes in. Breathing out (exhaling) happens automatically when the person stops breathing in. In a person with asthma, breathing in (inhaling) is not a problem. Incoming air can slide around the blockage, because the act of breathing in makes the airways expand. The problem comes when the person with asthma tries to breathe out. The air can no longer get past the blockage, and it remains trapped in the lungs. The person can then only take shallow breaths. Bronchodilators work by relaxing the smooth muscles that line the airways. This makes the airways open wider and allows air to leave the lungs. These drugs also are used to relieve breathing problems associated with **emphysema**, chronic **bronchitis**, and other lung diseases.

KEY TERMS

Anti-inflammatory—Medicine used to relieve swelling, pain, and other symptoms of inflammation.

Bronchitis—Inflammation of the air passages of the lungs.

Chronic—A word used to describe a long-lasting condition. Chronic conditions often develop gradually and involve slow changes.

Emphysema—A lung disease in which breathing becomes difficult.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Nebulizer—A device that turns liquid forms of medicine into a fine spray that can be inhaled.

Sulfite—A type of preservative that causes allergic reactions in some people.

Description

Some bronchodilators are inhaled, using a nebulizer or an inhalation aerosol. Others are taken as injections or by mouth. Most are available only by prescription, but a few, such as ephedrine, can be bought without a physician's prescription. Examples of bronchodilators are albuterol (Proventil, Ventolin), epinephrine (Primatene), ipratropium (Atrovent), metaproterenol (Alupent, Metaprel), and terbutaline (Brethine).

Recommended dosage

The recommended dosage depends on the type of bronchodilator and may be different for different patients. The physician who prescribed the drug or the pharmacist who filled the prescription can recommend correct dosage.

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Precautions

Bronchodilators come with patient instructions that must be carefully read before using the medicine. If there is any confusion about how to use the medicine, patients should check with the physician or pharmacist. These medicines must be used exactly as directed. Taking larger than recommended doses or using the medicine too often can lead to serious side effects and even **death**.

If symptoms do not improve or if they get worse after using a bronchodilator, the patient should call a physician right away.

Although some bronchodilators are available without a physician's prescription, these medicines should not be used unless a physician has diagnosed the patient's condition as asthma.

Research shows that frequent bronchodilator use over time can tighten airway muscles in some people. Some physicians advise patients to consider controlling asthma with anti-inflammatory drugs including inhaled **steroids** such as beclomethasone dipropionate (Beclovent, Vanceril), flunisolide (AeroBid) or triamcinolone acetonide (Azmacort). A 2004 Canadian study has questioned a standard practice of increasing steroids after asthma attacks or worsened symptoms. Additional research in 2004 showed that people with asthma who worked closely with their physicians to self-manage their asthma had fewer attacks, which reduces the need for bronchodilators. Carefully managing asthma also reduces visits to the emergency department and hospitalizations.

Persons with diabetes should be aware that the bronchodilator epinephrine may raise their blood sugar levels.

Patients who are using an aerosol bronchodilator and an aerosol form of either ipratropium or a corticosteroid such as beclomethasone dipropionate (Beclovent, Vanceril) should use the bronchodilator first, then wait five minutes before using the other medicine. A physician should be consulted before using any other inhaled medications or other asthma medicines. The physician must determine the proper amount of time between doses.

Some bronchodilator products contain sulfites that trigger an allergic reaction in certain people. Anyone who has a sulfite allergy should read the label carefully or check with a physician or pharmacist before using a bronchodilator. Call a physician immediately if any of these signs of an allergic reaction to sulfite occur:

- bluish coloration of the skin
- flushed or red face or skin
- faintness
- severe dizziness
- increased wheezing or other breathing problems
- skin rash, hives, or itching
- swelling of the face, lips, or eyelids

Special conditions

People with certain medical conditions or who are taking certain other medicines can have problems if they use bronchodilators. Before using these drugs, a physician should be made aware of any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to any bronchodilator or an inhaled form of any other drug in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

Patients who are allergic to soybeans, soy lecithin, peanuts, or drugs based on atropine should not use the bronchodilator ipratropium (Atrovent).

PREGNANCY. In studies of laboratory animals, some bronchodilators cause **birth defects** or **miscarriage** when the animals are given doses many times the usual human dose. Whether these drugs cause such problems in humans in unknown. Any woman who is pregnant or plans to become pregnant should check with her physician before using a bronchodilator.

BREASTFEEDING. Some bronchodilators pass into breast milk. **Breastfeeding** mothers should check with their physicians before using bronchodilators.

OTHER MEDICAL CONDITIONS. Before using bronchodilators, people with any of these medical problems should make sure their physicians are aware of their conditions:

- glaucoma
- brain damage
- convulsions (seizures)—recently or anytime in the past
- mental illness
- Parkinson's disease
- diabetes
- heart or blood vessel diseases
- rapid or irregular heartbeat
- high blood pressure
- overactive thyroid
- enlarged prostate
- obstruction of the neck of the bladder

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USE OF CERTAIN MEDICINES. Using bronchodilators with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Side effects

Some patients have a dry or irritated throat or a **dry mouth** after using bronchodilators. To help prevent these problems, gargling and rinsing the mouth or taking a sip of water after each dose.

The most common side effects are nervousness or restlessness and trembling. These problems usually go away as the body adjusts to the drug and do not require medical treatment. Less common side effects such as bad taste in the mouth, coughing, **dizziness** or lightheadedness, drowsiness, **headache**, sweating, fast or pounding heartbeat, **muscle cramps** or twitches, **nausea**, **vomiting**, **diarrhea**, sleep problems, and weakness also may occur and do not need medical attention unless they do not go away or they interfere with normal activities.

More serious side effects are not common, but may occur. If any of the following side effects occur, the physician who prescribed the medicine should be contacted as soon as possible:

- chest pain or discomfort
- irregular or fluttery heartbeat
- unusual bruising
- hives or rash
- swelling
- wheezing or other breathing problems
- numbness in the hands or feet
- blurred vision

Other side effects are possible. Anyone who has unusual symptoms after using a bronchodilator should get in touch with his or her physician.

Interactions

Bronchodilators may interact with a number of other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes these drugs should let the physician know all other medicines he or she is taking. Among the drugs that may interact with bronchodilators are:

- monoamine oxidase inhibitors (MAO inhibitors) such as phenelzine (Nardil) and tranylcypromine (Parnate), used to treat depression
- other bronchodilators
- tricyclic antidepressants such as amitriptyline (Elavil) and imipramine (Tofranil)
- beta blockers such as propranolol (Inderal) and atenolol (Tenormin), used to control high blood pressure
- digitalis medicines, used to treat heart conditions, such as digoxin (Lanoxin)
- drugs, such as certain diuretics (water pills), that lower potassium levels
- ergoloid mesylates such as Hydergine, used to treat symptoms of Alzheimer's disease or multiple small stokes
- ergotamine (Cafergot, Ergostat, and other brands), used to treat migraine and cluster headaches
- the antidepressant maprotiline (Ludiomil)

The list above does not include every drug that may interact with bronchodilators. Be sure to check with a physician or pharmacist before combining bronchodilators with any other prescription or nonprescription (over-the-counter) medicine.

Resources

PERIODICALS

"Study Calls Standard Asthma Management Into Doubt." *Doctor* July 15, 2004: 4.

"What's New in: Asthma and Allergic Rhinitis." *Pulse* September 20, 2004: 50.

"Wheezing? Check Your Inhaler." *Prevention* September 2004: 34.

ORGANIZATIONS

American Academy of Allergy, Asthma & Immunology, 555 East Wells Street, Suite 1100, Milwaukee, WI, 53202-3823, (414) 272-6071, http://www.aaaai.org.

Asthma and Allergy Foundation of America, 8201 Corporate Drive, Suite 1000, Landover, MD, 20785, (800) 727-8462, info@aafa.org, http://www.aafa.org/.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

Nancy Ross-Flanigan
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Bronchoscopy

Definition

Bronchoscopy is a procedure in which a hollow, flexible tube called a bronchoscope is inserted into the airways through the nose or mouth to provide a view of the tracheobronchial tree. It can also be used to collect bronchial and/or lung secretions and to perform tissue biopsy.

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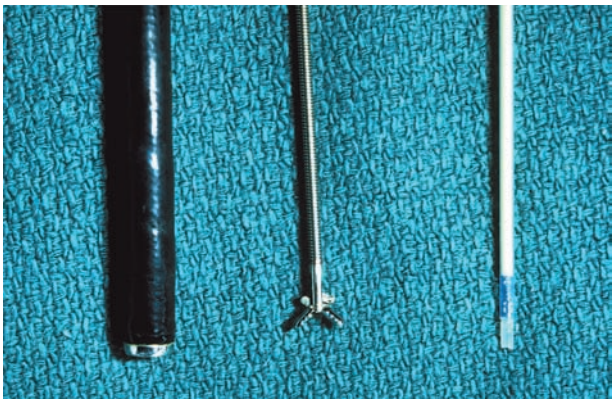

Instruments used in bronchoscopy procedures. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Purpose

During a bronchoscopy, the physician can visually examine the lower airways, including the larynx, trachea, bronchi, and bronchioles. The procedure is used to examine the mucosal surface of the airways for abnormalities that might be associated with a variety of lung diseases. Its use may be diagnostic or therapeutic.

Bronchoscopy may be used to examine and help diagnose all of the following:

- diseases of the lung, such as cancer or tuberculosis
- congenital deformity of the lungs
- suspected tumor, obstruction, secretion, bleeding, or foreign body in the airways
- airway abnormalities, such as tracheal stenoses
- persistent cough, or hemoptysis, that includes blood in the sputum

Bronchoscopy may also be used for the following therapeutic purposes:

- remove a foreign body in the lungs
- remove excessive secretions
- remove tumors in the airway
- treat stenosis (narrowing) of the airways, by using balloon dilatation or placing a stent

Bronchoscopy can also be used to collect the following biopsy specimens:

- sputum
- tissue samples from the bronchi or bronchioles
- cells collected from washing the lining of the bronchi or bronchioles

If the purpose of the bronchoscopy is to take tissue samples, or biopsy, a forceps or bronchial brush are used to obtain cells. Alternatively, if the purpose is to identify an infectious agent, a bronchoalveolar lavage can be performed to gather fluid for culture purposes. If any foreign matter is found in the airways, it can be removed as well. Tumors can be debulked (made smaller) through the use of laser, electrocautery, or **cryotherapy** during the bronchoscopy. A balloon can be passed into a narrowed area of the airway and inflated in order to treat stenosis. A stent (tiny artificial tube) can be placed during bronchoscopy, in order to keep a portion of the airway open.

The instrument used in bronchoscopy, a bronchoscope, is a slender, flexible tube less than 0.5 in. (2.5 cm) wide and approximately 2 ft. (0.3 m) long that uses fiber-optic technology (very fine filaments that can bend and carry light). There are two types of bronchoscopes: a standard tube that is more rigid and a fiber-optic tube that is more flexible. The rigid instrument does not bend, does not see as far down into the lungs as the flexible one, and may carry a greater risk of causing injury to nearby structures. Because a standard tube can cause more discomfort than the flexible bronchoscope, it usually requires **general anesthesia**. However, it is useful for taking large samples of tissue and for removing foreign bodies from the airways. During the procedure, the airway is not blocked since oxygen can be supplied through the bronchoscope.

Demographics

Nearly 500,000 bronchoscopies are performed annually in the United States. According to the National **Cancer** Institute, cancer of the lung and bronchi is the second most common cancer among both men and women and is the leading cause of cancer **death** in both sexes in the United States. Among men, lung cancer incidence rates per 100,000 people range from a low of approximately 14 among American Indians to a high of 117 among African Americans. Between these two extremes, rates fall into two groups, ranging from 42 to 53 for Hispanics, Japanese, Chinese, Filipinos, and Koreans, and from 71 to 89 for Vietnamese, Caucasians, Alaska Natives, and Hawaiians. The range among women is much narrower, from a rate of about 15 among Japanese to nearly 51 among Alaska Natives, only a three-fold difference. Rates for the remaining female populations fall roughly into two groups with low rates of 16–25 for Korean, Filipino, Hispanic, and Chinese women, and rates of 31–44 among Vietnamese, Caucasian, Hawaiian, and African American women. The rates among men are about two to three times greater than the rates among women in each of the racial/ethnic groups.

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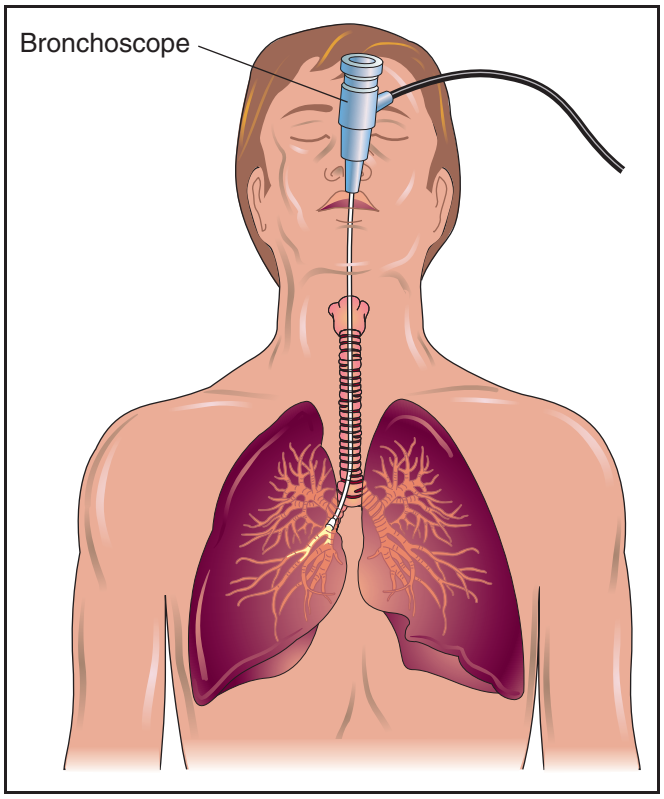

Bronchoscopy is a procedure in which a hollow, flexible tube is inserted into the airways, allowing the physician to visually examine the lower airways, including the larynx, trachea, bronchi, and bronchioles. It can also be used to collect specimens for bacteriological culture to diagnose infectious diseases such as tuberculosis. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Description

Bronchoscopy is usually performed in an **endoscopy** room, but may also be performed at the bedside. The patient is placed on the back or sits upright. A pulmonologist, a specialist trained to perform the procedure, sprays an anesthetic into the patient's mouth or throat. When anesthesia has taken effect and the area is numb, the bronchoscope is inserted into the mouth and passed into the throat. If the bronchoscope is passed through the nose, an anesthetic jelly is inserted into one nostril. While the bronchoscope is moving down the throat, additional anesthetic is put into the bronchoscope to anesthetize the lower airways. The physician observes the trachea, bronchi, and the mucosal lining of these passageways looking for any abnormalities that may be present. If samples are needed, a bronchial lavage may be performed, meaning that a saline solution is used to flush the area prior to collecting cells for laboratory analysis. Very small brushes, needles, or forceps may also be introduced through the bronchoscope to collect tissue samples from the lungs. If the procedure is therapeutic in nature, laser, electrocautery, cryotherapeutic, or balloon dilatation instruments may be passed through the bronchoscope, and a stent may be placed.

Preparation

The patient should fast for 6 to 12 hours prior to the procedure and refrain from drinking any liquids the day of the procedure. **Smoking** should be avoided for 24 hours prior to the procedure, and patients should also avoid taking any **aspirin** or ibuprofen-type medications. The bronchoscopy itself takes about 45–60 minutes. Prior to the bronchoscopy, several tests are usually done, including a **chest x ray** and blood work. Sometimes a bronchoscopy is done under general anesthesia, in which case the patient will have an intravenous (IV) line in the arm. More commonly, the procedure is performed under **local anesthesia**, which is sprayed into the nose or mouth. This is necessary to inhibit the gag reflex. A sedative may also be given. A signed consent form is necessary for this procedure.

Aftercare

After the bronchoscopy, the vital signs (heart rate, blood pressure, and breathing) are monitored. Sometimes patients have an abnormal reaction to anesthesia. Any sputum should be collected in an emesis basin so that it can be examined for the presence of blood. If a biopsy was taken, the patient should not **cough** or clear the throat as this might dislodge any blood clot that has formed and cause bleeding. No food or drink should be consumed for about two hours after the procedure or until the anesthesia wears off. There is a significant risk for **choking** if anything (including water) is ingested before the anesthetic wears off and the gag reflex has returned. To test if the gag reflex has returned, a spoon is placed on the back of the tongue for a few seconds with light pressure. If there is no gagging, the process is repeated after 15 minutes. The gag reflex should return in one or two hours. Ice chips or clear liquids should be taken before the patient attempts to eat solid food. Patients should be informed that the throat may be irritated for several days.

Patients should notify their healthcare provider if they develop any of these symptoms:

- hemoptysis (coughing up blood)
- shortness of breath, wheezing, or any trouble breathing
- chest pain
- fever, with or without breathing problems

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KEY TERMS

Anesthetic—A drug that causes loss of sensation. It is used to lessen the pain of surgery and medical procedures.

Biopsy—Procedure that involves obtaining a tissue specimen for microscopic analysis to establish a precise diagnosis.

Bronchi—The network of tubular passages that carry air to the lungs and allow air to be expelled from the lungs.

Bronchioles—Small airways extending from the bronchi into the lobes of the lungs.

Bronchoalveolar lavage—Washing cells from the air sacs at the end of the bronchioles.

Computed tomography (CT)—A special radiographic imaging technique that uses a computer to acquire multiple x rays into a two-dimensional sectional image.

Emesis basin—A basin used to collect sputum or vomit.

Endoscope—A highly flexible viewing instrument.

Endoscopy—The visual inspection of any cavity of the body using an endoscope.

Hemoptysis—The expectoration of blood or of blood containing sputum.

Larynx—The voice box.

Lavage—Washing out.

Neoplasm—A new growth or tumor.

Sputum—Matter ejected from the lungs, bronchi, and trachea through the mouth.

Stenosis—Narrowing of a duct or canal.

Trachea—The windpipe.

Tracheobronchial—Pertaining both to the tracheal and bronchial tubes or to their junction.

Risks

Use of the bronchoscope mildly irritates the lining of the airways, resulting in some swelling and inflammation, as well as hoarseness caused from abrading the vocal cords. If this abrasion is more serious, it can lead to respiratory difficulty or bleeding of the lining of the airways.

The bronchoscopy procedure is also associated with a small risk of disordered heart rhythm (arrhythmia), heart attacks, low blood oxygen (hypoxemia), and **pneumothorax** (a puncture of the lungs that allows air to escape into the space between the lung and the chest wall). These risks are greater with the use of a rigid bronchoscope than with a fiber-optic bronchoscope. If a rigid tube is used, there is also a risk of chipped teeth. The risk of transmitting **infectious disease** from one patient to another by the bronchoscope is also present. The Centers for Disease Control (CDC) reported cases of patient-to-patient transmission of infections following bronchoscopic procedures using bronchoscopes that were inadequately reprocessed by the automated endoscope reprocessing (AER) system. Investigation of the incidents revealed inconsistencies between the reprocessing instructions provided by the manufacturer of the bronchoscope and the manufacturer of the AER; or that the bronchoscopes were inadequately reprocessed.

Normal results

If the results of the bronchoscopy are normal, the windpipe (trachea) appears as smooth muscle with C-shaped rings of cartilage at regular intervals. There are no abnormalities either in the trachea or in the bronchi of the lungs.

Bronchoscopy results may also confirm a suspected diagnosis. This may include swelling, ulceration, or deformity in the bronchial wall, such as inflammation, stenosis, or compression of the trachea, neoplasm, and foreign bodies. The bronchoscopy may also reveal the presence of atypical substances in the trachea and bronchi. If samples are taken, the results could indicate cancer, disease-causing agents, or other lung diseases. Other findings may include constriction or narrowing (stenosis), compression, dilation of vessels, or abnormal branching of the bronchi. Abnormal substances that might be found in the airways include blood, secretions, or mucous plugs.

Morbidity and mortality rates

Bronchoscopy belongs to the group of procedures associated with highest inpatient mortality with a 12.7% mortality rate.

Alternatives

Depending upon the purpose of the bronchoscopy, alternatives may include a chest x ray or a computed tomography (CT) scan. If the purpose is to obtain biopsy specimens, one option is to perform surgery, which carries greater risks. Another option is percutaneous biopsy guided by CT.

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Resources

BOOKS

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Khatri, V. P., and J. A. Asensio. *Operative Surgery Manual*. Philadelphia: Saunders, 2003.

Koppen, W., J. F. Turner, and A. C. Mehta, eds. *Flexible Bronchoscopy*. 2nd ed. Oxford: Blackwell, 2004.

Mason, R. J., et al. *Murray & Nadel's Textbook of Respiratory Medicine*. 4th ed. Philadelphia: Saunders, 2007.

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"Public Health Advisory: Infections from Endoscopes Inadequately Reprocessed by an Automated Endoscope Reprocessing System." U. S. Food and Drug Administration, Center for Devices and Radiological Health. September 1999 [cited April 2003]. http://www.fda.gov/cdrh/safety/endoreprocess.html (accessed March 8, 2008).

ORGANIZATIONS

American College of Chest Physicians, 3300 Dundee Road, Northbrook, IL, 60062, (800) 343-2227, http://www.chestnet.org/accp.

Association of Perioperative Registered Nurses (AORN), 2170 South Parker Road, Suite 300, Denver, CO, 80231-5711, (800) 755-2676, (800) 847-0045, custsvc@aorn.org, http://www.aorn.org.

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Brucellosis

Definition

Brucellosis is a bacterial disease caused by members of the *Brucella* genus that can infect humans but primarily infects livestock. Symptoms of the disease include intermittent **fever**, sweating, chills, aches, and mental depression. The disease can become chronic and recur, particularly if untreated.

Description

Also known as undulant fever, Malta fever, Gibraltar fever, Bang's disease, or Mediterranean fever, brucellosis is most likely to occur among those individuals who regularly work with livestock. The disease originated in domestic livestock but was passed on to wild animal species, including the elk and buffalo of the western United States. In humans, brucellosis continues to be spread via unpasteurized milk obtained from infected cows or through contact with the discharges of cattle and goats during **miscarriage**. In areas of the world where milk is not pasteurized, such as in Latin America and the Mediterranean, the disease is still contracted by ingesting unpasteurized dairy products. However, in the United States, the widespread pasteurization of milk and nearly complete eradication of the infection from cattle has reduced the number of human cases from 6,500 in 1940 to less than 200 today.

Causes and symptoms

The disease is caused by several different species of parasitic bacteria of the genus Brucella. *B. abortus* is found in cattle and can cause cows to abort their fetuses. *B. suis* is most often found in hogs and is more deadly when contracted by humans than the organism found in cattle. *B. melitensis* is found in goats and sheep and causes the most severe illness in humans. *B. rangiferi* infects reindeer and caribou, and *B. canis* is found in dogs.

A human contracts the disease by coming into contact with an infected animal and either allowing the bacteria to enter a cut, breathing in the bacteria, or consuming unpasteurized milk or fresh goat cheese obtained from a contaminated animal. In the United States, the disease is primarily confined to slaughterhouse workers.

Scientists do not agree about whether brucellosis can be transmitted from one person to another, although some people have been infected from a tainted blood **transfusion** or bone marrow transplant. Newborn babies have also contracted the illness from their mothers during birth. Currently, it is believed that brucellosis can also be transmitted sexually.

The disease is not usually fatal, but the intermittent fevers (a source of its nickname, "undulant fever") can be exhausting. Symptoms usually appear between five days and a month after exposure and begin with a single bout of high fever accompanied by shivering, aching, and drenching sweats that last for a few days. Other symptoms may include **headache**, poor appetite, backache, weakness, and depression. Mental depression can be so severe that the patient may become suicidal.

In rare, untreated cases, the disease can become so severe that it leads to fatal complications, such as

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KEY TERMS

Antibody—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

Chronic—Disease or condition characterized by slow onset over a long period of time.

Parasite—An organism living in or on, and obtaining nourishment from, another organism.

Pasteurization—The process of applying heat, usually to milk or cheese, for the purpose of killing, or retarding the development of, pathogenic bacteria.

pneumonia or bacterial **meningitis**. *B. melitensis* can cause miscarriages, especially during the first three months of **pregnancy**. The condition can also occur in a chronic form, in which symptoms recur over a period of months or years.

Diagnosis

Brucellosis is usually diagnosed by detecting one or more *Brucella* species in blood or urine samples. The bacteria may be positively identified using biochemical methods or using a technique whereby, if present in the sample, the brucellosis bacteria are made to fluoresce. Brucellosis may also be diagnosed by culturing and isolating the bacteria from one of the above samples. Blood samples will also indicate elevated antibody levels or increased amounts of a protein produced directly in response to infection with brucellosis bacteria.

Treatment

Prolonged treatment with **antibiotics**, including **tetracyclines** (with streptomycin), co-trimoxazole, and **sulfonamides**, is effective. Bed rest is also imperative. In the chronic form of brucellosis, the symptoms may recur, requiring a second course of treatment.

Prognosis

Early diagnosis and prompt treatment is essential to prevent chronic infection. Untreated, the disease may linger for years, but it is rarely fatal. Relapses may also occur.

Prevention

There is no human vaccine for brucellosis, but humans can be protected by controlling the disease in livestock. After checking to make sure an animal is not already infected, and destroying those that are, all livestock should be immunized. Butchers and those who work in slaughterhouses should wear protective glasses and clothing, and protect broken skin from infection.

Some experts suggest that a person with the disease refrain from engaging in unprotected sex until free of the disease. The sexual partners of an infected person should also be closely monitored for signs of infection.

Resources

OTHER

"Brucellosis." Centers for Disease Control and Prevention. http://www.cdc.gov/ncidod/dbmd/diseaseinfo/brucellosis_g.htm (accessed November 24, 2010).

ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

Carol A. Turkington

Brugian filariasis *see* **Elephantiasis**

Bruises

Definition

Bruises, or ecchymoses, are a discoloration and tenderness of the skin or mucous membranes due to the leakage of blood from an injured blood vessel into the tissues. Pupura refers to bruising as the result of a disease condition. A very small bruise is called a petechia. These often appear as many tiny red dots clustered together, and could indicate a serious problem.

Description

Bruises change colors over time in a predictable pattern, so it is possible to estimate when an injury occurred by the color of the bruise. Initially, a bruise will be reddish, the color of the blood under the skin. After one to two days, the red blood cells begin to break

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A close-up view of woman's bruised left eye. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

down, and the bruise will darken to a blue or purplish color. This fades to green at about day six. Around the eighth or ninth day, the skin over the bruised area will have a brown or yellowish appearance, and it will gradually diminish back to its normal color.

Long periods of standing will cause the blood that collects in a bruise to seep through the tissues. Bruises are actually made of little pools of blood, so the blood in one place may flow downhill after awhile and appear in another. For instance, bruising in the back of the abdomen may eventually appear in the groin; bruising in the thigh or the knee will work its way down to the ankle.

Causes and symptoms

Healthy people may develop bruises from any injury that doesn't break through the skin. Vigorous **exercise** may also cause bruises due to bringing about small tears in blood vessels walls. In a condition known as purpura simplex, there is a tendency to bruise easily due to an increased fragility of the blood vessels. Bruises also develop easily in the elderly, because the skin and blood vessels have a tendency to become thinner and more fragile with **aging**, and there is an increased use of medications that interfere with the blood clotting system. In the condition known as purpura senilis, the elderly develop bruises from minimal contact that may take up to several months to completely heal.

The use of nonsteroidal anti-inflammatories such as ibuprofen (Advil) and naproxen (Aleve) may lead to increased bruising. **Aspirin**, antidepressants, **asthma** medications, and cortisone medications also have this effect. The anti-clotting medications known as blood thinners, especially the drug Warfarin (Coumadin), may be the cause of particularly severe bruising.

Sometimes bruises are connected with more serious illnesses. There are a number of diseases that cause excessive bleeding or bleeding from injuries too slight to have consequences in healthy people. An abnormal tendency to bleed may be due to hereditary bleeding disorders, certain prescription medications, diseases of the blood such as leukemia, and diseases that increase the fragility of blood vessels. If there are large areas of bruising or bruises develop very easily, this may herald a problem. Other causes that should be ruled out include **liver disease**, **alcoholism**, drug **addiction**, and acquired immune deficiency syndrome (**AIDS**). Bruising that occurs around the navel may indicate dangerous internal bleeding; bruising behind the ear, called Battle's sign, may be due to a skull fracture; and raised bruises may point to autoimmune disease.

Diagnosis

Bruising is usually a minor problem, which does not require a medical diagnosis. However, faced with extensive bruising, bruising with no apparent cause, or bruising in certain locations, a physician will pursue an evaluation that will include a number of blood tests. If the area of the bruise becomes hard, an x ray may be required.

Treatment

A bruise by itself needs no medical treatment. It is often recommended that ice packs be applied on and off during the first 24 hours of injury to reduce the bruising. After that, heat, especially moist heat, is recommended to increase the circulation and the healing of the injured tissues. Rest, elevation of the affected part, and compression with a bandage will also retard the accumulation of blood. Rarely, if a bruise is so large that the body cannot completely absorb it or if the site becomes infected, it may have to be surgically removed.

Alternative treatment

Several types of topical applications are usually recommend to speed healing and to reduce the **pain** associated with bruises. Vitamin K cream can be applied directly to the site of injury. Astringent herbs such as witch hazel, *Hamamelis virginiana*, can be used. This will tighten the tissues and therefore diminish the bruising.

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The homeopathic remedy, *Arnica montana*, can be applied as a cream or gel to unbroken skin.

Oral homeopathic remedies may reduce bruising, pain, and swelling as well. *Arnica montana*, at 30 mL (1 oz), taken one to two times per day is highly recommended. For ledum, 30 mL (1 oz) one to two times per day is also useful.

Prognosis

The blood under the skin that causes the discoloration of bruising should be totally reabsorbed by the body in three weeks or less. At that time, the skin color should completely return to normal.

Sometimes, a bruise may become solid and increase in size instead of dissolving. This may indicate blood trapped in the tissues, which may be need to be drained. This is referred to as a hematoma. Less commonly, the body may develop **calcium** deposits at the injury site in a process called heterotopic ossification.

Prevention

Vitamin K promotes normal clotting in the blood, and therefore may help reduce the tendency to bruise easily. Green leafy vegetables, alfalfa, broccoli, seaweed, and fish liver oils are dietary sources of vitamin K. Other good foods to eat would be those containing bioflavonoids, such as reddish-blue berries. These can assist in strengthening the connective tissue, which will decrease the spread of blood and bruising. Zinc and vitamin C supplements are also recommended for this.

Resources

BOOKS

Editors of Prevention. *The Doctors Book of Home Remedies: Quick Fixes, Clever Techniques, and Uncommon Cures to Get You Feeling Better Fast*. New York: St. Martin's Press, 2009.

Patience Paradox

Bruton's agammaglobulinemia *see* **X-linked agammaglobulinemia**

Bruxism

Definition

Bruxism is the habit of clenching and grinding the teeth. It most often occurs at night during sleep, but it may also occur during the day. It is an unconscious behavior, perhaps performed to release **anxiety**, aggression, or anger.

KEY TERMS

Enamel—The hard outermost surface of a tooth.

High spot—An area of a tooth or restoration that feels abnormal or uncomfortable because it hits its opposing tooth before other teeth meet.

Night guard—A removable, custom-fitted plastic appliance that fits between the upper and lower teeth to prevent them from grinding against each other.

Occlusion—The way upper and lower teeth fit together during biting and chewing.

Rolfing—Based on the belief that proper alignment of various parts of the body is necessary for physical and mental health, rolfing uses deep tissue massage and movement exercises in an attempt to bring the body into correct alignment.

Temporomandibular joint (TMJ)—The jaw joint formed by the mandible (lower jaw bone) moving against the temporal bone of the skull.

Description

Bruxism is one of the oldest disorders known, and approximately one in four adults experiences it. Most people are not aware of it before their teeth have been damaged.

Causes and symptoms

While bruxism is typically associated with **stress**, it may also be triggered by abnormal occlusion (the way the upper and lower teeth fit together), or crooked or missing teeth.

Symptoms of bruxism include: dull headaches; sore and tired facial muscles; earaches; sensitive teeth; and locking, popping, and clicking of the jaw.

During a dental examination, a dentist may recognize damage resulting from bruxism, including enamel loss from the chewing surfaces of teeth, flattened tooth surfaces, loosened teeth, and fractured teeth and fillings. Left untreated, bruxism may lead to tooth loss and jaw dysfunction.

Diagnosis

Medical and dental histories and examinations are necessary to differentiate bruxism from other conditions

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that may cause similar **pain**, such as ear infections, dental infections, and temporomandibular joint (TMJ) dysfunction. However, uncommonly worn-down teeth strongly suggest a diagnosis of bruxism.

Treatment

To prevent further damage to the teeth, bruxism is treated by placing a removable, custom-fitted plastic appliance called a night guard between the upper and lower teeth. Although the clenching and grinding behavior may continue, the teeth wear away the plastic instead of each other.

In some cases, abnormal occlusion may be adjusted and high spots removed so that the teeth fit together in a more comfortable position. Missing teeth may be replaced and crooked teeth may be straightened with orthodontic treatment to eliminate possible underlying causes of bruxism. In cases where jaw muscles are very tight, a dentist may prescribe **muscle relaxants**.

Alternative treatment

Stress management and behavior modification techniques may be useful to break the habit of clenching and teeth grinding. Tight jaw muscles may be relaxed by applying warm compresses to the sides of the face. Herbal muscle relaxants also can be helpful. **Massage therapy** and deep tissue realignment, including **rolfing**, can assist in releasing the clenching pattern. This is a more permanent alternative treatment for bruxism.

Prognosis

Bruxism may cause permanent damage to teeth and chronic jaw pain unless properly diagnosed and promptly treated. The behavior may be eliminated if its underlying causes are found and addressed.

Prevention

Increased awareness in patients prone to anxiety, aggression, or anger may prevent the habit of bruxism from developing.

ORGANIZATIONS

Academy of General Dentistry, 211 East Chicago Avenue, Suite 900, Chicago, IL, 60611-1999, (312) 440-0559, (888) 243-3368, http://www.agd.org.

American Dental Association, 211 E. Chicago Ave., Chicago, IL, 60611-2678, (312) 440-2500, http://www.ada.org.

Bethany Thivierge

Bubonic plague *see* **Plague**

Budd-Chiari syndrome

Definition

Budd-Chiari syndrome is a rare problem that results from blood clotting in the veins flowing out of the liver (hepatic veins). The high pressure of blood in these veins leads to an enlarged liver, and to an accumulation of fluid in the abdomen, called **ascites**.

Demographics

The exact frequency of Budd-Chiari syndrome is unknown. The syndrome is seen in all races and in both males and females. It appears to be more prevalent in Asian countries, with individuals presenting clinical symptoms during ages 30 to 40; however it may occur in children and in older individuals, as well.

Description

The liver, the largest internal organ in the human body, is responsible for many vital physiologic processes. Blood flow through the liver nourishes the liver, carries in substances that the liver will process, and carries away substances that the liver has produced. When blood cannot flow out freely from the liver, blood pressure rises in the veins of the liver, leading to **blood clots** within the liver. Also, some of the blood plasma can leak through the walls of the veins and accumulate within the abdomen (ascites).

Causes and symptoms

The major symptoms include **pain** in the upper right-hand portion of the abdomen and a buildup of fluid in the abdomen. In the United States, blood disorders are the most common causes. Among these disorders are **polycythemia vera** (an increase in the number of red blood cells) and sickle cell anemia. In parts of the world where **liver cancer** is common, a form of liver **cancer** is the most frequent cause.

Other causes sometimes include:

- certain infections
- use of oral contraceptives
- body changes in pregnancy and the postpartum period
- phlebitis (inflammation of a vein)
- injury to the abdomen
- a membrane web that causes blockage of the inferior vena cava

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Diagnosis

Diagnosis of Budd-Chiari syndrome can be made by an internist (a specialist in diseases of the internal organs), a gastroenterologist (a specialist in the diseases of the digestive system), or a general surgeon. On **physical examination**, the doctor will note that the liver is larger than normal. Often an ultrasound scan of the liver will show abnormalities in the size of the liver, an abnormal pattern of the veins in the liver, and other abnormalities. A CT scan will often show similar abnormalities.

Once these abnormalities are confirmed, the key test is called hepatic vein catheterization. In this test, a narrow tube is snaked through the body until it reaches the hepatic veins. An instrument at the tip of the catheter can measure the pressure within each segment of the hepatic vein.

In some cases, a tiny amount of radioactive material is injected into a patient, and then an abnormal pattern of radioactivity in the liver can be revealed. In other cases, a **liver biopsy** enables a physician to examine cells from the liver itself. Cells damaged by Budd-Chiari syndrome have a characteristic appearance easily identifiable to a physician.

Treatment

Surgery

Most patients with Budd-Chiari syndrome must have surgery. A surgeon will re-route blood flow around the clotted hepatic vein into a large vein called the vena cava. The exact technique will depend on the specific location of the clots and other factors. In certain patients, other surgical techniques may be used. For patients who otherwise would have less than six months to live, **liver transplantation** is sometimes performed.

In a few patients, a "balloon catheter" can open the blocked blood vessels, without the need for major surgery.

Drugs

Sometimes, anti-clotting drugs such as urokinase and tissue plasminogen activator (tPA) can be used for patients with a sudden onset of clotting in the veins of the liver. These drugs do not seem to work when the clots have become established.

Prognosis

If surgery is done before permanent liver damage sets in, long-term survival is possible. In these cases, damaged liver cells can actually recover. If patients are already very sick with **liver disease**, the surgery may not be as helpful.

KEY TERMS

Ascites—Accumulation of fluid in the abdomen.

Biopsy—Surgical removal of a tiny bit of tissue for examination under the microscope.

Catheter—A tubular surgical instrument.

Phlebitis—Inflammation of a vein.

Polycythemia vera—An excess number of red blood cells in the blood.

Sickle cell anemia—An inherited disease in which red blood cells take an unusual shape, leading to circulation problems.

Prevention

The best approach to prevention is to carefully control the blood disorders that can lead to Budd-Chiari syndrome.

Resources

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National Organization for Rare Diseases, P.O. Box 8923, Fairfield, CT, 06812, (213) 745–6518, http://www.rarediseases.org.

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Buerger's disease

Definition

Buerger's disease is an inflammation of the arteries, veins, and nerves in the legs, leading to restricted blood flow. Left untreated, Buerger's disease can lead to **gangrene** of the affected areas. Buerger's disease is also known as thromboangitis obliterans.

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KEY TERMS

Gangrene—A decay of the tissue in a part of the body that experiences restricted blood flow.

Inflammation—A local reaction to irritation, injury, or infection characterized by pain, swelling, redness, and occasional loss of function.

Ischemia—A decrease in the blood supply to an area of the body caused by obstruction or constriction of blood vessels.

Phlebitis—Inflammation of a vein.

Causes and symptoms

The exact cause of Buerger's disease is not known. It is seen most often in young to middle-aged men (ages 20–40) who are heavy smokers of cigarettes. Cases of this disease in nonsmokers are very rare; hence, cigarette **smoking** is considered a causative factor. Approximately 40% of the patients have a history of inflammation of a vein (phlebitis), which may play a role in the development of Buerger's disease.

The disease is mainly seen in the legs of affected persons, but may also appear in their arms. Early symptoms include decrease in the blood supply (arterial **ischemia**) and superficial (near the skin surface) phlebitis. The main symptom is **pain** in the affected areas. Onset of the disease is gradual and first occurs in the feet or hands. Inflammation occurs in small and medium-sized arteries and veins near the surface of the limb. In advanced cases, blood vessels in other parts of the body may be affected. There is a progressive decrease in the blood flow to the affected areas. The pulse in arteries of the feet is weak or undetectable. The lack of blood flow can lead to gangrene, which is decay of tissue due to restricted blood supply. A cold sensitivity in the hands, similar to that seen in **Raynaud's disease**, can develop. In this case, the hands turn color—white, blue, and then red—when exposed to the cold.

Diagnosis

Diagnosis is usually made from the clinical symptoms. Patients frequently complain of **numbness**, **tingling**, or burning sensations in the affected area before evidence of vascular inflammation becomes apparent.

Treatment

There is no effective medication or surgery for this disease. Patients must stop smoking to halt further development of the symptoms. **Vasodilators**, drugs that increase the diameter of the blood vessels, can be administered but may not be effective. Exposure of affected areas to heat or cold should be avoided. Trauma to the feet and other affected areas should be avoided and infections must be treated promptly.

Prognosis

The disease is progressive in patients who do not stop smoking. Areas with gangrene must be removed surgically.

Prevention

Smoking is the only known causative agent for this disease and should be avoided.

Resources

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Bulging eyes *see* **Exophthalmos**

Bulimia nervosa

Definition

Bulimia nervosa is a potentially life-threatening eating disorder that involves repeated **binge eating** followed by purging the body of calories to avoid gaining weight. The person who has bulimia has an irrational fear of gaining weight and a distorted body image. Bulimia nervosa can have potentially fatal health consequences.

Demographics

Bulimia nervosa is primarily a disorder of industrialized countries where food is abundant and the culture values a thin appearance. In Westernized countries, the rate of bulimia has been increasing since the 1950s. Bulimia is the most common eating disorder in the United States. Overall, about 3% of Americans are bulimic. Of these, 85%–90% are female. The rate is highest among adolescents and

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The cuts on the knuckles shown in this photograph are due to the teeth breaking the skin during self-induced vomiting. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

college women, averaging 5%–6%. In men, the disorder is more often diagnosed in homosexuals than in heterosexuals. Some experts believe that the number of diagnosed bulimics represents only the most severe cases and that many more people have bulimic tendencies but are successful in hiding their symptoms. In one study, 40% of college women reported isolated incidents of bingeing and purging.

Bulimia affects people from all racial, ethnic, and socioeconomic groups. The disorder usually begins later in life than **anorexia nervosa**. Most people begin bingeing and purging in their late teens through their twenties. Men tend to start at an older age than women. About 5% of people with bulimia begin the behavior after age 25. Bulimia is uncommon in children under age 14.

Description

Bulimia is an eating disorder whose main feature is eating an unreasonably large amount of food in a short time and then following this binge by purging the body of calories. Purging most often is done by self-induced **vomiting**, but it can also be done by laxative, enema, or diuretic **abuse**. Alternately, some people with bulimia do not purge but use extreme exercising and post-binge **fasting** to burn calories. Nonpurging bulimia is sometimes called exercise bulimia. Bulimia nervosa is officially recognized as a psychiatric disorder in the *Diagnostic and Statistical Manual for Mental Disorders Fourth Edition, Text Revision (DSM-IV-TR)* published by the American Psychiatric Association.

Many people with bulimia will consume 3,000–10,000 calories in an hour. For example, they will start out intending to eat one slice of cake and end up eating the entire cake. One distinguishing aspect of bulimia is how out of control people with bulimia feel when they are eating. They will eat and eat, continuing even when they feel full and become uncomfortable.

Most people with bulimia recognize that their behavior is not normal; they simply cannot control it. They usually feel ashamed and guilty over their binge/purge habits. As a result, they frequently become secretive about their eating and purging. They may, for example, eat at night after the family has gone to bed or buy

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food at the grocery store and eat it in the car before going home. Many bulimics choose high-fat, high-sugar foods that are easy to eat and easy to regurgitate. They become adept at inducing **vomiting**, usually by sticking a finger down their throat and triggering the gag reflex. After a while, they can vomit at will. Repeated purging has serious physical and emotional consequences.

Many individuals with bulimia are of normal weigh, and a fair number of men who become bulimic were overweight as children. This makes it difficult for family and friends to recognize someone suffering from this disorder. People with bulimia often lie about induced vomiting and laxative abuse, although they may complain of symptoms related to their binge/purge cycles and seek medical help for those problems. People with bulimia tend to be more impulsive than people with other **eating disorders**. Lack of impulse control often leads to risky sexual behavior, anger management problems, and alcohol and drug abuse.

A subset of people with bulimia also have anorexia nervosa. Anorexia nervosa is an eating disorder that involves self-imposed **starvation**. These people often purge after eating only a small or a normal-sized portion of food. Some studies have shown that up to 60% of people with bulimia have a history of anorexia nervosa. Some people are primarily anorexic and severely restrict their calorie intake while also purging the small amounts they do eat. Others move back and forth between anorectic and bulimic behaviors.

Dieting usually is the trigger that starts a person down the road to bulimia. The cycle might being with a person going on a rigorous low-calorie diet. Unable to stick with the unrealistic diet, he or she then overeats, feels guilty about overeating, and then exercises or purges to get rid of the unwanted calories. At first this may happen only occasionally, but gradually these sessions of bingeing and purging become routine and start to intrude on the person's friendships, daily activities, and health. Eventually these practices have serious physical and emotional consequences that need to be addressed by healthcare professionals.

Risk factors

Competitive athletes have an increased risk of developing bulimia nervosa, especially in sports where weight is tied to performance and where a low percentage of body fat is highly desirable. Jockeys, wrestlers, bodybuilders, figure skaters, cross-country runners, and gymnasts have higher than average rates of bulimia. People such as actors, models, cheerleaders, and dancers who are judged mainly on their appearance are also at high risk of developing the disorder. This same group of people is also at higher risk for developing anorexia nervosa.

Causes and symptoms

Causes

Bulimia nervosa is a complex disorder that does not have a single cause. Research suggests that some people have a predisposition toward bulimia and that some catalyst then triggers the behavior, which then becomes self-reinforcing. Hereditary, biological, psychological and social factors all appear to play a role.

- Heredity: Twin studies suggest that there is an inherited component to bulimia nervosa but that it is small. Having a close relative, usually a mother or a sister, with bulimia slightly increases the likelihood of other (usually female) family members developing the disorder. However, when compared with other inherited diseases or even to anorexia nervosa, the genetic contribution to developing this disorder appears less important than many other factors. Family history of depression, alcoholism, and obesity also increase the risk of developing bulimia.
- Biological factors: There is some evidence that bulimia is linked low levels of serotonin in the brain. Serotonin is a neurotransmitter. One of its functions is to help regulate the feeling of fullness or satiety that tells a person to stop eating. Neurotransmitters are also involved in other mental disorders that often occur with bulimia such as depression. Other research suggests that people with bulimia may have abnormal levels of leptin, a protein that helps regulate weight by telling the body to take in less food. Research in this area is relatively new, and the findings are still unclear.
- Psychological factors: Certain personality types appear to be more vulnerable to developing bulimia. People with bulimia tend to have poor impulse control. They are often involved in risky behaviors such as shoplifting, drug or alcohol abuse, and risky sexual activities. People with bulimia might have low-self worth and depend on the approval of others to feel good about themselves. They are aware that their behavior is abnormal. After a binge/purge session, they are ashamed and vow never to repeat the cycle, but the next time they are unable to control the impulse to eat and purge. They also tend to have a black-or-white, all-or-nothing way of seeing situations. Major depression, obsessive-compulsive disorder, and anxiety disorders are more common among individuals who are bulimic.

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KEY TERMS

Diuretic—A substance that removes water from the body by increasing urine production.

Electrolyte—Ions in the body that participate in metabolic reactions. The major human electrolytes are sodium (Na+), potassium (K+), calcium (Ca 2+), magnesium (Mg2+), chloride (Cl-), phosphate (HPO4 2-), bicarbonate (HCO3-), and sulfate (SO4 2-).

Neurotransmitter—One of a group of chemicals secreted by a nerve cell (neuron) to carry a chemical message to another nerve cell, often as a way of transmitting a nerve impulse. Examples of neurotransmitters include acetylcholine, dopamine, serotonin, and norepinephrine.

Obsessive-compulsive disorder—A psychiatric disorder in which a person is unable to control the desire to repeat the same action over and over again.

Serotonin—5-Hydroxytryptamine; a substance that occurs throughout the body with numerous effects including neurotransmission. Inadequate amounts of serotonin are implicated in some forms of depression and obsessive-compulsive disorder.

- Social factors: The families of people who develop bulimia are more likely to have members who have problems with alcoholism, depression, and obesity. These families also tend to have a high level of open conflict and disordered, unpredictable lives. Often something stressful or upsetting triggers the urge to diet stringently and then begin binge/purge behaviors. This may be as simple as a family member teasing about the person's weight, nagging about eating junk food, commenting on how clothes fit, or comparing the person unfavorably to someone who is thin. Life events such as moving, starting a new school, and breaking up with a boyfriend can also trigger binge/purge behavior. Overlaying the family situation is the false but unrelenting media message that thin is "good" and fat is "bad."

Signs and symptoms

People with bulimia are very good at hiding their behavior, and weight, heart rate, and blood pressure may all be normal. However, binge/purge cycles have physical consequences. These include:

- teeth damaged from repeated exposure to stomach acid from vomiting; eroded tooth enamel
- swollen salivary glands; sores in mouth and throat
- dehydration
- sores or calluses on knuckles or hands from using them to induce vomiting
- electrolyte imbalances revealed by laboratory tests
- dry skin
- fatigue
- irregular or absent menstrual cycles in women

Diagnosis

Diagnosis is based on several factors including a patient history, **physical examination**, the results of laboratory tests, and a mental status evaluation. A patient history is less helpful in diagnosing bulimia than in diagnosing many diseases because many people with bulimia lie about their bingeing and purging and their use of **laxatives**, **enemas**, and medications. The patient may, however, complain about related symptoms such as **fatigue** or feeling bloated. Many people with bulimia express extreme concern about their weight during the examination.

A physical examination begins with weight and blood pressure and moves through the body looking for the signs listed above. Based on the physical exam and patient history, the physician will order laboratory tests. In general, these tests will include a **complete blood count** (CBC), **urinalysis**, and blood chemistries (to determine electrolyte levels). People suspected of being exercise bulimic may need to have x rays to look for damage to bones from overexercising.

Psychiatric assessment

Several different evaluations can be used to examine a person's mental state. Psychiatric assessment usually includes four components:

- a thorough history of body weight, eating patterns, diets, typical daily food intake, methods of purging (if used), and concept of ideal weight
- a history of the patient's significant relationships with parents, siblings, and peers, including present or past physical, emotional, or sexual abuse
- a history of previous psychiatric treatment (if any) and assessment of comorbid (occurring at the same

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time as the bulimia) mood, anxiety, substance abuse, or personality disorders
- administration of standardized instruments that measure attitudes toward eating, body size, and weight; common tests for eating disorders include the Eating Disorder Examination, the Eating Disorder Inventory, the Eating Attitude Test (EAT), and the Kids' Eating Disorder Survey (KEDS).

Once all information has been compiled, bulimia nervosa is diagnosed when most of the following conditions are present:

- Repeated episodes of binge eating followed by behavior to compensate for the binge (i.e., purging, fasting, over-exercising). Binge eating is defined as eating a significantly larger amount of food in a limited time than most people typically would eat.
- Binge/purge episodes occur at least twice a week for a period of three or more months.
- The individual feels unable to control or stop an eating binge once it starts and will continue to eat even if uncomfortably full.
- The individual is overly concerned about body weight and shape and puts unreasonable emphasis on physical appearance when evaluating his or her self-worth.
- Bingeing and purging does not occur exclusively during periods of anorexia nervosa.

Tests

Treatment

Treatment for bulimia nervosa typically involves several therapy approaches. It is, however, complicated by several factors.

First, patients diagnosed with bulimia nervosa frequently have coexisting psychiatric disorders that typically include major depression (estimated to occur in 40%–70% of people with bulimia), dysthemic disorder, **anxiety disorders**, **substance abuse** disorders, or **personality disorders**. In the case of depression, the mood disorder may either precede or follow the onset of bulimia. With regard to substance abuse, about 30% of patients diagnosed with bulimia nervosa abuse either alcohol or stimulants over the course of the eating disorder. The personality disorders most often diagnosed in bulimics are the Cluster B disorders— borderline, narcissistic, histrionic, and antisocial. **Borderline personality disorder** is a disorder characterized by stormy interpersonal relationships, unstable self-image, and impulsive behavior. People with narcissistic personality disorder believe that they are extremely special and important and are unable to have empathy for others. Individuals with histrionic personality disorder seek attention almost constantly and are very emotional. Antisocial personality disorder is characterized by a behavior pattern of a disregard for others' rights—people with this disorder often deceive and manipulate others.

Although patients may have both bulimia nervosa and anorexia nervosa, a number of clinicians have noted that patients with predominate bulimia tend to develop impulsive and unstable personality disturbances, whereas patients with predominate anorexia tend to be more obsessional and perfectionistic. Estimates of the prevalence of personality disorders among patients with bulimia range between 2% and 50%. The clinician must then decide whether to treat the eating disorder and the comorbid conditions concurrently or sequentially. It is generally agreed, however, that a substance abuse disorder, if present, must be treated before the bulimia can be effectively managed. It is also generally agreed that **mood disorders** and bulimia can be treated concurrently, often using antidepressant medication along with therapy.

Traditional

Treatment choices depend on the degree to which the bulimic behavior has resulted in physical damage and whether the person is a danger to him or herself. Hospital impatient care may be needed to correct severe electrolyte imbalances that result from repeated vomiting and laxative abuse. Electrolyte imbalances can result in heart irregularities and other potentially fatal complications. Most people with bulimia do not require hospitalization. The rate of hospitalization is much lower than that for people with anorexia nervosa because many bulimics maintain a normal weight.

Day treatment or partial hospitalization where the patient goes every day to an extensive treatment program provides structured mealtimes, **nutrition** education, intensive therapy, medical monitoring, and supervision. If day treatment fails, the patient may need to be hospitalized or enter a full-time residential treatment facility.

Outpatient treatment provides medical supervision, nutrition counseling, self-help strategies, and **psychotherapy**. Self-help groups receive mixed reviews from healthcare professionals who work with bulimics. Some groups offer constructive support in stopping the binge/purge cycle, while others tend to reinforce the behavior.

Drugs

Drug therapy helps many people with bulimia. **Selective serotonin reuptake inhibitors** (SSRIs) such as fluoxetine (Prozac) and sertraline (Zoloft) have been

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approved by the United States Food and Drug Administration (FDA) for treatment of bulimia. These medications increase serotonin levels in the brain and are thought to affect the body's sense of fullness. They are used whether or not the patient shows signs of depression. Drug treatment should always be supplemented with psychotherapy.

Other drugs are being explored for use in the treatment of bulimia. Individuals with bulimia interested in entering a clinical trial at no cost can find a list and description of U.S. clinical trials currently enrolling volunteers at http://www.clinicaltrials.gov.

Therapy

Medical intervention helps alleviate the immediate physical problems associated with bulimia. Medication can help the person with bulimia break the binge/purge cycle. However drug therapy alone rarely produces recovery. Psychotherapy plays a major role helping the individual with bulimia recover from the disorder. Several different types of psychotherapy are used depending on the individual's situation. Generally, the goal of psychotherapy is to help the individual change his or her behavior and develop a healthy attitude toward their body and food.

Some types of psychotherapy that have been successful in treating people with bulimia are listed below.

- Cognitive behavior therapy (CBT) is designed to confront and then change the individual's thoughts and feelings about his or her body and behaviors toward food, but it does not address why those thoughts or feelings exist. Strategies to maintain self-control may be explored. This therapy is relatively short-term. CBT is often the therapy of choice for people with bulimia, and it is often successful at least in the short term.
- Interpersonal therapy is short-term therapy that helps the individual identify specific issues and problems in relationships. The individual may be asked to look back at his or her family history to try to recognize problem areas and work toward resolving them. Interpersonal therapy has about the same rate of success in people with bulimia as CBT.
- Family and/or couples therapy is helpful in dealing with conflict or disorder that may be a factor in triggering binge/purge behavior at home.
- Supportive-expressive therapy or group therapy may be helpful in addition to other types of therapy.

Nutrition and diet counseling

A nutrition consultant or dietitian is part of the team needed to successfully treat bulimia. These professionals usually do a dietary review along with nutritional counseling so that the recovering bulimic can plan healthy meals and develop a healthy relationship with food.

The following dietary changes may be helpful for bulimic individuals:

- Eating small but nutritious meals at regularly scheduled hours.
- Avoiding sweet, baked goods or any other foods that may cause craving.
- Avoiding allergenic foods.
- Limiting intake of alcohol, caffeine, monosodium glutamate (MSG), and salty foods.

Alternative and complementary therapies

SUPPLEMENTS. The following supplements may help improve bulimic symptoms and prevent deficiency of essential **vitamins** and minerals:

- Multivitamin and mineral supplement to prevent deficiency of essential nutrients.
- Vitamin B complex with C.
- Zinc supplement. Bulimic patients may have zinc deficiency, and zinc is an important mineral needed by the body for normal hormonal activity and enzymatic function.

HOMEOPATHY. A homeopathic physician may prescribe patient-specific remedies for the treatment of bulimia.

LIGHT THERAPY. **Light therapy**. Exposure to artificial light, available through full spectrum light bulbs or specially designed "light boxes," may be useful in reducing bulimic episodes, especially during the dark winter months.

HYPNOTHERAPY. **Hypnotherapy** may help resolve unconscious issues that contribute to bulimic behavior.

EXERCISE. **Yoga**, **qigong**, t'ai chi, or dance not only make patients physically healthier but can also make them feel better about themselves.

Other treatments.

Other potentially beneficial treatments for bulimia include Chinese herbal therapy, **hydrotherapy** and **biofeedback** training.

Prognosis

The long-term outlook for recovery from bulimia is mixed. About half of all bulimics show improvement in controlling their behavior after short-term interpersonal or **cognitive-behavioral therapy** with nutritional

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counseling and drug therapy. However, after three years, only about one-third are still doing well. Relapses are common, and binge/purge episodes and bulimic behavior often comes and goes for many years. **Stress** seems to be a major trigger for relapse.

The sooner treatment is sought, the better the chances of recovery. Without professional intervention, recovery is unlikely. Untreated bulimia can lead to **death** directly from causes such as rupture of the stomach or esophagus. Associated problems such as substance abuse, depression, **anxiety** disorders, and poor impulse control also contribute to the death rate.

Prevention

Some ways to prevent bulimia nervosa from developing are as follows:

- If you are a parent, do not obsess about your own weight, appearance, and diet in front of your children.
- Do not tease your children about their body shapes or compare them to others.
- Make it clear that you love and accept your children as they are.
- Try to eat meals together as a family whenever possible.
- Remind children that the models they see on television and in fashion magazines have extreme, not normal or healthy, bodies.
- Do not put your child on a diet unless advised to by your pediatrician.
- Block your child from visiting pro-bulimia Web sites. These are sites where people with bulimia give advice on how to purge and support each other's binge/purge behavior.
- If your child is a competitive athlete, get to know the coach and the coach's attitude toward weight.
- Be alert to signs of low self-worth, anxiety, depression, and drug or alcohol abuse and seek help as soon as these signs appear.
- If you think your child has an eating disorder, do not wait to intervene and the professional help. The sooner the disorder is treated, the easier it is to cure.

Relapses happen to many people with bulimia. People who are recovering from bulimia can help prevent themselves from relapsing by:

- never dieting—instead plan healthy meals
- eating with other people, not alone
- staying in treatment and keeping therapy appointments
- monitoring negative self-talk and practicing positive self-talk
- spending time doing something enjoyable every day
- getting at least seven hours of sleep each night
- spending time with friends or family

Resources

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ORGANIZATIONS

American Psychological Association, 750 First Street, NE, Washington, DC, 20002-4242, (202) 336-5500; TDD/TTY: (202) 336-6123, (800) 374-2721, apa@psych.org, http://www.apa.org.

National Association of Anorexia Nervosa and Related Eating Disorders (ANAD), P.O. Box 7, Highland Park, IL, 60035, (847) 831-3438, (847) 433-3996, http://www.anad.org.

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National Eating Disorders Association, 603 Stewart Street, Suite 803, Seattle, WA, 98101, (206) 382-3587, Help and Referral Line: (800) 931-2237, (206) 829-8501, info@NationalEatingDisorder.org, http://www.nationaleatingdisorders.org.

Tish Davidson, A.M.

Bulla *see* **Skin lesions**

Bumetanide *see* **Diuretics**

BUN *see* **Blood urea nitrogen test**

Bundle branch block

Definition

Bundle branch block (BBB) is a disruption in the normal flow of electrical pulses that drive the heart beat.

Description

Bundle branch block belongs to a group of heart problems called intraventricular conduction defects (IVCD). There are two bundle branches, right and left. The right bundle carries nerve impulses that cause contraction of the right ventricle (the lower chamber of the heart) and the left bundle carries nerve impulses that cause contraction of the left ventricle. The two bundles initially are together at a junction called the bundle of His. Nerve impulses come through the sinus node of the heart to the bundle of His and then move into the right and left bundle branches. Bundle branch block is a slowing or interruption of nerve impulses. A problem may exist in any of the three bundles.

Patients with BBB are generally without symptoms unless the disease is severe enough to cause a complete infranodal A-V block and very slow heart rate. In patients with right bundle branch block (RBBB), the nerve impulse is conducted slowly or not at all. The right ventricle finally receives the impulse through muscle-to-muscle spread, outside the regular nerve pathway. This mechanism of impulse transmission is slow and results in a delayed contraction of the right ventricle. There are several types of left bundle branch block (LBBB), each producing its own characteristic mechanism of failure. In each case, the nerve impulse is blocked or delayed. Patients with LBBB may have left ventricular disease or **cardiomyopathy**.

KEY TERMS

Electrocardiogram—The pattern of the heart's electrical impulses that indicate the order and condition of the heart's components.

QRS—A pattern seen in an electrocardiogram that indicates the pulses in a heartbeat and their duration. Variations from a normal QRS pattern indicate heart disease.

Causes and symptoms

Left bundle branch block usually happens as a consequence of other diseases such as arteriosclerosis, **rheumatic fever**, **congenital heart disease**, **myocarditis**, myocardial infarction, metastatic heart tumors, or other invasions of the heart tissue. Right bundle branch block happens less often from underlying heart disease.

Diagnosis

Detection of BBB usually takes place during a normal **physical examination**. The block shows up as a widening of the second heart sound. Confirmation of BBB is obtained by electrocardiogram (ECG). The pattern seen in the electrocardiogram indicates pulses in a heartbeat and their duration. A QRS duration of greater than 110 milliseconds is a diagnostic indication of BBB. There is a unique ECG pattern for blocks in each of the three bundles.

Treatment

There is no specific therapy for BBB. Patients are usually treated for associated heart diseases.

Prognosis

The prognosis of blockage in any of the three bundle branches depends on the prognosis of the associated heart disease. The associated diseases determine the outcome of the patient's health. Occasionally, disruptions in bundle branches lead to complete infranodal A-V block, a more serious blockage of nerve impulses. Approximately 2% of patients with BBB develop infranodal A-V blockage and these patients often require artificial **pacemakers**.

Resources

BOOKS

Fuster, Valentin, et al. *Hurst's the Heart*. 12th ed. New York: McGraw-Hill Professional, 2007.

John T. Lohr, PhD

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Bunion

Definition

A bunion is an abnormal enlargement of the joint (the first metatarsophalangeal joint, or MTPJ) at the base of the great or big toe (hallux). It is caused by inflammation and usually results from chronic irritation and pressure from poorly fitting footwear.

Description

A displacement of two major bones of the foot (hallux valgus) causes bunions, although not everyone with this displacement will develop the joint swelling and bone overgrowth that characterize a bunion. One of the bones involved is called the first metatarsal bone. This bone is long and slender, with the big toe attached on one end and the other end connected to foot bones closer to the ankle. This foot bone is displaced in the direction of the four other metatarsals connected with the toes. The other bone involved is the big toe itself, which is displaced toward the smaller toes. As the big toe continues to move toward the smaller toes, it may become displaced under or over the second toe. The displacement of these two foot bones causes a projection of bone on the inside portion of the forefoot. The skin over this projection often becomes inflamed from rubbing against the shoe, and a callus may form.

The joint contains a small sac (bursa) filled with fluid that cushions the bones and helps the joint to move smoothly. When a bunion forms, this sac becomes inflamed and thickened. The swelling in the joint causes additional **pain** and pressure in the toe.

Woman's right foot with bunion on big toe. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

KEY TERMS

Orthopedics—A medical specialty concerned with treating diseases, injuries, and malformations of the bones and supporting structures, such as tendons, ligaments, and muscles.

Orthotic—A device or brace to control, correct, or compensate for a bone deformity.

Podiatry—A medical specialty concerned with treating diseases, injuries, and malformations of the feet.

Causes and symptoms

Bunions may form as a result of abnormal motion of the foot during walking or running. One common example of an abnormal movement is an excessive amount of **stress** placed upon the inside of the foot. This leads to friction and irritation of the involved structures. Age has also been noted as a factor in developing bunions, in part because the underlying bone displacement worsens over time unless corrective measures are taken.

Wearing improperly fitting shoes, especially those with a narrow toe box and excessive heel height, often causes the formation of a bunion. This forefoot deformity is seen more often in women than men. The higher frequency in females may be related to the strong link between footwear fashion and bunions. In fact, in a recent survey of more than 350 women, nearly 90% wore shoes that were at least one size too small or too narrow.

Because genetic factors can predispose people to the hallux valgus bone displacement, a strong family history of bunions can increase the likelihood of developing this foot disorder. Various arthritic conditions and several genetic and neuromuscular diseases, such as **Down syndrome** and **Marfan syndrome**, cause muscle imbalances that can create bunions from displacement of the first metatarsal and big toe. Other possible causes of bunions are leg-length discrepancies, with the bunion present on the longer leg, and trauma occurring to the joint of the big toe.

Symptoms of bunions include the common signs of inflammation such as redness, swelling, and pain. The discomfort is primarily located along the inside of the foot just behind the big toe. Because of friction, a callus may develop over the bunion. If an overlapping of the toes is allowed, additional rubbing and pain occurs. Inflammation of this area causes a decrease in motion with associated discomfort in the joint between the big toe and the first metatarsal. If allowed to worsen, the

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skin over the bunion may break down and cause an ulcer, which also presents a problem of potential infection. (Foot ulcers can be particularly dangerous for people with diabetes, who may have trouble feeling the ulcer forming and healing if it becomes infected.)

Diagnosis

A thorough medical history and physical exam by a physician is always necessary for the proper diagnosis of bunions and other foot conditions. X rays can help confirm the diagnosis by showing the bone displacement, joint swelling, and, in some cases, the overgrowth of bone that characterizes bunions. Doctors will also consider the possibility that the joint pain is caused by or complicated by arthritis (which causes destruction of the cartilage of the joint), **gout** (which causes the accumulation of uric acid crystals in the joint), tiny **fractures** of a bone in the foot (stress fractures), or infection and may order additional tests to rule out these possibilities.

Treatment

Conservative

The first step in treating a bunion is to remove as much pressure from the area as possible. People with bunions should wear shoes that have enough room in the toe box to accommodate the bunion and avoid high-heeled shoes and tight-fitting socks or stockings. **Dressings** and pads help protect the bunion from additional shoe pressure. The application of splints or customized shoe inserts (orthotics) to correct the alignment of the big toe joint is effective for many bunions. Most patients are instructed to rest or choose exercises that put less stress on their feet, at least until the misalignment is corrected. In some cases, physicians also use steroid injections with local anesthetic around the bunion to reduce inflammation.

Surgery

If conservative treatment is not successful, surgical removal of the bunion may be necessary to correct the deformity. This procedure is called a bunionectomy, and there are many variations on the operation, which is usually performed by a surgeon who specializes in treating bone conditions (orthopedics) or by one who specializes in treating the foot (podiatry). Surgeons consider the angle of the bone misalignment, the condition of the bursa, and the strength of the bones when they choose which procedure to use. Most bunionectomies involve the removal of a section of bone and the insertion of pins to rejoin the bone. Sometimes the surgeons may move ligaments (which connect bone to bone in the joint) or tendons (which connect bone to muscle) in order to realign the bones. After this procedure, the bones and other tissues are held in place while they heal by compression dressings or a short cast. The individual must refrain from vigorous **exercise** for six weeks.

Alternative treatment

Deep friction massage techniques by a physical or massage therapist can be helpful to increase circulation, reduce inflammation, and prevent soft tissue buildup. **Physical therapy** also provides useful approaches such as ultrasound to help retard or reverse the formation of the bunion. Various taping techniques can be useful to realign the toe and decrease friction and rubbing that may be present. The homeopathic tissue salt *Calcarea phosphorica* can be useful in balancing the bone formation/remodeling.

Prognosis

Often modifications in footwear allow a good prognosis without surgery. If surgery is necessary, complete healing without complications requires approximately four to six weeks. Even after surgery corrects the bone misalignment, patients are usually instructed to continue wearing low-heeled, roomy shoes to prevent the bunion from reforming.

Prevention

Prevention begins with proper foot wear. Shoes with a wide and deep toe box are best. High-heeled shoes should not be worn for long periods of time. If a bunion is present and becomes inflamed, the foot should be elevated with the application of an ice pack over the painful area for not more than 20 minutes every other hour. If pain and swelling continue, a podiatrist or physician should be contacted.

Resources

OTHER

Griffith, H. Winter. "Complete Guide to Symptoms, Illness & Surgery." ThriveOnline. http://thriveonline.oxygen.com.

ORGANIZATIONS

American Orthopaedic Foot and Ankle Society, 6300 N. River Road, Suite 510, Rosemont, IL, 60018, (847) 698-4654, (800) 235-4855.

American Podiatric Medical Association, 9312 Old Georgetown Road, Bethesda, MD, 20814-1621, (301) 581-9200, http://www.apma.org.

Jeffrey P. Larson, RPT

Burkitt's lymphoma *see* **Malignant lymphomas**

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Burns

Definition

Burns are injuries to tissues caused by heat, friction, electricity, radiation, or chemicals.

Description

Burns are characterized by degree, based on the severity of the tissue damage. A first-degree burn causes redness and swelling in the outermost layers of skin (epidermis). A second-degree burn involves redness, swelling, and blistering, and the damage may extend beneath the epidermis to deeper layers of skin (dermis). A third-degree burn, also called a full-thickness burn, destroys the entire depth of skin, causing significant scarring. Damage also may extend to the underlying fat, muscle, or bone.

The severity of the burn is also judged by the amount of body surface area (BSA) involved. Health care workers use the "rule of nines" to determine the percentage of BSA affected in patients more than nine years old: each arm with its hand is 9% of BSA; each leg with its foot is 18%; the front of the torso is 18%; the back of the torso, including the buttocks, is 18%; the head and neck are 9%; and the genital area (perineum) is 1%. This rule cannot be applied to a young child's body proportions, so BSA is estimated using the palm of the patient's hand as a measure of 1% area.

The severity of the burn will determine not only the type of treatment, but also where the burn patient should receive treatment. Minor burns may be treated at home or in a doctor's office. These are defined as first- or second-degree burns covering less than 15% of an adult's body or less than 10% of a child's body, or a third-degree burn on less than 2% BSA. Moderate burns should be treated at a hospital. These are defined as first- or second-degree burns covering 15%–25% of an adult's body or 10%–20% of a child's body, or a third-degree burn on 2%–10% BSA. Critical, or major, burns are the most serious and should be treated in a specialized burn unit of a hospital. These are defined as first- or second-degree burns covering more than 25% of an adult's body or more than 20% of a child's body, or a third-degree burn on more than 10% BSA. In addition, burns involving the hands, feet, face, eyes, ears, or genitals are considered critical. Other factors influence the level of treatment needed, including associated injuries such as bone **fractures** and **smoke inhalation**, presence of a chronic disease, or a history of being abused. Also, children and the elderly are more vulnerable to complications from burn injuries and require more intensive care.

Classification of burns

First-degree burn	The burned area is painful. The outer skin is reddened. Slight swelling is present.
Second-degree burn	The burned area is painful. Deeper layers of skin (the dermis) are affected. Blisters may form. The area may have a wet, shiny appearance because of exposed tissue.
Third-degree burn	The burned area is insensitive due to the destruction of nerve endings. Skin is destroyed. Muscle tissue and bone underneath may be damaged. The area may be charred, white, or grayish in color.

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Causes and symptoms

Burns may be caused by even a brief encounter with heat greater than 120°F (49°C). The source of this heat may be the sun (causing a **sunburn**), hot liquids, steam, fire, electricity, friction (causing rug burns and rope burns), and chemicals (causing a caustic burn upon contact).

Signs of a burn are localized redness, swelling, and **pain**. A severe burn will also blister. The skin may also peel, appear white or charred, and feel numb. A burn may trigger a **headache** and **fever**. Extensive burns may induce **shock**, the symptoms of which are faintness, weakness, rapid pulse and breathing, pale and clammy skin, and bluish lips and fingernails.

Diagnosis

A physician will diagnose a burn based upon visual examination, and will also ask the patient or family members questions to determine the best treatment. He or she may also check for smoke inhalation, **carbon monoxide poisoning**, cyanide poisoning, other event-related trauma, or, if suspected, further evidence of **child abuse**.

Treatment

Burn treatment consists of relieving pain, preventing infection, and maintaining body fluids, electrolytes, and calorie intake while the body heals. Treatment of chemical or electrical burns is slightly different from the treatment of thermal burns but the objectives are the same.

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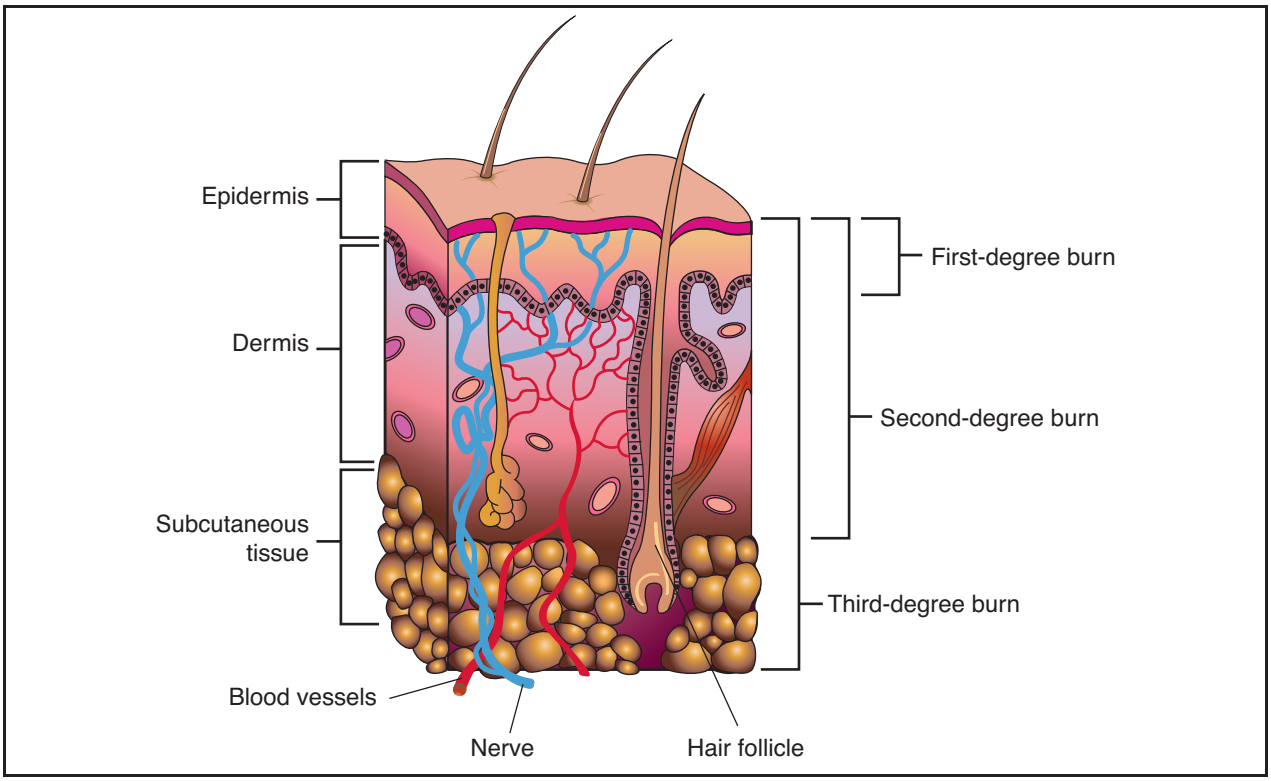

There are three classifications of burns: first-degree, second-degree, and third-degree. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Thermal burn treatment

The first act of thermal burn treatment is to stop the burning process. This may be accomplished by letting cool water run over the burned area or by soaking it in cool (not cold) water. Ice should never be applied to the burn. Cool (not cold) wet compresses may provide some pain relief when applied to small areas of first- and second-degree burns. Butter, shortening, or similar salve should never be applied to the burn since it prevents heat from escaping and drives the burning process deeper into the skin.

If the burn is minor, it may be cleaned gently with soap and water. Blisters should not be broken. If the skin of the burned area is unbroken and it is not likely to be further irritated by pressure or friction, the burn should be left exposed to the air to promote healing. If the skin is broken or apt to be disturbed, the burned area should be coated lightly with an antibacterial ointment and covered with a sterile bandage. **Aspirin**, **acetaminophen** (Tylenol), or ibuprofen (Advil) may be taken to ease pain and relieve inflammation. A doctor should be consulted if these signs of infection appear: increased warmth, redness, pain, or swelling; pus or similar drainage from the wound; swollen lymph nodes; or red streaks spreading away from the burn.

In situations where a person has received moderate or critical burns, lifesaving measures take precedence over burn treatment and emergency medical assistance must be called. A person with serious burns may stop breathing, and artificial respiration (also called mouth-to-mouth resuscitation or rescue breathing) should be administered immediately. Also, a person with burns covering more than 12% BSA is likely to go into shock; this condition may be prevented by laying the person flat and elevating the feet about 12 in (30 cm). Burned arms and hands should also be raised higher than the person's heart.

In rescues, a blanket may be used to smother any flames as the person is removed from danger. The person whose clothing is on fire should "stop, drop, and roll" or be assisted in lying flat on the ground and rolling to put out the fire. Afterwards, only burnt clothing that comes off easily should be removed; any clothing embedded in the burn should not be disturbed. Removing any smoldering apparel and covering the person with a light, cool, wet cloth, such as a

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KEY TERMS

Debridement—The surgical removal of dead tissue.

Dermis—The basal layer of skin; it contains blood and lymphatic vessels, nerves, glands, and hair follicles.

Epidermis—The outer portion of skin, made up of four or five superficial layers.

Shock—An abnormal condition resulting from low blood volume due to hemorrhage or dehydration. Signs of shock include rapid pulse and breathing, and cool, moist, pale skin.

sheet but not a blanket or towel, will stop the burning process.

At the hospital, the staff will provide further medical treatment. A tube to aid breathing may be inserted if the patient's airways or lungs have been damaged, as can happen during an explosion or a fire in a enclosed space. Also, because burns dramatically deplete the body of fluids, replacement fluids are administered intravenously. The patient is also given **antibiotics** intravenously to prevent infection, and he or she may also receive a **tetanus** shot, depending on his or her immunization history. Once the burned area is cleaned and treated with antibiotic cream or ointment, it is covered in sterile **bandages**, which are changed two to three times a day. Surgical removal of dead tissue (**debridement**) also takes place. As the burns heal, thick, taut scabs (eschar) form, which the doctor may have to cut to improve blood flow to the more elastic healthy tissue beneath. The patient will also undergo physical and **occupational therapy** to keep the burned areas from becoming inflexible and to minimize scarring.

In cases where the skin has been so damaged that it cannot properly heal, a skin graft is usually performed. A skin graft involves taking a piece of skin from an unburned portion of the patient's body (autograft) and transplanting it to the burned area. When doctors cannot immediately use the patient's own skin, a temporary graft is performed using the skin of a human donor (allograft), either alive or dead, or the skin of an animal (xenograft), usually that of a pig.

The burn victim also may be placed in a **hyperbaric chamber**, if one is available. In a hyperbaric chamber (which can be a specialized room or enclosed space), the patient is exposed to pure oxygen under high pressure, which can aid in healing. However, for this therapy to be effective, the patient must be placed in a chamber within 24 hours of being burned.

Chemical burn treatment

Burns from liquid chemicals must be rinsed with cool water for at least 15 minutes to stop the burning process. Any burn to the eye must be similarly flushed with water. In cases of burns from dry chemicals such as lime, the powder should be completely brushed away before the area is washed. Any clothing that may have absorbed the chemical should be removed. The burn should then be loosely covered with a sterile gauze pad and the person taken to the hospital for further treatment. A physician may be able to neutralize the offending chemical with another before treating the burn like a thermal burn of similar severity.

Electrical burn treatment

Before electrical burns are treated at the site of the accident, the power source must be disconnected if possible and the victim moved away from it to keep the person giving aid from being electrocuted. Lifesaving measures again take priority over burn treatment, so breathing must be checked and assisted if necessary. Electrical burns should be loosely covered with sterile gauze pads and the person taken to the hospital for further treatment.

Alternative treatment

In addition to the excellent treatment of burns provided by traditional medicine, some alternative approaches may be helpful as well, though major burns should always be treated by a medical practitioner. The homeopathic remedies *Cantharis* and *Causticum* can assist in burn healing. A number of botanical remedies, applied topically, can also help burns heal. These include aloe (*Aloe barbadensis*), oil of **St. John's wort** (*Hypericum perforatum*), calendula (*Calendula officinalis*), comfrey (*Symphytum officinale*), and tea tree oil (*Melaleuca* spp.). Supplementing the diet with vitamin C, vitamin E, and zinc also is beneficial for wound healing.

Prognosis

The prognosis is dependent upon the degree of the burn, the amount of body surface covered, whether critical body parts were affected, any additional injuries or complications like infection, and the promptness of medical treatment. Minor burns may heal in 5 to 10 days with no scarring. Moderate burns may heal in 10–14 days and may leave scarring. Critical or major burns take more than 14 days to heal and will leave significant

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scarring. Scar tissue may limit mobility and functionality, but **physical therapy** may overcome these limitations. In some cases, additional surgery may be advisable to remove scar tissue and restore appearance.

Prevention

Burns are commonly received in residential fires. Properly placed and working smoke detectors in combination with rapid evacuation plans will minimize a person's exposure to smoke and flames in the event of a fire. Children must be taught never to play with matches, lighters, fireworks, gasoline, and cleaning fluids.

Burns by scalding with hot water or other liquids may be prevented by setting the water heater thermostat no higher than 120°F (49°C), checking the temperature of bath water before getting into the tub, and turning pot handles on the stove out of the reach of children. Care should be used when removing covers from pans of steaming foods and when uncovering or opening foods heated in a microwave oven.

Thermal burns are often received from electrical appliances. Care should be exercised around stoves, space heaters, irons, and curling irons.

Sunburns may be avoided by the liberal use of a sunscreen containing either an opaque active ingredient such as zinc oxide or titanium dioxide or a nonopaque active ingredient such as PABA (para-aminobenzoic acid) or benzophenone. Hats, loose clothing, and umbrellas also provide protection, especially between 10 a.m. and 3 p.m. when the most damaging ultraviolet rays are present in direct sunlight.

Electrical burns may be prevented by covering unused electrical outlets with safety plugs and keeping electrical cords away from infants and toddlers who might chew on them. Persons should also seek shelter indoors during a thunderstorm to avoid being struck by lightning.

Chemical burns may be prevented by wearing protective clothing, including gloves and eyeshields. Chemical agents should always be used according to the manufacturer's instructions and properly stored when not in use.

Resources

OTHER

"Burns." MedlinePlus. http://www.nlm.nih.gov/medlineplus/burns.html (accessed November 24, 2010).

"Burns: First aid." MayoClinic.com. http://www.mayoclinic.com/health/first-aid-burns/FA00022 (accessed November 24, 2010).

ORGANIZATIONS

Shriners Hospitals for Children, 2900 Rocky Point Drive, Tampa, FL, 33607, (813) 281-0300, http://www.shrinershq.org/Hospitals/Main.

Bethany Thivierge

Bursitis

Definition

Bursitis is the painful inflammation of the bursa, a padlike sac found in areas subject to friction. Bursae cushion the movement between the bones, tendons and muscles near the joints. Bursitis is most often caused by repetitive movement and is known by several common names including weaver's bottom, clergyman's knee, and miner's elbow, depending on the affected individual's occupation and area of injury.

Description

There are over 150 bursae in the human body. Usually bursae are present from birth, but they may form in response to repeated pressure. Each sac contains a small amount of *synovial fluid,* a clear liquid that acts as a lubricant. Inflammation causes **pain** on movement. The most common site for bursitis to occur is the shoulder (subdeltoid), but it also is seen in the elbows (olecranon), hips (trochanteric), knees, heels (Achilles), and toes. The affected area may be referred to as "frozen," because movement is so limited. In the knee there are four bursae, and all can become inflamed with overuse.

Causes and symptoms

The most common cause of bursitis is repeated physical activity, but it can flare up for no known reason. It can also be caused by trauma, **rheumatoid arthritis**, **gout**, and acute or chronic infection.

Pain and tenderness are common symptoms. If the affected joint is close to the skin, as with the shoulder, knee, elbow, or Achilles tendon, swelling and redness are seen and the area may feel warm to the touch. The bursae around the hip joint are deeper, and swelling is not obvious. Movement may be limited and is painful. In the shoulder, it may be difficult to raise the arm out from the side of the body. Putting on a jacket or combing the hair becomes a troublesome activity.

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KEY TERMS

Arthritis—Inflammation of a joint that may lead to changes in the joint's structure. It causes pain and swelling. Rheumatoid arthritis is a chronic disease that leads to crippling deformities.

Diabetes mellitus—A metabolic disease caused by a deficiency of insulin, which is essential to process carbohydrates in the body.

Gout—A hereditary metabolic disease that is a form of arthritis and causes inflammation of the joints. It is more common in men.

Inflammation—The reaction of tissue to injury.

Kinesiology—The science or study of movement.

In acute bursitis symptoms appear suddenly; with chronic bursitis, pain, tenderness, and limited movement reappear after **exercise** or strain.

Diagnosis

When a patient has pain in a joint, a careful **physical examination** is needed to determine what type of movement is affected and if there is any swelling present. Bursitis will not show up on x rays, although sometimes there are also **calcium** deposits in the joint that can be seen. Inserting a thin needle into the affected bursa and removing (aspirating) some of the synovial fluid for examination can confirm the diagnosis. In most cases, the fluid will not be clear. It can be tested for the presence of microorganisms, which would indicate an infection, and crystals, which could indicate gout. In instances where the diagnosis is difficult, a local anesthetic (a drug that numbs the area) is injected into the painful spot. If the discomfort stops temporarily, then bursitis is probably the correct diagnosis.

Treatment

Conservative treatment of bursitis is usually effective. The application of heat, rest, and **immobilization** of the affected joint area is the first step. A sling can be used for a shoulder injury; a cane is helpful for hip problems. The patient can take **nonsteroidal anti-inflammatory drugs** (NSAIDs) like **aspirin**, ibuprofin, and naproxen. They can be obtained without a prescription and relieve the pain and inflammation. Once the pain decreases, exercises of the affected area can begin. If the nearby muscles have become weak because of the disease or prolonged immobility, then exercises to build strength and improve movement are best. A doctor or physical therapist can prescribe an effective regimen.

If the bursitis is related to an inflammatory condition like arthritis or gout, then management of that disease is needed to control the bursitis.

When bursitis does not respond to conservative treatment, an injection into the joint of a long-acting corticosteroid preparation, like prednisone, can bring immediate and lasting relief. A corticosteroid is a hormonal substance that is the most effective drug for reducing inflammation. The drug is mixed with a local anesthetic and works on the joint within five minutes. Usually one injection is all that is needed.

Surgery to remove the damaged bursa may be performed in extreme cases.

If the bursitis is caused by an infection, then additional treatment is needed. *Septic* bursitis is caused by the presence of a pus-forming organism, usually *staphylococcus aureus*. This is confirmed by examining a sample of the fluid in the bursa and requires treatment with **antibiotics** taken by mouth, injected into a muscle or into a vein (intravenously). The bursa will also need to be drained by needle two or three times over the first week of treatment. When a patient has such a serious infection, there may be underlying causes. There could be undiscovered diabetes, or an inefficient immune system caused by human **immunodeficiency** virus infection (HIV).

Alternative treatment

Alternative treatments take into consideration the role of diet in causing bursitis. The faulty use of calcium by the body, magnesium deficiency, and **food allergies** may have a role. Diet changes and vitamin supplements may be helpful. The use of herbs, homeopathy, **aromatherapy**, and **hydrotherapy** can help relieve symptoms. Ginger is useful in reducing inflammation. **Acupuncture** has been proven effective in treating hip and shoulder pain caused by bursitis and other conditions. Other therapies that deal effectively with musculoskeletal problems (relating to the muscles and skeleton), may also be helpful, such as body work, **magnetic field therapy**, **naturopathic medicine**, **chiropractic**, and **applied kinesiology**.

Prognosis

Bursitis usually responds well to treatment, but it may develop into a chronic condition if the underlying cause is not corrected.

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Prevention

Aggravating factors should be eliminated to prevent bursitis. Overexercising or the repetition of a movement that triggers the condition should be avoided. Doing exercises to strengthen the muscles around the joint will also help. When doing repetitive tasks, frequent breaks should be taken and the activity should be alternated with others using different parts of the body. To cushion the joints, it is a good idea to use cushioned chairs when sitting and foam kneeling pads for the knees. Leaning on the elbows, kneeling, or sitting on a hard surface for a long period of time should be avoided. Not wearing high heels can help prevent bursitis in the heel, as can changing to new running shoes as soon as the old ones are worn out.

Resources

OTHER

"Bursitis." MedlinePlus. http://www.nlm.nih.gov/medlineplus/bursitis.html (accessed November 24, 2010).

Karen Ericson, RN

Bypass surgery *see* **Coronary artery bypass graft surgery**

Byssinosis

Definition

Byssinosis is a chronic, asthma-like narrowing of the airways. Also called brown lung disease, byssinosis results from inhaling particles of cotton, flax, hemp, or jute.

Description

Although inhaling cotton dust was identified as a source of respiratory disease more than 300 years ago, byssinosis has been recognized as an occupational hazard for textile workers for less than 50 years. More than 800,000 workers in the cotton, flax, and rope-making industries are exposed in the workplace to airborne particles that can cause byssinosis. Only workers in mills that manufacture yarn, thread, or fabric have a significant risk of dying of this disease.

In the United States, byssinosis is almost completely limited to workers who handle unprocessed cotton. More than 35,000 textile workers have been disabled by byssinosis and 183 died between 1979 and 1992. Most of the people whose deaths were due to byssinosis lived in the textile-producing regions of North and South Carolina.

KEY TERMS

Wheeze—A whistling sound made by the flow of high-velocity air through narrowed airways. Wheezing is a symptom of several respiratory diseases including byssinosis and asthma.

Causes and symptoms

As many as 25% of workers with byssinosis have symptoms that continue or recur throughout the workweek. More severe breathing problems seem to result both from exposure to high levels of dust and from longer dust exposure. Workers who also smoke cigarettes suffer the most severe impairment.

Diagnosis

Tests that detect decreasing lung capacity during the workday are used to diagnose byssinosis. Obstructive patterns are likely in patients who have had recurrent symptoms for more than 10 years.

Treatment

Therapy for early-stage byssinosis focuses on reversing airway narrowing. **Antihistamines** may be prescribed to reduce tightness in the chest. **Bronchodilators** (drugs used to relax breathing passages and improve air flow) may be used with an inhaler or taken in tablet form. Reducing exposure is essential. Any worker who has symptoms of byssinosis or who has trouble breathing should transfer to a less-contaminated area.

Prognosis

Smoking, impaired lung function, and a history of respiratory allergy increase a textile worker's risk of developing byssinosis. Prolonged exposure makes patients wheeze more often and can cause chronic **bronchitis**. It does not lead to permanently disabling lung disease.

Prevention

Eliminating exposure to textile dust is the surest way to prevent byssinosis. Using exhaust hoods, improving ventilation, and employing wetting procedures are very successful methods of controlling dust levels to prevent byssinosis. Protective equipment required during certain

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procedures also prevents exposure to levels of contamination that exceed the current United States standard for cotton dust exposure.

ORGANIZATIONS

American Lung Association, 1301 Pennsylvania Ave. NW, Suite 800, Washington, DC, 20001, (202) 758-3355, (202) 452-1805, (800) 548-8252, info@lungusa.org, http://www.lungusa.org/.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

Maureen Haggerty

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C

C-reactive protein

Definition

C-reactive protein (CRP) is a protein produced by the liver and not normally found in the blood, except for people who smoke, are obese, or have an inflammatory condition somewhere in the body. CRP is measured in samples of blood and reported as ultra-sensitive CRP, US-CRP, or high sensitive CRP, HS-CRP.

Purpose

C-reactive protein appears in response to inflammation, infection, and illnesses such as heart disease, **cancer**, high blood pressure, and connective tissue diseases like **rheumatoid arthritis** and lupus erythematosis.

Individuals vary in the amount of CRP their livers produce. Some people with serious diseases, like rheumatoid arthritis and lupus, may not have elevated blood levels of CRP.

CRP is a sensitive but nonspecific test that signifies inflammation somewhere in the body; it does not help determine where or how serious it is. CRP levels begin rising within a few hours following an injury, surgery, or **heart attack**. Very high CRP levels are found after surgery, acute heart attack, or serious injury. There is a current theory that there is an inflammatory component factor in developing atherosclerotic plaques in the coronary and other major arteries, leading to hardening of the arteries. But, for people at low risk of heart disease, without cardiac symptoms, CRP levels are not useful as screening tests for heart-disease risk.

By taking multiple tests over time, the level of activity of some chronic conditions, like arthritis and other connective tissue diseases, can be followed.

CRP levels are useful in predicting the risk of complications in people with heart or **vascular disease** who have had a **stroke**, heart attack, or coronary treatment procedure like **angioplasty**. But therapy decisions are made on the basis of all clinical findings, not only on CRP levels.

Normal results

Normal CRP test results are zero to one milligram (mg) per liter of blood.

Resources

OTHER

Cleveland Clinic Heart and Vascular Institute. http://my.clevelandclinic.org/health/default.aspx.
MedlinePlus. http://www.nlm.nih.gov/nlmhome.html.

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C-section *see* **Cesarean section**
CABG surgery *see* **Coronary artery bypass graft surgery**
CAD *see* **Coronary artery disease**

Caffeine

Definition

Caffeine is a bitter plant alkaloid that acts as a mild central nervous system stimulant and as a diuretic. It is found especially in coffee beans, tea leaves, cacao beans, and kola nuts. Caffeine also is available in capsules and tablets and is added to soft drinks and energy bars and drinks. It is the most widely used psychoactive substance in the world.

Purpose

Caffeine is used to increase mental alertness and temporarily relieve **fatigue**. Throughout the world many people start their days with caffeine. It has been shown to improve short-term memory, enhance

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KEY TERMS

Atherosclerosis—Disease of arteries where cholesterol deposits (plaques) form on the inner surfaces of the arteries, possibly obstructing blood flow.

concentration, speed-up reaction time, and increase one's capacity for physical labor. These effects are all temporary. Caffeine does not replace the need for rest or sleep; nor does it boost functioning above normal levels. In habitual caffeine users its effects are due, in part, to the prevention of caffeine withdrawal.

In addition to being an ingredient in various foods and beverages such as coffee, tea, soft drinks, and chocolate, caffeine is used medicinally, both alone and as an additive in other drugs. It is added to some **antihistamines** to counteract drowsiness—a common antihistamine side effect. It is added to various over-the-counter (OTC) and prescription painkillers—especially **headache** remedies—to enhance their effectiveness. Some weight-loss medications and supplements also contain caffeine. Prescription citrated caffeine is used to treat breathing problems in premature infants.

Description

About 60 different plants produce caffeine as a natural pesticide against insect predators. The compound was first purified from coffee by the German chemist Friedrich Ferdinand Runge in 1819. In addition to coffee, tea, cacao, and kola nuts, caffeine is derived from yerba mate (*Ilex paraguariensis*) and guarana (*Paullina cupana*) berries.

Humans have consumed caffeine for thousands of years—chewing seeds or leaves of caffeine-producing plants or cooking them to prepare caffeine-containing beverages. Coffee was introduced to Europe from the Middle East in the seventeenth century and soon rivaled alcohol as the social beverage of choice. It is estimated that 90% of North Americans now consume caffeine on a daily basis.

Although caffeine has no nutritional value, the U.S. Food and Drug Administration (FDA) categorizes it as "generally recognized as safe" (GRAS) and recent research suggests that moderate amounts of caffeine may have some health benefits. It is absorbed from the stomach into the bloodstream where it:

- increases heart rate
- temporarily increases blood pressure
- relaxes smooth muscle cells in the airways
- releases fatty acids and glycerol for energy
- easily crosses the blood-brain barrier and affects the levels of neurotransmitters in the brain
- increases urine output

Recommended dosage

Individuals vary greatly in their sensitivity to caffeine and in the length of time that it remains in the body. Caffeine's effects are usually noticeable about 15 minutes after ingestion and typically last several hours. On average, one-half of ingested caffeine is eliminated from the body within three to four hours.

Moderate daily caffeine consumption—300–400 milligrams (mg), about 3–4 cups of coffee—is generally considered to be safe. However it can be difficult to determine an individual's caffeine consumption:

- A large number of products contain caffeine.
- Although caffeine must be listed as an ingredient on U.S. food labels, disclosure of the amount of caffeine per serving is not required.
- The caffeine content of coffees and teas varies greatly depending on the plant source, the location where the plants are grown, and how the beverages are prepared.

Approximate amounts of caffeine is some common products include:

- brewed coffee, 8 ounces (oz) or 240 milliliters (mL): 95–200 mg
- espresso coffee, 1 oz (30 mL): 58–75 mg
- brewed decaffeinated coffee, 8 oz (240 mL): 2–12 mg
- brewed black tea, 8 oz (240 mL): 40–120 mg
- brewed green tea, 8 oz (240 mL): about 15 mg
- decaffeinated tea, 8 oz (240 mL): 1–4 mg
- Mountain Dew, 12 oz (355 mL): 54 mg
- Coca-Cola Classic, 12 oz (355 mL): 35 mg
- Diet Coke, 12 oz (355 mL): 47 mg
- Pepsi, 12 oz (355 mL): 36–38 mg
- Sunkist Orange, regular or diet, 12 oz (355 mL): 41 mg
- Barq's Root Beer, 12 oz (355 mL): 23 mg
- Dr Pepper, 12 oz (355 mL): 42–44 mg
- Sprite, Fanta, 7Up, 12 oz (355 mL): 0 mg
- No Name (formerly Cocaine) energy drink, 8.4 oz (250 mL): 280 mg
- Red Bull energy drink, 8.3 oz (245 mL): 76 mg
- SoBe No Fear energy drink, 8 oz (240 mL): 83 mg
- Hershey's Special Dark Chocolate, 1.45 oz (41 g): 31 mg
- Hershey's Milk Chocolate, 1.55 oz (43 g): 9 mg
- Excedrin extra-strength headache tablet: 65 mg
- NoDoz maximum-strength caffeine tablet: 200 mg

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KEY TERMS

Alkaloid—A bitter organic base, such as caffeine or morphine, that contains nitrogen and usually oxygen, often occurs in plant seeds, and usually has physiological activity.

Caffeinism—A group of symptoms caused by excess caffeine.

Diuretic—A medication or other substance that increases urine excretion.

Neurotransmitter—A chemical that transmits impulses between nerve cells.

Stimulant—A drug or other substance that produces a temporary increase in activity or efficiency.

Precautions

Although caffeine is poisonous to dogs, horses, and some birds, in moderate amounts it is not usually harmful to humans and may even have health benefits in adults. However caffeine sensitivity is affected by weight, age, and various medications and there are large individual differences in reactions to caffeine. It is possible to overdose on caffeine and an overdose of caffeine pills is potentially fatal.

The mental and physical benefits of caffeine are temporary and can be followed by a "crash" when the caffeine wears off. Those who use caffeine to stay awake while driving or operating heavy machinery are at risk for accidents from fatigue once the effects dissipate.

Many people quickly develop tolerance to the effects of caffeine, along with mild physical and psychological dependencies. Discontinuing caffeine after regular use can cause withdrawal symptoms, especially headaches, within 12–24 hours. Other withdrawal symptoms can include irritability, **nausea**, inability to concentrate, sleepiness, fatigue, and mild depression. Withdrawal symptoms peak at about 48 hours and can last up to five days. Tapering off on caffeine—such as reducing consumption by one-half cup of coffee (about 50 mg) per day—minimizes or eliminates withdrawal symptoms.

The American Psychiatric Association's *Diagnostic and Statistical Manual of Mental Disorders* recognizes four different syndromes that can result from heavy overuse of caffeine:

- Caffeine intoxication is usually the result of taking caffeine pills (e.g., NoDoz). It is characterized by mental changes, rambling thoughts and speech, irregular heart beat, and all symptoms associated with caffeine overuse. In severe cases death can result from ventricular fibrillation (unsynchronized contractions of the heart ventricle).
- Caffeine-induced anxiety disorder is severe anxiety that interferes with daily social interactions and occurs after caffeine intoxication or heavy long-term use of caffeine.
- Caffeine-induced sleep disorder is insomnia that requires medical/psychiatric attention and occurs after prolonged caffeine consumption.
- Non-specific caffeine-induced disorder is an otherwise unspecified disorder that is associated with either acute or long-term caffeine consumption.

Pediatric

Children and teens are particularly sensitive to caffeine. Most children obtain their caffeine from soft drinks. Therefore beverages such as water, fruit juice, low-fat milk, or—at the least—caffeine-free sodas should be substituted for caffeine-containing soft drinks. Accidental ingestion of caffeine pills by children is a medical emergency. Coffee drinking often begins during adolescence and many teenagers consume caffeine-containing energy drinks and energy bars as well as coffee, leading to adverse effects.

Geriatric

The elderly also may be particularly sensitive to the adverse effects of caffeine.

Pregnant or breastfeeding

Caffeine has not been shown to cause **birth defects** and moderate amounts are considered safe during **pregnancy**. However caffeine may be eliminated from the body at a much slower rate in pregnant women. It is generally recommended that women limit their caffeine intake to the equivalent of two cups of coffee daily during pregnancy. Women who are having difficulty becoming pregnant should consider eliminating caffeine. Caffeine passes into breast milk and can cause restlessness, irritability, and sleeplessness in infants.

Other conditions and allergies

Patients with high blood pressure may be more susceptible to adverse effects of caffeine. Liver damage slows the elimination of caffeine from the body. Patients with these conditions should carefully monitor their caffeine intake.

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Side effects

Caffeinism is a group of symptoms caused by excess consumption of caffeine. Although the amount of caffeine required for these side effects varies with the individual, caffeinism generally develops in people who consume more than about 500 mg daily. Symptoms can be similar to those of caffeine withdrawal and may include:

- restlessness
- irritability
- nervousness
- anxiety
- muscle twitching
- headaches
- insomnia
- racing heart

Interactions

Caffeine may:

- increase the effectiveness of OTC and prescription medicines for migraines and other headaches
- increase urine output in people taking diuretics (water pills)
- take up to six hours to be eliminated from the bodies of women taking oral contraceptives
- be broken down more slowly in patients taking the antibiotics ciprofloxacin (Cipro) and norfloxacin (Noroxin)
- increase the concentration of theophylline in the blood
- increase the risks of ephedra (ma-huang) in herbal teas or banned dietary supplements

Resources

OTHER

Mayo Clinic. http://www.mayoclinic.com.

MedlinePlus. http://www.nlm.nih.gov/medlineplus/caffeine.html.

ORGANIZATIONS

American Dietetic Association, 120 South Riverside Plaza, Suite 2000, Chicago, IL, 60606-6995, (800) 877-1600, http://www.eatright.org.

American Heart Association, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, http://www.americanheart.org.

International Food Information Council Foundation, 1100 Connecticut Avenue, NW, Suite 430, Washington, DC, 20036, info@foodinsight.org, www.foodinsight.org.

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Margaret Alic, PhD

CAH *see* **Congenital adrenal hyperplasia**
Caisson disease *see* **Decompression sickness**
Calcaneal spurs *see* **Heel spurs**
Calcitonin *see* **Bone disorder drugs**

Calcium

Definition

Calcium (Ca) is the most abundant mineral in the body. About 99% of calcium in the body is in bones and teeth. The remaining 1% is in blood and soft tissue. Calcium in body fluids is an electrolyte with a charge of +2. Humans must meet their need for calcium through diet.

Calcium

Age	Recommended dietary allowance (mg)	Tolerable upper intake level (mg)
Children 0–6 mos.	210 (AI)	Not established
Children 7–12 mos.	270 (AI)	Not established
Children 1–3 yrs.	500	2,500
Children 4–8 yrs.	800	2,500
Children 9–13 yrs.	900	2,500
Adolescents 14–18 yrs.	1,300	2,500
Adults 19-50 yrs.	1,000	2,500
Adults 50> yrs.	1,200	2,500
Pregnant women 18≤ yrs.	1,300	2,500
Pregnant women 19≥ yrs.	1,000	2,500
Breastfeeding women 18≤ yrs.	1,300	2,500
Breastfeeding women 19≥ yrs.	1,000	2,500

Food	Calcium (mg)
Yogurt, plain, 1 cup	415
Cheese, mozzarella, 1.5 oz.	372
Sardines with bones, canned in oil, 3 oz.	324
Cheese, cheddar, 1.5 oz.	305
Milk, any type, 1 cup	300
Yogurt with fruit, 1 cup	245–384
Tofu, firm, with calcium sulfate, ½ cup	204
Orange juice, fortified, 6 oz.	200–260
Salmon with bones, canned, 3 oz.	181
Spinach, cooked, ½ cup	120
Beans, white, cooked, ½ cup	113
Instant breakfast drink, powder, prepared with water	105–250
Cereal, fortified, 1 cup	100–1,000
Bok choy, cooked, ½ cup	61
Beans, pinto or red, cooked, ½ cup	43
Bread, whole wheat, 1 slice	20

AI=Adequate intake
mg=milligram

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Purpose

Calcium is essential for

- building and maintaining strong bones and teeth
- muscle contraction
- blood vessel contraction and relaxation
- nerve impulse transmission
- regulating fluid balance in the body

Description

Most calcium in the body is stored in bones and teeth. Here it combines with phosphate to form strong, stable crystals. The remaining 1% is dissolved in body fluids and much of it forms Ca 2+ ions. In the body, these electrically charged particles are called electrolytes. Calcium and other electrolytes are not distributed evenly throughout the body. Dissolved calcium is found mainly in the fluid outside cells (extracellular fluid). Metabolic events cause the movement of calcium across cell membranes result in muscle contraction, nerve impulse transmission, and various chemical reactions. The cell then uses energy to restore the balance of calcium between the inside and outside of the cell membrane, so that the event can be repeated.

To remain healthy, the amount of calcium dissolved in body fluids must be stay within a very narrow range. Bone acts like a calcium bank. Bone is constantly being broken down by cells called osteoclasts and built up again by cells called osteoblasts. This process is called bone remodeling, and it continues throughout an individual's life. When excess calcium is present in the blood, osteoblasts deposit calcium into bones. When too little calcium is in the blood, osteoblasts dissolve calcium from bones and move it into the blood. This process is controlled by parathyroid hormone (PTH) secreted by the parathyroid glands. The parathyroid glands are extremely sensitive to the level of calcium in the blood, and in a healthy individual they are able to maintain the concentration of calcium ions fluctuates very little.

Normal calcium requirements

The United States Institute of Medicine (IOM) of the National Academy of Sciences has developed values called Dietary Reference Intakes (DRIs) for many **vitamins** and **minerals**. The DRIs consist of three sets of numbers. The Recommended Dietary Allowance (RDA) defines the average daily amount of the nutrient needed to meet the health needs of 97–98% of the population. The Adequate Intake (AI) is an estimate set when there is not enough information to determine an RDA. The Tolerable Upper Intake Level (UL) is the average maximum amount that can be taken daily without risking negative side effects.

The IOM has not set RDAs for calcium, but instead it has set AI levels for all age groups based on observed and experimental information. However, many studies show that Americans across almost all age groups are not meeting these AI levels. IAs and ULs for calcium are measured in milligrams (mg). The following list gives the recommended AL and UL levels of calcium for each age group.

- adults age 19–50: RDA 1,000 mg; UL 2,500 mg
- adults over age 50: RDA 1,200 mg; UL 2,500 mg

Sources of calcium

In the United States, dairy products—milk, yogurt, and cheese—are the main sources of dietary calcium. Low-fat dairy products, such as skim milk or reduced-fat cheese, contain about the same amount of calcium as whole milk products. Other sources of calcium include canned fish with bones, dark green leafy vegetables, and tofu made with calcium sulfate. Other types of tofu do not contain significant amounts of calcium. Processed foods such as orange juice, breakfast cereal, instant breakfast drinks, and bread are often fortified with calcium. This will be indicated on the label.

The following list gives the approximate calcium content for some common foods:

KEY TERMS

Dietary supplement—A product, such as a vitamin, mineral, herb, amino acid, or enzyme, that is intended to be consumed in addition to an individual's diet with the expectation that it will improve health.

Diuretic—A substance that removes water from the body by increasing urine production.

Electrolyte—Electrically charged particles (ions) that form when salts dissolve in water or fluids. Electrolytes regulate water balance in the body and play a critical role in almost every metabolic reaction.

Enzyme—Proteins that change the rate of a chemical reaction within the body without themselves being used up in the reaction.

Mineral—An inorganic substance found in the earth that is necessary in small quantities for the body to maintain a health. Examples: zinc, copper, iron.

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- milk, any type, 1 cup (8 ounces): 300 mg
- yogurt, plain, 8 ounces: 415 mg
- yogurt with fruit, 8 ounces: 245–384 mg
- cheddar cheese, 1.5 ounces: 305 mg
- mozzarella cheese, 1.5 ounces: 372 mg
- sardines with bones, canned in oil, 3 ounces: 324
- salmon with bones, canned, 3 ounces: 181 mg
- tofu, firm, made with calcium sulfate, 1/2 cup: 204 mg
- pinto or red beans, cooked, 1/2 cup: 43 mg
- white beans, cooked, 1/2 cup: 113 mg
- bok choy, 1/2 cup cooked: 61 mg
- spinach, cooked, 1/2 cup: 120 mg
- bread, whole wheat, 1 slice 20 mg
- orange juice, fortified, 6 ounces: 200–260 mg
- instant breakfast drink, powder prepared with water, 105–250 mg
- breakfast cereal, fortified, 1 cup: 100–1,000 mg

Although experts recommend that people meet as many of their vitamin and mineral needs through diet as possible, it is difficult for many people to get enough calcium from food alone. This is especially true for vegans, who eat no dairy products, adolescent girls who are very calorie conscious and tend to avoid milk and replace it with diet sodas, and people with **lactose intolerance** who cannot easily digest dairy products. Pregnant women and older individuals may also have a hard time eating enough to meet their calcium needs. People who do not get enough calcium through diet can benefit from taking a dietary supplement containing calcium.

Calcium supplements are available over-the-counter. The most common supplements supply calcium in the form of calcium carbonate or calcium citrate. Calcium carbonate is usually the most economical calcium supplement. People who are taking medications to reduce stomach acid may more easily absorb calcium citrate. Some supplements combine calcium and vitamin D because vitamin D helps the body absorb calcium. No calcium supplement contains enough calcium meet the entire daily adequate intake, because the pill would be too large to swallow. In addition, the body absorbs calcium best in doses of 500 mg or less. People who need more than 500 mg of supplemental calcium should divide the dose in half to be taken morning and evening.

Calcium deficiency

Calcium deficiency, called **hypocalcemia**, can occur because of inadequate calcium intake, excess calcium excretion by the kidney (usually caused by kidney damage), the inability to adequately absorb calcium, or because of interactions between calcium and some prescription drugs. People at highest risk of calcium deficiency are teenagers, women past the age of **menopause**, individuals who are lactose intolerant, vegans, and people with kidney (renal) damage.

Calcium deficiency rarely shows up in blood tests because calcium is withdrawn from the bones to maintain blood levels of calcium. The bones then become less dense, weaker, and more likely to break. This condition is called **osteoporosis** and it is most noticeable in the elderly who have a high rate of broken bones resulting from falls. Osteoporosis is a part of **aging**, but eating a healthy diet high in calcium, getting adequate vitamin D, and doing weight-bearing exercises regularly can delay its onset. Severe calcium deficiency, is usually caused by a medical condition rather than inadequate calcium intake. It causes symptoms such as **muscle cramps**, **tingling** in the fingers, lethargy, convulsions, heart rhythm abnormalities, and **death**. These symptoms can also be caused by many other diseases.

Calcium excess

Calcium excess is called **hypercalcemia**. It usually results from poor kidney function (renal failure) or from a malignant **cancer** tumor. It can also be caused by very large supplemental doses of vitamin D. Very rarely is hypercalcemia caused by too much calcium from food or dietary supplements. High levels of calcium interfere with the absorption of other minerals such as iron, zinc, magnesium, and phosphorous. People with hypercalcemia usually have multiple medical problems and are under the supervision of a physician.

Precautions

People of all ages, races, and gender need to be alert to getting enough calcium in their diet. Building strong, dense bones begins in childhood and adolescence, even though the results cannot be seen until old age. People mentioned previously as being at especially high risk of low dietary calcium intake should investigate taking a calcium supplement.

Interactions

Absorption of calcium is affected by several conditions.

- Age. Infants absorb as much as 60% of the calcium in their digestive system. This decreases to 15–20% in adulthood, and even less in old age.
- Amount of calcium consumed. The more calcium consumed at one time, the less efficient absorption

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becomes. Calcium from supplements should be spaced out during the day for maximum absorption.

- Vitamin D. The presence of vitamin D improves calcium absorption. Vitamin D deficiency can worsen calcium deficiency.
- Plant products. Phytic found in beans and oxalic acid found in spinach and leafy greens decrease the amount of calcium absorbed from those foods, but does not affect the absorption of calcium from other foods present at the same time in the intestine. Fiber such as wheat bran also reduced calcium absorption.

Prescription medications can also affect or be affected by the absorption of calcium. These include:

- digoxin
- fluroquinolones
- levothyroxine
- tetracycline antibiotics
- anticonvulsants
- thiazide-type diuretics
- glucacorticoids
- mineral oil
- stimulant laxatives
- antacids

People taking these drugs should check with their healthcare provider or pharmacist about potential adjustments in their medications or calcium intake.

Complications

No complications are expected when healthy people take calcium in amounts equal to the AI level and less than the UL level. Some people experience gas, **nausea**, and abdominal discomfort from calcium supplements. Taking the supplement with meals, taking smaller doses spread out over the day, or changing the type of supplement usually solves this problem. Complications of excess calcium and calcium deficiency were discussed previously.

Resources

BOOKS

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Gaby, Alan R., ed. *A-Z Guide to Drug-Herb-Vitamin Interactions Revised and Expanded 2nd Edition: Improve Your Health and Avoid Side Effects When Using Common Medications and Natural Supplements Together*. New York: Three Rivers Press, 2006.

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National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS). "Calcium Supplements: What to Look For." NIAMS, April 2005. http://www.niams.nih.gov/bone/hi/calcium_supp.htm

ORGANIZATIONS

American Dietetic Association, 120 South Riverside Plaza, Suite 2000, Chicago, IL, 60606-6995, (800) 877-1600, http://www.eatright.org.

International Food Information Council, 1100 Connecticut Avenue, NW Suite 430, Washington, DC, 20036, (202) 296-6540, (202) 296-6547, http://www.ific.org.

Linus Pauling Institute, Oregon State University, 571 Weniger Hall, Corvallis, OR, 97331-6512, (541) 717-5075, (541) 737-5077, http://lpi.oregonstate.edu.

National Institutes of Health Osteoporosis and Related Bone Diseases National Resource Center, 2 AMS Circle, Bethesda, MD, 20892-3676, (202) 223-0344, 202, 466-4325, (800) 624-BONE, http://www.niams.nih.gov/bone.

Office of Dietary Supplements, National Institutes of Health, 6100 Executive Blvd., Room 3B01, MSC 7517, Bethesda, MD, 20892-7517, (301) 435-2920, (301) 480-1845, http://ods.od.nih.gov.

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Calcium carbonate *see* **Antacids**

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Calcium channel blockers

Definition

Calcium channel blockers are medicines that slow the movement of calcium into the cells of the heart and blood vessels. This, in turn, relaxes blood vessels, increases the supply of oxygen-rich blood to the heart, and reduces the heart's workload.

Purpose

Calcium channel blockers are used to treat high blood pressure, to correct abnormal heart rhythms, and to relieve the type of chest **pain** called **angina** pectoris. Physicians also prescribe calcium channel blockers to treat panic attacks and **bipolar disorder** (manic depressive illness) and to prevent **migraine headache**.

Precautions

Seeing a physician regularly while taking calcium channel blockers is important. The physician will check to make certain the medicine is working as it should and will watch for unwanted side effects. People who have high blood pressure often feel perfectly fine. However, they should continue to see their prescribing physician even when they feel well so that he can keep a close watch on their condition. They should also continue to take their medicine even when they feel fine.

Calcium channel blockers will not cure high blood pressure, but will help to control the condition. To avoid the serious health problems associated with high blood pressure, patients may have to take this type of medication for the rest of their lives. Furthermore, the blockers alone may not be enough. People with high blood pressure may also need to avoid certain foods and keep their weight under control. The health care professional who is treating the condition can offer advice as to what measures may be necessary. Patients being treated for high blood pressure should not change their **diets** without consulting their physicians.

Anyone taking calcium channel blockers for high blood pressure should not take any other prescription or over-the-counter medication without first checking with the prescribing physician, as some of these drugs may increase blood pressure.

Some people feel drowsy or less alert than usual when taking calcium channel blockers. Anyone who takes these drugs should not drive, use machines, or do anything else that might be dangerous until they have found out how the drugs affect them.

People who normally have chest pain when they **exercise** or exert themselves may not have the pain when they are taking calcium channel blockers. This could lead them to be more active than they should be. Anyone taking calcium channel blockers should therefore consult with the prescribing physician concerning how much exercise and activity may be considered safe.

Some people get headaches that last for a short time after taking a dose of this medication. This problem usually goes away during the course of treatment. If it does not, or if the headaches are severe, the prescribing physician should be informed.

Patients taking certain calcium channel blockers may need to check their pulse regularly, as the drugs may slow the pulse too much. If the pulse is too slow, circulation problems may result. The prescribing physician can show patients the correct way to check their pulse.

This type of medication may cause the gums to swell, bleed, or become tender. If this problem occurs, a medical physician or dentist should be consulted. To help prevent the problem, care should be taken when brushing and flossing the teeth. Regular dental checkups and cleanings are also recommended.

Older people may be unusually sensitive to the effects of calcium channel blockers. This may increase the chance of side effects.

Special conditions

People with certain medical conditions or who are taking certain other medicines may develop problems if they also take calcium channel blockers. Before taking these drugs, the prescribing physician should be informed about any of these conditions:

ALLERGIES. Anyone who has had a previous unusual reaction to any calcium channel blocker should let his or her physician know before taking the drugs again. The physician should also be notified about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. The effects of taking calcium channel blockers during **pregnancy** have not been studied in humans. However, in studies of laboratory animals, large doses of these drugs have been reported to cause **birth defects**, **stillbirth**, poor bone growth, and other problems when taken during pregnancy. Women who are pregnant or who may become pregnant should check with their physicians before using these drugs.

BREASTFEEDING. Some calcium channel blockers pass into breast milk, but there have been no reports of problems in nursing babies whose mothers were taking this type of medication. However, women who need to take this medicine and want to breastfeed their babies should check with their physicians.

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OTHER MEDICAL CONDITIONS. Calcium channel blockers may worsen heart or blood vessel disorders.

The effects of calcium channel blockers may be greater in people with kidney or **liver disease**, as their bodies are slower to clear the drug from their systems.

Certain calcium channel blockers may also cause problems in people with a history of heart rhythm problems or with depression, Parkinson's disease, or other types of parkinsonism.

USE OF CERTAIN MEDICINES. Taking calcium channel blockers with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

As with most medications, certain side effects are possible and some interactions with other substances may occur.

Side effects

Side effects are not common with this medicine, but some may occur. Minor discomforts, such as **dizziness**, lightheadedness, flushing, **headache**, and **nausea**, usually go away as the body adjusts to the drug and do not require medical treatment unless they persist or they are bothersome.

If any of the following side effects occur, the prescribing physician should be notified as soon as possible:

- breathing problems, coughing or wheezing
- irregular, fast, or pounding heartbeat
- slow heartbeat (less than 50 beats per minute)
- skin rash
- swollen ankles, feet, or lower legs

Other side effects may occur. Anyone who has unusual symptoms after taking calcium blockers should contact the prescribing physician.

Interactions

Calcium channel blockers may interact with a number of other medications. When this happens, the effects of one or both of the drugs may change or the risk of side effects may increase. Anyone who takes calcium channel blockers should not take any other prescription or nonprescription (over-the-counter) medicines without first checking with the prescribing physician. Substances that may interact with calcium channel blockers include:

- Diuretics (water pills). This type of medicine may cause low levels of potassium in the body, which may increase the chance of unwanted effects from some calcium channel blockers.
- Beta-blockers, such as atenolol (Tenormin), propranolol (Inderal), and metoprolol (Lopressor), used to treat high blood pressure, angina, and other conditions. Also, eye drop forms of beta blockers, such as timolol (Timoptic), used to treat glaucoma. Taking any of these drugs with calcium channel blockers may increase the effects of both types of medicine and may cause problems if either drug is stopped suddenly.
- Digitalis heart medicines. Taking these medicines with calcium channel blockers may increase the action of the heart medication.
- Medicines used to correct irregular heart rhythms, such as quinidine (Quinidex), disopyramide (Norpace), and procainamide (Procan, Pronestyl). The effects of these drugs may increase if used with calcium channel blockers.
- Anti-seizure medications such as carbamazepine (Tegretol). Calcium channel drugs may increase the effects of these medicines.
- Cyclosporine (Sandimmune), a medicine that suppresses the immune system. Effects may increase if this drug is taken with calcium channel blockers.
- Grapefruit juice may increase the effects of some calcium channel blockers.

This list does not include every drug that may interact with calcium channel blockers. The prescribing physician or pharmacist will advise as to whether combining calcium channel blockers with any other prescription or nonprescription (over-the-counter) medication is appropriate or not.

Description

Calcium channel blockers are available only with a physician's prescription and are sold in tablet, capsule, and injectable forms. Some commonly used calcium channel blockers include amlopidine (Norvasc), diltiazem (Cardizem), isradipine (DynaCirc), nifedipine (Adalat, Procardia), nicardipine (Cardene), and verapamil (Calan, Isoptin, Verelan).

The recommended dosage depends on the type, strength, and form of calcium channel blocker and the condition for which it is prescribed. Correct dosage is determined by the prescribing physician and further information can be obtained from the pharmacist.

Calcium channel blockers should be taken as directed. Larger or more frequent doses should not be taken, nor should doses be missed. This medicine may take several weeks to noticeably lower blood pressure. The patient taking calcium channel blockers should keep taking the medicine, to give it time to work. Once it begins to work and symptoms improve, it should continue to be taken as prescribed.

This medicine should not be discontinued without checking with the prescribing physician. Some conditions may worsen when patients stop taking calcium

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KEY TERMS

Angina pectoris—A feeling of tightness, heaviness, or pain in the chest, caused by a lack of oxygen in the muscular wall of the heart.

Bipolar disorder—A severe mental illness, also known as manic depression, in which a person has extreme mood swings, ranging from a highly excited state—sometimes with a false sense of well–being—to depression.

Migraine—A throbbing headache that usually affects only one side of the head. Nausea, vomiting, increased sensitivity to light, and other symptoms often accompany migraine.

channel blockers abruptly. The prescribing physician will advise as to how to gradually taper down before stopping the medication completely.

Risks

A report from the European Cardiology Society in 2000 found that patients taking certain calcium channel blockers had a 27% greater risk of **heart attack**, and a 26% greater risk of **heart failure** than patients taking other high blood pressure medicines. However, there are many patients affected by conditions that still make calcium channel blockers the best choice for them. The patient should discuss this issue with the prescribing physician.

Normal results

The expected result of taking a calcium channel blocker is to either correct abnormal heart rhythms, return blood pressure to normal, or relieve chest pain.

Resources

BOOKS

Beers, Mark H., Robert S. Porter, and Thomas V. Jones, eds. *The Merck Manual of Diagnosis and Therapy*. 18th ed. Whitehouse Station, NJ: Merck Research Laboratories, 2006.

Deanna M. Swartout-Corbeil, R.N.

Calcium imbalance *see* **Hypercalcemia; Hypocalcemia**

Calcium polycarbophil *see* **Laxatives**

California flower essences *see* **Flower remedies**

Calluses *see* **Corns and calluses**

Calorie-modified diet *see* **Diets**

Calymmatobacteriosis *see* **Granuloma inguinale**

Campylobacter jejuni infection *see* **Campylobacteriosis**

Campylobacteriosis

Definition

Campylobacteriosis refers to infection by the group of bacteria known as *Campylobacter*. The term comes from the Greek word meaning "curved rod" referring to the bacteria's curved shape. The most common disease caused by these organisms is **diarrhea**, which most often affects children and younger adults. *Campylobacter* infections account for a substantial percent of food-borne illness encountered each year.

Description

There are over 15 different subtypes, all of which are curved Gram-negative rods. *C. jeuni* is the subtype that most often causes gastrointestinal disease. However, some species such as *C. fetus* produce disease outside the intestine, particularly in those with altered immune systems, such as people with **AIDS**, **cancer**, and **liver disease**.

Campylobacter are often found in the intestine of animals raised for food products and pets. Infected animals often have no symptoms. Chickens are the most common source of human infection. It is estimated that 1% of the general population is infected each year.

Causes and symptoms

Improper or incomplete food preparation is the most common way the disease is spread, with poultry accounting for over half the cases. Untreated water and raw milk are also potential sources.

The incubation period after exposure is from one to 10 days. A day or two of mild **fever**, muscle aches, and **headache** occur before intestinal symptoms begin. Diarrhea with or without blood and severe abdominal cramps are the major intestinal symptoms. The severity of symptoms is variable, ranging from only mild fever to **dehydration** and rarely **death** (mainly in the very young or old). The disease usually lasts about one week, but persists longer in about 20% of cases. At

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KEY TERMS

Antibiotic—A medication that is designed to kill or weaken bacteria.

Anti-motility medications—Medications such as loperamide (Imodium), dephenoxylate (Lomotil), or medications containing codeine or narcotics which decrease the ability of the intestine to contract. This can worsen the condition of a patient with dysentery or colitis.

Fluoroquinolones—A relatively new group of antibiotics that have had good success in treating infections with many Gram-negative bacteria. One drawback is that they should not be used in children under 17 years of age, because of possible effect on bone growth.

Food-borne illness—A disease that is transmitted by eating or handling contaminated food.

Gram-negative—Refers to the property of many bacteria that causes them to not take up color with Gram's stain, a method which is used to identify bacteria. Gram-positive bacteria which take up the stain turn purple, while Gram-negative bacteria which do not take up the stain turn red.

Guillain-Barré syndrome—Progressive and usually reversible paralysis or weakness of multiple muscles usually starting in the lower extremities and often ascending to the muscles involved in respiration. The syndrome is due to inflammation and loss of the myelin covering of the nerve fibers, often associated with an acute infection.

Meninges—Outer covering of the spinal cord and brain. Infection is called meningitis, which can lead to damage to the brain or spinal cord and even death.

Oral Rehydration Solution (ORS)—A liquid preparation developed by the World Health Organization that can decrease fluid loss in persons with diarrhea. Originally developed to be prepared with materials available in the home, commercial preparations have recently come into use.

Stool—Passage of fecal material; a bowel movement.

least 10% will have a relapse, and some patients will continue to pass the bacteria for several weeks.

Complications

Dehydration is the most common complication. Especially at the extremes of age, this should be watched for and treated with either Oral Rehydration Solution or intravenous fluid replacement.

Infection may also involve areas outside the intestine. This is unusual, except for infections with *C. fetus*. *C. fetus* infections tend to occur in those who have diseases of decreased immunity such as AIDS, cancer, etc. This subtype is particularly adapted to protect itself from the body's defenses.

Areas outside the intestine that may be involved are:

- Nervous system involvement either by direct infection of the meninges (outer covering of the spinal cord and brain) or more commonly by producing the Guillain-Barré syndrome (progressive and reversible paralysis or weakness of many muscles). In fact, *Campylobacter* may be responsible for 40% of the reported cases of this syndrome.
- Joint inflammation can occur weeks later (leading to an unusual form of arthritis).
- Infection of vessels and heart valves is a special characteristic of *C. fetus*. Immunocompromised patients may develop repeated episodes of passage of bacteria into the bloodstream from these sites of infection.
- The gallbladder, pancreas, and bone may be affected.

Diagnosis

Campylobacter is only one of many causes of acute diarrhea. Culture (growing the bacteria in the laboratory) of freshly obtained diarrhea fluid is the only way to be certain of the diagnosis.

Treatment

The first aim of treatment is to keep up **nutrition** and avoid dehydration. Medications used to treat diarrhea by decreasing intestinal motility, such as Loperamide or Diphenoxylate are also useful, but should only be used with the advice of a physician. **Antibiotics** are of value, if started within three days of onset of symptoms. They are indicated for those with severe or persistent symptoms. Either an erythromycin type drug or one of the **fluoroquinolones** (such as ciprofloxacin) for five to seven days are the accepted therapies.

Prognosis

Most patients with *Campylobacter* infection rapidly recover without treatment. For certain groups of

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patients, infection becomes chronic and requires repeated courses of antibiotics.

Prevention

Good hand washing technique as well as proper preparation and cooking of food is the best way to prevent infection.

Resources

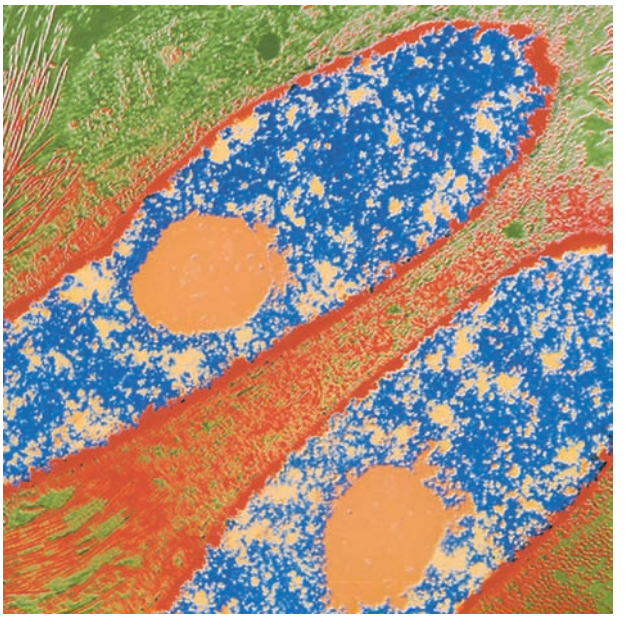
OTHER

Centers for Disease Control. http://www.cdc.gov.

ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

David Kaminstein, MD



A transmission electron micrograph (TEM) of two spindle cell nuclei from a human sarcoma. Sarcomas are cancers of the connective tissue (bone, nerves, smooth muscle). *(Dr. Brian Eyden/SPL/Photo Researchers, Inc.)*

Cancer

Definition

Cancer is not just one disease, but a large group of over 100 diseases. Its two main characteristics are uncontrolled growth of the cells in the human body and the ability of these cells to migrate from the original site and spread to distant sites. If the spread is not controlled, cancer can result in **death**.

Demographics

About 1.5 million Americans are diagnosed with cancer annually. One out of every four deaths in the United States is from cancer. More than 562,000 people in the United States are anticipated to die of cancer in 2009. This equates to more than 1,500 deaths from cancer per day. Overall, cancer death rates for both men and women have decreased since 2004. However, cancer ranks as the number one cause of death in persons under the age of 85 and ranks second only to heart disease as a cause of death overall in the United States.

Common pathogens and associated cancers

Causative agent	Type(s) of cancer
Viruses	
Epstein-Barr virus	Burkitt's lymphoma
Hepatitis B	Liver cancer
Hepatitis C	Liver cancer
Human immunodeficiency virus (HIV)	Kaposi's sarcoma, lymphoma
Papillomaviruses	Cervical cancer
Bacteria	
Helicobacter pylori	Stomach cancer, lymphomas

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Since the occurrence of cancer increases as individuals age, most of the cases are seen in adults, middle-aged or older. Seventy-seven percent of all cancers are diagnosed in people who are older than 55 years of age. The probability of an American male developing an invasive cancer or dying from cancer in his lifetime is 1 in 2; for American females the probability is 1 in 3. The most common cancers are skin cancer, lung cancer, **colon cancer**, **breast cancer** (in women), and **prostate cancer** (in men). In addition, cancer of the kidneys, ovaries, uterus, pancreas, bladder, rectum, and blood and lymph node cancer (leukemias and lymphomas) are also included among the 12 major cancers that affect most Americans.

Although most cancer occurs in adults, in the United States cancer is still responsible for more deaths in children under age 20 than any other disease. Each year, about 12,500 new cases of cancer are diagnosed in children compared to 1.5 million new cases annually in adults. About 2,300 children die of cancer in the U.S. each year. In general, children respond better to cancer treatment than adults do. Advances in treatment have resulted in better outcomes and increased long-term survival rates for children. Eighty

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percent of children newly diagnosed with cancer now live at least 5 years compared to about 60% in the mid-1970s. However, the incidence of cancer in children, especially acute lymphocytic leukemia and brain cancer, has increased steadily for the past 30 years.

Description

Cancer, by definition, is a disease of the genes. A gene is a small part of DNA, which is the master molecule of the cell. Genes make proteins, which are the ultimate workhorses of the cells. These proteins allow the body to carry out all the many processes that permit an individual to function—to breathe, think, and move.

Throughout people's lives, the cells in their bodies are growing, dividing, and replacing themselves. Many genes produce proteins that are involved in controlling the processes of cell growth and division. An alteration (mutation) to the DNA molecule can disrupt the genes and produce faulty proteins. This causes the cell to become abnormal and lose its restraints on growth. The abnormal cell begins to divide uncontrollably and eventually forms a new growth known as a tumor or neoplasm (medical term for cancer meaning "new growth").

In a healthy individual, the immune system can recognize the neoplastic cells and destroy them before they get a chance to divide. However, some mutant cells may escape immune detection and survive to become tumors or cancers.

Tumors are of two types, benign or malignant. A benign tumor is not considered cancer. It is typically slow-growing, does not spread or invade surrounding tissue, and once it is removed, does not usually recur. A malignant tumor, by contrast, is cancer. It invades surrounding tissue and spreads to other parts of the body. If the cancer cells have spread to the surrounding tissues, even after the malignant tumor is removed, it generally recurs.

A majority of cancers are caused by changes in the cell's DNA because of damage to the environment. Environmental factors that are responsible for causing the initial mutation in the DNA are called **carcinogens**, of which there are many types.

Some cancers have a genetic or inherited basis. In other words, individuals can inherit faulty DNA from a parent, which could predispose the person to getting cancer. While there is scientific evidence that both factors (environmental and genetic) play a role, less than 10% of all cancers are strictly linked to hereditary factors. Cancers that are known to have a hereditary link are breast cancer, colon cancer, **ovarian cancer**, and uterine cancer. Besides genes, certain physiological traits could be inherited and could contribute to cancers. For example, inheriting fair skin makes a person more likely to develop skin cancer, but only if that person also has prolonged exposure to intensive sunlight.

There are several different types of cancers:

- Carcinomas are cancers that arise in the epithelium (the layer of cells covering the body's surface and lining the internal organs and various glands). Ninety percent of human cancers fall into this category. Carcinomas can be subdivided into two types: adenocarcinomas (those that develop in an organ or a gland) and squamous cell carcinomas (those that originate in the skin).
- Melanomas also originate in the skin, usually in the pigment cells (melanocytes).
- Sarcomas are cancers of the supporting tissues of the body, such as bone, muscle, and blood vessels.
- Cancers of the blood and lymph glands are called leukemias and lymphomas, respectively.
- Gliomas are cancers of the nerve tissue.

Risk factors

The major risk factors for cancer are related to: tobacco and alcohol use, dietary factors, sexual and reproductive behavior, exposure to infectious agents, family history, occupation, and environmental factors including pollution.

Causes and symptoms

According to estimates of the American Cancer Society (ACS), approximately 40% of cancer deaths in 2009 were anticipated to be due to tobacco and excessive alcohol use. An additional one-third of the deaths were expected to be related to being overweight, being obese, lacking physical activity, and having poor **nutrition**. Many of the one million skin cancers diagnosed in 2009 were believed to be a direct result of over-exposure to ultraviolet light from the sun's rays.

Tobacco

Eighty to 90% of lung cancer cases occur in smokers. **Smoking** has also been shown to be a contributory factor in cancers of the upper respiratory tract, esophagus, larynx, bladder, pancreas, and probably liver, stomach, breast, and kidney as well. In the 2000s, scientists also confirmed that secondhand smoke (or passive smoking) can increase one's risk of developing cancer.

Alcohol

Excessive consumption of alcohol is a risk factor in certain cancers, such as **liver cancer**. Alcohol, in

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combination with tobacco, significantly increases the chances that an individual will develop mouth, pharynx, larynx, and esophageal cancers.

Diet

Thirty-five percent of all cancers are due to dietary causes. Excessive intake of fat leading to **obesity** has been associated with cancers of the breast, colon, rectum, pancreas, prostate, gall bladder, ovaries, and uterus.

Sexual and reproductive behavior

The human papillomavirus (HPV), which is sexually transmitted, has been shown to cause cancer of the cervix. Having multiple sexual partners and becoming sexually active at an early age have been shown to increase one's chances of contracting HPV. In addition, it has also been shown that women who do not have children or have children later in life have an increased risk for both ovarian and breast cancer.

Infectious agents

Between 1985 and 2005, scientists obtained evidence to show that approximately 15% of the world's cancer deaths can be traced to viruses, bacteria, or parasites. The most common cancer-causing pathogens and the cancers associated with them were shown previously in table form.

Family history

Certain cancers such as breast, colon, ovarian, and uterine cancer recur generation after generation in some families. A few cancers, such as the **eye cancer retinoblastoma**, a type of colon cancer, and a type of breast cancer known as early-onset breast cancer, have been shown to be linked to certain genes that can be tracked within a family. It is, therefore, possible that inheriting particular genes makes a person susceptible to certain cancers.

Occupational hazards

There is evidence to show that certain occupational hazards account for 4% of all cancer deaths. For example, asbestos workers have an increased incidence of lung cancer. Similarly, a higher likelihood of getting **bladder cancer** is associated with dye, rubber, and gas workers; skin and lung cancer with smelters, gold miners, and arsenic workers; leukemia with glue and varnish workers; liver cancer with PVC manufacturers; and lung, bone, and bone marrow cancer with radiologists and uranium miners.

Environment

Radiation is believed to cause 1 to 2% of all cancer deaths. Ultra-violet radiation from the sun accounts for a majority of melanoma deaths. Other sources of radiation are x rays, radon gas, and ionizing radiation from nuclear material.

Pollution

Several studies have shown a link between asbestos and cancer. Chlorination of water may account for a small rise in cancer risk. However, the main danger from pollution occurs when dangerous chemicals from industries escape into the surrounding environment. It has been estimated that 1% of cancer deaths are due to air, land, and water pollution.

Symptoms

Cancer is a progressive disease and goes through several stages. Each stage may produce a number of symptoms. Some symptoms are produced early and may occur due to a tumor that is growing within an organ or a gland. As the tumor grows, it may press on the nearby nerves, organs, and blood vessels. This causes **pain** and some pressure, which may be the earliest warning signs of cancer.

Despite the fact that there are over 100 different types of cancers, producing very different symptoms, the American Cancer Society (ACS) has established the following seven symptoms as possible warning signals of cancer:

- changes in the size, color, or shape of a wart or a mole
- a sore that does not heal
- persistent cough, hoarseness, or sore throat
- a lump or thickening in the breast or elsewhere
- unusual bleeding or discharge
- chronic indigestion or difficulty in swallowing
- any change in bowel or bladder habits

Many other diseases besides cancer can produce the same symptoms. However, it is important to have these symptoms checked, as soon as possible, especially if they linger. The earlier a cancer is diagnosed and treated, the better the chance of cure. Many cancers such as breast cancer may not have any early symptoms. Therefore, it is important to undergo routine screening tests such as breast self-exams and mammograms.

Diagnosis

Examination

Diagnosis of many cancers begins with a thorough **physical examination** and a complete medical history.

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Cancer incidence and mortality, 2010[1]

Type of cancer	Number of new diagnoses	Number of deaths
Breast cancer	207,090	39,840
Cervical cancer[2]	12,200	4,210
Colorectal cancer	142,570	51,370
Lung cancer	222,520	157,300
Non-Hodgkin lymphoma	65,540	20,210
Ovarian cancer	21,880	1,385
Prostate cancer	217,730	32,050
Skin cancer, melanoma	68,130	8,700
Skin cancer, non-melanoma	2,000,000	2,000
Testicular cancer	8,480	350

[1]Numbers are estimates
[2]Invasive

SOURCE: American Cancer Society.

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The doctor will observe, feel, and palpate (apply pressure by touch) different parts of the body in order to identify any variations from the normal size, feel, and texture of the organ or tissue.

As part of the physical exam, the doctor will inspect the patient's mouth. By focusing a light into the mouth, the physician will look for abnormalities in color, moisture, surface texture, or presence of any thickening or sore in the lips, tongue, gums, the hard palate on the roof of the mouth, and the throat. To detect **thyroid cancer**, the doctor will observe the front of the neck for swelling. He may gently manipulate the neck and palpate the front and side surfaces of the thyroid gland (located at the base of the neck) to detect any nodules or tenderness. As part of the physical examination, the doctor will also palpate the lymph nodes in the neck, under the arms, and in the groin. Many illnesses and cancers cause a swelling of the lymph nodes.

The doctor may conduct a thorough examination of the skin to look for sores that have been present for more than three weeks and that bleed, ooze, or crust; irritated patches that may itch or hurt; and any change in the size of a wart or a mole.

Examination of the female pelvis is used to detect cancers of the ovaries, uterus, cervix, and vagina. In the visual examination, the doctor looks for abnormal discharges or the presence of sores. Then, using gloved hands the physician palpates the internal pelvic organs such as the uterus and ovaries to detect any abnormal mass. Breast examination includes visual observation where the doctor looks for any discharge, unevenness, discoloration, or scaling. The doctor palpates both breasts to feel for masses or lumps.

For males, inspection of the testicles, rectum and the prostate is also included in the physical examination. The doctor inserts a gloved finger into the rectum and rotates it slowly to feel for any growths, tumors, or other abnormalities. The doctor also conducts an examination of the testes, in which the doctor observes the genital area and looks for swelling or other abnormalities. The testicles are palpated to identify any lumps, thickening, or differences in the size, weight, and firmness.

Tests

The doctor may order diagnostic tests if an abnormality has been detected on physical examination, or if the patient has some symptom that could be indicative of cancer.

Laboratory studies of sputum (sputum cytology), blood, urine, and stool can detect abnormalities that may indicate cancer. Sputum cytology is a test in which the phlegm that is coughed up from the lungs is microscopically examined. It is often used to detect lung cancer. Many blood tests used for cancer detection are typically easy to perform. The blood sample is obtained by a lab technician or a doctor by inserting a needle into a vein and is relatively painless. Blood tests can be either specific or non-specific. Often, in certain cancers, the cancer cells release particular proteins (called **tumor markers**) and blood tests can be used to detect the presence of these tumor markers. However, with a few exceptions, tumor markers are not used for routine screening of cancers, because several non-cancerous conditions also produce positive results. Blood tests are generally more useful in monitoring the effectiveness of the treatment, or in following the course of the disease and detecting recurrent disease.

Imaging tests such as **computed tomography scans** (CT scans), **magnetic resonance imaging** (MRI), ultrasound, and fiberoptic scope examinations help the doctors determine the location of the tumor even if it is deep within the body. Conventional x rays are often used for initial evaluation because they are relatively cheap, painless, and easily accessible. In order to increase the information obtained from a conventional x ray, air or a dye (such as barium or iodine) may be used as a contrast medium to outline or highlight parts of the body.

The most definitive diagnostic test is the biopsy, wherein a piece of tissue is surgically removed for microscope examination. Besides confirming a cancer, the biopsy also provides information about the type of cancer, the stage it has reached, the aggressiveness of the cancer, and the extent of its spread. Since a biopsy

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KEY TERMS

Benign—Mild, nonmalignant. Recovery is favorable with treatment.

Biopsy—The surgical removal and microscopic examination of living tissue for diagnostic purposes.

Bone marrow—Spongy material that fills the inner cavities of the bones. The progenitors of all the blood cells are produced in this bone marrow.

Carcinogen—Any substance capable of causing cancer by mutating the cell's DNA.

Chemotherapy—Treatment with certain anticancer drugs.

Epithelium—The layer of cells covering the body's surface and lining the internal organs and various glands.

Hormone therapy—Treatment of cancer by inhibiting the production of hormones such as testosterone and estrogen.

Immunotherapy—Treatment of cancer by stimulating the body's immune defense system.

Malignant—A general term for cells and the tumors they form that can invade and destroy other tissues and organs.

Metastasis—The spread of cancer from one part of the body to another.

Radiation therapy—Treatment using high-energy radiation from x-ray machines, cobalt, radium, or other sources.

Sore—An open wound, bruise, or lesion on the skin.

Tumor—An abnormal growth resulting from a cell that lost its normal growth control restraints and started multiplying uncontrollably.

X rays—High-energy radiation used in high doses, either to diagnose or treat disease.

provides the most accurate analysis, it is considered the gold standard of diagnostic tests.

Screening examinations conducted regularly by healthcare professionals can result in the detection of cancers of the breast, colon, rectum, cervix, prostate, testis, tongue, mouth, and skin at early stages, when treatment is more likely to be successful. Some of the routine screening tests recommended by the ACS are **sigmoidoscopy** (for colorectal cancer), **mammography** (for breast cancer), pap smear (for **cervical cancer**), and the PSA test (for prostate cancer). Self-examinations for cancers of the breast, testis, mouth, and skin can also help in detecting the tumors before the symptoms become serious.

A revolution in molecular biology and cancer genetics has contributed a great deal to the development of several tests designed to assess the risk of getting cancers. These new techniques include **genetic testing**, in which molecular probes are used to identify mutations in certain genes that have been linked to particular cancers. As of 2009, however, there remain some limitations to genetic testing and its utility appeared ambiguous, emphasizing the need to develop better strategies for early detection.

Treatment

Treatment and prevention of cancers continues to be the focus of a great deal of research as of 2010. Research into new cancer therapies includes cancer-targeting **gene therapy**, **cancer vaccines**, and other targeted therapies such as monoclonal antibodies. Most new therapies take years of clinical testing and research.

The aim of cancer treatment is to remove all or as much of the tumor as possible and to prevent the recurrence or spread of the primary tumor. While devising a treatment plan for cancer, the likelihood of curing the cancer has to be weighed against the side effects of the treatment. If the cancer is very aggressive and a cure is not possible, then the treatment should be aimed at relieving the symptoms and controlling the cancer for as long as possible.

Cancer treatment can take many different forms, and is typically tailored to the individual patient. The decision as to which type of treatment is the most appropriate depends on the type and location of cancer, the extent to which it has already spread, the patient's age, sex, general health status, and personal treatment preferences. The major types of treatment are: surgery, radiation, **chemotherapy**, biological therapy, targeted therapy, hormone therapy, and bone-marrow and **stem cell transplantation**.

Surgery

Surgery is the removal of a visible tumor and is the most frequently used cancer treatment. It is most

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effective when a cancer is small and/or confined to one area of the body.

Surgery can be used for many purposes:

- Treatment. Treatment of cancer by surgery involves removal of the tumor to cure the disease. This is typically done when the cancer is localized to a discrete area. Along with the cancer, some part of the normal surrounding tissue is also removed to ensure that no cancer cells remain in the area. Since cancer usually spreads via the lymphatic system, adjoining lymph nodes may be examined and sometimes are removed as well.
- Preventive surgery. Preventive or prophylactic surgery involves removal of an abnormal looking area that is likely to become malignant over time. For example, 40% of people with a colon disease known as ulcerative colitis ultimately die of colon cancer. Rather than live with the fear of developing colon cancer, these people may choose to have the colon removed which reduces the risk of developing colon cancer significantly.
- Diagnostic purposes. The most definitive tool for diagnosing cancer is a biopsy. Sometimes, a biopsy can be performed by inserting a needle through the skin. However, at other times, the only way to obtain a tissue sample for biopsy is by performing a surgical operation.
- Cytoreductive surgery is a procedure in which the doctor removes as much of the cancer as possible and then treats the remaining area with radiation therapy or chemotherapy or both.
- Palliative surgery is aimed at minimizing symptoms associated with cancer. Usually, in such cases, the tumor is so large or has spread so much that removing the entire tumor is not an option. For example, a tumor in the abdomen may be so large that it may press on and block a portion of the intestine, interfering with digestion and causing pain and vomiting.
- Debulking surgery can be used to remove a part of the blockage and to relieve associated symptoms. In tumors that are dependent on hormones, removal of the organs that secrete the hormones is an option. For example, in prostate cancer, the release of testosterone by the testicles stimulates the growth of cancerous cells. Hence, a man may undergo an orchiectomy (removal of testicles) to slow the progress of the disease. Similarly, in a type of aggressive breast cancer, removal of the ovaries (oophorectomy) stops the synthesis of hormones from the ovaries and may slow the progression of the cancer.

Radiation therapy

Radiation kills tumor cells. Radiation is used alone in cases in which a tumor is unsuitable for surgery. More often, it is used in conjunction with surgery and chemotherapy. Radiation can be either external or internal. In the external form, the radiation is aimed at the tumor from outside the body. In internal radiation (also known as brachytherapy), a radioactive substance in the form of pellets or liquid is placed at the cancerous site by means of a pill, injection, or insertion in a sealed container.

Chemotherapy

Chemotherapy is the use of drugs to kill cancer cells. It destroys the hard-to-detect cancer cells that have spread and are circulating in the body. Chemotherapeutic drugs can be given in many forms. The most common administration methods include oral (by mouth) or intravenous administration. Chemotherapy may be given alone or in conjunction with surgery, radiation, or both.

When chemotherapy is used before surgery or radiation, it is known as primary chemotherapy or neoadjuvant chemotherapy. An advantage of neoadjuvant chemotherapy is that since the cancer cells have not been exposed to anti-cancer drugs, they are especially vulnerable. It can, therefore, be used effectively to reduce the size of the tumor for surgery or target it for radiation. The more common use of chemotherapy is adjuvant therapy, which is given to enhance the effectiveness of other treatments. For example, after surgery, adjuvant chemotherapy is given to destroy any cancerous cells that still remain in the body.

Biological and targeted therapies

Biological and targeted therapies use the body's own immune system to destroy cancer cells. As of 2009, this form of treatment was being intensively studied in clinical trials. Many newer agents are used to treat a variety of cancers. The various agents being tested in clinical trials and used as treatment modalities include substances produced by the body (such as the interferons, interleukins, and growth factors), monoclonal antibodies, and vaccines. Unlike traditional vaccines, cancer vaccines do not prevent cancer. Instead, they are designed to treat people who already have the disease. Cancer vaccines work by boosting the body's immune system and training the immune cells to specifically destroy cancer cells.

Hormone therapy

Hormone therapy is standard treatment for some types of cancers that are hormone-dependent and grow faster in the presence of particular hormones. These

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include cancer of the prostate, breast, and uterus. Hormone therapy involves blocking the production or action of these hormones. As a result, the growth of the tumor slows, and survival may be extended.

Bone marrow, stem cell, and cord blood transplantation

The bone marrow is the tissue within the bone cavities that contains blood-forming cells. Healthy bone marrow tissue constantly replenishes the blood supply and is essential to life.

A bone marrow transplant is the removal of marrow from one person and the transplant of the blood-forming cells either to the same person or to someone else. Bone-marrow transplantation, while not a therapy in itself, is often used to "rescue" patients, by allowing those with cancer to undergo aggressive therapy. Stem cell transplants have been performed to replace bone marrow that has been destroyed by cancer, chemotherapy, or **radiation therapy**. Stem cells are specialized cells in the bone marrow from which the body receives a constant source of blood cells. Stem cells may also be harvested from umbilical cords, a process that is referred to as a cord blood transplant. Some cancers in which stem cell transplants may be used include leukemia, lymphoma, and **multiple myeloma**.

Alternative treatment

There are a multitude of alternative treatments available to help the person with cancer. They can be used in conjunction with, or separate from, surgery, chemotherapy, and radiation therapy. Alternative treatment of cancer is a complicated arena and a trained health practitioner should be consulted.

Although the effectiveness of complementary therapies such as **acupuncture** in alleviating cancer pain has not been clinically proven, many cancer patients find it safe and beneficial. Bodywork therapies such as massage and **reflexology** ease muscle tension and may alleviate side effects such as **nausea and vomiting**. Homeopathy and herbal remedies used in Chinese traditional herbal medicine also have been shown to alleviate some of the side effects of radiation and chemotherapy and are recommended by many doctors.

Certain foods, including many vegetables, fruits, and grains, are believed to offer protection against various cancers. However, isolation of the individual constituent of vegetables and fruits that are anti-cancer agents has proven difficult. In laboratory studies, **vitamins** such as A, C, and E, as well as compounds such as isothiocyanates and dithiolthiones found in broccoli, cauliflower, and cabbage, and beta-carotene found in carrots have been shown to protect against cancer. Studies have shown that eating a diet rich in fiber as found in fruits and vegetables reduces the risk of colon cancer. **Exercise** and a low fat diet help control weight and reduce the risk of endometrial, breast, and colon cancer.

Cancer treatment team

Many different specialists generally work together as a team to treat cancer patients. An oncologist is a physician who specializes in cancer care. The oncologist provides chemotherapy, hormone therapy, and any other non-surgical treatment that does not involve radiation. The oncologist often serves as the primary physician and coordinates the patient's treatment plan.

The radiation oncologist specializes in using radiation to treat cancer, whereas the surgical oncologist performs the operations needed to diagnose or treat cancer. Gynecologist-oncologists and pediatric-oncologists, as their titles suggest, are physicians involved with treating women's and children's cancers, respectively. Many other specialists also may be involved in the care of a cancer patient. For example, radiologists specialize in the use of x rays, ultrasounds, CT scans, MRI imaging and other techniques that are used to diagnose cancer. Hematologists specialize in disorders of the blood and are consulted in case of blood cancers and bone marrow cancers. The samples that are removed for biopsy are sent to a laboratory, where a pathologist examines them to determine the type of cancer and extent of the disease. There are many other specialties, and virtually any type of medical or surgical specialist may become involved with care of the cancer patient should it become necessary.

Prognosis

Lifetime risk is the phrase that cancer researchers use to refer to the probability that an individual over the course of a lifetime will develop cancer or die from it. In the United States, men have a one in two lifetime risk of developing cancer, and for women the risk is one in three. Overall, African Americans are more likely to develop cancer than whites. African Americans are also 30% more likely to die of cancer than whites.

Many cancers are curable if detected and treated in their early stages. A cancer patient's prognosis is affected by many factors, particularly the type of

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JANET D. ROWLEY (1925–)

Janet Davison Rowley was born in New York City on April 5, 1925, to Ethel Mary (Ballantyne) and Hurford Henry Davison. Rowley attended the University of Chicago, earning her B.S. degree in 1946 and her M.D. degree in 1948. She also married Donald A. Rowley in 1948, and the couple ultimately had four sons. Rowley completed both her internship and residency at Chicago hospitals before returning to the University of Chicago Medical School where she conducted research from 1962-1969. She became an associate professor, and finally, in 1977, earned her position as a full professor.

Rowley's research has focused on understanding cancer, with special emphasis on its cytogenetic causes. Her development and use of Giemsa and quinacrine stains enabled Rowley to discover oncogenes and to ultimately show a consistent shifting or translocation of genetic material in chronic myeloid leukemia cells. Rowley's discoveries and continued research have shown that malignant cells in humans undergo this translocation and deletion of genes that cause tumors to grow. Her research has given oncologists new pathways to explore concerning gene therapies for the treatment of cancer.

Co-editor and co-founder of the journal, *Genes, Chromosomes and Cancer*, Rowley has published an abundance of materials including *Chromosome Changes in Leukemia* (1978), *Genes and Cancer* (1984), and *Advances in Understanding Genetic Changes in Cancer* (1992). Rowley has also received many awards and honors for her work and research.

In 1984, Dr. Rowley was made the Blum-Riese Distinguished Service Professor at the University of Chicago, a position she still holds, as well as serving as the interim deputy dean for science since 2001. In 1998, she was one of three scientists awarded the prestigious Lasker Award for their work on translocation. She has published more than 400 articles and continues her research at the University of Chicago.

cancer the patient has, the stage of the cancer, the extent to which it has metastasized, and the aggressiveness of the cancer. In addition, the patient's age, general health status, and the effectiveness of the treatment being pursued are important factors.

To help predict the future course and outcome of the disease and the likelihood of recovery from the disease, doctors often use statistics. The five-year survival rates are the most common measures used. The number refers to the proportion of people with cancer who are expected to be alive five years after initial diagnosis compared with a similar population that is free of cancer. It is important to note that while statistics can give some information about the average survival experience of cancer patients in a given population, they cannot be used to indicate individual prognosis because no two patients are exactly alike.

Prevention

According to nutritionists and epidemiologists from leading universities in the United States, a person can reduce the chances of getting cancer by following some simple guidelines:

- eating plenty of vegetables and fruits
- exercising vigorously for at least 30 minutes on 5 or more days every week. Forty-five to sixty minutes of moderate to vigorous physical activity is preferable.
- avoiding excessive weight gain
- avoiding tobacco (even secondhand smoke)
- decreasing or avoiding consumption of animal fats and red meats
- avoiding excessive amounts of alcohol
- avoiding the midday sun (between 11 a.m. and 3 p.m.) when the sun's rays are the strongest
- avoiding risky sexual practices
- avoiding known carcinogens in the environment or work place

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American Cancer Society, 250 Williams Street, Atlanta, GA, 30303-1002, (800) ACS-2345, https://www.cancer.org/.

National Cancer Institute, 6116 Executive Blvd., Room 3036A, Bethesda, MD, 20892-8322, (800) 422-6237, http://www.cancer.gov.

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National Coalition for Cancer Survivorship, 1010 Wayne Avenue, 5th Floor, Suite 300, Silver Spring, MD, 20910, (888) 650-9127, http://www.canceradvocacy.org/.

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Cancer chemotherapy drugs *see* **Anticancer drugs**

Cancer therapy, definitive

Definition

Definitive **cancer** therapy is a treatment plan designed to control and potentially cure cancer using one or a combination of interventions including surgery, radiation, **chemotherapy**, biological or targeted therapies.

Purpose

The primary purpose of definitive care is to establish a cure and to destroy and remove all cancer cells from the person diagnosed with cancer.

Surgery

Surgery is not only a diagnostic tool, but is also used for **tumor removal**. The surgeon usually identifies potential candidates for tumor removal which typically occurs during a surgical procedure. Surgery can be curative for some stomach, genital/urinary, thyroid, breast, skin, and central nervous system cancers. The best chance for a surgical cure is usually with the first operation. It is essential that the cancer surgeon (oncologic surgeon) be experienced in the specific procedure.

Radiation therapy

Radiation therapy is administered to many cancer patients during the course of treatment of cancer. This type of treatment can be used as the sole method of cure for tumors in the mouth and neighboring structures in the oral cavity, vagina, prostate, cervix, esophagus, Hodgkin's disease, and certain types of cancer in the spinal cord and brain. Research and clinical trials have demonstrated that combination treatment is typically more effective than radiation therapy alone.

Chemotherapy

Chemotherapy is curative treatment strategy for some cancers. It is most effective against **choriocarcinoma**, cancer of the testis, some types of lymphomas, and cancer of skeletal muscles.

Biological and targeted therapies

Biological therapies and targeted therapies offer a newer and promising direction for cancer control and cure. Targeted therapies interfere with the actions of specific molecules involved in the growth and progression of cancerous tumors. One type of targeted therapy is directed toward stopping angiogenesis, which is the development of a blood supply to the tumor. Usually when cancer cells grow they manage to derive a blood supply that allows passage of nutrients promoting continuation of abnormal cancer growth. Treatment that focuses on destroying these blood vessels is called antiangiogenesis therapy. Cutting off the blood supply has been shown to destroy tumors, since this stops the flow of essential nutrients required for cancer growth.

Other examples of targeted therapies include use of certain growth factors which can stimulate self-destructive pathways in cancer cells (apoptosis) and **gene therapy**, which is directed toward inhibiting specific cellular signals that promote cancer cell multiplication.

Description

Surgery

Surgical removal of the tumor must be performed with care and accuracy. The surgeon must avoid overmanipulation of the surgical field. Too much movement within the area can cause cancer cell displacement into surrounding tissue. If this occurs and no further treatment is administered, the tumor may grow again. The surgeon also should perform an assessment concerning tissue removal around the cancer site. Tissue around the site may not seem cancerous by visual inspection, but adjacent structures may have cancer cells which can only be detected microscopically. Surrounding tissue removal is usually part of the operative procedure. Pieces of tumor and the surrounding area are analyzed microscopically during the operation for cell type. An adequate resection (removal of tissue) will reveal normal cells in the specimens analyzed from areas bordering the cancerous growth.

Surgery can also help to decrease the tumor bulk (size) and, along with other treatment measures, may provide a cure for certain cancers. Surgery generally works best on slow-growing cancers.

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Not only can surgery be curative for some cancers, but it is an essential diagnostic tool. Examples of diagnostic procedures which can be done in the surgical environment include an aspiration biopsy, in which a needle is inserted to extract (aspirate) fluid contained inside a cancerous growth; a needle biopsy in which the surgeon uses a specialized needle to obtain a core tissue specimen; an incision biopsy which removes a section from a large tumor; and an excision biopsy, a procedure which removes the entire tumor. The surgeon also can take samples of neighboring lymph nodes. Cancer in surrounding lymph nodes is an important mechanism for distant spread of cancer to other areas. If microscopic analysis determines the presence of cancer cells in lymph nodes, the surgeon may decide to perform a more aggressive surgical approach.

Radiation therapy

Similar to surgical intervention, radiation therapy is a localized treatment. It involves the administration of ionizing radiation to a solid tumor location. This generates reactive oxygen molecules, causing the destruction of DNA in local cells. There are three commonly used radiation therapy beams: gamma rays from a linear accelerator machine produce a focused beam; orthovoltage rays are of less energy, thus penetrate less and typically deliver higher doses to superficial tissues (efficient for treating skin cancers); and megavoltage rays are high energy producing beams that can penetrate deeply situated internal organs, while sparing extensive skin damage.

Brachytherapy delivers radiation internally by placing radioactive materials such as radioactive seeds and pellets within close proximity or directly into the cancerous tumor. Teletherapy delivers radiation to a specific area of the body using a machine which delivers a beam of radiation from a source which is external to the body.

Chemotherapy

Chemotherapy drugs work by disrupting cancer cell division which leads to cell **death**. Combining several different chemotherapy agents with different mechanisms of action and different toxicity profiles often results in more effective therapy and is known as combination chemotherapy. Chemotherapy is considered to be systemic therapy because it is typically administered via the blood and circulates through the entire body. The choice of chemotherapeutic agents depends on the specific type of cancer and the effectiveness of that drug(s) on the specific cancer being treated.

Curative chemotherapy usually requires multiple administrations of the chemotherapy drug over several months. This is referred to as a treatment cycle.

Biologic or targeted therapy

Targeted therapies, as the name implies, are designed to target specific molecular flaws of cancer cells. Some drugs in this classification target specific proteins produced by cancer cells, some target cancer cell communication pathways in an attempt to disrupt the pathways, some work to inhibit new blood vessel growth required to sustain a tumor, while other drugs target the pathways in cancer cells which facilitate the ability of cancer cells to metastasize.

Biologic therapies primarily function to alter the patient's response to cancer. These treatments tend to stimulate specific immune cells or immune chemicals to destroy cancer cells.

Precautions

Surgical resection requires an experienced surgeon and surgical team, preoperative assessment, imaging studies, and delicate operative technique. Care should be taken during the procedure to avoid unnecessary tumor manipulation, which can cause cancer cells to infiltrate adjacent structures. If manipulation is excessive, cells can enter nearby areas for future re-growth. Accurate isolation of the tumor also can help avoid contamination of the surgical area. Early ligation of the blood supply to the tumor is an essential component of a surgical cure.

Radiation therapy requires extensive treatment planning and imaging. Care must be taken to localize the cancer treatment field while attempting to spare normal tissue from the effects of radiation. This requires image monitoring and exact positioning during radiation treatment sessions.

Chemotherapy usually causes destruction of normal cells, and some cancer cells can develop immunity or become refractory to the effects of chemotherapy. These agents must be administered only by clinicians who are experienced and who have been educated specifically in the administration of these very potent drugs. Side effects and patient tolerance issues typically are anticipated and dosages may have to be specifically altered.

Biological or targeted therapies may cause patient toxicity resulting in extensive side effects. The side effect profile of biologic or targeted agents is usually different from the side effect profile of chemotherapy agents. Side effects of biologic or targeted agents are usually specific to the classification of the drug while some drugs have their own unique side effects.

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KEY TERMS

Bone marrow suppression—A decrease in cells responsible for providing immunity, carrying oxygen, and those responsible for normal blood clotting.

DNA—The molecule responsible for cell multiplication.

Titrate—To analyze the best end point (for dose) for a medication.

Preparation

For all treatment modalities imaging studies, biopsy, and constant blood analysis is essential before, during, and after treatments. Surgical candidates should undergo extensive pre-operative evaluation with imaging studies, blood chemistry analysis, stabilized health status, and readiness of staff for any potential complications and cell biopsy analysis. Patients with other pre-existing chronic disease may require intensive post-operative monitoring.

Prior to radiotherapy, the patient undergoes extensive imaging studies. Additional planning strategies include beam localization to spare normal tissues, calibration of fractionated doses, and specific positioning during treatment sessions.

Patients who receive curative chemotherapy should be informed of possible side effects associated with the chemotherapeutic agent. Patients should also be informed of temporary lifestyle changes and medications that may offer some symptomatic relief.

Patients undergoing biologic or targeted therapies should be advised of potential side effects, treatment cycles, and specific tests for monitoring progress.

Aftercare

Patients will typically be evaluated by imaging studies, blood analysis, **physical examination**, and will be observed for response to treatment. These follow-up visits usually occur at specific time intervals during the course of treatment. Surgical patients may require closer observation during the initial post-operative period to avoid potential complications. **Reconstructive surgery** can be considered to improve appearance and restore function. Certain surgical procedures (such as flaps and microsurgery of blood vessels) can restore new tissues to a previous surgery site.

Risks

Surgical risks

Surgical therapy can be both disfiguring and disabling. Any surgical procedure contains a risk for complications during and after the procedure in the post-operative period. Patients are monitored very closely during and after surgery to minimize the risk of complications.

Radiation risks

Many normal tissues can be adversely affected by radiation therapy. Side effects from radiation therapy are dependent on the area being treated. Some of the more common side effects which can occur shortly after a treatment cycle include **nausea**, **vomiting**, **fatigue**, loss of appetite, and bone marrow suppression (a decrease in the cells that provide defense against infections and those that carry oxygen to cells). Radiation therapy also can cause skin changes in the skin in the treatment field, difficulty swallowing, oral gum disease, and **dry mouth**. Additionally, radiation therapy can cause damage to local structures within the irradiated field.

Chemotherapy risks

Many commonly utilized chemotherapy agents cause bone marrow suppression as a side effect of treatment. Additionally, cells called platelets—important for normal blood clotting—may be significantly lowered, causing patients to bleed. This may be problematic enough to limit the treatment course. Bone marrow suppression can increase susceptibility to infection. Some chemotherapy agents may also cause **infertility**. Patients commonly have bouts of **nausea and vomiting** shortly after a treatment session. Rapidly multiplying normal cells also are affected such as skin cells (causing blistering and ulceration) and hair cells causing loss of hair, a condition called **alopecia**.

Biologic therapy risks

Biologic therapies can cause patients to develop suppression of cells that help the body fight against infection. As with all other treatment methods for cancer, patients will be screened very carefully to determine if the benefits of the treatment outweigh the potential risks to the patient.

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Cancer therapy, palliative

Definition

Palliative **cancer** therapy is treatment specifically designed to help improve symptoms at the end of life associated with advanced and/or terminal cancer. **Palliative care** has evolved to become an integral component of cancer care and is typically provided by a team of multidisciplinary health care professionals.

Demographics

Currently, it is estimated that approximately 40% of patients diagnosed with cancer—about 550,000 people per year in the United States—will die from their cancer. The end-of-life care of many of these patients will be delivered by professionals skilled in hospice or palliative cancer care.

Description

Palliative care is directed at improving symptoms associated with advanced and incurable cancer. The five major precepts of palliative care, which were delineated as part of the Robert Wood Johnson Foundation-funded Last Acts campaign to improve quality of care at the end of life, include:

- respect for patient wishes and goals related to end-of-life decisions
- provision of comprehensive end-of-life care
- integration of care delivery from a multidisciplinary perspective
- incorporating the caregiver in to the plan of care at the end of life
- developing adequate support systems for the patient, caregiver, and family

Palliative care can include surgery, **radiation therapy**, **chemotherapy**, hormone therapy, and other specialized therapies, as well as treatment of symptoms resulting from cancer, and providing relief from side effects of treatment. The primary objective of palliative care is to improve the quality of the remainder of a patient's life. Treatment usually involves a combination of modalities (multimodality approach) and numerous specialists typically are involved in the treatment planning process. Therapeutic planning usually involves careful coordination with the treatment team. The approach to palliative care also involves easing psychosocial problems and typically incorporates an emphasis on the patient's family.

Causes and symptoms

Some signs of advanced cancer include extreme **fatigue** and weakness that is progressive, unexplained weight loss, **pain**, and **shortness of breath**, especially if the cancer has spread to the lungs.

There is the potential for a wide range of symptoms as the cancer progresses to the advanced or terminal phase. These symptoms include pain, myoclonus, dyspnea, **anxiety**, **delirium**, and noisy breathing or "rattle" among a variety of other symptoms.

Pain is one of the common symptoms associated with cancer. Approximately 75% of terminal cancer patients have pain. Pain is a subjective symptom and thus it cannot be measured using technological approaches. Pain can be assessed using numeric scales (from 1 to 10, 1 is rated as no pain while 10 is severe) or by rating specific facial expressions associated with various levels of pain. The majority of cancer patients experience pain as a result of tumor mass that compresses neighboring nerves, bone, or soft tissues, or from direct nerve injury (neuropathic pain). Pain can occur from affected nerves in the ribs, muscles, and internal structures such as the abdomen (cramping type pain associated with obstruction). Many patients also experience various types of pain as a direct result of follow-up tests, treatments (surgery, radiation, and chemotherapy) and diagnostic procedures (i.e., biopsy).

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Diagnosis

Patients typically are informed that their diagnosis is terminal and treatments are directed to improve quality of life and ease suffering at the end of life.

Examination

The physician may perform a **physical examination** to help confirm advanced cancer based on the signs and symptoms the patient is experiencing. Results of this physical exam may include evidence of fluid in the lungs or abdominal area. An enlarged liver may be palpated by the physician, or external lumps that are comprised of tumor may be able to be seen and palpated on various areas of the body.

Tests

Blood test results that may confirm advanced cancer include elevated levels of **tumor markers** in the blood, elevated **liver function tests** and liver enzymes, and elevated or decreased white blood cells, red blood cells, and/or platelets, among other findings.

Imaging tests such as x rays and CT, MRI, **PET**, bone, and ultrasound scans may be conducted to determine the location and spread of the cancer.

A comprehensive palliative care assessment should be conducted to evaluate the following:

- benefits and risks associated with continuing treatments and therapies directed at controlling the cancer
- physical symptoms and problems such as pain, anorexia, dyspnea, nausea/vomiting, constipation, fatigue, weakness, alterations with sleep, and delirium, as well as other problems
- psychosocial symptoms and problems including spiritual needs
- the patient's and family's goals and wishes related to end-of-life care
- educational level to determine information needs and requirements
- the impact of cultural beliefs on preferences related to end-of-life care

Treatment

Surgery can be utilized for palliation after careful evaluation and planning. The use of surgery in these cases may reduce the tumor bulk and help improve the quality of life by relieving pain, alleviating obstruction, or controlling bleeding. Radiation therapy for terminal cancer patients can also alleviate pain, bleeding, and obstruction of neighboring areas. A combination of radiation therapy and bisphosphanates offers palliative relief to patients with metastatic bone disease (metastatic disease is cancer that has spread beyond the original site or organ to other areas of the body). Chemotherapy may be helpful to reduce tumor size and provide some reduction to metastatic disease. Long-term chemotherapy patients develop drug resistance, a situation that renders chemotherapeutic treatments ineffective. If this occurs, patients usually are given a second-line medication or, if admission criteria are met, they may participate in an experimental research protocol. Palliative treatments and terminal cancer in combination can cause many symptoms that can become problematic. These symptoms commonly include pain, **nausea**, **vomiting**, difficulty breathing, **constipation**, **dehydration**, agitation, and delirium. The palliative treatment-planning goal focuses on reducing these symptoms.

Surgery for **tumor removal**, biopsy, or size reduction is associated with postoperative pain and local nerve damage, which may be both severe and difficult to alleviate. Chemotherapy and radiation therapy also can produce nerve damage and severe pain. Additionally, patients with malignant cancer are susceptible to infections such as herpes, **pneumonia**, urinary tract infections, and wound **abscess**, all of which can cause severe pain. Pain associated with cancer and/or treatments can significantly impair the patient's abilities to perform daily tasks and hence impair quality of life. These complications may negatively impact the patient's psychological well-being.

Drugs

Drugs that may be used in palliative care include:

- opioids, benzodiazepines, glycopyrrolate, and scopolamine—used to treat dyspnea in advanced cancer
- appetite stimulants such as megestrol acetate, medroprogesterone acetate, and steroids—used to ameliorate the effects of anorexia/cachexia
- antiemetics such as prochlorperazine, haloperidol, metoclorpramide, 5-HT3 receptor antagonists, and others—used to treat nausea and vomiting
- biscodyl, glycerine suppositories, polyethylene glycol, lactulose, magnesium hydroxide, magnesium cirate, and/or methylnaltrexone—used to treat constipation in advanced cancer
- haloperidol, risperidone, olanzapine, or quetiapine fumarate—used in the treatment of delirium at the end of life

Prognosis

Palliative cancer care is typically offered to patients with six months to one year of life expectancy.

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Prevention

Currently, the only way to prevent a cancer from spreading and developing into an advanced or incurable cancer is to detect the cancer prior to metastatic spread and to initiate treatment for the cancer as soon as possible after diagnosis.

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American Cancer Society, 250 Williams Street, Atlanta, GA, 30303-1002, (800) ACS-2345, https://www.cancer.org/.

American Pain Society, 4700 W. Lake Ave., Glenview, IL, 60025, (847) 375-4715, (866) 574-2654, info@ampainsoc. org, http://www.ampainsoc.org/.

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Cancer therapy, supportive

Definition

Supportive **cancer** therapy is the use of medicines to counteract unwanted effects of cancer treatment.

Purpose

Along with their beneficial effects, many cancer treatments produce uncomfortable and sometimes harmful side effects. For example, cancer drugs may cause **nausea** or **vomiting**. They also may destroy red or white blood cells, resulting in a low blood count. Fortunately, many of these side effects can be relieved with other medicines.

Description

Different kinds of drugs are used for different purposes in supportive cancer therapy. To relieve **nausea and vomiting**, a physician may prescribe dolasetron (Anzemet), granisetron (Kytril) or ondansetron (Zofran). Drugs called colony stimulating factors are used to help the bone marrow make new white blood cells to replace those destroyed by cancer treatment. Examples of colony stimulating factors are filgrastim (Neupogen) and sargramostim (Leukine). Another type of drug, epoetin (Epogen, Procrit), stimulates the bone marrow to make new red blood cells and help patients overcome anemia. It is a synthetically made version of human erythropoietin that is made naturally in the body and has the same effect on bone marrow.

Some physicians who treat cancer recommend that their patients use **marijuana** to relieve nausea and **vomiting**. This practice is controversial for several reasons. Using marijuana, even for medicinal purposes, is illegal in most states. Also, most of the evidence that marijuana effectively relieves nausea and vomiting comes from reports of people who have used it, not from carefully designed scientific studies called clinical trials. An oral medication that contains one of the active ingredients of marijuana is available with a physician's prescription and sometimes is used to treat nausea and vomiting in patients undergoing cancer treatment. However, the drug, dronabinol (Marinol), takes longer to work than smoked marijuana and may be difficult for patients with nausea and vomiting to swallow and keep down.

In 1997, the National Institutes of Health issued a report calling for more research into medical uses of

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marijuana. The panel of experts who wrote the report also recommended that researchers investigate other ways of getting the active ingredients of marijuana into the body, such as nasal sprays, skin patches and inhalers. In 2000, the American Cancer Society funded research into a skin patch. A 2003 report said that a University of Kentucky researcher had applied for a patent for the patch which used synthetic cannabinoids.

Patients who want to use marijuana to relieve side effects of cancer treatment should talk to their physicians and should carefully consider the benefits and risks, both medical and legal.

Recommended dosage

The recommended dosage depends on the type of supportive cancer therapy. The physician who prescribed the drug or the pharmacist who filled the prescription can recommend the correct dosage.

Precautions

Dolasetron, granisetron, and ondansetron

If severe nausea and vomiting occur after taking these medications, patients should check with a physician.

The use of ondansetron after abdominal surgery may cover up symptoms of stomach problems.

People with **liver disease** may be more likely to have side effects from ondansetron.

Colony stimulating factors

Certain cancer drugs reduce the body's ability to fight infections. Although colony stimulating factors help restore the body's natural defenses, the process takes time. Getting prompt treatment for infections is important, even while taking this medicine. A patient should call the physician at the first sign of illness or infection, such as a **sore throat**, **fever**, or chills.

Seeing a physician regularly while taking this medicine is important. This will give the physician a chance to make sure the medicine is working and to check for unwanted side effects.

People with certain medical conditions may have problems if they take colony stimulating factors. In people who have **kidney disease**, liver disease, or conditions caused by inflammation or immune system problems, colony stimulating factors may make these problems worse. People with heart disease may be more likely to have side effects such as water retention and heart rhythm problems when they take these drugs. And people with lung disease may be more likely to have **shortness of breath**. Anyone who has any of these medical conditions should check with his or her physician before using colony stimulating factors.

Epoetin

This medicine may cause seizures (convulsions), especially in people with a history of seizures. Anyone who takes these drugs should not drive, use machines or do anything else that might be dangerous if they have had a seizure.

Epoetin helps the body make new red blood cells, but it cannot do its job unless there is plenty of iron in the body. The physician may recommend taking iron supplements or certain **vitamins** that help get iron into the body. Following the physician's orders to make sure the body has enough iron for this medicine makes it work. Iron supplements should not be taken unless they are prescribed by a physician.

In studies of laboratory animals, epoetin taken during **pregnancy** caused **birth defects**, including damage to the bones and spine. However, the drug has not been reported to cause problems in human babies whose mothers take it. Women who are pregnant or who may become pregnant should check with their physicians for the most up-to-date information on the safety of taking this medicine during pregnancy.

People with certain medical conditions may have problems if they take this medicine. For example, the chance of side effects may be greater in people with high blood pressure, heart or blood vessel disease, or a history of **blood clots**. Epoetin may not work properly in people who have bone problems or sickle cell anemia.

Research continues on the benefits of epoetin as a supportive cancer therapy. One 2003 report said new research showed doubt as to its effectiveness in treating anemia, while other reports confirmed it worked well. In mid-2003, a new large clinical trial (CREATE) was beginning in England to help determine epoetin's effectiveness.

Dronabinol

This medicine contains sesame oil and one of the active ingredients of marijuana. Anyone who has had allergic or unusual reactions to sesame oil or marijuana products should let his or her physician know before taking dronabinol.

Because dronabinol works on the central nervous system, it may add to the effects of alcohol and other drugs that slow down the central nervous system. Examples of these drugs are **antihistamines**, cold medicine, allergy medicine, sleep aids, medicine for

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seizures, tranquilizers, some **pain** relievers, and **muscle relaxants**. Dronabinol also may add to the effects of anesthetics, including those used for dental procedures. Anyone taking dronabinol should not drink alcohol and should check with his or her physician before taking any of the drugs listed previously.

This drug makes some people feel drowsy, dizzy, lightheaded or "high," with a sense of well-being. Because of these possible reactions, anyone who takes dronabinol should not drive, use machines or do anything else that might be dangerous until they have found out how the drug affects them. The **dizziness** and lightheadedness are especially likely when getting up after sitting or lying down. Getting up gradually and holding onto something for support should lessen the problem.

In laboratory studies, giving high doses of dronabinol to pregnant animals increased the risk of the unborn baby's **death**. The medicine's effects on pregnant women have not been studied. Women who are pregnant or who may become pregnant should check with their physicians before taking this medicine.

Dronabinol passes into breast milk and may affect nursing babies whose mothers take the medicine. Women who are **breastfeeding** their babies should check with their physicians before using dronabinol.

Because of its possible mind-altering effects, dronabinol should be used with care in children and older people. Both children and older people should be watched carefully when they are taking this medicine.

Using dronabinol may worsen some medical conditions, including high blood pressure, heart disease, **bipolar disorder**, and **schizophrenia**.

General precautions for all types of supportive cancer therapy

Anyone who previously has had unusual reactions to drugs used in supportive cancer therapy should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

Side effects

Dolasetron, granisetron, and ondansetron

The most common minor side effects are **headache**, dizziness or lightheadedness, drowsiness, **dry mouth**, **diarrhea**, **constipation**, abdominal pain or stomach cramps, and unusual tiredness or weakness. These problems usually do not require medical treatment.

A physician should be notified as soon as possible if fever occurs after taking granisetron.

If any of these symptoms occur after taking ondansetron, the patient should check with a physician immediately:

- breathing problems or wheezing
- chest pain or tightness in chest
- skin rash, hives or itching

Colony stimulating factors

As this medicine starts to work, it may cause mild pain in the lower back or hips. This is nothing to worry about, and it will usually go away within a few days. If the pain is too uncomfortable, the physician may prescribe a painkiller. A physician needs to know if the painkiller does not help.

Other possible side effects include headache, joint or muscle pain, and skin rash or **itching**. These side effects usually go away as the body adjusts to the medicine and do not need medical treatment. If they continue or interfere with normal activities, a physician should be notified.

Epoetin

This medicine may cause flu-like symptoms, such as muscle aches, bone pain, fever, chills, shivering, and sweating, within a few hours after it is taken. These symptoms usually go away within 12 hours. If they do not, or if they are troubling, a physician should be told. Other possible side effects that do not need medical attention are diarrhea, nausea or vomiting, and tiredness or weakness.

Certain side effects should be brought to a physician's attention as soon as possible. These include headache, vision problems, increased blood pressure, fast heartbeat, weight gain, and swelling of the face, fingers, lower legs, ankles, or feet.

Anyone who has chest pain or seizures after taking epoetin should check with a physician immediately.

Dronabinol

Side effects such as dizziness, drowsiness, confusion and clumsiness or unsteadiness usually do not need medical attention unless they are long-lasting or they interfere with normal activities.

Other side effects or signs of overdose should have immediate medical attention. These include:

- fast or pounding heartbeat
- constipation

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KEY TERMS

Bipolar disorder—A severe mental illness in which a person has extreme mood swings, ranging from a highly excited state — sometimes with a false sense of well-being — to depression

Bone marrow—Soft tissue that fills the hollow centers of bones. Blood cells and platelets (disk-shaped bodies in the blood that are important in clotting) are produced in the bone marrow.

Hallucination—A false or distorted perception of objects, sounds, or events that seems real. Hallucinations usually result from drugs or mental disorders.

Immune system—The body's natural defenses against disease and infection.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Schizophrenia—A severe mental disorder in which people lose touch with reality and may have illogical thoughts, delusions, hallucinations, behavioral problems, and other disturbances.

Sickle cell anemia—An inherited disorder in which red blood cells contain an abnormal form of hemoglobin, a protein that carries oxygen. The abnormal form of hemoglobin causes the red cells to become sickle- or crescent-shaped. The misshapen cells may clog blood vessels, preventing oxygen from reaching tissues and leading to pain, blood clots and other problems. Sickle cell anemia is most common in people of African descent and in people from Italy, Greece, India, and the Middle East.

- trouble urinating
- red eyes
- slurred speech
- mood changes, including depression, nervousness, or anxiety
- confusion
- forgetfulness
- changes in sight, smell, taste, touch, or hearing
- a sense that time is speeding up or slowing down
- hallucinations

General advice on side effects for all types of supportive cancer therapy

Other side effects are possible with any type of supportive cancer therapy. Anyone who has unusual symptoms during or after treatment with these drugs should get in touch with his or her physician.

Interactions

Anyone who has supportive cancer therapy should let the physician know all other medicines he or she is taking. Some combinations of drugs may interact, which may increase or decrease the effects of one or both drugs or may increase the risk of side effects. Patients should ask their physician if the possible interactions can interfere with drug therapy or cause harmful effects.

Resources

PERIODICALS

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Cancer vaccines

Definition

Cancer vaccines are biological response modifiers that stimulate the immune system. Cancer preventative vaccines are substances that prevent healthy people from developing cancer by targeting infectious organisms that contribute to cancer development. They work in the same way as traditional vaccines (e.g., **mumps**, **measles**, **rubella**, **polio**). Cancer treatment vaccines are a method of treating cancer involving administration of one or more substances characteristic of the cancer, called antigens, often in combination with factors that boost immune function. This induces the patient's immune system to attack and eliminate the cancerous cells.

Purpose

In 2006, the U.S. Food and Drug Administration (FDA) approved the cancer preventative vaccine, Gardasil, that protects against certain human papilloma viruses associated with the development of **cervical cancer**. A second preventative cancer vaccine called Cervarix, which also protects against certain human

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papilloma viruses, has been approved in Europe, but is not, as of 2010, available in the United States. The only other cancer preventative vaccine approved in the United States is the **hepatitis B** vaccine (HBV or HepB). It is an injection that protects individuals from contracting hepatitis B, a serious disease that contributes to the development of **liver cancer**.

Cancer treatment vaccines are in clinical trials in the United States, but as of 2010, none have been approved by the FDA. Most cancer vaccines are a method of treating cancer that has already occurred and are given to patients already diagnosed with cancer. As a cancer treatment method, the ultimate goal of most cancer vaccines is the elimination of tumor or cancerous cells from the body. Other cancer vaccines are given after the use of more traditional treatments, such as **chemotherapy**, radiation, or surgery, with the aim of suppressing the recurrence of the cancer.

Description

There are four general types of cancer vaccines, those that use whole tumor cells, those that use only one substance derived from the tumors, those using more than one substance derived from tumors, and those that administer primed cells from the patient's immune system.

Whole cell vaccines

Whole cell vaccines are autologous when they contain only inactivated tumor cells from the patient's own tumors. The cells have been isolated from the tumor and made to grow in the laboratory, a process known as creating a cell line. Allogeneic whole cell vaccines are made from inactivated tumor cells isolated from one or more other people. The main advantage to autologous vaccines is the direct relation between the vaccine and the tumor target. However, because of the screening of self antigens away from a body's own immune system, immune response to tumor antigens in autologous whole cells vaccines can be low.

Allogeneic vaccines avoid some of the problems of autologous vaccines. First, cell lines do not have to be created for each patient, a labor-intensive process that can have highly variable results. Second, the same vaccine can be given to all patients, making the response to the vaccine more predictable. Third, using a pool of tumor cells can increase the possibility of having the full repertoire of the tumor antigens in the vaccine. This helps to overcome the ability of tumor cells to escape notice by the immune system. Finally, by using well-characterized cell lines, it is much easier for the researcher to add genetic modifications that increase the immune system's response to the cells.

Isolated antigen vaccines

There are many kinds of vaccines that deliver only a portion of the tumor cell that will elicit an immune response, called an antigen. Some antigens are unique to a cancer type, some are unique to an individual tumor, while a very few are found in more than one cancer type. For example, vaccines against telomerase and human chorionic gonadotripin (hCG), two proteins produced by many cancers, have been developed, raising hopes for the development of a universal cancer vaccine.

The most common kind of antigen used in cancer vaccines is a protein or a part of a protein. The protein can actually be isolated from the tumor cells, or more commonly, produced in large quantity using genetic engineering techniques. When a part of a protein is used, experimental efforts generally preceded the vaccine production to determine what parts of the protein most often are the target of immune responses. Parts of proteins that elicit immune responses are called epitopes.

Antigens do not necessarily have to be proteins. Immune responses are also mounted against the carbohydrate (sugar) molecules present on the surface of the proteins. Tumor proteins can have unusual carbohydrate structures that set them apart from cells of normal tissue. Carbohydrates are also found in abundant numbers on the surface of the tumor cells. Accordingly, researchers have developed cancer vaccines that combine the tumor-characteristic carbohydrates anchored on protein bases. These vaccines are being tested for their ability to reduce the recurrence of **prostate cancer**.

Vaccines can also contain the naked genetic material encoding the protein (either deoxyribose nucleic acid, DNA, or ribose nucleic acid, RNA). After the genetic material gains entry to the cell, the cellular machinery uses it to produce the antigen and an immune response is mounted against it. Animal studies have found that these types of vaccines are very dependent on the particular antigen and the mode of administration of the vaccine. A unique method of delivery used with DNA or RNA vaccines is the coating of tiny gold beads with the genetic material and shooting the beads into the skin.

Genetically engineered viruses can also be used to bring the DNA or RNA into the cell. When used in this way the viruses are called viral vectors. One example of a viral vector being used as a cancer vaccine is based on the

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adenovirus. When viruses are used as vectors they have been altered to no longer cause disease, but they do retain the ability to infect human cells. Instead of making new viruses, the infected cells make the desired antigen, and the body responds against it. Viral vectors can also carry the genetic instructions for factors, called cytokines, which boost the immune system's response to the antigen. This process of using a virus that no longer causes a disease but promotes the creation of antigens is used to develop vaccines to prevent cancer from developing. As of 2010, there are two types of preventative vaccines for cancer; hepatitis B virus for the prevention of liver cancer and human papillomavirus vaccine, which reduces one of the main causes of cervical cancer.

Antigen-presenting cell (APC) vaccines

Vaccines can also be made that contain cells from the patient's own immune system called antigen-presenting cells (APCs). These cells play a central role in the development of an immune response against a particular antigen. Specifically, APCs ingest the antigen and present them to the T cells, a type of immune cells responsible for targeting and killing cells seen as foreign to the body. If T cells are exposed to the antigen by an APC, as opposed to seeing the antigen on the cell itself, they are more strongly activated. That is, more T cells that specifically attack that antigen are produced and the immune response against the foreign cell is stronger.

Dendritic cells are a type of APC that is most effective in activating T cells. For this reason, they are often the kind of cells used in APC vaccines. Unfortunately, the number of dendritic cells circulating in the blood at any one time is relatively low. New techniques have been developed that allow that small number of dendritic cells to be isolated and then stimulated outside the body to result in a usable number. During stimulation, the dendritic cells are exposed to the tumor antigen, a process known as priming. When injected into the body, the dendritic cells are primed to recruit large numbers of T cells specific against the tumor antigen.

Cytokines and adjuvants

Since tumor cells are able to escape detection by the immune system, an important component of many cancer vaccines is the addition of biological factors or chemical adjuvants to help boost immune response. One type of adjuvant is a cytokine, a factor normally produced by cells of the immune system to help recruit cells to the site of the foreign cells or help T cells function. Examples of cytokines used in vaccines are granulocyte/macrophage colony stimulating factor (GM-CSF, or sargramostim), the interleukins (especially IL-2), the interferons (INFs), and tumor necrosis factor alpha (TNF-α).

Adjuvants are chemical additions to vaccines that help boost the response to the contained cells or antigens. Adjuvants are derived from a variety of sources and can be isolated from animals, plants, or are synthetic chemical compounds. Several adjuvants in use with cancer vaccines are keyhole lympocianin (KLH, derived from shell-dwelling sea animals), incomplete Freud's adjuvant (IFA, mineral oil and an emulsifying agent), and QS-21 (a chemical derived from the soapbark tree).

Administration

The particular administration method and schedule varies for each clinical trial. Administration methods include intradural (injection within the skin), subcutaneous (injection below the skin), injection into the lymph nodes, or intravenous (injection into the veins). Typically, vaccines are administered as a series of several doses (initial challenge and boosters). Many clinical trials utilize various administration methods and timing strategies in order to determine the best means of inducing an anti-tumor immune response. Preventative vaccines are usually given in a series of three injections.

Risks

The greatest risk with cancer vaccines is that there will be no immune response and the treatment will be ineffective. Serious adverse reactions to the antigens, such as the attack of healthy cells, are theoretically possible, but these fears have not materialized. Other than some mild adverse reactions, such as **fever** and redness of the skin at the injection site, vaccine treatment appears relatively low-risk in the traditional sense.

Precautions

No vaccine has yet been approved by the FDA for the treatment of cancer. Accordingly, vaccines are not standard treatments and other more traditional treatments should be investigated first. Vaccines are available only through participation in clinical trials. Each trial has its own criteria that limits who can participate. Many cancers have a current trial for one or more types of vaccines.

Most vaccine trials test the response of the disease with and without the vaccine or the effect of substances added to the vaccine, called adjuvants. Such trials usually only accept patients who have already tried the standard treatment methods. Others test a standard treatment method with and without the addition of the

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KEY TERMS

Adjuvant—A substance added to a vaccine to increase the immune system's response to the vaccine contents.

Allogeneic—A type of vaccine made up of tumor cells derived from persons other than the patient.

Antigen—A substance characteristic of a tumor that evokes an immune response.

Antigen presenting cell—A cell of the immune system that ingests antigens and exposes them to cells of the immune system in a way that activates the cells to seek out and destroy any other cells displaying that antigen.

Autologous—A type of vaccine made up of tumor cells from the patient's own tumor.

Cytokine—A substance made by cells of the immune system that increases the response to a foreign substance.

Dendritic cell—A special type of antigen-presenting cell that is effective in stimulating T cells.

Epitope—A portion of a protein or other molecule that is the specific target of an immune response.

Hepatitis B—A virus that is spread through blood and sexual contact and causes hepatitis. Hepatitis causes the liver to inflame and can cause liver cancer.

Human papillomavirus (HPV)—A virus that causes abnormal tissue growth. Certain types of HPV can cause cervical and other types of cancer such as anal and vaginal cancer.

vaccine. A very few compare the standard treatment to the vaccine.

Looking at cancer vaccines overall, this treatment method has been more successful eliminating very small tumors rather than getting rid of a large tumor load. If the size of the tumor is significant, a more realistic goal is to shrink the tumor and reduce its effect on the patient's body, rather than total elimination of the cancer.

The complexity of the human immune system has made it very difficult to develop an effective vaccine. Tumors have strategies to evade detection by the immune system. Most notably, they mimic the outward appearance and antigens of the body's own cells. The immune system's built-in lack of response against "self" allows the tumor to escape notice by the body. Now fully aware of this phenomenon, researchers are working to develop methods of circumventing this problem to develop a highly effective vaccine system.

There has been a huge success with preventative cancer vaccines. A vaccine introduced in 2006 protects against four HPV viruses that cause 70% of cervical cancers and 90% of **genital warts**. The vaccine is most effective when given before a female becomes sexually active. It is recommended for all women ages 11–18 and may be given as young as age 9. Women ages 19–26 also may be vaccinated at the discretion of their physician. The vaccine is given in three doses over a six-month period and is covered by most health insurance programs.

Universal childhood **vaccination** against hepatitis B has been practiced in the United States since 1991. Hepatitis B vaccine usually is the first vaccine a child receives, most often while still in the hospital within 24 hours after birth. The second and third HBV immunizations are administered by the age of 18 months in conjunction with other routine childhood vaccinations.

The Centers for Disease Control and Prevention (CDC) estimates that before the launch of the infant HBV immunization program, about 33,000 American children of non-infected mothers acquired hepatitis B by the age of ten. This number has substantially decreased. In 2007, 4,519 cases of acute Hepatitis B in the United States were reported, the lowest ever recorded. However, this number is thought to be about a ten-fold underestimate because many new cases do not cause symptoms and are not reported.

Preparation

Before enrolling in a clinical trial, patients should discuss the potential benefits and risks with their doctor. Clinical trials can be located by contacting the research institutes directly or by searching the Internet. The National Cancer Institute is a good resource for information about clinical trials for cancer treatment. Patients should talk to their doctor about receiving preventative cancer vaccines.

Aftercare

One of the most striking advantages of vaccines compared to other cancer treatments is the relatively low incidence of side effects. If IFN is used as an immunoadjuvant, patients sometimes experience flu-like symptoms. However, other than some soreness at the site of injection, vaccine patients generally have no adverse reactions to this kind of treatment.

It is possible to have an allergic reaction to the HPV or hepatitis B vaccine or to experience some

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swelling or soreness around the injection site. Patients should contact their doctor if they have any unusual reactions to the vaccines.

Results

For each trial, a very small percentage of patients have complete, partial, or mixed response to experimental cancer treatment vaccines. A few others show a stabilization of the disease where deterioration of the condition would be expected. As traditional treatments were often unsuccessful with these patients, these results are significant. However, the very low rate of success underscores the complexity of the human immune system, the number of variables in the vaccine method, and the amount of research necessary to develop an effective vaccine treatment for this disease.

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ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd., NE, Atlanta, GA, 30329, (404) 320-3333, (800) ACS-2345, http://www.cancer.org.

Cancer Research and Prevention Foundation, 1600 Duke Street, Suite 500, Alexandria, VA, 22314, (703) 836-4412, (800) 227-2732, info@preventcancer.org, http://www.preventcancer.org.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (404) 639-3534, (800) CDC-INFO (800-232-4636). TTY: (888) 232-6348, inquiry@cdc.gov, http://www.cdc.gov.

National Cancer Institute Public Inquires Office, 6116 Executive Boulevard, Room 3036A, Bethesda, MD, 20892-8322, (800) 4-CANCER (800-422-6237). TTY: (800) 332-8615, http://www.cancer.gov.

National Vaccine Information Center, 407-H Church Street, Vienna, VA, 22180, (703) 938-0342, (703) 938-5768, contactNVIC@gmail.com, http://www.nvic.org.

National Vaccine Program Office, 200 Independence Avenue, SW Room 715-H, Washington, DC, 20201, (202) 619-0257, (877) 696-6775, (409) 772-5208, http://www.hhs.gov/nvpo/.

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Candida albicans infection *see* **Candidiasis**

Candidiasis

Definition

Candidiasis is an infection caused by a species of the yeast *Candida*, usually *Candida albicans*. This is a common cause of vaginal infections in women. Also, *Candida* may cause mouth infections in people with reduced immune function, or in patients taking certain **antibiotics**. *Candida* can be found in virtually all normal people but causes problems in only a fraction. In recent years, however, several serious categories of candidiasis have become more common, due to overuse of antibiotics, the rise of **AIDS**, the increase in organ transplantations, and the use of invasive devices (catheters, artificial joints, and valves)—all of which increase a patient's susceptibility to infection.

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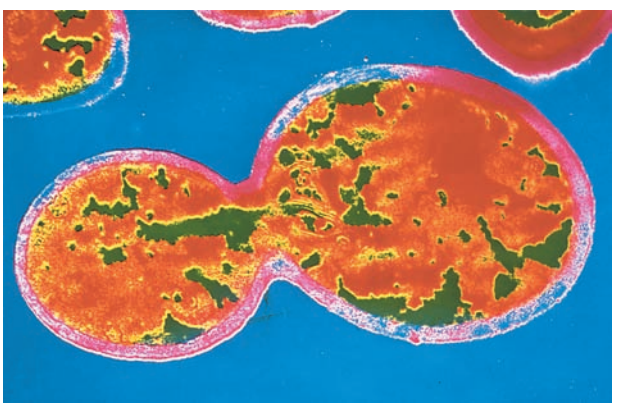
This patient's tongue is infected with candidiasis. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Demographics

The candida organism is present in the oropharyngeal areas in 30 to 55% of healthy young adults. About 75% of women are infected with vaginal candidiasis at least one time in their lifetime. The candida species is now the fourth most commonly isolated organism from blood cultures and is the most common cause of fungal infection in patients whose immune systems are compromised.

Risk factors

Patients at high risk for the development of candidiasis include patients who are often extremely ill.



A transmission electron microscopy (TEM) of *Candida albicans*. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Patients in neonatal, pediatric, and adult intensive care units are considered to be at high risk. Other high risk patients are patients who are immunosuppressed due to **chemotherapy**, **radiation therapy**, severe trauma, and organ transplantation. Patients undergoing procedures such as recent surgery, hemodialysis, **urinary catheterization**, central **venous access** device placement, and those on mechanical ventilation for longer than 3 days are at high risk for the development of invasive or systemic candidiasis.

Neonates and older adults over the age of 65 years are at highest risk for infection with the candida organism.

Description

Vaginal candidiasis

Over one million women in the United States develop vaginal yeast infections each year. It is not life-threatening, but it can be uncomfortable and frustrating.

Oral candidiasis

This disorder, also known as thrush, causes white, curd-like patches in the mouth or throat.

Deep organ candidiasis

Also known as invasive candidiasis, deep organ candidiasis is a serious systemic infection that can affect the esophagus, heart, blood, liver, spleen, kidneys, eyes, and skin. Like vaginal and oral candidiasis, it is an opportunistic disease that strikes when a person's resistance is lowered, often due to another illness. There are many diagnostic categories of deep organ candidiasis, depending on the tissues involved.

Causes and symptoms

Vaginal candidiasis

Most women with vaginal candidiasis experience severe vaginal **itching**. They also have a discharge that often looks like cottage cheese and has a sweet or bread-like odor. The vulva and vagina can be red, swollen, and painful. Sexual intercourse can also be painful.

Oral candidiasis

Whitish patches can appear on the tongue, inside of the cheeks, or the palate. Oral candidiasis typically occurs in people with abnormal immune systems. These can include people undergoing chemotherapy for **cancer**, people taking immunosuppressive drugs

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KEY TERMS

Biopsy—The removal and examination of tissue from a live body.

Colonize—To become established in a host.

Granulocytopenia—A condition characterized by a deficiency of white blood cells.

Nasogastric—Tube inserted through the nasal passages into the stomach.

Opportunistic—Infection caused by microorganisms that are usually harmless, but which can cause disease when a host's resistance is lowered.

Systemic—Afflicting an entire body system or the body in general.

to protect transplanted organs, or people with HIV infection.

Deep organ candidiasis

Anything that weakens the body's natural barrier against colonizing organisms—including stomach surgery, **burns**, nasogastric tubes, and catheters—can predispose a person for deep organ candidiasis. Rising numbers of AIDS patients, organ transplant recipients, and other individuals whose immune systems are compromised help account for the dramatic increase in deep organ candidiasis in recent years. Patients with granulocytopenia (deficiency of white blood cells) are particularly at risk for deep organ candidiasis.

Diagnosis

Often clinical appearance gives a strong suggestion about the diagnosis. Generally, a clinician will take a sample of the vaginal discharge or swab an area of oral plaque, and then inspect this material under a microscope. Under the microscope, it is possible to see characteristic forms of yeasts at various stages in the lifecycle.

Fungal blood cultures should be taken for patients suspected of having deep organ candidiasis. However, blood cultures may not detect up to 50% of cases of disseminated candidiasis. A more specific test to detect Beta-glucan, a fungal cell wall component, is the serum Beta-D-glucan detection assay. This test has shown to be highly specific in detecting fungal infections.

A tissue biopsy of suspected infected areas may also be helpful in confirming a diagnosis of systemic or disseminated candidiasis.

Treatment

Vaginal candidiasis

In most cases, vaginal candidiasis can be treated successfully with a variety of over-the-counter antifungal creams or suppositories. These include Monistat, Gyne-Lotrimin, and Mycelex. However, infections often recur. However, a single 150 mg dose of oral fluconazole (Diflucan) has been shown to as effective or better than topical antifungal agents when treating acute cases of vaginal candidiasis.

Oral candidiasis

This is usually treated with prescription lozenges or mouthwashes. Some of the most-used prescriptions are nystatin mouthwashes (Nilstat or Nitrostat) and clotrimazole lozenges. Other treatment options include amphotericin B oral suspension or treatment with systemic azole medications such as fluconazole (Diflucan), itraconazole (Sporonox), or posaconazole (Noxafil) for more severe oral infections.

Deep organ candidiasis

Guidelines for the treatment of invasive candidiasis were revised in 2009 by the Infectious Diseases Society of America (ISDA). The guidelines include the recommended use of drugs such as caspofungin (Cancidas), micafungin (Mycamine), and anidulafungin (Eraxis), which are classified as echinocandins, and the drugs voriconazole (Vfend) and posaconazole (Noxafil), which are classified as triazoles. Lipid formulations of amphotericin B are also recommended in the treatment of systemic fungal infections caused by candida organisms. Treatment with fluconazole (Diflucan) continues to be recommended as first line treatment for invasive candidiasis in non-neutropenic patients.

Alternative treatment

Home remedies for vaginal candidiasis include vinegar douches or insertion of a paste made from *Lactobacillus acidophilus* powder into the vagina. In theory, these remedies will make the vagina more acidic and therefore less hospitable to the growth of *Candida*. Fresh garlic (*Allium sativum*) is believed to have antifungal action, so incorporating it into the diet or inserting a gauze-wrapped, peeled garlic clove into the vagina may be helpful. The insert should be changed twice daily. Some women report success with these remedies; they should try a conventional treatment if an alternative remedy isn't effective.

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RACHEL FULLER BROWN (1898–1980)

Rachel Fuller Brown was born on November 23, 1898 in Springfield, Massachusetts. Brown was the oldest of two children born to Annie (Fuller) and George Hamilton Brown. In 1912, her father left their family in Missouri and her mother moved the family back to Springfield. Brown double-majored in history and chemistry at Mount Holyoke, receiving her A.B. degree in 1920. She also earned her M.A. degree from the University of Chicago. Brown began her doctoral studies at the University, but she experienced financial difficulties and took a job before she received her Ph.D. She worked at the Division of Laboratories and Research of the New York State Department of Health as an assistant chemist for seven years and finally returned to Chicago and completed her Ph.D.

In 1948, Brown and Elizabeth Hazen began researching fungal infections found in humans due to antibiotic treatments and diseases. Some of the antibiotics they discovered did indeed kill the fungus; however, they also killed the test mice. Finally, Hazen located a microorganism on a farm in Virginia, and Brown's tests indicated that the microorganism produced two antibiotics, one of which proved effective for treating fungus and candidiasis in humans. Brown purified the antibiotic which was patented under the name *nystatin*. In 1954, the antibiotic became available in pill form. Brown and Hazen continued their research and discovered two other antibiotics. Brown received numerous awards individually and with her research partner, Elizabeth Hazen. Rachel Brown died on January 14, 1980.

Prognosis

Vaginal candidiasis

Although most cases of vaginal candidiasis are cured reliably, these infections can recur. To limit recurrences, women may need to take a prescription anti-fungal drug or take other anti-fungal drugs on a preventive basis.

Oral candidiasis

These infections can also recur, sometimes because the infecting *Candida* develops resistance to one drug. Therefore, a physician may need to prescribe a different drug.

Deep organ candidiasis

The prognosis depends on the category of disease as well as on the condition of the patient when the infection strikes. Patients who are already suffering from a serious underlying disease are more susceptible to deep organ candidiasis that spreads throughout the body.

Mortality rates for disseminated candidiasis have not improved significantly over the years. It is estimated that as many as 30 to 40% of patients diagnosed with severe cases of systemic candidiasis will die from infection with this pathogen.

Prevention

Because *Candida* is part of the normal group of microorganisms that co-exist with all people, it is impossible to avoid contact with it. Good vaginal hygiene and good **oral hygiene** might reduce problems, but they are not guarantees against candidiasis.

Because hospital-acquired (nosocomial) deep organ candidiasis is on the rise, people need to be made aware of it. Patients should be sure that catheters and other medical devices are properly maintained and used for the shortest possible time lengths.

Resources

PERIODICALS

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Candidosis *see* **Candidiasis**

Canker sores

Definition

Canker sores are small white or yellowish sores or ulcers that develop inside the mouth. They are painful, self-healing, and can recur.

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Description

Canker sores occur on the inside of the mouth, usually on the inside of the lips, cheeks, and/or soft palate. They also can occur on the tongue and in the throat. Often, several canker sores will appear at the same time and may be grouped in clusters. Canker sores appear as a whitish, round area with a red border. The sores are painful and sensitive to touch. The average canker sore is about .25 inch (60 mm) in diameter, although they can occasionally be larger. Canker sores are not infectious.

Approximately 20% of Americans experience recurring canker sores. They are more common in women than in men. Women are more likely to have canker sores at certain times during their menstrual period, suggesting that they may be influenced by female hormones.

Canker sores are sometimes confused with **cold sores**. Cold sores are caused by herpes simplex virus. This disease, also known as oral herpes or **fever** blisters, can occur anywhere on the body. Most commonly, herpes infection occurs on the outside of the lips and the gums, and much less frequently on the inside the mouth. Unlike canker sores, cold sores are infectious.

Causes and symptoms

The exact cause of canker sores is uncertain; however, they seem to be related to a localized immune reaction. Other proposed causes for this disease are trauma to the affected areas from toothbrush scrapes or dental cleanings, **stress**, hormones, and **food allergies**. They may also be related to nutritional deficiencies.

Canker sores commonly tend to appear in response to stress. The initial symptom is a **tingling** or mildly painful, **itching** sensation in the area where the sore will appear. After one to three days, a small red swelling appears. The sore is round and whitish in color with a grayish colored center. Usually, there is a red ring of inflammation surrounding the sore. The main symptom is **pain**. Canker sores can be very painful, especially if the tongue touches them repeatedly. They last for one to two weeks and heal on their own.

Diagnosis

Canker sores are diagnosed by observation of the blister. A distinction between canker sores and cold sores must be made because cold sores are infectious, and herpes infection can be transmitted to other people. The two sores can usually be distinguished visually, and there are specific diagnostic tests for herpes infection.

KEY TERMS

Inflammation—A local reaction to tissue injury or damage, usually characterized by pain, swelling, and redness.

Ulcer—A site of damage to the skin or mucous membrane that is characterized by the formation of pus, death of tissue, and is frequently accompanied by an inflammatory reaction.

Treatment

Since canker sores heal by themselves, treatment is not usually necessary. Pain relief remedies, such as over-the-counter topical anesthetics, may be used to reduce the pain of the sores. The use of corticosteroid ointments sometimes speeds healing. Avoidance of spicy or acidic foods can help reduce the pain associated with canker sores.

Alternative treatment

Alternative therapies for canker sores are aimed at healing existing sores and preventing their recurrence. Several herbal remedies, including calendula (*Calendula officinalis*), myrrh (*Commiphora molmol*), and goldenseal (*Hydrastis canadensis*), may be helpful in the treatment of existing sores. Compresses soaked in teas made from these herbs are applied directly to the sores. The tannic acid in a tea bag can also help dry up the sores when the wet tea bag is used as a compress. Taking dandelion (*Taraxacum officinale*) tea or capsules may help heal sores and prevent future outbreaks. Since canker sores are often brought on by stress, such stress-relieving techniques as **meditation**, **guided imagery**, and certain **acupressure** exercises may help prevent canker sores or lessen their severity.

Prognosis

There is no cure for canker sores. They do not get larger or occur more frequently with age.

Resources

OTHER

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Captopril *see* **Angiotensin-converting enzyme inhibitors**
Carbamazepine *see* **Anticonvulsant drugs**
Carbidopa *see* **Antiparkinson drugs**

Carbohydrate intolerance

Definition

Carbohydrate intolerance is the inability of the body to completely process carbohydrates (a classification that includes sugars and starches) into a source of energy for the body, usually because of the deficiency of an enzyme needed for digestion.

Demographics

The rate of **lactose intolerance**, the inability to digest the sugar found in milk, is widespread and varies with ethnicity. About one-quarter of white Americans are thought to be lactose intolerant, of which half are thought to lack the enzyme lactase needed to digest lactose. The rate is lowest in people of Northern European ancestry (about 5%, increasing to 30% of Central Europeans and 70% of Southern Europeans. About 90% of Asians and Africans are lactose intolerant. Often intolerance increases as the individual moves from infancy through childhood and into adulthood. In addition, according to a poll done for the pharmaceutical company GlaxoSmithKline, about 30% of Americans show symptoms of complex carbohydrate intolerance.

Description

Carbohydrates are the primary source of energy for the body and, along with fats and proteins, one of the three major nutrients in the human diet. Carbohydrates are classified according to their structure based on the number of basic sugar (saccharide) units they contain.

A monosaccharide is the simplest carbohydrate and is called a simple sugar. Simple sugars include glucose (the form in which sugar circulates in the blood), fructose (found in fruit and honey), and galactose (produced by the digestion of milk). These simple sugars are important because they can be absorbed by the small intestine.

Two simple sugars linked together make a disaccharide. The disaccharide sugars present in the diet are maltose (a product of the digestion of starch), sucrose (table sugar), and lactose (the sugar in milk). These disaccharides must be broken down by enzymes into two simple sugars in order for them to be absorbed by the intestine. Polysaccharides are much more complex carbohydrates made up of many simple sugars, the most important of which are glycogen, which is stored in the liver, and starch.

Digestion of sugars

Digestion of food begins in the mouth, moves on to the stomach, and then into the small intestine. Along the way, specific enzymes are needed to process different types of sugars. An enzyme is a substance that acts as a catalyst to produce chemical changes without being changed itself. The enzymes lactase, maltase, and isomaltase (or sucrase) are needed to break down the disaccharides; when one or more enzymes is produced in inadequate amounts, the result is carbohydrate intolerance. Adult lactose intolerance is the most common of all enzyme deficiencies. Deficiencies in enzymes other than lactase are extremely rare.

Types of intolerance

Carbohydrate intolerance can be primary or secondary. Primary deficiency is caused by an enzyme defect present at birth or developed over time. The most common carbohydrate intolerance is lactose intolerance. Secondary deficiencies are caused by a disease or disorder of the intestinal tract; they disappear when the disease is treated. These include protein deficiency, **celiac disease**, and some intestinal infections.

Causes and symptoms

Enzymes play an important role in breaking down carbohydrates into forms that can pass through the intestine and be used by the body. Cooked starch is broken down in the mouth to a disaccharide by amylase, an enzyme in the saliva. The disaccharides maltose, sucrose, and lactose cannot be absorbed until they have been separated into simple sugar molecules by their corresponding enzymes present in the cells lining the intestinal tract. If this process is not completed, digestion is interrupted.

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KEY TERMS

Celiac disease—A disease, occurring in both children and adults, which is caused by a sensitivity to gluten, a protein found in grains. It results in chronic inflammation and shrinkage of the lining of the small intestine.

Digestion—The mechanical, chemical, and enzymatic process in which food is converted into the materials suitable for use by the body.

Enzyme—A substance produced by the body to assist in a chemical reaction. In carbohydrate intolerance, lack of an enzyme makes it impossible for one type of sugar to be broken down into a simpler form so that it can be absorbed by the intestines and used by the body.

Lactase—The enzyme needed to break down lactose, the sugar found in milk.

Metabolism—All the physical and chemical changes that take place within an organism.

Nutrient—Food or another substance that supplies the body with the elements needed for metabolism.

Sugars—Carbohydrates having the general composition of one part carbon, two parts hydrogen, and one part oxygen.

Although not common, a deficiency in the enzymes needed to digest lactose, maltose, and sucrose is sometimes present at birth. Intestinal lactase enzymes usually decrease naturally with age, but this happens to varying degrees. Because of the uneven distribution of enzyme deficiency based on race and ethnic heritage, especially in lactose intolerance, genetics are believed to play a role in the cause of primary carbohydrate intolerance.

Digestive diseases such as celiac disease and tropical sprue (which affect absorption in the intestine), as well as intestinal infections and injuries, can reduce the amount of enzymes produced. In **cancer** patients, for example, treatment with **radiation therapy** or **chemotherapy** may affect the cells in the intestine that normally secrete lactase, leading to secondary carbohydrate intolerance.

The severity of the symptoms depends on the extent of the enzyme deficiency, and range from a feeling of mild bloating to severe **diarrhea**. In the case of a lactase deficiency, undigested milk sugar remains in the intestine, where bacteria normally present in the intestine then ferment it. These bacteria produce gas, cramping, bloating, or a "gurgly" feeling in the abdomen. In a growing child, the main symptoms are diarrhea and a failure to gain weight. In an individual with lactase deficiency, gastrointestinal distress begins about 30 minutes to two hours after eating or drinking foods containing lactose. Food intolerances should not be confused with **food allergies**, which cause a biochemical allergic response in the body, but the symptoms of **nausea**, cramps, bloating, and diarrhea can be similar.

Sugars that are not broken down into one of the simplest forms cause the body to push fluid into the intestines, which results in watery diarrhea (osmotic diarrhea). Diarrhea may sweep other nutrients out of the intestine before they can be absorbed, causing **malnutrition**.

Diagnosis

Tests

Carbohydrate intolerance can be diagnosed using oral tolerance tests. The carbohydrate being investigated is given by mouth in liquid form and several blood levels are measured and compared to normal values. This helps evaluate the individual's ability to digest the sugar.

To identify lactose intolerance in children and adults, the hydrogen breath test is used to measure the amount of hydrogen in the breath. The patient drinks a beverage containing lactose and the breath is analyzed at regular intervals. If undigested lactose in the large intestine (colon) is fermented by bacteria, various gases are produced. Hydrogen is absorbed from the intestines and carried by the bloodstream into the lungs where it is exhaled. Normally there is very little hydrogen detectable in the breath, so its presence indicates faulty digestion of lactose.

When lactose intolerance is suspected in infants and young children, many pediatricians recommend simply changing from cow's milk to soy formula and watching for improvement. If needed, a stool sample can be tested for acidity. The inadequate digestion of lactose will result in an increase of acid in the waste matter excreted by the bowels and the presence of glucose.

Treatment

Traditional

Carbohydrate intolerance caused by temporary intestinal diseases disappears when the condition is successfully treated. In primary conditions, no treatment exists to improve the body's ability to produce the enzymes, but symptoms can be controlled by diet.

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For those individuals who are sensitive to even very small amounts of lactose, the lactase enzyme is available without a prescription. It comes in liquid form for use with milk. The addition of a few drops to a quart of milk will reduce the lactose content by 70% after 24 hours in the refrigerator. Heating the milk speeds up the process, and doubling the amount of lactase liquid will result in milk that is 90% lactose free. Chewable lactase enzyme tablets are also available. Three to six tablets taken before a meal or snack will aid in the digestion of solid foods. Lactose-reduced milk and other products are also available in stores. The milk contains the same nutrients as regular milk.

Because the degree of lactose intolerance varies so much, treatment should be tailored for the individual. Young children showing signs of intolerance should avoid milk products; infants should switch to soy-based formula. Older children and adults can adjust their intake of lactose depending on how much and what they can tolerate. For some, a small glass of milk will not cause problems, while others may be able to handle ice cream or aged cheeses such as cheddar or Swiss, but not other dairy products. Generally, small amounts of lactose-containing foods taken throughout the day are better tolerated than a large amount consumed all at once.

Because dairy products are an important source of **calcium**, people who reduce or severely limit their intake of dairy products may need to consider other ways to consume an adequate amount of calcium in their **diets**.

Prognosis

With good dietary management, individuals with carbohydrate intolerance can lead normal lives with minimal discomfort.

Prevention

Since the cause of the enzyme deficiency leading to carbohydrate intolerance is unknown, there is no way to prevent this condition.

Resources

OTHER

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Lactose Intolerance. MedlinePlus. June 8, 2010. http://www.nlm.nih.gov/medlineplus/lactoseintolerance.html

ORGANIZATIONS

American Gastroenterological Association (AGA), 4930 Del Ray Avenue, Bethesda, MD, 20814, (310) 654-2055, (301) 654-5920, www.gastro.org.

National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), National Institutes of Health, 2 Information Way, Bethesda, MD, 20892, (800) 891-5389. TTY: (866) 569-1162, nddic@niddk.nih.gov, http://digestive.niddk.nih.gov.

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Carbon monoxide poisoning

Definition

Carbon monoxide (CO) poisoning occurs when carbon monoxide gas is inhaled. CO is a colorless, odorless, highly poisonous gas that is produced by incomplete combustion. It is found in automobile exhaust fumes, faulty stoves and heating systems, fires, and cigarette smoke. Other sources include woodburning stoves, kerosene heaters, improperly ventilated water heaters and gas stoves, and blocked or poorly maintained chimney flues. CO interferes with the ability of the blood to carry oxygen. The result is **headache**, **nausea**, convulsions, and finally **death** by asphyxiation.

Description

Carbon monoxide, sometimes called coal gas, has been known as a toxic substance since the third century B.C. It was used for executions and suicides in early Rome. Today it is the leading cause of accidental poisoning in the United States. According to the *Journal of the American Medical Association*, 2,000 Americans die each year from accidental exposure to CO, and another 2,300 from intentional exposure (**suicide**). An additional 10,000 people seek medical attention after exposure to CO. The Consumer Products Safety Commission eported in 2004 that about 64% of unintentional CO poisoning deaths occur in the home.

Anyone who is exposed to CO will become sick, and the entire body is involved in CO poisoning. A developing fetus can also be poisoned if a pregnant woman breathes CO gas. Infants, people with heart or lung disease, or those with anemia may be more seriously affected. People such as underground parking garage attendants who are exposed to car exhausts in a

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confined area are more likely to be poisoned by CO. Firemen also run a higher risk of inhaling CO.

Causes and symptoms

Normally when a person breathes fresh air into the lungs, the oxygen in the air binds with a molecule called hemoglobin (Hb) that is found in red blood cells. This allows oxygen to be moved from the lungs to every part of the body. When the oxygen/hemoglobin complex reaches a muscle where it is needed, the oxygen is released. Because the oxygen binding process is reversible, hemoglobin can be used over and over again to pick up oxygen and move it throughout the body.

Inhaling carbon monoxide gas interferes with this oxygen transport system. In the lungs, CO competes with oxygen to bind with the hemoglobin molecule. Hemoglobin prefers CO to oxygen and accepts it more than 200 times more readily than it accepts oxygen. Not only does the hemoglobin prefer CO, it holds on to the CO much more tightly, forming a complex called carboxyhemoglobin (COHb). As a person breathes CO contaminated air, more and more oxygen transportation sites on the hemoglobin molecules become blocked by CO. Gradually, there are fewer and fewer sites available for oxygen. All cells need oxygen to live. When they don't get enough oxygen, cellular metabolism is disrupted and eventually cells begin to die.

The symptoms of CO poisoning and the speed with which they appear depend on the concentration of CO in the air and the rate and efficiency with which a person breathes. Heavy smokers can start off with up to 9% of their hemoglobin already bound to CO, which they regularly inhale in cigarette smoke. This makes them much more susceptible to environmental CO. The Occupational Safety and Health Administration (OSHA) has established a maximum permissible exposure level of 50 parts per million (ppm) over eight hours.

With exposure to 200 ppm for two to three hours, a person begins to experience headache, **fatigue**, nausea, and **dizziness**. These symptoms correspond to 15–25% COHb in the blood. When the concentration of COHb reaches 50% or more, death results in a very short time. Emergency room physicians have the most experience diagnosing and treating CO poisoning.

The symptoms of CO poisoning in order of increasing severity include:

- headache
- shortness of breath
- dizziness
- fatigue
- mental confusion and difficulty thinking
- loss of fine hand-eye coordination
- nausea and vomiting
- rapid heart rate
- hallucinations
- inability to execute voluntary movements accurately
- collapse
- lowered body temperature (hypothermia)
- coma
- convulsions
- seriously low blood pressure
- cardiac and respiratory failure
- death

In some cases, the skin, mucous membranes, and nails of a person with CO poisoning are cherry red or bright pink. Because the color change doesn't always occur, it is an unreliable symptom to rely on for diagnosis.

Although most CO poisoning is acute, or sudden, it is possible to suffer from chronic CO poisoning. This condition exists when a person is exposed to low levels of the gas over a period of days to months. Symptoms are often vague and include (in order of frequency) fatigue, headache, dizziness, sleep disturbances, cardiac symptoms, apathy, nausea, and memory disturbances. Little is known about chronic CO poisoning, and it is often misdiagnosed.

Diagnosis

The main reason to suspect CO poisoning is evidence that fuel is being burned in a confined area, for example a car running inside a closed garage, a charcoal grill burning indoors, or an unvented kerosene heater in a workshop. Under these circumstances, one or more persons suffering from the symptoms listed previously strongly suggests CO poisoning. In the absence of some concrete reason to suspect CO poisoning, the disorder is often misdiagnosed as **migraine headache**, **stroke**, psychiatric illness, **food poisoning**, alcohol poisoning, or heart disease.

Concrete confirmation of CO poisoning comes from a carboxyhemoglobin test. This blood test measures the amount of CO that is bound to hemoglobin in the body. Blood is drawn as soon after suspected exposure to CO as possible.

Other tests that are useful in determining the extent of CO poisoning include measurement of other arterial blood gases and pH; a **complete blood count**; measurement of other blood components such as **sodium**,

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potassium, bicarbonate, urea nitrogen, and lactic acid; an electrocardiogram (ECG); and a **chest x ray**.

Treatment

Immediate treatment for CO poisoning is to remove the victim from the source of carbon monoxide gas and get him or her into fresh air. If the victim is not breathing and has no pulse, **cardiopulmonary resuscitation** (CPR) should be started. Depending on the severity of the poisoning, 100% oxygen may be given with a tight fitting mask as soon as it is available.

Taken with other symptoms of CO poisoning, COHb levels of over 25% in healthy individuals, over 15% in patients with a history of heart or lung disease, and over 10% in pregnant women usually indicate the need for hospitalization. In the hospital, fluids and electrolytes are given to correct any imbalances that have arisen from the breakdown of cellular metabolism.

In severe cases of CO poisoning, patients are given hyperbaric **oxygen therapy**. This treatment involves placing the patient in a chamber breathing 100% oxygen at a pressure of more than one atmosphere (the normal pressure the atmosphere exerts at sea level). The increased pressure forces more oxygen into the blood. Hyperbaric facilities are specialized, and are usually available only at larger hospitals.

Prognosis

The speed and degree of recovery from CO poisoning depends on the length and duration of exposure to the gas. The half-life of CO in normal room air is four to five hours. This means that, in four to five hours, half of the CO bound to hemoglobin will be replaced with oxygen. At normal atmospheric pressures, but breathing 100% oxygen, the half-life for the elimination of CO from the body is 50–70 minutes. In hyperbaric therapy at three atmospheres of pressure, the half-life is reduced to 20–25 minutes.

Although the symptoms of CO poisoning may subside in a few hours, some patients show memory problems, fatigue, confusion, and mood changes for two to four weeks after their exposure to the gas.

Prevention

Carbon monoxide poisoning is preventable. Particular care should be paid to situations where fuel is burned in a confined area. Portable and permanently installed carbon monoxide detectors that sound a warning similar to smoke detectors are available for less than $50. Specific actions that will prevent CO poisoning include:

KEY TERMS

Carboxyhemoglobin (COHb)—Hemoglobin that is bound to carbon monoxide instead of oxygen.

Hemoglobin (Hb)—A molecule that normally binds to oxygen in order to carry it to our cells, where it is required for life.

Hypothermia—Development of a subnormal body temperature.

pH—A measurement of the acidity or alkalinity of a fluid. A neutral fluid, neither acid nor alkali, has a pH of 7.

- stopping smoking. Smokers have less tolerance to environmental CO
- having heating systems and appliances installed by a qualified contractor to assure that they are properly vented and meet local building codes
- inspecting and properly maintaining heating systems, chimneys, and appliances
- not using a gas oven or stove to heat the home
- not burning charcoal indoors
- making sure there is good ventilation if using a kerosene heater indoors
- not leaving cars or trucks running inside the garage
- keeping car windows rolled up when stuck in heavy traffic, especially if inside a tunnel

Resources

PERIODICALS

"Silencing the Silent Killer." *USA Today Magazine* March 2004: 77.

OTHER

"Carbon Monoxide Headquarters." Wayne State University School of Medicine. http://www.coheadquarters.com/CO1.htm.

ORGANIZATIONS

American Lung Association, 1301 Pennsylvania Ave. NW, Suite 800, Washington, DC, 20001, (202) 758-3355, (202) 452-1805, (800) 548-8252, info@lungusa.org, http://www.lungusa.org/.

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Carbunculosis *see* **Boils**

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Carcinoembryonic antigen test

Definition

The carcinoembryonic antigen (CEA) test is a laboratory blood study. CEA is a substance that is normally found only during fetal development, but may reappear in adults who develop certain types of **cancer**. CEA is produced when there is rapid multiplication of epithelial cells such as those of the digestive track. CEA is also found in the blood of individuals who are chronic smokers.

KEY TERMS

False negative—Results of testing indicates that cancer is not present when cancer is indeed present in the body.

False positive—Results of testing indicates that cancer is present when cancer is not present in the body.

Serial monitoring—Monitoring of results of several blood tests over time to detect a pattern of increasing, decreasing, or unchanging values in the blood.

Purpose

The CEA test is ordered for patients with known cancers. It is most commonly ordered when a patient has a cancer of the gastrointestinal system. These include cancer of the colon, rectum, stomach (gastric cancer), esophagus, liver, or pancreas. It is also used with cancers of the breast, lung, or prostate.

The CEA level in the blood is one of the factors that doctors consider when determining the prognosis, or most likely outcome of a cancer. In general, a higher CEA level predicts a more severe disease, one that is less likely to be curable. But it does not give clear-cut information. The results of a CEA test are considered along with other laboratory and/or imaging studies to follow the course of the disease.

Once treatment for the cancer has begun, CEA tests have a valuable role in monitoring the patient's progress. A decreasing CEA level means therapy is effective in fighting the cancer. A stable or increasing CEA level may mean the treatment is not working, and/or that the tumor is growing. It is important to understand that serial CEA measurements, several done over a period of time, are the most useful. A single test result is difficult to evaluate, but a number of tests, done weeks apart, shows trends in disease progression or regression.

Certain types of cancer treatments, such as hormone therapy for **breast cancer**, may cause the CEA level to go up. This elevation does not accurately reflect the state of the disease. It is sometimes referred to as a "flare response." Recognition that a rise in CEA may be temporary and due to therapy is significant. If this possibility is not taken into account, the patient may be unnecessarily discouraged. Further, treatment that is actually effective may be stopped or changed prematurely.

CEA tests are also used to help detect recurrence of a cancer after surgery and/or other treatment has been completed. A rising CEA level may be the first sign of cancer return, and may show up months before other studies or patient symptoms would raise concern. Unfortunately, this does not always mean the recurrent cancer can be cured. For example, only a small percentage of patients with colorectal cancers and rising CEA levels benefit from another surgical exploration. Those with recurrence in the same area as the original cancer, or with a single metastatic tumor in the liver or lung, have a chance that surgery will eliminate the disease. Patients with more widespread return of the cancer are generally not treatable with surgery. The CEA test will not separate the two groups.

Patients who are most likely to benefit from non–standard treatments, such as bone marrow transplants, may be determined on the basis of CEA values, combined with other test results. CEA levels may be one of the criteria for determining whether the patient will benefit from more expensive studies, such as CT scan or MRI.

Description

Determination of the CEA level is a laboratory blood test. Obtaining a specimen of blood for the study takes only a few minutes. CEA testing should be covered by most insurance plans.

The CEA test is not a screening test for cancer. It is not useful for detecting the presence of cancer since many cancers do not produce an increased CEA level. Some noncancerous diseases, such as hepatitis, inflammatory bowel disease, **pancreatitis**, and obstructive pulmonary disease, may cause an elevated CEA level.

Preparation

No preparation is required.

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Aftercare

No specific aftercare measures are required. Results will be sent to the healthcare provider who ordered the test originally. The health care provider will then discuss results with the patient.

Risks

There are no complications or side effects of this test. However, the results of a CEA study should be interpreted with caution. A single test result may not yield clinically useful information. Several studies over a period of months may be needed.

Another concern is the potential for false positive or false negative results. A false positive result means the test shows an abnormal value when cancer is not present. A false negative means the test reveals a normal value when cancer actually is present.

Results

The absolute numbers that are considered normal vary from one laboratory to another. Any results reported should come with information regarding the testing facility's normal range.

Abnormal results

A single abnormal CEA value may be significant, but must be regarded cautiously. In general, very high CEA levels indicate more serious cancer, with a poorer chance for cure. But some benign diseases and certain cancer treatments may produce an elevated CEA test. Cigarette **smoking** will also cause the CEA level to be abnormally high.

Resources

BOOKS

Van Leeuwen, A.M., and D.J. Poelhuis-Leth. *Davis's Comprehensive Handbook of Laboratory and Diagnostic Tests with Nursing Implications*. 3rd ed. Philadelphia: F.A. Davis Co., 2009.

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Iwanicki-Caron, I., et al. "Usefulness of Serum Carcinoembryonic Antigen Kinetic for Chemotherapy Monitoring in Patients with Unresectable Metastasis of Colorectal Cancer." *Journal of Clinical Oncology* 26, no. 22 (August 1, 2008): 3681–3886.

Ellen S. Weber, MSN
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Carcinogens

Definition

Carcinogens are substances capable of causing **cancer**. The United States Environmental Protection Agency (EPA) classifies many substances on the basis of their potential for causing cancer. Classifications are based on results of studies on animals or experience with humans. Classification categories refer to epidemiological studies, which are studies to identify the factors controlling the presence or absence of a disease.

Description

Group A, or Human Carcinogens, are substances for which there is a relationship between the substance and cancer that has been conclusively demonstrated through epidemiological studies of humans. Group B, or Probable Human Carcinogens are composed of two types of carcinogens. There is sufficient evidence from animal studies and limited epidemiological studies that B1 carcinogens cause cancer. B2 carcinogens are classified on the basis of sufficient evidence from animal studies only; epidemiological data are inadequate or nonexistent. Group C or Possible Human Carcinogens are substances where there is limited evidence from animal studies and no human epidemiological data. Group D or Not Classifiable as to Human Carcinogenicity are substances for which information is inadequate or completely lacking, so no assessment of the substance's cancer–causing potential is possible. Group E or Evidence of Noncarcinogenicity for Humans are substances that have tested negative in at least two adequate animal cancer tests in different species and in adequate epidemiological and animal studies.

As of 2010, the International Agency for Research on Cancer (IARC) has determined that the following list of agents and mixtures are carcinogenic to humans.

- Acetaldehyde associated with consumption of alcoholic beverages
- Acid mists, strong inorganic
- Aflatoxins (naturally occurring)
- 4–Aminobiphenyl
- Alcoholic beverages
- Aluminium production
- Areca nut
- Aristolochic acid
- Aristolochic acid–containing plants
- Arsenic and arsenic compounds
- Asbestos, all forms

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- Auramine production
- Azathioprine
- Benzene (used in nail polish remover, varnishes, airplane dopes, lacquers, and as a solvent)
- Benzidine and benzidine dyes
- Benzopyrene
- Betel quid with and without tobacco
- Beryllium and beryllium compounds
- N,N–Bis (2–Chloreothyl)–2–Naphthylamine (Chlomophaozine)
- Bis(chloromethyl) ether and technical grade chloromethyl methyl ether
- Busulphan (Myleran)
- 1, 3–Butadiene
- Cadmium and cadmium compounds
- Chlorambucil
- Chlornaphazine)
- Chromium and certain chromium compounds
- Clonorchis sinensis, infection with
- Coal, indoor emissions and gasification
- Coal–tar distillation
- Coke production
- Cyclophosphamide
- Cyclosporin (ciclosporin)
- Diethystilbestrol (DES)
- Epstein–Barr virus
- Erionite
- Estrogen therapy, postmenopausal
- Estrogen–progesterone combined menopausal therapy
- Estrogen–progesterone combined oral contraceptives
- Ethanol in alcoholic beverages
- Ethylene oxide
- Etoposide
- Etoposide in combination with cisplatin and bleomycin
- Fission products, including strontium–90
- Formaldehyde
- Haematite underground mining
- Helicobacter pylori, infection with
- *Helicobacter pylori* (infection)
- Hepatitis B and C virus (chronic infection)
- HIV virus type 1
- Human papillomavirus (HPV) types 16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, 59
- Human T–cell lypmhotropic virus type 1
- Ionizing radiation of all types
- Iron and steel founding occupational exposure
- Isopropyl alcohol manufacture using strong acids
- Kaposi sarcoma herpes virus
- Leather dust
- Magenta production
- Melphalan
- Methoxsalen with ultraviolet A radiation
- Mineral oils which are untreated or mildly treated
- MOPP and other combined chemotherapy especially alkylating agents
- 2–Naphthylamine
- Neutron radiation
- Nickel compounds
- N–Nitrosonornicotine (NNN) and 4–1–1–butanone (NNK)
- *Opisthorchis viverrini* (infection)
- Painter, occupational exposure
- 3,4,5,3,4–Pentachlorobiphenyl (PCB–126)
- 2,3,4,7,8–Pentachlorodibenzofuran
- Phenacetin and phenacetin–containing analgesic mixtures
- Phosphorus–32
- Plutonium
- Radioiodines, such as I–131
- Radionuclides, alpha– and beta–particle emission when internally deposited
- Radium–224, 226, and 228
- Radon–222
- Rubber industry (certain occupations)
- Salted fish, Chinese style
- Schistosoma haematobium, infection with
- Semsustine–3–1–nitrosurea, Methyl–CCNU
- Shale oils
- Silica
- Solar radiation
- Soot
- Sulfur mustard
- Tamoxifen (There is also evidence that this agent protects against contralateral breast cancer.)
- 2,3,7,8–Tetrachlorodibenzo–para–dioxin
- Thiotepa
- Thorium–232
- Tobacco, smoking, smokeless, and second–hand smoke
- Ortho–Toluidine
- Treosulfan
- Ultraviolet radiation encompassing UVA, UVB, and UVC
- Ultraviolet–emitting tanning devices
- Vinyl chloride

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- Wood dust
- X- and Gamma radiation

Resources

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Meister, Kathleen. *America's War on "Carcinogens": Reassessing the Use of Animal Tests Predict Human Cancer Risk*. Washington, DC: American Council on Science, 2005.

PERIODICALS

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OTHER

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International Agency for Research on Cancer. "IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Agents Classified by the IARC Monographs, Volumes 1–100." May 27, 2010 http:www.monographs.iarc.fr/ENG/Classification/index.php (accessed September 9, 2010).

ORGANIZATIONS

American Cancer Society, (800) ACS–2345, TTY (866) 228–4327, http://www.cancer.org.

United States Environmental Protection Agency (EPA), 1200 Pennsylvania Ave., NW, Washington, DC, 20460, (202) 272–0167, http://www.epa.gov.

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Carcinoid tumors *see* **Neuroendocrine tumors**

Cardiac arrest *see* **Sudden cardiac death**

Cardiac arrhythmias *see* **Arrhythmias**

Cardiac blood pool scan

Definition

A cardiac blood pool scan is a non-invasive test that uses a mildly radioactive marker to observe the functioning of the left ventricle of the heart.

Purpose

The left ventricle is the main pump for distributing blood through the body. A cardiac blood pool scan is used to determine how efficiently the left ventricle is working. The scan can detect aneurysms of the left ventricle, motion abnormalities caused by damage to the heart wall, cardiac shunts between the left and right ventricle, and coronary occlusive artery disease.

Precautions

Pregnant women are the only patients who should not participate in a cardiac blood pool scan. However, the accuracy of the results may be affected if the patient moves during imaging, has had other recent nuclear scans, or has an irregular heartbeat.

Description

A cardiac blood pool scan is sometimes called equilibrium radionuclide angiocardiography or gated (synchronized) cardiac blood pool imaging. A **multiple-gated acquisition (MUGA) scan** is a variation of this test.

To perform a cardiac blood pool scan, the patient lies under a special gamma scintillation camera that detects radiation. A protein tagged with a radioactive marker (usually technetium-99m) is injected into the patient's forearm.

The camera is synchronized with an electrocardiogram (ECG) to take a picture at specific times in the cycle of heart contraction and relaxation. When data from many sequential pictures is processed by a computer, a doctor can analyze whether the left ventricle is functioning normally.

The patient needs to remain silent and motionless during the test. Sometimes the patient is asked to **exercise**, then another set of pictures is taken for comparison. This test normally takes about 30 minutes.

Preparation

No changes in diet or medication are necessary. An ECG will probably be done before the test.

Aftercare

The patient may resume normal activities immediately.

Risks

Cardiac blood pool scans are a safe and effective way of measuring left ventricle function. The only risk is to the fetus of a pregnant woman.

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KEY TERMS

Aneurysm—A sac or bulge that forms because of a weak spot in the wall of an artery or heart chamber.

Cardiac shunt—A defect in the wall of the heart that allows blood from different chambers to mix.

Coronary occlusive artery disease—Blockage of the arteries that supply blood to the heart; frequently a precursor to a heart attack.

Electrocardiogram (ECG)—A graph that shows the electrical charges that trigger the heart to contract. Heart abnormalities alter the graph, giving clues to the source of the abnormality.

Ventricle—One of the two bottom chambers of the heart (the heart has four chambers). The left ventricle acts as the body's main pump for blood.

Normal results

A computer is used to process the information from the test, then the results are analyzed by a doctor. A normally functioning left ventricle will contract symmetrically, show even distribution of the radioactively tagged protein, and eject about 55–65% of volume of blood it holds on each contraction.

Abnormal results

Patients with damage to the ventricle or heart wall will show an uneven distribution of the radiopharmaceutical. The volume of blood ejected in each contraction will be less than 55%.

Resources

BOOKS

Pagana, Kathleen Deska, and Timothy J. Pagana. *Mosby's Manual of Diagnostic and Laboratory Tests*. 4th ed. St. Louis: Mosby, 2009.

Tish Davidson, A.M.

Cardiac catheterization

Definition

Cardiac catheterization (also called heart catheterization) is a diagnostic procedure which does a comprehensive examination of how the heart and its blood vessels function. One or more catheters is inserted through a peripheral blood vessel in the arm (antecubital artery or vein) or leg (femoral artery or vein) with x-ray guidance. This procedure gathers information such as adequacy of blood supply through the coronary arteries, blood pressures, blood flow throughout chambers of the heart, collection of blood samples, and x rays of the heart's ventricles or arteries.

A test that can be performed on either side of the heart, cardiac catheterization checks for different functions in both the left and right sides. When testing the heart's right side, tricuspid and pulmonary valve function are evaluated, in addition to measuring pressures of and collecting blood samples from the right atrium, ventricle, and pulmonary artery. Left-sided heart catheterization is performed by way of a catheter through an artery which tests the blood flow of the coronary arteries, function of the mitral and aortic valves, and left ventricle.

Purpose

The primary reason for conducting a cardiac catheterization is to diagnose and manage persons known or suspected to have heart disease, a frequently fatal condition that leads to 1.5 million heart attacks annually in the United States.

Symptoms and diagnoses that may lead to performing this procedure include:

- chest pain, characterized by prolonged heavy pressure or a squeezing pain
- abnormal treadmill stress test
- myocardial infarction, also known as a heart attack
- congenital heart defects, or heart problems that originated from birth
- a diagnosis of valvular-heart disease
- a need to measure the heart muscle's ability to pump blood

Typically performed along with **angiography**, a technique of injecting a dye into the vascular system to outline the heart and blood vessels, a catheterization can aid in the visualization of any blockages, narrowing, or abnormalities in the coronary arteries. If these signs are visible, the cardiologist may assess the patient's need and readiness for coronary bypass surgery, or perhaps a less invasive approach, such as dilation of a narrowed blood vessel either surgically or with the use of a balloon (**angioplasty**).

When looking at the left side of the heart, fluoroscopic guidance also allows the following diagnoses to be assessed:

- enlargement of the left ventricle

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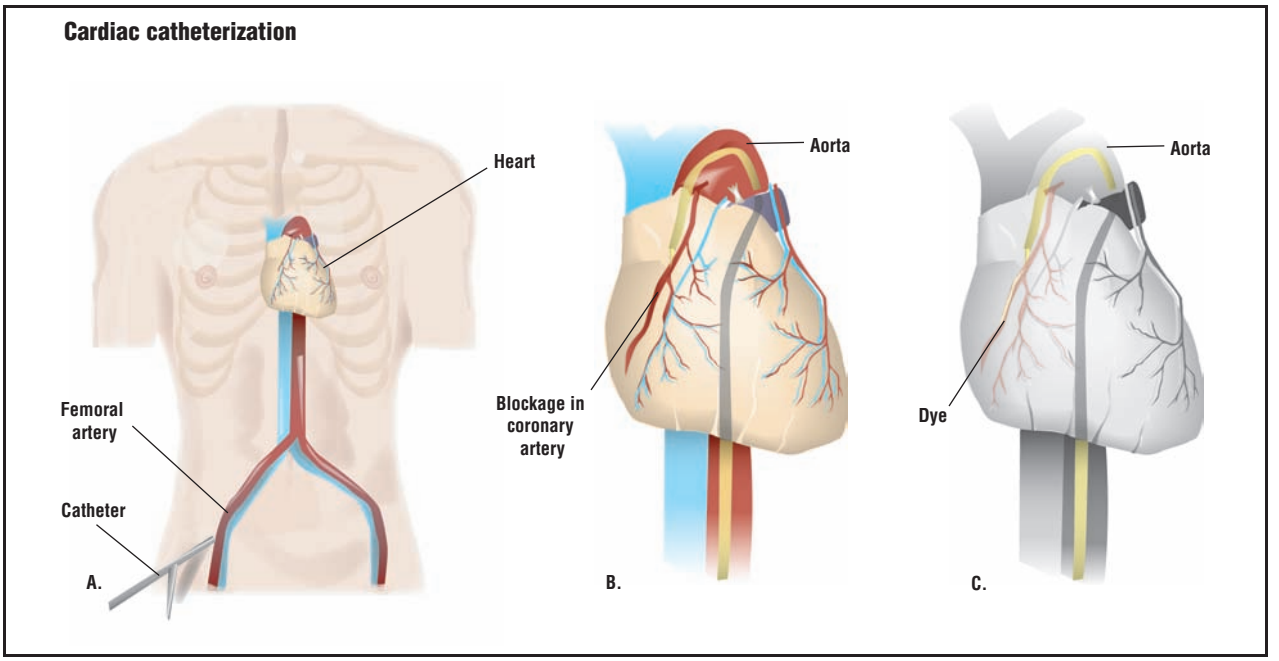

During cardiac catheterization, a catheter is fed into the femoral artery of the upper leg (A). The catheter is fed up to coronary arteries to an area of blockage (B). A dye is released, allowing visualization of the blockage (C). *(Illustration by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)*

- ventricular aneurysms (abnormal dilation of a blood vessel)
- narrowing of the aortic valve
- insufficiency of the aortic or mitral valve
- the detour of blood from one side of the heart to the other due to septal defects (also known as shunting)

Precautions

Cardiac catheterization is categorized as an "invasive" procedure which involves the heart, its valves, and coronary arteries, in addition to a large artery in the arm or leg. Due to the nature of the test, it is important to evaluate for the following conditions before considering this procedure:

- A diagnosis of a bleeding disorder, poor kidney function, or debilitation. Any of these pre-existing conditions typically raises the risk of the catheterization procedure and may be reason to cancel the procedure.
- A diagnosis of heart valve disease. If this is detected, antibiotics may be given before the test to prevent inflammation of the membrane which lines the heart (endocarditis).

Description

To understand how a cardiac catheterization is able to diagnose and manage heart disease, the basic workings of the heart muscle must also be understood. Just as the body relies on a constant supply of blood to aid in its everyday functions, so does the heart. The heart is made up of an intricate web of blood vessels (coronary arteries) that ensure an adequate supply of blood rich in oxygen and nutrients. It is easy to see how an abnormality in any of these arteries can be detrimental to the heart's function. These abnormalities cause the heart's blood flow to decrease and result in the condition known as **coronary artery disease** or coronary insufficiency.

Catheterization is a valuable tool in detecting and treating abnormalities of the heart. Through the use of fluoroscopic (x-ray) guidance, a catheter, which may resemble a balloon-tipped tube, is strung through the veins or arteries into the heart, so the cardiologist can monitor a body's various functions at each moment.

Generally a test that lasts two to three hours, a patient should expect the following prior to and during the catheterization procedure:

- A mild sedative may be given that will allow the patient to relax but remain conscious during the test.
- An intravenous needle will be inserted in the arm to administer medication. Electrodes will be attached to the chest to enable the painless procedure known as an electrocardiograph.

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- Prior to inserting a catheter into an artery or vein in the arm or leg, the incision site will be made numb by injecting a local anesthetic. When the anesthetic is injected it may feel like a pin-prick followed by a quick stinging sensation. Pressure may also be experienced as the catheter travels through the blood vessel.
- After the catheter is guided into the coronary-artery system, a dye (also called a radiocontrast material) is injected to aid in the identification of any abnormalities of the heart. During this time, the patient may experience a hot, flushed feeling or a quickly passing nausea. Coughing or breathing deeply aids in any discomfort.
- Medication may be given during the procedure if chest pain is experienced, and nitroglycerin may also be administered to allow expansion of the heart's blood vessels.
- When the test is complete, the physician will remove the catheter and close the skin with several sutures or tape.

Preparation

Prior to the cardiac catheterization procedure, it is important to relay information to the physician or nurse regarding **allergies** to shellfish (such as shrimp or scallops) which contain iodine, iodine itself, or the dyes that are commonly used in other diagnostic tests.

Because this procedure is categorized as a surgery, the patient will be instructed not to eat or drink anything for at least six hours prior to the test. Just before the test begins, the patient will urinate and change into a hospital gown, then lie flat on a padded table that may also be tilted in order for the heart to be examined from a variety of angles.

Aftercare

While cardiac catheterization may be performed on an out-patient basis, a patient may require close monitoring following the procedure while remaining in the hospital for at least 24 hours. The patient will be instructed to rest in bed for at least eight hours immediately after the test. If the catheter was inserted into a vein or artery in the leg or groin area, the leg will be kept extended for four to six hours. If a vein or artery in the arm was used to insert the catheter, the arm will need to remain extended for a minimum of three hours.

The patient should expect a hard ridge to form over the incision site that diminishes as the site heals. Bluish discoloration under the skin at the point of insertion should also be expected but fades in two weeks. It is also not uncommon for the incision site to bleed during the first 24 hours following surgery. If this should happen, the patient should apply pressure to the site with a clean tissue or cloth for 10–15 minutes.

Risks

Similar to all surgical procedures, the cardiac catheterization test does involve some risks. Complications that may occur during the procedure include

- cardiac arrhythmias (an irregular heart beat)
- pericardial tamponade (a condition that causes excess pressure in the pericardium which affects the heart due to accumulation of excess fluid)
- the rare occurrence of myocardial infarction (heart attack) or stroke may also develop due to clotting or plaque rupture of one or more of the coronary or brain arteries.

Before left-side catheterization is performed, the anticoagulant medication heparin may be administered. This drug helps decrease the risk of the development of a blood clot in an artery (thrombosis) and **blood clots** traveling throughout the body (embolization).

The risks of the catheterization procedure increase in patients over the age of 60, those who have severe **heart failure**, or persons with serious **valvular heart disease**.

Normal results

Normal findings from a cardiac catheterization will indicate no abnormalities of heart chamber size or configuration, wall motion or thickness, the direction of blood flow, or motion of the valves. Smooth and regular outlines on the x ray indicate normal coronary arteries.

An essential part of the catheterization is measuring intracardiac pressures, or the pressure in the heart's chambers and vessels. Pressure readings that are higher than normal are significant for a patient's overall diagnosis. The pressure readings that are lower, other than those which are produced as a result of **shock**, typically are not significant.

An ejection fraction, or a comparison of how much blood is ejected from the heart's left ventricle during its contraction phase with a measurement of blood remaining at the end of the left ventricle's relaxation phase, is also determined by performing a catheterization. The cardiologist will look for a normal ejection fraction reading of 60–70%.

Abnormal results

Cardiac catheterization provides valuable still and motion x-ray pictures of the coronary arteries that help in diagnosing coronary artery disease, poor heart function, disease of the heart valves, and septal defects (a defect in the septum, the wall that separates two heart chambers).

The most prominent sign of coronary artery disease is the narrowing or blockage in the coronary

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KEY TERMS

Aneurysm—An abnormal dilatation of a blood vessel, usually an artery. It can be caused by a congenital defect or weakness in the vessel's wall.

Angiography—In cardiac catheterization, a picture of the heart and coronary arteries is seen after injecting a radiopaque substance (often referred to as a dye) throughout the veins and arteries.

Angioplasty—An alternative to vascular surgery, a balloon catheter is used to mechanically dilate the affected area of the artery and enlarge the constricted or narrowed segment.

Aortic valve—The valve between the heart's left ventricle and ascending aorta that prevents regurgitation of blood back into the left ventricle.

Catheter—A tube made of elastic, elastic web, rubber, glass, metal, or plastic used to evacuate or inject fluids into the body. In cardiac catheterization, a long, fine catheter is used for passage through a blood vessel into the chambers of the heart.

Coronary bypass surgery—A surgical procedure which places a shunt to allow blood to travel from the aorta to a branch of the coronary artery at a point past an obstruction.

Left anterior descending coronary artery (LAD)—One of the heart's coronary artery branches from the left main coronary artery which supplies blood to the left ventricle.

Mitral valve—The bicuspid valve which is between the left atrium and left ventricle of the heart.

Pulmonary valve—The heart valve which is positioned between the right ventricle and the opening into the pulmonary artery.

Shunt—A passageway (or an artificially created passageway) that diverts blood flow from one main route to another.

Tricuspid valve—The right atrioventricular valve of the heart.

arteries, with narrowing that is greater than 70% considered significant. A clear indication for intervention (by angioplasty or surgery) is a finding of significant narrowing of the left main coronary artery and/or blockage or severe narrowing in the high, left anterior descending coronary artery.

A finding of impaired wall motion is an additional indicator of coronary artery disease, aneurysm, an enlarged heart, or a congenital heart problem. Using the findings from an ejection fraction test which measures wall motion, cardiologists look at an ejection fraction reading under 35% as increasing the risk of complications while also decreasing a successful long term or short term outcome with surgery.

Detecting the difference in pressure above and below the heart valve can verify heart valve disease. The greater narrowing correlates with the higher pressure difference.

To confirm septal defects, a catheterization measures oxygen content on both the left and right sides of the heart. The right heart pumps unoxygenated blood to the lungs, and the left heart pumps blood that contains oxygen from the lungs to the rest of the body. Right side elevated oxygen levels indicate left-to-right atrial or **ventricular shunt**. A left side that experiences decreased oxygen indicates a right-to-left shunt.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbinih.gov.

Beth A. Kapes

Cardiac compression *see* **Cardiac tamponade**

Cardiac conduction disorder *see* **Heart block**

Cardiac mapping *see* **Electrophysiology study of the heart**

Cardiac rehabilitation

Definition

Cardiac **rehabilitation** is a comprehensive **exercise**, education, and behavioral modification program designed to improve the physical and emotional condition of patients with heart disease.

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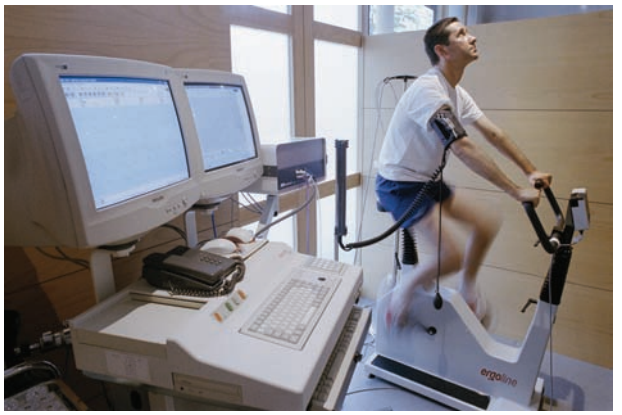

Man undergoing cardiac rehabilitation after receiving a heart transplant. *(RAJAU/PHANIE/Photo Researchers, Inc.)*

KEY TERMS

Angina—Chest pain.

Bypass surgery—A surgical procedure that grafts blood vessels onto arteries to reroute the blood flow around blockages in the arteries (arteriosclerosis).

Purpose

Heart attack survivors, bypass and **angioplasty** patients, and individuals with **angina**, congestive **heart failure**, and heart transplants are all candidates for a cardiac rehabilitation program. Cardiac rehabilitation is prescribed to control symptoms, improve exercise tolerance, and improve the overall quality of life in these patients.

Precautions

A cardiac rehabilitation program should be implemented and closely monitored by a trained team of healthcare professionals.

Description

Cardiac rehabilitation is overseen by a specialized team of doctors, nurses, and other healthcare professionals. Members of the cardiac rehabilitation team may include a dietician or nutritionist, physical therapist, exercise physiologist, psychologist, vocational counselor, occupational therapist, and social worker. The program frequently begins in a hospital setting and continues on an outpatient basis after the patient is discharged over a period of six to 12 months.

Components of a cardiac rehabilitation program vary by individual clinical need, and each program will be carefully constructed for the patient by his or her rehabilitation team.

- Exercise. Exercise programs typically start out slowly, with simple range-of-motion arm and leg exercises. Walking and stair climbing soon follow. Blood pressure is carefully monitored before and after exercise sessions, and patients are taught how to measure their heart rate and evaluate any possible cardiac symptoms during each session. Patients with advanced coronary disease may require continuous ECG monitoring throughout their exercise sessions. Once discharged from the hospital, the patient works with his cardiac team to create an individual exercise plan.
- Diet. Cardiac patients will work with a nutritionist or dietician to develop a low-fat, low-cholesterol diet plan. Patients with high blood pressure may be put on a salt-restricted diet and instructed to limit alcohol intake. Weight loss may also be a goal with obese cardiac patients.
- Counseling. A psychologist or social worker can help cardiac patients with issues that may be contributing to their heart condition, such as stress and anxiety. Relaxation techniques may be taught to patients to help them deal with these feelings. Cardiac patients frequently experience a period of depression, and group or individual counseling can be beneficial in overcoming these feelings. Vocational counselors can assist cardiac patients in returning to the workforce.
- Education. The patient and family should be fully educated on the physical limitations of the patient, his recommended diet and exercise plan, his emotional status, and the lifestyle changes required to improve the patient's overall health.
- Smoking cessation. Cardiac patients who smoke are twice as likely to have a heart attack in the following five years than non-smoking patients. These patients are strongly encouraged to enroll in a smoking cessation program, which typically includes patient education and behavioral counseling. Nicotine replacement therapy, which uses nicotine patches, nose spray, or gum to wean patients off of cigarettes, may also be part of the program. Antidepressants and anti-anxiety medication may be helpful in some cases.

Aftercare

Long-term maintenance is a critical feature of cardiac rehabilitation. Patients require support from their healthcare team, family, and friends to continue the lifestyle changes they implemented during the rehabilitation period.

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Risks

The risks of another heart attack during cardiac rehabilitation are slight, and greatly reduced by careful, continuous monitoring of the physical status of the patient.

Normal results

The outcome of the cardiac rehabilitation program depends on a number of variables, including patient follow-through, type and degree of heart disease, and the availability of an adequate support network for the patient. Patients who successfully complete the program will ideally reach an age-appropriate level of physical activity and be able to return to the workforce and/or other daily activities.

ORGANIZATIONS

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Paula Anne Ford-Martin

Cardiac tamponade

Definition

Cardiac tamponade occurs when the heart is squeezed by fluid that collects inside the sac that surrounds it.

Description

The heart is surrounded by a sac called the pericardium. When this sac becomes filled with fluid, the liquid presses on the heart, preventing the lower chambers of the heart from properly filling with blood.

Because the lower chambers (the ventricles) cannot fill with the correct amount of blood, less than normal amounts of blood reach the lungs and the rest of the body. This condition is very serious and can be fatal if not treated.

Causes and symptoms

Fluid can collect inside the pericardium and compress the heart when the kidneys do not properly remove waste from the blood, when the pericardium swells from unknown causes, from infection, or when the pericardium is damaged by **cancer**. Blunt or penetrating injury from trauma to the chest or heart can also result in cardiac tamponade when large amounts of blood fill the pericardium. Tamponade can also occur during heart surgery.

KEY TERMS

Pericardiocentesis—A procedure used to drain fluid out of the sac surrounding the heart. This is done by inserting a needle through the chest and into the sac.

When the heart is compressed by the surrounding fluid, three conditions occur: a reduced amount of blood is pumped to the body by the heart, the lower chambers of the ventricles are filled with a less than normal amount of blood, and higher than normal blood pressures occur inside the heart, caused by the pressure of the fluid pushing in on the heart from the outside.

When tamponade occurs because of trauma, the sound of the heart beats can become faint, and the blood pressure in the arteries decreases, while the blood pressure in the veins increases.

In cases of tamponade caused by more slowly developing diseases, **shortness of breath**, a feeling of tightness in the chest, increased blood pressure in the large veins in the neck (the jugular veins), weight gain, and fluid retention by the body can occur.

Diagnosis

When cardiac tamponade is suspected, accurate diagnosis can be life-saving. The most accurate way to identify this condition is by using a test called an echocardiogram. This test uses sound waves to create an image of the heart and its surrounding sac, making it easy to visualize any fluid that has collected inside the sac.

Treatment

If the abnormal fluid buildup in the pericardial sac is caused by cancer or **kidney disease**, drugs used to treat these conditions can help lessen the amount of fluid collecting inside the sac. Drugs that help maintain normal blood pressure throughout the body can also help this condition; however, these drugs are only a temporary treatment. The fluid within the pericardium must be drained out to reduce the pressure on the heart and restore proper heart pumping.

The fluid inside the pericardium is drained by inserting a needle through the chest and into the sac itself. This allows the fluid to flow out of the sac,

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relieving the abnormal pressure on the heart. This procedure is called **pericardiocentesis**. In severe cases, a tube (catheter) can be inserted into the sac or a section of the sac can be surgically cut away to allow for more drainage.

Prognosis

This condition is life-threatening. However, drug treatments can be helpful, and surgical treatments can successfully drain the trapped fluid, though it may reaccumulate. Some risk of **death** exists with surgical drainage of the accumulated fluid.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review. personal.info@heart.org.

Dominic De Bellis, PhD

Cardiac tumors *see* **Myxoma**

Cardiogenic shock *see* **Shock**

Cardiomyopathy

Definition

Cardiomyopathy is a chronic disease of the heart muscle (myocardium), in which the muscle is abnormally enlarged, thickened, and/or stiffened. The weakened heart muscle loses the ability to pump blood effectively, resulting in irregular heartbeats (**arrhythmias**) and possibly even **heart failure**.

Description

Cardiomyopathy, a disease of the heart muscle, primarily affects the left ventricle, which is the main pumping chamber of the heart. The disease is often associated with inadequate heart pumping and other heart function abnormalities. Cardiomyopathy is not common (affecting about 50,000 persons in the United States) but it can be severely disabling or fatal. Severe cases may result in heart failure and will require a heart transplant for patient survival. Cardiomyopathy is a heart condition that not only affects middle-aged and elderly persons, but can also affect infants, children, and adolescents.

There are four major types of cardiomyopathy:

- Dilated (congestive cardiomyopathy). This is the most common form of the disease. The heart cavity is enlarged and stretched (cardiac dilation), which results in weak and slow pumping of the blood, which in turn can result in the formation of blood clots. Abnormal heart rhythms (arrhythmias) and disturbances in the electrical conduction processes in the heart may also occur. Most patients with this type of cardiomyopathy develop congestive heart failure. There is also a genetically-linked cardiac disease, Barth syndrome, that can cause dilated cardiomyopathy. This syndrome affects male children, and is usually diagnosed at birth or within the first few months of life. Pregnant women during the last trimester of pregnancy or after childbirth may develop a type of dilated cardiomyopathy referred to as peripartum cardiomyopathy.
- Hypertrophic cardiomyopathy. With this type of cardiomyopathy, the muscle mass of the left ventricle enlarges, or hypertrophies. In hypertrophic obstructive cardiomyopathy (HOCM), the septum (wall) between the two heart ventricles (the pumping chambers) becomes enlarged and obstructs blood flow from the left ventricle. The thickened wall can also distort one leaflet of the mitral valve, which results in leakage. HOCM is most common in young adults. HOCM is often hereditary, caused by genetic mutations in the affected person's DNA. The disease is either inherited through one parent who is a carrier or through both parents who each contribute a defective gene. HOCM is also referred to as asymmetrical septal hypertrophy (ASH) or idiopathic hypertrophic subaortic stenosis (IHSS). In another form of hypertrophic cardiomyopathy, non-obstructive cardiomyopathy, the enlarged heart muscle does not obstruct the blood flow through the heart.
- Restrictive cardiomyopathy. This is a less common type of cardiomyopathy, in which the heart muscle of the ventricles becomes rigid. Restrictive cardiomyopathy affects the diastolic function of the heart, that is, it affects the period when the heart is relaxing between contractions. Since the heart cannot relax adequately between contractions, it is harder for the ventricles to fill with blood between heartbeats. This type of cardiomyopathy is usually the result of another disease.
- Arrhythmogenic right ventricular cardiomyopathy (ARVC). ARVC is very rare and is believed to be an inherited condition. With ARVC, heart muscle cells become disorganized and damaged and are replaced by fatty tissues. The damage appears to be a result of the body's inability to remove damaged cells. The damaged cells are replaced with fat, leading to abnormal electrical activity (arrhythmias) and abnormal heart contractions. ARVC is the most common cause of sudden death in athletes.

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Causes and symptoms

Cardiomyopathy may be caused by many different factors, including viral infections (e.g., **myocarditis**), heart attacks, **alcoholism**, long-term, severe high blood pressure, genetic neuromuscular diseases (e.g., muscular dystrophies and ataxias), genetic metabolic disorders, complications from **AIDS**, and other reasons that have not yet been identified (idiopathic cardiomyopathy). Cardiomyopathy caused by heart attacks (referred to as ischemic cardiomyopathy) results from scarring in the heart muscle. Larger **scars** or more numerous heart attacks increases the risk that ischemic cardiomyopathy will develop. Alcoholic cardiomyopathy usually develops about 10 years after sustained, heavy alcohol consumption. Other toxins that may cause cardiomyopathy include drugs and radiation exposure.

The major symptoms of cardiomyopathy include:

- shortness of breath
- temporary and brief loss of consciousness, especially after engaging in activity
- lightheadness, especially after engaging in activity
- decreased ability to tolerate physical exertion
- fatigue
- dizziness
- palpitations, that is, the sensation of feeling the heart beat
- chest pain (angina), whereby there is a feeling of sharp and unrelenting pressure in the middle of the chest (especially experienced by persons whose cardiomyopathy is a result of a previous heart attack)
- high blood pressure

Other symptoms that may be associated with cardiomyopathy include:

- abdominal swelling or enlargement
- swelling of legs or ankles
- low amount of urine during the daytime, but a need to urinate at night
- decreased alertness and difficulty concentrating
- cough
- loss of appetite

Diagnosis

A complete **physical examination** and health history review by a health care provider is recommended if a person is suspected to have cardiomyopathy. The examination may reveal the presence of an irregular heartbeat, heart murmur, or other abnormal heart and breath sounds.

Various invasive and non-invasive tests are performed as diagnostic tools for cardiomyopathy. An echocardiogram is the most informative noninvasive test for diagnosing the type of cardiomyopathy and the degree of dysfunction in the heart muscle. High frequency sound waves produce moving images of the beating heart on a video screen, which allows the measurement of muscle thickness, size, pumping ability, degree of obstruction, chamber size, and heart valve movement.

The use of non-invasive radiation-based imaging procedures, such as chest radiography, computed tomography (CT), or **magnetic resonance imaging** (MRI) procedures show the size, shape, and structure of the heart. If dilated cardiomyopathy is suspected, one of these techniques is performed first to see if the heart is enlarged and whether there is any fluid accumulation in the lungs.

An electrocardiogram (EKG) is a non-invasive procedure where electrodes are placed on the person's limbs and chest wall to provide a graphic record of the electrical activity of the heart. This test can show the amount of heart enlargement and reveal abnormal heart rhythms. Children with a normal echocardiogram may have an abnormal EKG, indicating that they may be a carrier of the cardiomyopathy gene and may develop the disease later in life. A person may also wear a Holter monitor, which is an external device that continuously records heart rhythms. The monitor can identify irregular heart rhythms associated with dilated, hypertrophic, or **restrictive cardiomyopathy**.

Genetic studies may help in understanding the cause of cardiomyopathy, since the disease may be a symptom of another genetic disorder. If a child under the age of 4 has cardiomyopathy, metabolic screening should be performed, for certain metabolic disorders with cardiomyopathy as a symptom can be controlled with a change in diet, drug therapy, or by a bone marrow transplant, which may reduce or reverse the progression of the cardiomyopathy. Since cardiomyopathy can be inherited and present initially without signs or symptoms, relatives of a patient with the disease should be screened periodically for evidences of the disease.

Invasive procedures, which involve the use of anesthesia, are used to determine the severity of the disease. In the radionuclide ventriculogram procedure, a low-dose radioactive material is injected into a vein and flows to the heart. The heart is photographed with a special camera to assess the contraction and filling of the ventricles at rest and with activity. **Cardiac**

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catheterization involves insertion of thin, flexible plastic tubes (catheters) into the heart from a blood vessel in the groin area. A dye is then injected that can indicate blood pressures, blood flow within the heart, and blockages in the arteries. Although rarely used, a heart muscle biopsy, where the doctor removes a few, tiny pieces of the heart for laboratory studies, can aid in diagnosing possible infections in the heart or metabolic abnormalities. An electrophysiology study is similar to heart catheterization. Catheters with fine wires are inserted through veins in the groin area into the heart. Electrical stimuli applied through the wires can indicate abnormal conduction pathways, arrhythmias, effectiveness of drugs, and the need for an implanted defibrillator.

Treatment

Although there is a long list of possible causes for cardiomyopathy, few are directly treatable or curable. Therefore, most therapy is directed toward treating the effects of the disease on the heart. If cardiomyopathy is diagnosed at an advanced stage, a critically ill patient will require immediate life-saving measures such as placement of a breathing tube and administration of medicines to improve heart function and blood pressure. Once the patient is stabilized, long-term therapy needs, such as oral medication, **pacemakers**, surgery, or **heart transplantation**, will be identified.

Initial treatments for cardiomyopathy for patients diagnosed in the earlier stages of cardiomyopathy include drug therapy to relieve heart failure, to decrease oxygen requirements and workload of the heart (by relaxing the arteries in the body), and to regulate abnormal heartbeats. Drugs that help the heart contract include **digoxin** for at-home use and dopamine, dobutamine, and milrinone for in-hospital use. **Diuretics** help relieve fluid overloads in heart failure. **Vasodilators**, ACE-inhibitors, and **beta blockers** dilate blood vessels in the body and lower blood pressure, thus reducing the workload for the heart. For patients at risk of developing **blood clots**, anticoagulation medication or blood thinners such as heparin or coumadin are prescribed along with diuretics such as Lasix and aldactone to relieve venous congestion. These drugs may result in side effects, so the patient must be carefully monitored to prevent complications.

When drugs are not effective or when arrhythmias require regulation, a pacemaker or a defibrillator may be implanted surgically into the patient. The procedures for implanting both devices involves placing a small mechanical device under the skin of the chest or abdomen with wire leads threaded through veins to the heart. A pacemaker is used to monitor and stabilize slow heartbeats, while a defibrillator ("an emergency room in the heart") detects and treats fast and potentially lethal heart rhythms. Since sudden **death** may occur in patients with cardiomyopathy, defibrillators are often recommended for persons who show evidence of arrhythmias.

For heart failure symptoms associated with restricted blood flow from the ventricles, septal **myomectomy**, which is considered major heart surgery, is sometimes recommended. This procedure involves surgical removal of the part of the thickened septal muscle that blocks the blood flow. In some cases, the mitral valve is replaced with an artificial valve. However, the procedure does not prevent sudden death due to hear arrhythmias nor does it stop the disease from progressing.

Since cardiomyopathy often becomes progressively worse, the heart can reach a state where it no longer responds to medication or to surgery. The treatment of "last resort" is a heart transplant, when the patient exhibits severe heart failure symptoms. A transplant can cure the symptoms of heart failure, but the surgery carries significant risks, such as infection, organ rejection, and side effects of required medications.

There are surgical procedures that can be implemented to sustain life until a transplant donor becomes available. Left **Ventricular Assist Device** (LVAD) provides mechanical circulatory support, while Dynamic Cardiomyoplasty is a procedure whereby a skeletal-muscular flap, created from a patient's chest muscle, is first taught to contract and then is wrapped around the heart to aid in contraction.

Alternative treatment

Alternative treatments are directed toward control of the effects of heart disease. **Exercise**, diet, **nutrition**, herbal therapies, **stress reduction**, and other life style changes (e.g., cessation of **smoking**) can all be used to complement conventional treatments. Certain herbs such as fox glove (*Digitalis purpurea*) and lily of the valley (*Convallaria majalis*) contain cardiac glycosides that make them particularly potent and may cause dangerous side effects. Their use should be supervised only be a qualified medical herbalist, with the concurrence of the primary conventional health care provider. Even the use of less potent herbs that improve cardiac function, such as hawthorn (*Crataegus laevigata*), should be approved by the conventional health care provider and administered under the supervision of a medical herbalist.

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KEY TERMS

Arrhythmia—An abnormal rhythm or irregularity of the heartbeat. The heartbeat may either be too fast (tachycardia) or too slow (bradicardia). Arrhythmias may cause symptoms such as palpitation or lightheadedness, but many have more serious consequences, including sudden death.

Congestive heart failure—Potentially lethal condition in which congestion develops in the lungs that is produced by a heart attack, poorly controlled or uncontrolled hypertension, or disease processes that weaken the heart.

Hypertrophy—Literally means an increase in the muscle mass (or weight) of the heart.

Mitral valve leaflets—The mitral valve is made up of two valve leaflets (the anteromedial leaflet and the posterolateral leaflet) and a ring around the valve, known as the mitral valve annulus. The orientation of the two leaflets resembles a bishop's miter, which is where the valve receives its name.

Myocardium—The muscular wall of the heart located between the inner endocardial layer and the outer epicardial layer.

Noninvasive—Refers to tests that generally do not invade the integrity of the body, such as echocardiography or electrocardiography. (Cardiac catheterization, on the other hand, in which catheters are introduced through blood vessels into the heart, is an example of an invasive test).

Septum (ventricular septum)—That portion of the heart wall that divides the right and left ventricles.

Ventricles—The two main (lower) pumping chambers of the heart; the right and left ventricles pump blood to the lungs and aorta, respectively.

Prognosis

Long-term prognosis can be unpredictable, as there can be a wide range of severities and outcomes associated with the disease. There is no cure, but some symptoms and complications can be managed and controlled with medication and implantable devices or with a heart transplant.

Prevention

Prevention of cardiomyopathy is focused on controlling risk factors for heart disease, which includes maintaining a healthy weight, exercising regularly, eating a well-balanced nutritious diet, and avoiding or minimizing smoking.

Resources

BOOKS

Dilated Cardiomyopathy: A Medical Dictionary, Bibliography, and Annotated Research Guide to Internet Resources. San Diego, CA: Icon Health Publications, 2004.

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Ommen, Steve R., and Nishimura, Rick A. *"A Physician's Guide to the Treatment of Hypertrophic Cardiomyopathy."HeartViews* 1(10): 393–401.

OTHER

Cleveland Clinic Heart Center. http://www.clevelandclinic.org/heartcenter/pub/guide/disease/hcm.asp.

National Heart, Blood, and Lung Institute, National Institutes of Health, NHLBI Health Information Center, P.O. Box 30105, Bethesda, MD 20824-0105. Telephone: (301) 592 8573; http://www.nhlbi.nih.gov.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review. personal.info@heart.org.

Children's Cardiomyopathy Foundation, P.O. Box 547, Tenafly, NJ, 07670, 201, 227-7016, (866) 808-2873, info@childrenscardiomyopathy.org, http://www.childrenscardiomyopathy.org.

Hypertrophic Cardiomyopathy Association, 328 Green Pond Rd. ; P.O. Box 306, Hibernia, NJ, 07842, (973) 983-7429, (973) 983-7870, support@4hcma.org, http://www. 4hcm.org/.

Judith Sims

Cardiopulmonary resuscitation

Definition

Cardiopulmonary resuscitation, commonly called CPR, is a lifesaving procedure performed when a person has stopped breathing or a person's heart has stopped beating.

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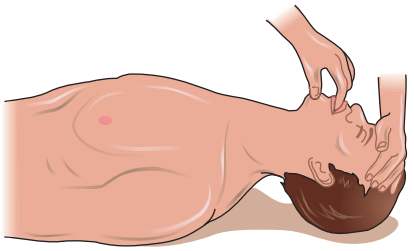

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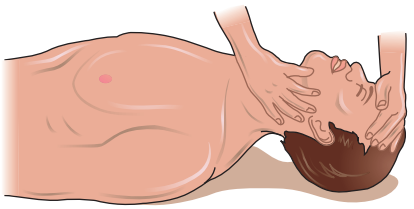

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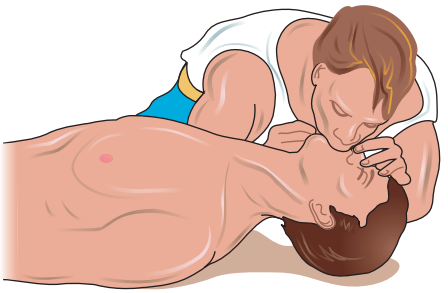

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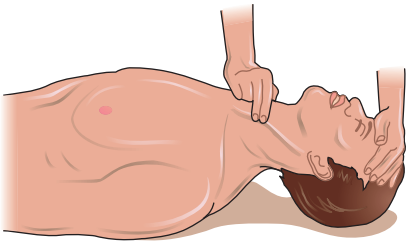

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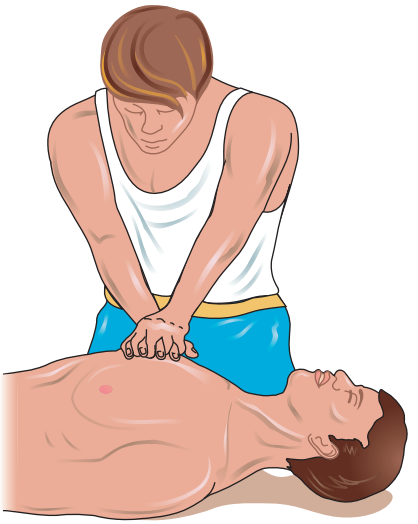

Figure E

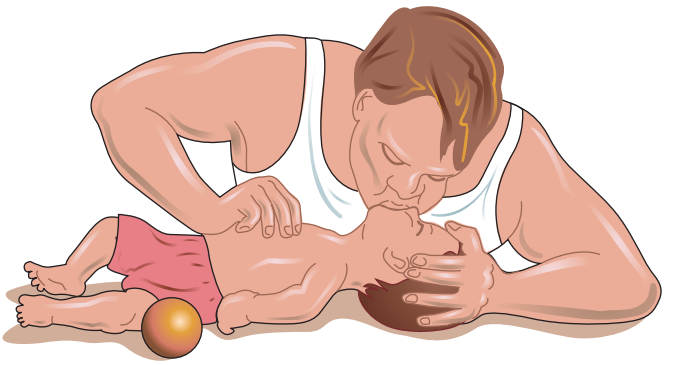

Figure F

Call 911 and immediately start CPR with compressions. Push hard on the center of the chest 30 times (E) at a rate of 100 compressions/minute. If you're trained in CPR, continue by opening the airway with a head tilt (B). Pinch the victim's nose shut, inhale normally, and create an airtight seal between your mouth and the victim's (C). Give two short breaths and watch for chest rise. Continue compressions and breaths until trained help arrives. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

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Purpose

The purpose of CPR is to bring oxygen to the individual's lungs and to keep blood circulating so oxygen gets to every part of the body. When a person is deprived of oxygen, permanent brain damage can begin in as little as four minutes and **death** can follow only minutes later. When performed quickly enough, CPR can save lives in such emergencies as **heart attack** or sudden cardiac arrest, electric shock, **near-drowning**, **drug overdose**, and other conditions in which the heart has stopped and there is no breathing.

Description

In 2010, over 300,000 Americans were expected to die of sudden cardiac arrest. Some of these people could be saved by the immediate application of CPR. In October of 2010, the instructions for performing CPR by people who have not received formal CPR training or who are not healthcare professionals was changed.

There are three physical symptoms that indicate a potential need for CPR to be performed immediately and for emergency medical support to be called: unconsciousness, absence of breathing, and no pulse detected (absence of heartbeat).

Unconsciousness

Unconsciousness is the loss of all awareness and failure to respond to questions, touch, or gentle shaking. When unconscious, a person cannot cough or clear the throat, which may allow the windpipe to become blocked, causing suffocation and death. People with a major illness or injury or who have had recent surgery are at risk for losing consciousness. Alcohol or drug overdose also can cause unconsciousness.

Individuals who are unconscious and *not breathing* need immediate CPR. Individuals who are unconscious and breathing (e.g., a traumatic **head injury**) need emergency medical care, and should be watched to assure that their breathing continues. If the person is conscious, he or she may be **choking** and need other medical help but *does not* need CPR. Fainting is a brief period of unconsciousness, which may occur from **dehydration** (lack of body fluids), low blood pressure, low blood sugar, excessive bleeding, or emotional distress. This is a temporary condition. Again, the individual may need medical help but does not normally need CPR because people who faint normally continue to breathe without assistance.

Failure to breathe

Apnea is the lack of spontaneous breathing. The individual may become limp and lifeless, have a seizure, or turn bluish (a sign of inadequate oxygen). Prolonged apnea is called respiratory arrest. In children, this can quickly lead to cardiac arrest in which the heart stops beating. In adults, cardiac arrest usually happens first, followed by respiratory arrest. In adults, common causes of apnea and respiratory arrest include choking, drug overdose, near-drowning, head injury, and cardiac arrest. In children, the causes may be different, such as **prematurity**, swelling of the airways (e.g., an **asthma** attack, an allergic reaction), choking on a foreign object, seizures, regurgitating food or near-drowning.

No pulse detected

If the rescuer is unable to detect a pulse or has difficulty feeling a pulse, it may be due to cardiac arrest (i.e., the heart has stopped beating). Not all rescuers are adept at finding a pulse either in the wrist or the carotid artery of the neck. Rescuers who are uncertain about whether there is a pulse should err on the side of caution and begin CPR.

Medical help and possibly CPR are needed immediately if any of these three symptoms are found. Time is critical. A local emergency number should be called immediately. If more than one person is available to help, one person can call the local emergency medical service (911 in the United States), while the other person begins CPR. If needed, the emergency dispatcher (the person who picks up emergency calls) can give step-by-step CPR instructions over the telephone.

Performing CPR

The explanation below is not a substitute for CPR training and is intended as a descriptive guideline only.

In 2010 the American Heart Association recommended that the three traditional steps for performing CPR be re-ordered for lay people who have had little or no training in CPR. This change applies to performing CPR on adults, children, and infants, but not on newborns. Formerly the steps were (in order): clear the airways, check for breathing, and begin chest compressions. This was known as the A-B-C method of CPR.

The 2010 recommendations have changed the order. Chest compressions should begin *first*, followed by clearing the airways and checking for breathing if the rescuer is adequately trained. There are two reasons for this change. First, most people have residual

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oxygen in their lungs from their last breath. It is most important that the blood be kept circulating continuously through chest compressions so that this oxygen reaches the brain without delay. Second, many lay people are reluctant to do mouth-to-mouth breathing on a stranger. After reviewing multiple studies that examined the outcome of CPR done by lay people, the American Heart Association has determined that chest compressions alone (hands-only CPR) are almost as effective as chest compressions with breathing, and that breathing need not be done by people untrained in CPR. The American Heart Association hopes that this change will encourage more bystanders to come to the aid of a cardiac arrest victim and potentially save more lives.

The steps to be followed in CPR by a layperson are as follows:

- If the victim appears to be unconscious, he or she should be shaken or tapped gently to check for any sign of consciousness. If there is no response, the rescuer should call emergency medical services immediately, or (preferably) send someone else to call for help. If the rescuer is alone, he or she should call for emergency services before beginning CPR.
- The victim should be placed on his or her back on a level surface such as the ground or the floor unless there is some sign of neck or back injuries, in which case the individual should not be moved. It is better to err on the side of caution and not move the individual if there is any question about whether moving will cause additional damage.
- The rescuer then places the heel of one hand in the middle of the chest, putting the other hand on top of the first, interlacing the fingers, and pressing down so that the chest is compressed by at two inches. Hard and fast compressions are essential if CPR is to be effective. The rescuer should not worry about damaging the breastbone or ribs. (These will heal; death is permanent.) When performing compressions, the rescuer should keep the elbows straight, center his or her shoulders over the individual, develop an up-and-down rhythm, and keep the hands firmly on the individual's chest. Compressions should be done on the center of the chest midway between the nipples. Compressions should be hard and fast at a rate of *at least* 100 times per minute. That is about the same rhythm as the beat of the Bee Gee's song "Stayin' Alive." Compressions should continue at this rate until the victim begins to breathe spontaneously or until trained medical help arrives.

If the rescuer has been trained in CPR, he or she may jut the victim's jaw forward, tilt the head back, and open the mouth. Using the finger, the rescuer should clear any debris from inside the mouth. The rescuer then should put his or her ear to the victim's open mouth, look for chest movement, listen for air flowing through the mouth or nose, and feel for air on his or her cheek. If there is no breathing, the rescuer pinches the individual's nose shut, makes a seal over the individual's mouth with his or her own mouth, and gives the individual two puffs of breath big enough to make the chest rise. If the chest does not rise, the individual's head should be repositioned to help ensure the tongue is kept away from the windpipe, then the rescuer should try again to give a breath. Chest compressions should continue with two puffs of breath given for every 50 compressions (two puffs per minute) until help arrives or the victim begins breathing spontaneously.

KEY TERMS

Apnea—A period of no breathing, sometimes sudden, sometimes prolonged.

Arrest—A sudden stopping of the function of a body organ, such as no breathing (respiratory arrest) or no beating of the heart (cardiac arrest).

Cardiopulmonary—Involving both heart and lungs.

Circulation—The passage of blood and delivery of oxygen through the veins and arteries of the body.

Respiratory—Referring to breathing in and breathing out, and the function of the lungs.

Resuscitation—Reviving an unconscious person or restoring breathing.

Benefits

Successful CPR is a life-saving procedure. It can restore breathing and circulation in the individual. Medical attention is required immediately even if successful CPR has been performed and the individual is breathing freely.

Precautions

Rescuers should observe the following:

- Do not leave the individual alone.
- Do not give the individual anything to eat or drink.
- Avoid moving the individual's head or neck if spinal injury is a possibility. To check for breathing when

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spinal injury is suspected, the rescuer should only listen for breath by the individual's mouth and watch the chest for movement.

- Do not place a pillow under the individual's head.

Preparation

As CPR is performed in emergency situations, there is no time to prepare the recipient for the procedure. It is necessary to place lay the recipient on a flat surface facing up before administering compressions.

Training in CPR is the best preparation the rescuer. Training is not difficult or expensive. The American Heart Association provides CPR instruction for the community, schools, and workplace, along with health care settings. Courses vary from short programs to teach laypersons the basics of CPR to advanced cardiac life support certification for healthcare professionals. CPR is taught as part of many first aid courses.

In addition, the American Heart Association has a 22-minute long self-directed program called CPR Anytime in an effort to prepare the public and people who would not otherwise attend a CPR course to be able to respond to an emergency with core CPR skills. CPR Anytime does not lead to certification, but research has shown that the program is effective in quickly training the lay public and could prove to be a valuable tool in increasing the overall number of CPR-prepared individuals.

Aftercare

When CPR is initiated, emergency responders have ideally already been notified and are on the way to the scene. It is important to stay with the affected person and continue CPR until breathing and circulation are restored and/or emergency medical personnel arrive. When emergency personnel assume care of the individual, the person who initially provided CPR can often be helpful by providing information to emergency responders.

Risks

Minor injuries such as bruising can occur with chest compressions. Sometimes chest compressions can result in one or more breaks in the ribs and accompanying damage to internal organs, especially in young children, the elderly, or debilitated persons. The American Heart Association states, however, that in the event of a suspected cardiac arrest, even CPR performed by an untrained bystander who receives instructions from an emergency dispatcher is more beneficial than the risk of injury in a person who is actually not in cardiac arrest.

Training and certification

Local medical personnel, staff at hospitals and fire departments, and members of the American Heart Association teach CPR courses for the community, schools, and workplaces, along with more extensive courses for allied health professionals. Courses vary from short programs to teach laypersons the basics of CPR to advanced cardiac life support certification for healthcare professionals. Certification must be renewed on a regular basis by taking a refresher course.

Prevention

People with serious health conditions can follow these general guidelines:

- Risk factors that contribute to heart disease should be reduced or eliminated. People can reduce risks if they stop smoking, lower blood pressure and cholesterol, lose excess weight, and reduce stress.
- Illegal recreational drugs should be avoided.
- Seeing a doctor regularly and being aware of any disease conditions or risk factors can help prevent or complicate illness, as can seeking and following the doctor's advice about diet and exercise.

Resources

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ORGANIZATIONS

American Heart Association, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, http://www.americanheart.org.

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Tish Davidson AM

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Cardioversion

Definition

Cardioversion refers to the process of restoring the heart's normal rhythm by applying a controlled electric shock to the exterior of the chest.

Purpose

When the heart beats too fast, blood no longer circulates effectively in the body. Cardioversion is used to stop this abnormal beating so that the heart can begin normal rhythm and pump more efficiently.

Precautions

Not all unusual heart rhythms (called **arrhythmias**) are dangerous or fatal. **Atrial fibrillation** and **atrial flutter** often revert to normal rhythms without the need for cardioversion. Healthcare providers may also try to correct the heart rhythm with medication or recommend a lifestyle change before trying cardioversion. However, **ventricular tachycardia** lasting more than 30 seconds and **ventricular fibrillation** require immediate cardioversion.

Description

Elective cardioversion is usually scheduled ahead of time. After arriving at the hospital, an intravenous (IV) catheter will be placed in the arm and oxygen will be given through a face mask. A short-acting general anesthetic will be administered through the vein. During the two or three minutes of anesthesia, the doctor will apply two paddles to the exterior of the chest and administer the electric shock. It may be necessary to give the shock two or three times to obtain normal rhythm.

Preparation

Medication to thin the blood is usually given for at least three weeks before elective cardioversion. Food intake should be stopped eight hours before the procedure.

Aftercare

Medical personnel will monitor the heart rhythm for a few hours, after which the patient is usually sent home. It is advisable to arrange for transportation home, because drowsiness may last several hours. The doctor may prescribe anti-arrhythmic medication to prevent the abnormal rhythm from returning.

KEY TERMS

Atrial fibrillation—A condition in which the upper chamber of the heart quivers instead of pumping in an organized way.

Atrial flutter—A rapid pulsation of the upper chamber of the heart that interferes with normal function.

Ventricular fibrillation—A condition in which the lower chamber of the heart quivers instead of pumping in an organized way.

Ventricular tachycardia—A rapid heart beat, usually over 100 beats per minute.

Risks

Cardioverters have been in use for many years and the risks are few. Those unlikely risks that remain include those instances when the device delivers greater or lesser power than expected or when power setting and control knobs are not set correctly. Unfortunately, in a number of cases, the heart prefers its abnormal rhythm and reverts to it despite cardioversion.

Normal results

Most cardioversions are successful and, at least for a time, restore the normal heart rhythm.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review. personal.info@heart.org.

Dorothy Elinor Stonely

Carisoprodol *see* **Muscle relaxants**

Carotid artery surgery *see* **Endarterectomy**

Carotid Doppler ultrasound *see* **Doppler ultrasonography**

Carotid endarterectomy *see* **Endarterectomy**

Carotid sinus massage

Definition

Carotid sinus massage involves rubbing the large part of the arterial wall at the point where the common carotid artery, located in the neck, divides into its two main branches.

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KEY TERMS

Angina pectoris—Chest pain usually caused by a lack of oxygen in the heart muscle.

Arrhythmia—Any deviation from a normal heart beat.

Atrial fibrillation—A condition in which the upper chamber of the heart quivers instead of pumping in an organized way.

Atrial flutter—Rapid, inefficient contraction of the upper chamber of the heart.

Carotid artery—One of the major arteries supplying blood to the head and neck.

Tachycardia—A rapid heart beat, usually over 100 beats per minute.

Purpose

Sinus, in this case, means an area in a blood vessel that is bigger than the rest of the vessel. This is a normal dilation of the vessel. Located in the neck just below the angle of the jaw, the carotid sinus sits above the point where the carotid artery divides into its two main branches. Rubbing the carotid sinus stimulates an area in the artery wall that contains nerve endings. These nerves respond to changes in blood pressure and are capable of slowing the heart rate. The response to this simple procedure often slows a rapid heart rate (for example, **atrial flutter** or atrial tachycardia) and can provide important diagnostic information to the physician.

Description

The patient will be asked to lie down, with the neck fully extended and the head turned away from the side being massaged. While watching an electrocardiogram monitor, the doctor will gently touch the carotid sinus. If there is no change in the heart rate on the monitor, the pressure is applied more firmly with a gentle rotating motion. After massaging one side of the neck, the massage will be repeated on the other side. Both sides of the neck are never massaged at the same time.

Preparation

No special preparation is needed for carotid sinus massage.

Aftercare

No aftercare is required.

Risks

The physician must be sure there is no evidence of blockage in the carotid artery before performing the procedure. Massage in a blocked area might cause a clot to break loose and cause a **stroke**.

Normal results

Carotid sinus massage will slow the heart rate during episodes of atrial flutter, fibrillation, and some tachycardias. It has been known to stop the arrhythmia completely. If the procedure is being done to help diagnose **angina** pectoris, massaging the carotid sinus may make the discomfort go away.

Resources

BOOKS

Fuster, Valentin, et al. *Hurst's the Heart*. 12th ed. New York: McGraw Hill Professional, 2007.

Dorothy Elinor Stonely

Carpal tunnel syndrome

Definition

Carpal tunnel syndrome is a disorder caused by compression at the wrist of the median nerve supplying the hand, causing **numbness and tingling**.

Description

The carpal tunnel is an area in the wrist where the bones and ligaments create a small passageway for the median nerve. The median nerve is responsible for both sensation and movement in the hand, in particular the thumb and first three fingers. When the median nerve is compressed, an individual's hand will feel as if it has "gone to sleep."

Women between the ages of 30 and 60 have the highest rates of carpal tunnel syndrome. Research has demonstrated that carpal tunnel syndrome is a very significant cause of missed work days due to **pain**. In 1995, about $270 million was spent on sick days taken for pain from repetitive motion injuries.

Causes and symptoms

Compression of the median nerve in the wrist can occur during a number of different conditions, particularly those conditions which lead to changes in fluid accumulation throughout the body. Because

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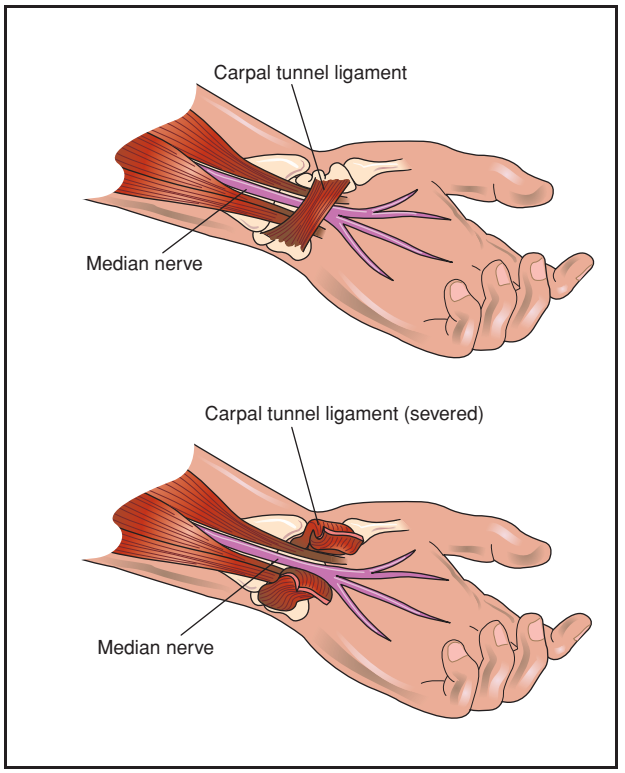

The most severe cases of carpal tunnel syndrome may require surgery to decrease the compression of the median nerve and restore its normal function. This procedure involves severing the ligament that crosses the wrist, thus allowing the median nerve more room and decreasing compression. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

the area of the wrist through which the median nerve passes is very narrow, any swelling in the area will lead to pressure on the median nerve. This pressure will ultimately interfere with the nerve's ability to function normally. **Pregnancy**, **obesity**, arthritis, certain thyroid conditions, diabetes, and certain pituitary abnormalities all predispose to carpal tunnel syndrome. Other conditions which increase the risk for carpal tunnel syndrome include some forms of arthritis and various injuries to the arm and wrist (including **fractures**, sprains, and **dislocations**). Furthermore, activities which cause an individual to repeatedly bend the wrist inward toward the forearm can predispose to carpal tunnel syndrome. Certain jobs which require repeated strong wrist motions carry a relatively high risk of carpal tunnel syndrome. Injuries of this type are referred to as "repetitive motion" injuries, and are more frequent among secretaries doing a lot of typing, people working at computer keyboards or cash registers, factory workers, and some musicians.

Symptoms of carpal tunnel syndrome include **numbness**, burning, **tingling**, and a prickly pin-like sensation over the palm surface of the hand, and into the thumb, forefinger, middle finger, and half of the ring finger. Some individuals notice a shooting pain which goes from the wrist up the arm, or down into the hand and fingers. With continued median nerve compression, an individual may begin to experience muscle weakness, making it difficult to open jars and hold objects with the affected hand. Eventually, the muscles of the hand served by the median nerve may begin to grow noticeably smaller (atrophy), especially the fleshy part of the thumb. Untreated, carpal tunnel syndrome may eventually result in permanent weakness, loss of sensation, or even **paralysis** of the thumb and fingers of the affected hand.

Diagnosis

The diagnosis of carpal tunnel syndrome is made in part by checking to see whether the patient's symptoms can be brought on by holding his or her hand in position with wrist bent for about a minute. Wrist x rays are often taken to rule out the possibility of a tumor causing pressure on the median nerve. A physician examining a patient suspected of having carpal tunnel syndrome will perform a variety of simple tests to measure muscle strength and sensation in the affected hand and arm. Further testing might include electromyographic or nerve conduction velocity testing to determine the exact severity of nerve damage. These tests involve stimulating the median nerve with electricity and measuring the resulting speed and strength of the muscle response, as well as recording speed of nerve transmission across the carpal tunnel.

Treatment

Carpal tunnel syndrome is initially treated with splints, which support the wrist and prevent it from flexing inward into the position which exacerbates median nerve compression. Some people get significant relief by wearing such splints to sleep at night, while others will need to wear the splints all day, especially if they are performing jobs which **stress** the wrist. Ibuprofen or other **nonsteroidal anti-inflammatory drugs** may be prescribed to decrease pain and swelling. When carpal tunnel syndrome is more advanced, injection of **steroids** into the wrist to decrease inflammation may be necessary.

The most severe cases of carpal tunnel syndrome may require surgery to decrease the compression of the median nerve and restore its normal function. Such a

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KEY TERMS

Carpal tunnel—A passageway in the wrist, created by the bones and ligaments of the wrist, through which the median nerve passes.

Electromyography—A type of test in which a nerve's function is tested by stimulating a nerve with electricity, and then measuring the speed and strength of the corresponding muscle's response.

Median nerve—A nerve which runs through the wrist and into the hand. It provides sensation and some movement to the hand, the thumb, the index finger, the middle finger, and half of the ring finger.

repair involves cutting that ligament which crosses the wrist, thus allowing the median nerve more room and decreasing compression. This surgery is done almost exclusively on an outpatient basis and is often performed without the patient having to be made unconscious. Careful injection of numbing medicines (**local anesthesia**) or nerve blocks (the injection of anesthetics directly into the nerve) create sufficient numbness to allow the surgery to be performed painlessly, without the risks associated with **general anesthesia**. Recovery from this type of surgery is usually quick and without complications.

Prognosis

Without treatment, continued pressure on the median nerve puts an individual at risk for permanent disability in the affected hand. Most people are able to control the symptoms of carpal tunnel syndrome with splinting and anti-inflammatory agents. For those who go on to require surgery, about 95% will have complete cessation of symptoms.

Prevention

Prevention is generally aimed at becoming aware of the repetitive motions which one must make which could put the wrist into a bent position. People who must work long hours at a computer keyboard, for example, may need to take advantage of recent advances in "ergonomics," which try to position the keyboard and computer components in a way that increases efficiency and decreases stress. Early use of a splint may also be helpful for people whose jobs increase the risk of carpal tunnel syndrome.

Resources

PERIODICALS

Seiler, John Gray. "Carpal Tunnel Syndrome: Update on Diagnostic Testing and Treatment Options." *Consultant* 37, no. 5 (May 1997): 1233.

Rosalyn Carson-DeWitt, MD

Casts *see* **Immobilization**

Cataract surgery

Definition

Cataract surgery is a procedure performed to remove a cloudy (natural) lens from the eye; usually an intraocular (artificial) lens is implanted at the same time. The removed lens, sometimes also called a crystalline lens, is called a cataract because the originally clear lens has turned cloudy. An ophthalmologist (commonly called an eye surgeon) usually performs such surgeries on an outpatient basis within a surgical center, hospital, or other professional medical facility. The commonly performed procedure, which takes less than an hour, is generally safe and nearly risk free.

Demographics

Nearly all cataract surgeries are performed on older people. As the eyes age, **cataracts** form on the lens of the eyes, which cause blurry vision, difficulties looking at bright lights, and other such vision problems. According to the National Institutes of Health, over 50% of people in the United States over the age of 80 years have a cataract or have had cataract surgery. Normally, people will have cataract surgery when the eyes degrade enough so that it is increasingly difficult to carry out daily activities of life. Often times, people, especially elderly adults, have other eye problems, such as **macular degeneration**, which are difficult to treat when cataracts are present. In such cases, it is often advisable to have the cataracts removed.

Purpose

The purpose of cataract surgery is to restore clear vision. It is indicated when cloudy vision due to cataracts has progressed to such an extent that it interferes with normal daily activities. Other symptoms of cataracts include colors that fade, excessive glare, inability to see well at night, double vision, and numerous changes in vision prescriptions (for **eye glasses** or contacts). It is one of the most commonly performed surgical procedures in the world.

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Precautions

Cataract surgery is not performed on both eyes at once. To avoid risking blindness in both eyes in the event of infection or other catastrophe, the first eye is allowed to heal before the cataract is removed from the second eye.

The presence of cataracts can mask additional eye problems, such as retinal damage, that neither doctors nor patients are aware of prior to surgery. Since such conditions will continue to impair sight after cataract removal if they are not identified and treated, the eventual outcome of cataract surgery will depend on the outcome of other problems.

In 1997 and 1998, evidence that cataract surgery can contribute to the progression of age-related macular degeneration (ARMD) was published. ARMD is the degeneration of the central part of the retina. However, as of 2010, studies have not shown such a conclusive relationship. Whether cataract surgery contributes to the progression of ARMD is still up to debate in the medical community. Accordingly, ARMD patients with cataracts must weigh the possible risks of the loss of central vision, within four or five years, against short-term improvement. When an ARMD patient chooses cataract surgery, the surgeon should shield the retina against bright light to protect it from possible light-induced damage during surgery and install an intraocular lens capable of absorbing ultraviolet and blue light, which seem to do the most damage.

Description

Just before the start of the surgery, eye drops are placed in the eye to dilate the pupil. Local anesthetics are provided to de-sensitive (numb) the area around the eye. A sedative may be provided for anxious patients so they can relax. The patient will remain awake during the surgery but may feel sleepy.

There are two types of cataract surgery: intracapsular and extracapsular. Intracapsular surgery is the removal of both the lens and the thin capsule that surround the lens. This type of surgery was common before 1980, but it has since been displaced by extracapsular surgery. Removal of the capsule requires a large incision and does not allow comfortable intraocular lens implantation. Thus, people who undergo intracapsular cataract surgery have long recovery periods and have to wear very thick glasses.

Extracapsular cataract surgery is the removal of the lens where the capsule is left in place. Each year in the United States, over a million cataracts are removed this way. Physicians and researchers continue to improve cataract surgery methods. Research from France in 2003 said that cataract removal and non-penetrating glaucoma surgery can be combined in glaucoma patients.

There are two methods for extracapsular cataract surgery. The usual technique is phacoemulsification. A tiny incision (about 0.12-inch, or 3-millimeter, long) is made next to the cornea (the eye's outer covering) in the front of the eye, and an ultrasonic probe is used to break up (emulsify) the cataract into minute pieces, which are then removed by suction. Stitches may or may not be used to close the small incision point.

When the lens is too hard to be emulsified ultrasonically, the surgeon will use a slightly different technique called extracapsular extraction, which requires a larger incision. The extracapsular extraction is performed during phacoemulsification. During the process, an incision—one with a length of about 0.37 inch (9 millimeters) long—is made, and the whole lens (without its capsule) is removed through the incision. In this method, stitches are usually necessary. Both kinds of extracapsular cataract surgery leave the back of the capsule intact, so a silicone or plastic intraocular lens can be stably implanted in about the same location as the original lens.

The surgery takes about 30 to 60 minutes for one eye. Once completed the patient will have a clear, artificial lens implanted into the empty capsule. The implant, called an intraocular lens (IOL), is made of acrylic, plastic, or silicone. There are a variety of different IOLs that can be implanted. Some are flexible, while others rigid. Some are made so they block ultraviolet (UV) radiation, while others function like bifocal or trifocal eye glasses.

Preparation

Patients must have a pre-operation **eye examination**, which will include ultrasound analysis to make sure the retina (the innermost layer of the eye, containing the light receptors) is intact and also to measure eye curvature so that a lens with the proper correction can be implanted. The patient also will have a pre-operative **physical examination**. In addition, patients start a course of antibiotic eye drops or ointment the day before surgery. Medications taken by the patient may be stopped under the advice of the surgeon. Such medications include any that may cause increased bleeding during surgery.

About 12 hours before the surgery, the physician may ask you to stop eating or drinking. The medical staff will also ask the patient to arrange for someone to remain at the surgical site to drive the patient home afterwards.

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KEY TERMS

Age-related macular degeneration (ARMD)—Degeneration of the macula (the central part of the retina where the rods and cones are most dense) that leads to loss of central vision in people over 60 years of age.

Cataract—Progressive opacity or clouding of an eye lens, which obstructs the passage of light to the retina.

Cornea—Clear outer covering of the front of the eye.

Intraocular lens—Lens made of silicone or plastic placed within the eye; can be corrective.

Retina—Innermost layer at the back of the eye, which contains light receptors, the rods and cones.

Aftercare

Proper post-operative care is especially important after cataract surgery. Patients will need someone to drive them home after the surgery and should not bend over or lift anything up for a few days after the surgery, or do anything strenuous for about two weeks. The sight through the repaired eye will be blurry over the first few days after surgery as the eye adjusts to the new lens. Patients should refrain from rubbing or pressing the eye, should wear glasses to protect their eye, and should wear a shield while sleeping so the eye will not be rubbed or bumped accidentally.

The patient will usually continue their antibiotic for two to three weeks and will also take anti-inflammatory medication for about the same length of time. If the patient experiences inflammation, redness, or **pain**, they should seek immediate medical treatment to avoid serious complications. If complications do not occur, the patient will normally visit the doctor a few days after the surgery and, then again, after a week and finally after a month.

Any type of after care is not necessary for the intraocular lens itself. It becomes a permanent part of the eye. The eye should be completely healed within eight weeks of the surgery.

Risks

Cataract surgery itself is quite safe and is almost always treated successfully; over 90% of the time, complications do not occur. However, complications can occur and should be noted by anyone thinking about cataract surgery. Possible complications include intraocular infection (endophthalmitis), central retinal inflammation (macular **edema**), post-operative glaucoma, **retinal detachment**, bleeding under the retina (choroidal hemorrhage), and tiny lens fragments in the back (vitreous) cavity of the eye, all of which can lead to loss of sight.

If the following symptoms occur, contact your doctor immediately:

- Nausea, vomiting, or disproportionate amount of coughing
- Loss of vision in the eye
- Redness in the eye
- Excessive, persistent pain (especially if pain medications are being used)
- Flashes of light or floaters (spots) on the front of the eye.

An added risk of complications can also occur when other diseases are present. Such diseases may prevent an otherwise successful surgery from being completed satisfactorily. In such cases, vision may not be improved due to diseases present within the body, and especially those diseases of the eyes, such as glaucoma. Consequently, it may be wise to treat such diseases before having cataract surgery.

Since increased use of the phacoemulsification method of cataract surgery, researchers have noted a decline in cases of infection (endophthalmitis). This probably is because injectable intraocular lenses do not make contact with the ocular surface. In 2004, the FDA approved a new capsular tension ring for use in cataract surgery that helps prevent lens dislocation and other possible complications of surgery.

After cataract surgery, some patients develop posterior capsule opacification (PCO). This complication occurs when the back of the lens capsule becomes cloudy and sight is again degraded. However, if this happens, then a procedure called yttrium-aluminum-garnet (YAG) laser capsulotomy can be performed. The procedure allows light to pass through the clouded capsule, which solves the problem.

Normal results

Ordinarily, according to the National Institutes of Health, about 95% of patients experience improved visual acuity and improved perception of the vividness of colors, leading to increased abilities in many activities, including reading, needlework, driving, golf, and tennis, for example. This improvement in sight should be apparent within a few days after the surgery. In addition, sometimes implanted corrective lenses eliminate the

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need for eyeglasses or **contact lenses**. Researchers and manufacturers also continue to work to improve the lenses available in cataract surgeries, so that eventual vision and outcome are improved.

Resources

PERIODICALS

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Groves, Nancy. "Advances in Cataract Surgery Driven by Technology; Surgeons Able to Achieve Better Outcomes with New IOL, Viscoadaptive Devices." *Ophthalmology Times* April 1, 2004: 39.

Mayer, E., et al. "A 10-year Retrospective Survey of Cataract Surgery and Endophthalmitis in a Single Yey Unit: Injectable Lenses Lower the Incidence of Endophthalmitis." *British Journal of Ophthalmology* July 2003: 867–873.

OTHER

"Cataract in Adults: A Patient's Guide." *National Library of Medicine Page*. http://text.nlm.nih.gov.

"Patient Information." *Digital Journal of Ophthalmology*. http://www.djo.harvard.edu/site.php?url=/patients/pi.

ORGANIZATIONS

American Academy of Ophthalmology (AAO), P. O. Box 7424, San Francisco, CA, 94120-7424, (415) 561-8500, (415) 561-8500, http://www.aao.org.

American Society of Cataract and Refractive Surgery, 4000 Legato Road, Suite 700, Fairfax, VA, 22033, (703) 591-2220, (703) 591-0614, http://www.ascrs.org.

Lorraine Lica, PhD
Teresa G. Odle

Cat-bite infection *see* **Animal bite infections**

Cat-scratch disease

Definition

Cat-scratch disease is an uncommon infection that typically results from a cat's scratch or bite. Most sufferers experience only moderate discomfort and find that their symptoms clear up without any lasting harm after a few weeks or months. Professional medical treatment is rarely needed.

Description

Cat-scratch disease (also called cat-scratch **fever**) is caused by the *Bartonella henselae* bacterium, which is found in cats around the world and is transmitted from cat to cat by fleas. Researchers have discovered that large numbers of North American cats carry antibodies for the disease (meaning that the cats have been infected at some point in their lives). Some parts of North America have much higher rates of cat infection than others, however. *Bartonella henselae* is uncommon or absent in cold climates, which fleas have difficulty tolerating, but prevalent in warm, humid places such as Memphis, Tennessee, where antibodies were found in 71% of the cats tested. The bacterium, which remains in a cat's bloodstream for several months after infection, seems to be harmless to most cats, and normally an infected cat will not display any symptoms. Kittens (cats less than one year old) are more likely than adult cats to be carrying the infection.

Bartonella henselae can infect people who are scratched or (more rarely) bitten or licked by a cat. It cannot be passed from person to person. Although cats are popular pets found in about 30% of American households, human infection appears to be rare. One study estimated that for every 100,000 Americans there are only 2.5 cases of cat-scratch disease each year (2.5/100,000). It is also unusual for more than one family member to become ill; a Florida investigation discovered multiple cases in only 3.5% of the families studied. Children and teenagers appear to be the most likely victims of cat-scratch disease, although the possibility exists that the disease may be more common among adults than previously thought.

Causes and symptoms

The first sign of cat-scratch disease may be a small blister at the site of a scratch or bite three to 10 days after injury. The blister (which sometimes contains pus) often looks like an insect bite and is usually found on the hands, arms, or head. Within two weeks of the blister's appearance, lymph nodes near the site of injury become swollen. Often the infected person develops a fever or experiences **fatigue** or headaches. The symptoms usually disappear within a month, although the lymph nodes may remain swollen for several months. Hepatitis, **pneumonia**, and other dangerous complications can arise, but the likelihood of cat-scratch disease posing a serious threat to health is very small. **AIDS** patients

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KEY TERMS

Acetaminophen—A drug for relieving pain and fever.

AIDS—Acquired immunodeficiency syndrome. A disease that attacks the immune system.

Antibiotics—A category of manufactured substances used to combat infection.

Antibodies—Special substances created by the body to combat infection.

Bacterium—A tiny organism. Some bacteria cause disease.

Hepatitis—A disease that inflames the liver.

Immune system—A body system that combats disease.

Immunocompromised—Having a damaged immune system.

Lymph nodes—Small, kidney-shaped organs that filter a fluid called lymph.

Pneumonia—A disease that inflames the lungs.

Pus—A thick yellowish or greenish fluid.

and other immunocompromised people face the greatest risk of dangerous complications.

Occasionally, the symptoms of cat-scratch disease take the form of what is called Parinaud's oculoglandular syndrome. In such cases, a small sore develops on the palpebral conjunctiva (the membrane lining the inner eyelid), and is often accompanied by **conjunctivitis** (inflammation of the membrane) and swollen lymph nodes in front of the ear. Researchers suspect that the first step in the development of Parinaud's oculoglandular syndrome occurs when *Bartonella henselae* bacteria pass from a cat's saliva to its fur during grooming. Rubbing one's eyes after handling the cat then transmits the bacteria to the conjunctiva.

Diagnosis

A family doctor should be called whenever a cat scratch or bite fails to heal normally or is followed by a persistent fever or other unusual symptoms such as long-lasting bone or joint **pain**. The appearance of painful and swollen lymph nodes is another reason for consulting a doctor. When cat-scratch disease is suspected, the doctor will ask about a history of exposure to cats and look for evidence of a cat scratch or bite and swollen lymph nodes. A blood test for *Bartonella henselae* may be ordered to confirm the doctor's diagnosis.

Treatment

For otherwise healthy people, rest and over-the-counter medications for reducing fever and discomfort (such as **acetaminophen**) while waiting for the disease to run its course are usually all that is necessary. **Antibiotics** are prescribed in some cases, particularly when complications occur or the lymph nodes remain swollen and painful for more than two or three months, but there is no agreement among doctors about when and how they should be used. If a lymph node becomes very swollen and painful, the family doctor may decide to drain it.

Prognosis

Most people recover completely from a bout of cat-scratch disease. Further attacks are rare.

Prevention

Certain common–sense precautions can be taken to guard against the disease. Scratches and **bites** should be washed immediately with soap and water, and it is never a good idea to rub one's eyes after handling a cat without first washing one's hands. Children should be told not to play with stray cats or make cats angry. Immunocompromised people should avoid owning kittens, which are more likely than adult cats to be infectious. Because cat-scratch disease is usually not a life-threatening illness and people tend to form strong emotional bonds with their cats, doctors do not recommend getting rid of a cat suspected of carrying the disease.

Resources

PERIODICALS

Smith, David L. "Cat-Scratch Disease and Related Clinical Syndromes." *American Family Physician* April 1997: 1783.

Howard Baker

Cat-scratch fever *see* **Cat-scratch disease**

CAT scan *see* **Computed tomography scans**

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Cataracts

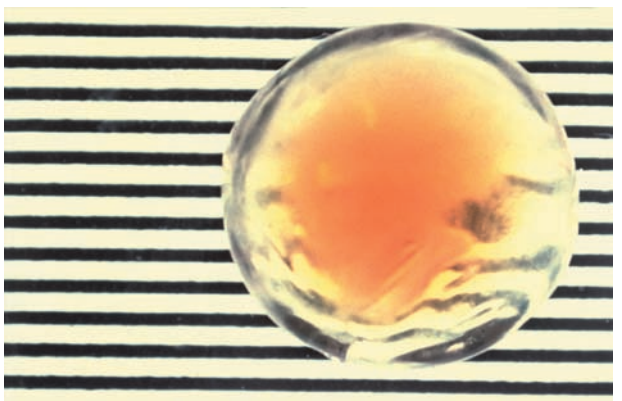
Definition

A cataract is a cloudiness or opacity in the normally transparent crystalline lens of the eye. This cloudiness can cause a decrease in vision and may lead to eventual blindness.

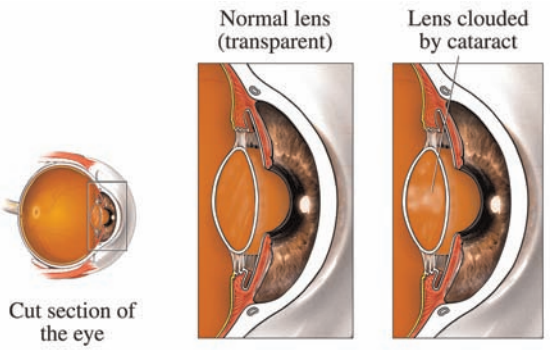
Description

The human eye has several parts. The outer layer of the eyeball consists of a transparent dome-shaped cornea and an opaque, white sclera. The cornea and sclera help protect the eye. The next layer includes the iris, pupil, and ciliary body. The iris is the colored part of the eye and the pupil is the small dark round hole in the middle of the iris. The pupil and iris allow light into the eye. The ciliary body contains muscles that help in the eye's focusing ability. The lens lies behind the pupil and iris. It is covered by a cellophane-like capsule. The lens is normally transparent, elliptical in shape, and somewhat elastic. This elasticity allows the lens to focus on both near and far objects. The lens is attached to the ciliary body by fibers (zonules of Zinn). Muscles in the ciliary body act on the zonules, which then change the shape of the lens. This process is called accommodation—the lens focuses images to help make vision clear. As people age, the lens hardens and changes shape less easily. As a result, the accommodation process becomes more difficult, making it harder to see things up close. This generally occurs around the age of 40 and continues until about age 65. The condition is called **presbyopia**. It is a normal condition of **aging**, generally resulting in the need for reading glasses.

The lens is made up of approximately 35% protein and 65% water. As people age, degenerative changes in the lens's proteins occur. Changes in the proteins, water content, enzymes, and other chemicals are some of the reasons for the formation of a cataract.



A dense cataract on lens of eye. *(© Margaret Cubberly/ Phototake. — All rights reserved.)*



Normal eye compared to an eye with a cataract. *(© Nucleus Medical Art, Inc/Alamy.)*

The major areas of the lens are the nucleus, the cortex, and the capsule. The nucleus is in the center of the lens, the cortex surrounds the nucleus, and the capsule is the outer layer. Opacities can occur in any area of the lens. Cataracts, then, can be classified according to location (nuclear, cortical, or posterior subcapular cataracts). The density and location of the cataract determine the amount of vision affected. If the cataract forms in the area of the lens directly behind the pupil, vision may be significantly impaired. A cataract that occurs on the outer edges or side of the lens will create less of a visual problem.

Cataracts in the elderly are so common that they are thought to be a normal part of the aging process. Between the ages of 52 and 64, there is a 50% chance of having a cataract, while at least 70% of those 70 and older are affected. In 2004, it was revealed that blacks are twice as likely to develop cataracts as whites. Cataracts associated with aging (senile or age-related cataracts) most often occur in both eyes, with each cataract progressing at a different rate. Initially, cataracts may not affect vision. If the cataract remains small or at the periphery of the lens, the visual changes may be minor.

Cataracts that occur in people other than the elderly are much less common. Congenital cataracts occur very rarely in newborns. Genetic defects or an infection or disease in the mother during **pregnancy** are among the causes of congenital cataracts. Traumatic cataracts may develop after a foreign body or trauma injures the lens or eye. Systemic illnesses, such as diabetes, may result in cataracts. Cataracts can also occur secondary to other eye diseases—for example, an inflammation of the inner layer of the eye (**uveitis**)

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or glaucoma. Such cataracts are called complicated cataracts. Toxic cataracts result from chemical toxicity, such as steroid use. Cataracts can also result from exposure to the sun's ultraviolet (UV) rays.

Causes and symptoms

Recent studies have been conducted to try to determine whether diet or the use of **vitamins** might have an effect on the formation of cataracts in older people. The results have been mixed, with some studies finding a connection and other studies finding none. Much interest has been focused on the use of antioxidant supplements as a protection against cataracts. Antioxidant vitamins such as vitamins A, C, E, and beta-carotene help the body clean-up oxygen-free radicals. Some vitamins are marketed specifically for the eyes. Patients should speak to their doctors about the use of such vitamins.

Smoking and alcohol intake have been implicated in cataract formation. Some studies have determined that a diet high in fat will increase the likelihood of cataract formation, while an increase in foods rich in **antioxidants** will reduce the incidence. More research is needed to determine if diet, smoking, alcohol consumption, or vitamins have any connection to the formation of cataracts.

There are several common symptoms of cataracts:

- gradual, painless onset of blurry, filmy, or fuzzy vision
- poor central vision
- frequent changes in eyeglass prescription
- changes in color vision
- increased glare from lights, especially oncoming headlights when driving at night
- "second sight" improvement in near vision (no longer needing reading glasses), but a decrease in distance vision
- poor vision in sunlight
- presence of a milky whiteness in the pupil as the cataract progresses.

Diagnosis

Both ophthalmologists and optometrists may detect and monitor cataract growth and prescribe prescription lenses for visual deficits. However, only an ophthalmologist can perform cataract extraction.

Cataracts are easily diagnosed from the reporting of symptoms, a visual acuity exam using an eye chart, and by examination of the eye itself. Shining a penlight into the pupil may reveal opacities or a color change of the lens even before visual symptoms have developed. An instrument called a slit lamp is basically a large microscope. This lets the doctor examine the front of the eye and the lens. The slit lamp helps the doctor determine the location of the cataract.

Some other diagnostic tests may be used to determine if cataracts are present or how well the patient may potentially see after surgery. These include a glare test, potential vision test, and contrast sensitivity test.

Treatment

For cataracts that cause no symptoms or only minor visual changes, no treatment may be necessary. Continued monitoring and assessment of the cataract is needed by an ophthalmologist or optometrist at scheduled office visits. Increased strength in prescription eyeglasses or **contact lenses** may be helpful. This may be all that is required if the cataract does not reduce the patient's quality of life.

Cataract surgery—the only option for patients whose cataracts interfere with vision to the extent of affecting their daily lives—is the most frequently performed surgery in the United States. It generally improves vision in over 90% of patients. Some people have heard that a cataract should be "ripe" before being removed. A cataract is considered ripe or mature when the lens is completely opaque. Most cataracts are removed before they reach this stage. Sometimes cataracts need to be removed so that the doctor can examine the back of the eye more carefully. This is important in patients with diseases that may affect the eye. If cataracts are present in both eyes, only one eye at a time should be operated on. Healing occurs in the first eye before the second cataract is removed, sometimes as early as the following week. A final eyeglass prescription is usually given about four to six weeks after surgery. Patients will still need reading glasses. The overall health of the patient needs to be considered in making the decision to operate. However, age alone need not preclude effective surgical treatment of cataracts. People in their nineties can have successful return of vision after **cataract surgery**.

Surgery to remove cataracts is generally an outpatient procedure. A local anesthetic is used and the procedure lasts about one hour. Removal of the cloudy lens can be done by several different procedures. The three types of cataract surgery available are:

- Extracapsular cataract extraction. This type of cataract extraction is the most common. The lens and the front portion of the capsule are removed. The back part of the capsule remains, providing strength to the eye.
- Intracapsular cataract extraction. The lens and the entire capsule are removed. This method carries an

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KEY TERMS

Aphakia—Absence of the lens of the eye.

Ciliary body—A structure in the eye that contains muscles that will affect the focusing of the lens.

Glaucoma—Disease of the eye characterized by increased pressure of the fluid inside the eye. Untreated, glaucoma can lead to blindness.

Phacoemulsification—Surgical procedure to remove a cataract using sound waves to disintegrate the lens which is then removed by suction.

Retina—The innermost layer of the eyeball. Images focused onto the retina are then sent to the brain.

Ultraviolet radiation (UV)—Invisible light rays that may be responsible for sunburns, skin cancers, and cataract formation.

Uveitis—Inflammation of the uvea. The uvea is a continuous layer of tissue that consists of the iris, the ciliary body, and the choroid. The uvea lies between the retina and sclera.

increased risk for detachment of the retina and swelling after surgery. It is rarely used.

- Phacoemulsification. This type of extracapsular extraction needs a very small incision, resulting in faster healing. Ultrasonic vibration is applied to the lens to break it up into very small pieces which are then aspirated out of the eye with suction by the ophthalmologist. A new liquid technique that its inventor says may one day replace ultrasound has been invented, but has not yet been proven in clinical trials.

A replacement lens is usually inserted at the time of the surgery. A plastic artificial lens called an intraocular lens (IOL) is placed in the remaining posterior lens capsule of the eye. When the intracapsular extraction method is used, an IOL may be clipped onto the iris. Contact lenses and cataract glasses (aphakic lenses) are prescribed if an IOL was not inserted. A folding IOL is used when phacoemulsification is performed to accommodate the small incision.

Antibiotic drops to prevent infection and **steroids** to reduce inflammation are prescribed after surgery. An eye shield or glasses during the day will protect the eye from injury while it heals. During the night, an eye shield is worn. The patient returns to the doctor the day after surgery for assessment, with several follow-up visits over the next two months to monitor the healing process.

Prognosis

The success rate of cataract extraction is very high, with a good prognosis. A visual acuity of 20/40 or better may be achieved. If an extracapsular cataract extraction was performed, a secondary cataract may develop in the remaining back portion of the capsule. This can occur one to two years after surgery. YAG capsulotomy is most often used for this type of cataract. YAG stands for yttrium aluminum garnet, the name of the laser used for this procedure. This is a painless outpatient procedure and requires no incision. The laser beam makes a small opening in the remaining back part of the capsule, allowing light through.

In a very small percentage (3–5%) of surgical cataract extractions, complications occur. Infections, swelling of the cornea (**edema**), bleeding, **retinal detachment**, and the onset of glaucoma have been reported. Some problems may occur one to two days, or even several weeks, after surgery. Any haziness, redness, decrease in vision, **nausea**, or **pain** should be reported to the surgeon immediately.

Prevention

Preventive measures emphasize protecting the eyes from UV radiation by wearing glasses with a special coating to protect against UV rays. Dark lenses alone are not sufficient. The lenses must protect against UV light (specifically, UV-A and UV-B). Antioxidants may also provide some protection by reducing free radicals that can damage lens proteins. A healthy diet rich in sources of antioxidants, including citrus fruits, sweet potatoes, carrots, green leafy vegetables, and/or vitamin supplements may be helpful. In 2004, research in England revealed that **nonsteroidal anti-inflammatory drugs** (over-the counter pain killers such as **aspirin**) may help decrease risk of cataracts by as much as 43%. When taking certain medications, such as steroids, more frequent eye exams may be necessary. Patients should speak to their doctors to see if medications may affect their eyes.

Resources

PERIODICALS

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Using Reusable Titanium Handpiece with Smooth Polymer Tip." *Ophthlamology Times* June 1, 2004: 50.

ORGANIZATIONS

American Academy of Ophthalmology (AAO), P. O. Box 7424, San Francisco, CA, 94120-7424, (415) 561-8500, (415) 561-8500, http://www.aao.org.

American Optometric Association, 243 North Lindbergh Blvd., St. Louis, MO, 63141, (314) 991-4100, (314) 991-4101, (800) 365-2219, http://www.aoa.org/.

Lighthouse International, 111 East 59th Street, New York, NY, 10022-120, (212) 821-9200, (212) 821-9707, (800) 829-0500, info@lighthouse.org, http://www.lighthouse.org.

Prevent Blindness America, 211 West Wacker Drive, Suite 1700, Chicago, IL, 60606, (800) 331-2020, http://www.preventblindness.org.

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Catatonia

Definition

Catatonia is a condition marked by changes in muscle tone or activity associated with a large number of serious mental and physical illnesses. There are two distinct sets of symptoms that are characteristic of this condition. In catatonic stupor the individual experiences a deficit of motor (movement) activity that can render him/her motionless. Catatonic excitement, or excessive movement, is associated with violent behavior directed toward oneself or others.

Features of catatonia may also be seen in Neuroleptic Malignant Syndrome (NMS) which is an uncommon (but potentially lethal) reaction to some medications used to treat major mental illnesses. NMS is considered a medical emergency since 25% of untreated cases result in **death**. Catatonia can also be present in individuals suffering from a number of other physical and emotional conditions such as drug intoxication, depression, and **schizophrenia**. It is most commonly associated with **mood disorders**.

Description

In catatonic stupor, motor activity may be reduced to zero. Individuals avoid bathing and grooming, make little or no eye contact with others, may be mute and rigid, and initiate no social behaviors. In catatonic excitement the individual is extremely hyperactive although the activity seems to have no purpose. Violence toward him/herself or others may also be seen.

NMS is observed as a dangerous side effect associated with certain neuroleptic (antipsychotic) drugs such as haloperidol (Haldol). It comes on suddenly and is characterized by stiffening of the muscles, **fever**, confusion, and heavy sweating.

Catatonia can also be categorized as intrinsic or extrinsic. If the condition has an identifiable cause, it is designated as extrinsic. If no cause can be determined following **physical examination**, laboratory testing, and history taking, the illness is considered to be intrinsic.

Causes and symptoms

The causes of catatonia are largely unknown although research indicates that brain structure and function are altered in this condition. While this and other information point to a physical cause, none has yet been proven. A variety of medical conditions also may lead to catatonia including head trauma, cerebrovascular disease, **encephalitis**, and certain metabolic disorders. NMS is an adverse side effect of certain **antipsychotic drugs**.

A variety of symptoms are associated with catatonia. Among the more common are echopraxia (imitation of the gestures of others) and echolalia (parrot-like repetition of words spoken by others). Other signs and symptoms include violence directed toward him/herself, the assumption of inappropriate posture, selective **mutism**, negativism, facial grimaces, and animal-like noises.

Catatonic stupor is marked by immobility and a behavior known as *cerea flexibilitas* (waxy flexibility) in which the individual can be made to assume bizarre (and sometimes painful) postures that they will maintain for extended periods of time. The individual may become dehydrated and malnourished because food and liquids are refused. In extreme situations such individuals must be fed through a tube. Catatonic excitement is characterized by hyperactivity and violence; the individual may harm him/herself or others. On rare occasions, **isolation** or restraint may be needed to ensure the individual's safety and the safety of others.

Diagnosis

Recognition of catatonia is made on the basis of specific movement symptoms. These include odd ways of walking such as walking on tiptoes or ritualistic pacing, and rarely, hopping and skipping. Repetitive odd movements of the fingers or hands, as well as

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KEY TERMS

Barbiturates—A group of medicines that slow breathing and lower the body temperature and blood pressure. They can be habit forming and are now used chiefly for anesthesia.

Benzodiazipines—This group of medicines is used to help reduce anxiety (especially before surgery) and to help people sleep.

Electroconvulsive therapy—This type of therapy is used to treat major depression and severe mental illness that does not respond to medications. A measured dose of electricity is introduced into the brain in order to produce a convulsion. Electroconvulsive therapy is safe and effective.

Mutism—The inability or refusal to speak.

Negativism—Behavior characterized by resistance, opposition, and refusal to cooperate with requests, even the most reasonable ones.

Neuroleptic drugs—Antipsychotic drugs, including major tranquilizers, used in the treatment of psychoses like schizophrenia.

imitating the speech or movements of others also may indicate that catatonia is present. There are no laboratory or other tests that can be used to positively diagnose this condition, but medical and neurological tests are necessary to rule out underlying lesions or disorders that may be causing the symptoms observed.

Treatment

Treatment of catatonia includes medications such as benzodiazipines (which are the preferred treatment) and rarely **barbiturates**. Antipsychotic drugs may be appropriate in some cases, but often cause catatonia to worsen. **Electroconvulsive therapy** may prove beneficial for clients who do not respond to medication. If these approaches are unsuccessful, treatment will be redirected to attempts to control the signs and symptoms of the illness.

Prognosis

Catatonia usually responds quickly to medication interventions.

Prevention

There is currently no known way to prevent catatonia because the cause has not yet been identified. Research efforts continue to explore possible origins. Avoiding excessive use of neuroleptic drugs can help minimize the risk of developing catatonic-like symptoms.

Resources

BOOKS

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Catecholamines tests

Definition

Catecholamines is a collective term for the hormones epinephrine, norepinephrine, and dopamine. Manufactured chiefly by the chromaffin cells of the adrenal glands, these hormones are involved in readying the body for the "fight-or-flight" response (also known as the alarm reaction). When these hormones are released, the heart beats stronger and faster, blood pressure rises, more blood flows to the brain and muscles, the liver releases stores of energy as a sugar the body can readily use (glucose), the rate of breathing increases and airways widen, and digestive activity slows. These reactions direct more oxygen and fuel to the organs most active in responding to stress–mainly the brain, heart, and skeletal muscles.

Purpose

Pheochromocytoma (a tumor of the chromaffin cells of the adrenal gland) and tumors of the nervous system (neuroblastomas, ganglioneuroblastomas, and ganglioneuromas) that affect hormone production can cause excessive levels of different catecholamines to be secreted. This results in constant or intermittent high blood pressure (**hypertension**). Episodes of high blood pressure may be accompanied by symptoms such as **headache**, sweating, **palpitations**, and **anxiety**. The catecholamines test can be ordered, then, to determine if high blood pressure and other symptoms are related to improper hormone secretion and to identify the type of tumor causing elevated catecholamine levels.

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KEY TERMS

Dopamine—Dopamine is a precursor of epinephrine and norepinephrine.

Epinephrine—Epinephrine, also called adrenaline, is a naturally occurring hormone released by the adrenal glands in response to signals from the sympathetic nervous system. These signals are triggered by stress, exercise, or by emotions such as fear.

Ganglioneuroma—A ganglioneuroma is a tumor composed of mature nerve cells.

Neuroblastoma—Neuroblastoma is a tumor of the adrenal glands or sympathetic nervous system. Neuroblastomas can range from being relatively harmless to highly malignant.

Norepinephrine—Norepinephrine is a hormone secreted by certain nerve endings of the sympathetic nervous system, and by the medulla (center) of the adrenal glands. Its primary function is to help maintain a constant blood pressure by stimulating certain blood vessels to constrict when the blood pressure falls below normal.

Pheochromocytoma—A pheochromocytoma is a tumor that originates from the adrenal gland's chromaffin cells, causing overproduction of catecholamines, powerful hormones that induce high blood pressure and other symptoms.

Description

The catecholamines test can be performed on either blood or urine. If performed on blood, the test may require one or two samples, depending on the physician's request. The first blood sample will be drawn after the patient has been lying down in a warm, comfortable environment for at least 30 minutes. If a second sample is needed, the patient will be asked to stand for 10 minutes before the blood is drawn. Instead of a venipuncture, which can be stressful for the patient, possibly increasing catecholamine levels in the blood, a plastic or rubber tube-like device called a catheter may be used to collect the blood samples. The catheter would be inserted in a vein 24 hours in advance, eliminating the need for needle punctures at the time of the test.

It may take up to a week for a lab to complete testing of the samples. Because blood levels of catecholamines commonly go up and down in response to such factors as temperature, **stress**, postural change, diet, **smoking**, **obesity**, and many drugs, abnormally high blood test results should be confirmed with a 24-hour urine test. In addition, catecholamine secretion from a tumor may not be steady, but may occur periodically during the day, and potentially could be missed when blood testing is used. The urine test provides the laboratory with a specimen that reflects catecholamine production over an entire 24-hour period. If urine is tested, the patient or a healthcare worker must collect all the urine passed over the 24-hour period.

Preparation

It is important that the patient refrain from using certain medications, especially cold or allergy remedies, for two weeks before the test. Certain foods—including bananas, avocados, cheese, coffee, tea, cocoa, beer, licorice, citrus fruit, vanilla, and Chianti—must be avoided for 48 hours prior to testing. However, people should be sure to get adequate amounts of vitamin C before the test, because this vitamin is necessary for catecholamine formation. The patient should be **fasting** (nothing to eat or drink) for 10 to 24 hours before the blood test and should not smoke for 24 hours beforehand. Some laboratories may call for additional restrictions. As much as possible, the patient should try to avoid excessive physical **exercise** and emotional stress before the test, because either may alter test results by causing increased secretion of epinephrine and norepinephrine.

Patients collecting their own 24-hour urine samples will be given a container with special instructions. The urine samples must be refrigerated.

Risks

Risks for the blood test are minimal, but may include slight bleeding from the venipuncture site, **fainting** or feeling lightheaded after blood is drawn, or blood accumulating under the puncture site (hematoma). There are no risks for the urine test.

Normal results

Reference ranges are laboratory-specific, vary according to methodology of testing, and differ between blood and urine samples. If testing is done by the method called High Performance Liquid Chromatography (HPLC), typical values for blood and urine follow.

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Reference ranges for blood catecholamines

Supine (lying down): Epinephrine less than 50 pg/mL, norepinephrine less than 410 pg/mL, and dopamine less than 90 pg/mL. Standing: Values for blood specimens taken when the subject is standing are higher than the ranges for supine posture for norepinephrine and epinephrine, but not for dopamine.

Reference ranges for urine catecholamines

Epinephrine 0–20 micrograms per 24 hours; norepinephrine 15–80 micrograms per 24 hours; dopamine 65–400 micrograms per 24 hours.

Abnormal results

Depending on the results, high catecholamine levels can indicate different conditions and/or causes:

- High catecholamine levels can help to verify pheochromocytoma, neuroblastoma, or ganglioneuroma. An aid to diagnosis is the fact that an adrenal medullary tumor (pheochromocytoma) secretes epinephrine, whereas ganglioneuroma and neuroblastoma secrete norepinephrine.
- Elevations are possible with, but do not directly confirm, thyroid disorders, low blood sugar (hypoglycemia), or heart disease.
- Electroshock therapy, or shock resulting from hemorrhage or exposure to toxins, can raise catecholamine levels.
- In the patient with normal or low baseline catecholamine levels, failure to show an increase in the sample taken after standing suggests an autonomic nervous system dysfunction (the division of the nervous system responsible for the automatic or unconscious regulation of internal body functioning).

Resources

BOOKS

Pagana, Kathleen Deska, and Timothy J. Pagana. *Mosby's Manual of Diagnostic and Laboratory Tests*. 4th ed. St. Louis: Mosby, 2009.

Janis O. Flores

Catheter ablation

Definition

Catheter ablation of an irregular heartbeat involves having a tube (a catheter) inserted into the heart through which electrical energy is sent to either reset the heartbeat or stop the heart from beating so a mechanical pacemaker can be put in place.

Purpose

Irregular heartbeats can occur in healthy people without causing any dangerous symptoms or requiring medical attention. Slight changes in the normal patterns of heartbeats often reset themselves without notice.

But when the heartbeat is greatly disrupted–either because of traumatic injury, disease, **hypertension**, surgery, or reduced blood flow to the heart caused by blockages in the blood vessels that nourish the heart–the condition must be recognized and treated immediately. Otherwise, it can be fatal.

Various drugs can be used to control and help reset these abnormal heart rhythms (**arrhythmias**). The technique of catheter ablation (meaning tube-guided removal) is used to interrupt the abnormal contractions in the heart, allowing normal heart beating to resume. **Atrial fibrillation and flutter** and **Wolff-Parkinson-White syndrome** are two of the most common disorders treated with catheter ablation.

Precautions

The improper correction of abnormal heartbeats can cause additional arrhythmias and can be fatal. Abnormalities in different areas of the heart cause different types of irregular heartbeats; the type of arrhythmia must be clearly defined before this procedure can be properly done.

Description

Catheter ablation involves delivering highly focused heat (or radio frequency energy) to specific areas of the heart. Radio frequency energy is very rapidly alternating electrical current that is produced at the tip of the catheter that is placed inside the heart. At the same time as the catheter is inserted, a second electrode is placed on the patient's skin. When the catheter is energized, the body conducts the energy from the catheter's tip, through the heart and to the electrode on the skin's surface, completing the circuit.

Although very little electricity is given off by the catheter, the instrument does generate a large amount of heat. This heat is absorbed by the heart tissue, causing a small localized burn and destroying the tissue in contact with the catheter tip; in this way, small regions of heart tissue are burned in a controlled manner. This controlled destruction of small sections

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During catheter ablation, a long flexible tube called a catheter is inserted into a vein in the patient's groin and guided toward the heart. A special x-ray machine called a fluoroscope helps the electrophysiologist visualize correct placement. *(Collette Placek. Reproduced by permission.)*

of heart muscle actually kills the nerve cells causing the irregular heartbeat, stopping the nerve signals that are passing through this section of the heart. This usually causes the irregular heartbeat to be reset into a normal heartbeat.

Preparation

People can undergo this procedure by having **general anesthesia** or by taking medicines to make them relaxed and sleepy (sedatives) along with painkillers. Once the type of irregular heartbeat is identified and these medicines are given, the catheter is inserted through a blood vessel and into the heart. Importantly, correct placement of the catheter is visualized by using a specialized type of x-ray machine called a fluoroscope.

Aftercare

Being sure the patient is comfortable during and after this procedure is very important. However, because each person may have a different arrhythmia and possibly other medical problems as well, each patient's needs must be evaluated individually.

Risks

Overall, fewer than 5% of people having this procedure experience complications. The most common complications are usually related to blood vessel injury when the catheter is inserted and to different heart-related problems due to the moving of the catheter within the heart. However, in general, this technique is safe and can control many different heart arrhythmias.

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KEY TERMS

Fluoroscope—A specialized x-ray machine used to visualize the placement of the catheter when attempting to correct irregular heartbeats.

Pacemaker—An electrical device that has electrodes attached to the heart to electrically stimulate the heart to beat normally. Pacemakers can be internal (placed under the skin) or external, with the electrodes placed on the skin or threaded through a tube placed into the heart.

Normal results

Depending upon the type of irregular heartbeat being treated, either the normal heartbeat resumes after treatment or the ability of the heart to beat on its own is lost, requiring the insertion of a pacemaker to stimulate the heart to beat regularly.

Abnormal results

Additional irregular heartbeats can occur as a result of this procedure, as can damage to the blood vessels that feed the heart. Because this procedure requires the use of the x-ray machine called a fluoroscope, there is exposure to x-ray radiation, but it is doubtful that this is harmful in adult patients. The risk versus benefit is considered with pediatric patients.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

Dominic De Bellis, PhD

Cat's cry syndrome *see* **Cri du chat syndrome**

CBC *see* **Blood count**

CEA test *see* **Carcinoembryonic antigen test**

CEB *see* **Chronic fatigue syndrome**

Cefaclor *see* **Cephalosporins**

Cefadroxil *see* **Cephalosporins**

Cefixime *see* **Cephalosporins**

Cefprozil *see* **Cephalosporins**

Cefurox *see* **Cephalosporins**

Celiac disease

Definition

Celiac disease is a disease of the digestive system that damages the small intestine and interferes with the absorption of nutrients from food.

Demographics

Celiac disease may be discovered at any age, from infancy through adulthood. The disorder is more commonly found among white Europeans or in people of European descent. It is very unusual to find celiac disease in African or Asian people. The exact incidence of the disease is uncertain. Estimates vary from one in 5,000, to as many as one in every 300 individuals with this background. The prevalence of celiac disease seems to be different from one European country to another, and between Europe and the United States. This may be due to differences in diet and/or unrecognized disease. A recent study of random blood samples tested for celiac disease in the United States showed one in 250 testing positive. It is clearly underdiagnosed, probably due to the symptoms being attributed to another problem, or lack of knowledge about celiac disease by physicians and laboratories.

Because celiac disease has a hereditary influence, close relatives (especially first degree relatives, such as children, siblings, and parents) have a higher risk of being affected with the condition. The chance that a first degree relative of someone with celiac disease will have the disease is about 10%.

As more is learned about celiac disease, it becomes evident that there are many variations which may not produce typical symptoms. It may even be clinically "silent," where no obvious problems related to the disease are apparent.

Description

Celiac disease occurs when the body reacts abnormally to gluten, a protein found in wheat, rye, barley, and possibly oats. When someone with celiac disease eats foods containing gluten, that person's immune system causes an inflammatory response in the small intestine, which damages the tissues and results in an impaired ability to absorb nutrients from foods. The inflammation and malabsorption create wide–ranging problems in many systems of the body. Since the body's own immune system causes the damage, celiac disease is classified as an autoimmune disorder. Celiac

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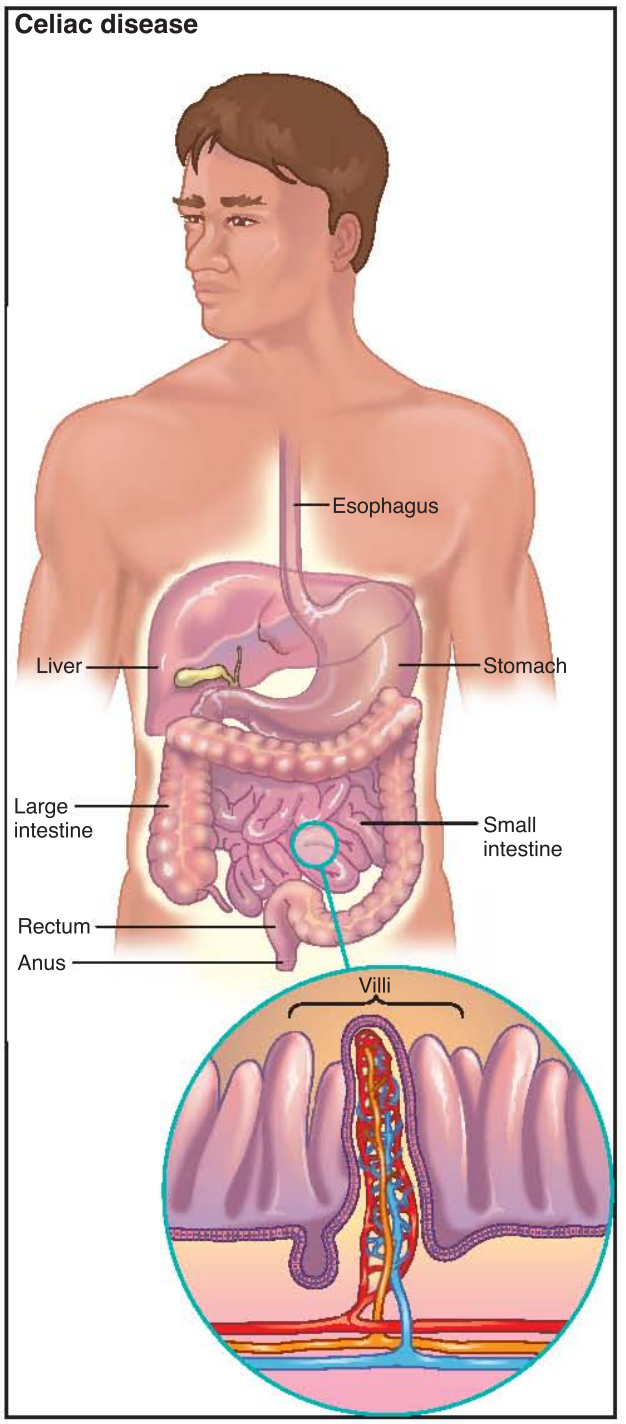

When people with celiac disease eat foods or use products containing gluten, their immune system responds by damaging or destroying villi in the intestine. Villi allows nutrients from food to be absorbed into the bloodstream; without healthy villi, a person becomes malnourished, regardless of the quantity of food eaten. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

disease may also be called sprue, nontropical sprue, gluten sensitive enteropathy, celiac sprue, and adult celiac disease.

Each person with celiac disease is affected differently. When food containing gluten reaches the small intestine, the immune system begins to attack a substance called gliadin, which is found in the gluten. The resulting inflammation causes damage to the delicate finger–like structures in the intestine, called villi, where food absorption actually takes place. This damage is referred to as villus atrophy. The patient may experience a number of symptoms related to the inflammation and the chemicals it releases, and/or the lack of ability to absorb nutrients from food, which can cause **malnutrition**.

Risk factors

People with **autoimmune disorders** are more at risk for celiac disease. Since it can run in families, risk is also increased if there is a family history of the condition.

Many disorders are associated with celiac disease, though the nature of the connection is unclear. One type of **epilepsy** is linked to celiac disease. Once their celiac disease is successfully treated, a significant number of these patients have fewer or no seizures. Patients with **alopecia** areata, a condition where hair loss occurs in sharply defined areas, have been shown to have a higher risk of celiac disease than the general population. There appears to be a higher percentage of celiac disease among people with **Down syndrome**, but the link between the conditions is unknown.

Several conditions attributed to a disorder of the immune system have been associated with celiac disease. People with insulin dependent diabetes (type I) have a much higher incidence of celiac disease. One source estimates that as many as one in 20 insulin–dependent diabetics may have celiac disease. Patients with juvenile chronic arthritis, some thyroid diseases, and IgA deficiency are also more likely to develop celiac disease.

There is an increased risk of intestinal lymphoma, a type of **cancer**, in individuals with celiac disease. Successful treatment of the celiac disease seems to decrease the chance of developing lymphoma.

Causes and symptoms

The exact cause of celiac disease is unknown. It can run in families and has a genetic basis, but the pattern of inheritance is complicated. The type of inheritance pattern that celiac disease follows is called

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multifactorial (caused by many factors, both genetic and environmental). Researchers think that several factors must exist in order for the disease to occur. First, the patient must have a genetic predisposition to develop the disorder. Then, something in their environment acts as a stimulus to trigger their immune system, causing the disease to become active for the first time. For conditions with multifactorial inheritance, people without the genetic predisposition are less likely to develop the condition with exposure to the same triggers. Or, they may require more exposure to the stimulus before developing the disease than someone with a genetic predisposition. Several factors may provoke a reaction including surgery, especially gastrointestinal surgery; a change to a low fat diet, which has an increased number of wheat–based foods; **pregnancy**; **childbirth**; severe emotional **stress**; or a viral infection. This combination of genetic susceptibility and an outside agent leads to celiac disease.

Each person with celiac disease is affected differently. When food containing gluten reaches the small intestine, the immune system begins to attack a substance called gliadin, which is found in the gluten. The resulting inflammation causes damage to the delicate finger–like structures in the intestine, called villi, where food absorption actually takes place. The patient may experience a number of symptoms related to the inflammation and the chemicals it releases, and or the lack of ability to absorb nutrients from food, which can cause malnutrition.

The most commonly recognized symptoms of celiac disease relate to the improper absorption of food in the gastrointestinal system. Many patients with gastrointestinal symptoms will have **diarrhea** and fatty, greasy, unusually foul–smelling stools. The patient may complain of excessive gas (flatulence), distended abdomen, weight loss, and generalized weakness. Not all people have digestive system complications; some people only have irritability or depression. Irritability is one of the most common symptoms in children with celiac disease.

Not all patients have these problems. Unrecognized and untreated celiac disease may cause or contribute to a variety of other conditions. The decreased ability to digest, absorb, and utilize food properly (malabsorption) may cause anemia (low red blood count) from iron deficiency or easy bruising from a lack of vitamin K. Poor mineral absorption may result in **osteoporosis**, or "brittle bones," which may lead to bone **fractures**. Vitamin D levels may be insufficient and bring about a "softening" of bones (osteomalacia), which produces **pain** and bony deformities, such as flattening or bending. Defects in the tooth enamel, characteristic of celiac disease, may be recognized by dentists. Celiac disease may be discovered during medical tests performed to investigate **failure to thrive** in infants, or lack of proper growth in children and adolescents. People with celiac disease may also experience **lactose intolerance** because they do not produce enough of the enzyme lactase, which breaks down the sugar in milk into a form the body can absorb. Other symptoms can include, **muscle cramps**, **fatigue**, delayed growth, **tingling** or **numbness** in the legs (from nerve damage), pale sores in the mouth (called aphthus ulcers), tooth discoloration, or missed menstrual periods (due to severe weight loss).

A distinctive, painful skin rash, called **dermatitis** herpetiformis, may be the first sign of celiac disease. Approximately 10% of patients with celiac disease have this rash, but it is estimated that 85% or more of patients with the rash have the disease.

KEY TERMS

Antibodies—Proteins that provoke the immune system to attack particular substances. In celiac disease, the immune system makes antibodies to a component of gluten.

Gluten—A protein found in wheat, rye, barley, and oats.

Villi—Tiny, finger–like projections that enable the small intestine to absorb nutrients from food.

Diagnosis

Examination

Because of the variety of ways celiac disease can manifest itself, it is often not diagnosed promptly. Its symptoms are similar to many other conditions including **irritable bowel syndrome**, **Crohn's disease**, ulcerative **colitis**, **diverticulosis**, intestinal infections, **chronic fatigue syndrome**, and depression. The condition may persist without diagnosis for so long that the patient accepts a general feeling of illness as normal. This leads to further delay in identifying and treating the disorder. It is not unusual for the disease to be identified in the course of medical examinations for seemingly unrelated problems.

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Tests

If celiac disease is suspected, a blood test can be ordered. This test looks for the antibodies to gluten (called antigliadin, anti–endomysium, and antireticulin) that the immune system produces in celiac disease. Antibodies are chemicals produced by the immune system in response to substances that the body perceives to be threatening. Some experts advocate not just evaluating patients with symptoms, but using these blood studies as a screening test for high–risk individuals, such as those with relatives (especially first degree relatives) known to have the disorder. An abnormal result points toward celiac disease, but further tests are needed to confirm the diagnosis. Because celiac disease affects the ability of the body to absorb nutrients from food, several tests may be ordered to look for nutritional deficiencies. For example, doctors may order a test of iron levels in the blood because low levels of iron (anemia) may accompany celiac disease. Doctors may also order a test for fat in the stool, since celiac disease prevents the body from absorbing fat from food.

Procedures

If celiac disease is suspected, a biopsy (removal of a tiny piece of tissue surgically) of the small intestine can be performed. This is usually done by a gastroenterologist, a physician who specializes in diagnosing and treating bowel disorders. It is generally performed in the office, or in a hospital's outpatient department. The patient remains awake, but is sedated. A narrow tube, called an endoscope, is passed through the mouth, down through the stomach, and into the small intestine. A small sample of tissue is taken and sent to the laboratory for analysis. If it shows a pattern of tissue damage characteristic of celiac disease, the diagnosis is established.

The patient is then placed on a gluten–free diet (GFD). The physician will periodically recheck the level of antibodies in the patient's blood. After several months, the small intestine is biopsied again. If the diagnosis of celiac disease was correct (and the patient followed the rigorous diet), healing of the intestine will be apparent. Most experts agree that it is necessary to follow these steps in order to be sure of an accurate diagnosis.

Treatment

Traditional

The only treatment for celiac disease is a gluten–free diet. This may be easy for the doctor to prescribe, but difficult for the patient to follow. For most people, adhering to this diet will stop symptoms and prevent damage to the intestines. Damaged villi can be functional again in three to six months. This diet must be followed for life. For people whose symptoms are cured by the gluten–free diet, this is further evidence that their diagnosis is correct.

Gluten is present in any product that contains wheat, rye, barley, or oats. It helps make bread rise, and gives many foods a smooth, pleasing texture. In addition to the many obvious places gluten can be found in a normal diet, such as breads, cereals, and pasta, there are many hidden sources of gluten. These include ingredients added to foods to improve texture or enhance flavor and products used in food packaging. Gluten may even be present on surfaces used for food preparation or cooking.

Fresh foods that have not been artificially processed, such as fruits, vegetables, and meats, are permitted as part of a GFD. Gluten–free foods can be found in health food stores and in some supermarkets. Mail–order food companies often have a selection of gluten–free products. Help in dietary planning is available from dieticians (health care professionals specializing in food and **nutrition**) or from support groups for individuals with celiac disease. There are many cookbooks on the market specifically for those on a GFD.

Treating celiac disease with a GFD is almost always completely effective. Gastrointestinal complaints and other symptoms are alleviated. Secondary complications, such as anemia and osteoporosis, resolve in almost all patients. People who have experienced lactose intolerance related to their celiac disease usually see those symptoms subside as well. Although there is no risk and much potential benefit to this treatment, it is clear that avoiding all foods containing gluten can be difficult.

Experts emphasize the need for lifelong adherence to the GFD to avoid the long–term complications of this disorder. They point out that although the disease may have symptom–free periods if the diet is not followed, silent damage continues to occur. Celiac disease cannot be "outgrown" or cured, according to medical authorities.

Prognosis

Treating celiac disease with a strict GFD is almost always completely effective. Gastrointestinal complaints and other symptoms are alleviated. Secondary complications, such as anemia and osteoporosis,

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resolve in almost all patients. People who have experienced lactose intolerance related to their celiac disease usually see those symptoms subside as well.

Patients with celiac disease must adhere to a strict GFD throughout their lifetime. Once the diet has been followed for several years, individuals with celiac disease have similar mortality rates as the general population. However, about 10% of people with celiac disease develop a cancer involving the gastrointestinal tract (both carcinoma and lymphoma).

There are a small number of patients who develop a refractory type of celiac disease, where the GFD no longer seems effective. Once the diet has been thoroughly assessed to ensure no hidden sources of gluten are causing the problem, medications may be prescribed. **Steroids** or **immunosuppressant drugs** are often used to try to control the disease. It is unclear whether these efforts meet with much success.

Prevention

There is no way to prevent celiac disease. However, the key to decreasing its impact on overall health is early diagnosis and strict adherence to the prescribed gluten–free diet.

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ORGANIZATIONS

American Celiac Disease Alliance, 2504 Duxbury Place, Alexandria, VA, 22308, (703) 622-3331, info@americanceliac.org, http://www.americanceliac.org.

Celiac Disease Foundation, 13251 Ventura Boulevard, #1, Studio City, CA, 91604, (818) 990–2354, (818) 990–2379, cdf@celiac.org, http://www.celiac.org.

Celiac Sprue Association/USA Inc., P.O. Box 31700, Omaha, NE, 68131–0700, (877) 272–4272, (402) 558–1347, celiacs@csaceliacs.org, http://www.csaceliacs.org.

Children's Digestive Health and Nutrition Foundation, P.O. Box 6, Flourtown, PA, 19031, (215) 233-0808, (215) 233-3918, mstallings@naspghan.org, http://www.cdhnf.org.

Gluten Intolerance Group of North America, 31214 124th Avenue SE, Auburn, WA, 98092-3667, (253) 833-6655, (253) 833-6675, info@gluten.net, http://www.gluten.net.

National Foundation for Celiac Awareness, 224 South Maple Street, Ambler, PA, 19002-0544, (215) 325-1306, info@celiaccentral.org, http://www. celiaccentral.org.

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Cell therapy

Definition

Cell therapy is the transplantation of human or animal cells to replace or repair damaged tissue.

Purpose

The purpose of cell therapy is to introduce cells into the body that will grow and replace damaged tissue. Cell therapy differs from conventional stem cell therapy in that the cells injected into the body in cell therapy are already differentiated (e.g., muscle cells, gland cells), whereas conventional stem cell therapy utilizes undifferentiated, usually embryonic cells. Cell therapy has long been used by alternative medicine practitioners who have claimed great benefits; these have not been replicated by conventional medical practitioners.

Description

The theory behind cell therapy has been in existence for several hundred years. The first recorded discussion of the concept of cell therapy can be traced to Phillippus Aureolus Paracelsus (1493-1541), a German-Swiss physician and alchemist who wrote in his *Der grossen Wundartzney* (Great Surgery Book) in 1536 that "the heart heals the heart, lung heals the lung, spleen heals the spleen; like cures like." Paracelsus and many of his contemporaries agreed that the best way to treat an illness was to use living tissue to restore the ailing. In 1667, at a laboratory in the palace of Louis XIV, Jean-Baptiste Denis (1640–1704) attempted to transfuse blood from a calf into a mentally ill patient. Since blood **transfusion** is, in effect, a form of cell therapy, this could be the first documented case of this procedure. However, the first recorded attempt at non-blood cellular therapy occurred in 1912 when German physicians attempted to treat children with **hypothyroidism** (underactive thyroid gland), with thyroid cells.

In 1931, Dr. Paul Niehans (1882–1971), a Swiss physician, became known as "the father of cell therapy" quite by chance. After a surgical accident by a colleague, Niehans attempted to replace a patient's severely damaged parathyroid glands with those of a steer. When the patient began to rapidly deteriorate before the transplant could take place, Niehans decided to dice the steer's parathyroid gland into fine pieces, mix the pieces in a saline solution, and inject them into the dying patient. He reported that immediately the patient began to improve and, in fact, lived for another 30 years.

Cell therapy as alternative medicine

Cell therapy as performed by alternative medicine practitioners is very different from the controlled research done by conventional stem cell medical researchers. Alternative practitioners refer to their form of cell therapy by several other different names including xenotransplant therapy, glandular therapy, and fresh cell therapy. The procedure involves the injection of either whole fetal xenogenic (animal) cells (e.g., from sheep, cows, pigs, and sharks) or cell extracts from human tissue. Several different types of cells may be administered simultaneously.

Just as Paracelsus's theory of "like cures like," the types of cells that are administered correspond in some way with the organ or tissue in the patient that is failing. In other words, the cells are not species specific, but only organ specific. Alternative practitioners cannot explain how this type of cell therapy works, but proponents claim that the injected cells travel to the similar organ from which they were taken to revitalize and stimulate that organ's function and regenerate its cellular structure. Supporters of cellular treatment believe that embryonic and fetal animal tissue contain active therapeutic agents distinct from **vitamins**, **minerals**, hormones, or enzymes. This theory and these claims are rejected by practitioners of conventional medicine.

Proponents of cell therapy claim that it has been used successfully to rebuild damaged cartilage in joints, repair spinal cord injuries, strengthen a weakened immune system, treat autoimmune diseases such as **AIDS**, and help patients with neurological disorders such as **Alzheimer's disease**, Parkinson's disease, and **epilepsy**. Further claims of positive results have been made in the treatment of a wide range of chronic conditions such as arteriosclerosis, congenital defects, and **sexual dysfunction**. The therapy has also been used to treat **cancer** patients at a number of clinics in Tijuana, Mexico. Most of these claims are anecdotal. None of these application is supported by well-designed, controlled clinical studies.

Cell therapy as conventional medicine

Cell therapy in conventional medicine is still in the research and early clinical trial stage. This research is an outgrowth of stem cell research, and is performed in government-regulated laboratories by traditionally trained scientists. Embryonic stem cells are cells taken from an embryo before they have differentiated (specialized) into such specific cell types as muscle cells, nerve cells, or skin cells. In laboratory test tube and animal experiments, stem cells often can be manipulated into differentiating into specific types cells that have the

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KEY TERMS

Anaphylactic shock—A severe allergic reaction that causes blood pressure drop, racing heart, swelling of the airway, rash, and possibly convulsions.

Culturing—To grow cells in a special substance, or media, in the laboratory.

Encephalitis—Inflammation of the brain that is often fatal.

Xenotransplant—Transplantation of animal cells or tissues into a human.

potential to replace differentiated cells in damaged organs. For example, in early 2008, researchers at the Diabetic Research Institute at the University of Miami in Florida were able to convert embryonic stem cells into insulin-producing cells and use them to treat insulin-dependent diabetes in mice.

Stem cells also have been found in bone marrow, and work is underway to see if other cells can be manipulated into transforming into differentiated cells. In January 2009, researchers at Northwestern University's Feinberg School of Medicine in Chicago announced that they had used a patient's own bone marrow stem cells to improve early symptoms of **multiple sclerosis**. Researchers noted improvement only in patients with early symptoms; in earlier research those with advanced symptoms had not improved. Other researchers are working on treating symptoms of **muscular dystrophy** with fully differentiated myoblasts (a kind of muscle cell) with mixed results. Still other are working with using cartilage cells (chondrocyte cells) to repair cartilage in joints such as the knee.

Stem cell therapy has potential to treat a wide range of diseases and disorders, but it is, for the most part, still in the test tube and animal research stage of development. Because of the ethical questions raised when the harvesting of stem cells destroys embryos, the United States has placed restrictions on some human stem cell research. These restrictions, however, do not apply to research that does not destroy embryos. However, much stem cell research is being carried out in other countries, especially Thailand, South Korea, and China, where fewer restrictions are placed on obtaining human stem cells for experimentation. A list of FDA-approved clinical trials involving stem cell therapy can be found at http://www.clinicaltrials.gov.

Preparations

Alternative practitioners use several processes to prepare cells for use. One procedure involves extracting cells from the patient and then culturing them in a laboratory until they multiply to the level needed for transplantation back into the same patient. Another procedure uses freshly removed fetal animal tissue that has been processed and suspended in a saline (salt water) solution. The preparation of fresh cells then may be either injected immediately into the patient or preserved by being freeze-dried or deep-frozen in liquid nitrogen before being injected. Injected cells may or may not be tested for pathogens, such as bacteria, viruses, or parasites, before use. Conventional cell therapy researchers work in laboratories where the growing environment of the cells is highly controlled and monitored to prevent contamination.

Precautions

Many forms of cell therapy in the United States are highly experimental procedures. Patients should approach any cell therapy treatments with extreme caution, inquire about their proven efficacy and legal use in the United States or their home country, and should only accept treatment only from a licensed physician who should educate the patient completely on the risks and possible side effects involved with cell therapy. These same cautions apply for patients interested in participating in FDA-approved clinical trials of cell therapy treatments.

Side effects

Because cell therapy encompasses a wide range of treatments and applications and many of these treatments are unproven and highly experimental, the full range of possible side effects of the treatments is not yet known. Anaphylactic shock, immune system reactions, and **encephalitis** are just a few of the known reported side effects in some patients to date.

Patients undergoing cell therapy treatments which use cells transplanted from animals or other humans run the risk of cell rejection, in which the body recognizes the cells as a foreign substance and uses immune system cells to attack and destroy them. Some forms of cell therapy use special coatings on the cells in an attempt to trick the immune system into recognizing the new cells as native to the body. There is also the chance of the cell solution transmitting a bacterial, viral, fungal, or parasitic infection to the patient. Careful screening and testing of cells for pathogens can reduce this risk.

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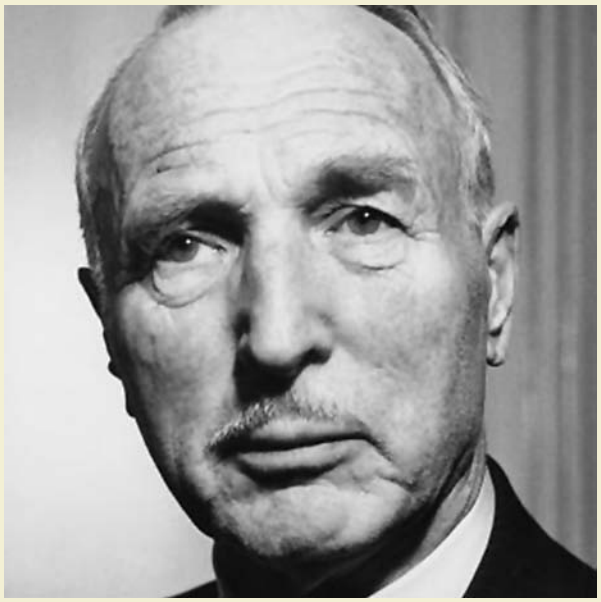
PAUL NIEHANS (1882–1971)



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Paul Niehans was born and raised in Switzerland. His father, a doctor, was dismayed when he entered the seminary, but Niehans quickly grew dissatisfied with religious life and took up medicine after all. He first studied at Bern, then completed an internship in Zurich.

Niehans enlisted in the Swiss Army in 1912. When war erupted in the Balkans, Niehans set up a hospital in Belgrade, Yugoslavia. The war provided him the opportunity to treat numerous patients, gaining a firsthand knowledge of the body and its workings.

Since 1913, Niehans had been intrigued with Alexis Carrel's experiments concerning the adaptive abilities of cells, though Niehans himself specialized in glandular transplants and by 1925 was one of the leading glandular surgeons in Europe.

Niehans referred to 1931 as the birth year of cellular therapy. That year, he treated a patient suffering from tetany whose parathyroid had been erroneously removed by another physician. Too weak for a glandular transplant, the patient was given injections of the parathyroid glands of steer, and she soon recovered. Niehans made more injections, even experimenting on himself, and reported he could cure illnesses through injections of live cells extracted from healthy animal organs. He believed adding new tissue stimulated rejuvenation and recovery.

Niehans treated Pope Pious XII with his injections and was nominated to the Vatican Academy of Science following the pope's recovery.

Niehans remained a controversial figure throughout his life. As of 2010, the Clinique Paul Niehans in Switzerland, founded by his daughter, continued his work. http://www. paulniehans.ch/clinic.htm

Research and general acceptance

Cell therapy as alternative healers practice it is generally rejected as effective by the traditionally-trained scientific community. Most of the claims made for these therapies are based on anecdotal evidence and are not backed by controlled clinical trials. While some mainstream cell therapy procedures have shown some success in clinical studies, others are still largely unproven, including cell therapy for cancer treatment. Until large, controlled human clinical studies are performed on cell therapy procedures, they will remain fringe treatments.

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ORGANIZATIONS

Alternative Medicine Foundation, P. O. Box 60016, Potomac, MD, 20859, (301) 340-1960, http://www.amfoundation.org.

Center for Cell and Gene Therapy. Baylor College of Medicine, One Baylor Plaza, Houston, TX, 77030, (713) 798-4028, (888) 550-9288, gradappboss@bcm.edu, http://www. bcm.edu/genetherapy/.

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Cellulitis

Definition

Cellulitis is a spreading bacterial infection just below the skin surface. It is most commonly caused by *Streptococcus pyogenes* or *Staphylococcus aureus*.

Description

The word "cellulitis" actually means "inflammation of the cells." Specifically, cellulitis refers to an infection of the tissue just below the skin surface. In humans, the skin and the tissues under the skin are the most common locations for microbial infection. Skin is the first defense against invading bacteria and other microbes. An infection can occur when this normally strong barrier is damaged due to surgery, injury, or a burn. Even something as small as a scratch or an insect bite allows bacteria to enter the skin, which may lead to an infection. Usually, the immune system kills any invading bacteria, but sometimes the bacteria are able to grow and cause an infection.

Once past the skin surface, the warmth, moisture, and nutrients allow bacteria to grow rapidly. Disease-causing bacteria release proteins called enzymes which cause tissue damage. The body's reaction to damage is inflammation which is characterized by **pain**, redness, heat, and swelling. This red, painful region grows bigger as the infection and resulting tissue damage spread. An untreated infection may spread to the lymphatic system (**acute lymphangitis**), the lymph nodes (**lymphadenitis**), the bloodstream (**bacteremia**), or into deeper tissues. Cellulitis most often occurs on the face, neck, and legs.

This person's lower leg is swollen and inflamed due to cellulitis. Cellulitis is a *Streptococcus* bacterial infection of the skin and the tissues beneath it. The face, neck, or legs are common sites of cellulitis. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Orbital cellulitis

A very serious infection, called **orbital cellulitis**, occurs when bacteria enter and infect the tissues surrounding the eye. In 50–70% of all cases of orbital cellulitis, the infection spreads to the eye(s) from the sinuses or the upper respiratory tract (nose and throat). Twenty-five percent of orbital infections occur after surgery on the face. Other sources of orbital infection include a direct infection from an eye injury, from a dental or throat infection, and through the bloodstream.

Infection of the tissues surrounding the eye causes redness, swollen eyelids, severe pain, and causes the eye to bulge out. This serious infection can lead to a temporary loss of vision, blindness, brain abscesses, inflammation of the brain and spinal tissues (**meningitis**), and other complications. Before the discovery of **antibiotics**, orbital cellulitis caused blindness in 20% of patients and **death** in 17% of patients. Antibiotic treatment has significantly reduced the incidence of blindness and death.

Causes and symptoms

Although other kinds of bacteria can cause cellulitis, it is most often caused by *Streptococcus pyogenes* (the bacteria that causes **strep throat**) and *Staphylococcus aureus*. *Streptococcus pyogenes* is the so-called "flesh-eating bacteria" and, in rare cases, can cause a dangerous, deep skin infection called necrotizing fasciitis. Orbital cellulitis may be caused by bacteria which cannot grow in the presence of oxygen (anaerobic bacteria). In children, *Haemophilus influenzae* type B frequently causes orbital cellulitis following a sinus infection.

Streptococcus pyogenes can be picked up from a person who has strep throat or an infected sore. Other cellulitis-causing bacteria can be acquired from direct contact with infected sores. Persons who are at a higher risk for cellulitis are those who have a severe underlying disease (such as **cancer**, diabetes, and **kidney disease**), are taking steroid medications, have a reduced immune system (because of **AIDS**, organ transplant, etc.), have been burned, have insect **bites**, have reduced blood circulation to limbs, or have had a leg vein removed for coronary bypass surgery. In addition, chicken pox, human or animal bite **wounds**, skin wounds, and recent surgery can put a person at a higher risk for cellulitis.

The characteristic symptoms of cellulitis are redness, warmth, pain, and swelling. The infected area appears as a red patch that gets larger rapidly within

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the first 24 hours. A thick red line which progresses toward the heart may appear indicating an infection of the lymph vessels (lymphangitis). Other symptoms which may occur include **fever**, chills, tiredness, muscle aches, and a general ill feeling. Some people also experience **nausea**, **vomiting**, stiff joints, and hair loss at the infection site.

The characteristic symptoms of orbital cellulitis are eye pain, redness, swelling, warmth, and tenderness. The eye may bulge out and it may be difficult or impossible to move. Temporary loss of vision, pus drainage from the eye, chills, fever, headaches, **vomiting**, and a general ill feeling may occur.

KEY TERMS

Inflammation—A local, protective response to tissue injury. It is characterized by redness, warmth, swelling, and pain.

Necrotizing fasciitis—A destructive infection which follows severe cellulitis and involves the deep skin and underlying tissues.

Sinuses—Air cavities found in the bones of the head. The sinuses which are connected to the nose are prone to infection.

Diagnosis

Cellulitis may be diagnosed and treated by a family doctor, an **infectious disease** specialist, a doctor who specializes in skin diseases (dermatologist), or in the case of orbital cellulitis, an eye doctor (ophthalmologist). The diagnosis of cellulitis is based mainly on the patient's symptoms. The patient's recent medical history is also used in the diagnosis.

Laboratory tests may be done to determine which kind of bacteria is causing the infection but these tests are not always successful. If the skin injury is visible, a sterile cotton swab is used to pick up a sample from the wound. If there is no obvious skin injury, a needle may be used to inject a small amount of sterile salt solution into the infected skin, and then the solution is withdrawn. The salt solution should pick up some of the bacteria causing the infection. A blood sample may be taken from the patient's arm to see if bacteria have entered the bloodstream. Also, a blood test may be done to count the number of white blood cells in the blood. High numbers of white blood cells suggest that the body is trying to fight a bacterial infection.

For orbital cellulitis, the doctor may often perform a special x-ray scan called computed tomography scan (CT). This scan enables the doctor to see the patient's head in cross-section to determine exactly where the infection is and see if any damage has occurred. A CT scan takes about 20 minutes.

Treatment

Antibiotic treatment is the only way to battle this potentially life-threatening infection. Mild to moderate cellulitis can be treated with the following antibiotics taken every four to eight hours by mouth:

- penicillins (Bicillin, Wycillin, Pen Vee, V-Cillin)
- erythromycin (E-Mycin, Ery-Tab)
- cephalexin (Biocef, Keflex)
- cloxacillin (Tegopen)

Other medications may be recommended, such as **acetaminophen** (Tylenol) or ibuprofen (Motrin, Advil) to relieve pain, and **aspirin** to decrease fever.

A normally healthy person is usually not hospitalized for mild or moderate cellulitis. General treatment measures include elevation of the infected area, rest, and application of warm, moist compresses to the infected area. The doctor will want to see the patient again to make sure that the antibiotic treatment is effective in stopping the infection.

Persons at high risk for severe cellulitis will probably be hospitalized for treatment and monitoring. Antibiotics may be given intravenously to patients with severe cellulitis. Complications such as deep infection, or bone or joint infections, might require surgical drainage and a longer course of antibiotic treatment. Extensive tissue destruction may require **plastic surgery** to repair. In cases of orbital cellulitis caused by a sinus infection, surgery may be required to drain the sinuses.

Prognosis

Over 90% of all cellulitis cases are cured after seven to ten days of antibiotic treatment. Persons with serious disease and/or those who are taking immunosuppressive drugs may experience a more severe form of cellulitis which can be life threatening. Serious complications include blood poisoning (bacteria growing in the blood stream), meningitis (brain and spinal cord infection), tissue death (necrosis), and/or lymphangitis (infection of the lymph vessels). Severe cellulitis caused by *Streptococcus pyogenes* can lead to destructive and life-threatening necrotizing fasciitis.

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Prevention

Cellulitis may be prevented by wearing appropriate protective equipment during work and sports to avoid skin injury, cleaning cuts and skin injuries with antiseptic soap, keeping wounds clean and protected, watching wounds for signs of infection, taking the entire prescribed dose of antibiotic, and maintaining good general health. Persons with diabetes should try to maintain good blood sugar control.

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Belinda Rowland, PhD

Central Mississippi Valley disease *see* **Histoplasmosis**

Central nervous system depressants

Definition

Central nervous system (CNS) depressants are drugs that reduce brain activity.

Purpose

These drugs are used to treat **anxiety**, muscle tension, **pain**, **insomnia**, acute **stress** reactions, panic attacks, and seizure disorders. In higher doses, some of them produce **coma** and anesthesia.

Description

Throughout history, humans have sought relief from anxiety and insomnia by using substances that induce a drowsy or calming effect. CNS depressants include a wide range of drugs such as alcohol, the most widely used depressant, **narcotics**, **barbiturates** (Amytal, Nembutal, Seconal), **benzodiazepines** (Ativan, Halcion, Librium, Valium, Xanax), chloral hydrate, Buspirone (Buspar) and Zolpidem (Ambien). Street names for illegal CNS depressants include Reds, Yellows, Blues, Barbs, and Downers.

Precautions

- Most CNS depressants have the potential to be physically and psychologically addictive.
- The body tends to develop tolerance for CNS depressants, and larger doses are needed to achieve the same effects.
- Sudden withdrawal from some CNS depressants can produce rebound insomnia or anxiety, occasionally resulting in life-threatening seizures.
- When depressant medications is discontinued, it should be done gradually to give the body time to adjust.
- The difference is small between effective doses and overdoses for some CNS depressants, such as barbiturates.
- Elderly people are subject to more profound and prolonged effects from CNS depressants.

Side effects

Adverse effects include confusion, **dizziness**, slurred speech, loss of muscle coordination, and impaired thinking and judgment.

Interactions

Interactions with benzodiazepines (Xanax, Ativan, Valium) include:

- These drugs can increase the effects of narcotics and other pain management medications.
- Antifungal drugs, Diflucan, Nizoral, Sporanox, greatly increase and prolong the effects of benzodiazepines.
- Anti-seizure medications, like Tegretol, can decrease the effectiveness of benzodiazepines.
- Cimetidine (Tagamet) can increase the effectiveness of benzodiazepines.
- Calcium channel blockers, like Cardizem, can increase and prolong the effects of benzodiazepines.
- Grapefruit juice can increase the effects of benzodiazepines.
- Macrolide antibiotics (erythromycin, Biaxin) can increase and prolong the effects of benzodiazepines.
- Modifinil (Provigil) may reduce the effects of benzodiazepines.
- AIDS and antiretroviral drugs may increase and prolong the effects of benzodiazepines.

Resources

BOOKS

Bezchlibnyk–Butler, et al. *Clinical Handbook of Psychotropic Drugs*. Ashland, OH: Hogrefe & Huber, 2009.

ORGANIZATIONS

American Society of Addiction Medicine, 4601 N. Park Avenue, Upper Arcade #101, Chevy Chase, MD, 20815, (301) 656-3920, (301) 656-3815, email@asam.org, http://www.asam.org.

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National Institute on Drug Abuse, 6001 Executive Blvd., Room 5213, Bethesda, MD, (301) 443-1124, information @nida.nih.gov, http://drugabuse.gov.

Ann Quigley
James Waun, MD, RPh

Central nervous system infections

Definition

The central nervous system, or CNS, comprises the brain, the spinal cord, and associated membranes. Under some circumstances, bacteria may enter areas of the CNS. If this occurs, abscesses or empyemas may be established.

Description

In general, the CNS is well defended against infection. The spine and brain are sheathed in tough, protective membranes. The outermost membrane, the dura mater, and the next layer, the arachnoid, entirely encase the brain and spinal cord. However, these defenses are not absolute. In rare cases, bacteria gain access to areas within the CNS.

Bacterial infection of the CNS can result in abscesses and empyemas (accumulations of pus). Abscesses have fixed boundaries, but empyemas lack definable shape and size. CNS infections are classified according to the location where they occur. For example, a spinal epidural **abscess** is located above the dura mater, and a cranial subdural **empyema** occurs between the dura mater and the arachnoid.

As pus and other material from an infection accumulate, pressure is exerted on the brain or spinal cord. This pressure can damage the nervous system tissue, possibly permanently. Without treatment, a CNS infection is fatal.

Causes and symptoms

Typically, bacterial invasion results from the spread of a nearby infection; for example, a chronic sinus or middle ear infection can extend beyond its initial site. Bacteria may also be conveyed to the CNS from distant sites of infection by the bloodstream. In rare cases, head trauma or surgical procedures introduce bacteria directly into the CNS. The source of infection cannot always be identified.

Specific symptoms of a CNS infection hinge on its exact location, but may include severe **headache** or back **pain**, weakness, sensory loss, and **fever**. An individual may report a stiff neck, **nausea** or **vomiting**, and tiredness or disorientation. There is a potential for seizures, **paralysis**, or **coma**.

Diagnosis

Examination

Physical symptoms, such as a fever and intense backache or a fever, severe headache, and stiff neck, raise the suspicion of a CNS infection.

Tests

Blood tests may indicate the presence of an infection but do not pinpoint its location. CT scans or MRI scans of the brain and spine can provide definitive diagnosis, with an MRI scan being the most sensitive.

Procedures

A **lumbar puncture** and analysis of the cerebrospinal fluid can help diagnose an epidural abscess; however, the procedure can be dangerous in cases of subdural empyema.

Treatment

A two-pronged approach is taken to treat CNS infections. First, antibiotic therapy against an array of potential infectious bacteria is begun. The second stage involves surgery to drain the infected site.

Although some CNS infections have been resolved with **antibiotics** alone, the more aggressive approach is often preferred. Surgery allows immediate relief of pressure on the brain or spinal cord, as well as an opportunity to collect infectious material for bacterial identification. Once the bacterial species is identified, drug therapy can be altered to a more specific antibiotic. Surgery may not be an option in some cases, such as when there are numerous sites of infection or when infection is located in an inaccessible area of the brain.

Prognosis

The fatality rate associated with CNS infections ranges from 10% to as high as 40%. Some survivors experience permanent CNS damage, resulting in partial paralysis, speech problems, or seizures. Rapid diagnosis and treatment are essential for a good prognosis. With prompt medical attention, an individual may recover completely.

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KEY TERMS

Abscess—A pus-filled area with definite borders.

Arachnoid—One of the membranes that sheathes the spinal cord and brain; the arachnoid is the second-layer membrane.

Cerebrospinal fluid—Fluid that is normally found in the spinal cord and brain. Abnormal levels of certain molecules in this fluid can indicate the presence of infection or damage to the central nervous system.

Computed tomography scan (CT)—Cross-sectional x rays of the body are compiled to create a three-dimensional image of the body's internal structures.

Dura mater—One of the membranes that sheathes the spinal cord and brain; the outermost layer.

Empyema—A pus-filled area with indefinite borders.

Lumbar puncture—A procedure in which a needle is inserted into the lower spine to collect a sample of cerebrospinal fluid.

Magnetic resonance imaging (MRI)—An imaging technique that uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

Prevention

Treatment for pre-existing infections, such as sinus or middle ear infections, may prevent some cases of CNS infection. Since some CNS infections are of unknown origin, not all are preventable.

Resources

BOOKS

Donaghy, Michael., ed. *Brain's Diseases of the Nervous System*. New York: Oxford University Press, 2009.

Murdoch, Bruce E. *Acquired Speech and Language Disorders*. 2nd ed. Hoboken, NJ: Wiley, 2010.

ORGANIZATIONS

Center for Disability Information and Referral, Indiana Institute on Disability and Community, 2853 East Tenth Street, Bloomington, IA, 47408-2696, (812) 855-9396, http://www.iidc.indiana.edu/cedir.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (404) 498-1515, (800) 311-3435, http://www.cdc.gov.

National Institute of Neurological Disorders and Stroke (NINDS), P.O. Box 5801, Bethesda, MD, 20824, (301) 496-5751, (800) 352-9424, http://www.ninds.nih.gov.

Julia Barrett
Laura Jean Cataldo, RN, EdD

Central nervous system stimulants

Definition

Central nervous system (CNS) stimulants are medicines that stimulate the release of excitatory chemicals (primarily norepinephrine) from nerve cells, increasing brain and nerve activity.

Purpose

By increasing brain and nerve activity, these drugs increase wakefulness and speed thinking and physical processes.

The most commonly used central nervous system stimulant is **caffeine**.

Central nervous system stimulant drugs are used to treat daytime lethargy and sleepiness and, paradoxically, attention deficit and hyperactivity disorders, presumably by improving the ability to organize, focus and concentrate mental activities.

Examples of central nervous system stimulants include modafinil (Provigil), sibutramine (Meridia), mistures of dextroamphetamines (Adderal), and methylphenidate (Ritalin, Concerta).

Description

With the exception of caffeine, which is available in a host of consumer products, these drugs are highly regulated, Class II **narcotics**.

These drugs are available in tablets, capsules, liquids, and patches.

Pregnancy and nursing

Studies on pregnant animals showed fetal teratogenic effects. They are not used in pregnant women unless the benefits outweigh potential risks. Nursing mothers pass small amounts of these drugs through their milk to babies,

Precautions

Children with structural abnormalities or diseases of the heart are at risk for sudden **death** from taking these drugs. Before starting on them, they should have a careful cardiac evaluation.

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Adults with heart abnormalities or diseases are at risk for sudden death, **stroke**, **heart attack**, or sudden death from taking these drugs. Before starting on them, they should have a careful cardiac evaluation.

These drugs can increase blood pressure and should be taken with caution by anyone who has **hyperthyroidism** or high blood pressure.

These drugs may increase manic episodes in people with bipolar manic-depressive disorder, and aggressive behavior, **psychosis** or thought disorders. They may increase the likelihood of seizures in people with **seizure disorder**.

These drugs should be used with caution by people who have a history of alcohol or drug **abuse**.

These drugs may produce drug-dependency and should not be withdrawn abruptly after prolonged use.

The brain adjusts and becomes tolerant to these drugs, so increasing doses are often needed to maintain the desired effects.

These drugs are not approved for use in children under the age of six; their use has been associated with growth retardation.

Side effects

- Angina, heart attack, and increased heart rate and arrhythmias
- High blood pressure
- Agitation and restlessness
- Confusion
- Headache
- Sleeplessness
- Anger and aggression
- Abdominal pain
- Decreased appetite
- Nausea, vomiting, and diarrhea
- Anemia

Drug interactions

When taken with **monoamine oxidase inhibitors** (MAOI) (Marplan, Nardil, Parnate), these drugs can produce dangerously high blood pressure.

Withdrawal syndrome

Abruptly stopping these drugs after prolonged use may result in extreme **fatigue**, depression, and **sleep disorders**.

James Waun, MD, RPh

Central retinal artery occlusion *see* **Retinopathies**

Central retinal vein occlusion *see* **Retinopathies**

Cephalosporins

Definition

Cephalosporins are antibiotic medications, in the beta-lactam (penicillin) family, that kill bacteria or prevent their growth.

Purpose

These drugs are used to treat bacterial infections in the middle ear, nose, throat, lungs, sinuses, urinary system, and skin.

They are sometimes used as alternatives to penicillin to prevent infections in people who have a history of heart damage and are susceptible to infections while undergoing dental and other procedures.

These drugs will *not* cure or prevent colds, flu, and other viral infections.

Description

Cephalosporin examples include cefaclor (Ceclor), cefadroxil (Duricef), cefazolin (Ancef, Kefzol, Zolicef), cefixime, (Suprax), cefoxitin (Mefoxin), cefprozil (Cefzil), ceftazidime (Ceptaz, Fortaz, Tazicef, Tazideme), cefuroxime (Ceftin), and cephalexin (Keflex).

Available only by prescription, these medicines come in tablet, capsule, liquid, eye and ear drop, and injectable forms.

Recommended dosage

The dosage depends on the form of drug used and the reason for its use.

All **antibiotics** should be taken exactly as directed for as long as directed. They should not be stopped if or when symptoms improve.

Some cephalosporins work best when taken on an empty stomach; others should be taken after meals. Read the advice tags on prescription labels or ask your pharmacists if there are special instructions regarding food.

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PREGNANCY. Cephalosporins pass through the placenta. While there are no well controlled studies on their possible risks to developing fetuses, caution is advised.

BREASTFEEDING. Cephalosporins passes into breast milk in small amounts and may affect the bowels of nursing babies.

OTHER MEDICAL CONDITIONS. Before using cephalosporins, people with any of these medical problems should make sure their physicians are aware of their conditions:

- Penicillin allergy. Cephalosporins are related to penicillins; people with a history of severe reactions to penicillin may also have allergic reactions to cephalosporins.
- Chronic kidney disease. The dose of cephalosporins may need to be reduced in people who have chronic kidney disease.
- Bleeding problems. Cephalosporins may increase the chance of bleeding in people with a history of bleeding problems.
- Liver disease and chronic malnutrition. Long term use of cephalosporins may lead to bleeding problems.

Side effects

- Headache, confusion, agitation, dizziness, and fatigue
- Skin rash or itching
- Joint aches or pains
- Fever
- Abdominal cramps, upset stomach, nausea, diarrhea
- Vaginal itching or discharge
- Unusual bruising or bleeding

Drug interactions

Cephalosporins may increase the blood levels of metformin used to treat type 2 diabetes.

Probenecid, used to treat chronic **gout**, may increase the blood levels of cephalosporins, increasing the possibility of diarrhea as an adverse effect.

Cephalosporins may increase the blood thinning effects of warfarin (Coumadin).

James Waun, MD. RPh

Cerebral abscess *see* **Brain abscess**

Cerebral amyloid angiopathy

Definition

Cerebral amyloid angiopathy (CAA) is also known as congophilic angiopathy or cerebrovascular **amyloidosis**. It is a disease of small blood vessels in the brain in which deposits of amyloid protein in the vessel walls may lead to **stroke**, brain hemorrhage, or **dementia**. Amyloid protein resembles a starch and is deposited in tissues during the course of certain chronic diseases.

Description

CAA may affect patients over age 45, but is most common in patients over age 65, and becomes more common with increasing age. Men and women are equally affected. In some cases, CAA is sporadic but it may also be inherited as an autosomal dominant condition (a form of inheritance in which only one copy of a gene coding for a disease need be present for that disease to be expressed; if either parent has the disease, a child has a 50% chance of inheriting the disease). CAA is responsible for 5–20% of brain hemorrhage, and up to 30% of lobar hemorrhages localized to one lobe of the brain. CAA may be found during an **autopsy** in over one-third of persons over age 60, even though they may not have had brain hemorrhage, stroke, or other manifestations of the disease during life. In **Alzheimer's disease**, CAA is more common than in the general population, and may occur in more than 80% of patients over age 60.

Causes and symptoms

The cause of amyloid deposits in blood vessels in the brain in sporadic CAA is not known. In hereditary CAA, genetic defects, typically on chromosome 21, allow accumulation of amyloid, a protein made up of units called beta-pleated sheet fibrils. The fibrils tend to clump together, so that the amyloid cannot be dissolved and builds up in the brain blood vessel walls. One form of amyloid fibril subunit proteins is the amyloid beta protein.

Different theories have been suggested for the source of amyloid beta protein in the brain. The systemic theory suggests that amyloid beta protein in the blood stream is deposited in blood vessels in the brain, causing weakness in the blood vessel wall and breakdown in the blood-brain barrier. Normally, the blood-brain barrier keeps proteins and other large molecules from escaping from the blood vessel to the brain tissue. When there is breakdown of the blood-brain barrier, amyloid beta protein leaks through the blood vessel

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wall, and is deposited in the brain substance, where it forms an abnormal structure called a neuritic plaque.

A second, more likely theory is that amyloid fibrils that form amyloid beta protein are produced by perivascular microglia, or support cells in contact with the brain blood vessel wall. The third theory is that the brain tissue gives rise to amyloid beta protein. Both the nerve cells and the glia are known to produce amyloid precursor protein, which increases with **aging** and with cell **stress**.

Bleeding into the brain may occur as tiny blood vessels carrying amyloid deposits become heavier and more brittle, and are therefore more likely to burst with minor trauma or with fluctuating blood pressure. Aneurysms, or ballooning of the blood vessel wall, may develop, and may also rupture as the stretched wall becomes thinner and is under more pressure. Amyloid deposits may destroy smooth muscle cells or cause inflammation in the blood vessel wall. This may also cause the blood vessel to break more easily.

The most common form of CAA is the sporadic form associated with aging. This type of CAA usually causes lobar hemorrhage, which may recur in different lobes of the brain. The frontal lobe (behind the forehead) and parietal lobe (behind the frontal lobe) are most often affected; the temporal lobe (near the temple) and occipital lobe (at the back of the brain) are affected less often; and the cerebellum (under the occipital lobe) is rarely affected. Approximately 10–50% of hemorrhages in sporadic CAA involve more than one lobe.

Symptoms of lobar hemorrhage in CAA include sudden onset of **headache**, neurologic symptoms such as weakness, sensory loss, visual changes, or speech problems, depending on which lobe is involved; and decreased level of consciousness (a patient who is difficult to arouse), **nausea**, and **vomiting**. Sporadic CAA may be associated with symptoms unrelated to lobar hemorrhage. Petechial hemorrhages (tiny hemorrhages involving many small vessels) may produce recurrent, brief neurologic symptoms secondary to seizures or decreased blood flow, or may produce rapidly progressive dementia (loss of memory and other brain functions) that worsens in distinct steps rather than gradually. Over 40% of patients with hemorrhage secondary to CAA also have dementia.

Genetic factors play a role in certain types of CAA and in diseases associated with CAA:

- Dutch type of hereditary cerebral hemorrhage with amyloidosis (build up of amyloid protein in blood vessels): autosomal dominant, with a genetic mutation involving the amyloid precursor protein. Onset is at age 40–60 with headaches, brain hemorrhage often in the parietal lobe, strokes, and dementia. More than half of patients die from their first hemorrhage. Patients with the Dutch type of CAA may produce an abnormal anticoagulant, or blood thinner, which makes hemorrhage more likely.
- Flemish type of hereditary cerebral hemorrhage with amyloidosis: autosomal dominant, with a mutation involving the amyloid precursor protein. Symptoms include brain hemorrhage or dementia.
- Familial Alzheimer's disease: autosomal dominant, comprising 5–10% of all Alzheimer's disease cases (a brain disease in which death of nerve cells leads to progressive dementia).
- Down Syndrome: caused by trisomy 21 (three rather than two copies of chromosome 21), causing excess amyloid precursor protein gene. Children with Down syndrome are mentally handicapped and may have heart problems.
- Icelandic type of hereditary cerebral hemorrhage with amyloidosis: autosomal dominant, with mutation in the gene coding for cystatin C. Symptoms often begin at age 30–40 with multiple brain hemorrhages, dementia, paralysis (weakness), and death in 10–20 years. Headache occurs in more than half of patients, and seizures occur in one-quarter. Unlike most other forms of CAA, most hemorrhages involve the basal ganglia deep within the brain. (Basal ganglia are islands of tissues in the cerebellum part of the brain.)
- Familial oculo-leptomeningeal amyloidosis: autosomal dominant with unknown gene defect(s), described in Japanese, Italian, and North American families. Symptoms can include dementia, ataxia (problems with coordination), spasticity (limb stiffness), strokes, seizures, peripheral neuropathy (disease affecting the nerves supplying the limbs), migraine, spinal cord problems, blindness, and deafness. Brain hemorrhage is rare as the amyloid protein is deposited in blood vessels in the eye and meninges (brain coverings), but not in the brain itself. In Italian families with the disease, patients may be affected as early as 20–30 years of age.
- British type of familial amyloidosis: autosomal dominant with unknown gene defect(s), associated with progressive dementia, spasticity, and ataxia. Brain stem, spinal cord, and cerebellum all exhibit amyloid deposits, but hemorrhage typically does not occur.

Diagnosis

As in most neurologic diseases, diagnosis is made most often from the patient's history, with careful inquiry into family history and the patient's onset

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KEY TERMS

Amyloid—Amyloid protein resembles a starch and is deposited in tissues during the course of certain chronic diseases.

Ataxia—Problems with coordination and walking.

Autosomal dominant—A form of inheritance in which only one copy of a gene coding for a disease need be present for that disease to be expressed. If either parent has the disease, a child has a 50% chance of inheriting the disease.

Chromosome—A cellular structure containing genetic information in the form of DNA.

Dementia—Loss of memory and other higher functions, such as thinking or speech, lasting six months or more.

Hemorrhage—Bleeding, or escape of blood through ruptured or unruptured blood vessel walls.

Lobar hemorrhage—Bleeding into one of the lobes of the brain.

Seizure—Epileptic convulsion, fit, or attack.

Spasticity—Limb stiffness related to disease of the brain or spinal cord.

Sporadic—A form of disease found in persons without a family history of the disease.

Stroke—Sudden neurological deficit related to impaired blood supply to the brain.

and pattern of symptoms, as well as neurologic examination. Brain computed tomography scan (CT) or **magnetic resonance imaging** (MRI) may identify lobar hemorrhage, stroke, or petechial hemorrhages, and are important in excluding arteriovenous malformation, **brain tumor**, or other causes of hemorrhage. **Angiography** (x-ray study of the interior of blood vessels and the heart) is not helpful in diagnosis of CAA, but may be needed to exclude aneurysm. **Brain biopsy** (surgical removal of a small piece of brain tissue) may show characteristic amyloid deposits, but is rarely performed, as the risk may not be justifiable in the absence of effective treatment for CAA. If diagnosis is uncertain, biopsy may be needed to rule out conditions which are potentially treatable. Definite diagnosis requires microscopic examination of brain tissue, either at biopsy, at autopsy, or at surgery when brain hemorrhage is drained. **Lumbar puncture** to examine cerebrospinal fluid proteins may show characteristic abnormalities, but is not part of the routine exam. In familial forms, genetic analysis may be helpful.

CAA with hemorrhage must be distinguished from other types of brain hemorrhage. In CAA, hemorrhage typically occurs in the lobar region, often ruptures into the subarachnoid space between the brain and its coverings, and occurs at night. In hemorrhage related to high blood pressure, hemorrhage is usually deeper within the brain, ruptures into the ventricles or cavities deep inside the brain, and occurs during daytime activities. Other causes of brain hemorrhage are **arteriovenous malformations**, trauma, aneurysms, bleeding into a brain tumor, **vasculitis** (inflammation of blood vessels), or bleeding disorders.

Treatment

Although there is no effective treatment for the underlying disease process of CAA, measures can be taken to prevent brain hemorrhage in patients diagnosed with CAA. High blood pressure should be treated aggressively, and even normal blood pressure can be lowered as much as tolerated without side effects from medications. Blood thinners such as Coumadin, antiplatelet agents such as **aspirin**, or medications designed to dissolve **blood clots** may cause hemorrhage in patients with CAA, and should be avoided if possible. If these medications are required for other conditions, such as heart disease, the potential benefits must be carefully weighed against the increased risks.

Seizures, or recurrent neurologic symptoms thought to be seizures, should be treated with anti-epileptic drugs, although Depakote (**sodium** valproate) should be avoided because of its antiplatelet effect. Anti-epileptic drugs are sometimes given to patients with large lobar hemorrhage in an attempt to prevent seizures, although the benefit of this is unclear.

Once brain hemorrhage has occurred, the patient should be admitted to a hospital (ICU) for neurologic monitoring and control of increased pressure within the brain, blood pressure control, and supportive medical care. Antiplatelet agents and blood thinners should be discontinued and their effects reversed, if possible. Surgery may be needed to remove brain hemorrhage, although bleeding during surgery may be difficult to control.

CAA may be rarely associated with cerebral vasculitis, or inflammation of the blood vessel walls. In

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these cases treatment with **steroids** or immune system suppressants may be helpful. Without tissue examination, vasculitis cannot be diagnosed reliably, and probably coexists with CAA too rarely to justify steroid treatment in most cases.

Prognosis

Since CAA is associated with progressive blood vessel degeneration, and since there is no effective treatment, most patients have a poor prognosis. Aggressive neurosurgical management allows increased survival following lobar hemorrhage, but 20–90% of patients die from the first hemorrhage or its complications, which include progression of hemorrhage, brain **edema** (swelling) with herniation (downward pressure on vital brain structures), seizures, and infections such as **pneumonia**. Many survivors have persistent neurologic deficits related to the brain lobe affected by hemorrhage, and are at risk for additional hemorrhages, seizures, and dementia. Prognosis is worse in patients who are older, or who have larger hemorrhages or recurrent hemorrhages within a short time.

Resources

PERIODICALS

Neau, J. P., et.al. "Recurrent Intracerebral Hemorrhage." *Neurology* 49, no. 1 (1997): 106–113.

Laurie Barclay, MD

Cerebral aneurysm

Definition

A cerebral aneurysm occurs at a weak point in the wall of a blood vessel (artery) that supplies blood to the brain. Because of the flaw, the artery wall bulges outward and fills with blood. This bulge is called an aneurysm. An aneurysm can rupture, spilling blood into the surrounding body tissue. A ruptured cerebral aneurysm can cause permanent brain damage, disability, or **death**.

Description

A cerebral aneurysm can occur anywhere in the brain. Aneurysms can have several shapes. The saccular aneurysm, once called a berry aneurysm, resembles a piece of fruit dangling from a branch. Saccular aneurysms are usually found at a branch in the blood vessel where they balloon out by a thin neck. Saccular cerebral aneurysms most often occur at the branch points of large arteries at the base of the brain. Aneurysms may also take the form of a bulge in one wall of the artery–a lateral aneurysm–or a widening of the entire artery–a fusiform aneurysm.

The greatest danger of aneurysms is rupture. Approximately 50–75% of stricken people survive an aneurysmal rupture. A ruptured aneurysm spills blood into the brain or into the fluid-filled area that surrounds the brain tissue. Bleeding into this area, called the subarachnoid space, is referred to as **subarachnoid hemorrhage** (SAH). About 25,000 people suffer a SAH each year. It is estimated that people with unruptured aneurysm have an annual 1–2% risk of hemorrhage. Under age 40, more men experience SAH. After age 40, more women than men are affected.

Most people who have suffered a SAH from a ruptured aneurysm did not know that the aneurysm even existed. Based on **autopsy** studies, medical researchers estimate that 1–5% of the population has some type of cerebral aneurysm. Aneurysms rarely occur in the very young or the very old; about 60% of aneurysms are diagnosed in people between ages 40 and 65.

Some aneurysms may have a genetic link and run in families. The genetic link has not been completely proven and a pattern of inheritance has not been determined. Some studies seem to show that first-degree relatives of people who suffered aneurysmal SAH are more likely to have aneurysms themselves. These studies reported that such immediate family members were four times more likely to have aneurysms than the general population. Other studies do not confirm these findings. Better evidence links aneurysms to certain rare diseases of the connective tissue. These diseases include **Marfan syndrome**, **pseudoxanthoma elasticum**, **Ehlers-Danlos syndrome**, and fibromuscular dysplasia. **Polycystic kidney disease** is also associated with cerebral aneurysms.

These diseases are also associated with an increased risk of aneurysmal rupture. Certain other conditions raise the risk of rupture, too. Most aneurysms that rupture are a half-inch or larger in diameter. Size is not the only factor, however, because smaller aneurysms also rupture. Cigarette **smoking**, excessive alcohol consumption, and recreational drug use (for example, use of **cocaine**) have been linked with an increased risk. The role, if any, of high blood pressure has not been determined. Some studies have implicated high blood

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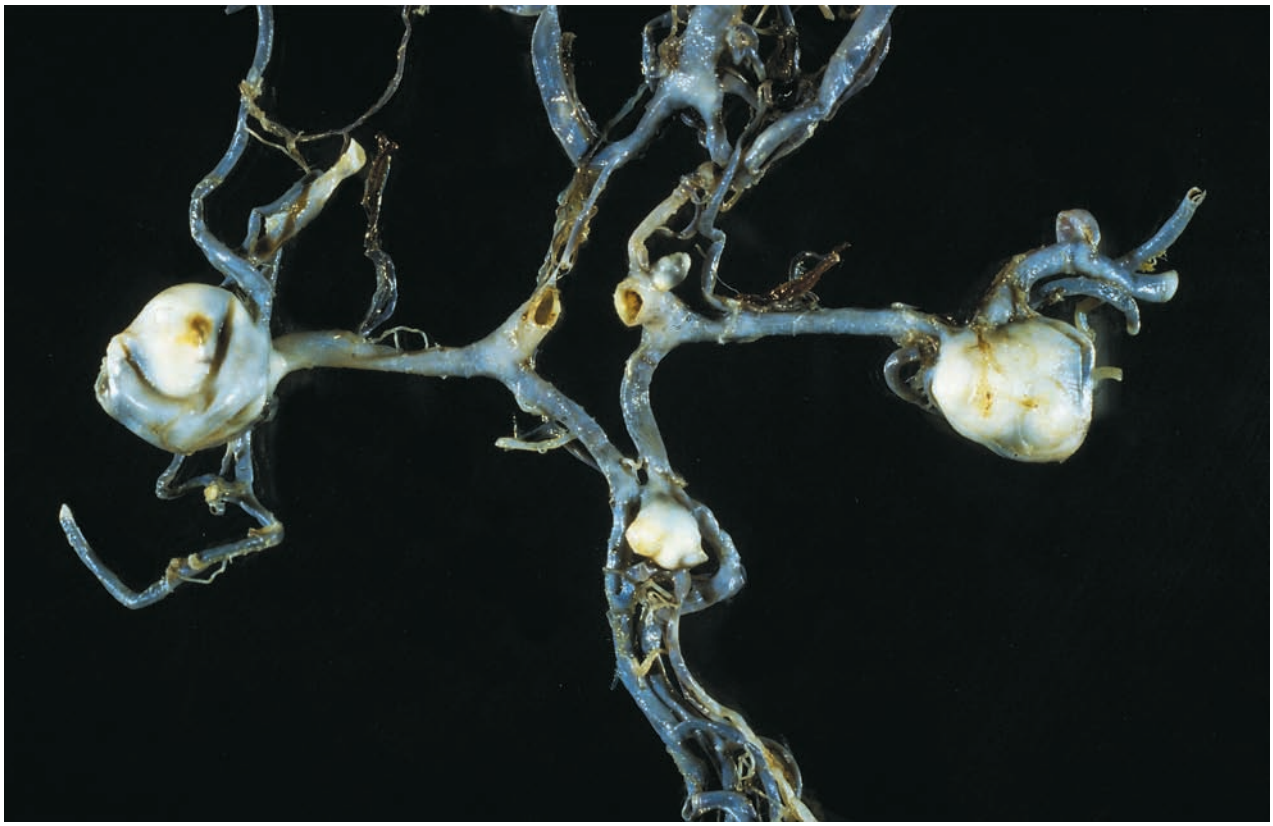

Three aneurysms can be seen in this section of a cerebral artery removed from a human brain. *(© Martin Rotker/Phototake. — All rights reserved.)*

pressure in aneurysm formation and rupture, but people with normal blood pressure also experience aneurysms and SAHs. High blood pressure may be a risk factor but not the most important one. **Pregnancy**, labor, and delivery also seem to increase the possibility that an aneurysm might rupture, but not all doctors agree. Physical exertion and use of **oral contraceptives** are not suspected causes for aneurysmal rupture.

Causes and symptoms

Cerebral aneurysms can be caused by brain trauma, infection, hardening of the arteries (**atherosclerosis**), or abnormal rapid cell growth (neoplastic disease), but most seem to arise from a congenital, or developmental, defect. These congenital aneurysms occur more frequently in women. Whatever the cause may be, the inner wall of the blood vessel is abnormally thin and the pressure of the blood flow causes an aneurysm to form.

Most aneurysms go unnoticed until they rupture. However, 10–15% of unruptured cerebral aneurysms are found because of their size or their location. Common warning signs include symptoms that affect only one eye, such as an enlarged pupil, a drooping eyelid, or **pain** above or behind the eye. Other symptoms are a localized **headache**, unsteady gait, a temporary problem with sight, double vision, or **numbness** in the face.

Some aneurysms bleed occasionally without rupturing. Symptoms of such an aneurysm develop gradually. The symptoms include headache, **nausea**, **vomiting**, neck pain, black-outs, ringing in the ears, **dizziness**, or seeing spots.

Eighty to ninety percent of aneurysms are not diagnosed until after they have ruptured. Rupture is not always a sudden event. Nearly 50% of patients who have aneurysmal SAHs also experience "the warning leak phenomenon." Persons with warning leak symptoms have sudden, atypical headaches that occur days or weeks before the actual rupture. These headaches are referred to as sentinel headaches. Nausea, **vomiting**, and dizziness may accompany sentinel headaches. Unfortunately, these symptoms can be confused with tension headaches or migraines, and treatment can be delayed until rupture occurs.

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When an aneurysm ruptures, most victims experience a sudden, extremely severe headache. This headache is typically described as the worst headache of the victim's life. **Nausea and vomiting** commonly accompany the headache. The person may experience a short loss of consciousness or prolonged **coma**. Other common signs of a SAH include a stiff neck, **fever**, and a sensitivity to light. About 25% of victims experience neurological problems linked to specific areas of the brain, swelling of the brain due to fluid accumulation (**hydrocephalus**), or seizure.

Diagnosis

Based on the clinical symptoms, a doctor will run several tests to confirm an aneurysm or an SAH. A computed tomography scan (CT) of the head is the initial procedure. A **magnetic resonance imaging** test (MRI) may be done instead of a CT scan. MRI, however, is not as sensitive as CT for detecting subarachnoid blood. A CT scan can determine whether there has been a hemorrhage and can assist in pinpointing the location of the aneurysm. The scan is most useful when it is done within 72 hours of the rupture. Later scans may miss the signs of hemorrhage.

If the CT scan is negative for a hemorrhage or provides an unclear diagnosis, the doctor will order a **cerebrospinal fluid (CSF) analysis**, also called a **lumbar puncture**. In this procedure, a small amount of cerebrospinal fluid is removed from the lower back and examined for traces of blood and blood-breakdown products. If this test is positive, cerebral **angiography** is used to map the brain's blood vessels and the damaged area. The angiography is done to pinpoint the aneurysm's location. About 15% of people who experience SAH have more than one aneurysm. For this reason, angiography should include both the common carotid artery that feeds the front of the brain and the vertebral artery that feeds the base of the brain. Occasionally, the angiography fails to find the aneurysm and must be repeated. If seizures occur, **electroencephalography** (EEG) may be used to measure the electrical activity of the brain.

Treatment

Unruptured aneurysm

If an aneurysm has not ruptured and is not causing any symptoms, it may be left untreated. Because there is a 1–2% chance of rupture per year, the cumulative risk over a number of years may justify surgical treatment. However, if the aneurysm is small or in a place that would be difficult to reach, or if the person who has the aneurysm is in poor health, the surgical treatment may be a greater risk than the aneurysm. Risk of rupture is higher for people who have more than one aneurysm. Unruptured aneurysm would probably be treated with a surgical procedure called the clip ligation, as described in the following text.

Ruptured aneurysm

The primary treatment for a ruptured aneurysm involves stabilizing the victim's condition, treating the immediate symptoms, and promptly assessing further treatment options, especially surgical procedures. The patient may require mechanical ventilation, oxygen, and fluids. Medications may be given to prevent major secondary complications such as seizures, rebleeding, and vasospasm (narrowing of the affected blood vessel). Vasospasm decreases blood flow to the brain and causes the death of nerve cells. A drug such as nimodipine (Nimotop) may help prevent vasospasm by relaxing the smooth muscle tissue of the arteries. Even with treatment, however, vasospasm may cause **stroke** or death.

To prevent further hemorrhage from the aneurysm, it must be removed from circulation. In general, surgical procedures should be performed as soon as possible to prevent rebleeding. The chances that aneurysm will rebleed are greatest in the first 24 hours, and vasospasm usually does not occur until 72 hours or more after rupture. If the patient is in poor condition or if there is vasospasm or other complication, surgical procedures may be delayed. The preferred surgical method is a clip ligation in which a clip is placed around the base of the aneurysm to block it off from circulation. Surgical coating, wrapping, or trapping of the aneurysm may also be performed. These procedures do not completely remove the aneurysm from circulation, however, and there is some risk that it may rebleed in the future. Newer techniques that look promising include balloon embolization, a procedure that blocks the aneurysm with an inflatable membrane introduced by means of a catheter inserted through the artery.

Prognosis

An unruptured aneurysm may not cause any symptoms over an entire lifetime. Surgical clip ligation will ensure that it won't rupture, but it may be better to leave the aneurysm alone in some cases. Familial cerebral aneurysms may rupture earlier than those without a genetic link.

The outlook is not as good for a person who suffers a ruptured aneurysm. Fifteen to twenty-five percent of people who experience a ruptured aneurysm do not survive. An additional 25–50% die as a

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KEY TERMS

Congenital—Existing at birth.

Ehlers-Danlos syndrome—A rare inheritable disease of the connective tissue marked by very elastic skin, very loose joints, and very fragile body tissue.

Embolization—A technique to stop or prevent hemorrhage by introducing a foreign mass, such as an air-filled membrane (balloon), into a blood vessel to block the flow of blood.

Fibromuscular dysplasia—A disorder that causes unexplained narrowing of arteries and high blood pressure.

Magnetic resonance angiography—A noninvasive diagnostic technique that uses radio waves to map the internal anatomy of the blood vessels.

Marfan syndrome—An inheritable disorder that affects the skeleton, joints, and blood vessels. Major indicators are excessively long arms and legs, lax joints, and vascular defects.

Nimodipine (Nimotop)—A calcium-channel blocker, that is, a drug that relaxes arterial smooth muscle by slowing the movement of calcium across cell walls.

Polycystic kidney disease—An abnormal condition in which the kidneys are enlarged and contain many cysts.

Pseudoxanthoma elasticum—A hereditary disorder of the connective, or elastic, tissue marked by premature aging and breakdown of the skin and degeneration of the arteries that leads to hemorrhages.

Subarachnoid hemorrhage (SAH)—Loss of blood into the subarachnoid space, the fluid-filled area that surrounds the brain tissue.

Vasospasm—Narrowing of a blood vessel caused by a spasm of the smooth muscle of the vessel wall.

result of complications associated with the hemorrhage. Of the survivors, 15–50% suffer permanent brain damage and disability. These conditions are caused by the death of nerve cells. Nerve cells can be destroyed by the hemorrhage itself or by complications from the hemorrhage, such as vasospasm or hydrocephalus. Hydrocephalus, a dilatation (expansion) of the fluid-filled cavity surrounding the brain, occurs in about 15% of cases. Immediate medical treatment is vital to prevent further complications and brain damage in those who survive the initial rupture. Patients who survive SAH and aneurysm clipping are unlikely to die from events related to SAH.

Prevention

There are no known methods to prevent an aneurysm from forming. If an aneurysm is discovered before it ruptures, it may be surgically removed. CT or MRI angiography may be recommended for relatives of patients with familial cerebral aneurysms.

Resources

OTHER

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"The Brain Aneurysm Report." *Neurosurgical Service Page*. Harvard Medical School. http://neurosurgery.mgh.harvard.edu/abta/primer.htm.

ORGANIZATIONS

Brain Aneurysm Foundation, 66 Canal St, Boston, MA, 02114, (999) 272-4602, office@bafound.org, http://www.bafound.org.

Julia Barrett

Cerebral angiography *see* **Angiography**

Cerebral palsy

Definition

Cerebral palsy (CP) is the term used for a group of nonprogressive disorders of movement and posture caused by abnormal development of, or damage to, motor control centers of the brain. CP is caused by events before, during, or after birth. The abnormalities of muscle control that define CP are often accompanied by other neurological and physical abnormalities.

Demographics

As of 2009, United Cerebral Palsy (UCP) estimates that some 764,000 children and adults in the United States display one or more of the symptoms of cerebral palsy. Approximately 8,000 babies and infants are diagnosed with the condition each year. In addition, some

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1,500 preschool age children are recognized each year to have cerebral palsy.

Description

Voluntary movement (walking, grasping, chewing, etc.) is primarily accomplished using muscles that are attached to bones, known as the skeletal muscles. Control of the skeletal muscles originates in the cerebral cortex, the largest portion of the brain. Palsy means **paralysis**, but may also be used to describe uncontrolled muscle movement or tension (hypertonia). Therefore, cerebral palsy encompasses any disorder of abnormal movement and paralysis caused by abnormal function of the cerebral cortex. In truth, however, CP does not include conditions due to progressive disease or degeneration of the brain. For this reason, CP is also referred to as static (nonprogressive) encephalopathy (disease of the brain). Also excluded from CP are any disorders of muscle control that arise in the muscles themselves and/or in the peripheral nervous system (nerves outside the brain and spinal cord).

CP is not a specific condition, but is more accurately considered a description of a broad but defined group of neurological and physical problems.

The severity of CP is quite variable. Some people with CP may have only minor difficulty with fine motor skills, such as grasping and manipulating items with their hands. A severe form of CP could involve significant muscle problems in all four limbs, **mental retardation**, seizures, and difficulties with vision, speech, and hearing.

Muscles that receive abnormal messages from the brain may be constantly contracted and tight (spastic), exhibit involuntary writhing movements (athetosis), or have difficulty with voluntary movement (dyskinesia). There can also be a lack of balance and coordination with unsteady movements (ataxia). A combination of any of these problems may also occur. Spastic CP and mixed CP constitute the majority of cases. Effects on the muscles can range from mild weakness or partial paralysis (*paresis*), to complete loss of voluntary control of a muscle or group of muscles (*plegia*). CP is also designated by the number of limbs affected. For instance, affected muscles in one limb is monoplegia, both arms or both legs is diplegia, both limbs on one side of the body is hemiplegia, and in all four limbs is quadriplegia. Muscles of the trunk, neck, and head may be affected as well.

Risk factors

Babies born prematurely or at low birth weights are at higher risk for cerebral palsy.

Two factors are involved in the risk for CP associated with **prematurity**. First, premature babies are at higher risk for various CP–associated medical complications, such as intracerebral hemorrhage, infection, and difficulty in breathing, to name a few. Second, the onset of **premature labor** may be induced, in part, by complications that have already caused neurologic damage in the fetus. A combination of both factors almost certainly plays a role in some cases of CP. The tendency toward premature delivery tends to run in families, but the genetic mechanisms are far from clear.

An increase in multiple birth pregnancies in recent years, especially in the United States, is blamed on the increased use of fertility drugs. As the number of fetuses in a **pregnancy** increases, the risks for abnormal development and premature delivery also increase. Children from twin pregnancies have four times the risk of developing CP as children from singleton pregnancies, owing to the fact that more twin pregnancies are delivered prematurely. The risk for CP in a child of triplets is up to 18 times greater. Furthermore, recent evidence suggests that a baby from a pregnancy in which its twin died before birth is at increased risk for CP.

Causes and symptoms

CP can be caused by a number of different mechanisms at various times—from several weeks after conception, through birth, to early childhood. For many years, it was accepted that most cases of CP were due to brain injuries received during a traumatic birth, known as birth asphyxia. However, research has shown that only 5–10% of CP can be attributed to birth trauma. Causes can be grouped into those that occur during pregnancy (prenatal), those that happen around the time of birth (perinatal), and those that occur after birth (postnatal).

Prenatal causes

Although much has been learned about human embryology in the last couple of decades, a great deal remains unknown. Studying prenatal human development is difficult because the embryo and fetus develop in a closed environment—the mother's womb. However, the relatively recent development of a number of prenatal tests has opened a window on the process. Add to that more accurate and complete evaluations of newborns, especially those with problems, and a clearer picture of what can go wrong before birth is possible.

The complicated process of brain development before birth is susceptible to many chance errors that

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can result in abnormalities of varying degrees. Some of these errors will result in structural anomalies of the brain, while others may cause undetectable, but significant, abnormalities in how the cerebral cortex is "wired." An abnormality in structure or wiring is sometimes hereditary, but is most often due to chance, or a cause unknown at this time. Whether and how much genetics played a role in a particular brain abnormality depends to some degree on the type of anomaly and the form of CP it causes.

Several maternal–fetal infections are known to increase the risk for CP, including **rubella** (German **measles**, now rare in the United States), cytomegalovirus (CMV), and **toxoplasmosis**. Each of these infections is considered a risk to the fetus only if the mother contracts it for the first time during that pregnancy. Even in those cases, though, most babies will be born normal. Most women are immune to all three infections by the time they reach childbearing age, but a woman's immune status can be determined using the TORCH (Toxoplasmosis, Rubella, Cytomegalovirus, and Herpes) test before or during pregnancy.

Just as a **stroke** can cause neurologic damage in an adult, so too can this type of event occur in the fetus. A burst blood vessel in the brain followed by uncontrolled bleeding (coagulopathy), known as intracerebral hemorrhage, could cause a fetal stroke, or a cerebral blood vessel could be obstructed by a clot (**embolism**). Infants who later develop CP, along with their mothers, are more likely than other mother–infant pairs to test positive for factors that put them at increased risk for bleeding episodes or **blood clots**. Some **coagulation disorders** are strictly hereditary, but most have a more complicated basis.

A teratogen is any substance to which a woman is exposed that has the potential to harm the embryo or fetus. Links between a drug or other chemical exposure during pregnancy and a risk for CP are difficult to prove. However, any substance that might affect fetal brain development, directly or indirectly, could increase the risk for CP. Furthermore, any substance that increases the risk for premature delivery and low birth weight, such as alcohol, tobacco, or **cocaine**, among others, might indirectly increase the risk for CP.

The fetus receives all nutrients and oxygen from blood that circulates through the placenta. Therefore, anything that interferes with normal placental function might adversely affect development of the fetus, including the brain, or might increase the risk for premature delivery. Structural abnormalities of the placenta, premature detachment of the placenta from the uterine wall (abruption), and placental infections (chorioamnionitis) are thought to pose some risk for CP.

Certain conditions in the mother during pregnancy might pose a risk to fetal development leading to CP. Women with autoimmune anti–thyroid or anti–phospholipid (APA) antibodies are at slightly increased risk for CP in their children. A potentially important clue uncovered recently points toward high levels of cytokines in the maternal and fetal circulation as a possible risk for CP. Cytokines are proteins associated with inflammation, such as from infection or **autoimmune disorders**, and they may be toxic to neurons in the fetal brain. More research is needed to determine the exact relationship, if any, between high levels of cytokines in pregnancy and CP. A woman has some risk of developing the same complications in more than one pregnancy, slightly increasing the risk for more than one child with CP.

Serious physical trauma to the mother during pregnancy could result in direct trauma to the fetus as well, or injuries to the mother could compromise the availability of nutrients and oxygen to the developing fetal brain.

Perinatal causes

Birth asphyxia significant enough to result in CP is now uncommon in developed countries. Tight nuchal cord (umbilical cord around the baby's neck) and prolapsed cord (cord delivered before the baby) are possible causes of birth asphyxia, as are bleeding and other complications associated with **placental abruption** and **placenta previa** (placenta lying over the cervix).

Infection in the mother is sometimes not passed to the fetus through the placenta, but is transmitted to the baby during delivery. Any such infection that results in serious illness in the newborn has the potential to produce some neurological damage.

Postnatal causes

The remaining 15% of CP is due to neurological injury sustained after birth. CP that has a postnatal cause is sometimes referred to as acquired CP, but this is only accurate for those cases caused by infection or trauma.

Incompatibility between the Rh blood types of mother and child (mother Rh negative, baby Rh positive) can result in severe anemia in the baby (**erythroblastosis fetalis**). This may lead to other complications, including severe **jaundice**, which can cause CP. Rh disease in the newborn is now rare in developed countries due to routine screening of maternal blood type and treatment of pregnancies at risk. The routine,

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effective treatment of jaundice due to other causes has also made it an infrequent cause of CP in developed countries. Rh blood type poses a risk for recurrence of Rh disease if treatment is not provided.

Serious infections that affect the brain directly, such as **meningitis** and **encephalitis**, may cause irreversible damage to the brain, leading to CP. A **seizure disorder** early in life may cause CP, or may be the product of a hidden problem that causes CP in addition to seizures. Unexplained (idiopathic) seizures are hereditary in only a small percentage of cases. Although rare in infants born healthy at or near term, intracerebral hemorrhage and brain embolism, like fetal stroke, are sometimes genetic.

Physical trauma to an infant or child resulting in brain injury, such as from **abuse**, accidents, or near drowning/suffocation, might cause CP. Likewise, ingestion of a toxic substance such as lead, mercury, poisons, or certain chemicals could cause neurological damage. Accidental overdose of certain medications might also cause similar damage to the central nervous system.

Prematurity and multiple birth pregnancy

Advances in the medical care of premature infants in the last 20 years have dramatically increased the rate of survival of these fragile newborns. However, as gestational age at delivery and birth weight of a baby decrease, the risk for CP dramatically increases. A term pregnancy is delivered at 37–41 weeks gestation. The risk for CP in a preterm infant (32–37 weeks) is increased about five–fold over the risk for an infant born at term. Survivors of extremely preterm births (less than 28 weeks) face as much as a fifty–fold increase in risk. About 50% of all cases of CP now being diagnosed are in children who were born prematurely.

Symptoms

By definition, the defect in cerebral function causing CP is nonprogressive. However, the symptoms of CP often change over time. Most of the symptoms of CP relate in some way to the aberrant control of muscles. To review, CP is categorized first by the type of movement/postural disturbance(s) present, then by a description of which limbs are affected, and finally by the severity of motor impairment. For example, spastic diplegia refers to continuously tight muscles that have no voluntary control in both legs, while athetoid quadraparesis describes uncontrolled writhing movements and muscle weakness in all four limbs. These three-part descriptions are helpful in providing a general picture, but cannot give a complete description of any one person with CP. In addition, the various "forms" of CP do not occur with equal frequency-spastic diplegia is seen in more individuals than is athetoid quadraparesis. CP can also be loosely categorized as mild, moderate, or severe, but these are very subjective terms with no firm boundaries between them.

A muscle that is tensed and contracted is hypertonic, while excessively loose muscles are hypotonic. Spastic, hypertonic muscles can cause serious orthopedic problems, including **scoliosis** (spine curvature), hip dislocation, or **contractures**. A contracture is shortening of a muscle, aided sometimes by a weak-opposing force from a neighboring muscle. Contractures may become permanent, or "fixed," without some sort of intervention. Fixed contractures may cause postural abnormalities in the affected limbs. Clenched fists and contracted feet (equinus or equinovarus) are common in people with CP. Spasticity in the thighs causes them to turn in and cross at the knees, resulting in an unusual method of walking known as a "scissors gait." Any of the joints in the limbs may be stiff (immobilized) due to spasticity of the attached muscles.

Athetosis and dyskinesia often occur with spasticity, but do not often occur alone. The same is true of ataxia. It is important to remember that "mild CP" or "severe CP" refers not only to the number of symptoms present, but also to the level of involvement of any particular class of symptoms.

Mechanisms that can cause CP are not always restricted to motor–control areas of the brain. Other neurologically based symptoms may include:

- mental retardation/learning disabilities
- behavioral disorders
- seizure disorders
- visual impairment
- hearing loss
- speech impairment (dysarthria)
- abnormal sensation and perception

These problems may have a greater impact on a child's life than the physical impairments of CP, although not all children with CP are affected by other problems. Many infants and children with CP have growth impairment. About one–third of individuals with CP have moderate–to–severe mental retardation, one–third have mild mental retardation, and one–third have normal intelligence.

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KEY TERMS

Asphyxia—Lack of oxygen. In the case of cerebral palsy, lack of oxygen to the brain.

Ataxia—A deficiency of muscular coordination, especially when voluntary movements are attempted, such as grasping or walking.

Athetosis—A condition marked by slow, writhing, involuntary muscle movements.

Cerebral palsy—Movement disability resulting from nonprogressive brain damage.

Coagulopathy—A disorder in which blood is either too slow or too quick to coagulate (clot).

Contracture—A tightening of muscles that prevents normal movement of the associated limb or other body part.

Cytokine—A protein associated with inflammation that, at high levels, may be toxic to nerve cells in the developing brain.

Diplegia—Paralysis affecting like parts on both sides the body, such as both arms or both legs.

Dorsal rhizotomy—A surgical procedure that cuts nerve roots to reduce spasticity in affected muscles.

Dyskinesia—Impaired ability to make voluntary movements.

Hemiplegia—Paralysis of one side of the body.

Hypotonia—Reduced or diminished muscle tone.

Quadriplegia—Paralysis of all four limbs.

Serial casting—A series of casts designed to gradually move a limb into a more functional position.

Spastic—A condition in which the muscles are rigid, posture may be abnormal, and fine motor control is impaired.

Spasticity—Increased muscle tone, or stiffness, which leads to uncontrolled, awkward movements.

Static encephalopathy—A disease of the brain that does not get better or worse.

Tenotomy—A surgical procedure that cuts the tendon of a contracted muscle to allow lengthening.

Diagnosis

Examination

Diagnosing CP in an infant is often a difficult and slow process that takes time to establish with certainty, as there are other health problems that can mimic the condition. The physician may suspect that the infant has CP because of a history of difficulties at birth, seizures, feeding problems, or low muscle tone. Detailed medical and developmental history, including the history of the pregnancy and delivery, medications taken by the mother during fetal development, infections, and fetal movement are all considered. A detailed family history, including the mother's history of **miscarriage**, relatives with similar conditions, ethnic background, and consanguinity (marriage between close blood relatives) can also prove helpful.

The signs of CP are not usually noticeable at birth. Children normally progress through a predictable set of developmental milestones through the first 18 months of life. Children with CP, however, tend to develop these skills more slowly because of their motor impairments, and delays in reaching milestones are usually the first symptoms of CP. Babies with more severe cases of CP are normally diagnosed earlier than others.

Selected developmental milestones, and the ages for normally acquiring them, are given in the following list. If a child does not acquire the skill by the age shown in parentheses, there is some cause for concern.

- Sits well unsupported—6 months (8–10 months)
- Babbles—6 months (8 months)
- Crawls—9 months (12 months)
- Finger feeds, holds bottle—9 months (12 months)
- Walks alone—12 months (15–18 months)
- Uses one or two words other than dada/mama—12 months (15 months)
- Walks up and down steps—24 months (24–36 months)
- Turns pages in books; removes shoes and socks—24 months (30 months)

Children do not consistently favor one hand over the other before 12–18 months, and doing so may be a sign that the child has difficulty using the other hand. This same preference for one side of the body may show up as asymmetric crawling or, later on, favoring one leg while climbing stairs.

It must be remembered that children normally progress at somewhat different rates, and slow beginning accomplishment is often followed by normal development. Other causes for developmental delay—some benign, some serious—should be excluded before

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considering CP as the answer. CP is nonprogressive, so continued loss of previously acquired milestones indicates that CP is not the cause of the problem.

Tests

No one test is diagnostic for CP, but certain factors increase suspicion. The Apgar score measures a baby's condition immediately after birth. Babies that have low Apgar scores are at increased risk for CP. Presence of abnormal muscle tone or movements may indicate CP, as may the persistence of infantile reflexes. Imaging of the brain using ultrasound, x rays, MRI, and/or CT scans may reveal a structural anomaly. Some brain lesions associated with CP include scarring, cysts, expansion of the cerebral ventricles (**hydrocephalus**), periventricular leukomalacia (an abnormality of the area surrounding the ventricles), areas of dead tissue (necrosis), and evidence of an intracerebral hemorrhage or blood clot. Ultrasound in the neonate (newborn) is also used as it provides information about the structures of the brain as well as diagnostic information on possible hemorrhage or hypoxic–ischemic (lack of oxygen) injury. Blood and urine biochemical tests, as well as genetic tests, may be used to rule out other possible causes, including muscle and peripheral nerve diseases, mitochondrial and metabolic diseases, and other inherited disorders. Evaluations by a pediatric developmental specialist and a geneticist may be of benefit.

Treatment

Cerebral palsy cannot be cured, but many of the disabilities it causes can be managed through planning and timely care. Treatment for a child with CP depends on the severity, nature, and location of the primary muscular symptoms, as well as any associated problems that might be present. Optimal care of a child with mild CP may involve regular interaction with only a physical therapist and occupational therapist, whereas care for a more severely affected child may include visits to multiple medical specialists throughout life. With proper treatment and an effective plan, most people with CP can lead productive, happy lives.

Parents of a child newly diagnosed with CP are not likely to have the necessary expertise to coordinate the full range of care their child will need. Although knowledgeable and caring medical professionals are indispensable for developing a care plan, a potentially more important source of information and advice is other parents who have dealt with the same set of difficulties. Support groups for parents of children with CP can be significant sources of both practical advice and emotional support. Many cities have support groups that can be located through the United Cerebral Palsy Association, and most large medical centers have special multidisciplinary clinics for children with developmental disorders.

Traditional

Spasticity, muscle weakness, coordination, ataxia, and scoliosis are all significant impairments that affect the posture and mobility of a person with CP. Physical and occupational therapists work with the patient and the family to maximize the ability to move affected limbs, develop normal motor patterns, and maintain posture. Assistive technology such as wheelchairs, walkers, shoe inserts, crutches, and braces are often required. A speech therapist and high–tech aids, such as computer–controlled communication devices, can make a tremendous difference in the life of those who have speech impairments.

Daily range of motion (ROM) exercises are important to prevent or delay contractures (fixed, rigid muscles) secondary to spasticity, and to maintain mobility of joints and soft tissues. Stretching exercises are performed to increase motion. Progressive resistance exercises also increase strength. Age–appropriate play and adaptive toys and games using the desired exercises are important to elicit the child's full cooperation. Strengthening knee extensor muscles helps to improve crouching and stride length. Postural and motor control training is important following the normal developmental sequence of children (i.e., achieve head and neck control if possible before advancing to trunk control).

Occupational therapists keep the child's developmental age in mind and use adaptive equipment as needed to help attain these milestones. For example, if a child is developmentally ready to stand and explore the environment, but is limited by lack of motor control, a stander or modified walker is used. Performance based upon previous success is encouraged to maintain the child's interest and cooperation. Assistive devices and durable medical equipment help attain function that may not be possible otherwise. Orthotic devices frequently are required to maintain functional joint position especially in persons who are non–ambulatory. Frequent reevaluation of orthotic devices is important as children quickly outgrow them and can develop skin irritation from improper use of orthotic devices.

Recreational therapy, especially hippotherapy (horseback riding therapy) is frequently a well–liked activity of parents and patients alike to help with

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muscle tone, range of motion, strength, coordination, and balance. Hippotherapy also offers many potential cognitive, physical, and emotional benefits. Incorporation of play into all of a child's therapies is important. The child should view physical and **occupational therapy** as fun, not work. Caregivers should seek fun and creative ways to stimulate children, especially those who have decreased ability to explore their own environments.

Drugs

Before fixed contractures develop, muscle–relaxant drugs such as diazepam (Valium), dantrolene (Dantrium), and baclofen (Lioresal) may be prescribed. Botulinum toxin (Botox), a newer and highly effective treatment, is injected directly into the affected muscles. Alcohol or phenol injections into the nerve controlling the muscle are another option. Multiple medications are available to control seizures, and athetosis can be treated using medications such as trihexyphenidyl HCl (Artane) and benztropine (Cogentin).

Alternative

Fixed contractures are usually treated with either serial casting or surgery. The most commonly used surgical procedures are tenotomy, tendon transfer, and dorsal rhizotomy. In tenotomy, tendons of the affected muscle are cut and the limb is cast in a more normal position while the tendon regrows. Alternatively, tendon transfer involves cutting and reattaching a tendon at a different point on the bone to enhance the length and function of the muscle. A neurosurgeon performing dorsal rhizotomy carefully cuts selected nerve roots in the spinal cord to prevent them from stimulating the spastic muscles. Neurosurgical techniques in the brain such as implanting tiny electrodes directly into the cerebellum, or cutting a portion of the hypothalamus, have very specific uses and have had mixed results.

Clinical trials

Many clinical trials for the treatment of cerebral palsy are currently sponsored by the National Institutes of Health (NIH) and other agencies. In 2009, NIH reported 53 on–going or recently completed studies.

A few examples include:

- The evaluation of the effectiveness of hyperbaric oxygen treatments and the potential longer term effects in children between the ages of 3 and 8 yrs with spastic CP. (NCT00290186)
- The classification of types of hypertonia in patients with cerebral palsy. (NCT00123708)
- A study of the radiographic and clinical outcomes of scoliosis surgical treatment in patients with CP. (NCT00680264)
- A study on how the muscle architecture of the quadriceps muscles in CP adapts to two separate training programs. (NCT00629070)
- The effectiveness of acupuncture as complementary therapy for CP. (NCT00221247)
- The effects of botulinum toxin injections on walking and on the changes it causes in the muscle, brain and spinal cord of CP patients. (NCT00503620)
- The assessment of the predictive value of generalized movements in preterm and term infants who are at risk for development of cerebral palsy. (NCT00749008)

Clinical trial information is constantly updated by NIH and the most recent information on CP trials can be found at: http://clinicaltrials.gov.

Prognosis

The prognosis of persons with CP varies according to the severity of the disorder. Some children have only mild problems in muscle tone and no problems with daily activities, while others are unable to purposefully move any part of the body. Regression, or worsening of long–term symptoms, is not characteristic of CP. If regression occurs, it is necessary to look for a different cause of the child's problems. In order for a child to be able to walk, a major cascade of events in motor control have to occur. A child must be able to hold up his head before he can sit up on his own, and he must be able to sit independently before he can walk on his own. It is generally assumed that if a child is not sitting up by himself by age four or walking by age eight, he will never be an independent walker. But a child who starts to walk at age three will certainly continue to walk unless he has a disorder other than CP.

In people with severe CP, motor problems often lead to medical complications, including more frequent and serious infections, severe breathing problems, feeding intolerance, and skin breakdown. These medical complications can lead to frequent hospitalizations and a shortened life expectancy. **Epilepsy** also occurs in about a third of children with CP and is more frequent in patients with spastic quadriplegia or mental retardation. Cognitive impairment occurs more frequently in CP than in the general population, and mental delays or some form of learning disability has been estimated to occur in over two thirds of CP cases.

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Prevention

Research in the early 2000s is focused on the possible benefits of recognizing and treating coagulopathies and inflammatory disorders in the prenatal and perinatal periods in order to reduce the incidence of CP and other congenital diseases. The use of magnesium sulfate in pregnant women with **preeclampsia** or threatened preterm delivery may reduce the risk of CP in very preterm infants. Finally, the risk of CP can be decreased through good maternal **nutrition**, avoidance of drugs and alcohol during pregnancy, and prevention or prompt treatment of infections.

Resources

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Cerebral Palsy International Research Foundation, 1025 Connecticut Avenue, Suite 701, Washington, DC, 20036, (202) 496-5060, nmaher@cpirf.org, http://www.cpirf.org.

Children's Hemiplegia and Stroke Assocn. (CHASA), 4101 West Green Oaks Blvd., Suite 305, Arlington, TX, 76016, (817) 492-4325, info437@chasa.org, http://www.hemi-kids.org.

Children's Neurobiological Solutions (CNS) Foundation, 1726 Franceschi Road, Santa Barbara, CA, 93101, (805) 898-4442, (866) CNS-5580, info@cnsfoundation.org, http://www.cnsfoundation.org.

March of Dimes Foundation, 1275 Mamaroneck Avenue, White Plains, NY, 10605, (914) 428-7100, (888) MODIMES, (914) 428-8203, askus@marchofdimes.com, http://www.marchofdimes.com.

National Institute of Neurological Disorders and Stroke (NINDS), PO Box 5801, Bethesda, MD, 20824, (301) 496-5751, (800) 352-9424, http://www.ninds.nih.gov.

Pedal with Pete, PO Box 274, Kent, OH, 44240, (800) 304-PETE, (330) 673-1240, petezeid@aol.com, http://www.pedalwithpete.com.

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United Cerebral Palsy (UCP), 1660 L Street, NW, Suite 700, Washington, DC, 20036, (202) 776-0406, (800) USA-5UCP, (202) 776-0414, national@ucp.org, http://www. ucp.org.

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Cerebrospinal fluid (CSF) analysis

Definition

Cerebrospinal fluid (CSF) analysis is a laboratory test to examine a sample of the fluid surrounding the brain and spinal cord. This fluid is a clear, watery liquid that protects the central nervous system from injury and cushions it from the surrounding bone structure. It contains a variety of substances, particularly glucose (sugar), protein, and white blood cells from the immune system. The fluid is withdrawn through a needle in a procedure called a **lumbar puncture**.

Purpose

The purpose of a CSF analysis is to diagnose medical disorders that affect the central nervous system. Some of these conditions include:

- viral and bacterial infections, such as meningitis, West Nile virus, herpes virus, and encephalitis
- tumors or cancers of the nervous system
- syphilis, a sexually transmitted disease
- bleeding (hemorrhaging) around the brain and spinal cord
- multiple sclerosis, a disease that affects the myelin coating of the nerve fibers of the brain and spinal cord
- Guillain-Barré syndrome, an inflammation of the nerves
- early-onset Alzheimer's disease; the levels of two substances known as amyloid beta (1–42) and phosphorylated tau in CSF appear to be useful diagnostic markers for early-onset Alzheimer's

CSF analysis is also used in forensic investigations to identify the presence of illicit drugs (e. g., heroin) or poisons in the bodies of murder, accidental overdose, or **suicide** victims.

Precautions

In some circumstances, a lumbar puncture to withdraw a small amount of CSF for analysis may lead to serious complications. Lumbar puncture should be performed only with extreme caution, and only if the benefits are thought to outweigh the risks, in certain conditions. For example, in people who have blood clotting (coagulation) or bleeding disorders, lumbar puncture can cause bleeding that can compress the spinal cord. If there is a large **brain tumor** or other mass, removal of CSF can cause the brain to droop down within the skull cavity (herniate), compressing the brain stem and other vital structures, and leading to irreversible brain damage or **death**. These problems are easily avoided by checking blood coagulation through a blood test and by doing a computed tomography scan (CT) or **magnetic resonance imaging** (MRI) scan before attempting the lumbar puncture. In addition, a lumbar puncture procedure should never be performed at the site of a localized skin infection on the lower back because the infection may be introduced into the CSF and may spread to the brain or spinal cord.

Description

The procedure to remove cerebrospinal fluid is called a lumbar puncture, or spinal tap, because the area of the spinal column used to obtain the sample is in the lumbar spine, or lower section of the back. In rare instances, such as a spinal fluid blockage in the middle of the back, a doctor may perform a spinal tap in the neck. The lower lumbar spine (usually between the vertebrae known as L4–5) is preferable because the spinal cord stops near L2, and a needle introduced below this level will miss the spinal cord and encounter only nerve roots, which are easily pushed aside.

A lumbar puncture takes about 30 minutes. Patients can undergo the test in a doctor's office, laboratory, or outpatient hospital setting. Sometimes it requires an inpatient hospital stay. If the patient has spinal arthritis, is extremely uncooperative, or obese, it may be necessary to introduce the spinal needle using x-ray guidance.

In order to get an accurate sample of cerebrospinal fluid, it is critical that a patient is in the proper position. The spine must be curved to allow as much space as possible between the lower vertebrae, or bones of the back, for the doctor to insert a lumbar puncture needle between the vertebrae and withdraw a small amount of fluid. The most common position is for the patient to lie on his or her side with the back at the edge of the exam table, head and chin bent down, knees drawn up to the chest, and arms clasped around the knees. (Small infants and people who are obese may need to curve their spines

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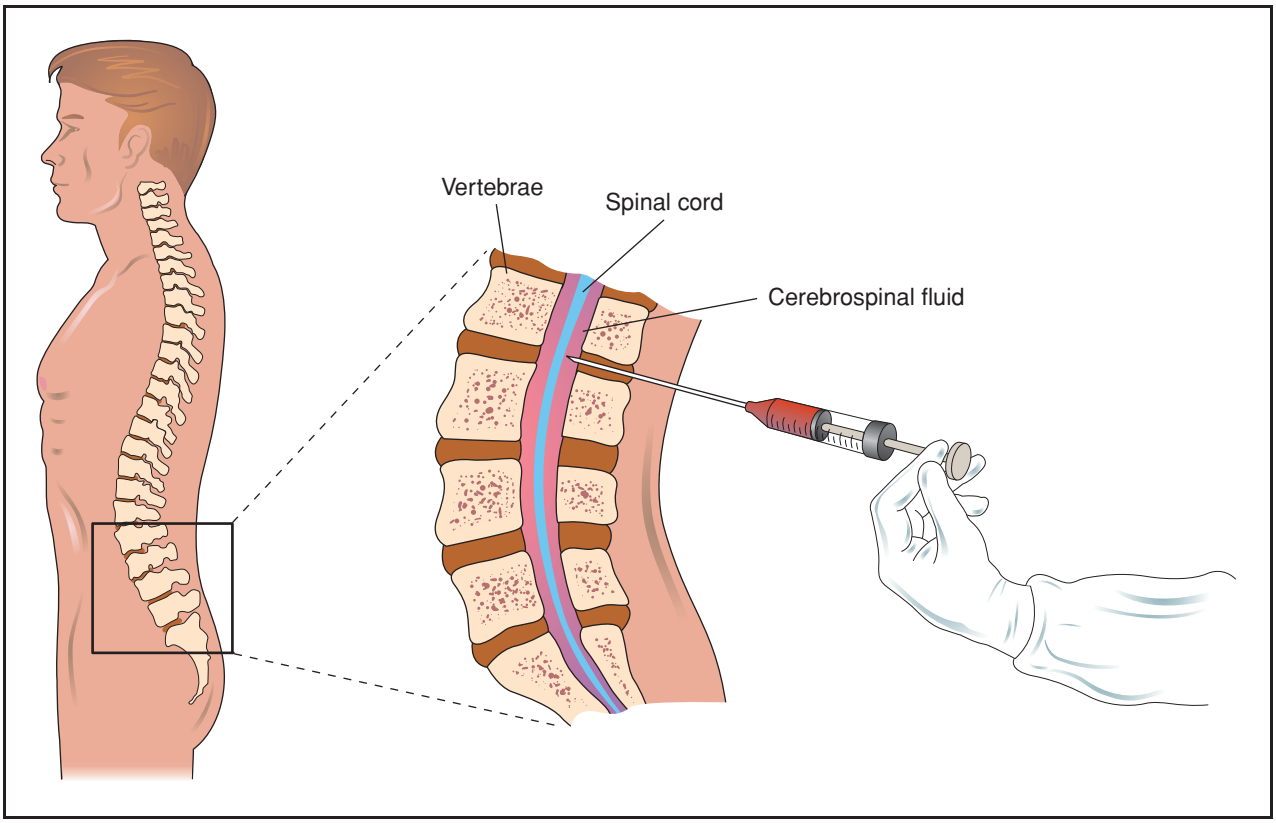

During a lumbar puncture, or spinal tap, a procedure in which cerebrospinal fluid is aspirated, the physician inserts a hollow, thin needle in the space between two vertebrae of the lower back and slowly advances it toward the spine. The cerebrospinal fluid pressure is then measured and the fluid is withdrawn for laboratory analysis. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

in a sitting position.) People should talk to their doctor if they have any questions about their position because it is important to be comfortable and to remain still during the entire procedure. In fact, the doctor will explain the procedure to the patient (or guardian) so that the patient can agree in writing to have it done (informed consent). If the patient is anxious or uncooperative, a short-acting sedative may be given.

During a lumbar puncture, the doctor drapes the back with a sterile covering that has an opening over the puncture site and cleans the skin surface with an antiseptic solution. Patients receive a local anesthetic to minimize any **pain** in the lower back.

The doctor inserts a hollow, thin needle in the space between two vertebrae of the lower back and slowly advances it toward the spine. A steady flow of clear cerebrospinal fluid, normally the color of water, will begin to fill the needle as soon as it enters the spinal canal. The doctor measures the cerebrospinal fluid pressure with a special instrument called a manometer and withdraws several vials of fluid for laboratory analysis. The amount of fluid collected depends on the type and number of tests needed to diagnose a particular medical disorder.

In some cases, the doctor must remove and reposition the needle. This occurs when there is not an even flow of fluid, the needle hits bone or a blood vessel, or the patient reports sharp, unusual pain.

Preparation

Patients can go about their normal activities before a lumbar puncture. Experts recommend that patients relax before the procedure to release any muscle tension, since the lumbar puncture needle must pass through muscle tissue before it reaches the spinal canal. A patient's level of relaxation before and during the procedure plays a critical role in the test's success.

Aftercare

After the procedure, the doctor covers the site of the puncture with a sterile bandage. Patients must avoid sitting or standing and remain lying down for as long as six hours after the lumbar puncture. They

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KEY TERMS

Encephalitis—An inflammation or infection of the brain and spinal cord caused by a virus or as a complication of another infection.

Guillain-Barré syndrome—An inflammation involving nerves that affect the extremities. The inflammation may spread to the face, arms, and chest.

Forensic—Referring to legal procedures or courts of law. Forensic medicine is the branch of medicine that obtains, analyzes, and presents medical evidence in criminal cases.

Immune system—Protects the body against infection.

Manometer—A device used to measure fluid pressure.

Meningitis—An infection or inflammation of the membranes or tissues that cover the brain and spinal cord, caused by bacteria or a virus.

Multiple sclerosis—A disease that destroys the covering (myelin sheath) of nerve fibers of the brain and spinal cord.

Spinal canal—The cavity or hollow space within the spine that contains cerebrospinal fluid.

Vertebrae—The bones of the spinal column. There are 33 along the spine, with five (called L1–L5) making up the lower lumbar region.

should also drink plenty of fluid to help prevent lumbar puncture **headache**, which is discussed in the next section.

Risks

For most people, the most common side effect after the removal of CSF is a headache. This occurs in 10–30% of adult patients and in up to 40% of children. It is caused by a decreased CSF pressure related to a small leak of CSF through the puncture site. These headaches usually are a dull pain, although some people report a throbbing sensation. A stiff neck and **nausea** may accompany the headache. Lumbar puncture headaches typically begin within two days after the procedure and persist from a few days to several weeks or months.

Since an upright position worsens the pain, patients with a lumbar puncture headache can control the pain by lying in a flat position and taking a prescription or non-prescription pain relief medication, preferably one containing **caffeine**. In rare cases, the puncture site leak is "patched" using the patient's own blood.

People should talk to their doctor about complications from a lumbar puncture. In most cases, this test to analyze CSF is a safe and effective procedure. Some patients experience pain, difficulty urinating, infection, or leakage of cerebrospinal fluid from the puncture site after the procedure.

Normal results

Normal CSF is clear and colorless. It may be cloudy in infections; straw- or yellow-colored if there is excess protein, as may occur with **cancer** or inflammation; blood-tinged if there was recent bleeding; or yellow to brown (xanthochromic) if caused by an older instance of bleeding.

A series of laboratory tests analyze the CSF for a variety of substances to rule out possible medical disorders of the central nervous system. The following are normal values for commonly tested substances:

- CSF pressure: 50–180 mm H_2O
- glucose: 40%–85 mg/dL
- protein: 15–50 mg/dL
- leukocytes (white blood cells) total less than 5 per mL
- lymphocytes: 60–70%
- monocytes: 30–50%
- neutrophils: none

Normally, there are no red blood cells in the CSF unless the needle passes though a blood vessel on route to the CSF. If this is the case, there should be more red blood cells in the first tube collected than in the last.

Abnormal results

Abnormal test result values in the pressure or any of the substances found in the cerebrospinal fluid may suggest a number of medical problems including a tumor or spinal cord obstruction; hemorrhaging or bleeding in the central nervous system; infection from bacterial, viral, or fungal microorganisms; or an inflammation of the nerves. It is important for patients to review the results of a cerebrospinal fluid analysis with their doctor and to discuss any treatment plans.

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American College of Forensic Examiners International (ACFEI), 2750 East Sunshine, Springfield, MO, 65804, (417) 881-3818, (417) 881-4702, (800) 423-9737, http://www. acfei.com.

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Cerebrovascular accident *see* **Stroke**

Cerebrovascular amyloidosis *see* **Cerebral amyloid angiopathy**

Cerumen impaction

Definition

Cerumen impaction is a condition in which earwax has become tightly packed in the external ear canal to the point that the canal is blocked.

Description

Cerumen impaction develops when earwax accumulates in the inner part of the ear canal and blocks the eardrum. It affects between 2% and 6% of the general population in the United States. Impaction does not happen under normal circumstances because cerumen is produced by glands in the outer part of the ear canal; it is not produced in the inner part. The cerumen traps sand or dust particles before they reach the ear drum. It also protects the outer part of the ear canal because it repels water. The slow movement of the outer layer of skin of the ear canal carries cerumen toward the outer opening of the ear. As the older cerumen reaches the opening of the ear, it dries out and falls away.

Causes and symptoms

Cerumen is most likely to become impacted when it is pushed against the eardrum by cotton-tipped applicators, hair pins, or other objects that people put in their ears; and when it is trapped against the eardrum by a hearing aid. Less common causes of cerumen impaction include overproduction of earwax by the glands in the ear canal, or an abnormally shaped ear canal.

The most important symptom of cerumen impaction is partial loss of hearing. Other symptoms are **itching**, **tinnitus** (noise or ringing in the ears), a sensation of fullness in the ear, and **pain**.

Diagnosis

The diagnosis of impacted cerumen is usually made by examining the ear canal and eardrum with an otoscope, an instrument with a light attached that allows the doctor to look into the canal.

Treatment

Irrigation is the most common method of removing impacted cerumen. It involves washing out the ear canal with water from a commercial irrigator or a syringe with a catheter attached. Although some doctors use Water Piks to remove cerumen, most do not recommend them because the stream of water is too forceful and may damage the eardrum. The doctor may add a small amount of alcohol, hydrogen peroxide, or other antiseptic. The water must be close to body temperature; if it is too cold or too warm, the patient may feel dizzy or nauseated. After the ear has been irrigated, the doctor will apply antibiotic ear drops to protect the ear from infection.

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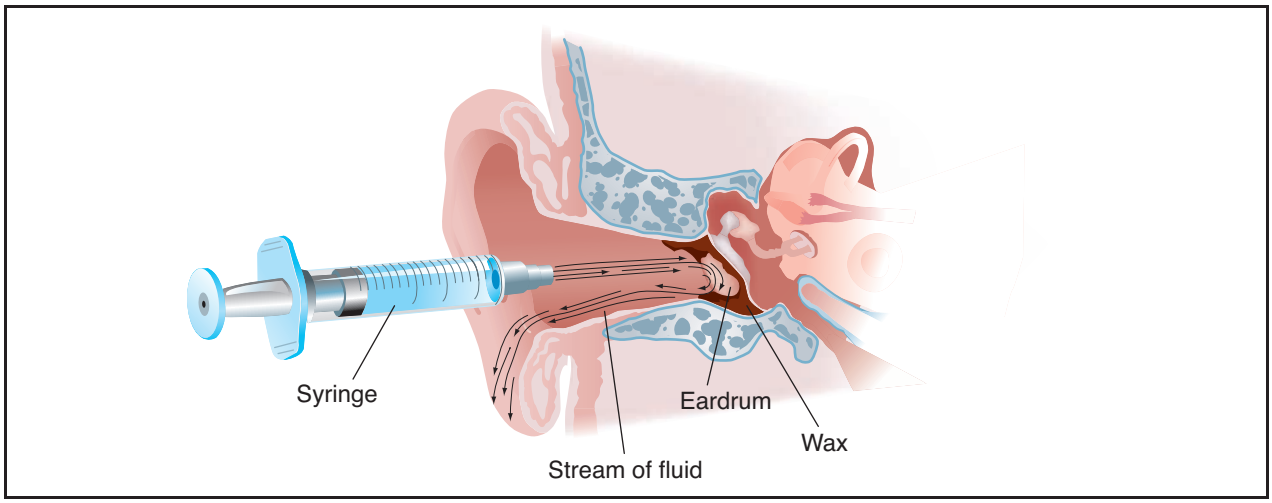

Ear wax is removed by flushing the ear canal with warm fluid. *(Illustration by Argosy, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

Irrigation should not be used to remove cerumen if the patient's eardrum is ruptured or missing; if the patient has a history of chronic **otitis media** (inflammation of the middle ear) or a **myringotomy** (cutting the eardrum to allow fluid to escape from the middle ear); or if the patient has hearing in only one ear.

If irrigation cannot be used or fails to remove the cerumen, the patient is referred to an ear, nose, and throat (ENT) specialist. The specialist can remove the wax with a vacuum device or a curette, which is a small scoop-shaped surgical instrument.

Some doctors prescribe special ear drops, such as Cerumenex, to soften the wax. The most common side effect of Cerumenex is an allergic skin reaction. Over-the-counter wax removal products include Debrox or Murine Ear Drops. A 3% solution of hydrogen peroxide may also be used. These products are less likely to irritate the skin of the ear.

Alternative treatment

One alternative method that is sometimes touted as a way to remove impacted cerumen is ear candling. Ear candling involves the insertion of a burning candle or a cone of wax-soaked linen or cotton into the affected ear. The person lies on his or her side with the affected ear uppermost. A collecting plate is placed on the ear to catch melted wax. The cone or candle is threaded through a hole in the plate into the ear canal and lit. A variation on this technique involves blowing herbal smoke into the ear through homemade pottery cones. Practitioners of ear candling claim that the heat from the burning candle or smoke creates a vacuum that draws out the impacted cerumen. Some also claim that ear candling improves hearing, relieves sinus infections, cures earache or swimmer's ear, stops tinnitus, or purifies the mind. None of these claims are true. Ear candling is not recognized as an acceptable alternative practice by naturopaths, homeopaths, practitioners of Native American medicine, or any other authority on complementary and alternative medicine.

Ear candling is not only an ineffective way to remove impacted cerumen, it can actually damage the ear. According to a 1996 survey of 122 otolaryngologists (doctors who specialize in treating ear, nose, and throat disorders) in the Spokane area, the doctors reported 21 severe ear injuries resulting from ear candling, including 13 cases of external **burns**, 7 cases of ear canal obstruction from melted candle wax, and 1 case of eardrum perforation. Ear candles cannot legally be sold as health devices in the United States because they do not have Food and Drug Administration (FDA) approval. A similar ban is in effect in Canada. Ear candles are, however, available over the Internet and in some health food stores with the labeling "for entertainment only."

Prognosis

In most cases, impacted cerumen is successfully removed by irrigation with no lasting side effects.

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KEY TERMS

Cerumen—The medical term for earwax.

Curette—A small scoop-shaped surgical instrument that can be used to remove cerumen if irrigation does not work or cannot be used.

Ear candling—An alternative method for removing impacted cerumen with a lighted hollow cone of paraffin or beeswax. It does not work, and is not considered an acceptable treatment for any ear problem or disorder.

Impaction—A condition in which earwax has become tightly packed in the outer ear to the point that the external ear canal is blocked.

Irrigation—The technique of removing cerumen from the ear canal by flushing it with water.

Myringotomy—Surgical cutting of the ear drum to allow fluid to escape from the middle ear.

Otitis media—Inflammation of the middle ear. Patients who have had recurrent otitis media should not have cerumen removed by irrigation.

Tinnitus—A sensation of noise or ringing in the ears. Tinnitus may be a symptom of cerumen impaction.

Irrigation can, however, lead to infection of the outer or the middle ear if the patient has a damaged or absent ear drum. Patients who try to remove earwax themselves with hair pins or similar objects run the risk of perforating the ear drum or damaging the fragile skin covering the ear canal, causing bleeding and the risk of infection.

Prevention

The best method of cleaning the external ear is to wipe the outer opening with a damp washcloth folded over the index finger, without going into the ear canal itself. Two techniques have been recommended to prevent cerumen from reaccumulating in the ear. The patient may place two or three drops of mineral oil into each ear once a week, allow it to remain for two or three minutes, and rinse it out with warm water; or place two drops of Domeboro otic solution in each ear once a week after showering.

Patients who wear **hearing aids** should have their ears examined periodically for signs of cerumen accumulation.

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ORGANIZATIONS

American Academy of Family Physicians (AAFP), 11400 Tomahawk Creek Parkway, Leawood, KS, 66211-2672, (913) 906-6000, (800) 274-2237, http://www.aafp.org.

American Academy of Otolaryngology, Head and Neck Surgery, One Prince St., Alexandria, VA, 22314-3357, (703) 836-4444, http://www.entnet.org.

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Cervical biopsy *see* **Cervical conization**

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Cervical cancer

Definition

Cervical **cancer** is a disease of the female reproductive system in which the cells lining the cervix (the area between the uterus body and vagina) become abnormal, start to grow uncontrollably, and form invasive tumors. Caught in its early stages, cervical cancer is highly curable; left untreated it can be fatal.

Demographics

In 2009, the American Cancer Society projected that about 11,270 new cases of invasive cervical cancer would be diagnosed in the United States, and about 4,700 American women would die from the disease. Although the median age for diagnosis of cervical cancer in the United States between 2000 and 2004 was 48, almost half of new cases of serious cervical cancer and deaths from cervical cancer are in women aged 65 and older. Rarely is cervical cancer diagnosed in women under age 20. In the United States poor and minority women have the highest rates of cervical cancer and cervical cancer deaths, most likely because they have less access to screening tests and healthcare.

Internationally, about half a million new cases of cervical cancer are diagnosed each year, at least three–quarters of which are in developing countries. In the developing world, cervical cancer is the second most common cancer in women and the third most common cause of cancer **death**, with nearly 300,000 women dying annually.

Description

There are two types of cervical cancers. They are named after type of cell that becomes cancerous. Between 80% and 90% of cervical cancers are squamous cell carcinomas. Squamous cells are thin, flat cells of the surfaces of the skin, the cervix, and linings of various organs. Squamous cell carcinoma originates in the squamous cells on the surface of the ectocervix, the part of the cervix that is next to the vagina. Most of the remaining 10–20% of cervical cancers are adenocarcinomas. This cancer originates in the mucus–producing cells of the inner cervix, or endocervix, the part of the cervix nearest the body of the uterus. Occasionally, cervical cancer may have characteristics of both types of carcinomas. This condition is called adenosquamous carcinoma or mixed carcinoma. In the United States adenocarcinomas have become increasingly common since the 1980s.

Cervical cancer usually is slow to develop. The initial abnormalities that occur in some cervical cells are not cancerous, and not every woman who has abnormal cervical cells develops cancer. The precancerous cells form a lesion called dysplasia. Dysplasia is a common condition, and the abnormal cells often disappear without treatment. Moderate to severe dysplasia may be called carcinoma in situ or non–invasive cervical cancer.

In some women, precancerous cells continue to change and become cancerous. This process often takes years, although it occasionally can happen within one year. When the abnormal cells become malignant (cancerous), they start to grow uncontrollably and invade the deeper layers of the cervix, becoming an invasive cervical cancer. Non–invasive cervical cancer is about four times more common than invasive cervical cancer.

Screening for cervical cancer is done with a **Pap test** or smear, in which cells are scraped from the cervix and examined for abnormalities under a microscope. In the United States and other developed countries, the rate of cervical cancer has declined steadily since the mid–1950s with widespread use of routine Pap tests. Because cervical cancer develops slowly, early detection makes cervical cancer highly treatable.

Risk factors

Risk factors for cervical cancer include:

- sexual intercourse before age 16
- numerous sexual partners
- sexual partners who have had many sexual partners
- giving birth to seven or more children
- smoking cigarettes
- a weakened immune system.

Diethylstilbestrol (DES), which was given to pregnant women in the United States between 1940 and 1971, may increase the risk of a rare type of cervical cancer in women who were exposed to the drug before birth.

Causes and symptoms

Infection with the human papilloma viruses (HPVs) is associated with about 90% of all cervical cancers. However, HPV infection is very common and only a small number of women with untreated HPV develop cervical cancer There are more than 80 types of HPV. About 30 of these types can be

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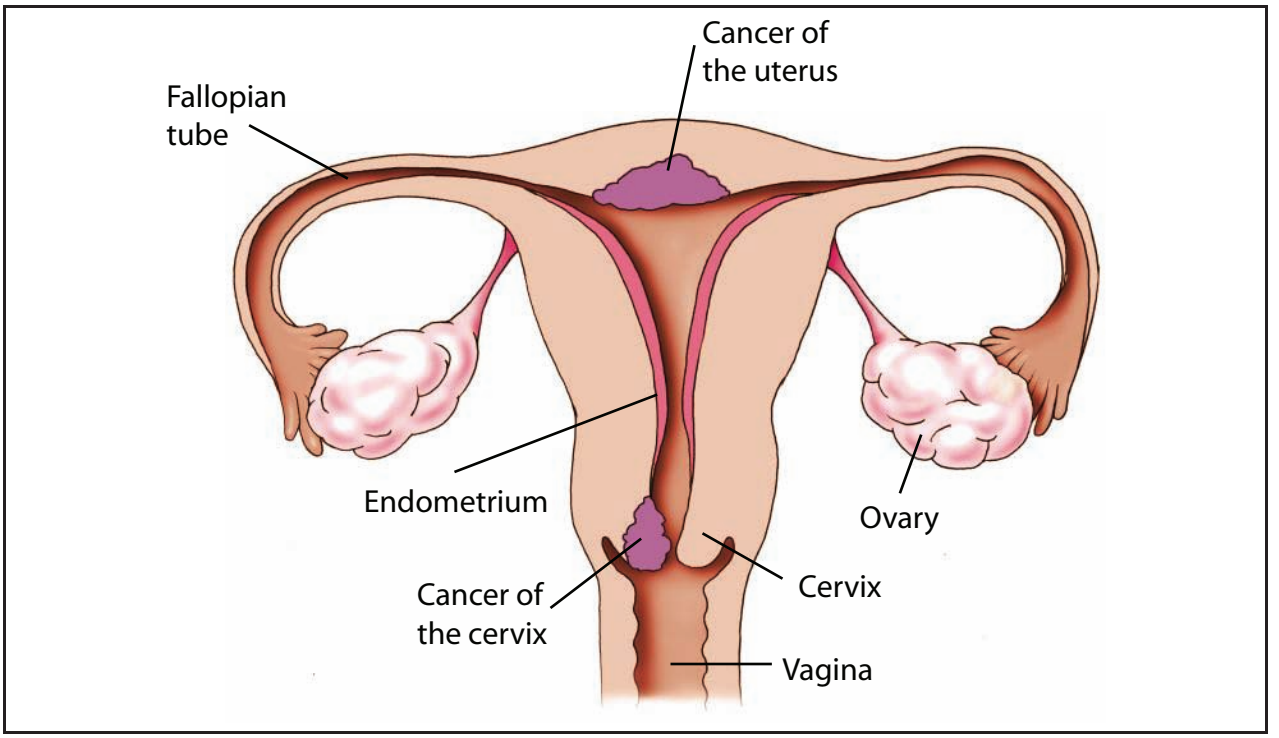

Illustrated anatomy of the female reproductive system showing cervical and uterine cancers. *(Illustration by Frank Forney. Reproduced by permission of Gale, a part of Cengage Learning.)*

transmitted sexually, including those that cause **genital warts** (papillomas). About half of sexually transmitted HPVs are associated with cervical cancer. These high–risk HPVs produce a protein that may cause cervical epithelial cells to grow uncontrollably. The virus also makes a second protein that interferes with tumor (cell growth) suppressors that are produced by the human immune system. HPV–16 or HPV–18 are associated with about 90% of invasive cervical cancers.

Although cervical cancer often has no signs or symptoms, possible signs and symptoms include:

- menstrual bleeding that is unusually prolonged or heavy
- vaginal bleeding between periods or after sexual intercourse, douching, or a pelvic exam
- bleeding after menopause
- painful sexual intercourse
- pelvic pain.

Diagnosis

Pap test

Most often, cervical cancer is first detected with a Pap test that is performed as part of a regular pelvic examination. The vagina is spread with a metal or plastic instrument called a speculum. A swab is used to remove mucus and cells from the cervix. This sample is sent to a laboratory for microscopic examination.

The Pap test is a screening tool rather than a diagnostic tool. It is very efficient at detecting cervical abnormalities. The Bethesda System commonly is used to report Pap test results. A negative test means that no abnormalities are present in the cervical tissue. A positive Pap test describes abnormal cervical cells as low–grade or high–grade squamous intraepithelial lesions (SILs), depending on the extent of dysplasia. About 5–10% of Pap tests show at least mild abnormalities. However, a number of factors other than cervical cancer can cause abnormalities, including inflammation from bacteria or yeast infections. A few months after the infection is treated, the Pap test is repeated.

Biopsy

Following an abnormal Pap test, a **colposcopy** is usually performed. The physician uses a magnifying scope to view the surface of the cervix. The cervix may be coated with an iodine solution that causes normal cells to turn brown and abnormal cells to turn white or yellow. This procedure is called a Schiller test. If any

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KEY TERMS

Adenocarcinoma—Cervical cancer that originates in the mucus–producing cells of the inner or endocervix.

Biopsy—Removal of a small sample of tissue for examination under a microscope; used for the diagnosis and treatment of cervical cancer and precancerous conditions.

Carcinoma in situ—Cancer that is confined to the cells in which it originated and has not spread to other tissues.

Cervix—The narrow, lower end of the uterus forming the opening to the vagina.

Colposcopy—Diagnostic procedure using a hollow, lighted tube (colposcope) to look inside the cervix and uterus.

Conization—Cone biopsy; removal of a cone–shaped section of tissue from the cervix for diagnosis or treatment.

Dysplasia—Abnormal cellular changes that may become cancerous.

Endocervical curettage—Biopsy performed with a curette to scrape the mucous membrane of the cervical canal.

Human papilloma virus (HPV)—A group of viruses that cause abnormal cell growth (warts or papillomas); some types can cause cervical cancer.

Hysterectomy—Removal of the uterus.

Interferon—Potent immune–defense protein produced by viral–infected cells. Manufactured interferon is used as an anticancer and antiviral drug.

Laparoscopy—Insertion of a tube through a very small surgical incision to remove tissue.

Loop electrosurgical excision procedure (LEEP)—Cone biopsy performed with a wire that is heated by electrical current.

Lymph nodes—Small, bean–shaped masses of tissue scattered along the lymphatic system that act as filters and immune monitors, removing fluids, bacteria, or cancer cells that travel through the lymph system. Cancer cells in the lymph nodes are a sign that the cancer has spread, and that it might recur.

Pelvic exenteration—Extensive surgery to remove the uterus, ovaries, pelvic lymph nodes, part or all of the vagina, and the bladder, rectum, and/or part of the colon.

Squamous cells—Thin, flat cells of the surfaces of the skin and cervix and linings of various organs.

Squamous intraepithelial lesion (SIL)—Abnormal growth of squamous cells on the surface of the cervix.

Vaginal stenosis—Narrowing of the vagina due to a build–up of scar tissue.

abnormal areas are observed, a colposcopic biopsy may be performed. A biopsy is the removal of a small piece of tissue for microscopic examination by a pathologist.

Other types of cervical biopsies may be performed. An endocervical curettage is a biopsy in which a narrow instrument called a curette is used to scrape tissue from inside the opening of the cervix. A cone biopsy, or conization, is used to remove a cone–shaped piece of tissue from the cervix. In a cold knife cone biopsy, a surgical scalpel or laser is used to remove the tissue. A loop electrosurgical excision procedure (LEEP) is a cone biopsy using a wire that is heated by an electrical current. Cone biopsies can be used to determine whether abnormal cells have invaded below the surface of the cervix. They also can be used to treat many precancers and very early cancers. Biopsies may be performed using a local or **general anesthesia**. They may cause cramping and bleeding.

Diagnosing the cancer stage

Following a diagnosis of cervical cancer, various procedures may be used to stage the disease (determine how far the cancer has spread). For example, additional pelvic exams may be performed under anesthesia.

Several procedures help to determine if cervical cancer has invaded the urinary tract. With **cystoscopy**, a lighted tube with a lens is inserted through the urethra (the urine tube from the bladder to outside the body) and into the bladder to examine these organs for cancerous cells. Tissue samples may be removed for microscopic examination by a pathologist. **Intravenous urography** (intravenous pyelogram or IVP) is an x ray of the urinary system, following the injection of special dye. The kidneys remove the dye from the bloodstream and the dye passes into the ureters (the tubes from the kidneys to the bladder) and bladder. IVP can detect a blocked ureter caused by the spread of cancer to the pelvic lymph nodes.

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A procedure called proctoscopy or **sigmoidoscopy** is similar to cystoscopy. It is used to determine whether the cancer has spread to the rectum or lower part of the large intestine.

Computed tomography (CT or CAT) scans, ultrasound, or other imaging techniques may be used to determine the spread of cancer to various parts of the body. With a CT scan, an x–ray beam rotates around the body, taking images from various angles. It is used to determine if the cancer has spread to the lymph nodes. **Magnetic resonance imaging** (MRI), which uses a magnetic field to image the body, sometimes is used for evaluating the spread of cervical cancer. Chest x rays may be used to detect cervical cancer that has spread to the lungs.

Cancer staging

The FIGO system of staging

Staging the cancer is important, as treatment depends in large part on how far the cancer has developed and spread. The International Federation of Gynecologists and Obstetricians (FIGO) system usually is used to stage cervical cancer:

- Stage 0: Carcinoma in situ; non–invasive cancer that is confined to the layer of cells lining the cervix.
- Stage I: Cancer that has spread into the connective tissue of the cervix but is confined to the uterus.
- Stage IA: Very small cancerous area that is visible only with a microscope.
- Stage IA1: Invasion area is less than 0.1 in (0.3 mm) deep and 0.3 in (7 mm) wide.
- Stage IA2: Invasion area is 0.1–0.2 in (3–5 mm) deep and less than 0.3 in (7 mm) wide.
- Stage IB: Cancer can be seen without a microscope or is deeper than 0.2 in (5 mm) or wider than 0.3 in (7 mm).
- Stage IB1: Cancer is no larger than 2 in (4 cm).
- Stage IB2: Stage IB cancer is larger than 2 in (4 cm).
- Stage II: Cancer has spread from the cervix but is confined to the pelvic region.
- Stage IIA: Cancer has spread to the upper region of the vagina, but not to the lower one–third of the vagina.
- Stage IIB: Cancer has spread to the parametrial tissue adjacent to the cervix.
- Stage III: Cancer has spread to the lower one–third of the vagina or to the wall of the pelvis and may be blocking the ureters.
- Stage IIIA: Cancer has spread to the lower vagina but not to the pelvic wall.
- Stage IIIB: Cancer has spread to the pelvic wall and/or is blocking the flow of urine through the ureters to the bladder.
- Stage IV: Cancer has spread to other parts of the body.
- Stage IVA: Cancer has spread to the bladder or rectum.
- Stage IVB: Cancer has spread to distant organs such as the lungs.
- Recurrent: Following treatment, cancer has returned to the cervix or some other part of the body.

Treatment

Sometimes cervical cancer must be treated immediately, but more often there is time to get a second opinion. In addition to the stage of the cancer, factors such as a woman's age, general health, and preferences may influence the choice of treatment. The exact location of the cancer within the cervix and the type of cervical cancer also are important considerations.

The standard treatments for cervical cancer are surgery, **radiation therapy**, and **chemotherapy**. Studies have shown that a combination of radiation therapy and chemotherapy reduces the death rate by 30–50%.

Treatment of precancer and carcinoma in situ

Most low–grade SILs that are detected with Pap tests revert to normal without treatment. Most high–grade SILs require treatment. Treatments to remove precancerous cells include:

- cold knife cone biopsy
- LEEP
- cryosurgery (freezing the cells with a metal probe)
- cauterization or diathermy (burning off the cells)
- laser surgery (burning off the cells with a laser beam)

These methods also may be used to treat cancer that is confined to the surface of the cervix (stage 0) and other early–stage cervical cancers in women who may want to become pregnant. They may be used in conjunction with other treatments. These procedures may cause bleeding or cramping. All of these treatments require close follow–up to detect any recurrence of the cancer.

Surgery

Surgical treatments include:

- conization
- LEEP
- laser surgery for a surface lesion or tumor
- cryosurgery

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- total vaginal hysterectomy (removal of the uterus and cervix through the vagina)
- total abdominal hysterectomy (removal of the uterus and cervix through a large abdominal incision)
- total laparoscopic hysterectomy (removal of the uterus and cervix with a laparoscope through a small abdominal incision)
- bilateral salpingo–oophorectomy (removal of the ovaries and fallopian tubes)
- radical hysterectomy (removal of the uterus, cervix, a portion of the vagina, and possibly the ovaries, fallopian tubes, and nearby lymph nodes)
- pelvic exenteration (removal of the uterus, cervix, ovaries, nearby lymph nodes, lower colon, rectum, and bladder, with construction of artificial openings for collecting feces and urine and possible plastic surgery to construct an artificial vagina).

Radiation

External radiation therapy uses high–energy x rays applied to the outside of the body to kill cancer cells. With internal radiation therapy thin tubes or implants containing a radioactive substance are placed in the vagina for a few hours or up to three days, two or more times over a period of several weeks.

Radiation therapy to the pelvic region can have many side effects:

- skin reaction in the area of treatment
- fatigue
- upset stomach and loose bowels
- vaginal stenosis (narrowing of the vagina due to build–up of scar tissue) leading to painful sexual intercourse
- premature menopause in young women
- problems with urination

Chemotherapy

Chemotherapy uses one or more drugs to kill cancer cells. It is used to treat disease that has spread beyond the cervix. The common drugs used for cervical cancer are cisplatin (Platinol), 5–fluorouracil (Efudex, Adrucil, Fluoroplex), ifosfamide (Ifex), paclitaxel (Taxol), and topotecan (Hycamtin). These drugs may be injected or taken by mouth.

The side effects of chemotherapy depend on a number of factors, including the type of drug, the dosage, and the length of the treatment. Side effects may include:

- nausea and vomiting
- fatigue
- changes in appetite
- hair loss (alopecia)
- mouth or vaginal sores
- infections
- menstrual cycle changes
- premature menopause
- infertility
- bleeding or anemia (low red blood cell count) With the exception of **menopause** and **infertility**, most of the side effects are temporary.

Treatment by stage

Common treatment options by stage are:

- O—conization; LEEP; laser surgery; cryosurgery; total hysterectomy for women who cannot or do not want to have children; internal radiation therapy for women who cannot have surgery
- IA—conization; total hysterectomy with or without bilateral salpingo–oophorectomy; radical hysterectomy with removal of lymph nodes; internal radiation therapy
- IB, IIA—combination internal and external radiation therapy; radical hysterectomy with removal of lymph nodes, possibly followed by radiation therapy and chemotherapy; radiation therapy plus chemotherapy
- IIB, III, IVA—internal and external radiation therapy and chemotherapy
- IVB—radiation therapy to relieve symptoms and improve quality of life; chemotherapy
- recurrent—pelvic exenteration followed by radiation therapy and chemotherapy; chemotherapy to relieve symptoms and improve quality of life.

Complementary and alternative treatment

Many complementary and alternative medicine (CAM) treatments claim to help prevent or cure various cancers. Complementary therapies are those used in addition to traditional Western medicine, while alternative therapies are used in place of conventional Western medicine. CAM treatments include **acupuncture**, bodywork therapies such as massage and **reflexology**, homeopathy, and herbal remedies used in **traditional Chinese medicine** or **Ayurvedic medicine** (traditional Indian medicine). Complementary and alternative treatment of cancer is a complicated arena. In some cases CAM is effective in relieving or reducing the symptoms associated with cancer and cancer treatment. Nevertheless, CAM treatments may interact with each other and

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with conventional treatments in ways that are not always well understood but that may alter the expected treatment results. In the United States, the National Center for Complementary and Alternative Medicine (NCCAM) within the National Institutes of Health supervises clinical trials of many CAM cancer therapies. Individuals should discuss all CAM therapies with their physician before beginning a treatment.

Certain foods, mainly vegetables, fruits, and grains, are believed by many people to offer protection against various cancers. As of 2007, the American Cancer Society (ACS) recommended a diet high in fruits, vegetables, and whole grains and low in calories and fats as the best way to maintain health. The ACS does not recommend taking mega–doses of any dietary supplements to cure or reduce the risk any cancer.

Prognosis

For cervical cancers that are diagnosed in the pre–invasive stage, the five–year–survival rate is almost 100%. When cervical cancer is detected in the early invasive stages, approximately 91% of women survive five years or more. Stage IVB cervical cancer is not considered curable. The five–year–survival rate for all cervical cancers combined is about 70%. The death rate from cervical cancer in the United States continues to decline by about 2% each year. Women over age 65 account for 40–50% of all deaths from cervical cancer.

Prevention

A vaccine introduced in 2006, Gardasil®, protects against four HPV viruses that cause 70% of cervical cancers and 90% of genital **warts**. The vaccine is most effective when given before a female becomes sexually active. It is recommended for all women ages 11–18 and may be given as young as age nine. Women ages 19–26 also may be vaccinated at the discretion of their physician. The vaccine is given in three doses over a six–month period and is covered by most health insurance programs. A second vaccine, Cervarix, was released in 2009 and protects against two types of HPV.

Since **vaccination** does not provide complete protection against all HPV viruses, sexual behaviors can put women at risk for HPV infection and cervical cancer. These behaviors include:

- sexual intercourse at age 16 or younger
- partners who began having intercourse at a young age
- multiple sexual partners
- sexual partners who have had multiple partners ("high–risk males")
- a partner who has had a previous sexual partner with cervical cancer

HPV infection may not produce any symptoms, so sexual partners may not know that they are infected. However, Pap tests can detect the infection. A DNA screening test for HPV can be done at the same time as the Pap test. **Condoms** do not necessarily prevent HPV infection.

Infection with the human **immunodeficiency** virus (HIV) that causes acquired immunodeficiency syndrome (**AIDS**) is a risk factor for cervical cancer. Women who test positive for HIV may have impaired immune systems that cannot correct precancerous conditions. Furthermore, sexual behavior that puts women at risk for HIV infection, also puts them at risk for HPV infection. There is some evidence suggesting that another sexually transmitted virus, the **genital herpes** virus, also may be involved in cervical cancer.

Smoking may double the risk of cervical cancer. Chemicals produced by tobacco smoke can damage the DNA of cervical cells. The risk increases with the number of years a woman smokes and the amount she smokes. A 2003 study also linked smoking to poorer outcomes and survivals in cervical cancer patients.

Most cases of cervical cancers are preventable, since they start with easily detectable precancerous changes. Therefore, the best prevention for cervical cancer is to have regular Pap tests. The American Cancer Society recommends that women begin having Pap tests about three years after first having sexual intercourse, but no later than 21 years of age. Women should continue screening every year with regular Pap tests until age 30. Once a woman has had three normal results in a row, she may get screened every two to three years. A doctor may suggest more frequent screening if a woman has certain risk factors for cervical cancer. Women who have had total hysterectomies including the removal of the cervix and those over age 70 who have had three normal results generally do not need to continue having Pap tests under these guidelines.

The National Breast and Cervical Cancer Early Detection Program provides free or low–cost Pap tests and treatment for women without health insurance, for older women, and for members of racial and ethnic minorities. The program is administered through

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individual states, under the direction of the Centers for Disease Control and Prevention.

Resources

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Spencer, Juliet V. *Cervical Cancer*. New York: Chelsea House, 2007.

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MedlinePlus. "Cervical Cancer." United States National Library of Medicine. June 2, 2009. http://www.nlm.nih.gov/medlineplus/cervicalcancer.html (accessed August 31, 2010).

ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd., NE, Atlanta, GA, 30329, (404) 320–3333, (800) ACS–2345, http://www.cancer.org.

American Social Health Association, National HPV and Cervical Cancer Prevention Resource Center, PO Box 13827, Research Triangle Park, NC, 27709, (919) 361–8400, (800) 227–8922, (919) 361–8425, http://www.ashastd.org/hpvccrc.

Cancer Research and Prevention Foundation, 1600 Duke Street, Suite 500, Alexandria, VA, 22314, (703) 836–4412, (800) 227–2732, info@preventcancer.org, http://www.preventcancer.org.

Gynecologic Cancer Foundation, 230 W. Monroe, Suite 2528, Chicago, IL, 60606, (312) 578–1439, (800) 444–4441, (312) 578–9769, info@thegcf.org, http://www.wcn.org/gcf.

National Cancer Institute, NCI Public Inquiries Office, 6116 Executive Blvd., Room 3036A, Bethesda, MD, 20892–8322, (800) 4–CANCER, http://www.cancer.gov.

Margaret Alic, Ph.D.
Tish Davidson, A.M.

Cervical conization

Definition

Cervical conization is both a diagnostic and treatment tool used to detect and treat abnormalities of the cervix. It is also known as a cone biopsy or cold knife cone biopsy.

Purpose

Cervical conization is performed if the results of a cervical biopsy have found a precancerous condition in the cervix. The cervix is the small cylindrical organ at the lower part of the uterus, which separates the uterus from the vagina. Cervical conization also may be performed if there is an abnormal cervical smear test (**Pap test**). A biopsy is a diagnostic test in which tissue or cells are removed from the body and examined under a microscope, primarily to look for **cancer** or other abnormalities.

Precautions

As with any operation that is performed under **general anesthesia**, the patient must not eat or drink anything for six to eight hours before surgery.

Description

The patient lies on the table with her legs raised in stirrups, similar to the position when having a Pap test. The patient is given general anesthesia, and the vagina is held open with an instrument called a speculum. Using a scalpel or laser the doctor removes a cone-shaped piece of the cervix containing the area with abnormal cells. The resulting crater is repaired by stitching flaps of tissue over the wound. Alternatively, the wound may be left open, and heat or freezing is used to stop bleeding.

Once the tissue has been removed, it is examined under a microscope for signs of cancer. If cancer is present, other tests will be needed. Surgery will be performed to remove the cervix and uterus (**hysterectomy**) and other treatments may be used as well. If the abnormal cells are precancerous, a laser can be used to destroy them.

Cold knife cone biopsy used to be the preferred treatment for removing abnormal cells in the cervix. Now, most cone biopsies are performed using **laser surgery**. Cold knife cone biopsy is generally used only for special situations. For example, if a biopsy did not remove all the abnormal cells, the cold knife cone procedure allows the physician to remove what's left.

Aftercare

An overnight stay in the hospital may be required. After the test, the patient may feel some cramps or discomfort for about a week. Women should not have sex, use tampons, or douche until after seeing their physician for a follow up appointment (a week or more after the procedure).

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KEY TERMS

Biopsy—The removal of a small piece of living tissue for examination under a microscope.

Pap test—The short term for Papanicolaou test, this procedure tests a smear of cellular material scraped from the cervix and examined under a microscope to detect abnormal cells.

Risks

Because cone biopsies carry risks such as bleeding and problems with subsequent pregnancies, they have been replaced with newer technologies except in a few circumstances.

About one in 10 women experience bleeding from the vagina about two weeks after the biopsy. There is also a slight risk of infection or perforation of the uterus. In a few women, the cervical canal becomes narrowed or completely blocked, which can later interfere with the movement of sperm. This can impair a woman's fertility.

If too much muscle tissue has been removed, the procedure can lead to an **incompetent cervix**, which can be a problem with subsequent pregnancies. An incompetent cervix cannot seal properly to maintain a **pregnancy**. If untreated, the condition increases the odds of **miscarriage** or **premature labor**.

Cervical conization also may temporarily alter cervical cells, which can make a Pap smear test hard to interpret accurately for three or four months.

Normal results

This procedure is only performed if an abnormality is known or suspected.

Abnormal results

The presence of precancerous or cancerous cells in the cervix.

ORGANIZATIONS

NCI Office of Communications and Education, 6116 Executive Blvd., Suite 300, Bethesda, MD, 20892-8322, (800) 4-CANCER (422-6237), cancergovstaff@mail.nih.gov, http://www.cancer.gov/aboutnci/cis.

Carol A. Turkington

Cervical disk disease

Definition

Cervical disk disease refers to a gradual deterioration of the spongy disks in the top part of the spine.

Description

The spine is made up of 33 bones called vertebrae separated by spongy rings of elastic material. These rings, known as disks, are often compared to shock absorbers because they help to cushion the vertebrae. Just as importantly, they also make it possible to turn the head and neck. Over time, these disks slowly become flattened and less elastic due to everyday wear and tear. When this process occurs in the disks of the neck, it is referred to as cervical disk disease. Other general terms for this process include degenerative disk disease and intervertebral disk disease.

Cervical disk disease affects everyone to some degree, often without causing any bothersome symptoms. However, this condition can also lead to specific problems related to nerve functioning. For example, the outer edge of a disk may tear, allowing the gelatinous material inside to bulge outward (**herniated disk**). This can put pressure on nerves that exit the spine. Two adjacent vertebrae may rub together (sometimes resulting in bone spurs) that can also pinch these nerves. In other cases, the inner part of the ring may push on the spinal cord itself, which passes through the disk. Any of these situations can cause **pain** and limit movement. While symptoms primarily affect the neck, they can also occur in other parts of the body.

Causes and symptoms

Cervical disk disease is a gradual process that occurs with **aging**, though poor posture, repeated lifting, and tobacco use can hasten its course. Symptoms include pain when moving the neck and limited neck movement. The condition can also affect the hand, shoulder, and arm resulting in pain, numbness/tingling, and weakness. If the spinal cord itself is affected, these symptoms may occur in the legs. Loss of bowel or bladder control may also occur.

Diagnosis

Cervical disk disease is typically diagnosed by an orthopedist or a neurologist. After taking a medical history and conducting a **physical examination**, the doctor will recommend an imaging procedure to

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KEY TERMS

Bone spur—An overgrowth of bone.

Cervical—Relating to the top part of the spine that is composed of the seven vertebrae of the neck and the disks that separate them.

Computed tomography (CT) scan—An imaging procedure that produces a three-dimensional picture of organs or structures inside the body.

Magnetic resonance imaging—A type of imaging that uses magnetic fields to generate a picture of internal structures.

Myelography—An imaging procedure involving the injection of a radioactive dye into the fluid surrounding the spine. A myelography can be used to detect herniated disks, nerve root damage, and other problems affecting the cervical spine.

Neurologist—A doctor who specializes in disorders of the brain and central nervous system.

Orthopedist—A doctor who specializes in disorders of the musculoskeletal system.

gather more information about the nature of the problem. This may include a CT scan, an MRI, or **myelography**. In addition, an electromyogram (EMG) may be used to evaluate the functioning of nerves in the arms, hands, or legs. Cervical disk disease is typically covered by medical insurance.

Treatment

Treatment usually involves **physical therapy**, several weeks of drug therapy with **nonsteroidal anti-inflammatory drugs** (NSAIDs), and limited use of a cervical collar (to reduce neck movement). Neck **traction** and **heat treatments** may also be recommended. In some cases, **steroids** or anesthetic drugs may be injected into the spinal canal to help alleviate symptoms. Aside from these measures, maintaining good posture and placing a pillow under the neck and head during sleep can be helpful. Treatment may last anywhere from several weeks to three months or more. Neck surgery is not usually advised unless other therapies have failed.

Alternative treatment

Acupuncture, therapeutic massage, and **yoga** are believed by some practitioners of alternative medicine to have generalized pain-relieving effects. However, any therapy that involves manipulating the neck is not recommended and be approved by primary doctor beforehand.

Prognosis

In most people symptoms go away within three months if not sooner. A smaller number may require surgery to correct the problem.

Prevention

While some degree of disk degeneration is inevitable, people can reduce their risk by practicing good posture (during sitting, standing, and lifting), performing neck-stretching exercises, maintaining an ideal weight, and quitting **smoking**.

ORGANIZATIONS

American Academy of Orthopaedic Surgeons, 6300 North River Road, Rosemont, IL, 60018-4262, (847) 823-7186, (847) 823-8125, pemr@aaos.org, http://www.aaos.org.

Greg Annussek

Cervical osteoarthritis *see* **Cervical spondylosis**

Cervical spondylosis

Definition

Cervical spondylosis refers to common age-related changes in the area of the spine at the back of the neck. With age, the vertebrae (the component bones of the spine) gradually form bone spurs, and their shock-absorbing disks slowly shrink. These changes can alter the alignment and stability of the spine. They may go unnoticed, or they may produce problems related to pressure on the spine and associated nerves and blood vessels. This pressure can cause weakness, **numbness**, and **pain** in various areas of the body. In severe cases, walking and other activities may be compromised.

Description

As it runs from the brain down the back, the spinal cord is protected by ringlike bones, called vertebrae, stacked one upon the other. The vertebrae are not in direct contact with one another, however. The intervening spaces are filled with structures called disks. The disks are made up of a tough, fibrous outer tissue with an inner core of elastic or gel-like tissue.

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One of the most important functions of disks is protecting the vertebrae and the nerves and blood vessels between the vertebrae. The disks also lend flexibility to the spinal cord, facilitating movements such as turning the head or bending the neck. As people age, disks gradually become tougher and more unyielding. Disks also shrink with age, which reduces the amount of padding between the vertebrae.

As the amount of padding shrinks, the spine loses stability. The vertebrae react by constructing osteophytes, commonly known as bone spurs. There are seven vertebrae in the neck; development of osteophytes on these bones is sometimes called cervical **osteoarthritis**. Osteophytes may help to stabilize the degenerating backbone and help protect the spinal cord.

By age 50, 25–50% of people develop cervical spondylosis; by 75 years of age, it is seen in at least 70% of people. Although shrunken vertebral disks, osteophyte growth, and other changes in their cervical spine may exist, many of these people never develop significant problems.

However, about 50% of people over age 50 experience neck pain and stiffness due to cervical spondylosis. Of these people, 25–40% have at least one episode of cervical radiculopathy, a condition that arises when osteophytes compress nerves between the vertebrae. Another potential problem occurs if osteophytes, degenerating disks, or shifting vertebrae narrow the spinal canal. This pressure compresses the spinal cord and its blood vessels, causing cervical spondylitic myelopathy, a disorder in which large segments of the spinal cord are damaged. This disorder affects fewer than 5% of people with cervical spondylosis. Symptoms of both cervical spondylitic myelopathy and cervical radiculopathy may be present in some people.

Causes and symptoms

As people age, shrinkage of the vertebral disks prompts the vertebrae to form osteophytes to stabilize the back bone. However, the position and alignment of the disks and vertebrae may shift despite the osteophytes. Symptoms may arise from problems with one or more disks or vertebrae.

Osteophyte formation and other changes do not necessarily lead to symptoms, but after age 50, half of the population experiences occasional neck pain and stiffness. As disks degenerate, the cervical spine becomes less stable, and the neck is more vulnerable to injuries, including muscle and ligament strains. Contact between the edges of the vertebrae can also cause pain. In some people, this pain may be referred–that is, perceived as occurring in the head, shoulders, or chest, rather than the neck. Other symptoms may include vertigo (a type of **dizziness**) or ringing in the ears.

The neck pain and stiffness can be intermittent, as can symptoms of radiculopathy. Radiculopathy refers to compression on the base, or root, of nerves that lead away from the spinal cord. Normally, these nerves fit comfortably through spaces between the vertebrae. These spaces are called intervertebral foramina. As the osteophytes form, they can impinge on this area and gradually make the fit between the vertebrae too snug.

The poor fit increases the chances that a minor incident, such as overdoing normal activities, may place excess pressure on the nerve root, sometimes referred to as a pinched nerve. Pressure may also accumulate as a direct consequence of osteophyte formation. The pressure on the nerve root causes severe shooting pain in the neck, arms, shoulder, and/or upper back, depending on which nerve roots of the cervical spine are affected. The pain is often aggravated by movement, but in most cases, symptoms resolve within four to six weeks.

Cervical spondylosis can cause cervical spondylitic myelopathy through stenosis- or osteophyte-related pressure on the spinal cord. **Spinal stenosis** is a narrowing of the spinal canal—the area through the center of the vertebral column occupied by the spinal cord. Stenosis occurs because of misaligned vertebrae and out-of-place or degenerating disks. The problems created by spondylosis can be exacerbated if a person has a naturally narrow spinal canal. Pressure against the spinal cord can also be created by osteophytes forming on the inner surface of vertebrae and pushing against the spinal cord. Stenosis or osteophytes can compress the spinal cord and its blood vessels, impeding or choking off needed nutrients to the spinal cord cells; in effect, the cells starve to **death**.

With the death of these cells, the functions that they once performed are impaired. These functions may include conveying sensory information to the brain or transmitting the brain's commands to voluntary muscles. Pain is usually absent, but a person may experience leg numbness and an inability to make the legs move properly. Other symptoms can include clumsiness and weakness in the hands, stiffness and weakness in the legs, and spontaneous twitches in the legs. A person's ability to walk is affected, and a wide-legged, shuffling gait is sometimes adopted to compensate for the lack of sensation in the legs and the

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accompanying, realistic fear of falling. In very few cases, bladder control becomes a problem.

Diagnosis

Cervical spondylosis is often suspected based on the symptoms and their history. Careful neurological examination can help determine which nerve roots are involved, based on the location of the pain and numbness, and the pattern of weakness and changes in reflex responses. To confirm the suspected diagnosis, and to rule out other possibilities, imaging tests are ordered. The first test is an x ray. X rays reveal the presence of osteophytes, stenosis, constricted space between the vertebrae, and misalignment in the cervical spine–in short, an x ray confirms that a person has cervical spondylosis. To demonstrate that the condition is causing the symptoms, more details are needed. Other imaging tests, such as **magnetic resonance imaging** (MRI) and computed tomography **myelography**, help assess effects of cervical spondylosis on associated nerve tissue and blood vessels.

An MRI may be preferred, because it is a noninvasive procedure and does not require injecting a contrast medium as does computed tomography myelography. MRIs also have greater sensitivity for detecting disk problems and spinal cord involvement, and the test allows the physician to create images of a larger area from various angles. However, these images may not show enough detail about the vertebrae themselves. Computed tomography myelography yields a superior image of the bones involved in cervical spondylosis. Added benefits include that it takes less time to perform and tends to be less expensive than an MRI. A good diagnosis may be reached with either a computed tomography myelography or an MRI, but sometimes complementary information from both tests is necessary. Nerve conduction velocity, electromyogram (EMG), and/or somatosensory evoked potential testing may help to confirm which nerve roots are involved.

Treatment

When possible, conservative treatment of symptoms is preferred. Conservative treatment begins with rest–either restricting normal activities to a less strenuous level or bed rest for three to five days. If rest is not adequate to relieve symptoms, a cervical orthosis may be prescribed, such as a soft cervical collar or stiffer neck brace to restrict neck movement and shift some of the head's weight from the neck to the shoulders. Cervical **traction** may also be suggested, either at home with the advice of a physical therapist or in a health-care setting.

Pain is treated with **nonsteroidal anti-inflammatory drugs**, such as **aspirin** or ibuprofen. If these drugs are ineffective, a short-term prescription for **corticosteroids** or **muscle relaxants** may be given. For chronic pain, **tricyclic antidepressants** can be prescribed. Although these drugs were developed to treat depression, they are also effective in treating pain. Once any pain is resolved, exercises to strengthen neck muscle and preserve flexibility are prescribed.

If the pain is severe, a short treatment of epidural corticosteroids may be prescribed with discretion. A corticosteroid such as prednisone can be combined with an anaesthetic and injected with a long needle into the space between the damaged disk and the covering of the nerve and spinal cord. Injection into the cervical epidural space relieves severe pain that is not managed with conventional treatment. Frequent use of this treatment is not medically recommended and is used only if the more conservative therapy is not effective.

If pain is continuous and does not respond to conservative treatment, surgery may be suggested. Surgery is usually not recommended for neck pain, but it may be necessary to address radiculopathy and myelopathy. Surgery is particularly recommended for people who have already developed moderate to severe symptoms of myelopathy, although age or poor health may prohibit that recommendation. The specific details of the surgery depend on the structures involved, but the overall goal is to relieve pressure on the nerve root, spinal cord, or blood vessels and to stabilize the spine.

Alternative treatment

Alternative therapy is not meant to replace conventional medical treatment, but it can be a useful adjunct. Its main roles are to relieve tension, manage pain, and strengthen neck and back muscles. Massage is one way to relieve tension, and **yoga** provides the additional benefit of strengthening muscles. **Chiropractic** and **acupuncture** have been reported to relieve the pain associated with disk problems, although great care needs to be taken to avoid exacerbating them. Practitioners of the **Alexander technique** or the **Feldenkrais method** can provide

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KEY TERMS

Alexander technique—A technique developed by Frederick Alexander that focuses on the variations in body posture, muscles, and breathing. Defects in these functions can lead to stress, nervous tension or possible loss of function.

Bone spur—Also called an osteophyte, it is an outgrowth or ridge that forms on a bone.

Cervical—Referring to structures within the neck.

Computed tomography myelography—This medical procedure combines aspects of computed tomography scanning and plain-film myelography. A CT scan is an imaging technique in which cross-sectional x rays of the body are compiled to create a three-dimensional image of the body's internal structures. Myelography involves injecting a water-soluble substance into the area around the spine to make it visible on x rays. In computed tomography myelography or CT myelography, the water-soluble substance is injected, but the imaging is done with a CT scan.

Disk—A ringlike structure that fits between the vertebrae in the spine to protect the bones, nerves, and blood vessels. The outer layer is a tough, fibrous tissue, and the inner core is composed of more elastic tissue.

Feldenkrais method—A therapy based on creating a good self image by correction and improvements of body movements.

Magnetic resonance imaging (MRI)—An imaging technique that uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

Myelopathy—A disorder in which the tissue of the spinal cord is diseased or damaged.

Orthosis—An external device, such as a splint or a brace, that prevents or assists movement.

Osteophyte—Also referred to as bone spur, it is an outgrowth or ridge that forms on a bone.

Radiculopathy—Sometimes referred to as a pinched nerve, it refers to compression of the nerve root–the part of a nerve between vertebrae. This compression causes pain to be perceived in areas to which the nerve leads.

Spine—A term for the backbone that includes the vertebrae, disks, and spinal cord as a whole.

Stenosis—A condition in which a canal or other passageway in the body is constricted.

Traction—A medical treatment that exerts a pulling or extending force. Used for cervical problems, it relieves pressure on structures between the vertebrae and muscular tension.

Vertebrae—The ringlike component bones of the spine.

instruction on correct posture and **exercise** that may help prevent further symptoms. Vitamin and mineral supplementation along with herbal therapies and homeopathy can help build and rebalance the weakened structure.

Prognosis

The gradual progression of cervical spondylosis cannot be stopped; however, it doesn't always cause symptoms. For the individuals who do experience problems, conservative treatment is very effective in managing the symptoms. Nearly all people with neck pain, approximately 75% of persons with radiculopathy, and up to 50% of people with myelopathy find relief through therapy alone. For the remaining people with radiculopathy or myelopathy, surgery may be recommended. Surgery is deemed successful in 70–80% of cases.

Prevention

Since cervical spondylosis is part of the normal **aging** process, not much can be done to prevent it. It may be possible to ward off some or all of the symptoms by engaging in regular physical exercise and limiting occupational or recreational activities that place pressure on the head, neck, and shoulders. The best exercises for the health of the cervical spine are non-contact activities, such as swimming, walking, or yoga. Once symptoms have already developed, the emphasis is on symptom management rather than prevention.

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Julia Barrett

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Cervicitis

Definition

Cervicitis is an inflammation of the cervix.

Description

Cervicitis is a inflammation of the cervix (the opening into the uterus). This inflammation can be chronic and may or may not have an identified cause.

Causes and symptoms

The most common cause of cervicitis is infection, either local or as a result of various **sexually transmitted diseases**, such as chlamydia or **gonorrhea**. Cervicitis can also be caused by birth control devices such as a cervical cap or diaphragm, or chemical exposure. Other risk factors include multiple sexual partners or cervical trauma following birth. In postmenopausal women, cervicitis is sometimes related to a lack of estrogen.

Although a woman may not notice any signs of infection, symptoms of cervicitis include the following:

- persistent unusual vaginal discharge
- abnormal bleeding, either between periods or following sexual intercourse
- painful sexual intercourse
- vaginal pain
- frequent need to urinate
- burning or itching in the vaginal area

Diagnosis

The standard method of diagnosing cervicitis is through a pelvic examination or a Pap smear. During the **pelvic exam**, the physician usually swabs the affected area, and then sends the tissue sample to a laboratory. The laboratory tries to identify the specific organism responsible for causing the cervicitis. A biopsy to take a sample of tissue from the affected area is sometimes required in order to rule out **cancer**. **Colposcopy**, a procedure used to look at the cervix under a microscope, may also be used to rule out cancer.

Treatment

The first course of treatment for cervicitis is usually **antibiotics**. If these medicines do not cure the cervicitis, other treatment options include:

- Loop Electrosurgical Excision Procedure (LEEP)
- cryotherapy
- electrocoagulation
- laser treatment

KEY TERMS

Cryotherapy—Freezing the affected tissue.

Electrocoagulation—Using electrical current to cauterize the affected tissue.

LEEP—Loop Electrosurgical Excision Procedure.

Prognosis

Cervicitis will usually be cured when the course of therapy is complete. Severe cases, however, may last for a few months, even after the therapy is complete. If the cervicitis was caused by a sexually transmitted disease, both partners should be treated with medication.

Prevention

Practicing safe sexual behavior, such as monogamy, is one way of lowering the prevalence of cervicitis. In addition, women who began sexual activity at a later age have been shown to have a lower incidence of cervicitis. Another recommendation is to use a latex condom consistently during intercourse. If the cervicitis is caused by any sexually transmitted disease, the patient is advised to notify all sexual partners.

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American College of Obstetricians and Gynecologists (ACOG), PO Box 96920, Washington, DC, 20090-6920, (202) 638-5577, http://www.acog.org.

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Cesarean section

Definition

A cesarean section is a surgical procedure in which incisions are made through a woman's abdomen and uterus to deliver her baby.

Purpose

Cesarean sections, also called c-sections or cesarean deliveries, are performed whenever abnormal conditions complicate labor and vaginal delivery, threatening the life or health of the mother or the baby. Dystocia, or difficult labor, is the other common cause of c-sections. According the National Center for Health Statistics, about 32%, or more than 1.4 million babies were delivered by cesarean section in the United States in 2007. The procedure is often used in cases where the mother has had a previous c-section.

The most common reason for performing cesarean section is that the woman has had a previous c-section. The "once a cesarean, always a cesarean" rule originated when the uterine incision was made vertically (termed a classical incision); the resulting scar was weak and had a risk of rupturing in subsequent deliveries. Today, the incision is usually made horizontally across the lower end of the uterus (called a low transverse incision), resulting in reduced blood loss and a decreased chance of rupture. This kind of incision allows many women to have a vaginal birth after a cesarean (VBAC).

The second most common reason that a c-section is performed is difficult **childbirth** due to non-progressive labor (dystocia). Difficult labor is commonly caused by one of the three following conditions: abnormalities in the mother's birth canal; abnormalities in the position of the fetus; or abnormalities in the labor, including weak or infrequent contractions. The mother's pelvic structure may not allow adequate passage for birth. When the baby's head is too large to fit through the pelvis, the condition is called cephalopelvic disproportion (CPD).

About 12% of c-sections are performed to deliver a baby in a breech presentation (buttocks or feet first). Breech presentation is found in about 3% of all births.

In about 9% of cases, c-sections are performed in response to fetal distress, which refers to any situation that threatens the baby such as the umbilical cord wrapped around the baby's neck. This may appear on the fetal heart monitor as an abnormal heart rate or rhythm. Fetal brain damage can result from oxygen deprivation. Fetal distress is often related to abnormalities in the position of the fetus or abnormalities in the birth canal, causing reduced blood flow through the placenta.

Other serious conditions may indicate the need for a cesarean section. One is prolapse of the umbilical cord; the cord is pushed into the vagina ahead of the baby and becomes compressed, cutting off blood flow to the baby. Another is **placental abruption**, whereby the placenta separates from the uterine wall before the baby is born, cutting off blood flow to the baby. The risk of this is especially high in multiple births (twins, triplets, etc.). A third factor is **placenta previa**, in which the placenta covers the cervix partially or completely, making vaginal delivery impossible. In some cases requiring c-section, the baby is in a transverse position, lying horizontally across the pelvis, perhaps with a shoulder in the birth canal.

The mother's age or health may make delivery by c-section the safer choice, especially in cases of maternal diabetes, **hypertension**, **genital herpes**, malignancies of the genital tract, and **preeclampsia** (high blood pressure related to **pregnancy**).

Choosing cesarean section

The incidence of cesarean section has increased greatly in the United States, rising from 21% in the 1990s to 32% in the 2000s. The greatest percentage increase is in cesarean sections that arise less from medical need and more from changes in obstetrical practice. This has occurred despite studies showing that babies born by cesarean section are at higher risk for neonatal complications.

There are a number of reasons why a woman and her obstetrician might choose a c-section in the absence of the usual indications. These include:

- Convenience. A scheduled c-section would allow a woman to choose the time and date of delivery to avoid conflicting with work or family obligations.
- Fear of childbirth. A woman might fear the pain of labor and delivery and feel that a scheduled c-section would allow her to circumvent it.
- Avoiding risks of vaginal delivery. Certain risks inherent to vaginal delivery (urinary or rectal incontinence, sexual dysfunction, dystocia) are

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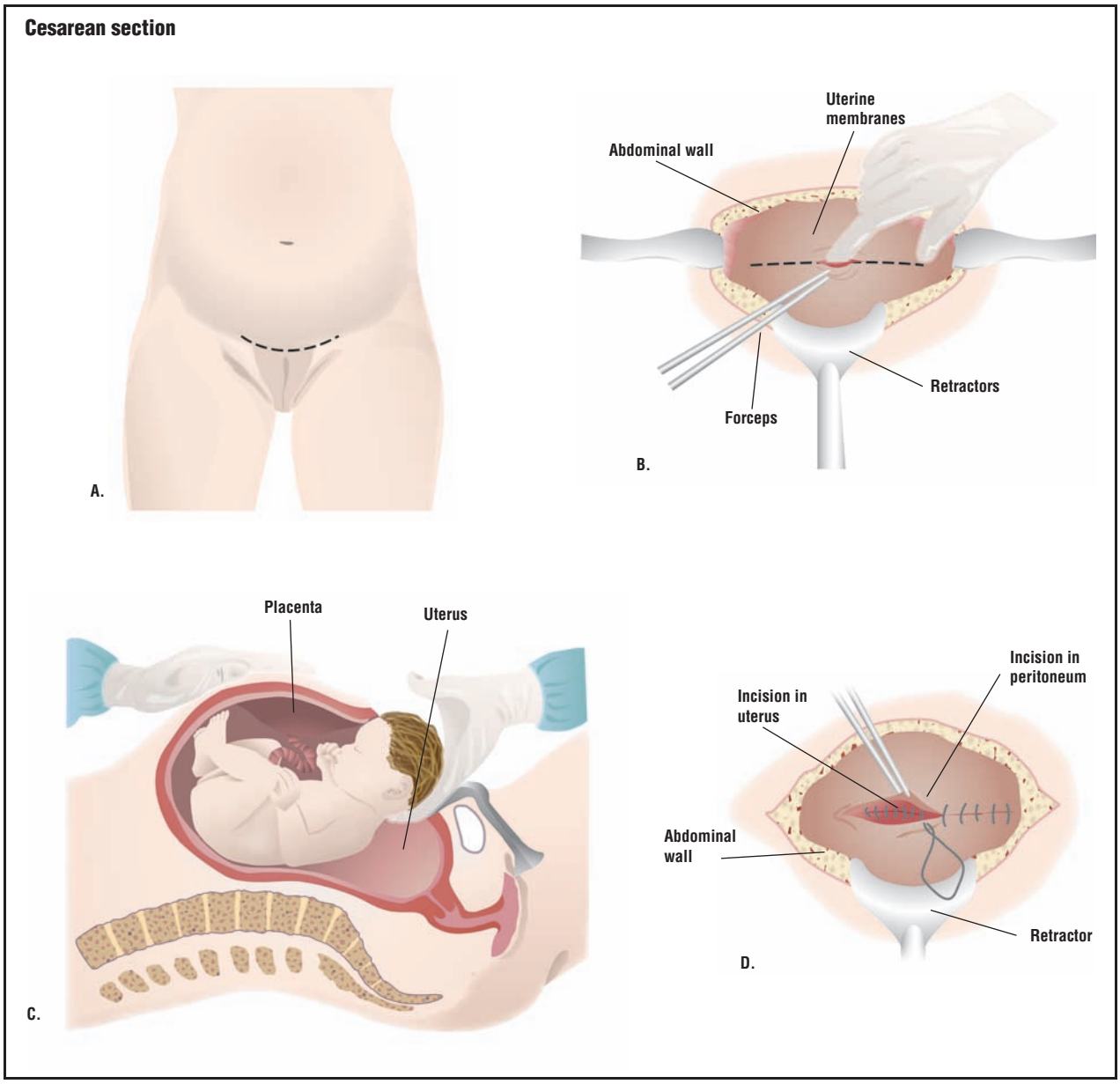

To remove a baby by cesarean section, an incision is made into the abdomen, usually just above the pubic hairline (A). The uterus is located and divided (B), allowing for delivery of the baby (C). After all the contents of the uterus are removed, the uterus is repaired and the rest of the layers of the abdominal wall are closed (D). *(Illustration by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)*

avoided in a c-section. On the other hand, risks also exist with a cesarean section.

Demographics

Women of higher socioeconomic status are more likely to have a c-section than women who live in low-income families. C-section rates are highest among non-Hispanic white women, followed in decreasing order by Asian American women, African American women, and Hispanic women.

Internationally there is a large variation in the incidence of cesarean section. In most of the well-developed world, the rate is about 21% of births. In less-developed countries, the rate is around 14% and in still developing countries where medical care is limited, the rate drops to about 2%. Internationally, the type of health care provided also affects the rate of

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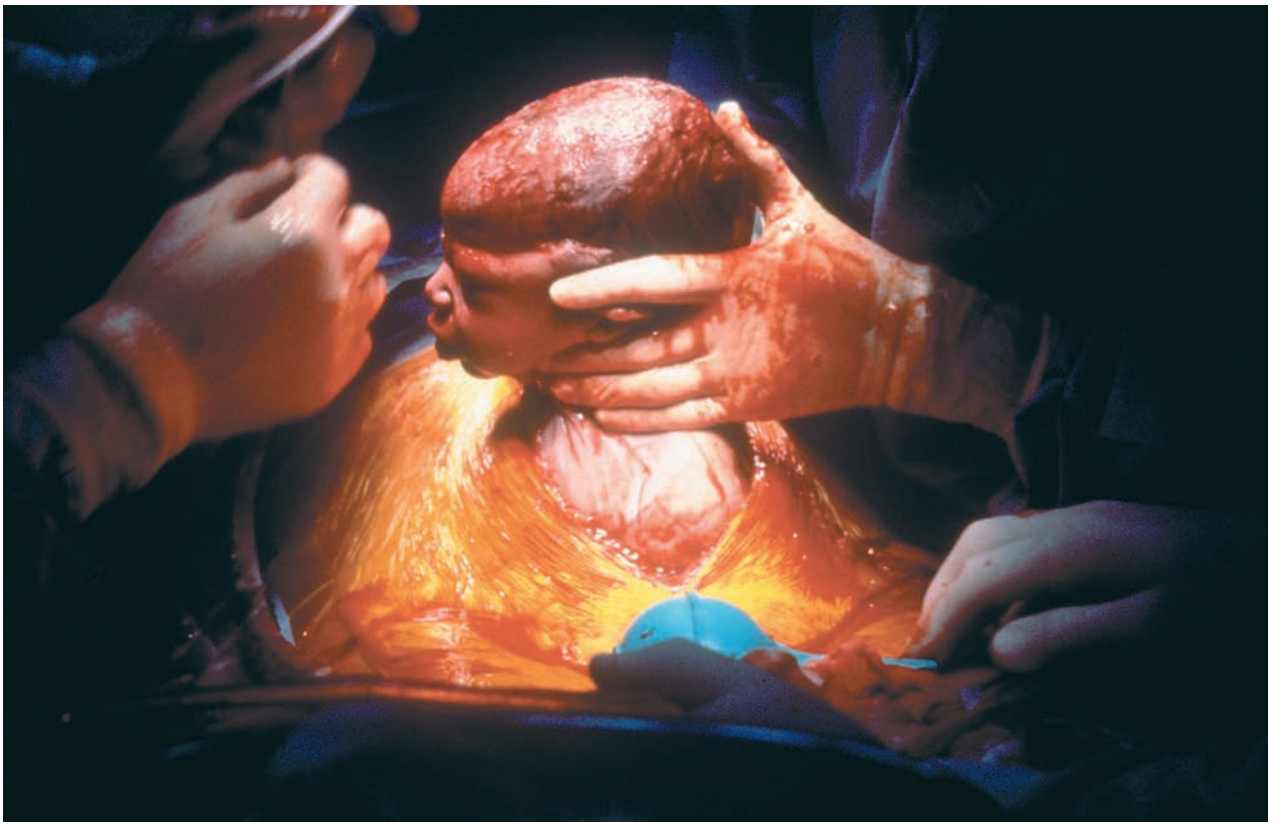

This baby is being delivered by cesarean section. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

this procedure. For example, in South America, the rate of cesarean sections among women who receive public health care is about 28% compared to a rate of 75% for those who have private health care.

Description

Regional anesthesia, either a spinal or epidural, is the preferred method of **pain** relief during a c-section. The benefits of regional anesthesia include allowing the mother to be awake during the surgery, avoiding the risks of **general anesthesia**, and allowing early contact between mother and child. Spinal anesthesia involves inserting a needle into a region between the vertebrae of the lower back and injecting numbing medications. An epidural is similar to a spinal except that a catheter is inserted so that numbing medications may be administered continuously. Some women experience a drop in blood pressure when a regional anesthetic is administered; this can be countered with fluids and/or medications.

In some instances, use of general anesthesia may be indicated. General anesthesia can be administered more rapidly in the case of an emergency (e.g., severe fetal distress). If the mother has a coagulation (blood clotting) disorder that would be complicated by a drop in blood pressure (a risk with regional anesthesia), general anesthesia is an alternative. A major drawback of general anesthesia is that the procedure carries with it certain risks such as pulmonary aspiration and failed intubation. The baby may also be affected by anesthetics since they cross the placenta; this effect is generally mild if delivery occurs within 10 minutes after anesthesia is administered.

Once the patient has received anesthesia, the abdomen is washed with an antibacterial solution, and a portion of the pubic hair may be shaved. The first incision opens the abdomen. Infrequently, it will be vertical from just below the navel to the top of the pubic bone or, more commonly, it will be a horizontal incision across and above the pubic bone (informally called a "bikini cut").

The second incision opens the uterus. In most cases, a transverse incision is made. This is the favored type because it heals well and makes it possible for a woman to attempt a vaginal delivery in the future. The classical incision is vertical. Because it provides a larger

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KEY TERMS

Breech presentation—The condition in which the baby enters the birth canal with its buttocks or feet first.

Cephalopelvic disproportion (CPD)—The condition in which the baby's head is too large to fit through the mother's pelvis.

Classic incision—In a cesarean section, an incision made vertically along the uterus.

Dystocia—Failure to progress in labor, either because the cervix will not dilate (expand) further or (after full dilation) the head does not descend through the mother's pelvis.

Hematoma—A collection of blood localized to an organ, tissue, or space of the body.

Low transverse incision—Incision made horizontally across the lower end of the uterus.

Placenta previa—The placenta totally or partially covers the cervix, preventing vaginal delivery.

Placental abruption—Separation of the placenta from the uterine wall before the baby is born, cutting off blood flow to the baby.

Preeclampsia—A pregnancy-related condition that causes high blood pressure and swelling.

Prolapsed cord—The umbilical cord is pushed into the vagina ahead of the baby and becomes compressed, cutting off blood flow to the baby.

Respiratory distress syndrome (RDS)—Difficulty breathing; found in infants with immature lungs.

Transverse presentation—The baby is laying sideways across the cervix instead of head first.

VBAC—Vaginal birth after cesarean.

opening than a low transverse incision, it is used in the most critical situations such as placenta previa. However, the classic incision causes more bleeding, a greater risk of abdominal infection, and a weaker scar.

Once the uterus is opened, the amniotic sac is ruptured, and the baby is delivered. The time from the initial incision to birth is typically five minutes. The umbilical cord is clamped and cut, and the newborn is evaluated. The placenta is removed from the mother, and her uterus and abdomen are stitched closed (surgical staples may be used instead in closing the outermost layer of the abdominal incision). From birth through suturing may take 30–40 minutes; the entire surgical procedure may be performed in less than one hour.

Diagnosis/Preparation

There are several ways that obstetricians and other doctors diagnose conditions that may make a c-section necessary. Ultrasound testing reveals the positions of the baby and the placenta and may be used to estimate the baby's size and gestational age. Fetal heart monitors, in use since the 1970s, transmit any signals of fetal distress. Oxygen deprivation may be determined by checking the amniotic fluid for meconium (feces); a lack of oxygen may cause an unborn baby to defecate. Oxygen deprivation may also be determined by testing the pH of a blood sample taken from the baby's scalp; a pH of 7.25 or higher is normal, between 7.2 and 7.25 is suspicious, and below 7.2 is a sign of trouble.

When a c-section becomes necessary, the mother is prepped for surgery. A catheter is inserted into her bladder and an intravenous (IV) line is inserted into her arm. Leads for monitoring the mother's heart rate, rhythm, and blood pressure are attached. In the operating room, the mother is given anesthesia, usually a regional anesthetic (epidural or spinal), making her numb from below her breasts to her toes. In some cases, a general anesthetic will be administered. Surgical drapes are placed over the body, except the head; these drapes block the direct view of the procedure.

Aftercare

A woman who undergoes a c-section requires both the care given to any new mother and the care given to any patient recovering from major surgery. She should be offered pain medication that does not interfere with **breastfeeding**. She should be encouraged to get out of bed and walk around eight to 24 hours after surgery to stimulate circulation (thus avoiding the formation of **blood clots**) and bowel movement. She should limit climbing stairs to once a day, and avoid lifting anything heavier than the baby. She should nap as often as the baby sleeps, and arrange for help with the housework, meals, and care of other children. She may resume driving after two weeks, although some doctors recommend waiting for six weeks, the typical recovery period from major surgery.

The aftereffects of a c-section vary, depending on the woman's age, physical fitness, and overall health. Following this procedure, a woman commonly experiences gas pains, incision pain, and uterine contractions (also common in vaginal delivery). Her hospital stay may be two to four days. Breastfeeding the baby is encouraged, taking care that it is in a position that keeps the baby from resting on the mother's incision.

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As the woman heals, she may gradually increase appropriate exercises to regain abdominal tone. Full recovery may be achieved in four to six weeks.

Risks

Because a c-section is a surgical procedure, it carries more risk to both the mother and the baby. The maternal **death** rate is less than 0.02%, but that is four times the maternal death rate associated with vaginal delivery. Complications occur in less than 10% of cases.

The mother is at risk for increased bleeding (a c-section may result in twice the blood loss of a vaginal delivery) from the two incisions, the placental attachment site, and possible damage to a uterine artery. The mother may develop infection of the incision, the urinary tract, or the tissue lining the uterus (endometritis); infections occur in approximately 7% of women after having a c-section. Less commonly, she may receive injury to the surrounding organs such as the bladder and bowel. When a general anesthesia is used, she may experience complications from the anesthesia. Very rarely, she may develop a wound hematoma at the site of either incision or other blood clots leading to pelvic **thrombophlebitis** (inflammation of the major vein running from the pelvis into the leg) or a pulmonary embolus (a blood clot lodging in the lung).

Undergoing a c-section may also inflict psychological distress on the mother, beyond hormonal mood swings and **postpartum depression** ("baby blues"). The woman may feel disappointment and a sense of failure for not experiencing a vaginal delivery. She may feel isolated if the father or birthing coach is not with her in the operating room, or if an unfamiliar doctor treats her rather than her own doctor or midwife. She may feel helpless from a loss of control over labor and delivery with no opportunity to actively participate. To overcome these feelings, the woman must understand why the c-section was necessary. She must accept that she could not control the unforeseen events that made the c-section the optimum means of delivery, and recognize that preserving the health and safety of both her and her child was more important than her delivering vaginally. Women who undergo a c-section should be encouraged to share their feelings with others. Hospitals can often recommend support groups for such mothers. Women should also be encouraged to seek professional help if negative emotions persist.

Babies born by cesarean section have an increased risk of breathing problems, especially if they are delivered before 39 weeks of pregnancy.

The prognosis for a successful vaginal birth after a cesarean (VBAC) may be at least 75%, especially when the c-section involved a low transverse incision in the uterus and there were no complications during or after delivery. However, very few American women attempt to give birth vaginally after a cesarean delivery.

Morbidity and mortality rates

Surgical injuries to the ureter or bowel occur in approximately 0.1% of c-sections. The risk of infection to the incision ranges from 2.5% to 15%. Urinary tract infections occur in 2–16% of patients post-c-section. The risk for developing a deep-vein thrombosis is three to five times higher in patients undergoing c-section than vaginal delivery.

Of the hundreds of thousands of women in the United States who undergo a c-section each year, about 500 die from serious infections, hemorrhaging, or other complications. The overall maternal mortality rate is estimated to be between 6 and 22 deaths per 100,000 births; approximately one-third of maternal deaths that occur after c-section can be attributed to the procedure. These deaths may be related to the health conditions that made the operation necessary, and not simply to the operation itself.

Special considerations

When a c-section is being considered because labor is not progressing, the mother should first be encouraged to walk around to stimulate labor. Labor may also be stimulated with the drug oxytocin. A woman should receive regular prenatal care and be able to alert her doctor to the first signs of trouble. Once labor begins, she should be encouraged to move around and to urinate. The doctor should be conservative in diagnosing dystocia and fetal distress, taking a position of "watchful waiting" before deciding to operate.

Approximately 3% of babies present at term in the breech position. Before opting to perform an elective c-section, the doctor may first attempt to reposition the baby; this is called external cephalic version. The doctor may also try a vaginal breech delivery, depending on the size of the mother's pelvis, the size of the baby, and the type of breech position the baby is in. However, a c-section is safer than a vaginal delivery when the baby is 8 lb (3.6 kg) or larger, in a breech position with the feet crossed, or in a breech position with the head hyperextended.

A vaginal birth after cesarean (VBAC) is an option for women who have had previous c-sections

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and are interested in a trial of labor (TOL). TOL is a purposeful attempt to deliver vaginally. The success rate for VBAC in patients who have had a prior low transverse uterine incision is approximately 70%. The most severe risk associated with TOL is uterine rupture: 0.2–1.5% of attempted VBACs among women with a low transverse uterine scar will end in uterine rupture, compared to 12% of women with a classic uterine incision. To minimize this risk, the American College of Obstetricians and Gynecologists (ACOG) recommends that VBAC be limited to women with full-term pregnancies (37–40 weeks) who have only had one previous low transverse c-section.

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American College of Obstetricians and Gynecologists, P.O. Box 96920, Washington, DC, 20090-6920, (202) 638-5577, http://www.acog.org.

Association of Women's Health, Obstetric, and Neonatal Nurses, 2000 L St., NW, Suite. 740, Washington, DC, 20036, (202) 261-2400, (800) 673-8499. Toll free in Canada (800) 245-0231, (202) 728-0575, customer service@ awhonn.org, http://www.awhonn.org.

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Cestodiasis *see* **Tapeworm diseases**

CFS *see* **Chronic fatigue syndrome**

CGD *see* **Chronic granulomatous disease**

Chagas' disease

Definition

Chagas' disease is named after Dr. Carlos Chagas who first found the organism in the early 1900s. It involves damage to the nerves that control the heart, digestive and other organs, and eventually leads to damage to these organs. Worldwide, Chagas' disease affects over 15 million persons, and kills 50,000 each year. Researchers believe that the parasite that causes the disease is only found in the Americas.

Description

When a person is infected with Chagas' disease, the parasite known as *Trypanosoma cruzi* first causes a mild, short-lived period of "acute" illness; then after a long period without symptoms, the effects of the infection begin to appear. The heart, esophagus, and colon are most frequently involved. These organs become unable to contract properly, and begin to stretch or dilate.

Causes and symptoms

T. cruzi is carried by insects or bugs known as reduviid or "kissing bugs." These insects are very common in Central and South America where they inhabit poorly constructed houses and huts. The insects deposit their waste material, exposing inhabitants to the parasites. The parasites then enter the body by way of a cut or via the eyes or mouth. *T. cruzi* can also be transmitted by blood **transfusion**. Eating uncooked, contaminated food or **breastfeeding** can also transmit the disease. The reduviids, in turn, become infected with the parasite by biting infected animals and humans.

There are three phases related to infection:

- Acute phase lasts about two months, with non-specific symptoms of low grade fever, headache, fatigue, and enlarged liver or spleen.
- Indeterminate phase lasts 10–20 years, during which time no symptoms occur, but the parasites are reproducing in various organs.
- Chronic phase is the stage when symptoms related to damage of major organs (heart, esophagus, colon) begin.

In the chronic phase, irregularities of heart rhythm, **heart failure**, and **blood clots** cause weakness, **fainting**, and even sudden **death**.

Esophageal symptoms are related to difficulty with swallowing and chest **pain**. Because the esophagus does

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KEY TERMS

Achalasia—An esophageal disease of unknown cause, in which the lower sphincter or muscle is unable to relax normally, and leads to the accumulation of material within the esophagus.

Endoscopy—Exam using an endoscope (a thin flexible tube which uses a lens or miniature camera to view various areas of the gastrointestinal tract). When the procedure is performed to examine certain organs such as the bile ducts or pancreas, the organs are not viewed directly, but rather indirectly through the injection of x ray.

Parasite—An organism that lives on or in another and takes nourishment (food and fluids) from that organism.

Regurgitation—Flow of material back up the esophagus and into the throat or lungs.

not empty properly, food regurgitates into the lungs causing **cough**, **bronchitis**, and repeated bouts of **pneumonia**. Inability to eat, weight loss, and **malnutrition** become a significant factor in affecting survival.

Involvement of the large intestine (colon) causes **constipation**, distention, and abdominal pain.

Diagnosis

The best way to diagnose acute infection is to identify the parasites in tissue or blood. Occasionally it is possible to culture the organism from infected tissue, but this process usually requires too much time to be of value. In the chronic phase, antibody levels can be measured. Efforts to develop new, more accurate tests are ongoing.

Treatment

In most cases treatment of symptoms is all that is possible. Present medications can reduce the duration and severity of an acute infection, but are only 50% effective, at best, in eliminating the organisms.

Cardiac effects are managed with **pacemakers** and medications. Esophageal complications require either endoscopic or surgical methods to improve esophageal emptying, similar to those used to treat the disorder known as **achalasia**. Constipation is treated by increasing fiber and bulk **laxatives**, or removal of diseased portions of the colon.

Prognosis

Those patients with gastrointestinal complications often respond to some form of treatment. Cardiac problems are more difficult to treat, particularly since transplant would rekindle infection.

Prevention

Visitors traveling to areas of known infection should avoid staying in mud, adobe, or similar huts. Mosquito nets and insect repellents are useful in helping to avoid contact with the bugs. Blood screening is not always effective in many regions where infection is common. It is necessary to carefully screen people who have emigrated from Central and South America before they make blood donations.

Resources

OTHER

Centers for Disease Control. http://www.cdc.gov.

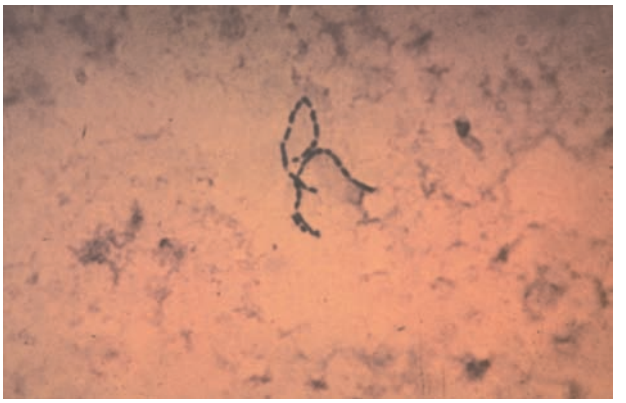
David Kaminstein, MD

Chalazion *see* **Eyelid disorders**

Chancroid

Definition

Chancroid is a sexually transmitted disease caused by a bacterial infection that is characterized by painful sores on the genitals.



A close-up view of a chancroid specimen. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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Description

Chancroid is an infection of the genitals that is caused by the bacterium *Haemophilus ducreyi*. Chancroid is a sexually transmitted disease, which means that it is spread from person to person almost always by sexual contact. However, there have been a few cases in which healthcare providers have become infected through contact with infected patients.

Common locations for chancroid sores (ulcers) in men are the shaft or head of the penis, foreskin, the groove behind the head of the penis, the opening of the penis, and the scrotum. In women, common locations are the labia majora (outer lips), labia minora (inner lips), perianal area (area around the anal opening), and inner thighs. It is rare for the ulcer(s) to be on the vaginal walls or cervix. In about 50% of the patients with chancroid, the infection spreads to either or both of the lymph nodes in the groin.

Chancroid is most commonly found in developing and third world countries. In the United States, the most common cause of genital ulcers is **genital herpes**, followed by **syphilis**, and then chancroid. There are about 1,500 cases of chancroid in the United States per year and it occurred primarily in African Americans, Hispanic Americans, and Native Americans. There are occasional localized outbreaks of chancroid in the United States. In addition, the practice of exchanging sex for drugs has lead to a link between crack **cocaine** use and chancroid.

Even though the incidence of chancroid in the United States decreased in the 1990s, there is an alarming connection between chancroid and human **immunodeficiency** virus (HIV) infection. HIV causes **AIDS** (acquired immunodeficiency syndrome) and is easily spread from person to person through chancroid ulcers. Uncircumcised men with chancroid ulcers have a 48% risk of acquiring HIV from sexual contact. Women with chancroid ulcers are also at a greater risk of being infected with HIV during sexual contact. Genital ulcers seem to act as doorways for HIV to enter and exit.

Causes and symptoms

Haemophilus ducreyi is spread from person to person by vaginal, anal, and oral sexual contact. Uncircumcised men are about three times more likely than circumcised men to become infected following exposure to *Haemophilus ducreyi*. Having unprotected sex, exchanging sex for drugs, and having unprotected sex with a prostitute are other risk factors. Many cases of chancroid in the United States occur in persons who had traveled to countries where the disease is more common.

Chancroid occurs when *Haemophilus ducreyi* penetrates the skin through an injury, like a scratch or cut. Once past the skin surface, the warmth, moisture, and nutrients allow bacteria to grow rapidly. The first sign of chancroid is a small, red papule that occurs within three to seven days following exposure to the bacteria, but may take up to one month. Usually within one day, the papule becomes an ulcer. The chancroid ulcer is painful, bleeds easily, drains a grey or yellowish pus, and has sharply defined, ragged edges. They can vary in size from an eighth of an inch to two inches in diameter. Men usually have only one ulcer, but women often have four or more. Sometimes "kissing" ulcers occur when one ulcer spreads the bacterial infection to an opposite skin surface. For example, kissing ulcers can form on the lips of the labia majora. Alternatively, women may not have any external sores but may experience painful urination, intercourse, and/or bowel movements and may have a vaginal discharge or rectal bleeding.

Signs that the infection has spread to the lymph node appear about one week after the formation of the genital ulcer. Lymph nodes are small organs in the lymphatic system that filter waste materials from nearly every organ in the body. This lymph node infection is called "lymphadenitis" and the swollen, painful lymph node is called a "bubo." The bubo, which appears as a red, spherical lump, may burst through the skin, releasing a thick pus and forming another ulcer.

Diagnosis

Chancroid may be diagnosed and treated by urologists (urinary tract doctors for men), gynecologists (for women), and **infectious disease** specialists. Part of the diagnosis of chancroid involves ruling out genital herpes and syphilis because genital ulcers are also symptoms of these diseases. The appearance of these three diseases can be close enough to be confusing. However, the presence of a pus-filled lump in the groin of a patient with a genital ulcer is highly specific for chancroid.

For a clear-cut diagnosis of chancroid, *Haemophilus ducreyi* must be isolated from the ulcer. To do this, a sterile cotton swab is wiped over the ulcer to obtain a pus sample. In the laboratory, the sample is put into special media and placed in an incubator. *Haemophilus ducreyi* takes from two to five days to grow in the laboratory. In addition, the pus may be examined under the microscope to see which bacteria are in the ulcer. A sample of the pus may also be tested to see if the herpes virus is present. A blood sample will probably be

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KEY TERMS

Bubo—A tender, swollen lymph node in the groin that may follow a chancroid ulcer.

Groin—The region of the body that lies between the abdomen and the thighs.

taken from the patient's arm to test for the presence of antibodies to the bacteria that causes syphilis.

Treatment

The only treatment for chancroid is **antibiotics** given either once or for several days. Antibiotics taken by mouth for one to two weeks include erythromycin (E-Mycin, Ery-Tab), amoxicillin plus clavulanic acid (Augmentin), co-trimoxazole (Bactrim, Septra), or ciprofloxacin (Cipro). Antibiotics given in one dose include ceftriaxone (Rocephin), spectinomycin (Trobicin), co-trimoxazole, or ofloxacin (Floxin).

The ulcer(s) may be cleaned and soaked to reduce the swelling. Salt solution **dressings** may be applied to the ulcer(s) to reduce the spread of the bacteria and prevent additional ulcers. A serious infection of the foreskin may require **circumcision**. Pus would be removed from infected lymph nodes by using a needle and syringe. Very large buboes may require surgical drainage.

Prognosis

Without treatment, chancroid may either go away quickly or patients may experience the painful ulcers for many months. A complete cure is obtained with antibiotic treatment. Severe ulcers may cause permanent **scars**. Severe scarring of the foreskin may require circumcision. Urethral fistulas (abnormal passageways from the urine tube to the skin) may occur and requires corrective surgery.

Prevention

The best prevention for chancroid is to use a condom during sexual intercourse. Chancroid can also be prevented by abstinence (avoidance of any sexual contact) and by being in a monogamous relationship with a disease-free partner. To prevent the spread of chancroid, it is important that all sexual contacts of the patient are identified and treated.

ORGANIZATIONS

Planned Parenthood Federation of America, 434 West 33rd St., New York, NY, 10001, (212) 541-7800, (212) 245-1845, (800) 230-7526, http://www.plannedparenthood.org.

Belinda Rowland, PhD

Change of life *see* **Menopause**

Character disorders *see* **Personality disorders**

Charcoal, activated

Definition

Activated charcoal is a fine black odorless and tasteless powder made from wood or other materials that have been exposed to high temperatures in an airless environment. The powder is treated (activated) with oxidizing gas or other chemicals to increase its ability to adsorb various substances. Activated charcoal is pure carbon that absorbs particles and gases in the body's digestive system.

Activated charcoal has been used since ancient times to cure various ailments and poisonings, and its healing effects have been documented since1550 B.C. by the Egyptians. In the 1980s, it was rediscovered as an oral treatment for **poisoning** and drug overdoses.

Description

Activated charcoal is not absorbed from the stomach or intestines and binds or adsorbs most drugs and poisons. Its most important use in humans is in treating **drug overdose** and poisoning. It is also sometimes used to treat **diarrhea** or excessive gas. It can be used to treat poisoned pets and animals. Other possible uses, in treating viruses, bacteria, bacterial toxic byproducts, snake venoms, and other substances, have not been supported by clinical studies. By adding water to the powder to make a paste, activated charcoal can be used as an external application to reduce **pain** and **itching** from **bites and stings**.

Poisons and drug overdoses

It is estimated that one million children accidentally overdose every year on medications, thinking they are candies, or eat, drink, or inhale poisonous household products. Infants and toddlers are at the greatest risk for accidental poisoning. Activated

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charcoal can absorb large quantities of poisons quickly in the intestines, is non-toxic, may be stored indefinitely, and can be conveniently administered at home. Charcoal binds irritating or toxic substances in the stomach and intestines, preventing their absorption, so they can be excreted in the stool. When poisoning is suspected, the local poison control center should always be contacted for instructions. They may recommend using activated charcoal, which should be available at home so that it can be immediately given to the poisoned child or pet. For severe poisoning, several doses of activated charcoal may be needed.

Activated charcoal is used in adults who have accidentally taken too much medication, or attempted **suicide** by intentionally taking a drug overdose.

Intestinal disorders

In the past, activated charcoal was a popular remedy for flatus (intestinal gas). But more recent studies have not shown its value. Other measures, like dietary changes or **biofeedback** training, are more effective in relieving patients' symptoms.

Charcoal has been used to treat other intestinal disorders like diarrhea, **constipation**, and cramps. There is little evidence to support these uses. Frequent use may decrease absorption of essential nutrients and cause constipation. So a laxative should be taken if several doses of charcoal are taken.

Other uses

Activated charcoal has been used to clean skin **wounds** and adsorb waste materials from the gastrointestinal tract. When used with other remedies such as aloe vera, acidophilus, and psyllium, charcoal helps keep symptoms of ulcerative **colitis** under control. While charcoal shows some anti-aging activity in rats, it is doubtful if it has the same effect in humans.

Apart from its medicinal applications, activated charcoal is used by biologists to cool cell suspensions; by public health physicians to filter disease organisms from drinking water; and by environmental scientists to remove organic pollutants from ocean sediments.

Recommended dosage

For poisoning

Activated charcoal is available without prescription. In cases of accidental poisoning or drug overdose, always call a poison control center for advice. If both syrup of **ipecac** and charcoal are recommended, ipecac should be given first to induce **vomiting**, and charcoal given only after **vomiting** stops. Activated charcoal may be mixed with a liquid and drunk, or put into a stomach tube. Activated charcoal is available as 1.1 oz (33 mL) and 0.5 oz (15 mL) containers as pre-mixed slurries, or as containers to which water or soda pop can be added. It is a good idea to keep activated charcoal at home for the immediate treatment of poisonings.

For acute poisoning, the dosage is as follows:

- Infants (under 1 year of age): 1 g/kg
- Children (1–12 years of age): 15–30 g or 1–2 g/kg with at least 8 oz of water
- Adults: 30–100 g or 1–2 g/kg with at least 8 oz of water

For diarrhea

Charcoal can be taken as tablets or capsules with water, or sprinkled onto foods. The dosage for treatment of diarrhea in adults is 520–975 mg after each meal and up to 5 g per day.

Precautions

Parents should keep activated charcoal on hand for emergencies.

Charcoal should not be given together with syrup of ipecac as it will adsorb the ipecac. It should not be taken until after the vomiting from ipecac stops.

Some activated charcoal products contain sorbitol, a sweetener and laxative that can cause **nausea**, vomiting, and diarrhea. These products should not be used in infants.

Charcoal may interfere with the absorption of medications and nutrients such as **vitamins** or **minerals**. It should not be taken for at least two hours after other medications.

Charcoal should not be used to treat poisonings caused by lye or other corrosives, strong acids, or petroleum products like gasoline or cleaning fluids. In those cases, charcoal may cause treatment for the condition to be delayed. It is also not effective in lithium, cyanide, iron, ethanol, or methanol overdoses or poisonings.

Chocolate syrup, sherbet, or ice cream may improve the taste of charcoal, but they may prevent it from working properly.

Activated charcoal may produce abdominal pain or swelling, and can complicate intestinal bleeding or obstruction.

Charcoal may be less effective in people with slow digestion.

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KEY TERMS

Adsorption—The binding of a chemical (e.g., drug or poison) to a solid material such as activated charcoal or clay.

Antidote—A remedy to counteract unwanted effects from medications or poisons.

Flatus—Gas or air in the digestive tract.

Charcoal should not be given for more than three or four days for treatment of diarrhea, as it may interfere with normal **nutrition**.

Charcoal should not be used in children under three years of age to treat diarrhea or gas.

Activated charcoal should be kept out of reach of children.

Side effects

Charcoal may cause constipation when taken for a drug overdose or accidental poisoning. A laxative should be taken after the crisis is over.

Activated charcoal normally causes stools to turn black.

Patients should consult a doctor if they have pain or swelling of the stomach.

Interactions

Chocolate syrup, ice cream, or sherbet mixed may prevent charcoal from working properly.

Resources

BOOKS

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ORGANIZATIONS

American Society of Health-System Pharmacists (ASHP), 7272 Wisconsin Avenue, Bethesda, MD, 20814, (301) 657-3000, (866) 279-0681, http://www.ashp.org.

United States Food and Drug Administration (FDA), 10903 New Hampshire Ave, Silver Spring, MD, 02993-0002, (888) 463-6332, http://www.fda.gov.

Rebecca J. Frey, PhD
James E. Waun, MD. RPh

Charcot Marie Tooth disease

Definition

Charcot Marie Tooth disease (CMT) is the name of a group of inherited disorders of the nerves in the peripheral nervous system (nerves throughout the body that communicate motor and sensory information to and from the spinal cord) causing weakness and loss of sensation in the limbs.

Description

CMT is named for the three neurologists who first described the condition in the late 1800s. It is also known as hereditary motor and sensory neuropathy, and is sometimes called peroneal muscular atrophy, referring to the muscles in the leg that are often affected. The age of onset of CMT can vary anywhere from young childhood to the 50s or 60s. Symptoms typically begin by the age of 20. For reasons yet unknown, the severity in symptoms can also vary greatly, even among members of the same family.

Although CMT has been described for many years, it is only since the early 1990s that the genetic cause of many of the types of CMT have become known.

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Therefore, knowledge about CMT has increased dramatically within a short time.

The peripheral nerves

CMT affects the peripheral nerves, those groups of nerve cells carrying information to and from the spinal cord. CMT decreases the ability of these nerves to carry motor commands to muscles, especially those furthest from the spinal cord located in the feet and hands. As a result, the muscles connected to these nerves eventually weaken. CMT also affects the sensory nerves that carry information from the limbs to the brain. Therefore people with CMT also have sensory loss. This causes symptoms such as not being able to tell if something is hot or cold or difficulties with balance.

There are two parts of the nerve that can be affected in CMT. A nerve can be likened to an electrical wire, in which the wire part is the axon of the nerve and the insulation surrounding it is the myelin sheath. The job of the myelin is to help messages travel very fast through the nerves. CMT is usually classified depending on which part of the nerve is affected. People who have problems with the myelin have CMT type 1 and people who have abnormalities of the axon have CMT type 2.

Specialized testing of the nerves, called nerve conduction testing (NCV), can be performed to determine if a person has CMT1 or CMT2. These tests measure the speed at which messages travel through the nerves. In CMT1, the messages move too slowly, but in CMT2 the messages travel at the normal speed.

Demographics

CMT has been diagnosed in people from all over the world. It occurs in approximately one in 2,500 people, which is about the same incidence as **multiple sclerosis**. It is the most common type of inherited neurologic condition.

Causes and symptoms

CMT is caused by changes (mutations) in any one of a number of genes that carry the instructions to make the peripheral nerves. Genes contain the instructions for how the body grows and develops before and after a person is born. There are probably at least 15 different genes that can cause CMT. However, many have not yet been identified.

CMT types 1 and 2 can be broken down into subtypes based upon the gene that is causing CMT. The subtypes are labeled by letters, so there is CMT1A, CMT1B, etc. Therefore, the gene with a mutation that causes CMT1A is different from the gene that causes CMT1B.

Types of CMT

CMT1A. The most common type of CMT is called CMT1A. It is caused by a mutation in a gene called peripheral myelin protein 22 (PMP22) located on chromosome 17. The job of this gene is to make a protein (PMP22) that makes up part of the myelin. In most people who have CMT, the mutation that causes the condition is a duplication (doubling) of the PMP22 gene. Instead of having two copies of the PMP22 gene (one on each chromosome) there are three copies. It is not known how this extra copy of the PMP22 gene causes the observed symptoms. A small percentage of people with CMT1A do not have a duplication of the PMP22 gene, but rather have a point mutation in the gene. A point mutation is like a typo in the gene that causes it to work incorrectly.

HEREDITARY NEUROPATHY WITH LIABILITY TO PRESSURE PALSIES (HNPP). HNPP is a condition that is also caused by a mutation in the PMP22 gene. The mutation is a deletion. Therefore, there is only one copy of the PMP22 gene instead of two. People who have HNPP may have some of the signs of CMT. However, they also have episodes where they develop weakness and problems with sensation after compression of certain pressure points such as the elbows or knee. Often these symptoms will resolve after a few days or weeks, but sometimes they are permanent.

CMT1B. Another type of CMT, called CMT1B, is caused by a mutation in a gene called myelin protein zero (MPZ) located on chromosome 1. The job of this gene is to make the layers of myelin stick together as they are wrapped around the axon. The mutations in this gene are point mutations because they involve a change (either deletion, substitution, or insertion) at one specific component of a gene.

CMTX. Another type of CMT, called CMTX, is usually considered a subtype of CMT1 because it affects the myelin, but it has a different type of inheritance than type 1 or type 2. In CMTX, the CMT–causing gene is located on the X chromosome and is called connexin 32 (Cx32). The job of this gene is to code for a class of protein called connexins that form tunnels between the layers of myelin.

CMT2. There are at least five different genes that can cause CMT type 2. Therefore, CMT2 has subtypes A, B, C, D, and E. As of early 2001, scientists have narrowed in on the location of most of the CMT2 causing genes. However, the specific genes and the

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mutations have not yet been found for most types. Very recently, the gene for CMT2E has been found. The gene is called neurofilament-light (NF-L). Because it has just been discovered, not much is known about how mutations in this gene cause CMT.

CMT3. In the past a condition called Dejerine-Sottas disease was referred to as CMT3. This is a severe type of CMT in which symptoms begin in infancy or early childhood. It is now known that this is not a separate type of CMT and in fact people who have onset in infancy or early childhood often have mutations in the PMP22 or MPZ genes.

CMT4. CMT4 is a rare type of CMT in which the nerve conduction tests have slow response results. However, it is classified differently from CMT1 because it is passed through families by a different pattern of inheritance. There are five different subtypes and each has only been described in a few families. The symptoms in CMT4 are often severe and other symptoms such as deafness may be present. There are three different genes that have been associated with CMT4 as of early 2001. They are called MTMR2, EGR2, and NDRG1. More research is required to understand how mutations in these genes cause CMT.

Inheritance

CMT1A and 1B, HNPP, and all of the subtypes of CMT2 have autosomal dominant inheritance. Autosomal refers to the first 22 pairs of chromosomes that are the same in males and females. Therefore, males and females are affected equally in these types. In a dominant condition, only one gene of a pair needs to have a mutation in order for a person to have symptoms of the condition. Therefore, anyone who has these types has a 50%, or one in two, chance of passing CMT on to each of their children. This chance is the same for each **pregnancy** and does not change based on previous children.

CMTX has X-linked inheritance. Since males only have one X chromosome, they only have one copy of the Cx32 gene. Thus, when a male has a mutation in his Cx32 gene, he will have CMT. However, females have two X chromosomes and therefore have two copies of the Cx32 gene. If they have a mutation in one copy of their Cx32 genes, they will only have mild to moderate symptoms of CMT that may go unnoticed. This is because their normal copy of the Cx32 gene does make normal myelin.

Females pass on one or the other of their X chromosomes to their children—sons or daughters. If a woman with a Cx32 mutation passes her normal X chromosome, she will have an unaffected son or daughter who will not pass CMT on to his or her children. If the woman passes the chromosome with Cx32 mutation on she will have an affected son or daughter, although the daughter will be mildly affected or have no symptoms. Therefore, a woman with a Cx32 mutation has a 50%, or a one in two, chance of passing the mutation to her children: a son will be affected, and a daughter may only have mild symptoms.

When males pass on an X chromosome, they have a daughter. When they pass on a Y chromosome, they have a son. Since the Cx32 mutation is on the X chromosome, a man with CMTX will always pass the Cx32 mutation on to his daughters. However, when he has a son, he passes on the Y chromosome, and therefore the son will not be affected. Therefore, an affected male passes the Cx32 gene mutation on to all of his daughters, but to none of his sons.

CMT4 has autosomal recessive inheritance. Males and females are equally affected. In order for a person to have CMT4, they must have a mutation in both of their CMT–causing genes—one inherited from each parent. The parents of an affected person are called carriers. They have one normal copy of the gene and one copy with a mutation. Carriers do not have symptoms of CMT. Two carrier parents have a 25%, or one in four, chance of passing CMT on to *each* of their children.

The onset of symptoms is highly variable, even among members of the same family. Symptoms usually progress very slowly over a person's lifetime. The main problems caused by CMT are weakness and loss of sensation mainly in the feet and hands. The first symptoms are usually problems with the feet such as high arches and problems with walking and running. Tripping while walking and sprained ankles are common. Muscle loss in the feet and calves leads to "foot drop" where the foot does not lift high enough off the ground when walking. Complaints of cold legs are common, as are cramps in the legs, especially after **exercise**.

In many people, the fingers and hands eventually become affected. Muscle loss in the hands can make fine movements such as working buttons and zippers difficult. Some patients develop tremor in the upper limbs. Loss of sensation can cause problems such as **numbness** and the inability to feel if something is hot or cold. Most people with CMT remain able to walk throughout their lives.

Diagnosis

Diagnosis of CMT begins with a careful **neurological exam** to determine the extent and distribution

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of weakness. A thorough family history should be taken at this time to determine if other people in the family are affected. Testing may also be performed to rule out other causes of neuropathy.

A nerve conduction velocity test should be performed to measure how fast impulses travel through the nerves. This test may show characteristic features of CMT, but it is not diagnostic of CMT. Nerve conduction testing may be combined with **electromyography** (EMG), an electrical test of the muscles.

A nerve biopsy (removal of a small piece of the nerve) may be performed to look for changes characteristic of CMT. However, this testing is not diagnostic of CMT and is usually not necessary for making a diagnosis.

Definitive diagnosis of CMT is made only by **genetic testing**, usually performed by drawing a small amount of blood. As of early 2001, testing is available to detect mutations in PMP22, MPZ, Cx32, and EGR2. However, research is progressing rapidly and new testing is often made available every few months. All affected members of a family have the same type of CMT. Therefore once a mutation is found in one affected member, it is possible to test other members who may have symptoms or are at risk of developing CMT.

Prenatal diagnosis

Testing during pregnancy to determine whether an unborn child is affected is possible if genetic testing in a family has identified a specific CMT-causing mutation. This can be done after 10–12 weeks of pregnancy using a procedure called **chorionic villus sampling** (CVS). CVS involves removing a tiny piece of the placenta and examining the cells. Testing can also be done by **amniocentesis** after 16 weeks gestation by removing a small amount of the amniotic fluid surrounding the baby and analyzing the cells in the fluid. Each of these procedures has a small risk of **miscarriage** associated with it, and those who are interested in learning more should check with their doctor or genetic counselor. Couples interested in these options should obtain **genetic counseling** to carefully explore all of the benefits and limitations of these procedures.

Treatment

There is no cure for CMT. However, physical and **occupational therapy** are an important part of CMT treatment. **Physical therapy** is used to preserve range of motion and minimize deformity caused by muscle shortening, or contracture. Braces are sometimes used to improve control of the lower extremities that can help tremendously with balance. After wearing braces, people often find that they have more energy because they are using less energy to focus on their walking. Occupational therapy is used to provide devices and techniques that can assist tasks such as dressing, feeding, writing, and other routine activities of daily life. Voice-activated software can also help people who have problems with fine motor control.

KEY TERMS

Axon—Skinny, wire-like extension of nerve cells.

Myelin—A fatty sheath surrounding nerves in the peripheral nervous system, which helps them conduct impulses more quickly.

Nerve conduction testing—Procedure that measures the speed at which impulses move through the nerves.

Neuropathy—A condition caused by nerve damage. Major symptoms include weakness, numbness, paralysis, or pain in the affected area.

Peripheral nerves—Nerves throughout the body that carry information to and from the spinal cord.

It is very important that people with CMT avoid injury that causes them to be immobile for long periods of time. It is often difficult for people with CMT to return to their original strength after injury.

There is a long list of medications that should be avoided if possible by people diagnosed with CMT such as hydralazine (Apresoline); megadoses of vitamin A, B_6, and D; Taxol; and large intravenous doses of penicillin. Complete lists are available from the CMT support groups. People considering taking any of these medications should weigh the risks and benefits with their physician.

Prognosis

The symptoms of CMT usually progress slowly over many years, but do not usually shorten life expectancy. The majority of people with CMT do not need to use a wheelchair during their lifetime. Most people with CMT are able to lead full and productive lives despite their physical challenges.

Resources

BOOKS

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OTHER

GeneClinics. University of Washington, Seattle. www.geneclinics.org.

HNPP—Hereditary Neuropathy with Liability to Pressure Palsies. http://www.hnpp.org.

OMIM—Online Mendelian Inheritance in Man. www.ncbi.nlm.nih.gov/Omim.

ORGANIZATIONS

Charcot Marie Tooth Association (CMTA), 2700 Chestnut Parkway, Chester, PA, 19013-4867, (610) 499-9264, (610) 499-9267, (800) 606-2682, info@charcot-marie-tooth.org, http://www.charcot-marie-tooth.org.

Muscular Dystrophy Association, 3300 East Sunrise Drive, Tucson, AZ, 85718, (800) 572-1717, http://www.mdausa.org.

The Neuropathy Association, Inc, 60 East 42nd Street, Suite 942, New York, NY, 10165, (212) 692-0662, (212) 692-0668, info@neuropathy.org, http://www.neuropathy.org.

Karen M. Krajewski, MS, CGC

Charcot's joints

Definition

Charcot's joints is a progressive degenerative disease of the joints caused by nerve damage resulting in the loss of ability to feel **pain** in the joint and instability of the joint.

Description

Charcot's joints, also called neuropathic joint disease, is the result of two conditions present in the joint. The first factor is the inability to feel pain in the joint due to nerve damage. The second factor is that injuries to the joint go unnoticed leading to instability and making the joint more susceptible to further injury. Repeated small injuries, strains, and even **fractures** can go unnoticed until finally the joint is permanently destroyed. Loss of the protective sensation of pain is what leads to the disintegration of the joint and often leads to deformity in the joint.

Although this condition can affect any joint, the knee is the joint most commonly involved. In individuals with **diabetes mellitus**, the foot is most commonly affected. The disease can involve only one joint or it may affect two or three joints. More than three affected joints is very rare. In all cases, the specific joint(s) affected depends on the location of the nerve damage.

Causes and symptoms

Many diseases and injuries can interfere with the ability to feel pain. Conditions such as diabetes mellitus, spinal injuries and diseases, **alcoholism**, and even **syphilis** can all lead to a loss of the ability to feel pain in some areas. Lack of pain sensation may also be congenital.

The symptoms of Charcot's joints can go unnoticed for some time and may be confused with **osteoarthritis** in the beginning. Swelling and stiffness in a joint without the expected pain, or with less pain than would be expected, are the primary symptoms of this condition. As the condition progresses, however, the joint can become very painful due to fluid build-up and bony growths.

Diagnosis

Charcot's joints is suspected when a person with a disease that impairs pain sensation exhibits painless swelling and/or stiffness in a joint. Standard x rays will show damage to the joint, and may also show abnormal bone growth and **calcium** deposits. Floating bone fragments from previous injuries may also be visible.

Treatment

In the early stages of Charcot's joints, braces to stabilize the joints can help stop or minimize the damage. When the disease has progressed beyond braces, surgery can sometimes repair the joint. If the damage is extensive, an artificial joint may be necessary.

Prognosis

Treatment of the disease causing loss of pain perception may help to slow the damage to the joints.

Prevention

Preventing or effectively managing the underlying disease can slow or in some cases reverse joint damage, but the condition cannot be prevented.

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Dorothy Elinor Stonely

Charley horse *see* **Muscle spasms and cramps**

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Chelation therapy

Definition

Chelation therapy is an intravenous treatment designed to bind heavy metals in the body in order to treat heavy metal toxicity. Proponents claim it also treats **coronary artery disease** and other illnesses that may be linked to damage from free radicals (reactive molecules).

Purpose

The benefits of EDTA chelation for the treatment of **lead poisoning** and excessively high **calcium** levels are undisputed. The claims of benefits for those suffering from **atherosclerosis**, coronary artery disease, and other degenerative diseases are more difficult to prove. Reported uses for chelation therapy include treatment of **angina**, **gangrene**, arthritis, **multiple sclerosis**, Parkinson's disease, **psoriasis**, and **Alzheimer's disease**. Improvement is also claimed for people experiencing diminished sight, hearing, smell, coordination, and sexual potency.

Description

Origins

The term chelation is from the Greek root word "chele," meaning "claw." Chelating agents, most commonly diamine tetraacetic acid (EDTA), were originally designed for industrial applications in the early 1900s. It was not until the World War II era that the potential for medical therapy was realized. The initial intent was to develop antidotes to poison gas and radioactive contaminants. The need for widespread therapy of this nature did not materialize, but more practical uses were found for chelation. During the following decade, EDTA chelation therapy became standard treatment for people suffering from lead poisoning. Patients who had received this treatment claimed to have other health improvements that could not be attributed to the lead removal only. Especially notable were comments from those who had previously suffered from **intermittent claudication** and angina. They reported suffering less **pain** and **fatigue**, with improved endurance, after chelation therapy. These reports stimulated further interest in the potential benefits of chelation therapy for people suffering from atherosclerosis and coronary artery disease.

If the preparatory examination suggests that there is a condition that could be improved by chelation therapy, and there is no health reason why it shouldn't be used, then the treatment can begin. The patient is generally taken to a comfortable treatment area, sometimes in a group location, and an intravenous line is started. A solution of EDTA together with **vitamins** and **minerals** tailored for the individual patient is given. Most treatments take three to four hours, as the infusion must be given slowly in order to be safe. The number of recommended treatments is usually between 20 and 40. They are given one to three times a week. Maintenance treatments can then be given at the rate of once or twice a month. Maximum benefits are reportedly attained after approximately three months after a treatment series. The cost of therapy is considerable, but it is a fraction of the cost of an expensive medical procedure like cardiac bypass surgery. Intravenous vitamin C and mercury chelation therapies are also offered.

Preparations

A candidate for chelation therapy should initially have a thorough history and physical to define the type and extent of clinical problems. Laboratory tests will be done to determine whether there are any conditions present that would prevent the use of chelation. Patients who have preexisting **hypocalcemia**, poor liver or kidney function, congestive **heart failure**, **hypoglycemia**, **tuberculosis**, clotting problems, or potentially allergic conditions are at higher risk for complications from chelation therapy. A Doppler ultrasound may be performed to determine the adequacy of blood flow in different regions of the body.

Precautions

It is important for people who receive chelation therapy to work with medical personnel who are experienced in the use of this treatment. Treatment should not be undertaken before a good physical, lifestyle evaluation, history, and any laboratory tests necessary are performed. The staff must be forthcoming about test results and should answer any questions the patient may have. Evaluation and treatment should be individualized and involve assessment of kidney function before each treatment with chelation, since the metals bound by the EDTA are excreted through the kidneys.

Although EDTA binds harmful, toxic metals like mercury, lead, and cadmium, it also binds some essential nutrients of the body, such as copper, iron, calcium, zinc, and magnesium. Large amounts of zinc are lost during chelation. Zinc deficiency can cause

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KEY TERMS

Angina—Chest pain caused by reduced oxygen to the heart.

Atherosclerosis—Arterial disease characterized by fatty deposits on inner arterial walls.

Hypocalcemia—Low blood calcium.

Hypoglycemia—Low blood sugar.

Intermittent claudication—Leg pain and weakness caused by walking.

Thrombophlebitis—Inflammation of a vein together with clot formation.

impaired immune function and other harmful effects. Supplements of zinc are generally given to patients undergoing chelation, but it is not known whether this is adequate to prevent deficiency. Also, chelation therapy does not replace proper **nutrition**, **exercise**, and appropriate medications or surgery for specific diseases or conditions.

Side effects

Side effects of chelation therapy are reportedly unusual, but are occasionally serious. Mild reactions may include, but are not limited to, local irritation at the infusion site, skin reactions, **nausea**, **headache**, **dizziness**, hypoglycemia, **fever**, leg cramps, or loose bowel movements. Some of the more serious complications reported have included hypocalcemia, kidney damage, decreased clotting ability, anemia, bone marrow damage, insulin **shock**, **thrombophlebitis** with **embolism**, and even rare deaths. However, some doctors feel that the latter groups of complications occurred before the safer method currently used for chelation therapy was developed.

Research and general acceptance

EDTA chelation is a highly controversial therapy. The treatment is approved by the United States Food and Drug Administration (FDA) for lead poisoning and seriously high calcium levels. However, for the treatment of atherosclerotic heart disease, EDTA chelation therapy is not endorsed by the American Heart Association (AHA), the FDA, the National Institutes of Health (NIH), or the American College of Cardiology. The AHA reports that there are no adequate, controlled, published scientific studies using currently approved scientific methods to support this therapy for the treatment of coronary artery disease. However, a pooled analysis from the results of over 70 studies showed positive results in all but one.

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ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

The American College for Advancement in Medicine, 8001 Irvine Center Drive, Ste 825, Irvine, CA, 92619, (949) 309-3538, (600) 532-3688, http://www.acamnet.org.

Judith Turner

Chemical debridement *see* **Debridement**

Chemical peel *see* **Skin resurfacing**

Chemobrasion *see* **Skin resurfacing**

Chemonucleolysis

Definition

Chemonucleolysis is a medical procedure that involves the dissolving of the gelatinous cushioning material in an intervertebral disk by the injection of an enzyme such as chymopapain.

Purpose

Between each vertebra lies a disk of cushioning material that keeps the spinal bones from rubbing together and absorbs some of the shock to the spine from body movements. In the center of the disk is soft, gelatinous material called the nucleus pulposus (NP). The NP is surrounded by a tough fibrous coating. Sometimes when the back is injured, this coating can weaken and bulge or tear to allow the NP to ooze out. When this happens, it is called a herniated nucleus pulposus (HNP), or—in common language—a **herniated disk**.

When the disk bulges or herniates, it can put pressure on nerves which originate in the spinal column, and go to other parts of the body. This causes lower back **pain**, and/or pain to the hips, legs, arms, shoulders, and neck, depending on the location of the

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herniated disk. Chemonucleolysis uses chymopapain, an enzyme derived from papyrus, to dissolve the disk material that has been displaced because of injury. Herniated disks are the cause of only a small proportion of cases of lower back pain, and chemonucleolysis is appropriate for only some cases of HNP.

Chemonucleolysis is a conservative alternative to disk surgery. There are three types of disk injuries. A protruded disk is one that is intact but bulging. In an extruded disk, the fibrous wrapper has torn and the NP has oozed out, but is still connected to the disk. In a sequestered disk, a fragment of the NP has broken loose from the disk and is free in the spinal canal. Chemonucleolysis is effective on protruded and extruded disks, but not on sequestered disk injuries. In the United States, chymopapain chemonucleolysis is approved only for use in the lumbar (lower) spine. In other countries, it has also been used successfully to treat cervical (upper spine) hernias.

Other indications that a patient is a good candidate for chemonucleolysis instead of surgery include:

- the patient is 18–50 years of age
- leg pain is worse than lower back pain
- other conservative treatments have failed
- The spot where the herniated disk presses on the nerve has been pinpointed by myelography, computed tomography scan (CT scan), or magnetic resonance imaging (MRI)
- the patient wishes to avoid surgery

Precautions

There are some situations in which chemonucleolysis should not be performed. Chymopapain is derived from the papaya. About 0.3% of patients are allergic to chymopapain and go into life-threatening shock when exposed to the enzyme. Chemonucleolysis should not be performed on patients allergic to chymopapain or papaya. It also should not be done:

- when the patient is pregnant
- if the disk is sequestered
- if the patient has had several failed back operations
- if a spinal cord tumor is present
- if the patient has a neurological disease such as multiple sclerosis

Other conditions may affect the appropriateness of chemonucleolysis, including **hypertension**, **obesity**, diabetes, and a family history of **stroke**.

KEY TERMS

Chymopapain—An enzyme from the milky white fluid of the papaya, used for medical purposes in chemonucleolysis.

Myelography—An x-ray test that evaluates the subarachnoid space of the spine.

Nucleus pulposus (NP)—An elastic, pulpy mass in the center of each vertebral disk.

Description

A small gauge needle is placed in the center of the affected disk. Chymopapain is introduced into the disk. The patient needs to remain still.

Preparation

Patients will need tests such as a myelogram or CT scan to pinpoint the herniated disk. Some doctors medicate the patient 24 hours prior to the operation in order to decrease the chances of post-operative lower back stiffness.

Aftercare

Patients may feel lower back stiffness, which goes away in few weeks. Heavy lifting and sports activities should be avoided for at least three months.

Risks

The greatest risk is that the patient may be allergic to chymopapain. The **death** rate for chemonucleolysis is only 0.02%. Complications overall are five to 10 times less than with conventional surgery, and the failure rate is roughly comparable to the failure rate in conventional disk surgery.

Normal results

Many patients feel immediate relief from pain, but, in about 30% of patients, maximal relief takes six weeks. The long term (seven to 20 years) success rate averages about 75%, which is comparable to the success rate for conventional surgery.

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Chemotherapy

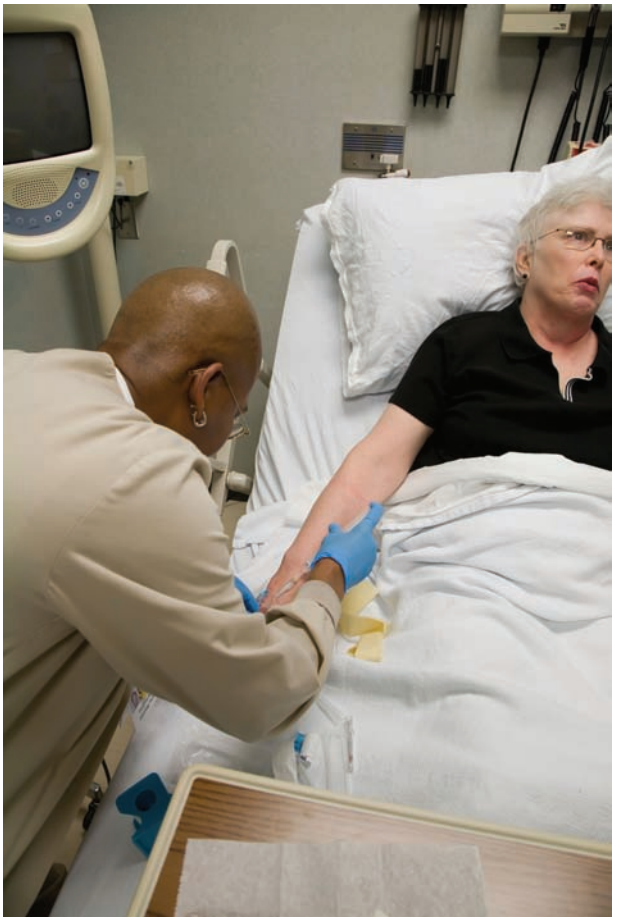
Definition

Chemotherapy is treatment of **cancer** with **anticancer drugs**.

Purpose

The main purpose of chemotherapy is to kill cancer cells. It usually is used to treat patients with cancer that has spread from the place in the body where it started (metastasized). Chemotherapy destroys cancer cells anywhere in the body. It even kills cells that have broken off from the main tumor and traveled through the blood or lymph systems to other parts of the body.

Chemotherapy can cure some types of cancer. In some cases, it is used to slow the growth of cancer cells or to keep the cancer from spreading to other parts of the body. When a cancer has been removed by surgery, chemotherapy may be used to keep the cancer from coming back (adjuvant therapy). Chemotherapy also can ease the symptoms of cancer, helping some patients have a better quality of life.



Woman undergoing a clinical trial to test a new chemotherapy treatment. *(© Jim West/Alamy.)*

Description

Numerous chemotherapy drugs are currently available to treat cancer and many more are being tested for their ability to destroy cancer cells. Most chemotherapy drugs interfere with a cell's ability to grow or multiply. Although these drugs affect all cells in the body, many useful treatments are most effective against rapidly growing cells. Cancer cells of some tumor types grow more quickly than most other body cells. Other cells that grow fast are cells of the bone marrow that produce blood cells, cells in the stomach and intestines, and cells of the hair follicles. Therefore, the most common side effects of chemotherapy are linked to the treatment's effects on other fast growing cells.

Types of chemotherapy drugs

Chemotherapy drugs are classified based on how they work. Drugs that kill cancer cells in a specific part of the cell cycle are called cell cycle specific agents:

- Antimetabolites interfere with the production of DNA and keep cells from growing and multiplying. An example of an antimetabolite is 5-fluorouracil (5-FU).
- Vinca alkaloids prevent cells from dividing normally. Vinblastine and vincristine are plant alkaloids obtained from the periwinkle plant.
- Epipodophyllotoxins work by damaging the cell prior to cell division. Drugs such as etoposide and teniposide are categorized as epipodophyllotoxins.
- Taxanes cause cell death by interfering with actions critical to cell function and by arresting cell division. Paclitaxel (Taxol) and docetaxel (Taxotere) are members of this drug group.
- Epothilones work similarly to the taxanes in causing cell death. Ixabepilone (Ixempra) is classified as an epothilone.
- Camptothecins such as toptecan (Hycamtin) and irinotecan (Camptosar) work in the synthesis phase of the cell cycle to cause cell death.
- Miscellanous agents include L-asparinginase (ELSPAR), which exerts its activity in the first growth phase of cell division, and bleomycin (Blenoxane), which works in the second growth phase to arrest cancer cell division.

Chemotherapy drug categories classified as having cell cycle nonspecific mechanisms of action include:

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- alkylating drugs that kill cancer cells by directly attacking DNA, the genetic material of the genes. Cyclophosphamide is an alkylating drug.
- antitumor antibiotics that are made from natural substances such as fungi in the soil. They interfere with important cell functions, including production of DNA and cell proteins. Doxorubicin (Adriamycin) and thiotepa belong to this group of chemotherapy drugs.

Combination chemotherapy

Chemotherapy usually is given in addition to other cancer treatments, such as surgery and **radiation therapy**. When given with other treatments, it is called adjuvant chemotherapy. An oncologist decides which chemotherapy drug or combination of drugs will work best for each patient. The use of two or more chemotherapy drugs together often works better than a single drug for treating cancer. This is called combination chemotherapy. Scientific studies of different drug combinations (clinical trials) help doctors learn which combinations work best for each type of cancer.

How chemotherapy is given

Chemotherapy is administered in different ways, depending on the drugs to be given and the type of cancer. Doctors decide the dose of chemotherapy drugs considering many factors, among them being the patient's height and weight.

Oral chemotherapy is given by mouth in the form a pill, capsule, or liquid. This is the easiest method and can usually be done at home.

Intravenous (IV) chemotherapy is injected into a vein. A small needle is inserted into a vein on the hand or lower arm. The needle usually is attached to a small tube called a catheter, which delivers the drug from an IV bag or bottle.

Intramuscular (IM) chemotherapy is injected into a muscle. Chemotherapy given by intramuscular injection is absorbed into the blood more slowly than IV chemotherapy. Because of this, the effects of IM chemotherapy may last longer than chemotherapy given intravenously. Chemotherapy also may be injected subcutaneously (SQ or SC), which means under the skin. Because of the toxic effects of many chemotherapy drugs on tissue, intramuscular and subcutaneous administration of these drugs is not common. Injection of chemotherapy directly into the cancer is called intralesional (IL) injection.

Chemotherapy may be given by a catheter or port temporarily inserted into a central, large vein or body cavity. A port is a small reservoir or container that is placed in a vein or under the skin in the area where the drug will be given. These methods eliminate the need for repeated injections and may allow patients to spend less time in the hospital while receiving chemotherapy. Intraperitoneal (IP) chemotherapy is administered into the abdominal cavity through a catheter or port. Chemotherapy given by catheter or port into the spinal fluid is called intrathecal (IT) administration. Catheters and ports may be placed in the chest cavity, bladder, or pelvis, depending on the location of the cancer to be treated.

Topical chemotherapy is given as a cream or ointment applied directly to the cancer. This method is more common in treatment of certain types of skin cancer.

Treatment location and schedule

Patients may receive chemotherapy in the doctor's office, or as an inpatient or outpatient at the hospital.

How often and how long chemotherapy is given depends on the type of cancer, how patients respond to the drugs, patients' health and ability to tolerate the drugs, and the types of drugs given. Chemotherapy administration may take only a few minutes or may last as long as several hours. Chemotherapy may be given daily, weekly, or monthly. A rest period may follow a course of treatment before the next course begins. In combination chemotherapy, more than one drug may be given at a time, or they may be given alternately, one following the other.

Precautions

There are many different types of chemotherapy drugs. Oncologists, doctors who specialize in treating cancer, determine which drugs are best suited for each patient. This decision is based on the type of cancer, the patient's age and health, and other drugs the patient is taking. Some patients should not be treated with certain chemotherapy drugs. Age and other conditions may affect the drugs with which a person may be treated. Heart disease, **kidney disease**, and diabetes are conditions that may limit the choice of treatment drugs.

Preparation

A number of medical tests are done before chemotherapy is started. The oncologist will determine how much the cancer has spread from the results of x rays

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KEY TERMS

Adjuvant therapy—Treatment given after surgery or radiation therapy to prevent the cancer from coming back.

Alkaloid—A type of chemical commonly found in plants and often having medicinal properties.

Alykylating drug—A drug that kills cells by directly damaging DNA.

Antiemetic—A medicine that helps control nausea; also called an anti-nausea drug.

Antimetabolite—A drug that interferes with a cell's growth or ability to multiply.

Platelets—Blood cells that function in blood clotting.

and other imaging tests and from samples of the tumor taken during surgery or biopsy.

Blood tests give the doctor important information about the function of the blood cells and levels of chemicals in the blood. A **complete blood count** (CBC) is commonly done before and regularly during treatment. The CBC shows the numbers of white blood cells, red blood cells, and platelets in the blood. Because chemotherapy affects the bone marrow, where blood cells are made, levels of these cells often drop during chemotherapy. The white blood cells and platelets are most likely to be affected by chemotherapy. A drop in the **white blood cell count** means the immune system cannot function properly. Low levels of platelets can cause a patient to bleed easily from a cut or other wound. A low red blood cell count can lead to anemia (deficiency of red blood cells) and **fatigue**.

When a chemotherapy treatment takes a long time, the patient may prepare for it by wearing comfortable clothes. Bringing a book to read or a tape to listen to may help pass the time and ease the **stress** of receiving chemotherapy. Some patients bring a friend or family member to provide company and support during treatment.

Sometimes, patients taking chemotherapy drugs known to cause **nausea** are given medications called anti-emetics before chemotherapy is administered. Anti-emetic drugs help to lessen feelings of nausea. Two anti-nausea medications that may be used are Kytril and Zofran.

Other ways to prepare for chemotherapy and help lessen nausea are:

- regularly eating nutritious foods and drinking lots of fluids
- eating and drinking normally until about two hours before chemotherapy
- eating high carbohydrate, low-fat foods and avoiding spicy foods

Aftercare

Tips for helping to control side effects after chemotherapy include:

- following any instructions given by the doctor or nurse
- taking all prescribed antinausea medications
- eating small amounts of bland foods
- drinking lots of fluids
- getting plenty of rest

Some patients find it helps to breathe fresh air or get mild **exercise**, such as taking a walk.

Risks

Chemotherapy drugs are toxic to normal cells as well as cancer cells. A dose that will destroy cancer cells will probably cause damage to some normal cells. Doctors adjust doses to do the least amount of harm possible to normal cells. Some patients feel few or no side effects, and others may have more serious side effects. In some cases, a dose adjustment may be required to reduce or stop a side effect.

Some chemotherapy drugs have more side effects than others. The most common side effects are:

- nausea and vomiting
- loss of appetite
- hair loss
- anemia and fatigue
- infection
- easy bleeding or bruising
- sores in the mouth and throat
- neuropathy and other damage to the nervous system
- kidney damage

Nausea and vomiting are common, but can usually be controlled by **antinausea drugs**, drinking fluids, and avoiding spicy foods. Loss of appetite may be due to nausea or the stress of undergoing cancer treatment.

Some chemotherapy drugs cause hair loss, but it is almost always temporary.

Low blood cell counts caused by the effect of chemotherapy on the bone marrow can lead to anemia, infections, and easy bleeding and bruising.

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Patients with anemia have too few red blood cells to deliver oxygen and nutrients to the body's tissues. Anemic patients feel tired and weak. If red blood cell levels fall too low, a blood **transfusion** may be given.

Patients receiving chemotherapy are more likely to get infections. This happens because their infection-fighting white blood cells are reduced. It is important to take measures to avoid getting infections. When the white blood cell count drops too low, the doctor may prescribe medications called colony stimulating factors that help white blood cells grow.

Platelets are blood cells that make the blood clot. When patients do not have enough platelets, they may bleed or bruise easily, even from small injuries. Patients with low blood platelets should take precautions to avoid injuries. Medicines such as **aspirin** and other **pain** relievers can affect platelets and slow down the clotting process.

Chemotherapy can cause irritation and dryness in the mouth and throat. Painful sores may form that can bleed and become infected. Precautions to avoid this side effect include getting dental care before chemotherapy begins, brushing the teeth and gums regularly with a soft brush, and avoiding mouth washes that contain salt or alcohol.

Normal results

The main goal of chemotherapy is to cure cancer. Many cancers are cured by chemotherapy. It may be used in combination with surgery and/or radiation therapy to keep a cancer from spreading to other parts of the body. Some widespread, fast-growing cancers are more difficult to treat. In these cases, chemotherapy may slow the growth of the cancer cells.

Doctors can tell if the chemotherapy is working by the results of medical tests. **Physical examination**, blood tests, and x rays are all used to check the effects of treatment on the cancer.

The possible outcomes of chemotherapy are:

- Complete remission or response. The cancer completely disappears. The course of chemotherapy is completed and the patient is tested regularly for a recurrence.
- Partial remission or response. The cancer shrinks in size but does not disappear. The same chemotherapy may be continued or a different combination of drugs may be tried.
- Stabilization. The cancer does not grow or shrink. Other therapy options may be explored. A tumor may remain stabilized for many years.
- Progression. The cancer continues to grow. Other therapy options may be explored.
- A secondary malignancy may develop as a result of being treated with some chemotherapy agents, and that second cancer may need additional chemotherapy or other treatment.

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American Cancer Society, (800) 227-2345, http://www.cancer.org.

National Cancer Institute, Building 31, Room 10A31, 31 Center Drive, MSC 2580, Bethesda, MD, 20892-2580, (800) 422-6237, http://www.cancer.gov.

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Chest drainage therapy

Definition

Chest drainage therapy involves the removal of air, blood, pus, or other secretions from the chest cavity.

Purpose

Chest drainage therapy is done to relieve pressure on the lungs, and remove fluid that could promote infection. Installing a chest drainage tube can be either an emergency or a planned procedure.

Removing air or fluids from the chest involves the insertion of a tube through the skin and the muscles between the ribs, and into the chest cavity. This cavity is also called the pleural space. Insertion of this tube is called thoracostomy, and chest drainage therapy is sometimes called thoracostomy tube drainage.

Conditions that may need to be treated by chest drainage therapy include **emphysema** (air in the tissues of the lungs), **tuberculosis**, and spontaneous **pneumothorax** (air in the chest cavity) that causes more than a

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25% collapse of the lung. Other conditions include **cancer** that causes excessive secretions, **empyema** (pus in the thoracic cavity), or hemothorax (blood in the thoracic cavity). Almost all chest drainage therapy is done to drain blood from the chest cavity after lung or heart surgery. In cases where the lung is collapsed, removing fluids by chest drainage therapy allows the lung to reinflate.

Oftentimes an x ray is performed prior to treatment to determine whether the problem is either fluid or air in the pleural space. Sometimes a procedure called **thoracentesis** is performed in an effort to avoid inserting a chest drainage tube. In this procedure a needle with a catheter is inserted into the pleural space and fluid is removed. When fluid continues to accumulate, chest drainage therapy is usually the next step. This is especially true when there is a lung infection underlying the fluid build-up.

Precautions

Chest drainage therapy is not done if a collapsed lung is not life-threatening. It also should be avoided for patients who have blood clotting problems.

Description

Most patients are awake when the chest drainage tube is inserted. They are given a sedative and a local anesthetic. Chest drainage tubes are usually inserted between the ribs. The exact location depends on the type of material to be drained and its location in the lungs.

An incision is made in the skin and through the muscles between the ribs. A chest tube is inserted and secured in place. The doctor connects one end of the tube to the chest drainage system.

The chest drainage system must remain sealed to prevent air from entering the chest cavity through the tube. One commonly used system is a water-seal drainage system, comprised of three compartments that collect and drain the fluid or air without allowing air to backflow into the tube. An alternative to this system is to connect the tube to a negative suction pump.

Once the tube and drainage system are in place, a **chest x ray** is done to confirm that the tube is in the right location, and that it is working. In some cases it may be necessary to insert more than one tube to drain localized pockets of fluid that have accumulated.

KEY TERMS

Empyema—Pus in the pleural cavity.

Hemothorax—Blood in the pleural cavity.

Pleural cavity—The area of the chest that includes the lining of the chest cavity, the space the lungs are located in, and the membrane covering of the lungs.

Spontaneous pneumothorax—Air in the chest cavity that occurs because of disease or other naturally occurring cause. Air and blood together in this space is called a pneumohemothorax.

Preparation

A chest x ray is usually done before the chest drainage tube is inserted. Sometimes fluid becomes trapped in isolated spaces in the lung, and it is necessary to do an ultrasound to determine where to locate the drainage tube. **Computed tomography scans** (CT) are useful in locating small pockets of fluids caused by cancer or tuberculosis.

Aftercare

Normally after the material has been removed from the chest cavity and the situation is resolved, the chest drainage tube is removed. In cases where the reason for the tube was air in the pleural cavity, the tube is clamped and left in place several hours before it is removed to make sure no more air is leaking into the space. If the patient is on mechanical ventilation, the tube is often left in place until a respirator is no longer necessary. Chest drainage therapy is usually done in conjunction with treating the underlying cause of the fluid build-up.

The fluid that has been drained is examined for bacterial growth, cancer cells, pus, and blood to determine the underlying cause of the condition and appropriate treatment.

Risks

Problems can arise in the insertion of the tube if the membrane lining the chest cavity is thick or if it has many **adhesions**. The tube will not drain correctly if the chest cavity contains **blood clots** or thick secretions that are often associated with infections. Excessive bleeding may occur during the insertion and positioning of the tube. Infection may result from the procedure. **Pain** is also a common complication.

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Normal results

The gas, pus, or blood is drained from the chest cavity, and the lungs reinflate or begin to function more efficiently. The site at which the tube was inserted heals normally.

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Chest pain *see* **Angina**

Chest physical therapy

Definition

Chest **physical therapy** is the term for a group of treatments designed to improve respiratory efficiency, promote expansion of the lungs, strengthen respiratory muscles, and eliminate secretions from the respiratory system.

Purpose

The purpose of chest physical therapy, also called chest physiotherapy, is to help patients breathe more freely and to get more oxygen into the body. Chest physical therapy includes postural drainage, chest percussion, chest vibration, turning, deep breathing exercises, and coughing. It is usually done in conjunction with other treatments to rid the airways of secretions. These other treatments include suctioning, nebulizer treatments, and the administration of expectorant drugs.

Chest physical therapy can be used with newborns, infants, children, and adults. People who benefit from chest physical therapy exhibit a wide range of problems that make it difficult to clear secretions from their lungs. Some people who may receive chest physical therapy include people with **cystic fibrosis** or neuromuscular diseases like **Guillain-Barré syndrome**, progressive muscle weakness (**myasthenia gravis**), or **tetanus**. People with lung diseases such as **bronchitis**, **pneumonia**, or **chronic obstructive pulmonary disease** (COPD) also benefit from chest physical therapy. People who are likely to aspirate their mucous secretions because of diseases such as **cerebral palsy** or **muscular dystrophy** also receive chest physical therapy, as do some people who are bedridden, confined to a wheelchair, or who cannot breathe deeply because of postoperative **pain**.

Precautions

Chest physical therapy should not be performed on people with

- bleeding from the lungs
- neck or head injuries
- fractured ribs
- collapsed lungs
- damaged chest walls
- tuberculosis
- acute asthma
- recent heart attack
- pulmonary embolism
- lung abscess
- active hemorrhage
- some spine injuries
- recent surgery, open wounds, or burns

Description

Chest physical therapy can be performed in a variety of settings including critical care units, hospitals, nursing homes, outpatient clinics, and at the patient's home. Depending on the circumstances, chest physical therapy may be performed by anyone from a respiratory care therapist to a trained member of the patient's family. Different patient conditions warrant different levels of training.

Chest physical therapy consists of a variety of procedures that are applied depending on the patient's health and condition. Hospitalized patients are reevaluated frequently to establish which procedures are most effective and best tolerated. Patients receiving long term chest physical therapy are reevaluated about every three months.

Turning

Turning from side to side permits lung expansion. Patients may turn themselves or be turned by a caregiver. The head of the bed is also elevated to promote drainage if the patient can tolerate this position. Critically ill patients and those dependent on mechanical respiration are turned once every one to two hours around the clock.

Coughing

Coughing helps break up secretions in the lungs so that the mucus can be suctioned out or expectorated.

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Patients sit upright and inhale deeply through the nose. They then exhale in short puffs or coughs. Coughing is repeated several times a day.

Deep breathing

Deep breathing helps expand the lungs and forces better distribution of the air into all sections of the lung. The patient either sits in a chair or sits upright in bed and inhales, pushing the abdomen out to force maximum amounts of air into the lung. The abdomen is then contracted, and the patient exhales. Deep breathing exercises are done several times each day for short periods.

Postural drainage

Postural drainage uses the force of gravity to assist in effectively draining secretions from the lungs and into the central airway where they can either be coughed up or suctioned out. The patient is placed in a head or chest down position and is kept in this position for up to 15 minutes. Critical care patients and those depending on mechanical ventilation receive postural drainage therapy four to six times daily. Percussion and vibration may be performed in conjunction with postural drainage.

Percussion

Percussion is rhythmically striking the chest wall with cupped hands. It is also called cupping, clapping, or tapotement. The purpose of percussion is to break up thick secretions in the lungs so that they can be more easily removed. Percussion is performed on each lung segment for one to two minutes at a time.

Vibration

As with percussion, the purpose of vibration is to help break up lung secretions. Vibration can be either mechanical or manual. It is performed as the patient breathes deeply. When done manually, the person performing the vibration places his or her hands against the patient's chest and creates vibrations by quickly contracting and relaxing arm and shoulder muscles while the patient exhales. The procedure is repeated several times each day for about five exhalations.

Preparation

The only preparation needed for chest physical therapy is an evaluation of the patient's condition and determination of which chest physical therapy techniques would be most beneficial.

KEY TERMS

Coughing—Coughing helps break up secretions in the lungs so that the mucus can be suctioned out or expectorated. Patients sit upright and inhale deeply through the nose. They then exhale in short puffs or coughs. Coughing is repeated several times per day.

Deep breathing—Deep breathing helps expand the lungs and forces better distribution of the air into all sections of the lung. The patient either sits in a chair or sits upright in bed and inhales, pushing the abdomen out to force maximum amounts of air into the lung. The abdomen is then contracted, and the patient exhales. Deep breathing exercises are done several times each day for short periods.

Percussion—This consists of rhythmically striking the chest wall with cupped hands. It is also called cupping, clapping, or tapotement. The purpose of percussion is to break up thick secretions in the lungs so that they can be more easily removed. Percussion is performed on each lung segment for one to two minutes at a time.

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Aftercare

Patients practice **oral hygiene** procedures to lessen the bad taste or odor of the secretions they spit out.

Risks

Risks and complications associated with chest physical therapy depend on the health of the patient. Although chest physical therapy usually poses few problems, in some patients it may cause

- oxygen deficiency if the head is kept lowered for drainage
- increased intracranial pressure
- temporary low blood pressure
- bleeding in the lungs
- pain or injury to the ribs, muscles, or spine
- vomiting
- inhaling secretions into the lungs
- heart irregularities

Normal results

The patient is considered to be responding positively to chest physical therapy if some, but not necessarily all, of these changes occur:

- increased volume of sputum secretions
- changes in breath sounds
- improved vital signs
- improved chest x ray
- increased oxygen in the blood as measured by arterial blood gas values
- patient reports of eased breathing

ORGANIZATIONS

Cystic Fibrosis Foundation, 6931 Arlington Road, 2nd floor, Bethesda, MD, 20814, (301) 951-4422, (301) 951-6378, (800) 344-4823, info@cff.org, http://www.cff.org.

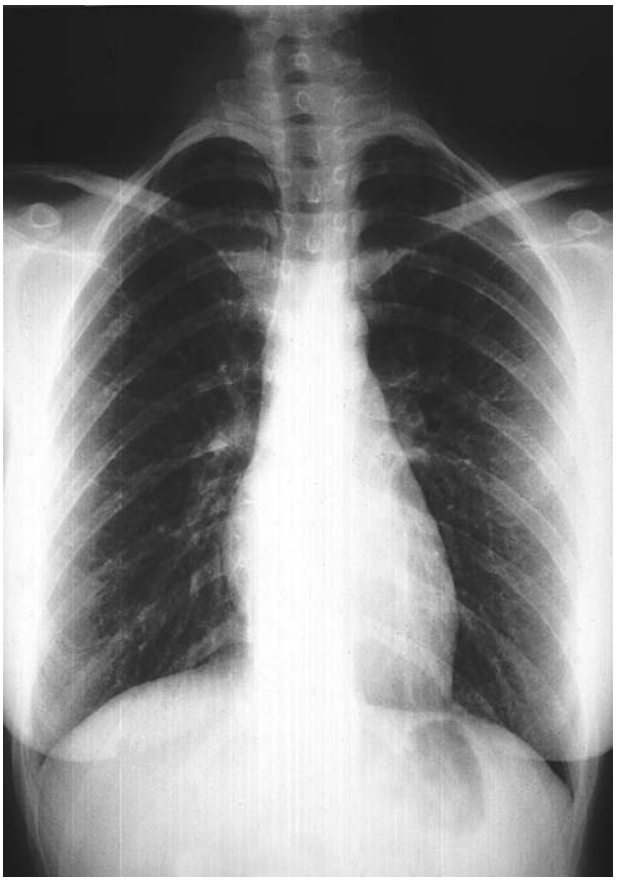
Tish Davidson, A.M.

Chest radiography *see* **Chest x ray**

Chest x ray

Definition

A chest x ray is a procedure used to evaluate organs and structures within the chest for symptoms of disease. Chest x rays include views of the lungs, heart, small portions of the gastrointestinal tract, thyroid gland, and the bones of the chest area. X rays are a form of radiation that can penetrate the body and produce an image on an x-ray film. Another name for the film produced by x rays is radiograph.



Normal adult chest x ray. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Purpose

Chest x rays are ordered for a wide variety of diagnostic purposes. In fact, this is probably the most frequently performed type of x ray. In some cases, chest x rays are ordered for a single check of an organ's condition, and at other times, serial x rays are ordered to compare to previous studies. Some common reasons for chest x rays include the following.

Pulmonary disorders

Chest films are frequently ordered to diagnose or rule out **pneumonia**. One type, **tuberculosis**, can be observed on chest x rays, as can cardiac disease and damage to the ribs or lungs. Other pulmonary disorders such as **pneumothorax** (presence of air or gas in

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KEY TERMS

Bronchi—Plural of bronchus. The air passages in the lungs through which inhaled air passes on its way through the lungs.

Diaphragm—The large muscle that is located between the abdomen and the chest area. The diaphragm aids in breathing.

Gastrointestinal—The digestive organs and structures, including the stomach and intestines.

Interstitial lung disease—About 180 diseases fall into this category of breathing disorders. Injury or foreign substances in the lungs (such as asbestos fibers) as well as infections, cancers, or inherited disorders may cause the diseases. They can lead to breathing or heart failure.

Lymphoid—Tissues relating to the lymphatic system. A thin, yellowish fluid called lymph fluid, travels throughout the body. The lymphatic system helps control fluids in the body.

Portable chest x ray—An x ray procedure taken by equipment that can be brought to the patient. The resulting radiographs may not be as high in quality as stationary x-ray radiographs, but allow a technologist to come to the patient.

Pulmonary—Refers to the lungs and the breathing system and function.

Serial x rays—A number of x rays performed at set times in the disease progression or treatment intervals. The radiographs will be compared to one another to track changes.

Sternum—Also referred to as the breast bone, this is the long flat bone in the middle of the chest.

Thorax—The chest area, which runs between the abdomen and neck and is encased in the ribs.

X ray—A form of electromagnetic radiation with shorter wavelengths than normal light. X rays can penetrate most structures.

the chest cavity outside the lungs) or **emphysema** may be detected or evaluated through the use of chest x ray.

Cancer

A chest x ray may be ordered by a physician to check for possible tumors of the lungs, lymphoid tissue, or bones of the thorax. These may be primary tumors, or the areas in which **cancer** originates in the body. X rays also check for secondary spread of cancer from another organ to the chest.

Cardiac disorders

While less sensitive than **echocardiography**, chest x ray can be used to check for disorders such as congestive **heart failure** or **pulmonary edema**.

Other

Chest x rays are used to see foreign bodies that may have been swallowed or inhaled, and to evaluate response to treatment for various diseases. Often the chest x ray is also used to verify correct placement of chest tubes or catheters. Chest x rays can be used to check for fluid surrounding the lungs (**pleural effusion**).

Description

Routine chest x rays consist of two views, the frontal view (referred to as posterioranterior or PA) and the lateral (side) view. It is preferred that the patient stand for this exam, particularly when studying collection of fluid in the lungs.

During the actual time of exposure, the technologist will ask the patient to hold his or her breath. It is very important in taking a chest x ray to ensure there is no motion that could detract from the quality and sharpness of the film image. The procedure will only take a few minutes and the time patients must hold their breath is a matter of a few seconds.

The chest x ray may be performed in a physician's office or referred to an outpatient radiology facility or hospital radiology department. In some cases, particularly for patients who cannot get out of bed, a portable chest x ray may be taken. Portable films are sometimes of poorer quality than those taken with permanent equipment, but are the best choice for some patients or situations when the patient cannot be moved or properly positioned for the chest x ray. Patients confined to bed may be placed in as upright a position as possible to get a clear picture, particularly of chest fluid.

Preparation

There is no advance preparation necessary for chest x rays. Once the patient arrives in the exam area, a hospital gown will replace all clothing on the upper body and all jewelry must be removed.

Aftercare

No aftercare is required by patients who have chest x rays.

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Risks

The only risk associated with chest x ray is minimal exposure to radiation, particularly for pregnant women and children. Those patients should use protective lead aprons during the procedure. Technologists are cautioned to check carefully for possible dislodging of any tubes or monitors in the chest area from the patient's placement during the exam.

Normal results

A radiologist, or physician specially trained in the technique and interpretation of x rays, will evaluate the results. A normal chest x ray will show normal structures for the age and medical history of the patient. Findings, whether normal or abnormal, will be provided to the referring physician in the form of a written report.

Abnormal findings on chest x rays are used in conjunction with a physician's physical exam findings, patient medical history, and other diagnostic tests, including laboratory tests, to reach a final diagnosis. For many diseases, chest x rays are more effective when compared to previous chest x-ray studies. The patient is asked to help the radiology facility in locating previous chest radiographs from other facilities.

Pulmonary disorders

Pneumonia shows up on radiographs as patches and irregular areas of density (from fluid in the lungs). If the bronchi (air passages in the lungs which are usually not visible) can be seen, a diagnosis of bronchial pneumonia may be made. Shifts or shadows in the hila (lung roots) may indicate enlarged lymph nodes of a malignancy. Widening of the spaces between ribs and increased lucency of the lung fields suggests emphysema. Other pulmonary diseases may also be detected or suspected through chest x ray.

Cancer

In nearly all patients with lung cancer, some sort of abnormality can be seen on a chest radiograph. Hilar masses (enlargements at that part of the lungs where vessels and nerves enter) are one of the more common symptoms as are abnormal masses and fluid buildup on the outside surface of the lungs or surrounding areas. Interstitial lung disease, which is a large category of disorders, many of which are related to exposure of substances (such as asbestos fibers), may be detected on a chest x ray as increased prominence of the interstitial pattern, often in the lower portions of the lungs.

Other

Congestive heart failure and other cardiac diseases may be indicated on the view of a heart and lung in a chest radiograph. **Fractures** of the sternum and ribs are sometimes detected as breaks on the chest x ray, though often dedicated bone films are needed. In some instances, the radiologist's view of the diaphragm may indicate an abdominal problem. Foreign bodies that may have been swallowed or inhaled can usually be located by the radiologist, as they will look different from any other tissue or structure in the chest. Serial chest x rays may be ordered to track changes over a period of time, usually to evaluate response to therapy of a malignancy.

ORGANIZATIONS

American Lung Association, 1740 Broadway, New York, NY, 10019, (800) 586-4872, http://www.lungusa.org.

National Heart, Lung and Blood Institute, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 251-1222, http://www.nhlbi.nih.gov.

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Chickenpox

Definition

Chickenpox is a common and highly contagious childhood disease that also occasionally affects adults. It is caused by the varicella–zoster virus. Chickenpox produces an itchy, blistery rash that typically lasts about a week and is sometimes accompanied by **fever** or other symptoms.

Demographics

Chickenpox is a common **infectious disease** with an estimated 60 million cases occurring annually worldwide. In temperate regions, the disease usually affects children under age 10; in tropical regions, adult cases are more common. The rate of infection is independent of race or gender, but is much lower in countries where **vaccination** against the disease is practiced. For example, before a vaccine against chickenpox was introduced in the United States in 1995, about 99% of the population got chickenpox by age 30. A decade after the vaccine was introduced, only about 10% of Americans who had not already had chickenpox got the disease.

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A five-year-old girl with chickenpox. The first symptom of the disease is the rash that is evident on the girl's back and neck. The rash and the mild fever that accompanies it should disappear in a week or two. *((Jim Selby/Photo Researchers, Inc.)*

Description

Chickenpox is very contagious. The virus is transmitted through either direct contact or coughing and sneezing. A person with chickenpox is contagious from one to two days before the outbreak of the chickenpox rash to about six days after the rash erupts. After being exposed, a person will show symptoms of chickenpox within 10–21 days. Individuals normally get chickenpox only once in a lifetime.

Most cases of chickenpox contracted by healthy children are mild, with the child experiencing seven to 10 days of discomfort. However, in children who are immunocompromised, such as those with leukemia, **AIDS**, or who are undergoing immunosuppression therapy in connection with an organ transplant, chickenpox can have serious complications including **death**. For example, the number of children with leukemia who die of complications from chickenpox is estimated at 7% to 28%. This compares to a death rate of about seven in every 100,000 healthy children. Abnormalities may occur in the fetuses of women who develop chickenpox during the first 22 weeks of **pregnancy**.

Risk factors

The greatest risk factor for acquiring chickenpox is the failure to vaccinate; almost every unvaccinated person exposed to the virus develops chickenpox. It may not be safe to vaccinate some children with compromised immune systems, leaving them highly vulnerable to both the disease and severe complications including death. Pregnant women who develop chickenpox during the first half of their pregnancy put the fetus at risk for **birth defects**.

Causes and symptoms

Chickenpox is caused by the varicella–zoster virus, a member of the herpes virus family. It easily spreads through the air or by direct contact with an infected person.

A case of chickenpox usually starts without warning or with only a mild fever and a slight feeling of illness. Within a few hours or days, small red spots begin to appear on the scalp, neck, or upper half of the trunk. After a further 12–24 hours, the spots typically become itchy, fluid–filled bumps called vesicles, which continue to appear for the next two to five days. In any area of skin, lesions in a variety of stages can be seen. These blisters can spread to cover much of the skin, and in some cases may be found inside the mouth, nose, ears, vagina, or rectum. Some people develop only a few blisters, but in most cases the number reaches 250–500.

The blisters soon begin to form scabs and fall off. Scarring usually does not occur unless the blisters have been scratched and become infected. Occasionally a minor and temporary darkening of the skin (called **hyperpigmentation**) develops around some of the blisters. The degree of itchiness can range from barely noticeable to extreme. Some people who contract chickenpox also have headaches, abdominal **pain**, or a fever. Full recovery usually takes five to 10 days after the first symptoms appear. The most severe cases of the disease tend to be found among adolescents and adults.

Although for most people chickenpox is no more than a matter of a few days of discomfort, some groups are at risk for developing complications, the most

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KEY TERMS

Acetaminophen—A drug for relieving pain and fever. Tylenol is the most common example.

Acyclovir—An antiviral drug used for combating chickenpox and other herpes viruses.

Dehydration—Excessive water loss by the body.

Encephalitis—A rare viral infection that causes inflammation in the membranes lining the brain.

Hepatitis—A disease that causes inflammation of the liver and serious liver damage.

Immune system—A mechanism that protects the body from foreign substances, foreign cells, and pathogens (viruses, bacteria). The thymus, spleen, lymph nodes, white blood cells, including the B cells and T cells, and antibodies are involved in the immune response, which aims to destroy these foreign bodies.

Immunocompromised—Having a damaged immune system.

Passive immunity—Immunity produced by providing a person with antibodies from another source than self. Infants are born with passive immunity acquired from their mothers.

Pneumonia—A disease that causes inflammation of the lungs. It can be caused by a bacterium or a virus.

Pus—A thick yellowish or greenish fluid containing inflammatory cells. Usually caused by bacterial infection.

Reye's syndrome—A rare but often fatal disease that involves the brain, liver, and kidneys. It may be brought on by giving salicylates to children (but not adults) who have a viral infection.

Salicylates—A group of drugs that includes aspirin and related compounds. Salicylates are used to relieve pain, reduce inflammation, and lower fever.

Shingles—A disease also called herpes zoster that causes a rash and a very painful nerve inflammation. An attack of chickenpox eventually gives rise to shingles in about 20% of the population.

Vaccination—Injection of a killed or weakened microbe in order to stimulate the immune system against the microbe, thereby preventing disease. Vaccinations, or immunizations, work by stimulating the immune system, the natural disease–fighting system of the body. The healthy immune system is able to recognize invading bacteria and viruses and produce substances (antibodies) to destroy or disable them. Vaccinations prepare the immune system to ward off a disease. To immunize against viral diseases, the virus used in the vaccine has been weakened or killed.

Varicella–zoster immune globulin (VZIG)—A substance that can reduce the severity of chickenpox symptoms.

Virus—A tiny particle that can cause infections by duplicating itself inside a cell using the cell's own reproductive mechanisms. Antibiotics are generally ineffective against viruses, though antiviral drugs exist for some viruses, including chickenpox.

common of which are bacterial infections of the blisters, **pneumonia**, **dehydration**, **encephalitis**, and hepatitis:

- Infants. Complications occur much more often among children less than one year old than among older children. The threat is greatest to newborns, who are more at risk of death from chickenpox than any other group. Under certain circumstances, children born to mothers who contract chickenpox just before delivery develop the disease and face an increased possibility of dangerous complications, including brain damage and death. If the infection occurs during the first half of pregnancy, there is a small risk of the baby being born with congenital abnormalities.
- Immunocompromised children. Children whose immune systems have been weakened by a genetic disorder, disease, or medical treatment usually experience the most severe symptoms of any group. They have the second–highest rate of death from chickenpox.
- Adults and children age 15 and older. Among this group, typical symptoms of chickenpox tend to be more severe, and the risk of complications is much higher than among young children. Adults are ten times more likely than children to require hospitalization from chickenpox.

Diagnosis

For otherwise healthy children, especially those with recent exposure to the disease, diagnosis usually can be made at home, by a school nurse, or by a doctor if the child's parent or caregiver is unsure that the

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disease is chickenpox. A doctor should be called immediately if:

- The child has a chronic disease or is undergoing a treatment that weakens the immune system.
- The child's fever goes above 102°F (38.9°C) or takes more than four days to disappear.
- The child's blisters appear infected. Signs of infection include pus drainage or excessive redness, warmth, tenderness, or swelling.
- The child seems nervous, confused, unresponsive, or unusually sleepy; complains of a stiff neck or severe headache; shows signs of poor balance or has trouble walking; finds bright lights hard to look at; is having breathing problems or is coughing a lot; is complaining of chest pain; is vomiting repeatedly; or is having convulsions. These may be signs of Reye's syndrome or encephalitis, two rare but potentially very dangerous conditions.

Treatment

Home remedies

Treatment usually takes place at home and focuses on reducing discomfort and fever. The individual should drink plenty of fluids and eat simple, nutritious foods. Soups, herbal teas, and fruit juices are good choices. If mouth blisters make eating or drinking an unpleasant experience, cold drinks and soft, bland foods can ease the discomfort.

Applying wet compresses or bathing in cool or lukewarm water once a day can help the itch. Adding four to eight ounces of baking soda or one to two cups of oatmeal to the bath may help ease **itching**. Oatmeal bath packets are sold by pharmacies. Only mild soap should be used in the bath. Patting, not rubbing, is recommended for drying off to prevent irritating the blisters. Calamine lotion also helps to reduce itchiness. Because scratching can cause blisters to become infected and lead to scarring, a child's nails should be cut short. Older children need to be warned not to scratch. For babies, light mittens or socks on the hands can help guard against scratching.

Drugs

Fever and discomfort can be reduced by **acetaminophen** (Tylenol, Tempera). **Aspirin** and any medications that contain aspirin or other salicylates must not be used for children with chickenpox because they appear to increase the chances of developing **Reye's syndrome**. The best idea is to consult a doctor or pharmacist if unsure about which medications are safe.

Because chickenpox is a viral disease, **antibiotics** are ineffective against it, although antibiotics may be prescribed if blisters become infected.

Children who are immunocompromised or healthy children who develop serious complications are often treated with the antiviral drug acyclovir (Zovirax), which is given intravenously. This drug may also be used under certain circumstances in adolescents and adults with chickenpox.

A substance called varicella–zoster immune globulin (VZIG), which reduces the severity of chickenpox symptoms, may be used to treat immunocompromised children and others at high risk of developing complications. VZIG is produced from a **gamma globulin** from blood of recently infected individuals. It provides some degree of passive immunity when administered by injection within 96 hours of known or suspected exposure to the disease. It is not useful if given more than 96 hours after exposure.

Alternative

Alternative practitioners recommend a variety of treatments with the aim of reducing discomfort, strengthening the immune system, and speeding healing. An alternative practitioner should be consulted about the best choice for each individual.

SUPPLEMENTS. Vitamin A may help to heal damaged skin. Vitamin C and bioflavonoids may help to reduce fever and stimulate the immune system. Zinc stimulates the immune system and is thought to promote healing; however zinc can cause **nausea and vomiting**. **Calcium** and magnesium may help to relieve restlessness and sleeping difficulties, but magnesium has a laxative effect at high doses.

HERBALS AND CHINESE MEDICINE. The following herbals may used internally (ingested) to treat chickenpox:

- Echinacea and goldenseal (*Hydrastis canadensis*) support the immune system and soothe skin and mucous membranes. Echinacea is also thought to have antiviral properties.
- Chamomile tea is a sleep aid.
- Chinese cucumber (*Trichosanthes kirilowii*) root tea is used to relieve symptoms of chickenpox.
- Elder flower, peppermint, and yarrow may reduce fever.
- Garlic has antiviral activity.
- Mullein (*Verbascum thapsus*).
- Yin Qiao Jie Du Wan (Honeysuckle and Forsythia Pill).

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- Ban Lan Gen Chong Ji (Isatis Infusion).

The following herbals are used externally (applied to skin) to treat chickenpox:

- Aloe leaf, calendula, and plantain relieve the itching of the chickenpox rash.
- Turmeric powder mixed with lime juice treats chickenpox rash.
- Garlic helps clear skin infection.

OTHER ALTERNATIVE REMEDIES. Homeopathic remedies are selected on a case–by–case basis. Some common remedy choices are apis, aconitum, belladonna, calendula, antimonium tartaricum, pulsatilla,*Rhus toxicodendron*, and sulphur.

The **acupressure** points Four Gates, Large Intestine 11, Spleen 10, and Stomach 36 help alleviate symptoms associated with chickenpox.

Alternative treatments should be used with care, as the benefits of many such treatments have not been confirmed by scientific research.

Prognosis

Most cases of chickenpox run their course within a week. Although complications from chickenpox generally are rare, the most common one is bacterial infection of the skin, initiated at the site of a chickenpox blister that has broken or was scratched open. Other complications include viral or bacterial pneumonia and rarely encephalitis (swelling of the brain). Anyone with a weakened immune system, lung diseases, **eczema** or other skin conditions, infants under one year of age, premature infants whose mothers have not had chickenpox, and newborns whose mothers had chickenpox around the time of delivery are at highest risk for developing complications are.

After symptoms subside, the varicella–zoster virus lies dormant in nerve cells where it may be reactivated years later by disease or age–related weakening of the immune system. The result is **shingles** (herpes zoster), a very painful rash and nerve inflammation, that develops in between 10% and 20% of all people who have ever had chickenpox. Shingles is particularly common in people over age 50. Shingles cause **numbness**, itching, or severe pain in skin areas where the affected nerve root is located. Within about three days cause clusters of blisters to form along the affected nerve. The blisters last two to three weeks. A vaccine against shingles is recommended for individuals age 60 and older.

Prevention

Vaccination against the varicella–zoster virus is the best way of preventing chickenpox. Vaccination has been proven to be about 85% effective for preventing all cases of chickenpox and about 95% effective in preventing severe cases. Side effects of the vaccine normally are limited to occasional soreness or redness at the injection site. The United States Centers for Disease Control and Prevention (CDC) guidelines state that the vaccine should be given to all children (with the exception of certain high–risk groups) at 12–18 months of age, preferably when they receive their measles–mumps–rubella (MMR) vaccine. For older children, up to age 12, the CDC recommends vaccination when a reliable determination that the child in question has already had chickenpox cannot be made. Vaccination also is recommended for any older child or adult considered susceptible to the disease, particularly those, such as health care workers and women of childbearing age.

A single dose of the vaccine was once thought sufficient for children up to age 12; older children and adults received a second dose four to eight weeks later. However, an outbreak at a daycare center in 2000 brought concern in the medical community about the permanence of immunity and the necessity of a second vaccination for younger children, since many of the affected children had already received a single dose of the vaccine. Since 2006, a second dose of the vaccine has become standard.

The chickenpox vaccine is not recommended for pregnant women, and women should delay pregnancy for three months following a complete vaccination. The vaccine is useful when given early after exposure to chickenpox and, if given in the midst of the incubation period, it may be preventative.

While there was initial concern regarding the vaccine's safety and effectiveness when first released, the vaccination has gained acceptance, and many states require it for admittance into daycare or public school. In 2004, 87.5% of toddlers ages 19–35 months in the United States were immunized; up nearly 20% from 2000.

The vaccine was approved for use in Australia in 2000 and is recommended for children starting at age 18 months. Between 2000 and 2006, 1.3 million doses of the vaccine have been given in Australia, with 342 reports of adverse effects and 115 reports of the vaccine' giving only partial protection, according to the Australian Adverse Drug Reaction Committee.

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MedlinePlus. "Chickenpox." U.S. National Library of Medicine. (January 27, 2010). http://www.nlm.nih.gov/medlineplus/chickenpox.html (accessed September 17, 2010).

ORGANIZATIONS

American Academy of Family Physicians (AAFP), PO Box 11210, Shawnee Mission, KS, 66207, (913) 906–6000, (800) 274–2237, (913) 906–6075, http://familydoctor.org.

American Academy of Pediatrics (AAP), 141 Northwest Point Blvd., Elk Grove Village, IL, 60007–1098, (847) 434–4000, (847) 434–8000, http://www.aap.org.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Rd., Atlanta, GA, 30333, (404) 639–3534, (800) CDC–INFO ((800) 232–4636). TTY: (888) 232–6348, inquiry@cdc.gov, http://www.cdc.gov.

Ken Wells
Tish Davidson, A.M.

Child abuse

Definition

Child abuse, sometimes called child maltreatment, describes four types of actions toward children: physical abuse, **sexual abuse**, psychological abuse, and neglect. In many cases, the same child experiences more than one type of abuse. The abusers can be parents or other family members, caregivers such as teachers or babysitters, acquaintances (including other children), and (in very rare instances) strangers.

Demographics

Child abuse was once viewed as a minor social problem affecting only a handful of American children. However, in the late twentieth century, issues of child welfare came under scrutiny by the media, law enforcement, and the helping professions. This increase in public and professional awareness led to a sharp rise in the number of reported cases of child abuse. Today child abuse is recognized as a problem that occurs among households of all racial, ethnic, and income levels, although the incidence of reported cases is higher in low-income households where adult caregivers experience greater financial **stress** and social difficulties, have less education and less understanding of child development, and may have less access to social services. In addition, children of parents who are substance abusers are more likely to experience abuse than children living in households where there is no **substance abuse**. Many child abusers were themselves abused as children.

Statistically, it is difficult to find reliable national figures for cases of child abuse because each state keeps its own records and has its own definitions of what constitutes abuse. Child abuse almost always occurs in private, and because abuse often is hidden from view and its victims may be too young or too frightened to speak out, experts suggest that its true prevalence is probably greater than the official data indicate. However, based on information states reported to the United States Department of Health and Human Services Administration for Children and Families, in 2007 Child Protective Services (CPS) investigated almost reports of child maltreatment of 3.5 million children. Of these, approximately 794,000 children were documented victims. Fifty-nine percent were victims of neglect, 10.8% of physical abuse, 7.6% of sexual abuse, 4.2% of psychological maltreatment, less than 1% of medical neglect, and 13.1 percent were victims of multiple maltreatments. Victims were split almost evenly between girls and boys.

Nearly 70% of abused children were maltreated by a parent, and almost three-quarters of these children were victims of repeated maltreatment. In addition, the National Child Abuse and Neglect Data System (NCANDS) reported that an estimated 1,760 children (2.35 children per 100,000) died from an injury where abuse or neglect was the cause or a contributing factor. Of these, more than 75% were under age 4, with the largest number of deaths occurring in infants under one year old.

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Child abuse signs and symptoms

Although these signs do not necessarily indicate that a child has been abused, they may help adults recognize that something is wrong. The possibility of abuse should be investigated if a child shows a number of these symptoms, or any of them to a marked degree:

Sexual abuse

Being overly affectionate or knowledgeable in a sexual way inappropriate to the child's age
Medical problems such as chronic itching, pain in the genitals, or venereal diseases
Other extreme reactions, such as depression, self-mutilation, suicide attempts, running away, overdoses, or anorexia
Personality changes, such as becoming insecure or clingy
Regressing to younger behavior patterns such as thumb sucking or bringing out discarded cuddly toys
Sudden loss of appetite or engaging in compulsive eating
Being isolated or becoming withdrawn
Inability to concentrate
Lack of trust or fear toward someone they know well, such as not wanting to be alone with a babysitter or specific family member
Starting to wet the bed again or having nightmares
Anxiety about clothing being removed
Suddenly starting to draw sexually explicit pictures
Trying to be "ultra-good" or perfect; overreacting to criticism

Physical abuse

Unexplained recurrent injuries or burns
Improbable excuses or refusal to explain injuries
Wearing clothes to cover injuries, even in hot weather
Refusal to undress for gym
Bald patches
Chronic running away
Fear of medical help or examination
Self-destructive tendencies
Aggression toward others
Fear of physical contact; shrinking back if touched
Admitting that they are punished, but the punishment is excessive (such as a child being beaten every night to make him/her study)
Fear of suspected abuser being contacted

Psychological abuse

Physical, mental, and psychological developmental lags
Sudden speech disorders
Continual self-depreciation (e.g., "I'm stupid, ugly, worthless," etc.)
Overreaction to mistakes
Extreme fear of any new situation
Inappropriate response to pain (e.g., "I deserve this")
Neurotic behavior (e.g., rocking, hair twisting, self-mutilation)
Extremes of passivity or aggression

Neglect

Constant hunger
Poor personal hygiene
No social relationships
Constant tiredness
Poor state of clothing
Compulsive scavenging
Emaciation
Untreated medical problems
Destructive tendencies

A child may be subjected to a combination of different kinds of abuse. It is also possible that a child may show no outward signs and hide what is happening from everyone.

(Table by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)

Description

Physical abuse

Physical abuse is nonaccidental infliction of physical injury to a child. Legal definitions of physical child abuse vary from state to state, but injuries requiring medical attention typically are regarded as abusive. Physical abuse takes many forms, including cuts, **bruises**, **burns**, broken bones, **poisoning**, and internal injuries. Nonetheless, difficulties associated with defining the line between discipline and abuse are well known. Many states explicitly note that spanking "when administered in a reasonable manner" does not constitute abuse. Thus, how severely parents can inflict physical punishment upon their children without it being considered abusive remains subject to interpretation.

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The physical abuser is usually a family member or other caregiver, and is likely to be male. The injuries can be inflicted by punching, kicking, biting, burning, beating, or use of a weapon such as a baseball bat or knife. A rare form of physical abuse is **Munchausen syndrome** by proxy, in which a caregiver (most often the mother) seeks attention by intentionally making the child sick or appear to be sick.

Sexual abuse

Children are sexually abused when they experience contact that is for the sexual gratification of an adult or a significantly older or dominant child when they are younger than the legal age of consent or at a stage of development at which they do not possess sufficient maturity to understand the nature of the acts and therefore to provide informed consent. Abusers may use coercion or deceptive manipulation, but often physical force is not necessary since the perpetrator is likely to be someone with whom the child has a trusting relationship and who is in a position of authority over the child. In many states, sexual activity is automatically assumed to be abuse when a defined age difference exists between the older abuser and the younger (minor) victim independent of any consent the victim may have given.

Sexual behaviors can include touching breasts, genitals, and buttocks while the victim is either dressed or undressed. Sexual abuse behavior also includes cunnilingus, fellatio, or penetration of the vagina or anus with sexual organs or objects. Sexual abuse does not have to involve any actual touching. Children can be coerced into disrobing and exposing themselves or watching adults disrobe or engage in sexual activity. Pornographic photography or videography also are forms of sexual abuse of children.

The U.S. Department of Justice estimates that one in six victims of a **sexual assault** is under age 12. Sexual abuse victims can be either boys or girls. Most, but not all, perpetrators are male. Despite publicity surrounding cases where a child is sexually assaulted by a stranger, almost all sexual abuse against children is perpetrated by a family member (e.g. father, stepfather, aunt, uncle, sibling, cousin) or family intimate (e.g., live-in lover or friend of the parent). Perpetrators go to great lengths to conceal sexual abuse. Children who have been sexually abused may not report the behavior due to threats, shame, or to a lack of understanding of what has happened.

Rape is the most violent form of sexual abuse. Rape is the perpetration of an act of sexual intercourse when:

- will is overcome by force or fear (from threats, use of weapons, or use of drugs).
- mental impairment renders the victim incapable of rational judgment.
- if the victim is below the legal age established for consent. According the U.S. Department of Justice, 54% of all rapes are of women under age 18.

Psychological abuse

Abuse of children is not limited to the physical body. Psychological abuse encompasses rejecting, ignoring, criticizing, belittling, humiliating, threatening the child with violence, or otherwise terrorizing the child, all of which have the effect of eroding the child's self-esteem and sense of security. It also can include isolating the child from friends or other family members or destroying the child's property.

Psychological abuse may be the result of actions not directed specifically at the child. The prevalence of domestic violence exposes children to intimidating and frightening scenes every day. Many children live in homes where domestic violence is an ongoing problem that they witness regularly often as a result of being "caught in the middle" of a parental altercation. Children who observe violence react with many of the same psychological symptoms as children who have experienced it directly. Psychological abuse often accompanies other types of abuse. It is difficult to prove and rarely is reported.

Neglect

Neglect is the failure to satisfy a child's basic needs. About 60% of cases of maltreatment documented by CPS involve neglect. Neglect can assume many forms. Physical neglect is the failure (beyond the constraints imposed by poverty) to provide adequate food, clothing, shelter, or supervision. Children may live in filthy conditions or situations where food is not provided, or where they develop infections or other medical conditions that go untreated. Failure to send children to school or otherwise provide for their education may also be considered neglect. Psychological neglect is the failure to satisfy a child's normal psychological needs and/or behavior that damages a child's normal psychological development (e.g., permitting drug abuse in the home, having the child witness domestic violence).

Risk factors

The greatest risk factor for abuse is being young. In 2007, almost 32% of victims of maltreatment were under age four while another 24% were between ages

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four and seven. The **death** rate from abuse is skewed even more heavily toward the young with 42.2% of deaths in 2007 occurring in children under one year old and 33.5% in children between the ages of one and three years.

Children who are handicapped and those who are nonrhythmic (that is, with unpredictable eating and sleeping patterns), are more likely to be abused. Similarly, children who are distractible, impulsive, or who have high activity levels are more likely to experience physical abuse.

Causes and symptoms

Sociocultural factors contributing to abuse

Poverty is the sociocultural factor most strongly linked to abuse. Although physical abuse occurs at all income levels, it happens more often in very poor families. It is true that in middle-class families, child injuries are treated by a sympathetic personal physician who may be less likely to diagnose and report abuse-related injuries than the physician in the emergency room who is more likely to treat poor families. Even with such reporting bias, however, poverty seems strongly linked to abuse. It seems that the frustrating effects of poverty on parents are instrumental in creating situations for parents' abuse.

Physical crowding, more likely to occur in poverty, is also associated with abuse. If too many people share a small living space, severe punishment of children as a means of maintaining control is more likely.

Job loss and dissatisfaction are often associated with child abuse. Higher rates of abuse exist in military compared to non-military families. It is generally felt that the link between these environmental stressors and abuse is strengthened by the absence of social support networks that might otherwise buffer the family against adversity. Having no one to assist with child care and no one to question the use of severe discipline increase the chance that a parent may injure a child.

Pedophiles exist in all economic and cultural groups. Psychologically, however, they share certain traits. Pedophiles often have a history of being abused themselves, and abusing other children seems to be triggered by increased life stressors, such as marital problems, job layoffs, or abuse of drugs.

Caregiver factors

Parents who were themselves abused as children are more likely to abuse their own children. However, not every parent who was abused becomes an abuser; some parents go to great lengths to insure that they never harm their children.

Parents who abuse their children are likely to be younger than the average parent. They are more likely to be single parents. Having mental illness, such as depression, or abusing drugs or alcohol also makes a parent more likely to abuse a child.

Abusive parents socialize differently from nonabusive parents. Nonabusive parents tend to use ignoring or time-out procedure, whereas abusive parents tend to shout, threaten, and spank. Some forms of child abuse escalate over time, with the parent spanking harder and more frequently to get the same effect or resorting to abuse to get results. Female caregivers inflict more soft tissue injuries, broken bones, and internal injuries than male caregivers. Severe injuries from a single, explosive incident in which the child is shaken, thrown, or struck are more likely to involve male caregivers.

Abusive parents often expect the child to perform behaviors he or she is not yet capable of performing. Parents who abuse their young children expect them to be able to control their impulses, recall and obey complex parental rules, and perform mature chains of behavior such a getting up, washing, and getting dressed by themselves. Nonabusive parents recognize that toddlers and preschool children are incapable of such behaviors. Understanding the limitations of a young child's memory, ability to be controlled by words, impulse control, and attention span is essential to developing reasonable expectations for the child. Parents who expect behavior the child cannot deliver are apt to progressively increase their control techniques in order to get the child to comply.

Abusive discipline is often the result of the belief that the young child is capable of better behavior and that he or she is deliberately misbehaving to cause the parent difficulty. Such parents often claim that their 18-month-old could stay clean if she wanted to but she dirties her pants just to make more work for the mother. Abusive parents who believe a child has chosen to misbehave inflict more punishment on their children than parents who accurately recognize when a child's behavior is not intentional.

Such abusive parents also often believe that effective parenting involves maintaining tight control over the child. A mother who can toilet train her child early and keep the child in line at the grocery store is viewed by abusive parents as a "good" mother. Closely tied to beliefs about the importance of control are aphorisms such as "spare the rod, spoil the child" and "respect

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comes through fear," which indicate that children learn best through the application of force.

Another belief abusive parents often hold is that their children should engage in reciprocal parenting. They believe that if they sometimes comfort, wait on, and take care of the child, the child should do the same for them. Such beliefs fit with abusive parents' lack of awareness of children's developmental capabilities and may also stem from the parents' own immaturity and lack of support from other adults. Regardless of the source, when such expectations are not met by the child, the parent often responds with anger and hostility.

Emotion

Anger is the most frequent trigger for parental abuse. Abusive parents appear to have a lower threshold for childish behaviors than average parents. Abusive parents are more upset by the same child cues than nonabusive parents. Thus, child behaviors that are merely irritating to average parents are infuriating to abusive parents. Finally, abusive parents may have less control over their anger than nonabusive parents, either because they are unaware of their level of anger, because they are chronically angry, or because they lack anger management skills.

When considering how emotion influences child abuse, it seems important to consider positive emotions as well. Abusive parents experience their children as less rewarding than nonabusive parents. In observation, abusive parents touch their children less, cuddle them less, less frequently call the affectionate names ("honey," "sweetheart"), and smile less at their children. Nonabusive parents respond flexibly to their children, letting the child lead the play interaction. Even in play, abusive parents have expectations that their children seem unable or unwilling to fulfill, making play a disagreeable chore rather than a rewarding endeavor. Abusive parents seem trapped by their own lack of skills, limited developmental understanding, inappropriate expectations, high negative emotion, and low enjoyment of the child.

Symptoms

Although these signs do not necessarily indicate that a child has been abused, they may help adults recognize that something is wrong. The possibility of abuse should be investigated if a child shows a number of these symptoms, or any of them to a marked degree:

Sexual Abuse

- Being overly affectionate or knowledgeable in a sexual way inappropriate to the child's age
- Medical problems such as chronic itching, pain in the genitals, venereal diseases
- Other extreme reactions, such as depression, self-mutilation, suicide attempts, running away, overdoses, anorexia
- Personality changes such as becoming insecure or clingy
- Regressing to younger behavior patterns such as thumb sucking or bringing out discarded cuddly toys
- Sudden loss of appetite or compulsive eating
- Being isolated or becoming withdrawn
- Inability to concentrate
- Lack of trust or fear someone they know well, such as not wanting to be alone with a babysitter or specific family member
- Starting to wet bed again, day or night/nightmares
- Become worried about clothing being removed
- Suddenly starting to draw sexually explicit pictures
- Trying to be "ultra-good" or perfect; overreacting to criticism

Physical Abuse

- Unexplained recurrent injuries or burns
- Improbable excuses or refusal to explain injuries
- Wearing clothes to cover injuries, even in hot weather
- Refusal to undress for gym
- Bald patches
- Chronic running away
- Fear of medical help or examination
- Self-destructive tendencies
- Aggression toward others
- Fear of physical contact; shrinking back if touched
- Admitting that they are punished, but the punishment is excessive (such as a child being beaten every night to make him/her study)
- Fear of suspected abuser being contacted

Psychological Abuse

- Physical, mental, and psychological developmental lags
- Sudden speech disorders
- Continual self-depreciation (e.g.,"I'm stupid, ugly, worthless")
- Overreaction to mistakes
- Extreme fear of any new situation
- Inappropriate response to pain (e.g., "I deserve this")
- Neurotic behavior (e.g., rocking, hair twisting, self-mutilation)

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KEY TERMS

Pedophile—A person who sexually abuses children.

- Extremes of passivity or aggression

Neglect

- Constant hunger
- Poor personal hygiene
- No social relationships
- Constant tiredness
- Poor state of clothing
- Compulsive scavenging
- Emaciation
- Untreated medical problems
- Destructive tendencies

A child may be subjected to a combination of different kinds of abuse. It is also possible that a child may show no outward signs and hide what is happening from everyone.

Diagnosis

Doctors and many other professionals who work with children are required by law to report suspected abuse to their state's CPS agency. Abuse investigations often are a group effort involving medical personnel, social workers, police officers, and others. Some hospitals and communities maintain child protection teams that respond to cases of possible abuse. Careful questioning of the parents is crucial, as is interviewing the child (if he or she is capable of being interviewed). Trained investigators must ensure, however, that their questioning does not further traumatize the child and also that their style of questioning does not prompt the child to give the answers the child thinks the questioner wants rather than accurate answers. A **physical examination** for signs of physical or sexual abuse or of neglect is necessary and may include x rays, blood tests, and other procedures.

Treatment

Notification of the appropriate authorities, treatment of the child's injuries, and protecting the child from further harm are the immediate priorities in abuse cases. If the child does not require hospital treatment, protection often involves placing him or her with relatives, in a group home, or in foster care. Once the immediate concerns are dealt with, it becomes essential to determine how the child's long-term medical, psychological, educational, and other needs can best be met. This process involves evaluating not only the child's needs but also the needs of the family (e.g., drug abuse counseling, parental skills training, anger management training). The authorities also must determine whether other children living in the same household also have been abused. On investigation, signs of physical abuse are discovered in about 20% of other children living in the abused child's household.

Prognosis

Child abuse often has lifelong consequences. Research shows that abused children and adolescents are more likely to do poorly in school, experience depression, extreme anger, antisocial personality traits, and other psychiatric problems. They also are more likely to become promiscuous, abuse drugs and alcohol, run away, and attempt **suicide**. As adults they often have trouble establishing intimate relationships.

Most children who have been abused experience some symptoms of posttraumatic stress disorder (PTSD). PTSD in children and adolescents may be acute or delayed, that is, the child may experience symptoms immediately or after a period of time has passed, perhaps when the child feels safe. Symptoms may include re-experiencing the abusive episodes at some level, feeling emotionally numb, or becoming physiologically aroused (elevated heart rate, respiration, and so forth). Children may experience disassociation and appear to "space out" when reminded of the abuse or perpetrator. They may have physical symptoms. They may become enraged or feel guilt at having provoked the episodes or survived them. They may have invasive memories, repeated behaviors, or fears related to the abusive situations. They may act out some of their issues in play—punishing the bad guy or victimizing another character while playing with dolls or action figures. In severe cases of chronic trauma, the child may develop serious or prolonged disassociation or depression. Severe and chronic abuse has also been implicated in cases of **multiple personality disorder**.

Once the abuse has stopped, some of these symptoms can be treated with some form of counseling or therapy. Some have argued that full recovery is a lifelong task. Adults who have been abused as children may have to face issues long after the abuse has stopped, when they enter into their own sexual relationships or when they raise their own children. Long-term therapy by a professional trained in working with abused children and adults offers the best chance of overcoming childhood abuse.

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Prevention

There are many barriers to changing abusive parental behavior. Most parents' own history suggests that strong physical discipline is the preferred model of parenting. Further, most abusive parents live in families and neighborhoods in which violence is not only condoned but also viewed as a necessary vehicle for interpersonal influence. The stresses that are omnipresent in abusive parents' lives assist in maintaining high levels of anger and depression, which block the positive enjoyment of the child. When the parent responds with strong physical discipline, the child's misbehavior typically stops, for that moment at any rate. Thus, the parent is intermittently rewarded for responding abusively. Thus, changing abusive parenting is a challenging task.

It may be preferable to prevent the development of abusive parenting by early interventions to give skills, alter developmental knowledge, change unreasonable parenting expectations, and block the steady build-up of anger and extinguishing of affection for the child. Prevention programs now target teenagers before **pregnancy** as well as young mothers to try to break the cycle of abuse.

Government efforts to prevent abuse include home-visitor programs aimed at high-risk families and school-based efforts to teach children how to respond to attempted sexual abuse. Psychological abuse prevention has been promoted through the media.

When children reach age three, parents should begin teaching them about "bad touches" and about confiding in a suitable adult if they are touched or treated in a way that makes them uneasy. Parents also need to exercise caution in hiring babysitters and other caregivers. Anyone who suspects abuse should report those suspicions to the police or his or her local CPS agency. Prevent Child Abuse America (listed in references) is an excellent source of information on the many support groups and other organizations that help abused and at-risk children and their families. One of these organizations, Parents Anonymous, sponsors local self-help groups throughout the United States, Canada, and Europe.

Resources

AMERICAN HELP HOTLINES

Childhelp National Child Abuse Hotline 1-800-4-A-CHILD. TDD for the Deaf 1-800-2-A-Child. Help for children who are being abused or adults who are concerned that a child they know is being abused or neglected.

Rape, Abuse and Incest National Network (RAINN) Online hotline http://www.rainn.org/get-help/national-sexual-assault-online-hotline or telephone: 1-800-656-HOPE. Online counseling and referral to local rape crisis centers using anonymous instant messaging or telephone counseling and referrals to local crisis center.

OTHER

"Child Abuse." *MedlinePlus, National Institutes of Health*. July 30, 2009 [August 20, 2009]. http://www.nlm.nih.gov/medlineplus/childabuse.html.

"Child Welfare Information Gateway." *United States Department of Health and Human Services*. July 22, 2009 [August 20, 2009]. http://www.childwelfare.gov.

ORGANIZATIONS

Parents Anonymous, 675 W. Foothill Blvd., Suite 220, Claremont, CA, 91711-3475, (909) 621-6184, (909) 625-6304, http://www.parentsanonymous.org.

Prevent Child Abuse America, 500 North Michigan Avenue, Suite 200, Chicago, IL, 60611-3703, (312) 663-3520, 1-800-CHILDREN, (312) 939-8962, mailbox@preventchildabuse.org, http://www.preventchildabuse.org/index.shtml.

Tish Davidson, A.M.

Child development *see* **Children's health**
Child safety *see* **Children's health**

Childbirth

Definition

Childbirth includes both labor (the process of birth) and delivery (the birth itself); it refers to the entire process as an infant makes its way from the womb down the birth canal to the outside world.

Description

Childbirth usually begins spontaneously, about 280 days after conception, but it may be started by artificial means if the **pregnancy** continues past 42 weeks gestation. The average length of labor is about 14 hours for a first pregnancy and about eight hours in subsequent pregnancies. However, many women experience a much longer or shorter labor.

Labor can be described in terms of a series of phases.

First stage of labor

During the first phase of labor, the cervix dilates (opens) from 0–10 cm. This phase has an early, or latent,

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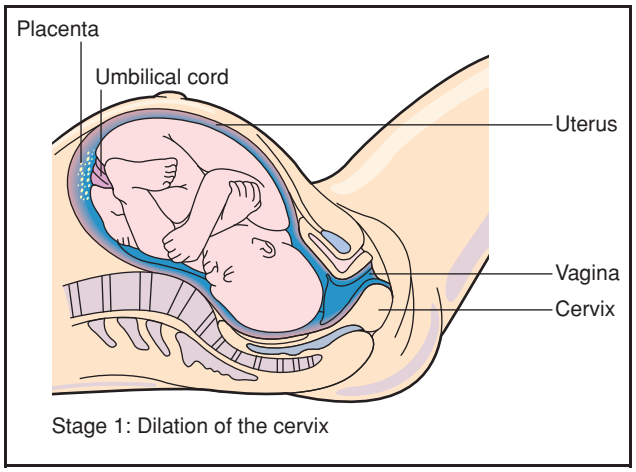
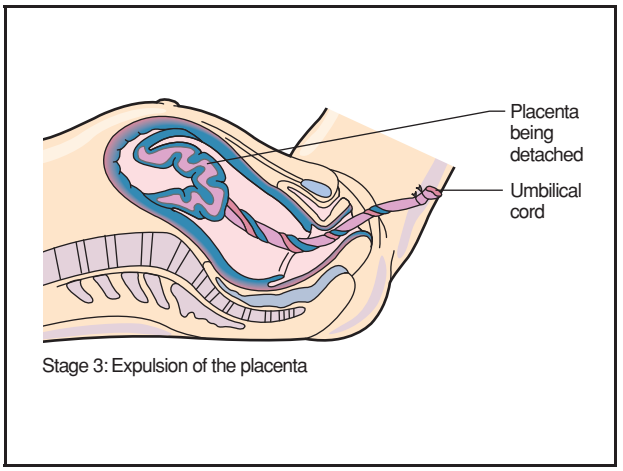


Stage 1: Dilation of the cervix. *(Illustration by Hans & Cassady, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

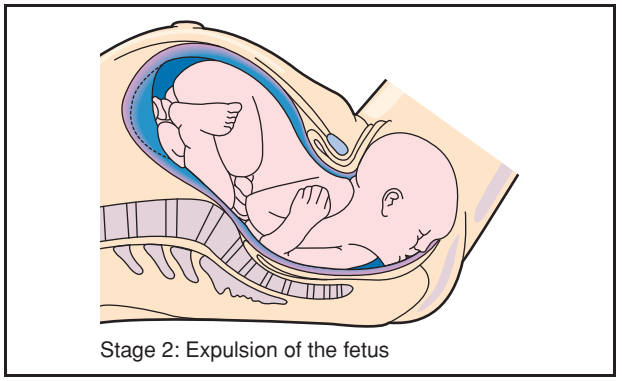


Stage 3: Expulsion of the placenta. *(Illustration by Hans & Cassady, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

phase and an active phase. During the latent phase, progress is usually very slow. It may take quite a while and many contractions before the cervix dilates the first few centimeters. Contractions increase in strength as labor progresses. Most women are relatively comfortable during the latent phase and walking around is encouraged, since it naturally stimulates the process.

As labor begins, the muscular wall of the uterus begins to contract as the cervix relaxes and expands. As a portion of the amniotic sac surrounding the baby is pushed into the opening, it bursts under the pressure, releasing amniotic fluid. This is called "breaking the bag of waters."

During a contraction, the infant experiences intense pressure that pushes it against the cervix, eventually forcing the cervix to stretch open. At the same time, the contractions cause the cervix to thin. During this first stage, a woman's contractions occur more and more often and last longer and longer. The doctor or nurse will do a periodic **pelvic exam** to determine how the mother is progressing. If the contractions aren't forceful enough to open the cervix, a drug may be given to make the uterus contract.



Stage 2: Expulsion of the fetus. *(Illustration by Hans & Cassady, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

As **pain** and discomfort increase, women may be tempted to request pain medication. If possible, though, administration of pain medication or anesthetics should be delayed until the active phase of labor begins—at which point the medication will not act to slow down or stop the labor.

The active stage of labor is faster and more efficient than the latent phase. In this phase, contractions are longer and more regular, usually occurring about every two minutes. These stronger contractions are also more painful. Women who use the breathing exercises learned in childbirth classes find that these can help cope with the pain experienced during this phase. Many women also receive some pain medication at this point—either a short-term medication, such as Nubain or Numorphan, or an epidural anesthesia.

As the cervix dilates to 8–9 cm, the phase called the transition begins. This refers to the transition from the first phase (during which the cervix dilates from 0–10 cm) and the second phase (during which the baby is pushed out through the birth canal). As the baby's head begins to descend, women begin to feel the urge to "push" or bear down. Active pushing by the mother should not begin until the second phase, since pushing

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too early can cause the cervix to swell or to tear and bleed. The attending healthcare practitioner should counsel the mother on when to begin to push.

Second stage of labor

As the mother enters the second stage of labor, her baby's head appears at the top of the cervix. Uterine contractions get stronger. The infant passes down the vagina, helped along by contractions of the abdominal muscles and the mother's pushing. Active pushing by the mother is very important during this phase of labor. If an epidural anesthetic is being used, many practitioners recommend decreasing the amount administered during this phase of labor so that the mother has better control over her abdominal muscles

When the top of the baby's head appears at the opening of the vagina, the birth is nearing completion. First the head passes under the pubic bone. It fills the lower vagina and stretches the perineum (the tissues between the vagina and the rectum). This position is called "crowning," since only the crown of the head is visible. When the entire head is out, the shoulders follow. The attending practitioner suctions the baby's mouth and nose to ease the baby's first breath. The rest of the baby usually slips out easily, and the umbilical cord is cut.

Episiotomy

As the baby's head appears, the perineum may stretch so tight that the baby's progress is slowed down. If there is risk of tearing the mother's skin, the doctor may choose to make a small incision into the perineum to enlarge the vaginal opening. This is called an **episiotomy**. If the woman has not had an epidural or pudendal block, she will get a local anesthetic to numb the area. Once the episiotomy is made, the baby is born with a few pushes.

Third stage

In the final stage of labor, the placenta is pushed out of the vagina by the continuing uterine contractions. The placenta is pancake shaped and about 10 inches in diameter. It has been attached to the wall of the uterus and has served to convey nourishment from the mother to the fetus throughout the pregnancy. Continuing uterine contractions cause it to separate from the uterus at this point. It is important that all of the placenta be removed from the uterus. If it is not, the uterine bleeding that is normal after delivery may be much heavier.

Breech presentation

Approximately 4% of babies are in what is called the "breech" position when labor begins. In breech presentation, the baby's head is not the part pressing against the cervix. Instead the baby's bottom or legs are positioned to enter the birth canal instead of the head. An obstetrician may attempt to turn the baby to a head down position using a technique called version. This is only successful approximately half the time.

The risks of vaginal delivery with breech presentation are much higher than with a head-first presentation. The mother and attending practitioner will need to weigh the risks and make a decision on whether to deliver via a **cesarean section** or attempt a vaginal birth. The extent of the risk depends to a great extent on the type of breech presentation, of which there are three. Frank breech (the baby's legs are folded up against its body) is the most common and the safest for vaginal delivery. The other types are complete breech (in which the baby's legs are crossed under and in front of the body) and footling breech (in which one leg or both legs are positioned to enter the birth canal). These are not considered safe to attempt vaginal delivery.

Even in complete breech, other factors should be met before considering a vaginal birth. An ultrasound examination should be done to be sure the baby does not have an unusually large head and that the head is tilted forward (flexed) rather than back (hyperextended). Fetal monitoring and close observation of the progress of labor are also important. A slowing of labor or any indication of difficulty in the body passing through the pelvis should be an indication that it is safer to consider a cesarean section.

Forceps delivery

If the labor is not progressing as it should or if the baby appears to be in distress, the doctor may opt for a forceps delivery. A forceps is a spoon-shaped device that resembles a set of salad tongs. It is placed around the baby's head so the doctor can pull the baby gently out of the vagina.

Forceps can be used after the cervix is fully dilated, and they might be required if:

- the umbilical has dropped down in front of the baby into the birth canal
- the baby is too large to pass through the birth canal unaided
- the baby shows signs of stress
- the mother is too exhausted to push

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Before placing the forceps around the baby's head, pain medication or anesthesia may be given to the mother. The doctor may use a catheter to empty the mother's bladder, and may clean the perineal area with soapy water. Often an episiotomy is done before a forceps birth, although tears can still occur.

The obstetrician slides half of the forceps at a time into the vagina and around the side of the baby's head to gently grasp the head. When both "tongs" are in place, the doctor pulls on the forceps to help the baby through the birth canal as the uterus contracts. Sometimes the baby can be delivered this way after the very next contraction.

The frequency of forceps delivery varies from one hospital to the next, depending on the experience of staff and the types of anesthesia offered at the hospital. Some obstetricians accept the need for a forceps delivery as a way to avoid cesarean birth. However, other obstetrical services do not use forceps at all.

Complications from forceps deliveries can occur. Sometimes they may cause nerve damage or temporary **bruises** to the baby's face. When used by an experienced physician, forceps can save the life of a baby in distress.

Vacuum-assisted birth

This method of helping a baby out of the birth canal was developed as a gentler alternative to forceps. Vacuum-assisted birth can only be used after the cervix is fully dilated (expanded), and the head of the fetus has begun to descend through the pelvis. In this procedure, the doctor uses a device called a vacuum extractor, placing a large rubber or plastic cup against the baby's head. A pump creates suction that gently pulls on the cup to ease the baby down the birth canal. The force of the suction may cause a bruise on the baby's head, but it fades away in a day or so.

The vacuum extractor is not as likely as forceps to injure the mother, and it leaves more room for the baby to pass through the pelvis. However, there may be problems in maintaining the suction during the vacuum-assisted birth, so forceps may be a better choice if it is important to remove the baby quickly.

Cesarean sections

A cesarean section, also called a c-section, is a surgical procedure in which incisions are made through a woman's abdomen and uterus to deliver her baby.

Cesarean sections are performed whenever abnormal conditions complicate labor and vaginal delivery, threatening the life or health of the mother or the baby. In 2002, just over 26% of babies were born by c-section, an increase of 7% from the previous year. The procedure may be used in cases where the mother has had a previous c-section and the area of the incision has been weakened. Dystocia, or difficult labor, is the another common reason for performing a c-section.

Difficult labor is commonly caused by one of the three following conditions: abnormalities in the mother's birth canal; abnormalities in the position of the fetus; abnormalities in the labor, including weak or infrequent contractions.

Another major factor is fetal distress, a condition where the fetus is not getting enough oxygen. Fetal brain damage can result from oxygen deprivation. Fetal distress is often related to abnormalities in the position of the fetus, or abnormalities in the birth canal, causing reduced blood flow through the placenta.

Other conditions also can make c-section advisable, such as vaginal herpes, **hypertension** (high blood pressure), and diabetes in the mother. Some parents choose to have a c-section because they fear the pain or unpredictability of labor or they want to avoid pelvic damage.

Causes and symptoms

One of the first signs of approaching childbirth may be a "bloody show," the appearance of a small amount of blood-tinged mucus released from the cervix as it begins to dilate. This is called the "mucus plug."

The most common sign of the onset of labor is contractions. Sometimes women have trouble telling the difference between true and false labor pains.

True labor pains:

- develop a regular pattern, with contractions coming closer together
- last from 15–30 seconds at the onset and get progressively stronger and longer (up to 60 seconds)
- may get stronger with physical activity
- occur high up on the abdomen, radiating throughout the abdomen and lower back

Another sign that labor is beginning is the breaking of the "bag of waters," the amniotic sac which had cushioned the baby during the pregnancy. When it breaks, it releases water in a trickle or a gush. Only about 10% of women actually experience this water flow in the beginning of labor, however. Most of the time, the rupture occurs sometime later in labor. If the

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amniotic sac doesn't rupture on its own, the doctor will break it during labor.

Some women have **diarrhea** or **nausea** as labor begins. Others notice a sudden surge of energy and the urge to clean or arrange things right before labor begins; this is known as "nesting."

Diagnosis

The onset of labor can be determined by measuring how much the cervix has dilated. The degree of dilation is estimated by feeling the opening cervix during a pelvic exam. Dilation is measured in centimeters, from zero to 10. Contractions that cause the cervix to dilate are the sign of true labor.

Fetal monitoring

Fetal monitoring is a process in which the baby's heart rate is monitored for indicators of **stress** during labor and birth. There are several types of fetal monitoring.

A special stethoscope called a fetoscope may be used. This is a simple and non-invasive method.

The Doppler method uses ultrasound; it involves a handheld listening device that transmits the sounds of the heart rate through a speaker or into an attached ear piece. It can usually pick up the heart sounds 12 weeks after conception. This method offers intermittent monitoring. It allows the mother freedom to move about and is also useful during contractions.

Electronic fetal monitoring uses ultrasound and provides a view of the heartbeat in relationship to the mother's contractions. It can be used either continuously or intermittently. It is often used in high risk pregnancies, and is not often recommended for low risk ones because it renders the mother immobile and requires interpretation.

Internal monitoring does not use ultrasound, is more accurate than electronic monitoring and provides continuous monitoring for the high risk mother. This requires the mother's water to be broken and that she be two to three centimeters dilated. It is used in high-risk situations only.

Telemetry monitoring is the newest type of monitoring. It uses radio waves transmitted from an instrument on the mother's thigh. The mother is able to remain mobile. It provides continuous monitoring and is used in high-risk situations.

Treatment

Most women choose some type of pain relief during childbirth, ranging from relaxation and imagery to drugs. The specific choice may depend on what's available, the woman's preferences, her doctor's recommendations, and how the labor is proceeding. All drugs have some risks and some advantages.

Regional anesthetics

Regional anesthetics include epidurals and spinals. In this technique, medication is injected into the space around the spinal nerves. Depending on the type of medications used, this type of anesthesia can block nerve signals, causing temporary pain relief, or a loss of sensation from the waist down. An epidural or spinal block can provide complete pain relief during cesarean birth.

An epidural is placed with the woman lying on her side or sitting up in bed with the back rounded to allow more space between the vertebrae. Her back is scrubbed with antiseptic, and a local anesthetic is injected in the skin to numb the site. The needle is inserted between two vertebrae and through the tough tissue in front of the spinal column. A catheter is put in place that allows continuous doses of anesthetic to be given.

This type of anesthesia provides complete pain relief, and can help conserve a woman's energy, since she can relax or even sleep during labor. This type of anesthesia requires an IV and fetal monitor. It may be harder for a woman to bear down when it comes time to push, although the amount of anesthesia can be adjusted as this stage nears.

Spinal anesthesia operates on the same principle as epidural anesthesia, and is used primarily in cases of c-section delivery. It is administered in the same way as an epidural, but the catheter is not left in place. The amount of anesthetic injected is large, since it must be injected at one time. Because of the anesthetic's effect on motor nerves, most women using it cannot push during delivery. This is a disadvantage in labor, but not an issue during a c-section. Spinals provide quick and strong anesthesia and allow for major abdominal surgery with almost no pain.

Narcotics

Short-acting **narcotics** can ease pain and do not interfere with a woman's ability to push. However, they can cause **sedation**, **dizziness**, nausea, and **vomiting**. Narcotics cross the placenta and may slow down

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KEY TERMS

Amniotic sac—The membranous sac that surrounds the embryo and fills with watery fluid as pregnancy advances.

Breech birth—Birth of a baby bottom-first, instead of the usual head first delivery. This can add to labor and delivery problems because the baby's bottom doesn't mold a passage through the birth canal as well as does the head.

Cervix—A small cylindrical organ about an inch or so long and less than an inch around that makes up the lower part and neck of the uterus. The cervix separates the body and cavity of the uterus from the vagina.

Embryo—The unborn child during the first eight weeks of its development following conception.

Gestation—The period from conception to birth, during which the developing fetus is carried in the uterus.

Perineum—The area between the thighs that lies behind the genital organs and in front of the anus.

Placenta—The organ that develops in the uterus during pregnancy and that links the blood supplies of mother and baby.

a baby's breathing; they can't be given too close to the time of delivery.

Natural childbirth and preparation for childbirth

There are several methods to prepare for childbirth. The one selected often depends on what is available through the healthcare provider. Overall, family involvement is receiving increased attention by the healthcare systems, and many hospitals now offer birthing rooms and maternity centers to help the entire family. There are several choices available for childbirth preparation.

Lamaze, or Lamaze-Pavlov, is the most common in the United States today. It was the first popular natural childbirth method, becoming popular in the 1960s. Breathing exercises and concentration on a focal point are practiced to allow mothers to control pain while maintaining consciousness. This allows the flow of oxygen to the baby and to the muscles in the uterus to be maintained. A partner coaches the mother throughout the birthing process.

The Read method, named for Dick Read, is a technique of breathing that was originated in the 1930s to help mothers deal with apprehension and tension associated with childbirth. This natural childbirth method uses different breathing for the different stages of childbirth.

The LeBoyer method stresses a relaxed delivery in a quiet, dim room. It attempts to avoid overstimulation of the baby and to foster mother-child bonding by placing the baby on the mother's abdomen and having the mother massage him or her immediately after the birth. Then the father washes the baby in a warm bath.

The Bradley method is called father-coached childbirth, because it focuses on the father serving as coach throughout the process. It encourages normal activities during the first stages of labor.

Resources

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Stevens, Laura Roe. "Gimme a C: Is Choosing a Cesarean Section for a Nonmedical Reason Wise?" *Fit Pregnancy* April–May 2004: 40–42.

ORGANIZATIONS

American Academy of Husband-Coached Childbirth, P.O. Box 5224, Sherman Oaks, CA, 91413, (800) 422-4784, (800) 423-2397.

American Society for Prophylaxis in Obstetrics/LAMAZE (ASPO/LAMAZE), 1840 Wilson Blvd., Ste. 204, Arlington, VA, 22201, (800) 368-4404.

Childbirth Education Foundation, P.O. Box 5, Richboro, PA, 18954, (215) 357-2792.

International Association of Parents and Professionals for Safe Alternatives in Childbirth, Rte. 1, Box 646, Marble Hill, MO, 63764, (314) 238-2010.

International Childbirth Education Association, P.O. Box 20048, Minneapolis, MN, 55420, (612) 854-8660.

Postpartum Support International, 927 North Kellogg Ave., Santa Barbara, CA, 93111, (805) 967-7636.

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Childhood disintegrative disorder *see* **Pervasive developmental disorders**

Childhood obesity

Definition

Childhood **obesity** is an excess percentage of body weight due to fat in children over age two, putting them at risk for a variety of health problems.

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Demographics

Childhood obesity is a rapidly growing public health problem in the United States. Although childhood obesity is increasing throughout most of the developed world, the problem is growing fastest in the United States. Over the past two decades the number of obese children has doubled and the number of obese adolescents has tripled. According to the National Health and **Nutrition** Examination Survey of 2003–2006, 31.9% of children and teens were overweight and 16.3% were obese. Thus more than 12 million American children are overweight or obese. Other surveys have found a total obesity rate among children and adolescents of 21–24%. Among American adults 32% are obese and 66% are either overweight or obese.

Significant differences exist in obesity rates among children of different races and ethnic groups, mirroring differences in the adult population. Significantly more Mexican American boys are overweight than non-Hispanic American black or white boys. Significantly more Mexican American girls and non-Hispanic American black girls are overweight compared with non-Hispanic white girls. Native Americans and Hawaiians also have higher rates of obesity than whites.

Description

Obesity in children over age two is assessed by the body mass index (BMI), which uses weight and height to calculate a healthy weight range. For most children and teens the BMI is an accurate indicator of body fat. It is age- and sex-specific and is often referred to as BMI-for-age. Children between the ages of 2 and 19 are assigned to a percentile based on their BMI. The percentile is a comparison of their weights with those of other children of the same age and gender. For example, if a boy is in the 65th percentile for his age group, 65 out of every 100 children his age weigh less than he does and 35 weigh more. Adult BMIs are interpreted differently.

The BMI weight categories for children are:

- underweight: below the 5th percentile
- healthy weight: 5th percentile to below the 85th percentile
- overweight: 85th percentile to below the 95th percentile
- obese: 95th percentile and above. Children in the top 15 percentiles are considered to be at risk for developing health problems because of their weight.

Risk factors

Risk factors for childhood obesity include:

- inherited tendency toward weight gain
- having at least one obese parent
- eating in response to stress, boredom, or loneliness
- poor sleeping habits
- binge-eating disorders
- mental illness

Causes and symptoms

Obesity is caused by taking in more calories than the body uses. This difference is called the "energy gap." A 2006 study done by the Harvard School of Public Health and published in the journal *Pediatrics* found that, on average, American children consume between 110 and 165 more calories than they use every day. Over a 10-year period these extra calories add 10 pounds to their weight. Teens who are already overweight consume an average of 700–1,000 extra calories every day, resulting in a 10-year average of 58 extra pounds.

The causes of this energy gap are related to both increased food intake and decreased energy usage. Causes of increasing food intake include:

- increased consumption of sugary beverages, accompanied by decreased consumption of milk
- more meals eaten away from home
- more super-sized portions, with portions in some fast-food restaurants having almost tripled since the 1970s
- more use of prepared foods in the home
- increased snacking between meals and fewer family meals
- fewer children taking their lunches from home to school
- increasingly poor eating habits such as skipping breakfast and snacking on high-fat, sugary foods
- increased advertising for high-sugar, high-fat foods directed at children

There are various causes of decreased energy output:

- Children spend more time watching television or at computers than in the past.
- School physical-education requirements have decreased. According to the Centers for Disease Control only 8% of elementary schools, 6.4% of middle schools, and 5.8% of high schools require daily physical-education classes.

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KEY TERMS

Body mass index (BMI)—A measure of body fat: the ratio of body weight in kilograms to the square of body height in meters.

Cognitive-behavioral therapy (CBT)—A psychotherapeutic approach that emphasizes correcting distorted thinking patterns and changing one's behaviors accordingly.

Hypothyroidism—Deficient thyroid gland activity, resulting in a lowered metabolic rate.

Prader-Willi syndrome—An uncommon genetic disorder that causes a constant feeling of hunger.

Saturated fat—Solid fats such as cheese, meat, butter, ice cream, palm and coconut oils, as well as whole-fat milk and cream; linked to coronary heart disease.

Trans fat—Fat that is produced by hydrogenation during food processing; trans fats increase bad cholesterol and decrease good cholesterol.

- Fewer children walk to school. In 1969 half of all U.S. school children walked or biked to school, including 87% of children living within 1 mile of their school. By 2003 only 15% of children walked or biked to school.
- Elementary schools have eliminated recesses. More than 28% of schools do not provide a regularly scheduled recess for grades 1–5.
- Increasing fear of crime limits children's outdoor activities.
- Growing affluence has increased teenage access to cars over the past 30 years.

In rare cases medical or genetic disorders can cause childhood obesity. For example Prader-Willi syndrome is a genetic disorder that causes an uncontrollable urge to eat. The only way to prevent a child with Prader-Willi disorder from constantly eating is to maintain an environment with no open access to food. Hormonal disorders such as **hypothyroidism** also can cause obesity. Certain medications such as cortisone and **tricyclic antidepressants** may cause weight gain as well. However these are exceptions. Most obese children eat too much and/or **exercise** too little.

The most obvious symptom of obesity is an accumulation of body fat. Other symptoms involve changes in body chemistry. Some of these changes cause disease in children and others put children at risk for developing health problems later in life.

Diagnosis

Examination

A diagnosis of obesity is usually made based on the child's BMI. The examination will include a family history, medical history, and a complete **physical examination**.

Tests

Tests will include standard blood and urine tests. A thyroid hormone test may be performed to rule out hypothyroidism as the cause of the obesity.

Procedures

Based on the physician's findings, other tests and procedures may be performed to rule out medical causes of the obesity.

Treatment

Traditional

Nutrition education usually involves the entire family. Obese children and their parents are typically referred to a registered dietician or nutritionist who can help them develop a plan for eliminating empty calories and increasing the amounts of nutrient-rich, low-calorie foods in their **diets**. A nutritionist or dietitian can help families understand how much and what kinds of food are appropriate for their child's age, weight, and activity level. Children may be asked to keep a food diary to record everything that they eat, in order to determine necessary changes in behavior and diet. Obese children are typically encouraged to increase their level of exercise rather than to drastically reduce their caloric intake.

Children who are overweight often have psychological and social problems that can be helped by **psychotherapy**. Cognitive-behavioral therapy (CBT) is designed to confront and change thoughts and feelings about one's body and behaviors toward food. CBT is relatively short-term and does not address the origins of those thoughts or feelings. CBT may include strategies to maintain self-control with regard to food. **Family therapy** may help children who overeat for emotional reasons related to conflicts within the family. Family therapy teaches strategies for reducing conflict, disorder, and **stress** that may be factors in triggering emotional eating.

Drugs

Weight-loss drugs or surgeries are used very rarely in children—only in the most extreme cases of health-

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threatening obesity after other methods of weight control have failed. However many overweight children suffer from **anxiety** and depression. Drug therapy to treat these conditions may help children better deal with their obesity and become more involved in physical activities and weight-loss strategies.

Alternative

Obese teenagers may benefit from structured weight-loss programs such as Weight Watchers or Jenny Craig, with the approval of their physician.

Home remedies

Treatment for childhood obesity begins and ends in the home. Families must make a commitment to following healthy nutritional guidelines, eliminating junk food, sugary drinks, and treats from the home, limiting sedentary activities, and increasing exercise.

The American Heart Association adapted the following dietary suggestions for children over age 2 from the federal *Dietary Guidelines for Americans*:

- Children aged 2–3 should obtain no more than 35% of their total calories from fats.
- Children over age 3 should limit their fat intake to about 30% of their total calories. These fats should be monounsaturated or polyunsaturated. Saturated fats and trans fats should be avoided.
- Fruit and vegetable intake should be increased, but fruit juice should be limited.
- At least half of all grains consumed should be whole grains.
- Sugary drinks, such as carbonated soft drinks, should be severely restricted.
- Dairy products should be low-fat or fat-free for children over age 2. Before age 2 children need milk fats for proper growth and development of the nervous system.
- Children should be offered a variety of foods, including fish and shellfish.
- Overfeeding children or making them "clean their plates" should be avoided.

It is often difficult for parents to determine how much food their child should eat at a particular age. However parents tend to overestimate the amount of food that small children require. Active children need more calories and slightly larger amounts of food. The American Heart Association guidelines for daily amounts of some common foods for children of different ages are based on children who are sedentary or physically inactive:

- children aged 2–3 years: total daily calories, 1,000; milk, 2 cups; lean meat or beans, 2 ounces; fruits, 1 cup; vegetables, 1 cup; grains, 3 ounces
- girls aged 4–8 years: total daily calories, 1,200; milk, 2 cups; lean meat or beans, 3 ounces; fruits, 1.5 cups; vegetables, 1 cup; grains, 4 ounces
- boys aged 4–8 years: total daily calories, 1,400; milk, 2 cups; lean meat or beans, 4 ounces; fruits, 1.5 cups; vegetables, 1.5 cups; grains, 5 ounces
- girls aged 9–13 years: total daily calories, 1,600; milk, 3 cups; lean meat or beans, 5 ounces; fruits, 1.5 cups; vegetables, 2 cups; grains, 5 ounces
- boys aged 9–13 years: total daily calories, 1,800; milk, 3 cups; lean meat or beans, 5 ounces; fruits, 1.5 cups; vegetables, 2.5 cups; grains, 6 ounces
- girls aged 14–18 years: total daily calories, 1,800; milk, 3 cups; lean meat or beans, 5 ounces; fruits, 1.5 cups; vegetables, 2.5 cups; grains, 6 ounces
- boys aged 14–18 years: total daily calories, 2,200; milk, 3 cups; lean meat or beans, 6 ounces; fruits, 2 cups; vegetables, 3 cups; grains, 7 ounces

Parents must be very careful in the ways that they approach weight loss with their children. Critical comments about weight from parents or excess zeal in enforcing a rigorous diet can trigger **eating disorders** such as **anorexia nervosa** or **bulimia nervosa** in some children, especially adolescent girls.

Prognosis

The younger that obese children are when they begin treatment, the better the chances that they will be able to maintain a normal weight. Obese children have an advantage over obese adults in that they are continuing to grow. Obese children that can maintain their weight without gaining may grow into a normal weight as they become taller.

Obese children are at increased risk for:

- type 2 diabetes, which was once seen primarily in older adults but is now being diagnosed in children and young adults at an alarmingly high rate
- high blood pressure (hypertension)
- fat accumulation in the liver (fatty liver/liver disease)
- sleep apnea
- early puberty
- eating disorders
- joint pain
- depression
- anxiety and stress
- low self-esteem
- social prejudice and discrimination

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Children who remain obese have a much greater likelihood of becoming obese adults with concomitant health problems. Studies have found that 26–41% of obese preschoolers become obese adults. Among obese school-aged children, 42–63% become obese adults. The greater the degree of obesity, the higher the likelihood that it will continue into adulthood.

Prevention

Beginning at age two, children and adolescents should have their BMI calculated at each routine physical examination.

Parents must take the lead in preventing childhood obesity. Teaching children to eat a healthy diet sets the framework for lifetime eating habits. Parents should:

- Serve a healthy variety of foods.
- Keep healthy snacks on hand.
- Use low-fat cooking methods such as broiling or baking.
- Eliminate junk snack food and sugary beverages from the home. This removes temptation and eliminates the need to nag about what not to eat.
- Eat meals together as a family, rather than grabbing food on the run.
- Limit visits to fast-food restaurants.
- Avoid using food as a reward.
- Pack healthy homemade school lunches.
- Encourage school officials to eliminate campus soda machines, bake sales, and fundraisers with candy and cookies.
- Limit television and computer time.
- Plan family activities that involve physical exercise, such as hiking, biking, or swimming.
- Encourage children to become more active in small ways, such as walking to school, biking to friends' houses, or perfoming chores such as walking the dog or mowing the lawn.
- Set realistic goals for weight control and reward children's efforts.
- Model the eating behaviors and active lifestyle that they would like their child to adopt.

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ORGANIZATIONS

American Academy of Pediatrics, 141 Northwest Point Blvd., Elk Grove Village, IL, 60007-1098, (874) 434-4000, (874) 434-8000, kidsdocs@aap.org, http://www. aap.org.

American Heart Association, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, http://www.americanheart.org.

Centers for Disease Control and Prevention, 1600 Clifton Road, Atlanta, GA, 30333, (888) 232-6348, (301) 563-6595, cdcinfor@cdc.gov, http://www.cdc.gov.

The Obesity Society, 8630 Fenton St., Suite 814, Silver Spring, MD, 20910, (301) 563-6526, (301) 563-6595, http://www.obesity.org.

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Weight-Control Information Network (WIN), 1 WIN Way, Bethesda, MD, 20892-3665, (888) 232-6348, (202) 828-1028, win@info.niddk.nih.gov, http://win.niddk.nih.gov.

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Children's health

Definition

Children's health encompasses the physical, mental, emotional, and social well-being of children from infancy through adolescence.

Description

All children should have regular well-child check-ups according to the schedule recommended by their physician or pediatrician. The American Academy of Pediatrics (AAP) advises that children be seen for well-baby checks at two weeks, two months, four months, six months, nine months, twelve months, fifteen months, and eighteen months. Well-child visits are recommended at ages two, three, four, five, six, eight, 10, and annually thereafter through age 21. Well-baby and well-child check-ups assess the child physically, behaviorally, developmentally, and emotionally and are important in spotting developmental delays or behavioral abnormalities early. Well-child check-ups usually include reviewing medical history, measuring height, weight, blood pressure, and temperature, vision, hearing, reflex screening, a developmental/behavioral assessment, **physical examination**, immunizations, guidance about developmental milestones, **nutrition**, injury prevention, and referrals as needed to a pediatric dentist or other pediatric specialists. In 2004, it was estimated from interviews with parents that 87% of children in the United States with health insurance had seen a physician for a well-child check up within the past year, while only 66% of children without health insurance had been seen.

Common childhood infections

Infection	Symptom(s)
Common cold	Runny nose, sneezing, cough, congestion
Conjunctivitis (pink eye)	Redness of the eye, pus-like discharge
Head lice	Intense itching, possible swelling of neck glands
Influenza	Fever, cough, chills, headache, fatigue, general discomfort
Mononucleosis	Weakness, fatigue, sore throat, fever, swollen lymph nodes
Otitis media (middle ear infection)	Fever, ear pulling, complaints of ear pain or fullness
Strep throat	Sore throat, fever, fatigue, swollen tonsils
Varicella (chickenpox)	Itchy, red, blistery rash; fever

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Immunization to protect against specific diseases is an important part of a child's healthcare program. Vaccines must be administered within certain time limits. When multiple doses are needed, a certain amount of time must elapse between each dose. As of 2009, the American Association of Pediatrics (AAP) and the Centers for Disease Control and Prevention (CDC) recommended these childhood immunizations:

- Hepatitis B vaccine. Three doses, beginning at birth and completed no later than 18 months with at least four weeks between doses.
- Rotavirus vaccine. Two or three doses depending on vaccine with the first dose given beginning no earlier than 6 weeks and no later than 14 weeks and the final dose completed no later than eight months.
- Diphtheria, Tetanus, and Pertussis (DTaP) vaccine. Doses at two and six months with a final dose between four and six years of age. A booster is given at 11–12 years of age.
- *Haemophilus influenzae* type b (Hib) vaccine. Three doses beginning no earlier than two months with a booster at 12–15 months.
- Pneumococcal conjugate vaccine. Doses at 2, 4, 6, and 12–15 months. High risk children may require additional doses of related vaccine.
- Inactivated Polio vaccine. Doses at 2, 4, 6–18 months and 4–6 years.
- Influenza vaccine. Two doses every year for children under age nine. Single dose every year through adulthood.
- Measles, Mumps, Rubella (MMR) vaccine. Two doses, the first no earlier than one year, the second between ages four and six years.
- Varicella (chickenpox) vaccine. Two doses, the first no earlier than one year, the second usually between ages four and six years.

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- Hepatitis A vaccine. Two doses, the first no earlier than one year, the second six months later. High risk children may require additional doses during adolescence.
- Meningococcal vaccine. One dose between the ages of 11 and 18 years. High risk children only may require dose between the ages of two and 10 years.
- Human papillomavirus (HPV) vaccine. Girls only, three doses beginning at age 11. Older unvaccinated females may be vaccinated up to age 26.

Mental health

Children who have difficulty in areas of language acquisition, cognitive (mental) development, and behavior control may have a mental health disorder. Mental health problems that arise in children include:

- Attention deficit hyperactivity disorder (ADHD). ADHD is estimated to affect 3–7% of school-age children in the United States and is 3–5 times more common in boys than in girls. It is a disorder characterized by excessive motor activity, distractibility, and poor impulse control.
- Learning disorders. Learning disabilities affect one in 10 school children in the United States.
- Depression, anxiety, and bipolar disorder. Affective, or mood, disorders are now more commonly recognized in children than in the past.
- Eating disorders. Anorexia nervosa, bulimia nervosa, and binge eating disorder frequently occur in adolescent girls. It is estimated that one out of every 100–200 adolescent girls meets all the diagnostic criteria for anorexia.
- Schizophrenia. A disorder characterized by bizarre thoughts and behaviors, paranoia, impaired sense of reality, and psychosis may be diagnosed in childhood or adolescence.
- Obsessive-compulsive disorder (OCD). Symptoms often begin in childhood or adolescence.
- Autism and pervasive developmental disorder. Severe developmental disabilities that cause a child to become withdrawn and unresponsive.
- Mental retardation. Children under age 18 with an IQ of 70 or below and impairments in adaptive functioning are considered mentally retarded.

Emotional and social health

Children take their first significant steps toward socialization and peer interaction when they begin to engage in cooperative play at around age four. Their social development progresses throughout childhood and adolescence as they expand their social contacts, develop friendships, start to be influenced by their peers, and begin to show interest in the opposite sex. In adolescence, there is a strong, but normal, trend away from involvement with family and toward establishing their own identity and values.

Several factors may have a negative impact on the emotional and social well-being of children:

- Violence. Bullying can cause serious damage to a child's sense of self-esteem and personal safety, as can experiences with community violence.
- Family turmoil. Divorce, domestic abuse, death of a family member, and other life-changing events that alter the family dynamic can have a serious impact on a child. Even a positive event such as the birth of a sibling or a move to a new city and school can put emotional strain on a child.
- Stress. The pressure to perform well academically and in extracurricular activities such as sports can be overwhelming to some children. Emphasis on physical appearance also creates stress that can lead to eating disorders.
- Peer pressure. Although it can have a positive impact, peer pressure is often a source of significant stress for children. This is particularly true in adolescence when "fitting in" is important to most teens.
- Drugs and alcohol. Curiosity is intrinsic to childhood, and more than 30% of children have experimented with alcohol by age 13. Open communication with children that sets forth parental expectations about drug and alcohol use is essential.
- Negative sexual experiences. Sexual abuse and assault can emotionally scar a child and instill negative feelings about sexuality and relationships. Early and/or indiscriminate sexual relationships can cause emotional harm and increase the likelihood of pregnancy and sexually transmitted diseases.

Causes and symptoms

Childhood health problems may be congenital (i.e., present at birth) or acquired through infection, immune system deficiency, or another disease process. They may also be caused by physical trauma (e.g., a car accident or a playground fall), exposure to a toxic substance (e.g., drug allergy, or exposure to poisonous chemical), or triggered by a genetic factor (e.g., **celiac disease**, sickle cell anemia) or environmental factors (e.g., dust mite **allergies**, pollen allergies).

Physical and mental health problems in childhood can cause a wide spectrum of symptoms. The following behaviors suggest a larger emotional, social, or mental disturbance that may need to be evaluated by a health care professional.

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- signs of alcohol and drug use
- suddenly falling grades or school avoidance
- lack of interest in activities that were previously enjoyable
- excessive anxiety
- persistent, prolonged depression
- withdrawal from friends and family
- involvement with violence or vandalism
- extreme or irrational perfectionism
- repeated, aggressive confrontations with authority figures
- age-inappropriate temper tantrums or inappropriate displays of anger
- self-inflicted injury
- bizarre behavior and/or speech
- trouble with the police
- sexual promiscuity
- prolonged, unexplained fatigue
- suicide threats or attempts

The causes of developmental disorders and delays and learning disabilities are not always fully understood. Pervasive developmental disorder (PDD) and autistic spectrum disorder (more commonly known as **autism**) are characterized by unresponsiveness and severe impairments in one or more of these areas:

- Social interaction. Autistic children often have difficulty interpreting social cues and are unaware of acceptable social behavior. They tend to be withdrawn and socially isolated. They frequently reject physical contact.
- Communication and language. A child with autism or PDD may not speak or may display limited or immature language skills.
- Behavior. Autistic or PDD children may have difficulty dealing with anger, can be self-injurious, and may display obsessive behavior.

Autism is associated with brain abnormalities, but the exact mechanisms that trigger the disorder are yet to be determined. Research suggests that it may be linked to certain congenital conditions such as **neurofibromatosis**, **fragile X syndrome**, and **phenylketonuria** (PKU). Despite much speculation, no well-designed, controlled studies have shown any link between autism and childhood vaccinations.

Diagnosis

Physical, intellectual, emotional, and social maturation are all-important markers of a child's overall health and well being. When evaluating children, pediatricians and child-care specialists assess related skill sets, such as a child's acquisition and use of language, fine and gross motor skills, cognitive growth, socialization, and achievement of certain milestones in these areas. A developmental milestone is a task or skill set that a child is expected to reach at a certain age or stage of life. For example, by age one, most children have achieved the physical milestone of walking with the assistance of an adult. Developmental disorders may be identified and/

KEY TERMS

Bipolar disorder—Formerly called manic-depressive disorder. A mood disorder characterized by alternating periods of overconfidence and activity (manic highs) and depressive lows.

Child development—The process of physical, intellectual, emotional, and social growth that occurs from infancy through adolescence. Erik Erikson, Margaret Mahler, Sigmund Freud, and Jean Piaget are among the most well-known child development theorists.

Immunization—Administering a vaccine that stimulates the body to create antibodies to a specific disease (immunity) without causing symptoms of the disease.

Learning disabilities—An impairment of the cognitive processes of understanding and using spoken and written language that results in difficulties with one or more academic skill sets (e.g., reading, writing, mathematics).

Motor skills—Controlled movement of muscle groups. Fine motor skills involve tasks that require dexterity of small muscles, such as buttoning a shirt. Tasks such as walking or throwing a ball involve the use of gross motor skills.

Obsessive-compulsive disorder (OCD)—An anxiety disorder in which a person cannot prevent himself from dwelling on unwanted thoughts, acting on urges, or performing repetitious rituals, such as washing his hands or checking to make sure he turned off the lights.

Psychological tests—Written, verbal, or visual tasks that assess psychological functioning, intelligence, and/or personality traits.

Type 1 diabetes—A chronic immune system disorder in which the pancreas does not produce sufficient amounts of insulin, a hormone that enables cells to use glucose for energy. Also called juvenile diabetes, it must be treated with insulin injections.

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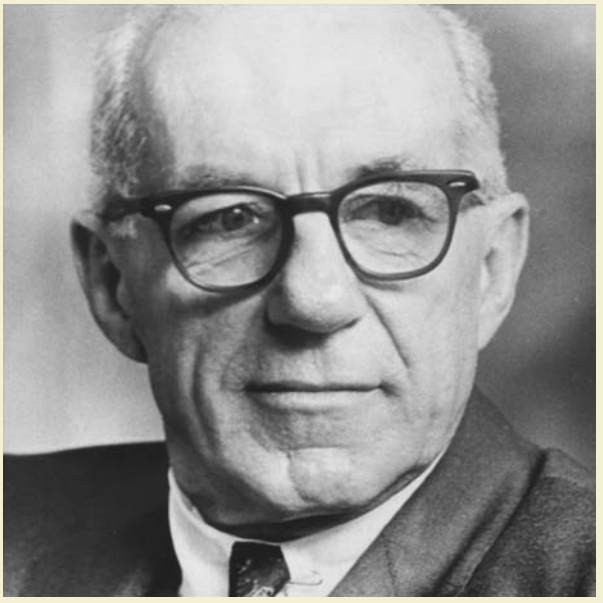
DR. BENJAMIN SPOCK (1903–1998)



(The Library of Congress.)

Benjamin Spock, pediatrician and political activist, was most noted for his authorship of *Baby and Child Care*, which significantly changed predominant attitudes toward the raising of infants and children. He began medical school at Yale University in 1925, and transferred to Columbia University's College of Physicians and Surgeons in 1927. Spock had decided well before starting his medical studies that he would "work with children, who have their whole lives ahead of them" and so, upon taking his M.D. degree in 1929 and serving his general internship at the prestigious Presbyterian Hospital, he specialized in pediatrics at a small hospital crowded with children in New York's Hell's Kitchen area.

On a summer vacation in 1943 he began to write his most famous book and he continued to work on it from 1944 to 1946 while serving as a medical officer in the Navy. The book sharply broke with the authoritarian tone and rigorous instructions found in earlier generations of baby-care books, most of which said to feed infants on a strict schedule and not to pick them up when they cried. Spock, who spent ten years trying to reconcile his psychoanalytic training with what mothers were telling him about their children, told his readers, "You know more than you think you do.... Don't be afraid to trust your own common sense.... Take it easy, trust your own instincts, and follow the directions that your doctor gives you." The response was overwhelming. *Baby and Child Care* rapidly became America's all-time best-seller except for Shakespeare and the Bible; by 1976 it had also eclipsed Shakespeare.

Spock prided himself in keeping up with the times, a fact that's reflected in the many revisions of *Baby and Child Care* in which he incorporated the latest medical developments and dealt with emerging social issues such as working mothers, daycare centers, and single parenthood.

or diagnosed by physicians, teachers, child psychologists, therapists, counselors, and other professionals who interact with children on a regular basis.

It is important to remember that all children are unique, and develop at different paces within this broad framework. Reaching a milestone early or late does not necessarily indicate a developmental problem. However, if a child is consistently lagging in achieving milestones or has a significant deficit in one developmental area, he or she may be experiencing developmental delays that warrant professional evaluation.

Pediatricians and other medical professionals typically diagnose physical illness and disease in children as well as provide preventative health care. In cases of illness and injury, children will undergo a thorough physical examination and patient history. Diagnostic tests may be performed as appropriate. In cases of mental or emotional disorders, a psychologist or psychiatrist will meet with the patient to conduct an interview and take a detailed social and medical history. Interviews with a parent or guardian and teacher may also be part of the diagnostic process. The physician may also administer one or more **psychological tests** (also called clinical inventories, scales, or assessments).

Treatment

Medications may be prescribed to treat certain childhood illnesses. Proper dosage is particularly important with infants and children, as medications such as **acetaminophen** can be toxic in excessive amounts. Parents and caregivers should always follow the instructions for use that accompany medications, and inform the child's pediatrician if the child is taking any other drugs or **vitamins** to prevent potentially negative **drug interactions**. Any side effects or adverse reactions to medication should be reported to the child's physician. If **antibiotics** are prescribed, the full course should always be taken. Parents should be especially careful when using herbal medicine or dietary supplements, as the pediatric doses for these treatments often have not been established.

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Other treatments for childhood illness and/or injuries include, but are not limited to, nutritional therapy, **physical therapy**, respiratory therapy, medical devices (e.g., **hearing aids**, glasses, braces), and in some cases, surgery.

Counseling is typically a first treatment for psychological disorders. Therapy approaches include **psychotherapy**, cognitive therapy, behavioral therapy, family counseling, and **group therapy**. Therapy or counseling may be administered by social workers, nurses, licensed counselors and therapists, psychologists, or psychiatrists. Psychoactive medication may be prescribed by a psychiatrist for symptom relief in children and adolescents with mental disorders.

Support groups may provide emotional support for children with chronic illnesses or mental disorders. This approach, which allows individuals to seek advice and counsel from others in similar circumstances, can be extremely effective, especially in older children who look toward their peers for guidance and support. Support groups for family members often help adults and siblings cope with a chronically ill child.

Speech therapy may help children with developmental delays in language acquisition. Children with **learning disorders** can benefit from special education classes and accommodations arrived at through professional evaluation and the creation of an individualized educational plan (IEP).

Alternative

Therapeutic approaches that encourage self-discovery and empowerment may be useful in treating some childhood emotional traumas and mental disorders. **Art therapy**, the use of the creative process to express and understand emotion, encompasses a broad range of humanistic disciplines, including visual arts, dance, drama, music, film, writing, literature, and other artistic genres. It can be particularly effective in children who may have difficulty gaining insight to emotions and thoughts they are otherwise incapable of expressing.

Certain mild herbal remedies may also be safely used with children, such as ginger (*Zingiber officinale*) tea for **nausea** and aloe vera salve for **burns**. Parents and caregivers should always consult their healthcare provider before administering herbs to children, as certain herbs may affect children differently than adults.

Prognosis

The prognosis for childhood health problems varies widely. In general, early detection and proper treatment can greatly improve the odds of recovery from many childhood illnesses and disabilities. Early intervention is key in helping a child with disabilities reach his or her full potential.

Some learning disabilities and mild developmental disorders can be overcome or greatly improved through appropriate therapies. As of 2009, there were no known medical treatments or pharmacological therapies that eliminate all of the symptoms associated with pervasive developmental disorder (PDD), autism spectrum disorder, and **mental retardation**. Mental illnesses such as **schizophrenia** and **bipolar disorder** are chronic, lifelong disorders, although their symptoms can often be controlled with medication.

Prevention

Parents can take precautions to ensure the safety of their children. Childproofing the home, following a recommended immunization schedule, educating children on safety, learning **first aid**, and taking children for regular well-child check-ups can help to protect against physical harm. In addition, encouraging open communication with children can help them grow both emotionally and socially. Providing a loving and supportive home environment can help to nurture an emotionally healthy child who is independent, self-confident, socially skilled, insightful, and empathetic toward others.

Because they are still developing motor skills, children may be particularly accident prone. Observing the following safety guidelines may help protect children from injury:

- Helmets and padding. Children should always wear a properly fitted helmet and appropriate protective gear when riding a bike, scooter, or similar equipment or participating in sports. They should ride on designated bike paths whenever possible, and learn bicycle safety rules (i.e., ride with traffic, use hand signals).
- Playground safety. Swing sets and other outdoor play equipment should be well-maintained, have at least 12 in (30 cm) of loose fill materials (e.g., sand, wood chips) underneath to cushion falls, and children should be properly supervised at play.
- Staying apprised of recalls. Children's toys, play equipment, and care products are frequently involved in product recalls. The U.S. Consumer Safety Products

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Commission (CSPC) is the agency responsible for tracking these recalls.

- Staying safe in the car. Up to 85% of children's car seats are improperly installed and/or used. Infants should always be in a rear-facing car seat until they are over 12 months of age and weigh more than 20 lb (9 kg). An infant or car seat should never be put in a front passenger seat that has an air bag. Once they outgrow their forward facing car seats, children between the ages of four and eight who weigh between 40–80 lb (18–36 kg) should ride in a booster seat. Every child who rides in a car over this age and weight should use a properly fitted lap and shoulder belt.
- Teaching children pedestrian safety. Young children should never be allowed to cross the street by themselves. Older children should know to follow traffic signs and signals, cross the street at the corner, and look both ways before stepping off the curb.
- Teaching children about personal safety. Children should know what to do in case they get lost or are approached by a stranger. It is also imperative that parents talk openly with their children about their body and sexuality, and what behavior is inappropriate, to protect them against sexual predators.

Childproofing the household is an important step toward keeping children healthy. To make a house a safe home, parents and caregivers should:

- Keep guns away from children. Accidental shootings in the home injure an estimated 1,500 children under age 14 each year. If a gun must be in the home, it should be securely locked in a tamper proof gun safe with the ammunition kept locked in a separate place.
- Keep matches, lighters, and flammable materials properly stored and out of the reach of children.
- Make sure hot water heaters are set to 120°F (49°C) or below to prevent scalding injuries.
- Equip the home with working fire extinguishers and smoke alarms; teach children what to do in case of fire.
- Secure all medications (including vitamins, herbs, and supplements), hazardous chemicals, and poisonous substances (including alcohol and tobacco) in ways that they cannot be accessed by children.
- Do not smoke. Aside from causing cancer and other health problems in smokers, second-hand smoke is hazardous to a child's health (e.g., increases their risk of developing allergies).
- Keep small children away from poisonous plants outdoors; remove any indoor plants that are toxic.
- Post the phone numbers of poison control and the pediatrician near the phone; teach children how to dial 9-1-1 and report an emergency.
- Children under age five should never be left alone in the bathtub, wading pool, or near any standing water source (including an open toilet). Fence all swimming pools and install a self-latching gate. Drowning is the leading cause of death by injury for children between the ages of one and four in the United States.
- Remove lead paint. Lead is a serious health hazard for children and can cause cognitive retardation. Houses built before 1978 should be tested for lead paint. If lead is found, the paint should be removed using the appropriate safety precautions.
- Be alert to coins, small play pieces, and similar items that are choking hazards for small children.

Resources

BOOKS

Brynie, Faith Hickman. *ADHD: Attention-Deficit Hyperactivity Disorder*. Minneapolis: Twenty-First Century Books, 2008.

Dietary Guidelines for Americans 2005. Washington, DC: U.S. Department of Health and Human Services, U.S. Department of Agriculture, 2005.

Larson Duyff, R. *ADA Complete Food and Nutrition Guide*. 3rd ed. Chicago: American Dietetic Association, 2006.

Robertson, Cathie. *Safety, Nutrition and Health in Early Education*. 4th ed. Florence, KY: Wadsworth Publishing, 2009.

Weight Watchers. *Weight Watchers Eat! Move! Play!: A Parent's Guide for Raising Healthy, Happy Kids*. Hoboken, NJ: Wiley, 2010.

ORGANIZATIONS

American Academy of Child and Adolescent Psychiatry, 3615 Wisconsin Avenue, NW, Washington, DC, 20016-3007, (202) 966-7300, (202) 966-2891, http://www.aacap.org.

American Academy of Family Physicians, P.O. Box 11210, Shawnee Mission, KS, 66207, (913) 906-6000, (800) 274-2237, (913) 906-6075, http://www.aafp.org.

American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, IL, 60007-1098, (847) 434-4000, http://www.aap.org.

American Dietetic Association, 120 South Riverside Plaza, Suite 2000, Chicago, IL, 60605, (800) 877-1600, http://www.eatright.org.

National Eating Disorders Association, 603 Stewart St., No. 803, Seattle, WA, 98101, (206) 382-3587, http://www.nationaleatingdisorders.org.

National Institute of Child Health and Human Development (NICHD) , P.O. Box 3006, Rockville, MD, 30847, (800) 370-2943, TTY: (800) 320-6942, (866)

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760-5947, NICHDInformationResourceCenter@mail.nih.gov, http://www.nichd.nih.gov.

Project EAT, Eating Among Teens, University of Minnesota, 1300 S. Second St., Suite 300, Minneapolis, MN, 55454, (612) 624-1818, http://www.epi.umn.edu/research/eat/index.shtm.

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Chinese traditional herbal medicine *see* **Traditional Chinese herbalism**

Chinese traditional medicine *see* **Traditional Chinese medicine**

Chiropractic

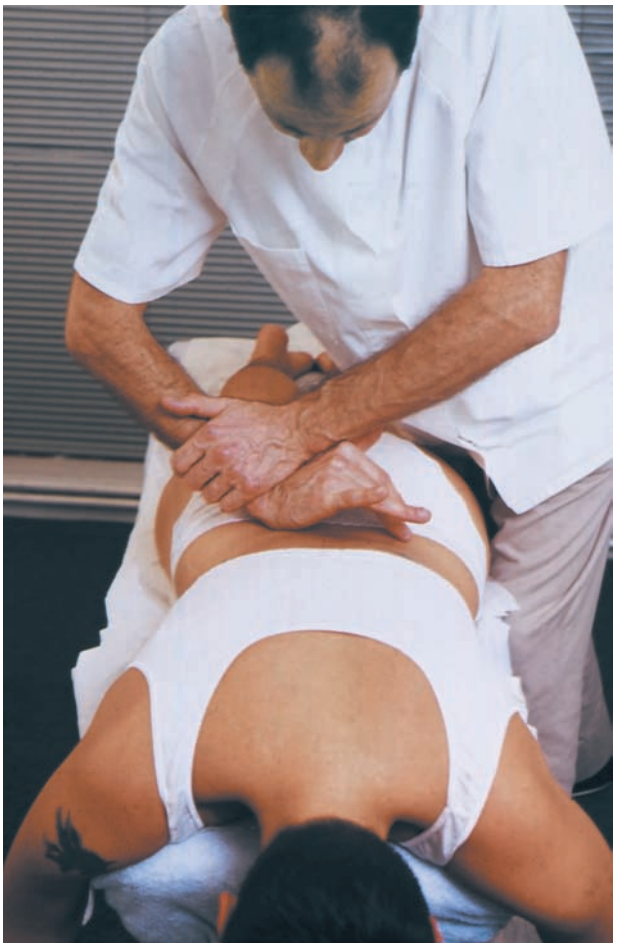
Definition

Chiropractic is from Greek words meaning done by hand. It is grounded in the principle that the body can heal itself when the skeletal system is correctly aligned and the nervous system is functioning properly. To achieve this, the practitioner uses his or her hands or an adjusting tool to perform specific manipulations of the vertebrae. When these bones of the spine are not correctly articulated, resulting in a condition known as subluxation, the theory is that nerve transmission is disrupted and causes **pain** in the back, as well as other areas of the body.

Chiropractic is one of the most popular alternative therapies currently available. Some would say it now qualifies as mainstream treatment as opposed to complementary medicine. Chiropractic treatment is covered by many insurance plans and in 2004, the U.S. Department of Veterans Affairs announced full inclusion of chiropractic care for veterans. It has become well-accepted treatment for acute pain and problems of the spine, including lower back pain and **whiplash**. Applications beyond that scope are not supported by current evidence, although there are ongoing studies into the usefulness of chiropractic for such problems as ear infections, **dysmenorrhea**, infant **colic**, migraine headaches, and other conditions.

Purpose

Most people will experience back pain at some time in their lives. Injuries due to overexertion and poor posture are among the most common. Depending on the cause and severity of the condition, options for treatment may include **physical therapy**, rest, medications, surgery, or chiropractic care. Chiropractic treatment carries none of the risks of surgical or pharmacologic treatment. Practitioners use a holistic approach to health. The goal is not merely to relieve the present ailment, but to analyze the cause and recommend appropriate changes of lifestyle to prevent the problem from occurring again. They believe in a risk/benefit analysis before use of any intervention. The odds of an adverse outcome are extremely low. Chiropractic has proven in several studies to be less expensive than many more traditional routes such as outpatient physical therapy. Relief from some neuromuscular problems is immediate, although a series of treatments is likely to be required to maintain the improvement. Spinal manipulation is an excellent option for acute lower back pain, and may also relieve neck pain as



An example of a McTimoney chiropractic technique on patient's lumbar vertebra. The McTimoney chiropractic is a system of adjustment by hand of displacements of the spinal column and bones. It can also be applied to animals. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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well as other musculoskeletal pain. Although most back pain will subside eventually with no treatment at all, chiropractic treatment can significantly shorten the time it takes to get relief. Some types of **headache** can also be successfully treated by chiropractic.

Description

Origins

Spinal manipulation has a long history in many cultures but Daniel D. Palmer is the founder of modern chiropractic theory, dating back to the 1890s. A grocer and magnetic healer, he applied his knowledge of the nervous system and manual therapies in an unusual situation. One renowned story concerns Harvey Lillard, a janitor in the office where Palmer worked. The man had been deaf for 17 years, ever since he had sustained an injury to his upper spine. Palmer performed an adjustment on a painful vertebra in the region of the injury and Lillard's hearing was reputedly restored. Palmer theorized that all communication from the brain to the rest of the body passes through the spinal canal, and areas that are poorly aligned or under **stress** can cause physical symptoms both in the spine and in other areas of the body. Thus the body has the innate intelligence to heal itself when unencumbered by spinal irregularities causing nerve interference. After his success with Lillard, other patients began coming to him for care, and responded well to adjustments. This resulted in Palmer's further study of the relationship between an optimally functional spine and normal health.

Palmer founded the first chiropractic college in 1897. His son, B. J. Palmer, continued to develop chiropractic philosophy and practice after his father's **death**. B. J. and other faculty members were divided over the role of subluxation in disease. B. J. saw it as the cause of all disease. The others disagreed and sought a more rational way of thinking, thus broadening the base of chiropractic education. From 1910 to 1920, many other chiropractic colleges were established. Other innovators, including John Howard, Carl Cleveland, Earl Homewood, Joseph Janse, Herbert Lee, and Claude Watkins, also helped to advance the profession.

The theories of the Palmers receive somewhat broader interpretation today. Many chiropractors believe that back pain can be relieved and health restored through chiropractic treatment even in patients who do not have demonstrable **subluxations**. Scientific development and research of chiropractic is gaining momentum. The twenty-first century will likely see the metaphysical concepts such as innate intelligence give way to more scientific proofs and reform.

Many people besides the Palmers have contributed to the development of chiropractic theory and technique. Some have gone on to create a variety of procedures and related types of therapy that have their roots in chiropractic, including McTimoney-Corley chiropractic, craniosacral manipulation, naprapathy, and **applied kinesiology**. **Osteopathy** is another related holistic discipline that utilizes spinal and musculoskeletal manipulation as a part of treatment, but osteopathic training is more similar in scope to that of an M.D.

Initial visit

An initial chiropractic exam will most often include a history and a physical. The patient should be asked about the current complaint, whether there are chronic health problems, family history of disease, dietary habits, medical care received, and any medications currently being taken. Further, the current complaint should be described in terms of how long it has been a problem, how it has progressed, and whether it is the result of an injury or occurred spontaneously. Details of how an injury occurred should be given. The physical exam should evaluate by observation and palpation whether the painful area has evidence of inflammation or poor alignment. Range of motion may also be assessed. In the spine, either hypomobility (fixation) or hypermobility may be a problem. Laboratory analysis is helpful in some cases to rule out serious infection or other health issues that may require referral for another type of treatment. Many practitioners also insist on x rays during the initial evaluation

Manipulation

When spinal manipulation is employed, it is generally done with the hands, although some practitioners may use an adjusting tool. A classic adjustment involves a high velocity, low amplitude thrust that produces a usually painless popping noise, and improves the range of motion of the joint that was treated. The patient may lie on a specially designed, padded table that helps the practitioner to achieve the proper positions for treatment. Some adjustments involve manipulating the entire spine, or large portions of it, as a unit; others are small movements designed to affect a single joint. Stretching, **traction**, and slow manipulation are other techniques that can be employed to restore structural integrity and relieve nerve interference.

A new use of technology with traditional chiropractic care has been introduced. Using a hand-held

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device that is pressed to the spine or joints, a chiropractor may soon be able to detect and manipulate the skeleton not only with his or her hands but with the computer-linked device that uses harmonic frequencies to detect a misalignment in the spine. The new technology was not widely accepted in 2004, however.

Length of treatment

The number of chiropractic treatments required will vary depending on several factors. Generally longer-term treatment is needed for conditions that are chronic, severe, or occur in conjunction with another health problem. Patients who are not in overall good health may also have longer healing times. Some injuries will inherently require more treatments than others in order to get relief. Care is given in three stages. Initially appointments are more frequent with the goal of relieving immediate pain. Next, the patient moves into a rehabilitative stage to continue the healing process and help to prevent a relapse. Finally, the patient may elect periodic maintenance, or wellness treatments, along with lifestyle changes if needed to stay in good health.

Follow-up care

Discharge and follow-up therapy are important. If an injury occurred as a result of poor fitness or health, a program of **exercise** or **nutrition** should be prescribed. Home therapy may also be recommended, involving such things as anti-inflammatory medication and applications of heat or ice packs. Conscious attention to posture may help some patients avoid sustaining a similar injury in the future, and the chiropractor should be able to discern what poor postural habits require correction. A sedentary lifestyle, particularly with a lot of time spent sitting, is likely to contribute to poor posture and may predispose a person to back pain and injury.

Types of practitioners

Some practitioners use spinal manipulation to the exclusion of all other modalities, and are known as straight chiropractors. Others integrate various types of therapy such as massage, nutritional intervention, or treatment with **vitamins**, herbs, or homeopathic remedies. They also embrace ideas from other health care traditions. This group is known as mixers. The vast majority of chiropractors, perhaps 85%, fall in this latter category.

DANIEL PALMER (1845–1913)

Chiropractic inventor, Daniel David Palmer, was born on March 7, 1845, in Toronto, Ontario. He was one of five siblings, the children of a shoemaker and his wife, Thomas and Katherine Palmer. Daniel Palmer and his older brother fell victim to wanderlust and left Canada with a tiny cash reserve in April 1865. They immigrated to the United States on foot, walking for 30 days before arriving in Buffalo, New York. They traveled by boat through the St. Lawrence Seaway to Detroit, Michigan. There they survived by working odd jobs and sleeping on the dock. Daniel Palmer settled in What Cheer, Iowa, where he supported himself and his first wife as a grocer and fish peddler in the early 1880s. He later moved to Davenport, Iowa, where he raised three daughters and one son.

Palmer was a man of high curiosity. He investigated a variety of disciplines of medical science during his lifetime, many of which were in their infancy. He was intrigued by phrenology and assorted spiritual cults, and for nine years he investigated the relationship between magnetism and disease. Palmer felt that there was one thing that caused disease. He was intent upon discovering this one thing, or as he called it: the great secret.

In September 1895, Palmer purported to have cured a deaf man by placing pressure on the man's displaced vertebra. Shortly afterward Palmer claimed to cure another patient of heart trouble, again by adjusting a displaced vertebra. The double coincidence led Palmer to theorize that human disease might be the result of dislocated or luxated bones, as Palmer called them. That same year he established the Palmer School of Chiropractic where he taught a three-month course in the simple fundamentals of medicine and spinal adjustment.

Palmer, who was married six times during his life, died in California in 1913; he was destitute. His son, Bartlett Joshua Palmer, successfully commercialized the practice of chiropractic.

Preparations

Patients should enter the chiropractic clinic with an open mind. This will help to achieve maximum results.

Precautions

Chiropractic is not an appropriate therapy for diseases that are severely degenerative and may require medication or surgery. Many conditions of the spine are amenable to manipulative treatment, but this does not include **fractures**. The practitioner should be informed in advance if the patient is on anticoagulants,

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or has **osteoporosis** or any other condition that may weaken the bones. Other circumstances might suggest the patient should not have chiropractic care. These should be detected in the history or physical exam. In addition to fractures, **Down syndrome**, some congenital defects, and some types of **cancer** are a few of the things that may preclude spinal manipulation. On rare occasions, a fracture or dislocation may occur. There is also a very slim possibility of experiencing a **stroke** as a result of spinal manipulation, but estimates are that it is no more frequent than 2.5 occurrences per one million treatments.

Patients should be wary of chiropractors who insist on costly x rays and repeated visits with no end in sight. Extensive use is not scientifically justifiable, especially in most cases of lower back pain. There are some circumstances when x rays are indicated, including acute or possibly severe injuries such as those that might result from a car accident.

Side effects

It is not uncommon to have local discomfort in the form of aches, pains, or spasms for a few days following a chiropractic treatment. Some patients may also experience mild headache or **fatigue** that resolves quickly.

Research and general acceptance

As recently as the 1970s, the American Medical Association (a national group of medical doctors) was quite hostile to chiropractic. AMA members were advised that it was unethical to be associated with chiropractors. Fortunately that has changed, and many allopathic or traditionally trained physicians enjoy cordial referral relationships with chiropractors. The public is strongly in favor of chiropractic treatment. Chiropractors see the lion's share of all patients who seek medical help for back problems, and chiropractic treatment is the most widely used of all alternative medical treatments.

Research has also supported the use of spinal manipulation for acute **low back pain**. There is some anecdotal evidence recommending chiropractic treatment for ailments unrelated to musculoskeletal problems, but there is not enough research-based data to support this. On the other hand, a chiropractor may be able to treat problems and diseases unrelated to the skeletal structure by employing therapies other than spinal manipulation.

Although many chiropractors limit their practice to spine and joint problems, others claim to treat disorders that are not closely related to the back or musculoskeletal system. These include **asthma**, bedwetting, **bronchitis**, coughs, **dizziness**, dysmenorrhea, earache, **fainting**, headache, hyperactivity, **indigestion**, **infertility**, migraine, **pneumonia**, and issues related to **pregnancy**. There are at least three explanations for the possible effectiveness for these conditions. One is that the problem could be linked to a nerve impingement, as may be possible with bedwetting, dizziness, fainting, and headache. In a second group, chiropractic treatment may offer some relief from complicating pain and spasms caused by the disease process, as with asthma, bronchitis, coughs, and pneumonia. The discomforts of pregnancy may also be relieved with gentle chiropractic therapy. A third possibility is that manipulation or use of soft-tissue techniques may directly promote improvement of some conditions. One particular procedure, known as the endonasal technique, is thought to help the eustachian tube to open and thus improve drainage of the middle ear. The tube is sometimes blocked off due to exudates or inflammatory processes. This can offer significant relief from earaches. Some headaches also fall in this category, as skilled use of soft tissue techniques and adjustment may relieve the muscle tension that may initiate some headaches.

Dysmenorrhea, hyperactivity, indigestion, and infertility are said to be relieved as a result of improved flow of blood and nerve energy following treatment. Evidence for this is anecdotal at best, but manipulation is unlikely to be harmful if causes treatable by other modalities have been ruled out.

For conditions such as cancer, fractures, infectious diseases, neurologic disease processes, and anything that may cause increased orthopedic fragility, chiropractic treatment alone is not an effective

KEY TERMS

Adjustment—A specific type of manipulation of the spine designed to return it to proper structural and functional form.

Allopathic—Conventional practice of medicine generally associated with M.D. physicians.

Dysmenorrhea—Painful menstruation.

Osteoporosis—A condition of decreased bone density, causing increased bone fragility, that is most common in elderly women.

Subluxation—Misalignment between vertebrae that structurally and functionally impairs nerve function.

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therapy, and may even be harmful in some cases. Those who have known circulatory problems, especially with a history of thrombosis, should not have spinal manipulation.

Resources

PERIODICALS

"Technology Takes Tiny Steps in Hands-on Chiropractic Industry." *Medical Letter on the CDC & FDA* June 20, 2004: 17.

"VA Includes Chiropractic Care for Veterans." *Managed Care Weekly* May 3, 2004: 23.

ORGANIZATIONS

American Chiropractic Association, 1701 Clarendon Boulevard, Arlington, VA, 22209, (703) 276-8800, (703) 243-2593, memberinfo@acatoday.org, http://www.acatoday.org.

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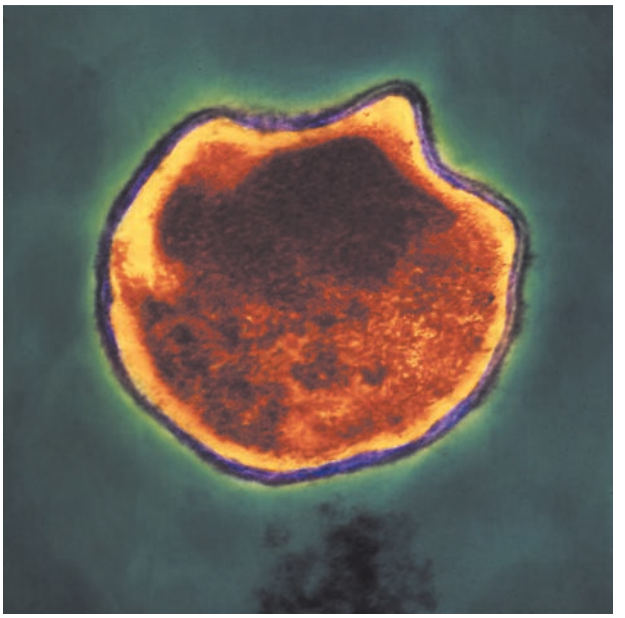
Teresa G. Odle

Chlamydial infections *see* **Chlamydial pneumonia; Epididymitis; Nongonococcal urethritis; Sexually transmitted diseases**



A transmission electron microscopy (TEM) of a sectioned *Chlamydia pneumonia* bacterium. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Chlamydial pneumonia

Definition

Chlamydial **pneumonia** refers to one of several types of pneumonia that can be caused by various types of the bacteria known as *Chlamydia*.

Description

Pneumonia is an infection of the lungs. The air sacs (alveoli) and/or the tissues of the lungs become swollen, and the alveoli may fill with pus or fluid. This prevents the lungs from taking in sufficient oxygen, which deprives the blood and the rest of the body's tissues of oxygen.

There are three major types of *Chlamydia*: *Chlamydia psittaci*, *Chlamydia pneumoniae*, and *Chlamydia trachomatis*. Each of these has the potential to cause a type of pneumonia.

Causes and symptoms

Chlamydia trachomatis is a major cause of **sexually transmitted diseases** (called **nongonococcal urethritis** and **pelvic inflammatory disease**). When a woman with an active chlamydial infection gives birth to a baby, the baby may aspirate (suck into his or her lungs) some of the mother's bacteria-laden secretions while passing through the birth canal. This can cause a form of relatively mild pneumonia in the newborn, occurring about two to six weeks after delivery.

Chlamydia psittaci is a bacteria carried by many types of birds, including pigeons, canaries, parakeets, parrots, and some gulls. Humans acquire the bacteria through contact with dust from bird feathers, bird droppings, or from the bite of a bird carrying the bacteria. People who keep birds as pets or who work where birds are kept have the highest risk for this type of pneumonia. This pneumonia, called psittacosis, causes **fever**, **cough**, and the production of sputum containing pus. This type of pneumonia may be quite severe, and is usually more serious in older patients. The illness can last several weeks.

Chlamydia pneumoniae usually causes a type of relatively mild "walking pneumonia." Patients experience fever and cough. This type of pneumonia is called a "community-acquired pneumonia" because it is easily passed from one member of the community to another.

Diagnosis

Laboratory tests indicating the presence of one of the strains of *Chlamydia* are sophisticated, expensive,

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KEY TERMS

Alveoli—The small air sacs clustered at the ends of the bronchioles in the lungs, in which oxygen-carbon dioxide exchange takes place.

Aspiration—When solids or liquids that should be swallowed into the stomach are instead breathed into the respiratory system, or when substances from the outside environment are accidentally breathed into the lungs.

Sputum—Material produced within the alveoli in response to an infectious or inflammatory process.

and performed in only a few laboratories across the country. For this reason, doctors diagnose most cases of chlamydial pneumonia by performing a **physical examination** of the patient, and noting the presence of certain factors. For instance, if the mother of a baby sick with pneumonia is positive for a sexually transmitted disease caused by *Chlamydia trachomatis*, the diagnosis is obvious. History of exposure to birds in a patient sick with pneumonia suggests that *Chlamydia psittaci* may be the culprit. A mild pneumonia in an otherwise healthy person is likely to be a community-acquired walking pneumonia, such as that caused by *Chlamydia pneumoniae*.

Treatment

Treatment varies depending on the specific type of *Chlamydia* causing the infection. A newborn with *Chlamydia trachomatis* improves rapidly with erythromycin. *Chlamydia psittaci* infection is treated with tetracycline, bed rest, oxygen supplementation, and codeine-containing cough preparations. *Chlamydia pneumoniae* infection is treated with erythromycin.

Prognosis

The prognosis is generally excellent for the newborn with *Chlamydia trachomatis* pneumonia. *Chlamydia psittaci* may linger, and severe cases have a **death** rate of as high as 30%. The elderly are hardest hit by this type of pneumonia. A young, healthy person with *Chlamydia pneumoniae* has an excellent prognosis. In the elderly, however, there is a 5–10% death rate from this infection.

Prevention

Prevention of *Chlamydia trachomatis* pneumonia involves recognizing the symptoms of genital infection in the mother and treating her prior to delivery of her baby.

Chlamydia psittaci can be prevented by warning people who have birds as pets, or who work around birds, to be careful to avoid contact with the dust and droppings of these birds. Sick birds can be treated with an antibiotic in their feed. Because people can contract psittacosis from each other, a person sick with this infection should be kept in **isolation**, so as not to infect other people.

Chlamydia pneumoniae is difficult to prevent because it is spread by respiratory droplets from other sick people. Because people with this type of pneumonia do not always feel very sick, they often continue to attend school, go to work, and go to other public places. They then spread the bacteria in the tiny droplets that are released into the air during coughing. Therefore, this pneumonia is very difficult to prevent and often occurs in outbreaks within communities.

ORGANIZATIONS

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Chlorhexidine *see* **Antibiotics, topical**

Chloroquine *see* **Antimalarial drugs**

Chlorzoxazone *see* **Muscle relaxants**

Choking

Definition

Choking is the inability to breathe because the trachea is blocked, constricted, or swollen shut.

Description

Choking is a medical emergency. When a person is choking, air cannot reach the lungs. If the airways cannot be cleared, **death** follows rapidly.

Anyone can choke, but choking is more common in children than in adults. Choking is a common cause of accidental death in young children who are apt to put toys or coins in their mouths, then unintentionally inhale them. About 3,000 adults die each year from choking on food.

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People also choke because infection causes the throat tissue to swell shut. It is believed that this is what caused George Washington's death. Allergic reactions can also cause the throat to swell shut. Acute allergic reactions are called anaphylactic reactions and may be fatal. Strangulation puts external pressure on the trachea causing another form of choking.

Finally, people can choke from obstructive **sleep apnea**. This is a condition where tissues of the body obstruct the airways during sleep. Sleep apnea is most common in obese men who sleep on their backs. **Smoking**, heavy alcohol use, lung diseases such as **emphysema**, and an inherited tendency toward a narrowed airway and throat all increase the risk of choking during sleep.

Causes and symptoms

There are three reasons why people choke. These are:

- mechanical obstruction
- tissue swelling
- crushing of the trachea

Regardless of the cause, choking cuts off the air supply to the lungs. Indications that a person's airway is blocked include:

- the person cannot speak or cry out
- the person's face turns blue from lack of oxygen
- the person desperately grabs at his or her throat
- the person has a weak cough and labored breathing that produces a high-pitched noise
- the person has all of the symptoms previously mentioned, then becomes unconscious
- during sleep, the person has episodes of gasping, pauses in breathing, and sudden awakenings

Diagnosis

Diagnosing choking due to mechanical obstruction is straightforward, since the symptoms are obvious even to an untrained person. In choking due to infection, the person, usually a child, will have a **fever** and signs of illness before labored breathing begins. If choking is due to an allergic reaction to medication or insect **bites**, the person's earlobes and face will swell, giving an external sign that internal swelling is also occurring.

Choking due to sleep apnea is usually diagnosed on reports of symptoms by the person's sleep partner. There are also alarm devices to detect the occurrence of sleep apnea. Eventually sleep may be interrupted so frequently that daytime drowsiness becomes a problem.

KEY TERMS

Trachea—The windpipe. A tube extending from below the voice box into the chest where it splits into two branches, the bronchi, that go to each lung.

Tracheotomy—The surgical creation of an opening in the trachea that functions as an alternative airway so that the patient may breathe.

Treatment

Choking, except during sleep apnea, is a medical emergency. If choking is due to allergic reaction or infection, people should summon emergency help or go immediately to an emergency room. If choking is due to obstructed airways, the **Heimlich maneuver** (an emergency procedure in which a person is grasped from behind in order to forcefully expel the obstruction) should be performed immediately. In severe cases a **tracheotomy** (an incision into the trachea through the neck below the larynx) must be performed.

Patients who suffer airway obstruction during sleep can be treated with a device similar to an oxygen mask that creates positive airway pressure and delivers a mixture of oxygen and air.

Prognosis

Many people are treated successfully for choking with no permanent effects. However, if treatment is unsuccessful, the person dies from lack of oxygen. In cases where the airway is restored after the critical period passes, there may be permanent brain damage.

Prevention

Watching children carefully to keep them from putting **foreign objects** in their mouth and avoiding giving young children food like raisins, round slices of hot dogs, and grapes can reduce the chance of choking in children. Adults should avoid heavy alcohol consumption when eating and avoid talking and laughing with food in their mouths. The risk of obstructive sleep apnea choking can be reduced by avoiding alcohol, tobacco smoking, tranquilizers, and sedatives before bed.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

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Cholangitis

Definition

The term cholangitis means inflammation of the bile ducts. The term applies to inflammation of any portion of the bile ducts, which carry bile from the liver to the gallbladder and intestine. The inflammation is produced by bacterial infection or sometimes other causes.

Description

Bile, which is needed for digestion, is produced in the liver and then enters the common bile duct (CBD) through the hepatic ducts. Bile enters the gallbladder between meals, when the muscle or sphincter that controls flow of bile between the CBD and intestine is closed. During this period, bile accumulates in the CBD; the pressure in the CBD rises, as would a pipe closed off at one end. The increase in pressure eventually causes the bile to flow into the gallbladder. During meals, the gallbladder contracts and the sphincter between the gallbladder and intestine relaxes, permitting bile to flow into the intestine and take part in digestion.

Bile that has just been produced by the liver is sterile (free of bacteria). This is partly due to its antibacterial properties; these are produced by the immunoglobulins (antibodies) secreted in bile, the bile acids which inhibit bacterial growth themselves, and mucus.

A small number of bacteria may be present in the bile ducts and gallbladder, getting there by moving backward from the intestine, which unlike the bile ducts, contains large numbers of bacteria. The normal flow of bile out of the ducts and into the intestine also helps keep too many organisms from multiplying. Bacteria also reach the bile ducts from the lymph tissue or from the blood stream.

When the passage of bile out of the ducts is blocked, the few bacteria that are there rapidly reproduce. A partial blockage to the flow of bile can occur when a stone from the gallbladder blocks the duct, and also allows bacteria to flow back into the CBD, and creates ideal conditions for their growth. Tumors, on the other hand, cause a more complete blockage of bile flow, both in and out, so fewer infections occur. The reproducing organisms are often able to enter the bloodstream and infect multiple organs such as the liver and heart valves.

Another source of inflammation of the bile ducts occurs in diseases of altered immunity, known as "autoimmune diseases." In these diseases, the body fails to recognize certain cells as part of its normal composition. The body thinks these cells are foreign and produces antibodies to fight them off, just as it fights against bacteria and viruses. Primary sclerosing cholangitis is a typical example of an autoimmune disease involving the bile ducts.

Causes and symptoms

As noted previously, the two things that are needed for cholangitis to occur are: 1) obstruction to bile flow, and 2) presence of bacteria within the bile ducts. The most common cause of cholangitis is infection of the bile ducts due to blockage by a gallstone. Strictures (portions of ducts that have become narrow) also function in the same way. Strictures may be due to congenital (birth) abnormalities of the bile ducts, form as a result of injury to the bile duct (such as surgery, trauma), or result from inflammation that leads to scar tissue and narrowing.

The bacterium most commonly associated with infection of the bile ducts is *Escherichia coli (E. coli)* which is a normal inhabitant of the intestine. In some cases, more than one type of bacteria is involved. Patients with **AIDS** can develop infection of narrowed bile ducts with unusual organisms such as *Cryptosporidium* and others.

The three symptoms present in about 70% of patients with cholangitis are abdominal **pain**, **fever**, and **jaundice**. Some patients only have chills and fever with minimal abdominal symptoms. Jaundice or yellow discoloration of the skin and eyes occurs in about 80% of patients. The color change is due to bile pigments that accumulate in the blood and eventually in the skin and eyes.

Inflammation due to the autoimmune disease primary sclerosing cholangitis leads to multiple areas of narrowing and eventual infection. Tumors can block the bile duct and also cause cholangitis, but as noted, infection is relatively infrequent; in fact cholangitis occurs in only about one in six patients with tumors.

Another type of bile duct infection occurs mainly in Southeast Asia and is known as recurrent pyogenic cholangitis or Oriental cholangitis. It has also been identified in Asians immigrating to North America. Most patients have stones in the bile ducts and/or gallbladder, and many cases are associated with the presence of parasites within the ducts. The role of parasites in causing infection is not clear. Many researchers believe that they are just coincidental, and have nothing to do with the stones or infection.

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KEY TERMS

Antibiotic—A medication that is designed to kill or weaken bacteria.

Bilirubin—A pigment produced by the liver that is excreted in bile which causes a yellow discoloration of the skin and eyes when it accumulates in those organs. Bilirubin levels can be measured by blood tests, and are most often elevated in patients with liver disease or a blockage to bile flow.

Computed tomography scan (CT scan)—A specialized x-ray procedure in which cross-sections of the area in question can be examined in detail. In evaluating the bile ducts, iodine-based dye is often injected intravenously. The procedure is of greatest value in diagnosing the complications of gallstones (such as abscesses, pancreatitis) rather than documenting the presence of a stone.

Endoscope—An endoscope as used in the field of gastroenterology is a thin flexible tube which uses a lens or miniature camera to view various areas of the gastrointestinal tract. When the procedure is performed to examine certain organs such as the bile ducts or pancreas, the organs are not viewed directly, but rather indirectly through the injection of x-ray dye into the bile duct.

Endoscopy—The performance of an exam using an endoscope is referred by the general term endoscopy. Diagnosis through biopsies or other means and therapeutic procedures can be done with these instruments.

Primary sclerosing cholangitis—A chronic disease in which it is believed that the immune system fails to recognize the cells that compose the bile ducts as part of the same body, and attempts to destroy them. It is not clear what exactly causes the disease, but it is frequently associated with another inflammatory disease of the digestive tract, ulcerative colitis. The inflammation of the ducts eventually produces formation of scar tissue, causing multiple areas of narrowing (strictures) that block bile flow and lead to bacterial infection. Liver transplant gives the best chance for long-term survival.

Ultrasound—A non-invasive procedure based on changes in sound waves of a frequency that cannot be heard, but respond to changes in tissue composition. It requires no preparation and no radiation occurs. It has become the "gold standard" for diagnosis of stones in the gallbladder, but is less accurate in diagnosing stones in the bile ducts. Gallstones as small as 2 mm can be identified. The procedure can now also be done through an endoscope, greatly improving investigation of the bile ducts.

Diagnosis

The symptoms mentioned previously are alone very suggestive of cholangitis; however, it is important to determine the exact cause and site of possible obstruction. This is because attacks are likely to recur, and different causes require different treatments. For example, the treatment of cholangitis due to a stone in the CBD is different from that due to bile duct strictures. An elevated white blood count suggests infection, but may be normal in 20% of patients. Abnormal or elevated tests of liver function, such as bilirubin and others are also frequently present. The specific bacteria is sometimes identified from blood cultures.

X-ray techniques

A number of x-ray techniques can assist in confirming the diagnosis of bile duct obstruction; these include ultrasound and **computed tomography scans** (CT scans). However, ultrasound often cannot tell if an obstruction is due to a stricture or stone, missing a stone in about half the cases. CT scans have an even poorer record of stone detection.

Another method of diagnosing and sometimes treating the cause of bile duct obstruction or narrowing is called **percutaneous transhepatic cholangiography**. In this procedure, dye is injected into the ducts by means of a needle placed into the liver. It is also used to drain bile and relieve an obstruction.

A newer imaging technique, magnetic resonance cholangiopancreatograpy (MRCP), may be used to determine the presence of CBD stones when other imaging techniques are inconclusive.

ENDOSCOPIC TECHNIQUES. An endoscope is a thin flexible tube that uses a lens or mirror to look at various parts of the gastrointestinal tract. **Endoscopic retrograde cholangiopancreatography** (ERCP) can accurately determine the cause and site of blockage. It also has the advantage of being able to treat the cause of obstruction, by removing stones and dilating (stretching) strictures. ERCP involves

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the injection of x-ray dye into the bile ducts through an endoscope. Endoscopic ultrasound is another endoscopic alternative, but is not as available as ERCP and is not therapeutic.

Treatment

The first aim is to control the bacterial infection. Broad-spectrum **antibiotics** are usually administered. Eighty % of patients respond promptly to conservative treatment with antibiotic therapy. If the infection does not come under control promptly (usually within 24 hours), as noted by decrease in fever and pain, then other methods to relieve the obstruction and infection will be needed. Either way, definitive treatment of the cause of bile duct infection is the next step, and this has undergone revolutionary changes in the past decade. Endoscopic, radiographic and other techniques have made it possible to successfully remove stones and dilate strictures that previously required surgical intervention, often with high morbidity and mortality.

Radiologic and endoscopic techniques

Just as with diagnosis, treatment of cholangitis involves a number of similar procedures that differ mainly in the way the bile ducts are entered. The aims of these techniques are immediate relief of obstruction and infection as well as correction of any abnormalities that have caused them. It is important to realize that even with **endoscopy**, x-ray dye is injected into the ducts and therefore the radiologist plays a role in both types of procedures. When endoscopy is used, the muscle between the intestine and bile duct is widened, to allow stones to pass. This is called a sphincterotomy and is often enough to relieve any obstruction and help clear infection. The widening of the muscle is needed if other procedures involving the bile duct are going to be performed. **Endoscopic sphincterotomy** with extraction of **gallstones** and/or insertion of a stent is now the treatment of choice for re-establishing biliary drainage in acute cholangitis. Common bile duct stones can be removed in most patients (up to 95% of patients) after the obstruction is removed with sphincterotomy.

The techniques mentioned previously can be summarized as follows:

- Insertion of a catheter or thin flexible tube to drain bile and relieve obstruction. When performed by insertion of a needle into the liver the technique is called percutaneous transhepatic biliary drainage (PTBD); when performed endoscopically the catheter exits through the nose and is called a nasobiliary drain.
- Balloons can be inserted into the ducts with either method to dilate strictures.
- Insertion of a prosthesis which is a rigid or flexible tube designed to keep a narrowed area open; it is usually placed after a stricture is dilated with a balloon.

Surgical treatment

Fortunately, with recent advances in the methods mentioned previously, this is a last option. Nonetheless, about 5–10% of patients will need to undergo surgical exploration of the bile ducts.

In some instances, the bile duct is so narrowed due to prior inflammation or tumor, that it needs connection to a different area of the intestinal tract to drain. This is rather complicated surgery and carries a mortality rate of 2%.

Prognosis

The outlook for those with cholangitis has markedly improved in the last several years due in large part to the development of the techniques described previously. For those patients whose episode of infection is caused by something other than a simple stone, the future is not as bright, but still often responsive to treatment. Some patients with autoimmune disease will need **liver transplantation**.

Prevention

This involves eliminating those factors that increase the risk of infection of the bile ducts, mainly stones and strictures. If it is medically possible, patients who have their gallbladder and suffer a bout of cholangitis should undergo surgical removal of the gallbladder and removal of any stones.

For other patients, a variety of therapies as outlined previously, including dissolving small stones with bile acids are also available. A combination of several of these methods is needed in some patients. Patients should discuss the risks and alternatives of these treatments with their physicians.

Resources

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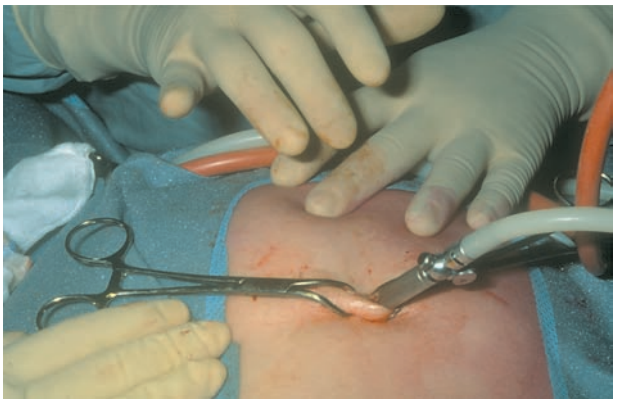
Cholecystectomy

Definition

A cholecystectomy is the surgical removal of the gallbladder. The two basic types of this procedure are open cholecystectomy and the laparoscopic approach. It is estimated that the laparoscopic procedure is currently used for approximately 80% of cases.

Purpose

A cholecystectomy is performed to treat cholelithiasis and **cholecystitis**. In cholelithiasis, **gallstones** of varying shapes and sizes form from the solid components of bile. The presence of stones, often referred to as gallbladder disease, may produce symptoms of excruciating right upper abdominal **pain** radiating to the right shoulder. The gallbladder may become the site of acute infection and inflammation, resulting in symptoms of upper right abdominal pain, **nausea and vomiting**. This condition is referred to as cholecystitis. The surgical removal of the gallbladder can provide relief of these symptoms.



A surgeon performs a laparoscopic cholecystectomy on a patient. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Precautions

Although the laparoscopic procedure requires **general anesthesia** for about the same length of time as the open procedure, **laparoscopy** generally produces less postoperative pain, and a shorter recovery period. The laparoscopic procedure would not be preferred in cases where the gallbladder is so inflamed that it could rupture, or when **adhesions** (additional fibrous bands of tissue) are present.

Description

The laparoscopic cholecystectomy involves the insertion of a long narrow cylindrical tube with a camera on the end, through an approximately 1 cm incision in the abdomen, which allows visualization of the internal organs and projection of this image onto a video monitor. Three smaller incisions allow for insertion of other instruments to perform the surgical procedure. A laser may be used for the incision and cautery (burning unwanted tissue to stop bleeding), in which case the procedure may be called laser laparoscopic cholecystectomy.

In a conventional or open cholecystectomy, the gallbladder is removed through a surgical incision high in the right abdomen, just beneath the ribs. A drain may be inserted to prevent accumulation of fluid at the surgical site.

Preparation

As with any surgical procedure, the patient will be required to sign a consent form after the procedure is explained thoroughly. Food and fluids will be prohibited after midnight before the procedure. **Enemas** may be ordered to clean out the bowel. If **nausea** or

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KEY TERMS

Cholecystitis—Infection and inflammation of the gallbladder, causing severe pain and rigidity in the upper right abdomen.

Cholelithiasis—Also known as gallstones, these hard masses are formed in the gallbladder or passages, and can cause severe upper right abdominal pain radiating to the right shoulder, as a result of blocked bile flow.

Gallbladder—A hollow pear-shaped sac on the under surface of the right lobe of the liver. Bile comes to it from the liver, and passes from it to the intestine to aid in digestion.

vomiting are present, a suction tube to empty the stomach may be used, and for laparoscopic procedures, a urinary drainage catheter will also be used to decrease the risk of accidental puncture of the stomach or bladder with insertion of the trocar (a sharp-pointed instrument).

Aftercare

Post-operative care for the patient who has had an open cholecystectomy, as with those who have had any major surgery, involves monitoring of blood pressure, pulse, respiration and temperature. Breathing tends to be shallow because of the effect of anesthesia, and the patient's reluctance to breathe deeply due to the pain caused by the proximity of the incision to the muscles used for respiration. The patient is shown how to support the operative site when breathing deeply and coughing, and given pain medication as necessary. Fluid intake and output is measured, and the operative site is observed for color and amount of wound drainage. Fluids are given intravenously for 24–48 hours, until the patient's diet is gradually advanced as bowel activity resumes. The patient is generally encouraged to walk 8 hours after surgery and discharged from the hospital within three to five days, with return to work approximately four to six weeks after the procedure.

Care received immediately after laparoscopic cholecystectomy is similar to that of any patient undergoing surgery with general anesthesia. A unique post-operative pain may be experienced in the right shoulder related to pressure from carbon dioxide used through the laparoscopic tubes. This pain may be relieved by laying on the left side with right knee and thigh drawn up to the chest. Walking will also help increase the body's reabsorption of the gas. The patient is usually discharged the day after surgery, and allowed to shower on the second postoperative day. The patient is advised to gradually resume normal activities over a three day period, while avoiding heavy lifting for about 10 days.

Risks

Potential problems associated with open cholecystectomy include respiratory problems related to location of the incision, wound infection, or **abscess** formation. Possible complications of laparoscopic cholecystectomy include accidental puncture of the bowel or bladder and uncontrolled bleeding. Incomplete reabsorption of the carbon dioxide gas could irritate the muscles used in respiration and cause respiratory distress.

Resources

OTHER

"Patient Information Documents on Digestive Diseases." *National Institute of Diabetes and Digestive and Kidney Disease*. http://www.niddk.nih.gov.

Kathleen D. Wright, RN

Cholecystitis

Definition

Cholecystitis refers to a painful inflammation of the gallbladder's wall. The disorder can occur a single time (acute), or can recur multiple times (chronic).

Description

The gallbladder is a small, pear-shaped organ in the upper right hand corner of the abdomen. It is connected by a series of ducts (tube-like channels) to the liver, pancreas, and duodenum (first part of the small intestine). To aid in digestion, the liver produces a substance called bile, which is passed into the gallbladder. The gallbladder concentrates this bile, meaning that it reabsorbs some of the fluid from the bile to make it more potent. After a meal, bile is squeezed out of the gallbladder by strong muscular contractions, and passes through a duct into the duodenum. Due to the chemical makeup of bile, the contents of the duodenum are kept at an optimal pH level for

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A close-up view of an inflamed gallbladder. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

digestion. The bile also plays an important part in allowing fats within the small intestine to be absorbed.

Demographics

Gallstone formation is seen in twice as many women as men, particularly those between the ages of 20 and 60. Pregnant women or those on birth control pills or estrogen replacement therapy have a greater risk of **gallstones**, as do Native Americans and Mexican Americans.

Risk factors

People who are overweight, or who lose a large amount of weight quickly, are at greater risk for developing gallstones. Not all individuals with gallstones go on to have cholecystitis, since many people never have any symptoms from their gallstones and never know they exist. However, the vast majority of people with cholecystitis are found to have gallstones. Rare causes of cholecystitis include severe **burns** or injury, massive systemic infection, severe illness, diabetes, obstruction by a tumor of the duct leaving the gallbladder, and certain uncommon infections of the gallbladder (including bacteria and worms).

Causes and symptoms

In about 95% of all cases of cholecystitis, the gallbladder contains gallstones. Gallstones are solid accumulations of the components of bile, particularly cholesterol, bile pigments, and **calcium**. These solids may occur when the components of bile are not in the correct proportion to each other. If the bile becomes overly concentrated, or if too much of one component is present, stones may form. When these stones block the duct leaving the gallbladder, bile accumulates within the gallbladder. The gallbladder continues to contract, but the bile cannot pass out of the gallbladder in the normal way. Back pressure on the gallbladder, chemical changes from the stagnating bile trapped within the gallbladder, and occasionally bacterial infection result in damage to the gallbladder wall. As the gallbladder becomes swollen, some areas of the wall do not receive adequate blood flow, and lack of oxygen causes cells to die.

When the stone blocks the flow of bile from the liver, certain normal byproducts of the liver's processing of red blood cells (called bilirubin) build up. The bilirubin is reabsorbed into the bloodstream, and over time this bilirubin is deposited in the skin and in the whites of the eyes. Because bilirubin contains a yellowish color, it causes a yellowish cast to the skin and eyes that is called **jaundice**.

Although there are rare reports of patients with chronic cholecystitis who never experience any **pain**, nearly 100% of the time cholecystitis is diagnosed after a patient has experienced a bout of severe pain in the region of the gallbladder and liver. The pain may be crampy and episodic, or it may be constant. The pain is often described as pushing through to the right upper back and shoulder. Because deep breathing increases the pain, breathing becomes shallow. **Fever** is often present, and **nausea and vomiting** are nearly universal. Jaundice occurs when the duct leaving the liver is also obstructed, although it may take a number of days for it to become apparent. When bacterial infection sets in, the patient may begin to experience higher fever and shaking chills.

Diagnosis

Examination

Diagnosis of cholecystitis involves a careful abdominal examination. The enlarged, tender gallbladder may be felt through the abdominal wall. Pressure in the upper right corner of the abdomen may cause the patient to stop breathing in, due to an increase in pain. This is called Murphy's sign. **Physical examination** may also reveal an increased heart rate and an increased rate of breathing.

Tests

Blood tests will show an increase in the white blood count and bilirubin. Ultrasound is used to look for gallstones and to measure the thickness of the gallbladder wall (a marker of inflammation and scarring). A scan of the liver and gallbladder, with careful attention to the system of ducts throughout

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KEY TERMS

Bile—A substance produced by the liver, and concentrated and stored in the gallbladder. Bile contains many different substances, including bile salts, cholesterol, and bilirubin. After a meal, the gallbladder pumps bile into the duodenum (the first part of the small intestine) to keep the intestine's contents at the appropriate pH for digestion, and to help break down fats.

Bilirubin—Produced when red blood cells break down. It is a yellowish color and when levels are abnormally high, it causes the yellowish tint to eyes and skin known as jaundice.

Cholecystectomy—An operation to remove the gallbladder.

Cholecystotomy—An operation during which the gallbladder is opened, gallstones are removed, and excess bile is drained. The gallbladder is not removed.

Duct—A tube through which various substances can pass. These substances can travel through ducts to another organ or into the bloodstream.

(called the biliary tree) is used to demonstrate obstruction of ducts.

Rare complications of cholecystitis include:

- massive infection of the gallbladder, in which the gallbladder becomes filled with pus (called empyema)
- perforation of the gallbladder, in which the build-up of material within the gallbladder becomes so great that the wall of the organ bursts, with a resulting abdominal infection called peritonitis
- formation of abnormal connections between the gallbladder and other organs (the duodenum, large intestine, stomach), called fistulas
- obstruction of the intestine by a very large gallstone (called gallstone ileus)
- emphysema of the gallbladder, in which certain bacteria that produce gas infect the gallbladder, resulting in stretching of the gallbladder and disruption of its wall by gas

Treatment

Traditional

Initial treatment of cholecystitis usually requires hospitalization. The patient is given fluids, salts, and sugars through a needle placed in a vein (intravenous or IV). No food or drink is given by mouth. A tube, called a nasogastric or NG tube, may need to be passed through the nose and down into the stomach to drain out the excess fluids. Medications for pain and IV administration of broad spectrum **antibiotics** are initiated.

Treatment almost always involves removal of the gallbladder, a surgery called **cholecystectomy**. It is not usually recommended that the patient have surgery while acutely ill, however, patients with complications may require emergency surgery (immediately following diagnosis) because the **death** rate increases in these cases. Similarly, patients who have cholecystitis with no gallstones have a 50% chance of death if the gallbladder is not quickly removed. Most patients do best if surgery is performed after they have been stabilized with fluids, possibly an NG tube, and administration of antibiotics. Results of recent research indicate that early operation (laparoscopic cholecystectomy) by an experienced surgeon within 72 hours of admission results in the best outcomes for the patient. In patients who have other serious medical problems that may increase the risks of gallbladder removal surgery, the surgeon may decide to leave the gallbladder in place. In this case, the operation may involve removing obstructing gallstones and draining infected bile (called cholecystotomy).

Both cholecystectomy and cholecystotomy may be performed via the classical open abdominal operation (laparotomy). Tiny, "keyhole" incisions, a flexible scope, and a laser device that shatters the stones (a laparoscopic laser) can be used to destroy the gallstones. The laparoscopic procedure can also be used to remove the gallbladder through one of the small incisions. Because of the smaller incisions, laparoscopic cholecystectomy is a procedure that is less painful and promotes faster healing.

Prognosis

Hospital management of cholecystitis ends the symptoms for about 75% of all patients. Of these patients, 25% will have another attack of cholecystitis within a year, and 60% will have another attack within six years. Each attack of cholecystitis increases a patient's risk of developing life-threatening complications, requiring emergency surgery. Therefore, early removal of the gallbladder, rather than a "wait-and-see" approach, is usually recommended. Cure is complete in those patients who undergo cholecystectomy.

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Prevention

Prevention of cholecystitis is best attempted by maintaining a reasonable ideal weight. Some studies have suggested that eating a diet high in fiber, vegetables, and fruit is also protective.

Resources

PERIODICALS

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Wilson, E., K. Gurusamy, C. Gluud, and B.R. Davidson. "Cost-Utility and Value-of-Information Analysis of Early versus Delayed Laparoscopic Cholecystectomy for Acute Cholecystitis." *British Journal of Surgery* 97, no. 2 (February 2010): 210–19.

ORGANIZATIONS

Digestive Disease National Coalition, 507 Capitol Court NE, Suite 200, Washington, DC, 20002, (202) 544-7497, http://www.ddnc.org.

National Digestive Diseases Information Clearinghouse, 2 Information Way, Bethesda, MD, 20892-3570, (800) 891-5389, http://www.digestive.niddk.nih.gov.

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Cholecystography *see* **Gallbladder x rays**
Choledocholithiasis *see* **Gallstones**
Cholelithiasis *see* **Gallstones**
Cholelithotomy *see* **Gallstone removal**

Cholera

Definition

Cholera is a serious, acute, **infectious disease** characterized by watery **diarrhea** that is caused by the bacterium *Vibrio cholerae*, first identified by Robert Koch in 1883 during a cholera outbreak in Egypt. The name of the disease comes from a Greek word meaning "flow of bile."

Demographics

Although cholera was a public health problem in the United States and Europe a hundred years ago, modern sanitation and the treatment of drinking water have virtually eliminated the disease in developed countries. In 2005, the World Health Organization (WHO) reported that there were 12 cases of cholera in the United States. Of these, eight were brought in by travelers and four were attributed to improperly cooked seafood in Louisiana following hurricanes Katrina and Rita.

A false color transmission electron micrograph (TEM) of *Vibrio cholerae bacterium* magnified 6,000 times its original size. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Internationally, cholera outbreaks continue to occur in less developed countries, particularly following such natural disasters such as hurricanes and tsunamis during which water supplies become contaminated. In 2007, WHO reported that cholera occurred in 53 countries. A total of 177,693 cases and 4,031 cholera deaths were reported that year. However, WHO estimates that the number of reported cases represents only five to 10 percent of actual cases. In areas where cholera occurs, it is the most feared epidemic diarrheal disease because people can die from **dehydration** that results from severe diarrhea within hours of infection.

Cholera often occurs in major outbreaks or epidemics; seven pandemics (countrywide or worldwide epidemics) of cholera were recorded between 1817 and 2010. WHO estimates that during any cholera epidemic, approximately 0.2–1% of the local population will contract the disease.

Anyone can get cholera, but infants, children, pregnant women, and the elderly are more likely to die from the disease because they become dehydrated faster than adults. There is no particular season in which cholera is more likely to occur.

Description

Cholera is spread by eating food or drinking water that has been contaminated with *V. cholerae*. Contamination usually occurs when human feces from a person who has the disease seeps into a community water

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supply. Fruits and vegetables also can be contaminated in areas where crops are fertilized with human feces. Cholera bacteria live in warm, brackish water and can infect persons who eat raw or undercooked seafood obtained from such waters. Cholera is rarely transmitted directly from one person to another.

Because of an extensive system of sewage and water treatment in the United States, Canada, Europe, Japan, and Australia, cholera is not a concern for visitors and residents of these countries. However, people visiting or living in other parts of the world, particularly the Indian subcontinent and in parts of Africa and South America, should be aware of the potential for contracting cholera and practice prevention. Fortunately, the disease is both preventable and treatable. Deaths usually occur in developing countries because of lack of access to hospitals and treatment.

Causes and symptoms

Cholera is caused by the bacterium *V. cholerae*. This bacterium is a gram–negative aerobic bacillus, or rod–shaped bacterium. It has two major biotypes: classic and El Tor. El Tor is the biotype responsible for most of the cholera outbreaks reported from 1961 through the 2000s.

Because *V. cholerae* is sensitive to acid, most cholera–causing bacteria die in the acidic environment of the stomach. However, when a person has ingested food or water containing large amounts of cholera bacteria, some will survive to infect the intestines. As would be expected, antacid usage or the use of any medication that blocks or reduces acid production in the stomach allows more bacteria to survive and cause infection.

In the small intestine, the rapidly multiplying bacteria produce a toxin that causes a large volume of water and electrolytes to be secreted into the bowels and then to be abruptly eliminated in the form of watery diarrhea. **Vomiting** may also occur. Symptoms begin to appear between one and three days after contaminated food or water has been ingested.

Most cases of cholera are mild, but about one in 20 patients experience severe, potentially life–threatening symptoms. In severe cases, fluids can be lost through diarrhea and **vomiting** at the rate of one quart per hour. This loss of fluid can produce a dangerous state of dehydration unless the lost fluids and electrolytes are rapidly replaced.

Signs of dehydration include intense thirst, little or no urine output, dry skin and mouth, an absence of tears, glassy or sunken eyes, **muscle cramps**, weakness, and rapid heart rate. The fontanelle (soft spot on an infant's head) will appear to be sunken or drawn in. Dehydration occurs most rapidly in the very young and the very old because they have fewer fluid reserves. A doctor should be consulted immediately any time signs of severe dehydration occur. Immediate replacement of lost fluids and electrolytes is necessary to prevent kidney failure, **coma**, and **death**.

KEY TERMS

Antibody—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

Bacillus—A rod–shaped bacterium. The organism that causes cholera is a gram–negative bacillus.

Biotype—A variant strain of a bacterial species with distinctive physiological characteristics.

Electrolytes—Salts and minerals that ionize in body fluids. Common human electrolytes are sodium, chloride, potassium, and calcium. Electrolytes control the fluid balance of the body and are important in muscle contraction, energy generation, and almost all major biochemical reactions in the body.

Pandemic—A widespread epidemic that affects whole countries or the entire world. There have been seven cholera pandemics since 1817.

Toxin—A poison. In the case of cholera, a poison secreted as a byproduct of the growth of the cholera bacteria in the small intestine.

Risk factors

Some people are at greater risk of having a severe case of cholera if they become infected. These risk factors include:

- People taking proton pump inhibitors, histamine (H2) blockers, or antacids to control acid indigestion. As noted earlier, *V. cholerae* is sensitive to stomach acid.
- People who have had chronic gastritis caused by infection with *Helicobacter pylori*.
- People who have had a partial gastrectomy (surgical removal of a portion of the stomach).

Diagnosis

Tests

Rapid diagnosis of cholera can be made by examining a fresh stool sample under the microscope for the presence of *V. cholerae* bacteria. Cholera can also be diagnosed by culturing a stool sample in the laboratory to isolate the cholera–causing bacteria. In

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addition, a blood test may reveal the presence of antibodies against the cholera bacteria. Because of the speed at which life–threatening dehydration can occur, in areas where cholera occurs often, however, patients are usually treated for diarrhea and vomiting symptoms as if they had cholera without laboratory confirmation.

Treatment

Traditional

The key to treating cholera lies in preventing dehydration by replacing fluids and electrolytes lost through diarrhea and vomiting. The discovery that rehydration can be accomplished orally revolutionized the treatment of cholera and other, similar diseases by making this simple, cost–effective treatment widely available throughout the world. WHO has developed an inexpensive oral replacement fluid containing appropriate amounts of water, sugar, and salts that is used worldwide. In cases of severe dehydration, replacement fluids must be given intravenously. Patients should be encouraged to drink when they can keep liquids down and eat when their appetite returns. Recovery generally takes three to six days.

Drugs

Adults may be given the antibiotic tetracycline to shorten the duration of the illness and reduce fluid loss. WHO recommends this antibiotic treatment only in cases of severe dehydration. If **antibiotics** are overused, the cholera bacteria may develop resistance to the drug, making the antibiotic ineffective in treating even severe cases of cholera. Tetracycline is not given to children whose permanent teeth have not come in because it can cause the teeth to become permanently discolored.

Other antibiotics that may be given to speed up the clearance of *V. cholerae* from the body include azithromycin (Zithromax), Doxycycline (Bio–Tab, Doryx, Vibramycin), ciprofloxacin (Cipro), and erythromycin.

Alternative

A possible complementary or alternative treatment for fluid loss caused by cholera is a plant–derived compound, an extract made from the tree bark of *Croton lechleri*, the Sangre de grado tree found in the South American rain forest. Researchers at a hospital research institute in California report that the extract appears to work by preventing the loss of chloride and other electrolytes from the body.

Prognosis

Cholera is a very treatable disease so long as resources are available for rehydration. Patients with milder cases of cholera usually recover on their own in three to six days without additional complications. They may eliminate the bacteria in their feces for up to two weeks. Chronic carriers of the disease are rare. With prompt fluid and electrolyte replacement, the death rate in patients with severe cholera is less than one percent. Untreated, the death rate can be greater than 50%. The difficulty in treating severe cholera does not lie in not knowing how to treat it but rather in getting medical care to the sick in developing areas of the world where medical resources are limited.

Prevention

The best form of cholera prevention is to establish good sanitation and waste treatment systems. In the absence of adequate sewage treatment, the following guidelines should be followed to reduce the possibility of infection:

- Boil water. Drink and brush teeth only with water that has been boiled or treated with chlorine or iodine tablets. Safe drinks include coffee and tea made with boiling water or carbonated bottled water and carbonated soft drinks.
- Cook foods. Eat only thoroughly cooked foods, and eat them while they are still hot. Avoid eating food from street vendors.
- Peel foods. Eat only fruit or nuts with a thick intact skin or shell that is removed immediately before eating.
- Avoid raw foods. Do not eat raw foods such as oysters or ceviche. Avoid salads and raw vegetables. Do not use untreated ice cubes in otherwise safe drinks.
- Avoid polluted water. Do not swim or fish in polluted water.

Preventive measures following natural disasters include guaranteeing the purity of community drinking water, either by large–scale chlorination and boiling, or by bringing in bottled or purified water from the outside. Other important preventive measures at the community level include provision for the safe disposal of human feces and good food hygiene.

Because cholera is one of the few infectious diseases that can be spread by human remains (through fecal matter leaking from corpses into the water supply), during natural disasters, emergency workers who handle human remains are at increased risk of

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infection. It is considered preferable to bury corpses rather than to cremate them, however, and to allow survivors time to conduct appropriate burial ceremonies or rituals. The remains should be disinfected prior to burial, and buried at least 90 feet (30 m) away from sources of drinking water.

A cholera vaccines exists that can be given to travelers and residents of areas where cholera is known to be active, but the vaccine is not highly effective. It provides only 25–50% immunity, and then only for a period of about six months. The vaccine is never given to infants under six months of age. The Centers for Disease Control and Prevention (CDC) does not currently recommend cholera **vaccination** for travelers. Residents of cholera–plagued areas should discuss the value of the vaccine with their doctor.

In 2006 another cholera vaccine known as WC/rBS was approved for use in the United States. It is also available in Sweden. This vaccine is designed to stimulate the formation of antibodies against both the cholera bacteria and the cholera toxin. It is more effective than previous vaccines but provides protection for only a limited time. The prevention strategies listed previously are still necessary precautions.

Resources

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Handa, Sajeev. "Cholera." eMedicine.com (February 26, 2010). http://emedicine.medscape.com/article/214911-overview (accessed September 17, 2010).

ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Rd., Atlanta, GA, 30333, (404) 639–3534, (800) CDC–INFO ((800) 232–4636). TTY: (888) 232–6348, inquiry@cdc.gov, http://www.cdc.gov.

World Health Organization (WHO), Avenue Appia 20, 1211 Geneva 27, Switzerland, +22 41 791 21 11, +22 41 791 31 11, info@who.int, http://www.who.int.

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Cholestasis

Definition

Cholestasis is a condition caused by rapidly developing (acute) or long-term (chronic) interruption in the excretion of bile (a digestive fluid that helps the body process fat). The term is taken from the Greek *chole*, bile, and *stasis*, standing still.

Description

Cholestasis is caused by obstruction within the liver (intrahepatic) or outside the liver (extrahepatic). The obstruction causes bile salts, the bile pigment bilirubin, and fats (lipids) to accumulate in the bloodstream instead of being eliminated normally.

Intrahepatic cholestasis is characterized by widespread blockage of small ducts or by disorders such as hepatitis that impair the body's ability to eliminate bile. Extrahepatic cholestasis can occur as a side effect of many medications. It can also occur as a complication of surgery, serious injury, tissue-destroying infection, or intravenous feeding. Extrahepatic cholestasis can be caused by conditions such as tumors and **gallstones** that block the flow of bile from the gallbladder to the first part of the small intestine (duodenum).

Pregnancy increases the sensitivity of the bile ducts to estrogen, and cholestasis often develops during the second and third trimesters of pregnancy. This condition is the second most common cause of **jaundice** during pregnancy, but generalized **itching** (pruritus gravidarum) is the only symptom most women experience. Cholestasis of pregnancy tends to run in families. Symptoms usually disappear within two to four weeks after the baby's birth but may reappear if the woman becomes pregnant again.

A similar condition affects some women who take birth control pills. Symptoms disappear after the woman stops using **oral contraceptives**. This condition does not lead to chronic **liver disease**. A woman who develops cholestasis from either of these causes (pregnancy or birth control hormones) has an increased risk of developing cholestasis from the other.

Benign familial recurrent cholestasis is a rare condition characterized by brief, repeated episodes of itching and jaundice. Symptoms often disappear. This condition does not cause **cirrhosis**.

Drug-induced cholestasis may be a complication of **chemotherapy** or other medications. The two major types of drug-induced cholestasis are direct toxic injury and reactions unique to an individual (idiosyncratic

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reactions). In direct toxic injury, the severity of symptoms parallels the amount of medication involved. This condition develops a short time after treatment begins, follows a predictable pattern, and usually causes liver damage.

Direct toxic reactions develop in 1% of all patients who take chlorpromazine (Thorazine), a tranquilizer and antinausea drug. Idiosyncratic reactions may occur at the onset of treatment or at a later time. Allergic responses are varied and are not related to the amount of medication being taken.

Newborns and infants are particularly susceptible to the development of cholestasis as a consequence of immaturity of the liver.

Causes and symptoms

Intrahepatic cholestasis is usually caused by hepatitis or by medications that can produce symptoms resembling hepatitis. Phenothiazine-derivative drugs, including chlorpromazine, can cause sudden **fever** and inflammation. Symptoms usually disappear after use of the drug(s) is stopped. In rare cases, a condition resembling chronic biliary cirrhosis (a progressive disease characterized by destruction of small bile ducts) persists even after the medication is stopped. Some patients experience a similar reaction in response to **tricyclic antidepressants** (amitriptyline, imipramine), phenylbutazone (Butazolidin), erythromycin estolate (Estomycin, Purmycin), and other drugs. Intrahepatic cholestasis may also be caused by alcoholic liver disease, **primary biliary cirrhosis**, **cancer** that has spread (metastasized) from another part of the body, and a number of rare disorders.

Extrahepatic cholestasis is most often caused by a stone obstructing the passage through which bile travels from the gallbladder to the small intestine (common bile duct) or by pancreatic cancer. Less often, the condition occurs as a result of non-cancerous narrowing of the common duct (strictures), ductal carcinoma, or disorders of the pancreas.

Cholestasis caused by the use of **steroids** causes little, if any, inflammation. Symptoms develop gradually and usually disappear after the drug is discontinued. Other drugs that can cause cholestasis are:

- allopurinol (Zyloprim)
- amitriptyline (Elavil)
- azathioprine (Imuran)
- benoxaprofen (Oraflex)
- capotril (Capoten)
- carbamazepine (Tegretol)
- cimetidine (Tagamet)
- hydralazine hydrochloride (Apresoline Hydrochloride)
- imipramine (Tofranil)
- penicillin
- quinidine sulfate (Quinidex)
- ranitidine (Zantac)
- sulfonamides (Apo-Sulfatrim, sulfamethoxazole)
- sulindac (Clinoril, Saldac)

Symptoms of both intrahepatic and extrahepatic cholestasis include a yellow discoloration of the skin (jaundice), dark urine, and pale stools. Itching over the skin may be severe if the condition is advanced.

Symptoms of chronic cholestasis include:

- skin discoloration
- scars or skin injuries caused by scratching
- bone pain
- yellowish fat deposits beneath the surface of the skin (xanthoma) or around the eyes (xanthelasma)

Patients with advanced cholestasis feel ill, tire easily, and are often nauseated. Abdominal **pain** and such systemic symptoms as anorexia, **vomiting**, and fever are usually due to the underlying condition that causes cholestasis.

Diagnosis

Examination and tests

Determining whether obstruction exists inside or outside the liver is the essential part of diagnosis. A history of hepatitis or heavy drinking, recent use of certain drugs, and symptoms like **ascites** (abnormal abdominal swelling) and splenomegaly (enlarged spleen) suggest intrahepatic cholestasis. Pain or rigidity in the gallbladder or pancreas suggest an extrahepatic form.

Blood tests and **liver function tests** can reveal the pattern and extent of liver injury, indicate functional abnormalities, and establish the cause of the condition. Most misdiagnoses occur when physicians rely more on laboratory analysis than on detailed medical history and the results of a thorough **physical examination**. Blood tests that may be ordered include measurement of serum bilirubin, serum bile salts, serum cholesterol, serum lipoprotein-X, serum 5-nucleotidase, and serum gamma-glutamyl transferase levels. Fecal fat levels may also be elevated in cholestasis. Special attention should be paid to liver function tests including levels of alkaline phosphatase (ALP). ALP levels more than three times greater than normal indicate cholestasis.

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KEY TERMS

Bile—A bitter yellow-green substance produced by the liver. Bile breaks down fats in the small intestine so that they can be used by the body. It is stored in the gallbladder and passes from the gallbladder through the common bile duct to the top of the small intestine (duodenum) as needed to digest fat.

Biliary—Of bile or of the gallbladder and bile ducts that transport bile and make up the biliary system or tract.

Computed tomography scans (CT)—An imaging technique in which cross-sectional x rays of the body are compiled to create a three-dimensional image of the body's internal structures.

Endoscopic retrograde cholangiopancreatography—A diagnostic procedure for mapping the pancreatic and common bile ducts. A flexible tube with a light transmitter (fiberoptics) is placed in the duct. A contrast dye is instilled directly into the duct and a series of x-ray images are taken.

Hepatic—Of the liver, from the Greek word *hepar*.

Liver function tests—Tests used to evaluate liver metabolism, storage, filtration, and excretion. The tests include alkaline phosphatase and serum alanine aminotransferase and aspartate aminotransferase.

Magnetic resonance imaging (MRI)—An imaging technique that uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

Percutaneous transhepatic cholangiography—An x-ray examination of the bile ducts. A needle is passed through the skin (percutaneous) across or over the liver (transhepatic) and directly into a bile duct to inject a contrast dye. The dye enhances the x-ray image mapping the system of bile ducts (cholangiography).

Phenothiazine-derivative drugs—A large family of drugs derived from phenothiazine, a compound that in itself is too poisonous for human consumption. Phenothiazine derivatives include tranquilizers, medications that prevent vomiting, antihistamines, and drugs used to enhance the effectiveness of anesthesia.

Ultrasonography—A test using sound waves to measure blood flow. Gel is applied to a hand-held transducer that is pressed against the patient's body. Images are displayed on a monitor.

Once the disease pattern has been established, ultrasound may be performed to determine whether obstruction of the large duct has caused widening of small ducts located close to it. **Computed tomography scans** (CT) and **magnetic resonance imaging** (MRI) can provide more detailed information about the source of the obstruction.

Procedures

If these imaging procedures do not provide the information a physician, internist, or gastroenterologist needs to make a diagnosis of cholestasis, one of these procedures may be performed:

- direct cholangiography, an x-ray map of the bile ducts, enhanced by the use of contrast dye
- percutaneous transhepatic cholangiography, used to identify obstructions that impede the flow of bile from the liver to the digestive system, takes x-ray images of the bile ducts after a contrast dye has been injected by a needle passed directly into a hepatic duct
- endoscopic retrograde cholangiopancreatography (ERCP), which uses a special dye to outline the pancreatic and common bile ducts and highlight the position of any obstruction; a special tube with a light transmitter is inserted into the duct and a series of x-ray images is taken

A doctor who thinks a physical obstruction is responsible for progressive deterioration of a patient's condition may consider an exploratory surgical procedure (diagnostic laparotomy). **Liver biopsy** is sometimes performed if imaging tests do not indicate why a duct is enlarged, but results of a single biopsy may not represent the status of the entire organ.

Treatment

Traditional

The goal of treatment is to eliminate or control the patient's symptoms. Discontinuing the use of certain drugs can restore normal liver function, but surgery may be needed to drain or remove obstructions or to widen affected ducts. A liver transplant may become necessary if complications occur.

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Drugs

Rifampin (Rifadin, Rimactane), an antibacterial drug; Phenobarbital (Luminol), a barbiturate anticonvulsant that decreases serum bilirubin levels by increasing hepatic enzyme metabolims; and other drugs including urosodeoxycholic acid (Actigall, Urosol), and bile salt resins are sometimes prescribed to cleanse the system and eliminate bile salts and other toxic compounds.

Home remedies

Patients who have chronic cholestasis and have trouble digesting fat may have to restrict the amount of fat in their diet and take **calcium** and water-soluble vitamin supplements.

Prognosis

Symptoms almost always disappear after the underlying condition is controlled.

Some patients who have cholestasis experience symptoms only after infection develops, but chronic bile-duct obstruction always leads to cirrhosis. It may also cause **osteoporosis** (fragile bones) or osteomalacia (soft bones).

Emergency care is not required unless inflammation of the bile ducts (**cholangitis**) develops. Cancer should be considered when an adult suddenly develops cholestasis after the age of 50.

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ORGANIZATIONS

American Liver Foundation, 75 Maiden Lane, Suite 603, New York, NY, 10038, (212) 668-1000, http://www.iverfoundation.org.

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Cholesterol test

Definition

The cholesterol test is a quantitative analysis of the cholesterol levels in a sample of the patient's blood. Total serum cholesterol (TC) is the measurement routinely taken. Doctors sometimes order a complete lipoprotein profile to better evaluate the risk for **atherosclerosis** (**coronary artery disease**, or CAD). The full lipoprotein profile also includes measurements of triglyceride levels (a chemical compound that forms 95% of the fats and oils stored in animal or vegetable cells) and lipoproteins (high density and low density). Blood fats also are called "lipids." It is estimated that more than 200 million cholesterol tests are performed each year in the United States.

The type of cholesterol in the blood is as important as the total quantity. Cholesterol is a fatty substance and cannot be dissolved in water. It must combine with a protein molecule called a lipoprotein in order to be transported in the blood. There are five major types of lipoproteins in the human body; they differ in the amount of cholesterol that they carry in comparison to other fats and fatty acids, and in their functions in the body. Lipoproteins are classified, as follows, according to their density:

- Chylomicrons. These are normally found in the blood only after a person has eaten foods containing fats. They contain about 7% cholesterol. Chylomicrons transport fats and cholesterol from the intestine into the liver, then into the bloodstream. They are metabolized in the process of carrying food energy to muscle and fat cells.
- Very low-density lipoproteins (VLDL). These lipoproteins carry mostly triglycerides, but they also contain 16–22% cholesterol. VLDLs are made in the liver and eventually become IDL particles after they have lost their triglyceride content.
- Intermediate-density lipoproteins (IDL). IDLs are short-lived lipoproteins containing about 30% cholesterol that are converted in the liver to low-density lipoproteins (LDLs).
- Low-density lipoproteins (LDL). LDL molecules carry cholesterol from the liver to other body tissues. They contain about 50% cholesterol. Extra LDLs are absorbed by the liver and their cholesterol is excreted into the bile. LDL particles are involved in the formation of plaques (abnormal deposits of cholesterol) in the walls of the coronary arteries. LDL is known as "bad cholesterol."

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- High-density lipoproteins (HDL). HDL molecules are made in the intestines and the liver. HDLs are about 50% protein and 19% cholesterol. They help to remove cholesterol from artery walls. Lifestyle changes, including exercising, keeping weight within recommended limits, and giving up smoking can increase the body's levels of HDL cholesterol. HDL is known as "good cholesterol."
- Lipoprotein subclasses. By identifying levels of multiple subclasses of lipid abnormalities, physicians can do a better job of prescribing lipid-lowering therapies, particularly in high-risk patients such as those with type 2 diabetes.

Because of the difference in density and cholesterol content of lipoproteins, two patients with the same total cholesterol level can have very different lipid profiles and different risk for CAD. The critical factor is the level of HDL cholesterol in the blood serum. Some doctors use the ratio of the total cholesterol level to HDL cholesterol when assessing the patient's degree of risk. A low TC/HDL ratio is associated with a lower degree of risk.

Purpose

The purpose of the TC test is to measure the levels of cholesterol in the patient's blood. The patient's cholesterol also can be fractionated (separated into different portions) in order to determine the TC/HDL ratio. The results help the doctor assess the patient's risk for coronary artery disease (CAD). High LDL levels are associated with increased risk of CAD whereas high HDL levels are associated with relatively lower risk.

In addition, the results of the cholesterol test can assist the doctor in evaluating the patient's metabolism of fat, or in diagnosing inflammation of the pancreas, **liver disease**, or disorders of the thyroid gland.

The frequency of cholesterol testing depends on the patient's degree of risk for CAD. People with low cholesterol levels may need to be tested once every five years. People with high levels of blood cholesterol should be tested more frequently, according to their doctor's advice. The doctor may recommend a detailed evaluation of the different types of lipids in the patient's blood. It is ideal to check the HDL and **triglycerides** as well as the cholesterol and LDL. In addition, the National Cholesterol Education Program (NCEP) suggests further evaluation if the patient has any of the symptoms of CAD or if she or he has two or more of the following risk factors for CAD:

- high blood pressure
- smoking
- diabetes
- low HDL levels
- family history of CAD before age 55

The necessity of widespread cholesterol screening is a topic with varying responses. In 2003, a report demonstrated that measuring the cholesterol of everyone at age 50 years was a simple and efficient way to identify those most at risk for heart disease from among the general population.

Precautions

Patients who are seriously ill or hospitalized for surgery should not be given cholesterol tests because the results will not indicate the patient's normal cholesterol level. Acute illness, high **fever**, **starvation**, or recent surgery lowers blood cholesterol levels.

Description

A pharmaceutical corporation announced in the spring of 2004 that it had received an application to patent a device that could use saliva to determine cholesterol levels. If the test becomes available, it could make screening much more convenient and accessible.

The cholesterol test requires a sample of the patient's blood. **Fasting** before the test is required to get an accurate triglyceride and LDL level. The blood is withdrawn by the usual vacuum tube technique from one of the patient's veins. The blood test takes between three and five minutes.

Preparation

Patients who are scheduled for a lipid profile test should fast (except for water) for 12–14 hours before the blood sample is drawn. If the patient's cholesterol is to be fractionated, he or she also should avoid alcohol for 24 hours before the test.

Patients also should stop taking any medications that may affect the accuracy of the test results. These include **corticosteroids**, estrogen or androgens, **oral contraceptives**, some **diuretics**, haloperidol, some **antibiotics**, and niacin. Antilipemics are drugs that lower the concentration of fatty substances in the blood. When these are taken by the patient, blood testing may be done frequently to evaluate the liver function as well as lipids. The patient's doctor will give the patient a list of specific medications to be discontinued before the test.

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Aftercare

Aftercare includes routine care of the skin around the needle puncture. Most patients have no aftereffects, but some may have a small bruise or swelling. A washcloth soaked in warm water usually relieves discomfort. In addition, the patient should resume taking any prescription medications that were discontinued before the test.

Risks

The primary risk to the patient is a mild stinging or burning sensation during the venipuncture, with minor swelling or bruising afterward.

Normal results

The "normal" values for serum lipids depend on the patient's age, sex, and race. Normal values for people in Western countries were once presumed to be 140–220 mg/dL in adults, although as many as 5% of the population has TC higher than 300 mg/dL. Among Asians, the figures are about 20% lower. As a rule, both TC and LDL levels rise as people get older. However, in 2001, the NCEP released stricter guidelines for LDL and total cholesterol.

Some doctors prefer to speak of "desired" rather than "normal" cholesterol values, on the grounds that "normal" refers to statistically average levels that may still be too high for good health. The NCEP has outlined the levels according to desirable and risk:

- Optimal LDL cholesterol: less than 100 mg/dL and total cholesterol less than 160 mg/dL
- Desirable LDL cholesterol: 100–129 mg/dL; total cholesterol 160–199 mg/dL
- Borderline high risk: LDL cholesterol 130–159 mg/dL; total cholesterol 200–239 mg/dL
- High risk: LDL cholesterol greater than 160 mg/dL; total cholesterol greater than or at 240 mg/dL.

KEY TERMS

Atherosclerosis—A disease of the coronary arteries in which cholesterol is deposited in plaques on the arterial walls. The plaque narrows or blocks blood flow to the heart. Atherosclerosis sometimes is called coronary artery disease, or CAD.

Fractionation—A laboratory test or process in which blood or another fluid is broken down into its components. Fractionation can be used to assess the proportions of the different types of cholesterol in a blood sample.

High-density lipoprotein (HDL)—A type of lipoprotein that protects against coronary artery disease by removing cholesterol deposits from arteries or preventing their formation.

Hypercholesterolemia—The presence of excessively high levels of cholesterol in the blood.

Lipid—Any organic compound that is greasy, insoluble in water, but soluble in alcohol. Fats, waxes, and oils are examples of lipids.

Lipoprotein—A complex molecule that consists of a protein membrane surrounding a core of lipids. Lipoproteins carry cholesterol and other lipids from the digestive tract to the liver and other body tissues. There are five major types of lipoproteins.

Low-density lipoprotein (LDL)—A type of lipoprotein that consists of about 50% cholesterol and is associated with an increased risk of coronary artery disease.

Plaque—An abnormal deposit of hardened cholesterol on the wall of an artery.

Triglyceride—A chemical compound that forms about 95% of the fats and oils stored in animal and vegetable cells. Triglyceride levels sometimes are measured as well as cholesterol when a patient is screened for heart disease.

Abnormal results

It is possible for blood cholesterol levels to be too low as well as too high.

Abnormally low levels

TC levels less than 160 mg/dL are associated with higher mortality rates from **cancer**, liver disease, respiratory disorders, and injuries. The connection between unusually low cholesterol and increased mortality is not clear, although some researchers think that the low level is a secondary sign of the underlying disease and not the cause of disease or **death**.

Low levels of serum cholesterol are also associated with **malnutrition** or **hyperthyroidism**. Further diagnostic testing may be necessary in order to locate the cause.

Abnormally high levels

Prior to 1980, **hypercholesterolemia** (an abnormally high TC level) was defined as any value above

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the 95th percentile for the population. These figures ranged from 210 mg/dL in persons younger than 20 to more than 280 mg/dL in persons older than 60. It is now known, however, that TC levels over 200 mg/dL are associated with significantly higher risk of CAD. Levels of 280 mg/dL or more are considered elevated. Treatment with diet and medication has proven to successfully lower risk of **heart attack** and **stroke**.

Elevated cholesterol levels also may result from hepatitis, blockage of the bile ducts, disorders of lipid metabolism, **nephrotic syndrome**, inflammation of the pancreas, or **hypothyroidism**.

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"Company Wins U.S. Patent for Saliva Cholesterol Test." *Heart Disease Weekly* May 23, 2004: 66.

"Study Shows Expanded Cholesterol Test Sparked Use of Lipid-lowering Therapy." *Heart Disease Weekly* July 13, 2003: 20.

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Cholesterol levels

Total cholesterol	
<200 mg/dL	Desirable (lowers the risk of developing coronary heart disease)
200 to 239 mg/dL	Borderline high
≥240 mg/dL	High (more than doubles the risk of developing coronary heart disease)
HDL ("good") cholesterol	
Men: <40 mg/dL Women: <50 mg/dL	Low (major risk factor for heart disease)
≥60 mg/dL	High (considered protective against heart disease)
LDL ("bad") cholesterol	
<100 mg/dL	Optimal
100 to 129 mg/dL	Near optimal
130 to 159 mg/dL	Borderline high
160 to 189 mg/dL	High
≥190 mg/dL	Very high
Triglycerides	
<150 mg/dL	Normal
150 to 199 mg/dL	Borderline high
200 to 499 mg/dL	High
≥ 500 mg/dL	Very high

SOURCE: American Heart Association, "What Your Cholesterol Levels Mean." Available online at: http://www.heart.org/HEARTORG/Conditions/Cholesterol/AboutCholesterol/What-Your-Cholesterol-Levels-Mean_UCM_305562_Article.jsp (accessed August 12, 2010).

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Cholesterol, high

Definition

Cholesterol is a waxy substance made by the liver and also acquired through diet. It is found in the blood and in all cells in the body. The body uses cholesterol to produce bile, some hormones, vitamin D, cell membranes, and myelin (the material that surrounds nerves). A high level of cholesterol in the blood is called **hypercholesterolemia**. High levels of blood cholesterol have been linked to heart disease.

Description

Cholesterol in small quantities is necessary for the body to function properly, but the liver is able to synthesize about 1,000 mg of cholesterol a day, which is all the body needs. However, because cholesterol is found in animal products— meat, fish, shellfish, egg yolks, and dairy products—people also get cholesterol through their diet, and too much cholesterol can be harmful.

Cholesterol does not dissolve in blood. Instead it moves through the circulatory system in combination with carrier substances called lipoproteins. There are two carrier-cholesterol combinations, low-density lipoprotein (LDL) or "bad" cholesterol and high-density lipoprotein or "good" cholesterol.

Most of the cholesterol in the body is LDL cholesterol. An excessive amount of LDL cholesterol is a major contributing factor to the development of heart disease. LDL picks up cholesterol in the liver and carries it through the circulatory system. When too much LDL cholesterol is present, it begins to drop out of the blood and stick to the walls of the arteries. The sticky material on artery walls is called plaque. (It is different from dental plaque that accumulates on teeth.) Plaque can reduce the amount of blood flowing through the arteries, and when bits of plaque break open, they can stimulate the formation of **blood clots**. If plaque or a blood clot block the coronary arteries that carry blood to the heart, **heart attack** (myocardial infarction) can occur. A **stroke** occurs if arteries carrying blood to the brain are blocked. In adults, a desirable LDL reading is less than 100 mg/dL.

High-density lipoprotein (HDL) or "good" cholesterol appears to carry excess LDL cholesterol away from the walls of the arteries to the liver where it can

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be processed and removed from the body. High levels of HDL cholesterol are helpful; they seem to help protect the body from heart disease and heart attack. Low levels seem to increase the risk of heart disease. In adults, a desirable level of HDL is greater than 60 mg/dL.

A desirable total cholesterol level (LDL + HDL) is less than 200 mg/dL. According to the United States Centers for Disease Control and Prevention (CDC), the average total cholesterol level in American adults is 203 mg/dL, and 17% of Americans over age 20 have total cholesterol levels of 240 mg/dL or higher. This percentage has decreased from a high of 33% in 1960 as people have become more aware of the connection between high cholesterol levels and heart disease.

Specific risk factors include a high-fat, high-calorie diet, family history of high cholesterol, **obesity**, **alcoholism**, and lack of regular **exercise**. Because cholesterol also is produced naturally in the liver, overproduction may occur in even in people who limit their intake of high-cholesterol food. The chance of developing high cholesterol increases after the age of 45, ans women are at higher risk of for developing high cholesterol levels than men. Both genetic inheritance and lifestyle factors affect cholesterol level.

Causes and symptoms

There are no readily apparent symptoms that indicate high LDL or low HDL cholesterol levels. The only way to determine cholesterol levels is through a simple blood test. According to the CDC, almost 75% of Americans reported in 2005 that they had had their cholesterol level checked within the previous five years.

Diagnosis

High cholesterol often is diagnosed from blood tests that are part of a routine **physical examination**. The condition usually is treated by general practitioners or family practice physicians unless other conditions concerns complicate the patient's health status. Total cholesterol, LDL, HDL, and **triglycerides** (another type of blood fat that plays a role in heart disease) are measured by a blood test called a lipid panel. The cost of a lipid panel is moderate and routinely is covered by health insurance and HMO plans, including Medicare. Home cholesterol testing kits are sold over the counter (without prescription), but these test only for total cholesterol. The results of a home test should be used only as a guide, and if the total cholesterol level is high, a physician should perform a lipid panel. The generally recommended levels of LDL, HDL, and total cholesterol are listed in the previous table. However, physician recommendations for individuals may vary depending on the individual's risk factors such as **hypertension** (high blood pressure), a family history of heart disease, current heart disease, diabetes, age, alcoholism, and **smoking**.

Treatment

Treatment normally begins with lifestyle changes unless the individual already has heart disease and/or has high cholesterol and additional risk factors. In such situations drug therapy may begin at the same time lifestyle changes are implemented. Drug therapy is not a substitute for lifestyle changes; the two must be used together to effectively reduce blood cholesterol levels.

Lifestyle changes

The main lifestyle changes used to treat high cholesterol are diet, exercise, weight loss, and stopping smoking. The National Heart, Lung, and Blood Institute has developed a diet called the Therapeutic Lifestyle Changes (TLC) diet designed to help lower cholesterol and control weight. TLC diet recommendations include the following:

- Fewer than 7% of daily total calories should come from saturated fat.
- No more than 25–35% of total daily calories should come from any type of fat.
- Daily intake of cholesterol should be no more than 200 mg. (In 2007, the average American man ate 337 mg of cholesterol daily and the average woman ate 217 mg daily.)
- Daily sodium intake should be no more than 2,400 mg.
- Daily total calories should be limited to what will maintain or reduce weight.

In addition to reducing cholesterol and fat, increasing the amount of fiber in the diet helps lower total blood cholesterol. High-fiber foods include products made with whole wheat (e.g., pasta, bread), brown rice, lentils, dried beans, and raw vegetables (e.g., celery, carrots, apples, pears). In the United States, food labels are required to list in the **nutrition** information panel calories, calories from fat, total fat, saturated fat, *trans* fat, cholesterol, **sodium**, total carbohydrates, dietary fiber, sugars, protein, vitamin A, vitamin C, **calcium**, and iron. In addition, the following words have specific legal meanings on food labels.

- Cholesterol-free: Less than 2 mg of cholesterol and 2 g of saturated fat per serving.
- Low cholesterol: no more than 20 mg of cholesterol and 2 grams of saturated fat per serving.

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- Fat-free: less than 0.5 grams of fat per serving.
- Low fat: no more than 3 grams or less of fat per serving.
- Less fat: A minimum of 25% less fat than the comparison food.
- Light (fat): A minimum of 50% less fat than the comparison food.

A calculator that factors in height, weight, age, and activity level to determine an individualized daily calorie and fats level can be found at http://www.nhlbisupport.com/cgi-bin/chd1/step2intro.cgi.

A vegetarian or vegan diet also may be effective in lowering cholesterol, since most cholesterol comes from eating cholesterol-containing animal products, which are reduced (vegetarian) or eliminated (vegan) in these **diets**. Vegetarians typically get up to 100% more fiber and up to 50% less cholesterol from food than non-vegetarians. The vegetarian low-cholesterol diet consists of at least six servings of whole grain foods, three or more servings of green leafy vegetables, two to four servings of fruit, two to four servings of legumes, and one or two servings of non-fat dairy products daily.

Exercise also is an important part of lowering LDL cholesterol and raising HDL cholesterol. Ideally, exercise should consist of 20–30 minutes of vigorous aerobic exercise (e.g., fast walking, bicycling, jogging, roller skating, swimming, walking up stairs) at least three times a week. Nevertheless, any regular exercise is helpful, especially for overweight individuals. Individuals should not avoid exercising simply because they cannot meet the ideal exercise regimen. Instead, they should make gentle exercise a part of their regular daily routine, gradually working up to more vigorous, sustained exercising.

Drug therapy

A variety of drugs may be prescrived to reduce cholesterol levels. All of these drugs have side effects that may make them unsuitable for certain individuals. Cholesterol-lowering medications include:

- Statins. These are the most frequently prescribed cholesterol-lowering class of drugs. Statins are effective in lowering LDL (bad) cholesterol by slowing the production of cholesterol in the body. However, some statins have been shown to cause a rare type of serious muscle damage (rhabdomyolysis). Other research suggests that statins benefit only to those at high risk for heart attack and not people at low to moderate risk. Examples of statins include atorvastatin (Lipitor), fluvastatin (Lescol), lovastatin (Altocor, Mevacor), pravastatin (Pravachol), and simvastatin (Zocor).
- Bile acid sequestrants, also called resins. These drugs increase the amount of bile excreted in feces. This forces the liver to make more bile, and since cholesterol is used in making bile, more cholesterol is used and less enters the bloodstream, thus lowering cholesterol levels. Bile acid sequestrants are prescribed along with other cholesterol-lowering drugs such as statins. Examples include acid sequestrants include cholestyramine (Prevalite, Questran), colesevelam (Welchol), and colestipol (Colestid).
- Niacin (nicotinic acid.) A dietary supplement that should be used only under supervision of a physician. It helps to lower LDL cholesterol.
- Cholesterol absorption inhibitors. These drugs reduce the amount or cholesterol in food that is absorbed by the intestines. Examples include Ezetimibe (Zetia) and a combination of ezetimibe and the statin simvastatin (Vytorin).
- Fibrates also called fibric acid derivatives. These mainly lower triglycerides, but also may raise HDL (good) cholesterol. They rarely used alone to treat high cholesterol. Examples include gemfibrozil (Loprid), clofibrate (Atromid-S), and fenofibrate (Tricor).

Alternative treatment

Alternative practitioners also recommend diet and exercise as first-line treatment to lower high cholesterol levels. Some herbal supplements are also recommended by alternative practitioners to reduce cholesterol levels. Individuals using any herbal remedy or alternative therapy should discuss its use with a physician. Harmful interactions between herbal remedies and conventional medicines are possible. The following are some of the alternative therapies that have been investigated.

- Garlic. As of 2009, the National Center for Complementary and Alternative Medicine (NCCAM) reported several studies that have shown short term (up to 3 months) reduction in total blood cholesterol levels when garlic (standardized dehydrated tablets, aged garlic extract, oil macerates, distillates, raw garlic) was compared to placebo treatments, but these reductions were not found in longer (6 month) studies. Research is ongoing to clarify these results.
- Soy. According to NCCAM, research suggests that soy may slightly lower levels of LDL cholesterol.

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- Green tea. Some alternative practitioners suggest that green tea can lower LDL cholesterol. NCCAM finds that there is not yet enough reliable data to evaluate this claim.
- Red clover, grape seed extract, flaxseed oil, blue-green algae. Although these may be recommended by alternative practitioners, there is little evidence that they affect cholesterol levels.
- Cholestin (red yeast rice). This dietary supplement is a processed form of red yeast fermented with rice. It is a remedy used for centuries in traditional Chinese medicine. Cholestin is not approved or regulated by the United States Food and Drug Administration (FDA). It may reduce LDL cholesterol and increase HDL cholesterol, but should not be taken in place of prescription cholesterol-lowering drugs. Before using, discuss this supplement cholestrin with a physician.

Prognosis

High cholesterol is a major risk factor for heart disease. Left untreated, too much LDL cholesterol may clog the blood vessels, leading to chest **pain** (**angina**), blood clots, and heart attacks. By reducing LDL and total cholesterol levels, people with heart disease may prevent further heart attacks and strokes, prolong and improve their quality of life, and slow or reverse cholesterol build up in the arteries. In people without heart disease, lowering cholesterol levels may decrease the risk of a first heart attack or stroke.

Prevention

The habit of eating a low-fat, low-cholesterol, high-fiber diet and regular exercise is the healthiest and least expensive way control cholesterol levels and reduce the risk of heart disease. Other preventative measures include not smoking, limiting alcohol consumption, and maintaining an optimal weight. In a small 2003 Canadian study, people who ate a low-fat vegetarian diet consisting of foods that are found to help lower cholesterol dropped their levels of LDL cholesterol as much as some individuals taking statin drugs. For people with high risk factors for heart disease or pre-existing heart disease, such as a family history of heart disease, diabetes, and being over the age of 45, cholesterol-lowering medication may be effective. However, as of 2009, there was some question about whether these drugs had a preventative effect in individuals with no pre-existing heart disease and low to moderate risk.

KEY TERMS

Dietary supplement—A product, such as a vitamin, mineral, herb, amino acid, or enzyme, that is intended to be consumed in addition to an individual's diet with the expectation that it will improve health.

Feces—The solid waste that is left after digestion. Feces form in the intestines and leave the body through the anus.

Fiber—Also known as roughage or bulk. Insoluble fiber moves through the digestive system almost undigested and gives bulk to stools. Soluble fiber dissolves in water and helps keep stools soft.

Hypertension—Abnormally high blood pressure in the arteries.

Placebo—A pill or liquid given during the study of a drug or dietary supplement that contains no medication or active ingredient. Usually study participants do not know if they are receiving a pill containing the drug or an identical-appearing placebo.

Triglycerides—A type of fat found in the blood. High levels of triglycerides can increase the risk of coronary artery disease.

Resources

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ORGANIZATIONS

American Dietetic Association, 120 S. Riverside Plaza, Suite 2000, Chicago, IL, 60606-6995, (312) 899-0040, 800 877-1600, http://www.eatright.org/.

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

National Cholesterol Education Program. National Heart, Lung, and Blood Information Center, P.O. Box 30105, Bethesda, MD, 30105, (301) 592-8573, (240) 629-3246, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi.nih.gov/about/ncep.

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Cholesterol-reducing drugs

Definition

Cholesterol-reducing drugs belong to a group of medicines that reduce the amount of cholesterol (a fat-like substance) in the blood.

Purpose

Drugs in this group are used as part of a comprehensive treatment program of cholesterol management that includes diet, physical activity, and weight control to reduce the risks of heart attacks and strokes.

Description

There are four classes of cholesterol lowering drugs: bile acid sequesterants, HMG-CoA inhibitors, fibric acid derivatives, and miscellaneous.

Examples of bile acid sequesterants include cholestyramine (Questran); colestipol (Colestid); and colesevalam (Welchol). These drugs act by binding with bile in the intestine to block the digestion of fats and increase the excretion of cholesterol in the stool.

HMG-CoA inhibitors are called statins. Examples include atorvastatin (Lipitor), cerivastatin (Baycol), fluvastatin (Lescol), lovastatin (Mevacor), pravastatin (Pravachol), simvastatin (Zocor), and rosuvastatin (Crestor). These drugs block a liver enzyme involved in producing cholesterol.

The class of fibric acid derivatives includes clofibrate (Atromid-S); gemfibrozil (Lopid); and fenofibrate (Tricor). These drugs may act by reducing the ability of the liver to make cholesterol.

Niacin, vitamin B_3, is a miscellaneous cholesterol reducing drug. It reduces the ability of the liver to make cholesterol. Exetimibe (Zetia) is also a miscellaneous drug. It acts by blocking the absorption of cholesterol from the intestine.

Sometimes drugs are combined together from more than one class.

Recommended dosage

The dose of drug depends on the type of drug used. The prescribing physician or the pharmacist who filled the prescription can advise about the correct dosage.

Precautions

Periodic blood tests are usually done to check cholesterol and liver enzyme levels.

Drugs in this group are part of a comprehensive treatment program for managing cholesterol and the risk of **heart attack** and **stroke**, including diet, physical activity and weight management.

People over 60 years of age may be more sensitive to the side/adverse effects of some cholesterol-reducing drugs.

Anyone taking statins should notify health care professionals before having surgery or receiving emergency treatment in order to reduce the risk of side/adverse effects from additional drugs used at those times.

ALLERGIES. Anyone who has had unusual reactions to cholesterol-reducing drugs in the past should inform prescribing physicians before taking the drugs again. Prescribers should be told about **allergies** to foods, dyes, preservatives or other substances.

PREGNANCY. Statins should not be taken by women who are pregnant as they may interfere with normal fetal development.

Bile sequesterants may interfere with the ability of pregnant women to absorb fat soluble **vitamins** necessary for normal fetal growth and development.

BREASTFEEDING. Because Questran, Welchol and Colestid interfere with the absorption of vitamins, women who use these drugs while **breastfeeding** should ask their physicians about taking vitamin supplements.

Women who are breastfeeding should talk to their physicians before using Lopid. Whether this drug passes into breast milk is not known. But because animal studies suggest that it may increase the risk of some types of **cancer**, women should carefully consider the safety of using it while breastfeeding.

Statins enter breast milk and should not be used by women who are breastfeeding their babies.

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OTHER MEDICAL CONDITIONS. Cholesterol-reducing drugs may make some medical problems worse. Before using these drugs, people with any of these medical conditions should make sure their physicians are aware of their conditions:

- stomach or liver problems, including stomach ulcer
- constipation
- hemorrhoids
- gallstones or gallbladder disease
- bleeding problems
- underactive thyroid

People with kidney or **liver disease** may be more likely to have blood problems or other side effects when they take certain cholesterol-reducing drugs. Some drugs of this type may actually raise cholesterol levels in people with liver disease.

Patients with any of the following medical conditions may develop problems that could lead to kidney failure if they take statins:

- organ transplant anti rejection medications
- recent major surgery
- seizures (convulsions) that are not well controlled

People with **phenylketonuria** (PKU) should be aware that sugar-free formulations of some cholesterol-reducing drugs contain phenylalanine.

USE OF CERTAIN MEDICINES. Cholesterol-reducing drugs may change the effects of other medicines. Patients should not take any other medicine that has not been prescribed or approved by a physician who knows they are taking cholesterol-reducing drugs.

Side effects

Lopid,Tricor, and Clofibrate

Adverse effects from these drugs include upset stomach, **nausea**, **vomiting** or **diarrhea**, **constipation**, **headache**, **fatigue**, **dizziness**, and skin rash.

Statins

Adverse effects from these drugs include headache; chest, back, and leg **pain**, cramps and weakness; swollen legs and feet; upset stomach, abdominal pain, and diarrhea or constipation.

Questran, Welchol, and Colestid

Adverse effects from these drugs include **heartburn**, upset stomach, nausea, **vomiting**, constipation, headache.

Zetia

Adverse effects from Zetia include fatigue and back and leg cramps, weakness and pain.

Niacin

Adverse effects from niacin include **palpitations**, irregular heart beat, flushed feeling of the skin, and dizziness.

Interactions

Lopid, Tricor, and Clofibrate

These drugs increase the blood thinning effects of warfarin (Coumadin).

These drugs increase the weakness and muscle damage, adverse effects, of statins. They should not be taken together.

statins

Antifungal drugs, Diflucan, Sporanoz and Nizoral increase the adverse effects of statins on muscles.

Lopid, Triccor, and Clofibrate decrease the effectiveness of statins and increase the risk of adverse muscle effects.

The antiseizure medicine Tegretol reduces the effectiveness of statins.

Cyclosporine, used to prevent organ rejection, increases the effectiveness and risk of adverse muscle effects of statins.

Diltiazem (Cardizem) increases the effects and risks of adverse muscle effects of statins.

Grapefruit juice increases the effects and risks of adverse muscle effects of statins.

The erythromycin family of **antibiotics** increases the risks of adverse muscle effects of statins.

Antiretroviral drugs used to treat **AIDS** may increase the risks of adverse muscle effects of statins.

Drugs used to treat **tuberculosis** may reduce the effectiveness of statins

Verapamil (Calan) may increase the effects and risks of adverse muscle effects of statins

Questran, Welchol, and Colestid

These drugs decrease the effectiveness of cortisone drugs.

These drugs decrease the effectiveness of statins.

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Taking some cholesterol-reducing drugs with blood thinners (anticoagulants) may increase the chance of bleeding.

Combining statins with gemfibrozil, cyclosporine (Sandimmune) or niacin may cause or worsen problems with the kidneys or muscles.

James Waun, MD, RPh

KEY TERMS

Cholinergic nerves—Nerves that are stimulated by acetylcholine.

Glaucoma—A disease of the eye with increased pressure that can produce blindness.

Myasthenia gravis—A disease with progressive weakness of skeletal, voluntary muscles.

Parasympathetic nervous system—The part of the nervous system responsible for secretions, skeletal and smooth muscle tone, and slowing heart rate.

Cholinergic drugs

Definition

Cholinergic drugs are medications that mimic the effects of acetylcholine, the naturally occurring neurotransmitter, on the parasympathetic nervous system.

Purpose

Cholinergic drugs produce the same effects as acetylcholine by stimulating smooth muscle contractions in the intestinal tract and bladder, dilating blood vessels, constricting bronchioles (breathing tubes), increasing production of saliva, mucus, sweat, and tears, and constricting the pupils in the eyes.

Cholinergic blockers (described elsewhere) are drugs that indirectly produce similar effects as cholinergic drugs by inhibiting the action of the naturally occurring enzyme, acetylcholinesterase, that inactivates acetylcholine.

Some cholinergic drugs, including edrophonium (Tensilon), neostigmine (Prostigmine), and piridogstimina (Mestinon) are used to improve muscle function in diagnosing and treating **myasthenia gravis**, a disease causing skeletal muscular weakness.

Pilocarpine (Isopto, Salagen, Pilopine) is a cholinergic drug that is used as an eye drop to constrict the pupil of the eye(s) to help control glaucoma, a disease caused by increased pressure inside the eye. As a tablet, it is used to counteract **dry mouth** from X-Ray treatments for cancers of the head and neck.

Bethanachol (Urecholine) is a cholinergic drug used to treat non-obstructive urinary retention after surgery and in **neurogenic bladder**.

Description

These drugs are available as capsules, tablets, injections, and eye drops.

Recommended dosage

Physicians prescribe dosage of these drugs depending on the circumstances of individual cases.

Precautions

These drugs should not be used if there is obstruction or weakness in the muscles in the urinary or digestive tracts.

Cholinergic drugs may aggravate **asthma**, peptic ulcer disease, or slow heart beat.

These drugs may aggravate **hyperthyroidism**, parkinsonism, **coronary artery disease**, or low blood pressure.

Adverse effects

Possible adverse effects of cholinergic drugs include:

- slow heart beat and low blood pressure, possibly leading to cardiac arrest.
- flushing of the skin
- muscle cramps, and pain
- nausea, abdominal cramps, and pain
- headache, convulsions
- difficulty breathing
- increased stomach acid and saliva
- urinary urgency

Resources

PERIODICALS

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Chondromalacia patellae

Definition

Chondromalacia patellae refers to the progressive erosion of the articular cartilage of the knee joint, that is the cartilage underlying the kneecap (patella) that articulates with the knee joint.

Description

Chondromalacia patellae (CMP), also known as patello-femoral **pain** syndrome or patello-femoral **stress** syndrome, is a syndrome that causes pain/discomfort at the front of the knee. It is associated with irritation or wear on the underside of the kneecap, or patella. In a normal knee, the articular cartilage is smooth and elastic and glides smoothly over the surface of the thighbone, or femur, when the knee is bent. Erosion of the cartilage roughens the surface and prevents this smooth action.

CMP is most common in adolescent females, although older people may also develop it. An average of two out of 10,000 people develop this condition, many of them runners or other athletes.

Causes and symptoms

CMP is the result of the normal **aging** process, overuse, injury, or uneven pressures exerted on the knee joint. In teens, CMP may be caused by uneven growth or uneven strength in the thigh muscles. Growth spurts, common in teens, may result in a mildly abnormal alignment of the patella, which increases the angle formed by the thigh and the patellar tendon (Q-angle). This condition adds to the damage. Symptoms include pain, normally around the kneecap, and a grinding sensation felt when extending the leg. The pain may radiate to the back of the knee, or it may be intermittent and brought on by squatting, kneeling, going up or down stairs, especially down, or by repeated bending of the joint.

Diagnosis

Diagnosis is established during a **physical examination** performed by a general practitioner or an orthopedist, and is based on frequency of symptoms and confirmed by x rays of the knee. The CMP erosion can also be seen on an MRI, although this type of scan is not routinely performed for this purpose. The patient should inform the doctor about any previous injuries to the joint.

Treatment

Initial treatment may consist of resting the knee using crutches, along with **aspirin**, Tylenol, or a non-steroidal anti-inflammatory drug (NSAID) such as Motrin for seven to 10 days. The person should limit sports activity until the joint is healed and may use ice followed by heat to decrease inflammation. When the doctor allows the patient to resume sports, a knee brace may be prescribed in the form of a stabilizer with a hole at the kneecap.

Treatment also includes low impact exercises to strengthen the quadriceps muscles which help stabilize the knee joint. **Physical therapy** may be suggested at the start of this program so as to help the patient learn the correct method of performing the exercises.

Approximately 85% of people do well with conservative CMP treatment. The remainder still have severe pain and may require **arthroscopic surgery** to repair the tissues inside the knee joint. In more severe cases, open surgery may be required to realign the kneecap and perhaps other corrections.

Alternative treatments

Physical therapy offers treatments that may help CMP patients. Aqua therapy has the benefit of exercising the knee without putting stress on it and it also strengthens the thigh muscles. **Biofeedback** can be used to learn tensing and relaxing specific muscles to relieve pain. These techniques have the benefit of no side effects. **Massage therapy** might be beneficial as well. **Calcium**, **minerals**, and **vitamins** as part of a balanced diet will aid healing and help prevent further problems.

Prognosis

In most teens with CMP, the prognosis is excellent since the damage is reversible when treatment starts before the cartilage begins to break down. With proper treatment and preventive techniques, teenagers will complete their growth without permanent damage to the joint. Only about 15% of patients require surgical intervention. Older people may go on to develop **osteoarthritis** in the knee.

Prevention

Proper exercises are the best preventive measure. Since tightness of thigh muscles is a risk factor, warming up before athletic activities is recommended, as well as participating in a variety of sports rather than just one. Stretching exercises increase flexibility of the quadriceps, hip flexors, and hamstrings. Strengthening exercises such as short arc leg extensions, straight leg raises,

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KEY TERMS

Arthroscopic knee surgery—Surgery performed to examine or repair tissues inside the knee joint through a special scope (arthroscope).

Femur—The thigh bone.

Isometric exercises—Exercises which strengthen through muscle resistance.

Osteoarthritis—Degenerative joint disease.

Quadriceps, hip flexors, hamstrings—Major muscles in the thigh area which affect knee mechanics.

quadriceps isometric exercises, and stationary bicycling are also recommended.

Resources

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Questions and Answers About Knee Problems. http://www.nih.gov/niams/healthinfo/kneeprobs/kneeqa.htm.
"What is CAM?" http://nccam.nih.gov/health/whatiscam/overview.htm.

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Chorea *see* **Movement disorders**

Choriocarcinoma

Definition

A choriocarcinoma is type of germ cell **cancer** containing trophoblast cells.

Demographics

Choriocarcinoma is a rare tumor type which, in women, develops in one out of every 40 hydatidiform **moles** and in one out of 20,000-40,0000 pregnancies in the United States. The incidence of choriocarcinoma is more prevalent in countries such as India (incidence rate of one in every 500-600 pregnancies), Mexico, Paraguay, and Sweden. African American women have the highest incidence rates of choriocarcinoma and have the lowest survival rates once diagnosed with this cancer. This type of cancer is 5-15 times more likely to be diagnosed in women over the age of 40 than in women under 40 years of age.

Choriocarcinoma that develops in men usually develops as a type of testicular tumor. Choriocarcinoma of the testes is a rare cancer in men. However, this tumor type, which is primarily diagnosed in younger men, is the most common cancer diagnosed in men between the ages of 15-35 years. This cancer affects white males more than males of other racial/ethnic groups.

Description

Choriocarcinomas are cancers that develop from germ cells, cells that ordinarily turn into sperm or eggs. Choriocarcinomas resemble the cells that surround an embryo in the uterus. Most of these cancers form inside the reproductive organs. Some originate in the testes or ovaries, especially in young adults. Others develop in the uterus after a **pregnancy** or miscarriage—particularly following the presence of a **hydatidiform mole**. A few choriocarcinomas arise in sites outside the reproductive organs.

Choriocarcinomas are one of the most dangerous germ cell cancers. They usually grow quickly and spread widely. Occasionally, this cancer grows so fast that the original tumor outgrows its blood supply and dies, leaving behind only a small scar.

Causes and symptoms

Choriocarcinomas result from genetic damage to a germ cell. Males with **Klinefelter syndrome** are especially likely to develop extragonadal **germ cell tumors**.

The symptoms of a choriocarcinoma vary, depending on where the tumor originates and where it spreads. In the uterus, the most common symptom is bleeding. Other symptoms associated with tumors that have metastasized include purple or blue/black nodules on the lower genital tract tissues, abdominal tenderness, and **jaundice** if the tumor has spread to the liver. Cancers in the ovary often have only subtle signs such as widening of the waistline or **pain**.

In the testes, choriocarcinomas can often be felt as small painless lumps.

Choriocarcinomas that spread to other organs may reveal their presence by bleeding. In the brain, this bleeding can cause a **stroke**.

Diagnosis

Examination

Choriocarcinomas are usually referred to an oncologist, a doctor who specializes in cancer treatment. To

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KEY TERMS

Biopsy—A sample of an organ taken to look for abnormalities. Also, the technique used to take such samples.

Chemotherapy—The treatment of cancer with drugs.

Computed tomography (CT) scan—A special x-ray technique that produces a cross sectional image of the organs inside the body.

Extragonadal—In a location other than the reproductive organs.

Germ cell—One of the cells that ordinarily develops into eggs or sperm (also sperm and eggs).

Gonads—The ovaries or testes.

Hydatidiform mole—Also called a molar pregnancy. A mass of abnormal, partially developed tissues inside the uterus (womb). Moles develop during a pregnancy that begins with an abnormal fertilization. The mass may or may not be cancerous.

Klinefelter syndrome—A condition caused by extra X chromosome(s) in a male, that results in small testes and infertility together with increased height, decreased facial hair, and sometimes breast enlargement.

Magnetic resonance imaging—A type of study that uses changes induced by magnets to see cells and tissues inside the body.

Ovaries—The female sex organs that make eggs and female hormones.

Remission—The disappearance of the symptoms of cancer, although all of the cancer cells may not be gone.

Reproductive organs—The group of organs (including the testes, ovaries, and uterus) whose purpose is to produce a new individual and continue the species.

Testes—The male sex organs that make sperm and male hormones.

Testicular cancer—A cancer that originates in the testes.

Trophoblast—The tissues that surround an embryo and attach it to the uterus.

Tumor—A lump made up of abnormal cells.

Uterus—The organ where a child develops (womb).

diagnose this tumor, the doctor will do a **physical examination** and examine the internal organs with x rays or ultrasound studies.

Tests

Spreading of the cancer is detected with x rays, ultrasound studies, computed tomography (CT), or **magnetic resonance imaging** (MRI) scans.

Most choriocarcinomas make human chorionic gonadotropin (beta-hCG), a hormone normally found only during pregnancy. The presence of hCG in the blood can help diagnose this cancer and monitor the success of treatment.

Procedures

Choriocarcinomas are not always biopsied before being treated, because they tend to bleed heavily.

Treatment

Women diagnosed with choriocarcinomas that have not metastasized or who are diagnosed with tumors that are of low risk for metastasis are usually treated with the **chemotherapy** agent methotrexate. Another chemotherapy drug, actinomycin D, may be used if the patient has been diagnosed with liver dysfunction. Beta-hCG levels are monitored to determine response to therapy.

Women diagnosed with metastatic disease are divided into two groups based on whether or not they are at high risk for treatment failure. Patients who are at lower risk are treated with methotrexate or actinomycin and are typically cured with chemotherapy. Women deemed to be at higher risk are treated with combination chemotherapy. Patients with metastasis to the brain also receive whole brain **radiation therapy**. Other patients with brain involvement may be treated with stereotactic radiotherapy. A **hysterectomy** may be required for women who experience vaginal bleeding that cannot be controlled by nonsurgical means.

Currently, there is no consensus as to the best treatment for testicular choriocarinomas. Some chemotherapy agents that may be used include a combination of the drugs bleomycin, etoposide, and cisplatin for four cycles and/or the drugs vinblastine and ifosfamide. However, most choriocarcinomas of the testicles respond poorly to chemotherapy.

Surgery is typically recommended to remove a testicle (or both testicles if cancer has been detected in both) utilizing a surgical procedure termed radical inguinal orchiectomy.

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Prognosis

The prognosis for choriocarcinomas in the uterus is very good. Although these tumors often spread throughout the body, chemotherapy results in a cure or remission in 75–100% of cases. The probability of a recurrence of choriocarcinoma in women who have been in remission with normal beta-hCG levels for at least one year is very small, typically less than 1%. Women who have had choriocarcinomas often go on to have normal pregnancies and deliveries.

Choriocarcinomas in other sites have a poorer prognosis. These tumors tend to spread quickly and do not respond well to chemotherapy. Although treatment can be effective, the outcome depends on how widely the cancer has metastasized. The prognosis is worse if the cancer can be found in the liver or brain, if hCG levels are high, or if the original tumor developed outside the gonads.

Choriocarcinomas of the testes metastasize early and typically do not respond to chemotherapy or radiation therapy. These cancers have a dismal prognosis with high mortality rates despite aggressive treatment.

Prevention

There is no known means of prevention. Early detection of the symptoms and prompt medical treatment can improve the odds of survival.

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Chorionic gonadotropin test *see* **Human chorionic gonadotropin pregnancy test**

Chorionic villus sampling

Definition

Chorionic villus sampling (CVS), also known as chorionic villus biopsy, is a prenatal test that can detect genetic and chromosomal abnormalities of a fetus.

Purpose

Chorionic villus sampling is performed on pregnant women who are at risk for carrying a fetus with a genetic or chromosomal defect. Although it carries a slightly higher risk, CVS may be used in place of **amniocentesis** for women who have one or more of the following risk factors:

- women age 35 and older. The chance of having a child with Down syndrome increases with maternal age. For instance, the chance of having a baby with Down syndrome is one in 378 for a 35-year-old woman and increases to one in 30 for a 45-year-old woman.
- a history of miscarriages or children born with birth defects.
- a family history of genetic disease. Prenatal genetic testing is recommended if either the mother or father of the unborn baby has a family history of genetic disease or is known to be a carrier of a genetic disease.

Analysis of the cells from the chorionic villus enables the detection of over 200 diseases and disorders such as **Down syndrome**, **Tay-Sachs disease**, and **cystic fibrosis**. Gross rearrangements of the chromosomes and chromosome additions or losses are detected.

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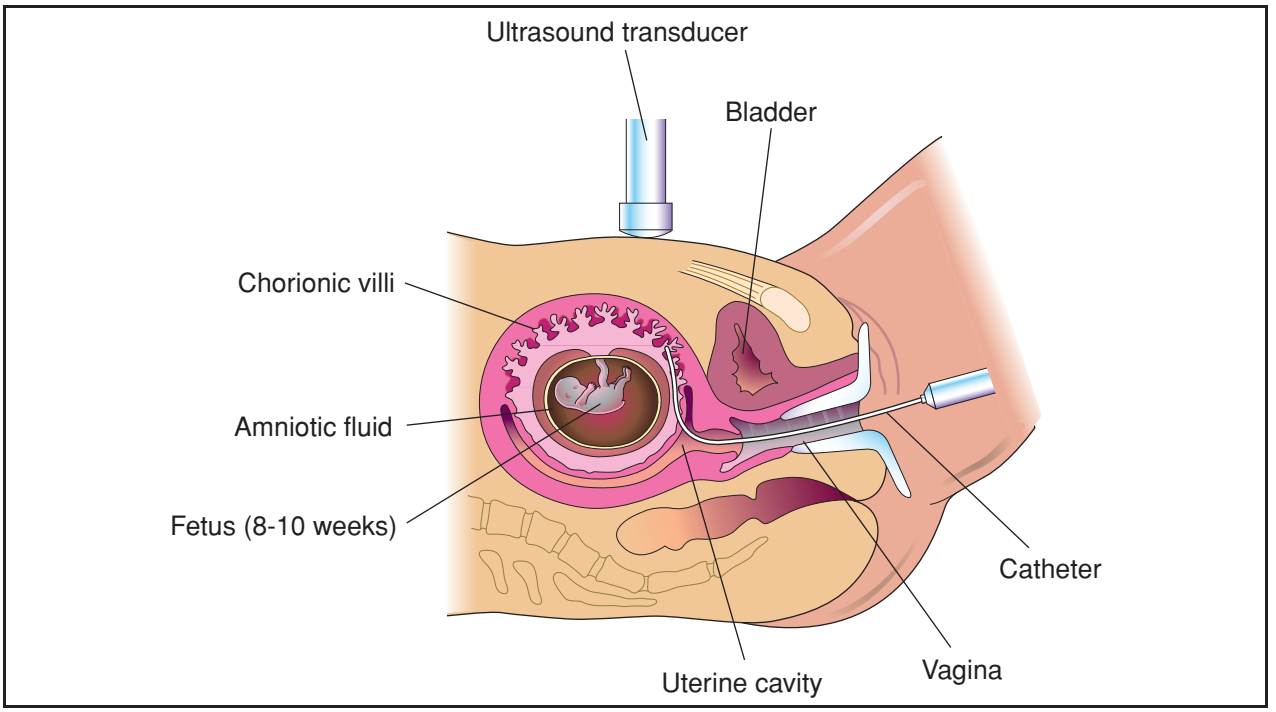

Chorionic villus sampling is performed on pregnant women who are at risk for carrying a fetus with a genetic or chromosomal defect. This procedure can be performed through the vagina and the cervix (transcervically) or through the abdomen (transabdominally). In the transcervical procedure, as depicted above, the physician uses ultrasound to help guide a catheter through the cervix into the uterus. By applying suction from the syringe attached to the other end of the catheter, a small sample of the chorionic villi is obtained. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Description

Chorionic villus sampling has been in use since the 1980s. This prenatal testing procedure involves taking a sample of the chorion frondosum—that part of the chorionic membrane containing the villi—for laboratory analysis. The chorionic membrane is the outer sac that surrounds the developing fetus. Chorionic villi are microscopic, finger-like projections that emerge from the chorionic membrane and eventually form the placenta. The cells that make up the chorionic villi are of fetal origin so laboratory analysis can identify any genetic, chromosomal, or biochemical diseases of the fetus.

Chorionic villus sampling is best performed between 10 and 12 weeks of **pregnancy**. The procedure is performed either through the vagina and the cervix (transcervically) or through the abdomen (transabdominally) depending upon the preferences of the patient or the doctor. In some cases, the location of the placenta dictates which method the doctor uses. Both methods are equally safe and effective. Following the preparation time, both procedures take only about five minutes. Women undergoing chorionic villus sampling may experience no **pain** at all or feel cramping or pinching. Occasionally, a second sampling procedure must be performed if insufficient villus material was obtained.

For the transcervical procedure, the woman lies on an examining table on her back with her feet in stirrups. The woman's vaginal area is thoroughly cleansed with an antiseptic, a sterile speculum is inserted into her vagina and opened, and the cervix is cleansed with an antiseptic. Using ultrasound as a guide, the doctor inserts a thin, plastic tube called a catheter through the cervix and into the uterus. The passage of the catheter through the cervix may cause cramping. The doctor carefully watches the image produced by the ultrasound and advances the catheter to the chorionic villi. By applying suction from the syringe attached to the other end of the catheter, a small sample of the chorionic villi are obtained. A cramping or pinching feeling may be felt as the sample is being taken. The catheter is then easily withdrawn.

For the transabdominal method, the woman lies on her back on an examining table. Ultrasound enables the doctor to locate the placenta. The specific area

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on the woman's abdomen is cleansed thoroughly with an antiseptic and a local anesthetic may be injected to numb the area. With ultrasound guidance, a long needle is inserted through the woman's abdominal wall, through the uterine wall and to the chorionic villi. The sample is obtained by applying suction from the syringe.

The chorionic villus sample is immediately placed into nutrient medium and sent to the laboratory. At the laboratory, the sample is examined under the microscope and any contaminating cells or material is carefully removed. The villi can be analyzed immediately, or incubated for a day or more to allow for cell division. The cells are stopped in the midst of cell division and spread onto a microscope slide. Cells with clearly separated chromosomes are photographed so that the type and number of chromosomes can be analyzed. Chromosomes are strings of DNA that have been tightly compressed. Humans have 23 pairs of chromosomes including the sex chromosomes. Rearrangements of the chromosomes or the presence of additional or fewer chromosomes can be identified by examination of the photograph. Down syndrome, for instance, is caused by an extra copy of chromosome 21. In addition to the chromosomal analysis, specialized tests can be performed as needed to look for specific diseases such as Tay-Sachs disease. Depending upon which tests are performed, results may be available as early as two days or up to eight days after the procedure.

Alternate procedures

There are alternate procedures for diagnosing genetic and chromosomal disorders of the fetus. Amniocentesis is commonly used and involves inserting a needle through the pregnant woman's abdomen to obtain a sample of amniotic fluid. Amniocentesis is usually performed in the second trimester at approximately 16 weeks gestation and the laboratory analysis may take two to three weeks. The two advantages of chorionic villus sampling are that it is performed during the first trimester and the results are available in about one week. The risk of **miscarriage** after amniocentesis is 0.5–1% (one to two women out of 200) which is lower than that for chorionic villus sampling (1–3%).

A noninvasive alternative is the maternal blood test called triple marker screening or multiple marker screening. A sample of the pregnant woman's blood is analyzed for three different markers: alphafetoprotein (AFP), human chorionic gonadotropin, and unconjugated estriol. The levels of these three markers in the mother's blood can identify unborn babies who are at risk for certain genetic or chromosomal defects. This screening test determines the chance that the fetus has the defect, but it cannot diagnose specific defects. A negative test result does not necessarily mean the unborn baby does not have a birth defect. For instance, this screening test can only predict 60–70% of the fetuses with Down syndrome. Pregnant women who have a positive triple marker screen are encouraged to undergo a diagnostic test, such as amniocentesis (by the time an AFP is done, it is too late to perform a CVS).

Benefits

Chorionic villi sampling allows parents of fetuses found to have a genetic defect to determine at an early stage whether to continue or terminate the pregnancy. Should the decision be made to continue the pregnancy, parents will have time to prepare, both physically and psychologically, for parenting a child with disabilities related to a genetic defect.

Precautions

Chorionic villus sampling is not recommended for women who have vaginal bleeding or spotting during the pregnancy. It is not typically recommended for women who have Rh sensitization from a previous pregnancy.

Preparation

Prior to the chorionic villus sampling procedure the woman needs to drink fluids and refrain from urinating to ensure her bladder is full. These preparations create a better ultrasound picture.

Aftercare

It is generally recommended that women undergoing chorionic villus sampling have someone drive them home and have no plans for the rest of the day. Women with Rh negative blood must receive a Rho (D) immune globulin injection following the procedure. Women should call their doctor if they experience excessive bleeding, vaginal discharge, **fever**, or abdominal pain after the procedure.

Risks

Of women who undergo transcervical chorionic villus sampling, one third experience minimal vaginal spotting and 7–10% experience vaginal bleeding. One out of five women experience cramping following the procedure. Two to three women out of 100 (or 2–3%) will miscarry following chorionic villus sampling. The

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KEY TERMS

Chorionic villi—Microscopic, finger-like projections that emerge from the outer sac which surrounds the developing baby. Chorionic villi are of fetal origin and eventually form the placenta.

Chromosomes—Human cells carry DNA in tightly compressed rod-like structures called chromosomes. Humans have 23 pairs of chromosomes including the sex chromosomes.

Down syndrome—A chromosomal disorder caused by an extra copy or a rearrangement of chromosome 21. Children with Down syndrome have varying degrees of mental retardation and may have heart defects.

Fetus—Term for an unborn baby after the eighth week of pregnancy. Prior to seven weeks, it is called an embryo.

Rh sensitization—A woman with a negative blood type (Rh negative) who has produced antibodies against her fetus with a positive blood type (Rh positive). The mother's body considered the fetal blood cells a foreign object and mounted an immune attack on it.

Ultrasound—A safe, painless procedure which uses sound waves to visualize internal organs. A wand that transmits and receives the sound waves is moved over the woman's abdomen and internal organs can be seen on a video screen.

risk of infection is very low. Rupture of the amniotic membranes is a rare complication. Women with Rh negative blood may be at an increased risk for developing Rh incompatibility following chorionic villus sampling.

There have been reports of limb defects in babies following chorionic villus sampling. However, in 1996 the World Health Organization reported that the incidence of babies born with limb defects from 138,966 women who had undergone chorionic villus sampling was the same as for women who had not. Therefore, this study found no connection between chorionic villus sampling and limb defects.

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ORGANIZATIONS

American College of Obstetricians and Gynecologists, P.O. Box 96920, Washington, DC, 20090-6920, (202) 638-5577, http://www.acog.org.

March of Dimes Foundation, 1275 Mamaroneck Avenue, White Plains, NY, 10605, (914) 997-4488, askus@marchofdimes.com, http://www.marchofdimes.com.

National Society of Genetic Counselors, 401 N. Michigan Avenue, Chicago, IL, 60611, (312) 321-6834, (312) 673-6972, nsgc@nsgc.org, http://www.nsgc.org.

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Choroiditis *see* **Uveitis**

Choroiretinitis *see* **Uveitis**

Chromosome studies *see* **Genetic testing**

Chronic arthritis of childhood *see* **Juvenile arthritis**

Chronic constrictive pericarditis *see* **Pericarditis**

Chronic Epstein-Barr virus *see* **Chronic fatigue syndrome**

Chronic fatigue syndrome

Definition

Chronic **fatigue** syndrome (CFS) is a condition that causes extreme tiredness. People with CFS have debilitating fatigue that lasts for six months or longer. They also have many other symptoms. Some of these are **pain** in the joints and muscles, **headache**, and **sore throat**. CFS does not have a known cause, but appears to result from a combination of factors.

Description

CFS is the most common name for this disorder, but it also has been called chronic fatigue and immune disorder (CFIDS), myalgic encephalomyelitis, low natural killer cell disease, post-viral syndrome, Epstein-Barr disease, and Yuppie flu. CFS has so many names

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because researchers have been unable to find out exactly what causes it and because there are many similar, overlapping conditions. Reports of a CFS-like syndrome called neurasthenia date back to 1869. Later, people with similar symptoms were said to have fibromyalgia because one of the main symptoms is myalgia, or muscle pain. Because of the similarity of symptoms, fibromyalgia and CFS are considered to be overlapping syndromes.

In the early to mid-1980s, there were outbreaks of CFS in some areas of the United States. Doctors found that many people with CFS had high levels of antibodies to the **Epstein-Barr virus** (EBV), which causes mononucleosis, in their blood. For a while they thought they had found the culprit, but it turned out that many healthy people also had high EBV antibodies. Scientists have also found high levels of other viral antibodies in the blood of people with CFS. These findings have led many scientists to believe that a virus or combination of viruses may trigger CFS.

CFS was sometimes referred to as Yuppie flu because it seemed to often affect young, middle-class professionals. In fact, CFS can affect people of any gender, age, race, or socioeconomic group. Although anyone can get CFS, most patients diagnosed with CFS are 25–45 years old, and about 80% of cases are in women. Estimates of how many people are afflicted with CFS vary due to the similarity of CFS symptoms to other diseases and the difficulty in identifying it. The Centers for Disease Control and Prevention (CDC) has estimated that four to 10 people per 100,000 in the United States have CFS. According to the CFIDS Foundation, about 500,000 adults in the United States (0.3% of the population) have CFS. This probably is a low estimate since these figures do not include children and are based on the CDC definition of CFS, which is very strict for research purposes.

Causes and symptoms

There is no single known cause for CFS. Studies have pointed to several different conditions that might be responsible. These include:

- viral infections
- chemical toxins
- allergies
- immune abnormalities
- psychological disorders

Although the cause is still controversial, many doctors and researchers now think that CFS may not be a single illness. Instead, they think CFS may be a group of symptoms caused by several conditions. One theory is that a microorganism, such as a virus, or a chemical injures the body and damages the immune system, allowing dormant viruses to become active. About 90% of all people have a virus in the herpes family dormant (not actively growing or reproducing) in their bodies since childhood. When these viruses start growing again, the immune system may overreact and produce chemicals called cytokines that can cause flu-like symptoms. Immune abnormalities have been found in studies of people with CFS, although the same abnormalities are also found in people with **allergies**, autoimmune diseases, **cancer**, and other disorders.

The role of psychological problems in CFS is very controversial. Because many people with CFS are diagnosed with depression and other psychiatric disorders, some experts conclude that the symptoms of CFS are psychological. However, many people with CFS did not have psychological disorders before getting the illness. Many doctors think that patients become depressed or anxious because of the effects of the symptoms of their CFS. One recent study concluded that depression was the result of CFS and was not its cause.

Having CFS is not just a matter of being tired. People with CFS have severe fatigue that keeps them from performing their normal daily activities. They find it difficult or impossible to work, attend school, or even to take part in social activities. They may have sleep disturbances that keep them from getting enough rest or they may sleep too much. Many people with CFS feel just as tired after a full night's sleep as before they went to bed. When they **exercise** or try to be active in spite of their fatigue, people with CFS experience what some patients call "payback"–debilitating exhaustion that can confine them to bed for days.

Other symptoms of CFS include:

- muscle pain (myalgia)
- joint pain (arthralgia)
- sore throat
- headache
- fever and chills
- tender lymph nodes
- trouble concentrating
- memory loss

A recent study at Johns Hopkins University found an abnormality in blood pressure regulation in 22 of 23 patients with CFS. This abnormality, called neurally mediated **hypotension**, causes a sudden drop in blood pressure when a person has been standing, exercising, or exposed to heat for a while. When this occurs,

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patients feel lightheaded and may faint. They often are exhausted for hours to days after one of these episodes. When treated with salt and medications to stabilize blood pressure, many patients in the study had marked improvements in their CFS symptoms.

Diagnosis

CFS is diagnosed by evaluating symptoms and eliminating other causes of fatigue. Doctors carefully question patients about their symptoms, any other illnesses they have had, and medications they are taking. They also conduct a **physical examination**, neurological examination, and laboratory tests to identify any underlying disorders or other diseases that cause fatigue. In the United States, many doctors use the CDC case definition to determine if a patient has CFS.

To be diagnosed with CFS, patients must meet both of the following criteria:

- Unexplained continuing or recurring chronic fatigue for at least six months that is of new or definite onset, is not the result of ongoing exertion, and is not mainly relieved by rest, and causes occupational, educational, social, or personal activities to be greatly reduced.
- Four or more of the following symptoms: loss of short-term memory or ability to concentrate; sore throat; tender lymph nodes; muscle pain; multijoint pain without swelling or redness; headaches of a new type, pattern, or severity; unrefreshing sleep; and post-exertional malaise (a vague feeling of discomfort or tiredness following exercise or other physical or mental activity) lasting more than 24 hours. These symptoms must have continued or recurred during six or more consecutive months of illness and must not have started before the fatigue began.

Treatment

There is no cure for CFS, but many treatments are available to help relieve the symptoms. Treatments usually are individualized to each person's particular symptoms and needs. The first treatment most doctors recommend is a combination of rest, exercise, and a balanced diet. Prioritizing activities, avoiding overexertion, and resting when needed are key to maintaining existing energy reserves. A program of moderate exercise helps to keep patients from losing physical conditioning, but too much exercise can worsen fatigue and other CFS symptoms. Counseling and **stress reduction** techniques also may help some people with CFS.

Many medications, **nutritional supplements**, and herbal preparations have been used to treat CFS. While many of these are unproven, others seem to provide some people with relief. People with CFS should discuss their treatment plan with their doctors, and carefully weigh the benefits and risks of each therapy before making a decision.

Drugs

Nonsteroidal anti-inflammatory drugs (NSAIDs), such as ibuprofen and naproxen, may be used to relieve pain and reduce **fever**. Another medication that is prescribed to relieve pain and **muscle spasms** is cyclobenzaprine (sold as Flexeril).

Many doctors prescribe low dosages of antidepressants for their sedative effects and to relieve symptoms of depression. **Antianxiety drugs**, such as **benzodiazepines** or buspirone may be prescribed for excessive anxiety that has lasted for at least six months.

Other medications that have been tested or are being tested for treatment of CFS are:

- Fludrocortisone (Florinef), a synthetic steroid, which is currently being tested for treatment of people with CFS. It causes the body to retain salt, thereby increasing blood pressure. It has helped some people with CFS who have neurally mediated hypotension.
- Beta-adrenergic blocking drugs, often prescribed for high blood pressure. Such drugs, including atenolol (Tenoretic, Tenormin) and propranolol (Inderal), are sometimes prescribed for neurally mediated hypotension.
- Gamma globulin, which contains human antibodies to a variety of organisms that cause infection. It has been used experimentally to boost immune function in people with CFS.
- Ampligen, a drug which stimulates the immune system and has antiviral activity. In one small study, ampligen improved mental function in people with CFS.

Alternative treatment

A variety of nutritional supplements are used for treatment of CFS. Among these are vitamin C, vitamin B_{12}, vitamin A, vitamin E, and various dietary **minerals**. These supplements may help improve immune and mental functions. Several herbs have been shown to improve immune function and have other beneficial effects. Some that are used for CFS are astragalus (*Astragalus membranaceus*), **echinacea** (*Echinacea* spp.), garlic (*Allium sativum*), **ginseng** (*Panax ginseng*), gingko (*Gingko biloba*), evening primrose oil (*Oenothera biennis*), shiitake

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KEY TERMS

Arthralgia—Joint pain.

Cytokines—Proteins produced by certain types of lymphocytes. They are important controllers of immune functions.

Depression—A psychological condition, with feelings of sadness, sleep disturbance, fatigue, and inability to concentrate.

Epstein-Barr virus (EBV)—A virus in the herpes family that causes mononucleosis.

Fibromyalgia—A disorder closely related to CFS. Symptoms include pain, tenderness, and muscle stiffness.

Lymph node—Small immune organs containing lymphocytes. They are found in the neck, armpits, groin, and other locations in the body.

Lymphocytes—White blood cells that are responsible for the actions of the immune system.

Mononucleosis—A flu-like illness caused by the Epstein-Barr virus.

Myalgia—Muscle pain.

Myalgic encephalomyelitis—An older name for chronic fatigue syndrome; encephalomyelitis refers to inflammation of the brain and spinal cord.

Natural killer (NK) cell—A lymphocyte that acts as a primary immune defense against infection.

Neurally mediated hypotension—A rapid fall in blood pressure that causes dizziness, blurred vision, and fainting, and is often followed by prolonged fatigue.

Neurasthenia—Nervous exhaustion–a disorder with symptoms of irritability and weakness, commonly diagnosed in the late 1800s.

mushroom extract (*Lentinus edodes*), borage seed oil, and quercetin.

Many people have enhanced their healing process for CFS with the use of a treatment program inclusive of one or more alternative therapies. **Stress** reduction techniques such as **biofeedback**, **meditation**, **acupuncture**, and **yoga** may help people with sleep disturbances relax and get more rest. They also help some people reduce depression and anxiety caused by CFS.

Prognosis

The course of CFS varies widely for different people. Some people get progressively worse over time, while others gradually improve. Some individuals have periods of illness that alternate with periods of good health. While many people with CFS never fully regain their health, they find relief from symptoms and adapt to the demands of the disorder by carefully following a treatment plan combining adequate rest, **nutrition**, exercise, and other therapies.

Prevention

Because the cause of CFS is not known, there currently are no recommendations for preventing the disorder.

Resources

OTHER

"Chronic Fatigue Syndrome." *National Institutes of Health*. http://www.nih.gov.

"The Facts about Chronic Fatigue Syndrome." *Centers for Disease Control*. http://www.cdc.gov/ncidod/diseases/cfs/facts1.htm.

ORGANIZATIONS

National CFIDS Foundation, 103 Aletha Road, Needham, MA, 02492, (781) 449-3535, (781) 449-8606, info@ncfnet. org, http://www.ncf-net.org/contact.

National Chronic Fatigue Syndrome and Fibromyalgia Association, PO Box 18426, Kansas City, MO, 64133, (816) 737-1343, http://www.ncfsfa.org.

The CFIDS Association of America, PO Box 220398, Charlotte, NC, 28222-0398, (704) 365-2343, cfids@cfids.org, http://www.cfids.org.

Toni Rizzo

Chronic granulomatous disease

Definition

Chronic granulomatous disease (CGD) is an inherited disorder in which white blood cells lose their ability to destroy certain bacteria and fungi.

Description

CGD is an X-linked genetic disease, meaning the defective gene is carried on the X chromosome (one of the sex chromosomes). Females have two copies of the

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X chromosome, whereas males have one X and one Y. CGD also is a recessive defect meaning that both copies of the chromosome must have the defect before it can be expressed. Females who have one X chromosome without the defect do not get this disease. Males, since they only have one X chromosome, get the disease if the defect is present. Thus, CGD affects mostly males.

CGD is an **immunodeficiency** disorder. Patients with immunodeficiency disorders suffer frequent infections. This happens because part of their immune system isn't working properly and the infectious microorganisms are not killed as rapidly as is normal. In CGD there is a defect in the ability of the white blood cells to kill bacteria and fungi. The white blood cells affected are phagocytic cells. They are part of the non-specific immune system and move via the blood to all parts of the body where they ingest and destroy microbes. Phagocytic cells are the first line of defense against microorganisms. In this disease, the decreased ability to kill microbes that they have ingested leads to a failure to effectively combat infectious diseases. Patients with CGD are subject to certain types of recurring infection, especially those of the skin, lungs, mouth, nose, intestines, and lymph nodes. With the exception of the lymph nodes, all of these areas are considered external tissues that come into contact with microorganisms from the environment. The lymph system drains all areas of the body to eliminate destroyed microorganisms and to assist the immune system in attacking microorganisms. Infections occur in the lymph nodes as a consequence of the normal draining function.

Causes and symptoms

The genetic defect that causes CGD reduces the amount of hydrogen peroxide and superoxide that white blood cells can make. These chemicals are important for killing bacteria and fungi. Without them the white blood cells ingest the microorganisms, but cannot kill them. In some cases, the microbes then replicate inside the white blood cell eventually causing its **death**.

Symptoms of the disease usually appear by age two. Frequent, recurrent infections of the skin, lungs (e.g. **pneumonia**), mouth (e.g. gingivitis), nose, intestines and lymph nodes are a hallmark of this disease. Patients may also develop multiple, recurrent liver abscesses and bone infections (**osteomyelitis**).

Diagnosis

Diagnosis is made based on the observation of a pattern of recurrent infections. Blood tests of lymphocyte and antibody functions will be normal. Tests of phagocytic cells will show normal ingestion, but a greatly decreased ability to kill bacteria.

KEY TERMS

Immunodeficiency—A weakening of the body's immune system.

Phagocytic cells—A cell that ingests microorganisms and foreign particles.

Treatment

Early, aggressive treatment of all infections is critical to the successful management of CGD. Patients are treated with **antibiotics** and immune serum. Antibiotics are used at the first sign of infection. Immune serum is a source of antibodies that help fight infections. Interferon gamma is an experimental treatment for CGD that has shown promising results. There is no cure for the underlying cause of chronic granulomatous disease

Prognosis

Although antibiotics can treat most infections and may help prevent others, premature death may result, typically due to repeated lung infections.

Prevention

Since CGD is a hereditary disorder, it cannot currently be prevented. Patients and their families may benefit from **genetic counseling**. Preventive (prophylactic) antibiotics may help keep some infections from occurring, and good hygiene, especially rigorous skin and mouth care, can help prevent infections in these areas. Avoiding crowds or other people who have infections are also effective preventive measures.

ORGANIZATIONS

Chronic Granulomatous Disease Association, 616 Monterey Road, San Marin, CA, 91108-1646, (626) 441-4118, cgda@socal.rr.com, http://www.cgd association.org.

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923, (800) 999-6673, http://www.rarediseases.org.

John T. Lohr, PhD

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Chronic kidney failure

Definition

Chronic kidney failure occurs when disease or disorder damages the kidneys so that they are no longer capable of adequately removing fluids and wastes from the body or of maintaining the proper level of certain kidney-regulated chemicals in the bloodstream.

Description

Chronic kidney failure, also known as chronic renal failure, affects over 250,000 Americans annually. It is caused by a number of diseases and inherited disorders, but the progression of chronic kidney failure is always the same. The kidneys, which serve as the body's natural filtration system, gradually lose their ability to remove fluids and waste products (urea) from the bloodstream. They also fail to regulate certain chemicals in the bloodstream, and deposit protein into the urine. Chronic kidney failure is irreversible, and will eventually lead to total kidney failure, also known as end-stage renal disease (ESRD). Without proper treatment intervention to remove wastes and fluids from the bloodstream, ESRD is fatal.

Causes and symptoms

Kidney failure is triggered by disease or a hereditary disorder in the kidneys. Both kidneys are typically affected. The four most common causes of chronic kidney failure include:

- Diabetes. Diabetes mellitus (DM), both insulin dependant (IDDM) and non-insulin dependant (NIDDM), occurs when the body cannot produce and/or use insulin, the hormone necessary for the body to process glucose. Long-term diabetes may cause the glomeruli, the filtering units located in the nephrons of the kidneys, to gradually lose functioning.
- Glomerulonephritis. Glomerulonephritis is a chronic inflammation of the glomeruli, or filtering units of the kidney. Certain types of glomerulonephritis are treatable, and may only cause a temporary disruption of kidney functioning.
- Hypertension. High blood pressure is unique in that it is both a cause and a major symptom of kidney failure. The kidneys can become stressed and ultimately sustain permanent damage from blood pushing through them at an excessive level of pressure over a long period of time.
- Polycystic kidney disease. Polycystic kidney disease is an inherited disorder that causes cysts to be formed on the nephrons, or functioning units, of the kidneys. The cysts hamper the regular functioning of the kidney.

Other possible causes of chronic kidney failure include **kidney cancer**, obstructions such as **kidney stones**, **pyelonephritis**, reflux nephropathy, **systemic lupus erythematosus**, **amyloidosis**, sickle cell anemia, **Alport syndrome**, and oxalosis.

Initially, symptoms of chronic kidney failure develop slowly. Even individuals with mild to moderate kidney failure may show few symtpoms in spite of increased urea in their blood. Among the symptoms that may be present at this point are frequent urination during the night and high blood pressure.

Most symptoms of chronic kidney failure are not apparent until **kidney disease** has progressed significantly. Common symptoms include:

- Anemia. The kidneys are responsible for the production of erythropoietin (EPO), a hormone which stimulates red cell production. If kidney disease causes shrinking of the kidney, this red blood cell production is hampered.
- Bad breath or a bad taste in mouth. Urea, or waste products, in the saliva may cause an ammonia-like taste in the mouth.
- Bone and joint problems. The kidneys produce vitamin D, which aids in the absorption of calcium and keeps bones strong. For patients with kidney failure, bones may become brittle, and in the case of children, normal growth may be stunted. Joint pain may also occur as a result of unchecked phosphate levels in the blood.
- Edema. Puffiness or swelling around the eyes, arms, hands, and feet.
- Frequent urination.
- Foamy or bloody urine. Protein in the urine may cause it to foam significantly. Blood in the urine may indicate bleeding from diseased or obstructed kidneys, bladder, or ureters.
- Headaches. High blood pressure may trigger headaches.
- Hypertension, or high blood pressure. The retention of fluids and wastes causes blood volume to increase, which in turn, causes blood pressure to rise.
- Increased fatigue. Toxic substances in the blood and the presence of anemia may cause feelings of exhaustion.
- Itching. Phosphorus, which is typically eliminated in the urine, accumulates in the blood of patients with

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kidney failure. This heightened phosphorus level may cause itching of the skin.

- Lower back pain. Pain where the kidneys are located, in the small of the back below the ribs.
- Nausea, loss of appetite, and vomiting. Urea in the gastric juices may cause upset stomach. This can lead to malnutrition and weight loss.

Diagnosis

Kidney failure is typically diagnosed and treated by a nephrologist, a doctor that specializes in treating the kidneys. The patient that is suspected of having chronic kidney failure will undergo an extensive blood work-up. A blood test will assess the levels of creatinine, blood urea nitrogen (BUN), uric acid, phosphate, **sodium**, and potassium in the blood. Urine samples will also be collected, usually over a 24-hour period, to assess protein loss.

Uncovering the cause of kidney failure is critical to proper treatment. A full assessment of the kidneys is necessary to determine if the underlying disease is treatable and if the kidney failure is chronic or acute. An x ray, MRI, computed tomography scan, ultrasound, renal biopsy, and/or arteriogram of the kidneys may be employed to determine the cause of kidney failure and level of remaining kidney function. X rays and ultrasound of the bladder and/or ureters may also be taken.

Treatment

Chronic kidney failure is an irreversible condition. Hemodialysis, peritoneal dialysis, or **kidney transplantation** must be employed to replace the lost function of the kidneys. In addition, dietary changes and treatment to relieve specific symptoms such as anemia and high blood pressure are critical to the treatment process.

Hemodialysis

Hemodialysis is the most frequently prescribed type of dialysis treatment in the United States. Most hemodialysis patients require treatment three times a week, for an average of three to four hours per dialysis "run" depending on the type of dialyzer used and their current physical condition. The treatment involves circulating the patient's blood outside of the body through an extracorporeal circuit (ECC), or dialysis circuit. The dialysis circuit consists of plastic blood tubing, a two-compartment filter known as a dialyzer, or artificial kidney, and a dialysis machine that monitors and maintains blood flow and administers dialysate, a chemical bath used to draw waste products out of the blood. The patient's blood leaves and enters the body through two needles inserted into the patient's vein, called an access site, and is pushed through the blood compartment of the dialyzer. Once inside of the dialyzer, excess fluids and toxins are pulled out of the bloodstream and into the dialysate compartment, where they are carried out of the body. At the same time, electrolytes and other chemicals in the dialysate solution move from the dialysate into the bloodstream. The purified, chemically-balanced blood is then returned to the body.

Peritoneal dialysis

In peritoneal dialysis (PD), the patient's peritoneum, or lining of the abdomen, acts as a blood filter. A catheter is surgically inserted into the patient's abdomen. During treatment, the catheter is used to fill the abdominal cavity with dialysate. Waste products and excess fluids move from the patient's bloodstream into the dialysate solution. After a waiting period of six to 24 hours, depending on the treatment method used, the waste-filled dialysate is drained from the abdomen, and replaced with clean dialysate. There are three types of peritoneal dialysis, which vary by treatment time and administration method: Continuous Ambulatory Peritoneal Dialysis (CAPD), Continuous Cyclic Peritoneal Dialysis (CCPD), and Intermittent Peritoneal Dialysis (IPD).

Kidney transplantation

Kidney transplantation involves surgically attaching a functioning kidney, or graft, from a brain dead organ donor (a cadaver transplant), or from a living donor, to a patient with ESRD. Patients with chronic renal disease who need a transplant and don't have a living donor register with UNOS (United Network for Organ Sharing), the federal organ procurement agency, to be placed on a waiting list for a cadaver kidney transplant. Kidney availability is based on the patient's health status. When the new kidney is transplanted, the patient's existing, diseased kidneys may or may not be removed, depending on the circumstances surrounding the kidney failure. A regimen of immunosuppressive, or anti-rejection medication, is required after transplantation surgery.

Dietary management

A diet low in sodium, potassium, and phosphorous, three substances that the kidneys regulate, is critical in managing kidney disease. Other dietary restrictions, such as a reduction in protein, may be prescribed depending on the cause of kidney failure and the type of dialysis treatment employed. Patients

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KEY TERMS

End-stage renal disease (ESRD)—Total kidney failure; chronic kidney failure is diagnosed as ESRD when kidney function falls to 5-10% of capacity.

Nephrotic syndrome—Characterized by protein loss in the urine, low protein levels in the blood, and fluid retention.

Ureters—The two ducts that pass urine from each kidney to the bladder.

with chronic kidney failure also need to limit their fluid intake.

Medications and dietary supplements

Kidney failure patients with **hypertension** typically take medication to control their high blood pressure. Epoetin alfa, or EPO (Epogen), a hormone therapy, and intravenous or oral iron supplements are used to manage anemia. A multivitamin may be prescribed to replace **vitamins** lost during dialysis treatments. Vitamin D, which promotes the absorption of **calcium**, along with calcium supplements, may also be prescribed.

Since 1973, Medicare has picked up 80% of ESRD treatment costs, including the costs of dialysis and transplantation and of some medications. To qualify for benefits, a patient must be insured or eligible for benefits under Social Security, or be a spouse or child of an eligible American. Private insurance and state Medicaid programs often cover the remaining 20% of treatment costs.

Prognosis

Early diagnosis and treatment of kidney failure is critical to improving length and quality of life in chronic kidney failure patients. Patient outcome varies by the cause of chronic kidney failure and the method chosen to treat it. Overall, patients with chronic kidney disease leading to ESRD have a shortened lifespan. According to the United States Renal Data System (USRDS), the lifespan of an ESRD patient is 18–47% of the lifespan of the age-sex-race matched general population. ESRD patients on dialysis have a lifespan that is 16–37% of the general population.

The demand for kidneys to transplant continues to exceed supply. In 1996, over 34,000 Americans were on the UNOS waiting list for a kidney transplant, but only 11,330 living donor and cadaver transplants were actually performed. Cadaver kidney transplants have a 50% chance of functioning nine years, and living donor kidneys that have two matching antigen pairs have a 50% chance of functioning for 24 years. However, some transplant grafts have functioned for over 30 years.

ORGANIZATIONS

American Association of Kidney Patients, 3505 E. Frontage Road, Suite 315, Tampa, FL, 33607, (813) 636-8122, (800) 749-2257, info@aakp.org, http://www.aakp.org.

American Kidney Fund (AKF), 6110 Executive Boulevard, Suite 1010, Rockville, MD, 20852, (800) 638-8299, http://www.kidneyfund.org.

National Kidney Foundation, Inc. , 30 East 33rd Street, New York, NY, 10016, (212) 889-2210, (212) 689-9261, (800) 622-9010, http://www.kidney.org/.

United States Renal Data System (USRDS), 914 South 8th Street, Suite S-206, Minneapolis, MN, 55404, (612) 347-7776, (888) 997-7737, usrds@usrds.org, http://www.usrds.org/.

Paula Anne Ford-Martin

Chronic leukemias *see* **Leukemias, chronic**

Chronic obstructive pulmonary disease

Definition

Chronic obstructive pulmonary disease (COPD) refers to two related, progressive diseases of the respiratory system, chronic **bronchitis** and **emphysema**. Emphysema is the enlargement and destruction of the air sacs (alveoli) of the lungs. Chronic bronchitis is ongoing inflammation that eventual results in narrowing of the airways. These are gradually progressive and permanent disease conditions in which there is persistent difficulty in expelling (exhaling) air from the lungs resulting in loss of lung function. Because **smoking** is the major cause of both diseases, chronic bronchitis and emphysema often occur together in the same individual.

Demographics

Almost all people with COPD are over age 40, and the highest rate of the disease is among those age 65 and older. More men than women have COPD, but at least in the United States the difference in rates between genders is narrowing.

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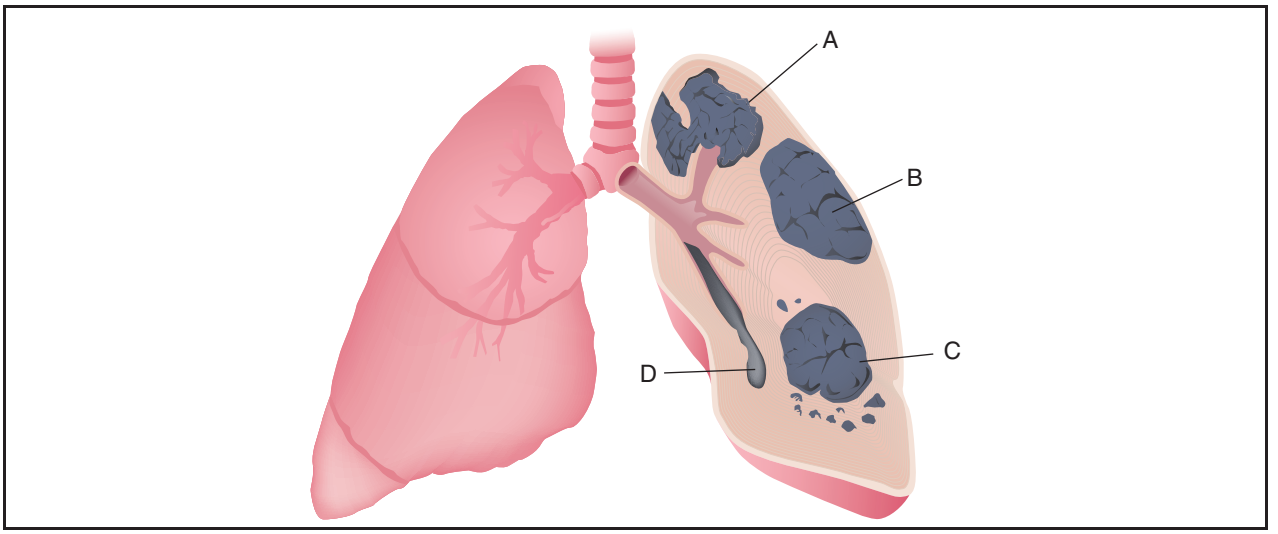

A. Lung cancer. B. Pneumonia. C. Emphysema. D. Phlegm from chronic bronchitis. *(Illustration by Argosy, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

The exact prevalence of COPD in the United States is unknown, although it is estimated to be about 10% of the population, and some experts believe that that is an underestimate because many cases go unreported. According to the United States Centers for Disease Control and Prevention (CDC), COPD was the fourth leading cause of **death** in the United States in 2008. Internationally, COPD was the fifth leading cause of death. International prevalence estimates vary from a high of about 20% in South Africa to a low of about 5% in parts of Germany. Chronic bronchitis is about four times more common than emphysema.

Description

The lungs are the site where oxygen enters the blood and carbon dioxide is removed from the blood. Healthy lungs perform this process, known as gas exchange, efficiently. When air is inhaled through the nose or mouth, it moves through the windpipe (trachea) to large bronchial tubes (bronchi) then through smaller tubes (bronchioles). At the ends of the bronchioles are small air sacs (alveoli). In healthy lungs, the alveoli and the bronchi are springy and elastic. Much like a balloon, the alveoli can fill up with inhaled air and deflate when air is exhaled. In people with COPD, the alveoli lose their elasticity and shape so that a smaller volume of air moves in or out with each breath. COPD develops slowly over many years. Once it develops, COPD is irreversible (permanent); the damage done to the lungs, airways, and walls of the airways cannot be repaired by the body.

Chronic bronchitis

In chronic bronchitis, prolonged exposure to irritants such as smoke or airborne chemicals cause airways to lose their elasticity and narrow. Inflammation also causes glands that line the bronchi to produce excessive amounts of mucus, further narrowing the airways and blocking airflow. The result is often a chronic **cough** that produces sputum (mainly mucus) and **shortness of breath**. Cigarette smoke and other irritants also damage the cilia, small hair-like projections that move bacteria and foreign particles out of the airways. When the cilia are damaged, there is an increased the risk of lung infections.

Emphysema

Emphysema is a disease in which cigarette smoke causes an overproduction of the enzyme elastase, one of the immune system's infection-fighting biochemicals. This results in irreversible destruction of a protein in the lung called elastin. Elastin is essential in maintaining the structure of the walls of the alveoli, the terminal small air sacs of the respiratory system where gas exchange takes place. As the walls of the alveoli rupture, the number of alveoli is reduced and many of those remaining are enlarged. This reduces the surface area for gas exchange and makes the lungs of the patient with emphysema less elastic and overinflated. Because higher pressure inside the chest that must be developed to force air out of the less-elastic lungs, the bronchioles, small air tubes of the respiratory system, tend to collapse during exhalation,

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blocking air flow. Stale air gets trapped in the air sacs and less fresh air can be inhaled.

Risk factors

Cigarette smoking is the greatest risk factor for developing COPD and accounts for about 80% of all cases. Cigar and pipe smoking also can cause COPD. Exposure to airborne pollutants (e.g., chemicals, industrial dust) in the work place also increases risk. Coal mining, cotton textile manufacturing, and gold mining are among the occupations where risk is increased, but the effects of these occupational exposures are lower than the effects of cigarette smoke. There is some debate about the role of exposure to air pollution in the development of COPD, but it is agreed to be a less important as a risk factor than cigarette smoking.

Causes and symptoms

The primary cause of COPD is cigarette smoking, along with the smoking of pipes and cigars. Secondary (passive) exposure to cigarette smoke is also a contributing factor to COPD. Occupational chemicals, dusts, and airborne particulates in the workplace also have been documented to be factors that can lead to the disease, as have air pollutants in the home. Outdoor air pollution has not been documented to be a significant factor to COPD, although such pollution is never good to anyone's lungs, especially those at risk for developing COPD.

Genetic and hereditary factors are also a consideration in developing COPD. One form of emphysema is known to run in families. People with this type of emphysema have a hereditary deficiency of a blood component, an enzyme inhibitor called alpha-1-antitrypsin (AAT). This type of emphysema is sometimes called early onset emphysema because it can appear when a person is as young as 30–40 years old. This type of emphysema is estimated to account for only 1–3% of all cases of emphysema. The risk of developing emphysema for an AAT-deficient individual who also smokes is much greater than for others.

The symptoms of COPD develop gradually, usually over years. The most common symptoms of chronic bronchitis are cough, production of sputum, and shortness of breath, especially with **exercise**. People with COPD also may experience **wheezing** and tightness in the chest. In emphysema, shortness of breath on exertion is the predominant early symptom. Coughing is usually minor, and there is little sputum. As emphysema progresses, shortness of breath occurs with less exertion, and eventually may be present even when at rest. At this point, a sputum-producing cough may also occur. Either chronic bronchitis or emphysema can lead to **respiratory failure**, a condition in which there occurs a dangerously low level of oxygen or a serious excess of carbon dioxide in the blood.

KEY TERMS

Alveoli—Terminal air sacs of the respiratory system, where gas (oxygen and carbon dioxide) exchange occurs.

Bronchi—Large air tubes of the respiratory system.

Bronchioles—Small air tubes of the respiratory system.

Bronchodilators—Drugs that open wider the bronchial tubes of the respiratory system.

Corticosteroids—A group of hormones that are used as drugs to block inflammation.

Forced expiratory volume (FEV1)—The maximum amount of air expired in one second.

Spirometer—An instrument used by a doctor to perform a breathing test.

Vital capacity (VC)—The largest amount of air expelled after one's deepest inhalation.

Diagnosis

A history of heavy smoking is not enough to diagnose COPD. The first step in making a diagnosis is a good medical evaluation, including a medical history and a **physical examination** of the chest using a stethoscope. This may be followed by a variety of tests to evaluate lung function.

Tests

A pulmonary function test is a measure of how much air is passing into and out of the lungs. Using a spirometer, an instrument that measures the air taken into and exhaled from the lungs, the doctor will determine two important values: (1) vital capacity (VC), the largest amount of air expelled after the deepest inhalation, and (2) forced expiratory volume (FEV1), the maximum amount of air expired in one second. The pulmonary function test can be performed in the doctor's office. A person with chronic cough and sputum production but normal **spirometry** results may simply be at risk for COPD. With mild COPD, the test usually shows mild airflow limitation, and the patient may not be aware that airflow in the lungs is reduced. With moderate COPD, the pulmonary

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function test shows that airflow limitation is worsening. The patient may have noticed that shortness of breath has worsened, particularly when walking fast or doing physical activity. Patients with severe or very severe COPD will have low volume readings.

Other tests used to diagnose COPD include diffusion studies, which determine how well oxygen in the air moves from the lungs into the blood. A blood sample may be taken to determine arterial blood gas. This test measures the amount of oxygen and carbon dioxide in the blood to see if these gases are being exchanged correctly. Low oxygen and high carbon dioxide levels are often indicative of chronic bronchitis, but not always of emphysema.

Chest x rays can detect only about half of the cases of emphysema. Chest x rays are rarely useful for diagnosing chronic bronchitis.

If infection is present, blood and sputum tests may be done to determine the cause of infection.

Many patients with lung disease also develop heart problems. An electrocardiogram (ECG) identifies signs of heart disease.

Treatment

Treatment for COPD is based on relieving symptoms, preventing complications, and improving a patient's overall health. The treatment varies depending on a patient's symptoms and stage of COPD. Treatment also may change over time and if a patient experiences complications or sudden onset of more severe symptoms.

Traditional

Only two treatments have been found to help people with COPD breathe more easily. Quitting smoking helps ease symptoms and slow the progress of the disease. Physicians will urge all patients with COPD who smoke to quit smoking. Quitting will not reverses the COPD, but will make the decline in lung function slower.

Supplemental oxygen is the only therapy that has been demonstrated to reduce the number of deaths in patients with COPD. The treatment usually is reserved for patients who are unable to get adequate oxygen on their own. The oxygen may be delivered by a portable tank that allows the patient to be mobile outside the home, through a concentrator unit placed in the home, or through some combination. Some patients will receive oxygen some of the time, such as when short of breath. Others may receive it only at night. Using extra oxygen more than 15 hours a day helps people perform activities with less shortness of breath, remain more alert during the day, and protects the heart and other organs from damage.

Drugs

Medications frequently prescribed for COPD patients include:

- Bronchodilators. These agents open narrowed airways and offer significant symptomatic relief for many, but not all, people with COPD. There are three types of bronchodilators: Beta2 agonists, anticholinergic agents, and theophylline and its derivatives. Depending on the specific drug, a bronchodilator may be inhaled, injected, or taken orally.
- Corticosteroids. Corticosteroids, usually inhaled, block inflammation and are most useful for patients with chronic bronchitis with or without emphysema. Steroids are generally not useful in patients who have emphysema.
- Antibiotics. Antibiotics are frequently given at the first sign of a respiratory infection, such as increased sputum production or a change in color of sputum from clear to yellow or green.
- Vaccines. To prevent pulmonary infection from viruses and bacteria, people with COPD should be vaccinated against influenza each year at least six weeks before flu season and have a one-time pneumococcal (pneumonia) vaccine.
- Expectorants. These agents help loosen and expel mucus secretions from the airways.
- Diuretics. These drugs are given to prevent excess water retention in patients with associated right heart failure.
- Augmentation therapy (for emphysema due to AAT-deficiency only). Replacement AAT (Prolastin), derived from human blood which has been screened for viruses, is injected weekly or bimonthly for life.

Pulmonary rehabilitation

A structured, outpatient pulmonary **rehabilitation** program improves functional capacity in certain patients with COPD. Services may include general exercise training, administration of oxygen and **nutritional supplements**, intermittent mechanical ventilator support, continuous positive airway pressure, relaxation techniques, breathing exercises and techniques (such as pursed lip breathing), and methods for mobilizing and removing secretions.

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Surgery

Surgical procedures for emphysema are very rare. They are expensive and often not covered by insurance. The great majority of patients cannot be helped by surgery, and no single procedure is ideal for those who can be helped.

Lung transplantation has been successfully employed in some patients with end-stage COPD. In the hands of an experienced team, the one-year survival rate is over 70% Lung transplantation is most often reserved for younger patients.

Lung volume reduction. These procedures remove 20–30% of severely diseased lung tissue; the remaining parts of the lung are joined together. Mortality rates can be as high as 15% and complication rates are even higher. When the operation is successful, patients report significant improvement in symptoms.

Alternative treatment

For both chronic bronchitis and emphysema, alternative practitioners recommend diet and nutritional supplements, a variety of herbal medicines, **hydrotherapy**, **acupressure** and **acupuncture**, **aromatherapy**, homeopathy, and **yoga**.

Home remedies

People with COPD may have more trouble breathing if they eat large meals because the stomach pushes on the diaphragm, the muscle that helps in breathing. Individuals with COPD also need to eat well-balanced **diets** because good **nutrition** helps fight infection. In the more severe stages of COPD, patients may experience weight loss and decreased muscle tissue, so these patients may need to eat high-calorie foods. Most people with COPD are encouraged to drink extra fluids to keep mucus thin and easier to cough up. Some have heart conditions and fluid retention and require fluid restriction.

Prognosis

COPD is a disease that can be treated and controlled, but not cured. Survival of patients with COPD is clearly related to the degree of their lung function when they are diagnosed and the rate at which they lose this function. Overall, the median survival is about 10 years for patients with COPD who have lost approximately two-thirds of their lung function at diagnosis.

Prevention

The most effective way to prevent COPD is to never smoke. Lifestyle modifications that can help prevent COPD, or improve function in COPD patients, include: quitting smoking, avoiding respiratory irritants and infections, avoiding allergens, maintaining good nutrition, drinking lots of fluids, avoiding excessively low or high temperatures and very high altitudes, maintaining proper weight, and exercising to increase muscle tone.

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ORGANIZATIONS

American Lung Association, 1301 Pennsylvania Ave., NW Suite 800, Washington, DC, 20004, (212) 315-8700, (800) LUNG-USA [(800) 548-8252], http://www.lungusa.org.

Global Alliance Against Chronic Respiratory Diseases (GARD), World Health Organization, Department of Chronic Diseases and Health Promotion, 20 Avenue Appia, CH-1211 27, Geneva, Switzerland., http://www.who.int/gard/en/index.html.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573; TTY: (240) 629-3255, (240) 629-3246, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi.nih.gov.

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Churg-Strauss syndrome *see* **Vasculitis**

Cingulotomy *see* **Psychosurgery**

Ciprofloxacin *see* **Fluoroquinolones**

Circadian rhythm sleep disorders *see* **Jet lag**

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Circumcision

Definition

The surgical removal of the foreskin of the penis or prepuce.

Purpose

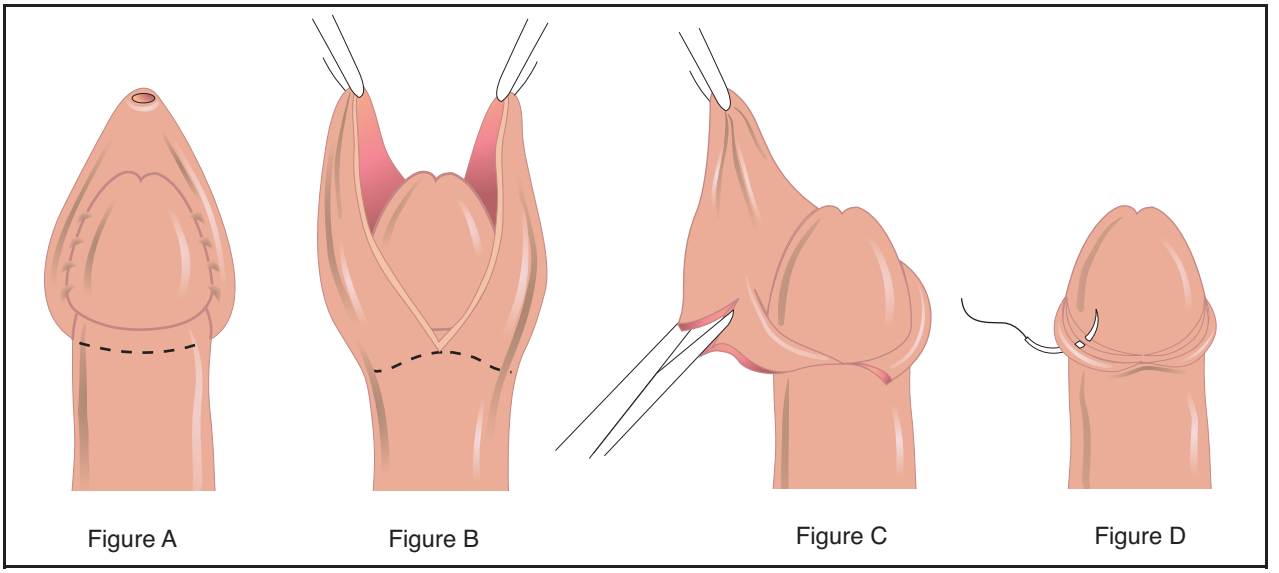
In the United States, circumcision in infant boys is performed for social, medical, or cultural/religious reasons. Once a routine operation urged by pediatricians and obstetricians for newborns in the middle of the twentieth century, circumcision has become an elective option that parents make for their sons on an individual basis. Families who practice Judaism or Islam may select to have their sons circumcised as a religious practice. Others choose circumcision for medical benefits.

Female circumcision (also known as **female genital mutilation**) is usually performed for cultural and social reasons by family members and others who are not members of the medical profession, with no anesthesia. Not only is the prepuce removed but often the vaginal opening is sewn to make it smaller. This practice is supposed to ensure the virginity of a bride on her wedding day. It also prevents the woman from achieving sexual pleasure during coitus. This practice is not universally approved by the medical profession and is considered by some as a human rights violation.

Though the incidence of male circumcision has decreased from 90% in 1979 to 60% in 1996, it is still the most common surgical operation in the United States. Circumcision rates are much lower for the rest of the industrialized world. In Britain, it is only done for religious practices or to correct a specific medical condition of the penis.

Some of the medical reasons parents choose circumcision are to protect against infections of the urinary tract and the foreskin, prevent **cancer**, lower the risk of getting **sexually transmitted diseases**, and prevent **phimosis** (a tightening of the foreskin that may close the opening of the penis). Though studies indicate that uncircumcised boys under the age of five are 20 times more likely than circumcised boys to have urinary tract infections (UTIs), the rate of incidence of UTIs is quite low. There are also indications that circumcised men are less likely to suffer from **penile cancer**, inflammation of the penis, or have many sexually transmitted diseases. Here again, the rate of incidence is low. Good hygiene usually prevents most infections of the penis. Phimosis and penile cancer are very rare, even in men who have not been circumcised. Education and good safe sex practices can prevent sexually transmitted diseases in ways that a surgical procedure cannot because these are diseases acquired through risky behaviors.

With these factors in mind, the American Academy of Pediatrics has issued a policy statement that



A typical circumcision procedure involves the following steps: Figure A: The surgeon makes an incision around the foreskin. Figure B: The foreskin is then freed from the skin covering the penile shaft. Figure C: The surgeon cuts the foreskin to the initial incision, lifting the foreskin from the mucous membrane. Figure D: The surgeon sutures the top edge of the skin that covers the penile shaft and the mucous membrane. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

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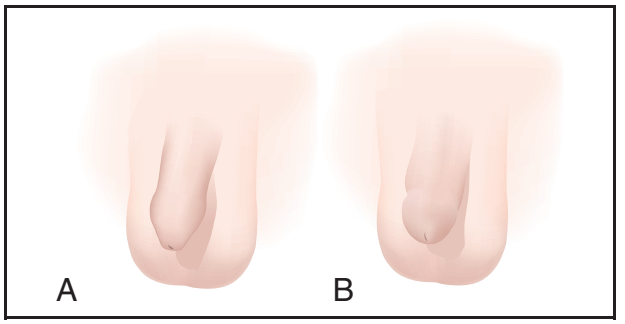

An uncircumcised penis (A) and a circumcised penis (B). *(Illustration by Argosy, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

states though there is existing scientific evidence that indicates the medical benefits of circumcision, the benefits are not strong enough to recommended circumcision as a routine practice.

Precautions

Circumcision should not be performed on infants with certain deformities of the penis that may require a portion of the foreskin for repair. The most common condition for surgery using the foreskin is **hypospadias**, a congenital deformity of the penis where the urinary tract opening is not at the tip of the glans. Also, infants with a large hydrocoele or **hernia** may suffer important complications through circumcision. Premature infants and infants with serious infections are also poor candidates to be circumcised, as are infants with **hemophilia**, other bleeding disorders, or whose mothers had taken **anticoagulant drugs**. In older boys or men, circumcision is a minor procedure. Therefore, it can be performed in virtually anyone without a serious illness or unusual deformity.

Description

The foreskin of the penis protects the sensitivity of the glans and shields it from irritation by urine, feces, and foreign materials. It also protects the urinary opening against infection and incidental injury.

In circumcision of infants, the foreskin is pulled tightly into a specially designed clamp, and the foreskin pulls away from the broadened tip of the penis. Pressure from the clamp stops bleeding from blood vessels that supplied the foreskin. In older boys or adults, an incision is made around the base of the foreskin, the foreskin is pulled back, and then it is cut away from the tip of the penis. Stitches are usually used to close the skin edges.

KEY TERMS

Foreskin—A covering fold of skin over the tip of the penis.

Glans—The cone-shaped tip of the penis.

Hernia—Bulging of abdominal structures through an abnormal opening in the muscular wall.

Hydrocele—Collection of fluid in the scrotum.

Hypospadias—A congenital deformity of the penis where the urinary tract opening is not at the tip of the glans.

Phimosis—A tightening of the foreskin that may close the opening of the penis.

Prepuce—A fold like the foreskin that covers the clitoris; another name for foreskin.

Preparation

Despite a long-standing belief that infants do not experience serious **pain** from circumcision, most authorities now believe that some form of **local anesthesia** is necessary. The physician injects local anesthesia at the base of the penis or under the skin around the penis (subcutaneous ring block). Both anesthetics block key nerves. EMLA cream, a topical formula of several anesthetics, can also be used.

Aftercare

After circumcision, the wound should be washed daily. An antibiotic ointment or petroleum jelly may be applied to the site. If there is an incision, a wound dressing will be present and should be changed each time the diaper is changed. Sometimes a plastic ring is used instead of a bandage. The ring will usually fall off in five to eight days. The penis will heal in seven to 10 days.

Infants who undergo circumcision may be fussy for some hours afterward, so parents should be prepared for crying, feeding problems, and sleep problems. Generally these go away within a day. In older boys, the penis may be painful, but this will go away gradually. A topical anesthetic ointment or spray may be used to relieve this temporary discomfort. There may also be a "bruise" on the penis, which typically goes away with no particular attention.

Risks

Complications following newborn circumcision appear in one out of every 500 procedures. Most

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complications are minor. Bleeding occurs in half of the complications and is usually easy to control. Infections are rare and present with **fever** and signs of inflammation.

There may be injuries to the penis itself, and these may be difficult to repair. In 2000, there were reports that the surgical clamps used in circumcision were at fault in over 100 injuries reported between July 1996 and January 2000. In nearly all cases, the clamps were assumed to be in working order but had been repaired with replacement parts that were not of the manufacturer's specifications. Physicians were urged to inspect the clamps before use and ensure that their dimensions fit their infant patients.

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Janie F. Franz

Cirrhosis

Definition

Cirrhosis is a chronic degenerative disease in which normal liver cells are damaged and are then replaced by scar tissue.

Demographics

Cirrhosis is the seventh leading cause of disease-related **death** in the United States. It is the third most common cause of death in adults between the ages of 45 and 65. It is twice as common in men as in women. The disease occurs in more than half of all malnourished chronic alcoholics, and kills about 25,000 people a year. In Asia and Africa, however, most deaths from cirrhosis are due to chronic **hepatitis B**.

Description

Cirrhosis changes the structure of the liver and the blood vessels that nourish it. The disease reduces the liver's ability to manufacture proteins and process hormones, nutrients, medications, and poisons.

Cirrhosis gets worse over time and can become potentially life threatening. This disease can cause:

- excessive bleeding (hemorrhage)
- impotence
- liver cancer
- coma due to accumulated ammonia and body wastes (liver failure)
- sepsis (blood poisoning)
- death

Types of cirrhosis

Portal or nutritional cirrhosis is the form of the disease most common in the United States. About 30–50% of all cases of cirrhosis are this type. Nine out of every ten people who have nutritional cirrhosis have a history of **alcoholism**. Portal or nutritional cirrhosis is also called Laënnec's cirrhosis.

Biliary cirrhosis is caused by intrahepatic bile-duct diseases that impede bile flow. Bile is formed in the liver and is carried by ducts to the intestines. Bile then helps digest fats in the intestines. Biliary cirrhosis can scar or block these ducts. It represents 15–20% of all cirrhosis.

Various types of chronic hepatitis, especially hepatitis B and **hepatitis C**, can cause postnecrotic cirrhosis. This form of the disease affects up to 40% of all patients who have cirrhosis.

Disorders like the inability to metabolize iron and similar disorders may cause pigment cirrhosis (**hemochromatosis**), which accounts for 5–10% of all instances of the disease.

Risk factors

Most risk factors for cirrhosis can be prevented or avoided. The primary risk factors are alcohol and chronic liver infections, such as hepatitis B and C. People at high risk of contracting hepatitis B include those exposed to the virus through contact with blood and body fluids. This includes healthcare workers and intravenous (IV) drug users. In the past, people have contracted hepatitis C through blood transfusions. **Obesity** and poor **nutrition** are also significant risk factors.

Certain hereditary diseases can increase an individual's risk for cirrhosis. In most cases, these cannot be prevented or avoided but risk may be reduced with proper treatment of the disease or disorder.

Causes and symptoms

Long-term alcoholism is the primary cause of cirrhosis in the United States. Men and women respond

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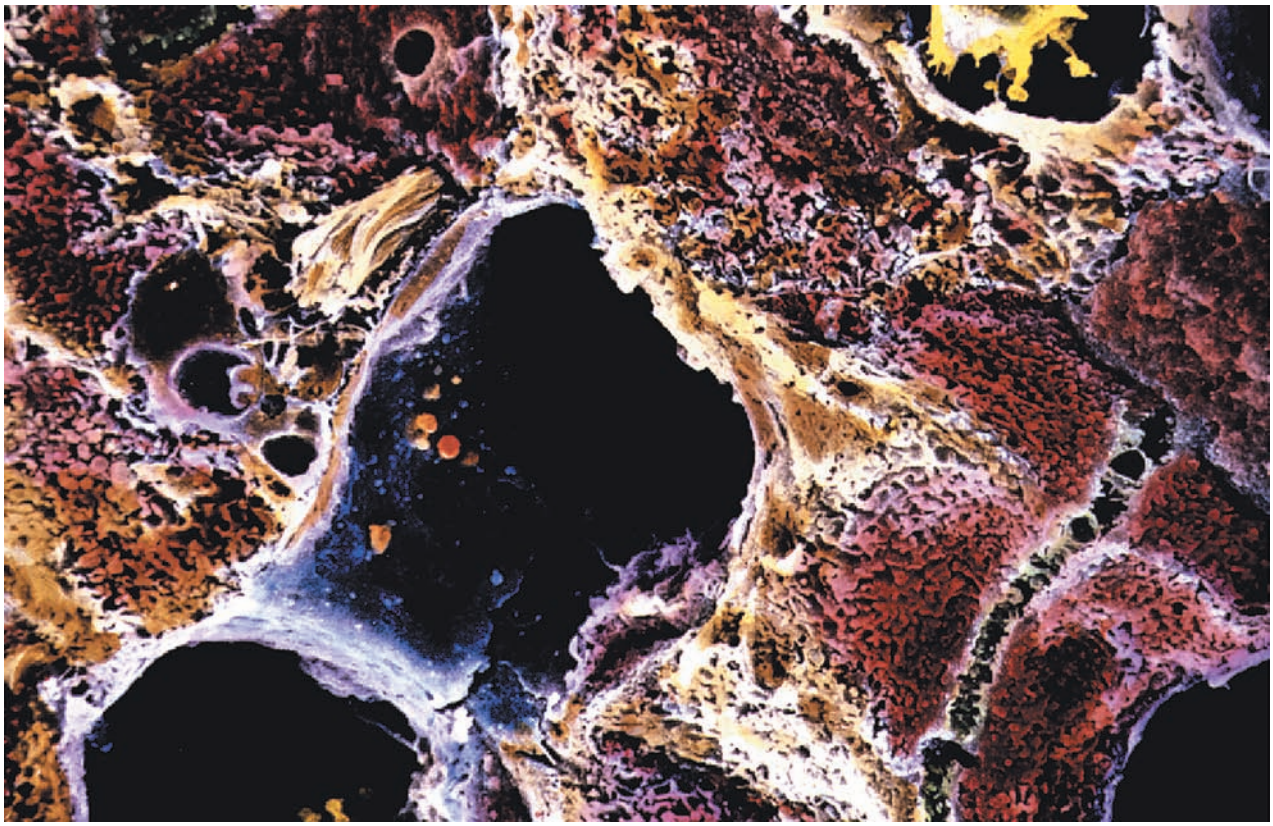

A micrograph of a human liver showing tissue damaged by cirrhosis. *(Professor P. Motta/Photo Researchers, Inc.)*

differently to alcohol. Although most men can safely consume two to five drinks a day, one or two drinks a day can cause liver damage in women. Individual tolerance to alcohol varies, but people who drink more and drink more often have a higher risk of developing cirrhosis. In some people, one drink a day can cause liver scarring.

Chronic liver infections, such as hepatitis B and particularly hepatitis C, are commonly linked to cirrhosis. Cirrhosis resulting from chronic hepatitis has emerged as a leading cause of death among HIV-positive patients; in Europe, about 30% of HIV-positive patients are co-infected with a hepatitis virus.

Liver injury, reactions to prescription medications, exposure to toxic substances, and repeated episodes of **heart failure** with liver congestion can cause cirrhosis. The disorder can also be a result of diseases that run in families (inherited diseases) like:

- a lack of a specific liver enzyme (alpha$_1$-antitrypsin deficiency)
- the absence of a milk-digesting enzyme (galactosemia)
- an inability to convert sugars to energy (glycogen storage disease)
- an absorption deficit in which excess iron is deposited in the liver, pancreas, heart, and other organs (hemochromatosis)
- a disorder characterized by accumulations of copper in the liver, brain, kidneys, and corneas (Wilson's disease)

Obesity has recently been recognized as a risk factor in nonalcoholic hepatitis and cirrhosis. Some surgeons recommend that patients scheduled for weight-reduction surgery have a **liver biopsy** to evaluate the possibility of liver damage.

Poor nutrition increases a person's risk of developing cirrhosis. In about 10 out of every 100 patients, the cause of cirrhosis cannot be determined. Many people who have cirrhosis do not have any symptoms (often called compensated cirrhosis). Their disease is detected during a routine physical or when tests for an unrelated medical problem are performed. This type of cirrhosis can also be detected when complications occur (decompensated cirrhosis).

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Symptoms of cirrhosis are usually caused by the loss of functioning liver cells or organ swelling due to scarring. The liver enlarges during the early stages of illness. The palms of the hands turn red and patients may experience:

- constipation
- diarrhea
- dull abdominal pain
- fatigue
- indigestion
- loss of appetite
- nausea
- vomiting
- weakness
- weight loss

As the disease progresses, the spleen enlarges and fluid collects in the abdomen (**ascites**) and legs (**edema**). Spider-like blood vessels appear on the chest and shoulders, and bruising becomes common. Men sometimes lose chest hair. Their breasts may grow and their testicles may shrink. Women may have menstrual irregularities.

Cirrhosis can cause extremely dry skin and intense **itching**. The whites of the eyes and the skin may turn yellow (**jaundice**), and urine may be dark yellow or brown. Stools may be black or bloody. Sometimes the patient develops persistent high blood pressure due to the scarring (portal **hypertension**). This type of hypertension can be life threatening. It can cause veins to enlarge in the stomach and in the tube leading from the mouth to the stomach (esophagus). These enlarged veins are called varices, and they can rupture and bleed massively.

Other symptoms of cirrhosis include:

- anemia
- bleeding gums
- decreased interest in sex
- fever
- fluid in the lungs
- hallucinations
- lethargy
- lightheadedness
- muscle weakness
- musty breath
- painful nerve inflammation (neuritis)
- slurred speech
- tremors

KEY TERMS

Biopsy—The removal of cells or tissue for examination from a surface or organ for examination under a microscope. A needle biopsy uses a long needle and syringe device to aspirate (remove by suction) a sample of the target tissue.

Computed tomography (CT) scan—A series of detailed images of areas inside the body taken at various angles; the images are created on a computer linked to an x-ray machine.

Jaundice—Yellowing of the skin and whites of the eyes when pigments normally eliminated by the liver collect in high amounts in the blood.

If the liver loses its ability to remove toxins from the brain, the patient may have additional symptoms. The patient may become forgetful and unresponsive, neglect personal care, have trouble concentrating, and acquire new sleeping habits. These symptoms are related to ammonia intoxication and the failure of the liver to convert ammonia to urea. High protein intake in these patients can also lead to these symptoms.

Diagnosis

Examination

A patient's medical history can reveal illnesses or lifestyles likely to lead to cirrhosis. Liver changes can be seen during a **physical examination**. A doctor who suspects cirrhosis may order blood and urine tests to measure liver function. Because only a small number of healthy cells are needed to carry out essential liver functions, test results may be normal even when cirrhosis is present.

Tests

Computed tomography scans (CT), ultrasound, and other imaging techniques can be used during diagnosis. They can help determine the size of the liver, indicate healthy and scarred areas of the organ, and detect **gallstones**.

Procedures

Cirrhosis is sometimes diagnosed during surgery or by examining the liver with a laparoscope. This viewing device is inserted into the patient's body through a tiny incision in the abdomen.

Liver biopsy is usually needed to confirm a diagnosis of cirrhosis. In this procedure, a tissue sample is

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removed from the liver and is examined under a microscope in order to learn more about the organ.

A newer and less invasive test involves the measurement of hyaluronic acid in the patient's blood serum. The serum hyaluronic acid test is most useful in monitoring the progress of **liver disease**; it is unlikely to completely replace liver biopsy in the diagnosis of cirrhosis.

Treatment

The goal of treatment is to cure or reduce the condition causing cirrhosis, prevent or delay disease progression, and prevent or treat complications.

Traditional

Salt and fluid intake are often limited, and activity is encouraged. A diet high in calories and moderately high in protein can benefit some patients. **Tube feedings** or vitamin supplements may be prescribed if the liver continues to deteriorate. Patients are asked not to consume alcohol.

Drugs

Iron supplements, **diuretics**, and **antibiotics** may be used for anemia, fluid retention, and ammonia accumulation associated with cirrhosis. Vasoconstrictors are sometimes needed to stop internal bleeding and antiemetics may be prescribed to control nausea.

Laxatives help the body absorb toxins and accelerate their removal from the digestive tract. **Beta blockers** may be prescribed to control cirrhosis-induced portal hypertension. Because the diseased liver can no longer efficiently neutralize harmful substances, medications must be given with caution. Interferon medicines may be used by patients with chronic hepatitis B and hepatitis C to prevent post-hepatic cirrhosis.

Surgery

Medication that causes scarring can be injected directly into veins to control bleeding from varices in the stomach or esophagus. Varices may require a special surgical procedure called balloon tamponade ligation to stop the bleeding. Surgery may be required to repair disease-related throat damage. It is sometimes necessary to remove diseased portions of the spleen and other organs.

Liver transplants can benefit patients with advanced cirrhosis. However, the new liver will eventually become diseased unless the underlying cause of cirrhosis is removed. Patients with alcoholic cirrhosis must demonstrate a willingness to stop drinking before being considered suitable transplant candidates.

The incidence of **liver cancer** related to cirrhosis in the United States has increased 75% since the early 1990s. Partial surgical removal of the liver in patients with early-stage **cancer** of the liver appears to be as successful as transplantation, in terms of the 5-year survival rate.

Alternative

Alternative treatments for cirrhosis are aimed at promoting the function of healthy liver cells and relieving the symptoms associated with the disease. Several herbal remedies may be helpful to cirrhosis patients. Dandelion (*Taraxacum officinale*) and rock-poppy (*Chelidonium majus*) may help improve the efficiency of liver cells. Milk thistle extract (*Silybum marianum*) may slow disease progression and significantly improve survival rates in alcoholics and other cirrhosis patients. Practitioners of homeopathy and **traditional Chinese medicine** can also prescribe treatments that support healthy liver function.

Home remedies

A balanced diet promotes regeneration of healthy liver cells. Eating five or six small meals throughout the day should prevent the sick or bloated feeling patients with cirrhosis often have after eating. Alcohol and **caffeine**, which destroy liver cells, should be avoided. So should any foods that upset the stomach. Patients with brain disease associated with cirrhosis should avoid excessive amounts of protein in the diet.

A patient can keep a food diary that describes what was eaten, when it was eaten, and how the patient felt afterwards. This diary can be useful in identifying foods that are hard to digest and in scheduling meals to coincide with the times the patient is most hungry.

Patients who have cirrhosis should weigh themselves every day and notify their doctor of a sudden gain of 5 lb (2.3 kg) or more. A doctor should also be notified if symptoms of cirrhosis appear in anyone who has not been diagnosed with the disease. A doctor should also be notified if a patient diagnosed with cirrhosis:

- vomits blood
- passes black stools
- seems confused or unresponsive
- shows signs of infection (redness, swelling, tenderness, pain)

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Prognosis

Cirrhosis-related liver damage cannot be reversed, but further damage can be prevented by patients who:

- eat properly
- get enough rest
- do not consume alcohol
- remain free of infection

If the underlying cause of cirrhosis cannot be corrected or removed, scarring will continue. The liver will fail, and the patient will probably die within five years. Patients who stop drinking after being diagnosed with cirrhosis can increase their likelihood of living more than a few years from 40% up to 70%.

Prevention

Eliminating alcohol **abuse** could prevent 75–80% of all cases of cirrhosis.

Other preventive measures include:

- obtaining counseling or other treatment for alcoholism
- taking precautions (practicing safe sex, avoiding dirty needles) to prevent hepatitis
- getting immunizations against hepatitis if a person is in a high-risk group
- receiving appropriate medical treatment quickly when diagnosed with hepatitis B or hepatitis C
- having blood drawn at regular intervals to rid the body of excess iron from hemochromatosis
- using medicines (chelating agents) to rid the body of excess copper from Wilson's disease
- wearing protective clothing and following product directions when using toxic chemicals at work, at home, or in the garden

In 2001, research scientists identified the protein segment and method in which excess tissue grows in diseases like cirrhosis. With further study, the discovery might one day result in an oral or inhalable peptide for those with cirrhosis.

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American Liver Foundation, 75 Maiden Lane, Suite 603, New York, NY, (212) 668-1000, http://www.liverfoundation.org.

National Institutes of Health (NIH), 9000 Rockville Pike, Bethesda, MD, 20892, (301) 496-4000, http://www.nih.gov.

United Network for Organ Sharing, P.O. Box 2484, Richmond, VA, 23218, (804) 782-4800, http://www.unos.org.

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Cisapride *see* **Antigastroesophageal reflux drugs**

CK test *see* **Creatine kinase test**

Clap *see* **Gonorrhea**

Clarithromycin *see* **Erythromycins**

Cleft lip and palate

Definition

A cleft is a birth defect that occurs when the tissues of the lip and/or palate of the fetus do not fuse very early in **pregnancy**. A cleft lip, sometimes referred to as a harelip, is an opening in the upper lip that can extend into the base of the nostril. A cleft palate is an opening in the roof of the mouth.

Description

Babies born with cleft lips will have an opening involving the upper lip. The length of the opening ranges from a small notch, to a cleft that extends into the base of the nostril. Cleft lips may involve one or both sides of the lip.

Babies born with cleft palates have openings in the palate, which is the roof of the mouth. The size and position of the opening varies. The cleft may be only in the hard palate, the bony portion of the roof of the mouth, opening into the floor of the nose. It may be only in the soft palate, the soft portion of the roof of the mouth. The cleft palate may involve both the hard and soft palate and may occur on both sides of the center of the palate.

This infant has a unilateral cleft lip and palate. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Babies may have cleft lips with or without cleft palates. Cleft palates may also occur without cleft lips.

The incidence of cleft lip and palate not associated with a syndrome is one in 700 newborns. Native Americans have an incidence of 3.6 in 1,000 newborns. The incidence among Japanese newborns is 2.1 in 1,000. The incidence among whites is one in 1,000 newborns. African Americans have an incidence of 0.3 in 1,000 newborns.

Causes and symptoms

Cleft lips and palates not associated with a syndrome are caused by a combination of genetic and environmental factors. Inheritance caused by such a combination is called multifactorial. The embryo inherits genes that increase the risk for cleft lip and/or palate. When an embryo with such genes is exposed to certain environmental factors the embryo develops a cleft.

The risk of a baby being born with a cleft lip or palate increases with the number of affected relatives and the number of relatives that have more severe clefts.

Environmental factors that increase the risk of cleft lip and palate include cigarette and alcohol use during pregnancy. Some drugs, such as phenytoin, **sodium** valproate, and methotrexate, also increase the incidence of clefting. The pregnant mother's **nutrition** may affect the incidence of clefting as well.

Babies born with a cleft lip will be seen to have an elongated opening in the upper lip. The size of this opening may range from a small notch in the upper lip to an opening that extends into the base of the nostril. The cleft lip may be below the right or left nostril or below both nostrils.

Babies born with a cleft palate will be seen to have an opening into the roof of the mouth. The size and position of the cleft varies and it may involve only the hard palate, or only the soft palate and may occur on both sides of the center of the palate.

In some cases the cleft palate will be covered with the normal lining of the mouth and can only be felt by the examiner.

Babies with cleft lips and palates have feeding difficulties, which are more severe in babies with cleft

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palates. The difficulty in feeding is due to the baby being unable to achieve complete suction. In the case of clefts of the hard palate, liquids enter the nose from the mouth through the opening in the hard palate.

A cleft palate also affects a child's speech, since the palate is necessary for speech formation. The child's speech pattern may still be affected despite surgical repair.

Ear infections are more common in babies born with cleft palates. The infections occur because the muscles of the palate do not open the Eustachian tubes that drain the middle ear. This allows fluid to collect and increases the risk of infection and **hearing loss**.

Teeth may also erupt misaligned.

Diagnosis

Cleft lip and palate can be diagnosed before birth by ultrasound. **Magnetic resonance imaging** (MRI) offers more accuracy for detecting cleft lip and palate, as it is a more detailed imaging method. It is particularly helpful in showing soft palate defects. In 2004, researchers reported discovery of a gene test for isolated cleft lip and cleft palate to help predict if parents who have one child with the isolated form of cleft lip or palate were likely to have a second child with the same defect. After birth, cleft lip and palate are diagnosed by physical exam.

Treatment

If cleft lip and/or palate are diagnosed by ultrasound before birth, further testing may be required to diagnose associated abnormalities if present. Referral to a cleft team is essential. A cleft team consists of specialists in the management of babies with clefts and includes surgeons as well as nurses and speech therapists. Members of the team inform the parents of all aspects of management. Feeding methods are also discussed, since feeding is the first problem that must be dealt with. It may be possible to breastfeed a baby born with only a cleft lip, but babies born with cleft palates usually have more problems with feeding and frequently require special bottles and teats. A palatal obturator is a device that fits into the roof of the mouth, thus blocking the cleft opening and allowing easier suckling.

Surgery to repair cleft lips is sometimes performed after orthodontic treatment to narrow the gap in the upper lip. The orthodontic treatment can involve acrylic splints with or without screws or may involve the use of adhesive tape placed across the gap in the lip. The orthodontic treatment for cleft lip should be started within the first three weeks of life and continue until the cleft lip is repaired.

The timing of surgical cleft lip repair depends on the judgment of the surgeon who will perform the operation. The procedure is usually performed between one and three months of age. The goals of the operation are to close the gap in the upper lip, place **scars** in the natural skin curves and to repair muscle so that the lip appears normal during movement. The closure is done in the three layers (skin, muscle, and mucosa) that line the inside of the lip. At the time of the procedure, if the nose is shaped abnormally due to the cleft lip, it is also corrected. Sometimes further surgery may be needed on the lip and/or nose to refine the result.

The goals of the surgeon repairing a cleft palate are normal speech, normal facial growth, and hearing for the affected infant. The repair of the cleft palate is usually performed between three and 18 months of age. The timing may extend beyond this and varies with the type of cleft palate and center where the procedure is being performed. Depending of the type of cleft palate, more than one operation may be needed to close the cleft and improve speech.

Nonsurgical treatment of a cleft palate is available for patients who are at high risk for surgery and consists of a prosthetic appliance worn to block the opening in the palate.

Babies born with cleft palates are vulnerable to ear infections. Their Eustachian tubes do not effectively drain fluid from the middle ear so fluid accumulates and infection sets in. This may lead to hearing loss. These children require drainage tubes to be inserted to prevent fluid accumulation.

Babies born with clefts usually require orthodontic treatment between 13 and 18 years of age. They also require **speech therapy**.

Prognosis

Babies born with cleft lip and palate have a good prognosis, and approximately 80% will develop normal speech. There is no known means of preventing clefting. Good prenatal care is essential and avoiding harmful substances appear to reduce the risk.

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Cleft Palate Foundation, Cleft Palate Foundation, Chapel Hill, NC, 27514-2820, (919) 933-9044, (919) 933-9604, info@cleftline.org, http://www.cleftline.org.

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Cleft palate *see* **Cleft lip and palate**

Clenched fist injury

Definition

A clenched fist injury (CFI) is a bite wound on the hand, caused when a person's closed fist strikes the teeth of another person, usually in the course of a fight. CFIs are sometimes referred to as closed fist injuries or fight bites.

Description

Clenched fist injuries are most common over the metacarpo phalangeal joint. Their appearance is deceptive because they do not bleed heavily and the underlying injury is hidden by soft tissue when the patient opens his hand and straightens the injured finger. CFIs can, however, have serious consequences, including infection, **cellulitis**, inflammation of the bone or bone marrow (**osteomyelitis**), septic arthritis, and inflammation of the sheaths covering the tendons of the hand (tenosynovitis). These may lead to permanent loss of function or **amputation**.

Most CFIs result in tissue injury due to the force of impact, ragged-edged tears in the skin resulting from contact with the teeth, and contamination of the wound by the bacteria in human saliva. As the patient opens his hand, the skin of the finger is pulled backward over the deeper part of the wound, thus sealing bacteria within the injured tissue. This sealing of the wound by normal motions of the finger is the reason why clenched fist injuries have the highest rate of infection of any human bite. The rate of infection of clenched-fist injuries varies from 15–50%.

Causes and symptoms

The causes of CFIs include fighting and other forms of aggressive behavior, often combined with drug or alcohol consumption.

The symptoms of clenched-fist injury include **pain** in the affected part of the hand and some stiffness of the injured finger with limitation of movement. If the patient has delayed getting medical treatment, there may be evidence of infection, including swelling, redness, and suppuration (a discharge of pus). The skin around the wound will be warm to the touch and **fever** may be present.

Diagnosis

Diagnosis of clenched fist injuries is usually made on the basis of the location of the injury and x-ray findings. The most common finding in CFI x rays is soft tissue swelling, but the x rays may also reveal air pockets in deep tissues or the joint spaces, fragments of teeth, fracture lines in the bones, or small loose bone chips. Diagnosis is often complicated by the fact that the patient will be reluctant to admit how the injury happened. The treating physician must maintain a high level of suspicion and often ask directly.

Treatment

Treatment of clenched fist injuries is complicated by several factors. One factor is the anatomical structure of the human hand, which contains many small closed spaces that make it easy for infection to spread and persist. Another is the number of disease-causing bacteria transmitted by human bites; at least 42 different species have been identified. In addition, CFIs typically do not receive immediate treatment because the patient is concerned about legal consequences. The longer the delay, the higher the chances of infection and permanent damage to the hand. Patients who wait longer than 24 hours to seek treatment or have signs of infection or damage to the tendon, joint capsule, or bones are usually referred immediately to a doctor who specializes in hand surgery.

The first step in treatment of clenched fist injury is irrigation, a procedure by which the wound is flushed with a stream of water under high pressure or with an antiseptic solution. Incision and drainage of the wound (I&D) may be required as well as **debridement**, the surgical removal of dead tissue and **foreign objects** from a wound. Careful examination of the depth of the wound is essential to proper treatment. The surgeon may need to enlarge the sides of the wound in order to

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make an accurate evaluation. The patient will be asked to move the affected joint through its full range of motion so that the surgeon can determine whether the tendon or joint capsule has been damaged. Following these procedures, the surgeon will pack the wound and put the hand in a splint. Bite **wounds** are never sutured (sewn shut) because of the possibility of enclosing bacteria inside the injury. After 24 hours, the packing will be removed and the hand reexamined for signs of infection.

If the wound has become infected, the patient is usually hospitalized and given parenteral (injectable) **antibiotics**. The wound is irrigated and examined to determine the extent of the injury. Cultures are taken for both aerobic (requiring air or oxygen to live) and anaerobic (not requiring air or oxygen) species of bacteria. The cultures should be taken from areas deep in the wound rather than from the surface for greater accuracy. **Tetanus** toxoid should be given if the patient has not been immunized within the last 10 years. The patient should also receive treatment and follow-up for the rare possibility of HIV and hepatitis transmission. Although no well-documented cases of HIV transmission by human bites exist, the potential for transmission by this route is still present.

Infected clenched fist injuries usually contain several disease-causing bacteria, the most common being *Streptococcus pyogenes*, *Staphylococcus aureus*, *Bacteroides sp.*, *Peptostreptococcus sp.*, and *Eikenella corrodens*. Broad-spectrum antibiotics are usually given. Uninfected and relatively superficial CFIs may be treated with oral penicillin plus dicloxacillin or Augmentin. For infected CFIs, parenteral penicillin G is usually given together with nafcillin or cefuroxime. CFIs infected by drug-resistant strains of *S. aureus* may require treatment with vancomycin. While some human bite wounds do not require routine use of antibiotics, a 2004 study confirmed that puncture wounds, deeper lacerations and bites to the hand all have high infection rates which may be lowered by preventive use of antibiotics.

Prognosis

The prognosis depends on the patient's underlying state of health and compliance with treatment; depth of the wound; the involvement of the joint capsule or tendon; and the length of time before the wound is treated. The more superficial the wound and the faster the treatment, the better the prognosis.

Prevention

The best way to prevent clenched fist injuries is to avoid fist fights, intoxication, and association with people who practice these forms of behavior. If involved in a fist fight, people should avoid directing punches at their opponent's mouth. The next best preventive measure is to get medical treatment at once for a clenched-fist injury.

KEY TERMS

Antibiotic—A chemical substance produced by a microorganism which can inhibit the growth of or kill other microorganisms.

Debridement—Surgical removal of damaged tissue and foreign objects from a wound.

I&D—Incision and drainage of a wound.

Irrigation—Cleansing a wound with large amounts of water and/or an antiseptic solution.

Parenteral—Administered inside the body but outside the digestive tract.

Tetanus toxoid—Tetanus toxoid is a vaccine used to prevent tetanus (also known as lockjaw).

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Massachusetts College of Emergency Physicians, 860 Winter Street, Waltham, MA, 02451, (781) 890-4407, (781) 890-4109, http://www.macep.org.

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Climacteric *see* **Menopause**
Clomiphene *see* **Infertility drugs**
Clonazepam *see* **Benzodiazepines**
Closed fracture reduction *see* **Fracture repair**
Clostridium difficile colitis *see* **Antibiotic-associated colitis**
Clotrimazole *see* **Antifungal drugs, topical**
Clotting disorders *see* **Coagulation disorders**

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Club drugs

Definition

Club drugs are a diverse group of recreation-enhancing substances, used illegally, and usually consumed along with alcohol at raves, bars, clubs, concerts, or parties.

Description

Club drugs include Ecstasy (MDMA), GHB (gamma hydroxybutyrate, liquid ecstasy, soap), Rohypnol (flunitraxapam, roofies, a relative of Valium and Xanax), Ketamine (Special K, Vitamin K), **methamphetamine** (meth, speed, crystal, crank), and **LSD** (acid).

These drugs have separate, different actions. They are usually produced or imported illegally, so their strengths and purity are unknowable. Taken together, with alcohol, and consumed in intense social situations, their effects cannot be accurately predicted.

Ecstasy (XTC, X, E, MDMA), the most commonly used club drug, was patented in 1914 by Merck and not used for six decades. In the 1970s and 1980s, psychologists and therapists began experimenting with it for treating **anxiety**, depression, and post traumatic **stress** syndrome. Patients reported various effects, including an increasing sense of empathy for self and others, **hallucinations**, and euphoria or ecstasy. Its use subsequently spread to the recreational drug subculture.

Ecstasy can increase body temperature, heart rate, and blood pressure, and can change perceptions of time, place and person. It can blunt sensations of thirst, allowing people to become dehydrated under its influence. It increases the amount of serotonin in the brain, producing euphoria, and/or anxiety and **paranoia**. After the drug wears off, temporarily decreased serotonin levels may leave users feeling depressed for days or even weeks.

MDMA is generally taken in doses of 125 milligrams, although effects are observable with as little as 60 milligrams. It is generally taken as tablets or capsules. Effects begin about an hour after ingestion, peak in three or four hours, and fade after six hours. Some users take a second dose to prolong the effects.

Dangers associated with Ecstasy include increased body temperature, complicated by excess physical activities such as dancing or immersion in hot tubs or saunas. **Dehydration**, increased heart rate and blood pressure are common. Because of its effects on serotonin in the brain, long-term Ecstasy users may have decreased memory. Other dangers include mixing the drug with alcohol, methamphetamine, or **cocaine**. People with heart problems, high blood pressure, or psychological disorders are at greater risk from taking this drug.

LSD (lysergic acid, acid) is a potent mood-changing drug that produces unpredictable effects, depending on the amount taken and the personality of the user. Effects range from euphoria to panic with intense hallucinations. Dangers associated with long term use of this drug include flash backs and **psychosis**.

Rohypnol (flunitrazepam, roofie) is a powerful sedative that is related to the sedative-tranquilizers, Valium and Xanax. It has been termed a "date rape" drug because it can cause "anterograde amnesia": those taking the substance may lose memory of events occurring under its effects. It is particularly dangerous to take Rohypnol with alcohol or other sedatives.

GHB (gamma hydroxybutyrate) is a substance with euphoric and depressant effects. There is a narrow range between safe, recreational use of GHB, overdose, producing **coma** or seizures, and life-threatening toxic dose.

Ketamine (special K, Vitamin K) is legitimately used as an animal tranquilizer. It can be taken orally, inhaled through the nose, or given intravenously and creates a sense of mind-body separation that can be experienced either pleasantly or as panic.

Methamphetamine (meth, crystal, speed, crank) is a dangerously addictive stimulant. Taken orally, inhaled through the nose, or given intravenously, it produces an intense rush of euphoric stimulation followed by an overwhelming desire for more drug. It increases heart rate and blood pressure and may lead to **heart attack**, **heart failure**, and **death**. Research has shown that it damages brain cells that produce dopamine and serotonin, contributors to pleasure, memory and motivation. Prolonged or excessive use of methamphetamine can slow thinking, depress mood, and impair muscle strength and coordination. Emotional problems associated with the use of methamphetamine include **addiction**, paranoia, anxiety, and **insomnia**. Methamphetamine use has been growing in the United States throughout the 2000s.

Diagnosis

Substance abuse is defined by the *Diagnostic and Statistical Manual IV* as occurring when: users take a substance in larger amounts or over longer time periods than intended; a persistent and unsuccessful desire to cease usage; spending large quantities of time procuring the substance; reduction in other social activities; continued use of a substance despite physical or emotional

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KEY TERMS

Hallucinogen—Substance that causes distorted perceptions and/or unreal dreams.

Neurotransmitter—Chemical in the brain that assists brain function.

Psychoactive—Substance that effects emotional and psychological perception in the brain.

problems caused by the substance; increased tolerance of the substance; withdrawal symptoms or increased use of a substance to avoid withdrawal symptoms.

Treatment

Treatment for problems associated with the use and **abuse** of club drugs include psychiatric, psychological, and substance abuse counseling, as well as emergency medical treatment for overdoses and complications.

Resources

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Swarts, Katherine. *Club Drugs*. Farmington Hills, MI: Greenhaven Press, 2006.

ORGANIZATIONS

DanceSafe, 536 45th Ave., Oakland, CA, 94609, http://www.dancesafe.org.

Multidisciplinary Association for Psychedelic Studies, 309 Cedar Street No. 2323, Santa Cruz, CA, 95060, (831) 429-6362, (831) 429-6370, http://www.maps.org.

National Institute on Drug Abuse, 6001 Executive Blvd., Room 5213, Bethesda, MD, (301) 443-1124, informa tion@ nida.nih.gov, http://drugabuse.gov.

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Clubfoot

Definition

Clubfoot is a condition in which one or both feet are twisted into an abnormal position at birth. The condition is also known as talipes or talipes equinovarus.

Person suffering from clubfoot. About one in every 1,000 newborns has some form of this birth defect. *(Photo Researchers, Inc.)*

Description

True clubfoot is characterized by abnormal bone formation in the foot. There are four variations of clubfoot, including talipes varus, talipes valgus, talipes equines, and talipes calcaneus. In talipes varus, the most common form of clubfoot, the foot generally turns inward so that the leg and foot look somewhat like the letter J. In talipes valgus, the foot rotates outward like the letter L. In talipes equinus, the foot points downward, similar to that of a toe dancer. In talipes calcaneus, the foot points upward, with the heel pointing down.

Clubfoot can affect one foot or both. Sometimes an infant's feet appear abnormal at birth because of the intrauterine position of the fetus birth. If there is no anatomic abnormality of the bone, this is not true clubfoot, and the problem can usually be corrected by applying special braces or casts to straighten the foot.

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The ratio of males to females with clubfoot is 2.5 to 1. The incidence of clubfoot varies only slightly. In the United States, the incidence is approximately 1 in every 1,000 live births. A 1980 Danish study reported an overall incidence of 1.20 in every 1,000 children; by 1994, that number had doubled to 2.41 in every 1,000 live births. No reason was offered for the increase.

Causes and symptoms

Experts do not agree on the precise cause of clubfoot. The exact genetic mechanism of inheritance has been extensively investigated using family studies and other epidemiological methods. No definitive conclusions have been reached as of the early 2000s, although a Mendelian pattern of inheritance is suspected. This may be due to the interaction of several different inheritance patterns, different patterns of development appearing as the same condition, or a complex interaction between genetic and environmental factors. The MSX1 gene has been associated with clubfoot in animal studies. As of the early 2000s, however, these findings have not been replicated in humans.

A family history of clubfoot has been reported in 24.4% of families in a single study. These findings suggest the potential role of one or more genes being responsible for clubfoot.

Several environmental causes have been proposed for clubfoot. Obstetricians feel that intrauterine crowding causes clubfoot. This theory is supported by a significantly higher incidence of clubfoot among twins compared to singleton births. Intrauterine exposure to the drug misoprostol has been linked with clubfoot. Misoprostol is commonly used when trying, usually unsuccessfully, to induce abortion in Brazil and in other countries in South and Central America. Researchers in Norway have reported that males who are in the printing trades have significantly more offspring with clubfoot than men in other occupations. For unknown reasons, **amniocentesis**, a prenatal test, has also been associated with clubfoot. One international study published in 2004 reported that amniocentesis done at 13 weeks of gestation was associated with a fourfold increase in the risk of clubfoot. The infants of mothers who smoke during **pregnancy** have a greater chance of being born with clubfoot than are offspring of women who do not smoke.

True clubfoot is usually obvious at birth. The four most common varieties have been described. A clubfoot has a typical appearance of pointing downward and being twisted inwards. Since the condition starts in the first trimester of pregnancy, the abnormality is quite well established at birth, and the foot is often very rigid. Uncorrected clubfoot in an adult causes only part of the foot, usually the outer edge, or the heel or the toes, to touch the ground. For a person with clubfoot, walking becomes difficult or impossible.

Diagnosis

True clubfoot is usually recognizable and obvious on **physical examination**. A routine x ray of the foot that shows the bones to be malformed or misaligned supplies a confirmed diagnosis of clubfoot. Ultrasonography is not always useful in diagnosing the presence of clubfoot prior to the birth of a child; however, ultrasound is increasingly used in the early 2000s to evaluate the severity of clubfoot after birth and monitor its response to treatment.

Treatment

Most orthopedic surgeons agree that the initial treatment of congenital (present at birth) clubfoot should be nonoperative. Nonsurgical treatment should begin in the first days of life to take advantage of the favorable fibroelastic properties of the foot's connective tissues, those forming the ligaments, joint capsules, and tendons. In a common treatment, a series of casts is applied over a period of months to reposition the foot into normal alignment. In mild cases, splinting and wearing braces at night may correct the abnormality.

Another treatment for clubfoot is the Ilizarov frame, named for the Russian physician who developed it in 1951. The Ilizarov frame has been used in the United States and Canada since 1981. It consists of two metal rings that encircle the leg to be corrected, wires that attach the rings to the bone, and metal rods between the rings that can be extended like a telescope. The frame must be applied by an orthopedic surgeon. After a week, the surgeon begins to lengthen the rods, usually at the rate of 1 mm per day. The frame must be kept in place for several months. Although the Ilizarov frame is somewhat cumbersome, it has been reported as giving satisfactory results in straightening clubfeet, particularly those untreated in infancy.

When clubfoot is severe enough to require surgery, the condition is usually not completely correctable, although significant improvement is possible. In the most severe cases, surgery may be required, especially when the Achilles tendon, which joins the muscles in the calf to the bone of the heel, needs to be lengthened. Because an early operation induces fibrosis, a scarring and stiffness of the tissue, surgery should be delayed until an affected child is at least three months old.

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KEY TERMS

Enterovirus—Any of a group of viruses that primarily affect the gastrointestinal tract.

Ilizarov frame—A device invented by a Russian physician for correcting deformities of the legs and feet, consisting of rings to be attached to the bone and rods extending between the rings that stretch the affected limb.

Intrauterine—Situated or occuring in the uterus.

Orthopedist—A doctor specializing in treatment of the skeletal system and its associated muscles and joints.

Much of a clubfoot abnormality can be corrected by the use of manipulation and casting during the first three months of life. Proper manipulative techniques must be followed by applications of appropriately molded plaster casts to provide effective and safe correction of most varieties of clubfoot. Long-term care by an orthopedist is required after initial treatment to ensure that the correction of the abnormality is maintained. Exercises, corrective shoes, or nighttime splints may be needed until the child stops growing.

Prognosis

With prompt, expert treatment, clubfoot is usually correctable. One group of French researchers found that 77% of the children they followed over a period of 11 to 18 years had good results from nonsurgical methods of treatment combined with **physical therapy**. Most individuals are able to wear regular shoes and lead active lives. If clubfoot is not appropriately treated, however, the abnormality may become fixed. This fixation affects the growth of the child's leg and foot, and some degree of permanent disability usually results.

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ORGANIZATIONS

Easter Seals Disability Services, 233 South Wacker Drive, Suite 2400, Chicago, IL, 60606, (312) 726-6200, (312) 726-1494, (800) 221-6827, http://www.easterseals.com.

March of Dimes Birth Defects Foundation, 1275 Mamaroneck Ave., White Plains, NY, 10605, (914) 997-4488, http://www.modimes.org.

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923, (800) 999-6673, http://www.rarediseases.org.

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Cluster headache

Definition

Cluster headaches are characterized by an intense one-sided **pain** centered by the eye or temple. The pain lasts for one to two hours on average and may recur several times in a day.

Description

Cluster headaches have been known as histamine headaches, red migraines, and Horton's disease, among others. The constant factor is the pain, which transcends by far the distress of the more common tension-type **headache** or even that of a **migraine headache**.

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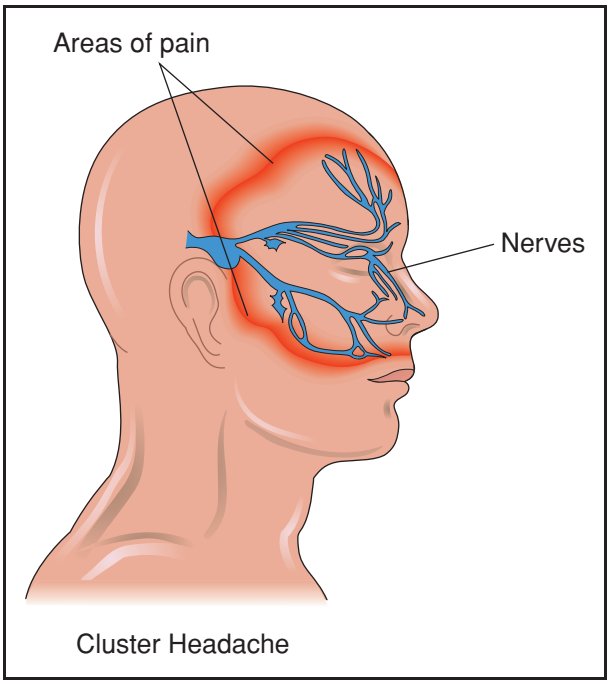

The primary cluster headache symptom is excruciating one-sided head pain located behind an eye or near the temple. Secondary symptoms include eye tearing, nasal congestion, and a runny nose. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Cluster headaches afflict less than 0.5% of the population and predominantly affect men; approximately 80% of sufferers are male. Onset typically occurs in the late 20s, but there is no absolute age restriction. Approximately 80% of cluster headaches are classified as episodic; the remaining 20% are considered chronic. Both display the same symptoms. However, episodic cluster headaches occur during one- to five-month periods followed by 6- to 24-month attack-free, or remission, periods. There is no such reprieve for chronic cluster headache sufferers.

Causes and symptoms

Biochemical, hormonal, and vascular changes induce cluster headaches, but why these changes occur remains unclear. Episodic cluster headaches seem to be linked to changes in day length, possibly signaling a connection to the so-called biological clock. Alcohol, tobacco, histamine, or **stress** can trigger cluster headaches. Decreased blood oxygen levels (hypoxemia) can also act as a trigger, particularly during the night when an individual is sleeping. Interestingly, the triggers do not cause cluster headaches during remission periods.

The primary cluster headache symptom is excruciating one-sided head pain centered behind an eye or near the temple. This pain may radiate outward from the initial focus and encompass the mouth and teeth. For this reason, some cluster headache sufferers may mistakenly attribute their pain to a dental problem. Secondary symptoms, occurring on the same side as the pain, include eye tearing, nasal congestion followed by a runny nose, pupil contraction, and facial drooping or flushing.

Diagnosis

Cluster headache symptoms guide the diagnosis. A medical examination includes recording headache details, such as frequency and duration, when it occurs, pain intensity and location, possible triggers, and any prior symptoms. This history allows other potential problems to be discounted.

Treatment

Treatment for cluster headaches is composed of induction, maintenance, and symptomatic therapies. The first two therapies are prophylactic treatments, geared toward preventing headaches. Symptomatic therapy is meant to stop or shorten a headache.

Induction and maintenance therapies begin together. Induction therapy is intended to break the headache cycle with drugs such as **corticosteroids** (for example, prednisone) or dihydroergotamine. These drugs are not meant for long-term therapy, but rather as a jump-start for maintenance therapy. Maintenance therapy drugs include verapamil, lithium carbonate, ergotamine, and methysergide. These drugs have long-term effectiveness, but must be taken for at least a week before a response is observed. With long-term treatment, methysergide must be stopped for one month each year to avoid dangerous side effects (formation of fibrous tissue inside the abdominal artery, lungs, and heart valves).

Despite prophylactic treatment, headaches may still occur. Symptomatic therapy includes oxygen inhalation, sumatriptan injection, and application of local anesthetics inside the nose. Surgery is a last resort for chronic cluster headaches that fail to respond to therapy.

Alternative treatment

Since some cluster headaches are triggered by stress, **stress reduction** techniques, such as **yoga**, **meditation**, and regular **exercise**, may be effective. Some cluster headaches may be an allergic response triggered by food or environmental substances, therefore

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KEY TERMS

Biological clock—A synonym for the body's circadian rhythm, the natural biological variations that occur over the course of a day.

Migraine headache—An intense throbbing pain that occurs on one or both sides of the head. The headache is usually accompanied by other symptoms, such as nausea, vomiting, and aversion to light.

Prophylactic—Referring to treatment that prevents symptoms from occurring.

Tension-type headache—A dull pain that seems to exert pressure on the head; the most common form of headache.

identifying and removing the allergen(s) may be key to resolution of the problem. Histamine is another suspected trigger of cluster headaches, and this response may be controlled with vitamin C and the bioflavonoids quercetin and bromelain (pineapple enzyme). Supplementation with essential fatty acids (EFA) will help decrease any inflammatory response.

Physical medicine therapies such as adjustments of the spine, craniosacral treatment, and massage at the temporomandibular joint (TMJ) can clear blockages, as can traditional Chinese medical therapies including **acupuncture**. Homeopathic treatment can also be beneficial. Nervous system relaxant herbs, used singly or in combination, can allow the central nervous system to relax as well as assist in peripheral nerve response. A few herbs to consider for relaxation are valerian (*Valeriana officinalis*), chamomile (*Matricaria recutita*), rosemary (*Rosemarinus officinalis*), and skullcap (*Scutellaria baicalensis*).

Prognosis

In general, drug therapy offers effective treatment.

Prevention

Avoiding triggers, adhering to medical treatment, and controlling stress can help ward off some cluster headaches.

ORGANIZATIONS

American Council for Headache Education (ACHE), 19 Mantua Road, Mount Royal, NJ, 08061, (856) 423-0043, (858) 423-0082, achehq@talley.com, http://www.achenet.org.

National Headache Foundation, 820 N. Orleans, Suite 217, Chicago, IL, 60610, (312), 274-2650, (888), NHF-5552, info@headaches.org, http://www.headaches.org.

Julia Barrett

CMV *see* **Cytomegalovirus infection**

CNS depressants *see* **Central nervous system depressants**

CNS stimulants *see* **Central nervous system stimulants**

Coagulation disorders

Definition

Coagulation disorders deal with disruption of the body's ability to control blood clotting. The most commonly known coagulation disorder is **hemophilia**, a condition in which patients bleed for long periods of time before clotting. There are other coagulation disorders with a variety of causes.

Description

Coagulation, or clotting, occurs as a complex process involving several components of the blood. Plasma, the fluid component of the blood, carries a number of proteins and coagulation factors that regulate bleeding. Platelets, small colorless fragments in the blood, initiate contraction of damaged blood vessels so that less blood is lost. They also help plug damaged blood vessels and work with plasma to accelerate blood clotting. A disorder affecting platelet production or one of the many steps in the entire process can disrupt clotting.

Coagulation disorders arise from different causes and produce different complications. Some common coagulation disorders are:

- Hemophilia, or hemophilia A (Factor VIII deficiency), an inherited coagulation disorder, affects about 20,000 Americans. This genetic disorder is carried by females but most often affects males.
- Christmas disease, also known as hemophilia B or Factor IX deficiency, is less common than hemophilia A with similar in symptoms.
- Disseminated intravascular coagulation disorder, also known as consumption coagulopathy, occurs as a result of other diseases and conditions. This disease accelerates clotting, which can actually cause hemorrhage.

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- Thrombocytopenia is the most common cause of coagulation disorder. It is characterized by a lack of circulating platelets in the blood. This disease also includes idiopathic thrombocytopenia.
- Von Willebrand's disease is a hereditary disorder with prolonged bleeding time due to a clotting factor deficiency and impaired platelet function. It is the most common hereditary coagulation disorder.
- Hypoprothrombinemia is a congenital deficiency of clotting factors that can lead to hemorrhage.
- Other coagulation disorders include Factor XI deficiency, also known as hemophilia C, and Factor VII deficiency. Hemophilia C afflicts one in 100,000 people and is the second most common bleeding disorder among women. Factor VII is also called serum prothrombin conversion accelerator (SPCA) deficiency. One in 500,000 people may be afflicted with this disorder that is often diagnosed in newborns because of bleeding into the brain as a result of traumatic delivery.

Causes and symptoms

Some coagulation disorders present symptoms such as severe bruising. Others will show no apparent symptoms, but carry the threat of severe internal bleeding.

Hemophilia

Because of its hereditary nature, hemophilia A may be suspected before symptoms occur. Some signs of hemophilia A are numerous large, deep **bruises** and **pain** and swelling of joints caused by internal bleeding. Patients with hemophilia do not bleed faster, just longer. A person with mild hemophilia may first discover the disorder with prolonged bleeding following a surgical procedure. If there is bleeding into the neck, head, or digestive tract, or bleeding from an injury, emergency measures may be required.

Mild and severe hemophilia A are inherited through a complex genetic system that passes a recessive gene on the female chromosome. Women usually do not show signs of hemophilia but are carriers of the disease. Each male child of the carrier has a 50% chance of having hemophilia, and each female child has a 50% chance of passing the gene on.

Christmas disease

Christmas disease, or hemophilia B, is also hereditary but less common than hemophilia A. The severity of Christmas disease varies from mild to severe, although mild cases are more common. The severity depends on the degree of deficiency of the Factor IX (clotting factor). Hemophilia B symptoms are similar to those of hemophilia A, including numerous, large and deep bruises and prolonged bleeding. The more dangerous symptoms are those that represent possible internal bleeding, such as swelling of joints, or bleeding into internal organs upon trauma. Hemophilia most often occurs in families with a known history of the disease, but occasionally, new cases will occur in families with no apparent history.

Disseminated intravascular coagulation

The name of this disorder arises from the fact that malfunction of clotting factors cause platelets to clot in small blood vessels throughout the body. This action leads to a lack of clotting factors and platelets at a site of injury that requires clotting. Patients with disseminated intravascular coagulation (DIC) will bleed abnormally even though there is no history of coagulation abnormality. Symptoms may include minute spots of hemorrhage on the skin, and purple patches or hematomas caused by bleeding in the skin. A patient may bleed from surgery or intravenous injection (IV) sites. Related symptoms include **vomiting**, seizures, **coma**, **shortness of breath**, **shock**, and severe pain in the back, muscles, abdomen, or chest.

DIC is not a hereditary disorder or a common one. It is most commonly caused by complications during **pregnancy** or delivery, overwhelming infections, acute leukemia, metastatic **cancer**, extensive **burns** and trauma, and even snakebites. There are a number of other causes of DIC, and it is not commonly understood why or how these various disorders can lead to the coagulation problem. What the underlying causes of DIC have in common is some factor that affects proteins, platelets, or other clotting factors and processes. For example, uterine tissue can enter the mother's circulation during prolonged labor, introducing foreign proteins into the blood, or the venom of some exotic snakes can activate one of the clotting factors. Severe head trauma can expose blood to brain tissue. No matter the cause of DIC, the results are a malfunction of thrombin (an enzyme) and prothrombin (a glycoprotein), which activate the fibrinolytic system, releasing clotting factors in the blood. DIC can alternate from hemorrhage to thrombosis, and both can exist, which further complicates diagnosis and treatment.

Thrombocytopenia

Thrombocytopenia may be acquired or congenital. It represents a defective or decreased production of platelets. Symptoms include sudden onset of small spots of hemorrhage on the skin, or bleeding into mucous membranes (such as nosebleeds). The

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disorder may also be evident as blood in vomit or stools, bleeding during surgery, or heavy menstrual flow in women. Some patients show none of these symptoms, but complain of **fatigue** and general weakness. There are several causes of thrombocytopenia, which is more commonly acquired as a result of another disorder. Common underlying disorders include leukemia, drug toxicity, or **aplastic anemia**, all of which lead to decreased or defective production of platelets in the bone marrow. Other diseases may destroy platelets outside the marrow. These include severe infection, disseminated intravascular coagulation, and **cirrhosis** of the liver. The idiopathic form most commonly occurs in children, and is most likely the result of production of antibodies that cause destruction of platelets in the spleen and to a lesser extent the liver.

Von Willebrand's disease is caused by a defect in the Von Willebrand clotting factor, often accompanied by a deficiency of Factor VIII as well. It is a hereditary disorder that affects both males and females. In rare cases, it may be acquired. Symptoms include easy bruising, bleeding in small cuts that stops and starts, abnormal bleeding after surgery, and abnormally heavy menstrual bleeding. Nosebleeds and blood in the stool with a black, tarlike appearance are also signs of Von Willebrand's disease.

Hypoprothrombinemia

This disorder is a deficiency in prothrombin, or Factor II, a glycoprotein formed and stored in the liver. Prothrombin, under the right conditions, is converted to thrombin, which activates fibrin and begins the process of coagulation. Some patients may show no symptoms, and others will suffer severe hemorrhaging. Patients may experience easy bruising, profuse nosebleeds, postpartum hemorrhage, excessively prolonged or heavy menstrual bleeding, and postsurgical hemorrhage. Hypoprothrombinemia may also be acquired rather than inherited, and usually results from a **Vitamin K deficiency** caused by liver diseases, newborn hemorrhagic disease, or a number of other factors.

Other coagulation disorders

Factor XI deficiency, or hemophilia C, occurs more frequently among certain ethnic groups, with an incidence of about one in 10,000 among Ashkenazi Jews. Nearly 50% of patients with this disorder experience no symptoms, but others may notice blood in their urine, nosebleeds, or bruising. Although joint bleeding seldom occurs, some factor XI patients will experience bleeding long after an injury occurs. Some women will experience prolonged bleeding after **childbirth**. Patients with factor VII deficiency vary greatly in their bleeding severity. Women may experience heavy menstrual bleeding, bleeding from the gums or nose, bleeding deep within the skin, and episodes of bleeding into the stomach, intestine, and urinary tract. Factor VII patients may also suffer bleeding into joints.

Diagnosis

Several blood tests can be used to detect various coagulation disorders. There are hundreds of different tests a doctor can order to look for indications of specific diseases. In addition to blood tests, physicians will complete a medical history and **physical examination**. In the case of acquired coagulation disorders, information such as prior or current diseases and medications will be important in determining the cause of the blood disorder.

- Hemohilia A will be diagnosed with laboratory tests detecting presence of clotting factor VIII, factor IX, and others, as well as the presence or absence of clotting factor inhibitors.
- Christmas disease will be checked against normal bleeding and clotting time, as well as for abnormal serum reagents in factor IX deficiency. Other tests of prothrombin time and thromboplastic generation may also be ordered.
- There is no one test or group of tests that can always make (or exclude) a diagnosis of DIC. DIC can be diagnosed through a number of laboratory tests that measure concentration of platelets and fibrinogen in the blood with normal counts and prolonged prothrombin time. Other supportive data include diminished levels of factors V, fibrinogen, and VIII, decreased hemoglobin, and others. Since many of the test results also indicate other disorders, the physician may have to put together several results to reach a diagnosis of DIC. Serial tests may also be recommended, because a single examination at one moment in time may not reveal the process that is occurring.
- Tests for thrombocytopenia include coagulation tests revealing a decreased platelet count, prolonged bleeding time, and other measurements. If these tests indicate that platelet destruction is causing the disorder, the physician may order bone marrow examination.
- Von Willebrand's disease will be diagnosed with the assistance of laboratory tests which show prolonged bleeding time, absent or reduced levels of factor VIII, normal platelet count, and others.

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- Hypothrombinemia is diagnosed with history information and the use of tests that measure vitamin K deficiency, deficiency of prothrombin, and clotting factors V, VII, IX, and X.
- Factor XI deficiency is diagnosed most often after injury-related bleeding. Blood tests can help pinpoint factor VII deficiency.

Treatment

In mild cases, treatment may involve the use of drugs that stimulate the release of deficient clotting factors. In severe cases, bleeding may only stop if the clotting factor that is missing is replaced through infusion of donated human blood in the form of fresh frozen plasma or cryoprecipitate.

- Hemophilia A in mild episodes may require infusion of a drug called desmopressin or DDAVP. Severe bleeding episodes will require transfusions of human blood clotting factors. Hemophiliacs are encouraged to receive physical therapy to help damaged joints and to exercise in non-contact sports such as swimming, bicycle riding, or walking.
- Christmas disease patients are treated similarly to hemophilia A patients. There are commercial products and human blood products available to provide coagulation. Cryoprecipitate was invented in 1965 to replace the need for whole plasma transfusions, which introduced more volume than needed. By the 1970s, people were able to infuse themselves with freeze-dried clotting factor. Superficial wounds can be cleaned and bandaged. Parents of hemophiliac children receiving immunizations should inform the vaccination provider in advance to decrease the possibility of bleeding problems. These children should probably not receive injections that go into the muscle.
- Treatment for disseminated intravascular coagulation patients is complicated by the large variety of underlying causes of the disorder. If at all possible, the physician will first treat this underlying disorder. If the patient is not already bleeding, this supportive treatment may eliminate the DIC. However, if bleeding is occurring, the patient may need blood, platelets, fresh frozen plasma, or other blood products. Heparin has been controversial in treating DIC, but it is often used as a last resort to stop hemorrhage. Heparin has not proven useful in treating patients with DIC resulting from heat stroke, exotic snakebites, trauma, mismatched transfusions, and acute problems resulting from obstetrical complications.
- Secondary acquired thrombocytopenia is best alleviated by treating the underlying cause or disorder. The specific treatment may depend on the underlying cause. Sometimes, corticosteroids or immune globulin may be given to improve platelet production.
- Von Willebrand's disease is treated by several methods to reduce bleeding time and to replace factor VIII, which consequently will replace the Von Willebrand factor. This may include infusion of cryoprecipitate or fresh frozen plasma. Desmopressin may also help raise levels of the Von Willebrand factor.
- Hypoprothrombinemia may be treated with concentrates of prothrombin. Vitamin K may also be produced, and in bleeding episodes, the patient may receive fresh plasma products.
- Factor XI (hemophilia C) is most often treated with plasma, since there are no commercially available concentrates of factor XI in the United States. Factor VII patients may be treated with prothrombin complex concentrates. As of early 1998, factor VII concentrate was not licensed in the United States and could only be used with special permission.

Alternative treatment

This can be a very severe condition and should be managed by a practitioner of alternative medicine in conjunction with a medical doctor; this condition should not be self managed. For patients known to suffer from hemophilia A or B and other bleeding disorders, avoidance of activities that can cause severe injury should be practiced. Comprehensive care addresses the whole person by helping to deal with the psychosocial aspects of the disease.

Prognosis

The prognosis for patients with mild forms of coagulation disorders is normally good. Many people can lead a normal life and maintain a normal life expectancy. Without treatment of bleeding episodes, severe muscle and joint pain, and, eventually, damage can occur. Any incident that causes blood to collect in the head, neck, or digestive system can be very serious and requires immediate attention. DIC can be severe enough to cause clots to form and a **stroke** could occur. DIC is also serious enough to cause **gangrene** in the fingers, nose, or genitals. The prognosis depends on early intervention and treatment of the underlying condition. Hemorrhage from a coagulation disorder, particularly into the brain or digestive track, can prove fatal. In the past, patients who received regular transfusions of human blood products were subject to increased risk of **AIDS** and other diseases. However, efforts have been made since the early 1990s to ensure the safety of the blood supply.

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KEY TERMS

Clotting factor—Also known as coagulation factors. Proteins in the plasma that serve to activate various parts of the blood clotting process by being transformed from inactive to active form.

Enzyme—A substance that causes a chemical reaction, usually a protein. Enzymes are secreted by cells.

Hemorrhage—Abnormal bleeding from the blood vessels.

Heparin—An anticoagulant, or blood clot "dissolver."

Idiopathic—Refers to a disease of unknown cause, and sometimes to a primary disease.

Metastatic—The term used to describe a secondary cancer, or one that has spread from one area of the body to another.

Serum reagents—Serum is fluid, or the fluid portion of the blood retained after removal of the blood cells and fibrin clot. Reagents are substances added to the serum to produce a chemical reaction.

Thrombosis—Formation of a clot in the blood that either blocks, or partially blocks a blood vessel. The thrombus may lead to infarction, or death of tissue, due to a blocked blood supply.

Prevention

Prevention of coagulation disorders varies. Acquired disorders may only be prevented by preventing onset of the underlying disorder (such as cirrhosis). Hereditary disorders can be predicted with prenatal testing and **genetic counseling**. Prevention of severe bleeding episodes may be accomplished by refraining from activities that could cause injury, such as contact sports. Open communication with healthcare providers prior to procedures or tests that could cause bleeding may prevent a severe bleeding incident.

ORGANIZATIONS

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

National Hemophilia Foundation, 116 West 32nd St., 11th Floor, New York, NY, 10001, (212) 328-3700, (212) 328-3777, http://www.hemophilia.org.

Teresa Odle

Coagulopathies *see* **Coagulation disorders**

Coal miner's disease *see* **Black lung disease**

Coal worker's pneumoconiosis *see* **Black lung disease**

Coarctation of the aorta

Definition

Coarctation of the aorta (CoA) is a defect that develops in the fetus in which there is a narrowing of the aortic arch, the main artery that delivers blood from the left ventricle of the heart to the rest of the body. The word *coarctation* by itself means a narrowing or constriction. Coarctation of the aorta is diagnosed in both newborns and adults.

Demographics

Coarctation of the aorta is a relatively common congenital heart defect; it is found in 6–8% of infants with **congenital heart disease**. It is more common in boys, the male:female ratio being 2:1. Although researchers are still studying data related to race and ethnicity, there is some evidence that Asian babies are 2% less likely to have CoA than babies born in Europe, North America, or South America. In the United States, Native Americans have a lower rate of CoA than other racial and ethnic groups. The reason for these differences is not known as of 2010.

Description

In humans, blood leaves the heart by way of the left ventricle and is distributed to the body by arteries. The aortic arch is the first artery to carry blood as it leaves the heart. Other arteries to the head and arms branch off the aortic arch. A narrowing of the aorta at any spot produces resistance to the flow of blood. This causes high blood pressure before the narrowing and low pressure below the narrowing (downstream). Parts of the body supplied by arteries that branch off the aortic arch before the narrowing have high blood pressure, while most of the lower body does not receive enough blood supply. Thus people with CoA have **hypertension** in their arms but low blood pressure in the legs and ankles. To compensate for the coarctation, the heart works harder, and the blood pressure rises.

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KEY TERMS

Anastomosis—A type of surgical procedure in which the surgeon joins together two parts of a hollow organ (such as a blood vessel or portion of the intestine) after a diseased or damaged section has been removed.

Aorta—The largest artery in the body, arising from the left ventricle (lower chamber) of the heart and extending down into the abdomen.

Coarctation—The medical term for a constriction or narrowing.

Congenital—Present at birth.

Ductus arteriosus—A blood vessel in the human fetus that connects the aortic arch to the pulmonary artery before birth and normally closes shortly after birth in healthy newborns.

Dyspnea—Difficulty in breathing. Usually associated with heart or lung diseases.

Electrocardiogram—A graph of the heart's beating produced by an instrument that detects the electrical signals made by the heart.

Gallop rhythm—An abnormal heart rhythm in which the doctor can hear three (sometimes four) sounds instead of the usual two, resembling the rhythm of a horse's gallop.

Hypertension—High blood pressure.

Notching—A deformity of the surface of the ribs that is often associated with coarctation of the aorta.

Turner syndrome—A genetic disorder that affects only females, in which one of the two X chromosomes that determine female sex is missing or otherwise abnormal.

Ventricular septal defect (VSD)—A defect or opening in the ventricular septum, the wall of tissue that separates the two lower chambers of the heart.

There are three basic forms of CoA, defined by the location of the constriction or narrowing with regard to the ductus arteriosus, a blood vessel that connects the aortic arch and the pulmonary artery in the developing fetus. The purpose of this vessel is to bypass the lungs in the fetus, which are still filled with fluid. The ductus arteriosus normally closes shortly after birth when the newborn begins to breathe. Coarctation of the aorta may occur at the point where the ductus arteriosus enters the aorta (ductal); before that point (preductal); or below that point (postductal):

- Ductal coarctation: This form of CoA usually first appears when the ductus arteriosus closes after birth.
- Preductal: This form of CoA is potentially life-threatening, as closure of the ductus arteriosus after birth may close off blood flow to the lower body.
- Postductal: This is the form of CoA most often seen in adults. It is associated with notching of the ribs, high blood pressure in the arms, and weak pulses in the legs.

The internal appearance of the narrowed part of the aorta varies somewhat from patient to patient. In some, the coarctation is localized whereas in others the narrowing involves a longer section of the aorta. The coarctation may look like a shelf of tissue partially closing off the aorta, or it may resemble a curtain or membrane with an irregular opening in the middle.

Risk factors

There are two major risk factors for coarctation of the aorta:

- The presence of one or more other heart defects, particularly ventricular septal defect, patent ductus arteriosus, or abnormalities of the bicuspid, mitral, or aortic valves in the heart.
- In females, Turner syndrome. Turner syndrome is a genetic disorder in which a girl or woman has only one of the two X chromosomes that determine female sex.

Causes and symptoms

In newborns with congenital heart disease, coarctation of the aorta develops while the baby is in the womb. The exact cause or trigger of the abnormal development is not completely understood as of 2010. In rare cases, CoA can develop in adolescents or adults as a result of severe trauma, severe hardening of the arteries, or a rare disorder causing inflammation of the arteries known as Takayasu's arteritis.

Among the consequences of coarctation of the aorta is ventricular hypertrophy, an enlarging of the left ventricle in response to the increased back pressure of the blood and the demand for more blood by the body. Symptoms in infants include **shortness of breath** (dyspnea), difficulty in feeding, pale skin, heavy sweating, and poor weight gain. Older children may develop measurable hypertension; they may also display **fatigue**, shortness of breath, cold feet, headaches, nosebleeds, or a feeling of lameness in their legs.

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Diagnosis

Children or adults with any of the following symptoms should see a doctor at once. Although these symptoms may have causes other than CoA, it is best to be checked, because early detection of CoA can be life-saving:

- Fainting
- Severe pains in the chest
- Shortness of breath
- Unexplained high blood pressure.

The initial diagnosis of CoA is often made by the infant or child's pediatrician, but in most cases the child will be referred to a pediatric cardiologist (heart specialist) for further evaluation. Approximately half of all infants with coarctation of the aorta are diagnosed within the first two months of life; however, the diagnosis is often missed during the first year. One study found that the average age of children referred to a pediatric cardiologist for treatment of CoA was 5 years. Frequently, there are other congenital cardiac complications present. The most common defects associated with coarctation of the aorta are **patent ductus arteriosus** (a ductus arteriosus that fails to close) and **ventricular septal defect** (VSD). In general, the younger the infant at the time of diagnosis, the greater the risk that he or she has other heart defects. Female infants with **Turner syndrome** have a 10% rate of also having coarctation. There is evidence that some cases of coarctation may be inherited.

Examination

Abnormal blood pressure readings can be detected during a **physical examination** in the doctor's office, as can abnormal heart rhythms. Infants with CoA usually have an abnormal "gallop" heart rhythm and may also have **heart murmurs**. Sometimes excessive arterial pulses can be seen in the carotid and suprasternal notch arteries, indicating increased pressure in these arteries, while the femoral pulse is weak or cannot be detected. The systolic pressure is higher in the arms than in the legs. Similar symptoms are seen in older children and adults. A 10 mm Hg (mercury) pressure difference between the upper and lower extremities is diagnostic for coarctation of the aorta. For some patients, the systolic pressure difference is observed only during **exercise**. Infants frequently have an abnormal electrocardiogram (ECG) that indicates that the right or both ventricles are enlarged, while in older children the ECG may be normal or show that the left ventricle is enlarged.

Tests

The doctor may also order imaging tests to evaluate any structural abnormalities in the heart and aorta. Enlargement of the heart can be seen in x rays. The coarctation may also be detected in echocardiographic examination or **magnetic resonance imaging** (MRI).

Procedures

In some cases the doctor may recommend **cardiac catheterization**. This is a procedure in which a long thin flexible tube called a catheter is threaded upward through an artery or vein in the leg until it reaches the heart. A dye is injected into the catheter in order to make the abnormalities in the aorta visible on x-ray. Cardiac catheterization helps doctors evaluate the location and severity of the CoA.

Treatment

Traditional

Drugs can be used to treat hypertension and **heart failure** while the patient is being evaluated for surgery. Surgery is recommended for infants with other associated cardiac defects and for those infants not responding to drug therapy. Surgery is indicated for infants that don't require immediate surgery, but who develop severe hypertension during the first several months of life. Patients are advised to avoid vigorous exercise prior to surgical correction of the coarctation. Recoarctation can occur in some patients even if they have had surgery; however, recoarctation can also be corrected by surgery.

Surgery

The first successful surgical correction of CoA was performed by a Swedish surgeon named Clarence Crafoord (1899–1983) in 1944. As of 2010, there are four major types of open-heart procedures used to repair CoAs in children:

- Resection and anastomosis. The surgeon removes the narrowed section of the aorta and reconnects the two ends of the blood vessel.
- Patch aortoplasty. The surgeon cuts across the narrowed section of the aorta and attaches a patch of synthetic material to widen the blood vessel.
- Flap angioplasty. The surgeon removes a portion of the left subclavian artery (the artery that carries blood to the left arm) and uses it to widen the narrowed portion of the aorta.

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- Bypass graft. The surgeon inserts a plastic tube called a graft between the normal portions of the aorta, bypassing the coarctation.

Drugs

Medication cannot be used to treat CoA, but it can be used to control the patient's blood pressure before surgery. Some people may also have to take blood pressure drugs after corrective surgery.

Infants with severe CoA may be given a drug called prostaglandin E to keep the ductus arteriosus open. The open ductus arteriosus will act like a bypass around the coarctation until the CoA can be repaired surgically.

Prognosis

Approximately half of all infants diagnosed with coarctation of the aorta have no other cardiac defects and will respond well to medical management. Most of these children will eventually outgrow the condition after several years of life. Although their hypertension may increase for several months early in life, it will eventually decrease as the circulatory system develops.

The average life span of adults who have untreated coarctation of the aorta is 34 years of age; 90% of such untreated patients die by age 50. The most common complications for children who have not had surgery are hypertension, aortic rupture, intracranial bleeding, congestive heart failure, and kidney or liver failure. Women who have an uncorrected coarctation of the aorta have a mortality rate of 10% during **pregnancy** and a 90% rate of complications.

Prevention

There is no known way to prevent coarctation of the aorta as of 2010 because the condition is present at birth in most cases. However, prompt evaluation of children with known heart defects or Turner syndrome for CoA can help in preventing complications of the condition. Surgeons recommend correcting the defect before age 10 if possible in order to prevent **death** in early adulthood; if coarctation is repaired before the age of 14 years, the 20-year survival rate is 91%. If the coarctation is repaired after age 14, the 20-year survival rate drops to 79%.

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ORGANIZATIONS

American College of Cardiology (ACC), Heart House, 2400 N Street NW, Washington, DC, 20037, (202) 375-6000, (202) 375-7000, http://www.acc.org/.

American Heart Association, 7272 Greenville Avenue, Dallas, TX, 75231, (301) 592-8573, (800) 242-8721, (301) 592-8563, www.americanheart.org.

Center for Adults with Congenital Heart Disease, University of Chicago Medical Center, 5841 S. Maryland Avenue, Chicago, IL, 60637, (888) UCH-0200, http://www.

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uchospitals.edu/specialties/heart/services/adult-congenital-heart/.

National Heart, Lung, and Blood Institute (NHLBI), Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, 240-629-3246, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi.nih.gov/.

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Cocaine

Definition

Cocaine is a highly addictive central nervous system stimulant found in the leaves of the coca plant, *Erythroxylon coca*.

Description

Pure cocaine is a white crystalline powder.

Though most cocaine is used recreationally and illegally, it has legitimate medical uses as a potent local, topical anesthetic for the eye, ear drum, and mucous membranes of the nose, mouth, and respiratory system.

Forms of the drug

Street names for powdered cocaine include: "coke," "blow," "C," "flake," "snow" "nose candy," "basa," "smack," "powder," and "toot."

Cocaine can be sniffed or "snorted." through the nose, dissolved in water and injected intravenously, and smoked in a pipe and inhaled through the lungs.

Crack cocaine is the form that is smoked. Crack gets its name from the crackling sound made as cocaine powder is cooked with baking soda. The off-white, cooked product is broken into small pieces called "rocks," or "kibbles & bits."

Both cocaine and crack are sometimes mixed with other substances, like methcathinone, or "cat." A mixture of crack and **marijuana** is known as a "woolah." Either cocaine or crack, used together with heroin, is called a "speedball." Alcohol, frequently used together with cocaine, is the most common fatal two-drug combination.

Cocaine's effects include loss of **fatigue**, mental alertness, and increased energy. Their intensity and duration depend on how the drug is used. The more rapidly it reaches the brain, the faster its effects are felt and the quicker they dissipate. Intravenous injection and **smoking** produce faster and more intense effects.

History

Coca leaves were chewed by the Incas and other inhabitants of the Andean region of South America for thousands of years as a stimulant, to combat **altitude sickness**, and to suppress appetite.

Late in the nineteenth century, cocaine hydrochloride, coca's psychoactive ingredient, was extracted from the leaves and soon found its way into many patent medicines and other popular products, like colas. The drug's negative effects soon became apparent and in 1914, the Harrison Act banned the use of cocaine in non-prescription products. Its use subsequently declined substantially.

The drug culture of the 1960s sparked renewed interest in cocaine and, with the advent of crack cocaine in the 1980s, cocaine **abuse** once again become a national problem. Its use declined in the early 1990s, but remains a significant problem in certain age groups and geographic areas. A mid-1990s government report stated that Americans spend more money on cocaine than on all other illegal drugs combined.

Causes and symptoms

Like other addictions, cocaine abuse results from complex combinations of factors like genetic predisposition, family history, **stress**, and other environmental issues. As many as three to four million people are estimated to be chronic cocaine users.

How cocaine affects the brain

Cocaine increases the brain's levels of dopamine by preventing its being recycled back into brain cells. Dopamine is responsible for feelings of pleasure; the higher the dopamine levels, the greater the sensations of pleasure. With repeated drug use, tolerance develops and more frequent use produces diminishing sensations of pleasure.

Short-term effects of use

The short-term effects of cocaine can include:

- rapid heartbeat
- constricted blood vessels
- dilated pupils
- increased temperature
- increased energy
- reduced appetite
- increased sense of alertness

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- euphoria
- sudden death due to overdose, heart attack, or stroke

Long-term effects of use

The long-term effects of cocaine and crack use include:

- dependence, addiction
- paranoia
- anxiety
- irritability
- mood swings
- restlessness
- weight loss and malnutrition
- auditory hallucinations
- loss of sense of smell
- nosebleeds
- ruptured nasal septum
- chronic runny nose
- hoarse voice
- bowel gangrene
- increased risk of contracting HIV and other blood-borne diseases

Cocaine use and pregnancy

The rise in the use of cocaine and crack in the 1980s raised fears about their effects on developing fetuses. But researchers have not been able to conclusively demonstrate consistent, adverse effects. Experts nowadays believe that the lack of good prenatal care, along with alcohol and tobacco use in cocaine users who are pregnant, are more important factors in premature delivery, low birth weight, and fetal and neonatal **death**.

The Center for Disease Control and Prevention (CDC), however, reports that mothers who use cocaine early in **pregnancy** are five times more likely to have babies with malformed urinary tracts than mothers who do not use the drug.

Thus, cocaine use, especially in the early weeks of pregnancy, is inadvisable.

Discouraging pregnant women from using cocaine, tobacco, and alcohol are important tasks for all health caregivers.

Diagnosis

Diagnosing cocaine **addiction** can be difficult. Many of the signs of short-term cocaine use are not obvious. Since cocaine users often also use other drugs, it may not be easy to distinguish the effects of one drug from another.

Cocaine use has been documented in significant numbers of eighth graders as well as older teens. Over all age groups, more men than women use the drug. The highest rate of cocaine use is found among adults 18 to 25 years old.

Medical complications

Cocaine has been linked to several serious health problems, including:

- arrhythmia
- heart attacks
- chest pain
- respiratory failure
- strokes
- seizures

Other complications may vary depending on how the drug is administered. Prolonged snorting, for example, can irritate the nasal septum, producing nosebleeds, chronic runny nose and ruptured nasal septum, and other problems. Intravenous users face an increased risk of infectious diseases such as HIV/AIDS and hepatitis.

Testing

Urine testing for cocaine can be useful in diagnosing cocaine abuse and monitoring adherence to drug-abuse treatment programs.

Treatment

The last two decades have seen a dramatic rise in the number of cocaine addicts seeking treatment. There are no specific, targeted treatments for cocaine abuse or addiction. Most programs combine **cognitive-behavioral therapy** with social support.

Pharmacological treatments

There are no specific medications for treating cocaine addiction.

Behavioral approaches

A wide range of behavioral interventions have successfully treated cocaine addiction. Approaches must be tailored to individuals' specific needs and available resources. Tailored programs with negotiated contingency rewards for drug avoidance, confirmed by urine testing, can work.

In cognitive-behavioral therapy, users learn to recognize, manage and avoid situations most likely to lead to cocaine use and develop healthy ways to cope with stressful situations.

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Residential programs/therapeutic communities may also be helpful, particularly in more severe cases. Patients typically spend 6 to 12 months in such programs, which may also include vocational retraining.

Alternative treatment

Various alternative or complementary approaches, often combined with conventional therapies, have been used in treating cocaine addiction. In Japan, the herb acorus has been traditionally used both to assist early-stage cocaine withdrawal and in later recovery stages. Other herbs sometimes used to treat drug addictions of various kinds include kola nut, guarana seed and yohimbe (to boost short-term energy), and valerian root, hops leaf, scullcap leaf, and chamomile (to calm the patient). The amino acids phenylalanine and tyrosine have been used to reduce cocaine addicts' craving for the drug. Vitamin therapy may be used to help strengthen the patient. Gentle massage has been used to help infants born with congenital cocaine addiction. Other techniques, such as **acupuncture**, EEG **biofeedback**, and visualization, may also be useful in treating addiction.

Prognosis

Addiction is a complex disorder, and prospects for individual addicts vary widely. A 2004 study found that recovering drug addicts continue to crave the high and rush that they initially received from using the drug. However, research also has consistently shown that treatment can significantly reduce both drug abuse and subsequent criminal activity. The comprehensive Services Research Outcomes Study (1998) found a 45% drop in cocaine use five years after treatment, compared to use during the five years before treatment. The study also found that females generally respond better to treatment than males, and older patients tend to reduce their drug use more than younger patients.

Research supports the ability of twelve step programs, along with other approaches, to improve addiction treatment outcomes. One study in outpatient drug-treatment programs found that participation in a 12-step program nearly doubled the chances of remaining drug-free.

Prevention

Despite significant variation over time, cocaine addiction has proven to be a persistent public health problem. Interdiction and source control are expensive and have failed to eliminate the problem. Some law enforcement officials recommend more emphasis on demand reduction through education and other measures to address the causes of cocaine addiction.

KEY TERMS

Apoxia—Apoxia refers to altitude sickness.

Arrhythmia—Irregular heartbeat.

Central nervous system—Part of the nervous system consisting of the brain, cranial nerves, and spinal cord. The brain is the center of higher processes, such as thought and emotion and is responsible for the coordination and control of bodily activities and the interpretation of information from the senses. The cranial nerves and spinal cord link the brain to the peripheral nervous system, that is the nerves present in the rest of body.

Nasal septum—The membrane that separates the nostrils.

Neurotransmitter—A chemical that carries nerve impulses across a synapse.

Synapse—The gap between two nerve cells.

Resources

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"Treating Cocaine Addiction with Viruses." *Ascribe Health News Service* June 21, 2004.

ORGANIZATIONS

Cocaine Anonymous, 21720 S. Wilmington Ave., Ste. 304, Long Beach, CA, 90810-1641, (310) 559-5833, (310) 559-2554, cawso@ca.org, http://www.ca.org/.

Nar-Anon Family Group Headquarters, 22527 Crenshaw Blvd., Suite 200B, Torrance, CA, 90505, (310) 534-8188, (800) 477-6291, naranonwso@nar-anon.org, http://www.nar-anon.org/Nar-Anon.

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Coccidioidomycosis

Definition

Coccidioidomycosis is an infection caused by inhaling the microscopic spores of the fungus *Coccidioides immitis*. Spores are the tiny, thick-walled

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structures that fungi use to reproduce. Coccidioidomycosis exists in three forms. The acute form produces flu-like symptoms. The chronic form can develop as many as 20 years after initial infection and, in the lungs, can produce inflamed, injured areas that can fill with pus (abscesses). Disseminated coccidioidomycosis describes the type of coccidioidomycosis that spreads throughout the body affecting many organ systems and is often fatal.

Description

Coccidioidomycosis is an airborne infection. The fungus that causes the disease is found in the dry desert soil of the southwestern United States, Mexico, and Central and South America. Coccidioidomycosis is sometimes called San Joaquin **fever**, valley fever, or desert fever because of its prevalence in the farming valleys of California. Although commonly acquired, overt coccidioidomycosis is a rare disease. Chronic infections occur in only one out of every 100,000 people.

Although anyone can get coccidioidomycosis, farm laborers, construction workers, and archaeologists who work where it is dusty are at greater risk to become infected. People of any age can get coccidioidomycosis, but the disease most commonly occurs in the 25–55 age group. In its acute form, coccidioidomycosis infects men and women equally.

Chronic and disseminated forms of coccidioidomycosis occur more frequently in men and pregnant women. Although it is not clear why, people of color are 10–20 times more likely to develop the disseminated form of the disease than caucasians. People who have a weakened immune system (immunocompromised), either from diseases such as **AIDS** or leukemia, or as the result of medications that suppressed the immune system (**corticosteroids**, **chemotherapy**), are more likely to develop disseminated coccidioidomycosis.

Causes and symptoms

When the spores of *C. immitis* are inhaled, they can become lodged in the lungs, divide, and cause localized inflammation. This is known as acute or primary coccidioidomycosis. The disease is not spread from one person to another. Approximately 60% of people who are infected exhibit no symptoms (asymptomatic). In the other 40%, symptoms appear 10–30 days after exposure. These symptoms include a fever which can reach 104°F (39.5°C), dry **cough**, chest pains, joint and muscle aches, **headache**, and weight loss. About two weeks after the start of the fever, some people develop a painful red rash or lumps on the lower legs. Symptoms usually disappear without treatment in about one month. People who have been infected gain partial immunity to reinfection.

The chronic form of coccidioidomycosis normally occurs after a long latent period of 20 or more years during which the patient experiences no symptoms of the disease. In the chronic phase, coccidioidomycosis causes lung abscesses that rupture, spilling pus and fluid into the lungs, and causing serious damage to the lungs. The patient experiences difficulty breathing and has a fever, chest **pain**, and other signs of **pneumonia**. Medical treatment is essential for recovery.

In its disseminated form, coccidioidomycosis spreads to other parts of the body including the liver, bones, skin, brain, heart, and lining around the heart (pericardium). Symptoms include fever, joint pain, loss of appetite, weight loss, night sweats, **skin lesions**, and difficulty breathing. Also, in 30–50% of patients with disseminated coccidioidomycosis, the tissue coverings of the brain and spinal cord become inflamed (**meningitis**).

Diagnosis

Many cases of coccidioidomycosis go undiagnosed because the symptoms resemble those of common viral diseases. However, a skin test similar to that for **tuberculosis** will determine whether a person has been infected. The test is simple and accurate, but it does not indicate whether the disease was limited to its acute form or if it has progressed to its chronic form.

Diagnosis of chronic or disseminated coccidioidomycosis is made by culturing a sample of sputum or other body fluids in the laboratory to isolate the fungus. A blood serum test is used to detect the presence of an antibody produced in response to *C. immitis* infection. Chest x rays are often used to assess lung damage, but alone cannot lead to a definitive diagnosis of coccidioidomycosis because other diseases can produce similar results on the x ray.

Treatment

In most cases of acute coccidioidomycosis, the body's own immune system is adequate to bring about recovery without medical intervention. Fever and pain can be treated with non-prescription drugs.

Chronic and disseminated coccidioidomycosis, however, are serious diseases that require treatment with prescription drugs. Patients with intact immune systems who develop chronic coccidiodomycosis are treated with the drug ketoconazole (Nizoral) or amphotericin B (Fungizone). Patients with suppressed

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KEY TERMS

Abscess—An area of inflamed and injured body tissue that fills with pus.

Acidophilus—The bacteria *Lactobacillus acidophilus* that usually found in yogurt.

Antibody—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

Antigen—A foreign protein to which the body reacts by making antibodies.

Asymptomatic—Persons who carry a disease but who do not exhibit symptoms of the disease are said to be asymptomatic.

Bifidobacteria—A group of bacteria normally present in the intestine. Commercial supplements containing these bacteria are available.

Corticosteroids—A group of hormones produced naturally by the adrenal gland or manufactured synthetically. They are often used to treat inflammation. Examples include cortisone and prednisone.

Immunocompromised—A state in which the immune system is suppressed or not functioning properly.

Meningitis—An inflammation of the membranes surrounding the brain or spinal cord.

Pericardium—The tissue sac around the heart.

immune systems are treated with amphotericin B (Fungizone). Amphotericin B is a powerful fungistatic drug with potentially toxic side effects. As a result, hospitalization is required in order to monitor patients. The patient may also receive other drugs to minimize the side effects of the amphotericin B.

Patients with AIDS must continue to take itraconazole (Sporonox) or fluconazole (Diflucan) orally or receive weekly intravenous doses of amphotericin B for the rest of their lives in order to prevent a relapse. Because of the high cost of fluconazole, Pfizer, the manufacturer of the drug, has established a financial assistance plan to make the drug available at lower cost to those who meet certain criteria. Patients needing this drug should ask their doctors about this program.

Alternative treatment

Alternative treatment for fungal infections focuses on creating an internal environment where the fungus cannot survive. This is accomplished by eating a diet low in dairy products, sugars, including honey and fruit juice, and foods like beer that contain yeast. This is complemented by a diet consisting, in large part, of uncooked and unprocessed foods. Supplements of **vitamins** C, E, A-plus, and B complex may also be useful. *Lactobacillus acidophilus* and *Bifidobacterium* will replenish the good bacteria in the intestines. Antifungal herbs, like garlic (*Allium sativum*), can be consumed in relatively large does and for an extended period of time in order to increase effectiveness.

Prognosis

Most people who are infected with coccidiodomycosis only suffer from the mild, acute form of the disease and recover without further complications. Patients who suffer from chronic coccidiodomycosis and who have no underlying lung or immune system diseases also stand a good change of recovery, although they must be alert to a relapse.

The picture for patients with the disseminated form of the disease, many of whom have AIDS, is less positive. Untreated disseminated coccidiodomycosis is almost always fatal within a short time. With treatment, chance of survival increases, but the **death** rate remains high when meningitis or diffuse lung (pulmonary) disease is present. AIDS patients must constantly guard against relapse.

Prevention

Because the fungus that causes coccidioidomycosis is airborne and microscopic, the only method of prevention is to avoid visiting areas where it is found in the soil. Unfortunately, for many people this is impractical. Maintaining general good health and avoiding HIV infection will limit coccidioidomycosis to the acute and relatively mild form in most people.

ORGANIZATIONS

American Lung Association, 1301 Pennsylvania Ave. NW, Suite 800, Washington, DC, 20001, (202) 758-3355, (202), 452-1805, (800) 548-8252, info@lungusa.org, http://www.lungusa.org/.

Canadian AIDS Treatment Information Exchange, 555 Richmond Street West, Suite 505, Toronto, Canada, Ontario, M5V 3B1, (426) 203-8242, (800) 263-1638, info@catie.ca, http://www.catie.ca.

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Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800), 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.
National AIDS Hotline, CDC, 1600 Clifton Road, Atlanta, GA, 30333, (800), 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov/hiv.
Project Inform, 1375 Mission Street, San Francisco, CA, 94103-2621, (415), 558-8669, (415), 558-0684, http://www.projinf.org.

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Coccyx injuries

Definition

The coccyx—or tailbone—is the last bone of the vertebral column, and usually consists of three to five fused vertebrae that connect with the sacrum, a part of the pelvis.

Description

The coccyx consists of fused vertebrae, which are not flexible like the other vertebrae of the vertebral column which are all interspaced by intervertebral disks and joined together by elastic ligaments. Since the spinal cord ends just before the coccyx begins, coccygeal vertebrae also lack a central foramen (hole). In the coccyx, the vertebrae generally fuse together in early adulthood and may also fuse with the sacrum, the bone located between the fifth lumbar vertebra and the coccyx, as a person ages. In males, the coccyx curves downward, and in females, it is straighter to allow a baby to pass through the birth canal without impediment.

Pain in or around the coccyx is called coccydynia or coccygodynia. Coccydynia presents a range of symptoms associated to a variety of underlying causes and conditions.

Causes and symptoms

Causes

Coccydynia can be caused by a number of factors. Usually, patients report pain after a fall onto their buttocks, as occurs when going down stairs or while skating. Others have pain during **pregnancy** or after **childbirth**. Some experience repetitive strain from rowing or cycling, and some cite anal intercourse as the cause of pain. In many cases, pain derives from a malformation of the coccyx itself. Sometimes bony spurs appear on the coccyx, but only seem to be painful in thin patients who do not have the padding to protect the region from the spur.

Other causes of coccydynia include **cancer** or damage to the sacrum that generates referred pain, meaning pain that appears in one region but originates from another. Muscle strain or tension, pinched nerves or damaged nerves, or dislocation of the coccyx due to gross **obesity** are other causes.

Symptoms

The most common symptom of coccydynia, irrespective of the cause of the condition, is pain when sitting, or when rising from a sitting position. If the condition lasts long enough, the patient may even experience pain when standing or lying down. Sometimes, **numbness** occurs in the lower part of the spine. Some patients will experience pain during bowel movements, sexual intercourse, or menstruation.

Secondary symptoms include back pain from sitting in odd positions in order to relieve pain, and painful feet from standing too much, because patients avoid sitting. Sometimes the entire buttocks experience pain. Rarely, exhaustion, depression, and lack of sleep may occur.

Diagnosis

Diagnosis of fracture is usually made by inserting a gloved finger in the rectum and pressing on the coccyx. X rays and **magnetic resonance imaging** (MRI) are also often used. Since coccyx pain may be the result of other factors like cancer, these must be ruled out through a variety of tests before treatment can begin.

Treatment

Treatment exists to either control the pain or eliminate the cause. Pain control may be dangerous if an underlying condition exists of which the pain is a warning sign. Nerve blocks and a variety of drugs are other options to control pain.

Elimination of the root cause of the pain is ideal. This is done through careful diagnosis and the application of manual treatments, corticosteroid injections into the coccyx vertebrae, or surgery. Injections into the fourth and fifth sacral nerves and coccygeal nerves often bring relief, but are considered more as a pain control measure than as curative treatment. Manual treatments have not been found to be effective. Surgery is a radical procedure whose indications are inconsistent and dependent on the subjectivity of the physician.

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KEY TERMS

Coccydynia—Also called coccygodynia. Pain in or around the coccyx.

Coccyx—The last bone of the spinal column, consisting of three to five fused vertebrae that connect with the sacrum, a part of the pelvis.

Foramen—A small opening, perforation, or orifice.

Magnetic resonance imaging (MRI)—An imaging technique that produces pictures of the inside of the body.

Sacrum—The triangle-shaped bone located between the fifth lumbar vertebra and the coccyx that consists of five vertebrae fused together. The sacrum joins on each side with the bones of the pelvis.

Spinal cord—Elongated nerve bundles that lie in the vertebral canal and from which the spinal nerves emerge.

Vertebrae—Bones in the cervical, thoracic, and lumbar regions of the body that make up the vertebral column. Vertebrae have a central foramen (hole), and their superposition makes up the vertebral canal that encloses the spinal cord.

Vertebral column—The vertebral column, also called the spinal column or spine, consists of a series of vertebrae connected by ligaments. It provides a supporting axis for the body and protects the spinal cord. The vertebral column consists of seven cervical vertebrae in the neck, followed by 12 thoracic vertebrae that connect to the ribs, five lumbar vertebrae in the lower back, the sacrum, and the coccyx.

Prognosis

With current treatment, prognosis is good and patients usually are able to live pain free.

Prevention

There probably is no real prevention, expect weight control. Some women may choose to give birth through ceasarian section instead of vaginally after an episode of coccyx pain from a previous delivery.

Resources

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Janie F. Franz

Cochlear implants

Definition

A cochlear implant is a surgical treatment for **hearing loss** that works like an artificial human cochlea in the inner ear, helping to send sound from the ear to the brain. It is different from a hearing aid, which simply amplifies sound.

Purpose

A cochlear implant bypasses damaged hair cells and helps establish some degree of hearing by stimulating the hearing (auditory) nerve directly.

Precautions

Because the implants are controversial, very expensive, and have uncertain results, the U.S. Food and Drug Administration (FDA) has limited the implants to people:

- who get no significant benefit from hearing aids
- who are at least two years old (the age at which specialists can verify severity of deafness)
- with severe to profound hearing loss

A close-up view of a cochlear implant. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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Description

Hearing loss is caused by a number of different problems that occur either in the hearing nerve or parts of the middle or inner ear. The most common type of deafness is caused by damaged hair cells in the cochlea, the hearing part of the inner ear. Normally, hair cells stimulate the hearing nerve, which transmits sound signals to the brain. When hair cells stop functioning, the hearing nerve remains unstimulated, and the person cannot hear. Hair cells can be destroyed by many things, including infection, trauma, loud noise, **aging**, or **birth defects**.

All cochlear implants consist of a microphone worn behind the ear that picks up sound and sends it along a wire to a speech processor, which is worn in a small shoulder pouch, pocket, or belt. The processor boosts the sound, filters out background noise, and turns sound into digital signals before sending it to a transmitter worn behind the ear. A magnet holds the transmitter in place through its attraction to the receiver-stimulator, a part of the device that is surgically attached beneath the skin in the skull. The receiver picks up digital signs forwarded by the transmitter, and converts them into electrical impulses. These electrical impulses flow through electrodes contained in a narrow, flexible tube that has been threaded into the cochlea.

As many as 24 electrodes (depending on the type of implant) carry the impulses that stimulate the hearing nerve. The brain then interprets the signals as specific sounds.

Despite the benefits that the implant appears to offer, some hearing specialists and members of the deaf community still believe that the benefits may not outweigh the risks and limitations of the device. Because the device must be surgically implanted, it carries some surgical risk. Also, manufacturers cannot promise how well a person will hear with an implant. Moreover, after getting an implant, some people say they feel alienated from the deaf community, while at the same time not feeling fully a part of the hearing world.

The sounds heard through an implant are different from the normal hearing sounds, and have been described as artificial or "robotlike." This is because the implant's handful of electrodes cannot hope to match the complexity of a person's 15,000 hair cells.

Surgical procedure

During the procedure, the surgeon makes an incision behind the ear and opens the mastoid bone (the ridge on the skull behind the ear) leading into the middle ear. The surgeon then places the receiver-stimulator in the bone, and gently threads the electrodes into the cochlea. This operation takes between one and one-half to five hours.

Preparation

Before a person gets an implant, specialists at an implant clinic conduct a careful evaluation, including extensive hearing tests to determine how well the candidate can hear.

Unfortunately, it is not possible to predict who will benefit from an implant. In general, the later in life a person becomes deaf, and the shorter the duration of deafness, the better the person is likely to understand speech with an implant. Likewise, someone with a healthy hearing nerve will do better than someone with a damaged nerve.

First, candidates undergo a trial with a powerful hearing aid. If the aid cannot improve hearing enough, a physician then performs a physical exam and orders a scan of the inner ear (some patients with a scarred cochlea are not good candidates). A doctor may also order a psychological exam to better understand the person's expectations. Patients need to be highly motivated, and have a realistic understanding of what an implant can and cannot do.

Aftercare

The patient remains in the hospital for a day or two after the surgery. After a month, the surgical **wounds** will have healed and the patient returns to the implant clinic to be fitted with the external parts of the device (the speech processor, microphone, and transmitter). A clinician tunes the speech processor and sets levels of stimulation for each electrode, from soft to loud.

The patient is then trained in how to interpret the sounds heard through the device. The length of the training varies from days to years, depending on how well the person can interpret the sounds heard through the device.

Risks

As with all operations, there are a few risks of surgery. These include:

- dizziness
- facial paralysis (rarely)
- infection at the incision site

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KEY TERMS

Cochlea—The hearing part of the inner ear. This snail-shaped structure contains fluid and thousands of microscopic hair cells tuned to various frequencies.

Hair cells—Sensory receptors in the inner ear that transform sound vibrations into messages that travel to the brain.

Inner ear—The interior section of the ear, where sound vibrations and information about balance are translated into nerve impulses.

Middle ear—The small cavity between the eardrum and the oval window that houses the three tiny bones of hearing.

Scientists are not sure about the long-term effects of electrical stimulation on the nervous system. It is also possible to damage the implant's internal components by a blow to the head, which will render the device unworkable.

Normal results

Most profoundly, deaf patients who receive an implant are able to discern medium and loud sounds, including speech, at comfortable listening levels. Many use sound clues from the implant, together with speech reading and other facial cues. Almost all adults improve their communication skills when combining the implant with speech reading (lip reading), and some can understand spoken words without speech reading. More than half of adults who lost hearing after they learned to speak can understand some speech without speech reading. About 30% can understand spoken sounds well enough to use the phone.

Children who were born deaf or who lost their hearing before they could speak have the most difficulty in learning to use the implant. Research suggests, however, that most of these children are able to learn spoken language and understand speech using the implant.

ORGANIZATIONS

Alexander Graham Bell Association for the Deaf and Hard of Hearing, 3417 Volta Place NW, Washington, DC, 20007, (202) 337-5220, (202) 337-8314, info@agbell.org, http://www.agbell.org.

American Speech Language Hearing Association, 2200 Research Boulevard , Rockville, MD, 20850-3289, (301) 296-5700, (301) 296-8580, (800) 638-8255, actioncenter@asha.org, http://asha.org/.

Cochlear Implant Club International, 5335 Wisconsin Ave. NW, Suite 440, Washington, DC, 20015-2052, (202) 895-2781.

National Association of the Deaf, 8630 Fenton St, #820, Silver Spring, MD, 20910, (301) 587-1788, (301) 587-1791, http://www.nad.org.

Carol A. Turkington

Cognitive-behavioral therapy

Definition

Cognitive-behavioral therapy is an action-oriented form of psychosocial therapy that assumes that maladaptive, or faulty, thinking patterns cause maladaptive behavior and "negative" emotions. (Maladaptive behavior is behavior that is counter-productive or interferes with everyday living.) The treatment focuses on changing an individual's thoughts (cognitive patterns) in order to change his or her behavior and emotional state.

Purpose

Theoretically, cognitive-behavioral therapy can be employed in any situation in which there is a pattern of unwanted behavior accompanied by distress and impairment. It is a recommended treatment option for a number of mental disorders, including affective (mood) disorders, **personality disorders**, social phobia, **obsessive-compulsive disorder** (OCD), **eating disorders**, **substance abuse**, **anxiety** or **panic disorder**, **agoraphobia**, **post-traumatic stress disorder** (PTSD), and attention-deficit/hyperactivity disorder (**ADHD**). It is also frequently used as a tool to deal with chronic **pain** for patients with illnesses such as **rheumatoid arthritis**, back problems, and **cancer**. Patients with **sleep disorders** may also find cognitive-behavioral therapy a useful treatment for **insomnia**.

Precautions

Cognitive-behavioral therapy may not be suitable for some patients. Those who do not have a specific behavioral issue they wish to address and whose goals for therapy are to gain insight into the past may be better served by psychodynamic therapy. Patients must also be willing to take a very active role in the treatment process.

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Cognitive-behavioral intervention may be inappropriate for some severely psychotic patients and for cognitively impaired patients (for example, patients with organic brain disease or a traumatic brain injury), depending on their level of functioning.

Description

Cognitive-behavioral therapy combines the individual goals of cognitive therapy and behavioral therapy.

Pioneered by psychologists Aaron Beck and Albert Ellis in the 1960s, cognitive therapy assumes that maladaptive behaviors and disturbed mood or emotions are the result of inappropriate or irrational thinking patterns, called *automatic thoughts*. Instead of reacting to the reality of a situation, an individual reacts to his or her own distorted viewpoint of the situation. For example, a person may conclude that he is "worthless" simply because he failed an exam or did not get a date. Cognitive therapists attempt to make their patients aware of these distorted thinking patterns, or cognitive distortions, and change them (a process termed cognitive restructuring).

Behavioral therapy, or behavior modification, trains individuals to replace undesirable behaviors with healthier behavioral patterns. Unlike psychodynamic therapies, it does not focus on uncovering or understanding the unconscious motivations that may be behind the maladaptive behavior. In other words, strictly behavioral therapists do not try to find out why their patients behave the way they do, they just teach them to change the behavior.

Cognitive-behavioral therapy integrates the cognitive restructuring approach of cognitive therapy with the behavioral modification techniques of behavioral therapy. The therapist works with the patient to identify both the thoughts and the behaviors that are causing distress, and to change those thoughts in order to readjust the behavior. In some cases, the patient may have certain fundamental core beliefs, called schemas, which are flawed and require modification. For example, a patient suffering from depression may be avoiding social contact with others, and suffering considerable emotional distress because of his isolation. When questioned why, the patient reveals to his therapist that he is afraid of rejection, of what others may do or say to him. Upon further exploration with his therapist, they discover that his real fear is not rejection, but the belief that he is hopelessly uninteresting and unlovable. His therapist then tests the reality of that assertion by having the patient name friends and family who love him and enjoy his company. By showing the patient that others value him, the therapist both exposes the irrationality of the patient's belief and provides him with a new model of thought to change his old behavior pattern. In this case, the person learns to think, "I am an interesting and lovable person; therefore I should not have difficulty making new friends in social situations." If enough "irrational cognitions" are changed, this patient may experience considerable relief from his depression.

A number of different techniques may be employed in cognitive-behavioral therapy to help patients uncover and examine their thoughts and change their behaviors. They include:

- Behavioral homework assignments. Cognitive-behavioral therapists frequently request that their patients complete homework assignments between therapy sessions. These may consist of real-life "behavioral experiments" where patients are encouraged to try out new responses to situations discussed in therapy sessions.
- Cognitive rehearsal. The patient imagines a difficult situation and the therapist guides him through the step-by-step process of facing and successfully dealing with it. The patient then works on practicing, or rehearsing, these steps mentally. Ideally, when the situation arises in real life, the patient will draw on the rehearsed behavior to address it.
- Journal. Patients are asked to keep a detailed diary recounting their thoughts, feelings, and actions when specific situations arise. The journal helps to make the patient aware of his or her maladaptive thoughts and to show their consequences on behavior. In later stages of therapy, it may serve to demonstrate and reinforce positive behaviors.
- Modeling. The therapist and patient engage in role-playing exercises in which the therapist acts out appropriate behaviors or responses to situations.
- Conditioning. The therapist uses reinforcement to encourage a particular behavior. For example, a child with ADHD gets a gold star every time he stays focused on tasks and accomplishes certain daily chores. The gold star reinforces and increases the desired behavior by identifying it with something positive. Reinforcement can also be used to extinguish unwanted behaviors by imposing negative consequences.
- Systematic desensitization. Patients imagine a situation they fear, while the therapist employs techniques to help the patient relax, helping the person cope with their fear reaction and eventually eliminate the anxiety altogether. For example, a patient in treatment for agoraphobia, or fear of open or public

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places, will relax and then picture herself on the sidewalk outside of her house. In her next session, she may relax herself and then imagine a visit to a crowded shopping mall. The imagery of the anxiety-producing situations gets progressively more intense until, eventually, the therapist and patient approach the anxiety-causing situation in real-life (a "graded exposure"), perhaps by visiting a mall. Exposure may be increased to the point of "flooding," providing maximum exposure to the real situation. By repeatedly pairing a desired response (relaxation) with a fear-producing situation (open, public spaces), the patient gradually becomes desensitized to the old response of fear and learns to react with feelings of relaxation.

- Validity testing. Patients are asked to test the validity of the automatic thoughts and schemas they encounter. The therapist may ask the patient to defend or produce evidence that a schema is true. If the patient is unable to meet the challenge, the faulty nature of the schema is exposed.

Initial treatment sessions are typically spent explaining the basic tenets of cognitive-behavioral therapy to the patient and establishing a positive working relationship between therapist and patient. Cognitive-behavioral therapy is a collaborative, action-oriented therapy effort. As such, it empowers the patient by giving him an active role in the therapy process and discourages any overdependence on the therapist that may occur in other therapeutic relationships. Therapy is typically administered in an outpatient setting in either an individual or group session. Therapists include psychologists (Ph.D., Psy.D., Ed.D. or M.A. degree), clinical social workers (M.S.W., D.S.W., or L.S.W. degree), counselors (M.A. or M.S. degree), or psychiatrists (M.D. with specialization in psychiatry) and should be trained in cognitive-behavioral techniques, although some brief cognitive-behavioral interventions may be suggested by a primary physician/caregiver. Treatment is relatively short in comparison to some other forms of **psychotherapy**, usually lasting no longer than 16 weeks. Many insurance plans provide reimbursement for cognitive-behavioral therapy services. Because coverage is dependent on the disorder or illness the therapy is treating, patients should check with their individual plans.

Rational-emotive behavior therapy

Rational-emotive behavior therapy (REBT) is a popular variation of cognitive-behavioral therapy developed in 1955 by psychologist Albert Ellis. REBT is based on the belief that a person's past experiences shape their belief system and thinking patterns. People form illogical, irrational thinking patterns that become the cause of both their negative emotions and of further irrational ideas. REBT focuses on helping patients discover these irrational beliefs that guide their behavior and replace them with rational beliefs and thoughts in order to relieve their emotional distress.

There are 10 basic irrational assumptions that trigger maladaptive emotions and behaviors:

- It is a necessity for an adult to be loved and approved of by almost everyone for virtually everything.
- A person must be thoroughly competent, adequate, and successful in all respects.
- Certain people are bad, wicked, or villainous, and should be punished for their sins.
- It is catastrophic when things are not going the way one would like.
- Human unhappiness is externally caused. People have little or no ability to control their sorrows or to rid themselves of negative feelings.
- It is right to be terribly preoccupied with and upset about something that may be dangerous or fearsome.
- It is easier to avoid facing many of life's difficulties and responsibilities than it is to undertake more rewarding forms of self-discipline.
- The past is all-important. Because something once strongly affected someone's life, it should continue to do so indefinitely.
- People and things should be different from the way they are. It is catastrophic if perfect solutions to the grim realities of life are not immediately found.
- Maximal human happiness can be achieved by inertia and inaction or by living passively and without commitment.

Meichenbaum's self-instructional approach

Psychologist Donald Meichenbaum pioneered the self-instructional, or "self-talk," approach to cognitive-behavioral therapy in the 1970s. This approach focuses on changing what people say to themselves, both internally and out loud. It is based on the belief that an individual's actions follow directly from this self-talk. This type of therapy emphasizes teaching patients coping skills that they can use in a variety of situations to help themselves. The technique used to accomplish this is self-instructional inner dialogue, a method of talking through a problem or situation as it occurs.

Preparation

Patients may seek therapy independently, or be referred for treatment by a primary physician,

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KEY TERMS

Automatic thoughts—Thoughts that automatically come to mind when a particular situation occurs. Cognitive-behavioral therapy seeks to challenge automatic thoughts.

Cognitive restructuring—The process of replacing maladaptive thought patterns with constructive thoughts and beliefs.

Maladaptive—Unsuitable or counterproductive; for example, maladaptive behavior is behavior that is inappropriate to a given situation.

Psychodynamic therapy—A therapeutic approach that assumes dysfunctional or unwanted behavior is caused by unconscious, internal conflicts and focuses on gaining insight into these motivations.

Relaxation technique—A technique used to relieve stress. Exercise, biofeedback, hypnosis, and meditation are all effective relaxation tools. Relaxation techniques are used in cognitive-behavioral therapy to teach patients new ways of coping with stressful situations.

Schemas—Fundamental core beliefs or assumptions that are part of the perceptual filter people use to view the world. Cognitive-behavioral therapy seeks to change maladaptive schemas.

psychologist, or psychiatrist. Because the patient and therapist work closely together to achieve specific therapeutic objectives, it is important that their working relationship is comfortable and their goals are compatible. Prior to beginning treatment, the patient and therapist should meet for a consultation session, or mutual interview. The consultation gives the therapist the opportunity to make an initial assessment of the patient and recommend a course of treatment and goals for therapy. It also gives the patient an opportunity to find out important details about the therapist's approach to treatment, professional credentials, and any other issues of interest.

In some managed-care clinical settings, an intake interview or evaluation is required before a patient begins therapy. The intake interview is used to evaluate the patient and assign him or her to a therapist. It may be conducted by a psychiatric nurse, counselor, or social worker.

Normal results

Many patients who undergo cognitive-behavioral therapy successfully learn how to replace their maladaptive thoughts and behaviors with positive ones that facilitate individual growth and happiness. Cognitive-behavioral therapy may be used in conjunction with pharmaceutical and other treatment interventions, so overall success rates are difficult to gauge. However, success rates of 65% or more have been reported with cognitive-behavioral therapy alone as a treatment for panic attacks and agoraphobia. Relapse has been reported in some patient populations, perhaps due to the brief nature of the therapy, but follow-up sessions can put patients back on track.

ORGANIZATIONS

Albert Ellis Institute, 45 East 65th St., New York, NY, 10021, (800) 323-4738, http://www.rebt.org.

Beck Institute, GSB Building, City Line and Belmont Avenues, Suite 700, Bala Cynwyd, PA, 19004-1610, (610) 664-3020, http://www.beckinstitute.org.

National Association of Cognitive-Behavioral Therapists, P.O. Box 2195, Weirton, WV, 26062, (800) 853-1135, http://www.nacbt.org.

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Colchicine *see* **Gout drugs**

COLD *see* **Chronic obstructive pulmonary disease**

Cold agglutinins test

Definition

The cold agglutinins test is performed to detect the presence of antibodies in blood that are sensitive to temperature changes. Antibodies are proteins produced by the immune system in response to specific disease agents; autoantibodies are antibodies that the body produces against one of its own substances. Cold agglutinins are autoantibodies that cause red blood cells to clump, but only when the blood is cooled below the normal body temperature of 98.6°F (37°C). The clumping is most pronounced at temperatures below 78°F (25.6°C).

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KEY TERMS

Agglutinin—An antibody that causes red blood cells to stick or clump together.

Antibody—A protein molecule produced by the immune system that is specific to a disease agent, such as *Mycoplasma pneumoniae*. The antibody combines with the organism and disables it.

Autoantibody—An antibody produced by the body in reaction to any of its own cells or cell products.

Cold agglutinins—Antibodies that cause clumping of red blood cells when the blood temperature falls below normal body temperature (98.6°F/37°C).

Hemolytic anemia—Oxygen deficiency in the blood, caused by shortened survival of red blood cells.

Mycoplasma—A type of free-living microorganism that has no cell wall. Mycoplasmas cause some varieties of pneumonia and urinary tract infections that stimulate the body to produce cold agglutinins.

Titer—The concentration of a substance in a given sample of blood or other tissue fluid.

Purpose

The cold agglutinins test is used to confirm the diagnosis of certain diseases that stimulate the body to produce cold agglutinins. The disease most commonly diagnosed by this test is mycoplasmal **pneumonia**, but mononucleosis, **mumps**, **measles**, **scarlet fever**, some parasitic infections, **cirrhosis** of the liver, and some types of **hemolytic anemia** can also cause the formation of cold agglutinins. Hemolytic **anemias** are conditions in which the blood is low in oxygen because the red blood cells are breaking down at a faster rate than their normal life expectancy of 120 days. In addition to these illnesses, some people have a benign condition called chronic cold agglutinin disease, in which exposure to cold causes temporary clumping of red blood cells and consequent **numbness** in ears, fingers, and toes.

Description

Since cold agglutinins cause red blood cells to clump only at temperatures lower than 98.6°F (37°C), the test consists of chilling a sample of the patient's blood. There is a bedside version of the test in which the doctor collects four or five drops of blood in a small tube, cools the tube in ice water for 30–60 seconds, and looks for clumping of red blood cells. If the cells clump after chilling and unclump as they rewarm, a cold agglutinin titer (concentration) greater than 1:64 is present. Bedside test results, however, should be confirmed by a laboratory. The laboratory test measures the clumping of red blood cells in different dilutions of the patient's blood serum at 39.2°F (4°C).

Normal results

The results of the cold agglutinins test require a doctor's interpretation. In general, however, a normal value is lower than 1:32.

Abnormal results

Any value higher than 1:32 suggests a diagnosis of mycoplasmal pneumonia or one of the other viral infections or disease conditions indicated by this test.

Resources

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Kjeldsberg, Carl R. *Practical Diagnosis of Hematologic Disorders*. 4th ed. Chicago: ASCP Press, 2006.

Rebecca J. Frey, PhD

Cold sensitivity antibodies test *see* **Cryoglobulin test**

Cold sores

Definition

Cold sores are the popular name for mouth sores caused by a type of herpes simplex virus (HSV) known as HSV-1. They are also sometimes referred to as **fever** blisters, herpes labialis, or oral herpes.

Demographics

Cold sores are a commonplace health problem around the world. According to the National Institutes of Health (NIH), about 80% of people in the United States are infected with HSV-1; other estimates give a figure of 90% of all adults worldwide. Most acquire the infection as children from contact with oral fluids from an infected person. Infection with the virus is thought to be equally common in both sexes and all races and ethnic groups. Although

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A close-up view of a patient's mouth with gingivostomatitis cold sores. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

infection with HSV-1 is common, only about 10% of infected people actually develop cold sores.

Description

Cold sores are small blisters that form around the outside of the mouth; they should be distinguished from **canker sores**, which form inside the mouth and are not contagious. Caused by a virus known as herpes simplex type 1, cold sores are contagious; direct contact with an infected person may result in contracting the virus. The virus that causes cold sores is related to the herpes simplex virus type 2, HSV-2, that causes **genital herpes**.

Risk factors

People with weakened immune systems, such as patients who have had an organ transplant or are being treated for **cancer** or HIV infection, are at increased risk of getting cold sores if they are exposed to HSV-1.

Causes and symptoms

Causes

The cause of cold sores is HSV-1. The virus enters the body through tiny breaks in the tissues lining the mouth, which is one reason it can easily be spread by kissing or by sharing drinking glasses and other food utensils. The first time a person is infected by the virus, they may simply run a fever without having cold sores. HSV-1 then lies dormant in the cells of the nervous system until it is activated by emotional **stress**, an upper respiratory infection, sun exposure, or some other trigger. It then travels back down the nerves to the skin surface. About 35% of people who get cold sores get them in the same area of skin each time.

KEY TERMS

Prodrome—A period before the acute phase of a disease when the patient notices characteristic warning symptoms.

Self-limited—A disease that runs its course without the need for professional medical treatment.

Topical—Any medication applied directly to the skin or the surface of the body.

Symptoms

Most people who become infected with HSV-1 develop cold sores within 20 days of infection, although symptoms may develop sooner. In most cases, the first eruption of the blisters is preceded by a prodrome, or period of warning symptoms before the main phase of the illness. The prodrome of cold sores usually consists of a **tingling**, **itching**, or burning sensation that starts one or two days before the blisters appear. The area of skin where the blisters will erupt may swell up, turn red, and be sore to the touch.

The sores themselves last about 7–10 days after they erupt. They appear most commonly on the lips or the area of skin between the upper lip and the nose, but may also appear on the cheeks. Cold sores sometimes appear inside the mouth. Some people may develop a **sore throat**, swelling of the lymph nodes in the neck, or have difficulty swallowing during an outbreak of cold sores.

The blisters associated with cold sores are small and thin-walled, filled with a clear fluid that may ooze out of the sores. HSV-1 is shed in the fluid from the sores and can be transmitted to other people if they come in contact with the blisters. This is the stage in the development of cold sores when the infection is most contagious. After a few days, the blisters break and form a yellow crust that eventually drops off, leaving an area of pinkish skin underneath. There is no permanent scar from a cold sore. Most people who get cold sores have one or two recurrences per year, although some have an outbreak every month.

Diagnosis

Most people can tell whether they have cold sores by the way they feel and where the sores appear. If necessary, the patient's doctor can run a blood test to

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tell whether the person is infected with HSV-1. This type of test is important if the person is HIV-positive or is being treated with **chemotherapy** for cancer.

Examination

In most cases, people do not need to visit the doctor or dentist for ordinary cold sores. They should make an appointment if they have any of the following symptoms or conditions:

- HIV or any other illness that weakens the immune system
- the cold sores do not heal on their own by the end of two weeks
- the patient's eyes feel sore or irritated
- the cold sores recur frequently
- the blisters are unusually large or painful

Tests

Testing is rarely needed to confirm a diagnosis of cold sores, as the doctor or dentist can usually tell by examining the patient in the office and noting the location of the blisters.

Treatment

Traditional

There is no permanent cure for HSV-1 infection. After a person is infected with the virus, it hides within nerve cells, making it difficult for the immune system to find and destroy it. HSV-1 remains in the body, so that cold sores can reappear at any time. Recurrences of oral herpes can be triggered by a number of factors, including getting the flu or a cold, not getting enough sleep, having dental work or oral surgery, getting traveler's **diarrhea**, menstruation (in women), emotional stress, an injury to the mouth or lips, or exposure to the sun for long periods of time. The connection between colds and flu in reactivating HSV-1 is the main reason why oral herpes is commonly known as cold sores or fever blisters.

Drugs

There are some medications that can be used to treat cold sores. The best time to start treating them is during the prodromal stage before the blisters appear. The doctor or dentist can prescribe an antiviral medication to shorten the length of the outbreak and reduce discomfort; the **antiviral drugs** most often prescribed for cold sores are acyclovir (Zovirax), famcyclovir (Famvir), and valacyclovir (Valtrex). Some of these drugs are taken by mouth while others can be applied to the sores as gels or creams. A topical cream containing 10% docosanol, an antiviral drug available without a prescription, has been shown to be an effective treatment for recurrent cold sores. Other treatments that can be used are topical anesthetics applied directly to the sores; and **aspirin**, Advil, or Tylenol to bring down fever.

Therapies for cold sores that are considered experimental as of 2010 include **photodynamic therapy** (PDT) and a medication taken by mouth made from vitamin C combined with a chemical compound derived from pine cones. One group of researchers reported that photodynamic therapy done with lasers reduced the size and swelling of the patients' cold sores but did not reduce the **pain** level or the frequency of recurrences, while a small study of four patients treated with laser PDT reported that all patients experienced at least some pain relief and found that their blisters healed more rapidly. Most observers think that PDT with lasers is a promising form of therapy for recurrent cold sores but needs further research.

Home remedies

Some people find that ice applied to cold sore blisters helps to relieve discomfort, while others are helped by warm compresses. An over-the-counter remedy that works for some people is zinc oxide cream.

Prognosis

Most cases of cold sores heal without any long-term problems, as the disease is considered self-limited; however, HSV-1 can cause an eye infection that may lead to permanent blindness if fluid from the sores gets into the eyes. For this reason it is important for people with cold sores to avoid scratching or squeezing the blisters.

Prevention

The National Institutes of Health (NIH) recommends the following measures to lower the risk of spreading HSV-1 to other parts of the body or to other people, and to lower the frequency of recurrences.

- Avoid kissing or close contact with others while the blisters are present.
- Avoid sharing items that touch the mouth. These include towels, washcloths, lipsticks, lip balms, razors, and toothbrushes as well as drinking glasses and food utensils.
- Keep the hands clean. Wash them frequently and avoid touching the eyes or genital area during an outbreak.
- Avoid putting the fingers in the mouth or biting fingernails.
- Try to avoid such common triggers of cold sores as colds or flu, high stress levels, or being short on sleep.

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- Avoid contact sports (football, wrestling, etc.) during an outbreak.
- Use sunblock on the lips and face when outdoors for long periods of time.

Some people with frequent recurrences of cold sores benefit from an over-the-counter dietary supplement called lysine, which is an amino acid (one of the building blocks of proteins). Patients should check with their doctor to see whether lysine might be helpful for them.

People who develop significant related illnesses during cold sore outbreaks, are frequently exposed to sunlight or other known triggers, or have frequent outbreaks of cold sores may wish to ask their doctor or dentist for an antiviral drug to help prevent recurrent outbreaks.

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ORGANIZATIONS

American Academy of Dermatology (AAD), P.O. Box 4014, Schaumburg, IL, 60168, (847) 330-0230, (866) 503-SKIN, (847) 240-1859, http://www.aad.org.

American Dental Association (ADA), 211 East Chicago Ave., Chicago, IL, 60611, (312) 440-2500, http://www.ada.org.

Rebecca J. Frey, PhD

Cold spot myocardial imaging *see* **Thallium heart scan**

Colds *see* **Common cold**

Colic

Definition

Colic is persistent, unexplained crying in a healthy baby between two weeks and five months of age.

Demographics

Colic affects between 10–30% of babies. It occurs equally in male and female babies and is independent of race or ethnicity.

Description

Colic is not a disease. Symptoms of colic usually appear when a baby is 14–21 days old, reach a crescendo at the age of three months, and disappear within the next eight weeks. Episodes occur frequently, but intermittently, and usually begin with prolonged periods of crying in the late afternoon or evening. Crying can last for a few minutes or continue for several hours.

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KEY TERMS

Gastroesophageal reflux—A condition in which the stomach contents back up into the esophagus. Because the stomach contents are highly acidic, this can cause irritation and heartburn.

Some babies who have colic are simply fussy. Others cry so hard that their faces turn red, then pale.

Causes and symptoms

No one knows what causes colic or why some babies are colicky and others are not. The condition may be the result of swallowing large amounts of air, which becomes trapped in the digestive tract and causes bloating and severe abdominal **pain**.

Other possible causes of colic include:

- digestive tract immaturity
- food intolerances
- hunger or overfeeding
- gastroesophageal reflux
- overheated milk or formula
- overstimulation resulting from noise, light, or activity

During a colicky episode, babies' bellies often look swollen, feel hard, and make a rumbling sound. Crying intensifies, tapers off, and then gets louder. Many babies grow rigid, clench their fists, curl their toes, and draw their legs toward their body. A burp or a bowel movement can end an attack. Most babies who have colic do not seem to be in pain between attacks.

Diagnosis

Pediatricians and family physicians suspect colic in an infant who:

- has cried loudly for at least three hours a day at least three times a week for three weeks or longer
- is not hungry but cries for several hours between dinnertime and midnight
- demonstrates the clenched fists, rigidity, and other physical traits associated with colic

The baby's medical history and a parent's description of eating, sleeping, and crying patterns are used to confirm a diagnosis of colic. Studies have shown that colic crying is different from regular crying in that it is higher pitched, more turbulent, and more urgent than regular crying. **Physical examination** and laboratory tests are used to rule out infection, intestinal blockage, and other conditions that can cause abdominal pain and other colic-like symptoms.

Treatment

Home remedies

Medications do not cure colic. Doctors sometimes recommend simethicone (Mylicon Drops) to relieve gas pain, but generally advise parents to take a practical approach to the problem.

Gently massaging the baby's back can release a trapped gas bubble, and holding the baby in a sitting position can help prevent air from being swallowed during feedings. Bottle-fed babies can swallow air if nipple holes are either too large or too small.

Nipple-hole size can be checked by filling a bottle with cold formula, turning it upside down, and counting the number of drops released when it is shaken or squeezed. A nipple hole that is the right size will release about one drop of formula every second.

Babies should not be fed every time they cry, but feeding and burping a baby more often may alleviate symptoms of colic. A bottle-fed baby should be burped after every ounce, and a baby who is **breastfeeding** should be burped every five minutes.

When cow's milk is the source of the symptoms, bottle-fed babies should be switched to a soymilk hydrolyzed protein formula. A woman whose baby is breastfeeding should eliminate dairy products from her diet for seven days, then gradually reintroduce them unless the baby's symptoms reappear.

Since intolerance to foods other than cow's milk may also lead to symptoms of colic, breastfeeding women may also relieve their babies' colic by eliminating from their diet:

- coffee
- tea
- cocoa
- citrus
- peanuts
- wheat
- broccoli and other vegetables belonging to the cabbage family

Rocking a baby in a quiet, darkened room can prevent overstimulation, and a baby usually calms down when cuddled in a warm, soft blanket.

Colicky babies cry less when they are soothed by the motion of a wind-up swing, a car ride, or being carried in a parent's arms. Pacifiers can soothe babies who are upset, but a pacifier should never be attached to a string.

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Alternative treatment

Applying gentle pressure to the webbed area between the thumb and index finger of either hand can calm a crying child. So can gently massaging the area directly above the child's navel and the corresponding spot on the spine. Applying warm compresses or holding your hand firmly over the child's abdomen can relieve cramping.

Teas made with chamomile (*Matricaria recutita*), lemon balm (*Melissa officinalis*), peppermint (*Mentha piperita*), or dill (*Anethum graveolens*) can lessen bowel inflammation and reduce gas. A homeopathic combination called "colic" may be effective, and constitutional homeopathic treatment can help strengthen the child's entire constitution.

A doctor should be notified if a baby who has been diagnosed with colic:

- develops a rectal fever higher than 101°F (38.3 °C)
- cries for more than four hours
- vomits
- has diarrhea or stools that are black or bloody
- loses weight
- eats less than normal

Prognosis

Colic is distressing, but it is not dangerous. Symptoms almost always disappear before a child is six months old.

Prevention

Many doctors believe that colic cannot be prevented. Some alternative practitioners, however, feel that colic can be prevented by an awareness of food intolerances and their impact.

Resources

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Deshpande, Prashant G. Colic. eMedicine.com October 7, 2009. http://emedicine.medscape.com/article/927760-overview

ORGANIZATIONS

American Academy of Family Physicians, P. O. Box 11210, Shawnee Mission, KS, 66207, (913) 906-6000, (800) 274-2237, (913) 906-6075, http://familydoctor.org.

American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, IL, 60007-1098, (847) 434-4000, (847) 434-8000, http://www.aap.org.

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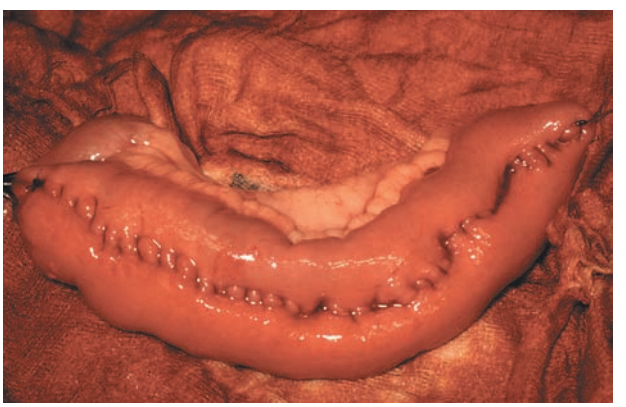
Colitis

Definition

Colitis, also called ulcerative colitis, is an inflammatory bowel disease closely related to **Crohn's disease**. In individuals with colitis, the lining of the colon (large intestine) becomes inflamed, cells lining the wall die, and ulcers form on the colon wall.

Demographics

In the United States, the prevalence rate of ulcerative colitis is estimated at between 35 and 100 individuals per 100,000 population. This means that more than 2 million Americans have ulcerative colitis, which is a lifelong disease. The disease develops most often before the individual reaches age 30, although it can develop as late as age 60. People of Jewish ethnicity appear to be more likely to develop ulcerative colitis, and women are slightly more likely to develop colitis than men. The disease is less common in South America, Asia, and Africa than in the United States.



A specimen of a colon indicating ulcerative colitis. *(Photo Researchers, Inc.)*

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KEY TERMS

Colonoscopy—A procedure in which the colon is cleansed and the a lighted fiber optic instrument is inserted through the anus to allow the physician to view the entire length of the colon and detect abnormalities in the colon lining, including polyps and ulcers.

Electrolyte—Ions in the body that participate in metabolic reactions. The major human electrolytes are sodium (Na+), potassium (K+), calcium (Ca 2+), magnesium (Mg2+), chloride (Cl-), phosphate (HPO4 2-), bicarbonate (HCO3-), and sulfate (SO4 2-).

Rectum—The last few inches of the large intestine that store waste until it is eliminated from the body through the anus.

Steroid—A family of compounds that share a similar chemical structure. This family includes estrogen and testosterone, vitamin D, cholesterol, and the drugs cortisone and prednisone.

Description

Colitis is an inflammatory bowel disease of uncertain origin. In this disease, the lining of the colon and rectum become inflamed and develop sores (ulcers) that produce pus and mucus. In mild cases, only the lining of the intestine is affected, but in severe cases, these ulcers may penetrate deeper layers of the colon or even perforate (break through) the colon wall. In ulcerative colitis, the inflamed area is continuous and develops only in the rectum and colon. This condition contrasts with Crohn's disease (a related inflammatory bowel disease), in which the inflamed area develops in patches and can occur in multiple places in the digestive system from the mouth to the rectum. There is no cure for ulcerative colitis, although treatment can bring symptoms under control or cause them to go into remission (disappear) for long periods.

Causes and symptoms

The cause of colitis is unclear. As of 2010, scientists believed that people who develop colitis carry an inherited susceptibility to developing the disease. Research has shown that people who have a parent or sibling with colitis are more likely to also develop colitis, and if one identical twins is affected, it is highly likely the other will also have the disease. However, inheritance does not completely predict who will develop colitis. Researchers believe that when a person with an inherited susceptibility to the disease is exposed to an outside agent, an inappropriate autoimmune reaction is triggered. As a result, the immune system attacks the body's own cells lining the intestine. No single outside trigger agent has been isolated. Suspect agents include bacteria, viruses, and environmental toxins. In the past, it was thought that **food allergies** could trigger colitis. Practitioners of conventional medicine subsequently determined that this was not the cause, although some alternative medical practitioners continued to accept the food allergy theory.

Symptoms associated with colitis include abdominal **pain** and cramps; frequent, urgent bowel movements; **diarrhea** with blood, pus, and mucus in the stool; and **fever**. Other signs of colitis occur because the disease interferes with the ability of the digestive system to absorb nutrients. These symptoms include **fatigue**, loss of appetite, weight loss, **dehydration**, and in severe cases, electrolyte imbalance. Because the immune system responds inappropriately, other parts of the body may be affected. The individual may develop joint pain, liver, kidney, and eye problems, and skin **rashes**. Although colitis is not caused by **stress** or food **allergies**, stress and certain foods (e.g., milk) tend to worsen symptoms.

Diagnosis

Symptoms of colitis mimic those of several other bowel diseases. Colitis is often diagnosed after extensive testing has ruled out other causes. After a health history and **physical examination**, the physician will order additional tests, including blood tests and a stool sample. The stool sample is examined for blood and parasites. Imaging tests include a **barium enema** and x rays of the intestine. By cleansing the intestine and filling it with barium, a white, chalky, non-toxic substance, abnormalities of the bowel are more easily seen on the x-ray film. Ultrasound and computed tomography, two non-invasive imaging techniques, may also be done. A definitive diagnosis usually is obtained by a **colonoscopy**, an invasive procedure that allows the physician to examine the colon lining for the entire length of the colon.

Treatment

The goal of colitis treatment is to control symptoms and improve quality of life. As of 2010, there was no cure for the disease. Conventional medicine treats the symptoms of ulcerative colitis primarily with drugs, although conventional practitioners also may recommend some complementary therapies suggested

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in the following text. Treatment is individualized and depends on the severity of the disease and the specific symptoms of the individual.

Drugs

Drug treatment depends on the severity of symptoms and whether ulcerative colitis is active or in remission. Anti-inflammatory drugs are at the heart of drug treatment for ulcerative colitis. Sulfasalazine (Azulfidine, EN-Tabs)is the most common anti-inflammatory drug used to treat mild to moderate ulcerative colitis because patients can safely take it for long maintenance periods, and it can be given with other drugs. Other anti-inflammatory drugs include mesalamine (Pentasa, Asacol, Rowasa, Canasa) and Balsalazide (Colazal). If these drugs do not provide adequate symptom relief, patients may be given **corticosteroids** such as prednisone and methylprednisolone. Corticosteroid drugs have substantial side effects and can be taken only for a short time during symptom flare-ups.

Medications used to treat diarrhea symptoms include diphenoxylate (Lomotil, Lofene), and loperamide (Imodium, Kaopectate). Anticholinergic drugs, which block the communication between nerves and muscles and thus reduce contraction of the intestine, include hyoscyamine (Anaspaz Cystospaz), and dicyclomine (Bentyl).

People with severe symptoms and complications beyond the digestive system may be hospitalized and given intravenous (IV) steroid drugs or drugs that suppress the immune system. These include the tumor necrosis factor inhibitor drug infliximab (Remicade), azathioprine (Imuran), cyclosporine (Neoral, Sandimmune), and 6-mercaptopurine (Purinethol). Since colitis is suspected of being caused by an inappropriate immune system response, suppressing the activity of the immune system may reduce symptoms. Once a flare-up is controlled, the individual continues on a maintenance dose of some combination of diarrhea-control, anti-inflammatory, and **immunosuppressant drugs**.

Surgery

Between 25% and 40% of people with ulcerative colitis develop symptoms so severe that they eventually need surgery (a colectomy) to remove their colon. When the colon is removed, the final portion of the small intestine is connected to a hole (stoma) in the abdomen. The individual wears a bag outside the body to collect waste. The bag must be emptied at regular intervals. Alternately, if part of the rectum is left intact the small intestine may be connected directly to the rectum after the colon is removed. Waste leaves the body through the anus in the regular manner. Bowel movements are more frequent and watery, as fluid that would normally be absorbed in the colon now passes out of the body.

Diet

Certain foods seem to worsen symptoms of colitis in many people. Individuals must determine their own problem foods and learn to avoid them. General suggestions for dietary changes that help many people include the following:

- Drink 8–10 glasses of water or clear fluids daily to prevent dehydration, which is especially important for people who have frequent watery bowel movements.
- Avoid high fiber foods. If symptoms are under control, some high-fiber foods may gradually be added back into the diet.
- Experiment with whether dairy products worsen symptoms; many people find that milk and cheese seem to exacerbate their symptoms.
- Avoid caffeine because it stimulates the digestive tract.
- Avoid drinking alcohol.
- Eat a low-fat diet.
- Eat smaller, more frequent meals.

Alternative and Complementary Therapies

HERBS. Certain herbal remedies have been shown to improve symptoms for some people. These include the following:

- Psyllium. Recommended by both alternative and conventional physicians, psyllium absorbs water and adds bulk to the stool.
- Boswellia resin (*Boswellia sacra.*) is thought to have anti-inflammatory properties. In a small study, when taken with sulfasalazine (a pharmaceutical drug), it increased the number of patients whose symptoms went into remission.
- Aloe (*Aloe vera*) juice or oral gel is thought to improve the chance of remission.
- Turmeric *Curcuma longa* is thought to have useful anti-inflammatory properties.

SUPPLEMENTS. Many people with moderate to severe symptoms develop vitamin and mineral deficiencies that need to be corrected with supplements and/or a multivitamin. Alternative practitioners also recommend a wide range of supplements that have shown mixed results in small trials. Some of these are:

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- Probiotics. Probiotics are beneficial living organisms, usually bacteria that supplement the beneficial bacteria normally found in the intestines. Some studies have found that a non-disease producing strain of *Escherichia coli* helps some people with ulcerative colitis remain in remission. Probiotics and their effects on digestive diseases were active areas of research in 2010. Several Food and Drug Administration approved clinical trials of probiotics are being conducted in the United States for people with colitis. Information on trials enrolling participants is available at http://www.clinicaltrials.gov.
- Fish oil. Some studies have found that fish oil supplements increased weight gain and decreased the need for anti-inflammatory drugs, while others found fish oil was ineffective in patients with ulcerative colitis.
- Folic acid (Vitamin B_9). Sulfasalazine inhibits the absorption of folic acid, so people taking this drug may need supplementation. However, taking folic acid supplements can mask a vitamin B_{12} deficiency, so people taking folic acid may also need to take B_{12}. A physician should be consulted before taking these vitamins.
- Dehydroepiandrosterone (DHEA). This natural steroid hormone is produced in small amounts by the body. In studies, improvement was seen only with large supplement doses with a high likelihood of undesirable side effects.
- Iron. People who have a lot of blood in their stool are at risk of becoming iron deficient (anemic).

HOME REMEDIES. Although stress does not cause colitis, it often worsens symptoms, so **stress reduction** techniques such as the following should be incorporated into the daily routine.

- Mild to moderate exercise can help stabilize bowel function and improve mood.
- Yoga helps to relax the body and relieve tension.
- Meditation calms the body and mind.
- Biofeedback training helps individuals have more control over their body and allows individuals to consciously enter a relaxed state.
- Support groups allow people to share tips and frustrations in an atmosphere of mutual understanding.

Prognosis

Colitis cannot be cured. Most people go though periods of remission followed by periods of flare-ups when symptoms worsen. Remission can last from months to years depending on the individual.

Prevention

Ulcerative colitis cannot be prevented. About 5% of people who have ulcerative colitis later develop **colon cancer**. Regular yearly colonoscopies can detect colon **cancer** early when it can be easily treated.

Resources

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ORGANIZATIONS

Alternative Medicine Foundation., PO Box 60016, Potomac, MD, 20859, (301) 340-1960, (301) 340-1936, http://www.amfoundation.org.

Crohn's & Colitis Foundation of America., 386 Park Avenue South, 17th Floor, New York, NY, 10016, (800) 932-2423, info@ccfa.org, http://www.ccfa.org.

National Digestive Diseases Information Clearinghouse (NDDIC)., 2 Information Way, Bethesda, MD, 20892-3570, (800) 891-5389; TTY (866) 569-1162 , (703) 738-4929, info@niddk.nih.gov, http://digestive.niddk.nih.gov.

Tish Davidson, A.M.

Collapsed lung *see* **Pneumothorax**

Colloidal bath *see* **Therapeutic baths**

Colon cancer

Definition

Cancer of the colon is a disease characterized by the development of malignant cells in the lining or epithelium of the large intestine. Malignant cells have lost normal control mechanisms governing growth. These cells may invade surrounding local tissue or they may spread throughout the body and invade other organ systems.

Synonyms for the colon include the large bowel or the large intestine. The rectum is the continuation of the large intestine into the pelvis that terminates in the anus.

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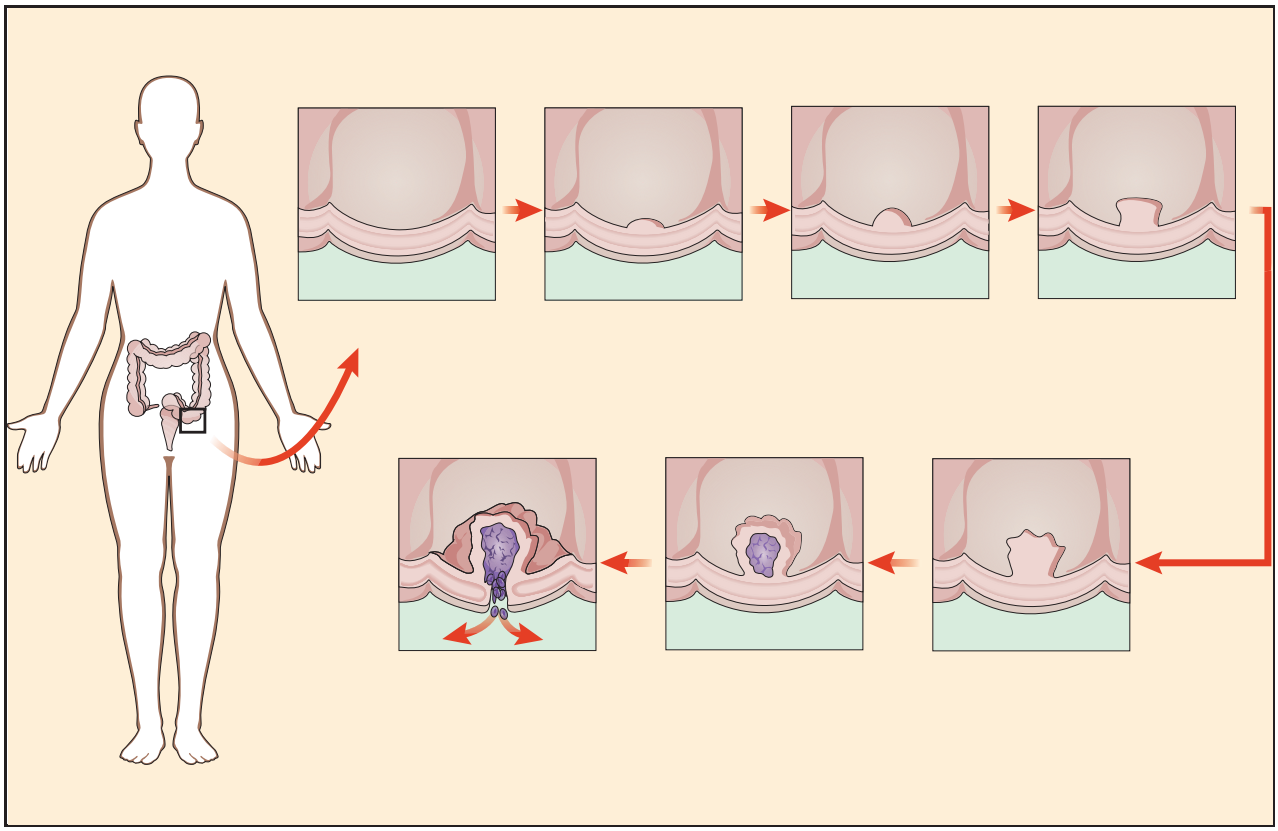

Illustration showing the development of a cancerous tumor within the colon. *(Illustration by Argosy, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

Demographics

There are at least 100,000 new cases of colon cancer diagnosed per year in the United States. Excluding skin cancers, colorectal cancer is the 4th most commonly diagnosed cancer in both men and women in the United States. Colorectal cancer is the second leading cause of deaths from cancer. The **death** rate from colon cancer has been declining for the last 30 years. The decline in the death rate is attributed to more accurate screening procedures, which find and make possible the removal of problematic polyps before they convert to cancer. Screening also facilitates finding cancer in earlier, more treatable stages. In addition, treatment methodologies for colon cancer have improved dramatically over the last decade.

There are over one million colon cancer survivors in the United States alone.

Approximately one-third of colon cancer cases are associated with familial clustering. First degree relatives of patients with newly diagnosed colorectal adenomas or invasive colorectal cancer are considered to be at high risk for the development of the disease and should be screened for the presence of colorectal cancer.

Description

Risk factors

Several risk factors are related to the development of colon cancer including:

- increasing age; most cases of colon cancer are diagnosed after age 50
- personal history of colon polyps or colorectal cancer
- personal history of inflammatory bowel disease such as ulcerative colitis or Crohn's disease
- family history of colorectal cancer, especially in a first degree relative (parent of sibling)
- presence of an inherited syndrome such as familial adenomatous polyposis (FAP) and hereditary non–polyposis colorectal cancer (HNPCC). Between 5 and 10% of people have an inherited gene that causes

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colorectal cancer. The two most common types of these syndromes are FAP and HNPCC.

- African American race
- Jews of Eastern European descent (Ashkenazi Jews). Members of this ethnic group have some of the highest rates of colorectal cancer in the world.
- consuming a diet high in red meats, processed meats, and cooking foods at high temperatures
- physical inactivity
- obesity
- history of smoking
- history of heavy alcohol use
- personal history of type II diabetes

The colon is a tubular organ beginning in the right lower abdomen. It ascends on the right side of the abdomen, traverses from right to left in the upper abdomen, descends vertically down the left side, takes an S–shaped curve in the lower left abdomen, and then flows into the rectum as it leaves the abdomen for the pelvis. These portions of the colon are named separately although they are part of the same organ.

- cecum, the beginning of the colon
- ascending colon, the right vertical ascent of the colon
- transverse colon, the portion traversing from right to left
- descending colon, the left vertical descent of the colon
- sigmoid colon, the S–shaped segment of colon above the pelvis

These portions of the colon are recognized anatomically based on the arterial blood supply and venous and lymphatic drainage of these segments of the colon. Lymph, a protein–rich fluid that bathes the cells of the body, is transported in small channels known as lymphatics that run alongside the veins of the colon. Lymph nodes are small filters through which the lymph travels on its way back to the bloodstream. Cancer can spread elsewhere in the body by invading the lymph and vascular systems. Therefore, these anatomic considerations become very important in the treatment of colon cancer.

The small intestine is the continuation of the upper gastrointestinal tract responsible for carrying ingested nutrients into the body. The waste left after the small intestine has completed absorption of nutrients amounts to about a quart (a few liters), of material per day and is directly delivered to the colon, (at the cecum), for processing. The colon is responsible for the preservation of fluid and electrolytes as it propels the increasingly solid waste toward the rectum and anus for excretion.

When cells lining the colon become malignant, they first grow locally and may invade partially or totally through the wall of the bowel and even into adjacent structures and organs. In the process, the tumor can penetrate and invade the lymphatics or the capillaries locally and gain access to the circulation. As the malignant cells work their way to other areas of the body, they again become locally invasive in the new area to which they have spread. These tumor deposits, originating from the colon primary tumor, are then known as metastases. If metastases are found in the regional lymph nodes from the primary, they are known as regional metastases, or regional nodal metastases. If they are distant from the primary tumor, they are known as distant metastases. The patient with distant metastases has systemic disease. Thus the cancer originating in the colon begins locally and, given time, can become systemic.

In most cases, colon cancer develops slowly over several years. Prior to a cancer's developing, a non–cancerous polyp may appear on the inner lining of the colon. A polyp typically begins as a benign (non–cancerous) growth of tissue. Over time, some polyps can convert into cancerous tumors.

There are two major types of polyps, adenomatous polyps (adenomas) and hyperplastic and inflammatory polyps. Adenomatous polyps are considered pre–cancerous lesions while hyperplastic and inflammatory polyps are generally not pre–cancerous.

Some individuals may have evidence of dysplasia (cells look abnormal) in the lining of the colon. These abnormal–looking cells may transform to cancerous cells over time. Individuals with a history of Crohn's disease or ulcerative **colitis** may show evidence of dysplasia in the colon.

More than 95% of colorectal cancers are classified as adenocarcinomas. This type of cancer originates from glands that secrete mucus which lubricates the lining of the colon.

Causes and symptoms

Causes

Carcinogenesis is the process by which agents in the environment may induce mutation. It is caused by agents known as **carcinogens** (cancer–causing agents). Specific carcinogens related to the development of colon cancer have been difficult to identify; however, dietary factors seem to be involved.

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KEY TERMS

Adenocarcinoma—Type of cancer beginning in glandular epithelium.

Adjuvant therapy—Treatment involving radiation, chemotherapy (drug treatment), or hormone therapy, or a combination of all three given after the primary treatment for the possibility of residual microscopic disease.

Anastomosis—Surgical reconnection of the ends of the bowel after removal of a portion of the bowel.

Anemia—The condition caused by too few circulating red blood cells, often manifested in part by fatigue.

Carcinogens—Substances in the environment that cause cancer, presumably by inducing mutations, with prolonged exposure.

Electolytes—Salts, such as sodium and chloride.

Epithelium—Cells composing the lining of an organ.

Lymph nodes—Cellular filters through which lymphatics flow.

Lymphatics—Channels that are conduits for lymph.

Malignant—Cells that have been altered such that they have lost normal control mechanisms and are capable of local invasion and spread to other areas of the body.

Metastasis—Site of invasive tumor growth that originated from a malignancy elsewhere in the body.

Mutation—A change in the genetic makeup of a cell that may occur spontaneously or be environmentally induced.

Occult blood—Presence of blood that cannot be seen with the naked eye.

Polyps—Localized growths of the epithelium that can be benign, precancerous, or harbor malignancy.

Radical resection—Surgical resection that takes the blood supply and lymph system supplying the organ along with the organ.

Resect—To remove surgically.

Sacrum—Posterior bony wall of the pelvis.

Systemic—Throughout the body.

Colon cancer is more common in industrialized nations. **Diets** high in fat, red meat, total calories, and alcohol seem to predispose people to the disease. Diets high in fiber appear to decrease risk. High–fiber diets may help lessen exposure of the colon lining to carcinogens from the environment, as the transit time through the bowel is faster with a high–fiber diet than it is with a low fiber diet.

Age plays a definite role in the predisposition to colon cancer. Two-thirds of all cases occur after age 50 and the average age for those who develop the disease is 62.

There is also a increased risk for colon cancer in the individual who smokes.

Patients who suffer from inflammatory diseases of the colon known as ulcerative colitis and Crohn's colitis are also at increased risk.

Researchers know there is a genetic link to many cases of colon cancer, those called familial cases. This type of colon cancer tends to run in families. In late 2003, a team of researchers identified the specific location on a human chromosome by analyzing blood samples from 53 families in which at least one member had a colon cancer or precancerous colon polyp.

The development of polyps of the colon almost always precedes the development of colon cancer by five or more years. Polyps are benign growths of the colon lining. They can be unrelated to cancer, precancerous, or malignant. Polyps, when identified, are removed for diagnosis. If the polyps are benign, the patient should undergo careful surveillance for the development of more polyps or the development of colon cancer.

Symptoms

Colon cancer causes symptoms related to its local presence in the large bowel or by its effect on other organs if it has spread. These symptoms may occur alone or in combination:

- a change in bowel habit
- blood in the stool
- bloating, persistent abdominal distention
- constipation
- a feeling of fullness even after having a bowel movement
- narrowing of the stool—so–called ribbon stools
- persistent, chronic fatigue
- abdominal discomfort
- unexplained weight loss
- (very rarely) nausea and vomiting

Most of these symptoms are caused by the physical presence of the tumor mass in the colon. Similar symptoms can be caused by other processes; they are not absolutely specific to colon cancer. The key is recognizing that the persistence of these symptoms

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without ready explanation should prompt the individual to seek medical evaluation.

If a tumor develops in the colon, it will begin to cause symptoms as it reaches a certain size. The symptoms are caused by the tumor blocking the opening in the colon. In addition, the tumor commonly oozes blood that is lost in the stool. (Often, this blood is not visible.) This condition results in anemia and chronic **fatigue**. Weight loss is a late symptom, often implying substantial obstruction or the presence of systemic disease.

Diagnosis

In all other cancers (breast and prostate, for example), screening tests look for small, malignant lesions. Screening for colorectal cancers, however, involves the search for pre–malignant, benign polyps. This screening can be close to 100% effective in preventing cancer development, not just in detecting small cancers.

Screening involves physical exam, simple laboratory tests, and the visualization of the lining of the colon. To visualize the colon epithelium, clinicians use x rays (indirect visualization) and **endoscopy** (direct visualization).

Examination

The **physical examination** involves the performance of a digital rectal exam (DRE). The DRE includes manual examination of the rectum, anus and the prostate. During this examination, the physician examines the anus and the surrounding skin for **hemorrhoids**, abscesses, and other irregularities. After lubricating the gloved finger and anus, the examiner gently slides the finger into the anus and follows the contours of the rectum. The examiner notes the tone of the anus and feels the walls and the edges for texture, tenderness, and masses as far as the examining finger can reach. At the time of this exam, the physician checks the stool on the examining glove with a chemical to see if any occult (invisible), blood is present. At home, after having a bowel movement, the patient is asked to swipe a sample of stool obtained with a small stick on a card. After three such specimens are on the card, the card is then easily chemically tested for occult blood also. (The stool analysis mentioned here is known as a **fecal occult blood test**, or FOBT, and, while it can be helpful, it is not 100% accurate. Only about 50% of cancers are FOBT–positive.) These exams are accomplished as an easy part of a routine yearly physical exam.

Tests

Proteins are sometimes produced by cancers and these may be elevated in the patient's blood. When this occurs, the protein produced is known as a tumor marker. There is a tumor marker for some cancers of the colon; it is known as carcinoembryonic antigen, or CEA. Unfortunately, this protein may be made by other adenocarcinomas as well, or it may not be produced by a particular colon cancer. Therefore, screening by chemical analysis for CEA has not been helpful. CEA has been helpful when used in a follow–up role for patients treated for colon cancer if their tumor makes the protein.

Procedures

Indirect visualization of the colon may be accomplished by inserting a compound of barium into the rectum and filling the colon with this compound. Barium compounds produce a white contrast image of the lining of the colon on x ray and thus the contour of the lining of the colon may be seen. Detail can be increased if the barium utilized is thinned and air also introduced. These studies are known as the **barium enema** (BE), and the double contrast barium enema (DCBE).

Direct visualization of the colon lining is accomplished using a scope or endoscope. The physician introduces the instrument through the rectum. Older, shorter scopes were rigid. Today, utilizing fiberoptic technology, the scopes are flexible and can reach into the colon much farther. If the left colon only is visualized, it is called flexible **sigmoidoscopy**. When the entire colon is visualized, the procedure is known as **colonoscopy**.

A procedure called virtual colonoscopy has been developed but debate continues on whether or not it is effective as colonoscopy. Virtual colonoscopy refers to the use of imaging, usually with computed tomography (CT) scans or **magnetic resonance imaging** (MRI) to produce images of the colon. Studies have shown that virtual colonoscopy is as effective as colonoscopy for screening purposes and it offers the advantage of being less invasive and less risky. However, many physicians are unwilling to accept it as a replacement for colonoscopy, particularly since some patients might still require the regular colonoscopy as a follow–up to the virtual procedure if a polyp or abnormality is found that requires biopsy.

Unlike the indirect visualizations of the colon (the BE and the DCBE), endoscopic screenings allow a physician to remove polyps and to biopsy suspicious tissue. (A biopsy is a removal of tissue for examination by a pathologist.) For this reason, many physicians

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prefer endoscopic screening. All of the visualizations, the BE, DCBE, and each type of endoscopy, require pre–procedure preparation (evacuation) of the colon.

If patients have symptoms that could possibly be related to colon cancer, the entire colon will be examined. The combination of a flexible sigmoidoscopy and DCBE may be performed, but the preferred evaluation of the entire colon and rectum is a complete colonoscopy. Colonoscopy allows direct visualization, photography, and the opportunity to obtain a biopsy of any abnormality visualized. If, for technical reasons, the entire colon is not visualized endoscopically, a DCBE should complement the colonoscopy.

The diagnosis of colon cancer is actually made by the performance of a biopsy of any abnormal lesion in the colon. When a tumor growth is identified, it could be either a benign polyp (or lesion) or a cancer; the biopsy resolves the issue. The endoscopist may take many samples to exclude any sampling errors.

If the patient has advanced disease at the time of diagnosis, areas where the tumor has spread (such as the liver) may be amenable to biopsy. Such biopsies are usually obtained using a special needle under **local anesthesia**.

Once a diagnosis of colon cancer has been established by biopsy, in addition to the physical exam, studies will be performed to assess the extent of the disease. Blood studies include a **complete blood count**, **liver function tests**, and a CEA. Imaging studies will include a CT scan (computed tomography scan) of the chest, abdomen, and pelvis. The scans will determine if the cancer has spread to the lung, will evaluate potential spread to the liver, and can determine whether any local spread of the primary tumor has occurred. If the patient has any neurologic symptoms, a CT scan of the brain will be performed, and if the patient is experiencing bone **pain**, a **bone scan** also will be performed.

Treatments

Once the diagnosis has been confirmed by biopsy, the clinical stage of the cancer is assigned. Stage is determined based on the characteristics of the primary tumor, its depth of penetration through the bowel, and the presence or absence of regional or distant metastases. Often, the depth of penetration through the bowel or the presence of regional lymph nodes can not be assigned before surgery.

Colon cancer is assigned stages I through IV, based on the following general criteria:

- Stage I: The tumor is confined to the epithelium or has not penetrated through the first layer of muscle in the bowel wall.
- Stage II: The tumor has penetrated through to the outer wall of the colon or has gone through it, possibly invading other local tissue.
- Stage III: The tumor has developed to include regional lymph node involvement.
- Stage IV: The cancer has spread to at least one distant organ (such as the liver or lungs) or lymph nodes, or has spread to a distant part of the peritoneum.

With many cancers other than colon cancer, staging plays an important role to best determine treatment options. Colon cancers are also graded based on how closely the cancer cells resemble normal cells. The grading scale is G1 to G4 with cells graded as G1 looking the most normal and cells graded as G4 looking the most abnormal. Low grade tumors (G1) tend to grow more slowly and are less likely to metastasize to distant organs which may result in a better prognosis.

Traditional

SURGERY. Almost all colon cancers are treated with surgery first, regardless of stage. Colon cancers through Stage III, and even some Stage IV colon cancers, are treated with surgery first, before any other treatments are considered.

Surgical removal of the involved segment of colon (colectomy) along with its blood supply and regional lymph nodes is the primary therapy for colon cancer. Usually, the partial colectomies are separated into right, left, transverse, or sigmoid sections based on the blood supply. The removal of the blood supply at its origin along with the regional lymph nodes that accompany it ensures an adequate margin of normal colon on either side of the primary tumor. When the cancer lies in a position such that the blood supply and lymph drainage between two of the major vessels, both vessels are taken to assure complete radical resection or removal (extended radical right or left colectomy). If the primary tumor penetrates through the bowel wall, any tissue adjacent to the tumor extension is also taken, if feasible.

Surgery is used as primary therapy for stages I through III colon cancer unless there are signs that local invasion will not permit complete removal of the tumor, as may occur in advanced stage III tumors. However, this circumstance is rare, occurring in less than 2% of all colon cancer cases.

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After the resection is completed, the ends of the remaining colon are reconstructed; the reattachment is called an anastomosis. Once healing has occurred, there may be a slight increase in the frequency of bowel movements. This effect usually lasts only for several weeks. Most patients go on to develop completely normal bowel function.

Occasionally, the anastomosis is risky and cannot be performed. When the anastomosis cannot be performed, a **colostomy** is performed instead. A colostomy is performed by bringing the end of the colon through the abdominal wall and sewing it to the skin. The patient will have to wear an appliance (a bag) to manage the stool. The colostomy may be temporary and the patient may undergo a reattachment at a later, safer date, or the colostomy may be permanent. In most cases, emergent colostomies are not reversed and are permanent.

RADIATION. **Radiation therapy** is used as an adjunct to surgery if there is concern about potential for local recurrence post–operatively and the area of concern will tolerate the radiation. For instance, if the tumor invaded muscle of the abdominal wall but was not completely removed, this area would be considered for radiation. Radiation may also be given in combination with **chemotherapy** prior to surgery (neoadjuvant therapy) to shrink the size of the tumor. Radiation has significant dose limits when residual bowel is exposed to it because the small and large intestine do not tolerate radiation well.

CHEMOTHERAPY. Chemotherapy is useful for patients who have had all identifiable tumor removed and are at risk for recurrence (adjuvant chemotherapy). The FOLFOX chemotherapy regimen is a common regimen administered as adjuvant therapy in the treatment of colon cancer. This regimen includes the drugs oxaliplatin, 5–FU, and leucovorin. The drugs 5–FU and leucovorin given in combination or the drug capcetibine given alone may also be used. Adjuvant chemotherapy administered after surgery may be continued for a total of six months of chemotherapy.

TARGETED THERAPIES. Targeted therapies work in ways that are different from the way chemotherapy works. Targeted therapies, as the name implies, target specific proteins on the cellular structures of cancer cells in an attempt to kill the cancer cells. The advantage of targeted therapy is that normal cells which do not contain the abnormal proteins the cancer cells contain are usually not affected by the targeted therapy. Therefore, side effects of these drugs are often less pronounced than the side effects from chemotherapy. Targeted therapy drugs used to treat colon cancer include bevacizumab (Avastin), cetuximab (Erbitux), and panitumumab (Vectibix).

Prognosis

Prognosis is the long–term outlook or survival after therapy. As expected, the survival rates are dependent upon the stage of the cancer at the time of diagnosis, making early detection crucial.

Colon cancer is highly treatable and often curable if detected when the cancer is localized in the bowel. Surgery is the primary treatment choice for most cases of colon cancer and results in a cure for about 50% of patients.

Five year survival rates for colon cancer range from 74% in patients diagnosed with Stage I disease to 6% for patients diagnosed in Stage IV.

Prevention

There is not an absolute method for preventing colon cancer. Still, there are steps an individual can take to dramatically lessen the risk or to identify the precursors of colon cancer so that it does not manifest itself. The patient with a familial history can enter screening and surveillance programs earlier than the general population. High–fiber diets and **vitamins**, avoiding **obesity**, and staying active lessen the risk. Avoiding cigarettes and alcohol may be helpful. By controlling these environmental factors, an individual can lessen risk and to this degree prevent the disease.

People who turn age 50, and all of those with a history of colon cancer in their families (even if younger than age 50), should speak with their physicians about the most recent screening recommendations from physician and cancer organizations. They should watch for symptoms and attend all recommended screenings to increase the likelihood of catching colon cancer early.

Resources

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Sargent, D., et al. "Evidence for Cure by Adjuvant Therapy in Colon Cancer: Observation Based on Individual Patient Data form 20,898 Patients in 18 Randomized Trials." *Journal of Clinical Oncology* 27 (2009):872–877.

ORGANIZATIONS

American Cancer Society, (800) ACS–2345, http://www.cancer.org.

Cancer Information Service of the NCI, 9000 Rockville Pike, Bethesda, MD, 20892, (800) 4–CANCER, NIHinfo@od.nih.gov, http://www.cancer.gov.

Colon Cancer Alliance, 1200 G Street, NW, Suite 800, Washington, DC, 20005, (202) 434–8980, (877) 422–2030, (866) 304–9075, aspiegel@ccalliance.org, www.ccalliance.org.

National Cancer Institute Cancer Trials, 6116 Executive Boulevard, Suite 300, Bethesda, MD, 20892–8322, (800) 422–6237, cancergovstaff@mail.nih.gov, http://www.cancer.gov.

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Colon therapy *see* **Colonic irrigation**

Colonic irrigation

Definition

Colonic irrigation is also known as **hydrotherapy** of the colon, high colonic, entero-lavage, or simply colonic. It is the process of cleansing the colon by passing several gallons of water through it with the use of special equipment. It is similar to an enema but treats the whole colon, not just the lower bowel. This has the effect of flushing out impacted fecal matter, toxins, mucous, and even parasites, that often build up over the passage of time. It is a procedure that should only be undertaken by a qualified practitioner.

Demographics

Colon and bowel **cancer** are two of the leading causes of **death** in the United States, and alternative practitioners insist that it can be prevented by efficient hygiene procedures. Providing that care is taken to replace the natural organisms that flourish in the bowel, many health benefits can be expected from colonic irrigation. In general, alternative practitioners maintain that an ill-functioning bowel is the source of all disease, and therefore keeping it clean will be an effective protection against this.

The cost of colonic irrigation treatments varies, but is generally $35–70 per session, which may last from 45 minutes to one hour. The cost of the machine itself is $4,000–12,000, but again, it should be noted that only qualified therapists should conduct sessions.

Purpose

Anyone suffering from gas, bloating, cramping pains, **acne** and other skin complaints, arthritis, and a list of bowel complaints such as **diverticulitis** and irritable bowel etc., may benefit from colonic irrigation. In particular, cancer patients are often advised to undertake a course of colonic irrigation sessions as an essential part of their treatment. When a biological cancer therapy begins to enable the body to breakdown a cancerous mass, it is essential that speedy and effective elimination of the resulting toxins is achieved.

Removing large amounts of toxic matter relieves the patient and can lead to the alleviation of symptoms such as arthritis, **chronic fatigue syndrome**, **candidiasis**, and a host of other illnesses. Properly executed, colonic irrigation can help restore normal peristaltic action to a sluggish bowel, thus reducing the need for more hydrotherapy treatments over time. In addition, removing the layer of fecal matter which coats the intestines in many individuals allows improved assimilation of the nutrients from foods and can alleviate symptoms of vitamin and other nutrient deficiencies. Many alternative health practitioners consider some form of hydrotherapy for the bowel to be essential in the treatment of degenerative diseases.

Description

Origins

Cleansing the colon with the use of hydrotherapy is not a new concept. Forms of colonic irrigation have been used successfully for decades to relieve chronic toxicity and even acute cases of toxemia.

Over time, many people develop a thick layer of fecal matter that coats their colon. It hardens and becomes impacted, reducing the efficiency of the bowel, and in some cases, completely obstructing normal elimination of waste matter from the body. It is quite common for people to have only one bowel movement per day, and some as few as one or two per week.

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Alternative practitioners advise that we probably should have one bowel movement for every meal that we eat. If not, then we are not eliminating wastes completely, and if input exceeds output, then we will surely suffer the consequences at some point.

Incomplete elimination of body wastes may result in the following, depending on where the deposits end up:

- sluggish system
- joint pain and arthritis
- irritable bowel syndrome
- diverticulitis
- Crohn's disease
- leaky gut syndrome
- heart problem
- migraine
- allergies
- bad breath
- acne and other skin problems such as psoriasis
- asthma
- early senility and Alzheimer's disease
- chronic fatigue syndrome
- cancer, particularly of the bowel
- multiple sclerosis

During colonic irrigation, a small speculum is passed into the patient's bowel through the rectum. This is attached to a tube, which leads to a machine that pumps temperature-controlled water into the colon at a controlled rate (to be controlled by either the practitioner or the patient). The temperature of the water should ideally be kept as close to body temperature as possible.

The patient will temporarily be filled with water up to the level of the entire colon. Patients say they can feel the water up under their ribs but that the process, although sometimes uncomfortable, is not painful. The amount of water will vary but will generally be in the region of between two and six liters (or quarts) at any one time. This triggers peristaltic action and the patient will begin to expel the water along with fecal matter back through the tube and into the machine.

The fecal matter is flushed out through a viewing tube, so that what is eliminated may be monitored. Quite often, unsuspected parasites are expelled, along with very old fecal material, very dark in color, which may have been in the colon for years. Some therapists comment that it looks like **aging** rubber.

During the treatment, the therapist will gently massage the patient's abdomen to help dislodge impacted fecal matter. In addition to massage, sometimes **acupressure**, **reflexology**, or lymphatic drainage techniques may be used to loosen deposits and stimulate the bowel. It is important that the right amount of water is used, as too much will cause discomfort and too little will be ineffective. If correctly done, colonic irrigation is not painful at all and some patients claim to sleep through their treatment.

Sanitation is vital to this process. The tubes and speculums used are generally disposable, but other parts of the machine, such as the viewing tube, must be sterilized after each patient.

Normally, a series of treatments will be required to achieve desired results regarding the elimination of impacted, decaying matter, and restoration of bowel regularity. Initially only gas and recent fecal matter may be expelled. The residue attached to the colon wall is usually the result of years of neglect, and therapists say that one cannot expect complete relief in only one session.

Impacted fecal matter can cause an imbalance of the natural organisms that normally populate the bowel, causing what is known as dysbiosis. Under ideal conditions, the bowel is populated by a variety of naturally occurring organisms. It seems that the enzymes occurring in fresh fruit and vegetables encourage these beneficial organisms. One of the results of eating processed denatured foods is that this natural balance is upset, and food may begin to rot in the bowel instead of being processed.

Decomposing matter can cause a toxic condition and may lead to many health problems, as **constipation** causes backed up pollution of the body cells. The process of repair and elimination of wastes enters a downward spiral which at best will cause **fatigue**, lack of energy and premature aging, and, at worst, can cause degenerative diseases, among them **allergies**, and even cancer and **Alzheimer's disease**.

Preparations

Most practitioners prefer that distilled or purified water is used for colonic irrigation, but others use sterilized tap water.

Precautions

It may be advisable to use a probiotic pessary after colonic irrigation, to ensure replacement of desirable natural flora. There are certain conditions that either partly or completely preclude the use of colonic irrigation, such as an active attack of **Crohn's disease**, bleeding ulcers, and hyperacidosis. If in doubt, a qualified

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KEY TERMS

Dysbiosis—The condition that results when the natural flora of the gut are thrown out of balance, such as when antibiotics are taken.

Peristalsis—The natural wave-like action of a healthy bowel that transports matter from one end of the bowel to the other.

Probiotics—Supplements of beneficial microorganisms that normally colonize the gut.

Toxemia—Poisoning of the blood.

practitioner should be consulted. Anyone suffering from these conditions should always notify the practitioner when receiving colonic irrigation treatments.

Side effects

Some allopathic practitioners claim that colonic irrigation flushes out essential electrolytes and friendly bacteria from the bowel and that it can be dangerous. Practitioners counter that this can easily be remedied with the use of probiotics, and that in any case, these possible disadvantages are easily offset by the benefits of having large amounts of putrefying matter, harmful organisms, and parasites removed from the system.

Research and general acceptance

Although many alternative health care practitioners swear by colonic irrigation, there is a large allopathic lobby that claims that there are no benefits to be had, and that there are dangers involved. However, there are many decades of records and research from the alternative health care community that indicate that this therapy may have a valuable place in the treatment of degenerative diseases and toxic conditions.

Resources

PERIODICALS

Norlela S, Izham C, Khalid BA. Colonic Irrigation-Induced Hyponatremia. *Malays J Pathol*. 2004 Dec;26(2):117-8.

ORGANIZATIONS

California Colon Hygienist Society, 333 Miller Ave., Suite 1, Mill Valley, CA, 94941, (415) 383-7224.

Patricia Skinner
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Colonoscopy

Definition

Colonoscopy is an endoscopic medical procedure that uses a colonoscope, a long, flexible, thin, lighted tube-like instrument containing a tiny video camera, that allows a visual examination of the lining of the colon (large intestine) and rectum.

Purpose

A colonoscopy is generally recommended when the patient complains of rectal bleeding, has a change in bowel habits, and/or has other unexplained abdominal symptoms. The test is frequently used to look for colorectal **cancer**, especially when polyps or tumor-like growths have been detected by a **barium enema** examination and other diagnostic imaging tests. Polyps can be removed through the colonoscope, and samples of tissue (biopsies) can be taken to detect the presence of cancerous cells. In addition, colonoscopy can also be used to remove foreign bodies from the colon, control hemorrhaging, and excise tumors.

A colonoscopy allows the physician to visualize the lining of the entire colon and, therefore, it also enables physicians to check for bowel diseases such as ulcerative **colitis** and **Crohn's disease**. Colonoscopy is being used increasingly as a screening tool in asymptomatic patients. It is recommended as a screening test in all people 50 years or older and is an essential tool for monitoring patients who have a past history of polyps or **colon cancer**.

Description

Colonoscopy can be performed either in a physician's office or in an endoscopic procedure room of a hospital or freestanding clinic. For otherwise healthy patients, colonoscopy is usually performed by a gastroenterologist or surgeon in an office or clinic setting. When performed on patients with other medical conditions that could cause complications or that require hospitalization, it is usually performed in the **endoscopy** department of a hospital, where more intensive physiologic monitoring and/or **general anesthesia** can be better provided.

An intravenous line is usually inserted into a vein in the patient's arm to administer a sedative and a painkiller. During the colonoscopy, patients lie on their sides with their knees drawn up toward the abdomen. The doctor begins the procedure by inserting a lubricated, gloved finger into the anus to check for any abnormal masses or blockage. A thin, well-

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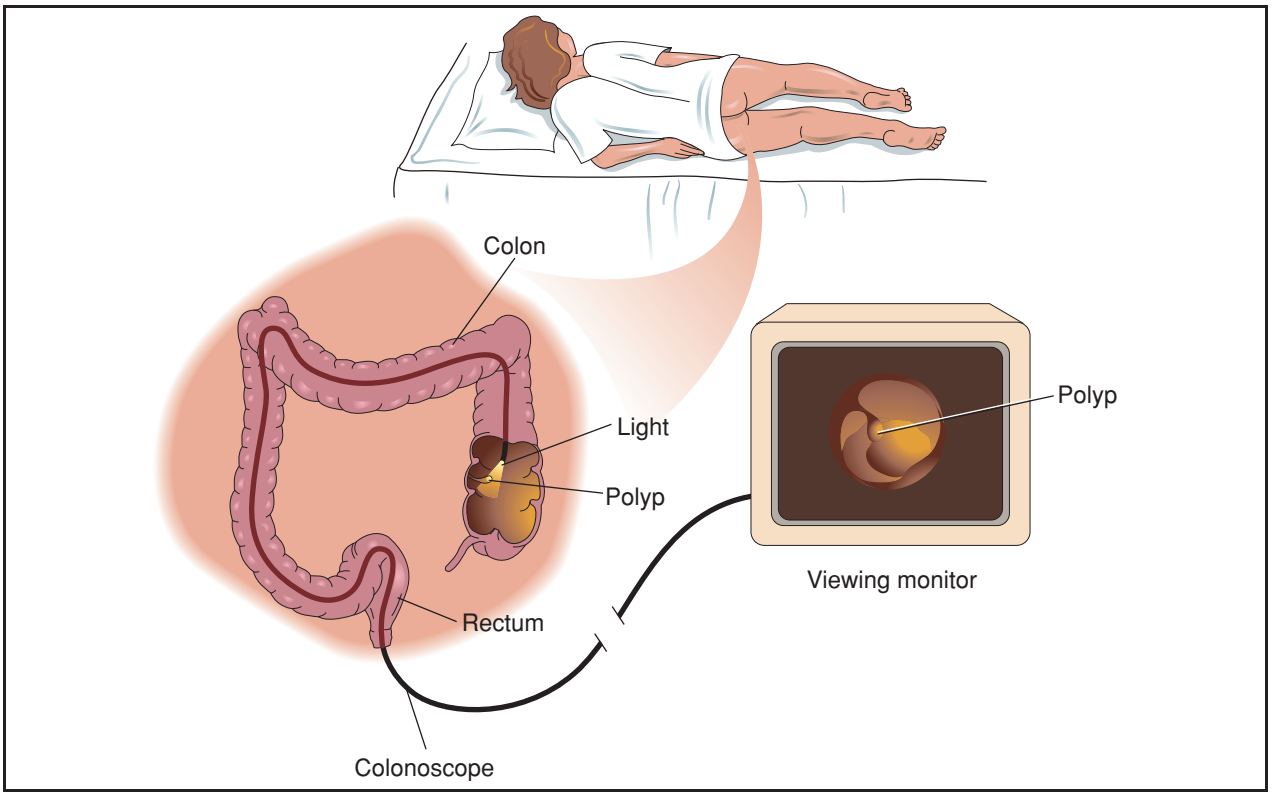

Colonoscopy is a procedure where a long and flexible tubular instrument called a colonoscope is inserted into the patient's anus in order to view the lining of the colon and rectum. It is performed to test for colorectal cancer and other bowel diseases, and enables the physician to collect tissue samples for laboratory analysis. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

lubricated colonoscope is then inserted into the anus and gently advanced through the colon. The lining of the large intestine is examined through the colonoscope. The physician views images on a television monitor, and the procedure can be documented using a video recorder. Still images can be recorded and saved on a computer disk or printed. Occasionally, air may be pumped through the colonoscope to help clear the path or open the colon. If excessive secretions, stool, or blood obstructs the viewing, they are suctioned out through the scope. The doctor may press on the abdomen or ask the patient to change position in order to advance the scope through the colon.

The entire length of the large intestine can be examined in this manner. If suspicious growths are present, tiny biopsy forceps or brushes are inserted through the colon and tissue samples (biopsies) are obtained. Small polyps or inflamed tissue also can be removed using tiny instruments passed through the scope. For removing tumors or performing other types of surgery on the colon during colonoscopy, an electrosurgical device or laser system may be used in conjunction with the colonoscope. To stop bleeding in the colon, a laser, heater probe, or electrical probe is used, or special medicines are injected through the scope. After the procedure, the colonoscope is slowly withdrawn and the instilled air is allowed to escape. The anal area is then cleansed with tissues. Tissue samples taken by biopsy are sent to a clinical laboratory, where they are analyzed by a pathologist.

The procedure may take anywhere from 30 minutes to two hours depending on how easy it is to advance the scope through the colon. Colonoscopy can be a long and uncomfortable procedure, and the bowel-cleansing preparation may be tiring and can produce **diarrhea** and cramping. During the colonoscopy, the sedative and the **pain** medications will keep the patient drowsy and relaxed. Some patients complain of minor discomfort and pressure from the colonoscope; however, the sedative and pain medication usually cause most patients to dose off during the procedure.

Preparation

Patients who regularly take **aspirin**, **nonsteroidal anti-inflammatory drugs** (NSAIDs), blood thinners,

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KEY TERMS

Barium enema—An x-ray test of the bowel performed after giving the patient an enema of a white chalky substance (barium) that outlines the colon and the rectum.

Biopsy—A procedure in which a sample of suspicious tissue is removed and examined by a pathologist for cancer or other disease.

Colonoscope—A thin, flexible, hollow, lighted tube that is inserted through the anus and rectum to the colon to enable the physician to view the entire lining of the colon.

Computed tomography (CT) scan—A radiologic imaging technique that uses computer processing to generate an image of the tissue density; also called computerized axial tomography (CAT) and computerized transaxial tomography (CTAT).

Crohn's disease—A chronic inflammatory disease that generally starts in the gastrointestinal tract and causes the immune system to attack one's own body.

Diverticulosis—A condition that involves the development of sacs that bulge through the large intestine's muscular walls, but are not inflamed. It may cause bleeding, stomach distress, and excess gas.

Electrosurgical device—A medical device that uses electrical current to cauterize or coagulate tissue during surgical procedures; often used in conjunction with laparoscopy.

Magnetic resonance imaging (MRI)—A test that provides pictures of organs and structures inside the body using radio waves. In many cases, an MRI provides information that cannot be obtained from X-ray tests.

Pathologist—A doctor who specializes in the diagnosis of disease by studying cells and tissues under a microscope.

Polyps—An abnormal growth that develops on the inside of a hollow organ such as the colon.

Sigmoidoscopy—A process of passing a long, hollow tubular instrument through the anus in order to permit inspection, diagnosis, treatment, and imaging, especially of the sigmoid flexure.

Ulcerative colitis—A chronic condition in which recurrent ulcers are found in the colon. It is manifested clinically by abdominal cramping and rectal bleeding.

Virtual colonoscopy—Two new techniques that provide views of the colon to screen for colon polyps and cancer. The images are produced by computerized manipulations rather than direct observation through the colonoscope; one technique uses the x-ray images from a CT scan, and the other uses magnetic images from an MRI scan.

or insulin should be sure to inform the physician at the time the colonoscopy is scheduled. The physician also should be notified if the patient has **allergies** to any medications or anesthetics, bleeding problems, or is pregnant. The doctor should be informed of all the medications the patient is taking and if he or she has had a barium enema x-ray examination recently. If the patient has had heart valves replaced, the doctor should be informed so that appropriate **antibiotics** can be administered to prevent infection. Patients with severe active colitis, extremely dilated colon (toxic megacolon), or severely inflamed bowel may not be candidates for colonoscopy. Patients requiring continuous ambulatory peritoneal dialysis are generally not candidates for colonoscopy due to a higher risk of developing internal bleeding. The risks associated with the procedure are explained to the patient beforehand, and the patient is asked to sign a consent form.

The colon must be thoroughly cleansed before performing colonoscopy. Consequently, for about two days before the procedure, considerable preparation is necessary to clear the colon of all stool. The patient is asked to refrain from eating any solid food for 24–48 hours before the test. Only clear liquid such as juices, broth, and gelatin are allowed. Red or purple juices should be avoided, since they can cause coloring of the colon that may be misinterpreted as blood during the colonoscopy. The patient is advised to drink plenty of water to avoid **dehydration**. A day before the colonoscopy, the patient is prescribed liquid, tablet, and/or suppository **laxatives** by the physician. In addition, commercial **enemas** may be prescribed. The patient is given specific instructions on how and when to use the laxatives and/or enemas. This preparatory emptying of the colon assures that the colonoscope will not be obstructed and that the physician will be able to clearly see the colon lining.

On the morning of the colonoscopy, the patient is not to eat or drink anything. Unless otherwise instructed by the physician, the patient should continue to take all current medications. **Vitamins** with iron, iron supplements, or iron preparations should be

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discontinued for a few weeks before the colonoscopy because iron residue in the colon can inhibit viewing during the procedure. These preparatory procedures are extremely important to ensure a thoroughly clean colon for examination.

After the procedure, the patient is kept under observation until the medications' effects wear off. The patient has to be driven home and can generally resume a normal diet and usual activities unless otherwise instructed. The patient is advised to drink plenty of fluids to replace those lost by laxatives and **fasting**.

For a few hours after the procedure, the patient may feel groggy. There may be some abdominal cramping and a considerable amount of gas may be passed. If a biopsy was performed or a polyp was removed, there may be small amounts of blood in the stool for a few days. If the patient experiences severe abdominal pain or has persistent and heavy bleeding, this information should be brought to the physician's attention immediately.

Risks

The procedure is practically free of complications and risks. Rarely, (two in 1,000 cases) a perforation (hole) may occur in the intestinal wall. Heavy bleeding due to the removal of the polyp or from the biopsy site occurs infrequently (one in 1,000 cases). Some patients may have adverse reactions to the sedatives administered during the colonoscopy, but severe reactions are very rare. Infections due to a colonoscopy are also extremely rare. Patients with artificial or abnormal heart valves are usually given antibiotics before and after the procedure to prevent an infection.

Normal results

The results are normal if the lining of the colon is a pale reddish pink and there are no abnormal masses visible. In this case, the patient probably will not have to undergo another colonoscopy for several years.

Abnormal results indicate polyps or other suspicious masses in the lining of the colon. Many polyps can be removed during the procedure, and tissue samples can be taken by biopsy. If cancerous cells are detected in the tissue samples, then a diagnosis of colon cancer is made. A pathologist analyzes the tumor cells further to estimate the tumor's aggressiveness and the extent of the disease. This is crucial before deciding on the mode of treatment for the disease. Abnormal findings could also be due to inflammatory bowel diseases such as ulcerative colitis or Crohn's disease. A condition called **diverticulosis**, which causes many small finger-like pouches to protrude from the colon wall, may also contribute to an abnormal result in the colonoscopy.

Morbidity and mortality rates

Colorectal cancer is the second leading cause of cancer deaths in the United States. In 2007, The American Cancer Society estimated that 52,180 people died from the disease. The World Health Organization (WHO) estimates that about 500,000 people worldwide die from colorectal cancer each year. Although colonoscopy screening can find precancerous growths (polyps), which lead to colorectal cancer, screening rates in the United States remain low. Removing polyps before they become cancerous can prevent the disease and potentially reduce deaths. Scientific evidence indicates that more than one-third of deaths from colorectal cancer could be avoided if people aged 50 years and older were screened regularly.

Alternatives

Individuals with a strong family history of colorectal cancer may wish to undergo genetic screening to detect a genetic alteration that may identify people who are more likely to develop the disease and who would benefit from earlier and more frequent screening. Only about 5% of colorectal cancers are inherited, so **genetic testing** provides limited benefits for most of the population.

Virtual colonoscopy is a new non-invasive technique for screening for colon polyps and cancer. The colon is cleaned out using potent laxatives just as it is for a standard colonoscopy. Instead of obtaining pictures through the insertion of a colonoscope, virtual colonoscopy uses X-ray images from a computerized tomography (CT) scan or **magnetic resonance imaging** (MRI) to create through computer manipulation two- and three-dimensional pictures of the colon.

Virtual colonoscopy offers several advantages. The procedure is non-invasive. It does not require patients to be sedated or put under anesthesia and is a good option for individuals who cannot or will not undergo standard colonoscopy. The procedure can be performed in less than one minute, compared with about 30–60 minutes plus recovery time required for standard colonoscopy. Another benefit of the CT scan is that it can find polyps that occasionally are missed by colonoscopy because the polyps lie behind folds within the colon.

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Disadvantages of virtual colonoscopy include:

- It has difficulty finding small polyps (<0.2 in [5 mm] in size) that are easily seen in a colonoscopy.
- It is less able to find flat polyps compared to a colonoscopy.
- Small pieces of stool can look like polyps on the CT scan and lead to a diagnosis of polyp when there is none.
- It is not possible to remove suspect polyps or take a biopsy. If polyps are found by virtual colonoscopy, a standard colonoscopy must be done to remove the polyps. As a result, the individual must undergo two procedures.

Resources

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American College of Gastroenterology, P.O. Box 342260, Bethesda, MD, 20827-2260, (301) 263-9000, http://www.acg.gi.org.

Colorectal Cancer Network (CCNetwork), P.O. Box 182, Kensington, MD, 20895-0182, (301) 879-1500, http://clickonium.com/colorectal-cancer.net/html/.

International Foundation for Functional Gastrointestinal Disorders (IFFGD), P.O. Box 170864, Milwaukee, WI, 53217, (414) 964-1799, (888) 964-2001, http://www.iffgd.org.

National Digestive Diseases Information Clearinghouse (NDDIC), 2 Information Way, Bethesda, MD, 20892-3570, (800) 891-5389, http://digestive.niddk.nih.gov.

Society of American Gastrointestinal Endoscopic Surgeons (SAGES), 11300 West Olympic Blvd., Suite 600, Los Angeles, CA, 90064, (310) 437-0544, http://www.sages.org.

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Color blindness

Definition

Color blindness, also called color vision deficiency (CVD), is a group of conditions that affect the perception of color, characterized by the inability to clearly distinguish different colors of the spectrum. The difficulties range from mild to severe. Color blindness is a misleading term because people with color blindness are not blind. Rather, they tend to see colors in a limited range of hues; a rare few may not see colors at all.

Demographics

In the United States, red–green color vision defects are the most common form of color vision deficiency. This condition affects males more often than females. Some 10 million American men (7% of the male population) either cannot distinguish red from green, or see red and green differently from most people. This is the commonest form of color blindness, and it affects only 0.4% of women. Blue–yellow color vision defects affect males and females equally. This condition occurs in fewer than 1 in 10,000 people worldwide. Complete achromatopsia affects an estimated 1 in 30,000 people. The condition much more prevalent among Pingelapese islanders, who live on one of the Eastern Caroline Islands of Micronesia. Some 5–10% of this population have a total absence of color vision.

Description

Normal color vision requires the use of specialized receptor cells called cones, which are located in the retina of the eye. There are three types of cones, termed red, blue, and green. Each cone contains a special pigment, called a photopigment, that is most sensitive to a particular wavelength of light. The combined input from all three types of cones produces normal color vision. An abnormality, or deficiency,

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of any of the types of cones will result in abnormal color vision.

There are three basic variants of color blindness. Red–green color blindness is by far the most common deficiency. Affected persons cannot distinguish well between shades of red and green. They see these colors differently than most people and may experience difficulty naming different hues.

Blue–yellow color blindness is an inability to distinguish both blue and yellow, which are seen as white or gray. The condition is quite rare. Red–green and blue–yellow color vision deficiency disrupt the perception of color, but do not affect the sharpness of vision.

A total inability to distinguish colors (achromatopsia) is exceedingly rare. These affected individuals view the world in shades of gray. They frequently have poor visual acuity and are extremely sensitive to light (photophobia), which causes them to squint in ordinary light.

Risk factors

A family history of color blindness increases the risk since most color vision problems are inherited. Another risk factor for color vision deficiency is **aging**. The eye's lens can darken and yellow over time, which can impair the ability of older adults to see dark colors. Certain medications can also increase risk. For example, the drug hydroxychloroquine (Plaquenil), used to treat **rheumatoid arthritis**, can cause color blindness.

Causes and symptoms

As of 2009, mutations in the CNGA3, CNGB3, GNAT2, OPN1LW, OPN1MW, and OPN1SW genes are known to cause color vision deficiency. The OPN1LW gene makes pigments (L cones) that are more sensitive to light at the red end of the visible spectrum while the OPN1MW gene makes pigments (M cones) that are more sensitive to yellow–green light in the middle of the visible spectrum. As for the OPN1SW gene, it makes pigments (S cones) that are more sensitive to blue–violet light at the end of the visible spectrum. Genetic changes involving the OPN1LW and OPN1MW genes accordingly lead to an absence of L or M cones or the production of abnormal cones that affect red–green color vision. Mutations of the OPN1SW gene leads to the premature destruction of S cones or the production of defective cones which impairs perception of the color blue and makes it difficult to detect differences between shades of blue and green. As for the CNGA3, CNGB3, and GNAT2 genes, their mutation is responsible for achromatopsia.

KEY TERMS

Achromatopsia—The inability to distinguish any colors.

Cones—Receptor cells that allow the perception of colors.

Photophobia—An extreme sensitivity to light.

Photopigment—Pigment that is most sensitive to a particular wavelength of light.

Retina—The light–sensitive layer of tissue in the back of the eye that receives and transmits visual signals to the brain through the optic nerve.

Rod—Photoreceptor that is highly sensitive to low levels of light and transmits images in shades of gray.

Color blindness is sometimes acquired. Chronic illnesses that can lead to color blindness include Alzheimer disease, **diabetes mellitus**, glaucoma, leukemia, **liver disease**, chronic **alcoholism**, **macular degeneration**, **multiple sclerosis**, **Parkinson disease**, sickle cell anemia, and **retinitis pigmentosa**. Accidents or strokes that damage the retina or affect particular areas of the brain can lead to color blindness. Some medications such as **antibiotics**, **barbiturates**, anti–tuberculosis drugs, high blood pressure medications, and several medications used to treat nervous disorders and psychological problems may cause color blindness. Industrial or environmental chemicals such as carbon monoxide, carbon disulfide, fertilizers, styrene, and some containing lead can cause loss of color vision. Occasionally, changes can occur in the affected person's capacity to see colors after age 60.

The inability to correctly identify colors is the only sign of color blindness. It is important to note that people with red/green or blue varieties of color blindness use other cues such as color saturation and object shape or location to distinguish colors. They can often distinguish red or green if they can visually compare the colors. However, most have difficulty accurately identifying colors without any other references. Most people with any impairment in color vision learn colors, as do other young children. These individuals often reach adolescence before their visual deficiency is identified.

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Diagnosis

Tests

There are several tests available to identify problems associated with color vision. The most commonly used is the American Optical/Hardy, Rand, and Ritter Pseudoisochromatic test. It is composed of several discs filled with colored dots of different sizes and colors. A person with normal color vision looking at a test item sees a number that is clearly located somewhere in the center of a circle of variously colored dots. A color–blind person is not able to distinguish the number.

The Ishihara test is comprised of eight plates that are similar to the American Optical Pseudoisochromatic test plates. The individual being tested looks for numbers among the various colored dots on each test plate. Some plates distinguish between red/green and blue color blindness. Individuals with normal color vision perceive one number. Those with red/green color deficiency see a different number. Those with blue color vision see yet a different number.

A third analytical tool is the Titmus II Vision Tester Color Perception test. The subject looks into a stereoscopic machine. The test stimulus most often used in professional offices contains six different designs or numbers on a black background, framed in a yellow border. Titmus II can test one eye at a time. However, its value is limited because it can only identify red/green deficiencies and is not highly accurate.

Treatment

There is no treatment or cure for color blindness. Most color vision deficient persons compensate well for their abnormality and usually rely on color cues and details that are not consciously evident to persons with typical color vision.

Clinical trials

Clinical trials on color blindness and related conditions are currently sponsored by the National Institutes of Health (NIH) and other agencies. In 2009, NIH reported 15 on–going or recently completed studies on vision deficiency.

A few examples include:

- A study measuring color vision in patients with a blue light filtering lens implant in one eye and non–tinted implant in the other eye to determine whether blue light filtering lenses limit color vision. (NCT00403143)
- Evaluation of optical coherence tomography (OCT) scanners, instruments that use a beam of light to measure the thickness of the retina, the light–sensitive inner lining of the back of the eye. (NCT00069199)
- A genetic study of patients suffering from retinal dystrophies, conditions responsible for numerous cases of blindness. (NCT00422721)

Clinical trial information is constantly updated by NIH and the most recent information on blindness trials can be found at: http://clinicaltrials.gov.

Prognosis

In the case of some types of acquired color deficiency, if the cause of the problem is removed, the condition may improve with time. But for most people with acquired color blindness, the damage is usually permanent.

Prevention

Color blindness cannot be prevented.

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ORGANIZATIONS

American Academy of Ophthalmology (AAO), PO Box 7424, San Francisco, CA, 94120-7424, (415) 561-8500, (415) 561-8533, patientinfo@aao.org, http://www.aao.org.
American Optometric Association (AOA), 243 N. Lindbergh Blvd., St. Louis, MO, 63141, (800) 365-2219, http://www.aoa.org.
National Eye Institute (NEI), 2020 Vision Place, Bethesda, MD, 20892-3655, (301) 496-5248, http://www.nei.nih.gov.
Prevent Blindness America, 211 West Wacker Drive, Suite 1700, Chicago, IL, 60606, (800) 331-2020, http://www.preventblindness.org.

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Colorectal cancer *see* **Colon cancer; Rectal cancer**

Colostomy

Definition

A colostomy is a surgical procedure that brings a portion of the large intestine through the abdominal wall to carry feces out of the body.

Purpose

A colostomy is a means to treat various disorders of the large intestine, including **cancer**, obstruction, inflammatory bowel disease, ruptured diverticulum, **ischemia** (compromised blood supply), or traumatic injury. Temporary colostomies are created to divert stool from injured or diseased portions of the large intestine, allowing rest and healing. Permanent colostomies are performed when the distal bowel (at the farthest distance) must be removed or is blocked and inoperable. Although colorectal cancer is the most common indication for a permanent colostomy, only about 10–15% of patients with this diagnosis require a colostomy.

Demographics

Estimates of all ostomy surgeries (those involving any opening from the abdomen for the removal of either feces or urine) range from 42,000 to 65,000 each year; about half are temporary. Emergency surgeries for bowel obstruction and/or perforation comprise 10–15% of all colorectal surgeries; a portion of these result in colostomy.

Description

Surgery will result in one of three types of colostomies:

- End colostomy. The functioning end of the intestine (the section of bowel that remains connected to the upper gastrointestinal tract) is brought out onto the surface of the abdomen, forming the stoma (artificial opening) by cuffing the intestine back on itself and suturing the end to the skin. The surface of the stoma is actually the lining of the intestine, usually appearing moist and pink. The distal portion of bowel (now connected only to the rectum) may be removed, or sutured closed and left in the abdomen. An end colostomy is usually a permanent ostomy, resulting from trauma, cancer, or another pathological condition.
- Double-barrel colostomy. This involves the creation of two separate stomas on the abdominal wall. The proximal (nearest) stoma is the functional end that is connected to the upper gastrointestinal tract and will drain stool; the distal stoma, connected to the rectum and also called a mucous fistula, drains small amounts of mucus material. This is most often a temporary colostomy performed to rest an area of bowel, and to be later closed.
- Loop colostomy. This surgery brings a loop of bowel through an incision in the abdominal wall.

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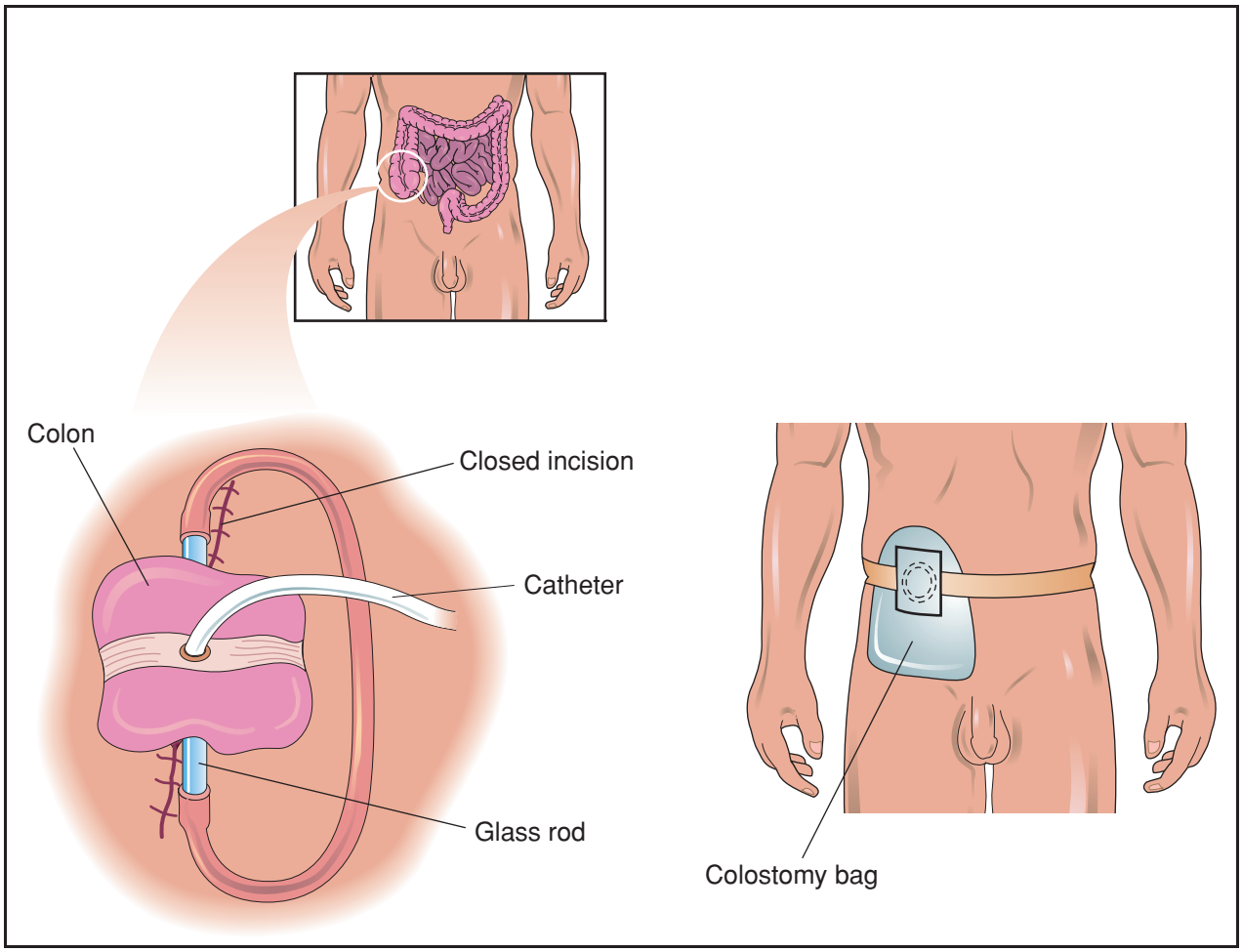

A colostomy is a surgical procedure in which a portion of the large intestine, or colon, is brought through the abdominal wall to carry feces out of the body. There are three types of colostomies: end colostomy, double-barrel colostomy, and loop colostomy. The loop colostomy is featured in the illustration above. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

The loop is held in place outside the abdomen by a plastic rod slipped beneath it. An incision is made in the bowel to allow the passage of stool through the loop colostomy. The supporting rod is removed approximately 7 to 10 days after surgery, when healing has occurred that will prevent the loop of bowel from retracting into the abdomen. A loop colostomy is most often performed for creation of a temporary stoma to divert stool away from an area of intestine that has been blocked or ruptured.

Diagnosis/Preparation

A number of diseases and injuries may require a colostomy. Among the diseases are inflammatory bowel disease and colorectal cancer. Determining whether this surgery is necessary is a decision the physician makes based on a number of factors, including patient history, amount of **pain**, and the results of tests such as **colonoscopy** and lower G.I. (gastrointestinal) series. Due to lifestyle impact of the surgery, the decision is made after careful consultation with the patient. However, an immediate decision may be made in emergency situations involving injuries or puncture **wounds** in the abdomen or intestinal perforations related to diverticulear disease, ulcers, or life-threatening cancer.

As with any surgical procedure, the patient will be required to sign a consent form after the procedure is explained thoroughly. Blood and urine studies, along with various x rays and an electrocardiograph (EKG), may be ordered as the doctor deems necessary. If possible, the patient should visit an enterostomal therapist, who will mark an appropriate place on the

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KEY TERMS

Diverticulum—Pouches that project off the wall of the intestine.

Embolism—Blockage of a blood vessel by any small piece of material traveling in the blood; the emboli may be caused by germs, air, blood clots, or fat.

Enema—Insertion of a tube into the rectum to infuse fluid into the bowel and encourage a bowel movement. Ordinary enemas contain tap water, mixtures of soap and water, glycerine and water, or other materials.

Intestine—Commonly called the bowels, divided into the small and large intestine. They extend from the stomach to the anus.

Ischemia—A compromise in blood supply delivered to body tissues that causes tissue damage or death.

Ostomy—A surgical procedure that creates an opening from the inside of the body to the outside, usually to remove body wastes (feces or urine).

abdomen for the stoma and offer preoperative education on ostomy management.

In order to empty and cleanse the bowel, the patient may be placed on a low-residue diet for several days prior to surgery. A liquid diet may be ordered for at least the day before surgery, with nothing by mouth after midnight. A series of **enemas** and/or oral preparations (GoLytely or Colyte) may be ordered to empty the bowel of stool. Oral anti-infectives (neomycin, erythromycin, or kanamycin sulfate) may be ordered to decrease bacteria in the intestine and help prevent postoperative infection. A nasogastric tube is inserted from the nose to the stomach on the day of surgery or during surgery to remove gastric secretions and prevent **nausea and vomiting**. A urinary catheter (a thin plastic tube) may also be inserted to keep the bladder empty during surgery, giving more space in the surgical field and decreasing chances of accidental injury.

Aftercare

Postoperative care for the patient with a new colostomy, as with those who have had any major surgery, involves monitoring of blood pressure, pulse, respirations, and temperature. Breathing tends to be shallow because of the effect of anesthesia and the patient's reluctance to breathe deeply and experience pain that is caused by the abdominal incision. The patient is instructed how to support the operative site during deep breathing and coughing, and given pain medication as necessary. Fluid intake and output is measured, and the operative site is observed for color and amount of wound drainage. The nasogastric tube will remain in place, attached to low, intermittent suction until bowel activity resumes. For the first 24–48 hours after surgery, the colostomy will drain bloody mucus. Fluids and electrolytes are infused intravenously until the patient's diet can gradually be resumed, beginning with liquids. Usually within 72 hours, passage of gas and stool through the stoma begins. Initially, the stool is liquid, gradually thickening as the patient begins to take solid foods. The patient is usually out of bed in eight to 24 hours after surgery and discharged in two to four days.

A colostomy pouch will generally have been placed on the patient's abdomen around the stoma during surgery. During the hospital stay, the patient and his or her caregivers will be educated on how to care for the colostomy. Determination of appropriate pouching supplies and a schedule of how often to change the pouch should be established. Regular assessment and meticulous care of the skin surrounding the stoma is important to maintain an adequate surface on which to attach the pouch. Some patients with colostomies are able to routinely irrigate the stoma, resulting in regulation of bowel function; rather than needing to wear a pouch, these patients may only need a dressing or cap over their stoma. Often, an enterostomal therapist will visit the patient in the hospital or at home after discharge to help the patient with stoma care.

Dietary counseling will be necessary for the patient to maintain normal bowel function and to avoid **constipation**, impaction, and other discomforts.

Risks

Potential complications of colostomy surgery include:

- excessive bleeding
- surgical wound infection
- thrombophlebitis (inflammation and blood clot to veins in the legs)
- pneumonia
- pulmonary embolism (blood clot or air bubble in the lungs' blood supply)

Psychological complications may result from colostomy surgery because of the fear of the perceived social stigma attached to wearing a colostomy bag. Patients may also be depressed and have feelings of low self-worth because of the change in their lifestyle

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and their appearance. Some patients may feel ugly and sexually unattractive and may worry that their spouse or significant other will no longer find them appealing. Counseling and education regarding surgery and the inherent lifestyle changes are often necessary.

Normal results

Complete healing is expected without complications. The period of time required for recovery from the surgery may vary depending on the patient's overall health prior to surgery and the patient's willingness to participate in stoma care. The colostomy patient without other medical complications should be able to resume all daily activities once recovered from the surgery. Adjustments in diet and daily personal care will need to be made.

Morbidity and mortality rates

Complications after colostomy surgery can occur. The doctor should be made aware of any of the following problems after surgery:

- increased pain, swelling, redness, drainage, or bleeding in the surgical area
- headache, muscle aches, dizziness, or fever
- increased abdominal pain or swelling, constipation, nausea or vomiting, or black, tarry stools

Stomal complications can also occur. They include:

- Death (necrosis) of stomal tissue. Caused by inadequate blood supply, this complication is usually visible 12–24 hours after the operation and may require additional surgery.
- Retraction (stoma is flush with the abdomen surface or has moved below it). Caused by insufficient stomal length, this complication may be managed by use of special pouching supplies. Elective revision of the stoma is also an option.
- Prolapse (stoma increases length above the surface of the abdomen). Most often this results from an overly large opening in the abdominal wall or inadequate fixation of the bowel to the abdominal wall. Surgical correction is required when blood supply is compromised.
- Stenosis (narrowing at the opening of the stoma). Often this is associated with infection around the stoma or scarring. Mild stenosis can be removed under local anesthesia; severe stenosis may require surgery for reshaping the stoma.
- Parastomal hernia (bowel causing bulge in the abdominal wall next to the stoma). This occurs due to placement of the stoma where the abdominal wall is weak or an overly large opening in the abdominal wall was made. The use of an ostomy support belt and special pouching supplies may be adequate. If severe, the defect in the abdominal wall should be repaired and the stoma moved to another location.

Mortality rates for colostomy patients vary according to the patient's general health upon admittance to the hospital. Even among higher risk patients, mortality is about 16%. This rate is greatly reduced (between 0.8% and 3.8%) when the colostomy is performed by a board-certified colon and rectal surgeon.

Alternatives

When a colostomy is deemed necessary, there are usually few to no alternatives to the surgery, though there can be alternatives in the type of surgery involved and adjuvant therapies related to the disease. For example, laparoscopic surgery is being used with many diseases of the intestinal tract, including initial cancers. For this surgery, the colon and rectal surgeon inserts a laparoscope (an instrument that has a tiny video camera attached) through a small incision in the abdomen. Other small incisions are made for the surgeon to insert laparoscopic instruments to use in creating the colostomy. This surgery often results in a shorter stay in the hospital, less postoperative pain, a quicker return to normal activities, and far less scarring. It is not recommended for patients who have had extensive prior abdominal surgery, large tumors, previous cancer, or serious heart problems.

In some cases, rather than giving patients a colostomy for low rectal cancers, the surgeon creates a Colo-anal Pouch. The Colo-anal J Pouch operation has been developed in order to surgically recreate the back passage (rectum). In this operation the rectum is removed and the sphincter muscles and anal canal are left in place.

The surgeon needs to remove the rectum because of the disease affecting it. The rectum is where you store body waste until you wish to empty your bowel. The sphincter muscles surrounding the anus (back passage) are left intact. These muscles are important for bowel control. Surgeons will make a new rectum from a piece of your remaining bowel, and this new rectum is called a Colo-anal J Pouch, or simply a Pouch. It is stitched to your anal canal and this will eventually allow you to go to the toilet in the usual manner. A temporary loop ileostomy will probably be made in order to allow the pouch to heal. This is the first stage of the procedure and the operation takes between two to four hours.

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Colostomy Irrigation

Colostomy irrigation is a way to regulate bowel movements by emptying the colon at a scheduled time. The process involves infusing water into the colon through the stoma. This stimulates the colon to empty. By repeating this process regularly, usually once per day or every other day, the colon is trained to empty with no spillage of waste in between irrigation. Colostomy irrigation also can help you avoid constipation. It is a personal decision patients should discuss with their doctors while still in the hospital after their surgery.

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ORGANIZATIONS

United Ostomy Association, Inc. (UOA), 19772 MacArthur Blvd., Suite 200, Irvine, CA, 92612-2405, (800) 826-0826, http://www.uoa.org.

Wound Ostomy and Continence Nurses Society, 2755 Bristol Street, Suite 110, Costa Mesa, CA, 92626, (714) 476-0268, http://www.wocn.org.

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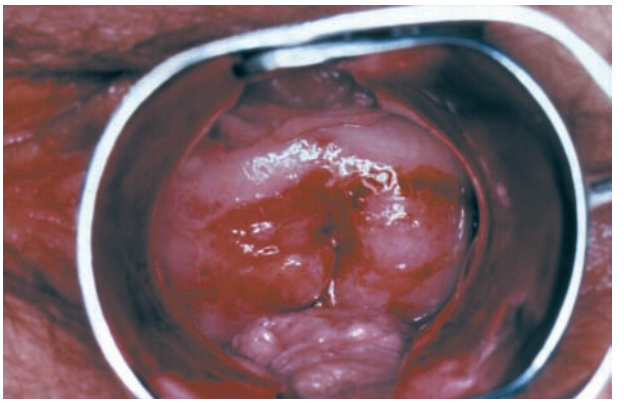
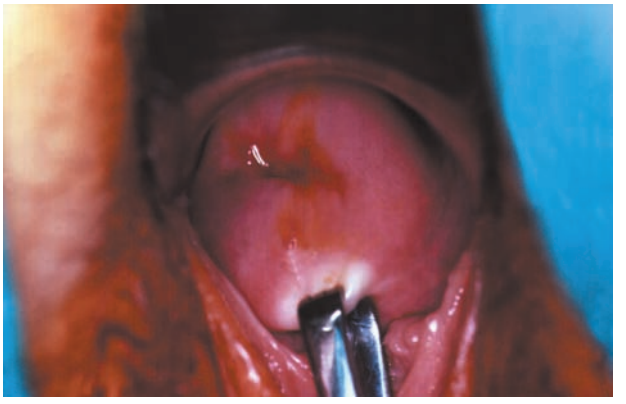
Colposcopy

Definition

Colposcopy is a procedure that allows a physician to examine a woman's cervix and vagina using a special microscope called a colposcope. Colposcopy is used to check for precancerous or abnormal areas.



This colposcopic view of the cervix reveals CIN 2 dysplasia, or abnormal growth of cells. This is the second stage in the development of cervical cancer. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*



A colposcopy makes it possible for a physician to view this healthy cervix without surgery. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Purpose

Colposcopy is used to identify or rule out the existence of any precancerous conditions in the cervical tissue. If a Papanicolaou (Pap) test shows abnormal cell growth, colposcopy is usually the first follow-up test performed. The physician will attempt to find the area that produced the abnormal cells and remove a sample of it for further study (biopsy) and diagnosis.

Colposcopy may also be performed if the cervix looks abnormal during a routine examination. It may be suggested for women with **genital warts** and for diethylstilbestrol (DES) daughters (women whose mothers took the anti-miscarriage drug DES when pregnant with them). Colposcopy is used in the emergency department to examine victims of **sexual assault** and **abuse** and document any physical evidence of vaginal injury.

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KEY TERMS

Biopsy—Removal of a sample of abnormal tissue for more extensive examination under a microscope.

Cervix—Narrow, lower end of the uterus forming the opening to the vagina.

Cryosurgery—Freezing and destroying abnormal cells.

Diathermy—Also called electrocautery, this is a procedure that heats and destroys abnormal cells.

Diethylstilbestrol (DES)—A synthetic form of estrogen that was widely prescribed to women from 1940 to 1970 to prevent complications during pregnancy, and linked to several serious birth defects and disorders of the reproductive system in daughters of women who took DES.

Dysplasia—Abnormal cellular changes that may become cancerous.

Human papillomavirus (HPV)—A family of viruses that cause common warts of the hands and feet, as well as lesions in the genital and vaginal area. More than 50 types of HPV have been identified, some of which are linked to cancerous and precancerous conditions, including cancer of the cervix. A vaccine is now available against some of these viruses.

Loop electrosurgical excision (LEEP)—A procedure that can help diagnose and treat cervical abnormalities using a thin wire loop that emits a low-voltage high-frequency radio wave that can excise tissue.

Monsel's solution—A solution used to stop bleeding.

Pap test—The common term for the Papanicolaou test, a simple smear method of removing cervical cells to screen for abnormalities that indicate cancer or a precancerous condition.

Speculum—A retractor used to separate the walls of the vagina to make visual examination easier.

Demographics

Cervical cancer affects millions of women worldwide. In the United States, the routine use of Pap tests has substantially decreased the rate of this **cancer**. With the introduction of a vaccine against the family of viruses associated with cervical cancer, the rate in the developed world is expected to continue to fall. Cervical cancer continues to be a major health problem for women in the developing world. Even in the United States, it is estimated that about one-third of women fail to follow up with colposcopy after an abnormal **Pap test**. Minority women, teenagers, and those of low socioeconomic status are the least likely to follow up.

Description

Colposcopy is usually performed in a physician's office and is similar to a regular gynecologic exam. An instrument called a speculum is inserted to hold the vagina open, and the gynecologist looks at the cervix and vagina using a colposcope, a low-power microscope designed to magnify the cervix 10–40 times its normal size. Most colposcopes are connected to a video monitor that displays the area of interest. Photographs are taken during the examination to document abnormal areas.

The cervix and vagina are swabbed with dilute acetic acid (vinegar). The solution highlights abnormal areas by turning them white (instead of a normal pink color). Abnormal areas can also be identified by looking for a characteristic pattern made by abnormal blood vessels.

If any abnormal areas are seen, the doctor takes a biopsy of the tissue, a common procedure that takes about 15 minutes. Several samples might be taken, depending on the size of the abnormal area. A biopsy may cause temporary discomfort and cramping, which usually go away within a few minutes. If the abnormal area appears to extend inside the cervical canal, a scraping of the canal may also be done. The biopsy results are usually available within a week.

If the tissue sample indicates abnormal growth (dysplasia) or is precancerous, and if the entire abnormal area can be seen, the doctor may destroy the tissue using one of several procedures, including ones that use high heat (diathermy), extreme cold (cryosurgery), or lasers. Another procedure, called loop electrosurgical excision (LEEP), uses low-voltage, high-frequency radio waves to excise tissue. If any of the abnormal tissue is within the cervical canal, a cone biopsy (removal of a conical section of the cervix for inspection) will be needed.

Diagnosis/Preparation

Women who are pregnant or who suspect that they are pregnant must tell their doctor before the

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procedure begins. Pregnant women may undergo colposcopy if they have an abnormal Pap test; special precautions, however, must be taken during biopsy of the cervix. Patients who are taking blood-thinning medications such as warfarin (Coumadin) should tell their doctor before the procedure.

Patients should be instructed not to douche, use tampons, or have sexual intercourse for 24 hours before colposcopy. Patients should empty their bladder and bowels before colposcopy for comfort. Colposcopy does not require any anesthetic medication because **pain** is minimal. If a biopsy is done, there may be mild cramps or a sharp pinching when the tissue is removed. To lessen this pain, the doctor may recommend ibuprofen (Motrin, Advil) taken the night before and the morning of the procedure (no later than 30 minutes before the appointment). Patients who are pregnant or allergic to **aspirin** or ibuprofen can instead take **acetaminophen** (Tylenol).

Aftercare

If a biopsy was done, there may be a dark vaginal discharge afterwards. After the sample is removed, the doctor applies Monsel's solution to the area to stop the bleeding. When this mixes with blood, it creates a black fluid that looks like coffee grounds. This fluid may be present for a several days after the procedure. It is also normal to have some blood spotting after colposcopy. Pain-relieving medication can be taken to lessen any post-procedural cramping.

Patients should not use tampons, douche, or have sex for at least a week after the procedure or until the doctor says it is safe because of the risk of infection.

Risks

Colposcopy is a very safe procedure. Patients may have bleeding or infection after biopsy. Bleeding is usually controlled with a topical medication prescribed by the physician or health care provider. If colposcopy is performed on a pregnant patient, there is a risk of **premature labor**.

A patient should call her doctor right away if she notices any of the following symptoms:

- heavy vaginal bleeding (more than one sanitary pad an hour);
- fever, chills, or an unpleasant vaginal odor; or
- lower abdominal pain.

Normal results

If visual inspection shows that the surface of the cervix is smooth and pink, this is considered normal. Areas that look abnormal may actually be normal variations; a biopsy will indicate whether the tissue is normal or abnormal.

Abnormal conditions that can be detected using colposcopy and biopsy include precancerous tissue changes (cervical dysplasia), cancer, and cervical **warts** caused by human papillomavirus.

Morbidity and mortality rates

Complications associated with colposcopy are extremely rare. There is a risk that the procedure will miss precancerous or cancerous tissues and thus prolong treatment until the cancer has become advanced. The American Cancer Society estimated that 11,270 new cases of cervical cancer were diagnosed in 2009 and 4,070 deaths could be attributed to the disease.

Alternatives

While the Pap test is an effective screening test for abnormal cell growth of the cervix, it is an inadequate diagnostic alternative to colposcopy because of the potential for false negative results (10–50%). In some instances, a repeat Pap test may be recommended before performing colposcopy (e.g., in the case of inflammation or no previous abnormal Pap test).

Resources

OTHER

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ORGANIZATIONS

American College of Obstetricians and Gynecologists, 409 12th St., SW, P.O. Box 96920, Washington, DC, 20090-6920, (202) 638-5577, http://www.acog.org.

American Society for Colposcopy and Cervical Pathology, 152 West Washington Street, Hagerstown, MD, 21740, (301) 733-3640, (800) 787-7227, http://www.asccp.org.

Association of Women's Health, Obstetric, and Neonatal Nurses, 2000 L St., NW, Suite 740, Washington, DC,

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20036, (202) 261-2400, (800) 673-8499, http://www.awhonn.org.
DES Action USA, 158 S. Stanwood Rd., Columbus, OH, 43209, (800) 337-9288, http://www.desaction.org.
Society of Gynecologic Oncologists, 230 West Monroe Street, Suite 710, Chicago, IL, 60606, (312) 235-4060, http://www.sgo.org.

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Coma

Definition

Coma, from the Greek word "koma," meaning deep sleep, is a state of extreme unresponsiveness, in which an individual exhibits no voluntary movement or behavior. Furthermore, in a deep coma, even painful stimuli (actions which, when performed on a healthy individual, result in reactions) are unable to affect any response, and normal reflexes may be lost.

Description

Coma lies on a spectrum with other alterations in consciousness. The level of consciousness required by, for example, someone reading this passage lies at one extreme end of the spectrum, while complete brain **death** lies at the other end of the spectrum. In between are such states as obtundation, drowsiness, and stupor. All of these are conditions which, unlike coma, still allow the individual to respond to stimuli, although such a response may be brief and require stimulus of greater than normal intensity.

In order to understand the loss of function suffered by a comatose individual, it is necessary to first understand the important characteristics of the conscious state. Consciousness is defined by two fundamental elements: awareness and arousal.

Awareness allows one to receive and process all the information communicated by the five senses, and thus relate to oneself and to the outside world. Awareness has both psychological and physiological components. The psychological component is governed by an individual's mind and mental processes. The physiological component refers to the functioning of an individual's brain, and therefore that brain's physical and chemical condition. Awareness is regulated by cortical areas within the cerebral hemispheres, the outermost layer of the brain that separates humans from other animals by allowing for greater intellectual functioning.

Arousal is regulated solely by physiological functioning and consists of more primitive responsiveness to the world, as demonstrated by predictable reflex (involuntary) responses to stimuli. Arousal is maintained by the reticular activating system (RAS). This is not an anatomical area of the brain, but rather a network of structures (including the brainstem, the medulla, and the thalamus) and nerve pathways, which function together to produce and maintain arousal.

Causes and symptoms

Coma, then, is the result of something that interferes with the functioning of the cerebral cortex and/or the functioning of the structures which make up the RAS. In fact, a huge and varied number of conditions can result in coma. A good way of categorizing these conditions is to consider the anatomic and the metabolic causes of coma. Anatomic causes of coma are those conditions that disrupt the normal physical architecture of the brain structures responsible for consciousness, either at the level of the cerebal cortex or the brainstem, while metabolic causes of coma consist of those conditions that change the chemical environment of the brain, thereby adversely affecting function.

There are many metabolic causes of coma, including:

- A decrease in the delivery to the brain of substances necessary for appropriate brain functioning, such as oxygen, glucose (sugar), and sodium.
- The presence of certain substances that disrupt the functioning of neurons. Drugs or alcohol in toxic quantities can result in neuronal dysfunction, as can substances normally found in the body, but that, due to some diseased state, accumulate at toxic levels. Accumulated substances that might cause coma include ammonia due to liver disease, ketones due to uncontrolled diabetes, or carbon dioxide due to a severe asthma attack.
- The changes in chemical levels in the brain due to the electrical derangements caused by seizures.

Diagnosis

As in any neurologic condition, history and examination form the cornerstone of diagnosis when the patient is in a coma; however, history must be obtained from family, friends, or EMS. The Glasgow Coma Scale is a system of examining a comatose patient. It is helpful for evaluating the depth of the coma, tracking the patient's progress, and predicting (somewhat) the ultimate outcome of the coma. The Glasgow Coma Scale assigns a different number of points for exam results in three

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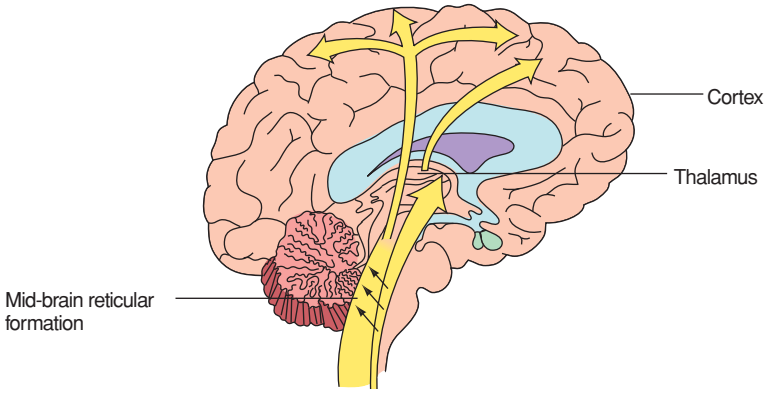
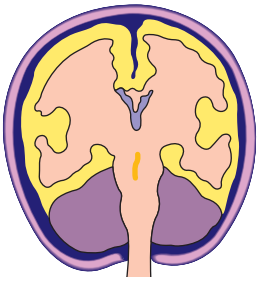


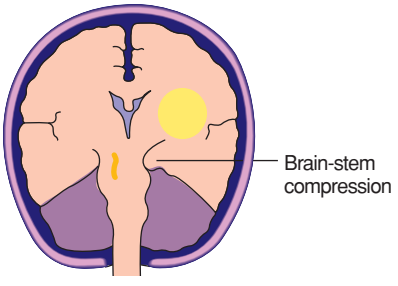
A side-view of the brain, showing movement of the reticular activating substance (RAS) essential to consciousness

Diffuse and bilateral damage to the cerebral cortex (relative preservation of brain-stem reflexes)

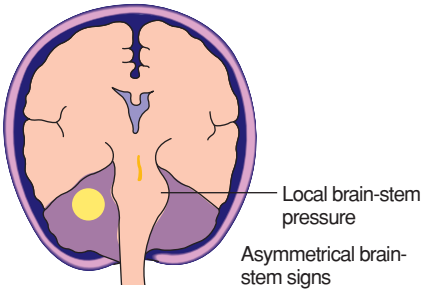


Possible causes
- Damage due to lack of oxygen or restricted blood flow, perhaps resulting from cardiac arrest, an anaesthetic accident, or shock
- Damage incurred from metabolic processes associated with kidney or liver failure, or with hypoglycemia
- Trauma damage
- Damage due to a bout with meningitis, encephalomyelitis, or a severe systemic infection

Mass lesions in this region resulting in compression of the brain-stem and damage to the reticular activating substance (RAS)

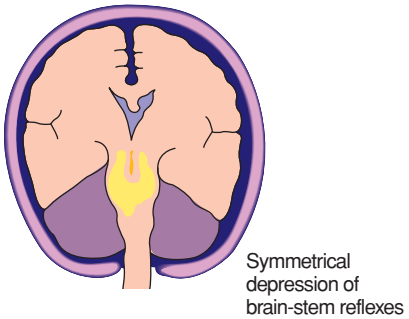


Structural lesions within this region also resulting in compression of the brain-stem and damage to the reticular activating substance (RAS)



Possible causes • Cerebellar tumors, abscesses, or hemorrhages

Lesions within the brain-stem directly suppressing the reticular activating substance (RAS)



Possible causes • Drug overdosage

The four brain conditions that result in coma. *(Illustration by Hans & Cassady, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

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KEY TERMS

Anatomic—Related to the physical structure of an organ or organism.

Metabolic—Refers to the chemical processes of an organ or organism.

Neuron—The cells within the body which make up the nervous system, specifically those along which information travels.

Physiological—Pertaining to the functioning of an organ, as governed by the interactions between its physical and chemical conditions.

Psychological—Pertaining to the mind, its mental processes, and its emotional makeup.

Stimulus/stimuli—Action or actions performed on an individual which predictably provoke(s) a reaction.

different categories: opening the eyes, verbal response (using words or voice to respond), and motor response (moving a part of the body). Fifteen is the largest possible number of total points, indicating the highest level of functioning. The highest level of functioning would be demonstrated by an individual who spontaneously opens his/her eyes, gives appropriate answers to questions about his/her situation, and can carry out a command (such as "move your leg" or "nod your head"). Three is the least possible number of total points and would be given to a patient for whom not even a painful stimulus is sufficient to provoke a response. In the middle are those patients who may be able to respond, but who require an intense or painful stimulus, and whose response may demonstrate some degree of brain malfunctioning (such as a person whose only response to **pain** in a limb is to bend that limb in toward the body). When performed as part of the admission examination, a Glasgow score of three to five points often suggests that the patient has likely suffered fatal brain damage, while eight or more points indicates that the patient's chances for recovery are good. Expansion of the pupils and respiratory pattern are also important. Metabolic causes of coma are diagnosed from blood work and **urinalysis** to evaluate blood chemistry, drug screen, and blood cell abnormalities that may indicate infection. Anatomic causes of coma are diagnosed from CT (computed tomography) or MRI (**magnetic resonance imaging**) scans.

Treatment

Coma is a medical emergency, and attention must first be directed to maintaining the patient's respiration and circulation, using intubation and ventilation, administration of intravenous fluids or blood as needed, and other supportive care. If head trama has not been excluded, the neck should be stablized in the event of fracture. It is obviously extremely important for a physician to determine quickly the cause of a coma, so that potentially reversible conditions are treated immediately. For example, an infection may be treated with **antibiotics**; a **brain tumor** may be removed; and brain swelling from an injury can be reduced with certain medications. Various metabolic disorders can be addressed by supplying the individual with the correct amount of oxygen, glucose, or **sodium**; by treating the underlying disease in **liver disease**, **asthma**, or diabetes; and by halting seizures with medication. Because of their low incidence of side effects and potential for prompt reversal of coma in certain conditions, glucose, the B-vitamin thiamine, and Narcan (to counteract any narcotic-type drugs) are routinely given.

Prognosis

Some conditions that cause coma can be completely reversed, restoring the individual to his or her original level of functioning. However, if areas of the brain have been sufficiently damaged due to the severity or duration of the condition which led to the coma, the individual may recover from the coma with permanent disabilities, or may even never regain consciousness. Take, for example, the situation of someone whose coma was caused by brain injury in a car accident. Such an injury can result in one of three outcomes. In the event of a less severe brain injury, with minimal swelling, an individual may indeed recover consciousness and regain all of his or her original abilities. In the event of a more severe brain injury, with swelling that resulted in further pressure on areas of the brain, an individual may regain consciousness, but may have some degree of impairment. The impairment may be physical (such as **paralysis** of a leg) or may even result in a change in the individual's intellectual functioning and/or personality. The most severe types of brain injury, short of death, result in states in which the individual loses all ability to function and remains deeply unresponsive. An individual who has suffered such a severe brain injury may remain in a coma indefinitely. This condition is termed persistent **vegetative state**.

Outcome from a coma is therefore quite variable and depends a great deal on the cause and duration of the coma. In the case of drug poisonings, extremely high rates of recovery can be expected following prompt medical attention. Patients who have suffered

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head injuries tend to do better than do patients whose coma was caused by other types of medical illnesses. Leaving out those people whose coma followed drug **poisoning**, only about 15% of patients who remain in a coma for more than just a few hours make a good recovery. Those adult patients who remain in a coma for greater than four weeks have almost no chance of eventually regaining their previous level of functioning. On the other hand, children and young adults have regained functioning even after two months in a coma.

ORGANIZATIONS

American Academy of Neurology, 1080 Montreal Ave., St. Paul, MN, 5516, (651) 695-2717, (651) 695-2791, (800) 879-1960, memberservices@aan.com, http://www.aan.com/.

Coma/Traumatic Brain Injury Recovery Association, 8300 Republic Airport Suite 106, Farmingdale, NY, 11735, (631) 756-1826, http://www.comarecovery.org.

Rosalyn Carson-DeWitt, MD

Combat neurosis *see* **Post-traumatic stress disorder**

Common cold

Definition

The common cold is a viral infection of the upper respiratory system, including the nose, throat, sinuses, eustachian tubes, trachea, larynx, and bronchial tubes. Although more than 200 different viruses can cause a cold, 30–50% are caused by a group known as rhinoviruses. Almost all colds clear up in less than two weeks without complications.

Common cold remedies and side effects

	Symptoms	Side effects
Antihistamines	Congestion Itchy eyes Runny nose Sneezing Stuffy nose	Drowsiness Dry mouth and eyes
Decongestants	Congestion Stuffy nose	Insomnia Rapid heartbeat Stimulation

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Description

Colds, sometimes called rhinovirus or coronavirus infections, are the most common illness to strike any part of the body. It is estimated that the average person has more than 50 colds during a lifetime. Anyone can get a cold, although preschool and grade school children catch them more frequently than adolescents and adults. Repeated exposure to viruses causing colds creates partial immunity.

Although most colds resolve on their own without complications, they are a leading cause of visits to the doctor and of time lost from work and school. Treating symptoms of the common cold has given rise to a multi-million dollar industry in over-the-counter medications.

Cold season in the United States begins in early autumn and extends through early spring. Although it is not true that getting wet or being in a draft causes a cold (a person has to come in contact with the virus to catch a cold), certain conditions may lead to increased susceptibility. These include:

- fatigue and overwork
- emotional stress
- poor nutrition
- smoking
- living or working in crowded conditions

Colds make the upper respiratory system less resistant to bacterial infection. Secondary bacterial infection may lead to middle ear infection, **bronchitis**, **pneumonia**, sinus infection, or **strep throat**. People with chronic lung disease, **asthma**, diabetes, or a weakened immune system are more likely to develop these complications.

Causes and symptoms

Colds are caused by more than 200 different viruses. The most common groups are rhinoviruses and coronaviruses. Different groups of viruses are more infectious at different seasons of the year, but knowing the exact virus causing the cold is not important in treatment.

People with colds are contagious during the first two to four days of the infection. Colds pass from person to person in several ways. When an infected person coughs, sneezes, or speaks, tiny fluid droplets containing the virus are expelled. If these are breathed in by other people, the virus may establish itself in their noses and airways.

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Colds may also be passed through direct contact. If a person with a cold touches his runny nose or watery eyes, then shakes hands with another person some of the virus is transferred to the uninfected person. If that person then touches his mouth, nose, or eyes, the virus is transferred to an environment where it can reproduce and cause a cold.

Finally, cold viruses can be spread through inanimate objects (door knobs, telephones, toys) that become contaminated with the virus. This is a common method of transmission in child care centers. If a child with a cold touches her runny nose, then plays with a toy, some of the virus may be transferred to the toy. When another child plays with the toy a short time later, he may pick up some of the virus on his hands. The second child then touches his contaminated hands to his eyes, nose, or mouth and transfers some of the cold virus to himself.

Once acquired, the cold virus attaches itself to the lining of the nasal passages and sinuses. This causes the infected cells to release a chemical called histamine. Histamine increases the blood flow to the infected cells, causing swelling, congestion, and increased mucus production. Within one to three days the infected person begins to show cold symptoms.

The first cold symptoms are a tickle in the throat, runny nose, and sneezing. The initial discharge from the nose is clear and thin. Later it changes to a thick yellow or greenish discharge. Most adults do not develop a **fever** when they catch a cold. Young children may develop a low fever of up to 102°F (38.9°C).

In addition to a runny nose and fever, signs of a cold include coughing, sneezing, nasal congestion, **headache**, muscle ache, chills, **sore throat**, hoarseness, watery eyes, tiredness, and lack of appetite. The **cough** that accompanies a cold is usually intermittent and dry.

Most people begin to feel better four to five days after their cold symptoms become noticeable. All symptoms are generally gone within ten days, except for a dry cough that may linger for up to three weeks.

Colds make people more susceptible to bacterial infections such as strep throat, middle ear infections, and sinus infections. A person whose cold does not begin to improve within a week; or who experiences chest **pain**, fever for more than a few days, difficulty breathing, bluish lips or fingernails, a cough that brings up greenish-yellow or grayish sputum, skin rash, **swollen glands**, or whitish spots on the tonsils or throat should consult a doctor to see if he or she has acquired a secondary bacterial infection that needs to be treated with an antibiotic.

People who have **emphysema**, chronic lung disease, diabetes, or a weakened immune system — either from diseases such as **AIDS** or leukemia, or as the result of medications, (**corticosteroids**, **chemotherapy** drugs)—should consult their doctor if they get a cold. People with these health problems are more likely to get a secondary infection.

Diagnosis

Colds are diagnosed by observing a person's symptoms. There are no laboratory tests readily available to detect the cold virus. However, a doctor may do a **throat culture** or blood test to rule out a secondary infection.

Influenza is sometimes confused with a cold, but flu causes much more severe symptoms and generally a fever. **Allergies** to molds or pollens also can make the nose run. Allergies are usually more persistent than the common cold. An allergist can do tests to determine if the cold-like symptoms are being caused by an allergic reaction. Also, some people get a runny nose when they go outside in winter and breathe cold air. This type of runny nose is not a symptom of a cold.

Treatment

There are no medicines that will cure the common cold. Given time, the body's immune system will make antibodies to fight the infection, and the cold will be resolved without any intervention. **Antibiotics** are useless against a cold. However, a great deal of money is spent by pharmaceutical companies in the United States promoting products designed to relieve cold symptoms. These products usually contain **antihistamines**, **decongestants**, and/or pain relievers.

Antihistamines block the action of the chemical histamine that is produced when the cold virus invades the cells lining the nasal passages. Histamine increases blood flow and causes the cells to swell. Antihistamines are taken to relieve the symptoms of sneezing, runny nose, itchy eyes, and congestion. Side effects are **dry mouth** and drowsiness, especially with the first few doses. Antihistamines should not be taken by people who are driving or operating dangerous equipment. Some people have allergic reactions to antihistamines. Common over-the-counter antihistamines include Chlor-Trimeton, Dimetapp, Tavist, and Actifed. The generic name for two common antihistamines are chlorpheniramine and diphenhydramine.

Decongestants work to constrict the blood flow to the vessels in the nose. This can shrink the tissue, reduce congestion, and open inflamed nasal passages, making breathing easier. Decongestants can make

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people feel jittery or keep them from sleeping. They should not be used by people with heart disease, high blood pressure, or glaucoma. Some common decongestants are Neo-Synepherine, Novafed, and Sudafed. The generic names of common decongestants include phenylephrine, phenylpropanolamine, pseudoephedrine, and in nasal sprays naphazoline, oxymetazoline, and xylometazoline.

Many over-the-counter medications are combinations of both antihistamines and decongestants; an ache and pain reliever, such as **acetaminophen** (Datril, Tylenol, Panadol) or ibuprofen (Advil, Nuprin, Motrin, Medipren); and a cough suppressant (dextromethorphan). Common combination medications include Tylenol Cold and Flu, Triaminic, Sudafed Plus, and Tavist D. **Aspirin** should not be given to children with a cold because of its association with a risk of **Reye's syndrome**, a serious disease.

Nasal sprays and nose drops are other products promoted for reducing nasal congestion. These usually contain a decongestant, but the decongestant can act more quickly and strongly than ones found in pills or liquids because it is applied directly in the nose. Congestion returns after a few hours.

People can become dependent on nasal sprays and nose drops. If used for a long time, users may suffer withdrawal symptoms when these products are discontinued. Nasal sprays and nose drops should not be used for more than a few days. The label lists recommendations on length and frequency of use.

Scientists reported in 2004 the possibility of a new oral drug for use in relieving common cold symptoms. Called pleconaril, it inhibited viral replication in at least 90% of rhinoviruses if taken within 24 hours of onset.

People react differently to different cold medications and may find some more helpful than others. A medication may be effective initially, then lose some of its effectiveness. Children sometimes react differently than adults. Over-the-counter cold remedies should not be given to infants without consulting a doctor first.

Care should be taken not to exceed the recommended dosages, especially when combination medications or nasal sprays are taken. Individuals should determine whether they wish to use any of these drugs. None of them shorten or cure a cold. At best they help a person feel more comfortable. People who are confused about the drugs in any over-the-counter cold remedies should ask their pharmacist for an explanation.

In addition to the optional use of over the counter cold remedies, there are some self-care steps that people can take to ease their discomfort. These include:

- drinking plenty of fluids, but avoiding acidic juices, which may irritate the throat
- gargling with warm salt water — made by adding one teaspoon of salt to 8 oz of water — for a sore throat
- not smoking
- getting plenty of rest
- using a cool-mist room humidifier to ease congestion and sore throat
- rubbing Vaseline or other lubricant under the nose to prevent irritation from frequent nose blowing
- for babies too young to blow their noses, the mucus should be suctioned gently with an infant nasal aspirator. It may be necessary to soften the mucus first with a few drops of salt water.

Alternative treatment

Alternative practitioners emphasize that people get colds because their immune systems are weak. They point out that everyone is exposed to cold viruses, but not everyone gets every cold. The difference seems to be in the ability of the immune system to fight infection. Prevention focuses on strengthening the immune system by eating a healthy diet low in sugars and high in fresh fruits and vegetables, practicing **meditation** to reduce **stress**, and getting regular moderate **exercise**.

Once cold symptoms appear, some naturopathic practitioners believe the symptoms should be allowed to run their course without interference. Others suggest the following:

- Inhaling a steaming mixture of lemon oil, thyme oil, eucalyptus, and tea tree oil (*Melaleuca* spp.). (Aromatherapy)
- Gargling with a mixture of water, salt, and turmeric powder or astringents such as alum, sumac, sage, and bayberry to ease a sore throat. (Ayurvedic medicine)
- Taking coneflower or goldenseal (*Hydrastis canadensis*). Other useful herbs to reduce symptoms include yarrow (*Achillea millefolium*), eyebright (*Euphrasia officinalis*), garlic (*Allium sativum*), and onions (*Allium cepa*). (Herbal)
- Microdoses of *Viscue album*, *Natrum muriaticum*, *Allium cepa*, or *Nux vomica*. (Homeopathy)
- Taking yin chiao (sometimes transliterated as yinquiao) tablets that contain honeysuckle and forsythia when symptoms appear. Natural herb loquat syrup for cough and sinus congestion and Chinese ephedra (*ma-huang*) for runny nose. (Chinese traditional medicine)

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KEY TERMS

Bronchial tubes—The major airways to the lungs and their main branches.

Coronavirus—A genus of viruses that cause respiratory disease and gastroenteritis.

Corticosteroids—A group of hormones produced naturally by the adrenal gland or manufactured synthetically. They are often used to treat inflammation. Examples include cortisone and prednisone.

Eustachian tube—A thin tube between the middle ear and the pharynx. Its purpose is to equalize pressure on either side of the eardrum.

Rhinovirus—A virus that infects the upper respiratory system and causes the common cold.

- The use of zinc lozenges every two hours along with high doses of vitamin C is suggested. Some practitioners also suggest eliminating dairy products for the duration of the cold. (Nutritional therapy).

The use of zinc lozenges may be moving toward acceptance by practitioners of traditional medicine. In 1996 the Cleveland Clinic tested zinc gluconate lozenges and found using zinc in the first 24 hours after cold symptoms occurred shortened the duration of symptoms. The mechanism by which zinc worked was not clear, but additional studies are underway.

At one time, the herb (*Echinacea* spp.) was touted as a remedy to relieve cold symptoms. However, a study published in 2004 reported that the herb failed to relieve cold symptoms in 400 children taking it and caused skin **rashes** in some children.

Prognosis

Given time, the body will make antibodies to cure itself of a cold. Most colds last a week to 10 days. Most people start feeling better within four or five days. Occasionally a cold will lead to a secondary bacterial infection that causes strep throat, bronchitis, pneumonia, sinus infection, or a middle ear infection. These conditions usually clear up rapidly when treated with an antibiotic.

Prevention

It is not possible to prevent colds because the viruses that cause colds are common and highly infectious. However, there are some steps individuals can take to reduce their spread. These include:

- washing hands well and frequently, especially after touching the nose or before handling food
- covering the mouth and nose when sneezing
- disposing of used tissues properly
- avoiding close contact with someone who has a cold during the first two to four days of their infection
- not sharing food, eating utensils, or cups with anyone
- avoiding crowded places where cold germs can spread
- eating a healthy diet and getting adequate sleep

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Common variable immunodeficiency

Definition

Common variable **immunodeficiency** is an immunodeficiency disorder characterized by a low level of antibodies. Patients with this disease are subject to recurring infections.

Description

Immunodeficiency means that the immune system is deficient in one or more of its components and is unable to respond effectively. Common variable immunodeficiency is the most common of the immunodeficiency disorders. Patients with this disease have frequent infections, especially those caused by the same microorganism. Recurring infections are an indication that the immune system is not responding normally and developing immunity to reinfection. Patients with common variable immunodeficiency have a normal number of B cells, the lymphocytes that make antibodies. In approximately one-third of these patients, the number of B cells in the blood that have IgG antibodies on their

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KEY TERMS

Antibodies—Molecules (immunoglobulins) produced by the immune system in response to the presence of a specific molecular trigger (antigen). Specific antibodies found in the blood or body tissues indicates that the corresponding antigen is present in the body.

Antigen—Part of an invading microorganism, which causes tissue damage and stimulates the body's immune system to produce antibodies.

Autoimmune disorder—A disorder in which the body's antibodies mistake the body's own tissues for foreign invaders. The immune system then attacks and causes damage to these tissues.

Immune globulin—A type of amino acid protein present in human serum.

Immune system—The system of the body responsible for producing various cells and chemicals that fight off infection by viruses, bacteria, fungi, and other foreign bodies. In autoimmune disease, these cells and chemicals are turned against the body itself.

surface is lower than normal, but there are normal numbers of B cells in their bone marrow. B cells with IgG antibodies on their surface are capable of responding to microorganisms. The lack of IgG on the surface of the B cells means that they are not prepared to fight infection. The T-cell lymphocytes, those cells responsible for cellular immunity, are usually normal, although some cell signal components may be lacking.

Causes and symptoms

The cause of common variable immunodeficiency is not known, although some forms seem to be hereditary. The main symptom is recurring infections that tend to be chronic rather than acute. Patients may develop **diarrhea** and, as a consequence of the diarrhea, do not absorb food efficiently. This can lead to malnourishment that can aggravate the disorder. Common variable immunodeficiency normally appears in children after the age of 10. **Autoimmune disorders** such as **rheumatoid arthritis**, **thyroiditis**, and **systemic lupus erythematosus** and certain cancers such as lymphomas and leukemias may be associated with common variable immunodeficiency.

Diagnosis

As is true of most immunodeficiency disorders, one of the first signs that the patient has the condition is recurrent infections. Patients with common variable immunodeficiency are subject to recurrent infections, especially those caused by microbes that do not normally cause disease.

Tests

The main diagnostic test that distinguishes common variable immunodeficiency from other immunodeficiency diseases is the low antibody level despite the normal number of B cells. Antibody levels are tested in the serum by a procedure called electrophoresis. This procedure both quantifies the amount of antibody present and identifies the various classes of antibodies. The main class of antibody for fighting infectious diseases is IgG.

Treatment

There is no treatment that will cure the disorder. Treatment for common variable immunodeficiency aims at boosting the body's immune response and preventing or controlling infections. Immune serum, obtained from donated blood, is given as a source of antibodies to boost the immune response. Immune serum is obtained from donated blood. It contains whatever antibodies the donors had in their blood. Consequently, it may not contain all the antibodies the patient needs and may lack antibodies specific for some of the recurring infections these patients develop. **Antibiotics** are used routinely at the first sign of an infection to help the patient eliminate infectious microorganisms.

Prognosis

With good medical care, people with common variable immunodeficiency usually have a normal life span.

Prevention

The disease itself cannot be prevented, but patients and their families can take precautions to prevent the recurrent infections commonly associated with it. For example, good hygiene and **nutrition** are important, as is avoiding crowds or other people who have active infections.

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American Academy of Family Physicians, 114 Tomahawk Creek Parkway, Leawood, KS, 66211-2672, (800) 274-2237, (913) 906-6269, fp@aafp.org, www.familydoctor.org.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Rd., Atlanta, GA, 30333, (800) 311-3435, http://www.cdc.gov.

National Institutes of Health (NIH), 9000 Rockville Pike, Bethesda, MD, 20892, (301) 496-4000, http://www.nih.gov.

U.S. National Library of Medicine, 8600 Rockville Pike, Bethesda, MD, 20894, http://www.nlm.nih.gov.

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Complement deficiencies

Definition

Complement deficiencies are a group of disorders in which there is a reduced level of specific proteins, complement, involved in proper immune functioning.

Description

Complement plays several functions in immunity. It can poke holes in bacteria, kill bacteria that are first targeted by antibodies, or, working with antibodies, point out which bacteria need to be engulfed by white blood cells. Without sufficient complement, the body is prone to frequent infections, like **pneumonia** or **meningitis**, or other illnesses, including autoimmune diseases, like **systemic lupus erythematosus**. Since there are more than 20 different types of complement, the disease that results depends on the specific complement that is lacking.

Cause and symptoms

A defect in the complement system can be genetic, but a secondary complement deficiency can also result from ailments that involve a lot of protein loss, including serious **burns**, liver or **kidney disease**, and autoimmune diseases, like lupus. Symptoms vary depending on the specific complement deficiency and the disease that results. Some people remain healthy with no symptoms at all. Others, who suffer from frequent infections, may develop a high **fever**, **diarrhea**, headaches with a stiff neck, or a **cough** with chest **pain**. If an autoimmune disease develops, like lupus, the person may lose weight, suffer from a rash, and have joint pain. Other symptoms of complement deficiency diseases (like hereditary angioedema, paroxysmal nocturnal hemoglobinuria, or leukocyte adhesion deficiency syndrome) include abdominal and back pain, skin infections, **edema** or swelling of the face, and red bumps on the skin.

Diagnosis

There are blood tests which determine the activity of the complement system. The two most common screening tests, CH50 and APH50, tell the physician which group of complement components have a defect. More specific blood tests for the individual complement components (e.g., C3 or C4 complement) are then performed. Other specialized blood tests, including C1 esterase level, Ham test, and a white blood count, may also be performed.

Treatment

There is no way to treat the actual complement deficiency. However, **antibiotics** are used to treat infections and vaccinations are given to reduce the risk of disease. Often, the person is vaccinated against infections that include **influenza**, pneumonia, and meningitis. In some cases, (e.g. a specific disease called paroxysmal nocturnal hemoglobinuria [NH]) a bone marrow transplant may be recommended.

Alternative treatment

There is no alternative treatment for complement problems.

Prognosis

Since complement deficiencies include a wide range of disorders, the prognoses can also vary widely. Some patients remain healthy their entire life. Others are hospitalized frequently because of infections which, if not properly treated, can be

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KEY TERMS

Autoimmune diseases—A group of diseases, like rheumatoid arthritis and systemic lupus erythematosus, in which immune cells turn on the body, attacking various tissues and organs.

Hereditary angioedema—A complement deficiency characterized by lymphatic vessel blockages that cause temporary swelling (edema) of areas of the skin, mucous membranes, and, sometimes, internal organs.

Leukocyte adhesion deficiency syndrome—A complement deficiency syndrome characterized by recurrent infections of the skin, mucous membranes, and gastrointestinal tract and the absence of pus formation. This disorder is sometimes apparent at birth when separation of the umbilical cord takes longer than normal.

Meningitis—An inflammation of the lining surrounding the brain and spinal cord.

Paroxysmal nocturnal hemoglobinuria (PNH)—A rare complement disorder characterized by episodes of red blood cell destruction (hemolysis) and blood in the urine (hemoglobinuria) that is worse at night.

Systemic lupus erythematosus—An autoimmune disease in which the immune system attacks the body's connective tissue. A butterfly-shaped facial rash is characteristic.

White blood cells—Cells that are key in immune defense. There are various types, including those that engulf and kill invading bacteria.

fatal. Those with autoimmune diseases could have a normal life expectancy. There are some complement deficiencies, that have a high mortality rate. In those cases, **death** may occur within 10 years after diagnosis.

Prevention

There is currently no way to prevent complement deficiencies.

Resources

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ORGANIZATIONS

Immune Deficiency Foundation, 40 West Chesapeake Avenue, Suite 308, Towson, MD, 21204, (800) 296-4433, http://www.primaryimmune.org/.

Jeanine Barone, Physiologist

Complete blood count

Definition

One of the most commonly ordered clinical laboratory tests, a complete blood count, also called a blood count (CBC), is a basic evaluation of the cells (red blood cells, white blood cells, and platelets) suspended in the liquid part of the blood (plasma). It involves determining the numbers, concentrations, and conditions of the different types of blood cells.

Purpose

The purpose of a CBC is to help physicians to diagnose conditions related to abnormalities in the blood such as infections and anemia.

Description

A complete blood count usually includes the following elements:

- Red blood cell count (also called RBC or erythrocyte count)
- Red blood cell indices—mean corpuscular volume (MCV, mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC)
- Hemoglobin (also called Hgb)
- Hematocrit (also called HCT)
- White blood cell count (also called WBC or leukocyte count)
- Platelet count (also called thrombocyte count)

Red blood cells (erythrocytes) transport oxygen between the lungs and cells throughout the rest of the body. They also transport carbon dioxide back to the lungs so it can be exhaled. A low red cell count may be due to anemia and cells in the body may not be getting the oxygen that they need. A red blood cell count that is abnormally high may be due to an uncommon condition called polycythemia.

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White blood cells (leukocytes) protect the body against infection. When an infection develops, white blood cells attack and destroy the pathogen (bacteria, virus, or other organism) causing it. White blood cells are larger than red blood cells but fewer in number. When a person has a bacterial infection, the number of white cells increases very quickly. The number of white blood cells is sometimes used to pinpoint an infection or to see how the body is reacting to **cancer** treatment.

Platelets (thrombocytes) are the smallest type of blood cell. They are essential to the process of blood clotting. When bleeding occurs, platelets swell, clump together, and form a sticky plug that helps to stop the bleeding. If the **platelet count** is too low, uncontrolled bleeding may occur. If the platelet count is too high, there is a chance of a blood clot forming in a blood vessel. Platelets may contribute to the process of hardening of the arteries (**atherosclerosis**).

There are three **red blood cell indices**: mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC). They are measured by a laboratory instrument machine that calculates their values from other measurements in a complete blood count. The mean corpuscular volume reflects the average size of red blood cells. The mean corpuscular hemoglobin value reflects the quantity of hemoglobin in an average red blood cell. The mean corpuscular hemoglobin concentration reflects the concentration of hemoglobin in an average red blood cell. These numbers are used in diagnosing different types of anemia.

The hemoglobin value reflects the amount of hemoglobin in blood and is a good measure of the ability of a person's blood stream to carry oxygen throughout the body. A hemoglobin molecule comprises much of he volume of red blood cells. It carries oxygen and gives red blood cells their normal color.

The **hematocrit** value reflects the amount of space (volume) that red blood cells occupy in the blood. The value is given as a percentage of red blood cells in a volume of blood. For example, a hematocrit of 46 means that 46% of the blood's volume is comprised of red blood cells. Males and females have different normal hematocrit values. The normal red blood cell count ranges from 4.2–5.4 million RBCs per microliter of blood for men and 3.6–5.0 million for women. Hemoglobin values range from 14–18 grams per deciliter of blood for men and 12–16 grams for women. The normal hematocrit is 42–54% for men and 36–48% for women. The normal number of white blood cells for both men and women is approximately 4,000–10,000 WBCs per microliter of blood.

KEY TERMS

Hematoma—A collection of blood that has entered a closed space.

Phlebotomist—Health care professional trained to obtain samples of blood.

Normal results

Normal values for the elements of a complete blood count include the following:

- Red blood cell (erythrocyte) count: 4.2–5.9 million
- White blood cell (leukocyte) count: 4,300–10,800
- Platelet (thrombocyte) count: 150,000–400,000
- Mean corpuscular volume (MCV): 86–98
- Mean corpuscular hemoglobin (MCH): 27–32
- Mean corpuscular hemoglobin concentration (MCHC): 32–36%
- Hemoglobin (Hgb): 13–18 for men and 12–16 for women
- Hematocrit (HCT): 45–52% for men and 37–48% for women

Abnormal results

Abnormal blood count results are seen in a variety of conditions. One of the most common is **anemias**, which are characterized by low RBC counts, hemoglobins, and hematocrits. Infections and leukemias are associated with increased numbers of WBCs.

A complete blood count can be ordered at any time.

Precautions

Precautions are generally not needed for a complete blood count.

At the time of drawing blood, the only precaution needed is to clean the venipuncture site with alcohol.

Side effects

The most common side effects of a complete blood count are minor bleeding (hematoma) or bruising at the site of venipuncture.

Interactions

There are no interactions for a complete blood count.

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American Association for Clinical Chemistry, 1850 K Street NW, Suite 625, Washington, DC, 20006, (800) 892-1400, (202) 887-5093, http://www.aacc.org/AACC.

American Society for Clinical Laboratory Science, 6701 Democracy Boulevard, Suite 300, Bethesda, MD, 20817, (301) 657-2768, (301) 657-2909, http://www.ascls.org.

American Society of Clinical Pathologists, 33 West Monroe Street, Suite 1600, Chicago, IL, 60603, (312) 541-4999, (312) 541-4998, http://www.ascp.org.

College of American Pathologists, 325 Waukegan Road, Northfield, IL, 60093-2750, (847) 832-7000, (800) 323-4040, (800) 823-8000, www.cap.org/apps/cap.portal.

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Computed tomography scans

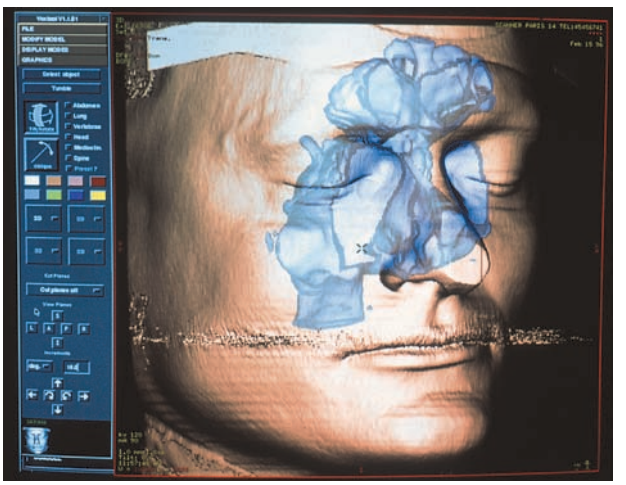
Definition

Computed tomography (CT) scans are completed with the use of a 360-degree x-ray beam and computer production of images. These scans allow for cross-sectional views of body organs and tissues.

Purpose

CT scans are used to image a wide variety of body structures and internal organs. Since the 1990s, CT equipment has become more affordable and available. In some diagnoses, CT scans have become the first imaging exam of choice. Because the computerized image is so sharp, focused, and three-dimensional, many tissues can be better differentiated than on standard x rays. Common CT indications include:

- Sinus studies. The CT scan can show details of a sinusitis, and bone fractures. Physicians may order CT of the sinuses to provide an accurate map for surgery.



CT scan of facial sinuses. *(Pascal Goetgheluck/Photo Researchers, Inc.)*

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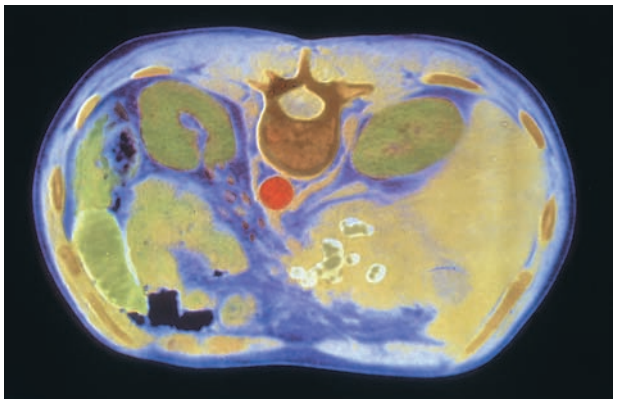

Colorized CT scan of human abdomen—aorta is dead center in red. *(SPL/Photo Researchers, Inc.)*

- Brain studies. Brain scans can detect hematomas, tumors, and strokes. The introduction of CT scanning, especially spiral CT, has helped reduce the need for more invasive procedures such as cerebral angiography.
- Body scans. CT scans of the body will often be used to observe abdominal organs, such as the liver, kidneys, adrenal glands, spleen, and lymph nodes, and extremities.
- Aorta scans. CT scans can focus on the thoracic or abdominal aorta to locate aneurysms and other possible aortic diseases.
- Chest scans. CT scans of the chest are useful in distinguishing tumors and in detailing accumulation of fluid in chest infections.

Precautions

Pregnant women or those who could possibly be pregnant should not have a CT scan unless the diagnostic benefits outweigh the risks. Pregnant patients should particularly avoid full body or abdominal scans. If the exam is necessary for obstetrics purposes, technologists are instructed not to repeat films if there are errors. Pregnant patients receiving CT or any x-ray exam away from the abdominal area may be protected by a lead apron; most radiation, known as scatter, travels through the body and is not blocked by the apron.

Contrast agents are often used in CT exams and the use of these agents should be discussed with the medical professional prior to the procedure. Patients should be asked to sign a consent form concerning the administration of contrast. One of the common contrast agents, iodine, can cause allergic reactions. Patients who are known to be allergic to iodine (or shellfish) should inform the physician prior to the CT scan.

Description

Computed tomography, also called CT scan, CAT scan, or computerized axial tomography, is a combination of focused x-ray beams and computerized production of an image. Introduced in the early 1970s, this radiologic procedure has advanced rapidly and is now widely used, sometimes in the place of standard x rays.

CT equipment

A CT scan may be performed in a hospital or outpatient imaging center. Although the equipment looks large and intimidating, it is very sophisticated and fairly comfortable. The patient is asked to lie on a gantry, or narrow table, that slides into the center of the scanner. The scanner looks like a doughnut and is round in the middle, which allows the x-ray beam to rotate around the patient. The scanner section may also be tilted slightly to allow for certain cross-sectional angles.

CT procedure

The patient will feel the gantry move very slightly as the precise adjustments for each sectional image are made. A technologist watches the procedure from a window and views the images on a computer screen.

It is essential that the patient lie very still during the procedure to prevent motion blurring. In some studies, such as chest CTs, the patient will be asked to hold his or her breath during image capture.

Following the procedure, films of the images are usually printed for the radiologist and referring physician to review. A radiologist can also interpret CT exams on a special computer screen. The procedure time will vary in length depending on the area being imaged. Average study times are from 30 to 60 minutes. Some patients may be concerned about claustrophobia, but the width of the "doughnut" portion of the scanner is such that many patients can be reassured of openness.

The CT image

While traditional x rays image organs in two dimensions, with the possibility that organs in the front of the body are superimposed over those in the back, CT scans allow for a more three-dimensional effect. Some have compared CT images to slices in a loaf of bread. Precise sections of the body can be located and imaged as cross-sectional views. The screen before the technologist shows a computer's analysis of each section detected by the x-ray beam. Thus, various densities of tissue can be easily distinguished.

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Contrast agents

Contrast agents are often used in CT exams and in other radiology procedures to illuminate certain details of anatomy which may not be easily seen. Some contrasts are natural, such as air or water. Other times, a water-based contrast agent is administered for specific diagnostic purposes. Barium sulfate is commonly used in gastroenterology procedures. The patient may drink this contrast, or receive it in an enema. Oral and rectal contrast are usually given when examining the abdomen or cells, and not given when scanning the brain or chest. Iodine is the most widely used intravenous contrast agent and is given through an intravenous needle.

If contrast agents are used in the CT exam, these will be administered several minutes before the study begins. Abdominal CT patients may be asked to drink a contrast medium. Some patients may experience a salty taste, flushing of the face, warmth or slight **nausea**, or **hives** from an intravenous contrast injection. Technologists and radiologists have equipment and training to help patients through these minor reactions and to handle more severe reactions. Severe reactions to contrast are rare, but do occur.

Spiral CT

Spiral CT, also called helical CT, is a newer version of CT scanning which is continuous in motion and allows for three-dimensional recreation of images. For example, traditional CT allows the technologist to take slices at very small and precise intervals one after the other. Spiral CT allows for a continuous flow of images, without stopping the scanner to move to the next image slice. A major advantage of spiral CT is the ability to reconstruct images anywhere along the length of the study area. The procedure also speeds up the imaging process, meaning less time for the patient to lie still. The ability to image contrast more rapidly after it is injected, when it is at its highest level, is another advantage of spiral CT's high speed.

Some facilities will have both spiral and conventional CT available. Although spiral is more advantageous for many applications, conventional CT is still a superior and precise method for imaging many tissues and structures. The physician will evaluate which type of CT works best for the specific exam purpose.

Preparation

If a contrast medium is administered, the patient may be asked to fast from about four to six hours prior to the procedure. Patients will usually be given a gown (like a typical hospital gown) to be worn during the procedure. All metal and jewelry should be removed to avoid artifacts on the film.

Aftercare

No aftercare is generally required following a CT scan. Immediately following the exam, the technologist will continue to watch the patient for possible adverse contrast reactions. Patients are instructed to advise the technologist of any symptoms, particularly respiratory difficulty. The site of contrast injection will be bandaged and may feel tender following the exam. Hives may develop later and usually do not require treatment.

Risks

Radiation exposure from a CT scan is similar to, though higher than, that of a conventional x ray. Although this is a risk to pregnant women, the exposure to other adults is minimal and should produce no effects. Although severe contrast reactions are rare, they are a risk of many CT procedures.

Normal results

Normal findings on a CT exam show bone, the most dense tissue, as white areas. Tissues and fat will show as various shades of gray, and fluids will be gray or black. Air will also look black. Intravenous, oral, and rectal contrast appear as white areas. The radiologist can determine if tissues and organs appear normal by the sensitivity of the gray shadows. In CT, the images that can cut through a section of tissue or organ provide three-dimensional viewing for the radiologist and referring physician.

Abnormal results

Abnormal results may show different characteristics of tissues within organs. Accumulations of blood or other fluids where they do not belong may be detected. Radiologists can differentiate among types of tumors throughout the body by viewing details of their makeup.

Sinus studies

The increasing availability and lowered cost of CT scanning has led to its increased use in sinus studies, either as a replacement for a sinus x ray or as a follow-up to an abnormal sinus radiograph. The sensitivity of CT allows for location of areas of sinus infection, particularly chronic infection. CT scans can show the extent and location of tiny **fractures** to the sinus and nasal bones. Foreign bodies in the sinus and nasal area are also easily detected by CT. CT imaging of the sinuses is important in evaluating trauma or disease

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KEY TERMS

Aneurysm—The bulging of the blood vessel wall. Aortic aneurysms are the most dangerous. Aneurysms can break and cause bleeding.

Contrast (agent, medium)—A substance injected into the body that illuminates certain structures that would otherwise be hard to see on the radiograph (film).

Gantry—A name for the couch or table used in a CT scan. The patient lies on the gantry while it slides into the x-ray scanner portion.

Hematoma—A collection of blood that has escaped from the vessels. It may clot and harden, causing pain to the patient.

Hydrocephalus—A collection of fluid on or around the brain. The pressure from the spinal fluid causes the ventricles to widen.

Metastasis—Secondary cancer, or cancer that has spread from one body organ or tissue to another.

Radiologist—A medical doctor specially trained in radiology (x ray) interpretation and its use in the diagnosis of disease and injury.

Spiral CT—Also referred to as helical CT, this method allows for continuous 360-degree x-ray image capture.

Thoracic—Refers to the chest area. The thorax runs between the abdomen and neck and is encased in the ribs.

of the sphenoid bone (the wedge shaped bone at the base of the skull). Sinus tumors will show as shades of gray indicating the difference in their density from that of normal tissues in the area.

Brain studies

The precise differences in density allowed by CT scan can clearly show tumors, strokes, or lesions in the brain area as altered densities. These lighter or darker areas on the image may indicate a tumor or hematoma within the brain and skull area. Different types of tumors can be identified by the presence of **edema**, by the tissue's density, or by studying blood vessel location and activity. The speed and convenience of CT often allows for detection of hemorrhage before symptoms even occur. Congenital abnormalities in children, such as **hydrocephalus**, may also be confirmed with CT. Hydrocephalus is suggested by enlargement of the fluid structures called ventricles of the brain.

Body scans

The body scan can identify abnormal body structures and organs. Throughout the body, a CT may indicate tumors or cysts, enlarged lymph nodes, abnormal collections of fluids, blood or fat, and metastasis of **cancer**. Tumors resulting from metastasis are different in makeup than primary tumors, or those that originate in the location of study. Fractures or damage to soft tissues and ligaments will be more easily seen on the sensitive images produced by CT scanning, though CT is not usually done for these. Liver conditions, such as **cirrhosis** or abscessed or **fatty liver**, may be observed on the body scan.

CT of the aorta

CT provides the ability to see and measure the thickness of the aortal wall, which is very helpful in diagnosing aortic aneurysms. The use of contrast will help see details within the aorta. In addition, density can identify calcification, and this helps differentiate between acute and chronic problems. An abnormal CT scan may indicate signs of aortic clots. Aortic rupture is suggested by signs such as a hematoma around the aorta or the escape of blood from its cavity.

Chest scans

In addition to those findings that may indicate aortic aneurysms, chest CT studies can show other problems in the heart and lungs, and distinguish between an **aortic aneurysm** and a tumor adjacent to the aorta. The computer will not only show differences between air, water, tissues, and bone, but will also assign numerical values to the various densities. Coin-sized lesions in the lungs may be indicative of **tuberculosis** or tumors. CT will help distinguish among the two. Enlarged lymph nodes in the chest area may indicate Hodgkin's disease. Spiral CT is particularly effective at identifying pulmonary emboli (clots in the lung's blood vessels).

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American College of Radiology, 1891 Preston White Drive, Reston, VA, 22091, (800) 227-5463, http://www.acr.org.

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Computerized axial tomography *see* **Computed tomography scans**

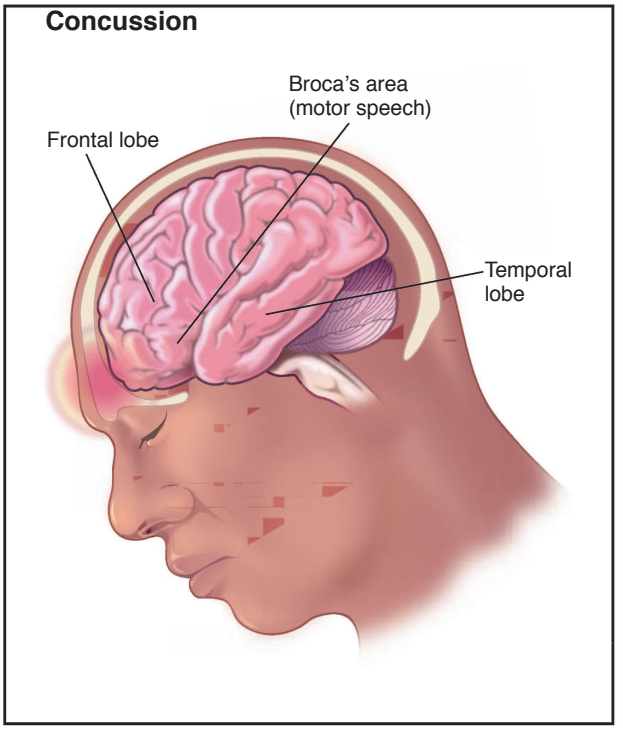
Concussion

Definition

Concussion is a trauma-induced change in mental status, with confusion and **amnesia**, and with or without a brief loss of consciousness. Concussion is also called traumatic brain injury.

Demographics

The incidence of concussion is estimated to be 2 per 1,000 individuals per year in the United States. Most of these concussions are mild, but about 10% cause disability or **death**. Statistics collected by the Centers for Disease Control and Prevention (CDC) between 2002 and 2006 showed that on average 1.7 million people suffered a concussion annually. Of them, about 275,000 were hospitalized, and 52,000 died.



An illustration of the head and brain, depicting the impact of a concussion on the parts of the brain. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Description

A concussion occurs when the head hits or is hit by an object, or when the brain is jarred against the skull, with sufficient force to cause temporary loss of function in the higher centers of the brain. The injured person may remain conscious or lose consciousness briefly, and is disoriented for some minutes after the blow.

While concussion usually resolves on its own without lasting effect, it can set the stage for a much more serious condition. "Second impact syndrome" occurs when a person with a concussion, even a very mild one, suffers a second blow before fully recovering from the first. The brain swelling and increased intracranial pressure that can result is potentially fatal. More than 20 such cases have been reported since the syndrome was first described in 1984.

Causes and symptoms

Causes

Playing contact sports is a risk factors for experiencing one or more concussions. According to the CDC, approximately 300,000 people sustain mild to moderate sports-related brain injuries each year. However, sports-related concussions are widely thought to be under reported because athletes do not want to be medically disqualified from continuing to play their sport. Most sports-related brain injuries occur in young men between the ages of 16 and 25 years.

The risk of concussion from football is extremely high, especially at the high school level. Studies show that approximately one in five players suffer concussion or more serious brain injury during their brief high-school careers. The rate at the collegiate level is approximately one in 20. Rates for hockey players are not known as certainly, but are believed to be similar.

Concussion and lasting brain damage is an especially significant risk for boxers, since the goal of the sport is, in fact, to deliver a concussion to the opponent. For this reason, the American Academy of Neurology has called for a ban on boxing. Repeated concussions over months or years can cause cumulative **head injury**. The cumulative brain injuries suffered by most boxers can lead to permanent brain

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damage. Multiple blows to the head can cause "punch-drunk" syndrome or **dementia** pugilistica, as evidenced by Muhammaed Ali, whose parkinsonism is a result of his career in the ring.

Falls account for the greatest number of concussions in children ages 0–4 years and in people over age 65. Individuals over age 75 have the greatest rate of hospitalization and death from concussions.

Motor vehicle accident are most likely to cause concussions that result in death. The death rate from motor vehicle concussions is highest in males ages 20–24 years. In motor vehicle accidents, concussion can occur without an actual blow to the head. Instead, concussion occurs because the skull suddenly decelerates or stops, which causes the brain to be jarred against the skull.

Child abuse is, unfortunately, another common cause of concussion.

Symptoms

Symptoms of concussion include:

- headache
- disorientation as to time, date, or place
- confusion
- dizziness
- vacant stare or confused expression
- incoherent or incomprehensible speech
- incoordination or weakness
- amnesia for the events immediately preceding the blow
- nausea or vomiting
- double vision
- ringing in the ears

These symptoms may last from several minutes to several hours. More severe or longer-lasting symptoms may indicate more severe brain injury. The person with a concussion may or may not lose consciousness from the blow. More prolonged unconsciousness indicates more severe brain injury.

The severity of concussion is graded on a three-point scale, used as a basis for treatment decisions.

- Grade 1: no loss of consciousness, transient confusion, and other symptoms that resolve within 15 minutes.
- Grade 2: no loss of consciousness, transient confusion, and other symptoms that require more than 15 minutes to resolve.
- Grade 3: loss of consciousness for any period.

KEY TERMS

Amnesia—A loss of memory that may be caused by brain injury, such as concussion.

Parkinsonism—A neurological disorder that includes a fine tremor, muscular weakness and rigidity, and an altered way of walking.

Days or weeks after the accident, the person may show symptoms of a condition called "post-concussion syndrome." Signs of **post-concussion syndrome** include:

- headache
- poor attention and concentration
- memory difficulties
- anxiety
- depression
- sleep disturbances
- light and noise intolerance

Diagnosis

Examination

It is very important for those attending a person with concussion to pay close attention to the person's symptoms and progression immediately after the accident. The duration of unconsciousness and degree of confusion are important indicators of the severity of the injury and help guide the diagnostic process and treatment decisions.

A doctor, nurse, or emergency medical technician may make an immediate assessment based on the severity of the symptoms; a neurologic exam of the pupils, coordination, and sensation; and brief tests of orientation, memory, and concentration. Those with very mild concussions may not need to be hospitalized or have expensive diagnostic tests.

Tests

Questionable or more severe cases may require computed tomography scan (CT) or **magnetic resonance imaging** (MRI) scans to look for brain injury. More extensive neuropsychologic testing may be done, especially on athletes who are at risk for repeat concussions.

Treatment

The symptoms of concussion usually clear quickly and without lasting effect, if no further injury is sustained during the healing process. Guidelines for

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returning to sports activities are based on the severity of the concussion.

Traditional

A grade 1 concussion can usually be treated with rest and continued observation alone. The person may return to sports activities that same day, but only after examination by a trained professional, and after all symptoms have completely resolved. If the person sustains a second concussion of any severity that same day, he or she should not be allowed to continue contact sports until he or she has been symptom-free, during both rest and activity, for one week.

A person with a grade 2 concussion must discontinue sports activity for the day, should be evaluated by a trained professional, and should be observed closely throughout the day to make sure that all symptoms have completely cleared. Worsening of symptoms, or continuation of any symptoms beyond one week, indicates the need for a CT or MRI scan. Return to contact sports should only occur after one week with no symptoms, both at rest and during activity, and following examination by a physician. Following a second grade 2 concussion, the person should remain symptom-free for two weeks before resuming contact sports.

A person with a grade 3 concussion (involving any loss of consciousness, no matter how brief) should be examined by a medical professional either on the scene or in an emergency room. More severe symptoms may warrant a CT or MRI scan, along with a thorough neurological and physical exam. The person should be hospitalized if any abnormalities are found or if confusion persists. Prolonged unconsciousness and worsening symptoms require urgent neurosurgical evaluation or transfer to a trauma center. Following discharge from professional care, the patient is closely monitored for neurological symptoms, which may arise or worsen. If headaches or other symptoms worsen or last longer than one week, a CT or MRI scan should be performed. Contact sports are avoided for one week following unconsciousness of only seconds, and for two weeks for unconsciousness of a minute or more.

For someone who has sustained a concussion of any severity, it is critically important that he or she avoid the possibility of another blow to the head until well after all symptoms have cleared to prevent second-impact syndrome. The previous guidelines were designed to minimize the risk of this syndrome. A person receiving a second grade 3 concussion should avoid contact sports for at least a month after all symptoms have cleared, and then only with the approval of a physician. If signs of brain swelling or bleeding are seen on a CT or MRI scan, the athlete should not return to the sport for the rest of the season, or even indefinitely.

Prognosis

About 90% of concussions leave no lasting neurological problems. Nonetheless, symptoms of post-concussion syndrome may last for weeks or even months.

Studies of concussion in contact sports have shown that the risk of sustaining a second concussion is even greater than it was for the first if the person continues to engage in the sport.

Prevention

Many cases of concussion can be prevented by using appropriate protective equipment. This includes seat belts and air bags in automobiles, and helmets in all contact sports. Helmets should also be worn when bicycling, skiing, skateboarding, or horseback riding. Soccer players should avoid heading the ball when it is kicked at high velocity from close range. Playground equipment should be underlaid with soft material, either sand or special matting.

The value of high-contact sports such as boxing, football, or hockey should be weighed against the high risk of brain injury during a young person's participation in the sport. Steering a child's general enthusiasm for sports into activities less apt to produce head impacts may reduce the likelihood of brain injury.

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ORGANIZATIONS

American Academy of Neurology, 1080 Montreal Avenue, St. Paul, MN, 55116, (651) 695-2717, (800) 879-1960, Fax: (651) 695-2791, http://www.aan.com.

Brain Injury Association of America, 1608 Spring Hill Road, Vienna, VA, 22182, (703) 761-0750, (800) 444-6443, (703) 761-0755, braininjuryinfo@biausa.org, http://www.biausa.org.

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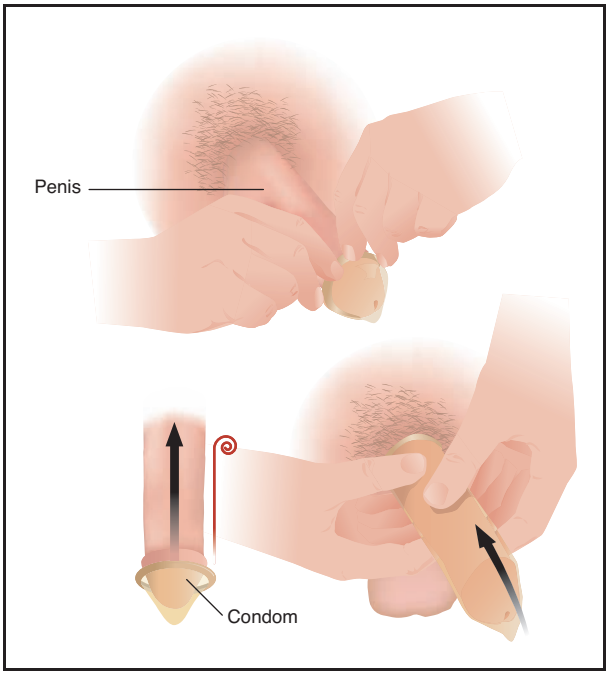
Condoms

Definition

Condoms are a barrier method of **contraception** intended to block the entry of semen from the male into the cervix of the female uterus, thus preventing fertilization of the female ovum. Most condoms are male-controlled contraceptive devices that consist of a thin flexible sheath placed over the erect male penis prior to intercourse. There are also female condoms, first introduced in 1984, that consist of a pouch with flexible rings at each end.

The derivation of the term *condom* is unknown. There was an urban legend for many years that the name was derived from either a court physician named Dr. Condom or the Earl of Condom, supposedly a noble at the court of King Charles II of England (1630–1685). Charles was known as the "Merry Monarch" and his court was famous for its irresponsible pleasure-seeking; however, there are no records of anyone named Condom in the court circle, and condoms were in use in England for over a century before Charles became king in 1660. Most historians of medicine now state that the origin of the word *condom* cannot be traced.



A condom is most effective when it is placed on the penis correctly without trapping air between the penis and the condom. *(Illustration by Argosy, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

Purpose

Both male and female condoms are used to prevent **pregnancy** and to protect against such **sexually transmitted diseases** (STDs) as human **immunodeficiency** virus (HIV), **gonorrhea**, chlamydia, and **syphilis**. To accomplish these goals, however, a condom must be applied and removed correctly. The Centers for Disease Control and Prevention (CDC) states, "To achieve the maximum protective effect, condoms must be used both consistently and correctly. Inconsistent use can lead to STD acquisition because transmission can occur with a single act of intercourse with an infected partner. Similarly, if condoms are not used correctly, the protective effect may be diminished even when they are used consistently."

In addition to standard condoms used for contraception and disease **prophylaxis**, there are also specialized condoms used to collect male semen for artificial insemination or sperm analysis as part of an **infertility** workup. Collection condoms are usually made of silicone or polyurethane rather than latex, as latex is harmful to sperm and may yield inaccurate results when the number and viability of the sperm are measured.

Demographics

Condoms have been the most widely used method of contraception and disease prevention worldwide since they were first mass manufactured in the late nineteenth century. After birth control pills were introduced in 1960, condoms became the second most common method of birth control in the developed countries. In Japan, however, 80% of married couples still prefer condoms to other methods of birth control, compared to 28% of couples in the United States and Canada. In Africa, only 8% of couples use condoms as a method of contraception.

Although exact statistics of the number of condoms manufactured each year worldwide are difficult to obtain, it is safe to assume that billions are produced, as the number purchased by the government of India alone for distribution in family planning clinics is 2 billion per year.

Description

Both male and female condoms collect the male semen at ejaculation, acting as a barrier to fertilization. Condoms serve as barriers to the exchange of bodily fluids and are subsequently an important tool in the prevention of sexually transmitted diseases (STDs).

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Male condoms

Male condoms are thin sheaths of latex (rubber), polyurethane (plastic), or animal tissue that are rolled onto an erect penis immediately prior to intercourse. They are commonly called "safes," "rubbers," or "prophylactics," from their use in preventing disease. In England they are sometimes called "French letters."

Because many men and women are allergic to latex, the Food and Drug Administration (FDA) approved the use of Vytex for condoms sold in the United States in May 2009. Vytex is a form of latex that has been treated to remove 90% of the proteins that cause allergic reactions. A completely allergen-free condom made of polyisoprene, a synthetic latex, is also available. Polyisoprene is more expensive than standard latex but has the advantages of being as flexible and soft as latex without triggering allergic reactions.

Most condoms made of animal tissue as of 2010 are made from sheep intestines and are labeled as lambskin. They provide more sensation than latex and are also less likely to trigger allergic reactions. They are also significantly more expensive than latex condoms and offer less protection against STDs. The reason for this difference is that sheep intestine is a porous material whose pores are large enough to permit the HIV virus and other infectious organisms to pass through even though the pores are small enough to block sperm.

Male condoms may be purchased lubricated, ribbed, or studded on the outside. Studded condoms should not be used for anal intercourse, however, because they can irritate the tissues lining the rectum and increase the risk of HIV transmission. To be effective, condoms must be removed carefully so as not to "spill" the contents into the vaginal canal. Condoms that leak or break do not provide complete protection against pregnancy or disease, although they are more effective than completely unprotected intercourse.

Female condoms

Female condoms are made of polyurethane and are inserted into the vaginal canal before sexual relations. The open end covers the outside of the vagina, and the closed ring fits over the cervix (opening into the uterus). Newer female condoms are made of nitrile, a synthetic rubber that is also used to make disposable surgical gloves. Nitrile is as flexible as latex but is more resistant to puncture.

Origins

Male condoms made from animal tissue and linen have been in use for centuries. In Japan and China, upper-class men used condoms made from tortoise shell or animal horn. The first documented use of condoms in Europe dates from 1564, in a treatise on preventing syphilis. Syphilis, which first entered Europe in the 1490s, was an extremely virulent disease at that time and could cause **death** within a few months. The 1564 treatise described the use of linen sheaths soaked in some kind of chemical solution and dried before wearing. Condoms made from pig bladders or intestines were also used during the Renaissance. These devices were initially used in Europe to prevent STDs; the first reference to their use as contraceptives was published in 1605.

Latex condoms were introduced in the late 1800s and gained immediate popularity because they were inexpensive and effective. The German army was the first to recommend condoms to soldiers, beginning in the late nineteenth century. Although condoms were the first effective method of contraception that the poor could afford, a common complaint made then as now by many consumers is that condoms reduce penis sensitivity and impair satisfaction. In addition, both men and women may develop **allergies** to latex. Consumer interest in female condoms was relatively slight when it was first introduced; however, the fact that the female condom can be used by women whose partners refuse to use a male condom has increased its popularity in a number of countries.

Benefits

An important fact to keep in mind when reading statistics about condom effectiveness is the distinction between "perfect" or "method effectiveness" use rates and "actual" or "typical" use rates. Perfect or method effectiveness rates include only consumers who use condoms properly and consistently. Typical or actual use rates include all persons who use condoms, including those who use them incorrectly or do not use them during every act of intercourse. Thus while perfect use of condoms results in a pregnancy rate of 2% per year, typical users have a pregnancy rate of 10% to 18% per year.

With regard to disease transmission, in 2000 the National Institutes of Health (NIH) reported that correct and consistent use of latex condoms reduces the risk of HIV/AIDS transmission by approximately 85% relative to a person's risk when unprotected. In 2007 the World Health Organization (WHO) reported a similar risk reduction rate of 80% to 95%. The CDC states that "Latex condoms, when used consistently and correctly, are highly effective in preventing the sexual transmission of HIV, the virus that causes **AIDS**. In addition, consistent and correct use of latex

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KEY TERMS

Carcinogen—Any substance or form of radiation that increases the risk of cancer or stimulates the growth of an existing cancer.

Contraception—The use of a device, sexual practice, or chemical intended to prevent conception; birth control.

Ejaculate—To expel semen.

Nonoxynol-9—The chemical name of the organic compound most commonly used in contraceptive creams, foams, and jellies. It was also used in the manufacture of spermicide-treated condoms until 2005, but the use of such condoms is now discouraged.

Perfect use—A measurement of the effectiveness of a contraceptive based only on those who use the method correctly and use it every time they have intercourse. It is also called the method effectiveness rate.

Prophylactic—A drug, medical device, or technique intended to prevent (rather than treat) disease. Condoms are sometimes called prophylactics.

Semen—The thick whitish liquid released from the penis during sexual intercourse. It contains sperm and other secretions.

Sperm or spermatozoa—The part of the semen that is generative—can cause fertilization of the female ovum.

Spermicide—An agent that is destructive to sperm.

Typical use—A measurement of the effectiveness of a contraceptive that counts all users, including those who use the method incorrectly or only occasionally.

Vagina—The genital canal in the female, leading from the vulva to the uterus.

condoms reduces the risk of other sexually transmitted diseases (STDs), including diseases transmitted by genital secretions, and to a lesser degree, genital ulcer diseases."

With regard to contraception, male condoms have an effectiveness rate of about 90% for preventing pregnancy when used correctly and consistently, but this rate can be increased to about 98% if used with a spermicide that is applied separately. (Several types of spermicides are available; they can be purchased in the form of contraceptive creams and jellies, foams, or films.) Benefits associated with this type of contraceptive device include easy availability (no prescription is required), convenience of use, and absence of serious side effects. The primary disadvantage is that sexual activity must be interrupted in order to put on the male condom.

Female condoms, when used correctly and at every instance of intercourse, were shown to prevent pregnancy in over 95% of women surveyed over the course of six months. When used inconsistently, the female condom was shown to have a failure rate of 21% in the same study. One benefit of the female condom is that it may be inserted immediately before sexual intercourse or up to eight hours prior, so that sexual activity does not need to be interrupted for its insertion. One study performed by a manufacturer of the female condom indicated that 50–75% of couples in numerous countries found the barrier acceptable for use.

Precautions

Before purchasing a condom, the user should check the expiration date. Prior to use, examine the condom for holes. If a lubricant is going to be used with a latex condom, it should be water-soluble because petroleum jellies, such as Vaseline, and other oil-based lubricants can weaken latex. It is also important to note that condoms made from animal tissue or plastic are not recommended as a protection against STDs.

Spermicide-treated condoms are no longer recommended because the spermicide used in them, a chemical called nonoxynol-9, was reported in 2003 to actually increase the risk of transmitting HIV because it causes tiny tears or breaks in the tissues lining the vagina or rectum. In addition, spermicide-treated condoms increase the risk of urinary tract infections in the female partner. After 2005, several major manufacturers of condoms stopped producing condoms treated with spermicide.

Preparation

A person intending to use a condom should avoid heavy drinking or drug use prior to having sex, because intoxication or a drug "high" can impair judgment and increase the risk of using the condom incorrectly.

A male condom should be removed carefully from its foil wrapper and placed on the tip of the erect penis. Leaving some space at the tip of the condom to collect

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the semen, the user then unrolls the condom downward toward the base of the penis.

To use a female condom, the woman inserts a flexible ring at the closed end of the sheath deep into the vagina; this ring holds the device in place. The flexible ring at the open end of the sheath remains outside the opening to the vagina and serves to guide the man's penis into the vagina.

Aftercare

To remove a male condom after use, the user should withdraw carefully, holding the condom around the base of the penis. To remove a female condom, the user should twist the outer ring shut and gently withdraw the condom from the vagina. Because most condoms are not biodegradable, they should not be flushed down toilets. Instead, they should be wrapped in toilet paper or a paper towel and discarded in a waste container.

Risks

In addition to the risks of pregnancy or disease transmission from incorrect or inconsistent use, condoms have been associated with risks from substances used in their manufacture. Nitrosamines, which are chemicals identified as carcinogenic in humans, are used by some manufacturers of latex condoms to increase the flexibility of the latex. One group of German researchers reported in 2005 that nitrosamines can migrate from rubber products into human sweat or tissue fluid.

Another risk of condom use is partner violence in some cultures and ethnic groups. Women in Africa and in some Latino subcultures in developed countries have reported threats of violence from their partners if they ask the men to use condoms as a form of contraception. In addition, there is a high correlation of alcohol **abuse**, condom non-use, and sexual assaults on women.

Research and general acceptance

Condoms are widely accepted as an effective method of contraception and disease prophylaxis. Research is ongoing, however, into improving the effective use of condoms among drug users and other high-risk populations, and into newer types of condoms. These newer types include:

- Rape-aXe. Rape-aXe is a female condom that has been produced since 2006. It consists of a latex sheath containing sharp barbs. The woman inserts the device like a tampon. If a male attacker attempts vaginal penetration, the device attaches itself to his penis and requires surgical removal, thus identifying the rapist.
- Spray-on condoms. As of 2010, several companies are working on developing a latex formula that could be sprayed on the penis and allowed to dry. The major difficulty is developing a compound that will dry in less time than 2–3 minutes.
- A so-called invisible condom. Developed by a university in Quebec, the invisible condom is a gel that hardens after insertion into the vagina or rectum, and then liquefies after several hours. It is still in the clinical trials phase as of 2010.
- Condoms containing lubricants intended to help the male partner maintain his erection, thus reducing the risk of condom slippage. These condoms are also still in clinical trials as of 2010.

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Centers for Disease Control and Prevention (CDC). *Condoms and STDs: Fact Sheet for Public Health Personnel*. http://www.cdc.gov/condomeffectiveness/latex.htm
Rape-aXe. *Introduction*. Page includes a video showing how the anti-rape female condom works. http://www.antirape.co.za/intro.htm

ORGANIZATIONS

American Congress of Obstetricians and Gynecologists (ACOG), 409 12th St., S.W., P.O. Box 96920, Washington, DC, 20090-6920, (202) 638-5577, resources@acog.org, http://www.acog.org/.
Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.
American Social Health Association (ASHA), P.O. Box 13827, Research Triangle Park, NC, 27709, (919) 361-8400, (919) 361-8425, http://www.ashastd.org/index.cfm.
National Institute of Allergy and Infectious Diseases (NIAID), 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-6612, (301) 496-5717, (866) 284-4107, (301) 402-3573, http://www3.niaid.nih.gov.
U.S. Food and Drug Administration (FDA), 10903 New Hampshire Ave., Silver Spring, MD, 20993, (888) 463-6332, http://www.fda.gov/.
AVERT, an International AIDS Charity, 4 Brighton Road, HorshamWest Sussex, United Kingdom, RH13 5BA, +44 (0)1403 210202, http://www.avert.org/.
World Health Organization (WHO), Avenue Appia 20, 1211 Geneva 27, Switzerland, + 41 22 791 21 11, + 41 22 791 31 11, info@who.int, http://www.who.int/en/.

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Conduct disorder

Definition

Conduct disorder (CD) is a behavioral and emotional disorder of childhood and adolescence. Children with conduct disorder act inappropriately, infringe on the rights of others, and violate the behavioral expectations of others.

Description

CD is present in approximately 9% of boys and 2–9% of girls under the age of 18. Children with conduct disorder act out aggressively and express anger inappropriately. They engage in a variety of antisocial and destructive acts, including violence toward people and animals, destruction of property, lying, stealing, truancy, and running away from home. They often begin using and abusing drugs and alcohol, and having sex at an early age. Irritability, temper tantrums, and low self-esteem are common personality traits of children with CD.

Causes and symptoms

There are two sub-types of CD, one beginning in childhood and the other in adolescence. There is no known cause. Researchers and physicians suggest that this disease may be caused by the following:

- poor parent-child relationships
- dysfunctional families
- drug abuse
- physical abuse
- poor relationships with other children
- cognitive problems leading to school failures
- brain damage
- biological defects

Difficulty in school is an early sign of potential conduct disorder problems. While the patient's IQ tends to be in the normal range, they can have trouble with verbal and abstract reasoning skills and may lag behind their classmates, and consequently, feel as if they don't "fit in." The frustration and loss of self-esteem resulting from this academic and social inadequacy can trigger the development of CD.

A dysfunctional home environment can be another major contributor to CD. An emotionally, physically, or sexually abusive home environment, a family history of antisocial personality disorder, or parental **substance abuse** can damage a child's perceptions of himself and put him on a path toward negative behavior. Other less obvious environmental factors can also play a part in the development of conduct disorder. Long-term studies have shown that maternal **smoking** during **pregnancy** may be linked to the development of CD in boys. Animal and human studies point out that nicotine can have undesirable effects on babies. These include altered structure and function of their nervous systems, learning deficits, and behavioral problems. In a study of 177 boys

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ages 7 to 12 years, those with mothers who smoked over one-half a package of cigarettes daily while pregnant were more apt to have a CD than those with mothers who did not smoke.

Other conditions that may cause or co-exist with CD include **head injury**, substance abuse disorder, major depressive disorder, and **attention deficit hyperactivity disorder (ADHD)**. Thirty to 50 percent of children diagnosed with **ADHD**, a disorder characterized by a persistent pattern of inattention and/or hyperactivity, also have CD.

CD is defined as a repetitive behavioral pattern of violating the rights of others or societal norms. Three of the following criteria, or symptoms, are required over the previous 12 months for a diagnosis of CD (one of the three must have occurred in the past 6 months):

- bullies, threatens, or intimidates others
- picks fights
- has used a dangerous weapon
- has been physically cruel to people
- has been physically cruel to animals
- has stolen while confronting a victim (for example, mugging or extortion)
- has forced someone into sexual activity
- has deliberately set a fire with the intention of causing damage
- has deliberately destroyed property of others
- has broken into someone else's house or car
- frequently lies to get something or to avoid obligations
- has stolen without confronting a victim or breaking and entering (e.g., shoplifting or forgery)
- stays out at night; breaks curfew (beginning before 13 years of age)
- has run away from home overnight at least twice (or once for a lengthy period)
- is often truant from school (beginning before 13 years of age)

Diagnosis

CD is diagnosed and treated by a number of social workers, school counselors, psychiatrists, and psychologists. Genuine diagnosis may require psychiatric expertise to rule out such conditions as **bipolar disorder** or ADHD. A comprehensive evaluation of the child should ideally include interviews with the child and parents, a full social and medical history, a cognitive evaluation, and a psychiatric exam. One or more clinical inventories or scales may be used to assess the child for conduct disorder—including the Youth Self-Report, the Overt Aggression Scale (OAS), Behavioral Assessment System for Children (BASC), Child Behavior Checklist (CBCL), and Diagnostic Interview Schedule for Children (DISC). The tests are verbal and/or written and are administered in both hospital and outpatient settings.

KEY TERMS

ADHD—Attention deficit hyperactivity disorder; a disorder characterized by a persistent pattern of inattention and/or hyperactivity.

Major depressive disorder—A mood disorder characterized by profound feelings of sadness or despair.

Treatment

Treating conduct disorder requires an approach that addresses both the child and his environment. Behavioral therapy and **psychotherapy** can help a child with CD to control his anger and develop new coping skills. Family **group therapy** may also be effective in some cases. Parents should be counseled on how to set appropriate limits with their child and be consistent and realistic when disciplining. If an abusive home life is at the root of the conduct problem, every effort should be made to move the child into a more supportive environment. Parent training programs are increasing in number.

For children with coexisting ADHD, substance abuse, depression, or **learning disorders**, treating these conditions first is preferred, and may result in a significant improvement to the CD condition. In all cases of CD, treatment should begin when symptoms first appear. Recent studies have shown Ritalin to be a useful drug for both ADHD and CD.

When aggressive behavior is severe, mood stabilizing medication, including lithium (Cibalith-S, Eskalith, Lithane, Lithobid, Lithonate, Lithotabs), carbamazepine (Tegretol, Atretol), and propranolol (Inderal), may be an appropriate option for treating the aggressive symptoms. However, placing the child into a structured setting or treatment program such as a psychiatric hospital may be just as beneficial for easing aggression as medication.

Prognosis

The prognosis for children with CD is not bright. Follow-up studies of conduct disordered children have

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shown a high incidence of antisocial personality disorder, affective illnesses, and chronic criminal behavior later in life. However, proper treatment of co-existing disorders, early identification and intervention, and long-term support may improve the outlook significantly.

Prevention

A supportive, nurturing, and structured home environment is believed to be the best defense against CD. Children with learning disabilities and/or difficulties in school should get immediate and appropriate academic assistance. Addressing these problems when they first appear helps to prevent the frustration and low self-esteem that may lead to CD later on.

Resources

BOOKS

Liabø, Kristin, and Joanna Richardson. *Conduct Disorder and Offending Behaviour in Young People: Findings from Research*. Philadelphia: Jessica Kingsley Publishers, 2007.

ORGANIZATIONS

American Academy of Child and Adolescent Psychiatry (AACAP), 3615 Wisconsin Ave. NW, Washington, DC, 20013-3007, (202) 966-7300, (202) 966-2891, communications@aacap.org, http://www.aacap.org.

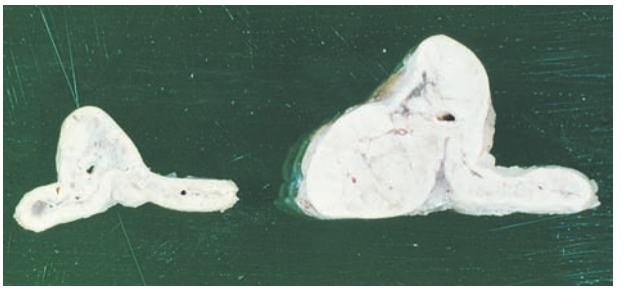
Paula Anne Ford-Martin

Conductive hearing loss *see* **Hearing loss**
Condylomata acuminata *see* **Genital warts**
Cone biopsy *see* **Cervical conization**

Congenital adrenal hyperplasia

Definition

Congenital adrenal hyperplasia (CAH) is a genetic disorder that affects the adrenal glands, a pair of walnut-sized organs located over the kidneys. It is characterized primarily by a deficiency in the steroid hormone group glucocorticoid (usually cortisol), and secondarily by deficient amounts of the steroid hormone group mineralocorticoid (usually aldosterone). Because these two hormones are produced in lower-than-normal amounts, CAH is also secondarily characterized by an over-production of the steroid hormone group androgen (such as testosterone). Due to it being hereditarily



Adrenal cortical hyperplasia. The adrenal on the right is normal; the one on the left shows hyperplasia. *(© Biophoto Associates/Photo Researchers, Inc.)*

caused, CAH is present at birth. CAH affects the sexual development of children.

Demographics

CAH is a genetic disorder that interferes with the normal growth and development, especially the sexual development. It affects male and female children equally. According to the National Institutes of Health, about one child in 10,000 to 18,000 children in the United States are born with congenital adrenal hyperplasia. It also affects adults, men and women equally, in all populations of the world. It is especially common in Yupik Eskimos, where the incidence is about one in 400.

Congenital adrenal hyperplasia is the most common adrenal gland disorder found in infants and children, occurring in one in 10,000 total births worldwide. It is also called adrenogenital syndrome.

Description

Congenital adrenal hyperplasia (CAH) is a form of adrenal insufficiency in which the enzyme that produces two important adrenal steroid hormones, cortisol and aldosterone, is deficient. Cortisol and aldosterone play roles in maintaining the body's health. Therefore, a low concentration of cortisol makes it difficult for a body to regulate blood pressure, maintain blood sugar levels, and energy levels. In addition, low levels of aldosterone produce lower **sodium** levels and higher potassium levels, which when not in balance can adversely effect muscle and nerve control.

Because cortisol and aldosterone production is impeded, the adrenal gland instead overproduces androgens (male steroid hormones). Consequently, females with CAH are generally born with genitals that appear more like male than female, such as an enlarged clitoris (which is called ambiguous external genitalia). They may also develop other male characteristics. However, females will possess normal internal reproductive tract

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structures (such as ovaries, fallopian tubes, and uterus). Males usually have normal genitals at birth but may experience premature sexual development; however, in a small percentage of cases such male infants have an enlarged penis. CAH causes abnormal growth for both sexes; with patients being tall as children but short as adults.

In its most severe form, called salt-wasting CAH, a life-threatening adrenal crisis can occur if the disorder is untreated. This form, which occurs in newborns and very young children, is also called classic congenital adrenal hyperplasia. The adrenal crisis can cause **dehydration**, **shock**, and **death** within 14 days of birth. There is also a mild form of CAH, which occurs later in childhood or young adult life. This form of CAH, called non-classic congenital adrenal hyperplasia, causes patients to have a partial enzyme deficiency.

Risk factors

Because it is an hereditary disease, a child or fetus is at increased risk if both parent have CAH or if both parent are carriers of the disease. Some ethnic groups have a higher risk for getting congenital adrenal hyperplasia than others. Ashkenazi Jews, who have descended from along the Rhine River in Germany, are most likely to contract CAH. Others at high risk include Eskimos, Hispanics, Italians, and Yugoslavs (a small group of southern Slavic people originally found in the former Yugoslavia).

Causes and symptoms

CAH is an inherited disorder that occurs when one of many different enzymes, which are used by the adrenal glands to produce cortisol, is not produced in sufficient quantities. The most commonly enzyme associated with the disorder is 21-hydroxylase. Consequently, CAH is also sometimes called 21-hydroxylase deficiency. (Two other enzymes associated with CAH are 1-beta-hydroxylase and 17-alpha-hydroxylase.) Because varied amounts of 21-hydroxylase are produced within the human body, the degree that CAH affects people is different. Some people have severe cases of CAH, while others have only mild cases.

CAH is a recessive disease, which means that a child must inherit one copy of the defective gene from each parent who is a carrier; when two carriers have children, each **pregnancy** carries a 25% risk of producing an affected child.

The symptoms inherent within this condition are due to the fetus manufacturing lower-than-normal levels of cortisol and being exposed to abnormally high levels of male sex hormones (androgens). In females, CAH produces an enlarged clitoris at birth and masculinization of features as the child grows, such as deepening tone of voice, facial hair, excess facial and armpit hair, and failure to menstruate or abnormal periods at **puberty**. Females with severe CAH may be mistaken for males at birth. In males, the genitals are usually normal at birth, but the child becomes muscular, the penis enlarges while the testes remain small, pubic and armpit hair appears, and the voice deepens long before normal puberty, sometimes as early as two to three years of age.

In the severe salt-wasting form of CAH, newborns may develop symptoms shortly after birth, including **vomiting**, dehydration, weight loss (and inability to regain birth weight), electrolyte (a compound such as sodium or **calcium** that separates to form ions when dissolved in water) changes, and cardiac arrhythmia.

In the mild form of CAH, which first occurs in late childhood or early adulthood, symptoms include early and excessive development of body hair, **fatigue**, high blood cholesterol, low blood pressure, low bone density, **nausea**, **obesity**, reduced ability to cope with infections, and severe **acne**. Even though the older child grows rapidly, once adulthood is reached, the eventual height of the person is usually shorter than normal. In addition, most males and females with CAH are infertile as adults. Women also have unusually irregular menstrual cycles. However, sometimes symptoms are not present.

Diagnosis

CAH is diagnosed by a careful examination of the genitals and blood and urine tests that measure the hormones produced by the adrenal gland. Abnormal levels of cortisol, aldosterone, and androgen will confirm the diagnosis. A number of states in the United States perform a hormonal test (a heel prick blood test) for CAH and other inherited diseases within a few days of birth. In questionable cases, **genetic testing** can provide a definitive diagnosis. For some forms of CAH, prenatal diagnosis is possible through chronic villus sampling in the first trimester and by measuring certain hormones in the amniotic fluid (within the womb) during the second trimester; what is called **amniocentesis**. Such tests are performed when parents (or other family members) are known carriers or have the disease, or older siblings of the parents have CAH.

Treatment

The goal of treatment for CAH is to return the androgen levels to normal. This is usually accomplished

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KEY TERMS

Adrenal glands—The two endocrine glands located above the kidney that secrete hormones and epinephrine.

Aldosterone—A hormone secreted by the adrenal glands that is important for maintaining salt and water balance in the body.

Androgens—Steroid hormones that cause masculinization.

Congenital—Present at birth.

Cortisol—A steroid hormone secreted by the adrenal cortex that is important for maintenance of body fluids, electrolytes, and blood sugar levels.

Hormone—A chemical messenger produced by the endocrine glands or certain other cells. Hormones are usually carried in the blood stream and regulate some metabolic activities.

Steroids—Hormones, including aldosterone, cortisol, and androgens, derived from cholesterol that share a four-ring structure.

through drug therapy, although surgery is an alternative. Lifelong treatment is required.

Drug therapy consists of one of a group of cortisol-like steroid medications called glucocorticoids. Oral hydrocortisone is prescribed for children, and prednisone or dexamethasone is prescribed for older patients. For patients with salt-wasting CAH, fludrocortisone, which acts like aldosterone (the missing hormone), is also prescribed. Infants and small children may also receive salt tablets, while older patients are told to eat salty foods. Medical therapy achieves hormonal balance most of the time, but CAH patients can have periods of fluctuating hormonal control that lead to increases in the dose of **steroids** prescribed. Side effects of steroids include stunted growth. Steroid therapy should not be suddenly stopped, since adrenal insufficiency results.

Patients with CAH should see a pediatric endocrinologist frequently. The endocrinologist will assess height, weight, and blood pressure, and order an annual x ray of the wrist (to assess bone age [bone mass]), as well as assess blood hormone levels. CAH patients with the milder form of the disorder are usually effectively treated with hydrocortisone or prednisone, if they need medical treatment at all.

Females with CAH who have masculine external genitalia require surgery to reconstruct the clitoris and/or vagina. This is usually performed between the ages of one and six months.

An experimental type of drug therapy—a three-drug combination, with an androgen blocking agent (flutamide), an aromatase inhibitor (testolactone), and low dose hydrocortisone—is currently being studied by physicians at the National Institutes of Health. Preliminary results are encouraging, but it will be many years before the safety and effectiveness of this therapy is fully known.

Adrenalectomy, a surgical procedure to remove the adrenal glands, is a more radical treatment for CAH. It was widely used before the advent of steroids. Currently, it is recommended for CAH patients with little or no enzyme activity and can be accomplished by **laparoscopy**. This is a minimally invasive type of surgery done through one or more small 1 inch (2.5 cm) incisions and a laparoscope, an instrument with a fiber-optic light containing a tube with openings for surgical instruments. Adrenalectomy is followed by hormone therapy, but in lower doses than CAH patients not treated surgically receive.

Prenatal treatment is also possible to diagnose CAH in a fetus. If diagnosed within the fetus, the doctor can prescribe a cortisosteroid drug, such as dexamethasone, to the pregnant woman. The drug will enter the womb from the mother's placenta and help to bring the fetus' adrenal glands back to normal function. A stronger dose of dexamethasone is usually prescribed for female fetuses and a milder dose to males.

Prognosis

Although CAH can potentially cause death in those it affects, the disorder can be controlled and successfully treated in most patients as long as they remain on drug therapy. When drug therapy is successfully applied, CAH patients usually lead normal lives. People with congenital adrenal hyperplasia will usually be shorter in height than most people, and they often times have fertility problems throughout their adult lives. Women are more likely to experience various sexual problems later in life if they had corrective surgery on their genitals. People with CAH may need some counseling to deal with their problems, but in all

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likelihood should lead a healthy and long life with proper treatment and care by their physician.

Prevention

Prenatal therapy, in which a pregnant woman at risk for a second CAH child is given dexamethasone to decrease secretion of androgens by the adrenal glands of the female fetus, has been in use for over ten years. This therapy is started in the first trimester when fetal adrenal production of androgens begins, but before prenatal diagnosis is done that would provide definitive information about the sex of the fetus and its disease status. This means that a number of fetuses are exposed to unnecessary steroid treatment in order to prevent the development of male-like genitals in female fetuses with CAH. Several hundred children have undergone this treatment with no major adverse effects, but its long-term risks are unknown. Since there is very little data on the effectiveness and safety of prenatal therapy, it should only be offered to patients who clearly understand the risks and benefits and who are capable of complying with strict monitoring and follow-up throughout pregnancy and after the child is born.

Parents with a family history of CAH, including a child who has CAH, should seek **genetic counseling**. Genetic testing during pregnancy can provide information on the risk of having a child with CAH.

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Congenital Adrenal Hyperplasia Due to 21-Hydroxylase Deficiency. The Johns Hopkins Children's Center. http://www.hopkinschildrens.org/cah/ (accessed September 9, 2010).

ORGANIZATIONS

American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, IL, 60007-1098, (847) 434-4000, http://www.aap.org/.

MAGIC Foundation, 6645 West North Avenue, Oak Park, IL, 60302, (708) 383-0808, (800) 362-4423, http://www.magicfoundation.org/.

National Adrenal Diseases Foundation, 505 Northern Boulevard, Great Neck, NY, 11021, (516) 487-4992, nadfmail@aol.com, http://medhlp.netusa.net/www/nadf.htm.

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Congenital amputation

Definition

Congenital **amputation** is the absence of a fetal limb or fetal part at birth. This condition may be the result of the constriction of fibrous bands within the membrane that surrounds the developing fetus (amniotic band syndrome) or the exposure to substances known to cause **birth defects** (teratogenic agents). Other factors, including genetics, may also play a role.

Description

An estimated one in 2000 babies are born with all or part of a limb missing, ranging from a missing part of a finger to the absence of both arms and both legs. Congenital amputation is the least common reason for amputation. However, there are occasional periods in history where the number of congenital amputations increased. For example, the thalidomide tragedy of the early 1960s occurred after pregnant mothers in western Europe were given a tranquilizer containing the drug. The result was a drastic increase in the number of babies born with deformed limbs. In this example, the birth defect usually presented itself as very small, deformed versions of normal limbs. More recently, birth defects as a result of radiation exposure near the site of the Chernobyl disaster in Russia have left numerous children with malformed or absent limbs.

Causes and symptoms

The exact cause of congenital amputations is unknown. However, according to the March of Dimes, most birth defects have one or more genetic factors and one or more environmental factors. It is also known that most birth defects occur in the first

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three months of **pregnancy**, when the organs of the fetus are forming. Within these crucial first weeks, frequently prior to when a woman is aware of the pregnancy, the developing fetus is most susceptible to substances that can cause birth defects (teratogens). Exposure to teratogens can cause congenital amputation. In other cases, tight amniotic bands may constrict the developing fetus, preventing a limb from forming properly if at all. It is estimated that this amniotic band syndrome occurs in between one in 12,000 and one in 15,000 live births.

An infant with congenital amputation may be missing an entire limb or just a portion of a limb. Congenital amputation resulting in the complete absence of a limb beyond a certain point (and leaving a stump) is called transverse deficiency or amelia. Longitudinal deficiencies occur when a specific part of a limb is missing; for example, when the fibula bone in the lower leg is missing, but the rest of the leg is intact. Phocomelia is the condition in which only a mid-portion of a limb is missing, as when the hands or feet are attached directly to the trunk.

Diagnosis

Many cases of congenital amputation are not diagnosed until the baby is born. Ultrasound examinations may reveal the absence of a limb in some developing fetuses, but routine ultrasounds may not pick up signs of more subtle defects. However, if a doctor suspects that the fetus is at risk for developing a limb deficiency (for example, if the mother has been exposed to radiation), a more detailed ultrasound examination may be performed.

Treatment

Successful treatment of a child with congenital amputation involves an entire medical team, including a pediatrician, an orthopedist, a psychiatrist or psychologist, a prosthetist (an expert in making prosthetics, or artificial limbs), a social worker, and occupational and physical therapists. The accepted method of treatment is to fit the child early with a functional prosthesis because this leads to normal development and less wasting away (atrophy) of the muscles of the limbs present. However, some parents and physicians believe that the child should be allowed to learn to play and perform tasks without a prosthesis, if possible. When the child is older, he or she can be involved in the decision of whether or not to be fitted for a prosthesis.

In the case of congenital amputation of the fingers, **plastic surgery** can sometimes be used to reconstruct the missing digits by transferring parts of the great and second toes to the hand. Some defects in the leg bones can be treated by removing the malformed bone, grafting bone from other parts of the child's body, and inserting a metal rod to strengthen the limb; this technique, however, is controversial as of the early 2000s.

There have been cases in which physicians have detected amniotic band constriction interfering with limb development fairly early in its course. In 1997, doctors at the Florida Institute for Fetal Diagnosis and Therapy reported two cases in which minimally invasive surgery freed constricting amniotic bands and preserved the affected limbs.

KEY TERMS

Amniotic band—An abnormal condition of fetal development in which fibrous bands of tissue develop out of the amniotic sac. The bands encircle and constrict parts of the baby's body, interfering with normal development and sometimes causing congenital amputation.

Prosthesis—An artificial replacement for a missing part of the body.

Teratogen—Any substance, agent, or process that interferes with normal prenatal development, causing the formation of one or more developmental abnormalities of the fetus.

Alternative treatment

Prevention of birth defects begins with building the well-being of the mother before pregnancy. Prenatal care should be strong and educational so that the mother understands both her genetic risks and her environmental risks. Several disciplines in alternative therapy also recommend various supplements and **vitamins** that may reduce the chances of birth defects. If a surgical procedure is planned, naturopathic and homeopathic pre- and post-surgical therapies can speed recovery.

Prognosis

A congenital limb deficiency has a profound effect on the life of the child and parents. However, **occupational therapy** can help the child learn to accomplish many tasks. In addition, some experts believe that early fitting of a prosthesis will enhance acceptance of the prosthesis by the child and parents.

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Prevention

Studies have suggested that a multivitamin including **folic acid** may reduce birth defects, including congenital abnormalities. **Smoking**, drinking alcohol, and eating a poor diet while pregnant may increase the risk of congenital abnormalities. Daily, heavy exposure to chemicals may be dangerous while pregnant.

Resources

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ORGANIZATIONS

International Child Amputee Network (I-CAN), P.O. Box 514, Abilene, TX, 79604-0514, job525@att.net, http://www.child-amputee.net/.

March of Dimes Birth Defects Foundation, 1275 Mamaroneck Ave., White Plains, NY, 10605, (914) 997-4488, http://www.modimes.org.

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923, (800) 999-6673, http://www.rarediseases.org.

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Congenital bladder anomalies

Definition

The two most common congenital bladder abnormalities are exstrophy and congenital diverticula. An exstrophic bladder is one that is open to the outside and turned inside-out, so that its inside is visible at birth, protruding from the lower abdomen. A diverticulum is an extension of a hollow organ, usually shaped like a pouch with a narrow opening.

Description

During fetal development, folds enclose tissues and organs and eventually fuse at the edges to form sealed compartments. Both in the front and the back, folds eventually become major body structures. In the back, the entire spinal column folds in like a pipe wrapped in a pillow. In the front, the entire lower urinary system is folded in.

- Exstrophy of the bladder represents a failure of this folding process to complete itself, so the organs form with more or less of their front side missing and open to the outside. At the same time, the front of the pelvic bone is widely separated. The abdominal wall is open, too. In fact, the defect often extends all the way to the penis in the male or splits the clitoris in the female.
- A congenital bladder diverticulum represents an area of weakness in the bladder wall through which extrudes some of the lining of the bladder. (A small balloon squeezed in a fist will create a diverticula-like effect between the fingers.) Bladder diverticula may be multiple, and they often occur at the ureterovesical junction—the entrance of the upper urinary system into the bladder. In this location, they may cause urine to reflux into the ureter and kidney, leading to infection and possible kidney damage.

Causes and symptoms

As with many **birth defects**, the causes are not well known. Lack of prenatal care and **nutrition** has been linked to many birth defects, however beyond the avoidance of known teratogens (anything that can cause a birth defect), there is little prevention possible. Exstrophy is rare, occurring in about one in 40,000 births. Diverticula are more common, but less serious.

If left untreated, the patient with bladder exstrophy will have no control over urination and is more likely to develop **bladder cancer**. Diverticula, particularly if it causes urine reflux, may lead to chronic infection and its subsequent consequences.

Diagnosis

A major consideration with congenital abnormalities is that they tend to be multiple. Further, each one is unique in its extent and severity. Exstrophy can involve the rectum and large bowel and coexist with hernias. The obvious bladder exstrophy seen at birth will prompt immediate action and a search for other anomalies.

Diverticula are not visible and will be detected only if they cause trouble. They are usually found in

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KEY TERMS

Congenital—Present at birth.

Cystoscopy—Examination of the urinary bladder with a thin telescope-like instrument.

Exstrophy—Being turned inside out combined with being outside the body.

Diverticulum—A pouch extending from a hollow organ.

Radiologist—A physician who specializes in creating images of the internal organs of the body.

Teratogen—Any agent that can cause birth defects.

Ureter—The tube that transports urine from the kidney to the bladder.

Ureterovesical junction—The joining of the ureter to the bladder.

Urologist—A physician who specializes in diseases of the urinary system.

an examination for the cause of recurring urinary infections. X rays of the urinary system or a **cystoscopy** (examination with a telescope-like instrument) will identify them. Often, the two procedures are done together: a urologist will perform the cystoscopy, then a radiologist will instill a contrast agent into the bladder and take x rays.

Treatment

Surgery is necessary and can usually produce successful results. If possible, the surgery must be done within 48 hours of birth. Prior to surgery, the exposed organs must be protected and all related defects identified and managed. Delay in the surgery leads to the frequent need to divert the urine into the bowel because the partially repaired bladder cannot control the flow. After surgery, the likelihood of infection requires monitoring.

Alternative treatment

After surgery, ongoing precautions to reduce frequency of infection may need to be used. Cranberry juice has the ability to keep bacteria from adhering to the membranes and can help prevent infection whenever there is increased risk. There are botanical and homeopathic treatments available; however, consultation by a trained practitioner is recommended before treatment.

Prognosis

With immediate surgery, three-quarters of patients can be successfully repaired. They will have control of their urine and no long-term consequences. The rate of infection is greater for those with congenital bladder anomalies, since any abnormality in the urinary system predisposes it to invasion by bacteria.

Prevention

Birth defects often have no precisely identified cause, therefore, prevention is limited to general measures such as early and continuous prenatal care, appropriate nutrition, and a healthy lifestyle.

Resources

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J. Ricker Polsdorfer, MD

Congenital bladder diverticulum *see* **Congenital bladder anomalies**

Congenital brain defects

Definition

Congenital brain defects are a group of disorders involving deficiencies of brain development. People are born with such brain defects (damage); thus, they are called congenital, or existing at birth. (Those brain defects that result from trauma or other types of injuries are called acquired brain defects, or non-congenital brain defects.) Congenital brain detects develop during the growth and development of the fetus. They are caused by a variety of factors, such as genetic defects, infections, prenatal problems, and environmental toxins. The causal factors disrupt the development of the brains of these fetuses, which, for the most part, leads to physical and cognitive problems after birth. Many disorders can be grouped within congenital brain defects.

Demographics

Congenital brain defects can occur in any population of humans around the world. They primarily affect fetuses within the womb or, in some cases, infants who have just been born. They do not generally

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favor one particular race or gender, although some of the disorders within congenital brain defects may favor a particular race or gender.

Description

Brain development begins shortly after conception and continues throughout the growth of a fetus. A complex genetic program coordinates the formation, growth, and migration of billions of neurons, or nerve cells, and their development into discrete, interacting brain regions. Interruption of this program, especially early in development, can cause structural defects in the brain. In addition, normal brain formation requires proper development of the surrounding skull, and skull defects may lead to brain malformation. Congenital brain defects may be caused by inherited genetic defects, spontaneous mutations within the genes of the embryo, or effects on the embryo due to infection, trauma, drug use, or environmental factors from the mother.

Some of the disorders grouped within congenital brain defects are anencephaly, encephalocele, **spina bifida**, Dandy-Walker malformation, holoprosencephaly, lissencephaly, schizencephaly, schizencephaly, and megalencephaly. They are described in the following paragraphs.

Anencephaly

Early on in embryonic development, a flat strip of tissue along the back of the fetus rolls up to form a tube. This so-called "neural tube" develops into the spinal cord and, at one end, the brain. Closure of the tube is required for subsequent development of the tissue within. Anencephaly (literally "without brain"), results when the topmost portion of the tube fails to close, which results in the absence of most of the brain (primarily the cerebral hemispheres and cerebellum) and skull. Anencephaly is the most common severe malformation seen in stillborn births. According to the National Institutes of Health, it occurs in about one out of 10,000 births; however, the exact figure is unknown because many pregnancies end up as miscarriages. It is about four times more common in females than males. Anencephaly is sometimes seen to run in families, and for parents who have conceived one anencephalic fetus, the risk of a second is as high as 5%. Fewer than half of babies with anencephaly are born alive, and survival beyond the first month is rare, with most babies dying within the first few days of being born.

Encephalocele

Encephalocele is a rare type of neural tube defect (NTD) that results in a sac-like protrusion (or projection) of part of the brain through a defect in the skull. It happens during **pregnancy** when the neural tube does not close completely. The most common site for encephalocele is along the front-to-back midline of the skull, usually at the rear, although frontal encephaloceles (in an area between the forehead and the nose) are more common among Asians. Pressure within the skull pushes out cranial tissue. The protective layer over the brain, the meninges, grows to cover the protrusion, as does skin in some cases. Defects in skull closure are thought to cause some cases of encephalocele, while defects in neural tube closure may cause others. Encephaloceles may be small and contain little or no brain tissue, or may be quite large and contain a significant fraction of the brain. The Centers for Diseases Control and Prevention states that in any given year about 375 babies are born in the United States with encephalocele; that is, about one in 10,000 births involve babies with encephalocele.

Spina Bifida

Failure of neural-tube closure below the level of the brain prevents full development of the surrounding vertebral bones and leads to spina bifida, or a divided spinal column. The medical community usually classifies three types of spina bifida. In spina bifida occulta, only a small separation in one or more vertebral bones of the spinal column occurs. This mild form of spina bifida usually involves few if any symptoms because the nerves within the spine are not adversely affected. Most children grow up without any problems. The only sign that may occur is a small lump or tiny tuft of hair near the spine. The second type, called meningocele, is a rare form of the condition, one in which the membranes around the spinal cord (the meninges) are pushed out through an opening in the vertebrae. Since the spinal cord develops normally, surgeons can remove the problematic membranes with little risk of further complications to the spine. In the third type, incomplete closure of the neural tube causes a protrusion of the spinal cord and meninges. This type is called myelomeningocele (also called open spina bifida or spina bifida cystica), and is the most severe form of spina bifida. In fact, when spina bifida is mentioned in common usage people are usually discussing myelomeningocele. Some cases of spina bifida are accompanied by another defect at the base of the brain, known as the Arnold-Chiari malformation or Chiari II malformation. For reasons that are unclear, part of the cerebellum is displaced downward into the spinal column. Symptoms may be present at birth or delayed until early childhood.

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Dandy-Walker Malformation

The Dandy-Walker malformation (DWM) is marked by incomplete formation, or absence of, the central section of the cerebellum, and the growth of cysts within the lowest of the brain's ventricles (the fourth ventricle). The cerebellum helps to coordinate movement for humans, along with assisting in behavior and cognition (learning). The ventricles are fluid-filled cavities within the brain, through which cerebrospinal fluid (CSF) normally circulates. The cysts may block the exit of the fluid, causing **hydrocephalus**. Symptoms may be present at birth or delayed until early childhood. DWM usually results in a size smaller than normal for the middle portion of the cerebellum, along with an abnormal position for it. The fourth ventricle is also enlarged, as is the base of the skull. Hydrocephalus sometimes also occurs with DWM. When this happens, spinal fluid is blocked from flowing. This results from excessive fluid in and around the brain. Neurological problems can occur when pressures increase inside the skull and the head swells.

Holoprosencephaly

Soon after closure of the neural tube, the embryonic forebrain (prosencephalon) divides into two halves, or cerebral hemispheres. Failure of division is termed holoprosencephaly (literally "whole forebrain"). Holoprosencephaly, in its most severe case called alobar, results in a single-lobed brain structure. It is almost always accompanied by severe facial and cranial deformities along the midline, including **cleft lip**, **cleft palate**, fused eye sockets and a single eye (cyclopia), and deformities of the limbs, heart, gastrointestinal tract, and other internal organs. Most infants are either stillborn or die soon after birth. In some intermediate cases of holoprosencephaly, the brain's hemispheres partially divide. This form is called semilobar holoprosencephaly. In a third case called lobar holoprosencephaly, the brain has considerable separation of the hemispheres. Survivors, those with less severe forms of the condition, suffer from neurological impairments and facial deformities, such as of the eyes, nose, and upper lip. In the least forms, the brain develops almost normally.

Lissencephaly

The normal ridges and valleys of the mature brain are formed after cells from the inside of the developing brain migrate to the outside and multiply. When these cells fail to migrate, the surface remains smooth, a rare, genetic condition called lissencephaly ("smooth brain"). Lissencephaly involves the cerebral cortex. Specifically, the normal folds (convolutions) of the cerebral cortex are not present. It causes the head to be abnormally small; what is called microcephaly. Lissencephaly occurs when the embryo does not develop normally due to defects in migration of nerve cells. It is often associated with facial abnormalities including a small jaw, a high forehead, a short nose, and low-set ears. The condition may also produce deformations in the fingers and hands, along with the toes. In addition, lissencephaly causes difficulties in swallowing, **muscle spasms**, seizures, and psychomotor retardation.

Schizencephaly

If damaged during growth, especially within the first 20 weeks, brain tissue may stop growing, while tissue around it continues to form. This causes an abnormal cleft or groove to appear on the surface of the brain, called schizencephaly (literally "split brain"). This cleft should not be confused with the normal wrinkled brain surface, nor should the name be mistaken for **schizophrenia**, a mental disorder. Generalized destruction of tissue or lack of brain development may lead to hydranencephaly, in which cerebrospinal fluid (CSF) fills much of the space normally occupied by the brain. Hydranencephaly is distinct from hydrocephalus, in which CSF accumulates within a normally formed brain, putting pressure on it and possibly causing skull expansion. Babies with schizencephaly usually have delays in learning skills such as language and speech. They normally have **mental retardation**, partial or complete **paralysis**, and a smaller-than-normal head. Some babies have unilateral clefts, in which clefts appear on only one hemisphere of the brain. They may be paralyzed on one side of their bodies; however, these babies may not have any degradation to their intelligence.

Megalencephaly

Excessive brain size is termed megalencephaly (literally "big brain"). Megalencephaly, is a condition described as an infant or child with an abnormally large, heavy head for his/her age and gender. It occurs more often in males than females. Megalencephaly is usually associated with brain that does not function properly. It is defined as any brain size above the 98th percentile (about two standard deviations) within the population. Some cases are familial (common among families, hereditary), and may be entirely benign. Others are due to metabolic or neurologic disease. Unilateral megalencephaly—sometimes also called hemimegalencephaly—is characterized by only one side of the brain being abnormally large. Megalencephaly is different from macrocephaly, which is also

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referred to as megacephaly or megalocephaly. Macrocephaly is a condition in which a large head does not necessarily mean is it considered "abnormally" large. Microcephaly, an opposite condition to macrocephaly, is considered a condition involving a smaller-than-average brain, but one that is not necessarily considered abnormal. It may be caused by failure of the brain to develop, or by intrauterine infection, drug toxicity, or brain trauma.

Causes and symptoms

Causes

Congenital brain defects may have genetic, infectious, toxic, or traumatic causes. In most cases, a certain cause cannot be identified.

GENETIC CAUSES. Some brain defects are caused by trisomy, the inclusion of a third copy of a chromosome normally occurring in pairs. Most trisomies occur because of improper division of the chromosomes during formation of eggs or sperm. Trisomy of chromosome 9 can cause some cases of Dandy-Walker and Chiari II malformation. Some cases of holoprosencephaly are caused by trisomy of chromosome 13, while others are due to abnormalities in chromosomes 7 or 18. Individual gene defects, either inherited or spontaneous, are responsible for other cases of congenital brain malformations.

DRUGS. Drugs known to cause congenital brain defects when used by the mother during critical developmental periods include:

- anticonvulsant drugs
- retinoic acid and tretinoin
- warfarin
- alcohol
- cocaine

OTHER. Other causes of congenital brain defects include:

- intrauterine infections, including cytomegalovirus, rubella, herpes simplex, and varicella zoster
- maternal diabetes mellitus
- maternal phenylketonuria
- fetal trauma

Symptoms

Besides the features listed previously, symptoms of congenital brain defects may include:

- Chiari II malformation: impaired swallowing and gag reflex, loss of the breathing reflex, facial paralysis, uncontrolled eye movements (nystagmus), impaired balance and gait.
- Dandy-Walker malformation: symptoms of hydrocephalus, lack of muscle tone or "floppiness," seizures, vomiting, spasticity, deafness, abnormal breathing patterns, irritability, visual impairment, deterioration of consciousness, paralysis.
- Lissencephaly: lack of muscle tone, irregular facial features, difficulty swallowing, seizures, developmental delay, spasticity, cerebral palsy.
- Hydranencephaly: visual impairment, deafness, blindness, paralysis, irritability, spasticity, seizures, temperature oscillations, lower-than-normal intelligence.
- Megalencephaly due to neurological or metabolic disease: mental retardation, seizures, brain cortex and spinal cord disfunction.

Diagnosis

Congenital brain defects are diagnosed either from direct **physical examination** or imaging studies including computed tomography (CT) scans and **magnetic resonance imaging** (MRI) scans. **Electroencephalography** (EEG) may be used to reveal characteristic abnormalities.

Prenatal diagnosis of neural tube defects causing anencephaly or meningomyelocele is possible through ultrasound examination and maternal blood testing for alpha-fetoprotein, which is almost always elevated. Ultrasound can also be used to diagnose Dandy-Walker and Chiari II malformations. **Amniocentesis** may reveal trisomies or other chromosomal abnormalities. Myelomeningocele is tested with a maternal serum alpha-fetoprotein (MSAFP) test, which tests the mother for alpha-fetoprotein (AFP), a protein that is produced by the fetus. Along with the MSAFP test, three other bloods tests may be used: human chorionic gonadotropin (HCG, a hormone produced by the placenta), Inhibin A (a hormone produced by the placenta), and Estriol (an estrogen produced by the fetus and placenta)

Treatment

Treatment generally varies depending on the type of defect. Meningomyelocele may be treated with surgery to close the open portion of the spinal cord. Surgery for encephalocele is possible only if there is a minimal amount of brain tissue protruding. Malformations associated with hydrocephalus (Dandy-Walker, Chiari II, and some cases of hydranencephaly) may be treated by installation of a drainage

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KEY TERMS

Amniocentesis—Removal of fluid from the sac surrounding a fetus for purposes of diagnosis.

Cerebrospinal fluid—Fluid produced within the brain for nutrient transport and structural purposes. CSF circulates through the ventricles, open spaces within the brain, and drains through the membranes surrounding the brain.

Congenital—Defect present at birth.

Fetus—The unborn human, developing in a woman's uterus, from the eighth week after fertilization to birth.

shunt for cerebrospinal fluid. Drugs may be used to treat some symptoms of brain defects, including seizures and spasticity.

Treatment for lissencephaly is unlikely to be successful in the most severe cases of it. However, support and care can be provided to the patient, and medication should control seizures. Treatment for megalencephaly has yet to be standardized. Treatment primarily depends on the symptoms and disabilities present with the patient.

Prognosis

Most congenital brain defects carry a very poor prognosis. Surgical treatment of meningomyelocele and encephalocele may be successful, with lasting neurological deficiencies, which vary in severity. Early treatment of hydrocephalus may prevent more severe brain damage. Infants and children with megalencephaly have a varied prognosis depending on the underlying cause and the related neurological disorder. For children with hemimegalencephaly, the prognosis is generally poor.

Prevention

Some cases of congenital brain defects can be prevented with good maternal **nutrition**, including **folic acid** supplements. Folic acid is a vitamin that has been shown to reduce the incidence of neural tube defects, both before and during pregnancy. Pregnant women should avoid exposure to infection, especially during the first trimester. Abstention from drugs and alcohol during pregnancy may reduce risk. **Genetic counseling** is advisable for parents who have had one child with anencephaly, since the likelihood of having another is increased.

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American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, IL, 60007-1098, (847) 434-4000, http://www.aap.org/.

National Institute of Neurological Disorders and Stroke, Post Office Box 5801, Bethesda, MD, 20824, (301) 496-5751, (800) 352-9424, (301) 402-2186, http://www.ninds.nih.gov/.

National Organization for Rare Disorders, Post Office Box 1968; 55 Kenosia Avenue, Danbury, CT, 06813-1968, (203) 744-0100, (800) 999-6673, (203) 798-2291, http://www.rarediseases.org.

March of Dimes Foundation, 1275 Mamaroneck Avenue, White Plains, NY, 10605, (914) 997-4488, http://www.marchofdimes.com/.

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Office of Rare Diseases Research, 6100 Executive Boulevard, Bethesda, MD, 20892-7518, (301) 402-4336, (888) 205-2311, (301) 480-9655, ordr@od.nih.gov, http://rarediseases.info.nih.gov/Default.aspx.

Richard Robinson

Congenital defects *see* **Birth defects**

Congenital heart disease

Definition

Congenital heart disease, also called congenital heart defect, includes a variety of malformations of the heart and/or its major blood vessels that are present at birth.

Description

Congenital heart disease occurs when the heart or blood vessels entering or leaving the heart do not develop normally before birth. Some infants are born with mild types of congenital heart disease that do not become apparent until later in life, but others need surgery as newborns or infants in order to survive.

Congenital heart disease is the most common birth defect. About 35,000 infants are born each year with some form of congenital heart disease. About half of these cases require medical treatment; the rest either correct (resolve) spontaneously shortly after birth or are so mild as to need no treatment or to go undetected. More than 1.4 million people with congenital heart defects were living in the United States in 2007.

Anatomy of the heart

The heart has four compartments or chambers, a left and right atrium above a left and right ventricle. These chambers keep blood carrying oxygen (oxygenated blood) from mixing with blood that has already given up its oxygen to cells (deoxygenated blood). Blood moves through the heart in a specific pattern. Deoxygenated blood returning from the body enters the right atrium. It moves through a valve into the right ventricle. When the right ventricle contracts, blood is pumped through another valve and is carried to the lungs where it picks up oxygen. The newly oxygenated blood returns to heart and enters the left atrium. It flows through a valve into the left ventricle, and is then pumped through another valve to the aorta, a large artery. From the aorta, oxygenated blood is distributed to the rest of the body. Congenital heart disease causes a disruption or inefficiency in this pattern.

There are many types of congenital heart defects, but they fall into four major categories:

- defects that obstruct the flow of blood to the heart, lungs, or the nearby blood vessels. This can be caused by narrowed or malformed blood vessels or heart valves.
- defects that allow oxygenated and deoxygenated blood to mix. This can be caused by holes in the partitions (septa) between chambers or leaky valves that separate the chambers.
- arrhythmias, which are defects in the timing of contractions of the various chambers so that the chambers do not fill and empty completely; heartbeat may be too fast, too slow, or uncoordinated.
- major structural defects such as missing or underdeveloped heart chambers or incorrectly located blood vessels.

Obstruction defects

When heart valves, arteries, or veins are narrowed, they partly or completely block the flow of blood. The most common obstruction defects are **pulmonary valve stenosis**, **aortic valve stenosis**, and **coarctation of the aorta**. Bicuspid aortic valve and subaortic stenosis are less common.

Stenosis is a narrowing of the valves or arteries. In pulmonary stenosis, the pulmonary valve does not open properly, forcing the right ventricle to work harder. In aortic stenosis, the improperly formed aortic valve is narrowed. As the left ventricle works harder to pump blood through the body, it becomes enlarged. In coarctation of the aorta, the aorta is constricted, reducing the flow of blood to the lower part of the body and increasing blood pressure in the upper body.

A bicuspid aortic valve has only two flaps instead of three, which can lead to stenosis in adulthood. Subaortic stenosis is a narrowing of the left ventricle below the aortic valve that limits the flow of blood from the left ventricle.

Cyanotic defects

Heart defects that cause a decreased, inadequate amount of oxygen in blood pumped to the body are called cyanotic defects. When a baby is born with a hole in the septum (the wall separating the right and left sides of the heart), blood can leak from one chamber to another, allowing oxygenated and deoxygenated blood to mix. This causes less oxygen to be

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delivered to the body. Major leakage can lead to enlargement of the heart and failing circulation. The most common types of septal defects are **atrial septal defect**, an opening between the two upper heart chambers, and **ventricular septal defect**, an opening between the two lower heart chambers. Ventricular septal defect accounts for about 15% of all cases of congenital heart disease in the United States.

Patent ductus arteriosus refers to the opening of a temporary blood vessel (ductus) that carries blood from the heart to the aorta before birth, allowing blood to bypass the lungs, which are not yet functional. The ductus should close spontaneously in the first few hours or days after birth. When it does not close in the newborn, some of the blood that should flow through the aorta returns to the lungs. Patent ductus arteriosus is common in premature babies, but rare in full-term babies. It also has been associated with mothers who had German **measles** (**rubella**) while pregnant.

Ebstein's anomaly is a rare congenital syndrome that causes malformed tricuspid valve leaflets, which allow blood to leak between the right ventricle and the right atrium. It also may cause a hole in the wall between the left and right atrium. Treatment often involves repairing the tricuspid valve.

Other cyanotic defects, including truncus arteriosus, total anomalous pulmonary venous return, and **tetralogy of Fallot**, result in a blue discoloration of the skin due to low oxygen levels. About 10% of cases of congenital heart disease in the United States are tetralogy of Fallot, which includes four defects. The major defects are a large hole between the ventricles, which allows oxygen-poor blood to mix with oxygen-rich blood, and narrowing at or beneath the pulmonary valve. The other defects are an overly muscular right ventricle and an aorta that lies over the ventricular hole.

Major structural defects

In transposition (reversal of position) of the great arteries, the pulmonary artery and the aorta are reversed, causing oxygenated blood to recirculate to the lungs while deoxygenated blood goes to the rest of the body. In tricuspid atresia, the baby lacks a triscupid valve and blood cannot flow properly from the right atrium to the right ventricle.

Hypoplastic left heart syndrome, a condition in which the left side of the heart is underdeveloped, is rare, but it is the most serious type of congenital heart disease. With this condition, blood reaches the aorta only from the ductus, which then closes normally within a few days of birth. In hypoplastic left heart syndrome, the baby seems normal at birth, but as the ductus closes, blood cannot reach the aorta and circulation fails.

Infants born with DiGeorge sequence can have heart defects such as a malformed aortic arch and tetralogy of Fallot. Researchers believe DiGeorge sequence most often is caused by mutations in genes in the region 22q11.

Other defects

Brugada syndrome is another rare congenital heart defect that appears in adulthood and may cause sudden **death** if untreated. Symptoms, which include rapid, uneven heart beat, often appear at night. Scientists believe that Brugada syndrome is caused by mutations in the gene SCN5A, which involves cardiac **sodium** channels.

Marfan syndrome is a connective tissue disorder that causes tears in the aorta. Since the disease also causes excessive bone growth, most Marfan syndrome patients are over six feet tall. In athletes, and others, it can lead to sudden death. Researchers believe the defect responsible for Marfan's syndrome is found in gene FBN1, on chromosome 15.

Causes and symptoms

In most cases, the causes of congenital heart disease are unknown. Genetic, environmental, and lifestyle factors all can be involved. The likelihood of having a child with congenital heart disease increases if a parent or other close relative has congenital heart disease or if there is a family history of early **sudden cardiac death**. Congenital heart disease is common in children with other genetic disorders that affect many organ systems, such **Down syndrome**. In addition, as of 2008, researchers had identified about ten genetic changes (mutations) that caused some type of congenital heart disease, but no widespread symptoms.

During **pregnancy**, viral infections such as German measles can result in congenital heart disease in the newborn. Women with diabetes and **phenylketonuria** (PKU, an inherited liver disorder) also are at higher risk of having children with congenital heart defects. Some cases of congenital heart disease result from the mother's excessive use of alcohol or taking illegal street drugs, such as **cocaine** or methamphetamines, during pregnancy. The mother's use of certain anticonvulsant (anti-seizure) drugs or dermatologic drugs (e.g., isotretinon [Accutane and other brand

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names], thalidomide) during pregnancy also can cause congenital heart disease.

Symptoms of congenital heart disease in general include **shortness of breath**, difficulty feeding in infancy, excessive sweating, **cyanosis** (bluish discoloration of the skin), heart murmur, respiratory infections that recur excessively, stunted growth, and limbs and muscles that are underdeveloped.

Symptoms of specific types of congenital heart disease are as follows:

- Patent ductus arteriosus: quick tiring, slow growth, susceptibility to pneumonia, rapid breathing. If the ductus is small, there are no symptoms.
- Hypoplastic left heart syndrome: ashen color, rapid and difficult breathing, inability to eat.
- Obstruction defects: cyanosis (skin that is discolored blue), chest pain, tiring easily, dizziness or fainting, congestive heart failure, and high blood pressure.
- Septal defects: difficulty breathing, stunted growth. Sometimes there are no symptoms.
- Cyanotic defects: cyanosis, sudden rapid breathing or unconsciousness, and shortness of breath and fainting during exercise.

Diagnosis

Echocardiography and cardiac **magnetic resonance imaging** (MRI) commonly are used to confirm congenital heart disease when it is suggested by the symptoms and **physical examination**. These are noninvasive (nothing enters the body) tests. An echocardiograph displays an image of the heart that is formed by sound waves. It may detect valve and other heart problems. Fetal echocardiography is used to help diagnose congenital heart disease in utero, usually after 20 weeks of pregnancy. Between 10 and 14 weeks of pregnancy, physicians also may use an ultrasound to look for a thickness at the nuchal translucency, a pocket of fluid in back of the embryo's neck, which may indicate a cardiac defect. Cardiac MRI, a scanning method that uses magnetic fields and radio waves, can help physicians evaluate congenital heart disease, but is not always necessary. Physicians also may use a **chest x ray** to look at the size and location of the heart and lungs, or an electrocardiograph (ECG), which measures electrical impulses to create a graph of the heartbeat. After birth pulse oximetry is a noninvasive way to measure the amount of oxygen in the blood (a sensor is clipped on a finger or toe). **Cardiac catheterization**, an invasive test done under anesthesia, allows a dye to be inserted into the heart so that blood circulation through the heart can be seen on an x ray. Cardiac catheterization also can measure pressure in the heart chambers to determine if there is blood mixing or leakage between heart chambers.

Treatment

Congenital heart disease is treated with drugs and/or surgery. Drugs used include **diuretics**, which increase the excretion water and salts, and **digoxin**, which strengthens the contraction of the heart, slows the heartbeat, and removes fluid from tissues.

Surgical procedures seek to repair the defect as much as possible and restore circulation to as close to normal as possible. Sometimes, multiple surgical procedures are necessary. Surgical procedures include arterial switch, balloon atrial septostomy, **balloon valvuloplasty**, Damus-Kaye-Stansel procedure, Fontan procedure, pulmonary artery banding, Ross procedure, shunt procedure, and venous switch or intra-atrial baffle.

Arterial switch, to correct **transposition of the great arteries**, involves connecting the aorta to the left ventricle and connecting the pulmonary artery to the right ventricle. Balloon atrial septostomy, also done to correct transposition of the great arteries, enlarges the atrial opening during heart catheterization. Balloon valvuloplasty uses a balloon-tipped catheter to open a narrowed heart valve, improving the flow of blood in pulmonary stenosis. It is sometimes used in aortic stenosis. Transposition of the great arteries also can be corrected by the Damus-Kaye-Stansel procedure, in which the pulmonary artery is cut in two and connected to the ascending aorta and the farthest section of the right ventricle.

For tricuspid atresia and pulmonary atresia, the Fontan procedure connects the right atrium to the pulmonary artery directly or with a conduit, and the atrial defect is closed. Pulmonary artery banding, narrowing the pulmonary artery with a band to reduce blood flow and pressure in the lungs, is used for ventricular septal defect, atrioventricular canal defect, and tricuspid atresia. Later, the band can be removed and the defect corrected with open-heart surgery.

To correct aortic stenosis, the Ross procedure grafts the pulmonary artery to the aorta. For tetralogy of Fallot, tricuspid atresia, or pulmonary atresia, the shunt procedure creates a passage between blood vessels, sending blood into parts of the body that need it. For transposition of the great arteries, venous switch creates a tunnel inside the atria to redirect oxygen-rich

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KEY TERMS

Aorta—The main artery located above the heart that pumps oxygenated blood out into the body. Many congenital heart defects affect the aorta.

Atrium (plural: atria)—The right or left upper chamber of the heart.

Cardiac catheterization—A diagnostic procedure (using a catheter inserted through a vein and threaded through the circulatory system to the heart) which does a comprehensive examination of how the heart and its blood vessels function.

Congenital—Refers to a disorder that is present at birth.

Cyanotic—Marked by bluish discoloration of the skin due to a lack of oxygen in the blood. It is one of the types of congenital heart disease.

Ductus—The blood vessel that joins the pulmonary artery and the aorta. When the ductus does not close at birth, it causes a type of congenital heart disease called patent ductus arteriosus.

Echocardiogram—A non-invasive imaging procedure used to create a picture of the heart's movement, valves, and chambers.

Electrocardiograph (ECG, EKG)—A test used to measure electrical impulses coming from the heart in order to gain information about its structure or function.

Endocarditis—Infection of the heart endocardium tissue, the inner most tissue and structures of the heart.

Hypoplastic—Incomplete or underdevelopment of a tissue or organ. Hypoplastic left heart syndrome is the most serious type of congenital heart disease.

Marfan syndrome—An inherited condition that affects connective tissue throughout the body including weakening the connective tissue found in arteries.

Neuchal translucency—A pocket of fluid at the back of an embryo's neck visible via ultrasound that, when thickened, may indicate the infant will be born with a congenital heart defect.

Septal—Relating to the septum, the thin muscle wall dividing the right and left sides of the heart. Holes in the septum are called septal defects.

Stenosis (plural: stenoses)—The narrowing or constriction of an opening or passageway in the body.

Ventricle—A lower pumping chambers of the heart. There are two ventricles, right and left. The right ventricle pumps oxygen-poor blood to the lungs to be re-oxygenated. The left ventricle pumps oxygen-rich blood to the body.

blood to the right ventricle and aorta and venous blood to the left ventricle and pulmonary artery.

When surgery is not a viable option to correct the problem, some patients undergo a heart transplant. Children with congenital heart disease require lifelong monitoring, even after successful surgery. The American Heart Association recommends regular dental check-ups and preventive use of **antibiotics** to protect patients from heart infection (**endocarditis**). However, a 2003 study reported that preventive antibiotics are underused in people with congenital heart disease. Many patients did not understand the risk of endocarditis. Since children with congenital heart disease often have slower growth, good **nutrition** is important. Physicians also may limit their athletic activity.

Prognosis

The outlook for children with congenital heart disease has improved markedly in the past two decades. Many types of congenital heart disease that would have been fatal now can be treated successfully. Because many children with these defects survive into adulthood, they will require continued medical observation as they mature. Research on diagnosing heart defects when the fetus is in the womb may lead to future treatment to correct some defects before birth. Promising new prevention methods and treatments include genetic screening and the cultivation of cardiac tissue in the laboratory that might be useful in repairing some congenital heart defects. As scientists continue to advance the study of genetics, they also will better understand genetic causes of many congenital heart diseases.

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March of Dimes Birth Defects Foundation, 1275 Mamaroneck Ave., White Plains, NY, 10605, (914) 997-4488, http://www.modimes.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

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Congenital hip dysplasia

Definition

A condition of abnormal development of the hip, resulting in hip joint instability and potential dislocation of the thigh bone from the socket in the pelvis. This condition has been more recently termed developmental hip dysplasia, as it often develops over the first few weeks, months, or years of life.

Description

Congenital hip dysplasia is a disorder in children that is either present at birth or shortly thereafter. During gestation, the infant's hip should be developing with the head of the thigh bone (femur) sitting perfectly centered in its shallow socket (acetabulum). The acetabulum should cover the head of the femur as if it were a ball sitting inside of a cup. In the event of congenital hip dysplasia, the development of the acetabulum in an infant allows the femoral head to ride upward out of the joint socket, especially when weight bearing begins.

Causes and symptoms

Clinical studies show a familial tendency toward hip dysplasia, with more females affected than males. This disorder is found in many cultures around the world. However, statistics show that the Native American population has a high incidence of hip dislocation. This has been documented to be due to the common practice of swaddling and using cradleboards for restraining the infants. This places the infant's hips into extreme adduction (brought together). The incidence of congenital hip dysplasia is also higher in infants born by caesarian and breech position births. Evidence also shows a greater chance of this hip abnormality in the first born compared to the second or third child. Hormonal changes within the mother during **pregnancy**, resulting in increased ligament laxity, is thought to possibly cross over to the placenta and cause the baby to have lax ligaments while still in the womb. Other symptoms of complete dislocation include a shortening of the leg and limited ability to abduct the leg.

Diagnosis

Because the abnormalities of this hip problem often vary, a thorough **physical examination** is necessary for an accurate diagnosis of congenital hip dysplasia. The hip disorder can be diagnosed by moving the hip to determine if the head of the femur is moving in and out of the hip joint. One specific method, called the Ortolani test, begins with each of the examiner's hands around the infant's knees, with the second and third fingers pointing down the child's thigh. With the legs abducted (moved apart), the examiner may be able to discern a distinct clicking sound with motion. If symptoms are present with a noted increase in abduction, the test is considered positive for hip joint instability. It is important to note this test is only valid a few weeks after birth.

The Barlow method is another test performed with the infant's hip brought together with knees in full bent position. The examiner's middle finger is placed over the outside of the hipbone while the thumb is placed on the inner side of the knee. The hip is abducted to where it can be felt if the hip is sliding out and then back in the joint. In older babies,

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if there is a lack of range of motion in one hip or even both hips, it is possible that the movement is blocked because the hip has dislocated and the muscles have contracted in that position. Also in older infants, hip dislocation is evident if one leg looks shorter than the other.

X-ray films can be helpful in detecting abnormal findings of the hip joint. X rays may also be helpful in finding the proper positioning of the hip joint for treatments of casting. Ultrasound has been noted as a safe and effective tool for the diagnosis of congenital hip dysplasia. Ultrasound has advantages over x rays, as several positions are noted during the ultrasound procedure. This is in contrast to only one position observed during the x ray.

Treatment

The objective of treatment is to replace the head of the femur into the acetabulum and, by applying constant pressure, to enlarge and deepen the socket. In the past, stabilization was achieved by placing rolled cotton diapers or a pillow between the thighs, thereby keeping the knees in a frog like position. More recently, the Pavlik harness and von Rosen splint are commonly used in infants up to the age of six months. A stiff shell cast may be used, which achieves the same purpose, spreading the legs apart and forcing the head of the femur into the acetabulum. In some cases, in older children between 6 to 18 months, surgery may be necessary to reposition the joint. Also at this age, the use of closed manipulation may be applied successfully, by moving the leg around manually to replace joint. Operations are not only performed to reduce the dislocation of the hip, but also to repair a defect in the acetabulum. A cast is applied after the operation to hold the head of the femur in the correct position. The use of a home **traction** program is now more common. However, after the age of eight years, surgical procedures are primarily done for **pain** reduction measures only. Total hip surgeries may be inevitable later in adulthood.

Alternative treatment

Nonsurgical treatments include **exercise** programs, orthosis (a force system, often involving braces), and medications. A physical therapist may develop a program that includes strengthening, range-of-motion exercises, pain control, and functional activities. **Chiropractic** medicine may be helpful, especially the procedures of closed manipulations, to reduce the dislocated hip joint.

KEY TERMS

Acetabulum—The large cup-shaped cavity at the junction of pelvis and femur or thigh bone.

Orthosis—A force system designed to control or correct or compensate for a bone deformity, deforming forces, or forces absent from the body.

Prognosis

Unless corrected soon after birth, abnormal stresses cause malformation of the developing femur, with a characteristic limp or waddling gait. If cases of congenital hip dysplasia go untreated, the child will have difficulty walking, which could result in life-long pain. In addition, if this condition goes untreated, the abnormal hip positioning will force the acetabulum to locate to another position to accommodate the displaced femur.

Prevention

Prevention includes proper prenatal care to determine the position of the baby in the womb. This may be helpful in preparing for possible breech births associated with hip problems. Avoiding excessive and prolonged infant hip adduction may help prevent strain on the hip joints. Early diagnosis remains an important part of prevention of congenital hip dysplasia.

ORGANIZATIONS

March of Dimes Birth Defects Foundation, 1275 Mamaroneck Ave., White Plains, NY, 10605, (914) 997-4488, http://www.modimes.org.

Jeffrey P. Larson, RPT

Congenital lobar emphysema

Definition

Congenital lobar **emphysema** is a chronic disease that causes respiratory distress in infants.

Description

Congenital lobar emphysema, also called infantile lobar emphysema, is a respiratory disease that occurs in infants when air enters the lungs but cannot leave

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easily. The lungs become over-inflated, causing respiratory function to decrease and air to leak out into the space around the lungs.

Half of the cases of congenital lobar emphysema occur in the first four weeks of life, and three-quarters occur in infants less than six months old. Congenital lobar emphysema is more common in boys than in girls.

Each person has two lungs, right and left. The right lung is divided into three sections, called lobes, and the left lung into two lobes. Congenital lobar emphysema usually affects only one lobe, and this is usually an upper lobe. It occurs most frequently in the left upper lobe, followed by the right middle lobe.

Causes and symptoms

The cause of congenital lobar emphysema often cannot be identified. The airway may be obstructed or the infant's lungs may not have developed properly. Congenital lobar emphysema is almost never of genetic origin.

Symptoms of congenital lobar emphysema include:

- shortness of breath
- wheezing
- lips and fingernail beds that have a bluish tinge

Diagnosis

Congenital lobar emphysema is usually identified within the first two weeks of the infant's life. It is diagnosed by respiratory symptoms and a **chest x ray**, which shows the over-inflation of the affected lobe and may show a blocked air passage.

Treatment

For infants with no, mild, or intermittent symptoms, no treatment is necessary. For more serious cases of congenital lobar emphysema, surgery is necessary, usually a **lobectomy** to remove the affected lung lobe.

Alternative treatment

Alternative treatments that may be helpful for congenital lobar emphysema are aimed at supporting and strengthening the patient's respiratory function. Vitamin and mineral supplementation may be recommended as may herbal remedies such as lobelia (*Lobelia inflata*) that strengthen the lungs and enhance their elasticity. Homeopathic constitutional care may also be beneficial for this condition.

KEY TERMS

Congenital—A disease or condition that is present at birth.

Emphysema—A condition in which the air sacs in the lungs become overinflated, causing a decrease in respiratory function.

Lobar—Relating to a lobe, a rounded projecting part of the lungs.

Prognosis

Surgery for congenital lobar emphysema has excellent results.

Prevention

Congenital lobar emphysema cannot be prevented.

ORGANIZATIONS

American Lung Association, 1301 Pennsylvania Ave. NW, Suite 800, Washington, DC, 20001, (202) 758-3355, (202) 452-1805, (800) 548-8252, info@lungusa.org, http://www.lungusa.org/.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

Lori De Milto

Congenital megacolon *see* **Hirschsprung's disease**

Congenital thymic hypoplasia *see* **DiGeorge syndrome**

Congenital ureter anomalies

Definition

The ureter drains urine from the kidney into the bladder. It is not simply a tube but an active organ that propels urine forward by muscular action. It has a valve at its bottom end that prevents urine from flowing backward into the kidney. Normally there is one ureter on each side of the body for each kidney. However, among the many abnormalities of ureteral development, duplication is quite common. Ureters may also be malformed in a variety of ways–some harmful, others not.

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Description

The urogenital system, for some reason, is more likely than any other to have **birth defects**, and they can occur in endless variety. Ureters can be duplicated completely or partially, they can be in the wrong place, they can be deformed, and they can end in the wrong place. The trouble these abnormalities bring is directly related to their effect on the flow of urine. As long as urine flows normally through them, and only in one direction, no harm is done.

- Duplication of ureters is quite common, either in part or completely. Kidneys are sometimes duplicated as well. Someone may have four kidneys and four ureters or two kidneys, half of each drained by a separate ureter, or a single kidney with two, three, or four ureters attached. As long as urine can flow easily in the correct direction, such malformations may never be detected. If, however, one of the ureters has a dead end, a stricture or stenosis (narrowing), or a leaky ureterovesical valve (valve between the ureter and bladder), infection is the likely result.
- Stricture or stenosis of a ureter prevents urine from flowing freely. Whenever flow is obstructed in the body–urine, bile, mucus, or any other liquid–infection follows. Ureters can be obstructed anywhere along their course, though the ureterovesical valve is the most common place.
- A ureter may have an ectopic (out of place) orifice (opening)–it may enter the bladder, or even another structure, where it does not belong and therefore without an adequate valve to control reflux.
- The primary ureter, or a duplicate, may not even reach the bladder, but rather terminate in a dead end. Urine will stagnate there and eventually cause infection.
- A ureter can be perfectly normal but in the wrong place, such as behind the vena cava (the large vein in the middle of the abdomen). A so-called retrocaval ureter may be pinched by the vena cava so that flow is hindered. Other aberrant locations may also lead to compression and impaired flow.

Besides infection, urine that backs up will cause the ureter and the kidney to dilate. Eventually, the kidney will stop functioning because of the back pressure. This condition is called hydronephrosis–a kidney swollen with urine.

Causes and symptoms

The causes of birth defects are multiple and often unknown. Furthermore, the precise cause of specific birth defects has only rarely been identified. Such is the case with congenital ureteral anomalies.

Practically the only symptom generated by ureteral abnormalities is **urinary tract infection**. A lower tract infection–in the bladder–is called **cystitis**. In children, it may cause **fever** and systemic symptoms, but in adults it causes only cloudy, burning, and frequent urine. Upper tract infections, on the other hand, can be serious for both adults and children, causing high fevers, back **pain**, severe generalized discomfort, and even leading to kidney failure or septicemia (infection spreading throughout the body by way of the blood stream).

In rare cases, urine from an ectopic ureter will bypass the bladder and dribble out of the bottom somewhere, through a natural orifice like the vagina or a completely separate unnatural opening.

Diagnosis

Serious or recurrent urinary infections will prompt a search for underlying abnormalities. **Cystoscopy** (looking into the bladder with a thin telescope-like instrument) and x rays with a contrast agent to illuminate the urinary system will usually identify the defect. **Computed tomography scans** (CT) and **Magnetic resonance imaging** (MRI) may provide additional information. Urine cultures to identify the infecting germs will be repeated frequently until the problem is corrected.

Treatment

Sometimes the recurring infections caused by flow abnormalities can be treated with repeated and changing courses of **antibiotics**. Over time, the infecting germs develop resistance to most treatments, especially the safer ones. If it can be done with acceptable risk, it is better to repair the defect surgically. Urologists have an arsenal of approaches to urine drainage that range from simply reimplanting a ureter into the bladder, in such a way that an effective valve is created, to building a new bladder out of a piece of bowel.

Alternative treatment

There are botanical and homeopathic treatments available for urinary tract infection. None can take the place of correcting a problem that is occurring because of a malformed or dysfunctional organ system. Once correction of the cause is addressed and there is unimpeded flow of urine, adequate fluid intake can contribute to prevention of future infections.

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KEY TERMS

Congenital—Present at birth.

Contrast agent—A chemical or other substance placed in the body to show structures that would not otherwise be visible on x ray or other imaging studies.

Cystoscopy—Looking into the urinary bladder with a thin telescope-like instrument.

Ectopic—Out of place.

Septicemia—A serious whole body infection spreading through the blood stream.

Ureterovesical valve—A sphincter (an opening controlled by a circular muscle), located where the ureter enters the bladder, that keeps urine from flowing backward toward the kidney.

Urogenital—Both the urinary system and the sexual organs, which form together in the developing embryo.

Prognosis

As long as damage to the kidneys from infection or back pressure has not become significant, the surgical repair of troublesome ureteral defects produces excellent long-term results in the great majority of cases. Monitoring for recurrent infections is always a good idea, and occasional checking of kidney function will detect hidden ongoing damage.

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Congestive cardiomyopathy

Definition

Cardiomyopathy is an ongoing disease process that damages the muscle wall of the lower chambers of the heart. Congestive cardiomyopathy is the most common form of cardiomyopathy. In congestive cardiomyopathy, also called dilated cardiomyopathy, the walls of the heart chambers stretch (dilate) to hold a greater volume of blood than normal. Congestive cardiomyopathy is the final stage of many heart diseases and the most common condition resulting in congestive **heart failure**.

Description

About 50,000 Americans develop cardiomyopathy each year. Of those, 87% have congestive cardiomyopathy. Primary cardiomyopathy accounts for only 1% of all deaths from heart disease.

When the heart muscle is damaged by a disease process, it cannot pump enough blood to meet the body's needs. Uninjured areas of the walls of the two lower heart chambers (called ventricles) stretch to make up for the lost pumping action. At first, the enlarged chambers allow more blood to be pumped with less force. The stretched muscle can also contract more forcefully. Over time, the heart muscle continues to stretch, ultimately becoming weaker. The heart is forced to work harder to pump blood by beating faster. Eventually it cannot keep up, and blood backs up into the veins, legs, and lungs. When this happens, the condition is called congestive heart failure.

Congestive cardiomyopathy usually affects both ventricles. Blood backed up into the lungs from the left ventricle causes fluid to congest the lung tissue. This is called **pulmonary edema**. When the right ventricle fails to pump enough blood, blood backs up into the veins causing **edema** in the legs, feet, ankles, and abdomen.

Causes and symptoms

Congestive cardiomyopathy may be caused by a number of conditions. Cardiomyopathy with a known cause is called secondary cardiomyopathy. When no cause can be identified, it is called primary cardiomyopathy or idiopathic cardiomyopathy. About 80% of all cases of cardiomyopathy do not have a known cause. Many heart specialists think that many cases of idiopathic congestive cardiomyopathy may be caused by a viral infection. Because cardiomyopathy may occur many years after a viral infection and viruses sometimes go undetected in laboratory tests, it is difficult to know if a virus is the cause. Some people have a weak heart from advanced **coronary artery disease** that causes heart muscle damage. This is sometimes called ischemic cardiomyopathy.

Conditions that can cause congestive cardiomyopathy are:

- coronary artery disease
- infections
- noninfectious inflammatory conditions
- alcohol and other drugs or toxins

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- hypertension
- nutritional and metabolic disorders
- pregnancy

Coronary artery disease is one of the most common causes of congestive cardiomyopathy. In coronary artery disease, the arteries supplying blood to the heart become narrowed or blocked. When blood flow to an area of the heart is completely blocked, the person has a **heart attack**. The heart muscle suffers damage when its blood supply is reduced or blocked. Significant recurrent muscle damage can occur silently. This damage can lead to congestive cardiomyopathy.

Infections caused by bacteria, viruses, and other microorganisms can involve the heart, causing inflammation of the heart muscle (**myocarditis**). The inflammation may damage the heart muscle and cause congestive cardiomyopathy. In the United States, the coxsackievirus B is the most common cause of viral congestive cardiomyopathy.

Myocarditis can also be caused by noninfectious disorders. For example, the conditions **sarcoidosis**, granulomatous myocarditis, and **Wegener's granulomatosis** cause inflammation and tissue **death** in the heart muscle.

Years of drinking excessive amounts of alcohol can weaken the heart muscle, leading to congestive cardiomyopathy. Other drugs and toxins, such as **cocaine**, pesticides, and other chemicals, may have the same effect.

High blood pressure (**hypertension**) puts extra pressure on blood vessels and the heart. This increased pressure makes the heart work harder to pump blood, which may thicken and damage the chamber walls.

Severe nutritional deficiencies can weaken the heart muscle and affect its pumping ability. Certain disorders of metabolism, including **diabetes mellitus** and thyroid disorders, can also lead to congestive cardiomyopathy.

Occasionally, inflammation of the heart muscle and congestive cardiomyopathy may develop late in **pregnancy** or shortly after a woman gives birth. This type of congestive cardiomyopathy is called peripartum cardiomyopathy. The cause of congestive cardiomyopathy in pregnancy is not known.

Congestive cardiomyopathy usually is a chronic condition, developing gradually over time. Patients with early congestive cardiomyopathy may not have symptoms. The most common symptoms are **fatigue** and **shortness of breath** on exertion. Unfortunately, **sudden cardiac death** is not uncommon with this condition. It stems from irregular heart rhythms in the ventricles (ventricular **arrhythmias**).

Patients with more advanced congestive cardiomyopathy may also have chest or abdominal pains, extreme tiredness, **dizziness**, and swelling of the legs and ankles.

Diagnosis

Diagnosis of congestive cardiomyopathy is based on:

- symptoms
- medical history
- physical examination
- chest x ray
- electrocardiogram (ECG; also called EKG)
- echocardiogram
- cardiac catheterization

The diagnosis is based on the patient's symptoms, a complete **physical examination**, and tests that detect abnormalities of the heart chambers. The physician listens to the heart with a stethoscope to detect abnormal heart rhythms and heart sounds. A heart murmur might mean that the heart valves are not closing properly due to the ventricles being enlarged.

A **chest x ray** can show if the heart is enlarged and if there is fluid in the lungs. Abnormalities of heart valves and other structures may also be seen on a chest x ray.

An electrocardiogram provides a record of electrical changes in the heart muscle during the heartbeat. It gives information on the heart rhythm and can show if the heart chamber is enlarged. An ECG can detect damage to the heart muscle and the amount of damage.

Echocardiography uses sound waves to make images of the heart. These images can show if the heart wall or chambers are enlarged and if there are any abnormalities of the heart valves. Echocardiography can also evaluate the pumping efficiency of the ventricles.

Cardiac catheterization usually is only used if a diagnosis cannot be made with other methods. In cardiac catheterization, a small tube (called a catheter) is inserted into an artery and passed into the heart. It is used to measure pressure in the heart and the amount of blood pumped by the heart. A small tissue sample of the heart muscle can be removed through the catheter for examination under a microscope (biopsy). This biopsy can show the type and amount of damage to the heart muscle.

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KEY TERMS

Angiotensin-converting enzyme (ACE) inhibitor—A drug that relaxes blood vessel walls and lowers blood pressure.

Atherosclerosis—Buildup of a fatty substance called a plaque inside blood vessels.

Cardiac catheterization—A diagnostic test for evaluating heart disease; a catheter is inserted into an artery and passed into the heart.

Cardiomyopathy—Disease of the heart muscle.

Congestive cardiomyopathy—Also called dilated cardiomyopathy; cardiomyopathy in which the walls of the heart chambers stretch, enlarging the heart ventricles so they can hold a greater volume of blood than normal.

Coxsackievirus B—A type of virus in the group Enterovirus that causes an infection similar to polio, but without paralysis.

Digitalis—A drug that helps the heart muscle to have stronger pumping action.

Dilated cardiomyopathy—Also called congestive cardiomyopathy; cardiomyopathy in which the walls of the heart chambers stretch, enlarging the heart ventricles so they can hold a greater volume of blood than normal.

Diuretic—A type of drug that helps the kidneys eliminate excess salt and water.

Edema—Swelling caused by fluid buildup in tissues.

Granulomatous myocarditis—Also called giant cell myocarditis, this noninfectious inflammation of the heart causes large areas of tissue death in the heart muscle, ventricular enlargement, and clots inside the heart chambers.

Idiopathic cardiomyopathy—Cardiomyopathy without a known cause.

Sarcoidosis—A chronic disease that causes formation of abnormal areas containing inflammatory cells, called granulomas, in any organ or tissue; in the heart, large areas of the heart muscle can be involved, causing cardiomyopathy.

Vasodilator—Any drug that relaxes blood vessel walls.

Ventricle—One of the two lower chambers of the heart.

Wegener's granulomatosis—A disease usually affecting males that causes the infiltration of inflammatory cells and tissue death in the lungs, kidneys, blood vessels, heart, and other tissues.

Treatment

When a patient is diagnosed with congestive cardiomyopathy, physicians try to find out the cause. If coronary artery disease is not the culprit, in most other cases a cause is not identified. When a condition responsible for the congestive cardiomyopathy is diagnosed, treatment is aimed at correcting the underlying condition. Congestive cardiomyopathy caused by drinking excess alcohol or by drugs or toxins can be treated by eliminating the alcohol or toxin completely. In some cases, the heart may recover after the toxic substance is removed from the body. Bacterial myocarditis is treated with an antibiotic to eliminate the bacteria.

There is no cure for idiopathic congestive cardiomyopathy. Medicines are given to reduce the workload of the heart and to relieve the symptoms.

One or more of the following types of medicines may be prescribed for congestive cardiomyopathy:

- digitalis
- diuretics
- vasodilators
- beta blockers
- angiotensin converting enzyme inhibitors (ACE inhibitors)
- angiotensin receptor blockers

Digitalis helps the heart muscle to have stronger pumping action. **Diuretics** help eliminate excess salt and water from the kidneys by making patients urinate more often. This helps reduce the swelling caused by fluid buildup in the tissues. **Vasodilators**, **beta blockers**, and ACE inhibitors lower blood pressure and expand the blood vessels so blood can move more easily through them. This action makes it easier for the heart to pump blood through the vessels.

Patients may also be given anticoagulant medications to prevent clots from forming due to pooling of blood in the heart chambers. Medicines to prevent abnormal heart rhythms (arrhythmias) may be given, but some of these drugs can also reduce the force of heart contractions. Automatic implantable cardioverter defibrillators

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(AICDs) can treat life-threatening arrhythmias, which are relatively common in severe cardiomyopathy.

Certain lifestyle changes may help reduce the workload on the heart and relieve symptoms. Some patients may need to change their diet, stop drinking alcohol, begin a physician-supervised **exercise** program, and/or stop **smoking**.

Severe congestive cardiomyopathy usually causes heart failure. When the heart muscle is damaged so severely that medicines cannot help, a heart transplant may be the only remaining treatment to be considered.

Prognosis

The outlook for a patient with congestive cardiomyopathy depends on the severity of the disease and the person's health. Generally, congestive cardiomyopathy worsens over time and the prognosis is not good. About 50% of patients with congestive cardiomyopathy live for five years after the diagnosis. Twenty five percent of patients are alive 10 years after diagnosis. Women with congestive cardiomyopathy live twice as long as men with the disease. Many of the deaths are caused by sudden abnormal heart rhythms.

Prevention

Because idiopathic congestive cardiomyopathy does not have a known cause, there is no sure way to prevent it. The best way to prevent congestive cardiomyopathy is to avoid known causes such as drinking excess alcohol or taking toxic drugs. Eating a nutritious diet and getting regular exercise to improve overall fitness also can help the heart to stay healthy.

Congestive cardiomyopathy may also be prevented by identifying and treating any conditions that might damage the heart muscle. These include high blood pressure and coronary artery disease. Regular blood pressure checks and obtaining immediate medical care for hypertension and symptoms of coronary artery disease, such as chest **pain**, are important to keep the heart functioning properly.

Finally, diagnosing and treating congestive cardiomyopathy before the heart becomes severely damaged may improve the outlook.

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ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

Heart and Stroke Foundation of Canada, 222 Queen Street, Suite 1402, Ottawa, CanadaON, K1P 5V9, (613) 569-4361, (613) 569-3278, http://www.heartandstroke.com.

Heart Association of Australia, Level 3, 80 William Street, Sydney, Australia, NSW 2011, 02 02 9219 2444, reception.sydney@heartfoundation.org.au, http://www.heartfoundation.org.au.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

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Congestive heart failure

Definition

Congestive **heart failure** (CHF) is a chronic, progressive condition in which the heart gradually becomes unable to pump enough blood to meet the needs of the body. This can result in failure of other organs and **death**. CHF is the leading cause of hospitalizations of people over age 65.

Description

The heart is a muscle containing four compartments or chambers that separate oxygen-poor blood from oxygen-rich blood. The atria are the top chambers. They receive blood from the body. The ventricles are the bottom chambers. They pump blood out to the

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body. Oxygen-poor blood enters the right atrium, then moves through a valve to the right ventricle. It is then pumped out of the right ventricle to the lungs where it picks up oxygen. The oxygen-rich blood returns to the left atrium of the heart, flows through a valve to the left ventricle, and is then pumped out to the body. This sequence occurs with every heartbeat. The timing of the contraction of each chamber of the heart must be tightly coordinated in order for each chamber empty efficiently and completely.

In CHF, the heart fails to pump enough blood to meet the needs of other organs in the body. This failure occurs for one of two reasons. In systolic heart failure (systole is the period when the heart contracts), disease weakens the wall of the ventricles, so that they pump less forcefully. In response, the heart muscle stretches to create larger chambers in the ventricles. This compensates for the heart's reduced pumping ability, but over time, the heart wall thickens, the chambers narrow, and the heart pumps out less and less blood. The volume of blood pumped out of the ventricle is called the ejection fraction (EF). In a healthy heart, the EF is greater than 50%, while in people with CHF, it is less than 50% and can be as low as 30%. Systolic heart failure is the most common kind of CHF.

In diastolic heart failure (diastole is the period when the heart relaxes and refills with blood), the heart is not weakened, but it becomes stiff. After each contraction, it does not relax enough to fill completely. The EF is normal (over 50%), but with less blood in the ventricle, the absolute amount of blood pumped is decreased. Diastolic heart failure is most common among people over age 75.

When the left side of the heart begins to fail, fluids collect in the lungs causing lung congestion (**pulmonary edema**) and difficulty breathing. When the right side of the heart begins to fail, fluid collects in the feet and legs causing swelling. CHF is often complicated by other health problems such as **coronary artery disease**, diabetes, high blood pressure, **alcoholism**, **emphysema**, **chronic obstructive pulmonary disease** (COPD), and renal (kidney) disease.

Demographics

About 5 million Americans have CHF, with about 500,000 new cases diagnosed each year. Most people with CHF are elderly. Only 1% of people under age 50 are diagnosed with CHF, but it is found in about 5% of people over age 75 and 25% of people over age 80. Men ages 40–75 are more likely to have CHF than women, but after age 75, the percentage of men and women with CHF is about equal. African Americans are 1.5 times more likely to die of CHF than white Americans. The number of people with CHF is expected to increase as the American population ages.

Causes and symptoms

The end cause of CHF is failure of the heart to pump enough blood, but many other conditions can contribute to or accelerate this failure. These include heart damage caused by disease and lifestyle. Some common conditions contributing to CHF that make the heart work harder and can increase the risk of CHF include:

- coronary artery disease
- prolonged, uncontrolled high blood pressure (hypertension)
- previous heart attack (myocardial infarction)
- heart valve abnormalities
- prolonged heart arrhythmias
- infection of the heart muscle or surrounding tissue (endocarditis)
- damage to the heart muscle from alcohol, cocaine, or other substance abuse
- congenital (present at birth) heart defects
- obesity
- diabetes, particularly poorly controlled diabetes
- smoking

Symptoms of CHF usually begin gradually and initially may go unnoticed. The exception is after a **heart attack**, when moderate-to-severe symptoms can develop rather rapidly. CHF symptoms are similar to those caused by many diseases, making diagnosis more difficult. Often symptoms are complicated by other diseases in the elderly such as diabetes, emphysema or other lung diseases, and reduced kidney function.

The first symptom usually noticed is **shortness of breath** when performing normal activities such as walking, cleaning the house, or doing easy yard work, along with general **fatigue**. Symptoms then progress to include:

- shortness of breath and difficulty breathing even at rest
- fluid retention and swelling of the feet and legs
- weakness and extreme fatigue
- dizziness from not enough oxygen reaching the brain
- fast and/or irregular heartbeat

Diagnosis

Diagnosis begins with a complete **physical examination** and a health, medication, and lifestyle history.

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The following tests are used to make a diagnosis of CHF:

- chest x ray: non-invasive test shows if fluid is building up in the lungs or if the heart is enlarged.
- electrocardiogram (ECG): non-invasive test helps detect abnormalities in heart rhythm and heart health by measuring the electrical activity of the heart
- blood tests: check for anemia (low iron) and chemical (electrolyte) imbalances in the blood.
- kidney function tests: help pinpoint the cause of fluid retention
- B-type natriuetic peptide (BNP) test: measures the hormone BNP, which is produced in greater quantity when the heart begins to fail
- echocardiogram: non-invasive imaging test that produces a picture of the heart in motion as it beats; extremely helpful in showing heart and valve damage.
- multiple-gated acquisition (MUGA) scan: imaging test that uses radioactive dye injected in the veins to produce a picture of blood circulation in the heart
- stress test: an electrocardiogram done while exercising or, for people who cannot exercise, while the heart is stimulated by medication

The degree or stage of CHF can be designated using several different scales. The two most common are the New York Heart Association (NYHA) scale that uses a numbered system (I-IV) that classifies CHF by symptoms and functional limits and the American College of Cardiology (ACC) scale that use a letter system (A-D) to designate risk factors for CHF.

Treatment

Treatment does not cure CHF, but it can slow its progression, extend life, and to some degree improve symptoms. Treatment of CHF falls into three categories: lifestyle changes, drug therapy, and surgery.

Lifestyle changes

Self-care lifestyle changes that help slow the progression of CHF include:

- reducing sodium (salt) in the diet
- eating a heart-healthy diet high in fresh fruits, fresh vegetables and whole grains, and low in fats, especially saturated (animal) fats.
- controlling calorie intake and losing weight if overweight or obese
- quitting smoking
- avoiding alcohol
- exercising moderately (e.g., walking) or joining a cardiac rehabilitation program
- treating any other health problems or underlying diseases
- elevating the feet when sitting to discourage fluid accumulation
- taking all medicines as prescribed
- weighing daily to check for sudden spikes in fluid retention
- scheduling regular examinations with a healthcare provider

Drug therapy

Many drugs are available to treat CHF. People with CHF often need more than one drug to control or slow symptoms. The development of new drugs to treat CHF is an area of active research because of the **aging** population of many developed countries.

Some common drugs used to treat CHF include:

- angiotensin converting enzyme (ACE) inhibitors. These drugs block the formation of angiotensin, a hormone that may adversely affect the heart. ACE inhibitors include captopril (Capoten), enalapril (Vasotec), lisinopril (Zestril, Prinvil), benazepril (Lotensin), and ramipril (Altace).
- angiotensin receptor blockers. These drugs also block the formation of angiotensin using a different mechanism than ACE inhibitors. They are generally less effective than ACE inhibitors and are given to people who do not tolerate ACE-inhibiting drugs. Examples include losartan (Cozzar), candesartan (Atacand), telmisartan (Micardis), valsartan (Diovan), and irbesartan (Avapro).
- beta-blockers. These drugs block the effect of stimulant hormones such as epinephrine (adrenalin) and norepinephrine (noradrenaline). Carvedilol (Coreg) is approved by the United Sates Food and Drug Administration (FDA) for this use, although other beta-blockers are sometimes prescribed as off-label use.
- digoxin (Lanoxin). This is one of the oldest treatments for CHF. It is a natural compound found in the plant foxglove *Digitalis purpurea*.
- diuretics. These drugs help rid the body of excess fluid by increasing urine production. Common diuretics include furosemide (Lasix), bumetanide (Bumex), torsemide (Demadex), metolazone (Zaroxolyn), spironolactone (Aldactone), and hydrochlorothiazide.
- hydralazine (Apresoline). A large study showed that this drug benefited African Americans but conferred

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no benefit on people of other races. Research is ongoing.

There are also drugs that a CHF patient should avoid because they worsen CHF or interfere with treatment drugs. These include **nonsteroidal anti-inflammatory drugs** (e.g., Aleve, Motrin), **decongestants** (e.g., Sudafed), **calcium channel blockers**, anti-arrhythmia drugs, growth hormones, **antacids** that contain **sodium**, and salt substitutes. Patients with CHF should not take any herbal remedy or dietary supplement without first consulting their healthcare provider. In addition, some drugs used to treat underlying diseases may need to be adjusted because they interfere with drug therapy for CHF.

Surgery

Surgery does not cure CHF although it can prolong life and improve the quality of life. Surgery can be done to remedy a defect or condition that is contributing to CHF. Examples are **heart valve repair** and coronary artery surgery to improve blood flow in the heart. Complete heart **transplant surgery** to treat CHF is severely limited by the number of donor hearts available. It is normally done only on younger patients such as those with congenital heart defects.

Nutrition/Dietetic concerns

Sodium (Na) found in salt promotes water retention in the body. People with CHF need to severely restrict their intake of salt. Salt is found in many processed foods, so that even a "no salt added" diet provides between 4,000–6,000 mg of salt daily. People with CHF need to limit their salt intake to no more than 2,000 mg of salt per day. This requires careful reading of food labels (sodium content is listed in the **nutrition** panel) and for many, a major change in the foods they eat. Fluid intake is also a concern for people with CHF and is often limited to no more than 8 cups (2 L) of fluids daily from all sources combined.

Exercise therapy

Studies have found that limited, supervised **exercise** can benefit people with CHF. An individualized **cardiac rehabilitation** program can provide an appropriate type and level of exercise.

Prognosis

CHF is a progressive condition; it can be slowed but not cured. Between 30% and 40% of people with CHF are hospitalized every year, and it is a leading cause of death among the elderly. About half the deaths among people with CHF are from progressive heart failure, and the other half are sudden deaths, most often due to severe heart **arrhythmias**. The average survival time from diagnosis is 3.2 years in men and 5.4 years in women. Nevertheless, survival times vary widely depending on the individual's general health, the treatment they receive, and how well they maintain their lifestyle and drug regimens.

KEY TERMS

Arrhythmia—An abnormal heart rhythm.

Atrium (plural Atria)—The right or left upper chamber of the heart.

Cardiac rehabilitation—A structured program of education and activity offered by hospitals and other organizations.

Coronary artery disease—Also called atherosclerosis, it is a build-up of fatty matter and debris in the coronary artery wall that causes narrowing of the artery.

Echocardiogram—A non-invasive imaging procedure used to create a picture of the heart's movement, valves, and chambers.

Electrocardiogram (ECG)—A noninvasive test records the electrical activity of the heart and is useful is assessing general heart health.

Off-label use—Drugs in the United States are approved by the Food and Drug Administration (FDA) for specific uses based on the results of clinical trials. However, it is legal for physicians to administer these drugs for other "off-label" uses. It is not legal for pharmaceutical companies to advertise drugs for off-label uses.

Stress test—A test that involves an electrocardiogram during rest and exercise to determine how the heart responds to stress.

Ventricle—A lower pumping chambers of the heart. There are two ventricles, right and left. The right ventricle pumps oxygen-poor blood to the lungs to be re-oxygenated. The left ventricle pumps oxygen-rich blood to the body.

Prevention

Prevention activities are the same as the lifestyle changes used to slow the progression of CHF, namely eating a heart-healthy diet, exercising regularly,

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maintaining a healthy weight, avoiding tobacco products, and limiting alcohol consumption. Treating or controlling any underlying diseases such as diabetes and high blood pressure also are important preventative steps.

Caregiver concerns

Staying on the prescribed drug regimen and making positive lifestyle changes is important in slowing the progression of CHF and improving patient symptoms. People with CHF often take multiple drugs several times a day. Care givers can help their charges achieve maximum benefits from their medications by familiarizing themselves with the required drug regimen and organizing a system that makes it easy for them and their charges to remember to take these medications. A medicine box with separate compartments for several times of day and all the days of the week is helpful. Another part of caring for a person with CHF is organizing a daily weighing in order to determine if fluid retention has suddenly increased. Finally, the care giver must understand and conform to the dietary needs of their charge, with special care paid to the amount of salt in the diet.

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"Hormone Therapy: Is It Right for You?" *MayoClinic.com* February 12, 2008. http://www.mayoclinic.com/health/hormone-therapy/WO00046

ORGANIZATIONS

Adult Congenital Heart Association, 6757 Greene St., Suite 335, Philadelphia, PA, 19119-3508, (215) 849-1260, (888) 921-2242, (215) 849-1261, info@achaheart.org, http://www.achaheart.org.

American Heart Association, 7272 Greenville Ave., Dallas, TX, 75231, (301) 223-2307, (800) 242-8721, http://www.americanheart.org.

Centers for Disease Control and Prevention, Division for Heart Disease and Stroke Prevention, 4770 Buford Hwy NE, Atlanta, GA, 30341-3717, (770) 488-2424, http://www.cdc.gov/cholesterol/faqs.htm.

European Society of Cardiology, The European Heart House, 2035 Route des Colles, B.P. 179-Les Templiers,

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Sophia-Antipolis, France, 06903, 33 4 9294 7600, 33 4 9294 7601, http://www.escardio.org.

Heart Foundation, 80 William St., Level 3, Sydney NSW Australia, 2011, 02 9219 2444, 300 36 27 87, http://www.heartfoundation.org.au.

National Heart, Lung, and Blood Institute, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (204) 629-3246, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi.nih.gov.

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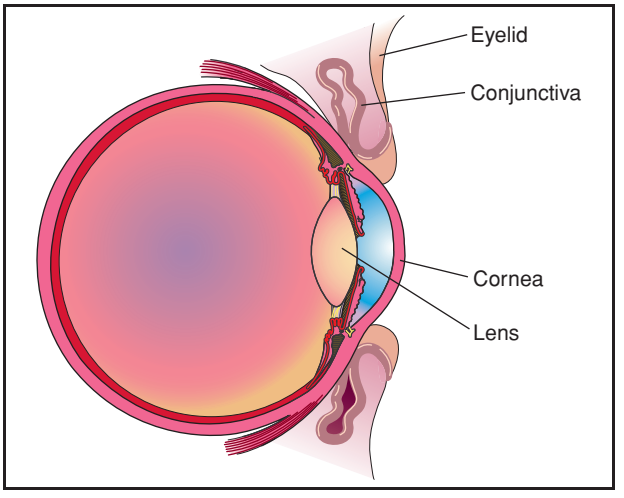
Congestive heart failure *see* **Heart failure**

Conjunctivitis

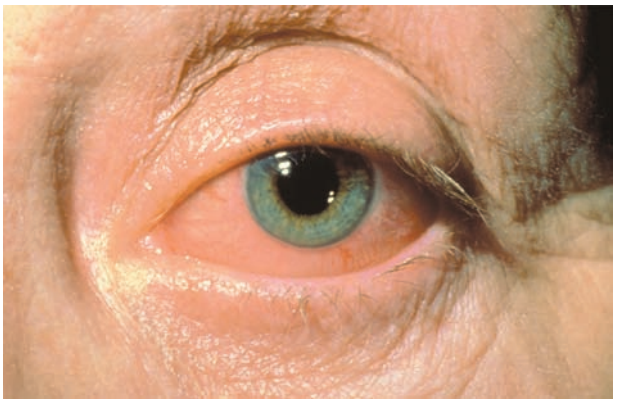
Definition

Conjuctivitis is an inflammation or redness of the lining of the white part of the eye and the underside of the eyelid (conjunctiva) that can be caused by bacterial or viral infection, allergic reaction, chemical irritants, or physical agents like infrared or ultraviolet light. Viral conjunctivitis is sometimes called pink eye or red eye because the tissues lining the affected eye often develop a bright pink color as well as being swollen.

Conjunctivitis in the newborn, sometimes called neonatal conjunctivitis or ophthalmia neonatorum, is sometimes discussed as a distinctive type of conjunctivitis because it is caused by an infection passed from the mother to the child during delivery. If untreated, it can cause blindness.



Conjunctivitis is the inflammation of the conjunctiva, a thin, delicate membrane that covers the eyeball and lines the eyelid. It may be caused by a viral infection, such as a cold or acute respiratory infection, or by such diseases as measles, herpes simplex, or herpes zoster. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*



This person has severe conjunctivitis, most likely caused by an allergic reaction. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Demographics

Conjunctivitis is a common eye disorder in all age groups worldwide, in part because it has so many possible causes. It is one of the most common nontraumatic eye disorders that are seen in hospital emergency rooms, accounting for about 1% of all ER visits in North America. The conjunctivae of the human eye are continually exposed to microorganisms and environmental agents that can cause infections or allergic reactions. Conjunctivitis can be acute or chronic depending upon how long the condition lasts, the severity of symptoms, and the type of organism or agent involved. It can also affect one or both eyes and, if caused by infection, can be very easily transmitted to others during close physical contact, particularly among children in a daycare center.

About 15% of people in the United States will have at least one episode of allergic conjunctivitis over a lifetime; rates in other countries are thought to be similar.

Viral conjunctivitis is most likely to affect people in the United States and Canada in the late fall and early spring. This type of conjunctivitis is equally common in males and females, and in members of all races and ethnic groups.

Between 1% and 2% of babies born in the United States are diagnosed with infectious neonatal conjunctivitis. The most common cause of this type of conjunctivitis is *Chlamydia trachomatis*, a parasite that lives within the tissues of an infected mother's cervix. The second most common cause is *Neisseria*

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gonorrhoeae, the gonococcus or bacterium that causes **gonorrhea**. Conjunctivitis caused by *N. gonorrhoeae* is potentially the most dangerous to newborns.

Description

The conjunctiva (plural, conjunctivae) in humans is a loose sheet of connective tissue that covers the eyeball and doubles back to form the inner lining of the eyelid. Some of the smaller tear glands that keep the eye lubricated are located within the conjunctivae. Because the conjunctivae are moist mucous membranes, **infectious disease** organisms can easily cling to them until they multiply and overwhelm the eye's defense mechanisms, producing redness, irritation, and sand-in-the-eye or itchy sensations, discharge, and sometimes photophobia (extreme sensitivity to light).

Conjunctivitis in newborns is typically characterized by swelling of the eyelid, tenderness of the eyeball, and a discharge. Depending on the organism causing the infection, the discharge may be either watery mucus or a liquid form of pus. In some cases the discharge may be thick enough to form a yellowish crust on the baby's eyelids.

Risk factors

The most common risk factors for conjunctivitis include:

- exposure to other children or family members with conjunctivitis
- exposure to allergens, most commonly grass or tree pollen
- recent history of an upper respiratory infection; this is a risk factor for viral conjunctivitis
- weakened immune system
- personal history of asthma or eczema; this is a risk factor for allergic conjunctivitis
- frequent use of eye cosmetics
- wearing contact lenses, particularly the extended-wear type

Causes and symptoms

The symptoms of conjunctivitis vary somewhat according to its cause. Conjunctivitis may be caused by a viral infection, such as a cold, acute respiratory infection, or disease such as **measles**, herpes simplex, or herpes zoster. Symptoms include mild to severe discomfort in one or both eyes, redness, swelling of the eyelids, and watery, yellow or green discharge. Symptoms may last anywhere from several days to two weeks. Infection with an adenovirus, may also cause a significant amount of pus-like discharge and a scratchy, foreign body-type of sensation in the eye. This may also be accompanied by swelling and tenderness of the lymph nodes near the ear.

Bacterial conjunctivitis can occur in adults and children and is caused by such organisms as *Staphylococcus*, *Streptococcus*, and *Hemophilus*. Symptoms of bacterial conjunctivitis include a pus-like discharge and crusty eyelids after awakening. Redness of the conjunctiva can be mild to severe and may be accompanied by swelling. Persons with symptoms of conjunctivitis who are sexually active may possibly be infected with the bacteria that cause either gonorrhea or chlamydia. There may be large amounts of pus-like discharge, and symptoms may include intolerance to light (photophobia), watery mucous discharge, and tenderness in the lymph nodes near the ear that may persist for up to three months.

Conjunctivitis may also be caused by such environmental hazards as wind, smoke, dust, and allergic reactions caused by pollen, dust, or grass. Symptoms range from **itching** and redness to a mucous discharge. Persons who wear **contact lenses** may develop allergic conjunctivitis caused by the various eye solutions and foreign proteins contained in them.

Other less common causes of conjunctivitis include exposure to sun lamps or the electrical arcs used during welding, and problems with inadequate drainage of the tear ducts.

In a few cases children can get conjunctivitis from accidental exposure to chemical irritants, such as strong detergents.

Diagnosis

The most important aspect of diagnosing conjunctivitis is to separate the cases with benign causes (the great majority) from the small group of cases with complications or more serious causes (particularly chemical injury). Conjunctivitis can be diagnosed by a primary care doctor, pediatrician, emergency room physician, or ophthalmologist (specialist in eye disorders); patients with severe inflammation or conjunctivitis caused by getting a strong chemical in the eye will usually be referred to an ophthalmologist.

Examination

An accurate diagnosis of conjunctivitis centers on taking a patient history to learn when symptoms began, the specific symptoms experienced, and other predisposing factors, such as upper respiratory

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KEY TERMS

Adenovirus—A virus that affects the upper respiratory tract.

Chlamydia—The most common bacterial sexually transmitted disease in the United States that often accompanies gonorrhea and is known for its lack of evident symptoms in the majority of women.

Gonococcus (plural, gonococci)—The bacterium *Neisseria gonorrheae* that causes gonorrhea, a sexually transmitted infection of the genitals and urinary tract. Gonococci may occasionally affect the eye, causing blindness if not treated.

Herpes simplex virus—A virus that can cause fever and blistering on the skin, mucous membranes, or genitalia.

Herpes zoster virus—Acute inflammatory virus that attacks the nerve cells on the root of each spinal nerve with skin eruptions along a sensory nerve ending.

Neonatal—Referring to the period shortly after birth.

Ophthalmia neonatorum—The medical term for conjunctivitis in newborns.

Photophobia—Extreme sensitivity to light.

Staphylococcus—A bacterial organism, looking much like a cluster of grapes, that can infect various body systems.

Streptococcus—An organism that causes infections of either the upper respiratory or gastrointestinal tract.

complaints, **allergies**, **sexually transmitted diseases**, herpes simplex infections, and exposure to schoolmates or other persons with pink eye. It may be helpful to learn whether an aspect of an individual's occupation may be the cause.

After taking the history, the doctor will examine the patient's eye with a light to check the eyelid and conjunctiva for swelling, change in color, discharge, and any other abnormalities. The doctor may also collect a small sample of the discharge for culture if bacterial conjunctivitis is suspected.

Tests

Laboratory tests are usually not indicated in adults unless initial treatment fails (usually within 24–36 hours) or an infection with gonorrhea or chlamydia is suspected. In such cases, the discharge may be cultured and Gram-stained to determine the organism responsible for the condition. Cultures and smears are relatively painless procedures.

Cultures are usually taken when the patient is a newborn, has a weakened immune system, or is thought to have conjunctivitis caused by *N. gonorrhoeae*.

Treatment

Traditional

The treatment of conjunctivitis depends on what caused the condition. In all cases, warm compresses applied to the affected eye several times a day may help to reduce discomfort. Some treatment choices will be based on patient preference, convenience of use, and cost to the patient.

Conjunctivitis due to a viral infection, particularly those due to adenoviruses, are usually treated by applying warm compresses to the eye(s) and applying topical antibiotic ointments to prevent secondary bacterial infections. Viral conjunctivitis caused by herpes simplex should be referred to an ophthalmologist. Topical **steroids** are commonly prescribed in combination with antiviral therapy.

Allergic conjunctivitis can be treated by removing the allergic substance from a person's environment, if possible; by applying cool compresses to the eye; and by administering eye drops four to six times daily for four days. Oral **antihistamines** may help to relieve itchy eyes. However, many of these drugs also dry the eyes. Therefore, many physicians suggest a combination of antihistamines and lubricating drops or the use of nasal corticosteroid sprays to help relieve allergic conjunctivitis, particularly when it is combined with nasal symptoms. Non steroidal anti-inflammatory drugs (NSAIDs) can be used to reduce the itching associated with allergic conjunctivitis as well as to reduce inflammation.

Drugs

Medications of various types are used to treat conjunctivitis caused by bacteria. In cases of bacterial conjunctivitis, a physician may prescribe an antibiotic eye ointment or eye drops containing **sodium** sulfacetamide (Sulamyd) to be applied daily for 7 to 14 days. If, after 72 hours, the condition does not improve, a physician

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or primary care provider should be notified because the bacteria involved may be resistant to the antibiotic used or the cause may not be bacterial. In May 2009 the U.S. Food and Drug Administration (FDA) approved a new drug, besifloxacin (Besivance), for the treatment of bacterial conjunctivitis. The new drug is given as eye drops, can be safely used in patients older than 12 months, and has fewer side effects than other antibacterial eye drops.

For cases of conjunctivitis caused by *N. gonorrhoeae*, a physician may prescribe an intramuscular injection of ceftriaxone (Rocephin) and a topical antibiotic ointment containing erythromycin or bactracin to be applied four times daily for two to three weeks. Sexual partners should also be treated.

With accompanying chlamydia infection, a topical antibiotic ointment containing erythromycin (Ilotycin) may be prescribed to be applied one to two times daily. In addition, oral erythromycin or tetracycline therapy may be indicated for three to four weeks. Again, sexual partners should also be treated.

Conjunctivitis in the newborn is treated with a combination of eye drops or eye ointments containing erythromycin or tetracycline. Salt water drops may be used to wash away any sticky crust that has formed on the eyelids. Babies born to mothers with untreated gonorrhea may need intravenous or intramuscular injections of ceftriaxone, ciprofloxacin, or cefotaxime.

Alternative

Conjunctivitis caused by gonococcal and chlamydial infection usually requires conventional medical treatment. With bacterial, viral, and allergic conjunctivitis, however, alternative options can be helpful. Internal immune enhancement with supplementation can aid in the resolution of bacterial and viral conjunctivitis. Removal of the allergic agent is an essential step in treating allergic conjunctivitis. As with any of the recommended treatments, however, if no improvement is seen within 48–72 hours, a physician should be consulted.

There are a number of acute homeopathic remedies designed to treat conjunctivitis. These include *Pulsatilla* (windflower, *Pulsatilla nigricans*), *Belladonna*, and eyebright (*Euphrasia officinalis*). Eye drops prepared with homeopathic remedies and/or herbs can be a good substitute for pharmaceutical eye drops. Eye washes can also be made. Herbal eyewashes made with eyebright (1 tsp. dried herb steeped in 1 pint of boiling water) or chamomile (*Matricaria recutita*; 2–3 tsp. in 1 pint of boiling water) may be helpful. Eyewashes should be strained and cooled before use, and close attention should be paid to make sure that any solution put into the eye is sterile.

Home remedies

Several simple home remedies may help relieve the discomfort associated with conjunctivitis. A boric acid eyewash can be used to clean and soothe the eyes. A warm compress applied to the eyes for 5–10 minutes three times a day can help relieve the discomfort of bacterial and viral conjunctivitis. A cool compress or cool, damp tea bags placed on the eyes can ease the discomfort of allergic conjunctivitis.

Prognosis

If treated properly, the prognosis for conjunctivitis in adults and older children is good. Conjunctivitis caused by an allergic reaction should clear up once the allergen is removed. Allergic conjunctivitis will likely recur if the individual again comes into contact with the particular allergen. Conjunctivitis caused by bacteria or a virus, if treated properly, is usually resolved in 10–14 days. If there is no relief of symptoms in 48–72 hours, or there is moderate to severe eye **pain**, changes in vision, or the conjunctivitis is suspected to be caused by herpes simplex, a physician should be notified immediately. If untreated or if treatment fails and is not corrected, conjunctivitis may cause **visual impairment** by spreading to other parts of the eye, such as the cornea.

Untreated conjunctivitis in newborns caused by sexually transmitted diseases can lead to blindness. A century ago, as many as 24% of American children enrolled in schools for the blind had lost their sight as a result of gonorrheal conjunctivitis.

Prevention

The American Academy of Ophthalmology recommends the following preventive measures to lower the risk of conjunctivitis:

- Wash hands frequently using antiseptic soap, and use single-use towels during the disease to prevent spreading the infection. People with viral conjunctivitis can spread the disease to others for as long as two weeks after symptoms appear.
- Avoid chemical irritants and known allergens; handle strong detergents, drain cleaners, ammonia, chlorine bleach, and other household chemicals with care.
- If in an area where welding occurs, using the proper protective eye wear and screens to prevent damaging the eyes.

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- Use a clean tissue to remove discharge from eyes.
- If medication is prescribed, finish the course of antibiotics as directed to make sure that the infection is cleared up and does not recur.
- Avoid such contact as vigorous physical activities with other persons until symptoms resolve; in particular, stay away from swimming pools.
- Women who use mascara and other eye cosmetics should replace them frequently and not share them with others.
- Avoid sharing pillowcases and bath towels.
- Clean contact lenses carefully and properly.

Chlamydial or bacterial conjunctivitis of the newborn can be avoided by treating the mother for sexually transmitted diseases before delivery; by delivering the baby by **cesarean section**; and by placing an antibiotic ointment in the baby's eyes as soon as possible after delivery.

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ORGANIZATIONS

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Consciousness disorders *see* **Coma**

Constipation

Definition

Constipation is difficulty in producing a bowel movement or infrequent, hard, dry stools that are painful or difficult to pass.

Demographics

Constipation is one of the most common medical complaints in the United States. About 2% of Americans describe being constipated continuously or frequently. Internationally, the incidence of constipation varies, depending largely on dietary habits.

Constipation can occur at any age, and is more common among individuals who resist the urge to move their bowels at their body's signal. This often happens when children start school or enter daycare and feel shy about asking permission to use the

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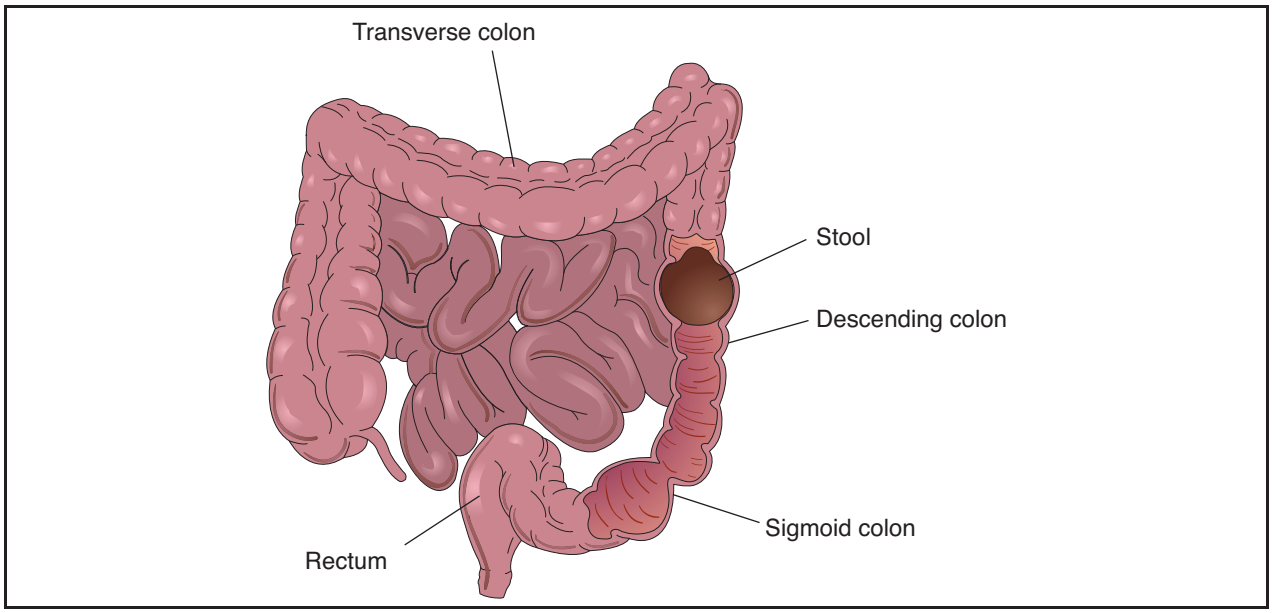

Constipation is an acute or chronic condition in which bowel movements occur less often than usual or consist of hard, dry stools that are painful or difficult to pass. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

bathroom. It also can happen to adults who are in jobs where they cannot take bathroom breaks at will.

Constipation is more common in women than in men and is especially likely to occur during **pregnancy**. Age alone does not increase the frequency of constipation, but people over age 65, especially women, are more likely to experience constipation.

Description

Bowel habits vary, but an adult who has not had a bowel movement in three days or a child who has not had a bowel movement in four days is considered constipated.

Although constipation is rarely serious, it can lead to:

- bowel obstruction
- chronic constipation
- hemorrhoids (a mass of dilated veins in swollen tissue around the anus)
- hernia (a protrusion of an organ through a tear in the muscle wall)
- spastic colitis (irritable bowel syndrome, a condition characterized by alternating periods of diarrhea and constipation)
- laxative dependency

Chronic constipation may be a symptom of other diseases such as colorectal **cancer**, depression, diabetes, **diverticulosis** (small pouches in the muscles of the large intestine), **lead poisoning**, or Parkinson's disease.

In someone who is elderly or disabled, constipation may be a symptom of bowel impaction, a more serious condition in which feces are trapped in the lower part of the large intestine. A doctor should be called if an elderly or disabled person is constipated for a week or more or if a child seems to be constipated.

A doctor should be notified whenever constipation occurs after starting a new prescription, vitamin, or mineral supplement or herbal remedy or when constipation is accompanied by blood in the stools, changes in bowel patterns, **fever**, or abdominal **pain**.

Causes and symptoms

Constipation usually results from not getting enough **exercise**, not drinking enough water, or from a diet that does not include an adequate amount of fiber-rich foods such as dried beans, bran cereals, fruits, raw vegetables, rice, and whole-grain breads.

Other causes of constipation include anal fissure (a tear or crack in the lining of the anus); **chronic kidney failure**; colon or **rectal cancer**; depression; **hypercalcemia** (abnormally high levels of **calcium** in the blood); **hypothyroidism** (underactive thyroid gland); illness requiring complete bed rest; **irritable bowel syndrome**; and **stress**.

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KEY TERMS

Beta blocker—An anti-hypertensive (blood pressure-lowering) drug that limits the activity of epinephrine, a hormone that increases blood pressure.

Calcium channel blocker—A drug that lowers blood pressure by regulating calcium-related electrical activity in the heart.

Diverticulitis—A condition of the diverticulum of the intestinal tract, especially in the colon, where inflammation may cause distended sacs extending from the colon and pain.

Constipation also can be a side effect of various medications including:

- aluminum salts in antacids
- antihistamines
- antipsychotic drugs
- aspirin
- belladonna (*Atopa belladonna,* source of atropine, a medication used to relieve spasms and dilate the pupils of the eye)
- beta blockers (medications used to stabilize irregular heartbeat, lower high blood pressure, reduce chest pain)
- blood pressure medications
- calcium channel blockers (medication prescribed to treat high blood pressure, chest pain, some types of irregular heartbeat and stroke, and some non-cardiac diseases)
- diuretics (drugs that promote the formation and secretion of urine)
- iron or calcium supplements
- narcotics (potentially addictive drugs that relieve pain and cause mood changes)
- tricyclic antidepressants (medications prescribed to treat chronic pain, depression, headaches, and other illnesses)

An adult who is constipated may feel bloated, have a **headache**, swollen abdomen, or pass rock-like feces; or strain, bleed, or feel pain during bowel movements. A constipated baby may strain, cry, draw the legs toward the abdomen, or arch the back when having a bowel movement.

Diagnosis

Everyone becomes constipated once in a while, but a doctor should be notified if significant changes in bowel patterns last for more than a week or if symptoms continue more than three weeks after increasing activity and fiber and fluid intake.

Examination

The patient's observations and medical history help a primary care physician diagnose constipation. The doctor uses his fingers to see if there is a hardened mass in the abdomen, and may perform a **rectal examination**.

Physical and psychological assessments and a detailed history of bowel habits are especially important when an elderly person complains of constipation.

Tests

Diagnostic procedures may include a **barium enema**, which reveals blockage inside the intestine; laboratory analysis of blood and stool samples for internal bleeding or other symptoms of systemic disease; and a **sigmoidoscopy** (examination of the sigmoid area of the colon with a flexible tube equipped with a magnifying lens).

Treatment

If changes in diet and activity fail to relieve occasional constipation, an over-the-counter laxative may be used for a few days. Preparations that soften stools or add bulk (bran, psyllium) work more slowly but are safer than Epsom salts and other harsh **laxatives** or herbal laxatives containing senna (*Cassia senna*) or buckthorn (*Rhamnus purshianna*), which can harm the nerves and lining of the colon.

Fiber supplements containing psyllium (*Plantago psyllium*) usually become effective within about 48 hours and can be used every day without causing dependency. Powdered flaxseed (*Linium usitatissimum*) works the same way. Insoluble fiber, like wheat or oat bran, is as effective as psyllium but may give the patient gas at first.

A woman who is pregnant should never use a laxative without consulting her doctor. Neither should anyone who is experiencing abdominal pain, **nausea**, or **vomiting**.

A warm-water or mineral oil enema can relieve constipation, and a non-digestible sugar (lactulose) or special electrolyte solution is recommended for adults and older children with stubborn symptoms.

If a patient has an impacted bowel, the doctor inserts a gloved finger into the rectum and gently dislodges the hardened feces.

Alternative treatment

Initially, alternative practitioners will suggest that the patient drink an adequate amount of water each

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day (six to eight glasses), exercise on a regular basis, and eat a diet high in soluble and insoluble fibers. Soluble fibers include pectin, flax, and gums; insoluble fibers include psyllium and brans from grains like wheat and oats. Fresh fruits and vegetables contain both soluble and insoluble fibers. Castor oil, applied topically to the abdomen and covered by a heat source (a heating pad or hot water bottle), can help relieve constipation when used nightly for 20–30 minutes.

ACUPRESSURE. This needleless form of **acupuncture** is said to relax the abdomen, ease discomfort, and stimulate regular bowel movements when diet and exercise fail to do so. After lying down, the patient closes his eyes and takes a deep breath. For two minutes, he applies gentle fingertip pressure to a point about two and one-half inches below the navel.

Acupressure can also be applied to the outer edges of one elbow crease and maintained for 30 seconds before pressing the crease of the other elbow. This should be done three times a day to relieve constipation.

AROMATHERAPY. Six drops of rosemary (*Rosmarinus officinalis*) and six drops of thyme (*Thymus* spp.) diluted by 1 oz of almond oil, olive oil, or another carrier oil can relieve constipation when used to massage the abdomen.

HERBAL THERAPY. A variety of herbal therapies can be useful in the treatment of constipation. Several herbs, including chamomile (*Matricaria recutita*), dandelion (*Taraxacum mongolicum*), and burdock (*Arctium lappa*), act as bitters, stimulating the movement of the digestive and excretory systems. There are also "laxative" herbs that assist with bowel movement. Two of these are senna (*Cassia senna*) and buckthorn (*Rhamnus purshiana*). These laxative-like herbs are stronger acting on elimination than bitters and can sometimes cause cramping (mixing them with a calming herb like fennel or caraway can help reduce cramping). Both senna and buckthorn are powerful herbs that are best used with direction from an experienced practitioner, since they can have adverse side effects and the patient may become dependent on them.

HOMEOPATHY. Homeopathy also can offer assistance with constipation. There are acute remedies for constipation that can be found in one of the many home remedy books on **homeopathic medicine**. A constitutional prescription can help rebalance someone who is struggling with constipation.

MASSAGE. Massaging the leg from knee to hip in the morning, at night, and before trying to move the bowels is said to relieve constipation. There is also a specific Swedish massage technique that can help relieve constipation.

YOGA. The knee-chest position, said to relieve gas and stimulate abdominal organs, involves:

- standing straight with arms at the sides
- lifting the right knee toward the chest
- grasping the right ankle with the left hand
- pulling the leg as close to the chest as possible
- holding the position for about eight seconds
- repeating these steps with the left leg

The cobra position, which can be repeated as many as four time a day, involves:

- lying on the stomach with legs together
- placing the palms just below the shoulders, holding elbows close to the body
- inhaling, then lifting the head (face forward) and chest off the floor
- keeping the navel in contact with the floor
- looking as far upward as possible
- holding this position for three to six seconds
- exhaling and lowering the chest

Prognosis

Changes in diet and exercise usually eliminate constipation.

Prevention

Most Americans consume between 11–18 g of fiber a day. Consumption of 35 g of fiber (an amount equal to five servings of fruits and vegetables, and a large bowl of high-fiber cereal) and between six and eight glasses of water each day can generally prevent constipation.

Daily use of 500 mg vitamin C and 400 mg magnesium may help to prevent constipation. Sitting on the toilet for 10 minutes at the same time every day, preferably after a meal, can induce regular bowel movements. This may not become effective for a few months, and it is important to defecate whenever necessary

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ORGANIZATIONS

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International Foundation for Functional Gastrointestinal Disorders, P.O. Box 170864, Milwaukee, WI 53217-8076, (414) 964-1799, (888) 964-2001, (414) 964-7176, iffgd@iffgd.org, http://www.iffgd.org.
National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), 2 Information Way, Bethesda, MD, 20892, (800) 891-5389. TTY: (866) 569-1162, nddic@niddk.nih.gov, http://digestive.niddk.nih.gov.

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Constitutional homeopathic remedies *see* **Homeopathic remedies, constitutional prescribing**

Consumption *see* **Tuberculosis**

Contact dermatitis

Definition

Contact **dermatitis** is the name for any skin inflammation that occurs when the skin's surface comes in contact with a substance originating outside the body. There are two kinds of contact dermatitis, irritant and allergic.

Demographics

At any given time in the United States, 2% of the population will have contact dermatitis. This condition accounts for between 4% and 7% of all visits to the dermatologist. Women are twice as likely as men to develop contact dermatitis, and are at highest risk immediately after giving birth.

The abdomen of a male patient afflicted with contact dermatitis, triggered by an allergic reaction to a nickel belt buckle. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Description

Contact dermatitis is a skin irritation that manifests as a rash. Thousands of natural and man-made substances can cause contact dermatitis, which is the most common skin condition requiring medical attention and the foremost source of work-related disease.

Risk factors

Florists, domestic workers, hairdressers, food preparers, and employees in industry, construction, and health care are the people most at risk of contracting work-related contact dermatitis.

Causes and symptoms

Irritant contact dermatitis (ICD) is the more commonly reported of the two kinds of contact dermatitis, and is seen in about 80% of cases. It can be caused by soaps, detergents, solvents, adhesives, fiberglass, and other substances that are able to directly injure the skin. Most attacks are slight and confined to the hands and forearms, but can affect any part of the body that comes in contact with an irritating substance. The symptoms can take many forms: redness, **itching**, crusting, swelling, blistering, oozing, dryness, scaliness, thickening of the skin, and a feeling of

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KEY TERMS

Allergen—A foreign substance that causes an allergic reaction in some sensitive people but not in most others.

Antibiotics—Substances used against microorganisms that cause infection.

Corticosteroids—A group of anti-inflammatory substances often used to treat skin conditions.

Immune response—The protective reaction by the immune system against foreign antigens (substances that the body perceives as potentially dangerous). The immune system combats disease by neutralizing or destroying antigens.

warmth at the site of contact. In extreme cases, severe blistering can occur and open sores can form. Jobs that require frequent skin exposure to water, such as hairdressing and food preparation, can make the skin more susceptible to ICD.

Allergic contact dermatitis (ACD) results when repeated exposure to an allergen (an allergy-causing substance) triggers an immune response that inflames the skin. Tens of thousands of drugs, pesticides, cosmetics, food additives, commercial chemicals, and other substances have been identified as potential allergens. Fewer than 30, however, are responsible the majority of ACD cases. Common culprits include **poison ivy**, **poison oak**, and poison sumac; fragrances and preservatives in cosmetics and personal care products; latex items such as gloves and **condoms**; and formaldehyde. Many people find that they are allergic to the nickel in inexpensive jewelry. ACD is usually confined to the area of skin that comes in contact with the allergen, typically the hands or face. Symptoms range from mild to severe and resemble those of ICD; a patch test may be needed to determine which kind of contact dermatitis a person is experiencing.

Diagnosis

Examination

Diagnosis begins with a **physical examination** and asking the patient questions about his or her health and daily activities. When contact dermatitis is suspected, the doctor attempts to learn as much as possible about the patient's hobbies, workplace duties, use of medications and cosmetics, etc.–anything that might shed light on the source of the disease. In some cases, an examination of the home or workplace is undertaken. If the dermatitis is mild, responds well to treatment, and does not recur, ordinarily the investigation is at an end. More difficult cases require patch testing to identify the allergen.

Tests

Patch testing is used to rule out ICD and determine which substances cause an allergic reaction. Most of the TRUE test is used, as it allows testing of multiple substances. A small amount of various diluted chemicals are applied to the skin and covered for two days. Forty-eight hours later, the covering is removed and the doctor examines the patch areas for a reaction. The area is examined again at 72 hours and in one week. Identifying the allergen may require repeated testing. If the TRUE test chemicals do not cause a reaction, additional specialized testing may be required. Patch testing works only with ACD, although it is considered an essential step in ruling out ICD.

Treatment

Traditional

The best treatment for contact dermatitis is to identify the allergen or irritating substance and avoid further contact with it. If the culprit is, for instance, a cosmetic, avoidance is a simple matter, but in some situations, such as an allergy to an essential workplace chemical for which no substitute can be found, avoidance may be impossible or force the sufferer to find new work or make other drastic changes in his or her life. Barrier creams and protective clothing such as gloves, masks, and long-sleeved shirts are ways of coping with contact dermatitis when avoidance is impossible, though they are not always effective.

For the symptoms themselves, treatments in mild cases include cool compresses and nonprescription lotions and ointments. When the symptoms are severe, **corticosteroids** applied to the skin or taken orally are used. Contact dermatitis that leads to a bacterial skin infection is treated with **antibiotics**.

Alternative treatment

Herbal remedies have been used for centuries to treat skin disorders including contact dermatitis. An experienced herbalist can recommend the remedies that will be most effective for an individual's condition. Among the herbs often recommended are:

- burdock (*Arctium lappa*) minimizes inflammation and boosts the immune system. It is taken internally

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as a tea or tincture (a concentrated herbal extract prepared with alcohol).

- calendula (*Calendula officinalis*) is a natural antiseptic and anti-inflammatory agent. It is applied topically in a lotion, ointment, or oil to the affected area.
- aloe (*Aloe barbadensis*) soothes skin irritations. The gel is applied topically to the affected area.

A homeopath treating a patient with contact dermatitis will do a thorough investigation of the individual's history and exposures before prescribing a remedy. One homeopathic remedy commonly prescribed to relieve the itching associated with contact dermatitis is *Rhus toxicodendron* taken internally three to four times daily.

Poison ivy, poison oak, and poison sumac are common culprits in cases of allergic contact dermatitis. Following exposure to these plants, rash development may be prevented by washing the area with soap and water within 15 minutes of exposure. The leaves of jewelweed (*Impatiens* spp.), which often grows near poison ivy, may neutralize the poison-ivy allergen if rubbed on the skin right after contact. Several topical remedies may help relieve the itching associated with allergic contact dermatitis, including the juice of plantain leaves (*Plantago major*); a paste made of equal parts of green clay and goldenseal root (*Hydrastis canadensis*); a paste made of salt, water, clay, and peppermint (*Mentha piperita*) oil; and calamine lotion.

Prognosis

If the offending substance is promptly identified and avoided, the chances of a quick and complete recovery are excellent. Otherwise, symptom management—not cure—is the best doctors can offer. For some people, contact dermatitis becomes a chronic and disabling condition that can have a profound effect on employability and quality of life.

Prevention

Avoidance of known or suspected allergens or irritating substances is the best prevention. If avoidance is difficult, barrier creams and protective clothing can be tried. Skin that comes in contact with an offending substance should be thoroughly washed as soon as possible.

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ORGANIZATIONS

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Contact lenses *see* **Eye glasses and contact lenses**

Continent urinary diversion *see* **Urinary diversion surgery**

Continuous ambulatory electrocardiography *see* **Holter monitoring**

Continuous positive airway *see* **Inhalation therapies**

Contraception

Definition

Contraception (birth control) prevents **pregnancy** by interfering with the normal process of ovulation, fertilization, and implantation. There are different kinds of birth control that act at different points in the process.

Purpose

Every month, a woman's body begins the process that can potentially lead to pregnancy. An egg (ovum) matures, the mucus that is secreted by the cervix (a cylindrical-shaped organ at the lower end of the uterus) changes to be more inviting to sperm, and the lining of the uterus grows in preparation for receiving a fertilized egg. Any woman who wants to prevent pregnancy must use a reliable form of birth control.

Birth control (contraception) is designed to interfere with the normal process and prevent the pregnancy that could result. There are different kinds of birth control that act at different points in the process, from

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Effectiveness of contraceptives: Percentage of women experiencing an unintended pregnancy within first year of typical[1] and perfect[2] contraceptive use

Form of birth control	Typical use	Perfect use
Birth control pills	8.0%	0.3%
Condom, female	21.0%	5.0%
Condom, male	15.0%	2.0%
Depo-Provera® (injection)	3.0%	0.3%
Diaphragm	16.0%	6.0%
Intrauterine devices (IUDs)	0.8%	0.6%
Spermicides	29.0%	18.0%

[1]Effectiveness based on average or typical usage.
[2]Effectiveness based on perfect or correct usage.

SOURCE: Centers for Disease Control and Prevention, "U.S. Medical Eligibility Criteria for Contraceptive Use, 2010," *Morbidity and Mortality Weekly Report*, vol. 59 (May 28, 2010). Available online at: http://www.cdc.gov/mmwr/pdf/rr/rr59e0528.pdf (accessed August 18, 2010).

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ovulation, through fertilization, to implantation. Each method has its own side effects and risks. Some methods are more reliable than others.

There are more different types of birth control available today than ever. They can be divided into a few groups based on how they work. These groups include:

- Hormonal methods—These use medications (hormones) to prevent ovulation. Hormonal methods include birth control pills (oral contraceptives), Depo Provera injections, and Norplant.
- Barrier methods—These methods work by preventing the sperm from getting to and fertilizing the egg. Barrier methods include the condom, diaphragm, and cervical cap. The condom is the only form of birth control that also protects against sexually transmitted diseases, including HIV (the virus that causes AIDS).
- Spermicides—These medications kill sperm on contact. Most spermicides contain nonoxynyl-9. Spermicides come in many different forms such as jelly, foam, tablets, and even a transparent film. All are placed in the vagina. Spermicides work best when they are used at the same time as a barrier method.
- Intrauterine devices—Intrauterine contraceptive devices (IUDs) are inserted into the uterus, where they stay from one to 10 years. An IUD prevents the fertilized egg from implanting in the lining of the uterus, and may have other effects as well.
- Tubal sterilization—Tubal sterilization is a permanent form of contraception for women. Each fallopian tube is either tied or burned closed. The sperm cannot reach the egg, and the egg cannot travel to the uterus.
- Vasectomy—is the male form of sterilization, and should also be considered permanent. In vasectomy, the vas defrens, the tiny tubes that carry the sperm into the semen, are cut and tied off. Thus, no sperm can get into the semen.
- A newer and somewhat controversial form of birth control is emergency contraception. This type is used after unprotected intercourse and sometimes is referred to as the "morning-after pill."

Unfortunately, there is no perfect form of birth control. Only abstinence (not having sexual intercourse) can protect against unwanted pregnancy with 100% reliability. The failure rates, which means the rates of pregnancy, for most forms of birth control are quite low. However, some forms of birth control are more difficult or inconvenient to use than others. In actual practice, the birth control methods that are more difficult or inconvenient have much higher failure rates because they are not used regularly or as prescribed.

Description

Most forms of birth control have one thing in common. They are only effective if used faithfully. Birth control pills will work only if taken every day; the diaphragm is effective only if used during every episode of sexual intercourse. The same is true for **condoms** and the cervical cap. Some methods automatically work every day. These methods include Depo Provera, Norplant, the **IUD**, and tubal sterilization.

There are many different ways to use birth control. They can be divided into several groups:

- By mouth (oral)—Birth control pills must be taken by mouth every day.
- Injected—Depo Provera is a hormonal medication that is given by injection every three months.
- Implanted—Norplant is a long-acting hormonal form of birth control that is implanted under the skin of the upper arm.
- Vaginal—Spermicides and barrier methods work in the vagina.
- Intrauterine—The IUD is inserted into the uterus.

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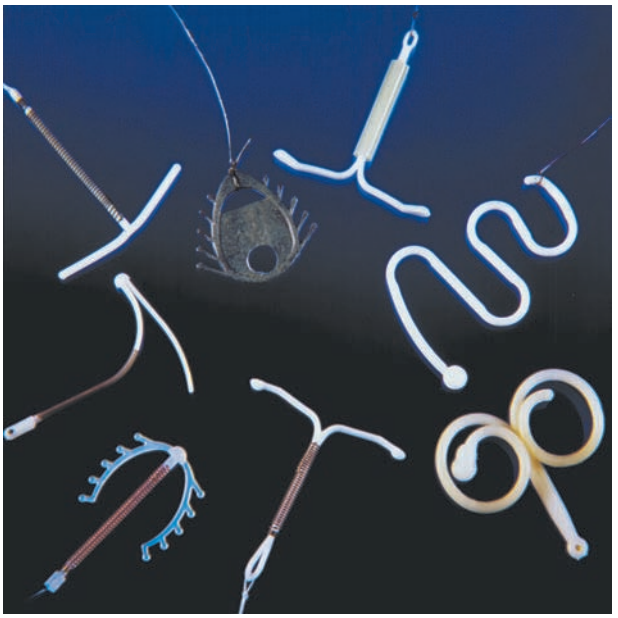

A variety of intrauterine contraceptive devices. The probability of a pregnancy for year of use is about 2 to 3%. IUDs made with copper coils should be replaced every 3 to 5 years. *(Photo Researchers, Inc.)*

Various forms of contraception. *(Charles Thatcher/Stone/Getty Images.)*

- Surgical—Tubal sterilization is a form of surgery. A doctor must perform the procedure in a hospital or surgical clinic. Many women need general anesthesia.

The methods of birth control differ from each other in the timing of when they are used. Some methods of birth control must be used specifically at the time of sexual intercourse (condoms, diaphragm, cervical cap, spermicides). **Emergency contraception** must be started as soon as possible after intercourse and no more than 72 hours after. All other methods of birth control (hormonal methods, IUDs, tubal sterilization) must be working all the time to provide protection.

Precautions

There are risks associated with certain forms of birth control. Some of the risks of each method appear in the following list:

- Birth control pills—The hormone (estrogen) in birth control pills can increase the risk of heart attack in women over 35, particularly those who smoke. Certain women cannot use birth control pills.
- IUD—The IUD can increase the risk of serious pelvic infection. The IUD can also injure the uterus by poking into or through the uterine wall. Surgery might be needed to fix this.
- Tubal sterilization—"Tying the tubes" is a surgical procedure and has all the risks of any other surgery, including those associated with anesthesia, as well as infection and bleeding.
- Emergency contraceptive pills should not be used regularly for birth control. They can interrupt the menstrual cycle and are not 100% effective. If the emergency contraception fails, an ectopic pregnancy can occur.

Preparation

No specific preparation is needed before using contraception. However, a woman must be sure that she is not already pregnant before using a hormonal method or having an IUD placed.

Aftercare

No aftercare is needed.

Risks

Many methods of birth control have side effects. Knowing the side effects can help a woman to determine which method of birth control is right for her.

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KEY TERMS

Fallopian tubes—The thin tubes that connect the ovary to the uterus. Ova (eggs) travel from the ovary to the uterus. If the egg has been fertilized, it can implant in the uterus.

Fertilization—The joining of the sperm and the egg; conception.

Implantation—The process in which the fertilized egg embeds itself in the wall of the uterus.

Ovulation—The release of an egg (ovum) from the ovary.

- Hormonal methods—The hormones in birth control pills, Depo Provera, and Norplant can cause changes in menstrual periods, changes in mood, weight gain, acne, and headaches. In addition, it may take many months to begin ovulating again once a woman stops using Depo Provera or Norplant.
- Barrier methods—A woman must insert the diaphragm in just the right way to be sure that it works properly. Some women get more urinary tract infections if they use a diaphragm. This is because the diaphragm can press against the urethra, the tube that connects the bladder to the outside.
- Spermicides—Some women and men are allergic to spermicides or find them irritating to the skin.
- IUD—The IUD is a foreign body that stays inside the uterus, and the uterus tries to get it out. A woman may have heavier menstrual periods and more menstrual cramping with an IUD in place.
- Tubal sterilization—Some women report increased menstrual discomfort after tubal ligation. It is not known if this is related to the tubal ligation itself.

There is no perfect form of birth control. Every method has a small failure rate and side effects. Some methods carry additional risks. However, every method of birth control can be effective if used properly.

Resources

PERIODICALS

"Contraception; Overview." *NWHRC Health Center – Contraception*. March 9, 2004.

"Ectopic Pregnancy Is a Possibility When Emergency Contraception Fails." *Health & Medicine Week* March 15, 2004: 222.

Amy B. Tuteur, MD
Teresa G. Odle

Contractures

Definition

Contractures are the chronic loss of joint motion due to structural changes in non-bony tissue. These non-bony tissues include muscles, ligaments, and tendons.

Description

Contractures can occur at any joint of the body. This joint dysfunction may be a result of **immobilization** from injury or disease; nerve injury, such as spinal cord damage and **stroke**; or muscle, tendon, or ligament disease.

Causes and symptoms

There are a number of pathologies and diseases that can lead to joint contractures. The primary causes resulting in a joint contraction are muscle imbalance, **pain**, prolonged bed rest, and immobilization. Because of the frequency of **fractures** and surgery, immobilization is the most frequent cause of joint contractures. Symptoms include a significant loss of motion to any specific joint that results in immobility. If the contracture is of a significant degree, pain can result even without any voluntary joint movement.

Diagnosis

Manual testing of joint mobility by a healthcare professional skilled in joint mobilization techniques (e.g., a physical therapist) will identify indications of restricted structures within the joint. Measuring the motion of the joint with a device termed a "goniometer" can be useful if the decrease of motion can be shown to be a proven result of a joint contracture. X rays can be of some benefit in the diagnosis of contractures, because a visible decrease in joint space may indicate a tight, contracted joint. Most physicians will make the diagnosis after a thorough **physical examination** involving physical and manual testing of the joint motion.

Treatment

Manual techniques

Joint mobilization and stretching of soft tissues is a common technique used to increase joint elasticity. Structures are stretched in similar directions to those which take place upon normal joint motion. Some healthcare professionals may use some form of heat prior to the stretching and mobilization. If appropriate,

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exercise may follow manual techniques to help maintain the additional motion achieved.

Mechanical techniques

Devices known as continuous passive motion machines are very popular, especially following surgery of joints. Continuous passive motion machines (CPM) are specifically adjusted to each individual's need. This method is administered within the first 24–72 hours after the injury or surgery. The joint is mechanically moved through the patient's tolerable motion. CPM machines have been proved to accelerate the return motion process, allowing patients more function in less time.

Casting or splinting

Casting or splinting techniques are used to provide a constant stretch to the soft tissues surrounding a joint. It is most effective when used to increase motion of a joint from prolonged immobilization. It is also popular for treating contractures resulting from an increase in muscle tone from nerve injury. After an initial holding cast is applied for 7 to 10 days, a series of positional casts are applied at weekly intervals. Before the application of each new cast, the joint is moved as much as can be tolerated by the patient, and measured by a goniometer. When as much motion as possible is obtained after stretching, another final cast is applied to maintain the newly acquired motion.

Surgery

In some cases, the contracture may be severe and not respond to conservative treatment. In this event, manipulation of the joint under a **general anesthesia** may be necessary.

Alternative treatment

In some areas of the body, **chiropractic** techniques have been found to be useful to improve motion. **Massage therapy** can be beneficial by promoting additional circulation to joint structures, causing better elasticity. **Yoga** can help prevent as well as rehabilitate a contracture and can facilitate the return of joint mobility.

Prognosis

Prognosis of contractures will depend upon the cause of the contracture. In general, the earlier the treatment for the contracture begins, the better the prognosis.

KEY TERMS

Mobilization—Making movable, restoring the power of motion in a joint. Movement which increases joint mobility.

Muscle tone—Also termed tonus; the normal state of balanced tension in the tissues of the body, especially the muscles.

Prevention

Prevention of contractures and deformities from **spinal cord injury**, fracture, and immobilization is achieved through a program of positioning, splinting if appropriate, and range-of-motion exercises either manually or mechanically aided. These activities should be started as early as possible for optimal results.

ORGANIZATIONS

American College of Rheumatology, 2200 Lake Boulevard NE, Atlanta, GA, 30319, (404) 633-3777, (404) 633-1870, acr@rheumatology.org, http://www.rheumatology.org/.

American Physical Therapy Association, 1111 North Fairfax St., Alexandria, VA, 22314-1488, (703) 684-2782, (703) 684-7343, (800) 999-2782, http://www.apta.org/.

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Conversion disorder *see* **Somatoform disorders**

Cooley's anemia *see* **Thalassemia**

Cooling treatments

Definition

Cooling treatments lower body temperature in order to relieve **pain**, swelling, constriction of blood vessels, and to decrease the liklihood of cellular damage by slowing the metabolism. Sponge baths, cold compresses, and cold packs are all wet cooling treatments. Dry treatments, such as ice bags and chemical cold packs, are also used to lower body temperature.

Purpose

The most common reason for cooling a body is **fever** or hyperthermia (extremely high fever). The body can sustain temperatures up to 104°F (40°C) with relative safety; however, when temperatures rise above 104°F (40°C), damage to the brain, muscles, blood,

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and kidneys is increasingly likely. Cooling treatments are also applied immediately following sprains, **bruises**, **burns**, eye injuries, and **muscle spasms** to help alleviate the resulting swelling, pain, and discoloration of the skin.

Cooling treatments slow chemical reactions within the body. For this reason, cooling tissues below normal temperature (98.6°F/37°C) can prevent injury from inadequate oxygen or **nutrition**. Cold water drowning victims suffering from **hypothermia** (cooling of the body below its normal temperature) have been successfully resuscitated after long periods underwater without medical complications because of this effect. For the past 40 years, heart surgeons have been experimenting with hypothermia to protect tissues from lack of blood circulation during an operation. Neurosurgeons are also working with hypothermia to protect the very sensitive brain tissues during periods of absent or reduced blood flow.

Description

Depending on the medical need, various cooling methods are used.

- Cold packs and ice bags are placed on a localized site and provide topical relief. These compresses should be covered with a waterproof material to protect the skin. Repeated treatments produce the desired pain and swelling relief.
- Cold treatments are placed on the groin and under the arms to treat hyperthermia. Treatments are refreshed periodically until the appropriate temperature is attained.
- A tepid sponge bath relieves fever without cooling the body too fast. Eighty degrees Fahrenheit is still 20°F below body temperature and yet warm enough not to drive blood from the skin, thereby preventing the cooling from getting to the body's core. Limbs are bathed first and then the chest, abdomen, back, and buttocks.
- Perfusion of isolated regions like the brain by using cooled blood is an experimental treatment, offering promising results for the treatment of stroke.

Preparation

Topical treatments are prepared with ice, cold water (59°F/15°C), and chemical cold packs. Tepid baths should be 80–93°F (26.7–34°C).

Risks

Small children, adults with circulation problems, and the elderly are all at risk of tissue damage. Rapid cooling causes chills, which in effect raise the body's temperature by raising its metabolism. **Blood clots** may form from thickened blood caused by the temperature change.

Resources

PERIODICALS

Plattner, O., et al. "Efficacy of Intraoperative Cooling Methods." *Anesthesiology* 87 (November 1997): 1089-1095.

J. Ricker Polsdorfer, MD

Coombs' tests

Definition

Coombs' tests are blood tests that identify the causes of anemia.

Purpose

Anemia, which literally means no blood, refers to blood with abnormally low oxygen-carrying capacity. The hemoglobin in red blood cells carries oxygen. One of the many causes of anemia is destruction of red blood cells, a process called hemolysis (*hemo* means blood and *lysis* means disintegration). A simple blood count detects anemia. Even the test done before a **blood donation** can identify anemia. To detect hemolysis requires other tests. The Coombs' tests are conducted in order to determine the cause of anemia.

One characteristic of hemolysis is the autoimmune response against the body's red blood cells. Instead of protecting the body from outside agents, the immune system attacks parts of its own body with a deluge of antibodies. Autoimmunity is thought to be the cause of many collagen-vascular diseases, including **rheumatoid arthritis** and **systemic lupus erythematosus**. It is also the cause of the autoimmune hemolytic **anemias**. The Coombs' tests detect the antibodies responsible for the destruction of the red blood cells.

Causes of autoimmune **hemolytic anemia** include:

- drugs such as penicillin, methyldopa (lowers blood pressure), and quinidine (treats heart rhythm disturbances)
- cancers of the lymph system–Hodgkin's disease and lymphomas
- virus infections
- collagen-vascular diseases
- mismatched blood transfusions
- Rh incompatibility between a mother and fetus. (erythroblastosis fetalis)

Many times the cause cannot be identified.

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KEY TERMS

Anemia—Reduced oxygen-carrying capacity of the blood, due to too little hemoglobin or too few red blood cells.

Antibody—A protein made by the immune system and used as a weapon against foreign invaders in the body.

Antigen—The chemical that stimulates an immune response.

Collagen-vascular disease—Various diseases inflaming and destroying connective tissue.

Hematologist—Physician who specializes in diseases of the blood.

Hemoglobin—The red pigment in blood that carries oxygen.

Hemolysis—Breaking apart red blood cells.

Rh—A blood typing group, like the ABO system. When a mother is Rh negative and her baby is Rh positive, she may develop antibodies to the baby's blood that will cause it to hemolyze.

Description

There are two Coombs' tests. A direct Coombs' test detects the two different antigens that might induce hemolysis in the patient's red blood cells. An indirect Coombs' test looks for antibodies to someone else's red blood cells in the patient's serum (the blood without the cells). Combining the two tests gives clues to the origin of the hemolysis.

Preparation

No preparation is needed for this test. It will probably be among the second or third set of blood tests done after anemia is diagnosed and there is a suspicion that its cause is hemolysis.

Aftercare

Coombs' tests are done on blood that is drawn from the arm.

Risks

Taking blood for testing is the most common medical procedure performed. The worst complication is a bruise at the site of the puncture or punctures. It is extremely rare for the needle to injure an important structure such as an artery or a nerve.

Normal results

If the Coombs' tests are negative, the anemia is unlikely to be autoimmune, and the hematologist will have to search elsewhere for a cause.

Abnormal results

If the test is positive, the antigens that react will narrow the search for a cause. Coombs' tests are also done for blood **transfusion** reactions to determine why the transfused blood did not match, and when there is a chance a newborn may have an Rh problem.

Resources

BOOKS

Fauci, Anthony S., et al., eds. *Harrison's Principles of Internal Medicine*. 17th ed. New York: McGraw–Hill Professional, 2008.

J. Ricker Polsdorfer, MD

Coordination tests *see* **Balance and coordination tests**

COPD *see* **Emphysema; Chronic obstructive pulmonary disease**

Copper deficiency *see* **Mineral deficiency**

Copper excess *see* **Wilson's disease**

Cor pulmonale

Definition

Cor pulmonale is an increase in bulk of the right ventricle of the heart, generally caused by chronic diseases or malfunction of the lungs. This condition can lead to **heart failure**.

Description

Cor pulmonale, or pulmonary heart disease, occurs in 25% of patients with **chronic obstructive pulmonary disease** (COPD). In fact, about 85% of patients diagnosed with cor pulmonale have COPD. Chronic **bronchitis** and **emphysema** are types of COPD. High blood pressure in the blood vessels of the lungs (**pulmonary hypertension**) causes the enlargement of the right ventricle. In addition to COPD, cor pulmonale may also be caused by lung diseases, such as **cystic fibrosis**, **pulmonary embolism**, and pneumoconiosis. Loss of lung tissue after **lung surgery** or certain chest-wall disturbances can produce cor pulmonale, as can neuromuscular

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diseases, such as **muscular dystrophy**. A large pulmonary thromboembolism (blood clot) may lead to acute cor pulmonale.

Causes and symptoms

Any respiratory disease or malfunction that affects the circulatory system of the lungs may lead to cor pulmonale. These circulatory changes cause the right ventricle to compensate for the extra work required to pump blood through the lungs. The right ventricle has thin walls and is crescent-shaped. The resulting pressure causes the right ventricle to dilate and bulge, eventually leading to its failure.

Cor pulmonale should be expected in any patient with COPD and other respiratory or neuromuscular diseases. Initial symptoms of cor pulmonale may actually reflect those of the underlying disease. These may include chronic coughing, **wheezing**, weakness, **fatigue**, and **shortness of breath**. **Edema** (abnormal buildup of fluid), weakness, and discomfort in the upper chest may be evident in cor pulmonale.

Diagnosis

An electrocardiograph (EKG) will show signs such as frequent premature contractions in the atria or ventricles. Chest x rays may show enlargement of the right descending pulmonary artery. This sign, along with an enlarged main pulmonary artery, indicates pulmonary artery **hypertension** in patients with COPD. **Magnetic resonance imaging** (MRI) is often the preferred method of diagnosis for cor pulmonale because it can clearly show and measure volume of the pulmonary arteries. Other tests used to support a diagnosis of cor pulmonale may include arterial **blood gas analysis**, **pulmonary function tests**, and **hematocrit**.

Treatment

Treatment of cor pulmonale is aimed at increasing a patient's exercise tolerance and improving oxygen levels of the arterial blood. Treatment is also aimed at the underlying condition that is producing cor pulmonale. Common treatments include **antibiotics** for respiratory infection; anticoagulants to reduce the risk of thromboembolism; and digitalis, oxygen, and **phlebotomy** to reduce red blood cell count. A low-salt diet and restricted fluids are often prescribed.

Alternative treatment

Co-management of the patient with cor pulmonale should be coordinated between the medical doctor and the alternative practitioner. The first step in treatment is to determine the cause of the condition and to evaluate all organ systems of the body. Dietary considerations, for example, a low-salt diet and reduced fluid intake aimed at reducing the edema associated with cor pulmonale, can be supportive aspects of treatment.

KEY TERMS

Ventricle—A cavity, as in the brain or heart. The right ventricle of the heart drives blood from the heart into the pulmonary artery, which supplies blood to the lungs.

Prognosis

The prognosis for cor pulmonale is poor, particularly because it occurs late in the process of serious disease.

Prevention

Cor pulmonale is best prevented by prevention of COPD and other irreversible diseases that lead to heart failure. **Smoking** cessation is critically important. Carefully following the recommended course of treatment for the underlying disease may help prevent cor pulmonale.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

Teresa Odle

Cori's disease *see* **Glycogen storage diseases**

Corkscrew esophagus *see* **Diffuse esophageal spasm**

Corneal abrasion

Definition

A corneal abrasion is a worn or scraped-off area of the outer, clear layer of the eye (cornea).

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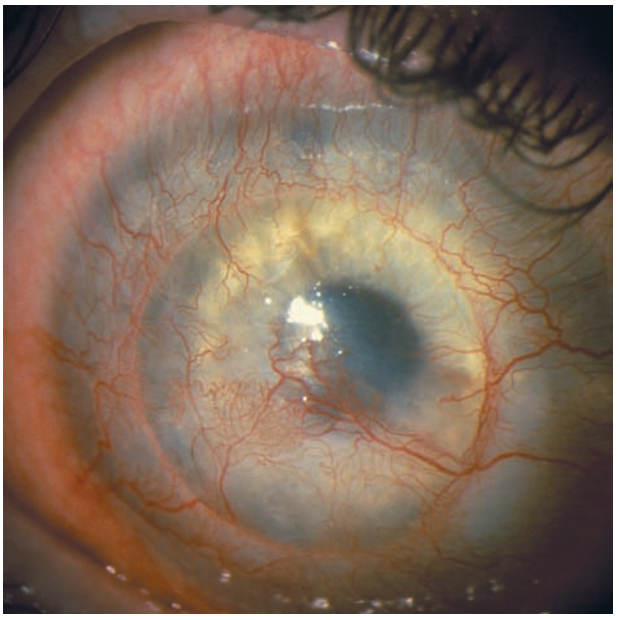

A close-up view of an abrasion on patient's cornea. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

KEY TERMS

Abrasion—An area of the body whose surface has been worn away by some abnormal process.

Cornea—The transparent structure on the front part of the eye.

Recurrent corneal erosion (RCE)—Repeated erosion of the cornea. May be a result of inadequate healing of a previous abrasion.

Slit lamp—An instrument used to examine the front of the eye.

Demographics

The exact incidence of corneal abrasions is not known; many are work-related; many result in time lost from work. In work-related injuries, men in their twenties are most likely to experience a corneal abrasion.

Description

The cornea is the clear, dome-shaped outer area of the eye. It lies in front of the colored part of the eye (iris) and the black hole in the iris (pupil). The outermost layer of the eyeball consists of the cornea and the white part of the eye (sclera). A corneal abrasion is a superficial cut or scrape on the cornea. A corneal abrasion is not as serious as a corneal ulcer, which is generally deeper and more severe than an abrasion.

Causes and symptoms

A corneal abrasion is usually the result of direct injury to the eye, often from a fingernail scratch, makeup brushes, **contact lenses**, foreign body, or even twigs. Patients often complain of feeling a foreign body in their eye, and they may have **pain**, sensitivity to light, or tearing.

Diagnosis

Examination

Ophthalmologists and optometrists who treat eye disorders are well qualified to diagnose corneal abrasions. The doctor will check the patient's vision (visual acuity) in both eyes with an eye chart. A patient history will also be taken, which may help to determine the cause of the abrasion. A slit lamp, which is basically a microscope and light source, will allow the doctor to see the abrasion. Fluorescein, a yellow dye, may be placed into the eye to determine the extent of the abrasion. The fluorescein will temporarily stain the affected area.

Treatment

The cornea has a remarkable ability to heal itself, so treatment is designed to minimize complications. If the abrasion is very small, the doctor might just suggest an eye lubricant and a follow-up visit the next day. A very small abrasion should heal in one to two days; others usually in one week. However, to avoid a possible infection, an antibiotic eye drop may be prescribed. Sometimes additional eye drops may make the eye feel more comfortable. Depending upon the extent of the abrasion, some doctors may patch the affected eye. It is important to go for the follow-up checkup to make sure an infection does not occur. Use of contact lenses should not be resumed without the doctor's approval.

Prognosis

In typical cases, the prognosis is good. The cornea will heal itself, usually within several days. A very deep abrasion may lead to scarring. If the abrasion does not heal properly, a recurrent corneal erosion (RCE) may result months or even years later. The symptoms are the same as for an abrasion (e.g., tearing, foreign body sensation, and blurred vision), but it will keep occurring. Similar or additional treatment for the RCE may be necessary.

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Prevention

Everyone should wear eye protection whenever this is recommended. This should be standard practice when using power tools and playing certain sports. Goggles should even be worn when mowing the lawn, because a twig can be thrown upward toward the face. Contact lens wearers should be careful to follow their doctor's instructions on caring for and wearing their lenses. Ill-fitting or dirty lenses could lead to an abrasion, so patients should go for their prescribed checkups.

Resources

OTHER

American Academy of Family Physicians. Corneal Abrasions. FamilyDoctor.org November 2009. http://familydoctor.org/online/famdocen/home/healthy/firstaid/basics/205.html

Kanh, Feras H. and Mark Silverberg. Corneal Abrasion. eMedicine.com May 6, 2010.http://emedicine.medscape.com/article/799316-overview

Corneal Abrasion (Scratch): First Aid. Mayo Foundation for Medical Education and Research. December 23, 2009. http://www.mayoclinic.com/health/first-aid-corneal-abrasion/fa00037

ORGANIZATIONS

American Academy of Family Physicians, P. O. Box 11210, Shawnee Mission, KS, 66207, (913) 906-6000, (800) 274-2237, (913) 906-6075, http://familydoctor.org.

EyeCare America Foundation of the American Academy of Ophthalmology, P. O. Box 429098, San Francisco, CA, 94142-9098, (877) 887-6327, (800) 324-EYES (3937), (415) 561-8567, pubserv@aao.org, http://www.eyecareamerica.org.

National Eye Institute Information Office, 31 Center Drive MSC 2510, Bethesda, MD, 20892-2510, (301) 496-5248, 2020@nei.nih.gov, http://www.nei.nih.gov.

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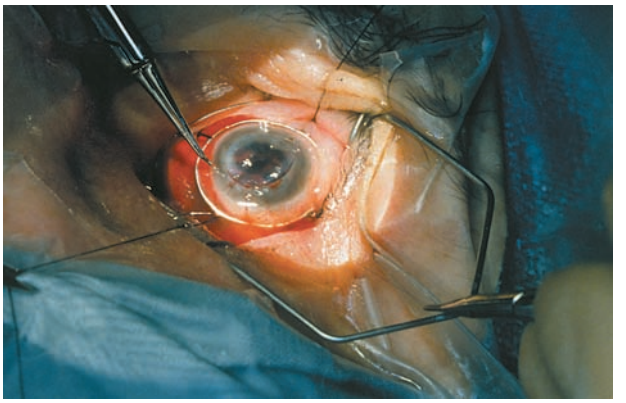
Corneal infection *see* **Keratitis**

Corneal keratoplasty *see* **Corneal transplantation**

Corneal transplantation

Definition

In corneal transplant, also known as keratoplasty, a patient's damaged cornea is replaced by the cornea from the eye of a human cadaver. This is the single most common type of human **transplant surgery** and has the highest success rate. Eye banks acquire and store eyes from donor individuals largely to supply the need for transplant corneas.



A corneal transplant in progress. *(© Chet Szymecki/Phototake. — All rights reserved.)*

Purpose

Corneal transplant is used when vision is lost in an eye because the cornea has been damaged by disease or traumatic injury. Some of the disease conditions that might require corneal transplant include the bulging outward of the cornea (keratoconus), a malfunction of the inner layer of the cornea (Fuchs' dystrophy), and painful swelling of the cornea (pseudophakic bullous keratopathy). Some of these conditions cause cloudiness of the cornea; others alter its natural curvature, which can also reduce the quality of vision.

Injury to the cornea can occur because of chemical **burns**, mechanical trauma, or infection by viruses, bacteria, fungi, or protozoa. The herpes virus produces one of the more common infections leading to corneal transplant.

Surgery would only be used when damage to the cornea is too severe to be treated with corrective lenses. Occasionally, corneal transplant is combined with other types of eye surgery (such as **cataract surgery**) to solve multiple eye problems in one procedure.

Precautions

Corneal transplant is a very safe procedure that can be performed on almost any patient who would benefit from it. Any active infection or inflammation of the eye usually needs to be brought under control before surgery can be performed.

Description

The cornea is the transparent layer of tissue at the very front of the eye. It is composed almost entirely of

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KEY TERMS

Cadaver—The human body after death.

Cataract—A condition of cloudiness of the lens of the eye.

Cornea—The transparent layer of tissue at the very front of the eye.

Corticosteroids—Synthetic hormones widely used to fight inflammation.

Epikeratophakia—A procedure in which the donor cornea is attached directly onto the host cornea.

Epithelial cells—Cells that form a thin surface coating on the outside of a body structure.

Fibrous connective tissue—Dense tissue found in various parts of the body containing very few living cells.

Fuchs' dystrophy—A hereditary disease of the inner layer of the cornea. Treatment requires penetrating keratoplasty. The lens of the eye may also be affected and require surgical replacement at the same time as the cornea.

Glaucoma—A vision defect caused when excessive fluid pressure within the eye damages the optic nerve.

Histocompatibility antigens—Proteins scattered throughout body tissues that are unique for almost every individual.

Keratoconus—An eye condition in which the cornea bulges outward, interfering with normal vision. Usually both eyes are affected.

Pseudophakic bullous keratopathy—Painful swelling of the cornea occasionally occurring after surgery to implant an artificial lens in place of a lens affected by cataract.

Retinal detachment—A serious vision disorder in which the light-detecting layer of cells inside the eye (retina) is separated from its normal support tissue and no longer functions properly.

Trephine—A small surgical instrument that is rotated to cut a circular incision.

a special type of collagen. It normally contains no blood vessels, but because it contains nerve endings, damage to the cornea can be very painful.

In a corneal transplant, a disc of tissue is removed from the center of the eye and replaced by a corresponding disc from a donor eye. The circular incision is made using an instrument called a trephine. In one form of corneal transplant (penetrating keratoplasty), the disc removed is the entire thickness of the cornea and so is the replacement disc. Over 90% of all corneal transplants in the United States are of this type. In lamellar keratoplasty, on the other hand, only the outer layer of the cornea is removed and replaced.

The donor cornea is attached with extremely fine sutures. Surgery can be performed under anesthesia that is confined to one area of the body while the patient is awake (**local anesthesia**) or under anesthesia that places the entire body of the patient in a state of unconsciousness (**general anesthesia**). Surgery requires 30–90 minutes.

Over 40,000 corneal transplants are performed in the United States each year. Medicare reimbursement for a corneal transplant in one eye was about $1,200 in 1997.

A less common but related procedure called epikeratophakia involves suturing the donor cornea directly onto the surface of the existing host cornea. The only tissue removed from the host is the extremely thin epithelial cell layer on the outside of the host cornea. There is no permanent damage to the host cornea, and this procedure can be reversed. It is usually employed in children. In adults, the use of **contact lenses** can usually achieve the same goals.

Preparation

No special preparation for corneal transplant is needed. Some eye surgeons may request the patient have a complete **physical examination** before surgery. The patient may also be asked to skip breakfast on the day of surgery.

Aftercare

Corneal transplant is often performed on an outpatient basis, although some patients need brief hospitalization after surgery. The patient will wear an eye patch at least overnight. An eye shield or glasses must be worn to protect the eye until the surgical wound has healed. Eye drops will be prescribed for the patient to use for several weeks after surgery. These drops include **antibiotics** to prevent infection as well as

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corticosteroids to reduce inflammation and prevent graft rejection.

For the first few days after surgery, the eye may feel scratchy and irritated. Vision will be somewhat blurry for as long as several months.

Sutures are often left in place for six months, and occasionally for as long as two years.

Risks

Corneal transplants are highly successful, with over 90% of operations in United States achieving restoration of sight. However, there is always some risk associated with any surgery. Complications that can occur include infection, glaucoma, **retinal detachment**, cataract formation, and rejection of the donor cornea.

Graft rejection occurs in 5–30% of patients, a complication possible with any procedure involving tissue transplantation from another person (allograft). Allograft rejection results from a reaction of the patient's immune system to the donor tissue. Cell surface proteins called histocompatibility antigens trigger this reaction. These antigens are often associated with vascular tissue (blood vessels) within the graft tissue. Since the cornea normally contains no blood vessels, it experiences a very low rate of rejection. Generally, **blood typing** and **tissue typing** are not needed in corneal transplants, and no close match between donor and recipient is required. Symptoms of rejection include persistent discomfort, sensitivity to light, redness, or a change in vision.

If a rejection reaction does occur, it can usually be blocked by steroid treatment. Rejection reactions may become noticeable within weeks after surgery, but may not occur until 10 or even 20 years after the transplant. When full rejection does occur, the surgery will usually need to be repeated.

Although the cornea is not normally vascular, some corneal diseases cause vascularization (the growth of blood vessels) into the cornea. In patients with these conditions, careful testing of both donor and recipient is performed just as in transplantation of other organs and tissues such as hearts, kidneys, and bone marrow. In such patients, repeated surgery is sometimes necessary in order to achieve a successful transplant.

Cornea donors are carefully screened. Individuals with infectious diseases are not accepted as donors.

ORGANIZATIONS

American Academy of Ophthalmology (AAO), P. O. Box 7424, San Francisco, CA, 94120-7424, (415) 561-8500, (415) 561-8500, http://www.aao.org.

Victor Leipzig, PhD

Corneal ulcers

Definition

The cornea, the clear front part of the eye through which light passes, is subject to many infections and to injury from exposure and from **foreign objects**. Infection and injury cause inflammation of the cornea–a condition called **keratitis**. Tissue loss because of inflammation produces an ulcer. The ulcer can either be centrally located, thus greatly affecting vision, or peripherally located. There are about 30,000 cases of bacterial corneal ulcers in the United States each year.

Description

The most common cause of corneal ulcers is germs, but most of them cannot invade a healthy cornea with adequate tears and a functioning eyelid. They gain access because injury has impaired these defense mechanisms. A direct injury from a foreign object inoculates germs directly through the outer layer of the cornea, just as it does to the skin. A caustic chemical can inflame the cornea by itself or so damage it that germs can invade. Improper use of **contact lenses** has become a common cause of corneal injury. Eyelid or tear function failure is

A close-up view of an ulcer on cornea. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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the other way to make the eye vulnerable to infection. Tears and the eyelid together wash the eye and prevent foreign material from settling in. Tears contain enzymes and other substances to help protect against infection. Certain diseases dry up tear production, leaving the cornea dry and defenseless. Other diseases paralyze or weaken the eyelids so that they cannot effectively protect and cleanse the eyes.

Causes and symptoms

Viruses, bacteria, fungi, and a protozoan called *Acanthamoeba* can all invade the cornea and damage it under suitable conditions.

- Bacteria from a common conjunctivitis (pink eye) rarely spread to the cornea, but can if untreated.
- Fecal bacteria are more likely to be able to infect the cornea.
- A bacterium called *Pseudomonas aeruginosa*, which can contaminate eyedrops, is particularly able to cause corneal infection.
- A group of incomplete bacteria known as *Chlamydia* can be transmitted to the eye directly by flies or dirty hands. One form of chlamydial infection is the leading cause of blindness in developing countries and is known as Egyptian ophthalmia or trachoma. Another type of *Chlamydia* causes a sexually transmitted disease.
- Other sexually transmitted diseases–for example, syphilis–can affect the cornea.

The most common viruses to damage the cornea are adenoviruses and herpes viruses. Viral and fungal infections are often caused by improper use of topical **corticosteroids**. If topical corticosteroids are used in a patient with the herpes simplex keratitis, the ulcer can get much worse and blindness could result.

Symptoms are obvious. The cornea is intensely sensitive, so corneal ulcers normally produce severe **pain**. If the corneal ulcer is centrally located, vision is impaired or completely absent. Tearing is present and the eye is red. It hurts to look at bright lights.

Diagnosis

The doctor will take a case history to try to determine the cause of the ulcer. This can include improper use of contact lenses; injury, such as a scratch from a twig; or severe dry eye. An instrument called a slit lamp will be used to examine the cornea. The slit lamp is a microscope with a light source that magnifies the cornea, allowing the extent of the ulcer to be seen. Fluorescein, a yellow dye, may be used to illuminate further detail. If a germ is responsible for the ulcer, identification may require scraping samples directly from the cornea, conjunctiva, and lids, and sending them to the laboratory.

KEY TERMS

Fluorescein—A fluorescent chemical used to examine the cornea.

Germ—A disease-causing microorganism.

Inflammation—The body's reaction to irritation.

Topical corticosteroids—Cortisone and related drugs used on the skin and in the eye, usually for allergic conditions.

Treatment

A corneal ulcer needs to be treated aggressively, as it can result in loss of vision. The first step is to eliminate infection. Broad spectrum **antibiotics** will be used before the lab results come back. Medications may then be changed to more specifically target the cause of the infection. A combination of medications may be necessary. Patients should return for their follow-up visits so that the doctor can monitor the healing process. The cornea can heal from many insults, but if it remains scarred, **corneal transplantation** may be necessary to restore vision. If the corneal ulcer is large, hospitalization may be necessary.

Prognosis

Treated early enough, corneal infections will usually resolve, perhaps even without the formation of an ulcer. However, left untreated, infections can lead to ulcers and the corneal ulcer can result in scarring or perforation of the cornea. Other problems may occur as well, including glaucoma. Patients with certain systemic diseases that impede healing (such as **diabetes mellitus** or **rheumatoid arthritis**) may need more aggressive treatment. The later the treatment, the more damage will be done and the more scarring will result. Corneal transplant is standard treatment with a high probability of success.

Prevention

Attentive care of contact lenses will greatly reduce the incidence of corneal damage and ulceration. Germs that cause no problems in the mouth or on the hands can damage the eye, so contact lens wearers must wash their hands before touching their lenses and must not use saliva to moisten them. Tap water should not be used to rinse the lenses. Contacts should be

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removed whenever there is irritation and left out until the eyes are back to normal. It is not advisable to wear contact lenses while swimming or in hot tubs. Daily wear contact lenses have been found to be less of a risk than contacts for overnight wear (extended wear). Organisms have been cultured from contact lens cases, so the cases should be rinsed in hot water and allowed to air dry. Cases should be replaced every three months. Patients should follow their doctors' schedules for replacement of the contacts.

Eye protection in the workplace, or wherever tiny particles are flying around, is essential. Ultraviolet (UV) coatings on glasses or sunglasses can help protect the eyes from the sun's rays. Goggles with UV protection should be worn when skiing or in suntanning salons to protect against UV rays. Prompt attention to any red eye should prevent progressive damage.

For people with inadequate tears, use of artificial tears eyedrops will prevent damage from drying. Eyelids that do not close adequately may temporarily have to be sewn shut to protect the eye until more lasting treatment can be instituted.

ORGANIZATIONS

American Academy of Ophthalmology (AAO), P. O. Box 7424, San Francisco, CA, 94120-7424, (415) 561-8500, (415) 561-8500, http://www.aao.org.

American Optometric Association, 243 North Lindbergh Blvd., St. Louis, MO, 63141, (314) 991-4100, (314) 991-4101, (800) 365-2219, http://www.aoa.org/.

Prevent Blindness America, 211 West Wacker Drive, Suite 1700, Chicago, IL, 60606, (800) 331-2020, http://www.preventblindness.org.

J. Ricker Polsdorfer, MD

Corns and calluses

Definition

A corn is a small, painful, raised bump on the outer skin layer. A callus is a rough, thickened patch of skin.

Description

Corns and calluses are one of the three major foot problems in the United States. The other two are foot infections and toenail problems. Corns and calluses affect about 5% of the population.

Corns usually appear on non-weight-bearing areas like the outside of the little toe or the tops of other toes. Women have corns more often than men, probably because women wear high-heeled shoes and other shoes that do not fit properly. Corns have hard cores shaped like inverted pyramids. Sharp **pain** occurs whenever downward pressure is applied, and a dull ache may be felt at other times.

Corns on toes. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Calluses occur most often on the heels and balls of the feet, the knees, and the palms of the hands. However, they can develop on any part of the body that is subject to repeated pressure or irritation. Calluses are usually more than an inch wide–larger than corns. They generally don't hurt unless pressure is applied.

Types of corns

A hard corn is a compact lump with a thick core. Hard corns usually form on the tops of the toes, on the outside of the little toe, or on the sole of the foot.

A soft corn is a small, inflamed patch of skin with a smooth center. Soft corns usually appear between the toes.

A seed corn is the least common type of corn. Occurring only on the heel or ball of the foot, a seed corn consists of a circle of stiff skin surrounding a plug of cholesterol.

Types of calluses

A plantar callus, a callus that occurs on the sole of the foot, has a white center. Hereditary calluses

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develop where there is no apparent friction, run in families, and occur most often in children.

Causes and symptoms

Corns and calluses form to prevent injury to skin that is repeatedly pinched, rubbed, or irritated. The most common causes are:

- shoes that are too tight or too loose, or have very high heels
- tight socks or stockings
- deformed toes
- walking down a long hill, or standing or walking on a hard surface for a long time

Jobs or hobbies that cause steady or recurring pressure on the same spot can also cause calluses.

Symptoms include hard growths on the skin in response to direct pressure. Corns may be extremely sore and surrounded by inflamed, swollen skin.

Diagnosis

Corns can be recognized on sight. A family physician or podiatrist may scrape skin off what seems to be a callus, but may actually be a wart. If the lesion is a wart, it will bleed. A callus will not bleed, but will reveal another layer of dead skin.

Treatment

Corns and calluses do not usually require medical attention unless the person who has them has **diabetes mellitus**, poor circulation, or other problems that make self-care difficult.

Treatment should begin as soon as an abnormality appears. The first step is to identify and eliminate the source of pressure. Placing moleskin pads over corns can relieve pressure, and large wads of cotton, lamb's wool, or moleskin can cushion calluses.

Using hydrocortisone creams or soaking feet in a solution of Epsom salts and very warm water for at least five minutes a day before rubbing the area with a pumice stone will remove part or all of some calluses. Rubbing corns just makes them hurt more.

Applying petroleum jelly or lanolin-enriched hand lotion helps keep skin soft, but corn-removing ointments that contain acid can damage healthy skin. They should never be used by pregnant women or by people who are diabetic or who have poor circulation.

It is important to see a doctor if the skin of a corn or callus is cut, because it may become infected. If a corn discharges pus or clear fluid, it is infected. A family physician, podiatrist, or orthopedist may:

- remove (debride) affected layers of skin
- prescribe oral antibiotics to eliminate infection
- drain pus from infected corns
- inject cortisone into the affected area to decrease pain or inflammation
- perform surgery to correct toe deformities or remove bits of bone

Alternative treatment

Standing and walking correctly can sometimes eliminate excess foot pressure. Several types of bodywork can help correct body imbalances. Bodywork is a term used for any of a number of systems, including **Aston-Patterning**, the **Feldenkrais method**, and **rolfing**, that manipulate the body through massage, movement education, or meditational techniques.

Aloe (*Aloe barbadensis*) cream is an effective skin softener, and two or three daily applications of calendula (*Calendula officinalis*) salve can soften skin and prevent inflammation. One teaspoon of lemon juice mixed with one teaspoon of dried chamomile (*Martricaria recutita*) tea and one crushed garlic clove dissolves thickened skin.

An ayurvedic practitioner may recommend the following treatment:

- apply each day a paste made by combining one teaspoon of aloe vera gel with half that amount of turmeric (*Circuma longa*)
- bandage overnight
- soak in warm water for 10 minutes every morning
- massage gently with mustard (*Brassica cruciferae*) oil

Prognosis

Most corns and calluses disappear about three weeks after the pressure that caused them is eliminated. They are apt to recur if the pressure returns.

Extreme pain can change the way a person stands or walks. Such changes can, in turn, cause pain in the ankle, back, hip, or knee.

Bursitis, a painful, inflamed fluid-filled sac, can develop beneath a corn. An ulcer or broken area within a corn can reach to the bone. Infection can have serious consequences for people who have diabetes or poor circulation.

Prevention

Corns and calluses can usually be prevented by avoiding friction-causing activities and wearing shoes that fit properly, are activity-appropriate, and are kept

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KEY TERMS

Ayurveda—Ayurveda is a system of wholistic medicine from India that aims to bring the individual into harmony with nature. It provides guidance regarding food and lifestyle, so that healthy people can stay healthy and people with health challenges can improve their health.

Bursitis—Inflammation of a bursa, a fluid-filled cavity or sac. In the body, bursae are located at places where friction might otherwise develop.

in good repair. Soles and heels that wear unevenly may indicate a need for corrective footwear or special insoles. Socks and stockings should not cramp the toes. Gloves, kneepads, and other protective gear should also be worn as needed.

Feet should be measured, while standing, whenever buying new shoes. It is best to shop for shoes late in the day, when feet are likely to be swollen. It is also important to buy shoes with toe-wiggling room and to try new shoes on both feet.

Resources

OTHER

"Foot Disorders: Corns." *Calgary Foot Clinic* http://www.foottalk.com/d_corns.html.

ORGANIZATIONS

American Podiatric Medical Association, 9312 Old Georgetown Road, Bethesda, MD, 20814-1621, (301) 581-9200, http://www.apma.org.

Maureen Haggerty

Coronary artery bypass graft surgery

Definition

Coronary artery bypass graft surgery (CABG) is a procedure in which one or more blocked coronary arteries are bypassed by a blood vessel graft to restore normal blood flow to the heart. These grafts usually come from the patient's own arteries and veins located in the leg, arm, or chest.

Purpose

Coronary artery bypass graft surgery, also called coronary artery bypass surgery and bypass operation, is performed to restore blood flow to the heart. Doing so relieves chest **pain** and **ischemia**, improves the patient's quality of life, and, in some cases, prolongs the patient's life. The goals of the procedure are to relieve symptoms of **coronary artery disease**, enable the patient to resume a normal lifestyle, and lower the risk of a **heart attack** or other heart problems.

According to the American Heart Association, appropriate candidates for coronary artery bypass graft surgery include patients for whom the following applies:

- have blockages in at least two or three major coronary arteries, especially if the blockages are in arteries that feed the heart's left ventricle or are in the left anterior descending artery;
- have angina so severe that even mild exertion causes chest pain;
- have poor left ventricular function; and
- cannot tolerate percutaneous transluminal coronary angioplasty and do not respond well to drug therapy.

Demographics

The American Heart Association estimated that in the United States in 2005, 469,000 coronary artery bypass procedures were performed on 261,000 individual patients. More than twice as many of these surgeries were performed on men than women. Fifteen thousand of these procedures were performed on people between the ages of 15–44, 188,000 on people between ages 45 and 64, and the remainder on people age 65 and older.

Description

Coronary artery bypass graft surgery builds a detour around one or more blocked coronary arteries with a graft from a healthy vein or artery. The graft goes around the clogged artery (or arteries) to create new pathways for oxygen-rich blood to flow to the heart.

Procedure

After **general anesthesia** is administered, the surgeon removes the veins or prepares the arteries for grafting. The surgeon decides which grafts to use based on the location of the blockage, the amount of blockage, and the size of the patient's coronary arteries. If the saphenous vein is to be used for the

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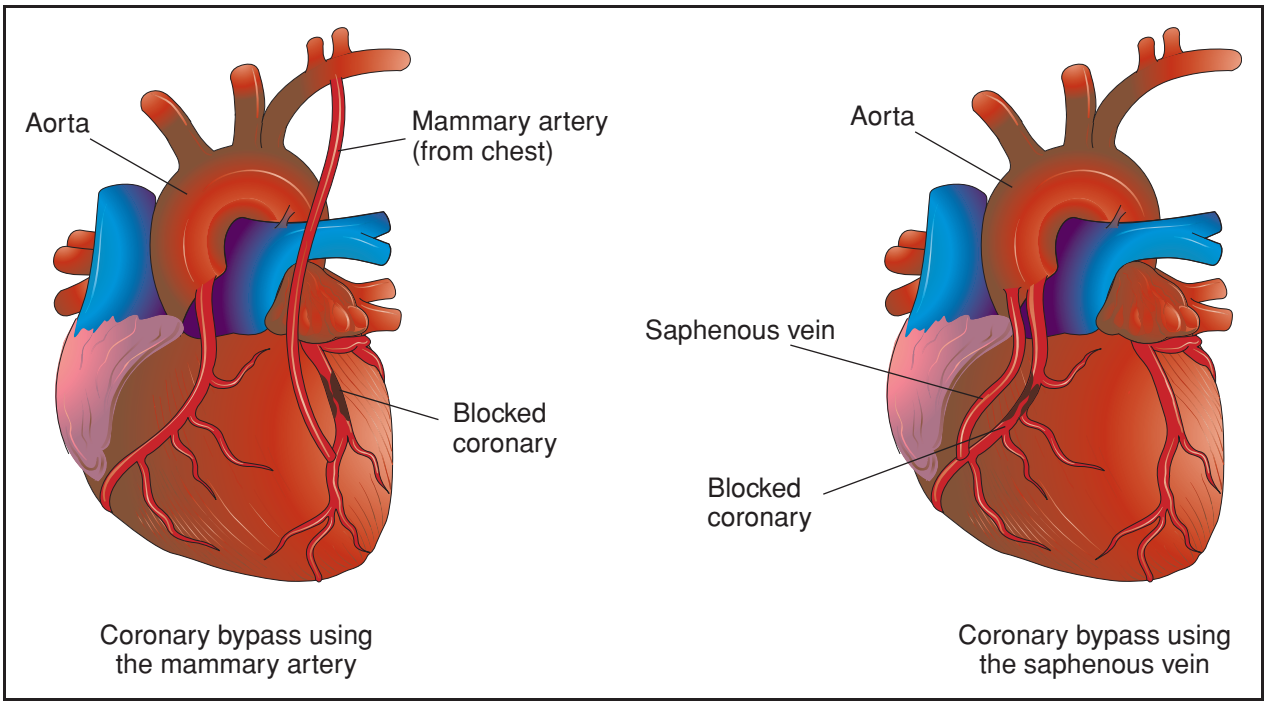

Coronary artery bypass graft surgery builds a detour around one or more blocked coronary arteries with a graft from a healthy vein or artery. The graft goes around the clogged artery (or arteries) to create new pathways for oxygen-rich blood to flow to the heart. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

graft, a series of incisions are made in the patient's thigh or calf. If the radial artery is to be used for the graft, incisions are made in the patient's forearm. More commonly, a segment of the internal mammary artery is used for the graft, and the incisions are made in the chest wall. The internal mammary arteries are often used because they have shown the best long-term results. The removal of veins or arteries for grafting does not deprive the area from which they are removed of adequate blood flow.

In traditional coronary artery bypass surgery, the surgeon makes an incision down the center of the patient's chest, cuts through the breastbone, and retracts the rib cage open to expose the heart. The patient is connected to a heart-lung bypass machine, also called a cardiopulmonary bypass pump, that takes over for the heart and lungs during the surgery. During this "on-pump" procedure, the heart-lung machine removes carbon dioxide from the blood and replaces it with oxygen. A tube is inserted into the aorta to carry the oxygenated blood from the bypass machine to the aorta for circulation to the body. The heart-lung machine allows heart contractions to be stopped, so the surgeon can operate on a still heart. Aortic clamps are used to restrict blood flow to the area of the heart where grafts will be placed so the heart is blood-free during the surgery. The clamps remain until the grafts are in place.

Some patients may be candidates for minimally invasive coronary artery bypass surgery or for off-pump bypass surgery. During minimally invasive surgery, smaller chest and graft removal incisions are used, promoting a quicker recovery and less risk of infection. Off-pump bypass surgery, also called beating heart surgery, is a surgical technique performed while the heart is still contracting (beating). The surgeon uses advanced equipment to stabilize portions of the heart and bypass the blocked artery while the rest of the heart keeps pumping and circulating blood through the body.

After the grafts are prepared, a small opening is made in the diseased coronary artery just below the blockage. Blood will be redirected through this opening once the graft is sewn in place. If a leg or arm vein is used, one end is connected to the coronary artery and the other to the aorta. If a mammary artery is used, one end is connected to the coronary artery while the other is already attached to the aorta and remains in place. The procedure is repeated on as many coronary arteries as necessary. On average, three or four coronary arteries are bypassed during surgery. Blood flow

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KEY TERMS

Angina—Also called angina pectoris, chest pain or discomfort that occurs when diseased blood vessels restrict blood flow to the heart.

Angiotensin-converting enzyme (ACE) inhibitor—A drug that lowers blood pressure by interfering with the breakdown of a protein-like substance involved in blood pressure regulation.

Aorta—The main artery that carries blood from the heart to the rest of the body. The aorta is the largest artery in the body.

Artery—A vessel that carries oxygen-rich blood to the body.

Atherectomy—A non-surgical technique for treating diseased arteries with a rotating device that cuts or shaves away obstructing material inside the artery.

Atrium (plural Atria)—The right or left upper chamber of the heart.

Beta blocker—An anti-hypertensive drug that limits the activity of epinephrine, a hormone that increases blood pressure.

Brachytherapy—The use of radiation during angioplasty to prevent the artery from narrowing again (a process called restenosis).

Calcium channel blocker—A drug that lowers blood pressure by regulating calcium-related electrical activity in the heart.

Cardiac rehabilitation—A structured program of education and activity offered by hospitals and other organizations.

Coronary artery disease—Also called atherosclerosis, it is a build-up of fatty matter and debris in the coronary artery wall that causes narrowing of the artery.

Echocardiogram—An imaging procedure used to create a picture of the heart's movement, valves, and chambers.

Graft—To implant living tissue surgically.

Homocysteine—An amino acid normally found in small amounts in the blood.

Ischemia—Decreased blood flow to an organ, usually caused by constriction or obstruction of an artery.

Lipoproteins—Substances that carry fat through the blood vessels for use or storage in other parts of the body.

Mammary artery—A chest wall artery that descends from the aorta and is commonly used for bypass grafts.

Radial artery—An artery located in the arm and used for bypass grafts.

Rotoblation—A non-surgical technique for treating diseased arteries.

Saphenous vein—A long vein in the thigh or calf commonly used for bypass grafts.

Stent—A device made of expandable, metal mesh that is placed (by using a balloon catheter) at the site of a narrowing artery; the stent stays in place to keep the artery open.

Sternum—Also called the breastbone, the sternum is the bone in the chest that is separated during open heart surgery.

Stress test—A test used to determine how the heart responds to stress.

Vein—A blood vessel that returns oxygen-depleted blood from various parts of the body to the heart.

Ventricle—A lower pumping chambers of the heart. There are two ventricles, right and left. The right ventricle pumps oxygen-poor blood to the lungs to be re-oxygenated. The left ventricle pumps oxygen-rich blood to the body.

is checked to assure the graft supplies adequate blood to the heart.

If the procedure was done on-pump, electric shocks start the heart pumping again after the grafts have been completed. The heart-lung machine is turned off and the blood slowly returns to normal body temperature. After implanting pacing wires and inserting a chest tube to drain fluid, the surgeon closes the chest cavity. Sometimes a temporary pacemaker is attached to the pacing wires to regulate the heart rhythm until the patient's condition improves. After surgery, the patient is transferred to an intensive care unit (ICU) for close monitoring.

Diagnosis/Preparation

Diagnosis

The diagnosis of coronary artery disease is made after the patient's medical history is carefully reviewed, a physical exam is performed, and the patient's symptoms are evaluated. Tests used to diagnose coronary artery disease include:

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- electrocardiogram;
- stress tests;
- cardiac catheterization;
- imaging tests such as a chest x ray, echocardiography, or computed tomography (CT) scan; and
- blood tests to measure blood cholesterol, triglycerides, and other substances.

Preparation

The patient should quit **smoking** or using tobacco products before the surgery, and the patient needs to make the commitment to be a nonsmoker after the surgery. There are many smoking cessation programs available through hospital or community groups. A health care provider can provide more information about ways quit smoking.

Coronary artery bypass graft surgery should ideally be postponed for three months after a heart attack. Whenever possible, patients should be medically stable before the surgery. If the patient develops a cold, **fever**, or **sore throat** within a few days before the surgery, he or she should notify the surgeon's office.

During a preoperative appointment, usually scheduled one to two weeks before surgery, the patient will receive information about what to expect during the surgery and the recovery period. The patient will usually meet the cardiologist, anesthesiologist, nurse clinicians, and surgeon during this appointment or just before the procedure.

The evening before the surgery, the patient showers with antiseptic soap provided by the surgeon's office. After midnight, the patient should not eat or drink anything.

The patient is usually admitted to the hospital on the day the surgery is scheduled. The patient should bring a list of current medications, **allergies**, and appropriate medical records upon admission to the hospital.

Before the surgery, the patient is given a blood-thinning drug (usually heparin) that helps to prevent **blood clots**. A sedative is given the morning of surgery. The chest and the area from where the graft will be taken are shaved.

Coronary **angiography** will have been previously performed to show the surgeon where the arteries are blocked and where the grafts might best be positioned. Heart monitoring is initiated. The patient is given general anesthesia before the procedure.

The length of the procedure depends upon the number of arteries being bypassed, but it generally takes from three to five hours or sometimes longer.

Aftercare

Recovery in the hospital

The patient recovers in a surgical intensive care unit for one to two days after the surgery. The patient will be connected to chest and breathing tubes, a mechanical ventilator, a heart monitor, and other monitoring equipment. A urinary catheter will be in place to drain urine. The breathing tube and ventilator are usually removed about six hours after surgery, but the other tubes remain in place as long as the patient is in the intensive care unit.

Drugs are prescribed to control pain and infection and to prevent unwanted blood clotting. Daily doses of **aspirin** are started within 6–24 hours after the procedure.

The patient is closely monitored during the recovery period. Vital signs and other parameters such as heart sounds, oxygen, and carbon dioxide levels in arterial blood are checked frequently. The chest tube is checked to ensure that it is draining properly. The patient may be fed intravenously for the first day or two.

Chest physiotherapy is started after the ventilator and breathing tubes are removed. The therapy includes coughing, turning frequently, and taking deep breaths. Sometimes oxygen is delivered via a mask to help loosen and clear secretions from the lungs. Other exercises will be encouraged to improve the patient's circulation and prevent complications due to prolonged bed rest.

If there are no complications, the patient begins to resume a normal routine on the second day, including eating regular food, sitting up, and walking around a bit. Before being discharged from the hospital, the patient usually spends a few days under observation in a non-surgical unit. During this time, counseling is usually provided on eating right and starting a light **exercise** program to keep the heart healthy. The average hospital stay after coronary artery bypass graft surgery is five to seven days.

Recovery at home

INCISION AND SKIN CARE. The incision should be kept clean and dry. When the skin is healed, the incision should be washed with soapy water. The scar should not be bumped, scratched, or otherwise disturbed. Ointments, lotions, and **dressings** should not be applied to the incision unless specific instructions have been given to do so.

DISCOMFORT. While the incision scar heals, which takes one to two months, it may be sore. **Itching**,

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tightness, or **numbness** along the incision are common. Muscle or incision discomfort may occur in the chest during activity.

Swelling or aching may occur in the legs if the saphenous vein was used for the graft. Special support stockings may be needed to decrease leg swelling after surgery. While sitting, the patient should not cross the legs and the feet should be elevated. Walking daily, even if the legs are swollen, will help improve circulation and reduce swelling.

LIFESTYLE CHANGES. The patient needs to make several lifestyle changes after surgery, including:

- quitting smoking. Smoking causes damage to the bypass grafts and other blood vessels, increases the patient's blood pressure and heart rate, and decreases the amount of oxygen available in the blood.
- managing weight. Maintaining a healthy weight, by watching portion sizes and exercising, is important. Being overweight increases the work of the heart.
- participating in an exercise program. The exercise program is usually tailored for the patient, who will be encouraged to participate in a cardiac rehabilitation program supervised by exercise professionals.
- making dietary changes. Patients should eat a lot of fruits, vegetables, whole grains, and non-fat or low-fat dairy products, and reduce fat intake to less than 30% of all calories.
- taking medications as prescribed. Aspirin and other heart medications may be prescribed, and the patient may need to take these medications for life.
- following up with health care providers. The patient must schedule follow-up visits to determine how effective the surgery was, to confirm that progressive exercise is safe, and to monitor his or her recovery and control risk factors.

Risks

Coronary artery bypass graft surgery is major surgery and patients may experience any of the normal complications associated with major surgery and anesthesia, such as the risk of bleeding, **pneumonia**, or infection. Other possible complications include:

- graft closure or blockage;
- development of blockages in other arteries;
- damage to the aorta;
- long-term development of atherosclerotic disease of saphenous vein grafts;
- abnormal heart rhythms;
- high or low blood pressure;
- recurrence of angina;
- blood clots that can lead to a stroke or heart attack;
- kidney failure;
- depression or severe mood swings; and
- possible short-term memory loss, difficulty thinking clearly, and problems concentrating for long periods (these effects generally subside within six months after surgery).

There is a higher risk for complications in patients who:

- are heavy smokers;
- have a history of lung, kidney, or metabolic diseases;
- have diabetes;
- have had a recent heart attack; or
- have a history of angina, ventricular arrhythmias, congestive heart failure, cerebrovascular disease, or mitral regurgitation.

Normal results

Full recovery from coronary artery bypass graft surgery takes two to three months and is a gradual process. Upon release from the hospital, the patient will feel weak because of the extended bed rest in the hospital. Within a few weeks, the patient should begin to feel stronger.

Most patients are able to drive in three to eight weeks, after receiving approval from their physician. Sexual activity can generally be resumed in three to four weeks, depending on the patient's rate of recovery.

It takes about six to eight weeks for the sternum to heal. During this time, the patient should not perform activities that cause pressure or weight on the breastbone or tension on the arms and chest. Pushing and pulling heavy objects (as in mowing the lawn) should be avoided and lifting objects more than 20 lbs (9 kg) is not permitted. The patient should not hold his or her arms above shoulder level for a long period, such as when doing household chores. The patient should try not to stand in one place for longer than 15 minutes. Stair climbing is permitted unless other instructions have been given. Within four to six weeks, people with sedentary office jobs can return to work. People with physical jobs, such as construction work or jobs requiring heavy lifting, must wait longer (up to 12 weeks) or may have to change careers.

About 90% of patients experience significant improvements after coronary artery bypass graft surgery. Patients experience full relief from chest pain and resume their normal activities in about 70% of the cases; the remaining 20% experience partial relief.

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Coronary artery bypass surgery does not prevent coronary artery disease from recurring. For most people, the graft remains open for about 10–15 years. Therefore, lifestyle changes are strongly recommended and medications are prescribed to reduce the risk for the return of coronary artery disease. About 40% of patients have a new blockage within 10 years after surgery and require a second bypass, change in medication, or an interventional procedure.

Morbidity and mortality rates

The risk of **death** while in the hospital during and after coronary artery bypass graft surgery is 1–2%, although the rate varies among individual hospitals and surgeons. In 5–10% of coronary artery bypass graft surgeries, the bypass graft stops supplying blood to the bypassed artery within one year. Younger people who are healthy except for the heart disease achieve good results with bypass surgery. Patients who have poorer results from coronary artery bypass graft surgery include those over the age of 70, those who have poor left ventricular function, are undergoing a repeat surgery or other procedures concurrently, and those who continue smoking, do not treat high cholesterol or other coronary risk factors, or have another debilitating disease.

Over the long term, symptoms recur in only about 3–4% of patients per year. Five years after coronary artery bypass graft surgery, survival expectancy is 90%, at 10 years it is about 85%, at 15 years it is about 55%, and at 20 years it is about 40%.

Angina recurs in about 40% of patients after 10 years. In most cases, it is less severe than before the surgery and can be controlled with drug therapy. In patients who have had vein grafts, 40% of the grafts are severely obstructed 10 years after the procedure. Repeat coronary artery bypass graft surgery may be necessary, and is usually less successful than the first surgery.

Alternatives

All patients with coronary artery disease can help improve their condition by making lifestyle changes such as quitting smoking, losing weight if they are overweight, eating healthy foods, reducing blood cholesterol, exercising regularly, and controlling diabetes and high blood pressure.

All patients with coronary artery disease should be prescribed medications to treat their condition. Antiplatelet medications such as aspirin or clopidogrel (Plavix) are usually recommended. Other medications used to treat angina may include **beta blockers**, nitrates, and angiotensin-converting enzyme (ACE) inhibitors. Medications may also be prescribed to lower lipoprotein levels, since elevated lipoprotein levels have been associated with an increased risk of cardiovascular problems.

Treatment with vitamin E is not recommended because it does not lower the rate of cardiovascular events in people with coronary artery disease. **Antioxidants** such as vitamin C and beta-carotene show some signs of helping reduce coronary artery disease, but not enough rigorously documented information about their effects is available and they are not recommended for routine use. Treatment with **folic acid** and **vitamins** B_6 and B_{12} lowers **homocysteine** levels (reducing the risk for cardiovascular problems), but more studies are needed to determine if lowered homocysteine levels correlate with a reduced rate of cardiovascular problems in treated patients.

Less invasive, nonsurgical interventional procedures, such as balloon **angioplasty**, stent placement, rotoblation, **atherectomy**, or brachytherapy, can be performed to open a blocked artery. These procedures may be the appropriate treatment for some patients before coronary artery bypass graft surgery is considered.

Enhanced external counterpulsation (EECP) may be a treatment option for patients who are not candidates for interventional procedures or coronary artery bypass graft surgery. During EECP, a set of cuffs is wrapped around the patient's calves, thighs, and buttocks. These cuffs gently but firmly compress the blood vessels in the lower limbs to increase blood flow to the heart. The inflation and deflation of the cuffs are electronically synchronized with the heartbeat and blood pressure using **electrocardiography** and blood pressure monitors. EECP may encourage blood vessels to open small channels to eventually bypass blocked vessels and improve blood flow to the heart. Not all patients are candidates for this procedure, and treatments, lasting one to two hours, must be repeated about five times a week for up to seven weeks.

Resources

BOOKS

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Your Total Health: Heart Health. http://yourtotalhealth.ivillage.com/heart-health.

ORGANIZATIONS

American College of Cardiology, Heart House2400 N. Street NW, Washington, DC, 20037, (800) 253-4636, http://www.acc.org.

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National Heart, Lung, and Blood Institute, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, http://www.nhlbi.nih.gov.

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Coronary artery disease

Definition

Coronary artery disease is a narrowing or blockage of the arteries and vessels that provide oxygen and nutrients to the heart. It is caused by **atherosclerosis**, an accumulation of fatty materials on the inner linings of arteries. The resulting blockage restricts blood flow to the heart. When the blood flow is completely cut off, the result is a **heart attack**.

Description

Coronary artery disease, also called coronary heart disease or heart disease, is the leading cause of **death** for both men and women in the United States. According to the American Heart Association, deaths from coronary artery disease have declined some since about 1990, but more than 40,000 people still died from the disease in 2000. About 13 million Americans have active symptoms of coronary artery disease.

Coronary artery disease occurs when the coronary arteries become partially blocked or clogged. This blockage limits the flow of blood from the coronary arteries, which are the major arteries supplying oxygen-rich blood to the heart. The coronary arteries expand when the heart is working harder and needs more oxygen. Arteries expand, for example, when a person is climbing stairs, exercising, or having sex. If the arteries are unable to expand, the heart is deprived of oxygen (myocardial **ischemia**). When the blockage is limited, chest **pain** or pressure, called **angina**, may occur. When the blockage cuts off the flow of blood, the result is heart attack (myocardial infarction or heart muscle death).

Healthy coronary arteries are clean, smooth, and slick. The artery walls are flexible and can expand to let more blood through when the heart needs to work harder. The disease process in arteries is thought to begin with an injury to the linings and walls of the arteries. This injury makes them susceptible to atherosclerosis and **blood clots** (thrombosis).

Causes and symptoms

Coronary artery disease is usually caused by atherosclerosis. Cholesterol and other fatty substances accumulate on the inner wall of the arteries. They attract fibrous tissue, blood components, and **calcium**, and harden into artery-clogging plaques. Atherosclerotic plaques often form blood clots that also can block the coronary arteries (coronary thrombosis). Congenital defects and **muscle spasms** can also block blood flow. Recent research indicates that infection from organisms such as chlamydia bacteria may be responsible for some cases of coronary artery disease.

A number of major contributing factors increase the risk of developing coronary artery disease. Some of these can be changed and some cannot. People with more risk factors are more likely to develop coronary artery disease.

Major risk factors

Major risk factors significantly increase the chance of developing coronary artery disease. Those that cannot be changed are:

- Heredity–People whose parents have coronary artery disease are more likely to develop it. African Americans also are at increased risk because they experience a higher rate of severe hypertension than whites.
- Sex–Men are more likely to have heart attacks than women and to have them at a younger age. Over age 60, however, women have coronary artery disease at a rate equal to that of men.
- Age–Men who are 45 years of age and older and women who are 55 years of age and older are more likely to have coronary artery disease. Occasionally, coronary disease may strike a person in the 30s. Older people (those over 65) are more likely to die of a heart attack. Older women are twice as likely as older men to die within a few weeks of a heart attack.

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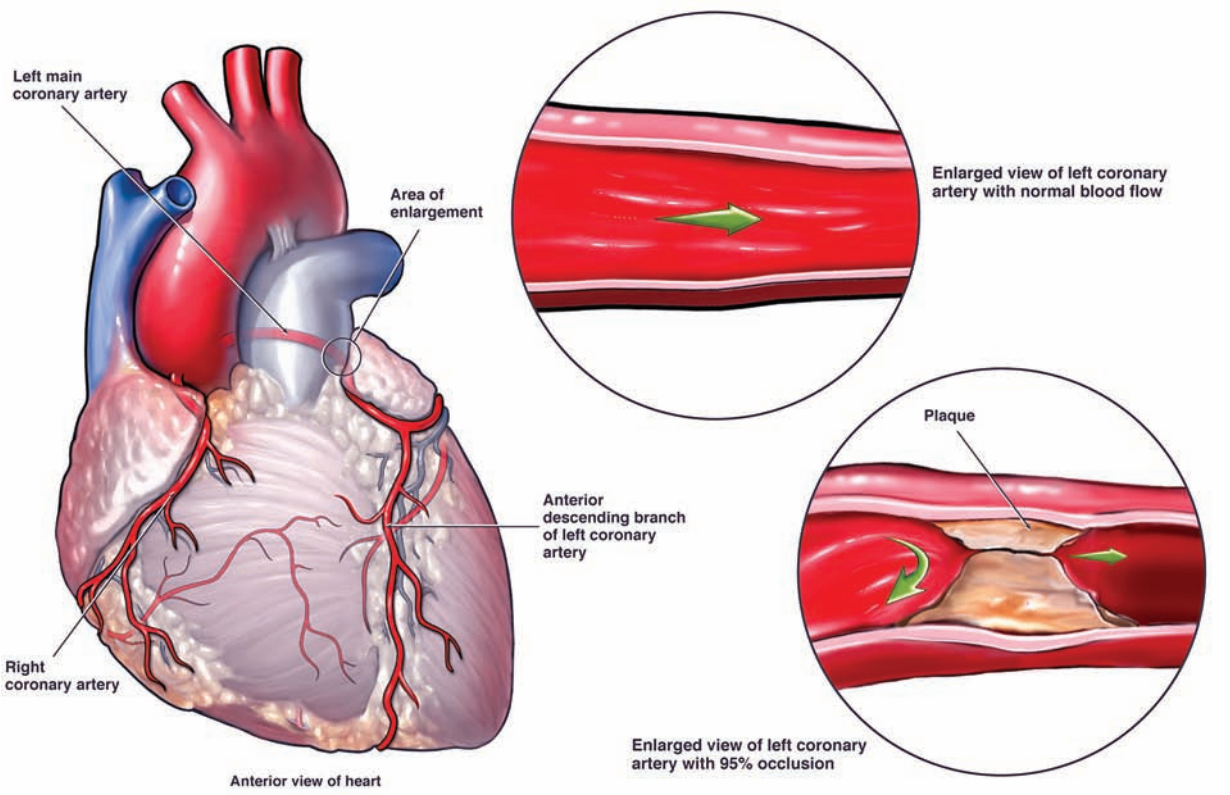

Normal blood flow through the coronary artery compared to blood flow blocked by an occlusion. *(© Nucleus Medical Art, Inc./ Alamy.)*

Major risk factors that can be changed are:

- Smoking–Smoking increases both the chance of developing coronary artery disease and the chance of dying from it. Smokers are two to four times more likely than are non-smokers to die of sudden heart attack. They are more than twice as likely as non-smokers to have a heart attack. They also are more likely to die within an hour of a heart attack. Second hand smoke also may increase risk.
- High cholesterol–Dietary sources of cholesterol are meat, eggs, and other animal products. The body also produces it. Age, sex, heredity, and diet affect one's blood cholesterol. Total blood cholesterol is considered high at levels above 240 mg/dL and borderline at 200-239 mg/dL. High-risk levels of low-density lipoprotein (LDL cholesterol) begin at 130-159 mg/dL, depending on other risk factors. Risk of developing coronary artery disease increases steadily as blood cholesterol levels increase above 160 mg/dL. When a person has other risk factors, the risk multiplies.
- High blood pressure–High blood pressure makes the heart work harder and weakens it over time. It increases the risk of heart attack, stroke, kidney failure, and congestive heart failure. A blood pressure of 140 over 90 or above is considered high. As the numbers rise, high blood pressure goes from Stage 1 (mild) to Stage 4 (very severe). In combination with obesity, smoking, high cholesterol, or diabetes, high blood pressure raises the risk of heart attack or stroke several times.
- Lack of physical activity–Lack of exercise increases the risk of coronary artery disease. Even modest physical activity, like walking, is beneficial if done regularly.
- Diabetes mellitus–The risk of developing coronary artery disease is seriously increased for diabetics. More than 80% of diabetics die of some type of heart or blood vessel disease.

Contributing risk factors

Contributing risk factors have been linked to coronary artery disease, but the degree of their significance is not known yet. Contributing risk factors are:

- Hormone replacement therapy–Evidence from a large trial called the Women's Health Initiative released in 2002 and 2003 found that hormone replacement therapy is a risk factor for coronary artery disease in postmenopausal women. The

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therapy was once thought to help protect women against heart disease, but in the trial, it was discovered that it was harmful to women with existing coronary artery disease.

- Obesity–Excess weight increases the strain on the heart and increases the risk of developing coronary artery disease even if no other risk factors are present. Obesity increases blood pressure and blood cholesterol and can lead to diabetes.
- Stress and anger–Some scientists believe that stress and anger can contribute to the development of coronary artery disease and increase the blood's tendency to form clots (thrombosis). Stress, the mental and physical reaction to life's irritations and challenges, increases the heart rate and blood pressure and can injure the lining of the arteries. Evidence shows that anger increases the risk of dying from heart disease. The risk of heart attack is more than double after an episode of anger.

Chest pain (angina) is the main symptom of coronary heart disease but it is not always present. Other symptoms include **shortness of breath**, and chest heaviness, tightness, pain, a burning sensation, squeezing, or pressure either behind the breastbone or in the arms, neck, or jaws. Many people have no symptoms of coronary artery disease before having a heart attack; 63% of women and 48% of men who died suddenly of coronary artery disease had no previous symptoms of the disease, according to the American Heart Association.

Diagnosis

Diagnosis begins with a visit to the physician, who will take a medical history, discuss symptoms, listen to the heart, and perform basic screening tests. These tests will measure weight, blood pressure, blood lipid levels, and **fasting** blood glucose levels. Other diagnostic tests include resting and exercise electrocardiogram, **echocardiography**, radionuclide scans, and coronary **angiography**. The treadmill exercise (**stress**) test is an appropriate screening test for those with high risk factors even when they feel well.

An electrocardiogram (ECG) shows the heart's activity and may reveal a lack of oxygen (ischemia). Electrodes covered with conducting jelly are placed on the patient's chest, arms, and legs. They send impulses of the heart's activity through an oscilloscope (a monitor) to a recorder that traces them on paper. The test takes about 10 minutes and is performed in a physician's office. A definite diagnosis cannot be made from **electrocardiography**. About 50% of patients with significant coronary artery disease have normal resting electrocardiograms. Another type of electrocardiogram, known as the exercise **stress test**, measures how the heart and blood vessels respond to exertion when the patient is exercising on a treadmill or a stationary bike. This test is performed in a physician's office or an exercise laboratory. It takes 15–30 minutes. It is not perfectly accurate. It sometimes gives a normal reading when the patient has a heart problem or an abnormal reading when the patient does not.

If the electrocardiogram reveals a problem or is inconclusive, the next step is exercise echocardiography or nuclear scanning (angiography). Echocardiography, cardiac ultrasound, uses sound waves to create an image of the heart's chambers and valves. A technologist applies gel to a hand-held transducer, then presses it against the patient's chest. The heart's sound waves are converted into an image that can be displayed on a monitor. It does not reveal the coronary arteries themselves, but can detect abnormalities in heart wall motion caused by coronary disease. Performed in a cardiology outpatient diagnostic laboratory, the test takes 30–60 minutes.

Radionuclide angiography enables physicians to see the blood flow of the coronary arteries. Nuclear scans are performed by injecting a small amount of radiopharmaceutical such as thallium into the bloodstream. A device that uses gamma rays to produce an image of the radioactive material (gamma camera) records pictures of the heart. Radionuclide scans are not dangerous. The radiation exposure is about the same as that in a **chest x ray**. The tiny amount of radioactive material used disappears from the body in a few days. Radionuclide scans cost about four times as much as exercise stress tests but provide more information.

In radionuclide angiography, a scanning camera passes back and forth over the patient who lies on a table. Radionuclide angiography is usually performed in a hospital's nuclear medicine department and takes 30–60 minutes. Thallium scanning usually is done in conjunction with an exercise stress test. When the stress test is finished, thallium or sestamibi is injected. The patient resumes exercise for one minute to absorb the thallium. For patients who cannot exercise, cardiac blood flow and heart rate may be increased by intravenous dipyridamole (Persantine) or adenosine. Thallium scanning is done twice, immediately after injecting the radiopharmaceutical and again four hours (and maybe 24 hours) later. It is usually performed in a hospital's nuclear medicine department. Each scan takes 30–60 minutes.

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Coronary angiography is the most accurate method for making a diagnosis of coronary artery disease, but it also is the most invasive. It is a form of **cardiac catheterization** that shows the heart's chambers, great vessels, and coronary arteries using x-ray technology. During coronary angiography the patient is awake but sedated. ECG electrodes are placed on the patient's chest and an intravenous line is inserted. A local anesthetic is injected into the site where the catheter will be inserted. The cardiologist inserts a catheter into a blood vessel and guides it into the heart. A contrast dye is injected to make the heart visible on x-ray cinematography. Coronary angiography is performed in a cardiac catheterization laboratory either in an outpatient or inpatient surgery unit. It takes from 30 minutes to two hours.

Treatment

Coronary artery disease can be treated many ways. The choice of treatment depends on the severity of the disease. Treatments include lifestyle changes and drug therapy, percutaneous transluminal coronary **angioplasty**, and coronary artery bypass surgery. Coronary artery disease is a chronic disease requiring lifelong care. Angioplasty or bypass surgery is not a cure.

People with less severe coronary artery disease may gain adequate control through lifestyle changes and drug therapy. Many of the lifestyle changes that prevent disease progression–a low-fat, low-cholesterol diet, weight loss if needed, exercise, and not smoking–also help prevent the disease from developing.

Drugs such as nitrates, beta-blockers, and calcium-channel blockers relieve chest pain and complications of coronary artery disease, but they cannot clear blocked arteries. Nitrates (nitroglycerin) improve blood flow to the heart. Beta-blockers (acebutelol, propranolol) reduce the amount of oxygen required by the heart during stress. One type of calcium-channel blocker (verapamil, diltiazem hydrochloride) helps keep the arteries open and reduces blood pressure. **Aspirin** helps prevent blood clots from forming on plaques, reducing the likelihood of a heart attack. Cholesterol-lowering medications are also indicated in most cases.

Percutaneous transluminal coronary angioplasty and bypass surgery are procedures that enter the body (invasive procedures) to improve blood flow in the coronary arteries. Percutaneous transluminal coronary angioplasty, usually called coronary angioplasty, is a non-surgical procedure. A catheter tipped with a balloon is threaded from a blood vessel in the thigh into the blocked artery. The balloon is inflated, compressing the plaque to enlarge the blood vessel and open the blocked artery. The balloon is deflated, and the catheter is removed. Coronary angioplasty is performed in a hospital and generally requires a stay of one or two days. Coronary angioplasty is successful about 90% of the time, but for one-third of patients, the artery narrows again within six months. The procedure can be repeated. It is less invasive and less expensive than coronary artery bypass surgery.

In coronary artery bypass surgery, a healthy artery or vein from an arm, leg, or chest wall is used to build a detour around the coronary artery blockage. The healthy vessel then supplies oxygen-rich blood to the heart. Bypass surgery is major surgery. It is appropriate for those patients with blockages in two or three major coronary arteries, those with severely narrowed left main coronary arteries, and those who have not responded to other treatments. It is performed in a hospital under **general anesthesia**. A heart-lung machine is used to support the patient while the healthy vein or artery is attached past the blockage to the coronary artery. About 70% of patients who have bypass surgery experience full relief from angina; about 20% experience partial relief. Only about 3–4% of patients per year experience a return of symptoms. Survival rates after bypass surgery decrease over time. At five years after surgery, survival expectancy is 90%; at 10 years about 80%, at 15 years about 55%, and at 20 years about 40%.

Various semi-experimental surgical procedures for unblocking coronary arteries are currently being studied. **Atherectomy** is a procedure in which the surgeon shaves off and removes strips of plaque from the blocked artery. In laser angioplasty, a catheter with a laser tip is inserted into the affected artery to burn or break down the plaque. A metal coil called a stent can be implanted permanently to keep a blocked artery open. Stenting is becoming more common.

Alternative treatment

Natural therapies may reduce the risk of certain types of heart disease, but once symptoms appear, conventional medical attention is necessary. A healthy diet (including cold-water fish as a source of essential fatty acids) and exercise, important components of conventional prevention and treatment strategies, also are emphasized in alternative approaches to coronary artery disease. Herbal medicine offers a variety of remedies that may have a beneficial effect on coronary artery disease. For example, ginger (*Zingiber officinale*) may help reduce cholesterol. Garlic (*Allium sativum*), ginger, and hot red or chili peppers all are circulatory enhancers that can help prevent blood

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clots. **Yoga** and other bodywork, massage, relaxation therapies, and talking therapies also may help prevent coronary artery disease and stop, or even reverse, the progression of atherosclerosis. Vitamin and mineral therapy to reduce, reverse, or protect against coronary artery disease include chromium, calcium and magnesium, B-complex **vitamins**, the antioxidant vitamins C and E, selenium, and zinc. **Traditional Chinese medicine** may recommend herbal remedies, massage, **acupuncture**, and dietary modification. However, studies released in 2003 showed that vitamins C and E fell short of claims that they helped narrow blockage caused by coronary artery disease. In fact, high doses of the vitamins should be avoided.

Prognosis

In many cases, coronary artery disease can be successfully treated. Advances in medicine and healthier lifestyles have caused a substantial decline in death rates from coronary artery disease since the mid-1980s. New diagnostic techniques enable doctors to identify and treat coronary artery disease in its earliest stages. New technologies and surgical procedures have extended the lives of many patients who would otherwise have died. Research on coronary artery disease continues.

Prevention

A healthy lifestyle can help prevent coronary artery disease and help keep it from progressing. A heart-healthy lifestyle includes eating right, regular exercise, maintaining a healthy weight, no **smoking**, moderate drinking, no recreational drugs, controlling **hypertension**, and managing stress. **Cardiac rehabilitation** programs are excellent to help prevent recurring coronary problems for people who are at risk and who have had coronary events and procedures.

Eating right

A healthy diet includes a variety of foods that are low in fat, especially saturated fat, low in cholesterol, and high in fiber. It includes plenty of fruits and vegetables, nuts and whole grains, and limited **sodium**. Some foods are low in fat but high in cholesterol and some are low in cholesterol but high in fat. Saturated fat raises cholesterol and, in excessive amounts, increases the amount of the clot-forming proteins in blood. Polyunsaturated and monounsaturated fats are good for the heart. Fat should comprise no more than 30% of total daily calories.

Cholesterol, a waxy substance containing fats, is found in foods such as meat, eggs, and other animal products. It also is produced in the liver. Soluble fiber can help lower cholesterol. Dietary cholesterol should be limited to about 300 milligrams per day. Many popular lipid-lowering drugs can reduce LDL cholesterol by an average of 25–30% when used with a low-fat, low-cholesterol diet.

Fruits and vegetables are rich in fiber, vitamins, and **minerals**. They are low calorie and nearly fat free. Vitamin C and beta-carotene, found in many fruits and vegetables, keep LDL cholesterol from turning into a form that damages coronary arteries.

Excess sodium can increase the risk of high blood pressure. Many processed foods contain large amounts of sodium. Daily intake should be limited to about 2,400 milligrams, about the amount in a teaspoon of salt.

The "Food Guide" Pyramid developed by the U.S. Departments of Agriculture and Health and Human Services provides easy-to-follow guidelines for daily heart-healthy eating. It recommends 6 to 11 servings of bread, cereal, rice, and pasta; three to five servings of vegetables; two to four servings of fruit; two to three servings of milk, yogurt, and cheese; and two to three servings of meat, poultry, fish, dry beans, eggs, and nuts. Fats, oils, and sweets should be used sparingly. Canola and olive oil are better for the heart than other cooking oils. Coronary patients should be on a strict diet. In 2003, the American Heart Association advised a diet rish in fatty fish such as salmon, herring, trout, or sardines. If people cannot eat daily servings of these fish, the association recommends three fish oil capsules per day.

Regular exercise

Aerobic exercise can lower blood pressure, help control weight, and increase HDL ("good") cholesterol. It may keep the blood vessels more flexible. The Centers for Disease Control and Prevention and the American College of Sports Medicine recommend moderate to intense aerobic exercise lasting about 30 minutes four or more times per week for maximum heart health. Three 10-minute exercise periods also are beneficial. Aerobic exercise–activities such as walking, jogging, and cycling–uses the large muscle groups and forces the body to use oxygen more efficiently. It also can include everyday activities such as active gardening, climbing stairs, or brisk housework. People with coronary artery disease or risk factors should consult a doctor before beginning an exercise program.

Maintaining a desirable body weight

About one-fourth of all Americans are overweight and nearly one-tenth are obese, according to the

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KEY TERMS

Atherosclerosis—A process in which the walls of the coronary arteries thicken due to the accumulation of plaque in the blood vessels. Atherosclerosis is the cause of coronary artery disease.

Angina—Chest pain that happens when diseased blood vessels restrict the flow of blood to the heart. Angina often is the first symptom of coronary artery disease.

Beta-blocker—A drug that blocks some of the effects of fight-or-flight hormone adrenaline (epinephrine and norepinephrine), slowing the heart rate and lowering the blood pressure.

Calcium-channel blocker—A drug that blocks the entry of calcium into the muscle cells of small blood vessels (arterioles) and keeps them from narrowing.

Coronary arteries—The main arteries that provide blood to the heart. The coronary arteries surround the heart like a crown, coming out of the aorta, arching down over the top of the heart, and dividing into two branches. These are the arteries in which coronary artery disease occurs.

HDL cholesterol—High-density lipoprotein cholesterol is a component of cholesterol that helps protect against heart disease. HDL is nicknamed "good" cholesterol.

LDL cholesterol—Low-density lipoprotein cholesterol is the primary cholesterol molecule. High levels of LDL increase the risk of coronary heart disease. LDL is nicknamed "bad" cholesterol.

Plaque—A deposit of fatty and other substances that accumulate in the lining of the artery wall.

Triglyceride—A fat that comes from food or is made from other energy sources in the body. Elevated triglyceride levels contribute to the development of atherosclerosis.

Surgeon General's Report on **Nutrition** and Health. People who are 20% or more over their ideal body weight have an increased risk of developing coronary artery disease. Losing weight can help reduce total and LDL cholesterol, reduce **triglycerides**, and boost HDL cholesterol. It also may reduce blood pressure. Eating right and exercising are two key components of losing weight.

Avoiding recreational drugs

Smoking has many adverse effects on the heart. It increases the heart rate, constricts major arteries, and can create irregular heartbeats. It raises blood pressure, contributes to the development of plaque, increases the formation of blood clots, and causes blood platelets to cluster and impede blood flow. Heart damage caused by smoking can be repaired by quitting. Even heavy smokers can return to heart health. Several studies have shown that ex-smokers face the same risk of heart disease as non-smokers within 5 to 10 years after quitting.

Drink in moderation. Modest consumption of alcohol may actually protect against coronary artery disease because alcohol appears to raise levels of HDL cholesterol. The American Heart Association defines moderate consumption as one ounce of alcohol per day, roughly one cocktail, one 8-ounce glass of wine, or two 12-ounce glasses of beer. However, even moderate drinking can increase risk factors for heart disease for some people (by raising blood pressure, for example). Excessive drinking always is bad for the heart. It usually raises blood pressure and can poison the heart and cause abnormal heart rhythms or even **heart failure**.

Do not use other recreational drugs. Commonly used recreational drugs, particularly **cocaine** and "crack," can seriously harm the heart and should never be used.

Seeking treatment for hypertension

High blood pressure, one of the most common and serious risk factors for coronary artery disease, can be controlled completely through lifestyle changes and medication. Moderate hypertension can be controlled by reducing dietary intake of sodium and fat, exercising regularly, managing stress, abstaining from smoking, and drinking alcohol in moderation. People for whom these changes do not work or people with severe hypertension may be helped by many categories of medication.

Managing stress

Everyone experiences stress. Stress sometimes can be avoided and when it is inevitable, it can be

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controlled. It is particularly important for those at risk for heart disease. A 2003 report showed that middle-aged men with high **anxiety** were less likely to adhere to heart healthy lifestyle practices. Techniques for controlling stress include: taking life more slowly, spending more time with family and friends, thinking positively, getting enough sleep, exercising, and practicing relaxation techniques.

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ORGANIZATIONS

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National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

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Coronary disease *see* **Coronary artery disease**

Coronary heart disease *see* **Coronary artery disease**

Coronary stenting

Definition

A coronary stent is an artificial support device used in the coronary artery to keep the vessel open.

Purpose

The coronary stent is a relatively new tool used to keep coronary arteries expanded, usually following a balloon **angioplasty**. Balloon angioplasty is used in patients with **coronary artery disease**. In this disease, the blood vessels on the heart become narrow. When this happens, the oxygen supply is reduced to the heart muscle. The primary cause of coronary artery disease is fat deposits blocking the arteries (**atherosclerosis**). In many cases, balloon angioplasty is unsuccessful and the vessel closes after the procedure (restenosis). By forming a rigid support, the stent can prevent restenosis and reduce the need for coronary bypass surgery. The stent is usually a stainless steel mesh tube. Since the stent will be placed inside an artery, the device comes in various sizes to match the size of the artery.

Precautions

Any foreign object in the body, like a stent, will increase the risk of thrombosis. Anticlotting medication is given to prevent this complication.

Description

Coronary stenting usually follows balloon angioplasty, which requires inserting a balloon catheter into the femoral artery in the upper thigh. When this catheter is positioned at the location of the blockage in the coronary artery, it is slowly inflated to widen that artery, and is then removed. The stent catheter is then threaded into the artery and the stent is placed around a deflated balloon. When this is correctly positioned in the coronary artery, the balloon is inflated, expanding the stent against the walls of the coronary artery. The balloon catheter is removed, leaving the stent in place to hold the coronary artery open. A cardiac **angiography** will follow to insure that the stent is keeping the artery open.

Alternative procedures

Balloon angioplasty and coronary stenting are performed to relieve the symptoms of coronary artery disease. By the time coronary artery disease progresses and requires balloon angioplasty, there is no alternative to balloon angioplasty other than coronary

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KEY TERMS

Balloon angioplasty—The use of a balloon attached to a catheter to widen an artery that has become narrowed. As the balloon is inflated, it opens the artery.

Cardiac angiography—A procedure used to visualize blood vessels of the heart. A catheter is used to inject a dye into the vessels; the vessels can then be seen by x ray.

Catheter—A long thin flexible tube that can be inserted into the body; in this case, it is threaded to the heart.

Restenosis—The narrowing of a blood vessel after it has been opened, usually by balloon angioplasty.

Thrombosis—The development of a blood clot in the vessels. This thrombosis may clog a blood vessel and stop the flow of blood.

bypass surgery. Coronary bypass surgery carries greater risks. However, since coronary artery disease can be related to high fat **diets**, **smoking**, and lack of **exercise**, changes in lifestyle may reduce the risk of developing the disease. Various medications for **cholesterol, high** blood pressure, and diabetes also can help treat or prevent coronary artery disease.

Preparation

Before the stent is inserted, the patient will probably be instructed to take **aspirin** for several days. Aspirin can help decrease the possibility of **blood clots** forming at the stent. Because anesthesia will be used during the procedure, the patient should not eat or drink after midnight of the previous day.

Aftercare

Following the procedure, blood thinners (anticoagulants) will be given through a needle in a vein for about 24 hours. The patient should remain flat and still for awhile to allow the femoral artery to heal from the insertion of the catheter. Medication to control blood clotting should be taken after the patient is discharged from the hospital. A special diet may also be recommended that is low in vitamin K and cholesterol. With time, the patient should begin light exercise, like walking. It is important that no **magnetic resonance imaging** (MRI) tests are given for six months because the magnetic field may move the stent.

Risks

Although coronary stents greatly reduce the risk of restenosis following balloon angioplasty, there is still some risk that the stented artery may close. Thrombosis, bleeding, and artery damage are also risks.

Resources

OTHER

AdvocateHealthCare. http://www.advocatehealth.com.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

Cindy L. A. Jones, PhD

Coronary thrombosis *see* **Heart attack**
Coronavirus infection *see* **Common cold**

Corticosteroids

Definition

Corticosteroids are group of natural and synthetic analogues of the hormones secreted by the hypothalamic-anterior pituitary-adrenocortical (HPA) axis, more commonly referred to as the pituitary gland. These include glucocorticoids, which are anti-inflammatory agents with a large number of other functions; mineralocorticoids, which control salt and water balance primarily through action on the kidneys; and corticotropins, which control secretion of hormones by the pituitary gland.

Purpose

Glucocorticoids have multiple effects, and are used for a large number of conditions. They affect glucose utilization, fat metabolism, and bone development, and are potent anti-inflammatory agents. They may be used for replacement of natural hormones in patients with pituitary deficiency (**Addison's disease**), as well as for a wide number of other conditions including, but not limited to, arthritis, **asthma**, anemia, various cancers, and skin inflammations. Additional uses include inhibition of **nausea and vomiting** after **chemotherapy**, treatment of **septic shock**, treatment of spinal cord injuries, and treatment of hirisutism (excessive hair growth). The choice of drug will vary with the condition. Cortisone and hydrocortisone, which have both glucocorticoid and mineralocorticoid effects, are the

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KEY TERMS

Hallucination—A false or distorted perception of objects, sounds, or events that seems real. Hallucinations usually result from drugs or mental disorders.

Hormone—A substance that is produced in one part of the body, then travels through the bloodstream to another part of the body where it has its effect.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Ointment—A thick, spreadable substance that contains medicine and is meant to be used on the outside of the body.

Pregnancy category— A system of classifying drugs according to their established risks for use during pregnancy. Category A: controlled human studies have demonstrated no fetal risk. Category B: animal studies indicate no fetal risk, but no human studies; or adverse effects in animals, but not in well-controlled human studies. Category C: no adequate human or animal studies; or adverse fetal effects in animal studies, but no available human data. Category D: evidence of fetal risk, but benefits outweigh risks. Category X: evidence of fetal risk. Risks outweigh any benefits.

drugs of choice for replacement therapy of natural hormone deficiency. Synthetic compounds, which have greater anti-inflammatory effects and less effect on salt and water balance, are usually preferred for other purposes. These compounds include dexamethasone, which is almost exclusively glucocorticoid in its actions, as well as prednisone, prednisolone, betamethasone, trimacinolone, and others. Glucocorticoids are formulated in oral dosage forms, topical creams and ointments, oral and nasal inhalations, rectal foams, and ear and eye drops.

Mineralocorticoids control the retention of **sodium** in the kidneys. In mineralocorticoid deficiency, there is excessive loss of sodium through the kidneys, with resulting water loss. Fludrocortisone (Florinef) is the only drug available for treatment of mineralocorticoid deficiency, and is available only in an oral dosage form.

Corticotropin (ACTH, adrenocorticotropic hormone) stimulates the pituitary gland to release cortisone. A deficiency of corticotropic hormone will have the same effects as a deficiency of cortisone. The hormone, which is available under the brand names Acthar and Actrel, is used for diagnostic testing, to determine the cause of a glucocorticoid deficiency, but is rarely used for replacement therapy since direct administration of glucocorticoids may be easier and offers better control over dosages.

Recommended dosage

The dosage of glucocorticoids varies with the drug, route of administration, condition being treated, and patient. Consult specific references.

Fludrocortisone, for use in replacement therapy, is normally dosed at 0.1 mg/day. Some patients require higher doses. It should normally be administered in conjunction with cortisone or hydrocortisone.

ACTH, when used for diagnostic purposes, is given as 10 to 25 units dissolved in 500 mL of 5% dextrose injection infused IV over eight hours. A long-acting form, which may be used for replacement therapy, is given by subcutaneous (SC) or intramuscular (IM) injection at a dose of 40 to 80 units every 24–72 hours.

Precautions

Glucocorticoids

The most significant risk associated with administration of glucocorticoids is suppression of natural corticosteroid secretion. When the hormones are administered, they suppress the secretion of ACTH, which in turn reduces the secretion of the natural hormones. The extent of suppression varies with dose, drug potency, duration of treatment, and individual patient response. While suppression is seen primarily with drugs administered systemically, it can also occur with topical drugs such as creams and ointments, or drugs administered by inhalation. Abrupt cessation of corticosteroids may result in acute adrenal crisis (Addisonian crisis) that is marked by **dehydration** with severe **vomiting** and **diarrhea**, **hypotension**, and loss of consciousness. Acute adrenal crisis is potentially fatal.

Chronic overdose of glucocorticoids leads to Cushingoid syndrome, which is clinically identical to **Cushing's syndrome** and differs only in that in Cushingoid the excessive **steroids** are from drug therapy rather than excessive glandular secretion. Symptoms vary, but most

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people have upper body **obesity**, rounded face, increased fat around the neck, and thinning arms and legs. In its later stages, this condition leads to weakening of bones and muscles with rib and spinal column **fractures**.

The short term adverse effects of corticosteroids are generally mild, and include **indigestion**, increased appetite, **insomnia**, and nervousness. There are also a very large number of infrequent adverse reactions, the most significant of which is drug-induced **paranoia**. **Delirium**, depression, menstrual irregularity, and increased hair growth are also possible. Consult detailed reviews for further information.

Long-term use of topical glucocorticoids can result in thinning of the skin. Oral steroid inhalations may cause fungal overgrowth in the oral cavity. Patients must be instructed to rinse their mouths carefully after each dose. Corticosteroids are **pregnancy** category C. The drugs have caused congenital malformations in animal studies, including **cleft palate**. **Breastfeeding** should be avoided.

Mineralocorticoids

Because fludrocortisone has glucocorticoid activity as well as mineralocorticoid action, the same hazards and precautions apply to fludrocortisone as to the glucocorticoids. Overdose of fludrocortisone may also cause **edema**, **hypertension** and congestive **heart failure**.

Corticotropin has all the same risks as the glucocorticoids. Prolonged use may cause reduced response to the stimulatory effects of corticotropin.

Warnings and contraindications

Use corticosteroids with caution in patients with the following conditions:

- osteoporosis or any other bone disease
- current or past tuberculosis
- glaucoma or cataracts
- infections of any type (virus, bacteria, fungus, amoeba)
- sores in the nose or recent nose surgery (if using nasal spray forms of corticosteroids)
- underactive or overactive thyroid
- liver disease
- stomach or intestine problems
- diabetes
- heart disease
- high blood pressure
- high cholesterol
- kidney disease or kidney stones
- myasthenia gravis
- systemic lupus erythematosus (SLE)
- emotional problems
- skin conditions that cause the skin to be thinner and bruise more easily

Interactions

Corticosteroids have many **drug interactions**. Consult specific references.

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Corticosteroids, dermatologic

Definition

Dermatologic **corticosteroids** are anti-inflammatory compounds formulated for application to the skin. They are intended for local effects only and are not meant for internal use.

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KEY TERMS

Corticosteroids—Any of the steroid hormones produced by the adrenal cortex or their synthetic equivalents.

Dermatitis—A disease in which the skin is red and painful. This condition may have different causes. In contact dermatitis, the redness is a reaction to something touching the skin, such as a fabric dye or a metal. Atopic dermatitis is an intense reddening reaction, associated with allergies.

Eczema—A skin disease that causes redness, itching, and scaly or crusty sores. In asteatotic eczema the skin is dry and scaly. Stasis eczema is caused by reduced blood flow.

Lichen planus—An uncommon disorder involving a recurrent, itchy, inflammatory rash or lesion on the skin or in the mouth. The exact cause is unknown, but the disorder is likely to be related to an allergic or immune reaction. The skin lesions are distinct from other disorders.

Systemic—Affecting the entire body.

Topical—Pertaining to a particular surface area and affecting only the area to which it is applied.

Ulceration—Being eroded away, as by an ulcer.

Purpose

Dermatologic corticosteroids are used to treat skin conditions that involve inflammation, usually marked by redness or **itching**. These include **contact dermatitis**, **atopic dermatitis**, nummular **eczema**, stasis eczema, asteatotic eczema, **lichen planus**, **lichen simplex chronicus**, insect and arthropod bite reactions, and first- and second-degree localized **burns** and sunburns.

In addition, dermatologic corticosteroids may be used together with other drugs to treat the symptoms of other conditions which are marked by inflammation of the skin.

Description

All dermatologic **steroids** are based on the natural hormone hydrocortisone, but most have been subject to chemical modification to increase their effectiveness. While many chemical changes to the original molecule will increase the anti-inflammatory effects, the best known is halogenation, replacing one or more of the carbon atoms in the molecule with an atom of fluorine or, less often, chlorine. This change increases the anti-inflammatory effects of the steroid but also increases the risk of some adverse effects.

Topical steroids are usually classed by their potency, ranging from very high to low potency. The most powerful steroids include clobetasol propionate, diflorasone diacetate, and halobetasol propionate. The high and medium potency group includes betamethasone valerate, desoximetasone, fluocininide, halcinonide, and fluandrenolide. Low potency topical steroids include desonide, dexamethasone, fluocinolone acetate, and hydrocortisone.

Topical steroids are particularly affected by their vehicle, which can alter the potency of the product and is particularly important in view of the parts of the body being treated. Lotions are liquid at room temperature and are usually the best choice for application to hairy areas of the body since they can easily reach past the hair. Creams are semi-solid and appropriate for application to most areas. They are usually designed to disappear and leave no sticky residue. This feature makes them appropriate for areas such as the palms of the hands, the face, or areas that are in direct contact with clothing. Ointments are thicker than creams and tend to stay on the skin longer than creams. Pastes are particularly thick ointments, often containing a powder such as zinc oxide, and may be used where a protective effect is needed.

Because of variations in skin thickness, it is essential to match the potency of the steroid with the area being treated. Areas of thick skin may require a very potent steroid in order to penetrate the outer layer of skin. In areas where the skin is thin, a high potency steroid may increase the risk of serious adverse reactions.

Recommended dosage

Most topical steroids are applied twice a day, but applications as frequently as four times a day may be appropriate. In some cases, penetration through the skin may be increased by use of occlusion.

Precautions

Excessive use of topical corticosteroids may lead to systemic side effects. Patients using high potency steroids over large areas of the body for a prolonged period should have adrenal function tests.

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Normally, areas covered by steroid creams should not be bandaged, since doing so increases the absorption of the steroid and may lead to increased adverse effects.

Some commercially available formulations of topical corticosteroids contain sulfites that may cause allergic reactions. Allergic reactions to other ingredients in topical formulations are very infrequent but have been reported.

Topical corticosteroids should not be used in patients with markedly impaired circulation since skin ulceration has occurred in these patients following use of the drugs.

Topical corticosteroids should be used with extreme caution in areas where the skin is infected and should never be used in infected areas unless the infection is being appropriately treated.

When used properly, these medicines have not been shown to cause problems in humans. Studies on **birth defects** have not been done in humans. However, studies in animals have shown that topical corticosteroids, when applied to the skin in large amounts or used for a long time, can cause birth defects. Maternal use of topical corticosteroids has not been reported to cause problems in nursing babies when used properly. However, corticosteroids should not be applied to the breasts before nursing.

Side effects

When dermatologic corticosteroids are used properly, adverse effects are very rare. Even so, the following effects have been reported:

- blood-containing blisters on skin
- burning and itching of skin
- increased skin sensitivity (for some brands of betamethasone lotion)
- lack of healing of skin condition
- numbness in fingers
- painful, red, or itchy, pus-containing blisters in hair follicles
- raised, dark red, wart-like spots on skin, especially when used on the face
- skin infection
- thinning of skin with easy bruising

Excessive use, either because of use of an inappropriately potent steroid, prolonged use, or inappropriate use of occlusion has been known to lead to more severe adverse effects. However, these reactions are very rare.

Interactions

When used properly, topical steroids have no **drug interactions** or interactions with foods because they do not reach significant levels in the body. Application of another ointment to the same area at the same time may dilute the corticosteroid ointment and result in lowered effectiveness.

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Corticosteroids, inhaled

Definition

Inhaled **corticosteroids** are glucocorticoids (a class of steroid hormones that are synthesized by the adrenal cortex and have anti-inflammatory activity) formulated to be used in the respiratory tract and lungs.

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Purpose

Inhaled corticosteroids are glucocorticoid compounds designed to be applied directly to the tissues of the respiratory tract. There are two types. The intranasal are deposited into the nasal passages and may be used to treat **nasal polyps**, perennial **allergic rhinitis**, seasonal allergic **rhinitis**, and recurrent chronic **sinusitis**.

The second type is used when the **steroids** are designed for deposition further into the respiratory tract. These are used for treatment of chronic **asthma** and prevention of asthmatic attacks.

Because they have anti-inflammatory effects, corticosteroids are invaluable in treatment of asthma and other respiratory conditions which are associated with an allergic reaction. In many cases, the corticosteroids are life saving. But **systemic corticosteroids** affect all parts of the body and may cause very severe adverse effects, particularly with long-term use. These reactions include inhibitions of the adrenal glands and weakening of bones. By administering these drugs by inhalation, it is possible to target the areas that require treatment and reduce the amount of drug that reaches other parts of the body. Some patients may be able to do without systemic steroids entirely, while others can reduce their doses of systemic steroids and thereby reduce the risk and severity of unwanted effects.

The drugs used as inhaled steroids are all anti-inflammatory corticosteroids and are very similar to each other in action and use. The way they are formulated, the size of the particles, the design of the inhaler, and whether the drugs are inhaled by the mouth or nose determine how far into the respiratory tract the steroids go. The formulations designed for nasal inhalation are only effective for nasal polyps or rhinitis because the steroid does not penetrate deeply into the respiratory tract. Oral inhalations, containing the same drug but in different particle size and inhaler design, deposit medication deeply into the lungs and are of value in treatment of asthma.

Description

As of 2007, there are eight corticosteroid medications designed for inhalation:

- beclomethasone dipropionate (Qvar, Vanceril, and Beclovent)
- budesonide (Pulmicort)
- flunisolide (AeroBID)
- fluticasone propionate (Flovent)
- triamcinolone acetonide (Azmacort)

Also, there is a combination drug of fluticasone propionate and salmeterol xinafoate (Advair Diskus) available for children over 12 years old. Although the different products vary in potency and duration of action, once dose size and frequency have been adjusted to offer comparable results, there do not appear to be significant differences between the drugs. The design of the inhalers, their ease of use, and the training each patient receives in the proper use of the inhaler may be of greater significance than the drug itself.

Recommended dosage

Although the different products vary in milligram potency, for practical purposes, doses are measured in puffs on the inhaler. For example, beclomethasone will deliver 40 micrograms each time the inhaler is used, while triamcinolone delivers 100 micrograms with each inhalation. However, the effects are essentially equal.

The appropriate dose of inhaled corticosteroids depends on the severity of the case, and in some instances, on what treatment has been used prior to starting inhaled steroid therapy. The doses listed are typical of the inhaled steroids used for asthma therapy but do not represent all possible cases:

- beclomethasone: one to two puffs two times a day
- budesonide: one to two puffs two times a day
- flunisolide: two puffs two times a day
- fluticasone propionate: available in forms that deliver either 50 or 100 micrograms of fluticase in each puff; typical initial dose, 100 micrograms two times a day, representing either one puff of the 100 microgram product or two puffs of the 50 microgram product
- triamcinolone acetonide: two puffs three or four times a day or four puffs twice a day, not to exceed 16 puffs daily

Precautions

Particular care is essential for patients who are transferred from systemic corticosteroids to inhaled steroids. Because the long-term use of oral steroids lowers the output of these compounds from the adrenal gland and normal production does not recur for several months, patients who have their oral doses reduced are at risk of adrenal insufficiency. This condition may become particularly serious in the event of trauma, surgery, or infections. While inhaled steroids may provide adequate control of asthma during these periods, the inhaled drugs do not replace the systemic compounds. In the event of **stress** or a severe asthma attack, oral therapy must immediately begin. Regular testing for cortisol levels is essential until the normal levels have been resumed.

For patients who had been on systemic therapy and are being switched to corticosteroid inhalation,

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the immediate period during which the oral dose is reduced may cause symptoms, including joint or muscle **pain**, tiredness, and depression. Continuous monitoring is required until normal functions have been resumed.

It is essential that patients learn proper use of inhalers. If inhalers are not used properly, the corticosteroids may not reach their intended site of action. Instead, they may be left in the mouth or swallowed and be deposited in the digestive tract. This situation may increase the risk of adverse effects, while reducing the protection from asthmatic attacks.

Inhaled corticosteroids are not for treatment of acute asthmatic attacks or rapid relief of bronchospasm.

Inhaled corticosteroids are designated as **pregnancy** category C. This designation means one of two levels of knowledge concerning the drugs adverse effects. In one instance, studies on animals show adverse fetal effects but there are no controlled studies on women. In the other instance, no studies on animals and women are not available.

KEY TERMS

Adrenal glands—The two glands that are located on top of the kidneys. These glands secrete several hormones, including the glucocorticoids which, among other things, influence the way the immune system works, and the mineralocorticoids, which affect retention of water and sodium.

Glucocorticoid—A class of steroid hormones that are synthesized by the adrenal cortex and have anti-inflammatory activity.

Perennial—Present at all seasons of the year.

Polyp—A small vascular growth on the surface of a mucous membrane.

Respiratory tract—The air passages from the nose to the air sacs of the lungs, including the pharynx, larynx, trachea, and bronchi.

Rhinitis—Inflammation of the mucous membranes of the nose.

Side effects

It can be difficult to evaluate the side effects of inhaled corticosteroids because many of the reported adverse effects are closely associated with dose reduction or discontinuation of systemic steroids. Not all of the adverse reactions listed have been associated with all of the marketed inhaled steroids, but because of the similarities between these drugs, an adverse reaction reported with one must be considered possible for the others.

The most common severe problem is white patches in the mouth due to localized infection. Additional common side effects are:

- cough
- general aches and pains or general feeling of illness
- greenish-yellow mucus in nose
- headache
- hoarseness or other voice changes
- loss of appetite
- runny, sore, or stuffy nose
- unusual tiredness
- weakness

Very rare but severe adverse effects include the following:

- blindness, blurred vision, eye pain
- large hives
- bone fractures
- diabetes mellitus (increased hunger, thirst, or urination)
- excess facial hair in women
- fullness or roundness of face, neck, and trunk
- growth reduction in children or adolescents
- heart problems
- high blood pressure
- hives and skin rash
- impotence in males
- lack of menstrual periods
- muscle wasting
- numbness and weakness of hands and feet
- weakness
- swelling of face, lips, or eyelids
- tightness in chest, troubled breathing, or wheezing

Interactions

Because inhaled steroids do not reach therapeutic levels in the blood stream, there are no serious interactions. Ketoconazole (Nizoral), an antifungal agent, has been reported to increase blood levels of budesonide and fluticasone, but it is unclear whether this has any importance when the steroids are administered by inhalation.

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Corticosteroids, systemic

Definition

Corticosteroids are a group of drugs which are chemically related to the hormones produced by the adrenal glands as a response to adrenocorticotropic hormone (ACTH), but excluding the sex hormones that are produced by this gland. The primary adrenal corticosteroids are cortisol and aldosterone. Cortisol is a glucocorticoid, responsible for influencing carbohydrate, fat, and protein metabolism. Aldosterone is a mineralocorticoid, responsible for regulating salt and water balance.

All corticosteroids, both natural ones and those which have been developed synthetically, share a similar chemical structure, which is based on the structure of cholesterol.

Purpose

The primary purpose of corticosteroids is replacement of naturally occurring hormones when the adrenal glands do not make enough of the natural hormones. Known as **Addison's disease**, this deficit is marked by low blood pressure, weight loss, loss of appetite, weakness, and a bronze-like **hyperpigmentation** of the skin. Addison's disease requires both glucocorticoid and mineralocorticoid treatment.

Because the glucocorticoids inhibit some portions of the immune response, they are used in treatment of a large number of diseases. The following list includes some of the established uses of systemic corticosteroids.

- acute, severe allergic reactions
- arthritis, osteoarthritis, rheumatoid arthritis, psoriatic arthritis, and gouty arthritis
- adrenocortical insufficiency
- allergic conjunctivitis
- allergic rhinitis
- anemia
- (acquired hemolytic and congenital hypoplastic)
- ankylosing spondylitis
- asthma
- beryliosis
- bursitis
- corneal ulcers
- Crohn's disease
- dermatitis (atopic, contact, exfoliative, and seborrheic)
- dermatomyositis
- erythema multiforme
- erythroblastopenia
- herpes zoster of the eye
- hypercalcemia secondary to cancer
- hypersensitivity reactions
- idiopathic thrombocytopenic purpura
- leukemia
- lupus erythematosis
- lymphoma
- multiple myeloma
- multiple sclerosis, acute exacerbations
- mycosis fungoides
- optic neuritis
- pemphigus
- pneumonitis (aspiration)
- rheumatic carditis
- Stevens-Johnson syndrome
- thrombocytopenia
- trichinosis with nerve or heart involvement
- tuberculosis, disseminated and fulminating
- tuberculous meningitis
- ulcerative colitis

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Dexamethasone, a related corticosteroid, is widely used to prevent the **nausea and vomiting** associated with **cancer** therapy.

Glucocorticoid treatment is not a cure for any disease or condition, but it may be used as supportive therapy in addition to other treatments.

Description

Because they both have mineralocorticoid and glucocorticoid effects, cortisone and hydrocortisone are preferred for use in treating adrenal insufficiency. When glucocorticoids are used for their anti-inflammatory and immunosuppressant properties and their effects on blood and lymphatic systems, synthetic compounds, which have increased glucocorticoid effects and minimal mineralocorticoid effects, are generally preferred.

A number of systemic corticosteroid compounds are commercially available. Although they are generally similar, they vary in their potency, sodium-retaining effects, and duration of action.

Short acting

Cortisone has both glucocorticoid and mineralocorticoid effects. It has the lowest potency of the commercially available corticosteroids and a short duration of action. It is appropriate for replacement therapy in patients with adrenal insufficiency.

Hydrocortisone has both glucocorticoid and mineralocorticoid effects. It is more potent than cortisone and has a somewhat longer duration of action. Although hydrocortisone may be used for its systemic effects, it is most commonly used in skin preparations.

Intermediate acting

Prednisone is probably the most widely used of the systemic **steroids**. It has about half the sodium-retaining effects of hydrocortisone but several times the anti-inflammatory effects. Because of the low level of mineralocorticoid effects, however, prednisone is not suitable for treatment of adrenal insufficiency unless it is used in combination with a mineralocorticoid drug. Prednisolone is very similar to prednisone. In addition to oral dosage form, it is available for subcutaneous, intramuscular, and intravenous injection.

Triamcinolone is slightly more potent than prednisone or prednisolone but has no sodium-retaining effects. It is administered various ways, including inhalation for respiratory problems and as ointments and creams for skin conditions. Methylprednisolone, which is similar to triamcinolone, is most commonly given by injection.

Long acting

Dexamethasone is a very potent glucocorticoid, with no mineralocorticoid activity. It is used in various forms, including tablets, injection, ointments, and eye and eardrops. In cancer treatment, dexamethasone is used both for its corticosteroid properties and as an antinauseant, to help control the side effects of other drugs. Betamethasone is similar to dexamethasone. Although the drug is available for systemic use, it is more commonly used in the form of inhalations and ointments. Other corticosteroids are available but are most often used in inhalation form, for **asthma**, **allergic rhinitis**, or other respiratory conditions.

Recommended dosage

Dosages of corticosteroids must be individualized based on the drug selected, the condition being treated, and the response of the patient. In adrenal insufficiency, a dose equivalent to 25 mg of cortisone or 20 mg of hydrocortisone is normally appropriate. In other conditions, a pharmacologic dose (any dose in excess of the replacement dose) is called for. The equivalent doses of corticosteroids are as follows:

- cortisone: 25 mg
- hydrocortisone: 20 mg
- prednisolone: 5 mg
- prednisone: 5 mg
- methylprednisolone: 4 mg
- triamcinolone: 4 mg
- dexamethason: 0.75 mg
- betamethasone: 0.6 mg

For short-term use, corticosteroids are normally administered in two or three doses each day. In most cases, an initial dose equivalent to 5 to 60 milligrams of prednisone per day is appropriate. Usually, a response will be seen within ten days. Once a response has been observed, the dose should be carefully reduced to the lowest dose that will provide adequate control. If no response is seen after a reasonable period of time, an alternative method of treatment should be considered. On rare occasions, patients will respond better to one corticosteroid than to others.

In the case of acute exacerbations of **multiple sclerosis**, doses as high as 200 milligrams of prednisone or prednisolone for a week followed by 80 mg every other day for one month have been used.

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Because administration of corticosteroids reduces the output of cortisone from the adrenal glands, dosing should be designed to minimize the effects of corticosteroid therapy on the adrenal glands. For patients who will be taking corticosteroids for a long time, a single dose of the corticosteroid is taken every other morning. This regimen provides benefits for most conditions, while minimizing many adverse effects of long-term steroid administration, including adrenal suppression and protein breakdown. Although alternate day treatment is the preferred dosing schedule, it is not suited for treatment of **rheumatoid arthritis** or ulcerative **colitis**, for which daily doses are essential. Only the shorter acting corticosteroids such as prednisone or prednisolone should be used for alternate-day dosing.

When corticosteroid treatment is being discontinued, it is frequently useful to reduce the dose gradually, over several days. Many of these tapering schedules have been described. In one tapering schedule glucocorticoid dosage is reduced by the equivalent of 2.5–5 mg of prednisone every three to seven days until the physiologic dose (e.g., 5 mg of prednisone or prednisolone, 0.75 mg of dexamethasone, or 20 mg of hydrocortisone) is reached. Other schedules may call for slower dose adjustments. The dose may have to be increased if there is a flare-up of the condition being treated while the dose is being reduced. Then, tapering may begin again, but at a slower rate.

Precautions

Because corticosteroids reduce the immune response, they should not be used in patients who have active fungal infections. Similarly, patients being treated with corticosteroids should avoid receiving live virus vaccines.

Corticosteroids may mask some signs of infection, and new infections may appear during their use. There may be decreased resistance and inability to localize infection. Any evidence of infection should be treated promptly with appropriate anti-infective therapy.

Corticosteroids may activate latent amebic infections. Therefore, it is recommended that latent or active **amebiasis** be ruled out before starting corticosteroid therapy in any patient who has spent time in the tropics or any patient with unexplained **diarrhea**.

Adequate human reproduction studies have not been done with corticosteroids. Use of these drugs in **pregnancy** or in women of childbearing potential requires that the anticipated benefits be weighed against the possible hazards to the mother and embryo or fetus. Infants born of mothers who have received substantial doses of corticosteroids during pregnancy should be carefully observed for signs of hypoadrenalism.

Corticosteroids have been associated with an increased risk of gastric ulcers, and patients are usually advised to take these drugs either with food or a drug which inhibits gastric acid. Those taking high dose steroids or on maintenance therapy should take the medication with meals or a gastric acid blocker to reduce the risk of gastric ulcers. However, these precautions are probably not needed for patients taking low doses for a short period of time.

Side effects

Corticosteroids are generally safe when used for a short period of time with appropriate monitoring. When used for longer periods, the frequency and severity of adverse effects increases dramatically. Many of these effects are the unavoidable results of the normal actions of the steroid drugs and must be considered when people decide on a course of long-term corticosteroid therapy.

Fluid and electrolyte disturbances

Sodium retention, fluid retention, congestive **heart failure** in susceptible patients, potassium loss, **calcium** loss, **hypertension** may result from long-term use.

Muscle and bone

Muscle weakness, loss of muscle mass, **osteoporosis**, compression **fractures** of the spine, aseptic necrosis of femoral and humeral heads, pathologic fracture of long bones, and tendon rupture are all possible effects from long-term use.

Gastrointestinal effects

Peptic ulcer with possible perforation and hemorrhage, perforation of the small and large bowel particularly in patients with inflammatory bowel disease, **pancreatitis**, abdominal distention, and ulcerative esophagitis can result from long-term use.

Skin reactions

Impaired wound healing, thin fragile skin, red spots, increased sweating, reduced reactions to skin tests, along with other reactions, including **rashes**, **itching** and swelling can all result from long-term use.

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KEY TERMS

Crohn's disease—A chronic inflammatory disease of unknown cause, involving any part of the gastrointestinal tract from mouth to anus, but commonly involving the large intestine, with scarring and thickening of the bowel wall. Crohn's disease frequently leads to intestinal obstruction and has a high rate of recurrence after treatment.

Erythema multiforme—A type of hypersensitivity (allergic) reaction that occurs in response to medications, infections, or illness. Medications associated with erythema multiforme include sulfonamides, penicillins, barbiturates, and phenytoin. Associated infections include herpes simplex and mycoplasma infections. In severe cases, the condition is called Stevens-Johnson syndrome.

Erythroblastopenia—A deficiency in the cells that create red blood cells. This condition may be severe and life-threatening, but there is a transient form, seen in young children, which resolves spontaneously and does not recur.

Hypercalcemia—An excessive amount of calcium in the blood. The most common cause an excess hormone secretion from the parathyroid gland, but hypercalcemia may also be seen in some cancers (lung, breast, multiple myeloma), as a side effect of some drugs, or from excess calcium in the diet.

Mycosis fungoides—The most common type of cutaneous T-cell lymphoma. This low-grade lymphoma primarily affects the skin. Generally, it has a slow course and often remains confined to the skin. Over time, in about 10% of cases, it can progress to the lymph nodes and internal organs.

Optic neuritis—Inflammation of the optic nerve (cranial nerve II) which connects to the retina of the eye. This variable condition can be present with any of the following symptoms: blurred vision, loss of visual acuity, loss of some or all color vision, complete or partial blindness, and pain behind the eye.

Pemphigus—An autoimmune disorder in which the immune system produces antibodies against specific proteins in the skin and mucous membrane. These antibodies produce a reaction that leads to a separation of skin cells.

Pneumonitis (aspiration)—Inflammation of the lung caused by inhaling a liquid, usually carbon based.

Stevens-Johnson syndrome—A severe form of erythema multiforme in which the systemic symptoms are severe and the lesions extensive, involving multiple body areas, especially the mucous membranes.

Trichinosis—A roundworm infection, usually contracted by eating raw or undercooked meat. Trichinosis is rare in the United States but a common infection in some parts of the world.

Ulcerative colitis—A chronic, episodic, inflammatory disease of the large intestine and rectum characterized by bloody diarrhea.

Nerves and central nervous system

Convulsions, increased intracranial pressure with **papilledema** (pseudotumor cerebri) usually after treatment, **dizziness** and loss of balance, **headache**, and emotional disturbances can result from long-term use.

Endocrine gland system

Menstrual irregularities, development of cushingoid state, suppression of growth in children, secondary adrenocortical and pituitary unresponsiveness (particularly in times of **stress**, as in trauma, surgery, or illness), decreased carbohydrate tolerance, manifestations of latent **diabetes mellitus**, hyperglycemia, increased requirements for insulin or oral hypoglycemic agents in diabetics, and increased hair growth can result from long-term use.

Eye problems

Cataracts, increased intraocular pressure, glaucoma, and bulging eyes can result from long-term use.

Other problems

Hypersensitivity, blood clotting problems, weight gain, increased appetite, **nausea**, and **hiccups** can result from long-term use.

In addition to this incomplete list of long-term effects, other serious effects have been associated with systemic corticosteroid treatment. The severity and likelihood of adverse effects increases both with dose and duration of treatment. Because of their greater effects on sodium and water, the natural corticosteroids, cortisone, and hydrocortisone are more likely to cause fluid and electrolyte problems than the

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pure glucocorticoids such as dexamethasone and betamethasone.

Interactions

Drugs that stimulate liver enzymes such as phenobarbital, phenytoin, and rifampin may increase the rate of elimination of corticosteroids and may require increases in corticosteroid dose to achieve the desired response.

Drugs such as troleandomycin and ketoconazole may reduce the rate of metabolism of corticosteroids and decrease the rate of elimination. Therefore, the dose of corticosteroid should be lowered to avoid steroid toxicity.

Corticosteroids may increase the rate of elimination of chronic high dose **aspirin**. This effect could lead to decreased salicylate serum levels or increase the risk of salicylate toxicity when corticosteroid is withdrawn.

The effects of corticosteroid treatment on anticoagulants vary. There have been reports of both increased anticoagulant activity and decreased anticoagulant activity. Careful monitoring is essential when corticosteroids are used together with anticoagulants.

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ORGANIZATIONS

American Academy of Allergy, Asthma & Immunology, 555 East Wells Street, Suite 1100, Milwaukee, WI, 53202-3823, (414) 272-6071, http://www.aaaai.org.

American Academy of Dermatology, PO Box 4014, Schaumburg, IL, 60168-4014, (847) 240-1859, (866) 503-SKIN (7546), http://www.aad.org.

Arthritis National Research Foundation, 200 Oceangate, Suite 830, Long Beach, CA, 90802, (562) 983-1410, (800) 588-2873, http://www.curearthritis.org.

Asthma and Allergy Foundation of America, 8201 Corporate Drive, Suite 1000, Landover, MD, 20785, (800) 727-8462, info@aafa.org, http://www.aafa.org/.

European Dermato-Epidemiology Network, Department of Dermatology, University Medical Centre, Groningen, The Netherlands, 9700 RB, 003150 3612520, 003150 3619247, p.j.coenraads@med.umcg.nl, http://eden.dermis.net.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

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Corticotropin test *see* **Adrenocorticotropic hormone test**

Cortisol tests

Definition

This test is a measure of serum cortisol (also known as hydrocortisone), or urine cortisol, (also known as urinary free cortisol), an important hormone produced by a pair of endocrine glands called the adrenal glands.

Purpose

This test is performed on patients who may have malfunctioning adrenal glands. Blood and urine cortisol, together with the determination of adrenocorticotropic hormone (ACTH), are the three most important tests in the investigation of **Cushing's syndrome** (caused by an overproduction of cortisol) and **Addison's disease** (caused by the underproduction of cortisol).

Precautions

Increased levels of cortisol are associated with **pregnancy**. Physical and emotional **stress** can also elevate cortisol levels. Drugs that may cause increased levels of cortisol include estrogen, **oral contraceptives**, amphetamines, cortisone, and spironolactone (Aldactone). Drugs that may cause

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KEY TERMS

Addison's disease—A rare disorder in which symptoms are caused by a deficiency of hydrocortisone (cortisol) and aldosterone, two corticosteroid hormones normally produced by a part of the adrenal glands called the adrenal cortex. Symptoms include weakness, tiredness, vague abdominal pain, weight loss, skin pigmentation and low blood pressure.

Adrenal glands—A pair of endocrine glands (glands that secrete hormones directly into the bloodstream) that are located on top of the kidneys.

Adrenocorticotropic hormone (ACTH)—Also called corticotropin, this hormone is produced by the pituitary gland to stimulate the adrenal cortex to release various corticosteroid hormones.

Cushing's syndrome—A hormonal disorder caused by an abnormally high level of corticosteroid hormones that are produced by the adrenal glands. Corticosteroid hormones control the body's use of nutrients and the excretion of salts and water in the urine. Symptoms include high blood sugar levels, a moon face, weight gain, and increased blood pressure.

decreased levels include androgens, aminoglutethimide, betamethasone, and other steroid medications, danazol, lithium, levodopa, metyrapone and phenytoin (Dilantin).

Description

Cortisol is a potent hormone known as a glucocorticoid that affects the metabolism of carbohydrates, proteins, and fats, but especially glucose. Cortisol increases blood sugar levels by stimulating the release of glucose from glucose stores in cells. It also acts to inhibit insulin, thus affecting glucose transport into cells.

The hypothalamus (an area of the brain), the pituitary gland (sometimes called the "master gland"), and the adrenal glands coordinate the production of cortisol. After corticotropin-releasing hormone (CRH) is made in the hypothalamus, CRH stimulates the pituitary to produce adrenocorticotropic hormone (ACTH). The production of ACTH in turn stimulates a part of the adrenal glands known as the adrenal cortex to produce cortisol. Rising levels of cortisol act as a negative feedback to curtail further production of CRH and ACTH, thus completing an elaborate feedback mechanism.

There are two methods for evaluating cortisol: blood and urine. The most reliable index of cortisol secretion is the 24-hour urine sample collection, but when blood levels are required or requested by the physician, plasma cortisol should be measured in the morning and again in the afternoon. Cortisol levels normally rise and fall during the day in what is called a diurnal variation, so that cortisol is at its highest level between 6–8 a.m. and gradually falls, reaching its lowest point around midnight. One reason for ordering blood cortisol levels versus a 24-hour urine collection is that sometimes the earliest sign of adrenal malfunction is the loss of this diurnal variation, even though the cortisol levels are not yet elevated. For example, individuals with Cushing's syndrome often have upper normal plasma cortisol levels in the morning and exhibit no decline as the day progresses.

Preparation

When testing for cortisol levels through the blood, a blood specimen is usually collected at 8 a.m. and again at 4 p.m. It should be noted that normal values may be transposed in individuals who have worked during the night and slept during the day for long periods of time.

When testing for cortisol level through the urine, a 24-hour urine sample is collected, refrigerated, and sent to the reference laboratory for examination.

Risks

Risks for the blood test are minimal, but may include slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after venipuncture, or hematoma (blood accumulating under the puncture site).

Results

Reference ranges for cortisol vary from laboratory to laboratory but are usually within the following ranges for blood:

- adults (8 a.m.): 6–28 mg/dL; adults (4 p.m.): 2–12 mg/dL

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- child one to six years (8 a.m.): 3–21 mg/dL; child one to six years (4 p.m.): 3–10 mg/dL
- newborn: 1/24 mg/dL

Reference ranges for cortisol vary from laboratory to laboratory, but are usually within the following ranges for 24-hour urine collection:

- adult: 10–100 mg/24 hours
- adolescent: 5–55 mg/24 hours
- child: 2–27 mg/24 hours

Abnormal results

Increased levels of cortisol are found in Cushing's syndrome, excess thyroid (**hyperthyroidism**), **obesity**, ACTH-producing tumors, and high levels of stress.

Decreased levels of cortisol are found in Addison's disease, conditions of low thyroid, and **hypopituitarism**, in which pituitary activity is diminished.

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Cosmetic dentistry

Definition

Cosmetic dentistry includes a variety of dental treatments aimed at improving the appearance of the teeth.

Purpose

The purpose of cosmetic dentistry is to improve the appearance of the teeth using bleaching, bonding, veneers, reshaping, **orthodontics**, or implants.

Description

Bleaching is done to lighten teeth that are stained or discolored. It entails the use of a bleaching solution applied by a dentist or a gel in a tray that fits over the teeth used at home under a dentist's supervision. Bonding involves applying tooth-colored plastic putty, called composite resin, to the surface of chipped or broken teeth. This resin is also used to fill cavities in front teeth (giving a more natural-looking result) and to fill gaps between teeth. Veneers are thin, porcelain shells that cover the front of the teeth. They can improve the appearance of damaged, discolored, misshapen, or misaligned teeth. Reshaping involves the removal of enamel from a misshapen tooth so that it matches other teeth. Orthodontics uses braces to correct the position of crowded or misaligned teeth. Implants are artificial teeth which are attached directly to the jaw to replace missing teeth.

Preparation

Bleaching involves having a custom-made bleaching tray made by the dentist. This tray is worn at home for several hours each day or night. Teeth slowly become white over a period of one to six weeks. Bleaching can also be done in a dentist's office. A heat- or light-activated bleaching solution is applied to six to eight teeth per visit.

Bonding involves etching the surface of the tooth so composite resin can adhere. The dentist then contours the resin to the right shape, and smooths and polishes the resin after it is hard and dry.

To prepare for the application of a veneer, a thin layer of enamel is removed from the tooth (so that the finished tooth will be flush with surrounding teeth) and an impression of the tooth is taken from which the veneer will be created. Before a veneer is applied, the tooth is etched with an acid solution and an adhesive resin is painted on the tooth. The veneer is then applied, the resin is hardened with a bonding light, and the dentist polishes the veneer.

During cosmetic reshaping, some enamel is removed from the uneven tooth so it more closely matches other teeth.

Orthodontics involves applying braces to the teeth, and wires are threaded through the braces. These wires are adjusted to gradually move the teeth to the desired new positions. Over time, crowded or misaligned teeth are straightened.

Implants are more secure and natural looking than dentures or bridgework, but are much more expensive. First, an anchor for the implant is attached to the jaw bone. This surgery can take several hours. About six months later, after the bone around the anchor has healed, a post is attached to the anchor, and an artificial tooth is attached to the post. The whole process may take about nine months to complete.

Aftercare

Periodic touch-up may be needed to keep the teeth white if the teeth have been bleached or bonded.

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KEY TERMS

Bleaching—Technique used to brighten stained teeth.

Bonding—Rebuilding, reshaping, and covering tooth defects using tooth-colored materials.

Composite resin—Plastic material matching natural tooth color used to replace missing parts of a tooth.

Also, the resin used in bonded teeth can be chipped by ice, popcorn kernels, or hard candy, requiring repair. Veneered teeth may need to be reveneered after five to 12 years. Once orthodontic braces are removed, regular visits to the orthodontist are advised because teeth can shift position. Implanted teeth require regular dental checkups to ensure that the anchor and post are stable.

Risks

After teeth are bleached, they may darken faster if exposed to staining products such as coffee or tobacco. Some patients experience increased sensitivity to cold while teeth are being bleached, but the sensitivity usually disappears shortly after completion of the treatment.

Bonded teeth, like bleached teeth, may also stain more easily than natural teeth. Bonding materials also chip easily.

Because cosmetic reshaping involves the removal of enamel, the process is irreversible because enamel cannot be replaced once it is removed.

The anchors of implanted teeth can loosen and cause **pain**; regular dental checkups are recommended.

Results

Cosmetic dentistry can improve the appearance of stained, chipped, misshapen, or crowded teeth.

ORGANIZATIONS

American Dental Association, 211 E. Chicago Ave., Chicago, IL, 60611-2678, (312) 440-2500, http://www.ada.org.

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Cosmetic surgery *see* **Plastic, cosmetic, and reconstructive surgery**

Costochondritis

Definition

Costochondritis is an inflammation and associated tenderness of the cartilage (i.e., the costochondral joints) that attaches the front of the ribs to the breastbone.

Description

Costochondritis causes **pain** in the lower rib area or upper breastbone. Some patients fear they are having a **heart attack**. The most severe pain is usually between the breast and the upper abdomen. The pain may be greater when in sitting or reclining positions. **Stress** may aggravate this condition. Generally the third or fourth ribs are affected. However, any of the seven costochondral junctions may be affected, and more often than not more than one site is involved. The inflammation can involve cartilage areas on both sides of the sternum, but usually is on one side only. Costochondritis should be distinguished from Tietze Syndrome, which is an inflammation involving the same area of the chest, but also includes swelling.

Causes and symptoms

The causes of costochondritis are not well-understood and may be difficult to establish. The most likely causes include injury, repetitive minor trauma, and unusual excessive physical activity.

The primary symptom of costochondritis is severe chest wall pain, which may vary in intensity. The pain becomes worse with trunk movement, deep breathing, and/or exertion, and better with decreased movement, quiet breathing, or changing of position. It is usually localized but may radiate extensively from the chest area. The pain has been described as sharp, nagging, aching, or pressure-like.

Diagnosis

Diagnosis is based on pain upon palpation (gentle pressing) of the affected joints. Swelling is not associated with costochondritis. Diagnosis is also dependent on the exclusion of other causes, including heart attack or bacterial or fungal infections found in IV drug users or postoperative **thoracic surgery** patients.

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KEY TERMS

Inflammation— Process whereby the immune system reacts to infection or other stimulus, characterized by pain, swelling, redness, and warmth of the affected part

Treatment

The goals of treatment are to reduce inflammation and to control pain. To accomplish these goals, nonsteroidal anti-inflammatory agents (NSAIDs) are used, with ibuprofen usually selected as the drug of choice. Other NSAIDS options are flurbiprofen, mefenamic acid, ketoprofen, and naproxen. Additional treatment recommendations include the use of local heat, **biofeedback**, and gentle stretching of the pectoralis muscles two to three times a day.

For more difficult cases, where the patient continues to exhibit pain and discomfort, cortisone injections are used as therapy.

Alternative treatment

Supplements that are used to reduce inflammation have been used to treat costochondritis. Examples of such supplements include ginger root, evening primrose oil, bromelain, vitamin E, omega-3 oils, and white willow bark. Glucosamine/chondroitin sulfate, which may aid in the healing of cartilage, has also been used. Other alternative therapies include **acupuncture** and massages.

Prognosis

The prognosis for recovery from costochondritis is good. For most patients, the condition lessens in six months to a year. However, after one year, about one-half of patients continue with some discomfort, while about one-third still report tenderness with palpation.

Prevention

Though the causes of costochondritis are not well known, avoidance of activities that may strain (e.g., the repetitive misuse of muscles) or cause trauma to the rib cage is recommended to prevent the occurrence of costochondritis. Modification of improper posture or ergonomics of the home or work place may also deter the development of this condition.

Resources

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Judith Sims

Cotrel-Dubousset spinal instrumentation *see* **Spinal instrumentation**

Cough

Definition

A cough is a forceful release of air from the lungs that can be heard. Coughing helps to protect the respiratory system by clearing it of irritants and secretions.

Demographics

Forty percent of Americans are estimated to experience a chronic cough, defined as a cough that persists for at least eight weeks, at some point during their lives.

Description

While people can generally cough voluntarily, a cough is usually a reflex triggered when an irritant stimulates one or more of the cough receptors found at different points in the respiratory system. These receptors then send a message to the cough center in the brain, which in turn tells the body to cough. A cough begins with a deep breath in, at which point the opening between the vocal cords at the upper part of the larynx (glottis) shuts, trapping the air in the lungs. As the diaphragm and other muscles involved in breathing press against the lungs, the glottis suddenly opens, producing an explosive outflow of air at speeds greater than 100 mi (160 km) per hour.

In normal situations, most people cough once or twice an hour during the day to clear the airway of irritants. However, when the level of irritants in the air is high or when the respiratory system becomes infected, coughing may become frequent and prolonged. It may interfere with **exercise** or sleep, and it

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may cause distress if accompanied by **dizziness**, chest **pain**, or breathlessness. In the majority cases, frequent coughing lasts one to two weeks and tapers off as the irritant or infection subsides. If a cough lasts more than eight weeks, it is considered a chronic cough, and physicians will try to determine a cause beyond an acute infection or irritant.

Coughs are generally described as either dry or productive. A dry cough does not bring up a mixture of mucus, irritants, and other substances from the lungs (sputum), while a productive cough does. In the case of a bacterial infection, the sputum brought up in a productive cough may be greenish, gray, or brown. In the case of an allergy or viral infection it may be clear or white. In the most serious conditions, the sputum may contain blood.

Causes and symptoms

In the majority of cases, coughs are caused by respiratory infections, including:

- colds or influenza, the most common causes of coughs
- bronchitis, an inflammation of the mucous membranes of the bronchial tubes
- croup, a viral inflammation of the larynx, windpipe, and bronchial passages that produces a bark-like cough in children
- whooping cough, a bacterial infection accompanied by the high-pitched cough for which it is named
- pneumonia, a potentially serious bacterial infection that produces discolored or bloody mucus
- tuberculosis, another serious bacterial infection that produces bloody sputum
- fungal infections, such as aspergillosis, histoplasmosis, and cryptococcoses

Environmental pollutants, such as cigarette smoke, dust, or smog, can also cause a cough. In the case of cigarette smokers, the nicotine present in the smoke paralyzes the hairs (cilia) that regularly flush mucus from the respiratory system. The mucus then builds up, forcing the body to remove it by coughing. Postnasal drip, the irritating trickle of mucus from the nasal passages into the throat caused by **allergies** or **sinusitis**, can also result in a cough. Some chronic conditions, such as **asthma**, chronic **bronchitis**, **emphysema**, and **cystic fibrosis**, are characterized in part by a cough. A condition in which stomach acid backs up into the esophagus (gastroesophageal reflux) can cause coughing, especially when a person is lying down. A cough can also be a side effect of medications that are administered via an inhaler. It can also be a side-effect of beta-blockers and ACE inhibitors, which are drugs used for treating high blood pressure.

Diagnosis

Examination

To determine the cause of a cough, a physician should take an exact medical history and perform an exam. Information regarding the duration of the cough, other symptoms may accompany it, and environmental factors that may influence it aid the doctor in his or her diagnosis. The appearance of the sputum will also help determine what type of infection, if any, may be involved. The doctor may even observe the sputum microscopically for the presence of bacteria and white blood cells.

Tests

Chest x rays may help indicate the presence and extent of such infections as **pneumonia** or **tuberculosis**. If these actions are not enough to determine the cause of the cough, a **bronchoscopy** or **laryngoscopy** may be ordered. These tests use slender tubular instruments to inspect the interior of the bronchi and larynx.

Treatment

Drugs

Treatment of a cough generally involves addressing the condition causing it. An acute infection such as pneumonia may require **antibiotics**, an asthma-induced cough may be treated with the use of **bronchodilators**, or an antihistamine may be administered in the case of an allergy. Physicians prefer not to suppress a productive cough, since it aids the body in clearing the respiratory system of infective agents and irritants. However, cough medicines may be given if the patient cannot rest because of the cough or if the cough is not productive, as is the case with most coughs associated with colds or flu. The two types of drugs used to treat coughs are antitussives and **expectorants**.

ANTITUSSIVES. Antitussives are drugs that suppress a cough. Narcotics—primarily codeine—are used as antitussives and work by depressing the cough center in the brain. However, they can cause such side effects as drowsiness, **nausea**, and **constipation**. Dextromethorphan, the primary ingredient in many over-the-counter cough remedies, also depresses the brain's cough center, but without the side effects associated with **narcotics**. Demulcents relieve coughing by coating irritated passageways.

EXPECTORANTS. Expectorants are drugs that make mucus easier to cough up by thinning it.

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KEY TERMS

Antitussives—Drugs used to suppress coughing.

Expectorant—Drug used to thin mucus.

Gastroesophageal reflux—Condition in which stomach acid backs up into the esophagus.

Glottis—The opening between the vocal cords at the upper part of the larynx.

Larynx—A part of the respiratory tract between the pharynx and the trachea, having walls of cartilage and muscle and containing the vocal cords.

Sputum—The mixture of mucus, irritants, and other substances expelled from the lungs by coughing.

Guaifenesin and terpin hydrate are the primary ingredients in most over-the-counter expectorants. However, some studies have shown that in acute infections, simply increasing fluid intake has the same thinning effect as taking expectorants.

Alternative treatment

Coughs due to bacterial or viral upper respiratory infections may be effectively treated with botanical and homeopathic therapies. The choice of remedy will vary and be specific to the type of cough the patient has. Some combination over-the-counter herbal and homeopathic cough formulas can be very effective for cough relief. Lingering coughs or coughing up blood should be treated by a trained practitioner.

Many health practitioners advise increasing fluids and breathing in warm, humidified air as ways of loosening chest congestion. Others recommend hot tea flavored with honey as a temporary home remedy for coughs caused by colds or flu. Various **vitamins**, such as vitamin C, may be helpful in preventing or treating conditions (including colds and flu) that lead to coughs. Avoiding mucous-producing foods can be effective in healing a cough condition. These mucous-producing foods vary, based on individual intolerance, but dairy products are a major mucous-producing food for most people.

Prognosis

Because the majority of coughs are related to the **common cold** or **influenza**, most will end in seven to 21 days. The outcome of coughs due to a more serious underlying disease depends on the pathology of that disease.

Prevention

It is important to identify and treat the underlying disease and origin of the cough. Avoiding **smoking** and direct contact with people experiencing cold or flu symptoms is recommended. Washing hands frequently during episodes of upper-respiratory illnesses is advised. Parents should follow recommended **vaccination** schedules for pertussis (**whooping cough**) to help prevent the disease from occurring.

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ORGANIZATIONS

American Lung Association, 1301 Pennsylvania Ave., NW Suite 800, Washington, DC, 20004, (212) 315-8700, (800)LUNG-USA [(800) 548-8252], http://www.lungusa.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573; TTY: (240) 629-3255, (240) 629-3246, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi.nih.gov.

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Cough suppressants

Definition

Cough suppressants, antitussives, are medicines that reduce or prevent coughing.

Purpose

These medicines are meant to be used to relieve dry, hacking coughs associated with minor conditions like colds and flu. They should not be used to treat coughs associated with coughs that are productive of phlegm or sputum, or from **smoking** or chronic lung conditions like **asthma** or **emphysema**.

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Description

Benzonatate (Tessalon) is chemically related to local anesthetics and comes in liquid-filled capsules that are available only by prescription.

Codeine and hydrocodone are opoid drugs that are combined in cough medicines used to suppress coughs. They are available only by prescription

Dextromethorphan is available in over-the-counter cough preparations as liquids, capsules, liquid-filled capsules, lozenges and tablets.

Recommended dosage:

Consult with prescribers or pharmacists regarding dose of prescription cough suppressant medications.

Tessalon is usually taken in 100mg capsules every four hours or three times daily.

Read labels on over-the-counter dextramethorphan cough suppressant medications.

Precautions

Because of fears of overdose, dextromethorphan products should not be given to children under four years of age.

Do not take more than the recommended daily dosage of cough suppressants.

A lingering cough could be a sign of a more serious medical condition. Coughs that last more than seven days or are associated with **fever**, rash, **sore throat**, or lasting **headache** should have medical attention.

People with **phenylketonuria** should be aware that some cough suppressant products contain the artificial sweetener aspartame, which breaks down in the body to phenylalanine.

All cough suppressants can produce or accentuate drowsiness associated with other medicines.

Anyone who has asthma or **liver disease** should check with a physician before taking dextromethorphan.

Women who are pregnant or **breastfeeding** or who plan to become pregnant should check with their physicians before taking dextromethorphan.

The dye tartrazine is an ingredient in some cough suppressant products. This dye causes allergic reactions in some people, especially those who are allergic to **aspirin**.

Side effects

Side effects may include drowsiness, **dizziness**, upset stomach or **nausea and vomiting**.

KEY TERMS

Asthma—A disease in which the air passages of the lungs become inflamed, narrowed, and irritable.

Chronic—A word used to describe a long-lasting condition. Chronic conditions often develop gradually and involve slow changes.

Emphysema—An irreversible lung disease in which breathing becomes increasingly more difficult.

Mucus and phlegm—Thick fluid produced by the moist membranes that line breathing passages.

Phenylketonuria (PKU)—A genetic disorder in which the body lacks an important enzyme. If untreated, the disorder can lead to brain damage and mental retardation.

Interactions

Taking dextromethorphan and **monoamine oxidase inhibitors** (MAOI) (Nardil, Marplan and Parnate) together can be deadly. The effects of MAOI last for up to two weeks after stopping the drugs.

Combining dextromethorphan and sibutramine (Meridia) can produce irritability, weakness and altered consciousness.

All cough suppressants can accentuate the sedative effects of sedative and tranquilizing medicines.

James Waun, MD, RPh

Coughing and deep-breathing exercises *see* **Chest physical therapy**

Couvade syndrome

Definition

Couvade syndrome, which is also known as sympathetic **pregnancy**, male pregnancy experience, or "pregnant dad syndrome," refers to a condition in which a father-to-be experiences some of the physical symptoms of pregnancy prior to the baby s birth. The term *couvade* comes from the French verb *couver*, meaning "to brood," in the sense of a bird protecting its eggs before they hatch.

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Description

The term couvade was first used by the anthropologist E. B. Tylor in 1865 to describe certain fatherhood rituals performed by husbands while their wives were giving birth. These rituals were found in many different historical periods as well as various cultures around the world, ranging from ancient Greece and parts of the Roman Empire to Chinese Turkestan, the Basque regions of northern Spain, China, Thailand, Borneo, parts of Russia, and many Indian tribes in North as well as South America. In some cultures the expectant father avoids eating certain foods or handling knives or other sharp tools while the mother is in labor. In Papua New Guinea the father builds a hut apart from the rest of the village and goes to bed when his wife s **childbirth** begins. He then stays in bed and imitates the pains of childbirth until the baby is born. A similar custom is observed among the Basques. Couvade rituals are thought to have a number of possible purposes, depending on the specific culture:

- To draw the attention of evil spirits away from the mother to the father instead.
- To strengthen the emotional bond between father and child.
- To show that the man is the child's biological father.
- To relieve the father's anxiety while the mother is in labor.
- To strengthen the father's relationship with supernatural beings so that he can guide the child into the world.

Ritual couvade is no longer observed in most developed countries, but the term couvade syndrome has been applied to the physical symptoms that many men in these countries experience during a wife's pregnancy, ranging from mild **nausea** or backaches to weight gain or **toothache**. One group of Italian researchers reported that the number of men who experience couvade syndrome ranges between 11 and 65 percent, while others estimate that as many as 80 percent of expectant fathers develop these symptoms. It is thought that more men in Western societies experience couvade syndrome in the early 2000s than was the case with previous generations of fathers, due in part to changes in men s involvement with the birthing process. Some doctors think that the participation of fathers in the delivery room as "coaches" or comforters is one reason for the increased number of men who develop pregnancy symptoms.

Causes and symptoms

Causes

Several different types of explanation have been proposed for couvade syndrome:

- It is a psychiatric disorder. This type of explanation is more common among European than American physicians. Some attribute the symptoms of couvade syndrome to jealousy of the woman s ability to give birth, while others maintain that they result from male guilt over impregnating the woman or to sibling rivalry—that is, the husband regards the wife as a competitor that he must try to outperform.
- It results from real biological changes in the expectant father s body. A team of Canadian researchers reported that their sample of expectant fathers had higher levels of estradiol (a female hormone) and lower levels of testosterone (a male sex hormone) in their blood and saliva than a control group of childless men. The researchers have cautioned, however, that their findings should be checked by studying groups of men from other cultures.
- It is a reaction to a changed social role; that is, the syndrome is one way that some men "work through" their feelings about assuming the social expectations and responsibilities associated with fatherhood.
- It is a set of psychosomatic symptoms that is within the range of normal experience and does not indicate mental illness. Psychosomatic refers to physical symptoms that are caused or influenced by emotional factors, such as stress headaches or "butterflies in the stomach" before an examination.

Symptoms

Expectant fathers may experience one or more of the following:

- weight gain
- nausea and vomiting
- stomach cramps
- constipation or diarrhea
- loss of appetite
- sleep disturbances
- food cravings
- headaches
- toothache
- nosebleeds
- itchy skin

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KEY TERMS

Anthropology—The study of the origins, biological characteristics, beliefs, and social customs of human beings.

Psychosomatic—Referring to physical symptoms that are caused or significantly influenced by emotional factors. Some doctors regard couvade syndrome as a psychosomatic condition.

Syndrome—A set of symptoms that occur together.

Only a few men, however, develop the more dramatic symptoms. Some studies report that couvade syndrome is most severe during the third or fourth month of the wife s pregnancy and again just before birth. Some researchers report that the syndrome is more common in first-time fathers, while others have found that it is equally likely to develop in men who already have children.

Diagnosis

Couvade syndrome is not listed as a diagnostic category in the most recent editions of the American *Diagnostic and Statistical Manual of Mental Disorders*, fourth edition, text revision (2000) or the World Health Organization's *International Classification of Diseases*, version 10 (1993). In addition, it is not described or discussed in most medical textbooks, although a few handbooks for doctors in family practice mention it in passing as a condition of unknown origin. Since most men with couvade syndrome have only mild symptoms, they are unlikely to consult a doctor about the condition by itself.

Treatment

There is no standard mainstream treatment recommended for couvade syndrome because it is not usually mentioned in medical textbooks. Anecdotal evidence, however, indicates that most fathers-to-be are helped by a simple explanation of the syndrome and reassurance that it is not uncommon among American and Canadian men.

Alternative treatment

Some expectant fathers report that **meditation** or such movement therapies as **yoga** and t'ai chi are calming and relaxing. Peppermint tea or ginger are herbal remedies that help to relieve nausea.

Prognosis

Couvade syndrome almost always goes away after the baby is born. While a few instances of the syndrome developing into full-blown **psychosis** (loss of contact with reality) have been reported in European medical journals, such cases are extremely rare.

Prevention

There is no known way to prevent couvade syndrome as doctors do not yet understand why some men develop it and others do not.

Resources

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Polinski, Michael. "Feeling Her Pain: The Male Pregnancy Experience." *Pregnancy Today*, http://www.pregnancytoday.com/reference/articles/malepg.htm.

ORGANIZATIONS

American Academy of Family Physicians (AAFP), 11400 Tomahawk Creek Parkway, Leawood, KS, 66211-2680, (913) 906-6000, (913) 906-6075, (800) 271-2237, http://www.aafp.org/.

Rebecca Frey, PhD

Cox-2 inhibitors

Definition

Cox-2 inhibitors are **nonsteroidal anti-inflammatory drugs** (NSAIDs) that are used to relieve **pain** and reduce inflammation.

Purpose

By blocking the Cox-2 enzyme in the intestine, these drugs were expected to lower the risk of ulcers that is inherent in using most other NSAIDS, while relieving pain and inflammation.

Description

Celecoxib (Celebrex) is the only available Cox-2 inhibitor drug.

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Celecoxib is used to treat rheumatoid and **osteoarthritis**, acute pain, and the pain associated with primary **dysmenorrhea**. In the U.S., but not Canada, the drug is also approved to reduce the number of **intestinal polyps** in familial adenomatous polyposis (FAP).

Recommended dosage

For osteoarthritis, the usual dose is 200 mg/day administered as a single dose or as 100 mg twice/day.

For **rheumatoid arthritis**: 100–200 mg twice/day.

Acute pain and primary dysmenorrhea: 400 mg initially, followed by an additional 200 mg dose if needed on the first day. On subsequent days, the recommended dose is 200 mg twice daily as needed.

Precautions

Celebrex is chemically related to sulfa drugs and should not be used by patients with sulfa allergy.

This drug should not be used to treat post-operative pain in patients who have had **coronary artery bypass graft surgery** (CABG).

Celebrex should not be used by patients who have had sensitivity reactions to **aspirin** or other NSAIDS.

This drug should not be used in patients who have aspirin-associated **asthma**.

Celebrex should not be used late in **pregnancy** as it may cause heart problems for newborn babies.

This drug may aggravate active peptic ulcers, liver, kidney and/or heart diseases and intestinal bleeding.

Side effects

The most common side effects of Celebrex include:

- high blood pressure
- headache
- upset stomach, abdominal pain, diarrhea, gas or bloating
- rash and sometimes more serious skin conditions
- fatigue
- swelling of the feet and legs
- severe allergic reaction, including swelling of the face, throat, tongue, lips, eyes, hoarseness and difficulty swallowing, or breathing

Interactions

Because of its large number of possible side/adverse effects, the effects of other drugs may make it difficult to tell with certainty which adverse effects come from which drug. Drugs that Celebrex can interact with include:

- Taking aspirin and other NSAIDS with Celebrex increases the risk of ulcers and intestinal bleeding.
- Celebrex increases the blood thinning effects of warfarin (Coumadin)
- Celebrex increases the blood thinning effects of the injectable anticoagulants heparin, enoxaparin (Lovenox) and Dalteparin (Fragmin).
- Fluconazole (Diflucan) may increase the blood levels, and possibility of adverse effects, of Celebrex.
- Celebrex increases the blood levels, and possibility of toxicity of lithium (Eskalith).

Resources

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Physicians' Desk Reference 2005. Montvale, NJ: Thomson Healthcare, 2004.

ORGANIZATIONS

Arthritis Foundation, P.O. Box 7669, Atlanta, GA, 30357-0669, (404) 872-7100, http://www.arthritis.org.

Arthritis National Research Foundation , 200 Oceangate, Suite 830, Long Beach, CA, 90802, (562) 983-1410, (800) 588-2873, http://www.curearthritis.org.

Samuel D. Uretsky, Pharm.D.
James Waun, MD, RPh

Coxsackievirus infections *see* **Enterovirus infections**

CPK test *see* **Creatine kinase test**

CPR *see* **Cardiopulmonary resuscitation**

Crab lice *see* **Lice infestation**

Cradle cap *see* **Seborrheic dermatitis**

Cramps *see* **Dysmenorrhea**

Cranial arteritis *see* **Temporal arteritis**

Cranial manipulation *see* **Craniosacral therapy**

Craniopharyngioma

Definition

Craniopharyngiomas are benign tumors which affect the central nervous system. This type of **brain tumor** is diagnosed primarily in children but can occur at any age.

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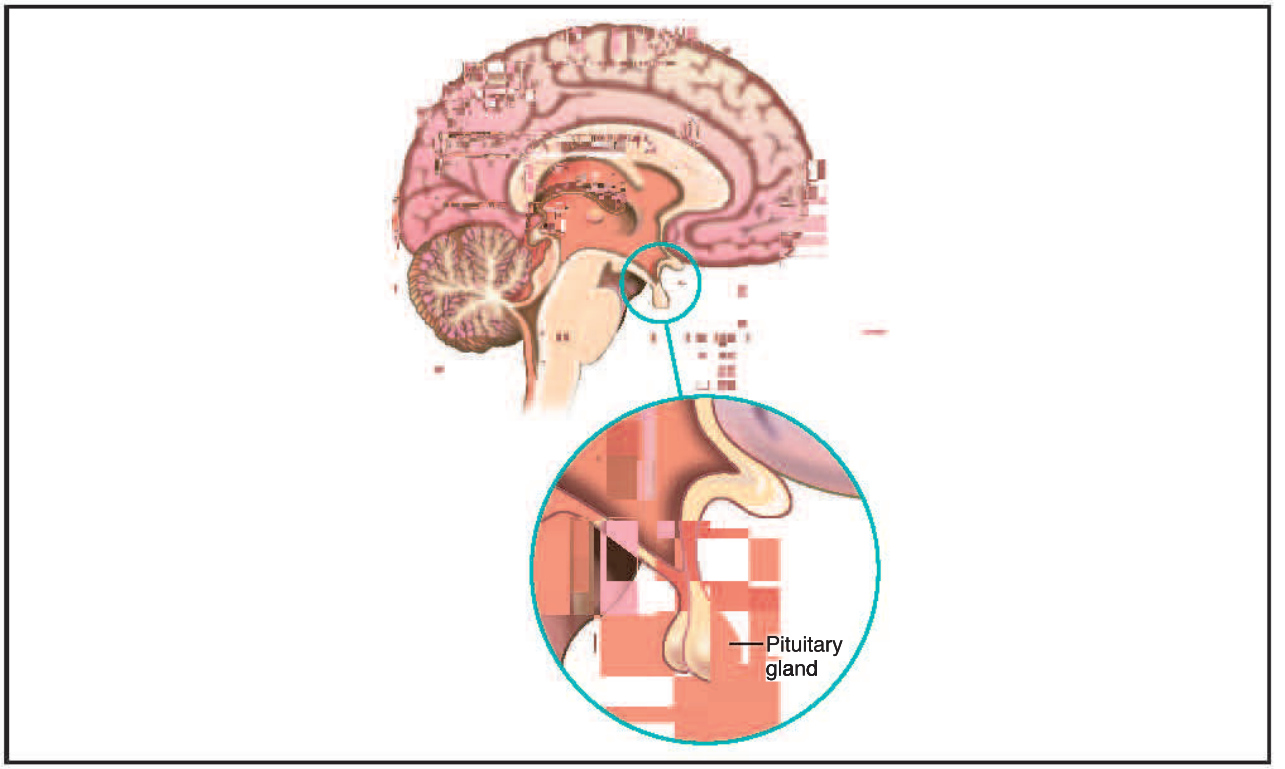

Craniopharyngiomas are a type of benign brain tumors that affect the functioning of the pituitary gland, which regulates the other endocrine glands in the body. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Demographics

Craniopharyngiomas are a rare type of benign brain tumor. Approximately 300 new cases of craniopharyngioma are diagnosed in the United States each year. Higher incidence rates of craniopharyngioma have been reported in Asia, Africa and Japan.

About 100 of the 300 new cases that occur in the U.S. each year occur in children ages 0–14 years. One incidence peak of craniopharyngioma occurs between the ages of 5–14. A second incidence peak has been noted in individuals ages 50–74 years.

Description

Craniopharyngiomas develop from embryonic squamous cells located along the craniopharyngeal duct. These tumors frequently occur near critical structures in the brain and can grow to be quite large. As they grow in size they can impair vision, obstruct the flow of cerebrospinal fluid and can affect the normal functioning of the pituitary gland and the hypothalamus which can result in serious complications. Although the tumors are classified as benign tumors, they have a propensity to recur even after treatment. Because of their typical locations near vital structures, treatment is often associated with significant morbidity.

Differences have been noted between craniopharyngiomas that occur in children and adults. Craniopharyngiomas affecting pediatric patients is predominantly of the adamantinomatous cell type. The squamous papillary variant is diagnosed more frequently in adults.

Risk factors

Currently, there are no risk factors identified related to the development of craniopharyngioma.

Causes and symptoms

At this time the cause of craniopharyngioma is unknown. Craniopharygiomas that occur in pediatric patients are thought to arise from the remnants of an embryonic structure that forms a portion of the pituitary gland. These cellular remnants transform into a

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KEY TERMS

Hypothalmus—An area of the brain located below the thalmus which regulates important functions such as body temperature, hunger and thirst.

Hypothyroidism—Insufficient production of thyroid hormone often resulting from an underactive thyroid gland. Can usually be treated with synthetic hormone replacement therapy.

Increased intracranial pressure—A rise in the normal pressure levels inside the brain.

Intracavitary—Inside a space or cavity within the body.

Morbidity—Adverse effects of treatment; a diseased condition or state; caused by disease; incidence of a particular disease.

Papilledema—Swelling which occurs at the level of the optic nerve. Presence of papilledema is indicative of increased intracranial pressure.

Pituitary gland—Often referred to as the master gland within the endocrine system. Produces hormones that control the functions of other glands within the endocrine system. Controls many body functions especially growth.

Projectile vomiting—Vomiting that occurs forcefully such that stomach contents may be ejected from the body in a way that propels expelled contents to a distance.

benign tumor by a process that is not yet fully understood. Researchers believe that a defect in the beta–catenin pathway at the cellular level may contribute to the development of craniopharyngioma. Beta-catenin is a component of the Wnt pathway which has a role in the regulation of cell development, cell differentiation, and cell growth.

The location of craniopharyngiomas in the brain leads to a variety of symptoms which result from compression of adjacent structures by the tumor. Symptoms associated with craniopharyngiomas include:

- Headache, a common presenting symptom, is present in up to 80% of cases and is a result of increasing intracranial pressure.
- Vomiting, which is often projectile in nature, commonly accompanies headaches in children. Projectile vomiting is also an indicator of increased intracranial pressure.
- Vision loss is another common symptom present at time of diagnosis. Vision loss varies in terms of pattern and severity of loss and ranges from blurred vision to complete visual field loss.
- Symptoms of growth hormone deficiency are present in up to 95% of cases. The most common clinical presentation is short stature.
- Symptoms of hypothyroidism including weight gain, tiredness and fatigue, dry skin and hair, intolerance to cold, anorexia and other related symptoms are often evident.
- Delayed puberty, which may occur in up to 100% of adolescents diagnosed with craniopharyngioma, is a common symptom.
- Mental changes, including seizures, are more commonly seen in adults but are rarely observed in children with craniopharyngioma.

Diagnosis

Examination

A thorough history will be elicited and a comprehensive **physical examination** will be conducted. The clinician's examination will focus on the presenting neurologic and endocrine signs and symptoms. The examination will include checks for **papilledema** and visual field problems which result from increased intracranial pressure. The clinician will also determine whether there is an enlarged head circumference. This finding combined with the presence of papilledema is highly suggestive of a mass within the brain.

The physician will also examine the child to determine whether growth has been compromised. Short stature and stunted growth that is not appropriate for age is a result of endocrine dysfunction and is commonly associated with craniopharyngioma.

Tests

Lab testing indicated for patients with craniopharyngioma includes testing to determine serum electrolyte levels, which may be impaired as a result of endocrine dysfunction. Other blood testing will include testing to determine levels of growth hormones, thyroid hormone, and follicle-stimulating and luteinizing hormones that may also be abnormal.

Radiology and imaging studies that may be performed include x-rays of the head and skull, computed

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tomography (CT) scans of the head, brain **magnetic resonance imaging** (MRI) and MRI/magnetic imaging **angiography** which is useful in preoperative planning. Tests to evaluate intellectual and psychological capabilities may also be conducted.

Treatment

Historically, the most common approach to treating craniopharyngioma was radical surgery which was used to remove as much of the tumor as possible in an effort to prevent recurrence. However, complications from radical surgical approaches often resulted in significant morbidity because of the location of the tumor and did not always prevent tumor recurrence with relapse of tumor occurring in as many as 60% of patients. In addition, the mortality rate from radical surgery although declining in recent years, can be as high as 10–25%.

Recent approaches to treating craniopharyngiomas include more conservative surgery followed by external beam **radiation therapy**. Outcomes from this treatment strategy include low rates of recurrence (5–20%) at 5–20 years with low long-term complications. However, radiation therapy may be not a viable treatment option for children less than 3 years of age because of the serious long-term side-effects associated with radiation therapy in this age group.

Patients with tumors that cannot be surgically removed, patients who are not candidates for treatment with radiation therapy, and those that relapse after treatment with surgery and radiation therapy may be candidates for **chemotherapy**. Systemic chemotherapy has not been effective in treating craniopharyngiomas however, some patients may respond to administration of intracavitary/intracystic administration of the chemotherapy agent bleomycin which is administered directly into the tumor cavity via a catheter.

Prognosis

Ten-year overall rates for patients whose tumors were able to be surgically resected range from 86–100%. Ten-year overall survival rates for patients whose tumors were not able to be completely surgically removed and for those whose tumors relapsed after treatment with surgery and radiation therapy range from 57–86%.

Patients require close monitoring of endocrine, ophthalmologic and neuropsychiatric function even after **tumor removal** and subsequent treatment. Assessment of growth and development, hormonal function, ophthalmologic function, and neuropsychiatric function is recommended. For example, problems with the visual field may indicate relapse of tumor. In addition, long-term hormone supplementation is required for virtually all patients diagnosed with craniopharyngioma.

Prevention

As the cause of craniopharyngiomas is not known, there is currently no known way to prevent occurrence of these rare tumors.

Following treatment, patients diagnosed with craniopharyngioma continue to require close follow–up to detect potential recurrence. Current recommendations related to follow-up include screening with brain MRI every 3 months for 1 year, followed by MRI every 6 months for 1 year and then MRI once per year until the fifth year. For patients who received radiation therapy, the recommended follow-up is an MRI every year or every other year for life to screen for the occurrence of a second malignancy.

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Childhood Brain Tumor Foundation, 20312 Watkins Meadow Drive, Germantown, Maryland, 20876, (310)

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515-2900, (877) 217-4166, http://www.childhoodbraintumor.org.

Genetic and Rare Disease Information Center (GARD), P.O. Box 8126, Gaithersburg, Maryland, 20898-8126, (888) 205-2311, (301) 251-4911, http://www.rarediseases.info.nih.gov/GARD.

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Craniosacral therapy

Definition

Craniosacral therapy is a holistic healing practice that uses very light touching to balance the craniosacral system in the body, which includes the bones, nerves, fluids, and connective tissues of the cranium and spinal area.

Purpose

According to Dr. John Upledger, craniosacral therapy is ideally suited for attention-deficit hyperactivity disorder, headaches, chronic middle ear infection, **pain**, and general health maintenance. It is recommended for **autism**, fibromyalgia, heart disease, **osteoarthritis**, **pneumonia**, **rheumatoid arthritis**, chronic sinus infections, and **gastroenteritis** (inflammation of the lining of the stomach or small intestine). It is also used with other therapies to treat **chronic fatigue syndrome**, back pain, and menstrual irregularity. In addition, other craniosacral practitioners have reported benefits for eye dysfunction, **dyslexia**, depression, motor coordination difficulties, temporomandibular joint dysfunction (TMD), hyperactivity, **colic**, **asthma** in babies, floppy baby syndrome, **whiplash**, **cerebral palsy**, certain **birth defects**, and other central nervous system disorders.

Description

Origins

The first written reference to the movement of the spinal nerves and its importance in life, clarity, and "bringing quiet to the heart" is found in a 4,000-year-old text from China. Craniosacral work was referred to as "the art of listening." Bone setters in the Middle Ages also sensed the subtle movements of the body. They used these movements to help reset **fractures** and **dislocations** and to treat headaches.

In the early 1900s, the research of Dr. William Sutherland, an American osteopathic physician, detailed the movement of the cranium and pelvis. Before his research it was believed that the cranium was a solid immovable mass. Sutherland reported that the skull is actually made up of 22 separate and movable bones that are connected by layers of tissue. He called his work cranial **osteopathy**. Nephi Cotton, an American chiropractor and contemporary of Sutherland, called this approach craniology. The graduates of these two disciplines have refined and enhanced these original approaches and renamed their work as sacro-occipital technique, cranial **movement therapy**, or craniosacral therapy.

Dr. John Upledger, an osteopathic physician, and others at the Department of Biomechanics at Michigan State University, College of Osteopathic Medicine learned of Sutherland's research and developed it further. He researched the clinical observations of various osteopathic physicians. This research provided the basis for Upledger's work that he named craniosacral therapy.

Craniosacral therapy addresses the craniosacral system. This system includes the cranium, spine, and sacrum that are connected by a continuous membrane of connective tissue deep inside the body, called the dura mater. The dura mater also encloses the brain and the central nervous system. Sutherland noticed that cerebral spinal fluid rises and falls within the compartment of the dura mata. He called this movement the primary respiratory impulse; today it is known as the craniosacral rhythm (CSR) or the cranial wave.

Craniosacral therapists can most easily feel the CSR in the body by lightly touching the base of the skull or the sacrum. During a session, they feel for disturbances in the rate, amplitude, symmetry, and quality of flow of the CSR. A therapist uses very gentle touch to balance the flow of the CSR. Once the cerebrospinal fluid moves freely, the body's natural healing responses can function.

A craniosacral session generally lasts 30–90 minutes. The client remains fully clothed and lays down on a massage table while the therapist gently assesses the flow of the CSR. Upledger describes several techniques which may be used in a craniosacral therapy session. The first is energy cyst release. According to Upledger, "This technique is a hands-on method of releasing foreign or disruptive energies from the patient's body. Energy cysts may cause the disruption of the tissues and organs where they are

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WILLIAM SUTHERLAND (1873–1954)

William Garner Sutherland studied osteopathy under its founder, Andrew Taylor Still. Dr. Sutherland made his own important discovery while examining the sutures of cranial bones the skull bones that protect the brain. What he noticed is that the sutures were designed for motion. Sutherland termed this motion the *Breath of Life.* Through his experiments and research he determined that primary respiration was essential to all other physiological functions.

When Sutherland developed his techniques for craniosacral therapy, he wanted it to serve as a vehicle for listening to the body's rhythmic motions, and treat the patterns of inertia, when those motions become congested. He believed that the stresses—any physical or emotional trauma—created an imbalance in the body that needed correction to restore it to full health. The therapy is a hands-on method so that the therapist can feel the subtleties of the patterns of movement and inertia. Sutherland felt that this was the way to encourage self-healing and restoration of the body's own mechanisms, taking a holistic approach to creating optimal health.

The Craniosacral Therapy Educational Trust, based on Sutherland's pioneering work, is located at 10 Normington Close, Leigham Court Road, London SW16 2QS, United Kingdom. http://www.cranio.co.uk/

located." The therapist feels these cysts in the client's body and gently releases the blockage of energy.

Sutherland first wrote about a second practice called direction of energy. In this technique the therapist intends energy to pass from one of his hands, through the patient, into the other hand.

The third technique is called myofascial release. This is a manipulative form of bodywork that releases tension in the fascia or connective tissue of the body. This form of bodywork uses stronger touch.

Upledger's fourth technique is position of release. This involves following the client's body into the positions in which an injury occurred and holding it there. When the rhythm of the CSR suddenly stops the therapist knows that the trauma has been released.

The last technique is somatoemotional release. This technique was developed by Upledger and is an offshoot of craniosacral therapy. It is used to release the mind and body of the residual effects of trauma and injury that are "locked in the tissues."

The cost of a session varies due to the length of time needed and the qualifications of the therapist. The cost may be covered by insurance when the therapy is performed or prescribed by a licensed health care provider.

Precautions

This gentle approach is extremely safe in most cases. However, craniosacral therapy is not recommended in cases of acute systemic infections, recent skull fracture, intracranial hemorrhage or aneurysm, or herniation of the medulla oblongata (brain stem). Craniosacral therapy does not preclude the use of other medical approaches.

Side effects

Some people may experience mild discomfort after a treatment. This may be due to re-experiencing a trauma or injury or a previously numb area may come back to life and be more sensitive. These side effects are temporary.

Research and general acceptance

More than 40 scientific papers have been published that document the various effects of craniosacral therapy. There are also 10 authoritative textbooks on this therapy. The most notable scientific papers include Viola M. Fryman's work documenting the successful treatment of 1,250 newborn children with birth defects. Edna Lay and Stephen Blood showed the effects on TMD, and John Wood documented results with psychiatric disorders. The American Dental Association has found craniosacral therapy to be an effective adjunct to orthodontic work. However, the conventional medical community has not endorsed these techniques.

Resources

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Milne, Hugh. *A Client's Introduction to Craniosacral Work*. Pamphlet. Milne Institute.

ORGANIZATIONS

Milne Institute Inc., P.O. Box 220, Big Sur, CA, 93920, (831) 667-2323, (831) 667-2525, infomilne@aol.com, http://www.milneinstitute.com/contact.

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Upledger Institute, 11211 Prosperity Farms Rd., Suite D-325, Palm Beach Gardens, FL, 33410, (561) 622-4334, (561) 622-4771, (800) 233-5880, upledger@upledger.com, http://www.upledger.com/.

Linda Chrisman

Craniotomy

Definition

Surgical removal of part of the skull to expose the brain.

Purpose

A craniotomy is the most commonly performed surgery for brain **tumor removal**. It may also be done to remove a blood clot and control hemorrhage, inspect the brain, perform a biopsy, or relieve pressure inside the skull.

Precautions

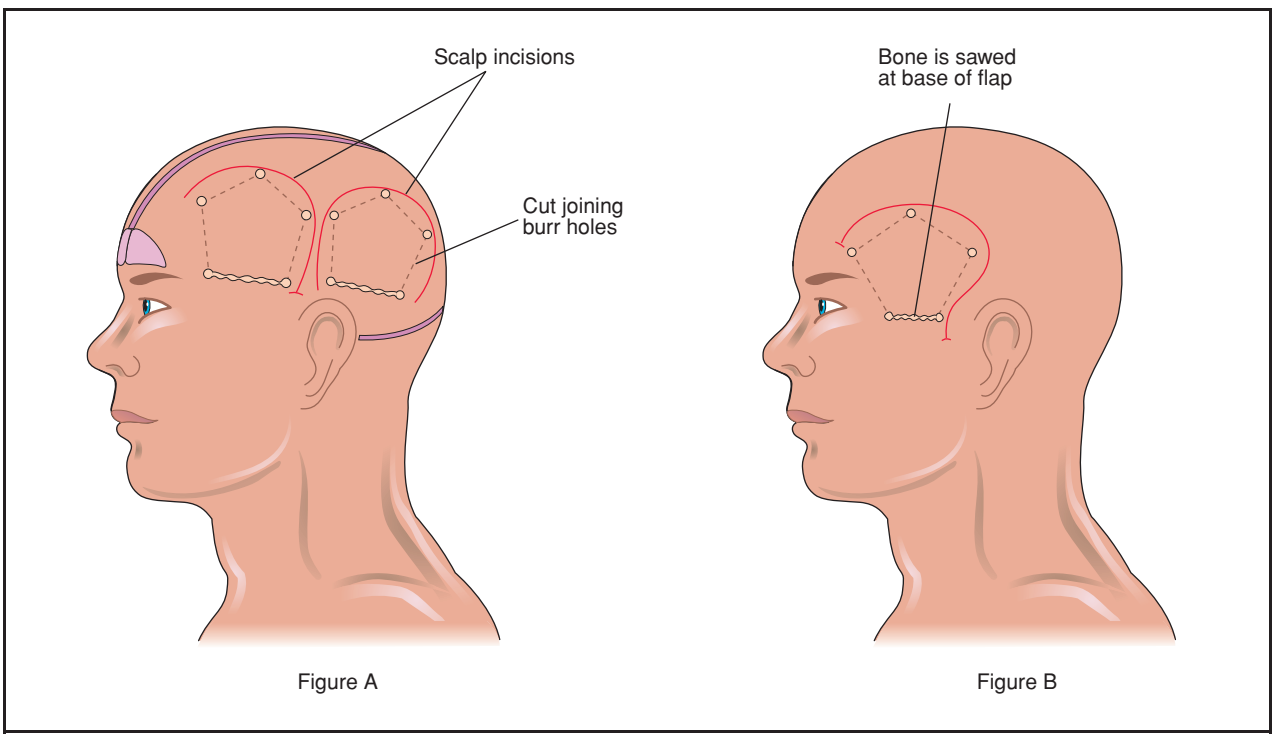
Before the operation, the patient will have undergone diagnostic procedures such as **computed tomography scans** (CT) or **magnetic resonance imaging** (MRI) scans to determine the underlying problem that required the craniotomy and to get a better look at the brain's structure. Cerebral **angiography** may be used to study the blood supply to the tumor, aneurysm, or other brain lesion.

Description

There are two basic ways to open the skull:

- a curving incision from behind the hairline, in front of the ear, arching above the eye
- at the nape of the neck around the occipital lobe

The surgeon marks with a felt tip pen a large square flap on the scalp that covers the surgical area. Following this mark, the surgeon makes an incision into the skin as far as the thin membrane covering the skull bone. Because the scalp is well supplied with blood, the surgeon will have to seal many small



A craniotomy is the most commonly performed surgery for brain tumor removal. There are two basic ways to open the skull: a curving incision from behind the hairline in front of the ear and at the nape of the neck (figure A). To reach the brain, the surgeon uses a hand drill to make holes in the skull, pushing a soft metal guide under the bone. The bone is sawed through until the bone flap can be removed to expose the brain (figure B). *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

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arteries. The surgeon then folds back a skin flap to expose the bone.

Using a high speed hand drill or an automatic craniotome, the surgeon makes a circle of holes in the skull, and pushes a soft metal guide under the bone from one hole to the next. A fine wire saw is then moved along the guide channel under the bone between adjacent holes. The surgeon saws through the bone until the bone flap can be removed to expose the brain.

After the surgery for the underlying cause is completed, the piece of skull is replaced and secured with pieces of fine, soft wire. Finally, the surgeon sutures the membrane, muscle, and skin of the scalp.

Preparation

Before the surgery, patients are usually given drugs to ease **anxiety**, and other medications to reduce the risk of swelling, seizures, and infection after the operation. Fluids may be restricted, and a diuretic may be given before and during surgery if the patient has a tendency to retain water. A catheter is inserted before the patient goes to the operating room.

The scalp is shaved in the operating room right before surgery; this is done so that any small nicks in the skin will not have a chance to become infected before the operation.

Aftercare

Oxygen, painkillers, and drugs to control swelling and seizures are given after the operation. Codeine may be given to relieve the **headache** that may occur as a result of stretching or irritation of the nerves of the scalp that happens during the craniotomy. Some type of drainage from the head may be in place, depending on the reason for the surgery.

Patients are usually out of bed within a day and out of the hospital within a week. Headache and **pain** from the scalp wound can be controlled with medications.

The bandage on the skull should be changed regularly. Sutures closing the scalp will be removed, but soft wires used to reattach the skull are permanent and require no further attention. The patient should avoid getting the scalp wet until all the sutures have been removed. A clean cap or scarf can be worn until the hair grows back.

Risks

Accessing the area of the brain that needs repair may damage other brain tissue. Therefore, the procedure carries with it some risk of brain damage that could leave the patient with some loss of brain function. The surgeon performing the operation can give the patient an assessment of the risk of his or her particular procedure.

KEY TERMS

Craniotome—A type of surgical drill used to operate on the skull. It has a self-controlled system that stops the drill when the bone is penetrated.

Results

While every patient's experience is different depending on the reason for the surgery, age, and overall health, if the surgery has been successful, recovery is usually rapid because of the good supply of blood to the area.

Possible complications after craniotomy include:

- swelling of the brain
- excessive intracranial pressure
- infection
- seizures

Resources

BOOKS

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Carol A. Turkington

Creatine kinase test

Definition

The creatine kinase test measures the blood levels of certain muscle and brain enzyme proteins.

Purpose

Creatine kinase (CK or CPK) is an enzyme (a type of protein) found in muscle and brain. Normally, very little CK is found circulating in the blood. Elevated levels indicate damage to either muscle or brain; possibly from a myocardial infarction (**heart attack**), muscle disease, or **stroke**.

There are three types, or isoforms, of CK:

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- CK-I, or BB, is produced primarily by brain and smooth muscle.
- CK-II, or MB, is produced primarily by heart muscle.
- CK-III, or MM, is produced primarily by skeletal muscle.

Precautions

No special precautions are necessary, except in patients with a bleeding disorder.

Description

A small amount of blood is drawn and used for laboratory analysis.

Preparation

Physical activity may cause a rise in CK levels, especially the CK-III fraction. Therefore, patients should not engage in strenuous physical activity the day of the test. The patient should report any recent injections, falls, or **bruises** that have occurred, as these may elevate CK levels as well.

Aftercare

No aftercare is required, except to keep the puncture site clean while it heals.

Risks

There are no risks to this test beyond the very slight risk of infection at the puncture site.

Results

In females, total CK should be 10–79 units per liter (U/L). In males, total CK should be 17–148 U/L. CK levels are reduced in the first half of **pregnancy**, and increased in the second half. CK levels are elevated in newborns.

The distribution of isoenzymes should be:

- CK-I: 0%
- CK-II: 0–5%
- CK-III: 95–100%.

Abnormal results

Elevation of CK-I may be seen in stroke, extreme **shock**, or **brain tumor**.

Elevation of CK-II is seen after a myocardial infarction. It begins to rise three to six hours after the heart attack, and may peak within 24 hours. It should then return to normal. For this reason, it is a useful marker for recent myocardial infarction, but not for one which occurred more than a day before the test.

Elevation of CK-III indicates skeletal muscle damage. This may occur from normal **exercise**, trauma, or muscle disease. CK levels may be very high early on in **muscular dystrophy**, but may fall to normal later as muscle tissue is lost. Elevated CK is also seen in **myositis**, myoglobinuria, **toxoplasmosis**, and **trichinosis**. **Hypothyroidism** may also cause elevated CK.

KEY TERMS

Skeletal muscles—Muscles that move the skeleton. All of the muscles under voluntary control are skeletal muscles.

Smooth muscles—Muscles that surround the linings of the digestive system, airways, and circulatory system.

Resources

BOOKS

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Richard Robinson

Creatine phosphokinase test *see* **Creatine kinase test**

Creatinine test

Definition

Creatine is an important compound produced by the body. It combines with phosphorus to make a high–energy phosphate compound in the body. Creatine phosphate is used in skeletal muscle contraction.

Purpose

The creatinine test is used to diagnose impaired kidney function and to determine renal (kidney) damage.

Precautions

A diet high in meat content can cause transient elevations of serum creatinine. Some drugs that may increase creatinine values include gentamicin,

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cimetidine, heavy-metal chemotherapeutic agents (e.g., cisplatin), and other drugs toxic to the kidneys, such as the **cephalosporins**.

Description

The creatinine test is used to measure the amount of creatinine in the blood. Because creatinine is a non-protein end-product of creatine phosphate, which is used in skeletal muscle contraction, the daily production of creatine, and the following product, creatinine, depends on muscle mass, which fluctuates very little.

Creatinine is excreted entirely by the kidneys, and therefore is directly related to renal function. When the kidneys are functioning normally, the serum creatinine level should remain constant and normal. Slight increases in creatine levels can appear after meals, especially after ingestion of large quantities of meat, and some diurnal variation may occur, with a low point at 7 a.m. and a peak at 7 p.m. Serious renal disorders, such as **glomerulonephritis**, **pyelonephritis**, and urinary obstruction, will cause abnormal elevations.

The creatinine level is interpreted in conjunction with another kidney function test called the Blood Urea Nitrogen (BUN). The serum creatinine level has much the same significance as the BUN but tends to rise later. Because of this, determinations of creatinine help to chronicle a disease process. Generally, a doubling of creatinine suggests a 50% reduction in kidney filtration rate.

Preparation

The creatinine test requires a blood sample. It is recommended that the patient be **fasting** (nothing to eat or drink) for at least eight hours before the test. The physician may also require that ascorbic acid (vitamin C), **barbiturates**, and **diuretics** be withheld for 24 hours.

Risks

Risks for this test are minimal, but may include slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after venipuncture, or hematoma (blood accumulating under the puncture site).

Results

Normal values can vary from laboratory to laboratory, but are generally in the following ranges:

- adult female: 0.5–1.1 mg/dL
- adult male: 0.6–1.2 mg/dL
- adolescent: 0.5–1.0 mg/dL
- child: 0.3–0.7 mg/dL
- infant: 0.2–0.4 mg/dL
- newborn: 0.3–1.2 mg/dL

Variations between sources for serum creatinine normal ranges are greater than for other important tests. For example, due to the greater amount of muscle mass generally present, males normally demonstrate higher creatinine levels than females. Also, because the kidney filtration rate normally increases in **pregnancy**, serum creatinine should be slightly less during such periods. In older patients, creatinine is reduced because of decreased muscle mass. Similarly, other patients may have creatinine levels in which muscle abnormalities must be taken into consideration, such as long-term corticosteroid therapy, high thyroid (**hyperthyroidism**), **muscular dystrophy**, or **paralysis**.

Abnormal results

Two to 4 mg/dL indicate the presence of impairment of renal function. Greater than 4 mg/dL indicates serious impairment in renal function.

Resources

BOOKS

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Janis O. Flores

KEY TERMS

Glomerulonephritis—Glomerulonephritis is an inflammation of the filtering units of the kidney (glomeruli). The condition hinders removal of waste products, salt, and water from the bloodstream, leading to serious complications. It is the most common cause of renal failure.

Pyelonephritis—Pyelonephritis is an inflammation of the kidney itself, usually caused by a bacterial infection. In its most serious form, complications can include high blood pressure (hypertension) and renal failure.

Creeping eruption *see* **Cutaneous larva migrans**

CREST syndrome *see* **Scleroderma**

Cretinism *see* **Hypothyroidism**

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Creutzfeldt-Jakob disease

Definition

Creutzfeldt-Jakob disease (CJD) is a transmissible, rapidly progressing, neurodegenerative disorder called a spongiform degeneration related to "mad cow disease."

Description

Before 1995, Creutzfeldt-Jakob disease was not well known outside the medical profession. Even within it, many practitioners did not know much about it. Most doctors had never seen a case. With the recognition of a so-called "new variant" form of CJD and the strong possibility that those with it became infected simply by eating contaminated beef, CJD has become one of the most talked-about diseases in the world. Additionally, the radical theory that the infectious agent is a normal protein that has been changed in its form also has sparked much interest.

First described in the early twentieth century independently by Creutzfeldt and Jakob, CJD is a neurodegenerative disease causing a rapidly progressing **dementia** ending in **death**, usually within eight months of symptom onset. It also is a very rare disease, affecting only about one in every million people throughout the world. In the United States, CJD is thought to affect about 250 people each year. CJD affects adults primarily between ages 50 and 75.

Spongiform encephalopathies

The most obvious pathologic feature of CJD is the formation of numerous fluid-filled spaces in the brain (vacuoles) resulting in a sponge-like appearance. CJD is one of several human "spongiform encephalopathies," diseases that produce this characteristic change in brain tissue. Others are kuru; Gerstmann-Straussler-Scheinker disease, a genetic disorder predominantly characterized by cerebellar ataxia (a kind of movement disorder); and fatal familial **insomnia**, with symptoms of progressive sleeplessness, weakness, and dysfunction of the nervous system that affects voluntary and involuntary movements and functions.

Kuru was prevalent among the Fore people in Papua, New Guinea, and spread from infected individuals after their deaths through the practice of ritual cannibalism, in which the relatives of the dead person honored him by consuming his organs, including the brain. Discovery of the infectious nature of kuru won the Nobel Prize for Carleton Gadjusek in 1976. The incubation period for kuru was between four to 30 years or more. While kuru has virtually disappeared since these cannibalistic practices stopped, several new cases continue to arise each year.

Cases of CJD have been grouped into three types: familial, iatrogenic, and sporadic.

- Familial CJD, representing 5–15% of cases, is inherited in an autosomal dominant manner, meaning that either parent may pass along the disease to a child, who then may develop CJD later in life.
- Iatrogenic CJD occurs when a person is infected during a medical procedure, such as organ donation, blood transfusion, or brain surgery. The rise in organ donation has increased this route of transmission; grafts of infected corneas and dura mater (the tissue covering the brain) have been shown to transmit CJD. Another source is hormones concentrated from the pituitary glands of cadavers, some of whom carried CJD, for use in people with growth hormone deficiencies. Iatrogenic infection from exposure to nerve-containing tissue represents a small fraction of all cases. The incubation period after exposure to the infectious agent is very long and is estimated to be from less than 10 to more than 30 years. It remains unlikely, but not impossible, that blood from patients with CJD is infectious to others by transfusion.
- Sporadic CJD represents at least 85% of all cases. Sporadic cases have no identifiable source of infection. Death usually follows first symptoms within eight months.

Animal forms and "mad cow disease"

Six forms of spongiform encephalopathies are known to occur in other mammals: scrapie in sheep, recognized for more than 200 years; chronic wasting disease in elk and mule deer in Wyoming and Colorado; transmissible mink encephalopathy; exotic ungulate encephalopathy in some types of zoo animals; feline spongiform encephalopathy in domestic cats; and bovine spongiform encephalopathy (BSE) in cows.

BSE was first recognized in Britain in 1986. Besides the spongiform changes in the brain, BSE causes dementia-like behavioral changes—hence the name "mad cow disease." BSE was thought to be an altered form of scrapie, transmitted to cows when they were fed sheep offal (slaughterhouse waste) as part of their feed, but researchers believe it is a primary cattle disease spread by contaminated feed.

The use of slaughterhouse offal in animal feed has been common in many countries and has been practiced for at least 50 years. The trigger for the BSE epidemic in

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Great Britain seems to have come in the early 1980s, when the use of organic solvents for preparation of offal was altered there. It is possible that these solvents had been destroying the agent called a prion, thereby preventing infection, and that the change in preparation procedure opened the way for the agent to "jump species" and cause BSE in cows that consumed scrapie-infected meal. The slaughter of infected (but not yet visibly sick) cows at the end of their useful farm lives, and the use of their carcasses for feed, spread the infection rapidly and widely. For at least a year after BSE was first recognized in British herds, infected bovine remains continued to be incorporated into feed, spreading the disease still further. Although milk from infected cows never has been shown to pass the infectious agent, passage from infected mother to calf may have occurred through unknown means. Researchers also have tried to confirm how to stop infection of the human food chain once the disease spread among cows. In 2003, a study reported that it spread through nervous system tissue in processed meat and that proper temperature and pressure controls could help ensure safety of commercial beef.

Beginning in 1988, the British government took steps to stop the spread of BSE, banning the use of bovine offal in feed and other products and ordering the slaughter of infected cows. By then, the slow-acting agent had become epidemic in British herds. In 1992, it was diagnosed in more than 25,000 animals (1% of the British herd). By mid-1997, the cumulative number of BSE cases in the United Kingdom had risen to more than 170,000. The feeding ban stemmed the tide of the epidemic; however, the number of new cases each week fell from a peak of 1,000 in 1993 to less than 300 two years later.

The export of British feed and beef to member countries was banned by the European Union, but cases of BSE had developed in Europe by then as well; however, by mid-1997, only about 1,000 cases had been identified. In 1989, the United States banned import of British beef and began monitoring United States herds in 1990. In December 2003, the first case of BSE was discovered in the United States. This prompted recommendations of new safeguards to prevent further spread. Among these were regulations banning animal blood in cattle feed.

Variant CJD: The human equivalent of mad cow disease

From the beginning of the BSE epidemic, scientists and others in Britain feared that BSE might jump species again to infect humans who had consumed infected beef. This, however, had never occurred in scrapie from sheep, a disease known for hundreds of years. In 1996, the first report of this possibility occurred and the fear seemed to be realized with the first cases of a new variant of Creutzfeldt-Jacob disease, termed nvCJD, now just vCJD. Its victims are much younger than the 60–65 year old average for CJD, and the time from symptom onset to death has averaged 12 months or more instead of eight. The disease appears to cause more psychiatric symptoms early on. EEG abnormalities characteristic of CJD are not typically seen in vCJD.

By early 2004, CJD had claimed 143 victims in Great Britain and 10 in other countries. It is of major concern that the number of cases per year seems to be increasing by a factor of 1.35 each year. The only known case in the United States to date had been acquired while the person had been in Great Britain.

Evidence is growing stronger that vCJD is in fact caused by BSE:

- almost all of the cases so far have occurred in Great Britain, the location of the BSE epidemic
- BSE injected into monkeys produces a disease very similar to vCJD
- BSE and vCJD produce the same brain lesions after the same incubation period when injected into laboratory mice
- brain proteins isolated from vCJD victims, but not from the other forms of CJD, share similar molecular characteristics with brain proteins of animals that died from BSE

Researchers now treat the BSE-vCJD connection as solidly established.

Assuming that BSE is the source, the question that has loomed from the beginning has been how many people will eventually be affected. Epidemiological models once placed estimates at tens of thousands, but in 2003, scientists predicted a quicker end to the epidemic and have substantially lowered the numbers expected to contract the disease. The exact incubation period of vCJD in humans is about 10 to 20 years or longer, so it is more difficult to predict the number of cases. Researchers know that some people are more susceptible to vCJD, including young people age 10 to 20 years old.

Causes and symptoms

Causes

It is clear that Creutzfeldt-Jakob disease is caused by an infectious agent, but it is not yet clear what type of agent that is. Originally assumed to be a virus, evidence is accumulating that, instead, CJD is caused

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by a protein called a prion (PREE-on, for "proteinaceous infectious particle") transmitted from victim to victim. The other spongiform encephalopathies also are hypothesized to be due to prion infection.

If this hypothesis is proven true, it would represent one of the most radical new ideas in biology since the discovery of deoxyribonucleic acid (DNA). All infectious diseases, in fact all life, use nucleic acids—DNA or ribonucleic acid (RNA)—to code the instructions needed for reproduction. Inactivation of the nucleic acids destroys the capacity to reproduce. However, when these same measures are applied to infected tissue from spongiform encephalopathy victims, infectivity is not destroyed. Furthermore, purification of infected tissue to concentrate the infectious fraction yields protein, not nucleic acid. While it remains possible that some highly stable nucleic acid remains hidden within the purified protein, this is seemingly less and less likely as further experiments are done. The "prion hypothesis," as it is called, is now widely accepted, at least provisionally, by most researchers in the field. The most vocal proponent of the hypothesis, Stanley Prusiner, was awarded the Nobel Prize in 1997 for his work in the prion diseases.

A prion is an altered form of a normal brain protein. The normal protein has a helical shape along part of its length. In the prion form, a sheet structure replaces the helix. According to the hypothesis, when the normal form interacts with the prion form, some of its helical part is converted to a sheet, thus creating a new prion capable of transforming other normal forms. In this way, the disease process resembles crystallization more than typical viral infection, in which the virus commands the host's cellular machinery to reproduce more of the virus. Build-up of the sheet form causes accumulation of abnormal protein clumps and degeneration of brain cells, which is thought to cause the disease.

The brain protein affected by the prion, called PrP, is part of the membrane of brain cells, but its exact function is unknown. Exposure to the infectious agent is, of course, still required for disease development. Prion diseases are not contagious in the usual sense, and transmission from an infected person to another person requires direct inoculation of infectious material.

Familial CJD, on the other hand, does not require exposure, but develops through the inheritance of other, more disruptive mutations in the gene for the normal PrP protein. The other two inherited human prion diseases, Gerstmann-Straussler-Scheinker disease and fatal familial insomnia, involve different mutations in the same gene.

The large majority of CJD cases are sporadic, meaning they have no known route of infection or genetic link. Causes of sporadic CJD are likely to be diverse and may include spontaneous genetic mutation, spontaneous protein changes, or unrecognized exposure to infectious agents. It is highly likely that future research will identify more risk factors associated with sporadic CJD.

Symptoms

About one in four people with CJD begin their illness with weakness, changes in sleep patterns, weight loss, or loss of appetite or sexual drive. A person with CJD may first complain of visual disturbances, including double vision, blurry vision, or partial loss of vision. Some visual symptoms are secondary to cortical blindness related to death of nerve cells in the occipital lobe of the brain responsible for vision. This form of visual loss is unusual in that patients may be unaware that they are unable to see. These symptoms may appear weeks to months before the onset of dementia.

The most characteristic symptom of CJD is rapidly progressing dementia, or loss of mental function. Dementia is marked by:

- memory loss
- impaired abstraction and planning
- language and comprehension disturbances
- poor judgment
- disorientation
- decreased attention and increased restlessness
- personality changes and psychosis
- hallucinations

Muscle spasms and jerking movements, called myoclonus, are also a prominent symptom of CJD. Balance and coordination disturbance (ataxia), is common in CJD, and is more pronounced in nvCJD. Stiffness, difficulty moving, and other features representing Parkinson's disease are seen and can progress to akinetic **mutism**, which is a state of being unable to speak or move.

Diagnosis

CJD is diagnosed by a clinical **neurological exam** and **electroencephalography** (EEG), which shows characteristic spikes called triphasic sharp waves. **Magnetic resonance imaging** (MRI) or **computed tomography scans** (CT) should be done to exclude other forms of dementia, and in CJD typically shows atrophy or loss of brain tissue. **Lumbar puncture**, or spinal tap, may be done to rule out other causes of

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KEY TERMS

Autosomal dominant inheritance—A pattern of inheritance in which a trait will be expressed if the gene is inherited from either parent.

Encephalopathy—Brain disorder characterized by memory impairment and other symptoms.

Iatrogenic—Caused by a medical procedure.

Nucleic acids—The cellular molecules DNA and RNA that act as coded instructions for the production of proteins and are copied for transmission of inherited traits.

dementia (as cell count, chemical analysis, and other routine tests are normal in CJD) and to identify elevated levels of marker proteins known as 14-3-3. Another marker, neuron-specific enolase, may also be increased in CJD. CJD is conclusively diagnosed after death by brain **autopsy**. Scientists are investigating whether testing lymphatic tissue such as the tonsil may be an early tool in vCJD diagnosis. Additionally, recent studies have suggested that other blood tests may be useful as well.

Treatment

There is no cure for CJD, and no treatment that slows the progression of the disease. Drug therapy and nursing care are aimed at minimizing psychiatric symptoms and increasing patient comfort. However, the rapid progression of CJD frustrates most attempts at treatment, since decreasing cognitive function and more prominent behavioral symptoms develop so quickly. Despite the generally grim prognosis, a few CJD patients progress more slowly and live longer than the average; for these patients, treatment will be more satisfactory. Scientists are investigating whether some medicines that can "break" the abnormal protein form may be useful and whether a vaccine could help.

Prognosis

Creutzfeldt-Jakob disease has proven invariably fatal, with death following symptom onset by an average of eight months. About 5% of patients live longer than two years. Death from vCJD has averaged approximately 12 months after onset. However, in 2003, clinicians reported improvement in a patient with vCJD who received a new experimental drug called Pentosan.

Prevention

There is no known way to prevent sporadic CJD, by far the most common type. Not everyone who inherits the gene mutation for familial CJD will develop the disease, but at present, there is no known way to predict who will and who will not succumb. The incidence of iatrogenic CJD has fallen with recognition of its sources, the development of better screening techniques for infected tissue, and the use of sterilization techniques for surgical instruments that inactivate prion proteins. Fortunately, scientists are making progress. In 2003, researchers announced that they had uncovered the basis for diagnosing, treating and possibly preventing prion diseases such as vCJD. Their research possibly could lead to a vaccine and immunotherapy drugs.

Strategies for prevention of vCJD are a controversial matter, as they involve a significant sector of the agricultural industry and a central feature of the diet in many countries. The infectious potential of contaminated meat is unknown, because the ability to detect prions within meat is limited. Surveillance of North American herds strongly suggests there is no BSE here, and strict regulations on imports of European livestock make future outbreaks highly unlikely. Therefore, avoidance of all meat originating in North America, simply on grounds of BSE risk, is a personal choice unsupported by current data.

Resources

PERIODICALS

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Cri du chat syndrome

Definition

Cri du chat syndrome occurs when a piece of chromosomal material is missing from a particular region on chromosome 5. The disorder is also called cat cry syndrome or chromosome deletion 5p syndrome. Individuals with this syndrome have unusual facial features, poor muscle tone (hypotonia), small head size (microcephaly), and **mental retardation**. A classic feature of the syndrome is the cat-like cry made by infants with this disorder.

Description

Dr. Jerome Lejeune first described cri du chat syndrome in 1963. The syndrome is named for the cat-like cry made by infants with this genetic disorder. *Cri du chat* means "cat's cry" in French. This unusual cry is caused by abnormal development of the larynx (organ in the throat responsible for voice production). Cri du chat syndrome is also called 5p deletion syndrome because it is caused by a deletion, or removal, of genetic material from chromosome 5. The deletion that causes cri du chat syndrome occurs on the short or "p" arm of chromosome 5. This deleted genetic material is vital for normal development. Absence of this material results in the features associated with cri du chat syndrome.

A high-pitched mewing cry during infancy is a classic feature of cri du chat. Infants with cri du chat also typically have low birth weight, slow growth, a small head (microcephaly) and poor muscle tone (hypotonia). Infants with cri du chat may have congenital heart defects. Individuals with cri du chat syndrome have language difficulties, delayed motor skill development, and mental retardation. Behavioral problems may also develop as the child matures.

It has been estimated that cri du chat syndrome occurs in one of every 50,000 live births. It accounts for 1 in every 500 cases of mental retardation. According to the 5p minus Society, approximately 50–60 children are born with cri du chat syndrome in the United States each year. It can occur in all races and in both sexes, although there is a slight female predominance. The male:female ratio is 3:4.

Causes and symptoms

Cri du chat is the result of a chromosome abnormality—a deleted piece of chromosomal material on chromosome 5. In about 80% of patients, the defective chromosome comes from the father. In 90% of patients with cri du chat syndrome, the deletion is sporadic. This means that it happens randomly and is not hereditary. If a child has cri du chat due to a sporadic deletion, the chance the parents could have another child with cri du chat is 1%. In approximately 10% of patients with cri du chat, there is a hereditary chromosomal rearrangement that causes the deletion. If a parent has this rearrangement, the risk for them to have a child with cri du chat is greater than 1%.

The severity of mental retardation in cri du chat syndrome is correlated with the extent of deletion of delta-catenin, a protein with an important role in brain functioning. The more extensive the deletion, the more profound the mental dysfunction.

An abnormal larynx causes the unusual cat-like cry made by infants that is a hallmark of the syndrome. As children with cri du chat get older, the cat-like cry becomes less noticeable. This feature can make the diagnosis more difficult in older patients. In addition to the cat-like cry, individuals with cri du chat also have unusual facial features. These facial differences can be very subtle or more obvious. Microcephaly (small head size) is common. During infancy many patients with cri du chat do not gain weight or grow normally. Approximately 30% of infants with cri du chat have a congenital heart defect. Hypotonia (poor muscle tone) is also common, leading to problems with eating and slow, but normal development. Mental retardation is present in all patients with cri du chat, but the degree of mental retardation varies among patients.

Diagnosis

During infancy, the diagnosis of cri du chat syndrome is strongly suspected if the characteristic cat-like cry is heard. If a child has this unusual cry or other features seen in cri du chat syndrome, chromosome testing should be performed. Chromosome analysis provides the definitive diagnosis of cri du chat syndrome and can be performed from a blood test. Chromosome analysis, also called karyotyping, involves staining the chromosomes and examining them under a microscope. In some cases the deletion of material from chromosome 5 can be easily seen. In other cases, further testing must be performed. FISH (fluorescence in-situ hybridization) is a special technique that detects very small deletions. The majority of the deletions that cause cri du chat syndrome can be identified using the FISH technique.

Cri du chat syndrome can be detected before birth if the mother undergoes **amniocentesis** testing or **chorionic villus sampling** (CVS). This testing would only

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KEY TERMS

Amniocentesis—A procedure performed at 16–18 weeks of pregnancy in which a needle is inserted through a woman's abdomen into her uterus to draw out a small sample of the amniotic fluid from around the baby. Either the fluid itself or cells from the fluid can be used for a variety of tests to obtain information about genetic disorders and other medical conditions in the fetus.

Centromere—The centromere is the constricted region of a chromosome. It performs certain functions during cell division.

Chorionic villus sampling (CVS)—A procedure used for prenatal diagnosis at 10–12 weeks gestation. Under ultrasound guidance a needle is inserted either through the mother's vagina or abdominal wall and a sample of cells is collected from around the early embryo. These cells are then tested for chromosome abnormalities or other genetic diseases.

Chromosome—A microscopic thread-like structure found within each cell of the body and consists of a complex of proteins and DNA. Humans have 46 chromosomes arranged into 23 pairs. Changes in either the total number of chromosomes or their shape and size (structure) may lead to physical or mental abnormalities.

Congenital—Refers to a disorder that is present at birth.

Deletion—The absence of genetic material that is normally found in a chromosome. Often, the genetic material is missing due to an error in replication of an egg or sperm cell.

Hypotonia—Reduced or diminished muscle tone.

Karyotyping—A laboratory procedure in which chromosomes are separated from cells, stained and arranged so that their structure can be studied under the microscope.

Microcephaly—An abnormally small head.

be recommended if the mother or father is known to have a chromosome rearrangement, or if they already have a child with cri du chat syndrome.

Treatment

There is no cure for cri du chat syndrome. Treatment consists of supportive care and developmental therapy. Behavioral modification therapy has been found to be useful to control head-banging, hyperactivity, and other behavioral problems that emerge during later childhood.

Prognosis

Individuals with cri du chat have a 10% mortality during infancy due to complications associated with congenital heart defects, hypotonia, and feeding difficulties. Once these problems are controlled, most individuals with cri du chat syndrome have a normal lifespan. The degree of mental retardation can be severe. However, a recent study suggested that the severity is somewhat affected by the amount of therapy received.

Resources

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ORGANIZATIONS

5p-Society, 7108 Katella Ave. no. 502, Stanton, CA, 96080, (562) 804-4506, (562) 920-5240, (888) 970-0777, director@ fivepminus.org, http://www.fivepminus.org/.

Cri du Chat Syndrome Support Group, PO Box 3408, Norwich, England, NR3 3WE, 440845 094-2725, admin@criduchat.org.uk, http://www.criduchat.org.uk.

Genetic Alliance, Inc., 4301 Connecticut Ave., NW, Suite 404, Washington, DC, 20008-2369, (202) 966-5557, (202) 966-8553, info@geneticalliance.org, http://www.geneticalliance.org.

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923, (800) 999-6673, http://www.rarediseases.org.

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Crib death *see* **Sudden infant death syndrome**

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Crohn's disease

Definition

Crohn's disease is a chronic inflammatory disorder that affects the digestive tract, characterized by cramping **pain**, **diarrhea**, and sometimes **nausea** or **vomiting**.

Demographics

It is estimated that there are about 500,000 persons with Crohn's disease in the United States, with another 500,000 suffering from ulcerative **colitis**. Another statistic that is given by some doctors is 7 cases per 100,000 in the general population in Canada and the United States. Crohn's is primarily a disorder of adults, most often beginning in late adolescence or the early adult years. The most common age at onset is between 15 and 30 years, although the disorder may begin at any age.

A barium x-ray showing the colon of a patient with Crohn's disease where the large and small intestines join (bottom left). *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

The rate of Crohn's disease in North America has been increasing since the 1960s, although the reasons for the increase are not known as of 2009. Southern Europe, South America, Africa, and Asia have considerably lower rates of the disease —as low as 0.5–0.08 cases per 100,000 people. Around the world, however, the rates of Crohn's disease are higher in cities than in rural areas, and higher among people with higher incomes than among lower-income groups.

One argument for the presence of a genetic factor in Crohn's disease is that it runs in some families; people who have a sibling with the disease are 30 times more likely to develop it than the normal population. Crohn's disease is also relatively common among certain ethnic groups, particularly Jews of Eastern European origin. A two- to four-fold increase in the frequency of Crohn's disease has been found among the Jewish population in the United States, Europe, and South Africa compared to other ethnic groups.

In terms of other ethnic groups in the United States, Crohn's disease appears to be slightly more common in non-Jewish Caucasians than in African or Asian Americans. The disease is more common in men than in women; the male/female ratio is 1.8:1.

Description

Crohn's disease is named for Dr. Burrill Bernard Crohn (1884–1983) who, with his colleagues, first described the disease in 1932. Crohn's disease can affect any part of the digestive system, however, it develops most often in the section of the small intestine just before the large intestine begins. This region is called the ileum, and Crohn's disease that develops there is sometimes called ileitus. The other common site for Crohn's disease is in the colon or large intestine.

Crohn's disease is one of several inflammatory bowel diseases. It can be mistaken for ulcerative colitis. Both these diseases cause watery diarrhea or bloody diarrhea and abdominal cramps or pain. Ulcerative colitis, however, affects only the layer of cells that line the intestine forming sores or ulcers on this surface. Crohn's disease begins in these same surface cells, but eats its way inward, damaging all four layers of the intestine and sometimes creating a hole (**fistula**) through the intestine and into other tissue. Another major difference between Crohn's disease

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and ulcerative colitis is that Crohn's disease can develop simultaneously in several spots in the digestive tract, resulting in areas of damaged with patches with healthy tissue in between. Ulcerative colitis, on the other hand, spreads uniformly across an area. Crohn's disease is somewhat treatable but not curable, and can cause many complications beyond the digestive system. Eventually the walls of the intestine thicken and blockages may occur that can only be corrected by surgery.

In some cases of Crohn's disease, the underlying layers of intestinal tissue are damaged also, leading to complete perforation (puncturing) of the wall of the intestine. This form of the disease is sometimes called penetrating Crohn's disease. Penetrating disease may cause a serious infection in the abdomen or the formation of fistulas. In Crohn's disease, fistulas are most likely to form in the area around the anus, leading to the formation of abscesses (pus-filled sores). About 30 percent of patients with Crohn's disease develop fistulas.

Another subtype of Crohn's disease is called stricturing disease. Stricture is the medical term for an abnormal narrowing of a hollow organ such as the bowel. In stricturing disease, the inflammation and swelling of tissue inside the bowel leads to changes in the size of the patient's stools and eventual blockage of the intestinal passages. Severe abdominal cramping is often an indication of stricturing disease, as are **nausea and vomiting**.

Risk factors

Risk factors for Crohn's disease include a family history of the disorder; a history of heavy **smoking**; and Eastern European Jewish ethnicity.

Causes and symptoms

Causes

At one time, researchers thought that **stress** and diet caused Crohn's disease, particularly by eating sweet or high-fat foods. It is also known that smoking is a risk factor for developing Crohn's. Now researchers know that these are not causes in the strict sense, although both stress and diet can worsen symptoms in people who already have the disease. What researchers do know is that Crohn's disease is caused by an inappropriate immune system reaction that affects cells in the digestive tract. Beyond that, the reasons why some people develop the disease are not clear as of 2009.

There is almost certainly an inherited component that predisposes some people to the disease. Individuals who are blood relatives of a parent, sibling, or child with Crohn's disease are 30 times more likely to develop the disease than the general population. Scientists believe multiple genes are involved in development of the disease. However, more than genetics determines who gets Crohn's disease, because only about 44% of identical twins both develop the disease. Researchers have found mutated (altered) genes in many, but not all, people who have Crohn's disease but do not yet have a clear understanding of what these genes do. As of early 2009, about 30 different genes have been identified that are thought to play a role in the development of Crohn's disease.

Current thinking is that interactions among genes, the environment, the individual's health, and body chemistry affect a person's risk of developing Crohn's disease. When foreign materials (antigens) enter the body, the immune system produces antibodies, which are proteins that neutralize the foreign invader. One theory about Crohn's disease is that some foreign organism or material stimulates an immune system response in the digestive system, and then through an error in genetic control, the response cannot be "turned off." A second theory suggests that the cells of the immune system mistake good bacteria, food, or some other substance that is normally present in the digestive tract and make antibodies against this material as if it were a foreign substance. Either way, an inappropriate immune system response occurs that appears to be the root cause of the symptoms people with Crohn's disease experience.

Symptoms

Symptoms of Crohn's disease vary, depending on the location of the damaged cells and the length of time the individual has had the disease. Symptoms can be mild or severe. They can develop suddenly or gradually, and they may improve or even disappear, and then worsen many times throughout an individual's life. Some people may have only occasional episodes of diarrhea, for example, while others may have 20–30 bowel movements in a single day that interfere with sleep, work, school, or other activities. In general, symptoms can be divided into those that affect the digestive tract and those that affect the rest of the body.

The most common symptoms that affect the digestive tract are:

- chronic diarrhea, the most common symptom
- abdominal pain or cramps, often in the lower right portion of the abdomen
- rectal bleeding
- blood in the stool or black tarry stools

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KEY TERMS

Abscess—A pus-filled sore surrounded by inflamed tissue.

Endoscope—A medical instrument that can be passed into an area of the body (e.g., the bladder or intestine) to allow examination of that area. The endoscope usually has a fiber-optic camera, which allows a greatly magnified image to be shown on a television screen viewed by the operator. Many endoscopes also allow the operator to retrieve a small sample (biopsy) of the area being examined.

Fistula—An abnormal tunnel or passage that forms between one part of the intestine and another or between the intestine and the body surface.

Gastroenterologist—A doctor who specializes in diagnosing and treating diseases of the digestive system.

Remission—A period in the course of a disease when symptoms disappear for a time.

Stoma—An opening made in the abdomen following surgery for colon cancer that allows wastes to pass from the body.

Stricture—The medical term for the abnormal narrowing of a hollow organ such as the bowel.

Ulceration—A pitted area or break in the continuity of a surface, such as the skin or mucous membrane.

- ulcers in the digestive tract, usually in the intestine
- fistulas, or holes in the intestine that connect the intestine to such other parts of the body as the bladder, stomach, vagina, or another section of bowel
- nausea and vomiting , usually from Crohn's disease in the stomach
- abscesses, fistulas, and ulcers around the anus, usually from Crohn's disease in the colon. These occur in about 45% of patients
- constipation, usually after many years when the bowel has thickened and the diameter of the intestine has narrowed

Symptoms of Crohn's disease also appear in other systems in the body. Some are the result of infection when fistulas develop. Others come from poor absorption of nutrients in the intestine over a long period. Some symptoms that occur outside the digestive tract include:

- persistent low-grade fever
- loss of appetite and weight loss
- fatigue
- anemia from blood loss and/or poor iron absorption
- skin infections
- eye infections
- arthritis and sore joints, usually in the large joints such as the knees or hips
- osteoporosis from poor calcium and vitamin D absorption
- poor blood clotting from inadequate vitamin K absorption
- stunted growth in children
- delayed puberty

Diagnosis

Examination

The most important aspect of diagnosing Crohn's disease is to distinguish it from other digestive disorders, including ulcerative colitis, intestinal parasites, and an intestinal obstruction. Normally the physician will begin the examination of a patient who might have Crohn's disease by taking a through medical and family history and standard blood and stool tests. Blood tests may reveal an increase in certain types of white blood cells, an indication that some type of inflammation or infection is occurring in the body. Blood tests may also reveal anemia and other signs of **malnutrition** due to malabsorption. Stool samples may be examined to make sure that no infectious agent is causing the diarrhea, and to see whether the waste products contain blood.

Special blood tests are available that can help differentiate between Crohn's disease and ulcerative colitis. These tests may be done if the results of other tests are questionable. According to the Crohn's & Colitis Foundation of America, it is quite difficult to tell these two diseases apart in about 10% of patients.

Tests

There is no single laboratory or imaging test that can be used to diagnose Crohn's disease. In addition to blood and stool tests, the four tests most commonly used to diagnose Crohn's are barium studies, computed tomography (CT) scans, sigmoidoscopies, and colonoscopies. In a barium study, the patient is given barium in enema form to coat the lining of

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the colon and rectum. Air is then blown into the colon in order to fill it. The resultant x-ray can be used to detect abnormalities in the lining of the intestine. CT scans are useful in detecting fistulas and abscesses.

Procedures

Sigmoidoscopies and colonoscopies are procedures that require special equipment inserted into the patient's body. A sigmoidoscope is a flexible lighted tube that can be inserted into the rectum and used to examine the last two feet of the colon. This procedure can be done in a doctor's office but does not provide a view of the entire colon. A colonoscope is a long flexible tube attached to a video camera and monitor that allows the doctor to examine the entire length of the patient's colon and rectum. The patient must take a laxative the night before to cleanse the bowel and may be given a sedative in the doctor's office to make them more comfortable. The doctor can also take tissue samples from the lining of the bowel for analysis.

Treatment

Traditional

As of 2009, there is no medical or surgical cure for Crohn's disease. Treatment consists of managing the patient's symptoms, getting the disease into remission, and preventing relapses. Patients with Crohn's disease are usually started on one or more different types of medications to relieve pain and discomfort. These medications may include cortisone and other drugs that reduce inflammation; drugs that block or lower the body's immune response; **antidiarrheal drugs** and fluid replacements; **antibiotics**; and **nutritional supplements**. Special high-calorie liquid formulas may be prescribed for patients whose intestines may need a rest.

Drugs

Individuals with mild to moderate Crohn's disease are usually treated first with such anti-inflammatory drugs as sulfasalazine (Azulfidine) or mesalamine (Asacol, Rowasa, Canasa). Individuals with moderate to severe Crohn's disease often are prescribed corticosteroid drugs. Prednisone (Deltasone, Orasone, Meticorten) is often the corticosteroid of choice. These drugs have significant side effects and cannot be used for long-term suppression of symptoms. Antibiotics are used to treat infection that may develop from fistula formation.

Biologic therapies use antibodies produced in the laboratory to treat disease. Infliximab (Remicade) is a laboratory-made antibody that blocks the production of an immune system factor that causes inflammation. This treatment is relatively new but appears to have a good success rate for relieving symptoms. Additional biologic therapies for Crohn's disease are under development. Individuals interested in participating in a clinical trial of a new drug or therapy for Crohn's disease at no cost can find a list of trials currently enrolling volunteers at http://www.clinicaltrials.gov.

Surgery

Patients who are not helped by medications or who have the stricturing form of the disease are usually treated by surgery. In most cases the surgeon removes the diseased part of the intestine and reconnects the healthy portions. This procedure may have to be repeated, however, as inflammation may develop in the area of the intestine next to where a diseased portion was removed. In cases in which the disease is located in the large intestine (colon), the surgeon may have to remove the entire colon in a procedure called a **colostomy**. In this procedure, an opening called a stoma is made in the wall of the abdomen and a portion of the remaining colon is attached to the stoma. The person's body wastes pass through the stoma and are collected in a special bag attached to the outside of the body.

Alternative

Acupuncture and **guided imagery** may be useful tools in treating pain associated with Crohn's disease. Acupuncture involves the placement of thin needles into the skin at targeted locations on the body known as acupoints in order to harmonize the energy flow within the human body. To treat chronic pain, such as that involved with Crohn's disease, an acupuncturist frequently places the acupuncture needles along what is known as the large intestine meridian.

Guided imagery involves creating a visual mental image of one's pain in one's mind. Once the pain can be visualized, the patient can adjust the image to make it more pleasing and, thus, more manageable. Other related alternative therapies include relaxation exercises, **yoga**, and **biofeedback**.

Several herbal remedies are also available to lessen pain symptoms and promote relaxation and healing. These include peppermint oil, slippery elm (*Ulmus rubra*), marsh mallow (*Althaea oficinalis*), and Chinese herbs. However, Crohn's patients

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should consult with their healthcare professional before taking them. Depending on the preparation and the type of herb, these remedies may aggravate the digestive tract or interact with prescription drugs that are being taken to control the inflammation of Crohn's disease.

Home remedies

Home treatment of Crohn's disease involves considerable adjustment of the patient's diet. Dietary changes are usually necessary to minimize pain, diarrhea, and other symptoms. In addition, regular physical **exercise** appears to be effective in lowering stress levels and regularizing bowel function.

Prognosis

Most people with Crohn's disease have periods of remission and are able to hold jobs and lead normal lives for the most part. Medical treatment of Crohn's disease, however, becomes less effective over time; about 80 percent of patients require surgery eventually. In addition, the disease can recur after surgery. The chance of a shortened life span or serious complications increases with the duration of the illness; patients with Crohn's disease also have an increased risk of colorectal **cancer**. The disease itself, however, is rarely fatal.

Prevention

There is no known way to prevent Crohn's disease as of 2009 because its causes are not yet understood.

Diet and nutrition

People with Crohn's disease tend to have vitamin and mineral deficiencies because damage to the lining of the intestine interferes with the absorption of nutrients, and chronic diarrhea hastens the loss of other nutrients. These deficiencies can cause specific disorders in other parts of the body. In addition, children with Crohn's disease also may need special high-calorie, high-nutrient liquid supplements to maintain normal growth. A nutritionist consulting with the patient's gastroenterologist can help determine the best diet and supplements to prevent nutritional deficiencies.

Although eating certain foods does not cause Crohn's disease, specific foods can worsen symptoms. Many people with Crohn's disease become lactose intolerant and must limit or eliminate dairy products from their diet. Alcohol, high fiber foods such as popcorn, and spicy foods can worsen diarrhea and abdominal cramping. Individuals must be alert to the effect of food on their symptoms until they figure out which foods to avoid.

Health care team roles

Crohn's disease is often diagnosed by primary care practitioners or gastroenterologists. In many instances, patients require surgical intervention. Imaging studies to assist in diagnosis are performed by x-ray technologists, and laboratory technologists may be involved in obtaining blood and stool samples for analysis.

Nurses, dieticians, and nutritional counselors have important roles in teaching patients about dietary changes to manage symptoms. Nurses, social workers, and **ostomy** specialists may also be involved in educating patients pre- and postoperatively about ostomy care.

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American College of Gastroenterology, P.O. Box 342260, Bethesda, MD, 20827-2260, 301-263-9000, http://www.acg.gi.org/.
Crohn's & Colitis Foundation of America., 386 Park Ave. S., 17th Floor, New York, NY, 10016-8804, 800-932-2423, info@ccfa.org, http://www.ccfa.org/.
National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), Building 31. Rm 9A06, 31 Center Drive, MSC 2560, Bethesda, MD, 20892-2560, 301-496-3583, http://www2.niddk.nih.gov/Footer/ContactNIDDK.htm, http://www2.niddk.nih.gov/.

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Cromolyn *see* **Antiasthmatic drugs**
Cross-eye *see* **Strabismus**
Cross-gender identification *see* **Gender identity disorder**

Croup

Definition

Croup is a common childhood ailment. Typically, it arises from a viral infection of the larynx (voice box) and is associated with mild upper respiratory symptoms such as a runny nose and **cough**. The key symptom is a harsh barking cough. Croup usually is not serious, and most children recover within a few days. In a small percentage of cases, a child develops breathing difficulties and may need medical attention.

Demographics

Croup is most common in children between ages one and two years, with an incidence of 5–6 cases per 100 population. It accounts for about 15% of children's doctor and emergency room visits in the United States. The number of cases peaks in late fall and early winter.

Description

At one time, the term croup was primarily associated with **diphtheria**, a life-threatening respiratory infection. Owing to widespread immunization, diphtheria has become rare in the United States and other parts of the developed world, and croup currently refers to a mild viral infection of the larynx. Croup is also known as laryngotracheitis, a medical term that describes the inflammation of the trachea (windpipe) and larynx.

Parainfluenza viruses are the typical root cause of the infection, but influenza (flu) and cold viruses may sometimes be responsible. All of these viruses are highly contagious and easily transmitted between individuals via sneezing and coughing. Children between the ages of three months and six years are usually affected, with the greatest incidence at one to two years of age. The characteristic harsh barking of a croupy cough can be very distressing, but it rarely indicates a serious problem. Most children with croup can be treated very effectively at home; however, 1–5% may require medical treatment.

Croup may sometimes be confused with more serious conditions, such as **epiglottitis** or bacterial tracheitis. These ailments arise from bacterial infection and must receive medical treatment.

Causes and symptoms

The larynx and trachea may become inflamed or swollen from an upper respiratory viral infection. The hallmark sign of croup is a harsh, barking cough. This cough may be preceded by one to three days of symptoms that resemble a slight cold. A croupy cough is often accompanied by a runny nose, hoarseness, and a low **fever**. When the child inhales, there may be a raspy or high-pitched noise called **stridor**, owing to the narrowed airway and accumulated mucus. In the presence of stridor, medical attention is required.

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KEY TERMS

Corticosteroid drug—A medication that acts like a type of hormone (cortisol) produced by the adrenal gland of the body. Corticosteroids produced by the body stimulate specific types of functional activity. As a drug, a corticosteroid (sometimes just called steroid) helps treat inflammation, infection, or trauma to the body.

Diphtheria—A serious, often fatal, bacterial infection that produces a toxin (poison) and an inflammation in the membrane lining of the throat, nose, trachea, and other tissues.

Epiglottitis—A bacterial infection that affects the epiglottis. The epiglottis is a flap of tissue that prevents food and fluid from entering the trachea. The infection causes it to become swollen, potentially blocking the airway. Other symptoms include a high fever, muffled voice, and an inability to swallow properly (possibly indicated by drooling).

Larynx—Also known as the voice box, the larynx is the part of the airway that lies between the pharynx and the trachea. It is composed of cartilage that contains the apparatus for voice production—the vocal cords and the muscles and ligaments that move the cords.

Reye's syndrome—A rare but often fatal disease that involves the brain, liver, and kidneys. It may brought on by giving salicylates (aspirin compounds) to children (but not adults) who have a viral infection.

Stridor—The high-pitched or rasping noise made when air is inhaled through narrowed airways.

Trachea—Commonly called the windpipe, it is the air pathway that connects the nose and mouth to the lungs.

However, the airway rarely narrows so much that breathing is impeded. Symptoms usually go away completely within a few days. Medical treatment may be sought if the child's symptoms do not respond to home treatment.

Emergency medical treatment is required immediately if the child has difficulty breathing, swallowing, or talking; develops a high fever (103°F [39.4°C] or more); seems unalert or confused; or has pale or blue-tinged skin.

Diagnosis

Croup is diagnosed based on the symptoms. If symptoms are particularly severe, or do not respond to treatment, an x ray of the throat area may be done to assess the possibility of epiglottitis or other blockage of the airway.

Treatment

Home remedies

Home treatment is the usual method of managing croup symptoms. It is important that the child is kept comfortable and calm to the best degree possible, because crying can make symptoms seem worse. Humid air can help a child with croup feel more comfortable. Recommended methods include sitting in a steamy bathroom with the hot water running or using a cool-water vaporizer or humidifier. However, although cool-mist therapy at home or in the hospital may add to the child's comfort, it does little to treat the actual condition. The child should drink frequently in order to stay well hydrated. To treat any fever, the child may be given an appropriate dose of **acetaminophen** (like Tylenol). Children should not be given **aspirin**, as it may cause **Reye's syndrome**, a life-threatening disease of the brain. **Antihistamines** and **decongestants** are ineffective in treating croup.

Medical treatment

If the child does not respond to home treatment, medical treatment at a doctor's office or an emergency room could be necessary. Based on the severity of symptoms and the response to treatment, the child may need to be admitted to a hospital.

For immediate symptom relief, epinephrine may be administered as an inhaled aerosol. Effects last for up to two hours, but there is a possibility that symptoms may return. For that reason, the child is kept under supervision for three or more hours. **Steroids** (**corticosteroids**) such as prednisone may be used to treat croup, particularly if the child has stridor when resting.

Of the 1–5% of children requiring medical treatment, approximately 1% need respiratory support. Such support involves intubation (inserting a tube into the trachea) and oxygen administration.

Alternative treatment

Botanical/herbal medicines can be helpful in healing the cough that is commonly associated with croup.

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Several herbs to consider for cough treatment include aniseed (*Pimpinella anisum*), sundew (*Drosera rotundifolia*), thyme (*Thymus vulgaris*), and wild cherry bark (*Prunus serotina*). **Homeopathic medicine** can be very effective in treating cases of croup. Choosing the correct remedy (a common choice is aconite or monkshood, *Aconitum napellus*) is always the key to the success of this type of treatment.

Prognosis

Croup is a temporary condition and children typically recover completely within three to six days. Children can experience one or more episodes of croup during early childhood; however, croup is rarely a dangerous condition.

Prevention

Croup is caused by highly transmissible viruses and is often difficult to impossible to prevent.

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American Academy of Family Physicians, P. O. Box 11210, Shawnee Mission, KS, 66207, (913) 906-6000, (800) 274-2237, (913) 906-6075, http://familydoctor.org.

American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, IL, 60007-1098, (847) 434-4000, (847) 434-8000, http://www.aap.org.

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Cryoglobulin test

Definition

Cryoglobulin is an abnormal blood protein associated with several diseases. Testing for cryoglobulin is done when a person has symptoms of this protein or is being evaluated for one of the associated diseases.

Purpose

Cryoglobulin clumps in cold temperatures. This physical characteristic causes people with cryoglobulin to have symptoms during cold weather: blanching, **numbness**, and **pain** in their fingers or toes (Raynaud's phenomenon); bleeding into the skin (purpura); and pain in joints (arthralgia). People with these symptoms or any other symptoms that appear in cold weather should be tested for cryoglobulin.

Diseases that cause the body to make extra or abnormal proteins are often associated with cryoglobulin. These diseases include cancers involving white blood cells, infections, **autoimmune disorders**, and rheumatoid diseases.

This test provides information about the cause of symptoms in a person who already has a disease process. It does not diagnose a specific disease or monitor the course of a disease.

Precautions

This test is not a screening test for disease in a person without symptoms.

Description

Laboratory testing for cryoglobulin is based on the fact that cryoglobulin clumps when cooled and dissolves when warmed. The test is done on a person's serum (the yellow liquid part of blood that separates from the cells after the **blood clots**). The serum is kept warm from the time drawn until the cells and the serum are separated in the laboratory. The serum is placed at 33.8°F (1°C) for one to seven days. If there is clumping, cryoglobulins are present. The amount of cryoglobulins is determined by measuring the amount of clumping. Negative tests are checked through seven days.

Additional testing is done to find out what kind of cryoglobulin protein is present. There are three kinds of cryoglobulin, each associated with different diseases.

The test, also called the cold sensitivity antibodies test, is covered by insurance when medically necessary. Results are usually available the following day.

Preparation

This test requires 15–20 mL of blood. A healthcare worker ties a tourniquet on the person's upper arm, locates a vein in the inner elbow region, and inserts a needle into that vein. Vacuum action draws

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KEY TERMS

Cryoglobulin—An abnormal blood protein associated with several diseases. It is characterized by its tendency to clump in cold temperatures.

the blood through the needle into an attached tube. Collection of the sample takes only a few minutes. The blood must be kept warm, at body temperature, until the laboratory can separate the cells from the serum.

Aftercare

Discomfort or bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Warm packs to the puncture site relieve discomfort.

Results

A normal result will be negative or absent.

If the person has cryoglobulin, the amount is reported. Larger amounts of cryoglobulin are associated with cancers or abnormalities involving white blood cells, moderate amounts are associated with autoimmune disorders and rheumatoid diseases, and smaller amounts are associated with infections.

The type of cryoglobulin is also reported. Type I cryoglobulin, also called monoclonal cryoglobulinemia, is found in cancers or abnormalities of white blood cells. Type II, also called mixed cryoglobulinemia, is associated with autoimmune disorders, rheumatoid diseases, and infections, particularly chronic **hepatitis B**.

The physician must interpret the cryoglobulin result along with other test results and the patient's clinical condition and medical history.

Resources

BOOKS

Pagana, Kathleen Deska, and Timothy J. Pagana. *Mosby's Manual of Diagnostic and Laboratory Tests*. 4th ed. St. Louis: Mosby, 2009.

Nancy J. Nordenson

Cryosurgery *see* **Cryotherapy**

Cryotherapy

Definition

Cryotherapy is a technique that uses an extremely cold liquid or instrument to freeze and destroy abnormal skin cells that require removal. The technique has been in use since the turn of the century, but modern techniques have made it widely available to dermatologists and primary care doctors. The technique is also called cryosurgery.

Purpose

Cryotherapy can be employed to destroy a variety of benign skin growths, such as **warts**, pre-cancerous lesions (such as actinic keratoses), and malignant lesions (such as basal cell and squamous cell cancers). The goal of cryotherapy is to freeze and destroy targeted skin growths while preserving the surrounding skin from injury.

Precautions

Cryotherapy is not recommended for certain areas of the body because of the danger of destruction of tissue or unacceptable scarring. These areas include: skin that overlies nerves, the corners of the eyes, the fold of skin between the nose and lip, the skin surrounding the nostrils, and the border between the lips and the rest of the face. Lesions that are suspected or known to be **malignant melanoma** should not be treated with cryotherapy, but should instead be removed surgically. Similarly, basal cell or squamous cell carcinomas that have reappeared at the site of a previously treated tumor should also be removed surgically. If it remains unclear whether a growth is benign or malignant, a sample of tissue should be removed for analysis (biopsy) by a pathologist before any attempts to destroy the lesion with cryotherapy. Care should be taken in people with diabetes or certain circulation problems when cryotherapy is considered for growths located on their lower legs, ankles, and feet. In these patients, healing can be poor and the risk of infection can be higher than for other patients.

Description

There are three main techniques to performing cryotherapy. In the simplest technique, usually reserved for warts and other benign skin growths, the physician will dip a cotton swab or other applicator into a cup containing a "cryogen," such as liquid nitrogen, and apply it directly to the skin growth to freeze it. At a temperature of −320°F (−196°C), liquid nitrogen

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is the coldest cryogen available. The goal is to freeze the skin growth as quickly as possible, and then let it thaw slowly to cause maximum destruction of the skin cells. A second application may be necessary depending on the size of the growth. In another cryotherapy technique, a device is used to direct a small spray of liquid nitrogen or other cryogen directly onto the skin growth. Freezing may last from five to 20 seconds, depending on the size of the lesion. A second freeze-thaw cycle may be required. Sometimes, the physician will insert a small needle connected to a thermometer into the lesion to make certain the lesion is cooled to a low enough temperature to guarantee maximum destruction. In a third option, liquid nitrogen or another cryogen is circulated through a probe to cool it to low temperatures. The probe is then brought into direct contact with the skin lesion to freeze it. The freeze time can take two to three times longer than with the spray technique.

Preparation

Extensive preparation prior to cryotherapy is not required. The area to be treated should be clean and dry, but sterile preparation is not necessary. Patients should know that they will experience some **pain** at the time of the freezing, but **local anesthesia** is usually not required. The physician may want to reduce the size of certain growths, such as warts, prior to the cryotherapy procedure, and may have patients apply salicylic acid preparations to the growth over several weeks. Sometimes, the physician will pare away some of the tissue using a device called a curette or a scalpel.

Aftercare

Redness, swelling, and the formation of a blister at the site of cryotherapy are all expected results of the treatment. A gauze dressing is applied and patients should wash the site three or four times daily while fluid continues to ooze from the wound, usually for five to 14 days. A dry crust then forms that falls off by itself. **Wounds** on the head and neck may take four to six weeks to heal, but those on the body, arms, and legs can take longer. Some patients experience pain at the site following the treatment. This can usually be eased with **acetaminophen** (Tylenol), though in some cases a stronger pain reliever may be required.

Risks

Cryotherapy poses little risk and can be well-tolerated by elderly and other patients who are not good candidates for other surgical procedures. As with other surgical procedures, there is some risk of scarring, infection, and damage to underlying skin and tissue. These risks are generally minimal in the hands of experienced users of cryotherapy.

KEY TERMS

Actinic keratosis—A crusty, scaly pre-cancerous skin lesion caused by damage from the sun. Frequently treated with cryotherapy.

Basal cell cancer—The most common form of skin cancer; it usually appears as one or several nodules having a central depression. It rarely spreads (metastisizes), but is locally invasive.

Cryogen—A substance with a very low boiling point, such as liquid nitrogen, used in cryotherapy treatment.

Melanoma—The most dangerous form of skin cancer. It should not be treated with cryotherapy, but should be removed surgically instead.

Squamous cell cancer—A form of skin cancer that usually originates in sun-damaged areas or pre-existing lesions; at first local and superficial, it may later spread to other areas of the body.

Results

Some redness, swelling, blistering and oozing of fluid are all common results of cryotherapy. Healing time can vary by the site treated and the cryotherapy technique used. When cryogen is applied directly to the growth, healing may occur in three weeks. Growths treated on the head and neck with the spray technique may take four to six weeks to heal; growths treated on other areas of the body may take considerably longer. Cryotherapy boasts high success rates in permanently removing skin growths; even for malignant lesions such as squamous cell and basal cell cancers, studies have shown a cure rate of up to 98%. For certain types of growths, such as some forms of warts, repeat treatments over several weeks are necessary to prevent the growth's return.

Abnormal results

Although cryotherapy is a relatively low risk procedure, some side effects may occur as a result of the treatment. They include:

- Infection. Though uncommon, infection is more likely on the lower legs where healing can take several months.
- Pigmentary changes. Both hypopigmentation (lightening of the skin) and hyperpigmentation (darkening

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of the skin) are possible after cryotherapy. Both generally last a few months, but can be longer lasting.

- Nerve damage. Though rare, damage to nerves is possible, particularly in areas where they lie closer to the surface of the skin, such as the fingers, the wrist, and the area behind the ear. Reports suggest this will disappear within several months.

ORGANIZATIONS

American Academy of Dermatology, PO Box 4014, Schaumburg, IL, 60168-4014, (847) 240-1859, (866) 503-SKIN (7546), http://www.aad.org.

American Society for Dermatologic Surgery, 5550 Meadowbrook Dr., Suite 120, Rolling Meadows, IL, 60008, (847) 956-0900, (847) 956-0999, http://www.asds.net/.

Richard H. Camer

Cryptococcosis

Definition

Cryptococcosis is an infection caused by inhaling the fungus *Cryptococcus neoformans*. It is one of the diseases most often affecting **AIDS** patients. Cryptococcosis may be limited to the lungs, but frequently spreads throughout the body. Although almost any organ can be infected, the fungus is often fatal if it infects the nervous system where it causes an inflammation of the membranes covering the brain and spinal cord (**meningitis**).

This lesion appearing on this person's body is due to exposure of the *C. neoformans* fungus. *(Photo Researchers, Inc.)*

Description

The fungus causing cryptococcis, *C. neoformans*, is found worldwide in soil contaminated with pigeon or other bird droppings. It has also been found on unwashed raw fruit. Cryptococcosis is a rare disease in healthy individuals, but is the most common fungal infection affecting people with AIDS.

People with Hodgkin's disease or who are taking large doses of drugs that suppress the functioning of the immune system (**corticosteroids**, **chemotherapy** drugs) are also more susceptible to cryptococcal infection. Cryptococcosis is also called cryptococcal meningitis (when the brain is infected), Busse-Buschke disease, European **blastomycosis**, torular meningitis, or torulosis.

Causes and symptoms

Once the cryptococcal fungus reaches the lungs, three things can happen. The immune system can heal the body without medical intervention, the disease can stay localized in the lungs, or it can spread throughout the body. In healthy people with normally functioning immune systems, the body usually heals itself, and the infected person notices no symptoms and has no complications (asymptomatic). The disease does not spread from one person to another.

Cryptococcosis is an opportunistic infection that puts people with immune system diseases at higher risk of developing more serious forms of the disease. In the United States, 6–10% of all patients with AIDS get cryptococcosis.

If the body does not heal itself, the fungus begins to grow in the lungs and form nodules that can be seen on chest x rays. In the early stages of infection, an individual usually only exhibits symptoms of a respiratory infection, such as a dry **cough**, so the disease is rarely diagnosed.

The fungus can remain dormant in the lungs and produce an active infection later if the immune system is weakened. If the disease becomes active, it can cause cryptococcal **pneumonia** in the lungs. Unfortunately, however, cryptococcal pneumonia has symptoms similar to other pneumonias (cough, chest **pain**, difficulty breathing), making it difficult to accurately diagnose. The infection can spread to other parts of the body, particularly the brain and central nervous system.

Most patients are not diagnosed as having cryptococcosis until they show signs of cryptococcal meningitis, or infection of the membranes surrounding the brain and spinal cord. Symptoms appear gradually

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KEY TERMS

Adrenal gland—A pair of organs located above the kidneys. The outer tissue of the gland produces the hormones epinephrine (adrenaline) and norepinephrine, while the inner tissue produces several steroid hormones.

Amphotericin B (Fengizone)—An antifungal medication, prescribed for topical or systemic use in treating fungal infections.

Antibody—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

Antigen—A foreign protein or particle capable of eliciting an immune response.

Asymptomatic—Persons who carry a disease but who do not exhibit symptoms of the disease are said to be asymptomatic.

Biopsy—The removal of a tissue sample for diagnostic purposes.

Cerebrospinal fluid (CSF)—The clear fluid that surrounds the spinal cord and brain and acts as a shock absorber.

Corticosteroids—A group of hormones produced naturally by the adrenal gland or manufactured synthetically. They are often used to treat inflammation. Examples include cortisone and prednisone.

Encephalitis—Inflammation of the brain.

Hodgkin's disease—A disease that causes chronic inflammation of the lymph nodes, spleen, liver and kidneys. It is also called malignant lymphoma.

Hydrocephalus—Build-up of fluid around the brain.

Immunocompromised—A state in which the immune system is suppressed or not functioning properly.

India ink test—A diagnostic test used to detect the cryptococcal organism *C. neoformans*. A dye, called India ink, is added to a sample of CSF fluid, and if the fungi is present, they will become visible as the dye binds to the capsule surrounding the fungus.

Lumbar puncture—Also called a spinal tap, a procedure in which a thin needle is used to withdraw a sample of cerebrospinal fluid for diagnostic purposes from the area surrounding the spine.

Meningitis—Inflammation of the membranes covering the brain and spinal cord called the meninges.

Molluscum contagiosum—A disease of the skin and mucuous membranes, caused by a poxvirus and found all over the world.

Opportunistic infection—An infection that is normally mild in a healthy individual, but which takes advantage of an ill person's weakened immune system to move into the body, grow, spread, and cause serious illness.

Pneumonia—Inflammation of the lungs, typically caused by a virus, bacteria, or other organism.

over a period of two to four weeks. **Fever** and **headache** are the most common symptoms, occurring in about 85% of patients. **Nausea**, **vomiting**, unwanted weight loss, and **fatigue** are also common. Other symptoms seen in 25–30% of patients are blurred vision, stiff neck, aversion to light, and seizures. Since the symptoms of classic meningitis, such as stiff neck and aversion to light, do not occur in many patients, diagnosis is often delayed. In addition to meningitis, inflammation of the brain (**encephalitis**) and brain lesions called cryptococcomas or tortulomas can also develop.

In addition to the brain, the cryptococcal infection can spread to the kidneys, bone marrow, heart, adrenal glands, lymph nodes, urinary tract, blood, and skin. Often times preceding the development of cryptococcal meningitis, painless **rashes** and lesions that mimic other skin diseases, such as *molluscum contagiosum*, may develop. A small percentage of patients with brain infections show infections in other organs as well.

Diagnosis

Physicians who regularly work with AIDS patients have the most experience in diagnosing cryptococcosis. The preferred methods of diagnosis use simple and very accurate blood and cerebrospinal fluid (CSF) tests that detect the presence of an antigen produced by the fungus. The cerebrospinal fluid test is generally more sensitive to detecting the meningitis form of the infection. CSF is collected during a procedure called a **lumbar puncture**, during which an anesthetic is applied to a small area of the back near the spine and a needle is used to withdraw a sample of cerebrospinal fluid from the space between the vertebrae and the spinal cord. Once obtained, a small

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amount of ink (called India ink) is added to a sample of CSF or a sample prepared from **skin lesions**. If the fungus is present, it will become visible when the ink binds to the capsule or covering that surrounds the fungus. Faster results are obtained with the India ink test, but it is less accurate than the blood test (75–85% accuracy compared to 99% accuracy with the blood test) because some strains are not visible using this method. Antigen tests are routinely recommended for non-symptomatic patients with advanced AIDS.

Another way to diagnose cryptococcosis is to culture a sample of sputum, tissue from a **lung biopsy**, or CSF in the laboratory to isolate the fungus. Cultures are also done to assess the effectiveness of treatment.

Chest x rays are useful in assessing lung damage and may reveal a single mass or multiple distinct nodules, but the x ray alone does not lead to a definitive diagnosis of cryptococcosis.

Treatment

Once cryptococcosis is diagnosed, treatment begins with amphotericin B (Fungizone), sometimes in combination with 5-flucytosine (Ancobon). Amphotericin B is a powerful fungistatic drug with potentially toxic side effects, such as kidney toxicity and lower concentrations of an important blood component called hemoglobin. This medication can also cause fever, chills, **nausea and vomiting**, **diarrhea**, headache, and muscle aches. Treatment is generally given intravenously during a hospital stay and continues until the patient is stable or improving (no more than two to three weeks). 5-flucytosine is given orally. Patients may also receive other medication to minimize the side effects from these drugs.

Amphotericin B, with or without 5-flucytosine, is given for several weeks until the patient is stable, after which the patient receives oral fluconazole (Diflucan). Fluconazole is a broad-spectrum antifungal drug with few serious side effects. Patients with AIDS must continue taking fluconazole for the rest of their lives to prevent a relapse of cryptococcosis. Sometimes fluconazole is given to patients with advanced AIDS as a preventative (prophylactic) measure.

Because of the high cost of fluconazole, the manufacturer of the drug, Pfizer, has established a financial assistance plan to make the drug available at lower cost to those who meet certain criteria. Patients needing this drug should ask their doctors about this program.

Prognosis

Untreated cryptococcosis is always fatal. The acute mortality rate for patients with AIDS is 10–25%. Most deaths are attributable to cryptococcal meningitis and occur within two weeks after diagnosis. For AIDS patients who do not receive continued suppressive therapy (fluconazole), the relapse rate is 50–60% within six months and a shortened life expectancy. Once the cryptococcosis infection has been successfully treated, individuals may be left with a variety of neurologic symptoms, such as weakness, headache, and hearing or visual loss. In addition, fluid may accumulate around the brain (**hydrocephalus**).

Prevention

The best way to prevent cryptococcosis is to stay free of HIV infection. People with suppressed immune systems should try to stay away from areas contaminated with pigeon or other bird droppings, such as the attics of old buildings, barns, and areas under bridges where pigeons roost.

ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

National AIDS Hotline, CDC, 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov/hiv.

National Prevention Information Network, P.O. Box 6003, Rockville, MD, 20849-6003, (888) 282-7681, (800) 458-5231, info@cdcnpin.org, http://www.cdcnpin.org.

Project Inform, 1375 Mission Street, San Francisco, CA, 94103-2621, (415) 558-8669, (415) 558-0684, http://www.projinf.org.

Tish Davidson, A.M.

Cryptococcus neoformans infection *see* **Cryptococcosis**

Cryptorchidism *see* **Undescended testes**

Cryptosporidiosis

Definition

Cryptosporidiosis refers to infection by the spore-forming protozoan known as *Cryptosporidia*. Protozoa are a group of parasites that infect the human intestine, and include the better known *Giardia*. *Cryptosporidia*

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KEY TERMS

Anti-motility medications—Medications such as loperamide (sold as Imodium), dephenoxylate (sold as Lomotil), or medications containing codeine or narcotics that decrease the ability of the intestine to contract. This can worsen the condition of a patient with dysentery or colitis.

Cyst—A protective sac that includes either fluid or the cell of an organism. The cyst enables many organisms to survive in the environment for long periods of time without need for food or water.

Immunocompromised—A change or alteration of the immune system that normally serves to fight off infections and other illnesses. This can involve changes in antibodies that the body produces (hygogammaglobulinemia), or defect in the cells that partake in the immune response. Diseases such as AIDS and cancer exhibit changes in the body's natural immunity.

Oral Rehydration Solution (ORS)—A liquid preparation developed by the World Health Organization that can decrease fluid loss in persons with diarrhea. Originally developed to be prepared with materials available in the home, commercial preparations have recently come into use.

Parasite—An organism that lives on or in another and takes nourishment (food and fluids) from that organism.

Protozoa—Group of extremely small single cell (unicellular) or acellular organisms that are found in moist soil or water. They tend to exist as parasites, living off other life forms.

Spore—A resistant form of certain species of bacteria, protozoa, and other organisms.

was first identified in 1976 as a cause of disease in humans.

Description

Cryptosporidia are normally passed in the feces of infected persons and animals in the form of cysts. The cysts can remain in the ground and water for months, and when ingested produce symptoms after maturing in the intestine and the bile ducts. When viewed under the microscope, they appear as small bluish-staining round bodies. Most common sources of infection are other humans, water supplies, or reservoirs. These are contaminated by animals that defecate in these areas. An outbreak in Milwaukee in 1993 in which over 400,000 persons were affected was traced to the city's water supply. Cysts of *Cryptosporidia* are extremely resistant to the disinfectants that are commonly used in most water treatment plants and are incompletely removed by filtration.

Most persons who experience significant symptoms have an altered immune system, and suffer from diseases such as **AIDS** and **cancer**. However, as shown in the Milwaukee outbreak, even those with normal immunity can experience symptoms.

Causes and symptoms

Cysts of *Cryptosporidia* mature in the intestine and bile ducts within three to five days of ingestion. As noted, large-scale infections from contaminated water supplies has been documented. However, human to human transmission (such as occurs in day care centers or through sexual behavior) is also an important cause.

Many individuals can be infected without any illness, but the major symptom is **diarrhea**, which is often watery and incapacitating. **Dehydration**, low-grade **fever**, **nausea**, and abdominal cramps are frequent.

In those with a normal immune system, the disease usually lasts about 10 days. For patients with altered immunity (immunocompromised), the story is quite different, with diarrhea becoming chronic, debilitating, and even fatal.

Complications

Dehydration and **malnutrition** are the most common effects of infection. In about 20% of AIDS patients, bile duct infection also occurs and causes symptoms similar to gallbladder attacks. Eighty percent or more of those with infection of the bile ducts die from the disease. The lungs and pancreas are also sometimes involved. *Cryptosporidia* are just one cause of the diarrhea wasting syndrome in AIDS, which results in severe weight loss and malnutrition.

Diagnosis

This is based on either finding the characteristic cysts in stool specimens, or on biopsy of an infected organ, such as the intestine.

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Treatment

The first aim of treatment is to avoid dehydration. Oral Rehydration Solution (ORS) or intravenous fluids may be needed. Medications used to treat diarrhea by decreasing intestinal motility (Anti-Motility Agents), such as loperamide or diphenoxylate, are also useful, but should only be used with the advice of a physician.

Treatment aimed directly at *Cryptosporidia* is only partially effective, and rarely eliminates the organism. The medication most commonly used is paromomycin (Humatin), but others are presently under evaluation.

Prognosis

Cryptosporidia rarely cause a serious disease in persons with normal immune systems. Replacement of fluids is all that is usually needed. On the other hand, those with altered immune systems often suffer for months to years. Paramomycin and other drugs have been able to improve symptoms in over half of those treated. Unfortunately, many organisms are resistant, and recurrence is frequent.

Prevention

The best way to prevent cryptosporidiosis is to minimize exposure to cysts from infected humans and animals. Proper hand washing technique, especially in day care centers, is recommended.

Resources

OTHER

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ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

David Kaminstein, MD

CSF analysis *see* **Cerebrospinal fluid (CSF) analysis**

CT-guided biopsy

Definition

Computed tomography (CT) is a process that images anatomic information from a cross-sectional plane of the body. Biopsy is the process of taking a sample of tissue from the body for analysis. CT is commonly used in biopsies to provide images that help guide the tools or equipment necessary to perform the biopsy to the appropriate area of the body.

Purpose

CT is used in the process of performing a biopsy, such as a needle biopsy, in order to guide the needle to the site of the biopsy and to provide rapid and precise localization of the needle. CT enables imaging of areas that are normally beyond visible boundaries. This enables the physician to see the target area clearly and help to ensure that the tissue being removed is from the target lesion.

Precautions

The patient that suffers from claustrophobia will want to discuss this with their physician. This procedure involves the patient being placed into the CT scanner, typically a small, enclosed area. Depending on the specific type of biopsies being performed, certain anesthetics will be used, so discuss drug **allergies** with your physician.

Description

CT can assist in providing more enhanced images of a suspicious lesion. It helps to determine whether a tumor is truly solitary or not. CT can characterize the tumor and aid in the estimation of malignancy.

Preparation

Since there are many different types of biopsies, you should follow the instructions from your physician to prepare for your CT-guided biopsy. Patients who suffer from claustrophobia should discuss their concerns with the physician. In some cases, medicine can be given that will relax the patient during the procedure.

Risks

CT-guided biopsy does not increase the risk of the biopsy any more than any other radiologic imaging such as x ray.

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KEY TERMS

Lesion—A pathologic change in tissues.

Malignancy—A locally invasive and destructive growth.

Results

Because the area being biopsied, as well as the specific type of biopsy procedure can vary, results will vary. Before undergoing the procedure, notification procedure should be clearly defined.

Resources

BOOKS

McPhee, Stephen, and Maxine Papadakis. *Current Medical Diagnosis and Treatment, 2010*, 49th ed. New York: McGraw–Hill Medical, 2009.

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PERIODICALS

Garpestad, E., et. al. "CT Fluoroscopy Guidance for Transbronchial Needle Aspiration." *Chest* 119 (February 2001).

Kim A. Sharp, M.Ln.

CT-myelogram *see* **Myelography**

CT scan *see* **Computed tomography scans**

Culture-fair test

Definition

A culture-fair test is test designed to be free of cultural bias, as far as possible, so that no one culture has an advantage over another. The test is designed to not be influenced by verbal ability, cultural climate, or educational level.

Purpose

The purpose of a culture-fair test is to eliminate any social or cultural advantages, or disadvantages, that a person may have due to their upbringing. The test can be administered to anyone, from any nation, speaking any language. A culture-fair test may help identify learning or emotional problems. The duration of the test varies for the individual types of tests available, but the time is approximately between 12–18 minutes per section (a test usually has two to four sections).

A culture-fair test is often administered by employers in order to determine the best location for new employees in a large company. The wide variety of culture-fair tests available allows the administrator to select which area is most vital, whether it be general intelligence, knowledge of a specific area, or emotional stability.

Precautions

There is doubt as to whether any test can truly be culturally unbiased or can ever be made completely fair to all persons independent of culture. There are no other precautions.

Description

A culture-fair test is a non-verbal paper-pencil test that can be administered to patients as young as four years old. The patient only needs the ability to recognize shapes and figures and perceive their respective relationships. Some examples of tasks in the test may include:

- completing series
- classifying
- solving matrices
- evaluating conditions

The culture-fair test is also often referred to as a culture-free test or unbiased test. There are many variations of the test including class, economic, and intelligence tests. The threading theme among the various tests is their design to be culturally unbiased.

Preparation

The only preparation necessary to administer the test is pre-ordered materials and a quiet and secluded location for the duration of the test.

Aftercare

Post-test treatment depends on the results of the test and the specifics of the individual patient. Any further treatment is best prescribed by the doctor.

Risks

There are no risks associated with the culture-fair test.

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Results

The results can be compared to the key that comes with the purchase of a culture-fair test. All results should be compared to the included key.

Resources

BOOKS

Maddox, Taddy. *Tests*. 6th ed. Austin, Texas: Pro–Ed, 2008.

Michael Sherwin Walston
Ronald Watson, PhD

Cultures for sexually transmitted diseases *see* **Sexually transmitted diseases cultures**

Cushing's syndrome

Definition

Cushing's syndrome is a relatively rare endocrine (hormonal) disorder resulting from excessive exposure to the hormone cortisol. The disorder, which leads to a variety of symptoms and physical abnormalities, is most commonly caused by taking medications containing the hormone over a long period of time. A more rare form of the disorder occurs when the body itself produces an excessive amount of cortisol.

Description

The adrenals are two glands, each of which is perched on the upper part of the two kidneys. The outer part of the gland is known as the cortex; the inner part is known as the medulla. Each of these parts of the adrenal gland is responsible for producing different types of hormones. Regulation of hormone production and release from the adrenal cortex involves the pituitary gland, a small gland located at the base of the brain. After the hypothalamus (the part of the brain containing secretions important to metabolic activities) sends "releasing hormones" to the pituitary gland, the pituitary secretes a hormone called adrenocorticotropic hormone (ACTH). The ACTH then travels through the bloodstream to the adrenal cortex, where it encourages the production and release of cortisol (sometimes called the "stress" hormone) and other adrenocortical hormones.

Cortisol, a very potent glucocorticoid—a group of adrenocortical hormones that protects the body from **stress** and affect protein and carbohydrate metabolism—is involved in regulating the functioning

Woman with Cushing's syndrome. *(Photo Researchers, Inc.)*

of nearly every type of organ and tissue in the body, and is considered to be one of the few hormones absolutely necessary for life. Cortisol is involved in:

- complex processing and utilization of many nutrients, including sugars (carbohydrates), fats, and proteins
- normal functioning of the circulatory system and the heart
- functioning of muscles
- normal kidney function
- production of blood cells
- normal processes involved in maintaining the skeletal system
- proper functioning of the brain and nerves
- normal responses of the immune system

Cushing's syndrome, also called hypercortisolism, has an adverse effect on all of the processes described

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above. The syndrome occurs in approximately 10 to 15 out of every one million people per year, usually striking adults between the ages of 20 and 50.

Causes and symptoms

The most common cause of Cushing's syndrome is the long-term use of glucocorticoid hormones in medications. Medications such as prednisone are used in a number of inflammatory conditions. Such conditions include **rheumatoid arthritis**, **asthma**, **vasculitis**, lupus, and a variety of other **autoimmune disorders** in which the body's immune cells accidentally attack some part of the body itself. In these disorders, the glucocorticoids are used to dampen the immune response, thereby decreasing damage to the body.

Cushing's syndrome can also be caused by three different categories of disease:

- a pituitary tumor producing abnormally large quantities of ACTH
- the abnormal production of ACTH by some source other than the pituitary
- a tumor within the adrenal gland overproducing cortisol

Although it is rare, about two-thirds of endogenous (occurring within the body rather than from a source outside the body, like a medication) Cushing's syndrome which is caused by excessive secretion of ACTH by a pituitary tumor, usually an adenoma (noncancerous tumor). The pituitary tumor causes increased growth of the adrenal cortex (hyperplasia) and increased cortisol production. Cushing's disease affects women more often than men.

Tumors in locations other than the pituitary can also produce ACTH. This is called ectopic ACTH syndrome ("ectopic" refers to something existing out of its normal place). Tumors in the lung account for more than half of all cases of ectopic ACTH syndrome. Other types of tumors that may produce ACTH include tumors of the thymus, the pancreas, the thyroid, and the adrenal gland. Nearly all adrenal gland tumors are benign (noncancerous), although in rare instances a tumor may actually be cancerous.

Symptoms of cortisol excess (resulting from medication or from the body's excess production of the hormone) include:

- weight gain
- an abnormal accumulation of fatty pads in the face (creating the distinctive "moon face" of Cushing's syndrome); in the trunk (termed "truncal obesity"); and over the upper back and the back of the neck (giving the individual what has been called a "buffalo hump")
- purple and pink stretch marks across the abdomen and flanks
- high blood pressure
- weak, thinning bones (osteoporosis)
- weak muscles
- low energy
- thin, fragile skin, with a tendency toward both bruising and slow healing
- abnormalities in the processing of sugars (glucose), with occasional development of actual diabetes
- kidney stones
- increased risk of infections
- emotional disturbances, including mood swings, depression, irritability, confusion, or even a complete break with reality (psychosis)
- irregular menstrual periods in women
- decreased sex drive in men and difficulty maintaining an erection
- abormal hair growth in women (in a male pattern, such as in the beard and mustache area), as well as loss of hair from the head (receding hair line)

Diagnosis

Diagnosing Cushing's syndrome can be complex. Diagnosis must not only identify the cortisol excess, but also locate its source. Many of the symptoms listed above can be attributed to numerous other diseases. Although a number of these symptoms seen together would certainly suggest Cushing's syndrome, the symptoms are still not specific to Cushing's syndrome. Following a review of the patient's medical history, **physical examination**, and routine blood tests, a series of more sophisticated tests is available to achieve a diagnosis.

24-hour free cortisol test

This is the most specific diagnostic test for identifying Cushing's syndrome. It involves measuring the amount of cortisol present in the urine over a 24-hour period. When excess cortisol is present in the bloodstream, it is processed by the kidneys and removed as waste in the urine. This 24-hour free cortisol test requires that an individual collect exactly 24-hours' worth of urine in a single container. The urine is then analyzed in a laboratory to determine the quantity of cortisol present. This technique can also be paired with the administration of dexamethasone, which in a

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KEY TERMS

Adenoma—A type of noncancerous (benign) tumor that often involves the overgrowth of certain cells of the type normally found within glands.

Adrenocorticotropic hormone (ACTH)—A pituitary hormone that stimulates the cortex of the adrenal glands to produce adrenal cortical hormones.

Cortisol—A hormone secreted by the cortex of the adrenal gland. Cortisol regulates the function of nearly every organ and tissue in the body.

Ectopic—In an abnormal position.

Endocrine—Pertaining to a gland that secretes directly into the bloodstream.

Gland—A collection of cells whose function is to release certain chemicals (hormones) that are important to the functioning of other, sometimes distantly located, organs or body systems.

Glucocorticoids—General class of adrenal cortical hormones that are mainly active in protecting against stress and in protein and carbohydrate metabolism.

Hormone—A chemical produced in one part of the body that travels to another part of the body in order to exert its effect.

Hypothalamus—the part of the brain containing secretions important to metabolic activities.

Pituitary—A gland located at the base of the brain, the pituitary produces a number of hormones, including hormones that regulate growth and reproductive function.

normal individual would cause urine cortisol to be very low. Once a diagnosis has been made using the 24-hour free cortisol test, other tests are used to find the exact location of the abnormality causing excess cortisol production.

Dexamethasone suppression test

This test is useful in distinguishing individuals with excess ACTH production due to a pituitary adenoma from those with ectopic ACTH-producing tumors. Patients are given dexamethasone (a synthetic glucocorticoid) orally every six hours for four days. Low doses of dexamethasone are given during the first two days; for the last two days, higher doses are administered. Before dexamethasone is administered, as well as on each day of the test, 24-hour urine collections are obtained.

Because cortisol and other glucocorticoids signal the pituitary to decrease ACTH, the normal response after taking dexamethasone is a drop in blood and urine cortisol levels. Thus, the cortisol response to dexamethasone differs depending on whether the cause of Cushing's syndrome is a pituitary adenoma or an ectopic ACTH-producing tumor.

However, the dexamethasone suppression test may produce false-positive results in patients with conditions such as depression, alcohol **abuse**, high estrogen levels, acute illness, and stress. On the other hand, drugs such as phenytoin and phenobarbital may produce false-negative results. Thus, patients are usually advised to stop taking these drugs at least one week prior to the test.

Corticotropin-releasing hormone (CRH) stimulation test

The CRH stimulation test is given to help distinguish between patients with pituitary adenomas and those with either ectopic ACTH syndrome or cortisol-secreting adrenal tumors. In this test, patients are given an injection of CRH, the corticotropin-releasing hormone that causes the pituitary to secrete ACTH. In patients with pituitary adenomas, blood levels of ACTH and cortisol usually rise. However, in patients with ectopic ACTH syndrome, this rise is rarely seen. In patients with cortisol-secreting adrenal tumors, this rise almost never occurs.

Petrosal sinus sampling

Although this test is not always necessary, it may be used to distinguish between a pituitary adenoma and an ectopic source of ACTH. Petrosal sinus sampling involves drawing blood directly from veins that drain the pituitary. This test, which is usually performed with **local anesthesia** and mild **sedation**, requires inserting tiny, flexible tubes (catheters) through a vein in the upper thigh or groin area. The catheters are then threaded up slowly until they reach veins in an area of the skull known as the petrosal sinuses. X rays are typically used to confirm the correct position of the catheters. Often CRH is also given during the test to increase the accuracy of results.

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When blood tested from the petrosal sinuses reveals a higher ACTH level than blood drawn from a vein in the forearm, the likely diagnosis is a pituitary adenoma. When the two samples show similar levels of ACTH, the diagnosis indicates ectopic ACTH syndrome.

Radiologic imaging tests

Imaging tests such as **computed tomography scans** (CT) and **magnetic resonance imaging** (MRI) are only used to look at the pituitary and adrenal glands after a firm diagnosis has already been made. The presence of a pituitary or adrenal tumor does not necessarily guarantee that it is the source of increased ACTH production. Many healthy people with no symptoms or disease whatsoever have noncancerous tumors in the pituitary and adrenal glands. Thus, CT and MRI is often used to image the pituitary and adrenal glands in preparation for surgery.

Treatment

The choice of a specific treatment depends on the type of problem causing the cortisol excess. Pituitary and adrenal adenomas are usually removed surgically. Malignant adrenal tumors always require surgical removal.

Treatment of ectopic ACTH syndrome also involves removing all of the cancerous cells that are producing ACTH. This may be done through surgery, **chemotherapy** (using combinations of cancer-killing drugs), or **radiation therapy** (using x rays to kill **cancer** cells), depending on the type of cancer and how far it has spread. Radiation therapy may also be used on the pituitary (with or without surgery) for patients who cannot undergo surgery, or for patients whose surgery did not successfully decrease pituitary release of ACTH.

There are a number of drugs that are effective in decreasing adrenal production of cortisol. These medications include mitotane, ketoconazole, metyrapone, trilostane, aminoglutethimide, and **mifepristone**. These drugs are sometimes given prior to surgery in an effort to reverse the problems brought on by cortisol excess. However, the drugs may also need to be administered after surgery (sometimes along with radiation treatments) in patients who continue to have excess pituitary production of ACTH.

Because pituitary surgery can cause ACTH levels to drop too low, some patients require short-term treatment with a cortisol-like medication after surgery. Patients who need adrenal surgery may also require glucocorticoid replacement. If the entire adrenal gland has been removed, the patient must take oral glucocorticoids for the rest of his or her life.

Prognosis

Prognosis depends on the source of the problem. When pituitary adenomas are identified as the source of increased ACTH leading to cortisol excess, about 80% of patients are cured by surgery. When cortisol excess is due to some other form of cancer, the prognosis depends on the type of cancer and the extent of its spread.

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Rosalyn Carson-DeWitt, MD

Cutaneous larva migrans

Definition

Cutaneous larvae migrans is a parasitic skin disease caused by a hookworm larvae that usually infests dogs, cats, and other animals. Humans can pick up the infection by walking barefoot on soil or beaches contaminated with animal feces.

Linear red rashes around a patient's knee caused by burrowing larvae of the dog hookworm *Ancylostoma braziliensis.* *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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Description

Cutaneous larvae migrans (also called "creeping eruption" or "ground itch") is found in southeastern and Gulf states, and in tropical developing countries.

The hookworms that cause the condition are small, round blood-sucking worms that infest about 700 million people around the world. Cutaneous larvae migrans occurs most often among children, those who crawl beneath raised buildings, and sunbathers who lie down on wet sand contaminated with hookworm larvae.

Causes and symptoms

After an animal passes feces that are infested with hookworm eggs, the eggs hatch into infective larvae that are able to penetrate human skin (even through solid material, such as a beach towel). The larvae are commonly found in shaded, moist, or sandy areas (such as beaches, a child's sandbox, or areas underneath a house), where they are easily picked up by bare feet or buttocks.

In minor infestations, there may be no symptoms at all. In more severe cases, a red elevation of the skin (papule) appears within a few hours after the larvae have penetrated the skin. This usually arises first in areas that are in contact with the soil, such as the feet, hands, and buttocks.

Between a few days and a few months after infection, the larvae begin to migrate beneath the skin, leaving extremely itchy red lines that may be accompanied by blisters. These red lines usually appear at the top of the sole of the foot or on the buttocks.

Tyically, the larvae travel through the bloodstream, to the lungs, and then migrate into the mouth where they are swallowed and attach to the small intestine lining. There they mature into adult worms. In cases where the larvae migrate through the lungs, they can produce anemia, **cough**, and **pneumonia**, in addition to the itchy rash.

Diagnosis

The condition can be diagnosed by microscopic inspection of feces which can reveal hookworm eggs. In addition visual inspection of the skin would reveal telltale itchy red lines and blisters.

Treatment

People without intestinal symptoms do not need treatment, since the worms will eventually die or be excreted. Thiabendazole or albendazole are used to treat the infestation. Mild infections can be treated by applying one of the drugs to the skin along the tracks and the normal skin surrounding the area. Thiabendazole also can be given internally, but taken this way it can cause side effects including **dizziness**, **nausea**, and **vomiting**

KEY TERMS

Larvae—Immature forms of certain worms.

Prognosis

No matter how severe an infestation, with adequate treatment patients recover completely. However, if the patient scratches the lesions open, the areas can become vulnerable to bacterial infection.

Prevention

In the United States, the prevalence of dogs and cats with hookworms is the reason why the infective larvae are found so commonly in soil and sand. The play habits of children, together with their attraction to pets, puts them at high risk for hookworm infection and cutaneous larvae migrans.

Human hookworm infestation can be prevented by practicing good personal hygiene, deworming pets, and not allowing children to play in potentially contaminated environments.

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Carol A. Turkington

Cutaneous T-cell lymphoma

Definition

Cutaneous T-cell lymphoma (CTCL) is a malignancy of the T-helper (CD4+) cells of the immune system.

Description

CTCL, also known as mycosis fungoides, is a **cancer** of the white blood cells that primarily affects the skin and only secondarily affects other sites. This disease involves the uncontrollable proliferation of T-lymphocytes known as T-helper cells, so named

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because of their role in the immune response. T-helper cells are characterized by the presence of a protein receptor on their surface called CD4. Accordingly, T-helper cells are said to be CD4+.

The proliferation of T-helper cells results in the penetration, or infiltration, of these abnormal cells into the epidermal layer of the skin. The skin reacts with slightly scaling lesions that itch, although the sites of greatest infiltration do not necessarily correspond to the sites of the lesions. The lesions are most often located on the trunk, but can be present on any part of the body. In the most common course of the disease, the patchy lesions progress to palpable plaques that are deeper red and have more defined edges. As the disease worsens, skin tumors develop that are often mushroom-shaped, hence the name mycosis fungoides. Finally, the cancer progresses to extracutanous involvement, often in the lymph nodes or the viscera.

CTCL is a rare disease, with an annual incidence of about 0.29 cases per 100,000 persons in the United States. It is about half as common in Eastern Europe. However, this discrepancy may be attributed to a differing physician awareness of the disease rather than a true difference in occurrence. In the United States, there are about 500–600 new cases a year and about 100–200 deaths. CTCL is usually seen in older adults; the median age at diagnosis is 55–60 years. It strikes twice as many men as women. The average life expectancy at diagnosis is 7–10 years, even without treatment.

Causes and symptoms

The cause of CTCL is unknown. Exposure to chemicals or pesticides has been suggested; however, the most recent study on the subject failed to show a connection between exposure and development of the disease. The ability to isolate various viruses from cell lines grown from cells of CTCL patients raises the question of a viral cause, but studies have been unable to confirm these suspicions.

The symptoms of CTCL are seen primarily in the skin, with itchy red patches or plaques and, usually over time, mushroom-shaped skin tumors. Any part of the skin can be involved and the extent and distribution of the rash or tumors vary greatly from patient to patient. The only really universal symptom of the disease is the itch and this symptom is usually what brings the patient to the doctor for treatment. If the disease spreads outside of the skin, the symptoms include swelling of the lymph nodes, usually most severe in those draining the areas with skin involvement. Spread to the viscera is most often manifested as disorders of the lungs, upper digestive tract, central nervous system, or liver but virtually any organ can be shown to be involved at **autopsy**.

Some patients with CTCL develop a leukemic phase of the disorder known as Sézary syndrome, which is characterized by the appearance of malignant T cells in the bloodstream. It is named for the French dermatologist who first identified the abnormal T cells.

Diagnosis

Diagnosis of CTCL is often difficult in the early stages because of its slow progression and ability to mimic many other benign skin conditions. The early patches of CTCL resemble **eczema**, **psoriasis**, and **contact dermatitis**. In a further complication, the early manifestations of the disease can respond favorably to the topical corticosteroid treatments prescribed for these skin disorders. This has the unfortunate result of the disease being missed and the patient remaining untreated for years. CTCL is most likely discovered when a physician maintains a suspicion about the disease, performs multiple skin biopsies, and provides close follow-up after the initial presentation.

Skin biopsies showing penetration of abnormal cells into the epidermal tissue are necessary to make a firm diagnosis of CTCL. Several molecular studies can also help support the diagnosis. The first looks at the cellular proteins seen on the surface of the abnormal cells. Many cases of CTCL show the retention of the CD4+ protein, but the loss of other proteins usually seen on the surface of mature CD4+ cells, such as Leu-8 or Leu-9. The abnormal cells also show unusual rearrangements at the genetic level for the gene that encodes the T-cell receptors. These rearrangements can be identified using Southern blot analysis. The information from the molecular tests, combined with the presence of abnormal cells in the epidermis, strongly supports the CTCL diagnosis.

Treatment

Treatment of CTCL depends on the stage of the disease. The current staging of this disease was first presented at the International Consensus Conference on CTCL in 1997. The staging attempts to show the complex interaction between the various outward symptoms of the disease and prognosis. The system has seven clinical stages based on skin involvement (tumor = T), lymph node involvement (LN), and presence of visceral metastases (M).

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The first stage, IA, is characterized by plaques covering less than 10% of the body (T1) and no visceral involvement (M0). Lymph node condition at this stage can be uninvolved, reactive to the skin disease, or dermatopathic (biopsies showing CTCL involvement) but not enlarged (LN0-2). The shorthand expression of this stage is therefore T1, LN0-2, M0. The next stage, IB, differs from IA in that greater than 10% of the body is covered by plaques (T2, LN0-2, M0). Stage IIA occurs with any amount of plaques in addition to the ability to palpate the lymph node and the lymph uninvolved, reactive, or dermatopathic (T1-2, LN0-2, M0).

Treatments applied to the skin are preferred for patients having these preliminary stages of the disease, commonly topical **chemotherapy** with mechlorethamine hydrochloride (nitrogen mustard) or **phototherapy** of psoralen plus ultraviolet A (PUVA). Topical chemotherapy involves application to the skin of nitrogen mustard, an alkylating agent, in a concentration of 10–20 mg/dL in an aqueous or ointment base. Treatment of affected skin is suggested at a minimum and application over the entire skin surface is often recommended. Care needs to be taken that coverage of involved skin is adequate, as patients who self-apply the drug often cannot reach all affected areas. The most common side effect is skin hypersensitivity to the drug. Nearly all patients respond favorably to this treatment, with a 32–61% complete response rate, based on amount of skin involvement. Unfortunately, only 10–15% of patients maintain a complete response rate after discontinuing the treatment.

Phototherapy involves treatment with an orally administered drug, 8-methyloxypsoralen, that renders the skin sensitive to long-wave ultraviolet light (UVA), followed by controlled exposure to the radiation. During the initial treatment period, which may last as long as six months, patients are treated two to three times weekly. This is reduced to about once monthly after initial clearing of the lesions. Redness of the skin and blistering are the most common side effects of the treatment and are much more common in patients presenting with overall skin redness, or erythroderma, so lower intensities of light are usually used in this case. About 50% of all patients experience complete clearance with this treatment. Some patients with very fair skin and limited skin involvement can successfully treat themselves at home with special lamps and no psoralen.

The next stage, IIB, involves one or more cutaneous tumors, in combination with absent or present palpable lymph nodes, lymph uninvolved, reactive, or dermatopathic, and no visceral involvement (T3, LN0-2, M0). Stage III is characterized by erythroderma, an abnormal redness over widespread areas of the skin (T4, LN0-2, M0).

For more extensive disease, **radiation therapy** is an effective treatment option. It is generally used after the topical treatments have proven ineffective. Individual plaques or tumors can be treated using electrons, orthovoltage x rays, or megavoltage photons with exposure in the range of 15 to 25 Gy. Photon therapy has proven particularly useful once the lymph nodes are involved. Another possibility is total-skin electron beam therapy (TSEB), although the availability of this treatment method is limited. It involves irradiation of the entire body with energized electrons. Side effects of this treatment include loss of finger and toe nails, acute redness of the skin, and inability to sweat for about six to 12 months after therapy. Almost all patients respond favorably to radiation treatment and any reoccurrence is usually much less severe.

Combination of different types of treatments is a very common approach to the management of CTCL. Topical nitrogen mustard or PUVA is often used after completion of radiation treatment to prolong the effects. The addition of genetically engineered interferon to PUVA therapy significantly increases the percentage of patients showing a complete response. Furthermore, although treatments using chemotherapy drugs alone, such as deoxycofomycin or etretinate, have been disappointing for CTCL, combining these drugs with interferon has shown promising results. Interferon has also been combined with retinoid treatments, although the mechanism of action of retinoids (Vitamin A analogues) against CTCL is unknown.

The final two stages of the disease are IVA and IVB. IVA presents as any amount of skin involvement, absent or present palpable lymph nodes, no visceral involvement, and lymph that contains large clusters of convoluted cells or obliterated nodes (T1-4, LN3-4). IVB differs in the addition of palpable lymph nodes and visceral involvement (T1-4, LN3-4, M1). All of the treatment methods described above are appropriate for the final two stages of the disease.

A newer drug that has been used to treat CTCL is bexarotene, a topical gel that is a synthetic retinoid analog. Bexarotene has been shown to be effective in clinical trials for stage IA or IB CTCL, and has fewer side effects than topical nitrogen mustard or electron beam radiotherapy. Another team of researchers at the University of Pennsylvania reported in 2003 that bexarotene combined with psoralen and UVA therapy

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KEY TERMS

Alkylating agent—A chemical that alters the composition of the genetic material of rapidly dividing cells, such as cancer cells, causing selective cell death; used as a topical chemotherapeutic agent to treat CTCL.

Cutaneous—Pertaining to the skin.

Erythroderma—An abnormal reddening of the entire skin surface.

Monoclonal antibody—An antibody produced by the identical offspring of a single cloned antibody-producing cell.

Mycosis fungoides—Another name for cutaneous T-cell lymphoma.

Sézary syndrome—A leukemic phase of CTCL that develops in some patients, characterized by the appearance of malignant T cells in the peripheral blood and sometimes in the lymph nodes. The syndrome is named for Alfred Sézary (1880-1956), a French dermatologist.

T-helper cells—A cellular component of the immune system that plays a major role in ridding the body of bacteria and viruses, characterized by the presence of the CD4 protein on its surface; the type of cell that divides uncontrollable with CTCL.

Total-skin electron beam therapy—A method of radiation therapy used to treat CTCL that involves bombarding the entire body surface with high-energy electrons.

is also effective in treating patients with advanced CTCL.

A treatment for advanced CTCL that is considered experimental as of mid-2003 is **alemtuzumab**, a monoclonal antibody. A Swedish study of 22 patients with advanced CTCL and Sézary syndrome found that alemtuzumab relieved symptoms in 55% of patients, with 32% in complete remission and 23% in partial remission.

Alternative treatment

Itching of the skin is one of the most troublesome symptoms of CTCL. One alternative treatment for itchiness is the application of a brewed solution of chickweed that is applied to the skin using cloth compresses. Another suggested topical application is a mixture of vitamin E, vitamin A, unflavored yogurt, honey, and zinc oxide. Evening primrose oil applied topically is also claimed to reduce itch and promote healing.

Prognosis

The prognosis for CTCL is dependent on the stage of the disease. Prognosis is very good if the disease has only progressed to Stage IA, with a mean survival of 20 or more years. At this point, the disease is a very low mortality risk to the patient, with most deaths occurring to persons in this group unrelated to CTCL. For patients diagnosed at stages IB and IIA, the median survival is about 12 years. The disease in both of these stages involves intermediate risk to the patient. Patients in stage III and IVA have a mean life expectancy of about five years. At these later stages, the disease is high risk, with most deaths occurring by infection due to the depleted immune system of the later-stage patient. Once a patient has reached stage IVB, the mean life expectancy is one year.

Prevention

Studies have been unable to link CTCL to any environmental or genetic factors, so prevention at this time is not possible.

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ORGANIZATIONS

American Academy of Dermatology, PO Box 4014, Schaumburg, IL, 60168-4014, (847) 240-1859, (866) 503-SKIN (7546), http://www.aad.org.
American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (800) 227-2345, http://www.cancer.org.
National Cancer Institute (National Institutes of Health), NCI Office of Communications and Education, 6116 Executive Blvd. Suite 300, Bethesda, MD, 20892-8322, (800) 4-CANCER (422-6237), cancergovstaff@mail.nih.gov, http://www.cancer.gov/.

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Cutis laxa

Definition

Cutis laxa (Latin for loose or lax skin) is a connective tissue disorder in which the skin lacks elasticity and hangs in loose folds.

Description

Cutis laxa is extremely rare; less than a few hundred cases worldwide have been described.

The several forms of cutis laxa are divided into primary cutis laxa, which is present from birth and is hereditary, secondary cutis laxa, which arises later in life and may be hereditary, and acquired cutis laxa, which arises later in life and is not hereditary. Loose skin, the primary and most obvious symptom of these diseases, is caused by underlying defects in connective tissue structure, which also cause more serious internal problems in vocal cords, bones, cartilage, blood vessels, bladder, kidney, digestive system, and lungs. The loose skin is particularly obvious on the face, and children with the disorder look sad or mournful.

There are four genetic forms of the disease: sex-linked, autosomal dominant, and two types of autosomal recessive inheritance. The recessive forms are the most common and are usually more severe than the other forms.

Causes and Symptoms

Sex-linked cutis laxa is caused by a defective gene on the X chromosome. In addition to loose skin, its symptoms are mild **mental retardation**, loose joints, bone abnormalities (like hooked nose, pigeon breast, and funnel breast), frequent loose stools, urinary tract blockages, and deficiencies in lysyl oxidase, an enzyme required for the formation of properly functioning connective tissue. (But the defective gene does not code for lysyl oxidase.)

Autosomal dominant cutis laxa is caused by a defective gene carried on an autosomal (not sex-linked) chromosome. Its symptoms are loose, hanging skin, missing elastic fibers, premature **aging**, and pulmonary **emphysema**. Only a few families are known with cutis laxa inherited as a dominant trait.

Autosomal recessive cutis laxa type 1 is caused by a defective gene on chromosome 5. Symptoms include emphysema; diverticula in the esophagus, duodenum, and bladder; lax and dislocated joints; tortuous arteries; hernias; lysyl oxidase deficiencies; and retarded growth.

Autosomal recessive cutis laxa type 2 is also inherited as a recessive trait. In addition to the loose skin, this form of the disease is characterized by bone abnormalities, the delayed joining of the cranial (skull) bones, hip dislocation, curvature of the spine, flat feet, and excessive **tooth decay**.

Acquired cutis laxa tends to follow (and may be caused by) severe illness characterized by **fever**, inflammation, and a severe skin rash (**erythema multiforme**); an injury to the nerves that control blood vessel dilation and contraction; or an autoimmune condition.

Diagnosis

The signs of cutis laxa are very obvious, and it is usually easy to diagnose by examining the skin. The determination of which form of cutis laxa is present is aided by information about the associated symptoms and by family histories.

Treatment

There is no effective cure for any of these disorders. Complications are treated by appropriate specialists,

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KEY TERMS

Autosomal—Refers to the 22 pairs (in humans) of chromosomes not involved with sex determination.

Connective tissue—Tissue that supports and binds other tissue; much of it occurs outside of cells (extra-cellular) and consists of fibrous webs of the polymers, elastin and collagen. Cutis laxa is associated with defects in these fibers.

Diverticula—Pouches in the walls of organs.

Dominant trait—A genetic trait where one copy of the gene is sufficient to yield an outward display of the trait; dominant genes mask the presence of recessive genes; dominant traits can be inherited from only one parent.

Duodenum—The uppermost part of the small intestine, about 10 in (25 cm) long.

Esophagus— The tube connecting the throat to the stomach, about 10 in (25 cm) long.

Funnel breast (also known as pectus excavatum)—A condition where there is a hollow depression in the lower part of the chest.

Gene—A portion of a DNA molecule that either codes for a protein or RNA molecule or has a regulatory function.

Lysyl oxidase—An enzyme required for the cross-linking of elastin and collagen molecules to form properly functioning connective tissue; present in relatively low levels in at least some forms of cutis laxa.

Pigeon breast (also known as pectus carinatum)—A chest shape with a central projection resembling the keel of a boat.

Recessive trait—An inherited trait that is outwardly obvious only when two copies of the gene for that trait are present; an individual displaying a recessive trait must have inherited one copy of the defective gene from each parent.

Sex-linked—Refers to genes or traits carried on one of the sex chromosomes, usually the X.

Tortuous arteries—Arteries with many bends and twists.

X chromosome—One of the two types of sex chromosomes; females have two X chromosomes, while males have one X chromosome and one Y chromosome.

for example, cardiologists, gastroenterologists, rheumatologists, and dermatologists. **Plastic surgery** can be helpful for cosmetic purposes, but the skin may become loose again.

Prognosis

The prognosis for cutis laxa varies with the form of the disorder. The effects may be relatively mild with individuals living a fairly normal, full life, or the disease may be fatal.

Prevention

The inherited forms of cutis laxa are genetically determined and are not currently preventable. **Genetic counseling** can be helpful for anyone with a family history of cutis laxa. The cause of acquired cutis laxa is not known, so no preventive measures can be taken.

Resources

OTHER

OMIM Homepage, Online Mendelian Inheritance in Man. http://www.ncbi.nlm.nih.gov/Omim.

ORGANIZATIONS

Coalitiion for Hertiable Disorders of Connective Tissue, 4301 Connecticut Avenue, NW, Suite 404, Washington, DC, 20008, (202) 362-9599, (202) 966-8553, chdct@pxe.org, http://www.chdct.org.

Lorraine Lica, PhD

Cuts *see* **Wounds**

CVA *see* **Stroke**

CVS *see* **Chorionic villus sampling; Cyclic vomiting syndrome**

Cyanosis

Definition

Cyanosis is a physical sign causing bluish discoloration of the skin and mucous membranes. Cyanosis is caused by a lack of oxygen in the blood. Cyanosis is associated with cold temperatures, **heart failure**, lung diseases, and smothering. It is seen in infants at birth

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This elderly woman's lips turned purple due to central cyanosis, a condition most commonly due to slow blood circulation, leading to a bluish skin coloration. *(Photo Researchers, Inc.)*

as a result of heart defects, **respiratory distress syndrome**, or lung and breathing problems.

Description

Blood contains a red pigment (hemoglobin) in its red blood cells. Hemoglobin picks up oxygen from the lungs, then circulates it through arteries and releases it to cells through tiny capillaries. After giving up its oxygen, blood circulates back to the lungs through capillaries and veins. Hemoglobin, as well as blood, is bright red when it contains oxygen, but appears dark or "bluish" after it gives up oxygen.

The blue discoloration of cyanosis is seen most readily in the beds of the fingernails and toenails, and on the lips and tongue. It often appears transiently as a result of slowed blood flow through the skin due to the cold. As such, it is not a serious symptom. However, in other cases cyanosis is a serious symptom of underlying disease.

Causes and symptoms

The blue color of the skin and mucous membranes is caused by a lack of oxygen in the blood. Low blood oxygen may be caused by poor blood circulation, or heart or breathing problems. It can also be caused by being in a low-oxygen environment or by **carbon monoxide poisoning**. More rarely, cyanosis can be present at birth as a sign of **congenital heart disease**, in which some of the blood is not pumped to the lungs where oxygen would make the blood a bright red color. Instead, the blood goes to the rest of the body and remains unoxygenated. Cyanosis also may be caused by poisoning from chemicals, drugs, or contaminated food and water.

KEY TERMS

Hemoglobin—A colored substance (pigment) in the blood that carries oxygen to tissues and gives blood its red color.

Respiratory distress syndrome—Also known as hyaline membrane disease, this is a condition of premature infants in which the lungs are imperfectly expanded due to a lack of a substance on the lungs that reduces tension.

Other signs of low blood oxygen may accompany cyanosis, including feeling lightheaded or fainting.

Treatment

Treatment of the underlying disease can restore proper color to the skin.

Prognosis

If the underlying condition (such as heart or lung disease) can be properly treated, the skin will return to its normal shade.

Resources

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Carol A. Turkington

Cyclic vomiting syndrome

Definition

Cyclic **vomiting** syndrome (CVS) is a rare idiopathic disorder characterized by recurring periods of **vomiting** in an otherwise normal child or adult. It was first described in 1882 by an English physician, Samuel Jones Gee. CVS is sometimes called abdominal migraine because it may be caused by some of the same mechanisms in the central nervous system that cause migraine headaches.

Description

Children in the pre–school or early school years are most susceptible to CVS, although the disorder

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KEY TERMS

Abdominal migraine—Another term that is sometimes used for CVS.

Idiopathic—Of unknown cause or spontaneous origin. CVS is sometimes called an idiopathic disorder because its cause(s) are still not known.

Prodrome—A symptom or group of symptoms that appears shortly before an acute attack of illness. The term comes from a Greek word that means "running ahead of."

can appear at any time from infancy to adulthood. One doctor reports that 43 of the 233 patients with CVS that he has treated were adults when their symptoms began. The average age of patients at onset is 5.2 years, but CVS has been diagnosed in patients as old as 73. This disorder was identified over a century ago, but its cause is still unknown. Episodes can be triggered by emotional **stress** or infections (particularly **sinusitis**), can last hours or days, and can return at any time. Abdominal **pain** is a frequent feature.

CVS appears to affect all races equally. The female:male ratio has been reported as 11:9.

Causes and symptoms

The cause of CVS is still unknown. Similarities to migraine suggest a common cause, but as yet no firm evidence has surfaced. It is known, however, that 82% of patients with CVS have a family history of migraine compared to 14% of control subjects. Patients can usually identify some factor that precedes an attack. Vomiting can be protracted and lead to such complications as **dehydration**; chemical imbalances; and tearing, burning, and bleeding of the esophagus (swallowing tube). Between attacks, there is no sign of any illness.

CVS has four distinct stages or phases:

- Prodrome. A prodrome is a warning symptom (or group of symptoms) that appears just before an acute attack of an illness. Patients with CVS often feel pain in the abdomen a few minutes or hours before the vomiting starts. Adults with CVS often have anxiety or panic attacks as a prodrome.
- Episode phase. During this phase, the patient is actively nauseated and vomiting. He or she may also feel drowsy or exhausted.
- Recovery phase.
- Symptom–free interval.

Diagnosis

The most important and difficult aspect of CVS is to be sure there is not an acute and life–threatening event in progress. So many different diseases can cause vomiting—from bowel obstruction to epilepsy—that an accurate and timely diagnosis is critical. Because there is no way to confirm a diagnosis of CVS, the physician must instead disprove every other diagnosis. This process, which is known as a diagnosis of exclusion, can be tedious, expensive, exhausting, and involving almost every system in the body. The first episode may be diagnosed as a stomach flu when nothing more serious turns up. Only after several episodes and several fruitless searches for a cause will a physician normally consider a diagnosis of CVS.

A careful history–taking is critical to making the correct diagnosis of CVS. A family history of migraine, particularly on the mother's side of the family, should alert the doctor to the possibility that the patient may have CVS.

In some cases, the doctor may refer the patient to a psychiatrist for evaluation in order to rule out **anxiety disorders** or an eating disorder.

Treatment

Several different medications have given good results in small trials. The antimigraine drugs amitriptyline and cyproheptadine performed well for one study group. Propranolol is sometimes effective, and erythromycin helped several patients in one study, not because it is an antibiotic but because it irritates the stomach and encourages it to move its contents forward instead of in reverse.

Another medication that has been reported to be successful in treating children with CVS is dexmedetomidine (Precedex), a drug originally developed to sedate patients on respirators in intensive care settings. Researchers found that dexmedetomidine relieved the **anxiety** as well as the **nausea** associated with CVS.

Antiemetic medication such as ondansetron (Zofran), antianxiety medication such as lorazepam (Ativan) and medication for stomach acid irritation such as ranitidine (Zantac) may be helpful during the prodrome phase.

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Acupuncture treatments have also been found to be helpful to some children with CVS.

Patients are urged to drink plenty of water and electrolyte fluids to stay healthy during the recovery phase, moving slowly to solid food as tolerated.

Prognosis

The disease may go on for many years without a change in pattern. If the acute complications of prolonged vomiting can be successfully prevented or managed, most patients can lead normal lives between episodes. Medications may ease the symptoms during attacks.

Resources

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ORGANIZATIONS

American Academy of Child and Adolescent Psychiatry, 3615 Wisconsin Ave., NW, Washington, DC, 20016–3007, (202) 966–7300, (202) 966–2891, http://www.aacap.org.

American Academy of Family Physicians, PO Box 11210, Shawnee Mission, KS, 66207 (913) 906–6000, (800) 274–2237, (913) 906–6075, http://www.aafp.org.

American Academy of Pediatrics, 141 Northwest Point Blvd., Elk Grove Village, IL, 60007–1098 (847) 434–4000, http://www.aap.org.

American Dietetic Association, 20 South Riverside Plaza, Suite 2000, Chicago, IL, 60605, (800) 877–1600, http://www.eatright.org.

Cyclic Vomiting Syndrome Association in the United States and Canada (CVSA—USA/Canada), 3585 Cedar Hill Road, NW, Canal Winchester, OH, 43110, (614) 837–2586, http://www.cvsaonline.or.

National Eating Disorders Association, 603 Stewart St., No. 803, Seattle, WA, 98101, (206) 382–3587, http://www.nationaleatingdisorders.org.

National Institute of Child Health and Human Development (NICHD), PO Box 3006, Rockville, MD, 30847, (800) 370–2943 TTY: (800) 320–6942, (866) 760–5947, NICHDInformationResourceCenter@mail.nih. gov, http://www.nichd.nih.gov.

National Organization for Rare Disorders, Inc. (NORD), 55 Kenosia Ave., PO Box 1968, Danbury, CT, 06813, (203) 744–0100, (800) 999–6673, http://www.rarediseases.org.

Nutrition.gov. USDA National Agricultural Library, Food and Nutrition Information Center, Nutrition.gov Staff, 10301 Baltimore Ave., Beltsville, MD, 20705–2351, http://www.nutrition.gov.

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Cyclobenzaprine *see* **Muscle relaxants**

Cyclophospha *see* **Anticancer drugs**

Cyclospora infection *see* **Cyclosporiasis**

Cyclosporiasis

Definition

Cyclosporiasis refers to infection by the spore-forming protozoan known as *Cyclospora*. Protozoa are a group of parasites that infect the human intestine. Parasites are organisms that live in another body, called the host, and get food and liquids from that host. This parasite is a member of the group of protozoa known

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KEY TERMS

Anti-motility medications—Medications such as loperamide (sold as Imodium), dephenoxylate (sold as Lomotil), or medications containing codeine or narcotics that decrease the ability of the intestine to contract. This can worsen the condition of a patient with dysentery or colitis.

Cyst—A protective sac that includes either fluid or the cell of an organism. The cyst enables many organisms to survive in the environment for long periods of time without need for food or water.

Immunocompromised—A change or alteration of the immune system that normally serves to fight off infections other illnesses. This can involve changes in antibodies that the body produces (hygogammaglobulinemia), or a defect in the cells that partake in the immune response. Diseases such as AIDS and cancer exhibit changes in the body's natural immunity.

Oral Rehydration Solution (ORS)—A liquid preparation developed by the World Health Organization that can decrease fluid loss in persons with diarrhea. Originally developed to be prepared with materials available in the home, commercial preparations have recently come into use.

Parasite—An organism that lives on or in another and takes nourishment (food and fluids) from that organism.

Protozoa—Group of extremely small single cell (unicellular) or acellular organisms that are found in moist soil or water. They tend to exist as parasites, living off other life forms.

Spore—A resistant form of certain species of bacteria, protozoa, and other organisms.

as coccidia, to which *Cryptosporidia* also belongs. This group of parasites infects the human intestine, and causes chronic recurrent infections in those with altered immunity or **AIDS**. Even in people with normal immune function, *Cyclopsora* can cause prolonged bouts of **diarrhea** and other gastrointestinal symptoms.

Description

Until recently, *Cyclospora* was considered to be a form of algae. The parasite causes a common form of waterborne infectious diarrhea throughout the world. Just how the parasite gets into water sources is not yet clear. It is known that ingestion of small cysts in contaminated water leads to disease.

Causes and symptoms

Symptoms begin after an incubation period of about a day or so following ingestion of cysts. A brief period of flu-like illness characterized by weakness and low-grade **fever** is followed by watery diarrhea, **nausea**, loss of appetite, and muscle aches. In some patients, symptoms may wax and wane for weeks, and there are those in whom nausea and burping may predominate. It is also believed that infection can occur without any symptoms at all.

In patients with abnormal immunity (immunocompromised patients), such as those with AIDS and **cancer**, prolonged diarrhea and severe weight loss often become a major problem. The bile ducts are also susceptible to infection in AIDS patients.

Diagnosis

The disease should be suspected in anyone with a history of prolonged or recurrent diarrhea. The parasite is identified either by staining stool specimens or by applying certain fluorescent ultraviolet techniques to find the characteristic cysts. Biopsy of an infected organ such as the intestine through an endoscope is another way to make the diagnosis.

Treatment

The first aim of treatment as with any severe diarrheal illness is to avoid **dehydration** and **malnutrition**. Oral Rehydration Solution (ORS) or intravenous fluids are sometimes needed. Medications used to treat diarrhea by decreasing intestinal motility, such as loperamide or diphenoxylate are also useful, but should only be used with the advice of a physician.

The use of the medication, trimethoprim-sulfamethoxazole (Bactrim) for one week can be successful in treating intestinal infections and prevents relapse in those with a normal immune system. The same medicine can be prescribed to treat infections of both the intestine or bile ducts in immunocompromised individuals, but maintenance or continuous treatment is often needed.

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Prognosis

The outlook is quite good for individuals in whom a diagnosis is made. Even without treatment, symptoms usually do not last much more than a month except in cases with altered immunity. Fortunately, treatment is usually successful even in those patients.

Prevention

Aside from a waterborne source as the origin of infection, little else is known about how the parasite is transmitted. Therefore, little can be done regarding prevention, except to maintain proper hand washing techniques and hygiene.

Resources

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ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

David Kaminstein, MD

Cyclosporine *see* **Immunosuppressant drugs**

Cystectomy

Definition

Cystectomy is a surgical procedure to remove the bladder.

Purpose

Cystectomy is performed to treat **cancer** of the bladder. Radiation and **chemotherapy** are also used to treat **bladder cancer**. Surgery is used to remove cancer when it is in the muscle of the bladder.

Precautions

Cystectomy is an aggressive treatment that may not be appropriate for patients with superficial tumors that respond to more conservative treatment.

Description

Cystectomy is a major surgical operation. The patient is placed under **general anesthesia**. An incision is made across the lower abdomen. The ureters are located, tied and cut. The ureters connect the kidneys to the bladder. Cutting them frees the bladder for removal. The bladder and associated organs are removed. In men the prostate is removed with the bladder. In women, the uterus, fallopian tubes, ovaries, and part of the vagina are removed with the bladder. The bladder collects urine from the kidneys for excretion at a later time. Since the bladder is removed, a new method must be created to remove the urine. A small piece of the small intestine is removed, cleaned, and tied at one end to form a tube. The other end is used to form a stoma, an opening through the abdominal wall to the outside. The ureters are then connected to the tube. Urine produced by the kidneys now flows down the ureters, into the tube, and through the stoma. The patient wears a bag to collect the urine.

Preparation

The medical team will discuss the procedure and tell the patient where the stoma will appear and what it will look like. The patient receives instruction on caring for a stoma and bag. Counseling may be initiated. A period of **fasting** and an enema may be required.

Aftercare

After the operation, the patient is given fluid-based **nutrition** until the intestines being to function normally again. **Antibiotics** are given to prevent infection of the incision sites. The nature of the organs removed mean that there will be major lifestyle changes for the person undergoing the operation. Men will become impotent because nerves controlling penile erection are cut during removal of the bladder. In women, **infertility** is a consequence because the ovaries and uterus are removed. However, most women who undergo cystectomy are postmenopausal and past their childbearing years.

Both men and women are fitted with an external bag that connects to the stoma and collects the urine. The bag is generally worn around the waist under the clothing. It takes a period of adjustment to get used to wearing the bag. Because there is no bladder, urine is excreted as it is produced, essentially continuously. The stoma must be treated properly to ensure that it does not become infected or blocked. Patients must be trained to care for their stoma. Often there is a period of psychological adjustment to the major change in life style created by the stoma and bag. Patients should be prepared for this by discussion with their physician.

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KEY TERMS

Ureters—Tubes that connect the kidneys to the bladder. Urine produced by the kidneys passes through the ureters to the bladder.

Risks

As with any major surgery, there is a risk of infection; in this case infection of the intestine is especially dangerous as it can lead to **peritonitis** (inflammation of the membrane lining the abdomen).

Results

Normal results

The bladder is successfully removed and a stoma created. Intestinal function returns to normal and the patient learns proper care of the stoma and bag. He or she adjusts to lifestyle changes and returns to a normal routine of work and recreation, some sports excluded.

Abnormal results

The patient develops an infection at the incision site. The patient does not make a successful psychological adjustment to the long term consequences of **impotence** and urinary diversion. In some women, the vagina is constricted, which may require a secondary procedure.

Resources

BOOKS

Beers, Mark H., Robert S. Porter, and Thomas V. Jones, eds. *The Merck Manual of Diagnosis and Therapy*. 18th ed. Whitehouse Station, NJ: Merck Research Laboratories, 2006.

John T. Lohr, PhD

Cystic fibrosis

Definition

Cystic fibrosis (CF) is an inherited disease that affects the lungs, digestive system, sweat glands, and male fertility. Its name derives from the fibrous scar tissue that develops in the pancreas, one of the principal organs affected by the disease.

Demographics

According to the Cystic Fibrosis Foundation, about 30,000 people in the United States and 70,000 worldwide have cystic fibrosis. It is one of the most common inherited diseases among Caucasians. About 1,000 new cases are diagnosed each year. About 12 million Americans are carriers of a faulty CF gene and many do not know that they are CF carriers.

Description

Cystic fibrosis (CF) is a disease of the mucus glands that affects many body systems. CF affects the body's ability to move salt and water in and out of cells, resulting in progressive damage to the respiratory system and chronic digestive system problems. It causes the lungs and pancreas to secrete thick mucus, blocking passageways and preventing proper function.

Many of the symptoms of CF can be treated with drugs or **nutritional supplements**. Close attention to and prompt treatment of respiratory and digestive complications have dramatically increased the expected life span of a person with CF. Several decades ago most children with CF died by age two years; today, about half of all people with CF live past age 31. That median age is expected to grow as new treatments are developed, and it is estimated that a person born in 1998 with CF has a median expected life span of 40 years.

Risk factors

Cystic fibrosis affects males and females equally and people from all racial and ethnic groups. However, the disease is most common among Caucasians of Northern European descent. It also occurs among Latinos and Native Americans, especially the Pueblo and Zuni. Cystic fibrosis is much less common among African Americans and Asian Americans.

Causes and symptoms

Cystic fibrosis is a genetic disease, meaning it is caused by a defect in the person's genes. Genes, found in the nucleus of all the body's cells, control cell function by serving as the blueprint for the production of proteins. Proteins carry out a wide variety of functions within cells. The gene that, when defective, causes CF is called the CFTR gene, which stands for cystic fibrosis transmembrane conductance regulator. A simple change in this gene leads to all the consequences of CF. There are over 1000 known defects in the CFTR gene that can cause CF. However, 70% of all people with an abnormal CFTR gene have the same defect, known as delta–F508.

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DOROTHY ANDERSEN (1901–1963)

(The Library of Congress.)

Dorothy Andersen was born on May 15, 1901, in Asheville, North Carolina. She was the only child of Hans Peter Andersen and the former Mary Louise Mason. Orphaned as a young adult, Andersen put herself through Saint Johnsbury Academy and Mount Holyoke College before enrolling in the Johns Hopkins School of Medicine, from which she received her M.D. in 1926.

Andersen turned instead to medical research as a pathologist at Babies Hospital of the Columbia-Presbyterian Medical Center in New York City, where she stayed for more than 20 years, eventually becoming chief of pathology in 1952. Andersen is probably best known for her discovery of cystic fibrosis in 1935. That discovery came about during the postmortem examination of a child who had supposedly died of celiac disease, a nutritional disorder. She searched for similar cases in the autopsy files and in medical literature, eventually realizing that she had found a disease that had never been described and to which she gave the name cystic fibrosis.

Genes can be thought of as long strings of chemical words, each made of chemical letters, called nucleotides. Just as a sentence can be changed by rearranging its letters, genes can be mutated, or changed, by changes in the sequence of their nucleotide letters. The gene changes in CF are called point mutations, meaning that the gene is mutated only at one small spot along its length. In other words, the delta–F508 mutation is a loss of one "letter" out of thousands within the CFTR gene. As a result, the CFTR protein made from its blueprint is made incorrectly, and cannot perform its function properly.

The CFTR protein helps to produce mucus. Mucus is a complex mixture of salts, water, sugars, and proteins that cleanses, lubricates, and protects many passageways in the body, including those in the lungs and pancreas. The role of the CFTR protein is to allow chloride ions to exit the mucus–producing cells. When the chloride ions leave these cells, water follows, thinning the mucus. In this way, the CFTR protein helps to keep mucus from becoming thick and sluggish, thus allowing the mucus to be moved steadily along the passageways to aid in cleansing.

In CF, the CFTR protein does not allow chloride ions out of the mucus–producing cells. With less chloride leaving, less water leaves, and the mucus becomes thick and sticky. It can no longer move freely through the passageways, so they become clogged. In the pancreas, clogged passageways prevent secretion of digestive enzymes into the intestine, causing serious impairment of digestion—especially of fat—which may lead to **malnutrition**. Mucus in the lungs may plug the airways, preventing good air exchange and, ultimately, leading to **emphysema**. The mucus is also a rich source of nutrients for bacteria, leading to frequent infections.

To understand the inheritance pattern of CF, it is important to realize that genes actually have two functions. First, as noted above, they serve as the blueprint for the production of proteins. Second, they are the material of inheritance: parents pass on characteristics to their children by combining the genes in egg and sperm to make a new individual.

Each person actually has two copies of each gene, including the CFTR gene, in each of his or her body cells. During sperm and egg production, however, these two copies separate, so that each sperm or egg contains only one copy of each gene. When sperm and egg unite, the newly created cell once again has two copies of each gene.

The two gene copies may be the same or they may be slightly different. For the CFTR gene, for instance, a person may have two normal copies, or one normal and one mutated copy, or two mutated copies. A person with two mutated copies will develop cystic fibrosis. A person

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with one mutated copy is said to be a carrier. A carrier will not have symptoms of CF, but can pass on the mutated CFTR gene to his or her children.

When two carriers have children, they have a one in four chance of having a child with CF each time they conceive. They have a two in four chance of having a child who is a carrier, and a one in four chance of having a child with two normal CFTR genes.

Approximately one in every 25 Americans of northern European descent is a carrier of the mutated CF gene, while only one in 17,000 African Americans and one in 30,000 Asian Americans are carriers. Since carriers are symptom–free, very few people will know whether or not they are carriers, unless there is a family history of the disease. Two white Americans with no family history of CF have a one in 2,500 chance of having a child with CF.

It may seem puzzling that a mutated gene with such harmful consequences would remain so common; one might guess that the high mortality of CF would quickly lead to loss of the mutated gene from the population. Some researchers now believe the reason for the persistence of the CF gene is that carriers, those with only one copy of the gene, are protected from the full effects of **cholera**, a microorganism that infects the intestine, causing intense **diarrhea** and eventual **death** by **dehydration**. It is believed that having one copy of the CF gene is enough to prevent the full effects of cholera infection, while not enough to cause the symptoms of CF. This so–called "heterozygote advantage" is seen in some other genetic disorders, including sickle–cell anemia.

The most severe effects of cystic fibrosis are seen in two body systems: the gastrointestinal (digestive) system and the respiratory tract, from the nose to the lungs. CF also affects the sweat glands and male fertility. Symptoms develop gradually, with gastrointestinal symptoms often the first to appear.

Gastrointestinal system

Ten to fifteen percent of babies who inherit CF have meconium **ileus** at birth. Meconium is the first dark stool that a baby passes after birth; ileus is an obstruction of the digestive tract. The meconium of a newborn with meconium ileus is thickened and sticky, due to the presence of thickened mucus from the intestinal glands. Meconium ileus causes abdominal swelling and **vomiting**, and often requires surgery immediately after birth. Presence of meconium ileus is considered highly indicative of CF. Borderline cases may be misdiagnosed, however, and attributed instead to a "milk allergy."

Other abdominal symptoms are caused by the inability of the pancreas to supply digestive enzymes to the intestine. During normal digestion, as food passes from the stomach into the small intestine, it is mixed with pancreatic secretions, which help to break down the nutrients for absorption. While the intestines themselves also provide some digestive enzymes, the pancreas is the major source of enzymes for the digestion of all types of foods, especially fats and proteins.

In CF, thick mucus blocks the pancreatic duct, which is eventually closed off completely by scar tissue formation, leading to a condition known as pancreatic insufficiency. Without pancreatic enzymes, large amounts of undigested food pass into the large intestine. Bacterial action on this rich food source can cause gas and abdominal swelling. The large amount of fat remaining in the feces makes it bulky, oily, and foul–smelling.

Because nutrients are only poorly digested and absorbed, the person with CF is often ravenously hungry, underweight, and shorter than expected for his age. When CF is not treated for a longer period, a child may develop symptoms of malnutrition, including anemia, bloating, and, paradoxically, appetite loss.

Diabetes becomes increasingly likely as a person with CF ages. Scarring of the pancreas slowly destroys those pancreatic cells which produce insulin, producing type I, or insulin–dependent, diabetes.

Gallstones affect approximately 10% of adults with CF. Liver problems are less common, but can be caused by the build–up of fat within the liver. Complications of liver enlargement may include internal hemorrhaging, abdominal fluid (**ascites**), spleen enlargement, and liver failure.

Other gastrointestinal symptoms can include a prolapsed rectum, in which part of the rectal lining protrudes through the anus; intestinal obstruction; and rarely, **intussusception**, in which part of the intestinal tube slips over an adjoining part, cutting off blood supply.

Somewhat fewer than 10% of people with CF do not have gastrointestinal symptoms. Most of these people do not have the delta–F508 mutation, but rather a different one, which presumably allows at least some of their CFTR proteins to function normally in the pancreas.

Respiratory tract

The respiratory tract includes the nose, the throat, the trachea (or windpipe), the bronchi (which branch off from the trachea within each lung), the smaller

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bronchioles, and the blind sacs called alveoli, in which gas exchange takes place between air and blood.

Swelling of the sinuses within the nose is common in people with CF. This usually shows up on x ray, and may aid the diagnosis of CF. However, this swelling, called pansinusitis, rarely causes problems, and does not usually require treatment.

Nasal polyps, or growths, affect about one in five people with CF. These growths are not cancerous, and do not require removal unless they become annoying. While nasal polyps appear in older people without CF, especially those with **allergies**, they are rare in children without CF.

The lungs are the site of the most life–threatening effects of CF. The production of a thick, sticky mucus increases the likelihood of infection, decreases the ability to protect against infection, causes inflammation and swelling, decreases the functional capacity of the lungs, and may lead to emphysema. People with CF will live with chronic populations of bacteria in their lungs, and lung infection is the major cause of death for those with CF.

The bronchioles and bronchi normally produce a thin, clear mucus, which traps foreign particles including bacteria and viruses. Tiny hair-like projections called cilia on the surface of these passageways slowly sweep the mucus along, out of the lungs and up the trachea to the back of the throat, where it may be swallowed or coughed up. This "mucociliary escalator" is one of the principal defenses against lung infection.

The thickened mucus of CF prevents easy movement out of the lungs, and increases the irritation and inflammation of lung tissue. This inflammation swells the passageways, partially closing them down, further hampering the movement of mucus. A person with CF is likely to **cough** more frequently and more vigorously as the lungs attempt to clean themselves out.

At the same time, infection becomes more likely since the mucus is a rich source of nutrients. **Bronchitis**, **bronchiolitis**, and **pneumonia** are frequent in CF. The most common infecting organisms are the bacteria *Staphylococcus aureus*, *Haemophilus influenzae*, and *Pseudomonas aeruginosa*. A small percentage of people with CF have infections caused by *Burkholderia cepacia*, a bacterium which is resistant to most current **antibiotics** (*Burkholderia cepacia* was formerly known as *Pseudomonas cepacia*). The fungus *Aspergillus fumigatus* may infect older children and adults.

The body's response to infection is to increase mucus production; white blood cells fighting the infection thicken the mucus even further as they break down and release their cell contents. These white blood cells also provoke more inflammation, continuing the downward spiral that marks untreated CF.

As mucus accumulates, it can plug up the smaller passageways in the lungs, decreasing functional lung volume. Getting enough air can become difficult; tiredness, **shortness of breath**, and intolerance of **exercise** become more common. Because air passes obstructions more easily during inhalation than during exhalation, over time, air becomes trapped in the smallest chambers of the lungs, the alveoli. As millions of alveoli gradually expand, the chest takes on the enlarged, barrel-shaped appearance typical of emphysema.

For unknown reasons, recurrent respiratory infections lead to "digital clubbing," in which the last joint of the fingers and toes becomes slightly enlarged.

Sweat glands

The CFTR protein helps to regulate the amount of salt in sweat. People with CF have sweat that is much saltier than normal, and measuring the saltiness of a person's sweat is the most important diagnostic test for CF. Parents may notice that their infants taste salty when they kiss them. Excess salt loss is not usually a problem except during prolonged exercise or heat. While most older children and adults with CF compensate for this extra salt loss by eating more salty foods, infants and young children are in danger of suffering its effects (such as heat prostration), especially during summer. Heat prostration is marked by lethargy, weakness, and loss of appetite, and should be treated as an emergency condition.

Fertility

Ninety-eight percent of men with CF are sterile, due to complete obstruction or absence of the vas deferens, the tube carrying sperm out of the testes. While boys and men with CF form normal sperm and have normal levels of sex hormones, sperm are unable to leave the testes, and fertilization is not possible. Most women with CF are fertile, though they often have more trouble getting pregnant than women without CF. In both boys and girls, **puberty** is often delayed, most likely due to the effects of poor **nutrition** or chronic lung infection. Women with good lung health usually have no problems with **pregnancy**, while those with ongoing lung infection often do poorly.

Diagnosis

The decision to test a child for cystic fibrosis may be triggered by concerns about recurring gastrointestinal

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KEY TERMS

Carrier—A person who possesses a gene for an abnormal trait without showing signs of the disorder. The person may pass the abnormal gene on to offspring.

CFTR—Cystic fibrosis transmembrane conductance regulator. The protein responsible for regulating chloride movement across cells in some tissues. When a person has two defective copies of the CFTR gene, cystic fibrosis is the result.

Emphysema—A chronic lung disease that begins with breathlessness during exertion and progresses to shortness of breath at all times, caused by destructive changes in the lungs.

Mucociliary escalator—The coordinated action of tiny projections on the surfaces of cells lining the respiratory tract, which moves mucus up and out of the lungs.

Mucolytic—An agent that dissolves or destroys mucin, the chief component of mucus.

Pancreatic insufficiency—Reduction or absence of pancreatic secretions into the digestive system due to scarring and blockage of the pancreatic duct.

or respiratory symptoms, or salty sweat. A child born with meconium ileus will be tested before leaving the hospital. Families with a history of CF may wish to have all children tested, especially if there is a child who already has the disease. Some hospitals now require routine screening of newborns for CF.

Sweat test

The sweat test is both the easiest and most accurate test for CF. In this test, a small amount of the drug pilocarpine is placed on the skin. A very small electrical current is then applied to the area, which drives the pilocarpine into the skin. The drug stimulates sweating in the treated area. The sweat is absorbed onto a piece of filter paper, and is then analyzed for its salt content. A person with CF will have salt concentrations that are one-and-one-half to two times greater than normal. The test can be done on persons of any age, including newborns, and its results can be determined within an hour. Virtually every person who has CF will test positively on it, and virtually everyone who does not will test negatively.

Genetic testing

The discovery of the CFTR gene in 1989 allowed the development of an accurate genetic test for CF. Genes from a small blood or tissue sample are analyzed for specific mutations; presence of two copies of the mutated gene confirms the diagnosis of CF in all but a very few cases. However, since there are so many different possible mutations, and since testing for all of them would be too expensive and time–consuming, a negative gene test cannot rule out the possibility of CF.

Couples planning a family may decide to have themselves tested if one or both have a family history of CF. Prenatal **genetic testing** is possible through **amniocentesis**. Many couples who already have one child with CF decide to undergo prenatal screening in subsequent pregnancies. Siblings in these families are also usually tested, both to determine if they will develop CF, and to determine if they are carriers, to aid in their own family planning. If the sibling has no symptoms, determining his or her carrier status is often delayed until the teen years or later, when he or she is closer to needing the information to make decisions.

Newborn screening

Some states now require screening of newborns for CF, using a test known as the IRT test. This is a blood test which measures the level of immunoreactive trypsinogen, which is generally higher in babies with CF than those without it. This test gives many false positive results immediately after birth, and so requires a second test several weeks later. A second positive result is usually followed by a sweat test.

Treatment

Traditional

There is no cure for cystic fibrosis. Treatment has advanced considerably in the past several decades, increasing both the life span and the quality of life for most people affected by CF. Early diagnosis is important to prevent malnutrition and infection from weakening the young child. With proper management, many people with CF engage in the full range of school and sports activities.

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People with CF usually require high-calorie **diets** and vitamin supplements. Height, weight, and growth of a person with CF are monitored regularly. Most people with CF need to take pancreatic enzymes to supplement or replace the inadequate secretions of the pancreas. Tablets containing pancreatic enzymes are taken with every meal; depending on the size of the tablet and the meal, as many as 20 tablets may be needed. Because of incomplete absorption even with pancreatic enzymes, a person with CF needs to take in about 30% more food than a person without CF. Low–fat diets are *not* recommended except in special circumstances, since fat is a source of both essential fatty acids and abundant calories.

Some people with CF cannot absorb enough nutrients from the foods they eat, even with specialized diets and enzymes. For these people, tube feeding is an option. Nutrients can be introduced directly into the stomach through a tube inserted either through the nose (a nasogastric tube) or through the abdominal wall (a **gastrostomy** tube). A jejunostomy tube, inserted into the small intestine, is also an option. Tube feeding can provide nutrition at any time, including at night while the person is sleeping, allowing constant intake of high–quality nutrients. The feeding tube may be removed during the day, allowing normal meals to be taken.

The key to maintaining respiratory health in a person with CF is regular monitoring and early treatment. Lung function tests are done frequently to track changes in functional lung volume and respiratory effort. Sputum samples are analyzed to determine the types of bacteria present in the lungs. Chest x rays are usually taken at least once a year. Lung scans, using a radioactive gas, can show closed off areas not seen on the x ray. Circulation in the lungs may be monitored by injection of a radioactive substance into the bloodstream.

People with CF live with chronic bacterial colonization; that is, their lungs are constantly host to several species of bacteria. Good general health, especially good nutrition, can keep the immune system healthy, which decreases the frequency with which these colonies begin an infection, or attack on the lung tissue. Exercise is another important way to maintain health, and people with CF are encouraged to maintain a program of regular exercise.

In addition, clearing mucus from the lungs helps to prevent infection, and mucus control is an important aspect of CF management. Bronchial drainage is used to allow gravity to aid the mucociliary escalator. For this technique, the person with CF lies on a tilted surface with head downward, alternately on the stomach, back, or side, depending on the section of lung to be drained. An assistant thumps the rib cage to help loosen the secretions. A device called a "flutter" offers another way to loosen secretions: it consists of a stainless steel ball in a tube. When a person exhales through it, the ball vibrates, sending vibrations back through the air in the lungs. Some special breathing techniques may also help clear the lungs.

Supplemental oxygen may be needed as lung disease progresses. **Respiratory failure** may develop, requiring temporary use of a ventilator to perform the work of breathing.

Drugs

Several drugs are available to prevent the airways from becoming clogged with mucus. **Bronchodilators** can help open up the airways; **steroids** reduce inflammation; and mucolytics loosen secretions. Acetylcysteine (Mucomyst) has been used as a mucolytic for many years but is not prescribed frequently now, while DNase (Pulmozyme) is a newer product gaining in popularity. DNase breaks down the DNA from dead white blood cells and bacteria found in thick mucus.

People with CF may pick up bacteria from other CF patients. This is especially true of *Burkholderia cepacia*, which is not usually found in people without CF. While the ideal recommendation from a health standpoint might be to avoid contact with others who have CF, this is not usually practical (since CF clinics are a major site of care), nor does it meet the psychological and social needs of many people with CF. At a minimum, CF centers recommend avoiding prolonged close contact between people with CF, and scrupulous hygiene, including frequent hand washing. Some CF clinics schedule appointments on different days for those with and without *B. cepacia* colonies.

Some doctors choose to prescribe antibiotics only during infection, while others prefer long–term antibiotic treatment against *S. aureus*. The choice of antibiotic depends on the particular organism or organisms found. Some antibiotics are given as aerosols directly into the lungs. Antibiotic treatment may be prolonged and aggressive.

Long-term use of ibuprofen has been shown to help some people with CF; presumably by reducing inflammation in the lungs. Close medical supervision is necessary, however, since the effective dose is high and not everyone benefits. Ibuprofen at the required

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doses interferes with kidney function, and together with aminoglycoside antibiotics, may cause kidney failure.

Alternative

Lung transplantation is another option for people with CF, although the number of people who receive them is still much lower than those who want them. Transplantation is not a cure, however, and has been likened to trading one disease for another. Long–term immunosuppression is required, increasing the likelihood of other types of infection. About 50% of adults and more than 80% of children who receive lung transplants live longer than two years. Some CF patients whose livers have been damaged by fibrosis also undergo liver transplants.

A number of experimental treatments are currently the subject of much research. Some evidence indicates that aminoglycoside antibiotics may help overcome the genetic defect in some CF mutations, allowing the protein to be made normally. While promising, these results would apply to only about 5% of those with CF.

Gene therapy is currently the most ambitious approach to curing CF. In this set of techniques, non–defective copies of the CFTR gene are delivered to affected cells, where they are taken up and used to create the CFTR protein. While elegant and simple in theory, gene therapy has met with a large number of difficulties in trials so far, including immune resistance, very short duration of the introduced gene, and inadequately widespread delivery.

In **homeopathic medicine**, the symptoms of the disease would be addressed to enhance the quality of life for the person with cystic fibrosis. Treating the cause of CF, because of the genetic basis for the disease, is not possible. Homeopathic medicine seeks to treat the whole person, however, and in cystic fibrosis, this approach might include:

- Mucolytics to help thin mucous.
- Supplementation of pancreatic enzymes to assist in digestion.
- Respiratory symptoms can be addressed to open lung passages.
- Hydrotherapy techniques to help ease the respiratory symptoms and help the body eliminate mucus.
- Immune enhancements can help prevent the development of secondary infections.
- Dietary enhancements and adjustments to treat digestive and nutritional problems.

Prognosis

People with CF may lead relatively normal lives. The possible effect of pregnancy on the health of a woman with CF requires careful consideration before beginning a family, as do issues of longevity, and their children's status as carriers. Although most men with CF are functionally sterile, new procedures for removing sperm from the testes are being tried, and may offer more men the chance to become fathers.

Approximately half of people with CF live past the age of 30. Because of better and earlier treatment, a person born today with CF is expected, on average, to live to age 40.

Prevention

CF is a genetic disorder that cannot be prevented. Screening people with a family history of CF may detect the cystic fibrosis gene in 60 to 90% of carriers, depending on the test used.

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"What Is Cystic Fibrosis?" *Cystic Fibrosis Foundation*. Information Page. http://www.cff.org/AboutCF (accessed November 15, 2009)

ORGANIZATIONS

Cystic Fibrosis Foundation, 6931 Arlington Road, Bethesda, MD, 20814, (301) 951-4422, (800) 344-4823, (301) 951-6378, http://www.cff.org.
National Heart, Lung, and Blood Institute (NHLBI), Building 31, Room 5A52, 31 Center Drive MSC 2486, Bethesda, MD, 20892, (301) 592-8573, (240) 629-3246, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi. nih.gov.
National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), Building 31, Room 9A06, 31 Center Drive, MSC 2560, Bethesda, MD, 20892-2560, (301) 496-3583, http://www2.niddk.nih.gov.

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Cystinuria

Definition

Cystinuria is an inborn error of amino acid transport that results in the defective absorption by the kidneys of the amino acid called cystine. The name means "cystine in the urine."

Description

Cystine is an amino acid. Amino acids are organic compounds needed by the body to make proteins and for many normal functions. When the kidneys do not absorb cystine, this compound builds up in the urine. When the amount of cystine in the urine exceeds its solubility (the greatest amount that can be dissolved), crystals form. As the amount of cystine continues to increase in the urine, the number of crystals also increases. When very large numbers of cystine crystals form, they clump together into what is called a stone.

Causes and symptoms

Cystinuria is a rare disease that occurs when people inherit an abnormal gene from their parents. This disease occurs in differing degrees of severity in people who have inherited either one or two abnormal genes. Humans have two copies of each gene. When both are abnormal, the condition is called homozygous for the disease. When one copy is normal and the other is abnormal, the condition is called heterozygous for the disease. Persons with one abnormal gene can have a milder form of cystinuria that rarely results in the formation of stones.

Severe cystinuria occurs when people are homozygous for the disease. For these individuals, the kidneys may excrete as much as 30 times the normal amount of cystine. Research has shown that this condition is caused by mutations on chromosome number two (humans have 23 pairs of chromosomes).

A person who has inherited cystinuria may have other abnormal bodily functions. In addition to excess levels of the amino acid cystine, high amounts of the amino acids lysine, arginine, and ornithine are found in the urine. This condition indicates that these amino acids are not being reabsorbed by the body.

When excess cystine crystals clump together to form a stone, the stone can block portions of the interior of the kidney or the tube (the ureter) that connects the kidney to the urinary bladder. These cystine stones can be painful, and depending upon where the stone becomes trapped, the **pain** can be felt in the lower back or the abdomen. **Nausea and vomiting** can also occur, and patients may sometimes feel the need to urinate often. Cystine stones can also cause blood in the urine. When the urinary tract is blocked by a stone, urinary tract infections or kidney failure may result.

Diagnosis

Small stones (called "silent") often do not cause any symptoms, although they can be detected by an

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KEY TERMS

Alkaline—A solution is considered alkaline if it contains fewer hydrogen atoms than pure water.

Amino acid—An organic compound made of an amino group (containing nitrogen and hydrogen) and a carbolic acid group. Amino acids are an essential part of protein molecules.

Nephroscope—An instrument made of a light source in a tube. The tube is inserted into the kidney through an incision in the back and used to locate kidney stones. The stones are broken up with high frequency sound waves and removed by suction through the scope.

Nitroprusside—A compound that is used in laboratory tests to identify large amounts of cystine in urine samples.

Uretoscope—A tube-shaped device inserted into the body through the urinary system that allows objects to be both seen and grasped for removal.

x ray. Large stones are often painful and easily noticed by the patient. Blood in the urine can also mean that a stone has formed.

When the urine contains extremely high amounts of cystine, yellow-brown hexagonal crystals are visible when a sample is examined under the microscope. Urine samples can also be mixed with chemicals that change color when high levels of cystine are present. When the compound nitroprusside is added to urine that has been made alkaline by the addition of ammonia, the urine specimen turns red if it contains excess cystine.

Treatment

No treatment can decrease cystine excretion. The best treatment for cystinuria is to prevent stones from forming. Stones can be prevented by drinking enough liquid each day (about 5–7 qts) to produce at least 8 pts of urine, thus keeping the concentration of cystine in the urine low. Because a person does not drink throughout the night, less urine is produced, and the likelihood of stone formation increases. This risk can be minimized by drinking water or other liquids just before going to bed.

Drug treatments

In addition to drinking large amounts of fluids, it is helpful to make the urine more alkaline. Cystine dissolves more easily in alkaline urine. To increase urine alkalinity, a person may take **sodium** bicarbonate and acetazolamide. Penicillamine, a drug that increases the solubility of cystine, may be prescribed for patients who do not respond well to other therapies. This drug must be used with caution, however, because it can cause serious side effects or allergic reactions. For those unable to take penicillamine, another drug, alpha-mercaptopropionylglycine (Thiola), may be prescribed.

Surgical treatments

Most stones can be removed from the body by normal urination, helped by drinking large amounts of water. Large stones that cannot be passed this way must be removed by surgical procedures.

Large stones can be surgically removed by having a device called a uretoscope placed into the urethra, up through the bladder and into the ureter, where the trapped stone can be seen and removed. Another method involves using sound-wave energy aimed from outside the body to break the large stone into small pieces that can be passed by urination. This external technique is called extracorporeal shock-wave **lithotripsy** (ESWL).

For large stones in the kidney, a procedure called percutaneous nephrolithomy may be used. In this procedure, the surgeon makes a small incision in the back over the kidney. An instrument called a nephroscope is inserted through the incision into the kidney. The surgeon uses the nephroscope to locate and remove the stone. If the stone is very large, it may be broken up into smaller pieces by an ultrasonic or other kind of probe before removal.

Prognosis

As many as 50% of patients who have had surgical treatment for a kidney stone will have another stone within five years if no medicines are used to treat this condition.

Prevention

Cystinuria is a genetic disorder that currently cannot be prevented.

ORGANIZATIONS

Cystinuria Support Network, 21001 NE 36th St., Redmond, WA, 98053, (425) 868-2996, sue@cystinuria.com, http://www.cystinuria.com.

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National Kidney Foundation, Inc. 30 East 33rd Street, New York, NY, 10016, (212) 889-2210, (212) 689-9261, (800) 622-9010, http://www.kidney.org/.

Dominic De Bellis, PhD

Cystitis

Definition

Cystitis is defined as inflammation of the urinary bladder. **Urethritis** is an inflammation of the urethra, which is the passageway that connects the bladder with the exterior of the body. Sometimes cystitis and urethritis are referred to collectively as a lower **urinary tract infection**, or UTI. Infection of the upper urinary tract involves the spread of bacteria to the kidney and is called **pyelonephritis**.

Description

The frequency of bladder infections in humans varies significantly according to age and sex. The male/female ratio of UTIs in children younger than 12 months is 4:1 because of the high rate of **birth defects** in the urinary tract of male infants. In adult life, the male/female ratio of UTIs is 1:50. After age 50, however, the incidence among males increases due to prostate disorders.

Cystitis in women

Cystitis is a common female problem. It is estimated that 50% of adult women experience at least one episode of dysuria (painful urination); half of these patients have a bacterial UTI. Between 2–5% of women's visits to primary care doctors are for UTI symptoms. About 90% of UTIs in women are uncomplicated but recurrent.

Cystitis in men

UTIs are uncommon in younger and middle-aged men, but may occur as complications of bacterial infections of the kidney or prostate gland.

Cystitis in children

In children, cystitis often is caused by congenital abnormalities (present at birth) of the urinary tract. **Vesicoureteral reflux** is a condition in which the child cannot completely empty the bladder. It allows urine to remain in or flow backward (reflux) into the partially empty bladder.

Causes and symptoms

The causes of cystitis vary according to sex because of the differences in anatomical structure of the urinary tract.

Females

Most bladder infections in women are so-called ascending infections, which means they are caused by disease agents traveling upward through the urethra to the bladder. The relative shortness of the female urethra (1.2–2 in. [3–5 cm] in length) makes it easy for bacteria to gain entry to the bladder and multiply. The most common bacteria associated with UTIs in women include ***Escherichia coli*** (about 80% of cases), *Staphylococcus saprophyticus*, *Klebsiella*, *Enterobacter*, and *Proteus* species. Risk factors for UTIs in women include:

- Sexual intercourse. The risk of infection increases if the woman has multiple partners.
- Use of a diaphragm for contraception
- An abnormally short urethra
- Diabetes or chronic dehydration
- The absence of a specific enzyme (fucosyltransferase) in vaginal secretions. The lack of this enzyme makes it easier for the vagina to harbor bacteria that cause UTIs.
- Inadequate personal hygiene. Bacteria from fecal matter or vaginal discharges can enter the female urethra because its opening is very close to the vagina and anus.
- History of previous UTIs. About 80% of women with cystitis develop recurrences within two years.

The early symptoms of cystitis in women are dysuria, or **pain** on urination; urgency, or a sudden strong desire to urinate; and increased frequency of urination. About 50% of female patients experience **fever**, pain in the lower back or flanks, **nausea and vomiting**, or shaking chills. These symptoms indicate pyelonephritis, or spread of the infection to the upper urinary tract.

Males

Most UTIs in adult males are complications of kidney or prostate infections. They usually are associated with a tumor or **kidney stones** that block the flow of urine and often are persistent infections caused by drug-resistant organisms. UTIs in men are most likely to be caused by *E. coli* or another gram-negative bacterium. *S. saprophyticus*, which is the second most common cause of UTIs in women, rarely causes infections in men. Risk factors for UTIs in men include:

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- Lack of circumcision. The foreskin can harbor bacteria that cause UTIs.
- Urinary catheterization. The longer the period of catheterization, the higher the risk of UTIs.

The symptoms of cystitis and pyelonephritis in men are the same as in women.

Hemorrhagic cystitis

Hemorrhagic cystitis, which is marked by large quantities of blood in the urine, is caused by an acute bacterial infection of the bladder. In some cases, hemorrhagic cystitis is a side effect of **radiation therapy** or treatment with cyclophosphamide. Hemorrhagic cystitis in children is associated with adenovirus type 11.

Diagnosis

When cystitis is suspected, the doctor will first examine the patient's abdomen and lower back, to evaluate unusual enlargements of the kidneys or swelling of the bladder. In small children, the doctor will check for fever, abdominal masses, and a swollen bladder.

The next step in diagnosis is collection of a urine sample. The procedure differs somewhat for women and men. Laboratory testing of urine samples now can be performed with dipsticks that indicate immune system responses to infection, as well as with microscopic analysis of samples. Normal human urine is sterile. The presence of bacteria or pus in the urine usually indicates infection. The presence of hematuria, or blood in the urine, may indicate acute UTIs, **kidney disease**, kidney stones, inflammation of the prostate (in men), **endometriosis** (in women), or **cancer** of the urinary tract. In some cases, blood in the urine results from athletic training, particularly in runners.

Females

Female patients often require a pelvic examination as part of the diagnostic workup for bladder infections. Normally, however, a midstream urine sample of 200 mL is collected to test for infection.

A count of more than 104 bacteria CFU/mL (colony forming units per milliliter) in the midstream sample indicates a bladder or kidney infection. A colony is a large number of microorganisms that grow from a single cell within a substance called a culture. A bacterial count can be given in CFU or (colony forming units).

In recent years, many health providers and insurance companies have adopted telephone treatment of women with presumed cystitis. Trained nurses diagnose uncomplicated bladder infections over the telephone based on the patient's symptoms and a series of questions prepared by physicians. The practice has been found safe and cost-effective.

Males

In male patients, the doctor will cleanse the opening to the urethra with an antiseptic before collecting the urine sample. The first 10 mL of specimen are collected separately. The patient then voids a midstream sample of 200 mL. Following the second sample, the doctor will massage the patient's prostate and collect several drops of prostatic fluid. The patient then voids a third urine specimen for prostatic culture.

A high bacterial count in the first urine specimen or the prostatic specimens indicates urethritis or prostate infections respectively. A bacterial count greater than 100,000 bacteria CFU/mL in the midstream sample suggests a bladder or kidney infection.

Other tests

Women with recurrent UTIs can be given ultrasound exams of the kidneys and bladder together with a voiding cystourethrogram to test for structural abnormalities. (A cystourethrogram is an x-ray test in which an iodine dye is used to better view the urinary bladder and urethra.) Voiding cystourethrograms are also used to evaluate children with UTIs. In some cases, **computed tomography scans** (CT scans) can be used to evaluate patients for possible cancers in the urinary tract.

Treatment

Medications

Uncomplicated cystitis is treated with **antibiotics**. These include penicillin, ampicillin, and amoxicillin; sulfisoxazole or sulfamethoxazole; trimethoprim; nitrofurantoin; **cephalosporins**; or **fluoroquinolones**. (Flouroquinolones generally are not used in children under 18 years of age.) A 2003 study showed that fluoroquinolone was preferred over amoxicillin, however, for uncomplicated cystitis in young women. Treatment for women is short-term; most patients respond within three days. Men do not respond as well to short-term treatment and require seven to 10 days of oral antibiotics for uncomplicated UTIs.

Patients of either sex may be given phenazopyridine or flavoxate to relieve painful urination.

Trimethoprim and nitrofurantoin are preferred for treating recurrent UTIs in women.

Over 50% of older men with UTIs also suffer from infection of the prostate gland. Some antibiotics, including amoxicillin and the cephalosporins, do not

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affect the prostate gland. Fluoroquinolone antibiotics or trimethoprim are the drugs of choice for these patients.

Patients with pyelonephritis can be treated with oral antibiotics or intramuscular doses of cephalosporins. Medications are given for 10–14 days, and sometimes longer. If the patient requires hospitalization because of high fever and **dehydration** caused by **vomiting**, antibiotics can be given intravenously.

Surgery

A minority of women with complicated UTIs may require surgical treatment to prevent recurrent infections. Surgery also is used to treat reflux problems (movement of the urine backward) or other structural abnormalities in children and anatomical abnormalities in adult males.

Alternative treatment

Alternative treatment for cystitis may emphasize eliminating all sugar from the diet and drinking lots of water. Drinking unsweetened cranberry juice not only adds fluid, but also is thought to help prevent cystitis by making it more difficult for bacteria to cling to the bladder wall. A variety of herbal therapies also are recommended. Generally, the recommended herbs are antimicrobials, such as garlic (*Allium sativum*), goldenseal (*Hydrastis canadensis*), and bearberry (*Arctostaphylos uva-ursi*), and/or demulcents that soothe and coat the urinary tract, including corn silk and marsh mallow (*Althaea officinalis*).

Homeopathic medicine also can be effective in treating cystitis. Choosing the correct remedy based on the individual's symptoms is always key to the success of this type of treatment. **Acupuncture** and Chinese traditional herbal medicine can also be helpful in treating acute and chronic cases of cystitis.

Prognosis

Females

The prognosis for recovery from uncomplicated cystitis is excellent.

Males

The prognosis for recovery from uncomplicated UTIs is excellent; however, complicated UTIs in males are difficult to treat because they often involve bacteria that are resistant to commonly used antibiotics.

KEY TERMS

Bacteriuria—The presence of bacteria in the urine.

Dysuria—Painful or difficult urination.

Hematuria—The presence of blood in the urine.

Pyelonephritis—Bacterial inflammation of the upper urinary tract.

Urethritis—Inflammation of the urethra, which is the passage through which the urine moves from the bladder to the outside of the body.

Prevention

Females

Women with two or more UTIs within a six-month period sometimes are given prophylactic treatment, usually nitrofurantoin or trimethoprim for three to six months. In some cases the patient is advised to take an antibiotic tablet following sexual intercourse.

Other preventive measures for women include:

- drinking large amounts of fluid
- voiding frequently, particularly after intercourse
- proper cleansing of the area around the urethra

In recent clinical trials in humans, a possible vaccine for recurrent urinary tract infections was being tested. The vaccine was administered via a vaginal suppository.

Males

The primary preventive measure for males is prompt treatment of prostate infections. Chronic **prostatitis** may go unnoticed, but can trigger recurrent UTIs. In addition, males who require temporary catheterization following surgery can be given antibiotics to lower the risk of UTIs.

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Cystometry

Definition

Cystometry is a test of bladder function in which pressure and volume of fluid in the bladder is measured during filling, storage, and voiding.

Purpose

The urinary bladder stores urine produced by the kidneys. The main muscle of the bladder wall, the detrusor, relaxes to allow expansion of the bladder during filling. The urethra, the tube through which urine exits, is held closed by a ring of muscle, known as the urethral sphincter. As volume increases, stretching of the detrusor and pressure on the sphincter sends signals to the brain, indicating the need for urination, or voiding. Voluntary relaxation of the sphincter and automatic contractions of the detrusor allow successful and virtually complete voiding.

A cystometry study is performed to diagnose problems with urination, including incontinence, urinary retention, and recurrent urinary tract infections. Urinary difficulties may occur because of weak or hyperactive sphincter or detrusor, or incoordination of their two activities. Infection of the bladder or urethra may cause incontinence, as can obstruction of the urethra from scar tissue, prostate enlargement, or other benign or cancerous growths. Loss of sensation due to nerve damage can lead to chronic overfilling.

Precautions

The mild irritation of the urinary tract necessary for insertion of the catheter may occasionally cause flushing, sweating, and **nausea**.

Description

The patient begins by emptying the bladder as much as possible. A thin plastic catheter is then slowly inserted into the urethra until it reaches the bladder. Measurements are taken of the residual urine volume and bladder pressure. Pressure measurements may require a rectal probe to account for the contribution of the abdominal muscles to the pressure recording.

The bladder is then gradually filled with either warm water, room temperature water, saline solution, carbon dioxide gas, or a contrast solution for x-ray analysis, depending on the type of study being done. The patient is asked to describe sensations during filling, including temperature sensations and when the first feeling of bladder fullness occurs. Once the bladder is completely full, the patient is asked to begin voiding, and measurements are again made of pressure and volume, as well as flow rate and pressure.

KEY TERMS

Detrusor—Muscle of the bladder wall.

Sphincter—Ring of muscle between the bladder and the urethra that functions to close off the urethra.

Urethra—Tube that empties urine from the bladder to the exterior of the body.

Preparation

There is no special preparation needed for this test. The patient may be asked to stop taking certain medications in advance of the test, including sedatives, cholinergics, and anticholinergics.

Aftercare

Cystometry can be somewhat uncomfortable. The patient may wish to reserve an hour or so afterward to recover. Urinary frequency or urgency, and some reddening of the urine, may last for a day. Increasing fluid intake helps to flush out the bladder, but caffeinated, carbonated, or alcoholic beverages are discouraged, because they may irritate the bladder lining. Signs of infection, such as **fever**, chills, **low back pain**, or persistent blood in the urine, should be reported to the examining physician.

Risks

There is a slight risk of infection due to tearing of the urethral lining.

Results

The normal bladder should not begin contractions during filling and should initially expand without resistance. A feeling of fullness occurs with a volume of 100–200 mL. The adult bladder capacity is 300–500 mL. The sphincter should relax and open when the patient wills it, accompanied by detrusor contractions. During voiding, detrusor contraction should be smooth and lead to a steady urine stream.

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Abnormal results

Inability of the bladder to relax during filling, or low bladder volume, may indicate interstitial **cystitis**, prostate enlargement, or **bladder cancer**. Contraction of the bladder during filling may be due to irritation from infection or cysts, obstruction of the bladder outlet, or neurological disease such as **stroke**, **multiple sclerosis**, or **spinal cord injury**. Diminished sensation may occur with nerve lesions, **peripheral neuropathy**, or chronic overfilling.

Resources

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Richard Robinson

Cystoscopy

Definition

Cystoscopy (cystourethroscopy) is a diagnostic procedure that uses a cystoscope, which is an endoscope especially designed for urological use to examine the bladder, lower urinary tract, and prostate gland. It can also be used to collect urine samples, perform biopsies, and remove small stones.

Purpose

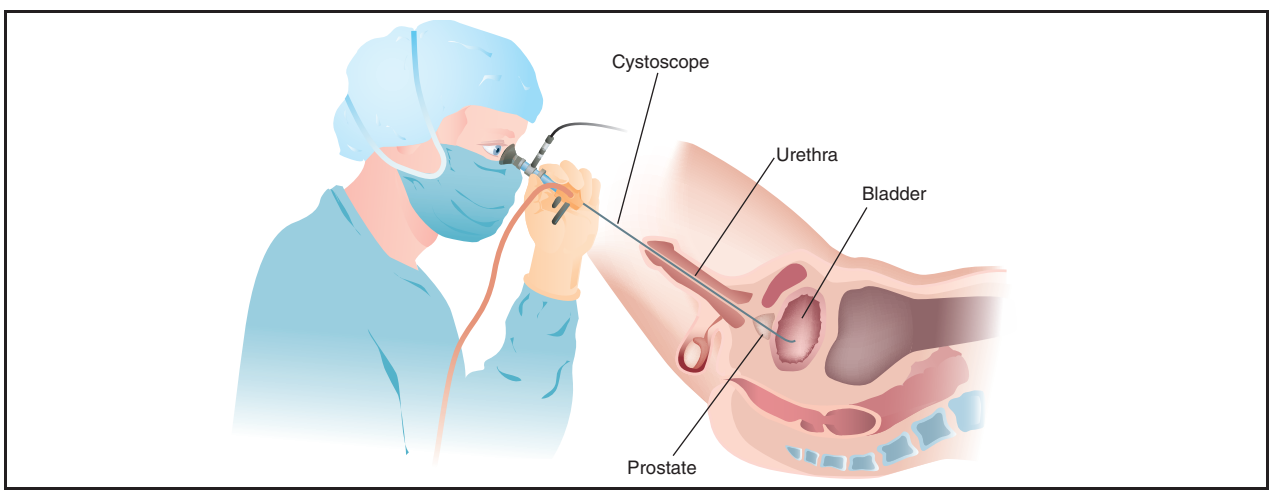
Cystoscopy is performed by urologists to examine the entire bladder lining and take biopsies of any questionable areas. Cystoscopy may be prescribed for patients who display the following conditions:

- blood in the urine (hematuria)
- inability to control urination (incontinence)
- urinary tract infection (UTI)
- signs of congenital abnormalities in the urinary tract
- suspected tumors in the bladder
- bladder or kidney stones
- signs or symptoms of an enlarged prostate
- pain or difficulty urinating (dysuria)
- disorders of or injuries to the urinary tract
- symptoms of interstitial cystitis

Blood and urine studies, in addition to x rays of the kidneys, ureters, and bladder, may be performed before a cystoscopy to obtain as much diagnostic information as possible. During the cystoscopy, a retrograde pyelogram may also be performed to examine the kidneys and ureters.

Description

There are two types of cystoscopes used to carry out the procedure, a rigid type and a flexible type. Both types are used for the same purposes and differ only in their method of insertion. The rigid type requires that the patient adopt the lithotomy position, meaning that the patient lies on his or her back with knees up and apart. The flexible cystoscope does not require the lithotomy position.



A cystoscope helps the doctor examine the urethra, bladder, and prostate. *(Illustration by Argosy, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

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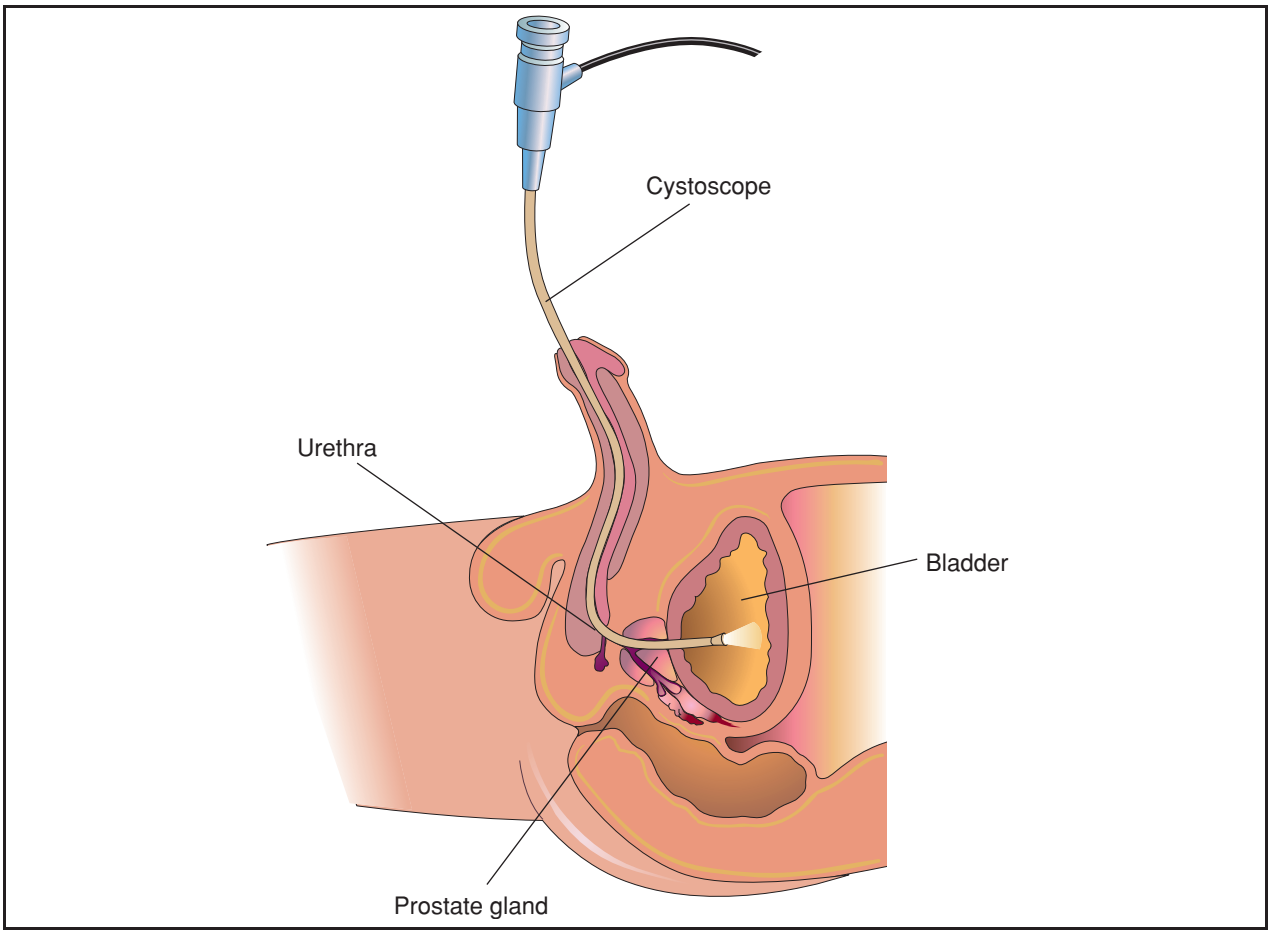

Cystoscopy is a diagnostic procedure which is used to view the bladder, collect urine samples, and examine the prostate gland. This procedure also enables biopsies to be taken. The primary instrument used in cystoscopy is the cystoscope, a tube which is inserted through the penis into the urethra, and ultimately into the bladder. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

A cystoscopy typically lasts from 10 to 40 minutes. The patient is asked to urinate before surgery and advised that relaxing pelvic muscles will help make this part of the procedure easier. A well-lubricated flexible or rigid cystoscope (urethroscope) is passed through the urethra into the bladder where a urine sample is taken. There may be some discomfort as the instrument is inserted. Fluid is then injected to inflate the bladder and allow the urologist to examine the entire bladder wall. The cystoscope uses a lighted tip for guidance and enables biopsies to be taken or small stones to be removed through a hollow channel in the cystoscope.

During a cystoscopy, the urologist may remove **bladder stones** or **kidney stones**, gather tissue samples, and perform x-ray studies. To remove stones, an instrument that looks like a tiny basket or grasper is inserted through the cystoscope so that small stones can be extracted through the scope's channel. For a biopsy, special forceps are inserted through the cystoscope to pinch off a tissue sample. Alternatively, a small brush-like instrument may be inserted to scrape off some tissue. To perform x-ray studies such as a retrograde pyelogram, a dye is injected into the ureter by way of a catheter passed through the cystoscope. After completion of all required tests, the cystoscope is removed.

Preparation

Before cytoscopy, patients may be asked to give a urine sample to check for infection and to avoid urinating for an hour before the procedure. A sedative may be given about one hour prior to the operation to help the patient relax. The region of the urethra is cleansed and a local anesthetic is applied. Spinal or **general anesthesia** may also be used for the procedure.

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KEY TERMS

Anesthetic—A drug that causes loss of sensation. It is used to lessen the pain of surgery and other medical procedures.

Bladder—The bladder is located in the lower part of the abdomen; it is a structure like a small balloon that collects urine for temporary storage and is emptied from time to time by urinating.

Catheter—A tubular, flexible surgical instrument for withdrawing fluids from (or introducing fluids into) a body cavity, especially one for introduction into the bladder through the urethra for the withdrawal of urine.

Cystoscope—Endoscope especially designed for urological use to examine the bladder, lower urinary tract, and prostate gland.

Diverticula—A pouch or sac occurring normally or from a herniation or defect in a membrane.

Endoscope—A highly flexible, thin viewing instrument used to see inside body cavities.

Endoscopy—A minimally invasive procedure that involves examination of body organs or cavities using an endoscope.

Interstitial cystitis—A chronic inflammatory condition of the bladder involving symptoms of bladder pain, frequent urination, and burning during urination.

Retrograde pyelogram—A pyelography or x-ray technique in which a dye is injected into the kidneys through the ureters.

Ureter—The tube that carries urine from each kidney to the bladder.

Urethra—The tube that carries urine from the bladder to outside the body. In females, the urethral opening is between the vagina and clitoris; in males, the urethra travels through the penis, opening at the tip.

Urogynecologist—A physician that specializes in female medical conditions concerning the urinary and reproductive systems.

Uroradiologist—A radiologist that specializes in diagnostic imaging of the urinary tract and kidneys.

Distension of the bladder with fluid is particularly painful, and if it needs to be done, as in the case of evaluating interstitial **cystitis**, general anesthesia is required. A signed consent form is necessary for this procedure.

Aftercare

After removal of the cystoscope, the urethra is usually sore, and patients should expect to feel a burning sensation while urinating for one or two days following the procedure. To alleviate discomfort or **pain**, patients may be prescribed pain medication, and **antibiotics** may also be required to prevent infection. Minor pain may also be treated with over-the-counter, nonprescription drugs such as **acetaminophen**. To relieve discomfort, patients may be advised to drink two 8-oz glasses of water each hour for two hours and to take a warm bath to relieve the burning feeling. If not able to bathe, they may be advised to hold a warm, damp washcloth over the urethral opening.

Patients who have undergone a cystoscopy are instructed to:

- take warm baths to relieve pain
- rest and refrain from driving for several days, especially if general anesthesia was used
- expect any blood in the urine to clear up in one to two days
- avoid strenuous exercise during recovery
- postpone sexual relations until the urologist determines that healing is complete

Risks

As with any surgical procedure, there are some risks involved with a cystoscopy. Complications may include profuse bleeding, a damaged urethra, a perforated bladder, a **urinary tract infection**, or an injured penis.

Patients should contact their physician if they experience any of the following symptoms after the procedure, including pain, redness, swelling, drainage, or bleeding from the surgical site; signs of generalized infection, which may include **headache**, muscle aches, **dizziness**, or an overall ill feeling and **fever**; **nausea** or **vomiting**; or difficult or painful urination.

Cystoscopy is a commonly performed procedure, but it is an invasive technique that involves small yet significant risk. If anesthesia is required, there is additional risk, particularly for people who are obese, smoke, or are in poor health. Those undergoing anesthesia must inform the doctor of any medications they are taking.

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Results

A successful cystoscopy includes a thorough examination of the bladder and collection of urine samples for cultures. If no abnormalities are seen, the results are indicated as normal. In this case, the bladder wall appears smooth and the bladder is seen to be of normal size, shape, and position, without obstructions, growths, or stones.

The treating physician can tell the patient what was seen inside the bladder right after the procedure. If a biopsy sample was taken, this will take several days to be examined and tested.

Cystoscopy allows the urologist to detect inflammation of the bladder lining, prostatic enlargement, or tumors. If these are seen, further evaluation or biopsies may be needed. Cystoscopy with bladder distention can also evaluate interstitial cystitis. Bladder stones, urethral strictures, diverticula, or congenital abnormalities can also be detected.

Alternatives

There are procedures that can provide some information about the lining of the bladder, for example, x rays; however, none of these provide as much information to the doctor as a cystoscopy.

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ORGANIZATIONS

American Urologic Association Foundation, 1000 Corporate Boulevard, Linthicum, MD, 21090, (410) 689-3700, (800) 828-7866, (410) 689-3800, auafoundation@auafoundation.org, http://www.urologyhealth.org.

American Urological Association, 1000 Corporate Boulevard, Baltimore, MD, 21090, (410) 689-3700, (866) 746-4282, (410) 689-3800, aua@AUAnet.org, http://www.auanet.org.

Interstitial Cystitis Association, 100 Park Avenue, Suite 108-A, Rockville, MD, 20850, (800) 435-7422, (301) 610-5308, ICAmail@ichelp.org, http://www.ichelp.org.

Society of Urologic Nurses and Associates, P.O. Box 56, East Holly Avenue, Pitman, NJ, 08071-0056, (856) 256-2335, (888) 827-7862, suna@ajj.com, http://www.suna.org.

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Cystourethroscopy *see* **Cystoscopy**

Cytomegalic inclusion disease *see* **Cytomegalovirus infection**

Cytomegalovirus antibody screening test

Definition

Cytomegalovirus (CMV) is a common human herpes virus. Detected by a blood test, antibodies to CMV are evidence of a current or past infection.

Purpose

Transmission of the virus can occur by coming into direct contact with oral, respiratory, or genital secretions of a person infected with the virus. Consequences of a CMV infection can be devastating in a pregnant woman; a patient who has recently undergone an organ, bone marrow, or stem cell transplant; or a person with human **immunodeficiency** virus (HIV). Blood products that are to be transfused to persons in these high risk groups should be screened for CMV antibodies. Antibody screening helps control the infection risk for these groups.

In a healthy, nonpregnant person, CMV infection is almost never serious. Symptoms, if present, are mild, often resembling **infectious mononucleosis** due to **Epstein-Barr virus**. Antibody screening distinguishes between these two infections.

Description

When first exposed to CMV, a person's immune system is triggered and quickly makes antibodies to fight the virus. Antibodies are special proteins designed to attack and destroy foreign material, in this case, the cytomegalovirus.

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The test combines a person's serum with a substance to which CMV antibodies attach. This antibody-antigen complex is measured and the amount of original antibody determined. If positive for antibodies, the serum is diluted, or titered, and the test repeated until the serum is so dilute it no longer gives a positive result. The last dilution that gives a positive result is the titer reported.

A test positive for CMV antibodies means the person has been infected with the virus, either currently or in the past; it does not mean the person has lifetime immunity. After an infection, this virus, like all members of the herpes virus group, can stay hidden inside a person and cause infection if the person's immune system later weakens and antibody protection decreases. In fact, reactivation of such hidden (or latent) infection is not at all uncommon and usually occurs without symptoms.

Transplant patients and people with weakened immune systems, including those with HIV, are vulnerable to infection from several routes, including from another person, from a donated organ or transfused blood, or from reactivation of a past infection. Before transplant, both the recipient and donor are usually tested for antibodies. A recipient who has never had CMV (negative for antibodies), should not receive an organ from a donor who has had CMV (positive for antibodies). CVM infection can be associated with organ rejection, or can cause illness such as **pneumonia**, hepatitis, or **death**. Similarly, blood is usually screened for CMV antibodies before being transfused into a person with a weakened immune system.

CMV infection is the most common congenital infection (existing at birth). The infection, passed from mother to baby, can cause permanent mental or physical damage, or death. The antibody screening test tells a woman whether or not she has antibody protection against the virus in case she is exposed during **pregnancy**. Pregnant women 25 years and older who are immune to CMV are much less likely to pass the virus to their babies than younger women who have never been exposed to CMV.

Tests that measure a specific type of antibody help tell the difference between a current and a past infection. Immunoglobulin M (IgM) antibodies appear at the beginning of an infection and last only weeks. Immunoglobulin G (IgG) antibodies appear 10–14 days later and can last a lifetime. A person suspected of having a current infection should be tested at the beginning of the infection and again 10–14 days later.

KEY TERMS

Antibody—A special protein built by the body as a defense against foreign material entering the body.

Cytomegalovirus (CMV)—A common human virus causing mild or no symptoms in healthy people, but permanent damage or death to an infected fetus, a transplant patient, or a person with HIV.

Titer—A dilution of a substance with an exact known amount of fluid. For example, one part of serum diluted with four parts of saline is a titer of 1:4.

The CMV antibody screening test is also called the transplant reaction screening test. Results are usually available the following day.

A newer test, the anti-CMV immediate early antigen monoclonal test, can detect CMV infection as early as three hours after infection.

It may be possible to test fetal blood for certain antibodies to CMV virus by drawing a blood sample from the umbilical cord. This may be an important test to add to prenatal care, since newborn babies with CMV often show no symptoms.

Preparation

The adult CMV antibody screening test requires 1 mL of blood. Collection of the sample takes only a few minutes.

Aftercare

Discomfort or bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Warm packs to the puncture site relieve discomfort.

Risks

There are no major risks involved with this testing.

Results

Normal results

A person without previous exposure to CMV will test negative.

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Abnormal results

The presence of antibodies means the person has been infected with CMV, either now or in the past. An antibody titer at least four times higher at the end of the illness than at the beginning, or the presence of IgM antibodies, indicates a recent or current first time infection.

People with weak immune systems may not generate antibodies against CMV. A current infection in a transplant patient or a person with HIV is confirmed with other tests, such as viral culture.

Resources

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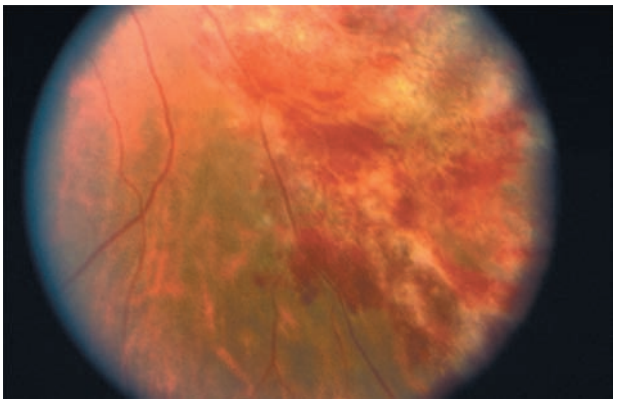
Cytomegalovirus infection

Definition

Cytomegalovirus (CMV) is a virus related to the group of herpes viruses. Infection with CMV can cause no symptoms, or can be the source of serious illness in people with weakened immune systems. CMV infection is also an important cause of **birth defects**.

Demographics

CMV is an extremely common organism worldwide. It is believed that about 60% of people in the United States have been infected by CMV at some point in their lives. Up to 90% of high risk groups, such as male homosexuals, are thought to be infected with CMV. CMV prevalence increases with age.



An infected retina of an AIDS patient. Cytomegaloviruses are herpes viruses that can, among other problems, act as opportunistic infectious agents in suppressed immune systems, a common problem with AIDS sufferers. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Description

CMV is found in almost all of the body's organs. It is also found in body fluids, including semen, saliva, urine, feces, breast milk, blood, and secretions of the cervix (the narrow, lower section of the uterus).

CMV is able to cross the placenta (the organ that provides oxygen and nutrients to the unborn baby in the uterus). Because of this, initial infection in a pregnant woman can lead to infection of the developing baby.

Risk factors

Individuals at high risk for infection with CMV include:

- children who attend day care at day care centers
- individuals who work in day care centers
- patients who receive blood transfusions
- organ transplant or bone marrow transplant patients who receive CMV mismatched organs or bone marrow from donors
- individuals with multiple sexual partners

Causes and symptoms

CMV is passed between people through contact with body fluids. CMV also can be passed through sexual contact. Babies can be born infected with CMV, either becoming infected in the uterus (congenital infection) or during birth (from infected cervical secretions). Congenital infection of CMV causes significant neurological problems and deafness in about 8,000 American newborns every year. The virus can

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also be spread through blood transfusions and during organ transplants.

Like other herpes viruses, CMV remains inactive (dormant) within the body for life after the initial infection. Some of the more serious types of CMV infections occur in people who have been harboring the dormant virus, only to have it reactivate when their immune system is stressed. Immune systems may be weakened because of treatment with **cancerchemotherapy**, medications given after organ transplantation, or diseases that significantly lower immune resistance like acquired **immunodeficiency** syndrome (**AIDS**).

In a healthy person, initial CMV infection often occurs without symptoms and is rarely noticed. If symptoms do occur, they typically occur 9–60 days after the first infection. Occasionally, a first-time infection with CMV may cause a mild illness called mononucleosis. Symptoms include **swollen glands**, liver, and spleen; **fever**; increased white blood cells; **headache**; **fatigue**; and **sore throat**. About 8% of all mononucleosis cases are due to CMV infection. A similar infection, though slightly more serious, may occur two to four weeks after receiving a blood **transfusion** containing CMV.

In people with weakened immune systems, CMV infection can cause more serious and potentially life-threatening illnesses. These illnesses include **pneumonia**, and inflammations of the liver (hepatitis), brain (**encephalitis**), esophagus (esophagitis), large intestine (**colitis**), and retina of the eye (retinitis).

Babies who contract CMV from their mothers during birth rarely develop any illness from these infections. Infants born prematurely who become CMV infected during birth have a greater chance of complications, including pneumonia, hepatitis, decreased blood platelets.

An unborn baby is at greatest risk for serious problems when the mother becomes infected with CMV for the first time while pregnant. About 10% of these babies will be born with obvious problems, including **prematurity**, lung problems, an enlarged liver and spleen, **jaundice**, anemia, low birth weight, small head size, and inflammation of the retina. About 90% of these babies may appear normal at birth. About 20% will later develop severe hearing impairments and **mental retardation**. Pregnant women 25 years and older who are immune to CMV are much less likely to pass the virus to their babies than younger women who have never been exposed to CMV.

KEY TERMS

Cervix—The narrowed, lowest part of the uterus through which a baby must pass in order to enter the birth canal.

Congenital—A condition that exists before birth and at birth.

Placenta—The organ that provides oxygen and nutrition from the mother to the unborn baby during pregnancy. The placenta is attached to the wall of the uterus and leads to the unborn baby via the umbilical cord.

Diagnosis

Tests

CMV can be detected using fluid or tissue cultures, blood testing, antigen assays, qualitative polymerase chain reaction (PCR) testing of blood and tissue samples, and by cytopathology.

Body fluids or tissues can be tested to reveal CMV infection. However, this information is not always particularly helpful because CMV stays dormant in the cells for life. Tests to look for special immune cells (antibodies) directed specifically against CMV are useful in proving that a person has been infected with CMV. These tests do not give any information regarding when the CMV infection first occurred.

A newer test, the anti-CMV immediate early antigen monoclonal antibody test, can detect CMV infection as early as three hours after infection with CMV.

Treatment

Drugs

Ganciclovir (Cytovene) and valganciclovir (Valcyte) are antiviral medications that have been used to prevent CMV in high-risk patients (such as solid organ transplant patients) or to treat patients infected with CMV. Treatment with intravenous ganciclovir is the preferred treatment for CMV. Valganciclovir, which is given orally once per day, may be used to treat some cases of existing CMV and has proved to be very effective when used for CMV **prophylaxis** in high-risk patients. It should not be used in patients with pre-existing **kidney disease**. Another antiviral medication, foscarnet (Foscavir), may be used to treat

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patients whose CMV infection has not responded to treatment with ganciclovir.

Antiviral drugs are not used to treat CMV infection in otherwise healthy patients because the drugs have significant side effects that outweigh their benefits.

Prognosis

Prognosis in healthy people with CMV infection is excellent.

About 0.1% of all newborn babies will have serious damage from CMV infection occurring while they were developing in the uterus.

Despite lengthy treatment courses with valganciclovir, relapse of CMV disease remains common among organ transplant recipients.

Prevention

Prevention of CMV infection in the normal, healthy person involves good handwashing. Blood products can be screened or treated to insure that they do not contain CMV.

Individuals who engage in high-risk behaviors, such as engaging in sexual activities with multiple sexual partners, should be educated as to their risk for infection with CMV.

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D

D & C *see* **Dilatation and curettage**

Dacryocystitis

Definition

Dacryocystitis is an inflammation of the tear sac (lacrimal sac) at the inner corner of the eye.

Description

Tears drain into little openings (puncta) in the inner corners of the eyelids. From there, the tears travel through little tube-like structures (canaliculi) to the lacrimal sac. The nasolacrimal ducts then take the tears from the lacrimal sac to the nose. That's why people need to blow their nose when they cry a lot.

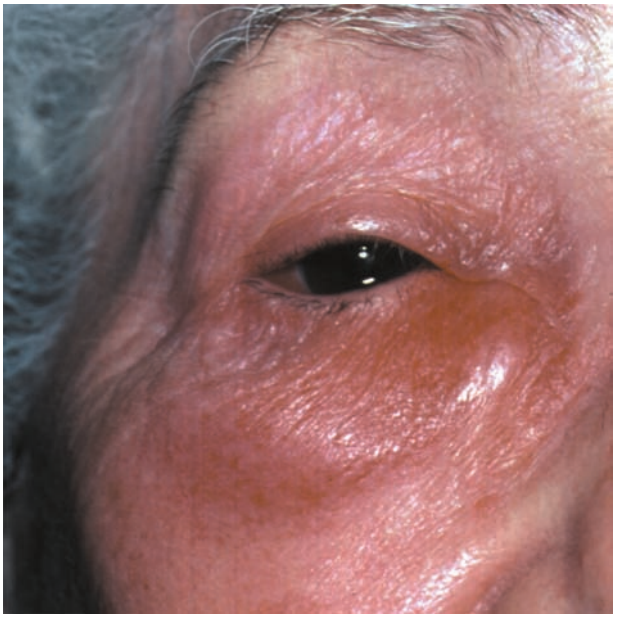
Dacryocystitis is usually caused by a blockage of the nasolacrimal duct, which allows fluid to drain into the nasal passages. When the lacrimal sac does not drain, bacteria can grow in the trapped fluid. This condition is most common in infants and people over 40 years old.

Causes and symptoms

In newborn infants, the nasolacrimal duct may fail to form an opening–a condition called dacryostenosis. The cause of dacryocystitis in adults is usually associated with inflammation and infection in the nasal region. Dacryocystitis can be acute, having a sudden onset, or it can be chronic, with symptoms occurring over the course of weeks or months. Symptoms of acute dacryocystitis can include **pain**, redness, tearing, and swelling at the inner corner of the eye by the nose. In chronic dacryocystitis, the eye area may be swollen, watery or teary, and, when pressure is applied to the area, there may be a discharge of pus or mucus through the punctum.

Diagnosis

Dacryocystitis usually occurs in only one eye. As mentioned, the symptoms can range from watery eyes, pain, swelling, and redness to a discharge of pus when pressure is applied to the area between the bridge of the nose and the inner eyelids. A sample of the pus may be collected on a swab or in a tube for laboratory analysis. The type of antibiotic and treatment may depend on which bacteria is present. In the acute form, a blood test may reveal an elevated white blood cell (WBC) count; with a chronic infection, the WBC count is usually normal. To identify the exact location of the blockage,



Dacryocystitis of the right eye. The inner corner of the lower lid is bulging from an inflamed tear sac. Blockage of the tear duct causes fluid to be trapped in the tear sac, which becomes infected. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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KEY TERMS

Canaliculi—Also known as lacrimal ducts, these tube-like structures carry the tears from the eyes to the lacrimal sac.

Cannula—A narrow tube that can be inserted into a duct.

Dacryocystography—An x ray of the tear duct after injection of a dye that is used to help locate a blockage in the duct.

Dacryocystorhinostomy—A surgical procedure to drain the tear sac into the nasal passage.

Dacryostenosis—Obstruction or narrowing of the nasolacrimal duct. May be present at birth.

Nasolacrimal duct—The tube that carries the tears from the lacrimal sac to the nose.

Punctum—Tiny opening at the inner corners of the upper and lower lids. The area for the beginning of tear drainage.

an x ray can be taken after a dye is injected into the duct in a procedure called dacryocystography.

Treatment

A warm compress applied to the area can help relieve pain and promote drainage. Topical and oral **antibiotics** may be prescribed if an infection is present. Intravenous antibiotics may be needed if the infection is severe. In some cases, a tiny tube (cannula) is inserted into the tear duct which is then flushed with a sterile salt water solution (sterile saline). If other treatments fail to clear up the symptoms, surgery (dacryocystorhinostomy) to drain the lacrimal sac into the nasal cavity can be performed. In extreme cases, the lacrimal sac will be removed completely.

In infants, gentle massage of the lacrimal sac four times daily for up to nine months can drain the sac and sometimes clear a blockage. As the infant grows, the duct may open by itself. If the duct does not open, it may need to be dilated with a minor surgical procedure.

Prognosis

Treatment of dacryocystitis with antibiotics is usually successful in clearing the infection that is present. If there is a permanent blockage that prevents drainage, infection may recur and surgery may be required to open the duct. If left untreated, the infected sac can rupture, forming an open, draining sore.

Prevention

There are no specific recommendations for the prevention of dacryocystitis, however, good hygiene may decrease the chances of infection.

Resources

BOOKS

Gorbach, Sherwood F., John S. Bartlett, and Neil R. Blacklow, eds. *Infectious Diseases*, 3rd ed. Philadelphia: W. B. Saunders Co., 2004.

Altha Roberts Edgren

Dandruff *see* **Seborrheic dermatitis**

Death

Definition

Death is defined as the cessation of all vital functions of the body including the heartbeat, brain activity (including the brain stem), and breathing.

Description

Death comes in many forms, whether it be expected after a diagnosis of terminal illness or an unexpected accident or medical condition.

Terminal illness

When a terminal illness is diagnosed, a person, family, friends, and physicians are all able to prepare for the impending death. A terminally ill individual goes through several levels of emotional acceptance while in the process of dying. First, there is denial and isolation. This is followed by anger and resentment. Thirdly, a person tries to escape the inevitable. With the realization that death is eminent, most people suffer from depression. Lastly, the reality of death is realized and accepted.

Causes and symptoms

The two leading causes of death for both men and women in the United States are heart disease and **cancer**. Accidental death was a distant third followed by such problems as **stroke**, chronic lung disorders, **pneumonia**, **suicide**, **cirrhosis**, **diabetes mellitus**, and murder. The order of these causes of death varies among persons of different age, ethnicity, and gender.

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KEY TERMS

Angiography—X rays of blood vessels filled with a contrast agent.

Caloric testing—Flushing warm and cold water into the ear stimulates the labyrinth and causes vertigo and nystagmus if all the nerve pathways are intact.

Electroencephalogram—Recording of electrical activity in the brain.

Hospice—Systematized care of dying persons.

Living will—A legal document detailing a person's wishes during the end of life, to be carried out by designated decision makers.

Stroke—Interruption of blood flow to a part of the brain with consequent brain damage, also known as a cerebrovascular accident (CVA).

Diagnosis

In an age of organ transplantation, identifying the moment of death may now involve another life. It thereby takes on supreme legal importance. It is largely due to the need for transplant organs that death has been so precisely defined.

The official signs of death include the following:

- no pupil reaction to light
- no response of the eyes to caloric (warm or cold) stimulation
- no jaw reflex (the jaw will react like the knee if hit with a reflex hammer)
- no gag reflex (touching the back of the throat induces vomiting)
- no response to pain
- no breathing
- a body temperature above 86 °F (30 °C), which eliminates the possibility of resuscitation following cold-water drowning
- no other cause for the above, such as a head injury
- no drugs present in the body that could cause apparent death
- all of the above for 12 hours
- all of the above for six hours and a flat-line electroencephalogram (brain wave study)
- no blood circulating to the brain, as demonstrated by angiography

Current ability to resuscitate people who have "died" has produced some remarkable stories. Drowning in cold water (under 50 °F/10 °C) so effectively slows metabolism that some persons have been revived after a half hour under water.

Treatment

Only recently has there been concerted public effort to address the care of the dying in an effort to improve their comfort and lessen their alienation from those still living. Hospice care represents one of the greatest advances made in this direction. There has also been a liberalization of the use of **narcotics** and other drugs for symptomatic relief and improvement in the quality of life for the dying.

Living will

One of the most difficult issues surrounding death in the era of technology is that there is now a choice, not of the event itself, but of its timing. When to die, and more often, when to let a loved one die, is coming within people's power to determine. This is both a blessing and a dilemma. Insofar as the decision can be made ahead of time, a living will is an attempt to address this dilemma. By outlining the conditions under which one would rather be allowed to die, a person can contribute significantly to that final decision, even if not competent to do so at the time of actual death. The problem is that there are uncertainties surrounding every severely ill person. Each instance presents a greater or lesser chance of survival. The chance is often greater than zero. The best living will follows an intimate discussion with decision makers covering the many possible scenarios surrounding the end of life. This discussion is difficult, for few people like to contemplate their own demise. However, the benefits of a living will are substantial, both to physicians and to loved ones who are faced with making final decisions. Most states have passed living will laws, honoring instructions on artificial **life support** that were made while a person was still mentally competent.

Euthanasia

Another issue that has received much attention is assisted suicide (euthanasia). In 1997, the State of Oregon placed the issue on the ballot, amid much consternation and dispute. Perhaps the main reason euthanasia has become front page news is because Dr. Jack Kevorkian, a pathologist from Michigan, is one of its most vocal advocates. The issue highlights the many new problems generated by increasing ability to intervene effectively in the final moments of life and unnaturally

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ELISABETH KÜBLER-ROSS (1926–2004)

Kübler-Ross was a contemporary physician who was a world authority on the subject of death and after-death states. Born in Switzerland on July 8, 1926, she worked as a country doctor before moving to the United States. During World War II she spent weekends at the Kantonspital (Cantonai Hospital) in Zürich, where she volunteered to assist escaped refugees. After the war she visited Majdanek concentration camp, where the horrors of the death chambers stimulated in her a desire to help people facing death and to understand the human impulses of love and destruction. She extended her medical background by becoming a practicing psychiatrist. Her formal work with dying patients began in 1965 when she was a faculty member at the University of Chicago. She also conducted research on basic questions concerning life after death at the Manhattan State Hospital, New York. Her studies of death and dying involved accounts by patients who reported out-of-the-body travel. Her research tends to show that while dying can be painful, death itself is a peaceful condition. Her 1969 text, *On Death and Dying*, was hailed by her colleagues and also became a popular best-seller.

In 1978 Kübler-Ross helped to found Shanti Nilaya (Final Home of Peace), a healing and growth center in Escondido, California. This was an extension of her well-known "Life-Death and Transition" workshops conducted in various parts of the United States and Canada, involving physicians, nurses, social workers, laypeople, and terminally ill patients. Much of Kübler-Ross's later research was directed toward proving the existence of life after death. Her publication *To Live Until We Say Goodbye* (1979) was both praised as a "celebration of life" and criticized as "prettifying" the real situation. She also dealt with issues such as AIDS and "near death" experiences. In the mid-1980s, Shanti Nilaya moved from San Diego County, California, to Head Waters, Virginia, where it continues to offer courses and short- and long-term therapeutic sessions. Information on the foundation that bears her name and continues her work can be found at http://www.ekrfoundation.org/

prolong the process of dying. The public appearance of euthanasia has also stimulated discussion about more compassionate care of the dying.

Prevention

Autopsy after death is a way to precisely determine a cause of death. The word autopsy is derived from Greek meaning to see with one's own eyes. A pathologist extensively examines a body and submits a detailed report to an attending physician. Although an autopsy can do nothing for an individual after death, it can benefit the family and, in some cases, medical science. Hereditary disorders and disease may be found. This knowledge could be used to prevent illness in other family members. Information culled from an autopsy can be used to further medical research. The link between **smoking** and lung cancer was confirmed from data gathered through autopsy. Early information about **AIDS** was also compiled through autopsy reports.

Resources

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Roger, V. L., et al. "Time Trends in the Prevalence of Atherosclerosis: A Population-based Autopsy Study." *American Journal of Medicine* 110, no. 4 (2001): 267–273.

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OTHER

American Association of Retired Persons. http://www.aarp.org.

Association for Death Education and Counseling. http://www.adec.org.

Death and Dying Grief Support. http://www.death-dying.com.

National Center for Health Statistics. http://www.cdc.gov/nchs.

ORGANIZATIONS

American Academy of Family Physicians (AAFP), 11400 Tomahawk Creek Parkway, Leawood, KS, 66211-2680, (913) 906-6000, (913) 906-6075, (800) 271-2237, http://www. aafp.org/.

American Medical Association, 515 N. State St., Chicago, IL, 60654, (800) 621-8335, http://www.ama-assn.org/.

American Society for Clinical Pathologists, 33 West Monroe Street, Suite 1600, Chicago, IL, 60603, (312) 541-4999, (312) 541-4998, (800) 267-2727, option 2, info@ascp.org, http://www.ascp.org/.

College of American Pathologists, 325 Waukegan Road, Northfield, IL, 60093-2750, (847) 832-7000, (847) 832-8000, (800) 323-4040, http://www.cap.org.

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Hospice Foundation of America, 1710 Rhode Island Ave., NW, Suite 400, Washington, DC, 20036, (202) 457-5811, (202) 457-5815, (800) 854-3402, hfaoffice@hospice foundation. org, http://www.hospice foundation.org.

L. Fleming Fallon, Jr., MD, DrPH

Debridement

Definition

Debridement is the process of removing nonliving tissue from pressure ulcers, **burns**, and other **wounds**.

Purpose

Debridement speeds the healing of pressure ulcers, burns, and other wounds. Wounds that contain nonliving (necrotic) tissue take longer to heal. The necrotic tissue may become colonized with bacteria, producing an unpleasant odor. Though the wound is not necessarily infected, the bacteria can cause inflammation and strain the body's ability to fight infection. Necrotic tissue may also hide pockets of pus called abscesses. Abscesses can develop into a general infection that may lead to **amputation** or **death**.

Precautions

Not all wounds need debridement. Sometimes it is better to leave a hardened crust of dead tissue, called an eschar, than to remove it and create an open wound, particularly if the crust is stable and the wound is not inflamed. Before performing debridement, the physician will take a medical history with attention to factors that might complicate healing, such as medications being taken and **smoking**. The physician will also note the cause of the wound and the ways it has been treated. Some ulcers and other wounds occur in places where blood flow is impaired, for example, the foot ulcers that can accompany **diabetes mellitus**. In such cases, the physician or nurse may decide not to debride the wound because blood flow may be insufficient for proper healing.

A burn sufferer undergoes debridement (the removal of dead skin). The patterns on his chest are from skin grafts. *(© Ann Chawatsky/Phototake. — All rights reserved.)*

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Description

In debridement, dead tissue is removed so that the remaining living tissue can adequately heal. Dead tissue exposed to the air will form a hard black crust, called an eschar. Deeper tissue will remain moist and may appear white, or yellow and soft, or flimsy. The four major debridement techniques are surgical, mechanical, chemical, and autolytic.

Surgical debridement

Surgical debridement (also known as sharp debridement) uses a scalpel, scissors, or other instrument to cut dead tissue from a wound. It is the quickest and most efficient method of debridement. It is the preferred method if there is rapidly developing inflammation of the body's connective tissues (**cellulitis**) or a more generalized infection (**sepsis**) that has entered the bloodstream. The procedure can be performed at a patient's bedside. If the target tissue is deep or close to another organ, however, or if the patient is experiencing extreme **pain**, the procedure may be done in an operating room. Surgical debridement is generally performed by a physician, but in some areas of the country an advance practice nurse or physician assistant may perform the procedure.

The physician will begin by flushing the area with a saline (salt water) solution, and then will apply a topical anesthetic gel to the edges of the wound to minimize pain. Using a forceps to grip the dead tissue, the physician will cut it away bit by bit with a scalpel or scissors. Sometimes it is necessary to leave some dead tissue behind rather than disturb living tissue. The physician may repeat the process again at another session.

Mechanical debridement

In mechanical debridement, a saline-moistened dressing is allowed to dry overnight and adhere to the dead tissue. When the dressing is removed, the dead tissue is pulled away too. This process is one of the oldest methods of debridement. It can be very painful because the dressing can adhere to living as well as nonliving tissue. Because mechanical debridement cannot select between good and bad tissue, it is an unacceptable debridement method for clean wounds where a new layer of healing cells is already developing.

Chemical debridement

Chemical debridement makes use of certain enzymes and other compounds to dissolve necrotic tissue. It is more selective than mechanical debridement. In fact, the body makes its own enzyme, collagenase, to break down collagen, one of the major building blocks of skin. A pharmaceutical version of collagenase is available and is highly effective as a debridement agent. As with other debridement techniques, the area first is flushed with saline. Any crust of dead tissue is etched in a cross-hatched pattern to allow the enzyme to penetrate. A topical antibiotic is also applied to prevent introducing infection into the bloodstream. A moist dressing is then placed over the wound.

Autolytic debridement

Autolytic debridement takes advantage of the body's own ability to dissolve dead tissue. The key to the technique is keeping the wound moist, which can be accomplished with a variety of **dressings**. These dressings help to trap wound fluid that contains growth factors, enzymes, and immune cells that promote wound healing. Autolytic debridement is more selective than any other debridement method, but it also takes the longest to work. It is inappropriate for wounds that have become infected.

KEY TERMS

Eschar—A hardened black crust of dead tissue that may form over a wound.

Pressure ulcer—Also known as a decubitus ulcer, pressure ulcers are open wounds that form whenever prolonged pressure is applied to skin covering bony outcrops of the body. Patients who are bedridden are at risk of developing pressure ulcers. Pressure ulcers are commonly known as bedsores.

Sepsis—A severe systemic infection in which bacteria have entered the blood stream.

Preparation

The physician or nurse will begin by assessing the need for debridement. The wound will be examined, frequently by inserting a gloved finger into the wound to estimate the depth of dead tissue and evaluate whether it lies close to other organs, bone, or important body features. The area may be flushed with a saline solution before debridement begins, and a topical anesthetic gel or injection may be applied if surgical or mechanical debridement is being performed.

Aftercare

After surgical debridement, the wound will be packed with a dry dressing for a day to control bleeding.

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Afterward, moist dressings are applied to promote wound healing. Moist dressings are also used after mechanical, chemical, and autolytic debridement. Many factors contribute to wound healing, which frequently can take considerable time. Debridement may need to be repeated.

Risks

It is possible that underlying tendons, blood vessels or other structures will be damaged during the examination of the wound and during surgical debridement. Surface bacteria may also be introduced deeper into the body, causing infection.

Normal results

Removal of dead tissue from pressure ulcers and other wounds speeds healing. Although these procedures cause some pain, they are generally well tolerated by patients and can be managed more aggressively. It is not uncommon to debride a wound again in a subsequent session.

ORGANIZATIONS

American Academy of Wound Management, 1155 15th Street, NW, Suite 500, Washington, DC, 20005, (202) 457-8408, (202) 530-0659, http://www.aawm.org.

Wound Care Institute, 1100 N.E. 163rd Street, Suite #101, North Miami Beach, FL, 33162, FishmanTamara@hotmail.com, http://www.woundcare.org.

Richard H. Camer

Decompression sickness

Definition

Decompression sickness (DCS) is a dangerous and occasionally lethal condition caused by nitrogen bubbles that form in the blood and other tissues of scuba divers who surface too quickly.

Description

According to the Divers Alert Network (DAN), a worldwide organization devoted to safe-diving research and promotion, less than 1% of divers fall victim to DCS or the rarer bubble problem called **gas embolism**, air **embolism**, or arterial gas embolism (AGE). A study of the United States military community in Okinawa, where tens of thousands of sport and military dives are made each year, identified 84 DCS and 10 AGE cases in 1989–95, including nine deaths. This translated into estimates of one case in every 7,400 dives and one **death** in every 76,900 dives. DCS symptoms can be quite mild, however, and many cases certainly go unnoticed by divers.

At times the terminology adopted by writers on DCS can be confusing. Some substitute the term decompression illness (DCI) for DCS. Others treat DCI as a label encompassing both DCS and AGE. An older term for DCS is caisson disease, coined in the nineteenth century when it was discovered that bridge construction crews working at the bottom of lakes and rivers in large pressurized enclosures (caissons) were experiencing joint **pain** (a typical DCS symptom) on returning to the surface.

Causes and symptoms

The air we breathe is mostly a mixture of two gases, nitrogen (78%) and oxygen (21%). Unlike oxygen, nitrogen is a biologically inert gas, meaning that it is not metabolized (converted into other substances) by the body. For this reason, most of the nitrogen we inhale is expelled when we exhale, but some is dissolved into the blood and other tissues. During a dive, however, the lungs take in more nitrogen than usual. This happens because the surrounding water pressure is greater than the air pressure at sea level (twice as great at 33 ft [10 m], for instance). As the water pressure increases, so does the pressure of the nitrogen in the compressed air inhaled by the diver. Because increased pressure causes an increase in gas density, the diver takes in more nitrogen with each breath than he or she would at sea level. Instead of being exhaled, however, the extra nitrogen safely dissolves into the tissues, where it remains until the diver begins his or her return to the surface (under some circumstances the extra nitrogen can cause **nitrogen narcosis**, but that condition is distinct from DCS). On the way up, decompression occurs (in other words, the water pressure drops), and with the change in pressure, the extra nitrogen gradually diffuses out of the tissues and is delivered by the bloodstream to the lungs, which expel it from the body. If the diver surfaces too quickly, however, potentially dangerous nitrogen bubbles can form in the tissues and cause DCS. These bubbles can compress nerves, obstruct arteries, veins, and lymphatic vessels, and trigger harmful chemical reactions in the blood. The precise reasons for bubble formation remain unclear.

How much extra nitrogen enters the tissues varies with the dive's depth and duration. Dive tables prepared by the U.S. Navy and other organizations specify how long most divers can safely remain at a particular depth. If the dive table limits are exceeded, the diver must pause on the way up to allow the nitrogen to diffuse into the

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KEY TERMS

Gas embolism—The presence of a gas bubble in the bloodstream that obstructs circulation.

Hyperbaric chamber—A sealed compartment in which air pressure is gradually increased and then gradually decreased, allowing nitrogen bubbles to shrink and the nitrogen to safely diffuse out of body tissue.

Lymphatic vessels—Vessels that carry a fluid called lymph from the tissues to the bloodstream.

Nitrogen narcosis—Also called "rapture of the deep," the condition is caused by increased nitrogen pressure at depth and is characterized by symptoms similar to alcohol intoxication.

bloodstream without forming bubbles; these pauses are called decompression stops, and are carefully calibrated. DCS can occur, however, even when a diver obeys safe diving rules. In such cases, the predisposing factors include **fatigue**, **obesity**, **dehydration**, **hypothermia**, and recent alcohol use. People who fly or travel to high-altitude locations without letting 12–24 hours pass after their last dive are at risk for DCS as well because their bodies undergo further decompression. This is true even when flying in commercial aircraft. Many travelers are unaware that to save money on fuel the cabin pressure in commercial aircraft is set much lower than the pressure at sea level. At 30,000 ft (9,144 m), for instance, cabin pressure is usually equivalent to the pressure at 7,000–8,000 ft (2,133–2,438 m) above sea level, a safe setting for everyone but recent divers. Exactly how long a diver should wait before flying or traveling to a high-altitude location depends on how much diving he or she has done and other considerations. If there is uncertainty about the appropriate waiting period, the sensible course of action is to let the full 24 hours pass.

Because the nitrogen bubbles that cause DCS can affect any of the body's tissues, including the blood, bones, nerves, and muscles, many kinds of symptoms are possible. Symptoms can appear minutes after a diver surfaces, and in about 80% of cases do so within eight hours. Pain is often the only symptom; this is sometimes called the bends, although many people incorrectly use that term as a synonym for DCS itself. The pain, which ranges from mild to severe, is usually limited to the joints, but can be felt anywhere. Severe **itching** (pruritis), skin **rashes**, and skin mottling (cutis marmorata) are other possible symptoms. All of these are sometimes classified as manifestations of type 1 or "mild" DCS. Type 2 or "serious" DCS can lead, among other things, to **paralysis**, brain damage, heart attacks, and death. Many DCS victims, however, experience both type 1 and type 2 symptoms.

Diagnosis

Diagnosis requires taking a medical history (questioning the patient about his or her health and recent activities) and conducting a **physical examination**.

Treatment

DCS is treated by giving the patient oxygen and placing him or her in a **hyperbaric chamber**, an enclosure in which the air pressure is first gradually increased and then gradually decreased. This shrinks the bubbles and allows the nitrogen to safely diffuse out of the tissues. Hyperbaric chamber facilities exist throughout the United States. No matter how mild one's symptoms may appear, immediate transportation to a facility is essential. Treatment is necessary even if the symptoms clear up before the facility is reached, because bubbles may still be in the bloodstream and pose a threat. DAN maintains a list of facilities and a 24-hour hotline that can provide advice on handling DCS and other diving emergencies.

Prognosis

DCS sufferers who undergo chamber treatment within a few hours of symptom onset usually enjoy a full recovery. If treatment is delayed the consequences are less predictable, although many people have been helped even after several days have passed. A 1992 DAN report on diving accidents indicated that full recovery following chamber treatment was immediate for about 50% of divers. Some people, however, suffer **numbness**, **tingling**, or other symptoms that last weeks, months, or even a lifetime. In the Okinawa study, six of the 94 patients experienced "long-lasting" symptoms even after repeated chamber treatments.

Prevention

The obvious way to minimize the risk of falling victim to DCS is to follow the rules on safe diving and air travel after a dive. People who are obese, suffer from lung or heart problems, or are otherwise in poor health should not dive. And because the effect of nitrogen diffusion on the fetus remains unknown, diving while pregnant is not recommended.

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ORGANIZATIONS

American College of Hyperbaric Medicine, 9875 South Franklin Drive, Suite 300, Franklin, Wisconsin, 53132, (414) 385-2943, (414) 385-8721, http://www.achm.org.

Divers Alert Network, 6 West Colony Place, Durham, NC, 27705, (919) 684-2948, (919) 490-6630, (800) 446-2671, http://www.diversalertnetwork.org.

Undersea and Hyperbaric Medical Society, 21 West Colony Place, Suite 280, Durham, NC, 27705, (919) 490-5140, (919) 490-5149, (877) 533-UHMS (8467), uhms@uhms@org, http://www.uhms.org.

Howard Baker

Decongestants

Definition

Decongestants are medicines used to relieve nasal congestion (stuffy nose).

Purpose

A congested or stuffy nose is a common symptom of colds and **allergies**. This congestion results when membranes lining the nose become swollen. Decongestants relieve the swelling by narrowing the blood vessels that supply the nose. This reduces the blood supply to the swollen membranes, causing the membranes to shrink.

These medicines do not cure colds or reverse the effects of histamines—chemicals released as part of the allergic reaction. They will not relieve all of the symptoms associated with colds and allergies, only the stuffiness.

When considering whether to use a decongestant for cold symptoms, keep in mind that most colds go away with or without treatment and that taking medicine is not the only way to relieve a stuffy nose. Drinking hot tea or broth or eating chicken soup may help. There are also adhesive strips can be placed on the nose to help widen the nasal passages, making breathing through the nasal passages a bit easier when congestion is present.

Precautions

Decongestant nasal sprays and nose drops may cause a problem called rebound congestion if used repeatedly over several days. When this happens, the nose remains stuffy or gets worse with every dose. The only way to stop the cycle is to stop using the drug. The stuffiness should then go away within about a week. Anyone who shows signs of severe rebound congestion should also contact his or her physician.

Do not use decongestant nasal sprays for more than three days. Decongestants taken by mouth should not be used for more than seven days. If the congestion has not gone away in this time, or if the symptoms are accompanied by **fever**, call a physician.

Do not use a decongestant nasal spray after the product's expiration date. If the product has become cloudy or discolored, throw it away and do not use it. Do not share droppers or spray bottles with anyone else, as this could spread infection. Do not let droppers and bottle tips touch countertops or other surfaces.

Some decongestants cause drowsiness. People who takes these drugs should not drive, use machines or do anything else that might be dangerous until they have found out how the drugs affect them.

In general, older people may be more sensitive to the effects of decongestants and may need to take lower doses to avoid side effects. People in this age group should not take long-acting (extended release) forms of decongestants unless they have previously taken a short-acting form with no ill effects.

Children may also be more sensitive to the effects of decongestants. Before giving any decongestant to a child, check the package label carefully. Some of these medicines are too strong for use in children. Serious side effects are possible if they are given large amounts of these drugs or if they swallow nose drops, nasal spray or eye drops. If this happens, call a physician or poison center immediately.

Special conditions

People with certain medical conditions or who are taking certain other medicines can have problems if they take decongestants. Before taking these drugs, be sure to let the physician know about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to decongestants in the past should let his or her physician know before these drugs or any similar drugs are prescribed. The physician should also be told about any allergies to foods, dyes, preservatives, or other substances.

PREGNANCY. In studies of laboratory animals, some decongestants have had unwanted effects on fetuses. However, it is not known whether such effects also occur in people. Women who are pregnant or who plan to become pregnant should check with their physicians before taking decongestants.

BREASTFEEDING. Some decongestants pass into breast milk and may have unwanted effects on nursing

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babies whose mothers take the drugs. Women who are **breastfeeding** should check with their physicians before using decongestants. If they need to take the medicine, it may be necessary to bottle feed the baby with formula while taking it.

OTHER MEDICAL CONDITIONS. Anyone with heart or blood vessel disease, high blood pressure, diabetes, **enlarged prostate**, or overactive thyroid should not take decongestants unless under a physician's supervision. The medicine can increase blood sugar in people with diabetes. It can be especially dangerous in people with high blood pressure, as it may increase blood pressure.

Before using decongestants, people with any of these medical problems should make sure their physicians are aware of their conditions:

- glaucoma
- history of mental illness

Decongestants may have a variety of side effects, and may also interact with other medications the patient is taking.

Side effects

DECONGESTANT NASAL SPRAYS AND NOSE DROPS. The most common side effects from decongestant nasal sprays and nose drops are sneezing and temporary burning, stinging, or dryness. These effects are usually temporary and do not need medical attention. If any of the following side effects occur after using a decongestant nasal spray or nose drops, stop using the medicine immediately and call the physician:

- increased blood pressure
- headache
- fast, slow, or fluttery heartbeat
- nervousness
- dizziness
- nausea
- sleep problems

DECONGESTANTS TAKEN BY MOUTH. The most common side effects of decongestants taken by mouth are nervousness, restlessness, excitability, **dizziness**, drowsiness, **headache**, **nausea**, weakness, and sleep problems. Anyone who has these symptoms while taking decongestants should stop taking them immediately.

Patients who have these symptoms while taking decongestants should call the physician immediately:

- increased blood pressure
- fast, irregular, or fluttery heartbeat
- severe headache
- tightness or discomfort in the chest
- breathing problems
- fear or anxiety
- hallucinations
- trembling or shaking
- convulsions (seizures)
- pale skin
- painful or difficult urination

Other side effects may occur. Anyone who has unusual symptoms after taking a decongestant should get in touch with his or her physician.

Interactions with other medicines

Decongestants may interact with a variety of other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Do not take decongestants at the same time as these drugs:

- Monoamine oxidase inhibitors (MAO inhibitors) such as phenzeline (Nardil) or tranylcypromine (Parnate), used to treat conditions including depression and **Parkinson's disease**. Do not take decongestants at the same time as a MAO inhibitor or within two weeks of stopping treatment with an MAO inhibitor unless a physician approves.
- Other products containing the same or other decongestants
- Caffeine.

In addition, anyone who takes decongestants should let the physician know all other medicines he or she is taking. Among the drugs that may interact with decongestants are:

- tricyclic antidepressants such as imipramine (Tofranil) or desipramine (Norpramin)
- the antidepressant maprotiline (Ludiomil)
- amantadine (Symmetrel)
- amphetamines
- medicine to relieve asthma or other breathing problems
- methylphenidate (Ritalin)
- appetite suppressants
- other medicine for colds, sinus problems, hay fever or other allergies
- beta-blockers such as atenolol (Tenormin) and propranolol (Inderal)
- digitalis glycosides, used to treat heart conditions

The list above does not include every drug that may interact with decongestants. Be sure to check with a physician or pharmacist before combining

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KEY TERMS

Fetus—A developing baby inside the womb.

Hallucination—A false or distorted perception of objects, sounds, or events that seems real. Hallucinations usually result from drugs or mental disorders.

decongestants with any other prescription or nonprescription (over-the-counter) medicine.

Description

Decongestants are sold in many forms, including tablets, capsules, caplets, gelcaps, liqui-caps, liquids, nasal sprays, and nose drops. These drugs are sometimes combined with other medicines in cold and allergy products designed to relieve several symptoms. Some decongestant products require a physician's prescription, but there are also many nonprescription (over-the-counter) products. Ask a physician or pharmacist about choosing an appropriate decongestant.

Commonly used decongestants include oxymetazoline (Afrin and other brands) and pseudoephedrine (Sudafed, Actifed, and other brands). The decongestant oxymetazoline is also used in some eye drops to relieve redness and **itching**.

The recommended dosage depends on the drug. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage, and always take the medicine exactly as directed. If using nonprescription (over-the-counter) types, follow the directions on the package label or ask a pharmacist for assistance. Never take larger or more frequent doses, and do not take the drug for longer than directed.

Risks

Anyone considering taking a decongestant should take a close look at the labels of any already in their medicine cabinet. In 2000, the Food and Drug Administration prohibited over-the-counter sales of medicines containing the decongestant phenylpropanolamine. The medicine is associated with an increased risk of **stroke** in people ages 18 to 49, especially women. Many cold remedies contained this medicine. Contact a pharmacist if there is any question about the ingredients in a medication. Over-the-counter remedies containing phenylpropanolamine should be discarded.

Normal results

The desired result when taking decongestants is the short-term relief of nasal congestion.

Resources

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Medline Plus Health Information. U.S.National Library of Medicine. http://www.nlm.nih.gov/medlineplus.

Deanna M. Swartout-Corbeil, R.N.

Decubitus ulcers *see* **Bedsores**

Deep vein thrombosis

Definition

Deep vein thrombosis (DVT) is a blood clot in a major vein that usually develops in the legs and/or pelvis.

Description

Deep vein thrombosis is a common but difficult to detect illness that can be fatal if not treated effectively. The disorder is estimated to affect 80 people per 100,000 population annually, but some experts feel this is an underestimate of the disorder because the condition often remains undetected and resolves on its on without complications. About 600,000 people are hospitalized in the United States for DVT each year. If left untreated, DVT can cause pulmonary emboli. This is a potentially fatal complication in which **blood clots** break off, travel through the circulatory system, and become lodged in and block an artery going to the lungs. Each year about 200,000 people die of pulmonary emboli caused by DVT. Deep vein thrombosis is also called venous thromboembolism, **thrombophlebitis** or phlebothrombosis.

Deep vein thrombosis is a major complication in patients who have had **orthopedic surgery** or pelvic, abdominal, or **thoracic surgery**. Patients with **cancer** and other chronic illnesses (including congestive **heart failure**), as well as those who have experienced a recent **heart attack** (myocardial infarction), are also at high risk for developing DVT. Deep vein thrombosis can be chronic, with recurrent episodes.

Causes and symptoms

Deep vein thrombosis is caused by blood clots in blood vessels that form in veins where blood flow is sluggish or has been disturbed, in pockets in the deep

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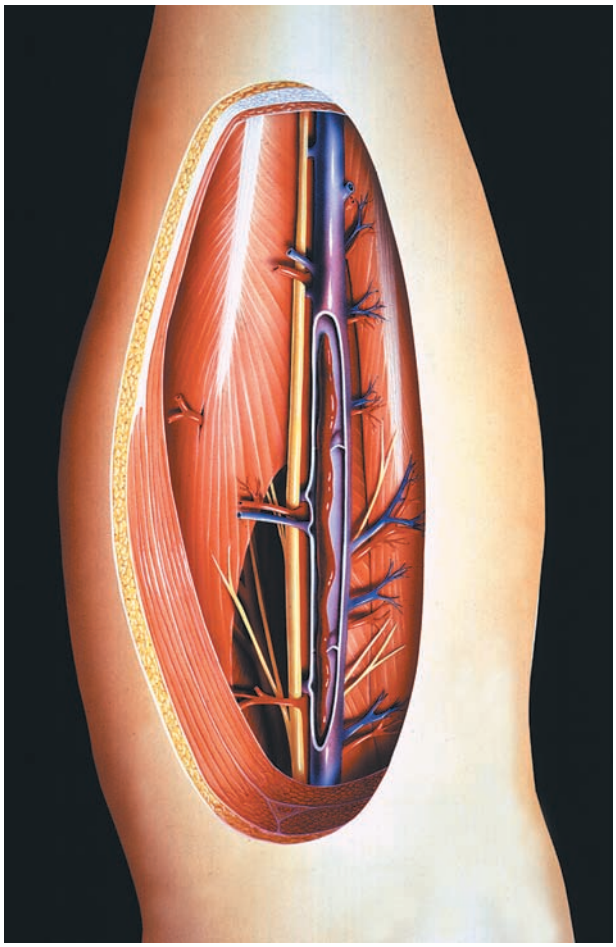

This illustration features a dissected human lower leg showing clot formation (thrombosis) along the length of a vein. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

veins of the calf, or in veins that have been traumatized. Symptoms include swelling and tenderness, **pain** in the calf or thigh, and possibly warmth. Fewer than half of all people with the condition experience symptoms, and symptoms tend to be nonspecific (e.g., leg pain may be caused by many other conditions). Some individuals and families have underlying clotting tendencies that can be tested for.

Diagnosis

Deep vein thrombosis can be detected through **venography** and radionuclide venography, **Doppler ultrasonography**, and impedance plethysmography. Venography is the most accurate test, but it is not used much because it is often painful, expensive, exposes the patient to radiation, and can cause allergic reactions and complications. Venography identifies the location, extent, and degree of attachment of the blood clots and enables the condition of the deep leg veins to be assessed. A contrast solution is injected into a foot vein through a catheter. The physician observes the movement of the solution through the vein with a fluoroscope while a series of x rays are taken. Venography takes 30–45 minutes and can be done in a physician's office, a laboratory, or a hospital. Radionuclide venography, in which a radioactive isotope is injected, is occasionally used, especially if a patient has had an allergic reaction to contrast solutions.

Doppler ultrasonography usually is the preferred procedure for detecting deep vein thrombosis. This technique uses sound waves to measure blood flow through leg veins and arteries. A blood pressure cuff is wrapped around the patient's ankle and a transducer with gel on it is placed over pulse points of the foot and lower leg. High-frequency sound waves bounce off the soft tissue, and the echoes are converted into images on a monitor. This procedure is very accurate in detecting clots above the knee that can become pulmonary embolisms. Usually performed in a physician's office or hospital outpatient diagnostic center, Doppler ultrasound takes about 30–45 minutes.

Impedance plethysmography is a noninvasive way to record changes in blood volume and vessel resistance. A blood pressure cuff is wrapped around the leg above the knee, four electrodes are placed near the knee and the ankle, and the cuff is inflated to compress the veins and reduce blood flow. The efficiency with which the veins return to normal is then measured. Performed in a physician's office, impedance plethysmography takes about 15 minutes.

Treatment

Deep vein thrombosis can be treated with drug therapy, bed rest, and gradient elastic stockings. Medications include anticoagulants that "thin" blood to

KEY TERMS

Catheter—A long, thin, flexible tube that can be inserted into a vein and moved through the cardiovascular system.

Pulmonary embolism—An obstruction of a blood vessel in the lungs, usually caused by a blood clot that blocks a coronary artery. Pulmonary embolism can be very serious and, in some cases, fatal.

Thrombosis—The development of a blood clot inside a blood vessel.

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prevent further growth of blood clots, as well as clot-dissolving drugs. Heparin is a common injectable anticoagulant and is usually followed by warfarin (Coumadin) tablets for at least three months. Bed rest with the patient's legs elevated is necessary until the condition improves. Gradient elastic stockings should then be worn, and standing for long periods avoided. In some cases, a filter is surgically placed in the major vein (the inferior vena cava) to trap emboli or clots before they get to the heart and lungs. In another surgical procedure, a catheter is inserted into the vein. When the clot is reached, a balloon at the end of the catheter is inflated, and then withdrawn along with the clot. However, this procedure risks dislodging the clot.

Alternative treatment

Deep vein thrombosis can be life threatening and must be treated with conventional medical therapies. However, some alternative therapies may be used in conjunction with conventional treatments to dissolve the clot. These therapies may help support the body and prevent recurrence. A conventional physician as well as a trained alternative health care practitioner should be consulted due to the severity of this condition.

Prognosis

Complications from DVT can be life threatening or chronically debilitating. Pulmonary emboli develop in about 10% of people with DVT and account for about 10% of all hospital deaths. DVT also can cause inflammation of the blood vessels resulting in loss of contractility and chronically decreased function. On the other hand, about three-quarters of people with DVT remain free of symptoms, and in many cases, the condition resolves with minimal treatment.

Prevention

Deep vein thrombosis can be prevented through prophylactic **anticoagulant drugs** and venous stasis prevention with gradient elastic stockings and intermittent pneumatic compression of the legs. Individuals should avoid standing or sitting for long periods without moving; walking or exercising the legs on long airplane and car trips helps keep blood from pooling in the legs and helps to prevent DVT. High-risk individuals often need to remain on oral anticoagulants (e.g., Coumadin) indefinitely.

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ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

Society for Vascular Surgery, 633 North Saint Clair Street, 22nd Floor, Chicago, IL, 60611, (312) 334-2300, (312) 334-2320, (800) 258-7188, vascular@vascularsociety.org, http://www.vascularweb.org.

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Deer-fly fever *see* **Tularemia**

Defibrillation

Definition

Defibrillation is a process in which an electronic device—which may be an external or an implantable device—sends an electric shock to the heart to stop an extremely rapid irregular heartbeat, and restore the normal heart rhythm.

Purpose

Defibrillation is performed to correct life-threatening fibrillations of the heart or such other **arrhythmias** as **ventricular tachycardia** that may result in cardiac arrest. It should be performed immediately after identifying that the patient is experiencing a cardiac emergency, has no pulse, and is unresponsive.

Precautions

Defibrillation should not be performed on a patient who has a pulse or is alert, as this could cause a lethal heart rhythm disturbance or cardiac arrest. The paddles used in the procedure should not be placed on a woman's breasts or over a pacemaker.

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Defibrillation by paddles. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Description

Normal and abnormal heart rhythms

Normal heart rhythm is established by the sinoatrial node (SAN), a group of cells located in the wall of the right atrium (upper chamber) of the heart near the entry of the superior vena cava. The superior vena cava is a major vein that carries deoxygenated blood from the upper part of the body to the heart. The SAN, sometimes called the body's natural pacemaker, discharges electrical impulses at the rate of 60–100 per minute that trigger the contractions of the heart muscle (myocardium). It is the regular contractions of the myocardium that enable blood to pumped efficiently throughout the rest of the body.

The contractions of the heart muscle result from depolarization, which is the change in a cell's membrane potential, making its electrical charge either more positive or less negative. The electrical impulses discharged by the sinoatrial node produce a wave of depolarization that moves from the right atrium to the left atrium and causes these two upper chambers of the heart to contract. The impulses then travel to another node in the heart known as the atrioventricular node or AV node. The AV node functions as a timing device that delays the conduction of the electrical impulses to the ventricles (lower chambers), thus preventing the atria and the ventricles from contracting at the same time. At the end of the cycle, the ventricles of the heart repolarize in preparation for the next heartbeat.

Ventricular fibrillation is a medical emergency in which the muscle of the ventricles twitches randomly rather than contracting in a coordinated manner from the apex of the heart to the outflow of the ventricles. It thus causes the heart to stop pumping blood into the arteries and general body circulation, leading to brain damage and/or cardiac arrest. The mechanisms leading to ventricular fibrillation are not completely understood as of 2010, and research into this type of cardiac emergency is ongoing. Most episodes of fibrillation occur in diseased or damaged hearts; however, others occur in so-called normal hearts. **Sudden cardiac death** accounts for approximately 300,000 deaths per year in the United States, of which 75–80% are due to ventricular fibrillation. Ventricular fibrillation is linked to more deaths each year in North America than lung **cancer**, **breast cancer**, or **AIDS**.

Emergency defibrillation

About 10% of the ability to restart the heart is lost with every minute that the heart stays in fibrillation. Irreversible brain damage leading to **death** can occur within 3–5 minutes unless the normal heart rhythm is restored through defibrillation. Because immediate defibrillation is crucial to the patient's survival, the American Heart Association (AHA) has called for the integration of defibrillation into an effective emergency cardiac care system. The system should include early access, early **cardiopulmonary resuscitation**, early defibrillation, and early advanced cardiac care.

The AHA has also drawn up guidelines for advanced cardiac **life support** (ACLS), a set of interventions for cardiac arrest and other heart-related medical emergencies. Only qualified health care providers can supply ACLS when needed, as the guidelines require the ability to manage the patient's airway, initiate intravenous treatment, read and interpret electrocardiograms (EKGs), and understand emergency drug administration. The present ACLS provider course requires about 14 hours of classroom work, including simulations, and the successful completion of a written examination.

How defibrillators work

Defibrillators deliver a brief electric shock to the heart, which enables the heart's natural pacemaker to regain control and establish a normal heart rhythm. The defibrillator is an electronic device with electrocardiogram leads and paddles. During defibrillation, the paddles are placed on the patient's chest, caregivers stand back, and the electric shock is delivered. The patient's pulse and heart rhythm are continually monitored. Medications to treat possible causes of the abnormal heart rhythm may be administered. Defibrillation continues until the patient's condition stabilizes or the procedure is ordered to be discontinued.

Some patients with a history of ventricular tachycardia or ventricular fibrillation may benefit from an **implantable cardioverter-defibrillator** or ICD. ICDs, in use since 1980, are small battery-powered devices

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KEY TERMS

Arrhythmia—Any of a number of conditions in which there is abnormal electrical activity in the heart. Some arrhythmias are minor while others are potentially life-threatening. They are also called cardiac dysrhythmias.

Automated external defibrillator (AED)—A portable electronic device that automatically diagnoses potentially life-threatening cardiac arrhythmias (ventricular fibrillation and ventricular tachycardia) and is able to treat them through defibrillation.

Cardiac arrest—A condition in which the heart stops functioning. Fibrillation can lead to cardiac arrest if not corrected quickly.

Depolarization—A change in a cell's membrane potential, making its electrical charge more positive or less negative. Defibrillation essentially depolarizes a portion of the heart muscle, allowing the heart's natural pacemaker to reestablish normal heart rhythm.

Myocardium—The medical term for the specialized involuntary muscle tissue found in the walls of the heart.

Pacemaker—A surgically implanted electronic device that sends out electrical impulses to regulate a slow or erratic heartbeat.

Sinoatrial node (SAN)—The heart's natural pacemaker, a group of cells located in the wall of the right atrium (upper chamber) of the heart near the entry of the superior vena cava, a major vein that carries deoxygenated blood from the upper part of the body to the heart.

Ventricular fibrillation—Uncoordinated contraction of the muscle in the ventricles (lower chambers) of the heart.

Ventricular tachycardia—An abnormally rapid heartbeat originating in one of the lower chambers of the heart. It can lead to ventricular fibrillation.

similar to **pacemakers** implanted by the surgeon in the patient's heart. It is estimated that over a million of these devices have been implanted as of 2010. ICDs continuously monitor the patient's heart rhythm and deliver an electrical shock when the rate of electrical activity in the patient's heart exceeds a preset number. The newest ICDs are programmed to detect the differences among a normal fast heart rhythm, ventricular tachycardia, and ventricular fibrillation. They can correct ventricular tachycardia before it progresses to ventricular fibrillation. The very newest ICDs are implanted under the skin of the patient's rib cage near the heart. Known as subcutaneous ICDs, these devices can deliver enough electricity to correct an abnormal heart rhythm without the need for wires or electrodes placed in or on the heart itself, thus lowering the risk of infection.

Early defibrillators, about the size and weight of a car battery, were used primarily in ambulances and hospitals. The newer automated external defibrillators (AEDs) are smaller, lighter, less expensive, and easier to use than the early defibrillators. They are computerized to provide simple verbal instructions to the operator and to make it impossible to deliver a shock to a patient whose heart is not fibrillating. The placement of public-access AEDs, urged by the American Heart Association, has expanded to cover many public locations in Canada and the United States as of 2010, including corporate and government offices, shopping centers, airports, casinos, hotels, sports arenas, universities, community centers, fitness centers, health clubs, and even some workplaces. Public-access AEDs often are brightly colored to increase their visibility, and mounted in protective cases near the entrances of buildings. The use of AEDs is now taught in **first aid**, first responder, and basic life support (BLS) level CPR classes as well as in military combat and front line hospitals.

Preparation

After help is called for, the emergency response team begins cardiopulmonary resuscitation (CPR) and continues until the defibrillator arrives. Electrocardiogram leads are attached to the patient's chest. Gel or paste is applied to the defibrillator paddles, or two gel pads are placed on the patient's chest. The caregivers verify lack of a pulse, and select a charge.

Preparation for the implantation of an ICD includes an electrocardiogram (EKG) and a series of other tests of the heart's function to determine what type of arrhythmia the patient is experiencing and whether he or she can benefit from an implanted device. As with most other procedures requiring **general anesthesia**, the patient will be asked not to eat or drink anything for a minimum of eight hours before the surgery.

Aftercare

After defibrillation, the patient's cardiac status, breathing, and vital signs are monitored until he or she is stable. Typically, this monitoring takes place

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after the patient has been removed to an intensive care or cardiac care unit in a hospital. An electrocardiogram and **chest x ray** are taken. The patient's skin is cleansed to remove gel or paste, and, if necessary, ointment is applied to **burns**. An intravenous line provides additional medication, as needed.

Patients who have received an ICD usually remain in the hospital for one or two days after the procedure so that doctors can test the device for proper functioning. They may need to use over-the-counter **pain** relievers for several days or weeks to relieve soreness after returning home. While patients with ICDs can lead relatively normal lives, they should avoid sports that involve vigorous movements of the shoulder, arm, or torso close to the implant site. They must also avoid equipment that uses large magnets or produces intense magnetic fields. Such equipment includes **magnetic resonance imaging** (MRI) devices.

Risks

Skin burns from the defibrillator paddles are the most common complication of defibrillation. Other risks include injury to the heart muscle, abnormal heart rhythms, and **blood clots**.

The risks of ICD placement include infection; swelling or bruising at the site of implantation; bleeding around the heart, a potentially life-threatening complication; and damage to the vein where the ICD leads are placed.

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ORGANIZATIONS

American Heart Association, 7320 Greenvilee Ave., Dallas, TX, 75231, (214) 373-6300, http://www.american heart.org.

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Definitive cancer therapy *see* **Cancer therapy, definitive**

Degenerative arthritis *see* **Osteoarthritis**

Dehydration

Definition

Dehydration is a condition in which the body loses too much water usually as a result of excess sweating, **vomiting**, and/or **diarrhea**. Hydration describes a condition of fluid balance (water homeostasis) when adequate fluid levels are maintained. When fluid balance is not maintained, the individual is said to be dehydrated.

Demographics

The very young and the very old are most likely to become dehydrated. Young children are at greater risk because they are more likely to get diseases that cause **vomiting**, diarrhea, and **fever**. Worldwide, dehydration is the leading cause of **death** in children. In the United States, 400–500 children under the age of 5 die every year of dehydration. The elderly are at risk because they

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are less likely to drink when they become dehydrated. The thirst mechanism often becomes less sensitive as people age. Also, their kidneys lose the ability to make highly concentrated urine. Older individuals who are confined to wheelchairs or bed and cannot get water for themselves (e.g. nursing home and hospital patients) are at risk of developing chronic dehydration.

Description

Dehydration occurs when more fluid is lost from the body than is taken in. Water is essential to life. Transporting nutrients throughout the body, removing wastes, regulating body temperature, lubrication of joints and membranes, and chemical reactions that occur during cellular metabolism all require water.

Water is distributed throughout three compartments in the body: inside the cells (intracellular), in the tissue (interstitial), and in the bloodstream (intravascular). Each compartment contains differing amounts of electrolytes that must remain in balance in order for body organs and systems to function correctly. Dehydration upsets this delicate balance. Total body water also varies in relation to age, gender, and amount of body fat. Adult males have approximately 60% water content, adult females have 50%, infants have an estimated 77%, and the elderly have 46% to 52%. An increase in body fat causes a decrease in the percent fluid content because fat does not contain significant amounts of water.

The amount of water a person needs to prevent dehydration varies widely depending on the individual's age, weight, level of physical activity, and the environmental temperature. The individual's health and the medications they take may also affect the amount of water a person needs. Most dehydration results from an acute, or sudden, loss of fluid. Slow-developing chronic dehydration can occur, however, most often in the frail elderly and infants and young children who must rely on others to supply them with liquids. Infants are also more likely to develop dehydration than adults because they have a higher metabolic rate and their immature kidneys have difficulty concentrating urine. Children who do not wet their diapers for three hours or more are dehydrated.

Healthy people lose water through urination, elimination of solid wastes, sweating, and breathing out water vapor. This water must be replaced through the diet. The United States Institute of Medicine (IOM) recommended in 2004 that relatively inactive adult men take in about 3.7 L (about 15 cups) of fluids daily and that women take in about of 2.7 liters (about 10 cups) to replace lost water. These recommendations are for total fluid intake from both beverages and food. Highly active adults and those living in very warm climates need more fluid.

About 80% of the water the average person needs is replaced by drinking liquids. The other 20% is found in food. Below are listed some foods and the percentage of water that they contain:

- iceberg lettuce 96%
- squash, cooked 90%
- cantaloupe, raw, 90%
- 2% milk 89%
- apple, raw 86%
- cottage cheese 76%
- potato, baked 75%
- macaroni, cooked 66%
- turkey, roasted 62%
- steak, cooked 50%
- cheese, cheddar 37%
- bread, white 36%
- peanuts, dry roasted 2%

Dehydration involves more than just water deficiency. Electrolytes are ions that form when salts dissolve in water or body fluids. In order for cells to function adequately, the various electrolytes, such as **sodium** ($Na+$) and potassium ($K+$), must remain within a very narrow range of concentrations. Often electrolytes are lost along with water. For example, sodium is lost in sweat. To prevent the effects of dehydration, both water and electrolytes must be replaced in the correct proportions.

Risk factors

Risk factors for dehydration in the general population include:

- Geographical location. People lose more water from the body in dry climates and at high altitudes.
- Environmental conditions. Heat waves and natural disasters affecting sanitation can lead to dehydration.
- Occupations requiring outdoor work in warm weather.
- Diseases and disorders that affect the body's water balance. These include diabetes, kidney disease, diseases of the adrenal gland, eating disorders, intestinal parasites, and alcoholism.
- Travel to countries where cholera, dengue, and other diarrheal diseases are endemic.
- Methamphetamine abuse.
- Malnutrition.

Risk factors for dehydration in seniors include:

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- Age over age 85
- Living alone and not drinking enough or having access to fluids
- Heavy alcohol consumption
- Taking such medications as diuretics, laxatives, and sedatives
- Having acute or chronic illnesses that affect normal eating and drinking habits
- Are confused or have mental problems or communication problems
- Having difficulty swallowing

Causes and symptoms

There are three basic types of dehydration, defined by the sodium/water balance in body fluids. Doctors who are treating patients with dehydration must determine the type of water loss to ensure appropriate treatment. In addition, water and sodium levels in the body are closely related; if one is abnormal, the other often is too.

Isotonic dehydration is an equal loss of water and sodium. Isotonic means that the number of particles contained on one side of a permeable membrane is the same as on the other side, thus there is no fluid shift in either direction. The amount of intracellular and extracellular water remains in balance. Isotonic dehydration can be caused by a complete fast, vomiting, and diarrhea.

Hypertonic dehydration occurs when water loss is greater than sodium loss. Blood sodium levels may be 145 mmol/l (normal range = 135 to 145 mmol/l). Higher blood sodium levels combined with decreased water in the intravascular space increases the osmotic pressure in the bloodstream, which, in turn, pulls more fluid out of the cells. This type of dehydration is usually caused by extended fever with limited oral rehydration. Mortality is more likely to occur from hypertonic than from isotonic dehydration.

Hypotonic dehydration occurs when sodium loss is greater than water loss. Blood sodium levels may be less than 135 mmol/l; and the osmotic pressure is greater inside the cells, which pulls more fluid out of the intravascular space into the intracellular space. This type of dehydration occurs with overuse of **diuretics**, which causes excessive sodium and potassium loss. Potassium depletion affects respiration, increases **nausea**, and, if severe enough, may cause respiratory arrest or central nervous system (CNS) seizures. Potassium depletion may also cause **arrhythmias** (irregular heartbeat). As a result, patients are told to take diuretics with orange juice or to eat a banana, both of which are high in potassium.

Causes

Diarrhea, often accompanied by vomiting, is the leading cause of dehydration. Both water and electrolytes are lost in large quantities. Diarrhea is often caused by bacteria, viruses, or parasites. Fever that often accompanies disease accelerates the amount of water that is lost through the skin. The smaller the child, the greater the risk of dehydration. Worldwide, acute diarrhea accounts for the death of about 4 million children each year. In the United States, about 220,000 children are hospitalized for dehydration caused by diarrhea annually.

Heavy sweating also causes dehydration and loss of electrolytes. Athletes, especially endurance athletes and individuals with active outdoor professions as roofers and road crew workers are at high risk of becoming dehydrated. Children who play sports outdoors can also be vulnerable to dehydration.

Certain chronic illnesses that disrupt fluid balance can cause dehydration. **Kidney disease** and hormonal disorders, such as diabetes, adrenal gland, or pituitary gland disorders, can cause fluid and electrolyte loss through excessive urination. Such disorders as **cystic fibrosis** or other genetic disorders resulting in inadequate absorption of nutrients from the intestines can cause chronic diarrhea that leads to dehydration. Individuals with **eating disorders** who abuse **laxatives**, diuretics, and **enemas**, or regularly cause themselves to vomit are vulnerable to severe electrolyte imbalances and dehydration. The same is true of people with **alcoholism**. People who have severe **burns** over a large part of their body also are likely to become dehydrated because they no longer have unbroken skin to act as a barrier to evaporation.

Symptoms

Dehydration can be mild, moderate or severe. Mild dehydration occurs when fluid losses equal 3–5%. At this point, the thirst sensation is felt, and is often accompanied by **dry mouth** and thick saliva.

Moderate dehydration occurs when fluid losses equal 6–9% of their body weight. This condition can occur rapidly in young children who are vomiting and/or have diarrhea. In an infant, a loss of as little as 2–3 cups of liquids can result in moderate dehydration. Signs of moderate dehydration include intense thirst, severely reduced urine production, sunken eyes, **headache**, **dizziness**, irritability, and decreased activity.

Severe dehydration occurs when fluid losses are 10% or more of their body weight. Severe dehydration is a medical emergency for individuals of any age. A loss of fluids equaling 15–20% of a person's body weight is fatal. Signs of severe dehydration include all those of

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KEY TERMS

Antiemetic—A type of drug given to stop vomiting.

Diuretic—A drug designed to encourage excretion of urine in people who accumulate excess fluid such as individuals with high blood pressure or heart conditions.

Electrolytes—Substances in the body that are able to conduct electricity. Electrolytes are essential in the normal functioning of body cells and organs.

Endemic—Referring to a disease that is prevalent in a particular location.

Hydration—Taking in water or fluid to replace loss of fluid.

Incontinence—Loss of ability to control urination or to control bowel movements (fecal incontinence).

Postural hypotension (orthostatic hypotension)—A sudden drop in blood pressure when rising from a sitting or lying down position.

Rupture—A tear or break in body tissue of an organ.

Water homeostasis—A condition of adequate fluid level in the body in which fluid loss and fluid intake are equally matched and sodium levels are within normal range.

moderate dehydration as well as lack of sweating, little or no urine production, dry skin that has little elasticity, low blood pressure, rapid heartbeat, fever, **delirium**, or **coma**.

Diagnosis

Mild dehydration can often be treated at home. However, a doctor should be consulted whenever:

- A child less than three months old develops a fever higher than 100 °F (37.8 °C)
- A child more than three months old develops a fever higher than 102 °F (38.9 °C)
- Symptoms of dehydration in an older child or adult worsen
- An individual urinates very sparingly, passes dark-colored urine, or does not urinate at all during a six-hour period
- Dizziness, listlessness, or excessive thirst occur
- A person who is dieting and using diuretics loses more than 3 lb (1.3 kg) in a day or more than 5 lb (2.3 kg) a week

A doctor's diagnosis of dehydration includes taking a recent health history, especially checking for the presence of specific illnesses, vomiting, diarrhea, **constipation**, fever, or such other noticeable symptoms as less frequent urination or lack of thirst. The doctor will also want to know about chronic illnesses and current medications.

Examination

In addition to taking the patient's history, dehydration is diagnosed by a **physical examination**. A healthcare professional or observant adult can usually tell by looking at someone that they are moderately or severely dehydrated. Visual signs are often enough to begin treatment.

Tests

Laboratory tests are important indicators of dehydration; blood tests include **complete blood count** (CBC), blood chemistries such as electrolytes (i.e., sodium, potassium, chloride), blood urea nitrogen (BUN), and creatinine, among others. Examination of urine and measurement of a 24-hour urine sample may be done to determine if output is normal or decreased. Heart rate and blood pressure will be measured and an electrocardiogram may be taken to see if heart rhythm is altered. In hospitalized patients with possible dehydration, fluid intake and output may be measured to determine if kidney function is impaired.

Other laboratory tests may be ordered to determine if an underlying condition (e.g., diabetes or an adrenal gland disorder) is the cause of the dehydration.

Treatment

Traditional

The goal of treatment is to restore fluid and electrolyte balance. For individuals with mild dehydration, this can be done in infants and children by giving them oral rehydration solutions such as Pedialyte, Infalyte, Naturalyte, Oralyte, or Rehydralyte. These are available in supermarkets and pharmacies without a prescription. These solutions have the proper balance of salts and sugars to restore the electrolyte balance. Water, apple juice, chicken broth, sodas, and similar fluids are effective in treating mild dehydration. Oral rehydration fluids can be given young children in small sips as soon as vomiting and diarrhea start. They may

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continue to vomit and have diarrhea, but some of the fluid will be absorbed.

A child who is vomiting should sip one or two teaspoons of liquid every 10 minutes. A child who is less than a year old and who is not vomiting should be given one tablespoon of liquid every 20 minutes. A child who is more than one year old and who is not vomiting should take two tablespoons of liquid every 30 minutes. A baby who is being breastfed should be given clear liquids for two consecutive feedings before **breastfeeding** is resumed. A bottle-fed baby should be given formula diluted with water to half the formula strength for the first 24 hours after symptoms of dehydration are identified.

To calculate fluid loss accurately, weight changes should be charted every day and a record kept of how many times a patient vomits or has diarrhea. A record of fluid output (including sputum or vomit) and of fluid intake or replacement should be kept for at least 24 to 48 hours to see if balance is being accomplished. Parents should note how many times a baby's diaper must be changed. If dehydration continues, emergency department treatment or hospitalization to receive intravenous fluids and electrolytes may be necessary.

Older children who are dehydrated can be given oral rehydration solutions or sports drinks such as Gatorade for moderate and severe dehydration, otherwise general fluids are fine. Athletes who are dehydrated should be given sports drinks. According to the American College of Sports Medicine, sports drinks are effective in supplying energy for muscles, maintaining blood sugar levels, preventing dehydration, and replacing electrolytes lost in sweat. Adults who are mildly or moderately dehydrated usually improve by drinking water and avoiding coffee, tea, and soft drinks that do not contain **caffeine**.

Individuals of all ages who are seriously dehydrated need to be treated by a medical professional. In the case of severe dehydration, the individual may be hospitalized and fluids given intravenously (IV; directly into the vein). Hospital care will include not only immediate replacement of fluids but may also involve treating an underlying chronic illness such as diabetes, kidney disease, or heart disease, which has resulted in fluid loss and dehydration.

Drugs

Treatment of dehydration may involve changing medications that have caused excessive fluid loss. In some cases patients may be given antiemetics or **antidiarrheal drugs** to stop the vomiting or diarrhea that may be causing the dehydration.

Home remedies

People can keep rehydration products in the home in case they are needed. Fluid replacement products that contain essential body chemicals and nutrients are available at pharmacies and some supermarkets; pharmacists can offer advice about the best ones to help correct or prevent dehydration and to restore electrolyte balance.

The World Health Organization (WHO) recommends a homemade solution to help the dehydrated person correct fluid levels and also receive needed sugars and nourishment. To rehydrate the body, the following ingredients can be combined and sipped frequently over several hours:

- 1 quart of water
- three-fourths teaspoon of table salt
- 1 teaspoon of baking powder
- 4 tablespoons of sugar
- 1 cup of orange juice

Prognosis

Mild dehydration rarely results in complications. It can usually be reversed by correcting fluid levels through drinking or receiving fluids intravenously. If the cause is eliminated and lost fluid is replaced, mild dehydration can usually be resolved in 24 to 48 hours.

On the other hand, vomiting and diarrhea that continue for several days without adequate fluid replacement can be fatal since more is lost than water and sodium. Severe potassium loss may lead to cardiac arrhythmias, respiratory distress or arrest, or convulsions (seizures). The risk of life-threatening complications is greater for young children and the elderly. Imbalances in the electrolyte sodium can cause too much water to be absorbed by brain cells, causing them to swell and rupture—a serious complication of dehydration. Underlying chronic diseases can complicate the correction of dehydration, resulting in organ system dysfunction. Severe dehydration can lead to **shock** and kidney failure, which can be life-threatening.

Prevention

Preventing dehydration is easier than treating it once it occurs. Drinking at least eight glasses of water a day prevents dehydration. More may be needed in hot weather. Beginning each day with a glass of water containing a small amount of lemon or other citrus juice helps restore fluid and blood sugar (glucose) levels that have diminished overnight. Water and other clear liquids (tea, juices, and clear soups) can

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be consumed slowly throughout the day rather than drinking too much at mealtimes, which will dilute digestive juices. Alcoholic beverages and excessive amounts of caffeine–containing drinks, which dehydrate the body, should be avoided.

Another way to prevent dehydration is to be alert to situations in which it could occur, such as exercising in hot weather or vomiting and diarrhea in infants and young children. Athletes and people who work in hot conditions should drink regularly whether or not they feel thirsty. Rehydration of young children should begin at the first sign of fluid loss. A healthcare provider should be consulted before the situation becomes serious. Caregivers of the mobility-impaired elderly and infants and young children who cannot get water for themselves should be offered fluids on a regular basis.

Nutrition/Dietetic concerns

Besides drinking to restore fluid balance, normal consumption of food is necessary when someone is dehydrated. Because intestinal upsets with either diarrhea or vomiting can result in loss of interest in eating or the temporary inability to keep food down or digest it, foods should be kept simple and as soft or liquid as possible, including weak tea, broth, bouillon, plain soups, and lightly cooked vegetables. Large amounts of fluids should not be consumed all at once as this delays gastric emptying and encourages urination. It is recommended that dehydrated individuals sip fluids in small amounts at frequent intervals (e.g. 100–200 mL every 20 minutes) to achieve effective rehydration. Flavored gelatin is often a good fluid replacement and is easy to digest. Such high-fiber foods as whole fruit, bread, grains, and meat should be avoided until the intestinal tract has had a rest. Milk is not a clear liquid and may not be tolerated; milk is not ideal for fluid replacement. Caffeine–containing drinks and alcohol encourage excess urination and should be avoided.

Caregiver concerns for the elderly

Any older individual who has an illness that causes fever, diarrhea, or vomiting may become dehydrated if fluid is not replaced through drinking water and other clear fluids. In these situations, caretakers must always watch for early signs of dehydration such as dry mouth, dark urine, and **fatigue** or irritability. Older individuals may not drink enough for various reasons: They may not feel thirsty; it may be difficult to hold a glass containing liquid; or they may have difficulty getting up from a chair or bed and want to avoid trips to the bathroom. Some elderly people take diuretic medications and have a time during the day, usually morning, when they urinate frequently. Some will not drink because they are incontinent and want to reduce the possibility of having accidents. Caregivers must always encourage drinking to replace what is excreted or replace fluid loss during certain illnesses through diarrhea, vomiting, or fever. Caregivers should also understand the symptoms of severe dehydration described above and know when to call the doctor or an ambulance.

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ORGANIZATIONS

American College of Gastroenterology, P.O. Box 342260, Bethesda, MD, 20827-2260, 301-263-9000, http://www.acg.gi.org/.
American College of Sports Medicine (ACSM), P.O. Box 1440, Indianapolis, IN, 46206-1440, 317-637-9200, 317-634-7817, http://www.acsm.org//AM/Template.cfm?Section=Home_Page.
Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, 800-232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.
International Society of Travel Medicine (ISTM), 2386 Clower Street, Suite A-102, Snellvile, GA, United States, 30078, +1 770 736 060, +1-770 736 0313, istm@istm.org, https://www.istm.org/.
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Delavirdine *see* **Non-nucleoside reverse transcriptase inhibitors**

Delayed hypersensitivity skin test

Definition

A delayed hypersensitivity test (DHT) is an immune function test measuring the presence of activated T cells that recognize a certain substance.

Purpose

The immune system protects against infection by viruses, bacteria, fungi, and parasites. After initial exposure to a foreign substance, or antigen, the immune system creates both antibodies and sensitized T cells. Both these immune agents respond when the body is reexposed to the antigen. Antibodies, which are circulating proteins, respond within minutes, to give what, is termed an immediate hypersensitivity reaction. T cells responses occur over several days, and are thus called delayed hypersensitivity reactions. The cascade of events initiated by the T cells leads to hardening (induration) and redness (erythema) at the injection site.

A DHT is performed for one of three reasons:

- To test for exposure to specific diseases, such as tuberculosis (TB). Tuberculosis testing is done by injecting into the skin a small volume of TB antigen, which contains no organisms (live or dead) but can still provoke an immune response.
- To test for allergic sensitivity to potential skin irritants, such as poison ivy. Skin allergy testing is usually done by placing a series of adhesive patches on the skin containing potential allergens, or allergy-causing substances.
- To assess the vitality of the T cell response as part of the evaluation of immune system health in infection, cancer, immune disorders, pre-transplantation screening, aging, and malnutrition. DHT can help predict survival in immunocompromised patients, and evaluate the success of restorative therapy. Antigens used for these tests must be ones the patient has been exposed to before, and, therefore, include inactivated antigens from common infectious agents to which the patient might have been exposed, such as mumps, *Candida albicans*, tetanus toxoid, and trichophyton (a skin fungus).

Precautions

No special precautions are necessary for most patients. Those with known hypersensitivity to certain skin irritants should alert the clinician performing the test. Some commercial preparations of fungal antigens contain mercury, a source of irritation to some patients.

Description

The most accurate TB test is the Mantoux test, in which a small amount of TB antigen is injected into the skin. The area is examined 48–72 hours after the injection.

In the patch test, 20–30 adhesive patches are usually placed on the upper back. The patches are kept in place and the area is kept dry for 48 hours. The patches are then removed, and the skin is examined 24 hours afterward, and possibly again a day or more following that. Patch testing is usually performed following a patient complaint of skin irritation from an unknown substance. Testing may suggest several candidates; identifying the right one requires careful review of the patient's possible exposure.

The test of overall T cell responsiveness is performed with several injections. Each area injected is circled and marked. Results are read 48 hours after the injection.

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KEY TERMS

Allergen—A foreign substance that provokes an immune reaction in some sensitive people but not in most others.

Anaphylaxis—An exaggerated, life-threatening hypersensitivity reaction to a previously encountered antigen.

Antibody—An immune system protein made to fight infection.

Antigen—A foreign substance detected that provokes an immune reaction.

Preparation

No special preparation is necessary.

Aftercare

Patches should be kept dry. Injection sites may be washed, but excessive rubbing should be avoided. Patches and injection sites may become reddened or irritated. If a patch causes severe **itching** or discomfort, the patient should remove it immediately.

Risks

DHT is quite safe for virtually all people. There is no risk of infection from the agents injected, since they are purified antigens, not whole organisms. Life threatening, hypersensitive reactions (**anaphylaxis**) are a very small risk; patients should notify the administering physician immediately if signs of **wheezing**, swelling, or diffuse redness of the skin develops.

Normal results

Absence of exposure to TB is indicated by absent or very little skin reaction; redness or hardness smaller than 5 mm (about 0.25 in) is considered normal for a person not exposed or infected with TB.

Patch test sites should be normal or only slightly red.

T cell responsiveness tests should be positive; that is, the injected areas should be reddened and hard. Two affected areas of 2 mm or more is considered a positive result.

Abnormal results

TB exposure is indicated by a reaction of 10 mm or more. The degree of redness is not important. A 5–10 mm area could indicate exposure if there is an underlying risk to TB.

Patch test areas that become reddened and irritated indicate reaction to the substance in the patch.

Absence of any reaction to injected areas indicates lack of T cell responsiveness, a condition called anergy. T cell anergy is seen in immune deficiency diseases including **AIDS**, some cases of infectious diseases, malignancies, immunosuppressive therapy (including corticosteroid treatment), some autoimmune diseases, **malnutrition**, major surgery, and some viral immunizations.

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Richard Robinson

Delirium

Definition

Delirium is a state of mental confusion that develops quickly and usually fluctuates in intensity.

Description

Delirium is a syndrome, or group of symptoms, caused by a disturbance in the normal functioning of the brain. The delirious patient has a reduced awareness of and responsiveness to the environment, which may be manifested as disorientation, incoherence, and memory disturbance. Delirium is often marked by **hallucinations**, **delusions**, and a dream-like state.

Delirium affects at least one in ten hospitalized patients, and is a common part of many terminal illnesses. Delirium is more common in the elderly than in the general population. While it is not a specific disease itself, patients with delirium usually fare worse than those with the same illness who do not have delirium.

Causes and symptoms

Causes

There are a large number of possible causes of delirium. Metabolic disorders are the single most common cause, accounting for 20–40% of all cases. This type of delirium, termed "metabolic encephalopathy," may

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result from organ failure, including liver or kidney failure. Other metabolic causes include **diabetes mellitus**, **hyperthyroidism** and **hypothyroidism**, vitamin deficiencies, and imbalances of fluids and electrolytes in the blood. Severe **dehydration** can also cause delirium.

Drug intoxication (intoxication confusional state) is responsible for up to 20% of delirium cases, either from side effects, overdose, or deliberate ingestion of a mind-altering substance. Medicinal drugs with delirium as a possible side effect or result of overdose include:

- anticholinergics, including atropine, scopolamine, chlorpromazine (an antipsychotic), and diphenhydramine (an antihistamine)
- sedatives, including barbiturates, benzodiazepines, and ethanol (drinking alcohol)
- antidepressant drugs
- anticonvulsant drugs
- nonsteroidal anti-inflammatory drugs (NSAIDs), including ibuprofen and acetaminophen
- corticosteroids, including prednisone
- anticancer drugs, including methotrexate and procarbazine
- lithium
- cimetidine
- antibiotics
- L-dopa

Delirium may result from ingestion of legal or illegal psychoactive drugs, such as:

- ethanol (drinking alcohol)
- marijuana
- LSD (lysergic acid diethylamide) and other hallucinogens
- amphetamines
- cocaine
- opiates, including heroin and morphine
- PCP (phencyclidine)
- inhalants

Drug withdrawal may cause delirium. Delirium tremens, or "DTs," may occur during alcohol withdrawal after prolonged or intense consumption. Withdrawal symptoms are possible from many of the psychoactive prescription drugs as well.

Poisons may cause delirium (toxic encephalopathy), including:

- solvents, such as gasoline, kerosene, turpentine, benzene, and alcohols
- carbon monoxide
- refrigerants (Freon)
- heavy metals, such as lead, mercury, and arsenic
- insecticides, such as Parathion and Sevin
- mushrooms, such as *Amanita* species
- plants such as jimsonweed (*Datura stramonium*) and morning glory (*Ipomoea* spp.)
- animal venoms

Other causes of delirium include:

- infection
- fever
- head trauma
- epilepsy
- brain hemorrhage or infarction
- brain tumor
- low blood oxygen (hypoxemia)
- high blood carbon dioxide (hypercapnia)
- post-surgical complication

Symptoms

The symptoms of delirium come on quickly, in hours or days, in contrast to those of **dementia**, which develop much more slowly. Delirium symptoms typically fluctuate through the day, with periods of relative calm and lucidity alternating with periods of florid delirium. The hallmark of delirium is a fluctuating level of consciousness. Symptoms may include:

- decreased awareness of the environment
- confusion or disorientation, especially of time
- memory impairment, especially of recent events
- hallucinations
- illusions and misinterpreted stimuli
- increased or decreased activity level
- mood disturbance, possibly including anxiety, euphoria or depression
- language or speech impairment

Diagnosis

Delirium is diagnosed through the medical history and recognition of symptoms during **mental status examination**. The most important part of diagnosis is determining the cause of the delirium.

Tests

Tests may include blood and urine analysis for levels of drugs, fluids, electrolytes, and blood gases, and to test for infection; **lumbar puncture** (spinal tap) to test for central nervous system infection; x ray, **computed tomography scans** (CT), or **magnetic**

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KEY TERMS

Dementia—A loss of mental ability severe enough to interfere with functioning. While dementia and delirium have some of the same symptoms, dementia has a much slower onset.

Electroencephalogram (EEG)—A chart of the brain wave patterns picked up by electrodes placed on the scalp. This is useful for diagnosing central nervous system disorders.

Encephalopathy—A brain dysfunction or disorder.

resonance imaging (MRI) scans to look for tumors, hemorrhage, or other brain abnormality; thyroid tests; **electroencephalography** (EEG); **electrocardiography** (ECG); and possibly others as dictated by the likely cause.

Treatment

Treatment of delirium begins with recognizing and treating the underlying cause. Delirium itself is managed by reducing disturbing stimuli, or providing soothing ones; use of simple, clear language in communication; and reassurance, especially from family members. Physical restraints may be needed if the patient is a danger to himself or others, or if he insists on removing necessary medical equipment such as intravenous lines or monitors. Sedatives or **antipsychotic drugs** may be used to reduce **anxiety**, hallucinations, and delusions.

Prognosis

Persons with delirium usually have a worse prognosis for the underlying disease than the person without delirium. Nonetheless, those without terminal illness usually recover from delirium. They may not regain all their original cognitive abilities, and may be left with some permanent impairments, including **fatigue**, irritability, difficulty concentrating, or mood changes.

Prevention

Prevention of delirium is focused on treating or avoiding its underlying causes. The most preventable forms are those induced by drugs. Strategies for reducing delirium include following prescriptions, consulting the prescribing physician immediately if symptoms occur, and consulting the physician before discontinuing the drug, even if it has been ineffective; avoiding intoxication with legal or illegal drugs, and seeking professional assistance before suddenly discontinuing an addictive drug such as alcohol or heroin. Maintaining good **nutrition**, which promotes general health, can minimize the likelihood of delirium from alcohol intoxication and withdrawal. Avoidance of exposure to solvents, insecticides, heavy metals, or biological poisons in the home or workplace is also important.

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Delta virus hepatitis *see* **Hepatitis D**

Delusions

Definition

A delusion is an unshakable belief in something untrue. These irrational beliefs defy normal reasoning, and remain firm even when overwhelming proof is presented to dispute them. Delusions are often accompanied by **hallucinations** and/or feelings of **paranoia**, which act to strengthen confidence in the delusion. They are distinct from culturally or religiously based beliefs that may be seen as untrue by outsiders.

Description

Delusions are a common symptom of several mood and personality-related mental illnesses, including **schizoaffective disorder**, **schizophrenia**, shared psychotic disorder, major depressive disorder, and **bipolar disorder**. They are also the major feature of delusional disorder. Individuals with delusional disorder have long-term, complex delusions that fall into one of six categories: persecutory, grandiose, jealousy, erotomanic, somatic, or mixed. There are also delusional disorders such as **dementia** that clearly have organic or physical causes.

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Persecutory

Individuals with persecutory delusional disorder are plagued by feelings of paranoia and an irrational, unshakable belief that someone is plotting against them, or out to harm them.

Grandiose

Individuals with grandiose delusional disorder have an inflated sense of self-worth. Their delusions center on their own importance, such as believing that they have done or created something of extreme value or have a "special mission."

Jealousy

Jealous delusions are unjustified and irrational beliefs that an individual's spouse or significant other has been unfaithful.

Erotomanic

Individuals with erotomanic delusional disorder believe that another person, often a stranger, is in love with them. The object of their affection is typically of a higher social status, sometimes a celebrity. This type of delusional disorder may lead to stalking or other potentially dangerous behavior.

Somatic

Somatic delusions involve the belief that something is physically wrong with the individual. The delusion may involve a medical condition or illness or a perceived deformity. This condition differs from **hypochondriasis** in that the deformity is perceived as a fixed condition not a temporary illness.

Mixed

Mixed delusions are characterized by two or more of persecutory, grandiose, jealousy, erotomanic, or somatic themes.

Causes and symptoms

Some studies have indicated that delusions may be generated by abnormalities in the limbic system, the portion of the brain on the inner edge of the cerebral cortex that is believed to regulate emotions. The exact source of delusions has not been conclusively found, but potential causes include genetics, neurological abnormalities, and changes in brain chemistry. Delusions are a known possible side effect of drug use and **abuse** (e.g., amphetamines, **cocaine**, PCP).

KEY TERMS

Hallucinations—False or distorted sensory experiences that appear to be real perceptions.

Paranoia—An unfounded or exaggerated distrust of others.

Shared psychotic disorder—Also known as folie à deux; shared psychotic disorder is an uncommon disorder in which the same delusion is shared by two or more individuals.

Diagnosis

Patients with delusional symptoms should undergo a thorough **physical examination** and patient history to rule out possible organic causes (such as dementia). If a psychological cause is suspected, a mental health professional will typically conduct an interview with the patient and administer one of several clinical inventories, or tests, to evaluate mental status.

Treatment

Delusions that are symptomatic of delusional disorder should be treated by a psychologist and/or psychiatrist. Though **antipsychotic drugs** are often not effective, antipsychotic medication such as thioridazine (Mellaril), haloperidol (Haldol), chlorpromazine (Thorazine), clozapine (Clozaril), or risperidone (Risperdal) may be prescribed, and cognitive therapy or **psychotherapy** may be attempted.

If an underlying condition such as schizophrenia, depression, or drug abuse is found to be triggering the delusions, an appropriate course of medication and/or psychosocial therapy is employed to treat the primary disorder. The medication typically includes an antipsychotic agent.

Prognosis

Delusional disorder is typically a chronic condition, but with appropriate treatment, a remission of delusional symptoms occurs in up to 50% of patients. However, because of their strong belief in the reality of their delusions and a lack of insight into their condition, individuals with this disorder may never seek treatment, or may be resistant to exploring their condition in psychotherapy.

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ORGANIZATIONS

American Psychiatric Association, 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209, (703) 907-7300, apa@psych.org, http://www.psych.org.

National Alliance on Mental Illness (NAMI), Colonial Place Three, 2107 Wilson Blvd., Suite 300, Arlington, VA, 22201, (703) 524-7600, (800) 950-NAMI (6264), (703) 524-9094, http://www.nami.org.

National Institute of Mental Health (NIMH), 6001 Executive Boulevard, Room 8184, MSC 9663, Bethesda, MD, 20892, (301) 443-4513, (866) 615-6464, (301) 443-4279, nimhinfo@nih.gov, http://www.nimh.nih.gov.

National Mental Health Association (NMHA), 2000 N. Beauregard Street, 6th Floor, Alexandria, VA, 22311, (703) 684-7722, (800) 969-NMHA, (703) 684-5968, http://www1.nmha.org.

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Dementia

Definition

Dementia is a condition characterized by a progressive, irreversible decline in mental ability, accompanied by changes in behavior, personality, and in the late stage, motor functions. There is commonly a loss of memory and skills required to carry out activities of daily living. These declining changes are severe enough to impair the ability of a person to perform a function or to interact socially. This operating definition encompasses 70–80 different types of dementia. They include changes due to diseases (e.g., **Alzheimer** and **Creutzfeldt-Jakob** diseases), changes due to **stroke** or repeated blows to the head (as suffered by boxers), and damage due to long-term alcohol **abuse**.

Demographics

The prevalence of dementia increases rapidly with age. It affects about 1% of people age 60–64 and approximately doubles every five years after age 60. By age 85, dementia affects between 30% and 50% of the population, or about five million individuals in the United States. The condition is somewhat more common among women than men. Some studies suggest that the risk for dementia is higher among African Americans and Hispanic Americans than it is for Caucasians. More than half of all nursing home admissions occur because of dementia. Surveys have found that dementia is the condition most feared by older adults in the United States.

The demographic distribution of dementia varies somewhat according to its cause. Moreover, recent research indicates that dementia in many individuals has overlapping causes, so that it is not always easy to assess the true rates of occurrence of the different types. For example, Alzheimer disease (AD) and multi-infarct dementia (MID) are found together in about 15–20% of cases.

Alzheimer disease

AD is by far the most common cause of dementia in the elderly, accounting for 60–80% of cases. It is estimated that about 5 million adults in the United States suffer from AD. The disease strikes women more often than men, but researchers do not know yet whether the sex ratio simply reflects the fact that women tend to live longer than men or whether female sex is itself a risk factor for AD.

Multi-infarct dementia

MID is responsible for between 15% and 20% of cases of dementia (not counting cases in which it coexists with AD). Unlike AD, MID is more common in men than in women. Diabetes, high blood pressure, a history of **smoking**, and heart disease are all risk factors for MID. Researchers in Sweden have suggested that MID is underdiagnosed, and may coexist with other dementias more frequently than is presently recognized.

Dementia with Lewy bodies

Dementia with Lewy bodies is now thought to be the second most common form of dementia after Alzheimer disease, but because researchers do not completely understand the relationship between Lewy bodies, AD, and **Parkinson's disease**, the demographic distribution of this type of dementia is also unclear.

Other dementias

FLD, Pick disease, **Huntington disease**, Parkinson's disease, HIV infection, **alcoholism**, head trauma, and other causes of dementia account for about 10% of

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all cases. In FLD and Pick dementia, women appear to be affected slightly more often than men.

Description

The definition of dementia has become more inclusive over the past several decades. Whereas earlier descriptions of dementia emphasized **memory loss**, the current *Diagnostic and Statistical Manual of Mental Disorders, Text Revision (DSM-IV-TR)* of the American Psychiatric Association defines dementia as an overall decline in intellectual function, including difficulties with language, simple calculations, planning and judgment, and abstract reasoning, as well as loss of memory. Dementia is not caused simply by **aging**, although it is quite common in older people. Many researchers regard it as resulting from injuries, infections, brain diseases, tumors, biochemical changes within the brain, or other disorders.

One of the challenges for health care professionals is to differentiate the early-stage cognitive deficits of dementia from normal age-related memory impairment. Individuals with age-related memory impairment may tend to learn new information more slowly, given additional time, their cognitive performance usually is adequate. Other problems that may be mistakenly labeled dementia include **delirium**, **psychosis**, depression, and the side effects of various medications

Dementia can be caused by as many as eighty different diseases and conditions, ranging from dietary deficiencies and metabolic disorders to head injuries and inherited diseases. The possible causes of dementia can be categorized as follows:

- Primary dementia. These dementias are characterized by damage to or wasting away of the brain tissue itself. They include Alzheimer disease (AD), Pick disease, and frontal lobe dementia (FLD).
- Multi-infarct dementia (MID). Sometimes called vascular dementia, this type is caused by blood clots in the small blood vessels of the brain. When the clots cut off the blood supply to the brain tissue, the brain cells are damaged and may die.
- Lewy body dementia. Lewy bodies are areas of injury found on damaged nerve cells in certain parts of the brain. They are associated with AD and Parkinson's disease, but researchers do not yet know whether dementia with Lewy bodies is a distinct type of dementia or a variation of AD or Parkinson's disease.
- Dementia related to alcoholism or exposure to heavy metals (e.g., arsenic, antimony, bismuth, mercury).
- Dementia related to infectious diseases. These infections may be caused by viruses (e.g., HIV, viral encephalitis); spirochetes (e.g., Lyme disease, syphilis); or prions (e.g., Creutzfeldt-Jakob disease).
- Dementia related to abnormalities in the structure of the brain. These may include a buildup of spinal fluid in the brain (hydrocephalus), tumors, or blood collecting beneath the membrane that covers the brain (subdural hematoma).

Dementia may also be associated with depression, low levels of thyroid hormone, niacin, or vitamin (B_{12}) deficiency. Dementia related to these conditions is often reversible.

Risk factors

Genetic factors play a role in several types of dementia, but the importance of these factors in the development of the dementia varies considerably. Alzheimer disease (AD) is known, for example, to have an autosomal (non-sex-related) dominant pattern in most early-onset cases as well as in some late-onset cases, and to show different degrees of penetrance (frequency of expression) in late-life cases. Researchers have not yet discovered how the genes associated with dementia interact with other risk factors to produce or trigger the dementia. One non-genetic risk factor presently being investigated is toxic substances in the environment.

Causes and symptoms

As indicated above, there are many different causes of dementia. What they all have in common is damage to or degeneration of nerve cells in the brain.

Dementia is marked by a gradual impoverishment of thought and other mental activities. Losses eventually affect virtually every aspect of mental functioning. The slow progression of dementia is in contrast with delirium, which involves some of the same symptoms, but has a very rapid onset and fluctuating course with alteration in the level of consciousness. However, delirium may occur with dementia, especially since the person with dementia is more susceptible to the delirium-inducing effects of many types of drugs.

Early-onset Alzheimer disease

In early-onset AD, which accounts for 2–7% of cases of AD, the symptoms develop before age 60. Early-onset AD usually is caused by an inherited genetic mutation. Early-onset AD is also associated with **Down syndrome**, in that persons with trisomy 21 (three forms of human chromosome 21 instead of a pair) often develop early-onset AD.

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Late-onset Alzheimer disease

Research indicates that late-onset Alzheimer disease is a polygenic disorder; that is, its development is influenced by more than one gene. It has been known since 1993 that a specific form of a gene for apolipoprotein E (APOE) on human chromosome 19 is a genetic risk factor for late-onset AD. In 1998 researchers at the University of Pittsburgh reported on another gene that controls the production of bleomycin hydrolase (BH) as a second genetic risk factor that acts independently of the APOE gene. In December 2000, three separate research studies reported that a gene on chromosome 10 that may affect the processing of amyloid-beta protein is also involved in the development of late-onset AD. Research in the genetic factors affecting AD is ongoing.

Multi-infarct dementia (MID)

While the chief risk factors for MID are high blood pressure, advanced age, and male sex, there is an inherited form of MID called CADASIL, which stands for cerebral autosomal dominant arteriopathy with subcortical infarcts and leukoencephalopathy. CADASIL can cause psychiatric disturbances and severe headaches as well as dementia.

Several studies have documented a link between elevated levels of an amino acid called **homocysteine** in the blood and the risk of developing dementia, likely vascular dementia. As homocysteine concentration can be modified by diet, the finding holds the potential that one risk factor for dementia may be controllable.

Frontal lobe dementias

Researchers think that between 25% and 50% of cases of frontal lobe dementia involve genetic factors. Pick dementia appears to have a much smaller genetic component than FLD. It is not yet known what other risk factors combine with inherited traits to influence the development of frontal lobe dementias.

Familial British dementia (FBD)

FBD is a rare autosomal dominant disorder that was first reported in the 1940s in a large British family extending over nine generations. FBD resembles Alzheimer in that the individual develops a progressive dementia related to amyloid deposits in the brain. In 1999 a mutated gene that produces the amyloid responsible for FBD was discovered on human chromosome 13. Studies of this mutation may yield further clues to the development of Alzheimer disease as well as FBD itself.

Creutzfeldt-Jakob disease

Although Creutzfeldt-Jakob disease is caused by a prion, researchers think that 5–15% of cases may have a genetic component.

Symptoms

The *DSM-IV-TR* specifies that certain criteria must be met for a individual to be diagnosed with dementia. One criterion is significant weakening of the individual's memory with regard to learning new information as well as recalling previously learned information. In addition, the individual must be found to have one or more of the following disturbances:

- Aphasia. Aphasia refers to loss of language function. People with dementia may use vague words like "it" or "thing" often because they cannot recall the exact name of an object. They also may echo what other people say, or repeat a word or phrase over and over. People in the later stages of dementia may totally stop speaking.
- Apraxia. Apraxia refers to loss of the ability to perform intentional movements even though the person is not paralyzed, has not lost their sense of touch, and knows what they are trying to do. For example, a individual with apraxia may stop brushing their teeth, or have trouble tying their shoelaces.
- Agnosia. Agnosia refers to loss of the ability to recognize objects even though the person's sight and sense of touch are normal. People with severe agnosia may fail to recognize family members or their own face reflected in a mirror.
- Problems with abstract thinking and complex behavior. This criterion refers to the loss of the ability to make plans, carry out the steps of a task in the proper order, make appropriate decisions, evaluate situations, show good judgment, etc. For example, a person with dementia might light a stove burner under a saucepan before putting food or water in the pan or be unable to record checks and balance his or her checkbook.

The *DSM-IV-TR* also specifies that these disturbances must be severe enough to cause problems in the person's daily life, and these disturbances they must represent a decline from a previously higher level of functioning.

The following sections will focus on the signs and symptoms that are used to differentiate among the various types of dementia during a diagnostic evaluation.

ALZHEIMER DISEASE. Dementia related to AD often progresses slowly; it may be accompanied by irritability, wide mood swings, and personality changes in the early stage. In second-stage AD, the individual typically gets

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KEY TERMS

Agnosia—Loss of the ability to recognize objects by use of the physical senses.

Amyloid—A waxy translucent substance composed mostly of protein, that forms plaques (abnormal deposits) in the brain.

Aphasia—Loss of previously acquired ability to speak, or to understand written or spoken language.

Apraxia—Impairment of the ability to make purposeful movements, but not paralysis or loss of sensation.

Creutzfeldt-Jakob disease—A degenerative disease of the central nervous system caused by a prion, or "slow virus."

Delirium—A disturbance of consciousness marked by confusion, difficulty paying attention, delusions, hallucinations, or restlessness. It can be distinguished from dementia by its relatively sudden onset and variation in the severity of the symptoms.

Hematoma—An accumulation of blood, often clotted, in a body tissue or organ, usually caused by a break or tear in a blood vessel.

Huntington disease—A midlife-onset inherited disorder characterized by progressive dementia and loss of control over voluntary movements. It is sometimes called Huntington's chorea.

Hydrocephalus—The excess accumulation of cerebrospinal fluid around the brain, often causing enlargement of the head.

Lewy bodies—Areas of injury found on damaged nerve cells in certain parts of the brain associated with dementia.

Multi-infarct dementia—Dementia caused by damage to brain tissue resulting from a series of blood clots or clogs in the blood vessels. It is also called vascular dementia.

Parkinson's disease—A disease of the nervous system most common in people over 60, characterized by a shuffling gait, trembling of the fingers and hands, and muscle stiffness. It may be related in some way to Lewy body dementia.

Pick's disease—A rare type of primary dementia that affects the frontal lobes of the brain. It is characterized by a progressive loss of social skills, language, and memory, leading to personality changes and sometimes loss of moral judgment.

Pseudodementia—A term for a depression with symptoms resembling those of dementia. The term dementia of depression is now preferred.

lost easily, is completely disoriented with regard to time and space, and may become angry, uncooperative, or aggressive. In final-stage AD, the individual is completely bedridden, has lost control over bowel and bladder functions, and may be unable to swallow or eat. The risk of seizures increases as the individual progresses from early to end-stage AD. **Death** usually results from an infection or **malnutrition**.

Multi-infarct dementia

In MID, symptoms are more likely to occur after age 70. In the early stages, the individual retains his or her personality more fully than a individual with AD. Another distinctive feature of this type of dementia is that it often progresses in a stepwise fashion; that is, the individual shows rapid changes in functioning, then remains at a plateau for awhile rather than showing a continuous decline. The symptoms of MID may also have a "patchy" quality; that is, some of the individual's mental functions may be severely affected while others are relatively undamaged. Other symptoms of MID include exaggerated reflexes, an abnormal gait (manner of walking), loss of bladder or bowel control, and inappropriate laughing or crying.

Dementia with Lewy bodies

This type of dementia may combine some features of AD, such as severe memory loss and confusion, with certain symptoms associated with Parkinson's disease including stiff muscles, a shuffling gait, and trembling or shaking of the hands. Visual **hallucinations** may be one of the first symptoms of dementia with Lewy bodies.

Frontal lobe dementias

The frontal lobe dementias are gradual in onset. Pick dementia is most likely to develop in persons between ages 40 and 60, while FLD typically begins before age 65. The first symptoms of the frontal lobe dementias often include socially inappropriate behavior (e.g., rude remarks, sexual acting-out, lack of personal hygiene). Individuals often are obsessed with

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eating and may put non-food items in their mouths as well as making frequent sucking or smacking noises. In the later stages of frontal lobe dementia or Pick's disease, the individual may develop muscle weakness, twitching, and **delusions** or hallucinations.

Creutzfeldt-Jakob disease

The dementia associated with Creutzfeldt-Jakob disease occurs most often in persons between ages 40 and 60. It is typically preceded by a period of several weeks in which the individual complains of unusual tiredness, **anxiety**, loss of appetite, or difficulty concentrating. This type of dementia also usually progresses much more rapidly than other dementias, usually over a span of a few months.

In some cases, a patient's primary physician may be able to diagnose the dementia; in many instances, however, the patient will be referred to a neurologist or a specialist in geriatric medicine. The differential diagnosis of dementia is complicated because of the number of possible causes, because more than one cause may be present, and because dementia can coexist with other conditions such as depression and delirium. Delirium is a temporary disturbance of consciousness marked by confusion, restlessness, inability to focus one's attention, hallucinations, or delusions. In elderly people, delirium is frequently a side effect of surgery, medications, infectious illnesses, or **dehydration**. Delirium can be distinguished from dementia by the fact that delirium usually comes on suddenly (in a few hours or days) and may vary in severity—it is often worse at night. Dementia develops much more slowly, over a period of months or years, and the patient's symptoms are relatively stable. It is possible for a person to have delirium and dementia at the same time.

Another significant diagnostic distinction in elderly patients is the distinction between dementia and age-associated memory impairment (AAMI). Older people with AAMI have a mild degree of memory loss; they do not learn new information as quickly as younger people, and they may take longer to recall a certain fact or to balance their checkbook, but they do not suffer the degree of memory impairment that characterizes dementia, and they do not get progressively worse.

Patient history

The doctor will begin by taking a full history, including the patient's occupation and educational level as well as medical history. The occupational and educational history allows the examiner to make a more accurate assessment of the extent of the patient's memory loss and other evidence of intellectual decline. In some cases the occupational history may indicate exposure to heavy metals or other toxins. A complete medical history allows the doctor to assess possibilities such as delirium, depression, alcohol-related dementia, dementia related to **head injury**, or dementia caused by infection. It is particularly important for the doctor to have a list of all the patient's medications, including over-the-counter preparations, because of the possibility that the patient's symptoms are related to side effects.

Mental status examination

A **mental status examination** (MSE) evaluates the patient's ability to communicate, follow instructions, recall information, perform simple tasks involving movement and coordination, as well as his or her emotional state and general sense of space and time. The MSE includes the doctor's informal evaluation of the patient's appearance, vocal tone, facial expressions, posture, and gait as well as formal questions or instructions. A common form that has been used since 1975 is the so-called Folstein Mini-Mental Status Examination, or MMSE. Questions that are relevant to diagnosing dementia include asking the patient to count backward from 100 by 7s, to make change, to name the current President, to repeat a short phrase after the examiner (e.g., "no ifs, ands, or buts") to draw a clock face or geometric figure, and to follow a set of instructions involving movement (e.g., "Show me how to throw a ball" or "Fold this piece of paper and place it under the lamp on the bookshelf"). The examiner may test the patient's abstract reasoning ability by asking him or her to explain a familiar proverb (e.g. "People who live in glass houses shouldn't throw stones") or test the patient's judgment by asking about a problem with a common-sense solution, such as what one does when a prescription runs out.

Neurological examination

A neurological examination includes an evaluation of the patient's cranial nerves and reflexes. The cranial nerves govern the ability to speak as well as sight, hearing, taste, and smell. The patient will be asked to stick out the tongue, follow the examiner's finger with the eyes, raise the eyebrows, etc. The patient is also asked to perform certain actions (e.g., touching the nose with the eyes closed) that test coordination and spatial orientation. The doctor will usually touch or tap certain areas of the body, such as the knee or the sole of the foot, to test the patient's reflexes. Failure to respond to the touch or tap may indicate damage to certain parts of the brain.

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Tests

Laboratory tests

Blood and urine samples are collected in order to rule out such conditions as thyroid deficiency, niacin (vitamin B_{12}) deficiency, **heavy metal poisoning**, **liver disease**, HIV infection, **syphilis**, anemia, medication reactions, or kidney failure. A **lumbar puncture** (spinal tap) may be done to rule out neurosyphilis.

Diagnostic imaging

The patient may be given a CT (computed tomography) scan or MRI (**magnetic resonance imaging**) to detect evidence of strokes, disintegration of the brain tissue in certain areas, **blood clots** or tumors, a buildup of spinal fluid, or bleeding into the brain tissue. **PET** (positron-emission tomography) or SPECT (single-emission computed tomography) imaging is not used routinely to diagnose dementia, but may be used to rule out Alzheimer disease or frontal lobe degeneration if a patient's CT scan or MRI is unrevealing.

Treatment and management

Reversible and responsive dementias

Some types of dementia are reversible, and a few types respond to specific treatments related to their causes. Dementia related to dietary deficiencies or metabolic disorders is treated with the appropriate **vitamins** or thyroid medication. Dementia related to HIV infection often responds well to zidovudine (Retrovir), a drug given to prevent the **AIDS** virus from replicating. Multi-infarct dementia is usually treated by controlling the patient's blood pressure and/or diabetes; while treatments for these disorders cannot undo damage already caused to brain tissue, they can slow the progress of the dementia. Patients with alcohol-related dementia often improve over the long term if they are able to stop drinking. Dementias related to head injuries, **hydrocephalus**, and tumors are treated by surgery.

It is important to evaluate and treat elderly patients for depression, because the symptoms of depression in older people often mimic dementia. This condition is sometimes called pseudodementia. In addition, patients who suffer from both depression and dementia often show some improvement in intellectual functioning when the depression is treated.

Irreversible dementias

As of 2009, there were no medications or surgical techniques that can cure Alzheimer disease, the frontal lobe dementias, MID, or dementia with Lewy bodies. There are also no "magic bullets" that can reverse or stop the progression of these dementias.

Early intervention may allow the patient to compensate for the alterations in functioning, help to minimize complications, and have an improved quality of life. It may also allow the patient and family to plan for the future and to identify resources.

Drugs

Periodically, new drugs are studied for the treatment of dementia. The only drugs approved as of 2009 for the symptomatic treatment of AD were tacrine (Cognex), donepazil (Aricept), rivastigmine (Exelon) and galantamine (Razadyne). These drugs may provide temporary improvement in cognitive functioning for about 40% of patients with mild-to-moderate AD. However, drug therapy can be complicated by forgetfulness, especially if the drug must be taken several times a day.

Psychotic symptoms, including **paranoia**, delusions, and hallucinations, may be treated with **antipsychotic drugs** such as haloperidol, chlorpromazine, risperidone, and clozapine. Side effects of these drugs can be significant. **Antianxiety drugs** such as diazepam (Valium) may improve behavioral symptoms, especially agitation and anxiety although buspirone (BuSpar) has fewer side effects. The anticonvulsant carbamazepine (Tegretol) is also sometimes prescribed for agitation. Depression is treated with antidepressants, usually beginning with **selective serotonin reuptake inhibitors** (SSRIs) such as fluoxetine (Prozac) or paroxetine (Paxil).

In general, medications are administered cautiously in the lowest possible effective doses to individuals with dementia in order to minimize side effects. Supervision of taking medications is generally required.

The primary goals of treatment for progressive dementias are to preserve as much functioning and independence as possible and to maintain quality of life as long as possible. Caring for a person with dementia can be difficult and complex. The patient must cope with functional and cognitive limitations, while family members or other caregivers must assume increasing responsibility for the person's physical needs. The patient and family should be educated early on in the disease progression to help them anticipate and plan for inevitable changes.

Behavioral treatment

Behavioral approaches may be used to reduce the frequency or severity of problem behaviors such as aggression or socially inappropriate conduct. Problem behavior may be a reaction to frustration or over-stimulation. Understanding and modifying the situations that trigger it can be effective; strategies may include

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breaking down complex tasks such as dressing or feeding into simpler steps, or reducing the amount of activity in the environment to avoid confusion and agitation. Pleasurable activities such as crafts, games, and music can provide therapeutic stimulation and improve mood.

Home modification

Modifying the environment can increase safety and comfort while decreasing agitation. Home modifications for safety include removal or lock-up of hazards such as sharp knives, dangerous chemicals, and tools. Childproof latches may be used to limit access as well. Bed rails and bathroom safety rails can be important safety measures. Confusion may be reduced with the use of simpler decorative schemes and the presence of familiar objects. Covering or disguising doors may reduce the tendency to wander. Positioning the bed in view of the bathroom can decrease incontinence.

Long-term institutional care may be required for the person with dementia, as profound cognitive losses often precede death by a number of years. Early planning for the financial burden of nursing home care is critical. Useful information about financial planning for long-term care is available through the Alzheimer's Association.

Family members or others caring for a person with dementia are often subject to extreme **stress**, and may develop feelings of anger, resentment, guilt, and hopelessness, in addition to the sorrow they feel for their loved one and for themselves. Depression is an extremely common consequence of being a full-time caregiver for a person with dementia. Support groups can be an important way to deal with the stress of caregiving. Contact numbers are available from the Alzheimer's Association; they may also be available through a local social service agency.

Alternative therapies

No alternative therapies have been found to conclusively prevent, reverse, or slow dementias except for those caused by nutrient deficiencies. However, alternative practitioners find some of the following helpful to individual patients.

NUTRITIONAL SUPPLEMENTS. Some **nutritional supplements** may be helpful, especially if dementia is caused by deficiency of these essential nutrients:

- Acetyl-L-carnitine may improve brain function and increases attention span, enhances ability to concentrate and increases energy in individuals with Alzheimer's disease.
- Antioxidants (vitamin E, vitamin C, beta-carotene, or selenium): may reduce the risk of contracting dementia by reducing the damaging effects of free radicals.
- B-complex vitamins and vitamin B_{12} may significantly improve mental function in individuals who have low levels of these essential nutrients.
- Coenzyme Q10 may help deliver more oxygen to the brain.
- DHEA may increase brain function in the elderly.
- Magnesium may be helpful if the dementia is caused by magnesium deficiency and/or accumulation of aluminum in the brain.
- Phosphotidylserine deficiency may decrease mental function and cause depression.
- Zinc may boost short-term memory and increase attention span.

Herbal treatment

Herbal remedies that may be helpful in treating dementia include Chinese or Korean **ginseng**, Siberian ginseng, gotu kola, and *Ginkgo biloba*. Of these, **ginkgo biloba** is the most well known and widely accepted by Western medicine.

Homeopathy

A homeopathic physician may prescribe patient-specific homeopathic remedies to alleviate symptoms of dementia.

Acupressure

This form of therapy uses hands to apply pressure on specific acupressure points to improve blood circulation and calm the nervous system.

Aromatherapy

Aromatherapists use essential oils as inhalants or in baths to improve mental performances and to calm the nerves.

Prognosis

The prognosis for reversible dementia related to nutritional or thyroid problems are usually good once the cause has been identified and treated. The prognoses for dementias related to alcoholism or HIV infection depend on the patient's age and the severity of the underlying disorder.

For those with irreversible progressive dementia, the outlook often includes slow deterioration in mental and physical capacities ending in death. Eventually, help is often required when swallowing, walking, and even sitting become difficult. Aid can consist of preparing special **diets** that can be more easily consumed and making surroundings safe in case of falls. Lift assists in areas such as the bathroom can also be useful. On

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average, people with Alzheimer disease live eight years past their diagnosis, with a range from one to 20 years. Patients with frontal lobe dementia or Pick disease live on average between 5 and 10 years after diagnosis. The course of Creutzfeldt-Jakob disease is much more rapid, with patients living between 5 and 12 months after diagnosis. Vascular dementia is usually progressive, with death resulting from stroke, infection, or heart disease.

Prevention

Dementia caused by repeated blows to the head can be prevented by avoiding sports where head trauma is common. Alcohol-abuse related dementia can be prevented by avoiding alcohol or minimized by receiving early treatment for alcoholism. Good **nutrition** can prevent nutrient-deficiency dementia. Unfortunately, most forms of dementia cannot be prevented.

Resources

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ORGANIZATIONS

American Geriatrics Society (AGS), Empire State Building, 350 Fifth Avenue, Suite 801, New York, NY, 10118, (212) 308-1414, (212) 832-8646, info@americangeriatrics.org, http://www.americangeriatrics.org.

National Institute of Neurological Disorders and Stroke (NINDS), P.O. Box 5801, Bethesda, MD, 20828, (301) 496-5751. TTY: (301) 468-5981, (800) 352-9424, http://www.ninds.nih.gov.

National Institute on Aging, Building 31, Room 5C27, 31 Center Drive, MSC 2292, Bethesda, MD, 20892, (301) 496-1752, TTY: (800) 222-4225, (301) 496-1072, http://www.nia.nih.gov.

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Demyelinating disease *see* **Multiple sclerosis**

Dengue fever

Definition

Dengue **fever** is a disease caused by one of a number of viruses that are carried by mosquitoes. These mosquitoes then transmit the virus to humans.

Description

The virus that causes dengue fever is called an arbovirus, which stands for arthropod-borne virus. Mosquitoes are a type of arthropod. In a number of regions, mosquitoes carry this virus and are responsible for passing it along to humans. These regions include the Middle East, the far East, Africa, and the Caribbean Islands. In these locations, the dengue fever arbovirus is endemic, meaning that the virus naturally and consistently lives in that location. The disease only shows up in the United States sporadically.

In order to understand how dengue fever is transmitted, several terms need to be defined. The word "host" means an animal (including a human) that can be infected with a particular disease. The word "vector" means an organism that can carry a particular disease-causing agent (like a virus or bacteria) without actually developing the disease. The vector can then pass the virus or bacteria on to a new host.

Many of the common illnesses in the United States (including the **common cold**, many viral causes of **diarrhea**, and **influenza** or "flu") are spread because the viruses that cause these illness can be passed directly from person to person. However, dengue fever cannot be passed directly from one infected person to another. Instead, the virus responsible for dengue fever requires an intermediate vector, a mosquito, that carries the virus from one host to another. The mosquito that carries the arbovirus responsible for dengue fever is the same type of mosquito that can transmit other diseases, including **yellow fever**. This mosquito is called *Aedes egypti*. The most common victims are children younger than 10 years of age.

Causes and symptoms

Dengue fever can occur when a mosquito carrying the arbovirus **bites** a human, passing the virus on to the new host. Once in the body, the virus travels to various glands where it multiplies. The virus can then enter the bloodstream. The presence of the virus within the blood vessels, especially those feeding the skin, causes changes to these blood vessels. The vessels swell and leak. The spleen and lymph nodes become enlarged, and patches of liver tissue die. A process called

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disseminated intravascular coagulation (DIC) occurs, where chemicals responsible for clotting are used up and lead to a risk of severe bleeding (hemorrhage).

After the virus has been transmitted to the human host, a period of incubation occurs. During this time (lasting about five to eight days) the virus multiplies. Symptoms of the disease appear suddenly and include high fever, chills, **headache**, eye **pain**, red eyes, enlarged lymph nodes, a red flush to the face, lower back pain, extreme weakness, and severe aches in the legs and joints.

This initial period of illness lasts about two or three days. After this time, the fever drops rapidly and the patient sweats heavily. After about a day of feeling relatively well, the patient's temperature increases again, although not as much as the first time. A rash of small red bumps begins on the arms and legs, spreading to the chest, abdomen, and back. It rarely affects the face. The palms of the hands and the soles of the feet become swollen and turn bright red. The characteristic combination of fever, rash, and headache are called the "dengue triad." Most people recover fully from dengue fever, although weakness and **fatigue** may last for several weeks. Once a person has been infected with dengue fever, his or her immune system keeps producing cells that prevent reinfection for about a year.

More severe illness may occur in some people. These people may be experiencing dengue fever for the first time. However, in some cases a person may have already had dengue fever at one time, recovered, and then is reinfected with the virus. In these cases, the first infection teaches the immune system to recognize the presence of the arbovirus. When the immune cells encounter the virus during later infections, the immune system over-reacts. These types of illnesses, called dengue hemorrhagic fever (DHF) or dengue shock syndrome (DSS), involve more severe symptoms. Fever and headache are the first symptoms, but the other initial symptoms of dengue fever are absent. The patient develops a **cough**, followed by the appearance of small purplish spots (petechiae) on the skin. These petechiae are areas where blood is leaking out of the vessels. Large bruised areas appear as the bleeding worsens and abdominal pain may be severe. The patient may begin to vomit a substance that looks like coffee grounds. This is actually a sign of bleeding into the stomach. As the blood vessels become more damaged, they leak more and continue to increase in diameter (dilate), causing a decrease in blood flow to all tissues of the body. This state of low blood flow is called shock. Shock can result in damage to the body's organs (especially the heart and kidneys) because low blood flow deprives them of oxygen.

KEY TERMS

Endemic—Naturally and consistently present in a certain geographical region.

Host—The organism (such as a monkey or human) in which another organism (such as a virus or bacteria) is living.

Vector—A carrier organism (such as a fly or mosquito) that delivers a virus (or other agent of infection) to a host.

Diagnosis

Diagnosis should be suspected in endemic areas whenever a high fever goes on for two to seven days, especially if accompanied by a bleeding tendency. Symptoms of shock should suggest the progression of the disease to DSS.

The arbovirus causing dengue fever is one of the few types of arbovirus that can be isolated from the serum of the blood. The serum is the fluid in which blood cells are suspended. Serum can be tested because the phase in which the virus travels throughout the bloodstream is longer in dengue fever than in other arboviral infections. A number of tests are used to look for reactions between the patient's serum and laboratory-produced antibodies. Antibodies are special cells that recognize the markers (or antigens) present on invading organisms. During these tests, antibodies are added to a sample of the patient's serum. Healthcare workers then look for reactions that would only occur if viral antigens were present in that serum.

Treatment

There is no treatment available to shorten the course of dengue fever, DHF, or DSS. Medications can be given to lower the fever and to decrease the pain of muscle aches and headaches. Fluids are given through a needle in a vein to prevent **dehydration**. Blood transfusions may be necessary if severe hemorrhaging occurs. Oxygen should be administered to patients in shock.

Prognosis

The prognosis for uncomplicated dengue fever is very good, and almost 100% of patients fully recover. However, as many as 6–30% of all patients die when DHF occurs. The **death** rate is especially high among the youngest patients (under one year old). In places

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where excellent medical care is available, very close monitoring and immediate treatment of complications lowers the death rate among DHF and DSS patients to about 1%.

Prevention

Prevention of dengue fever means decreasing the mosquito population. Any sources of standing water (buckets, vases, etc.) where the mosquitoes can breed must be eliminated. Mosquito repellant is recommended for those areas where dengue fever is endemic. To help break the cycle of transmission, sick patients should be placed in bed nets so that mosquitoes cannot bite them and become arboviral vectors.

ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

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Dental caries *see* **Tooth decay**

Dental cavity *see* **Tooth decay**

Dental fillings

Definition

Dental fillings are metal amalgams or composite resins used to fill a cavity.

Purpose

Dentists use dental fillings to restore teeth damaged by dental caries (**tooth decay**). Dental caries are caused by microorganisms that convert sugars in food to acids that erode the enamel of a tooth, creating a hole or cavity. The dentist cleans out the decayed part of the tooth and fills the opening with an artificial material (a filling) to protect the tooth's structure and restore the appearance and utility of the tooth.

Precautions

As in any dental procedure, the dentist and dental assistant will need to use sterile techniques. Gloves and masks are essential as well as the sterilization of equipment and tools. This not only helps prevent the spread of infectious diseases like **AIDS** and hepatitis, but also the **common cold**.

The patient's reaction to anesthesia is the other main concern of the dentist and dental assistant when performing dental fillings. Nitrous oxide should be avoided with pregnant patients, and local anesthetics should be used with caution, though they are considered safe. Local anesthetics like Novocain and lidocaine have been in practical use for decades with few side effects reported. Some patients, however, are allergic to these drugs.

Description

Though dentists are encountering fewer and smaller cavities in their patients, there is still a need for dentists to fill cavities. Old fillings wear out over time and need to be replaced. Recently, patients have begun to request more restorative work on their teeth, sometimes opting for full mouth restorations that involve installing crowns, bleaching teeth or applying veneers, and replacing dark metal fillings with tooth-colored ones that create a monochromatic view in a patient's mouth.

The dentist begins by removing the decayed area of the tooth and preparing the tooth to receive the filling. The dentist has a wide choice of dental filling materials to choose from.

Amalgam fillings

The most common and strongest filling material is amalgam. It is a silver filling that is usually placed on the rear molars, which endure more stress during chewing. Amalgam fillings—used for large, deep cavities—are strong and very resistant to wear. Amalgam has been in use since 1833.

Amalgam is a mixture (which is what the word means) of several metals, including liquid mercury (35% silver, 15% tin or tin and copper, a trace of zinc, and 50% mercury). When it is prepared, it has a malleable consistency that can easily be shaped to fit the prepared tooth. It hardens to a durable metal.

Despite its durability, many dentists and patients avoid amalgam fillings. Dentists have found that amalgam has a tendency to expand with time. As a result, teeth become fractured from the inside, often splitting the tooth. Patients often avoid amalgam for strictly aesthetic reasons. Amalgam fillings darken over time and make teeth look as if they are decayed.

The biggest reason amalgam has lost favor is a health concern due to its 50% mercury content. Although the American Dental Association (ADA) has pronounced amalgam safe in the quantity and composition of amalgam, some patients and dentists are disturbed by various

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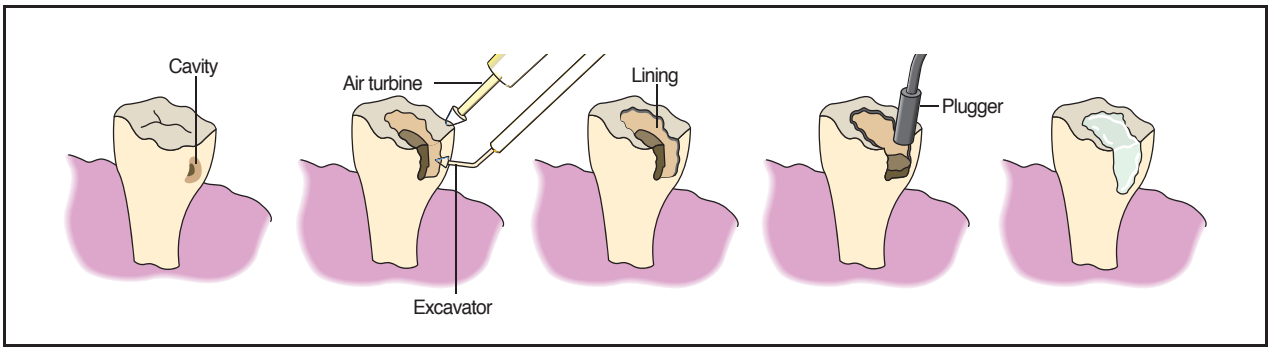

The process of filling a cavity. *(Illustration by Hans & Cassady, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

reports of illness in relation to the mercury in amalgam fillings. Mercury is a toxic material. Some states are required to dispose of mercury waste as if it were a hazardous product. There is also an added risk of inhaling mercury particles when old fillings are removed.

Gold fillings

Gold fillings or inlays are created outside of the mouth by a dental technician and then cemented into place. They are also used to fill the back molars. Gold fillings are very durable. Like amalgam, however, they are not as aesthetically pleasing as tooth-colored fillings.

Composite fillings

Composite fillings, often called white fillings, are made of a plastic resin and finely ground glass. They must be applied to the tooth surface in thin layers. Dentists try to match the color of composites with neighboring teeth for a more natural look, making the filling appear invisible. Composite resin fillings often are made smaller than amalgam fillings and require less tooth preparation, thereby saving more natural tooth surface.

Composite fillings are bonded to the tooth so that the tooth becomes stronger than it was before. They are also less sensitive to temperature changes in the mouth that can damage the tooth; therefore there is less chance that the tooth will shatter because of the filling.

These fillings may not be suitable for large cavities in molars. Though composite durability increased in the 1990s, a porcelain inlay or crown may be the best choice for a durable, natural-looking restoration of a molar.

The major drawback of composite resin fillings is cost. They average one-and-a-half to two times more than the price of amalgam fillings. They also can be stained from drinking coffee and tea. Large composite fillings tend to wear out sooner than amalgam fillings.

Composite fillings can last seven to 10 years, which is similar to the lifespan of amalgam fillings.

Resin ionomer

Resin ionomers are new, tooth-colored filling materials that contain a resin and fluoride. They are very suitable for children and for older adults who suffer from root decay that is more likely to occur as a person ages. These fillings seal the tooth and also protect it from future decay because of the fluoride that they release.

Preparation

During a routine checkup, the dentist may find a cavity in a tooth with a metal tooth probe. A new diagnostic tool, the DIAGNOdent, can detect evidence of cavities and pre-cavity conditions on the tooth's surface. A low-powered laser, the DIAGNOdent is able to detect decay so early that a dental cavity can be avoided. These pre-cavity areas can be protected with a sealant, thereby preventing further decay.

If the cavities found are relatively small and not very deep, there may be no need to anesthetize the area where the dental work will be done. High-speed drills often are able to clean out the decay quickly and with little discomfort. If the cavity is not very deep, the drill may not reach the sensitive nerves in the teeth, which usually cause **pain**. Children and some adults may need anesthesia in any case. The dentist and the dental assistant need to be aware of the patient's history and if the patient reacts adversely to **local anesthesia**.

There are some dentists who use electronic dental anesthesia (EDA), a device that sends electrical charges to the gum through electrodes. Sometimes this is enough anesthesia for the procedure. At other times, EDA numbs the area where the anesthesia is administered, so that the patient does not feel the needle as it goes into the gum. Some dentists also provide soothing

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KEY TERMS

Amalgam—A mixture of metals, primarily mercury used to make large, durable fillings. Also called silver fillings.

Anesthesia—A condition created by drugs that produces a numb feeling. General anesthesia produces unconsciousness whereas a local anesthesia produces numbness around the site where the drug was introduced.

Composite filling—A resin material that is tooth colored and is used to fill a tooth once decay has been removed. It is used most often in front teeth, but may be used in any tooth for aesthetic reasons.

Crown—An artificial covering prepared by a lab technician to fit over a damaged tooth or one weakened by decay.

Dental caries—Tooth decay caused by microorganisms that convert sugars in food to acids which erode the enamel of a tooth.

Dental laser—A device that generates a low-powered beam of light that is used in place of a dentist's drill to cut away decay from a tooth or remove gum tissue.

Enamel—The hard outer surface of a tooth.

music to calm patients during the procedure. Other dentists will use local anesthesia in combination with nitrous oxide-oxygen analgesia to minimize discomfort through the drilling phase of a filling.

Dental lasers that generate a low-powered beam of light are being used to cut away decay, but without the whine of the drill and without using anesthesia. Though a bit slower than the conventional drill, lasers are very efficient at preparing a tooth to receive a filling. Unfortunately, lasers cannot yet remove old fillings or prepare a tooth surface to receive a crown.

Air abrasion is another way to remove decay without using anesthesia. Air abrasion machines produce a spray of air and powder. There is no vibration or heat. Because it has no vibration, it avoids microfractures in the tooth that sometimes occur with drills. Air abrasion removes only a small amount of the tooth's structure. Therefore, it is suitable for small cavities and the repair and replacement of old fillings. It also can repair chipped teeth and clean discolored or stained teeth.

After the cavity is cleaned of decay, the walls of the tooth are shaped and are ready to receive a filling material. If a composite resin filling is used, the tooth next needs to be etched so that the resin will adhere to the tooth. The tooth then is filled, shaped, and polished. The composite filling then must be hardened by shining a special light on it.

Aftercare

The dentist and dental assistant should advise the patient that the teeth, lips, and tongue may be numb for several hours after the procedure, if a local anesthetic was used. Some patients experience sore gums or a sensitivity to hot and cold in the tooth that has just been filled. Normally, patients are advised to avoid chewing hard foods directly on new amalgam fillings for 24 hours. Composite fillings require no special caution since they set immediately. If patients experience continued pain or an uncomfortable bite, they should call their dentist.

Complications

Some patient's have allergic reactions to local anesthesia. The tooth that received a filling may be sensitive to changes in temperature or may be sore for a short time after the procedure.

Results

Fillings restore a tooth's function and appearance. They permit the patient to continue to eat and chew properly and last for several years. Normal fillings will need to be replaced over a patient's lifetime. Since fewer dental caries had been observed since the last decade of the twentieth century, dentists are initially filling fewer teeth, but are replacing fillings as they fail and sometimes systematically, especially if the patient decides to cosmetically enhance his or her teeth. Since many of the initial cavities are quite small, patients are opting for more aesthetically pleasing filling materials even if they are not as durable.

Health care team roles

When the dentist discovers a cavity, filling options are discussed with the patient. The dental assistant prepares the dentist's workstation and lays out the specific instruments that are needed. The dental assistant prepares the filling material according to the manufacturer's

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directions and assists the dentist in preparing the tooth for filling and in the filling procedure itself. The dental assistant cleans the patient's mouth and returns the procedure room to order. All of the instruments that have been used are sterilized by the dental assistant.

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American Dental Association, 211 East Chicago Avenue, Chicago, IL, 60611-2678, (312) 440-2500, www.ada.org.

American Dental Education Association, 1400 K Street, Suite 1100, Washington, DC, 20005, (202) 289-7201, (202) 289-7204, www.adea.org.

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Dental hygiene *see* **Oral hygiene**

Dental implants

Definition

Dental implants are surgically fixed substitutes for roots of missing teeth. Embedded in the jawbone, they act as anchors for a replacement tooth, also known as a crown, or a full set of replacement teeth.

Purpose

The purpose of dental implant surgery is to position metallic anchors in the jawbone so that they can receive the replacement teeth and hold them in place. Dental implants should be considered as an option for replacing failing or missing teeth, and often provide more predictable results than bridgework, resin bonded bridges, or endodontic treatment.

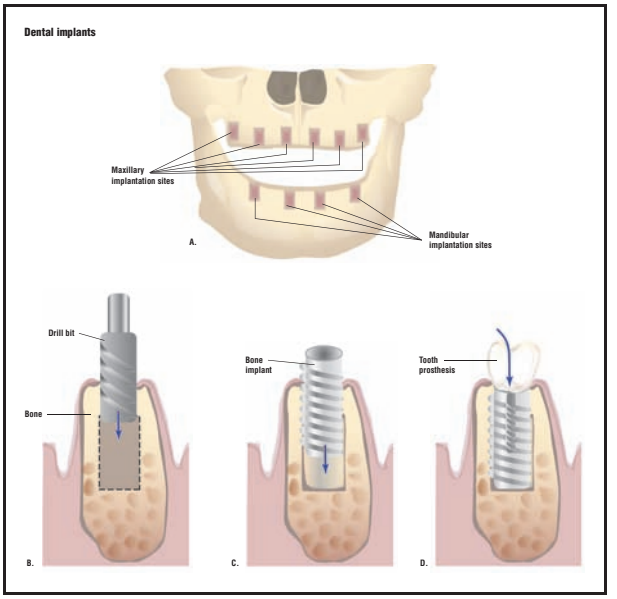
Demographics

In 2000, the estimated number of dental implants placed in the United States was 910,000, and this number is expected to increase at a rate of about 18% per year through 2010. Dental implants are equally popular in Europe, especially in Germany where the procedure is reimbursed by the national healthcare system.

Description

By replacing a lost tooth with a dental implant, the overall health and function of the surrounding teeth is maintained. The implant can prevent tooth migration and loss of structure and will help avoid loss of bone from the jaw in that area. Further, implants reduce the impact of the lost tooth on surrounding teeth, as traditional bridge structures often require reduction (filing down) of the two flanking teeth to hold the bridge in place with a crown. Implanting avoids such alterations to the surrounding teeth when replacing a lost tooth.

When replacing dentures, implants can provide even more benefits. Implants do not slip nor do they have the potential of limiting the diet to easily chewed



A dental drill is used to make a hole for the implant in the jawbone (B). The bone implant is secured into the drilled hole (C), and the tooth prosthesis is built onto the implant (D). *(Illustration by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)*

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KEY TERMS

Computed tomography (CT) scan—A method of imaging both hard and soft tissue of the body used in placement of dental implants that are not within the bone.

Crown—An artificial replacement tooth.

Endosteal implants—Dental implants that are placed within the bone.

Prosthetic tooth—The final tooth that is held in place by the dental implant anchor.

Resorbed—Absorbed by the body because of lack of function. This happens to the jawbone after tooth loss.

foods as can happen with poorly fitting dentures. If appropriate, implants are the method most able to surgically restore one or more missing teeth to their original conditions.

Under **local anesthesia**, the first step for most implant procedures is the exposure of the bone where the implant is to be made. This is followed by placement of the implant into the exposed jawbone. Implants that are placed in the bone are called endosteal implants and are made of titanium or a titanium alloy because this metal does not adversely interact with biological tissue. After placement of the implant, a cover screw is put in and the wound is closed with stitches and allowed to heal. In general, placements in the lower jaw need to heal about three months, while placements in the upper jaw need to heal about six months.

After healing, in a second surgical procedure, the implant is uncovered, the cover screw is removed, and a healing abutment or a temporary crown is placed in the implant. Temporary crowns are generally used for esthetic reasons, when the implant is in a place that is visible. Both healing abutments and temporary crowns allow the tissue around the implant to be trained to grow around the final prosthetic tooth.

After about two months, the soft tissue will be healed enough to receive the final prosthetic tooth. Impressions are used to make custom abutments that take into account the neck morphology of the implant. The prosthetic tooth is sometimes attached to a gold cylinder that can be screwed into the abutment or it can be directly cemented onto the abutment. This multi-stage process, where the two surgical procedures are separated by a lengthy healing time, has proven to provide excellent stability in the final implant. Single-step surgical implants are available, but some stability of the final implant is often lost by eliminating the healing step.

Preparation/Diagnosis

At the first appointment, the dentist or oral surgeon performs a thorough examination to determine whether implants are appropriate to replace the missing teeth. Often, x rays are necessary to discover the state of the jawbone, particularly if the teeth have been lost for some time. This information is used to determine if implants are appropriate and, if so, what particular type of implant would be best for the clinical situation.

There are two solutions commonly used if the initial examination indicates that the bone in the area where the implant is to occur is too resorbed to support the implant. The first is **bone grafting**. This involves undergoing a procedure that moves bone from one place in the body to another to enlarge the bone structure at the implant site. Often, bone can be moved from one place in the mouth to another. Sometimes a graft from a donor, or an animal, or artificial bone can be used if bone from the patient is not available. Grafting usually is done four to eight months before the implant procedure to allow the graft a chance to heal before it is disturbed with the implant process.

A second solution is the use of subperiosteal implants that ride above the bone but beneath the gum. These types of implants are not placed in the bone. A computed tomography (CT) scan is commonly used to obtain a model of the bone structure and then the implant fixture is molded to precisely fit the bone model.

Risks

The greatest risk following the surgical procedures is that the implant will fail. For implants placed within the bone, most failures occur within the first year and then occur at a rate of less than 1% per year thereafter. Recent research has indicated that tobacco use by the patient and use of a single-stage implant procedure are two risk factors that increase failure rate.

Normal results

Overall, the success rate for all implants runs from 90–95%. Most failed implants can be replaced with a second attempt.

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Dental injuries *see* **Dental trauma**

Dental sealants

Definition

A dental sealant is a thin layer of plastic substance that is painted over teeth to discourage the formation of dental caries (cavities).

Demographics

Dental sealants normally are applied to the permanent back teeth (pre-molars and molars) of children soon after these teeth erupt through the gum, most often between the ages of six and 12 years. In a 2005 study, the United States Centers for Disease Control and Prevention (CDC) found that only 32% of children aged 6–19 years had received dental sealants. One of the goals of the United States Department of Health and Human Services Initiative Healthy People 2010 is to increase the percentage of children who receive dental sealants to 50%.

Purpose

The purpose of applying dental sealants is to protect the teeth by sealing out food particles and acids produced by bacteria so that they do not accumulate on the tooth surface and cause decay.

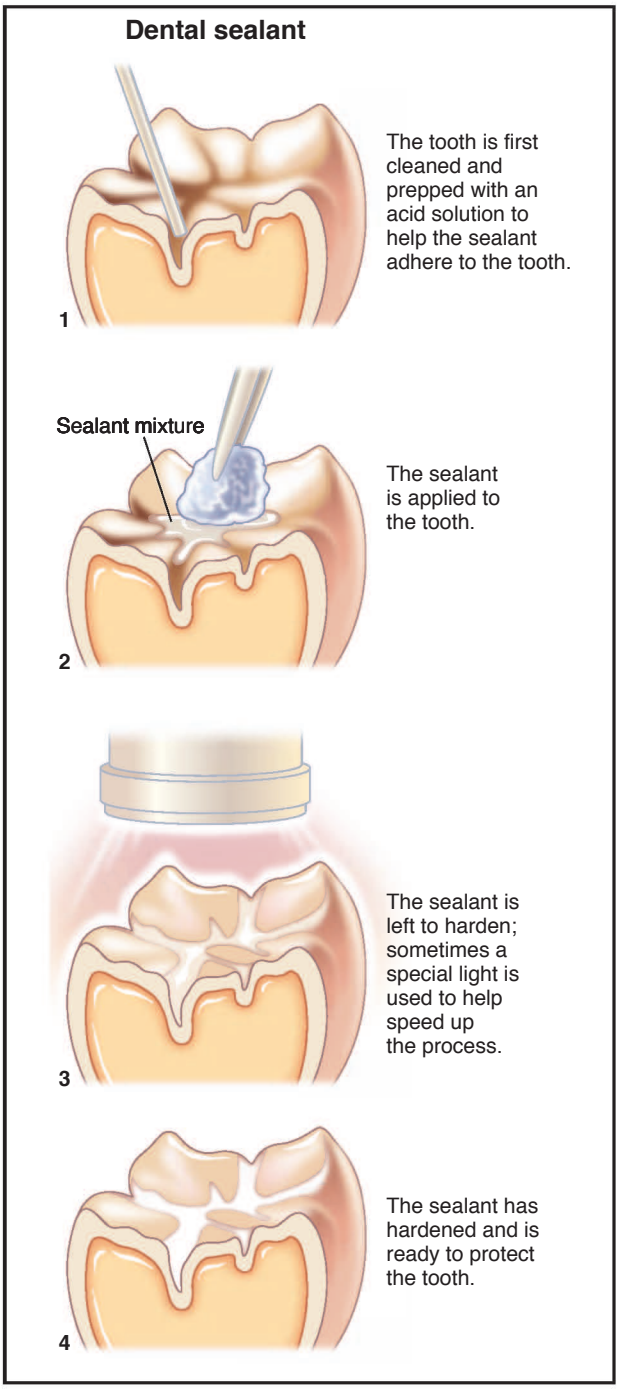

Illustration showing how a dental sealant is applied. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Description

Dental sealants, sometimes called tooth sealants, are plastic material that first appeared in the 1960s. Sealants usually are applied to the chewing teeth—the

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pre-molars and molars. These are teeth that have what dentists call "pits and fissures" or rough surfaces with deep grooves that a toothbrush has trouble cleaning.

Teeth continuously develop a coating plaque that consists of bacteria and mucin. In order to prevent **tooth decay**, plaque must be removed daily through brushing and flossing. The structure of the pre-molars and molars makes it very difficult to reach all surfaces with a toothbrush. When dental sealant is applied to these teeth, it protects the tooth enamel from plaque. This helps prevent tooth decay and may ultimately save the individual money by eliminating the need for fillings, crowns, or other treatment for tooth decay. Some dental insurance will pay for sealants but may put restrictions on when or to which teeth they may be applied. Individuals should check with their insurance company.

Dental sealants can be applied quickly and painlessly. The procedure is as follows:

- The tooth is cleaned and dried.
- An acid solution is painted on the tooth in order to roughen the surface so that the dental sealant adheres to the tooth better.
- The tooth is rinsed and dried.
- A liquid sealant is applied to the tooth.
- The sealant quickly hardens

In March 2008, the American Dental Association (ADA) made the following recommendations based on critical evaluation of studies conducted on dental sealants (evidence based medicine):

- Sealants should be placed on pits and fissures of children's and adolescent's permanent teeth when these teeth are at risk for developing dental caries.
- Sealants should be placed on teeth early before cavities develop.
- Resin-based sealants are the preferred type of sealant.

The expert committee appointed by the ADA to investigate sealants suggested that sealants be placed on adult teeth in danger of developing dental caries, However, studies of sealants in adults have not been adequate to make this a firm, evidence-based recommendation. The use of sealants in primary (baby) teeth is left to the discretion of the dentist and the parent.

KEY TERMS

Cavity—A hole or weak spot in the tooth surface caused by decay.

Dental caries—The medical term for tooth decay.

Enamel—The hard, outermost surface of a tooth.

Evidence-based medicine—Recommendations that are based on an evaluation of randomized, controlled trials; non-randomized trials; other experiments; descriptive studies; and reports of expert committees. Each class of evidence is graded (A to D, with A being the most reliable) based on the type and size of study. Recommendations and clinical practice guides can then be made using these grades.

Fluoride—A chemical compound containing fluorine that is used to treat water or applied directly to teeth to prevent decay.

Mucin—A protein in saliva that combines with sugars in the mouth to form plaque.

Plaque—A thin, sticky, colorless film that forms on teeth. Plaque is composed of mucin, sugars from food, and bacteria that live in the plaque.

Benefits

There is clear evidence that sealant applied when secondary pre-molars or molars erupt from the gum will reduce the likelihood of developing dental caries in these teeth. Adults may have sealants applied, but the benefit to adults has not been proven.

Precautions

The tooth must be free of decay before the sealant is applied. If tooth decay has already begun, there exists the possibility that they tooth will continue to decay under the sealant and that this will not be detected until much damage has already been done.

The sealant material may contain small amounts of bisphenol A (BPA), a material found in plastics that has been shown to cause **cancer** in animals. As of 2010, the ADA has stated that BPA is rarely used in dental sealants and that the small amount that may be present should not cause health concerns. Some European countries and Canada are considerably more concerned about the health risks of BPA than the United States. They are more likely to regulate the use of this material.

Preparation

The tooth is examined for any sign of decay. If no decay is found, the tooth is cleaned before the sealant is applied. If there is any sign of dental caries, the

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sealant should not be applied; instead, the decay should be removed and the tooth filled.

Aftercare

Sealants harden very quickly. No aftercare is needed. Sealants last on average five to ten years.

Risks

There are no known risks related to the application of dental sealants except for the concerns mentioned in the Precautions section.

Research and general acceptance

The American Dental Association and most other dental associations in developed countries endorse the use of dental sealants on secondary premolars and molars of children. Use of sealants in adults and on primary teeth of children is not specifically endorsed, but is left up to the discretion of the dentist and the patient.

Holistic dentists tend to be less enthusiastic about the use of dental sealants, citing concerns about trapping decay in the tooth and the presence of BPA in the sealant material.

Training and certification

Sealants are applied by a licensed dentist, often with the assistance of a certified dental hygienist.

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Dental trauma

Definition

Dental trauma is injury to the mouth, including teeth, lips, gums, tongue, and jawbones. The most common dental trauma is a broken or lost tooth.

Description

Dental trauma may be inflicted in a number of ways: contact sports, motor vehicle accidents, fights, falls, eating hard foods, drinking hot liquids, and other such mishaps. As oral tissues are highly sensitive, injuries to the mouth are typically very painful. Dental trauma should receive prompt treatment from a dentist.

Causes and symptoms

Soft tissue injuries, such as a "fat lip," a burned tongue, or a cut inside the cheek, are characterized by **pain**, redness, and swelling with or without bleeding. A broken tooth often has a sharp edge that may cut the tongue and cheek. Depending on the position of the fracture, the tooth may or may not cause **toothache** pain. When a tooth is knocked out (evulsed), the socket is swollen, painful, and bloody. A jawbone may be broken if the upper and lower teeth no longer fit together properly (**malocclusion**), or if the jaws have pain with limited ability to open and close (mobility), especially around the temporomandibular joint (TMJ).

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Diagnosis

Dental trauma is readily apparent upon examination. **Dental x rays** may be taken to determine the extent of the damage to broken teeth. More comprehensive x rays are needed to diagnose a broken jaw.

Treatment

Soft tissue injuries may require only cold compresses to reduce swelling. Bleeding may be controlled with direct pressure applied with clean gauze. Deep lacerations and punctures may require stitches. Pain may be managed with **aspirin** or **acetaminophen** (Tylenol, Aspirin Free Excedrin) or ibuprofen (Motrin, Advil).

Treatment of a broken tooth will vary depending on the severity of the fracture. For immediate **first aid**, the injured tooth and surrounding area should be rinsed gently with warm water to remove dirt, then covered with a cold compress to reduce swelling and ease pain. A dentist should examine the injury as soon as possible. Any pieces from the broken tooth should be saved and brought along.

If a piece of the outer tooth has chipped off, but the inner core (pulp) is undisturbed, the dentist may simply smooth the rough edges or replace the missing section with a small composite filling. In some cases, a fragment of broken tooth may be bonded back into place. If enough tooth is missing to compromise the entire tooth structure, but the pulp is not permanently damaged, the tooth will require a protective coverage with a gold or porcelain crown. If the pulp has been seriously damaged, the tooth will require **root canal treatment** before it receives a crown. A tooth, that is vertically fractured or fractured below the gumline will require root canal treatment and protective restoration. A tooth that no longer has enough remaining structure to retain a crown may have to be extracted (surgically removed).

When a permanent tooth has been knocked out, it may be saved with prompt action. The tooth must be found immediately after it has been lost. It should be picked up by the natural crown (the top part covered by hard enamel). It must not be handled by the root. If the tooth is dirty, it may be gently rinsed under running water. It should never be scrubbed, and it should never be washed with soap, toothpaste, mouthwash, or other chemicals. The tooth should not be dried or wrapped in a tissue or cloth. It must be kept moist at all times.

The tooth may be placed in a clean container of milk, cool water with or without a pinch of salt, or in saliva. If possible, the patient and the tooth should be brought to the dentist within 30 minutes of the tooth loss. Rapid action improves the chances of successful re-implantation; however, it is possible to save a tooth after 30 minutes, if the tooth has been kept moist and handled properly.

The body usually rejects re-implantation of a primary (baby) tooth. In this case, the empty socket is treated as a soft tissue injury and monitored until the permanent tooth erupts.

A broken jaw must be set back into its proper position and stabilized with wires while it heals. Healing may take six weeks or longer, depending on the patient's age and the severity of the fracture.

KEY TERMS

Crown—The natural part of the tooth covered by enamel. A restorative crown is a protective shell that fits over a tooth.

Eruption—The process of a tooth breaking through the gum tissue to grow into place in the mouth.

Evulsion—The forceful, and usually accidental, removal of a tooth from its socket in the bone.

Extraction—The surgical removal of a tooth from its socket in the bone.

Malocclusion—A problem in the way the upper and lower teeth fit together in biting or chewing.

Pulp—The soft innermost layer of a tooth containing blood vessels and nerves.

Root canal treatment—The process of removing diseased or damaged pulp from a tooth, then filling and sealing the pulp chamber and root canals.

Temporomandibular joint (TMJ)—The jaw joint formed by the mandible (lower jaw bone) moving against the temporal (temple and side) bone of the skull.

Alternative treatment

There is no substitute for treatment by a dentist or other medical professional. There are, however, homeopathic remedies and herbs that can be used simultaneously with dental care and throughout the healing process. Homeopathic arnica (*Arnica montana*) should be taken as soon as possible after the injury to help the body deal with the trauma. Repeating a dose several times daily for the duration of healing is also useful. Homeopathic hypericum (*Hypericum perforatum*) can be taken if nerve pain is involved, especially with a **tooth extraction** or root canal. Homeopathic comfrey

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(officinale) *Symphytum* may be helpful in treating pain due to broken jaw bones, but should only be used after the bones have been reset. Calendula (*Calendula officinalis*) and plantain (*Plantago major*) can be used as a mouth rinse to enhance tissue healing. These herbs should not be used with deep lacerations that need to heal from the inside first.

Prognosis

When dental trauma receives timely attention and proper treatment, the prognosis for healing is good. As with other types of trauma, infection may be a complication, but a course of **antibiotics** is generally effective.

Prevention

Most dental trauma is preventable. Car seat belts should always be worn, and young children should be secured in appropriate car seats. Homes should be monitored for potential tripping and slipping hazards. Child-proofing measures should be taken, especially for toddlers. In addition to placing gates across stairs and padding sharp table edges, electrical cords should be tucked away. Young children may receive severe oral **burns** from gnawing on live power cords.

Everyone who participates in contact sports should wear a mouthguard to avoid dental trauma. Athletes in football, ice hockey, wrestling, and boxing commonly wear mouthguards. The mandatory use of mouthguards in football prevents about 200,000 oral injuries annually. Mouthguards should also be worn along with helmets in noncontact sports such as skateboarding, in-line skating, and bicycling. An athlete who does not wear a mouthguard is 60 times more likely to sustain dental trauma than one who does. Any activity involving speed, an increased chance of falling, and potential contact with a hard piece of equipment has the likelihood of dental trauma that may be prevented or substantially reduced in severity with the use of mouthguards.

ORGANIZATIONS

American Academy of Pediatric Dentistry, 211 East Chicago Ave., Ste. 1700, Chicago, IL, 60611-2637, (312) 337-2169, (312) 337-6329, http://www.aapd.org.

American Association of Endodontists, 211 East Chicago Ave., Ste. 1100, Chicago, IL, 60611-2691, (312) 266-7255, (866) 451-9020, (800) 872-3636, info@aae.org, http://www.aae.org.

American Association of Oral & Maxillofacial Surgeons, 9700 West Bryn Mawr Avenue, Rosemont, IL, 60018-5701, (847) 678-6200, (847) 678-6286, (800) 822-6637, http://www.aaoms.org.

American Dental Association, 211 E. Chicago Ave., Chicago, IL, 60611-2678, (312) 440-2500, http://www.ada.org.

Bethany Thivierge

Dental x rays

Definition

Dental x rays are pictures taken of the mouth area using high-energy photons with very short wavelengths. They show the teeth and surrounding bone.

Purpose

Dental x rays are effective in discovering **tooth decay**, broken fillings, fractured teeth, tumors, occlusal trauma, or impacted or ectopic teeth that would otherwise be unseen by the eye, in between the teeth and below the gum tissue.

Description

Dental x rays are part of the dental examination for aiding in the diagnostic process. X rays are vital in the diagnosis of **root canal treatment** on checking the apical of the tooth and the surrounding structures for abscesses or bone loss. Without the aid of dental x rays, 60% of dental decay would be missed. Diagnostic x rays are essential in providing accurate information. The most common x rays taken are:

- bitewing x rays (vertical and horizontal bitewings)
- panoramic x rays
- periapical x rays
- occlusal x rays

Each is used in its own respective degree of diagnosis, with the bitewing x ray being the most common. Bitewings are the most effective in discovering tooth decay in between the teeth and on adjacent teeth. A bitewing shows only the top crown portion of the tooth structure. It is called a bitewing due to the way the patient can bite down and hold the film securely in place. The bitewing is good in diagnosing and evaluating periodontal conditions and bone levels between the teeth. They are also good in detecting tartar buildup.

The panoramic (a type of film used), or Panorex (brand name) is also commonly taken on the initial visit to the dental office. This type of x ray makes a complete circle of the head from one ear to the other,

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to produce a complete two-dimensional representation of all the teeth. This x ray will also show bone structure beneath the teeth and the temporomandibular joint (TMJ). The panoramic is the most commonly used x ray in the aid of diagnostic decisions regarding third molar extractions (wisdom teeth) for people who are edentulous (the tooth is not there/has not erupted). This special x ray, however, has its advantages and disadvantages.

One advantage of the panoramic is that a broad area is imaged, showing many structures. Furthermore, the exposure level emits low radiation. The panoramic is excellent for evaluation of trauma, tooth development, and certain anomalies. In some cases dental x rays can even reveal non-dental medical conditions. One study at the University of Buffalo School of Dental Medicine demonstrated that calcifications in the carotid arteries, which were exposed on standard panoramic x rays, served as predictors of **death** from cardiovascular disease.

The main disadvantage of panoramic x rays is that the image shown does not provide the fine detail of a bitewing x ray. The procedure for taking a panoramic x ray is also somewhat confining to the patient, as the x-ray machine takes a minute or more to fully encircle the head for the complete picture. These films are not good in aiding the diagnosis of decay, bone level, and certain types of periapical problems.

A periapical x ray is similar to a bitewing. This type of x ray shows the entire tooth area, from crown to root, and the bone surrounding the root from a side view. This type of film will reveal any root anomalies, changes in the bone and surrounding tissue, cysts, bone tumors, and abscesses. The fine detail in the periapical film is necessary in diagnosis and treatment planning, and is commonly taken during root canal treatment and crown restoration procedures.

Occlusal films are least common. These films show the whole bite of the lower or upper jaw. Occlusal x rays, when taken, are mainly taken on children to show the eruption order of the permanent teeth.

X rays pass through hard and soft tissue in the mouth. The x-ray beam is blocked by denser structures, such as teeth, fillings, jaws, and bones. Teeth appear lighter because fewer x rays go through the teeth to reach the film. Cavities and gum disease appear darker (shown by a dark spot in the tooth or loss of bone structure around the tooth) because of more x-ray penetration. On the film, the white images are the dense structures.

Operation

William Roentgen, a German scientist, discovered the x ray in 1895. He found that x rays are energy in the form of waves, similar to visible light. The only difference between light and x rays is that light does not have the ability to penetrate the body as x ray energy does. Light makes pictures of the outside of objects, while x rays have the ability to make pictures of the inside of objects. The roentgen represents the amount of exposure given off by one single energy photon. The amount of absorbed x ray in the body is a unit called a rad. A unit called "rem" accounts for the difference in biological effectiveness of different types of radiation, such as secondary radiation, or cosmic radiation. One rem equals one rad. One rad equals one R and one thousand milliroentgens, more commonly known as mrad; it is equal to one roentgen (R).

Research conducted by the Idaho Radiation Network set a maximum permissible x ray dose for one year at 5R (roentgens). A full mouth set of dental x rays consists of 18 to 20 films (bitewings, periapicals, occlusals, and panoramic x rays). The amount of radiation for receiving the full-mouth set of x rays is 10 to 20 mrads (milliroentgens). The benefits derived from x rays greatly outweigh the radiation concerns. The amount of radiation an average person receives each year from background sources (e.g., outer space, materials in the earth, foods consumed, and naturally radioactive materials in the body) is about 360 mrads.

Secondary radiation consists of the radiation waves left over after the source of radiation is stopped. Most secondary waves can penetrate tissue and are the most damaging waves from radiation. Measures taken to prevent damaging rays are:

- setting radiation exposure to lower settings depending on the patient's age, height, build and structure
- using high-speed films to minimize exposure time
- using lead-filled aprons to shield sensitive body parts, such as thyroid glands and gonads
- x-ray badges worn by dental staff to monitor the amount of radiation exposure in the workplace

Maintenance

Dental x rays are essential in diagnosing and treating oral disease, abnormal tooth development, or trauma. At the initial dental examination, a full-mouth set of x rays may be taken (bitewings and panoramic). Thereafter, it is the dentist who should determine when and how often x rays will be required.

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KEY TERMS

Apical—Rounded end of the root of a tooth that is embedded in hard tissue (bone); toward the apex of the root.

Crown—1. The upper part of the tooth, covered by enamel. 2. A dental restoration that is a protective shell fitting over a tooth.

Eruption—The process of a tooth breaking through the gum tissue to grow into place in the mouth.

Pulp—The soft, innermost part of a tooth containing blood and lymph vessels, and nerves.

Root canal treatment—The process of removing diseased or damaged pulp tissue from a tooth, then filling and sealing the pulp chamber and root canals.

Children are usually more cavity prone than adults; x rays may be taken with regard to degree of risk, or at the check-up examination every six months.

An adult presenting a **dental trauma** will need x rays to diagnose what the treatment should be. More x rays may be needed depending on the treatment plan and the extent of the injury.

The American Dental Association (ADA) recommends basic guidelines on taking dental x rays. On average, bitewing x rays should be taken approximately once a year. This is mainly to detect and treat any conditions early in their development. If the overall general health of the mouth is good, x rays can be taken every 18 to 24 months. The ADA also recommends that the type and frequency of dental x rays taken at an examination be based upon clinical judgment after the examination and consideration of the dental health and the general health of the patient.

Health care team roles

A registered dental assistant (RDA) or registered dental hygienist (RDH) commonly takes the x rays during a dental examination. They review the health and dental history, chart, and age of the patient to be x rayed. Adjustments are made to the x-ray unit depending on the size and age of the patient. The RDA then develops and mounts the x rays and presents them to the dentist. The dentist will interpret the x rays and complete the oral examination. A treatment plan will follow.

Training

An RDA and an RDH must have an x-ray certification in order to take and develop x rays. To become certified, full-mouth sets of x rays need to be taken. Knowledge of the x-ray machine unit is needed, as is the number of roentgens emitted from a variety of different x-ray machines. Furthermore, a working knowledge of angles and height of the x-ray unit is needed; this is necessary for taking fine-detailed images. Certification also requires knowledge of the principles of radiation safety.

Classes leading to certification as an RDA or RDH are available outside the work setting. Each state has different bylaws regarding x-ray licensing for technicians. The rules of the state in which one is interested in working should be consulted.

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ORGANIZATIONS

American Dental Association, 211 East Chicago Avenue, Chicago, IL, 60611-2678, (312) 440-2500, www.ada.org.

American Dental Education Association, 1400 K Street, Suite 1100, Washington, DC, 20005, (202) 289-7201, (202) 289-7204, www.adea.org.

American Dental Hygienists' Association, 444 North Michigan Avenue, Suite 3400, Chicago, IL, 60611, (312) 440-8900, mail@adha.net, www.adha.org.

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Depersonalization disorder *see* **Dissociative disorders**

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Depo-Provera/Norplant

Definition

Medroxyprogesterone is a long-acting progestin hormone that is inserted under the skin and prevents conception for up to five years. Depo-Provera is also a hormone, but is administered by intramuscular injection and provides protection against **pregnancy** for three months. Lunelle is another injectable contraceptive that is administered monthly (every 28 to 30 days); it was approved by the Food and Drug Administration (FDA) in October 2000. The hormone in Norplant and Depo-Provera is progestin, a synthetic hormone similar to one found naturally in a woman's body; Lunelle contains the hormones progestin and estrogen.

KEY TERMS

Cervix—Narrow, lower end of the uterus forming the opening to the vagina.

Hormone—A chemical produced in a gland or organ and transported by the blood to another area of the body where it produces a specific effect.

Pap test—A microscopic examination of cell samples taken from the cervix.

Uterus—The female reproductive organ that contains and nourishes a fetus from implantation until birth.

Purpose

The purpose of these hormones is to prevent pregnancy; they are about 99% effective in achieving this goal. No hormonal contraceptive methods provide protection from **AIDS** or other **sexually transmitted diseases**.

Depo-Provera and Lunelle are given as an injection and work in several ways to prevent conception. First, the egg (ovum) is prevented from maturing and being released. The mucus in the cervix (opening into the uterus or womb) becomes thicker, making it difficult for the sperm to enter. Depo-Provera and Lunelle also cause the lining of the uterus to become thinner, making implantation of a fertilized egg unlikely.

An injection of Depo-Provera or Lunelle must be given within the first five days of a normal period. Depo-Provera provides protection against pregnancy for three months, while Lunelle provides similar protection for one month. Ovulation (release of a mature egg) typically occurs within 60 days of the last injection of Lunelle, about twice as fast after use of Depo-Provera. Also, because Lunelle is a combined hormone contraceptive as opposed to progestin-only Depo-Provera and Norplant, it is less likely to cause irregular or absent menstruation.

A physician inserts a contraceptive implant under the skin of a woman's arm. *(Photo Researchers, Inc.)*

Norplant capsules contain a synthetic hormone that is slowly released over a period of up to five years. It functions like Depo-Provera in that it prevents the ovaries from producing ova (eggs) and also results in thicker mucus in the cervix, which prevents the sperm from passing through the cervix. Norplant can be inserted at any time.

Preparation

The woman being considered for Depo-Provera or Lunelle will have a pelvic and breast examination, a **Pap test** (a microscopic examination of cell samples taken from the cervix), blood pressure check, weight check, and a review of her medical history. Women who have **diabetes mellitus**, major depression, blood clotting problems, **liver disease**, or weight problems should use these methods only under strict medical supervision. Depo-Provera or Lunelle should not be used if the woman is pregnant, has unexplained vaginal bleeding, suffers from severe liver disease, has **breast cancer**, or has a history of **blood clots** or **stroke**.

Individuals who select Norplant will receive the same basic **physical examination**. If approved for this method, a site of implantation will be selected (usually the inside of the upper arm), and the area prepared for minor surgery. The skin will be washed with soap and water, and an antiseptic, such as iodine solution, will be applied. The physician will use a local anesthetic to numb the area, a small incision will be made, the six

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Norplant capsules will be inserted, and the incision sewn up (sutured). Protection against pregnancy normally begins within 24 hours. If necessary, the implants can be removed in 15–20 minutes. Norplant should not be used by women who are pregnant, have blood clotting problems, or have unexplained vaginal bleeding. Advantages include light periods with less cramping and decreased anemia. This form of birth control may also be protective against **endometrial cancer**.

Because Depo-Provera and Norplant use only the hormone progestin, they may provide an alternative for women who can not use estrogen-containing birth control pills. One benefit of Lunelle, however, is that its effects wear off more quickly than Depo-Provera, an important factor in the event that a woman has serious side effects or wants to become pregnant.

Risks

The most common side effects associated with Depo-Provera and Lunelle are yellowing of the skin, **headache**, nervousness, **dizziness**, abdominal **pain**, hair loss, rash, increase in the number of migraine headaches, increased or decreased interest in sexual intercourse, the development of dark spots on the skin, depression, and weakness; more serious is, liver disease and breast **cancer**. Danger signs that need to reported immediately include weight gain, heavy vaginal bleeding, frequent urination, blurred vision, **fainting**, severe abdominal pain, and coughing up blood. Because the effects of Depo-Provera may last up to 12 weeks, it may take a longer time for women trying to conceive to become pregnant after discontinuing the injections.

The main reactions to Norplant include headache, weight gain, irregular periods or no period at all, breast tenderness, **acne**, gain or loss of facial hair, color changes of the skin over the area of insertion, and **ovarian cysts**. The doctor should be notified immediately of lumps in the breast, heavy vaginal bleeding, yellowing of the skin or eyes, or infection of the incision. Women who use Norplant are discouraged from **smoking**.

As of 2010, Depo-Provera comes with a special warning that links prolonged use of the drug with bone density loss. The Food and Drug Administration's strident warning informs women that the drug can cause significant loss of bone density. Losses are greater when the drug is used longer. In addition, bone density loss may not reverse completely when women stop using Depo-Provera. The FDA's decision to add such a warning followed analyses by the agency and Pfizer of data about the drug's long-term effect on bone density among teens and adult women. The women's study ran from 1994 to 2010 and enrolled 540 women aged 25 to 38.

Normal results

These hormone contraceptive methods normally result in a success rate of 99%.

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James Waun, MD, RPh
Karl Finley

Depressive disorders

Definition

Depression or depressive disorders (unipolar depression) are mental illnesses characterized by a profound and persistent feeling of sadness or despair and/or a loss of interest in things that once were pleasurable. Disturbance in sleep, appetite, and mental processes are a common accompaniment.

Description

Everyone experiences feelings of unhappiness and sadness occasionally. But when these depressed feelings start to dominate everyday life and cause physical and mental deterioration, they become what are known as depressive disorders. There are two main categories of depressive disorders: major depressive disorder and dysthymic disorder. Major depressive disorder is a moderate to severe episode of depression lasting two or more weeks. Individuals experiencing this major depressive episode may have trouble sleeping, lose interest in activities they once took pleasure in, experience a change in weight, have difficulty concentrating, feel worthless and hopeless, or have a preoccupation with **death** or **suicide**. In children, major depression may be characterized by irritability.

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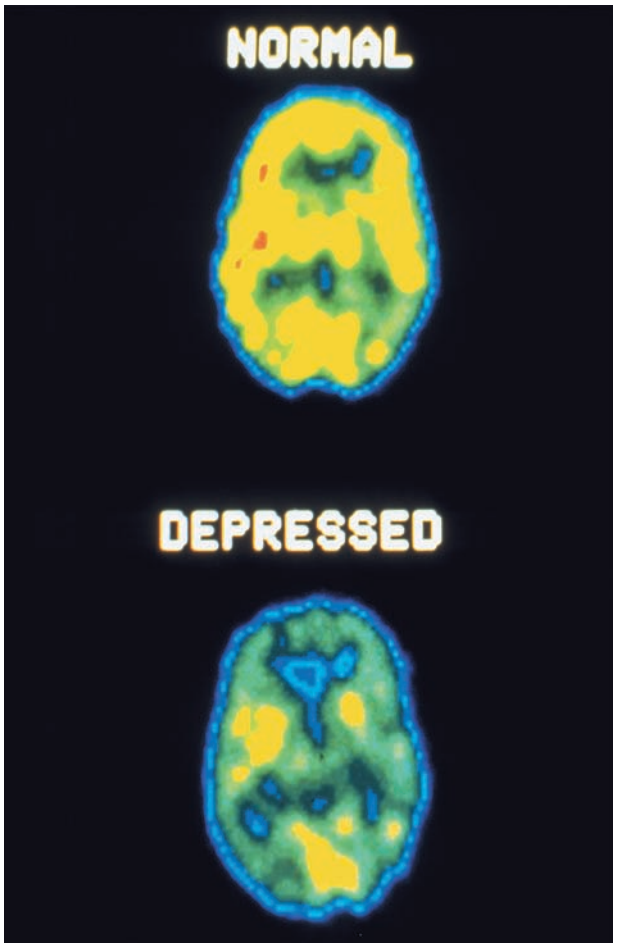

Positron emission tomography (PET) scans comparing a normal brain with that of someone with a depressed mental disorder. *(Photo Researchers, Inc.)*

In 2006 The National Institutes of Mental Health estimated that about 6.7% of Americans adults are affected by major depressive disorder, and about 1.5% are affected by dyrthmic disorder in a given year. Major depressive disorder has a median age of onset of 32 years, and affects women more frequently than men. Dyrthmic disorder has a median age of onset of 31 years. Both disorders may occur in any age group, from children to the elderly.

While major depressive episodes may be acute (intense but short-lived), dysthymic disorder is an ongoing, chronic depression that lasts two or more years (one or more years in children) and has an average duration of 16 years. The mild to moderate depression of dysthymic disorder may rise and fall in intensity, and those afflicted with the disorder may experience some periods of normal, non-depressed mood of up to two months in length. Its onset is gradual, and dysthymic patients may not be able to pinpoint exactly when they started feeling depressed. Individuals with dysthymic disorder may experience a change in sleeping and eating patterns, low self-esteem, **fatigue**, trouble concentrating, and feelings of hopelessness.

Depression also can occur in **bipolar disorder**, an affective mental illness that causes radical emotional changes and mood swings, from manic highs to depressive lows. The majority of bipolar individuals experience alternating episodes of **mania** and depression.

Causes and symptoms

The causes behind depression are complex and not yet fully understood. While an imbalance of certain neurotransmitters—the chemicals in the brain that transmit messages between nerve cells—is believed to play a key role in depression, external factors such as upbringing and environment (more so in dysthymia than major depression) may be as important. For example, it is speculated that, if an individual is abused and neglected throughout childhood and adolescence, a pattern of low self-esteem and negative thinking may emerge. From that, a lifelong pattern of depression may follow. Many different factors have been linked to major depression, including chronic **pain**, severe **obesity**, and **smoking** (among teenagers).

Heredity seems to play a role in who develops depressive disorders. Individuals with major depression in their immediate family are up to three times more likely to have the disorder themselves. It would seem that biological and genetic factors may make certain individuals pre-disposed or prone to depressive disorders, but environmental circumstances often may trigger the disorder.

External stressors and significant life changes, such as chronic medical problems, death of a loved one, divorce or estrangement, **miscarriage**, or loss of a job, also can result in a form of depression known as adjustment disorder. Although periods of adjustment disorder usually resolve themselves, occasionally they may evolve into a major depressive disorder.

Major depressive episode

Individuals experiencing a major depressive episode have a depressed mood and/or a diminished interest or pleasure in activities. Children experiencing a major depressive episode may appear or feel irritable rather than depressed. In addition, five or more of the following symptoms will occur on an almost daily basis for a period of at least two weeks:

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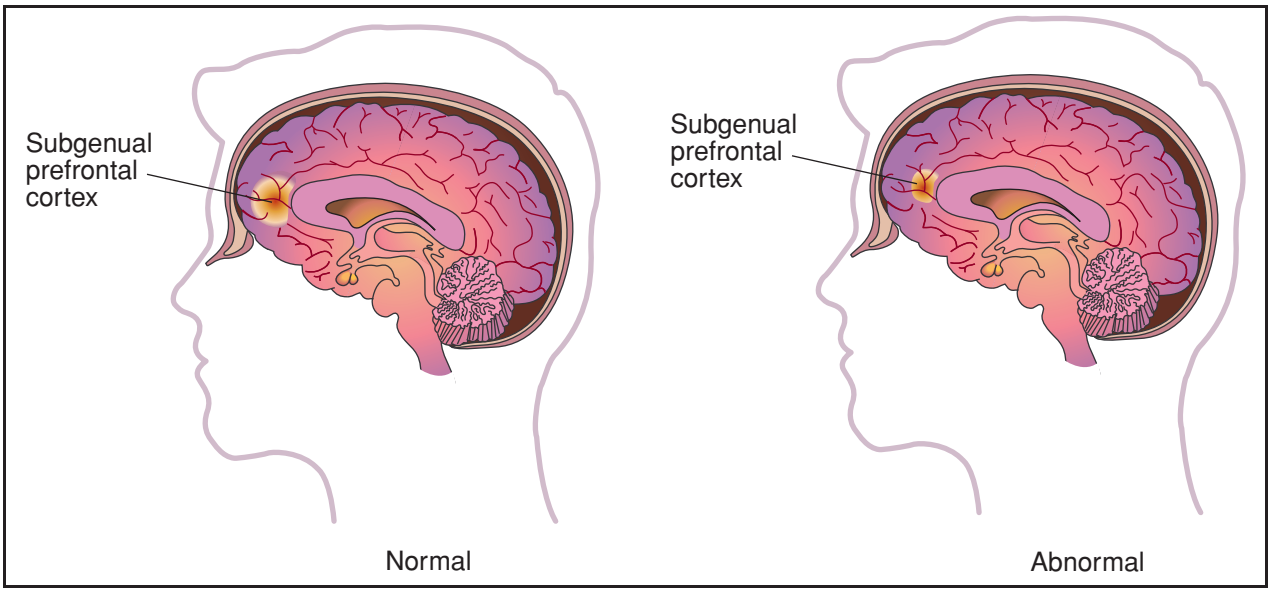

Recent scientific research has indicated that the size of the subgenual prefrontal cortex of the brain (located behind the bridge of the nose) may be a determining factor in hereditary depressive disorders. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

- Significant change in weight.
- Insomnia or hypersomnia (excessive sleep).
- Psychomotor agitation or retardation.
- Fatigue or loss of energy.
- Feelings of worthlessness or inappropriate guilt.
- Diminished ability to think or to concentrate, or indecisiveness.
- Recurrent thoughts of death or suicide and/or suicide attempts.

Dysthymic disorder

Dysthymia commonly occurs in tandem with other psychiatric and physical conditions. Up to 70% of dysthymic patients have both dysthymic disorder and major depressive disorder, known as double depression. **Substance abuse**, panic disorders, **personality disorders**, social **phobias**, and other psychiatric conditions also are found in many dysthymic patients. Dysthymia and medical conditions often co-occur. The connection between them is unclear, but it may be related to the way the medical condition and/or its pharmacological treatment affects neurotransmitters. Dysthymia is prevalent in patients with **multiple sclerosis**, **AIDS**, **hypothyroidism**, **chronic fatigue syndrome, Parkinson's disease,** diabetes, and post-cardiac transplantation. Dysthymic disorder can lengthen or complicate the recovery of patients with these and other medical conditions.

Along with an underlying feeling of depression, people with dysthymic disorder experience two or more of the following symptoms on an almost daily basis for a period for two or more years (many experience them for five or more years), or one year or more for children:

- under or overeating
- insomnia or hypersomnia
- low energy or fatigue
- low self-esteem
- poor concentration or trouble making decisions
- feelings of hopelessness

Diagnosis

In addition to an interview, several clinical inventories or scales may be used to assess a patient's mental status and determine the presence of depressive symptoms. Among these tests are: the Hamilton Depression Scale (HAM-D), Child Depression Inventory (CDI), Geriatric Depression Scale (GDS), Beck Depression Inventory (BDI), and the Zung Self-Rating Scale for Depression. These tests may be administered in an outpatient or hospital setting by a general practitioner, social worker, psychiatrist, or psychologist.

Treatment

Major depressive and dysthymic disorders are typically treated with a combination of antidepressants and psychosocial therapy. Psychosocial therapy focuses on the personal and interpersonal issues

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Signs of depression

Lack of interest or pleasure in daily activities
Significant weight loss (without dieting) or weight gain
Difficulty sleeping or excessive sleeping
Loss of energy
Feelings of worthlessness or guilt
Difficulty in making decisions
Restlessness
Recurrent thoughts of death

(Table by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)

behind depression, while antidepressant medication is prescribed to provide more immediate relief for the symptoms of the disorder. When used together correctly, therapy and antidepressants are a powerful treatment plan for the depressed patient.

Antidepressants

Selective serotonin reuptake inhibitors (SSRIs) such as fluoxetine (Prozac) and sertraline (Zoloft) reduce depression by increasing levels of serotonin, a neurotransmitter. Some clinicians prefer SSRIs for treatment of dysthymic disorder. **Anxiety**, **diarrhea**, drowsiness, **headache**, sweating, **nausea**, poor sexual functioning, and **insomnia** all are possible side effects of SSRIs. In early 2004, the U.S. Food and Drug Administration (FDA) issued warnings to physicians and parents about increased risk of suicide among children and adolescents taking SSRIs.

Tricyclic antidepressants (TCAs) are less expensive than SSRIs, but have more severe side-effects, which may include persistent **dry mouth**, **sedation**, **dizziness**, and cardiac **arrhythmias**. Because of these side effects, caution is taken when prescribing TCAs to elderly patients. TCAs include amitriptyline (Elavil), imipramine (Tofranil), and nortriptyline (Aventyl, Pamelor). A 10-day supply of TCAs can be lethal if ingested all at once, so these drugs may not be a preferred treatment option for patients at risk for suicide.

Monoamine oxidase inhibitors (MAOIs) such as tranylcypromine (Parnate) and phenelzine (Nardil) block the action of monoamine oxidase (MAO), an enzyme in the central nervous system. Patients taking MAOIs must cut foods high in tyramine (found in aged cheeses and meats) out of their diet to avoid potentially serious hypertensive side effects.

Heterocyclics include bupropion (Wellbutrin) and trazodone (Desyrel). Bupropion should not be prescribed to patients with a **seizure disorder**. Side effects of the drug may include agitation, anxiety, confusion, tremor, dry mouth, fast or irregular heartbeat, headache, low blood pressure, and insomnia. Because trazodone has a sedative effect, it is useful in treating depressed patients with insomnia. Other possible side effects of trazodone include dry mouth, gastrointestinal distress, dizziness, and headache.

Psychosocial therapy

Psychotherapy explores an individual's life to bring to light possible contributing causes of the present depression. During treatment, the therapist helps the patient to become self-aware of his or her thinking patterns and how they came to be. There are several different subtypes of psychotherapy, but all have the common goal of helping the patient develop healthy problem solving and coping skills.

Cognitive-behavioral therapy assumes that the patient's problematic thinking is causing the current depression and focuses on changing the depressed patient's thought patterns and perceptions. The therapist helps the patient identify negative or distorted thought patterns and the emotions and the behaviors that accompany them, and then retrains the depressed individual to recognize the thinking and react differently to it.

Electroconvulsant therapy

ECT, or **electroconvulsive therapy**, usually is employed after all psychosocial therapy and pharmaceutical treatment options have been explored. However, it is sometimes used early in treatment when severe depression is present and the patient refuses oral medication, or when the patient is becoming dehydrated, extremely suicidal, or psychotic.

The treatment consists of a series of electrical pulses that move into the brain through electrodes on the patient's head. ECT is given under **general anesthesia** and patients are administered a muscle relaxant to prevent convulsions. Although the exact mechanisms behind the success of ECT therapy are not known, it is believed that the electrical current modifies the electrochemical processes of the brain, consequently relieving depression. Headaches, muscle soreness, nausea, and confusion are possible side effects immediately following an ECT procedure. **Memory loss**, typically transient, also has been reported in ECT patients.

Alternative treatment

St. John's wort (*Hypericum perforatum*) is used throughout Europe to treat depressive symptoms.

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KEY TERMS

Hypersomnia—The need to sleep excessively; a symptom of dysthymic and major depressive disorder.

Neurotransmitter—A chemical in the brain that transmits messages between neurons, or nerve cells. Changes in the levels of certain neurotransmitters, such as serotonin, norepinephrine, and dopamine, are thought to be related to depressive disorders.

Psychomotor agitation—Disturbed physical and mental processes (e.g., fidgeting, wringing of hands, racing thoughts); a symptom of major depressive disorder.

Psychomotor retardation—Slowed physical and mental processes (e.g., slowed thinking, walking, and talking); a symptom of major depressive disorder.

Unlike traditional prescription antidepressants, this herbal antidepressant has few reported side effects. Despite uncertainty concerning its effectiveness, it is accepted by many practitioners of alternative medicine. Although St. John's wort appears to be a safe alternative to conventional antidepressants, care should be taken, as the herb can interfere with the actions of some pharmaceuticals, and because herbal supplements are not regulated by the FDA in the same way as conventional medications.

Homeopathic treatment also can be therapeutic in treating depression. Good **nutrition**, proper sleep, **exercise**, and full engagement in life are very important to a healthy mental state.

In several small studies, S-adenosyl-methionine (SAM, SAMe) was shown to be more effective than placebo and equally effective as tricyclic antidepressants in treating depression. The usual dosage is 200 mg to 400 mg twice daily. It may however cause some side effects, and an individual should discuss the possible risks and benefits with a doctor.

Prognosis

Untreated or improperly treated depression is the number one cause of suicide in the United States. Proper treatment relieves symptoms in 80–90% of depressed patients. After each major depressive episode, the risk of recurrence climbs significantly—50% after one episode, 70% after two episodes, and 90% after three episodes. For this reason, patients need to be aware of the symptoms of recurring depression and may require long-term maintenance treatment of antidepressants and/or therapy.

Research has found that depression may lead to other problems as well. Increased risk of heart disease has been linked to depression, particularly in postmenopausal women. And while chronic pain may cause depression, some studies indicate that depression may also cause chronic pain.

Prevention

Patient education in the form of therapy or self-help groups is crucial for training patients with depressive disorders to recognize symptoms of depression and to take an active part in their treatment program. Extended maintenance treatment with antidepressants may be required in some patients to prevent relapse. Early intervention for children with depression is usually effective in arresting development of more severe problems.

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American Psychiatric Association (APA), 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209, (888) 357-7924, apa@psych.org, http://www.psych.org.

American Psychological Association (APA), 750 First St. NE, Washington, DC, 20002-4242, (202) 336-5500, (800) 374-2721, http://www.apa.org/.

Depression and Bipolar Support Alliance (DBSA), 730 N. Franklin Street, Suite 501, Chicago, IL, 60654-7225, (312) 642-7243, (800) 826-3632, http://www.dbsalliance.org.

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National Alliance for the Mentally Ill (NAMI), 3803 N. Fairfax Dr., Ste. 100, Arlington, VA, 22203, (703) 524-7600, (703) 524-9094, (800) 950-6264, http://www.nami.org.

National Institute of Mental Health (NIMH), 6001 Executive Boulevard, Room 8184, MSC 9663, Bethesda, MD 20892-9663, (866) 615-6464, http://www.nimh.nih.gov.

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Depression *see* **Depressive disorders; Postpartum depression**

Dermabrasion *see* **Skin resurfacing**

Dermatitis

Definition

Dermatitis is a general term used to describe inflammation of the skin.

Description

Most types of dermatitis are characterized by an itchy pink or red rash.

Contact dermatitis is an allergic reaction to something that irritates the skin and is manifested by one or more lines of red, swollen, blistered skin that may itch or seep. It usually appears within 48 hours after touching or brushing against a substance to which the skin is sensitive. The condition is more common in adults than in children.

Contact dermatitis can occur on any part of the body, but it usually affects the hands, feet, and groin. Contact dermatitis usually does not spread from one person to another, nor does it spread beyond the area exposed to the irritant unless affected skin comes into contact with another part of the body. However, in the case of some irritants, such as **poison ivy**, contact dermatitis can be passed to another person or to another part of the body.

Dermatitis on hands and fingers. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Stasis dermatitis is characterized by scaly, greasy looking skin on the lower legs and around the ankles. Stasis dermatitis is most apt to affect the inner side of the calf.

Nummular dermatitis, which is also called nummular eczematous dermatitis or nummular **eczema**, generally affects the hands, arms, legs, and buttocks of men and women older than 55 years of age. This stubborn inflamed rash forms circular, sometimes itchy, patches and is characterized by flares and periods of inactivity.

Atopic dermatitis is characterized by **itching**, scaling, swelling, and sometimes blistering. In early childhood it is called infantile eczema and is characterized by redness, oozing, and crusting. It is usually found on the face, inside the elbows, and behind the knees.

Seborrheic dermatitis may be dry or moist and is characterized by greasy scales and yellowish crusts on the scalp, eyelids, face, external surfaces of the ears, underarms, breasts, and groin. In infants it is called "cradle cap."

Causes and symptoms

Allergic reactions are genetically determined, and different substances cause contact dermatitis to develop in different people. A reaction to resin produced by poison ivy, **poison oak**, or poison sumac is the most common source of symptoms. It is, in fact, the most common allergy in this country, affecting one of every two people in the United States.

Flowers, herbs, and vegetables can also affect the skin of some people. **Burns** and **sunburn** increase the risk of dermatitis developing, and chemical irritants that can cause the condition include:

- chlorine
- cleansers
- detergents and soaps
- fabric softeners
- glues used on artificial nails
- perfumes
- topical medications

Contact dermatitis can develop when the first contact occurs or after years of use or exposure.

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Stasis dermatitis, a consequence of poor circulation, occurs when leg veins can no longer return blood to the heart as efficiently as they once did. When that happens, fluid collects in the lower legs and causes them to swell. Stasis dermatitis can also result in a rash that can break down into sores known as stasis ulcers.

The cause of nummular dermatitis is not known, but it usually occurs in cold weather and is most common in people who have dry skin. Hot weather and **stress** can aggravate this condition, as can the following:

- allergies
- fabric softeners
- soaps and detergents
- wool clothing
- bathing more than once a day

Atopic dermatitis can be caused by **allergies**, **asthma**, or stress, and there seems to be a genetic predisposition for atopic conditions. It is sometimes caused by an allergy to nickel in jewelry.

Seborrheic dermatitis (for which there may also be a genetic predisposition) is usually caused by overproduction of the oil glands. In adults it can be associated with **diabetes mellitus** or gold allergy. In infants and adults it may be caused by a biotin deficiency.

Diagnosis

The diagnosis of dermatitis is made on the basis of how the rash looks and its location. The doctor may scrape off a small piece of affected skin for microscopic examination or direct the patient to discontinue use of any potential irritant that has recently come into contact with the affected area. Two weeks after the rash disappears, the patient may resume use of the substances, one at a time, until the condition recurs. Eliminating the substance most recently added should eliminate the irritation.

If the origin of the irritation has still not been identified, a dermatologist may perform one or more patch tests. This involves dabbing a small amount of a suspected irritant onto skin on the patient's back. If no irritation develops within a few days, another patch test is performed. The process continues until the patient experiences an allergic reaction at the spot where the irritant was applied.

Treatment

Treating contact dermatitis begins with eliminating or avoiding the source of irritation. Prescription or over-the-counter corticosteroid creams can lessen inflammation and relieve irritation. Creams, lotions, or ointments not specifically formulated for dermatitis can intensify the irritation. Oral **antihistamines** are sometimes recommended to alleviate itching, and **antibiotics** are prescribed if the rash becomes infected. Medications taken by mouth to relieve symptoms of dermatitis can make skin red and scaly and cause hair loss.

Patients who have a history of dermatitis should remove their rings before washing their hands. They should use bath oils or glycerine-based soaps and bathe in lukewarm saltwater.

Patting rather than rubbing the skin after bathing and thoroughly massaging lubricating lotion or nonprescription cortisone creams into still-damp skin can soothe red, irritated nummular dermatitis. Highly concentrated cortisone preparations should not be applied to the face, armpits, groin, or rectal area. Periodic medical monitoring is necessary to detect side effects in patients who use such preparations on **rashes** covering large areas of the body.

Coal-tar salves can help relieve symptoms of nummular dermatitis that have not responded to other treatments, but these ointments have an unpleasant odor and stain clothing.

Patients who have stasis dermatitis should elevate their legs as often as possible and sleep with a pillow between the lower legs.

Tar or zinc paste may also be used to treat stasis dermatitis. Because these compounds must remain in contact with the rash for as long as two weeks, the paste and **bandages** must be applied by a nurse or a doctor.

Coal-tar shampoos may be used for seborrheic dermatitis that occurs on the scalp. Sun exposure after the use of these shampoos should be avoided because the risk of sunburn of the scalp is increased.

Alternative treatment

Some herbal therapies can be useful for skin conditions. Among the herbs most often recommended are:

- Burdock root (*Arctium lappa*)
- Calendula (*Calendula officinalis*) ointment
- Chamomile (*Matricaria recutita*) ointment
- Cleavers (*Galium* ssp.)
- Evening primrose oil (*Oenothera biennis*)
- Nettles (*Urtica dioica*)

Contact dermatitis can be treated botanically and homeopathically. Grindelia (*Grindelia* spp.) and sassafras (*Sassafras albidum*) can help when applied topically. Determining the source of the problem and

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KEY TERMS

Allergic reaction—An inappropriate or exaggerated genetically determined reaction to a chemical that occurs only on the second or subsequent exposures to the offending agent, after the first contact has sensitized the body.

Corticosteriod—A group of synthetic hormones that are used to prevent or reduce inflammation. Toxic effects may result from rapid withdrawal after prolonged use or from continued use of large doses.

Patch test—A skin test that is done to identify allergens. A suspected substance is applied to the skin. After 24–48 hours, if the area is red and swollen, the test is positive for that substance. If no reaction occurs, another substance is applied. This is continued until the patient experiences an allergic reaction where the irritant was applied to the skin.

Rash—A spotted, pink or red skin eruption that may be accompanied by itching and is caused by disease, contact with an allergen, food ingestion, or drug reaction.

Ulcer—An open sore on the skin, resulting from tissue destruction, that is usually accompanied by redness, pain, or infection.

eliminating it is essential. Oatmeal baths are very helpful in relieving the itch. Bentonite clay packs or any mud pack draws the fluid out and helps dry up the lesions. Cortisone creams are not recommended.

Stasis dermatitis should be treated by a trained practitioner. This condition responds well to topical herbal therapies, however, the cause must also be addressed. Selenium-based shampoos, topical applications of flax oil and/or olive oil, and biotin supplementation are among the therapies recommended for seborrheic dermatitis.

Prognosis

Dermatitis is often chronic, but symptoms can generally be controlled.

Prevention

Contact dermatitis can be prevented by avoiding the source of irritation. If the irritant cannot be avoided completely, the patient should wear gloves and other protective clothing whenever exposure is likely to occur.

Immediately washing the exposed area with soap and water can stem allergic reactions to poison ivy, poison oak, or poison sumac, but because soaps can dry the skin, patients susceptible to dermatitis should use them only on the face, feet, genitals, and underarms.

Clothing should be loose fitting and 100% cotton. New clothing should be washed in dye-free, unscented detergent before being worn.

Injury to the lower leg can cause stasis dermatitis to ulcerate (form open sores). If stasis ulcers develop, a doctor should be notified immediately.

Yoga and other relaxation techniques may help prevent atopic dermatitis caused by stress.

Avoidance of sweating may aid in preventing seborrheic dermatitis.

A patient who has dermatitis should also notify a doctor if any of the following occurs:

- fever develops
- skin oozes or other signs of infection appear
- symptoms do not begin to subside after seven days' treatment
- he/she comes into contact with someone who has a wart, cold sore, or other viral skin infection

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Dermatomyositis

Definition

Dermatomyositis (DM) is a rare inflammatory muscle disease that leads to destruction of muscle tissue usually accompanied by **pain** and weakness.

Description

Dermatomyositis is one of a group of three related diseases called inflammatory **myopathies**. The other

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two are **polymyositis** and inclusion-body **myositis**. These diseases are rare; only about 20,000 people in the United States have dermatomyositis. Another estimates suggest that DM occurs in about 5.5 individuals out of every one million. The disease is of unknown origin and can develop in children and adults. Most often individuals either develop DM either between the ages of five and 14 or they do not develop it until they are over age 45. In all age groups, females are twice as likely to develop the disease than males. Although DM causes pain and weakness, it is not necessarily life threatening. However, adults, but not children, who develop DM have an increased risk of developing **cancer** and should be screened for malignancies regularly.

Causes and symptoms

The exact cause of dermatomyositis is unknown. It is an autoimmune disease. In a healthy body, cells of immune system attack only foreign or defective cells in the body to protect it from disease. In an autoimmune disease, the immune system attacks normal body cells. In the case of DM, immune system cells attack healthy cells of small blood vessels in the muscle and skin. Over time, this causes muscle fiber to shrink and sometimes cuts off blood supply to the muscle. DM tends to develop in muscles closest to the center of the body.

As yet, there is no clear explanation of what causes an individual to develop DM. It is thought that the disease may be triggered by a virus or exposure to certain drugs or vaccines. According to the **Muscular Dystrophy** Association, recent research suggests developing DM may be related to the mixing of blood cells that sometimes occurs between the mother and fetus during **pregnancy**. The disease is not directly inherited, although there may be some genetic sensitivity toward whatever triggers it.

Often the first sign of DM is the development of a patchy, scaly, violet to dark red skin rash on the face, neck, shoulders, upper chest, knees, or back. Often the rash appears before any signs of illness or muscle weakness. About 40% of children and teens develop hard, painful bumps under the skin that are deposits of **calcium**, a mineral used in bone formation. This condition, called calcinosis, is much less common in adults.

Muscle weakness, especially in the upper arms, hips, thighs, and neck, becomes apparent in activities such as climbing stairs or reaching up over the head. This weakness develops after the rash appears. Some people have difficulty swallowing and chewing when the muscles of the face and esophagus are affected. Individuals may also feel tried, weak, have a low-grade **fever**, weight loss, and joint stiffness. Some individuals have the rash for years before they progress to these symptoms, while in others the onset of symptoms is rapid. In children the development of symptoms is almost always gradual, making diagnosis especially difficult.

Diagnosis

DM can be difficult to diagnose, and often the first doctor an individual sees is a dermatologist for treatment of the rash and then is referred to a rheumatologist, specialist in internal medicine or neurologist when DM is suspected. Many tests may be done to rule out other diseases before a firm diagnosis is made. A blood test is done to measure the level of creatine kinase. Creatine kinase is an enzyme found in muscle tissue. When muscle is damaged, this enzyme leaks out into the blood. An increased level of creatine kinase in the blood suggests DM as a possible diagnosis. Another blood test may be done to test for specific immune system antibodies. Antibodies are proteins made in response to material the body thinks is foreign.

An electromyogram (EMG) is a test that measures electrical activity in muscles as they contract. Individuals with inflammatory myopathies usually have distinct patterns of electrical activity in the affected muscles. However, up to 15% of people with DM have normal electromyogram readings, so this test is not definitive. The definitive test is a muscle biopsy. The doctor takes a small sample of muscle tissue and examines it under a microscope. From this sample, the doctor can differentiate DM from other inflammatory myopathies and other muscle wasting diseases.

Treatment

The goal of treatment is to improve muscle strength and allow the individual to participate in normal daily activities. Individuals are given steroid drugs (prednisone, **corticosteroids**) that suppress the immune system. Over time, these drugs often produce undesirable side effects, so treatment is usually begun with a large dose, then tapered to the minimum dose needed for maintenance. People who do not respond well to steroid treatment may be treated with other immunosuppressive drugs or intravenous immunoglobulin. Individuals with DM are advised to avoid exposure to the sun, as sunlight worsens the skin rash. **Physical therapy** is often helpful in keeping joints from stiffening and freezing. Moderate **exercise** is also recommended.

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KEY TERMS

Immunoglobulin—Material containing specific antibodies to fight disease that can be injected into an individual to fight infection.

Inflammation—An infection or irritation of a tissue.

Myopathy—Relating to muscle tissue.

Alternative treatment

A healthy diet high is recommended for all individuals with supplemental protein for those with severe muscle damage.

Prognosis

The course of DM is highly variable. In about 20% of people, the disease spontaneously goes into remission and individuals are able to lead symptom-free lives for long periods. On the other hand, in about 5% of individuals the disease progresses to **death** because of heart and lung involvement. The majority of people continue to have some symptoms and require long-term treatment, but their degree of daily activity varies greatly.

Serious complications from DM include involvement of the muscles of the heart and lungs, difficulty eating and swallowing, and a tendency to develop cancer. This association is seen only in adults and not in children. Individuals over age 60 are more likely to have serious complications than younger individuals.

Prevention

There is no known way to prevent this disease.

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American Autoimmune Related Diseases Association, Inc., 22100 Gratiot Avenue, East Detroit, MI, 48021, (586) 776-3900, (586) 776-3903, http://www.aarda.org.

Muscular Dystrophy Association, 3300 East Sunrise Drive, Tucson, AZ, 85718, (800) 572-1717, http://www.mdausa.org.

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923, (800) 999-6673, http://www.rarediseases.org.

The Myositis Association, 1737 King Street, Suite 600, Alexandria, VA, 22314, (800) 821-7356, TMA@myositis.org, http://www.myositis.org.

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Dermatophyte infections *see* **Ringworm**

DES exposure

Definition

DES (diethylstilbestrol) is a hormone that was prescribed for pregnant women in the 1950s and early 1960s. Many years later, doctors discovered that the daughters of the women who received DES were at high risk for a variety of problems, including **infertility**, **premature labor**, and **cancer** of the vagina and cervix. Sons of DES mothers were also affected.

Demographics

It is estimated that five to 10 million people in the United States were exposed to DES between 1938 and 1971. The United States has approximately 250,000 to one million DES daughters.

Description

In the 1950s and early 1960s, several drug companies claimed that DES (diethylstilbestrol) could prevent miscarriages. DES is a synthetic hormone, related to estrogen. At the time, up to 20% of all pregnancies ended in **miscarriage**, making this an important breakthrough and DES was prescribed for many women who had bleeding in early **pregnancy**. Ultimately, it was found to have no effect on miscarriages and the practice of prescribing DES was stopped in the 1960s. Almost 10 years later, the daughters of women who had taken DES during pregnancy began to develop unusual symptoms.

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Doctors discovered that when these young women reached their teens, they were at higher risk for a variety of problems, including:

- clear cell adenocarcinoma of the vagina and cervix
- infertility
- premature labor and other problems in pregnancy

Sons of DES mothers were also affected, although fertility issues are not as common among DES sons as in DES daughters. Sons of DES mothers are more likely to be diagnosed with:

- increased rate of cryptorchidism (undescended testicles)
- increased incidence of epididymal cysts
- increased incidence of hypoplastic testes

KEY TERMS

Cervix—The opening at the bottom of the uterus.

Colposcopy—A special examination of the cervix using a magnifying scope. This is a procedure that can be done in the doctor's office.

Fallopian tubes—The tubes that carry the ovum (egg) from the ovary to the uterus.

Pap smear—A screening test for precancerous and cancerous cells on the cervix. This simple test is done during a routine pelvic exam and involves scraping cells from the cervix.

Causes and symptoms

DES has affected a very specific group of women. These are women who were exposed to DES in utero before 18 weeks of pregnancy. In other words, their mothers must have taken DES within the first four-to-five months of pregnancy. It is now known that the female reproductive organs are formed during that time. DES appears to interfere with proper growth and development of the uterus, cervix, vagina, and fallopian tubes. In some studies, DES was also associated with a modestly increased risk of **breast cancer** for DES mothers.

In the early 1970s, there was an increase in a rare form of cancer, clear cell adenocarcinoma of the vagina and cervix. Up until that time, doctors had seen these cancers only in elderly women. Suddenly, young women who had the disease appeared.

Researchers studied these women to see if they had anything in common. After extensive questioning and examination, it was found that all of the young women had been exposed to DES in utero in the early weeks of pregnancy.

It was a shocking discovery. Doctors had only recently recognized that medications and exposure to chemicals during pregnancy could cause **birth defects**. This was a birth defect that had gone undetected for almost two decades.

Since then, doctors have studied DES daughters very carefully. Fortunately, the risk of clear cell adenocarcinoma is actually quite low. In fact, it appears that if a DES daughter has not developed this cancer by age 30, she will not develop it. Since all DES daughters are now over age 30, there should be no further cases related to DES exposure. However, there are a number of other symptoms and problems associated with DES exposure.

- Cervix and vagina. DES daughters often have distinctive changes of the cervix and vagina that can be seen during a pelvic exam. These changes include a cervical hood (a vaginal fold draped over the cervix), cockscomb cervix (an abnormally shaped cervix), and adenosis (glandular cells normally located within the cervix that appear on the outside of the cervix and in the vagina).
- Fallopian tubes. Some DES daughters have fallopian tube abnormalities that lead to infertility.
- Uterus. Many DES daughters have a uterus that is abnormal in size and shape. The classic sign is the T-shaped uterus. In the normal uterus, the cavity (hollow space inside) is rounded. In a T-shaped uterus, the cavity is reduced to a thin T. The abnormal shape of the inside of the uterus makes it harder for a woman to get pregnant and leads to a higher risk of premature labor and birth.

Diagnosis

Women who have been exposed to DES should have a **pelvic exam** at least once a year. In addition to the usual pelvic exam and Pap smear, DES daughters should have Pap smears of the vagina and, if possible, **colposcopy**. During colposcopy, the doctor looks at the cervix and vagina through a special magnifying scope. In this way, tiny areas of abnormal cells can be seen. This procedure is easily performed in the doctor's office.

When DES daughters get pregnant, they may be at high risk for premature labor and birth and should be monitored very carefully.

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Not all women who were exposed to DES develop problems in pregnancy. However, if problems like infertility or miscarriage occur, the doctor may recommend a special x-ray test to check the woman's fallopian tubes and uterus. This special test is called a hysterosalpingogram.

Treatment

There is no treatment for the abnormalities of the fallopian tubes and uterus caused by DES exposure. Fortunately, there are treatments that can help with infertility and premature labor. Clear cell adenocarcinoma of the vagina or cervix must be treated with surgery and, possibly, **chemotherapy**.

Prevention

The practice of prescribing DES to prevent miscarriages has been banned in the United States for about five decades. Individuals, especially women, who were exposed to DES in utero, should notify their health care providers and should continue to be monitored.

The Centers for Disease Control and other agencies around the world continue to monitor the women who were prescribed DES and their offspring, including the third generation (grandchildren of the original mothers prescribed DES), to determine the effects, if any, of DES exposure on successive generations.

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Detached retina *see* **Retinal detachment**

Detoxification

Definition

Detoxification is one of the more widely used treatments and concepts in alternative medicine. It is based on the principle that illnesses can be caused by the accumulation of toxic substances (toxins) in the body. Eliminating existing toxins and avoiding new toxins are essential parts of the healing process. Detoxification utilizes a variety of tests and techniques.

Purpose

Detoxification is helpful for those patients suffering from many chronic diseases and conditions, including **allergies**, **anxiety**, arthritis, **asthma**, chronic infections, depression, diabetes, headaches, heart disease, high cholesterol, low blood sugar levels, digestive disorders, mental illness, and **obesity**. It is helpful for those with conditions that are influenced by environmental factors, such as **cancer**, as well as for those who have been exposed to high levels of toxic materials due to accident or occupation. Detoxification therapy is useful for those suffering from allergies or immune system problems that conventional medicine is unable to diagnose or treat, including **chronic fatigue syndrome**, environmental

Common herbs used for detoxification

Antibiotics	Anticatarrhals (help eliminate mucus)	Blood cleaners
Clove	Boneset	Buckthorn
Echinacea	Echinacea	Burdock root
Eucalyptus	Garlic	Dandelion root
Garlic	Goldenseal root	Echinacea
Myrrh	Hyssop	Red clover blossoms
Prickly ash bark	Sage	Yellow dock root
Propolis	Yarrow	
Wormwood		

Diaphoretics/skin cleaners	Diuretics	Laxatives
Boneset	Cleavers	Buckthorn
Burdock root	Corn silk	Cascara sagrada
Cayenne pepper	Horsetail	Dandelion root
Elder flowers	Juniper berries	Licorice root
Ginger root	Parsley leaf	Rhubarb root
Goldenseal root	Uva ursi	Senna
Oregon grape root	Yarrow	Yellow dock
Peppermint		
Yellow dock		

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illness/multiple chemical sensitivity, and fibromyalgia. Symptoms for those suffering these conditions may include unexplained **fatigue**, increased allergies, hypersensitivity to common materials, intolerance to certain foods and **indigestion**, aches and pains, low grade **fever**, headaches, **insomnia**, depression, sore throats, sudden weight loss or gain, lowered resistance to infection, general malaise, and disability. Detoxification can be used as a beneficial preventative measure and as a tool to increase overall health, vitality, and resistance to disease.

Description

Origins

Detoxification methods of healing have been used for thousands of years. **Fasting** is one of the oldest therapeutic practices in medicine. Hippocrates, the ancient Greek known as the "Father of Western medicine," recommended fasting as a means for improving health. **Ayurvedic medicine**, a traditional healing system that has developed over thousands of years, utilizes detoxification methods to treat many chronic conditions and to prevent illness.

Detoxification treatment has become one of the cornerstones of alternative medicine. Conventional medicine notes that environmental factors can play a significant role in many illnesses. Environmental medicine is a field that studies exactly how those environmental factors influence disease. Conditions such as asthma, cancer, chronic fatigue syndrome, **multiple chemical sensitivity**, and many others are strongly influenced by exposure to toxic or allergenic substances in the environment. The United States Centers for Disease Control estimate that over 80% of all illnesses have environmental and lifestyle causes.

Detoxification has also become a prominent treatment as people have become more aware of environmental pollution. It is estimated that one in every four Americans suffers from some level of **heavy metal poisoning**. Heavy metals, such as lead, mercury, cadmium, and arsenic, are by-products of industry. Synthetic agriculture chemicals, many of which are known to cause health problems, are also found in food, air, and water. American agriculture uses nearly 10lb (4.5 kg) of pesticides per person on the food supply each year. These toxins have become almost unavoidable. Pesticides that are used only on crops in the southern United States have been found in the tissue of animals in the far north of Canada. DDT, a cancer-causing insecticide that has been banned for decades, is still regularly found in the fatty tissue of animals, birds, and fish, even in extremely remote regions such as the North Pole.

The problem of toxins in the environment is compounded because humans are at the top of the food chain and are more likely to be exposed to an accumulation of toxic substances in the food supply. For instance, pesticides and herbicides are sprayed on grains that are then fed to farm animals. Toxic substances are stored in the fatty tissue of those animals. In addition, those animals are often injected with synthetic hormones, **antibiotics**, and other chemicals. When people eat meat products, they are exposed to the full range of chemicals and additives used along the entire agricultural chain. Detoxification specialists call this build up of toxins *bioaccumulation*. They assert that the bioaccumulation of toxic substances over time is responsible for many physical and mental disorders, especially ones that are increasing rapidly (like asthma, cancer, and mental illness). As a result, detoxification therapies are increasing in importance and popularity.

Toxins in the body include heavy metals and various chemicals such as pesticides, pollutants, and food additives. Drugs and alcohol have toxic effects in the body. Toxins are produced as normal by-products in the intestines by the bacteria that break down food. The digestion of protein also creates toxic by-products in the body.

The body has natural methods of detoxification. Individual cells get detoxified in the lymph and circulatory system. The liver is the principle organ of detoxification, assisted by the kidneys and intestines. Toxins can be excreted from the body by the kidneys, bowels, skin, and lungs. Detoxification treatments become necessary when the body's natural detoxification systems become overwhelmed. This can be caused by long-term effects of improper diet, **stress**, overeating, sedentary lifestyles, illness, and poor health habits in general. When a build up of toxic substances in the body creates illness, it's called toxemia. Some people's digestive tracts become unable to digest food properly, due to years of overeating and **diets** that are high in fat and processed foods and low in fiber (the average American diet). When this happens, food cannot pass through the digestive tract efficiently. Instead of being digested properly or eliminated from the bowel, food can literally rot inside the digestive tract and produce toxic by-products. This state is known as toxic colon syndrome or intestinal toxemia.

Detoxification therapies try to activate and assist the body's own detoxification processes. They also try to eliminate additional exposure to toxins and strengthen the body and immune system so that toxic imbalances won't occur in the future.

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Testing for toxic substances

Detoxification specialists use a variety of tests to determine the causes contributing to toxic conditions. These causes include infections, allergies, addictions, toxic chemicals, and digestive and organ dysfunction. Blood, urine, stool, and hair analyses, as well as **allergy tests**, are used to measure a variety of bodily functions that may indicate problems. Detoxification therapists usually have access to laboratories that specialize in sophisticated diagnostic tests for toxic conditions.

People who have toxemia are often susceptible to infection because their immune systems are weakened. Infections can be caused by parasites, bacteria, viruses, and a common yeast. Therapists will screen patients for underlying infections that may be contributing to illness.

Liver function is studied closely with blood and urine tests because the liver is the principle organ in the body responsible for removing toxic compounds. When the liver detoxifies a substance from the body, it does so in two phases. Tests are performed that indicate where problems may be occurring in these phases, which may point to specific types of toxins. Blood and urine tests can also be completed that screen for toxic chemicals such as PCBs (environmental poisons), formaldehyde (a common preservative), pesticides, and heavy metals. Another useful blood test is a test for zinc deficiency, which may reveal heavy metal **poisoning**. Hair analysis is used to test for heavy metal levels in the body. Blood and urine tests check immune system activity, and hormone levels can also indicate specific toxic compounds. A 24-hour urine analysis, where samples are taken around the clock, allows therapists to determine the efficiency of the digestive tract and kidneys. Together with stool analysis, these tests may indicate toxic bowel syndrome and digestive system disorders. Certain blood and urine tests may point to nutritional deficiencies and proper recovery diets can be designed for patients as well.

Detoxification therapists may also perform extensive allergy and hypersensitivity tests. Intradermal (between layers of the skin) and sublingual (under the tongue) allergy tests are used to determine a patient's sensitivity to a variety of common substances, including formaldehyde, auto exhaust, perfume, tobacco, chlorine, jet fuel, and other chemicals.

Food allergies require additional tests because these allergies often cause reactions that are delayed for several days after the food is eaten. The RAST (radioallergosorbent test) is a blood test that determines the level of antibodies (immunoglobulins) in the blood after specific foods are eaten. The cytotoxic test is a blood test that determines if certain substances affect blood cells, including foods and chemicals. The ELISA-ACT (enzyme-linked immunoserological assay activated cell test) is considered to be one of the most accurate tests for allergies and hypersensitivity to foods, chemicals, and other agents. Other tests for food allergies are the elimination and rotation diets, in which foods are systematically evaluated to determine the ones that are causing problems.

Detoxification therapists usually interview and counsel patients closely to determine and correct lifestyle, occupational, psychological, and emotional factors that may also be contributing to illness.

Detoxification therapies

Detoxification therapists use a variety of healing techniques after a diagnosis is made. The first step is to eliminate a patient's exposure to all toxic or allergenic substances. These include heavy metals, chemicals, radiation (from x rays, power lines, cell phones, computer screens, and microwaves), smog, polluted water, foods, drugs, **caffeine**, alcohol, perfume, excess noise, and stress. If **mercury poisoning** has been determined, the patient will be advised to have mercury fillings from the teeth removed, preferably by a holistic dentist.

Specific treatments are used to stimulate and assist the body's detoxification process. Dietary change is immediately enacted, eliminating allergic and unhealthy foods, and emphasizing foods that assist detoxification and support healing. **Detoxification diets** are generally low in fat, high in fiber, and vegetarian with a raw food emphasis. Processed foods, alcohol, and caffeine are avoided. **Nutritional supplements** such as **vitamins**, **minerals**, **antioxidants**, amino acids, and essential fatty acids are often prescribed. Spirulina is a sea algae that is frequently given to assist in eliminating heavy metals. Lipotropic agents are certain vitamins and nutrients that promote the flow of bile and fat from the liver.

Many herbal supplements are used in detoxification therapies as well. Milk thistle extract, called silymarin, is one of the more potent herbs for detoxifying the liver. Naturopathy, Ayurvedic medicine, and **traditional Chinese medicine** (TCM) recommend numerous herbal formulas for detoxification and immune strengthening. If infections or parasites have been found, these are treated with herbal formulas and, in difficult cases, antibiotics.

For toxic bowel syndrome and digestive tract disorders, herbal **laxatives** and high fiber foods such as psyllium seeds may be given to cleanse the digestive

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KEY TERMS

Allergen—A foreign substance, such as mites in house dust or animal dander, that when inhaled causes the airways to narrow and produces symptoms of asthma.

Antibody—A protein, also called immunoglobulin, produced by immune system cells to remove antigens (the foreign substances that trigger the immune response).

Fibromyalgia—A condition of debilitating pain, among other symptoms, in the muscles and the myofascia (the thin connective tissue that surrounds muscles, bones, and organs).

Hypersensitivity—The state where even a tiny amount of allergen can cause severe allergic reactions.

Multiple chemical sensitivity—A condition characterized by severe and crippling allergic reactions to commonly used substances, particularly chemicals. Also called environmental illness.

tract and promote elimination. Colonics are used to cleanse the lower intestines. Digestive enzymes are prescribed to improve digestion, and acidophilus and other friendly bacteria are reintroduced into the system with nutritional supplements.

Fasting is another major therapy in detoxification. Fasting is one of the quickest ways to promote the elimination of stored toxins in the body and to prompt the healing process. People with severe toxic conditions are supervised closely during fasting because the number of toxins in the body temporarily increases as they are being released.

Chelation therapy is used by detoxification specialists to rid the body of heavy metals. Chelates are particular substances that bind to heavy metals and speed their elimination. Homeopathic remedies have also been shown to be effective for removing heavy metals.

Sweating therapies can also detoxify the body because the skin is a major organ of elimination. Sweating helps release those toxins that are stored in the subcutaneous (under the skin) fat cells. Saunas, **therapeutic baths**, and **exercise** are some of these treatments. Body therapies may also be prescribed, including **massage therapy**, **acupressure**, **shiatsu**, manual lymph drainage, and **polarity therapy**. These body therapies seek to improve circulatory and structural problems, reduce stress, and promote healing responses in the body. Mind/body therapies such as **psychotherapy**, counseling, and stress management techniques may be used to heal the psychological components of illness and to help patients overcome their negative patterns contributing to illness.

Practitioners and treatment costs

The costs of detoxification therapies can vary widely, depending on the number of tests and treatments required. Detoxification treatments can be lengthy and involved since illnesses associated with toxic conditions usually develop over many years and may not clear up quickly. Detoxification treatments may be lengthy because they often strive for the holistic healing of the body, mind, and emotions.

Practitioners may be conventionally trained medical doctors with specialties in environmental medicine or interests in alternative treatment. The majority of detoxification therapists are alternative practitioners, such as naturopaths, homeopaths, ayurvedic doctors, or traditional Chinese doctors. Insurance coverage varies, depending on the practitioner and the treatment involved. Consumers should review their individual insurance policies regarding treatment coverage.

Preparations

Patients can assist diagnosis and treatment by keeping detailed diaries of their activities, symptoms, and contact with environmental factors that may be affecting their health. Reducing exposure to environmental toxins and making immediate dietary and lifestyle changes may speed the detoxification process.

Side effects

During the detoxification process, patients may experience side effects of fatigue, malaise, aches and pains, emotional duress, **acne**, headaches, allergies, and symptoms of colds and flu. Detoxification specialists claim that these negative side effects are part of the healing process. These reactions are sometimes called *healing crises*, which are caused by temporarily increased levels of toxins in the body due to elimination and cleansing.

Research and general acceptance

Although environmental medicine is gaining more respect within conventional medicine, detoxification

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treatment is scarcely mentioned by the medical establishment. The research that exists on detoxification is largely testimonial, consisting of individual personal accounts of healing without statistics or controlled scientific experiments. In the alternative medical community, detoxification is an essential and widely accepted treatment for many illnesses and chronic conditions.

Resources

OTHER

A Citizens Toxic Waste Manual. Greenpeace USA, 1436 U St. NW, Washington, DC 20009. (202) 462-1177.

ORGANIZATIONS

American Holistic Medical Association, 23366 Commerce Park, Suite 101B, Beachwood, OH, 44122, (216) 292-6644, (216) 292-6688, info@holisticmedicine.org, http://www.holisticmedicine.org.

Cancer Prevention Coalition, c/o University of Illinois at Chicago; School of Public Health, MC 922; 2121 West Taylor Street, Chicago, IL, 60612, (312) 996-2297, (312) 413-9898, http://www.preventcancer.com/.

Center for Occupational and Environmental Medicine, 7510 Northforest Dr, North Charleston, SC, 29420, (843) 572-1600, (843) 572-1795, allanl@coem.com, http://www. coem.com.

Douglas Dupler, MA

Detoxification diets

Definition

Detoxification diets, or detox diets for short, are a group of short-term diets intended to release accumulated toxins and waste products from the body. They are based on a theory of digestion and elimination usually associated with naturopathy, an alternative medical system that emphasizes the role of **nutrition** in restoring or improving the body's own self-healing properties. In general, detox diets emphasize the following:

- Minimal intake of chemicals on or in food by choosing organic or non-processed foods
- Increased intake of fruits, vegetables, and other foods thought to aid the process of detoxification
- Increased intake of foods and fluids that speed up the processes of urination and defecation

Detoxification diets can be categorized into several subgroups: raw food diets, which are based on the premise that uncooked foods prevent the accumulation of toxins in the digestive system; mono diets, in which the dieter consumes only one or two foods (sometimes in liquid form only) for a period of 10–14 days; juice **fasting**, in which the dieter consumes large quantities of fruit and vegetable juices along with water and herbal teas for one to three days; and vegetarian or semi-vegetarian detox diets, which allow the dieter some variety of cooked whole grains, steamed vegetables, fresh fruit, and small amounts of protein foods as well as several glasses of water and herbal teas each day.

Origins

Detoxification diets as a general practice can be traced back for over 5,500 years to an annual ritual of bodily and spiritual preparation known as *pancha karma*, which is part of the practice of **Ayurvedic medicine** in India. Ayurveda is a traditional system of health care that dates back to about 3500 BC; its name is Sanskrit for "science of long life." Pancha karma is undergone for disease prevention, which in Ayurvedic practice requires spiritual renewal and the breaking of negative emotional patterns as well as physical purification. It has three phases: a preparation phase, in which the person eliminates sweets, caffeinated drinks, and processed foods from the diet, as well as spending more time in **meditation** and taking walks in natural surroundings; the cleansing phase, which includes bloodletting, emesis (forced **vomiting**), nasal cleansing, and the use of **enemas** and **laxatives** as well as a very restricted diet of grains and vegetables; and a rejuvenation phase, in which solid foods are gradually reintroduced to the diet. Practitioners of Ayurveda in Canada and the United States generally omit **vomiting** and bloodletting in the second phase of pancha karma.

In Europe and North America the most important factor in the popularity of detoxification diets is naturopathy, an alternative approach to health care developed out of the natural healing movement in Germany and North America in the late nineteenth century. Naturopathy is closely connected with **vegetarianism**, particularly its raw-food offshoot. Naturopaths of the twenty-first century use a variety of techniques in treating patients, including **hydrotherapy**, spinal manipulation, and **physical therapy** as well as nutrition and dietary advice. There has been a revival of interest in naturopathy in the United States since the 1980s.

Naturopaths frequently recommend detoxification diets as a way of ridding the body of various toxins that they identify as coming from several sources:

- Heavy metals. These include such substances as cadmium, arsenic, nickel, aluminum, chromium, mercury,

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vanadium, strontium, antimony, cobalt, and lead, which are used in various manufacturing processes and some medical procedures as well as being present in batteries, electronic equipment, coins, cookware, food containers, and other common household items.

- Toxic chemicals taken directly into the digestive tract through alcoholic beverages, pesticide residues on supermarket produce, additives in processed foods, or drugs of abuse; or taken into the respiratory tract through breathing household solvents (nail polish remover, spot or stain removers containing benzene, etc.).
- Toxins in the digestive tract produced by yeast and other microorganisms. Ridding the body of this group of toxins is frequently cited as a reason for combining laxatives or enemas with detoxification diets. Mainstream physicians dispute the notion that normal digestion produces toxic substances in the colon that must be removed by a laxative or enema.
- Ammonia, urea, and other breakdown products of protein metabolism. Naturopaths often recommend a vegetarian lifestyle as well as periodic intensive detoxification practices in order to minimize the production of these byproducts of meat and dairy products consumption.

A third factor that has contributed to interest in detox diets in the 1990s and early 2000s is the environmental movement. Some people who are concerned about the impact on the environment of raising animals for food use detox diets as a transition into a long-term vegetarian or vegan lifestyle. In addition, growing awareness of the effects of exposure to industrial chemicals, pesticides, secondhand tobacco smoke, and other contaminants in the home environment as well as the workplace has led many people to consider detoxification diets as a preventive health practice to lower their risk of arthritis and other degenerative diseases.

Description

Practitioners of alternative medicine generally recommend the warmer months as the best time of year for a detox diet, although some dieters prefer January in order to counteract the effects of overindulgence in food and drink during the holidays. Many people suggest beginning a detox diet on the weekend or scheduling time off from work in order to allow time for extra rest if needed. Detox diets are usually used only once or twice a year.

Many detoxification diet books include a questionnaire or symptom checklist to help readers evaluate whether they need detoxification. The following list is typical; more than four "yes" answers indicates the individual could benefit from a detox diet:

- Do you have only one bowel movement per day, or only one every other day?
- Do you take prescription, recreational, or over-the-counter drugs?
- Do you eat meat more than twice a week?
- Do you eat fast foods or processed foods?
- Do you smoke, or are you exposed to secondhand smoke?
- Do you have any skin problems or digestive gas and bloating?
- Do you drink alcohol?
- Do you live in a major city?
- Do you drink tap water, coffee, or soda?
- Do you feel tired, sleep poorly, or have low energy?

Individuals considering a detox diet should prepare by cutting down gradually on caffeinated beverages a week to 10 days before the diet, as sudden elimination of these drinks often causes headaches. Dieters should also reduce their intake of sugary foods, chocolate, alcohol, dairy products, foods high in fat, foods containing wheat or yeast, and grains containing gluten (an elastic protein found in barley and rye). Recommended foods for detox diets (except the mono diets) include fresh organic fruits and vegetables; rice (both brown and basmati rice), rice cakes, and rice pasta; other grains such as millet, quinoa, and buckwheat; beans, lentils, and dried green or yellow peas; unsalted nuts; seeds; olive oil; and herbal teas. The dieter should plan to drink at least eight glasses of filtered or other non-tap water per day on a detox diet.

At the end of a detox diet, the dieter should return gradually to a full diet, perhaps vegetable soup or steamed vegetables the first day. They should not add fruits or vegetables until the second or third day.

Raw food diets

Raw food detox diets consist of foods that have not been heated above 92° to 118°F (33° to 48°C). These diets are based on the belief that raw foods have higher nutrient value and contain enzymes that assist digestion, allowing the other enzymes in the body to regulate other biological processes. Raw foodists also believe raw foods prevent **obesity** by lowering excessive food consumption, and their high fiber content helps detoxify the body by speeding up digestion and elimination.

Juice fasting

In a juice fast, the dieter is instructed to drink between 32 and 64 oz of fruit or vegetable juice per day, in addition to six glasses of warm filtered water.

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Although some modified juice fasts allow a small quantity of steamed vegetables, most are short-term liquid diets. Some therapists recommend one or more cups of herbal tea each day in addition to the juice and water. The juice must be fresh, obtained from organic fruits and vegetables processed through a juicer or juice extractor. Prepackaged juices cannot be used for a juice fast because they have been pasteurized. In addition, fresh juice must be consumed within a half hour of extraction; it cannot be refrigerated.

Mono diets

Mono diets are detox diets in which the dieter consumes only one food, usually apples, grapes, or some other fruit or vegetable, or one liquid, for a period of 10 to 14 days. The oldest mono diet is the so-called Miracle Grape Cure, attributed to Johanna Brandt, a woman from South Africa who claimed that eating grapes cured her of **stomach cancer**. In a book she published in 1928, Brandt stated that she alternated 12 hours of drinking only natural (unchlorinated) water with 12 hours of eating only purple grapes or drinking grape juice made from purple grapes. Recent modifications of this diet recommend following Brandt's plan to the letter for five weeks, followed by one week of a raw-food vegetarian diet.

The best-known mono diet is variously known as the Master Cleanser, lemonade diet, or maple syrup diet. Stanley Burroughs is generally credited with inventing this diet in 1941, although he did not publish it in book form until 1976. His book, which is only about fifty pages long, is still in print even though Burroughs died in 1991. The Master Cleanser involves drinking a mixture of lemon juice, cayenne pepper, and grade B maple syrup for a period of 10 to 14 days. The lemon/maple syrup drink is then followed by drinking a "saltwater flush," which is supposed to purge toxins from the stomach and bowels. This diet was popularized in the early 2000s by a book by Peter Glickman titled *Lose Weight, Have More Energy and Be Happier in 10 Days*, which is a modernization of Burrough's regimen.

Vegetarian or semivegetarian diets

Less stringent detox diets that allow some protein foods have been published; a typical example is the following diet plan for a week-long detox regimen by Elson Haas. Haas begins with general guidelines for the dieter:

- Eat slowly and chew the food well.
- Relax for a few minutes before and after each meal.
- Eat in a comfortable sitting position.
- Drink only herbal teas (peppermint, chamomile, or pau d'arco) after dinner.

The daily diet plan:

- Morning: two glasses of filtered or spring water, one glass with half a lemon squeezed into it.
- Breakfast: One piece of fresh fruit at room temperature, followed 15 to 30 minutes later by a bowl of cooked whole grains (millet, buckwheat, quinoa, brown rice, or amaranth), flavored with 2 tbsp of fruit juice.
- Lunch: One or two medium bowls of steamed vegetables, using a variety of root vegetables, leafy vegetables, asparagus, cabbage, kale, or others. A maximum of 3 tsp daily of a mixture of butter and canola or olive oil can be used for seasoning.
- Dinner: Same as lunch.
- Midmorning and midafternoon: One or two cups of vegetable water saved from the steamed vegetables, with a little sea salt or kelp added.
- A small portion (3 or 4 oz) of a protein food (fish, organic chicken, lentils, black beans, or garbanzo beans) may be eaten midafternoon if the dieter feels weak or extremely hungry.

Supplemental recommendations

An important part of many detoxification diets is the use of laxatives or enemas to cleanse the lower digestive tract. The removal of wastes is considered essential to prevent toxins in the intestines from being reabsorbed into the bloodstream. Some alternative therapists recommend mixtures of slippery elm or other herbs to cleanse the colon; others prefer saltwater laxatives, enemas, or colonics for cleansing the bowel. A colonic is a procedure in which a large amount of water, sometimes as much as 20 gal (76 L), is infused into the colon through the rectum a few pints at a time. It differs from an enema in that much more fluid is used; and a colonic is infused into the colon, whereas an enema infuses water or a cleansing solution into the rectum only. Mainstream physicians do not recommend colonics on the grounds that they are unnecessary, based on a nineteenth-century misunderstanding of the process of digestion, and very often uncomfortable for the patient. In some cases they pose serious risks to health.

Some therapists recommend the use of such dietary supplements as multivitamins, vitamin C, choline and methionine, milk thistle, or a laxative tea known as Smooth Move during a detox diet. These supplements are supposed to aid liver function and decrease such side effects of detox diets as headaches and **nausea**.

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Many advocates of detox diets suggest the use of meditation, affirmations, **yoga**, and other spiritual practices in order to improve the mental and emotional well-being. Others recommend undertaking the detox diet at a health spa, where such services as **massage therapy**, sauna baths, and whirlpool therapy or other forms of hydrotherapy are available.

Function

The primary function of detoxification diets is physical purification—removal of toxic substances from the body including the skin and respiratory system as well as the digestive tract—in order to raise energy levels; relieve such minor health complaints as poor skin, **bad breath**, or headaches; and improve the body's ability to heal from various diseases. These diets are not primarily intended as weight reduction regimens.

Spiritual or religious practice

Some people undertake detoxification diets as part of a general religious or spiritual retreat. The first stage of Ayurvedic pancha karma includes extra time given to meditation and nature walks as well as gradual exclusion of stimulants and solid foods from the diet. Many people also report relief from **insomnia** or other symptoms of emotional **stress** as a side benefit of detoxification diets.

Treatment of specific illnesses

Detoxification diets are sometimes recommended for the treatment of specific diseases and disorders, most commonly arthritis, **autoimmune disorders**, and depression, but they have also been claimed to be an effective treatment for severe infections (including **AIDS**) and **cancer**. However, there is insufficient evidence to support such claims.

Benefits

Claimed benefits of detox diets include higher energy levels, increased mental clarity and ability to concentrate, clearer skin, improved digestion, and more restful sleep. Many of these improvements may simply be due to better hydration as such diets encourage high fluid intake. Some people also lose weight on detox diets, but emphasize that weight reduction should never be the primary purpose of following one of these regimens.

Precautions

In general, anyone considering a detoxification diet should consult a health professional beforehand. Some serious diseases, including cancer, may have minor symptoms at onset, including headaches, **low back pain**, and **fatigue**. These symptoms can easily be misattributed to stress or poor eating habits. Some therapists recommend requesting blood, urine, stool, and **liver function tests** from a physician before undergoing a detoxification diet.

Individuals who should not undertake a detoxification diet are:

- Pregnant or lactating women.
- Children.
- People with diabetes, hypothyroidism, heart disease, anorexia or bulimia nervosa, kidney or liver disease, stomach ulcers, impaired immune function, epilepsy, cancer, terminal illness, active infections, or ulcerative colitis.
- People who are underweight.
- People with alcohol or drug addictions.
- People who have recently undergone surgery or treatment for severe burns.

Prescription medications should be taken as usual during a detoxification diet. The dieter should not discontinue medications or reduce dosages without consulting a physician.

Anyone on a detoxification diet who feels faint or dizzy, develops an abnormal heart rhythm, feels nauseated or vomits, or has signs of low blood pressure, should discontinue the fast and consult their doctor at once.

Detox diets may encourage yo-yo dieting, which is detrimental to health. They should not be undertaken more than three times a year without medical supervision.

Risks

The major risks to health from detoxification diets include metabolic crises in patients with undiagnosed diabetes; flare-ups or worsening of stomach ulcers; **dizziness** or **fainting** due to sudden lowering of blood pressure; **diarrhea** that may result in **dehydration** and an imbalance of electrolytes in the body; and protein or **calcium** deficiencies from unsupervised long-term juice fasts. Some people develop dental erosion from raw-food detoxification diets.

Other side effects reported include headaches (often caused by sudden withdrawal from **caffeine**), fatigue, **constipation** (from extra fiber combined with inadequate water intake), **acne**, irritability, **dysmenorrhea** (painful periods) in women, and intense hunger.

Raw-food detoxification diets increase the risk of contracting parasites or other foodborne illnesses caused by organisms normally destroyed in cooking

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or pasteurization. In addition, some raw vegetables, such as rhubarb leaves and stalks, buckwheat greens, kidney beans, kidney bean sprouts, and raw potatoes that have turned green are toxic, particularly if consumed in large quantities.

People on detoxification diets who undergo colonics are at risk of contracting an infection from improperly sterilized colonic equipment; of serious illness or **death** from electrolyte imbalances in the blood; or of serious illness or death resulting from perforation of the intestinal wall by improperly inserted equipment. Colonics can also worsen the symptoms of ulcerative **colitis**.

Research and general acceptance

Detoxification diets are generally dismissed as fads by such professional nutritionists' organizations as the American Dietetic Association (ADA) and other mainstream medical groups. Most physicians point out that the human body is a remarkably efficient organism that can rid itself of toxins through normal digestion, respiration, and excretion without elaborate diets or the assistance of enemas and laxatives. In addition, some fruits and vegetables may contain more toxins than meat, fish, and other protein-rich foods usually condemned by proponents of detoxification diets. Lastly, many physicians object to the naturopathic view of the digestive tract as a source of illness or toxicity.

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ORGANIZATIONS

American Dietetic Association, 120 S. Riverside Plaza, Suite 2000, Chicago, IL, 60606-6995, (312) 899-0040, (800) 877-1600, http://www.eatright.org.

American Holistic Medical Association, 23366 Commerce Park, Suite 101B, Beachwood, OH, 44122, (216) 292-6644, (216) 292-6688, http://www.holisticmedicine.org.

Rebecca J. Frey, PhD

Deviated septum

Definition

The nasal septum is a thin structure, separating the two sides of the nose. If it is not in the middle of the nose, then it is deviated.

Description

The nasal septum is composed of two parts. Toward the back of the head the nasal septum is rigid bone, but further forward the bone becomes cartilage. With one finger in each nostril this cartilage

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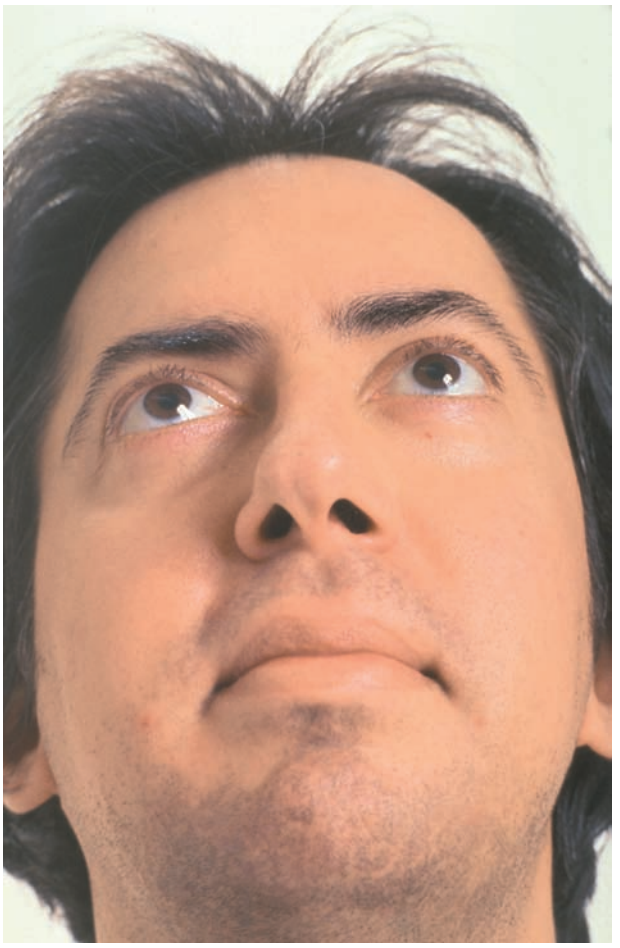

A close-up of person with a deviated septum. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

can easily be bent back and forth. If the nasal septum is sufficiently displaced to one side, it will impede the flow of air and mucus through the nose. This condition, called a deviated septum, can cause symptoms and disease.

Causes and symptoms

A deviated septum can be a simple variation in normal structure or the result of a broken nose. Any narrowing of the nasal passageway that it causes will threaten the drainage of secretions from the sinuses, which must pass through the nose. It is a general rule of medicine that when flow is obstructed, whether it is mucus from the sinuses or bile from the gall bladder, infection results. People with **allergic rhinitis** (hay fever) are at greater risk of obstruction because their nasal passageways are already narrowed by the swollen membranes lining them. The result is **sinusitis**, which can be acute and severe or chronic and lingering.

Diagnosis

It is easy to see that a septum is deviated. It is more difficult to determine if that deviation needs correction. It is common for a patient to complain that he/she can breathe through only one nostril. Then the diagnosis is easy. A deviated septum may also contribute to **snoring**, **sleep apnea**, and other breathing disorders.

Treatment

The definitive treatment is surgical repositioning of the septum, accomplished by breaking it loose and fixing it in a proper place while it heals. **Decongestants** like pseudoephedrine or phenylpropanolamine will shrink the membranes and thereby enlarge the passages. **Antihistamines**, nasal cortisone spray, and other allergy treatments may also be temporarily beneficial.

Alternative treatment

As a palliative, saline drops and sprays are very helpful in loosening mucus in the obstructed side and preventing drying in the other side, where all the air blows. Hot peppers, such as jalapenos, can produce enough tears and discharge to flush out a stopped-up nose. An even more effective treatment is called a nasal lavage, often done using a small pot with a spout. Saline solution is poured into one nostril and allowed to flow out the other nostril. Then, the process is repeated in reverse. These therapies are all useful to take care of symptoms, but do not correct the problem. Nasospecific, a procedure where a deflated balloon is inserted in the nostril and inflated to a large enough degree to adjust the septal deviation, can be an alternative to surgery. A trained practitioner in the nasospecific procedure is necessary.

Prognosis

Surgical repair is curative and carries little risk. Chronic infection can be painful and lead to complications until it is resolved. If there is continued obstruction, the infection will very likely return.

Prevention

Avoidance of virus colds, airborne dusts, air pollution, and known allergens will minimize the irritation and swelling of the membranes lining the nasal passages.

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KEY TERMS

Allergen—Any substance that irritates people sensitive (allergic) to it.

Allergic rhinitis—Swelling and inflammation of the nasal membranes caused by sensitivity to airborne matter like pollen or cat hair.

Saline—A salt solution in water. Normal saline has the same salt concentration as the body, 0.9%.

Sinuses—The nasal sinuses, air-filled cavities surrounding the eyes and nose, like the nose itself are lined with mucus-producing membranes. They provide cleansing to the nose, resonance to the voice, and structure to the face.

Sinusitis—Infection of the sinuses.

Sleep apnea—A condition in which breathing is temporarily interrupted during sleep. It leads to high blood pressure, sleepiness, and a variety of other problems.

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J. Ricker Polsdorfer, MD

Dextromethorphan *see* **Cough suppressants**

Diabetes insipidus

Definition

Diabetes insipidus (DI) is a disorder that causes the patient to produce tremendous quantities of urine. The massively increased urine output is usually accompanied by intense thirst.

Description

The balance of fluid within the body is maintained through a number of mechanisms. One important chemical involved in fluid balance is called antidiuretic hormone (ADH). ADH is produced by the pituitary, a small gland located at the base of the brain. In a healthy person and under normal conditions, ADH is continuously released. ADH influences the amount of fluid that the kidneys reabsorb into the circulatory system and the amount of fluid that the kidneys pass out of the body in the form of urine.

Production of ADH is regulated by the osmolality of the circulating blood. Osmolality refers to the concentration of dissolved chemicals (such as **sodium**, potassium, and chloride; together called solute) circulating in the fluid base of the blood (plasma). When there is very little fluid compared to the concentration of solute, the pituitary will increase ADH production. This tells the kidneys to retain more water and to decrease the amount of urine produced. As fluid is retained, the concentration of solute will normalize. At other times, when the fluid content of the blood is high in comparison to the concentration of solute, ADH production will decrease. The kidneys are then free to pass an increased amount of fluid out of the body in the urine. Again, this will allow the plasma osmolality to return to normal.

Diabetes insipidus occurs when either the amount of ADH produced by the pituitary is below normal (central DI), or the kidneys' ability to respond to ADH is defective (nephrogenic DI). In either case, a person with DI will pass extraordinarily large quantities of urine, sometimes reaching 10 or more liters each day. At the same time, the patient's blood will be very highly concentrated, with low fluid volume and high concentrations of solute.

DI occurs on average when a person is about 24 years old, and occurs more frequently in males than in females.

Causes and symptoms

DI may run in families. The cause of this type of DI is unknown. Other times, central DI can be caused by:

- an injury to the head
- brain surgery
- cancers that have spread to the pituitary gland (most commonly occurring with breast cancer)
- sarcoidosis (or other related disorders), causing destruction of the pituitary gland
- any condition or illness that causes decreased oxygen delivery to the brain

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- the use of certain medications that decrease ADH production (like the antiseizure drug phenytoin)
- the excessive use of alcohol

Central DI may also occur in women who are pregnant or have just given birth, and in patients with **AIDS** who have suffered certain types of brain infections. Nephrogenic DI sometimes occurs in patients who are taking the medication lithium, patients who have high levels of blood **calcium**, and patients who are pregnant.

DI is easily confused with an entirely unrelated disorder, psychogenic polydipsia. Polydipsia refers to drinking large amounts of water. Psychogenic polydipsia is a psychiatric problem that makes a person drink huge quantities of water uncontrollably.

Symptoms of DI include extreme thirst and the production of tremendous quantities of urine. Patients with DI typically drink huge amounts of water, and usually report a specific craving for cold water. When the amount of water passed in the urine exceeds the patient's ability to drink ample replacement water, the patient may begin to suffer from symptoms of **dehydration**. These symptoms include weakness, **fatigue**, **fever**, low blood pressure, increased heart rate, **dizziness**, and confusion. If left untreated, the patient could lapse into unconsciousness and die.

Diagnosis

Diagnosis should be suspected in any patient with sudden increased thirst and urination. Laboratory examination of urine will reveal very dilute urine, made up mostly of water with no solute. Examination of the blood will reveal very concentrated blood, high in solute and low in fluid volume.

A water deprivation test may be performed. This test requires a patient to stop all fluid intake. The patient is weighed just before the test begins, and urine is collected and examined hourly. The test is stopped when:

- the patient has lost more than 5% of his or her original body weight
- the patient has reached certain limits of low blood pressure and increased heart rate
- the urine is no longer changing significantly from one sample to the next in terms of solute concentration.

The next step of the test involves injecting a synthetic form of ADH, with one last urine sample examined 60 minutes later. Comparing plasma and urine osmolality allows the doctor to diagnose either central DI, nephrogenic DI, partial DI, or psychogenic polydipsia.

KEY TERMS

Concentration—Refers to the amount of solute present in a solution, compared to the total amount of solvent.

Dilute—A solution that has comparatively more fluid in it, relative to the quantity of solute.

Osmolality—A measure of the solute-to-solvent concentration of a solution.

Solute—Solid substances that are dissolved in liquid in order to make a solution.

Treatment

A number of medications can be given to decrease the quantity of fluid passed out into the urine. These include vasoprassin (Pitressin) injected and desmopressin acetate (DDAVP) inhaled through the nose, injected under the skin, or taken orally. Other medications that may be given include some antidiuretic drugs (chlorpropamide, clofibrate, carbamazepine). Patients with nephrogenic DI, however, will also require special **diets** that restrict the amount of solute taken in. These patients are also treated with a type of medication called a thiazide diuretic.

Prognosis

Uncomplicated diabetes insipidus is controllable with adequate intake of water and most patients can lead normal lives.

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ORGANIZATIONS

American Diabetes Association, 1701 North Beauregard Street, Alexandria, VA, 22311, (800) 342-2383, AskADA@diabetes.org, http://www.diabetes.org/.

Australian Diabetes Society, 145 Macquarie Street, Sydney, Australia, NSW 2000, 61(2) 9256 5462, 61(2) 9251-8174, suzie@diabetessociety.com.au, http://www.diabetes society.com.au.

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Canadian Diabetes Association, 1400-522 University Ave., Toronto, CanadaOntario, M5G 2R5, (800) 226-8464, info@diabetes.ca, http://www.diabetes.ca.
Juvenile Diabetes Research Foundation International, 26 Broadway, 14th Floor, New York, NY, 10004, (212) 785-9595, (800) 533-2873, info@jdrf.org, http://www.jdf.org.

Rosalyn Carson-DeWitt, MD
Ken R. Wells

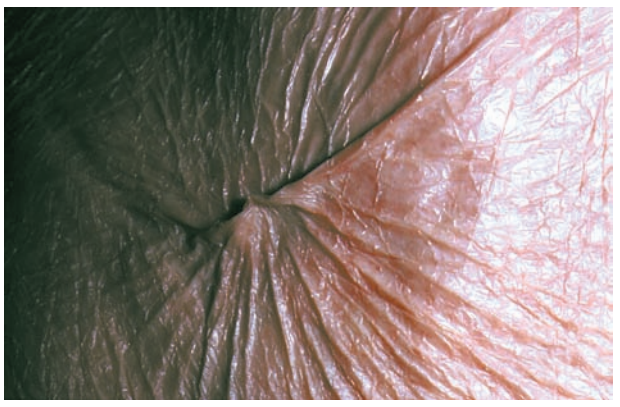
Diabetes mellitus

Definition

Diabetes mellitus is a condition in which the pancreas no longer produces enough insulin or cells stop responding to the insulin that is produced, so that glucose in the blood cannot be absorbed into the cells of the body. Symptoms include frequent urination, lethargy, weight loss, excessive thirst, and hunger. Treatment includes changes in diet, oral medications, and in some cases, daily injections of insulin or other hormone–like medications designed to boost insulin or lower blood sugar.

Demographics

Approximately 23 million Americans have diabetes, according to the American Diabetes Association. Unfortunately, as many as one-half are unaware they have it. The World Health Organization (WHO) estimates that as of 2010, 230 million people worldwide have diabetes, including 20 million in China, 31 million in India, 8.4 million in Indonesia, 33 million in Europe, 11 million in Africa, and two million in Mexico. WHO estimates that without large-scale, strategic intervention, the number of people with diabetes worldwide could double by 2030.



Wrinkled, dehydrated skin of a person in a diabetic coma. Untreated diabetes mellitus results in elevated blood glucose levels, causing a variety of symptoms that can culminate in a diabetic coma. *(Dr. P. Marazzi/SPL/Photo Researchers, Inc.)*

Description

Diabetes mellitus is a chronic disease that causes serious health complications including renal (kidney) failure, heart disease, **stroke**, limb **amputation**, and blindness. Every cell in the human body needs energy in order to function. The body's primary energy source is glucose, a simple sugar resulting from the digestion of foods containing carbohydrates (sugars and starches). Glucose from digested food circulates in the blood as a ready energy source for cells. Insulin is a hormone or chemical produced by cells in the pancreas, an organ located behind the stomach. Insulin bonds to a receptor site on the outside of cell and acts like a key to open a doorway into the cell, through which glucose can enter. Some of the glucose can be converted to concentrated energy sources like glycogen or fatty acids and saved for later use. When there is not enough insulin produced or when the doorway no longer recognizes the insulin key, glucose stays in the blood rather entering the cells.

The body will attempt to dilute the high level of glucose in the blood, a condition called hyperglycemia, by drawing water out of cells and into the bloodstream in an effort to dilute the sugar and excrete it in the urine. It is not unusual for people with undiagnosed diabetes to be constantly thirsty, drink large quantities of water, and to urinate frequently as their bodies try to get rid of the extra glucose. This creates high levels of glucose in the urine.

At the same time that the body is trying to get rid of glucose from the blood, cells are starving for glucose and sending signals to the body to eat more food, thus making patients extremely hungry. To provide energy for the starving cells, the body also tries to convert fats and proteins to glucose. The breakdown of fats and proteins for energy causes acid compounds called ketones to form in the blood. Ketones also will be excreted in the urine. As ketones build up in the blood, a condition called ketoacidosis can occur. This condition can be life–threatening if left untreated, leading to **coma** and **death**.

Types of diabetes mellitus

Type I diabetes, earlier called juvenile diabetes, begins most commonly in childhood, adolescence, or early adulthood. In this form of diabetes, the body produces little or no insulin. The disease is characterized

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by a sudden onset and occurs more frequently in populations descended from Northern European countries (Finland, Scotland, Scandinavia) than in those from Southern European countries, the Middle East, or Asia. In the United States, approximately three people in 1,000 develop Type I diabetes. This form is also called insulin–dependent diabetes because people who develop this type require daily injections of insulin.

Brittle diabetics are a subgroup of Type I in which patients have frequent and rapid swings of blood sugar levels between hyperglycemia (a condition where there is too much glucose or sugar in the blood) and **hypoglycemia** (a condition where there are abnormally low levels of glucose or sugar in the blood). These diabetics require several injections of different types of insulin during the day to keep the blood sugar level within a fairly normal range.

The more common form of diabetes, Type II diabetes, occurs in approximately three to five percent of Americans under 50 years of age, and increases to 10–15% in those over 50. More than 90% of the diabetics in the United States are Type II diabetics. Sometimes called adult–onset diabetes, this form of diabetes occurs most often in people who are overweight and who do not **exercise** enough. It is also more common in people of Native American, Hispanic, and African American descent. People who have migrated to Western cultures from East India, Japan, and Australian Aboriginal cultures also are more likely to develop Type II diabetes than those who remain in their original countries.

Type II is considered a milder form of diabetes because of its slow onset (sometimes developing over the course of several years) and because it frequently can be controlled with diet and oral medication. The consequences of uncontrolled and untreated Type II diabetes, however, are the just as serious as those for Type I. This form is also called non–insulin–dependent diabetes, a term that is somewhat misleading. Many people with Type II diabetes can control the condition with diet and oral medications, however, insulin injections are sometimes necessary if treatment with diet and oral medication is inadequate to maintain normal blood glucose levels

Another form of diabetes called **gestational diabetes** can develop during **pregnancy** and generally resolves after the baby is delivered. This diabetic condition develops during the second or third trimester of pregnancy in about two percent of pregnancies. In 2004, the incidence of gestational diabetes was reported to have increased 35% in 10 years. Children of women with gestational diabetes are more likely to be born prematurely, have hypoglycemia, have an excess of body fat, or have severe **jaundice** at birth. The condition usually is treated by diet; however, insulin injections may be required. Women who have diabetes during pregnancy are at higher risk for developing Type II diabetes within 5–10 years.

Diabetes also can develop as a result of pancreatic disease, **alcoholism**, **malnutrition**, or other severe illnesses that stress the body.

Causes and symptoms

Causes

The causes of diabetes mellitus are unclear, however, there seem to be both hereditary (genetic factors passed on in families) and environmental factors involved. Research has shown that some people who develop diabetes have common genetic markers. In Type I diabetes, the immune system, the body's defense system against infection, is assumed to be triggered by a virus or another microorganism that destroys cells in the pancreas that produce insulin. In Type II diabetes, age, **obesity**, and family history of diabetes play a role.

In Type II diabetes, the pancreas may produce enough insulin. However, cells have become resistant to the insulin produced and it may not work as effectively. Symptoms of Type II diabetes can begin so gradually that a person may not know that he or she has it. Early signs are lethargy, extreme thirst, and frequent urination. Other symptoms may include sudden weight loss, slow wound healing, urinary tract infections, gum disease, or blurred vision. It is not unusual for Type II diabetes to be detected while a patient is seeing a doctor about another health concern that is actually being caused by the yet undiagnosed diabetes.

Individuals who are at high risk of developing Type II diabetes mellitus include people who:

- are obese (more than 20% above their ideal body weight)
- have a relative with diabetes mellitus
- belong to a high–risk ethnic population (African American, Native American, Hispanic, or Native Hawaiian)
- have been diagnosed with gestational diabetes or have delivered a baby weighing more than nine lb (four kg)
- have high blood pressure (140/90 mmHg or above)
- have a high–density lipoprotein cholesterol level less than or equal to 35 mg/dL and/or a triglyceride level greater than or equal to 250 mg/dL
- have had impaired glucose tolerance or impaired fasting glucose on previous testing

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KEY TERMS

Cataract—A condition in which the lens of the eye becomes cloudy.

Diabetic peripheral neuropathy—A condition in which the sensitivity of nerves to pain, temperature, and pressure is dulled, particularly in the legs and feet.

Diabetic retinopathy—A condition in which the tiny blood vessels to the retina, the tissues that sense light at the back of the eye, are damaged, leading to blurred vision, sudden blindness, or black spots, lines, or flashing lights in the field of vision.

Glaucoma—A condition in which pressure within the eye causes damage to the optic nerve, which sends visual images to the brain.

Hyperglycemia—A condition in which there is too much glucose or sugar in the blood.

Hypoglycemia—A condition in which there is too little glucose or sugar in the blood.

Insulin—A hormone or chemical produced by the pancreas that is needed by cells of the body in order to use glucose (sugar), the body's main source of energy.

Ketoacidosis—A condition due to starvation or uncontrolled Type I diabetes. Ketones are acid compounds that form in the blood when the body breaks down fats and proteins. Symptoms include abdominal pain, vomiting, rapid breathing, extreme tiredness, and drowsiness.

Kidney dialysis—A process during which blood is filtered through a dialysis machine to remove waste products that would normally be removed by the kidneys. The filtered blood is then circulated back into the patient. This process also is called renal dialysis.

Pancreas—A gland located behind the stomach that produces insulin.

Several common medications can impair the body's use of insulin, causing a condition known as secondary diabetes. These medications include treatments for high blood pressure (furosemide, clonidine, and thiazide **diuretics**), drugs with hormonal activity (**oral contraceptives**, thyroid hormone, progestins, and glucocorticorids), and the anti–inflammation drug indomethacin. Several drugs that are used to treat **mood disorders** (such as **anxiety** and depression) also can impair glucose absorption. These drugs include haloperidol, lithium carbonate, Zyprexa (olanzapine), Seroquel (quetiapine), phenothiazines, **tricyclic antidepressants**, and adrenergic agonists. Other medications that can cause diabetes symptoms include isoniazid, nicotinic acid, cimetidine, **protease inhibitors** used to treat HIV, and heparin. A 2004 study found that low levels of the essential mineral chromium in the body may be linked to increased risk for diseases associated with **insulin resistance**. Vitamin D deficiencies have also been linked with impaired glucose tolerance, and vitamin D deficient diabetics tend to have more difficulty in controlling their blood glucose levels.

Symptoms

Symptoms of diabetes can develop suddenly (over days or weeks) in previously healthy children or adolescents, or can develop gradually (over several years) in overweight adults over the age of 40. The classic symptoms include feeling tired and sick, frequent urination, excessive thirst, excessive hunger, and weight loss.

Ketoacidosis, a condition due to **starvation** or uncontrolled diabetes, is common in Type I diabetes. Ketones are acid compounds that form in the blood when the body breaks down fats and proteins. Symptoms include abdominal **pain**, **vomiting**, rapid breathing, weight loss, extreme lethargy, and drowsiness. Patients with ketoacidosis also have a sweet breath odor. Left untreated, this condition can lead to coma and death.

With Type II diabetes, the condition may not become evident until the patient presents for medical treatment for some other condition. A patient may have heart disease, chronic infections of the gums and urinary tract, blurred vision, **numbness** in the feet and legs, or slow-healing **wounds**. Women may experience genital **itching**.

Diagnosis

Diabetes is suspected based on symptoms. Urine tests can confirm a diagnosis of diabetes based on the amount of glucose found. Urine tests can also detect ketones and protein in the urine that may help diagnose diabetes and assess how well the kidneys are functioning. These tests also can be used to monitor the disease once the patient is on a standardized diet, oral medications, or insulin.

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Urine tests

Clinistix and Diastix are paper strips or dipsticks that change color when dipped in urine. The test strip is compared to a chart that shows the amount of glucose in the urine based on the change in color. The level of glucose in the urine lags behind the level of glucose in the blood. Testing the urine with a test stick, paper strip, or tablet that changes color when sugar is present is not as accurate as blood testing. However it can give a fast and simple reading. It is no longer considered appropriate for use by diabetics as a means to assess glucose control.

Ketones in the urine can be detected using similar types of dipstick tests (Acetest or Ketostix). Ketoacidosis can be a life–threatening situation in Type I diabetics, so having a quick and simple test to detect ketones can assist in establishing a diagnosis sooner.

Another dipstick test can determine the presence of protein or albumin in the urine. Protein in the urine can indicate problems with kidney function and can be used to track the development of renal failure. A more sensitive test for urine protein uses radioactively tagged chemicals to detect microalbuminuria, small amounts of protein in the urine, that may not show up on dipstick tests.

Blood tests

FASTING GLUCOSE TEST. Blood is drawn from a vein in the patient's arm after a period at least eight hours after the patient has last eaten, usually in the morning before breakfast. Red blood cells are separated from the sample and the amount of glucose is measured in the remaining plasma. A plasma level of seven mmol/L (126 mg/L) or greater can indicate diabetes. The **fasting** glucose test is usually repeated on another day to confirm the results.

GLYCATED HEMOGLOBIN (A1C) TEST. This blood test indicates the average blood glucose level for the previous 60–90 days. Blood is drawn from a vein after the patient has fasted for at least eight hours. An A1C level that equals or exceeds 6.5 percent or more on two separate test dates indicates diabetes. In 2009, the International Diabetes Federation recommended the A1C test as the preferred method for diagnosing diabetes and monitoring the effectiveness of treatment.

ORAL GLUCOSE TOLERANCE TEST. Blood samples are taken from a vein before and after a patient drinks a thick, sweet syrup of glucose. In a non-diabetic, the level of glucose in the blood goes up immediately after the drink and then decreases gradually as insulin is used by the body to metabolize, or absorb, the sugar. In a diabetic, the glucose in the blood goes up and stays high after drinking the sweetened liquid. A plasma glucose level of 11.1 mmol/L (200 mg/dL) or higher at two hours after drinking the syrup confirms the diagnosis of diabetes.

A diagnosis of diabetes is confirmed if there are symptoms of diabetes and a plasma glucose level of at least 11.1 mmol/L, a fasting plasma glucose level of at least seven mmol/L; or a two–hour plasma glucose level of at least 11.1 mmol/L during an oral glucose tolerance test.

Home blood glucose monitoring kits are available so patients with diabetes can monitor their own levels. A small needle or lancet is used to prick the finger and a drop of blood is collected and analyzed by a monitoring device. Some patients may test their blood glucose levels several times during a day and use this information to adjust their doses of insulin.

Treatment

A successful pancreas transplant currently offers the only cure for Type 1 diabetes. Diabetes is usually managed with medication and lifestyle changes so that patients can live a relatively normal life. Treatment of diabetes focuses on two goals: keeping blood glucose within normal range and preventing the development of long-term complications. Careful monitoring of diet, exercise, and blood glucose levels are as important as the use of insulin or oral medications in preventing complications of diabetes.

Dietary changes

Diet and moderate exercise are the first treatments implemented in diabetes. For many Type II diabetics, weight loss may be an important goal in helping them to control their diabetes. A well-balanced, nutritious diet provides approximately 50–60% of calories from carbohydrates, approximately 10–20% of calories from protein, and less than 30% of calories from fat. The number of calories required by an individual depends on age, weight, and activity level. The calorie intake also needs to be distributed over the course of the entire day, so surges of glucose entering the blood system are kept to a minimum. Carbohydrates such as grains, vegetables, legumes, and fruits are healthier than carbohydrates provided by sweets and snack foods.

Keeping track of the number of calories and carbohydrates provided by different foods can become complicated, so patients usually are advised to consult a nutritionist or dietitian. An individualized, easy to manage diet plan can be set up for each patient. Both the American Diabetes Association and the American Dietetic Association recommend **diets** based on the use

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of food exchange lists. Each food exchange contains a known amount of calories in the form of protein, fat, or carbohydrate. A patient's diet plan will consist of a certain number of exchanges from each food category (meat or protein, fruits, breads and starches, vegetables, and fats) to be eaten at meal times and as snacks. Patients have flexibility in choosing which foods they eat as long as they stick with the number of exchanges prescribed.

For many Type II diabetics, weight loss is an important factor in controlling their condition. The food exchange system, along with a plan of moderate exercise, can help them lose excess weight and improve their overall health.

Oral medications

Oral medications are available to lower blood glucose in Type II diabetics. In 1990, 23.4 million outpatient prescriptions for oral antidiabetic agents were dispensed. By 2005, the number had increased to more than 100 million prescriptions. Oral antidiabetic agents accounted for more than $8 billion dollars in worldwide retail sales in 2005 and were the fastest-growing segment of diabetes drugs. There are five distinct classes of hypoglycemic agents available, each class displaying unique pharmacologic properties. These classes are the sulfonylureas, meglitinides, biguanides, thiazolidinediones and alpha-glucosidase inhibitors. In patients for whom diet and exercise do not provide adequate glucose control, therapy with a single oral agent can be tried. The drugs first prescribed for Type II diabetes are in a class of compounds called sulfonylureas and include tolbutamide, tolazamide, acetohexamide, and chlorpropamide. Other drugs in the same class include glyburide, glimeperide, and glipizide. How these drugs work is not well understood. However, they seem to stimulate cells of the pancreas to produce more insulin. Newer medications that are available to treat diabetes include Glucophage (metformin), Precose (acarbose), Glycet (miglitol), Actos (pioglitazone), and Avandia (rosiglitazone). The choice of medication depends in part on the individual patient profile. All drugs have side effects that may make them inappropriate for particular patients. Some for example, may stimulate weight gain or cause stomach irritation, so they may not be the best treatment for someone who is already overweight or who has stomach ulcers. Others, like metformin, have been shown to have positive effects such as reduced cardiovascular mortality. While these medications are an important aspect of treatment for Type II diabetes, they are not a substitute for a well-planned diet and moderate exercise. Oral medications have not been shown effective for Type I diabetes, in which the patient produces little or no insulin.

Constant advances are being made in development of new oral medications for persons with diabetes. One drug called Metaglip combining glipizide and metformin was approved in a single tablet. Along with diet and exercise, the drug is used as initial therapy for Type II diabetes. Another drug approved by the U.S. Food and Drug Administration (FDA) combines metformin and rosiglitazone (Avandia), a medication that increases muscle cells' sensitivity to insulin. It is marketed under the name Avandamet. Other combination drugs include Avandaryl (rosiglitazone and glimepiride), and Duetact (pioglitazone and glimepiride). As of 2010, more combination drugs were under development. So many new drugs are in the pipeline, a record 235 as of mid-2010, with many nearing FDA approval, that it is best to stay in touch with a physician for the latest information. Physicians can find the best drug, diet and exercise program to fit an individual patient's need. In 2007, a study in the *New England Journal of Medicine* suggested the use of Avandia (rosiglitazone) increased the risk of a **heart attack** and death from **heart failure**. Other studies regarding Avandia and its effect on heart health were underway as of mid-2010, including a pending review by the FDA. An FDA ruling also required that Avandia, Actos, Avandaryl, and Duetact carry stronger warnings on their labels.

Byetta (exenatide) and Victoza (liraglutide) are the first compunds in a class of injectable medicines called incretin mimetics to improve blood sugar levels in Type II diabetes. Byetta usually requires two injections daily compared to one with Victoza. However, long-term studies are under way to access a possible relationship between Victoza and an increased incidence of **pancreatitis** and thyroid tumors.

Insulin

Persons with Type I diabetes need daily injections of insulin to help their bodies use glucose. The amount and type of insulin required depends on the height, weight, age, food intake, and activity level of the individual diabetic patient. Some patients with Type II diabetes may need to use insulin injections if their diabetes cannot be controlled with diet, exercise, and oral medication. Injections are given subcutaneously, that is, just under the skin, using a small needle and syringe, using an injection pen, or an insulin pump. Injection sites can be anywhere on the body where there is looser skin, including the upper arm, abdomen, or upper thigh.

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Purified human insulin is most commonly used. Insulin from animal sources is no longer used. Insulin may be given as an injection of a single dose of one type of insulin once a day. Different types of insulin can be mixed and given in one dose or split into two or more doses during a day. Patients who require multiple injections over the course of a day may be able to use an insulin pump that administers small doses of insulin on demand. The small battery-operated pump is worn outside the body and is connected to a needle that is inserted into the abdomen. Pumps can be programmed to inject small doses of insulin at various times during the day, or the patient may be able to adjust the insulin doses to coincide with meals and exercise.

Regular insulin is fast–acting and starts to work within 15–30 minutes, with its peak glucose-lowering effect about two hours after it is injected. Its effects last for about four to six hours. NPH (neutral protamine Hagedorn) and Lente insulin are intermediate-acting, starting to work within one to three hours and lasting up to 18–26 hours. Ultra-lente is a long-acting form of insulin that starts to work within four to eight hours and lasts up to 24 hours.

Hypoglycemia, or low blood sugar, can be caused by too much insulin, too little food (or eating too late to coincide with the action of the insulin), alcohol consumption, or increased exercise. A patient with symptoms of hypoglycemia may be hungry, cranky, confused, and tired. The patient may become sweaty and shaky. Left untreated, the patient can lose consciousness or have a seizure. This condition is sometimes called an insulin reaction and should be treated by giving the patient something sweet to eat or drink like a candy, sugar cubes, fruit juice, or another high sugar snack.

Surgery

Transplantation of a healthy pancreas into a diabetic patient is a successful treatment, however, this transplant is usually done only if a kidney transplant is performed at the same time. Although a pancreas transplant is possible, it is often not clear if the potential benefits outweigh the risks of the surgery and drug therapy needed.

Alternative treatment

Since diabetes can be a life–threatening condition if not properly managed, persons should not attempt to treat this condition without medical supervision. A variety of alternative therapies can be helpful in managing the symptoms of diabetes and supporting patients with the disease. **Acupuncture** can help relieve the pain associated with **diabetic neuropathy** by stimulation of certain points. A qualified practitioner should be consulted. Herbal remedies also may be helpful in managing diabetes. Although there is no herbal substitute for insulin, some herbs may help adjust blood sugar levels or manage other diabetic symptoms. Some options include:

- fenugreek (*Trigonella foenum-graecum*) has been shown in some studies to reduce blood insulin and glucose levels while also lowering cholesterol
- bilberry (*Vaccinium myrtillus*) may lower blood glucose levels, as well as helping to maintain healthy blood vessels
- garlic (*Allium sativum*) may lower blood sugar and cholesterol levels
- onions (*Allium cepa*) may help lower blood glucose levels by freeing insulin to metabolize them
- cayenne pepper (*Capsicum frutescens*) can help relieve pain in the peripheral nerves (a type of diabetic neuropathy)
- gingko (*Gingko biloba*) may maintain blood flow to the retina, helping to prevent diabetic retinopathy

Other alternative medicine therapies for controlling blood sugar include chromium picolinate, alpha lipoic acid, cinnamon, evening primrose oil, and pygenol (pine bark extract). Any therapy that lowers stress levels also can be useful in treating diabetes by helping to reduce insulin requirements. Among the alternative treatments that aim to lower stress are **hypnotherapy**, **biofeedback**, and **meditation**.

Prognosis

Uncontrolled diabetes is a leading cause of blindness, end–stage renal disease, and limb amputations. It also doubles the risks of heart disease and increases the risk of stroke. Eye problems including **cataracts**, glaucoma, and diabetic retinopathy also are more common in diabetics.

Diabetic **peripheral neuropathy** is a condition where nerve endings, particularly in the legs and feet, become less sensitive. Diabetic foot ulcers are a particular problem since the patient does not feel the pain of a blister, callous, or other minor injury. Poor blood circulation in the legs and feet contribute to delayed wound healing. The inability to sense pain along with the complications of delayed wound healing can result in minor injuries, blisters, or **calluses** becoming infected and difficult to treat. In cases of severe infection, the infected tissue begins to break down and rot

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away. The most serious consequence of this condition is the need for amputation of toes, feet, or legs due to severe infection.

Heart disease and **kidney disease** are common complications of diabetes. Long-term complications may include the need for **kidney dialysis** or a kidney transplant due to kidney failure.

Babies born to diabetic mothers have an increased risk of **birth defects** and distress at birth.

Prevention

Research continues on diabetes prevention and improved detection of those at risk for developing diabetes. As of 2010, research was being conducted in a number of countries, including the United States, China, and Finland. While the onset of Type I diabetes is unpredictable, the risk of developing Type II diabetes can be reduced by maintaining ideal weight and exercising regularly. The physical and emotional stress of surgery, illness, pregnancy, and alcoholism can increase the risks of diabetes, so maintaining a healthy lifestyle is critical to preventing the onset of Type II diabetes and preventing further complications of the disease.

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ORGANIZATIONS

American Diabetes Association, 1701 North Beauregard St., Alexandria, VA, 22311, (800) 342–2383, AskADA@diabetes.org, http://www.diabetes.org.

American Dietetic Association, 120 South Riverside Plaza, Suite 2000, Chicago, IL, 60606–6995, (312) 899–0040, (800) 877–1600, knowledge@eatright.org, http://www.eatright.org.

Canadian Diabetes Association, National Life Building, 1400–522 University Ave., Toronto, ON, Canada, M5G 2R5, (800) 226–8464, info@diabetes.ca, http://www .diabetes.ca.

Juvenile Diabetes Research Foundation International, 26 Broadway, 14th Floor, New York, NY, 10004, (800) 533–2873, info@jdrf.org, http://www.jdrf.org.

Altha Roberts Edgren
Ken R. Wells

Diabetic control index *see* **Glycosylated hemoglobin test**

Diabetic foot infections

Definition

Diabetic foot infections are infections that can develop in the skin, muscles, or bones of the foot as a result of the nerve damage and poor circulation that is associated with diabetes.

Persons with diabetes often suffer from foot ulcers, as shown above. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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Description

People who have diabetes have a greater-than-average chance of developing foot infections. Because a person who has diabetes may not feel foot **pain** or discomfort, problems can remain undetected until **fever**, weakness, or other signs of systemic infection appear. As a result, even minor irritations occur more often, heal more slowly, and are more likely to result in serious health problems.

With diabetes, foot infections occur more frequently because the disease causes nervous system changes and poor circulation. Because the nerves that control sweating no longer work, the skin of the feet can become very dry and cracked, and **calluses** tend to occur more frequently and build up faster. If not trimmed regularly, these calluses can turn into open sores or ulcers. Because diabetic nerve damage can cause a loss of sensation (neuropathy), if the feet are not regularly inspected, an ulcer can quickly become infected and, if not treated, may result in the **death** of tissue (**gangrene**) or **amputation**.

The risk of infection is greatest for people who are over the age of 60 and for those who have one or more of the following:

- poorly controlled diabetes
- foot ulcers
- laser treatment for changes in the retina
- kidney or vascular disease
- loss of sensation (neuropathy)

Causes and symptoms

Bacteria can cause an infection through small cracks (fissures) that can develop in the dry skin around the heel and on other parts of the foot or through **corns**, calluses, blisters, hangnails, or ulcers. If not treated, the bacterial infection can destroy skin, tissue, and bone or spread throughout the body.

Common sites of diabetic foot infections include the following:

- blisters, corns, or callouses that bleed beneath the skin
- bunions, hammertoes, or other abnormalities in the bones of the foot
- scar tissue that has grown over the site of an earlier infection
- foot ulcers caused by pressure, nerve damage, or poor circulation (Ulcers occur most often over the ball of the foot, on the bottom of the big toe, or on the sides of the foot due to poorly fitting shoes.)
- injuries that tear or puncture the skin

KEY TERMS

Fissure—A deep crack.

Neuropathy—An abnormality of the nerves outside the brain and spinal cord.

Ulcer—A sore or lesion.

Diagnosis

A physician who specializes in the treatment of the foot (podiatrist) or the doctor who normally treats the patient's diabetes will treat the infection. An x ray of the foot will be taken to determine whether the bone has become infected. A sample from the wound will be cultured to identify the organism that is causing the infection so that the appropriate antibiotic can be selected.

Treatment

From the results of the culture, the appropriate antibiotic will be prescribed. Any dead or infected tissue will be surgically removed and, if necessary, a cast and/or special shoes may be used to protect the area. In addition, the patient will be instructed to keep off their feet. If the ulcer does not heal, the physician may perform surgery to increase blood flow to the foot. It is also important for the patient to practice good diabetes control and keep blood glucose levels from getting too high.

Alternative treatment

Acupuncture and vitamin C can boost the body's infection-fighting ability. A variety of other **vitamins** and herbs may improve general health and diabetes control. Because diabetes is a potentially deadly disease, it can be dangerous to try alternative approaches without a doctor's approval or without consulting a trained practitioner of alternative medicine.

Prognosis

Without proper treatment, diabetic foot infections can lead to serious illness, gangrene, amputation, and even death if the infection spreads throughout the body. If treated properly and the patient practices good **foot care**, the prognosis is generally optimistic.

Prevention

There are many things that a diabetic individual can do to prevent the occurrence of foot infections, including the following:

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- control blood glucose and do not allow it to get too high
- avoid smoking
- keep blood pressure and cholesterol under control
- exercise to stimulate blood flow
- keep feet clean, dry, and warm
- check your feet every day for blisters, scratches, and skin that is hard, broken, inflamed, or feels hot or cold when touched
- after bathing, carefully dry feet and apply thin coat of petroleum jelly or hand cream to prevent dry skin from cracking
- use a pumice stone and emery board to trim calluses
- do not neglect an ulcer, should one develop

ORGANIZATIONS

American Diabetes Association, 1701 North Beauregard Street, Alexandria, VA, 22311, (800) 342-2383, AskADA@diabetes.org, http://www.diabetes.org/.

Juvenile Diabetes Research Foundation International, 26 Broadway, 14th Floor, New York, NY, 10004, (212) 785-9595, (800) 533-2873, info@jdrf.org, http://www.jdf.org.

National Diabetes Information Clearinghouse (NDIC), 1 Information Way, Bethesda, MD, 20892-3560, (703) 738-4929, (800) 860-8747, ndic@info.niddk.nih.gov, http://diabetes.niddk.nih.gov/.

Maureen Haggerty

Diabetic ketoacidosis

Definition

Diabetic ketoacidosis is a dangerous complication of **diabetes mellitus** in which the chemical balance of the body becomes far too acidic.

Description

Diabetic ketoacidosis (DKA) always results from a severe insulin deficiency. Insulin is the hormone secreted by the body to lower the blood sugar levels when they become too high. Diabetes mellitus is the disease resulting from the inability of the body to produce or respond properly to insulin, required by the body to convert glucose to energy. In childhood diabetes, DKA complications represent the leading cause of **death**, mostly due to the accumulation of abnormally large amounts of fluid in the brain (cerebral **edema**). DKA combines three major features: hyperglycemia, meaning excessively high blood sugar kevels; hyperketonemia, meaning an overproduction of ketones by the body; and acidosis, meaning that the blood has become too acidic.

Insulin deficiency is responsible for all three conditions: the body glucose goes largely unused since most cells are unable to transport glucose into the cell without the presence of insulin; this condition makes the body use stored fat as an alternative source instead of the unavailable glucose for energy, a process that produces acidic ketones, which build up because they require insulin to be broken down. The presence of excess ketones in the bloodstream in turn causes the blood to become more acidic than the body tissues, which creates a toxic condition.

Causes and symptoms

DKA is most commonly seen in individuals with type I diabetes, under 19 years of age and is usually caused by the interruption of their insulin treatment or by acute infection or trauma. A small number of people with type II diabetes also experience ketoacidosis, but this is rare given the fact that type II diabetics still produce some insulin naturally. When DKA occurs in type II patients, it is usually caused by a decrease in food intake and an increased insulin deficiency due to hyperglycemia.

Some common DKA symptoms include:

- high blood sugar levels
- frequent urination (polyuria) and thirst
- fatigue and lethargy
- nausea
- vomiting
- abdominal pain
- fruity odor to breath
- rapid, deep breathing
- muscle stiffness or aching
- coma

Diagnosis

Diagnosis requires the demonstration of hyperglycemia, hyperketonemia, and acidosis. DKA is established if the patient's urine or blood is strongly positive for glucose and ketones. Normal glucose levels in a non-diabetic person on average range from 80–110 mg/dl. A person with diabetes will typically fluctuate outside those parameters. DKA glucose levels exceed 250 mg/dl and can reach 400 to 800 mg/dL. A low serum bicarbonate level (usually below 15 mEq/L) is also present, indicative of acidosis.

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KEY TERMS

Acidosis—A condition that causes the pH of the blood to drop and become more acidic.

Diabetes mellitus—Disease characterized by the inability of the body to produce or respond properly to insulin, required by the body to convert glucose to energy.

Edema—The presence of abnormally large amounts of fluid in the intercellular tissue spaces of the body.

Glucose—The type of sugar found in the blood.

Hyperglycemia—Condition characterized by excessively high levels of glucose in the blood, and occurs when the body does not have enough insulin or cannot use the insulin it does have to turn glucose into energy. Hyperglycemia is often indicative of diabetes that is out of control.

Hyperketonemia—Condition characterized by an overproduction of ketones by the body.

Hypoglycemia—Lower than normal levels of glucose in the blood.

Hypokalemia—A deficiency of potassium in the blood.

Insulin—A hormone secreted by the pancreas in response to high blood sugar levels that induces hypoglycemia. Insulin regulates the body's use of glucose and the levels of glucose in the blood by acting to open the cells so that they can intake glucose.

Ketones—Poisonous acidic chemicals produced by the body when fat instead of glucose is burned for energy. Breakdown of fat occurs when not enough insulin is present to channel glucose into body cells.

Lactic acidosis—A serious condition caused by the build up of lactic acid in the blood, causing it to become excessively acidic. Lactic acid is a by-product of glucose metabolism.

Metabolism—The sum of all chemical reactions that occur in the body resulting in growth, transformation of foodstuffs into energy, waste elimination, and other bodily functions.

Polyuria—Excessive secretion of urine.

Type I diabetes—Also called juvenile diabetes. Type I diabetes typically begins early in life. Affected individuals have a primary insulin deficiency and must take insulin injections.

Type II diabetes—Type II diabetes is the most common form of diabetes and usually appears in middle aged adults. It is often associated with obesity and may be delayed or controlled with diet and exercise.

A blood test or **urinalysis** can quickly determine the concentration of glucose in the bloodstream. Test strips are available to patients commercially can submerge in urine to detect the presence or concentration of ketones.

Treatment

Ketoacidosis is treated under medical supervision and usually in a hospital setting.

Basic treatment includes:

- administering insulin to correct the hyperglycemia and hyperketonemia
- replacing fluids lost through excessive urination and vomiting intravenously
- balancing electrolytes to re-establish the chemical equilibrium of the blood and prevent potassium deficiency (hypokalemia) during treatment
- treatment for any associated bacterial infection

Prognosis

With proper medical attention, DKA is almost always successfully treated. The DKA mortality rate is about 10%. **Coma** on admission adversely affects the prognosis. The major causes of death are circulatory collapse, **hypokalemia**, infection, and cerebral edema.

Prevention

Once diabetes has been diagnosed, prevention measures to avoid DKA include regular monitoring of blood glucose, administration of insulin, and lifestyle maintenance. Glucose monitoring is especially important during periods of **stress**, infection, and trauma when glucose concentrations typically increase as a response to these situations. Ketone tests should also be performed during these periods or when glucose is elevated.

ORGANIZATIONS

American Diabetes Association, 1701 North Beauregard Street, Alexandria, VA, 22311, (800) 342-2383, AskADA@diabetes.org, http://www.diabetes.org/.

Juvenile Diabetes Research Foundation International, 26 Broadway, 14th Floor, New York, NY, 10004, (212) 785-9595, (800) 533-2873, info@jdrf.org, http://www.jdf.org.

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National Institute of Diabetes and Digestive and Kidney Diseases, NIDDK, NIH Bldg 31, Rm 9A06 31 Center Drive, MSC 2560, Bethesda, MD, 20892-2560, (301) 496.3583, http://www2.niddk.nih.gov.

Gary Gilles

Diabetic neuropathy

Definition

Diabetic neuropathy is a nerve disorder caused by **diabetes mellitus**. Diabetic neuropathy may be diffuse, affecting several parts of the body, or focal, affecting a specific nerve and part of the body.

Demographics

The longer a person has diabetes, the more likely the development of one or more forms of neuropathy. Approximately 60–70% of patients with diabetes have neuropathy, but only about 5% experience painful symptoms.

Description

The nervous system consists of two major divisions: the central nervous systems (CNS), which includes the brain, the cranial nerves, and the spinal cord, and the peripheral nervous system (PNS), which includes the nerves that link the CNS with the sensory organs, muscles, blood vessels, and glands of the body. These peripheral nerves are either motor, meaning that they are involved in motor activity such as walking, or sensory, meaning that they carry sensory information back to the CNS. The PNS also works with the CNS to regulate involuntary (autonomic) processes such as breathing, heartbeat, blood pressure, etc.

There are two types of diffuse diabetic neuropathy that affect different nervous system functions. Diffuse **peripheral neuropathy** primarily affects the limbs, damaging the nerves of the feet and hands. Autonomic neuropathy is the other form of diffuse neuropathy and it affects the heart and other internal organs.

Focal—or localized—diabetic neuropathy affects specific nerves, most commonly in the torso, leg, or head.

Diabetic neuropathy can lead to muscular weakness, loss of feeling or sensation, and loss of autonomic functions such as digestion, erection, bladder control, and sweating among others.

KEY TERMS

Central nervous system (CNS)—Part of the nervous system consisting of the brain, cranial nerves, and spinal cord. The brain is the center of higher processes, such as thought and emotion, and is responsible for the coordination and control of bodily activities and the interpretation of information from the senses. The cranial nerves and spinal cord link the brain to the peripheral nervous system.

Diabetes mellitus—Disease characterized by the inability of the body to produce or respond properly to insulin, required by the body to convert glucose to energy.

Glucose—The type of sugar found in the blood.

Peripheral nervous system (PNS)—One of the two major divisions of the nervous system. PNS nerves link the central nervous system with sensory organs, muscles, blood vessels, and glands.

Causes and symptoms

The exact cause of diabetic neuropathy is not known. Researchers believe that the process of nerve damage is related to high glucose concentrations in the blood that could cause chemical changes in nerves, disrupting their ability to effectively send messages. High blood glucose is also known to damage the blood vessels that carry oxygen and other nutrients to the nerves. In addition, some people may have a genetic predisposition to develop neuropathy.

There is a wide range of symptoms associated with diabetic neuropathy, and they depend on which nerves and parts of the body are affected, as well as the type of neuropathy present. Some patients have very mild symptoms, while others are severely disabled.

Common symptoms of diffuse peripheral neuropathy include:

- numbness and feelings of tingling or burning
- insensitivity to pain
- needle-like jabs of pain
- extreme sensitivity to touch
- loss of balance and coordination

Common symptoms of diffuse autonomic neuropathy include:

- impaired urination and sexual function
- bladder infections

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- stomach disorders, due to the impaired ability of the stomach to empty (gastric stasis)
- nausea, vomiting, and bloating
- dizziness, lightheadedness, and fainting spells
- loss of appetite

Common symptoms of focal neuropathy include:

- pain in the front of a thigh
- severe pain in the lower back
- pain in the chest or stomach
- ache behind an eye
- double vision
- paralysis on one side of the face

In severe diabetic neuropathy loss of sensation can lead to injuries that are unnoticed, progressing to infections, ulceration and possibly **amputation**.

Diagnosis

Examination

The diagnosis of neuropathy is based on the symptoms that present during a physical exam. **Pain** assessment is usually the first step. Patients may have more than one type of pain, and the history helps the doctor determine whether a the pain has a neuropathic cause.

Tests

Based on finding during the physical exam, additional testing may be performed:

- screening tests for lost sensation
- nerve conduction studies to check the flow of electric current through a nerve
- electromyography (EMG) to see how well muscles respond to electrical impulses transmitted by nearby nerves
- ultrasound to show how the bladder and other parts of the urinary tract are functioning
- a nerve biopsy

Specialists who treat diabetic neuropathy include:

- neurologists: specialists in nervous system disorders
- urologists: specialists in urinary tract disorder
- gastroenterologists: specialists in digestive disorders
- podiatrists: specialists in caring for the feet

Treatment

Traditional

Treatment of diabetic neuropathy is usually focused on treating the symptoms associated with the neuropathy and addressing the underlying cause by improving the control of blood sugar levels, which may heal the early stages of neuropathy.

Drugs

There is no cure for the permanent nerve damage caused by neuropathy. To help control pain, drug therapy is normally used. The choice of proven drug therapies has broadened during the past decade. Pain medication, such as the topical skin cream capsaicin, is usually no stronger than codeine because of the potential for **addiction** with long-term use of such drugs.

Four main classes of drugs are available for **pain management**, alone or in combination: **tricyclic antidepressants** (Imipramine, Nortriptyline), narcotic **analgesics** (Morphine), anticonvulsants (Carbamazepine, Gabapentin), and antiarrhythmics.

Prognosis

Early stage diabetic neuropathy can usually be reversed with good glucose control. Once nerve damage has occurred it cannot be reversed. The prognosis is largely dependent on the management of the underlying condition, diabetes, which may halt the progression of the neuropathy and improve symptoms. Recovery, if it occurs, is slow.

Prevention

Tight glucose control and the avoidance of alcohol and cigarettes help protect nerves from damage.

Resources

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ORGANIZATIONS

American Diabetes Association, 1701 North Beauregard Street, Alexandria, VA, 22311, (800) DIABETES (800-342-2383), http://www.diabetes.org.

Juvenile Diabetes Foundation, 120 Wall St., 19th Floor, New York, NY, 10005, (800) 533-CURE, http://www.jdf.org.

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Dialysis, kidney

Definition

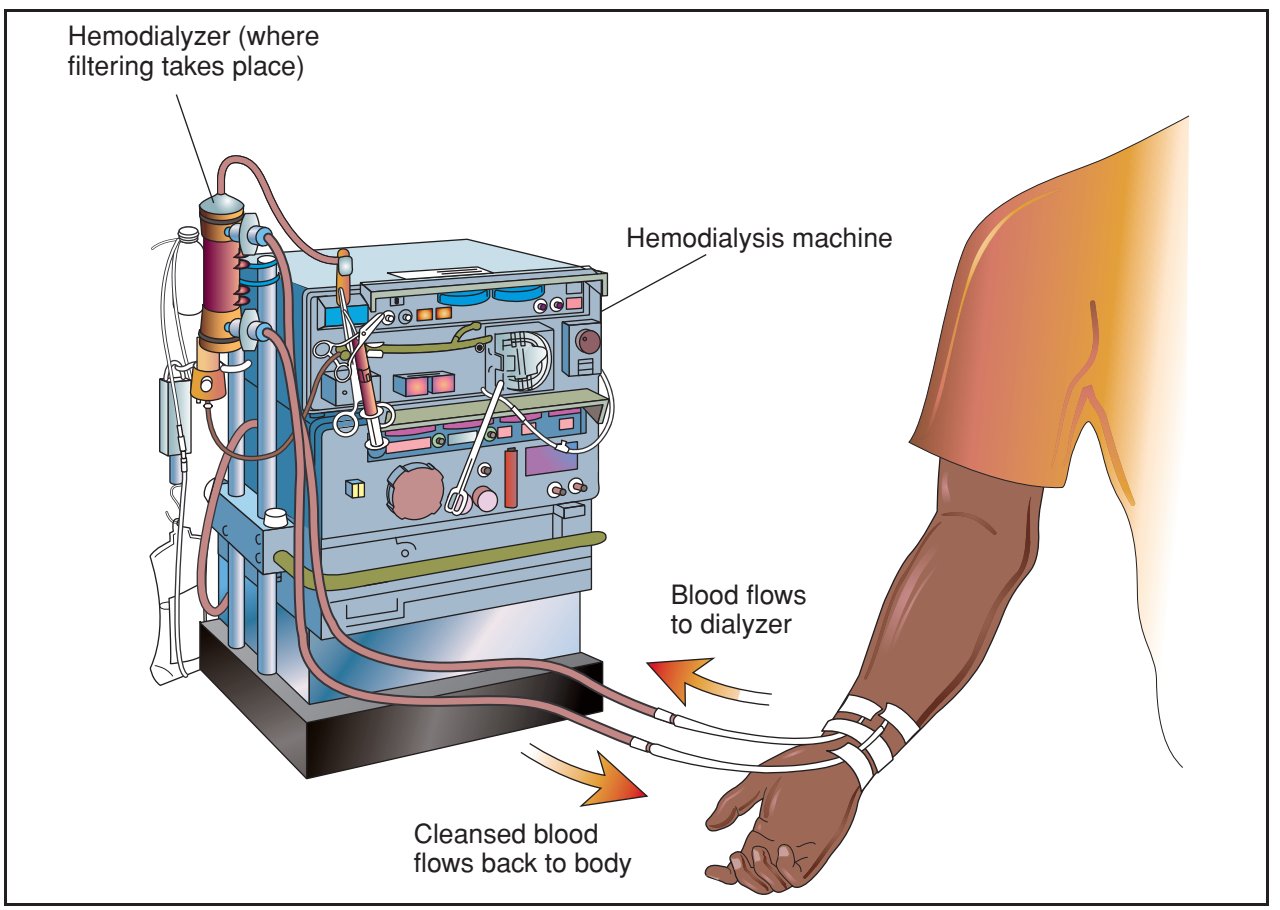
Dialysis treatment replaces the function of the kidneys, which normally serve as the body's natural filtration system. Through the use of a blood filter and a chemical solution known as dialysate, the treatment removes waste products and excess fluids from the bloodstream, while maintaining the proper chemical balance of the blood. There are two types of dialysis treatment: hemodialysis and peritoneal dialysis.

Purpose

Dialysis can be used in the treatment of patients suffering from poisoning or overdose, in order to quickly remove drugs from the bloodstream. Its most prevalent application, however, is for patients with temporary or permanent kidney failure. For patients with end-stage renal disease (ESRD), whose kidneys are no longer capable of adequately removing fluids and wastes from their body or of maintaining the proper level of certain kidney-regulated chemicals in the bloodstream, dialysis is the only treatment option available outside of **kidney transplantation**.

Demographics

In 1996 in the United States, over 200,000 people underwent regular dialysis treatments to manage their ESRD. As recently as 2007, the National Kidney and Urologic Diseases Information Clearinghouse (NKUDIC) reported that number increased to 368,544 residents receiving dialysis for ESRD. Of those individuals, 338,265 received in-center hemodialysis, 2,999 received home dialysis, and 26,364 received peritoneal dialysis.



Hemodialysis is the most frequently prescribed type of dialysis treatment in the United States. This treatment involves circulating the patient's blood outside of the body through a dialysis circuit. The blood is filtered and cleansed inside the hemodialyzer and returned to the body. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

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Description

There are two types of dialysis treatment: hemodialysis and peritoneal dialysis:

Hemodialysis

Hemodialysis is the most frequently prescribed type of dialysis treatment in the United States. The treatment involves circulating the patient's blood outside of the body through an extracorporeal circuit (ECC), or dialysis circuit. Two needles are inserted into the patient's vein, or access site, and are attached to the ECC, which consists of plastic blood tubing, a filter known as a dialyzer (artificial kidney), and a dialysis machine that monitors and maintains blood flow and administers dialysate. Dialysate is a chemical bath that is used to draw waste products out of the blood.

Since the 1980s, the majority of hemodialysis treatments in the United States have been performed with hollow fiber dialyzers. A hollow fiber dialyzer is composed of thousands of tube-like hollow fiber strands encased in a clear plastic cylinder several inches in diameter. There are two compartments within the dialyzer (the blood compartment and the dialysate compartment). The membrane that separates these two compartments is semipermeable. This means that it allows the passage of certain sized molecules across it, but prevents the passage of other, larger molecules. As blood is pushed through the blood compartment in one direction, suction or vacuum pressure pulls the dialysate through the dialysate compartment in a countercurrent, or opposite direction. These opposing pressures work to drain excess fluids out of the bloodstream and into the dialysate, a process called ultrafiltration.

A second process called diffusion moves waste products in the blood across the membrane into the dialysate compartment, where they are carried out of the body. At the same time, electrolytes and other chemicals in the dialysate solution cross the membrane into the blood compartment. The purified, chemically balanced blood is then returned to the body.

Most hemodialysis patients require treatment three times a week, for an average of three–four hours per dialysis "run." Specific treatment schedules depend on the type of dialyzer used and the patient's current physical condition. While the treatment prescription and regimen is usually overseen by a nephrologist (a doctor that specializes in the kidney), dialysis treatments are typically administered by a nurse or patient care technician in outpatient clinics known as dialysis centers, or in hospital-based dialysis units. In-home hemodialysis treatment is also an option for some patients, although access to this type of treatment may be limited by financial and lifestyle factors. An investment in equipment is required and another person in the household should be available for support and assistance with treatments.

Peritoneal dialysis

In peritoneal dialysis, the patient's peritoneum, or lining of the abdomen, acts as a blood filter. A catheter is surgically inserted into the patient's abdomen. During treatment, the catheter is used to fill the abdominal cavity with dialysate. Waste products and excess fluids move from the patient's bloodstream into the dialysate solution. After a waiting period of six to 24 hours, depending on the treatment method used, the waste-filled dialysate is drained from the abdomen, and replaced with clean dialysate.

There are three types of peritoneal dialysis:

- Continuous ambulatory peritoneal dialysis (CAPD). A continuous treatment that is self-administered and requires no machine. The patient inserts fresh dialysate solution into the abdominal cavity, waits four to six hours, and removes the used solution. The solution is immediately replaced with fresh dialysate. A bag attached to the catheter is worn under clothing.
- Continuous cyclic peritoneal dialysis (CCPD). An overnight treatment that uses a machine to drain and refill the abdominal cavity, CCPD takes 10–12 hours per session.
- Intermittent peritoneal dialysis (IPD). This hospital-based treatment is performed several times a week. A machine administers and drains the dialysate solution, and sessions can take up to 24 hours.

Peritoneal dialysis is often the treatment option of choice in infants and children, whose small size can make vascular (through a vein) access difficult to maintain. Peritoneal dialysis can also be done outside of a clinical setting, which is more conducive to regular school attendance.

Preparation

Patients are weighed immediately before and after each hemodialysis treatment to assess their fluid retention. Blood pressure and temperature are taken and the patient is assessed for physical changes since their last dialysis run. Regular blood tests monitor chemical and waste levels in the blood. Prior to treatment, patients are typically administered a dose of heparin, an anticoagulant that prevents blood clotting, to ensure the free flow of blood through the dialyzer and an uninterrupted dialysis run for the patient.

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KEY TERMS

Access site—The vein tapped for vascular access in hemodialysis treatments. For patients with temporary treatment needs, access to the bloodstream is gained by inserting a catheter into the subclavian vein near the patient's collarbone. Patients in long-term dialysis require stronger, more durable access sites, called fistulas or grafts, that are surgically created.

Dialysate—A chemical bath used in dialysis to draw fluids and toxins out of the bloodstream and supply electrolytes and other chemicals to the bloodstream.

Dialysis prescription—The general parameters of dialysis treatment that vary according to each patient's individual needs. Treatment length, type of dialyzer and dialysate used, and rate of ultrafiltration are all part of the dialysis prescription.

Dialyzer—An artificial kidney usually composed of hollow fiber which is used in hemodialysis to eliminate waste products from the blood and remove excess fluids from the bloodstream.

Erythropoietin—A hormone produced by the kidneys that stimulates the production of red blood cells by bone marrow.

ESRD—End-stage renal disease; chronic or permanent kidney failure.

Extracorporeal circuit (ECC)—The path the hemodialysis patient's blood takes outside of the body. It typically consists of plastic tubing, a hemodialysis machine, and a dialyzer.

Hematocrit (Hct) level—A measure of red blood cells.

Peritoneum—The abdominal cavity; the peritoneum acts as a blood filter in peritoneal dialysis.

Aftercare

Both hemodialysis and peritoneal dialysis patients need to be vigilant about keeping their access sites and catheters clean and infection-free during and between dialysis runs.

Dialysis is just one facet of a comprehensive treatment approach for ESRD. Although dialysis treatment is very effective in removing toxins and fluids from the body, there are several functions of the kidney it cannot mimic, such as regulating high blood pressure and red blood cell production. Patients with ESRD need to watch their diet and fluid intake carefully and take medications as prescribed to manage their disease.

Risks

Many of the risks and side effects associated with dialysis are a combined result of both the treatment and the poor physical condition of the ESRD patient. Dialysis patients should always report side effects to their healthcare provider.

Anemia

Hematocrit (Hct) levels, a measure of red blood cells, are typically low in ESRD patients. This deficiency is caused by a lack of the hormone erythropoietin, which is normally produced by the kidneys. The problem is elevated in hemodialysis patients, who may incur blood loss during hemodialysis treatments. Epoetin alfa, or EPO (sold under the trade name Epogen), a hormone therapy, and intravenous or oral iron supplements are used to manage anemia in dialysis patients.

Cramps, nausea, vomiting, and headaches

Some hemodialysis patients experience cramps and flu-like symptoms during treatment. These can be caused by a number of factors, including the type of dialysate used, composition of the dialyzer membrane, water quality in the dialysis unit, and the ultrafiltration rate of the treatment. Adjustment of the dialysis prescription often helps alleviate many symptoms.

Hypotension

Because of the stress placed on the cardiovascular system with regular hemodialysis treatments, patients are at risk for **hypotension**, a sudden drop in blood pressure. This can often be controlled by medication and adjustment of the patient's dialysis prescription.

Infection

Both hemodialysis and peritoneal dialysis patients are at risk for infection. Hemodialysis patients should keep their access sites clean and watch for signs of redness and warmth that could indicate infection. Peritoneal dialysis patients must follow the same precautions with their catheter. **Peritonitis**, an infection of the peritoneum, causes flu-like symptoms and can disrupt dialysis treatments if not caught early.

Infectious diseases

Because there is a great deal of blood exposure involved in dialysis treatment, a slight risk of contracting **hepatitis B** and **hepatitis C** exists. The hepatitis B **vaccination** is recommended for most hemodialysis patients. There has only been one documented case of HIV being transmitted in a United States dialysis unit

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to a staff member, and no documented cases of HIV ever being transmitted between dialysis patients in the United States. The strict standards of **infection control** practiced in modern hemodialysis units makes the chance of contracting one of these diseases very small.

Normal results

Puffiness in the patient related to **edema**, or fluid retention, may be relieved after dialysis treatment. The patient's overall sense of physical well-being may also be improved. Because dialysis is an ongoing treatment process for many patients, a baseline for normalcy can be difficult to gauge.

Precautions

Blood pressure changes associated with hemodialysis may pose a risk for patients with heart problems. Peritoneal dialysis may be the preferred treatment option in these cases.

Peritoneal dialysis is not recommended for patients with abdominal **adhesions** or other abdominal defects, such as a **hernia**, that might compromise the efficiency of the treatment. It is also not recommended for patients who suffer frequent bouts of **diverticulitis**, an inflammation of small pouches in the intestinal tract.

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Stam, Lawrence, E. *100 Questions & Answers About Kidney Dialysis*.Sudbury, MA: Jones and Bartlett Publishers, 2009.

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ORGANIZATIONS

American Association of Kidney Patients, 3505 E. Frontage Road, Suite 315, Tampa, FL, 33607, (813) 636-8122, (800) 749-2257, info@aakp.org, http://www.aakp.org.

American Urological Association Foundation, 1000 Corporate Blvd., Linthicum, MD, 21090, (410) 689-3700, (410) 689-3800, (866) 746-4282, auafoundation@auafoundation.org, http://www.urologyhealth.org/.

National Institute of Diabetes and Digestive and Kidney Diseases, NIDDK, NIH Bldg 31, Rm 9A06 31 Center Drive, MSC 2560, Bethesda, MD, 20892-2560, (301) 496-3583, http://www2.niddk.nih.gov/.

National Kidney Foundation, Inc. , 30 East 33rd Street, New York, NY, 10016, (212) 889-2210, (212) 689-9261, (800) 622-9010, http://www.kidney.org/.

United Network for Organ Sharing (UNOS), 700 N. 4th Street; PO Box 2484, Richmond, VA, 23218, (804) 782-4800, (804) 782-4817, (888) 894-6361, http://www.unos.org.

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Diaper rash

Definition

Dermatitis of the buttocks, genitals, lower abdomen, or thigh folds of an infant or toddler is commonly referred to as diaper rash.

Demographics

Diaper rash is believed to occur with the same frequency in infants who wear cloth or disposable diapers. It occurs most frequently in infants between eight and ten months of age, although it can occur in any child who wears diapers, generally from birth through about age three. It is estimated that about 10% of children will experience some significant diaper rash, although many more children will experience mild diaper rash at some time.

Baby with severe diaper rash. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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Description

Diaper rash is a term that covers a broad variety of skin conditions that occur on the same area of the body. Some babies are more prone to diaper rash than others.

Frequently a flat, red rash is caused by simple chafing of the diaper against tender skin, initiating a friction rash. This type of rash is not seen in the skin folds. It may be more pronounced around the edges of the diaper, at the waist and leg bands. The baby generally does not appear to experience much discomfort. Sometimes the chemicals or detergents in the diaper are contributing factors and may result in **contact dermatitis**. These **rashes** should clear up easily with proper attention. Ignoring the condition may lead to a secondary infection that is more difficult to resolve.

Friction of skin against itself can cause a rash in the baby's skin folds, called intertrigo. This rash appears as reddened areas that may ooze and is often uncomfortable when the diaper is wet. Intertrigo can also be found on other areas of the body where there are deep skin folds that tend to trap moisture.

Seborrheic dermatitis is the diaper area equivalent of cradle cap. It is scaly and greasy in appearance and may be worse in the folds of the skin.

Yeast, or candidal dermatitis, is the most common infectious cause of diaper rash. The affected areas are raised and quite red with distinct borders, and satellite lesions may occur around the edges. Yeast is part of the normal skin flora, and is often an opportunistic invader when simple diaper rash is left untreated. It is particularly common after treatment with **antibiotics**, which kill the good bacteria that normally keep the yeast population in check. Usual treatments for diaper rash often are not sufficient to treat this rash. Repeated or difficult to resolve episodes of yeast infection may warrant further medical attention, since this is sometimes associated with diabetes or immune system problems.

Another infectious cause of diaper rash is **impetigo**. This bacterial infection is characterized by blisters that ooze and crust.

Causes and symptoms

The outside layer of skin normally forms a protective barrier that prevents infection. One of the primary causes of dermatitis in the diaper area is prolonged skin contact with wetness. Under these circumstances, natural oils are stripped away, the outer layer of skin is damaged, and there is increased susceptibility to infection by bacteria or yeast.

Diagnosis

The presence of red, blotchy skin or **skin lesions** in the diaper area means that the baby has diaper rash. However, there are several types of rash that may require specific treatment in order to heal. It is useful to be able to distinguish them by appearance as described above.

A baby with a rash that does not clear up within two to three days with home treatment or a rash with pustules, blisters, or bleeding should be seen by a healthcare professional for further evaluation. A rash accompanied by other symptoms such as a **fever**, rash on other areas of the body, or **vomiting** should also be seen quickly by the baby's doctor.

Treatment

Traditional

Antibiotics are generally prescribed for rashes caused by bacteria, particularly impetigo. This may be a topical or oral formulation, depending on the size of the area involved and the severity of the infection.

Over-the-counter antifungal creams, such as Lotrimin, are often recommended to treat a rash resulting from yeast. If topical treatment is not effective, an oral antifungal may be prescribed.

Mild steroid creams, such as 0.5–1% hydrocortisone, can be used for seborrheic dermatitis and sometimes intertrigo. Prescription strength creams may be needed for short-term treatment of more stubborn cases.

Alternative

In the event of suspected yeast, a tablespoon of cider vinegar can be added to a cup of warm water and used as a cleansing solution. This is dilute enough that it should not burn, but acidifies the skin pH enough to hamper yeast growth.

What the baby eats can make a difference in stool frequency and acidity. When adding a new food to the diet, the baby should be observed closely to see whether rashes are produced around the baby's mouth or anus. If this occurs, the new food should be discontinued.

Babies who are taking antibiotics are more likely to get rashes due to yeast. To help bring the good bacterial counts back to normal, *Lactobacillus bifidus* can be added to the diet. It is available in powder form from most health food stores.

Some herbal preparations can be useful for diaper rash. Calendula reduces inflammation, tightens tissues, and disinfects. It has been recommended for seborrheic dermatitis as well as for general inflammation of the skin. The ointment should be applied at each diaper

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KEY TERMS

Dermatitis—Inflammation of the skin.

Pustule—A small raised pimple or blister-like swelling of the skin that contains pus.

change. Chickweed ointment can also be soothing for irritated skin and may be applied once or twice daily.

Home remedies

Good diaper hygiene will prevent or clear up many simple cases of diaper rash. Diapers should be checked very frequently and changed as soon as they are wet or soiled. Good air circulation is also important for healthy skin. Babies should have some time without wearing a diaper; a waterproof pad can be used to protect the bed or other surface. Rubber pants or other occlusive fabrics should not be used over the diaper area. There is no clear evidence that either cloth or disposable diapers are better at preventing diaper rash. It may be necessary for parents to experiment with diaper types to see if the baby's skin reacts better to cloth or disposable ones or if a particular brand works especially well. If the baby is wearing cloth diapers, they should be washed in a mild detergent and double rinsed. Using a larger size of diaper than normal until the rash heals can help speed healing and increase the baby's comfort.

The diaper area should be cleaned with something mild, even plain water. Some wipes contain alcohol or chemicals that can be irritating for some babies. Plain water may be the best cleansing substance when there is a rash. Using warm water in a spray bottle (or giving a quick bath) and then lightly patting the skin dry can produce less skin trauma than using wipes.

Barrier ointments can be valuable to treat rashes. Those that contain zinc oxide are especially effective. These creams and ointments protect already irritated skin from the additional insult of urine and stool, particularly if the baby has **diarrhea**. It is generally not recommended to use a talcum powder when changing the diaper, as inhaling the powder has been found to cause damage to infant's lungs.

Prognosis

Treated appropriately, diaper rash resolves fairly quickly if there is no underlying health problem or skin disease.

Prevention

Frequent diaper changes are important to keep the skin dry and healthy. Application of powders and ointments is not necessary when there is no rash. Finding the best combination of cleansing and diapering products for the individual baby will also help to prevent diaper rash.

Resources

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Nield, Linda S., and Deepak Kamat. " Prevention, Diagnosis, and Management of Diaper Dermatitis." *Clinical Pediatrics*. 46(6) (July 2007): 480–486.

ORGANIZATIONS

American Academy of Dermatology (AAD), PO Box 4014, Schaumburg, IL, 60168–4014, (847) 330–0230, (866) 503–SKIN (7546), (847) 240–1859, MRC@aad.org, http://www.aad.org.

American Academy of Family Physicians (AAFP), PO Box 11210, Shawnee Mission, KS, 66207, (913) 906–6000, (800) 274–2237, (913) 906–6075, http://familydoctor.org.

American Academy of Pediatrics (AAP), 141 Northwest Point Blvd., Elk Grove Village, IL, 60007–1098, (847) 434–4000, (847) 434–8000, http://www.aap.org.

Judith Turner
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Diaphragm (birth control)

Definition

Diaphragms are dome-shaped barrier methods of **contraception** that block sperm from entering the uterus. They are made of latex (rubber) and formed like a shallow cup. Since vaginas vary in size, each patient will need to be fitted by a doctor or nurse with a diaphragm that conforms to the shape and contour of the vagina as well as the strength of the muscles in the vaginal walls. Diaphragms must be used with spermicidal cream or jelly. The device should

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cause no discomfort, and neither the woman nor her partner should feel that it is there.

Purpose

The purpose of a diaphragm is to prevent access to the womb (uterus) by the sperm and thus prevent conception. The level of effectiveness is about 95%.

Precautions

Each client will undergo a **physical examination** and a Pap smear. If these are normal, the physician will fit the patient for the device and give instructions on how to insert, remove, and clean the object. She will also be taught the signs and symptoms of potential complications.

Description

Prior to insertion, the inside of the dome and the rim are covered with a thick layer (perhaps a tablespoon) of a spermicide that is compatible with the diaphragm being used. The domed area covers the opening into the uterus (cervix) and keeps the spermicide in place. As a result, any sperm that might get under the diaphragm will be destroyed.

Diaphragms may be inserted two–three hours prior to intercourse, and must be left in place for six to eight hours following sexual relations. During this time the woman may not swim, bathe, or douche, but she may shower. If she desires to have intercourse again before the six to eight hours have passed, the diaphragm should not be removed. Instead, an applicator full of spermicide should be deposited into the vagina.

A diaphragm will last for a year or more. It should be examined weekly for holes. This can be done by holding it up to the light or filling it with water.

Preparation

Before inserting the diaphragm, the woman should empty her bladder and wash her hands with soap and water. The device should be checked for leaks by filling it with water or holding it up to the light. A spermicidal jelly is then applied to the inside and outside, and especially around the rim. While standing with one foot elevated on a chair or step, lying down, or squatting, the woman folds the diaphragm inward toward the middle and inserts it into the vagina as far as it will go.

Aftercare

When removed, the diaphragm should be washed with a mild soap and water. After being dried, it can be dusted with corn starch before being returned to its container. The diaphragm should always be stored away from sunlight and heat in a cool, dry place. It should not be washed with harsh or perfumed soaps or used with perfumed powders because either of these substances can damage the diaphragm.

KEY TERMS

Spermicide—A substance that kills sperm.

Toxic shock syndrome—An uncommon, but potentially fatal, disease that has been associated with the use of diaphragms and vaginal tampons. The symptoms include high fever, vomiting, and diarrhea.

Risks

Although rare, wearing the diaphragm longer than the recommended time can result in **toxic shock syndrome**. The signs and symptoms of this serious illness include sudden onset of high **fever**, **vomiting**, **diarrhea**, **dizziness**, faintness, weakness, aching muscles and joints, and rash. The doctor must be notified immediately if any of these conditions appear. An allergic reaction to the spermicide or the material from which the device is made is also possible. Diaphragm use is also associated with an increased risk of bladder infections.

It should be noted that the diaphragm can become dislodged during intercourse, which could result in an unwanted **pregnancy**. To ensure a secure fit, a woman should be examined for a refitting if she gains or loses more than 10 lbs (4.5 kg), or after she gives birth.

Normal results

Consumers can expect an efficiency rate of about 95% in preventing pregnancy. Using a male condom in conjunction with the diaphragm decreases the potential for pregnancy. Diaphragms provide no protection against **AIDS** or other **sexually transmitted diseases**.

Resources

OTHER

"Guide to Safer Sex." *Sexual Health InfoCenter*. http://www.sexhealth.org/infocenter/GuideSS/diaphragm.htm.

ORGANIZATIONS

Planned Parenthood Federation of America, 434 West 33rd St., New York, NY, 10001, (212) 541-7800, (212) 245-1845, (800) 230-7526, http://www.plannedparenthood.org.

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Diaphragmatic hernia *see* **Hernia**

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Diarrhea

Definition

To most individuals, diarrhea means an increased frequency or decreased consistency of bowel movements; however, the medical definition is more exact than this. In many developed countries, the average number of bowel movements is three per day. However, researchers have found that diarrhea best correlates with an increase in stool weight; stool weights above 10oz (300 gs) per day generally indicates diarrhea. This is mainly due to excess water, which normally makes up 60–85% of fecal matter. In this way, true diarrhea is distinguished from diseases that cause only an increase in the number of bowel movements (hyperdefecation) or incontinence (involuntary loss of bowel contents).

Diarrhea is also classified by physicians into acute, which lasts one or two weeks, and chronic, which continues for longer than 2 or 3 weeks. Viral and bacterial infections are the most common causes of acute diarrhea.

Description

In many cases, acute infectious diarrhea is a mild, limited annoyance. However, worldwide acute infectious diarrhea has a huge impact, causing over five million deaths per year. While most deaths are among children under five years of age in developing nations, the impact, even in developed countries, is considerable. For example, over 250,000 individuals are admitted to hospitals in the United States each year because of one of these episodes. Rapid diagnosis and proper treatment can prevent much of the suffering associated with these devastating illnesses.

Chronic diarrhea also has a considerable effect on health, as well as on social and economic well being. Patients with **celiac disease**, inflammatory bowel disease, and other prolonged diarrheal illnesses develop nutritional deficiencies that diminish growth and immunity. They affect social interaction and result in the loss of many working hours.

Causes and symptoms

Diarrhea occurs because more fluid passes through the large intestine (colon) than that organ can absorb. As a rule, the colon can absorb several times more fluid than is required on a daily basis. However, when this reserve capacity is overwhelmed, diarrhea occurs.

Diarrhea is caused by infections or illnesses that either lead to excess production of fluids or prevent absorption of fluids. Also, certain substances in the colon, such as fats and bile acids, can interfere with water absorption and cause diarrhea. In addition, rapid passage of material through the colon can also do the same.

Symptoms related to any diarrheal illness are often those associated with any injury to the gastrointestinal tract, such as **fever**, **nausea**, **vomiting**, and abdominal **pain**. All or none of these may be present depending on the disease causing the diarrhea. The number of bowel movements can vary—up to 20 or more per day. In some patients, blood or pus is present in the stool. Bowel movements may be difficult to flush (float) or contain undigested food material.

The most common causes of acute diarrhea are infections (the cause of **traveler's diarrhea**), **food poisoning**, and medications. Medications are a frequent and often over-looked cause, especially **antibiotics** and **antacids**. Less often, various sugar free foods, which sometimes contain poorly absorbable materials, cause diarrhea.

Chronic diarrhea is frequently due to many of the same things that cause the shorter episodes (infections, medications, etc.); symptoms just last longer. Some infections can become chronic. This occurs mainly with parasitic infections (such as *Giardia*) or when patients have altered immunity (**AIDS**).

The following are the more usual causes of chronic diarrhea:

- AIDS
- colon cancer and other bowel tumors
- endocrine or hormonal abnormalities (thyroid, diabetes mellitus, etc.)
- food allergy
- inflammatory bowel disease (**Crohn's disease** and ulcerative colitis)
- lactose intolerance
- malabsorption syndromes (celiac and Whipple's disease)
- other (alcohol, microscopic colitis, radiation, surgery)

Complications

The major effects of diarrhea are **dehydration**, **malnutrition**, and weight loss. Signs of dehydration can be hard to notice, but increasing thirst, **dry mouth**, weakness or lightheadedness (particularly if worsening on standing), or a darkening/decrease in urination are suggestive. Severe dehydration leads to changes in the body's chemistry and could become life-threatening. Dehydration from diarrhea can result in kidney failure, neurological symptoms, arthritis, and skin problems.

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Diagnosis

Most cases of acute diarrhea never need diagnosis or treatment, as many are mild and produce few problems. But patients with fever over 102 °F (38.9 °C), signs of dehydration, bloody bowel movements, severe abdominal pain, known immune disease, or prior use of antibiotics need prompt medical evaluation.

When diagnostic studies are needed, the most useful are **stool culture** and examination for parasites; however these are often negative and a cause cannot be found in a large number of patients. The earlier cultures are performed, the greater the chance of obtaining a positive result. For those with a history of antibiotic use in the preceding two months, stool samples need to be examined for the toxins that cause **antibiotic-associated colitis**. Tests are also available to check stool samples for microscopic amounts of blood and for cells that indicate severe inflammation of the colon. Examination with an endoscope is sometimes helpful in determining severity and extent of inflammation. Tests to check changes in blood chemistry (potassium, magnesium, etc.) and a **complete blood count** (CBC) are also often performed.

Chronic diarrhea is quite different, and most patients with this condition will receive some degree of testing. Many exams are the same as for an acute episode, as some infections and parasites cause both types of diarrhea. A careful history to evaluate medication use, dietary changes, family history of illnesses, and other symptoms is necessary. Key points in determining the seriousness of symptoms are weight loss of over 10 lb (4.5 kg), blood in the stool, and nocturnal diarrhea (symptoms that awaken the patient from sleep).

Both prescription and over-the-counter medications can contain additives, such as lactose and sorbitol, that will produce diarrhea in sensitive individuals. Review of **allergies** or skin changes may also point to a cause. Social history may indicate if **stress** is playing a role or identify activities which can be associated with diarrhea (for example, diarrhea that occurs in runners).

A combination of stool, blood, and urine tests may be needed in the evaluation of chronic diarrhea; in addition a number of endoscopic and x-ray studies are frequently required.

Treatment

Treatment is ideally directed toward correcting the cause; however, the first aim should be to prevent or treat dehydration and nutritional deficiencies. The type of fluid and nutrient replacement will depend on whether oral feedings can be taken and the severity of fluid losses. Oral rehydration solution (ORS) or intravenous fluids are the choices; ORS is preferred if possible.

A physician should be notified if the patient is dehydrated, and if oral replacement is suggested then commercial (Pedialyte and others) or homemade preparations can be used. The World Health Organization (WHO) has provided this easy recipe for home preparation, which can be taken in small frequent sips:

- Table salt—3/4 tsp
- Baking powder—1 tsp
- Orange juice—1 c
- Water—1 qt (1l)

When feasible, food intake should be continued even in those with acute diarrhea. A physician should be consulted as to what type and how much food is permitted.

Anti-motility agents (loperamide, diphenoxylate) are useful for those with chronic symptoms; their use is limited or even contraindicated in most individuals with acute diarrhea, especially in those with high fever or bloody bowel movements. They should not be taken without the advice of a physician.

Other treatments are available, depending on the cause of symptoms. For example, the bulk agent psyllium helps some patients by absorbing excess fluid and solidifying stools; cholestyramine, which binds bile acids, is effective in treating bile salt induced diarrhea. Low fat **diets** or more easily digestible fat is useful in some patients. New **antidiarrheal drugs** that decrease excessive secretion of fluid by the intestinal tract is another approach for some diseases. Avoidance of medications or other products that are known to cause diarrhea (such as lactose) is curative in some, but should be discussed with a physician.

Alternative treatment

It is especially important to find the cause of diarrhea, since stopping diarrhea when it is the body's way of eliminating something foreign is not helpful and can be harmful in the long run.

One effective alternative approach to preventing and treating diarrhea involves oral supplementation of aspects of the normal flora in the colon with the yeasts *Lactobacillus acidophilus*, *L. bifidus*, or *Saccharomyces boulardii*. In clinical settings, these "biotherapeutic" agents have repeatedly been helpful in the resolution of diarrhea, especially antibiotic-associated diarrhea. Their effectiveness is also supported by the results of a research study published in the *Journal of the American Medical Association* in 1996.

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KEY TERMS

Anti-motiltiy medications—Medications such as loperamide (Imodium), diphenoxylate (Lomotil), or medications containing codeine or narcotics that decrease the ability of the intestine to contract. These can worsen the condition of a patient with dysentery or colitis.

Colitis—Inflammation of the colon.

Endoscope—An endoscope, as used in the field of gastroenterology, is a thin flexible tube that uses a lens or miniature camera to view various areas of the gastrointestinal tract. Both diagnosis, through biopsies or other means, and therapeutic procedures can be done with this instrument.

Endoscopy—The performance of an exam using an endoscope is known generally as endoscopy.

Lactose intolerance—An inability to properly digest milk and dairy products.

Oral rehydration solution (ORS)—A liquid preparation developed by the World Health Organization that can decrease fluid loss in persons with diarrhea. Originally developed to be prepared with materials available in the home, commercial preparations have recently come into use.

Steatorrhea—Excessive amounts of fat in the feces.

Nutrient replacement also plays a role in preventing and treating episodes of diarrhea. Zinc especially appears to have an effect on the immune system, and deficiency of this mineral can lead to chronic diarrhea. Also, zinc replacement improves growth in young patients. Plenty of fluids, especially water, should be taken by individuals suffering from diarrhea to prevent dehydration. The BRAT diet also can be useful in helping to resolve diarrhea. This diet limits food intake to bananas, rice, applesauce, and toast. These foods provide soluble and insoluble fiber without irritation. If the toast is slightly burnt, the charcoal can help sequester toxins and pull them from the body.

Acute homeopathic remedies can be very effective for treating diarrhea especially in infants and young children.

Prognosis

Prognosis is related to the cause of the diarrhea; for most individuals in developed countries, a bout of acute, infectious diarrhea is at best uncomfortable. However, in both industrialized and developing areas, serious complications and **death** can occur.

For those with chronic symptoms, an extensive number of tests are usually necessary to make a proper diagnosis and begin treatment; a specific diagnosis is found in 90% of patients. In some, however, no specific cause is found and only treatment with bulk agents or anti-motility agents is indicated.

Prevention

Proper hygiene and food handling techniques will prevent many cases. Traveler's diarrhea can be avoided by use of Pepto-Bismol and/or antibiotics, if necessary. The most important action is to prevent the complications of dehydration.

Resources

OTHER

"Directory of Digestive Diseases Organizations for Patients." *National Institute of Diabetes and Digestive and Kidney Disease*. http://www.niddk.nih.gov.

"A Neglected Modality for the Treatment and Prevention of Selected Intestinal and Vaginal Infections." *JAMA*. http://pubs.ama-assn.org.

Selected publications and documents on diarrhoeal diseases (including cholera). *World Health Organization (WHO)*. http://www.who.ch/chd/pub/cdd/cddpub.htm.

ORGANIZATIONS

World Health Organization (WHO), Avenue Appia 201211, Geneva, Switzerland, 27, 4122791-2111, info@who.int, http://www.who.int.

David Kaminstein, MD

Diazep *see* **Benzodiazepines**

Diclofenac *see* **Nonsteroidal anti-inflammatory drugs**

Dicyclomine *see* **Antispasmodic drugs**

Didanosine *see* **Antiretroviral drugs**

Diets

Definition

Humans may alter their usual eating habits for many reasons, including weight loss, disease prevention or treatment, removing toxins from the body, or to achieve a general improvement in physical and mental health. Others adopt special diets for religious reasons. In the case of some vegetarians and vegans,

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USDA MyPyramid food recommendations

Daily caloric intake	1,000	1,200	1,400	1,600	1,800	2,000	2,200	2,400	2,600	2,800	3,000	3,200
Fruits	1 cup	1 cup	1.5 cups	1.5 cups	1.5 cups	2 cups	2 cups	2 cups	2 cups	2.5 cups	2.5 cups	2.5 cups
Vegetables	1 cup	1.5 cups	1.5 cups	2 cups	2.5 cups	2.5 cups	3 cups	3 cups	3.5 cups	3.5 cups	4 cups	4 cups
Grains	3 oz-eq	4 oz-eq	5 oz-eq	5 oz-eq	6 oz-eq	6 oz-eq	7 oz-eq	8 oz-eq	9 oz-eq	10 oz-eq	10 oz-eq	10 oz-eq
Meat and beans	2 oz-eq	3 oz-eq	4 oz-eq	5 oz-eq	5 oz-eq	5.5 oz-eq	6 oz-eq	6.5 oz-eq	6.5 oz-eq	7 oz-eq	7 oz-eq	7 oz-eq
Milk	2 cups	2 cups	2 cups	3 cups	3 cups	3 cups	3 cups	3 cups	3 cups	3 cups	3 cups	3 cups
Oils	3 tsp	4 tsp	4 tsp	5 tsp	5 tsp	6 tsp	6 tsp	7 tsp	8 tsp	8 tsp	10 tsp	11 tsp
Discretionary calorie allowance	165	171	171	132	195	267	290	362	410	426	512	648

SOURCE: U.S. Department of Agriculture, Center for Nutrition Policy and Promotion.

(Table by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)

dietary changes are made out of ethical concerns for the rights of animals.

Purpose

People who are moderately to severely overweight can derive substantial health benefits from a weight-loss diet. A weight reduction of just 10–20 pounds can result in reduced cholesterol levels and lower blood pressure. Weight-related health problems include heart disease, diabetes, high blood pressure, and high levels of blood sugar and cholesterol.

In individuals who are not overweight, dietary changes also may be useful in the prevention or treatment of a range of ailments including acquired immuno deficiency syndrome (**AIDS**), **cancer**, **osteoporosis**, inflammatory bowel disease, chronic pulmonary disease, renal disease, **Parkinson's disease**, seizure disorders, and **food allergies** and intolerances.

Description

Origins

The practice of altering diet for special reasons has existed since antiquity. For example, Judaism has included numerous dietary restrictions for thousands of years. One ancient Jewish sect, the Essenes, is said to have developed a primitive **detoxification** diet aimed at preparing the bodies, minds, and spirits of its members for the coming of a "messiah" who would deliver them from their Roman captors. Preventive and therapeutic diets became popular during the late twentieth century. Books promoting the latest dietary plan continue to make the bestseller lists, although not all of the information given is considered authoritative.

The idea of a healthful diet is to provide all of the calories and nutrients needed by the body for optimal performance, at the same time ensuring that neither nutritional deficiencies nor excesses occur. Diet plans that claim to accomplish those objectives are so numerous they are virtually uncountable. These diets employ a variety of approaches, including the following:

- Fixed-menu: Offers little choice to the dieter. Specifies exactly which foods will be consumed. Easy to follow, but may be considered boring to some dieters.
- Formula: Replaces some or all meals with a nutritionally balanced liquid formula or powder.
- Exchange-type: Allows the dieter to choose between selected foods from each food group.
- Flexible: Doesn't concern itself with the overall diet, simply with one aspect such as fat or energy.

Diets also may be classified according to the types of foods they allow. For example, an omnivorous diet consists of both animal and plant foods, whereas a lacto-ovo-vegetarian diet permits no animal flesh, but includes eggs, milk, and dairy products. A vegan diet is a stricter form of **vegetarianism** in which eggs, cheese, and other milk products are prohibited.

A third way of classifying diets is according to their purpose: religious, weight-loss, detoxification, lifestyle-related, or aimed at prevention or treatment of a specific disease.

Precautions

Dieters should be cautious about plans that severely restrict the size of food portions, or that eliminate entire food groups from the diet. It is highly probable that they will become discouraged and drop out of such programs. The best diet is one that can be maintained indefinitely without ill effects, that offers sufficient variety and balance to provide everything needed for good health, and that is considerate of personal food preferences. Many controversies have

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arisen in the past over the benefits and risks of high-protein, low carbohydrate diets such as the **Atkins diet**. Most physician groups and health organizations have spoken out negatively against the program. In 2003, these statements were largely supported. Though clinical trials showed that these types of diets worked in lowering weight without raising cholesterol for the short-term, many of the participants gained a percentage of the weight back after only one year. A physician group also spoke out about high protein diets' dangers for people with decreased kidney function and the risk of bone loss due to decreased **calcium** intake.

Low-fat diets are not recommended for children under the age of two. Young children need extra fat to maintain their active, growing bodies. Fat intake may be gradually reduced between the ages of two and five, after which it should be limited to a maximum of 30% of total calories through adulthood. Saturated fat should be restricted to no more than 10% of total calories.

Weight-loss dieters should be wary of the "yo-yo" effect that occurs when numerous attempts are made to reduce weight using high-risk, quick-fix diets. This continued "cycling" between weight loss and weight gain can slow the basal metabolic rate and can sometimes lead to **eating disorders**. The dieter may become discouraged and frustrated by this success/failure cycle. The end result of yo-yo dieting is that it becomes more difficult to maintain a healthy weight.

Caution also should be exercised about weight loss diets that require continued purchases of special prepackaged foods. Not only do these tend to be costly and over-processed, they also may prevent dieters from learning the food-selection and preparation skills essential to maintenance of weight loss. Further, dieters should consider whether they want to carry these special foods to work, restaurants, or homes of friends.

Concern has been expressed about weight-loss diet plans that do not include **exercise**, considered essential to long-term weight management. Some diets and supplements may be inadvisable for patients with special conditions or situations. In fact, use of the weight loss supplement ephedra was found to cause serious conditions such as **heart attack** and **stroke**. In 2003, the U.S. Food and Drug Administration (FDA) was considering controlling or banning the supplement. In short, most physician organizations see fad diets as distracting from learning how to achieve weight control over the long term through healthy lifestyle changes such as eating smaller, more balanced meals and exercising regularly.

Certain fad diets purporting to be official diets of groups such as the American Heart Association and the Mayo Clinic are in no way endorsed by those institutions. People thinking of starting such a diet should check with the institution to ensure its name has not been misappropriated by an unscrupulous practitioner.

Side effects

A wide range of side effects (some quite serious) can result from special diets, especially those that are nutritionally unbalanced. Further problems can arise if the dieter is taking high doses of dietary supplements. Food is essential to life, and improper **nutrition** can result in serious illness or **death**.

Research and general acceptance

It is agreed among traditional and complementary practitioners that many patients could substantially benefit from improved eating habits. Specialized diets have proved effective against a wide variety of conditions and diseases. However, dozens of unproved but widely publicized fad diets emerge each year, prompting widespread concerns about their usefulness, cost to the consumer, and their safety.

Resources

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American Dietetic Association, 120 S. Riverside Plaza, Suite 2000, Chicago, IL, 60606-6995, (312) 899-0040, (800) 877-1600, http://www.eatright.org/.

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Diffuse esophageal spasm

Definition

Diffuse esophageal spasm is a term used to define an uncoordinated or spastic esophagus.

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Description

The esophagus is a muscular tube that actively transports food from the throat to the stomach by rhythmic contractions known as peristalsis. The actual mechanism and anatomy are quite complex, involving three distinct segments and allowing a person to swallow even when upside-down. Diffuse esophageal spasm describes a condition where the entire esophagus is spastic—along its entire length, the muscular activity is increased and uncoordinated. The name corkscrew esophagus describes perfectly the appearance of this disorder on x rays.

X rays may reveal a slightly different appearance and result in the designation rosary bead esophagus, but the cause is still diffuse spasm, and the two entities behave in the same way.

Causes and symptoms

The cause appears to be disruption of the complex system of nerves that coordinates the muscular activity. The result is difficulty swallowing (dysphagia) and **pain** that feels like a **heart attack** and can involve the entire chest, jaw, and arms.

Diagnosis

Swallowing problems usually call for esophagograms. In the x-ray department, the patient is given a contrast agent to drink. During swallowing, x rays record the passage of the agent down the esophagus and into the stomach. Instead of a straight tube with well-coordinated waves of contraction, the resulting x rays show a writhing organ resembling a giant corkscrew.

Another test that is used in many disorders of esophageal motility is manometry. Pressures inside the esophagus are measured every inch or so using a balloon device that is passed all the way down to the stomach. The result is a precise record of its activity that yields a specific diagnosis.

Treatment

Soft and liquid foods pass more easily than solid pieces. Medications of several types are helpful—nifedipine, hydralazine, isoproterenol, and nitrates being the most successful. Several other treatments have uncertain results. For severe cases, relief is obtained two-thirds of the time by cutting the muscles along the entire length of the esophagus. This is a major surgical procedure.

Prognosis

This condition does not go away, nor is treatment entirely satisfactory. Patients need to be careful of what they eat and continue on medication if a beneficial one is found. Fortunately, the condition does not get progressively worse as time passes.

KEY TERMS

Contrast agent—A substance that produces shadows on x rays.

Manometry—Measurement of pressure.

Peristalsis—Slow, rhythmic contractions of the muscles in a tubular organ, such as the intestines, that propel the contents along.

Resources

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J. Ricker Polsdorfer, MD

DiGeorge syndrome

Definition

DiGeorge syndrome (also called 22q11 deletion syndrome, congenital thymic hypoplasia, or third and fourth pharyngeal pouch syndrome) is a birth defect that is caused by an abnormality in chromosome 22 and affects the baby's immune system. The disorder is marked by absence or underdevelopment of the thymus and parathyroid glands. It is named for Angelo DiGeorge, the pediatrician who first described it in 1965. Some researchers prefer to call it DiGeorge anomaly, or DGA, rather than DiGeorge syndrome, on the grounds that the defects associated with the disorder represent the failure of a part of the human embryo to develop normally rather than a collection of symptoms caused by a single disease.

Description

The prevalence of DiGeorge syndrome is debated; the estimates range from 1:4000 to 1:6395. Because the symptoms caused by the chromosomal abnormality vary somewhat from patient to patient, the syndrome probably occurs much more often than was previously thought. DiGeorge syndrome is sometimes described as one of the "CATCH 22" disorders, so named because of their characteristics—cardiac defects, abnormal facial features, thymus underdevelopment, **cleft palate**, and

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hypocalcemia—caused by a deletion of several genes in chromosome 22. The specific facial features associated with DiGeorge syndrome include low-set ears, wide-set eyes, a small jaw, and a short groove in the upper lip. The male/female ratio is 1:1. The syndrome appears to be equally common in all racial and ethnic groups.

Causes and symptoms

DiGeorge syndrome is caused either by inheritance of a defective chromosome 22 or by a new defect in chromosome 22 in the fetus. The type of defect that is involved is called deletion. A deletion occurs when the genetic material in the chromosomes does not recombine properly during the formation of sperm or egg cells. The deletion means that several genes from chromosome 22 are missing in DiGeorge syndrome patients. Although efforts have been made in the early 2000s to identify individual candidate genes for DGA, it appears that a combination of several genes in the deleted area is responsible for the disorder. Detailed genetic mapping of chromosome 22 has, however, identified a so-called DiGeorge critical region (DGCR), which has been completely sequenced.

According to a 1999 study, 6% of children with DiGeorge syndrome inherited the deletion from a parent, while 94% had a new deletion. Other conditions that are associated with DiGeorge syndrome are diabetes (a condition where the pancreas no longer produces enough insulin) in the mother and **fetal alcohol syndrome** (a pattern of **birth defects**, and learning and behavioral problems affecting individuals whose mothers consumed alcohol during **pregnancy**). Other chromosomal abnormalities that have been found in patients diagnosed with DGA include deletions on chromosomes 10p13, 17p13, and 18q21.

The loss of the genes in the deleted material means that the baby's third and fourth pharyngeal pouches fail to develop normally during the twelfth week of pregnancy. This developmental failure results in a completely or partially absent thymus gland and parathyroid glands. In addition, 74% of fetuses with DiGeorge syndrome have severe heart defects. The child is born with a defective immune system and an abnormally low level of **calcium** in the blood. Some children with DGA are also born with malformations of the genitals or urinary tract.

These defects usually become apparent within 48 hours of birth. The infant's heart defects may lead to **heart failure**, or there may be seizures and other evidence of a low level of calcium in the blood (**hypocalcemia**).

DiGeorge syndrome is also associated with an increased risk of **autoimmune disorders**. Cases have been reported of DGA in association with Graves' disease, immune thrombocytopenic purpura, juvenile **rheumatoid arthritis**, and severe **eczema**.

Diagnosis

Diagnosis of DiGeorge syndrome can be made by ultrasound examination around the eighteenth week of pregnancy, when abnormalities in the development of the heart or the palate can be detected. Another technique that is used to diagnose the syndrome before birth is called fluorescence in situ hybridization, or FISH. This technique uses DNA probes from the DiGeorge region on chromosome 22. FISH can be performed on cell samples obtained by **amniocentesis** as early as the fourteenth week of pregnancy. It confirms about 95% of cases of DiGeorge syndrome.

If the mother has not had prenatal testing, the diagnosis of DiGeorge syndrome is sometimes suggested by the child's facial features at birth. In other cases, the doctor makes the diagnosis during heart surgery when he or she notices the absence or abnormal location of the thymus gland. The diagnosis can be confirmed by blood tests for calcium, phosphorus, and parathyroid hormone levels, and by the sheep cell test for immune function.

Treatment

Hypocalcemia

Hypocalcemia in DiGeorge patients is unusually difficult to treat. Infants are usually given calcium and vitamin D by mouth. Severe cases have been treated by transplantation of fetal thymus tissue or bone marrow.

Heart defects

Infants with life-threatening heart defects are treated surgically.

Defective immune function

Children with DiGeorge syndrome should be kept on low-phosphorus **diets** and kept away from crowds or other sources of infection. They should not be immunized with vaccines made from live viruses or given **corticosteroids**.

Prognosis

The prognosis is variable; many infants with DiGeorge syndrome die from overwhelming infection, seizures, or heart failure within the first year. One study of a series of 558 patients reported 8% mortality within six months of birth, with heart defects accounting for all but one of the deaths. Infections resulting from severe immune deficiency are the second most common cause

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KEY TERMS

Deletion—A genetic abnormality in which a segment of a chromosome is lost. DiGeorge syndrome is caused by a deletion on human chromosome 22.

Fetal alcohol syndrome—A cluster of birth defects that includes abnormal facial features and mental retardation, caused by the mother's consumption of alcoholic beverages during pregnancy.

Fluorescence in situ hybridization (FISH)—A technique for diagnosing DiGeorge syndrome before birth by analyzing cells obtained by amniocentesis with DNA probes. FISH is about 95% accurate.

Hypocalcemia—An abnormally low level of calcium in the blood.

Hypoplasia—A deficiency or underdevelopment of a tissue or body structure.

T cells—A type of white blood cell produced in the thymus gland. T cells are an important part of the immune system. Infants born with an underdeveloped or absent thymus do not have a normal level of T cells in their blood.

of **death** in patients with DGA. Advances in heart surgery indicate that the prognosis is most closely linked to the severity of the heart defects and the partial presence of the thymus gland. In most children who survive, the number of T cells, a type of white blood cell, in the blood rises spontaneously as they mature. Survivors are likely to be mentally retarded, however, and to have other developmental difficulties, including seizures or other psychiatric and neurological problems in later life.

Prevention

Genetic counseling is recommended for parents of children with DiGeorge syndrome because the disorder can be detected prior to birth. Although most children with DiGeorge syndrome did not inherit the chromosome deletion from their parents, they have a 50% chance of passing the deletion on to their own children.

Because of the association between DiGeorge syndrome and fetal alcohol syndrome, pregnant women should avoid drinking alcoholic beverages.

Resources

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ORGANIZATIONS

Canadian 22q Central, 338 Spruce Street North, Timmins, CanadaOntario, P4N 6N5 , (705) 268-3099, steph.stpierre@c22c.org, http://www.c22c.org.

Chromosome Disorder Outreach, P.O. Box 724, Boca Raton, FL, 33429-0724, (561) 395-4252, info@chromodisorder.org, http://www.chromodisorder.org.

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923, (800) 999-6673, http://www.rarediseases.org.

Velo-Cardio-Facial Syndrome Educational Foundation, Inc., P.O. Box 874, Milltown, NJ, 08850, (214) 360-4740, info@vcfsef.org, http://www.vcfsef.org/.

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Digital rectal examination

Definition

The digital **rectal examination** (DRE) is a routine part of the **physical examination** and includes manual examination of the rectum, anus and, in men, the prostate.

Purpose

The purpose of the digital rectal examination is to identify lesions within the rectum and the prostate. It is the most widely used and oldest technique for the detection of **prostate cancer** and is used in screening for **colon cancer** and for the detection of **rectal polyps**.

Description

Usually the patient is positioned on the left side with the knees close to the chest. Sometimes the patient is asked to stand up and lean over the examination table. For women, sometimes this examination is part of the routine gynecological exam, and it may be done in a different manner than described here.

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KEY TERMS

Fissure—Any cleft or groove, normal or otherwise, especially a deep fold in the anus.

Lesion—Any pathological or traumatic discontinuity of tissues or loss of function of a part.

Palpation—A simple technique in which a doctor presses lightly on the surface of the body to feel the organs or tissues underneath.

Peritonitis—Inflammation of the peritoneum. It may be accompanied by abdominal pain and tenderness, constipation, vomiting and moderate fever.

Polyp—Growth, usually benign, protruding from a mucous membrane.

Rectal prolapse—Protrusion of the rectal mucous membrane through the anus.

Skin tag—A small outgrowth of skin tissue that may be smooth or irregular, flesh-colored and benign.

During the examination, the health care practitioner examines the anus and the surrounding skin for **hemorrhoids**, tags, fissures and abscesses. After lubricating the gloved finger and anus, the examiner gently slides the finger into the anus and follows the contours of the rectum. The examiner notes the tone of the anus and feels the walls and the edges for texture, tenderness and masses as far as the examining finger can reach. The examiner evaluates the prostate for nodules and tenderness. Stool on the finger should be examined for blood, color, texture and tested for fecal occult blood.

The examination takes less than two minutes and can be uncomfortable when the patient is not relaxed or is anxious. Occasionally, when the DRE is performed on a man the penis may become erect. A gentle reminder and reassurance helps to relieve the embarrassment associated with the unexpected erection.

Preparation

The patient must be carefully positioned and the doctor should take care to explain the examination to the patient and to explain to the patient what to expect. The digital rectal examination may be uncomfortable and embarrassing. Much of the discomfort can be reduced by an understanding, unhurried and gentle examiner.

Precautions

When there are infections of the anus and of the rectum, the digital rectal examination should not be performed. Manipulation of the anal and rectal tissues increases the risk of infection and of bleeding.

Results

In the normal anus and rectum, there are no hemorrhoids or bleeding about the anus. The anal tone is not loose. The rectum is smooth and non-tender. No masses should be palpated, or felt.

The digital rectal examination is helpful in identifying areas of **peritonitis** or tender areas that can be felt through the wall of the rectum. It is used to identify perineal disease or deformity, abnormal location of the anus, **rectal prolapse** and atrophy of the gluteal muscle. Digital examination can detect a stenosis (or narrowing) of the anal canal, assess the tone and strength of the anal muscles or detect the presence of a rectal mass or fecal impaction.

Any masses, including hard stool, blood or tenderness is considered abnormal. **Cancer** masses may be flattened, nodular, cauliflower-like or ring-shaped. Polyps can be felt, but must be visualized using **anoscopy** or flexible **sigmoidoscopy** to be distinguished from other lesions, such as internal hemorrhoids or malignant growths. Hard masses of feces may be felt and may be removed.

Aftercare

Aftercare of the digital rectal examination is minimal. It requires removal of the lubricating jelly residue from around the anus. The lubricating jelly dissolves easily in water and may be washed off in bathing after the examination. It can be removed with toilet paper immediately after the examination.

Resources

BOOKS

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LeBlond, Richard, Donald Brown, and Richard DeGowin. *DeGowin's Diagnostic Examination*, 9th ed. New York: McGraw-Hill, 2009.

ORGANIZATIONS

American College of Gastroenterology, P.O. Box 342260, Bethesda, MD, 20827-2260, (301) 263-9000, http://www.acg.gi.org.

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Digoxin

Definition

Digitalis occurs naturally in the foxglove plant, (*Digitalis purpurea*), was used for centuries to treat heart disease. Currently, its active ingredient, digoxin (Lanoxin), is manufactured synthetically.

Purpose

Digoxin increase the strength and speed of heart muscle contractions and is used to treat congestive **heart failure**, where the heart is unable to pump all of the blood it receives.

Digoxin is used to slow the heart rate and improve the efficiency of the ventricles (main pumping chambers) when there are rapid or irregular heart beats, like **atrial flutter** or fibrillation.

Digitalis purpurea. *(Photo Researchers, Inc.)*

The drug is also used to strengthen the heart in some cases of **shock**, like from **heart attack** or **sepsis** (overwhelming infection).

Description

Digoxin is available in tablet, capsule, liquid, and injectable forms.

Recommended dosage

The dose of digoxin is individualized for each patient. Physicians can tailor the dose based on patient response and laboratory measures of blood levels of the drug.

Precautions

This drug should be taken exactly as directed.

Digoxin is used with caution, or not given, in patients who have a number of serious heart diseases, like recent heart attack, subaortic ventricular stenosis and second or third degree **heart block**.

The elderly, newborns, and people with reduced kidney function are more sensitive to the effects of digoxin,

There is a narrow therapeutic range between effective and toxic doses of digoxin.

People taking digoxin should regularly check their pulse rate and rhythm; changes can signify side effects and should be reported to treating physicians.

Digitalis drugs are responsible for many accidental poisonings in children. Keep this medicine out of the reach of children.

Be alert to the signs and symptoms of digoxin overdose. If any of these signs occur, check with your physician soon:

- loss of appetite
- nausea
- vomiting
- pain in the lower stomach
- diarrhea
- tiredness or weakness
- extremely slow or irregular heartbeat (or fast heartbeat in children)
- blurred vision or other vision changes
- drowsiness
- confusion, unusual fatigue or depression
- headache
- fainting

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Before taking digoxin, people with any of the following the medical problems should make sure their physicians are aware of their conditions:

- heart disease
- heart rhythm problems
- severe lung disease
- kidney disease
- liver disease
- thyroid disease

Side effects

In therapeutic doses, side effects are rare with digoxin. If skin rash, **hives**, or any other unusual or troublesome symptoms occur, check with your physician.

Interactions

Many drugs, foods and herbs can increase or decrease the effectiveness of digoxin. For example:

- Taking digoxin with other heart medicines or stimulant drugs like diet pills, amphetamines, or ephedra can increase the risk of heart rhythm problems.
- Calcium channel blocking drugs, like Procardia and Norvasc, used to treat high blood pressure, may cause higher than usual levels of digoxin.
- Many diuretics, like Hydrodiuril, cause the body to lose potassium and increase the risk of side effects from digoxin.
- Potassium supplements, like K-Dur, used to replentish potassium supplies in patients taking diuretics, can increase the risk of digoxin toxicity.
- Cholesterol-lowering drugs like Lipitor may increase digoxin levels in the blood.
- Cholestyramine, Questran, may reduce the absorption of digoxin. To reduce this possible problem, digoxin should be taken several hours before or after taking these medicines.
- Anti-diarrhea medicines may decrease the absorption of digoxin.
- St. Johns wort and natural licorice can decrease the effect of digoxin.

Check with a pharmacist on the possible interactions of all of the medications you take with digoxin.

James Waun, MD, RPh

Dilatation and curettage

Definition

Dilatation and curettage (D & C) is a gynecological procedure in which the lining of the uterus (endometrium) is scraped away.

Purpose

D & C is commonly used to obtain tissue for microscopic evaluation to rule out **cancer**. D & C may also be used to diagnose and treat heavy menstrual bleeding, and to diagnose endometrial polyps and **uterine fibroids**. A D & C can be used as a treatment as well, to remove **pregnancy** tissue after a **miscarriage**, incomplete abortion, or **childbirth**. Endometrial polyps may be removed, and sometimes benign uterine tumors (fibroids) may be scraped away. D & C can also be used as an early abortion technique up to 16 weeks.

Description

D & C is usually performed under **general anesthesia**, although local or epidural anesthesia can also be used. A local lessens risk and costs, but the woman will feel cramping during the procedure. The type of anesthesia used often depends upon the reason for the D & C.

In the procedure (which takes only minutes to perform), the doctor inserts an instrument to hold open the vaginal walls, and then stretches the opening of the uterus to the vagina (the cervix) by inserting a series of tapering rods, each thicker than the previous one, or by using other specialized instruments. This process of opening the cervix is called dilation.

Once the cervix is dilated, the physician inserts a spoon-shaped surgical device called a curette into the uterus. The curette is used to scrape away the uterine lining. One or more small tissue samples from the lining of the uterus or the cervical canal are sent for analysis by microscope to check for abnormal cells.

Although simpler, less expensive techniques such as a vacuum aspiration are quickly replacing the D & C as a diagnostic method, it is still often used to diagnose and treat a number of conditions.

Preparation

Because opening the cervix can be painful, sedatives may be given before the procedure begins. Deep breathing and other relaxation techniques may help ease cramping during cervical dilation.

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Aftercare

A woman who has had a D & C performed in a hospital can usually go home the same day or the next day. Many women experience backache and mild cramps after the procedure, and may pass small **blood clots** for a day or so. Vaginal staining or bleeding may continue for several weeks.

Most women can resume normal activities almost immediately. Patients should avoid sexual intercourse, douching, and tampon use for at least two weeks to prevent infection while the cervix is closing and to allow the endometrium to heal completely.

Risks

The primary risk after the procedure is infection. Signs of infection include:

- fever
- heavy bleeding
- severe cramps
- foul-smelling vaginal discharge

A woman should report any of these symptoms to her doctor, who can treat the infection with **antibiotics** before it becomes serious.

KEY TERMS

Endometrial polyps—A growth in the lining of the uterus (endometrium) that may cause bleeding and can develop into cancer.

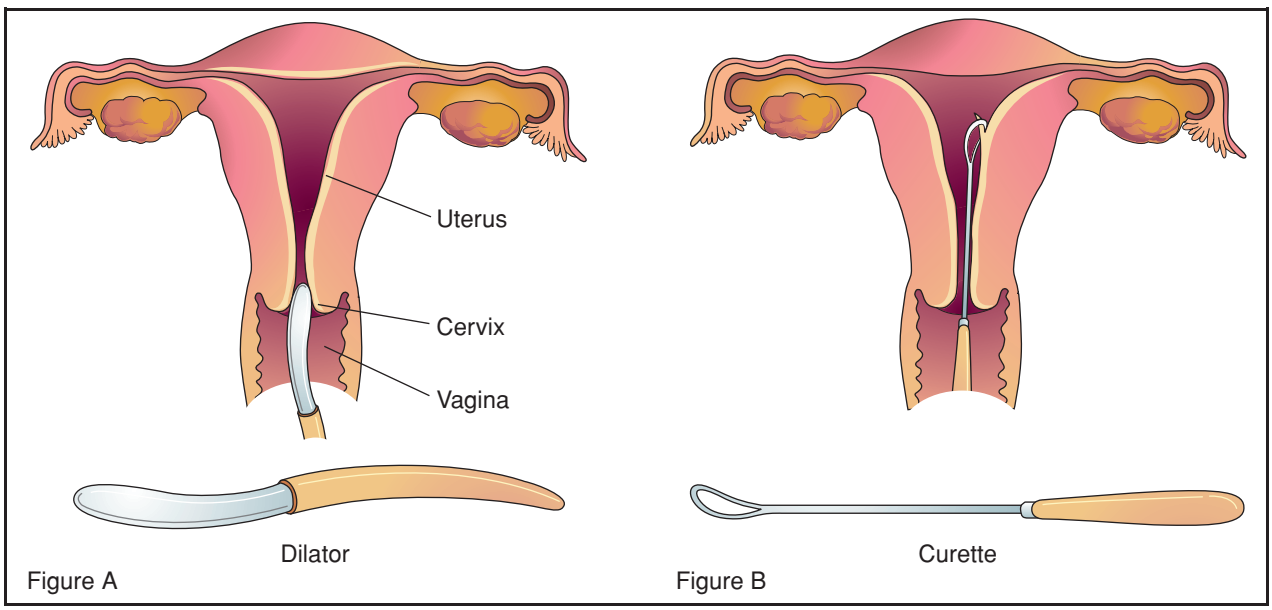
Epidural anesthesia—A type of anesthesia that is injected into the epidural space of the spinal cord to numb the nerves leading to the lower half of the body.

Uterine fibroid—A noncancerous tumor of the uterus that can range from the size of a pea to the size of a grapefruit. Small fibroids require no treatment, but those causing serious symptoms may need to be removed.

D & C is a surgical operation, which carries certain risks associated with general anesthesia. Rare complications include puncture of the uterus (which usually heals on its own) or puncture of the bowel or bladder (which require further surgery to repair).

Normal results

Removal of the uterine lining causes no side effects, and may be beneficial if the lining has thickened so



Dilatation and curettage (D & C) is used primarily to diagnose and treat heavy menstrual bleeding and to diagnose endometrial polyps, uterine fibroids, uterine cancer and cervical cancer. When performing a D & C, the physician inserts a speculum to separate and hold the vaginal walls, then stretches open the cervix with a dilator. Once the cervix is dilated, the physician will insert a curette into the uterus and scrape away small portions of the uterine lining for laboratory analysis. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

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much that it causes heavy periods. The uterine lining soon grows again normally, as part of the menstrual cycle.

Resources

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Carol A. Turkington

Dilated cardiomyopathy *see* **Congestive cardiomyopathy**

Diltiazem *see* **Calcium channel blockers**

Dilution test *see* **Kidney function tests**

Diphenhydramine *see* **Antihistamines**

Diphtheria

Definition

Diphtheria is a potentially fatal, contagious disease that usually involves the nose, throat, and air passages, but may also infect the skin. Its most striking feature is the formation of a grayish membrane covering the tonsils and upper part of the throat.

Demographics

Before 1920 when the diphtheria toxoid was introduced, diphtheria was a major childhood killer, with 200,000 cases reported annually in the United States. In the twenty first century, diphtheria is rare and sporadic in the developed world because of widespread immunization. In countries that do not have routine immunization against this infection, periodic outbreaks occur. The largest recent outbreak occurred in the countries comprising the former Soviet Union and the Baltic States. From 1990–1995, 157,000 cases and 5,000 deaths were reported in this region, accounting for more than 80% of all diphtheria cases reported during those years. Other, smaller outbreaks have been reported in sub-Saharan Africa, India, and France. Like many other upper respiratory diseases, diphtheria is most likely to occur during the cold months. Individuals who have not been immunized may get diphtheria at any age; mortality rates are highest in those under five years or over 40 years of age.

Description

Diphtheria is spread most often by droplets from the coughing or sneezing of an infected person or carrier. The incubation period is two to seven days, with an average of three days. It is vital to seek medical help at once when diphtheria is suspected, because treatment requires emergency measures for adults as well as children.

Risk factors for developing diphtheria include:

- failure to immunize or incomplete immunization
- living in crowded, unhygienic conditions
- having a compromised immune system
- traveling to developing regions of the world where diphtheria is more common

Causes and symptoms

The symptoms of diphtheria are caused by toxins produced by the diphtheria bacillus, *Corynebacterium diphtheriae* (from the Greek for "rubber membrane"). In fact, toxin production is related to infections of the bacillus itself with a particular bacterial virus called a phage (from bacteriophage; a virus that infects bacteria). The infection destroys healthy tissue in the upper area of the throat around the tonsils, or in open **wounds** in the skin. Fluid from dying cells then coagulates to form the telltale gray or grayish-green membrane. Inside the membrane, the bacteria produce an exotoxin, which is a poisonous secretion that causes the life-threatening symptoms of diphtheria. The exotoxin is carried throughout the body in the bloodstream, destroying healthy tissue in other parts of the body.

The most serious complications caused by the exotoxin are inflammations of the heart muscle (**myocarditis**) and damage to the nervous system. The risk of serious complications is increased as the time between onset of symptoms and the administration of antitoxin increases and as the size of the membrane formed increases. Myocarditis may cause disturbances in the heart rhythm (**arrhythmias**) and may result in **heart failure**. Symptoms of nervous system involvement can include seeing double vision (diplopia), painful or difficult swallowing (dysphagia), and slurred speech or loss of voice, which are all indications of the exotoxin's effect on nerve functions. The exotoxin may also cause severe swelling in the neck ("bull neck").

The signs and symptoms of diphtheria vary according to the location of the infection.

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Nasal

Nasal diphtheria produces few symptoms other than a watery or bloody discharge. On examination, there may be a small visible membrane in the nasal passages. Nasal infection rarely causes complications by itself, but it is a public health problem because it spreads the disease more rapidly than other forms of diphtheria.

Pharyngeal

Pharyngeal diphtheria gets its name from the pharynx, which is the part of the upper throat that connects the mouth and nasal passages with the voice box (larynx). This is the most common form of diphtheria, causing the characteristic grayish throat membrane. The membrane often bleeds if it is scraped or cut. It is important not to try to remove the membrane because the trauma may increase the body's absorption of the exotoxin. Other signs and symptoms of pharyngeal diphtheria include mild **sore throat**, **fever** of 101–102 °F (38.3–38.9 °C), a rapid pulse, and general body weakness.

Laryngeal

Laryngeal diphtheria, which involves the voice box or larynx, is the form most likely to produce serious complications. The fever is usually higher in this form of diphtheria (103–104 °F or 39.4–40 °C) and the patient is very weak. Patients may have a severe **cough**, have difficulty breathing, or lose their voice completely. The development of a "bull neck" indicates a high level of exotoxin in the bloodstream. Obstruction of the airway may result in difficulty breathing, respiratory compromise, and **death**.

Skin

This form of diphtheria, which is sometimes called cutaneous diphtheria, accounts for about 33% of diphtheria cases. It is found chiefly among people with poor hygiene, and is more common in tropical climates. Any break in the skin can become infected with diphtheria. The infected tissue develops an ulcerated area and a diphtheria membrane may form over the wound but is not always present. The wound or ulcer is slow to heal and may be numb or insensitive when touched.

Diagnosis

Because diphtheria must be treated as quickly as possible, doctors usually make the diagnosis on the basis of the visible symptoms without waiting for test results.

Examination

In making the diagnosis, the doctor examines the patient's eyes, ears, nose, and throat in order to rule out other diseases that may cause fever and sore throat, such as **infectious mononucleosis**, a sinus infection, or **strep throat**. The most important single symptom that suggests diphtheria is the membrane. When a patient develops skin infections during an outbreak of diphtheria, the doctor will consider the possibility of cutaneous diphtheria and take a smear to confirm the diagnosis.

Tests

The diagnosis of diphtheria can be confirmed by the results of a culture obtained from the infected area. Material from the swab is put on a microscope slide and stained using a procedure called Gram's

KEY TERMS

Antitoxin—An antibody against an exotoxin, usually derived from horse serum.

Bacillus—A rod–shaped bacterium, such as the diphtheria bacterium.

Carrier—A person who may harbor an organism without symptoms and may transmit it to others.

Cutaneous—Located in the skin.

Diphtheria–tetanus–pertussis (DTP)—The standard preparation used to immunize children against diphtheria, tetanus, and whooping cough. A so-called "acellular pertussis" vaccine (aP) is usually used since its release in the mid-1990s in a combined vaccine known as DTaP.

Exotoxin—A poisonous secretion produced by bacilli which is carried in the bloodstream to other parts of the body.

Gram's stain—A dye staining technique used in laboratory tests to determine the presence and type of bacteria.

Loeffler's medium—A special substance used to grow diphtheria bacilli to confirm a diagnosis.

Myocarditis—Inflammation of the heart tissue.

Toxoid—A preparation made from inactivated exotoxin, used in immunization.

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stain. The diphtheria bacillus is called Gram-positive because it holds the dye after the slide is rinsed with alcohol. Under the microscope, diphtheria bacilli look like beaded rod-shaped cells, grouped in patterns that resemble Chinese characters. Another laboratory test involves growing the diphtheria bacillus on a special material called Loeffler's medium.

Treatment

Diphtheria is a serious disease requiring hospital treatment in an intensive care unit if the patient has developed respiratory symptoms. Treatment includes a combination of medications and supportive care:

Antitoxin

The most important step is prompt administration of diphtheria antitoxin, without waiting for laboratory results. The antitoxin is made from horse serum and works by neutralizing any circulating exotoxin. The doctor must first test the patient for sensitivity to animal serum. Patients who are sensitive (about 10%) must be desensitized with diluted antitoxin, since the antitoxin is the only specific substance that will counteract diphtheria exotoxin. No other type if antitoxin is available for the treatment of diphtheria.

The dose of antitoxin ranges from 20,000–100,000 units, depending on the severity and length of time of symptoms occurring before treatment. Diphtheria antitoxin is usually given intravenously. It must be obtained from the United States Centers for Disease Control and Prevention (CDC) and may not be available in some parts of the world.

Antibiotics

Antibiotics are given to kill the bacteria, to prevent the spread of the disease, and to protect the patient from developing **pneumonia**. They are not a substitute for treatment with antitoxin. Both adults and children may be given penicillin, ampicillin, or erythromycin. Erythromycin appears to be more effective than penicillin in treating people who are carriers because of better penetration into the infected area.

Cutaneous diphtheria is usually treated by cleansing the wound thoroughly with soap and water, and giving the patient antibiotics for 10 days.

Supportive care

Diphtheria patients need bed rest with intensive nursing care, including extra fluids, oxygenation, and monitoring for possible heart problems, airway blockage, or involvement of the nervous system. Patients with laryngeal diphtheria are kept in a **croup** tent or high-humidity environment; they may also need throat suctioning or emergency surgery if their airway is blocked.

Patients recovering from diphtheria should rest at home for a minimum of two to three weeks, especially if they have heart complications. In addition, patients should be immunized against diphtheria after recovery, because having the disease does not always induce antitoxin formation and protect them from re-infection.

Prevention of complications

Diphtheria patients who develop myocarditis may be treated with oxygen and with medications to prevent irregular heart rhythms. An artificial pacemaker may be needed. Patients with difficulty swallowing can be fed through a tube inserted into the stomach through the nose. Patients who cannot breathe are usually put on mechanical respirators.

Prognosis

The prognosis depends on the size and location of the membrane and on early treatment with antitoxin; the longer the delay, the higher the death rate. The most vulnerable patients are children under age five and those who develop pneumonia or myocarditis. Death rates generally range from five to 10 percent and may reach as high as 20% in young children and older adults. Nasal and cutaneous diphtheria are rarely fatal.

Prevention

Prevention of diphtheria has four aspects:

Immunization

Universal immunization is the most effective means of preventing diphtheria. The standard course of immunization for healthy children is three doses of DTaP (diphtheria-tetanus-acellular pertussis) preparation given between two months and six months of age, with booster doses given at 18 months and again between the ages of four and six years. At 12 years a booster shot of is given. Adults should be immunized at 10-year intervals with Td (tetanus-diphtheria) toxoid. A toxoid is a bacterial toxin that is treated to make it harmless but still can induce immunity to the disease.

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Isolation of patients

Diphtheria patients must be isolated for one to seven days or until two successive cultures show that they are no longer contagious (up to six weeks). Children placed in **isolation** are usually assigned a primary nurse for emotional support.

Identification and treatment of contacts

Because diphtheria is highly contagious and has a short incubation period, family members and other contacts of diphtheria patients must be watched for symptoms and tested to see if they are carriers. They are usually given antibiotics for seven days and a booster shot of diphtheria/tetanus toxoid.

Reporting cases to public health authorities

Reporting is necessary to track potential epidemics, to help doctors identify the specific strain of diphtheria, and to see if resistance to penicillin or erythromycin has developed.

Resources

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"Vaccines." United States Centers for Disease Control and Prevention (CDC). (March 30, 2010). http://www.cdc.gov/vaccines (accessed September 17, 2010).

ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Rd., Atlanta, GA, 30333, (404) 639–3534, (800) CDC–INFO (800–232–4636). TTY: (888) 232–6348, inquiry@cdc.gov, http://www.cdc.gov.
World Health Organization (WHO), Avenue Appia 20, 1211 Geneva 27, Switzerland, +22 41 791 21 11, +22 41 791 31 11, info@who.int, http://www.who.int.

Rebecca J. Frey, PhD
Tish Davidson, A.M.

Diplegia *see* **Paralysis**
Direct Coombs' test *see* **Coombs' tests**
Direct laryngoscopy *see* **Laryngoscopy**

Discoid lupus erythematosus

Definition

Discoid lupus erythematosus (DLE) is a disease in which coin-shaped (discoid) red bumps appear on the skin.

Description

The disease called discoid lupus erythematosus only affects the skin, although similar discoid **skin lesions** can occur in the serious disease called **systemic lupus erythematosus** (SLE). Only about 10% of all patients with DLE will go on to develop the multi-organ disease SLE.

The tendency to develop DLE seems to run in families. Although men or women of any age can develop DLE, it occurs in women three times more frequently than in men. The typical DLE patient is a woman in her 30s.

Causes and symptoms

The cause of DLE is unknown. It is thought that DLE (like SLE) may be an autoimmune disorder. **Autoimmune disorders** are those that occur when cells of the immune system are misdirected against the body. Normally, immune cells work to recognize and help destroy foreign invaders like bacteria, viruses, and fungi. In autoimmune disorders, these cells mistakenly recognize various tissues of the body as foreign invaders, and attack and destroy these tissues. In SLE, the misdirected immune cells are antibodies. In DLE, the damaging cells are believed to be a type of white blood cell called a T lymphocyte. The injury to the skin results in inflammation and the characteristic discoid lesions.

Discoloration of the hands is one characteristic of discoid lupus erythematosus. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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In DLE, the characteristic skin lesion is circular and raised. The reddish rash is about 5–10 mm in diameter, with the center often somewhat scaly and lighter in color than the darker outer ring. The surface of these lesions is sometimes described as "warty." There is rarely any **itching** or **pain** associated with discoid lesions. They tend to appear on the face, ears, neck, scalp, chest, back, and arms. As DLE lesions heal, they leave thickened, scarred areas of skin. When the scalp is severely affected, there may be associated hair loss (**alopecia**).

People with DLE tend to be quite sensitive to the sun. They are more likely to get a **sunburn**, and the sun is likely to worsen their discoid lesions.

Diagnosis

Diagnosis of DLE usually requires a **skin biopsy**. A small sample of a discoid lesion is removed, specially prepared, and examined under a microscope. Usually, the lesion has certain microscopic characteristics that allow it to be identified as a DLE lesion. Blood tests will not reveal the type of antibodies present in SLE, and **physical examination** usually does not reveal anything other than the skin lesions. If antibodies exist in the blood, or if other symptoms or physical signs are found, it is possible that the discoid lesions are a sign of SLE rather than DLE.

Treatment

Treatment of DLE primarily involves the use of a variety of skin creams. **Sunscreens** are used for protection. Steroid creams can be applied to decrease inflammation. Occasionally, small amounts of a steroid preparation will be injected with a needle into a specific lesion. Because of their long list of side effects, steroid preparations taken by mouth are avoided. Sometimes, short-term treatment with oral **steroids** will be used for particularly severe DLE outbreaks. Medications used to treat the **infectious diseasemalaria** are often used to treat DLE.

Alternative treatment

Alternative treatments for DLE include eating a healthy diet, low in red meat and dairy products and high in fish containing **omega-3 fatty acids**. These types of fish include mackerel, sardines, and salmon. Following a healthy diet is thought to decrease inflammation. Dietary supplements believed to be helpful include **vitamins** B, C, E, and selenium. Vitamin A is also recommended to improve DLE lesions. Constitutional homeopathic treatment can help heal DLE as well as help prevent it developing into SLE.

KEY TERMS

Antibody—Specialized cells of the immune system that can recognize organisms invading the body (like bacteria, viruses, and fungi). The antibodies are then able to start a complex chain of events designed to kill these foreign invaders.

Autoimmune disorder—A disorder in which the body's antibodies mistake the body's own tissues for foreign invaders. The immune system then attacks and causes damage to these tissues.

Immune system—The system of specialized organs, lymph nodes, and blood cells throughout the body that work together to defend the body against foreign invaders (bacteria, viruses, fungi, etc.).

Prognosis

For the most part, the prognosis for people with DLE is excellent. While the lesions may be cosmetically unsightly, they are not life threatening and usually do not cause a patient to change his or her lifestyle. Only about 10% of patients with DLE will go on to develop SLE.

Prevention

DLE cannot be prevented. Recommendations to prevent flares of DLE in patients with the disease include avoiding exposure to sun and consistently using sunscreen.

ORGANIZATIONS

American College of Rheumatology, 2200 Lake Boulevard NE, Atlanta, GA, 30319, (404) 633-3777, (404) 633-1870, acr@rheumatology.org, http://www.rheumatology.org/.

Lupus Foundation of America, 2000 L Street, N.W., Suite 710, Washington, DC, 20036, (202) 349-1155, (202) 349-1156, (800) 558-0121, http://www.lupus.org.

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Disk removal

Definition

One of the most common types of back surgery is disk removal (diskectomy), the removal of an intervertebral disk, the flexible plate that connects any two

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KEY TERMS

Diskectomy—The surgical removal of a portion of an intervertebral disk.

Dura—The strongest and outermost of three membranes that protect the brain, spinal cord, and nerves of the cauda equina.

Herniated disk—A blisterlike bulging or protrusion of the contents of the disk out through the fibers that normally hold them in place. It is also called a ruptured disk, slipped disk, or displaced disk.

Intervertebral disk—Cylindrical elastic-like gel pads that separate and join each pair of vertebrae in the spine.

Laminectomy—An operation in which the surgeon cuts through the covering of a vertebra to reach a herniated disk in order to remove it.

Vertebra—The bones that make up the back bone (spine).

adjacent vertebrae in the spine. Intervertebral disks act as shock absorbers, protecting the brain and spinal cord from the impact produced by the body's movements.

Purpose

About 150,000 Americans undergo disk removal each year in the United States. Removing the intervertebral disk is performed to treat back **pain** that has lasted at least six weeks as a result of an abnormal disk and that has not responded to conservative treatment. Surgery is also performed if there is pressure on the lumbosacral nerve roots that causes weakness or bowel or bladder disfunction.

As a person ages, the disks between the vertebrae degenerate and dry out, and the fibers holding them in place tear. Eventually, the disk can form a blister-like bulge, compressing nerves in the spine and causing pain. This is called a "prolapsed" (or herniated) disk. If such a disk causes muscle weakness or interferes with bladder or bowel function because it is pressing on a nerve root, immediate surgery to remove the disk may be needed.

The aim of the surgery is to try to relieve all pressure on nerve roots by removing the pulpy material from the disk, or the disk itself. If it is necessary to remove material from several nearby vertebrae, the spine may become unsteady. In this case, the surgeon will perform a spinal fusion, removing all the disks between two or more vertebrae and roughening the bones so that the vertebrae heal together. Bone strips taken from the patient's leg or hip may be used to help hold the vertebrae together. Spinal fusion decreases pain but it also decreases spinal mobility.

Precautions

The doctor will obtain x rays, neuroimaging studies, including computed tomography scan (CT scan) myelogram and **magnetic resonance imaging** (MRI), and clinical exams to determine the precise location of the affected disk.

Description

The surgery is done under general anaesthesia, which puts the patient to sleep and affects the whole body. Operating on the patient's back, the neurosurgeon or orthopedic surgeon makes an opening into the vertebral canal, and then moves the dura and the bundle of nerves called the "cauda equina" (horse's tail) aside, which exposes the disk. If a portion of the disk has moved from between the vertebrae out into the nerve canal, it is simply removed. If the disk itself has become fragmented and partially displaced, or not fragmented but bulging extensively, the surgeon will remove the bulging or displaced part of the disk and the part that lies in the space between the vertebrae.

Preparation

The patient is given an injection an hour before the surgery to dry up internal fluids and encourage drowsiness.

Aftercare

After the operation, the patient will awaken lying flat and face down, and must remain this way for several days, changing position only to avoid **bedsores**. There maybe slight pain or stiffness in the back area.

Patients should sleep on a firm mattress and avoid bending at the waist, lifting heavy weights, or sitting in one spot for a long time (such as riding in a car).

After surgery, patients can usually leave the hospital on the fourth or fifth day. They must:

- avoid sitting for more than 15–20 minutes
- use a reclined chair

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- avoid bending, twisting, or lifting
- begin gentle walking (indoors or outdoors), gradually increasing
- begin stationary biking or gentle swimming after two weeks
- continue exercise for the next four weeks
- slow down if they experience more than minor pain in the back or leg

Risks

All surgery carries some risk due to heart and lung problems or the anesthesia itself, but this risk is generally extremely small. (The risk of **death** from **general anesthesia** for all types of surgery, for example, is only about 1 in 1,600.)

The most common risk of the surgery is infection, which occurs in 1–2% of cases. Rarely, the surgery can damage nerves in the lower back or major blood vessels in front of the disk. Occasionally, there may be some residual **paralysis** of a particular leg or bladder muscle after surgery, but this is the result of the disk problem that necessitated the surgery, not the operation itself.

While disk removals can relieve pain in 90% of cases, there are some people who do not get pain relief, depending on how long they had the condition requiring surgery and other factors.

Normal results

After about five days, most patients can leave the hospital. They can resume all normal activities, including work, after four to six weeks of recuperation at home.

In properly evaluated patients, there is a very good chance that disk removal will be successful in easing pain. Even in patients over age 60, disk surgery has a "good to excellent" result for 87% of patients. Disk surgery can relieve both back and leg pain, but the greatest pain relief will occur with the leg pain.

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Carol A. Turkington

Diskectomy *see* **Disk removal**

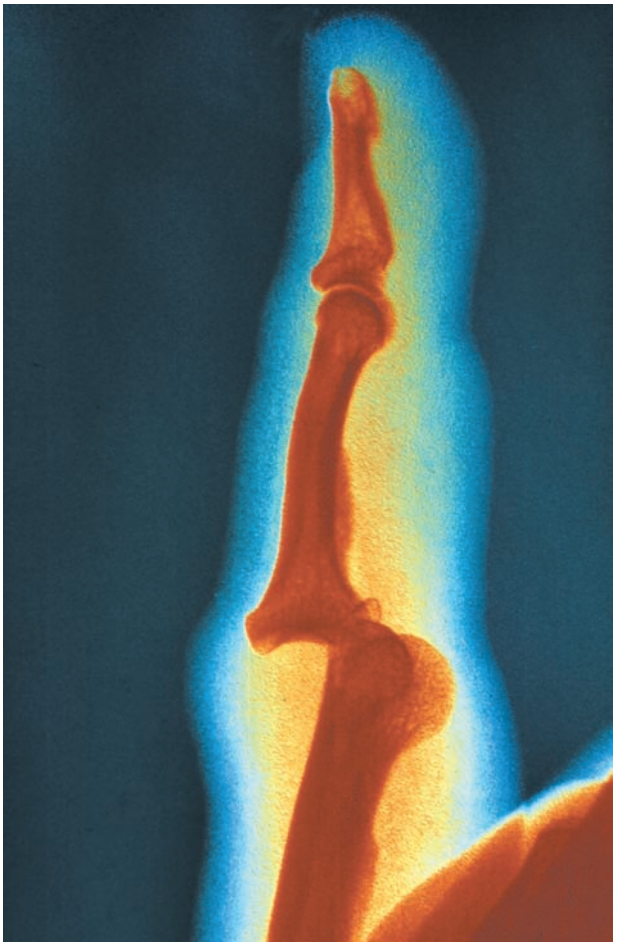
Dislocations and subluxations

Definition

In medicine, the terms dislocation and subluxation refer to the displacement of bones that form a joint. These conditions affecting the joint most often result from trauma that causes adjoining bones to no longer align with each other. A partial or incomplete dislocation is called a subluxation.

Description

In a healthy joint, the bones are normally held together with tough, fibrous bands called ligaments. These ligaments are attached to each bone along with a fibrous sac surrounding the joint called the articular capsule or joint capsule. The ligaments and joint capsule are relatively strong and nonelastic but permit movement within normal limits for each particular joint. In



This x ray shows the dislocation between two bones in a finger. *(Photo Researchers, Inc.)*

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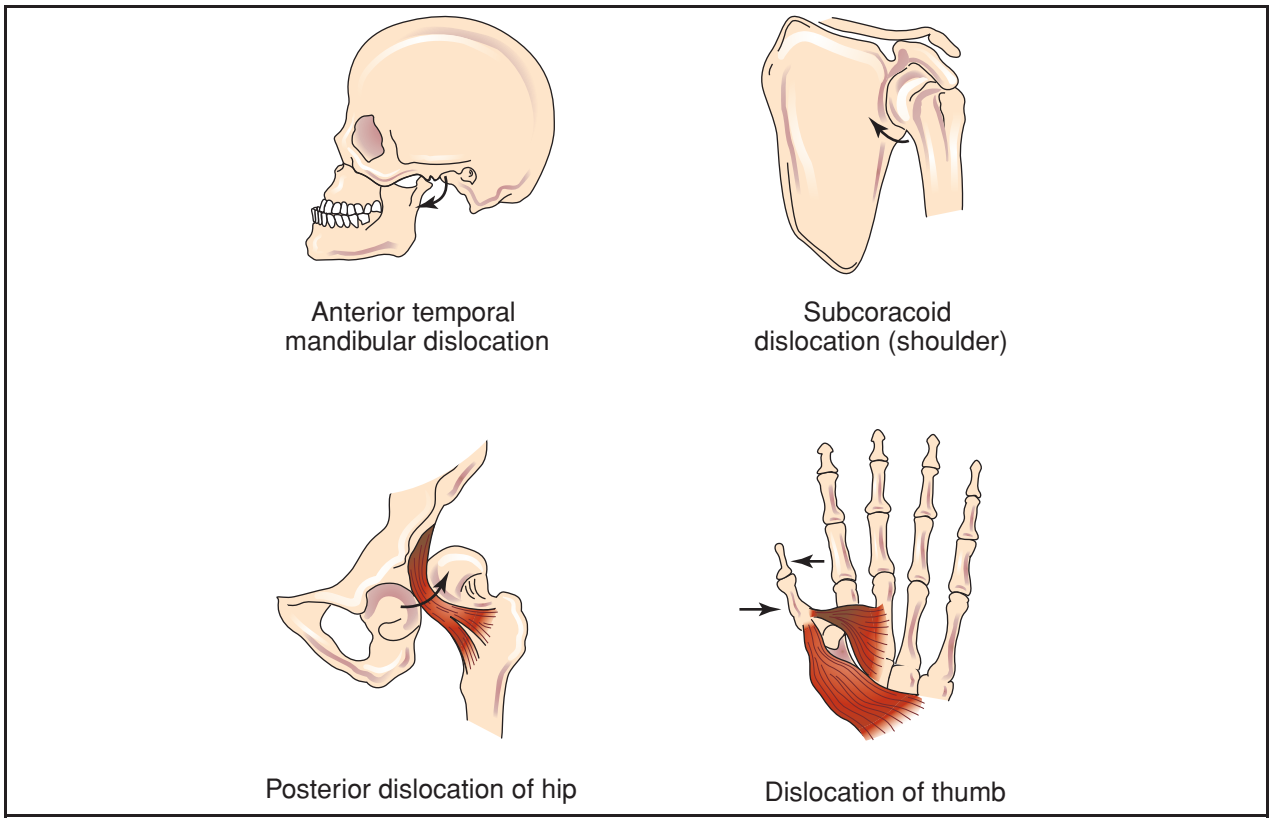

Dislocations and subluxations refer to the displacement of bones that form a joint. Such conditions most often result from trauma causing adjoining bones to no longer touch each other. A partial or incomplete dislocation is called a subluxation. The illustrations above indicate dislocation of the jaw bone, shoulder blade, hip bone, and the thumb. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

the event of a dislocation, one of the bones making up the joint is forced out of its natural alignment from excessive stretching and tearing of the joint ligaments and capsule. Muscles and tendons surrounding the joint are usually stretched and injured to some degree.

Causes and symptoms

A violent movement at the joint that exceeds normal limits usually causes a joint dislocation. Although dislocations often result from trauma, they sometimes occur as a result of disease affecting the joint structures. In the process of the dislocation, there is tearing of the ligaments and the articular capsule, which are vital structures for connecting the bone. Following a dislocation, the bones affected are often immobile and the affected limb may be locked in an abnormal position; **fractures** are also a concern with severe dislocations.

Important factors in recognizing a dislocation or subluxation include a history of experiencing a fall or receiving a blow in a particular joint followed by the sudden onset of loss of function to the involved limb. Immediately after the dislocation, the joint almost always swells significantly and feels painful when pressure is applied (point tenderness). If trauma to the joint causing the dislocation or subluxation is violent in nature, small chips of bone can be torn away with the supporting structures. Chronic recurrent dislocations may take place without severe **pain** because of the somewhat slack condition of the surrounding muscles and other supporting tissues. A first-time dislocation is considered and treated as a possible fracture. Risk factors that can increase susceptibility of joint dislocation and subluxation are shallow or abnormally formed joint surfaces present at birth (congenital) and/or other diseases of ligaments and tissue around a joint. Some infants are born with a hip dislocation. Both sexes and all ages are affected.

Diagnosis

A thorough medical history and physical exam by a physician is the first step in the correct diagnosis of dislocations and subluxations. X rays of the joint and

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adjacent bones can locate and help determine the extent of dislocated joints.

Treatment

Immediately after the dislocation, the application of ice is helpful to control swelling and decrease pain. If the patient needs to be transported, it is important to prevent the joint from moving (**immobilization**). At times, a cast or splint may be used to immobilize the joint and ensure proper alignment and healing. The treatment of realigning bones following a dislocation is called reduction. This may include simple maneuvers that manipulate the joint to reposition the bones or surgical procedures to restore the joint to its normal position. A **general anesthesia** or muscle relaxant may be used to help make joint reduction possible by relaxing surrounding muscles in spasm. **Acetaminophen** or **aspirin** are sometimes used to control moderate pain, and **narcotics** may be prescribed by the physician if the pain is severe. Recurring dislocation may require surgical reconstruction or replacement of the joint. It is not recommended to attempt to reset a dislocated joint outside of a medical environment with experienced medical personnel, because a fracture may be present.

Alternative treatment

Chiropractic care has been shown to be effective for joint subluxation and dislocation, especially in the spine. Swelling can be addressed using botanical therapies. Bromelain, a pineapple enzyme, and turmeric (*Curcuma longa*) are the most potent botanical remedies for this purpose. Acute homeopathic care with *arnica* (*Arnica montana*) can reduce the trauma to the body. Ligament and tendon strengthening can be assisted both botanically and homeopathically.

Prognosis

Joint ligaments have poor blood supply and, therefore, heal slowly. This healing process continues long after the symptoms of the dislocation injury have diminished. Once a joint has been either subluxated or completely dislocated, the connective tissue binding or holding it in correct alignment is stretched to such an extent that the joint becomes extremely vulnerable to repeated dislocations. However, this chance of recurrent dislocation and subluxation will decrease if a proper **rehabilitation** program is implemented to strengthen surrounding muscles of the joint. Most joint dislocations are curable with prompt treatment. After the dislocation has been corrected, the joint may require immobilization with a cast or sling for two to eight weeks.

KEY TERMS

Articular capsule—An envelope of tissue that surrounds a free moving joint, composed of an external layer of white fibrous tissue and an external synovial membrane that secretes a lubricant into the joint.

Prevention

When an individual is involved in strenuous sports or heavy work, involved joints may be protected by elastic bandage wraps, tape wraps, knee and shoulder pads, or special support stockings. Keeping the muscles surrounding the joint strong will also help prevent dislocations. Long-term problems may also be prevented by allowing an adequate amount of time for an injured joint to rest and heal prior to resuming full activity.

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Jeffrey P. Larson, RPT

Disopyramide *see* **Antiarrhythmic drugs**

Disproportionate dwarfism *see* **Achondroplasia**

Dissecting aneurysm *see* **Aortic dissection**

Dissecting hematoma *see* **Aortic dissection**

Disseminated lupus erythematosus *see* **Systemic lupus erythematosus**

Dissociative disorders

Definition

The dissociative disorders are a group of mental disorders that affect consciousness defined as causing significant interference with the patient's general functioning, including social relationships and employment.

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Demographics

The dissociative disorders vary in their severity and the suddenness of onset. It is difficult to give statistics for their frequency in the United States because they are a relatively new category and are often misdiagnosed. Criteria for diagnosis require significant impairment in social or vocational functioning.

Description

In order to have a clear picture of these disorders, dissociation should first be understood. Dissociation is a mechanism that allows the mind to separate or compartmentalize certain memories or thoughts from normal consciousness. These split-off mental contents are not erased. They may resurface spontaneously or be triggered by objects or events in the person's environment.

Dissociation is a process that occurs along a spectrum of severity. It does not necessarily mean that a person has a dissociative disorder or other mental illness. A mild degree of dissociation occurs with some physical stressors; people who have gone without sleep for a long period of time, have had "laughing gas" for dental surgery, or have been in a minor accident often have brief dissociative experiences. Another example of dissociation is a person becoming involved in a book or movie so completely that the surroundings or the passage of time are not noticed. Another example might be driving on the highway and taking several exits without noticing or remembering. Dissociation is related to hypnosis in that hypnotic trance also involves a temporarily altered state of consciousness. Most patients with dissociative disorders are highly hypnotizable.

People in other cultures sometimes have dissociative experiences in the course of religious (in certain trance states) or other group activities. These occurrences should not be judged in terms of what is considered "normal" in the United States.

Moderate or severe forms of dissociation are caused by such traumatic experiences as childhood **abuse**, combat, criminal attacks, brainwashing in hostage situations, or involvement in a natural or transportation disaster. Patients with **acute stress disorder**, **post-traumatic stress disorder** (PTSD), or conversion disorder and somatization disorder may develop dissociative symptoms. Recent studies of trauma indicate that the human brain stores traumatic memories in a different way than normal memories. Traumatic memories are not processed or integrated into a person's ongoing life in the same fashion as normal memories. Instead, they are dissociated, or split off, and may erupt into consciousness from time to time without warning. The affected person cannot control or "edit" these memories. Over a period of time, these two sets of memories, the normal and the traumatic, may coexist as parallel sets without being combined or blended. In extreme cases, different sets of dissociated memories may alter subpersonalities of patients with dissociative identity disorder (**multiple personality disorder**).

Dissociative amnesia

Dissociative **amnesia** is a disorder in which the distinctive feature is the patient's inability to remember important personal information to a degree that cannot be explained by normal forgetfulness. In many cases, it is a reaction to a traumatic accident or witnessing a violent crime. Patients with dissociative amnesia may develop depersonalization or trance states as part of the disorder, but they do not experience a change in identity.

Dissociative fugue

Dissociative fugue is a disorder in which a person temporarily loses his or her sense of personal identity and travels to another location where he or she may assume a new identity. Again, this condition usually follows a major stressor or trauma. Apart from inability to recall their past or personal information, patients with dissociative fugue do not behave strangely or appear disturbed to others. Cases of dissociative fugue are more common in wartime or in communities disrupted by a natural disaster.

Depersonalization disorder

Depersonalization disorder is a disturbance in which the patient's primary symptom is a sense of detachment from the self. Depersonalization as a symptom (not as a disorder) is quite common in college-age populations. It is often associated with **sleep deprivation** or recreational drug use. It may be accompanied by derealization (where objects in an environment appear altered). Patients sometimes describe depersonalization as feeling like a robot or watching themselves from the outside. Depersonalization disorder may also involve feelings of **numbness** or loss of emotional "aliveness."

Dissociative identity disorder (DID)

Dissociative identity disorder (DID) is the newer name for multiple personality disorder (MPD). DID is considered the most severe dissociative disorder and involves all of the major dissociative symptoms.

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Dissociative disorder not otherwise specified (DDNOS)

DDNOS is a diagnostic category ascribed to patients with dissociative symptoms that do not meet the full criteria for a specific dissociative disorder.

Causes and symptoms

The moderate to severe dissociation that occurs in patients with dissociative disorders is understood to result from a set of causes:

- an innate ability to dissociate easily
- repeated episodes of severe physical or sexual abuse in childhood
- lack of a supportive or comforting person to counteract abusive relative(s)
- the influence of other relatives with dissociative symptoms or disorders

The relationship of dissociative disorders to childhood abuse has led to intense controversy and lawsuits concerning the accuracy of childhood memories. The brain's storage, retrieval, and interpretation of memories are still not fully understood. Controversy also exists regarding how much individuals presenting dissociative disorders have been influenced by books and movies to describe a certain set of symptoms (scripting).

Amnesia

Amnesia in a dissociative disorder is marked by gaps in a patient's memory for long periods of time or for traumatic events. Doctors can distinguish this type of amnesia from loss of memory caused by head injuries or drug intoxication, because the amnesia is "spotty" and related to highly charged events and feelings.

Depersonalization

Depersonalization is a dissociative symptom in which the patient feels that his or her body is unreal, is changing, or is dissolving. Some patients experience depersonalization as being outside their bodies or watching a movie of themselves.

Derealization

Derealization is a dissociative symptom in which the external environment is perceived as unreal. The patient may see walls, buildings, or other objects as changing in shape, size, or color. In some cases, the patient may feel that other persons are machines or robots, though the patient is able to acknowledge the unreality of this feeling.

Identity disturbances

Patients with dissociative fugue, DDNOS, or DID often experience confusion about their identities or even assume new identities. Identity disturbances result from the patient having split off entire personality traits or characteristics as well as memories. When a stressful or traumatic experience triggers the reemergence of these dissociated parts, the patient may act differently, answer to a different name, or appear confused by his or her surroundings.

Diagnosis

Examination

When a doctor is evaluating a patient with dissociative symptoms, he or she will first rule out physical conditions that sometimes produce amnesia, depersonalization, or derealization. These physical conditions include **epilepsy**, head injuries, brain disease, side effects of medications, **substance abuse**, intoxication, **AIDS**, **dementia** complex, or recent periods of extreme physical **stress** and sleeplessness. In some cases, the doctor may give the patient an electroencephalogram (EEG) to exclude epilepsy or other seizure disorders.

Tests

If the patient appears to be physically normal, the doctor will rule out psychotic disturbances, including **schizophrenia**. In addition, doctors can use some **psychological tests** to narrow the diagnosis. One is a screener, the Dissociative Experiences Scale (DES). If the patient has a high score on this test, he or she can be evaluated further with the Dissociative Disorders Interview Schedule (DDIS) or the Structured Clinical Interview for *DSM-IV* Dissociative Disorders (SCID-D). It is also possible for doctors to measure a patient's hypnotizability as part of a diagnostic evaluation.

Treatment

Treatment of the dissociative disorders often combines several methods.

Drugs

Some doctors prescribe tranquilizers or antidepressants for the **anxiety** and/or depression that often accompany dissociative disorders. Patients with dissociative disorders are at risk for abusing or becoming dependent on medications.

Alternative

Patients with dissociative disorders often require treatment by a therapist with some specialized

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KEY TERMS

Amnesia—A general medical term for loss of memory that is not due to ordinary forgetfulness. Amnesia can be caused by head injuries, brain disease, or epilepsy, as well as by dissociation.

Depersonalization—A dissociative symptom in which the patient feels that his or her body is unreal, is changing, or is dissolving.

Derealization—A dissociative symptom in which the external environment is perceived as unreal.

Dissociation—A psychological mechanism that allows the mind to split off traumatic memories or disturbing ideas from conscious awareness.

Fugue—A dissociative experience during which a person travels away from home, has amnesia for their past, and may be confused about their identity but otherwise appear normal.

Hypnosis—The means by which a state of extreme relaxation and suggestibility is induced: used to treat amnesia and identity disturbances that occur in dissociative disorders.

Multiple personality disorder (MPD)—An older term for dissociative identity disorder (DID).

Trauma—A disastrous or life-threatening event that can cause severe emotional distress, including dissociative symptoms and disorders.

understanding of dissociation. This background is particularly important if the patient's symptoms include identity problems. Many patients with dissociative disorders are helped by both group and individual treatment.

Hypnosis is frequently recommended as a method of treatment for dissociative disorders, partly because hypnosis is related to the process of dissociation. Hypnosis may help patients recover repressed ideas and memories. Therapists treating patients with DID sometimes use hypnosis in the process of "fusing" the patient's alternate personalities.

Prognosis

Prognoses for dissociative disorders vary. Recovery from dissociative fugue is usually rapid. Dissociative amnesia may resolve quickly, but can become a chronic disorder in some patients. Depersonalization disorder, DDNOS, and DID are usually chronic conditions. DID often requires five or more years of treatment for recovery.

Prevention

Since the primary cause of dissociative disorders is thought to involve extended periods of humanly inflicted trauma, prevention depends on the elimination of **child abuse** and psychological abuse of adult prisoners or hostages.

Resources

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ORGANIZATIONS

American Psychiatric Association, 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209, (703) 907-7300, apa@psych.org, http://www.psych.org.

American Psychological Association (APA) , 750 First St. NE, Washington, DC, 20002-4242, (202) 336-5700, http://www.apa.org.

National Alliance on Mental Illness (NAMI), Colonial Place Three, 2107 Wilson Blvd., Suite 300, Arlington, VA, 22201, (703) 524-7600, (800) 950-NAMI (6264), (703) 524-9094, http://www.nami.org.

National Institute of Mental Health (NIMH), 6001 Executive Boulevard, Room 8184, MSC 9663, Bethesda, MD, 20892, (301) 443-4513, (866) 615-6464, (301) 443-4279, nimhinfo@nih.gov, http://www.nimh.nih.gov.

National Mental Health Association (NMHA), 2000 N. Beauregard Street, 6th Floor, Alexandria, VA, 22311, (703) 684-7722, (800) 969-NMHA, (703) 684-5968, http://www1.nmha.org.

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Dissociative identity disorder *see* **Multiple personality disorder**

Distal pancreatectomy

Definition

A distal **pancreatectomy** is the partial surgical removal of the pancreas, meaning that only the body and tail of the pancreas are removed and the head of the organ is left attached. A total pancreatectomy is the

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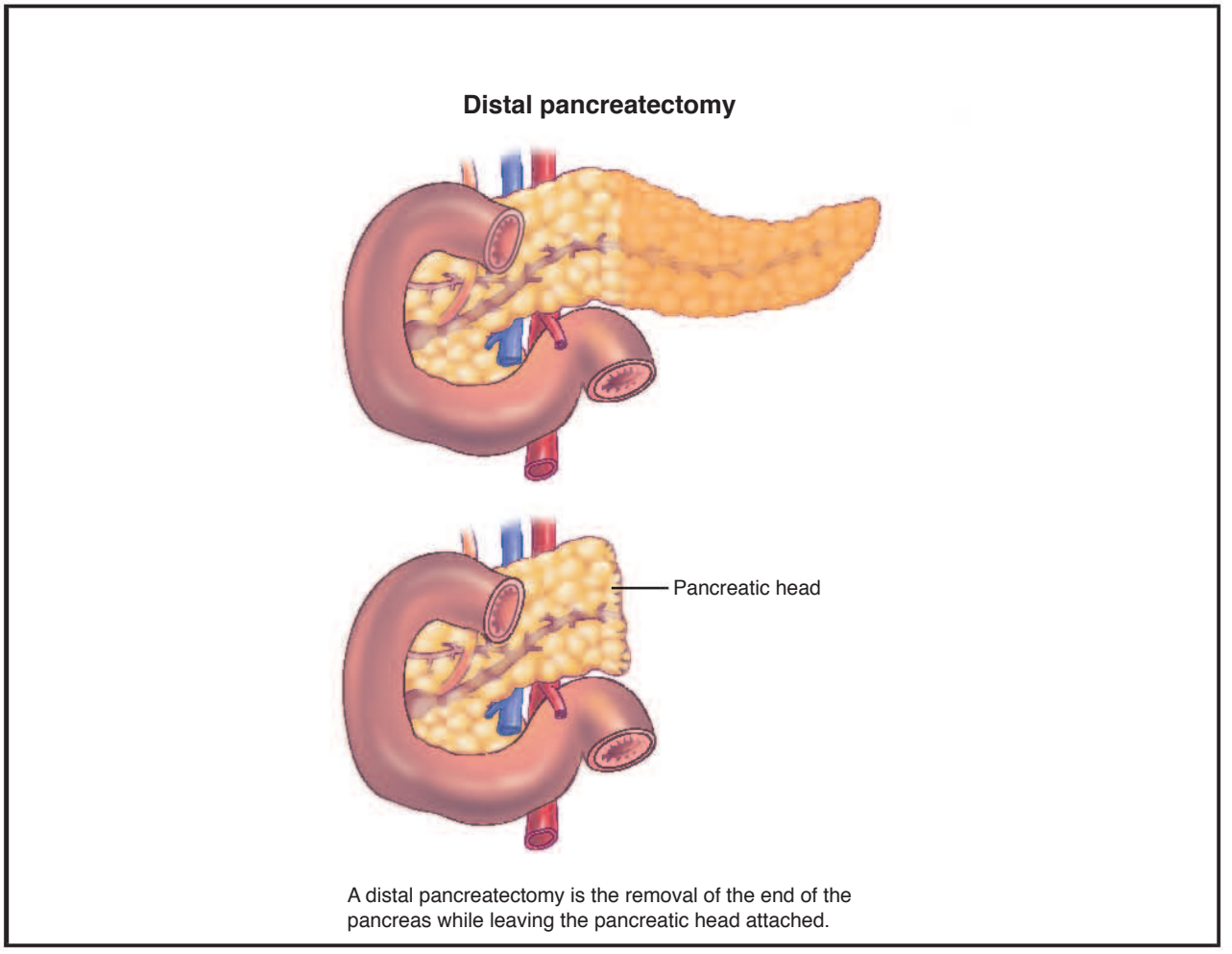

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removal of the entire organ, usually along with the spleen, gallbladder, common bile duct, and portions of the small intestine and stomach. When the duodenum is removed along with all or part of the pancreas, the procedure is called a pancreaticoduodenectomy, which surgeons sometimes refer to as "Whipple's procedure." Pancreaticoduodenectomies are increasingly used to treat a variety of malignant and benign diseases of the pancreas. This procedure often involves removal of the regional lymph nodes as well.

Purpose

A distal pancreatectomy is the most effective treatment for a cancerous tumor of the tail or bottom half of the pancreas (islet cell tumors), an abdominal organ that secretes digestive enzymes, insulin, and other hormones. The thickest part of the pancreas near the duodenum (a part of the small intestine) is called the head, the middle part is called the body, and the thinnest part adjacent to the spleen is called the tail.

While surgical removal of tumors in the pancreas is the preferred treatment, it is only possible in the 10–15% of patients who are diagnosed early enough for a potential cure. Patients who are considered suitable for surgery usually have small tumors in the head of the pancreas (close to the duodenum, or first part of the small intestine), have **jaundice** as their initial symptom, and have no evidence of metastatic disease (spread of **cancer** to other sites). The stage of the cancer will determine whether the pancreatectomy to be performed should be total or distal.

A distal pancreatectomy may be indicated when the pancreas has been severely injured by trauma, especially injury to the body and tail of the pancreas.

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KEY TERMS

Chemotherapy—A cancer treatment that uses synthetic drugs to destroy the tumor either by inhibiting the growth of the cancerous cells or by killing the cancer cells.

Computed tomography (CT) scan—An imaging technique that creates a series of pictures of areas inside the body, taken from different angles. The pictures are created by a computer linked to an x-ray machine.

Endoscopic retrograde cholangiopancreatography (ERCP)—A procedure to x ray the ducts (tubes) that carry bile from the liver to the gallbladder and from the gallbladder to the small intestine.

Laparoscopy—In this procedure, a laparoscope (a thin, lighted tube) is inserted through an incision in the abdominal wall to determine if the cancer is within the pancreas only or has spread to nearby tissues and if it can be removed by surgery later. Tissue samples may be removed for biopsy.

Magnetic resonance imaging (MRI)—A procedure in which a magnet linked to a computer is used to create detailed pictures of areas inside the body.

Pancreas—A large gland located on the back wall of the abdomen, extending from the duodenum (first part of the small intestine) to the spleen. The pancreas produces enzymes essential for digestion, and the hormones insulin and glucagon, which play a role in diabetes.

Pancreaticoduodenectomy—Removal of all or part of the pancreas along with the duodenum. Also known as "Whipple's procedure" or "Whipple's operation."

Pancreatitis—Inflammation of the pancreas, either acute (sudden and episodic) or chronic, usually caused by excessive alcohol intake or gallbladder disease.

Positron emission tomography (PET) scan—An imaging system that creates a picture showing the location of tumor cells in the body. A substance called radionuclide dye is injected into a vein, and the PET scanner rotates around the body to create the picture. Malignant tumor cells show up brighter in the picture because they are more active and take up more dye than normal cells.

Radiation therapy—A treatment using high energy radiation from x-ray machines, cobalt, radium, or other sources.

Ultrasonogram—A procedure where high-frequency sound waves that cannot be heard by human ears are bounced off internal organs and tissues. These sound waves produce a pattern of echoes which are then used by the computer to create sonograms, or pictures of areas inside the body.

While such surgery removes normal pancreatic tissue as well, the long-term consequences of this surgery are minimal, with virtually no effects on the production of insulin, digestive enzymes, and other hormones.

Description

A distal pancreatectomy can be performed through an open surgery technique, in which case one large incision is made, or it can be performed laparoscopically, in which case the surgeon makes four small incisions to insert tube-like surgical instruments. The abdomen is filled with gas, usually carbon dioxide, to help the surgeon view the abdominal cavity. A camera is inserted through one of the tubes and displays images on a monitor in the operating room. Other instruments are placed through the additional tubes. The laparoscopic approach allows the surgeon to work inside the patient's abdomen without making a large incision.

In a distal pancreatectomy, the surgeon clamps and cuts the blood vessels, and the pancreas is stapled and divided for removal. If the disease affects the splenic artery or vein, the spleen is also removed.

During the procedure, several tubes are also inserted for postoperative care. To prevent tissue fluid from accumulating in the operated site, a temporary drain leading out of the body is inserted, as well as a **gastrostomy** or g-tube leading out of the stomach in order to help prevent **nausea and vomiting**. A jejunostomy or j-tube may also be inserted into the small intestine as a pathway for supplementary feeding.

Diagnosis/Preparation

Patients with symptoms of a pancreatic disorder undergo a number of tests before surgery is even considered. These can include ultrasonography, x-ray examinations, **computed tomography scans** (CT scan), and **endoscopic retrograde cholangiopancreatography** (ERCP), a specialized imaging technique to visualize the ducts that carry bile from the liver to the gallbladder. Tests may also include **angiography**, another imaging technique used to visualize the

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arteries feeding the pancreas, and needle aspiration cytology, in which cells are drawn from areas suspected to contain cancer. Such tests are required to establish a correct diagnosis for the pancreatic disorder and in the planning the surgery.

Since many patients with pancreatic cancer are undernourished, appropriate nutritional support, sometimes by **tube feedings**, may be required prior to surgery.

Some patients with pancreatic cancer deemed suitable for a distal pancreatectomy will also undergo **chemotherapy** and/or **radiation therapy**. This treatment is aimed at shrinking the tumor, which will improve the chances for successful surgical removal. Sometimes, patients who are not initially considered surgical candidates may respond so well to chemoradiation that surgical treatment becomes possible. Radiation therapy may also be applied during the surgery (intraoperatively) to improve the patient's chances of survival, but this treatment is not yet in routine use. Some studies have shown that intraoperative radiation therapy extends survival by several months.

Patients undergoing distal pancreatectomy that involves removal of the spleen may receive preoperative medication to decrease the risk of infection.

Aftercare

Extended hospitalization is usually required for an open distal pancreatectomy, with an average hospital stay of one to two weeks. Recovery time is much quicker with laparoscopic distal pancreatectomy.

Some pancreatic cancer patients may also receive combined chemotherapy and radiation therapy after surgery. This additional treatment has been clearly shown to enhance survival rates.

After surgery, patients experience **pain** in the abdomen and are prescribed pain medication. Follow-up exams are required to monitor the patient's recovery and remove implanted tubes.

In some cases of distal pancreatectomies, pancreatic insufficiency may arise. This is a condition caused because food can no longer be normally processed with the enzymes normally produced by the pancreas. Insulin secretion is likewise no longer possible. These conditions are treated with pancreatic enzyme replacement therapy, which supplies digestive enzymes; and with insulin injections. The occurrence of pancreatic insufficiency after distal pancreatectomy is dependent upon the patient's general health condition before surgery and on the extent of pancreatic tissue removal.

Risks

The most common complication is pancreatic fluid leak at the site of the cut.

Normal results

Patients usually resume normal activities within a month after surgery, although they are asked to avoid heavy lifting for six to eight weeks and not to drive as long as they take narcotic medication.

When a distal pancreatectomy is performed for chronic **pancreatitis**, the majority of patients obtain some relief from pain. Some studies report that one-half to three-quarters of patients become free of pain.

Morbidity and mortality rates

The mortality rate for pancreatectomy has decreased in recent years to 5–10%, depending on the extent of the surgery and the experience of the surgeon. A study of 650 patients at Johns Hopkins Medical Institution, Baltimore, found that only nine patients, or 1.4%, died from complications related to surgery.

Unfortunately, pancreatic cancer is the most lethal form of gastrointestinal malignancy. However, for a highly selective group of patients, a pancreatectomy offers a chance for cure, especially when performed by experienced surgeons. The risk for tumor recurrence is increased when the tumor is larger than 1.2 in (3 cm) and the cancer has spread to the lymph nodes or surrounding tissue.

Alternatives

Depending on the medical condition, a **pancreas transplantation** may be considered as an alternative for some patients.

Resources

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ORGANIZATIONS

American College of Gastroenterology, P.O. Box 342260, Bethesda, MD, 20827-2260, (301) 263-9000, http://www.acg.gi.org.

American Gastroenterological Association (AGA), 4930 Del Ray Avenue, Bethesda, MD, 20814, (301) 654-2055, (301) 654-5920, member@gastro.org, http://www.gastro.org.

National Cancer Institute, NCI Public Inquiries Office, 6116 Executive Boulevard, Bethesda, MD, 20892-8322, (800) 422-6237, http://www.cancer.gov.

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Diuretics

Definition

Diuretics are medicines that help reduce the amount of water in the body.

Purpose

Diuretics are used to treat the buildup of excess fluid in the body that occurs with some medical conditions such as congestive **heart failure**, **liver disease**, and **kidney disease**. Some diuretics are also prescribed to treat high blood pressure. These drugs act on the kidneys to increase urine output. This reduces the amount of fluid in the bloodstream, which in turn lowers blood pressure.

Description

There are several types of diuretics, also called water pills:

- Loop diuretics, such as bumetanide (Bumex) and furosemide (Lasix), get their name from the loop-shaped part of the kidneys where they have their effect.
- Thiazide diuretics include such commonly used diuretics as hydrochlorothiazide (HydroDIURIL, Esidrix), chlorothiazide (Diuril), and chlorthalidone (Hygroton).
- Potassium-sparing diuretics prevent the loss of potassium, which is a problem with other types of diuretics. Examples of potassium-sparing diuretics are amiloride (Midamor) and triamterene (Dyrenium).

In addition, some medicines contain combinations of two diuretics. The brands Dyazide and Maxzide, for example, contain the thiazide diuretic hydrochlorothiazide with the potassium-sparing diuretic triamterene.

Some nonprescription (over-the-counter) medicines contain diuretics. However, the medicines described here cannot be bought without a physician's prescription. They are available in tablet, capsule, liquid, and injectable forms.

Recommended dosage

The recommended dosage depends on the type of diuretic and may be different for different patients. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage, and take the medicine exactly as directed.

Precautions

Seeing a physician regularly while taking a diuretic is important. The physician will check to make sure the medicine is working as it should and will watch for unwanted side effects.

Some people feel unusually tired when they first start taking diuretics. This effect usually becomes less noticeable over time, as the body adjusts to the medicine.

Because diuretics increase urine output, people who take this medicine may need to urinate more often, even during the night. Health care professionals can help patients schedule their doses to avoid interfering with their sleep or regular activities.

For patients taking the kinds of diuretics that rob potassium from the body, physicians may recommend adding potassium-rich foods or drinks, such as citrus fruits and juices, to the diet. Or they may suggest taking a potassium supplement or taking another medicine that keeps the body from losing too much potassium. If the physician recommends any of these measures, be sure to closely follow his or her directions. Do not make other diet changes without checking with the physician. People who are taking potassium-sparing diuretics should not add potassium to their **diets**, as too much potassium may be harmful.

People who take diuretics may lose too much water or potassium when they get sick, especially if they have severe **vomiting** and **diarrhea**. They should check with their physicians if they become ill.

These medicines make some people feel lightheaded, dizzy, or faint when they get up after sitting or lying down. Older people are especially likely to have this problem. Drinking alcohol, exercising, standing for long periods, or being in hot weather may make the problem worse. To lessen the problem, get up gradually and hold onto something for support

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if possible. Avoid drinking too much alcohol and be careful in hot weather or when exercising or standing for a long time.

Anyone who is taking a diuretic should be sure to tell the health care professional in charge before having surgical or dental procedures, medical tests, or emergency treatment.

Some diuretics make the skin more sensitive to sunlight. Even brief exposure to sun can cause a severe **sunburn**, **itching**, a rash, redness, or other changes in skin color. While being treated with this medicine, avoid being in direct sunlight, especially between 10 a.m. and 3 p.m.; wear a hat and tightly woven clothing that covers the arms and legs; use a sunscreen with a skin protection factor (SPF) of at least 15; protect the lips with a sun block lipstick; and do not use **tanning** beds, tanning booths, or sunlamps. People with fair skin may need to use a sunscreen with a higher skin protection factor.

Special conditions

People who have certain medical conditions or who are taking certain other medicines may have problems if they take diuretics. Before taking these drugs, be sure to let the physician know about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to diuretics or **sulfonamides** (sulfa drugs) in the past should let his or her physician know before using a diuretic. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. Diuretics will not help the swelling of hands and feet that some women have during **pregnancy**. In general, pregnant women should not use diuretics unless a physician recommends their use. Although studies have not been done on pregnant women, studies of laboratory animals show that some diuretics can cause harmful effects when taken during pregnancy.

BREASTFEEDING. Some diuretics pass into breast milk, but no reports exist of problems in nursing babies whose mothers use this medicine. However, thiazide diuretics may decrease the flow of breast milk. Women who are **breastfeeding** and need to use a diuretic should check with their physicians.

OTHER MEDICAL CONDITIONS. Side effects of some diuretics may be more likely in people who have had a recent **heart attack** or who have liver disease or severe kidney disease. Other diuretics may not work properly in people with liver disease or severe kidney disease. Diuretics may worsen certain medical conditions, such as **gout**, **kidney stones**, **pancreatitis**, lupus erythematosus, and hearing problems. In addition, people with diabetes should be aware that diuretics may increase blood sugar levels. People with heart or blood vessel disease should know that some diuretics increase cholesterol or triglyceride levels. The risk of an allergic reaction to certain diuretics is greater in people with bronchial **asthma**. Before using diuretics, people with any of these medical problems should make sure their physicians are aware of their conditions. Also, people who have trouble urinating or who have high potassium levels in their blood may not be able to take diuretics and should check with a physician before using them.

USE OF CERTAIN MEDICINES. Taking diuretics with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Side effects

Some side effects, such as loss of appetite, **nausea and vomiting**, stomach cramps, diarrhea, and **dizziness**, usually lessen or go away as the body adjusts to the medicine. These problems do not need medical attention unless they continue or interfere with normal activities.

Patients taking potassium-sparing diuretics should know the signs of too much potassium and should check with a physician as soon as possible if any of these symptoms occur:

- irregular heartbeat
- breathing problems
- numbness or tingling in the hands, feet, or lips
- confusion or nervousness
- unusual tiredness or weakness
- weak or heavy feeling in the legs

Patients taking diuretics that cause potassium loss should know the signs of too little potassium and should check with a physician as soon as possible if they have any of these symptoms:

- fast or irregular heartbeat
- weak pulse
- nausea or vomiting
- dry mouth
- excessive thirst
- muscle cramps or pain
- unusual tiredness or weakness
- mental or mood changes

Interactions

Diuretics may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be

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KEY TERMS

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Lupus erythematosus—A chronic disease that affects the skin, joints, and certain internal organs.

Pancreas—A gland located beneath the stomach. The pancreas produces juices that help break down food.

Potassium—A mineral found in whole grains, meat, legumes, and some fruits and vegetables. Potassium is important for many body processes, including proper functioning of the nerves and muscles.

Triglyceride—A substance formed in the body from fat in the diet. Triglycerides are the main fatty materials in the blood. Together with protein, they make up high- and low-density lipoproteins (HDLs and LDLs). Triglyceride levels are important in the diagnosis and treatment of many diseases including high blood pressure, diabetes, and heart disease.

greater. Anyone who takes a diuretic should let the physician know all other medicines he or she is taking and should ask whether the possible interactions can interfere with drug therapy. Among the drugs that may interact with diuretics are:

- Angiotensin-converting enzyme (ACE) inhibitors, such as benazepril (Lotensin), captopril (Capoten), and enalapril (Vasotec), used to treat high blood pressure. Taking these drugs with potassium-sparing diuretics may cause levels of potassium in the blood to be too high, increasing the chance of side effects.
- Cholesterol-lowering drugs such as cholestyramine (Questran) and colestipol (Colestid). Taking these drugs with combination diuretics such as Dyazide and Maxzide may keep the diuretic from working. Take the diuretic at least one hour before or four hours after the cholesterol-lowering drug.
- Cyclosporine (Sandimmune), a medicine that suppresses the immune system. Taking this medicine with potassium-sparing diuretics may increase the chance of side effects by causing levels of potassium in the blood to be too high.
- Potassium supplements, other medicines containing potassium, or salt substitutes that contain potassium. Taking these with potassium-sparing diuretics may lead to too much potassium in the blood, increasing the chance of side effects.
- Lithium, used to treat bipolar disorder (manic-depressive illness). Using this medicine with potassium-sparing diuretics may allow lithium to build up to poisonous levels in the body.
- Digitalis heart drugs, such as digoxin (Lanoxin). Using this medicine with combination diuretics such as triamterene-hydrocholorthiazide (Dyazide, Maxzide) may cause blood levels of the heart medicine to be too high, making side effects such as changes in heartbeat more likely.

The list above does not include every drug that may interact with diuretics. Check with a physician or pharmacist before combining diuretics with any other prescription or nonprescription (over-the-counter) medicine.

Nancy Ross-Flanigan

Diverticulitis *see* **Diverticulosis and diverticulitis**

Diverticulosis and diverticulitis

Definition

Diverticulosis refers to a condition in which the inner, lining layer of the large intestine (colon) bulges out (herniates) through the outer, muscular layer. These outpouchings are called diverticula. Diverticulitis refers to the development of inflammation and infection in one or more diverticula.

Description

Diverticula tend to occur most frequently in the last segment of the large intestine, the sigmoid colon. They occur with decreasing frequency as one examines further back toward the beginning of the large intestine. The chance of developing diverticula increases with age, so that by the age of 50, about 20–50% of all people will have some diverticula. By the age of 90, virtually everyone will have developed some diverticula. Most diverticula measure about 3 mm to just over 3 cm in diameter. Larger diverticula, termed giant diverticula, are quite infrequent, but may measure as large as 15 cm in diameter.

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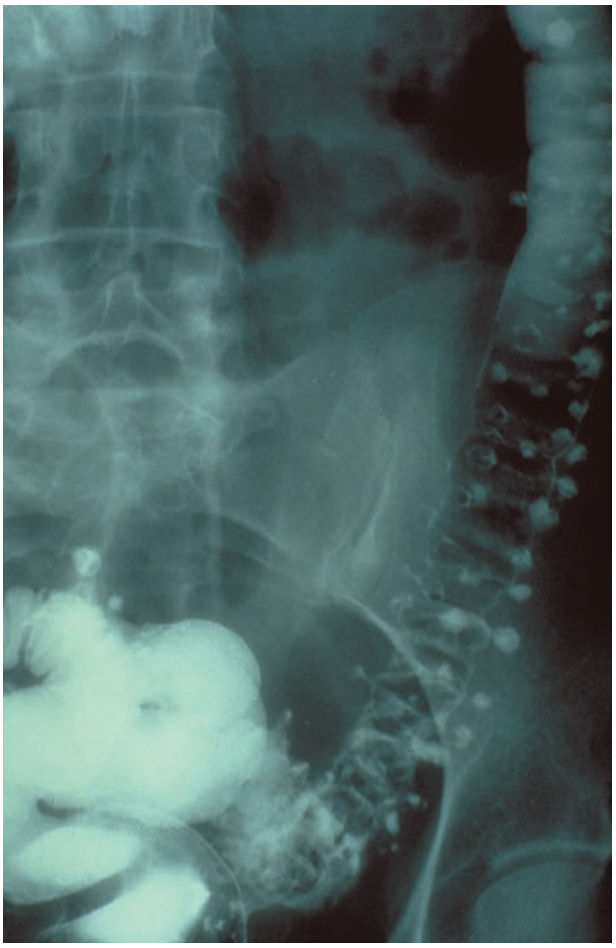

A barium study x ray showing colonic diverticulosis. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Causes and symptoms

Diverticula are believed to be caused by overly forceful contractions of the muscular wall of the large intestine. As areas of this wall spasm, they become weaker and weaker, allowing the inner lining to bulge through. The anatomically weakest areas of the intestinal wall occur next to blood vessels which course through the wall, so diverticula commonly occur in this location.

Diverticula are most common in the developed countries of the West (North America, Great Britain, northern and western Europe). This is thought to be due to the diet of these countries, which tends to be quite low in fiber. A diet low in fiber results in the production of smaller volumes of stool. In order to move this smaller stool along the colon and out of the rectum, the colon must narrow itself significantly, and does so by contracting down forcefully. This causes an increase in pressure, which, over time, weakens the muscular wall of the intestine and allows diverticular pockets to develop.

The origin of giant diverticula development is not completely understood, although one theory involves gas repeatedly entering and becoming trapped in an already-existing diverticulum, causing stretching and expansion of that diverticulum.

The great majority of people with diverticulosis will remain symptom-free. Many diverticula are quite accidentally discovered during examinations for other conditions of the intestinal tract.

Some people with diverticulosis have symptoms such as **constipation**, cramping, and bloating. It is unclear whether these symptoms are actually caused by the diverticula themselves, or whether some other gastrointestinal condition (such as **irritable bowel syndrome**) might be responsible. A complication of diverticulosis occurs because many diverticula develop in areas very near blood vessels. Therefore, one serious risk of diverticulosis involves bleeding. Although an infrequent complication, the bleeding can be quite severe. Seventy-five percent of such bleeding episodes occur due to diverticula located on the right side of the colon. About 50% of the time, such bleeding will stop on its own.

One of the most common and potentially serious complications of diverticulosis is inflammation and infection of a particular diverticulum, called diverticulitis.

Diverticulitis is three times more likely to occur in the left side of the large intestine. Since most diverticula are located in the sigmoid colon (the final segment of the large intestine which empties into the rectum), most diverticulitis also takes place in the sigmoid. The elderly have the most serious complications from diverticulitis, although very severe infections can also occur in patients under the age of 50. Men are three times as likely as women to be stricken with diverticulitis.

Diverticulitis is believed to occur when a hardened piece of stool, undigested food, and bacteria (called a fecalith) becomes lodged in a diverticulum. This blockage interferes with the blood supply to the area, and infection sets in.

An individual with diverticulitis will experience **pain** (especially in the lower left side of the abdomen) and **fever**. In response to the infection and the irritation of nearby tissues within the abdomen, the abdominal muscles may begin to spasm. About 25% of all patients with diverticulitis will have some rectal bleeding, although this rarely becomes severe. Walled-off pockets of infection, called abscesses, may appear within the wall of the intestine, or even on the exterior surface of

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the intestine. When a diverticulum weakens sufficiently, and is filled to bulging with infected pus, a perforation in the intestinal wall may develop. When the infected contents of the intestine spill out into the abdomen, the severe infection called **peritonitis** may occur. Peritonitis is an infection and inflammation of the lining of the abdominal cavity, the peritoneum. Other complications of diverticulitis include the formation of abnormal connections between two organs that normally do not connect (fistulas; for example, the intestine and the bladder), and scarring outside of the intestine which squeezes off a portion of the intestine, obstructing it.

Diagnosis

As mentioned, the majority of diverticula do not cause any symptoms, and are often found by coincidence during an examination being performed for some other medical condition.

When diverticula are suspected because a patient begins to have sudden rectal bleeding, the location of the bleeding can be studied by performing an **angiography**. Angiography involves inserting a tiny tube through an artery in the leg, and moving it up into one of the major arteries of the gastrointestinal system. A particular chemical (contrast medium) which will show up on x-ray films is injected, and the area of bleeding is located by looking for an area where the contrast is leaking into the interior (lumen) of the intestine.

A procedure called **endoscopy** provides another method for examining the colon and locating the site of bleeding. In endoscopy, a small, flexible scope (endoscope) is inserted through the rectum and into the intestine. The scope usually bears a fiber-optic camera, which allows the view through this endoscope to be projected onto a television screen. The operator can introduce the endoscope further and further through the intestine to find the location of the bleeding.

Diagnosis of diverticulitis is not difficult in patients with previously diagnosed diverticulosis. The presence of abdominal pain and fever in such an individual would make the suspicion of diverticulitis quite high. Examination of the abdomen will usually reveal tenderness to touch, with the patient's abdominal muscles contracting strongly to protect the tender area. During a rectal exam (performed by inserting a finger into the rectum), a doctor may be able to feel an abnormal mass. Touching this mass may prove painful to the patient.

When a practitioner is suspicious of diverticulitis as the cause for the patient's symptoms, he or she will most likely avoid the types of tests usually used to diagnose gastrointestinal disorders. These include **barium enema** and endoscopy. The concern is that the increased pressure exerted on the intestine during these exams may increase the likelihood of intestinal perforation. After medical treatment for the diverticulitis, these examinations may be performed in order to learn the extent of the patient's disease.

Treatment

Only about 20% of patients with diverticulosis ever have symptoms which lead them to seek medical help. Most people never know that they have diverticula. For those individuals who have cramping pain and constipation believed to be due to diverticulosis, the usual prescription involves increasing the fiber in the diet. This can be done by adding special diet supplements of bran or psyllium seed, which increase stool volume. Bleeding diverticula can usually be treated by bed rest, with blood **transfusion** needed for more severe bleeding (hemorrhaging). In cases of very heavy hemorrhaging, medications which encourage clotting can be injected during the course of a diagnostic angiography.

While there are almost no situations when uncomplicated diverticulosis requires surgery, giant diverticula always require removal. This is due to the very high chance of infection and perforation of these diverticula. When giant diverticula are diagnosed, the usual treatment involves removing that portion of the intestine.

Treatment for uncomplicated diverticulitis usually requires hospitalization. "Resting the bowel" is a mainstay of treatment, and involves keeping the patient from eating or sometimes even drinking anything by mouth. Therefore, the patient will need to receive fluids through a needle in the vein (intravenous or IV fluids). **Antibiotics** will also be administered through the IV. Some physicians will agree to try treatment at home for very mildly ill patients. These patients will be put on a liquid diet and receive oral antibiotics.

The various complications of diverticulitis need to be treated aggressively, because the **death** rate from such things as perforation and peritonitis is quite high. Abscesses can be drained of their infected contents by inserting a needle through the skin of the abdomen and into the **abscess**. When this is unsuccessful, open abdominal surgery will be required to remove the piece of the intestine containing the abscess. Fistulas require surgical repair, including the removal of the length of intestine containing the origin of the **fistula**, followed by immediate reconnection of the two free ends of intestine. Peritonitis requires open surgery. The entire abdominal cavity is cleaned by being irrigated (washed) with a warmed sterile saltwater

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KEY TERMS

Angiography—An x-ray study of the arteries in a particular part of the body. Angiography is often performed in order to localize internal bleeding.

Bowel obstruction—A blockage in the intestine which prevents the normal flow of waste down the length of the intestine.

Colostomy—A procedure performed when a large quantity of intestine is removed. The end piece of the intestine leading to the rectum is closed.

Diverticula—Outpouchings in the large intestine caused when the inner, lining layer of the large intestine (colon) bulges out (herniates) through the outer, muscular layer.

Endoscopy—Examination of an area of the gastrointestinal tract by putting a lighted scope, usually bearing a fiber-optic camera, into the rectum, and passing it through the intestine.

Fistula—An abnormal connection formed between two organs that usually have no connection whatsoever.

Sigmoid colon—The final portion of the large intestine that empties into the rectum.

solution, and the damaged piece of intestine is removed. Obstructions require immediate surgery to prevent perforation. Massive, uncontrollable bleeding, while rare, may require removal of part or all of the large intestine.

During any of these types of operations, the surgeon must make an important decision regarding the quantity of intestine which must be removed. When the amount of intestine removed is great, it may be necessary to perform a **colostomy**. A colostomy involves pulling the end of the remaining intestine through the abdominal wall, to the outside. This bit of intestine is then fashioned so that a bag can be fit over it. The patient's waste (feces) collect in the bag, because the intestine no longer connects with the rectum. This colostomy may be temporary, in which case another operation will be required to reconnect the intestine, after some months of substantial healing has occurred. Other times, the colostomy will need to be permanent, and the patient will have to adjust to living permanently with the colostomy bag. Most people with colostomies are able to go on with a very active life.

Occasionally, a patient will have such severe diverticular disease that a surgeon recommends planning ahead, and schedules removal of a portion of the colon. This is done to avoid the high risk of surgery performed after a complication has set in. Certain developments in a patient will identify those patients who are at very high risk of experiencing dangerous complications. Such elective surgery may be recommended:

- when an older individual has had several attacks of diverticulitis
- when someone under the age of 50 has had even one attack
- when treatment does not get rid of a painful mass
- when the intestine appears to be narrowing on x-ray examination (this could suggest the presence of cancer)
- when certain patients begin to regularly experience painful urination or urinary infections (this suggests that there may be a connection between the intestine and the bladder)
- when there is any question of cancer
- when the diverticular disease appears to be progressing rapidly

Prognosis

The prognosis for people with diverticula is excellent, with only 20% of such patients ever seeking any medical help for their condition.

While diverticulitis can be a difficult and painful disease, it is usually quite treatable. Prognosis is worse for individuals who have other medical problems, particularly those requiring the use of steroid medications, which increase the chances of developing a serious infection. Prognosis is also worse in the elderly.

Prevention

While there is no absolutely certain way to prevent the development of diverticula, it is believed that high-fiber **diets** are of help. Foods that are recommended for their high fiber content include whole grain breads and cereals, and all types of fruits and vegetables. Most experts suggest that individuals take in about 0.71–1.23 oz (20–35 g) of fiber daily. If this is not possible to achieve through a person's diet, there are fiber products which can be mixed into 8 oz (237 mL) of water or juice, and which provide about 0.13–19 oz (4–6 g) of fiber.

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ORGANIZATIONS

National Digestive Diseases Information Clearinghouse (NDDIC), 2 Information Way, Bethesda, MD, 20892-3570, (703) 738-4929, (800) 891-5389, http://digestive.niddk.nih.gov.

Rosalyn Carson-DeWitt, MD

Dizziness

Definition

As a disorder, dizziness is classified into three categories—vertigo, syncope, and nonsyncope nonvertigo. Each category has a characteristic set of symptoms, all related to the sense of balance. In general, syncope is defined by a brief loss of consciousness (**fainting**) or by dimmed vision and feeling uncoordinated, confused, and lightheaded. Many people experience a sensation like syncope when they stand up too fast. Vertigo is the feeling that either the individual or the surroundings are spinning. This sensation is like being on a spinning amusement park ride. Individuals with nonsyncope nonvertigo dizziness feel as though they cannot keep their balance. This feeling may become worse with movement.

Description

The brain coordinates information from the eyes, the inner ear, and the body's senses to maintain balance. If any of these information sources is disrupted, the brain may not be able to compensate. For example, people sometimes experience **motion sickness** because the information from their body tells the brain that they are sitting still, but information from the eyes indicates that they are moving. The messages do not correspond and dizziness results.

Vision and the body's senses are the most important systems for maintaining balance, but problems in the inner ear are the most frequent cause of dizziness. The inner ear, also called the vestibular system, contains fluid that helps fine tune the information the brain receives from the eyes and the body. When fluid volume or pressure in one inner ear changes, information about balance is altered. The discrepancy gives conflicting messages to the brain about balance and induces dizziness.

Certain medical conditions can cause dizziness, because they affect the systems that maintain balance. For example, the inner ear is very sensitive to changes in blood flow. Because medical conditions such as high blood pressure or low blood sugar can affect blood flow, these conditions are frequently accompanied by dizziness. Circulation disorders are the most common causes of dizziness. Other causes are **head injury**, ear infection, **allergies**, and nervous system disorders.

Dizziness often disappears without treatment or with treatment of the underlying problem, but it can be long term or chronic. According to the National Institutes of Health, 42% of Americans will seek medical help for dizziness at some point in their lives. The costs may exceed a billion dollars and account for five million doctor visits annually. Episodes of dizziness increase with age. Among people aged 75 or older, dizziness is the most frequent reason for seeing a doctor.

Causes and symptoms

Careful attention to symptoms can help determine the underlying cause of the dizziness. Underlying problems may be benign and easily treated or they may be dangerous and in need of intensive therapy. Not all cases of dizziness can be linked to a specific cause. More than one type of dizziness can be experienced at the same time and symptoms may be mixed. Episodes of dizziness may last for a few seconds or for days. The length of an episode is related to the underlying cause.

The symptoms of syncope include dimmed vision, loss of coordination, confusion, lightheadedness, and sweating. These symptoms can lead to a brief loss of consciousness or fainting. They are related to a reduced flow of blood to the brain; they often occur when a person is standing up and can be relieved by sitting or lying down. Vertigo is characterized by a sensation of spinning or turning, accompanied by **nausea**, **vomiting**, ringing in the ears, **headache**, or **fatigue**. An individual may have trouble walking, remaining coordinated, or keeping balance. Nonsyncope nonvertigo dizziness is characterized by a feeling of being off balance that becomes worse if the individual tries moving or performing detail-intense tasks.

A person may experience dizziness for many reasons. Syncope is associated with low blood pressure, heart problems, and disorders in the autonomic nervous system, the system of involuntary functions such as breathing. Syncope may also arise from emotional distress, **pain**, and other reactions to outside stressors. Nonsyncope nonvertigo dizziness may be caused by

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rapid breathing, low blood sugar, or **migraine headache**, as well as by more serious medical conditions.

Vertigo is often associated with inner ear problems called vestibular disorders. A particularly intense vestibular disorder, Méniére's disease, interferes with the volume of fluid in the inner ear. This disease, which affects approximately one in every 1,000 people, causes intermittent vertigo over the course of weeks, months, or years. Méniére's disease is often accompanied by ringing or buzzing in the ear, **hearing loss**, and a feeling that the ear is blocked. Damage to the nerve that leads from the ear to the brain can also cause vertigo. Such damage can result from head injury or a tumor. An **acoustic neuroma**, for example, is a benign tumor that wraps around the nerve. Vertigo can also be caused by disorders of the central nervous system and the cirulatory system, such as hardening of the arteries (arteriosclerosis), **stroke**, or **multiple sclerosis**.

Some medications cause changes in blood pressure or blood flow. These medications can cause dizziness in some people. Prescription medications carry warnings of such side effects, but common drugs, such as **caffeine** or nicotine, can also cause dizziness. Certain **antibiotics** can damage the inner ear and cause hearing loss and dizziness.

Diet may cause dizziness. The role of diet may be direct, as through alcohol intake. It may be also be indirect, as through arteriosclerosis caused by a high-fat diet. Some people experience a slight dip in blood sugar and mild dizziness if they miss a meal, but this condition is rarely dangerous unless the person is diabetic. Food sensitivities or allergies can also be a cause of dizziness. Chronic conditions, such as heart disease, and serious acute problems, such as seizures and strokes, can cause dizziness. However, such conditions usually exhibit other characteristic symptoms.

Diagnosis

During the initial medical examination, an individual with dizziness should provide a detailed description of the type of dizziness experienced, when it occurs, and how often each episode lasts. A diary of symptoms may help track this information. Report any symptoms that accompany the dizziness, such as a ringing in the ear or nausea, any recent injury or infection, and any medication taken.

Blood pressure, pulse, respiration, and body temperature are checked, and the ear, nose, and throat are scrutinized. The sense of balance is assessed by moving the individual's head to various positions or by tilt-table testing. In tilt-table testing, the person lies on a table that can be shifted into different positions and reports any dizziness that occurs.

Further tests may be indicated by the initial examination. Hearing tests help assess ear damage. X rays, computed tomography scan (CT scan), and **magnetic resonance imaging** (MRI) can pinpoint evidence of nerve damage, tumor, or other structural problems. If a vestibular disorder is suspected, a technique called electronystagmography (ENG) may be used. ENG measures the electrical impulses generated by eye movements. Blood tests can determine diabetes, high cholesterol, and other diseases. In some cases, a heart evaluation may be useful. Despite thorough testing, an underlying cause cannot always be determined.

Treatment

Treatment is determined by the underlying cause. If an individual has a cold or **influenza**, a few days of bed rest is usually adequate to resolve dizziness. Other causes of dizziness, such as mild vestibular system damage, may resolve without medical treatment.

If dizziness continues, drug therapy may prove helpful. Because circulatory problems often cause dizziness, medication may be prescribed to control blood pressure or to treat arteriosclerosis. Sedatives may be useful to relieve the tension that can trigger or aggravate dizziness. Low blood sugar associated with diabetes sometimes causes dizziness and is treated by controlling blood sugar levels. An individual may be asked to avoid caffeine, nicotine, alcohol, and any substances that cause allergic reactions. A low-salt diet may also help some people.

When other measures have failed, surgery may be suggested to relieve pressure on the inner ear. If the dizziness is not treatable by drugs, surgery, or other means, **physical therapy** may be used and the patient may be taught coping mechanisms for the problem.

Alternative treatment

Because dizziness may arise from serious conditions, it is advisable to seek medical treatment. Alternative treatments can often be used alongside conventional medicine without conflict. Relaxation techniques, such as **yoga** and **massage therapy** that focus on relieving tension, are popularly recommended methods for reducing **stress**. Aromatherapists recommend a warm bath scented with essential oils of lavender, geranium, and sandalwood.

Homeopathic therapies can work very effectively for dizziness, and are especially applicable when no organic cause can be identified. An osteopath or

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KEY TERMS

Acoustic neuroma—A benign tumor that grows on the nerve leading from the inner ear to the brain. As the tumor grows, it exerts pressure on the inner ear and causes severe vertigo.

Arteriosclerosis—Hardening of the arteries caused by high blood cholesterol and high blood pressure.

Autonomic nervous system—The part of the nervous system that controls involuntary functions such as breathing and heart beat.

Computed tomography (CT)—An imaging technique in which cross-sectional x rays of the body are compiled to create a three-dimensional image of the body's internal structures.

Electronystagmography—A method for measuring the electricity generated by eye movements. Electrodes are placed on the skin around the eye and the individual is subjected to a variety of stimuli so that the quality of eye movements can be assessed.

Magnetic resonance imaging (MRI)—An imaging technique that uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

Vestibular system—The area of the inner ear that helps maintain balance.

chiropractor may suggest adjustments of the head, jaw, neck, and lower back to relieve pressure on the inner ear. Acupuncturists also offer some treatment options for acute and chronic cases of dizziness. Nutritionists may be able to offer advice and guidance in choosing dietary supplements, identifying foods to avoid, and balancing nutritional needs.

Prognosis

Outcome depends on the cause of dizziness. Controlling or curing the underlying factors usually relieves dizziness. In some cases, dizziness disappears without treatment. In a few cases, dizziness can become a permanent disabling condition and a person's options are limited.

Prevention

Most people learn through experience that certain activities will make them dizzy and they learn to avoid them. For example, if reading in a car produces motion sickness, an individual leaves reading materials for after the trip. Changes to the diet can also cut down on episodes of dizziness in susceptible people. Relaxation techniques can help ward off tension and **anxiety** that can cause dizziness.

These techniques can help minimize or even prevent dizziness for people with chronic diseases. For example, persons with Méniére's disease may avoid episodes of vertigo by leaving salt, alcohol, and caffeine out of their **diets**. Reducing blood cholesterol can help diminish arteriosclerosis and indirectly treat dizziness.

Some cases of dizziness cannot be prevented. Acoustic neuromas, for example, are not predictable or preventable. When the underlying cause of dizziness cannot be discovered, it may be difficult to recommend preventive measures. Alternative approaches designed to rebalance the body's energy flow, such as **acupuncture** and constitutional homeopathy, may be helpful in cases where the cause of dizziness cannot be pinpointed.

ORGANIZATIONS

EAR Foundation of Arizona, 668 North 44th Street, Suite 300, Phoenix, AZ, 85008 , (602) 685-1050, (602) 239-5117, melissa@earfoundationaz.com, http://www.earfoun dationaz.com.

Vestibular Disorders Association (VEDA), P.O. Box 4467, Portland, OR, 97208-4467, (503) 229-8064, (800) 837-8428, http://www.vestibular.og.

Julia Barrett

DKA *see* **Diabetic ketoacidosis**

DLE *see* **Discoid lupus erythematosus**

Domestic violence *see* **Abuse**

Donovanosis *see* **Granuloma inguinale**

Doppler echocardiography *see* **Echocardiography**

Doppler ultrasonography

Definition

Doppler ultrasonography is a non-invasive diagnostic procedure that changes sound waves into an image that can be viewed on a monitor.

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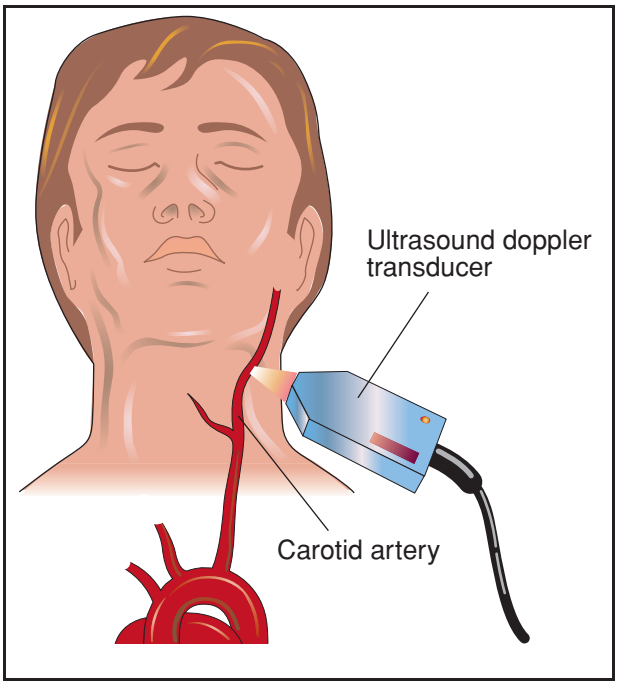

Doppler ultrasonography can detect the direction, velocity, and turbulence of blood flow. Because it is non-invasive and uses no x rays, Doppler ultrasonography is widely used for numerous diagnostic procedures. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

KEY TERMS

Doppler effect—The principle that the sound of an object moving toward you has a higher pitch than the sound when it is moving away from you.

Transducer—The part of a machine that changes signals in one form into another form.

Ultrasound—Sound that is too high for the human ear to hear.

Purpose

Doppler ultrasonography can detect the direction, velocity, and turbulence of blood flow. It is frequently used to detect problems with heart valves or to measure blood flow through the arteries. Specifically, it is useful in the work up of **stroke** patients, in assessing blood flow in the abdomen or legs, and in viewing the heart to monitor carotid artery diseases.

Precautions

The test is widely used because it is noninvasive, uses no x rays, and gives excellent images. It is harmless, painless, and widely available.

Description

Doppler ultrasonography makes use of two different principles. The ultrasound principle is this: when a high-frequency sound is produced and aimed at a target, it will be reflected by its target and the reflected sound can be detected back at its origin. In addition, it is known that certain crystals (called piezoelectric crystals) produce an electrical pulse when vibrated by a returning sound.

The Doppler principle is simply that sound pitch increases as the source moves toward the listener and decreases as it moves away.

Medical science utilizes these two principles in the following way. A transducer (sometimes called a probe) containing piezoelectric crystals sends a series of short sound pulses into the body and pauses between each pulse to listen for the returning sounds. The machine then determines the direction and depth of each returning sound and coverts this into a point of light on a television monitor. Thousands of these pulses are computed and displayed every second to produce an image of the organ being studied. The image allows the doctor to see the organ functioning in real time.

The newest addition to this test is the addition of color. Adding color to the image shows the direction and rate of blood flow more clearly.

During a Doppler ultrasonography procedure the technician will apply a gel to the skin, then place the transducer against the skin at various angles. The transducer sends the information it receives to a television monitor that shows a moving image of the organ being studied. The technician can save these images either on video tape, paper, or x-ray film for further study.

Preparation

There is no special preparation needed for this test. The ultrasound technician may apply a clear gel to the skin in order to help the transducer more freely over the body.

Aftercare

No aftercare is necessary.

Normal results

A Doppler ultrasonography test showing no restricted blood flow is a normal finding.

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Abnormal results

Disrupted or obstructed blood flow through the neck arteries may indicate the person is a risk of having a stroke. (Narrowed arterial flow in the legs does not necessarily indicate a risk of stroke.)

Resources

BOOKS

Allan, Paul L. P., et al. *Clinical Doppler Ultrasound*, Philadelphia: Churchill Livingstone Elsevier, 2006.

Dorothy Elinor Stonely

Down syndrome

Definition

Down syndrome is the most common chromosome disorder and genetic cause of intellectual disability. It occurs because of the presence of an extra copy of chromosome 21. For this reason, it is also called trisomy 21.

Demographics

As of 2009, the Centers for Disease Control (CDC) estimate that each year about 3,357 babies in the United States are born with Down syndrome. In other words, about 13 of every 10,000 babies born in the United States each year is born with Down syndrome. It affects an equal number of male and female babies. The majority of cases of Down syndrome occur due to an extra chromosome 21 within the egg cell supplied by the mother (nondisjunction).

Down syndrome occurs with equal frequency across all ethnic groups and subpopulations.

Description

Named after John Langdon Down, the first physician to identify the syndrome, Down syndrome is the result of genetic variations. When the reproductive cells, the sperm and ovum, combine at fertilization, the fertilized egg that results contains 23 chromosome pairs. A normal fertilized egg that will develop into a female contains chromosome pairs 1 through 22, and the XX pair. A normal fertilized egg that will develop into a male contains chromosome pairs 1 through 22, and the XY pair. When the fertilized egg contains extra material from chromosome number 21, this results in Down syndrome. This event is called nondisjunction and it occurs in 95% of Down syndrome cases. The baby therefore receives an extra chromosome at conception. Because of this extra chromosome 21, individuals affected with Down syndrome have 47 instead of 46 chromosomes. This additional genetic material disrupts the normal course of development, causing the characteristic features of Down syndrome.

Risk factors

Parents who have already have a baby with Down syndrome or who have abnormalities in their own chromosome 21 are at higher risk for having a baby with Down Syndrome. The chance of having a baby with Down syndrome also increases as a woman gets older. As a woman's age (maternal age) increases, the risk of having a Down syndrome baby increases significantly. By the time the woman is age 35, the risk increases to one in 400; by age 40 the risk increases to one in 110; and, by age 45, the risk becomes one in 35. There is no increased risk of either mosaicism or translocation with increased maternal age.

Causes and symptoms

Down syndrome is a chromosomal disorder caused by an error in cell division that results in the presence of an additional third chromosome 21. In approximately one to two percent of Down syndrome cases, the original egg and sperm cells contain the correct number of chromosomes, 23 each. The problem occurs sometime shortly after fertilization—during the phase when cells are dividing rapidly. One cell divides abnormally, creating a line of cells with an extra copy of chromosome 21. This form of genetic disorder is called mosaicism. The individual with this type of Down syndrome has two types of cells: those with 46 chromosomes (the normal number), and those with 47 chromosomes (as occurs in Down syndrome). Individuals affected with this mosaic form of Down syndrome generally have less severe signs and symptoms of the disorder.

Another relatively rare genetic accident that causes Down syndrome is called translocation. During cell division, chromosome 21 somehow breaks. The broken off piece of this chromosome then becomes attached to another chromosome. Each cell still has 46 chromosomes, but the extra piece of chromosome 21 results in the signs and symptoms of Down syndrome. Translocations occur in about 3–4% of cases of Down syndrome.

While Down syndrome is a chromosomal disorder, a baby is usually identified at birth through observation of a set of common physical characteristics. Not all affected babies will exhibit all of the symptoms

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discussed. There is a large variability in the number and severity of these characteristics from one affected individual to the next. Babies with Down syndrome tend to be overly quiet, less responsive to stimuli, and have weak, floppy muscles. A number of physical signs may also be present. These include: a flat appearing face; a small head; a flat bridge of the nose; a smaller than normal, low-set nose; small mouth, which causes the tongue to stick out and to appear overly large; upward slanting eyes; bright speckles on the iris of the eye (Brushfield spots); extra folds of skin located at the inside corner of each eye near the nose (epicanthal folds); rounded cheeks; small, misshapen ears; small, wide hands; an unusual deep crease across the center of the palm (simian crease); an inwardly curved little finger; a wide space between the great and the second toes; unusual creases on the soles of the feet; overly flexible joints (sometimes referred to as being double-jointed); and shorter-than-normal stature.

Other types of defects often accompany Down syndrome. Approximately 30–50% of all children with Down syndrome are found to have heart defects. A number of different heart defects are common in Down syndrome. All of these result in abnormal patterns of blood flow within the heart. Abnormal blood flow within the heart often means that less oxygen is sent into circulation throughout the body, which can cause **fatigue**, a lack of energy, and poor muscle tone.

Malformations of the gastrointestinal tract are present in about 5–7% of children with Down syndrome. The most common malformation is a narrowed, obstructed duodenum (the part of the intestine into which the stomach empties). This disorder, called duodenal atresia, interferes with the baby's milk or formula leaving the stomach and entering the intestine for digestion. The baby often vomits forcibly after feeding, and cannot gain weight appropriately until the defect is repaired.

Another malformation of the gastrointestinal tract that is seen in patients with Down syndrome is an abnormal connection between the windpipe (trachea) and the digestive tube of the throat (esophagus) called a tracheo-esophageal **fistula** (T-E fistula). This connection interferes with eating and/or breathing because it allows air to enter the digestive system and/or food to enter the airway.

Other medical conditions occurring in patients with Down syndrome include an increased chance of developing infections, especially ear infections and **pneumonia**; certain kidney disorders; thyroid disease (especially low or hypothyroid); **hearing loss**; vision impairment requiring glasses (corrective lenses); and a 20 times greater chance than the population as a whole of developing leukemia.

Development in a baby and child affected with Down syndrome occurs at a much slower than normal rate. Because of weak, floppy muscles (hypotonia), babies learn to sit up, crawl, and walk much later than their unaffected peers. Talking is also quite delayed. The level of **mental retardation** is considered to be mild-to-moderate in Down syndrome. The degree of mental retardation varies a great deal from one child to the next. While it is impossible to predict the severity of Down syndrome at birth, with proper education, children who have Down syndrome are capable of learning. Most children affected with Down syndrome can read and write and are placed in special education classes in school. The majority of individuals with Down syndrome become semi-independent adults, meaning that they can take care of their own needs with some assistance.

As people with Down syndrome age, they face an increased chance of developing the brain disease called Alzheimer's (sometimes referred to as **dementia** or senility). Most people have a 12% chance of developing Alzheimer's, but almost all people with Down syndrome will have either **Alzheimer's disease** or a similar type of dementia by the age of 50. Alzheimer disease causes the brain to shrink and to break down. The number of brain cells decreases, and abnormal deposits and structural arrangements occur. This process results in a loss of brain functioning. People with Alzheimer's have strikingly faulty memories. Over time, people with Alzheimer's disease will lapse into an increasingly unresponsive state.

As people with Down syndrome age, they also have an increased chance of developing a number of other illnesses, including **cataracts**, thyroid problems, diabetes, and seizure disorders.

Diagnosis

Examination

Diagnosis is usually suspected at birth, when the characteristic physical signs of Down syndrome are observed.

Tests

Once Down syndrome is suspected, **genetic testing** (chromosome analysis) can be undertaken in order to verify the presence of the disorder. This testing is usually done on a blood sample, although chromosome analysis can also be done on other types of tissue, including the skin. The cells to be studied are prepared

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KEY TERMS

Chromosome—A microscopic thread-like structure found within each cell of the body and consists of a complex of proteins and DNA. Humans have 46 chromosomes arranged into 23 pairs. Changes in either the total number of chromosomes or their shape and size (structure) may lead to physical or mental abnormalities.

Karyotype—A standard arrangement of photographic or computer-generated images of chromosome pairs from a cell in ascending numerical order, from largest to smallest.

Mental retardation—Significant impairment in intellectual function and adaptation in society. Usually associated an intelligence quotient (IQ) below 70.

Mosaic—A term referring to a genetic situation in which an individual's cells do not have the exact same composition of chromosomes. In Down syndrome, this may mean that some of the individual's cells have a normal 46 chromosomes, while other cells have an abnormal 47 chromosomes.

Nondisjunction—Non-separation of a chromosome pair, during either meiosis or mitosis.

Translocation—The transfer of one part of a chromosome to another chromosome during cell division. A balanced translocation occurs when pieces from two different chromosomes exchange places without loss or gain of any chromosome material. An unbalanced translocation involves the unequal loss or gain of genetic information between two chromosomes.

Trisomy—The condition of having three identical chromosomes, instead of the normal two, in a cell.

in a laboratory. Chemical stain is added to make the characteristics of the cells and the chromosomes stand out. Chemicals are added to prompt the cells to go through normal development, up to the point where the chromosomes are most visible, prior to cell division. At this point, they are examined under a microscope and photographed. The photograph is used to sort the different sizes and shapes of chromosomes into pairs. In most cases of Down syndrome, one extra chromosome 21 will be revealed. The final result of such testing, with the photographed chromosomes paired and organized by shape and size, is called the individual's karyotype. An individual with Down syndrome will have a 47 XX + 21 karyotype if they are female and a 47 XY + 21 karyotype if they are male.

Women who become pregnant after the age of 35 are offered prenatal tests to determine whether or not their developing baby is affected with Down syndrome. A genetic counselor meets with these families to inform them of the risks and to discuss the types of tests available to make a diagnosis prior to delivery. Because there is a slight risk of **miscarriage** following some prenatal tests, all testing is optional, and couples need to decide whether or not they desire to take this risk in order to learn the status of their unborn baby.

Screening tests are used to estimate the chance that an individual woman will have a baby with Down syndrome. A test called the maternal serum alpha-fetoprotein test (MSAFP) is offered to all pregnant women under the age of 35. If the mother decides to have this test, it is performed between 15 and 22 weeks of **pregnancy**. The MSAFP screen measures a protein and two hormones that are normally found in maternal blood during pregnancy. A specific pattern of these hormones and protein can indicate an increased risk for having a baby born with Down syndrome. However, this is only a risk and MSAFP cannot diagnose Down syndrome directly. Women found to have an increased risk of their babies being affected with Down syndrome are offered **amniocentesis**. The MSAFP test can detect up to 60% of all babies who will be born with Down syndrome.

Ultrasound screening for Down syndrome is also available. This is generally performed in the mid-trimester of pregnancy. Abnormal growth patterns characteristic of Down syndrome such as growth retardation, heart defects, duodenal atresia, T-E fistula, shorter than normal long-bone lengths, and extra folds of skin along the back of the neck of the developing fetus may all be observed via ultrasonic imaging.

The only way to definitively establish (with about 99% accuracy) the presence or absence of Down syndrome in a developing baby is to test tissue during the pregnancy itself. This is usually done either by amniocentesis, or **chorionic villus sampling** (CVS). All women under the age of 35 who show a high risk for having a baby affected with Down syndrome via an MSAFP screen and all mothers over the age of 35 are offered either CVS or amniocentesis. In CVS, a tiny tube is inserted into the opening of the uterus to retrieve a small sample of the placenta (the organ that attaches the growing baby to the mother via the umbilical cord, and provides oxygen and **nutrition**). In amniocentesis, a small amount of the fluid in which the baby is floating is withdrawn with a long, thin needle. CVS may be performed as early as 10 to 12 weeks into a pregnancy. Amniocentesis is generally not performed until at least the fifteenth week. Both CVS and amniocentesis carry

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small risks of miscarriage. Approximately 1% of women miscarry after undergoing CVS testing, while approximately one-half of one percent miscarry after undergoing amniocentesis. Both amniocentesis and CVS allow the baby's own karyotype to be determined.

Approximately 75% of all babies diagnosed prenatally as affected with Down syndrome do not survive to term and spontaneously miscarry. In addition, these prenatal tests can only diagnose Down syndrome, not the severity of the symptoms that the unborn child will experience. For this reason, a couple might use this information to begin to prepare for the arrival of a baby with Down syndrome, to terminate the pregnancy, or in the case of miscarriage or termination, decide whether to consider adoption as an alternative.

Treatment

Traditional

No treatment is available to cure Down syndrome. Treatment is directed at addressing the individual concerns of a particular patient. For example, heart defects may require surgical repair, as will duodenal atresia and T-E fistula. Many Down syndrome patients will need to wear glasses to correct vision. Patients with hearing impairment benefit from **hearing aids**.

While some decades ago all children with Down syndrome were quickly placed into institutions for lifelong care, research shows very clearly that the best outlook for children with Down syndrome is a normal family life in their own home. This requires careful support and education of the parents and the siblings. It is a life-changing event to learn that a new baby has a permanent condition that will affect essentially all aspects of his or her development. Some community groups help families deal with the emotional effects of raising a child with Down syndrome. Schools are required to provide services to children with Down syndrome, sometimes in separate special education classrooms, and sometimes in regular classrooms (this is called mainstreaming or inclusion).

As of May 2000, the genetic sequence for chromosome 21 was fully determined, which opens the door to new approaches to the treatment of Down syndrome through the development of gene-specific therapies.

Alternative

Clinical trials for the treatment of Down syndrome are currently sponsored by the National Institutes of Health (NIH) and other agencies. In 2009, NIH reported 20 ongoing or recently completed studies.

A few examples include:

- The evaluation of a new prenatal blood test for Down syndrome. (NCT00877292)
- The evaluation of the efficacy on language and cognitive function in Down syndrome patients who take Rivastigmine. (NCT00748007)
- The evaluation of the efficacy and tolerability of Continuous Positive Pressure in case of SAOS by Down Syndrome patients. (NCT00394290)
- A study to assess whether memantine is effective and safe in preventing age related cognitive deterioration in people with Down's syndrome (DS) age 40 and over. (NCT00240760)

Clinical trial information is constantly updated by NIH and the most recent information on Down syndrome trials can be found at: http://clinicaltrials.gov/search/open/condition=%22Down+Syndrome%22

Prognosis

The prognosis for an individual with Down syndrome is quite variable, depending on the types of complications (heart defects, susceptibility to infections, development of leukemia, etc.). The severity of the retardation can also vary significantly. Without the presence of heart defects, about 90% of children with Down syndrome live into their teens. People with Down syndrome appear to go through the normal physical changes of **aging** more rapidly, however. The average age of **death** for an individual with Down syndrome is about 50 to 55 years.

Still, the prognosis for a baby born with Down syndrome is better than ever before. Because of modern medical treatments, including **antibiotics** to treat infections, and surgery to treat heart defects and duodenal atresia, life expectancy has greatly increased. Community and family support allows people with Down syndrome to have rich, meaningful relationships. Because of educational programs, some people with Down syndrome are able to hold jobs.

Prevention

There is no known way to prevent the Down syndrome. Women expecting to give birth however, can take steps before and during pregnancy to have a healthy pregnancy. Steps include taking a daily multivitamin with **folic acid** (400 micrograms), not **smoking**, and not drinking alcohol during pregnancy. Once a couple has had one baby with Down syndrome, they are often concerned about the likelihood of future offspring also being born with the disorder.

When a baby with Down syndrome has the type that results from a translocation, it is possible that one

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of the two parents is a carrier of a balanced translocation. A carrier has rearranged chromosomal information and can pass it on, but he or she does not have an extra chromosome and therefore is not affected with the disorder. When one parent is a carrier of a translocation, the chance of future offspring having Down syndrome is greatly increased. The specific risk will have to be assessed by a genetic counsellor. Approximately 60% of women with Down syndrome are fully capable of having children. The risk of a woman with trisomy 21 having a child affected with Down syndrome is 50%.

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ORGANIZATIONS

March of Dimes Foundation, 1275 Mamaroneck Avenue, White Plains, NY, 10605, (914) 428-7100, (888) MODIMES, (914) 428-8203, askus@marchofdimes.com, http://www.marchofdimes.com.

National Association for Down Syndrome (NADS), PO Box 206, Wilmette, IL, 60091, (630) 325-9112, info@nads.org, http://www.nads.org.

National Center on Birth Defects and Developmental Disabilities, Centers for Disease Control and Prevention, 1600 Clifton Rd., Atlanta, GA, 75231, (800) 232-4636, http://www.cdc.gov/ncbddd/index.html.

National Down Syndrome Society, 666 Broadway, 8th Floor, New York, NY, 10012, (800) 221-4602, (212) 979-2873, info@ndss.org, http://www.ndss.org.

National Institute of Child Health and Human Development (NICHD), 31 Center Drive, Rm. 2A32, MSC 2425, Bethesda, MD, 20892-2425, (301) 496-5133, (301) 496-7101, http://www.nichd.nih.gov.

Paul A. Johnson
Monique Laberge, PhD

Down's syndrome *see* **Down syndrome**
Doxazosin *see* **Alpha$_1$-adrenergic blockers**
Doxepin *see* **Antidepressants, tricyclic**
Doxycycline *see* **Tetracyclines**
Dracontiasis *see* **Guinea worm infection**
Dracunculiasis *see* **Guinea worm infection**
Drooping eyelid *see* **Ptosis**
Drowning *see* **Near-drowning**

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Drug abuse *see* **Substance abuse and dependence**
Drug addiction *see* **Substance abuse and dependence**
Drug dependence *see* **Substance abuse and dependence**

Drug metabolism/interactions

Definition

Drug metabolism is the process by which the body breaks down and converts medication into active chemical substances.

Precautions

Drugs can interact with other drugs, foods, and beverages. Interactions can lessen or magnify the desired therapeutic effect of a drug, or may cause unwanted or unexpected side effects. There are thousands of possible drug-to-drug and drug-to-food interactions, and many medications and supplements are contraindicated (not recommended) under certain conditions or in patients with specific diseases and disorders. This is why it is imperative that patients always keep their physician fully informed about all drugs and dietary supplements (including herbal remedies) they are taking.

Description

The primary site of drug metabolism is the liver, the organ that plays a major role in metabolism, digestion, **detoxification**, and elimination of substances from the body. Enzymes in the liver are responsible for chemically changing drug components into substances known as metabolites. Metabolites are then bound to other substances for excretion through the lungs, or bodily fluids such as saliva, sweat, breast milk, and urine, or through reabsorption by the intestines. The primary mode of excretion is through the kidneys.

The family of liver isoenzymes known as cytochrome P-450 are crucial to drug metabolism. These enzymes (labeled CYP1A2, CYP2C9, CYP2C19, CYP2D6, and CYP3A4) have a catabolic action on substances, breaking them down into metabolites. Consequently, they also act to lower the concentration of medication in the bloodstream.

Drug interactions can occur when one drug inhibits or induces a P-450 that acts on another drug. An example is nicotine, a drug contained in tobacco, and known to induce P-450s. Individuals with **liver disease** (e.g., **cirrhosis**) may also have insufficient levels of P-450 enzymes. As a result, the concentration of drugs metabolized by these enzymes (e.g., amprenavir and other **protease inhibitors**) remains high and can build up to toxic levels in the bloodstream. In addition, certain medications and foods, such as grapefruit juice, can inactivate or lessen the metabolic activity of P-450s. Changing the drug dosage can alleviate the problem in some cases.

The metabolic rate can vary significantly from person to person, and drug dosages that work quickly and effectively in one individual may not work well for another. Factors such as genetics, environment, **nutrition**, and age also influence drug metabolism; infants and elderly patients may have a reduced capacity to metabolize certain drugs, and may require adjustments in dosage.

Causes and symptoms

Drugs that commonly interact with other medications include:

- Diuretics. Diuretics such as hydrochlorothiazide can reduce serum potassium and sodium electrolyte levels when taken with digoxin and lithium, respectively.
- Monoamine oxidase inhibitors (MAOIs). MAOI antidepressants can cause convulsions and other serious side effects when used with tricyclic antidepressants (e.g., Imipramine, Nortriptyline), selective serotonin reuptake inhibitors (SSRIs), or sympathomimetic drugs (e.g., amphetamines).
- Antibiotics. Antibiotics may reduce the efficiency of oral contraceptives.
- Metals. Medications containing metals, such as antacids with aluminum additives and iron supplements, can reduce the absorption of tetracyclines and fluoroquinolones.
- Drugs that inhibit liver enzyme function. Drugs that slow drug metabolism include ciprofloxacin, erythromycin, fluoxetine, nefazodone, paroxetine, and ritonavir. The therapeutic effect of other medications taken with these drugs may be amplified. Warfarin, a blood thinner, should be used with great caution in individuals taking these drugs.

Foods and beverages that may interact with drugs include:

- Grapefruit juice. Grapefruit juice inhibits the metabolism of many medications, including cyclosporine, felodipine, nifedipine, nitrendipine, nisoldipine, carbamazepine, triazolam, and midazolam.
- Foods and beverages with tyramines. Red wine, malted beers, smoked foods (e.g., fish and meats),

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dried fruits, and aged cheeses may contain tyramines, and can cause a severe and dangerous elevation in blood pressure when taken with MAOI inhibitors (a class of antidepressants).

- Dairy products. Milk, cream, and other dairy products containing calcium can prevention the absorption of antibiotics such as tetracycline, doxycycline, and ciprofloxacin when they are taken with the drug. In addition, whole milk with vitamin D can cause milk-alkali syndrome in patients taking aluminum hydroxide antacids.
- Caffeinated beverages. The caffeine contained in coffee and colas can influence drug metabolism.
- Alcohol. Alcohol is a central nervous system depressant, and should not be taken with other CNS depressants (e.g., antipsychotics, antihistamines). In addition, certain fermented beverages may contain tyramines.

This list is not all-inclusive and individuals should always let their doctor and pharmacist know when they are taking other medications, herbal remedies, or dietary supplements. Anyone who experiences a serious reaction to a drug that is not consistent with its product labeling should report the event to their doctor and/or the MedWatch adverse event reporting system of the United States Food and Drug Administration (FDA).

Alternative treatment

The growing use of herbal supplements has also increased the opportunity for adverse drug and herbal interactions. In 2000, the FDA issued a warning on the popular herb **St. John's wort** (*Hypericum perforatum*). The supplement was found to inhibit the effect of indinavir, a protease inhibitor used in the treatment of HIV. It may also affect the action of cyclosporine and other protease inhibitors (e.g., amprenavir, ritonavir). Further clinical studies are still necessary to determine the full metabolic effects of the herb.

Other herbs which may interact with allopathic medications include gingko bilboa, **ginseng**, and garlic, which may all heighten the blood thinning effect of the anticoagulant warfarin. Because herbs are regulated by the FDA as dietary supplements, they do not require the same extensive clinical trials and premarket testing as drugs do before they are cleared for sale in the United States. As such, there is still much to learn about the potential interactions and adverse effects associated with herbal supplements. Individuals who experience serious side effects from dietary supplements should report them to FDA's MedWatch program.

KEY TERMS

Catabolism—A process of metabolism that breaks down complex substances into simple ones.

Cirrhosis—Liver disease characterized by the widespread disruption of the normal liver structure and function.

CNS depressant—Anything that depresses, or slows, the sympathetic impulses of the central nervous system (i.e., respiratory rate, heart rate).

Drug interaction—A chemical or physiological reaction that can occur when two different drugs are taken together.

Enzymes—Organic substances (proteins) composed of amino acids that trigger and regulate chemical reactions in the body. There are over 700 identified human enzymes.

Liver—A solid organ located on the right in the upper abdomen. It plays a major role in metabolism, digestion, detoxification, and elimination of substances from the body.

Metabolism—The sum of all the physical and chemical processes occurring in the body to organize and maintain life.

Metabolites—Substances produced by metabolism or by a metabolic process.

Milk-alkali syndrome—Elevated blood calcium levels and alkalosis caused by excessive intake of milk and alkalis. Usually occurs in the treatment of peptic ulcer.

Diagnosis

Drug interactions can be difficult to detect. In some cases, adverse reactions may closely resemble the symptoms of the disease or condition the medication was prescribed to treat. Patients who take a number of medications or self-treat with over-the-counter drugs and/or herbal remedies may not be able to determine which drug actually triggered the interaction. A 2001 study by University of Florida researchers found that less than half of the women participating disclosed their use of herbal therapies to their healthcare providers. In cases where a serious drug or herb interaction occurs, withholding this information can delay diagnosis and put the patient at increased risk.

Treatment

Treatment of a drug interaction is dependant on a number of factors, including the medication(s) or

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supplements used and the medical history of the patient. A dosage adjustment may reverse the effects of some interactions. Serious or life-threatening interactions will require more aggressive therapies.

Prevention

Patients with chronic health conditions, particularly those with liver disorders, should always inform their healthcare professional before taking any over-the-counter (OTC) medications or dietary supplements. Because of the risk for a drug-to-drug interaction, individuals should also let their doctor know if they are taking drugs prescribed by other physicians. Individuals should closely follow instructions for use and package directions on both prescription and over-the-counter drugs. Consulting with a pharmacist and/or physician may be beneficial if package directions are unclear to the patient.

As a rule, grapefruit juice should not be taken with medication unless recommended by a doctor. Patients taking MAOI inhibitors should always check food and beverage labels to ensure tyramines are not included, and should avoid all fermented drinks.

Resources

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United States Food and Drug Administration (FDA). MedWatch Adverse Events Reporting Program, 5600 Fishers Lane, Rockville, MD, 20857, (800) 332-0178, (800) 332-1088, http://www.fda.gov/medwatch/.

Paula Anne Ford-Martin

Drug overdose

Definition

A drug overdose is the accidental or intentional use of a drug or medicine in an amount that is higher than is normally used.

Drug-related emergency department (ED) visits, by selected drugs, 2008[1]

Drug	Number of visits
Alternative medicines	1,952
Analgesics	528,566
Antidepressants	99,037
Antihistamines	9,261
Anxiolytics, sedatives, and hypnotics	394,874
Cocaine	482,188
Heroin	200,666
Marijuana	374,435
Methamphetamine	66,308
Muscle relaxants	58,702
PCP	37,266
Topical agents	4,478
Total ED visits	**1,999,861[2]**

[1]Most recent year for which estimates were available.
[2]Includes drugs not listed in this chart.

SOURCE: Office of Applied Studies, SAMHSA, Drug Abuse Warning Network, 2008 (December 2009 update).

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Description

All drugs have the potential to be misused, whether legally prescribed by a doctor, purchased over-the-counter at the local drug store, or bought illegally on the street. Taken in combination with other drugs or with alcohol, even drugs normally considered safe can cause **death** or serious long term consequences. Children are particularly at risk for accidental overdose, accounting for over one million poisonings each year from drugs, alcohol, and other chemicals and toxic substances. People who suffer from depression and who have suicidal thoughts are also at high risk for drug overdose.

Causes and symptoms

Accidental drug overdose may be the result of misuse of prescription medicines or commonly used medications like **pain** relievers and cold remedies. Symptoms differ depending on the drug taken. Some of the drugs commonly involved in overdoses are listed below along with symptoms and outcomes.

Acetaminophen is the generic name for the commonly used pain reliever Tylenol. Overdose of this drug causes liver damage with symptoms that include loss of appetite, tiredness, **nausea and vomiting**, paleness, and sweating. The next stage of symptoms indicates liver failure and includes abdominal pain and tenderness, swelling of the liver, and abnormal blood tests for

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liver enzymes. In the last stage of this poisoning, liver failure advances and the patient becomes jaundiced, with yellowing of the skin and whites of the eyes. They may also experience kidney failure, bleeding disorders, and encephalopathy (swelling of the brain).

Anticholinergic drugs (drugs that block the action of acetylcholine, a neurotransmitter) like atropine, scopolamine, belladonna, **antihistamines**, and antipsychotic agents cause the skin and moist tissues (like in the mouth and nose) to become dry and flushed. Dilated pupils, an inability to urinate, and mental disturbances are also symptoms. Severe toxicity can lead to seizures, abnormal heart rhythms, extremely high blood pressure, and **coma**.

Antidepressant drugs like amitriptyline, desipramine, and nortriptyline can cause irregular heart rate, **vomiting**, low blood pressure, confusion, and seizures. An overdose of antidepressants also causes symptoms similar to those seen with anticholinergic drug overdoses.

Cholinergic drugs (drugs that stimulate the parasympathetic nervous system) like carbamate and pilocarpine cause **nausea**, **diarrhea**, increased secretion of body fluids (sweat, tears, saliva, and urine), **fatigue**, and muscle weakness. Convulsions are possible. Death can occur due to **respiratory failure** and **heart failure**.

Cocaine and crack cocaine overdoses cause seizures, high blood pressure, increased heart rate, **paranoia**, and other changes in behavior. **Heart attack** or **stroke** are serious risks within three days after cocaine overdose.

Depressant drugs (tranquilizers, **antianxiety drugs**, sleeping pills) cause sleepiness, slowed or slurred speech, difficulty walking or standing, blurred vision, impaired ability to think, disorientation, and mood changes. Overdose symptoms can include slowed breathing, very low blood pressure, stupor, coma, **shock**, and death.

Digoxin, a drug used to regulate the heart, can cause irregular heart beats, nausea, confusion, loss of appetite, and blurred vision.

Narcotics or opiates are drugs like heroin, morphine, and codeine. Clonidine and diphenoxylate (Lomotil) are also in this category. Overdose with opiate drugs causes **sedation** (sleepiness), low blood pressure, slowed heart rate, and slowed breathing. Pinpoint pupils, where the black centers of the eyes become smaller than normal, are common in opiate overdose. However, if other drugs are taken at the same time as the opiates, they may counteract this effect on the pupils. A serious risk is that the patient will stop breathing.

Salicylates are found in **aspirin** and some creams or ointments used for muscle and joint pain (like Ben-Gay), and creams for **psoriasis**, a skin condition. Initial symptoms are gastrointestinal irritation, **fever**, and **vomiting**, possibly with blood in the vomit. This overdose will cause **metabolic acidosis** and **respiratory alkalosis**, conditions where the body's acid/base balance is malfunctioning. Symptoms include rapid heart beat and fast breathing. Nervous system symptoms include confusion, **hallucinations**, tiredness, and ringing in the ears. An increased tendency to bleed is also common. Serious complications include acute renal failure, coma, and heart failure. Acute salicylate poisoning can lead to death.

Diagnosis

Diagnosis of a drug overdose may be based on the symptoms that develop, however, the drug may do extensive damage to the body before significant symptoms develop. If the patient is conscious, he or she may be able to tell what drugs were taken and in what amounts. The patient's recent medical and social history may also help in a diagnosis. For example, a list of medications that the patient takes, whether or not alcohol was consumed recently, even if the patient has eaten in the last few hours before the overdose, can be valuable in determining what was taken and how fast it will be absorbed into the system.

Different drugs have varying effects on the body's acid/base balance and on certain elements in the blood like potassium and **calcium**. Blood tests can be used to detect changes in body chemistry that may give clues to what drugs were taken. Blood can also be screened for various drugs in the system. Once the overdose drug is identified, blood tests can be used to monitor how fast the drug is being cleared out of the body. Urine tests can also be used to screen for some drugs and to detect changes in the body's chemistry. Blood and urine tests may show if there is damage to the liver or kidneys as a result of the overdose.

Treatment

Immediate care

If a drug overdose is discovered or suspected, and the person is unconscious, having convulsions, or is not breathing, call for emergency help immediately. If the person who took the drug is not having symptoms, do not wait to see if symptoms develop; call a poison control center immediately. Providing as much information as possible to the poison control center can help determine what the next course of action should be.

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The poison control center, paramedics, and emergency room staff will want to know:

- What drug(s) were taken? (Try to locate the drug's container.)
- How much of the drug was taken?
- When was the drug taken?
- Was the drug taken with alcohol or any other drugs or chemicals?
- What is the age of the patient?
- What symptoms are the patient experiencing?
- Is the patient conscious?
- Is the patient breathing?

The poison control center may recommend trying to get the patient to vomit. A liquid called **ipecac** syrup, which is used to induce vomiting, is available from pharmacies without a prescription. Pediatricians may recommend that families keep ipecac syrup on hand in households with children. This medication should be used only on the advice of a medical professional. Vomiting should not be induced if the patient is unconscious.

Emergency care

Emergency medical treatment may include:

- Assessment of the patient's airway and breathing to making sure that the trachea, the passage to the lungs, is not blocked. If needed, a tube may be inserted through the mouth and into the trachea to help the patient breath. This procedure is called intubation.
- Assessment of the patient's heart rate, blood pressure, body temperature, and other physical signs that might indicate the effects of the drug.
- Blood and urine samples may be collected to test for the presence of the suspected overdose drug, and any other drugs or alcohol that might be present.
- Elimination of the drug that has not yet been absorbed is attempted. Vomiting may be induced using ipecac syrup or other drugs that cause vomiting. Ipecac syrup should not be given to patients who overdosed with tricyclic antidepressants, theophylline, or any drug that causes a significant change in mental status. If a patient vomits while unconscious, there is a serious risk of choking.
- Gastric lavage, or washing out the stomach, may be attempted. For this procedure a tube flexible tube is inserted through the nose, down the throat, and into the stomach. The contents of the stomach are then suctioned out through the tube. A solution of saline (salt water) is injected into the tube to rinse out the stomach. This solution is then suctioned out. This is the process used when someone has his/her stomach pumped.
- Activated charcoal is sometimes given to absorb the drug.
- Medication to stimulate urination or defecation may be given to try to flush the excess drug out of the body faster.
- Intravenous (IV) fluids may be given. An intravenous line, a needle inserted into a vein, may be put into the arm or back of the hand. Fluids, either sterile saline (salt water solution) or dextrose (sugar water solution), can be administered through this line. Increasing fluids can help to flush the drug out of the system and to reestablish balance of fluids and minerals in the body. The pH (acid/base balance) of the body may need to be corrected by administering electrolytes like sodium, potassium, and bicarbonate through this IV line. If drugs need to be administered quickly, they can also be injected directly into the IV line.
- Hemodialysis is a procedure where blood is circulated out of the body, pumped through a dialysis machine, then reintroduced back into the body. This process can be used to filter some drugs out of the blood. It may also be used temporarily or long term if the kidneys are damaged due to the overdose.
- Antidotes are available for some drug overdoses. An antidote is another drug that counteracts or blocks the overdose drug. For example, acetaminophen overdose can be treated with an oral medication, N-acetylcysteine (Mucomyst), if the level of acetaminophen found in the blood is extremely high. Naloxone is an anti-narcotic drug that is given to counteract narcotic poisoning. Nalmefen or methadone may also be used.
- Psychiatric evaluation may be recommended if the drug overdose was taken deliberately.

KEY TERMS

Gastric lavage—Also called a stomach pump. For this procedure, a flexible tube is inserted through the nose, down the throat, and into the stomach and the contents of the stomach are suctioned out. The inside of the stomach is rinsed with a saline (salt water) solution.

Intubation—A procedure where a tube is inserted through the mouth and into the trachea keep the airway open and to help the patient breathe.

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Prognosis

While many victims of drug overdose recover without long term effects, there can be serious consequences. Some drug overdoses cause the failure of major organs like the kidneys or liver, or failure of whole systems like the respiratory or circulatory systems. Patients who survive drug overdose may need **kidney dialysis**, kidney or liver transplant, or ongoing care as a result of heart failure, stroke, or coma. Death can occur in almost any drug overdose situation, particularly if treatment is not started immediately.

Prevention

To protect children from accidental drug overdose, all medications should be stored in containers with child resistant caps. All drugs should be out of sight and out of reach of children, preferably in a locked cabinet. Prescription medications should be used according to directions and only by the person whose name is on the label. Threats of **suicide** need to be taken seriously and appropriate help sought for people with depression or other mental illness that may lead to suicide.

Resources

OTHER

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Altha Roberts Edgren

Drug therapy monitoring

Definition

Drug therapy monitoring, also known as Therapeutic Drug Monitoring (TDM), is a means of monitoring drug levels in the blood.

Purpose

TDM is employed to measure blood drug levels so that the most effective dosage can be determined, with toxicity prevented. TDM is also utilized to identify noncompliant patients (those patients who, for whatever reason, either cannot or will not comply with drug dosages as prescribed by the physician).

Therapeutic Drug Monitoring: Therapeutic and toxic ranges

Drug name	Use	Therapeutic level*	Toxic level
Acetaminophen	Analgesic, antipyretic	Depends on use	>250 mcg/mL
Amikacin	Antibiotic	12–25 mcg/mL**	>25
Aminophylline	Bronchodilator	10–20 mg/mL	>20
Amitriptyline	Antidepressant	120–150 ng/mL	>500
Carbamazepine	Anticonvulsant	5–12 mg/mL	>12
Chloramphenicol	Antibiotic	10–20 mcg/mL	>25
Digoxin	Cardiotonic	0.8–2.0 ng/mL	>2.4
Gentamicin	Antibiotic	5–10 mcg/mL	>12
Lidocaine	Antiarrhythmic	1.5–5.0 mcg/mL	>5
Lithium	Antimanic	0.8–1.2 mEq/L	>2.0
Nortriptyline	Antidepressant	50–150 ng/mL	>500
Phenobarbital	Anticonvulsant	10–30 mcg/mL	>40
Phenytoin	Anticonvulsant	10–20 mcg/mL	>30
Procainamide	Antiarrhythmic	4–10 mcg/mL	>16
Propranolol	Antiarrhythmic	50–100 ng/mL	>150
Quinidine	Antiarrhythmic	2–5 mcg/mL	>10
Salicylate	Analgesic	100–250 mcg/mL	>300
Theophylline	Bronchodilator	10–20 mg/mL	>20
Tobramycin	Antibiotic	5–10 mcg/mL**	>12
Valproic acid	Anticonvulsant	50–100 mcg/mL	>100

*Values are laboratory-specific.
**Concentration obtained 30 minutes after the end of a 30-minute infusion.

SOURCE: National Institutes of Health, U.S. National Library of Medicine.

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Precautions

Because so many different factors influence blood drug levels, the following points should be taken into consideration during TDM: the age and weight of the patient; the route of administration of the drug; the drug's absorption rate, excretion rate, delivery rate, and dosage; other medications the patient is taking; other diseases the patient has; the patient's compliance regarding the drug treatment regimen; and the laboratory methods used to test for the drug.

Description

TDM is a practical tool that can help the physician provide effective and safe drug therapy in patients who need medication. Monitoring can be used to confirm a blood drug concentration level that is above or below the therapeutic range, or if the desired therapeutic effect of the drug is not as expected. If this is the case, and dosages beyond normal then have to be prescribed, TDM can minimize the time that elapses.

TDM is important for patients who have other diseases that can affect drug levels, or who take other medicines that may affect drug levels by interacting

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with the drug being tested. As an example, without drug monitoring, the physician cannot be sure if a patient's lack of response to an antibiotic reflects bacterial resistance, or is the result of failure to reach the proper therapeutic range of antibiotic concentration in the blood. In cases of life-threatening infections, timing of effective antibiotic therapy is critical to success. It is equally crucial to avoid toxicity in a seriously ill patient. Therefore, if toxic symptoms appear with standard dosages, TDM can be used to determine changes in dosing.

Drawn blood, used for TDM, demonstrates a drug action in the body at any specific time, whereas drug levels examined from urine samples reflect the presence of a drug over many days (depending on the rate of excretion). Therefore, blood testing is the procedure of choice when definite data are required. However, for adequate absorption and therapeutic levels to be accurate, it is important to allow for sufficient time to pass between the administration of the medication and the collection of the blood sample.

Blood specimens for drug monitoring can be taken at two different times: during the drug's highest therapeutic concentration ("peak" level), or its lowest ("trough" level). Occasionally called residual levels, trough levels show sufficient therapeutic levels; whereas peak levels show **poisoning** (toxicity). Peak and trough levels should fall within the therapeutic range.

Preparation

In preparing for this test, the following guidelines should be observed:

- Depending on the drug to be tested, the physician should decide if the patient is to be fasting (nothing to eat or drink for a specified period of hours) before the test.
- For patients suspected of symptoms of drug toxicity, the best time to draw the blood specimen is when the symptoms are occurring.
- If there is a question as to whether an adequate dose of the drug is being achieved, it is best to obtain trough (lowest therapeutic concentration) levels.
- Peak (highest concentration) levels are usually obtained one to two hours after oral intake, approximately one hour after intramuscular (IM) administration (a shot in the muscle), and approximately 30 minutes after intravenous (IV) administration. Residual, or trough, levels are usually obtained within 15 minutes of the next scheduled dose.

Risks

Risks for this test are minimal, but may include slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after blood is drawn, or accumulation of blood under the puncture site (hematoma).

Resources

BOOKS

Pagana, Kathleen Deska, and Timothy J. Pagana. *Mosby's Manual of Diagnostic and Laboratory Tests*. 4th ed. St. Louis: Mosby, 2009.

Janis O. Flores

Drugs used in labor

Definition

These drugs are used to induce (start) or continue labor.

Purpose

The drug decribed here, oxytocin, makes the uterus (womb) contract. Physicians use it to deliberately start labor. Because there are some risks with using oxytocin, this should be done only when there are good medical reasons. Any woman who is being given oxytocin should make sure she has discussed the benefits and risks with her physician.

Oxytocin also may be used to control bleeding after delivery or to help make the milk flow in women who are **breastfeeding** their babies.

Description

Oxytocin is a hormone and is available only with a physician's prescription. When used to start or continue labor, it is slowly injected into a vein. A nasal spray form is used to increase milk flow in breastfeeding. Some commonly used brand names are Pitocin and Syntocinon.

Recommended dosage

The dosages given here are average doses. However, doses may be different for different patients. Follow the orders of the physician who prescribed the drug.

For increasing milk production:

One spray into one or both nostrils, two–three minutes before nursing or using a breast pump.

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KEY TERMS

Cesarean section—The delivery of a baby through a surgical procedure.

Fetus—A developing baby inside the womb.

Hormone—A substance that is produced in one part of the body, then travels through the bloodstream to another part of the body where it has its effect.

For starting or continuing labor:

The physician in charge will determine the appropriate dose.

Precautions

Oxytocin does not help increase or continue labor in all patients. When it does not help, the physician may deliver the baby by **cesarean section**.

In women who are especially sensitive to oxytocin, the drug may cause contractions to become too strong. This could tear the uterus or deprive the fetus of blood and oxygen during labor.

Oxytocin does not help improve milk flow in all women who are breastfeeding. Check with a physician if the drug does not seem to be working.

Women with heart disease, high blood pressure, or **kidney disease** should let their physicians know about these conditions before taking oxytocin. Also, anyone who has had an unusual reaction to oxytocin in the past should inform their physician.

Side effects

Oxytocin has caused irregular heartbeat and increased bleeding in some women after delivery. It may also cause **jaundice** (yellowing of the eyes and skin) in newborns.

Other side effects are rare, but may include **nausea**, **vomiting**, confusion, **dizziness**, convulsions, breathing problems, **headache**, **hives**, skin rash, **itching**, pelvic or abdominal **pain**, and weakness. The nasal spray form may cause watery eyes or irritation of the nose.

Interactions

Anyone who takes oxytocin should let the physician know all other medicines she is taking.

Nancy Ross-Flanigan

Dry mouth

Definition

Dry mouth, known medically as xerostomia, is the abnormal reduction of saliva due to medication, disease, or medical therapy.

Description

Dry mouth due to the lack of saliva can be a serious medical problem. Decreased salivation can make swallowing difficult, can decrease taste sensation, and can promote **tooth decay**.

Causes and symptoms

Dry mouth, resulting from thickened or reduced saliva flow, can be caused by a number of factors: medications, both prescription and over-the-counter; such systemic diseases as anemia, HIV infection, or diabetes, manifestations of **Sjögren's syndrome** (as **rheumatoid arthritis**, lupus, chronic hardening and thickening of the skin, or chronic and progressive inflammation of skeletal muscles); infections of the salivary glands; blockage of the salivary ducts caused by stones or tumors forming in the ducts through which the saliva passes; **dehydration**; such medical therapies as local surgery or radiation; secretion reduction normally involved in the **aging** process; and emotional **stress**.

Diagnosis

The diagnosis of dry mouth is not difficult. The patient will state that his or her saliva is very thick or nonexistent. Finding the cause of dry mouth may be more difficult and require some laboratory testing. Salivary gland biopsy for stones or tumors should be performed if indicated.

Treatment

The treatment of dry mouth involves the management of the condition causing it. If dry mouth is caused by medication, the medication should be changed. If dry mouth is caused by blockage of the salivary ducts, the cause of the blockage should be investigated. When systemic diseases, such as diabetes and anemia, are brought under control dry mouth problems may decrease.

The use of caffeine-containing beverages, alcoholic beverages, and mouthwashes containing alcohol should be minimized. The drinking of water and fruit juices will decrease dry mouth problems. Chewing gum and lemon drops can be used to stimulate saliva flow. Bitters also can initiate salivary flow as long as the salivary glands

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KEY TERMS

Salivary duct—Tube through which saliva is carried from the salivary gland to the mouth.

Salivary gland—Gland in which saliva forms.

Sialogogue—A medication given to increase the flow of saliva.

Xerostomia—The medical term for dry mouth.

and ducts are functional. Commercial saliva substitutes are available without prescription and can be used as frequently as needed. Use of a humidifier in the bedroom reduces nighttime oral dryness.

Dry mouth caused by the aging process or **radiation therapy** for **cancer** can be treated by such oral medications as pilocarpine (Salagen). Drugs that are given to increase the flow of saliva are known as sialogogues.

Prognosis

The prognosis for patients with xerostomia due to medication problems is good, if the offending agent can be changed. Dry mouth due to systemic problems may be eliminated or improved once the disease causing the dry mouth is under control. Persistent xerostomia can be managed well with saliva substitutes.

Prevention

A patient needs to ask his or her health care provider if any medication to be prescribed will cause dry mouth. Patients with persistent xerostomia need to practice good **oral hygiene** and visit a dentist on a regular basis; the lack of adequate saliva can cause severe dental decay. The salivary glands are very sensitive to radiation, so any patient scheduled for radiation therapy of the head and neck needs to discuss with the radiation therapist ways to minimize exposure of the salivary glands to radiation.

Resources

BOOKS

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ORGANIZATIONS

American Dental Association, 211 E. Chicago Ave., Chicago, IL, 60611-2678, (312) 440-2500, http://www.ada.org.

American Medical Association, 515 N. State St., Chicago, IL, 60654, (800) 621-8335, http://www.ama-assn.org/.

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Dry skin *see* **Ichthyosis**

Dual energy x-ray absorptiometry (DXA) scan *see* **Bone density test**

DUB *see* **Dysfunctional uterine bleeding**

Duchenne muscular dystrophy *see* **Muscular dystrophy**

Duodenal atresia *see* **Duodenal obstruction**

Duodenal obstruction

Definition

Duodenal obstruction is a failure of food to pass out of the stomach either from a complete or partial obstruction.

Description

The duodenum is the first part of the intestine, into which the stomach, the gall bladder, and the pancreas empty their contents. The pylorus connects the duodenum with the stomach and contains the valve that regulates stomach emptying. Obstruction usually occurs right at this outlet, so that the gall bladder and pancreas are unable to drain their secretions without hindrance.

Causes and symptoms

Obstruction of the duodenum occurs in adults and infants, each for a different set of reasons. In adults, the usual cause is a peptic ulcer of such antiquity that

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repeated cycles of injury and scarring have narrowed the passageway. Medical treatment of ulcers has progressed to the point where such obstinate ulcer disease is rarely seen any more. In infants, the conditions are congenital—either the channel is underdeveloped or the pylorus is overdeveloped. The first type is called duodenal hypoplasia and the second is termed hypertrophic **pyloric stenosis**. In rare cases, the channel may be missing altogether, a condition called duodenal atresia. To say that these anomalies are congenital is not to say their cause is understood. As with most **birth defects**, the specific cause is not known.

Food that cannot exit the stomach in the forward direction will return whence it came. **Vomiting** is the constant symptom of duodenal obstruction. It may be preceded by **indigestion** and **nausea** as the stomach attempts to squeeze its contents through an ever narrowing outlet.

Hypertrophic pyloric stenosis appears soon after birth. The infant will vomit feedings, lose weight, and be restless and irritable.

Diagnosis

X rays taken with contrast material in the stomach readily demonstrate the site of the blockage and often the ulcer that caused it. Gastroscopy is another way to evaluate the problem. In infants, x rays may not be necessary to detect pyloric stenosis. It is often possible to feel the enlarged pylorus, like an olive, deep under the ribs and see the stomach rippling as it labors to force food through.

Treatment

Bowel obstruction requires a surgeon, sometimes immediately. Newer surgical techniques constantly improve the outcome, but obstruction is a mechanical problem that needs a mechanical solution. Most adults who come to surgery for obstruction have suffered for years from peptic ulcer disease. They will usually benefit from **ulcer surgery** at the same time their obstruction is relieved. The surgeon will therefore select a procedure that combines relief of obstruction with remedy for ulcer disease. There are many choices. In fact, even without obstruction, functional considerations require ulcer surgery to include enhancement of stomach emptying.

To treat an infant with hypertrophic pyloric stenosis, some surgeons have had success with forceful balloon dilation of the pylorus done through a gastroscope, but the standard procedure is to cut across the overdeveloped circular muscle that is constricting the stomach outlet. There are reports of infant hypertrophic pyloric stenosis remitting without surgery following a very careful feeding schedule, but mortality is unacceptably high.

KEY TERMS

Atresia—Failure to develop; complete absence.

Contrast agent—A substance that produces shadows on an x ray so that hollow structures can be more easily seen.

Gastroscopy—Looking into the stomach with a flexible viewing instrument called a gastroscope.

Hypoplasia—Incomplete development.

Peptic ulcer—A wound in the lower stomach and duodenum caused by stomach acid and a newly discovered germ called *Helicobacter pylori*.

Prognosis

A functioning and unrestricted intestine is a prerequisite for living independent of the most advanced and continuous medical care available. Achieving this desirable goal is the rule with surgery for duodenal obstructions of all types. The bowel is so malleable that there is a rearrangement to suit every occasion. The variety of possible configurations is limited only by the surgeon's imagination.

Prevention

Prompt and effective treatment of peptic ulcers will prevent chronic scarring and narrowing. Drugs developed over the past few decades have all but eliminated the need for ulcer surgery.

Resources

BOOKS

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J. Ricker Polsdorfer, MD

Duodenal stenosis *see* **Duodenal obstruction**

Duodenal ulcers *see* **Ulcers (digestive)**

Duodenum x rays *see* **Hypotonic duodenography**

Duplicated ureter *see* **Congenital ureter anomalies**

Dwarfism *see* **Achondroplasia; Pituitary dwarfism**

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Dysentery

Definition

Dysentery is a general term for a group of gastrointestinal disorders characterized by inflammation of the intestines, particularly the colon. Characteristic features include abdominal **pain** and cramps, straining at stool (tenesmus), and frequent passage of watery **diarrhea** or stools containing blood and mucus. The English word dysentery comes from two Greek words meaning "ill" or "bad" and "intestine."

It should be noted that some doctors use the word "dysentery" to refer only to the first two major types of dysentery discussed below, while others use the term in a broader sense. For example, some doctors speak of **schistosomiasis**, a disease caused by a parasitic worm, as bilharzial dysentery, while others refer to acute diarrhea caused by viruses as viral dysentery.

Description

Dysentery is a common but potentially serious disorder of the digestive tract that occurs throughout the world. It can be caused by a number of infectious agents ranging from viruses and bacteria to protozoa and parasitic worms; it may also result from chemical irritation of the intestines. Dysentery is one of the oldest known gastrointestinal disorders, having been described as early as the Peloponnesian War in the fifth century B.C. Epidemics of dysentery were frequent occurrences aboard sailing vessels as well as in army camps, walled cities, and other places in the ancient world where large groups of human beings lived together in close quarters with poor sanitation. As late as the eighteenth and nineteenth centuries, sailors and soldiers were more likely to die from the "bloody flux" than from injuries received in battle. It was not until 1897 that a bacillus (rod-shaped bacterium) was identified as the cause of one major type of dysentery.

Dysentery in the modern world is most likely to affect people in the less developed countries and travelers who visit these areas. According to the Centers for Disease Control and Prevention (CDC), most cases of dysentery in the United States occur in immigrants from the developing countries and in persons who live in inner-city housing with poor sanitation. Other groups of people at increased risk of dysentery are military personnel stationed in developing countries, frequent travelers, children in day care centers, people in nursing homes, and men who have sex with other men.

Causes and symptoms

Causes

The most common types of dysentery and their causal agents are as follows:

- Bacillary dysentery. Bacillary dysentery, which is also known as shigellosis, is caused by four species of the genus *Shigella*: *S. dysenteriae*, the most virulent species and the one most likely to cause epidemics; *S. sonnei*, the mildest species and the most common form of *Shigella* found in the United States; *S. boydii*; and *S. flexneri*. *S. flexneri* is the species that causes Reiter's syndrome, a type of arthritis that develops as a late complication of shigellosis. About 15,000 cases of shigellosis are reported to the CDC each year for the United States; however, the CDC maintains that the true number of annual cases may be as high as 450,000, since the disease is vastly underreported. About 85 percent of cases in the United States are caused by *S. sonnei*. The *Shigella* organisms cause the diarrhea and pain associated with dysentery by invading the tissues that line the colon and secreting an enterotoxin, or harmful protein that attacks the intestinal lining.
- Amebic dysentery. Amebic dysentery, which is also called intestinal amebiasis and amebic colitis, is caused by a protozoon, *Entamoeba histolytica*. *E. histolytica*, whose scientific name means "tissue-dissolving," is second only to the organism that causes malaria as a protozoal cause of death. *E. histolytica* usually enters the body during the cyst stage of its life cycle. The cysts may be found in food or water contaminated by human feces. Once in the digestive tract, the cysts break down, releasing an active form of the organism called a trophozoite. The trophozoites invade the tissues lining the intestine, where they are usually excreted in the patient's feces. They sometimes penetrate the lining itself, however, and enter the bloodstream. If that happens, the trophozoites may be carried to the liver, lung, or other organs. Involvement of the liver or other organs is sometimes called metastatic amebiasis.
- Balantidiasis, giardiasis, and cryptosporidiosis. These three intestinal infections are all caused by protozoa, *Balantidium coli*, *Giardia lamblia*, and *Cryptosporidium parvum* respectively. Although most people infected with these protozoa do not become severely ill, the disease agents may cause dysentery in children or immunocompromised individuals. There are about 3,500 cases of cryptosporidiosis reported to the CDC each year in the United States, and about 22,000 cases of giardiasis.
- Viral dysentery. Viral dysentery, which is sometimes called traveler's diarrhea or viral gastroenteritis, is

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caused by several families of viruses, including rotaviruses, caliciviruses, astroviruses, noroviruses, and adenoviruses. There are about 3.5 million cases of viral dysentery in infants in the United States each year, and about 23 million cases each year in adults. The CDC estimates that viruses are responsible for 9.2 million cases of dysentery related to food poisoning in the United States each year. Whereas most cases of viral dysentery in infants are caused by rotaviruses, caliciviruses are the most common disease agents in adults. Noroviruses were responsible for about half of the outbreaks of dysentery on cruise ships reported to the CDC in 2002.

- Dysentery caused by parasitic worms. Both whipworm (trichuriasis) and flatworm or fluke (schistosomiasis) infestations may produce the violent diarrhea and abdominal cramps associated with dysentery. Schistosomiasis is the second most widespread tropical disease after malaria. Although the disease is rare in the United States, travelers to countries where it is endemic may contract it. The World Health Organization (WHO) estimates that about 200 million people around the world carry the parasite in their bodies, with 20 million having severe disease.

Symptoms

In addition to the characteristic bloody and/or watery diarrhea and abdominal cramps of dysentery, the various types have somewhat different symptom profiles:

- Bacillary dysentery. The symptoms of shigellosis may range from the classical bloody diarrhea and tenesmus characteristic of dysentery to the passage of nonbloody diarrhea that resembles the loose stools caused by other intestinal disorders. The high fever associated with shigellosis begins within one to three days after exposure to the organism. The patient may also have pain in the rectum as well as abdominal cramping. The acute symptoms last for three to seven days, occasionally for as long as a month. Bacillary dysentery may lead to two potentially fatal complications outside the digestive tract: bacteremia (bacteria in the bloodstream), which is most likely to occur in malnourished children; and hemolytic uremic syndrome, a type of kidney failure that has a mortality rate above 50 percent.
- Amebic dysentery. Amebic dysentery often has a slow and gradual onset; most patients with amebiasis visit the doctor after several weeks of diarrhea and bloody stools. Fever is unusual with amebiasis unless the patient has developed a liver abscess as a complication of the infection. The most serious complication of amebic dysentery, however, is fulminant or necrotizing colitis, which is a severe inflammation of the colon characterized by dehydration, severe abdominal pain, and the risk of perforation (rupture) of the colon.
- Dysentery caused by other protozoa. Dysentery associated with giardiasis begins about 1–3 weeks after infection with the organism. It is characterized by bloating and foul-smelling flatus, nausea and vomiting, headaches, and low-grade fever. These acute symptoms usually last for three or four days. The symptoms of cryptosporidiosis are mild in most patients but are typically severe in patients with AIDS. Diarrhea usually starts between seven and 10 days after exposure to the organism and may be copious. The patient may have pain in the upper right abdomen, nausea, and vomiting, but fever is unusual.
- Viral dysentery. Viral dysentery has a relatively rapid onset; symptoms may begin within hours of infection. The patient may be severely dehydrated from the diarrhea but usually has only a low-grade fever. The diarrhea itself may be preceded by one to three days of nausea and vomiting. The patient's abdomen may be slightly tender but is not usually severely painful.
- Dysentery caused by parasitic worms. Patients with intestinal schistosomiasis typically have a gradual onset of symptoms. In addition to bloody diarrhea and abdominal pain, these patients usually have fatigue. An examination of the patient's colon will usually reveal areas of ulcerated tissue, which is the source of the bloody diarrhea.

Diagnosis

Patient history and physical examination

The **physical examination** in the primary care doctor's office will not usually allow the doctor to determine the specific parasite or other disease agent that is causing the bloody diarrhea and other symptoms of dysentery, although the presence or absence of **fever** may help to narrow the diagnostic possibilities. The patient's age and history are usually better sources of information. The doctor may ask about such matters as the household water supply and food preparation habits, recent contact with or employment in a nursing home or day care center, recent visits to tropical countries, and similar questions. The doctor will also need to know when the patient first noticed the symptoms.

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The doctor will also evaluate the patient for signs of **dehydration** resulting from the loss of fluid through the intestines. **Fatigue**, drowsiness, dryness of the mucous membranes lining the mouth, low blood pressure, loss of normal skin tone, and rapid heartbeat (above 100 beats per minute) may indicate that the patient is dehydrated.

Laboratory tests

The most common laboratory test to determine the cause of dysentery is a stool sample. The patient should be asked to avoid using over-the-counter **antacids** or antidiarrheal medications until the sample has been collected, as these preparations can interfere with the test results. The organisms that cause **cryptosporidiosis**, bacillary dysentery, amebic dysentery, and **giardiasis** can be seen under the microscope, as can the eggs produced by parasitic worms. In some cases repeated stool samples, a sample of mucus from the intestinal lining obtained through a proctoscope, or a tissue sample from the patient's colon may be necessary to confirm the diagnosis. Antigen testing of a stool sample can be used to diagnose a rotavirus infection as well as parasitic worm infestations.

The doctor will also usually order a blood test to evaluate the electrolyte levels in the patient's blood in order to assess the need for rehydration.

Imaging studies

Imaging studies (usually CT scans, x rays, or ultrasound) may be performed in patients with amebic dysentery to determine whether the lungs or liver have been affected. They may also be used to diagnose schistosomiasis, as the eggs produced by the worms will show up on ultrasound or MRI studies of the liver, intestinal wall, or bladder.

Treatment

Medications are the primary form of treatment for dysentery:

- Bacillary dysentery. Dysentery caused by *Shigella* is usually treated with such antibiotics as trimethoprim-sulfamethoxazole (Bactrim, Septra), nalidixic acid (NegGram), or ciprofloxacin (Cipro, Ciloxan). Because the various species of *Shigella* are becoming resistant to these drugs, however, the doctor may prescribe one of the newer drugs described below. Patients with bacillary dysentery should not be given antidiarrheal medications, including loperamide (Imodium), paregoric, and diphenolate (Lomotil), because they may make the illness worse.
- Amebic dysentery. The most common drugs given for amebiasis are diloxanide furoate (Diloxide), iodoquinol (Diquinol, Yodoxin), and metronidazole (Flagyl). Metronidazole should not be given to pregnant women but paromomycin (Humatin) may be used instead. Patients with very severe symptoms may be given emetine dihydrochloride or dehydroemetine, but these drugs should be stopped once the patient's symptoms are controlled.
- Dysentery caused by other protozoa. Balantidiasis, giardiasis, and cryptosporidiosis are treated with the same drugs as amebic dysentery; patients with giardiasis resistant to treatment may be given albendazole (Zentel) or furazolidone (Furoxone).
- Viral dysentery. The primary concern in treating viral dysentery, particularly in small children, is to prevent dehydration. Antinausea and antidiarrhea medications should not be given to small children. Probiotics, including *Lactobacillus casei* and *Saccharomyces boulardii*, have been shown to reduce the duration and severity of viral diarrhea in small children by 30–70 percent.
- Dysentery caused by parasitic worms. Whipworm infestations are usually treated with anthelminthic medications, most commonly mebendazole (Vermox). Schistosomiasis may be treated with praziquantel (Biltricide), metrifonate (Trichlorfon), or oxamniquine, depending on the species causing the infestation.

Newer drugs that have been developed to treat dysentery include tinidazole (Tindamax, Fasigyn), an antiprotozoal drug approved by the Food and Drug Administration (FDA) in 2004 to treat giardiasis and **amebiasis** in adults and children over the age of three years. This drug should not be given to women in the first three months of **pregnancy**. In addition, adults taking tinidazole should not drink alcoholic beverages while using it, or for three days after the end of treatment. The other new drug is nitazoxanide (Alinia), another antiprotozoal medication that has the advantage of lacking the bitter taste of metronidazole and tinidazole.

Fluid replacement is given if the patient has shown signs of dehydration. The most common treatment is an oral rehydration fluid containing a precise amount of salt and a smaller amount of sugar to replace electrolytes as well as water lost through the intestines. Infalyte and Pedialyte are oral rehydration fluids formulated for the special replacement needs of infants and young children.

Surgery

Surgery is rarely necessary in treating dysentery, but may be required in cases of fulminant **colitis**,

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particularly if the patient's colon has perforated. Patients with liver abscesses resulting from amebic dysentery may also require emergency surgery if the **abscess** ruptures. In some cases exploratory surgery may be needed to determine whether severe abdominal pain is caused by schistosomiasis, amebic dysentery, or **appendicitis**.

Alternative treatments

There are a number of alternative treatments for dysentery, most of which are derived from plants used by healers for centuries. Because dysentery was known to ancient civilizations as well as modern societies, such alternative systems as **traditional Chinese medicine** (TCM) and **Ayurvedic medicine** developed treatments for it.

Ayurvedic medicine

Ayurvedic medicine recommends fruits and herbs, specifically cumin seed, bael fruit (*Aegle marmelos*, also known as Bengal quince), and arjuna (*Terminalia arjuna*) bark for the treatment of dysentery. Ayurvedic practitioners may also give the patient dietary supplements known as Isabbael, Lashunadi Bati, and Bhuwaneshar Ras. To rehydrate the body, adult patients may be given a combination of slippery elm water and barley to drink, at least a pint per day.

Traditional Chinese medicine

To treat dysentery, traditional Chinese doctors use astringent drugs, which are intended to constrict or tighten mucous membranes and other body tissues to slow down fluid loss. Myrobalan fruit (*Terminalia chebula*), nut galls (swellings produced on the leaves and stems of oak trees by the secretions of certain insects), and opium extracted from the opium poppy (*Papaver somniferum*) are the natural materials most commonly used. Paregoric, a water-based solution of morphine that is still used in the West to treat diarrhea, is derived from the opium poppy.

Other plant-based remedies

Researchers in Mexico reported in early 2005 that the roots of *Geranium mexicanum*, a plant that produces a sap traditionally used to treat coughs or diarrhea, contains compounds that are active against both *Giardia lamblia* and *Entamoeba histolytica*. Plant biologists in Africa are studying the effectiveness of African mistletoe (*Tapinanthus dodoneifolius*), a traditional remedy for dysentery among the Hausa and Fulani tribes of Nigeria.

Dietary supplements

A study published in the *American Journal of Clinical Nutrition* in early 2005 reported that supplemental zinc (twice the recommended daily dietary allowance) boosts the body's immune response during acute **shigellosis**.

Homeopathy

There are at least ten different homeopathic remedies used to treat diarrhea. Contemporary homeopaths, however, distinguish between diarrhea that can be safely treated at home with such homeopathic remedies as *Podophyllum*, *Veratrum album*, *Bryonia*, and *Arsenicum*, and diarrhea that indicates dysentery and should be referred to a physician. Signs of dehydration (loss of normal skin texture, **dry mouth**, sunken eyes), severe abdominal pain, blood in the stool, and unrelieved **vomiting** are all indications that mainstream medical care is required.

Prognosis

Most adults in developed countries recover completely from an episode of dysentery. Children are at greater risk of becoming dehydrated, however; bacillary dysentery in particular can lead to a child's **death** from dehydration in as little as 12–24 hours.

- Bacillary dysentery. Most patients recover completely from shigellosis, although their bowel habits may not become completely normal for several months. About 3 percent of people infected by *S. flexneri* will develop Reiter's syndrome, which may lead to a chronic form of arthritis that is difficult to treat. Elderly patients or those with weakened immune systems sometimes develop secondary bacterial infections after an episode of shigellosis.
- Amebic dysentery. Most people in North America who become infected with *E. histolytica* do not become severely ill. Patients who develop a severe case of amebic dysentery, however, are at increased risk for such complications as fulminant colitis or liver abscess. About 0.5 percent of patients with amebic dysentery develop fulminant colitis, but almost half of these patients die. Between 2 and 7 percent of cases of amebic liver abscess result in rupture of the abscess with a high mortality rate. Men are 7–12 times more likely to develop a liver abscess than women. Any patient diagnosed with amebic dysentery should have stool samples examined for relapse 1, 3, and 6 months after treatment with medications whether or not they have developed complications.

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KEY TERMS

Anthelminthic (also spelled anthelmintic)—A type of drug or herbal preparation given to destroy parasitic worms or expel them from the body.

Bacillus—A rod-shaped bacterium. One common type of dysentery is known as bacillary dysentery because it is caused by a bacillus.

Enterotoxin—A type of harmful protein released by bacteria and other disease agents that affects the tissues lining the intestines.

Fulminant—Occurring or flaring up suddenly and with great severity. A potentially fatal complication of amebic dysentery is an inflammation of the colon known as fulminant colitis.

Probiotics—Food supplements containing live bacteria or other microbes intended to improve or restore the normal balance of microorganisms in the digestive tract.

Proctoscope—An instrument consisting of a thin tube with a light source, used to examine the inside of the rectum.

Protozoan (plural, protozoa)—A member of the simplest form of animal life, a one-celled organism. Amebic dysentery is caused by a protozoan.

Reiter's syndrome—A group of symptoms that includes arthritis, inflammation of the urethra, and conjunctivitis, and develops as a late complication of infection with *Shigella flexneri*. The syndrome was first described by a German doctor named Hans Reiter in 1918.

Tenesmus—Straining to urinate or defecate without being able to do so. Tenesmus is a characteristic feature of bacillary dysentery.

Trophozoite—The active feeding stage of a protozoal parasite, as distinct from its encysted stage.

- Dysentery caused by other protozoa. Cryptosporidiosis may lead to respiratory infections or pancreatitis in patients with AIDS. The risk of these complications, however, is reduced in AIDS patients who are receiving highly active antiretroviral therapy (HAART).
- Viral dysentery. Most people in North America recover completely without complications unless they become severely dehydrated. Viral dysentery in children in developing countries, however, is a major cause of mortality.
- Dysentery caused by parasitic worms. Untreated whipworm infections can lead to loss of appetite, chronic diarrhea, and retarded growth in children. Untreated schistosomiasis can develop into a chronic intestinal disorder in which fibrous tissue, small growths, or strictures (abnormal narrowing) may form inside the intestine. Patients treated for schistosomiasis should have stool samples checked for the presence of worm eggs 3 and 6 months after the end of treatment.

Prevention

The disease agents that cause dysentery do not confer immunity against reinfection at a later date. There are no vaccines for bacillary dysentery or amebic dysentery; however, a vaccine against schistosomiasis is under investigation. An oral vaccine against **rotavirus infections** was developed for small children but was withdrawn in 2004 because it was associated with an increased risk of small-bowel disorders. Newer vaccines against rotaviruses and caliciviruses are being developed.

Public health measures

Public health measures to control the spread of dysentery include the following:

- Requiring doctors to report cases of disease caused by *Shigella*, *Entamoeba histolytica*, and other parasites that cause dysentery. Careful reporting allows the CDC and state public health agencies to investigate local outbreaks and plan prevention efforts.
- Posting advisories for travelers about outbreaks of dysentery and other health risks in foreign countries. The Travelers' Health section of the CDC website (http://wwwnc.cdc.gov/travel/) is a good source of up-to-date information.
- Instructing restaurant workers and other food handlers about proper methods of hand washing, food storage, and food preparation.
- Instructing workers in day care centers and nursing homes about the proper methods for changing and cleaning soiled diapers or bedding.
- Inspecting wells, other sources of drinking water, and swimming pools for evidence of fecal contamination.

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Personal precautions

Individuals can lower their risk of contracting dysentery by the following measures:

- Not allowing anyone in the household who has been diagnosed with amebic or bacillary dysentery to prepare food or pour water for others until their doctor confirms that they are no longer carrying the disease agent.
- Avoiding anal sex or oral-genital contacts.
- Washing the hands carefully with soap and water after using the bathroom, and supervising the handwashing of children in day care centers or those at home who are not completely toilet-trained.
- When traveling, drinking only boiled or treated water, and eating only cooked hot foods or fruits that can be peeled by the traveler.
- Avoiding swimming in fresh water in areas known to have outbreaks of schistosomiasis.

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ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

Infectious Diseases Society of America (IDSA), 1300 Wilson Blvd., Suite 300, Arlington, VA, 22209, (703) 299-0200, (703) 299-0204, http://www.idsociety.org/.

World Health Organization (WHO), Avenue Appia 201211, Geneva, Switzerland, 27, 4122791-2111, info@who.int, http://www.who.int.

Rebecca Frey, PhD

Dysfunctional uterine bleeding

Definition

Dysfunctional uterine bleeding is irregular, abnormal uterine bleeding that is not caused by a tumor, infection, or **pregnancy**.

Description

Dysfunctional uterine bleeding (DUB) is a disorder that occurs most frequently in women at the beginning and end of their reproductive lives. About half the cases occur in women over 45 years of age, and about one fifth occur in women under age 20.

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Dysfunctional uterine bleeding is diagnosed when other causes of uterine bleeding have been eliminated. Failure of the ovary to release an egg during the menstrual cycle occurs in about 70% of women with DUB. This is probably related to a hormonal imbalance.

DUB is common in women who have **polycystic ovary syndrome** (cysts on the ovaries). Women who are on dialysis may also have heavy or prolonged periods. So do some women who use an intrauterine device (**IUD**) for birth control.

DUB is similar to several other types of uterine bleeding disorders and sometimes overlaps these conditions.

Menorrhagia

Menorrhagia, sometimes called hypermenorrhea, is another term for abnormally long, heavy periods. This type of period can be a symptom of DUB, or many other diseases or disorders. In menorrhagia, menstrual periods occur regularly, but last more than seven days, and blood loss exceeds 3 oz (88.7 mL). Passing **blood clots** is common. Between 15–20% of healthy women experience debilitating menorrhagia that interferes with their normal activities. Menorrhagia may or may not signify a serious underlying problem.

Metrorrhagia

Metrorrhagia is bleeding between menstrual periods. Bleeding is heavy and irregular as opposed to ovulatory spotting which is light bleeding, in midcycle, at the time of ovulation.

Polymenorrhea

Polymenorrhea describes the condition of having too frequent periods. Periods occur more often than every 21 days, and ovulation usually does not occur during the cycle.

Causes and symptoms

Dysfunctional uterine bleeding often occurs when the endometrium, or lining of the uterus, is stimulated to grow by the hormone estrogen. When exposure to estrogen is extended, or not balanced by the presence of progesterone, the endometrium continues to grow until it outgrows its blood supply. Then it sloughs off, causing irregular bleeding. If the bleeding is heavy enough and frequent enough, anemia can result.

Menorrhagia is representative of DUB. It is caused by many conditions including some outside the reproductive system. Causes of menorrhagia include:

- adenomyosis (a benign condition characterized by growths in the area of the uterus)
- imbalance between the hormones estrogen and progesterone
- fibroid tumors
- pelvic infection
- endometrial cancer (cancer of the inner mucous membrane of the uterus)
- endometrial polyps
- endometriosis (a condition in which endometrial or endrometrial-like tissue appears outside of its normal place in the uterus)
- use of an intrauterine device (IUD) for contraception
- hypothyroidism
- blood clotting problems (rare)
- lupus erythematosus
- pelvic inflammatory disease
- steroid therapy
- advanced liver disease
- renal (kidney) disease
- chemotherapy (cancer treatment with chemicals)

To diagnose dysfunctional uterine bleeding, many of the potential causes mentioned above must be eliminated. When all potential causes connected with pregnancy, infection, and tumors (benign or malignant) are eliminated, then menorrhagia is presumed to be caused by dysfunctional uterine bleeding.

Diagnosis

Diagnosis of any menstrual irregularity begins with the patient herself. The doctor will ask for a detailed description of the problem, and take a history of how long it has existed, and any patterns the patient has observed. A woman can assist the doctor in diagnosing the cause of abnormal uterine bleeding by keeping a record of the time, frequency, length, and quantity of bleeding. She should also tell the doctor about any illnesses, including long-standing conditions, like **diabetes mellitus**. The doctor will also inquire about sexual activity, use of contraceptives, current medications, and past surgical procedures.

Laboratory tests

After taking the woman's history, the gynecologist or family practitioner does a pelvic examination and Pap smear. To rule out specific causes of abnormal bleeding, the doctor may also do a pregnancy test and blood tests to check the level of thyroid hormone. Based on the initial test results, the doctor may want to do tests to determine the level of other hormones that play a role in reproduction. A test of blood clotting time and an adrenal function test are also commonly done.

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Imaging

Imaging tests are important diagnostic tools for evaluating abnormal uterine bleeding. Ultrasound examination of the pelvic and abdominal area is used to help locate **uterine fibroids**, also called uterine leiomyoma, a type of tumor. Visual examination through hysterscopy—where a camera inside a thin tube is inserted directly into the uterus so that the doctor can see the uterine lining—is also used to assess the condition of the uterus.

Hystersalpingography can help outline endometrial polyps and fibroids and help detect **endometrial cancer**. In this procedure an x ray is taken after contrast media has been injected into the cervix. **Magnetic resonance imaging** (MRI) of the pelvic region can also be used to locate fibroids and tumors.

Invasive procedures

Endometrial biopsy (the removal and examination of endometrial tissue) is the most important testing procedure. It allows the doctor to sample small areas of the uterine lining, while cervical biopsy allows the cervix to be sampled. Tissues are then examined for any abnormalities.

Dilatation and curettage (D & C), once common is rarely done today for diagnosis of DUB. It is done while the patient is under either general or regional anesthesia. Women over 30 are more likely to need a D & C, as part of the diagnostic procedure, than younger women.

Because DUB is diagnosed by eliminating other possible disorders, diagnosis can take a long time and involve many tests and procedures. Older women are likely to need more extensive tests than adolescents because the likelihood of reproductive cancers is greater in this age group, and therefore must be definitively eliminated before treating bleeding symptoms.

Treatment

Treatment of DUB depends on the cause of the bleeding and the age of the patient. When the underlying cause of the disorder is known, that disorder is treated. Otherwise the goal of treatment is to relieve the symptoms to a degree that uterine bleeding does not interfere with a woman's normal activities or cause anemia.

Generally the first approach to controlling DUB is to use **oral contraceptives** that provide a balance between the hormones estrogen and progesterone. Oral contraceptives are often very effective in adolescents and young women in their twenties. NSAIDs (**nonsteroidal anti-inflammatory drugs**), like Naprosyn and Motrin, are also used to treat DUB.

When bleeding cannot be controlled by hormone treatment, surgery may be necessary. Dilatation and curettage sometimes relieves the symptoms of DUB. If that fails, endometrial ablation removes the uterine lining, but preserves a woman's uterus. This procedure is sometimes be used instead of **hysterectomy**. However, as it affects the uterus, it can only be used when a woman has completed her childbearing years. The prescription of iron is also important to decrease the risk of enemia.

Until the 1980s, hysterectomy often was used to treat heavy uterine bleeding. Today hysterectomy is used less frequently to treat DUB, and then only after other methods of controlling the symptoms have failed. A hysterectomy leaves a woman unable to bear children, and, therefore, is limited largely to women who are unable to, or uninterested in, bearing children. Still, hysterectomy is a common treatment for long-standing DUB in women done with childbearing.

Alternative treatment

Alternative practitioners concentrate on good **nutrition** as a way to prevent heavy periods that are not caused by uterine fibroids, endometrial polyps, **endometriosis**, or **cancer**. Iron supplementation (100 mg per day) not only helps prevent anemia, but also appears to reduce menorrhagia in many women. Other recommended dietary supplements include **vitamins** A and C. Vitamin C improves capillary fragility and enhances iron uptake.

Vitamin E and bioflavonoid supplements are also recommended. Vitamin E can help reduce blood flow, and bioflavonoids help strengthen the capillaries. Vitamin K is known to play a role in clotting and is helpful in situations where heavy bleeding may be due to clotting abnormalities.

Botanical medicines used to assist in treating abnormal bleeding include spotted cranesbill (*Geranium maculatum*), birthroot (*Trillium pendulum*), blue cohosh (*Caulophyllum thalictroides*), witch hazel (*Hamamelis virginiana*), shepherd's purse (*Capsella bursa-pastoris*), and yarrow (*Achillea millifolia*). These are all stiptic herbs that act to tighten blood vessels and tissue. Hormonal balance can also be addressed with herbal formulations containing phytoestrogens and phytoprogesterone.

Prognosis

Response to treatment for DUB is highly individual and is not easy to predict. The outcome depends largely on the woman's medical condition and her age. Many women, especially adolescents, are successfully treated with hormones (usually oral contraceptives). As

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KEY TERMS

Dilatation and curettage (D & C)—A procedure performed under anesthesia during which the cervix is dilated, and tissue lining the uterus is scraped out with a metal spoon-shaped instrument or a suction tube. The procedure can be either diagnostic, or to remove polyps.

Endometrial biopsy—The removal of tissue either by suction or scraping of samples of tissue from the uterus. The cervix is not dilated. The procedure has a lower rate of diagnostic accuracy than a D & C, but can be done as an office procedure under local anesthesia.

Endometrial cancer—Cancer of the inner mucous membrane of the uterus.

Fibroids, or fibroid tumors—Fibroid tumors are noncancerous (benign) growths in the uterus. They occur in 30–40% of women over age 40, and do not need to be removed unless they are causing symptoms that interfere with a woman's normal activities.

Hypothyroidism—A disorder in which the thyroid gland produces too little thyroid hormone causing a decrease in the rate of metabolism with associated effects on the reproductive system.

Lupus erythematosus—A chronic inflammatory disease in which inappropriate immune system reactions cause abnormalities in the blood vessels and connective tissue.

Progesterone—A hormone naturally secreted by the ovary, or manufactured synthetically, that prepares the uterus for implantation of a fertilized egg.

Prostaglandins—A group of chemicals that mediate, or determine the actions of other chemicals in the cell or body.

a last resort, hysterectomy removes the source of the problem by removing the uterus, but this operation is not without risk, or the possibility of complications.

Prevention

Dysfunctional uterine bleeding is not a preventable disorder.

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Tish Davidson, A.M.

Dyslexia

Definition

Dyslexia is a learning disability noted for spatial reversals and shifts. It is characterized by problems in reading, spelling, writing, and sometimes math. In many cases, dyslexia appears to be inherited.

Demographics

Estimates of people with dyslexia range from 2–15% of the United States population. Most research studies give a figure of 5%. Originally it was thought that dyslexia affected more boys than girls (in a ratio of 5:1), but later studies found boys to be only slightly more likely than girls to be dyslexic. Figures for diagnosed child dyslexics are skewed because for various reasons boys tend to be referred more frequently for special education. Diagnosis is complicated by the fact that anywhere from 20–55% of dyslexics also suffer from attention deficit/hyperactivity disorder (**ADHD**), a behavioral disorder that may aggravate reading problems.

Description

Dyslexia is a specific learning disability characterized by a significant disparity between an individual's general intelligence and his or her language skills, usually reflected in school performance. The word dyslexia is derived from the Greek word, *dys* (meaning poor or inadequate) and the word *lexis* (meaning words or language). The term was coined in 1887 by German physician Rudolf Berlin who published a case study of a young boy who had difficulties with reading and writing in spite of having normal intelligence. In 1896, W. Pringle Morgan, a British doctor, published the first English-language case study of dyslexia. It concerned a 14-year-old boy who had not yet learned to read, even though his other intellectual abilities were well within the normal range.

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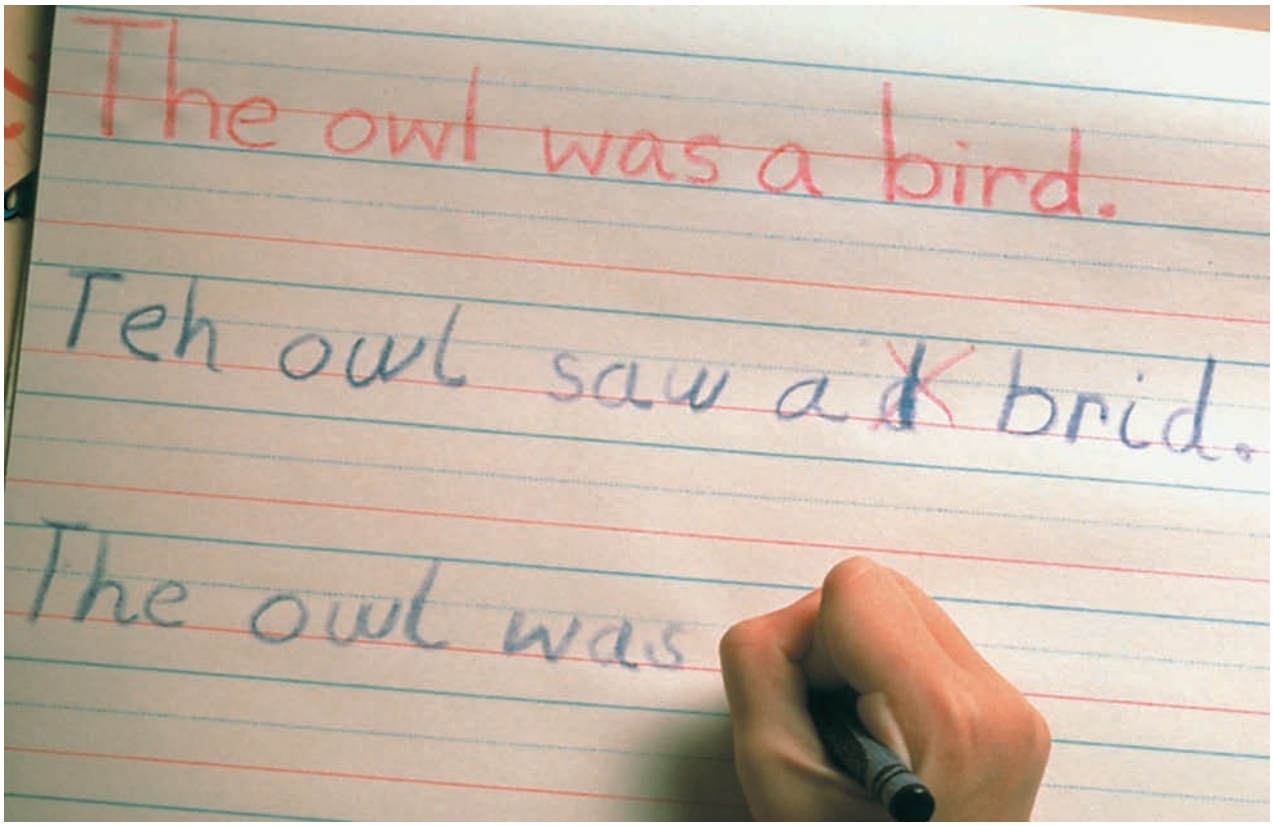

A student with dyslexia has difficulty copying words. *(Will & Deni McIntyre/Science Source/Photo Researchers, Inc.)*

Most individuals with dyslexia have average or above average intelligence, and it is speculated that they have heightened visual-spatial and motor awareness. Many famous inventors, artists, and other creative people have had dyslexia; Thomas Edison, Albert Einstein, Winston Churchill, Michael Faraday, Woodrow Wilson, Guglielmo Marconi, General George Patton, and Auguste Rodin are all thought to have been dyslexic.

Risk factors

Dyslexia is believed to be strongly familial. About 40% of boys and 20% of girls with a dyslexic parent develop the disorder. Dyslexia is believed to occur equally in all races.

Causes and symptoms

There are many different theories about the causes and classifications of different types of dyslexia, but few hard conclusions. It is generally agreed that there is a strong hereditary component of dyslexia. Several genetic studies have found gene linkages on chromosomes 1 and 6 that demonstrate heterogeneous (multiple methods of) transmission. As of 2009, four specific genes linked to dyslexia have been identified, and all four participate in brain development. **Positron emission tomography (PET)** studies have shown that dyslexics assigned reading tasks show a lower level of activity than children with normal reading skills in a part of the brain known as the left inferior parietal cortex, a region that is necessary for the rapid perception of word forms. Studies using functional **magnetic resonance imaging** (fMRI) pinpointed the left inferior frontal gyrus, the left inferior parietal lobule, and the left middle temporal gyrus as areas of low activation in dyslexic children given word tests to complete. Another indication that specific areas of the brain are involved in dyslexia comes from case studies of children who have suffered **stroke**. In one study reported in 2006, a six-year-old boy had suffered a stroke affecting the left hemisphere of his brain. He was able to read words that he had learned prior to the stroke, but attempts to read unfamiliar words were unsuccessful until he received special training.

The most obvious symptoms of the dyslexic show up in reading and writing; however, listening, speaking, and general organizational skills are also affected. The individual with dyslexia may have trouble transferring information across modalities, for example

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from verbal to written forms. The dyslexic's characteristic reversal of letters, confusion between such similar letters as "b" and "d," omission of words when reading aloud, trouble sounding out words, and difficulty following written instructions were first thought to be the result of vision and perceptual problems—that is, a failure of taking in the stimulus. Only a small percentage of dyslexics have vision disorders, however, and it is now generally agreed by physicians, researchers, and educators that dyslexia is primarily a language disorder. Whereas the non-dyslexic intuitively learns phonic (sound) rules while learning to read, the dyslexic needs specific and methodical drills and practice to learn the visual-auditory associations necessary for reading comprehension and written expression.

The most common symptoms of dyslexia include:

- lack of awareness of sounds
- delayed speech
- difficulty understanding spoken words
- difficulty reading single words
- extreme difficulty spelling words
- extreme difficulty with handwriting
- difficulty with locational and time indicators: up/down, right/left, yesterday/tomorrow
- lack of enjoyment in reading
- difficulty transferring information across modalities: writing down thoughts or speech, reading out loud

Diagnosis

Anyone who is suspected to have dyslexia should have a comprehensive evaluation, including hearing, vision, and intelligence testing. The test should include all areas of learning and learning processes, not just reading.

Currently, children and adults are usually referred for testing for dyslexia because of repeated problems in school or work settings. As further research pinpoints the genes responsible for some cases of dyslexia, there is a possibility that earlier testing will be established to allow for early interventions. Earlier interventions could help to prevent the negative educational outcomes that can be associated with dyslexia.

Tests

Children who demonstrate a reading level greater than two SEs below expected level for their age, intelligence, and education are generally diagnosed as dyslexic. Once reading problems are identified, a comprehensive series of tests of neuropsychological function (vision, hearing, and speech), intelligence, and achievement (word and letter recognition) will determine the existence of visual and auditory problems, behavior problems, or subnormal intelligence, all of which may have symptoms similar to dyslexia. Because children of different ages have different levels of normal language skill, the specific tests used will differ by age group.

A child normally develops phonological awareness—the ability to differentiate between speech sounds and recognize their written symbols—while learning to read. The ability to sound out nonsense words (for example, the lines from Lewis Carroll's poem "Jabberwocky": "Twas brillig and the slithy toves/ Did gyre and gimble in the wabe") is a strong indicator of phonological awareness. In cases in which the dyslexic has compensated for the disability by paying special attention to context or simply by rote memorization, a nonsense-word test may reveal the reader's underlying phonological disability despite his academic success.

While teachers and physicians are trained to recognize some language problems, many symptoms of dyslexia will be noticeable to parents. Contrary to popular thought, a child's mirror writing (writing backwards), reversal of letters, and confusion over which hand to use are not definitively signs of dyslexia, and may only indicate lack of development.

Treatment

If caught early, especially before the third grade, dyslexia is highly treatable through special education. Dyslexia is categorized as a learning disability under the national Education for All Handicapped Children Act passed in 1975. Dyslexic children are entitled to a comprehensive evaluation by a team of educational specialists, to an individualized education plan (IEP), and to ongoing evaluation under the terms of the federal Individuals with Disabilities Education Act (IDEA), first passed in 1990 and amended in 2004. Parents or caretakers may request the initial evaluation, may participate in all levels of the process, and must give their consent before the treatment plan begins.

Traditional

There are many treatment approaches available to the public, ranging from visual stimulation to **diets** to enhancement of regular language education. But it is generally agreed that specialized education is the only successful remedy, and the American Academy of Ophthalmology, the American Academy of Pediatrics, and the American Association for Pediatric Ophthalmology and **Strabismus** have issued a policy statement warning against visual treatments and recommending

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KEY TERMS

Attention deficit disorder (ADD)—A learning disability characterized by an inability to pay attention. It may be different from dyslexia in that dyslexic individuals are highly aware and able to pay attention, but unable to make sense of their perceptions.

Attention deficit hyperactivity disorder (ADHD)—A learning disability characterized by an inability to sit still or concentrate well. It has been demonstrated to be diagnostically different from dyslexia by speech and vocalization patterns.

Monoamine oxidase (MAO) inhibitors—A group of anti-depressant drugs.

Neurotransmitter—A chemical substance which facilitates the passing of messages along nerve pathways. There are several different neurotransmitters used in the human nervous system, each with distinct effects on mood, movement and perception.

Point of view—In a person with dyslexia, this term is used to describe the angle from which their mind's eye views an object. This point of view may be unanchored and moving about, as if several different people were telling what they see all at the same time.

a cross-disciplinary educational approach. In fact, the first researcher to identify and study dyslexia, Dr. Samuel Torrey Orton, developed the core principles of such an approach in the 1920s. The work of three of his followers—Bessie Stillman, Anna Gillingham, and Beth Slingerland—underlies many of the programs in wide use today such as project READ, the Wilson Reading System, and programs based on the Herman method. These and other successful programs have three characteristics in common. They are:

- Sound/symbol based. They break words down into their smallest visual components: letters and the sounds associated with them.
- Multisensory. They attempt to form and strengthen mental associations among visual, auditory, and kinesthetic channels of stimulation. The student simultaneously sees, feels, and says the sound-symbol association; for example, a child may trace the letter or letter combination with his finger while pronouncing a word out loud.
- Highly structured. Remediation begins at the level of the single letter-sound, works up to digraphs, then syllables, then into words and sentences in a very systematic fashion. Repetitive drill and practice serve to form necessary sound-symbol associations.

Whatever remediation program is used, the IEP itself should define the student's specific problems and learning objectives, rather than make vague or general recommendations such as "John needs more support in reading comprehension." A good example of a specific learning objective would be "Max will be able to identify the following sound/symbol association in nonsense words: consonants, short and long vowels, and blends." When ADD is co-diagnosed with dyslexia, special care should be taken to identify specific reading problems and to define cognitive as well as behavioral learning objectives.

Drugs

Treatment for dyslexia can sometimes include use of anti-motion drugs, addressing the symptoms of balance and coordination which results from visual perception alterations; stimulant drugs, such as pemoline (Cylert) or methylphenidate (Ritalin), to address symptoms of low self esteem, restlessness, and distractibility, and 'nootropics' drugs, a class of drugs believed to improve cognitive function. The stimulant drugs may be more effective for **learning disorders** related to ADHD or ADD than for dyslexia. The drug piracetam (Nootropil), a nootropic, although reported as a possible treatment for dyslexia, is also reported to have legal issues because it has not been approved for use in the United States by the Food and Drug Administration (FDA).

Reported potential side effects of the stimulants include nervousness and **insomnia**, and are contraindicated with **epilepsy**, **allergies**, blood pressure problems, or with use of monoamine oxidase (MAO) inhibitors. Long-term use of stimulants in children are reported to adversely affect growth, may ironically depress the nervous system or lead to loss of consciousness. By reducing natural levels of stimulants in the brain, they may also cause dependence. The stimulants and nootropics are said to increase the effects of alcohol and amphetamines. Other possible interactions include use of anti-convulsants or anti-epileptics; tricyclic anti-depressants; anti-coagulants, like Coumadin; and "atropine-like drugs" that blocks the neurotransmitter acetylcholine.

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Alternative

Ronald D. Davis, writing in *The Gift of Dyslexia* outlines an alternative and complementary treatment consistent with the "moving point of view" model. According to this model, and the reason why letters seem to change shape and float, why lines of print appear to move, and why words appear to be other than they are is that the dyslexic individual sees the world predominantly through his or her "mind's eye," rather than through his or her physiologic eye. In other words, people with dyslexia more than all others, sees what they 'think' they see, rather than what their eyeballs see. To further complicate matters, they do this so quickly that they easily become confused when the multiple facets do not produce a solid view.

The object of treatment proposed by Ronald Davis, a dyslexic individual himself, is to train the mind's eye to return to a learned, anchored, viewpoint when they realize they are seeing with their mind, and not with their eyeballs. This is accomplished with assessment testing, followed by one-on-one exercises that retrain mental perception pathways. Using the gifts of the dyslexic individual—their imagination and curiosity—these exercises involve creative physical activities, including the use of modeling clay, "koosh" balls, and movement training. Davis founded the Reading Research Council's Dyslexia Correction Center in 1982, and the Davis Dyslexia Association International, which trains educators and therapists, in 1995.

Prognosis

If left unaddressed, a person with dyslexia may become "functionally illiterate," able to function limited by their ability to read, spell, have their handwriting understood, or do arithmetic. Recognizing that dyslexia is a developed learning disorder affecting people of extraordinary curiosity, imagination and intelligence—people of genius, often— from a productive or functional point of view, dyslexia may contribute significantly, positively or negatively, to performance levels. From an emotional or psychological point of view, dyslexia affects self esteem, and promotes confusion and frustration, that may contribute to under achievement.

Many people with dyslexia becoming very successful. The eventual outcome for an individual with dyslexia depends on a wide variety of factors, including severity of the disorder, age of diagnosis, and achievement level in other non-language areas. Early diagnosis and intervention are important in improving long-term outcomes.

Prevention

There is no known way to prevent dyslexia.

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ORGANIZATIONS

Council for Learning Disabilities, 11184 Antioch Road, Box 405, Overland Park, KS, 66210, (913) 491-1011, (913)491-1012, http://www.cldinternational.org.

International Dyslexia Association, 40 York Road, 4th Floor, Baltimore, MD, 21204, (410) 296-0232, (410) 321-5069, http://www.interdys.org.

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Dyslipidemia *see* **Hyperlipoproteinemia**

Dysmenorrhea

Definition

Dysmenorrhea is the occurrence of painful cramps during a woman's menstrual period. The English word comes from three Greek words that mean "painful," "month," and "flow." Most women experience some discomfort during their periods; however, dysmenorrhea is diagnosed when the **pain** is so severe

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as to limit the woman's normal activities or require medical or surgical treatment.

Demographics

Dysmenorrhea is by definition a disorder that affects only females of childbearing age. Some studies indicate that the rate of dysmenorrhea is highest among adolescents and young adults, and declines with age. Survey results are highly variable, ranging from 29% in one family practice setting to 90% in a group of Swedish adolescents. One group of researchers reported that 67% of teenagers in their sample reported dysmenorrhea, compared to 27% of women in their 30s. Primary dysmenorrhea is the leading cause of recurrent short-term absence from school among adolescent American girls. In the workplace, dysmenorrhea causes 600 million missed work hours in the United States each year and an economic loss of $2 billion.

Secondary dysmenorrhea is more common in older women than in teenagers; in general, women who experience dysmenorrhea for the first time after age 25 have secondary dysmenorrhea.

As far as is known as of 2010, race or ethnicity is not a risk factor for dysmenorrhea.

Description

Women with dysmenorrhea describe the pain in their abdomens as variously shooting, stabbing, burning, sharp, throbbing, or nauseating. Dysmenorrhea may precede the onset of the woman's period by several days, or accompany it. It usually subsides as the woman's flow tapers off.

In some women, dysmenorrhea is accompanied by unusually heavy blood loss—a condition known as menorrhagia.

Risk factors

The likelihood that a woman will have painful cramps increases if she:

- has a family history of painful periods
- leads a stressful life
- smokes
- has never borne a child
- is below 20 years of age
- began puberty before age 11
- has heavy periods
- doesn't get enough exercise
- drinks large quantities of beverages containing caffeine (coffee, tea, cola, energy drinks)
- has attempted to lose weight rapidly
- has pelvic inflammatory disease (PID)
- has a history of sexual abuse

Causes and symptoms

Dysmenorrhea is called "primary" when there is no specific abnormality, and "secondary" when the pain is caused by an underlying gynecological problem. It is believed that primary dysmenorrhea occurs when prostaglandins, hormone-like substances produced by uterine tissue, trigger strong muscle contractions in the uterus during menstruation. However, the level of prostaglandins does not seem to correlate with how strong a woman's cramps are. Some women have high levels of prostaglandins and no cramps, whereas other women with low levels have severe cramps. This is why experts assume that cramps must also be related to other causes, such as **diets**, genetics, **stress**, and different body types, in addition to prostaglandins. The first year or two of a girl's periods are not usually very painful. However, once ovulation begins, the blood levels of the prostaglandins rise, leading to stronger contractions.

Secondary dysmenorrhea may be caused by **endometriosis**, fibroids, **ovarian cysts**, an **ectopic pregnancy**, or an infection in the pelvis.

Symptoms of dysmenorrhea include a dull, throbbing cramping in the lower abdomen that may radiate to the lower back and thighs. In addition, some women may experience **nausea and vomiting**; **diarrhea** or **constipation**; hypersensitivity to lights, sounds, or odors; general irritability and **fatigue**; heavy sweating; or **dizziness**. Cramps usually last for two or three days at the beginning of each menstrual period. Many women often notice their painful periods disappear after they have their first child, probably due to the stretching of the opening of the uterus or because the birth improves the uterine blood supply and muscle activity, although other women do not notice a change in their level of menstrual discomfort after **childbirth**.

Diagnosis

A doctor should perform a thorough **pelvic exam** and take a patient history to rule out any underlying condition that could cause unusually painful cramps. The patient history will include such information as the patient's age at the time of her first period, family history of painful periods, sexual activity (if any), method of **contraception** used (if any), number of children, the regularity of the menstrual cycle, the cycle's length, date of the last menstrual period, and duration and amount of menstrual flow.

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KEY TERMS

Cervix—The neck or lower narrow portion of the uterus that opens into the upper end of the vagina.

Ectopic pregnancy—A pregnancy in which the fertilized egg has implanted outside the uterus, most often in the Fallopian tubes, although in some cases the pregnancy implants in the ovary or in the abdomen. A ruptured ectopic pregnancy is a medical emergency.

Endometrioma—A type of cyst formed when endometrial tissue grows within the ovary.

Endometriosis—The growth of uterine tissue outside the uterus.

Fibroids—Benign (noncancerous) growths that arise from the smooth muscle layer and connective tissue of the uterus. They sometimes cause secondary dysmenorrhea.

Hormone—A chemical messenger secreted by a gland and released into the blood, where it travels to distant cells to exert an effect.

Hysterectomy—Surgical removal of the entire uterus.

Menorrhagia—Unusually heavy or prolonged menstrual period. It may or may not be associated with dysmenorrhea.

Ovary—One of the two almond-shaped glands in the female body that produces the hormones estrogen and progesterone.

Ovulation—The monthly release of an egg from an ovary.

Progesterone—The hormone produced by the ovary after ovulation that prepares the uterine lining for a fertilized egg.

Uterus—The female reproductive organ that contains and nourishes a fetus from implantation of the fertilized egg until birth.

Examination

An office examination of the patient's abdomen is usually sufficient in adolescents who have not been sexually active. Women who are sexually active should have a pelvic examination.

Tests

There are no laboratory tests that can be used to diagnose primary dysmenorrhea; however, the doctor may order a blood test to rule out a systemic infection, or take a smear of the cervix to evaluate the patient for a sexually transmitted disease.

If the abdominal and pelvic examinations suggest secondary dysmenorrhea, an ultrasound of the pelvis is the next step in evaluating endometriosis or ovarian cysts as possible causes of the dysmenorrhea. Other imaging studies that can be used include CT scans and MRIs.

Procedures

The doctor may recommend either a **hysteroscopy** or a **laparoscopy** to check for such causes of secondary dysmenorrhea as fibroids, ovarian cysts, endometriosis, or an ectopic **pregnancy**. In a hysteroscopy, the doctor inserts a thin lighted tube called an endoscope into the uterine cavity. The doctor can remove a small sample of uterine tissue for biopsy as well as examining the interior of the uterus visually. In a laparoscopy, the doctor makes small incisions in the skin of the abdomen and inserts an endoscope with a small camera lens. Laparoscopy can also be used for surgical removal of endometriomas, which are a type of cyst formed when endometrial tissue grows inside the ovaries rather than in the uterus. In extreme cases, the doctor may recommend a hysterectomy—surgical removal of the entire uterus.

A qualified physician is required in order to fit a woman with the Mirena (an intrauterine device described below). The woman's cervix must be dilated before insertion; the process is uncomfortable, and some doctors use a local anesthetic to reduce discomfort.

Treatment

Traditional

Drugs

Several over-the-counter medications can lessen or completely eliminate the pain of primary dysmenorrhea. Most popular are the **nonsteroidal anti-inflammatory drugs** (NSAIDs), which prevent or decrease the formation of prostaglandins. These include **aspirin**, ibuprofen (Advil), and naproxen (Aleve). For more severe pain, prescription-strength ibuprofen (Motrin) is available. These drugs are usually begun at the first sign of the period and taken for a day or two. Although NSAIDs

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are effective in providing short-term relief from cramps, some researchers think that long-term use of these medications increases the risk of side effects, particularly diarrhea and peptic ulcer.

If an NSAID is not available, **acetaminophen** (Tylenol) may also help ease the pain. Heat applied to the painful area may bring relief, and a warm bath twice a day also may help.

Hormonal therapy is another approach to dysmenorrhea that works for many women, although it involves prescription medications rather than over-the-counter pain relievers. Birth control pills and **Depo-Provera**, an injected contraceptive that must be given every 3 months, work by preventing ovulation. Depo-Provera is also given as a treatment for endometriosis as well as contraception.

Studies of a drug patch containing glyceryl trinitrate to treat dysmenorrhea suggest that it also may help ease pain. This drug has been used in the past to ease preterm contractions in pregnant women. One common side effect of the patch, however, is **headache**.

In 2002, an intrauterine device (**IUD**) was introduced to help eliminate the pain of menstrual cramps related to endometriosis. The IUD, known as Mirena, is approved for use in the United States as a contraceptive. The device works by releasing small amounts of progestin (a hormone) as well as preventing a fertilized egg from implanting in the lining of the uterus. Mirena cannot, however, be used by women with a history of **pelvic inflammatory disease**, current **gonorrhea** or chlamydia infection, or cervical or **breast cancer**.

There are two drugs that can be given to completely suppress menstrual periods—danazol (Danocrine) and leuprolide acetate (Lupron). These are generally regarded as treatments of last resort for secondary dysmenorrhea that is not helped by other medications. Both Danocrine and Lupron are expensive drugs with severe side effects.

Alternative

There are a variety of alternative therapies for dysmenorrhea. As of 2010, however, most of these have not been well studied.

NUTRITIONAL THERAPY. The following dietary changes may help prevent or treat menstrual pain:

- Increased dietary intake of foods such as fiber, calcium, soy foods, fruits and vegetables.
- Decreased consumption of foods that exacerbate PMS. They include caffeine, salt and sugar.
- Quitting smoking. Smoking has been found to worsen cramps.
- Taking daily multi-vitamin and mineral supplements that contain high doses of magnesium and vitamin B_6 (pyridoxine), and flaxseed or fish oil supplements. Recent research suggests that vitamin B supplements, primarily vitamin B_6 in complex, magnesium, calcium, zinc, vitamin E, and fish oil supplements (omega-3 fatty acids) also may help relieve cramps.

HERBAL THERAPY. An herbalist may recommend one of the following herbal remedies for menstrual pain:

- Chasteberry (*Vitex agnus-castus*) for women who also experience breast pain, irregular periods, and ovarian cysts.
- Dong quai (*Angelica sinensis*) for women with typical menstrual pain.
- Licorice (*Glycyrrhiza glabra*) for abdominal bloating and cramping.
- Black cohosh (*Cimifuga racemosa*) for relief of menstrual pain as well as mood swing and depression.

PHYSICAL EXERCISE. Several **yoga** positions are popular as methods to ease menstrual pain. In the "cat stretch" position, the woman rests on her hands and knees, slowly arching the back. The pelvic tilt is another popular yoga position, in which the woman lies with knees bent, and then lifts the pelvis and buttocks.

Exercise may be a way to reduce the pain of menstrual cramps through the brain's production of endorphins, the body's own painkillers.

OTHER REMEDIES. Acupuncture and Chinese herbs are other popular alternative treatments for cramps. There are particular formulas depending on the pattern of imbalance. **Aromatherapy** and massage may ease pain for some women. Transcutaneous **electrical nerve stimulation** (TENS) has been touted as a safe and practical way to relieve the pain of dysmenorrhea. It works by using electrodes to stimulate nerve fibers. Some women find relief through visualization, concentrating on the pain as a particular color and gaining control of the sensations. Others find that imagining a white light hovering over the painful area can actually lessen the pain for brief periods. Simply changing the position of the body can help ease cramps. The simplest technique is assuming the fetal position with knee pulled up to the chest while hugging a heating pad or pillow to the abdomen. Also, orgasm can make a woman feel more comfortable by releasing tension in the pelvic muscles.

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Prognosis

Dysmenorrhea is a treatable condition with a good-to-excellent prognosis in most women. As noted above, most adolescents with primary dysmenorrhea outgrow their painful cramps as they enter their 20s and 30s. Older women with secondary dysmenorrhea usually do well after surgery to remove fibroids or endometriomas; some of these procedures can be done in outpatient surgical clinics. A complete **hysterectomy** is usually done as an inpatient procedure, but most women recover without complications.

Prevention

Most of the causes of secondary dysmenorrhea cannot be prevented as of 2010. However, avoidance of **caffeine**, alcohol, and sugar prior to the onset of the period, and NSAIDs taken a day before the period begins may eliminate cramps for some women with primary dysmenorrhea.

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ORGANIZATIONS

American Congress of Obstetricians and Gynecologists (ACOG), 409 12th St., S.W., P.O. Box 96920, Washington, DC, 20090-6920, (202) 638-5577, resources@acog.org, http://www.acog.org/.

Society for Adolescent Health and Medicine (SAHM), 111 Deer Lake Road, Suite 100, Deerfield, IL, 60015, (847) 753-5226, (847) 480-9282, info@adolescenthealth. org, http://www.adolescenthealth.org.

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Dysmetria *see* **Movement disorders**

Dyspareunia

Definition

Dyspareunia is painful sexual intercourse in women. It is **pain** in the genitals or pelvis that is persistent or recurrent and is experienced at any time before, during, or following sexual intercourse. Dyspareunia usually results from a physical problem but can also stem from psychological difficulties.

Demographics

About 20% of women experience pain with intercourse at some point in their lives and it is estimated that one to two percent of women suffer from dyspareunia. However the true incidence may be higher since many women with dyspareunia do not seek help. The incidence of dyspareunia is significantly higher in women who have been raped or otherwise sexually abused.

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Description

There are two types of dyspareunia. Primary dyspareunia begins with the onset of sexual activity and persists. Acquired or secondary dyspareunia occurs after some period of normal sexual function. Occasional discomfort or pain during intercourse is not unusual and is not considered to be dyspareunia.

The American Psychiatric Association's *Diagnostic and Statistical Manual of Mental Disorders*, fourth edition, text revised (*DSM-IV-TR*), classifies dyspareunia as a **sexual dysfunction**. However this listing is controversial, and some practitioners argue that it should be reclassified as a pain disorder in *DSM-V*.

The pain associated with dyspareunia may be confined to the genitals or can be located anywhere within the pelvis. Women with dyspareunia often have **vaginismus**, an involuntary tightening or spasm of the vaginal muscles in response to penetration, which can make intercourse painful or impossible.

Dyspareunia can cause embarrassment or shame. It can lead to relationship problems and may cause a woman to avoid sexual relationships altogether.

Risk factors

Risk factors for dyspareunia include:

- infection or another medical problem
- certain medications, such as antidepressants or high blood pressure medicines
- depression or anxiety
- emotional or psychological stress, especially with regard to a woman's relationship with her sexual partner
- a history of sexual abuse

Causes and symptoms

Primary dyspareunia can result from psychosocial as well as physical factors. Once a woman associates sex with pain, she may find it difficult to relax and become aroused, leading to dyspareunia:

- Prior sexual trauma—such as rape or childhood sexual abuse—can cause dyspareunia. Even when a woman later desires sex, the act of intercourse may trigger memories of the trauma and interfere with her enjoyment. Vaginismus is common in such situations.
- Misinformation or lack of information about sex, a belief that sex is wrong or evil, or fear of sex can lead to dyspareunia.
- A painful initial sexual experience can cause a woman to associate sex with pain.
- Guilt, anxiety, tension, or fear of pregnancy can prevent sexual arousal and cause the vaginal muscles to tense.

Secondary dyspareunia also can have both physical and psychological causes. A clear physical cause for dyspareunia can be identified in about 30–40% of women who consult a sex counselor for this condition. Dyspareunia in postmenopausal women usually results from lack of natural lubrication due to low estrogen levels. Estrogen deficiency can also cause dyspareunia after **childbirth** or while **breastfeeding**. Conditions that affect the skin around the vagina may cause pain during the insertion of a tampon, or even while sitting or wearing pants, as well as during sexual intercourse. Other physical causes of secondary dyspareunia include:

- lack of foreplay, causing vaginal dryness
- a yeast, vaginal, or urinary tract infection
- herpes sores, genital warts, or other sexually transmitted infections (STIs)
- inflammation of the vagina
- vulvar vestibulitis, an unexplained stinging or burning around the opening of the vagina
- eczema or other skin problems in the genital area
- genital irritation from soaps, detergents, douches, or feminine hygiene products
- injury to the vagina and/or surrounding tissues from an accident, pelvic surgery, female circumcision, or episiotomy, which can also cause vaginismus
- intercourse too soon after surgery or childbirth
- an improperly fitted diaphragm or cervical cap for birth control
- an allergic or other reaction to a birth control product such as foams, jellies, or a latex diaphragm or condom
- certain medications that may decrease sexual desire or arousal and natural lubrication, including antidepressants, high blood pressure medications, sedatives, antihistamines, or certain birth control pills

Pain that is felt deep in the pelvis, that occurs with deep penetration, that occurs only in certain positions, or that occurs with orgasm can result from lack of arousal or tension, but is much more likely to be indicative of a medical problem such as:

- fibroid growths in the uterus
- a tipped uterus
- a prolapsed uterus—a uterus that has slipped into the vagina—or a retroverted uterus
- infections in the cervix, uterus, or fallopian tubes

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- an ovarian infection or certain other ovarian conditions such as cysts, especially if the pain is experienced only in certain sexual positions
- past surgery resulting in scar tissue, such as a hysterectomy
- endometriosis
- pelvic inflammatory disease
- cystitis
- irritable bowel syndrome
- hemorrhoids
- radiation or chemotherapy treatments for cancer

Vasocongestion—the unrelieved accumulation of blood in the dilated blood vessels—can cause dyspareunia. The pelvic area normally becomes congested with blood during sexual arousal. Orgasm quickly relieves this congestion. Dyspareunia from vasocongestion can occur when frequent arousal does not result in orgasm.

Psychological factors that can interfere with arousal and lead to painful intercourse include:

- anxiety or depression that leads to loss of interest in sex
- concerns about one's physical appearance
- fear of intimacy
- stress, which can affect the muscles of the pelvic floor
- relationship problems, including an abusive or emotionally distant sexual partner, loss of attraction to a partner, or fear that a partner has lost interest

Like the causes of dyspareunia, symptoms can vary greatly. The most common symptom of dyspareunia is pain at the vaginal opening as the penis enters the vagina. Entry may be difficult and the pain may be sharp or burning. The vagina may feel very dry; however the pain often occurs only upon initial penetration. Pain deep within the pelvis can resemble menstrual cramps. The pain may eventually ease or may continue throughout intercourse or as long as thrusting continues. Vasocongestion can cause an aching pain in the pelvic region that persists for hours after intercourse. Some women experience pain only with particular partners or under certain circumstances.

Diagnosis

Examination

A complete medical and sexual history and a gynecological exam including a **pelvic exam** may be necessary to determine the physical cause of dyspareunia. The type and location of the pain and the circumstances under which it occurs can be important clues as to the underlying cause. The examination should include questions about sexual activities as they relate to the pain. A psychological evaluation can help identify possible psychosocial causes for the disorder. Women who have been raped or abused may suffer from **post-traumatic stress disorder** (PTSD) or **generalized anxiety disorder** as well as dyspareunia.

KEY TERMS

Estrogen—A female hormone produced by the ovaries that stimulates the growth of the lining of the uterus.

Sexually transmitted infection (STI)—An infectious disease that is transmitted through sexual activity.

Vaginismus—A painful spasmodic vaginal contraction.

Vulvar vestibulitis—A localized inflammation of the vestibule—the region immediately surrounding the opening of the vagina and the urethra.

Tests

Laboratory tests may be performed to test for yeast, bacterial, or other types of infection, including STIs. Urine or **allergy tests** may also be performed.

Procedures

In some cases a **pelvic ultrasound** or **laparoscopy** may be necessary to determine the physical cause underlying dyspareunia. Laparoscopy is a procedure in which a slender instrument called a laparoscope is used to view the pelvic organs.

Treatment

Traditional

Treatment of dyspareunia involves addressing the underlying problem, whether it is physical, psychological, or emotional. Dyspareunia can usually be treated by personal changes or medications. Only rarely is surgery required to treat an underlying problem.

Women whose dyspareunia is accompanied by vaginismus may be given a set of devices to use at home to dilate the vaginal opening. These aides retrain the vaginal muscles and help prevent the involuntary muscle tightening that is characteristic of vaginismus. Starting with a very small device, the woman uses progressively larger devices as she overcomes her pain or fear, eventually working up to a penis–sized device.

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Counseling can be helpful for identifying and reframing negative feelings about sex. Women who have been abused or raped may benefit from counseling techniques that are designed to help overcome the fears and issues resulting from traumatic experiences. Couples therapy can improve communication between partners and resolve problems that may be affecting their sexual relationship. **Sex therapy** can provide information about the physical aspects of arousal and orgasm. A sex therapist will offer suggestions for improving sexual techniques. For example increased foreplay and allowing the woman to control the timing and method of penetration may help her relax and become more easily aroused.

Drugs

There are no specific medications for treating dyspareunia:

- Antibiotics or antiviral drugs may be required for urinary tract infections, STIs, or vaginal infections.
- Over-the-counter or prescription estrogen creams, tablets, or a flexible vaginal ring can often relieve dyspareunia in postmenopausal women.
- A medication may need to be changed if it is interfering with natural lubrication.
- Medications that increase blood flow or relax muscles can be helpful in some situations.
- Stool softeners can relieve dyspareunia caused by hemorrhoids.

Alternative

Desensitization training can teach vaginal relaxation exercises to decrease pain during intercourse.

Home remedies

The use of a vaginal lubricant, even temporarily, can often relieve dyspareunia. Kegal or pelvic–floor exercises also can decrease dyspareunia.

Prognosis

With treatment dyspareunia can usually be overcome, allowing for satisfying sexual relationships. However treatment can take several months, particularly for survivors of violent trauma such as **rape**. Persistent dyspareunia can cause women to lose all interest in sex.

Prevention

Methods for preventing dyspareunia include:

- communicating with one's partner about what is sexually pleasurable or painful
- prolonging foreplay to stimulate arousal and lubrication
- using a water- or silicone-based lubricant
- avoiding scented bath products such as shower gel and body washes, which can irritate the genitals and interfere with natural lubrication
- avoiding douching
- waiting at least six weeks after childbirth before resuming intercourse
- changing sexual positions; for example a woman may be better able to control penetration if she is on top

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ORGANIZATIONS

American Academy of Family Physicians (AAFP), 11400 Tomahawk Creek Pkwy., Leawood, KS, 66211–2680, (913) 906–6000, (800) 274–6000, (913) 906–6075, http://www.aafp.org/online/en/home.html.
American College of Obstetricians and Gynecologists (ACOG), PO Box 96920, Washington, DC, 20090–6920, (202) 638–5577, (800) 673–8444, resources@acog.org, http://www.acog.org.

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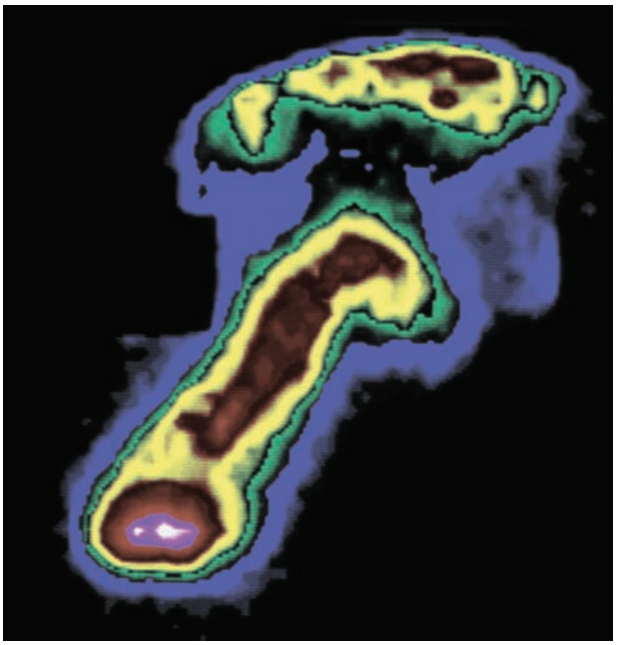

A false-color gamma scan of a human stomach with dyspepsia, or indigestion, during tests to study its rate of emptying. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Dyspepsia

Definition

Dyspepsia can be defined as painful, difficult, or disturbed digestion, which may be accompanied by symptoms such as **nausea and vomiting**, **heartburn**, bloating, and stomach discomfort.

Causes and symptoms

The digestive problems may have an identifiable cause, such as bacterial or viral infection, peptic ulcer, gallbladder, or **liver disease**. The bacteria *Helicobacter pylori* is often found in those individuals suffering from duodenal or gastric ulcers. Investigation of recurrent **indigestion** should rule out these possible causes.

Often, there is no organic cause for the problem, in which case dyspepsia is classified as functional or nonulcer dyspepsia. There is evidence that functional dyspepsia may be related to abnormal motility of the upper gastrointestinal tract (a state known as dysmotility in which the esophagus, stomach, and upper intestine behave abnormally). These patients may respond to a group of drugs called prokinate agents. A review of eating habits (e.g., chewing with the mouth open, gulping food, or talking while chewing) may reveal a tendency to swallow air. This may contribute to feeling bloated, or to excessive belching. **Smoking**, **caffeine**, alcohol, or carbonated beverages may contribute to the discomfort. When there is sensitivity or allergy to certain food substances, eating those foods may cause gastrointestinal distress. Some medications are associated with indigestion. Stomach problems may also be a response to **stress** or emotional unrest.

Diagnosis

A **physical examination** by a health care professional may reveal mid-abdominal **pain**. A **rectal examination** may be done to rule out bleeding. If blood is found on rectal exam, laboratory studies, including a blood count may be ordered. **Endoscopy** and barium studies may be used to rule out underlying gastrointestinal disease. Upper gastrointestinal x-ray studies using barium may allow for visualization of abnormalities. Endoscopy permits collection of tissue and culture specimens which may be used to further confirm a diagnosis.

Treatment

The treatment of dyspepsia is based on assessment of symptoms and suspected causative factors. Clinical evaluation is aimed at distinguishing those patients who require immediate diagnostic work-ups from those who can safely benefit from more conservative initial

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KEY TERMS

Anemia—Diagnosed through laboratory study of the blood, a deficiency in hemoglobin or red blood cells, often associated with paleness or loss of energy.

Endoscopy—A diagnostic procedure using a lighted instrument to examine a body cavity or internal organ. Endoscopy permits collection of tissue and culture specimens.

treatment. Some of the latter may require only reassurance, dietary modifications, or antacid use. Medications to block production of stomach acids, prokinate agents, or antibiotic treatment may be considered. Further diagnostic investigation is indicated if there is severe abdominal pain, pain radiating to the back, unexplained weight loss, difficulty swallowing, a palpable mass, or anemia. Additional work-up is also indicated if a patient does not respond to prescribed medications.

Prognosis

Statistics show an average of 20% of patients with dyspepsia have duodenalor gastric ulcer disease, 20% have **irritable bowel syndrome**, fewer than 1% of patients had **cancer**, and the range for functional, or non-ulcer dyspepsia (**gastritis** or superficial erosions), was from 5–40%.

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Dysphasia

Definition

Dysphasia is a language disorder in which there is a partial or complete impairment of the ability to communicate resulting from brain injury or degeneration. Because dysphasia is sometimes confused with the similar (but unrelated) medical word dysphagia (a problem with swallowing), the term **aphasia** is often used interchangeably with dysphasia. Conversely, aphasia is sometimes referred to as the "complete" inability to express oneself with verbal and written communications and the inability to comprehend such spoken and written means of communications. Further, dysphasia often denotes the "partial" inability to communicate in these ways—both resulting from an injury to, or degeneration of, the brain. Various amounts of disability can occur depending on the severity of the damage and to the portion of the brain affected. Dysphasia is derived from "dys" meaning difficult and "phasis" meaning speech. Aphasia is derived from "aphaatos", which means speechless.

Demographics

The acquired speech disorder called dysphasia can occur in any human. Men and women are affected equally from the condition. Because any human can be injured because of a blow or other such sudden impact to the brain or by degeneration of the brain (such as through a **stroke** or a tumor), dysphasia can occur in any person. However, people more at risk for dysphasia are those who are more likely to be involved in head injuries. These groups of people include males between the ages of 15 and 24 years of age. They are at increased risk because of their lifestyle, which frequently involves high-risk activities such as sports. In addition, young children and the elderly—those over the age of 75 years of age—are also at elevated risk for dysphasia because of their susceptibility to head injuries, such as from accidental falls. In addition, infants are sometimes shook violently, which can lead to brain trauma and, consequently, dysphasia.

Description

Approximately one million Americans suffer from one of the various forms of dysphasia, and an additional 80,000 new cases occur annually, as of statistics from 2007. However, by 2020, the number of current cases is estimated to increase to two million Americans and the number of annual new cases in the United States is projected to increase to 180,000, according to the National Aphasia Association. The term "dysphasia" is more frequently used by European health professionals, whereas in North American the term, "aphasia" is more commonly preferred. These two terms, however, can be and are used interchangeably. They both refer to the full or partial loss of verbal communication skills due to damage or degeneration of the brain's language centers. Developmental dysphasia is considered to be a learning disability, but will not be the focus of this article.

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Verbal communication is derived from several regions located in the language-dominant hemisphere of the brain. These include the adjacent inferior parietal lobe, the inferolateral lobe, and the posterosuperior temporal lobe, as well as the subcortical connection between these areas. Disease, direct trauma, lesion, or infarction involving one or more of these regions can disrupt or prevent proper language function. Dysphasia does not necessarily prevent proper cognitive function, so the patient can think and feel with perfect clarity. This can be extremely frustrating for the patient, as they cannot express these thoughts and feelings to others.

Dysphasia can occur in a variety of forms, depending on how the communicative disruption manifests. Classically, dysphasia can affect one or more of the basic language functions: comprehension (understanding spoken language), naming (identifying items with words), repetition (repeating words or phrases), and speech. Although there are several sub-types of dysphasias, they most commonly manifest in one of three syndromes: expressive dysphasia, receptive dysphasia, or global dysphasia.

Expressive Dysphasia

Expressive dysphasia, also known as motor dysphasia, produces a conscious and recognizable disruption of a patient's speech production and language output. This includes the impairment of speech initiation, proper grammatical sequencing, and proper word forming and articulation. Although patients can perfectly understand what is said to them, they have great difficulty communicating their thoughts. They often express themselves with disjointed words and sentences. The problem is called agrammatism, which means the inability to speak in a grammatically correct manner. In the problem, sufferers omit many words within a sentence so that its meaning becomes disjointed and incomprehensible at times. In less severe cases, the sentence structure may become mixed up. For instance, the sentence "The tree is green." may become "The green is tree."

BROCA'S DYSPHASIA. Broca's dysphasia is the most common type of expressive dysphasia. It is caused by damage to the lower area of the premotor cortex, located just in front of the primary motor cortex. This region is most commonly referred to as the Broca's area. Speech for patients suffering from Broca's dysphasia may be completely impossible. Others may be able to form single words or full sentences, but only through great effort. "Telegraphing," the omission of articles and conjunctions, may also be exhibited.

TRANSCORTICAL DYSPHASIA. Also known as isolation syndrome, transcortical dysphasia is caused by damage to the language-dominant brain that separates all or parts of the central region from the rest of the brain. There are three sub-classes of transcortical dysphasia, which define the impairments to a patient's ability to repeat words, sentences, and phrases: transcortical motor dysphasia, transcortical sensory dysphasia, and mixed transcortical dysphasia. Additional impairments may occur depending on the extent and location of the damage.

Receptive Dysphasia

Receptive dysphasia, also known as sensory dysphasia, impairs the patient's comprehension and meaning of language. Unlike expressive dysphasia, the patient can speak fluently and articulately, but will utilize meaningless words, nonsensical grammar, and unnecessary phrases to the point of becoming incomprehensible. However, they will be completely unaware of their mistakes. Additionally, the patient will find it difficult to comprehend spoken language and/or word-object relation.

WERNICKE'S DYSPHASIA. Also known as semantic dysphasia, Wernicke's dysphasia is the most common of the receptive dysphasia. It is caused by damage to the Wernicke's area, located in the posterior superior temporal lobe of the language-dominant hemisphere. Although the patient can speak clearly and at length, many of their words, phases, and sentences will be nonsensical in nature. Additionally, they will experience difficulty in understanding spoken language, if not suffer a complete lack of comprehension. Semantic distinctions between words may become mixed up and jumbled, furthering confusion.

ANOMIC DYSPHASIA. Anomic dysphasia, also referred to as amnesic dysphasia, is caused by damage to the temporal parietal area and/or the angular gyrus region. Although very similar to Wernicke's dysphasia, anomic dysphasia is distinguished by its disruption of a patient's word-retrieval skills. They will be unable to correctly name people or objects, causing them to pause or substitute generalized words (like "thing"). Otherwise, the patient will exhibit few, if any, language impairments.

CONDUCTION DYSPHASIA. Also known as associative dysphasia, conduction dysphasia is a relatively uncommon disease (representing only 10% of the cases). Damage to the upper temporal lobe, lower parietal, or connection between the Wernicke's and Broca's areas can result in the inability to repeat words, phrases,

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or sentences. The patient may also suffer the inability to describe people or objects in the proper terms.

Global Dysphasia

Global dysphasia, the third most common form of dysphasia, results from damage to both the anterior and posterior regions of the language-dominant hemisphere. In global dysphasia, all of the patient's language skills are disrupted, along with the ability to comprehend language; however, some may be disrupted more severely than others. In global dysphasia, the symptoms of both expressive dysphasia and receptive dysphasia occurs, and in a severe form.

Causes and symptoms

As of the early 2010s, over one million people in the United States suffer a permanent type of dysphasia. Although dysphasia may manifest in several ways, the common cause for its onset is damage or trauma to the brain. Stroke, in particular, is the most common cause for dysphasia. A stroke is caused from a blockage or rupture of a blood vessel within the brain. This problem causes blood flow to be reduced or cut off to brain cells, which then die or are damaged. Of the half million stroke victims reported annually in the United States, approximately 100,000 will suffer some form of dysphasia. Infection, direct trauma, various injuries, **transient ischemic attack** (TIA), brain tumors, and degeneration (such as **dementia**) can also instigate the onset of dysphasia.

Symptoms of dysphasia will quickly manifest after damage to the brain has occurred, and will present in accordance to the particular type of dysphasia suffered. Due to the proximity to areas of the brain that control motor function, expressive dysphasias can be accompanied by noticeable motor impairment. The majority of symptoms will be language related, including:

- Difficulty remembering words
- Difficulty naming objects and/or people
- Difficulty speaking in complete and/or meaningful sentences
- Difficulty speaking in any fashion
- Using unrecognizable words
- Difficulty reading or writing
- Difficulty expressing thoughts and feelings
- Difficulty understanding spoken language
- Using incorrect or jumbled words
- Using words in the wrong order.

These symptoms may vary depending on the severity of the affliction, along with part of the brain that has been damaged. Some people with dysphasia may comprehend what other people say but have difficulty responding to such words or finding the correct words to say. Others may be able to understand the written word, but cannot speak them out loud.

Diagnosis

Dysphasia is frequently diagnosed while the patient is being treated for injury to the brain, be it from trauma or disease. The health professional, typically a neurologist, will conduct standard cognitive tests, including tests to determine whether the patient's language centers have been affected. If the patient exhibits signs of difficulty communicating, they will often be referred to a speech-language pathologist. In turn, the pathologist will conduct a comprehensive examination of the patient's ability language and comprehension skills. This examination may begin with evaluating the patient's ability to repeat words and phrases, recognize and describe objects, and comprehend what is said to them. More extensive and standardized language-based tests may be required, including the Porch Index of Speech Ability and the Boston Diagnostic Aphasia Examination. Based on the result of the examinations, the health professional will be able to determine the type of dysphasia inflicting the patient. More extensive damage may require the use of computed tomography (CT) or **magnetic resonance imaging** (MRI) for an effective diagnosis.

Treatment

A specific treatment is not available, due to the various forms of the condition, and its severity. Initially it is necessary to treat and stabilize the injury underlying the development of the patient's dysphasia. In some cases, such as with damage caused by TIA, a full recovery can be expedient and takes only a few days. Unfortunately, most dysphasias can take months, if not years, to recover from the problem. Even after prolonged therapy, many patients never achieve a full recovery. Efficacy of treatment greatly depends on the promptness with which it begins. **Speech therapy** is effective at promoting a full or partial recovery. For this reason, many medical facilities have speech-language pathologists on staff to begin the initial treatment process as quickly as possible.

There is not a medical or surgical cure for dysphasia. Treatment, instead, relies strongly upon the use of various speech therapies. Much like **physical therapy** strengthens muscles and bones back to normalcy, speech therapy allow the patient to regain language function, as well as rebuild their communications

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skills. Treatment is typically conducted with a trained speech therapist. However, group sessions are common and allow the patient to practice their language skills in a non-threatening environment with others sharing their disability. Although much of therapeutic work is conducted by a speech therapist, friends and family also play a vital role in the patient's recovery. They can help the patient continually practice and **exercise** language skills while outside the therapeutic setting. Many times, family members are included on therapy sessions to teach them how to communicate with and understand the patient.

There are several treatments available, which utilize the patient's remaining language abilities to rebuild and compensate for those that were lost. These include out-put focused therapy (stimulation-response), psycholinguistic therapy (cognitive), cognitive neurorehabilitation, and combinations thereof. Although these treatments approach aphasia differently, they all share a common thread by identifying the specific communication deficits and then targeting them with various modalities (computer-aided therapy, picture cards, reading and writing exercises, speech practice, etc.). These techniques stimulate the various parts of the brain associated with language, memory, and understanding, and thus allow it to heal. Therapies may frequently use computers to assist the patient in regaining the ability to communicate. In addition, patients who cannot recover from dysphasia can use communication devices, such as computers, to convey their thoughts back and forth between friends and family.

Medical researchers are also experimenting with and testing various drugs that may be used in the future to treat dysphasia, either in combination with speech therapy or not.

Prognosis

Fortunately, about half of patients will suffer from transient dysphasia, in which the symptoms fade completely after only a few days. However, a patient's prognosis will greatly depend on several factors, such as the cause and the location and extent of the underlying damage. Additional factors of importance are the patient's age, general health, and mental health and motivation. Children under the age of eight years usually regain their language skills even after serious damage to the brain. Handedness may also be an indicator for recovery, as left-handed individuals have language centers located in both hemispheres of the brain (not just the left). As such, left-handed patients have access to language skills from either side of the brain, which can expedite their recovery.

KEY TERMS

Transient ischemic attack—Also known as a mini-stroke, a transient ischemic attack is caused by a temporary interruption of blood flow in an area of the brain. Unlike in a true stroke, normal brain function will return with 24 hours.

Even with speech therapy, dysphasia may take several years to overcome. Indeed, some patients will never regain their pre-trauma skill level of communication and speech. In such cases, alternative methods of communications may be necessary, such as sign language.

Prevention

Dysphasia can be prevented by avoiding the causes of brain injury and stroke, such as high blood pressure. In particular, eating a healthy diet and not **smoking** to maintain proper blood pressure will help prevent damaging strokes. Although it is impossible to predict head trauma, the use of head protection while participating in dangerous sports or activities can reduce the risk of serious brain damage.

Resources

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ORGANIZATIONS

American Stroke Association, 7272 Greenville Avenue, Dallas, TX, 75231, (888) 478-7653, http://www.strokeassociation.org/STROKEORG/.

National Aphasia Association, 350 Seventh Avenue, New York City, NY, 10001, (800) 922-4622, http://www.aphasia.org/.

National Institute on Deafness and Other Communication Disorders, 31 Center Drive, MSC 2320, Bethesda, MD, 20892-2320, (800) 241-1044, nidcdinfo@nidcd.nih.gov, http://www.nidcd.nih.gov/.

Speakability, 1 Royal Street, London, United Kingdom, SE1 7LL, 030 7261 9572, 020 7928 9542, speakability@speakability.org.uk, http://www.speakability.org.uk/.

Jason Fryer

Dyspnea *see* **Shortness of breath**

Dysthymic disorder *see* **Depressive disorders**

Dystonia *see* **Movement disorders**

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E

E. coli see **Escherichia coli**

E. coli infection see **Enterobacterial infections**

E. coli O157:H7 infection see **Escherichia coli**

Ear canal infection see **Otitis externa**

Ear exam with an otoscope

Definition

An otoscope is a hand-held instrument with a tiny light and a cone-shaped attachment called an ear speculum, which is used to examine the ear canal. An ear examination is a normal part of most physical examinations by a doctor or nurse. It is also done when an ear infection or other type of ear problem is suspected.

Purpose

An otoscope is used to look into the ear canal to see the ear drum. Redness or fluid in the eardrum can indicate an ear infection. Some otoscopes can deliver a small puff of air to the eardrum to see if the eardrum will vibrate (which is normal). This type of ear examination with an otoscope can also detect a build up of wax in the ear canal, or a rupture or puncture of the eardrum.

Precautions

No special precautions are required. However, if an ear infection is present, an ear examination may cause some discomfort or **pain**.

Description

An ear examination with an otoscope is usually done by a doctor or a nurse as part of a complete **physical examination**. The ears may also be examined if an ear infection is suspected due to **fever**, ear pain, or **hearing loss**. The patient will often be asked to tip the head slightly toward the shoulder so the ear to be examined is pointing up. The doctor or nurse may hold the ear lobe as the speculum is inserted into the ear, and may adjust the position of the otoscope to get a better view of the ear canal and eardrum. Both ears are usually examined, even if there seems to be a problem with just one ear.

Preparation

No special preparation is required prior to an ear examination with an otoscope. The ear speculum, which is inserted into the ear, is cleaned and sanitized before it is used. The speculums come in various sizes, and the doctor or nurse will select the size that will be most comfortable for the patient's ear.

Aftercare

If an ear infection is diagnosed, the patient may require treatment with **antibiotics**. If there is a buildup of wax in the ear canal, it might be rinsed or scraped out.

Risks

This type of ear examination is simple and generally harmless. Caution should always be used any time an object is inserted into the ear. This process could irritate an infected external ear canal and could rupture an eardrum if performed improperly or if the patient moves.

Normal results

The ear canal is normally skin-colored and is covered with tiny hairs. It is normal for the ear canal to

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KEY TERMS

Ear speculum—A cone- or funnel-shaped attachment for an otoscope which is inserted into the ear canal to examine the eardrum.

Otoscope—A hand-held instrument with a tiny light and a funnel-shaped attachment called an ear speculum, which is used to examine the ear canal and eardrum.

have some yellowish-brown earwax. The eardrum is typically thin, shiny, and pearly-white to light gray in color. The tiny bones in the middle ear can be seen pushing on the eardrum membrane like tent poles. The light from the otoscope will reflect off of the surface of the ear drum.

Abnormal results

An ear infection will cause the eardrum to look red and swollen. In cases where the eardrum has ruptured, there may be fluid draining from the middle ear. A doctor may also see scarring, retraction of the eardrum, or bulging of the eardrum.

ORGANIZATIONS

American Academy of Otolaryngology—Head and Neck Surgery, 1650 Diagonal Road, Alexandria, VA, 22314-2857, (703) 836-4444, http://www.entnet.org.

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Altha Roberts Edgren

Ear, nose, and throat surgery

Definition

Ear, nose, and throat surgery is the surgical treatment of diseases, injuries, or deformations of the ears, nose, throat, head, and neck areas.

Purpose

The purpose of surgery to the ears, nose, throat, head, and neck is to treat an abnormality, such as a defect or disease, in these anatomical areas. An anatomical deformity is a change that usually occurs during embryological development, leaving the affected person with the apparent defect. A disease in this area usually develops later in life, such as **head and neck cancer**. Additionally, the specialty known as otorhinolaryngology (ears [*oto*], nose [*rhino*], and throat [*laryn*], referring to the larynx or throat) also includes surgical intervention for diseases in the head and neck regions. Most ears, nose, and throat (ENT) surgeons in the United States are referred to as otolaryngologist and the specialty as otolaryngology. **Ear surgery** is usually performed to correct specific causes of **hearing loss**. Nose surgery can include different types of procedures necessary to treat sinus problems, like sinus surgery. Throat surgery can include complicated procedures such as **cancer** of the larynx resulting in a **laryngectomy**, or more simple procedures such as surgical removal of the adenoids, known as an **adenoidectomy**, or tonsils, known as a **tonsillectomy**. Head and neck surgery may be necessary to remove a tumor or reconstruct an area after disfigurement from trauma or injury.

Demographics

Ears, nose, and throat surgery comprises many different types of surgical procedures and spans over all age groups regardless of gender or ethnicity. Pediatric otolaryngology, a subspecialty, is the branch that treats ENT problems for infants and children.

Description

ENT surgery is the oldest surgical specialty in the United States, and it is one of the most elaborate fields of surgical specialty services, using advanced technology and a broad range of procedures that also includes major **reconstructive surgery** to correct deformity or injury. **Cosmetic surgery** can include surgical procedures to improve wrinkles in the face, contours of the nose and ears, chin augmentation, and **hair transplantation**.

Typically, ear surgery corrects defects causing hearing loss or impairment. Such procedures include **stapedectomy**, the removal of all or part of a bone in the middle ear called the stapes; tympanoplasty, or reconstruction of the ear drum; and **cochlear implants**, which is implantation of a device to stimulate nerve ends within the inner portion of the ear to enable hearing. Surgery of the ear also includes **myringotomy**, or insertion of **ear tubes** to drain fluid in persons with chronic ear infections.

Common surgical procedures of the throat include removal of tonsils (tonsillectomy) or adenoids (adenoidectomy). The tonsils, found on either side and in back

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KEY TERMS

Cancer staging—A surgical procedure to remove a lymph node and examine the cells for cancer. It determines the extent of the cancer and how far it has spread.

of the throat, and adenoids, which are higher up the throat behind the nose, are masses of lymph tissue that play an active role in body defenses to fight infection. The tonsils and adenoids can get chronically infected, in which case surgical removal is usually indicated to relieve breathing problems and infection recurrence. Furthermore, chronic inflammation of the adenoids can cause repeated middle ear infections that can ultimately impair hearing.

Surgery of the nose can include procedures that treat sinus diseases. Advanced endoscopic surgery for sinus and nasal disorders can eliminate the need for external incisions and greater surgical precision. Other common surgical procedures include correction of a deviated nasal septum (**septoplasty**) and for chronic nasal obstruction (congestion).

Surgery of the neck region can commonly include **tracheotomy**, a surgical procedure in which an opening is made in the trachea or windpipe. Tracheotomy is indicated for a person who is unable to deliver enough oxygen to the lungs. ENT surgeons also perform complicated surgical procedures for the treatment of malignant head and neck cancers. In addition to **tumor removal**, when indicated, ENT surgeons may perform an operation called **radical neck dissection**, during which the ENT will remove cancer that has spread via lymphatic vessels to regional neck lymph nodes. Neck dissection is also useful since specimens can be removed for pathological examination, which can provide important information concerning metastasis, or spread, and can direct the treatment plan (i.e., **radiation therapy** and/or **chemotherapy** may be recommended for aggressive cancers). ENT surgeons also treat sleep-related disorders such as **sleep apnea** and excessive **snoring**; a procedure called laser-assisted uvula palatoplasty (LAUP) will remove tissue to allow for unobstructed airflow.

Other ENT procedures include surgical reconstruction of ear deformities (otoplasties), special surgery for diseases in the inner ear, and skull-based surgeries (neuro-otology). As well, ENT surgeons can surgically treat abnormalities near the eye, perform oral surgery for treatment of dental and jaw injury, and remove skin cancer within the head and neck region. ENT surgeons also perform special surgical techniques that can preserve nerve and blood vessel function (microsurgery) and reconstruction of bone and soft tissue.

Diagnosis/Preparation

A careful history and **physical examination** of the ears, nose, throat, head, and neck is a standard approach during initial consultation. Different instruments with light sources, like an otoscope for ear examinations, enable ENT surgeons to quickly visualize the ears, nose, and throat. Visualization of these areas can reveal the severity of the disease or deformity. The head and neck area is inspected and the neck and throat area is typically felt with the surgeon's hands, a technique known as palpation. Special technological advancements have enabled ENT surgeons to further visualize deep internal anatomical structures. Nasal **endoscopy** allows visualization of the upper airway to detect anatomical problems related to sinuses. Videostroboscopy can be used to visualize the vocal cords, and triple endoscopy (**laryngoscopy**, esophagoscopy, and **bronchoscopy**) can diagnose and stage head and neck cancers. Preparation before surgery is fairly standardized and includes blood work-up and instructions to have nothing to eat or drink after midnight of the night before the procedure.

Aftercare

The aftercare for ENT surgery depends on the procedure and state of the health of the patient. The aftercare for a patient who is 60 years old with head/neck cancer is more extensive than a tonsillectomy performed in a young adolescent or child. Generally, aftercare should be directed toward wound care and knowledge gained from the surgeon specifically detailing the expected length of average convalescence. Wound care, such as cleansing and dressing changes, and postoperative follow-up with the ENT surgeon is essential. Medications for **pain** may be prescribed. Patients stay in the hospital for eight to 10 hours for the effects of anesthesia to subside for same-day surgical procedures like a tonsillectomy, or they may be admitted for a few days for more complicated procedures, such as those related to cancer treatment. Aftercare and convalescence may take longer for complicated procedures such as advanced cancer, temporal-bone surgery for nerve disorders that can affect balance, or for tumors.

Risks

The risk of ENT surgery depends on the procedure and the health status of the patient. Some procedures

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do not have much risk, while complications for other procedures can carry considerable risk. For example, the risk of a complicated operation such as neck dissection could result in loss of ear sensation, since the nerve that provides the feeling of sensation is commonly severed during the procedure.

Normal results

There will be a cure or an improvement of the primary disease. Ear surgery should help individuals hear well. Throat surgery can help remove chronically inflamed tonsils, adenoids, polyps, or cancer. Nose surgery for deviated septums or nasal congestion will improve breathing problems and help a person breath more easily and effectively through the nose. Neck surgery can help remove diseased tissue and prevent further spread of cancer. Surgery for sleep apnea will remove redundant tissue that blocks airways and obstructs normal airflow.

Morbidity and mortality rates

Outcome and disease progression vary for each disease state. There are no general statistics for all ENT procedures. Some procedures are generally correlated with excellent morbidity, such as over 90% success rates for all cases receiving tympanoplasty, and no mortality, while others may be associated with poor outcome and much illness, like advanced head/neck cancer.

Alternatives

Usually, surgery is indicated when benefit from surgery is a clear-cut primary intervention or when medical, or conservative treatment has failed to provide sustained symptomatic improvement. A person diagnosed with cancer may not have an alternative conservative treatment, depending on the stage of their cancer; however, a person with sinus problems may be treated conservatively with **antibiotics**, saline nasal spray wash, steroid nasal spray, and/or antihistamine spray before indication or necessity for surgery. There are many other services that the ENT surgeon uses to treat specific diseases, including audiology services for diagnostic and therapeutic purposes, like **hearing aids**, and services to treat disorders of speech and voice.

Resources

BOOKS

Corbridge, Rogan, and Nicholas Steventon. *Oxford Handbook of ENT and Head and Neck Surgery*. New York: Oxford University Press, 2006.

Stamm, Aldo C. and Wolfgang Craf. *Micro-endoscopic Surgery of the Paranasal Sinuses and the Skull Base*. New York: Springer, 2000.

ORGANIZATIONS

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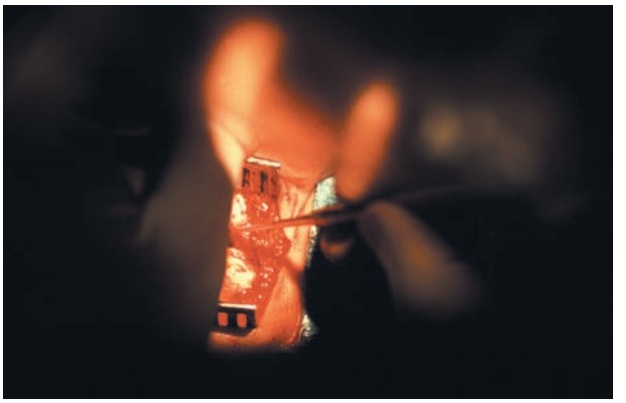
Ear surgery

Definition

Ear surgery is the treatment of diseases, injuries, or deformations of the ear by operation with instruments.

Purpose

Ear surgery is performed to correct certain types of **hearing loss**, and to treat diseases of, injuries to, or deformities of the ear's auditory tube, middle ear, inner ear, and auditory and vestibular systems. Ear surgery is commonly performed to treat conductive hearing loss, persistent ear infections, unhealed perforated eardrums, congenital ear defects, and tumors.



Microsurgery being performed in the inner ear.
(Hans Halberstadt/Photo Researchers, Inc.)

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Ear surgery is performed on children and adults. In some cases, surgery is the only treatment; in others, it is used only when more conservative medical treatment fails.

Precautions

The precautions vary, depending on the type of ear surgery under consideration. For example, **stapedectomy** (removal of parts of the middle ear and insertion of prosthesis parts) should not be performed on people with external or middle ear infection or inner ear disease. For people with complete hearing loss in the other ear, it should be performed cautiously. Microsurgery for the removal of a cholesteatoma (a cyst-like mass of cells in the middle ear) should not be performed on patients who are extremely ill or have other medical conditions. Tympanoplasty (any surgical procedure on the eardrum or middle ear) should not be performed on patients with chronic sinus or nasal problems or with medical problems such as poorly controlled diabetes and heart disease. Surgery for congenital microtia and atresia (abscense of normal bodily openings, such as the outer ear canal) should not be performed if the middle ear space is totally or almost totally absent.

Description

Most ear surgery is microsurgery, performed with an operating microscope to enable the surgeon to view the very small structures of the ear. The use of minimally invasive **laser surgery** for middle ear procedures is growing. Laser surgery reduces the amount of trauma due to vibration, enhances coagulation, and enables surgeons to access hard to reach places in the middle ear. Laser surgery can be performed in an office operating suite. Types of ear surgery include stapedectomy, tympanoplasty, **myringotomy** and ear tube surgery, ear surgery to repair a **perforated eardrum**, **cochlear implants**, and **tumor removal**.

Stapedectomy

To restore hearing loss, which is usually due to **otosclerosis**, stapedectomy is performed. Stapedectomy is the removal of all or part of the stapes, one of the bones in the middle ear, and replacement with a tiny prosthesis. An incision is made in the middle ear, the small bones are identified, and the stapes is removed. The stainless steel wire and cellulose sponge prosthesis is inserted, blood and fluid are drained, and the wound is closed. Performed in a hospital or outpatient surgical facility under local or general anesthetic, full recovery takes about three weeks but hearing should improve immediately.

Tympanoplasty

Tympanoplasty is performed to reconstruct the eardrum after partial or total conductive hearing loss, usually caused by chronic middle ear infections, or perforations that do not heal. This is usually a same day surgery, performed under either local or **general anesthesia**. After making an incision in the ear to view the perforation, the ear drum is elevated away from the ear canal and lifted forward. If the bones of hearing (ossicular chain) are functioning, tissue is taken from the ear and grafted to the eardrum to close the perforation. A thin sheet of silastic and Gelfoam hold the graft in place. The ear is stitched together, and a sterile patch is placed on the outside of the ear canal. Tympanoplasty is successful in over 90% of all cases. The need for ossicular reconstruction (reconstruction of tiny bones of the middle ear) is sometimes known before surgery and even when identified during surgery, can usually be done while reconstructing the eardrum. If the gap between the anvil bone and the stapes is small, a small piece of bone or cartilage from the patient can be inserted; if is is large, the incus bone is removed, modelled into a prosthesis, and reinserted between the stapes and the malleus. Reconstruction could also be achieved by inserting a strut made from artificial bone. For tympanoplasty with ossicular reconstruction, the patient usually stays in the hospital overnight. The recovery period is about four weeks.

Myringotomy and ear tube surgery

Myringotomy and ear tube surgery is performed to drain ear fluid and prevent ear infections when **antibiotics** don't work or when ear infections are chronic. The process normalizes pressure in the middle ear and decreases fluid accumulation. It is most commonly performed on infants and children, in whom ear infections are most frequent, and may be done on one or both ears. The surgeon makes a small hole in the ear drum, then uses suction to remove fluid. A small ear tube of metal or plastic is inserted into the ear drum to allow continual drainage. The tube prevents infections as long as it stays in place, which varies from six months to three years. When the tube falls out, the hole grows over. As many of 25% of children under the age of two who need **ear tubes** may need them again. Myringotomy and ear tube surgery is performed in a hospital, using a general anesthetic for most children and a local anesthetic for older children or adults. No anesthetic may be used for infants. The procedure usually takes about two hours. Most patients can go home

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the same day; children under three years of age and those with chronic diseases usually stay overnight.

Ear surgery for a perforated eardrum

Ear surgery for a perforated eardrum is only performed in rare cases where it does not heal on its own. In most cases, this is performed in a surgeon's office using a topical anesthetic. The surgeon scratches the undersurface of the eardrum, stimulating the skin to heal and the eardrum to close. A thin patch placed on the eardrum's outer surface allows the skin under the eardrum to heal.

Cochlear implants

Cochlear implants stimulate nerve ends within the inner ear, enabling deaf children to hear. The device has a microphone that remains outside the ear, a processor that selects and codes speech sounds, and a receiver/stimulator to convert the coded sounds to electric signals that stimulate the hearing nerve and are recognized by the brain as sound. During surgery, an incision is made behind and slightly above the ear. A circular hole is drilled in the bone to receive the device's internal coil. The mastoid bone leading to the middle ear is opened to receive the electrodes. The internal coil is inserted and secured, followed by the electrodes. The wound is stitched up and when it heals, an external unit comprised of a stimulator with a microphone is worn behind the ear. Performed in a hospital under general anesthesia, the operation takes about two hours and usually requires a hospital stay overnight. The patient can resume normal activities in two to three weeks.

Ear surgery for tumors

Some ear tumors can be very serious and should be removed surgically. For a tumor on the skin of the ear canal, the skin is removed surgically, the bone beneath it is drilled away and a skin graft is placed in the ear canal. If the tumor is near the eardrum, the skin of the ear canal and the eardrum are removed along with the bone surrounding the ear canal. A skin graft is placed on the bare bone. For basal cell cancers and low grade glandular malignancies, surgical resection of the ear canal is adequate. Squamous cell carcinoma, a serious form of **cancer**, of the external ear canal requires radical surgery, followed by **radiation therapy**. Cholesteatoma, a benign tumor caused by an infection in a perforated eardrum that did not heal properly and can destroy the bones of hearing, is removed with microsurgery. **Mastoidectomy** is performed for **mastoiditis**, an inflammation of the middle ear, if medical therapy does not work. Petrous apicectomy is performed to drain the petrous apicitis, the bone between the middle ear and the clivis.

KEY TERMS

Auditory—Relating to the sense of the organs of hearing.

Cholesteatoma—A cystic mass of cells in the middle ear, occurring as a congential defect or as a serious complication of a disease or traumtic condition of the ear.

Otologic—Relating to the study, diagnosis, and treatment of diseases of the ear and related structures.

Ear surgery for congenital ear defects

Congenital atresia, the absence of the external ear canal, and congenital microtia, abnormal growth of the external ear, often occur together, although atresia can occur without microtia. Surgery to reconstruct the ear usually takes place when the child is four or five years old and may require several operations. A facial plastic surgeon and an ear surgeon work together, repairing the microtia first and then the atresia. During surgery, a bony opening is created over the bones of hearing. The surfaces of the bony ear canal are then relined with a skin graft from the thigh or abdomen. Tissue from behind the eardrum is used to create a new eardrum. In many cases, the middle ear will also need to be reconstructed. Surgery is performed in a hospital under general anesthesia.

Other types of ear surgery

Surgery may also be appropriate to remove multiple bony overgrowths of the ear canal or in rare cases of compromised auditory tube function, to narrow the tube.

Preparation

The preparation depends upon the type of ear surgery performed. For many procedures, blood and urine studies and hearing tests are conducted.

Aftercare

The type of aftercare depends upon the type of surgery performed. In most cases, the ear(s) should be kept dry and warm. Non-prescription drugs such as **acetaminophen** can be used for **pain**.

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Risks

The type of risk depends on the type of surgery performed. Total hearing loss is rare.

ORGANIZATIONS

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Lori De Milto

Ear tubes *see* **Myringotomy and ear tubes**

Ear wax impaction *see* **Cerumen impaction**

Eardrum perforation *see* **Perforated eardrum**

Eastern equine encephalitis *see* **Arbovirus encephalitis**

Eating disorders

Definition

Eating disorders are psychiatric illnesses that result in abnormal eating patterns that have a negative effect on health.

Demographics

In general, more women have eating disorders than men. About 90% of people with **anorexia nervosa** and **bulimia nervosa** are female. Almost as many men as women develop binge-eating disorder. Anorexia athletica, muscle dysmorphic disorder, and orthorexia nervosa tend to be more common in men. Rumination, **pica**, and **Prader-Willi syndrome** affect men and women equally.

Anorexia can occur in people as young as age 7. However, the disorder most often begins during adolescence. It is most likely to start at one of two times, either age 14 or 18 and affects mainly white girls. There is a secondary peak of individuals who become anorexic in their 40s.

Bulimia is the most common eating disorder in the United States. Overall, about 3% of Americans are bulimic. Of these 85–90% are female. The rate is highest among adolescents and college women, averaging

Symptoms of eating disorders

Anorexia nervosa	Bulimia nervosa	Binge-eating disorder
Resistance to maintaining body weight at or above a minimally normal weight for age and height	Recurrent episodes of binge eating, characterized by eating an excessive amount of food within a discrete period of time and by a sense of lack of control over eating during the episode	Recurrent episodes of binge eating, characterized by eating an excessive amount of food within a discrete period of time and by a sense of lack of control over eating during the episode
Intense fear of gaining weight or becoming fat, even though underweight	Recurrent inappropriate compensatory behavior in order to prevent weight gain, such as self-induced vomiting or misuse of laxatives, diuretics, enemas, or other medications (purging); fasting; or excessive exercise	The binge-eating episodes are associated with at least 3 of the following: eating much more rapidly than normal; eating until feeling uncomfortably full; eating large amounts of food when not feeling physically hungry; eating alone because of being embarrassed by how much one is eating; feeling disgusted with oneself, depressed, or very guilty after overeating
Disturbance in the way in which one's body weight or shape is experienced, undue influence of body weight or shape on self-evaluation, or denial of the seriousness of the current low body weight	The binge eating and inappropriate compensatory behaviors both occur, on average, at least twice week for 3 months	Marked distress about the binge-eating behavior
Infrequent or absent menstrual periods (in females who have reached puberty)	Self-evaluation is unduly influenced by body shape and weight	The binge eating occurs, on average, at least 2 days a week for 6 months
		The binge eating is not associated with the regular use of inappropriate compensatory behaviors (e.g., purging, fasting, excessive exercise)

SOURCE: National Institute of Mental Health, National Institutes of Health, U.S. Department of Health and Human Services

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5–6%. In men, the disorder is more often diagnosed in homosexuals than in heterosexuals. Bulimia usually develops in women the late teens and early twenties and in men around age 25 or later. It affects all racial, ethnic, and socioeconomic groups.

Estimates of the number of Americans who have binge-eating disorder range from less than 1% to 4%, with 2% being the most commonly cited figure. Although women with binge-eating disorder outnumber men three to two, **binge eating** is the most common male eating disorder. Binge-eating disorder is a problem of middle age and affects blacks and whites equally.

Prader-Willi syndrome begins in the toddler years. Not enough is known about the other disorders to determine when they are most likely to develop or which races or ethnic groups are most likely to be at risk.

Description

Eating disorders are mental disorders. They develop when a person has an unrealistic attitude toward or abnormal perception of his or her body. This causes behaviors that lead to destructive eating patterns that have negative physical and emotional consequences. Individuals with eating disorders often hide their symptoms and resist seeking treatment. Depression, **anxiety disorders**, and other mental illnesses often are present in people who have eating disorders, although it is not clear whether these cause the eating disorder or are a result of it.

The two best-known eating disorders, anorexia nervosa and bulimia nervosa, have formal diagnostic criteria and are recognized as psychiatric disorders in the *Diagnostic and Statistical Manual for Mental Disorders Fourth Edition (DSM-IV-TR)* published by the American Psychiatric Association (APA). Other eating disorders have recognized sets of symptoms, but have not been researched thoroughly enough to be considered separate psychiatric disorders as defined by the APA.

Anorexia nervosa

In the North America and Europe, anorexia nervosa is the most publicized of all eating disorders. It gained widespread public attention with the rise of the ultra-thin fashion model. People who have anorexia nervosa are obsessed with body weight. They constantly monitor their food intake and starve themselves to become thin. No matter how much weight they lose, they continue to restrict their calorie intake in an effort to become ever thinner. Some anorectics **exercise** to extreme or abuse drugs or herbal remedies that they believe will help them burn calories faster. A few purge their body of the few calories they do eat by abusing **laxatives**, **enemas**, and **diuretics**. In time, they reach a point where their health is seriously, and potentially fatally, impaired.

People with anorexia nervosa have an abnormal perception of their body. They genuinely believe that they are fat, even when the clearly are life-threateningly thin. They will deny that they are too thin, or, if they admit they are thin, deny that their behavior will affect their health. People with anorexia will lie to family, friends, and healthcare providers about how much they eat. Many vigorously resist treatment and accuse the people trying to cure them of wanting to make them fat. Anorexia nervosa is the most difficult eating disorder to recover from.

Competitive athletes of all races have an increased risk of developing anorexia nervosa, especially in sports where weight is tied to performance. Jockeys, wrestlers, figure skaters, cross-country runners, and gymnasts (especially female gymnasts) have higher than average rates of anorexia. People such as actors, models, cheerleaders, and dancers (especially ballet dancers) who are judged mainly on their appearance are also at high risk of developing the disorder. This same group of people is also at higher risk for developing bulimia nervosa.

Bulimia nervosa

Bulimia nervosa is the only other eating disorder with specific diagnostic criteria defined by the *DSM-IV-TR*. People with bulimia often consume unreasonably large amounts of food in a short time. Afterwards, they purge their body of calories. This is done most often by self-induced **vomiting**, often accompanied by laxative abuse. A subset of people with bulimia does not vomit after eating, but fast and exercise obsessively to burn calories. Both behaviors result in impaired health.

People with bulimia feel out of control when they are binge eating. Unlike people with anorexia, they recognize that their behavior is abnormal. Often they are ashamed and feel guilty about their behavior and will go to great lengths to hide their binge/purge cycles from their family and friends. People with bulimia are often of normal weight. Although their behavior results in negative health consequences, because they are less likely to be ultra-thin, these consequences are less likely to be life-threatening.

Binge eating disorder

Binge eating is quite common, but it rises to the level of a disorder only when bingeing occurs at least

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twice a week for three months or more. People with binge-eating disorder may eat thousands of calories in an hour or two. While they are eating, they feel out of control and may continue to eat long after they feel full. Binge eaters do not purge or exercise to get rid of the calories they have eaten. As a result, many, but not all, people with binge-eating disorder, are obese, although not all obese people are binge eaters.

Binge eaters are usually ashamed of their behavior and try to hide it by eating in secret and hoarding food for future binges. After a binge, they usually feel disgusted with themselves and guilty about their eating behavior. They often promise themselves that they will never binge again, but are unable to keep this promise. Binge-eating disorder often takes the form of an endless cycle—rigorous dieting followed by an eating binge followed by guilt and rigorous dieting, followed by another eating binge. The main health consequences of binge eating are the development of obesity-related diseases such as type 2 diabetes, **sleep apnea**, **stroke**, and **heart attack**.

Lesser-known eating disorders

Quite a few eating problems are called disorders even though they do not have formal diagnostic criteria. They fall under the APA definition of eating disorders not otherwise specified. Many have only recently come to the attention of researchers and have been the subject of only a few small studies. Some have been known to the medical community for years but are rare.

Purge disorder is thought by some experts to be a separate disorder from bulimia. It is distinguished from bulimia by the fact that the individual maintains a normal or near normal weight despite purging by **vomiting** or laxative, enema, or diuretic abuse.

Anorexia athletica is a disorder of compulsive exercising. The individual places exercise above work, school, or relationships and defines his or her self-worth in terms of athletic performance. People with anorexia athletica also tend to be obsessed less with body weight than with maintaining an abnormally low percentage of body fat. This disorder is common among elite athletes.

Muscle dysmorphic disorder is the opposite of anorexia nervosa. Where the anorectic thinks she is always too fat, the person with muscle dysmorphic disorder believes he is always too small. This belief is maintained even when the person is clearly well muscled. Abnormal eating patterns are less of a problem in people with muscle dysmorphic disorder than damage from compulsive exercising (even when injured) and the abuse of muscle-building drugs such as anabolic **steroids**.

Orthorexia nervosa is a term coined by Steven Bratman, a Colorado physician, to describe "a pathological fixation on eating 'proper,' 'pure,' or 'superior' foods." People with orthorexia allow their fixation with eating the correct amount of properly prepared healthy foods at the correct time of day to take over their lives. This obsession interferes with relationships and daily activities. For example, they may be unwilling to eat at restaurants or friends' homes because the food is "impure" or improperly prepared. The limitations they put on what they will eat can cause serious vitamin and mineral imbalances. Orthorectics are judgmental about what other people eat to the point where it interferes with personal relationships. They justify their fixation by claiming that their way of eating is healthy. Some experts believe orthorexia may be a variation of **obsessive-compulsive disorder**.

Rumination syndrome occurs when an individual, either voluntarily or involuntarily, regurgitates food almost immediately after swallowing it, chews it, and then either swallows it or spits it out. Regurgitation syndrome is the human equivalent of a cow chewing its cud. The behavior often lasts up to two hours after eating. It must continue for at least one month to be considered a disorder. Occasionally the behavior simply stops on its own, but it can last for years.

Pica is the eating of non-food substances by people developmentally past the stage where this is normal (usually around age 2). Earth and clay are the most common non-foods eaten, although people have been known to eat hair, feces, lead, laundry starch chalk, burnt matches, cigarette butts, light bulbs, and other equally bizarre non-foods. This disorder has been known to the medical community for years, and in some cultures (mainly tribes living in equatorial Africa) is considered normal. Pica is most common among people with **mental retardation** and developmental delays. It only rises to the level of a disorder when health complications require medical treatment.

Prader-Willi syndrome is a genetic defect that spontaneously arises in chromosome 15. It causes low muscle tone, short stature, incomplete sexual development, mental retardation, and an uncontrollable urge to eat. People with Prader-Willi syndrome never feel full. The only way to stop them from eating themselves to **death** is to keep them in environments where food is locked up and not available. Prader-

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KEY TERMS

Body dysmorphic disorder—A psychiatric disorder marked by preoccupation with an imagined physical defect.

Diuretic—A substance that removes water from the body by increasing urine production.

Electrolyte—Ions in the body that participate in metabolic reactions. The major human electrolytes are sodium (Na+), potassium (K+), calcium (Ca 2+), magnesium (Mg2+), chloride (Cl-), phosphate (HPO4 2-), bicarbonate (HCO3-), and sulfate (SO4 2-).

Lanugos—A soft, downy body hair that develops on the chest and arms of anorexic women.

Neurotransmitter—One of a group of chemicals secreted by a nerve cell (neuron) to carry a chemical message to another nerve cell, often as a way of transmitting a nerve impulse. Examples of neurotransmitters include acetylcholine, dopamine, serotonin, and norepinephrine.

Purging—The use of vomiting, diuretics, or laxatives to clear the stomach and intestines after a binge.

Serotonin—5-Hydroxytryptamine; a substance that occurs throughout the body with numerous effects including neurotransmission. Inadequate amounts of serotonin are implicated in some forms of depression and obsessive-compulsive disorder.

Willi syndrome is a rare disease, and although it is caused by a genetic defect, tends not to run in families, but rather is an accident of development. Only 12,000–15,000 people in the United States have Prader-Willi syndrome.

Causes and symptoms

Eating disorders have multiple causes. There appears to be a genetic predisposition in some people toward developing an eating disorder. Biochemistry also seems to play a role. Neurotransmitters in the brain, such as serotonin, play a role in regulating appetite. Abnormalities in the amount of some neurotransmitters are thought to play a role in anorexia, bulimia, and binge-eating disorder. Other disorders have not been studied enough to draw any conclusions. Interestingly, serotonin also helps regulate mood, and low serotonin levels are thought to play a role in causing depression.

Personality type can also put people at risk for developing an eating disorder. Low self-worth is common among all people with eating disorders. Binge eaters and people with bulimia tend to have problems with impulse control and anger management. A tendency toward obsessive-compulsive behavior and black-or-white, all-or-nothing thinking also put people at higher risk.

Social and environmental factors also affect the development and maintenance of eating disorders and may trigger relapses during recovery. Relationship conflict, a disordered, unstructured home life, job or school **stress**, transition events such as moving or starting a new job all seems to act as triggers for some people to begin disordered eating behaviors. Dieting (nutritional and social stress) is the most common trigger of all. The United States in the early twenty-first century is a culture obsessed with thinness. The media constantly send the message through words and images that being not just thin, but ultra-thin, is fashionable and desirable. Magazines aimed mostly at women devote thousands of words every month to diet and exercise advice that creates a sense of dissatisfaction, unrealistic goals, and a distorted body image.

Signs and symptoms of anorexia and bulimia

Eating disorders have physical and psychological consequences. These include:

- excessive weight loss; loss of muscle
- stunted growth and delayed sexual maturation in preteens
- gastrointestinal complications: liver damage, diarrhea, constipation, bloating, stomach pain
- cardiovascular complications: irregular heartbeat, low pulse rate, cardiac arrest
- urinary system complications: kidney damage, kidney failure, incontinence, urinary tract infections
- skeletal system complications: loss of bone mass, increased risk of fractures, teeth eroded by stomach acid from repeat vomiting
- reproductive system complications (women): irregular menstrual periods, amenorhhea, infertility

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- reproductive system complications (men): loss of sex drive, infertility
- fatigue, irritation, headaches, depression, anxiety, impaired judgment and thinking
- fainting, seizures, low blood sugar
- chronically cold hands and feet
- weakened immune system, swollen glands, increased susceptibility to infections
- development of fine hair called lanugos on the shoulders, back, arms, and face, head hair loss, blotchy, dry skin
- potentially life-threatening electrolyte imbalances
- coma
- increased risk of self-mutilation (cutting)
- increased risk of suicide
- death

Signs and symptoms of binge eating

Symptoms of binge eating may be difficult to detect. Binge eating is different from continuously snacking. Binge eaters are often secretive about food and their bingeing is often done in private. **Obesity** and obesity-related diseases such as **hypertension** (high blood pressure,) type 2 diabetes, and joint **pain** are signs that binge-eating disorder could be present, but not all obese people are binge-eaters. Behaviors such as secretive eating, constant dieting without losing weight, obsessive concern about weight, depression, **anxiety**, and **substance abuse** are all clues, but none of these signs are definitive. The individual may complain about symptoms related to obesity, such as **fatigue** and **shortness of breath**, or mention unsuccessful dieting, but again, these signs are not definitive.

Diagnosis

Diagnosis is based on several factors including a patient history, **physical examination**, laboratory tests, and a mental status evaluation. A patient history is less helpful in diagnosing eating disorders than in diagnosing many diseases because many people with an eating disorder lie repeatedly about how much they eat, purge, or use laxatives, enemas, and medications. The patient may, however, complain about related symptoms such as fatigue, headaches, **dizziness**, **constipation**, or frequent infections.

Tests

A physical examination begins with weight and blood pressure and moves through all the signs listed above. Based on the physical exam, the physician will order laboratory tests. In general these tests will include a **complete blood count** (CBC), **urinalysis**, blood chemistries (to determine electrolyte levels), and **liver function tests**. The physician may also order an electrocardiogram to look for heart abnormalities. Other conditions including metabolic disorders, brain tumors (especially hypothalamus and pituitary gland lesions), diseases of the digestive tract, and a condition called superior mesenteric artery syndrome can cause weight loss or vomiting after eating. People with this condition sometimes vomit after meals because the blood supply to the intestine is blocked. The physician may perform tests needed to rule out the presence of these disorders and assess the patient's nutritional status.

The individual may be referred to a psychiatrist for a mental status evaluation. The physician will evaluate things such as whether the person is oriented in time and space, appearance, observable state of emotion (affect), attitude toward food and weight, delusional thinking, and thoughts of self-harm or **suicide**. This evaluation helps to distinguish between an eating disorder and other psychiatric disorders, including depression, **schizophrenia**, social phobia, obsessive-compulsive disorder, and **body dysmorphic disorder**. Two diagnostic tests that are often used are the Eating Attitudes Test (EAT) and the Eating Disorder Inventory (EDI).

Treatment

Treatment depends on the degree to which the individual's health is impaired.

Traditional medical treatment

Hospitalization is recommended for anorectics or bulimics with any of the following characteristics:

- weight of 40% or more below normal; or weight loss over a three-month period of more than 30 pounds
- severely disturbed metabolism
- severe bingeing and purging
- signs of psychosis
- severe depression or risk of suicide
- family in crisis

Hospital impatient care is first geared toward correcting problems that present as immediate medical crises, such as severe **malnutrition**, severe electrolyte imbalance, irregular heart beat, pulse below 45 beats per minute, or low body temperature. Patients are hospitalized if they are a high suicide risk, have severe clinical depression, or exhibit signs of an altered

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mental state. They may also need to be hospitalized to interrupt weight loss, stop the cycle of vomiting, exercising and/or laxative abuse, treat substance disorders, or for additional medical evaluation.

Individuals with eating disorders are treated with a variety of medications to address physical problems brought about by their eating disorder and to treat additional psychiatric problems such as depression, anxiety, and suicidal thoughts. The medications used will vary depending on the individual; however, depression is common among people with eating disorders and is most often treated with **antidepressant drugs**.

Psychotherapy

The mainstay of treatment is **psychotherapy**. An appropriate therapy is selected based on the type of eating disorder and the individual's psychological profile. Some of the common therapies used in treating eating disorders include:

- Cognitive behavior therapy (CBT) is designed to confront and then change the individual's thoughts and feelings about his or her body and behaviors toward food, but it does not address why those thoughts or feelings exist. Strategies to maintain self-control may be explored. This therapy is relatively short-term. CBT is often the therapy of choice for people with eating disorders.
- Psychodynamic therapy, also called psychoanalytic therapy, attempts to help the individual gain insight into the cause of the emotions that trigger their dysfunctional behavior. This therapy tends to be more long term than CBT.
- Interpersonal therapy is short-term therapy that helps the individual identify specific issues and problems in relationships. The individual may be asked to look back at his or her family history to try to recognize problem areas or stresses and work toward resolving them.
- Dialectical behavior therapy consists of structured private and group sessions in which the therapist and patient(s) work at reducing behaviors that interfere with quality of life, finding alternate solutions to current problem situations, and learning to regulate emotions.
- Family and couples therapy is helpful in dealing with conflict or disorder that may be a factor in perpetuating the eating disorder. Family therapy is especially useful in helping parents who are anorectics avoid passing on their attitudes and behaviors on to their children.

Nutrition education

A **nutrition** consultant or dietitian is an essential part of the team needed to successfully treat eating disorders. The first treatment concern is to get the individual medically stable by increasing calorie intake and balancing electrolytes. After that, nutritional therapy is needed to support the long process of recovery and stable weight gain. This is an intensive process involving nutrition education, meal planning, nutrition monitoring, and helping the anorectic develop a healthy relationship with food. However, nutritional counseling alone will not resolve an eating disorder.

Alternative and complementary treatment

Alternative treatments should serve as complements to a conventional treatment program. Alternative therapies for anorexia nervosa include diet and nutrition counseling, herbal therapy, **hydrotherapy**, **aromatherapy**, **Ayurvedic medicine**, and mind/body medicine.

The following herbs may help reduce anxiety and depression which are often associated with this disorder:

- chamomile (*Matricaria recutita*)
- lemon balm (*Melissa officinalis*)
- linden (*Tilia* spp.) flowers

Essential oils of herbs such as bergamot, basil, chamomile, sage, and lavender may help stimulate appetite, relax the body, and fight depression. They can be diffused into the air, inhaled, massaged, or put in bath water.

Relaxation techniques such as **yoga**, **meditation**, and t'ai chi can relax the body and release stress, anxiety, and depression.

Hypnotherapy may help resolve unconscious issues that contribute to anorexic behavior.

Other alternative treatments that may be helpful include hydrotherapy, **magnetic field therapy**, **acupuncture**, **biofeedback**, Ayurvedic medicine, and **traditional Chinese medicine**.

Prognosis

Recovery from eating disorders can be a long, difficult process interrupted by relapses. About half of all anorectics recover. Up to 20% die of complications of the disorder. The recovery rate for people with bulimia is slightly higher. Binge eaters experience many relapses and may have trouble controlling their weight

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even if they stop bingeing. Not enough is known about the other eating disorders to determine recovery rates. All eating disorders have serious social and emotional consequences. All except rumination disorder have serious health consequences. The sooner a person with an eating disorder gets professional help, the better the chance of recovery.

Prevention

Prevention involves both preventing and relieving stresses and enlisting professional help as soon as abnormal eating patterns develop. Some things that may help prevent an eating disorder from developing are listed below:

- Parents should not obsess about their weight, appearance, and diet in front of their children.
- Parents should not put their child on a diet unless instructed to by a pediatrician.
- Do not tease people about their body shapes or compare them to others.
- Make it clear that family members are loved and accepted as they are.
- Try to eat meals together as a family whenever possible; avoid eating alone.
- Avoid using food for comfort in times of stress.
- Monitoring negative self-talk; practice positive self-talk.
- Spend time doing something enjoyable every day.
- Stay busy, but not overly busy; get enough sleep every night.
- Become aware of the situations that are personal triggers for abnormal eating behaviors and look for ways to avoid or defuse them.
- Do not go on extreme diets.
- Be alert to signs of low self-worth, anxiety, depression, and drug or alcohol abuse and seek help as soon as these signs appear.

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ORGANIZATIONS

American Psychological Association, 750 First Street, NE, Washington, DC, 20002-4242, (202) 336-5500; TDD/TTY: (202) 336-6123, (800) 374-2721, apa@psych.org, http://www.apa.org.

National Association of Anorexia Nervosa and Related Eating Disorders (ANAD), P.O. Box 7, Highland Park, IL, 60035, (847) 831-3438, (847) 433-3996, http://www.anad.org.

National Eating Disorders Association, 603 Stewart Street, Suite 803, Seattle, WA, 98101, (206) 382-3587, Help and Referral Line: (800) 931-2237, (206) 829-8501, info@NationalEatingDisorder.org, http://www.nationaleatingdisorders.org.

Tish Davidson, A.M.

Eaton agent pneumonia *see* **Mycoplasma infections**

Ebola virus infection *see* **Hemorrhagic fevers**

Ecchymosis *see* **Bruises**

ECG *see* **Electrocardiography**

Echinacea

Definition

Echinacea is the term given to several plants in the Asteraceae/Compositae family. It is known as the coneflower, narrow-leaf cone-flower, and black susan.

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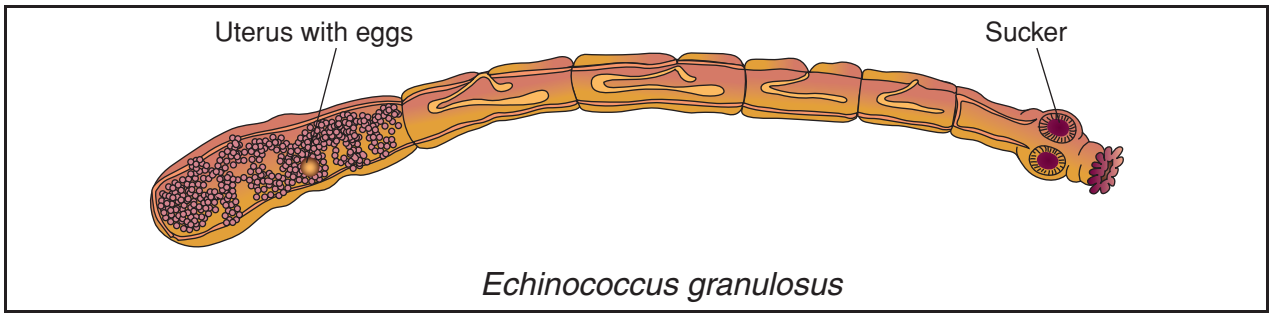

Infection with the larva of *Echinococcus granulosus* (shown above) is responsible for the disease echinococcosis. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Description

Echinacea is native to, and abundant in, the North American prairie. The plants are indigenous, perennial herbs in North America and thrive when planted in temperate climates in Europe and Asia.

Echinacea propagates easily from seed or root cuttings.

Purpose

Native Americans chewed Echinacea roots to relieve toothaches and inflamed gums. They used teas of the roots and leaves to relieve stomach pains, treat colds and infections, and heal skin **wounds** and infections.

European herbalists and physicians have used Echinacea for over a hundred years to treat colds and respiratory and urinary infections, and to treat wounds.

Echinacea is second only to Ginko in herbal sales in the U.S.

Preparations

The quality and potency of herbal supplements depends on the soil and weather conditions where the herb is grown, the timing and care in harvesting it, and the manner in which it is prepared and stored.

Echinacea has been clinically tested for a number of conditions, including preventing and treating colds and respiratory infections, **cancer**, boosting immune systems, increasing white blood counts after **radiation therapy**, inflammation of the eye, vaginal yeast infections, and **genital herpes**.

In all of those conditions, clinical Study results are, at best, inconclusive. It does not appear to prevent colds.

For treating colds, capsules containing from 300-1200mg can be taken per day for 7 days.

Precautions

Though used as medicines, herbal products like Echinacea are regulated like dietary supplements in the United States. Thus, manufacturers are responsible only for their production processes. Imported herbals may not meet U.S. manufacturing standards. Approval of herbals is based on traditional use, not demonstrated safety and effectiveness. Before an herbal can be forcefully withdrawn from the market, the FDA must prove that it is unsafe.

Many herbal products vary from stated label potency.

Side effects

People who are allergic to ragweed, mums, marigolds or daisies, or who have **asthma** may also react negatively to Echinaceae.

In therapeutic doses, Echinacea is generally safe. Approximately 1% of people taking the herb experience mild abdominal discomfort.

Interactions

Drug-herbal and herbal-herbal interactions are not well understood and have not been thoroughly tested. Patients must be careful observers of themselves for changes as they take new drugs or herbs, or as they take these products over many months.

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KEY TERMS

Allergenic—A substance capable of causing an allergic reaction.

Cholangitis—Infection or inflammation of the bile ducts; often causes abdominal pain, fever, and jaundice.

Computed tomography (CT) scan—A specialized x-ray procedure in which cross-sections of the area in question can be examined in detail.

Cyst—A protective sac that includes either fluid or the cell of an organism. The cyst enables many organisms to survive in the environment for long periods of time without need for food or water.

Embryo—The very beginning stages of development of an organism.

Jaundice—The yellow-greenish coloring of the skin and eyes due to the presence of bile pigments. The presence of jaundice is usually, but not always, a sign of liver disease.

Tapeworm—An intestinal parasite that attaches to the intestine or travels to other organs such as the liver and lungs.

Ultrasound—A noninvasive procedure based on changes in sound waves of a frequency that cannot be heard, but respond to changes in tissue composition.

Resources

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James Waun, MD, RPh,

Echinococcosis

Definition

Echinococcosis (Hydatid disease) refers to human infection by the immature (larval) form of tapeworm, *Echinococcus*. One of three forms of the *Echinococcus* spp., *E. granulosus*, lives on dogs and livestock, and infects humans through contact with these animals. Allergic reactions and damage to various organs from cyst formation are the most common forms of disease in humans.

Description

E. granulosus is found in many areas of Africa, China, South America, Australia, New Zealand, and Mediterranean and eastern Europe, as well as in parts of the western United States. The parasite lives in regions where dogs and livestock cohabitate. Direct exposure to infectious dogs, as well as parasitic eggs released into the environment during shedding, are both sources of human infection.

In humans, cysts containing the larvae develop after ingestion of eggs. Cysts form primarily in the lungs and liver. Cysts developing in the liver are responsible for about two-thirds of echinococcosis cases. Echinococcosis is a significant public health problem in many areas of the world, but control programs have decreased the rate of infection in some regions. In Kenya alone, the numbers of persons infected each year is as high as 220 per 100,000 population.

Causes and symptoms

After ingestion, the eggs develop into embryos within the intestines and then travel to the liver and lungs through major blood vessels. The embryos then begin to form cysts within the liver and lungs, causing damage as they enlarge over a period of five to 20 years. Cysts may become over 8 in (20.3 cm) or more in size and contain a huge amount of highly allergenic fluid. Studies show that while the liver is most often targeted, lungs, brain, heart, and bone can also be affected.

The major symptoms are due to compression damage, blockage of vessels and ducts (such as the bile ducts), and leakage of fluid from cysts. The following symptoms are frequent.

- Liver involvement causes pain and eventually jaundice or cholangitis due to blockage of bile ducts. Infection of cysts leads to abscesses in up to 20%.
- Lung cysts cause cough and chest pain.
- Bone cysts cause fractures and damage to bone tissue.
- Heart involvement leads to irregularities of heart beat and inflammation of the covering of the heart (pericardium).
- Allergic reactions occur from leakage of cyst fluid that contains antigens. Itching, fever, and rashes are

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frequent, and fatal allergic reactions (anaphylaxis) have been reported. Eosinophils, which are blood cells involved in allergic reactions, are increased in many patients.

Diagnosis

X rays, **computed tomography scans** (CT scans), and ultrasound are very helpful in detecting cysts. Some cysts will develop characteristic hardening of organ tissues from **calcium** deposits (calcifications). Blood tests to detect antibodies are useful when positive, but up to 50% of patients have negative results. Examination of aspirated cyst fluid for parasites can be diagnostic, but carries the danger of a fatal allergic reaction. Treatment with anti-parasitic medications before aspiration is reported to decrease allergic complications and decrease the risk of spread during the procedure.

Treatment

Treatment depends on the size and location of cysts, as well as the symptoms they are producing. Surgical removal of cysts and/or surrounding tissue is the accepted method of treatment, but carries a risk of cyst rupture with spread or allergic reactions. Recent studies using medication alongside aspiration and drainage of cysts instead of surgery are very encouraging.

The medication albenzadole can be taken before or after surgery or alone without surgery. However, its effectiveness as a single treatment is still not known. Multiple courses of medication are often necessary, with cure rates of only about 30%. Response to treatment is best monitored by serial CT scans or similar x-ray studies.

Prevention

Good hand washing, treating infected dogs, and preventing dogs' access to slaughter houses discourage spread of the disease. Limiting the population of stray dogs has also been helpful.

Resources

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David Kaminstein, MD

Echinococcus granulosus infection *see* **Echinococcosis**

Echocardiography

Definition

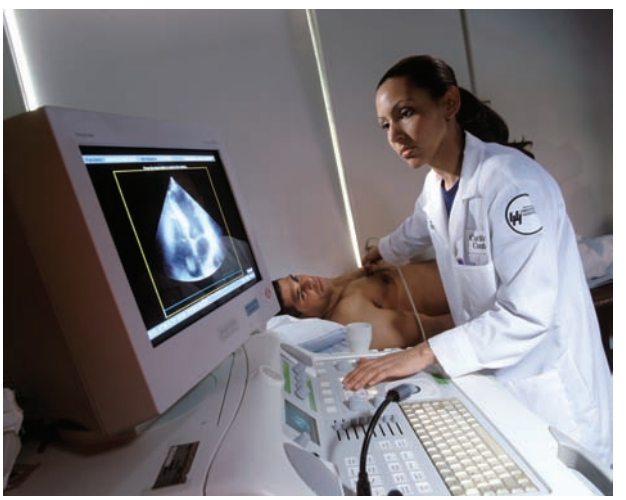
Echocardiography is a noninvasive diagnostic test that uses ultrasound waves to produce an moving image of the heart.

Purpose

Echocardiography is one of the most widely used diagnostic tests for heart disease. Ultrasound waves generated by a device placed on the skin rebound or echo off the heart and are processed by a computer. The resulting image can show the size, shape, and movement of the heart's valves and chambers, as well as the flow of blood through the heart.

Echocardiography may reveal abnormalities such damage to the heart tissue from a **heart attack** or as a poorly functioning heart valve. Echocardiography is especially useful for assessing disorders of the heart valves. It not only allows doctors to evaluate the condition of the heart valves, but also can show abnormalities in the pattern of blood flow. For example, echocardiography can show the backward flow of blood through heart valves that remain partially open and should be fully closed.

By assessing the motion of the heart wall, echocardiography can help detect the presence and assess the severity of **coronary artery disease**, as well as help determine whether chest **pain** is related to heart disease. Additionally, echocardiography can help detect **hypertrophic cardiomyopathy**, a condition in which



A patient during an echocardiography test. *(© Yoav Levy/Phototake. — All rights reserved.)*

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the walls of the heart thicken in an attempt to compensate for heart muscle weakness.

Echocardiography is also used to evaluate **heart murmurs** (abnormal heart sounds), determine the causes of congestive **heart failure**, assess enlarged hearts, hearts with septal defects (holes between pumping chambers), and to monitor the heart in patients with diseases that may affect heart function (e.g., lupus erythematosus, lung diseases). The biggest advantage to echocardiography is that it is noninvasive (it does not involve breaking the skin or entering body cavities), and it has no known risks or side effects. It also gives a more detailed picture of the heart than other imaging techniques. Echocardiography is often used in conjunction with other diagnostic tests for the heart such as **electrocardiography**.

Echocardiography is usually performed in the cardiology department at a hospital, but may also be performed in a cardiologist's office or an outpatient imaging center. Because the ultrasound scanners used to perform echocardiography are portable (handheld) or mobile, echocardiography can be performed in a hospital emergency department or at the bedside of patients who cannot be moved.

Description

Echocardiography creates an image of the heart using ultra-high-frequency sound waves—sound waves that are too high in frequency to be heard by the human ear. The technique is very similar to ultrasound scanning commonly used to visualize the fetus during **pregnancy**.

An echocardiography examination generally lasts 15–30 minutes. The patient lies bare-chested on an examination table. A special gel is spread over the chest to help the transducer make good contact and to slide smoothly over the skin. The transducer, also called a probe, is a small handheld device at the end of a flexible cable. The transducer is placed against the chest and directs ultrasound waves into the chest. Some of the waves get echoed (or reflected) back to the transducer. Since different tissues and blood reflect ultrasound waves differently, these returning sound waves can be translated into a meaningful image of the heart that is displayed on a monitor and recorded. The patient does not feel the sound waves, and the entire procedure is painless.

Occasionally, variations of the echocardiography test are used. For example, Doppler echocardiography employs a special transducer that allows technicians to measure and analyze the direction and speed of blood flow through blood vessels and heart valves. This makes it especially useful for detecting and evaluating backflow through the heart valves. By assessing the speed of blood flow at different locations around an obstruction, it can also help to precisely locate the obstruction.

KEY TERMS

Lupus erythematosus—A chronic autoimmune disease that affects the skin, joints, and certain internal organs.

An **exercise** echocardiogram, or stress echo, is an echocardiogram performed during exercise, when the heart muscle must work harder to supply blood to the body. This allows doctors to detect heart problems that might not be evident when the body is at rest and needs less blood. For patients who are unable to exercise, certain drugs can be used to mimic the effects of exercise by dilating the blood vessels and making the heart beat faster.

A transesophageal is done when it is difficult to get a clear picture of the heart using standard electrocardiogram techniques (e.g., interference from internal scar tissue, **obesity**). A transducer is attached to an endoscope, a thin tube that is threaded down the throat after it has been numbed. This position allows a clearer picture of the heart.

During the examination, a trained sonographer takes measurements and, using the ultrasound scanner's computer, make calculations, including measuring blood flow speed. Most ultrasound scanners are equipped with videotape recorders or digital imaging/archiving devices to record the real-time examination, and with medical image printers to print out hard copies of still images. Information from the echocardiogram is then evaluated by a cardiologist.

Preparation

The patient removes any clothing and jewelry above the waist.

Aftercare

No special measures need to be taken following echocardiography. The procedure is painless.

Risks

There are no known complications associated with the use of echocardiography. There is a slight risk of having a heart attack during an exercise echocardiogram, due to the stress put on the heart during the test,

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mostly for patients with a history of heart attack or other risk factors.

Normal results

A normal echocardiogram shows a normal heart structure and the normal flow of blood through the heart chambers and heart valves. However, a normal echocardiogram does not rule out the possibility certain types of heart disease.

An echocardiogram may show a number of abnormalities in the structure and function of the heart, including:

- thickening of the wall of the heart muscle (especially the left ventricle)
- abnormal motion of the heart muscle
- blood leaking backward through the heart valves
- decreased blood flow through a heart valve due to narrowing of the valve (stenosis)

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ORGANIZATIONS

American College of Cardiology, Heart House, 2400 N Street NW, Washington, DC, 20037, (202) 375-6000, (202) 375-7000, resource@acc.org, http://www.acc.org.

American Heart Association, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, http://www.americanheart.org.

American Registry of Diagnostic Medical Sonographers, 51 Monroe Street, Plaza One East, Rockville, MD, 20850-2400, (301) 738-8401, (800) 541-9754, (301) 738-031, http://www.ardms.org.

American Society of Echocardiography, 2100 Gateway Centre Boulevard, Suite 310, Morrisville, NC, 27560, (919) 861-5574, (919) 882-9900, http://www.asecho.org.

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Echovirus infections *see* **Enterovirus infections**

Eclampsia *see* **Preeclampsia and eclampsia**

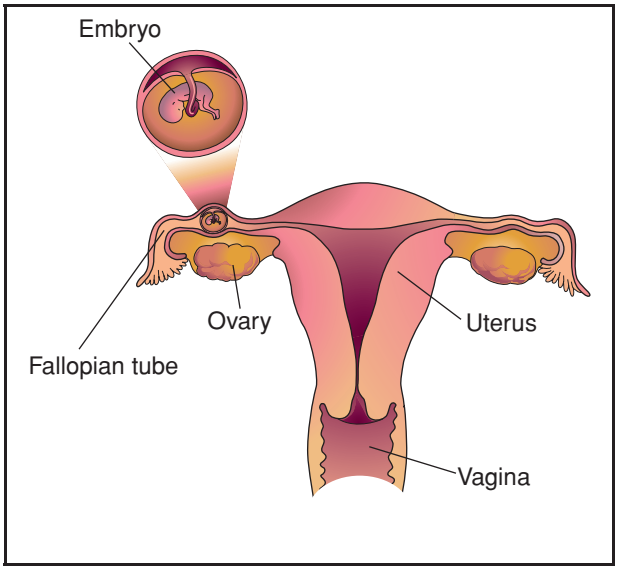
ECT *see* **Electroconvulsive therapy**

Ectopic orifice of the ureter *see* **Congenital ureter anomalies**

Ectopic pregnancy

Definition

In an ectopic **pregnancy**, the fertilized egg implants in a location outside the uterus and tries to develop there. The word ectopic means "in an abnormal place or position." The most common site is the fallopian tube, the tube that normally carries eggs from the ovary to the uterus. However, ectopic pregnancy can also occur in the ovary, the abdomen, and the cervical canal (the opening from the uterus to the vaginal canal). The phrases tubal pregnancy, ovarian pregnancy, cervical pregnancy, and abdominal pregnancy refer to the specific area of an ectopic pregnancy.



In an ectopic pregnancy, the fertilized egg implants in a location outside the uterus and attempts to develop at that site. The most common site of an ectopic pregnancy is the fallopian tube, but it can occur in the ovary, the abdomen, and the cervical wall. More than 95% of all ectopic pregnancies occur in the fallopian tube. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

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Description

Once a month, an egg is produced in a woman's ovary and travels down the fallopian tube where it meets the male's sperm and is fertilized. In a normal pregnancy the fertilized egg, or zygote, continues on its passage down the fallopian tube and enters the uterus in three to five days. The zygote continues to grow, implanting itself securely in the wall of the uterus. The zygote's cells develop into the embryo (the organism in its first two months of development) and placenta (a spongy structure that lines the uterus and nourishes the developing organism).

In a tubal ectopic pregnancy, the fertilized egg cannot make it all the way down the tube because of scarring or obstruction. The fallopian tube is too narrow for the growing zygote. Eventually the thin walls of the tube stretch and may burst (rupture), resulting in severe bleeding and possibly the **death** of the mother. More than 95% percent of all ectopic pregnancies occur in the fallopian tube. Only 1.5% develop in the abdomen; less than 1% develop in the ovary or the cervix.

Causes and symptoms

As many as 50% of women with ectopic pregnancies have a history of **pelvic inflammatory disease** (PID). This is an infection of the fallopian tubes (salpingitis) that can spread to the uterus or ovaries. It is most commonly caused by the organisms *Gonorrhea* and *Chlamydia* and is usually transmitted by sexual intercourse.

Other conditions also increase the risk of ectopic pregnancy. They include:

- Endometriosis. A condition in which the tissue that normally lines the uterus is found outside the uterus, and can block a fallopian tube.
- Exposure to diethylsilbestrol (DES) as a fetus. If a woman's mother took DES (a synthetic version of the hormone estrogen) during pregnancy, the woman may have abnormalities in her fallopian tubes that can make ectopic pregnancy more likely.
- Taking hormones. Estrogen and progesterone are hormones that regulate the menstrual cycle and may be in medications prescribed by a doctor for birth control or other reasons. Taking these hormones can affect the interior lining of the fallopian tubes and slow the movement of the fertilized egg down the tube. Women who become pregnant in spite of taking some progesterone-only contraceptives have a greater chance of an ectopic pregnancy. Ectopic pregnancy is also more likely when the ovaries are artificially stimulated with hormones to produce eggs for in vitro fertilization (a procedure in which eggs are taken from a woman's body, fertilized, and then placed in the uterus in an attempt to conceive a child).
- Use of an intrauterine device (IUD). These contraceptive devices are designed to prevent fertilized eggs from becoming implanted in the uterus, but they have only a minimal effect on preventing ectopic pregnancies. Therefore, if a woman becomes pregnant while using an IUD for contraception, the fertilized egg is more likely to be implanted someplace other than the uterus. For example, among women who become pregnant while using a progesterone-bearing IUD, about 15% have ectopic pregnancies.
- Surgery on a fallopian tube. The risk of ectopic pregnancy can be as high as 60% after undergoing elective tubal sterilization, a procedure in which the fallopian tubes are severed to prevent pregnancy. Women who have successful surgery to reverse the procedure are also more likely to have an ectopic pregnancy.

Early symptoms

In an ectopic pregnancy all the hormonal changes associated with a normal pregnancy may occur. The early symptoms include: **fatigue**; **nausea**; a missed period; breast tenderness; **low back pain**; mild cramping on one side of the pelvis; and abnormal vaginal bleeding, usually spotting.

Later symptoms

As the embryo grows too large for the confined space in the tube, the first sign that something is wrong may be a stabbing **pain** in the pelvis or abdomen. If the tube has ruptured, blood may irritate the diaphragm and cause shoulder pain. Other warning signs are lightheadedness and **fainting**.

Diagnosis

To confirm an early diagnosis of ectopic pregnancy, the doctor must determine first that the patient is pregnant and that the location of the embryo is outside the uterus. If an ectopic pregnancy is suspected, the doctor will perform a pelvic examination to locate the source of pain and to detect a mass in the abdomen.

Several laboratory tests of the patient's blood provide information for diagnosis. Measurement of the human chorionic gonadotropin (hCG) level in

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the patient's blood serum is the most useful laboratory test in the early stages. In a normal pregnancy, the level of this hormone doubles about every two days during the first 10 weeks. In an ectopic pregnancy, the rate of the increase is much slower and the low hCG for the stage of the pregnancy is a strong indication that the pregnancy is abnormal. (It could also represent a **miscarriage** in progress.) The level is usually tested several times over a period of days to determine whether or not it is increasing at a normal rate.

Progesterone levels in the blood are also measured. Lower than expected levels can indicate that the pregnancy is not normal.

An ultrasound examination may provide information about whether or not the pregnancy is ectopic. A device called a transducer, which emits high frequency sound waves, is moved over the surface of the patient's abdomen or inserted into the vagina. The sound waves bounce off of the internal organs and create an image on a screen. The doctor should be able to see whether or not there is a fetus developing in the uterus after at least five weeks of gestation. Before that point, a normal pregnancy is too small to see.

A culdocentesis may also help confirm a diagnosis. In this procedure a needle is inserted into the space at the top of the vagina, behind the uterus and in front of the rectum. Blood in this area may indicate bleeding from a ruptured fallopian tube.

A **laparoscopy** will enable the doctor to see the patient's reproductive organs and examine an ectopic pregnancy. In this technique, a hollow tube with a light on one end is inserted through a small incision in the abdomen. Through this instrument the internal organs can be observed.

Treatment

Ectopic pregnancy requires immediate treatment. The earlier the condition is treated, the better the chance to preserve the fallopian tube intact for future normal pregnancies.

Medical

If the ectopic pregnancy is discovered in a very early stage of development, the drug methotrexate may be given. The best results are obtained when the pregnancy is less than six weeks old and the tubal mass is no more than 1.4 in (3.5 cm) in diameter. Methotrexate, which has been used successfully since 1987, works by inhibiting the growth of rapidly growing cells. (It is also used to treat some cancers.) Most side effects are mild and temporary, but the patient must be monitored after treatment. Usually the medication is injected into the muscle in a single dose, but may also be given intravenously or injected directly into the fallopian tube to dissolve the embryonic tissue. Methotrexate has also been used to treat ovarian, abdominal, and cervical pregnancies that are discovered in the early stages.

Surgical

When a laparoscopy is done to visualize the ectopic pregnancy, the scope can be fitted with surgical tools and used to remove the ectopic mass immediately after it is identified. The affected fallopian tube can be repaired or removed as necessary. This procedure can be done without requiring the patient to stay in the hospital overnight.

When the pregnancy has ruptured, a surgical incision into the abdomen, or laparotomy, is performed to stop the immediate loss of blood and to remove the embryo. This usually requires **general anesthesia** and a hospital stay. Every effort is made to preserve and repair the injured fallopian tube. However, if the fallopian tube has already ruptured, repair is extremely difficult and the tube is usually removed.

Alternative treatment

Ectopic pregnancy was first described in the eleventh century and was a potentially fatal condition until the advent of surgery and blood transfusions in the early twentieth century. The sophisticated diagnostic tools and surgical procedures developed since the 1970s have equipped modern medicine with the tools to not only save a woman's life, but also to preserve her future fertility.

Although there are herbal remedies for the temporary relief of the common symptoms of **anxiety** and abdominal discomfort, prompt medical treatment is the only sure remedy for ectopic pregnancy.

Prognosis

Ectopic pregnancies are the leading cause of pregnancy-related deaths in the first trimester and account for 9% of all pregnancy-related deaths in the United States. More than 1% of pregnancies are ectopic, and they are becoming more common. The reason for this increase is not clearly understood, though it is thought that the dramatic increase in **sexually transmitted diseases** (STD) is at least partly responsible.

The earlier an ectopic pregnancy is diagnosed and treated, the better the outcome. The chances of having a successful pregnancy are lower after an ectopic pregnancy, but depend on the extent of permanent

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KEY TERMS

Embryo—In humans, the developing organism from conception until approximately the end of the second month.

Fallopian tube—The tube that carries the egg from the ovary to the uterus.

Human chorionic gonadotropin (hCG)—A hormone excreted during the development of an embryo or fetus.

Laparoscopy—Examination of the contents of the abdominal cavity with a fiberoptic tube inserted through a small incision.

Laparotomy—Surgical incision into the abdomen to locate, repair, and/or remove injured or diseased tissues.

Pelvic inflammatory disease (PID)—Acute or chronic inflammation in the pelvic cavity, particularly inflammation of the fallopian tubes (salpingitis) and its complications.

Rupture—A breaking apart of an organ or tissue.

Salpingitis—Inflammation of the fallopian tube.

Tubal pregnancy—Pregnancy in one of the fallopian tubes.

Zygote—The fertilized egg.

fallopian tube damage. If the tube has been spared, chances are as high as 60%. The chances of a successful pregnancy after the removal of one tube are 40%.

Prevention

Many forms of ectopic pregnancy cannot be prevented. However, tubal pregnancies, which make up the majority of ectopic pregnancies, may be prevented by avoiding conditions that cause damage to the fallopian tubes. Since half of all women who experience ectopic pregnancy have a history of PID, avoiding this infection or getting early diagnosis and treatment for sexually transmitted diseases will decrease the risk of a future problem.

ORGANIZATIONS

Resolve, 1760 Old Meadow Rd., Suite 500, McLean, VA, 22102, (703) 556-7172, (703) 506-3266, http://www.resolve.org.

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Eczema

Definition

Eczema, also called **atopic dermatitis** (AD), is a non-contagious inflammation of the skin characterized by dry, red, itchy, and oozing lesions that become scaly, crusty, or hardened. Various other types of **dermatitis** are sometimes referred to as eczema or eczematous, although AD is the most common type.

Demographics

Worldwide 10–20% of people develop atopic dermatitis at some point in their lives. Although eczema can affect anyone at any age, it is most common in children under age five. An estimated 65% of eczema cases begin during the first year of life and 90% develop before the age of five. The incidence of eczema and other allergic diseases appears to have increased in recent decades. As of 2009 it was estimated that almost one in ten American babies develop eczema.

Description

Eczema is sometimes described as "the itch that rashes," because scratching irritated areas sometimes initiates a rash. Eczema can be mild and intermittent or severe and chronic, disappearing as children grow up or lasting a lifetime. Eczema is frequently related to some form of allergy, including **allergies** to foods or inhalants.

The areas of the body affected by eczema tend to vary with age. Infants frequently have eczema on the face and other areas of the head. The stomach and limbs also may be affected. Older children commonly have more severe eczema on flexor surfaces—the inner wrists and elbows, backs of the knees, and tops of the ankles, as well as the hands and feet. The knees, elbows, hands, and feet may continue to be a problem into adulthood. Occasionally eczema becomes widespread throughout the body.

Other types of dermatitis that may be described as eczematous, but which usually affect older children and adults, include:

- contact dermatitis, which results from skin contact with an irritant or allergen
- nummular dermatitis, which usually affects people over the age of 55
- stasis dermatitis, which results from poor circulation in the legs

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KEY TERMS

Allergic reaction—An immune system reaction to a substance in the environment; symptoms include rash, inflammation, sneezing, itchy watery eyes, runny nose, or skin irritations.
Antigen—A foreign protein or particle that causes the body to produce specific antibodies that bind to the antigen.
Atopy—Allergies, such as eczema, that are probably hereditary, with symptoms that develop upon exposure to specific environmental allergens.
Corticosteroids—A group of hormones produced by the adrenal glands or manufactured synthetically. They are often used to treat inflammation. Examples include cortisone and prednisone.

Dermatitis—Inflammation of the skin.

Patch test—Scratch test; a test to identify allergens, in which the suspected substance is pricked or scratched into the skin and observed for the development of redness and swelling that are indicative of an allergic reaction.

Rash—Spotted, pink or red skin eruptions that may be accompanied by itching.

Risk factors

The major risk factor for eczema appears to be a family history of eczema and/or allergies.

Causes and symptoms

In many cases the exact cause of eczema is unknown, although it often appears to result from an interaction between an inherited genetic predisposition towards allergies and exposure to specific environmental allergens, especially those that are inhaled or ingested.

The hallmark sign of eczema is a red, itchy rash and skin that is abnormally dry. Chronic or severe cases of eczema can result in thick plaques (patches of slightly raised skin), serous (watery) exudates, or infection.

Diagnosis

Examination

Eczema is diagnosed by the appearance and location of the rash. An individual or family history of allergies, including **food allergies**, hay **fever**, or **asthma**, supports the diagnosis of eczema.

Tests

There are no laboratory tests for diagnosing eczema. Sometimes dermatologists conduct skin tests—scratch or patch tests or intradermal injections—to attempt to identify suspected allergens. A small amount of the suspected allergen is dabbed, scratched, or pricked into the skin, usually on the back. If no irritation develops within a few days, patch tests for other suspected allergens may be performed sequentially. Blood tests can measure the levels of immunoglobulin E (IgE)—the antibodies involved in allergic reactions—and, in some cases, the levels of IgE that are specific for a given antigen.

Procedures

In rare cases a **skin biopsy** may be required to rule out certain diseases.

Treatment

Traditional

The best treatment for eczema is to identify the cause and eliminate it. Since this is often not possible, medications and home treatments for hydrating the skin are the best options. Since **itching** or scratching eczema can irritate and damage the skin and cause **rashes**, any treatment that reduces the itching is helpful.

Drugs

Drug treatments for eczema include:

- oral antihistamines to decrease itching
- calamine lotion
- mild topical corticosteroids containing at least 1% hydrocortisone
- rarely, oral corticosteroids for severe itching and inflammation
- topical antibiotics to prevent or treat infection
- oral antibiotics for widespread infection
- topical pimecrolimus (Elidel) and tacrolimus (Protopic)—immunomodulators that may be used in adults and children over age two when other treatments have failed

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Alternative

Light therapy or **phototherapy** can effectively treat eczema, either by controlled exposure to natural sunlight or artificial ultraviolet A (UVA) and/or ultraviolet B (UVB) light. However a dermatologist should be consulted about the benefits and risks of phototherapy.

There are a number of alternative therapies that may prove helpful for treating eczema:

- acupuncture
- autogenic training, meditation, and self-hypnosis
- hypnotherapy—using the power of suggestion to relieve itching
- massage to reduce stress
- reflexology focusing on areas of the body corresponding to the eczema-affected patches, as well the solar plexus, adrenal glands, pituitary gland, liver, kidneys, gastrointestinal tract, and reproductive glands
- aromatherapy with small amounts of essential oils of lavender, bergamot, and geranium to decrease itching and inflammation; however improper dilutions of essential oils can worsen eczema
- evening primrose (*Oenothera biennis*) oil (EPO) diluted in a carrier oil and massaged into the skin

Herbal therapies that are often recommended for skin conditions such as eczema include:

- calendula (*Calendula officinalis*) ointment, for its anti-inflammatory and antiseptic properties
- chickweed (*Stellaria media*) ointment, to soothe itching
- evening primrose oil—topically to relieve itching and internally as a fatty acid supplement
- German chamomile (*Chamomilla recutita*) ointment, for its anti-inflammatory properties
- nettle (*Urtica dioica*) ointment, to relieve itching
- peppermint (*Menta piperita*) lotion, for its antibacterial and antiseptic properties
- traditional Chinese herbal formulas, both applied topically and taken internally, to moisten the skin, prevent itching, nourish the blood, and encourage healing Individuals vary in their responses to herbal treatments. Chronic, severe, or infected eczema requires the attention of a healthcare professional.

Various **nutritional supplements** may aid in treating eczema:

- Oral EPO, which contains gamma-linolenic acid, has been shown to significantly reduce itching from eczema at doses of approximately 6 grams (g) daily.
- Fish oil at a dose of about 1.8 g per day has been shown to improve AD.
- Vitamin C can promote both skin healing and the immune system. Doses of 50–75 milligrams per kilogram (mg/kg) of body weight have been shown to relieve symptoms of AD.
- Supplemental copper may be required with high doses of vitamin C.
- Vitamin E may be of use in treating eczema.

Home remedies

Home care for eczema focuses on keeping the skin clean and moist and avoiding irritants and known allergens as much as possible. Frequent long, tepid soaks help hydrate very dry skin; however soaking in plain water can be painful during severe episodes of eczema:

- Adding one-half cup of table salt to one-half tub of water creates a normal saline solution, similar to that present in the body tissues, and may relieve burning.
- Adding baking soda, a muslin bag filled with milled oats, or the commercial preparation Aveeno to the water can be soothing.
- Research has shown that dilute bleach baths—one-half cup (118 milliliters) of bleach in 40 gallons (151 liters) of warm water—can treat eczema by killing bacteria growing on the skin. The affected areas should be soaked for 5–10 minutes once or twice per week.
- Commercial Domeboro powder may be helpful.
- Bath water should cover as much of the skin as possible. Wet towels may be draped around the shoulders, upper trunk, and arms if they are above the water level.
- The face should be dabbed frequently during bathing to keep it moist.
- The use of soap should be minimized and limited to very mild agents such as Cetaphil.

Drying off should involve two–three minutes of gentle patting, followed by the thick application of a water-barrier ointment, such as Aquaphor, Unibase, or Vaseline. Oil or creams applied to damp skin can seal in moisture. However moisturizing lotions containing alcohol dry the skin and may burn when applied to eczema. Babies' skin should be kept lubricated with appropriate bath oils, lotions, creams, or ointments.

Soaking wraps are an alternative to bathing. Cotton towels or other cloths are soaked in tepid water, possibly containing table salt or Domeboro powder, and used to cover the bare skin as thoroughly as

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possible. The patient lies on a bed with a waterproof sheet and is covered by a second waterproof covering, such as vinyl sheeting or plastic wrap, to slow evaporation. The wraps are left in place for as long as possible, but for at least 30 minutes, followed by the application of a water barrier and any topical medications.

Environmental changes can provide relief for many eczema sufferers:

- Pet dander and cigarette smoke should be kept out of the home, or at least out of the room.
- Clothing should be loose fitting to prevent irritation from rubbing.
- Clothing and bedding should be 100% soft cotton.
- Clothing and bedding should be washed before initial use to rid them of potentially irritating residues.
- Laundry soap should by dye- and perfume-free.
- Laundry should be run through a double-rinse cycle to remove any vestiges of detergent.
- Bedding should be washed in hot water to kill dust mites, which can be major irritants to people with eczema.
- Fabric softener or dryer sheets are frequently scented and may be irritating.
- Clothes and bedding should not be dried outdoors where pollen and other potential allergens can cling to them.
- Mattresses and pillowcases can be covered by special casings that are impervious to microscopic dust mites.
- Dust-collecting items, such as curtains, carpeting, and stuffed animals, should be kept to a minimum.
- Vacuuming and dusting should be performed regularly when the patient is out of the room.

Temperature extremes can aggravate eczema, so heating and cooling should be employed appropriately, along with the use of a home humidifier. Eczema can interfere with normal body temperature regulation and can be aggravated by sweating. Central air-conditioning is preferable to evaporative cooling or open windows that can bring allergens into the house. Car air-conditioning is preferable to open windows. Electrostatic filters and vent covers can remove irritants from household air. These should be changed or cleaned frequently. A HEPA filter unit and a vacuum with a built-in HEPA filter can remove a high percentage of the dust and pollen.

It is difficult to keep children from scratching and damaging irritated and itchy skin:

- Fingernails should be kept short, using a nail file for a smoother edge.
- Pajamas and clothing with maximum coverage help to protect the bare skin from fingernails.
- Mittens or socks can be used to prevent scratching at night.
- Infant gowns with hand coverings are useful for very young children.

Prognosis

Although there is no cure for eczema, most children improve with age, often by age five. For others however, eczema is a lifelong problem. Diligent daily skin care and avoidance of known triggers can largely control most cases. However as many as 75% of children with eczema will develop other allergies, including hay fever, food allergies, or asthma.

Prevention

Breastfeeding an infant may help prevent eczema, particularly if there is a family history of eczema or allergies. It also may help for the breastfeeding mother to avoid foods that are common allergens. These include wheat, eggs, milk products, peanuts, and fish. If breastfeeding is not possible, a hypoallergenic formula should be used if there is family history of allergies.

Avoidance of known triggers and diligent skin care can minimize eczema flare-ups. A twice-daily emollient (moisturizing) routine should be followed even when the eczema appears to be under control. Eczematous skin is more susceptible to infection and patients should try to avoid contact with people infected with **chickenpox**, **cold sores**, and other contagious skin infections.

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"What is Eczema?" *American Academy of Dermatology*. http://www.skincarephysicians.com/eczemanet/whatis.html

ORGANIZATIONS

American Academy of Dermatology, PO Box 4014, Schaumburg, IL, 60168, (847) 240-1280, (866) 503-SKIN (7546), (847) 240-1859, http://www.aad.org.

American Academy of Family Physicians, 11400 Tomahawk Creek Parkway, Leawood, KS, 66211-2680, (913) 906-6000, (800) 274-6000, (913) 906-6075, http://www.aafp.org/online/en/home.html.

Food Allergy & Anaphylaxis Network, 11781 Lee Jackson Hwy., Suite 160, Fairfax, VA, 22033-3309, (800) 929-4040, (703) 691-2713, faan@foodallergy.org, http://www.foodallergy.org.

National Center for Complementary and Alternative Medicine, National Institutes of Health, 9000 Rockville Pike, Bethesda, MD, 20892, info@nccam.nih.gov, http://nccam.nih.gov.

National Eczema Association, 4460 Redwood Highway, Suite 16D, San Rafael, CA, 94903-1953, (415) 499-3474, (800) 818-7546, info@nationaleczema.org, http://www.nationaleczema.org.

National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS), Information Clearinghouse, National Institutes of Health, 1 AMS Circle, Bethesda, MD, 20892-3675, (301) 495-4484, (877) 22-NIAMS (226-4267), (301) 718-6366, NIAMSinfo@mail.nih.gov, http://www.niams.nih.gov.

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ED *see* **Impotence**

Edema

Definition

Edema is a condition of abnormally large fluid volume in the circulatory system or in tissues between the body's cells (interstitial spaces).

Description

Normally the body maintains a balance of fluid in tissues by ensuring that the same of amount of water entering the body also leaves it. The circulatory system transports fluid within the body via its network of blood vessels. The fluid, which contains oxygen and nutrients needed by the cells, moves from the walls of the blood vessels into the body's tissues. After its nutrients are used up, fluid moves back into the blood vessels and returns to the heart. The lymphatic system (a network of channels in the body that carry lymph, a colorless fluid containing white blood cells to fight infection) also absorbs and transports this fluid. In edema, either too much fluid moves from the blood vessels into the tissues, or not enough fluid moves from the tissues back into the blood vessels. This fluid imbalance can cause mild to severe swelling in one or more parts of the body.

Causes and symptoms

Many ordinary factors can upset the balance of fluid in the body to cause edema, including:

- Immobility. The leg muscles normally contract and compress blood vessels to promote blood flow with walking or running. When these muscles are not used, blood can collect in the veins, making it difficult for fluid to move from tissues back into the vessels.

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Gross lymphedema in the arm of an elderly woman following radiotherapy treatment for breast cancer. *(Dr. P. Marazzi/Photo Researchers, Inc.)*

- Heat. Warm temperatures cause the blood vessels to expand, making it easier for fluid to cross into surrounding tissues. High humidity also aggravates this situation.
- Medications. Certain drugs, such as steroids, hormone replacements, nonsteroidal anti-inflammatory drugs (NSAIDs), and some blood pressure medications may affect how fast fluid leaves blood vessels.
- Intake of salty foods. The body needs a constant concentration of salt in its tissues. When excess salt is taken in, the body dilutes it by retaining fluid.
- Menstruation and pregnancy. The changing levels of hormones affect the rate at which fluid enters and leaves the tissues.

Some medical conditions may also cause edema, including:

- Heart failure. When the heart is unable to maintain adequate blood flow throughout the circulatory system, the excess fluid pressure within the blood vessels can cause shifts into the interstitial spaces. Left-sided heart failure can cause pulmonary edema, as fluid shifts into the lungs. The patient may develop rapid, shallow respirations, shortness of breath, and a cough. Right-sided heart failure can cause pitting edema, a swelling in the tissue under the skin of the lower legs and feet. Pressing this tissue with a finger tip leads to a noticeable momentary indentation.
- Kidney disease. The decrease in sodium and water excretion can result in fluid retention and overload.
- Thyroid or liver disease. These conditions can change the concentration of protein in the blood, affecting fluid movement in and out of the tissues. In advanced liver disease, the liver is enlarged and fluid may build-up in the abdomen.
- Malnutrition. Protein levels are decreased in the blood, and in an effort to maintain a balance of concentrations, fluid shifts out of the vessels and causes edema in tissue spaces.

Some conditions that may cause swelling in just one leg include:

- Blood clots. Clots can cause pooling of fluid and may be accompanied by discoloration and pain. In some instances, clots may cause no pain.

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- Weakened veins. Varicose veins, or veins whose walls or valves are weak, can allow blood to pool in the legs. This is a common condition.
- Infection and inflammation. Infection in leg tissues can cause inflammation and increasing blood flow to the area. Inflammatory diseases, such as gout or arthritis, can also result in swelling.
- Lymphedema. Blocked lymph channels may be caused by infection, scar tissue, or hereditary conditions. Lymph that can't drain properly results in edema. Lymphedema may also occur after cancer treatments, when the lymph system is impaired by surgery, radiation, or chemotherapy.
- Tumor. Abnormal masses can compress leg vessels and lymph channels, affecting the rate of fluid movement.

Symptoms vary depending on the cause of edema. In general, weight gain, puffy eyelids, and swelling of the legs may occur as a result of excess fluid volume. Pulse rate and blood pressure may be elevated. Hand and neck veins may be observed as fuller.

Diagnosis

Edema is a sign of an underlying problem, rather than a disease unto itself. A diagnostic explanation should be sought. Patient history and presenting symptoms, along with laboratory blood studies, if indicated, assist the health professional in determining the cause of the edema.

Treatment

Treatment of edema is based on the cause. Simple steps to lessen fluid build-up may include:

- Reducing sodium intake. A high sodium level causes or aggravates fluid retention.
- Maintaining proper weight. Being overweight slows body fluid circulation and puts extra pressure on the veins.
- Exercise. Regular exercise stimulates circulation.
- Elevation of the legs. Placing the legs at least 12 in (30.5 cm) above the level of the heart for 10–15 minutes, three to four times a day, stimulates excess fluid re-entry into the circulatory system.
- Use of support stocking. Elastic stockings, available at most medical supply or drug stores, will compress the leg vessels, promoting circulation and decreasing pooling of fluid due to gravity.
- Massage. Massaging the body part can help to stimulate the release of excess fluids, but should be avoided if the patient has blood clots in the veins.

KEY TERMS

Digitalis—A naturally occuring compound used in the preparation of the medication, digoxin, prescribed to increase the heart rate and strengthen the force of the heart's contractions.

Diuretics—Medications used in the treatment of fluid overload, to promote excretion of sodium and water.

Interstitial spaces—Areas of the body occuring outside the vessels or organs, between the cells.

Pitting edema—A swelling in the tissue under the skin, resulting from fluid accumulation, that is measured by the depth of indentation made by finger pressure over a boney prominence.

- Travel breaks. Sitting for long periods will increase swelling in the feet and ankles. Standing and/or walking at least every hour or two will help stimulate blood flow.

The three "Ds"–diuretics, digitalis, and diet–are frequently prescribed for medical conditions that result in excess fluid volume. **Diuretics** are medications that promote urination of **sodium** and water. **Digoxin** is a digitalis preparation that is sometimes needed to decrease heart rate and increase the strength of the heart's contractions. Dietary recommendations include less sodium in order to decrease fluid retention. Consideration of adequate protein intake is also made.

For patients with **lymphedema**, a combination of therapies may prove effective. Combined decongestive therapy includes the use of manual lymph drainage (MLD), compression bandaging, garments and pumps, and **physical therapy**. MLD involves the use of light massage of the subcutaneous tissue where the lymph vessels predominate. Massage begins in an area of the body trunk where there is normal lymph function and proceeds to areas of lymphatic insufficiency, in an effort to stimulate new drainage tract development. (MLD should not be used for patients with active **cancer**, deep vein clots, congestive **heart failure**, or cellulitis.) MLD sessions are followed by application of compression garments or pumps. Physical therapy is aimed at strengthening the affected limb and increasing joint mobility.

Alternative treatment

Dietary changes, in addition to cutting back the amount of sodium eaten, may also help reduce edema.

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Foods that worsen edema, such as alcohol, **caffeine**, sugar, dairy products, soy sauce, animal protein, chocolate, olives, and pickles, should be avoided. Diuretic herbs can also help relieve edema. One of the best herbs for this purpose is dandelion (*Taraxacum mongolicum*), since, in addition to its diuretic action, it is a rich source of potassium. (Diuretics flush potassium from the body and it must be replaced to avoid potassium deficiency.) **Hydrotherapy** using daily contrast applications of hot and cold (either compresses or immersion) may also be helpful.

ORGANIZATIONS

Austin Wound and Lymphedema Center, 5750 Balcones Dr., Ste. 110, Austin, TX, 78731, (512) 453-1930, http://www.woundandlymphedemacare.com.

Kathleen D. Wright, RN

Edrophonium test *see* **Tensilon test**

Edwards' syndrome

Definition

Edwards' syndrome is caused by an extra copy of chromosome 18. For this reason, it is also called trisomy 18 syndrome. The extra chromosome is lethal for most babies born with this condition. It causes major physical abnormalities and severe **mental retardation**, and very few children afflicted with this disease survive beyond a year.

Description

Humans normally have 23 pairs of chromosomes. Chromosomes are numbered 1–22, and the 23rd pair is composed of the sex chromosomes, X and Y. A person inherits one set of 23 chromosomes from each parent. Occasionally, a genetic error occurs during egg or sperm cell formation. A child conceived with such an egg or sperm cell may inherit an incorrect number of chromosomes.

In the case of Edwards' syndrome, the child inherits three, rather than two, copies of chromosome 18. Trisomy 18 occurs in approximately one in every 3,000 newborns and affects girls more often than boys. Women older than their early thirties have a greater risk of conceiving a child with trisomy 18, but it can occur in younger women.

Causes and symptoms

A third copy of chromosome 18 causes numerous abnormalities. Most children born with Edwards' syndrome appear weak and fragile, and they are often underweight. The head is unusually small and the back of the head is prominent. The ears are malformed and low-set, and the mouth and jaw are small. The baby may also have a **cleft lip** or **cleft palate**. Frequently, the hands are clenched into fists, and the index finger overlaps the other fingers. The child may have clubfeet and toes may be webbed or fused.

Numerous problems involving the internal organs may be present. Abnormalities often occur in the lungs and diaphragm (the muscle that controls breathing), and heart defects and blood vessel malformations are common. The child may also have malformed kidneys and abnormalities of the urogenital system.

Diagnosis

Physical abnormalities point to Edwards' syndrome, but definitive diagnosis relies on karyotyping. Karyotyping involves drawing the baby's blood or bone marrow for a microscopic examination of the chromosomes. Using special stains and microscopy, individual chromosomes are identified, and the presence of an extra chromosome 18 is revealed.

Trisomy 18 can be detected before birth. If a pregnant woman is older than 35, has a family history of genetic abnormalities, has previously conceived a child with a genetic abnormality, or has suffered earlier miscarriages, she may undergo tests to determine whether her child carries genetic abnormalities. Potential tests include maternal serum analysis or screening, ultrasonography, **amniocentesis**, and **chorionic villus sampling**.

Treatment

There is no cure for Edwards' syndrome. Since trisomy 18 babies frequently have major physical abnormalities, doctors and parents face difficult choices regarding treatment. Abnormalities can be treated to a certain degree with surgery, but extreme invasive procedures may not be in the best interests of an infant whose lifespan is measured in days or weeks. Medical therapy often consists of supportive care with the goal of making the infant comfortable, rather than prolonging life.

Prognosis

Most children born with trisomy 18 die within their first year of life. The average lifespan is less than two months for 50% of the children, and 90–95% die before their first birthday. The 5–10% of children who survive

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KEY TERMS

Aminocentesis—A procedure in which a needle is inserted through a pregnant woman's abdomen and into her uterus to withdraw a small sample of amniotic fluid. The amniotic fluid can be examined for signs of disease or other problems afflicting the fetus.

Chorionic villus sampling—A medical test that is best done during weeks 10–12 of a pregnancy. The procedure involves inserting a needle into the placenta and withdrawing a small amount of the chorionic membrane for analysis.

Chromosome—A structure composed of deoxyribonucleic acid (DNA) contained within a cell's nucleus (center) where genetic information is stored. Human have 23 pairs of chromosomes, each of which has recognizable characteristics (such as length and staining patterns) that allow individual chromosomes to be identified. Identification is assigned by number (1–22) or letter (X or Y).

Karyotyping—A laboratory test used to study an individual's chromosome make-up. Chromosomes are separated from cells, stained, and arranged in order from largest to smallest so that their number and structure can be studied under a microscope.

Maternal serum analyte screening—A medical procedure in which a pregnant woman's blood is drawn and analyzed for the levels of certain hormones and proteins. These levels can indicate whether there may be an abnormality in the unborn child. This test is not a definitive indicator of a problem and is followed by more specific testing such as amniocentesis or chorionic villus sampling.

Trisomy—A condition in which a third copy of a chromosome is inherited. Normally only two copies should be inherited.

Ultrasound—A medical test that is also called ultrasonography. Sound waves are directed against internal structures in the body. As sound waves bounce off the internal structure, they create an image on a video screen. An ultrasound of a fetus at weeks 16–20 of a pregnancy can be used to determine structural abnormalities.

their first year are severely mentally retarded. They need support to walk, and learning is limited. Verbal communication is also limited, but they can learn to recognize and interact with others.

Prevention

Edwards' syndrome cannot be prevented.

ORGANIZATIONS

Chromosome 18 Registry & Research Society, 7155 Oakridge Drive, San Antonio, TX, 78229, (210) 657-4968, Office@Chromosome18.org, http://www.chromosome18.org.

Support Organization for Trisomy 18, 13, and Related Disorders (SOFT), 2982 South Union Street, Rochester, NY, 14624, (585) 594-4621, (800) 716-7638, barbsoft@ rochester.rr.com, http://www.trisomy.org.

Julia Barrett

EEG *see* **Electroencephalography**

Egyptian conjunctivitis *see* **Trachoma**

Ehlers-Danlos syndrome

Definition

The Ehlers-Danlos syndromes (EDS) refer to a group of inherited disorders that affect collagen structure and function. Genetic abnormalities in the manufacturing of collagen within the body affect connective tissues, causing them to be abnormally weak.

Description

Collagen is a strong, fibrous protein that lends strength and elasticity to connective tissues such as the skin, tendons, organ walls, cartilage, and blood vessels. Each of these connective tissues requires collagen tailored to meet its specific purposes. The many roles of collagen are reflected in the number of genes dedicated to its production. There are at least 28 genes in humans that encode at least 19 different types of collagen. Mutations in these genes can affect basic construction as well as the fine-tuned processing of the collagen.

EDS was originally described by Dr. Van Meekeren in 1682. Dr. Ehlers and Dr. Danlos further characterized

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Elasticity of the skin is one characteristic of this rare disorder. *(© Biophoto Associates/Photo Researchers, Inc.)*

the disease in 1901 and 1908, respectively. Today, according to the Ehlers-Danlos National Foundation, one in 5,000 to one in 10,000 people are affected by some form of EDS.

EDS is a group of genetic disorders that usually affects the skin, ligaments, joints, and blood vessels. Classification of EDS types was revised in 1997. The new classification involves categorizing the different forms of EDS into six major sub-types, including classical, hypermobility, vascular, kyphoscoliosis, arthrochalasia, and dermatosparaxis, and a collection of rare or poorly defined varieties. This new classification is simpler and based more on descriptions of the actual symptoms.

Classical type

Under the old classification system, EDS classical type was divided into two separate types: type I and type II. The major symptoms involved in EDS classical type are the skin and joints. The skin has a smooth, velvety texture and **bruises** easily. Affected individuals typically have extensive scaring, particularly at the knees, elbows, forehead, and chin. The joints are hyperextensible, giving a tendency towards dislocation of the hip, shoulder, elbow, knee, or clavicle. Due to decreased muscle tone, affected infants may experience a delay in reaching motor milestones. Children may have a tendency to develop hernias or other organ shifts within the abdomen. Sprains and partial or complete joint dilocations are also common. Symptoms can range from mild to severe. EDS classical type is inherited in an autosomal dominant manner.

There are three major clinical diagnostic criteria for EDS classical type. These include skin hyperextensibility, unusually wide **scars**, and joint hypermobility. At this time there is no definitive test for the diagnosis of classical EDS. Both DNA and biochemical studies have been used to help identify affected individuals. In some cases, a **skin biopsy** has been found to be useful in confirming a diagnosis. Unfortunately, these tests are not sensitive enough to identify all individuals with classical EDS. If there are multiple affected individuals in a family, it may be possible to perform prenatal diagnosis using a DNA information technique known as a linkage study.

Hypermobility type

Excessively loose joints are the hallmark of this EDS type, formerly known as EDS type III. Both large joints, such as the elbows and knees, and small joints, such as toes and fingers, are affected. Partial and total joint **dislocations** are common, and particularly involve the jaw, knee, and shoulder. Many individuals experience chronic limb and joint **pain**, although x rays of these joints appear normal. The skin may also bruise easily. **Osteoarthritis** is a common occurrence in adults. EDS hypermobility type is inherited in an autosomal dominant manner.

There are two major clinical diagnostic criteria for EDS hypermobility type. These include skin involvement (either hyperextensible skin or smooth and velvety skin) and generalized joint hypermobility. At this time there is no test for this form of EDS.

Vascular type

Formerly called EDS type IV, EDS vascular type is the most severe form. The connective tissue in the intestines, arteries, uterus, and other hollow organs may be unusually weak, leading to organ or blood vessel rupture. Such ruptures are most likely between ages 20 and 40, although they can occur any time, and may be life-threatening.

There is a classic facial appearance associated with EDS vascular type. Affected individuals tend to have large eyes, a thin pinched nose, thin lips, and a slim body. The skin is thin and translucent, with veins dramatically visible, particularly across the chest.

The large joints have normal stability, but small joints in the hands and feet are loose, showing hyperextensibility. The skin bruises easily. Other complications may include collapsed lungs, premature **aging** of the skin on the hands and feet, and ruptured arteries and veins. After surgery there tends to be poor wound healing, a complication that tends to be frequent and severe. **Pregnancy** also carries the risk complications. During and after pregnancy there is an increased risk of the uterus rupturing and of arterial bleeding. Due to the severe complications associated with EDS type IV,

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death usually occurs before the fifth decade. A study of 419 individuals with EDS vascular type, completed in 2000, found that the median survival rate was 48 years, with a range of six to 73 years. EDS vascular type is inherited in an autosomal dominant manner.

There are four major clinical diagnostic criteria for EDS vascular type. These include thin translucent skin, arterial/intestinal/uterine fragility or rupture, extensive bruising, and characteristic facial appearance. EDS vascular type is caused by a change in the gene COL3A1, which codes for one of the collagen chains used to build Collage type III. Laboratory testing is available for this form of EDS. A skin biopsy may be used to demonstrate the structurally abnormal collagen. This type of biochemical test identifies more than 95% of individuals with EDS vascular type. Laboratory testing is recommended for individuals with two or more of the major criteria.

DNA analysis may als be used to identify the change within the COL3A1 gene. This information may be helpful for **genetic counseling** purposes. Prenatal testing is available for pregnancies in which an affected parent has been identified and their DNA mutation is known or their biochemical defect has been demonstrated.

Kyphoscoliosis type

The major symptoms of kyphoscoliosis type, formerly called EDS type VI, are general joint looseness. At birth, the muscle tone is poor, and motor skill development is subsequently delayed. Also, infants with this type of EDS have an abnormal curvature of the spine (**scoliosis**). The scoliosis becomes progressively worse with age, with affected individuals usually unable to walk by age 20. The eyes and skin are fragile and easily damaged, and blood vessel involvement is a possibility. The bones may also be affected as demonstrated by a decrease in bone mass. Kyphoscoliosis type is inherited in an autosomal recessive manner.

There are four major clinical diagnostic criteria for EDS kyphoscoliosis type. These include generaly loose joints, low muscle tone at birth, scoliosis at birth (which worsens with age), and a fragility of the eyes, which may give the white area of the eye a blue tint or cause the eye to rupture. This form of EDS is caused by a change in the PLOD gene on chromosome 1, which encodes the enzyme lysyl hydroxylase. A laboratory test is available in which urinary hydroxylysyl pryridinoline is measured. This test, performed on urine is extremely senstive and specific for EDS kyphoscolios type. Laboratory testing is recommended for infants with three or more of the major diagnostic criteria.

Prenatal testing is available if a pregnancy is known to be at risk and an identified affected family member has had positive laboratory testing. An **amniocentesis** may be performed in which fetal cells are removed from the amniotic fluid and enzyme activity is measured.

Arthrochalasia type

Dislocation of the hip joint typically accompanies arthrochalasia type EDS, formerly called EDS type VIIB. Other joints are also unusually loose, leading to recurrent partial and total dislocations. The skin has a high degree of stretchability and bruises easily. Individuals with this type of EDS may also experience mildly diminished bone mass, scoliosis, and poor muscle tone. Arthrochalasia type is inherited in an autosomal dominant manner.

There are two major clinical diagnostic criteria for EDS arthrochalasia type. These include sever generalized joing hypermobility and bilateral hip dislocation present at birth. This form of EDS is caused by a change in either of two components of Collage type I, called proa1(I) type A and proa2(I) type B. A skin biopsy may be preformed to demonstrate an abnormality in either components. Direct DNA testing is also available.

Dermatosparaxis type

Individuals with this type of EDS, once called type VIIC, have extremely fragile skin that bruises easily but does not scar excessively. The skin is soft and may sag, leading to an aged appearance even in young adults. Individuals may also experience hernias. Dermatosparaxis type is inherited in an autosomal recessive manner.

There are two major clinical diagnostic criteria for EDS dematosparaxis type. These include severe skin fragility and sagging or aged appearing skin. This form of EDS is caused by a change in the enzyme called procollagen I N-terminal peptidase. A skin biopsy may be preformed for a definitive diagnosis of Dermatosparaxis type.

Other types

There are several other forms of EDS that have not been as clearly defined as the aforementioned types. Forms of EDS within this category may present with soft, mildly stretchable skin, shortened bones, chronic **diarrhea**, joint hypermobility and dislocation, bladder rupture, or poor wound healing. Inheritance patterns within this group include X-linked recessive, autosomal dominant, and autosomal recessive.

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Causes and symptoms

There are numerous types of EDS, all caused by changes in one of several genes. The manner in which EDS is inherited depends on the specific gene involved. There are three patterns of inheritance for EDS: autosomal dominant, autosomal recessive, and X-linked (extremely rare).

Chromosomes are made up of hundreds of small units known as genes, which contain the genetic material necessary for an individual to develop and function. Humans have 46 chromosomes, which are matched into 23 pairs. Because chromosomes are inherited in pairs, each individual receives two copies of each chromosome and likewise two copies of each gene.

Changes or mutations in genes can cause genetic diseases in several different ways, many of which are represented within the spectrum of EDS. In autosomal dominant EDS, only one copy of a specific gene must be changed for a person to have EDS. In autosomal recessive EDS, both copies of a specific gene must be changed for a person to have EDS. If only one copy of an autosomal recessive EDS gene is changed the person is referred to as a carrier, meaning they do not have any of the signs or symptoms of the disease itself, but carry the possibility of passing on the disorder to a future child. In X-linked EDS a specific gene on the X chromosome must be changed. However, this affects males and females differently because males and females have a different number of X chromosomes.

The few X-linked forms of EDS fall under the category of X-linked recessive. As with autosomal recessive, this implies that both copies of a specific gene must be changed for a person to be affected. However, because males only have one X-chromosome, they are affected if an X-linked recessive EDS gene is changed on their single X-chromosome. That is, they are affected even though they have only one changed copy. On the other hand, that same gene must be changed on both of the X-chromosomes in a female for her to be affected.

Although there is much information regarding the changes in genes that cause EDS and their various inheritance patterns, the exact gene mutation for all types of EDS is not known.

Diagnosis

Clinical symptoms such as extreme joint looseness and unusual skin qualities, along with family history, can lead to a diagnosis of EDS. Specific tests, such as skin biopsies are available for diagnosis of certain types of EDS, including vascular, arthrochalasia, and dermatosparaxis types. A skin biopsy involves removing a small sample of skin and examining its microscopic structure. A urine test is available for the Kyphoscoliosis type.

Management of all types of EDS may include genetic counseling to help the affected individual and their family understand the disorder and its impact on other family members and future children.

If a couple has had a child diagnosed with EDS the chance that they will have another child with the same disorder depends on with what form of EDS the child has been diagnosed and if either parent is affected by the same disease or not.

Individuals diagnosed with an autosomal dominant form of EDS have a 50% chance of passing the same disorder on to a child in each pregnancy. Individuals diagnosed with an autosomal recessive form of EDS have an extremely low risk of having a child with the same disorder.

X-linked recessive EDS is accompanied by a slightly more complicated pattern of inheritance. If a father with an X-linked recessive form of EDS passes a copy of his X chromosome to his children, the sons will be unaffected and the daughters will be carriers. If a mother is a carrier for an X-linked recessive form of EDS, she may have affected or unaffected sons, or carrier or unaffected daughters, depending on the second sex chromosome inherited from the father.

Prenatal diagnosis is available for specific forms of EDS, including kyphoscoliosis type and vascular type. However, prenatal testing is only a possibility in these types if the underlying defect has been found in another family member.

Treatment

Medical therapy relies on managing symptoms and trying to prevent further complications. There is no cure for EDS.

Braces may be prescribed to stabilize joints, although surgery is sometimes necessary to repair joint damage caused by repeated dislocations. **Physical therapy** teaches individuals how to strengthen muscles around joints and may help to prevent or limit damage. Elective surgery is discouraged due to the high possibility of complications.

Alternative treatment

There are anecdotal reports that large daily doses 0.04–0.14 oz (1–4 g) of vitamin C may help decrease

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KEY TERMS

Arthrochalasia—Excessive loosness of the joints.

Blood vessels—General term for arteries, veins, and capillaries that transport blood throughout the body.

Cartilage—Supportive connective tissue that cushions bone at the joints or which connects muscle to bone.

Collagen—The main supportive protein of cartilage, connective tissue, tendon, skin, and bone.

Connective tissue—A group of tissues responsible for support throughout the body; includes cartilage, bone, fat, tissue underlying skin, and tissues that support organs, blood vessels, and nerves throughout the body.

Dermatosparaxis—Skin fragility caused by abnormal collagen.

Hernia—A rupture in the wall of a body cavity, through which an organ may protrude.

Homeopathic—A holistic and natural approach to healthcare.

Hyperextensibility—The ability to extend a joint beyond the normal range.

Hypermobility—Unusual flexibility of the joints, allowing them to be bent or moved beyond their normal range of motion.

Joint dislocation—The displacement of a bone.

Kyphoscoliosis—Abnormal front-to-back and side-to-side curvature of the spine.

Ligament—A type of connective tissue that connects bones or cartilage and provides support and strength to joints.

Osteoarthritis—A degenerative joint disease that causes pain and stiffness.

Scoliosis—An abnormal, side-to-side curvature of the spine.

Tendon—A strong connective tissue that connects muscle to bone.

Uterus—A muscular, hollow organ of the female reproductive tract. The uterus contains and nourishes the embryo and fetus from the time the fertilized egg is implanted until birth.

Vascular—Having to do with blood vessels.

bruising and aid in wound healing. Constitutional homeopathic treatment may be helpful in maintaining optimal health in persons with a diagnosis of EDS. An individual with EDS should discuss these types of therapies with their doctor before beginning them on their own. Therapy that does not require medical consultation involves protecting the skin with sunscreen and avoiding activities that place **stress** on the joints.

Prognosis

The outlook for individuals with EDS depends on the type of EDS with which they have been diagnosed. Symptoms vary in severity, even within one sub-type, and the frequency of complications changes on an individual basis. Some individuals have negligible symptoms while others are severely restricted in their daily life. Extreme joint instability and scoliosis may limit a person's mobility. Most individuals will have a normal lifespan. However, those with blood vessel involvement, particularly those with EDS vascular type, have an increased risk of fatal complications.

EDS is a lifelong condition. Affected individuals may face social obstacles related to their disease on a daily basis. Some people with EDS have reported living with fears of significant and painful skin ruptures, becoming pregnant (especially those with EDS vascular type), their condition worsening, becoming unemployed due to physical and emotional burdens, and social stigmatization in general.

Constant bruises, skin **wounds**, and trips to the hospital take their toll on both affected children and their parents. Prior to diagnosis parents of children with EDS have found themselves under suspicion of **child abuse**.

Some people with EDS are not diagnosed until well into adulthood and, in the case of EDS vascular type, occasionally not until after death due to complications of the disorder. Not only may the diagnosis itself be devastating to the family, but in many cases other family members find out for the first time they are at risk for being affected.

Although individuals with EDS face significant challenges, it is important to remember that each person is unique with their own distinguished qualities and potential. Persons with EDS go on to have families, to have careers, and to be accomplished citizens, surmounting the challenges of their disease.

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Resources

OTHER

GeneClinics. http://www.geneclinics.org.

ORGANIZATIONS

Ehlers-Danlos Support Group - UK., P.O. Box 337, Aldershot, Surrey, GU12 6WZ, UK, 01252690940, http://www.ehlers-danlos.org/.

Elhers-Danlos National Foundation, 1760 Old Meadow Road, Suite 500, McLean, VA, 22102, (703) 506-2892, http://www.ednf.org/.

Java O. Solis, MS

Ehrlichiosis

Definition

Ehrlichiosis is a bacterial infection that is spread by ticks. Symptoms include **fever**, chills, **headache**, muscle aches, and tiredness.

Description

Ehrlichiosis is a tick-borne disease caused by infection with *Ehrlichia* bacteria. Ticks are small, blood-sucking arachnids. Although some ticks carry disease-causing organisms, most do not. When an animal or person is bitten by a tick that carries bacteria, the bacteria are passed to that person or animal during the tick's feeding process. It is believed that the tick must remain attached to the person or animal for at least 24 hours to spread the infection.

There are two forms of ehrlichiosis in the United States; human monocytic ehrlichiosis and human granulocytic ehrlichiosis. Monocytic ehrlichiosis is caused by *Ehrlichia chaffeensis*, which is spread by the Lone Star tick, *Amblyomma americanum*. As of 2006, about 600 cases of monocytic ehrlichiosis had been reported in 30 states, primarily in the southeastern and south central United States. The bacteria that causes granulocytic ehrlichiosis is not known, but suspected to be either *Ehrlichia equi* or *Ehrlichia phagocytophila*. Granulocytic ehrlichiosis is probably spread by the blacklegged tick *Ixodes scapularis* (which also spreads **Lyme disease**). About 100 cases of granulocytic ehrlichiosis have been reported in Connecticut, Massachusetts, Rhode Island, Minnesota, New York, and Wisconsin.

KEY TERMS

Tick-borne disease—A disease that is spread to animals by the bite of an infected tick.

Causes and symptoms

Both forms of ehrlichiosis have similar symptoms, and the illnesses can range from mild to severe and life-threatening. Risk factors include old age and exposure to ticks through work or recreation. Symptoms occur seven to 21 days following a tick bite although patients may not recall being bitten. Fever, tiredness, headache, muscle aches, chills, loss of appetite, confusion, **nausea**, and **vomiting** are common to both diseases. A rash may occur.

Diagnosis

Ehrlichiosis may be diagnosed and treated by doctors who specialize in blood diseases (hematologists) or an **infectious disease** specialist. Because ehrlichiosis is not very common and the symptoms are not unique, it may be misdiagnosed. A recent history of a tick bite is helpful in the diagnosis. Blood tests will be done to look for antibodies to *Ehrlichia*. Staining and microscopic examination of the blood sample may show *Ehrlichia* bacteria inside white blood cells. Another test, called polymerase chain reaction (PCR), is a very sensitive assay to detect bacteria in the blood sample, but it is not always available.

Treatment

Antibiotic treatment should begin immediately if ehrlichiosis is suspected, even if laboratory results are not available. Treatment with either tetracycline (Sumycin, Achromycin V) or doxycycline (Monodox, Vibramycin) is recommended. Many patients with ehrlichiosis are admitted to the hospital for treatment.

Prognosis

For otherwise healthy people, a full recovery is expected following treatment for ehrlichiosis. Elderly patients are at a higher risk for severe disease, which may be fatal. Serious complications include lung or gastrointestinal bleeding. Two to 10 patients out of 100 die from the disease.

Prevention

The only prevention for ehrlichiosis is to minimize exposure to ticks by staying on the trail when walking

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through the woods, avoiding tall grasses, wearing long sleeves and tucking pant legs into socks, wearing insect repellent, and checking for ticks after an outing. Remove a tick as soon as possible by grasping the tick with tweezers and gently pulling.

Resources

BOOKS

Gorbach, Sherwood F., John S. Bartlett, and Neil R. Blacklow, eds. *Infectious Diseases*, 3rd ed. Philadelphia: W. B. Saunders Co., 2004.

Belinda Rowland, PhD

EKG *see* **Electrocardiography**

Elder abuse

Definition

Elder **abuse** is a general term used to describe harmful acts toward an elderly adult, such as physical abuse, **sexual abuse**, emotional or psychological abuse, financial exploitation, and neglect, including self-neglect.

Description

Results from the National Elder Abuse Incidence Study, funded in part by the Administration on **Aging**, suggest that over 500,000 people 60 years of age and older are abused or neglected each year in the United States. It was also found that four times as many incidents of abuse, neglect, or self-neglect are never reported, causing researchers to estimate that as many as two million elderly persons in the United States are abused each year. In 90% of the cases, the abusers were found to be family members and most often were the adult children or spouses of those abused. In addition, equal numbers of men and women have been identified as the abusers. However, women, especially those over 80 years of age, tend to be victimized more than men.

Elder abuse can take place anywhere, but the two main settings addressed by law are domestic settings, such as the elder's home or the caregiver's home, and institutional settings, such as a nursing home or group home. In general, there are five basic types of elderly abuse: physical, sexual, emotional or psychological, financial, and neglect. Data from National Center on Elder Abuse indicates that more than half of the cases reported involve some kind of neglect, whereas 1 in 7 cases involve physical abuse. It is considered neglect when a caretaker deprives an elderly person of the necessary care needed in order to avoid physical or mental harm. Sometimes the behavior of an elderly person threatens his or her own health; in those cases, the abuse is called self-neglect. Physical abuse refers to physical force that causes bodily harm to an elderly person, such as slapping, pushing, kicking, pinching, or burning.

About 1 in 8 cases of elderly abuse involve some form of financial exploitation, which is defined as the use of an elderly person's resources without his or her consent. The National Center on Elder Abuse defines emotional and psychological abuse of a senior as causing anguish, **pain**, or distress through verbal or nonverbal acts, such as verbal assaults, insults, intimidation, and humiliation, for example. Isolating elderly persons from their friends and family as well as giving them the silent treatment are two other forms of emotional and psychological abuse. Any kind of non-consensual sexual contact with an elderly person that takes place without his or her consent is considered sexual abuse.

Causes and symptoms

Elder abuse is a complex problem that can be caused by many factors. According to the National Center on Elder Abuse, social isolation and mental impairment are two factors of elder abuse. Studies show that people advanced in years, such as in their eighties, with a high level of frailty and dependency are more likely to be victims of elder abuse than people who are younger and better equipped to stand up for themselves. Because spouses make up a large percentage of elder abusers, at least 40% statistically, some research has been done in the area, which shows that a pattern of domestic violence is associated with many of the cases. The risk of elder abuse appears to be especially high when adult children live with their elderly parents for financial reasons or because they have personal problems, such as drug dependency or mental illness. Some experts have speculated that elderly people living in rural areas with their caretakers may have a higher risk of being abused than city dwellers. The idea behind this theory is that the opportunity exists for the abuse to occur, but there is less likelihood that the abuser will be caught. More research in this very important area is needed in order to illuminate the relationship between these factors.

The National Center on Elder Abuse identifies the following as signs of elder abuse:

- Bruises, pressure marks, broken bones, abrasions, and burns may indicate physical abuse or neglect.
- Unexplained withdrawal from normal activities and unusual depression may be indicators of emotional abuse.

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- Bruises around the breasts or genital area, as well as unexplained bleeding around the genital area, may be signs of sexual abuse.
- Large withdrawals of money from an elder's bank account, sudden changes in a will, and the sudden disappearance of valuable items may be indications of financial exploitation.
- Bedsores, poor hygiene, unsanitary living conditions, and unattended medical needs may be signs of neglect.
- Failure to take necessary medicines, leaving a burning stove unattended, poor hygiene, confusion, unexplained weight loss, and dehydration may all be signs of self-neglect.

Diagnosis and Treatment

The National Committee for the Prevention of Elder Abuse notes that Adult Protective Services (APS) caseworkers are often on the front lines when it comes to elderly abuse. People being abused or those who believe abuse is taking place can turn to their local APS office for help. The APS routinely screens calls, keeps all information confidential, and, if necessary, sends a caseworker out to conduct an investigation. In the event that a crisis intervention is needed, the APS caseworker can arrange for any necessary emergency treatment. If it is unclear whether elder abuse has taken place, the APS caseworker can serve as a liaison between the elderly person and other community agencies.

According to the National Committee for the Prevention of Elder Abuse, "professionals in the field of aging are often the first to discover signs of elder abuse." Providing encouragement and advice, they play a critical role in educating others with regard to the needs of the elderly. They not only provide valuable support to the victims of abuse, but they also monitor high-risk situations and gather important information that can help validate that abuse has taken place.

Some people might think that a person who has cognitive impairment might be unable to describe mistreatment; however, that is not the case. In fact, guidelines set by the American Medical Association call for "routine questions about abuse and neglect even among patients with cognitive impairment in order to improve the identification of cases and implement appropriate treatment and referral." Rather than an inability to describe mistreatment, what might stop an elderly person from reporting abuse is a sense of embarrassment or fear of retaliation. To complicate matters, differences exist among cultural groups regarding what defines abuse.

Therefore, most states have established laws that define elder abuse and require health care providers to report any cases they encounter with penalties attached for failing to do so. Indeed, statistics show that health care providers, for example, report almost 25% of the known cases of elder abuse. Therefore, physicians play a very important role in identifying and treating elders who have been abused. And yet, in an article published by the *Journal of the American Geriatrics Society*, Dr. Conlin pointed out that only 1 of every 13 cases of elder abuse are reported by physicians. There may be several reasons for this. In some cases, the problem may simply go unnoticed, especially if the physician has no obvious reason to suspect any wrongdoing. In other cases, the patient may hide or deny the problem.

In recent years, much media attention has been focused on elderly abuse that takes place in institutional settings. Anyone who believes that a loved one is being abused while in a nursing home or other institutional setting should contact the authorities for assistance immediately.

Prognosis

The mortality rate of an elderly person who has been mistreated is higher than the mortality rate of an elderly person who has not experienced abuse. Nonetheless, numerous success stories exist regarding successful interventions. Social workers and health care professionals, as well as concerned citizens from a variety of backgrounds, have played a key role in identifying and obtaining treatment for abused elders.

Prevention

Planning for the future is one of the best ways to avoid elder abuse. Consider a variety of retirement options, ones that will encourage safety as well as independence. It is important to stay active in the community. Avoiding isolation minimizes the likelihood that abuse will occur. Seek professional counsel when necessary; it is important for everyone to know their rights and to be advocates on their own behalf.

Resources

OTHER

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Lee Ann Paradise,

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Electric shock injuries

Definition

Electricity is a form of energy generated by the flow of electrons across a potential gradient from high to low concentration through a conductive material. Electrical injuries in humans are caused by contact with an electrical current, either natural lightning or mechanically generated.

Demographics

Electrical injuries were rare in industrialized societies until the 1870s and 1880s, when a series of inventions by Thomas Edison (1847–1931) and George Westinghouse (1846–1914) made it possible to transmit electricity over long-distance wires from one location to another for commercial and scientific purposes. The first fatal industrial accident involving an electric shock occurred in Lyon, France, in 1879.

As of 2010, electrical injuries are responsible for about 1,000 deaths in the United States each year, or about 1% of all accidental deaths. About a quarter of these fatalities are caused by natural lightning. Electric shocks are responsible for 5% of all admissions to specialized burn treatment units in North America.

In the United States, 80% of all electrical injuries occur in adult men, largely because of occupational choices. Among children, the male: female ratio is 3:1. Low-voltage injuries are most common among toddlers; high-voltage injuries primarily affect risk-taking adolescents and adults in high-risk occupations.

According to the Bureau of Labor Statistics, electric shocks are the second leading cause of **death** in the construction industry in North America. With regard to injuries caused by contact with overhead powerlines, between 27% and 60% of cases resulted in over 31 days lost from work—compared to 18%–20% for all other occupational injury and illness. Injuries caused by electric shocks are also costly to employers; a researcher at the Electric Power Research Institute in Palo Alto, California, estimates that the cost to American employers is approximately $15.75 million *per case* in direct and indirect costs.

Description

Accidental electrical injuries

Electrical injuries are classified according to three factors: power source (lightning or human-generated electricity; voltage (high or low); and type of current (alternating or direct). Each is associated with certain patterns of injury. Most electrical injuries are accidental.

The minimum current that humans can feel is 1 milliampere (abbreviated mA). An ampere, named for the French mathematician and physicist André-Marie Ampère (1775–1836), is a measure of the amount of electric charge passing a given point per unit time. One ampere represents 6.241 x 10^{18} electrons passing a given point in a wire in one second of time. In general, a current of 100 mA will be lethal if it passes through sensitive parts of the human body; a current as low as 60 mA can cause **ventricular fibrillation**, irregular contraction of the muscles in the two lower chambers of the heart.

Intentional use of electric shocks

Electric shocks have been used in medicine to treat mental illness, particularly depression (**electroconvulsive therapy** or ECT); to correct irregular heart rhythms (**defibrillation** and **cardioversion**); and to relieve **pain** by stimulating opioid receptors in the central nervous system (transcutaneous **electrical nerve stimulation** or TENS).

Electricity was used as a form of torture or punishment almost as soon as it was known to cause accidental workplace injuries. Since the 1930s, the Nazis and other tyrannical regimes used cattle prods and similar devices to torture people. The tasers currently used by some police departments are electroshock devices that cause strong involuntary contractions of the muscles controlling movement, thus temporarily incapacitating violent or intoxicated suspects.

Electrocution as a method of capital punishment was introduced in the late 1880s on the recommendation of a committee in New York State seeking a more humane method of execution than hanging. Thomas Edison recommended the use of alternating current to electrocute criminals, maintaining that it would cause instantaneous death. The first use of the electric chair in New York in 1890, however, was a disaster, requiring eight minutes to cause death. George Westinghouse is reported to have said that it would have been more humane to use an axe. As of 2010, only six states still use the electric chair as an option for execution.

Risk factors

Risk factors for electrical injuries include:

- Working or playing outside during an electrical storm.
- Employment in an occupation related to the generation of electricity or servicing of electrical equipment or power lines.

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KEY TERMS

Alternating current (AC)—An electric current in which the flow of the electric charge periodically reverses direction. AC is the form in which electricity is usually delivered to homes. The usual household wall outlet (120 volts) provides a current with 120 reversals of the direction of flow occurring each second and is termed 60-cycle alternating current.

Amperage—A measurement of the amount of electric charge passing a given point per unit time. One ampere represents about 6.241 x 10^{18} electrons passing a given point in a wire in one second of time.

Antibiotics—Substances used against microorganisms that cause infection.

Arc flash—A type of electrical explosion resulting from electrical breakdown of the gases in air, which normally does not conduct electricity. Arc flashes can occur where there is sufficient voltage in an electrical system and a path to the ground or to lower voltage.

Cataract—Clouding of the lens of the eye or its capsule (surrounding membrane).

Computed tomography scan (CT scan)—A process that uses x rays to create three-dimensional images of structures inside the body.

Direct current (DC)—An electric current in which the electric charge moves in only one direction. It is the type of current produced by batteries and solar cells.

Electrolytes—Substances that conduct electric current within the body and are essential for sustaining life.

Magnetic resonance imaging (MRI)—The use of electromagnetic energy to create images of structures inside the body.

Skin grafting—A technique in which a piece of healthy skin from the patient's body (or a donor's) is used to cover another part of the patient's body that has lost its skin.

Taser—Also called a conducted electrical weapon or CEW, a taser is an electroshock device used by some police departments in various countries to subdue armed or otherwise dangerous suspects without having to use lethal force. Tasers work by interfering with the ' capacity to control voluntary muscles. The name *taser* is an acronym for *Thomas A. Swift's Electric Rifle*, an adventure novel about a fictional weapon published in 1911.

Voltage—The force necessary to drive an electric current between two specified points. A large voltage exerts a greater force, which moves more electrons through a wire at a given rate of time.

- Employment in the construction industry, mining, or public transportation.
- Natural disasters, including hurricanes, tornadoes, earthquakes, and ice storms, which bring down or disrupt high-voltage power lines.
- Theft of copper and other metals from construction sites and other areas close to high-voltage wires.

Causes and symptoms

Causes

Electricity damages the cells in human tissues in two basic ways: heating and blast force. The passage of electrical current through cell membranes causes their temperatures to rise, leading to disruption of the cell membrane itself (at 108°F); denaturation of protein molecules in the cell (at 113°F); and destruction of DNA (at 149°F or higher). In most cases of high-voltage electrical shock, heat damage occurs immediately at contact points but requires 1–3 seconds to injure deeper tissues. The blast force of electric current can cause significant blunt trauma injuries.

The overall severity of electrical injury depends on the current's pressure (voltage), the amount of current (amperage), the type of current (direct vs. alternating), the body's resistance to the current, the current's path through the body, and how long the body remains in contact with the current. The interplay of these factors can produce effects ranging from barely noticeable **tingling** to instant death; every part of the body is vulnerable. Although the severity of injury is determined primarily by the voltage, low voltage can be just as dangerous as high voltage under the right circumstances. People have been killed by shocks of just 50 volts. Electric voltage of 380 volts or less is considered low voltage. The United States national electric code defines high voltage as 600 volts or higher. High voltage is generated at power plants and is transformed down to approximately 120 volts for most wall outlets in homes.

Symptoms

Electric shocks can affect all the major organ systems in the human body. How electric shocks affect the skin is determined by the skin's resistance, which in

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turn is dependent upon the wetness, thickness, and cleanliness of the skin. Thin or wet skin is much less resistant than thick or dry skin. When skin resistance is low, the current may cause little or no skin damage but severely burn internal organs and tissues. Conversely, high skin resistance can produce severe skin **burns** but prevent the current from entering the body.

The nervous system (the brain, spinal cord, and nerves) is particularly vulnerable to injury. In fact, neurological problems are the most common kind of nonlethal harm suffered by electric shock victims. Some neurological damage is minor and clears up on its own or with medical treatment, but some is severe and permanent. Neurological problems may be apparent immediately after the accident, or gradually develop over a period of up to three years.

Damage to the respiratory and cardiovascular systems is most acute at the moment of injury. Electric shocks can paralyze the respiratory system or disrupt heart action, causing instant death. Also at risk are the smaller veins and arteries, which dissipate heat less easily than the larger blood vessels and can develop **blood clots**. Damage to the smaller vessels is probably one reason why **amputation** is often required following high-voltage injuries.

Many other sorts of injuries are possible after an electric shock, including **cataracts**, kidney failure, and substantial destruction of muscle tissue. The victim may suffer a fall or be hit by debris from exploding equipment. An electric arc flash may set clothing or nearby flammable substances on fire. Arc flashes can produce light intense enough to cause permanent blindness as well as heat intense enough (5000°F to 7000°F) to melt bone and vaporize the surfaces of nearby human beings and other objects. Strong shocks are often accompanied by violent **muscle spasms** that can break and dislocate bones. These spasms can also freeze the victim in place and prevent him or her from breaking away from the source of the current. Alternating current is considered three times as dangerous as direct current for this reason: high-voltage DC tends to cause one strong muscle spasm that throws the victim away from the source, whereas the cyclical flow of electrons in AC of the same voltage causes **paralysis** of the muscles that holds the victim in contact with the current.

Diagnosis

Diagnosis relies on gathering information about the circumstances of the accident, a thorough **physical examination**, and monitoring of cardiovascular and kidney activity. When at all possible, witnesses of the accident should be questioned about the circumstances of the event, particularly if the victim has lost consciousness or normal mental status. The victim's neurological condition can fluctuate rapidly and requires close observation. A computed tomography scan (CT scan) or **magnetic resonance imaging** (MRI) may be necessary to check for brain injury. Blood and urine samples may be taken. In some cases, the doctor may make a trial incision into burned muscle to assess the extent of tissue damage. The tissue sample is frozen and examined under a microscope to see whether the muscle tissue is still viable. If an arm or leg damaged by electricity is determined not to be viable, immediate amputation is necessary.

Treatment

Treatment of an electrical injury usually begins at the scene, although first responders will generally take the victim to an emergency department or specialized burn or trauma center as soon as possible. The victim of a severe electrical injury may be examined and treated by a variety of specialists, including emergency physicians, plastic surgeons, neurologists, ophthalmologists, and orthopedic surgeons.

Traditional

When an electric shock accident happens at home or in the workplace, the main power should immediately be shut off and 911 should be called. If that cannot be done, and current is still flowing through the victim, the alternative is to stand on a dry, nonconducting surface such as a folded newspaper, flattened cardboard carton, or plastic or rubber mat and use a nonconducting object such as a wooden broomstick (never a damp or metallic object) to push the victim away from the source of the current. The victim and the source of the current must not be touched while the current is still flowing, for this contact can electrocute the rescuer. Emergency medical help should be summoned as quickly as possible. Trained electricians must use lineman's gloves to separate the victim from the circuit by a specially insulated pole. Looping a polydacron rope around the injured patient is another method of pulling him or her from the electric power source. Ideally, the electrician or first responder should stand on a dry surface during the rescue. People who are trained to perform **cardiopulmonary resuscitation** (CPR) should, if appropriate, begin **first aid** while waiting for emergency medical help to arrive.

Burn victims usually require treatment at a specialized burn center. Fluid replacement therapy is necessary to restore lost fluids and electrolytes. Severely

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injured tissue is repaired surgically, which can involve **skin grafting** or amputation. **Antibiotics** and antibacterial creams are used to prevent infection. Victims may also require treatment for kidney failure. Following surgery, **physical therapy** to facilitate recovery, and psychological counseling to cope with disfigurement, may be necessary.

Prognosis

The mortality rate for electrical injuries in the United States as of 2010 is 3–5%. Many survivors, however, require amputation or are permanently disfigured by their burns. **Anxiety disorders** are common in survivors of high-voltage electrical injuries. About 73% of pregnant women injured by lightning or high-voltage electricity lose the baby. Injuries from household appliances and other low-voltage sources are less likely to produce extreme damage.

Prevention

Prevention of electrical injuries in the home or workplace begins with age-appropriate education about the nature of electricity and the importance of safety measures. The National Safety Council in the United States and Hydro-Québec (a power company) in Canada have handouts, videos, quizzes, and fact sheets about electrical safety on their websites (http://www.nsc.org/ and http://www.hydroquebec.com/security/index.html), some of which are listed under Resources below. These materials are written for the general public and are intended to help people recognize dangerous situations and take steps to protect themselves and their families before an electrical accident occurs.

People who are employed in workplaces with high-voltage electrical equipment or whose jobs require working with electricity should follow all safety precautions recommended by the National Safety Council:

- Those working near high-voltage lines should wear Class B helmets, which are designed to withstand 20,000 volts of AC for 3 minutes.
- Special insulated gloves should be worn, either Class 2 (provides protection against 20,000 volts) or Class 4 (protection against 40,000 volts), along with tinted eyewear to protect the eyes against arc flashes.
- Only employees with special training and authorization should work on high-voltage lines or equipment; other workers should not try to perform tasks for which they are not qualified or trained.
- Rubber-soled shoes or work boots must be worn on damp or wet surfaces.
- Workers should check that circuits, wiring, insulation, equipment, and cords or extension cords are in good repair.
- Hazards of any kind, including water or spills as well as damaged or defective equipment, should be reported to supervisors at once.

Parents and other adults need to be alert to possible electric dangers in the home. Damaged electric appliances, wiring, cords, and plugs should be repaired or replaced. Electrical repairs should be attempted only by people with the proper training. Hair dryers, radios, and other electric appliances should never be used in the bathroom or anywhere else they might accidentally come in contact with water. Young children need to be kept away from electric appliances and should be taught about the dangers of electricity as soon as they are old enough. Electric outlets require safety covers in homes with young children.

People should be particularly careful when using metal ladders outside or when installing outdoor television or CB radio base antennas, as accidental contact with an overhead power line can be fatal. In the late 1970s, there were about 100 deaths each year in the United States involving amateur installation of outdoor antennas.

During thunderstorms, people should go indoors immediately, even if no rain is falling, and boaters should return to shore as rapidly as possible. People who cannot reach indoor shelter should move away from such metallic objects as golf clubs and fishing rods and lie down in low-ground areas. Standing or lying under or next to tall or metallic structures is unsafe. An automobile is appropriate cover, as long as the radio is off. Telephones, computers, hair dryers, and other appliances that can act as conduits for lightning should not be used during thunderstorms.

Resources

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Hydro-Québec. *The Four Shock Factors*. This is a pop-up animation about electrical safety that viewers can watch at their own pace.http://www.hydroquebec.com/security/pop_4acteurs.html
Hydro-Québec. *What to Do in Case of Electric Shock*. http://www.hydroquebec.com/security/que_faire_choc.html
National Safety Council (NSC). *Electrical Safety*. http://www.nsc.org/news_resources/Resources/Documents/Electrical_Safety.pdf

ORGANIZATIONS

American Burn Association, 625 N. Michigan Ave., Suite 2550, Chicago, IL, 60611, 312-642-9260, 312-642-9130, info@ameriburn.org, http://www.ameriburn.org/.
American College of Emergency Physicians (ACEP), 1125 Executive Circle, Irving, TX, 75038-2522, 972-550-0911, 800-798-1822, 972-580-2816, http://www. acep.org/.
American Society of Plastic Surgeons (ASPS), 444 East Algonquin Road, Arlington Heights, IL, 60005, 847-228-9900, http://www.plasticsurgery.org/.
Chicago Electrical Trauma Research Institute (CETRI), 4047 West 40th Street, Chicago, IL, 60632, 800-516-8709, info@cetri.org, http://www.cetri.org/.
National Safety Council (NSC), 1121 Spring Lake Drive, Itasca, IL, 60143, 630-285-1121, 800-621-7615, 630-285-1315, http://www.nsc.org/Pages/Home.aspx.

Howard Baker
Rebecca J. Frey, PhD

Electrical nerve stimulation

Definition

Electrical nerve stimulation, also called transcutaneous electrical nerve stimulation (TENS), is a non-invasive, drug-free **pain management** technique. By sending electrical signals to underlying nerves, the battery-powered TENS device can relieve a wide range of chronic and acute **pain**.

Purpose

TENS is used to relieve pain caused by a variety of chronic conditions, including:

- neck and lower back pain
- headache/migraine
- arthritis
- post-herpetic neuralgia (lingering chronic pain after an attack of shingles)
- sciatica (pain radiating from lower back, through the legs, to the foot)
- temporomandibular joint pain
- osteoarthritis
- amputation (phantom limb)
- fibromyalgia (a condition causing aching and stiffness throughout the body)

The device is also effective against short-term pain, such as:

- shingles (painful skin eruptions along the nerves)
- bursitis (inflammation of tissue surrounding a joint)
- childbirth
- post-surgical pain
- fractures
- muscle and joint pain
- sports injuries
- menstrual cramps

Precautions

Because TENS may interfere with pacemaker function, patients with **pacemakers** should consult a

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KEY TERMS

Fibromyalgia—A condition characterized by aching and stiffness, fatigue and poor sleep, as well as tenderness at various sites on the body.

Osteoarthritis—A painful joint disease aggravated by mechanical stress.

Phantom limb—The perception that a limb is present (and throbbing with pain) after it has been amputated.

Post-herpetic neuralgia—Lingering pain that can last for years after an attack of shingles.

Sciatica—Pain that radiates along the sciatic nerve, extending from the buttock down the leg to the foot.

Temporomandibular joint pain (TMJ)—Pain and other symptoms affecting the head, jaw, and face that are caused when the jaw joints and muscles controlling them don't work together correctly.

cardiologist before using a TENS unit. Patients should also avoid electrical stimulation in the front of the neck, which can be hazardous. The safety of the device during **pregnancy** has not been established.

TENS doesn't cure any condition; it simply eases pain. Patients who are not sure what is causing their pain should consult a physician before using TENS.

Description

The TENS device is a small battery-powered stimulator that produces low-intensity electrical signals through electrodes on or near a painful area, producing a **tingling** sensation that reduces pain. There is no dosage limitation, and the patient controls the amount of pain relief.

Some experts believe TENS works by blocking pain signals in the spinal cord, or by delivering electrical impulses to underlying nerve fibers that lessen the experience of pain. Others suspect that the electrical stimulation triggers the release of natural painkillers in the body.

Patients can rent a TENS unit before buying one, to see if it is effective against their pain.

Preparation

After TENS has been prescribed, a doctor will refer the patient to a TENS specialist, who will explain how to use the machine. The specialist works with the patient to determine the settings and electrode placements for the best pain relief.

Risks

TENS is nonaddictive and completely safe. The only side effect may be a slight skin irritation or redness in some people, which can be prevented by using different gels or electrodes.

Normal results

The amount of relief a person gets using TENS depends on the underlying cause of the pain, a person's mental state, and whether or not medication is also used. At least one study found that both a real TENS machine and a placebo were equally effective in reducing pain. This suggests that at least part of its effectiveness may be due to the patient's belief in its ability to ease pain.

Carol A. Turkington

Electrical stimulation of the brain

Definition

Electrical stimulation of the brain (ESB) is a relatively new technique used to treat chronic **pain** and **tremors** associated with **Parkinson's disease**. ESB is administered by passing an electrical current through an electrode implanted in the brain.

Purpose

While the implantation of electrodes in the brain is used to treat or diagnose several disorders, the term ESB is limited here to the treatment of tremors, and as a **pain management** tool for patients suffering from back problems and other chronic injuries and illnesses.

Precautions

An ESB tremor control device, used in treating **Parkinson's** patients, may interfere with or be affected by cardiac **pacemakers** and other medical equipment. As a result, patients with other implanted medical equipment may not be good candidates for the therapy.

Description

Electrical stimulation of the brain, or deep brain stimulation, is effective in treating tremor in up to 88% of **Parkinson's** disease patients. An electrode is implanted into the thalamus (part of the brain) of the

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KEY TERMS

Infarction—A sudden insuffiency of local blood supply.

Neuralgia—Pain extending along one or more nerves.

Neuropathy—A functional disturbance or change in the nervous system.

Parkinson's disease—A chronic neurological illness that causes tremors, stiffness, and difficulty in moving and walking.

patient, and attached to an electric pulse generator via an extension wire. The pulse generator is implanted into the patient's pectoral, or chest area, and the extension wire is tunneled under the skin. The pulse generator sends out intermittent electrical stimulation to the electrode in the thalamus, which inhibits or partially relieves the tremor. The generator can be turned on and off with a magnet, and needs to be replaced every three to five years.

Similar methods have been used to treat chronic pain that responded unfavorably to conventional therapies. A remote transmitter allows these patients to trigger electric stimulation to relieve their symptoms on an as-needed basis. Patients with failed back syndrome, trigeminal neuropathy (pertaining to the fifth cranial nerve), and **peripheral neuropathy** fared well for pain control with this treatment, while patients with **spinal cord injury** and postherpetic neuralgia (pain along the nerves following herpes) did poorly.

Preparation

The patient should be free of any type of infection before undergoing an ESB procedure. He or she may be advised to discontinue any medication for a prescribed period of time before surgery.

Aftercare

After **neurosurgery**, patients should undergo regular head dressing changes, minimize exposure to others, and practice good personal hygiene in order to prevent a brain infection. The head may also be kept elevated for a prescribed period of time in order to decrease swelling of the brain.

Risks

The implantation of electrodes into the brain carries risks of hemorrhage, infarction, infection, and cerebral **edema**. These complications could cause irreversible neurological damage.

Patients with an implanted ESB tremor control device may experience headaches, disequilibrium (a disturbance of the sense of balance), burning or **tingling** of the skin, or partial **paralysis**.

Normal results

ESB is effective in pain control for specific conditions. It can provide long-term pain relief with few side effects or complications.

For the control of tremors a deep brain stimulator does provide some relief. It is recommended for patients with tremors severe enough to affect their quality of life.

Resources

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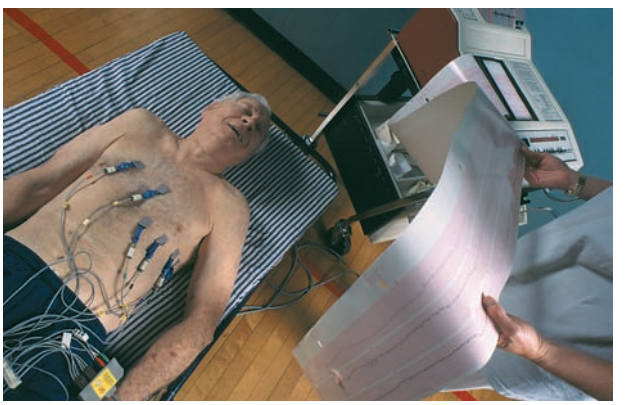
Paula Anne Ford-Martin

Electrocardiography

Definition

Electrocardiography is a commonly used noninvasive procedure for recording electrical changes in the heart. The record, which is called an electrocardiogram



A patient undergoing electrocardiography. *(Russell Curtis/Photo Researchers, Inc.)*

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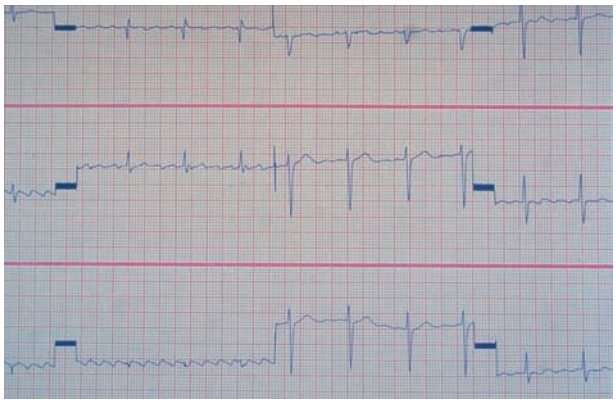

An EKG strip indicating atrial flutter. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

(ECG or EKG), shows the series of waves related to the electrical impulses that occur during each beat of the heart. The results are printed on paper and/or displayed on a monitor to provide a visual representation of heart function. The waves in a normal record are named P, Q, R, S, and T, and follow in alphabetical order. The number of waves may vary, and other waves may be present.

Purpose

Electrocardiography is a starting point for detecting many cardiac problems, including **angina** pectoris, stable angina, ischemic heart disease, **arrhythmias** (irregular heartbeat), tachycardia (fast heartbeat), bradycardia (slow heartbeat), myocardial infarction (**heart attack**), and certain congenital heart conditions. It is used routinely in physical examinations and for monitoring a patient's condition during and after surgery, as well as in the intensive care setting. It is the basic measurement used in **exercise** tolerance tests (i.e., **stress** tests) and is also used to evaluate symptoms such as chest **pain**, **shortness of breath**, and **palpitations**.

Demographics

The ECG is a common diagnostic test, with about 30 million performed each year in the United States.

Men are more likely to experience heart attacks than women, although a woman's risk of heart attack rises after **menopause**. African-Americans, Hispanics, and Native Americans are all at greater risk for cardiovascular disease than Caucasians, in part because of the higher incidence of **diabetes mellitus** (a major risk factor for cardiovascular disease) in these populations.

KEY TERMS

Ambulatory monitoring—ECG recording over a prolonged period during which the patient can move around.

Arrhythmia or dysrhythmia—Abnormal rhythm in hearts that contract in an irregular way.

ECG or EKG—A record of the waves that relate to the electrical impulses produced at each beat of the heart.

Ectopic beat—Abnormal heart beat arising elsewhere than from the sinoatrial node.

Electrodes—Tiny wires in adhesive pads that are applied to the body for ECG measurement.

Fibrillation—Rapid, uncoordinated contractions of the upper or the lower chambers of the heart.

Holter monitor—A portable device used to record heart rhythms over a period of at least 24 hours. It is named for the doctor who invented it in the 1960s.

Lead—Name given the electrode when it is attached to the skin.

Reperfusion therapy—Restoration of blood flow to an organ or tissue; following a heart attack, quickly opening blocked arteries to reperfuse the heart muscles to minimize damage.

Telemedicine—The use of communications or information technology to deliver clinical care or diagnosis. The medical information may be conveyed by telephone, Internet connections, or other electronic networks.

Description

The patient disrobes from the waist up, and electrodes (tiny wires in adhesive pads) are applied to specific sites on the arms, legs, and chest. When attached, these electrodes are called leads; three to 12 leads may be employed for the procedure.

Muscle movement may interfere with the recording, which lasts for several beats of the heart. In cases where rhythm disturbances are suspected to be infrequent, the patient may wear a small Holter monitor in order to record continuously over a 24-hour period. This is known as ambulatory monitoring.

Special training is required for interpretation of the electrocardiogram. To summarize in the simplest manner the features used in interpretations, the P wave of the electrocardiogram is associated with the contraction of the atria—the two chambers of the

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heart that receive blood from the veins. The QRS series of waves, or QRS complex, is associated with ventricular contraction, with the T wave coming after the contraction. The ventricles are the two chambers of the heart that receive blood from the atria and that send the blood into the arteries. Finally, the P-Q or P-R interval gives a value for the time taken for the electrical impulse to travel from the atria to the ventricle (normally less than 0.2 seconds).

Newer developments in electrocardiography include the Open ECG Project, an online group of doctors and technical experts who aim to develop an open-source, low-cost 12-lead PC-based ECG with interpretive software. The first step toward that goal might be a 3-lead PC-based ECG. The project hopes to make ECGs affordable in the Third World and other areas lacking medical facilities with standard ECG equipment. Another new device is the AngelMed Guardian, an implantable device similar to a pacemaker that records cardiac data and detects shifts in the ST segment of the heart waves—an early warning sign of a heart attack. The Guardian has been implanted in 55 patients in the United States and Brazil as of late 2009 and is presently undergoing phase 2 clinical trials with the Food and Drug Administration (FDA).

In terms of telecommunications, software is now available that allows health care personnel to download ECG notes to tablet PCs or iPhones. This technology was introduced in January 2009 and is now widely used in telemedicine. It has already proved valuable in such countries as the Philippines and other island-based nations, where fixed telephone wiring is often difficult to construct and maintain.

Diagnosis/Preparation

Patients are asked not to eat for several hours before a **stress test**. Before the leads are attached, the skin is cleaned to obtain good electrical contact at the electrode positions and, occasionally, shaving the chest may be necessary. Patients should avoid using greasy or oily skin creams or lotions before the test. They should wear a shirt or blouse that can be easily removed. Women should avoid wearing full-length hosiery, as the legs must be bare for the test.

Heart problems are diagnosed by the pattern of electrical waves produced during the EKG, and an abnormal rhythm can be called dysrhythmia. The cause of dysrhythmia is ectopic beats. Ectopic beats are premature heartbeats that arise from a site other than the sinus node—commonly from the atria, atrioventricular node, or the ventricle. When these dysrhythmias are only occasional, they may produce no symptoms or simply a feeling that the heart is turning over or "flip-flopping." These occasional dysrhythmias are common in healthy people, but they also can be an indication of heart disease.

The varied sources of dysrhythmias provide a wide range of alterations in the form of the electrocardiogram. Ectopic beats display an abnormal QRS complex. This can indicate disease associated with insufficient blood supply to the heart muscle (myocardial **ischemia**). Multiple ectopic sites lead to rapid and uncoordinated contractions of the atria or ventricles. This condition is known as fibrillation. When the atrial impulse fails to reach the ventricle, a condition known as **heart block** results.

Aftercare

To avoid skin irritation from the salty gel used to obtain good electrical contact, the skin should be thoroughly cleaned after removal of the electrodes.

Risks

The EKG is a noninvasive procedure that is virtually risk-free for the patient. There is a slight risk of heart attack for individuals undergoing a stress test EKG, but patients are carefully screened for their suitability for this test before it is prescribed.

Risk factors for heart disease include **obesity**, **hypertension** (high blood pressure), high **triglycerides** and total blood cholesterol, low HDL ("good") cholesterol, tobacco **smoking**, and increased age. People who have diabetes mellitus (either type 1 or type 2) are also at increased risk for cardiovascular disease.

Normal results

When the heart is operating normally, each part contracts in a specific order. Contraction of the muscle is triggered by an electrical impulse. These electrical impulses travel through specialized cells that form a conduction system. Following this pathway ensures that contractions will occur in a coordinated manner.

When the presence of all waves is observed in the electrocardiogram, and these waves follow the order defined alphabetically, the heart is said to show a normal sinus rhythm, and impulses may be assumed to be following the regular conduction pathway.

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In the normal heart, electrical impulses—at a rate of 60–100 times per minute—originate in the sinus node. The sinus node is located in the first chamber of the heart, known as the right atrium, where blood reenters the heart after circulating through the body. After traveling down to the junction between the upper and lower chambers, the signal stimulates the atrioventricular node. From here, after a delay, it passes by specialized routes through the lower chambers or ventricles. In many disease states, the passage of the electrical impulse can be interrupted in a variety of ways, causing the heart to perform less efficiently.

The heart is described as showing arrhythmia or dysrhythmia when time intervals between waves, or the order or the number of waves do not fit the normal pattern described above. Other features that may be altered include the direction of wave deflection and wave widths.

Morbidity and mortality rates

According to the American Heart Association, cardiovascular disease is the number one cause of **death** in the United States. It is also the leading cause of death among people with diabetes.

Alternatives

Electrocardiography is the gold standard for detecting heart conditions involving irregularities in electrical conduction and rhythm. Other tests that may be used in conjunction with an EKG include an echocardiogram (a sonogram of the heart's pumping action) and a stress test—an EKG that is done in conjunction with treadmill or other supervised exercise to observe the heart's function under stress—may also be performed.

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European Society of Cardiology, The European Heart House, 2035 Route des Colles, B.P. 179-Les Templiers, Sophia-Antipolis, France, 06903, 33 4 9294 7600, 33 4 9294 7601, http://www.escardio.org.

Heart Foundation, 80 William St., Level 3, SydneyNSW, Australia, 2011, 02 9219 2444, 300 36 27 87, http://www.heartfoundation.org.au.

National Heart, Lung, and Blood Institute, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (204) 629-3246, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi.nih.gov.

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Electroconvulsive therapy

Definition

Electroconvulsive therapy (ECT) is a medical treatment for severe mental illness in which a small, carefully controlled amount of electricity is introduced into the brain. This electrical stimulation, used in conjunction with anesthesia and muscle relaxant

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medications, produces a mild generalized seizure or convulsion. While used to treat a variety of psychiatric disorders, it is most effective in the treatment of severe depression, and provides the most rapid relief currently available for this illness.

Purpose

The purpose of electroconvulsive therapy is to provide relief from the signs and symptoms of mental illnesses such as severe depression, **mania**, and **schizophrenia**. ECT is indicated when patients need rapid improvement because they are suicidal, self-injurious, refuse to eat or drink, cannot or will not take medication as prescribed, or present some other danger to themselves. Antidepressant medications, while effective in many cases, may take two–six weeks to produce a therapeutic effect. Antipsychotic medications used to treat mania and schizophrenia have many uncomfortable and sometimes dangerous side effects, limiting their use. In addition, some patients develop **allergies** and therefore are unable to take their medicine.

Precautions

The most common risks associated with ECT are disturbances in heart rhythm. Broken or dislocated bones occur very rarely.

Description

The treatment of severe mental illness, such as schizophrenia, using electroconvulsive therapy was introduced in 1938 by two Italian doctors named Cerletti and Bini. In those days many doctors believed that convulsions were incompatible with schizophrenia since, according to their obervations, this disease rarely occurred in individuals suffering from **epilepsy**. They concluded, therefore, that if convulsions could be artifically produced in patients with schizophrenia, the illness could be cured. Some doctors were already using a variety of chemicals to produce seizures, but many of their patients died or suffered severe injuries because the strength of the convulsions could not be well controlled.

Electroconvulsive therapy is among the most controversial of all procedures used to treat mental illness. When it was first introduced, many people were frightened simply because it was called "shock treatment." Many assumed the procedure would be painful, others thought it was a form of electrocution, and still others believed it would cause brain damage. Unfortunately, unfavorable publicity in newspapers, magazines, and movies added to these fears.

Indeed, in those early years, patients and families were rarely educated by doctors and nurses regarding this or other forms of psychiatric treatment. In addition, no anesthesia or **muscle relaxants** were used. As a result, patients had violent seizures, and even though they did not remember them, the procedure itself was frightening.

The way these treatments are given today is very different from the procedures used in the past. Currently, ECT is offered on both an inpatient and outpatient basis. Hospitals have specially equipped rooms with oxygen, suction, and **cardiopulmonary resuscitation** (CPR) in order to deal with the rare emergency.

The treatment is carried out as follows: approximately 30 minutes before the scheduled treatment time, the patient may receive an injection of a medication (such as atropine) that keeps the pulse rate from decreasing too much during the convulsion. Next, the patient is placed on a cot and hooked up to a machine that automatically takes and displays vital signs (temperature, pulse, respiration, and blood pressure) on a television-like monitor. A mild anesthetic is then injected into a vein, followed by a medication (such a Anectine) that relaxes all of the muscles in the body so that the seizure is mild, and the risk of broken bones is virtually eliminated.

When the patient is both relaxed and asleep, an airway is placed in the mouth to aid with breathing. Electrodes are placed on the sides of the head in the temple areas. An electric current is passed through the brain by means of a machine specifically designed for this purpose. The usual dose of electricity is 70–150 volts for 0.1–0.5 seconds. In the first stage of the seizure (tonic phase), the muscles in the body that have not been paralyzed by medication contract for a period of five to 15 seconds. This is followed by the second stage (clonic phase) that is characterized by twitching movements, usually visible only in the toes or in a non-paralyzed arm or leg. These are caused by alternating contraction and relaxation of these same muscles. This stage lasts approximately 10–60 seconds. The entire procedure, from beginning to end, lasts about 30 minutes.

The total number of treatments a patient will receive depends upon many factors such as age, diagnosis, the history of illness, family support, and response to therapy. Patients with depression, for example, usually require six to 12 treatments. Treatments are usually administered every other day, three times a week.

The electrodes may be placed on both sides of the head (bilateral) or one side (unilateral). While bilateral

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ECT appears to be somewhat more effective, unilateral ECT is preferred for individuals who experience prolonged confusion or forgetfulness following treatment. Many doctors begin treatment with unilateral ECT, then change to bilateral if the patient is not improving.

Post-treatment confusion and forgetfulness are common, though disturbing symptoms associated with ECT. Doctors and nurses must be patient and supportive by providing patients with factual information about recovery. Elderly patients, for example, may become increasingly confused and forgetful as the treatments continue. These symptoms usually subside with time, but a small minority of patients state that they have never fully recovered from these effects.

With the introduction of antipsychotics in the 1950s, the use of ECT became less frequent. These new medications provided relief for untold thousands of patients who suffered greatly from their illness. However, there are a number of side effects associated with these drugs, some of which are irreversible. Another drawback is that some medications do not produce a therapeutic effect for two–six weeks. During this time the patient may present a danger to himself or others. In addition, there are patients who do not respond to medicine or who have severe allergic reactions. For these individuals, ECT may be the only treatment that will help.

Preparation

Patients and relatives are prepared for ECT by being shown video tapes that explain both the procedure and the risks involved. The physician then answers any questions these individuals may have, and the patient is asked to sign an "Informed Consent Form." This gives the doctor and the hospital permission to administer the treatment.

Once the form is signed, the doctor performs a complete **physical examination**, and orders a number of tests that can help identify any potential problem. These tests may include a **chest x ray**, an electrocardiogram (ECG), **urinalysis**, spinal x ray, brain wave (EEG), and **complete blood count** (CBC).

Some medications, such as lithium and a type of antidepressant known as **monoamine oxidase inhibitors**, should be discontinued for some time before treatment. Patients are instructed not to eat or drink for at least eight hours prior to the procedure in order to reduce the possibility of **vomiting** and **choking**.

Aftercare

After the treatment, patients are moved to a recovery area. Vital signs are recorded every five minutes until the patient is fully awake, which may take 15–30 minutes. Some initial confusion may be present but usually disappears in a matter of minutes. There may be complaints of **headache**, muscle **pain**, or back pain. Such discomfort is quickly relieved by mild medications such as **aspirin**.

KEY TERMS

Mania—A mood disorder in which a person experiences prolonged elation or irritability characterized by overactivity that can lead to exhaustion and medical emergencies.

Relapse—A return of the signs and symptoms of an illness.

Schizophrenia—A severe mental illness in which a person has difficulty distinguishing what is real from what is not real. It is often characterized by hallucinations, delusions, and withdrawal from people and social activities.

Risks

Advanced medical technology has substantially reduced the complications associated with ECT. These include slow heart beat (bradycardia), rapid heart beat (tachycardia), **memory loss**, and confusion. Persons at high risk for ECT include those with recent **heart attack**, uncontrolled blood pressure, brain tumors, and previous spinal injuries.

Normal results

ECT often produces dramatic improvement in the signs and symptoms of major depression, especially in elderly individuals, sometimes during the first week of treatment. While it is estimated that 50% of these patients will experience a future return of symptoms, the prognosis for each episode of illness is good. Mania also often responds well to treatment. The picture is not as bright for schizophrenia, which is more difficult to treat and is characterized by frequent relapses.

A few patients are placed on maintenance ECT. This means they return to the hospital every one–two months, as needed, for an additional treatment. These individuals are thus able to keep their illness under control and lead a normal and productive life.

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National Institutes of Health, 9000 Rockville Place, Bethesda, MD, 20892, (301) 496-4000, NIHinfo@od.nih.gov, http://www.nih.gov.

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Electrocution *see* **Electric shock injuries**

Electroencephalography

Definition

Electroencephalography, or EEG, is a neurological test that uses an electronic monitoring device to measure and record electrical activity in the brain.

Purpose

The EEG is a key tool in the diagnosis and management of **epilepsy** and other seizure disorders. It is also used to assist in the diagnosis of brain damage and disease (e.g., **stroke**, tumors, **encephalitis**), **mental retardation**, **sleep disorders**, degenerative diseases such as **Alzheimer's disease** and **Parkinson's disease**, and certain mental disorders (e.g., **alcoholism**, **schizophrenia**, **autism**).

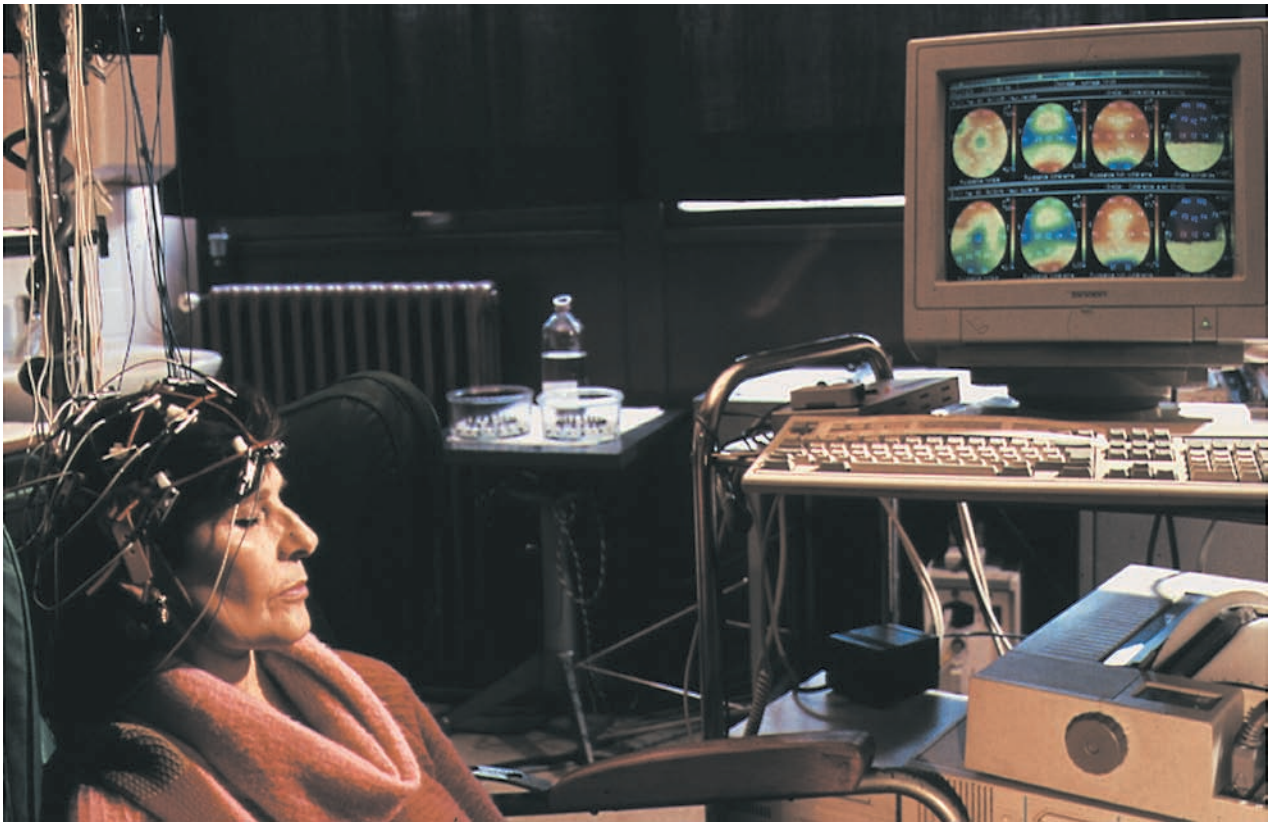
An EEG may also be used to monitor brain activity during surgery and to determine brain **death**.

Precautions

Electroencephalography should be administered and interpreted by a trained medical professional only. Data from an EEG is only one element of a complete medical and/or psychological patient assessment, and should never be used alone as the sole basis for a diagnosis.

Description

Before the EEG begins, a nurse or technician attaches approximately 16–20 electrodes to the patient's scalp with a conductive, washable paste. Depending on



This woman is undergoing an electroencephalogram (EEG) to diagnose Alzheimer's disease. On the computer screen at the right are the colored scans of the electrical activity in her brain. Alzheimer's patients show a specific abnormality in their EEGs. *(Catherine Pouedras/Photo Researchers, Inc.)*

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the purpose for the EEG, implantable or invasive electrodes are occasionally used. Implantable electrodes include sphenoidal electrodes, which are fine wires inserted under the zygomatic arch, or cheekbone; and depth electrodes, which are surgically-implanted into the brain. The EEG electrodes are painless, and are used to measure the electrical activity in various regions of the brain.

For the test, the patient lies on a bed, padded table, or comfortable chair and is asked to relax and remain still during the EEG testing period. An EEG usually takes no more than one hour. During the test procedure, the patient may be asked to breathe slowly or quickly; visual stimuli such as flashing lights or a patterned board may be used to stimulate certain types of brain activity. Throughout the procedure, the electroencephalograph machine makes a continuous graphic record of the patient's brain activity, or brainwaves, on a long strip of recording paper or on a computer screen. This graphic record is called an electroencephalogram.

The sleep EEG uses the same equipment and procedures as a regular EEG. Patients undergoing a sleep EEG are encouraged to fall asleep completely rather than just relax. They are typically provided a bed and a quiet room conducive to sleep. A sleep EEG lasts up to three hours.

In an ambulatory EEG, patients are hooked up to a portable cassette recorder. They then go about their normal activities, and take their normal rest and sleep for a period of up to 24 hours. During this period, the patient and patient's family record any symptoms or abnormal behaviors, which can later be correlated with the EEG to see if they represent seizures.

Many insurance plans provide reimbursement for EEG testing. Costs for an EEG range from $100 to more than $500, depending on the purpose and type of test (i.e., asleep or awake, and invasive or non-invasive electrodes). Because coverage may be dependent on the disorder or illness the EEG is evaluating, patients should check with their individual insurance plan.

Preparation

Full instructions should be given to EEG patients when they schedule their test. Typically, individuals on medications that affect the central nervous system, such as anticonvulsants, stimulants, or antidepressants, are told to discontinue their prescription for a short time prior to the test (usually one to two days). Patients may be asked to avoid food and beverages that contain **caffeine**, a central nervous system stimulant. However, any such request should be cleared by the treating physician. Patients may also be asked to arrive for the test with clean hair free of spray or other styling products.

KEY TERMS

Epilepsy—A neurological disorder characterized by recurrent seizures with or without a loss of consciousness.

Ictal EEG—Used to measure brain activity during a seizure. May be useful in learning more about patients who aren't responding to conventional treatments.

Patients undergoing a sleep EEG may be asked to remain awake the night before their test. They may be given a sedative prior to the test to induce sleep.

Aftercare

If the patient has suspended regular medication for the test, the EEG nurse or technician should advise him when he can begin taking it again.

Risks

Being off medication for one–two days may trigger seizures. Certain procedures used during EEG may trigger seizures in patients with epilepsy. Those procedures include flashing lights and deep breathing. If the EEG is being used as a diagnostic for epilepsy (i.e., to determine the type of seizures an individual is suffering from), this may be a desired effect, although the patient needs to be monitored closely so that the seizure can be aborted if necessary. This type of test is known as an ictal EEG.

Normal results

In reading and interpreting brainwave patterns, a neurologist or other physician will evaluate the type of brainwaves and the symmetry, location, and consistency of brainwave patterns. He will also look at the brainwave response to certain stimuli presented during the EEG test (such as flashing lights or noise). There are four basic types of brainwaves: alpha, beta, theta, and delta. "Normal" brainwave patterns vary widely, depending on factors of age and activity. For example, awake and relaxed individuals typically register an alpha wave pattern of eight to 13 cycles per second. Young children and sleeping adults may have a delta wave pattern of under four cycles per second.

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Abnormal results

The EEG readings of patients with epilepsy or other seizure disorders display bursts or spikes of electrical activity. In focal epilepsy, spikes are restricted to one hemisphere of the brain. If spikes are generalized to both hemispheres of the brain, multifocal epilepsy may be present.

The diagnostic brainwave patterns of other disorders varies widely. The appearance of excess theta waves (four to eight cycles per second) may indicate brain injury. Brain wave patterns in patients with brain disease, mental retardation, and brain injury show overall slowing. A trained medical specialist should interpret EEG results in the context of the patient's medical history, and other pertinent medical test results.

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Paula Anne Ford-Martin

Electrolyte disorders

Definition

An electrolyte disorder is an imbalance of certain ionized components (i.e., bicarbonate, **calcium**, chloride, magnesium, phosphate, potassium, and **sodium**) in the blood.

Description

Electrolytes are ionized molecules found throughout the blood, tissues, and cells of the body. These molecules, which are either positive (cations) or negative (anions), conduct an electric current and help to balance pH and acid-base levels in the body. Electrolytes also facilitate the passage of fluid between and within cells through a process known as osmosis and play a part in regulating the function of the cardiovascular, neuromuscular, endocrine, and excretory systems.

The serum electrolytes include:

- Sodium (Na). A positively charged electrolyte that helps to balance fluid levels in the body and facilitates neuromuscular functioning.
- Potassium (K). A main component of cellular fluid, this positive electrolyte helps to regulate neuromuscular function and osmotic pressure.
- Calcium (Ca). A cation, or positive electrolyte, that affects neuromuscular performance and contributes to skeletal growth and blood coagulation.
- Magnesium (Mg). Influences muscle contractions and intracellular activity. A cation.
- Chloride (Cl). An anion, or negative electrolyte, that regulates blood pressure.
- Phosphate (HPO_4). Negative electrolyte that impacts metabolism and regulates acid-base balance and calcium levels.
- Bicarbonate (HCO_3). A negatively charged electrolyte that assists in the regulation of blood pH levels. Bicarbonate insufficiencies and elevations cause acid-base disorders (i.e., acidosis, alkalosis).

Risk factors

Medications, chronic diseases, and trauma (for example, **burns**, or **fractures**, etc.) may cause the concentration of certain electrolytes in the body to become too high (hyper-) or too low (hypo-). When this happens, an electrolyte imbalance, or disorder, results.

Causes and symptoms

Sodium

HYPERNATREMIA. Sodium helps the kidneys to regulate the amount of water the body retains or excretes. Consequently, individuals with elevated serum sodium levels experience a loss of fluids, or **dehydration**. **Hypernatremia** can be caused by inadequate water intake, excessive fluid loss (i.e., **diabetes insipidus**, **kidney disease**, severe burns, and prolonged **vomiting** or **diarrhea**), or sodium retention (caused by excessive sodium intake or aldosteronism). In addition, certain drugs, including loop **diuretics**, **corticosteroids**, and antihypertensive medications may cause elevated sodium levels.

Symptoms of hypernatremia include:

- thirst
- orthostatic hypotension
- dry mouth and mucous membranes
- dark, concentrated urine
- loss of elasticity in the skin
- irregular heartbeat (tachycardia)
- irritability
- fatigue
- lethargy
- heavy, labored breathing
- muscle twitching and/or seizures

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HYPONATREMIA. Up to 1% of all hospitalized patients and as many as 18% of nursing home patients develop **hyponatremia**, making it one of the most common electrolyte disorders. Diuretics, certain psychoactive drugs (i.e., fluoxetine, sertraline, haloperidol), specific antipsychotics (lithium), vasopressin, chlorpropamide, the illicit drug ecstasy, and other pharmaceuticals can cause decreased sodium levels. Low sodium levels may also be triggered by inadequate dietary intake of sodium, excessive perspiration, water intoxication, and impairment of adrenal gland or kidney function.

Symptoms of hyponatremia include:

- nausea, abdominal cramping, and/or vomiting
- headache
- edema (swelling)
- muscle weakness and/or tremor
- paralysis
- disorientation
- slowed breathing
- seizures
- coma

Potassium

HYPERKALEMIA. **Hyperkalemia** may be caused by ketoacidosis (diabetic **coma**), myocardial infarction (**heart attack**), severe burns, kidney failure, **fasting**, **bulimia nervosa**, gastrointestinal bleeding, adrenal insufficiency, or **Addison's disease**. Diuretic drugs, cyclosporin, lithium, heparin, ACE inhibitors, **beta blockers**, and trimethoprim can increase serum potassium levels, as can heavy **exercise**. The condition may also be secondary to hypernatremia. Symptoms may include:

- weakness
- nausea and/or abdominal pain
- irregular heartbeat (arrhythmia)
- diarrhea
- muscle pain

HYPOKALEMIA. Severe dehydration, aldosteronism, **Cushing's syndrome**, kidney disease, long-term diuretic therapy, certain **penicillins**, laxative **abuse**, congestive **heart failure**, and adrenal gland impairments can all cause depletion of potassium levels in the bloodstream. A substance known as glycyrrhetinic acid, which is found in licorice and chewing tobacco, can also deplete potassium serum levels. Symptoms of **hypokalemia** include:

- weakness
- paralysis
- increased urination
- irregular heartbeat (arrhythmia)
- orthostatic hypotension
- muscle pain
- tetany

Calcium

HYPERCALCEMIA. Blood calcium levels may be elevated in cases of thyroid disorder, **multiple myeloma**, metastatic **cancer**, multiple bone fractures, milk-alkali syndrome, and Paget's disease. Excessive use of calcium-containing supplements and certain over-the-counter medications (i.e., **antacids**) may also cause **hypercalcemia**. In infants, lesser known causes may include blue diaper syndrome, Williams syndrome, secondary **hyperparathyroidism** from maternal **hypocalcemia**, and dietary phosphate deficiency. Symptoms include:

- fatigue
- constipation
- depression
- confusion
- muscle pain
- nausea and vomiting
- dehydration
- increased urination
- irregular heartbeat (arrhythmia)

HYPOCALCEMIA. Thyroid disorders, kidney failure, severe burns, **sepsis**, **vitamin D deficiency**, and medications such as heparin and glucogan can deplete blood calcium levels. Lowered levels cause:

- muscle cramps and spasms
- tetany and/or convulsions
- mood changes (depression, irritability)
- dry skin
- brittle nails
- facial twitching

Magnesium

HYPERMAGNESEMIA. Excessive magnesium levels may occur with end-stage renal disease, Addison's disease, or an overdose of magnesium salts. Hypermagnesemia is characterized by:

- lethargy
- hypotension
- decreased heart and respiratory rate
- muscle weakness
- diminished tendon reflexes

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KEY TERMS

Acid-base balance—A balance of acidity and alkalinity of fluids in the body that keeps the pH level of blood around 7.35–7.45.

Aldosteronism—A condition defined by high serum levels of aldosterone, a hormone secreted by the adrenal gland that is responsible for increasing sodium reabsorption in the kidneys.

Addison's disease—A disease characterized by a deficiency in adrenocortical hormones due to destruction of the adrenal gland.

Bulimia nervosa—An eating disorder characterized by binging and purging (self-induced vomiting) behaviors.

Milk-alkali syndrome—Elevated blood calcium levels and alkalosis caused by excessive intake of milk and alkalis. Usually occurs in the treatment of peptic ulcer.

Orthostatic hypotension—A drop in blood pressure that causes faintness or dizziness and occurs when one rises to a standing position. Also known as postural hypotension.

Osmotic pressure—Pressure that occurs when two solutions of differing concentrations are separated by a semipermeable membrane, such as a cellular wall, and the lower concentration solute is drawn across the membrane into the higher concentration solute (osmosis).

Tetany—A disorder of the nervous system characterized by muscle cramps, spasms of the arms and legs, and numbness of the extremities.

HYPOMAGNESEMIA. Inadequate dietary intake of magnesium, often caused by chronic **alcoholism** or **malnutrition**, is a common cause of hypomagnesemia. Other causes include malabsorption syndromes, **pancreatitis**, aldosteronism, burns, hyperparathyroidism, digestive system disorders, and diuretic use. Symptoms of low serum magnesium levels include:

- leg and foot cramps
- weight loss
- vomiting
- muscle spasms, twitching, and tremors
- seizures
- muscle weakness
- arrthymia

Chloride

HYPERCHLOREMIA. Severe dehydration, kidney failure, hemodialysis, traumatic brain injury, and aldosteronism can cause hyperchloremia. Drugs such as boric acid and ammonium chloride and the intravenous (IV) infusion of sodium chloride can also boost chloride levels, resulting in hyperchloremic **metabolic acidosis**. Symptoms include:

- weakness
- headache
- nausea
- cardiac arrest

HYPOCHLOREMIA. Hypochloremia usually occurs as a result of sodium and potassium depletion (i.e., hyponatremia, hypokalemia). Severe depletion of serum chloride levels causes **metabolic alkalosis**. This alkalization of the bloodstream is characterized by:

- mental confusion
- slowed breathing
- paralysis
- muscle tension or spasm

Phosphate

HYPERPHOSPHATEMIA. Skeletal fractures or disease, kidney failure, **hypoparathyroidism**, hemodialysis, **diabetic ketoacidosis**, acromegaly, systemic infection, and intestinal obstruction can all cause phosphate retention and build-up in the blood. The disorder occurs concurrently with hypocalcemia. Individuals with mild hyperphosphatemia are typically asymptomatic, but signs of severe hyperphosphatemia include:

- tingling in hands and fingers
- muscle spasms and cramps
- convulsions
- cardiac arrest

HYPOPHOSPHATEMIA. Serum phosphate levels of 2 mg/dL or below may be caused by hypomagnesemia and hypokalemia. Severe burns, alcoholism, diabetic ketoacidosis, kidney disease, hyperparathyroidism, **hypothyroidism**, Cushing's syndrome, malnutrition, hemodialysis, vitamin D deficiency, and prolonged diuretic therapy can also diminish blood phosphate levels. There are typically few physical signs of mild

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phosphate depletion. Symptoms of severe hypophosphatemia include:

- muscle weakness
- weight loss
- bone deformities (osteomalacia)

Diagnosis

Examination

Diagnosis is performed by a physician or other qualified healthcare provider who will take a medical history, discuss symptoms, perform a complete **physical examination**, and prescribe appropriate laboratory tests. Because electrolyte disorders commonly affect the neuromuscular system, the provider will test reflexes. If a calcium imbalance is suspected, the physician will also check for Chvostek's sign, a reflex test that triggers an involuntary facial twitch, and Trousseau's sign, a muscle spasm that occurs in response to pressure on the upper arm.

Tests

Serum electrolyte imbalances can be detected through blood tests. Blood is drawn from a vein on the back of the hand or inside of the elbow by a medical technician, or phlebotomist, and analyzed at a lab.

Normal levels of electrolytes are:

- Sodium: 135–145 mEq/L (serum)
- Potassium: 3.5–5.5 mEq/L (serum)
- Calcium: 8.8–10.4 mg/dL (total Ca; serum); 4.7–5.2 mg/dL (unbound Ca; serum)
- Magnesium: 1.4–2.1 mEq/L (plasma)
- Chloride: 100–108 mEq/L (serum)
- Phosphate: 2.5–4.5 mg/dL (plasma; adults)

Standard ranges for test results may vary due to differing laboratory standards and physiological variances (gender, age, and other factors). Other blood tests that determine pH levels and acid-base balance may be performed.

Treatment

Treatment of electrolyte disorders depends on the underlying cause of the problem and the type of electrolyte involved. If the disorder is caused by poor diet or improper fluid intake, nutritional changes may be prescribed. If medications such as diuretics triggered the imbalance, discontinuing or adjusting the drug therapy may effectively treat the condition. Fluid and electrolyte replacement therapy, either intravenously or by mouth, can reverse electrolyte depletion.

Hemodialysis treatment may be required to reduce serum potassium levels in hyperkalemic patients with impaired kidney function. It may also be recommended for renal patients with severe hypermagnesemia.

Prognosis

A patient's long-term prognosis depends upon the root cause of the electrolyte disorder. When treated quickly and appropriately, electrolyte imbalances in and of themselves are usually effectively reversed.

When they are mild, some electrolyte imbalances have few to no symptoms and may pass unnoticed. For example, transient hyperphosphatemia is usually fairly benign. However, long-term elevations of blood phosphate levels can lead to potentially fatal soft tissue and vascular calcifications and bone disease, and severe serum phosphate deficiencies (hypophosphatemia) can cause encephalopathy, coma, and **death**.

Severe hypernatremia has a mortality rate of 40–60%. Death is commonly due to cerebrovascular damage and hemorrhage resulting from dehydration and shrinkage of the brain cells.

Prevention

Physicians should use caution when prescribing drugs known to affect electrolyte levels and acid-base balance. Individuals with kidney disease, thyroid problems, and other conditions that may place them at risk for developing an electrolyte disorder should be educated on the signs and symptoms.

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Electrolyte supplements

Definition

Electrolyte supplements are a varied group of prescription and nonprescription preparations used to correct imbalances in the body's electrolyte levels. Electrolytes themselves are substances that dissociate into ions (electrically charged atoms or atom groups) when they melt or are dissolved, thus serving to conduct electricity. In the human body, electrolytes are critical to the proper distribution of water, muscle contraction and expansion, transmission of nerve impulses, delivery of oxygen to body tissues, heart rate and rhythm, acid-base balance, and other important functions or conditions.

The ions that are formed when electrolytes are dissolved in body fluids are either positively or negatively charged. Positively charged ions are called cations, and are formed when an atom or atom group loses electrons. The most important cations in the human body are **sodium**, potassium, magnesium, and **calcium** ions. Negatively charged ions are called anions, and are formed when an atom or atom group gains electrons. The principal anions in the body include bicarbonate, chloride, phosphate, and sulfate ions, as well as ions formed by certain protein compounds or organic acids.

About 60% of an adult human male's total body weight is water. In adult women, the figure is about 55%, and is even lower in the elderly and in obese people. Two-thirds of total body water (TBW) lies inside cells and is known as intracellular fluid or ICF. The remaining third of TBW lies outside the cells and is called extracellular fluid or ECF. About 75% of ECF lies in connective tissue or the spaces between tissues outside the blood vessels (interstitial spaces), while the remaining 25% is within the blood vessels. In addition to representing different proportions of TBW, ICF and ECF differ significantly in their electrolyte content. Whereas the major cation in ICF is potassium, the most important cation in ECF is sodium. These differences in electrolyte levels help to regulate the movement of water between ICF and ECF.

Children are more vulnerable than adults to fluid and electrolyte imbalances, in part because they have different ratios of TBW to total body weight, and of ICF to ECF. A newborn baby carried to full term has a TBW ratio between 75 and 80%. The baby's total body water ratio decreases by 4–5% during the first week after birth and reaches the adult level of 60% by twelve months of age. Similarly, a newborn has an ICF:ECF ratio of 55:45, which falls to the adult ratio of 70:30 during the first year of life. In addition to these different fluid ratios, children's kidneys are less efficient than adults in regulating water balance; children have smaller organ systems that dissipate body heat less efficiently; and their core body temperature rises faster than that of an adult when they become dehydrated. All these factors help to explain why some electrolyte supplements are formulated specifically for children.

Purpose

The purpose of electrolyte supplements is to restore the proper ratio of total body water to total body weight and the correct proportions of the various electrolytes in body fluids. Electrolyte imbalances may result from excessive intake or inadequate elimination of electrolytes on the one hand or by insufficient intake or excessive elimination on the other hand.

Body regulation of water and electrolytes

Under normal conditions, the water and electrolyte content of the body is regulated by the kidneys, the secretion of antidiuretic hormone, and the sensation of thirst. The average adult needs to take in about 700–800 mL (about 1.5–1.7 pints) of water per day in order to match the water lost through perspiration, breathing, and excretion of waste products (urine and feces). The water taken in by mouth is added to the 200–300 mL (0.42–0.63 pints) of water that are formed in the body each day through tissue breakdown.

The amount of water needed to match fluid losses may be considerably greater than the average during **exercise** or in patients with **fever**, severe **vomiting**, or **diarrhea**. Adults with fever typically lose an additional 0.75–1.0 oz of fluid per day for each degree that their temperature rises above normal. With regard to diarrhea, adults with **cholera** have been reported to lose as much as a quart of fluid per hour in their stools. The fluid lost in this way contains sodium, potassium, and chloride, resulting in electrolyte imbalances in cholera patients as well as **dehydration**.

Exercise raises the total metabolism of the body to 5–15 times the resting rate. Most of this energy (70–90%) is released as heat, which is partially dissipated by the evaporation of sweat. Depending on weather conditions, the type and weight of clothing being worn, and the intensity of exercise or physical work performed, adults may lose anywhere from 1 to 2.5 qt of fluid per hour through perspiration. Sweat contains sodium chloride as well as smaller amounts of potassium, calcium, and magnesium. In order to maintain the proper balance of electrolytes in the body as well as fluid,

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athletes or people employed in outdoor work during warm weather may need to replace the electrolytes lost in sweat by taking capsules or drinking beverages containing supplemental electrolytes.

With regard to the sense of thirst, it is not always an accurate indication of the body's need for water. Researchers have found that many people do not feel thirsty until they have already lost about 2% of their total body weight through fluid losses. As a result, most people do not replace enough fluid during exercise or hot weather simply by drinking water until they no longer feel thirsty. In addition, the **aging** process, certain mental disorders, or drugs may affect a person's sense of thirst.

At the other extreme of water intake, a person may drink excessive amounts of water due to misunderstandings about their need for extra fluid during exercise. This condition is known as water intoxication or hyperhydration. It leads to abnormally low levels of sodium in the blood, a condition known as **hyponatremia**. This condition is also known as exercise-associated hyponatremia (EAH). Water intoxication may lead to swelling of the brain, confusion, disorientation, and eventually **coma** or **death**. Several marathon runners have died from water intoxication, as have teenagers who consumed large amounts of water after taking doses of Ecstasy (MDMA), a so-called "club drug." Other persons at risk for water intoxication include people with **eating disorders** and children with **mental retardation**. Research reported in the *New England Journal of Medicine* revealed that as many as 13% of marathon runners developed hyponatremia during the course of a race as a result of drinking too much water, usually 3 qt or more. Female athletes appear to be at greater risk of water intoxication and hyponatremia than male athletes.

Conditions associated with fluid and electrolyte imbalance

Several common conditions can lead to fluid and electrolyte imbalance:

- Exposure to extended periods of extremely hot weather.
- High levels of athletic activity, military training, or outdoor work in such fields as construction, agriculture, forestry, fishing, and certain types of manufacturing.
- Extreme changes in diet.
- Reduced fluid intake.
- Medication side effects. Certain drugs, particularly diuretics, beta-blockers, and vasodilators, may increase the loss of electrolytes in urine and/or interfere with the body's ability to regulate its temperature during exercise or in hot weather.
- Severe illnesses characterized by high fever, recurrent diarrhea, and/or frequent vomiting. Such illnesses include cholera, viral gastroenteritis (stomach flu), shigellosis, and amebic dysentery.
- Severe burns covering more than 10% of the body.
- Surgical creation of a stoma or urinary diversion. These operations sometimes lead to an increased loss of body fluids while the patient's body is adjusting to the changes in urination and excretion resulting from the surgery. In addition, some forms of weight loss surgery intended to bypass parts of the small intestine in which food absorption occurs have a 70% rate of electrolyte imbalances as a complication of the operation.
- Diseases affecting the kidneys. These include diabetes mellitus, diabetes insipidus, and syndrome of inappropriate antidiuretic hormone secretion (SIADH) as well as cancer or infections of the kidneys.
- In infants, premature birth.

Description

The various electrolyte supplements used in the United States and Canada are intended to prevent or treat electrolyte imbalances in very different situations or groups of patients. They range from sports drinks and other supplements used by amateur or professional athletes to prevent **muscle cramps** and improve athletic performance, to liquids used at home to prevent dehydration in children with diarrhea, to injections administered as part of enteral (feeding through a tube or stoma directly into the small intestine) or parenteral **nutrition** (intravenous feeding that bypasses the digestive tract).

The major categories of electrolyte supplements are:

- Sports drinks. Sports drinks are beverages specially formulated to contain appropriate amounts of electrolytes and carbohydrates as well as water to replace the fluid and sodium lost through sweat during athletic activities. These beverages are popular with athletes at the college level. According to the American College of Sports Medicine as well as American and Canadian dietitians' associations, sports drinks are effective in supplying food energy for the muscles, maintaining proper levels of blood sugar, maintaining the proper functioning of the thirst mechanism, and lowering the risk of dehydration or hyponatremia. Other researchers have noted that the flavoring added to sports drinks encourages athletes to drink more during periods of exercise and thus maintain

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KEY TERMS

Anion—An ion carrying a negative charge owing to a surplus of electrons. Anions in the body include bicarbonate, chloride, phosphate, sulfate, certain organic acids, and certain protein compounds.

Cation—An ion carrying a positive charge due to a loss of electrons. Cations in the body include sodium, potassium, magnesium, and calcium ions.

Cholera—A severe bacterial infection of the small intestine characterized by profuse diarrhea and eventual dehydration. Cholera is still a frequent cause of death among children in developing countries.

Electron—An elementary particle carrying a negative charge. Electrons may exist either independently or as components of an atom outside its nucleus.

Enteral nutrition—Nourishment given through a tube or stoma directly into the small intestine, thus bypassing the upper digestive tract.

Hyponatremia—Insufficient sodium in the blood.

Interstitial spaces—Spaces within body tissues that are outside the blood vessels. Also known as interstitial compartments.

Ion—An atom or group of atoms that acquires an electrical charge by the gain or loss of electrons.

Metabolism—The sum of an organism's physical and chemical processes that produce and maintain living tissue, and make energy available to the organism. Insulin resistance is a disorder of metabolism.

Parenteral nutrition—Nutrition supplied intravenously, thus bypassing the patient's digestive tract entirely.

Stoma—A surgical opening made in the abdominal wall to allow waste products to pass directly to the outside.

Water intoxication—A potentially life-threatening condition caused by drinking too much water, which leads to hyponatremia and may result in seizures, coma, and death.

proper levels of hydration. Sports drinks can be purchased in supermarkets and health food stores; they include such well-known beverages as Gatorade and Powerade. Some of these supplements come in a semisolid form known as energy gels, which contain caffeine or various herbal compounds as well as carbohydrates and electrolytes.

- Over-the-counter powders and tablets. Some athletes–particularly those who participate in long-distance running or endurance cycling—prefer capsules or concentrated powders to maintain their electrolyte balance during exercise. The powders are mixed with 12 or 16 oz of cold water prior to drinking, while the capsules can be taken before, during, and after exercise. Most contain flavorings to mask the naturally salty or bitter taste of the electrolytes themselves. Common brand names include eForce, NutriBiotic, and Endurolytes;. These products are regarded by the Food and Drug Administration (FDA) as dietary supplements.
- Over-the-counter electrolyte replenishers for children. Infants and young children are more vulnerable to dehydration than adults, particularly from severe gastroenteritis or diarrhea. A child may become dehydrated in less than a day from recurrent vomiting or episodes of diarrhea. Some doctors recommend that parents keep oral rehydration fluids containing mixtures of carbohydrates and electrolytes specially formulated for children in the medicine chest at home in case the child becomes dehydrated from a stomach virus or similar illness. Common brand names for these products, which are regulated by the FDA as medical foods, include Pedialyte, Infalyte, Naturalyte, and Rehydralyte. Most come in a powdered form to be mixed with water as well as liquid forms; Pedialyte is also available as fruit-flavored freezer pops.
- Oral rehydration formulae for children and adults. Oral rehydration salts, also known as ORS, have been a staple of treatment for cholera and other diseases accompanied by severe diarrhea in developing countries for almost half a century. First researched in the 1940s, oral rehydration salts were adopted by the World Health Organization (WHO) in 1978 in order to reduce the risk of death from dehydration caused by cholera-related diarrhea. Since the introduction of ORS, the number of children around the world who die from acute diarrhea has been reduced from 5 million per year to 1.3 million. Reformulated by WHO in 2002, the ORS salts come in packets to be kept in the home and mixed with water as soon as a child (or adult) falls ill. The formula is a low-glucose and low-sodium mixture. If the WHO packets are unavailable, a comparable form of oral rehydration solution can be made by adding 8 tsp of table sugar, ½ tsp of salt, ½ tsp of baking soda (bicarbonate of soda), and $^1/_3$ tsp of potassium chloride to 1 L (1.05 qt) of water. In an emergency, a solution prepared

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from 1 tbsp of sugar and ½ tsp of salt added to 1 L of water can be used to treat diarrhea.

- Multiple electrolyte injections. Various mixtures of electrolytes are available by prescription in injectable form to be added to enteral or parenteral nutrition formulae. These forms of feeding are used in patients who require supplementation or complete replacement of feeding by mouth, including patients with various intestinal disorders, AIDS, or severe burns. Basic solutions for total parenteral nutrition, or TPN, contain the electrolytes sodium, potassium, chloride, phosphate, and magnesium, although the exact proportion of electrolytes can be tailored to an individual patient's needs. Some injectable formulae contain dextrose, a sugar, and acetate or lactate as well as the five major electrolytes. Common brand names include TPN Electrolytes, Lypholyte, Nutrilyte, Plasma-Lyte 148, and others. Some patients are taught to use these injectable formulae at home.

Recommended dosage

Recommended dosages for electrolyte supplements are:

- Sports drinks. Since sports drinks and energy gels are not medications in the strict sense, the amount consumed will vary not only from person to person but also in a given individual from day to day depending on weather conditions, level of athletic conditioning, length of activity, and other factors. To lower the risk of dehydration in adults in hot weather, the American College of Sports Medicine recommends drinking approximately 2 to 3 mL/lb of body weight of water or sports drink four hours before exercising. Overhydration during this time period should be avoided. During exercise, enough fluid should be consumed to prevent a water deficit greater then 2% of body weight. Recommended beverages are those that contain electrolytes and carbohydrates. If the exercise event lasts longer than an hour, consumption of carbohydrate beverages that contain 6–8% carbohydrate is recommended. After exercise, rapid and complete recovery from exercise-induced dehydration can be accomplished by drinking at least 16–24 oz (450–675 mL) of fluid for every pound of weight lost during exercise. To replace fluids and electrolytes lost during endurance events lasting longer than two hours, the current recommendation is consumption of sports drinks that contain 0.5–0.7 g/L of sodium and 0.8–2.0 g/L of potassium and that also contain carbohydrate.
- Over-the-counter powders and tablets. The usual recommended dose of powdered electrolytes is one scoopful (or prepackaged envelope) of powder dissolved in 12–16 oz of water before exercising. Capsules may be taken as follows: 1–3 capsules 30–60 minutes before exercising; 1–6 capsules per hour during the workout; and 1–3 capsules after exercising.
- Over-the-counter electrolyte replenishers for children. Dosages for Pedialyte and similar oral rehydration solutions for children are usually based on the child's age and weight. The child's doctor should determine the quantity to be given if the child is younger than 12 months of age. Children between the ages of one and two years are usually given 34 mL of electrolyte solution per pound of body weight during the first eight hours of treatment and 75 mL per pound of body weight during the next 16 hours, although the doctor may adjust the dose if the child is very thirsty. Children between the ages of two and ten are given 23 mL of electrolyte solution per pound of body weight for the first four to six hours of treatment, followed by 45 mL per pound taken over the next 18–24 hours. Freezer pops may be given to children older than one year as often as the child desires.
- Oral rehydration formulae. The WHO form of oral rehydration liquid is made by adding the full contents of one packet of powdered oral rehydration salts to a quart of drinking water. The solution should not be boiled. A fresh quart of solution should be mixed each day. Infants and young children should be given the solution in small amounts by spoon as often as possible. Adults and teenagers should take the WHO formula according to the doctor's directions.
- Multiple electrolyte injections. Basic TPN solutions are usually made up in liter batches and adjusted to each individual patient's needs. The standard adult dosage is 2 L per day, usually administered by drip through a needle or catheter placed in the patient's vein for a 10–12-hour period once a day or five days per week. The patient may be given several units of premixed TPN fluid to store at home in the refrigerator or freezer. Each dose should be taken from the refrigerator 4–6 hours prior to use to allow it to warm to room temperature. TPN solution stored in a freezer should be moved to a refrigerator 24 hours before use.

Precautions

Sports drinks should not be given to rehydrate children with **vomiting** or diarrhea, as they do not contain the proper balance of carbohydrates and electrolytes needed by children's bodies.

Over-the-counter powders and tablets should always be taken with adequate amounts of water and kept out of the reach of children.

Over-the-counter electrolyte replenishers for children should be stored out of the reach of children and

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away from heat and direct sunlight. In addition, they should not be given to patients with intestinal blockage.

WHO oral rehydration salts and packets of similar formulae should not be stored in damp places, as moisture can cause the contents to lose their effectiveness. These products should also be kept away from heat or direct sunlight. Unused oral rehydration solution should be discarded at the end of each day. As with electrolyte replenishers for children, oral rehydration formulae should not be given to patients with intestinal blockage.

Patients using multiple electrolyte injections as part of **total parenteral nutrition** should have their blood and urine checked at regular intervals while they are receiving these medicines. They should also be taught to recognize the signs of infection at the injection site (**pain**, swelling, redness, or a cold sensation). In addition, these patients should not use sports drinks, other electrolyte supplements, or over-the-counter medications (including herbal preparations) without consulting their doctor. The injections should not be used if the fluid looks cloudy, has solid particles floating in it, or has separated. The injections should be stored away from sunlight and moisture. In addition, patients receiving multiple electrolyte injections should not stop them suddenly without telling their doctor, as the dosage may need to be reduced slowly before the TPN is discontinued.

Side effects

Some persons do not like the salty taste of many sports drinks. They may wish to consider products containing glycine, which is an amino acid that neutralizes the salty taste of the electrolytes themselves. A more serious side effect of sports drinks is **tooth decay**. An article published by researchers at the University of Maryland Dental School showed that sports drinks erode tooth enamel at a rate three to 11 times faster than cola-based soft drinks.

No side effects have been reported for over-the-counter powders and tablets.

Side effects from children's electrolyte replenishers may include allergic reactions, including **hives**, swelling of the face or hands, trouble breathing, **tingling** in the mouth or throat. Other side effects may include signs of too much sodium in the body, such as **dizziness**, seizures, muscle twitching, or restlessness. The doctor should be notified immediately if any of these side effects occur. A less serious side effect that occurs in some children is mild vomiting.

Oral rehydration formulae may produce the same side effects as electrolyte replenishers for children.

Minor side effects from multiple electrolyte injections may include increased frequency of urination, **dry mouth**, increased thirst, or drowsiness. Serious side effects include rapid weight gain, yellowing of the skin or eyes, fruity odor on the breath, **numbness** or tingling in the hands or feet, uneven heartbeat, **shortness of breath**, confusion, or weakness with muscle twitching. Patients should notify their doctor immediately if they notice any of these side effects.

Interactions

Sports drinks may raise blood electrolyte levels in patients receiving total parenteral nutrition. They should not be consumed by patients receiving multiple electrolyte injections.

Children receiving premixed forms of electrolyte replenishers should not eat food with added salt or drink fruit juices until the diarrhea has stopped.

No interactions with other medications have been reported with oral rehydration formulae for adults or over-the-counter powders and tablets. However, the doctor should be informed of all other medications the patient is taking in case a dosage adjustment is necessary.

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ORGANIZATIONS

American College of Sports Medicine (ACSM), P.O. Box 1440, Indianapolis, IN, 46206-1440, (317) 637-9200, (317) 634-7817, http://www.acsm.org.

American Society of Health-System Pharmacists (ASHP), 7272 Wisconsin Avenue, Bethesda, MD, 20814, (301) 657-3000, (866) 279-0681, http://www.ashp.org.

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Electrolyte tests

Definition

Electrolytes are positively and negatively charged molecules, called ions, that are found within cells, between cells, in the bloodstream, and in other fluids throughout the body. Electrolytes with a positive charge include **sodium**, potassium, **calcium**, and magnesium; the negative ions are chloride, bicarbonate, and phosphate. The concentrations of these ions in the bloodstream remain fairly constant throughout the day in a healthy person. Changes in the concentration of one or more of these ions can occur during various acute and chronic disease states and can lead to serious consequences.

Purpose

Tests that measure the concentration of electrolytes are useful in the emergency room and to obtain clues for the diagnosis of specific diseases. Electrolyte tests are used for diagnosing dietary deficiencies, excess loss of nutrients due to urination, **vomiting**, and **diarrhea**, or abnormal shifts in the location of an electrolyte within the body. When an abnormal electrolyte value is detected, the physician may either act to immediately correct the imbalance directly (in the case of an emergency) or run further tests to determine the underlying cause of the abnormal electrolyte value. Electrolyte disturbances can occur with malfunctioning of the kidney (renal failure), infections that produce severe and continual diarrhea or **vomiting**, drugs that cause loss of electrolytes in the urine (**diuretics**), **poisoning** due to accidental consumption of electrolytes, or diseases involving hormones that regulate electrolyte concentrations.

Precautions

Electrolyte tests are performed from routine blood tests. The techniques are simple, automated, and fairly uniform throughout the United States. During the preparation of blood plasma or serum, health workers must take care not to break the red blood cells, especially when testing for serum potassium. Because the concentration of potassium within red blood cells is much higher than in the surrounding plasma or serum, broken cells would cause falsely elevated potassium levels.

Description

Electrolyte tests are typically conducted on blood plasma or serum, urine, and diarrheal fluids. Electrolytes can be classified in at least five different ways. One way is that some electrolytes tend to exist mostly inside cells, or are intracellular, while others tend to be outside cells, or are extracellular. Potassium, phosphate, and magnesium occur at much greater levels inside the cell than outside, while sodium and chloride occur at much greater levels extracellularly. A second classification distinguishes those electrolytes that participate directly in the transmission of nerve impulses and those that do not. Sodium, potassium, and calcium are the important electrolytes involved in nerve impulses, and disorders affecting them are most closely associated with neurological disorders. A third classification focuses on electrolytes that are able to form a tight union, or complex, with one another. Calcium and phosphate have the greatest tendency to form complexes with each other. Disorders that cause an increase in either plasma calcium or phosphate can result in the deposit of calcium-phosphate crystals in the soft tissues of the body. A fourth classification concerns those electrolytes that influence the acidity or alkalinity of the bloodstream, also known as the pH. The pH of the bloodstream is normally in the range of 7.35–7.45. A decrease below this range is called acidosis, while a pH above this range is called alkalosis. The electrolytes most closely associated with the pH of the bloodstream are bicarbonate, chloride, and phosphate.

Preparation

All electrolyte tests can be performed on plasma or serum. Plasma is prepared by withdrawing a blood sample and placing it in a test tube containing a chemical that prevents blood from clotting (an

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anticoagulant). Serum is prepared by withdrawing a blood sample, placing it in a test tube, and allowing it to clot. The blood spontaneously clots within a minute of withdrawing the blood from a vein. The serum or plasma is then rapidly spun with a centrifuge in order to remove the blood cells or clot.

Normal results

Electrolyte concentrations are similar whether measured in serum or plasma. Values can be expressed in terms of weight per unit volume (mg/deciliter; mg/dL) or in the number of molecules in a volume, or molarity (**moles** or millimoles/liter; M or mM). The range of normal values sometimes varies slightly between different age groups, for males and females, and between different analytical laboratories.

The normal level of serum sodium is in the range of 136–145 mM. The normal levels of serum potassium are 3.5–5.0 mM. Note that sodium occurs at a much higher concentration than potassium. The normal concentration of total serum calcium (bound calcium plus free calcium) is in the range of 8.8–10.4 mg/dL. About 40% of the total calcium in the plasma is loosely bound to proteins; this calcium is referred to as bound calcium. The normal range of free calcium is 4.8–5.2 mg/dL. The normal concentration of serum magnesium is in the range of 2.0–3.0 mg/dL.

The normal concentration range of chloride is 350–375 mg/dL or 98–106 mM. The normal level of phosphate, as expressed as the concentration of phosphorus, is 2.0–4.3 mg/dL. Bicarbonate is an electrolyte that is freely and spontaneously interconvertable with carbonic acid and carbon dioxide. The normal concentration of carbonic acid (H_2CO_3) is about 1.35 mM. The normal concentration of bicarbonate (HCO_3^-) is about 27 mM. The concentration of total carbon dioxide is the sum of carbonic acid and bicarbonate; this sum is normally in the range of 26–28 mM. The ratio of bicarbonate/carbonic acid is more significant than the actual concentrations of these two forms of carbon dioxide. Its normal value is 27/1.35 (equivalent to 20/1).

Abnormal results

Positively charged electrolytes

High serum sodium levels (**hypernatremia**) occur at sodium concentrations over 145 mM, with severe hypernatremia over 152 mM. Hypernatremia is usually caused by diseases that cause excessive urination. In these cases, water is lost, but sodium is still retained in the body. The symptoms include confusion and can lead to convulsions and **coma**. Low serum sodium levels (**hyponatremia**) are below 130 mM, with severe hyponatremia at or below 125 mM. Hyponatremia often occurs with severe diarrhea, with losses of both water and sodium, but with sodium loss exceeding water loss. Hyponatremia provokes clinical problems only if serum sodium falls below 125 mM, especially if this has occurred rapidly. The symptoms can be as mild as tiredness but may lead to convulsions and coma.

High serum potassium (**hyperkalemia**) occurs at potassium levels above 5.0 mM; it is considered severe over 8.0 mM. Hyperkalemia is relatively uncommon, but sometimes occurs in patients with kidney failure who take potassium supplements. Hyperkalemia can result in abnormal beating of the heart (cardiac **arrhythmias**). Low serum potassium (**hypokalemia**) occurs when serum potassium falls below 3.0 mM. It can result from low dietary potassium, as during **starvation** or in patients with **anorexia nervosa**; from excessive losses via the kidneys, as caused by diuretic drugs; or by diseases of the adrenal or pituitary glands. Mild hypokalemia causes muscle weakness, while severe hypokalemia can cause **paralysis**, the inability to breathe, and cardiac arrhythmias.

High levels of calcium ions (**hypercalcemia**) occur at free calcium ion concentrations over 5.2 mg/dL or total serum calcium above 10.4 mg/dL. Hypercalcemia usually occurs when the body dissolves bone at an abnormally fast rate, increasing both serum calcium and serum phosphate. Sudden hypercalcemia can cause vomiting and coma, while prolonged and moderate hypercalcemia results in the deposit of calcium phosphate crystals in the kidneys and eye. **Hypocalcemia** occurs when serum free calcium ions fall below 4.4 mg/dL, or when total serum calcium falls below 8.8 mg/dL. Hypocalcemia can result from **hypoparathyroidism** (low parathyroid hormone), from failure to produce 1,25-dihydroxyvitamin D, from low levels of plasma magnesium, and from phosphate poisoning (the phosphate enters the bloodstream and forms a complex with the free serum calcium). Hypocalcemia can cause depression and **muscle spasms**.

Hypermagnesemia occurs at serum magnesium levels over 25 mM (60 mg/dL). Hypermagnesemia is rare but can occur with the excessive consumption of magnesium salts. Hypomagnesemia occurs when serum magnesium levels fall below 0.8 mM, and can result from poor **nutrition**. Chronic **alcoholism** is the most common cause of hypomagnesemia, in part because of poor diet. Magnesium levels below 0.5 mM (1.2 mg/dL) cause serum calcium levels to decline. Some of the symptoms of hypomagnesemia, including twitching and convulsions, actually result from the

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concurrent hypocalcemia. Hypomagnesemia can also result in hypokalemia and thereby cause cardiac arrhythmias.

Negatively charged electrolytes

Serum chloride levels sometimes increase to abnormal levels as an undesirable side effect of medical treatment with sodium chloride or ammonium chloride. The toxicity of chloride results not from the chloride itself, but from the fact that the chloride occurs as the acid, hydrogen chloride (more commonly known as hydrochloric acid, or HCl). An overdose of chloride may cause the accumulation of hydrochloric acid in the bloodstream, with consequent acidosis. **Renal tubular acidosis**, one of many kidney diseases, involves the failure to release acid into the urine. The acidosis produces weakness, **headache**, **nausea**, and cardiac arrest. Low plasma chloride leads to the opposite situation: a decline in the acid content of the bloodstream. This is known as alkalization of the bloodstream, or alkalosis. Hydrochloric acid, originally from extracellular fluids, can be lost by vomiting. At its most severe, alkalosis results in paralysis (tetany).

Hyperphosphatemia occurs at serum phosphate levels above 5 mg/dL. It can result from the failure of the kidneys to excrete phosphate into the urine, causing phosphate to accumulate in the bloodstream. Hyperphosphatemia can also be caused by the impaired action of parathyroid hormone and by phosphate poisoning. Severe hyperphosphatemia can cause paralysis, convulsions, and cardiac arrest. These symptoms result because the phosphate, occurring in elevated levels, complexes with free serum calcium, resulting in hypocalcemia. Tests for heart function (an electrocardiogram) and parathyroid hormone levels are used in the diagnosis of hyperphosphatemia. Hypophosphatemia occurs if serum phosphorus falls to 2.0 mg/dL or lower. It often results from a shift of inorganic phosphate from the bloodstream to various organs and tissues. This shift can be caused by a rise in pH (alkalization) of the bloodstream, which can occur during hyperventilation, a reaction in various disease states. A shift in phosphate to intracellular tissues may draw calcium away from the bloodstream via the formation of insoluble calcium phosphate crystals within cells, with consequent hypocalcemia. Thus, tests for abnormalities in phosphate metabolism also involve tests for serum calcium.

Bicarbonate metabolism involves several compounds. When dietary starches, sugars, and fats are broken down for energy production, carbon dioxide is created. Much of this carbon dioxide (CO_2) spontaneously converts to carbonic acid (H_2CO_3), and some of the carbonic acid spontaneously converts to bicarbonate (HCO_3^-) plus a hydrogen ion (H^-). Eventually, almost every molecule of carbon dioxide produced in the body, whether in the form of carbon dioxide, carbonic acid, or bicarbonate, must convert back to carbon dioxide in order to leave via the lungs during normal breathing.

If one holds one's breath, carbon dioxide cannot escape from the lungs, but continues to be generated within the body. This results in an increase in production of carbonic acid. A portion of the carbonic acid breaks apart (dissociates), causing an increase in hydrogen ions in the plasma, with a resulting acidosis. Tests for serum bicarbonate levels are accompanied by tests for acidosis (pH test). Conversely, when one breathes too rapidly (hyperventilation), the carbon dioxide is drawn off from the bloodstream and expelled in the breath at an increased rate. This results in an increase in the rate of combination of bicarbonate with hydrogen ions, resulting in alkalosis. Acidosis and alkalosis can be produced by means other than by altering the rate of breathing. The carbonic acid and bicarbonate in the bloodstream minimize (or buffer) any trend to acidosis or alkalosis. Tests for bicarbonate are generally accompanied by tests for blood pH and possibly tests for kidney malfunction, abnormal hormone function, or gastrointestinal disorders.

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Tom Brody, PhD

Electromyography

Definition

Electromyography (EMG) is a diagnostic procedure that is used to determine the health of muscles, along with the nerve cells that control these muscles, or what are called motor neurons. In purpose, the EMG is an electrical recording of muscle activity that aids in the diagnosis of neuromuscular disease. The EMG scan, sometimes also called a myogram, is used to identify the electrical signals that originate from these motor neurons (which cause the muscles to

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move). These electrical signals identified by the EMG allows the medical specialist to interpret such signals in order to diagnosis any problems within the muscles and the nerves that control them.

Purpose

Muscles are stimulated by signals from nerve cells called motor neurons. This stimulation causes electrical activity in the muscle, which in turn causes contraction. An electrode, which consists of a very small, solid needle (pin), is inserted through the skin and into the muscle. It is connected to a recording device that detects this electrical activity. When a needle is used the process is called a needle EMG, or simply an EMG. The needle electrode and recorder pair is called an electromyography machine, which includes a monitor called an oscilloscope. A speaker is included, which provides crackling sounds as the electrical intensity rises and falls.

EMG can determine whether a particular muscle is responding appropriately to stimulation, and whether a muscle remains inactive when not stimulated. Thus, during the test, the patient will be asked to contract particular muscles, such as those in the leg. The electrical wave produced on the EMG machine will determine the condition of the muscle and nerves as it responds to the contraction. Usually a nerve conduction velocity (NCV) test (or nerve conduction study) is also performed at the same time as an EMG. This test consists of two electrode being placed apart on the surface of the skin. One electrode is activated so that a muscle is electronically simulated. The second electrode senses the activity (electrical impulse) of the muscle as it moves. The NCV test measures the intensity and speed at which electrical signals pass between two points.

The EMG procedure is performed most often to help diagnose different diseases causing weakness. Although EMG is a test of the motor system, it may help identify abnormalities of nerves or spinal nerve roots that may be associated with **pain** or **numbness**. Other symptoms for which EMG may be useful include numbness, **tingling**, atrophy, stiffness, fasciculation (twitch), pain or cramping, deformity, and spasticity (abnormal muscle performance, such as muscle weakness). EMG results can help determine whether symptoms are due to a muscle disease or a neurological disorder, and, when combined with clinical findings, usually allow a confident diagnosis.

EMG can help diagnose many muscle and nerve disorders, including (but not restricted to) the following:

- muscular dystrophy or polymyositis
- congenital myopathies
- myasthenia gravis
- mitochondrial myopathies
- metabolic myopathies
- myotonias
- peripheral neuropathies
- radiculopathies
- nerve lesions
- amyotrophic lateral sclerosis
- polio
- spinal muscular atrophy
- Guillain-Barré syndrome
- ataxias
- myasthenias

Precautions

Only a few special precautions are needed for this test. Patients with a history of bleeding disorder should consult with their treating physician before the test. Any person taking blood-thinning medications should inform the neurologist or other medical professional conducting the EMG procedure. A person with a pacemaker or other electrical medical device should inform the medical team of this before the procedure. If a muscle biopsy is planned as part of the diagnostic work-up, the EMG should not be performed at the same site, as it may effect the appearance of the muscle.

Description

During an EMG test, a fine needle is inserted into the muscle to be tested. This may cause some discomfort, similar to that of an injection. Recordings are made while the muscle is at rest, and then during the contraction. The person performing the test may move the limb being tested, and direct the patient to move it with various levels of force. The needle may be repositioned in the same muscle for further recording. Other muscles may be tested as well.

A slightly different test, the *nerve conduction velocity* test, is often performed at the same time with the same equipment. In this test, stimulating and recording electrodes are used, and small electrical shocks are applied to measure the ability of the nerve to conduct electrical signals. This test may cause mild tingling and discomfort similar to a mild shock from static electricity. Evoked potentials may also be performed for additional diagnostic information. Nerve conduction velocity and evoked potential testing are especially

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helpful when pain or sensory complaints are more prominent than weakness.

The EMG procedure will take usually from thirty to sixty minutes to complete.

Preparation

Very few special preparations are needed before the EMG. Natural oils on the skin should be removed before the test. Therefore, take a shower or bath before the procedure. In addition, do not apply creams or lotions. The doctor supervising and interpreting the test should be given information about the symptoms, medical conditions, suspected diagnosis, neuroimaging studies, and other test results.

Aftercare

Minor bruising may occur after the procedure; it will fade over the next few days. Minor pain and bleeding may continue for several hours after the test. The muscle may be tender for a day or two. If any of these do not go away after several days, contact your family doctor or other medical professional. The doctor will not restrict activities after the test is completed under normal circumstances.

Risks

There are not significant risks in performing this procedure. The only minor risks occur when a needle is inserted under the skin. Such risks may include pain or discomfort, bleeding, bruising, or infection. Since medicine is not being injected under the skin, less pain is usually the case when compared to the insertion of a regular needle.

In addition, there is a minute risk for nerve injury when the needle is inserted under the skin. When such an electrode is inserted into the chest wall, a small risk is present that the puncture could cause air to leak into the cavity between the lungs and the chest wall. In such a case, a collapsed lung could result; although it is highly unlikely.

When the nerve conduction velocity test is performed, the patient will perceive a brief and very mild shock or tingling sensation.

Results

The results of the test are available immediately upon completion of the EMG. However, a trained medical specialist, such as a neurologist, is needed to analyze and interpret the results.

KEY TERMS

Motor neurons—Nerve cells that transmit signals from the brain or spinal cord to the muscles.

Motor unit action potentials—Spikes of electrical activity recorded during an EMG that reflect the number of motor units (motor neurons and the muscle fibers they transmit signals to) activated when the patient voluntarily contracts a muscle.

Normal results

There should be some brief EMG activity during needle insertion. This activity may be increased in diseases of the nerve and decreased in long-standing muscle disorders where muscle tissue is replaced by fibrous tissue or fat. Muscle tissue normally does not show EMG activity when at rest or when moved passively by the examiner. When the patient actively contracts the muscle, spikes (motor unit action potentials) should appear on the recording screen, reflecting the electrical activity within. As the muscle is contracted more forcefully, more groups of muscle fibers are recruited or activated, causing more EMG activity.

Abnormal results

The interpretation of EMG results is not a simple matter, requiring analysis of the onset, duration, amplitude, and other characteristics of the spike patterns.

Electrical activity at rest is abnormal; the particular pattern of firing may indicate denervation (for example, a nerve lesion, radiculopathy, or lower motor neuron degeneration), myotonia, or inflammatory myopathy.

Decreases in the amplitude and duration of spikes are associated with muscle diseases, which also show faster recruitment of other muscle fibers to compensate for weakness. Recruitment is reduced in nerve disorders.

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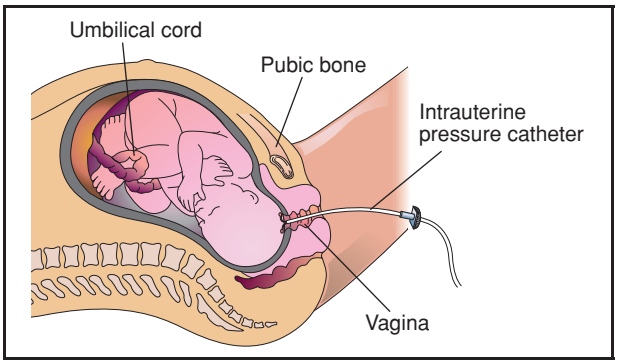
American Association of Neuromuscular and Electrodiagnostic Medicine, 2621 Superior Drive NW, Rochester, MN, 55901, (507) 288-0100, (507) 288-1225, aanem@aanem.org, http://www.aanem.org/.

Richard Robinson



Electronic fetal monitoring (EFM) is performed late in pregnancy or continuously during labor to ensure normal delivery of a healthy baby. EFM can be utilized either externally or internally in the womb. The illustration above shows the internal procedure, in which an electrode is attached directly to the baby's scalp to monitor the heart rate. Uterine contractions are recorded using an intrauterine pressure catheter which is inserted through the cervix into the uterus. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Electronic fetal monitoring

Definition

The electronic fetal monitor (EFM) is a device that records a fetus's heart rate and the presence or absence of the mother's uterine contractions.

Purpose

The EFM is used to assess fetal well being during routine prenatal visits. It is also used during labor and delivery when high-risk factors exist or when a clinical condition develops beforehand that places the fetus at risk. High-risk factors for EFM during labor include:

- low gestational age
- high maternal age
- placenta or cord problems
- meconium in the amniotic fluid
- maternal hypertension
- protein in the urine (proteinuria)

A fetus having trouble in labor often exhibits characteristic changes in heart rate after a contraction (late decelerations). Trouble also is indicated by significant slowing of the heart rate during a contraction (variable deceleration). If the fetus is not receiving enough oxygen to withstand the stress of labor, and delivery is many hours away, a **cesarean section** (C-section) may be necessary.

Description

The monitor produces a continuous paper record of the fetal heart rate (FHR) and records uterine contractions. FHR is captured on the top part of the paper printout; uterine activity, when monitored, appears on the lower part of the tracing.

Electronic fetal monitoring can be performed externally or internally. The external ultrasound approach is non-invasive and uses sensors (electrodes) placed on the mother's abdomen with an elastic belt. Another belt holds the contraction monitor.

External electronic fetal monitoring includes a non-stress test, which measures fetal heart rate (FHR) accelerations with normal movement of the fetus. Sometimes the fetal movement is encouraged by giving the mother a small meal or something to drink. Fetal acoustic stimulation and moving the fetus by rubbing the abdomen gently also may be used.

Two contraction stress tests, which measure the placenta's ability to provide enough oxygen to the fetus during pressure, are also used with electronic fetal monitoring. The nipple stimulation contractions **stress test** involves the mother self-stimulating her nipple while contractions and FHR are monitored. Another test, called oxytocin stimulation, involves the administration of the hormone oxytocin intravenously

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KEY TERMS

Cesarean section—Also called a C-section; delivery of a baby through an incision in the mother's abdomen instead of through the vagina.

Late deceleration—Transient slowing of the fetal heart (brachycardia), which reaches its height more than 30 seconds after the peak of the uterine contraction and may indicate the fetus is not receiving enough oxygen (hypoxia).

Non-stress test—A record of the fetal heart rate in the absence of contractions (stress).

Reactive stress test—A positive sign of fetal well being. The FHR rises at least 20 beats per minute above the baseline heart rate for at least 20 seconds, occurring at least twice in a 20-minute period.

Variable deceleration—Fetal bradycardia below 100 beats per minute denoting compression of the umbilical cord at the height of a uterine contraction.

until three uterine contractions are observed within ten minutes, during which time the FHR is monitored.

Sometimes, it is difficult to hear the fetus's heartbeat with the monitoring device. Other times, the monitor may show subtle signs of a developing problem. In either case, the physician may recommend the use of an internal monitor, which provides a more accurate record of the fetus's heart rate. The internal monitor (or fetal scalp electrode) uses an electrode attached to the fetus's scalp through the cervix during an internal vaginal exam. The internal monitor can only be used when the cervix is dilated. In complicated pregnancies, continuous EFM is recommended during labor.

Benefits

Electronic fetal monitoring allows the physician to judge the well being of the fetus before and during delivery. Should the fetus appear to be in distress, the physician can recommend immediate delivery via cesarean section. EFM also allows an evaluation of the strength of the mother's contractions. Should labor not be progressing normally, medical intervention can be ordered.

Precautions

In general, no risks are associated with external fetal monitoring. However, the test can initiate labor and is generally not given to mothers at risk for preterm labor or with a condition that requires a cesarean section. Internal monitoring poses risks associated with improper placement of the electrodes. Some data suggest that EFM leads to unnecessary cesarean sections. Another drawback includes loss of maternal mobility when used during labor, which may slow labor.

Preparation

There are no special preparations required for external fetal monitoring. Preparation for placement of an internal scalp lead (ISL) is the same as for a routine vaginal exam.

Aftercare

No special preparations are required for electronic fetal monitoring.

Risks

Fetal monitoring is not a perfect test. Fetal assessment in labor is subject to differences in interpretation and consequent intervention; therefore, institutional policies and procedures should be followed.

Results

The normal fetal heart rate ranges from 120 to 160 beats per minute (bpm). Just as an adult's heart rate increases with movement, FHR increases when the fetus moves. A reactive heart rate tracing (also known as a reactive non-stress test, or NST) is considered a positive sign of fetal well being. A non-reactive NST may or may not imply fetal well being. The monitor strip is considered to be reactive when the FHR rises at least 15 to 20 bpm above the baseline heart rate for at least 20 seconds. This must occur at least twice in a 20-minute period.

Results are considered abnormal if the FHR drops below 120 or rises above 160 for sustained periods. In either of these cases the fetus may be exhibiting fetal distress. A mean FHR of less than 110 bpm may indicate bradycardia (slow heart beat). A mean FHR of over 160 bpm may indicate a tachycardia (rapid beating of the heart). However, some babies who are having problems may not exhibit such clear signs.

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During a contraction, the flow of oxygen from the mother through the placenta to the fetus is temporarily stopped. It is as if the fetus has to hold its breath during each contraction. Both the placenta and the fetus are designed to withstand this condition. Between contractions, the fetus should be receiving more than enough oxygen to do well during the contraction.

One sign that a fetus is not getting enough oxygen between contractions is a drop in the FHR after the contraction (late deceleration). The heart rate recovers to a normal level between contractions, only to drop again after the next contraction. This is a subtler sign of distress. Trouble is also indicated by significant slowing during a contraction (variable decelerations).

Training and certification

Electronic fetal monitoring is primarily conducted by specialists in obstetrics and gynecology. Qualified registered nurses and advanced practice nurses may assist in or conduct electronic fetal monitoring.

Applying the external monitor is simple, but requires practice in the proper placement of the monitoring devices. The interpretation of the tracings, however, requires continued vigilance in education and clinical practice. Training should include instruction electronic FHR monitoring and evaluation of uterine activity.

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ORGANIZATIONS

American College of Nurse-Midwives, 8403 Colesville Rd, Suite 1550, Silver Spring, MD, 20919, (240) 485-1800, (240) 485-1818, http://www.midwife.org.

American College of Obstetricians and Gynecologists, P.O. Box 96920, Washington, DC, 20090-6920, (202) 638-5577, http://www.acog.org.

Association of Women's Health, Obstetric, and Neonatal Nurses, 2000 L St., NW, Suite. 740, Washington, DC, 20036, (202) 261-2400, (800) 673-8499. Toll free in Canada (800) 245-0231, (202) 728-0575, customerservice@awhonn.org, http://www.awhonn.org.

Society for Maternal-Fetal Medicine, 409 12th Street, SW, Washington, DC, 20024, (202) 863-2476, (202) 554-1132, smfm@smfm.org, https://www.smfm.org.

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Electrophysiology study of the heart

Definition

An electrophysiology (EP) study of the heart is a nonsurgical analysis of the electrical conduction system (normal or abnormal) of the heart. The test employs cardiac catheters and sophisticated computers to generate electrocardiogram (EKG) tracings and electrical measurements with exquisite precision from within the heart chambers.

The EP study can be performed solely for diagnostic purposes. It also is performed to pinpoint the exact location of electrical signals (cardiac mapping) in conjunction with a therapeutic procedure called **catheter ablation**.

The test is simple, not painful, and performed in a special laboratory under controlled clinical circumstances by cardiologists and nurses who subspecialize in electrophysiology.

Purpose

A cardiologist may recommend an EP study when the standard EKG, Holter monitor, event recorder, **stress test**, echocardiogram, or angiogram cannot provide enough information to evaluate an abnormal heart rhythm, called an arrhythmia.

An EP study also may be beneficial in diagnosing a suspected arrhythmia in a patient who shows symptoms of an arrhythmia but in whom it could not be detected from other tests.

The purpose and great value of an EP study is that it offers more detailed information to the doctor about the electrical activity in the heart than the aforementioned noninvasive tests because electrodes are placed directly *on* heart tissue. This allows the electrophysiologist to determine the specific location of an arrhythmia and, oftentimes, correct it during the same procedure. This corrective treatment is permanent and considered a cure, and, in many cases, the patient may not need to take heart medications.

EP studies may be helpful in assessing:

- certain tachycardias or bradycardias of unknown cause
- patients who have been resuscitated after experiencing sudden cardiac death
- various symptoms of unknown cause, such as chest pain, shortness of breath, fatigue, or syncope (dizziness/fainting)
- response to anti-arrhythmic therapy

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An electrophysiologist nurse monitors a patient's heart rhythm during an electrophysiology study for tachycardia. *(Collette Placek. Reproduced by permission.)*

Precautions

Pregnant patients should not undergo an EP study because of exposure to radiation during the study, which may be harmful to the growing baby.

Patients who have **coronary artery disease** may need to have that treated before having an EP study.

Description

The rhythmic pumping action of the heart, which is essentially a muscle, is the result of electrical impulses traveling throughout the walls of the four heart chambers. These impulses originate in the sinoatrial (SA) node, which are specialized cells situated in the top right chamber of the heart: the right atrium. Normally, the SA node, acting like a spark plug, spontaneously generates the impulses, which travel through specific pathways throughout the atria to the atrioventricular (AV) node. The AV node is a relay station, sending the impulses to more specialized muscle fibers throughout the bottom chambers of the heart: the ventricles. If these pathways become damaged or blocked or if extra (abnormal) pathways exist, the heart's rhythm may be altered (perhaps too slow, too fast, or irregular), which can seriously affect the heart's pumping ability.

The patient is transported to the x-ray table in the EP lab and connected to various monitors. Sterile sheets are placed over him or her. A minimum of two catheters are inserted into the right femoral (thigh) vein in the groin area. Depending on the type of arrhythmia, the number of catheters used in an EP test and their route to the heart may vary. For certain tachycardias, two more catheters may be inserted in the left groin and one in the internal jugular (neck) vein or in the subclavian (below the clavicle) vein. The catheters are about 0.08 in (2 mm) in diameter, about the size of a spaghetti noodle. The catheters used in catheter ablation are slightly larger.

With the help of fluoroscopy (x rays on a television screen), all the catheters are guided to several

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KEY TERMS

Ablation—Remove or destroy, such as by burning or cutting.

Angiogram—X ray of a blood vessel after special x-ray dye has been injected into it.

Bradycardia—Slow heartbeat.

Cardiac catheter—Long, thin, flexible tube that is threaded into the heart through a blood vessel.

Cardiologist—Doctor who specializes in diagnosing and treating heart diseases.

Echocardiogram—Ultrasound image of the heart.

Electrocardiogram—Tracing of the electrical activity of the heart.

Electrode—Medium for conducting an electrical current–in this case, platinum wires.

Electrophysiology—Study of how electrical signals in the body relate to physiologic function.

Event recorder—A small machine, worn by a patient usually for several days or weeks, that is activated by the patient to record his or her EKG when a symptom is detected.

Fibrillation—Rapid, random contraction (quivering).

Holter monitor—A small machine, worn by a patient usually for 24 hours, that continuously records the patient's EKG during usual daily activity.

Stress test—Recording a patient's EKG during exercise.

Supraventricular tachycardia—A fast heart beat that originates above the ventricles.

Tachycardia—Fast heartbeat.

Vascular—Pertaining to blood vessels.

specific locations in the heart. Typically, four to 10 electrodes are located on the end of the catheters, which have the ability to send electrical signals to stimulate the heart (called pacing) and to receive electrical signals from the heart–but not at the same time (just as a walkie-talkie cannot send and receive messages at the same time).

First, the electrodes are positioned to receive signals from inside the heart chambers. This allows the doctor to measure how fast the electrical impulses travel currently in the patient's heart. These measurements are called the patient's baseline measurements. Next, the electrodes are positioned to pace: The EP team actually tries to induce (sometimes in combination with various heart drugs) the arrhythmia that the patient has previously experienced so the team can observe it in a controlled environment, compare it to the patient's clinical or spontaneous arrhythmia, and decide how to treat it.

Once the arrhythmia is induced and the team determines it can be treated with catheter ablation, cardiac mapping is performed to locate precisely the origin and route of the abnormal pathway. When this is accomplished, the ablating electrode catheter is positioned directly against the abnormal pathway, and high radio-frequency energy is delivered through the electrode to destroy (burn) the tissue in this area.

Preparation

The following preparations are made for an EP study:

- the patient may be advised to stop taking certain medications, especially heart drugs, that may interfere with the test results.
- blood tests usually are ordered the week before the test.
- the patient undergoes conscious sedation (awake but relaxed) during the test. This is accomplished quite often with the anesthetic drugs VersedR (Roche laboratories) and fentanyl.
- a local anesthetic is injected at the site of catheter insertion.

Aftercare

The patient needs to rest flat in bed for several hours after the procedure to allow healing at the catheter insertion sites.

The patient often returns home either the same day of the test or the next day. Someone should drive him or her home.

The doctor may prescribe drugs and/or insert an AFCD to treat the arrhythmia and may do a possible follow-up EP study.

Risks

The EP diagnostic study and catheter ablation are low-risk procedures. There is a small risk of bleeding and/or infection at the site of catheter insertion, but this occurs less than 1% of the time. Blood clot

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formation occurs only two in 1,000 instances and is minimized with blood thinner medications administered during the procedure. Vascular injuries causing hemorrhage or **thrombophlebitis** are possible but occur less than 0.7% of the time. Cardiac perforations occur only in one or two per 1,000 instances. If the right internal jugular vein is accessed, the small possibility of puncturing the lung with the catheter exists, which, at worst, could cause a collapsed lung.

Because **ventricular tachycardia** or fibrillation (lethal **arrhythmias**) may be induced in the patient, the EP lab personnel must be prepared to defibrillate the patient as necessary.

Normal results

The heart initiates and conducts electrical impulses normally.

Abnormal results

Confirmation of arrhythmias, such as:

- supraventricular tachycardias
- ventricular arrhythmias
- accessory (extra) pathways
- bradycardias

ORGANIZATIONS

Cardiac Arrhythmia Research and Education Foundation (C.A.R.E.), 427 Fulton Street; P.O. Box 69, Seymour, WI, 54165, (920) 833-7000, (920) 833-7005, (800) 404-9500, care@careforhearts.org, http://www.longqt.com/ .

Midwest Heart Specialists. , 1901 S. Meyers Road, Suite 350, Oak Brook Terrace, IL, 60181, (630) 932-2165, (630) 268-9609, http://www.midwestheart.com.

Collette L. Placek

Electroshock therapy *see* **Electroconvulsive therapy**

Elephantiasis

Definition

The word elephantiasis is a vivid and accurate term for the syndrome it describes: the gross (visible) enlargement of the arms, legs, or genitals to elephantoid size.

Man suffering from elephantiasis. *(© C. James Webb/ Phototake. — All rights reserved.)*

Description

True elephantiasis is the result of a parasitic infection caused by three specific kinds of round worms. The long, threadlike worms block the body's lymphatic system–a network of channels, lymph nodes, and organs that helps maintain proper fluid levels in the body by draining lymph from tissues into the bloodstream. This blockage causes fluids to collect in the tissues, which can lead to great swelling, called "lymphedema." Limbs can swell so enormously that they resemble an elephant's foreleg in size, texture, and color. This is the severely disfiguring and disabling condition of elephantiasis.

There are a few different causes of elephantiasis, but the agents responsible for most of the elephantiasis in the world are filarial worms: white, slender round worms found in most tropical and subtropical places. They are transmitted by particular kinds (species) of mosquitoes, that is, bloodsucking insects. Infection

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with these worms is called "lymphatic filariasis" and over a long period of time can cause elephantiasis.

Lymphatic **filariasis** is a disease of underdeveloped regions found in South America, Central Africa, Asia, the Pacific Islands, and the Caribbean. It is a disease that has been present for centuries, as ancient Persian and Indian writings clearly described elephant-like swellings of the arms, legs, and genitals. It is estimated that 120 million people in the world have lymphatic filariasis. The disease appears to be spreading, in spite of decades of research in this area.

Other terms for elephantiasis are Barbados leg, elephant leg, morbus herculeus, mal de Cayenne, and myelolymphangioma.

Other situations that can lead to elephantiasis are:

- a protozoan disease called leishmaniasis
- a repeated streptococcal infection
- the surgical removal of lymph nodes (usually to prevent the spread of cancer)
- a hereditary birth defect

Causes and symptoms

Three kinds of round worms cause elephantiasis filariasis: *Wuchereria bancrofti*, *Brugia malayi*, and *Brugia timori*. Of these three, *W. bancrofti* makes up about 90% of the cases. Man is the only known host of *W. bancrofti*.

Culex, *Aedes*, and *Anopheles* mosquitoes are the carriers of *W. bancrofti*. *Anopheles* and *Mansonia* mosquitoes are the carriers of *B. malayi*. In addition, *Anopheles* mosquitoes are the carriers of *B. timori*.

Infected female mosquitoes take a blood meal from a human, and in doing so, introduce larval forms of the particular parasite they carry to the person. These larvae migrate toward a lymphatic channel, then travel to various places within the lymphatic system, usually positioning themselves in or near lymph nodes throughout the body. During this time, they mature into more developed larvae and eventually into adult worms. Depending upon the species of round worm, this development can take a few months or more than a year. The adult worms grow to about 1 in (2.5 cm) to 4 in (10 cm) long.

The adult worms can live from about three to eight years. Some have been known to live to 20 years, and in one case 40 years. The adult worms begin reproducing numerous live embryos, called microfilariae. The microfilariae travel to the bloodstream, where they can be ingested by a mosquito when it takes a blood meal from the infected person. If they are not ingested by a mosquito, the microfilariae die within about 12 months. If they are ingested by a mosquito, they continue to mature. They are totally dependent on their specific species of mosquito to develop further. The cycle continues when the mosquito takes another blood meal.

Most of the symptoms an infected person experiences are due to the blockage of the lymphatic system by the adult worms and due to the substances (excretions and secretions) produced by the worms.

The body's allergic reactions may include repeated episodes of **fever**, shaking chills, sweating, headaches, **vomiting**, and **pain**. Enlarged lymph nodes, swelling of the affected area, skin ulcers, bone and joint pain, tiredness, and red streaks along the arm or leg also may occur. Abscesses can form in lymph nodes or in the lymphatic vessels. They may appear at the surface of the skin as well.

Long-term infection with lymphatic filariasis can lead to **lymphedema**, hydrocele (a buildup of fluid in any saclike cavity or duct) in the scrotum, and elephantiasis of the legs, scrotum, arms, penis, breasts, and vulvae. The most common site of elephantiasis is the leg. It typically begins in the ankle and progresses to the foot and leg. At first the swollen leg may feel soft to the touch but eventually becomes hard and thick. The skin may appear darkened or warty and may even crack, allowing bacteria to infect the leg and complicate the disease. The microfilariae usually don't cause injury. In some instances, they cause "eosinophilia," an increased number of eosinophils (a type of white blood cells) in the blood.

This disease is more intense in people who never have been exposed to lymphatic filariasis than it is in the native people of tropical areas where the disease occurs. This is because many of the native people often are immunologically tolerant.

Diagnosis

The only sure way to diagnose lymphatic filariasis is by detecting the parasite itself, either the adult worms or the microfilariae.

Microscopic examination of the person's blood may reveal microfilariae. But many times, people who have been infected for a long time do not have microfilariae in their bloodstream. The absence of them, therefore, does not mean necessarily that the person is not infected. In these cases, examining the urine or hydrocele fluid or performing other clinical tests is necessary.

Collecting blood from the individual for microscopic examination should be done during the night

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KEY TERMS

Antigen—Any substance (usually a protein) that causes an immune response by the body to produce antibodies.

Filarial—Threadlike. The word "filament" is formed from the same root word.

Host—A person or animal in which a parasite lives, is nourished, grows, and reproduces.

Lymph—A watery substance that collects in the tissues and organs of the body and eventually drains into the bloodstream.

Lymphatic system—A network composed of vessels, lymph nodes, the tonsils, the thymus gland, and the spleen. It is responsible for transporting fluid and nutrients to the bloodstream and for maturing certain blood cells that are part of the body's immune system.

Lymphedema—The unnatural accumulation of lymph in the tissues of the body, which results in swelling in that area.

Protozoa—(Plural form of protozoan) Single-celled organisms (not bacteria) of which about 30 kinds cause disease in humans.

Streptococcal—Pertaining to any of the *Streptococcus* bacteria. These organisms can cause pneumonia, skin infections, and many other diseases.

when the microfilariae are more numerous in the bloodstream. (Interestingly, this is when mosquitoes bite most frequently.) During the day microfilariae migrate to deeper blood vessels in the body, especially in the lung. If it is decided to perform the blood test during the day, the infected individual may be given a "provocative" dose of medication to provoke the microfilariae to enter the bloodstream. Blood then can be collected an hour later for examination.

Detecting the adult worms can be difficult because they are deep within the lymphatic system and difficult to get to. Biopsies usually are not performed because they usually don't reveal much information.

Treatment

The drug of choice in treating lymphatic filariasis is diethylcarbamazine (DEC). The trade name in the United States is Hetrazan.

The treatment schedule is typically 2 mg/kg per day, three times a day, for three weeks. The drug is taken in tablet form.

DEC kills the microfilariae quickly and injures or kills the adult worms slowly, if at all. If all the adult worms are not killed, remaining paired males and females may continue to produce more larvae. Therefore, several courses of DEC treatment over a long time period may be necessary to rid the individual of the parasites.

DEC has been shown to reduce the size of enlarged lymph nodes and, when taken long-term, to reduce elephantiasis. In India, DEC has been given in the form of a medicated salt, which helps prevent spread of the disease.

The side effects of DEC almost all are due to the body's natural allergic reactions to the dying parasites rather than to the DEC itself. For this reason, DEC must be given carefully to reduce the danger to the individual. Side effects may include fever, chills, **headache**, **dizziness**, **nausea and vomiting**, **itching**, and joint pain. These side effects usually occur within the first few days of treatment. These side effects usually subside as the individual continues taking the drug.

There is an alternate treatment plan for the use of DEC. This plan is designed to kill the parasites slowly (to reduce allergic reactions to the dead microfilariae and dying adult worms within the body). Lower doses of DEC are taken for the first few days, followed by the higher dose of 2 mg/kg per day for the remaining three weeks. In addition, **steroids** may be prescribed to prevent the individual's body from reacting severely to the dead worms.

Another drug used is Ivermectin. Early research studies of Ivermectin show that it is excellent in killing microfilariae, but the effects of this drug on the adult worms are still being investigated. It is probable that patients will need to continue using DEC to kill the adult worms. Mild side effects of Ivermectin include headache, fever, and myalgia.

Other means of managing lymphatic filariasis are pressure **bandages** to wrap the swollen limb and elastic stockings to help reduce the pressure. Exercising and elevating a bandaged limb also can help reduce its size.

Surgery can be performed to reduce elephantiasis by removing excess fatty and fibrous tissue, draining the swelled area, and removing the dead worms.

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Prognosis

With DEC treatment, the prognosis is good for early and mild cases of lymphatic filariasis. The prognosis is poor, however, for heavy parasitic infestations.

Prevention

The two main ways to control this disease are to take DEC preventively, which has shown to be effective, and to reduce the number of carrier insects in a particular area.

Avoiding mosquito **bites** with insecticides and insect repellents is helpful, as is wearing protective clothing and using bed netting.

Much effort has been made in cleaning the breeding sites (stagnant water) of mosquitoes near people's homes in areas where filariasis is found.

Before visiting countries where lymphatic filariasis is found, it would be wise to consult a travel physician to learn about current preventative measures.

ORGANIZATIONS

National Lymphedema Network, 116 New Montgomery Street, Suite 235, San Francisco, CA, 94105, (415) 908-3681, (415) 908-3813, (800) 541-3259, nln@lymphnet.org, http://www.lymphnet.org.

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923, (800) 999-6673, http://www.rarediseases.org.

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ELISA (Enzyme-linked immunosorbent assay) *see* **AIDS tests**

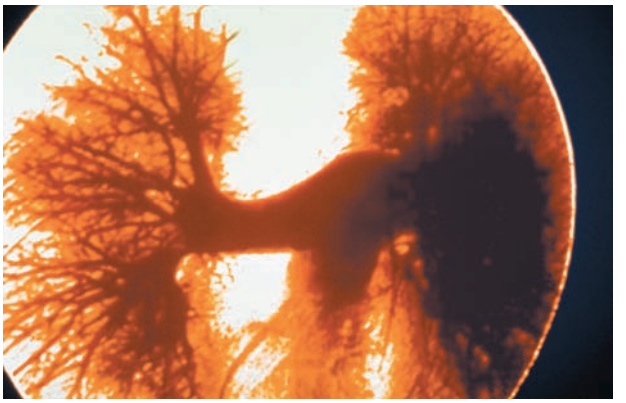
Embolism

Definition

An embolism is an obstruction in a blood vessel due to a blood clot or other foreign matter that gets stuck while traveling through the bloodstream. The plural of embolism is emboli.

Description

Emboli have moved from the place where they were formed through the bloodstream to another part of the body, where they obstruct an artery and block the flow of blood. The emboli are usually formed from **blood clots** but are occasionally comprised of air, fat, or tumor tissue. Embolic events can be multiple and small, or single and massive. They can be life-threatening and require immediate emergency medical care. There are three general categories of emboli: arterial, gas, and pulmonary. Pulmonary emboli are the most common.



A close-up view of a pulmonary embolism. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Arterial embolism

In arterial emboli, blood flow is blocked at the junction of major arteries, most often at the groin, knee, or thigh. Arterial emboli are generally a complication of heart disease. An **arterial embolism** in the brain (cerebral embolism) causes **stroke**, which can be fatal. An estimated 5–14% of all strokes are caused by cerebral emboli. Arterial emboli to the extremities can lead to tissue **death** and **amputation** of the affected limb if not treated effectively within hours. Intestines and kidneys can also suffer damage from emboli.

Gas embolism

Gas emboli result from the compression of respiratory gases into the blood and other tissues due to rapid changes in environmental pressure, for example, while flying or scuba diving. As external pressure decreases, gases (like nitrogen) that are dissolved in the blood and other tissues become small bubbles that can block blood flow and cause organ damage.

Pulmonary embolism

In a **pulmonary embolism**, a common illness, blood flow is blocked at a pulmonary artery. When emboli block the main pulmonary artery, and in cases where there are no initial symptoms, a pulmonary embolism can quickly become fatal. According to the American Heart Association, an estimated 600,000

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Americans develop pulmonary emboli annually and 60,000 die from it.

A pulmonary embolism is difficult to diagnose. Less than 10% of patients who die from a pulmonary embolism were diagnosed with the condition. More than 90% of cases of pulmonary emboli are complications of **deep vein thrombosis**, blood clots in the deep vein of the leg or pelvis.

Causes and symptoms

Arterial emboli are usually a complication of heart disease where blood clots form in the heart's chambers. Gas emboli are caused by rapid changes in environmental pressure that could happen when flying or scuba diving. A pulmonary embolism is caused by blood clots that travel through the blood stream to the lungs and block a pulmonary artery. More than 90% of the cases of pulmonary embolism are a complication of deep vein thrombosis, which typically occurs in patients who have had **orthopedic surgery** and patients with **cancer** or other chronic illnesses like congestive **heart failure**.

Risk factors for arterial and pulmonary emboli include: prolonged bed rest, surgery, **childbirth**, **heart attack**, stroke, congestive heart failure, cancer, **obesity**, a broken hip or leg, **oral contraceptives**, sickle cell anemia, chest trauma, certain congenital heart defects, and old age. Risk factors for gas emboli include: scuba diving, amateur plane flight, **exercise**, injury, obesity, **dehydration**, excessive alcohol, colds, and medications such as **narcotics** and **antihistamines**.

Symptoms of an arterial embolism include:

- severe pain in the area of the embolism
- pale, bluish cool skin
- numbness
- tingling
- muscular weakness or paralysis

Common symptoms of a pulmonary embolism include:

- labored breathing, sometimes accompanied by chest pain
- a rapid pulse
- a cough that may produce sputum
- a low-grade fever
- fluid build-up in the lungs

Less common symptoms include:

- coughing up blood
- pain caused by movement or breathing
- leg swelling
- bluish skin
- fainting
- swollen neck veins

Diagnosis

An embolism can be diagnosed through the patient's history, a physical exam, and diagnostic tests. The use of various tests may change, as physicians and clinical guidelines evaluate the most effective test in terms of accuracy and cost. For arterial emboli, cardiac ultrasound and/or arteriography are ordered. For a pulmonary embolism, a **chest x ray**, lung scan, pulmonary **angiography**, **electrocardiography**, arterial blood gas measurements, and **venography** or venous ultrasound could be ordered.

Diagnosing an arterial embolism

Ultrasound uses sound waves to create an image of the heart, organs, or arteries. The technologist applies gel to a hand-held transducer, then presses it against the patient's body. The sound waves are converted into an image that can be displayed on a monitor. Performed in an outpatient diagnostic laboratory, the test takes 30–60 minutes.

An arteriogram is an x ray in which a contrast medium is injected to make the arteries visible. It can be performed in a radiology unit, outpatient clinic, or diagnostic center of a hospital.

Diagnosing a pulmonary embolism

A chest x ray can show fluid build-up and detect other respiratory diseases. The perfusion lung scan shows poor flow of blood in areas beyond blocked arteries. The patient inhales a small amount of radiopharmaceutical and pictures of airflow into the lungs are taken with a gamma camera. Then a different radiopharmaceutical is injected into an arm vein and lung blood flow is scanned. A normal result essentially rules out a pulmonary embolism. A lung scan can be performed in a hospital or an outpatient facility and takes about 45 minutes.

Pulmonary angiography is one of the most reliable tests for diagnosing a pulmonary embolism. Pulmonary angiography is a radiographic test that involves injection of a radio contrast agent to show the pulmonary arteries. A cinematic camera records the blood flow through the patient, who lies on a table. Pulmonary angiography is usually performed in a hospital's radiology department and takes 30–60 minutes.

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An electrocardiograph shows the heart's electrical activity and helps distinguish a pulmonary embolism from a heart attack. Electrodes covered with conducting jelly are placed on the patient's chest, arms, and legs. Impulses of the heart's activity are traced on paper. The test takes about 10 minutes.

Arterial blood gas measurements are sometimes helpful but, alone, they are not diagnostic for pulmonary embolism. Blood is taken from an artery instead of a vein, usually in the wrist.

Venography is used to look for the most likely source of a pulmonary embolism, deep vein thrombosis. It is very accurate, but it is not used often, because it is painful, expensive, exposes the patient to a fairly high dose of radiation, and can cause complications. Venography identifies the location, extent, and degree of attachment of the blood clots and enables the condition of the deep leg veins to be assessed. A contrast solution is injected into a foot vein through a catheter. The physician observes the movement of the solution through the vein with a fluoroscope while a series of x rays are taken. Venography takes between 30–45 minutes and can be done in a physician's office, a laboratory, or a hospital. Radionuclide venography, in which a radioactive isotope is injected, is occasionally used, especially if a patient has had reactions to contrast solutions. Venous ultrasound is the preferred evaluation of leg veins.

As noninvasive methods such as high-speed computed tomography (CT) scanning improve, they may be used to diagnose emboli. For instance, spiral (also called helical) CT scans may be the preferred tool for diagnosing pulmonary embolism in pregnant women.

Treatment

Patients with emboli require immediate hospitalization. They are generally treated with clot-dissolving and/or clot-preventing drugs. **Thrombolytic therapy** to dissolve blood clots is the definitive treatment for a severe pulmonary embolism. Streptokinase, urokinase, and recombinant tissue plasminogen activator (TPA) are used. Heparin has been the anticoagulant drug of choice for preventing formation of blood clots. A new drug has been approved for treatment of acute pulmonary emboli. Called fondaparinux (Arixtra), it usually is administered with Warfarin, an oral anticoagulant. Warfarin is sometimes used with other drugs to treat acute embolism events and is usually continued after the hospitalization to help prevent future emboli. Arixtra also has been used on an ongoing basis to prevent pulmonary emboli.

In the case of an arterial embolism, the affected limb is placed in a dependent position and kept warm.

KEY TERMS

Anticoagulants—Drugs that suppress, delay, or prevent blood clots. Anticoagulants are used to treat embolisms.

Artery—A blood vessel that carries blood from the heart to other body tissues. Embolisms obstruct arteries.

Deep vein thrombosis—A blood clot in the calf's deep vein. This frequently leads to pulmonary embolism if untreated.

Emboli—Clots or other substances that travel through the blood stream and get stuck in an artery, blocking circulation.

Thrombolytics—Drugs that dissolve blood clots. Thrombolytics are used to treat embolisms.

Embolectomy is the treatment of choice in the majority of early cases of arterial emboli in the extremities. In this procedure, a balloon-tipped catheter is inserted into the artery to remove thromboembolic matter.

With a pulmonary embolism, **oxygen therapy** is often used to maintain normal oxygen concentrations. For people who can't take anticoagulants and in some other cases, surgery may be needed to insert a device that filters blood returning to the heart and lungs.

Prognosis

Of patients hospitalized with an arterial embolism, 25–30% die, and 5–25% require amputation of a limb. About 10% of patients with a pulmonary embolism die suddenly within the first hour of onset of the condition. The outcome for all other patients is generally good; only 3% of patients die who are properly diagnosed early and treated. In cases of an undiagnosed pulmonary embolism, about 30% of patients die.

Prevention

Embolism can be prevented in high risk patients through antithrombotic drugs such as heparin, venous interruption, gradient elastic stockings, and intermittent pneumatic compression of the legs. The combination of graduated compression stockings and low-dose heparin is significantly more effective than low-dose heparin alone.

Gradient elastic stockings, also called anti-embolism stockings, decrease the risk of blood clots by compressing superficial leg veins and forcing blood into the deep veins. They can be knee-, thigh-, or

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waist-length. Many physicians order the use of stockings before surgery and until there is no longer an elevated risk of developing blood clots. The risk of deep vein thrombosis after surgery is reduced 50% with the use of these stockings. The American Heart Association recommends that the use of graduated compression stockings be considered for all high-risk surgical patients.

Intermittent pneumatic compression involves wrapping knee- or thigh-high cuffs around the legs to prevent blood clots. The cuffs are connected to a pump that inflates and deflates, mimicking the heart's normal pumping action and reducing the pooling of blood. Intermittent pneumatic compression can be used during surgery and recovery and continues until there is no longer an elevated risk of developing blood clots. The American Heart Association recommends the use of intermittent pneumatic compression for patients who cannot take anticoagulants, for example, spinal cord and brain trauma patients.

Resources

PERIODICALS

Doyle, Nora M., et al. "Diagnosis of Pulmonary Embolism: A Cost-effective Analysis." *American Journal of Obstetrics and Gynecology* September 2004: 1019–1024.

Truelove, Christiane. "First for Pulmonary Embolism." *Med Ad News* August 2004: 82.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

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Emergency contraception

Definition

Emergency **contraception** or emergency birth control uses either emergency contraceptive pills (ECPs) or a Copper-T intrauterine device (**IUD**) to help prevent **pregnancy** following unprotected vaginal intercourse.

Purpose

Emergency contraception may be used to prevent pregnancy after vaginal intercourse when:

- A birth control method was not used. Young people, in particular, may not be prepared for their first experience of sexual intercourse.
- A condom broke or slipped and ejaculation occurred within the woman's vagina.
- The male failed to withdraw from the vagina before ejaculation.
- A woman failed to take her birth control pills.
- A diaphragm, cap, or shield slipped out of place, followed by ejaculation within the vagina.
- A woman's "safe days" were miscalculated.
- A woman was raped or otherwise forced to have unprotected intercourse.

Women who missed taking their **oral contraceptives** may consider emergency contraception if:

- A new packet of pills was started at least two days late.
- Two to four of the first seven active (hormone-containing) pills (days 1–7) were missed.
- Five or more active pills were missed consecutively.

On average eight out of every 100 fertile women will become pregnant after having one episode of unprotected vaginal intercourse during the second or third week of their menstrual cycle. Following treatment with combined ECPs, only two of those 100 women will become pregnant—a 75% reduction. Following treatment with progestin-only ECPs, only one woman out of the 100 will become pregnant—an 89% reduction. Following emergency insertion of an IUD there is a 99.9% reduction in the risk of pregnancy.

Precautions

Emergency contraception does not work after the onset of pregnancy; nor should it be used as a regular method of birth control. ECPs do not prevent pregnancy from intercourse that occurs following the treatment; another birth control method must be used to prevent pregnancy. Although ECPs will not affect an existing pregnancy and will not harm the fetus, emergency contraception should not be used if a woman is already pregnant.

Frequent use of ECPs can result in irregular or unpredictable menstrual periods. Additional doses of ECPs usually do not reduce the risk of pregnancy and they increase the risk of side effects including **nausea and vomiting**.

Almost all women can use emergency contraception safely, even those who cannot use oral contraceptives as a regular method of birth control because

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of heart disease, **blood clots**, **stroke**, or other cardiovascular problems. The anti-convulsive medication Dilantin may reduce the effectiveness of ECPs. Some physicians recommend doubling the first of the two ECP doses if taken with Dilantin.

Progestin-only ECPs (POPs) are not recommended for women who:

- may be pregnant already
- have a hypersensitivity to any component of the medication
- have abnormal, undiagnosed genital bleeding.

Copper-T IUDs should not be used for emergency contraception if a woman:

- is pregnant
- has a history of pelvic inflammatory disease (PID) that has impaired her fertility
- has one of numerous other conditions affecting her reproductive system
- has—or is currently at risk for contracting—a sexually transmitted disease (STD) such as HIV/AIDS, chlamydia, or gonorrhea, since IUD insertion can introduce infectious agents into the sterile uterine cavity.

Those at risk for contracting an STD include women who:

- have been raped
- have had unprotected sex with a new partner
- are in a non-monogamous relationship
- use intravenous drugs
- have partners who use intravenous drugs

Description

Although emergency contraception—sometimes called post-coital or morning-after contraception—has been available for over a quarter of a century, almost one-half of the 6.3 million pregnancies in the United States each year are unintended. Among teen pregnancies 80% are unintentional. About one-half of unintended pregnancies are caused by contraceptive failure, either a failure of the method or a mistake by the user. The remainder of unintended pregnancies occurs because birth control was not employed. Emergency contraception could help prevent some of the 1.4 million abortions that take place in the United States every year.

Emergency contraception prevents pregnancy by one of the following methods:

- delaying or inhibiting ovulation—the release of eggs from the ovary
- altering the transport of the sperm or egg, thereby preventing fertilization of the egg by a sperm
- altering the endometrium or uterine lining, thereby preventing implantation—the attachment of the fertilized egg to the wall of the uterus

The mechanism by which ECPs prevent pregnancy depends on the stage of the woman's menstrual cycle. In most cases ECPs delay or inhibit ovulation and have no effect on implantation. IUDs used as emergency contraception appear to interfere with implantation of the fertilized egg; although they also may prevent fertilization, as they are thought to do when they are used as a regular method of birth control.

Emergency contraceptive pills (ECPs)

ECPs contain synthetic hormones that mimic the hormones produced by a woman's body. Many common brands of birth control pills can be used for emergency contraception even though they are not labeled for that use. Any of the first 21 pills in a regular 28-pill package of oral contraceptives can be used for emergency contraception. The last seven pills in 28-pill packs do not contain hormones. The number of pills that constitute an emergency contraceptive dose depends on the brand of pill. The same brand should be used for both doses of ECPs. Many ECPs are available outside of the United States, where they are packaged, labeled, and sold for emergency contraceptive purposes.

COMBINED ECPs. Combined ECPs available in the United States contain 100 micrograms of the synthetic estrogen, ethinyl estradiol, and 0.5–0.6 mg of the synthetic progestin levonorgestrel per dose. Combined ECPs are taken according to the Yuzpe Regimen, named after A. Albert Yuzpe, the Canadian researcher who first demonstrated their safety and effectiveness in 1974. With the Yuzpe Regimen, the first dose of combined ECPs is taken as soon as possible after unprotected intercourse and the second dose is taken 12 hours later. However the timing of the second dose can vary by a few hours without diminishing its effectiveness. The Preven Emergency Contraceptive Kit—the first product to be specifically labeled and marketed for emergency contraception—is no longer available.

Combined ECPs available in the United States include:

- Alesse, manufactured by Wyeth-Ayerst; five pink pills per dose
- Aviane, manufactured by Duramed; five orange pills per dose
- Cryselle, manufactured by Barr; four white pills per dose

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- Enpresse from Barr; four orange pills per dose
- Lessina from Barr; five pink pills per dose
- Levlen from Berlex; four light orange pills per dose
- Levlite from Berlex; five pink pills per dose
- Levora from Watson; four white pills per dose
- Lo/Ovral from Wyeth-Ayerst; four white pills per dose
- Low-Ogestrel from Watson; four white pills per dose
- Lutera from Watson; five white pills per dose
- Nordette from Wyeth-Ayerst; four light orange pills per dose
- Ogestrel from Watson; two white pills per dose
- Ovral from Wyeth-Ayerst; two white pills per dose
- Portia from Barr; four pink pills per dose
- Seasonale from Barr; four pink pills per dose
- Tri-Levlen from Berlex; four yellow pills per dose
- Triphasil from Wyeth-Ayerst; four yellow pills per dose
- Trivora from Watson; four pink pills per dose

PROGESTIN-ONLY ECPs. Progestin-only ECPs (POPs) are prescribed frequently, particularly for women who cannot take estrogen or who are **breastfeeding**. POPs contain 0.75 mg of levonorgestrel per dose. They are equally effective regardless of whether the two doses are taken simultaneously or 12–24 hours apart. POPs are most effective if taken within 72 hours of unprotected intercourse; however they reduce the risk of pregnancy if taken within 120 hours.

Progestin-only pills include:

- Plan B from Barr is the only drug available in the United States that is specifically designed and designated as an ECP—one white pill per dose.
- Ovrette from Wyeth-Ayerth requires swallowing 20 yellow pills for each dose.

The Copper-T IUD

The Copper-T 380A IUD (ParaGard) is a T-shaped device that provides emergency contraception if inserted into the uterus by a healthcare provider within seven days after unprotected intercourse. It can be removed by the healthcare provider after the woman's next menstrual period begins or it can remain in place for up to 10–12 years as an effective method of birth control.

Availability

In most of the United States, emergency contraception requires a special prescription or a prescription for a monthly supply of an appropriate oral contraceptive. Most physicians do not routinely discuss the use of emergency contraception with their patients and some pharmacies refuse to carry ECPs.

Emergency contraception is available from:

- public and college health clinics
- women's health centers
- Planned Parenthood clinics
- private doctors
- hospital emergency rooms, except those affiliated with a religion that opposes the use of birth control
- pharmacists directly, in a small number of states.

Some healthcare providers may prescribe ECPs over the telephone. **Sexual assault** victims may be offered ECPs in the hospital emergency room.

In many countries ECPs are available without a prescription. However in the United States emergency contraception remains controversial. In September of 2004, the U. S. Department of Justice released guidelines for the treatment of sexual assault victims without mentioning the option of emergency contraception. As of early 2005, the U.S. Food and Drug Administration (FDA) had delayed approval of over-the-counter (OTC) status for Plan B. However many professional healthcare organizations and advocacy groups for women's reproductive rights were working to make ECPs available without a prescription in the United States.

Costs

The cost of emergency contraception varies greatly according to region and location and any additional required services. Family-planning clinics and public healthcare centers may provide lower-cost emergency contraception or charge according to an income-based sliding scale.

Estimated costs for emergency contraception are:

- $8–$35 for Plan B
- $20–$50 for combined ECPs
- $50–$70 for other progestin-only ECPs
- $35–$150 for a visit to a healthcare provider
- $10–$20 for a pregnancy test
- about $400 for an exam, IUD, and insertion; however the IUD can remain in place for up to 12 years.

Preparation

For emergency contraception to be effective, it must be used as soon as possible following unprotected intercourse. Some healthcare providers and **women's health** centers prescribe or supply packets of ECPs—called EC-to-Go—so that they are available immediately if required. Supplies of ECPs are

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particularly important for women who are at high risk for having unprotected intercourse. EC-to-Go also avoids the cost of an extra visit to a healthcare provider.

Studies have found that neither the use of ECPs, nor having a supply of ECPs on hand, reduce the likelihood that women, including teenagers, will use conventional contraceptive methods. In fact it has been shown that the use of ECPs often increases the likelihood that a regular birth control method will be employed.

If an office visit is required, a healthcare provider may take a medical history, perform a pregnancy test on a urine sample, and—provided that pregnancy has not occurred—discuss the appropriate type of emergency contraception.

Aftercare

For about 10–15% of women who take ECPs, the timing, duration, and/or amount of bleeding for their next menstrual period may be different than usual. About 50% of women have their first post-ECP menstrual period one to three days earlier or later than expected. Most often it is earlier than expected. Bleeding may be normal or heavier, lighter, or more spotty than usual.

Following IUD insertion, a woman may need to be escorted or driven home and she may require rest.

Risks

Emergency contraception is considered to be both safe and effective for teenagers as well as adult women. However emergency contraception may not prevent an ectopic pregnancy—a pregnancy outside of the uterus, in the fallopian tubes or abdomen. Ectopic pregnancies are medical emergencies and can be fatal.

Side effects of ECPs

About 50% of women feel sick to their stomachs for approximately 24 hours after taking combined ECPs. **Nausea** occurs in 30–50% of women and 15–25% of women experience **vomiting**. Only 23% of women who take progestin-only ECPs experience nausea and only 6% have **vomiting**.

If vomiting occurs within one hour of taking ECPs, the dose may have to be repeated. OTC medications such as Dramamine II, Bonine, or their generic equivalents, taken one hour before the ECPs, reduce the risk of nausea by 27% and the risk of vomiting by 64%; however there is about a 30% risk of drowsiness. If vomiting occurs after the first dose of an ECP, antinausea medication should be taken one hour before the second dose. The second dose also may be taken as a vaginal suppository by placing the pills as far as possible into the vagina for absorption through the vaginal tissue.

Other side effects of ECPs can include:

- breast tenderness
- abdominal pain
- irregular bleeding
- dizziness
- headaches
- fatigue.

Side effects usually last only one to two days and are far less frequent with progestin-only ECPs as compared with combined ECPs.

Side effects of IUD insertion

Side effects of IUD insertion may include:

- abdominal discomfort
- vaginal bleeding or spotting
- infection.

However the risk of pelvic infection is very small among women who are not at risk for STDs.

Other possible side effects of IUD insertion include:

- heavy menstrual flow
- cramping
- infertility
- uterine puncture.

Normal results

The effectiveness of emergency contraception depends both on the stage of the woman's menstrual cycle and on how soon the emergency contraception is used following unprotected vaginal intercourse. The closer a woman is to ovulation—her fertile period during which eggs are released from the ovary—the less effective emergency contraception will be.

ECPs are less effective than the most popular birth control methods:

- If taken within 72 hours of unprotected intercourse, combined ECPs are about 75% effective for preventing pregnancy.

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KEY TERMS

Emergency contraceptive pills; ECPs—Medication containing synthetic hormones for preventing pregnancy after unprotected vaginal intercourse.

Endometrium—The lining of the uterus.

Ethinyl estradiol—A semi-synthetic derivative of estradiol—an estrogen or female sex hormone—used in birth control pills and combined ECPs.

Implantation—The embedding of a fertilized egg in the inner wall of the uterus.

Intrauterine device; IUD—A device inserted into the uterus to prevent pregnancy.

Levonorgestrel—A synthetic progestin used in ECPs.

Ovulation—The discharge of an ovum (egg) from the mature follicle of the ovary.

Progestin—A synthetic or natural drug that acts on the uterine lining.

Yuzpe Regimen—A two-dose treatment with combined ECPs to prevent pregnancy after unprotected intercourse; the first dose is taken as soon as possible and the second dose is taken 12 hours after the first.

- Progestin-only ECPs are 95% effective if taken within 24 hours of unprotected intercourse and about 89% effective if taken within 72 hours.
- A Copper-T IUD is 99.9% effective if inserted within seven days of unprotected intercourse.

If a normal menstrual period does not begin within three weeks after taking ECPs, or if signs of pregnancy develop, a healthcare provider should be consulted immediately.

Signs of pregnancy include:

- a missed menstrual period
- nausea
- unexplained fatigue
- enlarged or sore breasts
- headaches
- frequent urination

The majority of women express satisfaction with emergency contraception. One study of 235 women who had used ECPs found that 91% were satisfied with the method and 97% would recommend it to others.

Resources

BOOKS

Emergency Contraception: A Medical Dictionary, Bibliography, and Annotated Research Guide to Internet References. San Diego: ICON Health Publications, 2004.

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Frequently Asked Questions About Emergency Contraception. The National Women's Health Information Center. November 2002 [cited March 6, 2005]. http://www.4woman.gov/faq/econtracep.htm.

Not-2-Late.com. The Emergency Contraception Website. Office of Population Research, Princeton University and the Association of Reproductive Health Professionals. [Cited March 6, 2005]. http://ec.princeton.edu.

ORGANIZATIONS

American College of Obstetricians and Gynecologists, PO Box 96920, Washington, DC, 20090-6920, (202) 638-5577, http://www.acog.org.

Association of Reproductive Health Professionals, 1901 L Street, NW, Suite 300, Washington, DC, 20036, (202) 466-3825, http://arhp.org.

Office of Population Research, Princeton University, Wallace Hall, Princeton, NJ, 08544, (609) 258-4870, (609) 258-1039, http://opr.princeton.edu.

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PATH, PO Box 900922, Seattle, WA, 98109, (206) 285-3500, (206) 285-6619, info@path.org, http://www.path.org.
Planned Parenthood Federation of America, Inc., 434 West 33rd St., New York, NY, 10001, (212) 541-7800, (212) 245-1845, (800) 230-7526, http://search.plannedparenthood.org.
United States Food and Drug Administration (FDA), 10903 New Hampshire Ave, Silver Spring, MD, 02993-0002, (888) 463-6332, http://www.fda.gov.

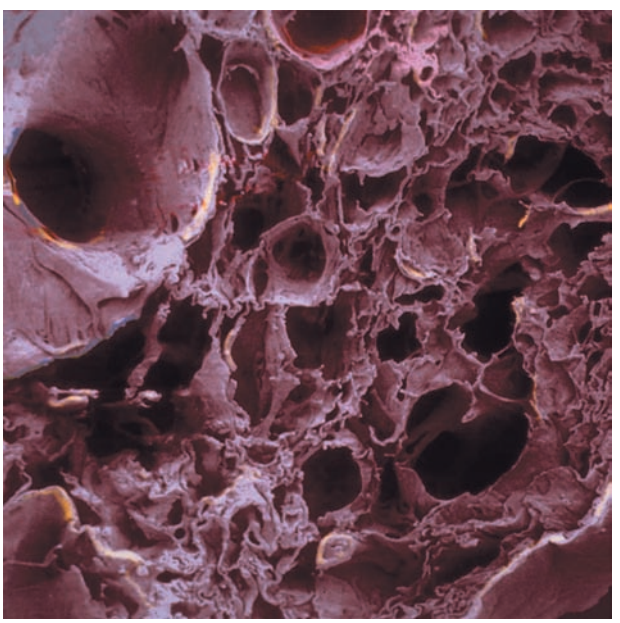
Margaret Alic, Ph.D.

EMG *see* **Electromyography**
Emollient bath *see* **Therapeutic baths**

Emphysema

Definition

Emphysema is a chronic respiratory disease in which there is progressive overinflation of the air sacs (alveoli) in the lungs, causing a loss of lung function and often breathlessness. Its name comes from a Greek word meaning "to blow into," hence "air-containing" or "air-inflated." Emphysema is sometimes grouped together with chronic **bronchitis** under the name of **chronic obstructive pulmonary disease**, or COPD. Many people who are diagnosed with emphysema also have chronic bronchitis.



A scanning electron microscopy (SEM) of lung tissue indicating emphysema. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

X ray showing emphysema in the lungs. *(Photo Researchers, Inc.)*

Demographics

Emphysema is increasing in the United States, Canada, and other developed countries primarily because of cigarette **smoking**. It is almost entirely a disease of adults. About 12 million adults in the United States have been diagnosed with the disease as of 2009; however, many doctors believe emphysema is underdiagnosed. Between 4 and 6 percent of male adults and 1–3 percent of female adults in North America are estimated to have emphysema. The number of women diagnosed with the disease is rising rapidly; the year 2000 was the first year that more women than men were identified as having emphysema. In 2005, almost 66,000 females died compared to 61,000 males. According to the American Lung Association, the cost to the United States for COPD each year is approximately $42.6 billion, including $26.7 billion in direct health care expenditures, $8.0 billion in indirect morbidity costs and $7.9 billion in indirect mortality costs.

Rates of emphysema are rising worldwide as more people in the developing countries take up cigarette smoking. The Global Initiative for Chronic Obstructive Lung Disease (GOLD) estimates that 9–10 percent of adults around the world have either chronic bronchitis or emphysema.

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People who develop emphysema as a result of smoking generally start to have symptoms in their late 40s or early 50s. Those who have emphysema because of a genetic condition (described below) may begin to have symptoms in their 30s. This genetic condition, discovered by a Swedish doctor in 1963 and known as alpha 1-antitrypsin deficiency (A1AT), is more common in Caucasians than in members of other races and accounts for about 2 percent of all emphysema cases in the United States. Current estimates suggest that between 60,000 and 100,000 Americans have severe A1AT deficiency, but only 4% of these patients have been identified.

Worldwide, people of Spanish, Portuguese, Scandinavian, and Saudi Arabian ancestry are at increased risk of emphysema associated with A1AT deficiency. The genetic disorder is thought to affect as many as 4 percent of these populations. Newborns in Sweden are routinely screened for A1AT deficiency as of 2009.

Description

Emphysema is a lung disease in which a person's ability to breathe easily and deeply is steadily weakened over time by the destruction of lung tissue. The human lung consists of tissue containing millions of tiny air sacs called alveoli, which are arranged like bunches of grapes around very small air tubes called bronchioles. There are about 300 million alveoli in each lung. When a person breathes in air, the air travels from the nose and mouth through the windpipe and then into the right and left bronchi, which are the main air passages into each of the two lungs. The bronchi divide and subdivide repeatedly into smaller and smaller air passages, finally ending in the bronchioles and alveoli. In a normal person, oxygen from the air that has been taken in is exchanged in the walls of the alveoli for carbon dioxide in the person's blood. When the person breathes out, the carbon dioxide leaves the body in the air that travels out from the lungs and through the upper airway to the nose and mouth.

To perform their function effectively, the tissue in the lungs that separates the alveoli from one another needs to be as elastic as possible. The alveoli contain tiny elastic fibers in their cell walls that allow them to act like miniature balloons. What happens in emphysema is that tobacco smoke or other irritants causes the alveoli to become inflamed and lose their elasticity. The bronchioles start to collapse, which traps air inside the alveoli and overstretches them. In time the alveoli rupture, leading to the formation of fewer but larger air sacs in the lungs. The smaller areas of alveoli destruction are known as blebs and the larger ones are called bullae. These larger and less flexible sacs are less efficient in forcing air out of the lungs when the person breathes out. As a result, the person has to breathe more frequently or breathe harder in order to get enough oxygen and get rid of carbon dioxide.

In addition to the loss of elasticity in the alveoli, the cells in the airways secrete more mucus than usual, which collects in the airways and clogs them, making breathing even more difficult.

Risk factors

Cigarette smoking is the biggest single risk factor for emphysema. Some people who do not smoke cigarettes, however, are at increased risk of emphysema. They include:

- People who work in occupations that expose them to high levels of dust from grain or cotton, or chemical irritants. These occupations include mining, certain types of agricultural work, and lumbering. Most miners suffer from emphysema to some degree after a lifetime in the mining pit. In fact, emphysema is sometimes referred to as miner's lung or black lung.
- People exposed to high levels of automobile exhaust or secondhand smoke.
- People who are HIV-positive.
- People who abuse intravenous drugs. The cotton fibers and other materials used as fillers in these drugs can irritate and eventually destroy lung tissue.
- People who smoke marijuana. Marijuana smoke may be even more damaging to some people than tobacco because it is inhaled deeply and held in by the smoker.
- People with certain diseases that affect connective tissue, such as Marfan syndrome and Ehlers-Danlos syndrome.
- People whose occupations require heavy use of the lungs for blowing, such as trumpet players, woodwind players, and glassblowers.

Causes and symptoms

Causes

Emphysema is caused by a weakening of the tissues in the lungs as a result of inflammation due to tobacco smoke or other chemical irritants in the air, or a hereditary deficiency of a protein that protects the elasticity of lung tissue. As the bronchioles in the lungs collapse and the alveoli become enlarged, the lungs become less efficient in getting rid of carbon dioxide and the person has to breathe more frequently in order to get enough oxygen. In addition, the person has to use their chest muscles to expel air from the lungs forcefully rather than being able to rely on the normal movement of

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KEY TERMS

Alveolus (plural: alveoli)—The medical term for one of the tiny air sacs in the lungs where oxygen is transferred from the lungs to the blood and carbon dioxide is removed.

Arterial blood gases test—A test to analyze blood for oxygen, carbon dioxide, and bicarbonate content, as well as blood pH (acidity level). Used to test the effectiveness of respiration.

Bronchiole—A very small thin-walled air passage in the lungs that branches off from a bronchus.

Bronchus (plural: bronchi)—One of the two major divisions of the airway that lead into the right and left lungs.

Cor pulmonale—Enlargement and structural change of the right ventricle of the heart as a result of emphysema or other respiratory disorder.

Diaphragm—A sheet of muscle tissue that divides the chest cavity from the abdominal cavity.

Peak flow measurement—Measurement of the maximum rate of airflow attained during a forced vital capacity determination.

Progressive—A term that refers to a disease that gets worse over time.

Pulmonary—Related to or associated with the lungs.

Pulse oximetry—The noninvasive monitoring or determination of oxygen-hemoglobin saturation of the blood.

Spirometer—A device that is used to test the air capacity of a person's lungs and the amount of air that enters and leaves the lungs during breathing.

Ventricle—One of the two lower chambers of the heart.

the diaphragm during breathing. This need to use muscular force leads to the development of a so-called barrel chest; that is, the person's chest is almost the same size from front to back as from side to side.

About 2 percent of cases of emphysema are caused by a deficiency of a liver enzyme known as alpha 1-antitrypsin, or A1AT. The enzyme ordinarily protects the alveoli in the lungs from damage by another enzyme that harms connective tissue. In people with A1AT deficiency, there is not enough of the protective enzyme to keep the alveoli in good working condition. A1AT is an inherited condition caused by a mutation in a gene on the long arm of chromosome 14.

Symptoms

The most noticeable symptoms of emphysema are breathlessness, coughing, and **wheezing**. These symptoms typically develop gradually over many years. It is a common occurrence for many emphysema patients to have lost over half of their functioning lung tissue before they become aware that something is wrong. The **cough**, which is often dismissed as "smoker's cough," may be productive of large amounts of dark, thick sputum.

In addition to **shortness of breath**, coughing, and wheezing, people with emphysema often develop the following symptoms:

- Pursed-lips breathing. This is a way of partially closing the lips that allows the person to fully exhale. When the mouth opening is smaller, the airways that have been weakened by the disease open wide and allow the person to expel more air from the lungs.
- Greater difficulty exercising or doing work that requires physical activity.
- Loss of appetite and weight loss. Eating can make it harder to breathe because the stomach expands during a meal and pushes upward against the diaphragm.
- Fatigue. Emphysema leads to a lower level of oxygen in the blood, which in turn causes people to feel tired easily.
- Swelling of the feet, ankles, or legs.
- Slow recovery from such upper respiratory infections as colds and flu. Those with emphysema are at risk for a variety of other complications resulting from weakened lung function, including pneumonia, pulmonary hypertension, cor pulmonale, and chronic respiratory failure.

Diagnosis

Many patients are diagnosed with emphysema in the course of seeking treatment for chronic bronchitis. The first step in diagnosing emphysema is a careful patient history, particularly a history of smoking.

Examination

A history of heavy smoking alone, however, is not enough for a physician to differentiate emphysema

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from other respiratory diseases. A physician will combine information on symptoms, medical history, **physical examination**, lung function tests, and **chest x ray** results to make a diagnosis of emphysema. One of the first clues may be a hollow sound heard through a stethoscope as the patient's chest is being tapped. The hollow sound is the result of the enlargement or rupture of the lungs' alveoli.

Tests

A variety of **pulmonary function tests** may be ordered. In the early stages of emphysema, the only result may be dysfunction of the small airways. Patients with emphysema may show an increase in the total amount of air that is in the lungs (total lung capacity), but a decrease in the amount of air that can be breathed out after taking a deep breath (vital capacity). With severe emphysema, vital capacity is substantially below normal. **Spirometry**, a procedure that measures air flow and lung volume, helps in the diagnosis of emphysema.

A chest x ray is often ordered to aid in the diagnosis of emphysema, though patients in the early stages of the disease may have normal findings. Abnormal findings on the chest x ray include overinflation of the lungs and an abnormally increased chest diameter. The diaphragm may appear depressed or flattened. In addition, patients with advanced emphysema may show a smaller or vertical heart. The physician may observe blisters in the lungs and bulging of the accessory muscles of the respiratory system. Late in the disease, an EKG will show signs of right ventricular failure in the heart and increased hemoglobin due to lower levels of oxygen in the patient's blood.

Other tests that may be performed include peak flow measurements, arterial blood gases, and pulse oximetry.

A1AT deficiency can be diagnosed by a simple fingerstick blood test. Individuals with symptoms of emphysema or COPD should ask their doctor whether this test is appropriate for them. Their doctor can order the test, or they can choose to be tested on a confidential basis through the Alpha-1 Foundation's Alpha-1 Coded Testing (ACT) study. The foundation's contact information is listed below.

Treatment

There is no cure for emphysema as of 2009. Treatment is focused on slowing the progress of the disease and easing the patient's symptoms. The first part of treatment for patients who smoke is quitting the habit. Smoking cessation programs may be effective. Consistent encouragement along with the help of health care professionals as well as family and friends can help increase the success rate of someone attempting to quit smoking.

Traditional

Drugs

The next stage in treatment is the use of medications. The doctor may prescribe one or more of the following types of drugs:

- Bronchodilators. Bronchodilators are drugs that work by opening up the airways, which allows for more efficient exchange of carbon dioxide and oxygen. Some are taken in tablet form while others are dispensed in inhalers. Depending on the severity of the patient's emphysema, they may use the inhaler only when needed for shortness of breath or they may take a dose of the medication at prescribed regular intervals. There are three primary categories of bronchodilators: sympathomimetics (isoproterenol, metaproterenol, terbutaline, albuterol), which can be inhaled, taken by mouth, or injected; parasympathomimetics (atropine); and methylxanthines (theophylline), which may be administered intravenously, orally, or rectally.
- Steroids (beclomethasone, dexamethasone, triamcinolone, flunisolide). This type of medication works by lowering the inflammation in the tissues lining the airways. These drugs can also be taken in pill form or through inhalers. Some patients' lung function improves with corticosteroids, and inhaled steroids may be beneficial to patients with few side effects.
- Antibiotics. People who have infections in the lungs as well as emphysema may be given antibiotics to treat the infections.
- Expectorants. These are drugs that can help to loosen respiratory secretions, enabling the patient to more easily expel them from the airways.

Many of the medications prescribed for emphysema involve the use of a metered dose inhaler (MDI) that may require special instruction to be used correctly. MDIs are a convenient and safe method of delivering medication to the lungs. If they are used incorrectly, however, the medication will not get to the right place. Proper technique is essential for inhaled medication to be effective.

Among all other treatments for emphysema, only **oxygen therapy** has shown an increase in the survival rate.

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Home oxygen therapy may improve the survival times in those patients with advanced emphysema who also have low blood oxygen levels. It may improve the patient's tolerance of **exercise**, as well as improve their performance in certain aspects of brain function and muscle coordination. The functioning of the heart may also improve with an increased concentration of oxygen in the blood. Oxygen may also decrease **insomnia** and headaches. Some patients may receive oxygen only at night, but studies have illustrated that it is most effective when administered at least 18 but preferably 24 hours per day. Portable oxygen tanks prescribed to patients carry a limited supply and must be refilled on a regular basis by a home health provider. Medicare and most insurance companies cover a large proportion of the cost of home oxygen therapy. Patients should be instructed regarding special safety issues involving the transport and presence of oxygen in the home.

Surgery

Emphysema is sometimes treated surgically. In some cases, part of the diseased lung is removed. This procedure, which is called lung volume reduction, creates space for the remaining portions of the lungs; it does improve breathing and quality of life for some patients. Another surgical option is **lung transplantation**. This is a risky procedure, however, and requires the patient to take medications to prevent the rejection of the transplanted lung. In addition, not everyone qualifies for transplantation, and those who do are limited by the short supply of available organs. Up through 2006, emphysema was the single most common diagnosis of American patients awaiting lung transplantation.

Other interventions

For those patients with advanced emphysema, keeping the air passages reasonably clear of secretions can prove difficult. Some common methods for mobilizing and removing secretions include:

- Postural drainage. This helps to remove secretions from the airways. The patient lies in a position that allows gravity to aid in draining different parts of the lung. This is often done after the patient inhales an aerosol medication. The basic position involves the patient lying on the bed with his chest and head over the side and the forearms resting on the floor.
- Chest percussion. This technique involves lightly clapping the back and chest, and may help to loosen thick secretions.
- Coughing and deep breathing. These techniques may aid the patient in bringing up secretions.
- Aerosol treatments. These treatments may involve solutions of saline, often mixed with a bronchodilator, which are then inhaled as an aerosol. The aerosols thin and loosen secretions. A treatment normally takes 10 to 15 minutes, and is given three or four times a day.

Another important part of treatment for emphysema is called pulmonary **rehabilitation**. This approach is aimed at educating patients about their disease and helping them with lifestyle changes that will slow the progression of the disease and improve quality of life. Pulmonary rehabilitation includes a physical exercise program designed to improve the patient's physical endurance and energy level. Many patients are also encouraged to lose weight in order to reduce the burden on their lungs. One important benefit of pulmonary rehabilitation is psychological: patients report that their self-esteem and sense of control over their life improve when they start to see benefits from the rehabilitation program.

Patients with emphysema can learn to perform a variety of self-help measures that may help improve their symptoms and their ability to participate in everyday activities. These measures include:

- Avoiding any exposure to dust and fumes.
- Avoiding air pollution, including secondhand cigarette smoke.
- Avoiding other people who have infections like colds or flu, and getting a pneumonia vaccination and a yearly flu shot.
- Drinking plenty of fluids. This helps to loosen respiratory secretions so they can be brought up more easily through coughing.
- Avoiding extreme temperatures of heat or cold, and also avoiding high altitudes. Special precautions can be taken that may enable the emphysema patient to fly on a plane.
- Maintaining adequate nutritional intake. Normally a high-protein diet taken in many small feedings is recommended.

Treatment for A1AT deficiency

Emphysema related to A1AT deficiency can be treated by intravenous infusions of the A1AT protein as well as by avoiding breathing substances that irritate the lungs and by lung transplantation if needed. The intravenous protein infusions are derived from donated human blood plasma. This type of treatment is called augmentation therapy; present recommendations are

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that patients should not begin this treatment before the symptoms of emphysema appear. Augmentation therapy is not a cure for emphysema but can slow its progression.

Alternative

There are several alternative approaches to relieving the symptoms of emphysema. As with mainstream treatments, these are not cures for the disease.

HERBALISM. Herbs can be beneficial in helping the body to ward off infection, and easing the asthmatic symptoms that often accompany emphysema.

Some beneficial herbs are:

- Lobelia. This is a mild sedative, also having strong expectorant properties. It is widely used for chest complaints, including emphysema and bronchitis, and can help to shorten an asthma attack.
- Thyme. A tea made with thyme is recommended for overcoming shortness of breath. It is also a powerful antiseptic.
- Mullein. This is another traditional remedy for chest complaints. To make a tea, one boils two tablespoons of the dried leaves with a glass of milk and drinks the mixture.
- Echinacea. Echinacea is a powerful immune system stimulant and strengthens the body in general, warding off colds and infections.
- Lungwort. A member of the borage family, this herb is very healing for the lungs. It should be taken as an infusion.
- Black cohosh. This herb is an expectorant and astringent. It relieves coughing.
- Sage. This is one of the most useful of all herbs and is said to be good for whatever it is taken for. It is antiviral and bactericidal.
- Garlic. A very powerful antiviral, garlic can be of real help to those trying to avoid infections and lung congestion.

CHINESE HERBAL MEDICINE. Qing Qi Hua Tan Wan (Pinellia expectorant pills) are the Chinese herbalists' treatment for chronic lung complaints, particularly bronchitis and **asthma**.

JUICE THERAPY. Kitty Campion, a British naturopathic herbalist expert, recommends the following juices for the treatment of emphysema: equal parts of carrot juice, parsnip juice, watercress juice, and potato juice, or equal parts of orange juice and lemon juice, diluted half and half with a strong decoction of rosehip tea.

AROMATHERAPY. **Aromatherapy** involves massaging the patient with potent plant essential oils, which have been proven to enter the circulation through the skin. The constituents of the oils can have a powerful effect on a variety of illnesses, but since their beneficial qualities are also transported through the air, they are considered to be doubly beneficial to those who suffer from respiratory ailments.

Aromatherapy oils for respiratory disease:

- *Canada balsam* may alleviate respiratory symptoms and is an expectorant. It is also a bactericide and recommended for those suffering from chronic chest ailments.
- *Tolu balsam* is an excellent treatment for chest infections.
- *Frankincense* is good for infection and catarrhal discharge.
- *Niaouli* is a very strong antiseptic and beneficial for pulmonary trouble.
- *Rose damascena* is recommended for bronchial complaints, and it also lifts the spirits.
- *Tea tree oil* is one of the most potent anti-viral, anti-bacterial and anti-fungal agents known to herbal medicine, therefore, highly beneficial as a preventative measure against chest infection.

ACUPUNCTURE. This ancient Chinese system of holistic treatment works on the principle that illness is the result of blockage in the flow of life force. The practitioner aims to stimulate relevant meridians in the body and thus release trapped life force, returning bodily functions to normal. The treatment is virtually painless.

Treatment can be expected to improve blood circulation and the capacity of the body to restore itself. Research has indicated that **acupuncture** can produce changes in the electrical fields of body cells, which promote a return to the body's normal state. Consequently, few negative side effects are associated with acupuncture treatment.

Prognosis

Emphysema is known to shorten a patient's life span. It is the fourth most common cause of **death** in the United States as of 2009, being responsible for 4.5 percent of all deaths and a contributing factor in another 4.3 percent. Some patients, however, live longer than others depending on the cause of their emphysema and the measurement of their lung capacity at diagnosis. Complications of emphysema include higher risks for **pneumonia** and acute bronchitis. In general, men have worse prognoses than women. Patients who have smoked 20 cigarettes per day for 20 years or longer with a severely reduced

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breathing capacity have the worst prognosis; only 5 percent survive for 12 years after diagnosis. Smoking has been estimated to speed up the appearance of emphysema in patients with A1AT deficiency by 19 years.

The prognosis for emphysema associated with A1AT deficiency is poor. Long-term studies of the efficacy of augmentation therapy have not been carried out as of 2009 although the therapy has been used for about 20 years and is considered safe. Most patients with this form of emphysema suffer some degree of disability and a shortened life expectancy.

Prevention

Most cases of emphysema can be prevented by simply not smoking or by quitting smoking as soon as possible and avoiding secondhand smoke. Emphysema related to genetic factors cannot always be prevented, but its development can be postponed in people who inherited the defective gene by avoiding smoking.

Health care team roles

Many members of the health care team may treat a patient with emphysema. The patient usually seeks help from a physician first, who will make the diagnosis. In the course of the diagnostic workup, x-ray technicians and respiratory therapists may treat the patient. The nurse plays an important role in assessing the patient, administering medications, in teaching the patient how best to cope with and understand the disease, and—in some cases—provides home care. The physical therapist may assist the patient to find ways of increasing their strength and activity tolerance.

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American Lung Association, 1301 Pennsylvania Ave., NW, Suite 800, Washington, DC, 20004, 212-315-8700, 800-548-8252, http://www.lungusa.org/site/c.dvLUK9O0E/b.22542/k.CA6A/Home.htm.

National Emphysema Foundation, 128 East Avenue, Norwalk, CT, 06851, 203-866-5000, 203-286-1105, http://www.emphysemafoundation.org/.

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National Heart, Lung, and Blood Institute (NHLBI), Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, 301-592-8573, 240-629-3246, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi.nih.gov/.
Global Initiative for Chronic Obstructive Lung Disease (GOLD), http://www.goldcopd.com/.

Deanna M. Swartout-Corbeil, RN
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Empyema

Definition

Empyema is a condition in which pus and fluid from infected tissue collects in a body cavity. The name comes from the Greek word *empyein* meaning pus-producing (suppurate). Empyema is most often used to refer to collections of pus in the space around the lungs (pleural cavity), but sometimes refers to similar collections in the gall bladder or the pelvic cavity. Empyema in the pleural cavity is sometimes called empyema thoracis, or empyema of the chest, to distinguish it from empyema elsewhere in the body.

Description

Empyema may have a number of causes but is most frequently a complication of **pneumonia**. Its development can be divided into three phases: an acute phase in which the body cavity fills with a thin fluid containing some pus; a second stage in which the fluid thickens and a fibrous, coagulation protein (fibrin) begins to accumulate within the cavity; and a third or chronic stage in which the lung or other organ is encased within a thick covering of fibrous material.

Causes and symptoms

Empyema thoracis can be caused by a number of different organisms, including bacteria, fungi, and amebas, in connection with pneumonia, chest **wounds**, chest surgery, lung abscesses, or a ruptured esophagus. The infective organism can get into the pleural cavity either through the bloodstream or other circulatory system, in secretions from lung tissue, or on the surfaces of surgical instruments or objects that cause open chest wounds. The most common organisms that cause empyema are the following bacteria: *Streptococcus pneumoniae*, *Haemophilus influenzae*, and *Staphylococcus aureus*. *S. aureus* is the most common cause in all age groups, accounting for 90% of cases of empyema in infants and children. Pelvic empyema in women is most often caused by *Bacteroides* strains or *Pseudomonas aeruginosa*. In elderly, chronically ill, or alcoholic patients, empyema is often caused by *Klebsiella pneumoniae* species of bacteria.

When the disease organisms arrive in the cavity surrounding the lungs, they infect the tissues that cover the lungs and line the chest wall. As the body attempts to fight off the infection, the cavity fills up with tissue fluid, pus, and dead tissue cells. Empyema of the gall bladder or pelvis results from similar reactions to infection in those parts of the body.

The signs and symptoms of empyema vary somewhat according to the location of the infection and its severity. In empyema thoracis, patients usually exhibit symptoms of pneumonia, including **fever**, **cough**, **fatigue**, **shortness of breath**, and chest **pain**. They may prefer to lie on the side of the body affected by the empyema. Family members may notice **bad breath**. In severe cases, the patient may become dehydrated, cough up blood or greenish-brown sputum, run a fever as high as 105°F (40.6°C), or fall into a **coma**.

Patients with thoracic empyema may develop potentially life-threatening complications if the condition is not treated. The infected tissues may develop large collections of pus (abscesses) that can rupture into the patient's airway, or the infection may spread to the tissues surrounding the heart. In extreme cases the empyema may spread to the brain by means of bacteria carried in the bloodstream.

In pelvic empyema, the infection produces large amounts of thick, foul-smelling pus that is rapidly replaced even after drainage. Empyema of the gallbladder is marked by intense pain on the upper right side of the abdomen, high fever, and rigidity of the muscles over the infected area.

Diagnosis

A physician may consider the possibility of empyema thoracis in patients with pneumonia or other symptoms of lung infection. When listening to sounds within the patient's chest with a stethoscope, the sounds of breathing will be partly muffled and harder to hear in the patients with empyema. The area of the chest over the infection will sound dull when tapped or thumped (percussed). On an x ray, empyema thoracis will appear as a cloudy or opaque area. The amount of fluid present in the pleural cavity can be estimated using an ultrasound imaging procedure. The diagnosis of empyema, however, has to be confirmed with laboratory tests because its symptoms can be caused by other disease conditions.

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KEY TERMS

Abscess—An area of inflamed and injured body tissue that fills with pus.

Decortication—Surgical removal of the fibrous peel that covers the lungs in third-stage empyema.

Empyema—The collection of pus in a body cavity, particularly the lung or pleural cavity.

Fibrin—A fibrous blood protein vital to coagulation and blood clot formation.

Percussion—A diagnostic technique in which the back, chest, or abdomen is tapped to determine whether body cavities contain abnormal fluid.

Pleural cavity—The space surrounding the lungs, including the membranes covering the lungs and lining the inside of the chest wall.

Pneumonia—Inflammation of the lungs usually caused by a virus, bacteria, or other organism.

Resection—The surgical removal of part of an organ or body structure, as in rib resection.

Suppurate—To produce or discharge pus.

Thoracentesis—A procedure in which fluid is withdrawn from the pleural cavity through a needle inserted between the ribs. The fluid may be withdrawn either for diagnostic tests or to drain the cavity.

Video-assisted thoracic surgery (VATS)—A technique used to aid in the placement of chest tubes or when performing decortications when treating advanced empyema.

The diagnosis of empyema is usually confirmed by analyzing a sample of fluid taken from the pleural cavity. The sample is obtained by a procedure called **thoracentesis**. In this procedure, the patient is given a local anesthetic, a needle is inserted into the pleural cavity through the back between the ribs on the infected side, and a sample of fluid is withdrawn. If the patient has empyema, there will be a very high level of one particular kind of immune cell (white blood cells), a high level of protein, and a very low level of blood sugar. The fluid can also be tested for the specific disease organism by staining or tissue cultures. In some cases, the color, smell, or consistency of the tissue fluid also helps to confirm the diagnosis.

Treatment

Empyema is treated using a combination of medications and surgical techniques. Treatment with medication involves intravenously administering a two-week course of **antibiotics**. It is important to give antibiotics as soon as possible to prevent first-stage empyema from progressing to its later stages. The antibiotics most commonly used are penicillin and vancomycin. Patients experiencing difficulty breathing are also given **oxygen therapy**.

Surgical treatment of empyema has two goals: drainage of the infected fluid and closing up of the space left in the pleural cavity. If the infection is still in its early stages, the fluid can be drained by thoracentesis. In second-stage empyema, the surgeon will insert a chest tube in the patient's rib cage or remove part of a rib (rib resection) in order to drain the fluid. In third-stage empyema, the surgeon may cut or peel away the thick fibrous layer coating the lung. This procedure is called decortication. When the fibrous covering is removed, the lung will expand to fill the space in the chest cavity. The doctor can use video-assisted **thoracic surgery** (VATS) techniques to position the chest tube or to perform a limited decortication. The VATS technique allows a physician to see within the body during certain surgical procedures. Empyema of the gallbladder is a serious condition that is treated with intravenous antibiotics and surgical removal of the gallbladder.

Prognosis

The prognosis for recovery is generally good, except in those cases with complications, such as a **brain abscess** or blood poisoning, or cases caused by certain types of streptococci.

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Rebecca J. Frey, PhD

Enalapril *see* **Angiotensin-converting enzyme inhibitors**

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Encephalitis

Definition

Encephalitis is an inflammation of the brain, usually caused by a direct viral infection or a hypersensitivity reaction to a virus or foreign protein. Brain inflammation caused by a bacterial infection is sometimes called cerebritis. When both the brain and spinal cord are involved, the disorder is called encephalomyelitis. An inflammation of the brain's covering, or meninges, is called **meningitis**.

Description

Encephalitis is an inflammation of the brain. The inflammation is a reaction of the body's immune system to infection or invasion. During the inflammation, the brain's tissues become swollen. The combination of the infection and the immune reaction to it can cause **headache** and a **fever**, as well as more severe symptoms in some cases.

Approximately 2,000 cases of encephalitis are reported to the Centers for Disease Control in Atlanta, GA each year. The viruses causing primary encephalitis can be epidemic or sporadic. The **polio** virus is an epidemic cause. Arthropod-borne viral encephalitis is responsible for most epidemic viral encephalitis. The viruses live in animal hosts and mosquitos that transmit the disease. The most common form of non-epidemic or sporadic encephalitis is caused by the herpes simplex virus, type 1 (HSV-1) and has a high rate of **death**. **Mumps** is another example of a sporadic cause.

Causes and symptoms

Causes

There are more than a dozen viruses that can cause encephalitis, spread by either human-to human contact or by animal **bites**. Encephalitis may occur with several common viral infections of childhood. Viruses and viral diseases that may cause encephalitis include:

- chickenpox
- measles
- mumps
- Epstein-Barr virus (EBV)
- cytomegalovirus infection
- HIV
- herpes simplex
- herpes zoster (shingles)
- herpes B
- polio
- rabies
- mosquito-borne viruses (arboviruses)

Primary encephalitis is caused by direct infection by the virus, while secondary encephalitis is due to a post-infectious immune reaction to viral infection elsewhere in the body. Secondary encephalitis may occur with **measles**, **chickenpox**, mumps, **rubella**, and EBV. In secondary encephalitis, symptoms usually begin five to 10 days after the onset of the disease itself and are related to the breakdown of the myelin sheath that covers nerve fibers.

In rare cases, encephalitis may follow **vaccination** against some of the viral diseases listed above. **Creutzfeldt-Jakob disease**, a very rare brain disorder caused by an infectious particle called a prion, may also cause encephalitis.

Mosquitoes spread viruses responsible for equine encephalitis (eastern and western types), St. Louis encephalitis, California encephalitis, and **Japanese encephalitis**. **Lyme disease**, spread by ticks, can cause encephalitis, as can Colorado tick fever. **Rabies** is most often spread by animal bites from dogs, cats, mice, raccoons, squirrels, and bats and may cause encephalitis.

Equine encephalitis is carried by mosquitoes that do not normally bite humans but do bite horses and birds. It is occasionally picked up from these animals by mosquitoes that do bite humans. Japanese encephalitis and St. Louis encephalitis are also carried by mosquitoes. The risk of contracting a mosquito-borne virus is greatest in mid- to late summer, when mosquitoes are most active, in those rural areas where these viruses are known to exist. Eastern equine encephalitis occurs in eastern and southeastern United States; western equine and California encephalitis occur throughout the West; and St. Louis encephalitis occurs throughout the country. Japanese encephalitis does not occur in the United States, but is found throughout much of Asia. The viruses responsible for these diseases are classified as arbovirus and these diseases are collectively called **arbovirus encephalitis**.

Herpes simplex encephalitis, the most common form of sporadic encephalitis in western countries, is a disease with significantly high mortality. It occurs in children and adults and both sides of the brain are affected. It is theorized that brain infection is caused by the virus moving from a peripheral location to the brain via two nerves, the olfactory and the trigeminal (largest nerves in the skull).

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KEY TERMS

Cerebrospinal fluid analysis—A analysis that is important in diagnosing diseases of the central nervous system. The fluid within the spine will indicate the presence of viruses, bacteria, and blood. Infections such as encephalitis will be indicated by an increase of cell count and total protein in the fluid.

Computerized tomography (CT) Scan—A test to examine organs within the body and detect evidence of tumors, blood clots, and accumulation of fluids.

Electroencephalagram (EEG)—A chart of the brain waves picked up by the electrodes placed on the scalp. Changes in brain wave activity can be an indication of nervous system disorders.

Inflammation—A response from the immune system to an injury. The signs are redness, heat, swelling, and pain.

Magnetic resonance imaging (MRI)—MRI is diagnostic radiography using electromagnetic energy to create an image of the central nervous system (CNS), blood system, and musculoskeletal system.

Vaccine—A prepartation containing killed or weakened microorganisms used to build immunity against infection from that microorganism.

Virus—A very small organism that can only live within a cell. They are unable to reproduce outside that cell.

Herpes simplex encephalitis is responsible for 10% of all encephalitis cases and is the main cause of sporadic, fatal encephalitis. In untreated patients, the rate of death is 70% while the mortality is 15–20% in patients who have been treated with acyclovir. The symptoms of herpes simplex encephalitis are fever, rapidly disintegrating mental state, headache, and behavioral changes.

Symptoms

The symptoms of encephalitis range from very mild to very severe and may include:

- headache
- fever
- lethargy (sleepiness, decreased alertness, and fatigue)
- malaise
- nausea and vomiting
- visual disturbances
- tremor
- decreased consciousness (drowsiness, confusion, delirium, and unconsciousness)
- stiff neck
- seizures

Symptoms may progress rapidly, changing from mild to severe within several days or even several hours.

Diagnosis

Diagnosis of encephalitis includes careful questioning to determine possible exposure to viral sources. Tests that can help confirm the diagnosis and rule out other disorders include:

- Blood tests. These are to detect antibodies to viral antigens, and foreign proteins.
- Cerebrospinal fluid analysis (spinal tap). This detects viral antigens, and provides culture specimens for the virus or bacteria that may be present in the cerebrospinal fluid.
- Electroencephalogram (EEG).
- CT and MRI scans.

A **brain biopsy** (surgical gathering of a small tissue sample) may be recommended in some cases where treatment to date has been ineffective and the cause of the encephalitis is unclear. Definite diagnosis by biopsy may allow specific treatment that would otherwise be too risky.

Treatment

Choice of treatment for encephalitis will depend on the cause. Bacterial encephalitis is treated with **antibiotics**. Viral encephalitis is usually treated with **antiviral drugs** including acyclovir, ganciclovir, foscarnet, ribovarin, and AZT. Viruses that respond to acyclovir include herpes simplex, the most common cause of sporadic (non-epidemic) encephalitis in the United States.

The symptoms of encephalitis may be treated with a number of different drugs. **Corticosteroids**, including prednisone and dexamethasone, are sometimes prescribed to reduce inflammation and brain swelling. **Anticonvulsant drugs**, including dilantin and phenytoin, are used to control seizures. Fever may be reduced with **acetaminophen** or other fever-reducing drugs.

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A person with encephalitis must be monitored carefully, since symptoms may change rapidly. Blood tests may be required regularly to track levels of fluids and salts in the blood.

Prognosis

Encephalitis symptoms may last several weeks. Most cases of encephalitis are mild, and recovery is usually quick. Mild encephalitis usually leaves no residual neurological problems. Overall, approximately 10% of those with encephalitis die from their infections or complications such as secondary infection. Some forms of encephalitis have more severe courses, including herpes encephalitis, in which mortality is 15–20% with treatment, and 70–80% without. Antiviral treatment is ineffective for eastern equine encephalitis, and mortality is approximately 30%.

Permanent neurological consequences may follow recovery in some cases. Consequences may include personality changes, **memory loss**, language difficulties, seizures, and partial **paralysis**.

Prevention

Because encephalitis is due to infection, it may be prevented by avoiding the infection. Minimizing contact with others who have any of the viral illnesses listed above may reduce the chances of becoming infected. Most infections are spread by hand-to-hand or hand-to-mouth contact; frequent hand washing may reduce the likelihood of infection if contact cannot be avoided.

Mosquito-borne viruses may be avoided by preventing mosquito bites. Mosquitoes are most active at dawn and dusk, and are most common in moist areas with standing water. Minimizing exposed skin and use of mosquito repellents on other areas can reduce the chances of being bitten.

Vaccines are available against some viruses, including polio, herpes B, Japanese encephalitis, and equine encephalitis. Rabies vaccine is available for animals; it is also given to people after exposure. Japanese encephalitis vaccine is recommended for those traveling to Asia and staying in affected rural areas during transmission season.

ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

Richard Robinson

Encephalocele *see* **Congenital brain defects**

Encopresis

Definition

Encopresis is repeatedly having bowel movements in places other than the toilet after the age when bowel control can normally be expected.

Description

Most children have established bowel control by the time they are four years old. After that age, when they repeatedly have bowel movements in inappropriate places, they may have encopresis. In the United States, encopresis affects 1–2% of children under age 10. About 80% of these are boys.

Encopresis can be either involuntary or voluntary. Involuntary encopresis is related to **constipation**, passing hard painful feces, and difficult bowel movements. Often children with involuntary encopresis stain their underpants with liquid feces. They are usually unaware that this has happened. Voluntary encopresis is much less common and is associated with behavioral or psychological problems. Both types of encopresis occur most often when the child is awake, rather than at night.

Causes and symptoms

Although a few children experience encopresis because of malformations of the lower bowel and anus or irritable bowel disease, most have no physical problems to explain this disorder. Constipation is present in about 80% of children who experience involuntary encopresis. As feces moves through the large intestine, water is removed. The longer the feces stays in the large intestine, the more water is removed, and the harder the feces becomes. The result can be hard or painful bowel movements. In response, children may start to hold back when they feel the urge to eliminate in order to avoid **pain**. This starts a cycle of constipation that results in retentive encopresis.

Once elimination is avoided, the bowel becomes full of hard feces. This stretches the large intestine. Eventually the intestine becomes so stretched that liquid feces backed up behind the blockage is able to leak around the hard feces. Children with this type of encopresis do not feel the urge to have a bowel movement and are often surprised when their pants are stained with foul smelling liquid feces. This leakage of feces is called overflow incontinence. Parents sometimes mistake this soiling for **diarrhea**, because the feces expelled is liquid. Every so often, children with involuntary encopresis may pass large stools, sometimes with volumes big enough to clog the toilet, but the relief this brings is temporary.

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Although about 95% of encopresis is involuntary, some children intentionally withhold bowel movements. The American Psychiatric Association (APA) recognizes voluntary encopresis without constipation as a psychological disorder. This disorder is said to occur when a child who has control over his bowel movements chooses to have them in an inappropriate place. The feces is a normal consistency, not hard. Sometimes it is smeared in an obvious place, but it may also be hidden from adults.

Voluntary encopresis may result from a power struggle between caregivers and the child during toilet training, or the child may have developed an unusual fear of the toilet. It is also associated with **oppositional defiant disorder** (ODD), **conduct disorder**, **sexual abuse**, and high levels of psychological **stress**. For example, children who were separated from their parents during World War II were reported to have a high rate of encopresis. However, parents and caregivers should be aware that very few children soil intentionally and most do not have a behavioral or psychological problem and should not be punished for their soiling accidents.

Diagnosis

Diagnosis is based primarily on the child's history of inappropriate bowel movements. Physical examinations are almost always normal, except for a mass of hard feces blocking the lower intestine. Other physical causes of soiling, such as illness, reaction to medication, **food allergies**, and physical disabilities, may also be ruled out through history and a **physical examination**. In addition, to be diagnosed with encopresis the child must be old enough to establish regular bowel control—usually chronologically and developmentally at least four years of age.

Treatment

The goal of treatment is to establish regular, soft, pain free bowel movements in the toilet. First the physician tries to determine the cause of encopresis, whether physical or psychological. Regardless of the cause, the bowel must be emptied of hard, impacted feces This can be done using an enema, **laxatives**, and/or stool softeners such as mineral oil. **Enemas** and laxatives should be used only at a doctor's recommendation.

Next, the child is given stool softeners to keep feces soft and to give the stretched intestine time to shrink back to its normal size. This shrinking process may take several months, during which time stool softeners may need to be used regularly. Children also need two or three regularly scheduled toilet sits daily in an effort to establish consistent bowel habits. These toilet sits are often more effective if done after meals. Maintaining soft, easy-to-pass stools is also important if the child is afraid of the toilet because of past painful bowel movements. A child psychologist or psychiatrist can suggest treatment for the rare child with serious behavioral problems such as smearing or hiding feces.

KEY TERMS

Feces—Waste products eliminated from the large intestine; excrement.

Incontinence—The inability to control the release of urine or feces.

Laxative—Material that encourages a bowel movement.

Stools—Feces; bowel movements.

Alternative treatment

Many herbal stool softeners and laxatives are available as both tablets and liquids. Psyllium, the seed of several plants of the genus *Plantago* is one of the most effective. Other natural remedies for constipation include castor seed oil (*Ricinus communis*), senna (*Cassia senna* or *Senna alexandrina*), and dong quai *Angelica polymorpha* or *Angelica sinensis*).

Prognosis

For almost all children, once constipation is controlled, the problem of soiling disappears. This make take several months, and relapses may occur, but with effective prevention strategies, encopresis can be eliminated. Children who are in a power struggle over toileting usually outgrow their desire to have bowel movements in inappropriate places. The prognosis for children with serious behavioral and psychological problems that result in smearing or hiding feces depends largely on resolving the underlying problems.

Prevention

The best way to prevent encopresis is to prevent constipation. Methods of preventing constipation include:

- increasing the amount of liquids, especially water, the child drinks
- adding high fiber foods to the diet (e.g. dried beans, fresh fruits and vegetables, whole wheat bread and pasta, popcorn)

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- establishing regular bowel habits
- limiting the child's intake of dairy products (e.g. milk, cheese, yogurt, ice cream) that promote constipation.
- treating constipation promptly with stool softeners, so that it does not become worse.

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ORGANIZATIONS

American Academy of Child and Adolescent Psychiatry (AACAP), 3615 Wisconsin Ave. NW, Washington, DC, 20013-3007, (202) 966-7300, (202) 966-2891, communications@aacap.org, http://www.aacap.org.

Tish Davidson, A.M.

Endarterectomy

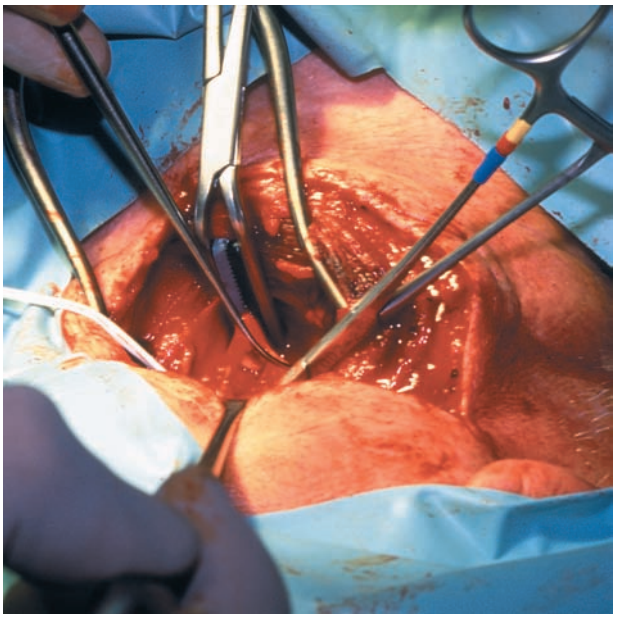
Definition

Endarterectomy is an operation to remove or bypass the fatty deposits, or blockage, in an artery narrowed by the buildup of fatty tissue (**atherosclerosis**).

Purpose

Removing the fatty deposits restores normal blood flow to the part of the body supplied by the artery. An endarterectomy is performed to treat cerebrovascular disease in which there is a serious reduction of blood supply to the brain (carotid endarterectomy), or to treat **peripheral vascular disease** (impaired blood supply to the legs).

Endarterectomy is most often performed on one of the two main arteries in the neck (the carotids) opening the narrowed arteries leading to the brain. When performed by an experienced surgeon, the practice is extremely effective, reducing the risk of **stroke** by up to 70%. Recent studies indicate it is effective in preventing stroke, even among those patients who had no warning signs except narrowed arteries detected by their doctors on a routine exam.



In this procedure, surgeons are removing plaque from the carotid artery. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Precautions

Before the surgery, a full medical exam is usually done to assess any specific health problems, such as diabetes, high blood pressure, heart disease, or stroke. If possible, reversible health problems, such as cigarette **smoking** or being overweight, should be corrected.

Description

Carotid artery disease

Every person has four carotid arteries (the internal and external carotids on each side of the neck) through which blood from the heart moves into the brain. If one of these arteries becomes blocked by fat and cholesterol, the patient may have a range of symptoms, including:

- weakness in one arm, leg, half of the face, or one entire side of the body
- numbness or tingling
- paralysis of an arm, leg, or face
- slurred speech
- dizziness
- confusion, fainting, or coma
- stroke

Removing this fatty buildup, or bypassing a blocked segment, may restore blood flow to the brain, eliminate or decrease the symptoms, and lessen the risk of a stroke.

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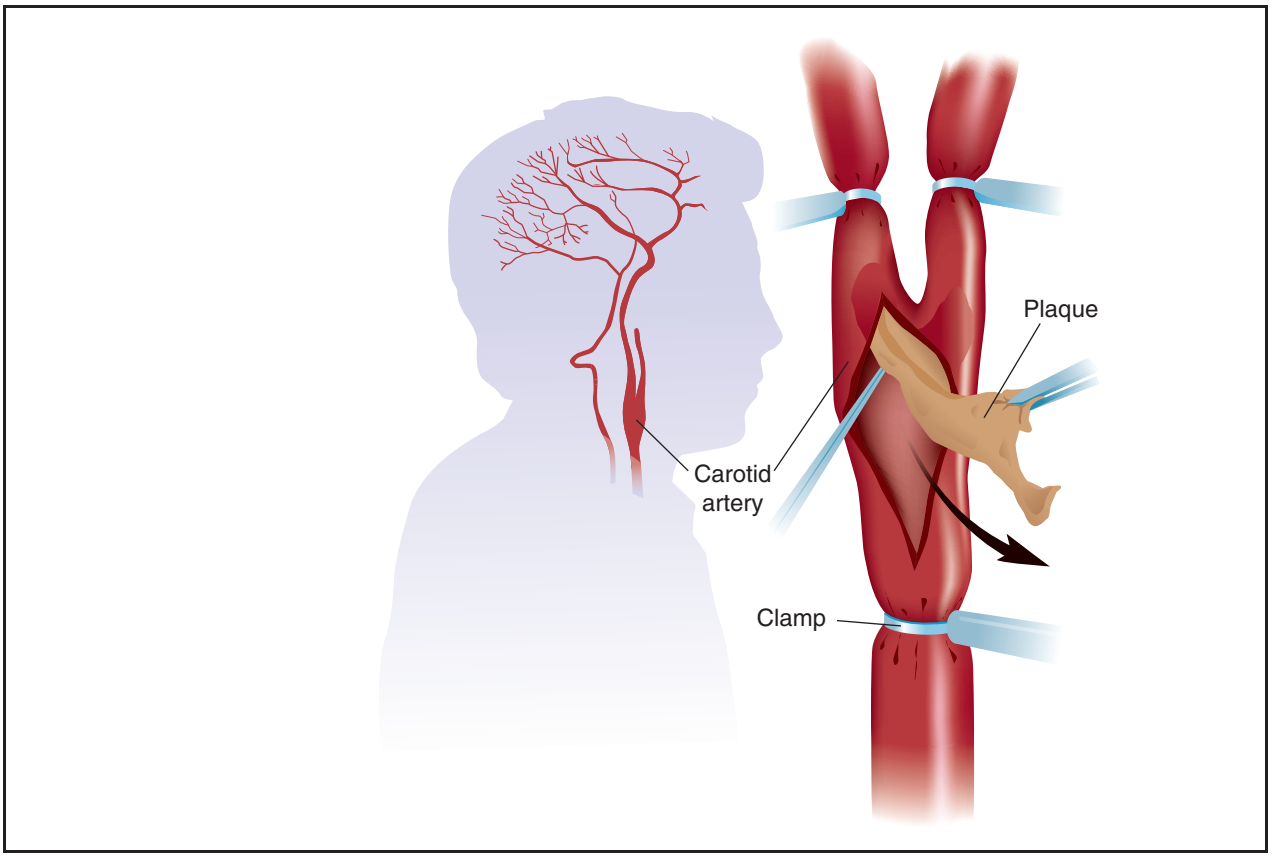

Plaque is removed from the carotid artery by clamping the artery, cutting the plaque out, and closing the opening back up. *(Illustration by Argosy, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

Peripheral vascular disease

When the blood vessels in the legs (and sometimes the arms) become narrowed, this can restrict blood flow and cause **pain** in the affected area. In severe cases, the tissue may die, requiring **amputation**.

The narrowing is usually caused by buildup of fatty plaques in the vessels, often as the result of smoking, high blood pressure, or poorly-controlled **diabetes mellitus**. The vessels usually narrow slowly, but it's possible for a blood clot to form quickly, causing sudden severe pain in the affected leg or arm.

Procedure

Endarterectomy is a delicate operation that may require several hours. The surgeon begins by making an incision over the blocked artery and inserting a tube above and below the blockage to redirect the blood flow while the artery is opened.

Next, the surgeon removes the fat and cholesterol buildup, along with any **blood clots** that have formed, with a blunt dissecting instrument. Then the surgeon bathes the clean wall in salt solution combined with heparin, an anticoagulant. Then the surgeon stitches the artery just enough so that the bypass shunt tube can be removed, and then he/she stitches the artery completely closed. After checking to make sure no blood is leaking, the surgeon next closes the skin incision with stitches.

The operation should improve symptoms, although its long-term effects may be more limited, since arterial narrowing is rarely confined to one area of one artery. If narrowing is a problem throughout the body, arterial **reconstructive surgery** may be required.

The total cost of an endarterectomy, including diagnostic tests, surgery, hospitalization, and follow-up care, will vary according to hospital, doctor, and area of the country where the operation is performed, but a patient can expect to pay in the range of $15,000. Patients who are very young, very old, or very ill, or who need more extensive surgery, may require more expensive treatment.

Preparation

Before surgery, the doctor pinpoints the location of the narrowed artery with an x-ray procedure called

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KEY TERMS

Carotid arteries—The four principal arteries of the neck and head. There are two common carotid arteries, each of which divides into the two main branches (internal and external).

Diabetes mellitus—A disorder in which the pancreas doesn't produce enough (or any) insulin. As a result, the blood levels of sugar become very high. Among other things, diabetes can lead to the breakdown of small blood vessels and a high risk of atherosclerosis and high blood pressure.

Stroke—Damage to the part of the brain caused by an interruption of the blood supply. In some cases, small pieces of plaque in the carotid artery may break loose and block an artery in the brain. A narrowed carotid artery also can be the source of blood clots travelling to the brain, or the artery can become completely clogged, blocking all blood flow to the brain.

angiography. For surgery to be effective, the degree of narrowing should be at least 70%, but it should not be total. Patients undergoing angiography are given a local anesthetic, but the endarterectomy itself requires the use of a **general anesthesia**.

Aftercare

After the surgery, the patient spends the first two days lying flat in bed. Patients who have had carotid endarterectomy should not bend the neck sharply during this time. Because the blood flow to the brain is now greatly increased, patients may experience a brief but severe **headache**, or lightheadedness. There may be a slight loss of sensation in the skin, or maybe a droop in the mouth, if any of the nerves in the neck were lightly bruised during surgery. In time, this should correct itself.

Risks

The amount of risk depends on the hospital, the skill of the surgeon, and the severity of underlying disease. Patients who have just had an acute stroke are at greatest risk. During carotid artery surgery, blood flow is interrupted through the artery, so that **paralysis** and other stroke symptoms may occur. These may resolve after surgery, or may result in permanent stroke. Paralysis is usually one-sided; other stroke symptoms may include loss of half the field of vision, loss of sensation, double vision, speech problems, and personality changes. Risks of endarterectomy to treat either carotid artery or peripheral **vascular disease** include:

- reactions to anesthesia
- bleeding
- infection
- blood clots

Normal results

The results after successful surgery are usually striking. The newly opened artery should help to restore normal blood flow. In carotid endarterectomy, surgery should prevent the risk of brain damage and stroke. However, the buildup of fat and cholesterol usually affects all arteries, not just the one that was operated on. Affected arteries in other parts of the body may be equally clogged and potentially dangerous. Even arteries that were operated electively will likely begin to clog up again after the surgery.

For this reason, lifestyle changes (no smoking, low fat, low cholesterol diet) are important, especially if diet and lifestyle contributed to the development of the problem in the first place.

ORGANIZATIONS

National Institute of Neurological Disorders and Stroke (NINDS), NIH Neurological Institute, P. O. Box 5801, Bethesda, MD, 20824, (301) 496-5751, (800) 352-9424, http://www.ninds.nih.gov/.

Carol A. Turkington

Endemic syphilis *see* **Bejel**

Endocardial resection *see* **Myocardial resection**

Endocarditis

Definition

The endocardium is the inner lining of the heart muscle, which also covers the heart valves. When the endocardium becomes damaged, bacteria from the

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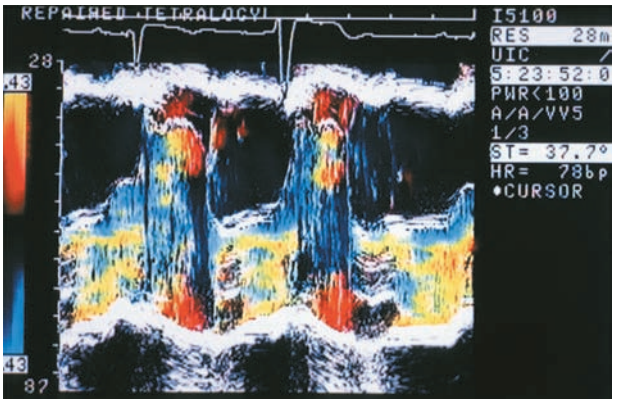
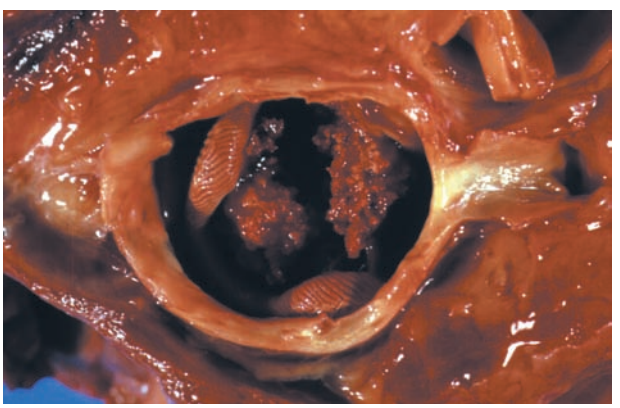


This echocardiogram shows an aortic regurgitation due to endocarditis, an infection of the lining membrane of the cardiac chambers. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

blood stream can become lodged on the heart valves or heart lining. The resulting infection is known as endocarditis.

Description

The endocardium lines all four chambers of the heart–two at the top (the right and left atria) and two at the bottom (the right and left ventricles)–through which blood passes as the heart beats. It also covers the four valves (the tricuspid valve, the pulmonary valve, the mitral valve, and the aortic valve), which normally open and close to allow the blood to flow in only one direction through the heart during each contraction.



A close-up view of an infected artificial heart valve showing bacterial endocarditis (the granulated tissue at center of image). When infection occurs early after surgery, it is likely that organisms have gained entry during the operative period. This type of infection is usually caused by *Staphylococcus epidermidis* and *S. aureus* and is treated with antibiotic drugs. *(Dr. E. Walker/Photo Researchers, Inc.)*

For the heart to pump blood efficiently, the four chambers must contract and relax, and the four valves must open and close, in a well coordinated fashion. By damaging the valves or the walls of the heart chambers, endocarditis can interfere with the ability of the heart to do its job.

Endocarditis rarely occurs in people with healthy, normal hearts. Rather, it most commonly occurs when there is damage to the endocardium. The endocardium may be affected by a congenital heart defect, such as **mitral valve prolapse**, in which blood leaks through a poorly functioning mitral valve back into the heart. It may also be damaged by a prior scarring of the heart muscle, such as **rheumatic fever**, or replacement of a heart valve. Any of these conditions can damage the endocardium and make it more susceptible to infection.

Bacteria can get into the blood stream (a condition known as **bacteremia**) in a number of different ways: It may spread from a localized infection such as a **urinary tract infection**, **pneumonia**, or skin infection or get into the blood stream as a result of certain medical conditions, such as severe **periodontal disease**, **colon cancer**, or inflammatory bowel disease. It can enter the blood stream during minor procedures, such as periodontal surgery, tooth extractions, teeth cleaning, tonsil removal, prostate removal, or endoscopic examination. It can also be introduced through in-dwelling catheters, which are used for intravenous medications, intravenous feeding, or dialysis. In people who use intravenous drugs, the bacteria can enter the blood stream through unsterilized, contaminated needles and syringes. (People who are prone to endocarditis generally need to take prescribed **antibiotics** before certain surgical or dental procedures to help prevent this infection.)

If not discovered and treated, infective endocarditis can permanently damage the heart muscle, especially the valves. For the heart to work properly, all four valves must be functioning well, opening at the right time to let blood flow in the right direction and closing at the right time to keep the blood from flowing in the wrong direction. If the valve is damaged, this may allow blood to flow backward–a condition known as regurgitation. As a result of a poorly functioning valve, the heart muscle has to work harder to pump blood and may become weakened, leading to **heart failure**. Heart failure is a chronic condition in which the heart is unable to pump blood well enough to supply blood adequately to the body.

Another danger associated with endocarditis is that the vegetation formed by bacteria colonizing on

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KEY TERMS

Aortic valve—The valve between the left ventricle of the heart and the aorta.

Bacteremia—An infection caused by bacteria in the blood.

Congestive heart failure—A condition in which the heart muscle cannot pump blood as efficiently as it should.

Echocardiography—A diagnostic test using reflected sound waves to study the structure and motion of the heart muscle.

Embolus—A bit of foreign material, such as gas, a piece of tissue, or tiny clot, that travels in the circulation until it becomes lodged in a blood vessel.

Endocardium—The inner wall of the heart muscle, which also covers the heart valves.

Mitral valve—The valve between the left atrium and the left ventricle of the heart.

Osler's nodes—Small, raised, reddish, tender areas associated with endocarditis, commonly found inside the fingers or toes.

Petechiae—Tiny purple or red spots on the skin associated with endocarditis, resulting from hemorrhages under the skin's surface.

Pulmonary valve—The valve between the right ventricle of the heart and the pulmonary artery.

Transducer—A device that converts electrical signals into ultrasound waves and ultrasound waves back into electrical impulses.

Transesophageal echocardiography—A diagnostic test using an ultrasound device, passed into the esophagus of the patient, to create a clear image of the heart muscle.

Tricuspid valve—The valve between the right atrium and the right ventricle of the heart.

Vegetation—An abnormal growth of tissue around a valve, composed of blood platelets, bacteria, and a protein involved in clotting.

heart valves may break off, forming emboli. These emboli may travel through the circulation and become lodged in blood vessels. By blocking the flow of blood, emboli can starve various tissues of nutrients and oxygen, damaging them. For instance, an embolus lodged in the blood vessels of the lungs may cause pneumonia-like symptoms. An embolus may also affect the brain, damaging nerve tissue, or the kidneys, causing **kidney disease**. Emboli may also weaken the tiny blood vessels called capillaries, causing hemorrhages (leaking blood vessels) throughout the body.

Causes and symptoms

Most cases of infective endocarditis occur in people between the ages of 15 and 60, with a median age at onset of about 50 years. Men are affected about twice as often as women are. Other factors that put people at increased risk for endocarditis are congenital heart problems, heart surgery, previous episodes of endocarditis, and intravenous drug use.

While there is no single specific symptom of endocarditis, a number of symptoms may be present. The most common symptom is a mild **fever**, which rarely goes above 102°F (38.9°C). Other symptoms include chills, weakness, **cough**, trouble breathing, headaches, aching joints, and loss of appetite.

Emboli may also cause a variety of symptoms, depending on their location. Emboli throughout the body may cause Osler's nodes, small, reddish, painful bumps most commonly found on the inside of fingers and toes. Emboli may also cause petechiae, tiny purple or red spots on the skin, resulting from hemorrhages under the skin's surface. Tiny hemorrhages resembling splinters may also appear under the fingernails or toenails. If emboli become lodged in the blood vessels of the lungs, they may cause coughing or **shortness of breath**. Emboli lodged in the brain may cause symptoms of a mini-stroke, such as **numbness**, weakness, or **paralysis** on one side of the body or sudden vision loss or double vision. Emboli may also damage the kidneys, causing blood to appear in the urine. Sometimes the capillaries on the surface of the spleen rupture, causing the spleen to become enlarged and tender to the touch. Anyone experiencing any of these symptoms should seek medical help immediately.

Diagnosis

Doctors begin the diagnosis by taking a history, asking the patient about the symptoms mentioned above. During a **physical examination**, the doctor may also uncover signs such as fever, an enlarged spleen, signs of kidney disease, or hemorrhaging. Listening to the patient's chest with a stethoscope, the

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doctor may also hear a heart murmur. A heart murmur may indicate abnormal flow of blood through one of the heart chambers or valves.

Doctors take a sample of the patient's blood to test it for bacteria and other microorganisms that may be causing the infection. They usually also use a test called **echocardiography**, which uses ultrasound waves to make images of the heart, to check for abnormalities in the structure of the heart wall or valves. One of the tell-tale signs they look for in echocardiography is vegetation, the abnormal growth of tissue around a valve composed of blood platelets, bacteria, and a clotting protein called fibrin. Another tell-tale sign is regurgitation, or the backward flow of blood, through one of the heart valves. A normal echocardiogram does not exclude the possibility of endocarditis, but an abnormal echocardiogram can confirm its presence. If an echocardiogram cannot be done or its results are inconclusive, a modified technique called **transesophageal echocardiography** is sometimes performed. Transesophageal echocardiography involves passing an ultrasound device into the esophagus to get a clearer image of the heart.

Treatment

When doctors suspect infective endocarditis, they will admit the patient to a hospital and begin treating the infection before they even have the results of the **blood culture**. Their choice of antibiotics depends on what the most likely infecting microorganism is. Once the results of the blood culture become available, the doctor can adjust the medications, using specific antibiotics known to be effective against the specific microorganism involved.

Unfortunately, in recent years, the treatment of endocarditis has become more complicated as a result of antibiotic resistance. Over the past few years, especially as antibiotics have been overprescribed, more and more strains of bacteria have become increasingly resistant to a wider range of antibiotics. For this reason, doctors may need to try a few different types of antibiotics–or even a combination of antibiotics–to successfully treat the infection. Antibiotics are usually given for about one month, but may need to be given for an even longer period of time if the infection is resistant to treatment.

Once the fever and the worst of the symptoms have gone away, the patient may be able to continue antibiotic therapy at home. During this time, the patient should make regular visits to the health care team for further testing and physical examination to make sure that the antibiotic therapy is working, that it is not causing adverse side effects, and that there are no complications such as emboli or heart failure. The patient should alert the health-care team to any symptoms that could indicate serious complications: For instance, trouble breathing or swelling in the legs could indicate congestive heart failure. **Headache**, joint **pain**, blood in the urine, or **stroke** symptoms could indicate an embolus, and fever and chills could indicate that the treatment is not working and the infection is worsening. Finally, **diarrhea**, rash, **itching**, or joint pain may suggest a bad reaction to the antibiotics. Anyone experiencing any of these symptoms should alert the health care team immediately.

In some cases, surgery may be needed. These include cases of congestive heart failure, recurring emboli, infection that doesn't respond to treatment, poorly functioning heart valves, and endocarditis involving prosthetic (artificial) valves. The most common surgical treatment involves cutting away (debriding) damaged tissue and replacing the damaged valve.

Prognosis

If left untreated, infective endocarditis continues to progress and is always fatal. However, if it is diagnosed and properly treated within the first six weeks of infection, the infection can be completely cured in about 90% of the cases. The prognosis depends on a number of factors, such as the patient's age and overall physical condition, the severity of the diseases involved, the exact site of the infection, how vulnerable the microorganisms are to antibiotics, and what kind of complications the endocarditis may be causing.

Prevention

Some people are especially prone to endocarditis. These include people with past episodes of endocarditis, those with congenital heart problems or heart damage from rheumatic fever, and those with artificial heart valves. Intravenous drug users are also at increased risk. Anyone who falls into a high-risk category should alert his or her health-care professionals before undergoing any surgical or dental procedures. High-risk patients must be treated in advance with antibiotics before these procedures to minimize the risk of infection.

Resources

BOOKS

Brusch, John L. *Endocarditis Essentials 2011*. Sudbury, MA: Jones & Bartlett Learning, 2011.

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ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

Robert Scott Dinsmoor

Endocrine pancreatic cancer *see* **Pancreatic cancer, endocrine**

Endometrial biopsy

Definition

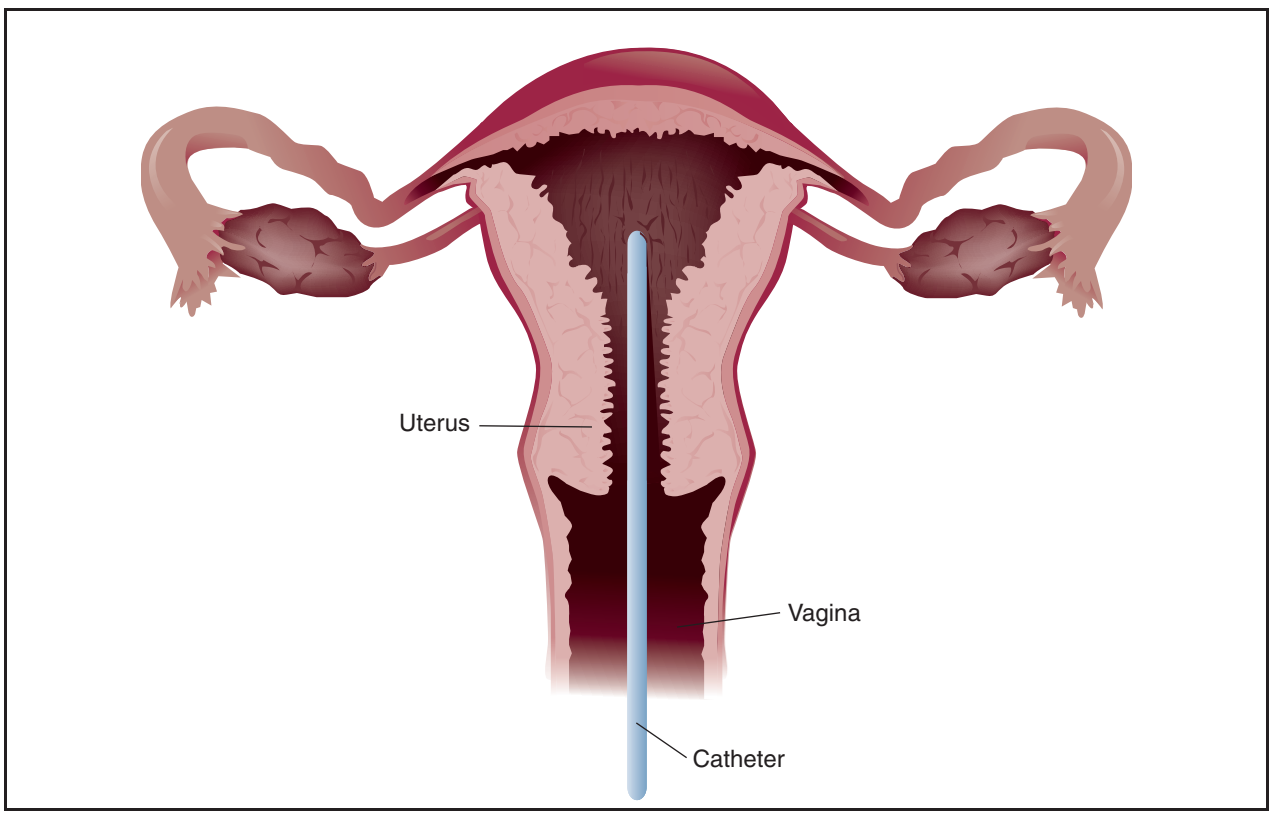
Endometrial biopsy is a procedure in which a sample of the endometrium (tissue lining the inside of the uterus) is removed for microscopic examination.

Purpose

The test is most often performed to find out the cause of abnormal uterine bleeding. Abnormal bleeding includes bleeding between menstrual periods, excessive bleeding during a menstrual period, or bleeding after **menopause**. Since abnormal uterine bleeding can indicate **cancer**, an endometrial biopsy is done to rule out **endometrial cancer** or hyperplasia (a potentially precancerous condition).

Endometrial biopsies are also done as a screening test for endometrial cancer in postmenopausal women on **hormone replacement therapy**. Hormone replacement therapy usually requires a woman to take estrogen and progesterone. An endometrial biopsy is particularly useful in cases where postmenopausal women take estrogen, but cannot take progesterone. Estrogen in the system without the balancing effect of progesterone has been linked to an increased risk of endometrial cancer.

An endometrial biopsy can be used as part of an **infertility** exam to rule out problems with the



A catheter is inserted into the uterus to remove uterine cells for further examination. *(Illustration by Argosy, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

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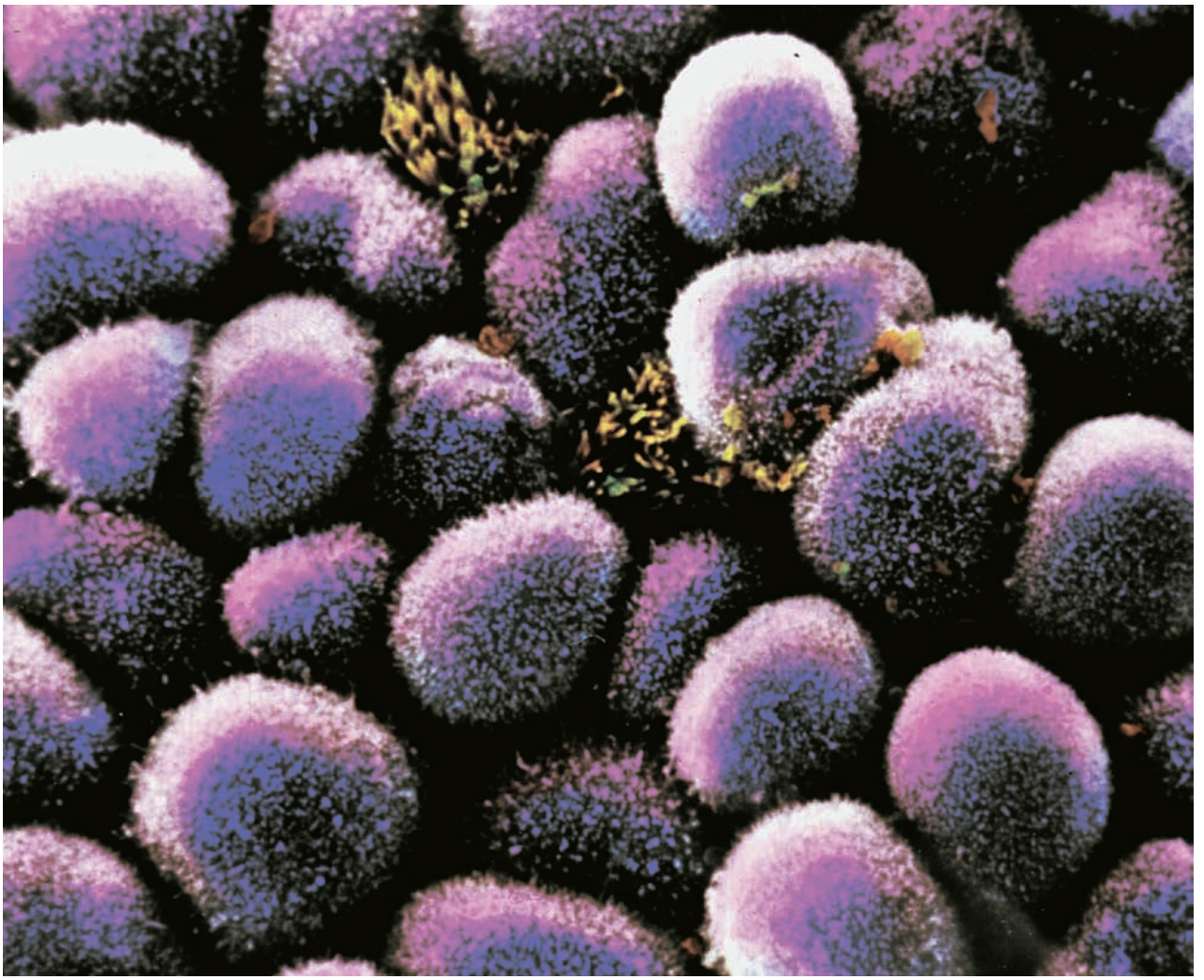

A micrograph image of the internal human uterine wall depicting the mucosa, or endometrium. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

development of the endometrium. This condition is called luteal phase defect and can cause the endometrium to not support a **pregnancy**. An endometrial biopsy can also be used to evaluate the problem of repeated early miscarriages.

Description

The test is performed by a doctor who specializes in women's reproductive health (an obstetrician/gynecologist). The test is performed either in the doctor's office or in a local hospital. The patient may be asked to take **pain** medication (like ibuprofen) an hour or so before the procedure. A local anesthetic may be injected into the cervix in order to decrease pain and discomfort during the procedure.

The woman is asked to lie on her back with knees apart and feet in stirrups. The doctor first conducts a thorough exam of the pelvic region, including the vulva (the external genitals), vagina, and uterus. A speculum (an instrument that is used to hold the walls of the vagina open) is inserted into the vagina and then a small, hollow plastic tube is passed into the uterine cavity. A small piece of the uterine lining is evacuated with a plunger attached to the tube. Once the sample is obtained, the instruments are removed. The sample is sent to the laboratory for microscopic examination.

The patient may experience some pain when the cervix is grasped. The patient may also feel some cramping, pressure, and discomfort when the instruments are inserted into the uterus and the tissue sample is collected.

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KEY TERMS

Biopsy—Surgical removal and microscopic examination of living tissue for diagnostic purposes.

Cervix—The opening of the uterus extending into the vagina.

Endometrium—The layer lining the inner cavity of the uterus; this layer changes daily throughout the menstrual cycle.

Uterus—The hollow, muscular female organ that supports the development and nourishment of the unborn baby during pregnancy.

Preparation

For the small number of endometrial biopsies that are done as part of infertility testing, a pregnancy test is often performed before the procedure. Since the biopsy is performed late in the menstrual cycle, it is possible that the woman may be pregnant.

Aftercare

The biopsy may cause a small amount of bleeding (spotting). The woman can resume normal activities right away. If cramping becomes severe, heavy bleeding occurs, or the woman develops a high temperature, the doctor should be notified immediately.

If the test is being done to determine the cause of infertility, the onset of the menstrual period following the biopsy should be reported to the doctor. This will allow the doctor to correctly predict if the endometrium has been developing at the expected rate.

Risks

The risks of an endometrial biopsy are very small. There is a possibility that prolonged bleeding may occur after the procedure. There is also a slight chance of infection. Very rarely, there are instances when the uterus is pierced (perforated) or the cervix is torn because of the biopsy.

Results

Most biopsies are done to rule out endometrial cancer or endometrial hyperplasia. A normal result shows no cancerous or precancerous cells. Normal results also show that the uterine lining is changing at the proper rate. If it is, then the results of the biopsy are said to be "in-phase" because the tissue looks appropriate and has developed normally for the late phase of the menstrual cycle.

If the endometrium is not developing at the appropriate rate, the results are said to be "out-of-phase" or abnormal. The endometrium has not developed appropriately and cannot support a pregnancy. This condition is called luteal phase defect and may need to be treated with progesterone.

Abnormal appearance of the cells forming the uterine tissue could indicate uterine cancer, or the presence of fibroids or polyps in the uterus.

Resources

BOOKS

Katz, V.L. "Diagnostic Procedures: Imaging, Endometrial Sampling, Endoscopy: Indications and Contraindications." In Katz, V.L., Lentz, G.M., Lobo, R.A., Gershenson, D.M. Eds. *Comprehensive Gynecology*. 5th ed. Philadelphia: Mosby, 2007.

OTHER

"Endometrial Biopsy." *MedlinePlus*. September 2, 2009. http://www.nlm.nih.gov/medlineplus/ency/article/003917.htm (accessed October 3, 2010).

ORGANIZATIONS

American Cancer Society, (800) 227-2345, http://www.cancer.org.

Cancer Research Institute, One Exchange Plaza, 55 Broadway, Suite 1802, New York, NY, 10006, (800) 992-2623, http://www.cancerresearch.org.

Gynecologic Cancer Foundation, 230 W. Monroe, Suite 2528, Chicago, IL, 60606, (800) 444-4441, http://www.thegcf.org.

National Cancer Institute, Building 31, Room 10A31, 31 Center Drive, MSC 2580, Bethesda, MD, 20892-2580, (800) 422-6237, http://www.cancer.gov.

Lata Cherath, PhD
Melinda Granger Oberleitner
RN, DNS, APRN, CNS

Endometrial cancer

Definition

Endometrial **cancer** develops when the cells that make up the inner lining of the uterus (the endometrium) become abnormal and grow uncontrollably.

Description

Endometrial cancer (also called uterine cancer) is the fourth most common type of cancer among

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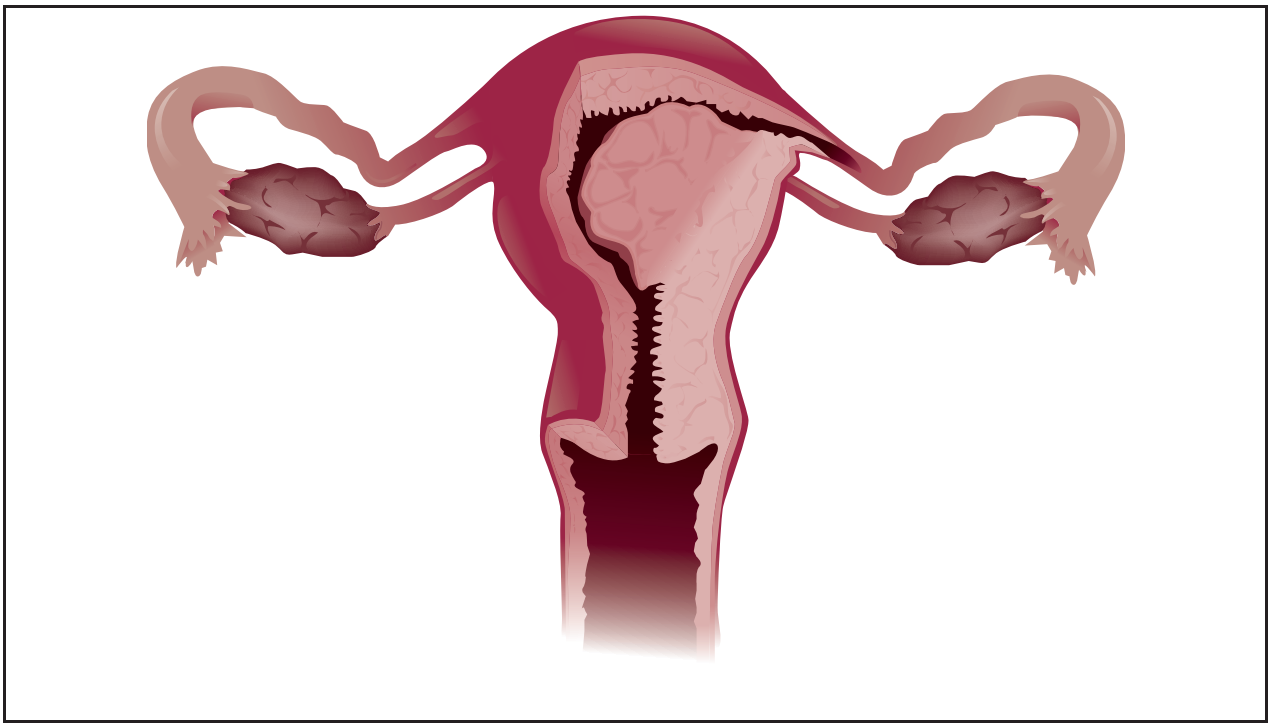

Cancer located in the uterus. *(Illustration by Argosy, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

women and the most common gynecologic cancer. Approximately 34,000 women are diagnosed with endometrial cancer each year. In 2010, approximately 7,950 women died from this cancer. Although endometrial cancer generally occurs in women who have gone through **menopause** and are 45 years of age or older, 30% of the women with endometrial cancer are younger than 40 years of age. The average age at diagnosis is 60 years old.

The uterus, or womb, is the hollow female organ that supports the development of the unborn baby during **pregnancy**. The uterus has a thick muscular wall and an inner lining called the endometrium. The endometrium is very sensitive to hormones and it changes daily during the menstrual cycle. The endometrium is designed to provide an ideal environment for the fertilized egg to implant and begin to grow. If pregnancy does not occur, the endometrium is shed causing the menstrual period.

More than 95% of uterine cancers arise in the endometrium. The most common type of uterine cancer is adenocarcinoma. It arises from an abnormal multiplication of endometrial cells (atypical adenomatous hyperplasia) and is made up of mature, specialized cells (well-differentiated). Less commonly, endometrial cancer arises without a preceding hyperplasia and is made up of poorly differentiated cells. The more common of these types are the papillary serous and clear cell carcinomas. Poorly differentiated endometrial cancers are often associated with a less promising prognosis.

The highest incidence of endometrial cancer in the United States is in Caucasians, Hawaiians, Japanese, and African Americans. American Indians, Koreans, and Vietnamese have the lowest incidence. African American and Hawaiian women are more likely to be diagnosed with advanced cancer and, therefore, have a higher risk of dying from the disease.

Causes and symptoms

Although the exact cause of endometrial cancer is unknown, it is clear that high levels of estrogen, when not balanced by progesterone, can lead to abnormal growth of the endometrium. Factors that increase a woman's risk of developing endometrial cancer are:

- Age. The risk is considerably higher in women who are over the age of 50 and have gone through menopause.
- Obesity. Being overweight is a very strong risk factor for this cancer. Fatty tissue can change other normal

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body chemicals into estrogen, which can promote endometrial cancer.

- Estrogen replacement therapy. Women receiving estrogen supplements after menopause have a 12 times higher risk of getting endometrial cancer if progesterone is not taken simultaneously.
- Diabetes. Diabetics have twice the risk of getting this cancer as nondiabetic women. It is not clear if this risk is due to the fact that many diabetics are also obese and hypertensive. One 1998 study found that women who were obese and diabetic were three times more likely to develop endometrial cancer than women who were obese but nondiabetic. This study also found that nonobese diabetics were not at risk of developing endometrial cancer.
- Hypertension. High blood pressure (or hypertension) is also considered a risk factor for uterine cancer.
- Irregular menstrual periods. During the menstrual cycle, there is interaction between the hormones estrogen and progesterone. Women who do not ovulate regularly are exposed to high estrogen levels for longer periods of time. If a woman does not ovulate regularly, this delicate balance is upset and may increase her chances of getting uterine cancer.
- Early first menstruation or late menopause. Having the first period at a young age (the mean age of menses is 12.16 years in African American girls and 12.88 years in caucasian girls) or going through menopause at a late age (over age 51) seem to put women at a slightly higher risk for developing endometrial cancer.
- Tamoxifen. This drug, which is used to treat or prevent breast cancer, increases a woman's chance of developing endometrial cancer. Tamoxifen users tend to have more advanced endometrial cancer with an associated poorer survival rate than those who do not take the drug. In many cases, however, the value of tamoxifen for treating breast cancer and for preventing the cancer from spreading far outweighs the small risk of getting endometrial cancer.
- Family history. Some studies suggest that endometrial cancer runs in certain families. Women with inherited mutations in the BRCA1 and BRCA2 genes are at a higher risk of developing breast, ovarian, and other gynecologic cancers. Those with the hereditary nonpolyposis colorectal cancer gene have a higher risk of developing endometrial cancer.
- Breast, ovarian, or colon cancer. Women who have a history of these other types of cancer are at an increased risk of developing endometrial cancer.
- Low parity or nulliparity. Endometrial cancer is more common in women who have born few (low parity) or no (nulliparity) children. The high levels of progesterone produced during pregnancy has a protective effect against endometrial cancer. The results of one study suggest that nulliparity is associated with a lower survival rate.
- Infertility. Risk is increased due to nulliparity or the use of fertility drugs.
- Polycystic ovary syndrome. The increased level of estrogen associated with this abnormality raises the risk of cancers of the breast and endometrium.

The most common symptom of endometrial cancer is unusual vaginal spotting, bleeding, or discharge. In women who are near menopause (perimenopausal), symptoms of endometrial cancer could include bleeding between periods (intermenstrual bleeding), heavy bleeding that lasts for more than seven days, or short menstrual cycles (fewer than 21 days). For women who have gone through menopause, any vaginal bleeding or abnormal discharge is suspect. **Pain** in the pelvic region and the presence of a lump (mass) are symptoms that occur late in the disease.

Diagnosis

If endometrial cancer is suspected, a series of tests will be conducted to confirm the diagnosis. The first step will involve taking a complete personal and family medical history. A **physical examination**, which will include a thorough pelvic examination, will also be done.

The doctor may order an **endometrial biopsy**. This is generally performed in the doctor's office and does not require anesthesia. A thin, flexible tube is inserted through the cervix and into the uterus. A small piece of endometrial tissue is removed. The patient may experience some discomfort, which can be minimized by taking an anti-inflammatory medication (like Advil or Motrin) an hour before the procedure.

If an adequate amount of tissue was not obtained by the endometrial biopsy, or if the biopsy tissue looks abnormal but confirmation is needed, the doctor may perform a **dilatation and curettage** (D & C). This procedure is done in the outpatient surgery department of a hospital and takes about an hour. The patient may be given **general anesthesia**. The doctor dilates the cervix and uses a special instrument to scrape tissue from inside the uterus.

The tissue that is obtained from the biopsy or the D & C is sent to a laboratory for examination. If cancer is found, then the type of cancer will be

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determined. The treatment and prognosis depends on the type and stage of the cancer.

Trans-vaginal ultrasound may be used to measure the thickness of the endometrium. For this painless procedure, a wand-like ultrasound transducer is inserted into the vagina to enable visualization and measurement of the uterus, the thickness of the uterine lining, and other pelvic organs.

Other possible diagnostic procedures include sonohysterography and **hysteroscopy**. For sonohysteroscopy, a small tube is passed through the cervix and into the uterus. A small amount of a salt water (saline) solution is injected through the tube to open the space within the uterus and allow ultrasound visualization of the endometrium. For hysteroscopy, a wand-like camera is passed through the cervix to allow direct visualization of the endometrium. Both of these procedures cause discomfort, which may be reduced by taking an anti-inflammatory medication prior to the procedure.

Treatment

Clinical staging

The International Federation of Gynecology and Obstetrics (FIGO) has adopted a staging system for endometrial cancer. The stage of cancer is determined after surgery. Endometrial cancer is categorized into four stages (I, II, III, and IV) that are subdivided (A, B, and possibly C) based on the depth or spread of cancerous tissue. Seventy percent of all uterine cancers are stage I, 10–15% are stage II, and the remainder are stages III and IV. The cancer is also graded (G1, G2, and G3) based upon microscopic analysis of the aggressiveness of the cancer cells.

The FIGO stages for endometrial cancer are:

- Stage I. Cancer is limited to the uterus.
- Stage II. Cancer involves the uterus and cervix.
- Stage III. Cancer has spread out of the uterus but is restricted to the pelvic region.
- Stage IV. Cancer has spread to the bladder, bowel, or other distant locations.

The mainstay of treatment for most stages of endometrial cancer is surgery. **Radiation therapy**, hormonal therapy, and **chemotherapy** are additional treatments (called adjuvant therapy). The necessity of adjuvant therapy is a controversial topic which should be discussed with the patient's treatment team.

Surgery

Most women with endometrial cancer, except those with stage IV disease, are treated with a **hysterectomy**. A simple hysterectomy involves the removal of the uterus. In a bilateral **salpingo-oophorectomy** with total hysterectomy, the ovaries, fallopian tubes, and uterus are removed. This may be necessary because endometrial cancer often spreads to the ovaries first. The lymph nodes in the pelvic region may also be biopsied or removed to check for metastasis. Hysterectomy is traditionally performed through an incision in the abdomen (laparotomy), however, endoscopic surgery (**laparoscopy**) with vaginal hysterectomy is also being used. Women with stage I disease may require no further treatment. However, those with higher grade disease will receive adjuvant therapy.

Radiation therapy

The decision to use radiation therapy depends on the stage of the disease. Radiation therapy may be used before surgery (preoperatively) and/or after surgery (postoperatively). Radiation given from a machine that is outside the body is called external radiation therapy. Sometimes applicators containing radioactive compounds are placed inside the vagina or uterus. This is called internal radiation therapy or brachytherapy and requires hospitalization.

Side effects are common with radiation therapy. The skin in the treated area may become red and dry. **Fatigue**, upset stomach, **diarrhea**, and **nausea** are also common complaints. Radiation therapy in the pelvic area may cause the vagina to become narrow (vaginal stenosis), making intercourse painful. **Premature menopause** and some problems with urination may also occur.

Chemotherapy

Chemotherapy is usually reserved for women with stage IV or recurrent disease because this therapy is not a very effective treatment for endometrial cancer. The **anticancer drugs** are given by mouth or intravenously. Side effects include stomach upset, **vomiting**, appetite loss, hair loss, mouth or vaginal sores, fatigue, menstrual cycle changes, and premature menopause. There is also an increased chance of infections.

Hormonal therapy

Hormonal therapy uses drugs like progesterone to slow the growth of endometrial cells. These drugs are usually available as pills. This therapy is usually reserved for women with advanced or recurrent

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KEY TERMS

Adjuvant therapy—A treatment done when there is no evidence of residual cancer in order to aid the primary treatment. Adjuvant treatments for endometrial cancer are radiation therapy, chemotherapy, and hormone therapy.

Atypical adenomatous hyperplasia—The overgrowth of the endometrium. This precancerous condition is estimated to progress to cancer in one third of the cases.

Dilatation and curettage (D & C)—A procedure in which the doctor opens the cervix and uses a special instrument to scrape tissue from the inside of the uterus.

Endometrial biopsy—A procedure in which a sample of the endometrium is removed and examined under a microscope.

Endometrium—The mucosal layer lining the inner cavity of the uterus. The endometrium's structure changes with age and with the menstrual cycle.

Estrogen—A female hormone responsible for stimulating the development and maintenance of female secondary sexual characteristics.

Estrogen replacement therapy (ERT)—A treatment in which estrogen is used therapeutically during menopause to alleviate certain symptoms such as hot flashes. ERT has also been shown to reduce the risk of osteoporosis and heart disease in women.

Progesterone—A female hormone that acts on the inner lining of the uterus and prepares it for implantation of the fertilized egg.

Progestins—A female hormone, like progesterone, that acts on the inner lining of the uterus.

disease. Side effects include fatigue, fluid retention, and appetite and weight changes.

Alternative treatment

Although alternative and complementary therapies are used by many cancer patients, very few controlled studies on the effectiveness of such therapies exist. Mind-body techniques, such as prayer, **biofeedback**, visualization, **meditation**, and **yoga**, have not shown any effect in reducing cancer, but they can reduce **stress** and lessen some of the side effects of cancer treatments. Clinical studies of hydrazine sulfate found that it had no effect on cancer and even worsened the health and well-being of the study subjects. One clinical study of the drug amygdalin (Laetrile) found that it had no effect on cancer. Laetrile can be toxic and has caused deaths. Shark cartilage, although highly touted as an effective cancer treatment, is an improbable therapy that has not been the subject of clinical study.

The American Cancer Society has found that the "metabolic diets" pose serious risk to the patient. The effectiveness of the macrobiotic, Gerson, and Kelley **diets** and the Manner metabolic therapy has not been scientifically proven. The FDA was unable to substantiate the anticancer claims made about the popular Cancell treatment.

There is no evidence for the effectiveness of most over-the-counter herbal cancer remedies. Some herbals have shown an anticancer effect. As shown in clinical studies, Polysaccharide krestin, from the mushroom *Coriolus versicolor*, has significant effectiveness against cancer. In a small study, the green alga *Chlorella pyrenoidosa* has been shown to have anticancer activity. In a few small studies, evening primrose oil has shown some benefit in the treatment of cancer.

Prognosis

Because it is possible to detect endometrial cancer early, the chances of curing it are excellent. The five year survival rates for endometrial cancer by stage are: 90%, stage I; 60%, stage II; 40%, stage III; and 5%, stage IV. Endometrial cancer most often spreads to the lungs, liver, bones, brain, vagina, and certain lymph nodes.

Prevention

Women (especially postmenopausal women) should report any abnormal vaginal bleeding or discharge to the doctor. Controlling **obesity**, blood pressure, and diabetes can help to reduce the risk of this disease. Women on estrogen replacement therapy have a substantially reduced risk of endometrial cancer if progestins are taken simultaneously. Long term use of birth control pills has been shown to reduce the risk of this cancer. Women who have irregular periods may be prescribed birth control pills to help prevent endometrial cancer. Women who are taking tamoxifen and those who carry the hereditary nonpolyposis colorectal cancer gene should be screened regularly, receiving annual pelvic examinations.

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ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (800) 227-2345, http://www.cancer.org.

Cancer Research Institute (National Headquarters), One Exchange Plaza, 55 Broadway, Suite 1802, New York, NY, (212) 688-7515, (212) 832-9376, (800) 992-2623, http://www.cancerresearch.org/.

Gynecologic Cancer Foundation, 230 W. Monroe, Suite 2528, Chicago, IL, 60606, (312) 578-1439, (312) 578-9769, info@thegcf.org, http://www.wcn.org/.

National Cancer Institute (National Institutes of Health), NCI Office of Communications and Education, 6116 Executive Blvd. Suite 300, Bethesda, MD, 20892-8322, (800) 4-CANCER (422-6237), cancergovstaff@mail.nih.gov, http://www.cancer.gov/.

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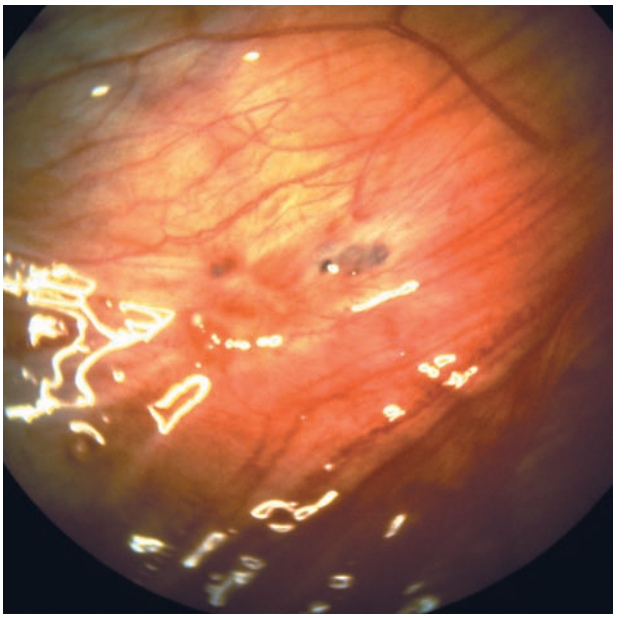
Endometriosis

Definition

Endometriosis is a condition in which bits of the tissue similar to the tissue lining the uterus (endometrium) grow in other parts of the body

Demographics

It is difficult to determine the exact number of women who have endometriosis because some never show symptoms, but estimates suggest that 6–8% of women of childbearing age in the United States have the condition. It most commonly is diagnosed in women between the ages of 25 and 40. Endometriosis can appear in the teenage girls, but rarely before the start of menstruation. It is seldom seen in postmenopausal women and occurs independent of race or ethnicity. The prevalence of endometriosis in the United States has remained stable since the early 1980s.



An endoscopic view of endometriosis on pelvic wall.
(Custom Medical Stock Photo, Inc. Reproduced by permission.)

Description

Endometrial tissue like that lining the uterus sometimes develops in other parts of the body. These patches of misplaced endometrial tissue are called implants. Like the endometrial lining the uterus, this tissue builds up and sheds in response to monthly hormonal cycles (menstruation). However, there is no natural outlet for the material from these implants. Instead, it moves onto surrounding tissues, causing swelling, inflammation, and often **pain**. Repeated irritation leads to the development of scar tissue and **adhesions** in the area of the endometrial implants. Depending on their location, these **scars** may interfere with a woman's ability to conceive a child.

Endometrial implants are found most often on the pelvic organs—the ovaries, Fallopian tubes, and in the cavity behind the uterus. They can also be found on organs in the abdominal cavity such as the bladder and large intestine (colon). Occasionally, this tissue grows in distant parts of the body such as the lungs, arms, and kidneys.

Endometriosis is a progressive condition that usually advances slowly, over the course of many years. Doctors rank cases from minimal to severe based on

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factors such as the number and size of the endometrial implants, their appearance and location, and the extent of the scar tissue and adhesions in the vicinity of the growths.

Risk factors

If a first-degree female relative (mother, sister) has endometriosis, a woman has a higher risk of also developing the disorder. Another possible risk factor is the length of a woman's menstrual cycle. Women whose periods last longer than a week with an interval of less than 27 days between them seem to be more prone to the condition. This corresponds with studies that show that women with the most stable hormone levels are less likely to develop endometriosis. In addition, some studies have found that women who are tall and thin with a lower than average body mass index (BMI) are more likely to develop endometriosis, although there is no understanding of why this occurs.

Causes and symptoms

Endometriosis was once called the "career woman's disease" because it was thought to be a product of delayed childbearing. The statistics defy such a narrow generalization; however, the hormonal changes that accompany **pregnancy** may slow the progress of the condition.

Although the exact cause of endometriosis is unknown, several theories have been put forward to explain the origins of the disorder. These include:

- Retrograde (reverse) menstruation theory. Originally proposed in the 1920s, this theory states that a partial reversal in the direction of menstrual flow (a common event) sends discarded endometrial cells into the Fallopian tubes and then into the body cavity where they attach to internal organs and seed endometrial implants. There is considerable evidence to support this explanation. Reversed menstrual flow occurs in 70–90% of women and is thought to be more common in women with endometriosis. However, this does not explain why many women with retrograde menstrual flow do not develop endometriosis.
- Vascular-lymphatic theory. This theory suggests that the lymph system or blood vessels (vascular system) is the vehicle for the distribution of endometrial cells out of the uterus.
- Coelomic metaplasia theory. The endometrium and the peritoneal mesothelium arise from the same embryonic cells called coelomic wall epithelium. According to this hypothesis, some cells in the peritoneal mesothelium retain their embryonic ability to transform into endometrium, either spontaneously or after chronic irritation caused by exposure to retrograde menstrual flow.
- Iatrogenic theory. Iatrogenic disorders are those caused by the action of a physician. This theory suggests that surgery or procedures in the region of the woman's reproductive organs either deposits endometrial cells in inappropriate places where they grow or in some stimulates other cells to develop into endometrium.

In addition to these theories, the following factors are thought to influence the development of endometriosis:

- Heredity. A woman's chance of developing endometriosis is seven times greater if her mother or sisters have the disease.
- Immune system function. Women with endometriosis may have lower functioning immune systems that have trouble eliminating stray endometrial cells. This would explain why a high percentage of women experience reversed menstrual flow while relatively few develop endometriosis.
- Dioxin exposure. Some research suggests a link between the exposure to dioxin (TCCD), a toxic chemical found in weed killers, and the development of endometriosis.

While many women with endometriosis suffer debilitating chronic or acute pain symptom, others have none and are unaware they have the disorder. There does not, however, seem to be any relation between the severity of the symptoms and the extent of the disorder.

The most common symptoms of endometriosis are:

- Menstrual pain (dysmenorrhea). Pain in the lower abdomen that begins a day or two before the menstrual period starts and continues through to the end is typical of endometriosis. Some women also report lower back aches and pain during urination and bowel movement, especially during their periods.
- Painful sexual intercourse. Pressure on the vagina and cervix causes severe pain for some women.
- Abnormal bleeding. Heavy menstrual periods, irregular bleeding, and spotting are common features of endometriosis.
- Infertility. There is a strong association between endometriosis and infertility, although the reasons for this have not been fully explained. It is thought that the build up of scar tissue and adhesions blocks the Fallopian tubes and prevents the ovaries from

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KEY TERMS

Adhesions—Web-like scar tissue that may develop as a result of surgery or a disease such as endometriosis and bind organs to one another.

Endometrial implants—Growths of endometrial tissue that attach to organs, primarily in the pelvic cavity.

Endometrium—The tissue lining the uterus that grows and sheds each month during a woman's menstrual cycle.

Estrogen—Any of several steroid hormones, produced mainly in the ovaries, that stimulate the development of the endometrium and the development of female secondary sexual characteristics.

Hormonal therapy—Use of hormone medications to inhibit menstruation and relieve the symptoms of endometriosis.

Iatrogenic—Resulting from the activity of the physician.

Laparoscopy—A diagnostic procedure, which when performed for endometriosis performed by inserting a slender, wand-like instrument through a small incision in the woman's abdomen.

Menopause—The end of a woman's menstrual periods when a woman no longer can conceive a child.

Retrograde menstruation—Menstrual flow that travels into the body cavity rather than being expelled through the uterus.

releasing eggs. Endometriosis may also affect fertility by causing hormonal irregularities and a higher rate of early miscarriage.

Diagnosis

If a doctor suspects endometriosis, the first step will be to perform a **pelvic exam** to try to feel if implants are present. Very often there is no strong evidence of endometriosis from a physical exam.

Tests

The only way to make a definitive diagnosis is through minor surgery called a **laparoscopy**. A laparoscope, a slender scope with a light on the end, is inserted into the woman's abdomen through a small incision near her belly button. This allows the doctor to examine the internal organs for endometriotic growths. Often, a sample of tissue (biopsy) is taken for later examination in the laboratory. Endometriosis is sometimes unintentionally discovered when a woman has abdominal surgery for another reason such as **tubal ligation** or **hysterectomy**.

Various imaging techniques such as transvaginal ultrasonography or endorectal ultrasonography, computed tomography scan (CT scan), **magnetic resonance imaging** (MRI) can offer some additional information but are not useful in making the initial diagnosis. They may be done, however, to rule out other conditions with similar symptoms. Various other tests such as a pregnancy test, may also be done to rule out other conditions. A test for the blood protein CA125 is not useful in making the initial diagnosis, but testing for this substance before and after treatment can predict a recurrence of the disease.

Treatment

How endometriosis is treated depends on the woman's symptoms, her age, the extent of the disease, and her personal preferences. The condition cannot be fully eradicated without surgery. Conservative treatment focuses on managing the pain, preserving fertility, and delaying the progress of the condition.

Drugs

Over-the-counter pain relievers such as **aspirin** and **acetaminophen** (Tylenol) are useful for mild cramping and menstrual pain.)ver-the-counter or prescription-strength **nonsteroidal anti-inflammatory drugs** (NSAIDs), such as ibuprofen (Motrin, Advil) and naproxen (Aleve, Naprosyn), may be effective. If pain is severe, a doctor may prescribe narcotic pain medications, although these can be addicting and are rarely used.

Hormonal therapies may effectively treat symptoms of endometriosis, but they also act as contraceptives. Before beginning hormone treatment, a woman should discuss her reproductive plans with her physician.

The following hormonal treatments may be used to treat endometriosis:

- Oral contraceptives. Continuously taking estrogen-progestin pills tricks the body into thinking it is pregnant. This state of pseudo pregnancy may result

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in pelvic pain and a temporary withering of endometrial implants.

- Danazol (Danocrine) and gestrinone are synthetic male hormones that lower estrogen levels, prevent menstruation, and shrink endometrial tissues. Negative side effects include weight gain and menopause-like symptoms and cause some women to develop masculine characteristics.
- Progestins. Medroxyprogesterone (Depo-Provera) and related drugs also may be used in treating endometriosis. They have been proven effective in minimizing pain and halting the progress of the condition but are rarely used because of the high rate of side effects.
- Gonadotropin-releasing hormone (GnHR) agonists. These estrogen-inhibiting drugs successfully limit pain and prevent the growth of endometrial implants. They can cause menopause symptoms, however, and doses have to be closely regulated to prevent bone loss associated with low estrogen levels.

Surgery

Removing the uterus, ovaries, and Fallopian tubes is the only permanent method of eliminating endometriosis. This is an extreme measure that deprives a woman of her ability to bear children and forces her body into early **menopause**. In some cases, endometrial implants can be removed with **laser surgery** performed through a laparoscope. For women with minimal endometriosis, this technique usually is successful in reducing pain and slowing the condition's progress. It may help infertile women increase their chances of becoming pregnant.

Alternative therapies

Although severe endometriosis should not be self-treated, many women find they can help relieve symptoms through alternative therapies. In a survey conducted by the Endometriosis Association, 40% to 60% of the women who used alternative medicines reported relief of pain and other symptoms.

DIET. A high-fiber diet, particularly from grains and beans, may decrease cramping and inflammation. The oils in seeds, nuts, and certain fish (cod, salmon, mackerel, and sardines) may help to relieve cramping. Carrots, beets, lemons, cauliflower, Brussels sprouts, cabbage, onions, garlic, citrus fruits, vegetables, chicory, radicchio, and yogurt may help to reduce symptoms Sugar and animal fats can increase inflammation and aggravate pain. Milk and meat may contain hormones, so these should be avoided. Vegetarian or vegan **diets** may be recommended for those with endometriosis. Occasionally, an allergy elimination diet may be recommended.

SUPPLEMENTS. The following supplements can be used to treat endometriosis:

- vitamin B complex to help the liver break down excess estrogen
- vitamin C to reduce heavy menstrual bleeding
- calcium
- bioflavonoids to help reduce heavy menstrual bleeding
- magnesium to relieve pain and flush out toxins
- vitamin E to heal inflamed tissues
- iron for anemia resulting from heavy bleeding
- lipotropic factors (Choline, methionine, and inositol enhance liver function)
- fish oil capsules, flax oil, or any essential fatty acid to reduce cramping

HERBAL REMEDIES. Several herbal remedies for endometriosis exist. The first four in this list are the most commonly used remedies:

- Genistein (soy/isoflavone) helps the body excrete excess estrogen and possibly blocks estrogen's effect.
- Cramp bark *(Viburnum opulus)* helps ease cramping
- Dong quai *(Angelica sinensis)* balances hormone levels and reduces inflammation.
- Black cohosh *Cimicifuga racemosa)* helps the body excrete excess estrogen and improves the health of pelvic organs.
- Red clover *(Trifolium pratense)* balances hormone levels.
- Milk thistle *(Silybum marianum)* may improve liver function.
- Life root *(Senecio aureus)* may improve the health of pelvic organs
- Feverfew *(Chrysanthemum parthenium)* eases pain and cramping.
- Dandelion eases pain and cramping and supports the liver.
- Yarrow *(Archillea millefolium)* eases cramping and restores hormonal balance.
- Evening primrose *(Oenothera biennis)* oil relieved endometriosis symptoms in 90% of patients in one study.
- Shepherd's purse *(Capsella bursa-pastoris)* reduces heavy menstrual bleeding and tones the uterus.
- Meadowsweet *(Filipendula ulmaria)* reduces pain.

OTHER THERAPIES. Other remedies for endometriosis include **acupuncture** or **acupressure** to relieve pain, visualization, **guided imagery**, naturopathy,

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homeopathy (Lilium tigrum, sepia, and belladonna), **hydrotherapy**, **exercise**, and **meditation**.

Home remedies

Studies have shown that by gradually increasing their level of physical activity some women are able to reduce their level of pelvic pain. However, for unknown reasons, this does not work for all women.

Prognosis

Most women who have endometriosis have minimal symptoms and do well with conservative treatment. Overall, endometriosis symptoms recur in an average of 40% of women over the five years following treatment. With hormonal therapy, pain returned after five years in 37% of patients with minimal symptoms and 74% of those with severe cases. The highest success rate followed complete removal of implants using laser surgery. Eighty percent of these women were still pain-free five years later. In cases that do not respond to these treatments, a woman and her doctor may consider surgery to remove her reproductive organs. The most serious complication from endometriosis is reduced fertility or complete **infertility**.

Prevention

There is no proven way to prevent endometriosis.

Resources

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ORGANIZATIONS

American College of Obstetricians and Gynecologists, P.O. Box 96920, Washington, DC, 20090-6920, (202) 638-5577, http://www.acog.org.

Endometriosis Association, 8585 N. 76th Place, Milwaukee, WI, 53223, (414) 355-2200, (414) 355-6065, http://endometriosisassn.org.

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Endometritis *see* **Pelvic inflammatory disease**

Endorectal ultrasound

Definition

Endorectal ultrasound (ERUS) is a procedure where a probe is inserted into the rectum and high frequency sound waves (ultrasound waves) are generated. The pattern of echoes as they bounce off tissues is converted into a picture (sonogram) on a television screen.

Purpose

ERUS is used as a diagnostic procedure in **rectal cancer** to determine stage of the tumor and as a post-radiation, presurgical examination to assess extent of tumor shrinkage. ERUS can also be used in cases of anal **fistula** (an abnormal passage) and problems with the anal sphincter muscles (muscles that control the opening and closing of the anus).

Precautions

Normal precautions should be taken with any diagnostic procedure. Since the population in which this procedure is normally done is elderly, the imaging staff should be extra cautious about stressing the patient. The procedure is invasive and may be embarrassing to some. Other patients may be anxious about their medical condition since endorectal ultrasounds are not routine. This places an added burden on already stressed hearts and nervous systems. Physicians, nurses, and technicians may need to be prepared for **stress** reactions that could include the heart, **asthma**, or anxious behaviors.

Description

ERUS has been used as a means to determine the depth of rectal cancers and to assess whether the tumor has affected surrounding tissues. This pre-

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KEY TERMS

Anal sphincter muscles—Muscles that control the opening and closing of the anus.

Fistula—An abnormal passage.

Sonogram—The picture formed by the pattern of echoes from an ultra sound.

Ultrasound waves—High-frequency sound waves.

treatment procedure has proven to be an accurate tool for tailoring surgery for patients.

Problems with interpretation of the sonograms after radiation and before surgery have resulted in tumors being identified that were merely the formation of fibrous tissues that remained after the tumors had been eliminated by the radiation. Yet, some of the fibrous areas actually hid residual tumors. Rectal anatomy itself can affect the accuracy of ultrasound reading. This makes ERUS problematic in determining the amount of tumor reduction a patient has after **radiation therapy**.

Preparation

The patient must evacuate the bowels completely before the procedure is done. This usually is assisted though the use of several **enemas**. The patient may be told to adhere to a liquid diet the day prior to doing this procedure. The probe is inserted, usually with little discomfort for the patient since it will only be examining the first few inches of the colon.

Aftercare

Since ERUS is a minor invasive procedure, there is no aftercare.

Risks

There are no risks to having an ultrasound.

Normal results

Normal results after an endorectal ultrasound are normal, healthy tissues.

Abnormal results

Abnormal results range from any number of congenital deformities in the lining of the rectum to serious rectal cancers.

Resources

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Janie F. Franz

Endoscopic retrograde cholangiopancreatography

Definition

Endoscopic retrograde cholangiopancreatography (ERCP) is an imaging technique used to diagnose diseases of the pancreas, liver, gallbladder, and bile ducts. It combines **endoscopy** and x-ray imaging.

Purpose

ERCP is used in the management of diseases that affect the gastrointestinal tract, specifically the pancreas, liver, gall bladder, and bile ducts. The pancreas is an organ that secretes pancreatic juice into the upper part of the intestine. Pancreatic juice is composed of specialized proteins that help to digest fats, proteins, and carbohydrates. Bile is a substance that helps to digest fats; it is produced by the liver, secreted through the bile ducts, and stored in the gallbladder. Bile is released into the small intestine after a person has eaten a meal containing fat.

A doctor may recommend ERCP if a patient is experiencing abdominal **pain** of unknown origin, weight loss, or **jaundice**. These may be symptoms of biliary disease. For instance, **gallstones** that form in the gallbladder or bile ducts may become stuck there, causing cramping or dull pain in the upper right area of the abdomen, **fever**, and/or jaundice. Other causes of biliary obstruction include tumors, injury from gallbladder surgery, or inflammation. The bile ducts may also become narrowed (called a biliary stricture)

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KEY TERMS

Bile—A bitter yellowish-brown fluid secreted by the liver that contains bile salts, bile pigments, cholesterol, and other substances. It helps the body to digest and absorb fats.

Congenital—Present at birth.

Endoscope—An instrument with a light source attached that allows the doctor to examine the inside of the digestive tract or other hollow organ.

Gastrointestinal tract—A group of organs and related structures that includes the esophagus, stomach, liver, gallbladder, pancreas, small intestine, large intestine, rectum, and anus.

Jaundice—A condition characterized by deposits of bile pigments in the skin, mucous membranes, and the whites of the eyes. It is also known as icterus.

Magnetic resonance imaging—A technique that uses a strong magnetic field and pulses of radio waves to produce cross-sectional images of the body.

Stent—A thin rod-like or tube-like device made of wire mesh, inserted into a blood vessel or duct to keep it open.

Stricture—An abnormal narrowing of a duct or canal.

as a result of **cancer**, blunt trauma to the abdomen, **pancreatitis** (inflammation of the pancreas), or **primary biliary cirrhosis** (PBC). PBC may be caused by a condition called primary sclerosing **cholangitis**, an inflammation of the bile ducts that may cause pain, jaundice, **itching**, or other symptoms. These symptoms may also be experienced by a patient with cholangitis, or with infection of the bile ducts caused by bacteria or parasites.

ERCP can also be used to diagnose a number of pancreatic disorders. Pancreatitis is an inflammation of the pancreas, caused by chronic alcohol **abuse**, injury, obstruction of the pancreatic ducts (e.g., by gallstones), or other factors. The condition may be either acute (having a severe but short course) or chronic (persistent). Symptoms of pancreatitis include abdominal pain, weight loss, **nausea**, and **vomiting**. ERCP may be used to diagnose cancer of the pancreas; pancreatic pseudocysts (collections of pancreatic fluid); or strictures of the pancreatic ducts. Certain congenital disorders may also be identified by ERCP, such as pancreas divisum, a condition in which parts of the pancreas fail to fuse during fetal development.

Demographics

Diseases of the pancreas and biliary tract affect millions of Americans each year. According to the National Health and **Nutrition** Survey, gallbladder disease affects approximately 6.3 million men and 14.2 million women in the United States between the ages of 24 and 74. Approximately one million new cases of gallstones are diagnosed each year. The incidence of gallstones is higher among women; adults over the age of 40; and people who are overweight. Primary sclerosing cholangitis occurs at a rate of two to seven cases per 100,000 persons. The rate of **gallbladder cancer** is approximately 2.5 out of 100,000 persons. In addition, approximately 87,000 cases of pancreatitis and 30,000 cases of pancreatic cancer are diagnosed each year in the United States.

Description

ERCP is performed with the patient given either a sedative or **general anesthesia**. The physician then sprays the back of the patient's throat with a local anesthetic. The endoscope (a thin, hollow tube attached to a viewing screen) is then inserted into the mouth. It is threaded down the esophagus, through the stomach, and into the duodenum (upper part of the small intestine) until it reaches the spot where the bile and pancreatic ducts empty into the duodenum. At this point a small tube called a cannula is inserted through the endoscope and used to inject a contrast dye into the ducts. The term "retrograde" in the name of the procedure refers to the backward direction of the dye as it is injected through the ducts. A series of x-rays are then taken as the dye moves through the ducts.

If the x-rays show that a problem exists, ERCP may be used as a therapeutic tool. Special instruments can be inserted into the endoscope to remove gallstones, take samples of tissue for further examination (e.g., in the case of suspected cancer), or place a special tube called a stent into a duct to relieve an obstruction.

Diagnosis/Preparation

ERCP is generally not performed unless other less invasive diagnostic tests have first been used to determine the cause of a patient's symptoms. Such tests include:

- complete medical history and physical examination
- blood tests (certain diseases can be diagnosed by abnormal levels of blood components)

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- ultrasound imaging (a procedure that uses high-frequency sound waves to visualize structures in the human body)
- computed tomography (CT) scan (an imaging device that uses x-rays to produce two-dimensional cross-sections on a viewing screen)

Before undergoing ERCP, the patient will be instructed to refrain from eating or drinking for at least six hours to ensure that the stomach and upper part of the intestine are empty. Arrangements should be made for someone to take the patient home after the procedure, as he or she will not be able to drive. The physician should also be given a complete list of all prescription, over-the-counter, and alternative medications or preparations that the patient is taking. The patient should also notify the doctor if he or she is allergic to iodine because the contrast dye contains it.

Aftercare

After the procedure, the patient will remain at the hospital or outpatient facility until the effects of the sedative wear off and no signs of any complications have appeared. A longer stay may be warranted if the patient experiences complications or if other procedures were performed.

Risks

Complications that have been reported with ERCP include pancreatitis; cholangitis (inflammation of the bile ducts); **cholecystitis** (inflammation of the gallbladder); injury to the duodenum; pain; bleeding; infection; and formation of **blood clots**. Factors that increase the risk of complications include liver damage, bleeding disorders, a history of post-ERCP complications, and a less experienced endoscopist.

Normal results

Following ERCP, the patient's biliary and pancreatic ducts should be free of stones and show no strictures, obstructions, or evidence of infection or inflammation.

Morbidity and mortality rates

The overall complication rate associated with ERCP is approximately 11%. Pancreatitis may occur in up to 7% of patients. Cholangitis and cholecystitis occur in less than 1% of patients. Infection, injury, bleeding, and blot clot formation also occur in less than 1%. The mortality rate for ERCP is approximately 0.1%.

Alternatives

Although less invasive techniques exist (such as computed tomography and ultrasonography) to help to diagnose gastrointestinal diseases, these imaging studies are often not precise enough to allow for definite diagnosis of certain conditions. **Percutaneous transhepatic cholangiography** (PTCA) is an alternative to ERCP that involves the insertion of a long, flexible needle through the skin to the bile ducts; contrast dye is then injected into the ducts so that they may be visualized by x-ray. PTCA may be recommended if ERCP fails or cannot be performed. Magnetic resonance cholangiopancreatography (MRCP) is an imaging technology that allows for non-invasive examination of the biliary and pancreatic ducts. Its disadvantage, however, is that unlike ERCP, it cannot be used for therapeutic procedures as well as imaging.

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Endoscopic sclerotherapy *see* **Sclerotherapy for esophageal varices**

Endoscopic sphincterotomy

Definition

Endoscopic sphincterotomy or endoscopic retrograde sphincterotomy (ERS) is a relatively new endoscopic technique developed to examine and treat abnormalities of the bile ducts, pancreas and

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KEY TERMS

Endoscope, Endoscopy—An endoscope as used in the field of gastroenterology is a thin flexible tube which uses a lens or miniature camera to view various areas of the gastrointestinal tract. When the procedure is performed to examine certain organs such as the bile ducts or pancreas, the organs are not viewed directly, but rather indirectly through the injection of x-ray dye. The performance of an exam using an endoscope is referred by the general term endoscopy. Diagnosis through biopsies or other means and therapeutic procedures can be done with these instruments.

NSAIDS—This abbreviation stands for non-steroidal anti-inflammatory drugs, which are medications such as Ibufprofen that are used to control pain and inflammation. Most may be purchased over the counter. One of their major side effects is that they decrease the effect of the normal blood clotting factors in blood. In patients undergoing surgical or endoscopic procedures, this can lead to an increased risk of bleeding.

gallbladder. The procedure was developed as an extension to the diagnostic examination, ERCP (**endoscopic retrograde cholangiopancreatography**); with the addition of "sphincterotomy," abnormalities found during the study could be treated at the same time without the need for invasive surgery.

The term ERS has three parts to its definition;

- endoscopic refers to the use of an endoscope
- retrograde refers to the insertion of the endoscope *up* into the ducts in a direction opposite to or against the normal flow of bile *down* the ducts
- sphincterotomy, which means cutting of the sphincter or muscle that lies at the juncture of the intestine with both the bile and pancreatic ducts.

Purpose

Until the 1970s, patients with symptoms related to disease of the bile ducts or pancreas frequently needed surgery to diagnose the cause and treat any abnormalities. ERCP allowed physicians for the first time to obtain high quality x rays of the common bile and pancreatic ducts, and detect areas of narrowing (strictures), stones, and tumors. ERCP was not initially designed for treatment. ERS was developed shortly after and enabled physicians to treat the abnormalities identified by the injection of dye and x rays.

The revolutionary technique made possible the endoscopic removal of stones and stretching of areas of narrowing (strictures). It has since been expanded to include drainage of bile from blocked ducts and treatment of various abnormalities of the pancreas.

Precautions

The most important precaution related to both ERCP and ERS is to have the procedure performed by an experienced physician. ERS is technically more difficult than many other gastrointestinal endoscopic studies, including ERCP. Patients should inquire as to the physician's experience with the procedure. The physician should also be informed of any **allergies**, medication use, and medical problems.

Description

ERS is generally performed only after ERCP has been successfully accomplished and detail of the anatomy and abnormalities is known. During ERS, a number of various instruments are inserted through the endoscope in order to "cut" or stretch the sphincter. Once this is done, additional instruments are passed that enable the removal of stones and the stretching of narrowed regions of the ducts. Drains (stents) can also be used to prevent a narrowed area from rapidly returning to its previously narrowed state.

Preparation

The upper intestinal tract must be empty for the procedure, so patients must not eat or drink for at least six to 12 hours before the exam. Patients need to inquire about taking their medications before the procedure. Some patients may require **antibiotics** before and/or after the procedure. When possible, **aspirin** or NSAIDS should not be taken within several days before the procedure, because they interfere with blood clotting.

Aftercare

When ERS is performed, physicians will usually want to observe the patient closely for several hours to ensure that there are no signs of complications. **Pain** or any other unusual symptoms should be reported. Admission to the hospital may be advised.

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Risks

ERS complications are related either to the drugs used during the procedure, or the results of dye injection or cutting of tissue. The overall complication rate is 5–10%. During the exam, the endoscopist can cut or stretch structures (such as the muscle leading to the bile duct) to treat the cause of the patient's symptoms. Cutting or stretching of these structures can sometimes cause a hole or perforation. The use of sedatives also carries a risk of decreasing cardiac and respiratory function, however, it is very difficult to perform these procedures without these drugs.

Other major complications related to ERCP or ERS are **pancreatitis** (inflammation of the pancreas) and **cholangitis** (inflammation of the bile ducts). **Bacteremia** (the passage of bacteria into the blood stream) and bleeding are also risks.

Normal results

Certain standards have been set for the diameter or width of the pancreatic and bile ducts. Measurements by x ray are used to determine if the ducts are too large (dilated) or too narrow (strictured). Lastly, the ducts and gallbladder should be free of any solid particles, such as stones, and free of areas of narrowing.

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David Kaminstein, MD

Endoscopy

Definition

An endoscopy is a procedure that uses a small camera mounted on a thin, flexible tube called an endoscope to allow a doctor to see inside the body.

Purpose

Endoscopy is used to provide the doctor or surgeon with the ability to see inside the patient's body. Unlike many other forms of imaging, such as x-ray and ultrasound, endoscopy can provide the doctor with a real-time view with true colors. It also is sometimes used to remove polyps, cauterize bleeding, or remove samples for examination under the microscope.

Patient undergoing an endoscopic exam. *(© National Audubon Society Collection/Photo Researchers, Inc.)*

Endoscopy is used in a variety of settings. It is often used to help diagnose the cause of **pain** or other symptoms that are of unclear origin. It can also be used during minimally invasive surgery, when an endoscopy is passed through a very small incision so that the surgeon is able to view the inside of the patient and perform the surgery.

Description

During endoscopy, a small camera or viewer attached to the end of a thin, usually flexible tube, is passed into the individual. This device is called an endoscope. The endoscope is usually introduced into the patient through the mouth, rectum, ureter, or a small incision. The place of endoscope entry is determined by the are of the body the doctor wishes to view.

Some endoscopes have a view piece that allows the doctor to see directly into the patient. Others have camera at the end, which sends video signals through fiber optic wires in the endoscope to a television monitor in the procedure room. This allows the doctor and others to get a clear, enlarged view of the area of interest, and can allow for recording the procedure to review later if there are any questions.

In most cases the patient is mildly or heavily sedated during the procedure. Many patients actual sleep through the majority of the procedure. The area under investigation may also receive **local anesthesia** if discomfort from the procedure is expected.

Many endoscopes allow the doctor not only to see the inside of the patient, but also to perform some

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KEY TERMS

Biopsy—Removal of a small tissue sample from the body to examine for evidence of disease.

Gastroenterologist—A doctor who specializes in diagnosing and treating conditions of the gastrointestinal system, including the mouth, pharynx, esophagus, diaphragm, stomach, gall bladder, bile duct, liver, small intestine, large intestine, and anus.

Polyp—An abnormal growth of tissue arising from and protruding from a mucous membrane.

additional procedures. Some endoscopes have a device for cauterizing as an available attachment, which can be sued to stop internal bleeding in the area being investigated. Other endoscopes allow the doctor to cut and remove polyps during the procedure. Some endoscopes allows for the biopsy of suspicious tissue during the procedure, removing the need for an additional, usually more invasive procedure later.

One of the newest endoscopy technologies, capsule endoscopy, allows the physician to examine the esophagus, stomach, and small intestine. For this procedure, the patient swallows a capsule (slightly larger than a large vitamin) containing video chips, lights, and a transmitter. Rapid photos are made as the capsule travels through the digestive tract, and are transmitted to a receiver worn around the patient's waist. The capsule eventually passes in the stool, and images are downloaded from the receiver for the physician to evaluate. Limitations of capsule endoscopy include the inability to gather samples or remove polyps, and the fact the capsule battery sometimes fades before the capsule travels to the area targeted for inspection.

Precautions

The precautions for endoscopy vary depending on the type of endoscopy performed. Individuals who have conditions that require regular consumption of food or liquids may not be good candidates for endoscopy. Individuals who are allergic to one or more sedatives or anesthesia products should alert their doctor and health care team so that alternative medications can be found and special precautions can be taken.

Preparation

The preparation for an endoscopy depends heavily on the type of endoscopy being performed. The patient is generally instructed not to eat or drink for a certain amount of time before the procedure. If there is food in the upper digestive system this can reduce visibility, and **vomiting** can occur causing complications. If an endoscopy is being performed on the lower digestive tract the patient may be prescribed **laxatives** or one or more **enemas** before the procedure so that the area of interest is clearly visible.

The patient may be required to stop taking, or reduce the dosage of, some medications, supplements, or herbs before the procedure. Blood thinners can increase the risk of bleeding as a complication of the procedure, so individuals taking blood thinners may be asked to stop for a few days before the procedure. The patient is given specific instructions for his or her case, usually when the endoscopy is scheduled.

Aftercare

After the endoscopy the patient is often brought to a special recovery room to wait until the effects of any sedatives administered wear off, and to ensure there were no complications from the procedure. The patient should arrange for transportation home after the procedure because he or she will not be able to drive after **sedation**. Generally, patients can begin to eat and drink again as desired after the procedure is over. The patient will generally begin to feel better quickly as any medication administered wears off, although some soreness may occur. The patient should usually allow the remainder of the day to rest after the procedure.

Risks

An endoscopy can result in soreness in the area in which the endoscopy was performed. Bloating and gas sometimes occur after endoscopies performed on the gastrointestinal tract. In rare cases endoscopy can cause bleeding, and in extremely rare cases can cause rupture or tearing of the intestinal wall. If anesthesia or sedatives were used these can have their own risks of complications. In most cases no serious complications result from endoscopy.

Results

An endoscopy produces pictures of the area being looked at so that the doctor can use them to assist in making a diagnosis. In some cases the endoscopy will also produce samples that can be examined under the microscope. The results of the endoscopy will vary depending on the reason it was performed, the area examined, and whether any biopsies were taken. A normal endoscopy will produce images that show

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healthy, normally functioning organs and tissues with no tears, growths, or bleeding. An abnormal endoscopy may show growths, bleeding, tearing of the intestinal wall, abnormal coloration, or a variety of other problems.

Caregiver concerns

A doctor determines the need for an endoscopy based on a **physical examination** of the patient, the patient's self-reported symptoms, a health history, and the results of any other diagnostic imaging, blood, or urine tests. The endoscopy may be performed in a doctor's office, in a clinic, or in a hospital. In general, an endoscopy is performed by a doctor who specializes in the area being imaged. For example, an endoscopy of the upper digestive system is performed by a gastroenterologist, a doctor who specializes in the gastrointestinal system. A surgeon may perform an endoscopy if the endoscopy is being used to visualize the surgery site during minimally invasive surgery.

During the procedure, a variety of other health care team members may assist the doctor or surgeon who is performing the endoscopy. Technologists may help to set up and monitor video and other equipment. One or more nurses may supervise the administration of any medications or sedatives, and may help to monitor the patient's vital signs during the procedure. If the patient is going to be under **general anesthesia** during the procedure, an anesthesiologist will administer the anesthesia and be present during the procedure to monitor the patient. If the endoscopy is being performed doing a surgery a variety of operating room nurses, technologists, and technicians may be present to assist. If any material is removed during the procedure for a biopsy, a laboratory technician may examine the sample to determine if it is cancerous.

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ORGANIZATIONS

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Enemas

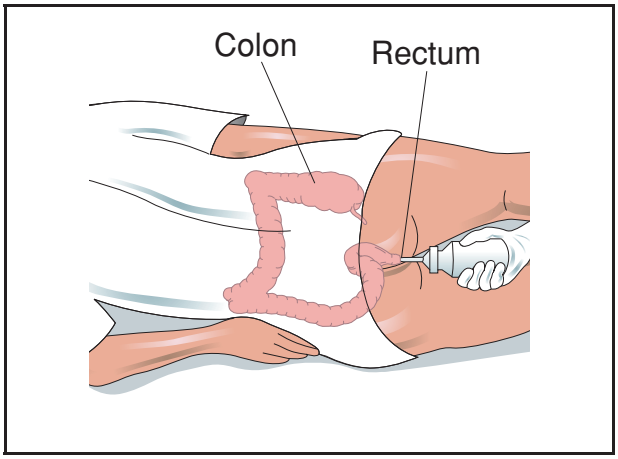
Definition

An enema is the insertion of a solution into the rectum and lower intestine.

Purpose

Enemas may be given for the following purposes:

- to remove feces when an individual is constipated or impacted,



Enemas may be given for the following purposes: to remove feces when an individual is constipated, or to remove feces and cleanse the rectum in preparation for an examination, or prior to surgery to prevent contamination. There are two types of enemas: the high enema, given to cleanse the large bowel, and the low enema, to cleanse only the lower bowel. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

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- to remove feces and cleanse the rectum in preparation for an examination,
- to remove feces prior to a surgical procedure to prevent contamination of the surgical area,
- to administer drugs or anesthetic agents.

Precautions

The rectal tube used for infusion of the enema solution should be smooth and flexible to decrease the possibility of damage to the mucous membrane that lines the rectum. Tap water is commonly used for adults but should not be used for infants because of the danger of electrolyte (substance that conducts electric current within the body and is essential for sustaining life) imbalance. The colon absorbs water, and repeated tap water enemas can cause cardiovascular overload and electrolyte imbalance. Similarly, repeated saline enemas can cause increased absorption of fluid and electrolytes into the bloodstream, resulting in overload. Individuals receiving frequent enemas should be observed for overload symptoms that include **dizziness**, sweating, or **vomiting**.

Soap suds and saline used for cleansing enemas can cause irritation of the lining of the bowel, with repeated use or a solution that is too strong. Only white soap should be used; the bar should not have been previously used, to prevent infusing undesirable organisms into the individual receiving the enema. Common household detergents are considered too strong for the rectum and bowel. The commercially prepared castile soap is preferred, and should be used in concentration no greater than 5 cc soap to 1,000 cc of water.

Description

Cleansing enemas act by stimulation of bowel activity through irritation of the lower bowel, and by distention with the volume of fluid instilled. When the enema is administered, the individual is usually lying on the left side, which places the sigmoid colon (lower portion of bowel) below the rectum and facilitates infusion of fluid. The length of time it takes to administer an enema depends on the amount of fluid to be infused. The amount of fluid administered will vary depending on the age and size of the person receiving the enema, however general guidelines would be:

- Infant: 250 cc or less
- Toddler and preschooler: 500 cc or less
- School-aged child: 500–1,000 cc
- Adult: 750–1,000 cc

KEY TERMS

Electrolyte—A substance that conducts electric current within the body and is essential for sustaining life.

Intestine—Also called the bowels and divided into large and small intestine, they extend from the stomach to the anus, where waste products exit the body. The small intestine is about 20 ft (6.1m) long and the large intestine, about 5 ft (1.5m) long.

Rectum—The portion of bowel just before the anus. The prefix *recto* is used with a variety of words in relation to conditions that affect the rectum.

Some may differentiate between high and low enemas. A high enema, given to cleanse as much of the large bowel as possible, is usually administered at higher pressure and with larger volume (1,000 cc), and the individual changes position several times in order for the fluid to flow up into the bowel. A low enema, intended to cleanse only the lower bowel, is administered at lower pressure, using about 500 cc of fluid.

Oil retention enemas serve to lubricate the rectum and lower bowel, and soften the stool. For adults, about 150–200 cc of oil is instilled, while in small children, 75–150 cc of oil is considered adequate. Salad oil or liquid petrolatum are commonly used at a temperature of 91°F (32.8°C). There are also commercially prepared oil retention enemas. The oil is usually retained for one to three hours before it is expelled.

The rectal tube used for infusion of the solution, usually made of rubber or plastic, has two or more openings at the end through which the solution can flow into the bowel. The distance to which the tube must be inserted is dependent upon the age and size of the patient. For adult, insertion is usually 3–4 in (7.5–10 cm); for children, approximately 2–3 in (5–7.5 cm); and for infants, only 1–1.5 in (2.5–3.75 cm). The rectal tube is lubricated before insertion with a water soluble lubricant to ease insertion and decrease irritation to the rectal tissues.

The higher the container of solution is placed, the greater the force in which the fluid flows into the patient. Routinely, the container should be no higher than 12 in (30 cm) above the level of the bed; for a high cleansing enema, the container may be 12–18 in (30–45 cm) above the bed level, because the fluid is to be instilled higher into the bowel.

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Preparation

The solution used in the procedure is measured, mixed, and warmed before administration of the enema.

Aftercare

If necessary, a specimen will be collected for diagnostic evaluation. If the enema was given to alleviate **constipation**, the better approach to combatting constipation in the future is with a high fiber diet (five to six servings of whole grain foods) and adequate fluid intake (seven to eight glasses of water per day). Regular **exercise** and going to the bathroom when necessary will also help. If constipation is a chronic problem, medical help should be consulted to determine if there is underlying disorder.

Risks

Habitual use of enemas as a means to combat constipation can make the problem even more severe when their use is discontinued. Enemas should be used only as a last resort for treatment of constipation and with a doctor's recommendation. Enemas should not be administered to individuals who have recently had colon or rectal surgery, a **heart attack**, or who suffer from an unknown abdominal condition or an irregular heartbeat.

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Enhanced external counterpulsation

Definition

Enhanced external counterpulsation (EECP) is a noninvasive procedure in which a set of inflatable cuffs (much like blood pressure cuffs) mechanically compress the blood vessels in the patient's lower limbs to increase blood flow in the coronary arteries of the heart. The blood pressure cuffs (also called stockings) are wrapped around the patient's calves, lower thighs, and upper thighs. Computer technology, **electrocardiography**, and blood pressure monitors enable the pressure cuffs to be inflated and deflated in time with the patient's heartbeat and blood pressure.

Purpose

EECP is performed to restore blood flow to the heart and to relieve chest **pain** (**angina** pectoris) and **ischemia**. The goals of the procedure are to relieve the symptoms of **coronary artery disease**, enable the patient to resume a normal lifestyle, and lower the risk of a **heart attack** or other heart problems. EECP may encourage blood vessels to open small channels (called collateral blood vessels) to eventually bypass blocked vessels and improve blood flow to the heart.

Demographics

The concept of counterpulsation is not new; it was first introduced in 1953 at Harvard, and refined in the late 1950s. Early models of EECP, however, used nonsequenced pulsation; that is, compression of the patient's blood vessels was performed simultaneously along the full length of the body. In the 1970s, researchers in China reported on a sequential compression system in which four sets of pressure cuffs were applied to the patient's legs, buttocks, and arms. Favorable reports about the effectiveness of sequential compression encouraged a research team at SUNY Stony Brook to develop the three-cuff EECP model in use in the early 2000s. The computerized technology currently available with EECP makes it a relatively new procedure compared to the systems used in the 1960s and early 1970s. As of 2008, it was available in about 200 centers across the United States.

EECP is used to treat patients with chronic stable angina, coronary artery disease, or high blood pressure. The Food and Drug Administration (FDA) approved EECP for the treatment of congestive **heart failure** (CHF) in the early 2000s. Researchers at the Ohio Heart and Vascular Center reported in 2006 that EECP improved **exercise** duration as well as quality of life in patients with CHF. The treatment may be appropriate for patients who are not eligible for such nonsurgical interventional procedures as balloon **angioplasty**, stent placement, rotablation, **atherectomy**, or brachytherapy. It may also be used for patients who do not qualify for such surgical treatments as **coronary artery bypass graft surgery**.

EECP is not the first-line treatment for angina. Rather, it is reserved for patients who have not achieved good results from medication or interventional management of their symptoms. To be eligible for EECP, a patient must have coronary artery disease that includes at least one heart vessel with at least 70% obstruction. In addition, the patient must have evidence of either an infarction or significant ischemia on a **stress test** with nuclear or echocardiographic imaging.

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KEY TERMS

Angina—Also called angina pectoris; chest pain or discomfort that occurs when diseased blood vessels restrict blood flow to the heart.

Aorta—The main artery that carries blood from the heart to the rest of the body; the largest artery in the body.

Artery—A vessel that carries oxygen-rich blood to the body.

Atherectomy—A nonsurgical technique for treating diseased arteries with a rotating device that cuts or shaves away obstructing material inside the artery.

Atria (singular, atrium)—The right and left upper chambers of the heart.

Balloon angioplasty—A nonsurgical technique for treating diseased arteries by temporarily inflating a tiny balloon inside an artery.

Beta blocker—An antihypertensive drug that limits the activity of epinephrine, a hormone that increases blood pressure.

Brachytherapy—The use of radiation during angioplasty to prevent the artery from narrowing again (a process called restenosis).

Calcium channel blocker—A drug that lowers blood pressure by regulating calcium-related electrical activity in the heart.

Cardiac catheterization—An invasive procedure used to create x rays of the coronary arteries, heart chambers and valves.

Collateral vessel—A side branch or network of side branches of a large blood vessel.

Coronary artery disease—Also called atherosclerosis, it is a buildup of fatty matter and debris in the coronary artery wall that causes narrowing of the artery.

Echocardiogram—An imaging procedure used to create a picture of the heart's movement, valves and chambers.

Electrocardiogram (ECG, EKG)—A test that records the electrical activity of the heart, using small electrode patches attached to the skin on the chest.

Infarction—An area of dead tissue caused by obstruction of the blood supply to that tissue.

Ischemia—Decreased blood flow to an organ, usually caused by constriction or obstruction of an artery.

Rotablation—A nonsurgical technique for treating diseased arteries in which a special catheter with a diamond-coated tip is guided to the point of narrowing in the artery. The catheter tip spins at high speed and grinds away the blockage or plaque on the artery walls.

Stent—A device made of expandable metal mesh that is placed (by using a balloon catheter) at the site of a narrowing artery. The stent remains in place to keep the artery open.

Stress test—A test that determines how the heart responds to stress.

Vein—A blood vessel that returns oxygen-depleted blood from various parts of the body to the heart.

Ventricles—The lower pumping chambers of the heart that propel blood to the lungs and the rest of the body.

EECP may benefit patients with such other medical conditions as **erectile dysfunction**, **kidney disease**, eye disease, **diabetic neuropathy**, **restless legs syndrome**, and other circulatory disorders. More research is needed to evaluate the outcomes of EECP for these patients.

Many insurance providers and Medicare have approved EECP treatment for reimbursement. Medicare pays about $5,500 for the full series of 35 treatments.

Contraindications

EECP is not recommended for patients who have certain types of valve disease, uncontrolled **arrhythmias** (irregular heart rhythms), severe **hypertension**, uncontrolled congestive heart failure, significant blockages or **blood clots** in the leg arteries, or those who have had a recent **cardiac catheterization**, angioplasty, or bypass surgery. It should also not be given to pregnant women.

Description

While the patient lies on a bed, the leg cuffs are deflated and inflated with each heartbeat. A computer synchronizes the compression of the cuffs with the heartbeat. The electrocardiogram indicates when each heartbeat begins, triggering the cuffs to be mechanically deflated. As each heartbeat ends, the cuffs are mechanically inflated in sequential order, starting with the cuffs on the calves and working

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upward to the cuffs on the lower and then the upper thighs. The pressure produced by the inflation of the cuffs when the heart is at rest pushes the blood in the legs upward toward the heart. The deflating action that occurs just when the heart begins to beat reduces the work of the heart as it pumps blood to other parts of the body. Inflation is controlled by a pressure monitor that inflates the cuffs to about 300 mm Hg. When timed correctly, the procedure increases the cardiac output.

EECP treatments are performed on an outpatient basis and generally last one to two hours. Treatments must be repeated about five times a week for up to seven weeks to achieve improved circulation. This 35-hour regimen is generally followed because it was used in the first multicenter study of EECP in 1999.

Diagnosis/Preparation

Preparation

The patient is usually instructed to wear tight-fitting seamless cycling pants or athletic tights to prevent chafing, one of the main adverse side effects.

Before the procedure, the patient's weight, blood pressure, pulse, and breathing rate are measured and recorded. The patient's legs are examined for areas of redness and signs of potential vascular problems.

The patient is asked to record his or her symptoms during the course of treatment to determine whether and how symptoms improve over time. The patient should record the severity and duration of troublesome symptoms, the time the symptoms occurred, and any activities that may have triggered the symptoms. This patient record is reviewed before each treatment session.

PATIENT EDUCATION. The healthcare team will ensure that the patient understands the potential benefits and risks of the procedure. Informative and instructional handouts are usually provided to explain the procedure. Because the procedure requires multiple outpatient visits (generally 35 visits over a seven-week period), the patient must be able to meet the treatment schedule.

INFORMED CONSENT. Informed consent is an educational process between healthcare providers and patients. Before any procedure is performed, the patient is asked to sign a consent form. Before signing the form, the patient should understand the nature and purpose of the diagnostic procedure or treatment; the risks and benefits of the procedure; and alternatives, including the option of not proceeding with the test or treatment. During the discussion about the procedure, the healthcare providers are available to answer all of the patient's questions.

SMOKING CESSATION. Patients who will undergo any procedure to treat cardiovascular disease are encouraged to stop **smoking** and using any tobacco products before the procedure, and to make a commitment to be a nonsmoker after the procedure. There are several smoking cessation programs available in the community. The patient should ask a healthcare provider for more information if he or she needs help quitting smoking.

Aftercare

Discomfort

Patients report little or no discomfort during the procedure. Some people may feel tired after the first few treatments, but this loss of energy improves over time.

Lifestyle changes

To manage heart disease, the patient needs to make several lifestyle changes before and after the procedure, including:

- Quitting smoking. Smoking causes damage to blood vessels, increases the patient's blood pressure and heart rate, and decreases the amount of oxygen available in the blood.
- Managing weight. Maintaining a healthy weight, by watching portion sizes and exercising, is important. Being overweight increases the work of the heart.
- Participating in an exercise program. The cardiac rehabilitation exercise program is usually tailored for the patient, who will be supervised by professionals.
- Making dietary changes. Patients should eat a lot of fruits, vegetables, grains, and nonfat or low-fat dairy products, and reduce fats to less than 30% of all calories. Alcoholic beverages should be limited or avoided.
- Taking medications as prescribed. Aspirin and other heart medications may be prescribed, and the patient may need to take these medications for life.
- Following up with healthcare providers. The patient should visit the physician regularly for follow-up visits to control risk factors.

Risks

EECP is a relatively safe and effective treatment, and few adverse side effects have been reported. The main adverse side effect is chafing (skin irritation from

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the compression of the cuffs). To reduce or prevent this side effect, patients are instructed to wear tight-fitting cycling pants or athletic tights. Leg pain is another adverse side effect.

Normal results

The benefits of EECP are comparable to the results of angioplasty and coronary artery bypass graft surgery: 70–80% of patients experience significant improvement after EECP treatment for as long as five years. The largest research study on EECP indicates that after receiving treatment, patients used less medication, had fewer angina attacks with less severe symptoms, and increased their capacity to exercise without experiencing symptoms. EECP improves the patient's sense of well-being and overall quality of life, and in some cases, prolongs the patient's life. Benefits five years after EECP treatment are comparable to surgical outcomes.

The effects of EECP treatment last from three to five years and sometimes longer.

EECP does not prevent coronary artery disease from recurring; therefore, lifestyle changes are strongly recommended and medications are prescribed to reduce the risk of recurrent disease.

Morbidity and mortality rates

Morbidity and mortality have not been reported with this procedure.

Alternatives

All patients with coronary artery disease can help improve their condition by making lifestyle changes such as quitting smoking, losing weight if they are overweight, eating healthful foods, reducing blood cholesterol, exercising regularly, and controlling diabetes and high blood pressure.

All patients with coronary artery disease should be prescribed medications to treat their condition. Such antiplatelet medications as **aspirin** or clopidogrel (Plavix) are usually recommended. Other medications used to treat angina may include **beta blockers**, nitrates, and angiotensin-converting enzyme (ACE) inhibitors. Medications may also be prescribed to lower lipoprotein levels, since elevated lipoprotein levels have been associated with an increased risk of cardiovascular problems.

Treatment with vitamin E is not recommended because it does not lower the rate of cardiovascular events in people with coronary artery disease. Although such **antioxidants** as vitamin C, beta-carotene, and probucol show promising results, they are not recommended for routine use. Treatment with **folic acid** and **vitamins** B_6 and B_{12} lowers **homocysteine** levels (reducing the risk for cardiovascular problems), but more studies are needed to determine if lowered homocysteine levels correlate with a reduced rate of cardiovascular problems in treated patients.

Such nonsurgical interventional procedures as balloon angioplasty, stent placement, rotablation, atherectomy, or brachytherapy can be performed to open a blocked artery.

Coronary artery bypass graft surgery is a surgical procedure in which one or more blocked coronary arteries are bypassed by a blood vessel graft to restore normal blood flow to the heart. These grafts usually come from the patient's own arteries and veins located in the leg, arm, or chest.

Resources

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ORGANIZATIONS

American College of Cardiology, Heart House, 2400 N. Street NW, Washington, DC, 20037, (202) 375-6000, (202) 375-7000, resource@acc.org, http://www.acc.org.

American Heart Association, 7272 Greenville Avenue, Dallas, TX, 75231, (214) 373-6300, (800) 242-8721, http://www.americanheart.org.

Cleveland Clinic Heart and Vascular Institute, The Cleveland Clinic Foundation, 9500 Euclid Avenue, F25, Cleveland, OH, 44195, (216) 445-9288, (800) 223-2273, http://www.clevelandclinic.org/heartcenter.

International ECP Therapists Association, 1500 Sunday Drive, Suite 102, Raleigh, NC, 27607, (877) 558-0409, http://www.ietaonline.com.

National Heart, Lung, and Blood Institute (NHLBI), NHLBI Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

Texas Heart Institute, Heart Information Service, P.O. Box 20345, Houston, TX, 77225-0345, (832) 355-1000, (800) 292-2221, http://www.texasheartinstitute.org.

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Enlarged prostate

Definition

A non-cancerous condition that affects many men past 50 years of age, enlarged prostate makes urinating more difficult by narrowing the urethra, a tube running from the bladder through the prostate gland. It can be effectively treated by surgery and, today, by certain drugs.

Description

The common term for enlarged prostate is BPH, which stands for benign (non-cancerous) prostatic hyperplasia or hypertrophy. Hyperplasia means that the prostate cells are dividing too rapidly, increasing the total number of cells, and, therefore, the size of the organ itself. Hypertrophy simply means "enlargement." BPH is part of the **aging** process. The actual changes in the prostate may start as early as the 30s but take place very gradually, so that significant enlargement and symptoms usually do not appear until after age 50. Past this age the chances of the prostate enlarging and causing urinary symptoms become progressively greater. More than 40% of men in their 70s have an enlarged prostate. Symptoms generally appear between ages 55–75. About 10% of all men eventually will require treatment for BPH.

BPH has been viewed as a rare condition in African, Chinese, and other Asian peoples for reasons that are not clear.

Causes and symptoms

The cause of BPH is a mystery, but age-related changes in the levels of hormones circulating in the blood may be a factor. Whatever the cause, an enlarging prostate gradually narrows the urethra and obstructs the flow of urine. Even though the muscle in the bladder wall becomes stronger in an attempt to push urine through the smaller urethra, in time, the bladder fails to empty completely at each urination. The urine that collects in the bladder can become infected and lead to stone formation. The kidneys themselves may be damaged by infection or by urine constantly "backing up."

When the enlarging prostate gland narrows the urethra, a man will have increasing trouble starting the urine stream. Because some urine remains behind in the bladder, he will have to urinate more often, perhaps two or three times at night (nocturia). The need to urinate can become very urgent and, in time, urine may dribble out to stain a man's clothing. Other symptoms of BPH are a weak and sometimes a split stream and general aching or **pain** in the perineum (the area between the scrotum and anus). Some men may have considerable enlargement of the prostate before even mild symptoms develop.

If a man must strain hard to force out the urine, small veins in the bladder wall and urethra may rupture, causing blood to appear in the urine. If the urinary stream becomes totally blocked, the urine collecting in the bladder may cause severe discomfort, a condition called acute urinary retention. Urine that stagnates in the bladder can easily become infected. A burning feeling during urination and **fever** are clues that infection may have developed. Finally, if urine backs up long enough it may increase pressure in the kidneys, though this rarely causes permanent kidney damage.

Diagnosis

When a man's symptoms point to BPH, the first thing the physician will want to do is a **digital rectal**

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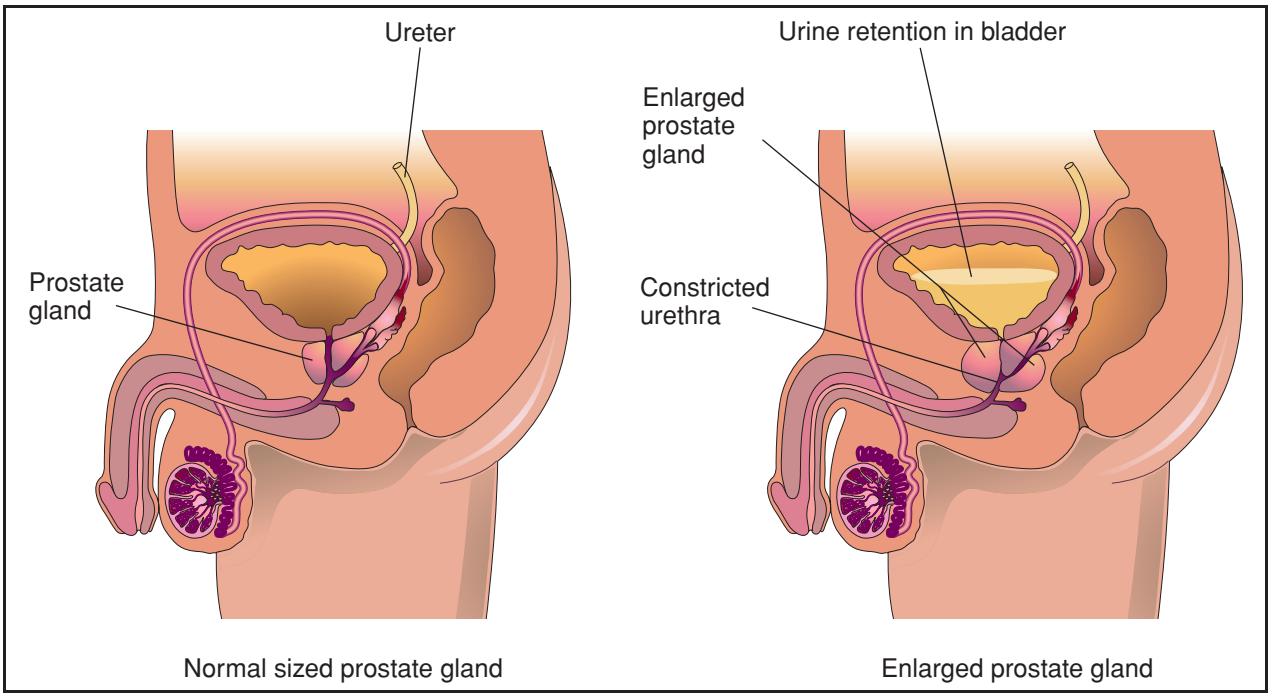

An enlarged prostate is a non-cancerous condition in which the narrowing of the urethra makes the elimination of urine more difficult. It most often occurs in men over age 50. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

examination, inserting a finger into the anus to feel whether—and how much—the prostate is enlarged. A smooth prostate surface suggests BPH, whereas a distinct lump in the gland might mean **prostate cancer**. The next step is a blood test for a substance called prostate-specific antigen or PSA. Between 30–50% of men with BPH have an elevated PSA level. This does not mean **cancer** by any means, but other measures are needed to make sure that the prostate enlargement is in fact benign. An ultrasound exam of the prostate, which is entirely safe and delivers no radiation, can show whether it is enlarged and may show that cancer is present.

If digital or ultrasound examination of the prostate raises the suspicion of cancer, most urologists will recommend that a prostatic tissue biopsy be performed. This is usually done using a lance-like instrument that is inserted into the rectum. It pierces the rectal wall and, guided by the physcian's finger, obtains six to eight pieces of prostatic tissue that are sent to the laboratory for microscopic examination. If cancer is present, the prognosis and treatment are changed accordingly.

A catheter placed through the urethra and into the bladder can show how much urine remains in the bladder after the patient urinates—a measure of how severe the obstruction is. Another and very simple test for obstruction is to have the man urinate into a uroflowmeter, which measures the rate of urine flow. A very certain—though invasive—way of confirming obstruction from an enlarged prostate is to pass a special viewing instrument called a cystoscope into the bladder, but this is not often necessary.

It is routine to check a urine sample for an increased number of white blood cells, which may mean there is infection of the bladder or kidneys. The same sample may be cultured to show what type of bacterium is causing the infection, and which **antibiotics** will work best. The state of the kidneys may be checked in two ways: imaging by either ultrasound or injecting a dye (the intravenous urogram, or pyelogram); or a blood test for creatinine, which collects in the blood when the kidneys cannot eliminate it.

Treatment

Drugs

A class of drugs called alpha-adrenergic blockers, which includes phenoxybenzamine and doxazosin, relax the muscle tissue surrounding the bladder outlet and lining the wall of the urethra to permit urine to flow more freely. These drugs improve obstructive symptoms, but do not keep the prostate from enlarging. Other drugs (**finasteride** is a good example) do

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KEY TERMS

Catheter—A rubber or plastic tube placed through the urethra into the bladder to remove excess urine when the flow of urine is cut off, or to prevent urinary infection.

Creatinine—One of the "waste" substances normally excreted by the kidneys into the urine. When urine flow is slowed, creatinine may collect in the blood and cause toxic effects.

Hyperplasia—A condition where cells, such as those making up the prostate gland, rapidly divide abnormally and cause the organ to become enlarged.

Hypertrophy—A technical term for enlargement, as in BPH (benign prostatic hypertrophy).

Urethra—In males, the tube that conducts urine from the bladder through the penis to the outside of the body. When narrowed by an enlarging prostate, symptoms of BPH develop.

Urinary retention—The result of progressive obstruction of the urethra by an enlarging prostate, causing urine to remain in the bladder even after urination.

shrink the prostate and may delay the need for surgery. Symptoms may not, however, improve until the drug has been used for three months or longer. Antibiotic drugs are given promptly whenever infection is diagnosed. Some medications, including **antihistamines** and some **decongestants**, can make the symptoms of BPH suddenly worse and even cause acute urinary retention, and therefore should be avoided.

Intermediate treatments

When drugs have failed to control symptoms of BPH but the physician does not believe that conventional surgery is yet needed, a procedure called transurethral needle ablation may be tried. In the office and using **local anesthesia**, a needle is inserted into the prostate and radiofrequency energy is applied to destroy the tissue that is obstructing urine flow. Another new approach is microwave hyperthermia, using a device called the Prostatron to deliver microwave energy to the prostate through a catheter. This procedure is done at an outpatient surgery center.

Surgery

For many years the standard operation for BPH has been transurethral resection (TUR) of the prostate. Under general or spinal anesthesia, a cystoscope is passed through the urethra and prostate tissue surrounding the urethra is removed using either a cutting instrument or a heated wire loop. The small pieces of prostate tissue are washed out through the scope. No incision is needed for TUR. There normally is some blood in the urine for a few days following the procedure. In a few men—less than 5% of all those having TUR—urine will continue to escape unintentionally. Other uncommon complications include a temporary rise in blood pressure with mental confusion, which is treated by giving salt solution. Impotence—the inability to achieve lasting penile erections—does occur, but probably in fewer than 10% of patients. A narrowing or stricture rarely develops in the urethra, but this can be treated fairly easily.

Alternatives to TUR, some only recently introduced, include:

- Laser ablation of the prostate. Laser energy is applied to the prostate through a special fiber passed through a cystoscope. The procedure is done in an operating room, and several patients have retained urine postoperatively.
- Transurethral incision of the prostate. Less invasive than standard TUR, an incision is made through the prostate to open up the part of the urethra passing through it. This may work well in men whose prostate is not grossly enlarged.
- Transurethral vaporization. A small roller ball is used to break up and vaporize the obstructing prostatic tissue, rather than cutting it away as in standard TUR. This is equally successful but patients usually can leave the hospital within 24 hours, and there is less blood loss.
- If the prostate is greatly enlarged—as is the case in about 5–10% of those diagnosed – an incision is made to perform an open prostatectomy, removing the entire gland under direct vision.

Alternative treatment

An extract of the **saw palmetto** (*Serenoa repens* or *S. serrulata*) has been shown to stop or decrease the hyperplasia of the prostate. Symptoms of BPH will improve after taking the herb for one to two months, but continued use is recommended.

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Prognosis

In a man without symptoms whose prostate is enlarged, it is hard to predict when urinary symptoms will develop and how rapidly they will progress. For this reasons some specialists (urologists) advise a period of "watchful waiting." When BPH is treated by conventional TUR, there is a small risk of complications but, in the great majority of men, urinary symptoms will be relieved and their quality of life will be much enhanced. In the future, it is possible that the less invasive forms of surgical treatment will be increasingly used to achieve results as good as those of the standard operation. It also is possible that new medications will be developed that shrink the prostate and eliminate obstructive symptoms so that surgery can be avoided altogether.

Prevention

Whether or not BPH is caused by hormonal changes in aging men, there is no known way of preventing it. Once it does develop and symptoms are present that interfere seriously with the patient's life, timely medical or surgical treatment will reliably prevent symptoms from getting worse. Also, if the condition is treated before the prostate has become grossly enlarged, the risk of complications is minimal. One of the potentially most serious complications of BPH, urinary infection (and possible infection of the kidneys), can be prevented by using a catheter to drain excess urine out of the bladder so that it does not collect, stagnate, and become infected.

ORGANIZATIONS

American Urological Association Foundation, 1000 Corporate Blvd., Linthicum, MD, 21090, (410) 689-3700, (410) 689-3800, (866) 746-4282, auafoundation@auafoundation.org, http://www.urologyhealth.org/.

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Entamoeba histolytica infection *see* **Amebiasis**

Enteric fever *see* **Typhoid fever**

Enterically transmitted non-A non-B *see* **Hepatitis E**

Enterobacterial infections

Definition

Enterobacterial infections are disorders of the digestive tract and other organ systems produced by a group of gram-negative, rod-shaped bacteria called Enterobacteriaceae. Gram-negative means that the organisms do not retain the violet color of the dye used to make Gram stains. The most troublesome organism in this group is ***Escherichia coli***. Other enterobacteria are species of *Salmonella*, *Shigella*, *Klebsiella*, *Enterobacter*, *Serratia*, *Proteus*, and *Yersinia*.

Description

Enterobacterial infections can be produced by bacteria that normally live in the human digestive tract without causing serious disease, or by bacteria that enter from the outside. In many cases these infections are nosocomial, which means that they can be acquired in the hospital. *Klebsiella* and *Proteus* sometimes cause **pneumonia**, ear and sinus infections, and urinary tract infections. *Enterobacter* and *Serratia* often cause bacterial infection of the blood (**bacteremia**), particularly in patients with weakened immune systems.

Diarrhea caused by enterobacteria is a common problem in the United States. It is estimated that each person in the general population has an average of 1.5 episodes of diarrhea each year, with higher rates in children, institutionalized people, and Native Americans. This type of enterobacterial infection can range from a minor nuisance to a life-threatening disorder, especially in infants, elderly persons, **AIDS** patients, and malnourished people. Enterobacterial infections are one of the two leading killers of children in developing countries.

Causes and symptoms

Causes

Enterobacterial infections in the digestive tract typically start when the organisms invade the mucous tissues that line the digestive tract. They may be bacteria that are already present in the stomach and intestines, or they may be transmitted by contaminated food and water. It is also possible for enterobacterial infections to spread by person-to-person contact. The usual incubation period is 12–72 hours.

***ESCHERICHIA COLI* INFECTIONS.** *E. coli* infections cause most of the enterobacterial infections in the United States. The organisms are categorized according to whether they are invasive or noninvasive. Noninvasive types of *E. coli* include what are called enteropathogenic *E. coli*, or EPEC, and enterotoxigenic *E. coli*, or ETEC. EPEC and ETEC types produce a bacterial poison (toxin) in the stomach that interacts with the digestive juices and causes the patient to lose large amounts of water through the intestines.

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The invasive types of *E. coli* are called enterohemorrhagic *E. coli*, or EHEC, and enteroinvasive *E. coli,* or EIEC. These subtypes invade the stomach tissues directly, causing tissue destruction and bloody stools. EHEC can produce complications leading to **hemolytic-uremic syndrome** (HUS), a potentially fatal disorder marked by the destruction of red blood cells and kidney failure. EHEC has become a growing problem in the United States because of outbreaks caused by contaminated food. A particular type of EHEC known as O157:H7 has been identified since 1982 in undercooked hamburgers, unpasteurized milk, and apple juice. Between 2–7% of infections caused by O157:H7 develop into HUS.

Symptoms

The symptoms of enterobacterial infections are sometimes classified according to the type of diarrhea they produce.

WATERY DIARRHEA. Patients infected with ETEC, EPEC, some types of *Salmonella*, and some types of *Shigella* develop a watery diarrhea. These infections are located in the small intestine, result from bacterial toxins interacting with digestive juices, do not produce inflammation; and do not usually need treatment with **antibiotics**.

BLOODY DIARRHEA (DYSENTERY). Bloody diarrhea is sometimes called **dysentery**. It is produced by EHEC, EIEC, some types of *Salmonella*, some types of *Shigella*, and *Yersinia*. In dysentery, the infection is located in the colon, cells and tissues are destroyed, inflammation is present, and antibiotic therapy is usually required.

NECROTIZING ENTEROCOLITIS (NEC). **Necrotizing enterocolitis** (NEC) is a disorder that begins in newborn infants shortly after birth. Although NEC is not yet fully understood, it is thought that it results from a bacterial or viral invasion of damaged intestinal tissues. The disease organisms then cause the **death** (necrosis) of bowel tissue or **gangrene** of the bowel. NEC is primarily a disease of **prematurity**; 60–80% of cases occur in high-risk preterm infants. NEC is responsible for 2–5% of cases in newborn intensive care units (NICU). Enterobacteriaceae that have been identified in infants with NEC include *Salmonella*, *E. coli*, *Klebsiella*, and *Enterobacter*.

Diagnosis

Patient history

The diagnosis of enterobacterial infections is complicated by the fact that viruses, protozoa, and other types of bacteria can also cause diarrhea. In most cases of mild diarrhea, it is not critical to identify the organism because the disorder is self-limiting. Some groups of patients, however, should have stool tests. They include:

- patients with bloody diarrhea,
- patients with watery diarrhea who have become dehydrated,
- patients with watery diarrhea that has lasted longer than three days without decreasing in amount,
- patients with disorders of the immune system.

The patient history is useful for public health reasons as well as helping the doctor determine what type of enterobacterium may be causing the infection. The doctor will ask about the frequency and appearance of the diarrhea as well as other digestive symptoms. If the patient is nauseated and **vomiting**, the infection is more likely to be located in the small intestine. If the patient is running a **fever**, a diagnosis of dysentery is more likely. The doctor will also ask if anyone else in the patient's family or workplace is sick. Some types of enterobacteriaceae are more likely to cause group outbreaks than others. Other questions include the patient's food intake over the last few days and whether he or she has recently traveled to countries with **typhoid fever** or **cholera** outbreaks.

Physical examination

The most important parts of the **physical examination** are checking for signs of severe fluid loss and examining the abdomen to rule out typhoid fever. The doctor will look at the inside of the patient's mouth and evaluate the skin for signs of **dehydration**. The presence of a skin rash and an enlarged spleen suggests typhoid rather than a bacterial infection. If the patient's abdomen hurts when the doctor examines it, a diagnosis of dysentery is more likely.

Laboratory tests

The most common test that is used to identify the cause of diarrhea is the stool test. Examining a stool sample under a microscope can help to rule out parasitic and protozoal infections. Routine stool cultures, however, cannot be used to identify any of the four types of *E. coli* that cause intestinal infections. ETEC, EPEC, and EIEC are unusual in the United States and can usually be identified only by specialists in research laboratories. Because of concern about EHEC outbreaks, however, most laboratories in the United States can now screen for O157:H7 with a test that identifies its characteristic toxin. All patients with bloody diarrhea should have a stool sample tested for *E. coli* O157:H7.

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KEY TERMS

Dysentery—A type of diarrhea caused by infection and characterized by mucus and blood in the stools.

Empirical treatment—Medical treatment that is given on the basis of the doctor's observations and experience.

Escherichia coli—A type of enterobacterium that is responsible for most cases of severe bacterial diarrhea in the United States.

Hemolytic-uremic syndrome (HUS)—A potentially fatal complication of *E. coli* infections characterized by kidney failure and destruction of red blood cells.

Necrotizing enterocolitis (NEC)—A disorder in newborns caused by bacterial or viral invasion of vulnerable intestinal tissues.

Nosocomial infections—Infections acquired in hospitals.

Toxin—A poison produced by certain types of bacteria.

Treatment

The initial treatment of enterobacterial diarrhea is usually empiric. Empiric means that the doctor treats the patient on the basis of the visible symptoms and professional experience in treating infections, without waiting for laboratory test results. Since the results of stool cultures can take as long as two days, it is important to prevent dehydration. The patient will be given fluids to restore the electrolyte balance and paregoric to relieve abdominal cramping.

Newborn infants and patients with immune system disorders will be given antibiotics intravenously once the organism has been identified. Gentamicin, tobramycin, and amikacin are being used more frequently to treat enterobacterial infections because many of the organisms are becoming resistant to ampicillin and cephalosporin antibiotics.

Alternative treatment

Alternative treatments for diarrhea are intended to relieve the discomfort of abdominal cramping. Most alternative practitioners advise consulting a medical doctor if the patient has sunken eyes, dry eyes or mouth, or other signs of dehydration.

Herbal medicine

Herbalists may recommend cloves taken as an infusion or ginger given in drop doses to control intestinal cramps, eliminate gas, and prevent **vomiting**. Peppermint (*Mentha piperita*) or chamomile (*Matricaria recutita*) tea may also ease cramps and intestinal spasms.

Homeopathy

Homeopathic practitioners frequently recommend *Arsenicum album* for diarrhea caused by contaminated food, and *Belladonna* for diarrhea that comes on suddenly with mucus in the stools. *Veratrum album* would be given for watery diarrhea, and *Podophyllum* for diarrhea with few other symptoms.

Prognosis

The prognosis for most enterobacterial infections is good; most patients recover in about a week or 10 days without needing antibiotics. HUS, on the other hand, has a mortality rate of 3–5% even with intensive care. About a third of the survivors have long-term problems with kidney function, and another 8% develop high blood pressure, seizure disorders, and blindness.

Prevention

The World Health Organization (WHO) offers the following suggestions for preventing enterobacterial infections, including *E. coli* O157:H7 dysentery:

- Cook ground beef or hamburgers until the meat is thoroughly done. Juices from the meat should be completely clear, not pink or red. All parts of the meat should reach a temperature of 70°C (158°F) or higher.
- Do not drink unpasteurized milk or use products made from raw milk.
- Wash hands thoroughly and frequently, especially after using the toilet.
- Wash fruits and vegetables carefully, or peel them. Keep all kitchen surfaces and serving utensils clean.
- If drinking water is not known to be safe, boil it or drink bottled water.
- Keep cooked foods separate from raw foods, and avoid touching cooked foods with knives or other utensils that have been used with raw meat.

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ORGANIZATIONS
Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

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Enterobiasis

Definition

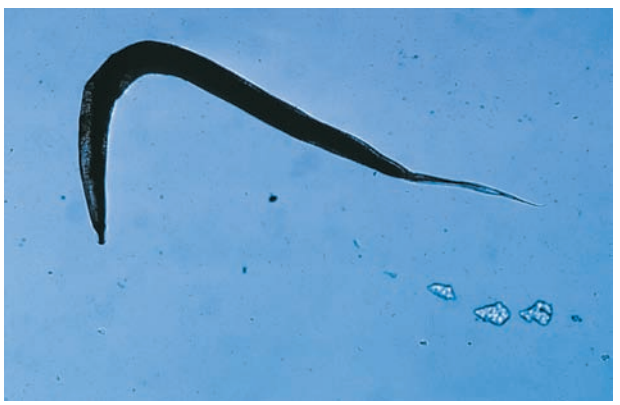
Enterobiasis, or pinworm infection as it is commonly called, is an intestinal infection caused by the parasitic roundworm called *Enterobius vermicularis*. The most common symptom of this irritating, but not particularly dangerous, disease is **itching** around the anal area.

Description

Enterobiasis is also called seatworm infection or oxyuriasis. In the United States, enterobiasis is the most common worm infection, and some estimate that approximately 10% of the United States population is infected. Worldwide, approximately 200 million people are infected. Enterobiasis can affect people of any age, but is most common among children ages 5–14 and particularly affects those in the daycare setting.

Causes and symptoms

The disease is highly contagious and is caused by a parasitic worm called *Enterobius vermicularis*. The adult female worm is about the size of a staple (approximately 0.4 in [1 cm long] and 0.02 in [0.5 mm] wide) and has a pointed tip. The disease is transmitted by ingesting the eggs of the pinworm. These eggs travel to the small intestine where, after approximately one month, they hatch and mature into adult worms. During the night, the female adult worms travel to the area around the anus and deposit eggs in the folds of the anal area. A single female pinworm can lay 10,000 eggs and, after laying eggs, dies. The eggs are capable of causing infection after six hours at body temperature.



The pinworm of the genus *Enterobius* pictured above is the source of this infestation occurring in children. *(Photo Researchers, Inc.)*

Significant itching in the anal region is caused by the movement of the adult worm as the eggs are deposited. When an individual scratches the anal region, the tiny eggs get under the finger nails and in the underwear and night clothes. Anything the individual touches with the contaminated fingers, for example, toys, bedding, blankets, bathroom door knobs, or sinks, becomes contaminated. The eggs are very hardy and can live on surfaces for two to three weeks. Anyone touching these contaminated surfaces can ingest the eggs and become infected. An individual can also become infected by inhaling and swallowing the eggs, for example, when the bedcovers are shaken.

Many individuals with enterobiasis exhibit no symptoms. When present, however, symptoms of the infection begin approximately two weeks after ingesting the pinworm eggs. The main symptom is itching around the anus. Because the itching intensifies at night, when the female worms comes to the anus to lay eggs, it often leads to disrupted sleep and irritability. Poor sleeping at night in small children can be related to pinworms. Occasionally, the itching causes some bleeding and bruising in the region, and secondary bacterial infections can occur. In females, the itching may spread to the vagina and sometimes causes an infection of the vaginal region (vaginitis). Enterobiasis usually lasts one to two months.

Diagnosis

First, a physician will rule out other potential causes of the itching, such as **hemorrhoids**, lice, or fungal or bacterial infection. Once these have been ruled out, an accurate diagnosis of enterobiasis will require that either the eggs or the adult worms are detected. Rarely, the adult worms are seen as thin, yellowish-white threads, about 0.4 in (1 cm) long, in the stools of the infected person. Usually, an hour or so after the individual goes to sleep, the adult female worms may be seen moving around laying eggs if a flashlight is shone at the rectal area.

An easier method is to observe the eggs under the microscope. In order to collect a specimen for laboratory diagnosis, the physician may provide a paddle with

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KEY TERMS

Anus—The opening through which feces are eliminated.

Hemorrhoid—An area around the anus where veins become dilated and the tissue swells, causing itching and pain.

Rectum—The end of the large intestine in which feces collects for elimination through the anus.

Vaginitis—Inflammation of the vagina.

a sticky adhesive on one side, or an individual may be instructed to place a piece of shiny cellophane tape sticky side down against the anal opening. The best time to perform this test is at night or as soon as the individual wakes up in the morning, before having a bowel movement or taking a bath or shower. The pinworm eggs will stick to the tape, which can then be placed on a specimen slide. When under a microscope in the laboratory, the eggs will be clearly visible.

Treatment

In order to treat the disease, either mebendazole (Vermox) or pyrantel pamoate (Pin-X) will be given in two oral doses spaced two weeks apart. These medications eradicate the infection in approximately 90% of cases. Re-infection is common and several treatments may be required. Because the infection is easily spread through contact with contaminated clothing or surfaces, it is recommended that all family members receive the therapeutic dose. Sometimes a series of six treatments are given, each spaced two weeks apart. If family members continue to be infected, a source outside the house may be responsible.

To relieve the rectal itching, a shallow warm bath with either half a cup of table salt, or Epsom salts is recommended. Also, application of an ointment containing zinc oxide or regular petroleum jelly can be used to relieve rectal itching.

Prognosis

Pinworms cause little damage and can be easily eradicated with proper treatment. Full recovery is expected.

Prevention

The disease can be prevented by treating all the infected cases and thus eliminating the source of infection. Some ways to keep from catching or spreading the disease include the following recommendations:

- wash hands thoroughly before handling food and eating
- keep finger nails short and clean
- avoiding scratching the anal area
- take early morning showers to wash away eggs deposited overnight
- once the infection has been identified, and treatment is started, change the bed linen, night clothes, and underwear daily
- machine wash linens in hot water and dry with heat to kill any eggs
- open the blinds or curtains since eggs are sensitive to sunlight

Resources

BOOKS

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Lata Cherath, PhD

Enterohemorrhagic *E. coli* see **Escherichia coli**

Enterostomy

Definition

An enterostomy is an operation in which the surgeon makes a passage into the patient's small intestine through the abdomen with an opening to allow for drainage or to insert a tube for feeding. The opening is called a stoma, from the Greek word for mouth. Enterostomies may be either temporary or permanent. They are classified according to the part of the intestine that is used to create the stoma. If the ileum, which is the lowest of the three sections of the small intestine, is used to make the stoma, the operation is called an ileostomy. If the jejunum, which is the middle section of the small intestine, is used, the operation is called a jejunostomy. Some people use the word *ostomy* as a word that covers all types of enterostomies.

Purpose

Enterostomies are performed in order to create a new opening for the passage of fecal matter when normal intestinal functioning is interrupted or when

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diseases of the intestines cannot be treated by medications or less radical surgery. Some situations that may require enterostomies include:

- Healing of inflamed bowel segments. Enterostomies performed for this reason are usually temporary.
- Emergency treatment of gunshot or other penetrating wounds of the abdomen. An enterostomy is needed to prevent the contents of the intestine from causing a serious inflammation of the inside of the abdominal cavity (peritonitis). These enterostomies are also often temporary.
- Placement of a tube for enteral feeding. Enteral feeding is a method for conveying nutritional solutions directly into the stomach or jejunum through a tube. Tube enterostomies may be long-term but are not permanent.
- Removal of diseased sections of the intestines. Ileostomies performed for this reason are permanent. The most common disorders requiring permanent ileostomy are Crohn's disease, familial polyposis, and ulcerative colitis. Familial polyposis and ulcerative colitis are serious health risks because they can develop into cancer.
- Treatment of advanced cancer or other causes of intestinal obstruction.

Precautions

Enterostomies are usually performed only as emergency treatments for traumatic injuries in the abdomen or as final measures for serious disorders of the intestines. Most patients do not refuse to have the operation performed when the need for it is explained to them. A small minority, however, refuse enterostomies because of strong psychological reactions to personal disfigurement and the need to relearn bowel habits.

Description

Ileostomy

Ileostomies represent about 25% of enterostomies. They are performed after the surgeon removes a diseased colon and sometimes the rectum as well. The most common ileostomy is called a Brooke ileostomy after the English surgeon who developed it. In a Brooke ileostomy, the surgeon makes the stoma in the lower right section of the abdomen. The ileum is pulled through an opening (incision) in the muscle layer. The surgeon then turns the cut end of the intestine inside out and sews it to the edges of the hole. He or she then positions an appliance for collecting the fecal material. The appliance consists of a plastic bag that fits over the stoma and lies flat against the abdomen. The patient is taught to drain the bag from time to time during the day. Ileostomies need to be emptied frequently because the digested food contains large amounts of water. Shortly after the operation, the ileostomy produces 1–2 qt.(0.9–1.9 l) of fluid per day; after a month or two of adjustment, the volume decreases to 1–2 pt (0.5–0.9) per day.

KOCK POUCH (CONTINENT ILEOSTOMY). The Kock pouch is a variation of the basic ileostomy and is named for its Swedish inventor. In the Kock technique, the surgeon forms a pouch inside the abdominal cavity behind the stoma that collects the fecal material. The stoma is shaped into a valve to prevent fluid from leaking onto the patient's abdomen. The patient then empties the pouch several times daily by inserting a tube (catheter) through the valve. The Kock technique is sometimes called a continent ileostomy because the fluid is contained inside the abdomen. It is successful in 70–90% of patients who have it done.

Jejunostomy

A jejunostomy is similar to an ileostomy except that the stoma is placed in the second section of the small intestine rather than the third. Jejunostomies are performed less frequently than ileostomies. They are almost always temporary procedures.

Tube enterostomies

Tube enterostomies are operations in which the surgeon makes a stoma into the stomach itself or the jejunum in order to insert a tube for liquid nutrients. Tube enterostomies are performed in patients who need tube feeding for longer than six weeks, or who have had recent mouth or nose surgery. As long as the patient's intestinal tract can function, **tube feedings** are considered preferable to intravenous feeding. Enteral **nutrition** is safer than intravenous fluids and helps to keep the patient's digestive tract functioning.

Preparation

Preoperative preparation includes both patient education and physical preparation.

Patient education

If the patient is going to have a permanent ileostomy, the doctor will explain what will happen during the operation and why it is necessary. Most patients are willing to accept an ostomy as an alternative to the chronic **pain** and **diarrhea** of ulcerative **colitis** or the risk of **cancer** from other intestinal disorders. The patient can also meet with an enterostomal therapist (ET) or a member of the United Ostomy Association, which is a support group for people with ostomies.

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KEY TERMS

Crohn's disease—A disease of the intestines that causes inflammation leading to scarring, thickening of the walls of the intestine, and eventual obstruction.

Duodenum—The first of the three segments of the small intestine. The duodenum connects the stomach and the jejunum.

Enteral nutrition—A technique for feeding patients with liquid formulas conveyed directly into the stomach or jejunum through tubes.

Enterostomal therapist (ET)—A specialized counselor, usually a registered nurse, who provides ostomy patients with education and counseling before the operation. After surgery, the ET helps the patient learn to take care of the stoma and appliance, and offers long-term emotional support.

Familial polyposis—A disease that runs in families in which lumps of tissue (polyps) form inside the colon. Familial polyposis may develop into cancer.

Ileum—The third segment of the small intestine, connecting the jejunum and the large intestine.

Jejunum—The second of the three segments of the small intestine, connecting the duodenum and the ileum.

Kock pouch—A type of ileostomy in which the surgeon forms an artificial rectum from a section of the ileum. A Kock pouch is sometimes called a continent ileostomy because it is drained with a tube.

Ostomy—A common term for all types of enterostomies.

Stoma—The surgically constructed mouth or passage between the intestine and the outside of the patient's body.

Tube enterostomy—An enterostomy performed to allow the insertion of a feeding tube into the jejunum or stomach.

Ulcerative colitis—A disease of the colon characterized by inflammation of the mucous lining, ulcerated areas of tissue, and bloody diarrhea.

Medical preparation

The patient is prepared for surgery with an evaluation of his or her nutritional status, possible need for blood transfusions, and **antibiotics** if necessary. If the patient does not have an intestinal obstruction or severe inflammation, he or she may be given a large quantity of a polyethylene glycol (PEG) solution to cleanse the intestines before surgery.

Aftercare

Aftercare of an enterostomy is both psychological and medical.

Medical aftercare

If the enterostomy is temporary, aftercare consists of the usual monitoring of surgical **wounds** for infection or bleeding. If the patient has had a permanent ileostomy, aftercare includes learning to use the appliance or empty the Kock pouch; learning to keep the stoma clean; and readjusting bathroom habits. Recovery takes a long time because major surgery is a shock to the system and the intestines take several days to resume normal functioning. The patient's fluid intake and output will be checked frequently to minimize the risk of **dehydration**.

Patient education

Ileostomy patients must learn to watch their fluid and salt intake. They are at greater risk of becoming dehydrated in hot weather, from **exercise**, or from diarrhea. In some cases they may need extra bananas or orange juice in the diet to keep up the level of potassium in the blood.

Patient education includes social concerns as well as physical self-care. Many ileostomy patients are worried about the effects of the operation on their close relationships and employment. If the patient has not seen an ET before the operation, the aftercare period is a good time to find out about self-help and support groups. The ET can also evaluate the patient's emotional reactions to the ostomy.

Risks

Enterostomies are not considered high-risk operations by themselves. About 40% of ileostomy patients have complications afterward, however; about 15% require minor surgical corrections. Possible complications include:

- skin irritation caused by leakage of digestive fluids onto the skin around the stoma; Irritation is the most common complication of ileostomies

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- diarrhea
- the development of abscesses
- gallstones or stones in the urinary tract
- inflammation of the ileum
- odors can often be prevented by a change in diet
- intestinal obstruction
- a section of the bowel pushing out of the body (prolapse)

Normal results

Normal results include recovery from the surgery with few or no complications. About 95% of people with ostomies recover completely, are able to return to work, and consider themselves to be in good health. Many ileostomy patients enjoy being able to eat a full range of foods rather than living on a restricted diet. Some patients, however, need to be referred to psychotherapists to deal with depression or other emotional problems after the operation.

ORGANIZATIONS

United Ostomy Association, Inc. (UOA), PO Box 512, Northfield, MN, 55057-0512, (800) 826-0826, info@ostomy.org, http://www.ostomy.org.

Rebecca J. Frey, PhD

Enterovirus infections

Definition

Enteroviruses are so named because they reproduce initially in the gastrointestinal tract after infection occurs. Despite, this, they usually do not lead to intestinal symptoms; rather it is their spread to organs, such as the nervous system, heart, skin, and others that causes disease. Enteroviruses are part of a larger group of viruses known as Picornaviruses. The word comes from the combination of "pico" (Spanish, meaning "a little bit"), and RNA (ribonucleic acid, an important component of genetic material).

Description

There are four groups of enteroviruses: Coxsackievirus, Echovirus, ungrouped Enterovirus, and Y Poliovirus.

Viruses are generally divided into those that use DNA (deoxyribonucleic acid) or RNA as their genetic material; all enteroviruses are RNA viruses. They are found worldwide, but infection is more common in areas of poor hygiene and overcrowding.

Although most cases of enterovirus do not produce symptoms, some five to 10 million individuals in the United States each year suffer from one of the enteroviral diseases. Illness is more common in the very young. While there are close to 70 different strains of enteroviruses, over 70% of infections are caused by only 10 types.

The virus is most commonly transmitted by the fecal-oral route (contamination of fingers or objects by human waste material); in some instances transmission is through contaminated food or water. Passage of some strains of virus by way of air droplets can lead to respiratory illness. Infection of fetuses by way of the placenta also has been documented. Breast milk contains antibodies which can protect newborns.

The incubation period for most enteroviruses ranges from two to 14 days. In areas of temperate climate, infections occur mainly in the summer and fall.

Causes and symptoms

Enteroviruses are believed to be the cause of at least 10 distinct illnesses. Once they enter the body, they multiply in the cells that line the gastrointestinal tract, and eventually reach sites of lymphatic tissue (such as the tonsils). While most of these diseases are of short duration and do not cause significant injury, some can produce severe illness. Each presents its own unique symptoms. And a 2003 report to the Infectious Diseases Society of America reminded physicians that infants with enteroviral infections often present early in their illnesses with no signs of **fever**, complicating diagnosis.

The main syndromes caused by the various enteroviruses are the following:

- Summer grippe (nonspecific febrile illness). This is the most common syndrome, and is characterized by flu-like symptoms of fever, headache, and weakness, that typically last three to four days. Many patients also develop upper respiratory symptoms and some nausea and vomiting. One of the major ways to distinguish this disease from influenza, is the fact that grippe most often occurs in the summer.
- Generalized disease of the newborn is a potentially serious infection in which infants from one week to three months of age develop a syndrome that can be difficult to distinguish from a severe bacterial

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infection. Fever, irritability, and decreased responsiveness or excessive sleepiness are the major symptoms. Inflammation of heart muscle (myocarditis), low blood pressure, hepatitis, and meningitis sometimes complicate the illness.

- Aseptic meningitis encephalitis is a well known syndrome caused by this group of viruses. In fact, enteroviruses are responsible for over 90% of cases of aseptic meningitis, and most often hit children and young adults. Headache, fever, avoidance of light, and eye pain are characteristic. Drowsiness may be prominent, and other symptoms include sore throat, cough, muscle pain, and rash. Occasionally, not only the meninges—the covering around the brain and spinal cord—is infected, but also brain tissue itself, producing encephalitis. The illness resolves after about a week or so, and permanent damage is unusual. Enteroviruses can also produce the Guillian-Barré syndrome, which involves weakness and paralysis of the extremities and even the muscles of respiration.
- Pleurodynia (Bornholm's disease) is due to viral infection and inflammation of the chest and abdominal muscles used for breathing. Pain occurs as acute episodes, lasting 30 minutes or so. Coxsackie B virus is the usual cause of the illness.
- Myocarditis and/or pericarditis involves infection of the heart muscle (myocardium) and the covering around the heart (pericardium). Infants and young adults are the most susceptible, and for some reason, more than two-thirds of cases occur in males. The disease usually begins as an upper respiratory tract infection with cough, shortness of breath, and fever. Chest pain, increasing shortness of breath, irregularities of cardiac rhythm, and heart failure sometimes develop. Some patients wind up with long-term heart failure if the heart muscle is significantly affected.
- Exanthems is the medical term for rashes, and enterovirus is the number one cause of summer and fall rashes in children. They occur anywhere on the body, and often resemble diseases such as measles.
- Hand-foot-and-mouth disease occurs initially as a sore throat (often involving the tongue as well), and is followed by a rash on the hands, and sometimes the feet. The rash often forms small blisters, which lead to ulcers. Symptoms generally resolve within a week. A specific Coxsackievirus (A16) is the most frequent cause of this highly infectious disease.
- Herpangina is most often caused by one of the Coxsackie A viruses, and appears as the acute onset of fever and sore throat. This last symptom is particularly severe, as the virus produces multiple ulcers in the throat. Swallowing becomes very painful; symptoms can persist for several weeks.

KEY TERMS

Antibodies—Proteins that are formed by the body and play a role in defense against infection.

Antibiotic—A medication that is designed to kill or weaken bacteria.

Meninges—Outer covering of the spinal cord and brain. Infection is called meningitis, which can lead to damage to the brain or spinal cord and lead to death.

- Acute hemorrhagic conjunctivitis involves viral infection of the conjunctiva, which is a covering around the eye. Pain, blurred vision, aversion to light, and a discharge from the eye are the main symptoms. Headache and fever occur in about one in five patients. The disease runs its course in about 10 days.

A number of other illnesses have been attributed to enteroviruses, including **pneumonia** and other respiratory infections, **myositis** or muscle inflammation, arthritis, and acute inflammation of the kidneys. It is clear then that these viruses produce a number of various illnesses, most often in younger age groups.

Diagnosis

In the majority of cases, diagnosis is based on the characteristic symptoms that the virus produces (such as the chest **pain** in pleurodynia). Rarely is it necessary to identify a specific strain of virus causing the illness. It is more important to be certain that the infection is due to a virus that does not require treatment with **antibiotics**.

Culture, or growing the organism outside of the body, is helpful only when obtained from areas that tend to indicate recent infection, such as from swollen joints, cerebrospinal fluid, or blood. Cultures from other areas, such as the throat, can be misleading. This is because the virus may remain for long periods of time in places with a large amount of lymphatic tissue. As a rule, cultures done early in the illness are more likely to identify the virus.

New techniques that involve identification of viral genetic material (PCR) are useful in certain cases, but are not indicated for routine testing.

Treatment

As noted above, enterovirus is capable of attacking many different organs and producing a variety of symptoms. Most infections are mild and improve without complications, requiring no specific therapy.

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When the virus attacks critical organs however, such as the heart, respiratory muscles, nervous system, etc., specialized care is often needed.

No effective antiviral medication for enterovirus has undergone investigation in patients, though some drugs appeared promising for the future. In some patients who are unable to produce antibodies (hypogammaglobunemia), administrating antibodies themselves is helpful.

Prognosis

The overall outlook for enterovirus infection depends on the organs involved, and the immune condition of the individual patient. Unless vital organs are involved or immunity is abnormal, infection causes few problems. On the other hand, patients who have diseases that affect antibody production can develop chronic infection of the brain or meninges. A 2003 study found that enterovirus infections can increase the risk of type 1 diabetes in children who are genetically predisposed to diabetes.

Prevention

In the hospital setting, the best means of avoiding transmission of infection is the use of good hand-washing practices and other appropriate precautions (gowns and gloves for hospital staff). The virus is found in feces for up to one week after infection; therefore precautions that isolate waste material (enteric precautions) will help decrease the chance of spreading the illness.

Resources

PERIODICALS

"Enterovirus Infections Increase Risk of Type 1 Diabetes in High-Risk Children." *Diabetes Week* June 16, 2003: 22.

Tucker, Miriam E. "Fever Often Absent in Early Enteroviral Illness (Severe Cases)." *Pediatric News* January 2003: 20–22.

OTHER

"Weekly Clinicopathological Exercises: Case 47- 1993: A 28-Year-Old Man with Recurrent Ventricular Tachycardia and Dysfunction of Multiple Organs." *New England Journal of Medicine Online*. http://content.nejm.org.

David Kaminstein, MD
Teresa G. Odle

Entropy *see* **Eyelid disorders**

Enuresis *see* **Bed-wetting**

Environmental medicine *see* **Wilderness medicine**

Enzyme therapy

Definition

Enyzme therapy is a plan of dietary supplements of plant and animal enzymes used to facilitate the digestive process and improve the body's ability to maintain balanced metabolism.

Purpose

In traditional medicine, enzyme supplements are often prescribed for patients suffering from disorders that affect the digestive process, such as **cystic fibrosis**, Gaucher's disease, and **celiac disease**. A program of enzyme supplementation is rarely recommended for healthy patients. However, proponents of enzyme therapy believe that such a program is beneficial for everyone. They point to enzymes' ability to purify the blood, strengthen the immune system, enhance mental capacity, cleanse the colon, and maintain proper pH balance in urine. They feel that by improving the digestive process, the body is better able to combat infection and disease.

Some evidence exists that pancreatic enzymes derived from animal sources are helpful in **cancer** treatment. The enzymes may be able to dissolve the coating on cancer cells and may make it easier for the immune system to attack the cancer.

A partial list of the wide variety of complaints and illnesses that can be treated by enzyme therapy includes:

- AIDS
- anemia
- alcohol consumption
- anxiety
- acute inflammation
- back pain
- cancer
- colds
- chronic fatigue syndrome
- colitis
- constipation
- diarrhea
- food allergies
- gastritis
- gastric duodenal ulcer
- gout
- headaches
- hepatitis

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KEY TERMS

Celiac disease—A chronic disease characterized by defective digestion and use of fats.

Cystic fibrosis—A genetic disease that causes multiple digestive, excretion, and respiratory complications. Among the effects, the pancreas fails to provide secretions needed for the digestion of food.

Duodenum—The first part of the small intestine.

Gaucher's disease—A rare genetic disease caused by a deficiency of enzymes needed for the processing of fatty acids.

Metabolism—The system of chemical processes necessary for living cells to remain healthy.

- hypoglycemia
- infections
- mucous congestion
- multiple sclerosis
- nervous disorders
- nutritional disorders
- obesity
- premenstrual syndrome (PMS)
- stress

Description

Origins

Enzymes are protein molecules used by the body to perform all of its chemical actions and reactions. The body manufactures several thousands of enzymes. Among them are the digestive enzymes produced by the stomach, pancreas, small intestine, and the salivary glands of the mouth. Their energy-producing properties are responsible for not only the digestion of nutrients, but their absorption, transportation, metabolization, and elimination as well.

Enzyme therapy is based on the work of Dr. Edward Howell in the 1920s and 1930s. Howell proposed that enzymes from foods work in the stomach to pre-digest food. He advocated the consumption of large amounts of plant enzymes, theorizing that if the body had to use less of its own enzymes for digestion, it could store them for maintaining metabolic harmony. Four categories of plant enzymes are helpful in pre-digestion: protease, amylase, lipase, and cellulase. Cellulase is particularly helpful because the body is unable to produce it.

Animal enzymes, such as pepsin extracted from the stomach of pigs, work more effectively in the duodenum. They are typically used for the treatment of nondigestive ailments.

The seven categories of food enzymes and their activities

- amylase breaks down starches
- cellulase breaks down fibers
- lactase breaks down dairy products
- lipase breaks down fats
- maltase breaks down grains
- protease breaks down proteins
- sucrase breaks down sugars

Enzyme theory generated further interest as the human diet became more dependent on processed and cooked foods. Enzymes are extremely sensitive to heat, and temperatures above 118°F (48°C) destroy them. Modern processes of pasteurization, canning, and microwaving are particularly harmful to the enzymes in food.

Enzyme supplements are extracted from plants like pineapple and papaya and from the organs of cows and pigs. The supplements are typically given in tablet or capsule form. Pancreatic enzymes may also be given by injection. The dosage varies with the condition being treated. For nondigestive ailments, the supplements are taken in the hour before meals so that they can be quickly absorbed into the blood. For digestive ailments, the supplements are taken immediately before meals accompanied by a large glass of fluids. Pancreatic enzymes may be accompanied by doses of vitamin A.

Preparations

No special preparations are necessary before beginning enzyme therapy. However, it is always advisable to talk to a doctor or pharmacist before purchasing enzymes and beginning therapy.

Precautions

People with **allergies** to beef, pork, pineapples, and papaya may suffer allergic reactions to enzyme supplements. Tablets are often coated to prevent them from breaking down in the stomach, and usually shouldn't be chewed or crushed. People who have

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difficulty swallowing pills can request enzyme supplements in capsule form. The capsules can then be opened and the contents sprinkled onto soft foods like applesauce.

Side effects

Side effects associated with enzyme therapy include **heartburn**, **nausea and vomiting**, **diarrhea**, bloating, gas, and **acne**. According to the principles of therapy, these are temporary cleansing symptoms. Drinking eight to 10 glasses of water daily and getting regular **exercise** can reduce the discomfort of these side effects. Individuals may also experience an increase in bowel movements, perhaps one or two per day. This is also considered a positive effect.

Plant enzymes are safe for pregnant women, although they should always check with a doctor before using enzymes. Pregnant women should avoid animal enzymes. In rare cases, extremely high doses of enzymes can result in a build up of uric acid in the blood or urine and can cause a break down of proteins.

Research and general acceptance

In the United States, the Food and Drug Administration (FDA) has classified enzymes as a food. Therefore, they can be purchased without a prescription. However, insurance coverage is usually dependent upon the therapy resulting from a doctor's orders.

Resources

OTHER

Enzyme Therapy for Your Health. http://members.tripod.com/~colloid/enzyme.htm.

Questions and Answers about Food Enzymes and Nutrition. http://www.enzymes.com.

Therapies: Enzyme Therapy. http://library.thinkquest.org/24206/enzyme-therapy.html.

Mary McNulty

Eosinophilic granuloma *see* **Histiocytosis X**

Eosinophilic pneumonia

Definition

Eosinophilic **pneumonia** is a group of diseases in which there is an above normal number of eosinophils in the lungs and blood.

KEY TERMS

Infiltrates—Cells or body fluids that have passed into a tissue or body cavity.

Sputum—Material coughed up from the throat or lungs.

Description

Eosinophilia is an increase in the number of eosinophils. Eosinophilic pneumonia is characterized by a large number of eosinophils in the lungs, usually in the absence of an **infectious disease**. Eosinophils are one of the white blood cells and are classified as a granulocyte. They are part of the non-specific immune system and participate in inflammatory reactions. Eosinophils contain cationic molecules that are useful for destroying infectious agents, especially heiminthic parasites (worms). There are several types of eosinophilic pneumonia. Loffler's pneumonia is a temporary infiltration of eosinophils into the lungs. The patient will feel tired, have a **cough**, spasms of the bronchial airway, and difficulty breathing. Loffler's pneumonia will clear spontaneously, but slowly over the course of about a month. Another form of eosinophilic pneumonia, pulmonary infiltrates with eosinophilia (PIE), is a more serious and potentially fatal disease. In PIE, the patient experiences **asthma**, pulmonary infiltrates, disorders of the peripheral nervous system, central nervous systems symptoms, and periarteritis nodosa.

Causes and symptoms

Pneumonia with eosinophils occurs as part of a hypersensitivity reaction. A hypersensitivity reaction is an over-reaction of the immune system to a particular stimulus. As part of the hypersensitive reaction, cells of the immune system are produced in increased numbers and migrate into areas targeted by the hypersensitivity reaction. In the case of eosinophilic pneumonia, the lungs are the target. Generally, eosinophilia pneumonia is not a reaction to an infection. There is a correlation between asthma and eosinophilic pneumonia. Eosinophilic pneumonia can also be caused by drugs and, in some people, by polluted air. The symptoms range from mild (coughing, **wheezing**, and **shortness of breath**) to severe and life threatening (severe shortness of breath and difficulty getting enough oxygen). The symptoms may resolve spontaneously or can persist for long periods of time. In a few cases, the disease may rapidly produce life-threatening pneumonia.

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Diagnosis

Since eosinophilia is common to a number of conditions, the physician must rule out asthma and infection by helminths when diagnosing eosinophilic pneumonia. A whole blood count will reveal an increased number of eosinophils in the blood. An x ray of the lungs may show the presence of infiltrates (the eosinophils and fluid). If sputum is produced in coughing, eosinophils will be seen instead of the more normal profile of granulocytes seen when an infectious agent is present.

Treatment

Eosinophilic pneumonia may not respond to drugs used to treat asthma. Eosinophilic pneumonia is usually treated with **steroids**, particularly glucocorticosteroids. Steroids are not effective against infectious agents, but the main disease process in eosinophilic pneumonia is an inflammatory reaction, not a response to infection. When eosinophilia is produced as a consequence of asthma or an infection by helminths, treatment of the asthma or helminths will reduce the eosinophilia.

Resources

BOOKS

Beers, Mark H., Robert S. Porter, and Thomas V. Jones, eds. *The Merck Manual of Diagnosis and Therapy*. 18th ed. Whitehouse Station, NJ: Merck Research Laboratories, 2006.

John T. Lohr, PhD

Ephedrine *see* **Bronchodilators**

Epicondylitis *see* **Tennis elbow**

Epidemic icterus *see* **Hepatitis A**

Epidemic typhus *see* **Typhus**

Epidemic viral gastroenteritis *see* **Rotavirus infections**

Epidermolysis bullosa

Definition

Epidermolysis bullosa (EB) is a group of rare inherited skin diseases that are characterized by the development of blisters following minimal pressure to the skin. Blistering often appears in infancy in response to simply being held or handled. In rarer forms of the disorder, EB can be life-threatening. There is no cure for the disorder. Treatment focuses on preventing and treating **wounds** and infection.

Description

Epidermolysis bullosa has three major forms and at least 16 subtypes. The three major forms are EB simplex, junctional EB, and dystrophic EB. These can range in severity from mild blistering to more disfiguring and life-threatening disease. Physicians diagnose the form of the disease based on where the blister forms in relation to the epidermis (the skin's outermost layer) and the deeper dermis layer.

The prevalence of epidermolysis varies among different populations. A study in Scotland estimated the prevalence to be one in 20,400. Researchers in other parts of the world estimate the prevalence to be one in 100,000. This variance is due to the variability of expression. Many cases of epidermolysis bullosa are often not accurately diagnosed and thus, are not reported.

Causes and symptoms

EB can be inherited as the result of a dominant genetic abnormality (only one parent carries the abnormal gene) or a recessive genetic abnormality (both parents carry the abnormal gene).

EB simplex results from mutations in genes responsible for keratin 5 and 14, which are proteins that give cells of the epidermis its structure. EB simplex is transmitted in an autosomal dominant fashion.

Dystrophic EB is caused by mutations in genes for type VII collagen, the protein contained in the fibers anchoring the epidermis to the deeper layers of the skin. The genetic mutations for junctional EB are found in the genes responsible for producing the protein Laminin-5. Dystrophic EB is an autosomal disorder and will only result if both parents transmit an abnormal gene during conception.

EB simplex, the most common form of EB, is the least serious form of the disease. In most affected individuals, the blisters are mild and do not scar after they heal. Some forms of EB simplex affect just the hands and feet. Other forms of EB simplex can lead to more widespread blistering, as well as hair loss and missing teeth. Recurrent blistering is annoying but not life threatening.

The second, or junctional, form of EB does not lead to scarring. However, skin on the areas prone to blistering, such as elbows and knees, often shrinks. In one variation of junctional EB, called gravis junctional EB of Herlitz, the blistering can be so severe that

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KEY TERMS

Collagen—The main supportive protein of cartilage, connective tissue, tendon, skin, and bone.

Dermis—The layer of skin beneath the epidermis.

Epidermis—The outermost layer of the skin.

Keratin—A tough, nonwater-soluble protein found in the nails, hair, and the outermost layer of skin. Human hair is made up largely of keratin.

affected infants may not survive due to massive infection and **dehydration**.

The third form of EB, dystrophic EB, varies greatly in terms of severity, but more typically affects the arms and legs. In one variation, called Hallopeau-Siemens EB, repeated blistering and scarring of the hands and feet causes the fingers and toes to fuse, leaving them dysfunctional and with a mitten-like appearance.

Diagnosis

Physicians and researchers distinguish between the three major subtypes of EB based on which layer of the epidermis separates from the deeper dermis layer of the skin below. Patients suspected of having EB should have a fresh blister biopsied for review. This sample of tissue is examined under an electron microscope or under a conventional microscope using a technique called immunofluorescence, which helps to map the underlying structure.

Knowing that a family member has EB can help establish the diagnosis, but it is possible that parents or siblings will show no sign of the disease, either because it is caused by a new genetic mutation, or because the parents are carriers of the recessive trait and do not display the disease.

Treatment

The most important treatment for EB is daily wound care. Because the skin is very fragile, care must be taken to be certain that dressing changes do not cause further damage. Tape should not be applied directly to skin and **bandages** should be soaked off. Infection is a major concern, so a topical antibiotic, such as bacitracin, mupirocin, or sulfadiazine, should be routinely applied. Among persons with recessive dystrophic EB, the anticonvulsant phenytoin is sometimes effective because it decreases production of an enzyme that breaks down collagen.

Prognosis

The prognosis of EB varies depending on the subtype of the disease. Individuals with EB simplex can live long, fulfilling lives. The severity of the junctional and dystrophic forms of EB can vary greatly. Infants affected with some forms of the disease often do not survive infancy; other forms can lead to severe scarring and disfigurement.

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University of Iowa College of Medicine. http://www.uihealthcare.com/depts/med/dermatology/index.html.

ORGANIZATIONS

American Academy of Dermatology, PO Box 4014, Schaumburg, IL, 60168-4014, (847) 240-1859, (866) 503-SKIN (7546), http://www.aad.org.

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Epididymitis

Definition

Epididymitis is an inflammation or infection of the epididymis—the long coiled tube at the back of each testicle that stores and transports sperm. Epididymitis causes swelling and **pain** in the testicle. There are many causes of epididymitis, but the most common cause is a sexually transmitted bacterial infection.

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Demographics

Epididymitis is the most common cause of pain in the scrotum of adult males. It occurs most frequently in sexually active men between the ages of 18 and 40. Epididymitis is the second most common cause of scrotal pain in adolescent males, but seldom occurs in those who are not sexually active since most cases are caused by sexually transmitted infections (STIs). Boys, older men, and homosexual men are more likely to have epididymitis caused by a non-sexually transmitted bacterial **urinary tract infection**. These are particularly common among members of the military who **exercise** for extended periods without emptying their bladders. They are also more common in males with anatomical abnormalities of the urinary tract or who have undergone surgery for urinary tract problems.

Description

Epididymitis most often stems from an STI or other infection in the urethra (the tube that drains urine from the bladder) or other parts of the urinary tract that has spread to the epididymis. In prepubescent boys epididymitis usually begins with a bladder or kidney infection that spreads to the epididymis. Acute epididymitis is usually associated with the most severe pain and swelling. It comes on quickly and subsides with treatment. Chronic epididymitis continues for more than six weeks after treatment begins or recurs frequently. If the testicle as well as the epididymis is inflamed, the condition is known as epididymo-orchitis.

Risk factors

High-risk sexual behaviors put males at risk for epididymitis caused by an STI. High-risk behaviors include multiple sexual partners, a sexual partner with an STI, or sex without a condom. A previous STI increases the risk for future STIs.

Risk factors for epididymitis caused by a non-sexually transmitted infection include:

- infection of the urinary tract, bladder, kidney, or prostate
- previous or chronic urinary tract or prostate infections
- other recent illness
- an uncircumcised penis
- an anatomical abnormality of the urinary tract, such as narrowing of the urethra
- medical procedures that can introduce bacteria into the genitourinary tract, including surgery or urinary catheterization
- prostate enlargement

Risk factors for epididymitis in boys include:

- painful urination
- a history of urinary tract infections
- abnormal bladder function
- abnormalities of the genitals and/or urinary tract

Causes and symptoms

The most common causes of epididymitis among sexually active males under age 35 are the bacteria *Chlamydia trachomatis* and *Neisseria gonorrhoeae*, the causative organisms of the STIs chlamydia and **gonorrhea**, respectively. These infections begin in the urethra and spread to the testicle. The most common cause of epididymitis in prepubescent boys, homosexual men, and older men is a urinary tract infection that spreads to the testicle. Such infections are most often caused by ***Escherichia coli*** (*E. coli*). Other bacteria, such as *Ureaplasma*, can also cause epididymitis. In prepubescent boys epididymitis is usually associated with a congenital abnormality that predisposes them to urinary tract infections.

Other causes of epididymitis include:

- bacterial infection of the prostate (prostatitis)
- infection with *Mycobacterium tuberculosis*, which causes tuberculosis (TB)
- rarely, a fungal infection
- injury or infection of the scrotum
- irritation from urine that has accumulated in the vas deferens (the sperm duct leading from the epididymitis)
- urine that has flowed backwards into the epididymitis, as can occur with heavy lifting or strain
- an enlarged prostate that obstructs the bladder outlet
- partial blockage of the urethra
- urethral catheterization
- the heart arrhythmia medication amiodarone The cause of chronic epididymitis is sometimes difficult or impossible to determine.

Epididymitis is characterized by testicular pain. Usually only one testicle is affected. The pain of acute epididymitis generally develops gradually over several hours or days and is accompanied by a sudden redness and swelling of the testicle. The symptoms of chronic epididymitis generally come on much more gradually. The affected testicle is hard and sore and the other testicle may feel tender. Enlarged lymph nodes in the groin can cause pain in the scrotum, which intensifies throughout the day and may become so severe that it is impossible to walk normally. Bowel movements can

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KEY TERMS

Acute—Sharp or severe, reaching a crisis rapidly.

Catheter—A hollow flexible tube that is inserted into a body cavity, duct, or vessel for the passage of fluids.

Chronic—Of long duration or frequent recurrence.

Epididymis—The duct between the testis and the vas deferens for the passage of sperm.

Prostate—The walnut–shaped gland that surrounds the urethra at the neck of the bladder in males and supplies fluid for semen.

Sexually transmitted infection (STI)—An infectious disease that is transmitted through sexual activity.

Testicle, testis—One of the pair of male sex glands, located in the scrotum, which produces hormones and sperm.

Urethra—The opening at the end of the penis that drains urine from the bladder.

Vas deferens—The duct that stores sperm and carries it from the epididymis to the ejaculatory duct.

increase the pain. Other symptoms of epididymitis include:

- chills
- a low-grade fever
- acute urethritis or inflammation of the urethra
- painful urination
- urgent or frequent need to urinate
- painful intercourse and/or ejaculation
- possibly a discharge from the urethra and blood in the semen
- a lump on the testicle
- pain or discomfort in the lower abdominal or pelvic region

Diagnosis

Examination

Diagnosis of epididymitis includes a medical history, sexual history, and a **physical examination**. The patient will be examined for enlarged lymph nodes in the groin, an enlarged testicle, tenderness in the area of the testicle where the epididymis attaches, and discharge from the penis. A **rectal examination** may reveal prostate tenderness or enlargement. Epididymitis may require consultation with a urologist.

Tests

Initial tests involve screening for an STI or other infection:

- urinalysis to check for the presence of bacteria and white blood cells, possibly including urine from an initial stream, mid-stream, and after a prostate massage
- urine cultures to identify the organism responsible for an infection
- tests of any discharge from the urethra and prostate gland
- a white blood cell count, which is usually elevated in the presence of infection

Procedures

Ultrasound or a nuclear scan of the testicles can reveal an enlarged epididymis and rule out conditions such as twisting of the spermatic cord (**testicular torsion**) or a testicular tumor. A nuclear scan involves injecting trace amounts of a radioactive material and using a special camera to detect areas of increased blood flow, indicating epididymitis, or decreased blood flow, indicating torsion.

Treatment

Traditional

Epididymitis is generally treated with **antibiotics** to rid the body of infection. If a pocket of pus (an **abscess**) has formed, it may need to be surgically drained. In some instances part or all of the epididymis or even the testicle must be surgically removed. An epididymectomy removes the inflamed section of the epididymis through a small incision in the scrotum. A **vasectomy** prevents fluid and sperm from passing through the epididymis. Surgery is usually performed only in cases of severe chronic epididymitis, on elderly patients undergoing prostate surgery, or when the epididymitis is caused by an underlying physical defect. However tuberculous epididymitis often requires surgical removal of a testicle.

Drugs

- Epididymitis caused by an STI or other bacterial infection is treated with antibiotics, usually for at least two weeks. Sexual partners must also be treated

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for an STI. The antibiotics must be taken exactly as prescribed, even if the symptoms disappear before the course of antibiotics is completed.

- If a second course of treatment does not completely eradicate symptoms, long-term anti-inflammatory therapy may be required.
- Tuberculous epididymitis is treated with anti-tuberculosis medications.
- Over-the-counter nonsteroidal anti-inflammatory drugs (NSAIDs), such as ibuprofen or naproxen, are used to reduce inflammation and relieve pain.
- For severe pain a local anesthetic such as lidocaine (Xylocaine) may be injected directly into the spermatic cord.
- Epididymitis caused by amiodarone is treated by temporarily discontinuing the drug or reducing the dosage.

Alternative

Although antibiotics are required to treat infections that cause epididymitis, alternative therapies can reduce inflammation and promote healing. **Fasting** is recommended for some patients, since digestion slows down the body's healing mechanisms. A water fast may be preferred, but if this is not possible, a fruit- and vegetable-juice fast or a light diet of fresh fruits and vegetables is recommended.

Traditional Chinese medicine prescribes herbal formulas designed for individuals and their particular symptoms. Herbs for treating epididymitis that are toxic and should be used only under the direct supervision of an experienced herbalist include:

- philodendron (Huang Bai) for inflammation in the lower torso
- pulsatilla for pain and swelling, especially in the genitals
- podophyllum

Other herbs for treating epididymitis include:

- echinacea
- horsetail
- saw palmetto berries
- cranberry extract
- chimaphilla

Other alternative treatments for epididymitis include:

- homeopathic remedies prescribed specifically for the individual by a homeopathic practitioner
- acupuncture, which may help ward off another infection
- aromatherapy, such as a hot sitz bath with drops of juniper berry or sandalwood to relieve symptoms of infection
- chiropractic manipulation to strengthen bladder muscles by adjusting the joints and bones in the pelvic area to help control infection

Home remedies

Epididymitis usually requires at least one or two days of bed rest until symptoms subside. Scrotal elevation is considered to be very important: the patient lies with a folded towel under the scrotum to position it above the level of the heart. This improves blood flow out of the testicle, reduces swelling and pain, and promotes healing. Other self-care for epididymitis includes:

- applying scrotal cold packs, which should be wrapped in a towel and removed every 30 minutes to avoid skin damage
- hydrotherapy—sitting in water as hot as can be tolerated for 15–30 minutes once or twice a day, to alleviate discomfort and speed recovery
- drinking plenty of fluids to treat infection
- avoiding caffeine
- using stool softeners or eating plenty of fruit, nuts, whole-grain cereals, and other foods with laxative properties to prevent constipation
- avoiding strenuous activities until symptoms disappear
- wearing an athletic supporter when resuming normal activities
- avoiding sexual activity until symptoms have disappeared and possibly for as long as one month afterward

Prognosis

Symptoms of epididymitis caused by an STI or other bacterial infection usually improve within a few days of beginning antibiotic treatment. However complete healing may take weeks or even months. Chronic epididymitis may require years of medication and ongoing treatment. Even an epididymectomy may not relieve scrotal pain.

Untreated epididymitis can lead to serious complications including:

- abscesses
- chronic epididymitis
- shrinkage (atrophy) of the affected testicle
- rarely, reduced fertility or infertility

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Prevention

Many cases of epididymitis can be prevented through monogamy, the use of **condoms**, and avoiding sex with a partner who is infected with an STI. If the epididymitis is caused by an STI, all sexual partners must be treated to prevent re-infection. Drinking plenty of fluids to increase urine flow helps prevent urine retention, which can lead to infection and epididymitis.

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ORGANIZATIONS

American Academy of Family Physicians, 11400 Tomahawk Creek Parkway, Leawood, KS, 66211-2680, (913) 906-6000, (800) 274-6000, (913) 906-6075, http://www.aafp.org/online/en/home.html.

American Urological Association, 1000 Corporate Boulevard, Linthicum, MD, 21090, (410) 689-3700, (866) RING-AUA (746-4282), (410) 689-3800, aua@AUAnet. org, http://www.auanet.org.

Lisa Frick
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Epidural abscess *see* **Central nervous system infections**

Epidural anesthetic *see* **Anesthesia, local**

Epiglottitis

Definition

Epiglottitis is an infection of the epiglottis, which can lead to severe airway obstruction.

Description

When air is inhaled (inspired), it passes through the nose and the nasopharynx or through the mouth and the oropharynx. These are both connected to the larynx, a tube made of cartilage. The air continues down the larynx to the trachea. The trachea then splits into two branches, the left and right bronchi (bronchial tubes). These bronchi branch into smaller air tubes that run within the lungs, leading to the small air sacs of the lungs (alveoli).

Either food, liquid, or air may be taken in through the mouth. While air goes into the larynx and the respiratory system, food and liquid are directed into the tube leading to the stomach, the esophagus. Because food or liquid in the bronchial tubes or lungs could cause a blockage or lead to an infection, the airway is protected. The epiglottis is a leaf-like piece of cartilage extending upwards from the larynx. The epiglottis can close down over the larynx when someone is eating or drinking, preventing these food and liquids from entering the airway.

Epiglottitis is an infection and inflammation of the epiglottis. Because the epiglottis may swell considerably, there is a danger that the airway will be blocked off by the very structure designed to protect it. Air is then unable to reach the lungs. Without intervention, epiglottitis has the potential to be fatal.

Epiglottitis is primarily a disease of two to seven-year-old children, although older children and adults can also contract it. Boys are twice as likely as girls to develop this infection. Because epiglottitis involves swelling and infection of tissues, which are all located at or above the level of the epiglottis, it is sometimes referred to as supraglottitis (*supra,* meaning above). About 25% of all children with this infection also have **pneumonia**.

Causes and symptoms

The most common cause of epiglottitis is infection with the bacteria called *Haemophilus influenzae type b*. Other types of bacteria are also occasionally responsible for this infection, including some types of *Streptococcus* bacteria and the bacteria responsible for causing **diphtheria**.

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KEY TERMS

Epiglottis—A leaf-like piece of cartilage extending upwards from the larynx, which can close like a lid over the trachea to prevent the airway from receiving any food or liquid being swallowed.

Extubation—Removal of a breathing tube.

Intubation—Putting a breathing tube into the airway.

Laryngospasm—Spasm of the larynx.

Larynx—The part of the airway lying between the pharynx and the trachea.

Nasopharynx—The part of the airway into which the nose leads.

Oropharynx—The part of the airway into which the mouth leads.

Supraglottitis—Another term for epiglottitis.

Trachea—The part of the airway that leads into the bronchial tubes.

Tracheostomy—A procedure in which a small opening is made in the neck and into the trachea. A breathing tube is then placed through this opening.

A patient with epiglottitis typically experiences a sudden **fever**, and begins having severe throat and neck **pain**. Because the swollen epiglottis interferes significantly with air movement, every breath creates a loud, harsh, high-pitched sound referred to as **stridor**. Because the vocal cords are located in the larynx just below the area of the epiglottis, the swollen epiglottis makes the patient's voice sound muffled and strained. Swallowing becomes difficult, and the patient may drool. The patient often leans forward and juts out his or her jaw, while struggling for breath.

Epiglottitis strikes suddenly and progresses quickly. A child may begin complaining of a **sore throat**, and within a few hours be suffering from extremely severe airway obstruction.

Diagnosis

Diagnosis begins with a high level of suspicion that a quickly progressing illness with fever, sore throat, and airway obstruction is very likely to be epiglottitis. If epiglottitis is suspected, no efforts should be made to look at the throat, or to swab the throat in order to obtain a culture for identification of the causative organism. These maneuvers may cause the larynx to go into spasm (laryngospasm), completely closing the airway. These procedures should only be performed in a fully-equipped operating room, so that if laryngospasm occurs, a breathing tube can be immediately placed in order to keep the airway open.

An instrument called a laryngoscope is often used in the operating room to view the epiglottis, which will appear cherry-red and quite swollen. An x-ray picture taken from the side of the neck should also be obtained. The swollen epiglottis has a characteristic appearance, called the "thumb sign."

Treatment

Treatment almost always involves the immediate establishment of an artificial airway: inserting a breathing tube into the throat (intubation); or making a tiny opening toward the base of the neck and putting a breathing tube into the trachea (tracheostomy). Because the patient's apparent level of distress may not match the actual severity of the situation, and because the disease's progression can be quite surprisingly rapid, it is preferable to go ahead and place the artificial airway, rather than adopting a wait-and-see approach.

Because epiglottitis is caused by a bacteria, **antibiotics** such as cefotaxime, ceftriaxone, or ampicillin with sulbactam should be given through a needle placed in a vein (intravenously). This prevents the bacteria that are circulating throughout the bloodstream from causing infection elsewhere in the body.

Prognosis

With treatment (including the establishment of an artificial airway), only about 1% of children with epiglottitis die. Without the artificial airway, this figure jumps to 6%. Most patients recover form the infection, and can have the breathing tube removed (extubation) within a few days.

Prevention

Prevention involves the use of a vaccine against *H. influenzae type b* (called the Hib vaccine). It is given to babies at two, four, six, and 15 months. Use of this vaccine has made epiglottitis a very rare occurrence.

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ORGANIZATIONS

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Epilepsy

Definition

Epilepsy is a chronic (persistent) disorder of the nervous system. The primary symptoms of this disease are periodic or recurring seizures that are triggered by sudden episodes of abnormal electrical activity in the brain. The term "seizure" refers to any unusual body functions or activities that are under the control of the nervous system.

Demographics

Epilepsy affects about one percent of the population. Approximately 2.3 million Americans and 40 million people throughout the world have epilepsy. It is the second most common neurological disorder. According to the Epilepsy Foundation, about 30% of the 200,000 new cases reported every year begin in childhood, particularly in early childhood and around the time of adolescence. Another period of relatively high incidence is in people over the age of 65.

Description

The word epilepsy is derived from the Greek term for seizure. Seizures can involve a combination of sensations, muscle contractions, and other abnormal body functions. Seizures may appear spontaneously—without any apparent cause—or can be triggered by a specific type of stimulus such as a flashing light. Specific cases of epilepsy may result from known causes, such as brain injury, or may have no apparent cause (referred to as *idiopathic epilepsy*). Idiopathic epilepsy may be initiated by a combination of genetic and environmental factors.

An epileptic seizure involves a transient (temporary) episode of abnormal electrical activity in the brain. During a seizure, many nerve cells within a specific region of the brain may begin to fire at the same time. This activity may then spread out over other parts of the brain. In addition to abnormal physical symptoms, seizures can bring on emotions ranging from fear, anger, and rage, to joy or happiness. During a seizure, patients may experience disorientation, spontaneous sensations of sounds, smells, visions, and distorted visual perception—such as misshapen objects and places.

Epilepsy can be caused by some event or condition that results in damage to the brain such as strokes, tumors, abscesses, trauma (physical injury), or infections such as **meningitis**. Epilepsy can also be triggered by inherited (genetic) factors or some form of injury or trauma at birth. Epilepsy cases that seem to have no readily identifiable cause are referred to as "idiopathic" cases in medical terminology. Symptoms of this disease can appear at any age. Seizures can damage and destroy brain cells and scar tissue can develop in the section of brain tissue where seizures originate.

There are many forms of epileptic seizures. The parts of the body that are affected by a seizure and the distinctive characteristics, duration and severity of the symptoms can distinguish each type of epilepsy. Patients can experience more than one type of seizure. The nature of the symptoms depends on where in the brain the seizure originated and how much of the brain is involved. Seizures can be classified as either "generalized" or "partial." Partial seizures involve abnormal activity in a specific region of the brain.

Generalized (also called tonic–clonic) seizures last about two minutes and are the result of abnormal electrical activity that spreads out over both sides or hemispheres of the brain. They were formerly referred to as grand mal seizures. The patient will usually lose consciousness and fall during the episode. The term "tonic" refers to the first phase of a generalized seizure in which the body muscles become taunt or stiff. This is followed by strong, rhythmic muscular contractions (convulsions) of the "clonic" phase. Sometimes a patient's breathing may be hampered by a brief stoppage of the respiratory muscles, causing the skin to develop a bluish tinge due to lack of oxygen.

Epileptic seizures can also be classified as complex or simple. Complex seizures generally involve a loss of consciousness, whereas simple seizures do not. Simple partial seizures can begin as a localized (focal) seizure and then evolve into a secondary generalized episode in which the initial abnormal electrical activity spreads to involve other parts of the brain. Patients may actually remember the physical and psychological events that occur during a simple seizure, such as the types of movement, emotions, and sensations, but frequently are completely unaware of the event. Partial seizures are more common in adults.

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An absence seizure (once called *petit mal*) typically results in brief periods of lack of awareness and some abnormal muscle movement. The patient generally remains conscious during the seizure episode, but may become absent–minded and unresponsive. They may also appear to be starring. Absence seizures last about 5–10 seconds.

How seizures affect a person's memory depends where in the brain seizures occur. Seizures can interfere with learning, storage, and retrieval of new information. For example, a form of epilepsy that produces seizures in the temporal lobe of the brain can cause a serious deterioration (loss) of memory function. Early treatment can help prevent or reduce **memory loss**.

In some forms of epilepsy, seizures can be triggered by a particular mental—or cognitive—activity. For example, the simple activity of reading aloud can trigger a seizure in patients with reading epilepsy. Symptoms include face **muscle spasms**. In medical terms, this type of epilepsy is referred to as idiopathic localization–related epilepsy. This means that seizures occur in one part of the brain (in this case, the temporal lobes) and that there is no apparent cause that brought on the disease.

Risk factors

Certain factors may increase the risk of epilepsy. The Mayo Clinic lists the following:

- Age: the onset of epilepsy is most common during early childhood and after age 65, but the condition can occur at any age.
- Sex: men are slightly more at risk of developing epilepsy than are women.
- Family history: a family history of epilepsy may increase the risk of developing a seizure disorder.
- Head injuries: head injuries injuries are responsible for many cases of epilepsy.
- Stroke and other vascular diseases: these conditions can lead to brain damage that may trigger epilepsy.
- Brain infections: infections like meningitis, which causes an inflammation in the brain or spinal cord, can increase the risk of epilepsy.
- Prolonged seizures in childhood: high fevers in childhood can sometimes be associated with prolonged seizures and subsequent epilepsy later in life.

Causes and symptoms

Epilepsy has many causes that have an effect on the clinical presentation of symptoms. In order for epilepsy to occur, there must be an underlying physical problem in the brain. The problem can be so mild that a person can be perfectly normal aside from having seizures. The brain has roughly 50–100 billion neurons. Each neuron can have up to 10,000 contacts with neighboring neurons. Hence, trillions of connections exist. However, only a very small area of dysfunctional brain tissue is necessary to create a persistent generator of seizures and, hence, epilepsy. The following are potential causes of epilepsy:

- genetic and/or hereditary
- perinatal neurological insults
- trauma with brain injury
- stroke
- brain tumors
- infections such as meningitis and encephalitis
- multiple sclerosis
- idiopathic (unknown or genetic)

Any of the above conditions has the potential for causing the brain or a portion of it to be dysfunctional and produce recurrent seizures. Regardless of the exact cause, epilepsy is a paroxysmal (sudden) condition. It involves the synchronous discharging of a population of neurons. This is an abnormal event that, depending on the location in the brain, will correspond to the particular symptoms of a seizure. The International League Against Epilepsy (ILAE) issued a classification of types of seizures. Individual seizure types are based on the clinical behavior (semiology) and electrophysiological characteristics as seen on an electroencephalogram (EEG). Generalized seizures included in the list include:

- tonic–clonic seizures (includes variations beginning with a clonic or myoclonic phase)
- clonic seizures, including without tonic features and with tonic features
- typical absence seizures
- atypical absence seizures
- myoclonic absence seizures
- tonic seizures
- spasms
- myoclonic seizures
- eyelid myoclonia, including without absences and with absences
- myoclonic atonic seizures
- negative myoclonus
- atonic seizures
- reflex seizures in generalized epilepsy syndromes

Partial (or focal) seizures included in the ILAE list are:

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- focal sensory seizures with elementary sensory symptoms (e.g., occipital and parietal lobe seizures) and experiential sensory symptoms (e.g., temporo–parieto–occipital junction seizures)
- focal motor seizures with elementary clonic motor signs, asymmetrical tonic motor seizures (e.g., supplementary motor seizures), typical (temporal lobe) automatisms (e.g., mesial temporal lobe seizures), hyperkinetic automatisms, focal negative myoclonus, and inhibitory motor seizures
- gelastic seizures
- hemiclonic seizures
- secondarily generalized seizures
- reflex seizures in focal epilepsy syndromes

The International League Against Epilepsy has also issued the following classification of epilepsies and epileptic syndromes:

- benign familial neonatal seizures
- early myoclonic encephalopathy
- Ohtahara syndrome
- migrating partial seizures of infancy (syndrome in development)
- West syndrome
- benign myoclonic epilepsy in infancy
- benign familial and non–familial infantile seizures
- Dravet's syndrome
- HH syndrome
- myoclonic status in nonprogressive encephalopathies (syndrome in development)
- benign childhood epilepsy with centrotemporal spikes
- early onset benign childhood occipital epilepsy (Panayiotopoulos type)
- late–onset childhood occipital epilepsy (Gastaut type)
- epilepsy with myoclonic absences
- epilepsy with myoclonic–astatic seizures
- Lennox–Gastaut syndrome
- Landau–Kleffner syndrome (LKS)
- epilepsy with continuous spike–and–waves during slow–wave sleep (other than LKS)
- childhood absence epilepsy
- progressive myoclonus epilepsies
- idiopathic generalized epilepsies with variable phenotypes include juvenile absence epilepsy, juvenile myoclonic epilepsy, and epilepsy with generalized tonic–clonic seizures only
- reflex epilepsies
- idiopathic photosensitive occipital lobe epilepsy
- other visual sensitive epilepsies
- primary reading epilepsy
- startle epilepsy
- autosomal dominant nocturnal frontal lobe epilepsy
- familial temporal lobe epilepsies
- generalized epilepsies with febrile seizures plus (syndrome in development)
- familial focal epilepsy with variable foci (syndrome in development)
- symptomatic focal epilepsies
- limbic epilepsies
- mesial temporal lobe epilepsy with hippocampal sclerosis
- mesial temporal lobe epilepsy defined by specific etiologies
- neocortical epilepsies
- Rasmussen syndrome

Classifying epilepsy is used in the evaluation and management of patients with seizure disorders. The combination of seizure type(s), etiology (cause), age of onset, family history, and other medical or neurological conditions can help identify an epilepsy syndrome. Syndrome classification schemes are revised periodically as individual components of particular categories are better understood.

The term idiopathic refers to a cause that is unknown. Cryptogenic is a term that suggests that an underlying cause is suspected, but not yet fully understood. Symptomatic is a term that is applied to epilepsies that are a result of understood underlying pathologies.

The management and prognosis vary considerably among these differing syndromes. Epilepsies that have a genetic basis can be inherited or occur spontaneously. A detailed family history can often identify other family members who have had seizures. However, because seizures are common, it is possible to have more than one family member with epilepsy, though the causes may not be related. To say that a particular type of epilepsy is genetic does not mean that it is necessarily transmitted by heredity. Often, disorders can have a genetic cause, but may be spontaneously occurring in only one member of a family. In this case, there may simply be a random mutation in that particular person's genes.

Genetic factors contribute to about 40% of all epilepsy cases. Most of the generalized epilepsy syndromes and some of the partial epilepsy syndromes have an inherited component. Medical researchers suggest that at least 500 genes may somehow be

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KEY TERMS

Aura—A sensation of a cold breeze or bright light that precedes the onset of a seizure.

Automatisms—Movements during a seizure that are semi–purposeful but involuntary.

Clonic—Referring to clonus, rapid contractions and relaxations of a muscle.

Convulsion—Involuntary contractions of body muscles that accompany a seizure episode.

Gelastic seizures—Seizures manifesting with brief involuntary laughter.

Gray matter—The portion of the brain that contains neurons, as opposed to white matter, which contains nerve tracts.

Infantile spasms—Clusters of rapid jerks followed by stiffening or jackknife movements. Usually starts in the first year of life and stops by age 4.

Idiopathic—Of unknown origin.

Lesion—A defective or injured section or region of the brain (or other body organ).

Magnetic resonance imaging (MRI)—A technique that employs magnetic fields and radio waves to create detailed images of internal body structures and organs, including the brain.

Myoclonic—A rapid, involuntary muscle contraction, particularly near the eye.

Myoclonus—Jerking, involuntary movements of the arms and legs. These may occur normally during sleep.

Neuron—A unique type of cell found in the brain and body that is specialized to process and transmit information.

Partial seizure—A seizure that starts in one particular part of the brain. The abnormal electrical activity may remain confined to that area, or may spread to the entire brain. Also called a focal seizure.

Reflex seizure—Seizure brought on by specific sensory stimuli.

Seizure—Any unusual body functions or activity that is under the control of the nervous system.

Spike wave discharge—Characteristic abnormal wave pattern in the electroencephalogram that is a hallmark of an area that has the potential of generating a seizure.

involved in the development of various forms of epilepsy. It is believed that some of these genes can make people with epilepsy more susceptible or sensitive to environmental factors that initiate or start seizures. Only a few types of epilepsy are thought to be caused by just one type of gene.

Gene mutations can cause a variety of nervous system abnormalities that are associated with epilepsy. Different mutations may lead to abnormal brain development or progressive degeneration of brain tissue. Some gene mutations make nerve cells hyperexcitable. These abnormal nerve cells can trigger outbursts of abnormal patterns of electrical activity that can initiate an epileptic seizure.

Specific gene locations (called gene markers) have been linked to various forms of the disease, such as juvenile myoclonic epilepsy. However, researchers have discovered that some individuals who possess this gene do not develop symptoms of this disease. In some pairs of identical twins with this gene, one twin may appear normal while the other develops typical symptoms of epilepsy. Thus, genetic inheritance seems to be just one of many factors that influence the possibility of developing epilepsy symptoms.

Some genetic mutations may also reduce the effectiveness of antiepileptic medication. One of the major goals of epilepsy research is to determine how a patient's genetic makeup can influence their drug therapy.

With epilepsy, symptoms vary considerably depending on the type. The common link among the epilepsies is, of course, seizures. The different epilepsies can sometimes be associated with more than one seizure type. This is the case with Lennox–Gastaut syndrome.

The specific symptoms of epilepsy accordingly depend in part on the particular seizures that occur and other medical problems that may be associated. Seizures, themselves, can take on a variety of features. A simple sustained twitching of an extremity could be a partial seizure. If a seizure arises in the occipital lobes of the brain, then a visual experience can occur. Aura is a term often used to describe symptoms that a person may feel prior to the loss of consciousness of a seizure. However, auras are, themselves, small partial seizures that have not spread in the brain to involve consciousness. Smells, well–formed **hallucinations**, **tingling** sensations, or **nausea** have all occurred

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in auras. The particular sensation can be a clue as to the location in the brain where a seizure starts. Partial seizures can then spread to involve other areas of the brain and lead to an alteration of consciousness, and possibly convulsions. In certain epilepsy syndromes such as Lennox–Gastaut, there can be more than one type of seizure experienced, such as atonic, atypical absence, and tonic–axial seizures.

Diagnosis

Examination

The diagnosis of epilepsy is relatively straightforward: when people suffer two or more seizures, they are considered to have epilepsy. However, diagnosing the specific epilepsy syndrome is much more complex. The first step in the evaluation process is to obtain a very detailed history of the illness, not only from the patient but from the family as well. In a child, this includes birth history, complications, if any, maternal history, and developmental milestones. At any age, other medical problems are also considered. Medications that have been taken or currently being prescribed are documented. Since seizures can impair consciousness, the patient may not be able to recall specifics. In these cases, family or friends that have witnessed the episodes can fill in the gaps about the particulars of the seizure. The description of the behaviors during a seizure helps to categorize the type of seizure and with the overall diagnosis.

A complete **physical examination** is performed, especially a **neurological exam**. Because seizures are an episodic disorder, abnormal neurological findings may not be present. Frequently, people with epilepsy have a normal exam. However, in some, there can be abnormal findings that can provide clues to the underlying cause of epilepsy. For example, if someone has had a **stroke** that subsequently caused seizures, then the neurological exam can be expected to reveal a focal neurological deficit such as weakness or language difficulties. In some children with seizures, there can be a variety of associated neurologic abnormalities such as **mental retardation** and **cerebral palsy** that are themselves non–specific but indicate that the brain has suffered, at some point in development, an injury or malformation. Also, subtle findings on examination can lead to a diagnosis of tuberous sclerosis. This is an autosomal dominantly inherited disorder associated with infantile spasms in 25% of cases. On examination, patients have so–called ash–leaf spots and adenoma sebaceum on the skin. There can also be a variety of systemic abnormalities that involve the kidneys, retina, heart, and gums, depending on severity.

Tests

In the course of evaluating epilepsy, a number of tests are typically ordered. Usually, **magnetic resonance imaging** (MRI) of the brain is performed. This is a scan that can help to find causes of epilepsy such as tumors, strokes, trauma, and congenital malformations. However, while MRI can reveal incredible brain details, it cannot image the presence of abnormalities in the microscopic neuronal environment. Another test that is routinely ordered is an electroencephalogram (EEG). Unlike the MRI scan, this can be considered a functional test of the brain. The EEG measures the electrical activity of the brain. Some seizure disorders or epilepsies have a characteristic EEG with particular abnormalities that can help in diagnosis. Blood tests are also frequently ordered to help screen for abnormalities that could be a factor in the cause of seizures. Occasionally, **genetic testing** is performed in those instances where a known genetic cause is suspected and can be tested. A major concern in the course of an evaluation of epilepsy is to identify the presence of life–threatening causes such as brain tumors, infections, and cerebrovascular disease.

Treatment

Traditional

Currently, no cure exists for epilepsy. However, a wide range of treatment programs are available that provide varying degrees of success in controlling the symptoms of epilepsy.

Drugs

Medication is the most effective and widely used treatment for the symptoms of epilepsy. Most medications work by interfering with or stopping the abnormal electrical activity in nerve cells that cause seizures. This form of treatment is generally referred to as anticonvulsant therapy. Medication is considered effective if the patient is free of seizures for at least one year.

As with any medication, individuals can have very different experiences with same drug. Consequently, it is difficult to predict the efficacy of treatment. A key concept of treatment is to first strive for monotherapy (or single drug therapy). This simplifies treatment and minimizes the chance of side effects. Sometimes, however, two or more drugs may be necessary to achieve satisfactory control of seizures. As with any treatment, potential side effects can be worse than the disease itself. Moreover, there is little point in controlling seizures if severe side effects limit quality of life. If a **seizure disorder** is characterized by mild, focal, or

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brief symptoms that do not interfere with routine activities, then aggressive treatments may not be advisable. Epilepsy medications do not cure epilepsy; the medications can only control the frequency and severity of seizures. A list of the most commonly used medications in the management of epilepsy includes:

- phenobarbital
- phenytoin (Dilantin, Phenytek)
- clonazepam (Klonipin)
- ethosuxamide (Zarontin)
- carbamazepine (Tegretol, Carbatrol)
- divalproex sodium (Depakote, Depakene)
- felbamate (Felbatol)
- gabapentin (Neurontin)
- lamotrigine (Lamictal)
- topiramate (Topamax)
- tiagabine (Gabatril)
- zonisamide (Zonegran)
- oxcarbazepine (Trileptal)
- leviteracetam (Keppra)

Anticonvulsants are powerful drugs that can produce a variety of side effects, including nausea, **fatigue**, **dizziness**, and weight change. They can also increase the risk of **birth defects**, especially involving the early stages of embryonic development of the nervous system if taken during **pregnancy**.

Doctors prefer to put their patients on just one type of anticonvulsant drug. Some patients, however, experience more effective relief from their epilepsy symptoms by taking a combination of two different but complementary forms of medication. The choice of medication depends on the type of seizure that affects a patient, the patient's medical history—including response to other drug therapies, their age, and gender. For example, the drug Carbamazepine is one of the most effective medications and has little impact on important cognitive functions such as thinking, memory and learning.

Newer medications generally produce fewer side effects than their predecessors. Research into **gene therapy** may ultimately be the most effective form of epilepsy treatment, but is still in the very early stages.

Unfortunately, medication is ineffective for more than one third of known cases of epilepsy. More than 30% of patients with epilepsy cannot maintain adequate control of their seizures. Some genetic mutations may reduce the effectiveness of antiepileptic medications.

Alternative

Surgery is recommended for some patients for whom medication cannot effectively control the frequency or severity of their seizures. Surgery is a treatment option only in extreme cases where doctors can identify the specific site in the brain where seizures originate. The most promising candidates for surgery are those with a single lesion on the temporal, frontal, or occipital lobes of the brain.

Prior to surgery, the patient must complete extensive testing to determine the precise patterns of seizures and to locate their point of origin in the brain. Patients spend extended stays in hospital during which their seizures are recorded on video and with the aid of EEGs. This machine records patterns of electrical activity in the brain using sensors (referred to as "electrodes") attached to various parts of the body.

The surgical procedure involves the removal of a small part of brain tissue in the "suspected" region. The anterior temporal lobe and hippocampus are the most common areas in which tissue is removed. In some studies, more than 83% of patients become free of seizures following surgery. Ninety–seven percent show significant improvement in their condition.

Vagus Nerve Stimulation (VNS) is another form of treatment for some cases of epilepsy that are unresponsive (referred to as refractory epilepsy) to other forms of medical therapy. VNS may also be recommended for patients who cannot tolerate the side effects of medication. This procedure involves implanting a device that stimulates the Vagus nerve, located in the left side of the neck. In one study, this treatment reduced seizures by 78%.

A special dietary program is another treatment option for patients who are not good candidates for surgery or who have had little success with anticonvulsant medication. This form of treatment called the Ketogenic Diet can be effective for many types of epilepsy. It is most appropriate for young children whose parents can follow the rigid requirements of the diet. Older children and adults tend to have greater difficulty in sticking to the dietary rules for an extended period of time. The Ketogenic Diet is a stringent diet that is very high in fat, but low in proteins, carbohydrates, and calories. The excessive fat produces high levels of a substance called ketones (which the body makes when it breaks down fat for energy). Somehow these ketones help reduce the incidence of epileptic seizures. The success of this form of treatment varies. For some patients, the high fat diet is the best form of treatment. For others, the diet is less effective.

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As of 2009, 153 clinical trials for the study and treatment of epilepsy were being sponsored by the National Institutes of Health (NIH)and other agencies.

A few examples include:

- The effectiveness and safety of diazepam for patients with epilepsy who receive antiepileptic drugs. (NCT00319501)
- The role played by the brain chemical serotonin in seizures. (NCT00439387)
- The effectiveness and dose requirements of levetiracetam in subjects with newly diagnosed childhood absence epilepsy. (NCT00361010)
- The effectiveness of electrical brain stimulation to reduce epileptic seizures. (NCT00344877)
- The use of simultaneous EEG and functional magnetic resonance imaging (fMRI) to study the different brain regions involved in child absence seizures and how they are related to attention and cognition. (NCT00393666)
- The effectiveness and safety of seletracetam when it is used in addition to other anti–epileptic medications by patients with partial onset seizures. (NCT00422110)
- The evaluation of standard diagnostic tests and treatments for patients with epilepsy. (NCT00013845)
- The collection of brain tissue samples for research purposes from patients undergoing surgery to treat epilepsy. (NCT00025714)
- The use of functional magnetic resonance imaging (fMRI) and diffusion tensor imaging (DTI) to examine how the brain processes tasks involving language and emotion in normal volunteers and in patients with epilepsy. (NCT00081432)

Clinical trial information is constantly updated by NIH and the most recent information on epilepsy trials can be found at: http://clinicaltrials.gov.

Prognosis

The prognosis of epilepsy varies widely depending on the cause, severity, and patient's age. Even individuals with a similar diagnosis may have different experiences with treatment. For example, in benign epilepsy of childhood with centrotemporal spikes (also called benign rolandic epilepsy), the prognosis is excellent with nearly all children experiencing remission by their teens. With childhood absence epilepsy, the prognosis is variable. In this case, the absence seizures become less frequent with time, but almost half of patients may eventually develop generalized tonic–clonic seizures. Overall, the seizures are responsive to an appropriate anticonvulsant. On the other hand, the seizures in Lennox–Gastaut syndrome are very difficult to control. In this case, however, the ketogenic diet can help. In seizures that begin in adulthood, one can expect that medications will control seizures in up to 60–70% of cases. However, in some of the more than 30% of medically intractable cases, epilepsy surgery can improve or even cure the problem.

Overall, most patients have a good chance of controlling seizures with the available treatment options. The goal of treatment is complete cessation of seizures since a mere reduction in seizure frequency and/or severity may continue to limit patients' quality of life: for instance, they may not be able to drive, sustain employment, or be productive in school.

Prevention

Head injuries are associated with many epilepsy cases. The risk can be reduced by always wearing a seat belt while riding in a car and by wearing a helmet while bicycling, skiing, riding a motorcycle or engaging in other activities with a high risk of **head injury**. **Vascular disease** may also lead to epilepsy. Limiting alcohol intake, avoiding cigarettes, eating a healthy diet and exercising regularly can reduce the risk for these diseases.

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ORGANIZATIONS

Antiepileptic Drug Pregnancy Registry, MGH East, CNY-149, 10th Floor 149 13th Street, Charlestown, MA, 02129-2000, (800) 233-2334, (617) 724-8307, info@aedpregnancyregistry.org, http://www2.massgeneral.org/aed.

Charlie Foundation to Help Cure Pediatric Epilepsy, 1223 Wilshire Blvd., Suite 815, Santa Monica, CA, 90403, (310) 393-2347, (310) 453-4585, ketoman@aol.com, http://www.charliefoundation.org.

Citizens United for Research in Epilepsy (CURE), 730 North Franklin Street, Suite 404, Chicago, IL, 60654, (312) 255-1801, (312) 255-1809, info@CUREepilepsy.org, http://www.CUREepilepsy.org.

Epilepsy Foundation, 8301 Professional Place, Landover, MD, 20785-7223, (301) 459-3700, (800) 332-1000, (301) 577-2684, postmaster@efa.org, http://www.epilepsyfoundation.org.

Epilepsy Institute, 257 Park Avenue South, New York, NY, 10010, (212) 677-8550, (212) 677-5825, website@epilepsyinstitute.org, http://www. epilepsyinstitute.org.

Epilepsy Therapy Project, P.O. Box 742, Middleburg, VA, 20118, (540) 687-8077, (540) 687-8066, epilepsytherapy@epilepsytherapy.org, http://www.epilepsy.com.

National Institute of Neurological Disorders and Stroke (NINDS), PO Box 5801, Bethesda, MD, 20824, (301) 496-5751, (800) 352-9424, http://www.ninds.nih.gov.

People Against Childhood Epilepsy (PACE), 7 East 85th Street, Suite A3, New York, NY, 10028, (212) 665-PACE, (212) 327-3075, pacenyemail@aol.com, http://www.paceusa.org.

Monique Laberge, PhD
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Epinephrine *see* **Bronchodilators**

Episiotomy

Definition

An episiotomy is a surgical incision made in the area between the vagina and anus (perineum). This is done during the last stages of labor and delivery to expand the opening of the vagina to prevent tearing during the delivery of the baby.

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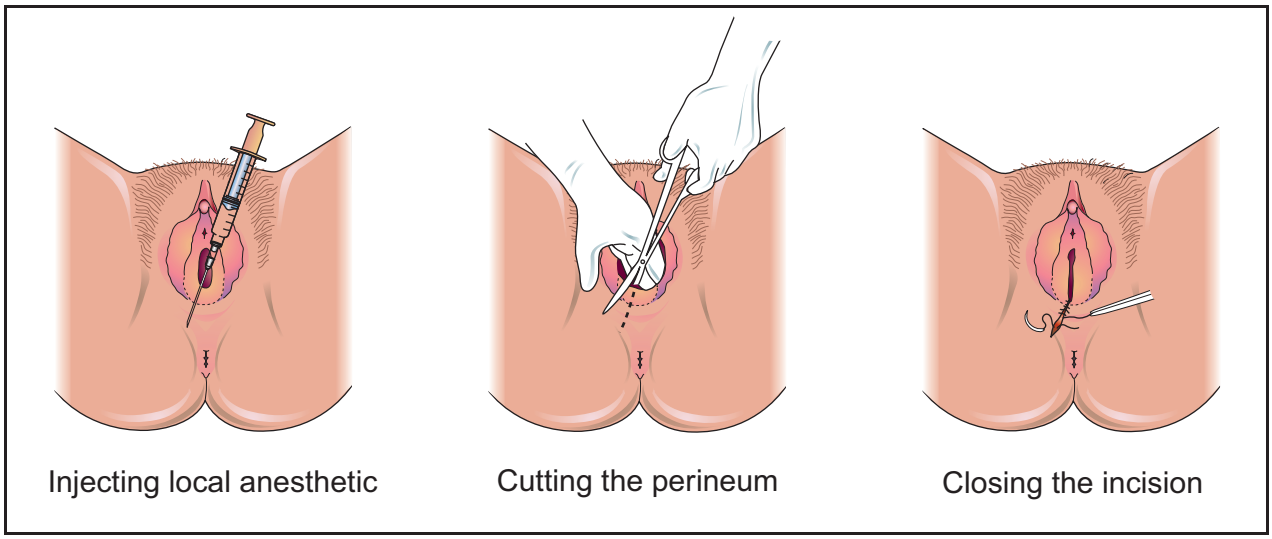

An episiotomy is a surgical incision made in the perineum, the area of tissue between the vaginal opening and the anus, during the birthing process. This procedure may be used if the tissue around the vaginal opening begins to tear or is not stretching enough to allow the baby to be delivered vaginally. In the United States, the rate of episiotomies being performed is estimated at 65–95%. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Purpose

This procedure is usually done during the delivery or birthing process when the vaginal opening does not stretch enough to allow the baby to be delivered without tearing the surrounding tissue.

Precautions

Prior to the onset of labor, pregnant women may want to discuss the use of episiotomy with their care providers. It is possible that, with adequate preparation and if the stages of labor and delivery are managed with adequate coaching and support, the need for an episiotomy may be reduced.

Description

An episiotomy is a surgical incision, usually made with sterile scissors, in the perineum as the baby's head is being delivered. This procedure may be used if the tissue around the vaginal opening begins tearing or does not seem to be stretching enough to allow the baby to be delivered.

In most cases, the physician makes a midline incision along a straight line from the lowest edge of the vaginal opening to toward the anus. In other cases, the episiotomy is performed by making a diagonal incision across the midline between the vagina and anus. This method is used much less often, may be more painful, and may require more healing time than the midline incision. After the baby is delivered through the extended vaginal opening, the incision is closed with stitches. A local anesthetic agent may be applied or injected to numb the area before it is sewn up (sutured).

Several reasons are cited for performing episiotomies. Some experts believe that an episiotomy speeds up the birthing process, making it easier for the baby to be delivered. This can be important if there is any sign of distress that may harm the mother or baby. Because tissues in this area may tear during the delivery, another reason for performing an episiotomy is that a clean incision is easier to repair than a jagged tear and may heal faster. Although the use of episiotomy is sometimes described as protecting the pelvic muscles and possibly preventing future problems with **urinary incontinence**, it is not clear that the procedure actually helps.

The use of episiotomy during the birthing process is fairly widespread in the United States. Estimates of episiotomy use in hospitals range from 65–95% of deliveries, depending on how many times the mother has given birth previously. This routine use of episiotomy is being reexamined in many hospitals and health care settings. However, an episiotomy is always necessary during a forceps delivery because of the size of the forceps.

Preparation

It may be possible to avoid the need for an episiotomy. Pregnant women may want to talk with their

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KEY TERMS

Kegel exercises—A series of contractions and relaxations of the muscles in the perineal area. These exercises are thought to strengthen the pelvic floor and may help prevent urinary incontinence in women.

Perineum—The area between the opening of the vagina and the anus in a woman, or the area between the scrotum and the anus in a man.

Sitz bath—A shallow tub or bowl, sometimes mounted above a toilet, that allows the perineum and buttocks to be immersed in circulating water.

Urinary incontinence—The inability to prevent the leakage or discharge of urine. This situation becomes more common as people age, and is more common in women who have given birth to more than one child.

care providers about the use of episiotomy during the delivery. Kegel exercises are often recommended during the **pregnancy** to help strengthen the pelvic floor muscles. Prenatal perineal massage may help to stretch and relax the tissue around the vaginal opening. During the delivery process, warm compresses can be applied to the area along with the use of perineal massage. Coaching and support are also important during the delivery process. A slowed, controlled pushing during the second stage of labor (when the mother gets the urge to push) may allow the tissues to stretch rather than tear. Also, an upright birthing position (rather than one where the mother is lying down) may decrease the need for an episiotomy.

Aftercare

The area of the episiotomy may be uncomfortable or even painful for several days. Several practices can relieve some of the **pain**. Cold packs can be applied to the perineal area to reduce swelling and discomfort. Use of the **Sitz bath** available at the hospital or birth center can ease the discomfort, too. This unit circulates warm water over the area. A squirt bottle with water can be used to clean the area after urination or defecation rather than wiping with tissue. Also, the area should be patted dry rather than wiped. Cleansing pads soaked in witch hazel (such as Tucks) are very effective for cleaning the area and also feel soothing.

Risks

Several side effects of episiotomy have been reported, including infection, increased pain, prolonged healing time, and increased discomfort once sexual intercourse is resumed. There is also the risk that the episiotomy incision will be deeper or longer than is necessary to permit the birth of the infant. There is a risk of increased bleeding.

Normal results

In a normal and well managed delivery, an episiotomy may be avoided altogether. If an episiotomy is deemed to be necessary, a simple midline incision will be made to extend the vaginal opening without additional tearing or extensive trauma to the perineal area. Although there may be some pain associated with the healing of the episiotomy incision, relief can usually be provided with mild pain relievers and supportive measures, such as the application of cold packs.

Abnormal results

An episiotomy incision that is too long or deep may extend into the rectum, causing more bleeding and an increased risk of infection. Additional tearing or tissue damage may occur beyond the episiotomy incision, leaving a cut and a tear to be repaired.

Resources

OTHER

Childbirth.org. http://www.childbirth.org.

Altha Roberts Edgren

Epispadias *see* **Hypospadias and epispadias**

Epistaxis *see* **Nosebleed**

EPS *see* **Electrophysiology study of the heart**

Epstein-Barr virus

Definition

Epstein-Barr virus, or EBV, is the name given to a member of the herpesvirus family that is associated with a variety of illnesses—from **infectious mononucleosis** (IM) and **multiple sclerosis** to nasopharyngeal

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cancer and Burkitt's lymphoma. EBV is also known as human herpesvirus 4 or HHV-4. It is named for Anthony Epstein and Yvonne Barr, who identified the virus in 1964 in tissue samples sent to them from Uganda by Denis Burkitt (1911–1993), for whom Burkitt's lymphoma was named.

Demographics

EBV occurs in nearly all regions of the world, and is considered among the most common infectious viruses known to humankind. It is likely as of 2009 that its genetic diversity is greater than was thought when it was first identified. In the United States, the Center for Disease Control (CDC) estimates that 95% of adult Americans between the ages of 35 and 40 years have been infected with EBV, but it is less prevalent in children and teenagers. This pattern of infecting adults more than children persists throughout other prosperous Western countries, but does not hold true in underdeveloped regions such as Africa and Asia. In Africa, most children have been infected by EBV by the age of three years.

About 10% of cancers of the stomach are associated with EBV. The reason for this association is not known as of 2009.

Nasopharyngeal cancer is uncommon in the West but more prevalent in the Far East. It affects three times as many men as women, and usually occurs in adults between the ages of 40 and 50 years. This type of cancer is diagnosed in fewer than 1 in every 100,000 Caucasians but in 10–53 persons per 100,000 in mainland China, Taiwan, Hong Kong, and Malaysia. It also occurs more frequently in Eskimos in Greenland and Alaska, and in Tunisians, with about 20 cases per 100,000 people per year. The prevalence rate for adults of Asian descent in the United States is 3–4.2 cases per 100,000 persons per year. Nasopharyngeal cancer accounts for less than 1% of malignancies in children. It affects 1 in every 100,000 children in North America and Europe each year, but between 8 and 25 of every 100,000 children in Asia.

Description

Herpesviruses have long been known. The name actually comes from the Greek adjective *herpestes*, which means creeping. Many herpesvirus species appear to establish a lifelong presence in the human body, remaining dormant for long periods and becoming active for some, often inexplicable, reason. EBV is only one of several members of the Herpesvirus family that have similar traits. Others include varicella zoster virus—the cause of both **chickenpox** and shingles—, and the herpes simplex virus responsible for both **cold sores** and **genital herpes**. EBV is usually transmitted through saliva but not blood, and is not normally an airborne infection.

Individuals with EBV infections typically show some elevation in the **white blood cell count** and a noticeable increase in lymphocytes—white blood cells associated with the immune response of the body. IM is a time-limited infection that usually lasts from one to two months. Symptoms include **fever**, malaise, **sore throat**, **swollen glands** and (sometimes) swollen spleen and/or liver.

EBV infections that lead to Burkitt's lymphoma in Africa typically affect the jaw and mouth area, while the (very rare) incidences of Burkitt's lymphoma found in developed countries are more apt to manifest tumors in the abdominal region, most commonly in the intestines, kidneys, or ovaries.

Causes and symptoms

EBV and mononucleosis

EBV is normally transmitted by contact with the saliva of an infected person; it is not ordinarily transmitted through the air. The virus takes about 4 to 6 weeks to incubate, and thus infected persons can spread the disease to others over a period of several weeks. After entering the patient's mouth and upper throat, the virus infects B cells, which are a certain type of white blood cell produced in the bone marrow. The infected B cells are then carried into the lymphatic system, where they affect the liver and spleen and cause the lymph nodes to swell and enlarge. The infected B cells are also responsible for the fever, swelling of the tonsils, and sore throat that characterize mononucleosis.

Most people who become infected with EBV do not have any symptoms, however. In children, EBV infection is usually asymptomatic; when it does cause symptoms, they are difficult to distinguish from routine mild childhood infections. Teenagers who were not exposed to EBV in childhood have a 35% to 50% chance of developing infectious mononucleosis (IM) from EBV. The most common symptoms of IM in teenagers are fever, sore throat, and swollen lymph glands. The patient may also have an enlarged spleen and liver.

After the symptoms of mononucleosis go away, the EBV virus remains in a few cells in the patient's throat tissues or blood for the rest of the person's life. The virus occasionally reactivates and may appear in samples of the person's saliva, but it does not cause

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KEY TERMS

B cell—A type of white blood cell produced in the bone marrow that makes antibodies against viruses.

Lymphocyte—Any of a group of white blood cells of crucial importance to the immune system's production of a tailor-made defense against specific invading organisms.

Lymphoma—A group of cancers in which the cells of tissue usually found in the lymph nodes or spleen multiply abnormally.

Malaria—A serious disease prevalent in the tropics. It is caused by parasites and produces severe fever and sometimes complications affecting the kidneys, liver, brain, and blood. It is spread by the Anopheles mosquito and can be fatal.

Nasopharyngeal—Referring to the passage connecting the nasal cavity behind the nose to the top of the throat behind the soft palate.

new symptoms of illness. EBV infection does not cause any problems during **pregnancy**, such as miscarriages or **birth defects**.

EBV and cancer

EBV has been linked to IM in the Western world for decades. It has also become associated consistently with nasopharyngeal cancers in Asia (especially China) and Burkitt's lymphoma in Africa and Papua New Guinea. According to the CDC, EBV is not the sole cause of these two malignancies, but does play an important role in the development of both cancers. The mechanism that allows Epstein-Barr virus to at least help in producing such diverse illnesses in diverse regions of the world has been the subject of increasing research and scrutiny. One theory regarding the higher rate of nasopharyngeal cancer in Asia is that EBV interacts with chemicals called nitrosamines, used in the preparation of salted fish and other preserved foods popular in the region, to trigger changes in cells that lead to cancer.

It is known that EBV is one of the herpesviruses that remain in the human body for life. Under certain, still not-understood conditions, it alters white blood cells normally associated with the immune system, changing the B cells (white blood cells normally associated with making antibodies), and causing them to reproduce uncontrollably. EBV can bind to these white blood cells to produce a solid mass made up of B cells—called Burkitt's lymphoma—or to the mucous membranes of the mouth and nose and cause nasopharyngeal cancer. Since Burkitt's lymphoma typically occurs in people living in moist, tropical climates, the same regions where people usually contract **malaria**, some doctors speculate that the immune system is altered by its response to malaria. When EBV infection occurs, the altered immune system reacts by producing a tumor.

Special concerns

Though studies about the hereditary tendency of abnormal cell development after EBV infection are incomplete, researchers have found it to be associated with abnormalities on multiple human chromosomes, including chromosomes 1, 2, 3, 4, 5, 6, 8, 9, 11, 13, 14, 15, 16, 17, 22, and the X chromosome.

Diagnosis

The diagnosis of mononucleosis caused by EBV is usually based on the results of blood tests combined with the doctor's examination of the patient's throat and neck. The doctor will also tap on or feel the patient's abdomen to see whether the liver and spleen have become enlarged.

A patient infected by EBV will have an increased number of white blood cells in the blood sample, an increased number of abnormal white blood cells, and antibodies to the Epstein-Barr virus. These antibodies can be detected by a test called the monospot test, which gives results within a day but may not be accurate during the first week of the patient's illness. Another type of blood test for EBV antibodies takes longer to perform but gives more accurate results within the first week of symptoms.

Treatment

Traditional

Drugs

Because EBV infections are viral in origin, **antibiotics** are ineffective against them. Much research is geared toward the development of a vaccines effective against both the virus and cancer.

Treatment for mononucleosis caused by EBV consists of self-care at home until the symptoms go away. Patients should rest in bed if possible and drink plenty of

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fluids. Nonaspirin **pain** relievers like Advil or Tylenol can be taken to bring down the fever and relieve muscle aches and pains. Throat lozenges or gargling with warm salt water may help ease the discomfort of a sore throat.

Because mononucleosis can affect the spleen, patients should avoid vigorous **exercise** or contact sports for at least one month after the onset of symptoms or until the spleen returns to its normal size. This precaution will lower the risk of rupture of the spleen.

With regard to cancers associated with EBV, such **anticancer drugs** as cyclophosphamide or **radiation therapy** have been shown to be effective against Burkitt's lymphoma in four out of five cases.

Alternative

The goal of alternative treatment is to lower the white blood cell count to normal levels. Treatment often includes such **nutritional supplements** as flaxseed oil or shark cartilage, vitamins—including **vitamins** C and K, and mineral supplements containing magnesium and potassium. Well-conducted randomized clinical trials have not yet been conducted to prove the efficacy of these therapies.

Prognosis

Mononucleosis caused by EBV rarely leads to serious complications. In most patients, the fever goes down in about 10 days but **fatigue** may last for several weeks or months. Some people do not feel normal again for about three months. A patient who feels sick longer than 4 months, however, should go back to the doctor to see whether they have another disease or disorder in addition to mononucleosis. In some cases the patient is diagnosed with **chronic fatigue syndrome** or CFS. The Epstein-Barr virus does not cause CFS; however, it appears to make some patients with mononucleosis more susceptible to developing chronic fatigue syndrome.

The prognosis for nasopharyngeal cancer associated with EBV in adults is poor, because about 60% of these cancers have already metastasized to other regions of the head and neck by the time diagnosis is made. The prognosis for this type of cancer in children is also relatively poor. The survival rates for children treated only with radiation therapy are about 45%. When **chemotherapy** and radiation therapy are used together, long-term survival rates range from 55% to 80%.

Prevention

As of 2009 there is no vaccine that can prevent mononucleosis caused by EBV. In addition, the fact that many people can be infected with the virus and transmit it to others without having symptoms of the disease means that mononucleosis is almost impossible to prevent. The best precautionary measure is for patients who have been diagnosed with mono to avoid kissing or other close personal contact with others, and to wash their drinking glasses, food dishes, and eating utensils separately from those of other family members or friends for several days after the fever goes down. It is not necessary for people with mono to be completely isolated from other people, however.

Because the Epstein-Barr virus remains in the body after the symptoms of mononucleosis go away, people who have had IM should not donate blood for at least 6 months after their symptoms started.

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International Association for Research on Epstein-Barr Virus and Related Diseases, [site hosted at Baylor College of Medicine, Houston, TX], ebv-webmaster@bcm.edu, http://www.bcm.edu/ebvassociation/index.htm.

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Epstein-Barr virus test

Definition

The Epstein-Barr virus test is a blood test, or group of tests, to determine the presence or absence of antibodies in the blood stream directed against proteins of the Epstein-Barr virus, the cause of **infectious mononucleosis**.

Purpose

The test is primarily used to detect whether first time infection (called primary infection) with the Epstein-Barr virus is currently occurring, or has occurred within a short period of time. The pattern of the antibodies detected can, however, tell if the person has never been infected with the Epstein-Barr virus, or if the infection occurred in the more distant past. These tests are mostly utilized in the diagnosis of Epstein-Barr virus-associated infectious mononucleosis when the more common diagnostic test, the heterophile antibody, is negative, or in situations where the infection is manifesting unusual symptoms. Therefore, the tests are often not needed in a situation where a doctor believes that a person has mononucleosis and the heterophile test (also called the monospot test) is positive.

In addition, Epstein-Barr virus testing is usually not needed in the evaluation of a patient who has long-lasting **fatigue**, and may have the **chronic fatigue syndrome**. Initially, it was thought that discovering a particular pattern of antibodies to this virus was helpful in the diagnosis of chronic fatigue syndrome, but this no longer appears to be the case.

Precautions

As in any blood test, standard precautions should be performed to prevent infection at the site where the blood is obtained, and to prevent excess bleeding. Normally, the site is cleaned with an antiseptic liquid prior to the blood being obtained; a sterile non-reusable needle and syringe are used; and, once the needle is removed, pressure is placed at the site until bleeding has stopped.

Description

These tests are more often performed in a consulting laboratory than at a physician's office or in a hospital laboratory. Like most antibody tests, they are performed on serum, the liquid part of the blood obtained after the whole blood is allowed to clot in a tube. Antibodies can be detected against several components of the Epstein-Barr virus (EBV). These components are the EBV early antigen (EA), the viral capsid antigen (VCA), and the nuclear antigen (EBNA). These several antigens are different proteins that are produced in the process (stages) of the virus' growth.

At the time of infection with Epstein-Barr virus, antibodies to EA are found and usually last for four to six months only. This antibody, however, persists substantially longer in about 10% of persons who have had EBV infection in the more remote past. The absence of antibody to EA when other EBV antibodies are present strongly suggests that first time infection with EBV occurred in the past.

Antibody to VCA is found both early and late in EBV infection. At the time of infection, antibody of both the IgM and IgG types are detectable. After four to six months, usually, only the IgG antibody against VCA can be found.

Unlike antibodies to EA and VCA, antibody to EBNA does not usually develop until recovery from first time infection of this virus. Therefore, finding detectable amounts of antibody to EBNA during an illness which might be caused by EBV makes the causal relationship very unlikely.

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Preparation

The skin area from which the blood sample will be obtained is wiped with an antiseptic such as alcohol or iodine.

Aftercare

The aftercare is similar to that for any blood test. Usually, pressure is applied to the area for several moments until bleeding stops. If the results are difficult to interpret, it may be necessary to re-test later, after waiting one to three weeks. The change in the amounts of antibody detected between the two tests can be particularly useful, at times, in helping to make a diagnosis.

Risks

There are no risks over and above those of having blood drawn for any other purpose. These tests are more expensive than many other blood tests but are usually covered by medical insurance.

Normal results

The pattern of the three antibodies can be used to determine whether the person has not had infection with EBV to this point (is susceptible to infection); is currently, or recently, infected with EBV for the first time; or has had first time infection with EBV sometime in the past (more than six months ago).

If one defines "normal" results as either not having EBV in the past, and call that category one; or having had it in the past, and call that category two. Most young children below the age of five will fall into category one, while most adults over the age of 20 years will fall into category two.

The results for susceptibility are:

- antibody to EA = negative
- antibody to VCA (either IgM or IgG) = negative
- antibody to EBNA = negative

The results for past infection are:

- antibody to EA = negative (90% of time)
- antibody to VCA IgM = negative
- Antibody to VCA IgG = positive
- Antibody to EBNA = Positive.

It is important to realize that the Epstein-Barr virus, like all the human herpes viruses, does not totally leave the body after the patient recovers from illness. With EBV, the virus will intermittently recur in the saliva of people without any symptoms. Such people will have a test pattern of previous infection. It is this group of people who can transmit EBV to others without themselves being ill.

Abnormal results

The results for current or recent infection are:

- antibody to EA = positive
- antibody to VCA IgM = positive
- antibody to VCA IgG = positive
- antibody to EBNA = negative.

Without the pattern of the three antibodies, it can be difficult to be accurate in interpretation. The presence of antibody to VCA IgM is the best single test for current or recent first time infection.

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ERCP *see* **Endoscopic retrograde cholangiopancreatography**

Erectile disorder *see* **Impotence**

Erectile dysfunction

Definition

Erectile dysfunction (ED) is the consistent inability to achieve or maintain a penile erection that is sufficient for satisfactory sexual intercourse.

Demographics

It is estimated that 15–30 million American men suffer from some degree of ED. Of these, 10–20 million have severe ED resulting in the complete inability to attain or maintain a penile erection. As the population ages, the number of American men with ED is projected to increase by nearly 10 million by 2025. The worldwide incidence of ED is projected to be more than 320 million by 2025.

The incidence of ED increases with advancing age, along with the incidence of chronic disorders and conditions that are commonly associated with ED, including diabetes, **hypertension**, and cardiovascular disease.

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It is estimated that 26% of men in their 50s, 40% of men in their 60s, and 77% of men 75 and older have some degree of ED. However ED is notorious for being underreported, undiagnosed, and under–treated due to its perceived stigma. It is estimated that 70% of ED cases remain undiagnosed. In a survey of general medical practice, less than 12% of men with ED reported having received treatment. Thus, the true incidence of ED may be much higher than most estimates.

Description

ED is defined as the consistent inability to achieve or maintain an erection, usually associated with **fatigue**, anger, depression, or other stressful emotions. However the term "impotence" is now rarely used because of its association with weakness and lack of power.

Penile erection occurs when the penis becomes engorged with blood. The anatomical compartments—the two corpora cavernosa and the corpus spongiosum—can be distended with up to seven times the normal amount of blood. This change results in an erection in association with the relaxation of the penile muscles.

The sequence of events resulting in penile erection is complex. Erection is usually initiated by sexual arousal stimuli in the brain as a result of visual, auditory, or olfactory sensations or erotic thoughts. Tactile (touch) sensations of the penis, acting through the spinal cord, play a similar role. Sexual arousal results in the release of nitric oxide from specialized cells. Nitric oxide causes the formation of cyclic glutamine monophosphate (cGMP), which is responsible for dilating the blood vessels of the penis and relaxing the penile muscles, enabling increased blood flow and erection. Compression of the dilated blood vessels against the firm outer lining of the penis prevents the blood from escaping and perpetuates the erection. An enzyme called phosphodiesterase 5 (PDE5) causes the breakdown of cGMP and, along with nerves from the sympathetic nervous system, enables the penis to return to its flaccid relaxed state. Any defect in this complex cascade of events can result in ED.

Sex is an important quality–of–life issue for adults of all ages and ED usually results in a reduced quality of life. Many affected men experience depression, distress, and relationship difficulties as a result of ED. Despite this, ED sufferers often fail to seek help. Reasons for this failure include:

- ignorance of the availability of safe and effective ED therapies
- inadequate information from physicians about the timing of medications, the need for preliminary sexual arousal, and other factors
- concerns about marital discord and a lack of partner support
- concerns about invasiveness, adverse effects, discomfort, inconvenience, and cost of therapies
- high rates of discontinuation of therapy due to inadequate responses and adverse effects

Risk factors

ED is frequently associated with vascular conditions such as hypertension and coronary artery heart disease and may even serve as marker for detection of cardiovascular disorders. Additionally ED is associated with depression that is distinct from depression resulting from ED. Lifestyle factors—such as **obesity**, physical inactivity, cigarette **smoking**, and excessive intake of alcohol—are also risk factors for ED.

Causes and symptoms

Because of the complicated nature of the human sexual response and the complex physiology of penile erection and relaxation, it is often difficult or even impossible to determine the cause of an individual case of ED precisely. Often ED is the result of multiple factors. Normal erectile function requires the coordination of vascular, neurologic, hormonal, and psychological components and any condition that interferes with one or more of these processes can result in ED.

Although the incidence of ED increases with advancing age it is no longer regarded as an inevitable consequence of **aging**. Likewise, whereas most cases of ED were once considered primarily psychological and/or psychiatric in origin, it is now recognized that organic, non–psychological factors play a much more significant role, with physical causes being responsible for at least 80% of cases. However significant psychological and social factors—such as guilt, depression, **anxiety**, tension, or marital discord—are often present in addition to one or more underlying physical components:

- Diabetes mellitus is the single most common cause of ED, as a result of combined nerve and blood vessel damage. As many as 50% of male diabetics have ED.
- Hardening of the arteries (arteriosclerosis) is the most common vascular (circulation–related) cause of ED. Diseases of the aorta or the arteries supplying the pelvis and penis or damage to arteries from trauma, surgery, or irradiation can cause ED. Surgery involving the prostate gland may affect both arteries and nerves.
- A variety of diseases and factors can influence penile circulation. For example Peyronie's disease, characterized by fibrous tissue and bending of the penis,

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KEY TERMS

Dopamine—A chemical in brain tissue that transmits nerve impulses (a neurotransmitter) and helps to regulate movement and emotions.

Hypertension—Abnormally high arterial blood pressure, which if left untreated can lead to heart disease and stroke.

Hypogonadism—Functional incompetence of the male gonads, with impaired production of hormones and germ cells.

Prolactin—A hormone produced by the pituitary gland.

Prostate—The walnut–shaped gland that surrounds the urethra at the neck of the bladder in males and supplies fluid for semen.

Testosterone—The primary male sex hormone.

Urethra—The tube in the penis that discharges urine from the bladder to the outside of the body.

limits the expandability of penile tissues and prevents venous compression, enabling blood to exit the penis. Arteriosclerotic plaque, injury to the inner lining blood vessels from trauma, surgery, or irradiation, or aortic occlusion (blockage in a main artery leading out of the heart) can compromise penile blood flow and prevent erection.

- Neurological causes of ED include diseases of the brain and spinal cord, such as Alzheimer's disease or multiple sclerosis, respectively.
- Hormonal or endocrine causes of ED are uncommon, although deficient testicular function and low circulating levels of the male sex hormone testosterone can result in erectile dysfunction. These are referred to as hypogonadism and can be due to congenital abnormalities or testicular disease.
- Various classes of medications can cause ED, although not all drugs within a class have the same effects. For example some antidepressants are associated with ED, whereas the antidepressant trazodone (Desyrel) tends to prolong penile erection. Some high blood pressure medications, central nervous system medications such as methyldopa for **Parkinson's disease**, sedatives or tranquilizers such as barbiturates, and anti–anxiety medications such as diazepam (Valium) also can cause ED.
- Tobacco, alcohol, and illicit drugs, including heroin, can cause ED.
- Psychological factors—including stress, fatigue, depression, guilt, low self–esteem, or negative feelings for or by a sexual partner—can precipitate ED. Depressive symptoms or difficulty coping with anger can be particularly detrimental.
- ED is the main symptom of a mental disorder known as male erectile disorder.

Although the primary ED symptom is the inability to attain or maintain an adequate erection for completed sexual activity, patterns of ED vary. Some men are unable to attain any erection. Others cannot maintain an erection adequate for penetration. Some men lose their erection during sexual intercourse. Others experience an erection only upon awakening or during masturbation.

Diagnosis

Examination

Thorough medical, psychosocial (both psychological and social), and sexual histories are an essential first step in the diagnosis of ED. A general medical history can indicate the existence of ED–associated conditions such as high blood pressure, diabetes, or arteriosclerosis, as well as medications that may contribute to ED and any history of **substance abuse**. A psychosocial history includes current sexual practices, the existence of stresses or performance anxiety, and any special circumstances under which ED occurs. The sexual partner's participation in the taking of a psychosocial history can be beneficial. The sexual history assists in distinguishing ED from other abnormalities in sexual function, such as ejaculatory and orgasmic disturbances or loss of sexual desire. The patient's sexual history includes:

- the frequency and duration of sexual intercourse
- the degree and quality of penile erections
- nocturnal erections
- the success or failure of penetration
- any sexual dysfunction of the partner, such as painful intercourse (dyspareunia) or vaginal dryness

Self–administered questionnaires can assist in the evaluation of sexual function. The International Index of Erectile Function (IIEF) is the most widely used. It addresses:

- sexual desire
- erectile function
- orgasmic function
- intercourse satisfaction
- overall satisfaction

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A routine **physical examination** is conducted with special emphasis on the genitourinary, circulatory, and neurologic systems. The physician may look for evidence of **hypogonadism** or congenital conditions causing defective testicular function. The genitalia are examined for testicular size and consistency and penile deformities. A **rectal examination** can evaluate the size and consistency of the prostate gland and certain muscular reflexes. Vital signs such as blood pressure and pulse are measured.

Tests

Blood tests and/or other assessments for high blood cholesterol, hypertension, coronary artery heart disease, and depression may be performed, since ED can be a marker or symptom of such disorders. Blood levels of the hormones testosterone and prolactin may be measured.

Procedures

There are several diagnostic procedures for ED:

- Duplex Doppler ultrasonography provides information about both arterial and venous blood flow.
- Pharmacological testing involves the injection of a small amount of an agent—such as 10 micrograms of alprostadil (prostaglandin E1)—that produces an erection in a patient with normal erectile function.
- Nocturnal studies are used to identify erectile dysfunction due to organic causes. Patients are monitored in a sleep laboratory for nocturnal erections during sleep, since men with physiologically normal erectile function have erections during sleep. A self–test can also be performed.

Treatment

Traditional

There are a variety of treatment options for ED, including a combination of therapies:

- Psychosexual therapy, individual psychotherapy, or couples therapy may be recommended.
- Vacuum constriction device therapy involves a mechanical device for increasing penile blood flow and erection.
- Various types of penile prostheses can be surgically inserted into the penis to produce erections.
- In rare cases surgery may be used to correct a defect that interferes with penile erection.

Drugs

There are various drug treatments for ED:

- Adjustment of prescription or over–the–counter medications may be required.
- PDE5 inhibitors relax the muscles in the penis to increase penile blood flow and produce an erection. This class of drugs includes sildenafil (Viagra), vardenafil (Levitra), and tadalafil (Cialis). These should not be used by men who take nitroglycerin for heart problems because they can cause a sudden drop in blood pressure. PDE5 inhibitors also have been associated with an increased risk for a rare condition called nonarteritic ischemic optic neuropathy, which can lead to sudden vision loss.
- Apomorphine is a morphine derivative that targets dopamine receptors to facilitate erections.
- Alpha–adrenergic blockers target adrenergic receptors in smooth muscles, causing the blood vessels to dilate more easily.
- Intracavernous injection therapy (ICIT) is the injection of penile structures with the drugs alprostadil (Caverject), papaverine (Pavabid), or phentolamine, which promote blood flow.
- Intraurethral therapy is the insertion of alprostadil into the urethra to increase blood flow and muscle relaxation.

Alternative

Herbal remedies for ED include:

- dehydroepiandrosterone (DHEA)
- ginkgo
- ginseng
- L–arginine
- yohimbe
- epimedium (horny goat weed)
- zinc
- folic acid and vitamin E in combination with Viagra

Alternative treatments should be used with care, as the benefits of many such treatments have not been confirmed by scientific research.

Home remedies

A first step in ED treatment is the alteration or elimination of modifiable risk factors or causes, including smoking, obesity, and substance or alcohol abuse.

Prognosis

A better understanding of ED, combined with new, more effective therapies, has markedly improved the prognosis. It is estimated that at least 65% of all ED cases can be treated successfully. The modification

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of risk factors—such as physical inactivity, smoking, excessive alcohol intake, certain medications, and obesity—improve the prognosis. However other risk factors—including aging and conditions such as diabetes or pelvic surgery affecting nerves—negatively impact the prognosis.

Prevention

Physicians can help prevent ED by prescribing high blood pressure and other medications that are not associated with ED for their at–risk patients. Various lifestyle changes can help prevent ED. These include:

- not smoking
- losing weight
- not abusing alcohol or other substances

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American Diabetes Association (ADA), 1710 North Beauregard St., Alexandria, VA, 22311, (800) DIABETES, http://www.diabetes.org.

American Urological Association (AUA), 1000 Corporate Blvd., Linthicum, MD, 21090, (410) 689–3700, (866) RING–AUA (746–4282), (410) 689–3800, aua@AUAnet.org, http://www.auanet.org.

National Kidney and Urologic Diseases Information Clearinghouse, 3 Information Way, Bethesda, MD, 20892–3580, (703) 738–4929, (800) 891–5390, (703) 738–4929, nkudic@info.niddk.nih.gov, http://kidney.niddk.nih.gov.

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Erectile dysfunction treatment

Definition

Erectile dysfunction (ED)—the consistent inability to achieve or maintain an erection long enough to engage in satisfactory sexual intercourse—is most often treated with drugs. However, in some cases, more invasive techniques or devises must be used to treat ED.

Purpose

The purpose of ED treatment is to enable men to achieve and maintain erections of sufficient strength and duration to engage in sexual intercourse. This usually requires maintaining an erection for 30–60 minutes.

Demographics

It is estimated that 15–30 million American men suffer from some degree of ED and 10–20 million of these men are completely unable to attain or maintain a penile erection. About 75% of men in the general population who have tried ED drugs have found them to be helpful. Although these drugs have revolutionized ED treatment, some men—for example **prostate cancer** patients and those with ED stemming from psychological issues—often require alternative treatments.

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Description

Sexual arousal normally causes the release of nitric oxide from specialized cells. Nitric oxide causes the formation of cyclic glutamine monophosphate (cGMP), which is responsible for dilating the blood vessels of the penis and relaxing the penile muscles, enabling increased blood flow and erection. Compression of the dilated blood vessels against the firm outer lining of the penis prevents blood from escaping and perpetuates the erection. An enzyme called phosphodiesterase–5 (PDE5) breaks down cGMP, resulting in decreased blood flow to the penis, which then returns to its flaccid relaxed state. The most common drugs for treating ED are PDE5 inhibitors.

A first step in ED treatment is the alteration or elimination of modifiable factors that can cause the disorder. These include **smoking**, **obesity**, and alcohol or other **substance abuse**. An adjustment in prescription or over–the–counter medications that can cause ED also may be required. ED that is caused, at least in part, by psychosocial factors may be treated with psychosexual therapy, individual **psychotherapy**, or couples therapy.

There are three prescription oral PDE5 inhibitors available in the United States for treating physical causes of ED: **sildenafil citrate** (Viagra), vardenafil hydrochloride (Levitra), and tadalafil (Cialis). These drugs increase the supply of nitric oxide to open blood vessels and relax muscles in the penis, thereby increasing penile blood flow and producing an erection. Once sexual activity is completed, blood flow to the penis decreases and the erection is lost.

Available dosages of PDE5 inhibitors are as follows:

- Viagra: 25, 50, and 100 milligrams (mg), with an average recommended dose of 50 mg
- Levitra: 2.5, 5, 10, and 20 mg tablets
- Cialis: 5, 10, and 20 mg tablets, with 10 mg as the recommended starting dose. Some evidence indicates that higher doses of sildenafil and vardenafil, but not tadalafil, provoke better responses than lower doses. ED drugs are covered by most insurance plans.

The three PDE5 inhibitors are very similar and appear to be equally effective. Viagra and Levitra must be taken without food and are effective for up to four hours. Cialis can be taken with or without food and is effective for up to 36 hours.

Other drugs that are sometimes used to treat ED include:

- testosterone, for hypogonadism in which levels of the male sex hormone are low
- apomorphine, a morphine derivative that targets dopamine receptors to facilitate erections
- alpha–adrenergic blockers, which target adrenergic receptors in smooth muscles causing blood vessels to dilate more readily

Herbal remedies that may improve ED in some cases include:

- dehydroepiandrosterone (DHEA)
- ginkgo
- ginseng
- L–arginine
- yohimbe
- epimedium (horny goat weed)
- zinc
- folic acid and vitamin E in combination with Viagra

Alternative treatments should be used with care, as the benefits of many such treatments have not been confirmed by scientific research.

Intracavernous injection therapy (ICIT) is the injection of penile structures with drugs that promote blood flow. The drugs are injected into the corpora cavernosa—the erectile tissues that form the bulk of the penis and that become engorged with blood during an erection. Alprostadil (prostaglandin E1; Caverject) and papaverine hydrochloride (Pavabid) relax the smooth muscle tissue to enhance blood flow into the penis. Injection therapy often involves a three–drug combination commonly referred to as the "Knoxville formula," apparently after the city of its original introduction. Although there are a number of slightly different formulations in use, they all involve alprostadil, papaverine, and phentolamine mesylate.

Intraurethral therapy or MUSE (medical urethral system for erection) involves administering alprostadil into the urethral opening of the penis. A thin tube—about the width of a spaghetti noodle—is inserted into the urethral opening and a plunger is pressed to deliver a tiny pellet containing alprostadil. The drug must be injected shortly before intercourse. It takes about 10 minutes to achieve an erection that lasts about one hour.

Vacuum pump therapy involves inserting the penis into a clear plastic cylinder and pumping air out of the cylinder to form a partial vacuum, which helps draw blood into the corpora cavernosa. A special ring is placed over the base of the penis to trap the blood.

Implanted **penile prostheses** are usually a last resort for treating ED. These are implanted in the corpora cavernosa to make the penis rigid without the need for blood flow. The semi–rigid type of prosthesis consists of a pair of flexible silicone rods that

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can be bent up or down. An inflatable device consists of cylinders implanted in the corpora cavernosa, a fluid reservoir implanted in the abdomen, and a pump placed in the scrotum. Squeezing the pump moves fluid into the cylinders to inflate them and make them rigid. Squeezing the pump again reverses the process. Men can resume sexual activity six ro eight weeks after implantation surgery.

In rare cases when narrowed or diseased veins are responsible for ED, surgery may be required to reroute the blood flow into the corpora cavernosa or to remove leaking blood vessels that interfere with penile erection.

Origins

Drugs for treating ED are relatively new:

- Alprostadil was first approved for ED by the U.S. Food and Drug Administration (FDA) in 1995.
- Sildenafil was originally developed in 1991 as a treatment for angina (chest pain). Viagra received FDA approval as a treatment for ED in 1998.
- Levitra and Cialis received FDA approval in 2003.

Benefits

It is estimated that at least 65% of all ED cases can be treated successfully. Addressing risk factors, such as physical inactivity, smoking, excessive alcohol intake, certain medications, and obesity, improves the prognosis. Levitra can often improve erectile function even in men with other medical problems, such as diabetes or prostate surgery. Cialis has also been shown to improve erectile function in most men, including those with severe ED. Cialis does not need to be taken on an empty stomach and is not affected by high–fat foods.

Precautions

- PDE5 inhibitors alone do not result in an erection; nor do they increase sexual desire. They require sexual stimulation and arousal to be effective.
- PDE5 inhibitors cannot be taken more than once a day.
- Viagra and Levitra should be taken on an empty stomach to be effective.
- High–fat foods can interfere with the absorption of Viagra.
- Men who experience cardiovascular symptoms—such as dizziness, chest or arm pain, or nausea—after taking a PDE5 inhibitor should cease all sexual activity and consult their physician before taking the drug again.
- PDE5 inhibitors should not be used by women or children or by men without ED.
- Many ED treatments, often labeled as "dietary supplements," are available online. The FDA has warned consumers that these products may contain unlabeled PDE5 inhibitors that should not be used except under a physician's supervision, as well as various other substances that may be harmful.
- Implantable penile prostheses cause the penis to always be erect.
- Although inflatable implants allow for planned erections, they have a slightly higher malfunction rate than silicone rods.
- Implants permanently destroy the ability to achieve a natural erection.

PDE5 inhibitors do not cause side effects in most people; however higher doses increase the risk of side effects. The most common side effects of PDE5 inhibitors are mild to moderate **headache** or **nausea**, which usually disappear within a few hours. Less common side effects include:

- flushing
- indigestion
- stuffy or runny nose
- back pain and muscle aches with Levitra and Cialis
- temporary vision changes, including "blue vision," with Viagra

Geriatric

ED treatments may be less effective in geriatric patients. Men over age 65 should start with the lowest possible dose of a PDE5 inhibitor.

Other conditions and allergies

- Since sexual activity can put stress on the heart, men with heart conditions should talk to their physicians about the advisability of sexual activity prior to using any ED treatment.
- ED treatments may be less effective in men who have had pelvic surgery affecting nerves.
- PDE5 inhibitors are only about 60–65% effective in diabetics.
- Men with kidney or liver impairment should begin with the lowest possible dose of a PDE5 inhibitor.
- PDE5 inhibitors should not be used by men who take nitroglycerin or other nitrate drugs for heart problems.
- Men who use alpha–blockers—sometimes prescribed for high blood pressure or prostate problems—also should not take PDE5 inhibitors, since such combinations can cause an unsafe drop in blood pressure.
- Numerous other drugs can interact with PDE5 inhibitors.

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KEY TERMS

Angina—A condition in which lack of blood to the heart causes severe chest pain.

Arrhythmia—An irregularity in the normal rhythm or force of the heartbeat.

Atherosclerosis—Hardening of the arteries; an arterial disease in which raised areas of degeneration and cholesterol deposits (plaques) form on the inner surfaces of the arteries.

Dopamine—A chemical in brain tissue that transmits nerve impulses (a neurotransmitter) and helps to regulate movement and emotions.

Corpora cavernosa—The pair of columns of erectile tissue on either side of the penis that, together with the corpus spongiosum, produce an erection when filled with blood.

Phosphodiesterase–5 (PDE5) inhibitors—The drugs Viagra, Levitra, and Cialis, which are used to treat ED.

Priapism—A prolonged erection lasting more than four hours.

Testosterone—The primary male sex hormone.

Urethra—The tube in the penis that discharges urine from the bladder to the outside of the body.

PDE5 inhibitors are known to increase cardiovascular nerve activity and can trigger temporary **hypotension** (low blood pressure). They may not be safe for patients with:

- atherosclerosis
- heart problems including angina (chest pains), abnormal heart rhythms (arrhythmias), heart failure, or recent heart attack
- uncontrolled high or low blood pressure
- stroke within the past six months
- eye problems, such as retinitis pigmentosa, or relatives with certain eye problems
- sickle cell anemia, leukemia, or other health problems that can cause priapism

Preparation

Viagra is taken 60 minutes or more prior to sexual activity. Levitra and Cialis are taken 30 minutes or more before sex.

Aftercare

Blood pressure should be monitored after taking PDE5 inhibitors.

Risks

Priapism, a prolonged erection, is a very rare side effect of all prescription ED medications. Alprostadil and papaverine sometimes cause painful erections or priapism that must be treated with a shot of epinephrine. Any erection lasting more than four hours requires immediate medical attention because priapism can permanently damage the penis.

There are other risks associated with ED treatments:

- PDE5 inhibitors increase the risk of heart attack in patients with unstable heart disease or who take nitrate medications.
- PDE5 inhibitors may be associated with an increased risk for a rare condition called nonarteritic ischemic optic neuropathy, which can lead to sudden vision loss.
- The injection of ED medications is often painful. Alprostadil injection can cause pain and burning in the urethra for about five to 15 minutes.
- Vacuum pump therapy can cause bruising if the vacuum is left on for too long.

Resources

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ORGANIZATIONS

American Urological Association (AUA), 1000 Corporate Blvd., Linthicum, MD, 21090, (410) 689–3700, (866) RING–AUA (746–4282), (410) 689–3800, aua@AUAnet.org, http://www.auanet.org.

National Kidney and Urologic Diseases Information Clearinghouse (NKUDIC), 3 Information Way, Bethesda, MD, 20892–3580, (703) 738–4929, (800) 891–5390, (703) 738–4929, nkudic@info.niddk.nih.gov, http://kidney.niddk.nih.gov.

U.S. Food and Drug Administration (FDA), 10903 New Hampshire Ave., Silver Spring, MD, 20993–0002, (888) INFO–FDA, http://www.fda.gov.

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Ergotamine *see* **Antimigraine drugs**

Erosive gastritis *see* **Gastritis**

Erysipelas

Definition

Erysipelas is a skin infection that often follows **strep throat**.

KEY TERMS

Bacteremia—The presence of bacteria in the blood.

Streptococcus—A bacteria that causes erysipelas and strep throat, as well as other infections.

Description

Erysipelas, also called St. Anthony's fire, is caused by infection by Group A *Streptococci*. This same type of bacteria is responsible for such infections as strep throat, and infections of both surgical and other kinds of **wounds** in the skin. The infection occurs most often in young infants and the elderly.

Causes and symptoms

Erysipelas usually occurs rather abruptly. When the preceding infection was strep throat, the rash begins on the face. Occasionally, when the preceding infection was of a wound from an injury or operation, the rash will appear on an arm or leg.

Classically, the usual presentation is a bright-red, butterfly-shaped rash appearing across the bridge of the nose and the cheeks. It is hot to the touch, painful, shiny, and swollen, with clearly defined margins. The edges of the rash are a raised ridge, hard to the touch. There may be fluid-filled bumps scattered along the area. The rash spreads rapidly. Some patients have swelling of the eyelids, sometimes so severe that their eyes swell shut. The patient may have **fever**, chills, loss of energy, **nausea and vomiting**, and swollen, tender lymph nodes. In severe cases, walled-off areas of pus (abscesses) may develop beneath the skin. If left untreated, the streptococcal bacteria may begin circulating in the bloodstream (a condition called **bacteremia**). A patient may then develop an overwhelming, systemic infection called **sepsis**, with a high risk of **death**.

Diagnosis

The rash of erysipelas is very characteristic, raising the practitioner's suspicion towards that diagnosis, especially when coupled with a history of recent strep infection. Attempts to culture (grow) the bacteria from a sample of the rash usually fail. When the bacteria are present in the blood, they may be grown in a laboratory, and identified under a microscope. Other laboratory tests involve reacting fluorescently-tagged antibodies with a sample of the patient's infected

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tissue. This type of test may be successful in positively identifying the streptococcal bacteria.

Treatment

Penicillin is the drug of choice for treating erysipelas. It can usually be given by mouth, although in severe cases (or in cases of diagnosed bacteremia) it may be given through a needle placed in a vein (intravenously).

Even with antibiotic treatment, swelling may continue to spread. Other symptoms, such as fever, **pain**, and redness, usually decrease rapidly after penicillin is started. Cold packs and pain relievers may help decrease discomfort. Within about five to 10 days, the affected skin may begin drying up and flaking off.

Prognosis

With prompt treatment, the prognosis from erysipelas is excellent. Delay of treatment, however, increases the chance for bacteremia and the potential for death from overwhelming sepsis. This is particularly true of people with weakened immune systems (babies, the elderly, and people ill with other diseases, especially Acquired **Immunodeficiency** Syndrome, or **AIDS**). Frequently, an individual who has had erysipelas will have it occur again in the same location.

Prevention

Prevention involves appropriate and complete treatment of **streptococcal infections**, including strep throat and wound infections.

Resources

PERIODICALS

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Rosalyn Carson-DeWitt, MD

Erythema infectiosum *see* **Fifth disease**

Erythema multiforme

Definition

Erythema multiforme is a skin disease that causes lesions and redness around the lesions.

KEY TERMS

Herpes virus—Viruses that can infect the skin, mucous membranes, and brain, and they are responsible for such diseases as herpes simplex, chicken pox, and shingles.

Mycoplasma pneumonia—An incomplete bacterium that infects the lung.

Description

Erythema multiforme appears on the skin and the mucous membranes (the lining of the mouth, digestive tract, vagina, and other organs). Large, symmetrical red blotches appear all over the skin in a circular pattern. On mucous membranes, it begins as blisters and progresses to ulcers. A more advanced form, called Stevens-Johnson syndrome, can be severe and even fatal.

Causes and symptoms

Erythema multiforme has many causes, most commonly are drugs. Penicillin, **sulfonamides**, certain **epilepsy** drugs, **aspirin**, and **acetaminophen** are the most likely medication-induced causes. Erythema multiforme can also be caused by certain diseases. Herpes virus and mycoplasma **pneumonia** are likely infectious causes.

Diagnosis

The appearance of the rash is sufficiently unique to identify it on sight. Having identified it, the physician will determine the underlying cause.

Treatment

Erythema multiforme is inadvertently treated when the causative agent, whether it be a drug or a disease, is treated. In severe cases, cortisone-like medication is often used along with general supportive measures and prevention of infection.

Prognosis

As a rule, the rash abates by itself without damaging the skin. Only in the case of infection, severe blistering, or continued use of an offending drug does complications occur.

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Resources

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J. Ricker Polsdorfer, MD

Erythema nodosum

Definition

Erythema nodosum is a skin disorder characterized by painful red nodules appearing mostly on the shins.

Description

Erythema nodosum is an eruption of tender red lumps on both shins and occasionally the arms and face. Bruising often accompanies the nodule formation. Erythema nodosum is most prevalent in young adults.

Causes and symptoms

Erythema nodosum can be caused by many important and treatable diseases. Among them are **tuberculosis**, several fungal lung infections, **leprosy**, inflammatory bowel disease, and some potentially dangerous bacterial infections. Drugs can also induce erythema nodosum. The most common are penicillin, **sulfonamides**, and birth control pills.

Diagnosis

There are a few other skin eruptions that mimic erythema nodosum, so the physician may have to perform a biopsy to sort them out. There are a few types of *panniculitis,* fat inflammation, that may signal a **cancer** somewhere in the body, and there are other kinds of inflammation that may confuse the diagnosis.

Once the skin problem has been diagnosed, its underlying cause must then be identified. A lengthy evaluation may ensue, and often times the cause remains unknown.

Treatment

Painful nodules can be treated with mild **pain** killers and local application of ice packs. Medical attention will be directed toward the underlying disease.

KEY TERMS

Biopsy—Surgical removal of tissue for diagnostic purposes.

Panniculitis—Inflammation of fatty tissue.

The nodules will eventually disappear, leaving no trace behind.

Resources

BOOKS

Cecil, Russell L., Lee Goldman, and D. A. Audiello.*Cecil Medicine*. 23rd ed, Philadelphia: Saunders Elsevier, 2008.

J. Ricker Polsdorfer, MD

Erythremia *see* **Polycythemia vera**

Erythroblastosis fetalis

Definition

Erythroblastosis fetalis refers to two potentially disabling or fatal blood disorders in infants: Rh incompatibility disease and ABO incompatibility disease. Either disease may be apparent before birth and can cause fetal **death** in some cases. The disorder is caused by incompatibility between a mother's blood and her unborn baby's blood. Because of the incompatibility, the mother's immune system may launch an immune response against the baby's red blood cells. As a result, the baby's blood cells are destroyed, and the baby may suffer severe anemia (deficiency in red blood cells), brain damage, or death.

Description

Red blood cells carry several types of proteins, called antigens, on their surfaces. The A, B, and O antigens are used to classify a person's blood as type A, B, AB, or O. Each parent passes one A, B, or O antigen gene to their child. How the genes are paired determines the person's blood type.

A person who inherits an A antigen gene from each parent has type A blood; receiving two B antigen genes corresponds with type B blood; and inheriting A and B antigen genes means a person has type AB blood. If the O antigen gene is inherited from both parents, the child has type O blood; however, the

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pairing of A and O antigen genes corresponds with type A blood; and if the B antigen gene is matched with the O antigen gene, the person has type B blood.

Another red blood cell antigen, called the Rh factor, also plays a role in describing a person's blood type. A person with at least one copy of the gene for the Rh factor has Rh-positive blood; if no copies are inherited, the person's blood type is Rh-negative. In **blood typing**, the presence of A, B, and O antigens, plus the presence or absence of the Rh-factor, determine a person's specific blood type, such as A-positive, B-negative, and so on.

A person's blood type has no effect on health. However, an individual's immune system considers only that person's specific blood type, or a close match, acceptable. If a radically different blood type is introduced into the bloodstream, the immune system produces antibodies, proteins that specifically attack and destroy any cell carrying the foreign antigen.

Determining a person's blood type is very important if she becomes pregnant. Blood cells from the unborn baby (fetal red blood cells) can cross over into the mother's bloodstream, especially at delivery. If the mother and her baby have compatible blood types, the crossover does not present any danger. However, if the blood types are incompatible, the mother's immune system manufactures antibodies against the baby's blood.

Usually, this incompatibility is not a factor in a first **pregnancy**, because few fetal blood cells reach the mother's bloodstream until delivery. The antibodies that form after delivery cannot affect the first child. In later pregnancies, fetuses and babies may be in grave danger. The danger arises from the possibility that the mother's antibodies will attack the fetal red blood cells. If this happens, the fetus or baby can suffer severe health effects and may die.

There are two types of incompatibility diseases: Rh incompatibility disease and ABO incompatibility disease. Both diseases have similar symptoms, but Rh disease is much more severe, because anti-Rh antibodies cross over the placenta more readily than anti-A or anti-B antibodies. (The immune system does not form antibodies against the O antigen.) Therefore, a greater percentage of the baby's blood cells are destroyed by Rh disease.

Both incompatibility diseases are uncommon in the United States due to medical advances over the last 50 years. For example, prior to 1946 (when newborn blood transfusions were introduced) 20,000 babies were affected by Rh disease yearly. Further advances, such as suppressing the mother's antibody response, have reduced the incidence of Rh disease to approximately 4,000 cases per year.

Rh disease only occurs if a mother is Rh-negative and her baby is Rh-positive. For this situation to occur, the baby must inherit the Rh factor gene from the father. Most people are Rh-positive. Only 15% of the Caucasian population is Rh-negative, compared to 5–7% of the African-American population and virtually none of Asian populations.

ABO incompatibility disease is almost always limited to babies with A or B antigens whose mothers have type O blood. Approximately one third of these babies show evidence of the mother's antibodies in their bloodstream, but only a small percentage develop symptoms of ABO incompatibility disease.

Cause and symptoms

Rh disease and ABO incompatibility disease are caused when a mother's immune system produces antibodies against the red blood cells of her unborn child. The antibodies cause the baby's red blood cells to be destroyed and the baby develops anemia. The baby's body tries to compensate for the anemia by releasing immature red blood cells, called erythroblasts, from the bone marrow.

The overproduction of erythroblasts can cause the liver and spleen to become enlarged, potentially causing liver damage or a ruptured spleen. The emphasis on erythroblast production is at the cost of producing other types of blood cells, such as platelets and other factors important for blood clotting. Since the blood lacks clotting factors, excessive bleeding can be a complication.

The destroyed red blood cells release the blood's red pigment (hemoglobin) which degrades into a yellow substance called bilirubin. Bilirubin is normally produced as red blood cells die, but the body is only equipped to handle a certain low level of bilirubin in the bloodstream at one time. Erythroblastosis fetalis overwhelms the removal system, and high levels of bilirubin accumulate, causing hyperbilirubinemia, a condition in which the baby becomes jaundiced. The **jaundice** is apparent from the yellowish tone of the baby's eyes and skin. If hyperbilirubinemia cannot be controlled, the baby develops kernicterus. The term kernicterus means that bilirubin is being deposited in the brain, possibly causing permanent damage.

Other symptoms that may be present include high levels of insulin and low blood sugar, as well as a condition called hydrops fetalis. Hydrops fetalis is characterized by an accumulation of fluids within the

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KEY TERMS

Amniocentesis—A procedure in which a needle is inserted through a pregnant woman's abdomen and into her uterus to withdraw a small sample of amniotic fluid. The amniotic fluid can be examined for sign of disease or other problems afflicting the fetus.

Amniotic fluid—The fluid that surrounds a fetus in the uterus.

Anemia—A condition in which there is an abnormally low number of red blood cells in the bloodstream. Major symptoms are paleness, shortness of breath, unusually fast or strong heart beats, and tiredness.

Antibody—A protein molecule produced by the immune system in response to a protein that is not recognized as belonging in the body.

Antigen—A protein that can elicit an immune response in the form of antibody formation. With regard to red blood cells, the major antigens are A, B, O, and the Rh factor.

Bilirubin—A yellow-colored end-product of hemoglobin degradation. It is normally present at very low levels in the bloodstream; at high levels, it produces jaundice.

Cordocentesis—A procedure for delivering a blood transfusion to a fetus. It involves a fine needle being threaded through a pregnant woman's abdomen and into the umbilical cord with the aid of ultrasound imaging.

Hemoglobin—A molecule in red blood cells that transports oxygen and gives the cells their characteristic color.

Hydrops fetalis—A condition in which a fetus or newborn baby accumulates fluids, causing swollen arms and legs and impaired breathing.

Hyperbilirubinemia—A condition in which bilirubin accumulates to abnormally high levels in the bloodstream

Placenta—A protective membrane that surrounds and protects the fetus during pregnancy.

Platelet—A blood factor that is important in forming blood clots.

Rh factor—An antigen that is found on the red blood cells of most people. If it is present, the blood type is referred to as Rh-positive; if absent, the blood type is Rh-negative.

baby's body, giving it a swollen appearance. This fluid accumulation inhibits normal breathing, because the lungs cannot expand fully and may contain fluid. If this condition continues for an extended period, it can interfere with lung growth. Hydrops fetalis and anemia can also contribute to heart problems.

Diagnosis

Erythroblastosis fetalis can be predicted before birth by determining the mother's blood type. If she is Rh-negative, the father's blood is tested to determine whether he is Rh-positive. If the father is Rh-positive, the mother's blood will be checked for antibodies against the Rh factor. A test that demonstrates no antibodies is repeated at week 26 or 27 of the pregnancy. If antibodies are present, treatment is begun.

In cases in which incompatibility is not identified before birth, the baby suffers recognizable characteristic symptoms such as anemia, hyperbilirubinemia, and hydrops fetalis. The blood incompatibility is uncovered through blood tests such as the Coombs test, which measures the level of maternal antibodies attached to the baby's red blood cells. Other blood tests reveal anemia, abnormal blood counts, and high levels of bilirubin.

Treatment

When a mother has antibodies against her unborn infant's blood, the pregnancy is watched very carefully. The antibodies are monitored and if levels increase, **amniocentesis**, fetal umbilical cord blood sampling, and ultrasound are used to assess any effects on the baby. Trouble is indicated by high levels of bilirubin in the amniotic fluid or baby's blood, or if the ultrasound reveals hydrops fetalis. If the baby is in danger, and the pregnancy is at least 32–34 weeks along, labor is induced. Under 32 weeks, the baby is given blood transfusions while still in the mother's uterus.

There are two techniques that are used to deliver a blood **transfusion** to a baby before birth. In the first, a needle is inserted through the mother's abdomen and uterus, and into the baby's abdomen. Red blood cells injected into the baby's abdominal cavity are absorbed into its bloodstream. In early pregnancy or if the baby's bilirubin levels are gravely high, cordocentesis is performed. This procedure involves sliding a very fine

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needle through the mother's abdomen and, guided by ultrasound, into a vein in the umbilical cord to inject red blood cells directly into the baby's bloodstream.

After birth, the severity of the baby's symptoms are assessed. One or more transfusions may be necessary to treat anemia, hyperbilirubinemia, and bleeding. Hyperbilirubinemia is also treated with **phototherapy**, a treatment in which the baby is placed under a special light. This light causes changes in how the bilirubin molecule is shaped, which makes it easier to excrete. The baby may also receive oxygen and intravenous fluids containing electrolytes or drugs to treat other symptoms.

Prognosis

In many cases of blood type incompatibility, the symptoms of erythroblastosis fetalis are prevented with careful monitoring and blood type screening. Treatment of minor symptoms is typically successful and the baby will not suffer long-term problems.

Nevertheless, erythroblastosis is a very serious condition for approximately 4,000 babies annually. In about 15% of cases, the baby is severely affected and dies before birth. Babies who survive pregnancy may develop kernicterus, which can lead to deafness, speech problems, **cerebral palsy**, or **mental retardation**. Extended hydrops fetalis can inhibit lung growth and contribute to **heart failure**. These serious complications are life threatening, but with good medical treatment, the fatality rate is very low. According to the U.S. Centers for Disease Control and Prevention, there were 21 infant deaths in the United States during 1996 that were attributable to hemolytic disease (erythroblastosis fetalis) and jaundice.

Prevention

With any pregnancy, whether it results in a live birth, **miscarriage**, **stillbirth**, or abortion, blood typing is a universal precaution against blood compatibility disease. Blood types cannot be changed, but adequate forewarning allows precautions and treatments that limit the danger to unborn babies.

If an Rh-negative woman gives birth to an Rh-positive baby, she is given an injection of immunoglobulin G, a type of antibody protein, within 72 hours of the birth. The immunoglobulin destroys any fetal blood cells in her bloodstream before her immune system can react to them. In cases where this precaution is not taken, antibodies are created and future pregnancies may be complicated.

Resources

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Julia Barrett

Erythrocyte sedimentation rate

Definition

The erythrocyte sedimentation rate (ESR), or sedimentation rate (sed rate), is a measure of the settling of red blood cells in a tube of blood during a specified period of time. The rate is an indication of inflammation and increases in many diseases.

Purpose

ESR is increased in rheumatoid diseases, most infections, and in **cancer**. An advanced rate does not diagnose a specific disease, but it does indicate that an underlying disease may be present.

A physician can use ESR to monitor a person with an associated disease. When the disease worsens, the ESR may increase; when the disease improves, the ESR may decrease. The ESR does not always follow the course of cancer.

ESR is called an acute-phase reactant test, meaning that it reacts to acute conditions in the body, such as infection or trauma. The rate increase follows a rise in temperature and increase in **white blood cell count**, peaks after several days, and usually lasts longer than the elevated temperature or increased white blood cell count.

Description

The ESR test is a simple test dating back to the ancient Greeks. A specific amount of diluted, unclotted blood is placed in a special narrow tube and left undisturbed for a specified amount of time. The red cells settle towards the bottom of the tube, and the pale yellow liquid (plasma) rises to the top. After the specified time has elapsed, measurements are taken of the distance the red cells traveled to settle at the bottom of the tube. Methods used include the Westergren, the modified Westergren and the Wintrobe methods. Each method produces slightly different results.

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KEY TERMS

Acute phase reactant—A substance in the blood that increases as a response to an acute conditions such as infection, injury, tissue destruction, some cancers, burns, surgery, or trauma.

Rouleaux—The stacking up of red blood cells, caused by extra or abnormal proteins in the blood that decrease the normal distance red cells maintain between each other.

Most laboratories use the Westergren or modified Westergren method.

Normally red cells do not settle far toward the bottom of the tube. Many diseases make extra or abnormal proteins that cause the red cells to move close together, stack up, and form a column (rouleaux). In a group, red cells are heavier and fall faster. The faster they fall, the further they settle, and the higher the ESR.

The ESR test is covered by insurance when medically necessary. Results are usually available the same or following day.

Preparation

This test requires about 5mL of blood. A healthcare worker ties a tourniquet on the patient's upper arm, locates a vein in the inner elbow region, and inserts a needle into that vein. Vacuum action draws the blood through the needle into an attached tube. Collection of the sample takes only a few minutes.

Aftercare

Discomfort or bruising may occur at the puncture site. Pressure applied to the puncture site until the bleeding stops reduces bruising. Warm packs to the puncture site relieve discomfort. The patient may feel dizzy or faint.

Risks

There are no major risks associated with this blood test.

Results

A normal value does not rule out disease. Normal values for the Westergren method are:

- Newborns (male or female): 0–2 mm/hr
- Females less than 50 years old: 0–25 mm/hr
- Males less than 50 years old: 0–15 mm/hr
- Females 50 years and older: 0–30 mm/hr
- Males 50 years and older: 0–20 mm/hr

Abnormal results

The highest ESR levels are usually seen in a cancer of a certain type of white blood cell (**multiple myeloma**) and rheumatoid disease, such as **rheumatoid arthritis**. Many other diseases also increase the ESR: infection, **kidney disease**, anemia, diseases involving white blood cells, cancer, and autoimmune and inflammatory diseases.

Any disease that changes the shape and size of red blood cells decreases the ESR. Distorted cells, such as with **sickle cell disease**, do not stack, and consequently do not settle far, even in the presence of an ESR-associated disease. Diseases that cause the body to make less protein or extra red blood cells also decrease the ESR.

Some medications, including anticonvulsants, **oral contraceptives**, and others may cause an increase in the ESR. Drugs such as cortisone and quinine may cause a decrease in ESR values.

Resources

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Erythromycins and macrolide antibiotics

Definition

Macrolides are **antibiotics** that kill bacteria or prevent their growth.

Purpose

Macrolides are used to treat bacterial infections in various sites:

- middle and inner ear
- eyes
- sinuses

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- tonsils
- throat and larynx (voice box)
- lungs (pneumonia and bronchitis)
- skin (infected eczema, acne, psoriasis)
- genitalia, sexually transmitted diseases (Chlamydia, gonorrhea)

These antibiotics are used to prevent infections prior to dental and other procedures for patients at risk for developing infections of the heart valves (**endocarditis**).

Macrolide antibiotics can be used as alternatives to penicillin for people with penicillin **allergies**.

These antibiotics will *not* cure colds, flu, and other viral infections.

Description

Members of the macrolide antibiotic family include erythromycin (Erythrocin, Ery-C, E-Mycin, azithromycin (Zithromax) and clarithromycin (Biaxin). They are available by prescription as capsules, tablets (including chewable), liquids, and for injection.

Recommended dosage

Dosage depends on the drug used and the reason for its use.

Antibiotics should always be taken exactly as directed, for as long as they are prescribed. Do not stop antibiotics if symptoms begin improving.

Precautions

These drugs should be used with caution by patients with liver or **kidney disease**.

People who have inherited blood disorders, like porphyria, should not take these antibiotics.

Macrolides increase the risk of heart arrhythmia in patients who have prolonged Q-T interval on EKG.

These antibiotics may aggravate muscle weakness in patients with **Myasthenia Gravis**.

ALLERGIES. Anyone who has had unusual reactions to a macrolide antibiotic previously should avoid taking it again.

PREGNANCY. There are no well controlled studies on these antibiotics and **pregnancy**.

BREASTFEEDING. Macrolide antibiotics pass into breast milk, though no specific dangers have been identified.

KEY TERMS

Bronchitis—Infection of the air passages in the lungs.

Gonorrhea—A sexually transmitted infection with fever and a pussy penile discharge in males and abdominal pain and vaginal discharge in females.

Bacteria—Organisms that can only be seen under a microscope.

Pneumonia—Infection of the lungs caused by bacteria, viruses, or chemical irritants.

Sinus—Air-filled cavities in the bones of the skull.

Side effects

Macrolide antibiotics may widen the Q-T interval on EKG. People who are at risk for developing severe heart **arrhythmias**, or who take drugs that widen the Q-T interval, should avoid taking these antibiotics.

The more common side effects from macrolides include mild **diarrhea**, **nausea**, **vomiting**, and stomach or abdominal cramps that go away as the body adjusts to the drug.

Less commonly, sore mouth or tongue and vaginal **itching** may occur. These rarely require medical attention.

If these, more serious, side effects occur, seek medical help:

- severe abdominal pain, and continued nausea, vomiting, or diarrhea
- fever
- skin rash, redness, or itching
- unusual tiredness or weakness
- swelling of the lips, face or neck

Interactions

Prescribers need to know the medications their patients take; this class of antibiotics may interact with many drugs.

Food may change the effects of erythromycin and clarithromycin (Biaxin), increasing the risks of side or adverse effects.

Grapefruit juice may increase the absorption of macrolide antibiotics, possibly increasing the possibility of adverse or side effects.

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St Johns Wort may decrease blood levels of erythromycin.

The effectiveness of combined **oral contraceptives** may be reduced when macrolide antibiotics are taken. It would be wise to use an additional method of preventing pregnancy for up to seven days after discontinuing these antibiotics.

Taking quinolone antibiotics (Tequin, Levaquin, Avelox) with erythromycin increases the potential for fatal heart arrhythmias.

Macrolide antibiotics increase the risk of fatal heart arrhythmias when taken with medications to treat heart arrhythmias, (Cordarone, Norpace, Tikosyn, Sotalol, Bretylium, and Quinidine).

Macrolide antibiotics increase the blood-thinning effects of warfarin (Coumadin).

Macrolide antibiotics increase the adverse, muscle wasting effects of cholesterol-reducing medications (Lipitor, Zocor, Mevacor).

People who take **digoxin** (Lanoxin) and macrolide antibiotics together risk developing digoxin toxicity.

People who take carbamazepine (Tegretol) for seizures, **schizophrenia**, ethanol withdrawal, restless-leg syndrome, or **post-traumatic stress disorder** (PTSD) risk developing carbamazepine toxicity when they take macrolide antibiotics.

Macrolide antibiotics increase the effects of Colchicine used to treat **Gout**, increasing the risk of toxicity.

Macrolide antibiotics increase the effects, and toxicity, of ergot drugs used to treat migraine headaches.

Macrolide antibiotics increase the effects, and toxicity, of pimozide (Orap) and clozapine (Clozaril) used to treat **psychosis**.

Macrolide antibiotics increase the effects, and toxicity, of verapamil (Calan) used to treat **angina** (heart **pain**) and rapid heartbeats.

Macrolide antibiotics increase the sedative effects of anti-anxiety medications Buspar and **benzodiazepines** Xanax, Valium, and Halcion.

Taken together, macrolide antibiotics and theophyllines (Choledyl, Theo-Dur and Uniphyl), used to treat chronic **asthma** and asthma-like conditions, adversely effect each other. Theophyllin levels increase in the blood, increasing the chance of toxicity, and macrolide effectiveness is reduced.

Resources

OTHER

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Erythropoietin *see* **Cancer therapy, supportive; Immunologic therapies**

Erythropoietin test

Definition

Erythropoietin, also called EPO, is a type of protein called a glycoprotein that is formed mainly in the kidneys to stimulate the production of red blood cells.

Purpose

The erythropoietin (EPO) test is used to determine if hormonal secretion is causing changes in the red blood cells. The test has great value in evaluating low hemoglobin (anemia), and another disorder called polycythemia, in which unusually large numbers of red blood cells are found in the blood. The EPO test is also used to identify kidney tumors and identify or assess **kidney disease** It also may be used to evaluate **abuse** by athletes who believe commercially prepared erythropoietin enhances performance.

Precautions

Not every laboratory is equipped to evaluate EPO, so the reference laboratory (a large commercial lab that does tests for hospitals not equipped to do them) performing the test may require as many as four days to complete the analysis. It should also be noted that EPO values increase in **pregnancy**, in which significantly higher levels are found before the twenty-fourth week.

Description

Erythropoietin is produced primarily in the kidneys but interacts with other factors in the bone marrow to increase red cell production. EPO is unique among the blood cell growth factors, because it is the only one that behaves like a hormone.

Erythropoietin acts as the principal regulator in the production of red blood cells (erythrocytes) by controlling the number, the kinds, and the survival of the cells.

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KEY TERMS

Anemia—A condition in which the hemoglobin concentration in the blood is below normal.

Polycythemia vera—A condition characterized by an unusually large number of red blood cells in the blood due to increased production by the bone marrow. Symptoms include headaches, blurred vision, high blood pressure, dizziness, and night sweats.

Secondary polycythemia—Secondary polycythemia occurs when the excess of red blood cells is caused by a condition other than polycythemia vera. For example, when low levels of oxygen in the blood stimulate the bone marrow to produce more red blood cells, as in chronic lung disease.

Because of this ability, it is being investigated for use in **cancer** patients to prevent anemia (hemoglobin concentration in the blood is lower than normal), or to treat anemia that has been induced by **chemotherapy** and **bone marrow transplantation** (BMT).

The correction of anemia can result in reduced **transfusion** requirements, so the erythropoietin test is used to diagnose anemia, including the anemia of end-stage renal disease. Erythropoietin determination is also valuable in diagnosing a condition known as polycythemia, when increased numbers of red blood cells occur. Levels of erythropoietin are extremely low in **polycythemia vera** but are normal or high in **secondary polycythemia**. It happens rarely, but cysts in the liver or kidneys, as well as tumors in the kidneys or brain, can also produce erythropoietin. Patients with these conditions can have high levels of erythropoietin and may develop secondary polycythemia.

Kidney disease can cause anemia and many patients on **kidney dialysis** will require monthly EPO tests to check their hemoglobin levels.

Some athletes use EPO to enhance performance, as the increased red cell volume adds more oxygen-carrying capacity to the blood. Adverse reactions to this practice can include clotting abnormalities, **headache**, seizures, high blood pressure, **nausea**, **vomiting**, **diarrhea**, and rash.

Preparation

The EPO test requires a blood sample. The patient is to fast with nothing to eat or drink for at least eight hours before the test. It is also suggested that the patient lie down for 30 minutes before the test.

Risks

Risks for this test are minimal, but may include slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after venipuncture, and hematoma (blood accumulating under the puncture site).

Normal results

Reference values vary from laboratory to laboratory, but a general normal range is 11–48 mU/mL (milliunits per milliliter).

Abnormal results

Low levels of EPO are found in anemic patients with inadequate or absent production of erythropoietin. Severe kidney disease may decrease production of EPO, and congenital absence of EPO can occur.

Elevated levels of EPO can be found in some **anemias** when the body tries to overcompensate for reduced blood volume. Elevated levels are also seen in polycythemia, and erythropoietin-secreting tumors.

Resources

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ESB *see* **Electrical stimulation of the brain**

Escherichia coli

Definition

Escherichia coli (*E. coli*) is one of several types of bacteria that normally inhabit the intestine of humans and animals (commensal organism). Some strains of *E. coli* are capable of causing disease under certain conditions when the immune system is compromised or disease may result from an environmental exposure to the organism.

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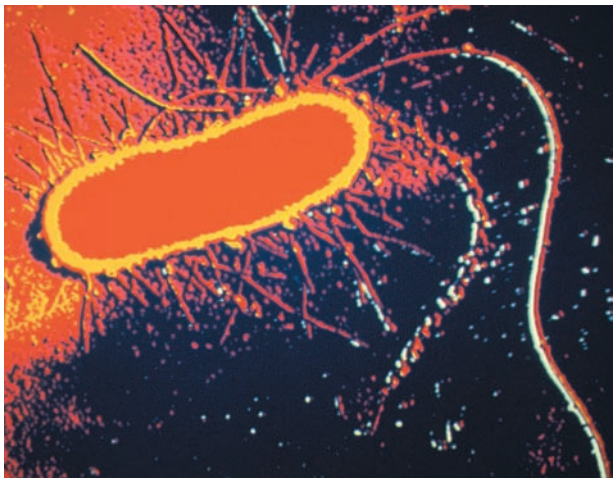

A magnified image of the E. coli bacterium. *(© Howard Sochurek/Corbis.)*

Demographics

Neonatal **meningitis** caused by *E. coli* is associated with a mortality rate of 8%. The organism is the leading cause of urinary tract infections in men and in women. The bacterium also causes approximately 30 to 45% of traveler's **diarrhea** in people traveling to Mexico.

Description

E. coli bacteria may give rise to infections in **wounds**, the urinary tract, biliary tract, and abdominal cavity (**peritonitis**). This organism may cause septicemia, neonatal meningitis, infantile **gastroenteritis**, tourist diarrhea, and hemorrhagic diarrhea. An *E. coli* infection may also arise due to environmental exposure. Infections with this type of bacteria pose a serious threat to public health with outbreaks arising from food and water that has been contaminated with human or animal feces or sewage. This type of bacteria has been used as a biological indicator for safety of drinking water since the 1890s. Exposure may occur during hospitalization, resulting in **pneumonia** in immunocompromised patients or those on a ventilator.

Causes and symptoms

The symptoms of infection and resulting complications are dependent upon the strain of *E. coli* and the site of infection. These bacteria produce toxins that have a wide range of effects. Symptoms caused by some *E. coli* infections range from mild to severe, bloody diarrhea, acute abdominal **pain**, **vomiting**, and **fever**. Gastrointestinal complications that can cause *E. coli* infections include **irritable bowel syndrome** (IBS), ischemic **colitis**, **appendicitis**, perforation of the large bowel, and in some instances **gangrene** in the colon. Other known *E. coli*-causing infections include chronic renal failure, **pancreatitis**, and **diabetes mellitus**. Neurological symptoms such as drowsiness, seizure, and **coma** may occur. In infants, *E. coli* infections are present in cases of infantile gastroenteritis and neonatal meningitis.

Strains of *E. coli* that produce diarrhea were initially distinguished by their O (somatic) antigens found on the bacterial surface. Although there is an overlap in characteristics between strains, they may be classified into four main groups; enterohemorrahagic (0157), enteropathogenic (055,0111), enterotoxigenic (06,078), and enteroinvasive (0124,0164).

E.coli O157 (VTEC)

The O157:H7 strain is the member of the group most often associated with a particularly severe form of diarrhea. (The O indicates the somatic antigen, while the H denotes the flagellar antigen, both of which are found on the cell surface of the bacteria.) The bacterium was discovered in 1977, and first reports of infections followed in 1982. *E. coli* O157:H7, as it is frequently referred to by researchers, causes bloody diarrhea in many infected patients. It accounts for about 2% of all cases of diarrhea in the western world, and at least one-third of cases of hemorrhagic colitis, or about 20,000 cases per year.

E. coli O157:H7 is also the most common cause of unique syndromes, known as **hemolytic-uremic syndrome** (HUS) and thrombocytopenic purpura (TTP), which cause kidney failure, **hemolytic anemia**, and **thrombocytopenia**. Infection with this strain of bacteria often subsides without further complications. However, about 5% of people who are infected develop HUS/TTP. This infection also accounts for the majority of episodes of HUS, especially in children.

This strain of bacteria produces a potent toxin called verotoxin, named for the toxin's ability to kill green monkey kidney or "vero" cells. Bacteria that produce verotoxin are referred to as verotoxin-producing *E. coli* (VTEC). The numbers of bacteria that are necessary to reproduce infectious levels of bacteria are quite small, estimated at 10-100 viable bacteria. These toxins are lethal for intestinal cells and those that line vessels (endothelial cells), inhibiting protein synthesis and causing cell **death**. It is believed that the damage to blood vessels results in the formation of clots, which eventually leads to HUS. HUS/TTP is a serious, often fatal, syndrome that has other causes in addition to *E. coli* O157:H7; it is characterized by the breaking up of red blood cells (hemolysis) and kidney failure (uremia). The syndrome occurs most often in the very young and very old.

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KEY TERMS

Antigen—A substance, usually a protein, that causes the formation of an antibody and reacts specifically with that antibody.

Anti-motility medications—Medications such as loperamide (Imodium), dephenoxylate (Lomotil), or medications containing Codeine or narcotics that decrease the ability of the intestine to contract. This can worsen the condition of a patient with dysentery or colitis.

Colitis—Inflammation of the colon or large intestine, usually causing diarrhea that may be bloody.

Food irradiation methods—A process using radiant energy to kill microorganisms in food, to extend the amount of time in which food can be sold and eaten safely.

Oral Rehydration Solution (ORS)—A liquid preparation developed by the World Health Organization that can decrease fluid loss in persons with diarrhea. Originally developed to be prepared with materials available in the home, commercial preparations have recently come into use.

Urea—Chemical formed during the body's metabolism of nitrogen and normally excreted by the kidney. Urea levels rise in the blood when kidney failure occurs.

E. coli O157:H7 is commonly found in cattle and poultry, and outbreaks of disease have been associated with cattle and bovine products. There are reports of contamination from unpasteurized apple juice, hamburger meat, radish sprouts, lettuce, and potatoes, as well as other food sources. Environmental contamination may occur in water drained from cattle pastures or water containing human sewage used for drinking or swimming. Human to human transmission, through contact with fecal matter, has also been identified in daycare centers.

After an incubation period of three to four days on average, watery diarrhea begins, which rapidly progresses to bloody diarrhea in many cases. **Nausea**, **vomiting**, and low-grade fever are frequently present. Gastrointestinal symptoms last about one week, and recovery is often spontaneous. Symptomatic infection may occur in about 10% of infected individuals. About 5-10% of individuals, usually at the extremes of age develop HUS/TTP, and ultimately, kidney failure. Patients taking **antibiotics** or medications for gastric acidity may also be at risk. Neurological symptoms can occur as part of HUS/TTP and consist of seizures, **paralysis**, and coma. **Rectal prolapse** may be a complication, and in some cases colitis, appendicitis, perforation of the large bowel, and gangrene in the bowel. Systemically, the most prevalent complications of *E. coli* 157 infections are HUS and TTP.

E. coli non-O157 (VTEC)

These strains of *E. coli* produce verotoxin, but are strains other than O157. There have been as many as 100 different types implicated in the development of disease. Strain OH111 was found to be involved in outbreaks in Australia, Japan, and Italy. The O128, O103, and O55 groups have also been implicated in diarrhea outbreaks. In Britain, cases of infantile gastroenteritis in maternity hospitals and neonatal units have been attributed to the *E. coli*) non-0157 group. Many of these organisms have been identified in cattle.

Enterotoxigenic E. coli

Two toxins may be produced by this group, the heat-labile enterotoxin (LT) that can produce enteritis in infants, and a heat stable enterotoxin (ST), the action of which has yet to be determined.

Enteroinvasive E. coli

Some strains of the enteroinvasive *E. coli* have been involved in the development of gastroenteritis in infants. These organisms do not produce an enterotoxin. The cells of the intestine are affected, with the development of symptoms that are typical of a shigellae infection.

Diagnosis

Diagnosis of a specific type of infection is dependent upon the characteristics of the particular strain of the organism.

E. coli O157:H7 (HUS)

This particular strain of *E. coli* is suspected when bloody diarrhea, bloody stools, lack of fever, elevated leukocyte count, and abdominal tenderness are present. Stool cultures are used to tentatively identify the bacteria. Unfortunately, cultures are often negative or inconclusive if done after 48 hours of

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symptoms. Further tests are usually needed for confirmation of infection. This may include a full blood count, blood film, and tests to determine urea, electrolyte, and LDH (lactate dehydrogenase) levels. Damaged red blood cells and elevated levels of creatinine, urea, and LDH with a drop in **platelet count** may indicate that HUS will develop. Immunomagnetic separation is used for diagnosis as well.

E. coli non-O157 (VTEC)

Diagnosis is often difficult for these types of bacteria, but production of enterohemolysin (Ehly) is used as an indicator. Other diagnostic tests are used to detect verotoxins, including ELISA (enzyme-linked immunosorbent assays), colony immunoblotting, and DNA-based tests.

E. coli 0157 STEC

Methods for detection of this type of bacteria are under development, including culture growth media selective for this organism. Immunomagnetic separation and specific ELISA, latex agglutination tests, colony immunoblot assays, and other immunological-based detection methods are being explored.

Treatment

Traditional

Uncomplicated cases of the *E. coli* O157:H7 infection clear up within ten days. It is not certain that antibiotics are helpful in treating *E. coli* O157:H7. Antimicrobials that may be administered include doxycycline (Vibramycin), trimethoprim/sulfamethoxazole (Bactrim DS, Septra), **fluoroquinolones** (Cipro), and rifaximin (Xifaxan, RedActiv, Flonorm). **Dehydration** resulting from diarrhea must be treated with either Oral Rehydration Solution (ORS) or intravenous fluids. Anti-motility agents that decrease the intestines' ability to contract, should not be used in any patient with bloody diarrhea. Treatment of HUS, if it develops, involves correction of clotting factors, plasma exchange, and **kidney dialysis**. Blood transfusions may be required. Treatment methods for other *E. coli* infections are similar.

Drugs

Antibiotics are often used in the treatment of *E. coli* infections, but their role is controversial. Some antibiotics may enhance the development of HUS/TTP depending upon their action, as well as the use of anti-diarrhea medications that should be avoided. Treatment with third-generation cephalosporin antibiotics such as ceftriaxone (Rocephin) is indicated for neonatal meningitis.

Antibiotic therapy may be complicated by the presence of antibiotic resistant organisms. These organisms appear to be increasing since the late 1990s and are resistant to the **penicillins** and **cephalosporins** as well as to the fluoroquinolones and gentamicin, which in the past, were reserved to treat only the most serious of infections.

Prognosis

In most cases of O157:H7, symptoms last for about a week and recovery is often spontaneous. Ten percent of individuals with *E. coli* O157:H7 infection develop HUS; 5% of those die of the disease. Some who recover from HUS are left with some degree of kidney damage and possibly irritable bowel syndrome. Additionally, there is a possibility of chronic *E. coli* infection.

Infants that develop *E. coli* infections may be permanently affected. Gastroenteritis may leave the child with **lactose intolerance**. Neonates developing meningitis from *E. coli* strains have a high morbidity and mortality rate. Some of these neonates may develop neurological and developmental dysfunction.

Prevention

Thorough cooking of all meat and poultry products and adhering to proper food preparation is the most effective way to avoid infection. More studies are needed to determine the appropriate safety margins for killing these bacteria. Food irradiation methods are also being developed to sanitize food. The enforcement of regulations for meat production and water are critical. Steam pasteurization is used in the United States and is being explored in other countries. Vaccinations to *E. coli* 0157 are under development, as are medications aimed at limiting the effects of the verotoxin.

Prevention of *E. coli* gastroenteritis in infants is best achieved by **breastfeeding**. Breast milk contains antibodies that combat the infection. For bottle-fed infants, care should be taken in the preparation of the milk and bottles. Good hygiene of the umbilical cord area is important. Keeping this area clean and dry may reduce infection.

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Esophageal acidity test *see* **Esophageal function tests**

Esophageal aperistalsis *see* **Achalasia**

Esophageal atresia

Definition

Esophageal atresia is a serious birth defect in which the esophagus, the long tube that connects the mouth to the stomach, is segmented and closed off at any point. This condition usually occurs with **tracheoesophageal fistula**, a condition in which the esophagus is improperly attached to the trachea, the nearby tube that connects the nasal area to the lungs. Esophageal atresia occurs in approximately 1 in 4,000 live births.

Description

Failure of an unborn child (fetus) to develop properly results in **birth defects**. Many of these defects involve organs that do not function, or function only incidentally, before birth, and, as a result, go undetected until the baby is born. In this case, the digestive tract is unnecessary for fetal growth, since all **nutrition** comes from the mother through the placenta and umbilical cord.

During fetal development, the esophagus and the trachea arise from the same original tissue. Normally, the two tubes would form separately (differentiate); however, in cases of esphageal atresia and tracheoesophageal fistulas, they do not, resulting in various malformed configurations. The most common configuration is the "C" type, in which the upper part of the esophagus abruptly ends in a blind pouch, while the lower part attaches itself to the trachea. This configuration occurs in 85–90% of cases. Esophageal atresia without involvement of the trachea occurs in only 8% of cases.

KEY TERMS

Fetal—Refers to the fetus, also known in the first two months after conception as an embryo.

Fistula—Unnatural connection between two hollow organs or one organ and the outside.

Causes and symptoms

The cause of esophageal atresia, like that of most birth defects, is unknown.

An infant born with this defect will at first appear all right, swallowing normally. However, the blind pouch will begin to fill with mucus and saliva that would normally pass through the esophagus to the stomach. These secretions back up into the mouth and nasal area, causing the baby to drool excessively. When fed, the baby will also immediately regurgitate what he or she has eaten. **Choking** and coughing may also occur as the baby breaths in the fluid backing up from the esophagus. Aspiration **pneumonia**, an infection of the respiratory system caused by inhalation of the contents of the digestive tract, may also develop.

Diagnosis

Physicians who suspect esophageal atresia after being presented with the above symptoms diagnose the condition using x-ray imaging or by passing a catheter through the nose and into the esophagus. Esophageal atresia is indicated if the catheter hits an obstruction 4–5 in (10–13 cm) from the nostrils.

Treatment

Infants with esophageal atresia are unlikely to survive without surgery to reconnect the esophagus. The procedure is done as soon as possible; however, **prematurity**, the presence of other birth defects, or complications of apiration pneumonia may delay surgery. Once diagnosed, the baby will be fed intravenously until he or she has recovered sufficiently from the operation. Mucus and saliva will also be continuously removed via a catheter until recovery has occured. When surgery is performed, the esophagus is reconnected and, if neccessary, separated from the trachea. If the two ends of the esophagus are too far apart to be reattached, tissue from the large intestine is used to join them.

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Prognosis

Surgery to correct esophageal atresia is usually successful. Post-operative complications may include difficulty swallowing, since the esophagus may not contract efficiently, and gastrointestinal reflux, in which the acidic contents of stomach back up into the lower part of the esophagus, possibly causing ulcers.

Resources

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J. Ricker Polsdorfer, MD

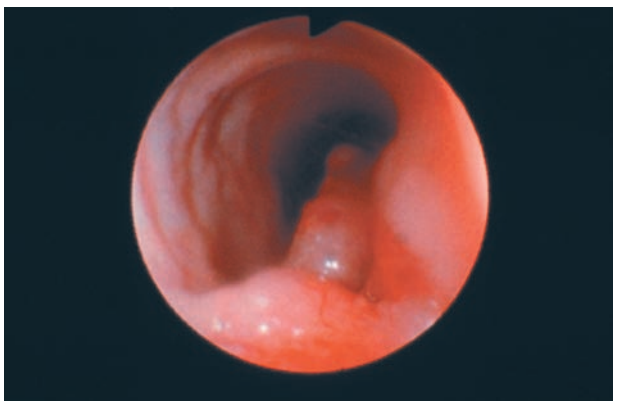
Esophageal cancer

Definition

Esophageal **cancer** is a malignancy that develops in tissues of the hollow, muscular canal (esophagus) along which food and liquid travel from the throat to the stomach.

Description

Esophageal cancer usually originates in the inner layers of the lining of the esophagus and grows outward. In time, the tumor can obstruct the passage of food and liquid, making swallowing painful and difficult. Since most patients are not diagnosed until the late stages of the disease, esophageal cancer is associated with poor quality of life and low survival rates.



A close-up view of a cancerous esophageal tumor. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Squamous cell carcinoma is the most common type of esophageal cancer, accounting for 95% of all esophageal cancers worldwide. The esophagus is normally lined with thin, flat squamous cells that resemble tiny roof **shingles**. Squamous cell carcinoma can develop at any point along the esophagus but is most common in the middle portion.

Adenocarcinoma has surpassed squamous cell carcinoma as the most common type of esophageal cancer in the United States. Adenocarcinoma originates in glandular tissue not normally present in the lining of the esophagus. Before adenocarcinoma can develop, glandular cells must replace a section of squamous cells. This occurs in Barrett's esophagus, a precancerous condition in which chronic acid reflux from the stomach stimulates a transformation in cell type in the lower portion of the esophagus.

A very small fraction of esophageal cancers are melanomas, **sarcomas**, or lymphomas.

There is great variability in the incidence of esophageal cancer with regard to geography, ethnicity, and gender. The overall incidence is increasing. About 13,000 new cases of esophageal cancer are diagnosed in the United States each year. During the same 12-month period, 12,000 people die of this disease. It strikes between five and ten North Americans per 100,000. In some areas of China the cancer is endemic.

Squamous cell carcinoma usually occurs in the sixth or seventh decade of life, with a greater incidence in African-Americans than in others. Adenocarcinoma develops earlier and is much more common in white patients. In general, esophageal cancer occurs more frequently in men than in women.

Causes and symptoms

The exact cause of esophageal cancer is unknown, although many investigators believe that chronic irritation of the esophagus is a major culprit. Most of the identified risk factors represent a form of chronic irritation. However, the wide variance in the distribution of esophageal cancer among different demographic groups raises the possibility that genetic factors also play a role.

Several risk factors are associated with esophageal cancer.

- Tobacco and alcohol consumption are the major risk factors, especially for squamous cell carcinoma. Smoking and alcohol abuse each increase the risk of squamous cell carcinoma by five-fold. The effects of the two are synergistic, in that the combination of smoking and alchohol increases the risk by 25- to

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100- fold. It is estimated that drinking about 13 ounces of alcohol every day for an extended period of time raises the risk of developing esophageal cancer by 18%. That likelihood increases to 44% in individuals who also smoke one or two packs of cigarettes a day. Smokeless tobacco also increases the risk for esophageal cancer.

- Gastroesophageal reflux is a condition in which acid from the stomach refluxes backwards into the lower portion of the esophagus, sometimes causing symptoms of heartburn. In some cases of gastroesophageal reflux, the chronic exposure to acid causes the inner lining of the lower esophagus to change from squamous cells to glandular cells. This is called Barrett's esophagus. Patients with Barrett's esophagus are roughly 30 to 40 times more likely than the general population to develop adenocarcinoma of the esophagus.
- A diet low in fruits, vegetables, zinc, riboflavin, and other vitamins can increase risk of developing to esophageal cancer.
- Caustic injury to the esophagus inflicted by swallowing lye or other substances that damage esophageal cells can lead to the development of squamous cell esophageal cancer in later life.
- Achalasia is a condition in which the lower esophageal sphincter (muscle) cannot relax enough to let food pass into the stomach. Squamous cell esophageal cancer develops in about 6% of patients with achalasia.
- Tylosis is a rare inherited disease characterized by excess skin on the palms and soles. Affected patients have a much higher probability of developing esophageal cancer than the general population. They should have regular screenings to detect the disease in its early, most curable stages.
- Esophageal webs, which are protrusions of tissue into the esophagus, and diverticula, which are outpouchings of the wall of the esophagus, are associated with a higher incidence of esophageal cancer.

Symptoms

Unfortunately, symptoms generally don't appear until the tumor has grown so large that the patient cannot be cured. Dysphagia (trouble swallowing or a sensation of having food stuck in the throat or chest) is the most common symptom. Swallowing problems may occur occasionally at first, and patients often react by eating more slowly and chewing their food more carefully and, as the tumor grows, switching to soft foods or a liquid diet. Without treatment, the tumor will eventually prevent even liquid from passing into the stomach. A sensation of burning or slight mid-chest pressure is a rare, often-disregarded symptom of esophageal cancer. Painful swallowing is usually a symptom of a large tumor obstructing the opening of the esophagus. It can lead to regurgitation of food, weight loss, physical wasting, and **malnutrition**. Anyone who has trouble swallowing, loses a significant amount of weight without dieting, or cannot eat solid food because it is too painful to swallow should see a doctor.

Diagnosis

A barium swallow is usually the first test performed on a patient whose symptoms suggest esophageal cancer. After the patient swallows a small amount of barium, a series of x rays can highlight any bumps or flat raised areas on the normally smooth surface of the esophageal wall. It can also detect large, irregular areas that narrow the esophagus in patients with advanced cancer, but it cannot provide information about disease that has spread beyond the esophagus. A double contrast study is a barium swallow with air blown into the esophagus to improve the way the barium coats the esophageal lining. **Endoscopy** is a diagnostic procedure in which a thin lighted tube (endoscope) is passed through the mouth, down the throat, and into the esophagus. Cells that appear abnormal are removed for biopsy. Once a diagnosis of esophageal cancer has been confirmed through biopsy, staging tests are performed to determine whether the disease has spread (metastasized) to tissues or organs near the original tumor or in other parts of the body. These tests may include computed tomography, endoscopic ultrasound, **thoracoscopy**, **laparoscopy**, and **positron emission tomography**.

Treatment

Treatment for esophageal cancer is determined by the stage of the disease and the patient's general health. The most important distinction to make is whether the cancer is curable. If the cancer is in the early stages, cure may be possible. If the cancer is advanced or if the patient will not tolerate major surgery, treatment is usually directed at palliation (relief of symptoms only) instead of cure.

Staging

Stage 0 is the earliest stage of the disease. Cancer cells are confined to the innermost lining of the esophagus. Stage I esophageal cancer has spread slightly deeper, but still has not extended to nearby tissues, lymph nodes, or other organs. In Stage IIA, cancer has invaded the thick, muscular layer of the esophagus

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KEY TERMS

Computed tomography—A radiology test by which images of cross-sectional planes of the body are obtained.

Endoscopic ultrasound—A radiology test utilizing high frequency sound waves, conducted via an endoscope.

Laparoscopy—Examination of the contents of the abdomen through a thin, lighted tube passed through a small incision.

Positron emission tomography—A radiology test by which images of cross-sectional planes of the body are obtained, utilizing the properties of the positron. The positron is a subatomic particle of equal mass to the electron, but of opposite charge.

Synergistic—The combined action of two or more processes is greater than the sum of each acting separately.

Thoracoscopy—Examination of the contents of the chest through a thin, lighted tube passed through a small incision.

that propels food into the stomach and may involve connective tissue covering the outside of the esophagus. In Stage IIB, cancer has spread to lymph nodes near the esophagus and may have invaded deeper layers of esophageal tissue. Stage III esophageal cancer has spread to tissues or lymph nodes near the esophagus or to the trachea (windpipe) or other organs near the esophagus. Stage IV cancer has spread to distant organs like the liver, bones, and brain. Recurrent esophageal cancer is disease that develops in the esophagus or another part of the body after initial treatment.

Surgery

The most common operations for the treatment of esophageal cancer are esophagectomy and esophagogastrectomy. Esophagectomy is the removal of the cancerous part of the esophagus and nearby lymph nodes. This procedure is performed only on patients with very early cancer that has not spread to the stomach. Esophagogastrectomy is the removal of the cancerous part of the esophagus, nearby lymph nodes, and the upper part of the stomach. The resected esophagus is replaced with the stomach or parts of intestine so the patient can swallow. These procedures can significantly relieve symptoms and improve the nutritional status of more than 80% of patients with dysphagia. Although surgery can cure some patients whose disease has not spread beyond the esophagus, but more than 75% of esophageal cancers have spread to other organs before being diagnosed. Less extensive surgical procedures can be used for palliation.

Chemotherapy

Oral or intravenous **chemotherapy** alone will not cure esophageal cancer, but pre-operative treatments can shrink tumors and increase the probability that cancer can be surgically eradicated. Palliative chemotherapy can relieve symptoms of advanced cancer but will not alter the outcome of the disease.

Radiation

External beam or internal radiation, delivered by machine or implanted near cancer cells inside the body, is only rarely used as the primary form of treatment. Post-operative radiation is sometimes used to kill cancer cells that couldn't be surgically removed. Palliative radiation is effective in relieving dysphagia in patients who cannot be cured. However, radiation is most useful when combined with chemotherapy as either the definitive treatment or preoperative treatment.

Palliation

In addition to surgery, chemotherapy, and radiation, other palliative measures can provide symptomatic relief. Dilatation of the narrowed portion of the esophagus with soft tubes can provide short-term relief of dysphagia. Placement of a flexible, self-expanding stent within the narrowed portion is also useful in allowing more food intake.

Follow-up treatments

Regular barium swallows and other imaging studies are necessary to detect recurrence or spread of disease or new tumor development.

Alternative treatment

Photodynamic therapy (PDT) involves intravenously injecting a drug that is absorbed by cancer cells and kills them after they are exposed to specific laser beams. PDT can be used for palliation, but it also cured some early esophageal cancers during preliminary studies. Researchers are comparing its benefits with those of more established therapies.

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Endoscopic laser therapy involves delivering short, powerful laser treatments to the tumor through an endoscope. It can improve dysphagia, but multiple treatments are required, and the benefit is seldom long-lasting.

Prognosis

Since most patients are diagnosed when the cancer has spread to lymph nodes or other structures, the prognosis for esophageal cancer is poor. Generally, no more than half of all patients are candidates for curative treatment. Even if cure is attempted, the cancer can recur.

Prevention

There is no known way to prevent esophageal cancer.

Resources

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ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (800) 227-2345, http://www.cancer.org.

National Coalition for Cancer Survivorship, 1010 Wayne Ave., Suite 770, Silver Spring, MD, 20910, (301) 650-9127, (301) 565-9670, (888) 650-9127, info@canceradvocacy.org, http://www.canceradvocacy.org.

Maureen Haggerty
Kevin O. Hwang, M.D.

Esophageal disorders

Definition

The esophagus is a tube that connects the back of the mouth to the stomach. Abnormalities of the esophagus generally fall into one of four categories: structural abnormalities, motility disorders, inflammatory disorders, and malignancies.

Description

The main function of the esophagus is to move food from the back of the mouth to the stomach. The adult esophagus is about 10 in (25 cm) long. It is consists of a layer of cells that secretes mucus and two layers of muscle, one circular and one longitudinal. This combination of muscles allows the esophagus to contract and propel food from the mouth the stomach. This rhythmic contraction is called peristalsis. At the end of the esophagus nearest the mouth is a ring of muscle called the upper esophageal sphincter (UES). A similar muscular ring called the lower esophageal sphincter (LES) is found 1–1.5 in (2–4 cm) above the point where the esophagus enters the stomach. The LES contracts to prevent the contents of the stomach from backflowing into the lower end of the esophagus.

Structural abnormalities

Structural abnormalities of the esophagus can be either congenital or acquired. Congenital abnormalities occur in about 1 of every 3,000–5,000 births. The two most common congenital esophageal abnormalities are **esophageal atresia** (EA) and **tracheoesophageal fistula** (TEF).

EA is a condition in which the esophagus is interrupted and the portion of the tube near the mouth is not connected to the portion that goes into the stomach. Usually the upper part of the tube ends in a blind pouch. This creates a life-threatening condition for the newborn who is unable to eat.

TEF is a condition in which the esophagus is connected to the trachea (windpipe). The trachea and the esophagus lie parallel to each other in the neck. Sometimes during fetal development, a connection called a **fistula** develops between these two tubes. This allows food to enter the trachea and be inhaled into the lungs causing a life-threatening condition called aspiration **pneumonia**. Often TEF and EA are present in the same infant. Both these conditions must be surgically corrected for the infant to survive.

Other, less common congenital structural abnormalities include webs, stenosis, cysts, and diverticula. Webs are thin membranes that lie across the esophagus and cause a partial obstruction. Stenosis is the abnormal reduction in the diameter of the esophagus due to thickening of the esophageal wall Diverticula are pouches of tissue that extend off the esophagus. Both diverticula and stenosis can be either congenital or acquired later in life.

Acquired structural abnormalities of the esophagus include Schatzki ring and **hiatal hernia**. Schatzki ring, sometimes called a **lower esophageal ring**, is a circular band of tissue located where the esophagus empties into the stomach. This ring is found in 6–14% of individuals, and for most people the presence of this ring does not create symptoms. Schatzki ring is found equally in all

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races and in both men and women. Schatzki rings that cause symptoms usually occur in middle age individuals. The ring can cause intermittent problems swallowing food or food impaction where the esophagus enters the stomach.

The esophagus passes a gap in the diaphragm called the diaphragmatic hiatus in order to reach the stomach. Hiatal hernia (also called hiatus hernia) is a condition that occurs when a portion of the stomach pushes up through this gap next to the esophagus. Although a hiatus hernia is not a direct structural abnormality of the esophagus, it is associated with **gastroesophageal reflux disease** (GERD) or **heartburn** in which the acidic stomach contents backflow into the lower part of the esophagus and erode the cell lining. Hiatal hernia is very common and often causes no symptoms. It is treated as a separate entry.

Lacerations, tears, and ruptures of the esophagus, known as **Mallory-Weiss syndrome** and Boerhaave syndrome, are life-threatening disorders. Mallory-Weiss syndrome usually occurs in alcoholics. In both conditions, tears result from **vomiting** and retching. The resulting bleeding creates a medical emergency that can be fatal.

Motility abnormalities

Motility abnormalities create difficulty in swallowing, called dysphagia. Dysphagia is a symptom of several esophageal motility disorders as well as several obstructive disorders such as esophageal webs or Schatzki ring.

Achalasia is an esophageal motility disorder caused by uncoordinated contractions of the two muscular layers that make up the esophagus. Because muscular contractions are disorganized, peristalsis and the orderly movement of food down the esophagus does not occur. In addition, with achalasia the lower esophageal sphincter remains contracted when food is present in the esophagus which prevents the food from entering the stomach. This causes the esophagus to bulge above the LES, a condition called megaesophagus.

Achalasia is caused by destruction of some of the nerve cells that control muscular contraction of the esophagus. This disorder generally begins in young adults and becomes progressively worse as the individual ages. Individuals with achalasia also have a higher risk of developing **esophageal cancer** at an earlier than usual age.

Individuals can also develop esophageal motility disorders secondary to other muscle diseases. **Scleroderma** is a disorder in which smooth muscle begins to atrophy. The smooth muscle in the esophagus can be affected just like other smooth muscle in the body, making swallowing difficult. Scleroderma esophagus is also associated with GERD and increased risk of **cancer** of the esophagus. Other conditions such as **diabetes mellitus**, **alcoholism**, and some psychiatric disorders can also produce secondary esophageal motility disorders.

Inflammatory disorders

Inflammatory esophageal disorders fall under the general name of esophagitis. Esophagitis causes the esophagus to become swollen and the lining of the esophagus becomes eroded and sore. It is present in about 5% of the population in the United States. There are four main types of esophagitis: reflux, infection, corrosive, and radiation. Reflux esophagitis is caused by GERD when the lower esophageal sphincter does not close tightly and the acidic contents of the stomach enter esophagus. GERD is common and is treated in depth in a separate entry. Infectious esophagitis can be caused fungal, viral, or bacterial infections. Infectious esophagitis occurs frequently in individuals with compromised immune systems, such as those with **AIDS** or leukemia. Corrosive esophagitis occurs when an individual either intentionally or accidentally swallows harsh chemicals such as lye. Radiation esophagitis is a complication of radiation treatments for cancer of the esophagus or lung.

Malignancies

Barrett's esophagus is a pre-cancerous condition which has a high risk of developing into esophageal cancer. It is found most commonly in white males in their 50s and 60s and is usually associated with years of chronic GERD.

Cancers of the esophagus tend to be aggressive and have poor outcomes. Adenocarcinoma is the primary cancer of the esophagus. Esophageal cancers are treated in detail in a separate entry.

Causes and symptoms

The causes of esophageal disorders depend on the type of disorder. Congenital defects are caused by errors in development. It is not clear why some structural disorders, such as Schatzki ring and hiatal hernia, occur. Many more people have these defects than develop symptoms or seek medical care, so that the presence of these asymptomatic structural defects is found only during autopsies. Other individuals develop symptoms that require medical attention.

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Obesity and advancing age are thought to be contributing factors in developing symptoms.

Achalasia is caused by **death** of nerve cells that control the muscles that make peristalsis possible. These nerve cells are destroyed by T cells that are part of the body's immune system. It is not clear what triggers these T cells to attack inappropriately. Difficulty swallowing develops slowly, usually beginning in young adults, although the disorder can occur in children. As nerve control is lost, the LES fails to relax, preventing food from entering the stomach. As a result, the lower part of the esophagus becomes stretched creating a condition called megaesophagus. At night, food is often regurgitated and can be inhaled into the lungs, creating the risk of aspiration pneumonia. Achalasia can also be caused by **Chagas' disease**, a disease rare in North America, but common in Central and South America. Individuals with achalasia are also at higher risk to develop esophageal cancer, esophageal infections, and esophageal rupture.

Inflammatory esophagitis is most often caused by GERD. Infectious esophagitis can be caused by fungi, usually *Candida albicans*, bacteria, or viruses. Fungal infections usually occur in individuals who have diabetes, a weakened immune system, or who are taking **antibiotics**. Antibiotics change the balance of naturally occurring bacteria in the esophagus and allow fungi, which are normally present in the digestive tract, to grow unchecked. The most common causes of viral esophagitis are cytomegalovirus (CMV) and *Herpes simplex*. These are usually opportunistic infections in individuals with HIV/AIDS.

Corrosive esophagitis is usually caused by swallowing harsh chemicals, but it can also be caused by certain medications. Radiation esophagus is a side effect of **radiation therapy** for cancer.

Diagnosis

EA and TEF can sometimes be diagnosed in fetal ultrasounds before birth. If not, these defects become obvious soon after birth, because the infant is unable to eat. The inability to pass a tube from the mouth to the stomach is a definite diagnosis for EA. TEF can be detected through x-rays.

A barium swallow x ray with video is the basic method of diagnosing most esophageal disorders. For a barium swallow x ray, the individual drinks a barium, a material that coats the esophagus and shows up on x-ray film. A video camera records the passage of the barium down the esophagus in order to detect **swallowing disorders** or pockets and pouches (diverticula) bulging from the esophagus. A barium swallow is also used to detect Schatzki rings.

Upper gastrointestinal **endoscopy** is often used in conjunction with a barium swallow to diagnose esophageal disorders. In an endoscopy, a thin, fiberoptic tube with a tiny camera is inserted into the esophagus. This allows the physician to see the lining of the esophagus. Endoscopes are equipped to take samples (biopsies) of any areas that may appear pre-cancerous or cancerous or to collect samples to test for the organism causing infectious esophagitis.

GERD can often be diagnosed from symptoms such as heartburn and regurgitation. Mallory-Weiss tears and Boerhaave syndrome are difficult to diagnose. Individuals with these disorders are often severely ill and have intense chest **pain** and **vomiting**, however chest x rays are normal 10–15% of the time. CT scans may be used in conjunction with chest x rays.

Treatment

Surgery is the only treatment for EA and TEF. It is done as soon as possible, based on the condition of the infant and any other **birth defects** that may be present that could affect the surgery.

Schatzki rings and hiatal hernias often cause no or mild symptoms and need no treatment. In severe cases, Schatzki rings are treated with bougienage. In this treatment, a series of tubes of ever-increasing diameter are inserted through the esophagus to stretch the ring. Stretching can also be done with balloon dilation. Surgery is done when no other treatment succeeds in relieving symptoms. Large hiatal hernias can be repaired surgically, but often there is not need for treatment. GERD accompanies many hiatal hernias. GERD can be treated with drugs to block acid production in the stomach (H2 blockers or **proton pump inhibitors**) and changes in diet. In severe cases of GERD stomach surgery may be necessary.

Mallory-Weiss syndrome and Boerhaave syndrome are medical emergencies. The individual is stabilized and the tear or rupture is repaired surgically. The chance of infection (**sepsis**) is high, so individuals are admitted to intensive care and do not take any food or liquid by mouth for 7–10 days. Hospital stays can last months, and repeated tears are possible.

Achalasia is treated with drugs that relax the smooth muscle and allow the LES to relax and open. When this fails, surgery to may be needed. Individuals that are not good candidates for surgery (the elderly or frail) may be treated by injecting botulinum toxin (botox) into the LES to prevent it from closing. The

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KEY TERMS

Atrophy—To wither and become unresponsive.

Congenital—Present at birth.

Diaphragm—A muscle that separates the cavity containing the lungs from the abdomen.

Diverticula—Abnormal pouches of tissue that bulge off the main part of the digestive system.

Peristalsis—A wave of contractions passing through a hollow muscular tube such as the esophagus or intestine.

disadvantage of this treatment is its expense and the fact that more than one injection is needed.

Infectious esophagitis is treated by treating the underlying cause of the disease with antifungal, antiviral or antibiotic medications. These can be given either by mouth or intravenously (IV) depending on the severity of the disease.

Malignancies are treated with **chemotherapy** and radiation. See the entry on esophageal cancer for specific details.

Prognosis

The outcome of treatment depends on the type of disorder, severity, age, and general health of the individual. EA and TEF surgeries are often successful, but infants born with these conditions frequently have other congenital abnormalities that compromise their health.

When needed, treatment for Schatzki rings produces relief of symptoms, but almost always has to be repeated periodically.

Mallory-Weiss and Boerhaave syndromes are often fatal. Thirty to fifty percent of individuals die from these disorders even if they are diagnosed promptly. If diagnosis is delayed, the death rate can be as high as 90%.

Achalasia and scleroderma esophagus are progressive diseases that need continued therapy. They frequently lead to serious weight loss and **malnutrition**.

The outcome for treatment of inflammatory esophagitis depends almost entirely on the success of treating the underlying cause. Where individuals have a weakened immune system, infectious esophagitis can be an ongoing problem. When inflammatory esophagitis is caused by GERD, treatment along with lifestyle modification is usually successful in providing relief.

Esophageal cancers are aggressive and have generally poor outcomes.

Prevention

Many symptoms of esophageal disorders can be prevented or alleviated by lifestyle changes that include:

- weight loss to control obesity
- eating slowly and chewing food well
- eating smaller and more frequent meals
- not eating several hours before going to bed
- limiting the use of alcohol and caffeine

Resources

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Esophageal diverticula *see* **Esophageal pouches**

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Esophageal function tests

Definition

The esophagus is the swallowing tube through which food passes on its way from the mouth to the stomach. The main function of this organ is to propel food down into the stomach. There is also a mechanism to prevent food from coming back up or "refluxing" from the stomach into the esophagus. Esophageal function tests are used to determine if these processes are normal or abnormal.

Purpose

The esophagus is a long, muscular tube that also has two muscles (or sphincters) at the top and bottom. All of these muscular areas must contract in an exact sequence for swallowing to proceed normally. There are three main symptoms that occur when esophageal function is abnormal: difficulty with swallowing (dysphagia), **heartburn**, and chest **pain**.

Doctors perform a variety of tests to evaluate these symptoms. **Endoscopy**, which is not a test of esophageal function, is often used to determine if the lining of the esophagus has any ulcers, tumors, or areas of narrowing (strictures). Many times, however, endoscopy only shows the doctor if there is injury to the esophageal lining, and the procedure gives no information about the cause of the problem.

Therefore, in addition to endoscopy, several studies are available that measure esophageal function. There are three basic types of tests used to assess esophageal function:

- Manometry is used to study the way the muscles of the esophagus contract, and is most useful for the investigation of difficulty with swallowing.
- Esophageal pH monitoring measures changes in esophageal acidity, and is valuable for evaluating patients with heartburn or gastroesophageal reflux disease (GERD).
- X-ray studies investigate swallowing difficulties. They either follow the progress of barium during swallowing using a fluoroscope, or they use radioactive scanning techniques.

Precautions

Pregnant patients undergoing x-ray exams should carefully review the risks and benefits with their doctors. Most x-ray exams of the gastrointestinal tract do not involve radiation levels that are harmful to the unborn baby.

Description

Manometry

This study is designed to measure the pressure changes produced by contraction of the muscular portions of the esophagus. An abnormality in the function of any one of the segments of the swallowing tube causes difficulty in swallowing. Doctors call this symptom dysphagia. This exam is most useful in evaluating those patients whose endoscopy is negative.

During manometry, the patient swallows a thin tube carrying a device that senses changes in pressures in the esophagus. Readings are taken at rest and during swallowing. Medications are sometimes given during the study to help in the diagnosis. The results are then transmitted to recording equipment. Manometry can best identify diseases that produce disturbances of motility or contractions of the esophagus.

ESOPHAGEAL PH MONITORING. This procedure involves measuring the esophagus' exposure to acid that has "refluxed" from the stomach. The test is ideal for evaluating recurring heartburn or GERD. Too much acid produces not only heartburn, but also ulcers that can bleed or produce areas of narrowing (strictures) when they heal.

Normally, acid refluxes into the esophagus in only small amounts for short periods of time. A muscle called the lower esophageal sphincter prevents excessive reflux. Spontaneous contractions that increase esophageal emptying and production of saliva are other important protective mechanisms.

"pH" is the scientific term that tells just how acidic or alkaline a substance is. Researchers have shown that in the esophagus, the presence of acid is damaging only if it persists for prolonged periods. Therefore, the test has been designed to monitor the level of acidity over 24 hours, usually in the home. In this way, patients maintain their daily routine, documenting their symptoms, and at what point in their activities they occurred. During this period, a thin tube with a pH monitor remains in the esophagus to record changes. After the study, a computer is used to compare changes in acidity with symptoms reported by the patient.

Surgery is an effective and long-lasting treatment for symptoms of recurrent reflux and is the choice of many patients and doctors. pH monitoring is usually performed before surgery to confirm the diagnosis and to judge the effects of drug therapy.

X-RAY TESTS. These fall into two categories: (1) those done with the use of barium and a fluoroscope; and (2) those performed with radioactive materials.

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Studies performed with fluoroscopy are of greatest value in identifying a structural abnormality of the esophagus. Although this is not truly an esophageal function test, it does allow doctors to consider other diagnostic possibilities. Often a sandwich or marshmallow coated with barium is used to identify the site of an obstruction.

During fluoroscopy, the radiologist can observe the passage of material through the esophagus in real time, and video recordings can also be done. This is particularly useful when the swallowing symptoms appear to involve mainly the upper region of the esophagus. The most common cause of swallowing difficulties is a previous **stroke**, although other diseases of the neuromuscular system (like **myasthenia gravis**) can produce the same symptoms.

Scans using low-dose radioactive materials are useful because they are able not only to demonstrate that food passes through the esophagus more slowly than normal, but also how slow. These studies involve swallowing food coated with material that is followed by a nuclear medicine scanner. Scans are best used when other methods have failed to make a diagnosis, or if it is necessary to determine the degree of the abnormality. Scans mainly serve as research tools.

Preparation

Patients should not eat or drink for several hours before the exam. Many medications affect the esophagus; doses sometimes need to be adjusted or even stopped for a while. Patients must inform doctors of all medications taken, including over-the-counter medications (purchased without a doctor's prescription), and any known **allergies**.

Aftercare

For most of these studies, no special care is needed after the procedure. Patients can often go about normal daily activities following any of these tests. One exception is for those who undergo an x-ray exam with the use of barium. This can have a constipating effect and patients should ask about using a mild laxative later on.

Risks

Exposure of a fetus to x rays, especially in the first three months, is a potential risk.

Other studies of esophageal function are essentially free of any significant risk. The tubes passed during these procedures are small, and most patients adjust to them quite well. However, since medications cannot be used to relax patients, some may not tolerate the exam.

Abnormal results

Manometry is used to diagnose abnormalities related to contraction or relaxation of the various muscular regions of the esophagus. These studies cannot distinguish whether injury to either the muscle or nerves of the esophagus is producing the abnormal results. Only the final effect on esophageal muscle is identified. Results should be interpreted in light of the patient's entire medical history.

For example, there are many diseases that cause poor relaxation of the lower esophageal sphincter. When no cause is found, the disease is called **achalasia**.

Abnormal results of pH tests can confirm symptoms of heartburn or indicate a cause of chest pain (or rarely, swallowing difficulties). Doctors may want to start or change medications based on these results, or even repeat the test using different doses of medication. As noted above, these studies are indicated before surgical treatment of GERD.

X-ray tests can only serve to document an abnormality, and they are far from perfect. If they are negative, then other studies are often needed.

Resources

PERIODICALS

Lazarescu, A., et al. "Perception of dysphagia: lack of correlation with objective measurements of esophageal function." *Neurogastroenterology and Motility* (Dec 2010): 1292.

David Kaminstein, MD

Esophageal laceration *see* **Mallory-Weiss syndrome**

Esophageal manometry *see* **Esophageal function tests**

Esophageal pouches

Definition

Esophageal pouches, also known as esophageal diverticula, are pocket-like structures formed when the interior space of the esophagus, the tube that connects the mouth to the stomach, protrudes into the walls that surround it.

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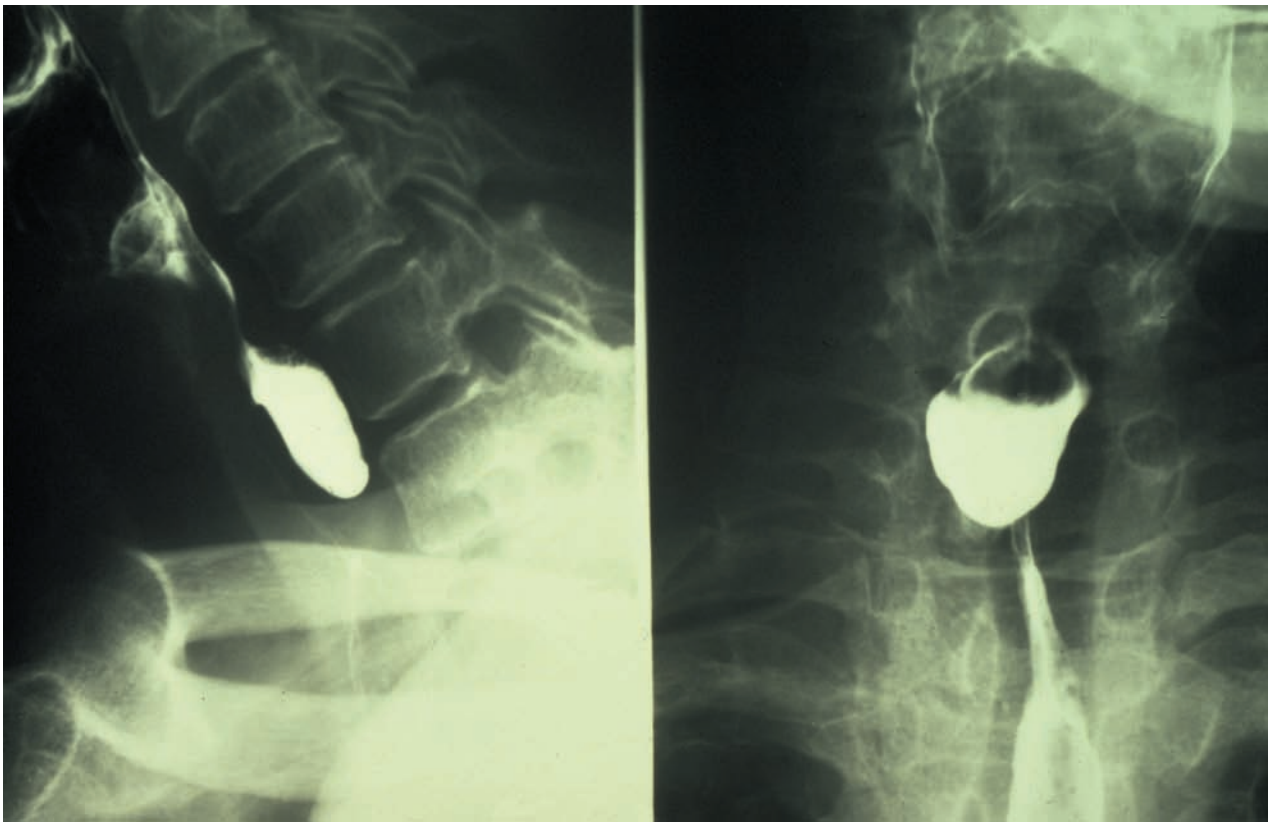

A split x-ray image of the upper chest, neck, and esophagus (left), and chest and esophagus (right). *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Description

The esophagus is a muscular tube that propels food into the stomach. A defect in the wall of the esophagus may allow the lining to herniate, creating a space where food can be caught. Pouches can appear anywhere between the throat and the stomach. They occur primarily in men and usually later in life.

Different names for the condition apply to different locations along the esophagus:

- Zenker's diverticula are pharyngeal pouches, or ones that occur in the upper neck area at the top of the esophagus.
- Traction diverticula are a type of mid-esophageal pouch.
- Epiphrenic diverticula occur at the bottom of the esophagus near where it enters the stomach.

Causes and symptoms

To propel food into the stomach (or out of it during **vomiting**) the esophagus generates internal pressure just like the bowel. Under certain circumstances, that pressure can herniate the esophageal lining through a weakness in the wall, creating a pouch (a balloon squeezed in the hand will herniate through the fingers in the same way). Pouches are more common in people who have motility disorders of the esophagus, swallowing that is not well coordinated and may be spastic. A **traction** diverticulum can develop from a scar that pulls the esophagus out of shape. Food and saliva can collect in all of these pouches.

Pouches in the neck usually cause **bad breath** (halitosis) and the regurgitation of swallowed food and saliva. Some patients with Zenker's diverticula can push on their neck and make old food appear in their mouths. Pouches near the stomach may cause swallowing problems, conditions known as *achalasia* or *dysphagia*. Mid-esophageal pouches usually cause no symptoms.

In the most serious cases, a person may be unable to swallow because the esophagus is obstructed, or the esphagus may rupture, spilling its contents into the chest or neck.

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KEY TERMS

Achalasia—Failure of the lower end of the esophagus (or another tubular valve) to open, resulting in obstruction, either partial or complete.

Contrast agent—A substance that produces shadows on an x ray so that hollow structures can be more easily seen.

Dysphagia—Difficult swallowing.

Esophagoscopy—Looking down the esophagus with a flexible viewing instrument.

Herniate—To protrude beyond usual limits.

Manometry—Pressure measurement.

Diagnosis

Difficulty swallowing, bad breath, or food reappearing in the back of the mouth are among the signs physicians look for when diagnosing this condition. Sometimes the patient may also experience **pain** in the chest resembling a **heart attack**. A series of x rays taken while swallowing a contrast agent usually demonstrates the diverticulum clearly. An esophagoscopy may also be needed to gather more detail. Manometry, measuring pressures inside the esophagus using a balloon that is passed down it, may help determine the cause of the diverticula.

Treatment

Treatment for this condition is primarily aimed at alleviating symptoms. Physicians direct the patient to eat a bland diet, to chew his or her food thoroughly, and to drink water after eating to clean out the pouches. If the condition is severe, several types of surgery are available to remove the pouches and repair the defects. If a pouch is due to a stenosis (narrowing) in the esophagus it may be possible to relieve it by passing a dilator through it, a process called bougeinage.

Prognosis

The two complications that can render these nuisances dangerous, obstruction and rupture, are emergencies. Both require immediate medical attention. Other than that, diverticula will usually grow slowly over the years, gradually increasing the symptoms they cause.

Resources

BOOKS

Fauci, Anthony S., et al., eds. *Harrison's Principles of Internal Medicine*. 17th ed. New York: McGraw–Hill Professional, 2008.

J. Ricker Polsdorfer, MD

Esophageal ulcers *see* **Ulcers (digestive)**

Esophagogastroduodenoscopy

Definition

An endoscope as used in the field of gastroenterology (the medical study of the stomach and intestines) is a thin, flexible tube that uses a lens or miniature camera to view various areas of the gastrointestinal tract. When the procedure is limited to the examination of the inside of the gastrointestinal tract's upper portion, it is called upper **endoscopy** or esphagogastroduodenoscopy (EGD). With the endoscope, the esophagus (swallowing tube), stomach, and duodenum (first portion of the small intestine) can be easily examined, and abnormalities frequently treated. Patients are usually sedated during the exam.

Purpose

EGD is performed to evaluate or treat symptoms relating to the upper gastrointestinal tract, such as:

- upper abdominal or chest pain
- nausea or vomiting
- difficulty swallowing (dysphagia)
- bleeding from the upper intestinal tract
- anemia (low blood count). EGD can be used to treat certain conditions, such as an area of narrowing or bleeding in the upper gastrointestinal tract

Upper endoscopy is more accurate than x rays for detecting inflammation, ulcers, or tumors. It is used to diagnose early **cancer** and can frequently determine whether a growth is benign (not cancerous) or malignant (cancerous).

Biopsies (small tissue samples) of inflamed or "suspicious" areas can be obtained and examined by a pathologist. Cell scrapings can also be taken by the introduction of a small brush; this helps in the diagnosis of cancer or infections.

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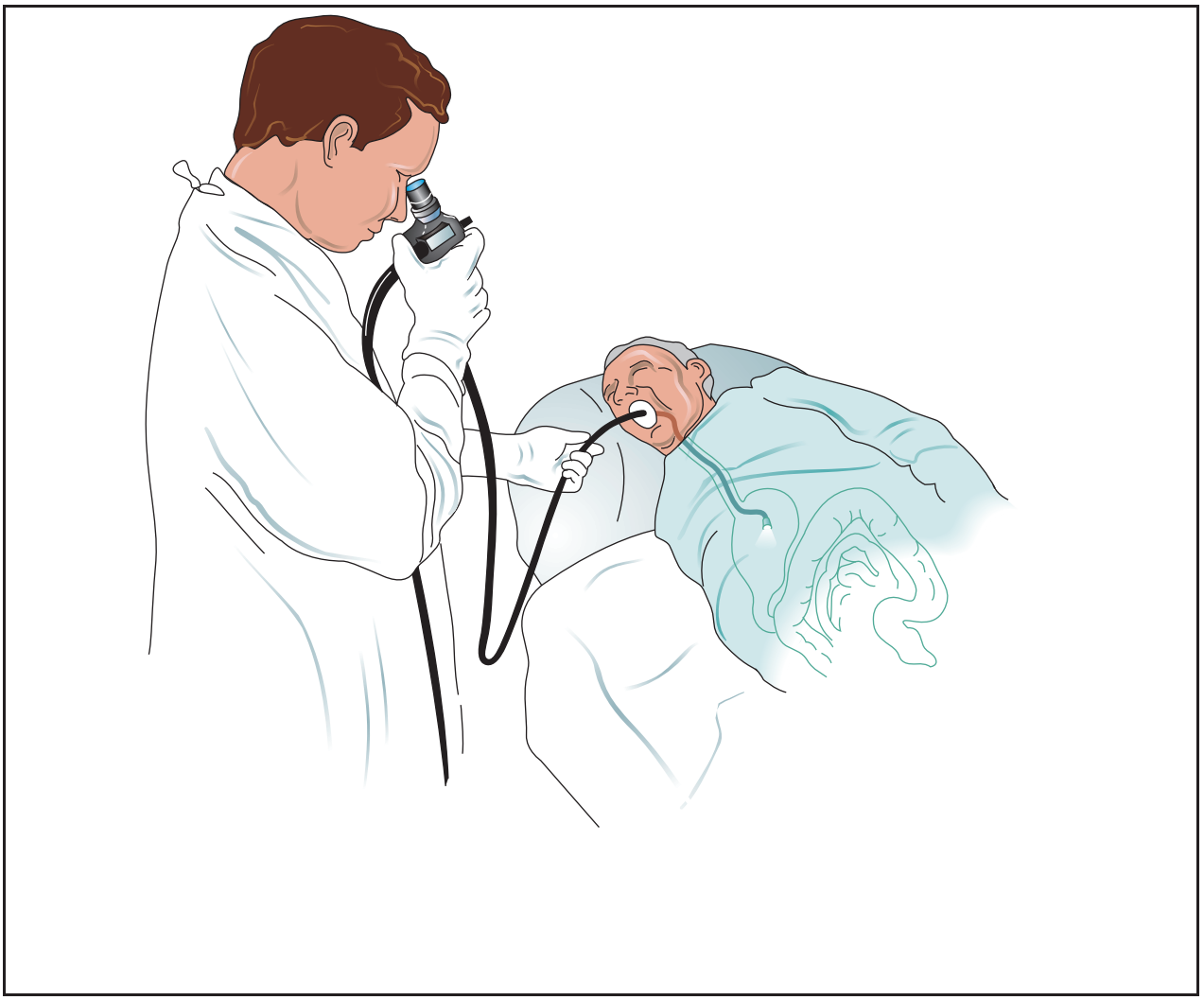

Esophagogastroduodenoscopy (EGD) is performed to evaluate or treat symptoms relating to the upper gastrointestinal tract. By inserting an endoscope into the mouth and guiding it through the gastrointestinal tract, the esophagus, stomach, and duodenum can be examined and abnormalities treated. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

When treating conditions in the upper gastrointestinal tract, small instruments are passed through the endoscope that can stretch narrowed areas (strictures), or remove swallowed objects (such as coins or pins). In addition, bleeding from ulcers or vessels can be treated by a number of endoscopic techniques.

Recent studies have shown the usefulness of endoscopic removal of early tumors of the esophagus or stomach. This is done either with injection of certain materials (like alcohol), or with the use of instruments (like lasers) that burn the tumor. Other techniques combining medications and lasers also show promise.

Precautions

Patients should inquire as to the doctor's expertise with these procedures, especially when therapy is the main goal. The doctor should be informed of any **allergies**, medication use, and medical problems.

Description

First, a "topical" (local) medication to numb the gag reflex is given either by spray or is gargled. Patients are usually sedated for the procedure (though not always) by injection of medications into a vein. The endoscopist then has the patient swallow the scope, which is passed

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KEY TERMS

Pathologist—A doctor who specializes in the anatomic (structural) and chemical changes that occur with diseases. These doctors function in the laboratory, examining biopsy specimens, and regulating studies performed by the hospital laboratories (blood tests, urine tests, etc). Pathologists also perform autopsies.

through the upper gastrointestinal tract. The lens or camera at the end of the instrument allows the endoscopist to examine each portion of the upper gastrointestinal tract; photos can be taken for reference. Air is pumped in through the instrument to allow proper observation. Biopsies and other procedures can be performed without any significant discomfort.

Preparation

The upper intestinal tract must be empty for the procedure, so it is necessary NOT to eat or drink for at least 6–12 hours before the exam. Patients need to inquire about taking their medications before the procedure.

Aftercare

Someone should be available to take the person home after the procedure and stay with them for a while; patients will not be able to drive themselves due to **sedation**. **Pain** or any other unusual symptoms should be reported immediately.

It is important to recognize early signs of any possible complication. The doctor should be notified if the patient has **fever**, trouble swallowing, or increasing throat, chest, or abdominal pain.

Risks

EGD is safe and well tolerated; however, complications can occur as with any procedure. These are most often due to medications used during the procedure, or are related to endoscopic therapy. The overall complication rate of EGD is less than 2%, and many of these complications are minor (such as inflammation of the vein through which medication is given). However, serious ones can and do occur, and almost half of them are related to the heart or lungs. Bleeding or perforations (holes in the gastrointestinal tract) are also reported, especially when tumors or narrowed areas are treated or biopsied. Infections have also been rarely transmitted; improved cleaning techniques should be able to prevent them.

Resources

OTHER

"Understanding Upper Endoscopy." *American Society for Gastrointestinal Endoscopy*. http://www.asge.org.

David Kaminstein, MD

Essential tremor *see* **Tremors**
Estradiol *see* **Hormone replacement therapy**
Estrogen *see* **Hormone replacement therapy**
Estrogen fractions test *see* **Sex hormones tests**
Estrogen replacement therapy *see* **Hormone replacement therapy**
Ethambutol *see* **Antituberculosis drugs**
Etodolac *see* **Nonsteroidal anti-inflammatory drugs**

Evoked potential studies

Definition

Evoked potential studies are a group of tests of the nervous system that measure electrical signals along the nerve pathways.

Purpose

Nerves convey information to the body by sending electrical signals down the length of the nerve. These signals can be recorded by wires placed over the nerves on the surface of the skin, in a procedure called an evoked potential (EP) study. The person conducting the test evokes the patient's neural activity by visual or auditory stimulation or using a mild electrical shock. This causes changes in the electrical potential in the nerves. Analysis of the signals can provide information about the condition of nerve pathways, especially those in the brain and spinal cord. They can indicate the presence of disease or degeneration, and can help determine the location of nerve lesions.

There are three major types of EP studies used regularly:

- Visual evoked potentials are used to diagnose visual losses due to optic nerve damage, especially from multiple sclerosis. They are also useful to diagnose

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"hysterical blindness," in which loss of vision is not due to any nerve damage.

- Auditory evoked potentials are used to diagnose hearing losses. They can distinguish damage to the acoustic nerve (which carries signals from the ear to the brain stem) from damage to the auditory pathways within the brainstem. Most auditory EPs record activity from the brainstem, and are therefore called "brainstem auditory evoked potentials." Disorders diagnosed with auditory EPs include acoustic neuroma (tumors of the inner ear) and multiple sclerosis (chronic disease in which nerves lose patches of their outer covering). They may also be used to assess high frequency hearing ability, to determine brain death, and to monitor brainstem function during surgery
- Somatosensory evoked potentials record transmission of nerve impulses from the limbs to the brain, and can be used to diagnose nerve damage or degeneration within the spinal cord or nerve roots from multiple sclerosis, trauma, or other degenerative disease. Somatosensory EPs can be used to distinguish central versus peripheral nerve disease, when combined with results from a nerve conduction velocity test, which measures nerve function in the extremities.

Precautions

Evoked potential studies are painless, noninvasive, and without any significant risk. Somatosensory EP tests involve very mild electric shocks, usually felt as a **tingling**.

Description

The person performing the test locates and marks specific spots on the patient's head for placement of electrodes. These spots are cleaned, and an adhesive conducting paste is applied. Cup electrodes are attached. For somatosensory EP, spots on the arm or leg are also marked and cleaned; electrodes may be taped in place. The patient sits or reclines in a chair throughout the tests.

For a visual EP, the patient focuses on a TV screen which displays a checkerboard pattern. The eye not being tested is covered with a patch. For children or others whose attention may wander, goggles are used which show the pattern to one eye at a time. Each eye is usually tested twice, and the entire procedure takes approximately 30–45 minutes.

For auditory EP, headphones are used to deliver a series of clicks to one ear at a time. A masking or static sound is played into the other ear. Each ear is usually tested twice, and the entire procedure takes approximately 30–45 minutes.

KEY TERMS

Nerve conduction velocity test—A test of the speed of conduction of nerves, performed on the nerves in the arm and leg.

For somatosensory EP, mild electrical shocks are delivered to the arm or leg. This may cause some twitching and tingling. The stimulus lasts for about two minutes at a time, and the entire procedure takes approximately 30 minutes.

After the tests, the electrodes are removed with acetone and the scalp is cleaned.

Preparation

Hair must be clean, dry, and free of any braids, pins, or jewelry. The patient should shampoo before the test, and must not use any hair spray, gel, or other hair care products after shampooing. Clothing should be loose and comfortable. The patient may eat and take some medications as usual before the test, although sedative medications should be avoided on the day of the test, if possible. It is best to check with the physician supervising the test for specific instructions.

Aftercare

This test is painless and has no residual effects. The patient may return to work or other activities immediately afterward.

Normal results

EP test results are displayed as jagged electrical tracings (wave forms), which have characteristic shapes, heights, and lengths, indicating the speed and intensity of signal transmission. Results are read by someone trained in evoked potential studies.

Abnormal results

Changes in the electrical tracings may indicate damage to or degeneration of nerve pathways to the brain from the eyes, ears, or limbs. Absence of any activity may mean complete loss of nerve function in that pathway. Other changes may provide evidence of the type and location of nerve damage.

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Resources

BOOKS

Husain, Aatif M. *Illustrated Manual of Clinical Evoked Potentials*. New York: Demos Medical Publishing, 2011.

Richard Robinson

Evoked responses *see* **Evoked potential studies**

Exanthema subitum *see* **Roseola**

Exercise

Definition

Exercise can be defined as physical activity that involves planned, structured, and repetitive bodily movements for the purpose of maintaining or improving physical fitness and overall health. Exercise includes cardiovascular training, muscle-strength training, and stretching activities for flexibility and to prevent injury. Typical exercise activities include walking, running, cycling, swimming, weight training, aerobics, and individual and team sports.

Purpose

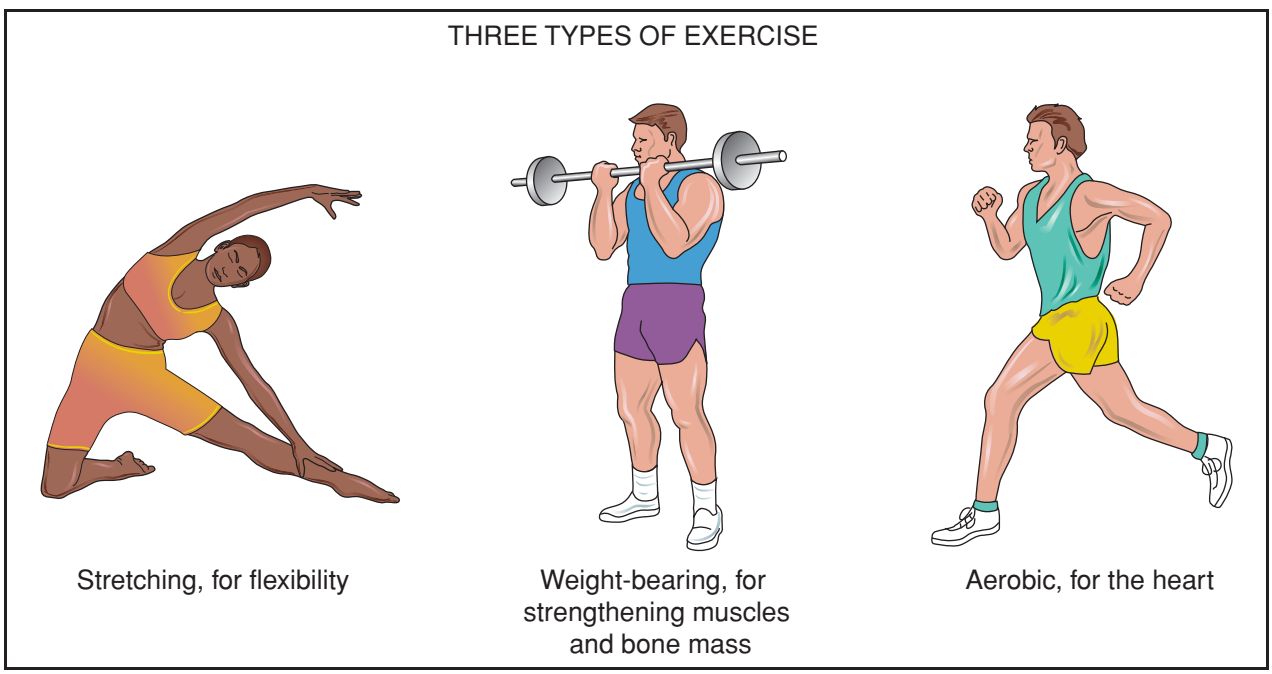
Regular exercise is important for the physical, mental, and emotional health of people of all ages—from young children to the elderly. Exercise promotes:

- weight maintenance or weight loss
- cardiovascular efficiency
- musculoskeletal strength and flexibility
- improved functioning of the metabolic, endocrine, and immune systems
- bone density
- lower cholesterol levels
- recovery from illness, injury, or surgery
- mental and emotional wellbeing

The beneficial effects of exercise diminish within two weeks of substantially reducing physical activity. Physical fitness is lost completely if exercise is not resumed within two to eight months.

Demographics

The National Institutes of Health (NIH) has identified inactivity as a major public health problem in the United States, and most North American adults would benefit from increasing their level of physical activity. More than 60% of American adults do not get enough physical activity to provide health benefits and more than 25% are inactive during their leisure



Exercise is utilized to improve health, maintain fitness, and is important as a means of physical rehabilitation. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

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time. Lack of exercise is a major contributor to the current epidemic of **obesity**, since people burn fewer calories than they take in, resulting in weight gain. Sedentary lifestyles and unhealthy eating patterns are responsible for at least 300,000 deaths from chronic disease each year in the United States. Likewise a recent survey in the United Kingdom found that only one-third of adults meet recommended goals for physical activity.

Insufficient exercise is more prevalent among women than men and among those with lower levels of economic stability and educational achievement. However the number of adult Americans who are exercising regularly is on the increase. According the Centers for Disease Control and Prevention (CDC), between 2001 and 2005 the number of women exercising at least 30 minutes per day increased by 8.6% and the number of men increased by 3.5%.

Geriatric

Exercise generally decreases with age. It is estimated that two-thirds of Americans over age 65 have at least one chronic condition, with 36 million suffering from some form of arthritis. Lack of exercise is a significant contributor to conditions such as **osteoarthritis**, lower back **pain**, and **osteoporosis**. More than 300,000 total joint replacements are performed each year due to osteoarthritis.

Description

Exercise programs should include three types of exercise: strengthening, including weight or resistance training, stretching and flexibility exercises, and cardiovascular exercise. Recent studies have indicated that muscle strength and aerobic fitness make independent contributions to health and that more muscle strength correlates with lower **death** rates, regardless of aerobic fitness. The American College of Sports Medicine recommends two strength-training workouts per week, each consisting of about ten repetitions of ten exercises for strengthening all of the major muscle groups. **Yoga** is often recommended for stretching, bending, and improving overall flexibility.

Chosen exercises should be interesting and appealing: studies have found that people are more likely to stick with an exercise program when they enjoy the activity, whether as an individual, with a partner, or with a group or team. Convenience is also an important consideration. Exercise can take place at home, outdoors, at a health club or fitness center, school, church, or community center. Taking a class, working out with a friend, competing, or setting personal goals can help maintain motivation. Walking for exercise can be combined with various enjoyable activities, such as bird watching, museum visits, window shopping, or exercising the dog. Group exercises and team sports are good ways to socialize. Varying exercise routines every few weeks can benefit different muscle groups and help prevent boredom. In addition, since the human body adjusts rapidly to most exercises, continuing the same routine for too long can result in decreased benefits.

The most efficient cardiovascular exercises for improving physical fitness include:

- brisk walking (3–4 mph), whether outside, in a mall, or on a treadmill
- jogging
- running
- bicycling, either outside or on a stationary bike
- stair climbing
- elliptical cross-training on exercise machines
- aerobics
- swimming
- water exercise or aerobics
- rowing
- cross-country (Nordic) skiing
- jumping rope—a particularly good exercise for children

Other exercises that provide cardiovascular conditioning—but are less endurance-promoting because they usually require frequent starting and stopping—include:

- dancing
- basketball
- soccer
- softball
- badminton
- racquetball
- squash
- tennis
- table tennis
- volleyball
- skating
- golfing, if walking and carrying clubs

Teenagers can get cardiovascular exercise through school sports including:

- baseball
- cross country
- track and field
- cheerleading

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- drill team
- field hockey
- football
- lacrosse
- wrestling

People who are generally sedentary can still get exercise through their occupation, housework, home repair, gardening, using stairs instead of an elevator, and various recreational pursuits. People with health problems can find exercises that accommodate their injuries or disorders. The American Council on Exercise suggests specific exercises for the elderly and for adults with problems such as **asthma**, chronic pain, bad knees, shoulder injuries, arthritis, and flat feet.

Regularity and intensity are key elements of exercise. It has generally been recommended that all adults get at least 30 minutes of moderate-intensity exercise on most days of the week. However the most recent consensus is to aim for 150 minutes per week, regardless of how it is divided up. The latest evidence suggests that three ten-minute bouts of exercise are as beneficial as one 30-minute workout. Improving cardiovascular endurance requires at least 20–60 minutes of cardiovascular exercise three to five days per week. The U.S. Department of Health and Human Services recommends at least 60 minutes of physical activity for children and teens on most or all days of the week.

Defining "moderate intensity" can be tricky. Until recently exercise intensity was generally gauged by increased heart rate. However intensity is more accurately measured by metabolic rate, as represented by units of metabolic equivalents or METS. METS is an individual's metabolic rate during exercise divided by the metabolic rate when sitting still. The latter is defined as 1 kilocalorie per kilogram (kg) of body weight per hour or an oxygen uptake of 3.5 milliliters per kg per minute. Moderate activity is defined as 3–6 METS. Although a precise measurement requires determining oxygen intake in a laboratory, charts of average METS for various activities are available. Examples of METS include:

- walking, 2–8
- running, 8–18
- bicycling, 4–16
- stationary bicycling, 3–12.5
- general health-club exercise, 5.5
- calisthenics, 3–8
- weight lifting, 3–6
- swimming, 6–11
- cross-country skiing, 7–16.5
- downhill skiing, 5–8
- volleyball, 3–8
- dancing, 3–10
- basketball, 4.5–8
- tennis, 5–8
- tai chi, 4
- stretching, hatha yoga, 2.5
- household tasks, 2–9
- mowing with a hand mower, 6

Exercise geared to a target heart rate is typically about 70% of the maximum heart rate for one's age. Heart rate is calculated by counting the pulse, usually about halfway through a 20–30-minute workout. Fingers are placed firmly but lightly over the inside of the wrist or on the neck just below the angle of the jaw; however too much pressure on the neck can slow down the heart rate. The palm also can be placed over the heart to count the number of beats. A zero is added to a six-second count or a ten-second count is multiplied by six to obtain the beats per minute (bpm). Maximum bpm is calculated by subtracting one's age from 220. For example:

- Target heart rate during cardiovascular exercise for a healthy 50-year-old might be 170 multiplied by 70% or 119 bpm.
- A particularly fit 50-year-old might have a target heart rate of 80% of maximum or 136 bpm.
- A 50-year-old with a medical condition may have a target exercising heart rate of only 50% or 85 bpm. A bpm above the target rate indicates a need to slow down, whereas a bpm below the target indicates a need to speed up the pace of exercise.

There are other methods for measuring the intensity of cardiovascular exercise:

- Classes and DVDs usually include a timed heart-rate check and a chart of target rates by age.
- Electronic exercise pulse monitors are available.
- A simple "talk test" is based on speaking a complete sentence: the pace of exercise is too high if the sentence cannot be completed and too low if it is overly easy to speak the sentence.
- Cardiovascular exercise usually involves sweating; therefore people who no longer sweat during their exercise routine may need to increase the intensity, duration, or frequency of their workouts.

Improved fitness in response to exercise appears to be genetically determined and to run in families. Some previously sedentary people show less improvement in fitness than would be expected following

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weeks of a vigorous exercise program and about 10% show no improvement at all. However even those who show no improvement in fitness measures still respond to exercise with lowered blood pressure and cholesterol, improved insulin levels, and less abdominal fat.

Origins

Throughout most of human history, most people had plenty of exercise. Then, early in the twentieth century, the rate of heart attacks in Western countries began to increase dramatically. The first indication that this might be due to lack of exercise came in a landmark 1953 study of London bus conductors: conductors, who spent their days collecting fares from seated passengers and walking up and down the stairs of double-decker buses, had half the number of heart attacks as seated bus drivers. Since then countless studies have confirmed the positive effects of exercise, not just on the heart and circulatory system, but on virtually every system of the body.

Benefits

Exercise promotes:

- cardiovascular fitness, including improved heart function and increased heart, lung, and muscle endurance
- muscle strength and mass
- flexibility
- weight loss
- lowered blood pressure
- bone density and strength, which reduces the risk of fractures and osteoporosis
- mental health and psychological and emotional well-being from the release of brain hormones called endorphins

Additional benefits of cardiovascular exercise include:

- improved immune system function
- improved utilization and control of blood sugar
- decreased cholesterol and triglycerides
- decreased abdominal fat
- increased energy levels
- less fatigue
- improved appetite
- improved sleep
- reduced stress
- pain reduction

Regular exercise lowers the risk of a **heart attack** by 50–80%. Exercise also has been shown to reduce the risk of:

- stroke
- cancer
- diabetes
- liver and kidney disease
- osteoporosis
- depression
- dementia

Even those who are overweight or obese can become aerobically fit with exercise. Studies have found that the risk of dying is more closely related to fitness than to weight. In fact people who are fit but obese have a lower risk of dying than people who are unfit but of normal weight.

More than 30 million Americans undergo surgery each year. Each patient's surgical risk, complications, and outcome depend, at least in part, on their physical fitness: how well their cardiovascular and pulmonary systems withstand the **stress** of anesthesia; how quickly their bones and muscles recover after surgical procedures; and how well their metabolic and immune systems respond to surgery and the risk of infection.

Precautions

- Everyone should have a physical examination before embarking on an exercise program for the first time or after a long period of inactivity.
- Exercise intensity and duration should be increased gradually.
- People who are very weak may need to build strength before they can participate in cardiovascular exercise.
- Warming up before and stretching after exercise are very important.
- People should pace themselves and check their heart rate or otherwise judge their level of exertion.
- If exercising becomes "very hard" or worse, it is important to slow the pace.
- Although some discomfort, such as aches or stiffness, are to be expected during the first few days of a new exercise, if pain is intrusive it is important to stop the activity or get instruction on technique.
- Strenuous cardiovascular exercise should never be halted abruptly without a cool-down, since blood that has concentrated in the working muscles can pool and cause dizziness or lightheadedness.
- Cardiovascular exercise requires a healthy diet with plenty of vegetables.

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KEY TERMS

Aerobic exercise—Any exercise that increases the body's oxygen consumption and improves the functioning of the cardiovascular and respiratory systems.

Cholesterol—A fat-soluble steroid alcohol (sterol) found in animal fats and oils and produced in the body from saturated fats. High cholesterol levels contribute to the development of cardiovascular disease.

Endorphins—A class of peptides in the brain that are produced during exercise and bind to opiate receptors, resulting in pleasant feelings and pain relief.

Metabolic equivalent of task; MET—The energy cost of a physical activity, measured as a multiple of the resting metabolic rate, which is defined as 3.5 milliliters of oxygen consumed per kilogram (kg) of body weight per minute, equivalent to 1 kilocalorie per kg per hour.

Obesity—Excessive weight due to accumulation of fat, usually defined as a body mass index (BMI) of 30 or above or body weight greater than 30% above normal on standard height-weight tables.

Physical activity—Any activity that involves moving the body and burning calories.

Physical fitness—A combination of muscle strength, cardiovascular health, and flexibility that is usually attributed to regular exercise and good nutrition.

Sedentary—Inactivity and lack of exercise; a lifestyle that is a major risk factor for becoming overweight or obese and developing chronic diseases.

Stress test—An electrocardiogram recorded before, during, and after a period of increasingly strenuous cardiovascular exercise, usually on a treadmill or stationary bicycle.

Target heart rate—The heart rate, in beats per minute (bpm), that should be maintained during cardiovascular exercise by an individual of a given age.

Triglycerides—Neutral fats; lipids formed from glycerol and fatty acids that circulate in the blood as lipoprotein. Elevated triglyceride levels contribute to the development of cardiovascular disease.

- It is best to wait up to two hours after a full meal before exercising and about an hour after exercising before having a meal, although a small healthy snack before exercising can boost energy levels.
- It is important to drink enough fluid to replace water that is lost as sweat; however coffee, tea, colas, chocolate, or alcohol can cause the body to lose fluid.
- Simple home exercises, such as a balance board, can reduce the risk of recurrent sprained ankles.
- Taking a few days off from cardiovascular exercise every month can help rejuvenate the body.

Geriatric

Both maximum heart rate and cardiac output are lower in older adults, in part due to a decrease in the beta-adrenergic response. Older adults should have a **stress test** before embarking on a cardiovascular exercise program. A good result on a stress test is a bpm that is 80% of the age-adjusted maximum, with 90% considered excellent.

Other conditions

Various medical conditions can affect exercise. For example people with back problems should avoid exercises that require twisting or vigorous forward movements, such as aerobic dancing or rowing. People with spinal disk disease should avoid high-impact activities.

Preparation

Exercise should begin with a light or very light warm-up of five to ten minutes that may include gentle stretching to loosen muscles and joints and help prevent injury. The warm-up may involve slowly beginning the conditioning activity—warming up for a brisk walk or jog by walking slowly or strolling, or warming up to ride a stationary bike by pedaling slowly with no resistance. Warming up increases blood flow to the muscles, increases muscle temperature, and prepares them to work harder.

Aftercare

Cardiovascular exercise should be followed by a light or very light five-or ten-minute cool-down to allow the heart and circulation to gradually return to a resting state. The cool-down can include the same activity as the conditioning phase at a slower pace—slower walking or pedaling with reduced resistance on a stationary bike.

Most doctors encourage patients to become active as soon as possible following surgery. Aftercare is individualized and there may be limitations on physical activity; however the goal is to return the patient to normal daily activities and exercise routines.

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Patients should ask for explicit guidelines concerning exercise.

Risks

Exercise poses a risk of injury, particularly if exercises are inappropriate or improperly performed. Too much exercise can be as harmful as too little; overuse of certain muscles and joints can lead to problems such as **tennis elbow** or **shin splints**. High-intensity exercises, such as high-impact aerobics and jogging, are not recommended as frequently as in the past. Running, in particular, is hard on the knees and ankle joints, and there is a risk of sprained ankles and injuries from falls. About one half of all regular runners and players of team sports suffer some type of musculoskeletal injury each year.

Inadequate rest increases the risk of **stroke** and circulatory problems. Injury or illness from overtraining is sometimes indicated by a high resting heart rate, sleeping difficulties, or exhaustion. The risk of a heart attack can rise as much as 100-fold for a completely unfit individual who undertakes vigorous exercise such as jogging or shoveling snow. In contrast, a person who runs five times per week merely doubles their risk of heart attack during vigorous exercise. The risk of heart attack subsides about one-half hour after exercising and pales in comparison to the lifetime benefits of regular exercise.

Pregnant or breastfeeding

Some types of exercise are inappropriate for pregnant women. Pregnant women are generally advised not to exercise for two consecutive days.

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"Target Heart Rate Calculator." *WebMD*.http://www.webmd.com/fitness-exercise/healthtool-target-heart-rate-calculator

Wilkerson, Rick, ed. "Sports & Exercise." *Your Orthopaedic Connection*.http://orthoinfo.aaos.org/menus/sports.cfm

ORGANIZATIONS

American College of Sports Medicine, PO Box 1440, Indianapolis, IN, 46202-1440, (317) 637-9200, (317) 634-7817, http://www.acsm.org.

American Council on Exercise, 4851 Paramount Drive, San Diego, CA, 92123, (858) 279-8227, (888) 825-3636, (858) 576-6564, support@acefitness.org, http://www.acefitness.org.

American Heart Association, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, http://www.americanheart.org.

National Institute of Arthritis and Musculoskeletal and Skin Diseases, Information Clearinghouse, 1 AMS Circle, Bethesda, MD, 20892-3675, (301) 495-4484, (877) 22-NIAMS (226-4267), (301) 718-6366, NIAMSinfo@-mail.nih.gov, http://www.niams.nih.gov.

U.S. Centers for Disease Control and Prevention, 1600 Clifton Road, Atlanta, GA, 30333, (800) CDC-INFO (232-4636), cdcinfo@cdc.gov, http://www.cdc.gov.

Margaret Alic, PhD

Exercise electrocardiogram *see* **Stress test**

Exercise stress test *see* **Stress test**

Exhibitionism *see* **Sexual perversions**

Exocrine pancreatic cancer *see* **Pancreatic cancer, exocrine**

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Exophthalmos

Definition

When there is an increase in the volume of the tissue behind the eyes, the eyes will appear to bulge out of the face. The terms exophthalmos and proptosis apply. Proptosis can refer to any organ that is displaced forward, while exophthalmos refers just to the eyes.

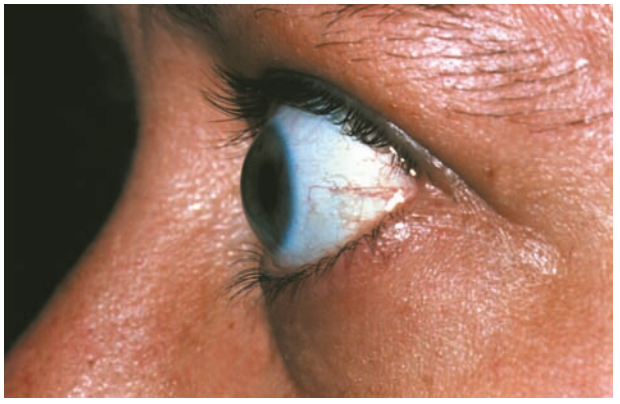
Description

The eye socket (orbit) is made of bone and therefore will not yield to increased pressure within it. Only forward displacement of the eyeball (globe) will allow more room if tissue behind the eye is increasing.

Causes and symptoms

The most common cause of exophthalmos is Graves' disease, overactivity of the thyroid gland. The contents of the orbits swell due to inflammation, forcing the eyes forward. The inflammation affects primarily the muscles. This combination of muscle impairment and forward displacement reduces eye movement, causing double vision and crossed eyes (**strabismus**). The optic nerves can also be affected, reducing vision, and the clear membrane (conjunctiva) covering the white part of the eyes and lining the inside of the eyelids can swell. Finally, the eyes may protrude so far that the eyelids cannot close over them, leading to corneal damage.

Exophthalmos from Graves' disease is bilateral (occurring on both sides), but not necessarily symmetrical. In contrast, exophthalmos from orbital tumors or a blood clot in the brain happens on only one side.



A side view of the bulging eye (exophthalmos) of a person suffering from thytoxicosis. Exophthalmos is caused by swelling of the soft tissue in the eye socket, which forces the eyeball to be pushed forward and the eyelids stretched apart. *(Dr. P. Marazzi/Photo Researchers, Inc.)*

KEY TERMS

Conjunctivae—The clear membranes that line the inside of the eyelids and cover the white part (sclera) of the eyeballs.

Cornea—The clear, dome-shaped part of the front of the eye, through which light first enters the eye. It is located in front of the colored part of the eye (iris).

Inflammation—The body's reaction to invasion by foreign matter, particularly infection. The result is swelling and redness from an increase in water and blood, and pain from the chemical activity of the reaction.

Strabismus—Any deviation of the eyes from a common direction. Commonly called a turned eye.

Thyroid—A gland in the neck overlying the windpipe that regulates the speed of metabolic processes by producing a hormone, thyroxin.

Diagnosis

Exophthalmos is obvious when it is advanced enough to cause complications. When there is doubt in the early stages, a mechanical device called an exophthalmometer can measure the protrusion. **Computed tomography scans** (CT scans) are of great value in examining the bony components of the orbit. **Magnetic resonance imaging** (MRI) scanning is equally valuable for displaying the contents of the orbit, because it "sees through" the bone.

Treatment

If a tumor is growing behind the eye, it needs to be removed. If Graves' disease is the cause, it may subside with treatment of the overactive thyroid, but this is not guaranteed. Local care to the front of the eye to keep it moist is necessary if the eyelid cannot close.

Prognosis

Exophthalmos can be progressive. Its progress must be carefully followed, treating complications as they occur.

Prevention

Vision can usually be preserved with attentive treatment. There is currently no way to prevent any of the underlying conditions that lead to exophthalmos.

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KEY TERMS

Asthma—A disease in which the air passages of the lungs become inflamed and narrowed.

Bronchitis—Inflammation of the air passages of the lungs.

Chronic—A word used to describe a long-lasting condition. Chronic conditions often develop gradually and involve slow changes.

Cough suppressant—Medicine that stops or prevents coughing.

Emphysema—An irreversible lung disease in which breathing becomes increasingly difficult.

Mucus—Thick fluid produced by the moist membranes that line many body cavities and structures.

Phlegm—Thick mucus produced in the air passages.

Respiratory tract—The air passages from the nose into the lungs.

Secretion—A substance, such as saliva or mucus, that is produced and given off by a cell or a gland.

Resources

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J. Ricker Polsdorfer, MD

Expectorants

Definition

Expectorants are drugs that loosen and clear mucus and phlegm from the respiratory tract.

Purpose

The drug described here, guaifenesin, is a common ingredient in **cough** medicines. It is classified as an expectorant, a medicine that helps clear mucus and other secretions from the respiratory tract. However, some debate exists about how effectively guaifenesin does this. In addition, some cough medicines contain other ingredients that may cancel out guaifenesin's effects. **Cough suppressants** such as codeine, for example, work against guaifenesin because they discourage coughing up the secretions that the expectorant loosens.

There are other ways to loosen and clear the respiratory secretions associated with colds. These include using a humidifier and drinking six to eight glasses of water a day.

Description

Guaifenesin is an ingredient in many cough medicines, such as the brand names Anti-Tuss, Dristan Cold & Cough, Guaifed, GuaiCough, and some Robitussin products. Some products that contain guaifenesin are available only with a physician's prescription; others can be bought without a prescription. They come in several forms, including capsules, tablets, and liquids.

Recommended dosage

Adults and children 12 and over

200–400 mg every four hours. No more than 2,400 mg in 24 hours.

Children 6–11

100–200 mg every four hours. No more than 1,200 mg in 24 hours.

Children 2–5

50–100 mg every four hours. No more than 600 mg in 24 hours.

Children under two

Not recommended.

Precautions

Do not take more than the recommended daily dosage of guaifenesin.

Guaifenesin is not meant to be used for coughs associated with **asthma**, **emphysema**, chronic **bronchitis**, or **smoking**. It also should not be used for coughs that are producing a large amount of mucus.

A lingering cough could be a sign of a serious medical condition. Coughs that last more than seven days or are associated with **fever**, rash, **sore throat**, or

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lasting **headache** should have medical attention. Call a physician as soon as possible.

Some studies suggest that guaifenesin causes **birth defects**. Women who are pregnant or plan to become pregnant should check with their physicians before using any products that contain guaifenesin. Whether guaifenesin passes into breast milk is not known, but no ill effects have been reported in nursing babies whose mothers used guaifenesin.

Side effects

Side effects are rare, but may include **vomiting**, **diarrhea**, stomach upset, headache, skin rash, and **hives**.

Interactions

Guaifenesin is not known to interact with any foods or other drugs. However, cough medicines that contain guaifenesin may contain other ingredients that do interact with foods or drugs. Check with a physician or pharmacist for details about specific products.

Nancy Ross-Flanigan

Exstrophy of the urinary bladder *see* **Congenital bladder anomalies**

External fetal monitoring *see* **Electronic fetal monitoring**

External otitis *see* **Otitis externa**

External sphincter electromyography

Definition

External sphincter **electromyography** helps physicians determine how well the external urinary sphincter muscle is working by measuring the electrical activity in it during contraction and relaxation.

Purpose

The external sphincter muscle is the ring-like muscle that controls urine release from the bladder. When a patient cannot voluntarily control urination (incontinence), a physician may order this test to determine if the problem is caused by the failure of this muscle. The voluntary contraction or release of a muscle such as the external sphincter involves a complex process in which the nerves controlling the muscle signal it to move through the release and uptake of chemicals called neurotransmitters and the generation of electrical impulses. This test records the electrical impulses given off when the muscle contracts or relaxes and allows the physician to determine if the muscle is working properly, if it has been damaged by disease, or some other condition.

Precautions

Patients who are taking **muscle relaxants** or drugs that act like or have an effect on the neurotransmitter acetylcholine (cholinergic or anti-cholinergic drugs) should tell the doctor since they will change the test results. The results will also be altered if the patient moves during the test or if the electrodes are improperly placed.

Description

The patient puts on a surgical gown and lies down on the examining table. The procedure, which takes between 30–60 minutes, may be conducted one of three ways:

- Skin electrodes. This is the most commonly used method of recording information. The skin where the electrodes will be placed is cleaned and shaved and an electrically conductive paste is applied. The electrodes are then taped in place. For female patients, the electrodes are taped around the urethra, while for male patients they are placed between the scrotum and the anus.
- Needle electrodes. This is considered the most accurate method, since the electrodes are inserted directly into the muscle, using needles to guide placement. For male patients, a gloved finger is inserted in the rectum, then needles with wires attached are inserted through the skin between the anus and the scrotum. For female patients, the needles are inserted around the urethra. The discomfort of placing the needles is about the same as that of an injection. The needles are withdrawn, and the wires are taped to the thigh.
- Anal plug electrodes. The tip of an anal plug is lubricated and inserted into the rectum as the patient relaxes the anal sphincter. Electrodes are attached to the anal plug.

Once the electrodes are in place and attached to the recording device, the patient is asked to alternately contract and relax the external sphincter muscle. The electrical activity generated during these contractions and relaxations is recorded on a graph called an electromyogram.

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KEY TERMS

Anti-cholinergic drug—A medication that blocks or subdues the action of the neurotransmitter acetylcholine.

Cholinergic drug—A medication that mimics or enhances the action of the neurotransmitter acetylcholine.

Sphincter—A circular muscle that aids in the opening or closing of an opening in the body.

Preparation

Before the test, the patient should discuss with the doctor whether it is necessary to temporarily discontinue any medications, and follow the doctor's orders. No changes in diet or activity are necessary.

Aftercare

Women may see some blood in their urine the first time they urinate after the test. Blood in the urine of men or blood in the urine of women after the first urination should be reported the doctor. The patient should take a warm bath and drink plenty of fluids to ease any discomfort after the test.

Risks

Complications of external sphincter electromyography are rare. Occasionally patients report blood in their urine after being tested with needle electrodes. Also, the urethra may become mildly irritated causing a change in the normal frequency of urination.

Normal results

In a normally functioning external sphincter muscle, the electromyogram will show increased electrical activity when the patient tightens the muscle and a little or no electrical activity when it is relaxed.

Abnormal results

A diseased external sphincter muscle will produce an abnormal pattern of electrical activity. Conditions that affect the external sphincter may include **multiple sclerosis**, **neurogenic bladder**, **Parkinson's disease**, **spinal cord injury**, and stress incontinence. However, additional tests must be done in order to confirm any of these diagnoses.

Resources

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Tish Davidson, A.M.

Extracorporeal membrane oxygenation

Definition

Extracorporeal membrane oxygenation (ECMO) is a special procedure that uses an artificial heart-lung machine to take over the work of the lungs and sometimes also the heart.

Purpose

In newborns, ECMO is used to support or replace an infant's undeveloped or failing lungs by providing oxygen and removing carbon dioxide waste products so the lungs can rest. Infants who need ECMO may include those with:

- meconium aspiration syndrome, (breathing in of a newborn's first stool by a fetus or newborn, which can block air passages and interfere with lung expansion)
- persistent pulmonary hypertension, (a disorder in which the blood pressure in the arteries supplying the lungs is abnormally high)
- respiratory distress syndrome (a lung disorder usually of premature infants that causes increasing difficulty in breathing, leading to a life-threatening deficiency of oxygen in the blood)
- congenital diaphragmatic hernia, (the profusion of part of the stomach through an opening in the diaphragm)
- pneumonia
- blood poisoning

ECMO also is used to support a child or adult patient's damaged, infected, or failing lungs for a few hours to allow treatment or healing. It is effective for those patients with severe, but reversible, heart or lung problems who have not responded to treatment with a ventilator, drugs, or extra oxygen. Adults and children who need ECMO usually have one of these problems:

- heart failure
- pneumonia
- respiratory failure caused by trauma or severe infection

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KEY TERMS

Carotid artery—Two main arteries (passageway carrying blood from the heart to other parts of the body) that carry blood to the brain.

Congenital diaphragmatic hernia—The profusion of part of the stomach through an opening in the diaphragm.

Meconium aspiration syndrome—Breathing in of meconium (a newborn's first stool) by a fetus or newborn, which can block air passages and interfere with lung expansion.

Membrane oxygenator—The artificial lung that adds oxygen and removes carbon dioxide.

Pulmonary hypertension—A disorder in which the blood pressure in the arteries supplying the lungs is abnormally high.

Respiratory distress syndrome—A lung disorder usually of premature infants that causes increasing difficulty in breathing, leading to a life-threatening deficiency of oxygen in the blood.

Venoarterial (V-A) bypass—The type of ECMO that provides both heart and lung support, using two tubes (one in the jugular vein and one in the carotid artery).

Venovenous (V-V) bypass—The type of ECMO that provides lung support only, using a tube inserted into the jugular vein.

The ECMO procedure can help a patient's lungs and heart rest and recover, but it will not cure the underlying disease. Any patient who requires ECMO is seriously ill and will likely die without the treatment. Because there is some risk involved, this method is used only when other means of support have failed.

Demographics

ECMO is used most often in newborns and young children, but it also can be used as a last resort for adults whose heart or lungs are failing.

Description

There are two types of ECMO. Venoarterial (V-A) ECMO supports the heart and lungs, and is used for patients with blood pressure or heart functioning problems in addition to respiratory problems. Venovenous (V-V) ECMO supports the lungs only.

V-A ECMO requires the insertion of two tubes, one in the jugular and one in the carotid artery. In the V-V ECMO procedure, the surgeon places a plastic tube into the jugular vein through a small incision in the neck.

Once in place, the tubes are connected to the ECMO circuit, and then the machine is turned on. The patient's blood flows out through the tube and may look very dark because it contains very little oxygen. A pump pushes the blood through an artificial membrane lung, where oxygen is added and carbon dioxide is removed. The size of the artificial lung depends on the size of the patient; sometimes adults need two lungs. The blood is then warmed and returned to the patient. A steady amount of blood (called the flow rate) is pushed through the ECMO machine every minute. As the patient improves, the flow rate is lowered. Many patients require heavy **sedation** while they are on ECMO to lessen the amount of oxygen needed by the muscles.

if the patient improves, the amount of ECMO support is decreased gradually until the machine is turned off for a brief trial period. If the patient does well without ECMO, the treatment is stopped.

Typically, newborns remain on ECMO for three to seven days, although some babies need more time (especially if they have a diaphragmatic **hernia**). Once the baby is off ECMO, he or she will still need a ventilator (breathing machine) for a few days or weeks. Adults may remain on ECMO for days to weeks, depending on the condition of the patient, but treatment may be continued for a longer time depending on the type of heart or lung disease, the amount of damage to the lungs before ECMO was begun, and the presence of any other illnesses or health problems.

Benefits

ECMO can be a life-saving procedure when time is needed for the lungs to recover.

Precautions

Typically, ECMO patients have daily chest x rays and blood work, and constant vital sign monitoring. They are usually placed on a special rotating bed that is designed to decrease pressure on the skin and help move secretions from the lungs.

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After the patient is stable on ECMO, the breathing machine settings will be lowered to "rest" settings, which allow the lungs to rest without the risk of too much oxygen or pressure from the ventilator.

Preparation

Before ECMO is begun, the patient receives medication to ease **pain** and restrict movement.

Aftercare

Because infants on ECMO may have been struggling with low oxygen levels before treatment, they may be at higher risk for developmental problems. They will need to be monitored as they grow.

Risks

Bleeding is the biggest risk for ECMO patients, since blood thinners are given to guard against **blood clots**. Bleeding can occur anywhere in the body, but is most serious when it occurs in the brain. This is why doctors periodically perform ultrasound brain scans of anyone on ECMO. **Stroke**, which may be caused by bleeding or blood clots in the brain, has occurred in some patients undergoing ECMO.

If bleeding becomes a problem, the patient may require frequent blood transfusions or operations to control the bleeding. If the bleeding cannot be stopped, ECMO will be withdrawn.

Other risks include infection or vocal cord injury. Some patients develop severe blood infections that cause irreversible damage to vital organs.

There is a small chance that some part of the complex equipment may fail, which could introduce air into the system or affect the patient's blood levels, causing damage or **death** of vital organs (including the brain). For this reason, the ECMO circuit is constantly monitored by a trained technologist.

Resources

OTHER

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ORGANIZATIONS

American Society of Extra-Corporeal Technology, 2209 Dickens Road, Richmond, VA, 23230-2005, (804) 565-636, (804) 282-0090, amsect@amsect.org, http://www.amsect.org.

Extracorporeal Life Support Organization (ELSO), 2600 Plymouth Road, Building 300, Room 303, Ann Arbor, MI, 48109-2800, (734) 998-6601, (734) 998-6602, http://www.elso.med.umich.edu.

Carol A. Turkington
Tish Davidson, AM

Extracorporeal shock-wave *see* **Lithotripsy**

Extrinsic allergic alveolitis *see* **Hypersensitivity pneumonitis**

Eye and orbit sonograms *see* **Eye and orbit ultrasounds**

Eye and orbit ultrasounds

Definition

Ultrasound imaging equipment allows eye specialists (ophthalmologists) to "see" the eye in great detail without the **pain** and risk of exploratory surgery, or the limitations and uncertainty inherent to traditional visual examination. Ultrasound is used to detect and diagnose many eye diseases and injuries, to measure the eye prior to corrective surgery, and directly as a treatment tool.

Purpose

An ophthalmologist uses ultrasonic imaging to help diagnose the underlying cause(s) of a patient's symptoms, to assess the general condition of an injured eye, and to measure the eye prior to corrective surgery. Situations that may call for ultrasonic imaging include:

- Excessive tearing or visible infection. These external symptoms could indicate a serious underlying problem such as a tumor, an internal infection, the presence of a deeply lodged irritant (foreign body), or the effects of a previously unrecognized injury. When presented with general symptoms, ultrasound can speed diagnosis if a serious condition is suspected.
- Impaired vision. Fuzzy vision, poor night vision, restricted (tunnel) vision, blind spots, extreme light sensitivity, and even blindness can all stem from inner eye conditions ranging from glaucoma and cataracts, to retinitis, detached retina, tumors, or impaired blood circulation. Again, high resolution ultrasound can quickly identify causes and pinpoint their location. A special type of ultrasound, known

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KEY TERMS

Cataracts—A clouding of the lens of the eye or the material immediately surrounding it, causing blurred vision. For many people it occurs naturally with aging, but may also result from injury.

Glaucoma—A common eye disease characterized by increased fluid pressure in the eye that damages the optic nerve, which carries sensations to the brain. Glaucoma can be caused by another eye disorder, such as a tumor or congenital malformation, or appear without obvious cause, but if untreated it generally leads to blindness.

Intraocular—Literally, within the eye.

Ophthalmologist—A medical doctor specializing in eye care who is generally, but not necessarily, an eye surgeon.

Retina—The third and innermost membrane of the eye, which contains the light-sensitive nerve tissue that leads into the optic nerve and is the primary instument of vision. Inflammation of the retina (retinitis) has many causes, including over-exposure to intense light, diabetes, and syphilis.

as Doppler, can even perceive and measure circulation in the tiny blood vessels of the eye.

- Eye trauma. The eye can be damaged by a direct impact or a puncture wound, as a result of a general head trauma, or by intense light exposure. Even when the cause of injury is obvious, ultrasound can reveal the exact type, extent, and location of damage, from deformations and ruptures to internal bleeding, and help to guide emergency care efforts.
- Lens replacement surgery. Exact measurement of the eye's optical dimensions with ultrasound greatly improves the visual outcome for cataract patients receiving permanent synthetic lenses; and for severely myopic patients receiving implanted corrective lenses.

Ophthalmic ultrasound imaging is also used routinely to guide the precise placement of instruments during surgery, and can be used directly for the treatment of glaucoma and tumors of the eye.

Precautions

Ultrasound of the eye, properly performed by qualified personnel using appropriate equipment, has no risks. There is no evidence to suggest that the procedure itself poses any threat to a healthy eye, or worsens the condition of a diseased or injured eye.

Description

Ophthalmic ultrasound equipment sends high frequency pulses of sound into the eye, where they bounce off the boundaries between different structures in the eye and produce a distinctive pattern of echoes. This echo pattern is received and interpreted by a computer to produce an image on a television screen. The time it takes an echo to return to the receiver corresponds to the depth it traveled into the eye.

Single transducer (the sound transmitter/receiver) ultrasound is used to measure distances within the eye. This is A-mode ultrasound. A linear array of transducers in a single small probe, B-mode, provides a picture of a cross section through the eye. Doppler mode ultrasound combines B-mode with the ability to detect and measure the flow of blood in the tiny vessels of the eye.

As a direct treatment tool, the vibrations of high intensity A-mode ultrasound can be used to heat and erode tumors. The same technique can be used to control glaucoma by selectively destroying the cells which produce the fluid that causes the internal pressure of the eye to rise.

The procedure followed in a regular ultrasonic **eye examination** is relatively simple. The patient relaxes in a comfortable chair in a darkened room. Mild anesthetic eye drops are administered and the head is held secure. The ultrasonic probe, coated with a sterile gel to ensure good contact, is lightly pressed against the eye as the images are made. The probe may be applied to the eyelid or directly to the eye, as necessary. The patient feels nothing else, and the whole office procedure takes about 15 minutes.

Preparation

Preparation by the patient is generally unnecessary, although under special circumstances an ophthalmologist may perform pretest procedures. The ophthalmologist and/or ultrasound technician will conduct all preparations at the time of the test.

Aftercare

Patients may experience partial and temporary blurred vision, as well as "eye strain" headaches. These symptoms usually fade within an hour of the

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procedure, during which time patients should rest their eyes and avoid all activities that require good eyesight, like driving.

Risks

Improperly focused, high-intensity ultrasound could burn and physically disrupt delicate eye tissue and cause injury. This risk is, however, slight and would arise only from improper use, or as a potential side effect of tumor or glaucoma treatment.

Normal results

A normal ultrasound scan would indicate a fully healthy eye. For therapeutic ultrasound, a normal result would be an improvement in the targeted condition, such as shrinking of a tumor or lessening of pressure inside the eye of a glaucoma patient.

Abnormal results

Because diagnostic ultrasound is generally used to investigate symptoms, the results of a scan will often be abnormal and they will detect evidence of an underlying condition.

ORGANIZATIONS

American Academy of Ophthalmology (AAO), P. O. Box 7424, San Francisco, CA, 94120-7424, (415) 561-8500, (415) 561-8500, http://www.aao.org.

American Institute of Ultrasound in Medicine, 14750 Sweitzer Lane, Suite 100, Laurel, MD, 20707-5906, (301) 498-4100, (301) 498-4450, http://www.aium.org.

National Eye Institue, 2020 Vision Place, Bethesda, MD, (301) 496-5248, http://www.nei.nih.gov/.

Kurt Richard Sternlof

Eye cancer

Definition

Eye **cancer** refers to a cancerous growth in any part of the eye. Some eye cancers are considered to be primary tumors, indicating the tumor originated in the eye or the orbit of the eye. Other eye cancers represent metastases from primary cancers elsewhere in the body. The most common type of primary intraocular cancer in adults is intraocular melanoma or melanoma of the eye. The most common type of eye cancer affecting children is **retinoblastoma**.

Demographics

All types of eye cancer are rare in comparison to other cancerous tumors. According to the American Cancer Society, 2,480 people in the United States will be diagnosed with cancer of the eye or orbit in 2010, and 230 persons will die from the disease. Most of these cases of eye cancer will be caused by melanoma. Lymphomas are the second most common tumors of the eye in adults. Most cases of melanoma and lymphomas of the eye begin elsewhere in the body.

Retinoblastoma in children is an extremely rare type of cancer in the United States with about 300 new cases diagnosed each year. The average age at diagnosis is two years of age. This type of cancer is rarely diagnosed in children older than age six. Most of the time the cancer is confined to one eye. However in about one–third of cases, tumors affect both eyes.

Description

Eye cancers can be grouped into three basic categories according to their location in the eye: tumors of the eyelid and conjunctiva; intraocular tumors; and orbital tumors. This article will focus on retinoblastoma, the most common eye cancer in children, and intraocular melanoma, the most common eye cancer in adults.

Retinoblastoma typically begins as a small tumor in the retina, the tissue that lies at the very back of the eye. In growing children, the retina originates from cells called retinoblasts that grow and divide very quickly. These cells eventually become the mature cells of the retina when they stop growing. In the case of retinoblastoma the retinoblasts do not stop growing but, instead, form a tumor that can continue to grow and cause further complications if not treated quickly.

Retinoblastoma typically has three classifications: intraocular, extraocular, and recurrent retinoblastoma. In the intraocular form the cancer can be found in one or both eyes but not in tissue external to the eye. In the extraocular form the cancer has spread outside the eye. It can spread to the tissue surrounding the eye or it can invade other areas of the body. In the recurrent form the cancer returns after previously being treated. It may recur in the eye, its surrounding tissues, or elsewhere in the body.

Intraocular melanoma is a rare cancer overall, yet it is the most common eye cancer seen in adults. Intraocular melanoma occurs when cancer cells are found in the uvea of the eye. The uvea includes the iris (the colored portion of eye), the ciliary body (an eye muscle

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KEY TERMS

Brachytherapy—A type of radiation treatment for cancer in which the source of the radiation is applied directly to the surface of the body.

Carcinogen—A substance that is known to cause cancer.

Conjunctiva—The thin membrane that lines the eyelids.

Cornea—The transparent front portion of the exterior cover of the eye.

Enucleation—Surgical removal of the eyeball.

Iris (plural, irides)—The circular pigmented membrane behind the cornea of the eye that gives the eye its color. The iris surrounds a central opening called the pupil.

Ocular melanoma—A malignant tumor that arises within the structures of the eye. It is the most common eye tumor in adults.

Ophthalmology—The branch of medicine that deals with the diagnosis and treatment of eye disorders.

Orbit—The bony cavity that contains the eyeball.

Pupil—The opening in the center of the iris of the eye that allows light to enter the eye.

Uvea—The middle of the three coats of tissue surrounding the eye, comprising the choroid, iris, and ciliary body. The uvea is pigmented and well supplied with blood vessels.

that focuses the lens) and the choroid (found in the back of the eye next to the retina).

Intraocular cancer of the iris usually grows slowly and usually does not spread. The tumor is seen on the iris as a spot that is darker than the surrounding area. Intraocular cancer of the choroid or ciliary body occurs in the back of the eye. This type of cancer is classified by size with a small tumor being two to three mm or smaller and a medium or large tumor being larger than three mm.

Intraocular cancer can spread and become extraocular as well. If not found and treated early enough it can spread to surrounding tissues, the optic nerve or into the orbit (eye socket).

Causes and symptoms

The causes of intraocular melanoma are not yet fully understood. Individuals who appear to be at high risk for the development of intraocular melanoma include:

- individuals with light skin and eye color
- people diagnosed with dysplastic nevus syndrome
- people with abnormal brown spots in the uvea of the eye
- individuals who have been exposured to the sun and/or sunlamps

The symptoms of this type of cancer usually begin with blurred vision and tenderness of the eye. Other symptoms include appearance of floaters in the eye and changes in the position of the eyeball in the eye socket. Advanced symptoms may include loss of vision. Most of the time, these symptoms are painless. If symptoms persist a person should make an appointment with an eye specialist.

About 75% of cases of retinoblastoma are of the non–hereditary or sporadic type. This type of retinoblastoma affects only one eye.

A form of hereditary or congenital retinoblastoma has been identified. This form of retinoblastoma is also referred to as bilateral retinoblastoma because most of the cases involve cancer in both eyes. However, about 15% of cases of hereditary or congenital retinoblastoma occur in one eye only.

Signs and symptoms associated with retinoblastoma include:

- leukocoria or white papillary reflex, also referred to as cat's eye reflex, the most common sign observed at time of diagnosis
- strabismus, or improper alignment of the eyes, the second most common finding
- poor vision
- red, painful eyes
- white spots on the iris
- orbital inflammation
- glaucoma
- retinal detachment

Diagnosis

The diagnosis of eye cancer is usually made by an ophthalmologist, a doctor who specializes in treating eye disorders. In the case of cancerous growths, the doctor is usually able to see the tumor through the pupil or directly on the iris if the cancer is intraocular

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melanoma of the iris. Because the doctor can usually readily see the tumor a biopsy is rarely needed.

An ultrasound or a fluorescein **angiography** are two tests doctors use to further diagnose eye cancers. In an ultrasound, sound waves are pointed at the tumor and, depending on how they reflect off the tumor, the doctor can better diagnose the disorder. In a fluorescein angiography a fluorescent dye is injected into the patient's arm. When this dye circulates through the body and reaches the eye a series of rapid pictures are taken through the pupil. The tumor will show up in these photos.

Most retinoblastomas can be diagnosed as part of a detailed **eye examination** by an experienced ophthalmologist. Once a diagnosis is confirmed, imaging tests such as ultrasound, CT or MRI scans, and bone scans may be ordered to help to determine the size of the tumor and to ascertain to what extent the cancer has spread.

Treatment

The modalities used to treat intraocular melanoma depend on the size of the tumor and on how far the tumor has spread. If the tumor is in the advanced stages and there is little hope of regaining vision, the most effective treatment is an enucleation, the removal of the eye. Enucleation is a drastic treatment option and is avoided if possible. Other eye surgeries include the following:

- choroidectomy: removal of part of the choroid
- iridectomy: removal of part of the iris
- iridocyclectomy: removal of parts of the ciliary body and parts of iris
- iridotrabeculectomy: removal of parts of the supporting tissues around the cornea and iris

In cases in which the tumor is small and there is a good chance that vision will be restored, less drastic measures than the above surgeries are taken. Radiation and **chemotherapy** are two courses of treatment that may help to destroy an existing tumor and prevent its spread to other areas of the body. **Radiation therapy** can utilize external beam radiation therapy or brachytherapy approaches. Most cases of intraocular melanoma respond poorly to chemotherapy, however.

The most common type of laser treatment used for intraocular melanoma is transpupillary thermotherapy. This procedure uses infrared light to heat and destroy the tumor in one to three treatment sessions in most people.

Treatment for retinoblastoma is best performed by health care providers who are experienced in the care of young children with this very rare type of cancer. Most of the time the most experienced practitioners can be found at major children's cancer centers and hospitals.

The treatment options for retinoblastoma depend on the stage of the cancer and can include one or more of the following modalities:

- surgery, which may include enucleation of one or both eyes if the tumor is large and/or if vision has been permanently destroyed
- radiation therapy utilizing brachytherapy or external beam radiation therapy
- photocoagulation, a procedure which employs the use of lasers to treat patients with small tumors
- cryotherapy, a treatment that utilizes probes that have been frozen to very low temperatures. The probes freeze and destroy small tumors
- thermotherapy, which utilizes heat to kill small tumors
- chemotherapy, which may be used to reduce the size of large tumors before other treatment modalities are used. A common chemotherapy regimen used in the treatment of retinoblastoma is a combination of the drugs carboplatin and vincristine. Other chemotherapy drugs which may be utilized include cisplatin, etoposide, teniposide, cyclophosphamide, and doxorubicin.

Prognosis

Most forms of retinoblastoma and intraocular melanoma are treatable. Enucleation can usually be avoided if the tumor is found early enough. In addition, primary cancers of the eye have a relatively low mortality rate if treated promptly.

Up to 90% of children diagnosed with retinoblastoma can be cured if the cancer is diagnosed and treated in early stages.

Prevention

Retinoblastoma is not considered a preventable disease. Individuals with hereditary or congenital retinoblastoma diagnosed in family members should notify their health care providers and may be monitored more frequently to detect any early signs of disease.

As intraocular melanoma is diagnosed more frequently in individuals with light skin and eyes, these individuals should have frequent eye exams conducted by experienced ophthalmologists. Minimizing exposure to the sun and to artificial sources of sunlight

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such as **tanning** beds and sunlamps is also recommended to decrease the possibility for development of intraocular melanoma. Individuals with abnormal brown spots on the uvea of the eye should also be closely monitored by experienced ophthalmologists for any changes that would indicate a progression to a cancerous tumor in the eye.

Resources

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ORGANIZATIONS

American Academy of Ophthalmology, PO Box 7424, San Francisco, CA, 94120–7424, http://www.aao.org.

American Cancer Society, (800) 227–2345, http://www.cancer.org.

Canadian Ophthalmological Society, 610–1525 Carling Ave., Ottawa, ON, K1Z 8R9, http://www.eyesite.ca.

National Eye Institute, Information Office, 31 Center Dr., MSC 2510, Bethesda, MD, 20892–2510, http://www.nei.nih.gov.

Ocular Oncology Service, Wills Eye Hospital, 840 Walnut St., Suite 1440, Philadelphia, PA, 19107, http://www.eyecancerinfo.com.

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Eye examination

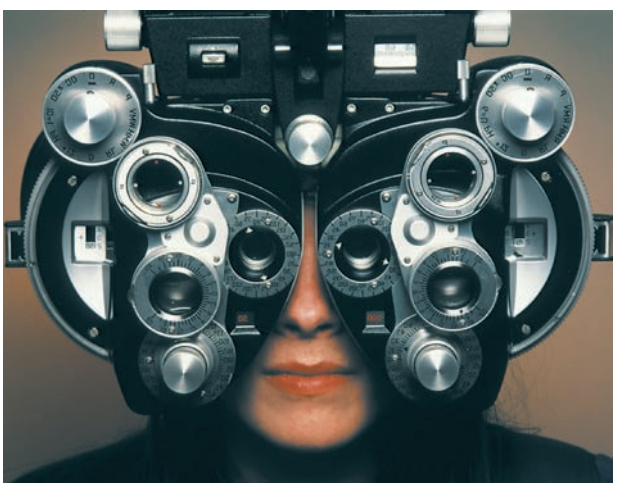
Definition

An eye examination is a series of tests that measure a person's ocular health and visual status, to detect abnormalities in the components of the visual system, and to determine how well the person can see.

Purpose

An eye examination is performed by an ophthalmologist, (M.D. or D.O. -doctor of **osteopathy**), or an optometrist (O.D.) to determine if there are any pre-existing or potential vision problems. Eye exams may also reveal the presence of many non-eye diseases. Many systemic diseases can affect the eyes, and since the blood vessels on the retina are observed during the exam, certain problems may be uncovered (e.g., high blood pressure or diabetes).

Infants should be examined by a physician to detect any physical abnormalities. Frequency of eye exams then generally differs with age and the health of the person. Eye exams can be performed in infants, and if a problem is noted the infant can be seen, generally by a pediatric ophthalmologist. A child with no symptoms should have an eye exam at age three. Early exams are important because permanent decreases in vision (e.g., **amblyopia**, also called lazy eye) can occur if not treated early (usually by ages 6–9). Again, with no other symptoms, the second exam should take place before first grade. After first grade, the American Optometric Association recommends an eye exam every two years; ages 19–40, every two to three years;



A woman looking through a refractor. *(John Greim/Photo Researchers, Inc.)*

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ages 41–60, every two years; and annually after that. However, these are recommendations for healthy people with no risk factors. Patients should ask their doctors how often they should come for exams. Some patients have risk factors for eye disease (e.g., people with diabetes or a family history of eye disease; African Americans, who are at higher risk for glaucoma) and may need more frequent checkups. Also, if children seem to be having trouble in school, problems with reading, rubbing their eyes when reading, etc., an eye exam may be necessary sooner.

Precautions

The examiner needs to know if the patient is taking any medications or has any existing health conditions. Some medications, even over-the-counter (OTC) medications can affect vision or even interfere with the eyedrops the doctor may use during the exam. Certain eyedrops would not be used if the patient has **asthma**, heart problems, or other conditions.

The patient may need someone to drive them home in case the eyes were dilated. Bringing sunglasses to the exam may also help decrease the glare from light until the dilating drops wear off.

Description

An eye examination, given by an ophthalmologist or optometrist, costs about $100. It may or may not be covered by insurance. It begins with information from the patient (case history) and continues with a set of primary tests, plus additional specialized tests given as needed, dictated by the outcomes of initial testing and the patient's age. The primary tests can be divided into two groups, those that evaluate the physical state of the eyes and surrounding areas, and those that measure the ability to see.

The order of the tests for the exam may differ from doctor to doctor, however, most exams will include the following procedures:

Information gathering and initial observations

The examiner will take eye and medical histories that include the patient's chief complaint, any past eye disorders, all medications being taken (e.g., OTC medications, **antibiotics**, and birth control pills), any blood relatives with eye disorders, and any systemic disorders the patient may have. The patient should also tell the doctor about hobbies and work conditions. This information helps in modifying prescriptions and lets the doctor know how the patient uses his or her eyes. For example, using a computer screen vs. construction work, the working distance of a computer screen may affect the prescription; the construction worker needs protective eyewear.

The patient should bring their current pair of glasses to the exam. The doctor can get the prescription from the glasses by using an instrument called a lensometer.

Visual acuity examination

Visual acuity measures how clearly the patient can see. It is measured for each eye separately, with and without the current prescription. It is usually measured with a Snellen eye chart, a poster with lines of different-sized letters, each line with a number at the side denoting the distance from which a person with normal vision can read that line. Other kinds of eye charts with identifiable figures are available for children or anyone unfamiliar with the Roman alphabet. These charts are made to be placed at a certain distance (usually 20 ft) from the person being tested. At this distance, people with normal vision can read a certain line (usually the lowest), marked the 20/20 line; these people are said to have 20/20 vision. For people who can't read the smallest line, the examiner assigns a ratio based on the smallest line they can read. The first number (numerator) of the ratio is the distance between the chart and the patient, and the second number (denominator) is the distance where a person with normal vision would be able to read that line. The ratio 20/40 means the patient can see at 20 ft. what people with normal vision can see at 40 ft. away.

When a patient is unable to read any lines on the chart, they are moved closer until they can read the line with the largest letters. The acuity is still measured the same way. A ratio of 5/200 means the person being tested can see at 5 ft what a normal person can see 200 ft.

When a patient cannot read the chart at all, the examiner may hold up some fingers and ask the patient to count them at various distances, and records the result as "counting fingers" at the distance of recognition. If the patient cannot count the examiner's fingers at any distance, the examiner determines if the patient can see hand movements. If so, the result is recorded as "hand movements." If not, the examiner determines if the patient can detect light from a penlight. If the patient can detect the light but not its direction, the result is recorded at "light perception." If the patient can recognize its direction, the result is recorded as "light projection." If the patient cannot detect the light at all, the result is recorded as "no light perception."

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Eye movement examination and cover tests

The examiner asks the patient to look up and down, and to the right and left to see if the patient can move the eyes to their full extent. The examiner asks the patient to stare at an object, then quickly covers one eye and notes any movement in the eye that remains uncovered. This procedure is repeated with the other eye. This, and another similar cover test, helps to determine if there is an undetected eye turn or problem with fixation. The doctor may also have the patient look at a pen and follow it as it is moved close to the eyes. This checks convergence.

Iris and pupil examination

The doctor checks the pupil's response to light (if it dilates and constricts appropriately). The iris is viewed for symmetry and physical appearance. The iris is checked more thoroughly later using a slit lamp.

Refractive error determination-Refraction

The examiner will determine the refractive error and obtain a prescription for corrective lenses for people whose visual acuity is less than 20/20. An instrument called a phoropter, which the patient sits behind, is generally used (sometimes the refraction can be done with a trial frame that the patient wears). The phoropter is equipped with many lenses that allow the examiner to test many combinations of corrections to learn which correction allows the patient to see the eye chart most clearly. This is the part of the exam when the doctor usually says, "Which is better, one or two?" The phoropter also contains prisms, and sometimes the doctor will intentionally make the patient see double. This may help in determining a slight eye turn. The exam will check vision at distance and near (reading).

A prescription for corrective lenses can also be supplied by automated refracting devices, which measure the necessary refraction by shining a light into the eye and observing the reflected light. Another objective way to obtain a prescription is using a hand-held retinoscope. As in the automated method just mentioned, the doctor shines a light in the patient's eyes and can determine an objective prescription. This is helpful in young children or infants.

Sometimes drops will be instilled in the patient's eyes before this part of the exam. The drops may relax accommodation so that the refraction will be more accurate. This is helpful in children and people who are farsighted.

After the refraction and other visual status tests, for example color tests or binocularity tests (can the patient see 3-D, or have depth perception), the doctor will check the health of the eyes and surrounding areas. The main instruments used are the ophthalmoscope and the slit lamp.

Ophthalmoscopic examination

These observations are best accomplished after dilating the pupils and require an ophthalmoscope. The ophthalmoscope most frequently used is a called a *direct ophthalmoscope*. It is a hand-held illuminated 15X multi-lens magnifier that lets the examiner view the inside back area of the eye (fundus). The retina, blood vessels, optic nerve, and other structures are examined.

Slit lamp examination

The slit lamp is a microscope with a light source that can be adjusted. This magnifies the external and some internal structures of the eyes. The lid and lid margin, cornea, iris, pupil, conjunctiva, sclera, and lens are examined. The slit lamp is also used in contact lens evaluations. A little probe called a tonometer may be used at this time to check the pressure of the eyes. A colored eyedrop may be instilled immediately prior to this test. The drop has a local anesthetic so the patient won't feel the probe touch the eye. It is a quick procedure.

Visual field measurement

A perimeter, the instrument for measuring visual fields, is a hollow hemisphere, equipped with a light source that projects dots of light over the inside surface. The patient's head is positioned so that the eye being tested is at the center of the sphere and (about 13 in. 33 cm) from all points on the inside surface of the hemisphere. The patient stares straight ahead at an image on the center of the surface and signals whenever he or she detects a flash of light. The perimeter records which flashes are seen and which are missed and maps the patient's field of vision and blindspots.

Intraocular pressure (IOP) measurement

Tonometers are used to measure IOP. Some tonometers measure pressure by expelling a puff of air (noncontact tonometer) towards the eyeball from a very short distance. Other tonometers are placed directly on the cornea. The noncontact tonometers are not as accurate as the contact tonometers and are sometimes used for screenings.

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KEY TERMS

Amblyopia—Decreased visual acuity, usually in one eye, in the absence of any structural abnormality in the eye.

Conjunctiva—The mucous membrane that covers the white part of the eyes (sclera) and lines the eyelids.

Cornea—Clear outer covering of the front of the eye.

Floaters—Translucent specks that float across the visual field, due to small objects floating in the vitreous humor.

Fundus—The inside of an organ. In the eye, refers to the back area that can be seen with the ophthalmoscope.

Glaucoma—There are many types of glaucoma. Glaucoma results in optic nerve damage and a decreased visual field and blindness if not treated. It is usually associated with increased IOP, but that is not always the case. The three factors associated with glaucoma are increased IOP, a change in the optic nerve head, and changes in the visual field.

Gonioscope—An instrument used to inspect the eye (e.g., the anterior chamber). It consists of a magnifier and a lens equipped with mirrors; it's placed on the patient's cornea.

Iris—The colored ring just behind the cornea and in front of the lens that controls the amount of light sent to the retina.

Macula—The central part of the retina where the rods and cones are densest.

Ophthalmoscope—An instrument designed to view structures in the back of the eye.

Optic nerve—The nerve that carries visual messages from the retina to the brain.

Pupil—The circular opening that looks like a black hole in the middle of the iris.

Retina—The inner, light-sensitive layer of the eye containing rods and cones; transforms the image it receives into electrical messages which are then sent to the brain via the optic nerve.

Sclera—The tough, fibrous, white outer protective covering that surrounds the eye.

Slit lamp—A microscope that projects a linear slit beam of light onto the eye; allows viewing of the conjunctiva, cornea, iris, aqueous humor, lens, and eyelid.

Tonometer—An instrument that measures intraocular pressure (IOP).

Ultrasonography—A method of obtaining structural information about internal tissues and organs where an image is produced because different tissues bounce back ultrasonic waves differently.

Completing the evaluation with additional tests

Depending upon the results other tests may be necessary. These can include, but are not limited to binocular indirect ophthalmoscopy, gonioscopy, color tests, contrast sensitivity testing, ultasonography, and others. The patient may have to return for additional visits.

Results

External observations

INITIAL OBSERVATIONS AND SLIT LAMP EXAM. Some general observations the doctor may be looking for include: head tilt; drooping eyelids (**ptosis**); eye turns; red eyes (injection); eye movement; size, shape, and color of the iris; clarity of the cornea, anterior chamber, and lens. The anterior chamber lies behind the cornea and in front of the iris. If it appears cloudy or if cells can be seen in it during the slit lamp exam an inflammation may be present. A narrow anterior chamber may put the patient at risk for glaucoma. A clouding of the normally clear lens is called a cataract.

Internal observations

OPHTHALMOSCOPIC EXAM. The observations include, but are not limited to the retina, blood vessels, and optic nerve. The optic nerve enters the back of the eye and can be checked for swelling or other problems. The blood vessels can be viewed as can the retina. The macula is a 3–5 mm area in the back of the eye and is responsible for central vision. The fovea is a small area located within the macula and is responsible for sharp vision. When a person looks at something, they are pointing the fovea at the object. Changes in the macular area can be observed with the ophthalmoscope. Retinal tears or detachments can also be seen.

Visual ability

VISUAL ACUITY. The refraction will determine the refractive status for each eye for distance and for near. A prescription for glasses is made after taking many things into consideration. The eye doctor may alter a prescription based upon many factors. Different

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materials for glasses may be suggested. For example, polycarbonate may be suggested for children or people active in sports because it is very impact resistant. Bifocals, trifocals, single-vision spectacles, and **contact lenses** are also options.

VISUAL FIELDS. A normal visual field extends about 60° upward, about 75° downward, about 65° toward the nose, and about 100° toward the ear and has one blind spot close to the center. Defects in the visual field signify damage to the retina, optic nerve, or the neurological visual pathway.

Seeing clearly does not necessarily mean the eyes are healthy or that the eyes are working together as a team. Regular checkups can detect abnormalities, hopefully before a problem arises. The eye doctor can suggest ways to help protect the eyes and vision (e.g., safety goggles, ultraviolet (UV) coatings on lenses). A person should also have an eye exam if they notice a change in vision, eyestrain, blur, flashes of light, a sudden onset of floaters (little dots), distortion of objects, double vision, redness, **pain** or discharge.

ORGANIZATIONS

American Academy of Ophthalmology (AAO), P. O. Box 7424, San Francisco, CA, 94120-7424, (415) 561-8500, (415) 561-8500, http://www.aao.org.

American Optometric Association, 243 North Lindbergh Blvd., St. Louis, MO, 63141, (314) 991-4100, (314) 991-4101, (800) 365-2219, http://www.aoa.org/.

Lorraine Lica, PhD

Eye exercises *see* **Vision training**

Eye glasses and contact lenses

Definition

Eyeglasses and contact lenses are devices that correct refractive errors in vision. Eyeglass lenses are mounted in frames worn on the face, sitting mostly on the ears and nose, so that the lenses are positioned in front of the eyes. Contact lenses appear to be worn in direct contact with the cornea, but they actually float on a layer of tears that separates them from the cornea.

Purpose

The purpose of eyeglasses and contact lenses is to correct or improve the vision of people with nearsightedness (**myopia**), farsightedness (**hyperopia**), **presbyopia**, and **astigmatism**.

Precautions

People allergic to certain plastics should not wear contact lenses or eyeglass frames or lenses manufactured from that type of plastic. People allergic to nickel should not wear Flexon frames. People at risk of being in accidents that might shatter glass lenses should wear plastic lenses, preferably polycarbonate. (Lenses made from polycarbonate, the same type of plastic used for the space shuttle windshield, are about 50 times stronger than other lens materials.) Also, people at risk of receiving electric shock should avoid metal frames.

People employed in certain occupations may be prohibited from wearing contact lenses, or may be required to wear safety eyewear over the contact lenses. Some occupations, such as construction or auto repair, may require safety lenses and safety frames. Physicians and employers should be consulted for recommendations.

Description

Eyes are examined by optometrists (O.D.) or by ophthalmologists (M.D. or D.O.—doctor of **osteopathy**). Prescriptions, if necessary, are then given to patients for glasses. The glasses are generally made by an optician. A separate contact lens-fitting exam is necessary if the patient wants contact lenses, because an eyeglass prescription is not the same as a contact lens prescription.

Eyeglasses

More than 140 million people in the United States wear eyeglasses. People whose eyes have refractive errors do not see clearly without glasses, because the light emitted from the objects they are observing does not come into focus on their retinas. For people who are farsighted, images come into focus behind the retina; for people who are nearsighted, images come into focus in front of the retina.

LENSES. Lenses work by changing the direction of light so that images come into focus on the retina. The greater the index of refraction of the lens material and the greater the difference in the curvature between the two surfaces of the lens, the greater the change in direction of light that passes through it, and the greater the correction.

Lenses can be unifocal, with one correction for all distances, or they can be correct for more than one distance (multifocal). One type of multifocal, the bifocal, has an area of the lens (usually at the bottom) that

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corrects for nearby objects (about 14 in from the eyes); the remainder of the lens corrects for distant objects (about 20 ft from the eyes). Another type of multifocal, a trifocal, has an area in-between that corrects for intermediate distances (usually about 28 in). Conventional bifocals and trifocals have visible lines between the areas of different correction; however, lenses where the correction gradually changes from one area to the other, without visible lines, have been available since the 1970s. Such lenses are sometimes called progressives or no-line bifocals.

To be suitable for eyeglass lenses, a material must be transparent, without bubbles, and have a high index of refraction. The greater the index of refraction, the thinner the lens can be. Lenses are made from either glass or plastic (hard resin). The advantage of plastic is that it is lightweight and more impact resistant than glass. The advantage of glass is that it is scratch resistant and provides the clearest possible vision.

Glass was the first material to be used for eyeglass lenses, and was used for several hundred years before plastic was introduced.

Optical-quality acrylic was introduced for eyeglass use in the early 1940s, but because it was easily scratched, brittle, and discolored rapidly, it did not supplant glass as the material of choice. Furthermore, it wasn't suitable for people with large refractive errors. A plastic called CR-39, introduced in the 1960s, was more suitable. Today, eyeglass wearers can also choose between polycarbonate, which is the most impact-resistant material available for eyewear, and polyurethane, which has exceptional optical qualities and higher refraction than the conventional plastics even glass. Patients with high prescriptions should ask about high index material options for their lenses. Aspheric lenses are also useful for high prescriptions. They are flatter and lighter than conventional lenses.

There are many lenses and lens-coating options for individual needs, including coatings that block the ultraviolet (UV) light or UV and blue light, which have been found to be harmful to the eyes. Such coatings are not needed on polycarbonate lenses, which already have UV protection. UV coatings are particularly important on sunglasses and ski goggles. Sunglasses, when nonprescription, should be labeled with an indication that they block out 99–100% of both UV-A and UV-B rays.

There are anti-scratch coatings that increase the surface hardness of lenses (an important feature when using plastic lenses) and anti-reflective (AR) coatings that eliminate almost all glare and allow other people to see the eyes of the wearer. AR coatings may be particularly helpful to people who use computers or who drive at night. Mirror coatings that prevent other people from seeing the wearer's eyes are also available. There is a whole spectrum of tints, from light tints to darker tints, used in sunglasses. Tint, however, does not block out UV rays, so a UV coating is needed. Polaroid lenses that block out much of the reflected light also allow better vision in sunny weather and are helpful for people who enjoy boating. Photosensitive (photochromatic) lenses that darken in the presence of bright light are handy for people who don't want to carry an extra set of glasses. Photochromatic lenses are available in glass and plastic.

FRAMES. Frames can be made from metal or plastic, and they can be rimless. There is an almost unlimited variety of shapes, colors, and sizes. The type and degree of refractive correction in the lens determine to some extent the type of frame most suitable. Some lenses are too thick to fit in metal rims, and some large-correction prescriptions are best suited to frames with small-area lenses.

Rimless frames are the least noticeable type, and they are lightweight because the nosepiece and temples are attached directly to the lenses, eliminating the weight of the rims. They tend to not be as sturdy as frames with rims, so they are not a good choice for people who frequently remove their glasses and put them on again. They are also not very suitable for lenses that correct a high degree of farsightedness, because such lenses are thin at the edges.

Metal frames are less noticeable than plastic, and they are lightweight. They are available in solid gold, gold-filled, anodized aluminum, nickel, silver, stainless steel, and now titanium and titanium alloy. Until the late 1980s, when titanium-nickel alloy and titanium frames were introduced, metal frames were, in general, more fragile than plastic frames. The titanium frames, however, are very strong and lightweight. An alloy of titanium and nickel, called Flexon, is not only strong and lightweight, but returns to its original shape after being twisted or dented. It is not perfect for everyone, though, because some people are sensitive to its nickel. Flexon frames are also relatively expensive.

Plastic frames are durable, can accommodate just about any lens prescription, and are available in a wide range of prices. They are also offered in a variety of plastics (including acrylic, epoxy, cellulose acetate, cellulose propionate, polyamide, and nylon) and in different colors, shapes, and levels of resistance to breakage. Epoxy frames are resilient and return to their original shape after being deformed, so they do not need to be adjusted as frequently as other types.

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Nylon frames are almost unbreakable. They revert to their original shape after extreme trauma and distortion; because of this property, though, they cannot be readjusted after they are manufactured.

FIT. The patient should have the distance between the eyes (PD) measured, so that the optical centers of the lenses will be in front of the patient's pupils. Bifocal heights also have to be measured with the chosen frame in place and adjusted on the patient. Again, this is so the lenses will be positioned correctly. If not positioned correctly, the patient may experience eyestrain or other problems. This can occur with over-the-counter reading glasses. The distance between the lenses is for a "standard" person. Generally, this will not be a problem, but if a patient is sensitive or has more closely set eyes, for example, it may pose a problem. Persons buying ready-made sunglasses or reading glasses should hold them up to see if they appear clear. They should also hold the lenses to see an object with straight lines reflected off of the lenses. If the lines don't appear straight, the lenses may be warped or inferior.

Patients may sometimes need a few days to adjust to a new prescription; however, problems should be reported, because the glasses may need to be rechecked.

Contact lenses

More than 32 million people in the United States wear these small lenses that fit on top of the cornea. They provide a field of view unobstructed by eyeglass frames; they do not fog up or get splattered, so it is possible to see well while walking in the rain; and they are less noticeable than any eyeglass style. On the other hand, they take time to get accustomed to; require more measurements for fitting; require many follow-up visits to the eye doctor; can lead to complications such as infections and corneal damage; and may not correct astigmatism as well as eyeglasses, especially if the astigmatism is severe.

Originally, hard contact lenses were made of a material called PMMA. Although still available, the more common types of contact lenses are listed below:

- Rigid gas-permeable (RGP) daily-wear lenses are made of plastic that does not absorb water but allows oxygen to get from the atmosphere to the cornea. (This is important because the cornea has no blood supply and needs to get its oxygen from the atmosphere through the film of tears that moves beneath the lens.) They must be removed and cleaned each night.
- Rigid gas-permeable (RGP) extended-wear lenses are made from plastic that also does not absorb water but is more permeable to oxygen than the plastic used for daily-wear lenses. They can be worn up to a week.
- Daily wear soft lenses are made of plastic that is permeable to oxygen and absorbs water; therefore, they are soft and flexible. These lenses must be removed and cleaned each night, and they do not correct all vision problems. Soft lenses are easier to get used to than rigid lenses, but are more prone to tears and do not last as long.
- Extended-wear soft lenses are highly permeable to oxygen, are flexible by virtue of their ability to absorb water, and can usually be worn for up to one week. They do not correct all vision problems. There is more of a risk of infection with extended-wear lenses than with daily-wear lenses.
- Extended-wear disposable lenses are soft lenses worn continually for up to six days and then discarded, with no need for cleaning.
- Planned-replacement soft lenses are daily wear lenses that are replaced on a regular schedule, which is usually every two weeks, monthly, or quarterly. They must also be cleaned.

Soft contact lenses come in a variety of materials. There are also different kinds of RGP and soft multifocal contact lenses available. Monovision, where one contact lens corrects for distance vision while the other corrects for near vision, may be an option for presbyopic patients. Monovision, however, may affect depth perception and may not be appropriate for everyone. Contact lenses also come in a variety of tints. Soft contacts are available that can make eyes appear a different color. Even though such lenses have no prescription, they must still be fitted and checked to make sure that an eye infection does not occur. People should never wear someone else's contact lenses. This can lead to infection or damage to the eye.

Tiny, surgically implanted contact lenses may one day replace eyeglasses, contact lenses and **laser surgery** for some patients with extreme nearsightedness. Called intraocular lenses, they were still investigational in the spring of 2004, and although they are surgically installed, they can be removed. Researchers expected FDA approval in 2004.

Aftercare

Contact lens wearers must be examined periodically by their eye doctors to make sure that the lenses fit properly and that there is no infection. Infection and lenses that do not fit properly can damage the cornea. Patients can be allergic to certain solutions that are used to clean or lubricate the lenses. For that reason, patients should not randomly switch products without speaking

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KEY TERMS

Astigmatism—Assymetric vision defects due to irregularities in the cornea.

Cornea—The clear outer covering of the front of the eye.

Index of refraction—A constant number for any material for any given color of light that is an indicator of the degree of the bending of the light caused by that material.

Lens—A device that bends light waves.

Permeable—Capable of allowing substances to pass through.

Polycarbonate—A very strong type of plastic often used in safety glasses, sport glasses, and children's eyeglasses. Polycarbonate lenses have approximately 50 times the impact resistance of glass lenses.

Polymer—A substance formed by joining smaller molecules. For example, plastic, acrylic, cellulose acetate, cellulose propionate, nylon, etc.

Presbyopia—A condition affecting people over the age of 40 where the system of accommodation that allows focusing of near objects fails to work because of age-related hardening of the lens of the eye.

Retina—The inner, light-sensitive layer of the eye containing rods and cones; transforms the image it receives into electrical messages sent to the brain via the optic nerve.

Ultraviolet (UV) light—Part of the electromagnetic spectrum with a wavelength just below that of visible light. It is damaging to living material, especially eyes and DNA.

with their doctor. Contact lens wearers should seek immediate attention if they experience eye **pain**, a burning sensation, red eyes, intolerable sensitivity to light, cloudy vision, or an inability to keep the eyes open.

To avoid infection, it is important for contact lens wearers to exactly follow their instructions for lens insertion and removal, as well as cleaning. Soft contact lens wearers should never use tap water to rinse their lenses or to make up solutions. All contact lens wearers should also always have a pair of glasses and a carrying case for their contacts with them, in case the contacts have to be removed due to eye irritation.

Risks

Wearing contact lenses increases the risk of corneal damage and eye infections.

Normal results

The normal expectation is that people will achieve 20/20 vision while wearing corrective lenses. A new technology for customized eyeglasses patented in 2004 claims to achieve exceptional vision assessment and 20/10 acuity by using wavefront measurements and precise parameters to produce measurements such as pupil size and distance, along with other customized lens and frame features.

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American Optometric Association, 243 North Lindbergh Blvd., St. Louis, MO, 63141, (314) 991-4100, (314) 991-4101, (800) 365-2219, http://www.aoa.org/.

Optician Association of America, 678 Parkside Drive, Palatine, IL, 60067, (847) 202-1411, http://www.eyewebmasters.com.

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Teresa G. Odle

Eye muscle surgery

Definition

Eye muscle surgery is surgery to weaken, strengthen, or reposition any of the muscles that move the eyeball (the extraocular muscles).

Purpose

The purpose of eye muscle surgery is generally to align the pair of eyes so that they gaze in the same

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KEY TERMS

Botulinum toxin (botulin)—A neurotoxin made by *Clostridium botulinum*; causes paralysis in high doses, but is used medically in small, localized doses to treat disorders associated with involuntary muscle contraction and spasms, in addition to strabismus.

Conjunctiva—The mucous membrane that covers the eyes and lines the eyelids.

Extraocular muscles—The muscles (lateral rectus, medial rectus, inferior rectus, superior rectus, superior oblique, and inferior oblique) that move the eyeball.

Orbit—The cavity in the skull containing the eyeball; formed from seven bones: frontal, maxillary, sphenoid, lacrimal, zygomatic, ethmoid, and palatine.

Retina—The inner, light-sensitive layer of the eye containing rods and cones; transforms the image it receives into electrical messages sent to the brain via the optic nerve.

Sclera—The tough, fibrous, white outer protective covering of the eyeball.

Strabismus—A disorder where the two eyes do not point in the same direction.

direction and move together as a team, either to improve appearance or to aid in the development of binocular vision in a young child. To achieve binocular vision, the goal is to align the eyes so that the location of the image on the retina of one eye corresponds to the location of the image on the retina of the other eye.

In addition, sometimes eye muscle surgery can help people with other eye disorders (**nystagmus** and Duane syndrome, for example).

Precautions

Depth perception (stereopsis) develops around the age of three months old. For successful development of binocular vision and the ability to perceive three-dimensionally, the surgery should not be postponed past the age of four. The earlier the surgery the better the outcome, so an early diagnosis is important. Surgery may even be performed before two years old. After surgery, if binocular vision is to develop, corrective lenses and eye exercises (vision therapy) will probably be necessary.

Description

The extraocular muscles attach via tendons to the sclera (the white, opaque, outer protective covering of the eyeball) at different places just behind an imaginary equator circling the top, bottom, left, and right of the eye. The other end of each of these muscles attaches to a part of the orbit (the eye socket in the skull). These muscles enable the eyes to move up, down, to one side or the other, or any angle in between.

Normally both eyes move together, receive the same image on corresponding locations on both retinas, and the brain fuses these images into one three-dimensional image. The exception is in **strabismus** which is a disorder where one or both eyes deviate out of alignment, most often outwardly (exotropia) or toward the nose (esotropia). The brain now receives two different images, and either suppresses one or the person sees double (diplopia). This deviation can be adjusted by weakening or strengthening the appropriate muscles to move the eyes toward the center. For example, if an eye turns upward, the muscle at the bottom of the eye could be strengthened.

Rarely, eye muscle surgery is performed on people with nystagmus or Duane syndrome. Nystagmus is a condition where one or both eyes move rapidly or oscillate; it can sometimes be helped by moving the eyes to the position of least oscillation. Duane syndrome is a disorder where there is limited horizontal eye movement; it can sometimes be relieved by surgery to weaken an eye muscle.

There are two methods to alter extraocular muscles. Traditional surgery can be used to strengthen, weaken, or reposition an extraocular muscle. The surgeon first makes an incision in the conjunctiva (the clear membrane covering the sclera), then puts a suture into the muscle to prevent it from getting lost and loosens the muscle from the eyeball with a surgical hook. During a resection, the muscle is detached from the sclera, a piece of muscle is removed so the muscle is now shorter, and the muscle is reattached to the same place. This strengths the muscle. In a recession, the muscle is made weaker by repositioning it. More than one extraocular eye muscle might be operated on at the same time.

Another way of weakening eye muscles, using botulinum toxin injected into the muscle, was introduced in the early 1980s. Although the botulinum toxin wears

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off, the realignment may be permanent, depending upon whether neurological connections for binocular vision were established during the time the toxin was active. This technique can also be used to adjust a muscle after traditional surgery.

The cost of eye muscle surgery is about $2,000–$4,000, and about 700,000 surgeries are performed annually in the United States.

Preparation

Patients should make sure their doctors are aware of any medications that they are taking, even over-the-counter medications. Patients should not take **aspirin**, or any other blood-thinning medications for ten days prior to surgery, and should not eat or drink after midnight the night before.

Aftercare

Patients will need someone to drive them home after their surgery. They should continue to avoid aspirin and other non-steroidal anti-inflammatory agents for an additional three days, but they can take **acetaminophen** (e.g., Tylenol). Patients should discuss this with the surgeon to be clear what medications they can or cannot take. **Pain** will subside after two to three days, and patients can resume most normal activities within a few days. Again, this may vary with the patient and the patient should discuss returning to normal activity with the surgeon. They should not get their eyes wet for three to four days and should refrain from swimming for 10 days. Operated eyes will be red for about two weeks.

Risks

As with any surgery, there are risks involved. Eye muscle surgery is relatively safe, but very rarely a cut muscle gets lost and can not be retrieved. This, and other serious reactions, including those caused by anesthetics, can result in vision loss in the affected eye. Occasionally, retinal or nerve damage occurs. Double vision is not uncommon after eye muscle surgery. As mentioned earlier, glasses or vision therapy may be necessary.

Normal results

Cosmetic improvement is likely with success rate estimates varying from about 65–85%. According to the best statistics, binocular vision is improved in young children about 35% of the time. There is no improvement, or the condition worsens 15–35% of the time. A second operation may rectify less-than-perfect outcomes.

Resources

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American Academy of Pediatric Ophthalmology and Strabismus (AAPOS), PO Box 193832, San Francisco, CA, 94119-3832, (415) 561-8505, (415) 561-8531, aapos@aao.org, http://www.aapos.org.

Lorraine Lica, PhD

Eye training *see* **Vision training**

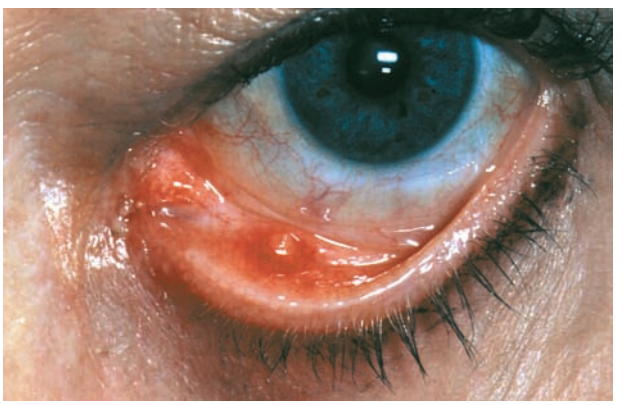
Eyelid disorders

Definition

An eyelid disorder is any abnormal condition that affects the eyelids.

Description

Eyelids consist of thin folds of skin, muscle, and connective tissue. The eyelids protect the eyes and spread tears over the front of the eyes. The inside of the eyelids are lined with the conjunctiva of the eyelid (the palpebral conjunctiva), and the outside of the lids are covered with the body's thinnest skin. Some common lid problems



A chalazion on the eyelid. This condition is caused by an obstruction of one of the meibomian glands which lubricate the edge of the eyelid. *(Photo Researchers, Inc.)*

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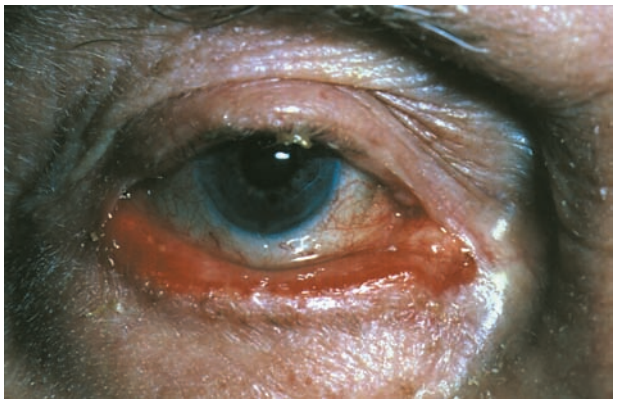

A close-up of the eye of an elderly patient showing ectropion of the lower eyelid. Ectropion is a condition in which the eyelid turns away from the eye. The most common type is senile ectropion (seen here), in which the droop of the eyelid is due to loss of tissue elasticity in old age and weakness in the muscles surrounding the eye. *(Dr. P. Marazzi/Photo Researchers, Inc.)*

include the following: stye, blepharitis, chalazion, entropion, ectropion, eyelid **edema**, and eyelid tumors.

Stye

A stye is an infection of one of the three types of eyelid glands near the lid margins, at the base of the lashes.

Chalazion

A chalazion is an enlargement of a meibomian gland (an oil-producing gland in the eyelid), usually not associated with an infectious agent. More likely, the gland opening is clogged. Initially, a chalazion may resemble a stye, but it usually grows larger. A chalazion may also be located in the middle of the lid and be internal.

Blepharitis

Blepharitis is the inflammation of the eyelid margins, often with scales and crust. It can lead to eyelash loss, chalazia, styes, ectropion, corneal damage, excessive tearing, and chronic **conjunctivitis**.

Entropion

Entropion is a condition where the eyelid margin (usually the lower one) is turned inward; the eyelashes touch the eye and irritate the cornea.

Ectropion

Ectropion is a condition where one or both eyelid margins turn outward, exposing both the conjunctiva that covers the eye and the conjunctiva that lines the eyelid.

Eyelid edema

Eyelid edema is a condition where the eyelids contain excessive fluid.

Eyelid tumors

Eyelids are susceptible to the same skin tumors as the skin over the rest of the body, including noncancerous tumors and cancerous tumors (**basal cell carcinoma**, squamous cell carcinoma, **malignant melanoma**, and sebaceous gland carcinoma). Eyelid muscles are susceptible to sarcoma.

Causes and symptoms

Stye

Styes are usually caused by bacterial **staphylococcal infections**. The symptoms are **pain** and inflammation in one or more localized regions near the eyelid margin.

Chalazion

A chalazion is caused by a blockage in the outflow duct of a meibomian gland. Symptoms are inflammation and swelling in the form of a round lump in the lid that may be painful.

Blepharitis

Some cases of blepharitis are caused by bacterial infection and some by head lice, but in some cases, the cause is unclear. It may also be caused by an overproduction of oil by the meibomian glands. Blepharitis can be a chronic condition that begins in early childhood and can last throughout life. Symptoms can include **itching**, burning, a feeling that something is in the eye, inflammation, and scales or matted, hard crusts surrounding the eyelashes.

Entropion

Entropion usually results from **aging**, but sometimes can be due to a congenital defect, a spastic eyelid muscle, or a scar on the inside of the lid from surgery, injury, or disease. It is accompanied by excessive tearing, redness, and discomfort.

Ectropion

Similar to entropion, the usual cause of ectropion is aging. It also can be due to a spastic eyelid muscle or a scar, as in entropion. It also can be the result of **allergies**. Symptoms are excessive tearing and hardening of the eyelid conjunctiva.

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Eyelid edema

Eyelid edema is most often caused by allergic reactions, for example, allergies to eye makeup, eyedrops or other drugs, or plant allergens such as pollen. **Trichinosis**, a disease caused by eating undercooked meat, also causes eyelid edema. However, swelling can also be caused by more serious causes, such as infection, and can lead to **orbital cellulitis** which can threaten vision. Symptoms can include swelling, itching, redness, or pain.

Eyelid tumors

Tumors found on the eyelids are caused by the same conditions that cause these tumors elsewhere on the body. They are usually painless and may or may not be pigmented. Some possible causes include **AIDS** (**Kaposi's sarcoma**) or increased exposure to ultraviolet (UV) rays which may lead to skin **cancer**.

Diagnosis

An instrument called a slit lamp is generally used to magnify the structures of the eyes. The doctor may press on the lid margin to see if oil can be expressed from the meibomian glands. The doctor may invert the lid to see the inside of the lid. Biopsy is used to diagnose cancerous tumors.

Treatment

Stye

Styes are treated with warm compresses for 10–15 minutes, three to four times a day. Chloramphenicol ointment may be used as well. Sometimes **topical antibiotics** may be prescribed if the infection is spreading.

Chalazion

About 25% of chalazia will disappear spontaneously, but warm compresses may speed the process. Chloramphenicol ointment may be used as well. Because chalazia are inside the lid, topical medications are generally of no benefit. Medication may need to be injected by the doctor into the chalazion or if that doesn't help the chalazion may need to be excised. If what appears to be a chalazion recurs on the same site as any previous one, the possibility of sebaceous gland carcinoma should be investigated by biopsy.

Blepharitis

Blepharitis is treated with hot compresses, with antibiotic ointment, and by cleaning the eyelids with a moist washcloth and then with baby shampoo. Good hygiene is essential. Patients can try to keep rooms dry, such as by placing a bowl of water on top of a radiator. Tear film supplements such as hypromellose can help moisten the eyes when dry. If itching, soreness, or redness occurs from the tear film drops, they should be stopped. Topical or systemic **antibiotics** also may be prescribed. If the blepharitis doesn't clear up with treatment or if it seems to be a chronic problem, the patient may have **acne rosacea**. These patients may need to see a dermatologist as well.

Entropion and ectropion

Both entropion and ectropion can be surgically corrected. Prior to surgery, the lower lid of entropion can be taped down to keep the lashes off the eye, and both can be treated with lubricating drops to keep the cornea moist.

Eyelid edema

Patients with swollen eyelids should contact their eye doctor. A severely swollen lid can press on the eye and possibly increase the intraocular pressure. An infection needs to be ruled out. Or, something as simple as an allergy to nail polish and then touching the eyes can cause swelling. The best treatment for allergic eyelid edema is to find and remove the substance causing the allergy. When that is not possible, as in the case of plant allergens, cold compresses and immunosuppresesive drugs such as corticosteroid creams are helpful. However, **steroids** can cause **cataracts** and increase intraocular pressure and patients must be very careful not to get the cream in their eyes. This should not be done unless under a doctor's care. For edema caused by trichinosis, the trichinosis must be treated.

Eyelid tumors

Cancerous tumors should be removed upon discovery, and noncancerous tumors should be removed before they become big enough to interfere with vision or eyelid function. Eyelid tumors require special consideration because of their sensitive location. It is important that treatment not compromise vision, eye movement, or eyelid movement. Accordingly, eyelid reconstruction will sometimes accompany tumor excision.

Prognosis

The prognosis for styes and chalazia is good to excellent. With treatment, blepharitis, ectropion, and

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KEY TERMS

Allergen—A substance capable of inducing an allergic response.

Allergic reaction—An immune system reaction to a substance in the environment; symptoms include rash, inflammation, sneezing, itchy watery eyes, and runny nose.

Conjunctiva—The mucous membrane that covers the white part of the eyes and lines the eyelids.

Edema—A condition where tissues contain excessive fluid.

Meibomian gland—Oil-producing glands in the eyelids that open near the eyelid margins.

entropion usually have good outcomes. The prognosis for nonmalignant tumors, basal cell carcinoma, and squamous cell carcinoma is good once they are properly removed. Survival rate for malignant melanoma depends upon how early it was discovered and if it was completely removed. Sebaceous carcinomas are difficult to detect, so poor outcomes are more frequent.

All of these eyelid disorders, if not treated, can lead to other, possibly serious vision problems—dry eye, **astigmatism**, or even vision loss, for example. An ophthalmologist or optometrist should be consulted.

Prevention

Good lid hygiene is very important. Regular eyelid washing with baby shampoo helps prevent styes, chalazia, blepharitis, and eyelid edema. To avoid these problems, it's also important to refrain from touching and rubbing the eyes and eyelids, especially with hands that have not just been washed.

Blepharitis is associated with dandruff, which is caused by a kind of bacteria that is one of the causes of blepharitis. Controlling dandruff by washing the hair, scalp, and eyebrows with shampoo containing selenium sulfide to kill the bacteria helps control the blepharitis. When using anything near the eyes, it is important to read the label or consult with a doctor first.

Avoiding allergens helps prevent allergic eyelid edema. Staying inside as much as possible when pollen counts are high and eliminating the use of, or at least removing eye makeup thoroughly, or using hypoallergenic makeup may help if the person is sensitive to those substances.

Sunscreen, UV-blocking sunglasses, and wide brimmed hats can help prevent eyelid tumors.

Entropian and ectropian seem to be unpreventable.

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American Optometric Association, 243 North Lindbergh Blvd., St. Louis, MO, 63141, (314) 991-4100, (314) 991-4101, (800) 365-2219, http://www.aoa.org/.
American Society of Ophthalmic Plastic and Reconstructive Surgery, 5841 Cedar Lake Road, Suite 204, Minneapolis, MN, 55416, (952) 646-2038, (952) 545-6073, http://www.asoprs.org.

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Eyelid edema *see* **Eyelid disorders**
Eyelid plastic surgery *see* **Blepharoplasty**

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F

Fabry's disease *see* **Lipidoses**

Facelift

Definition

Facelift surgery is a cosmetic procedure that can involve removing excess skin and fat, tightening muscles, and redraping the remaining skin of the face and neck. This surgery is usually done to counter signs of **aging** produced by sunlight, time, and gravity.

Purpose

The purpose of facelift surgery, also known as facialplasty, rhytidoplasty, or cervicofacial rhytidectomy, is to improve the appearance of the face by removing excess skin and unwanted fat, and tightening some of the underlying muscles. The procedure is designed to counter sagging and looseness in skin and muscle tissue caused by gravity as the patient ages. Facelift surgery will not erase all facial wrinkles, as the term rhytidectomy (which literally means "surgical removal of wrinkles") might imply. Wrinkles around the mouth and eyes, for example, may benefit little from facelift surgery. Other procedures, such as **blepharoplasty**, chemical peel, or dermabrasion, also may be necessary to reduce wrinkling.

Precautions

Patients with other medical conditions should consult with their primary physicians before undergoing facelift surgery. Lung problems, heart disease, and other medical conditions can lead to a higher risk of complications. Patients should tell their surgeon about medications they are taking. Some medications can alter the way their **blood clots**. These include female hormones, **aspirin**, and some non-aspirin **pain** relievers. Surgeons typically instruct patients to stop taking these medications for some time before surgery. This may improve recovery time. In addition, it may lower the risk that a hematoma, or a pocket of blood below the skin, will form. Hematoma formation is the most frequent complication of facelift surgery.

Description

Facelift surgery can usually be performed on an outpatient basis with local anesthetics. Patients typically also receive "twilight anesthesia," an intravenous sedative that helps to lower their awareness of the procedure being performed.

A number of variations of facelift surgery exist. The patient's facial structure, how much correction is needed, and the preferences of the surgeon performing the procedure will help determine which variation is used. In a typical facelift surgery, the surgeon begins by making an incision within the hairline just above the ear. The incision continues down along the front edge of the ear, around the earlobe, and then up and behind the ear extending back into the hairline. The location of this incision is designed to hide any scarring caused by the procedure. The same procedure is repeated on the other side of the face. Using various instruments, the surgeon will then work to separate the skin of the face from its underlying tissue, moving down to the cheek and into the neck area and below the chin. Fat deposits over the cheeks and in the neck may be removed surgically or with **liposuction** at this time. The surgeon will then work to free up and tighten certain bands of muscle and tissue that extend up from the shoulder, below the chin, and up and behind the neck. If these muscles and tissue are not tightened, the looseness and sagging appearance of the skin will return. The surgeon will then trim excess skin from the edges of the original incision, pull the skin back, and staple or suture it into place.

Preparation

Prior to the procedure, a patient meets with his or her surgeon to discuss the surgery, clarify the results

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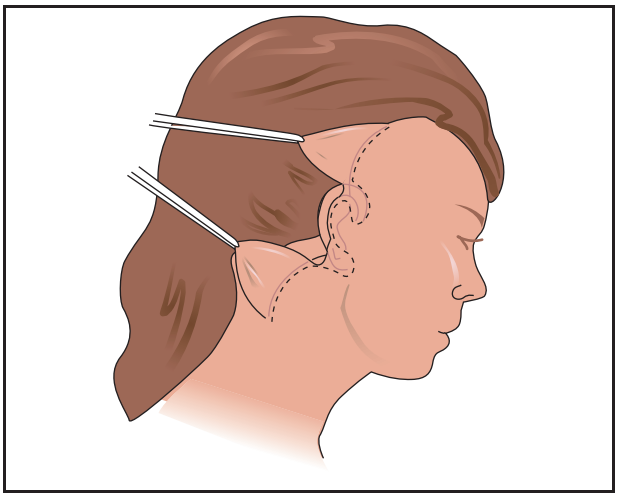

In a typical facelift surgery, the surgeon begins by making an incision within the hairline just above the ear. The incision continues down along the front of the ear, around the earlobe, and then up and behind the ear extending back into the hairline, as shown above. The same procedure is repeated on the other side of the face. The surgeon will then separate the skin from the tissue, remove fat deposits over the cheeks and neck, tighten up muscles and tissues below the chin and upwards behind the neck. The surgeon will then trim excess skin from the original incision, pull the skin back, and suture it into place. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

KEY TERMS

Hematoma—A complication of surgery in which a collection of blood forms below the skin.

Rhytidectomy—Another term for facelift surgery, it literally means "wrinkle excision."

Twilight anesthesia—An intravenous mixture of sedatives and other medications that decreases a patient's awareness of the procedure being performed.

that can be achieved, and discuss the potential risks and benefits of the procedure. Having realistic expectations is important in any cosmetic procedure. Patients may be told, for example, that although facelift surgery can improve the contour of the face and neck, other procedures may be necessary to reduce the appearance of wrinkles in some locations. Patients may be instructed to stop taking aspirin, birth control or female hormones, and other medications affecting blood clotting about two weeks before the procedure. Some physicians may instruct the patient to take supplemental vitamins C and K in the belief that this promotes healing. Patients will also be advised to stop **smoking** and to avoid exposure to passive smoke before the procedure and afterward. Some surgeons also recommend **antibiotics** be taken beforehand to limit the risk of infection. Some surgeons also use a steroid injection before or after the procedure, to reduce swelling.

Aftercare

After the surgery, a small tube may be placed under the skin temporarily to reduce the risk of hematoma. The patient may spend a few hours resting in a recovery room to ensure no bleeding has occurred. The patient then returns home. Some surgeons recommend that the patient remain reclining for the next 24 hours, consume a liquid diet, and avoid any movements that lead the neck to flex. Ice packs for the first few days can help to reduce swelling and lower the risk of hematoma. Patients usually continue to take an antibiotic until the first stitches come out about five days after the procedure. The balance are removed seven to ten days later. Most patients return to work and limited activities within two weeks of the procedure.

Risks

The major complication seen following facelift surgery is a hematoma. If a hematoma forms, the patient may have to return to have the stitches reopened to find the source of the bleeding. Most hematomas form within 48 hours of surgery. The typical sign is pain or swelling affecting one side of the face but not the other.

Another risk of facelift surgery is nerve damage. Sometimes it can affect the patient's ability to raise an eyebrow, or distort his or her smile, or leave only limited feeling in the earlobe. Most of these nerve injuries, however, repair themselves within two to six months. Poor healing, infection, and negative reactions to the anesthesia are also risks associated with facelift surgery.

Normal results

Some swelling and bruising is normal following facelift surgery. After these disappear, the patient should see a noticeable improvement in the contour of the face and neck. Most individuals who have facelift surgery find that they are satisfied with the results. Over time, the skin on the neck and face will begin to sag again as normal aging continues. The individual

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may choose to have additional facelift surgeries in the future to reduce new signs of aging.

Abnormal results

Some individuals may find that their facelift surgeries did not produce the results expected. This is especially likely to be a problem if the individual did not discuss realistic outcomes for the procedure with the surgeon ahead of time. It is generally normal to feel some disappointment with the procedure in the first few weeks afterwards, when bruising and swelling have not yet completely healed. Most people find that they are satisfied with their surgeries a few months later, after the healing process is complete.

Resources

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Bailey, Kristen, ed. *Cosmetic Surgery*. Detroit, MI: Greenhaven Press, 2005.

ORGANIZATIONS

American Society for Dermatologic Surgery, 5550 Meadowbrook Dr., Suite 120, Rolling Meadows, IL, 60008, (847) 956-0900, (847) 956-0999, http://www.asds.net/.

American Society of Plastic Surgeons, 444 E. Algonquin Rd., Arlington Heights, IL, 60005, (847) 228-9900, http://www.plasticsurgery.org/.

Richard H. Camer

Factitious disorders

Definition

Factitious disorders are a group of mental disturbances in which patients intentionally act physically or mentally ill without obvious benefits. The name factitious comes from a Latin word that means artificial. These disorders are not **malingering**, which is defined as pretending illness when the "patient" has a clear motive, such as financial gain.

Description

Patients with factitious disorders produce or exaggerate the symptoms of a physical or mental illness by a variety of methods, including contaminating urine samples with blood, taking hallucinogens, injecting themselves with bacteria to produce infections, and other similar behaviors.

No reliable statistics on the frequency of factitious disorders are available, but factitious disorders are more common in men than in women. The following conditions are sometimes classified as factitious disorders:

Munchausen syndrome

Munchausen syndrome refers to patients whose factitious symptoms are dramatized and exaggerated. Many persons with Munchausen go so far as to undergo major surgery repeatedly, and, to avoid detection, at several locations. Many have been employed in hospitals or in healthcare professions. The syndrome's onset is in early adulthood.

Munchausen by proxy

Munchausen by proxy is the name given to factitious disorders in which a parent or other caregiver may but are falsify a child's medical history or tamper with laboratory tests in order to make the child appear sick. Occasionally, the parent may actually injure the child to assure that he or she will be treated.

Ganser's syndrome

Ganser's syndrome is an unusual dissociative reaction to extreme **stress** in which the patient gives absurd or silly answers to simple questions. It has sometimes been labeled as psychiatric malingering, but is more often classified as a factitious disorder.

Causes and symptoms

No single explanation of factitious disorders covers all cases. These disorders are variously attributed to underlying **personality disorders**; **child abuse**; the wish to repeat a satisfying childhood relationship with a doctor; and the desire to deceive or test authority figures. Also, the wish to assume the role of patient and receive care is involved. In many cases, the suffering of a major personal loss has been implicated.

The following are regarded as indications of a factitious disorder:

- dramatic but inconsistent medical history
- extensive knowledge of medicine and/or hospitals
- negative test results followed by further symptom development
- symptoms that occur only when the patient is not being observed
- few visitors
- arguments with hospital staff or similar acting-out behaviors

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KEY TERMS

Ganser's syndrome—An unusual factitious disorder characterized by dissociative symptoms and absurd answers to direct questions.

Malingering—Pretending to be sick in order to be relieved of an unwanted duty or obtain some other obvious benefit.

Munchausen by proxy—A factitious disorder in which a parent or other caregiver may falsify a child's medical history or take other action to make a healthy child appear sick.

Munchausen syndrome—A factitious disorder in which the patient's symptoms are dramatized and exaggerated.

- eagerness to undergo operations and other procedures

When patients with factitious disorders are confronted, they usually deny that their symptoms are intentional. They may become angry and leave the hospital. In many cases they enter another hospital, which has led to the nickname "hospital hoboes."

Diagnosis

Diagnosis of factitious disorders is usually based on the exclusion of bona fide medical or psychiatric conditions, together with a combination of the signs listed earlier. In some cases, the diagnosis is made on the basis of records from other hospitals.

Treatment

Treatment of factitious disorders is usually limited to prompt recognition of the condition and the refusal to give unnecessary medications or to perform unneeded procedures. Individuals with factitious disorder do not usually remain in the hospital long enough for effective psychiatric treatment. Some clinicians have tried psychotherapeutic treatment for factitious disorder patients, and anecdotal reports suggest that antidepressant or antipsychotic medications are helpful in certain cases.

Prognosis

Some patients have only one or two episodes of factitious disorders; others develop a chronic form that may be lifelong. Successful treatment of the chronic form appears to be rare.

Resources

BOOKS

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Rebecca J. Frey, PhD

Factor IX deficiency *see* **Hemophilia**

Factor VIII deficiency *see* **Hemophilia**

Failure to thrive

Definition

Failure to thrive (FTT) is used to describe a serious delay in a child's growth or development. This diagnosis usually is applied to infants and children up to two years of age who do not gain or maintain weight as they should. Failure to thrive is not a specific disease, but rather a cluster of symptoms that may come from a variety of sources.

Demographics

Premature infants are at greatest risk for failure to thrive. As many as 10% of hospitalized young children show some signs of failure to thrive. The rate of failure to thrive for non-specific physiological reasons (non-organic failure to thrive) is higher in the United Sates than in other developed countries. Internationally, **malnutrition** is the most common cause of failure to thrive.

Description

Shortly after birth most infants lose some weight. After that expected loss, infants normally gain weight at a steady and predictable rate. When an infant does not gain weight as expected, or continues to lose weight, he or she is not thriving. Failure to thrive may be due to one or more conditions.

Organic failure to thrive (OFTT) implies that the organs involved with digestion and absorption of food are malformed or incomplete so the baby cannot digest its food. Nonorganic failure to thrive (NOFTT) is the most common cause of FTT and implies the baby is not receiving enough food due to economic factors, parental neglect, or psychosocial problems.

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KEY TERMS

Esophagus—The muscular tube that leads from the back of the throat to the stomach. Coated with mucus and surrounded by muscles, it pushes food to the stomach by contraction.

Psychosocial—A term referring to the mind's ability, consciously or unconsciously, to adjust and relate the body to its social environment.

Causes and symptoms

Occasionally, underlying physical conditions inhibit an infant's ability to take in, digest, or process food. These defects can occur anywhere in the digestive tract—in the esophagus, stomach, small or large intestine, rectum, or anus. Usually the defect is an incomplete development of the organ, and it must be surgically corrected. Other physical causes of FTT include hormonal abnormalities, chromosomal abnormalities, **cystic fibrosis**, and metabolic disorders. Most physical defects can be detected shortly after birth.

Failure to thrive may also result from lack of available food or the quality of the food offered. This can be due to economic factors in the family, parental beliefs and concepts of **nutrition**, or neglect of the child. In addition, if the infant is breastfed, the quality or quantity of the mother's milk may be the source of the problem.

Psychosocial problems, often stemming from lack of a nurturing parent-child relationship can lead to a failure to thrive. The child may exhibit poor appetite due to depression related to from insufficient attention from parents.

Infants and toddlers whose growth is substantially less than expected, are considered to be suffering from FTT.

Diagnosis

Infants are weighed at birth, and that weight is used as a baseline in future well-baby check-ups. If the infant is not gaining weight at a predictable rate, the doctor will do a more extensive examination. If no apparent physical deformities in the digestive tract exist, the doctor will examine the child's environment. As part of that examination, the doctor will look at the family history of height and weight. In addition, the parents will be asked about feedings, illnesses, and family routines. If the mother is **breastfeeding** the doctor will also evaluate her diet, general health, and well-being as it affects the quantity and quality of her milk.

Treatment

If the baby has an underlying physical reason for failure to thrive, such as a disorder of swallowing mechanism or intestinal problems, correcting that problem should reverse the condition. If the condition is caused by environmental factors, the physician will suggest several ways parents may provide adequate food for the child. Maternal education and parental counseling may also be recommended. In extreme cases, hospitalization or a more nurturing home may be necessary.

Prognosis

The first year of life is important as a foundation for growth and physical and intellectual development in the future. Children with extreme failure to thrive in the first year may never catch up to their peers, even if their physical growth improves. In about one-third of these extreme cases, mental development remains below normal and roughly half will continue to have psychosocial and eating problems throughout life.

When failure to thrive is identified and corrected early, most children catch up to their peers and remain healthy and well-developed.

Prevention

Initial failure to thrive caused by physical defects cannot be prevented but can often be corrected before they become a danger to the child. Maternal education and emotional and economic support systems all help to prevent failure to thrive in those cases where no physical deformity exists.

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Rabinowitz, Simon S., Madhavi Katturupalli, and Genie Rogers. Failure to Thrive. emedicine.com. May 4, 2010. http://emedicine.medscape.com/article/985007-overview

ORGANIZATIONS

American Academy of Family Physicians, P.O. Box 11210, Shawnee Mission, KS, 66207, (913) 906-6000, (800) 274-2237, (913) 906-6075, http://familydoctor.org.

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American Academy of Pediatrics, 141 Northwest Point Blvd., Elk Grove Village, IL, 60007-1098, (847) 434-4000, (847) 434-8000, http://www.aap.org.
American College of Gastroenterology (ACG), P.O. Box 34226, Bethesda, MD, 20827-2260, (301) 263-9000, http://www.acg.gi.org.
American Gastroenterological Association (AGA), 4930 Del Ray Ave., Bethesda, MD, 20814, (310) 654-2055, (301) 654-5920, http://www.gastro.org.
March of Dimes Foundation, 1275 Mamaroneck Ave., White Plains, NY, 10605, (914) 997-4488, askus@marchofdimes.com, http://www.marchofdimes.com.

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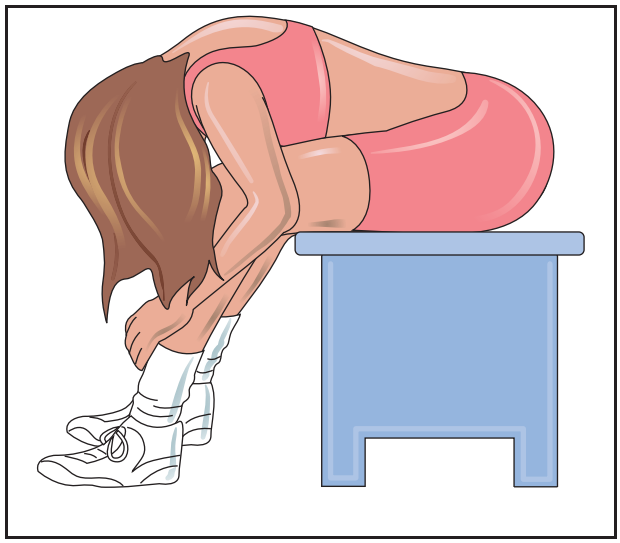
Fainting

Definition

Fainting, also called syncope, is a transient loss of consciousness and muscle control brought about by an inadequate amount of oxygen reaching the brain.

Demographics

Fainting is a common occurrence. About six people faint for the first time for every 1,000 patient years.



If a person is feeling faint, unconsciousness may be prevented by sitting with the head between the knees, as shown in the illustration above, or by lying flat with the legs raised. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Of these, about 3% will faint again. In people with heart disease, the rate of repeat fainting is about 10%.

The incidence of fainting is about the same worldwide; it appears to be unaffected by gender or ethnicity. However, the elderly are more likely to faint than younger people, and children rarely faint. One reason the elderly are more likely to faint is that fainting often is associated with heart disease, which is much more common in the elderly.

Description

A person who faints temporarily loses consciousness and muscle control. The period of unconsciousness lasts anywhere from a few seconds to a few minutes. Recovery is spontaneous. Fainting normally causes no permanent damage to the brain, although the individual may be injured by falling when losing muscle control.

Physicians distinguish several categories of fainting. Cardiac fainting (cardiac syncope) occurs because heart disease prevents the heart from pumping enough blood to the brain. A person with cardiac syncope tends to faint more than once. Cardiac syncope is a sign of a serious health problem. In a study by the New York Heart Association, 45% of individuals with heart disease and cardiac syncope died within one year compared to 12% of equally ill people who did not faint.

Reflex fainting occurs in response to events such as emotional **stress**, fear, or physical **pain**. Situational fainting occurs reproducibly when the individual assumes a certain posture or performs a specific act. For example, micturation syncope produces a feeling of lightheadedness immediately after urinating. Reflex and situational fainting are not life-threatening and rarely indicate the presence of serious disease.

Orthostatic hypotension occurs when a person rises from lying or sitting to standing. Changing position causes blood pressure to drop suddenly in some people, resulting in a feeling of lightheadedness or a brief faint. Orthostatic **hypotension** can be caused by certain drugs (both prescription and illicit), heavy alcohol consumption, some diseases (e.g., Parkinson's disease, **dementia**) and decreased blood volume (e.g., **dehydration**, severe blood loss).

Risk factors

Risk factors for fainting include heart disease, blood loss, dehydration, emotional distress, heavy use of alcohol, and use of illicit drugs or misuse of prescription drugs. Anemia may contribute to

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KEY TERMS

Cardiomyopathy—Disease of the heart muscle.

Patient years—The number of patients multiplied by the number of years that they were followed in a study divided by the number of study events that occurred (in this case, the number of fainting episodes of the group).

Parkinson's disease—A neurological disorder caused by deficiency of dopamine, a neurotransmitter, that assists in transmitting messages between the nerves within the brain. It is characterized by muscle tremor or palsy and rigid movements.

fainting, as may a drop in blood-sugar levels, especially in people with diabetes.

Causes and symptoms

Fainting is caused by inadequate amounts of oxygen reaching the brain. Cardiac syncope can be brought on by **vascular disease**, congestive **heart failure**, irregular heart rhythms (cardiac arrhythmia), heart valve disease, or disease of the heart muscle (**cardiomyopathy**). The causes of less serious types of fainting are based on emotional responses, changes in blood pressure, decreased blood volume, etc. In all cases, the individual feels lightheaded and briefly loses consciousness.

Diagnosis

The goal of diagnosis is to distinguish between fainting and a seizure or **stroke**, and to determine the cause for fainting.

Examination

During an examination, the physician assesses vital signs and takes a medical history, along with a detailed history of the event and circumstances under which fainting occurred. A drug history, including herbal and dietary supplements, is also be taken.

Tests

Depending on initial findings, the age of the individual, and the circumstances surrounding the fainting episode, extensive follow-up cardiac testing may be ordered to look for evidence of heart rhythm irregularities, congestive heart failure, heart valve damage, **heart murmurs**, and blockage of the blood vessels. Neurological tests may be performed.

Treatment

Treatment depends on the underlying cause of the fainting. In cases of reflex and situational fainting, no treatment may be needed. People experiencing orthostatic hypotension are counseled on how to move safely from lying or standing to prevent injury from fainting. People with cardiac fainting continue medical care, most likely supervised by a cardiologist.

Prognosis

People with reflex or situational fainting normally experience no lasting effects from fainting, although they may injure themselves from falling when losing consciousness. Injury is especially likely with the elderly who often break bones when falling.

Individuals who faint because they have heart disease are at increased risk for health problems including stroke and **heart attack**. The outcome of their situation depends on the severity of their heart disease and their response to treatment. Generally, cardiac syncope is a warning sign of serious heart problems that need ongoing medical care.

Prevention

Cardiac syncope is best prevented by following the advice of a cardiologist and taking heart medicine exactly as prescribed. Diabetics can help prevent fainting by monitoring and controlling their blood-sugar levels. Remaining well-hydrated, especially when playing sports or when ill with **diarrhea** and **vomiting**, also can help prevent lightheadedness and fainting.

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American Academy of Family Physicians, P.O. Box 11210, Shawnee Mission, KS, 66207, (913) 906-6000, (800) 274-2237, (913) 906-6075, http://familydoctor.org.

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American Heart Association, 7272 Greenville Ave., Dallas, TX, 75231, (800) 242-8721, http://www.heart.org.

Tish Davidson, AM

Falciparum malaria *see* **Malaria**
Fallopian tube ligation *see* **Tubal ligation**
Fallopian tube removal *see* **Salpingectomy**
Fallopian tube x-rays *see* **Hysterosalpingography**
Famciclovir *see* **Antiviral drugs**

Familial Mediterranean fever

Definition

Familial Mediterranean **fever** (FMF) is an inherited disorder of the inflammatory response characterized by recurring attacks of fever, accompanied by intense **pain** in the abdomen, chest, or joints. Attacks usually last 12–72 hours, and can occasionally involve a skin rash. **Kidney disease** is a serious concern if the disorder is not treated. FMF is most prevalent in people of Armenian, Sephardic-Jewish, Arabic, and Turkish ancestry.

Description

FMF could be described as a disorder of "inappropriate" inflammation. That is, an event that in a normal situation causes a mild or unnoticeable inflammation might cause a severe inflammatory response in someone with FMF. Certain areas of the body are at risk for FMF-related symptoms. A serosa is a serous (fluid-producing) membrane that can be found inside the abdominal cavity (peritoneum), around the lungs (pleura), around the heart (pericardium), and inside the joints (synovium). The symptoms of FMF are due to inflammation of one or more of the serosal membranes (serositis). Thus, FMF is also sometimes called recurrent polyserositis.

During an attack, large numbers of neutrophils, a type of white blood cell, move into the affected areas causing painful inflammation and fever. These episodes may be accompanied by a skin rash or joint pain. In a few cases, chronic arthritis is a problem. **Amyloidosis** is a potentially serious condition in which proteins called amyloids are mistakenly produced and deposited in organs and tissues throughout the body. Left untreated, amyloidosis often leads to kidney failure, which is the major long-term health risk in FMF.

In most cases, the attacks of fever and pain are first noticed in childhood or adolescence. The interval between these episodes may be days or months, and is not predictable. However, during these intervals people with FMF typically lead normal lives. It is not entirely clear what brings on an attack, but people with FMF often report mild physical trauma, physical exertion, or emotional **stress** just prior to the onset of symptoms. Treatment for FMF involves an oral medication called colchicine, which is highly effective for the episodes of fever and pain, as well as for amyloidosis and the kidney disease that can result from it.

FMF is most common in certain ethnic groups from the eastern Mediterranean region, but cases in other ethnic groups in other parts of the world are increasingly being reported. FMF is also known by many other names. They include: recurrent hereditary polyserositis, benign paroxysmal **peritonitis**, familial paroxysmal polyserositis, paroxysmal polyserositis, familial recurrent polyserositis, periodic fever, periodic amyloid syndrome, periodic peritonitis syndrome, Reimann periodic disease, Reimann syndrome, Siegel-Cattan-Mamou syndrome, and Armenian syndrome.

Estimates of the incidence of FMF in specific eastern Mediterranean populations range from one in 2,000 to one in 100, depending on the population studied. Specific mutations in a gene—the MEFV gene—may cause a somewhat different course of the disease. Such mutations are more common in certain ethnic groups. A few mutations in the MEFV gene likely became common in a small population in the eastern Mediterranean several thousand years ago. It is postulated that carrying a single copy of a mutated gene produced a modified (but not abnormal) inflammatory response that may have been protective against some infectious agent at that time. Those who carried a single "beneficial" mutation in the MEFV gene were more likely to survive and reproduce, which may explain the high carrier frequency (up to one in five) in some populations. People of Armenian, Sephardic-Jewish, Arabic, and Turkish ancestry are at greatest risk for FMF. However, a better understanding and recognition of the symptoms of FMF in recent years has resulted in more reports of the condition in other ethnic groups, such as Italians and Armenian-Americans.

Causes and symptoms

FMF is a genetic condition inherited in an autosomal recessive fashion. Mutations in the MEFV gene

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(short for Mediterranean Fever) on chromosome number 16 are the underlying cause of FMF. Autosomal recessive inheritance implies that a person with FMF has mutations in both copies of the MEFV gene. All genes come in pairs, and one copy of each pair is inherited from each parent. If neither parent of a child with FMF has the condition, it means they carry one mutated copy of the MEFV gene, but also one normal copy, which is enough to protect them from disease. If both parents carry the same autosomal recessive gene, there is a one in four chance in each **pregnancy** that the child will inherit both recessive genes, and thus have the condition.

The MEFV gene carries the instructions for production of a protein called pyrin, named for pyrexia, a medical term for fever. The research group in France that co-discovered the protein named it marenostrin, after ancient Latin words that referred to the Mediterranean Sea. The movement of neutrophils into an area of the body where trauma or infection has occurred is the major cause of inflammation, which is a normal process. Research has shown that pyrin has some function in controlling neutrophils. In a situation where minor trauma or stress occurs, some initial inflammation may follow, but a functional pyrin protein is responsible for shutting down the response of neutrophils once they are no longer needed. An abnormal pyrin protein associated with FMF may be partly functional, but unstable. In some instances, the abnormal pyrin itself seems to be "stressed," and loses its ability to regulate neutrophils and inflammation. Left unregulated, a normal, mild inflammation spirals out of control. Exactly what causes pyrin in FMF to lose its ability to control neutrophils in some situations is not known.

The recurrent acute attacks of FMF typically begin in childhood or adolescence. Episodes of fever and painful inflammation usually last 12–72 hours. About 90% of people with FMF have their first attack by age 20. The group of symptoms that characterizes FMF includes the following:

Fever

An FMF attack is nearly always accompanied by a fever, but it may not be noticed in every case. Fevers are typically 100–104 °F (38–40 °C). Some people experience chills prior to the onset of fever.

Abdominal pain

Nearly all people with FMF experience abdominal pain at one point or another, and for most, it is the most common complaint. The pain can range from mild to severe, and can be diffuse or localized. It can mimic **appendicitis**, and many people with undiagnosed FMF have undergone appendectomies or exploratory surgery of the abdomen, only to have the fever and abdominal pain return.

Chest pain

Pleuritis, also called **pleurisy**, occurs in up to half of the affected individuals in certain ethnic groups. The pain is usually on one side of the chest. **Pericarditis** would also be felt as chest pain.

Joint pain

About 50% of people with FMF experience joint pain during attacks. The pain is usually confined to one joint at a time, and often involves the hip, knee, or ankle. For some people, however, the recurrent joint pain becomes chronic arthritis.

Myalgia

Up to 20% of individuals report muscle pain. These episodes typically last less than two days, and tend to occur in the evening or after physical exertion. Rare cases of muscle pain and fever lasting up to one month have been reported.

Skin rash

A rash, described as erysipelas-like erythema, accompanies attacks in a minority of people, and most often occurs on the front of the lower leg or top of the foot. The rash appears as a red, warm, swollen area about 4–6 in (10–15 cm) in diameter.

Amyloidosis

FMF is associated with high levels in the blood of a protein called serum amyloid A (SAA). Over time, excess SAA tends to be deposited in tissues and organs throughout the body. The presence and deposition of excess SAA is known as amyloidosis. Amyloidosis may affect the gastrointestinal tract, liver, spleen, heart, and testes, but effects on the kidneys are of greatest concern. The frequency of amyloidosis varies among the different ethnic groups, and its overall incidence is difficult to determine because of the use of colchicine to avert the problem. Left untreated, however, those individuals who do develop amyloidosis of the kidneys may require a renal transplant, or may even die of renal failure. The frequency and severity of a person's attacks of fever and serositis seem to have no relation to whether they will develop amyloidosis. In fact, a few people with FMF have been described who have had amyloidosis but apparently no other FMF-related symptoms.

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KEY TERMS

Acute phase reactants—Blood proteins whose concentrations increase or decrease in reaction to the inflammation process.

Amyloid—A waxy translucent substance composed mostly of protein, that forms plaques (abnormal deposits) in the brain.

Amyloidosis—Accumulation of amyloid deposits in various organs and tissues in the body such that normal functioning of an organ is compromised.

Colchicine—A compound that blocks the assembly of microtubules–protein fibers necessary for cell division and some kinds of cell movements, including neutrophil migration. Side effects may include diarrhea, abdominal bloating, and gas.

Leukocyte—A white blood cell. The neutrophils are a type of leukocyte.

Leukocytosis—An increase in the number of leukocytes in the blood.

Neutrophil—The primary type of white blood cell involved in inflammation. Neutrophils are a type of granulocyte, also known as a polymorphonuclear leukocyte.

Pericarditis—Inflammation of the pericardium, the membrane surrounding the heart.

Peritonitis—Inflammation of the peritoneum, the membrane surrounding the abdominal contents.

Pleuritis—Inflammation of the pleura, the membrane surrounding the lungs.

Pyrexia—A medical term denoting fevers.

Serositis—Inflammation of a serosal membrane. Polyserositis refers to the inflammation of two or more serosal membranes.

Synovitis—Inflammation of the synovium, a membrane found inside joints.

Other symptoms

A small percentage of boys with FMF develop painful inflammation around the testes. Headaches are a common occurrence during attacks, and certain types of **vasculitis** (inflammation of the blood vessels) seem to be more common in FMF.

Diagnosis

Individually, the symptoms that define FMF are common. Fevers occur for many reasons, and nonspecific pains in the abdomen, chest, and joints are also frequent ailments. Several infections can result in symptoms similar to FMF (Mallaret **meningitis**, for instance), and many people with FMF undergo exploratory abdominal surgery and ineffective treatments before they are finally diagnosed. Membership in a less commonly affected ethnic group may delay or hinder the correct diagnosis.

In general, symptoms involving one or more of the following broad groups should lead to suspicion of FMF: Unexplained recurrent fevers, polyserositis, skin rash, and/or joint pain; abnormal blood studies; and renal or other disease associated with amyloidosis. A family history of FMF or its symptoms would obviously be an important clue, but the recessive nature of FMF means patients usually have no family history. The diagnosis may be confirmed when a person with unexplained fever and pain responds to treatment with colchicine, since colchicine is not known to have a beneficial effect on any other condition similar to FMF. Abnormal results on a blood test typically include **leukocytosis** (elevated number of neutrophils in the blood), an increased **erythrocyte sedimentation rate** (rate at which red blood cells form a sediment in a blood sample), and increased levels of proteins associated with inflammation (called acute phase reactants) such as SAA.

Direct analysis of the MEFV gene for FMF mutations is the only method to be certain of the diagnosis. However, it is not yet possible to detect all MEFV gene mutations that might cause FMF. Thus, if DNA analysis is negative, clinical methods must be relied upon. If both members of a couple were proven to be FMF carriers through **genetic testing**, highly accurate prenatal diagnosis would be available in any subsequent pregnancy.

Similar syndromes of periodic fever and inflammation include familial Hibernian fever and hyperimmunoglobulinemia D syndrome, but both are more rare than FMF.

Treatment

Colchicine is a chemical compound that can be used as a medication, and is frequently prescribed for **gout**. Some years ago, colchicine was discovered to

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also be effective in reducing the frequency and severity of attacks in FMF. Treatment for FMF at this point consists of taking colchicine daily. Studies have shown that about 75 percent of FMF patients achieve complete remission of their symptoms, and about 95% show marked improvement when taking colchicine. Lower effectiveness has been reported, but there is some question about the number of FMF patients who choose not to take their colchicine between attacks when they are feeling well, and thus lose some of the ability to prevent attacks. Compliance with taking colchicine every day may be hampered by its side effects, which include **diarrhea**, **nausea**, abdominal bloating, and gas. There is a theoretical risk that colchicine use could damage chromosomes in sperms and eggs, or in an embryo during pregnancy, or that it might reduce fertility. However, studies looking at reproduction in men and women who have used colchicine have so far not shown any increased risks. Colchicine is also effective in preventing, delaying, or reversing renal disease associated with amyloidosis.

Other medications may be used as needed to deal with the pain and fever associated with FMF attacks. Dialysis and/or renal transplant might become necessary in someone with advanced kidney disease. Given its genetic nature, there is no cure for FMF, nor is there likely to be in the near future. Any couple that has a child diagnosed with FMF, or anyone with a family history of the condition (especially those in high-risk ethnic groups), should be offered **genetic counseling** to obtain the most up-to-date information on FMF and testing options.

Prognosis

For those individuals who are diagnosed early enough and take colchicine consistently, the prognosis is excellent. Most will have very few, if any, attacks of fever and polyserositis, and will likely not develop serious complications of amyloidosis. The problem of misdiagnosing FMF continues, but education attempts directed at both the public and medical care providers should improve the situation. Future research should provide a better understanding of the inflammation process, focusing on how neutrophils are genetically regulated. That information could then be used to develop treatments for FMF with fewer side effects, and might also assist in developing therapies for other diseases in which abnormal inflammation and immune response are a problem.

ORGANIZATIONS

National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS), 1 AMS Circle, Bethesda, MD, 20892-3675, (301) 495-4484, (301) 718-6366, (877) 226-4267, NIAMSinfo@mail.nih.gov, http://www.niams.nih.gov/.http://niam.com/

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923, (800) 999-6673, http://www.rarediseases.org.

National Society of Genetic Counselors, 401 N. Michigan Ave., 22nd Floor, Chicago, IL, 60611, (312) 321-6834, nsgc@nsgc.org , http://www.nsgc.org.

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Familial polyposis

Definition

Familial polyposis is an inherited condition that primarily affects the large intestine (colon and rectum). Large numbers of projecting masses of swollen and thickened or tumorous membrane (polyps) develop on the inner lining of this part of the bowel. The polyps eventually become malignant.

Demographics

Familial polyposis is a rare disease. Estimates of incidence of the disease vary from one in 7,000 to one in every 31,000 people in the United States. However, it may be very common in affected families. Familial polyposis is inherited in an autosomal dominant pattern. This means that a person with Familial polyposis has a 50% chance of passing the condition down to each of their children. Familial polyposis can also develop in someone with no family history of the disorder due to a new genetic mutation in that individual. It is thought that approximately 1% of all colorectal cancers in the United States can be attributed to Familial polyposis.

Description

Familial polyposis is known by many synonyms, most include some combination of words that reflect what is known about the disease. As the disease is inherited, the word “family” is often included. Because these mushroom-like growths are the most obvious manifestation of the disorder, the word “polyp” is usually in the term as well. Adenoma is frequently included and refers to the particular kind of polyp that is typically discovered. Some of the names found in medical texts and journals include polyposis coli, familial colonic polyposis, multiple familial polyposis, familial adenomatous colon polyposis, adenomatosis of the colon and rectum (ACR), and familial adenomatous polyposis (FAP).

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KEY TERMS

Gene—The basic unit of heredity, made of DNA. Each gene occupies a certain location on a chromosome.

Mutation—An alteration in a gene, especially one capable of producing a new trait, or a change in function.

The last term and its abbreviation have been commonly used since the early 1990s.

Familial polyposis or familial adenomatous polyposis is a premalignant disease. This means that a person with FAP, if left untreated, will invariably develop **cancer**. Individuals with this disorder grow hundreds to thousands of polyps throughout their large intestines. The polyps, which may also be called adenomas, commonly develop just after **puberty**. Approximately half of all FAP patients have polyps by age 16. About 90% have detectable polyps by age 25. Usually by age 35–40, one or more of these polyps becomes cancerous. The average age at which patients with FAP tend to develop **colon cancer** is 39 years.

Risk factors

Relatives of individuals with diagnosed FAP are at high risk of having the disease themselves. This condition has no other known risk factors.

Causes and symptoms

FAP is caused by a germline (inherited) mutation in the adenomatous polyposis coli (APC) gene. APC is a tumor suppressor gene, although its exact function is not yet completely understood. Researchers theorize that the normal gene directs the manufacture of a protein that helps control cell growth. The mutated gene section in FAP generates an abnormal protein that does not perform its normal function. Cells grow out of control, causing the development of multiple, sometimes hundreds or thousands of polyps. One or more of these eventually becomes cancerous.

Many individuals develop polyps without displaying any symptoms. Others experience such gastrointestinal problems as **diarrhea**, **constipation**, abdominal cramps, blood in the stool, or weight loss. FAP patients may also develop nonmalignant tumors (desmoid tumors), and/or some bone and dental abnormalities. In addition, they may exhibit a spot on the retina of the eye (congenital hypertrophy of the retinal pigment epithelium, or CHRPE). These eye changes often precede the development of polyposis.

Diagnosis

Tests

The abnormal portion of the gene that causes FAP in most patients can be detected. A blood test can then be performed to identify family members who have the same mutation and who will eventually develop the condition. Children who have a parent with FAP, and siblings of affected patients whose parental history is incomplete, should be evaluated. The polyps characteristic of FAP have been found in children as young as age five. Testing of appropriate individuals should take place as soon as the diagnosis of FAP is established in one member of a family.

Relatives of people with diagnosed FAP should exercise caution regarding where they seek advice and testing. One study of a commercially available blood test found that less than 20% of patients received any **genetic counseling**, and almost one-third of their physicians misinterpreted the test results.

Registries for FAP patients can be found at many sites in the United States. Such a registry specializes in identification, assistance, and education of people with a particular disease, and is usually a separate department in a research hospital. A team of health professionals who have expertise in the disorder staff the registry.

Testing within a research setting and/or at a facility with a registry of patients with FAP is more likely to safeguard against problems, such as the misunderstanding of test results. Patients who participate in a research project sometimes receive counseling, as well as blood tests, at no charge. Insurance coverage varies. Concerns about confidentiality and future insurance and employment discrimination may prompt individuals to pay for the examination out-of- pocket.

Procedures

If the abnormal gene is found in a family member, annual screening for colon polyps is recommended beginning at age 10 to 12 years. Flexible **sigmoidoscopy** is used for this examination. It is usually done in a physician's office, or in a hospital department, most often by a gastroenterologist or a surgeon. Food intake may be restricted for 24 hours prior to the procedure. Before the study, the intestine is cleared of stool by one or more small **enemas**. Some physicians prefer to sedate the patient to help them relax. A flexible, lighted, hollow tube (sigmoidoscope) is

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inserted into the anus and maneuvered into the large intestine. The physician examines the wall of the colon to look for polyps. If polyps are found, one or more may be removed for biopsy.

Most patients report little discomfort during the examination. The procedure itself takes five to 15 minutes. The patient may be at the facility an hour or more if recovery from **sedation** is needed. If no medication was administered, driving and resumption of normal activities are permitted immediately.

If the diagnosis of FAP is confirmed by sigmoidoscopy or **colonoscopy**, a front- and side-viewing **esophagogastroduodenoscopy** (EGD) procedure is strongly recommended. This procedure helps to determine if adenomas are present in other areas of the gastrointestinal tract such as the stomach and duodenum (small intestine). The second most common site for cancer development other than in the colorectal area in patients with FAP is the duodenum. This test is recommended every one to three years for individuals diagnosed with FAP.

Other screening tests that may be recommended include ultrasounds or CT scans to determine the presence of desmoid tumors in the abdominal area and to check for the development of pancreatic cancer. Ultrasound of the thyroid may be ordered because of the increased risk for **thyroid cancer** in patients with FAP.

In some cases, the portion of the gene responsible for FAP cannot be identified. Family members of these patients cannot have a predictive blood test. The current recommendation for these patients is the same as that for patients with a diagnosed FAP gene: to undergo to an annual examination with flexible sigmoidoscopy. A noninvasive screening **eye examination** to detect CHRPE, associated with FAP, may also be performed.

Treatment

Traditional

The only definitive treatment for FAP is surgical removal of the lower intestine. In very young people, surgical removal of the colon (colectomy) may be delayed until the late teens or early 20s when most patients would be considered psychologically ready for such a procedure. However, surgery may be done at an earlier age if it is determined that the polyps are at an advanced histologic stage.

Several surgical choices are available to treat this condition. Some authorities advocate removal of the colon, leaving the rectum or lowest portion of the intestine in place. The small intestine can be attached to the rectum, allowing normal bowel function. This is often called ileorectal anastomosis. Others argue that this section is also liable to develop polyps, needs to be monitored regularly, and may require eventual removal.

Excision of the entire lower intestine with preservation of normal bowel function is possible. This entails a more complex surgical procedure. The patient may experience more complications and a longer recovery period. However, the risk of polyp development in this area is very low. Periodic examination of the intestine may not be needed once healing is complete.

The more intricate surgery may be referred to as a J-pouch procedure, an ileal pouch-anal anastomosis, a restorative proctocolectomy, or an ileoanal reservoir procedure. It involves creating a "pouch" of tissue from the small intestine, which is attached to the anus. This serves as a reservoir or holding area for stool, much as the rectum does normally. The surgery is often done in several stages. A temporary ileostomy, which creates an opening of the small intestine onto the abdomen, is required. When all procedures are completed, and after a recuperation period, the patient regains normal bowel function through the anus.

Some researchers suggest that as **genetic testing** becomes more developed, the specific portion of the gene involved may dictate the type of surgery chosen. Those at high risk of developing **rectal polyps** may be advised to have the more complex operation. FAP patients considered to be at lower risk for rectal polyps might be counseled to consider the less radical surgery.

Drugs

Medical therapy to treat the adenomatous polyps has been attempted. Some **nonsteroidal anti-inflammatory drugs** have been effective in reducing the number and size of the polyps in colorectal tissue that remains after surgery such as in an ileoanal anastomosis.

Individuals with FAP are at increased risk for cancers of the upper digestive tract including the upper portion of the small bowel (duodenum) and the channels where bile flows (biliary tract). Cancers of the thyroid, pancreas, and adrenal gland are also more commonly found among FAP patients. Periodic examination for the development of malignancy in these areas is considered part of the treatment of FAP. In some cases, such as cancer involving the duodenum, the tests themselves carry a chance of complications. The risk of the study must be weighed against the potential benefits of knowing the results. Desmoid tumors also occur more frequently in

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patients with FAP. Although they are not malignant, they grow quickly into surrounding tissues, causing many difficulties, even **death** in some cases.

Prognosis

The major cause of death in many patients with FAP remains colorectal cancer. One study suggested that even with improved disease recognition, social and emotional factors, such as fear of surgery, may significantly delay a patient's treatment.

In patients who have undergone colectomy, desmoid tumors and cancers of the upper gastrointestinal tract are the leading causes of death. Medical surveillance is critical for patients with FAP even after surgical removal of the colon.

Prevention

FAP cannot be prevented. Aggressive diagnosis, treatment, and follow-up monitoring are keys to successful management of the disease.

Resources

PERIODICALS

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ORGANIZATIONS

Familial Polyposis Registry, Department of Colorectal Surgery, Cleveland Clinic Foundation, 9500 Euclid Ave., Cleveland, OH, 44195-5001, (216) 444-6470.

National Organization for Rare Disorders, 55 Kenosia Ave., P.O. Box 1968, Danbury, CT, 06813-1968, (203) 744-0100, (800) 999-6673, http://www.rarediseases.org.

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Family therapy

Definition

Family therapy is a form of **psychotherapy** that involves all the members of a nuclear or extended family. It may be conducted by a pair or team of therapists. In many cases the team consists of a man and a woman in order to treat gender-related issues or serve as role models for family members. Although some forms of family therapy are based on behavioral or psychodynamic principles, the most widespread form is based on family systems theory. This approach regards the family as a whole, as the unit of treatment, and emphasizes such factors as relationships and communication patterns rather than traits or symptoms in individual members.

Family therapy is a relatively recent development in psychotherapy. It began shortly after World War II, when doctors, who were treating schizophrenic patients, noticed that the patients' families communicated in disturbed ways. The doctors also found that the patients' symptoms rose or fell according to the level of tension between their parents. These observations led to considering a family as an organism or system with its own internal rules, patterns of functioning, and tendency to resist change. The therapists started to treat the families of schizophrenic patients as whole units rather than focusing on the hospitalized member. They found that in many cases the family member with **schizophrenia** improved when the "patient" was the family system. (This should not be misunderstood to mean that schizophrenia is caused by family problems, although family problems may worsen the condition.) This approach of involving the entire family in the treatment plan and therapy was then applied to families with problems other than the presence of schizophrenia.

Family therapy is becoming an increasingly common form of treatment as changes in American society are reflected in family structures. It has led to two further developments: couple's therapy, which treats relationship problems between marriage partners or gay couples; and the extension of family therapy to religious communities or other groups that resemble families.

Purpose

Family therapy is often recommended in the following situations:

- Treatment of a family member with schizophrenia or multiple personality disorder (MPD). Family therapy helps other family members understand their relative's disorder and adjust to the psychological changes that may be occurring in the relative.

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- Families with problems across generational boundaries. These would include problems caused by parents sharing housing with grandparents, or children being reared by grandparents.
- Families that deviate from social norms (common-law relationships, gay couples rearing children, etc.). These families may not have internal problems but may be troubled by outsiders' judgmental attitudes.
- Families with members from a mixture of racial, cultural, or religious backgrounds.
- Families who are scapegoating a member or undermining the treatment of a member in individual therapy.
- Families where the identified patient's problems seem inextricably tied to problems with other family members.
- Blended families with adjustment difficulties.

Most family therapists presuppose an average level of intelligence and education on the part of adult members of the family.

Precautions

Some families are not considered suitable candidates for family therapy. They include:

- families in which one, or both, of the parents is psychotic or has been diagnosed with antisocial or paranoid personality disorder
- families whose cultural or religious values are opposed to, or suspicious of, psychotherapy
- families with members who cannot participate in treatment sessions because of physical illness or similar limitations
- families with members who have very rigid personality structures. (Here, members might be at risk for an emotional or psychological crisis)
- families whose members cannot or will not be able to meet regularly for treatment
- families that are unstable or on the verge of breakup

Description

Family therapy tends to be short-term treatment, usually several months in length, with a focus on resolving specific problems such as **eating disorders**, difficulties with school, or adjustments to **bereavement** or geographical relocation. It is not normally used for long-term or intensive restructuring of severely dysfunctional families.

In family-therapy sessions, all members of the family and all therapists (families may have more than one) are present at most sessions. The therapists seek to analyze the process of family interaction and communication as a whole; they do not take sides with specific members. They may make occasional comments or remarks intended to help family members become more conscious of patterns or structures that had been previously taken for granted. Family therapists, who work as a team, also model new behaviors for the family through their interactions with each other during sessions.

Family therapy is based on family-systems theory, which understands the family to be a living organism that is more than the sum of its individual members. Family therapy uses systems theory to evaluate family members in terms of their position or role within the system as a whole. Problems are treated by changing the way the system works rather than trying to "fix" a specific member. Family systems theory is based on several major concepts:

The identified patient

The identified patient (IP) is the family member with the symptom that has brought the family into treatment. The concept of the IP is used by family therapists to keep the family from scapegoating the IP or using him or her as a way of avoiding problems in the rest of the system.

Homeostasis (balance)

The concept of homeostasis means that the family system seeks to maintain its customary organization and functioning over time. It tends to resist change. The family therapist can use the concept of homeostasis to explain why a certain family symptom has surfaced at a given time, why a specific member has become the IP, and what is likely to happen when the family begins to change.

The extended family field

The extended family field refers to the nuclear family, plus the network of grandparents and other members of the extended family. This concept is used to explain the intergenerational transmission of attitudes, problems, behaviors, and other issues.

Differentiation

Differentiation refers to the ability of each family member to maintain his or her own sense of self, while remaining emotionally connected to the family. One mark of a healthy family is its capacity to allow members to differentiate, while family members still feel that they are "members in good standing" of the family.

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KEY TERMS

Blended family—A family formed by the remarriage of a divorced or widowed parent. It includes the new husband and wife, plus some or all of their children from previous marriages.

Differentiation—The ability to retain one's identity within a family system while maintaining emotional connections with the other members.

Extended family field—A person's family of origin plus grandparents, in-laws, and other relatives.

Family-systems theory—An approach to treatment that emphasizes the interdependency of family members rather than focusing on individuals in isolation from the family. This theory underlies the most influential forms of contemporary family therapy.

Genogram—A family tree diagram that represents the names, birth order, sex, and relationships of the members of a family. Therapists use genograms to detect recurrent patterns in the family history and to help the members understand their problem(s).

Homeostasis—The tendency of a family system to maintain internal stability and resist change.

Identified patient (IP)—The family member in whom the family's symptom has emerged or is most obvious.

Nuclear family—The basic family unit, consisting of father, mother, and their biological children.

Triangling—A process in which two family members lower the tension level between them by drawing in a third member.

Triangular relationships

Family systems theory maintains that emotional relationships in families are usually triangular. Whenever any two persons in the family system have problems with each other, they will "triangle in" a third member as a way of stabilizing their own relationship. The triangles in a family system usually interlock in a way that maintains family homeostasis. Common family triangles include a child and his or her parents; two children and one parent; a parent, a child, and a grandparent; three siblings; or a husband, wife, and an in-law.

Family therapy can be and is usually provided by clinical social workers or licensed therapists known as marriage and family therapists. Many of these therapists have postgraduate degrees and often become credentialed by the American Association for Marriage and Family Therapy (AAMFT).

Preparation

In some instances, a pediatrician or other primary care provider may have referred the family to a specialist in family therapy. It is estimated that as many as 50 percent of office visits to pediatricians have to do with children's developmental problems that are affecting their families. Some family doctors use symptom checklists or psychological screeners to assess a family's need for therapy.

Family therapists may be either psychiatrists, clinical psychologists, or other professionals certified by a specialty board in marriage and family therapy. They will usually evaluate a family for treatment by scheduling a series of interviews with the members of the immediate family, including young children, and significant or symptomatic members of the extended family. This process allows the therapist(s) to find out how each member of the family sees the problem, as well as to form first impressions of the family's functioning. Family therapists typically look for the level and types of emotions expressed, patterns of dominance and submission, the roles played by family members, communication styles, and the locations of emotional triangles. They will also note whether these patterns are rigid or relatively flexible.

Preparation also usually includes drawing a genogram, which is a diagram that depicts significant persons and events in the family's history. Genograms also include annotations about the medical history and major personality traits of each member. Genograms help in uncovering intergenerational patterns of behavior, marriage choices, family alliances and conflicts, the existence of family secrets, and other information that sheds light on the family's present situation.

Risks

The chief risk in family therapy is the possible unsettling of rigid personality defenses in individuals, or couple relationships that had been fragile before the beginning of therapy. Intensive family therapy may also be difficult for psychotic family members.

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Normal results

Normal results vary, but in good circumstances, they include greater insight, increased differentiation of individual family members, improved communication within the family, loosening of previously automatic behavior patterns, and resolution of the problem that led the family to seek treatment.

Resources

BOOKS

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Famine fever *see* **Relapsing fever**

Fanconi's syndrome

Definition

Fanconi's syndrome is a set of kidney malfunctions brought about by a variety of seemingly unrelated disorders. Kidney malfunction leads to excessive urine production and excessive thirst, resulting in deficits of water, **calcium**, potassium, magnesium, and other substances in the body. It often leads to bone disease and stunted growth.

Description

Normally, kidneys cleanse the blood and keep its salt, water, and acidity in balance, leaving what the body needs in the blood and putting what the body doesn't need into the urine, which leaves the body. This task is performed in two steps. First, the blood is filtered through a kidney structure with small holes that keep the cells and large molecules in the blood. Second, some of the small molecules in the filtrate, needed by the body, are reabsorbed and returned to the bloodstream.

This reabsorption step is defective in Fanconi's syndrome. As a consequence, substances that are normally reabsorbed, such as glucose, amino acids, small proteins, water, calcium, potassium, magnesium, bicarbonate, and phosphate, are lost and the body becomes overly acidic.

Fanconi's syndrome is also known as Fanconi syndrome, renal Fanconi syndrome, Fanconi renal-tubular syndrome, and Lignac-de Toni-Debré-Fanconi syndrome. Fanconi's anemia, however, is a totally different disease.

Causes and symptoms

Causes

Fanconi's syndrome can be caused by a variety of genetic defects and by certain environmental assaults.

The genetic diseases known to give rise to Fanconi's syndrome are cystinosis (the most common cause in children), **galactosemia**, glycogen storage disease, **hereditary fructose intolerance**, Lowe syndrome, **Wilson disease**, tyrosinemia, medullary cystic disease, vitamin D dependency, and familial idiopathic Fanconi's syndrome.

Environmental assaults that cause Fanconi's syndrome include exposure to heavy metals (like cadmium, lead, mercury, platinum, uranium), certain drugs (like outdated tetracycline and gentamicin), other substances (like Lysol, paraquat, toluene, the amino acid lysine taken as a nutritional supplement), and **kidney transplantation**.

Symptoms

Fanconi's syndrome symptoms related directly to impaired absorption include excessive urine production and urination; excessive thirst; **dehydration**; **constipation**; **anorexia nervosa**; **vomiting**; elevated levels of glucose, phosphate, calcium, uric acid, amino acids, and protein (especially beta$_2$-microglobulin and lysozyme) in the urine; elevated levels of chloride and decreased levels of phosphate and calcium in the blood; and excessively acidic blood.

The most noticeable indirect consequences of impaired reabsorption are two bone diseases: **rickets** and osteomalacia. Rickets affects children and is associated with bone deformities, failure to grow, and difficulty walking. If a person acquires Fanconi's syndrome as an adult, the bone disease is termed osteomalacia and is accompanied by severe bone **pain** and spontaneous

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KEY TERMS

Acidosis—Condition where the body is more acidic than normal; associated with headache, nausea, vomiting, and visual disturbances.

Fanconi's anemia—An inherited form of aplastic anemia.

Filtrate—The part of filtered material that flows through the filter.

Idiopathic—Refers to a disease of unknown cause.

Polydipsia—Excessive thirst.

Polyuria—Excessive production of urine.

fractures. Unlike rickets due to **malnutrition**, these diseases cannot be reversed with vitamin D. Muscle weakness and occasional **paralysis** are other indirect consequences of the ineffective reabsorption.

Diagnosis

Diagnosis of Fanconi's syndrome can be made by urine and blood tests. It is also important to find the underlying cause to decide on the best treatment. Other symptoms specific to a particular patient will point to other useful diagnostic tests. For example, high levels of blood galactose in conjunction with symptoms of Fanconi's syndrome indicate the patient is suffering from galactosemia, while high blood levels of cadmium indicate the patient is suffering from cadmium **poisoning**.

Treatment

Fanconi's syndrome is best treated by attacking the underlying cause whenever possible. For example, when cystinosis is treated with the drug cysteamine to lower cystine levels in the body or Wilson disease is treated with penicillamine to lower the levels of copper, accompanying symptoms of Fanconi's syndrome will subside. If the patient has acquired the disease from a heavy metal or another toxic agent, all contact with the toxic agent should stop; the condition will then likely disappear.

Nevertheless, additional treatment will be necessary either when it's not possible to treat the underlying cause or while waiting for the kidneys to resume normal function. This is done by restricting **sodium** chloride (table salt), giving **antacids** to counteract the excessive acidity of the blood, and supplying potassium supplements.

Kidney transplant is the treatment of last resort, used for patients whose kidneys have failed.

Prognosis

Fanconi's syndrome can be reversible. Fanconi's syndrome caused by kidney transplantation usually reverses itself within the first year after **transplant surgery**. When caused by a toxin in the environment, Fanconi's syndrome generally can be reversed by removing the causative agent from the patient's environment. If it is caused by a genetic disease, it can usually be reversed by treating the disease. However, if Fanconi's syndrome is not treated or if treatment is unsuccessful, the kidneys can fail.

Prevention

Fanconi's syndrome caused secondarily by the genetic diseases galactosemia, glycogen-storage disease, hereditary fructose intolerance, and tyrosinemia is prevented by appropriate dietary restrictions to treat the genetic disease, starting in infancy.

Fanconi's syndrome caused by heavy metals and other toxins can be prevented by avoiding these substances.

Resources

OTHER

"Online Mendelian Inheritance in Man." *OMIM Homepage,* http://www.ncbi.nlm.nih.gov/Omim.

ORGANIZATIONS

National Kidney Foundation, Inc. , 30 East 33rd St., New York, NY, 10016, (212) 889-2210, (212) 689-9261, (800) 622-9010, http://www.kidney.org/.

The American Society of Nephrology, 1725 I St., NW, Suite 510, Washington, DC, 20006, (202) 659-0599, (202) 659-0709, http://www.asn-online.org.

Lorraine Lica, PhD

Farsightedness *see* **Hyperopia**

FAS *see* **Fetal alcohol syndrome**

Fasciotomy

Definition

Fasciotomy is a surgical procedure that cuts away the fascia to relieve tension or pressure.

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Purpose

The fascia is thin connective tissue covering, or separating, the muscles and internal organs of the body. It varies in thickness, density, elasticity, and composition, and is different from ligaments and tendons.

The fascia can be injured either through constant strain or through trauma. Fasciitis is an inflammation of the fascia. The most common condition for which fasciotomy is performed is plantar fasciitis, an inflammation of the fascia on the bottom of the foot that is sometimes called a heel spur or stone bruise.

Plantar fasciitis is caused by long periods on the feet, being overweight, and wearing shoes that do not support the foot well. Teachers, mail carriers, runners, and others who make heavy use of their feet are especially likely to suffer from plantar fasciitis.

Plantar fasciitis results in moderate to disabling heel **pain**. If nine to 12 months of conservative treatment (reducing time on feet, non-steroidal anti-inflammatory drugs, arch supports) under the supervision of a doctor does not result in pain relief, a fasciotomy may be done. Fasciotomy removes a small portion of the fascia to relieve tension and pain. Connective tissue grows back into the cut space left by the cut, effectively lengthening the fascia.

When a fasciotomy is performed on other parts of the body, it is usually done to relieve pressure from a compression injury to a limb. This type of injury often occurs during contact sports. The blood vessels of the limb are damaged. They swell and leak, causing inflammation. Fluid builds up in the area contained by the fascia. A fasciotomy is done to relieve this pressure and prevent tissue **death**. Similar injury occurs in high voltage electrical **burns** where deep tissue damage occurs.

Precautions

In the case of injury, fasciotomy is done on an emergency basis, and the outcome of the surgery depends largely on the general health of the patient. Plantar fasciotomies are appropriate for most people whose foot problems cannot be resolved in any other way.

Description

Fasciotomy in the limbs is usually done by a surgeon under general or regional anesthesia. An incision is made in the skin, and a small area of fascia is removed where it will best relieve pressure. Then the incision is closed.

Plantar fasciotomy is an endoscopic (performed with the use of an endoscope) procedure. It is done by a foot specialist in a doctor's office or outpatient surgical clinic under **local anesthesia** and takes 20 minutes to one hour. The doctor makes two small incisions on either side of the heel. An endoscope is inserted in one to guide the doctor in identifying the location to make the cut. A tiny knife is inserted in the other. A portion of the fascia is cut from near the heel, after which then the incisions are closed.

KEY TERMS

Endoscope—A tube that contains a tiny camera and light, and that is inserted in the body to allow a doctor to see inside without making a large incision.

Preparation

Little preparation is done before a fasciotomy. When the fasciotomy is related to burn injuries, the fluid and electrolyte status of the patient are constantly monitored.

Aftercare

Aftercare depends on the reason for the fasciotomy. People who have endoscopic plantar fasciotomy can walk without pain almost immediately, return to wearing their regular shoes within three to five days, and return to normal activities within three weeks. Most will need to wear arch supports in their shoes.

Risks

In endoscopic plantar fasciotomy, the greatest risk is that the arch will drop slightly as a result of this surgery, causing other foot problems. Risks involved with other types of fasciotomy are those associated with the administration of anesthesia and the development of **blood clots**.

Normal results

Fasciotomy in the limbs reduces pressure, thus reducing tissue death. Endoscopic plantar fasciotomy has a success rate of 90–95%.

Resources

OTHER

"Plantar fasciitis (heel spur)." http://www.footspecialist.com/sub.php?page=prob_heel_plantar.php.

Tish Davidson, A.M.

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Fasting

Definition

Fasting is voluntarily not eating food for varying lengths of time. Fasting is used as a medical therapy for many conditions. It is also a spiritual practice in many religions.

Purpose

Fasting can be used for nearly every chronic condition, including **allergies**, **anxiety**, arthritis, **asthma**, depression, diabetes, headaches, heart disease, high cholesterol, low blood sugar, digestive disorders, mental illness, and **obesity**. Fasting is an effective and safe weight-loss method. It is frequently prescribed as a **detoxification** treatment for those with conditions that may be influenced by environmental factors, such as **cancer** and **multiple chemical sensitivity**. Fasting has been used successfully to help treat people who have been exposed to high levels of toxic materials due to accident or occupation. Fasting is thought to be beneficial as a preventative measure to increase overall health, vitality, and resistance to disease. Fasting is also used as a method of mental and spiritual rejuvenation.

Description

Origins

Used for thousands of years, fasting is one of the oldest therapies in medicine. Many of the great doctors of ancient times and many of the oldest healing systems have recommended it as an integral method of healing and prevention. Hippocrates, the father of Western medicine, believed fasting enabled the body to heal itself. Paracelsus, another great healer in the Western tradition, wrote 500 years ago that "fasting is the greatest remedy, the physician within." **Ayurvedic medicine**, the world's oldest healing system, has long advocated fasting as a major treatment.

Fasting has also been used in nearly every religion in the world, including Christianity, Judaism, Buddhism, and Islam. Many of history's great spiritual leaders fasted for mental and spiritual clarity, including Jesus, Buddha, and Mohammed. In one of the famous political acts of the last century, the Indian leader Mahatma Gandhi fasted for 21 days to promote peace.

Fasting has been used in Europe as a medical treatment for years. Many spas and treatment centers, particularly those in Germany, Sweden, and Russia, use medically supervised fasting. Fasting has gained popularity in American alternative medicine over the past several decades, and many doctors feel it is beneficial. Fasting is a central therapy in detoxification, a healing method founded on the principle that the build-up of toxic substances in the body is responsible for many illnesses and conditions.

The principle of fasting is simple. When the intake of food is temporarily stopped, many systems of the body are given a break from the hard work of digestion. The extra energy gives the body the chance to heal and restore itself, and burning stored calories gets rid of toxic substances stored in the body.

The digestive tract is the part of the body most exposed to environmental threats, including bacteria, viruses, parasites, and toxins. It requires the most immune system support. When food is broken down in the intestines, it travels through the blood to the liver, the largest organ of the body's natural detoxification system. The liver breaks down and removes the toxic by-products produced by digestion, including natural ones and the chemicals now present in the food supply. During fasting, the liver and immune system are essentially freed to detoxify and heal other parts of the body.

Many healers claim that fasting is a particularly useful therapy for Americans and for the modern lifestyle, subjected to heavy **diets**, overeating, and constant exposure to food additives and chemicals. Some alternative practitioners have gone so far as to estimate that the average American is carrying 5-10 pounds of toxic substances in their bodies, for which fasting is the quickest and most effective means of removal.

Physiology of fasting

Through evolution, the body became very efficient at storing energy and handling situations when no food was available. For many centuries, fasting was probably a normal occurrence for most people, and the body adapted to it. It is estimated that even very thin people can survive for 40 days or more without food. The body has a special mechanism that is initiated when no food is eaten. Fasting is not **starvation**, but rather the body's burning of stored energy. Starvation occurs when the body no longer has any stored energy and begins using essential tissues such as organs for an energy source. Therapeutic fasts are stopped long before this happens.

Many physiological changes occur in the body during fasting. During the first day or so, the body uses its glycogen reserves, the sugars that are the basic energy supply. After these are depleted, the body begins using fat. However, the brain, which has high fuel requirements, still needs glucose (sugars converted from glycogen). To obtain glucose for the brain, the

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body begins to break down muscle tissue during the second day of the fast. Thus, during fasting some muscle loss will occur. To fuel the brain, the body would need to burn over a pound of muscle a day, but the body has developed another way to create energy that saves important muscle mass. This protein-sparing process is called ketosis, which occurs during the third day of a fast for men and the second day for women. In this highly efficient state, the liver begins converting stored fat and other nonessential tissues into ketones, which can be used by the brain, muscles, and heart as energy. It is at this point in the fast that sensations of hunger generally go away, and many people experience normal or even increased energy levels. Hormone levels and certain functions become more stable in this state as well. The goal of most fasts is to allow the body to reach the ketosis state in order to burn excess fat and unneeded or damaged tissue. Thus, fasts longer than three days are generally recommended as therapy.

Weight loss occurs most rapidly during the first few days of a fast, up to 2 pounds per day. In following days, the figure drops to around 0.5 pound per day. An average weight loss of a pound a day for an entire fast can be expected.

Performing a fast

Fasts can be performed for varying lengths of time, depending on the person and his or her health requirements. For chronic conditions, therapists recommend from two to four weeks to get the most benefits. Seven-day fasts are also commonly performed. A popular fasting program for prevention and general health is a three-day fast taken four times per year, at the change of each season. These can be easily performed over long weekends. Preventative fasts of one day per week are used by many people as well.

Juice fasts are also used by many people, although these are not technically fasts. Juice fasts are less intensive than water fasts because the body doesn't reach the ketosis stage. The advantage of juice fasts is that fruit and vegetable drinks can supply extra energy and nutrients. People can fit a few days of juice fasting into their normal schedules without significant drops in energy. Juice fasts are also said to have cleansing and detoxifying effects. The disadvantage of juice fasts is that the body never gets to the ketosis stage, so these fasters are thought to lack the deep detoxification and healing effects of the water fast.

Medical supervision is recommended for any fast over three days. Most alternative medicine practitioners, such as homeopaths, naturopathic doctors, and ayurvedic doctors, can supervise and monitor patients during fasts. Those performing extended fasts and those with health conditions may require blood, urine, and other tests during fasting. There are many alternative health clinics that perform medically supervised fasts as well. Some conventional medical doctors may also supervise patients during fasts. Costs and insurance coverage vary, depending on the doctor, clinic, and requirements of the patient.

Preparations

Fasts must be entered and exited with care. To enter a fast, the diet should be gradually lightened over a few days. First, heavy foods such as meats and dairy products should be eliminated for a day or two. Grains, nuts, and beans should then be reduced for several days. The day before a fast, only easily digested foods like fruits, light salads, and soups should be eaten. During the fast, only pure water and occasional herbal teas should be drunk.

Fasts should be ended as gradually as they are entered, going from lighter to heavier foods progressively. The diet after a fast should emphasize fresh, wholesome foods. Fasters should particularly take care not to overeat when they complete a fast.

Precautions

Fasting isn't appropriate for everyone and, in some cases, could be harmful. Any person undertaking a first fast longer than three days should seek medical supervision. Those with health conditions should always have medical support during fasting. Plenty of water should be taken by fasters since **dehydration** can occur. Saunas and sweating therapies are sometimes recommended to assist detoxification, but should be used sparingly. Those fasting should significantly slow down their lifestyles. Taking time off of work is helpful, or at least reducing the work load. Fasters should also get plenty of rest. **Exercise** should be kept light, such as walking and gentle stretching.

Side effects

Those fasting may experience side effects of **fatigue**, malaise, aches and pains, emotional duress, **acne**, headaches, allergies, swelling, **vomiting**, **bad breath**, and symptoms of colds and flu. These reactions are sometimes called *healing crises*, which are caused by temporarily increased levels of toxins in the body due to elimination and cleansing. Lower energy levels should be expected during a fast.

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KEY TERMS

Ayurvedic medicine—A traditional healing system developed in India.

Toxin—A substance that has poisonous effects on the body.

Research and general acceptance

The physiology of fasting has been widely studied and documented by medical science. Beneficial effects such as lowered cholesterol and improved general functioning have been shown. Fasting as a treatment for illness and disease has been studied less, although some studies around the world have shown beneficial results. A 1984 study showed that workers in Taiwan who had severe chemical **poisoning** had dramatic improvement after a 10-day fast. In Russia and Japan, studies have demonstrated fasting to be an effective treatment for mental illness. Fasting has been featured on the cover of medical journals, although mainstream medicine has generally ignored fasting and detoxification treatments as valid medical procedures.

The majority of research that exists on fasting is testimonial, consisting of individual personal accounts of healing without statistics or controlled scientific experiments. In the alternative medical community, fasting is an essential and widely accepted treatment for many illnesses and chronic conditions.

ORGANIZATIONS

Fasting Center International, 32 West Anapurna St., #360, Santa Barbara, CA, 93101, http://www.fasting.com

Douglas Dupler, MA

Fasting blood sugar test *see* **Blood sugar tests**

Fasting plasma glucose test *see* **Blood sugar tests**

Fatigue

Definition

Fatigue is physical and/or mental exhaustion that can be triggered by **stress**, medication, overwork, or mental and physical illness or disease.

Description

Everyone experiences fatigue occasionally. It is the body's way of signaling its need for rest and sleep. But when fatigue becomes a persistent feeling of tiredness or exhaustion that goes beyond normal sleepiness, it is usually a sign that something more serious is amiss.

Physically, fatigue is characterized by a profound lack of energy, feelings of muscle weakness, and slowed movements or central nervous system reactions. Fatigue can also trigger serious mental exhaustion. Persistent fatigue can cause a lack of mental clarity (or feeling of mental "fuzziness"), difficulty concentrating, and in some cases, **memory loss**.

Causes and symptoms

Fatigue may be the result of one or more environmental causes such as inadequate rest, improper diet, work and home stressors, or poor physical conditioning, or one symptom of a chronic medical condition or disease process in the body. Heart disease, low blood pressure, diabetes, end-stage renal disease, iron-deficiency anemia, **narcolepsy**, and **cancer** can cause long-term, ongoing fatigue symptoms. Acute illnesses such as viral and bacterial infections can also trigger temporary feelings of exhaustion. In addition, mental disorders such as depression can also cause fatigue.

A number of medications, including **antihistamines**, **antibiotics**, and blood-pressure medications, may cause drowsiness as a side effect. Individuals already suffering from fatigue who are prescribed one of these medications may wish to check with their healthcare providers about alternative treatments.

Extreme fatigue which persists unabated for at least six months, is not the result of a diagnosed disease or illness, and is characterized by flu-like symptoms such as swollen lymph nodes, **sore throat**, and muscle weakness and/or **pain**, may indicate a diagnosis of **chronic fatigue syndrome**. Chronic fatigue syndrome (sometimes called chronic fatigue immune deficiency syndrome), is a debilitating illness that causes overwhelming exhaustion and a constellation of neurological and immunological symptoms. An estimated 1.5-2 million Americans suffer from the disorder.

Diagnosis

Because fatigue is a symptom of a number of different disorders, diseases, and lifestyle choices, diagnosis may be difficult. A thorough examination and patient history by a qualified healthcare provider is the first

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step in determining the cause of the fatigue. A physician can rule out physical conditions and diseases that feature fatigue as a symptom, and can also determine if prescription drugs, poor dietary habits, work environment, or other external stressors could be triggering the exhaustion. Several diagnostic tests may also be required to rule out common physical causes of exhaustion. These may include blood tests to check for iron-deficiency anemia.

Diagnosis of chronic fatigue syndrome is significantly more difficult. Because no specific biological marker or conclusive blood test exists to check for the disorder, healthcare providers must rely on the patient's presentation and severity of symptoms to make a diagnosis. In many cases, individuals with chronic fatigue syndrome go through a battery of invasive diagnostic tests and several years of consultation with medical professionals before receiving a correct diagnosis.

Treatment

Conventional medicine recommends the dietary and lifestyle changes as outlined as a first line of defense against fatigue. Individuals who experience occasional fatigue symptoms may benefit from short-term use of caffeine-containing central nervous stimulants, which make people more alert, less drowsy, and improve coordination. However, these should be prescribed with extreme caution, as overuse of the drug can lead to serious **sleep disorders**, like **insomnia**.

Another reason to avoid extended use of **caffeine** is its associated withdrawal symptoms. People who use large amounts of caffeine over long periods build up a tolerance to it. When that happens, they have to use more and more caffeine to get the same effects. Heavy caffeine use can also lead to dependence. If an individual stops using caffeine abruptly, withdrawal symptoms may occur, including **headache**, fatigue, drowsiness, yawning, irritability, restlessness, **vomiting**, or runny nose. These symptoms can go on for as long as a week.

Alternative treatment

The treatment of fatigue depends on its direct cause. Several commonly prescribed treatments for non-specific fatigue include dietary and lifestyle changes, the use of essential oils and herbal therapies, deep-breathing exercises, **traditional Chinese medicine**, and color therapy.

Dietary changes

Inadequate or inappropriate nutritional intake can cause fatigue symptoms. To maintain an adequate energy supply and promote overall physical well-being, individuals should eat a balanced diet and observe the following nutritional guidelines:

- Drink plenty of water. Individuals should try to drink nine to 12 glasses of water a day. Dehydration can reduce blood volume, which leads to feelings of fatigue.
- Eat iron-rich foods (eg., liver, raisins, spinach, apricots). Iron enables the blood to transport oxygen throughout the tissues, organs, and muscles, and diminished oxygenation of the blood can result in fatigue.
- Avoid high-fat meals and snacks. High-fat foods take longer to digest, reducing blood flow to the brain, heart, and the rest of the body while blood flow is increased to the stomach.
- Eat unrefined carbohydrates and proteins together for sustained energy.
- Balance proteins. Limiting protein to 15-20 grams per meal and two snacks of 15 grams is recommended, but not getting enough protein adds to fatigue. Pregnant or breastfeeding women should get more protein.
- Get the recommended daily allowance of B complex vitamins (specifically, pantothenic acid, folic acid, thiamine, and vitamin B_{12}). Deficiencies in these vitamins can trigger fatigue.
- Get the recommended daily allowance of selenium, riboflavin, and niacin. These are all essential nutritional elements in metabolizing food energy.
- Control portions. Individuals should only eat when they're hungry, and stop when they're full. An overstuffed stomach can cause short-term fatigue, and individuals who are overweight are much more likely to regularly experience fatigue symptoms.

Lifestyle changes

Lifestyle factors such as a high-stress job, erratic work hours, lack of social or family support, or erratic sleep patterns can all cause prolonged fatigue. If stress is an issue, a number of relaxation therapies and techniques are available to help alleviate tension, including massage, **yoga**, **aromatherapy**, **hydrotherapy**, progressive relaxation exercises, **meditation**, and **guided imagery**. Some individuals may also benefit from individual or family counseling or **psychotherapy** sessions to work through stress-related fatigue that is a result of family or social issues.

Maintaining healthy sleep patterns is critical to proper rest. Having a set "bedtime" helps to keep sleep on schedule. A calm and restful sleeping environment is also important to healthy sleep. Above all, the

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bedroom should be quiet and comfortable, away from loud noises and with adequate window treatments to keep sunlight and streetlights out. Removing distractions from the bedroom such as televisions and telephones can also be helpful.

Essential oils

Aromatherapists, hydrotherapists, and other holistic healthcare providers may recommend the use of essential oils of rosemary (*Rosmarinus officinalis*), eucalyptus blue gum (*Eucalyptus globulus*), peppermint, (*Mentha x piperata*), or Scots pine oil (*Pinus sylvestris*) to stimulate the nervous system and reduce fatigue. These oils can be added to bathwater or massage oil as a topical application. Citrus oils such as lemon, orange, grapefruit, and lime have a similar effect, and can be added to a steam bath or vaporizer for inhalation.

Herbal remedies

Herbal remedies that act as circulatory stimulants can offset the symptoms of fatigue in some individuals. An herbalist may recommend an infusion of ginger (*Zingiber officinale*) root or treatment with cayenne (*Capsicum annuum*), balmony (*Chelone glabra*), damiana (*Turnera diffusa*), **ginseng** (*Panax ginseng*), or rosemary (*Rosmarinus officinalis*) to treat ongoing fatigue.

An infusion is prepared by mixing the herb with boiling water, steeping it for several minutes, and then removing the herb from the infusion before drinking. A strainer, tea ball, or infuser can be used to immerse loose herb in the boiling water before steeping and separating it. A second method of infusion is to mix the loose herbal preparation with cold water first, bringing the mixture to a boil in a pan or teapot, and then separating the tea from the infusion with a strainer before drinking.

Caffeine-containing, **central-nervous-system stimulants** such as tea (*Camellia senensis*) and cola (*Cola nitida*) can provide temporary, short-term relief of fatigue symptoms. However, long-term use of caffeine can cause restlessness, irritability, and other unwanted side effects, and in some cases may actually work to increase fatigue after the stimulating effects of the caffeine wear off. To avoid these problems, caffeine intake should be limited to 300 mg or less a day (the equivalent of four to eight cups of brewed, hot tea).

Traditional Chinese medicine

Chinese medicine regards fatigue as a blockage or misalignment of *qi*, or energy flow, inside the human body. The practitioner of Chinese medicine chooses **acupuncture** and/or herbal therapy to rebalance the entire system. The Chinese formula Minot Bupleurum soup (or Xiao Chia Hu Tang) has been used for nearly 2,000 years for the type of chronic fatigue that comes after the flu. In this condition, the person has low-grade **fever**, **nausea**, and fatigue. Additional formulas are helpful in other cases. Acupuncture involves the placement of a series of thin needles into the skin at targeted locations on the body, locations known as acupoints, in order to harmonize the energy flow within the human body.

Deep-breathing exercises

Individuals under stress often experience fast, shallow breathing. This type of breathing, known as chest breathing, can lead to **shortness of breath**, increased muscle tension, inadequate oxygenation of blood, and fatigue. Breathing exercises can both improve respiratory function and relieve stress and fatigue.

Deep-breathing exercises are best performed while laying flat on the back on a hard surface, usually the floor. The knees are bent, and the body (particularly the mouth, nose, and face) is relaxed. One hand should be placed on the chest and one on the abdomen to monitor breathing technique. With proper breathing techniques, the abdomen will rise farther than the chest. The individual takes a series of long, deep breaths through the nose, attempting to raise the abdomen instead of the chest. Air is exhaled through the relaxed mouth. Deep breathing can be continued for up to 20 minutes. After the **exercise** is complete, the individual checks again for body tension and relaxation. Once deep breathing techniques have been mastered, an individual can use deep breathing at any time or place as a quick method of relieving tension and preventing fatigue.

Color therapy

Color therapy, also known as chromatherapy, is based on the premise that certain colors are infused with healing energies. The therapy uses the seven colors of the rainbow to promote balance and healing in the mind and body. Red promotes energy, empowerment, and stimulation. Physically, it is thought to improve circulation and stimulate red blood cell production. Red is associated with the seventh chakra, located at the root; or base of spine. In yoga, the chakras are specific spiritual energy centers of the body.

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KEY TERMS

Aromatherapy—The therapeutic use of plant-derived, aromatic essential oils to promote physical and psychological well-being.

Guided imagery—The use of relaxation and mental visualization to improve mood and/or physical well-being.

Hydrotherapy—Hydrotherapy, or water therapy, is use of water (hot, cold, steam, or ice) to relieve discomfort and promote physical well-being.

Therapeutic color can be administered in a number of ways. Practitioners of Ayurvedic, or traditional Indian medicine, wrap their patients in colored cloth chosen for its therapeutic hue. Individuals suffering from fatigue would be wrapped in reds and oranges chosen for their uplifting and energizing properties. Patients may also be bathed in light from a color filtered light source to enhance the healing effects of the treatment.

Individuals may also be treated with color-infused water. This is achieved by placing translucent red colored paper or colored plastic wrap over and around a glass of water and placing the glass in direct sunlight so the water can soak up the healing properties and vibrations of the color. Environmental color sources may also be used to promote feelings of stimulation and energy. Red wall and window treatments, furniture, clothing, and even food may be recommended for their energizing healing properties.

Color therapy can be used in conjunction with both hydrotherapy and aromatherapy to heighten the therapeutic effect. Spas and holistic healthcare providers may recommend red color baths or soaks, which combine the benefits of a warm or hot water soak with energizing essential oils and the fatigue-fighting effects of bright red hues used in color therapy.

Prognosis

Fatigue related to a chronic disease or condition may last indefinitely, but can be alleviated to a degree through some of the treatment options outlined here. Exhaustion that can be linked to environmental stressors is usually easily alleviated when those stressors are dealt with properly.

Chronic fatigue syndrome has no known cure, but steps can be taken to lessen symptoms and improve quality of life for these individuals while researchers continue to seek a cure.

Prevention

Many of the treatments as outlined are also recommended to prevent the onset of fatigue. Getting adequate rest and maintaining a consistent bedtime schedule are the most effective ways to combat fatigue. A balanced diet and moderate exercise program are also important to maintaining a consistent energy level.

Resources

BOOKS

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Paula Anne Ford-Martin

Fatty liver

Definition

Fatty liver is the collection of excessive amounts of **triglycerides** and other fats inside liver cells.

Demographics

Fatty liver not due to **alcoholism**, is called non-alcoholic fatty **liver disease** (NAFLD) and affects up to 25–35% of the U.S. population. With an increase in **obesity** in the population over the last 30 years, the incidence of NAFLD has also increased, even affecting about 2.5% of the pediatric population. The prevalence of NAFLD among racial and ethnic groups is not well known, although it is thought to affect both sexes equally.

Severe NAFLD (also called steatohepatitis or NASH) affects 2–5% of Americans, is seen in people 40–60 years old, and is more common in women than men. This form of fatty liver is a leading causes of **cirrhosis** (up to 25%) in adults in the United States.

Fatty liver develops in 90–100% of individuals presenting with heavy alcohol use.

Description

Also called steatosis, fatty liver can be a temporary or long-term condition. The condition is not

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harmful itself, but may indicate some other type of problem. Left untreated, it can contribute to other illnesses. It is usually reversible once the cause of the problem is diagnosed and corrected. Hard return for new para The liver is the organ responsible for changing fats eaten in the diet to types of fat that can be stored and used by the body. Triglycerides are one of the forms of fat stored by the body and used for energy and new cell formation. The breakdown of fats in the liver can be disrupted by alcoholism, **malnutrition**, **pregnancy**, or **poisoning**. In fatty liver, large droplets of fat, containing mostly triglycerides, collect within cells of the liver. The condition is generally not painful and may go unnoticed for a long period of time. In severe cases, the liver can increase to more than three times its normal size, and may be painful and tender.

KEY TERMS

Jaundice—A condition in which where the skin and whites of the eyes take on a yellowish color due to an increase of bilirubin (a compound produced by the liver) in the blood.

Reye's syndrome—A serious, life-threatening illness in children, usually developing after a bout of flu or chickenpox, and often associated with the use of aspirin. Fatal cases show evidence of accumulation of fat in the liver.

Triglycerides—A type of fat consumed in the diet and produced by and stored in the body as an energy source.

Causes and symptoms

The most common cause of fatty liver in the United States is alcoholism. In alcoholic fatty liver, overconsumption of alcohol changes the way that the liver breaks down and stores fats. Often, people with chronic alcoholism also suffer from malnutrition by eating irregularly and not consuming a balanced diet. Conditions that can also cause fatty liver are other forms of malnutrition (especially when there is not enough protein in the diet), obesity, **diabetes mellitus**, and **Reye's syndrome** in children. Pregnancy can cause a rare, but serious form of fatty liver that starts late in pregnancy and may be associated with **jaundice** and liver failure. Some drug overdoses or toxic chemical poisonings, such as carbon tetrachloride, can also cause fatty liver.

Often, fatty liver carries no symptoms. If symptoms occur, they can include **pain** under the rib cage on the right side of the body, swelling of the abdomen, jaundice, and **fever**. Symptoms that occur less often in alcoholic fatty liver, but more often in pregnancy-related fatty liver, are **nausea**, **vomiting**, loss of appetite, and abdominal pain.

Diagnosis

During a **physical examination**, a doctor might notice that the liver is enlarged and tender when the abdomen is palpated (examined with the tips of the fingers while the patient lies flat). Blood tests may be used to determine if the liver is functioning properly. A **liver biopsy**, where a small sample of liver tissue is removed with a long needle or though a very small incision, can be used to confirm fatty liver. In pregnant women, the fatty liver condition is usually associated with another serious complication, pre-eclampsia or **eclampsia**. In this condition, the mother has seriously high blood pressure, swelling, and possibly seizures. Laboratory abnormalities include elevations of the SGOT (serum glutamic-oxaloacetic transaminase) and SGPT (serum glutamic pyruvic transaminase). In many cases alkaline phosphatase will be significantly elevated due to **cholestasis** produced by the fatty infiltration.

Treatment

Treatment involves correcting the condition that caused fatty liver and providing supportive care. In fatty liver caused by alcoholism, the treatment is to give up drinking alcohol and to eat a healthy, well-balanced diet. In fatty liver associated with pregnancy, the recommended treatment is to deliver the baby, if the pregnancy is far enough along. Vitamin and mineral supplements along with nutritional support may be useful.

Prognosis

Fatty liver is usually reversible if recognized and treated. Some long-term tendency toward other types of liver problems may exist, depending on how long and how severe the fatty liver condition was. In pregnant women with the condition, the situation can be life-threatening for both the mother and the infant. Left untreated, it results in a high risk of **death** for both the mother and baby. Severe liver damage that may require a liver transplant can occur in the mother if the condition is not recognized early.

Prevention

Prevention consists of maintaining a well-balanced diet and healthy lifestyle with moderate or

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no alcohol consumption. Pregnant women require good prenatal care so that symptoms can be recognized and treated as early as possible. To prevent Reye's syndrome, children should not be given **aspirin** to treat symptoms of the flu or other viruses.

Resources

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ORGANIZATIONS

American Liver Foundation. 1425 Pompton Ave., Cedar Grove, NJ 07009. (800) 223-0179. http://www.liverfoundation.org.

National Institutes of Health (NIH), 9000 Rockville Pike, Bethesda, MD, 20892, (301) 496-4000, http://www.nih.gov/index.html.

National Organization for Rare Diseases. P.O. Box 8923, Fairfield, CT 06812. (213) 745-6518. http://www.rarediseases.org.

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Febrile agglutination tests *see* **Fever evaluation tests**

Fecal fat test *see* **Stool fat test**

Fecal incontinence

Definition

Fecal incontinence is the inability to control the passage of gas or stools (feces) through the anus. For some people fecal incontinence is a relatively minor problem, as when it is limited to a slight occasional soiling of underwear, but for other people it involves a considerable loss of bowel control and has a devastating effect on quality of life and psychological well-being. Fortunately, professional medical treatment is usually able to restore bowel control or at least substantially reduce the severity of the condition.

Description

Fecal incontinence, also called bowel incontinence, can occur at any age, but is most common among people over the age of 65, who sometimes have to cope with **urinary incontinence** as well. It was reported in 1998 that about 2% of adults experience fecal incontinence at least once a week whereas for healthy independent adults over the age of 65 the figure is about 7%. An extensive American survey, published in 1993, found fecal soiling in 7.1% of the surveyed population, with gross incontinence in 0.7%. For men and women the incidence of soiling was the same, but women were almost twice as likely to suffer from gross incontinence.

The wider public health impact of fecal incontinence is considerable. In the United States, more than $400 million is spent each year on disposable underwear and other incontinence aids. Fecal incontinence is the second most common reason for seeking a nursing home placement. One-third of the institutionalized elderly suffer from this condition. Incontinence sufferers, however, often hesitate to ask their doctors for help because they are embarrassed or ashamed. The 1993 American survey discovered that only one-sixth of those experiencing soiling had sought medical advice, and only one-half of those afflicted with gross incontinence.

Causes and symptoms

Fecal incontinence can result from a wide variety of medical conditions, including childbirth-related anal injuries, other causes of damage to the anus or rectum, and nervous system problems.

Vaginal-delivery **childbirth** is a major cause of fecal incontinence. In many cases, childbirth results in damage to the anal sphincter, which is the ring of muscle that closes the anus and keeps stools within the rectum until a person can find an appropriate opportunity to defecate. Nerve injuries during childbirth may also be a factor in some cases. An ultrasound study of first-time mothers found sphincter injuries in 35%. About one-third of the injured women developed fecal incontinence or an uncontrollable and powerful urge to defecate (urgency) within six weeks of giving birth. Childbirth-related incontinence is usually restricted to gas, but for some women involves the passing of liquid or solid stools.

The removal of **hemorrhoids** by surgery or other techniques (hemorrhoidectomies) can also cause anal damage and fecal incontinence, as can more complex

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operations affecting the anus and surrounding areas. Anal and rectal infections as well as **Crohn's disease** can lead to incontinence by damaging the muscles that control defecation. For some people, incontinence becomes a problem when the anal muscles begin to weaken in midlife or old age.

Dementia, **mental retardation**, strokes, brain tumors, **multiple sclerosis**, and other conditions that affect the nervous system can cause fecal incontinence by interfering with muscle function or the normal rectal sensations that trigger sphincter contraction and are necessary for bowel control. One study of multiple sclerosis patients discovered that about half were incontinent. Nerve damage caused by long-lasting **diabetes mellitus** (**diabetic neuropathy**) is another condition that can give rise to incontinence.

Diagnosis

Medical assessments in cases of fecal incontinence typically involve three steps: asking questions about the patient's past and current health (the medical history); a **physical examination** of the anal region; and testing for objective information regarding anal and rectal function.

Patient history

The medical history relies on questions that allow the doctor to evaluate the nature and severity of the problem and its effect on the patient's life. The doctor asks, for instance, how long the patient has been suffering from incontinence; how often and under what circumstances incontinence occurs; whether the patient has any control over defecation; and whether the patient has obstacles to defecation in his or her everyday surroundings, such as a toilet that can be reached only by climbing a long flight of stairs. For women who have given birth, a detailed obstetric history is also necessary.

Physical examination

The physical examination begins with a visual inspection of the anus and the area lying between the anus and the genitals (the perineum) for hemorrhoids, infections, and other conditions that might explain the patient's difficulties. During this phase of the examination the doctor asks the patient to bear down. Bearing down enables the doctor to check whether **rectal prolapse** or certain other problems exist. Rectal prolapse means that the patient's rectum has been weakened and drops down through the anus. Next, the doctor uses a pin or probe to **stroke** the perianal skin. Normally this touching, called the anal wink test, causes the anal sphincter to contract and the anus to pucker; if it does not, nerve damage may be present. The final phase of the examination requires the doctor to examine internal structures by carefully inserting a gloved and lubricated finger into the anal canal. This allows the doctor to judge the strength of the anal sphincter and a key muscle (the puborectalis muscle) in maintaining continence; to look for abnormalities such as **scars** and rectal masses; and to learn many other things about the patient's medical situation. At this point the doctor performs the anal wink test again and asks the patient to squeeze and bear down.

Laboratory tests

Information from the medical history and physical examination usually needs to be supplemented by tests that provide objective measurements of anal and rectal function. Anorectal manometry, a common procedure, involves inserting a small tube (catheter) or balloon device into the anal canal or rectum. Among other things, manometry measures pressure levels in the anal canal, rectal sensation, and anal and rectal reflexes. Tests are also available for assessing nerve damage. An anal ultrasound probe can supply accurate images of the anal sphincter and reveal whether injury has occurred. **Magnetic resonance imaging**, which requires the insertion of a coil into the anal canal, is useful at times.

Treatment

Fecal incontinence arising from an underlying condition such as diabetic neuropathy can sometimes be helped by treating the underlying condition. When that does not work, or no underlying condition can be discovered, one approach is to have the patient use a suppository or enema to stimulate defecation at the same time every day or every other day. The goal is to restore regular bowel habits and keep the bowels free of stools. Medications such as loperamide (Imodium) and codeine phosphate are often effective in halting incontinence, but only in less severe cases involving liquid stools or urgency. Dietary changes and exercises done at home to strengthen the anal muscles may also help.

Good results have been reported for **biofeedback** training, although the subject has not been properly researched. In successful cases, patients regain complete control over defecation, or at least improve their control, by learning to contract the external part of the anal sphincter whenever stools enter the rectum. All healthy people have this ability. Biofeedback training begins with the insertion into the rectum of a balloon

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KEY TERMS

Anus—The opening at the lower end of the rectum.

Colostomy—A surgical procedure in which an opening is made in the wall of the abdomen to allow a part of the large intestine (the colon) to empty outside the body.

Crohn's disease—A disease marked by inflammation of the intestines.

Defecation—Passage of stools through the anus.

Hemorrhoids—Enlarged veins in the anus or rectum. They are sometimes associated with fecal incontinence.

Rectum—The lower section of the large intestine that holds stools before defecation.

Sphincter—A circular band of muscle that surrounds and encloses an opening to the body or to one of its hollow organs. Damage to the sphincter surrounding the anus can cause fecal incontinence.

Stools—Undigested food and other waste that is eliminated through the anus.

Suppository—A solid medication that slowly dissolves after being inserted into the rectum or other body cavity.

manometry device hooked up to a pressure monitor. The presence of stools in the rectum is simulated by inflating the balloon, which causes pressure changes that are recorded on the monitor. The monitor also records sphincter contraction. By watching the monitor and following instructions from the equipment operator, the patient gradually learns to contract the sphincter automatically in response to fullness in the rectum. Sometimes one training session is enough, but often several are needed. Biofeedback is not an appropriate treatment in all cases, however. It is used only with patients who are highly motivated; who are able, to some extent, to sense the presence of stools in the rectum; and who have not lost all ability to contract the external anal sphincter. One specialist suggests that possibly two-thirds of incontinence sufferers are candidates for biofeedback.

Some people may require surgery. Sphincter damage caused by childbirth is often effectively treated with surgery, however, as are certain other kinds of incontinence-related sphincter injuries. Sometimes surgical treatment requires building an artificial sphincter using a thigh muscle (the gracilis muscle). At one time a **colostomy** was necessary for severe cases of incontinence, but is now rarely performed.

Prognosis

Fecal incontinence is a problem that usually responds well to professional medical treatment, even among elderly and institutionalized patients. If complete bowel control cannot be restored, the impact of incontinence on everyday life can still be lessened considerably in most cases. When incontinence remains a problem despite medical treatment, disposable underwear and other commercial incontinence products are available to make life easier. Doctors and nurses can offer advice on coping with incontinence, and people should never be embarrassed about seeking their assistance. Counseling and information are also available from support groups.

ORGANIZATIONS

International Foundation for Functional Gastrointestinal Disorders, P.O. Box 17864, Milwaukee, WI, 53217-8076, (414) 964-1799, (414) 964-7176, (888) 964-2001, iffd@iffgd.org, http://www.iffgd.org/.

National Association for Continence, P.O. Box 1019, Charleston, SC, 29402-1019, (843) 377-0900, (843) 377-0905, (800) 252-3337, memberservices@nafc.org, http://www.nafc.org.

National Digestive Diseases Information Clearinghouse (NDDIC), 2 Information Way, Bethesda, MD, 20892-3570, (703) 738-4929, (800) 891-5389, http://digestive.niddk.nih.gov.

Howard Baker

Fecal lipids test *see* **Stool fat test**

Fecal occult blood test

Definition

The fecal occult blood test (FOBT) is performed as part of a routine **physical examination** during the examination of the rectum. It is used to detect microscopic blood in the stool and is a screening tool for colorectal **cancer**. The word "occult" in the test's name means that the blood is hidden from view.

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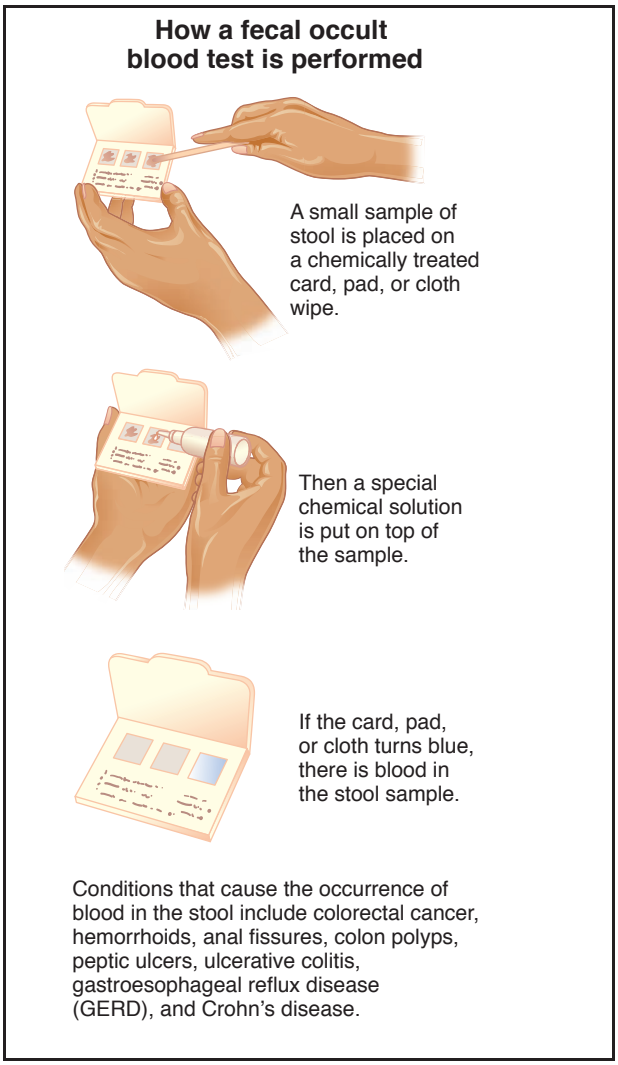

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KEY TERMS

Endoscopy—The use of a flexible lighted tube inserted into a body opening to evaluate the internal surfaces of an organ.

Globin—The protein component of hemoglobin. Newer fecal occult blood tests screen for the presence of globin in the stool rather than heme.

Guaiac—A compound derived from the wood resin of guaiacum trees. Guaiac reacts with blood in the stool to produce a blue-colored reaction when peroxide is added to the sample.

Heme—The iron-containing pigment found in hemoglobin.

Hemoglobin—The iron-containing protein found in blood that carries oxygen from the lungs to the rest of the body.

Occult—Not visible or easily detected.

Purpose

FOBT uses chemical indicators on stool samples to detect the presence of blood not otherwise visible. Blood originating from or passing through the gastrointestinal tract can signal many conditions requiring further diagnostic procedures and, possibly, medical treatment. These conditions may be benign or malignant; some of them include:

- colon, rectal, and gastric (stomach) cancers
- ulcers
- hemorrhoids
- polyps
- inflammatory bowel disease
- irritations or lesions of the gastrointestinal tract caused by such medications as nonsteroidal anti-inflammatory drugs, also called NSAIDs
- irritations or lesions of the gastrointestinal tract caused by such stomach acid disorders as reflux esophagitis

The FOBT is used routinely (in conjunction with a **rectal examination** performed by a physician) to screen for colorectal cancer, particularly in patients older than 50. The ordering of this test should not be taken as an indication that cancer is suspected. The FOBT must be combined with regular screening **endoscopy** (such as a **sigmoidoscopy**) to detect cancers at an early stage.

Precautions

Certain foods and medicines can influence the test results. Some fruits contain chemicals that prevent the guaiac, the chemical in which the test paper is soaked, from reacting with the blood. **Aspirin** and some NSAIDs irritate the stomach, resulting in bleeding, and should be avoided prior to the examination. Red meat and many vegetables and fruits containing vitamin C also should be avoided for a specified period of time prior to the test. All these factors could produce a false-positive result.

Description

Feces for the stool samples are obtained either by the physician at the rectal examination or by the

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patient at home, using a small spatula or a collection device. In most cases, the collection of stool samples can easily be done at home, using a kit supplied by the physician. The standard kit contains a specially prepared card on which a small sample of stool will be spread, using a stick provided in the kit. The sample is placed in a special envelope and either mailed or brought in for analysis. When the physician applies hydrogen peroxide to the back of the sample, the paper will turn blue if an abnormal amount of blood is present.

Types of fecal occult blood tests

Hemoccult is the most commonly used fecal occult blood test. It measures the presence of heme, an iron-containing pigment found in hemoglobin. The Hemoccult test takes less than five minutes to perform and may be performed in the physician's office or in the laboratory. The Hemoccult blood test can detect bleeding from the colon as low as 0.5 mg per day.

Newer tests that use anti-hemoglobin antibodies (or immunochemical tests) to detect blood in the stool are also used. These tests screen for globin, the protein component of hemoglobin, rather than heme. Immunochemical tests can detect up to 0.7 mg of hemoglobin in the stool and do not require dietary restrictions. Immunochemical tests:

- are not accurate for screening for stomach cancer
- are more sensitive than Hemoccult tests in detecting colorectal cancer
- are more expensive than Hemoccult tests

HemoQuant, another fecal occult blood test, is used to detect as much as 500 mg/g of blood in the stool. Like the Hemoccult, the HemoQuant test is affected by recent consumption of red meat. It is not affected by chemicals in vegetables.

Fecal blood may also be measured by the amount of chromium in the red blood cells in the feces. The stool is collected for three to 10 days. The test is used in cases where the exact amount of blood loss is required. It is the only test that can exclude blood loss from the gastrointestinal area with accuracy.

A newer fecal occult blood test is based on enzyme immunoassay. This technique does not rely on guaiac, so it is not influenced by diet or medications used prior to the test. The fecal immunoassay test, or FIT, also requires fewer specimen collections. FITs are increasingly replacing the older guaiac-based FOBTs in many settings as of 2010. A 2009 editorial in the *American Journal of Gastroenterology* urged the use of FITs on the grounds that they do not require patients on blood thinners or NSAIDs to stop taking these medications during stool collection and thereby increase their risk of cardiovascular problems.

Two newer tests are based on DNA analysis of stool samples for biological markers of colorectal cancer. The first test of this type, PreGen-Plus, was first used in 2004 but held up for widespread distribution by a warning letter from the U.S. Food and Drug Administration (FDA) in October 2008. ColoSure, a DNA test that measures only one biomarker for colorectal cancer, was made available in the summer of 2008. It retails for about $220. ColoSure is not as accurate as a **colonoscopy** but is less invasive and is intended to be used for patients who resist having a colonoscopy. Widespread use of these new tests remains to be seen. As of 2010, the newer DNA stool tests appear to be cost-effective only in patients who are not compliant with other screening methods for colorectal cancer.

Over-the-counter (OTC) fecal occult blood test kits are now available for purchase at most pharmacies in the United States and Canada. These tests, however, are not as reliable as those performed in doctors' offices or laboratories.

Preparation

For 72 hours prior to collecting samples, patients should avoid red meats, NSAIDs (including aspirin), **antacids**, **steroids**, iron supplements, and vitamin C, including citrus fruits and other foods containing large amounts of vitamin C. Foods like uncooked broccoli, uncooked turnips, cauliflower, uncooked cantaloupe, uncooked radish and horseradish, and parsnips should not be eaten during the 72 hours prior to the examination. Fish, chicken, pork, fruits (other than melons) and many cooked vegetables are permitted in the diet.

People should postpone an FOBT if they are presently having **diarrhea**, **constipation**, a flare-up of **hemorrhoids**, severe **sore throat**, or a menstrual period.

Results

Many factors can result in false-positive and false-negative findings.

Positive results

It is important to note that a true-positive finding signifies only the presence of blood—it is not an indication of cancer. The National Cancer Institute states that, in its experience, less than 10% of all positive

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results were caused by cancer. The FOBT is positive in 1–5% of the unscreened population and 2–10% of those are found to have cancer. The physician will want to follow up on a positive result with further tests, as indicated by other factors in the patient's history or condition.

Negative results

Alternatively, a negative result (meaning no blood was detected) does not guarantee the absence of **colon cancer**, which may bleed only occasionally or not at all. (Only 50% of colon cancers are FOBT-positive.)

Conclusions

Screening using the FOBT has been demonstrated to reduce the mortality associated with colorectal cancer. However, because only half of colorectal cancers are FOBT-positive, FOBT must be combined with regular screening endoscopy or colonoscopy to increase the accuracy of detection of premalignant colorectal polyps and cancers.

Resources

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Mayo Clinic. *Fecal Occult Blood Test*. http://www.mayoclinic.com/health/fecal-occult-blood-test/MY00620

ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (800) ACS-2345, http://www.cancer.org.

National Cancer Institute (NCI), (800) 4-CANCER (422-6237), http://rex.nci.nih.gov.

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Feldenkrais method

Definition

The Feldenkrais method is an educational system that allows the body to move and function more efficiently and comfortably. Its goal is to re-educate the nervous system and improve motor ability. The system can accomplish much more, relieving pressure on joints and weak points, allowing the body to heal repetitive strain injuries. Continued use of the method can relieve **pain** and lead to higher standards of achievement in sports, the martial arts, dancing, and other physical disciplines.

Pupils are taught to become aware of their movements and to become aware of how they use their bodies, thus discovering possible areas of **stress** and strain. The goal of Feldenkrais is to take the individual from merely functioning, to functioning well, free of pain and restriction of movement. Feldenkrais himself stated that his goal was, "to make the impossible possible, the possible easy, and the easy, elegant."

Purpose

This method of re-educating the nervous system can be beneficial to a wide range of people, including athletes, children, the elderly, martial artists, those who are handicapped, people with special needs, and those with degenerative diseases. It has proved popular with artists, particularly musicians, a number of

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whom have used Feldenkrais to improve their performance.

The Feldenkrais Guild of North America (FGNA) states that more than half of the those who turn to Feldenkrais practitioners are seeking relief from pain. Many people who have pain from an injury compensate by changing their movements to limit pain. Often these changed movements remain after the pain from the original injury is gone, and new pain may occur. Feldenkrais helps students become aware of the changed movements and allows them to learn new movements that relieve their pain.

Apart from the obvious physical benefits of more efficient movement and freedom from pain and restriction, Feldenkrais practitioners assert that it has other positive benefits for overall physical and mental health, including increased awareness, flexibility, and coordination, and better relaxation. Feldenkrais practitioners have noted other benefits in their students, including improvements in awareness, flexibility, coordination, breathing, digestion, sleep, mood, mental alertness, energy, and range of motion, as well as reduced stress and **hypertension**, and fewer headaches and backaches.

Musicians and athletes can improve their performance in many ways when they learn to use their bodies more efficiently. Feldenkrais can help injured athletes regain lost potential and free them from pain and restriction of movement.

Numerous accounts note remarkable results when Feldenkrais is taught to handicapped children so that they can learn to function despite their limitations. Handicapped people can learn to make full use of whatever potential they have, and to have more confidence in their abilities. Practitioners who specialize in teaching Feldenkrais to those who have handicaps have in many cases allowed the patient to discover ways of performing tasks that were previously thought to be impossible for them.

The elderly, whose movements are often restricted by pain and stiffness, can learn to overcome these obstacles with Feldenkrais instruction. In some instances, even severe cases of arthritis have been conquered. Theoretically, Feldenkrais can make possible renewed levels of energy and freedom from restriction.

Description

Origins

Moshe Feldenkrais (1904–1984) was a Russian-born Israeli physicist and engineer who was also an active soccer player and judo master. He devised his system in response to his own recurring knee injury, which had restricted his movement and caused him great pain over a long period of time. Feldenkrais believed that repeated muscle patterns cause the parts of the brain controlling those muscles to stay in a fixed pattern as well. He thought that the more the muscles are used, the more parts of the brain can be activated. He devised a method of re-educating the neuromuscular system and re-evaluating movement to increase efficiency and reduce stress, using his knowledge of mechanics and engineering, and applying some of his martial arts training.

Feldenkrais is described as being a dual system, with two components: "Awareness Through Movement" and "Functional Integration." The system aims to re-educate the body so that habitual movements that cause strain or pain can be relearned to improve efficiency and eliminate dangerous or painful action.

Feldenkrais helps to translate intention into action. In practice, an individual can learn to achieve his or her highest potential, while at the same time learning to avoid and eliminate stresses, strains, and the possibility of injury.

MOSHE FELDENKRAIS (1904–1984)

Moshe Feldenkrais was born on the border between Russia and Poland. When he was only a boy of 13, he traveled to Palestine on foot. The journey took a year, and once there, young Feldenkrais worked as a laborer and cartographer, also tutoring others in mathematics. Moving to France in 1933, he graduated in mechanical and electrical engineering from the Ecole des Travaux Publiques de Paris.

Feldendrais became the first person to open a Judo center in Paris after meeting with Jigaro Kano. He was also one of the first Europeans to become a black belt in Judo, in 1936.

Obtaining his Ph.D. at the Sorbonne, he went on to assist Nobel Prize laureate Frédéric Joliot-Curie at the Curie Institute. During World War II in England, he worked on the new sonar anti-submarine research.

Prompted by a recurring leg injury, he applied his knowledge of the martial arts and his training as an engineer to devise a method of re-integrating the body. The concept was that more efficient movement would allow for the treatment of pain or disability, and the better-functioning of the body as a whole. Later on, he would begin to teach what he had learned to others in Tel Aviv.

In addition to many books about judo, including *Higher Judo*, he wrote six books on his method.

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KEY TERMS

Neuromuscular—The body system of nerves and muscles as they function together.

Repetitive strain injury—Injury resulting from a repeated movement such as typing or throwing a ball.

Functional integration

During this session, the patient wears comfortable clothing, and may sit, stand, walk, or lie on a low padded table. The practitioner helps the pupil by guiding him or her through a number of movements. The practitioner may use touch to communicate with the student, but touch is not used to correct any movements. The purpose of this session is to increase a student's awareness of his or her own movement and become open to different possibilities for movement. The instruction can be focused on a particular activity that the student does every day, or that causes him or her pain. The student can learn to alter habitual movements and re-educate the neuromuscular system. This type of session is particularly useful for those who have limitations originating from misuse, stress, illness, or accident. It can also help athletes and musicians perform to the best of their ability by increasing their possibilities for movement. It offers students the potential for improving their physical and mental performance in addition to heightening the sense of well-being.

Awareness through movement

Feldenkrais's martial arts background can be clearly identified in many of the aspects of Awareness Through Movement (ATM). During group sessions, pupils are taught to become acutely aware of all their movements and to imagine them, so that they can improve the efficiency of their actions in their minds, and put them into practice. Pupils are encouraged to be disciplined about practicing their exercises so they may achieve maximum benefit.

Awareness through movement is described as an exploratory, nonjudgmental process through which pupils are encouraged to observe and learn about themselves and their movements. The range of this therapy is wide, and thousands of different lessons are available to help specific areas.

Preparations

No preparation is necessary for the practice of Feldenkrais, and all are encouraged to seek help from this system. No condition is considered a preclusion to the benefits of Feldenkrais.

Precautions

As with any therapy or treatment, care should be taken to choose a qualified practitioner. Feldenkrais practitioners stress that the body must not be forced to do anything, and if any movement is painful, or even uncomfortable, it should be discontinued immediately and the patient should seek professional help.

Side effects

No known side effects are associated with the practice of Feldenkrais.

Research and general acceptance

Since Feldenkrais began to teach his method, it has gradually gained acceptance as an education system. Published research using the method can be found in United States and foreign publications.

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ORGANIZATIONS

American Pain Society, 4700 W. Lake Ave., Glenview, IL, 60025, (847) 375-4715, http://www.ampainsoc.org.

Benson-Henry Institute for Mind Body Medicine at Massachusetts General Hospital, 151 Merrimac St., 4th Floor, Boston, MA, 02114, (617) 643-6090, http://www.massgeneral.org/bhi.

The Center for Mindfulness in Medicine, Health Care and Society. University of Massachusetts Medical School., 55 Lake Ave., North, Worcester, MA, 01655, (508) 856-2656, (508) 856-1977, mindfulness@umassmed.edu, http://www.umassmed.edu/cfm/.

Feldenkrais Guild of North America, 3611 SW Hood Ave., Suite 100, Portland, OR, 97201, (503) 221-6612, (800) 775-2118, (503) 221-6616, http://www.feldenkrais.com.

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Female circumcision *see* **Female genital mutilation**

Female condom *see* **Condom**

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Female genital mutilation

Definition

Female genital mutilation (FGM)—also called female genital cutting (FGC) or female circumcision—is the cutting or partial or total removal of the external female genitalia. It is performed for cultural or other non–medical reasons, most often on girls between the ages of four and ten.

Demographics

The World Health Organization (WHO) estimates that between 100 million and 140 million girls and women have undergone some form of FGM, with as many as three million girls at risk for the procedure each year. FGM is a deeply rooted cultural tradition in some 28 African countries and a few Middle Eastern and Asian nations. Although it is illegal in many countries, including 18 African nations, enforcement is minimal. In the United States it is illegal to perform FGM on anyone under age 18.

Nearly half of all women who have been genitally mutilated live in Egypt or Ethiopia, although the rates of FGM in Egypt and some other countries appear to be on the decline. FGM is practiced to a lesser degree in Indonesia, India, and Pakistan. The countries in which the highest percentages of females are subjected to FGM are as follows (where two percentages are given, the lower percentage refers to girls aged 15–19 and the higher percentage is for women aged 35–39, suggesting that the practice is on the decline):

- Guinea: 99%
- Somalia: 97–99%
- Djibouti: 98%
- Egypt: 81–96%
- Eritrea: 95%
- Mali: 94%
- Sierra Leone: 90%
- Ethiopia: 62–81%
- Gambia: 80%
- Côte d'Ivoire: 28–44%
- Kenya: 15–35%

FGM is practiced by people of all educational levels and social classes and various religions, including Christians, Muslims, and animists. In some countries it is more common in rural areas and in other countries it is more prevalent in cities.

Although FGM is most often performed on girls before they reach **puberty**, it is practiced on women of all ages, from infancy through adulthood. The usual age for FGM varies with the country and region within a country. Sometimes it is performed just before a woman marries or during her first **pregnancy**. In Egypt about 90% of girls are cut between the ages of four and 12. In Yemen more than 75% of girls are cut during the first two weeks of life. In Burkina Faso, Côte d'Ivoire, Egypt, Kenya, and Mali, the age for FGM is decreasing, perhaps because younger children are less able to resist or because in countries where it is illegal, the practice is more easily concealed with younger girls.

Description

FGM includes a wide range of procedures. The simplest form of FGM involves a small cut to the clitoris or labial tissue. A Sunna **circumcision** removes the prepuce—a fold of skin that covers the clitoris—and/or the tip of the clitoris. A clitoridectomy is the removal of the entire clitoris and some or all of the surrounding tissue. Clitoridectomies account for approximately 80% of FGMs. The most extreme form of genital mutilation is excision and infibulation, in which the clitoris and all of the surrounding tissues of the external genitalia are cut away and the remaining skin is sewn together, leaving only a small opening for the passage of urine and menstrual blood. This sewing shut of the vagina is designed to ensure virginity until marriage. Infibulation accounts for approximately 15% of FGM procedures.

FGM is usually performed in the home or some other non–medical setting. Often it is performed by a family member or a local "circumciser," using scissors, knives, razor blades, or other instruments that have not necessarily been sterilized. However in Egypt up to 90% of FGMs are now performed by medical professionals.

With increased immigration to Western countries from regions where female circumcision is common, the practice has come to the attention of health professionals in the United States, Canada, Europe, and Australia. Some families return to their native countries to have their daughters circumcised. In an effort to integrate old customs with modern medical care, some immigrant families have requested that Western physicians perform the procedure. This can place doctors in the difficult position of trying to be sensitive to cultural traditions and choosing between performing female circumcision in a medical facility under anesthesia and sanitary conditions or refusing, knowing that the FGM may be performed without medical supervision. In 2010 the American Academy of Pediatrics, in a controversial change of policy, suggested

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KEY TERMS

Circumcision—A procedure, usually with religious or cultural significance, in which the prepuce—the skin covering the tip of the male penis or the female clitoris, is cut away.

Clitoridectomy—A procedure in which the clitoris and possibly some of the surrounding labial tissue at the opening of the vagina is removed.

Clitoris—The small erectile organ at the front of the female vulva that is the site of female sexual pleasure.

Infibulation—A procedure that closes the labia majora to prevent sexual intercourse, leaving only a small opening for the passage of urine and menstrual blood.

Labia majora—The outer fatty folds of the vulva.

Prepuce—The fold of tissue covering the clitoris in females and the tip of the penis in males.

Vulva—The external female genital organs, including the labia majora, labia minora, clitoris, and vestibule of the vagina.

that U.S. doctors be allowed to perform a ceremonial pinprick on girls to prevent them from being sent abroad for FGM.

Causes and symptoms

FGM is practiced for a variety of cultural, social, political, and economic reasons:

- FGM is usually an integral part of community tradition.
- Most parents believe that genital cutting protects—rather than harms—their daughters.
- In some cultures FGM is considered a necessary rite of passage for girls and may even mark their introduction to sexual activity.
- Although FGM represents social and cultural control of female sexuality, some cultures believe that FGM actually empowers women by protecting their family's reputation and ensuring that they will marry.
- Female circumcision is believed to protect a girl's virginity and prevent unwed pregnancy, which could bring shame upon the family.
- In some cultures uncircumcised females are considered to be dirty or unmarriageable and may be treated poorly.
- In some societies FGM is believed to quell female sexual desire.
- Some people believe that their religion requires female circumcision.
- Some people believe in superstitions—that the clitoris will continue to grow if it is not removed or that external genitalia are unclean and can kill an infant during birth.

The effects of FGM depend on the degree of cutting, the cleanliness of the instruments, and the health of the female at the time of the procedure. FGM is usually performed without anesthesia and almost always causes bleeding and **pain**. The pain is usually most severe on the following day when the patient first urinates onto the wound.

The immediate risks of FGM include:

- physical and/or psychological trauma
- hemorrhage (excessive bleeding)
- severe pain
- infection, including abscesses, fever, sepsis (blood infection), shock, tetanus, or gangrene
- death due to excessive blood loss or infection

Long–term complications usually occur with the more severe forms of FGM and include:

- scarring
- poor drainage of urine and menstrual blood, leading to infection
- chronic urinary tract infections
- cysts and abscesses
- incontinence
- pelvic and back pain
- painful menstruation
- very painful sexual intercourse due to scarring of most of the vagina
- lack of sexual pleasure
- inability to undergo normal gynecological exams and procedures
- increased risk for sexually transmitted infections (STIs), including HIV/AIDS, both from contaminated instruments and also because the damaged tissues are more likely to tear during sex, facilitating the transmission of infectious agents

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- infertility rates as high as 25–30%, usually related vaginal scarring that makes sexual intercourse difficult
- childbirth complications, including prolonged labor, tearing, heavy bleeding, and infection
- psychological symptoms similar to post–traumatic stress syndrome (PTSD), including anxiety, depression, and sleep abnormalities, although these conditions are rare

Diagnosis

Diagnosis and treatment of FGM requires the care of culturally sensitive gynecologists and women's healthcare specialists who are familiar with the different types of FGM and their complications.

Treatment

Traditional

A girl or young woman who has recently had FGM may require supportive care to control bleeding. Treatment may be necessary for any complications. Women who have undergone FGM may require specialized gynecologic, obstetric, and reproductive care by knowledgeable practitioners.

In the United States female immigrants with FGM often undergo defibulation or **reconstructive surgery** to reverse or repair their genitalia. Some surgical procedures that were originally developed for sex–change operations have been adapted for treating women with FGM. These techniques may involve cutting away scar tissue and skin to expose whatever remains of the clitoris, as well as more extensive reconstruction.

Drugs

Females who have recently undergone FGM may require **antibiotics** to prevent infection.

Prognosis

FGM can adversely affect a woman's quality of life, particularly with regard to sexual enjoyment and **childbirth**. FGM is associated with postpartum hemorrhage, **episiotomy**, extended hospital stays, **stillbirth**, infant resuscitation, and infant and maternal **death**. Circumcised pregnant women sometimes must deliver by Caesarian section.

Prevention

Many national and international medical organizations—including the American Medical Association, Canadian medical associations, and the World Health Organization (WHO)—oppose the practice of female genital mutilation. The United Nations considers FGM to be a violation of human rights and several African and Asian nations have called for an end to the practice. WHO has undertaken a number of projects aimed at decreasing the incidence of FGM. These include:

- a statement addressing the regional status of FGM and encouraging the development of national policies against the practice
- training community workers to oppose FGM
- developing educational materials about FGM for community healthcare workers
- providing alternative job training for circumcisers

Other approaches to halting the practice of FGM include:

- community meetings, discussions, theater productions, and songs
- educational programs conducted by respected local women
- work by Islamic and other religious leaders to change the perception that FGM is required by religion
- substitution of other coming–of–age rituals for girls
- laws prohibiting FGM except as the free choice of an adult woman

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Center for Reproductive Rights, 120 Wall St., New York, NY, 10005, (917) 637–3600, (917) 637–3666, http://reproductiverights.org.

U.S. Department of Health and Human Services, Office on Women's Health, 200 Independence Ave., SW, Rm. 728E, Washington, DC, 20201, (202) 205–1960, (800) 994–9662, (202) 401–4005, http://www.womenshealth.gov.

World Health Organization, Avenue Appia 20, 1211 Geneva 27, Switzerland, 41 22 791 21 11, 41 22 791 31 11, info@who.int, http://www.who.int/en/.

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Female infertility *see* **Infertility**

Female orgasmic disorder

Definition

Female orgasmic disorder (FOD) is the persistent or recurrent inability to achieve orgasm (climax or sexual release) despite adequate sexual arousal and stimulation. FOD is also called orgasmic dysfunction or anorgasmia. It used to be called "inhibited sexual orgasm."

Demographics

The inability to achieve orgasm, discontent with the quality of orgasms, and the ability to achieve orgasm only with a particular type of sexual stimulation are very common sexual complaints among women. It has been suggested that 33–50% of all women are dissatisfied with the frequencies of their orgasms and that fewer than one third of women consistently experience orgasm with sexual activity. However FOD applies to the 10–15% of women have never experienced an orgasm, regardless of the situation or stimulation, and to women who can no longer achieve an orgasm. Women who have never experienced orgasm are more likely to be unmarried, young, and/or sexually inexperienced. FOD has also been associated with **menopause** and **aging**, although many women find that their orgasms increase with age.

Description

When a woman becomes sexually excited, the blood vessels in the pelvic region expand, allowing more blood to flow to the genitals—the same process that occurs when men become sexually excited. This effusion is followed by seepage of fluid into the vagina to provide lubrication before and during intercourse. These events are called the "lubrication–swelling response."

Body tension and blood flow to the pelvic region continue to build as sexual stimulation increases, either by direct pressure on the clitoris or pressure on the walls of the vagina and cervix. An orgasm occurs when the tension is released. It is accompanied by a feeling of intense physical pleasure and involuntary, rhythmic contractions of the pelvic floor muscles and possibly the vagina and uterus. The contractions carry blood away from the genital region. However the exact physiological mechanisms of the female orgasm are not well-understood. Furthermore, women do not necessarily experience orgasms in the same way, and an individual woman may experience orgasms differently at various times and in different situations. Orgasms vary in intensity, length, and the number of contractions, and, unlike men, women can have multiple orgasms in a short period of time. Some 50–80% of women experience orgasm only through direct clitoral stimulation. Mature, more sexually experienced women may find it easier to have orgasms than younger or sexually inexperienced women.

FOD is a type of **sexual dysfunction** that affects the quality of a woman's sexual experience. It often occurs in conjunction with other sexual dysfunctions. Women with FOD experience sexual arousal and lubrication. However as body tension builds, they have extreme difficulty or are completely unable to reach climax and release the tension. This can lead to frustration and less–than–fulfilling sexual experiences for both partners, as well as anger, frustration, and other relationship problems.

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According to the American Psychiatric Association's *Diagnostic and Statistical Manual of Mental Disorders,* the *DSM,* a diagnosis of FOD requires that the anorgasmia is not due solely to physiological problems and is not a symptom of another major mental health disorder. However FOD can be caused by a combination of physiological and psychological difficulties. For a diagnosis of FOD the condition also must cause personal distress or relationship problems.

FOD is most often a primary or lifelong condition, in which women never achieve orgasm with any type of stimulation, including self–stimulation (masturbation), direct stimulation of the clitoris by a partner, or vaginal intercourse. Secondary or acquired FOD affects women who have experienced orgasm at least once in the past, but have lost the ability following an illness or emotional trauma or as a side effect of surgery or medication. Acquired FOD is often temporary. Anorgasmia may also be classified as general, which means that orgasm is never achieved under any circumstances or with any partner; or situational, which means that orgasm is only achieved under certain circumstances or with certain types of sexual activity.

Risk factors

Recent studies of twins suggest that genes and heredity play a large role in the development of FOD. A history of sexual or physical **abuse** is also a risk factor for FOD.

Causes and symptoms

FOD is characterized by a woman's inability to achieve orgasm, by extreme difficulty in regularly reaching climax, or having only unsatisfying orgasms. Some women often come close to orgasm but never reach it. FOD can be caused by psychological factors or by a combination of psychological and physiological factors.

Psychological causes of FOD include:

- feelings of isolation, disconnection, or boredom during sex
- shyness or embarrassment
- performance anxiety or sexual activity that is overly goal–oriented, with excessive pressure to achieve orgasm
- past sexual or physical abuse, rape, incest, or other traumatic sexual experiences
- emotional abuse
- fear of pregnancy
- fear of rejection
- fear of loss of control during orgasm

KEY TERMS

Anorgasmia—A sexual dysfunction characterized by the inability to achieve orgasm.

Clitoris—The small erectile organ at the front of the female vulva that is the site of female sexual pleasure.

Estrogen—Any of several naturally occurring or synthetic steroid hormones that promote the growth and maintenance of the female reproductive system.

Kegel exercises—Repetitive contractions to tone the pubococcygeal muscle for enhancing sexual response during intercourse or controlling incontinence.

Orgasm—The climax of sexual excitement, usually characterized by vaginal contractions by the female and ejaculation of semen by the male.

Testosterone—The primary male sex hormone, which is also produced at low levels in females.

- self–image problems
- relationship problems
- life stresses, such as financial worries, job loss, or divorce
- guilt or negative feelings toward sex or sexual pleasure—attitudes that are usually learned in childhood or adolescence
- religious or cultural beliefs about sex
- other mental health disorders, such as major depression

Various prescription and over–the–counter medications can cause aorgasmia. These include:

- antidepressants called selective serotonin reuptake inhibitors (SSRIs) such as fluoxetine (Prozac), paroxetine (Paxil), and sertraline (Zoloft)
- anti-anxiety drugs such as Xanax
- sedatives such as Halcion
- narcotics
- antihistamines
- blood-pressure medications
- chemotherapy drugs

Other physiological causes of FOD include:

- inadequate sexual stimulation and the inability to discuss or explore more stimulating sexual techniques
- lower estrogen levels during and after menopause, which reduce lubrication and require greater

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stimulation for relaxing and promoting blood flow to the clitoris and vagina
- other normal aging processes
- smoking, alcohol, or other substance abuse
- hormonal disorders and chronic illnesses that affect general health and sexual interest
- damage to the blood vessels of the pelvic region
- conditions that affect or damage pelvic nerves, including pelvic surgery, multiple sclerosis, diabetes, neurological disease, or spinal cord injury
- pelvic floor prolapse—a loosening of the muscles that support internal pelvic organs
- removal of the clitoris (female genital mutilation), a cultural practice in much of Africa and some regions of the Middle East and Asia

Diagnosis

FOD is often self–diagnosed. However a woman who has never had an orgasm may not realize what is missing in her sexual experience without diagnosis by a physician, women's healthcare specialist, psychiatrist, psychologist, or sex therapist.

Examination

Diagnosis of FOD includes a complete physical exam and medical, psychological, and sexual histories. The clinician or therapist helps determine whether the problem is primary or acquired and general or situational. FOD sometimes occurs in conjunction with sexual aversion disorder and/or **female sexual arousal disorder**, complicating the diagnosis. A diagnosis of FOD requires that:

- Orgasms occur less frequently than would be expected based on the patient's age, sexual experience, and level of sexual stimulation.
- The absence of orgasm results in emotional distress or relationship difficulties.
- The cause is psychological or a combination of psychological and physical factors.
- The absence of orgasm is not a symptom of another psychological disorder, such as depression.

Tests

Blood tests may be performed to measure the levels of estrogen and testosterone.

Treatment

Traditional

Treatment of FOD requires addressing any underlying physiological causes, psychological factors such as depression, and lifestyle factors such as **substance abuse**. Medications may require adjustment. Any associated sexual dysfunctions, such as lack of interest in sex or painful intercourse, must also be addressed. FOD is commonly treated with education, counseling, cognitive behavioral therapy, **psychotherapy**, and/or **sex therapy**.

Psychotherapy or counseling can be effective for treating psychological causes of FOD, especially those causes that are rooted in **sexual abuse**, past sexual or emotional experiences, or cultural taboos. Couples therapy may be used to resolve relationship issues that have either caused or resulted from FOD. These processes require time and a joint commitment by couples.

Sex therapists have specialized training for assisting individuals and couples in overcoming sexual dysfunctions. Sex therapy may include:

- directed exercises for increasing stimulation and decreasing inhibitions
- techniques for relaxation, sexual exploration, and direct clitoral stimulation
- encouragement of masturbation, either by self–-stimulation or with a vibrator
- Kegel exercises for enhancing sexual response
- communication training and relationship enhancement for couples
- desensitization—learning to halt responses that are preventing orgasm, particularly in women with severe sexual anxiety

Drugs

Estrogen or a combination of estrogen and progesterone may be used to treat FOD in menopausal women and others with low hormone levels. FOD is sometimes treated with methyltestosterone, a synthetic form of the male sex hormone testosterone, although this practice is controversial and can have various side effects. Testosterone appears to be most effective for women with low testosterone levels resulting from surgical removal of the ovaries.

Alternative

Zestra is a botanical massage oil that warms the clitoris and may increase sexual arousal and orgasm. L–arginine in various **nutritional supplements** relaxes blood vessels and increases blood flow to the genital area, especially the clitoris.

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Home remedies

One of the most important factors in overcoming FOD is open and honest communication between partners about sexuality and sexual techniques. Erotic books or videos may help initiate such conversations. Sometimes focusing on clitoral stimulation is all that is needed to overcome FOD. Experimenting with different sexual positions may improve clitoral stimulation. Using a vibrator during sex can also help trigger orgasms.

Many women have found that Kegel exercises, which involve the repetitive contraction and relaxation of the pelvic floor muscles, can improve both the frequency and intensity of orgasmic experiences. Repeatedly stopping and starting a urine stream identifies the muscles to be exercised, working up to five sets of ten contractions per day. The longer the contractions are held, the more benefit may result.

Prognosis

FOD can often be successfully treated with a combination of psychotherapy and guided sexual exercises. However women should not expect to always achieve orgasm in every situation; nor should they expect to always be satisfied with the strength and quality of their climax. Women whose FOD is not due to an identifiable condition or disorder may be more difficult to treat. Unresolved FOD usually results in a decline in sexual desire and can create resentment and conflict within relationships.

Prevention

Although there is no sure way to prevent FOD, reducing life factors that cause **stress** can be effective. Healthy attitudes toward sex and education about sexual stimulation and responses can help prevent FOD. Seeking counseling or psychotherapy for past trauma or relationship issues can help minimize FOD and other sexual dysfunction problems.

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ORGANIZATIONS

American Association of Sex Educators, Counselors, and Therapists (AASECT), P.O. Box 1960, Ashland, VA, 23005–1960, (804) 752–0026, (804) 752–0056, aacect@aasect.org, http://www.aasect.org.

American College of Obstetricians and Gynecologists (ACOG), P.O. Box 96920, Washington, DC, 20090–6920, (202) 638–5577, (800) 673–8444, resources@acog.org, http://www.acog.org.

U.S. Department of Health and Human Services, Office on Women's Health, 200 Independence Ave., SW, Rm. 728E, Washington, DC, 20201, (202) 205–1960, (800) 994–9662, (202) 401–4005, http://www.womenshealth.gov.

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Female sexual arousal disorder

Definition

Female sexual arousal disorder (FSAD) is a woman's persistent or recurrent inability to achieve or maintain an adequate lubrication-swelling response during sexual activity. Sometimes FSAD is defined

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ALFRED KINSEY (1894–1956)

Alfred Kinsey became a household name in the 1950s with his groundbreaking research on the sexual mores of American women and men. His two major texts, *Sexual Behavior in the Human Male* (1948) and *Sexual Behavior in the Human Female* (1953), opened the way for research into human sexuality.

Kinsey and his colleagues at the Institute for Sex Research at Indiana University conducted thousands of interviews with men and women about their sexual habits. The 804-page *Sexual Behavior in the Human Male* sold 185,000 copies in its first year and became a *New York Times* bestseller. The work was scientifically based and nonjudgmental, with frank descriptions of biological functions. Although early polls indicated that most Americans were relieved to have an honest and open airing of human sexual practices, there was a tremendous backlash from conservative and religious organizations. *Sexual Behavior in the Human Female* caused an even greater stir. Its more controversial findings included the low incidence of female frigidity, high rates of premarital and extramarital sex, the rapidness of erotic responses, and a detailed discussion of clitoral versus vaginal orgasm. As sales of the book reached 250,000 in the United States alone, Kinsey's methods and motives came under scrutiny. Evangelist Billy Graham stated: "It is impossible to estimate the damage this book will do to the already deteriorating morals of America." Kinsey's research funding was revoked and for the remainder of his life he struggled to find support for his work.

simply as the inability to become sexually aroused or to maintain arousal despite sexual desire. FSAD stems from both physiological and psychological factors. It often results in avoidance of sex, painful intercourse, and sexual tension in relationships.

Demographics

FSAD is common in older women due to decreased hormone production after **menopause** and medical conditions associated with **aging**. However, because FSAD often occurs in combination with other female sexual dysfunctions and can be difficult to distinguish from them, and because women are often reluctant to seek help for FSAD, it is difficult to determine its incidence. There is also disagreement within the medical community concerning the exact demarcations of the various female sexual dysfunctions. One published review of the medical literature found that 22–43% of women experience some form of **sexual dysfunction**. Another study found that about 20% of women have problems with sexual lubrication.

Description

FSAD results from a woman's inability to undergo lubrication and swelling in response to sexual desire and stimulation. This lack of response interferes with sexual desire and satisfying intercourse.

William Masters and Virginia Johnson—the first researchers to extensively examine the physical components of human sexuality—identified four stages of sexual response: excitement, plateau, climax or orgasm, and resolution. More recent models have included emotional aspects of arousal. One model identifies three stages: desire, arousal, and orgasm. FSAD affects the excitement or arousal stage.

The first physiological change in the female body upon becoming aroused or sexually excited is the expansion of the blood vessels in the pelvic region, allowing more blood to flow to the lower abdomen and genitals. Some women experience this as a feeling of fullness in the pelvis, and either consciously or involuntarily contract the muscles in the genital area. The increased blood flow normally results in transudation—the seepage of fluid through the walls of the blood vessels—in this case into the vagina to provide lubrication before and during intercourse. Vaginal lubrication can occur very rapidly, within one minute, and is often very noticeable. The increase in blood flow also expands the upper portion of the vagina, the uterus, and the cervix. The lower third of the vagina, the labia, and the area around the clitoris swell and may tingle. The breasts also swell slightly. Together these physiological changes constitute the lubrication-swelling response, designed to facilitate entry of the penis into the vagina.

With FSAD the lubrication-swelling response is either absent or is not maintained through the completion of sexual activity. The lack of arousal and lubrication can result in painful intercourse (**dyspareunia**), emotional distress, and/or relationship problems. FSAD can be lifelong or acquired and generalized or situation-specific.

Causes and symptoms

The major symptom of FSAD is insufficient transudation, often resulting in painful and unsatisfactory intercourse. In addition to vaginal dryness, there is a

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KEY TERMS

Clitoris—The small erectile organ at the front of the female vulva that is the site of female sexual pleasure.

Dyspareunia—Difficult or painful sexual intercourse.

Estrogen—Any of several naturally occurring or synthetic steroid hormones that promote the growth and maintenance of the female reproductive system.

Kegel exercises—Repetitive contractions to tone the pubococcygeal muscle of the pelvic floor for enhancing sexual response during intercourse or controlling incontinence.

Labia—The fatty folds of the vulva.

Testosterone—The primary male sex hormone, which is also produced at low levels in females.

Transudation—The passage of fluid, as through blood vessels into the vagina.

Vulva—The external female genital organs, including the labia majora, labia minora, clitoris, and vestibule of the vagina.

lack of swelling, **tingling**, or throbbing in the genital region. Generalized FSAD occurs with different partners and in many different situations, whereas situation-specific FSAD occurs only with certain partners or under particular circumstances. FSAD can be caused by psychological factors or a combination of psychological and physiological factors. Whereas some women have never had a normal lubrication-swelling response, others develop FSAD from physiological changes, such as illness or emotional trauma, or as a side effect of surgery, **radiation therapy** for **cancer**, or a medication. Physiologically based FSAD can lead to psychological problems that reinforce the disorder.

Arousal disorder that primarily affects the genitals can result from low estrogen or testosterone levels during and after menopause, as well as from vaginal or bladder infections, or changes in the skin around the vulva. Other physiological causes of FSAD include:

- insufficient sexual stimulation
- irritation from contraceptive creams or foams
- smoking, which decreases blood flow throughout the body
- illicit drug use
- lower levels of sex hormones due to breastfeeding
- medical conditions that cause changes in hormone levels, including thyroid disorders, adrenal gland disorders, or removal of the ovaries
- side effects of medications such as antidepressants, antipsychotics, sedatives, high-blood-pressure drugs, or birth control pills or other hormone-containing medications
- reduced blood flow due to damaged blood vessels in the pelvic region, often from medical conditions such as coronary artery disease, high blood pressure, or diabetes
- damage to nerves in the pelvic area, as from diabetes or multiple sclerosis

Psychological causes of FSAD include:

- fear or anxiety around sex
- chronic mild depression (dysthymia)
- emotional stress
- low self-esteem
- past sexual abuse
- emotional abuse
- bereavement
- self-image problems
- relationship problems
- other mental health disorders, including major depression, post-traumatic stress disorder, or obsessive-compulsive disorder

Diagnosis

Since most women occasionally experience difficulties with sexual arousal, a diagnosis of FSAD requires that the deficient lubrication-swelling response is persistent or has occurred intermittently over an extended period and causes emotional distress or relationship difficulties. The *Diagnostic and Statistical Manual of Mental Disorders* (*DSM-IV-TR*) requires that FSAD be caused by psychological factors alone or a combination of psychological and physiological factors. Under these criteria, arousal disorder caused by physiological factors alone, such as injury, illness, or menopause is diagnosed as sexual dysfunction due to a general medical condition. Arousal disorder caused by medication or **substance abuse** alone is diagnosed as substance-induced sexual dysfunction. Arousal difficulties that are symptoms of a major psychological disorder, such as depression, or that result from inadequate sexual stimulation are not considered to be FSAD.

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Examination

FSAD is usually diagnosed after a woman reports sexual difficulties to her gynecologist, family doctor, psychotherapist, or sex therapist. The physician will take complete medical, psychological, and sexual histories, including a list of medications and details about sexual symptoms. A **physical examination**, including a gynecological/pelvic exam, will be performed.

Tests

Blood and urine tests may be performed to rule out undiagnosed diabetes or other medical conditions. Hormone levels in the blood may be measured.

Treatment

Traditional

FSAD treatment requires addressing underlying physiological and psychological causes. **Psychotherapy**, either individual or couples therapy, addresses emotions, communication, relationship problems, and problem-solving strategies. **Sex therapy** focuses primarily on the sexual dysfunction. However many couples experiencing sexual dysfunction develop relationship problems and can benefit from traditional psychotherapy even after sexual arousal difficulties are resolved.

The U.S. Food and Drug Administration (FDA) has approved one medical device for treating FSAD. The Eros-Clinical Therapy Device (Eros-CTD) is a small vacuum pump that fits over the clitoral area and exerts a gentle sucking action that stimulates blood flow. In clinical trials the device has proved safe and effective for increasing blood flow, sensation, and vaginal lubrication.

Drugs

Sometimes medications, such as the type or timing of an antidepressant, can be adjusted. Poor lubrication related to decreasing hormone levels associated with menopause can often be successfully treated with **hormone replacement therapy** (HRT), such as estrogen or testosterone. Nonprescription lubricating gels and hormone creams can supplement a woman's natural lubricant. These are especially useful for pre- and postmenopausal women and for those with occasional arousal difficulties.

Research is focusing on new drugs that increase blood flow to the female genitals, thereby improving lubrication. Some of these drugs are aimed at increasing nitric oxide levels, similar to the drug sildenafil (Viagra) for men.

Alternative

A type of **meditation** called mindfulness, which promotes increased awareness and acceptance, has been found to be helpful in treating FSAD, at least when practiced in the context of **group therapy**.

Home remedies

Home remedies for FSAD include:

- Kegel exercises that increase blood flow to the vulvar and vaginal tissues
- relaxation techniques
- aerobic exercise
- changing the circumstances and settings of sexual activity
- sexual activities other than vaginal intercourse
- exploring sexual techniques that increase stimulation
- experimenting with a vibrator, fantasies, or erotic movies
- couples focusing exercises to enhance intimacy, lessen anxiety, and increase arousal

Prognosis

Because of the multiple causes of FSAD individual responses to treatment vary widely. Poor lubrication related to menopause generally has a favorable prognosis. Stress-related causes of FSAD can often be resolved. However couples may need to work through relationship issues that have caused FSAD—or resulted from it—before sexual arousal improves. This process takes time and a joint commitment to problem solving.

Prevention

A healthy, well-balanced diet, adequate rest, regular gynecological exams, and seeking counseling or psychotherapy for problems can minimize the risk for sexual arousal disorder. Aerobic **exercise** and not **smoking** also can help prevent FSAD.

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ORGANIZATIONS

American Academy of Family Physicians, 11400 Tomahawk Creek Parkway, Leawood, KS, 66211-2680, (913) 906-6000, (800) 274-6000, (913) 906-6075, http://www.aafp.org/online/en/home.html.

American Association of Sex Educators, Counselors, and Therapists, P.O. Box 1960, Ashland, VA, 23005-1960, (804) 752-0026, (804) 752-0056, aacect@aasect.org, http://www.aasect.org.

American College of Obstetricians and Gynecologists, P.O. Box 96920, Washington, DC, 20090-6920, (202) 638-5577, (800) 673-8444, resources@acog.org, http://www.acog.org.

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Femoral hernia *see* **Hernia**

Ferritin test *see* **Iron tests**

Fetal alcohol syndrome

Definition

Fetal alcohol syndrome (FAS) is a pattern of **birth defects**, learning, and behavioral problems affecting individuals whose mothers drank alcohol during **pregnancy**.

Demographics

The occurrence FAS/FASD is independent of race, ethnicity, or gender of the individual. Individuals from different genetic backgrounds exposed to similar amounts of alcohol during pregnancy may show different symptoms of FAS. The reported rates of FAS vary widely among different populations studied depending on the degree of alcohol use within the population and the monitoring methods used. Studies by the Centers for Disease Control (CDC) show that, as of 2008, FAS occurs in 0.2 to 1.5 per 1,000 live births in different areas of the United States. FASDs are believed to occur approximately three times as often as FAS.

Description

FAS is the most severe of a range of disorders represented by the term fetal alcohol spectrum disorder (FASD). FAS/FASD is caused by exposure of a developing fetus to alcohol. FASD is used to describe individuals with some, but not all, of the features of FAS. Other terms used to describe specific types of FASD are alcohol-related neurodevelopmental disorder (ARND) and alcohol-related birth defects (ARBD).

FAS is the most common preventable cause of **mental retardation**. This condition was first recognized and reported in the medical literature in 1968 in France and in 1973 in the United States. Alcohol is a teratogen, the term used for any drug, chemical, maternal disease, or other environmental exposure that can cause birth defects or functional impairment in a developing fetus. Some features of FAS that may be present at birth include low birth weight, **prematurity**, and microcephaly. Characteristic facial features may be present at birth or may become more obvious over time. Signs of brain damage include delays in development, behavioral abnormalities, and mental retardation, but affected individuals exhibit a wide range of abilities and disabilities.

FAS is a lifelong condition. It is not curable and has serious long-term consequences. Learning, behavioral, and emotional problems are common in adolescents and adults with FAS/FASD. The costs of FAS to the American economy were estimated in 2006 as $321 million annually.

Risk factors

The only risk factor for a child to develop FAS is the consumption of alcohol by a woman who is

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KEY TERMS

Cleft plate—A congenital malformation in which there is an abnormal opening in the roof of the mouth that allows the nasal passages and the mouth to be improperly connected.

IQ—Abbreviation for Intelligence Quotient. Compares an individual's mental age to his/her true or chronological age and multiplies that ratio by 100.

Microcephaly—An abnormally small head.

Miscarriage—Spontaneous pregnancy loss.

Placenta—The organ responsible for oxygen and nutrition exchange between a pregnant mother and her developing baby.

Strabismus—An improper muscle balance of the ocular muscles resulting in crossed or divergent eyes.

Teratogen—Any drug, chemical, maternal disease, or exposure that can cause physical or functional defects in an exposed embryo or fetus.

pregnant. There is no known amount of alcohol use that is safe during pregnancy, nor is there a particular stage of pregnancy during which alcohol use is safe.

Causes and symptoms

The only cause of FAS is maternal use of alcohol during pregnancy. FAS is not a genetic or inherited disorder. Alcohol consumed by the mother freely crosses the placenta and damages the developing fetus. Alcohol use by the father cannot cause FAS. Not all offspring who are exposed to alcohol during pregnancy have signs or symptoms of FAS; individuals of different genetic backgrounds may be more or less susceptible to the damage that alcohol can cause. The amount of alcohol, stage of development of the fetus, and the pattern of alcohol use create the range of symptoms that encompass FASD.

Classic features of FAS include short stature, low birth weight, poor weight gain, microcephaly, and a characteristic pattern of abnormal facial features. These facial features in infants and children may include small eye openings (measured from inner corner to outer corner), epicanthal folds (folds of tissue at the inner corner of the eye), small or short nose, low or flat nasal bridge, smooth or poorly developed philtrum (the area of the upper lip above the colored part of the lip and below the nose), thin upper lip, and small chin. Some of these features are nonspecific, meaning they can occur in other conditions, or be appropriate for age, racial, or family background.

Other major and minor birth defects that have been reported to occur in conjunction with FAS/FASD include **cleft palate**, congenital heart defects, **strabismus**, **hearing loss**, defects of the spine and joints, alteration of the hand creases, small fingernails, and toenails. Since FAS was first described in infants and children, the diagnosis is sometimes more difficult to recognize in older adolescents and adults. Short stature and microcephaly remain common features, but weight may normalize, and the individual may actually become overweight for his/her height. The chin and nose grow proportionately more than the middle part of the face, and dental crowding may become a problem. The small eye openings and the appearance of the upper lip and philtrum may continue to be characteristic. Pubertal changes typically occur at the normal time.

Newborns with FAS may have difficulty nursing due to a poor sucking response, have irregular sleep-wake cycles, decreased or increased muscle tone, seizures or **tremors**. Delays in achieving developmental milestones such as rolling over, crawling, walking, and talking may become apparent in infancy. Behavior and learning difficulties typical in the preschool or early school years include poor attention span, hyperactivity, poor motor skills, and slow language development. Attention deficit-hyperactivity disorder (**ADHD**) is often associated with FASD. Learning disabilities or mental retardation may be diagnosed during this time.

During middle school and high school years the behavioral difficulties and learning difficulties can be significant. Memory problems, poor judgment, difficulties with daily living skills, difficulties with abstract reasoning skills, and poor social skills are often apparent by this time. It is important to note that animal and human studies have shown that neurologic and behavioral abnormalities can be present without characteristic facial features. These individuals may not be identified as having FAS, but may fulfill criteria for alcohol-related neurodevelopmental disorder (ARND).

FASD continues to affect individuals into adulthood. One study looked at FAS adults and found that about 95% had mental health problems, 82% lacked the ability to live independently, 70% had problems

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staying employed, 60% had been in trouble with the law, and 50% of men and 70% of women were alcohol or drug abusers.

Another long-term study found that the average IQ of the group of adolescents and adults with FAS in the study was 68 (70 is lower limit of the normal range). However, the range of IQ was quite large, ranging from a low of 20 (severely retarded) to a high of 105 (normal). Academic abilities and social skills were also below normal levels. The average achievement levels for reading, spelling, and arithmetic were fourth grade, third grade, and second grade, respectively. The Vineland Adaptive Behavior Scale was used to measure adaptive functioning in these individuals. The composite score for this group showed functioning at the level of a seven-year-old. Daily living skills were at a level of nine years, and social skills were at the level of a six-year-old.

Diagnosis

In 1996, the Institute of Medicine suggested a five-level system to describe the birth defects, learning problems, and behavioral difficulties in offspring of women who drank alcohol during pregnancy. This system contains criteria including confirmation of maternal alcohol exposure, characteristic facial features, growth problems, learning and behavioral problems, and birth defects known to be associated with prenatal alcohol exposure.

FAS is a clinical diagnosis, which means that no blood, x-ray or psychological test can be performed to confirm the suspected diagnosis. The diagnosis is made based on the history of maternal alcohol use, and detailed **physical examination** for the characteristic major and minor birth defects and characteristic facial features. It is often helpful to examine siblings and parents of an individual suspected of having FAS, either in person or by photographs, to determine whether findings on the examination might be familial, of if other siblings may also be affected. Sometimes, genetic tests are performed to rule out other conditions that may present with developmental delay or birth defects. Individuals with developmental delay, birth defects, or other unusual features are often referred to a clinical geneticist, developmental pediatrician, or neurologist for evaluation and diagnosis of FAS. Psychoeducational testing to determine IQ and/or the presence of learning disabilities may also be part of the evaluation process.

Treatment

There is no cure for FAS. The disorder is irreversible. Nothing can change the physical features or brain damage associated with maternal alcohol use during the pregnancy. Children should have psychoeducational evaluation to help plan appropriate educational interventions. Common associated diagnoses such ADHD, depression, or **anxiety** can be recognized and treated. The disabilities that present during childhood persist into adult life. However, some of the behavioral problems mentioned may be avoided or lessened by early and correct diagnosis, better understanding of the life-long complications of FAS, and intervention. The goal of treatment is to help the individual affected by FAS become as independent and successful in school, employment, and social relationships as possible.

Prognosis

The prognosis for FAS/FASD depends on the severity of birth defects and the brain damage present at birth. **Miscarriage**, **stillbirth**, or **death** in the first few weeks of life may be outcomes in very severe cases. Generally individuals with FAS have a long list of mental health problems and associated social difficulties: alcohol and drug problems, inappropriate sexual behavior, problems with employment, trouble with the law, inability to live independently, and often confinement in prison, drug or alcohol treatment centers, or psychiatric institutions.

Some of the factors that have been found to reduce the risk of learning and behavioral disabilities in FAS individuals include diagnosis before the age of six years, stable and nurturing home environments, never having experienced personal violence, and referral and eligibility for disability services. Some physical birth defects associated with FAS are treatable with surgery. The long-term data help in understanding the difficulties that individuals with FAS encounter throughout their lifetime and can help families, caregivers, and professionals provide the care, supervision, education and treatment geared toward their special needs.

Prevention

FAS and FASD are completely preventable by avoiding all use of alcohol while pregnant. Prevention efforts include public education efforts aimed at the entire population, not just women of child bearing age, appropriate treatment for women with high-risk drinking habits, and increased recognition and knowledge about FAS/FASD by professionals, parents, and caregivers.

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ORGANIZATIONS

Fetal Alcohol Spectrum Disorders Center for Excellence, 2101 Gaither Rd., Suite 600, Rockville, MD, 20850, (866) STOP-FAS (786-7327), http://fasdcenter.samhsa.gov.

Fetal Alcohol Syndrome (FAS) World Canada, 250 Scarborough Golf Club Rd., Toronto, ON, Canada, M1J 3G8, (416) 264-8000, (416) 264-8222, info@fasworld.com, http://www.fasworld.com.

March of Dimes Foundation, 1275 Mamaroneck Ave. White Plains, NY, 10605, (914) 997-4488, askus@marchofdimes.com, http://www.marchofdimes.com.

National Institute on Alcohol Abuse and Alcoholism (NIAAA), 5635 Fishers Ln., MSC 9304, Bethesda, MD, 20892-9304, (301) 443-3860, http://www.niaaa.nih.gov.

National Organization on Fetal Alcohol Syndrome (NOFAS), 900 17th St., NW, Suite 910, Washington, DC, 20006, (202) 785-4585, (800) 66-NOFAS , (202) 466-6456, http://www.nofas.org.

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Fetal death *see* **Stillbirth**

Fetal hemoglobin test

Definition

Fetal hemoglobin (Hemoglobin F), alkali-resistant hemoglobin, HBF (or Hb F), is the major hemoglobin component in the bloodstream of the fetus. After birth, it decreases rapidly until only traces are found in normal children and adults.wct 2

Purpose

The determination of fetal hemoglobin is an aid in evaluating low concentrations of hemoglobin in the blood (anemia), as well as the hereditary persistence of fetal hemoglobin, and a group of inherited disorders affecting hemoglobin, among which are the thalassemias and sickle cell anemia.

Description

At birth, the newborn's blood is comprised of 60–90% of fetal hemoglobin. The fetal hemoglobin then rapidly decreases to 2% or less after the second to fourth years. By the time of adulthood, only traces (0.5% or less) are found in the bloodstream.

In some diseases associated with abnormal hemoglobin production (see section on Hemoglobinopathy), fetal hemoglobin may persist in larger amounts. When this occurs, the elevation raises the question of possible underlying disease.

For example, HBF can be found in higher levels in hereditary hemolytic **anemias**, in all types of leukemias, in **pregnancy**, diabetes, thyroid disease, and during anticonvulsant drug therapy. It may also reappear in adults when the bone marrow is overactive, as in the disorders of **pernicious anemia**, **multiple myeloma**, and metastatic **cancer** in the marrow. When HBF is increased after age four, it should be investigated for cause.

Hemoglobinopathy

Hemoglobin is the oxygen-carrying pigment found in red blood cells. It is a large molecule made in the bone marrow from two components, heme and globin.

Defects in hemoglobin production may be either genetic or acquired. The genetic defects are further subdivided into errors of heme production (porphyria), and those of globin production (known collectively as the **hemoglobinopathies**).

Hemoglobinopathy is divided into two categories. In the first category, abnormal globin chains give rise

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KEY TERMS

Anemia—A disorder characterized by a reduced blood level of hemoglobin, the oxygen-carrying pigment of blood.

Hemolytic anemia—A form of anemia caused by premature destruction of red cells in the blood stream (a process called hemolysis). Hemolytic anemias are classified according to whether the cause of the problem is inside the red blood cell (in which case it is usually an inherited condition), or outside the cell (usually acquired later in life).

to abnormal hemoglobin molecules. In the second category, normal hemoglobin chains are produced but in abnormal amounts. An example of the first category is the disorder of sickle cell anemia, the inherited condition characterized by curved (sickle-shaped) red blood cells and chronic **hemolytic anemia**. Disorders in the second category are called the thalassemias, which are further divided into types according to which amino acid chain is affected (alpha or beta), and whether there is one defective gene (**thalassemia** minor) or two defective genes (thalassemia major).

Preparation

This test requires a blood sample. The patient is not required to be in a **fasting** state (nothing to eat or drink for a period of hours before the test).

Risks

Risks for this test are minimal, but may include slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after venipuncture, or hematoma (blood accumulating under the puncture site).

Normal results

Reference values vary from laboratory to laboratory but are generally found within the following ranges:

- six months to adult: up to 2% of the total hemoglobin
- newborn to six months: up to 75% of the total hemoglobin

Abnormal results

Greater than 2% of total hemoglobin is abnormal.

Resources

BOOKS

Pagana, Kathleen Deska, and Timothy J. Pagana. *Mosby's Manual of Diagnostic and Laboratory Tests*. 4th ed. St. Louis: Mosby, 2009.

Janis O. Flores

Fetishes *see* **Sexual perversions**

Fever

Definition

A fever is any body temperature elevation over 100 °F (37.8 °C).

Description

A healthy person's body temperature fluctuates between 97 °F (36.1 °C) and 100 °F (37.8 °C), with the average being 98.6 °F (37 °C). The body maintains stability within this range by balancing the heat produced by the metabolism with the heat lost to the environment. The "thermostat" that controls this process is located in the hypothalamus, a small structure located deep within the brain. The nervous system constantly relays information about the body's temperature to the thermostat, which in turn activates different physical responses designed to cool or warm the body, depending on the circumstances. These responses include: decreasing or increasing the flow of blood from the body's core, where it is warmed, to the surface, where it is cooled; slowing down or speeding up the rate at which the body turns food into energy (metabolic rate); inducing shivering, which generates heat through muscle contraction; and inducing sweating, which cools the body through evaporation.

A fever occurs when the thermostat resets at a higher temperature, primarily in response to an infection. To reach the higher temperature, the body moves blood to the warmer interior, increases the metabolic rate, and induces shivering. The "chills" that often accompany a fever are caused by the movement of blood to the body's core, leaving the surface and extremities cold. Once the higher temperature is achieved, the shivering and chills stop. When the infection has been overcome or drugs such as **aspirin** or **acetaminophen** (Tylenol) have been taken, the thermostat resets to normal and the body's cooling

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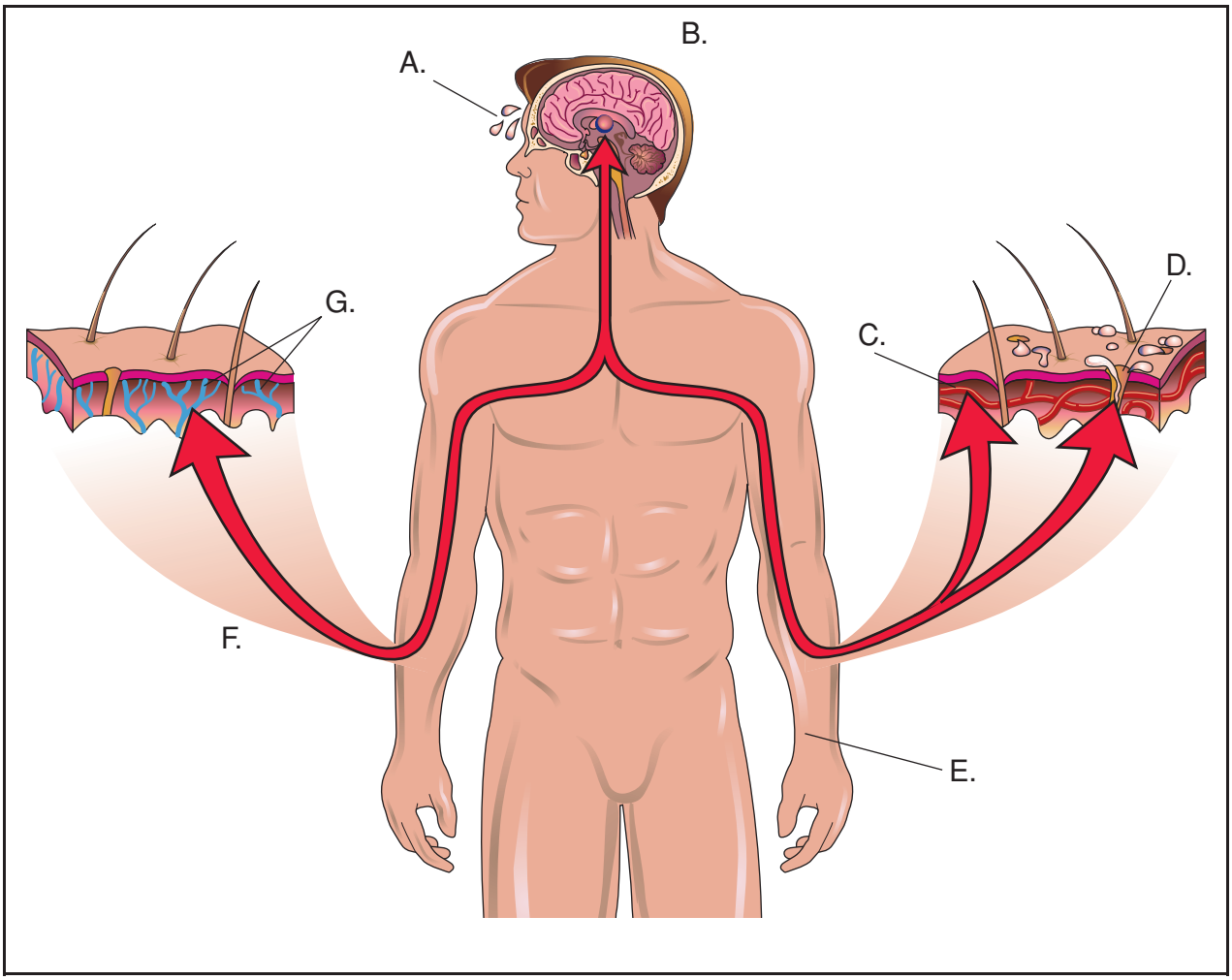

A dramatic rise in body temperature often includes the following symptoms: A. Loss of fluid results in dehydration. B. The hypothalamic set-point is increased, raising metabolism. C. Blood vessels in skin dilate. D. Sweat glands produce excess perspiration. E. Increased pulse rate. F. Increased hypothalmic set-point may introduce chills and shivering to promote heat production from muscles. G. Skin becomes more heat-sensitive. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

mechanisms switch on: the blood moves to the surface and sweating occurs.

Fever is an important component of the immune response, though its role is not completely understood. Physicians believe that an elevated body temperature has several effects. The immune system chemicals that react with the fever-inducing agent and trigger the resetting of the thermostat also increase the production of cells that fight off the invading bacteria or viruses. Higher temperatures also inhibit the growth of some bacteria, while at the same time speeding up the chemical reactions that help the body's cells repair themselves. In addition, the increased heart rate that may accompany the changes in blood circulation also speeds the arrival of white blood cells to the sites of infection.

Causes and symptoms

Fevers are primarily caused by viral or bacterial infections, such as **pneumonia** or **influenza**. However, other conditions can induce a fever, including allergic reactions; autoimmune diseases; trauma, such as breaking a bone; **cancer**; excessive exposure to the sun; intense **exercise**; hormonal imbalances; certain drugs; and damage to the hypothalamus. When an infection occurs, fever-inducing agents called pyrogens are released, either by the body's immune system or by the invading cells themselves, that trigger the resetting of the thermostat. In other circumstances, the immune system may overreact (allergic reactions) or become damaged (autoimmune diseases), causing the uncontrolled release of pyrogens. A **stroke** or tumor

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KEY TERMS

Antipyretic—A drug that lowers fever, like aspirin or acetaminophen.

Autoimmune disease—Condition in which a person's immune system attacks the body's own cells, causing tissue destruction.

Febrile seizure—Convulsions brought on by fever.

Malignant hyperthermia—A rare, inherited condition in which a person develops a very high fever when given certain anesthetics or muscle relaxants in preparation for surgery.

Meningitis—A potentially fatal inflammation of the thin membrane covering the brain and spinal cord.

Metabolism—The chemical process by which the body turns food into energy, which can be given off as heat.

Pyrogen—A chemical circulating in the blood that causes a rise in body temperature.

Reye's syndrome—A disorder principally affecting the liver and brain, marked by the rapid development of life-threatening neurological symptoms.

can damage the hypothalamus, causing the body's thermostat to malfunction. Excessive exposure to the sun or intensely exercising in hot weather can result in heat stroke, a condition in which the body's cooling mechanisms fail. Malignant hyperthermia is a rare, inherited condition in which a person develops a very high fever when given certain anesthetics or **muscle relaxants** in preparation for surgery.

How long a fever lasts and how high it may go depends on several factors, including its cause, the age of the patient, and his or her overall health. Most fevers caused by infections are acute, appearing suddenly and then dissipating as the immune system defeats the infectious agent. An infectious fever may also rise and fall throughout the day, reaching its peek in the late afternoon or early evening. A low-grade fever that lasts for several weeks is associated with autoimmune diseases such as lupus or with some cancers, particularly leukemia and lymphoma.

Diagnosis

A fever is usually diagnosed using a thermometer. A variety of different thermometers are available, including traditional glass and mercury ones used for oral or rectal temperature readings and more sophisticated electronic ones that can be inserted in the ear to quickly register the body's temperature. For adults and older children, temperature readings are usually taken orally. Younger children who cannot or will not hold a thermometer in their mouths can have their temperature taken by placing an oral thermometer under their armpit. Infants generally have their temperature taken rectally using a rectal thermometer.

As important as registering a patient's temperature is determining the underlying cause of the fever. The presence or absence of accompanying symptoms, a patient's medical history, and information about what he or she may have ingested, any recent trips taken, or possible exposures to illness help the physician make a diagnosis. Blood tests can aid in identifying an infectious agent by detecting the presence of antibodies against it or providing samples for growth of the organism in a culture. Blood tests can also provide the doctor with white blood cell counts. Ultrasound tests, **magnetic resonance imaging** (MRI) tests, or computed tomography (CT) scans may be ordered if the doctor cannot readily determine the cause of a fever.

Treatment

Physicians agree that the most effective treatment for a fever is to address its underlying cause, such as through the administration of **antibiotics**. Also, because a fever helps the immune system fight infection, it usually should be allowed to run its course. Drugs to lower fever (antipyretics) can be given if a patient (particularly a child) is uncomfortable. These include aspirin, acetaminophen (Tylenol), and ibuprofin (Advil). Aspirin, however, should not be given to a child or adolescent with a fever since this drug has been linked to an increased risk of **Reye's syndrome**. Bathing a patient in cool water can also help alleviate a high fever.

A fever requires emergency treatment under the following circumstances:

- newborn (three months or younger) with a fever higher than 100.5 °F (38 °C)
- infant or child with a fever higher than 103 °F (39.4 °C)
- fever accompanied by severe headache, neck stiffness, mental confusion, or severe swelling of the throat

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A very high fever in a small child can trigger seizures (febrile seizures) and therefore should be treated immediately. A fever accompanied by the listed symptoms can indicate the presence of a serious infection, such as **meningitis**, and should be brought to the immediate attention of a physician.

Prognosis

Most fevers caused by infection end as soon as the immune system rids the body of the pathogen and do not produce any lasting effects. The prognosis for fevers associated with more chronic conditions, such as autoimmune disease, depends upon the overall outcome of the disorder.

Resources

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Bridget Travers

Fever blister *see* **Cold sore**

Fever evaluation tests

Definition

Fever evaluation tests, better known as febrile agglutinins tests, are performed to detect the presence of antibodies in the blood that are sensitive to temperature changes. Antibodies are proteins produced by the immune system in response to specific infectious agents, such as viruses or bateria. Febrile agglutinins are antibodies that cause red blood cells to clump, but only when the blood is warmed to temperatures higher than the average body temperature of 98.6 °F (37 °C).

Purpose

The febrile agglutinins test is used to confirm the diagonsis of certain infectious diseases that stimulate the body to produce febrile agglutinins. The disease most commonly diagnosed by this test is **brucellosis**, a infection caused by bacteria belonging to the genus *Brucella* and characterized by intermittent fever, sweating, chills, aches, and mental depression. The test is also used to diagnose certain other infectious diseases: salmonellosis, caused by *Salmonella* bacteria and marked by **nausea** and severe **diarrhea**; rickettsial infections, a group of diseases caused by the bacteria *Rickettsia*; and **tularemia**, also called rabbit fever, a bacterial infection characterized by a high fever and swollen lymph nodes. The febrile agglutinins test can also be used to confirm the presence of two types of **cancer**, leukemia and lymphoma; however, doctors rarely use the test for this purpose, since other diagnostic tests are more reliable.

Description

A febrile agglutinins test can be performed at a doctor's office or a hospital. A nurse or technician will collect a few drops of blood (about 7 mL) in a small tube that has been cooled slightly. The specimen is then taken to a laboratory where it heated and examined for clumping. If the cells clump after warming and unclump as they cool, a febrile agglutinin titer (concentration) of greater than 1:80 is present.

Normal results

The results of febrile agglutinins tests require a doctor's interpretation. In general, however, a normal value is lower than 1:32.

Abnormal results

A value higher than 1:80 suggests a diagnosis for brucellosis or one of the other conditions indicated by this test.

Jill S. Lasker

Fever of unknown origin

Definition

Fever of unknown origin (FUO) refers to the presence of a documented fever for a specified time, for which a cause has not been found after a basic medical evaluation. The classic criteria developed in 1961 included: temperature greater than 101 °F (38.3 °C) for at least three weeks, and inability to find a cause after one week of study. Within the past decade, a revision has been proposed that categorizes FUO into classic, hospital acquired FUO, FUO associated with low white blood counts, and HIV associated FUO (**AIDS** related).

Description

Fever is a natural response of the body that helps in fighting off foreign substances, such as

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microorganisms, toxins, etc. Body temperature is set by the thermoregulatory center, located in an area in the brain called hypothalamus. Body temperature is not constant all day, but actually is lowest at 6 a.m. and highest around 4–6 p.m. In addition, temperature varies in different regions of the body; for example, rectal and urine temperatures are about one degree Fahrenheit higher than oral temperature and rectal temperature is higher than urine. It is also important to realize that certain normal conditions can effect body temperature, such as **pregnancy**, food ingestion, age, and certain hormonal changes.

Substances that cause fever are known as "pyrogens." Pyrogens come in two types: exogenous and endogenous. Those that originate outside the body, such as bacterial toxins, are called "exogenous" pyrogens. Pyrogens formed by the body's own cells in response to an outside stimulus (such as a bacterial toxin) are called "endogenous" pyrogens.

Researchers have discovered that there are several endogenous pyrogens. These are made up of small groups of amino acids, the building blocks of proteins. These natural pyrogens have other functions in addition to inducing fever; they have been named "cytokines." When cytokines are injected into humans, fever and chills develop within an hour. Interferon, tumor necrosis factor, and various interleukins are the major fever producing cytokines.

The production of fever is a very complex process. Somehow, these cytokines cause the thermoregulatory center in the hypothalamus to reset the normal temperature level. The body's initial response is to conserve heat by vasoconstriction, a process in which blood vessels narrow and prevent heat loss from the skin and elsewhere. This alone will raise temperature by two to three degrees. Certain behavioral activities also occur, such as adding more clothes, seeking a warmer environment, etc. If the hypothalamus requires more heat, then shivering occurs.

Fever is a body defense mechanism. It has been shown that one of the effects of temperature increase is to slow bacterial growth. However, fever also has some downsides: The body's metabolic rate is increased and with it, oxygen consumption. This can have a devastating effect on those with poor circulation. In addition, fever can lead to seizures in the very young.

When temperature elevation occurs for an extended period of time and no cause is found, the term FUO is then used. The far majority of these patients are eventually found to have one of several diseases.

Causes and symptoms

The most frequent cause of FUO is still infection, though the percentage has decreased in recent years. **Tuberculosis** remains an important cause, especially when it occurs outside the lungs. The decrease in infections as a cause of FUO is due in part to improved culture techniques. In addition, technological advances have made it easier to diagnose non-infectious causes. For example, tumors and autoimmune diseases in particular are now easier to diagnose. (An autoimmune disease is one that arises when the body tolerance for its own cell antigenic cell markers disappears.)

Allergies to medications can also cause prolonged fever; sometimes patients will have other symptoms suggesting an allergic reaction, such as a rash.

FUO has many possible causes. Generally though, a diagnosis can be found. About 10% of patients will wind up without a definite cause, and about the same percentage have "factitious fevers" (either self-induced or no fever at all).

Some general symptoms tend to occur along with fever. These are called constitutional symptoms and consist of myalgias (muscle aches), chills, and **headache**.

Diagnosis

Few symptoms in medicine present such a diagnostic challenge as fever. Nonetheless, if a careful, logical, and thorough evaluation is performed, a diagnosis will be found in most cases. The patient's past medical history as well as travel, social, and family history should be carefully searched for important clues.

Usually the first step is to search for an infectious cause. Skin and other screening tests for diseases such as tuberculosis, and examination of blood, urine, and stool, are generally indicated. Antibody levels to a number of infectious agents can be measured; if these are rising, they may point to an active infection.

Various x-ray studies are also of value. In addition to standard examinations, recently developed radiological techniques using ultrasound, computed tomography scan (CT scan) and **magnetic resonance imaging** (MRI) scans are now available. These enable physicians to examine areas that were once accessible only through surgery. Furthermore, new studies using radioactive materials (nuclear medicine), can detect areas of infection and inflammation previously almost impossible to find, even with surgery.

Biopsies of any suspicious areas found on an x-ray exam can be performed by either traditional or newer surgical techniques. Material obtained by biopsy is then

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KEY TERMS

AIDS—Acquired immune deficiency syndrome is often represented by these initials. The disease is associated with infection by the human immunodeficiency virus (HIV), and has the main feature of repeated infections, due to failure of certain parts of the immune system. Infection by HIV damages part of the body's natural immunity, and leads to recurrent illnesses.

Antibiotic—A medication that is designed to kill or weaken bacteria.

Computed tomography scan (CT Scan)—A specialized x-ray procedure in which cross-sections of the area in question can be examined in detail. This allows physicians to examine organs such as the pancreas, bile ducts, and others which are often the site of hidden infections.

Magnetic Resonance Imaging (MRI)—This technique is similar to CT Scan, but based on the magnetic properties of various areas of the body to compose images.

NSAID—Nonsteroidal anti-inflammatory drugs are medications such as aspirin and ibuprofen that decrease pain and inflammation. Many can now be obtained without a doctor's prescription.

Ultrasound—A non-invasive procedure based on changes in sound waves of a frequency that cannot be heard, but respond to changes in tissue composition. It is very useful for diagnosing diseases of the gallbladder, liver, and hidden infections, such as abscesses.

examined by a pathologist to look for clues as to the cause of the fever. Evidence of infection, tumor or other diseases can be found in this way. Portions of the biopsy are also sent to the laboratory for culture in an attempt to grow and identify an infectious organism.

Patients with HIV are an especially difficult problem, as they often suffer from many unusual infections. HIV itself is a potential cause of fever.

Treatment

Most patients who undergo evaluation for FUO do not receive treatment until a clear-cut cause is found. **Antibiotics** or medications designed to suppress a fever (such as NSAIDs) will only hide the true cause. Once physicians are satisfied that the fever has no infectious cause, they may use medications such as NSAIDs, or **corticosteroids** to decrease inflammation and diminish constitutional symptoms.

The development of FUO in certain settings, such as that acquired by patients in the hospital or in those with a low white blood count, often needs rapid treatment to avoid serious complications. Therefore, in these instances patients may be placed on antibiotics after a minimal number of diagnostic studies. Once test results are known, treatment can be adjusted as needed.

Prognosis

The outlook for patients with FUO depends on the cause of the fever. If the basic illness is easily treatable and can be found rather quickly, the potential for a cure is quite good. Some patients continue with temperature elevations for six months or more. If no serious disease is found, medications such as NSAIDs are used to decrease the effects of the fever. Careful follow-up and reevaluation is recommended in these cases.

Resources

BOOKS

Fauci, Anthony S., et al., eds. *Harrison's Principles of Internal Medicine*. 17th ed. New York: McGraw–Hill Professional, 2008.

David Kaminstein, MD

Fiber-modified diet *see* **Diets**

Fibrin degradation products *see* **Fibrin split products**

Fibrin split products

Definition

Fibrin split products (FSP) are fragments of protein released from a dissolving clot. The fibrin split products test is one of several tests done to evaluate a person with blood-clotting problems (coagulation), particularly disseminated intravascular coagulation (DIC).

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KEY TERMS

Coagulation—The entire process of blood clotting.

Coagulation cascade—A sequence of biochemical activities to stop bleeding by forming a clot.

Disseminated intravascular coagulation (DIC)—A serious medical condition that develops when the normal balance between bleeding and clotting is disturbed. Excessive bleeding and clotting injures body organs, and causes anemia or death.

Fibrin split products (FSP)—Pieces of the protein fibrin released from a dissolving clot.

Fibrinolysis—The clot dissolving portion of the coagulation process.

Titer—A dilution of a substance with an exact known amount of fluid. For example, one part of serum diluted with four parts of saline is a titer of 1:4.

Purpose

High levels of FSP in a person's blood are associated with DIC, a serious medical condition that develops when the normal balance between bleeding and clotting is disturbed. Excessive bleeding and clotting injures body organs, and causes anemia or **death**.

Description

Coagulation begins typically with an injury to some part of the body. The injury sets in motion a cascade of biochemical activities (the coagulation cascade) to stop the bleeding, by forming a clot from a mixture of the blood protein fibrin and platelets.

Once bleeding is stopped, another blood protein dissolves the clot by breaking down the fibrin into fragments. Measurement of these fragments gives information about the clot-dissolving portion of coagulation, called fibrinolysis.

In DIC, the coagulation cascade is triggered in an abnormal way. A blood infection, a **transfusion** reaction, a large amount of tissue damage, such as a burn, a dead fetus, and some cancers can begin the chain of biochemical events leading to **blood clots**. The coagulation cascade becomes overwhelmed with excessive clotting followed by excessive bleeding. As the large number of clots dissolve, fibrin split products accumulate in the blood and encourage even more bleeding.

Laboratory tests for FSP are done on the yellow liquid portion left over after blood clots (serum). A person's serum is mixed with a substance that binds to FSP. This bound complex is measured, and the original amount of FSP is determined. Some test methods give an actual measurement of FSP; some give a titer, or dilution. Methods that provide a titer look for the presence or absence of FSP. If the serum is positive for FSP, the serum is diluted, or titered, and the test is done again. These steps are repeated until the serum is so dilute that it no longer gives a positive result. The last dilution that gives a positive result is the titer reported.

The FSP test is covered by insurance when medically necessary. Results are usually available within one to two hours. Other names for this test are fibrin degradation products, fibrin breakdown products, or FDP.

Preparation

This test requires 0.17 oz (5/14m) of blood. A healthcare worker ties a tourniquet on the patient's upper arm, locates a vein in the inner elbow region, and inserts a needle into that vein. Vacuum action draws the blood through the needle into an attached tube. Collection of the sample takes only a few minutes.

Aftercare

Discomfort or bruising may occur at the puncture site. Pressure applied to the puncture site until the bleeding stops reduces bruising. Warm packs to the puncture site relieve discomfort. The patient may feel dizzy or faint.

Risks

People with coagulation problems may bleed longer than normal. The healthcare provider must make sure bleeding has stopped before leaving the patient unattended.

Normal results

Negative at a less than or equal to 1:4 dilution or less than 10 g/mL.

Abnormal results

High levels of FSP indicate DIC. Results of the test must be interpreted by the physician according to

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the person's clinical symptoms and medical history. Other conditions that increase blood clotting activity also increase FSP: venous thrombosis, surgery and transplants, blood clots in the lung, certain cancers, and **heart attack** (myocardial infarction).

Resources

BOOKS

McPherson, Richard A., Matthew R Pincus, and John Bernard Henry. *Henry's Clinical Diagnosis and Management by Laboratory Methods*. Philadelphia: Saunders/Elsevier, 2007.

Nancy J. Nordenson

Fibrinogen test

Definition

Fibrinogen (Factor I) is a protein that originates in the liver. It is converted to fibrin during the blood-clotting process (coagulation).

Purpose

The fibrinogen test aids in the diagnosis of suspected clotting or bleeding disorders caused by fibrinogen abnormalities.

Precautions

This test is not recommended for patients with active bleeding, acute infection or illness, or in those patients who have received blood transfusions within four weeks.

Drugs that may increase fibrinogen levels include estrogens and **oral contraceptives**. Drugs that may cause decreased levels include anabolic **steroids**, androgens, phenobarbital, urokinase, streptokinase, and valproic acid.

Description

Fibrinogen plays two essential roles in the body: It is a protein called an acute-phase reactant that becomes elevated with tissue inflammation or tissue destruction, and it is also a vital part of the "common pathway" of the coagulation process.

In order for blood to clot, fibrinogen must be converted to fibrin by the action of an enzyme called thrombin. Fibrin molecules clump together to form long filaments, which trap blood cells to form a solid clot.

The conversion of fibrinogen to fibrin is the last step of the "coagulation cascade," a series of reactions in the blood triggered by tissue injury and platelet activation. With each step in the cascade, a coagulation factor in the blood is converted from an inactive to an active form. The active form of the factor then activates several molecules of the next factor in the series, and so on, until the final step, when fibrinogen is converted into fibrin.

The factors involved in the coagulation cascade are numbered I, II, and V through XIII. Factor I is fibrinogen, while factor II (fibrinogen's immediate precursor) is called prothrombin. Most of the coagulation factors are made in the liver, which needs an adequate supply of vitamin K to manufacture the different clotting factors.

When fibrinogen acts as an "acute-phase reactant," it rises sharply during tissue inflammation or injury. When this occurs, high fibrinogen levels may be a predictor for an increased risk of heart or circulatory disease. Other conditions in which fibrinogen is elevated are cancers of the stomach, breast, or kidney, and inflammatory disorders like **rheumatoid arthritis**.

Reduced fibrinogen levels can be found in **liver disease**, **prostate cancer**, lung disease, bone marrow lesions, malnourishment, and certain bleeding disorders. The low levels can be used to evaluate disseminated intravascular coagulation (DIS), a serious medical condition that develops when there is a disturbed balance between bleeding and clotting. Other conditions related to decreased fibrinogen levels are those in which fibrinogen is completely absent (congenital afibrinogenemia), conditions in which levels are low (hypofibrinogenemia), and conditions of abnormal fibrinogen (dysfibrinogenemia). Obstetric complications or trauma may also cause low levels. Large-volume blood transfusions cause low levels because banked blood does not contain fibrinogen.

Preparation

This test is performed with a blood sample, which can be drawn at any time of day. The patient does not have to be **fasting** (nothing to eat or drink).

Aftercare

Because a fibrinogen test is often ordered when a bleeding disorder is suspected, the patient should apply pressure or a pressure dressing to the blood-drawn site site for a period of time after blood is drawn, and then reexamine the site for bleeding.

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KEY TERMS

Fibrin—The last step in the coagulation process. Fibrin forms strands that add bulk to a forming blood clot to hold it in place and help "plug" an injured blood vessel wall.

Platelet—An irregularly shaped cell-like particle in the blood that is an important part of blood clotting. Platelets are activated when an injury causes a blood vessel to break. They change shape from round to spiny, "sticking" to the broken vessel wall and to each other to begin the clotting process.

Prothrombin—A type of protein called a glycoprotein that is converted to thrombin during the clotting process.

Thrombin—An enzyme that converts fibrinogen into strands of fibrin.

Risks

Risks for this test are minimal, but may include slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after procedure, or the seeing the accumulation of blood under the puncture site (hematoma).

Normal results

Normal reference ranges are laboratory-specific, but are usually within the following:

- adult: 200 mg/dL–400 mg/dL
- newborn: 125 mg/dL–300 mg/dL

Abnormal results

Spontaneous bleeding can occur with values less than 100 mg/dL.

Resources

BOOKS

Pagana, Kathleen Deska, and Timothy J. Pagana. *Mosby's Manual of Diagnostic and Laboratory Tests*. 4th ed. St. Louis: Mosby, 2009.

Janis O. Flores

Fibroadenoma

Definition

Fibroadenomas are benign breast tumors commonly found in young women. Fibroadenoma means "a tumor composed of glandular (related to gland) and fibrous (containing fibers) tissues."

Description

Breast fibroadenomas, abnormal growths of glandular and fibrous tissues, are most common between the ages of 15 and 30, and are found in 10% of all women (20% of African-American women). They are found rarely in postmenopausal women.

Described as feeling like marbles, these firm, round, movable, and "rubbery" lumps range from 1–5 cm in size. Giant fibroadenomas are larger, lemon-sized lumps. Usually single, from 10–15% of women have more than one.

While some types of breast lumps come and go during the menstrual cycle, fibroadenomas typically do not disappear after a woman's period, and should be checked by a doctor.

Causes and symptoms

The cause of breast fibroadenomas is unknown. They may be dependent upon estrogen, because they are common in premenopausal women, can be found in postmenopausal women taking estrogen, and because they grow larger in pregnant women.

Fibroadenomas usually cause no symptoms and may be discovered during **breast self-examination**, or during a routine check-up.

Diagnosis

When the doctor takes a complete medical history, they will ask when the lump was first noticed, if there were any symptoms or changes in lump size, and if there is any personal or family history of breast disease.

The doctor thoroughly feels the breasts (palpates). Tests are done, usually including **mammography** or ultrasound scans, or surgical removal of cells or tissue for examination under a the microscope (biopsy).

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KEY TERMS

Aspiration—To withdraw material with a needle and syringe.

Biopsy—To remove cells or tissue for microscopic examination.

Estrogen—Female sex hormone produced by the ovaries.

Diagnostic tests include:

- mammogram, an x-ray examination of the breast
- ultrasound scan, a technique that uses sound waves to display a two-dimensional image of the breast, showing whether a lump is solid or fluid-filled (cystic)
- fine-needle aspiration biopsy, a minor procedure wherein fluid or cells are drawn out of the lump through a small needle (aspirated)
- core biopsy, a procedure wherein a larger piece of tissue is withdrawn from the lump through a larger needle
- incisional biopsy, a surgical procedure wherein a piece of the lump is removed through an cut (incision)
- excisional biopsy, a surgical procedure wherein the entire lump is removed through an cut (incision)

Most insurance plans cover the costs of diagnosing and treating fibroadenomas.

Treatment

Performed usually in outpatient settings, breast fibroadenomas are removed by **lumpectomy**, or surgical excision under local or **general anesthesia**. Sometimes lumps in younger women are not removed but are monitored by self-examination, yearly doctor check-ups, and mammograms. Surgery is generally recommended for women over 30, and for lumps that are painful or enlarging.

Alternative treatment

Alternative treatments for breast fibroadenomas include a low-fat, high-fiber, vegetarian-type diet; a reduction in **caffeine** intake; supplementation with evening primrose oil (*Oenothera biennis*), flax oil, or fish oil and **vitamins** E and C; and the application of hot compresses to the breast. In addition, a focus on liver cleansing is important to assist the body in conjugation and elimination of excess estrogens. Botanical remedies can be useful in hormone balancing, as can **acupuncture** and homeopathy. Massaging the breasts with castor oil, straight or infused with herbs or essential oils, can help fibroadenomas reduce and dissipate, as well as keep women in touch with changes in their breast tissue.

Prognosis

Breast fibroadenomas are not cancerous. The lumps recur in up to 20% of women. A small number of lumps disappear on their own.

Prevention

Breast fibroadenomas cannot be prevented. They can be discovered early by regular breast self-examination.

ORGANIZATIONS

American College of Obstetricians and Gynecologists (ACOG), P.O. Box 96920, Washington, DC, 20090-6920, (202) 638-5577, http://www.acog.org.

Mercedes McLaughlin

Fibrocystic breast disease *see* **Fibrocystic condition of the breast**

Fibrocystic condition of the breast

Definition

Fibrocystic condition of the breast is a term that may refer to a variety of symptoms: breast lumpiness or tenderness, microscopic breast tissue, and/or the x-ray or ultrasound picture of the breast. It has been called a "wastebasket" diagnosis because a wide range of vaguely defined benign breast conditions may be labeled as fibrocystic condition. It is not a **cancer**, and the majority of types of fibrocystic conditions do not increase the risk of **breast cancer**.

Description

There is no such thing as a normal or typical female breast. Breasts come in all shapes and sizes, with varying textures from smooth to extremely lumpy. The tissues of the female breast change in response to hormone levels, normal **aging**, nursing (**lactation**), weight fluctuations, and injury. To further complicate matters, the breast has several types of tissue; each of these tissue types may respond differently to changes in body chemistry.

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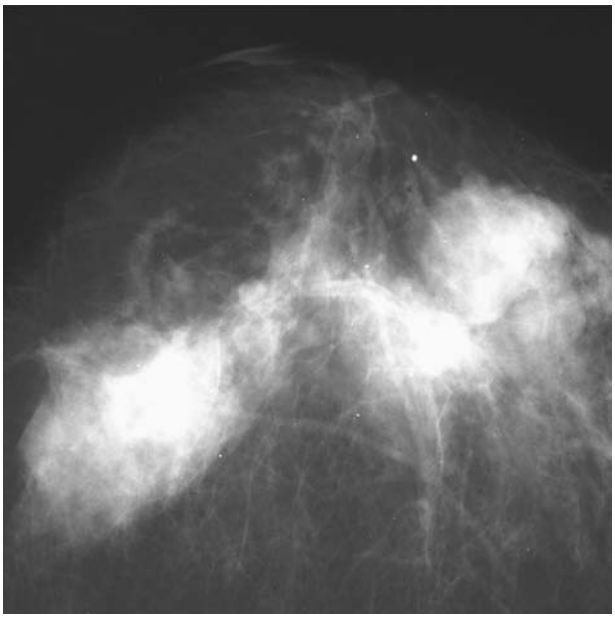

A mammogram of a female breast indicating multiple cysts. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Fibrocystic breast condition may be called fibrocystic disease, although it is clearly not a single, specific disease process. Variations or changes in the way the breast feels or looks on x-ray may cause the condition to be called "fibrocystic change." Other names have been used to refer to this imprecise and ill-defined term: mammary dysplasia, mastopathy, chronic cystic **mastitis**, indurative mastopathy, mastalgia, lumpy breasts, or physiologic nodularity.

Estimates vary, but 40–90% of all women have some evidence of "fibrocystic" condition, change, or disease. It is most common among women between the ages 30 and 50, but may be seen at other ages.

Causes and symptoms

Fibrocystic condition of the breast refers to technical findings on diagnostic testing (signs); however, this discussion focuses on symptoms that may fall under the general category of the fibrocystic condition. First, a brief review of the structure and function of the breast may be useful.

The breast is not supposed to be a soft, smooth organ. It is actually a type of sweat gland. Milk, the breasts' version of sweat, is secreted when the breast receives appropriate hormonal and environmental stimulation.

The normal breast contains milk glands, with their accompanying ducts, or pipelines, for transporting the milk. These complex structures may not only alter in size, but can increase or decrease in number as needed. Fibrous connective tissue, fatty tissue, nerves, blood and lymph vessels, and lymph nodes, with their different shapes and textures, lie among the ever-changing milk glands. It is no wonder that a woman's breasts may not feel uniform in texture and that the "lumpiness" may wax and wane.

The fibrocystic condition refers to the tenderness, enlargement, and/or changing "lumpiness" that many women encounter just before or during their menstrual periods. At this time, female hormones are preparing the breasts for **pregnancy**, by stimulating the milk-producing cells, and storing fluid. Each breast may contain as much as three to six teaspoons of excess fluid. Swelling, with increased sensitivity or **pain**, may result. If pregnancy does not occur, the body reabsorbs the fluid, and the engorgement and discomfort are relieved.

Symptoms of fibrocystic breast condition range from mildly annoying in some women to extremely painful in others. The severity of discomfort may vary from month to month in the same woman. Although sometimes distressing, this experience is the body's normal response to routine hormonal changes.

This cycle of breast sensitivity, pain and/or enlargement, can also result from medications. Some hormone replacement therapies (estrogen and progesterone) used for postmenopausal women can produce these effects. Other medications, primarily, but not exclusively those with hormones may also provoke these symptoms.

Breast pain unrelated to hormone shifts is called "noncyclic" pain. "Trigger-zone breast pain" is a term that may also be used to describe this area-specific pain. This type of pain may be continuous, or it may be felt intermittently. Trauma, such as a blow to the chest area, a prior **breast biopsy**, or sensitivity to certain medications may also underlie this type of pain. Fibrocystic condition of the breast may be cited as the cause of otherwise unexplained breast pain.

Lumps, apart from those clearly associated with hormone cycles, may also be placed under the heading of fibrocystic condition. These lumps stand out from enlarged general breast tissue. Although noncancerous lumps may occur, the obvious concern with such lumps is cancer.

Noncancerous breast lumps include:

- Adenosis. This condition refers to the enlargement of breast lobules, which contain a greater number of glands than usual. If a group of lobules are found

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near each other, the affected area may be large enough to be felt.

- Cysts. These are fluid-filled sacs in the breast and probably develop as ducts that become clogged with old cells in the process of normal emptying and filling. Cysts usually feel soft and round or oval. However, a cyst deep within the breast may feel hard, as it pushes up against firmer breast tissue. A woman with a cyst may experience pain, especially if it increases in size before her menstrual cycle, as is often the case. Women between the age of 30 and 50 are most likely to develop cysts.
- Epithelial hyperplasia. Also called proliferative breast disease, this condition refers to an overgrowth of cells lining either the ducts or the lobules.
- Fibroadenomas. These are tumors that form in the tissues outside the milk ducts. The cause of fibroadenomas is unknown. They generally feel smooth and firm, with a somewhat rubber-like texture. Typically a fibroadenoma is not attached to surrounding tissue and moves slightly when touched. They are most commonly found in adolescents and women in their early 20s but can occur at any age.
- Fibrosis. Sometimes one area of breast tissue persistently feels thicker or more prominent than the rest of the breast. This feeling may be caused by old hardened scar tissue and/or dead fat tissue as a result of surgery or trauma. Often the cause of this type of breast tissue is unknown.
- Miscellaneous disorders. A number of other benign (noncancerous) breast problems may be placed under the heading of "fibrocystic condition." These problems include disorders that may lead to breast inflammation (mastitis), infection, and/or nipple discharge.

Atypical ductal hyperplasia

Known as atypical ductal hyperplasia (ADH), this is a condition in which the cells lining the milk ducts of the breast are growing abnormally. This condition may appear as spots of **calcium** salts, or calcifications, on the mammogram. A biopsy removed from the breast would confirm the diagnosis. Atypical ductal hyperplasia is not a cancer. In most women, this condition will cause no problems. However, for some women, especially women with family histories of breast cancer, the risk of developing breast cancer is increased. (One study with more than 3,000 female participants indicated that about 20% of the participants who had atypical hyperplasia and a family history of breast cancer, developed breast cancer, as compared to the 8% of participants who developed the disease with atypical hyperplasia and no family history of breast cancer.) For women with ADH and a family history of breast cancer, more frequent mammograms and closer monitoring may be required.

Diagnosis

Breast cancer is the most common concern of women who feel a breast lump or experience an abnormal breast symptom. For peace of mind, and to rule out any possibility of cancer, any newly discovered breast lumps should be brought to the attention of a family physician or an obstetrician-gynecologist. He or she will obtain a history and conduct thorough **physical examination** of the area. Depending on the findings of the physical examination, the patient is usually referred for tests. The most common of these tests include:

- Mammography. A mammogram is an x-ray examination of the breasts. The two major types of abnormalities doctors look for are masses and calcifications; either abnormality may be benign or malignant. The size, shape, and edges of these masses help doctors determine whether or not cancer is present. Sometimes, however, this test may be difficult to interpret, however, due to dense breast tissue.
- Ultrasonography. If a suspicious lump is detected during mammography, an ultrasound (the use of high-frequency sound waves to outline the shape of various organs and tissues in the body) is useful (although not definitive) in distinguishing benign from cancerous growths.
- Ductography. A ductogram (also called a galactogram) is a test that is sometimes useful in evaluating nipple discharge. A very fine tube is threaded into the opening of the duct onto the nipple. A small amount of dye is injected, outlining the shape of the duct on an x-ray, and indicates whether or not there is a mass in the duct.
- Biopsy. If a lump cannot be proven benign by mammography and ultrasound, a breast biopsy may be considered. Usually a tissue sample is removed through a needle (fine-needle aspiration biopsy, or FNAB) to obtain a sample of the lump. The sample is examined under the microscope by a pathologist, and a detailed diagnosis regarding the type of benign lesion or cancer is established. In some cases, however, FNAB may not provide a clear diagnosis, and another type of biopsy (such as a surgical biopsy, core-needle biopsy, or other stereotactic biopsy methods—such as the mammotome or advanced breast biopsy instrument) may be required.

Other breast conditions such as inflammation or infection are usually recognized on the basis of suspicious history, **breastfeeding**, or characteristic

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KEY TERMS

Advanced Breast Biopsy Instrument (ABBI)—Uses a rotating circular knife and thin heated electrical wire to remove a large cylinder of abnormal breast tissue.

Lobules—A small lobe or subdivision of a lobe (often on a gland) that may be seen on the surface of the gland by bumps or bulges.

Lymph nodes—Rounded, encapsulated bodies consisting of an accumulation of lymphatic tissue.

Mammotome—A method for removing breast biopsies using suction to draw tissue into an opening in the side of a cylinder inserted into the breast tissue. A rotating knife then cuts tissue samples from the rest of the breast; also known as a vacuum-assisted biopsy.

Stereotactic biopsy—A biopsy taken by precisely locating areas of abnormal growth through the use of delicate instruments.

symptoms such as pain, redness, and swelling. A positive response to appropriate therapies often confirms the diagnosis.

Treatment

Once a specific disorder within the broad category of fibrocystic condition is identified, treatment can be prescribed. There are a number of treatment options for women with a lump that has been diagnosed as benign. If it is not causing a great deal of pain, the growth may be left in the breast. However, some women may choose to have a lump, such as a **fibroadenoma**, surgically removed, especially if it is large. Another option to relieve the discomfort of a painful benign lump is to have the cyst suctioned, or drained. If there is any uncertainty regarding diagnosis, the fluid may be sent to the lab for analysis.

Symptoms of cycle breast sensitivity and engorgement may also be treated with diet, medication, and/or physical modifications. For example,

- Although no scientific data is available to support this claim, many women have reported relief of symptoms when caffeine was reduced or eliminated from their diets. Decreasing salt before and during the period when breasts are most sensitive may also ease swelling and discomfort. Low-fat diets and elimination of dairy products also appear to decrease soreness for some women. However, it may take several months to realize the effects of these various treatments.
- Over-the-counter analgesics such as acetaminophen (Tylenol) or ibuprofen (Advil) may be recommended. In some cases, treatment with prescription drugs such as hormones or hormone blockers may prove successful. Oral contraceptives may also be prescribed.
- Warm soaks or ice packs may provide comfort. A well-fitted support bra can minimize physical movement and do much to relieve breast discomfort. Breast massage may promote removal of excess fluid from tissues and alleviate symptoms. Massaging the breast with castor oil, straight or infused with herbs or essential oils, can help reduce and dissipate fibroadenomas as well as keep women in touch with changes in their breast tissue.
- Infections are often treated with warm compresses and antibiotics. Lactating women are encouraged to continue breastfeeding because it promotes drainage and healing. However, a serious infection may progress to form an abscess that may need surgical drainage.
- Some studies of alternative or complementary treatments, although controversial, have indicated that vitamins A, B complex and E, and mineral supplements may reduce the risk of developing fibrocystic condition of the breast. Evening primrose oil (*Oenothera biennis*), flaxseed oil, and fish oils have been reported to be effective in relieving cyclic breast pain for some women.

Prognosis

Most benign breast conditions carry no increased risk for the development of breast cancer. However, a small percentage of biopsies uncover overgrowth of tissue in a particular pattern in some women; this pattern indicates a 15–20% increased risk of breast cancer over the next 20 years. Strict attention to early detection measures, such as annual mammograms, is especially important for these women.

Prevention

There is no proven method of preventing the various manifestations of fibrocystic condition from occurring. Some alternative health care practitioners believe that eliminating foods high in methyl xanthines (primarily coffee and chocolate) can decrease or reverse fibrocystic breast changes.

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Resources

BOOKS

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American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (800) 227-2345, http://www.cancer.org.
American College of Obstetricians and Gynecologists (ACOG), P.O. Box 96920, Washington, DC, 20090-6920, (202) 638-5577, http://www.acog.org.
NCI Office of Communications and Education, 6116 Executive Blvd. Suite 300, Bethesda, MD, 20892-8322, (800) 4-CANCER (422-6237), cancergovstaff@mail.nih.gov, http://www.cancer.gov/aboutnci/cis.

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Fibroids *see* **Uterine fibroids**

Fibromyalgia

Definition

Fibromyalgia is an inflammation of the fibrous or connective tissue (muscles, joints, ligaments, and tendons) of the body. It is characterized by muscle **pain**, **fatigue**, and multiple tender points on the body. Many individuals with fibromyalgia describe the symptoms as similar to the aches and pains of a severe case of the flu. Fibrositis, and fibromyositis are names given to a set of symptoms believed to be caused by the same general problem.

Description

Fibromyalgia is more common than was once thought. According to the American College of Rheumatology, as many as 2–4% of the U.S. population may be affected by the disorder. Fibromyalgia is more prevalent in adults than children, with more women affected than men, particularly women of childbearing age.

KEY TERMS

Connective tissue—Tissue that supports and binds other body tissue and parts.

Lyme disease—An acute recurrent inflammatory disease involving one or a few joints, believed to be transmitted by a tick-borne virus. The condition was originally described in the community of Lyme, Connecticut, but has also been reported in other parts of the United States and other countries. Knees and other large joints are most commonly involved with local inflammation and swelling.

Rheumatology—The study of disorders characterized by inflammation, degeneration of connective tissue, and related structures of the body. These disorders are sometimes collectively referred to as rheumatism.

Causes and symptoms

The exact cause of fibromyalgia is not known. Sometimes it occurs in several members of a family, suggesting that it may be an inherited disorder. Researchers have investigated a number of possible causes, including genetic causes, **sleep disorders**, specific injuries, infections, problems with muscle metabolism, problems with the neurons that transmit information about pain, and nervous system abnormalities. Research is frequently unable to determine if a specific problem, such as sleep disturbances, results from fibromyalgia or are a possible cause of the condition. It is likely that a number of factors must occur in combination to cause fibromyalgia.

Pain is the major symptom with aches, tenderness, and stiffness of multiple muscles, joints, and soft tissues. The pain may move from one part of the body to another. It is most common in the neck, shoulders, chest, arms, legs, hips, and back. Although the pain is present most of the time and may last for years, the severity of the pain may fluctuate.

Symptoms of fatigue may result from the individual's chronic pain coupled with **anxiety** about the problem and how to find relief. The inflammatory process also produces chemicals that are known to cause fatigue. Other common symptoms are tension headaches, difficulty swallowing, recurrent abdominal pain, **diarrhea**, and **numbness** or **tingling** of the extremities. **Stress**, anxiety, depression, or lack of sleep can increase symptoms. Intensity of symptoms is variable, ranging from gradual improvement to episodes of recurrent symptoms.

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Diagnosis

Diagnosis is difficult and frequently missed because symptoms of fibromyalgia are vague and generalized. Coexisting nerve and muscle disorders such as **rheumatoid arthritis**, spinal arthritis, or **Lyme disease** may further complicate the diagnostic process. As of 2008, no tests were available to specifically diagnose fibromyalgia. The diagnosis is usually made after ruling out other medical conditions with similar symptoms such as lupus and **hypothyroidism**.

Because of the emotional distress experienced by people with this condition and the influence of stress on the symptoms themselves, fibromyalgia has often been labeled a psychological problem. Although the debate about fibromyalgia continues, research on possible causes of the condition and public awareness campaigns have helped promote fibromyalgia's validity as a physiological problem.

The American College of Rheumatology has developed standards for fibromyalgia that healthcare practitioners can use to diagnose this condition. According to these standards, individuals can be diagnosed with fibromyalgia if they have widespread pain in combination with tenderness in at least 11 of the 18 sites known as trigger points. Trigger point sites include the base of the neck, along the backbone, in front of the hip and elbow, and at the rear of the knee and shoulder.

Treatment

Fibromyalgia has no known cure. Therefore, the goal of treatment is successful symptom management. Treatment usually requires a combination of therapies, including medication, **exercise**, and lifestyle adjustments. On June 21, 2007, the U.S. Food and Drug Administration (FDA) approved the first drug to treat fibromyalgia. Although previously many doctors had prescribed a variety of medications intended to help reduce the symptoms of fibromyalgia, Lyrica (pregabalin) was the first drug approved specifically for the treatment of fibromyalgia. Made by Pfizer, Lyrica was already used to treat pain associated with nerve damage caused by diabetes, pain following **shingles**, and partial seizures. A study of 1,800 patients showed that Lyrica was also effective in treating the pain associated with fibromyalgia in many people. Lyrica was not found to be effective in everyone with fibromyalgia, however, and it can have side effects, including sleepiness, **dizziness**, weight gain, swelling of the feet and hands, blurred vision, and **dry mouth**.

In addition to treatment with medication there are many other ways of managing the symptoms of fibromyalgia. Adequate rest is essential, as is a healthy diet. The diet should include a large variety of fruits and vegetables, which provide the body with trace elements and **minerals** that are necessary for healthy muscles. Avoidance of stimulating foods or drinks (such as coffee) and medications such as **decongestants** prior to bedtime is advised. Individuals should have a clear understanding of their role in the recovery process because it determines the successful management of this condition.

Other treatments found to be helpful include heat and occasionally cold-compress applications. A regular stretching program is often useful. Aerobic activities focusing on increasing the heart rate are the preferred forms of exercise over most other forms of exertion. Exercise programs need to include good warm-up and cool-down sessions, with special attention given to avoiding exercises causing joint pain. **Hydrotherapy** exercises (exercises in a pool or tub) may be useful in providing a low-impact exercise environment while soothing muscle and joint pain.

Massage therapy can be helpful, especially when a family member is instructed on specific massage techniques to manage episodes of increased symptoms. Short sessions are most helpful as repetitious movement can aggravate the condition. Specific attention to mental health, including psychological treatment, may also be important, since depression may precede or accompany fibromyalgia. Relaxation exercises, **yoga**, **aromatherapy**, **guided imagery**, and other relaxation therapies can be useful in easing stress and promoting overall well-being. A Mayo Clinic study released in 2006 found that **acupuncture** can be helpful in relieving the symptoms of fibromyalgia.

Herbalists and aromatherapists may recommend tub soaks or compresses with lavender (*Lavandula angustifolia*), chamomile (*Chamaemelum nobilis*), or juniper (*Juniperus communis*) to soothe muscle and joint pain.

Allopathic treatment

People with fibromyalgia often need a rheumatology consultation (a meeting with a doctor who specializes in disorders of the joints, muscles, and soft tissue) to decide the cause of various rheumatic symptoms, to be educated about fibromyalgia and its treatment, and to exclude other rheumatic diseases. A treatment program must be individualized to meet the patient's needs. The rheumatologist, as the team leader, enlists and coordinates the expertise of other health professionals in the care of the patient.

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Prognosis

Fibromyalgia is a chronic health problem. The symptoms sometimes improve and at other times worsen, but they often continue for months to years.

Fibromyalgia can be a stressful and frustrating condition for a majority of patients. Successful treatment often requires a period of trial and error to pinpoint which agents and activities work best for the individual. Support from a health care team and coordination of care through follow-up calls to outside health care providers may be beneficial.

Clinical parameters are **pain management**, improved sleep management, introduction of relaxation techniques (including massage and **biofeedback** if needed), and monitoring alternative treatments and medication. Education is an integral part of the treatment and management of fibromyalgia and its symptoms.

A wide variety of health care providers may be involved in an individual's care, including nurses, physicians, a rheumatologist or other subspecialist, nutritionist, physical therapist, alternative medicine caregiver, or mental health care provider.

Prevention

No known or specific prevention for fibromyalgia exists. However, similar to many other medical conditions, remaining as healthy as possible with a good diet, safe exercise, and adequate rest is the best prevention.

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ORGANIZATIONS

American Pain Society, 4700 W. Lake Ave., Glenview, IL, 60025, (847) 375-4715., http://www.ampainsoc.org.

National Chronic Fatigue Syndrome and Fibromyalgia Association, P.O. Box 18426, Kansas City, MO, 64133, (913) 321-2278, http://www.ncfsfa.org/.

National Fibromyalgia Association, 2121 S. Towne Centre Place, Suite 300, Anaheim, CA, 92806, (714) 921-0150., http://www.fmaware.org.

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Fibromyomas *see* **Uterine fibroids**
Fibrous breast lumps *see* **Fibroadenoma**

Fifth disease

Definition

Fifth disease is a mild childhood illness caused by the human parvovirus B19 that causes flu-like symptoms and a rash.

Demographics

Anyone can get the disease, but it occurs more frequently in school–aged children. Outbreaks most often occur in the winter and spring, peaking every four to seven years. About 60% of adults have had the disease by age 20.

Description

Fifth disease got its name because it was fifth on a list of common childhood illnesses that are accompanied by a rash, including **measles**, **rubella** or German measles, **scarlet fever** (or scarlatina), and scarlatinella, a variant of scarlet **fever**. The Latin name for the

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This infant has a rash caused by Fifth disease, or *erythema infectiosum*. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

disease is *erythema infectiosum*, meaning infectious redness. It is also called the "slapped cheek disease" because, when the bright red rash first appears on the cheeks, it looks as if the face has been slapped. The disease is usually mild, and both children and adults normally recover quickly without complications. In fact, some individuals exhibit no symptoms and never feel ill.

Causes and symptoms

Fifth disease is caused by the human parvovirus B19, a member of the Parvoviridae family of viruses that lives in the nose and throat of the infected person. The virus is spread through the air by coughing and sneezing. Because the virus needs a rapidly dividing cell in order to multiply, it attacks the red blood cells of the body. Once infected, a person is believed to be immune to re–infection.

Symptoms appear four to 21 days after exposure to the virus. Initial symptoms are flu–like and include **headache**, body ache, **sore throat**, a mild fever of 101 °F (38.3 °C), and chills. It is at this time, before development of the rash, that individuals are contagious. These symptoms last for two to three days. In children, a bright red rash that looks like a slap mark develops suddenly on the cheeks. The rash may be flat or raised and may or may not be itchy. Sometimes, the rash spreads to the arms, legs, and trunk, where it has a lace–like or net–like appearance. The rash can also involve the palms of the hands and soles of the feet. By the time the rash appears, individuals are no longer infectious. On average, the rash lasts for 10–11 days, but may last for as long as five to six weeks. The rash may fade away and then reappear upon exposure to sunlight, hot baths, emotional distress, or vigorous **exercise**.

Adults generally do not develop a rash, but instead may have swollen and painful joints, especially in the hands and feet. In adults, symptoms such as sore throat, headache, muscle and joint **pain**, abdominal pain, **diarrhea**, and **vomiting** occur more frequently than in children and usually are more severe. Joint pain can be arthritis–like and last for several months, especially in women, but the disease does not appear to progress to **rheumatoid arthritis**.

The virus causes the destruction of red blood cells; therefore, a deficiency in the oxygen–carrying capacity of the blood (anemia) can result. In healthy people, the anemia is mild and lasts only a short while. In people with weakened immune systems, either because they have a chronic disease such as HIV infection/AIDS or **cancer** and are immunocompromised; or they are receiving medication to suppress the immune system and are therefore immunosuppressed (e.g., organ transplant recipients), this anemia can be severe and last long after the infection has subsided. Symptoms of anemia include **fatigue**, lack of healthy color, lack of energy, and **shortness of breath**. Some individuals with **sickle cell disease**, iron deficiency, a number of different hereditary blood disorders, and those who have received bone marrow transplantations may be susceptible to developing a potentially life–threatening complication called a transient aplastic crisis, in which the body is temporarily unable to form new red blood cells.

In very rare instances, the virus can cause inflammation of different areas of the body, including the brain (**encephalitis**), the covering of the brain and spinal cord (**meningitis**), the lungs (pneumonitis), the liver (hepatitis), and the heart muscle (**myocarditis**). The virus also can aggravate symptoms for people with an autoimmune disease called **systemic lupus erythematosus** (SLE).

Some concern surrounds fifth disease in pregnant women. Although no association with an increased number of **birth defects** or **mental retardation** has been demonstrated, there is concern that infection during the first three months of **pregnancy** may slightly increase the risk of **miscarriage**. Some concern also exists that infection later in pregnancy may involve a very small risk of premature delivery or **stillbirth**. As a

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KEY TERMS

Anemia—A congenital or acquired deficiency in the iron–carrying capacity of the blood.

Antibody—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

Immunocompromised—A state in which the immune system is weakened or is not functioning properly due to chronic disease.

Immunosuppressed—A state in which the immune system is suppressed by medications during the treatment of other disorders, such as cancer, or following an organ transplantation.

Reye's syndrome—A very serious, rare disease, most common in children, that involves an upper respiratory tract infection followed by brain and liver damage.

Sickle cell disease—A hereditary blood disorder in which red blood cells are misshapen into crescent or sickle shapes resulting in a reduced oxygen–carrying capacity of the lungs.

Systemic lupus erythematosus (SLE)—A chronic, inflammatory, autoimmune disorder in which the individual's immune system attacks, injures, and destroys the body's own organs and tissues. It may affect many organ systems including the skin, joints, lungs, heart, and kidneys.

result, women who get fifth disease while they are pregnant should be monitored closely by a physician.

Diagnosis

Examination

Fifth disease usually is suspected based on a patient's symptoms, including the typical appearance of the bright red rash on the cheeks, patient history, age, and time of year. The physician will exclude other potential causes for the symptoms and rash, including rubella, **infectious mononucleosis**, bacterial infections such as **Lyme disease**, allergic reactions, and SLE.

Tests

In addition, a blood test is available for fifth disease, but it is generally used only for pregnant women and for people who have weakened immune systems or who have blood disorders, such as sickle cell disease. The test involves measuring for a particular antibody or protein that the body produces in response to infection with the human parvovirus B19. The test is 92–97% specific for this disease.

Because fifth disease can pose problems for an unborn fetus exposed to the disease through the mother, testing may also be conducted while a fetus is still in the uterus. This test uses fluid collected from the sac around the fetus (amniotic fluid) instead of blood to detect the viral DNA.

Treatment

In general, no specific treatment for fifth disease is required. The symptoms can be treated using over–the counter medications, such as **acetaminophen** (Tylenol) or ibuprofen (Motrin, Advil). If the rash itches, calamine lotion can be applied. **Aspirin** is not given to children under the age of 18 to prevent the development of a serious illness called **Reye's syndrome**.

Patients who are receiving medications to suppress the immune system in the treatment of some other condition may be allowed to temporarily decrease the medications in order to allow the immune system to combat the infection and recover from the anemia. Those with weakened (not suppressed) immune systems, such as HIV/AIDS patients, may be given immunoglobulin intravenously to help the immune system fight the infection. People with severe anemia or who experience an aplastic crisis may require hospitalization and blood transfusions.

Prognosis

Generally, fifth disease is mild, and patients tend to improve without any complications. In cases where the patient is either immunocompromised or immunosuppressed, a life–threatening aplastic crisis can occur. With prompt treatment, however, the prognosis is good. Mothers who develop the infection while pregnant can pass the infection on to their fetus, and as such, stand a very small increased risk of miscarriage and stillbirth. Tests and treatments, however, can be performed on the fetus while still in the uterus that can reduce the risk of anemia or other complications.

Prevention

Currently, there is no vaccine against fifth disease. Because people with fifth disease are contagious

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before definitive symptoms appear, it is very difficult to prevent infection. Avoiding contact with persons who exhibit symptoms of a cold and maintaining good personal hygiene by regularly washing hands may minimize the chances of an infection. Pregnant women should avoid exposure to persons infected with the disease and notify their obstetrician immediately if they are exposed so that they can be tested and monitored closely.

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ORGANIZATIONS

National Institute of Allergy and Infectious Diseases, Office of Communications and Government Relations, 6610 Rockledge Dr., MSC 6612, Bethesda, MD, 20892–6612, (301) 496–5717, (866) 284–4107 or TDD: (800)877–8339 (for hearing impaired), (301) 402–3573, http://www3.niaid.nih.gov.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Rd., Atlanta, GA, 30333, (404) 639–3534, (800) CDC–INFO (800–232–4636). TTY: (888) 232–6348, inquiry@cdc.gov, http://www.cdc.gov.

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Filariasis

Definition

Filariasis is the name for a group of tropical diseases caused by various thread-like parasitic round worms (nematodes) and their larvae. The larvae transmit the disease to humans through a mosquito bite. Filariasis is characterized by **fever**, chills, **headache**, and **skin lesions** in the early stages and, if untreated, can progress to include gross enlargement of the limbs and genitalia in a condition called **elephantiasis**.

Description

Approximately 170 million people in the tropical and subtropical areas of Southeast Asia, South America, Africa, and the islands of the Pacific are affected by this debilitating parasitic disease. While filariasis is rarely fatal, it is the second leading cause of permanent and long-term disability in the world. The World Health Organization (WHO) has named filariasis one of only six "potentially eradicable" infectious diseases and has embarked upon a 20-year campaign to eradicate the disease.

In all cases, a mosquito first **bites** an infected individual then bites another uninfected individual, transferring some of the worm larvae to the new host. Once within the body, the larvae migrate to a particular part of the body and mature to adult worms. Filariasis is classified into three distinct types according to the part of the body that becomes infected: lymphatic filariasis affects the circulatory system that moves tissue fluid and immune cells (lymphatic system); subcutaneous filariasis infects the areas beneath the skin and whites of the eye; and serous cavity filariasis infects body cavities but does not cause disease. Several different types of worms can be responsible for each type of filariasis, but the most common species include the following: *Wucheria bancrofti, Brugia malayi* (lymphatic filariasis), *Onchocerca volvulus, Loa loa, Mansonella streptocerca, Dracunculus medinensis* (subcutaneous filariasis), *Mansonella pustans*, and *Mansonella ozzardi* (serous cavity filariasis).

The two most common types of the disease are Bancroftian and Malayan filariasis, both forms of lymphatic filariasis. The Bancroftian variety is found throughout Africa, southern and southeastern Asia, the Pacific islands, and the tropical and subtropical regions of South America and the Caribbean. Malayan filariasis occurs only in southern and southeastern Asia. Filariasis is occasionally found in the United States, especially among immigrants from the Caribbean and Pacific islands.

A larvae matures into an adult worm within six months to one year and can live between four and six years. Each female worm can produce millions of larvae, and these larvae only appear in the bloodstream at night, when they may be transmitted, via an insect bite, to another host. A single bite is usually not enough to acquire an infection, therefore, short-term travelers are usually safe. A series of multiple bites over a period of time is required to establish an infection. As a result, those individuals who are regularly active outdoors at night and those who spend more time in remote jungle areas are at an increased risk of contracting the filariasis infection.

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KEY TERMS

Abscess—An area of inflamed and injured body tissue that fills with pus.

Antibody—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

Conjunctiva—The mucous membrane that lines the inside of the eyelid and the exposed surface of the eyeball.

Elephantiasis—A condition characterized by the gross enlargement of limbs and/or the genitalia that is also accompanied by a hardening and stretching of the overlying skin. Often a result of an obstruction in the lymphatic system caused by infection with a filarial worm.

Encephalitis—Inflammation of the brain.

Lymphatic system—The circulatory system that drains and circulates fluid containing nutrients, waste products, and immune cells, from between cells, organs, and other tissue spaces.

Microfilariae—The larvae and infective form of filarial worms.

Nematode—Round worms.

Subcutaneous—The area directly beneath the skin.

Causes and symptoms

In cases of lymphatic filariasis, the most common form of the disease, the disease is caused by the adult worms actually living in the lymphatic vessels near the lymph nodes where they distort the vessels and cause local inflammation. In advanced stages, the worms can actually obstruct the vessels, causing the surrounding tissue to become enlarged. In Bancroftian filariasis, the legs and genitals are most often involved, while the Malayan variety affects the legs below the knees. Repeated episodes of inflammation lead to blockages of the lymphatic system, especially in the genitals and legs. This causes the affected area to become grossly enlarged, with thickened, coarse skin, leading to a condition called elephantiasis.

In conjunctiva filariasis, the worms' larvae migrate to the eye and can sometimes be seen moving beneath the skin or beneath the white part of the eye (conjunctiva). If untreated, this disease can cause a type of blindness known as onchocerciasis.

Symptoms vary, depending on what type of parasitic worm has caused the infection, but all infections usually begin with chills, headache, and fever between three months and one year after the insect bite. Swelling, redness, and **pain** may also occur in the arms, legs, or scrotum. Areas of pus (abscesses) may appear as a result of dying worms or a secondary bacterial infection.

Diagnosis

The disease is diagnosed by taking a patient history, performing a **physical examination**, and by screening blood specimens for specific proteins produced by the immune system in response to this infection (antibodies). Early diagnosis may be difficult because, in the first stages, the disease mimics other bacterial skin infections. To make an accurate diagnosis, the physician looks for a pattern of inflammation and signs of lymphatic obstruction, together with the patient's possible exposure to filariasis in an area where filariasis is common. The larvae (microfilariae) can also be found in the blood, but because mosquitos, which spread the disease, are active at night, the larvae are usually only found in the blood between about 10 p.m. and 2 a.m.

Treatment

Either ivermectin, albendazole, or diethylcarbamazine is used to treat a filariasis infection by eliminating the larvae, impairing the adult worms' ability to reproduce, and by actually killing adult worms. Unfortunately, much of the tissue damage may not be reversible. The medication is started at low doses to prevent reactions caused by large numbers of dying parasites.

While effective, the medications can cause severe side effects in up to 70% of patients as a result either of the drug itself or the massive **death** of parasites in the blood. Diethylcarbamazine, for example, can cause severe allergic reactions and the formation of pus-filled sores (abscesses). These side effects can be controlled using **antihistamines** and anti-inflammatory drugs (**corticosteroids**). Rarely, treatment with diethylcarbamazine in someone with very high levels of parasite infection may lead to a fatal inflammation of the brain (**encephalitis**). In this case, the fever is followed by headache and confusion, then stupor and **coma** caused when massive numbers of larvae and

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parasites die. Other common drug reactions include **dizziness**, weakness, and **nausea**.

Symptoms caused by the death of the parasites include fever, headache, muscle pain, abdominal pain, **nausea and vomiting**, weakness, dizziness, lethargy, and **asthma**. Reactions usually begin within two days of starting treatment and may last between two and four days.

No treatment can reverse elephantiasis. Surgery may be used to remove surplus tissue and provide a way to drain the fluid around the damaged lymphatic vessels. Surgery may also be used to ease massive enlargement of the scrotum. Elephantiasis of the legs can also be helped by elevating the legs and providing support with elastic **bandages**.

Prognosis

The outlook is good in early or mild cases, especially if the patient can avoid being infected again. The disease is rarely fatal, and with continued WHO medical intervention, even gross elephantiasis is now becoming rare.

Prevention

The best method of preventing filariasis is to avoid repeated bites by the mosquitoes that carry the disease. Some methods of preventing insect bites include the following:

- limit outdoor activities at night, particularly in rural or jungle areas
- wear long sleeves and pants and avoid dark-colored clothing that attracts mosquitoes
- avoid perfumes and colognes
- treat one or two sets of clothing ahead of time with permethrin (Duramon, Permanone).
- wear DEET insect repellent or, especially for children, try citronella or lemon eucalyptus, to repel insects
- if sleeping in an open area or in a room with poor screens, use a bed net to avoid being bitten while asleep
- use air conditioning, the cooler air makes insects less active.

In addition, filariasis can be controlled in highly infested areas by taking ivermectin preventatively before being bitten. Currently, there is no vaccine available, but scientists are working on a preventative vaccine at this time.

Resources

OTHER

Centers for Disease Control.http://www.cdc.gov.
International Society of Travel Medicine. http://www.istm.org.
"Lymphatic Filariasis." *Centers for Disease Control*. http://www.cdc.gov/travel/yellowbk/page117.htm.

ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Rd., Atlanta, GA, 30333, (800) 232-4636, cdcinfo @cdc.gov, http://www.cdc.gov.

Carol A. Turkington

Filgras *see* **Cancer therapy, supportive; Immunologic therapies**

Finasteride

Definition

Finasteride is a drug that belongs to the class of androgen inhibitors, which means that it blocks the production of male sex hormones.

Purpose

Finasteride has two main purposes: the treatment of urinary problems in men caused by benign prostatic hypertrophy (BPH) or enlargement of the prostate gland; and the stimulation of new hair growth in men with male pattern baldness. Finasteride was first approved by the U.S. Food and Drug Administration (FDA) in 1992 under the trade name Proscar as a treatment for BPH. This drug may be used alone or in combination with the drug doxazosin (Cardura) to treat BPH. It received a second FDA approval in December 1997 under the trade name Propecia for the treatment of hair loss in men.

Results of a large clinical trial, the **Prostate Cancer** Prevention Trial, which were released in 2010, revealed that finasteride (Proscar) reduced the risk for prostate **cancer** by as much as 25% in men (ages 55 and older) enrolled in the trial. In the near future, men with an increasing prostate specific antigen (PSA) level and who are considered by their physicians to be at high risk for the development of prostate cancer may be prescribed finasteride to decrease their risk for developing prostate cancer.

Finasteride works to relieve such symptoms of prostate enlargement as urinary urgency, the need to

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KEY TERMS

Alopecia—The medical term for baldness.

Androgens—A group of hormones that produce masculine characteristics.

Chemo preventative—Description of a drug given in order to prevent the development of a specific disease.

Dysuria—Painful or difficult urination.

Incontinence—Inability to control urination or defecation.

Nocturia—Excessive need to urinate at night.

Prostate—A gland in males below the bladder that surrounds the urethra. Enlargement of the prostate may cause problems in urination.

Urgency—A sudden and powerful need to urinate.

urinate frequently at night (nocturia), inability to completely empty the bladder, incontinence, or painful urination (dysuria) by blocking the production of DHT. DHT causes the prostate gland to grow and increase pressure on the bladder. As the swollen prostate gradually shrinks, the patient finds it easier to pass urine without discomfort and to empty the bladder completely before going to sleep. Some doctors also prescribe finasteride as pretreatment for prostate surgery, as it lowers the risk of severe bleeding during the operation.

Description

U.S. and Canadian brand names

Finasteride is sold in the United States and Canada under the brand names Proscar (indicated for the treatment of BPH) and Propecia (indicated for the treatment of male pattern baldness). Finasteride inhibits the body's production of an enzyme called 5-alpha-reductase, which is needed to convert testosterone to another androgen called 5-alpha-dihydrotestosterone (DHT). Finasteride is a white powder that can be dissolved in alcohol or chloroform but is very difficult to dissolve in water. Both Proscar and Propecia are manufactured as coated tablets to be taken by mouth.

Recommended dosage

- Proscar: Finasteride for treatment of an enlarged prostate is taken once a day as a 5-mg tablet. The pill may be crushed or broken if the patient finds it hard to swallow.
- Propecia: Finasteride for hair regrowth is taken once a day as a 1-mg tablet. The drug may be taken with or without meals.

Precautions

Finasteride should be stored in a dry place and kept at a temperature between 59°F and 86°F (15–30°C). Heat and moisture may cause the drug to lose its potency.

Tablets, especially crushed or broken tablets, should not be touched by a pregnant woman as the drug can be absorbed through the skin. If the woman is carrying a male fetus, the drug can cause abnormalities in the baby's sex organs. The FDA issued a warning in 2003 that men taking finasteride should not donate blood until one month after the final dose of the drug, on the grounds that their blood could contain high enough levels of the medication to cause **birth defects** in a male baby if given to a pregnant woman.

Patients should be advised that finasteride takes several months to reach its full effect—as long as six months for BPH and three months for hair regrowth. In addition, the drug's effects on the body are not permanent; the prostate will start to enlarge again or the hair growth will be lost if the patient stops taking the drug.

Proscar can affect the results of a prostate-specific antigen (PSA) test for cancer of the prostate.

Finasteride should be used cautiously by men with liver disorders.

Finasteride is not indicated for the treatment of hair loss in women in the United States.

Side effects

Reported side effects from using finasteride include:

- impotence or loss of interest in sex
- lumps or pain in the breast or a discharge from the nipple
- skin rash, itching, or hives
- swelling of the lips or face
- a smaller quantity of ejaculate during intercourse (which does not affect fertility)
- headaches, dizziness, or diarrhea
- pain in the testicles

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These side effects are more common with the 5-mg dose, but usually disappear when the drug is discontinued.

Interactions

Finasteride has not been reported to cause significant interactions with other medications.

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Melinda Granger Oberleitner, RN, DNS, APRN, CNS

Fingernail removal *see* **Nail removal**

Fingertip injuries

Definition

Fingertip trauma covers cuts, accumulation of blood (hematoma), bone breakage, or **amputation** in the fingertip.

Description

The fingertips are specialized areas of the hand with highly developed sensory and manipulative functions. Large sensory and motor areas located in the brain regulate the precise and delicate functions of fingertips. The fingertip is the site where extensor and flexor tendons insert. Fingertip injuries are extremely common since the hands hold a wide array of objects. In 2001, approximately 10% of all accidents in the United States that were referred for emergency room consults involved the hand. Hand injuries are frequently the result of job injuries and account for 11–14% of on-the-job injuries and 6% of compensation paid injuries. Injury to the nail bed occurs in approximately 15–24% of fingertip injuries.

Fingertip injuries can result in amputation or tissue loss. The injury is assessed whether the bone and underlying tissue are intact and the size of the wound area. The pulp is the area of skin opposite the fingernail and is usually very vulnerable to injury. Pulp injuries commonly occur in persons who use or are in close contact with fast moving mechanical devices. These injuries can crush, cut, and puncture. The fingertips can also be injured by common crushing accidents. This could cause the development of a subungal hematoma (an accumulation of blood under the nail).

At the base of the distal phalanx (the first circular skin fold from the tip) injuries can occur that can fracture the underlying bone in the area. Quite commonly a hammer, closing a door, or sport accidents usually cause these injuries. These **fractures** can be simple, requiring little treatment or more complicated involving the joint. The accident may involve the point of insertion of a tendon. Usually this occurs when the terminal joint is being forced to flex while held straight. This motion typically occurs when tucking in sheets during bed making, a common cause of tendon injury. This injury causes a loss of extension (straightening the finger) ability.

Causes and symptoms

Accidental amputations will usually result in profuse bleeding and tissue loss. Injuries to the pulp can occur as from fast-moving mechanical instruments, such as drills. These injuries may puncture the pulp. Injuries such as a subungal hematoma are caused by a crushing type injury. Fractures typically occur as the result of crushing injuries or tendon avulsion. These crushing injuries are frequently caused during sport injury and can be treated by simple interventions such as **immobilization** or more complex procedures if tendons are affected (the trauma is then treated as a tendon injury). Fractures can cause **pain** and, depending on the extent of swelling, there may be some restriction of movement. Tendon injuries can be caused when the terminal joint is exposed to force flexing motion (moving the finger toward the palm) while held straight.

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KEY TERMS

Distal—Movement away from the origin.

Flex—To bend.

Laceration—A cut in the skin

Phalanx—A bone of the fingers or toes.

Tendon—A structure that connects a skeletal muscle to bone.

Diagnosis

The attending clinician should evaluate the injury in a careful and systematic manner. The appearance of the hand can provide valuable information concerning presence of fractures, vascular status, and tendon involvement. Bones and joints should be evaluated for motion and tenderness. Nerves should be examined for sensory (feeling sensations) and motor (movement) functioning. Amputations usually profusely bleed and there is tissue loss. The wound is treated based on loss of tissue, bone, and wound area. Injuries to the pulp can be obvious during inspection. Subungal hematoma usually present a purplish-black discoloration under the nail. This is due to a hematoma underneath the nail. Radiographs may be required to assess the alignment of fractures or detect foreign bodies. Patients usually suffer from pain since injuries to the fingertip bone are usually painful and movement may be partially restricted due to swelling of the affected area. Tendon injuries usually result in the loss of ability to straighten or bend the finger.

Treatment

Amputation in which bone and underlying tissue are intact and the wound area is 1 cm or less, should be cleaned and treated with a dressing. With these types of **wounds**, healthy tissue will usually grow and replace the injured area. Larger wounds may require surgical intervention. Puncture wounds should be cleaned and left open to heal. Patients typically receive **antibiotics** to prevent infection. A procedure called trephining treats subungal hematomas. This procedure is usually done with a straight cutting needle positioned over the nail. The clinician spins the needle with forefinger and thumb until a hole is made through the nail.

Patients who have extensive crush injuries or subungal hematomas involving laceration to skin folds or nail damage should have the nail removed to examine the underlying tissue (called the matrix). Patients who have a closed subungal hematoma with an intact nail and no other damage (no nail disruption or laceration) are treated conservatively. If the fracture is located two-thirds below the fingertip, immobilization using a splint may be needed. Conservative treatment is recommended for crush injuries that fracture the terminal phalanx if a subungal hematoma is not present. Severe fractures near the fist circular skin crease may require surgical correction to prevent irregularity of the joint surface, which can cause difficulty with movement. Injury to a flexor tendon usually requires surgical repair. If this is not possible, the finger and wrist should be placed in a splint with specific positioning to prevent further damage.

Prognosis

Prognosis depends on the extent of traumatic damage to the affected area. Nail lacerations that are not treated may cause nail deformities. When amputation is accompanied with loss of two-thirds of the nail, half of the fingers develop beaking, or a curved nail. Aftercare and follow up are important components of treatment. The patient is advised to keep the hand elevated, check with a clinician two days after treatment, and to splint fractures for two weeks in the extended position. Usually a nail takes about 100 days to fully grow. Healing for an amputation takes about 21-27 days. This markedly decreases in elderly patients, primarily due to a compromised circulation normally part of advancing age.

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Laith Farid Gulli, M.D.

First aid

Definition

First aid is the treatment of minor injuries or conditions or immediate care or treatment for a medical emergency that is administered while awaiting professional help.

Purpose

First aid ranges from cleaning and bandaging a minor scrape to saving a life with **cardiopulmonary**

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resuscitation (CPR). It is often required to stop bleeding or to stabilize and protect an ill or injured person until they can get to a hospital or emergency help arrives on the scene. First aid may be used to treat:

- cuts, scrapes, and scratches
- nosebleeds
- severe bleeding
- heat exhaustion and heatstroke
- frostnip and frostbite
- burns
- poisoning
- choking
- a foreign object in the eye or nose
- injured or broken bones
- head or spinal injuries
- seizures
- shock
- unconsciousness
- respiratory or heart failure

Demographics

Every year millions of children require first aid for minor injuries, serious accidents, or life-threatening emergencies. For this reason, every home, automobile, daycare, and school should be equipped with a well-stocked first-aid kit and every parent, caregiver, and teacher should be trained in first aid and CPR.

Description

First aid for a minor scrape, cut, or puncture wound may include:

- using sterile gauze, tissue, or a clean, soft cloth to apply gentle, firm pressure to stop bleeding
- cleaning with cool running water or soaking the wound
- using a soft cloth and gentle soap to clean around the injury
- using a soft, damp cloth or tweezers cleaned with rubbing alcohol to remove dirt or debris
- applying antibiotic ointment
- covering with butterfly tape, adhesive strips, or sterile gauze and adhesive tape, if the injury is in an area that could get dirty or rubbed by clothing
- changing bandages daily

For severe bleeding:

- lie down and cover the injured person to prevent loss of body heat
- if possible, elevate the legs to increase blood flow to the brain and prevent fainting or elevate the injured area above the level of the heart to slow bleeding
- apply firm, gentle pressure to the wound for at least 20 minutes
- add more gauze or cloth if needed, without removing the lower layers
- pressure may be applied to a main artery leading to the injured area
- tightly wrap the wound with a bandage or clean cloth and tape
- immobilize the injured part and leave bandages in place once the bleeding has stopped

For a nosebleed:

- sit, leaning slightly forward to drain the blood out of the nose, but with the head above the level of the heart
- squeeze the soft part of the nose, using the thumb and index finger, until the bleeding stops or for at least five minutes
- do not do anything to make the bleeding restart, such as bending over or blowing through the nose

For heat exhaustion or heatstroke:

- rest in a cool, shady spot, with unnecessary clothing removed
- drink plenty of water or other fluids
- be bathed or sprayed with cool water
- be cooled by evaporating water from the skin

For **frostnip** or **frostbite**:

- dress in dry clothing in a warm environment and drink warm fluids
- if emergency help is not immediately available for frostbite, the frozen parts should be immersed in warm water (100°F, 38°C) or treated with warm compresses for 30 minutes
- if warm water is unavailable, gently wrap the affected person in blankets
- thawed areas should be kept still and wrapped to prevent refreezing

For **burns**:

- clothing should be gently removed from around the burn, unless it is stuck to the skin
- first-degree burns should be soaked in cool water for at least five minutes and loosely wrapped with a dry gauze bandage or a clean soft towel or sheet
- second-degree burns should be soaked in cool water for 15 minutes and covered with a dry nonstick dressing that is changed daily

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- third-degree burns should be covered with a cool, wet, sterile bandage or clean cloth, without first soaking the burn; if possible, the burned area should be raised above the level of the heart until medical assistance is available
- electrical burns should be covered with gauze without rinsing
- for chemical burns, any contaminated clothing or jewelry should be removed and any dry chemical brushed off the skin; the burn should be gently rinsed with cool, running water for at least 20 minutes; loosely wrapped with a dry, sterile, dressing or gauze or a clean cloth; and rewashed if the pain worsens

If someone begins **choking**, they should be given abdominal thrusts— known as the **Heimlich maneuver**. For an infant under one year:

- place the infant face down over the rescuer's forearm with the head lower than the chest and the neck and head supported with the rescuer's fingers
- apply five quick blows to the infant's back, between the shoulders, with the heel of the free hand
- if no object is ejected, place the infant face-up on a table or floor and give five quick chest thrusts, with two fingers in the middle of the breastbone just below the level of the nipples
- repeat the five back blows and five chest thrusts until the object is dislodged and the infant starts breathing
- if the infant becomes unresponsive or unconscious, CPR must be performed; check the mouth for the object before each rescue breath

To perform the Heimlich maneuver on someone over one year of age (including adults):

- wrap the rescuer's arms around the choking person's waist from behind
- make a fist with one hand and grasp it with the other hand with the thumb just above the person's navel; quickly thrust upward and inward until the object is dislodged or the person begins breathing
- if the person loses consciousness, lower them to the floor for CPR

For a foreign object in the eye:

- sit in a well-lit area.
- pull down the lower lid while the individual looks up and then pull the upper lid while they look down to look for the object
- if the object is floating in the tear film, it can be flushed out with lukewarm water or a saline solution, using an eyecup or small glass

For a foreign object lodged in the nose:

- blow out gently through the nose, but not hard or repeatedly
- if only one nostril is affected, gentle pressure can be used to close the other nostril while blowing out
- if the object is visible, it may be removed with tweezers

For a bone injury:

- remove clothing from the injured limb without moving it
- apply an ice pack wrapped in cloth
- make a simple splint—use anything firm and padded with something soft—to prevent the limb from moving or bending; the splint must extend beyond the joints above and below the injury

A fall from a distance greater than a person's height or a bicycle or automobile accident can result in a head or spinal injury. The injured person should not be moved and the head, neck, and spine should be stabilized until help arrives.

A person having a seizure should:

- be laid on the ground or floor, preferably on the right side, with no nearby objects
- have clothing around the head and neck loosened
- be comforted and remain lying down until fully recovered

A person in **shock** should:

- be laid face-up, unless a head or spinal injury is suspected
- have the legs elevated about 12 in (30 cm), if possible
- have tight clothing loosened
- be covered with a blanket
- be kept warm, still, and comfortable
- may have the lips moistened with water, but should be given nothing by mouth
- be raised to a half-sitting position if vomiting or having trouble breathing, unless there is a head or spinal injury
- should be turned to the side if the child vomits or bleeds from the mouth

An unconscious person should be placed in the recovery position if there is no possibility of a spinal injury. While lying face-up:

- the arm closest to the rescuer is placed by the person's side and tucked under the buttock
- the other arm is placed across the person's chest
- the ankles are crossed with the far leg over the near leg

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KEY TERMS

Aloe vera—An extract from the plant *Aloe barbadensis* that is used in skin creams and for treating burns.

Automatic external defibrillator (AED)—An electronic device for restoring regular heart rhythm.

Cardiopulmonary resuscitation (CPR)—A procedure for restoring normal breathing following cardiac arrest. It includes clearing the air passages, mouth-to-mouth artificial respiration, and heart massage by exerting pressure on the chest.

Heimlich maneuver—The application of sudden upward pressure on the upper abdomen to force a foreign object from the trachea of a choking victim; developed by the American surgeon Henry Jay Heimlich.

Shock—Severe depression of vital physiological processes, characterized by paleness, a rapid but weak pulse, rapid and shallow breathing, and low blood pressure; typically caused by injury, severe bleeding, or burns.

Tetanus—An acute infectious disease caused by a toxin produced by the bacterium *Clostridium tetani* and usually introduced into the body through a wound.

- the person is rolled over toward the rescuer by pulling on clothing at the hip, while supporting the head with the other hand
- one arm is bent up and the other down to support the upper and lower body
- the head is tilted back to allow air to move freely in and out of the mouth

If there is **vomiting** or bleeding from the mouth, the person should be rolled to the side in one move, while supporting the neck and back. They should be kept warm and gently restrained if awakened.

CPR should be performed on a someone who is not breathing and is unconscious or unresponsive. The technique used is slightly different for infants, children, and adults.

To perform CPR on an infant:

- place the infant face-up on a hard, flat surface
- tilted back and lift the chin so the mouth opens
- completely cover the mouth and nose of an infant under one year of age and give two rescue breaths
- check to see if the infant's chest rises with each breath; if it does, then begin chest compressions, otherwise repeat breathing
- give the infant 30 chest compressions using two fingers in the middle of the breastbone just below nipple level
- continue the cycle of two breaths and 30 chest compressions until emergency help arrives or the child begins breathing

To perform CPR on a child or an adult:

- place the person face-up on a hard, flat surface
- tilted back and lift the chin so the mouth opens
- completely cover the mouth and give two long rescue breaths
- check to see if the person's chest rises with each breath; if it does, then begin chest compressions, otherwise repeat breathing
- give 30 chest compressions using the heel of the hand on the lower half of the chest for children; for adults, place the heel of one hand on the center of the chest just below the nipples and the other hand on top of the first with the rescuer's body weight over the arms
- continue the cycle of two breaths and 30 chest compressions until emergency help arrives or the child begins breathing

Benefits

First aid can save lives. It can also prevent injuries from worsening or becoming infected and can speed healing.

Precautions

Serious injuries or emergency medical situations require summoning emergency responders, usually by calling 911, or rushing the child to a hospital emergency room or other critical care facility. Precautions for administering first aid depend on the type of injury. The most important precautions include never:

- moving a person if there is any possibility of spinal injury
- applying a tourniquet to stop bleeding
- attempting to remove a deeply imbedded object
- attempting to replace organs
- using direct heat on frostbite or rubbing frostbitten skin

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- thawing frostbitten skin if there is a risk of refreezing
- breaking burn blisters or applying ice or any ointment or lotion to burns except under a doctor's direction
- giving anything to someone who may have ingested a toxin and never inducing vomiting, unless directed by the poison control center
- attempting to remove an object embedded in the eyeball or rubbing the eyes
- probing the nose for an object that is not visible and easily grasped
- washing or moving bone injuries
- restraining movement or putting anything in the mouth of a person having a seizure
- attempting to awake an unconscious person by shaking, slapping, or using cold water
- putting a pillow under an unconscious person's head, as this can block an airway

If possible, wear gloves and wash hands before and after administering first aid. It is also a good idea to ensure that a child's **tetanus** shots are current.

Preparation

An individual can prepare for first-aid by taking first-aid classes, learning CPR and renewing CPR certification at least every two years, and by learning to use an automatic external defibrillator (AED).

Basic first aid can be taught to children. It is a good idea for babysitters to also receive training in first aid and CPR.

Every home and automobile should have a well-stocked first-aid kit. Use a container that is clean, strong, and easy to carry and open to store items. First-aid kits are often designed for specific activities, such as hiking, camping, or boating, and should include items geared toward those activities. For example, include ointment for mosquito **bites** in a camping kit. A first-aid manual should also be stored in the kit.

Keep the container out of the reach of young children, but easily accessible to adults and anyone trained in its use. The contents should be checked every three months for missing items and expired medicines. Medicines should be in their original containers and marked with dosage and instructions.

A general purpose first-aid kit should contain:

- emergency and physician phone numbers
- a list of allergies and medications for all family members
- medical consent and medical history forms
- a first-aid manual
- a waterproof flashlight and batteries
- a cell phone and charger
- duct tape
- scissors, tweezers, needles, and safety pins
- a non-mercury, non-glass, oral thermometer
- sterile, disposable gloves
- eye goggles or eye shield
- a breathing barrier or mouthpiece for CPR
- a mylar emergency blanket
- aluminum finger splints
- a tooth-saver kit
- a bulb suction device for flushing out wounds
- instant cold packs
- assorted adhesive bandages, gauze pads, roller gauze, and compress dressings
- adhesive cloth tape
- an elastic (Ace) bandage
- sterile cotton balls and cotton-tipped swabs
- plastic bags for waste
- soap, hand sanitizer, and alcohol wipes
- antiseptic solution or wipes
- sterile eyewash or saline solution
- petroleum jelly or other lubricant
- aloe vera gel
- calamine lotion
- antibiotic ointment or cream
- hydrocortisone ointment or cream
- a medicine cup or spoon and oral medicine syringe
- aspirin, acetaminophen, and ibuprofen
- anti-diarrhea medication
- antihistamines
- decongestant
- cough suppressant
- antacid
- laxatives
- sunscreen
- prescription medications that do not need refrigeration
- any prescribed medical supplies

Aftercare

Most small cuts, scrapes, and abrasions heal without any special care, although it may be necessary to apply an antibiotic ointment. **Bandages** should be changed daily or whenever they become wet or dirty. After a bone injury is treated, the area should be

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elevated and ice packs or cold compresses should be applied every few hours for 20-minute periods.

Risks

An individual should be cautious about providing first-aid and must assess the situation before getting involved. If the situation is dangerous, such as the scene of an accident, the individual should not intervene and instead contact emergency personnel by dialing 9-1-1.

When coming in contact with blood or other bodily fluids, there may be a risk of infection with HIV or hepatitis virus. Wearing latex gloves can help prevent disease transmission. A mouth-to-mouth barrier device may not protect against contracting an infection when giving rescue breaths.

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ORGANIZATIONS

American Academy of Family Physicians, 11400 Tomahawk Creek Parkway, Leawood, KS, 66211-2680, (913) 906-6000, (800) 274-6000, (913) 906-6075, http://www.aafp.org.

American College of Emergency Physicians, P.O. Box 619911, Dallas, TX, 75261-9911, (972) 550-0911, (800) 798-1822, (972) 580-2816 , membership@acep.org, http://www3.acep.org.

American Red Cross, 2025 E St., NW, Washington, DC, 20006, (202) 303–5000, http://www.redcross.org.

Ready Campaign, Federal Emergency Management Agency, 500 C St., SW, Washington, DC, 20024, (202) 646-3272, ready@dhs.gov, http://www.ready.gov.

Margaret Alic, PhD

Fish and shellfish poisoning

Definition

Fish and shellfish **poisoning** is a common but often unrecognized group of illnesses related to food. Three of these illnesses include ciguatera, scombroid, and paralytic shellfish poisoning.

Ciguatera

Definition

Ciguatera (from the Spanish word for a poisonous snail) is a food-related illness that causes abdominal and neurological symptoms.

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Causes and symptoms

Ciguatera is caused by eating fish that have a toxin called ciguatoxin. Scientists believe this toxin is acquired by the fish through the food chain, and is originally produced by small algae microorganisms (dinoflagellates). The fish most likely contaminated with ciguatoxin are those that feed close to tropical reefs, including red snapper, grouper, and barracuda. Larger fish are more likely to contain the toxin. Although not as common in the United States, ciguatera is commonly diagnosed on many of the islands in the Pacific Ocean.

Illness from ciguatera can occur in just a few minutes to about 30 hours after eating. Most cases occur one to six hours after eating the contaminated fish. Initial symptoms are abdominal cramps, **nausea**, **vomiting**, or watery **diarrhea**. The most characteristic symptoms of the illness are those involving the nervous system. These include **numbness and tingling** around the lips, tongue, and mouth; **itching**; **dry mouth**; metallic taste in the mouth; and blurry vision. In more prominent cases, patients may complain of temporary blindness, a slow pulse, and a feeling that their teeth are loose. Patients may also have the strange symptom of reversal of hot and cold sensations on the skin, where cold things feel very hot or painful to the touch. In very severe cases, patients may experience difficulties in breathing or low blood pressure.

Diagnosis

Ciguatera diagnosis is based on the typical combination of symptoms after eating fish. There are no readily available blood or urine tests to detect the poisoning, but some researchers have developed a test for the toxin left on any remaining fish. A person does not have to be in a tropical area to get ciguatera. Fish can be caught from one of these distant areas, and can then be shipped and eaten locally. It is important to report suspected cases to local public health officials because more cases may occur from other contaminated fish.

Treatment

The treatment for this illness is general. Patients are given fluids (by mouth or through a vein) and medications to decrease the itching or to treat **vomiting** and/or diarrhea. The neurological symptoms can cause discomfort and treatment with amitriptyline (a medicine that has been used for depression) may be useful. Other medications may also be given.

Prognosis

Although **death** can occur, almost all patients diagnosed with ciguatera will recover. Recovery, however, can be slow and some symptoms can last for weeks or even months. Symptoms can also be aggravated by other illnesses or alcohol.

Prevention

Knowing the kinds of fish linked to ciguatera can help a person avoid eating high-risk fish. However, more than 400 different kinds of fish have been linked to the disease, even salmon. A particular fish in a given area may be more likely to cause ciguatera than other fish. For example, red snapper is most often the source of ciguatera in the Pacific, while barracuda is more likely to contain the toxin in Florida. This is why it is illegal to sell barracuda in Florida for human consumption. Cooking the fish does not prevent ciguatera.

Scombroid

Definition

Scombroid is a fish-associated illness caused by eating improperly handled fish. Fish linked to this disease are usually in the Scombridae family, which includes yellowfin tuna, skipjack, bonito, and mackerel.

Causes and symptoms

Scombroid occurs after eating fish that has not been properly refrigerated after capture. Unlike ciguatera, the toxins linked with scombroid are not contracted by the fish from its surroundings. Bacteria that are normally found in fish act directly on a chemical (called histidine) in the flesh of fish that are not properly cooled when stored. This interaction produces histamine and other chemicals that cause the illness when the fish is eaten.

Symptoms of scombroid occur quickly after eating the fish, as soon as 10 minutes. Since histamine is released by certain cells in the body during an allergic reaction, scombroid can be confused with a fish allergy. Scombroid causes flushing of the face, sweating, a burning feeling in the mouth or throat, vomiting, diarrhea, and headaches. A rash that looks like a **sunburn** may occur, and a small number of patients have **hives**. Some patients have a metallic or peppery taste in their mouths. In more severe cases, rapid pulse, blurred vision, and difficulty breathing can occur. Symptoms usually last about four hours.

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Diagnosis

Like ciguatera, scombroid poisoning is diagnosed based on typical symptoms occurring after eating fish. There are usually no available tests for the patient. Experimentally, however, elevated levels of histamine-related products have been found in the urine. It may be possible for public health officials to test any remaining fish flesh for histamine levels. Improperly refrigerated fish caught in both temperate and tropical waters have been linked to the illness. An outbreak of similar cases may be helpful in correctly diagnosing the problem.

Treatment

The treatment for scombroid is usually general. **Antihistamines** like diphenhydramine (Benadryl) may shorten the duration of the illness, but the illness will go away on its own. Some doctors have found that cimetidine (Tagamet) given through a vein may be helpful as well. In rare, more severe cases, epinephrine (adrenaline) may be used.

Prognosis

Although sometimes dramatic and alarming symptoms can occur, scombroid is usually not serious. The patient should be reassured that scombroid is not a fish allergy.

Prevention

Adequate storage of the target fish will always prevent scombroid. Since the fish does not appear spoiled or smell bad, the consumer cannot detect the risk of the illness before eating the fish. Cooking the fish does not prevent scombroid. Suspected cases should be reported to public health officials.

Paralytic shellfish poisoning

Definition

Paralytic shellfish poisoning (PSP) is a nervous system disease caused by eating cooked or raw shellfish that contain environmental toxins. These toxins are produced by a group of algae (dinoflagellates). It is unclear whether these toxins are related to the "blooming" of the algae, also called red tide because the algae can turn the water reddish brown. PSP occurs mostly in May through November.

Causes and symptoms

PSP develops usually within minutes after eating a contaminated shellfish, most commonly a mussel, clam, or oyster. Symptoms include **headache**, a floating feeling, **dizziness**, lack of coordination, and **tingling** of the mouth, arms, or legs. Muscle weakness causing difficulty swallowing or speaking may occur. Abdominal symptoms such as nausea, vomiting, and diarrhea can also occur. Unlike ciguatera and scombroid, PSP may have a much more serious outcome. PSP may cause difficulty breathing related to weakness or **paralysis** of the breathing muscle. The symptoms may last for six to 12 hours, but a patient may continue to feel weak for a week or more.

KEY TERMS

Algae—Plants that have one cell.

Histamine—A chemical found naturally in the body that produces inflammation and increases blood flow; the uncomfortable symptoms of an allergy attack or an allergic reaction are generally caused by the release of histamine.

Toxin—A poisonous substance usually produced by a living thing.

Diagnosis

PSP diagnosis is based on symptoms after eating shellfish, even if the shellfish are adequately cooked. No blood or urine test is available to diagnose the illness, but tests in mice to detect the toxin from the eaten fish can be done by public health officials.

Treatment

The treatment of PSP is mostly supportive. If early symptoms are recognized, the doctor will try to flush the toxin from the gastrointestinal tract with medications that create diarrhea. Vomiting may be induced if the patient has no signs of weakness. In cases where the muscles of breathing are weakened, the patient may be placed on a respirator until the weakness goes away. However, this measure is not usually needed. Likewise, the use of a machine to clean the blood (dialysis) has been used in severe cases.

Prognosis

The prognosis for PSP is quite good, especially if the patient has passed the initial 12 hours of illness without needing breathing support. Most deaths occur during this period if breathing help is not available.

Prevention

Measures to control PSP require detecting rising numbers of algae in coastal waters by periodic

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microscopic examination. By law, shellfish beds are closed when levels of the toxin-producing organisms are above acceptable standards. Cooking the shellfish does not prevent this disease. Suspected cases should be reported to public health officials.

Resources

PERIODICALS

Barton, Erik D., Paula Tanner, Steven G. Turchen, et al. "Ciguatera Fish Poisoning: A Southern California Epidemic." *Western Journal of Medicine* 163, no. 1 (July 1995): 31–35.

Larry I. Lutwick, MD, FACP

Fistula

Definition

A fistula is a permanent abnormal passageway between two organs in the body or between an organ and the exterior of the body.

Description

Fistulas can arise in any part of the body, but they are most common in the digestive tract. They can also develop between blood vessels and in the urinary, reproductive, and lymphatic systems. Fistulas can occur at any age or can be present at birth (congenital). Some are life-threatening, others cause discomfort, while still others are benign and go undetected or cause few symptoms. Diabetics, individuals with compromised immune systems (**AIDS**, **cancer**) and individuals with certain gastrointestinal diseases (**Crohn's disease**, inflammatory bowel disease) are at increased risk of developing fistulas.

Fistulas are categorized by the number of openings they have and whether they connect two internal organs or open through the skin. There are four common types:

- Blind fistulas are open on one end only.
- Complete fistulas have one internal opening and one opening on the skin.
- Horseshoe fistulas are complex fistulas with more than one opening on the exterior of the body.
- Incomplete fistulas are tubes of skin that are open on the outside but closed on the inside and do not connect to any internal structure.

Fistulas of the digestive tract

Anal and rectal fistulas develop in the wall of the anus or rectum. They connect the interior of the body to one or several openings in the skin. Anal and rectal fistulas almost always begin as an inflammation in an anal gland. The inflammation then moves into muscle tissue and develops into an **abscess**. In about half of all cases, the abscess develops into a fistula, degrading the muscle until an opening in the skin is created. About nine people of every 100,000 develop anal fistulas, with men almost twice more likely to develop the condition than women. Although they may develop at any age, the average age for the development of anal fistulas is 38.

Intestinal fistulas can develop in both the large and small intestine. They are commonly associated with diseases such as inflammatory bowel disease (IBD) and Crohn's disease.

Tracheoesophageal fistulas (TEF) are usually **birth defects**. The windpipe, or trachea, is abnormally connected to the esophagus. This allows air to enter the digestive system and makes it possible to breathe food into the lungs (aspiration). In many cases, the esophagus is also incomplete, causing immediate feeding problems. There are several types of TEFs categorized by where the fistula is located and how the esophagus and trachea are connected, but all are life-threatening and require prompt surgery to repair. TEFs occur in about one of every 1,500–3,000 births.

Fistulas of the urinary and reproductive tract

The most common type of fistula involving these systems is a vesicovaginal fistula, in which the woman's vagina is connected to the urinary bladder. This causes leakage of urine from the vagina and results in frequent vaginal and bladder infections. Fistulas may also develop between the vagina and the large intestine (a enterovaginal fistula) so that feces leaks from the vagina. Although both these types of fistulas are uncommon in the developed world, they are common in poor developing countries and result from long, difficult labor and **childbirth**, especially in very young girls. As a result, they are sometimes referred to as obstetric fistulas.

Some experts suggest that in parts of Africa, as many as 3–4 women develop these fistulas for every 1,000 births. Others estimate that as many as 2 million women worldwide are living with unrepaired obstetric fistulas. If left unrepaired, obstetric fistulas cause women to constantly leak urine and feces. As

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expected, they may suffer severe social issues, extreme hardship and psychological trauma.

Fistulas of the circulatory system

Arteriovenous fistulas (AVF) can develop between an artery and a vein in any part of the body. These fistulas vary in size, length, and frequency. Arteries contain blood carrying oxygen to all parts of the body, while veins carry blood that has given up its oxygen back to the lungs. Connections between arteries and veins cause changes in blood pressure that result in abnormal development of the walls of the arteries and abnormal blood flow. Arteriovenous fistulas that are present at birth are sometimes referred to as **arteriovenous malformations** (AVMs). Many arteriovenous fistulas are present, but not evident at birth, and become obvious only after trauma. AVFs can also be acquired from penetrating trauma.

Causes and symptoms

The causes and symptoms of fistulas vary depending on their location. Anal and rectal fistulas are usually caused by an abscess. Symptoms include constant throbbing **pain** and swelling in the rectal area. Pus is sometimes visible draining from the fistula opening on the skin. Many individuals have a **fever** resulting from the infection causing the abscess.

Vaginal fistulas are caused by infection and trauma to the tissue during childbirth. They are easily detected, because the woman smells unpleasant and leaks urine or feces through her vagina. Rarely these fistulas may develop as a complication of **hysterectomy**.

Tracheoesophageal fistulas are the result of errors in the development of the fetus. They are evident at birth, because the infant is unable to swallow or eat normally and are considered a medical emergency that requires surgery if the infant is to survive.

Arteriovenous fistulas are most often congenital defects. Symptoms vary depending on the size and location of the fistula. Often the skin is bright pink or dark red in the area of the fistula. Individuals may complain of pain. The pain is a result of some tissues not receiving enough oxygen because of abnormal blood flow.

Diagnosis

Tests use to determine the presence of a fistula vary with the location of the fistula. When there is an opening to the outside, the physician may be able to see the fistula and probe it. Various imaging studies such as x-rays, CT scans, barium **enemas**, **endoscopy**, and ultrasonography are used to locate less visible fistulas.

KEY TERMS

Abscess—A collection of pus surrounded by inflamed, infected tissue.

Lymphatic system—The part of the circulatory system that carries lymph, a clear fluid that is involved in immune system response.

Treatment

Anal and rectal fistulas are treated by draining the pus the infected area. The individual also is usually given **antibiotics** to help prevent recurrence of the abscess. If this fails to heal the fistula, surgery may be necessary.

Intestinal fistulas are treated first by reducing the inflammation in the intestine and then, if necessary with surgery. Treatment varies considerably depending on the degree of severity of symptoms the fistula causes. TEFs are always treated with surgery. Obstetric fistulas must also be repaired with surgery. The treatment of arteriovenous fistulas depends on the size and location of the fistula and usually includes surgery.

Alternative treatment

No effective alternative treatments for fistulas are known.

Prognosis

The outcome of fistulas depends on the type and cause of the condition. Surgical repair of obstetric fistulas is almost always successful. Unfortunately, many women in developing countries do not have access to this type of surgery. Treatment of anal and rectal fistulas is almost always successful, although fistulas may recur in up to 18% of individuals. The outcome of surgery on TEFs is highly variable, especially since infants born with this condition often have other developmental abnormalities that may affect the outcome of fistula repair. The degree of successful repair of arteriovenous fistulas depends on their size and location. Uncontrolled bleeding is the most common complication of surgery to repair AVFs.

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Prevention

Obstetric fistulas are the only preventable fistulas. These can be prevented with good prenatal and childbirth care and by avoiding **pregnancy** in very young girls. Although anal and rectal fistulas are not preventable, their damage can be minimized by prompt drainage and treatment.

Resources

OTHER

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Zagrodnik, Dennis II. *Fistula-in-Ano,* ii June 2004 [cited 3 March 2005]. http://www.emedicine.com/med/topic2710.htm.

ORGANIZATIONS

American Society of Colon and Rectal Surgeons, 85 W. Algonquin Rd., Suite 550, Arlington Heights, IL, 60005, (847) 290-9184, (847) 290-9203, ascrs@fascrs.org, http://www.fascrs.org/.

Tish Davidson, A.M.

5p-syndrome *see* **Cri du chat syndrome**

Flesh-eating disease

Definition

Flesh-eating disease is more properly called necrotizing fasciitis, a rare condition in which bacteria destroy tissues underlying the skin. This tissue **death**, called necrosis or **gangrene**, spreads rapidly. This disease can be fatal in as little as 12 to 24 hours.

Description

Although the term is technically incorrect, flesh-eating disease is an apt descriptor: The infection appears to devour body tissue. Media reports increased in the middle and late 1990s, but the disease is not new. Hippocrates described it more than three millennia ago and thousands of reports exist from the Civil War. Approximately 500 to 1,500 cases of necrotizing fasciitis occur in the United States each year.

Flesh-eating disease is divided into two types. Type I is caused by anaerobic bacteria, with or without the presence of aerobic bacteria. Type II, also called hemolytic streptococcal gangrene, is caused by group A streptococci; other bacteria may or may not be present. The disease may also be called synergistic gangrene.

Type I fasciitis typically affects the trunk, abdomen, and genital area. For example, Fournier's gangrene is a "flesh-eating" disease in which the infection encompasses the external genitalia. The arms and legs are most often affected in type II fasciitis, but the infection may appear anywhere.

Causes and symptoms

The two most important factors in determining whether a person will develop flesh-eating disease are: the virulence (ability to cause disease) of the bacteria and the susceptibility (ability of a person's immune system to respond to infection) of the person who becomes infected with this bacteria.

In nearly every case of flesh-eating disease, a skin injury precedes the disease. As bacteria grow beneath the skin's surface, they produce toxins. These toxins destroy superficial fascia, subcutaneous fat, and deep fascia. In some cases, the overlying dermis and the underlying muscle are also affected.

Initially, the infected area appears red and swollen and feels hot. The area is extremely painful, which is a prominent feature of the disease. Over the course of hours or days, the skin may become blue-gray, and fluid-filled blisters may form. As nerves are destroyed the area becomes numb. An individual may go into **shock** and develop dangerously low blood pressure. Multiple organ failure may occur, quickly followed by death.

Diagnosis

The appearance of the skin, paired with **pain** and **fever** raises the possibility of flesh-eating disease. An x-ray, **magnetic resonance imaging** (MRI), or **computed tomography scans** (CT scans) of the area reveals a feathery pattern in the tissue, caused by accumulating gas in the dying tissue. Necrosis is evident during exploratory surgery, during which samples are collected for bacterial identification.

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KEY TERMS

Aerobic bacteria—Bacteria that require oxygen to live and grow.

Anaerobic bacteria—Bacteria that require the absence of oxygen to live and grow.

CT scan (computed tomography scan)—Cross-sectional x-rays of the body are compiled to create a three-dimensional image of the body's internal structures.

Debridement—Surgical procedure in which dead or dying tissue is removed.

Dermis—The deepest layer of skin.

Fascia, deep—A fibrous layer of tissue that envelopes muscles.

Fascia, superficial—A fibrous layer of tissue that lies between the deepest layer of skin and the subcutaneous fat.

Gangrene—An extensive area of dead tissue.

Hyperbaric oxygen therapy—A treatment in which the patient is placed in a chamber and breathes oxygen at higher-than-atmospheric pressure. This high-pressure oxygen stops bacteria from growing and, at high enough pressure, kills them.

Magnetic resonance imaging (MRI)—An imaging technique that uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

Necrosis—Abnormal death of cells, potentially caused by disease or infection.

Subcutaneous—Referring to the area beneath the skin.

Treatment

Rapid, aggressive medical treatment, specifically, antibiotic therapy and surgical **debridement**, is imperative. **Antibiotics** may include penicillin, an aminoglycoside or third-generation cephalosporin, and clindamycin or metronidazole. **Analgesics** are employed for pain control. During surgical debridement, dead tissue is stripped away. After surgery, patients are rigorously monitored for continued infection, shock, or other complications. If available, hyperbaric **oxygen therapy** has also be used.

Prognosis

Flesh-eating disease has a fatality rate of about 30%. Diabetes, arteriosclerosis, immunosuppression, **kidney disease**, **malnutrition**, and **obesity** are connected with a poor prognosis. Older individuals and intravenous drug users may also be at higher risk. The infection site also has a role. Survivors may require **plastic surgery** and may have to contend with permanent physical disability and psychological adjustment.

Prevention

Flesh-eating disease, which occurs very rarely, cannot be definitively prevented. The best ways to lower the risk of contracting flesh-eating disease are:

- take care to avoid any injury to the skin that may give the bacteria a place of entry
- when skin injuries do occur, they should be promptly washed and treated with an antibiotic ointment or spray
- people who have any skin injury should rigorously attempt to avoid people who are infected with streptococci bacteria, a bacteria that causes a simple strep throat in one person may cause flesh-eating disease in another
- have any areas of unexplained redness, pain, or swelling examined by a doctor, particularly if the affected area seems to be expanding

Resources

BOOKS

Lewis Tilden, Thomasine E. *Help! What's Eating My Flesh?: Runaway Staph and Strep Infections!* New York: Franklin Watts, 2008.

ORGANIZATIONS

National Necrotizing Fasciitis Foundation, 2731 Porter SW, Grand Rapids, MI, 49509, nnfffeb@aol.com, http://www.nnff.org.

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Flight medicine *see* **Aviation medicine**

Floppy mitral valve *see* **Mitral valve prolapse**

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Flower remedies

Definition

Flower remedies are specially prepared flower essences, containing the healing energy of plants. They are prescribed according to a patient's emotional disposition, as ascertained by the therapist, doctor, or patients themselves.

Purpose

Flower remedies are more homeopathic than herbal in the way they work, effecting energy levels rather than chemical balances. They have been described as "liquid energy." The theory is that they encapsulate the flowers' healing energy, and are said to deal with and overcome negative emotions, and so relieve blockages in the flow of human energy that can cause illness.

Description

Origins

Perhaps the most famous and widely used system is the Bach flower remedies. This system originated in the 1920s when British physician and bacteriologist, Dr. Edward Bach (1886–1936), noticed that patients with physical complaints often seemed to be suffering from **anxiety** or some kind of negative emotion. He concluded that assessing a patient's emotional disposition and prescribing an appropriate flower essence could treat the physical illness. Bach was a qualified medical doctor, but he also practiced homeopathy.

As a result of his own serious illness in 1917, Bach began a search for a new and simple system of medicine that would treat the whole person. In 1930, he gave up his flourishing practice on Harley Street at the Royal London Homeopathic Hospital and moved to the countryside to devote his life to this research. At this point, he ceased to dispense the mixture of homeopathy and allopathic medicine that he had been using. Instead, he began investigating the healing properties of plant essences and discovered that he possessed an "intuition" for judging the properties of each flower. Accordingly, he developed the system of treatment that bears his name, and is also the foundation for all other flower-remedy systems.

The Bach Flower Remedies were ostensibly the only system of significance from the 1920s until in the 1970s, when there was a renewed interest in the subject by doctors working in the field of natural medicine. Perhaps the most notable was Dr. Richard Katz, who was seeking new methods of dealing with modern **stress** and the resulting ailments. He focused on the concept of a psychic, psychological effect and chose to pursue this line of research.

In 1979, Katz founded the Flower Essence Society in California, (FES). This society pledged to further the research and development of Bach's principles. FES hosts a database of more than 100 flower essences from more than 50 countries. FES is now an international organization of health practitioners, researchers, students, and others concerned with flower essence therapy.

The society has connections with an estimated 50,000 active practitioners from around the world, who use flower essence therapy as part of their treatment. FES encourages the study of the plants themselves to determine the characteristics of flower essences. They are compiling an extensive database of case studies and practitioner reports of the use of essences therapeutically, allowing verification and development of the original definitions. They are also engaged in the scientific study of flower essence therapy.

FES says they have developed the theories of Paracelsus and Goethe who researched the "signatures" and "gestures" of botanical specimens, on the premise that the human body and soul are a reflection of the system of nature. FES plant research interprets the therapeutic properties of flower essences according to these insights.

In this regard, they have devised 12 "windows of perception" for monitoring the attributes of plants. Each of these windows reveals an aspect of the plant's qualities, although they maintain that what they are seeking is a "whole which is greater than the sum of its parts." The 12 windows are not considered independent classifications, but more of a blended tapestry of views of the qualities that each plant possesses.

The first window is concerned with the "form" of a plant—its shape classification. The second focuses on its "gesture" or spatial relationship. The third window is a plant's botanical classification: The Flower Essence Society maintains that considering a plant's botanical family is essential to obtaining an overview of its properties as a flower essence. The fourth window concerns the time orientation of a particular specimen regarding the daily and seasonal cycles. Why do some flowers bloom at different times of the day, while others, such as the evening primrose, respond to the moon? The fifth window observes a plant's relationship to its environment. Where a plant chooses to grow, and where it cannot survive, reveals much about its qualities. The sixth window observes a plant's relationship to the Four Elements and the Four Ethers, as FES maintains that plants

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EDWARD BACH (1886–1936)

Edward Bach was a graduate of University College Hospital (M.B., B.S., M.R.C.S.) in England. He left his flourishing Harley Street practice in favor of homeopathy, seeking a more natural system of healing than allopathic medicine. He concluded that healing should be as simple and natural as the development of plants, which were nourished and given healing properties by earth, air, water, and sun.

Bach believed that he could sense the individual healing properties of flowers by placing his hands over the petals. His remedies were prepared by floating summer flowers in a bowl of clear stream water exposed to sunlight for three hours.

He developed 38 remedies, one for each of the negative states of mind suffered by human beings, which he classified under seven group headings: fear, uncertainty, insufficient interest in present circumstances, loneliness, over-sensitivity to influences and ideas, despondency or despair, and overcare for the welfare of others. The Bach remedies can be prescribed for plants, animals, and other living creatures as well as human beings.

exist in one of the elemental or etheric forces in addition to their physical life. "Elements" refers to those developed by the Greeks, as opposed to the modern concept of "molecular building blocks." It seems that commonly, two elements predominate in a plant, indicating a polarity of qualities, while two can be said to be recessive. The seventh window relates to a plant's relationship with the other kingdoms of nature: mineral, animal, and human, while the eighth relates to the color and color variations of a plant. Katz explains how the language of color tells us so much about the "soul qualities" of a plant. The ninth window concerns all other sensory perceptions of a plant, such as fragrance, texture, and taste. The 10th window involves assessing the chemical substances and properties; the 11th studies medicinal and herbal uses, as by studying the physical healing properties of plants, we can also understand something of their more subtle effects on the soul. Finally, the 12th window involves the study of the lore, mythology, folk wisdom, and spiritual and ritual qualities associated with a particular plant. Katz relates how in the past, human beings were more in touch with the natural world, and the remnants of this unconscious plant wisdom live on in the form of folklore, mythology, and so on.

Because flower remedies operate on approximately the same principles as homeopathy, practitioners quite often prescribe the two therapies in conjunction with each other. They can also be used concurrently with allopathic medicine.

The system consists of 38 remedies, each for a different disposition. The basic theory is that if the remedy for the correct disposition is chosen, the physical illness resulting from the present emotional state can then be cured. There is a rescue remedy made up of five of the essences—cherry plum, clematis, impatiens, rock star, and star of Bethlehem—that is recommended for the treatment of any kind of physical or emotional shock. Therapists recommended that rescue remedy be kept on hand to help with all emergencies.

The 38 Bach Remedies are:

- agrimony: puts on a cheerful front, hides true feelings, and worries or problems
- aspen: feelings of apprehension, dark foreboding, and premonitions
- beech: critical, intolerant, picky
- centaury: easily comes under the influence of others, weak willed
- cerato: unsure, no confidence in own judgement, intuition, and seeks approval from others
- cherry plum: phobic, fear of being out of control, and tension
- chestnut bud: repeats mistakes, does not learn from experience
- chicory: self-centered, possessive, clingy, demanding, self pity
- clematis: absent minded, dreamy, apathetic, and lack of connection with reality
- crab apple: a "cleanser" for prudishness, self–disgust, feeling unclean
- elm: a sense of being temporarily overwhelmed in people who are usually capable and in control
- gentian: discouraged, doubting, despondent
- gorse: feelings of pessimism, accepting defeat
- heather: need for company, talks about self, and concentrates on own problems
- holly: jealousy, envy, suspicion, anger, and hatred
- honeysuckle: reluctance to enter the present and let the past go
- hornbeam: reluctant to face a new day, weary, can't cope (mental fatigue)
- impatiens: impatience, always in a hurry, and resentful of constraints

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- larch: feelings of inadequacy and apprehension, lack of confidence and will to succeed
- mimulus: fearful of specific things, shy, and timid
- mustard: beset by "dark cloud" and gloom for no apparent reason
- oak: courageous, persevering, naturally strong but temporarily overcome by difficulties
- olive: for physical and mental renewal, to overcome exhaustion from problems of long–standing
- pine: for self–reproach, always apologizing, assuming guilt
- red chestnut: constant worry and concern for others
- rock rose: panic, intense alarm, dread, horror
- rock water: rigid–minded, self–denial, restriction
- scleranthus: indecision, uncertainty, fluctuating moods
- star of Bethlehem: consoling, following shock or grief or serious news
- sweet chestnut: desolation, despair, bleak outlook
- vervain: insistent, fanatical, over–enthusiastic
- vine: dominating, overbearing, autocratic, tyrannical
- walnut: protects during a period of adjustment or vulnerability
- water violet: proud, aloof, reserved, enjoys being alone
- white chestnut: preoccupation with worry, unwanted thoughts
- wild oat: drifting, lack of direction in life
- wild rose: apathy, resignation, no point in life
- willow bitter: resentful, dissatisfied, feeling life is unfair

Originally, Bach collected the dew from chosen flowers by hand to provide his patients with the required remedy. This became impractical when his treatment became so popular that production could not keep up with demand. He then set about finding a way to manufacture the remedies, and found that floating the freshly picked petals on the surface of spring water in a glass bowl and leaving them in strong sunlight for three hours produced the desired effect. Therapists explain that the water is "potentized" by the essence of the flowers. The potentized water can then be bottled and sold. For more woody specimens, the procedure is to boil them in a sterilized pan of water for 30 minutes. These two methods produce "mother tinctures" and the same two methods devised by Bach are still used today. Flower essences do not contain any artificial chemical substances, except for alcohol preservative.

Bach remedies cost around $10 each, and there is no set time limit for treatment. It may take days, weeks, or in some cases months. Flower essences cost around $6 each, and there is also no set time for the length of treatment, or the amount of essences that may be taken. These treatments are not generally covered by medical insurance.

Precautions

Bach remedies and flower essences are not difficult to understand, and are considered suitable for self administration. The only difficulty may be in finding the correct suggested remedy, as it can sometimes be tricky to pinpoint an individual's emotional disposition. They are even safe for babies, children, and animals. An important aspect of treatment with flower remedies, is that if you feel instinctively that you need a particular remedy, you are encouraged to act on that instinct. However, it is advisable not to continue a particular remedy once you feel you no longer need it, and to try a different one if you feel that progress is not being made.

The remedies are administered from a stoppered bottle and need to be diluted. Individuals sensitive to alcohol can apply the concentrate directly to temples, wrists, behind the ears, or underarms. They should be kept in a cool dark place; like this they should last indefinitely. However, a diluted remedy should not be kept longer than three weeks. Two drops of each diluted remedy should be taken four times a day, including first thing in the morning and last thing at night. If the rescue remedy is being used, four drops should be used instead. Most therapists recommend that they be taken in spring water, but the remedy can be taken directly from the bottle, if care is taken that the dropper does not touch the tongue, as this would introduce bacteria that would spoil the remedy.

It is not recommended that more than six or seven Bach remedies be used at any one time. Instead, it is preferable to divide a larger amount up into two lots to ensure the optimum effectiveness of the remedies. No combination, or amount of combinations of the remedies can cause any harm, rather they become less effective.

Unlike FES, the Bach Centre does not encourage research to "prove" that the remedies work, preferring that people find out for themselves. They strive to keep the use of the Bach remedies as simple as possible, and to this end they do not keep case records. Bach warned before he died that others would try to change his work and make it more complicated. He was determined to keep it simple so that anyone could use it, and that is why he limited the system to only 38 remedies. The

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KEY TERMS

Aura—Emanation of light from living things (plants and animals) that can be recorded by Kirlian photography.

Essence—The constituent of a plant that determines its characteristics.

Potentize—The process of transferring the healing energy of a plant into spring water.

Window—A perspective adopted to assess the property of a given plant.

Centre points out that many who have used Bach's research as a starting point have added other remedies to the list, even some that Bach himself rejected.

Side effects

Flower remedies or essences are generally regarded as being totally safe, and there are no known side effects apart from the rare appearance of a slight rash, which is not a reason to discontinue treatment, says the Bach Centre.

Research and general acceptance

Bach flower remedies and flower essences have not yet officially won the support of allopathic medicine, despite the fact that more and more medical doctors are referring patients for such treatments on the strength of personal conviction. However, it is difficult to discount the scores of testimonials. Some practitioners refer skeptics to the research that has been done regarding the "auras" of living things. Theoretically, the stronger the aura, the more alive an organism is. Flower essences have very strong auras.

Resources

BOOKS

McCabe, Vinton. *The Healing Bouquet: Exploring Bach Flower Remedies*. Laguna Beach, CA: Basic Health, 2007.

ORGANIZATIONS

Flower Essence Society, P.O. Box 459, Nevada City, NV, 95959, (530) 265-9163, (530) 265-0584, (800) 736-9222, info@flowersociety.org, http://www.flowersociety.org/.

Patricia Skinner

Flu *see* **Influenza**

Flucona *see* **Antifungal drugs, systemic**

Fluke infections

Definition

Fluke infections are diseases of the digestive tract and other organ systems caused by several different species of parasitic flatworms (trematodes) that have complex life cycles involving hosts other than human beings. Trematode comes from a Greek word that means having holes and refers to the external suckers that adult flukes use to draw nourishment from their hosts. Fluke infections are contracted by eating uncooked fish, plants, or animals from fluke-infected waters. Symptoms vary according to the type of fluke infection.

Description

In humans, fluke infections can be classified according to those diseases caused by liver flukes and those caused by lung flukes. Diseases caused by liver flukes include fascioliasis, opisthorchiasis, and clonorchiasis. Cases of liver fluke infection have been reported in Europe and the United States, as well as the Middle East, China, Japan, and Africa. Diseases caused by lung flukes include paragonimiasis. Paragonimiasis is a common infection in the Far East, Southeast Asia, Africa, Central and South America, Indonesia, and the Pacific Islands. It is estimated that

A micrograph of adult intestinal blood flukes, *Schistosoma mansoni*. Humans can become infected while bathing or working in contaminated water. *(Photo Researchers, Inc.)*

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between 40 million and 100 million people worldwide suffer from either liver or lung fluke infections.

In their adult stage, liver and lung flukes are symmetrical in shape, ranging between 1/4–1 in in length, and look somewhat like long, plump leaves or blades of grass. They enter through the mouth and can infect any person at any age.

Causes and symptoms

The symptoms of fluke infection differ somewhat according to the type of fluke involved. All forms of liver and lung fluke infection, however, have the following characteristics:

- most persons who get infected do not develop symptoms (asymptomatic)
- the early symptoms of an acute fluke infection are not unique to these diseases alone (nonspecific symptoms)
- infection does not confer immunity against re-infection by the same species or infection by other species of flukes
- infection is usually associated with eating uncooked fish, plants, or animals that live in fresh water

Fascioliasis

Fascioliasis is caused by *Fasciola hepatica*, the sheep liver fluke. The fluke has a three-part life cycle that begins when eggs from a host's feces are deposited in water. The eggs release free-swimming larvae (miracidia) that infect snails. The snails then release free-swimming larvae with tails (cercariae) that form cysts containing larvae in the infective stage (metacercariae) on vegetation growing in fresh water. Humans become infected when they eat watercress, water chestnuts, or other plants covered with the encysted metacercariae.

When a person eats contaminated plants, the cysts are broken open in the digestive system, and the metacercariae leave their cysts, pass through the wall of the intestine, and enter the liver, where they cause inflammation and destroy tissue. After a period of 10–15 weeks in the liver, the adult flukes move to the bile ducts and produce eggs. Acute fascioliasis is marked by abdominal **pain** with **headache**, loss of appetite, anemia, and **vomiting**. Some patients develop **hives**, muscle pains, or a yellow-color to the skin and whites of the eyes (**jaundice**). Chronic forms of the disease may produce complications, including blockage of the bile ducts or the migration of adult flukes to other parts of the body.

Opisthorchiasis and clonorchiasis

These infections are caused by *Clonorchis sinensis*, the Chinese liver fluke, and *Opisthorchis viverrini* or *O. felineus*. The diseases are widespread, affecting more than 20 million people in Japan, China, Southeast Asia, and India. The life cycle of these liver flukes is similar to that of *F. hepatica* except that the etacercariae are encysted in freshwater fish rather than on plants. Dogs, cats, and other mammals that eat raw fish can be infected with opisthorchiasis and clonorchiasis.

The symptoms of opisthorchiasis and clonorchiasis are similar to those of fascioliasis and include both acute and chronic forms. In acute infection, the patient may be tired, have a low-grade **fever**, pains in the joints, a swollen liver, abdominal pain, and a skin rash. The acute syndrome may be difficult to diagnose because the fluke eggs do not appear in the patient's stool for three to four weeks after infection. Patients with the chronic form of the disease experience a loss of appetite, **fatigue**, low-grade fever, **diarrhea**, and an enlarged liver that feels sore when the abdomen is pressed.

Paragonimiasis

Paragonimiasis is caused by a lung fluke, either *Paragonimus westermani* or *P. skrjabini*. These flukes are larger than liver flukes and infect meat- or fish-eating animals as well as humans. Their life cycle is similar to that of liver flukes except that their encysted larvae infect crabs and crayfish rather than plants or fish. Humans can ingest the encysted metacercariae from drinking contaminated water or eating raw or undercooked crabs and crayfish.

In humans, the metacercariae are released from their cysts in the small intestine and migrate to the lungs or the brain in 1% of cases. In the lungs, the flukes lay their eggs and form areas of inflammation covered with a thin layer of fibrous tissue. These areas of infection may eventually rupture, causing the patient to **cough** up fluke eggs, blood, and inflamed tissue. The period between the beginning of the infection and the appearance of the eggs during coughing is about six weeks. Patients with lung infections may have chest pain and fever as well as rust-colored or bloody sputum. Lung infections can lead to **lung abscess**, **pneumonia**, or **bronchitis**. Patients with fluke infections of the brain may experience seizures or a fatal inflammation of brain tissue called **encephalitis**. Some patients also develop diarrhea and abdominal pain or lumps under the skin that contain adult flukes.

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KEY TERMS

Aspirator—A medical instrument that uses suction to withdraw fluids from the lungs, digestive tract, or other parts of the body for laboratory testing.

Asymptomatic—Persons who carry a disease and are usually capable of transmitting the disease but, who do not exhibit symptoms of the disease are said to be asymptomatic.

Cercaria (plural, cercariae)—An intermediate-stage of the fluke larva, released into water by infected snails.

Cross-reaction—A reaction that occurs in blood testing when a disease agent reacts to the specific antibody for another disease agent. Cross-reactions are common in blood tests for fluke infections because the different species are closely related.

Encysted—Enclosed in a cyst or capsule. Flukes spend part of their life cycle as encysted larvae.

Fluke—A parasitic flatworm that has external suckers. Flukes are sometimes called trematodes.

Host—The living animal that supplies nutrition to a parasite.

Jaundice—Yellowing of the skin and the whites of the eyes as a result of excess bile in the blood due to an improperly functioning liver.

Metacercaria (plural, metacercariae)—The encysted stage of a fluke larva that produces infection in human beings.

Miracidium (plural, miracidia)—The free-swimming larval form in the life cycle of the liver fluke.

Parasite—An organism that lives on or inside an animal of a different species and feeds on it or draws nutrients from it.

Trematode—Parasitic flatworms or another name for fluke, taken from a Greek word that means having holes.

Diagnosis

Diagnosis of fluke infections is based on a combination of the patient's history, particularly travel or residence in areas known to have flukes, and identification of the fluke's eggs or adult forms. In some patients, the eggs are found in fluid from the lungs, bile duct, or small intestine. Samples of these fluids can be obtained with a suction instrument (aspirator). Because most types of fluke infections are rare in the United States, stool specimens or body fluid samples may need to be sent to a laboratory with experts in unusual diseases or conditions to identify the specific parasite. In some cases, adult flukes may be found in the patient's stools, vomit, sputum, or skin lumps (for lung flukes). In the case of lung flukes, it is important for the doctor to rule out **tuberculosis** as a possible diagnosis. A tuberculosis skin test and **chest x-ray** will usually be sufficient to do this.

Blood tests may be useful in diagnosing fluke infections, but their usefulness is limited because of cross-reactions. A cross-reaction occurs in blood testing when a particular disease agent reacts with antibodies specific to another disease agent. This result means that the doctor may know that the person is infected by flukes but cannot tell from the blood test alone which specific type of fluke is causing the disease. In addition, blood tests for fluke infections cannot distinguish between past and current infections. In some cases, sophisticated imaging techniques, such as **computed tomography scans** (CT scans) or ultrasound scans of the patient's chest or brain (for lung flukes) or abdomen (for liver flukes), are useful in confirming a diagnosis of fluke infection.

Treatment

Liver and lung fluke infections are treated with medications. These include triclabendazole, praziquantel, bithionol, albendazole, and mebendazole. Praziquantel works by paralyzing the flukes' suckers, forcing them to drop away from the walls of the host's blood vessels. In the United States, bithionol is available only from the Centers for Disease Control (CDC). Depending on the species of fluke and the severity of infection, the course of treatment can vary from several days to several weeks. Cure rates vary from 50–95%. Most patients experience mild temporary side effects from these drugs, including diarrhea, **dizziness**, or headache.

Prognosis

The prognosis for recovery from liver fluke infections is good, although patients with serious infections may be more vulnerable to other diseases, particularly if significant liver damage has occurred. Most patients with lung fluke infections also recover, however, severe infections of the brain can cause **death** from the destruction of central nervous system or brain tissue.

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Prevention

No vaccines have been developed that are effective against lung or liver fluke infections. Prevention of these infections includes the following measures:

- boiling or purifying drinking water
- avoiding raw or undercooked fish or salads made from fresh aquatic plants; all food eaten in areas with fluke infestations should be cooked thoroughly; pickling or smoking will not kill fluke cysts in fish or shellfish
- control or eradication of the snails that serve as the flukes' intermediate hosts

Resources

BOOKS

McPhee, Stephen, and Maxine Papadakis. *Current Medical Diagnosis and Treatment, 2010*, 49th ed. New York: McGraw–Hill Medical, 2009.

Rebecca J. Frey, PhD

Fluoroquinolones

Definition

Fluoroquinolones are medicines that kill bacteria or prevent their growth.

Purpose

Fluoroquinolones are antimicrobials, medicines used to treat infections caused by microorganisms. Physicians prescribe these drugs for bacterial infections in many parts of the body. For example, they are used to treat bone and joint infections, skin infections, urinary tract infections, inflammation of the prostate, serious ear infections, **bronchitis**, **pneumonia**, **tuberculosis**, some **sexually transmitted diseases** (STDs), and some infections that affect people with **AIDS**.

Description

Fluoroquinolones are available only with a physician's prescription and are sold in tablet and injectable forms. Examples of these medicines are moxifloxacin (Avelox), ciprofloxacin (Cipro), ofloxacin (Floxin), levofloxacin (Levaquin), lomefloxacin (Maxaquin), norfloxacin (Noroxin), enoxacin (Penetrex), gatifloxacin (Tequin), and sparfloxacin (Zagam).

In the wake of the **anthrax** terrorist attacks in the United States in 2001, ciprofloxacin received extensive media attention because it was the only drug labeled as approved by the U.S. Food and Drug Administration (FDA) for both **prophylaxis** and treatment of inhalation anthrax (the most serious form of the disease). However, in late October 2001, the FDA issued a notice clarifying that the antibiotic doxycycline is also approved for anthrax prophylaxis and that doxycycline and amoxicillin are also approved for treatment for all forms of anthrax. The FDA encouraged companies to update labeling of these products with this previously unspecified information.

Recommended dosage

The recommended dosage depends on the type and strength of fluoroquinolone, and the kind of infection for which it is being taken. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

To make sure the infection clears up completely, take the medicine for as long as it has been prescribed. Do not stop taking the drug just because symptoms begin to improve. Symptoms may return if the drug is stopped too soon.

Fluoroquinolones work best when they are at constant levels in the blood. To help keep levels constant, take the medicine in doses spaced evenly through the day and night. Do not miss any doses. For best results, take this medicine with a full glass of water and drink several more glasses throughout the day, every day during treatment with the drug. The extra water will help prevent some side effects. Some fluoroquinolones should be taken on an empty stomach; others may be taken with meals. Check package directions or ask the physician or pharmacist for instructions on how to take the medicine.

Precautions

An important precaution for any antibiotic is that unnecessary use or abuse of **antibiotics** can encourage drug-resistant strains of bacteria to develop and proliferate. These drug-resistant strains then become difficult, or even impossible, to treat. Bacteria found in hospitals appear to have become especially resilient, and are causing increasing difficulty for patients and the doctors treating them. Following the U.S. 2001 anthrax attacks, for example, the American Medical Association urged its members not to prescribe ciprofloxacin unnecessarily. One fear is that the overuse of the drug could reduce its effectiveness against infections such as **typhoid fever**, hospital-acquired pneumonia, and others.

Research suggests that fluoroquinolones may cause bone development problems in children and teenagers.

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KEY TERMS

Bacteria—Tiny, one-celled forms of life that cause many diseases and infections.

Bronchitis—Inflammation of the air passages of the lungs.

Digestive tract—The stomach, intestines, and other parts of the body through which food passes.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Microorganism—An organism that is too small to be seen with the naked eye.

Pneumonia—A disease in which the lungs become inflamed. Pneumonia may be caused by bacteria, viruses, or other organisms, or by physical or chemical irritants.

Prostate—A donut-shaped gland in males below the bladder that contributes to the production of semen.

Sexually transmitted disease (STD)—A disease that is passed from one person to another through sexual intercourse or other intimate sexual contact.

Tendon—A tough band of tissue that connects muscle to bone.

Tuberculosis—An infectious disease that usually affects the lungs, but may also affect other parts of the body. Symptoms include fever, weight loss, and coughing up blood.

Urinary tract—The passage through which urine flows from the kidneys out of the body.

Infants, children, teenagers, pregnant women, and women who are **breastfeeding** should not take this medicine unless directed to do so by a physician.

Although such side effects are rare, some people have had severe and life-threatening reactions to fluoroquinolones. Call a physician immediately if any of these signs of a dangerous reaction occur:

- swelling of the face and throat
- swallowing problems
- shortness of breath
- rapid heartbeat
- tingling of fingers or toes
- itching or hives
- loss of consciousness

Some fluoroquinolones may weaken the tendons in the shoulder, hand, or heel, making the tendons more likely to tear. Anyone who notices **pain** or inflammation in these or other tendon areas should stop taking the medicine immediately and call a physician. Rest and avoid **exercise** until the physician determines whether the tendons are damaged. If the tendons are torn, surgery may be necessary to repair them.

These medicines make some people feel drowsy, dizzy, lightheaded, or less alert. Anyone who takes these drugs should not drive, use machines or do anything else that might be dangerous until they have found out how the drugs affect them.

This medicine may increase sensitivity to sunlight. Even brief exposure to sun can cause a severe **sunburn** or a rash. While being treated with fluoroquinolones, avoid being in direct sunlight, especially between 10 a.m. and 3 p.m.; wear a hat and tightly woven clothing that covers the arms and legs; use a sunscreen with a skin protection factor (SPF) of at least 15; protect the lips with a sun block lipstick; and do not use **tanning** beds, tanning booths, or sunlamps.

Do not take **antacids** that contain aluminum, **calcium**, or magnesium at the same time as fluoroquinolones. The antacids may keep the fluoroquinolones from working as they should. If antacids are needed, take them at least two hours before or two hours after taking norfloxacin or ofloxacin, at least four hours before or two hours after taking ciprofloxacin. Follow the same instructions for taking sucralfate (Carafate), a medicine used to treat stomach ulcers and other irritation in the digestive tract and mouth.

Anyone who has had unusual reactions to fluoroquinolones or related medicines such as cinoxacin (Cinobac) or nalidixic acid (NegGram) in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

Before using fluoroquinolones, people with any of these medical problems should make sure their physicians are aware of their conditions:

- kidney disease
- liver disease with kidney disease
- diseases of the brain or spinal cord, including hardening of the arteries in the brain, epilepsy, and other seizure disorders

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Taking fluoroquinolones with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Side effects

The most common side effects are mild **diarrhea**, **nausea**, **vomiting**, stomach or abdominal pain, **dizziness**, drowsiness, lightheadedness, nervousness, sleep problems, and **headache**. These problems usually go away as the body adjusts to the drug and do not require medical treatment unless they are bothersome.

More serious side effects are not common, but may occur. If any of the following side effects occur, check with a physician immediately:

- skin rash or other skin problems such as itching, peeling, hives, or redness
- fever
- agitation or confusion
- hallucinations
- shakiness or tremors
- seizures or convulsions
- tingling of fingers or toes
- pain where the medicine was injected (lasting after the injection)
- pain in the calves, spreading to the heels
- swelling of the calves or lower legs
- swelling of the face or neck
- swallowing problems
- rapid heartbeat
- shortness of breath
- loss of consciousness

Other rare side effects may occur. Anyone who has unusual symptoms after taking fluoroquinolones should get in touch with his or her physician.

Interactions

Fluoroquinolones may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes fluoroquinolones should let the physician know all other medicines he or she is taking. Among the drugs that may interact with fluoroquinolones are:

- antacids that contain aluminum, calcium, or magnesium
- medicines that contain iron or zinc, including multivitamin and mineral supplements
- sucralfate (Carafate)
- caffeine
- blood thinning drugs such as warfarin (Coumadin)
- airway opening drugs (bronchodilators) such as aminophylline, theophylline (Theo-Dur and other brands), and oxtriphylline (choledyl and other brands)
- didanosine (Videx), used to treat HIV infection.

This list does not include every drug that may interact with fluoroquinolones. Be sure to check with a physician or pharmacist before combining fluoroquinolones with any other prescription or nonprescription (over-the-counter) medicine.

Resources

OTHER

"Fluoroquinolones (Systemic)." National Library of medicine. www.nlm.nih.gov/medlineplus/druginfo/fluoroquinolonessystemic202656.html.

Rosalyn Carson-DeWitt, MD

Fluoxetine *see* **Selective serotonin reuptake inhibitors**

Flurbiprofen *see* **Nonsteroidal anti-inflammatory drugs**

Focal glomeruloscle *see* **Nephrotic syndrome**

Folic acid

Definition

Folic acid is a water-soluable vitamin belonging to the B-complex group of **vitamins**. These vitamins help the body break down complex carbohydrates into simple sugars to be used for energy. Excess B vitamins are excreted from the body rather than stored for later use. This is why sufficient daily intake of folic acid is necessary.

Description

Folic acid is also known as folate, or folacin. It is one of the nutrients most often found to be deficient in the Western diet, and there is evidence that deficiency is a problem on a worldwide scale. Folic acid is found in leafy green vegetables, beans, peas and lentils, liver, beets, brussel sprouts, poultry, nutritional yeast, tuna, wheat germ, mushrooms, oranges, asparagus, broccoli, spinach, bananas, strawberries, and cantaloupes. In 1998, the U.S. Food and Drug Administration (FDA) required food manufacturers to add folic acid

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KEY TERMS

Homocysteine—An amino acid involved in the breakdown and absorption of protein in the body.

Preeclampsia—A serious disorder of late pregnancy in which the blood pressure rises, there is a large amount of retained fluids, and the kidneys become less effective and excrete proteins directly into the urine.

Raynaud's disease—A symptom of various underlying conditions affecting blood circulation in the fingers and toes and causing them to be sensitive to cold.

Recommended Dietary Allowance (RDA)—Guidelines for the amounts of vitamins and minerals necessary for proper health and nutrition established by the National Academy of Sciences in 1989.

Water-soluble vitamins—Vitamins that are not stored in the body and are easily excreted. They must, therefore, be consumed regularly as foods or supplements to maintain health.

to enriched bread and grain products to boost intake and to help prevent neural tube defects (NTD).

Purpose

Folic acid works together with vitamin B_{12} and vitamin C to metabolize protein in the body. It is important for the formation of red and white blood cells. It is necessary for the proper differentiation and growth of cells and for the development of the fetus. It is also used to form the nucleic acid of DNA and RNA. It increases the appetite and stimulates the production of stomach acid for digestion and it aids in maintaining a healthy liver. A deficiency of folic acid may lead to anemia, in which there is decreased production of red blood cells. This reduces the amounts of oxygen and nutrients that are able to get to the tissues. Symptoms may include **fatigue**, reduced secretion of digestive acids, confusion, and forgetfulness. During **pregnancy**, a folic acid deficiency may lead to **preeclampsia**, premature birth, and increased bleeding after birth.

People who are at high risk of strokes and heart disease may greatly benefit by taking folic acid supplements. An elevated blood level of the amino acid **homocysteine** has been identified as a risk factor for some of these diseases. High levels of homocysteine have also been found to contribute to problems with **osteoporosis**. Folic acid, together with vitamins B_6 and B_{12}, helps break down homocysteine, and may help reverse the problems associated with elevated levels.

Pregnant women have an increased need for folic acid, both for themselves and their child. Folic acid is necessary for the proper growth and development of the fetus. Adequate intake of folic acid is vital for the prevention of several types of **birth defects**, particularly NTDs. The neural tube of the embryo develops into the brain, spinal cord, spinal column, and the skull. If this tube forms incompletely during the first few months of pregnancy a serious, and often fatal, defect results in **spina bifida** or anencephaly. Folic acid, taken from one year to one month before conception through the first four months of pregnancy, can reduce the risk of NTDs by 50–70%. It also helps prevent a **cleft lip and palate**.

Research shows that folic acid can be used to successfully treat cervical dysplasia, a condition diagnosed by a Pap smear, of having abnormal cells in the cervix. This condition is considered to be a possible precursor to **cervical cancer**, and is diagnosed as an abnormal Pap smear. Daily consumption of 1,000 mcg of folic acid for three or more months has resulted in improved cervical cells upon repeat Pap smears.

Studies suggest that long-term use of folic acid supplements may also help prevent lung and **colon cancer**. Researchers have also found that alcoholics who have low folic acid levels face a greatly increased possibility of developing colon cancer.

Preparations

To correct a folic acid deficiency, supplements are taken in addition to food. Since the functioning of the B vitamins is interrelated, it is generally recommended that the appropriate dose of B-complex vitamins be taken in place of single B vitamin supplements. The Recommended Dietary Allowances (RDA) for folate is 400 mcg per day for adults, 600 mcg per day for pregnant women, and 500 mcg for nursing women. Medicinal dosages of up to 1,000-2,000 mcg per day may be prescribed.

Precautions

Folic acid is not stable. It is easily destroyed by exposure to light, air, water, and cooking. Therefore, the supplement should be stored in a dark container in

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a cold, dry place, such as a refrigerator. Many medications interfere with the body's absorption and use of folic acid. This includes sulfa drugs, sleeping pills, estrogen, anti-convulsants, birth control pills, **antacids**, quinine, and some **antibiotics**. Using large amounts of folic acid (e.g., more than 5,000 mcg per day) can mask a vitamin B_{12} deficiency and thereby risk of irreversible nerve damage.

Side effects

At levels of 5,000 mcg or less, folic acid is generally safe for use. Side effects are uncommon. However, large doses may cause **nausea**, decreased appetite, bloating, gas, decreased ability to concentrate, and **insomnia**. Large doses may also decrease the effects of phenytoin (Dilantin), a seizure medication.

Interactions

As with all B-complex vitamins, it is best to take folic acid with the other B vitamins. Vitamin C is important to the absorption and functioning of folic acid in the body.

Resources

OTHER

"Folic Acid." http://www.cybervitamins.com/folicacid.htm.
"Folic Acid: Coming to A Grocery Store Near You." http://www.mayohealth.org/mayo/9710/htm/folic.htm.
"Folic acid (oral/injectible)." Dr. Koop.com.Inc. 700 N. Mopac, Suite 400, Austin, TX 48731. http://www.drkoop.com/hcr/drugstore/pharmacy/leaflets/english/d00241a1.asp.
Pregnancy and Nutrition Update. http://www.mayohealth.org/mayo/9601/htm/pregvit.htm.

ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Rd., Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

Patience Paradox

Folic acid deficiency anemia

Definition

Folic acid deficiency, an abnormally low level of one of the B **vitamins**, results in anemia characterized by red blood cells that are large in size but few in number.

Description

Folic acid is necessary for growth and cellular repair, since it is a critical component of DNA and RNA as well as essential for the formation and maturation of red blood cells. Folic acid deficiency is one of the most common of all vitamin deficiencies. Although it occurs in both males and females, folic acid deficiency anemia most often affects women over age 30. It becomes increasingly common as age impedes the body's ability to absorb folic acid, a water-soluble vitamin that is manufactured by intestinal bacteria and stored for a short time in the liver. Folic acid deficiency has also been implicated as a cause of neural tube defects in the developing fetus. Recent research has shown that adequate amounts of folic acid can prevent up to one-half of these **birth defects**, if women start taking folic acid supplements shortly before conception. Research from China in 2004 showed that women who were low in B vitamins and folate before conception, though not technically anemic, still had increased risk of lower birth weight babies and adverse **pregnancy** outcome.

A healthy adult needs at least 400 mcg of folic acid every day. Requirements at least double during pregnancy, and increase by 50% when a woman is **breastfeeding**. The average American diet, high in fats, sugar, and white flour, provides about 200 mcg of folic acid, approximately the amount needed to maintain tissue stores of the substance for six to nine months before a deficiency develops. Most of the folic acid in foods (with the exception of the folic acid added to enriched flour and breakfast cereals) occurs as folate. Folate is only about pne-half as available for the body to use as is the folic acid in pills and supplements. Folate also is easily destroyed by sunlight, overcooking, or the storing of foods at room temperature for an extended period of time.

Good dietary sources of folate include:

- leafy green vegetables
- liver
- mushrooms
- oatmeal
- peanut butter
- red beans
- soy
- wheat germ

Causes and symptoms

This condition usually results from a diet lacking in foods with high folic acid content, or from the

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body's inability to digest foods or absorb foods having high folic acid content. Other factors that increase the risk of developing folic acid deficiency anemia are:

- age
- alcoholism
- birth control pills, anticonvulsant therapy, sulfa antibiotics, and certain other medications
- illness
- smoking
- stress

Fatigue is often the first sign of folic acid deficiency anemia. Other symptoms include:

- anorexia nervosa
- pale skin
- paranoia
- rapid heart beat
- sore, inflamed tongue
- weakness
- weight loss

Diagnosis

Diagnostic procedures include blood tests to measure hemoglobin, an iron-containing compound that carries oxygen to cells throughout the body. Symptoms may be reevaluated after the patient has taken prescription folic acid supplements.

Treatment

Folic acid supplements are usually prescribed, and self-care includes avoiding:

- alcohol
- non-herbal tea, antacids, and phosphates (contained in beer, ice cream, and soft drinks), which restrict iron absorption
- tobacco

A person with folic acid deficiency anemia should rest as often as necessary until restored energy levels make it possible to resume regular activities. A doctor should be seen if **fever**, chills, muscle aches, or new symptoms develop during treatment, or if symptoms do not improve after two weeks of treatment.

Alternative treatment

Alternative therapies for folic acid deficiency anemia may include **reflexology** concentrated on areas that influence the liver and spleen. Increasing consumption of foods high in folate is helpful. Eating a mixture of yogurt (8 oz) and turmeric (1 tsp) also may help resolve symptoms. A physician should be contacted if the tongue becomes slick or smooth or the patient:

- bruises or tires easily
- feels ill for more than five days
- feels weak or out of breath
- looks pale or jaundiced

Prognosis

Although adequate folic acid intake usually cures this condition in about three weeks, folic acid deficiency anemia can make patients infertile or more susceptible to infection. Severe deficiencies can result in congestive **heart failure**.

Prevention

Eating raw or lightly cooked vegetables every day will help maintain normal folic acid levels, as will taking a folic acid supplement containing at least 400 mcg of this vitamin. Because folic acid deficiency can cause birth defects, all women of childbearing age who can become pregnant should consume at least 400 mcg of folic acid daily; a woman who is pregnant should have regular medical checkups, and take a good prenatal vitamin.

Resources

PERIODICALS

Ronnenberg, Alayne G., et al. "Preconception Hemoglobin and Ferritin Concentrations Are Associated With Pregnancy Outcome in a Prospective Cohort of Chinese Women." *The Journal of Nutrition* October 2004: 2586–2592.

Maureen Haggerty
Teresa G. Odle

Follicle-stimulating hormone test

Definition

The follicle-stimulating hormone (FSH) test measures the amount of FSH in the blood. FSH is a hormone that regulates the growth and development of eggs and sperm, and this test is used to diagnose or evaluate disorders involving the pituitary gland and reproductive system.

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KEY TERMS

Anovulatory bleeding—Bleeding without release of an egg from an ovary.

Hypopituitarism—Underactivity of the pituitary gland.

Hypothalamus—The part of the brain that controls the endocrine system.

Klinefelter's syndrome—Chromosomal abnormality characterized by small testes and male infertility.

Multiple endocrine neoplasia—Abnormal tissue growth on one or more of the endocrine (hormone-secreting) glands.

Polycystic ovary disease—A condition in which a woman has little or no menstruation, is infertile, has excessive body hair, and is obese. The ovaries may contain several cysts.

Turner syndrome—Chromosomal abnormality characterized by immature reproductive organs in women.

Purpose

FSH testing is performed if a physician suspects the patient may have a disorder involving the reproductive system or pituitary gland. The pituitary gland produces FSH, which stimulates the growth of the sacks (follicles) that surround the eggs in a woman's ovaries. This is important for the process of ovulation, in which the egg is released. In men, FSH stimulates production of sperm. If there are abnormal levels of FSH in the blood it may mean that one of several disorders are present. Normal fluctuations occur as a result of **puberty**, the menstrual cycle, **pregnancy**, and **menopause**.

The FSH test is performed more often on women than on men. In women, it is used to determine if menopause has begun, to diagnose **infertility** and **menstrual disorders** (such as anovulatory bleeding), to measure hormone levels in children who enter puberty at an early age, and to diagnose other disorders. In men, it can be used to determine early puberty, abnormal tissue growth on one or more of the hormone-secreting (endocrine) glands (called multiple endocrine neoplasia), or to diagnose other disorders.

Description

The FSH test is a blood test. Blood will be drawn from the patient and analyzed in a laboratory.

Preparation

In preparation for the test, there are no food or fluid intake restrictions. Patients may be advised to discontinue certain medications for 48 hours before the test. A menstruating woman having hot flashes or irregular periods should be tested on the second or third day of her menstrual cycle. A woman who has missed a period and is having other menopausal symptoms can be tested at any time.

Aftercare

No aftercare is necessary.

Risks

There are no risks associated with this test.

Normal results

Normal FSH test results vary according to age and sexual maturity. The phase of a woman's menstrual cycle or use of birth-control pills also affects test results.

For an adult male, normal results range from about 4–25 units of FSH in every liter of blood (U/L) or about 5–20 micro-international units in every milliliter.

For a premenopausal woman, normal values range from 4–30 U/L or 5–20 micro-international units per milliliter. In a pregnant woman, FSH levels are too low to measure. After menopause, normal values range from 40–250 U/L or 50–100 micro-international units per milliliter.

FSH levels fluctuate during premenopause. If no other symptoms are present, an elevated FSH level should not be interpreted as proof that menopause has begun.

Abnormal results

Anorexia nervosa and disorders of the hypothalamus or pituitary gland can result in abnormally low FSH levels.

Abnormal levels can also indicate:

- infertility
- hypopituitarism
- Klinefelter syndrome (in men)
- turner syndrome
- ovarian failure
- polycystic ovary syndrome

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Resources

OTHER

"Follicle-Stimulating Hormone Test." *Health Answers.com* www.healthanswers.com.

Maureen Haggerty

Follicular cysts *see* **Ovarian cysts**

Folliculitis

Definition

Folliculitis is inflammation or infection of one or more hair follicles (openings in the skin that enclose hair).

Description

Folliculitis can affect both women and men at any age. It can develop on any part of the body, but is most likely to occur on the scalp, face, or parts of the arms, armpits, or legs not usually covered by clothing.

Small, yellowish-white blister-like lumps (pustules) surrounded by narrow red rings are usually present with both bacterial folliculitis and fungal folliculitis. Hair can grow through or alongside of the pustules, which sometimes ooze blood-stained pus.

Acne folliculitis. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Folliculitis can cause **boils** and, in rare instances, serious skin infections. Bacteria from folliculitis can enter the blood stream and travel to other parts of the body.

Causes and symptoms

Folliculitis develops when bacteria, such as *Staphylococcus,* or a fungus enters the body through a cut, scrape, surgical incision, or other break in the skin near a hair follicle. Scratching the affected area can trap fungus or bacteria under the fingernails and spread the infection to hair follicles on other parts of the body.

The bacteria that cause folliculitis are contagious. A person who has folliculitis can infect others who live in the same household.

Factors that increase the risk of developing folliculitis include:

- dermatitis
- diabetes
- dirty, crowded living conditions
- eczema
- exposure to hot, humid temperatures
- infection in the nose or other recent illness
- tight clothing

Diagnosis

Diagnosis is based on the patient's medical history and observations. Laboratory analysis of the substance drained from a pustule can be used to distinguish bacterial folliculitis from fungal folliculitis.

Treatment

Bacterial folliculitis may disappear without treatment, but is likely to recur. Non-prescription **topical antibiotics** like Bacitracin, Mycitracin, or Neomycin, gently rubbed on to affected areas three or four times a day, can clear up a small number of bacterial folliculitis pustules. Oral **antibiotics** such as erythromycin (Erythocin) may be prescribed if the infection is widespread. The drug griseofulvin (Fulvicin) and topical antifungal medications are used to treat fungal folliculitis.

A doctor should be notified if:

- pustules spread after treatment has begun or reappear after treatment is completed
- the patient's fever climbs above 100 °F (37.8 °C)
- the patient develops boils or swollen ankles

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- redness, swelling, warmth, or pain indicate that the infection has spread
- unexplained new symptoms appear

Alternative treatment

Eating a balanced diet, including protein, complex carbohydrates, healthy fats, fresh fruits and vegetables, and drinking eight to 10 glasses of water a day may stimulate the body's immune system and shorten the course of the infection. Garlic (*Allium sativum*) and goldenseal (*Hydrastis canadensis*), both antiseptic agents against staph infections, may be taken. The daily dosage would vary from person to person and is based on the severity of the infection. **Echinacea** (*Echinacea* spp.) is helpful in modulating immune function. Again, the dosage would vary.

Daily doses of 30–50 mg zinc and 1,000–5,000 mg Vitamin C (taken in equal amounts at several times during the day), and 300–2,000 mg bioflavinoids can also strengthen the body's infection-fighting ability. High doses of **vitamins** and **minerals** should not be used without a doctor's approval.

Prognosis

If properly treated, the symptoms of bacterial folliculitis generally disappear in about two weeks. Fungal folliculitis should clear up within six weeks. But it can worsen if the condition is misdiagnosed and inappropriately treated with steroid creams.

Prevention

Anyone who has a tendency to develop folliculitis should cleanse the skin with antibacterial soap twice a day and before shaving and should not use oily skin lotions. Men should not shave while the beard area is infected. When they begin shaving again, they should use a new blade each time. Women who have had fungal folliculitis should use depilatory creams instead of razors. Daily shampooing can help prevent folliculitis in the scalp. The spread of infection can be prevented by not sharing towels or washcloths.

Resources

OTHER

"Folliculitis." *Thrive Online*. http://thriveonline.oxygen.com.

Maureen Haggerty

Food allergies

Definition

Food **allergies** are the body's abnormal responses to harmless foods; the reactions are caused by the immune system's reaction to some food proteins.

Description

Food allergies are often confused with food intolerance. However, the two conditions have different causes and produce different symptoms. A food allergy is also known as food hypersensitivity. The allergy is caused when a person eats something that the immune system incorrectly identifies as harmful.

Food allergies

About 4% of adults have food allergies according to the National Institute of Allergy and Infectious Diseases (NIAID). The condition affects approximately 6 to 8% of children age 4 and younger.

The immune system works to protect the body and creates food-specific antibodies. The antibodies are proteins that battle antigens, substances that are foreign or initially outside the body. The introduction of an antigen produces the immune response. Antibodies are created to destroy the antigen or counteract its effectiveness.

The food that triggered that reaction is called an allergen. The antibodies are like an alarm system coded to detect the food regarded as harmful. The next time the person eats that food, the immune

Common food allergies

The following food allergens are identified by the Food and Drug Administration (FDA) as the most common and must be clearly labeled on food packaging:

- Milk
- Eggs
- Peanuts
- Tree nuts (such as almonds, cashews, walnuts)
- Fish (such as bass, cod, flounder)
- Shellfish (such as crab, lobster, shrimp)
- Soy
- Wheat

SOURCE: Mayo Clinic, "Food allergies: Watch food labels for these top 8 allergens." Available online at: http://www.mayoclinic.com/health/food-allergies/AA00057 (accessed August 10, 2010).

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system discharges a large amount of histamine and chemicals. This process meant to protect the body against the allergen causes an allergic reaction that can affect the respiratory tract, digestive tract, skin, and cardiovascular system.

Allergic reactions can occur in minutes or in up to two hours after the person ate the food. Symptoms include swelling of the tongue, **diarrhea**, and **hives**. In severe cases, the allergic reaction can be fatal. The most severe reaction is **anaphylaxis**, which could be life-threatening.

Food intolerance

While food allergies involve the immune system, food intolerance is not related to the immune system. For example, a person who is lactose intolerant has a shortage of lactose, the digestive enzyme that breaks down the sugar in milk and dairy products. That person could experience stomach **pain** or bloating several hours after drinking milk.

People who are food-intolerant can sometimes consume that food and not experience intolerance symptoms. Those diagnosed with food allergies must avoid the foods that produce the allergic reactions.

Allergy-producing foods

Although approximately 160 foods produce allergic reactions, about 90% of reactions are caused by some or all items within eight food families. These are milk, eggs, peanuts, tree nuts, fish, shellfish, wheat, and soy. These foods can cause severe reactions. The most adverse reactions are caused by peanuts and tree nuts. According to NIAID, about 0.6% of Americans are impacted by peanut allergies. Approximately 0.4% of Americans have allergic reactions to tree nuts.

Food allergy demographics

Most children have allergies to eggs, milk, peanuts or tree nuts, and soy, according to the American Dietetic Association (ADA). The young generally outgrow their allergies. They are more likely to outgrow milk and soy allergies, according to NIAID. However, children and adults usually allergic to peanuts and tree nuts for life. The most frequent causes of food allergies in adulthood are peanuts, tree nuts, fish, and shellfish.

Allergies are hereditary. There is a tendency for the immune system to create immunoglobulin E (IgE) antibodies in people with family histories of allergies and allergic conditions like hay **fever** and **asthma**, according to NIAID. The likelihood of a child having food allergies increases when both parents are allergic.

Furthermore, people are allergic to the foods that are eaten frequently in their countries. A rice allergy is more common in Japan, and codfish allergies occur more in Scandinavian countries, according to NIAID.

Causes and symptoms

Food allergies are caused by the immune system's reaction to a food item that it believes is harmful. When the food is digested, the immune system responds by creating immunoglobulin E (IgE) antibodies as a defense. The antibodies are proteins found in the bloodstream. Formed to protect the body against harmful substances, the antibodies are created after the person's first exposure to the allergen.

The majority of food allergies are caused by foods in eight families. In some families, every food causes an allergic reaction. In other families like shellfish, a person may be allergic to one species, but able to eat others. The allergy-inducing foods include:

- Milk. The dairy family includes milk, ice cream, yogurt, butter, and some margarines. Nondairy foods that contain casein must be avoided. Prepared foods that contain milk range from breads and doughnuts to sausage and soup, according to the ADA.
- Eggs. Although a person may be allergic to either the egg white or yolk, the entire egg must be avoided because there is a risk of cross-contamination. Eggs are an ingredient in mayonnaise. Moreover, products such as baked goods, breads, pasta, yogurt, and batter on fried foods may contain eggs. In addition, some egg-substitute products contain egg whites.
- Peanuts. Peanuts grow in the ground and are legumes like lentils and chickpeas. A person with a peanut allergy may not be allergic to other legumes or tree nuts. Products to be avoided include peanuts, peanut butter, peanut oil, and some desserts and candy. In addition, some Asian dishes are prepared with a peanut sauce. Tree nuts include almonds, cashews, pecans, walnuts, Brazil nuts, chestnuts, hazelnuts, macadamia nuts, pine nuts, pistachios, and hickory nuts. Products containing tree nuts include nut oil, nut oil, desserts, candy, crackers, and barbecue sauce. A person may be allergic to one type of nut but able to eat other nuts. That should be determined after consulting with a doctor.
- Fish. Fish allergy is generally diagnosed as an allergy to all fish species because the allergen is similar among the different species.
- Shellfish. Shellfish species include lobster, crab, shrimp, clams, oysters, scallops, mollusks, and crawfish. An allergy to one type of shellfish may indicate an allergy to others.

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- Wheat. Wheat is a grain found in numerous foods including breads, cereals, pastas, lunch meats, desserts, and bulgar. It is also found in products such as enriched flour and farina.
- Soy. The soybean is a legume, and people who have this allergy are rarely allergic to peanuts or other legumes. Soy is an ingredient in many processed foods including crackers and baked goods, sauces, and soups. There is also soy in canned tuna, according to the ADA.

The chemical reaction

During the initial exposure, many IgE antibodies are created. These attach to mast cells. These cells are located in tissue throughout the body, especially in areas such as the nose, throat, lungs, skin, and gastrointestinal tract. These are also the areas where allergic reactions occur.

The antibodies are in place, and a reaction is triggered the next time the person eats the food regarded as harmful. As the allergen reacts with the IgE, the body releases histamine and other chemicals. Histamine is a chemical located in the body's cells. When released during an allergic reaction, histamine and other chemicals cause symptoms like inflammation.

The type of allergic reaction depends on where the antibodies are released, according to NIAID. Chemicals released in the ears, nose, and throat could cause the mouth to itch. The person may also have difficulty breathing or swallowing. If the allergen triggers a reaction in the gastrointestinal tract, the person could experience stomach pain or diarrhea. An allergic reaction that affects skin cells could produce hives. This condition also known as urticaria is an allergic reaction characterized by **itching**, swelling, and the presence of patchy red areas called wheals.

Severe allergic reaction

Anaphylaxis is a severe allergic reaction that is potentially life-threatening. Also known as an anaphylactic reaction, this condition requires immediate medical attention. The reaction occurs within seconds or up to several hours after the person ate the allergy-inducing food.

Symptoms can include difficulty breathing, a **tingling** feeling in the mouth, and a swelling in the tongue and throat. The person may experience hives, **vomiting**, abdominal cramps, and diarrhea. There is also a sudden drop in blood pressure. Anaphylaxis may be fatal if not treated promptly.

Each year, some 150 Americans die from food-induced anaphylaxism, according to NIAID. The casualties are generally adolescents and young adults. The risk increases for people who have allergies and asthma. Also at increased risk are people who experienced previous episodes of a naphylaxis.

The peanut is one of the primary foods that trigger an anaphylactic reaction. Tree nuts also cause the reaction. The nuts generally linked to anaphylaxis are almonds, Brazil nuts, cashews, chestnuts, hazelnuts, macadamia nuts, pecans, pine nuts, pistachios and walnuts. Fish, shellfish, and eggs can also set off the reaction, according to the ADA.

Cross-reactivity

Cross-reactivity is the tendency of a person with one allergy to reaction to another allergen. A person allergic to crab might also be allergic to shrimp. In addition, someone with ragweed sensitivity could experience sensations when trying to eat melons during ragweed pollinating season, according to NIAID. The person's mouth would start itching, and the person wouldn't be able to eat the melon. The cross-reaction happens frequently with cantaloupes. The condition is known as oral allergy syndrome.

Diagnosis

Food allergies are diagnosed by first determining whether a person has an allergy or if symptoms are related to a condition like food intolerance. The medical professional may be a board-certified allergist, a doctor with education and experience in treating allergies. However, some health plans may require that the patient first see a family practice doctor.

If food allergies are suspected, the doctor will take a detailed case history. The doctor asks the patient if there is a family history of allergies. Other questions are related to the patient's adverse reactions.

The doctor's questions include how the food was prepared, the amount eaten and what time the reaction happened. The patient describes the symptoms and actions taken to relieve them. The doctor also asks if the patient had other similar experiences when eating that food.

The patient receives a physical exam. In addition, the doctor may ask the patient to keep a food diary, a log of what the person eats for one to two weeks. The medical history and the food diary are used in conjunction with testing to diagnose the patient.

Allergy tests

Doctors generally start the testing process with a skin test or a blood test. The prick skin test, which is

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also known as the scratch test, examines the patient's reaction to a solution containing a protein that triggers allergies.

The doctor places a drop of the substance on the patient's arm or back. The doctor then uses a needle to prick or scratch the skin. This allows the potential allergen to enter the patient's skin. If more than one food allergy is suspected, the test is repeated with other proteins applied to the skin. After about 15 minutes, the doctor can read the reactions on the patient's skin.

If there is no reaction, the patient is probably not allergic to that food. The possibility of an allergy is indicated by the presence of a wheal, a bump that resembles a mosquito bite. The wheal signifies a positive reaction to the test. However, the test may show a false positive, which is a reaction to a food that does not cause allergies.

The skin test is not appropriate for people who are severely allergic or have skin conditions like **eczema**. Those people are given the RAST (radioallergosorbent test). This test measures the presence of food-specific IgE in the blood. After a sample of the patient's blood is taken, it is sent to a laboratory. The sample is tested with different foods. Levels of antibodies are measured, and the reactions to different proteins are ranked. While measurement systems may vary, a high ranking indicates a high number of antibodies. Lab results are generally completed within a week.

Results to this test may not be conclusive. A negative test may not have identified antibodies in the patient's blood. Positive results make it probable but not definite that the patient has allergies.

Costs for blood and skin tests will vary, with fees typically ranging from $10 to more than $300. Insurance may cover some of the cost. While both tests are reliable, they aren't 100% accurate. If questions remain, the diagnosis takes into account the patient's medical history and the food diary. If necessary, the patient is put on a special diet.

Elimination diet

If the skin or blood test shows strong positive results, the doctor may put the patient on an elimination diet. This is done when needed to narrow the list of suspected allergens. The person stops eating the foods suspected of causing the allergic reaction. That food is eliminated from the diet for from two to four weeks. If allergy symptoms improve, the food is probably an allergen.

If more confirmation is needed, the doctor may ask the patient to start eating the food again. The elimination diet procedure is generally not utilized if the patient initially had a severe reaction.

Food challenges

Other tests called food challenges may be performed. The challenges are done in a medical setting, with a doctor present. The patient is given capsules that each contain a different food. Some capsules contain allergy-producing foods. Other capsules may be placebos that won't produce a reaction.

The patient swallows the capsule, and the doctor watches for an allergic reaction. In an open food challenge, doctor and patient are aware of the capsule contents. In a single-blind food challenge, only the doctor knows. In a double-blind challenge, neither doctor nor patient knows the contents.

Challenges are rarely authorized by health care providers. Testing is time-consuming and many allergens are difficult to evaluate with the challenges, according to NIAID.

Treatment

The treatment for food allergies is to avoid eating the food that causes the allergy. This preventive treatment includes reading food labels. Manufacturers are required by the U.S. Food and Drug Administration to list a product's ingredients on the label. However, if there is a question about an ingredient, the person should contact the manufacturer before eating the food. When dining out, people should ask if food contains the allergen or ingredients contain the allergy-inducing foods.

When reading food labels, people with food allergies should know that:

- Words indicating the presence of milk include lactose, ghee, and whey.
- Words signifying eggs in a product include albumin, globulin, and ovomucin.
- While it is apparent that peanuts are an ingredient in a product like peanut butter, there could be peanuts in hydrolyzed plant protein and hydrolyzed vegetable protein.
- People with tree nut allergies should carefully read the labels of products such as cereals and barbecue sauce.
- The American Dietetic Association cautions that surimi, an ingredient in imitation seafood, is made from fish muscle. Furthermore, fish in the form of

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anchovies is sometimes an ingredient in Worcestshire sauce.

- Words on labels that signal the presence of wheat include gluten, sietan, and vital gluten.

Allergies and children

Parents of children with food allergies need to monitor their children's food choices. They also must know how to care for the child if there is an allergic reaction. Parents need to notify the child's school about the condition. Caregivers should be informed, too. Both the school and caregivers should know how to handle an allergic reaction. Care must be taken because a highly allergic person could react to a piece of food as small as 1/44,000 of a peanut kernel, according to NIAID.

Living with severe allergies

Despite precautions, people may accidentally eat something that causes an allergic reaction. People with severe allergies must be prepared to treat the condition and prevent an anaphylactic reaction. A medical alert bracelet should be worn. This informs people that the person has a food allergy and could have severe reactions.

To reduce the risks from an anaphylactic reaction, the person carries a syringe filled with epinephrine, which is adrenaline. This is a prescription medication sold commercially as the EpiPen auto injector. While prices vary, one syringe costs about $50.

The person with allergies must know how to inject the epinephrine. It is helpful for other family members to know how to do this, and parents of an allergic child must be trained in the procedure.

The person is injected at the first sign of a severe reaction. Medical attention is required, and the person should be taken to an emergency room. The person will be treated and monitored because there could be a second severe reaction about four hours after the initial one.

Allergy treatment research

There was no cure for food allergies as of the spring of 2005. That could change, with some relief available for people diagnosed with peanut allergies. According to a study reported on in 2003 in the *New England Journal of Medicine*, 84 people who took the drug TNX-901 had a decrease in their IgE antibody levels.

Organizations including the Food Allergy & Anaphylaxis Network (FAAN) lauded the results of the study that was conducted from July of 1999 through March of 2002. Work on that study was stopped in 2004 when biotechnology companies Genentech, Novartis, and Tanox concentrated efforts instead on use of an asthma medication for treating peanut allergies. Research started in June of 2004 on omalizumab, a medication sold commercially as Xolair. The study of Xolair's effectiveness was expected to take from two to three years.

Alternative treatment

The only treatment for food allergies is for a person to stop eating the food that causes the allergies. Some alternative treatments may be helpful in easing the symptoms caused by allergies. However, people should check with their health care providers before embarking on an alternative treatment.

Prognosis

Food allergies cannot be cured, but they can be managed. The allergen-inducing foods should be avoided. These foods should be replaced with others that provide the **vitamins** and nutrients needed for a healthy diet. Organizations including the American Dietetic Association recommend the following dietetic changes:

- Milk is a source of calcium and vitamins A and D. For people with milk allergies, alternate choices of calcium include calcium-fortified orange juice and cereal.
- Since eggs are an ingredient in products like bread, egg-free sources of grains are an alternate source of vitamin B.
- Peanuts are a source of vitamin E, niacin, and magnesium. Other sources of these nutrients include other legumes, meat, and grains.
- Fish is a source of protein and nutrients like B vitamins and niacin. Alternate sources of these nutrients should be sought.
- Wheat is a source of many nutrients including niacin and riboflavin. The person allergic to wheat should substitute products made from grains such as oat, corn, rice and barley.
- Although soybeans are rich in nutrients, very little soy is used in commercial products. As a result, a person with this food allergy would not need to find a safe substitute in order to get needed nutrients.

Prevention

People prevent the return of food allergies by following treatment guidelines. These include

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avoiding the foods that cause allergic reactions, reading food labels, and taking measures to prevent an anaphylactic reaction.

Anaphylaxis is a major concern after a diagnosis of severe food allergies. To reduce the risks associated this reaction, people with food allergies should wear medical alert bracelets and never go anywhere without epinephrine. If possible, family members or friends of adults with allergies should learn how to administer this medication.

The American Dietetic Association advises people to develop an emergency plan. ADA recommendations include preparing a list of the foods the person is allergic to, three emergency contacts, the doctor's name, and a description of how to treat the reaction. This list is kept with the epinephrine syringe.

Resources

BOOKS

Brostoff, Jonathan, and Linda Gamlin. *The Complete Guide to Food Allergy and Intolerance*. Kingsbridge: Quality Health, 2008.

Wood, Robert A., and Joe Kraynak. *Food Allergies for Dummies*. Hoboken, NJ: Wiley, 2007.

OTHER

Food Allergy An Overview. National Institute of Allergy and Infectious Diseases. July 2004. [cited March 30, 2005]. http://www.niaid.nih.gov/publications/pdf/foodallergy.pdf.

Peanut Anti-IgE Study Update. The Food Allergy & Anaphylaxis Network. September 2, 2004 [cited April 5]. http://www.foodallergy.org/Research/antiigetherapy.html.

ORGANIZATIONS

American Academy of Allergy, Asthma & Immunology, 555 East Wells Street, Suite 1100, Milwaukee, WI, 53202-3823, (414) 272-6071, http://www.aaaai.org.

American Dietetic Association, 120 S. Riverside Plaza, Suite 2000, Chicago, IL, 60606-6995, (312) 899-0040, (800) 877-1600, http://www.eatright.org/.

National Institute of Allergies and Infectious Diseases, 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-6612, (301) 496-5717, (301) 402-3573, (866) 284-4107, ocpostoffice@niaid.nih.gov, http://www.niaid.nih.gov.

The Food Allergy & Anaphylaxis Network, 11781 Lee Jackson Hwy., Suite 160, Fairfax, VA, 22033-3309, (703) 691-2713, (800) 929-4040, http://www.foodallergy.org.

Liz Swain,

Food poisoning

Definition

Food poisoning is a general term for health problems arising from eating contaminated food. Food may be contaminated by bacteria, viruses, environmental toxins, or toxins present within the food itself, such as the poisons in some mushrooms or certain seafood. Symptoms of food poisoning usually involve **nausea**, **vomiting** and/or **diarrhea**. Some food-borne toxins can affect the nervous system.

Description

Every year millions of people suffer from bouts of **vomiting** and diarrhea each year that they blame on "something I ate." These people are generally correct. Each year in the United States, one to two bouts of diarrheal illness occur in every adult. The Centers for Disease Control and Prevention (CDC) estimates that six to 33 million cases of food poisoning occur in the United States annually. Many cases are mild and pass so rapidly that they are never diagnosed. Occasionally a severe outbreak creates a newsworthy public health hazard.

Classical food poisoning, sometimes incorrectly called ptomaine poisoning, is caused by a variety of different bacteria. The most common are *Salmonella*, *Staphylococcus aureus*, ***Escherichia coli*** O157:H7 or other *E. coli strains, Shigella*, and *Clostridium botulinum*. Each has a slightly different incubation period

Common pathogens causing food poisoning

Pathogen	Common host(s)
Campylobacter	Poultry
Clostridium botulinum	Home and improperly canned foods
Escherichia coli O157:H7 *(E. coli)*	Undercooked, contaminated ground beef
Listeria monocytogenes	Found in a variety of raw foods, such as uncooked meats and vegetables, and in processed foods that become contaminated after processing
Salmonella	Poultry, eggs, meat, and milk
Shigella	This bacteria is transmitted through direct contact with an infected person or from food or water that have become contaminated
Vibrio vulnificus	Contaminated seafood

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ALICE CATHERINE EVANS (1881–1975)

(© Corbis.)

Alice Catherine Evans was born on January 29, 1881, in Neath, Pennsylvania. Evans was the second of two children born to Anne Evans and William Howell. Evans taught grade school for four years because she could not afford to pay college tuition. Following her time as a teacher, Evans enrolled at the Cornell University College of Agriculture, earning her B.S. degree. Evans' professor recommended her for a scholarship, which she received, and she began her master's degree program at the University of Wisconsin where she earned her degree in 1910.

In 1911, Evans took a position with the University of Wisconsin's Dairy Division as a researcher studying cheese-making instead of continuing her education. In 1913, she moved to Washington, D.C., with the division and worked with a team on identifying the cause of contamination in raw cow's milk. By 1917, Evans' research had shown that the bacteria responsible for undulant (Malta) fever was very similar to one found when a cow experienced a spontaneous abortion. When administered to guinea pigs, the two bacteria produced similar results. Her findings were met with much skepticism but, as time went on, Evans' research began to gain support. She continued to document cases of the disease and to argue for the pasteurization process. Finally, after 1930, officials responsible for public health and safety realized the need for this process, which ultimately became a standard procedure. Evans retired from her position with the National Institute of Health in 1945 and died on September 5, 1975.

and duration, but all except *C. botulinum* cause inflammation of the intestines and diarrhea. Sometimes food poisoning is called bacterial **gastroenteritis** or infectious diarrhea. Food and water can also be contaminated by viruses (such as the Norwalk agent that causes diarrhea and the viruses of **hepatitis A** and E), environmental toxins (heavy metals), and poisons produced within the food itself (**mushroom poisoning** or **fish and shellfish poisoning**).

Careless food handling during the trip from farm to table creates conditions for the growth of bacteria that make people sick. Vegetables that are eaten raw, such as lettuce, may be contaminated by bacteria in soil, water, and dust during washing and packing. Home canned and commercially canned food may be improperly processed at too low a temperature or for too short a time to kill the bacteria.

Raw meats carry many food-borne bacterial diseases. The United States Food and Drug Administration (FDA) estimates that 60% or more of raw poultry sold at retail carry some disease-causing bacteria. Other raw meat products and eggs are contaminated to a lesser degree. Thorough cooking kills the bacteria and makes the food harmless. However, properly cooked food can become re-contaminated if it comes in contact with plates, cutting boards, countertops, or utensils that were used with raw meat and not cleaned and sanitized.

Cooked foods can also be contaminated after cooking by bacteria carried by food handlers or from bacteria in the environment. It is estimated that 50% of healthy people have the bacteria *Staphylococcus aureus* in their nasal passages and throat, and on their skin and hair. Rubbing a runny nose, then touching food can introduce the bacteria into cooked food. Bacteria flourish at room temperature, and will rapidly grow into quantities capable of making people sick. To prevent this growth, food must be kept hot or cold, but never just warm.

Although the food supply in the United States is probably the safest in the world, anyone can get food poisoning. Serious outbreaks are rare. When they occur, the very young, the very old, and those with immune system weaknesses have the most severe and life-threatening cases. For example, this group is 20 times more likely to become infected with the *Salmonella* bacteria than the general population.

Travel outside the United States to countries where less attention is paid to sanitation, water

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purification, and good food handling practices increases the chances that a person will get food poisoning. People living in institutions such as nursing homes are also more likely to get food poisoning.

Causes and symptoms

The symptoms of food poisoning occur because food-borne bacteria release toxins or poisons as a byproduct of their growth in the body. These toxins (except those from *C. botulinum*) cause inflammation and swelling of the stomach, small intestine and/or large intestine. The result is abdominal muscle cramping, vomiting, diarrhea, **fever**, and the chance of **dehydration**. The severity of symptoms depends on the type of bacteria, the amount consumed, and the individual's general health and sensitivity to the bacterial toxin.

Salmonella

According to a 2001 report from the CDC, *Salmonella* caused almost 50,000 culture-confirmed cases of food poisoning in the United States annually. However, between two and four million probably occur each year. *Salmonella* is found in egg yolks from infected chickens, in raw and undercooked poultry and in other meats, dairy products, fish, shrimp, and many more foods. The CDC estimates that one out of every 50 consumers is exposed to a contaminated egg yolk each year. However, thorough cooking kills the bacteria and makes the food harmless. *Salmonella* is also found in the feces of pet reptiles such as turtles, lizards, and snakes.

About one out of every 1,000 people get food poisoning from *Salmonella*. Of these, two-thirds are under age 20, with the majority under age nine. Most cases occur in the warm months between July and October.

Symptoms of food poisoning begin eight to 72 hours after eating food contaminated with *Salmonella*. These include traditional food poisoning symptoms of abdominal **pain**, diarrhea, vomiting, and fever. The symptoms generally last one to five days. Dehydration can be a complication in severe cases. People generally recover without antibiotic treatment, although they may feel tired for a week after the active symptoms subside.

Staphylococcus aureus

Staphylococcus aureus is found on humans and in the environment in dust, air, and sewage. The bacteria is spread primarily by food handlers using poor sanitary practices. Almost any food can be contaminated, but salad dressings, milk products, cream pastries, and any food kept at room temperature, rather than hot or cold are likely candidates.

It is difficult to estimate the number of cases of food poisoning from *Staphylococcus aureus* that occur each year, because its symptoms are so similar to those caused by other foodborne bacteria. Many cases are mild and the victim never sees a doctor.

Symptoms appear rapidly, usually one to six hours after the contaminated food is eaten. The acute symptoms of vomiting and severe abdominal cramps without fever usually last only three to six hours and rarely more than 24 hours. Most people recover without medical assistance. Deaths are rare.

Escherichia coli (E. coli)

There are many strains of *E. coli*, and not all of them are harmful. The strain that causes most severe food poisoning is *E. coli O157:H7*. Food poisoning by *E. coli* occurs in three out of every 10,000 people. Foodborne *E. coli* is found and transmitted mainly in food derived from cows such as raw milk, raw or rare ground beef and fruit or vegetables that are contaminated.

Symptoms of food poisoning from *E. coli* are slower to appear than those caused by some of the other foodborne bacteria. *E. coli* produces toxins in the large intestine rather than higher up in the digestive system. This accounts for the delay in symptoms and the fact that vomiting rarely occurs in *E. coli* food poisoning.

One to three days after eating contaminated food, the victim with *E. coli O157:H7* begins to have severe abdominal cramps and watery diarrhea that usually becomes bloody within 24 hours. There is little or no fever, and rarely does the victim vomit. The bloody, watery diarrhea lasts from one to eight days in uncomplicated cases.

Campylobacter jejuni (C. jejuni)

According to the FDA, *C. jejuni* is the leading cause of bacterial diarrhea in the United States. It is responsible for more cases of bacterial diarrhea than *Shigella* and *Salmonella* combined. Anyone can get food poisoning from *C. jejuni*, but children under five and young adults between the ages of 15 and 29 are more frequently infected.

C. jejuni is carried by healthy cattle, chickens, birds, and flies. It is not carried by healthy people in the United States or Europe. The bacteria is also found ponds and stream water. The ingestion of only a few hundred *C. jejuni* bacteria can make a person sick.

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Symptoms of food poisoning begin two to five days after eating food contaminated with *C. jejuni*. These symptoms include fever, abdominal pain, nausea, **headache**, muscle pain, and diarrhea. The diarrhea can be watery or sticky and may contain blood. Symptoms last from seven to 10 days, and relapses occur in about one quarter of people who are infected. Dehydration is a common complication. Other complications such as arthritis-like joint pain and **hemolytic-uremic syndrome** (HUS) are rare.

Shigella

Shigella is a common cause of diarrhea in travelers to developing countries. It is associated with contaminated food and water, crowded living conditions, and poor sanitation. The bacterial toxins affect the small intestine.

Symptoms of food poisoning by *Shigella* appear 36–72 hours after eating contaminated food. These symptoms are slightly different from those associated with most foodborne bacteria. In addition to the familiar watery diarrhea, nausea, vomiting, abdominal cramps, chills and fever occur. The diarrhea may be quite severe with cramps progressing to classical **dysentery**. Up to 40% of children with severe infections show neurological symptoms. These include seizures caused by fever, confusion, headache, lethargy, and a stiff neck that resembles **meningitis**.

The disease runs its course usually in two to three days but may last longer. Dehydration is a common complication. Most people recover on their own, although they may feel exhausted, but children who are malnourished or have weakened immune systems may die.

Clostridium botulinum (C. botulinum)

C. botulinum, which causes both adult **botulism** and infant botulism, is unlike any of the other foodborne bacteria. First, *C. botulinum* is an anaerobic bacterium in that it can only live in the absence of oxygen. Second, the toxins from *C. botulinum* are neurotoxins. They poison the nervous system, causing **paralysis** without the vomiting and diarrhea associated with other foodborne illnesses. Third, toxins that cause adult botulism are released when the bacteria grows in an airless environment outside the body. They can be broken down and made harmless by heat. Finally, botulism is much more likely to be fatal even in tiny quantities.

Adult botulism outbreaks are usually associated with home canned food, although occasionally commercially canned or vacuum packed foods are responsible for the disease. *C. botulinum* grows well in non-acidic, oxygen-free environments. If food is canned at too low heat or for too brief a time, the bacteria is not killed. It reproduces inside the can or jar, releasing its deadly neurotoxin. The toxin can be made harmless by heating the contaminated food to boiling for ten minutes. However, even a very small amount of the *C. botulinum* toxin can cause serious illness or **death**.

Symptoms of adult botulism appear about 18–36 hours after the contaminated food is eaten, although there are documented times of onset ranging from four hours to eight days. Initially a person suffering from botulism feels weakness and **dizziness** followed by double vision. Symptoms progress to difficulty speaking and swallowing. Paralysis moves down the body, and when the respiratory muscles are paralyzed, death results from asphyxiation. People who show any signs of botulism poisoning must receive immediate emergency medical care to increase their chance of survival.

Infant botulism is a form of botulism first recognized in 1976. It differs from food-borne botulism in its causes and symptoms. Infant botulism occurs when a child under the age of one year ingests the spores of *C. botulinum*. These spores are found in soil, but a more common source of spores is honey.

The *C. botulinum* spores lodge in the baby's intestinal tract and begin to grow, producing their neurotoxin. Onset of symptoms is gradual. Initially the baby is constipated. This is followed by poor feeding, lethargy, weakness, drooling, and a distinctive wailing cry. Eventually, the baby loses the ability to control its head muscles. From there the paralysis progresses to the rest of the body.

Diagnosis

One important aspect of diagnosing food poisoning is for doctors to determine if a number of people have eaten the same food and show the same symptoms of illness. When this happens, food poisoning is strongly suspected. The diagnosis is confirmed when the suspected bacteria is found in a **stool culture** or a fecal smear from the person. Other laboratory tests are used to isolate bacteria from a sample of the contaminated food. Botulism is usually diagnosed from its distinctive neurological symptoms, since rapid treatment is essential. Many cases of food poisoning go undiagnosed, since a definite diagnosis is not necessary to effectively treat the symptoms. Because it takes time for symptoms to develop, it is not necessarily the most recent food one has eaten that is the cause of the symptoms.

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KEY TERMS

Diuretic—Medication that increases the urine output of the body.

Electrolytes—Salts and minerals that produce electrically charged particles (ions) in body fluids. Common human electrolytes are sodium chloride, potassium, calcium, and sodium bicarbonate. Electrolytes control the fluid balance of the body and are important in muscle contraction, energy generation, and almost all major biochemical reactions in the body.

Lactobacillus acidophilus—This bacteria is found in yogurt and changes the balance of the bacteria in the intestine in a beneficial way.

Platelets—Blood cells that help the blood to clot.

Treatment

Treatment of food poisoning, except that caused by *C. botulinum*, focuses on preventing dehydration by replacing fluids and electrolytes lost through vomiting and diarrhea. Electrolytes are salts and **minerals** that form electrically charges particles (ions) in body fluids. Electrolytes are important because they control body fluid balance and are important for all major body reactions. Pharmacists can recommend effective, pleasant-tasting, electrolytically balanced replacement fluids that are available without a prescription. When more fluids are being lost than can be consumed, dehydration may occur. Dehydration more likely to happen in the very young, the elderly, and people who are taking **diuretics**. To prevent dehydration, a doctor may give fluids intravenously.

In very serious cases of food poisoning, medications may be given to stop abdominal cramping and vomiting. Anti-diarrheal medications are not usually given. Stopping the diarrhea keeps the toxins in the body longer and may prolong the infection.

People with food poisoning should modify their diet. During period of active vomiting and diarrhea they should not try to eat and should drink only clear liquids frequently but in small quantities. Once active symptoms stop, they should eat bland, soft, easy to digest foods for two to three days. One example is the BRAT diet of bananas, rice, applesauce, and toast, all of which are easy to digest. Milk products, spicy food, alcohol and fresh fruit should be avoided for a few days, although babies should continue to breastfeed. These modifications are often all the treatment that is necessary.

Severe bacterial food poisonings are sometimes treated with **antibiotics**. Trimethoprim and sulfamethoxazole (Septra, Bactrim), ampicillin (Amcill, Polycill) or ciprofloxacin (Ciloxan, Cipro) are most frequently used.

Botulism is treated in a different way from other bacterial food poisonings. Botulism antitoxin is given to adults, but not infants, if it can be administered within 72 hours after symptoms are first observed. If given later, it provides no benefit.

Both infants and adults require hospitalization, often in the intensive care unit. If the ability to breathe is impaired, patients are put on a mechanical ventilator to assist their breathing and are fed intravenously until the paralysis passes.

Alternative treatment

Alternative practitioners offer the same advice as traditional practitioners concerning diet modification. In addition they recommend taking charcoal tablets, *Lactobacillus acidophilus*, *Lactobacillus bulgaricus*, and citrus seed extract. An electrolyte replacement fluid can be made at home by adding one teaspoon of salt and four teaspoons of sugar to one quart of water. For food poisoning other than botulism, two homeopathic remedies, either *Arsenicum album* or *Nux vomica*, are strongly recommended.

Prognosis

Most cases of food poisoning (except botulism) clear up on their own within one week without medical assistance. The ill person may continue feel tired for a few days after active symptoms stop. So long as the ill person does not become dehydrated, there are few complications. Deaths are rare and usually occur in the very young, the very old and people whose immune systems are already weakened.

Complications of *Salmonella* food poisoning include arthritis-like symptoms that occur three to four weeks after infection. Although deaths from *Salmonella* are rare, they do occur. Most deaths caused by *Salmonella* food poisoning have occurred in elderly people in nursing homes.

Adults usually recover without medical intervention, but many children need to be hospitalized as the

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result of *E. coli* food poisoning. *E. coli* toxins may be absorbed into the blood stream where they destroy red blood cells and platelets. Platelets are important in blood clotting. About 5% of victims develop hemolytic-uremic syndrome which results in sudden kidney failure and makes dialysis necessary. (Dialysis is a medical procedure used to filter the body's waste product when the kidneys have failed).

Botulism is the deadliest of the bacterial foodborne illnesses. With prompt medical care, the death rate is less than 10%.

Prevention

Food poisoning is almost entirely preventable by practicing good sanitation and good food handling techniques. These include:

- Keep hot foods hot and cold foods cold.
- Cook meat to the recommended internal temperature, use a meat thermometer to check and cook eggs until they are no longer runny.
- Refrigerate leftovers promptly, do not let food stand at room temperature.
- Avoid contaminating surfaces and other foods with the juices of uncooked meats.
- Wash fruits and vegetables before using.
- Purchase pasteurized dairy products and fruit juices.
- Throw away bulging or leaking cans or any food that smells spoiled.
- Wash hands well before and during food preparation and after using the bathroom.
- Sanitize food preparation surfaces regularly.

Resources

OTHER

U. S. Food and Drug Administration. Center for Food Safety and Applied Nutrition. *Bad Bug Book*. http://vm.cfsan.fda.gov.

Suzanne M. Lutwick, MPH

Foot acupressure *see* **Reflexology**

Foot care

Definition

Foot care involves all aspects of preventative and corrective care of the foot and ankle. Doctors specializing in foot care are called podiatrists.

Purpose

During an average lifetime, each person walks about 115,000 miles and three-quarters of people have foot problems at some point in their lives.

Foot problems can arise from wearing ill-fitting shoes, from general wear and tear, as a result of injury, or as a complication of disease. People with **diabetes mellitus** or circulatory diseases are 20 times more likely to have foot problems than the general public.

Podiatrists are doctors who specialize in treating the foot and ankle. Other doctors who have experience with foot problems are family physicians, orthopedists, sports medicine specialists, and those who care for diabetics. Problems with the feet include foot **pain**, joint inflammation, plantar **warts**, fungal infections (like **athlete's foot**), nerve disorders, torn ligaments, broken bones, bacterial infections, and tissue injuries (like **frostbite**).

Precautions

People with diabetes or circulatory disorders should be alert to even small foot problems. In these people, a break in the skin can lead to infection, **gangrene**, and **amputation**.

Description

Daily foot care for people likely to develop foot problems includes washing the feet in tepid water with mild soap and oiling the feet with vegetable oil or a lanolin-based lotion. Toenails should be cut straight across above the level of the skin after soaking the feet in tepid water. **Corns and calluses** should not be cut. If they need removal, it should be done under the care of a doctor. Athletes foot and plantar warts should also be treated by a doctor if they develop in high risk patients.

Many people with diabetes or circulatory disorders have problems with cold feet. These problems can be reduced by avoiding **smoking** tobacco (smoking constricts the blood vessels), wearing warm socks, not crossing the legs while sitting or not sitting in one position too long, or avoiding constricting stockings.

People with circulatory problems should not use heating pads or hot water bottles on their feet, as even moderate heat can damage the skin if circulation is impaired.

Preparation

No special preparation other than an understanding of the nature of foot problems is necessary to begin routine foot care.

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Aftercare

Foot care is preventative and should be ongoing throughout a person's life.

Risks

There are no risks associated with foot care. The risks are in ignoring the feet and allowing problems to develop.

Normal results

With regular care, foot disorders such as infections, skin ulcers, and gangrene can be prevented.

ORGANIZATIONS

American Diabetes Association, 1701 North Beauregard St., Alexandria, VA, 22311, (800) 342-2383, AskADA @diabetes.org, http://www.diabetes.org/.

American Podiatric Medical Association, 9312 Old Georgetown Rd., Bethesda, MD, 20814-1621, (301) 581-9200, http://www.apma.org.

Tish Davidson, A.M.

Foreign bodies *see* **Foreign objects**

Foreign objects

Definition

Foreign means "originating elsewhere" or simply "outside the body." Foreign objects, also known as foreign bodies, typically become lodged in the eyes, ears, nose, airways, and rectum of human beings.

Demographics

Swallowing foreign bodies is a fairly common pediatric emergency; about 80,000 cases involving persons 19 years old or younger are reported each year to the 67 poison control centers in the United States. In a recent survey of the parents of 1,500 children, 4% reported that their children had swallowed a foreign object of some kind. The highest incidence of swallowed foreign bodies is in children between the ages of six months and four years.

The type of object most frequently swallowed varies somewhat across different historical periods and cultures. A recent study comparing the Jackson collection of foreign bodies removed from children between 1920 and 1932 with data collected from North American children's hospitals between 1988 and 2000 found that coins have replaced safety pins as the objects most commonly swallowed by American children. In Asia, fish bones are a frequent offender because fish is a dietary staple in most countries of the Far East.

X-ray of swallowed spoon and blade in the intestine. *(Photo Researchers, Inc.)*

In younger children, boys are at slightly greater risk than girls (53–47%) of swallowing foreign objects. Among teenagers, males are at a much higher risk than females of swallowing foreign bodies or inserting them into the rectum.

Younger children usually swallow or insert foreign objects into their bodies accidentally, usually as a result of play or exploring their environment. Adolescents are more likely to swallow or insert foreign bodies intentionally as a risk-taking behavior, a bid for attention, or while under the influence of drugs or alcohol. A small minority of teenagers who harm themselves by swallowing or inserting foreign bodies have **schizophrenia** or another psychotic disorder.

Description

Both children and adults experience problems caused by foreign objects getting stuck in their bodies.

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Young children are naturally curious and may intentionally put shiny objects, such as coins or button batteries, into their mouths. They also like to stick things in their ears and up their noses. Adults may accidentally swallow a non-food object or inhale a foreign body that gets stuck in the throat. Even if an object like a toothpick successfully passes through the esophagus and into the stomach, it can get stuck inside the rectum. Airborne particles can lodge in the eyes of people at any age.

Foreign bodies can be in hollow organs (like swallowed batteries) or in tissues (like bullets). They can be inert or irritating. If they irritate, they will cause inflammation and scarring. They can bring infection with them or acquire it and protect it from the body's immune defenses. They can obstruct passageways either by their size or by the scarring they cause. Some can be toxic.

Causes and symptoms

Eyes

Dust, dirt, sand, or other airborne material can lodge in the eyes, causing minor irritation and redness. More serious damage can be caused by hard or sharp objects that penetrate the surface and become embedded in the cornea or conjunctiva (the mucous membranes around the inner surface of the eyelids). Swelling, redness, bleeding from the surface blood vessels, sensitivity to light, and sudden vision problems are all symptoms of foreign matter in the eyes.

Ears and nose

Children will sometimes put things into their noses, ears, and other openings. Beans, popcorn kernels, raisins, and beads are just a few of the many items that have been found in these bodily cavities. On occasion, insects may fly into the ears and nose. **Pain**, **hearing loss**, and a sense of something stuck in the ear are symptoms of foreign bodies in the ears. A smelly, bloody discharge from one nostril is a symptom of foreign bodies in the nose.

Airways and stomach

At a certain age children will eat anything. A very partial list of items recovered from young stomachs includes: coins, chicken bones, fish bones, beads, rocks, plastic toys, pins, keys, round stones, marbles, nails, rings, batteries, ball bearings, screws, staples, washers, a heart pendant, a clothespin spring, and a toy soldier. Some of these items pass right on through and come out the other end. The progress of metal objects has been successfully followed with a metal detector. Others, like sharp bones, can get stuck and cause trouble. Batteries are corrosive and must be removed immediately.

Some objects can be inhaled unintentionally. The most commonly inhaled item is probably a peanut. A crayon and a cockroach have been found in a child's windpipes. These items always cause symptoms (difficulty swallowing and spitting up saliva, for instance) and may elude detection for some time while the child is being treated for **asthma** or recurring **pneumonia**.

Adults are not exempt from unusual inedibles. Dental devices are commonly swallowed. Adults with mental illness or subversive motives may swallow inappropriate objects, such as toothbrushes.

Rectum

Sometimes a foreign object will successfully pass through the throat and stomach only to get stuck at the juncture between the rectum and the anal canal. Items may also be self-introduced to enhance sexual stimulation and then get stuck. Sudden sharp pain during elimination may signify that an object is lodged in the rectum. Other symptoms vary depending upon the size of the object, its location, how long it has been in place, and whether or not infection has set in.

Diagnosis

The symptoms are as diverse as the objects and their locations. The most common manifestation of a foreign object anywhere in the body is infection. Even if the object started out sterile, germs may still be introduced. Blockage of passageways—breathing, digestive or excretory—is another result. Pain is common.

Treatment

Eyes

Small particles like sand may be removable without medical help, but if the object is not visible or cannot be retrieved, prompt emergency treatment is necessary. Trauma to the eyes can lead to loss of vision. Before attempting any treatment, the person should move to a well-lit area where the object can be better viewed. Hands should be washed and only clean, preferably sterile, materials should make contact with the eyes. If the particle is small, it may be dislodged by blinking or pulling the upper lid over the lower lid and flushing out the speck. A clean cloth can also be used to remove the particle. Once the object is

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KEY TERMS

Bronchoscope—An illuminated instrument that is inserted into the airway to inspect and retrieve objects from the bronchial tubes.

Conjunctiva—Mucous membranes around the inner surface of the eyelid.

Cornea—The rounded, transparent portion of the eye that covers the pupil and iris and lets light into the interior

Endoscopy—The surgical use of long, thin instruments that have both viewing and operating capabilities.

Heimlich maneuver—An emergency procedure for removing a foreign object lodged in the airway that is preventing the person from breathing.

removed, the eye should be rinsed with clean, lukewarm water or an opthalmic wash.

If the foreign object cannot be removed at home, the eye should be lightly covered with sterile gauze to discourage rubbing. A physician will use a strong light and possibly special eye drops to locate the object. Surgical tweezers can effectively remove many objects. An antibiotic sterile ointment and a patch may be prescribed. If the foreign body has penetrated the deeper layers of the eye, an ophthalmic surgeon will be consulted for emergency treatment.

Ears and nose

A number of ingenious extraction methods have been devised for removing foreign objects from the nose and ears. A bead in a nostril, for example, can be popped out by blowing into the mouth while holding the other nostril closed. Insects can be floated out of the ear by pouring warm (not hot) mineral oil, olive oil, or baby oil into the ear canal. Items that are lodged deep in the ear canal are more difficult to remove because of the possibility of damaging the ear drum. These require emergency treatment from a qualified physician.

Airways and stomach

Mechanical obstruction of the airways, which commonly occurs when food gets lodged in the throat, can be treated by applying the **Heimlich maneuver**. If the object is lodged lower in the airway, a bronchoscope (a special instrument to view the airway and remove obstructions) can be inserted. If the object is blocking the entrance to the stomach, a fiberoptic endoscope (an illuminated instrument that views the interior of a body cavity) may be used. The physician typically administers a sedative and anesthetizes the throat. The foreign object will then either be pulled out or pushed into the stomach, depending on whether or not the physician thinks it will pass through the digestive tract on its own. Objects in the digestive tract that are not irritating, sharp, or large may be followed as they continue on through. Sterile objects that are not causing symptoms may be left in place. Surgical removal of the offending object is necessary if it is causing symptoms.

Rectum

A rectal retractor can remove objects that a physician can feel during **physical examination**. Surgery may be required for objects deeply lodged within the recturm.

Prevention

Using common sense and following safety precautions are the best ways to prevent foreign objects from entering the body. Parents and other child care providers should toddler-proof their homes. Batteries should be stored in a locked cabinet and properly disposed of after use. To minimize the chance of youngsters inhaling food, parents should not allow children to eat while walking or playing. Adults should chew food thoroughly and not talk while chewing. Many eye injuries can be prevented by wearing safety glasses while using tools

Resources

PERIODICALS

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Gilchrist, B. F., et al. "Pearls and Perils in the Management of Prolonged, Peculiar, Penetrating Esophageal Foreign Bodies in Children." *Journal of Pediatric Surgery* 32, no. 10 (October 1997): 1429-31.

Shivakumar, A., et al. "Foreign Bodies in Upper Digestive Tract." *Indian Journal of Otolaryngology and Head and Neck Surgery* 58, no. 1 (January-March 2006): 63-68.

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Karl Finley

47, XXY syndrome *see* **Klinefelter syndrome**

Fourn *see* **Flesh-eating disease**

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Fracture repair

Definition

Fracture repair is the process of rejoining and realigning the ends of broken bones. This procedure is usually performed by an orthopedist, general surgeon, or family doctor. In cases of an emergency, **first aid** measures should be evoked for temporary realignment and **immobilization** until proper medical help is available.

Purpose

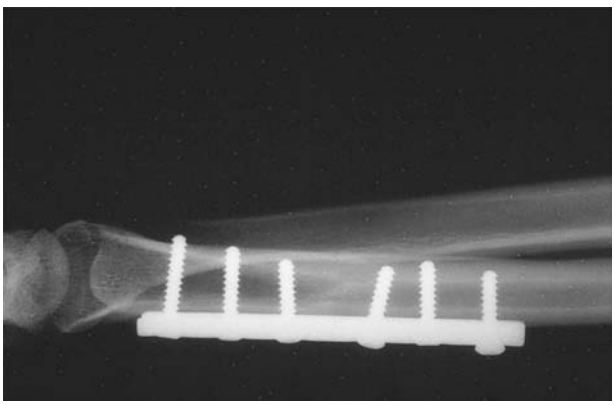
Fracture repair is required when there is a need for restoration of the normal position and function of the broken bone. Throughout the stages of fracture healing, the bones must be held firmly in the correct position. In the event the fracture is not properly repaired, malalignment of the bone may occur, resulting in possible physical dysfunction of the bone or joint of that region of the body.

Precautions

Precautions for fracture repair are anything found to be significant with patients' medical diagnosis and history. This would include an individual's tolerance to anesthesia and the presence of bleeding disorders that may be present to complicate surgery.

Description

Fracture repair is applied by means of **traction**, surgery, and/or by immobilization of the bones. The bone fragments are aligned as close as possible to the normal position without injuring the skin. Metal wires or screws may be needed to align smaller bone fragments. Once the broken ends of the bone are set, the affected area is immobilized for several weeks and kept rigid with a sling, plaster cast, brace or splint. With the use of traction, muscle pull on the fracture site is overcome by weights attached to a series of ropes running over pulleys. Strategically implanted electrical stimulation devices have proven beneficial in healing a fracture site, especially when the fracture is healing poorly and repair by other means is difficult.



An x-ray image of a healing fracture. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Preparation

Emergency splinting may be required to immobilize the body part or parts involved. When fracture repair is necessary, the procedure is often performed in a hospital but can also be successfully done in an outpatient surgical facility, doctor's office or emergency room. Before any surgery for fracture repair, blood and urine studies may be taken from the patient. X-rays may follow this if not previously acquired. It has been noted however, that not all **fractures** are immediately apparent on an initial x-ray examination. In this case, where a fracture is definitely suspected the extent of the fracture can be properly diagnosed by repeating the x-rays 10–14 days later. Depending upon the situation, local or **general anesthesia** may be used for fracture repair.

Aftercare

After surgery, x-rays may be again taken through the cast or splint to evaluate if rejoined pieces remain in good position for healing. This is usually performed either before the application of the splint or at least before the patient is awakened from the general anesthesia. The patient needs to be cautious not to place excess pressure on any part of the cast until it is completely dry. The patient also should avoid excess pressure on the operative site until complete healing has taken place and the injury has been re-examined by the physician. If the cast becomes exposed to moisture it may soften and require repair. The patient should also be instructed to keep the injured region propped up whenever possible to reduce the possibility of swelling.

Risks

Surgical risks of fracture repair are greater in patients over 60 years of age because the bones often taking longer to heal properly. **Obesity** may place extra stress on the healing site, affecting healing and possibly risking reinjury. **Smoking** may slow the healing process after fracture repair, as well as poor **nutrition**, **alcoholism**, and chronic illness. Some medications may affect

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KEY TERMS

Compound fracture—A fracture in which the broken end or ends of the bone have torn through the skin. Compound fractures are also known as open fractures

Staphylococcal infection—An infection caused by any of several pathogenic species of Staphylococcus, commonly characterized by the formation of abscesses of the skin or other organs.

Streptococcal infection—An infection caused by a pathogenic bacteria of one of several species of the genus Streptococcus or their toxins. Almost any organ in the body may be involved.

the fracture site, causing poor union. Such medications include anti-hypertensives and cortisone.

Possible complications following fracture repair include excessive bleeding, improper fit of joined bone ends, pressure on nearby nerves, delayed healing, and a permanent incomplete healing of the fracture. If there is a poor blood supply to the fractured site with one of the portions of broken bone not properly supplied by the blood, the bony portion will die and healing of the fracture will not take place. This is called aseptic necrosis. Poor immobilization of the fracture from improper casting which permits motion between the bone parts may prevent healing and repair of the bone with possible deformity. Infection can interfere with bone repair. This risk is greater in the case of a compound fracture (a bone fracture causing an open wound) where ideal conditions are present for severe streptococcal and **staphylococcal infections**. Occasionally, fractured bones in the elderly may possibly never heal properly. The risk is increased when nutrition is poor.

Normal results

Once the procedure for fracture repair is completed, the body begins to produce new tissue to bridge the broken pieces. At first, this tissue (called a callus) is soft and easily injured. Later, the body deposits bone **minerals** until the callus becomes a solid piece of bone. The fracture site is thus strengthened further with extra bone. It usually takes about six weeks for a broken bone to heal together. The exact time required for healing depends on the type of fracture and the extent of damage. Before the use of x-rays, fracture repair was not always accurate, resulting in crippling deformities. With modern x-ray technology, the physician can view the extent of the fracture, check the setting following the repair, and be certain after the procedure that the bones have not moved from their intended alignment. Children's bones usually heal relatively rapidly.

Abnormal results

Abnormal results of fracture repair include damage to nearby nerves or primary blood vessels. Improper alignment causing deformity is also an abnormal outcome, however, with today's medical technology it is relatively rare.

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Jeffrey P. Larson, RPT

Fractures

Definition

A fracture is a complete or incomplete break in a bone resulting from the application of excessive force.

Description

A fracture usually results from traumatic injury to bones causing the continuity of bone tissues or bony cartilage to be disrupted or broken. Fracture classifications include simple, compound, incomplete and complete. Simple fractures (more recently called "closed") are not obvious as the skin has not been ruptured and remains intact. Compound fractures (now commonly called "open") break the skin, exposing bone and causing additional soft tissue injury and possible infection. A single fracture means that one fracture only has occurred and multiple fractures refer to more than one fracture occurring in the same bone. Fractures are termed complete if the break is completely through the bone and described as incomplete or "greenstick" if the fracture occurs partly across a bone shaft. This latter type of fracture is often the result of bending or crushing forces applied to a bone.

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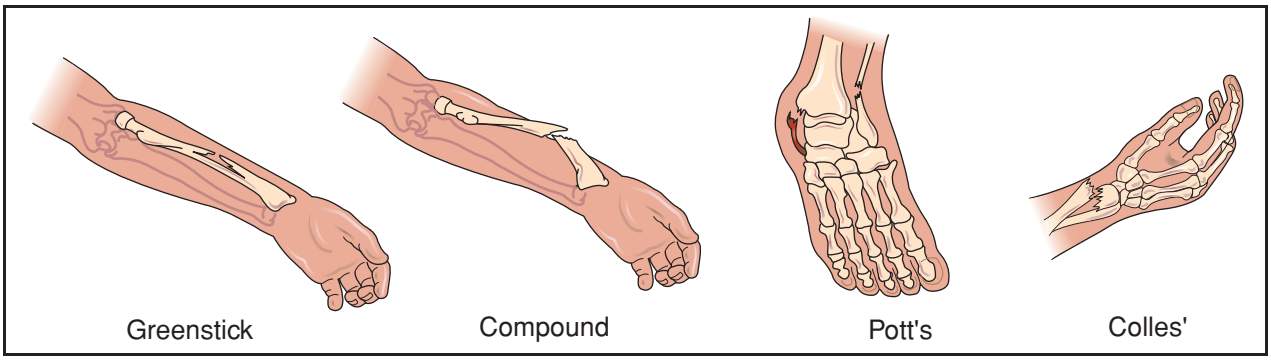

Fractures usually result from a traumatic injury to a bone where the continuity of bone tissues or bony cartilage is disrupted or broken. The illustrations above feature common sites where fractures occur. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Fractures are also named according to the specific part of the bone involved and the nature of the break. Identification of a fracture line can further classify fractures. Types include linear, oblique, transverse, longitudinal, and spiral fractures. Fractures can be further subdivided by the positions of bony fragments and are described as comminuted, non-displaced, impacted, overriding, angulated, displaced, avulsed, and segmental. Additionally, an injury may be classified as a fracture-dislocation when a fracture involves the bony structures of any joint with associated dislocation of the same joint.

Fractures line identification

Linear fractures have a break that runs parallel to the bone's main axis or in the direction of the bone's shaft. For example, a linear fracture of the arm bone could extend the entire length of the bone. Oblique and transverse fractures differ in that an oblique fracture crosses a bone at approximately a 45° angle to the bone's axis. In contrast, a transverse fracture crosses a bone's axis at a 90° angle. A longitudinal fracture is similar to a linear fracture. Its fracture line extends along the shaft but is more irregular in shape and does not run parallel to the bone's axis. Spiral fractures are described as crossing a bone at an oblique angle, creating a spiral pattern. This break usually occurs in the long bones of the body such as the upper arm bone (humerus) or the thigh bone (femur).

Bony fragment position identification

Comminuted fractures have two or more fragments broken into small pieces, in addition to the upper and lower halves of a fractured bone. Fragments of bone that maintain their normal alignment following a fracture are described as being non-displaced. An impacted fracture is characterized as a bone fragment forced into or onto another fragment resulting from a compressive force. Overriding is a term used to describe bony fragments that overlap and shorten the total length of a bone. Angulated fragments result in pieces of bone being at angles to each other. A displaced bony fragment occurs from disruption of normal bone alignment with deformity of these segments separate from one another. An avulsed fragment occurs when bone fragments are pulled from their normal position by forceful muscle contractions or resistance from ligaments. Segmental fragmented positioning occurs if fractures in two adjacent areas occur, leaving an isolated central segment. An example of segmental alignment is when the arm bone fractures in two separate places, with displacement of the middle section of bone.

Causes and symptoms

Individuals with high activity levels appear to be at greater risk for fractures. This group includes children and athletes participating in contact sports. Because of an increase in bone brittleness with **aging**, elderly persons are also included in this high-risk population. Up to the age of 50, more men suffer from fractures than women due to occupational hazards. However, after the age of 50, women are more prone to fractures than men. Specific diseases causing an increased risk for fractures include Paget's disease, **rickets**, **osteogenesis imperfecta**, **osteoporosis**, bone **cancer** and tumors, and prolonged disuse of a nonfunctional body part such as after a **stroke**.

Symptoms of fractures usually begin with **pain** that increases with attempted movement or use of the area and swelling at the involved site. The skin in the area may be pale and an obvious deformity may be present. In more severe cases, there may be a loss of

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pulse below the fracture site, such as in the extremities, accompanied by **numbness**, **tingling**, or **paralysis** below the fracture. An open or compound fracture is often accompanied by bleeding or bruising. If the lower limbs or pelvis are fractured, pain and resistance to movement usually accompany the injury causing difficulty with weight bearing.

Diagnosis

Diagnosis begins immediately with an individual's own observation of symptoms. A thorough medical history and physical exam by a physician often reveals the presence of a fracture. An x-ray of the injured area is the most common test used to determine the presence of a bone fracture. Any x-ray series performed involves at least two views of the area to confirm the presence of the fracture because not all fractures are apparent on a single x-ray. Some fractures are often difficult to see and may require several views at different angles to see clear fracture lines. In some cases, CT, MRI or other imaging tests are required to demonstrate fracture. Sometimes, especially with children, the initial x-ray may not show any fractures but repeat seven to 14 days later may show changes in the bone(s) of the affected area. If a fracture is open and occurs in conjunction with soft tissue injury, further laboratory studies are often conducted to determine if blood loss has occurred.

In the event of exercise-related stress fractures (micro-fractures due to excessive stress), a tuning fork can provide a simple, inexpensive test. The tuning fork is a metal instrument with a stem and two prongs that vibrate when struck. If an individual has increased pain when the tuning fork is placed on a bone, such as the tibia or shinbone, the likelihood of a stress fracture is high. Bone scans also are helpful in detecting stress fractures. In this diagnostic procedure, a radioactive tracer is injected into the bloodstream and images are taken of specific areas or the entire skeleton by CT or MRI.

Treatment

Treatment depends on the type of fracture, its severity, the individual's age and general health. The first priority in treating any fracture is to address the entire medical status of the patient. Medical personnel are trained not allow a painful, deformed limb to distract them from potentially life-threatening injury elsewhere or **shock**. If an open fracture is accompanied by serious soft tissue injury, it may be necessary to control bleeding and the shock that can accompany loss of blood.

First aid is the appropriate initial treatment in emergency situations. It includes proper splinting, control of blood loss, and monitoring vital signs such as breathing and circulation.

Immobilization

Immobilization of a fracture site can be done internally or externally. The primary goal of immobilization is to maintain the realignment of a bone long enough for healing to start and progress. Immobilization by external fixation uses splints, casts, or braces. This may be the primary and only procedure for fracture treatment. Splinting to immobilize a fracture can be done with or without **traction**. In emergency situations if the injured individual must be moved by someone other than a trained medical person, splinting is a useful form of fracture management. It should be done without causing additional pain and without moving the bone segments. In a clinical environment, plaster of Paris casts are used for immobilization. Braces are useful as they often allow movement above and below a fracture site. Treatments for stress fractures include rest and decreasing or stopping any activity that causes or increases pain.

Fracture reduction

Fracture reduction is the procedure by which a fractured bone is realigned in normal position. It can be either closed or open. Closed reduction refers to realigning bones without breaking the skin. It is performed with manual manipulation and/or traction and is commonly done with some kind of anesthetic. Open reduction primarily refers to surgery that is performed to realign bones or fragments. Fractures with little or no displacement may not require any form of reduction.

Traction is used to help reposition a broken bone. It works by applying pressure to restore proper alignment. The traction device immobilizes the area and maintains realignment as the bone heals. A fractured bone is immobilized by applying opposing force at both ends of the injured area, using an equal amount of traction and countertraction. Weights provide the traction pull needed or the pull is achieved by positioning the individual's body weight appropriately. Traction is a form of closed reduction and is sometimes used as an alternative to surgery. Since it restricts movement of the affected limb or body part, it may confine a person to bed rest for an extended period of time.

A person may need open reduction if there is an open, severe, or comminuted fracture. This procedure allows a physician to examine and surgically correct associated soft tissue damage while reducing the

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KEY TERMS

Avulsion fracture—A fracture caused by the tearing away of a fragment of bone where a strong ligament or tendon attachment forcibly pulls the fragment away from the bone tissue.

Axis—A line that passes through the center of the body or body part.

Comminuted fracture—A fracture where there are several breaks in a bone creating numerous fragments.

Compartment syndrome—Compartment syndrome is a condition in which a muscle swells but is constricted by the connective tissue around it, which cuts off blood supply to the muscle.

Contrast hydrotherapy—A series of hot and cold water applications. A hot compress (as hot as an individual can tolerate) is applied for three minutes followed by an ice cold compress for 30 seconds. These applications are repeated three times each and ending with the cold compress.

Osteogenesis imperfecta—A genetic disorder involving defective development of connective tissues, characterized by brittle and fragile bones that are easily fractured by the slightest trauma.

Osteoporosis—Literally meaning "porous bones," this condition occurs when bones lose an excessive amount of their protein and mineral content, particularly calcium. Over time, bone mass and strength are reduced leading to increased risk of fractures.

Paget's disease—Chromic disorder of unknown cause, usually affecting middle aged and elderly people, characterized by enlarged and deformed bones. Excessive breakdown and formation of bone tissue occurs with Paget's disease and can cause bone to weaken, resulting in bone pain, arthritis, deformities, and fractures.

Reduction—The restoration of a body part to its original position after displacement, such as the reduction of a fractured bone by bringing ends or fragments back into original alignment. The useof local or general anesthesia usually accompanies a fracture reduction. If performed by outside manipulation only, the reduction is described as closed; if surgery is necessary, it is described as open.

Rickets—A condition caused by the dietary deficiency of vitamin D, calcium, and usually phosphorus, seen primarily in infancy and childhood, and characterized by abnormal bone formation.

Traction—The process of placing a bone, limb, or group of muscles under tension by applying weights and pulleys. The goal is to realign or immobilize the part or to relieve pressure on that particular area to promote healing and restore function.

fracture and, if necessary, applying internal or external devices. Internal fixation involves the use of metallic devices inserted into or through bone to hold the fracture in a set position and alignment while it heals. Devices include plates, nails, screws, and rods. When healing is complete, the surgeon may or may not remove these devices. Virtually any hip fracture requires open reduction and internal fixation so that the bone will be able to support the patient's weight.

Alternative treatment

In addition to the importance of **calcium** for strong bones, many alternative treatment approaches recommend use of mineral supplements to help build and maintain a healthy, resilient skeleton. Some physical therapists use electro-stimulation over a fractured site to promote and expedite healing. Chinese traditional medicine may be helpful by working to reconnect chi through the meridian lines along the line of a fracture. Homeopathy can enhance the body's healing process. Two particularly useful homeopathic remedies are *Arnica* (*Arnica montana*) and *Symphytum* (*Symphytum officinalis*). If possible, applying contrast **hydrotherapy** to an extremity (e.g., a hand or foot) of a fractured area can assist healing by enhancing circulation.

Prognosis

Fractures involving joint surfaces almost always lead to some degree of arthritis of the joint. Fractures can normally be cured with proper first aid and appropriate aftercare. If determined necessary by a physician, the fractured site should be manipulated, realigned, and immobilized as soon as possible. Realignment has been shown to be much more difficult after six hours. Healing time varies from person to person with the elderly generally needing more time to heal completely. A non-union fracture may result when a fracture does not heal, such as in the case of an elderly person or an individual with medical

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complications. Recovery is complete when there is no bone motion at the fracture site, and x rays indicate complete healing. Open fractures may lead to bone infections, which delay the healing process. Another possible complication is compartment syndrome, a painful condition resulting from the expansion of enclosed tissue and that may occur when a body part is immobilized in a cast.

Prevention

Adequate calcium intake is necessary for strong bones and can help decrease the risk of fractures. People who do not get enough calcium in their **diets** can take a calcium supplement. **Exercise** can help strengthen bones by increasing bone density, thereby decreasing the risk of fractures from falls. A University of Southern California study reported that older people who exercised one or more hours per day had approximately half the incidence of hip fractures as those who exercised fewer than 30 minutes per day or not at all.

Fractures can be prevented if safety measures are taken seriously. These measures include using seat belts in cars and encouraging children to wear protective sports gear. Estrogen replacement for women past the age of 50 has been shown to help prevent osteoporosis and the fractures that may result from this condition. In one study, elderly women on estrogen replacement therapy demonstrated the lowest occurrence of hip fractures when compared to similar women not on estrogen replacement therapy.

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American Academy of Orthopaedic Surgeons, 6300 North River Rd., Rosemont, IL, 60018-4262, (847) 823-7186, (847) 823-8125, pemr@aaos.org, http://www.aaos.org.

American College of Sports Medicine (ACSM), 401 West Michigan St., P.O. Box 1440, Indianapolis, IN, 46202-3233, (317) 637-9200, (317) 634-7817, http://www.acsm.org.

Children's Orthopedics of Atlanta, 5445 Meridian Mark Rd., Suite 250, Atlanta, GA, 30342, (404) 255-1933, (404) 256-7924, http://www.childrensortho.com.

Nemours Foundation, 10140 Centurion Parkway, Jacksonville, FL, 32256, (904) 697-4100, (904) 697-4220, http://www.nemours.org.

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Fragile X syndrome

Definition

Fragile X syndrome is the most common form of inherited **mental retardation**. Individuals with this condition have developmental delay, variable levels of mental retardation, and behavioral and emotional difficulties. They may also have characteristic physical traits. Generally, males are affected with moderate mental retardation and females with mild mental retardation.

Description

Fragile X syndrome is also known as Martin-Bell syndrome, Marker X syndrome, and FRAXA syndrome. It is the most common form of inherited mental retardation. Fragile X syndrome is caused by a mutation in the FMR-1 gene, located on the X chromosome. The role of the gene is unclear, but it is probably important in early development.

In order to understand fragile X syndrome it is important to understand how human genes and chromosomes influence this condition. Normally, each cell in the body contains 46 chromosomes (23 pairs). These chromosomes consist of genetic material (DNA) needed for the production of proteins, which lead to growth, development, and physical/intellectual characteristics. The first 22 pairs of chromosomes are the same in males and females. The remaining two chromosomes are called the sex chromosomes (X and Y). The sex chromosomes determine whether a person is male or female. Males have only one X chromosome, which is inherited from the mother at conception, and they receive a Y chromosome from the father. Females

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inherit two X chromosomes, one from each parent. Fragile X syndrome is caused by a mutation in a gene called FMR-1. This gene is located on the X chromosome. The FMR-1 gene is thought to play an important role in the development of the brain, but the exact way that the gene acts in the body is not fully understood.

Fragile X syndrome affects males and females of all ethnic groups. It is estimated that about one in 4,000-6,250 males are affected with fragile X syndrome. There are approximately one-half as many females with fragile X syndrome as there are males. The carrier frequency in unaffected females is one in 100-600, with one study finding a carrier frequency of one in 250.

Causes and symptoms

For reasons not fully understood, the CGG sequence in the FMR-1 gene can expand to contain between 54 and 230 repeats. This stage of expansion is called a premutation. People who carry a premutation do not usually have symptoms of fragile X syndrome, although there have been reports of individuals with a premutation and subtle intellectual or behavioral symptoms. Individuals who carry a fragile X premutation are at risk to have children or grandchildren with the condition. Female premutation carriers may also be at increased risk for earlier onset of **menopause**; however, premutation carriers may exist through several generations of a family and no symptoms of fragile X syndrome will appear.

The size of the premutation can expand over succeeding generations. Once the size of the premutation exceeds 230 repeats, it becomes a full mutation and the FMR-1 gene is disabled. Individuals who carry the full mutation may have fragile X syndrome. Since the FMR-1 gene is located on the X chromosome, males are more likely to develop symptoms than females. This is because males have only one copy of the X chromosome. Males who inherit the full mutation are expected to have mental impairment. A female's normal X chromosome may compensate for her chromosome with the fragile X gene mutation. Females who inherit the full mutation have an approximately 50% risk of mental impairment. The phenomenon of an expanding trinucleotide repeat in successive generations is called anticipation. Another unique aspect of fragile X syndrome is that mosaicism is present in 15–20% those affected by the condition. Mosaicism is when there is the presence of cells of two different genetic materials in the same individual.

The mutation involves a short sequence of DNA in the FMR-1 gene. This sequence is designated CGG. Normally, the CGG sequence is repeated between six to 54 times. People who have repeats in this range do not have fragile X syndrome and are not at increased risk to have children with fragile X syndrome. Those affected by fragile X syndrome have expanded CGG repeats (more than 200) in the first exon of the FMR1 gene (the full mutation)

Fragile X syndrome is inherited in an X-linked dominant manner (characters are transmitted by genes on the X chromosome). When a man carries a premutation on his X chromosome, it tends to be stable and usually will not expand if he passes it on to his daughters (he passes his Y chromosome to his sons). Thus, all of his daughters will be premutation carriers like he is. When a woman carries a premutation, it is unstable and can expand as she passes it on to her children, therefore a man's grandchildren are at greater risk of developing the syndrome. There is a 50% risk for a premutation carrier female to transmit an abnormal mutation with each **pregnancy**. The likelihood for the premutation to expand is related to the number of repeats present; the higher the number of repeats, the greater the chance that the premutation will expand to a full mutation in the next generation. All mothers of a child with a full mutation are carriers of an FMR-1 gene expansion. Ninety-nine% of patients with fragile X syndrome have a CGG expansion, and less than 1% have a point mutation or deletion on the FMR1 gene.

Individuals with fragile X syndrome appear normal at birth but their development is delayed. Most boys with fragile X syndrome have mental impairment. The severity of mental impairment ranges from learning disabilities to severe mental retardation. Behavioral problems include attention deficit and hyperactivity at a young age. Some may show aggressive behavior in adulthood. Short attention span, poor eye contact, delayed and disordered speech and language, emotional instability, and unusual hand mannerisms (hand flapping or hand biting) are also seen frequently. Characteristic physical traits appear later in childhood. These traits include a long and narrow face, prominent jaw, large ears, and enlarged testes. In females who carry a full mutation, the physical and behavioral features and mental retardation tend to be less severe. About 50% of females who have a full mutation are mentally retarded. Other behavioral characteristics include whirling, spinning, and occasionally **autism**.

Children with fragile X syndrome often have frequent ear and sinus infections. Nearsightedness and

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KEY TERMS

Amniocentesis—A procedure performed at 16–18 weeks of pregnancy in which a needle is inserted through a woman's abdomen into her uterus to draw out a small sample of the amniotic fluid from around the baby. Either the fluid itself or cells from the fluid can be used for a variety of tests to obtain information about genetic disorders and other medical conditions in the fetus.

CGG or CGG sequence—Shorthand for the DNA sequence: cytosine-guanine-guanine. Cytosine and guanine are two of the four molecules, otherwise called nucleic acids, that make up DNA.

Chorionic villus sampling (CVS)—A procedure used for prenatal diagnosis at 10-12 weeks gestation. Under ultrasound guidance a needle is inserted either through the mother's vagina or abdominal wall and a sample of cells is collected from around the early embryo. These cells are then tested for chromosome abnormalities or other genetic diseases.

Chromosome—A microscopic thread-like structure found within each cell of the body that consists of a complex of proteins and DNA. Humans have 46 chromosomes arranged into 23 pairs. Changes in either the total number of chromosomes or their shape and size (structure) may lead to physical or mental abnormalities.

FMR-1 gene—A gene found on the X chromosome. Its exact purpose is unknown, but it is suspected that the gene plays a role in brain development.

Mitral valve prolapse—A heart defect in which one of the valves of the heart (which normally controls blood flow) becomes floppy. Mitral valve prolapse may be detected as a heart murmur but there are usually no symptoms.

Premutation—A change in a gene that precedes a mutation; this change does not alter the function of the gene.

X chromosome—One of the two sex chromosomes (the other is Y) containing genetic material that, among other things, determine a person's gender.

lazy eye are also common. Many babies with fragile X syndrome may have trouble with sucking and some experience digestive disorders that cause frequent gagging and **vomiting**. A small percentage of children with fragile X syndrome may experience seizures. Children with fragile X syndrome also tend to have loose joints which may result in joint **dislocations**. Some children develop a curvature in the spine, flat feet, and a heart condition known as **mitral valve prolapse**.

Diagnosis

Any child with signs of developmental delay of speech, language, or motor development with no known cause should be considered for fragile X testing, especially if there is a family history of the condition. Behavioral and developmental problems may indicate fragile X syndrome, particularly if there is a family history of mental retardation. Definitive identification of the fragile X syndrome is made by means of a genetic test to assess the number of CGG sequence repeats in the FMR-1 gene. Individuals with the premutation or full mutation may be identified through **genetic testing**. Genetic testing for the fragile X mutation can be done on the developing baby before birth through **amniocentesis** or **chorionic villus sampling** (CVS), and is 99% effective in detecting the condition due to trinucleotide repeat expansion. Prenatal testing should only be undertaken after the fragile X carrier status of the parents has been confirmed and the couple has been counseled regarding the risks of recurrence. While prenatal testing is possible to do with CVS, the results can be difficult to interpret and additional testing may be required.

Treatment

Presently there is no cure for fragile X syndrome. Management includes such approaches as **speech therapy**, **occupational therapy**, and **physical therapy**. The expertise of psychologists, special education teachers, and genetic counselors may also be beneficial. Drugs may be used to treat hyperactivity, seizures, and other problems. Establishing a regular routine, avoiding overstimulation, and using calming techniques may also help in the management of behavioral problems. Children with a troubled heart valve may need to see a heart specialist and take medications before surgery or dental procedures. Children with frequent ear and sinus infections may need to take medications or have special tubes placed in their ears to drain excess fluid. Mainstreaming of children with fragile X syndrome into regular classrooms is encouraged because they do well imitating

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behavior. Peer tutoring and positive reinforcement are also encouraged.

Prognosis

Early diagnosis and intensive intervention offer the best prognosis for individuals with fragile X syndrome. Adults with fragile X syndrome may benefit from vocational training and may need to live in a supervised setting. Life span is typically normal.

A 2004 study found that men who are carriers of the fragile X gene but have not have the mutation severe enough to have fragile X syndrome may begin to show signs of tremor disorder, gait instability and memory impairment as they age. The higher prevalence of these symptoms among grandfathers of children with fragile x syndrome was noted so a study was done to investigate their symptoms compared to men of the same age without the mutation. About 17% of the grandfathers in their 50s had the condition, 37% of those in their 60s, 47% of men in their 70s and 75% of men in their 80s. Often, these men have been diagnosed with other diseases such as Parkinson's or Alzheimer's rather than with fragile X-associated tremor/ataxia syndrome, the name which has been given to these late symptoms from the fragile x mutation.

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ORGANIZATIONS

FRAXA Research Foundation, 45 Pleasant St., Newburyport, MA, 01950, (978) 462-1866, kclapp@fraxa.org, http://www.fraxa.org.

The Arc, 1660 L St., NW, Suite 301, Washington, DC, 20036, (202) 534-3700, (202) 534-3731, (800) 433-5255, info@thearc.org, http://thearc.org.

The National Fragile X Foundation, (925) 938-9300, (925) 938-9315, (800) 688-8765, http://www.fragilex.org.

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Frambesia *see* **Yaws**

Francisella tularensis infection *see* **Tularemia**

Fresh cell therapy *see* **Cell therapy**

Friedreich's ataxia

Definition

Friedreich's ataxia (FA) is an inherited, progressive nervous system disorder causing loss of balance and coordination.

Description

Ataxia is a condition marked by impaired coordination. Friedreich's ataxia is the most common inherited ataxia, affecting between 3,000–5,000 people in the United States. FA is an autosomal recessive disease, which means that two defective gene copies must be inherited to develop symptoms, one from each parent. A person with only one defective gene copy will not show signs of FA, but may pass along the gene to offspring. Couples with one child affected by FA have a 25% chance in each **pregnancy** of conceiving another affected child.

Causes and symptoms

Causes

The gene for FA codes for a protein called frataxin. Normal frataxin is found in the cellular energy structures known as mitochondria, where it is thought to be involved in regulating the transport of iron. In FA, the frataxin gene on chromosome 9 is expanded with nonsense information known as a "triple repeat." This extra DNA interferes with normal production of frataxin, thereby impairing iron transport. Normally, there are 10-21 repeats of the frataxin gene. In FA, this sequence may be repeated between 200-900 times. The types of symptoms and severity of FA seems to be associated with the number of repetitions. Patients with more copies have more severe symptomatology. Researchers are still wrestling with how frataxin and the repeats on chromosome 9 are involved in causing FA. One theory suggests that FA develops in part because defects in iron transport prevent efficient use of cellular energy supplies.

The nerve cells most affected by FA are those in the spinal cord involved in relaying information between muscles and the brain. Tight control of movement requires complex feedback between the muscles promoting a movement, those restraining it, and the brain. Without this control, movements become uncoordinated, jerky, and inappropriate to the desired action.

Symptoms

Symptoms of FA usually first appear between the ages of 8 and 15, although onset as early as 18 months

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or as late as age 25 is possible. The first symptom is usually gait incoordination. A child with FA may graze doorways when passing through, for instance, or trip over low obstacles. Unsteadiness when standing still and deterioration of position sense is common. Foot deformities and walking up off the heels often results from uneven muscle weakness in the legs. **Muscle spasms and cramps** may occur, especially at night.

Ataxia in the arms follows, usually within several years, leading to decreased hand-eye coordination. Arm weakness does not usually occur until much later. Speech and swallowing difficulties are common. **Diabetes mellitus** may also occur. **Nystagmus**, or eye tremor, is common, along with some loss of visual acuity. **Hearing loss** may also occur. A side-to-side curvature of the spine (**scoliosis**) occurs in many cases, and may become severe.

Heartbeat abnormalities occur in about two thirds of FA patients, leading to **shortness of breath** after exertion, swelling in the lower limbs, and frequent complaints of cold feet.

Diagnosis

Diagnosis of FA involves a careful medical history and thorough **neurological exam**. Lab tests include **electromyography**, an electrical test of muscle, and a nerve conduction velocity test. An electrocardiogram may be performed to diagnose heart arrhythmia.

Direct DNA testing is available, allowing FA to be more easily distinguished from other types of ataxia. The same test may be used to determine the presence of the genetic defect in unaffected individuals, such as siblings.

Treatment

There is no cure for FA, nor any treatment that can slow its progress. Amantadine may provide some limited improvement in ataxic symptoms, but is not recommended in patients with cardiac abnormalities. Physical and **occupational therapy** are used to maintain range of motion in weakened muscles, and to design adaptive techniques and devices to compensate for loss of coordination and strength. Some patients find that using weights on the arms can help dampen the worst of the uncoordinated arm movements.

Heart **arrhythmias** and diabetes are treated with drugs specific to those conditions.

Prognosis

The rate of progression of FA is highly variable. Most patients lose the ability to walk within 15 years of symptom onset, and 95% require a wheelchair for mobility by age 45. Reduction in lifespan from FA complications is also quite variable. Average age at **death** is in the mid-thirties, but may be as late as the mid-sixties. As of mid-1998, the particular length of the triple repeat has not been correlated strongly enough with disease progression to allow prediction of the course of the disease on this basis.

KEY TERMS

Ataxia—A condition marked by impaired coordination.

Scoliosis—An abnormal, side-to-side curvature of the spine.

Prevention

There is no way to prevent development of FA in a person carrying two defective gene copies.

Resources

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ORGANIZATIONS

Muscular Dystrophy Association, 3300 East Sunrise Dr., Tucson, AZ, 85718, (800) 572-1717, http://www.mdausa.org.

Rosalyn Carson-DeWitt, MD

Frostbite and frostnip

Definition

Frostbite is the term for damage to the skin and other tissues caused by freezing. Frostnip is a milder form of cold injury; it is sometimes described as the first stage of frostbite.

Demographics

Frostbite is most likely to occur among military personnel, people who work outdoors in cold weather, mountain climbers, skiers and other winter sports

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A human hand with frostbite. *(SIU/Photo Researchers, Inc.)*

participants, homeless people, travelers stranded outside in cold weather, and people who live close to the polar regions. In a few cases frostbite is caused by industrial accidents, when workers who must handle liquid nitrogen or other liquefied gases fail to protect their hands or use proper safety equipment. It is estimated that frostbite in North America and northern Europe causes 2.5 hospital admissions per 100,000 people annually. The true rate is unknown because there is no standardized reporting system for this disorder.

Most frostbite victims are male, but this ratio is thought to reflect occupational choices and interest in high-risk outdoor sports rather than a genetic factor.

According to U.S. military statistics, African American male soldiers are 4 times as likely and African American female soldiers 2.2 times as likely to suffer frostbite as their Caucasian or Native American counterparts. Pacific Islanders and other ethnic and racial groups from warmer climates are also thought to be more likely to suffer frostbite. British Army findings are similar. In addition to race, certain diseases, including diabetes, thyroid disorders, arthritis, and some infections increase a person's risk of developing frostbite during exposure to cold.

Most frostbite victims are middle-aged adults between the ages of 35 and 50; one study found the average age of patients treated for frostbite is 41.

Description

Frostbite is most likely to affect the face, hands, and feet; however, the shins, knees, and the outer portions of the eyes may also be affected. Freezing of exposed tissues results in the formation of ice crystals inside the cell wall. There is a variation of frostbite known as mountain frostbite, which affects mountain climbers and others exposed to extremely cold temperatures at high altitude. It combines tissue freezing with oxygen deprivation and general body **dehydration**.

Risk factors

Risk factors for frostbite and frostnip include:

- military service or employment that requires being outdoors for long periods of time in cold weather or cold climates
- participation in mountain climbing, alpine skiing, or other winter sports
- homelessness
- alcohol or substance abuse
- mental illness
- previous exposure to frostbite or cold injury
- (Nicotine causes blood vessels to constrict, thus lowering the body's ability to circulate blood to the hands, feet, and face.)
- malnutrition
- underlying infection
- medical conditions that affect a person's ability to feel or respond to cold, including dehydration, exhaustion, diabetes, or circulatory disorders

Causes and symptoms

Causes

Frostbite is caused by exposure of skin and underlying tissues to extreme cold, usually environmental. When the skin is exposed to temperatures at or below 32°F (0°C), the blood vessels in the skin start to constrict. This closing down of the blood flow in the extremities is the body's protective strategy for preserving normal body temperature in the body core (the heart and other internal organs).

Skin exposed to temperatures a little below the freezing mark can take hours to freeze, but very cold skin can freeze in minutes or seconds. Air temperature, wind speed, and moisture all affect how cold the skin becomes. A strong wind can lower skin temperature considerably by dispersing the thin protective layer of warm air that surrounds our bodies. Wet clothing readily draws heat away from the skin because water is a potent conductor of heat. The evaporation of moisture on the skin also produces cooling. For these reasons, wet skin or clothing on a windy day can lead to frostbite even if the air temperature is above the freezing mark.

Three nearly simultaneous physiological processes underlie frostbite injury: tissue freezing, tissue hypoxia, and the release of inflammatory mediators. Tissue

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KEY TERMS

Amputation—Surgical removal of a limb.

Debridement—The medical term for the surgical removal of dead or damaged soft tissue.

Dermis—The layer of skin just below the epidermis.

Epidermis—The outermost layer of the skin.

Gangrene—Decay and death of soft tissue due to loss of blood supply.

Hypoxia—The medical term for deprivation of an adequate oxygen supply, either to specific tissues or to the entire organism.

freezing causes ice crystal formation and other changes that damage and eventually kill cells. Much of this harm occurs because the ice produces pressure changes that cause water (crucial for cell survival) to flow out of the cells. Tissue hypoxia (oxygen deficiency) occurs when the blood vessels in the hands, feet, and other extremities narrow in response to cold. Among its many tasks, blood transfers body heat to the skin, which then dissipates the heat into the environment. Blood vessel narrowing is the body's way of protecting vital internal organs at the expense of the extremities by reducing heat flow away from the core. However, blood also carries life-sustaining oxygen to the skin and other tissues, and narrowed vessels result in oxygen starvation. Narrowing also causes acidosis (an increase in tissue acidity) and increases blood viscosity (thickness). Ultimately, blood stops flowing through the capillaries (the tiny blood vessels that connect the arteries and veins) and **blood clots** form in the arterioles and venules (the smallest arteries and veins). Damage also occurs to the endothelial cells that line the blood vessels. Hypoxia, blood clots, and endothelial damage lead, in turn, to the release of inflammatory mediators (substances that act as links in the inflammatory process), which promote further endothelial damage, hypoxia, and cell destruction.

Symptoms

The early stage of frostbite is sometimes called frostnip. Short-term symptoms include loss of feeling or aching **pain** in the affected part, followed by redness of the skin and tissue swelling. Unfortunately, a victim is often unaware of frostbite until someone else points it out because the frozen tissues are numb. Long-term symptoms include intense pain in the affected part, **tingling** sensations, cracks in the skin, dry skin, loss of fingernails, joint stiffness, loss of bone or muscle tissue, and increased sensitivity to cold. If left untreated, frostbitten skin gradually darkens and blisters after a few hours. Skin destroyed by frostbite is completely black, looks burnt, and may hang loosely from the underlying tissues.

Diagnosis

Diagnosis of frostbite is usually made in the field on the basis of the appearance of the frostbitten parts of the body. Some doctors use a four-degree classification of injuries:

- First-degree: The epidermis (outermost layer of the skin) is reddened, swollen, and may look waxy. There is also a loss of sensation in the affected skin.
- Second-degree: The skin is reddened, swollen, and has formed blisters filled with a clear or milky fluid.
- Third-degree: The blisters are filled with blood and the skin begins to turn black.
- Fourth-degree: The epidermis, dermis, and underlying muscles, tendons, and bones are damaged.

Examination

Examination of the patient usually has to be done at the scene rather than in a doctor's office, although it can also be conducted in an ambulance, helicopter, or other emergency medical transport. The doctor will examine the condition of the affected parts, including skin color, the presence of blisters, and other features. If the patient has also been injured in an accident, the doctor will also evaluate the patient for sprains, broken bones, and internal injuries.

Tests

A technique that can be used to diagnose the extent of soft-tissue injury after frostbite is technetium scintigraphy. This is a technique in which radioactive technetium is administered intravenously. The radioactive element is taken up differently by healthy and damaged tissue, and the pattern of "hot spots" and "cold spots" as traced by a scanner allows the doctor to tell whether and where deep tissues have been damaged by frostbite. Scintigraphy can also be used to monitor the recovery of the injured tissues following emergency treatment.

X-rays and other imaging studies will not help in diagnosing frostbite but may be used to evaluate the injured person for broken or fractured bones.

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Treatment

Traditional

FROSTBITE. Emergency medical help should always be summoned whenever frostbite is suspected. While waiting for help to arrive, one should, if possible, remove wet or tight clothing and put on dry, loose clothing or wraps. A splint and padding are used to protect the injured area. The patient should not be allowed to walk on frostbitten toes or feet, as the weight of the body will cause further damage to tissue—unless walking is the only way the patient can get to shelter.

Rubbing the area with snow or anything else is dangerous. The key to prehospital treatment is to avoid partial thawing and refreezing, which releases more inflammatory mediators and makes the injury substantially worse. For this reason, the affected part must be kept away from such heat sources as campfires and car heaters. In addition, the injured person should not be given alcohol or tranquilizers, as these will increase loss of body heat. Experts advise rewarming in the field only when emergency help will take more than two hours to arrive and refreezing can be prevented.

Because the outcome of a frostbite injury cannot be predicted at first, all hospital treatment follows the same route. Treatment begins by rewarming the affected part for 15–30 minutes in water at a temperature of 104–108 °F (40–42.2 °C). This rapid rewarming halts ice crystal formation and dilates narrowed blood vessels. Aloe vera (which acts against inflammatory mediators) is applied to the affected part, which is then splinted, elevated, and wrapped in a dressing. Depending on the extent of injury, blisters may be debrided (cleaned by removing foreign material) or simply covered with aloe vera. Except when injury is minimal, treatment generally requires a hospital stay of several days, during which **hydrotherapy** and **physical therapy** are used to restore the affected part to health. Experts recommend a cautious approach to tissue removal, and advise that 22–45 days must pass before a decision on **amputation** can safely be made.

If frostbitten skin is not treated and its blood vessels are affected, **gangrene** may set in. Gangrene is the **death** of soft tissue due to loss of blood supply. It may be treated by surgical removal of the affected tissue if caught early; otherwise, the surgeon may have to amputate the affected digit or limb to prevent bacterial infections from spreading from the dead tissue to the rest of the body.

FROSTNIP. Frostnipped fingers are helped by blowing warm air on them or holding them under one's armpits. Other frostnipped areas can be covered with warm hands. The injured areas should never be rubbed.

Drugs

The goals of medical therapy for frostbite are pain control and prevention of such complications as further tissue damage or infection. Patients being treated in the hospital for severe frostbite may be given morphine for **pain management** as **narcotics** are needed in most cases to reduce the excruciating pain that occurs as sensation returns during rewarming. A **tetanus** shot and penicillin G are used to prevent infection, and the patient is given ibuprofen or another NSAID to combat inflammation.

Alternative

Alternative practitioners suggest several kinds of treatment to speed recovery from frostbite after leaving the hospital. Bathing the affected part in warm water or using contrast hydrotherapy can help enhance circulation. Contrast hydrotherapy involves a series of hot and cold water applications. A hot compress (as hot as the patient can stand) is applied to the affected area for three minutes followed by an ice cold compress for 30 seconds. These applications are repeated three times each, ending with the cold compress. Nutritional therapy to promote tissue growth in damaged areas may also be helpful.

Homeopathic and botanical therapies may also assist recovery from frostbite. Homeopathic *Hypericum* (*Hypericum perforatum*) is recommended when nerve ending are affected (especially in the fingers and toes) and *Arnica* (*Arnica montana*) is prescribed for **shock**. Cayenne pepper (*Capsicum frutescens*) can enhance circulation and relieve pain. Drinking hot ginger (*Zingiber officinale*) tea also aids circulation. Other possible approaches include **acupuncture** to avoid permanent nerve damage and **oxygen therapy**.

Prognosis

Patients with early recovery of sensation in the affected part, blisters filled with clear fluid, and healthy-appearing skin color have a better prognosis for full recovery than those whose skin has turned bluish, has blood-filled blisters, and looks frozen.

People who have recovered from frostbite have an increased risk of another episode during future exposures to cold. They should take extra precautions to dress properly for extreme cold or avoid it altogether. They may also notice that the frostbitten parts of their body

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are more sensitive to ordinary cold weather, and ache or tingle whenever they are outdoors.

The extreme throbbing pain that many frostbite sufferers endure for days or weeks after rewarming is not the only prolonged symptom of frostbite. Other possible consequences of frostbite include skin—color changes, nail deformation or loss, joint stiffness and pain, **hyperhidrosis** (excessive sweating), and heightened sensitivity to cold. For everyone, a degree of sensory loss lasting at least four years—and sometimes a lifetime—is inevitable. About 65% of people with severe frostbite will eventually develop arthritis in the affected hand, foot, or leg.

Prevention

With the appropriate knowledge and precautions, frostbite can be prevented even in the coldest and most challenging environments. Appropriate clothing and footwear are essential. To prevent heat loss and keep the blood circulating properly, clothing should be worn loosely and in layers. Covering the hands, feet, and head is also crucial for preventing heat loss; mittens are better than gloves for keeping hands warm. Outerwear should be wind- and water-resistant; and wet clothing and footwear must be replaced as quickly as possible. People should also be aware of the early warning signs of frostbite, which include redness of the skin, prickling sensations, and **numbness**.

Alcohol and drugs should be avoided because of their harmful effects on judgment and reasoning. Experts also warn against alcohol use and **smoking** in the cold because of the circulatory changes they produce. Paying close attention to the weather report before venturing outdoors and avoiding such unnecessary risks as driving in isolated areas during a blizzard are also important precautionary measures. In addition, when traveling in cold weather, people should carry emergency supplies and warm clothing in case they become stranded. Last, people who are hiking or skiing in cold temperatures should use a buddy system in case one person is injured and must be evacuated quickly.

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ORGANIZATIONS

American College of Emergency Physicians (ACEP), 1125 Executive Circle, Irving, TX, 75038-2522, (972) 550-0911, (800) 798-1822, 972-580-2816, http://www.acep.org/.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Rd., Atlanta, GA, 30333, (800) 232-4636, cdcinfo @cdc.gov, http://www.cdc.gov.

Wilderness Medical Society (WMS), 2150 S 1300 E, Suite 500, Salt Lake City, UT, 84106, (801) 990-2988, (801) 990-2987, wms@wms.org, http://www.wms.org/.

International Society of Travel Medicine (ISTM), 315 W. Ponce de Leon Ave., Suite 245, Decatur, GA, United States, 30030, (404) 373-8282, (404) 373-8283, istm@istm.org, https://www.istm.org/.

Howard Baker
Rebecca J. Frey, PhD

Frostnip *see* **Frostbite and frostnip**

FSH test *see* **Follicle-stimulating hormone test**

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Fugu poisoning

Definition

Fugu poisoning occurs when a person eats the flesh of a fugu, also known as a puffer fish, which contains lethal toxins.

Description

Fugu, also known as puffer fish, blowfish, or globefish, has long been a food delicacy in Japan, but has only been introduced in the United States in the last 30-40 years. The fugu and related species may contain a tetrodotoxin, an extremely potent neurotoxin and one of the most toxic substances known, which produces critical illness and often **death**. Between January 1 and April 1, 2002, at least 10 cases of fugu poisoning were reported in the United States, according to the Centers for Disease Control and Prevention (CDC) in Atlanta. All persons recovered from the poisonings. All of the fish came from the Atlantic Ocean off the coast of Titusville, Florida. Fugu caught in southern U.S. waters, such as the Gulf of Mexico, may also be toxic. Tetrodotoxin has been detected in pufferfish throughout the Pacific Ocean and the Baja California coastal region. Cases of fugu poisoning are sporadically diagnosed, but many more are not recognized or reported. The earliest cases reported to the CDC involved poisonings in Florida during the mid-1970s. Since 1950, only three known fatalities have occurred in the United States, all in Florida.

The dangers of puffer fish consumption have long been recognized. Artifacts recovered from an Egyptian tomb indicate that puffer fish poisoning has been known since approximately 2400-2700 B.C. In journals covering expeditions from 1772-1775, Pacific explorer Captain James Cook provided a vivid description of what some believe to be puffer fish poisoning. Fugu are found in waters throughout the world. Scientists have found that toxic fugu have unique exocrine glands for the secretion of tetrodotoxin. The fish appear to actively produce the toxin, rather than passively acquire it from the environment. For these fish, tetrodotoxin may serve as a natural defense mechanism to repel predators. The flesh of the fugu is generally eaten raw in paper-thin slices, known as sashimi. Part of the reported delight in eating fugu is the **tingling** oral sensation induced by minute amounts of tetrodotoxin in the flesh. For this reason, eating fugu is considered an "experience," rather than just a meal in Japan. The experience is expensive, however, since a plate of this delicacy can cost as much as $500.

Causes and symptoms

The most common symptoms of fugu poisioning are tingling and burning of the mouth and tongue, **numbness**, drowsiness, and incoherent speech. These symptoms usually occur 30 minutes to two hours after ingestion of the fish, depending on the amount of toxin ingested. In severe cases, ataxia (the inability to coordinate the movements of muscles), muscle weakness, **hypotension** (low blood pressure) and cardiac **arrhythmias** (irregular heartbeat) may develop, followed by muscle twitching and respiratory **paralysis**, and death can occur. In several cases, people died within 17 minutes after eating pufferfish.

Diagnosis

The initial diagnosis is usually made by observation of early symptoms, including an abnormal or unexplained tingling, pricking, or burning sensation on the skin around the mouth and throat. Definitive diagnosis can only be made in a medical laboratory by examination of the ingested fish and identification of the specific toxins. Ill persons should be advised to proceed to a hospital emergency department and contact their local poison control center.

Treatment

There is no antidote for fugu poisoning, therefore treatment is limited to supportive measures and the removal of the unabsorbed toxin. If spontaneous **vomiting** does not occur, it should be induced. Gastric lavage (stomach washing) with an alkaline solution has been suggested, as well as **endoscopy** to remove the poison from the proximal small bowel. Following lavage, **activated charcoal** is reported to effectively bind the toxin. Other steps include administration of oxygen, assisted breathing, intravenous atropine for bradycardia (slow heartbeat) and intravenous fluids, along with dopamine, to manage hypotension. Since tetrodotoxins and opiates are similar, use of an opiate antagonist may be useful, according to the American Academy of Family Physicians.

Alternative treatment

There is no alternative medicine treatment for fugu poisoning.

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KEY TERMS

Ataxia—A lack of muscle control.

Arrhythmia—An irregularity in the normal rhythm or force of the heartbeat.

Atropine—A poisonous alkaloid obtained from belladonna or related plants, used medically to dilate the pupils of the eyes and to stop spasms.

Endoscopy—The use of a medical instrument consisting of a long tube inserted into the body, usually through a small incision, for diagnostic examination and surgical procedures.

Exocrine—Relating to external secretion glands, such as sweat glands or salivary glands that release a secretion through a duct to the surface of an organ.

Hypotension—Low blood pressure.

Lavage—The washing out of a hollow body organ, for example, the stomach, using a flow of water.

Neurotoxin—A substance that damages, destroys, or impairs the functioning of nerve tissue.

Prognosis

The mortality rate may be as high as 60%. Epidemiologic evidence suggests that recovery can be expected if an affected person survives beyond 24 hours. After 24 hours, a person with fugu poisoning usually makes a full recovery.

Prevention

The only prevention is not to eat any of the species of fugu that contain toxins.

Resources

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ORGANIZATIONS

American Association of Poison Control Centers, 515 King St., Suite 510, Alexandria, VA, 22314, (703) 894-1858, (703) 683-2812, (800) 222-1222, info@aapcc.org, http://www.aapcc.org.

Ken R. Wells

Fugue *see* **Dissociative disorders**

FUO *see* **Fever of unknown origin**

Furosemide *see* **Diuretics**

Furunculosis *see* **Boils**

Fusobacterium infection *see* **Anaerobic infections**

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G

G6PD deficiency *see* **Glucose-6-phosphate dehydrogenase deficiency**

Galactorrhea

Definition

Galactorrhea is the secretion of breast milk in men, or in women who are not **breastfeeding** an infant.

Description

Lactation, or the production of breast milk, is a normal condition occurring in women after delivery of a baby. Many women who have had children may even be able to express a small amount of breast milk from the nipple up to two years after **childbirth**. Galactorrhea, or hyperlactation, however, is a rare condition that can occur in both men and women, where a white or grayish fluid is secreted by the nipples of both breasts. While this condition is not serious in itself, galactorrhea can indicate more serious conditions, including hormone imbalances or the presence of tumors.

Causes and symptoms

Causes

Galactorrhea is associated with a number of conditions. The normal production of breast milk is controlled by a hormone called prolactin, which is secreted by the pituitary gland in the brain. Any condition that upsets the balance of hormones in the blood or the production of hormones by the pituitary gland or sexual organs can stimulate the production of prolactin.

Often, a patient with galactorrhea will have a high level of prolactin in the blood. A tumor in the pituitary gland can cause this overproduction of prolactin. At least 30% of women with galactorrhea, menstrual abnormalities, and high prolactin levels have a pituitary gland tumor. Other types of brain tumors, head injuries, or **encephalitis** (an infection of the brain) can also cause galactorrhea.

Tumors or growths in the ovaries or other reproductive organs in women, or in the testicles or related sexual organs of men, can also stimulate the production of prolactin. Any discharge of fluid from the breast after a woman has passed **menopause** may indicate **breast cancer**. However, most often the discharge associated with breast **cancer** will be from one breast only. In galactorrhea both breasts are usually involved. The presence of blood in the fluid discharged from the breast could indicate a benign growth in the breast tissue itself. In approximately 10–15% of patients with blood in the fluid, carcinoma of the breast tissue is present.

A number of medications and drugs can also cause galactorrhea as a side-effect. Hormonal therapies (like **oral contraceptives**), drugs for treatment of depression or other psychiatric conditions, tranquilizers, morphine, heroin, and some medications for high blood pressure can cause galactorrhea.

Several normal physiologic situations can cause production of breast milk. Nipple stimulation in men or women during sexual intercourse may induce lactation, for women particularly during or just after **pregnancy**.

Even after extensive testing, no specific cause can be determined for some patients with galactorrhea.

Symptoms

The primary symptom of galactorrhea is the discharge of milky fluid from both breasts. In women, galactorrhea may be associated with **infertility**, menstrual cycle irregularities, hot flushes, or amenorrhea–a condition where menstruation stops completely. Men may experience loss of sexual interest and **impotence**. Headaches and visual disturbances have also been associated with some cases of galactorrhea.

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KEY TERMS

Amenorrhea—Abnormal cessation of menstruation.

Bromocriptine—Also known as Parlodel, the main drug used to treat galactorrhea by reducing levels of the hormone prolactin.

Hyperlactation—Another term for galactorrhea.

Lactation—The production of breast milk.

Diagnosis

Galactorrhea is generally considered a symptom that may indicate a more serious problem. Collection of a thorough medical history, including pregnancies, surgeries, and consumption of drugs and medications is a first step in diagnosing the cause of galactorrhea. A **physical examination**, along with a breast examination, will usually be conducted. Blood and urine samples may be taken to determine levels of various hormones in the body, including prolactin and compounds related to thyroid function.

A mammogram (an x ray of the breast) or an ultrasound scan (using high frequency sound waves) might be used to determine if there are any tumors or cysts present in the breasts themselves. If a tumor of the pituitary gland is suspected, a series of computer assisted x rays called a computed tomography scan (CT scan) may be done. Another procedure that may be useful is a **magnetic resonance imaging** (MRI) scan to locate tumors or abnormalities in tissues.

Treatment

Treatment for galactorrhea will depend on the cause of the condition and the symptoms. The drug bromocriptine is often prescribed first to reduce the secretion of prolactin and to decrease the size of **pituitary tumors**. This drug will control galactorrhea symptoms and in many cases may be the only therapy necessary. Oral estrogen and progestins (hormone pills, like birth control pills) may control symptoms of galactorrhea for some women. Surgery to remove a tumor may be required for patients who have more serious symptoms of **headache** and vision loss, or if the tumor shows signs of enlargement despite drug treatment. **Radiation therapy** has also been used to reduce tumor size when surgery is not possible or not totally successful. A combination of drug, surgery, and radiation treatment can also be used.

Galactorrhea is more of a nuisance than a real threat to health. While it is important to find the cause of the condition, even if a tumor is discovered in the pituitary gland, it may not require treatment. With very small, slow-growing tumors, some physicians may suggest a "wait and see" approach.

Prognosis

Treatment with bromocriptine is usually effective in stopping milk secretion, however, symptoms may recur if drug therapy is discontinued. Surgical removal or radiation treatment may correct the problem permanently if it is related to a tumor. Frequent monitoring of hormone status and tumor size may be recommended.

Prevention

There is no way to prevent galactorrhea. If the condition is caused by the use of a particular drug, a patient may be able to switch to a different drug that does not have the side-effect of galactorrhea.

Resources

BOOKS

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Altha Roberts Edgren

Galactosemia

Definition

Galactosemia is an inherited disease in which the transformation of galactose to glucose is blocked, allowing galactose to increase to toxic levels in the body. If galactosemia is untreated, high levels of galactose cause **vomiting**, **diarrhea**, lethargy, low blood sugar, brain damage, **jaundice**, liver enlargement, **cataracts**, susceptibility to infection, and **death**.

Description

Galactosemia is a rare but potentially life-threatening disease that results from the inability to metabolize galactose. Serious consequences from galactosemia can be prevented by screening newborns at birth with a simple blood test.

Galactosemia is an inborn error of metabolism. "Metabolism" refers to all chemical reactions that

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take place in living organisms. A metabolic pathway is a series of reactions where the product of each step in the series is the starting material for the next step. Enzymes are the chemicals that help the reactions occur. Their ability to function depends on their structure, and their structure is determined by the deoxyribonucleic acid (DNA) sequence of the genes that encode them. Inborn errors of metabolism are caused by mutations in these genes which do not allow the enzymes to function properly.

Sugars are sometimes called "the energy molecules," and galactose and glucose are both sugars. For galactose to be utilized for energy, it must be transformed into something that can enter the metabolic pathway that converts glucose into energy (plus water and carbon dioxide). This is important for infants because they typically get most of their nutrient energy from milk, which contains a high level of galactose. Each molecule of lactose, the major sugar constituent of milk, is made up of a molecule of galactose and a molecule of glucose, and so galactose makes up 20% of the energy source of a typical infant's diet.

Three enzymes are required to convert galactose into glucose-1-phosphate (a phosphorylated glucose that can enter the metabolic pathway that turns glucose into energy). Each of these three enzymes is encoded by a separate gene. If any of these enzymes fail to function, galactose build-up and galactosemia result. Thus, there are three types of galactosemia with a different gene responsible for each.

Every cell in a person's body has two copies of each gene. Each of the forms of galactosemia is inherited as a recessive trait, which means that galactosemia is only present in individuals with two mutated copies of one of the three genes. This also means that carriers, with only one copy of a gene mutation, will not be aware that they are carrying a mutation (unless they have had a genetic test), as it is masked by the normal gene they also carry and they have no symptoms of the disease. For each step in the conversion of galactose to glucose, if only one of the two copies of the gene controlling that step is normal (i.e. for carriers), enough functional enzyme is made so that the pathway is not blocked at that step. If a person has galactosemia, both copies of the gene coding for one of the enzymes required to convert glucose to galactose are defective and the pathway becomes blocked. If two carriers of the same defective gene have children, the chance of any of their children getting galactosemia (the chance of a child getting two copies of the defective gene) is 25% (one in four) for each **pregnancy**.

Classic galactosemia occurs in the United States about one in every 50,000–70,000 live births.

Causes and symptoms

Galactosemia I

Galactosemia I (also called classic galactosemia), the first form to be discovered, is caused by defects in both copies of the gene that codes for an enzyme called galactose-1-phosphate uridyl transferase (GALT). There are 30 known different mutations in this gene that cause GALT to malfunction.

Newborns with galactosemia I appear normal at birth, but begin to develop symptoms after they are given milk for the first time. Symptoms include **vomiting**, diarrhea, lethargy (sluggishness or **fatigue**), low blood glucose, jaundice (a yellowing of the skin and eyes), enlarged liver, protein and amino acids in the urine, and susceptibility to infection, especially from gram negative bacteria. Cataracts (a grayish white film on the eye lens) can appear within a few days after birth. People with galactosemia frequently have symptoms as they grow older even though they have been given a galactose-free diet. These symptoms include **speech disorders**, cataracts, ovarian atrophy, and **infertility** in females, learning disabilities, and behavioral problems.

Galactosemia II

Galactosemia II is caused by defects in both copies of the gene that codes for an enzyme called galactokinase (GALK). The frequency of occurrence of galactosemia II is about one in 100,000–155,000 births.

Galactosemia II is less harmful than galactosemia I. Babies born with galactosemia II will develop cataracts at an early age unless they are given a galactose-free diet. They do not generally suffer from liver damage or neurologic disturbances.

Galactosemia III

Galactosemia III is caused by defects in the gene that codes for an enzyme called uridyl diphosphogalactose-4-epimerase (GALE). This form of galactosemia is very rare.

There are two forms of galactosemia III, a severe form, which is exceedingly rare, and a benign form. The benign form has no symptoms and requires no special diet. However, newborns with galactosemia III, including the benign form, have high levels of galactose-1-phosphate that show up on the initial screenings for elevated galactose and galactose-1-phosphate. This situation illustrates one aspect of the importance of follow-up enzyme function tests. Tests showing normal levels of GALT and GALK allow people affected by the benign form of galactosemia III to enjoy a normal diet.

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KEY TERMS

Casein hydrolysate—A preparation made from the milk protein casein, which is hydrolyzed to break it down into its constituent amino acids. Amino acids are the building blocks of proteins.

Catalyst—A substance that changes the rate of a chemical reaction, but is not physically changed by the process.

Enzyme—A protein that catalyzes a biochemical reaction or change without changing its own structure or function.

Galactose—One of the two simple sugars, together with glucose, that makes up the protein, lactose, found in milk. Galactose can be toxic in high levels.

Glucose—One of the two simple sugars, together with galactose, that makes up the protein, lactose, found in milk. Glucose is the form of sugar that is usable by the body to generate energy.

Lactose—A sugar made up of of glucose and galactose. It is the primary sugar in milk.

Metabolic pathway—A sequence of chemical reactions that lead from some precursor to a product, where the product of each step in the series is the starting material for the next step.

Metabolism—The total combination of all of the chemical processes that occur within cells and tissues of a living body.

Recessive trait—An inherited trait or characteristic that is outwardly obvious only when two copies of the gene for that trait are present.

The severe form has symptoms similar to those of galactosemia I, but with more severe neurological problems, including seizures. Only two cases of this rare form has been reported .

Diagnosis

The newborn screening test for classic galactosemia is quick and straightforward; all but three states require testing on all newborns. Blood from a baby who is two to three days old is usually first screened for high levels of galactose and galactose-1-phosphate. If either of these compounds is elevated, further tests are performed to find out which enzymes (GALT, GALK, or GALE) are present or missing. DNA testing may also be performed to confirm the diagnosis.

If there is a strong suspicion that a baby has galactosemia, galactose is removed from the diet right away. In this case, an initial screen for galactose or galactose-1-phosphate will be meaningless. In the absence of galactose in the diet, this test will be negative whether the baby has galactosemia or not. In this case, tests to measure enzyme levels must be given to find out if the suspected baby is indeed galactosemic.

In addition, galactosemic babies who are refusing milk or vomiting will not have elevated levels of galactose or galactose phosphate, and their condition will not be detected by the initial screen. Any baby with symptoms of galactosemia (for example, vomiting) should be given enzyme tests.

Treatment

Galactosemia I and II are treated by removing galactose from the diet. Since galactose is a breakdown product of lactose, the primary sugar constituent of milk, this means all milk and foods containing milk products must be totally eliminated. Other foods like legumes, organ meats, and processed meats also contain considerable galactose and must be avoided. Pills that use lactose as a filler must also be avoided. Soy-based and casein hydrolysate-based formulas are recommended for infants with galactosemia.

Treatment of the severe form of galactosemia III with a galactose-restricted diet has been tried, but this disorder is so rare that the long-term effects of this treatment are unknown.

Prognosis

Early detection in the newborn period is the key to controlling symptoms. Long-term effects in untreated babies include severe **mental retardation**, **cirrhosis** of the liver, and death. About 75% of the untreated babies die within the first two weeks of life. On the other hand, with treatment, a significant proportion of people with galactosemia I can lead nearly normal lives, although speech defects, learning disabilities, and behavioral problems are common. A 2004 study revealed that children and adolescents with classic galactosemia often have lower quality of life than peers without the disease, exhibiting problems with cognition (thinking and intellectual skills) and social function. In addition,

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cataracts due to galactosemia II can be completely prevented by a galactose-free diet.

Prevention

Since galactosemia is a recessive genetic disease, the disease is usually detected on a newborn screening test, since most people are unaware that they are carriers of a gene mutation causing the disease. For couples with a previous child with galactosemia, prenatal diagnosis is available to determine whether a pregnancy is similarly affected. Families in which a child has been diagnosed with galactosemia can have DNA testing which can enable other more distant relatives to determine their carrier status. Prospective parents can then use that information to conduct family planning or to prepare for a child with special circumstances. Children born with galactosemia should be put on a special diet right away, to reduce the symptoms and complications of the disease.

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"GeneCards: Human Genes, Proteins and Diseases." http://bioinfo.weizmann.ac.il/cards.

"Vermont Newborn Screening Program." http://healthvermont.gov/regs/newborn_screening_reg.aspx.

ORGANIZATIONS

Association for Neuro-Metabolic Disorders, 5223 Brookfield Lane, Sylvania, OH, 43560-1809, (419) 885-1809.

National Endocrine and Metabolic Diseases Information Service, 6 Information Way, Bethesda, MD, 20892–3569, (703) 738–4929, (888) 828–0904, endoandmeta@info.niddk.nih.gov, http://endocrine.niddk.nih.gov.

Parents of Galactosemic Children, PO Box 2401, Mandeville, LA, 70470-2401, (866) 9007421, http://www.galactosemia.org.

Amy Vance, MS, CGC
Teresa G. Odle

Gallbladder cancer

Definition

Cancer of the gallbladder is cancer of the pear-shaped organ that lies on the undersurface of the liver.

Description

Bile from the liver is funneled into the gallbladder by way of the cystic duct. Between meals, the gallbladder stores a large amount of bile. To do this, it must absorb much of the water and electrolytes from the bile. In fact, the inner surface of the gallbladder is the most absorptive surface in the body. After a meal, the gallbladder's muscular walls contract to deliver the bile back through the cystic duct and eventually into the small intestine, where the bile can help digest food.

Demographics

About 5,000 people are diagnosed with gallbladder cancer each year in the United States, making it the fifth most common gastrointestinal cancer. It is more common in females than males and most patients are elderly. Southwest American Indians have a particularly high incidence— six times that of the general population.

Causes and symptoms

Gallstones are the most significant risk factor for the development of gallbladder cancer. Roughly 75 to 90 percent of patients with gallbladder cancer also have gallstones. Larger gallstones are associated with a higher chance of developing gallbladder cancer. Chronic inflammation of the gallbladder from infection also increases the risk for gallbladder cancer.

Unfortunately, sometimes cancer of the gallbladder does not produce symptoms until late in the disease. When symptoms are evident, the most common is **pain** in the upper right portion of the abdomen, underneath the right ribcage. Patients with gallbladder cancer may also report symptoms such as **nausea**, **vomiting**, weakness, **jaundice**, skin **itching**, **fever**, chills, poor appetite, and weight loss.

Diagnosis

Gallbladder cancer is often misdiagnosed because it mimics other more common conditions, such as gallstones, **cholecystitis**, and **pancreatitis**. But the imaging tests that are utilized to evaluate these other conditions can also detect gallbladder cancer. For example, ultrasound is a quick, noninvasive imaging test that reliably diagnoses gallstones and cholecystitis. It can also detect the presence of gallbladder cancer as well as show how far the cancer has spread. If cancer is suspected, a computed tomography scan is useful in confirming the presence of an abnormal mass and further demonstrating the size and extent of the tumor. Cholangiography, usually performed to evaluate a patient with jaundice, can also detect gallbladder cancer.

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KEY TERMS

Cholangiography—Radiographic examination of the bile ducts after injection with a special dye

Cholecystitis—Inflammation of the gallbladder, usually due to infection

Computed tomography—A radiology test by which images of cross-sectional planes of the body are obtained

Jaundice—Yellowish staining of the skin and eyes due to excess bilirubin in the bloodstream

Metastasis—The spread of tumor cells from one part of the body to another through blood vessels or lymphatic vessels

Pancreatitis—Inflammation of the pancreas

Stent—Slender hollow catheter or rod placed within a vessel or duct to provide support or maintain patency

Ultrasound—A radiology test utilizing high frequency sound waves

There are no specific laboratory tests for gallbladder cancer. Tumors can obstruct the normal flow of bile from the liver to the small intestine. Bilirubin, a component of bile, builds up within the liver and is absorbed into the bloodstream in excess amounts. This can be detected in a blood test, but it can also manifest clinically as jaundice. Elevated bilirubin levels and clinical jaundice can also occur with other conditions, such as gallstones.

On occasion, gallbladder cancer is diagnosed incidentally. About one percent of all patients who have their gallbladder removed for symptomatic gallstones are found to have gallbladder cancer. The cancer is found either by the surgeon or by the pathologist who inspects the gallbladder with a microscope.

Treatment

Staging of gallbladder cancer is determined by the how far the cancer has spread. The effectiveness of treatment declines as the stage progresses. Stage I cancer is confined to the wall of the gallbladder. Approximately 25% of cancers are at this stage at the time of diagnosis. Stage II cancer has penetrated the full thickness of the wall, but has not spread to nearby lymph nodes or invaded adjacent organs. Stage III cancer has spread to nearby lymph nodes or has invaded the liver, stomach, colon, small intestine, or large intestine. Stage IV disease has invaded very deeply into two or more adjacent organs or has spread to distant lymph nodes or organs by way of metastasis.

Early Stage I cancers involving only the innermost layer of the gallbladder wall can be cured by simple removal of the gallbladder. Cancers at this stage are sometimes found incidentally when the gallbladder is removed in the treatment of gallstones or cholecystitis. The majority of patients have good survival rates. Late Stage I cancers, which involve the outer muscular layers of the gallbladder wall, are generally treated in the same way as Stage II or III cancers. Removal of the gallbladder is not sufficient for these stages. The surgeon also removes nearby lymph nodes as well as a portion of the adjacent liver (radical surgery). Survival rates for these patients are considerably worse than for those with early Stage I disease. Patients with early Stage IV disease may benefit from radical surgery, but the issue is controversial. Late Stage IV cancer has spread too extensively to allow complete excision. Surgery is not an option for these patients.

Other therapies

When long-term survival is not likely, the focus of therapy shifts to improving quality of life. Jaundice and blockage of the stomach are two problems faced by patients with advanced cancer of the gallbladder. These can be treated with surgery, or alternatively, by special interventional techniques employed by the gastroenterologist or radiologist. A stent can be placed across the bile ducts in order to re-establish the flow of bile and relieve jaundice. A small feeding tube can be placed in the small intestine to allow feeding when the stomach is blocked. Pain may be treated with conventional pain medicines or a celiac **ganglion** nerve block.

Current **chemotherapy** or **radiation therapy** cannot cure gallbladder cancer, but they may offer some benefit in certain patients. For cancer that is too advanced for surgical cure, treatment with chemotherapeutic agents such as 5-fluorouracil may lengthen survival for a few months. The limited benefit of chemotherapy must be weighed carefully against its side effects. Radiation therapy is sometimes used after attempted surgical resection of the cancer to extend survival for a few months or relieve jaundice.

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Abeloff, Martin D., et al. *Clinical Oncology*. 4th ed. New York: Churchill Livingstone/Elsevier, 2008.

Sabiston, David C., et al. *Sabiston Textbook of Surgery: The Biological Basis of Modern Surgical Practice*. Philadelphia: Saunders/Elsevier, 2008.

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National Cancer Institute Cancer Trials web site. http://www.cancertrials.gov.

Kevin O. Hwang, MD

Gallbladder disease *see* **Cholecystitis**

KEY TERMS

Cholecystitis—Inflammation of the gallbladder.

Cholescintigraphy—Another term for a gallbladder nuclear medicine scan.

Hepatobiliary scan—Another term for a gallbladder nuclear medicine scan.

Scintillation or gamma camera—A camera, somewhat like an x-ray machine, used to photograph internal organs after the patient has been injected with a radioactive material.

Gallbladder nuclear medicine scan

Definition

A nuclear medicine scan of the gallbladder is used to produce a set of images that look like x rays. The procedure uses a small amount of radioactive dye which is injected into the body. The dye accumulates in the organ, in this case, the gallbladder. A special camera called a scintillation or gamma camera produces images based on how the dye travels through the system and how the radiation is absorbed by the tissues. The procedure is also called cholescintigraphy or a hepatobiliary scan.

Purpose

A nuclear medicine scan can be used to diagnose disease and to find abnormalities in a body organ. A gallbladder scan can detect **gallstones**, tumors, or defects of the gallbladder. It can also be used to diagnose blockages of the bile duct that leads from the gallbladder to the small intestine. Unlike ultrasound, a gallbladder nuclear medicine scan can assess gallbladder function.

Precautions

Women who are pregnant or **breastfeeding** should tell their doctors before a scan is performed. Some medications or even eating a high fat meal before the procedure can interfere with the results of the scan.

Description

The gallbladder is a small pear-shaped sac located under the liver. The liver produces bile, a yellowish-green mixture of salts, acids, and other chemicals, that are stored in the gallbladder. Bile is secreted into the small intestine to help the body digest fats from foods.

Gallbladder disease, gallstones, **cancer**, or other abnormalities can cause **pain** and other symptoms. A gallbladder condition might be suspected if a patient has chronic or occasional pain in the upper right side of the abdomen. The pain may be stabbing and intense with sudden onset or it may be more of a dull, occasional ache. Loss of appetite, **nausea and vomiting** can also occur. **Fever** may indicate the presence of infection. **Jaundice**, a yellowing of the skin and whites of the eyes, may also indicate that the gallbladder is involved.

A gallbladder nuclear medicine scan may be used to diagnose gallstones, blockage of the bile duct or other abnormalities, and to assess gallbladder functioning and inflammation (**cholecystitis**). The scan is usually performed in a hospital or clinical radiology department. The patient lies on an examination table while a small amount of radioactive dye is injected into a vein in the arm. This dye circulates through the blood and collects in the gallbladder. As the dye moves through the gallbladder, a series of pictures is taken using a special camera called a *scintillation* or *gamma camera*. This procedure produces images that look like x rays. The test usually takes one to two hours to complete, but can last up to four hours.

The results of the scan are read by a radiologist, a doctor specializing in x rays and other types of scanning techniques. A report is sent, usually within 24 hours, to the doctor who will discuss the results with the patient.

Preparation

The patient may be required to withhold food and liquids for up to eight hours before the scan.

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Aftercare

No special care is required after the procedure. Once the scan is complete, the patient can return to normal activities.

Risks

Nuclear medicine scans use a very small amount of radioactive material, and the risk of radiation is minimal. Very rarely, a patient may have a reaction to the dye material used.

Normal results

A normal scan shows a gallbladder without gallstones. There will be no evidence of growths or tumors, and no signs of infection or swelling. The normal gallbladder fills with bile and secretes it through the bile duct without blockages.

Abnormal results

An abnormal scan may show abnormal gallbladder emptying (suggesting gallbladder dysfunction or inflammation), or gallstones in the gallbladder or in the bile duct. The presence of tumors, growths or other types of blockages of the duct or the gallbladder itself could also appear on an abnormal scan.

Resources

OTHER

"Nuclear Medicine." Washington Radiology Associates Page. http://www.wrapc.com.

Altha Roberts Edgren

Gallbladder surgery *see* **Cholecystectomy**

Gallbladder x rays

Definition

This is an x-ray exam of the gallbladder (GB), a sac-like organ that stores bile that is located under the liver. The study involves taking tablets containing dye (contrast) which outline any abnormalities when x rays are taken the following day. The test was once the standard for diagnosing diseases of the GB such as **gallstones**, but is used less frequently now. This is due to advances in diagnostic ultrasound, which is quick, accurate and doesn't involve exposure to ionizing radiation. When functional parameters of the gallbladder need to be demonstrated, scintigraphy is now the study of choice. OCG, however, can be useful when a gallbladder is contracted down due to the presence of many, many gallstones. It can also help determine whether the cystic duct is clear, prior to surgical procedures such as **lithotripsy**. OCG may also be used to evaluate gallbladder disease that doesn't involve gallstones, such as adenomyomatosis of the gallbladder or cholesterolosis of the gallbladder.

Purpose

This test, also known as an oral cholecystogram or OCG, is usually ordered to help physicians diagnose disorders of the gallbladder, such as gallstones and tumors, which show up as solid dark structures. It is performed to help in the investigation of patients with upper abdominal **pain**. The test also measures gallbladder function, as the failure of the organ to visualize can signify a non-functioning or diseased gallbladder. The gallbladder may also not visualize if the bilirubin level is over 4 and the study should not be performed under these circumstances.

Precautions

Your physician must be notified if you are pregnant or allergic to iodine. Patients with a history of severe kidney damage, have an increased risk of injury or side effects from the procedure. In those cases, ultrasound is commonly used instead of the x-ray examination. Some people experience side effects from the contrast material (dye tablets), especially **diarrhea**. During preparation for the test, patients should not use any **laxatives**. Diabetics should discuss the need for any adjustment in medication with their physician.

Description

The exam is performed in the radiology department. The night before the test, patients swallow six tablets (one at a time) that contain the contrast (x-ray dye). The following day at the hospital, the radiologist examines the gallbladder with a fluoroscope (a special x ray that projects the image onto a video monitor). Sometimes, patients are then asked to drink a highfat formula that will cause the gallbladder to contract and release bile. X rays will then be taken at various intervals. There is no discomfort from the test. If the gallbladder is not seen, the patient may be asked to return the following day for x rays.

Preparation

The day before the test patients are instructed to eat a high fat lunch (eggs, butter, milk, salad oils,

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KEY TERMS

Bile—A yellow-green liquid produced by the liver, which is released through the bile ducts into the small intestines to help digest fat.

Bilirubin—A reddish-yellow pigment formed from the destruction of red blood cells, and metabolized by the liver. Levels of bilirubin in the blood increase in patients with liver disease or blockage of the bile ducts.

Ultrasound—A non-invasive procedure based on changes in sound waves of a frequency that cannot be heard, but respond to changes in tissue composition. It requires no preparation and no radiation occurs; it has become the "gold standard" for diagnosis of stones in the gallbladder, but is less accurate in diagnosing stones in the bile ducts. Gallstones as small as 2 mm can be identified.

or fatty meats), and a fat-free meal (fruits, vegetables, bread, tea or coffee, and only lean meat) in the evening. Two hours after the evening meal, six tablets containing the contrast medium, are taken, one a time. After that, no food or fluid is permitted until after the test.

Aftercare

No special care is required after the study.

Risks

There is a small chance of an allergic reaction to the contrast material. In addition, there is low radiation exposure. X rays are monitored and regulated to provide the minimum amount of radiation exposure needed to produce the image. Most experts feel that the risk is low compared with the benefits. Pregnant women and children are more sensitive to the risks of x rays, and the risk versus benefits should be discussed with the treating physician.

Normal results

The x ray will show normal structures for the age of the patient. The gallbladder should visualize, and be free of any solid structures, such as stones, polyps, etc.

Abnormal results

Abnormal results may show gallstones, tumors, or cholesterol polyps (a tumor growing from the lining that is usually noncancerous). Typically stones will "float" or move around as the patient changes position, whereas tumors will stay in the same place.

Resources

OTHER

"Gall Bladder Exam." Harvard Medical School. http://www.bih.harvard.edu/radiology/Modalities/Xray/xraysSubdivsf/gallbl.html.

"Gallstones." National Institutes of Health. http://www.niddk.nih.gov/health/digest/pubs/gallstns/gallstns.htm.

Rosalyn Carson-DeWitt, MD

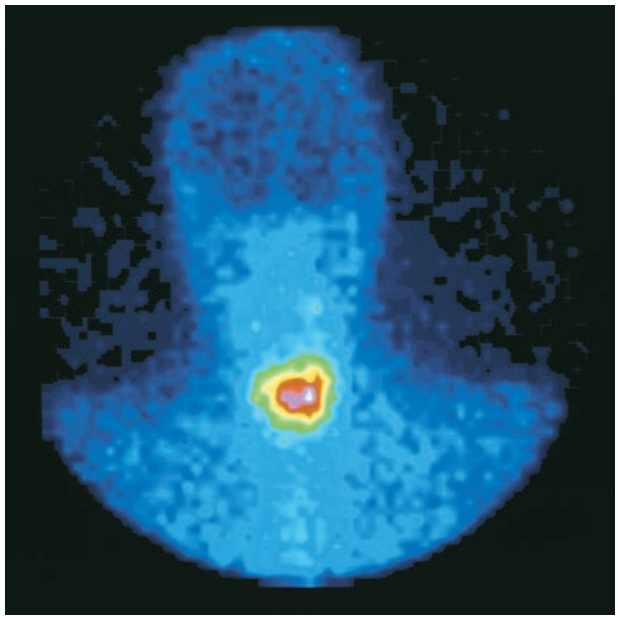
Gallium scan of the body

Definition

A gallium scan of the body is a nuclear medicine test that is conducted using a camera that detects gallium, a form of radionuclide, or radioactive chemical substance.

Purpose

Most gallium scans are ordered to detect cancerous tumors, infections, or areas of inflammation in the body. Gallium is known to accumulate in inflamed,



Gallium scan highlighting the thyroid gland.
(Photo Researchers, Inc.)

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infected, or cancerous tissues. The scans are used to determine whether a patient with an unexplained **fever** has an infection and the site of the infection, if present. Gallium scans also may be used to evaluate **cancer** following **chemotherapy** or **radiation therapy**.

Precautions

Children and women who are pregnant or **breast-feeding** are only given gallium scans if the potential diagnostic benefits will outweigh the risks.

Description

The patient will usually be asked to come to the testing facility 24–48 hours before the procedure to receive the injection of gallium. Sometimes, the injection will be given only four to six hours before the study or as long as 72 hours before the procedure. The timeframe is based on the area or organs of the body being studied.

For the study itself the patient lies very still for approximately 30–60 minutes. A camera is moved across the patient's body to detect and capture images of concentrations of the gallium. The camera picks up signals from any accumulated areas of the radionuclide. In most cases, the patient is lying down throughout the procedure. Back (posterior) and front (anterior) views will usually be taken, and sometimes a side (lateral) view is used. The camera may occasionally touch the patient's skin, but will not cause any discomfort. A clicking noise may be heard throughout the procedure; this is only the sound of the scanner registering radiation.

Preparation

The intravenous injection of gallium is done in a separate appointment prior to the procedure. Generally, no special dietary requirements are necessary. Sometimes the physician will ask that the patient have light or clear meals within a day or less of the procedure. Many patients will be given **laxatives** or an enema prior to the scan to eliminate any residual gallium from the bowels.

Aftercare

There is generally no aftercare required following a gallium scan. However, women who are breastfeeding who have a scan will be cautioned against breastfeeding for four weeks following the exam.

Risks

There is a minimal risk of exposure to radiation from the gallium injection, but the exposure from one gallium scan is generally less than exposure from x rays.

KEY TERMS

Benign—Not cancerous. Benign tumors are not considered immediate threats, but may still require some form of treatment.

Gallium—A form of radionuclide that is used to help locate tumors and inflammation (specifically referred to as GA67 citrate).

Malignant—This term, usually used to describe a tumor, means cancerous, becoming worse and possibly growing.

Nuclear medicine—A subspecialty of radiology used to show the function and anatomy of body organs. Very small amounts of radioactive substances, or tracers, are detected with a special camera as they accumulate in certain organs and tissues.

Radionuclide—A chemical substance, called an isotope, that exhibits radioactivity. A gamma camera, used in nuclear medicine procedures, will pick up the radioactive signals as the substance gathers in an organ or tissue. They are sometimes referred to as tracers.

Normal results

A radiologist trained in nuclear medicine or a nuclear medicine specialist will interpret the exam results and compare them to other diagnostic tests. It is normal for gallium to accumulate in the liver, spleen, bones, breast tissue, and large bowel.

Abnormal results

An abnormal concentration of gallium in areas other than those where it normally concentrates may indicate the presence of disease. Concentrations may be due to inflammation, infection, or the presence of tumor tissue. Often, additional tests are required to determine if the tumors are malignant (cancerous) or benign.

Even though gallium normally concentrates in organs such as the liver or spleen, abnormally high concentrations will suggest certain diseases and conditions. For example, Hodgkin's or non-Hodgkin's lymphoma may be diagnosed or staged if there is abnormal gallium activity in the lymph nodes. After a patient receives cancer treatment, such as radiation therapy or chemotherapy, a gallium scan may help to find new or recurring tumors or to record regression of a treated tumor. Physicians can narrow causes of liver problems by noting abnormal gallium activity in the liver.

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Gallium scans also may be used to diagnose lung diseases or a disease called **sarcoidosis**, in the chest.

Resources

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"A Patient's Guide to Nuclear Medicine." *University of Iowa Virtual Hospital*. July 2, 2001. http://www.vh.org/Patients/IHB/Rad/NucMed/PatGuideNucMed/PatGuideNucMed.html.

ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (800) 227-2345, http://www.cancer.org.

American College of Nuclear Medicine, 1850 Samuel Morse Drive, Reston, VA, 20190-5316, (703) 326-1190, (703) 708-9015.

American Liver Foundation, 75 Maiden Lane, Suite 603, New York, NY, 10038, (212) 668-1000, (212) 483-8179, http://www.liverfoundation.org.

Society of Nuclear Medicine (SNM), 1850 Samuel Morse Dr., Reston, VA, 20190, (703) 708-9000, (703) 708-9015, http://www.snm.org.

Teresa Odle

Gallstone removal

Definition

Also known as cholelithotomy, gallstone removal is the medical procedure that rids the gallbladder of calculus buildup.

Purpose

The gallbladder is not a vital organ. Its function is to store bile, concentrate it, and release it during digestion. Bile is supposed to retain all of its chemicals in solution, but commonly one of them crystallizes and forms sand, gravel, and finally stones.

The chemistry of **gallstones** is complex and interesting. Like too much sugar in solution, chemicals in bile will form crystals as the gallbladder draws water out of the bile. The solubility of these chemicals is based on the concentration of three chemicals, not just one–bile acids, phospholipids, and cholesterol. If the chemicals are out of balance, one or the other will not remain in solution. Certain people, in particular the Pima tribe of Native Americans in Arizona, have a genetic predisposition to forming gallstones. Scandinavians also have a higher than average incidence of this disease. Dietary fat and cholesterol are also implicated in their formation. Overweight women in their middle years constitute the vast majority of patients with gallstones in every group.

As the bile crystals aggregate to form stones, they move about, eventually occluding the outlet and preventing the gallbladder from emptying. This creates symptoms. It also results in irritation, inflammation, and sometimes infection of the gallbladder. The pattern is usually one of intermittent obstruction due to stones moving in and out of the way. All the while the gallbladder is becoming more scarred. Sometimes infection fills it with pus–a serious complication.

On occasion a stone will travel down the cystic duct into the common bile duct and get stuck there. This will back bile up into the liver as well as the gallbladder. If the stone sticks at the Ampulla of Vater, the pancreas will also be plugged and will develop **pancreatitis**. These stones can cause a lot of trouble.

Bile is composed of several waste products of metabolism, all of which are supposed to remain in liquid form. The complex chemistry of the liver depends on many chemical processes, which depend in turn upon the chemicals in the diet and the genes that direct those processes. There are greater variations in the output of chemical waste products than there is allowance for their cohabitation in the bile. Incompatible mixes result in the formation of solids.

Gallstones will cause the sudden onset of **pain** in the upper abdomen. Pain will last for 30 minutes to several hours. Pain may move to the right shoulder blade. **Nausea** with or without **vomiting** may accompany the pain.

Precautions

Individuals suffering from sickle cell anemia, children, and patients with large stones may seek other treatments.

Description

Laparoscopic cholecystectomy

Surgery to remove the entire gallbladder with all its stones is usually the best treatment, provided the patient is able to tolerate the procedure. Over the past decade, a new technique of removing the gallbladder using a laparoscope has resulted in quicker recovery and much smaller surgical incisions than the six-inch gash under the right ribs that used to be standard. Not everyone is a candidate for this approach.

If a stone is lodged in the bile ducts, additional surgery must be done to remove it. After surgery, the surgeon will ordinarily leave in a drain to collect bile until

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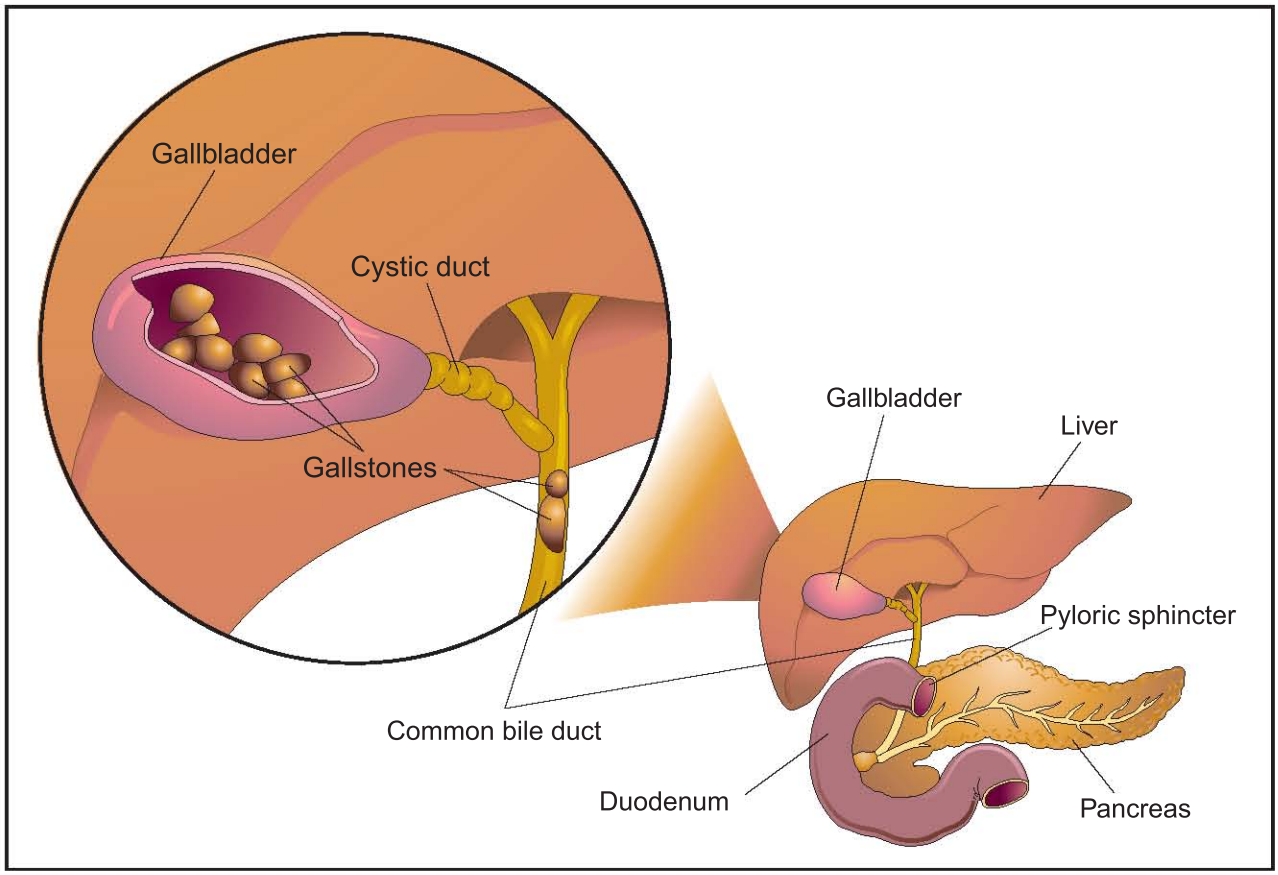

Gallstone removal, also known as cholelithotomy, usually involves the surgical removal of the entire gallbladder, but in recent years the procedure done by laparoscopy has resulted in smaller surgical incisions and faster recovery time. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

the system is healed. The drain can also be used to inject contrast material and take x rays during or after surgery.

Endoscopic retrograde cholangiopancreatoscopy (ERCP)

A procedure called endoscopic retrograde cholangiopancreatoscopy (ERCP) allows the removal of some bile duct stones through the mouth, throat, esophagus, stomach, duodenum, and biliary system without the need for surgical incisions. ERCP can also be used to inject contrast agents into the biliary system, providing superbly detailed pictures.

Cholelithotomy

Rare circumstances require different techniques. Patients too ill for a complete **cholecystectomy** (removal of the gallbladder), sometimes only the stones are removed, a procedure called cholelithotomy. But that does not cure the problem. The liver will go on making faulty bile, and stones will reform, unless the composition of the bile is altered.

Ursodeoxycholic acid

For patients who cannot receive the laparoscopic procedure, there is also a nonsurgical treatment in which ursodeoxycholic acid is used to dissolve the gallstones. Extracorporeal shock-wave **lithotripsy** has also been successfully used to break up gallstones. During the procedure, high-amplitude sound waves target the stones, slowly breaking them up.

Preparation

There are a number of imaging studies that identify gallbladder disease, but most gallstones will not show up on conventional x rays. That requires contrast agents given by mouth that are excreted into the bile. Ultrasound is very useful and can be enhanced by doing it through an endoscope in the stomach. CT (**computed tomography scans**) and MRI (**magnetic resonance**

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KEY TERMS

Cholecystectomy—Surgical removal of the gallbladder.

Cholelithotomy—Surgical incision into the gallbladder to remove stones.

Contrast agent—A substance that causes shadows on x rays (or other images of the body).

Endoscope—One of several instruments designed to enter body cavities. They combine viewing and operating capabilities.

Jaundice—A yellow color of the skin and eyes due to excess bile that is not removed by the liver.

Laparoscopy—Surgery through pencil-sized viewing instruments and tools so that incisions need be less than half an inch long.

imaging) scanning are not used routinely but are helpful in detecting common duct stones and complications.

Aftercare

Without a gallbladder, stones rarely reform. Patients who have continued symptoms after their gallbladder is removed may need an ERCP to detect residual stones or damage to the bile ducts caused by the stones before they were removed. Once in a while the Ampulla of Vater is too tight for bile to flow through and causes symptoms until it is opened up.

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J. Ricker Polsdorfer, MD

Gallstones

Definition

A gallstone is a solid crystal deposit that forms in the gallbladder, which is a pear–shaped organ that stores bile salts until they are needed to help digest fatty foods. Gallstones can migrate to other parts of the digestive tract and cause severe **pain** with life–threatening complications.

Demographics

Gallstones are the most common of all gallbladder problems. They are responsible for 90% of gallbladder and bile duct disease, and are the fifth most common reason for hospitalization of adults in the United States. Over half a million people per year in the United States develop symptoms of or complications from gallstones that require removal of the gallbladder.

Gallstones usually develop in adults between the ages of 20 and 50; about 20% of patients with gallstones are over 40. The risk of developing gallstones increases with age. At least 20% of people over 60 have a single large stone or as many as several thousand smaller ones. The gender ratio of gallstone patients changes with age. Young women are between two and six times as likely to develop gallstones as are men in the same age group. In patients over 50, the condition affects men and women with equal frequency. The lifetime risk for developing gallstones is 50% in women and about 30% in men. Mexican Americans and Native Americans develop gallstones more often than any other segment of the population.

Description

Gallstones vary in size and chemical structure. A gallstone may be as tiny as a grain of sand or as large as a golf ball. Eighty percent of gallstones are composed of cholesterol. They are formed when the liver produces more cholesterol than digestive juices can liquefy. The remaining 20% of gallstones are composed of **calcium** and an orange–yellow waste product called bilirubin. Bilirubin gives urine its characteristic color and sometimes causes **jaundice**.

Risk factors

Some risk factors associated with the development of cholesterol gall stones include:

- female gender
- increasing age
- Mexican or Native American ancestry
- history of multiple pregnancies
- conditions which result in gallbladder stasis (decreased movement or flow of bile in the gallbladder) such as rapid weight loss and high spinal cord injuries

Women who take oral birth control pills containing estrogen, women using other estrogen–dispensing birth control devices, and some men who are prescribed estrogen and/or estrogen–like drugs for the treatment of **prostate cancer** are also at high risk. Up to 25% of

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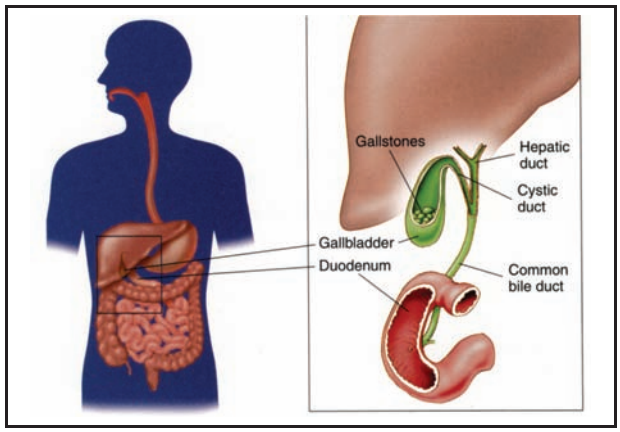

Gallstones form in the gallbladder but can migrate to other parts of the body via the bile duct. *(Illustration by Frank Forney. Reproduced by permission of Gale, a part of Cengage Learning.)*

people who develop gallstones develop the stones as a result of hereditary predisposition.

Definitions

Gallstones can cause several different disorders. Cholelithiasis is defined as the presence of gallstones within the gallbladder itself. Choledocholithiasis is the presence of gallstones within the common bile duct that leads into the first portion of the small intestine (the duodenum). The stones in the duct may have been formed inside it or carried there from the gallbladder. These gallstones prevent bile from flowing into the duodenum. Ten percent of patients with gallstones have choledocholithiasis, which is sometimes called common–duct stones. Patients who do not develop infection usually recover completely from this disorder.

Cholecystitis is a disorder marked by inflammation of the gallbladder. It is usually caused by the passage of a stone from the gallbladder into the cystic duct, which is a tube that connects the gallbladder to the common bile duct. In five to 10 percent of cases, however, cholecystitis develops in the absence of gallstones. This form of the disorder is called acalculous cholecystitis. Cholecystitis causes painful enlargement of the gallbladder and is responsible for 10–25% of all gallbladder surgery. Chronic cholecystitis is most common in the elderly. The acute form is most likely to occur in middle–aged adults.

Cholesterolosis or cholesterol polyps is characterized by deposits of cholesterol crystals in the lining of the gallbladder. This condition may be caused by high levels of cholesterol or inadequate quantities of bile salts, and is usually treated by surgery.

Gallstone **ileus**, which results from a gallstone's blocking the entrance to the large intestine, is most common in elderly people. Surgery usually cures this condition.

Narrowing (stricture) of the common bile duct develops in as many as five percent of patients whose gallbladders have been surgically removed. This condition is characterized by inability to digest fatty foods and by abdominal pain, which sometimes occurs in spasms. Patients with stricture of the common bile duct are likely to recover after appropriate surgical treatment.

Causes and symptoms

Gallstones are caused by an alteration in the chemical composition of bile. Bile is a digestive fluid that helps the body absorb fat. Gallstones tend to run in families. In addition, high levels of estrogen, insulin, or cholesterol can increase a person's risk of developing them.

Pregnancy or the use of birth control pills can slow down gallbladder activity and increase the risk of gallstones. So can diabetes, **pancreatitis**, and **celiac disease**. Other factors influencing gallstone formation are:

- infection
- obesity
- intestinal disorders
- coronary artery disease or other recent illness
- multiple pregnancies
- a high–fat, low–fiber diet
- smoking
- heavy drinking
- rapid weight loss

Gallbladder attacks usually follow a meal of rich, high–fat foods. The attacks often occur in the middle of the night, sometimes waking the patient with intense pain that ends in a visit to the emergency room. The pain of a gallbladder attack begins in the abdomen and may radiate to the chest, back, or the area between the shoulders. Other symptoms of gallstones include:

- inability to digest fatty foods
- low-grade fever
- chills and sweating
- nausea and vomiting
- indigestion
- gas
- belching
- clay-colored bowel movements

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KEY TERMS

Acalculous cholecystitis—Inflammation of the gallbladder that occurs without the presence of gallstones.

Bilirubin—A reddish–yellow waste product produced by the liver that colors urine and is involved in the formation of some gallstones.

Celiac disease—Inability to digest wheat protein (gluten), which causes weight loss, lack of energy, and pale, foul–smelling stools.

Cholecystectomy—Surgical removal of the gallbladder.

Cholecystitis—Inflammation of the gallbladder.

Choledocholithiasis—The presence of gallstones within the common bile duct.

Cholelithiasis—The presence of gallstones within the gallbladder.

Cholesterolosis—Cholesterol crystals or deposits in the lining of the gallbladder.

Common bile duct—The passage through which bile travels from the cystic duct to the small intestine.

Gallstone ileus—Obstruction of the large intestine caused by a gallstone that has blocked the intestinal opening.

Lithotripsy—A nonsurgical technique for removing gallstones by breaking them apart with high–frequency sound waves.

Diagnosis

Examination

Gallstones may be diagnosed by a family doctor, a specialist in digestive problems (a gastroenterologist), or a specialist in internal medicine. The doctor will first examine the patient's skin for signs of jaundice and feel (palpate) the abdomen for soreness or swelling.

Tests

After the basic **physical examination**, the doctor will order blood counts or blood chemistry tests to detect evidence of bile duct obstruction and to rule out other illnesses that cause **fever** and pain, including stomach ulcers, **appendicitis**, and heart attacks.

Procedures

More sophisticated procedures used to diagnose gallstones include:

- Ultrasound imaging. Ultrasound is noninvasive, has an accuracy (sensitivity) rate of 96% in detecting gallstones, and is the least expensive imaging technique.
- Cholecystography (cholecystogram, gallbladder series, gallbladder x ray). This type of study shows how the gallbladder contracts after the patient has eaten a high–fat meal.
- Fluoroscopy. This imaging technique allows the doctor to distinguish between jaundice caused by pancreatic cancer and jaundice caused by gallbladder or bile duct disorders.
- Endoscopy (ERCP). ERCP uses a special dye to outline the pancreatic and common bile ducts and locate the position of the gallstones.
- Radioisotopic scan. This technique reveals blockage of the cystic duct.

Treatment

Watchful waiting

One–third of all patients with gallstones never experience a second attack. For this reason many doctors advise watchful waiting after the first episode. Reducing the amount of fat in the diet or following a sensible plan of gradual weight loss may be the only treatments required for occasional mild attacks. A patient diagnosed with gallstones may be able to manage more troublesome episodes by:

- applying heat to the affected area
- resting and taking occasional sips of water
- using non–prescription forms of acetaminophen (Tylenol or Anacin–3)

A doctor should be notified if pain intensifies or lasts for more than three hours; if the patient's fever rises above 101°F (38.3°C); or if the skin or whites of the eyes turn yellow.

Surgery

Surgical removal of the gallbladder (**cholecystectomy**) is the most common conventional treatment for recurrent attacks. Laparoscopic surgery, the technique most widely used, is a safe, effective procedure that involves less pain and a shorter recovery period than traditional open surgery. In this technique, the

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doctor makes a small cut (incision) in the patient's abdomen and removes the gallbladder through a long tube called a laparoscope.

Nonsurgical approaches

Patients who are too ill for surgery may benefit from gradual medical dissolution therapy with ursodeoxycholic acid (ursodiol). This technique typically requires months of therapy before stones are dissolved.

Alternative treatment

Alternative therapies, like non–surgical treatments, may provide temporary relief of gallstone symptoms. Alternative approaches to the symptoms of gallbladder disorders include homeopathy, Chinese traditional herbal medicine, and **acupuncture**. Dietary changes may also help relieve the symptoms of gallstones. Since gallstones seem to develop more often in people who are obese, eating a balanced diet, exercising, and losing weight may help keep gallstones from forming.

Prognosis

Forty percent of all patients with gallstones have "silent gallstones" that produce no symptoms. Silent stones, discovered only when their presence is indicated by tests performed to diagnose other symptoms, do not require treatment.

Gallstone problems that require treatment can be surgically corrected. Although most patients recover, some develop infections that must be treated with **antibiotics**.

In rare instances, severe inflammation can cause the gallbladder to burst. The resulting infection can be fatal.

Prevention

The best way to prevent gallstones is to minimize risk factors. Obese adults who lose large amounts of weight very quickly including those who undergo **bariatric surgery** are at high risk for the development of gallstones. Prophylactic treatment with ursodeoxycholic acid may be prescribed in these situations.

Participation in regular **exercise** may decrease the probability of gallstone formation in some people.

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National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), Building 31, Room 9A06, 31 Center Drive, MSC 2560, Bethesda, MD, 20892–2560, (301) 496–3583, http://www.niddk.nih.gov.

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Gamete intrafallopian transfer *see* **Infertility therapies**

Gamma-glutamyl transferase test *see* **Liver function tests**

Gamma globulin

Definition

Gamma globulin is a type of protein found in the blood. When Gamma globulins are extracted from the blood of many people and combined, they can be used to prevent or treat infections.

Purpose

This medicine is used to treat or prevent diseases that occur when the body's own immune system is not effective against the disease. When disease-causing agents enter the body, they normally trigger the production of antibodies, proteins that circulate in the blood and help fight the disease. Gamma globulin contains some of these antibodies. When Gamma globulins are taken from the blood of people who have recovered from diseases such as **chickenpox** or hepatitis, they can be given to other people to make them temporarily immune to those diseases. With hepatitis, for example, this is done when someone who has not been vaccinated against hepatitis is exposed to the disease.

Some diseases or disorders that may require treatment with Gamma globulin include:

- skin diseases such as lupus erythematosus and scleroderma
- hematologic disorders such as idiopathic thrombocytopenia purpura (ITP)

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KEY TERMS

Hepatitis—Inflammation of the liver caused by a virus, chemical or drugs. There are several different types of hepatitis, including the most common forms: hepatitis A, hepatitis B, and hepatitis C.

Immune system—The body's natural defenses against disease and infection.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

- Kawasaki disease
- graft versus host disease associated with bone marrow, stem cell, and other transplant procedures

Description

Gamma globulin, also known as immunoglobulin, immune serum globulin or serum therapy, is injected either into a vein (the most common method) or into a muscle. When injected into a vein, it produces results more quickly than when injected into a muscle.

U.S. brand names

Some of the brand names of products that contain Gamma globulin and that are sold in the United States include:

- Gammagard S/D
- Gammar-IV
- Gamimmune-N
- Iveegam
- Polygam S/D
- Sandoglobulin
- Venoglobulin-I or Venoglobulin-S
- Carimune/Panglobulin
- Gamunex

Recommended dosage

Doses are different for different people and depend on the person's body weight and the condition for which he or she is being treated.

Precautions

Anyone who has had unusual reactions to Gamma globulin in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

Individuals who have a history of reactions to blood products or who have experienced a blood product **transfusion** reaction in the past should inform their health care providers prior to receiving Gamma globulin products.

People who have certain medical conditions may have problems if they take Gamma globulins. For example:

- Gamma globulins may worsen heart problems or deficiencies of immunoglobin A (IgA, a type of antibody.)
- Certain patients with low levels of Gamma globulins in the blood (conditions called aGamma globulinemia and hypoGamma globulinemia) may be more likely to have side effects when they take Gamma globulin.
- Patients receiving Gamma globulin who have a history of liver and/or kidney problems should be monitored closely while receiving this product.

Side effects

Minor side effects such as **headache**, backache, joint or muscle **pain**, and a general feeling of illness usually go away as the body adjusts to this medicine. These problems do not need medical attention unless they continue.

Other side effects, such as breathing problems or a fast or pounding heartbeat, should be brought to a physician's attention immediately.

Anyone who shows the following signs of overdose should check with a physician immediately:

- unusual tiredness or weakness
- dizziness
- nausea
- vomiting
- fever
- chills
- tightness in the chest
- red face
- sweating

Interactions

Anyone who takes Gamma globulin should let the physician know all other medicines he or she is taking and should ask whether interactions with Gamma globulin could interfere with treatment.

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Resources

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Gamma knife surgery

Definition

Gamma knife surgery, also referred to as stereotactic radiosurgery, utilizes intersecting radiation beams targeted to a specific location in the brain to treat brain tumors and other abnormalities within the brain. Despite the name, no surgical incisions are required with this type of procedure.

Purpose

Gamma Knife radiosurgery is used to treat benign and malignant brain tumors which are considered to be inoperable because of their location in the brain which makes them inaccessible to conventional surgical approaches. This type of radiosurgery is also effective in treating **cancer** which has spread or metastasized to the brain.

Gamma Knife surgery can also be used to treat many conditions including the following:

- tumors of the pituitary gland which are located deep in brain tissue
- benign tumors such as schwannomas or acoustic neuromas which affect the acoustic nerve and can lead to problems with balance and hearing if left untreated
- trigeminal neuralgia, a condition which causes severe facial pain
- arteriovenous malformations (AVMs), a condition in which abnormal veins and arteries connect directly to each other rather than through the normal anatomic network of smaller blood vessels known as capillaries

Gamma Knife surgery is also increasingly used to treat patients with tumors in areas other than the brain. Recent studies report the effectiveness of this technology on the treatment of inoperable lung tumors and in the treatment of cancers of the head and neck.

Demographics

According to the manufacturer, the number of patients treated with Gamma Knife surgery has increased by more than 300% over the past five years and more than 500,000 people have received treatment utilizing this technology to date. There are over 125 Gamma Knife treatment centers in the United States.

Description

Gamma Knife technology was developed in the 1950s by Dr. Lars Leksell, a Swedish professor of **neurosurgery**, and radiation biologist, Borje Larsson, who pioneered the use of radiation beams in combination with stereotactic or precise guiding devices that could focus the beams with surgical precision. Thus, the term stereotactic (guided) radio(radiation) surgery was coined. In 1967, the first Gamma Knife device, which used cobalt–60 as the radiation source, was constructed. Gamma Knife technology became available in the United States in 1987.

Current Gamma Knife technology utilizes cobalt–60 photon radiation to deliver the radiation dose to targeted areas within the brain with pinpoint accuracy while sparing adjacent normal tissue from the deleterious effects of radiation. The radiation dose is calculated specifically for each patient taking into account tumor type, tumor shape, and tumor location including tumor depth. The precise dose to be delivered is determined based on the results of highly sophisticated imaging tests such as angiograms, **magnetic resonance imaging** (MRI), and/or computed tomography (CT) scans. Currently, most neurosurgeons use one MRI scan to determine the area to be treated. The results of these imaging tests are then placed into dose planning software which can model the affected area in 3 dimensions. The specific dose, individualized for each patient, is based on the results obtained from the treatment planning software, and is calculated by a radiation oncologist and a medical physicist.

Despite being called surgery, no actual surgery and no blade or knife is involved in the treatment process. There is no incision made in Gamma Knife surgery and no brain tissue is removed from the body. Radiation, delivered by a machine, is targeted into the affected brain tissue while sparing adjacent normal tissue.

Each Gamma Knife treatment unit can store 200 sources of cobalt–60 radiation. Thousands of radiation beams can then be generated from these sources and targeted to the area of the brain to be treated.

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KEY TERMS

Benign—Not cancerous.

Malignant—Cancerous.

Radiosurgery—Precise delivery of a large dose of radiation to a targeted area within the brain.

Stereotactic—Precise guidance or positioning.

Each individual beam does not contain enough energy to harm normal tissue as it passes through brain tissue to reach the target. However, when all of the beams intersect and converge on the target, the combined effect of the energy in all of the radiation beams is powerful enough to treat the tissue in the area. According to the manufacturer, by keeping the patient immobilized during the actual treatment in combination with using three–dimensional treatment planning that is computer–aided, the radiation dose can be targeted with such precision that the level of accuracy is about one–tenth of one millimeter, which is about the thickness of an individual strand of human hair. The end result is that the calculated radiation dose reaches the targeted tissue, adjacent normal tissue is spared and the entire process is accomplished in a single treatment session.

Preparation

Unlike other **radiation therapy** procedures which may require multiple daily treatment visits, treatment using Gamma Knife technology is typically completed in one visit to the treatment center and is done on an outpatient basis. The patient will be asked not to consume food or water past midnight the night before the procedure is scheduled. Patients should ask their physicians if they may consume a small amount of water with their medications, however. Patients should inform the physician if they are taking oral medications or insulin to control diabetes.

Patients will also be asked if they are allergic to shellfish or iodine in anticipation of radiologic imaging techniques they will undergo as part of the treatment planning process. Patients should inform the staff if they have any implanted medical devices such as **pacemakers**, cardiac stents, artificial heart valves and other similar devices.

The staff at most treatment facilities will instruct the patient not to wear jewelry or makeup, including nail polish, on the day of the procedure. Once the treatment planning process begins the patient will be asked to remove eyeglasses, **contact lenses**, dentures, and wigs.

Preparation for treatment involves application of a stereotactic head frame. The frame, which is comprised of lightweight aluminum material, is attached to the head using four screws after **local anesthesia** is applied to the sites where the screws will be inserted. The primary purpose of the head frame is to allow for the precise targeting of the area within the brain which is to be treated. Hair will not be cut or shaved to position the head frame. The frame is designed to limit movement during radiologic imaging procedures such as magnetic resonance imaging (MRI) and/or computed tomography (CT) scanning and during the actual treatment process. An angiogram may also be required depending on the particular condition being treated. During the imaging process, a device called a coordinate box is affixed to the head frame. The coordinate box provides reference points on the images to facilitate development of a treatment plan. The time needed to secure the head frame and to complete the imaging tests, which are part of the treatment planning process, typically takes several hours. Results of the imaging tests are directed to a computerized planning system. The patient is allowed to rest while the treatment plan is being individualized and customized for that specific patient, however the head frame must remain attached during this time.

Once treatment planning is complete, the actual treatment begins. The patient remains awake during treatment and may be able to listen to music during the procedure. The actual treatment may take a few minutes or more than an hour depending on the size, location, and configuration of the area in the brain being targeted for treatment. The patient can communicate with the staff during the treatment if necessary and will be monitored at all times with audio and video monitoring.

While wearing the head frame which is then attached to a helmet located inside the treatment machine, the patient is positioned on a movable treatment table. The treatment table moves into a section of the treatment machine that is shaped like a dome. The patient may not know unless told that the treatment has started because the treatment itself is silent and does not cause **pain** nor is the patient able to feel any radiation.

Aftercare

Once the treatment is completed, the head frame is removed and the patient may be allowed to go home. Patients who have undergone **angiography** may have to lie still and remain at the treatment center for

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several hours to ensure that bleeding from the angiogram catheter entry and exit site does not occur and that swelling at the site is minimized. Rarely, some patients may have to be monitored overnight.

Some individuals may experience minor **headache** and pain at the site on the scalp where the head frame was affixed. Some patients may also experience minor swelling at the site. The effects from the actual radiation treatment are not immediate and may not be felt for weeks, months, or longer after the treatment. Most individuals can return to their regular routine in one to two days after treatment.

After the procedure, some patients may experience swelling in brain tissue adjacent to the area being treated. The swelling can usually be controlled with oral **steroids**.

Follow–up care usually involves additional images of the area which can be obtained by angiography, MRI, and/or CT scans. The results of these imaging studies are compared to the studies done before the procedure to determine whether the stereotactic radiosurgery procedure was effective.

Risks

Due to the noninvasive nature of this procedure, there are minimal risks involved with Gamma Knife surgery. Some patients, especially pediatric patients, may require **sedation** and/or anesthesia to complete the treatment planning process and the actual treatment. Rarely, a small number of these patients may experience side–effects and risks associated with sedation and/or anesthesia.

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International Radiosurgery Association, 2002 N. 2nd Street, Harrisburg, PA, 17110, (717) 260-9809, http://www.irsa.org.

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Ganglion

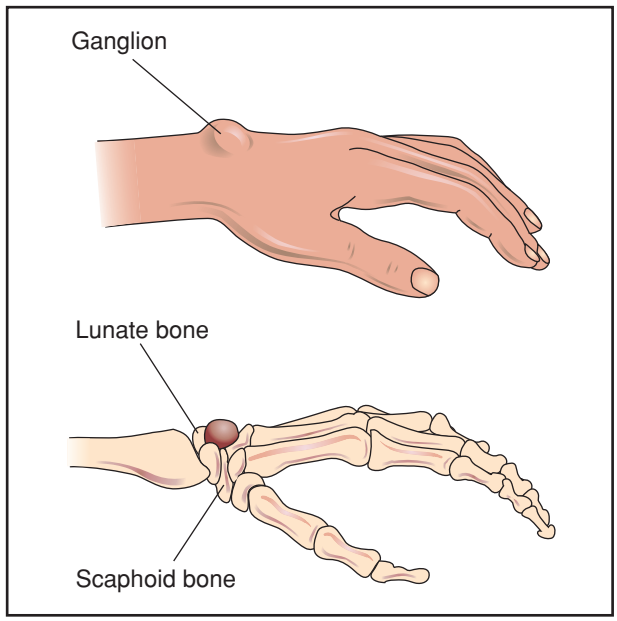
Definition

A ganglion is a small, usually hard bump above a tendon or in the capsule that encloses a joint. A ganglion is also called a synovial **hernia** or synovial cyst.

Description

A ganglion is a non-cancerous cyst filled with a thick, jelly-like fluid. Ganglions can develop on or beneath the surface of the skin and usually occur between the ages of 20 and 40.

Most ganglions develop on the hand or wrist. This condition is common in people who bowl or who play handball, raquetball, squash, or tennis. Runners and



A ganglion is a non-cancerous cyst filled with a thick, jelly-like fluid. Ganglions can develop on or beneath the surface of the skin, most likely on the hand or wrist, although runners and skiers often develop them on the foot. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

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athletes who jump, ski, or play contact sports often develop foot ganglions.

Causes and symptoms

Mild sprains or other repeated injuries can irritate and tear the thin membrane covering a tendon, causing fluid to leak into a sac that swells and forms a ganglion.

Ganglions are usually painless, but range of motion may be impaired. Flexing or bending the affected area can cause discomfort, as can continuing to perform the activity that caused the condition.

Cysts on the surface of the skin usually develop slowly but may result from injury or severe strain. An internal ganglion can cause soreness or a dull, aching sensation, but the mass cannot always be felt. Symptoms sometimes become evident only when the cyst causes pressure on a nerve or outgrows the membrane surrounding it.

Diagnosis

Diagnosis is usually made through **physical examination** as well as such imaging studies as x ray, ultrasound, and **magnetic resonance imaging** (MRI). Fluid may be withdrawn from the cyst and evaluated.

Treatment

Some ganglions disappear without treatment, and some reappear despite treatment.

Acetaminophen (Tylenol) or other over-the-counter **analgesics** can be used to control mild **pain**. **Steroids** or local anesthetics may be injected into cysts that cause severe pain or other troublesome symptoms. Surgery performed in a hospital operating room or an outpatient facility, is the only treatment guaranteed to remove a ganglion. The condition can recur if the entire cyst is not removed.

A doctor should be notified if the surgical site drains, bleeds, or becomes

- inflamed
- painful
- swollen or if the patient feels ill or develops:
- head or muscle aches
- dizziness
- fever following surgery

The patient may bathe or shower as usual, but should keep the surgical site dry and covered with a bandage for two or three days after the operation. Patients may resume normal activities as soon as they feel comfortable doing so.

Prognosis

Possible complications include excessive post-operative bleeding and infection of the surgical site. Calcification, or hardening, of the ganglion is rare.

Prevention

Exercises that increase muscle strength and flexibility can prevent ganglions. Warming and cooling down before and after workouts may also decrease the rate of developing ganglions.

Resources

OTHER

"Ganglion Cysts." American Society for Surgery of the Hand. (Accessed November 21, 2010). http://www. assh.org/Public/HandConditions/Pages/GanglionCysts.aspx.

Maureen Haggerty

Gangrene

Definition

Gangrene is the term used to describe the decay or **death** of an organ or tissue caused by a lack of blood supply. It is a complication resulting from infectious or inflammatory processes, injury, or degenerative changes associated with chronic diseases, such as **diabetes mellitus**.

Description

Gangrene may be caused by a variety of chronic diseases and post–traumatic, post–surgical, and

A close-up of gangrene in the toes of a diabetic patient. *(Photo Researchers, Inc.)*

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spontaneous causes. There are three major types of gangrene: dry, moist, and gas (a type of moist gangrene).

Dry gangrene is a condition that results when one or more arteries become obstructed. In this type of gangrene, the tissue slowly dies, due to receiving little or no blood supply, but does not become infected. The affected area becomes cold and black, begins to dry out and wither, and eventually drops off over a period of weeks or months. Dry gangrene is most common in persons with advanced blockages of the arteries (arteriosclerosis) resulting from diabetes.

Moist gangrene may occur in the toes, feet, or legs after a crushing injury or as a result of some other factor that causes blood flow to the area to stop suddenly. When blood flow ceases, bacteria begin to invade the muscle and thrive, multiplying quickly without interference from the body's immune system.

Gas gangrene, also called myonecrosis, is a type of moist gangrene that is commonly caused by bacterial infection by *Clostridium welchii, Cl. perfringes, Cl. septicum, Cl. novyi, Cl. histolyticum, Cl. sporogenes*, or other species that are capable of thriving under conditions where there is little oxygen (anaerobic conditions). Once present in tissue, these bacteria produce gasses and toxins as they grow. Normally inhabiting the gastrointestinal, respiratory, and female genital tract, they often infect thigh **amputation wounds**, especially in those individuals who have lost control of their bowel functions (incontinence). Gangrene, incontinence, and debility often occur together in patients with diabetes, and it is in the amputation stump of diabetic patients that gas gangrene is often found to occur.

Other causative organisms for moist gangrene include various bacterial strains, including those of the *Streptococcus* and *Staphylococcus* genera. A serious, but rare form of infection with Group A *Streptococcus* can impede blood flow and, if untreated, can progress to synergistic gangrene, more commonly called necrotizing fasciitis, or infection of the skin and tissues directly beneath the skin.

Chronic diseases, such as diabetes mellitus, arteriosclerosis, or diseases affecting the blood vessels, such as **Buerger's disease** or Raynaud's disease, can cause gangrene. Post–traumatic causes of gangrene include compound fractures, **burns**, and injections given under the skin or in a muscle. Gangrene may occur following surgery, particularly in individuals with diabetes mellitus or other long–term (chronic) disease. In addition, gas gangrene can be also be a complication of dry gangrene or occur spontaneously in association with an underlying **cancer**.

In the United States, approximately 50% of moist gangrene cases are the result of a severe traumatic injury, and 40% occur following surgery. Car and industrial accidents, crush injuries, and gunshot wounds are the most common traumatic causes. Because of prompt surgical management of wounds with the removal of dead tissue, the incidence of gangrene from trauma has significantly diminished. Surgeries involving the bile ducts or intestine are the most frequent procedures causing gangrene. Approximately two–thirds of cases affect the extremities, and the remaining one–third involve the abdominal wall.

Symptoms

Areas of either dry or moist gangrene are initially characterized by a red line on the skin that marks the border of the affected tissues. As tissues begin to die, dry gangrene may cause some **pain** in the early stages or may go unnoticed, especially in the elderly or in those individuals with diminished sensation to the affected area. Initially, the area becomes cold, numb, and pale before later changing in color to brown, then black. This dead tissue will gradually separate from the healthy tissue and fall off.

Moist gangrene and gas gangrene are distinctly different. Gas gangrene usually involves muscle, rather than skin. In moist or gas gangrene, there is a sensation of heaviness in the affected region that is followed by severe pain. The pain is caused by swelling resulting from fluid or gas accumulation in the tissues. This pain peaks, on average, between one to four days following the injury, with a range of eight hours to several weeks. The swollen skin may initially be blistered, red, and warm to the touch before progressing to a bronze, brown, or black color. In approximately 80% of cases, the affected and surrounding tissues may produce crackling sounds (crepitus), as a result of gas bubbles accumulating under the skin. The gas may be felt beneath the skin (palpable). In wet gangrene, the pus is foul–smelling, while in gas gangrene, there is no true pus, just an almost "sweet" smelling watery discharge.

Fever, rapid heart rate, rapid breathing, altered mental state, loss of appetite, **diarrhea**, **vomiting**, and vascular collapse may also occur if bacterial toxins are allowed to spread in the bloodstream. Gas gangrene can be a life–threatening condition and should receive prompt medical attention

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KEY TERMS

Aerobic—Organism that grows and thrives only in environments containing oxygen.

Anaerobic—Organism that grows and thrives in an oxygen–free environment.

Arteriosclerosis—Build–up of fatty plaques in arteries that can lead to the obstruction of blood flow.

Aseptic—Without contamination by bacteria or other microorganisms.

Crepitus—A crackling sound.

Gram stain—A staining procedure used to visualize and classify bacteria. The Gram stain procedure allows the identification of purple (Gram positive) organisms and red (Gram negative) organisms.

Hyperbaric oxygen—Medical treatment in which oxygen is administered in specially designed chambers, under pressures greater than that of the atmosphere, in order to treat specific medical conditions.

Incontinence—A condition characterized by the inability to control urination or bowel functions.

Myonecrosis—The destruction or death of muscle tissue.

Sepsis—The spreading of an infection in the bloodstream.

Thrombosis—The formation of a blood clot in a vein or artery that may obstruct local blood flow or may dislodge, travel downstream, and obstruct blood flow at a remote location.

Diagnosis

A diagnosis of gangrene will be based on a combination of patient history, a **physical examination**, and results of blood and other laboratory tests. A physician will look for a history of recent trauma, surgery, cancer, or chronic disease. Blood tests will be used to determine whether infection is present and determine the extent to which an infection has spread.

A sample of drainage from a wound, or obtained through surgical exploration, may be cultured with oxygen (aerobic) and without oxygen (anaerobic) to identify the microorganism causing the infection and to aid in determining which antibiotic will be most effective. The sample obtained from a person with gangrene will contain few, if any, white blood cells and, when stained (with Gram stain) and examined under the microscope, will show the presence of purple (Gram positive), rod–shaped bacteria.

X–ray studies and more sophisticated imaging techniques, such as computed tomography scans (CT) or **magnetic resonance imaging** (MRI), may be helpful in making a diagnosis since gas accumulation and muscle death (myonecrosis) may be visible. These techniques, however, are not sufficient alone to provide an accurate diagnosis of gangrene.

Precise diagnosis of gas gangrene often requires surgical exploration of the wound. During such a procedure, exposed muscle may appear pale, beefy–red, or in the most advanced stages, black. If infected, the muscle will fail to contract with stimulation, and the cut surface will not bleed.

Treatment

Gas gangrene is a medical emergency because of the threat that infection will spread rapidly via the bloodstream and infect vital organs. It requires immediate surgery and administration of **antibiotics**.

Areas of dry gangrene that remain free from infection (aseptic) in the extremities are most often left to wither and fall off. Treatments applied to the wound externally (topically) are generally not effective without adequate blood supply to support wound healing. Assessment by a vascular surgeon, along with x rays to determine blood supply and circulation to the affected area, can help determine whether surgical intervention would be beneficial.

Once the causative organism has been identified, moist gangrene requires the prompt initiation of intravenous, intramuscular, and/or topical broad–spectrum antibiotic therapy. In addition, the infected tissue must be removed surgically (**debridement**), and amputation of the affected extremity may be necessary. Pain medications (**analgesics**) are prescribed to control discomfort. Intravenous fluids and, occasionally, blood transfusions are indicated to counteract **shock** and replenish red blood cells and electrolytes. Adequate hydration and **nutrition** are vital to wound healing.

Although still controversial, some cases of gangrene are treated by administering oxygen under pressure greater than that of the atmosphere (hyperbaric) to the patient in a specially designed chamber. The theory behind using hyperbaric oxygen is that more oxygen

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will dissolve in the patient's bloodstream, and therefore, more oxygen will be delivered to the gangrenous areas. By providing optimal oxygenation, the body's ability to fight off bacterial infection are believed to be improved, and there is a direct toxic effect on bacteria that thrive in an oxygen–free environment. Some studies have shown that the use of hyperbaric oxygen produces marked pain relief, reduces the number of amputations required, and reduces the extent of surgical debridement required. Patients receiving hyperbaric oxygen treatments must be monitored closely for evidence of oxygen toxicity. Symptoms of this toxicity include slow heart rate, profuse sweating, ringing in the ears, shortness of breath, **nausea and vomiting**, twitching of the lips/cheeks/eyelids/nose, and convulsions.

The emotional needs of the patient must also be met. The individual with gangrene should be offered moral support, along with an opportunity to share questions and concerns about changes in body image. In addition, particularly in cases where amputation was required, physical, vocational, and rehabilitation therapy will also be required.

Prognosis

Except in cases where the infection has been allowed to spread through the blood stream, prognosis is generally favorable. Anaerobic wound infection can progress quickly from initial injury to gas gangrene within one to two days, and the spread of the infection in the blood stream is associated with a 20–25% mortality rate. If recognized and treated early, however, approximately 80% of those with gas gangrene survive, and only 15–20% require any form of amputation. Unfortunately, the individual with dry gangrene often has multiple other health problems that complicate recovery, and it is usually those other system failures that can prove fatal.

Prevention

Patients with diabetes or severe arteriosclerosis should take particular care of their hands and feet because of the risk of infection associated with even a minor injury. Education about proper **foot care** is vital. Diminished blood flow as a result of narrowed vessels will not lessen the body's defenses against invading bacteria. Measures taken towards the reestablishment of circulation are recommended whenever possible. Any abrasion, break in the skin, or infected tissue should be cared for immediately. Any dying or infected skin must be removed promptly to prevent the spread of bacteria.

Penetrating abdominal wounds should be surgically explored and drained, any tears in the intestinal walls closed, and antibiotic treatment begun early. Patients undergoing elective intestinal surgery should receive preventive antibiotic therapy. Use of antibiotics prior to and directly following surgery has been shown to significantly reduce the rate of infection from 20–30% to four to eight percent.

Resources

BOOKS

Holt, Tim, and Sudhesh Kumar. *ABC of Diabetes (ABC Series)*, 6th ed. Hoboken, NJ: BMJ Books, 2010.

Murray, Craig, editor. *Amputation, Prosthesis Use, and Phantom Limb Pain: An Interdisciplinary Perspective*. New York, NY: Springer, 2009.

Pierce, Dino Paul. *The Diabetes Handbook: Create Awareness and a New You*. Charleston, SC: CreateSpace, 2009.

Vaughn, Richard, A. *Beating The Odds: 64 Years of Diabetes Health*. Charleston, SC: CreateSpace, 2010.

ORGANIZATIONS

American Diabetes Association, 1701 North Beauregard St., Alexandria, VA, 22311, (800) DIABETES (800–342–2383), http://www.diabetes.org.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Rd., Atlanta, GA, 30333, (404) 498–1515, (800) 311–3435, http://www.cdc.gov.

Center for Disability Information and Referral, Indiana Institute on Disability and Community, 2853 East Tenth St., Bloomington, IN, 47408–2696, (812) 855–9396, http://www.iidc.indiana.edu/cedir.

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Gas embolism

Definition

Gas **embolism**, also called air embolism, is the presence of gas bubbles in the bloodstream that obstruct circulation.

Description

Gas embolism may occur with decompression from increased pressure; it typically occurs in ascending divers who have been breathing compressed air. If a diver does not fully exhale upon ascent, the air in the lungs expands as the pressure decreases, overinflating the lungs and forcing bubbles of gas (emboli) into the bloodstream. When gas emboli reach the arteries to the brain, the blood blockage causes unconsciousness.

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KEY TERMS

Compressed air—Air that is held under pressure in a tank to be breathed underwater by divers. A tank of compressed air is part of a diver's scuba (self-contained underwater breathing apparatus) gear.

Compression—An increase in pressure from the surrounding water that occurs with increasing diving depth.

Decompression—A decrease in pressure from the surrounding water that occurs with decreasing diving depth.

Emboli—Plural of embolus. An embolus is something that blocks the blood flow in a blood vessel. It may be a gas bubble, a blood clot, a fat globule, a mass of bacteria, or other foreign body. It usually forms somewhere else and travels through the circulatory system until it gets stuck.

Hyperbaric chamber—A sealed compartment in which patients are exposed to controlled pressures up to three times normal atmospheric pressure. Hyperbaric treatment may be used to regulate blood gases, reduce gas emboli, and provide higher levels of oxygen more quickly in cases of severe gas poisoning.

Recompression—Restoring the elevated pressure of the diving environment to treat gas embolism by decreasing bubble size.

Gas embolism is second only to drowning as a cause of **death** among divers.

Gas embolism may also result from trauma or medical procedures such as catheterization and open heart surgery that allow air into the circulatory system.

Causes and symptoms

Gas embolism occurs independent of diving depth; it may occur in as little as 6 ft of water. It is frequently caused by a diver holding his breath during ascent. It may also result from an airway obstruction or other condition that prevents a diver from fully exhaling.

The primary sign of gas embolism is immediate loss of consciousness; it may or may not be accompanied by convulsions.

Diagnosis

Any unconscious diver should be assumed to be the victim of gas embolism, regardless of whether consciousness was lost during or promptly after ascent. A doctor may also find pockets of air in the chest around the lungs and sometimes a collapsed lung from overinflation and rupture. Coughing up blood or a bloody froth around the mouth are visible signs of lung injury.

Treatment

Prompt **recompression treatment** in a hyperbaric (high-pressure) chamber is necessary to deflate the gas bubbles in the bloodstream, dissolve the gases into the blood, and restore adequate oxygenated blood flow to the brain and other organs. Recompression by returning the diver to deeper water will not work, and should not be attempted. The patient should be kept lying down and given oxygen while being transported for recompression treatment.

Before the diver receives recompression treatment, other lifesaving efforts may be necessary. If the diver isn't breathing, artificial respiration (also called mouth-to-mouth resuscitation or rescue breathing) should be administered. In the absence of a pulse, **cardiopulmonary resuscitation** (CPR) must be performed.

Prognosis

The prognosis is dependent upon the promptness of recompression treatment and the extent of the damage caused by oxygen deprivation.

Prevention

All divers should receive adequate training in the use of compressed air and a complete evaluation of fitness for diving. People with a medical history of lung cysts or spontaneous collapsed lung (**pneumothorax**), and those with active **asthma** or other lung disease must not dive, for they would be at extreme risk for gas embolism. Patients with conditions such as **alcoholism** and drug abuse are also discouraged from diving. Individuals with certain other medical conditions such as diabetes may be able to dive safely with careful training and supervision.

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ORGANIZATIONS

American College of Hyperbaric Medicine, 9875 South Franklin Drive, Suite 300, Franklin, Wisconsin, 53132, (414) 385-2943, (414) 385-8721, http://www.achm.org.

Divers Alert Network, 6 West Colony Place, Durham, NC, 27705, (919) 684-2948, (919) 490-6630, (800) 446-2671, http://www.diversalertnetwork.org.

Undersea and Hyperbaric Medical Society, 21 West Colony Place, Suite 280, Durham, NC, 27705, (919) 490-5140, (919) 490-5149, (877) 533-UHMS (8467), uhms@uhms@org, http://www.uhms.org.

Bethany Thivierge

Gas gangrene *see* **Gangrene**

Gastrectomy

Definition

Gastrectomy is the surgical removal of all or part of the stomach.

Purpose

Gastrectomy is performed for several reasons, most commonly to remove a malignant tumor or to cure a perforated or bleeding stomach ulcer.

Description

Gastrectomy for cancer

Removal of the tumor, often with removal of surrounding lymph nodes, is the only curative treatment for various forms of gastric (stomach) **cancer**. For many patients, this entails removing not just the tumor but part of the stomach as well. The extent to which lymph nodes should also be removed is a subject of some debate, but some studies show additional survival benefit associated with removal of a greater number of lymph nodes.

Gastrectomy, either total or subtotal (also called partial), is the treatment of choice for gastric adenocarcinomas, primary gastric lymphomas (originating in the stomach), and the rare leiomyosarcomas (also called gastric **sarcomas**). Adenocarcinomas are by far the most common form of **stomach cancer** and are less curable than the relatively uncommon lymphomas, for which gastrectomy offers good odds for survival.

After gastrectomy, the surgeon may "reconstruct" the altered portions of the digestive tract so that it continues to function. Several different surgical techniques are used, but, generally speaking, the surgeon attaches any remaining portion of the stomach to the small intestine.

Gastrectomy for gastric cancer is almost always done by the traditional "open" surgery technique, which requires a wide incision to open the abdomen. However, some surgeons use a laparoscopic technique that requires only a small incision. The laparoscope is connected to a tiny video camera that projects a picture of the abdominal contents onto a monitor for the surgeon's viewing. The stomach is operated on through this incision.

The potential benefits of laparoscopic surgery include less postoperative **pain**, decreased hospitalization, and earlier return to normal activities. The use of laparoscopic gastrectomy is limited, however. Only patients with early stage gastric cancers or those whose surgery is only intended for palliation—pain and symptomatic relief rather than cure—should be considered for this minimally invasive technique. It can only be performed by surgeons experienced in this type of surgery.

Gastrectomy for ulcers

Gastrectomy is also occasionally used in the treatment of severe peptic ulcer disease or its complications. While the vast majority of peptic ulcers (gastric ulcers in the stomach or duodenal ulcers in the duodenum) are managed with medication, partial gastrectomy is sometimes required for peptic ulcer patients who have complications. These include patients who do not respond satisfactorily to medical therapy, those who develop a bleeding or perforated ulcer, and those who develop pyloric obstruction, a blockage to the exit from the stomach.

The surgical procedure for severe ulcer disease is also called an antrectomy, a limited form of gastrectomy in which the antrum, a portion of the stomach, is removed. For duodenal ulcers, antrectomy may be combined with other surgical procedures that are aimed at reducing the secretion of gastric acid, which is associated with ulcer formation. This additional surgery is commonly a **vagotomy**, surgery on the vagus nerve that disables the acid-producing portion of the stomach.

Preparation

Before undergoing gastrectomy, patients may need a variety of tests, such as x rays, **computed tomography**

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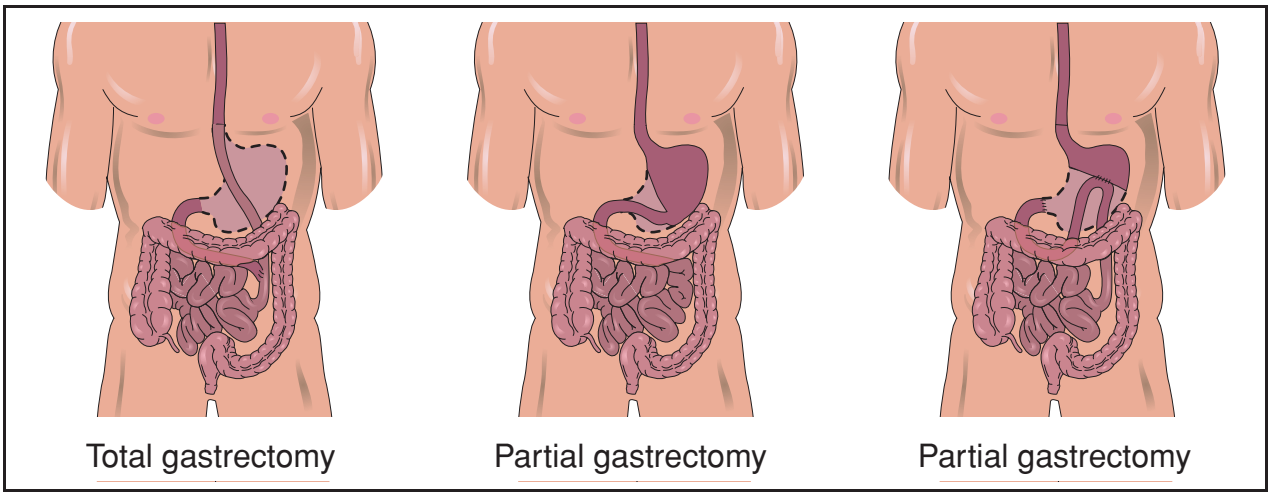

Gastrectomy, the surgical removal of all or part of the stomach, is performed primarily to remove a malignant tumor or to cure a bleeding stomach ulcer. Following the gastrectomy, the surgeon may reconstruct the altered portions of the digestive tract so that it continues to function. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

scans (CT scans), ultrasonography, or endoscopic biopsies (microscopic examination of tissue), to assure the diagnosis and localize the tumor or ulcer. **Laparoscopy** may be done to diagnose a malignancy or to determine the extent of a tumor that is already diagnosed. When a tumor is strongly suspected, laparoscopy is often performed immediately before the surgery to remove the tumor; this avoids the need to anesthetize the patient twice and sometimes avoids the need for surgery altogether if the tumor found on laparoscopy is deemed inoperable.

Aftercare

It is important to follow any instructions that have been given for postoperative care. Major surgery usually requires a recuperation time of several weeks.

Risks

Surgery for peptic ulcer is effective, but it may result in a variety of postoperative complications. After gastrectomy, as many as 30% of patients have significant symptoms. An operation called highly selective vagotomy is now preferred for ulcer management, and is safer than gastrectomy.

After a gastrectomy, several abnormalities may develop that produce symptoms related to food intake. This happens largely because the stomach, which serves as a food reservoir, has been reduced in its capacity by the surgery. Other surgical procedures that often accompany gastrectomy for ulcer disease can also contribute to later symptoms: vagotomy, which lessens acid production and slows stomach emptying, and **pyloroplasty**, which enlarges the opening between the stomach and small intestine to facilitate emptying of the stomach.

Some patients experience light-headedness, heart **palpitations** or racing heart, sweating, and **nausea and vomiting** after a meal. These may be symptoms of "dumping syndrome," as food is rapidly "dumped" into the small intestine from the stomach. This is treated by adjusting the diet and pattern of eating, for example, eating smaller, more frequent meals, and limiting liquids.

Patients who have abdominal bloating and pain after eating, frequently followed by **nausea and vomiting**, may have what is called the afferent loop syndrome. This is treated by surgical correction. Patients who have early satiety (feeling of fullness after eating), abdominal discomfort, and **vomiting** may have bile reflux **gastritis** (also called bilious vomiting), which is also surgically correctable. Many patients also experience weight loss.

Reactive **hypoglycemia** is a condition that results when blood sugar becomes too high after a meal, stimulating the release of insulin, about two hours after eating. A high-protein diet and smaller meals are advised.

Ulcers recur in a small percentage of patients after surgery for peptic ulcer, usually in the first few years. Further surgery is usually necessary.

Vitamin and mineral supplementation is necessary after gastrectomy to correct certain deficiencies, especially vitamin B_{12}, iron, and folate. Vitamin D and **calcium** are also needed to prevent and treat the bone problems that often occur. These include softening

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KEY TERMS

Antrectomy—A surgical procedure for ulcer disease in which the antrum, a portion of the stomach, is removed.

Laparoscopy—The examination of the inside of the abdomen through a lighted tube, sometimes accompanied by surgery.

and bending of the bones, which can produce pain, and **osteoporosis**, a loss of bone mass. According to one study, the risk for spinal **fractures** may be as high as 50% after gastrectomy.

Depending on the extent of surgery, the risk for post-operative **death** after gastrectomy for gastric cancer has been reported as 1–3% and the risk of non-fatal complications as 9–18%.

Normal results

Overall survival after gastrectomy for gastric cancer varies greatly by the stage of disease at the time of surgery. For early gastric cancer, the five-year survival rate is up to 80–90%; for late-stage disease, the prognosis is bad. For gastric adenocarcinomas that are amenable to gastrectomy, the five-year survival rate is 10–30%, depending on the location of the tumor. The prognosis for patients with gastric lymphoma is better, with five-year survival rates reported at 40–60%.

Most studies have shown that patients can have an acceptable quality of life after gastrectomy for a potentially curable gastric cancer. Many patients will maintain a healthy appetite and eat a normal diet. Others may lose weight and not enjoy meals as much. Some studies show that patients who have total gastrectomies have more disease-related or treatment-related symptoms after surgery and poorer physical function than patients who have subtotal gastrectomies. There does not appear to be much difference, however, in emotional status or social activity level between patients who have undergone total versus subtotal gastrectomies.

Resources

BOOKS

Sleisenger, Marvin H., et al. *Sleisenger & Fordtran's Gastrointestinal and Liver Disease: Pathophysiology, Diagnosis, Management*. St. Louis, Mo.: MD Consult, 2009.

Caroline A. Helwick

Gastric acid determination

Definition

Gastric acid determination, also known as stomach acid determination, gastric analysis, or basal gastric secretion, is a procedure to evaluate gastric (stomach) function. The test specifically determines the presence of gastric acid, as well as the amount of gastric acid secreted. It is often done in conjunction with the gastric acid stimulation test, a procedure that measures gastric acid output after injection of a drug to stimulate gastric acid secretion.

Purpose

The purpose of the gastric acid determination is to evaluate gastric function by measuring the amount of acid as suctioned directly from the stomach. The complete gastric acid determination includes the basal gastric secretion test, which measures acid secretion while the patient is in a **fasting** state (nothing to eat or drink), followed by the gastric acid stimulation test, which measures the secretion of gastric acid for one hour after injection of pentagastrin or a similar drug that stimulates gastric acid output. The Gastric acid stimulation test is done when the basal secretion test suggests abnormalities in gastric secretion. It is normally performed immediately afterward.

The basal gastric secretion test is indicated for patients with obscure gastric **pain**, loss of appetite, and weight loss. It is also utilized for suspected peptic (related to the stomach) ulcer, severe stomach inflammation (**gastritis**), and Zollinger-Ellison (Z-E) syndrome (a condition in which a pancreatic tumor, called a **gastrinoma**, stimulates the stomach to secrete excessive amounts of acid, resulting in peptic ulcers). Because external factors like the sight or odor of food, as well as psychological **stress**, can stimulate gastric secretion, accurate testing requires that the patient be relaxed and isolated from all sources of sensory stimulation. Abnormal basal secretion can suggest various gastric and duodenal disorders, so further evaluation requires the gastric acid stimulation test.

The gastric acid stimulation test is indicated when abnormalities are found during the basal secretion test. These abnormalities can be caused by a number of disorders, including duodenal ulcer, **pernicious anemia**, and gastric **cancer**. The test will detect abnormalities, but x rays and other studies are necessary for a definitive diagnosis.

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KEY TERMS

Achlorhydria—An abnormal condition in which hydrochloric acid is absent from the secretions of the gastric glands in the stomach.

Pernicious anemia—One of the main types of anemia, caused by inadequate absorption of vitamin B_{12}. Symptoms include tingling in the hands, legs, and feet, spastic movements, weight loss, confusion, depression, and decreased intellectual function.

Zollinger-Ellison syndrome—A rare condition characterized by severe and recurrent peptic ulcers in the stomach, duodenum, and upper small intestine, caused by a tumor, or tumors, usually found in the pancreas. The tumor secretes the hormone gastrin, which stimulates the stomach and duodenum to produce large quantities of acid, leading to ulceration. Most often cancerous, the tumor must be removed surgically; otherwise total surgical removal of the stomach is necessary.

Precautions

Because both the basal gastric secretion test and the gastric acid stimulation test require insertion of a gastric tube (intubation) through the mouth or nasal passage, neither test is recommended for patients with esophageal problems, **aortic aneurysm**, severe gastric hemorrhage, or congestive **heart failure**. The gastric acid stimulation test is also not recommended in patients who are sensitive to pentagastrin (the drug used to stimulate gastric acid output).

Description

This test, whether performed for basal gastric acid secretion, gastric acid stimulation, or both, requires the passage of a lubricated rubber tube, either by mouth or through the nasal passage, while the patient is in a sitting or reclining position on the left side. The tube is situated in the stomach, with proper positioning confirmed by fluoroscopy or x ray.

Basal gastric acid secretion

After a wait of approximately 10–15 minutes for the patient to adjust to the presence of the tube, and with the patient in a sitting position, specimens are obtained every 15 minutes for a period of 90 minutes. The first two specimens are discarded to eliminate gastric contents that might be affected by the stress of the intubation process. The patient is allowed no liquids during the test, and saliva must be ejected to avoid diluting the stomach contents.

The four specimens collected during the test constitute the *basal acid output*. If analysis suggests abnormally low gastric secretion, the gastric acid stimulation test is performed immediately afterward.

Gastric acid stimulation test

After the basal samples have been collected, the tube remains in place for the gastric acid stimulation test. Pentagastrin, or a similar drug that stimulates gastric acid output, is injected under the skin (subcutaneously). After 15 minutes, a specimen is collected every 15 minutes for one hour. These specimens are called the *poststimulation specimens*. As is the case with the basal gastric secretion test, the patient can have no liquids during this test, and must eject saliva to avoid diluting the stomach contents.

Preparation

The patient should be fasting (nothing to eat or drink after the evening meal) on the day prior to the test, but may have water up to one hour before the test. **Antacids**, anticholinergics, cholinergics, alcohol, H_2-receptor antagonists (Tagamet, Pepcid, Axid, Zantac), reserpine, adrenergic blockers, and adrenocorticosteroids should be withheld for one to three days before the test, as the physician requests. If pentagastrin is to be administered for the gastric acid secretion test, medical supervision should be maintained, as possible side effects may occur.

Aftercare

Complications such as **nausea**, **vomiting**, and abdominal distention or pain are possible following removal of the gastric tube. If the patient has a **sore throat**, soothing lozenges may be given. The patient may also resume the usual diet and any medications that were withheld for the test(s).

Risks

There is a slight risk that the gastric tube may be inserted improperly, entering the windpipe (trachea)

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and not the esophagus. If this happens, the patient may have a difficult time breathing or may experience a coughing spell until the tube is removed and reinserted properly. Also, because the tube can be difficult to swallow, if a patient has an overactive gag reflex, there may be a transient rise in blood pressure due to **anxiety**.

Normal results

Reference values for the *basal gastric secretion test* vary by laboratory, but are usually within the following ranges:

- men: 1–5 mEq/h
- women: 0.2–3.8 mEq/h

Reference values for the *gastric acid stimulation test* vary by laboratory, but are usually within the following ranges:

- men: 18–28 mEq/h
- women: 11–21 mEq/h

Abnormal results

Abnormal findings in the *basal gastric secretion test* are considered nonspecific and must be evaluated in conjunction with the results of a gastric acid stimulation test. Elevated secretion may suggest different types of ulcers; when markedly elevated, Zollinger-Ellison syndrome is suspected. Depressed secretion can indicate gastric cancer, while complete absence of secretion (achlorhydria) may suggest pernicious anemia.

Elevated gastric secretion levels in the gastric acid stimulation test may be indicative of duodenal ulcer; high levels of secretion again suggest Zollinger-Ellison syndrome.

Resources

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Janis O. Flores

Gastric bypass

Definition

A gastric bypass is one type of elective bariatric (weight-loss) surgery done on the digestive system to help morbidly obese people lose weight. Gastric bypass surgery is also called malabsorptive surgery because it creates an alternate route for food traveling through the digestive system that bypasses a section of the small intestine where many nutrients are absorbed.

Purpose

Gastric bypass surgery is intended to treat severe (morbid) **obesity** in people who have tried unsuccessfully to lose weight and whose excess weight threatens their health and well being. Obesity is defined by the body mass index (BMI). The BMI calculation compares weight to height. Adults age 20 and older are evaluated as follows:

- BMI below 18.5: underweight
- BMI 18.5–24.9: normal weight
- BMI 25.0–29.9: overweight
- BMI 30 and above: obese
- BMI 40 and above: morbidly or severely obese

Obesity is linked to an increased likelihood of developing more than 20 different diseases and disorders, including high blood pressure (**hypertension**), type 2 diabetes, heart disease, **stroke**, deep vein **blood clots**, fatty **liver disease**, **sleep apnea**, **heartburn**, **gastroesophageal reflux disease** (GERD), gallstone disease, arthritis, **colon cancer**, breathing problems, and depression. Gastric bypass surgery reduces the amount of nutrients that are absorbed from food. It is performed in conjunction with bariatric restriction surgery in which the size of the stomach is reduced through surgical application of a band or stomach staples that close off a portion of the stomach. People who have had restriction surgery can eat only small amounts at a time before feeling full. Reduced food intake along with reduced nutrient absorption can lead to dramatic weight loss.

Demographics

Obesity is the second leading cause (after tobacco use) of preventable **death** in the United States. The number of overweight and obese Americans has steadily increased since 1960. According to the National Institutes of Health, in 2006, 34% of Americans were overweight and 27% were obese. Of these, 15 million were morbidly obese, however, less than 1% chose to undergo a surgical weight-loss procedure.

The number of all surgical weight-loss procedures has increased rapidly. In 1995, only 20,000 weight-loss surgeries were performed in the United States. By 2006, 170,000 of these surgeries were done. In 2006, the United States government agreed to pay for certain bariatric surgeries for individuals who qualified

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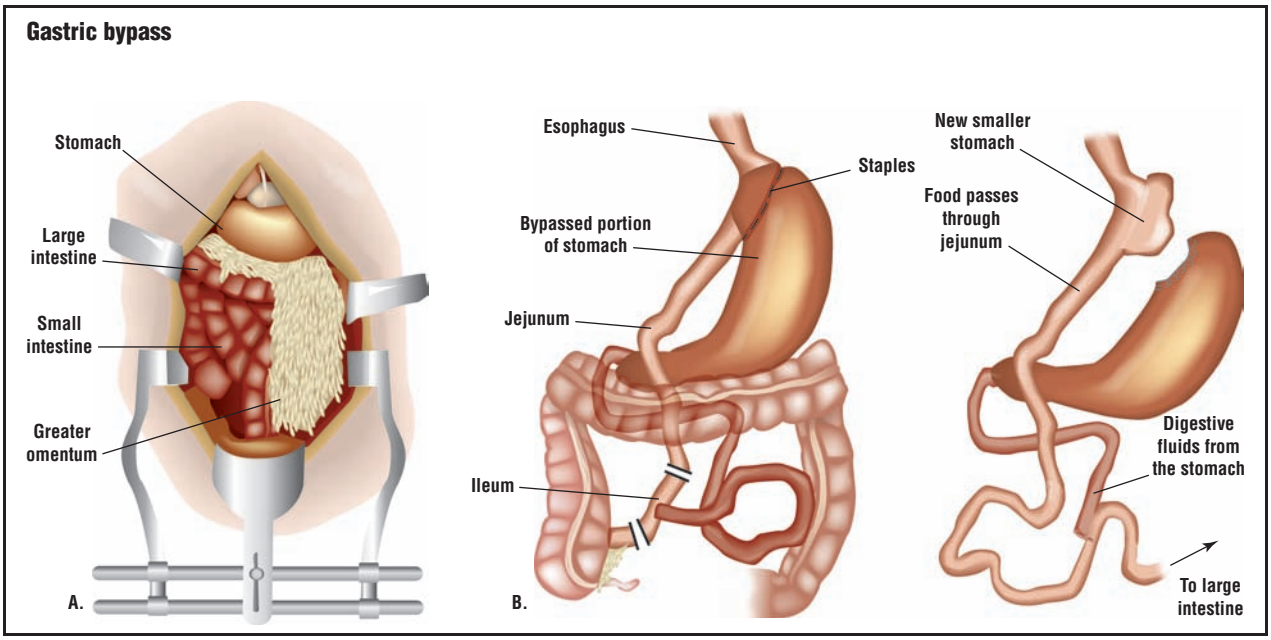

In this Roux-en-Y gastric bypass, a large incision is made down the middle of the abdomen (A). The stomach is separated into two sections. Most of the stomach will be bypassed, so food will no longer go to it. A section of jejunum (small intestine) is then brought up to empty food from the new smaller stomach (B). Finally, the surgeon connects the duodenum to the jejunum, allowing digestive secretions to mix with food further down the jejunum. *(Illustration by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)*

for Medicare. At that time, about 395,000 Americans ages 65–69 were medically eligible for **obesity surgery**. With Medicare coverage, it is likely that more older people will have weight-loss surgery. In 2006, the average patient having **bariatric surgery** was a woman in her late 30s who weighed about 300 pounds (135 kg).

Description

There are several different variations on gastric bypass, all of which are malabsorptive surgeries designed to lower caloric intake by reducing the amount of nutrients absorbed by the digestive system. These include:

- gastric bypass with long gastrojejunostomy
- Roux-en-Y (RNY) gastric bypass
- transected (Miller) RNY bypass
- laparoscopic RNY bypass
- vertical (Fobi) gastric bypass
- distal RNY bypass
- biliopancreatic (BPD) diversion

All bariatric procedures create an alternate route for food through the digestive system so that the food bypasses part of the intestine. These procedures are accompanied by a procedure to reduce the size of the stomach so that less food can be comfortably consumed. Choice of procedure relies on the patient's overall health status and on the surgeon's judgment and experience.

In the operating room, the patient is put under **general anesthesia** by the anesthesiologist. Once the patient is asleep, an endotracheal tube is placed through the mouth into the trachea (windpipe) to connect the patient to a respirator during surgery. A urinary catheter is also placed in the bladder to drain urine during surgery and for the first two days after surgery. This also allows the surgeon to monitor the patient's hydration. A nasogastric (NG) tube is also placed through the nose to drain secretions and is typically removed the morning after surgery.

The most common gastric bypass operation is the Roux-en-Y (RNY) gastric bypass. In this surgery, a small stomach pouch is created by stapling and banding the stomach. The pouch is about the size of an egg and initially can hold 1–2 oz (30–60 mL), as compared to the 40–50 oz (1.2–1.5 L) held by a normal stomach. It is created along the more muscular side of the stomach, which makes it less likely to stretch over time.

Next, a Y-shaped piece of intestine is attached to the pouch on one end, and the jejunum, or middle part

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KEY TERMS

Gastrojejunostomy—A surgical procedure in which the stomach is surgically connected to the jejunum (middle portion of the small intestine).

Gastroesophageal reflux disease (GERD)—A condition in which gastric juice from the stomach backs up into the bottom of the esophagus and causes irritation, inflammation, or erosion of the cells lining the esophagus.

Heartburn—A pain in the center of the chest behind the breastbone caused by the contents of the stomach flowing backwards (refluxing) into the lower end of the esophagus and causing irritation.

Hernia—The protrusion of a loop or section of an organ or tissue through an abnormal opening.

Laparoscopy—The examination of the inside of the abdomen through a lighted tube (endoscope), sometimes accompanied by surgery done through a small incision.

Malabsorption—Poor absorption of materials in the digestive system.

Morbidly obese—Definition of a person who is 100 lb (45 kg) or more than 50% overweight and has a body mass index above 40.

Osteoporosis—A condition found in older individuals in which bones decrease in density and become fragile and more likely to break. It can be caused by lack of vitamin D and/or calcium in the diet.

Sleep apnea—A temporary interruption in breathing during sleep.

Small intestine—Consists of three sections: duodenum (nearest the stomach), jejunum, and ileum (nearest the colon or large intestine). Different nutrients are absorbed in different sections of the small intestine.

Type 2 diabetes—Sometimes called adult-onset diabetes, this disease prevents the body from properly using glucose (sugar), but can often be controlled with diet and exercise.

of the small intestine, on the other. This allows food to bypass the duodenum, or first part of the small intestine, where nutrients are absorbed. The food then continues normally through the rest of the small intestine and the large intestine.

The RNY gastric bypass can also be performed laparoscopically. The result is the same as an open surgery RNY, except that instead of opening the patient with a long incision on the stomach, surgeons make a small incision and insert a pencil-thin optical instrument called a laparoscope, to project a picture to a TV monitor. The laparoscopic RNY results in smaller **scars**, as usually only three to four small incisions are made. The average time required to complete the laparoscopic RNY gastric bypass is approximately two hours.

The great advantage of Roux-en-Y gastric bypass is that individuals lose, on average, 60–70% of their excess weight and are able to maintain the weight loss for 10 years or more. As a result, most obesity-related health problems are substantially reduced or cured when weight is lost and that weight loss is maintained. Medicare usually pays for this surgery.

However, Roux-en-Y surgery also has some serious disadvantages, including:

- This surgery is more difficult for the surgeon than restrictive surgeries, and involves permanently altering the digestive system.
- Many vitamins and minerals are absorbed in the part of the small intestine bypassed by this surgery. The individual must commit to a lifetime of taking nutritional supplements to prevent serious vitamin and mineral deficiencies.
- Tearing, bleeding, and infection at the sites where the incisions and reconnections are potentially fatal complications.
- Dumping syndrome may occur in response to meals high in sugar. Dumping occurs when food moves too fast through the intestine and causes symptoms of nausea, bloating, weakness, sweating, fainting, and diarrhea.

Biliopancreatic diversion (BPD), another type of malabsorptive surgery, bypasses an even longer section of the small intestine. In BPD, about two-thirds of the stomach is surgically withdrawn, leaving a pouch that can hold about 3 cups of food. A bypass is then created to the ileum, or final portion of the small intestine. In all, about 9 ft (3 m) of intestine are bypassed. As a result, many fewer calories and nutrients are absorbed. The main advantage of BPD is the large amount of excess weight—between 75% and 80%—that is lost over the first two years and the health benefits that this loss brings. Medicare would usually pay for this surgery. Disadvantages are the same as for Roux-en Y surgery, but nutrient deficiencies are greater. Because fat is poorly digested as a result of this surgery, bowel movements are frequent and stools are especially foul smelling.

Diagnosis/Preparation

A diagnosis of obesity relies on a body weight assessment based on the body mass index (BMI) and

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waist circumference measurements. Waist circumference exceeding 40 in (101 cm) in men and 35 in (89 cm) in women increases disease risk. Gastric bypass as a weight-loss treatment is considered only for morbidly obese patients whose health is impaired by their obesity. To be candidates for gastric bypass surgery, individuals need to have failed at serious attempts to lose weight in the past, be in good mental health, demonstrate an understanding of the risks associated with this surgery, and be willing to make a lifetime commitment to changing eating habits.

Before the surgery, the patient will undergo a physical and psychological examination and receive nutritional counseling. To prepare for the surgery itself, an intravenous (IV) line is placed, and the patient may be given a sedative to help relax before going to the operating room.

Aftercare

Patients experience postoperative **pain** and the other common discomforts of major surgery, such as the NG tube and a dry mouth. Pain is managed with medication. A large dressing covers the surgical incision on the abdomen of the patient and is usually removed by the second day in the hospital. Short showers 48 hours after surgery are usually allowed. Patients are also fitted with special socks to improve blood flow in their legs and prevent blood clot formation. At the surgeon's discretion, some patients may have a **gastrostomy** tube (g-tube) inserted during surgery to drain secretions from the larger bypassed portion of the stomach. After a few days, it will be clamped and will remain closed. When inserted, the g-tube usually remains for another four to six weeks. It is kept in place in the unlikely event that the patient may need direct feeding into the stomach.

By the evening after surgery or the next day at the latest, patients are usually able to sit up or walk around. Gradually, physical activity may be increased, with normal activity resuming three to four weeks after surgery. Patients are also taught breathing exercises and are asked to cough frequently to clear their lungs of mucus. Postoperative pain medication is prescribed to ease discomfort and initially administered by an epidural. At the time patients are discharged from the hospital, they will be given oral medications for pain. Most patients will typically have a three-day hospital stay if their surgery is uncomplicated.

After gastric bypass or BPD, the individual does not eat anything for one or two days, giving the bowel time to rest. During this time, all **nutrition** is given intravenously. Once the person begins eating, the diet will include:

- liquids such as juice, broth, milk, or diluted cooked cereal for two or three days
- pureed foods that have the texture of baby food for two or three weeks while the stomach heals; these foods must be smooth and contain no large pieces
- soft foods such as ground meat and soft-cooked fruits and vegetables for about eight weeks
- regular food can be eaten in very small amounts

Most people begin by eating six tiny meals a day. These meals should be high in protein. Food must be chewed thoroughly. Liquids are drunk between meals, not with them. Vitamin and mineral supplements are essential.

Risks

Gastric bypass surgery has many of the same risks associated with other major abdominal operations. Life-threatening complications or death are rare, occurring in less than 1% of patients. Significant side effects, such as wound healing problems, difficulty in swallowing food, infections, and extreme **nausea**, can occur in 10–20% of patients. Blood clots after major surgery are rare, but extremely dangerous; if they occur, they may require re-hospitalization and anticoagulants (blood-thinning medications).

Some risks are specific to gastric bypass surgery, including:

- Dumping syndrome. Usually occurs when sweet foods are eaten or when food is eaten too quickly. When the food enters the small intestine, it causes cramping, sweating, and nausea.
- Abdominal hernias. These are the most common complications, requiring follow-up surgery. Incisional hernias occur in 10–20% of patients and require follow-up surgery.
- Narrowing of the stoma. The stoma, or opening between the stomach and intestines, can sometimes become too narrow, causing vomiting. The stoma can be repaired by an outpatient procedure that uses a small endoscopic balloon to stretch it.
- Gallstones. They develop in more than a third of obese patients undergoing gastric surgery. Gallstones are clumps of cholesterol and other matter that accumulate in the gallbladder. Rapid or major weight loss increases a person's risk of developing gallstones.
- Leakage of stomach and intestinal contents. Leakage of stomach and intestinal contents from the staple

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and suture lines into the abdomen can occur. This is a rare occurrence and sometimes seals itself. If not, another operation is required.

- Nutritional deficiencies. People who have gastric bypass surgery or BPD need extensive nutritional counseling and must take vitamin and mineral supplements for the rest of their lives. Most iron and **calcium** is absorbed in the duodenum, the first part of the intestine that is bypassed by these operations. Calcium deficiency can lead to **osteoporosis**, and iron deficiency can cause anemia.

In BPD, only 25% of the fat in food is absorbed because so much of the small intestine is bypassed. The fat-soluble **vitamins** A, D, E, and K are absorbed along with fat. When the body absorbs too little fat, inadequate amounts of these fat-soluble vitamins are absorbed, so dietary supplements containing these vitamins must be taken. Other vitamins that may not be absorbed in adequate amounts are vitamin B_{12}, **folic acid**, and vitamin B_1 (thiamine). Research published in the journal *Neurology* in March 2007 found that a very small number of people developed a brain disorder called Wernicke encephalopathy 4–12 weeks after bariatric surgery. This disorder is caused by a deficiency of vitamin B_1. Most of the people who developed the disorder had failed to take their vitamin supplements as prescribed after surgery.

Normal results

Most people who have surgery for obesity lose anywhere from 50–80% of their excess weight. However, quite a few put pounds back on beginning several years after surgery. The main reason for weight gain is noncompliance with their nutrition and **exercise** plan. Also, over time the size of the stomach pouch in restrictive surgeries tends to stretch, allowing people to eat more and still feel comfortable. On the positive side, people who lose weight through surgery almost always see great improvement in any obesity-related diseases they have.

According to the *American Journal of Medicine*, gastric bypass surgery resolves Type 2 Diabetes in over 80 percent of morbidly obese people. They also are asking for more research to determine the benefits for non-obese diabetics as well.

Alternatives

Surgical alternatives

Lap-band and adjustable gastric band restrictive surgery used alone represent alternatives to gastric bypass surgery. Lap-Band surgery achieves restriction by placing a saline (salt water) filled bag around the stomach, pinching off a portion of it leaving only a small pouch at the top. The exit to the pouch is narrowed so that the rate at which the pouch empties is slowed. Because the pouch is so small, the individual can only eat about half a cup of food at a time without feeling nauseated. Since there is no cutting, stapling, or stomach rerouting involved, the procedure is the least invasive of all weight-loss surgeries. Patients generally experience less pain and scarring, and their hospital stay is shorter than with malabsorptive surgeries. In addition, a port allows access to the saline bag, so that the size of the stomach pouch can be adjusted without additional surgery. This surgery is reversible; the band or saline bag can be removed and the digestive system will function normally. Weight loss averages 50–65% of the excess body weight during the first two years. The procedure is often covered by Medicare.

Gastric band surgery uses a different technique to reduce the size of the stomach. The United States Food and Drug Administration (FDA) approved this surgery in 2001. Its long-term effects have not been studied.

Vertical banded gastroplasty (VBG) is also known as stomach stapling. This surgery is performed less often than lap-band surgery. With VBG, part of the stomach is stapled shut, making it smaller so that individuals feel full sooner. The advantage of VBG is that the procedure is quick and has few complications. Disadvantages are that average weight loss is less than with other weight-loss surgeries, and staples can pull out allowing small leaks between the stomach and the abdomen to develop. Infection is possible, but rare (less than 1%).

Nonsurgical alternatives

Diet and nutrition counseling is the main nonsurgical method of weight loss. Diet therapy involves instruction on how to adjust a diet to reduce the number of calories eaten. Reducing calories moderately is essential in achieving gradual and steady weight and in maintaining the loss. Strategies of diet and nutrition therapy include teaching individuals about the calorie content of different foods, food composition (fats, carbohydrates, and proteins), reading nutrition labels, types of foods to buy, and how to prepare foods. To be healthful, a diet must provide balanced nutrition along with calorie reduction.

Physical activity, especially when combined with a healthy low-calorie diet is another nonsurgical way to lose weight. Moderate physical activity, progressing to 30 minutes or more five or more days a week, is

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recommended for weight loss. Physical activity has also been reported to be a key part of maintaining weight loss. Abdominal fat and, in some cases, waist circumference can be modestly reduced through physical activity. Strategies of successful weight loss through long-term physical activity involve selecting enjoyable activities that can be scheduled into a regular daily routine.

Behavior therapy aims to improve diet and physical activity patterns and develop habits and new behaviors that promote weight loss. Behavioral therapy strategies for weight loss and maintenance include keeping a food and exercise diary, identifying high-risk situations such as having high-calorie foods in the house and learning to avoiding these situations, using non-food rewards for specific actions such as exercising regularly, developing realistic goals and modifying false beliefs about weight loss and body image, developing a social support network (family, friends, or colleagues), and joining a support group that will encourage weight loss in a positive and motivating manner.

Drug therapy is another nonsurgical alternative option for treating obesity. The United States Food and Drug Administration (FDA) has approved three prescription drugs for treating obesity: orlistat (Xenical), phentermine (an appetite suppressant available under more than a dozen trade names), and sibutramine (Meridia in the United States, Reductil in Europe). In 2007, orlistat became available in the United States as an over-the-counter (nonprescription) drug under the name Alli. These drugs alone are not magic bullets for weight loss and should be used in addition to calorie reduction and regular exercise.

Resources

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ORGANIZATIONS

American Obesity Association, 1250 24th Street, NW, Suite 300, Washington, DC, 20037, (202) 776-7711, http://www.obesity.org.

American Society for Bariatric Surgery, 7328 West University Avenue, Suite F, Gainesville, FL, 32607, (352) 331-4900, http://www.asbs.org.

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Gastric carcinoma *see* **Stomach cancer**

Gastric emptying scan

Definition

A gastric emptying scan (GES) is an x-ray exam using special radioactive material that allows physicians to identify abnormalities related to emptying of the stomach. Diseases that involve changes in the way the stomach contracts (motility disorders) are best diagnosed by this test.

Purpose

The study is used most frequently to evaluate patients who have symptoms suggestive of decreased, delayed, or rapid gastric emptying, and no visible abnormality to explain their symptoms.

Symptoms pointing to a delay in gastric emptying are non-specific, and may be due to a number of causes, such as ulcers, diabetes, tumors, and others. These symptoms include **nausea**, upper abdominal bloating, and at times **vomiting**. Another significant symptom is called "early satiety," which means feeling full after eating only a small amount of food. In some patients, weight loss is also present. In addition to symptoms, the finding of a large amount of material in the stomach after an overnight fast suggests abnormal emptying, but does not distinguish between an actual blockage or an irregularity

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KEY TERMS

Endoscopy—The examination of the inside of an organ with an instrument that has a light at the end of it and an optical system for examination of the organ.

Motility—Motility is spontaneous movement. One example is the automatic stomach contractions that move the food content along from the stomach into the intestines. A motility disease is one that involves changes in the way the stomach contracts.

in gastric contractions. It is therefore essential to find out what is causing material to remain in the stomach.

Since many diseases can produce the above symptoms, structural lesions (such as tumors or regions of narrowing or scar tissue) need to be ruled out first. This is usually done by upper gastrointestinal series test or by **endoscopy** (examination of the inside of an organ, in this instance the stomach, with an instrument that has a light at the end of it and an optical system for examination of the organ). Once it is clear that a mechanical or physical lesion is not the cause of symptoms, attempts to document an abnormality in the nervous or muscular function of the stomach is then begun. GES is usually the first step in that evaluation.

Precautions

The exam should not be performed on pregnant women, but is otherwise quite safe. Since eggs are usually used to hold the radioactive material, patients should notify their physician if they are allergic to eggs. However, other materials can be used in place of an egg.

Description

Gastric emptying scans have undergone several changes since the initial studies in the late 1970s. During the study, patients are asked to ingest an egg sandwich containing a radioactive substance (for example, technetium) that can be followed by a special camera. The emptying of the material from the stomach is then followed and displayed both in the form of an image, as well as the percentage emptied over several hours (generally two and four hours). Studies are in progress using substances that are not radioactive, but this procedure is not available to the patient as of yet.

Preparation

The only preparation involved is for the patient to fast overnight before the test.

Risks

The radiation exposure during the study is quite small and safe, unless the patient is pregnant.

Normal results

There are several different measurements considered normal, depending on the radioactive material and solid meal used. The value is expressed as a percentage of emptying over a period of time. For a technetium-filled egg sandwich, normal emptying is 78 minutes for half the material to leave the stomach, with a variation of 11 minutes either way.

Abnormal results

GES scan studies that show emptying of the stomach in a longer than accepted period is abnormal. Severity of test results and symptoms do not always match; therefore, the physician must carefully interpret these findings. Diabetic injury to the nerves that supply the stomach (called diabetic gastroparesis) is one of the most common causes of abnormal gastric motility. However, up to 30% of patients have no obvious cause to explain the abnormal results and symptoms. These cases are called idiopathic (of unknown cause). GES is often used to follow the effect of medications used for treatment of motility disorders.

ORGANIZATIONS

American Pseudo-Obstruction & Hirschsprung's Society, 158 Pleasant St., North Andover, MA, 01845-2797, (978) 685-4477, (978) 685-4488, aphs@tiac.net.

David Kaminstein, MD

Gastric lavage *see* **Stomach flushing**
Gastric stapling *see* **Obesity surgery**
Gastric ulcers *see* **Ulcers (digestive)**

Gastrinoma

Definition

Gastrinomas are tumors associated with a rare gastroenterological disorder known as Zollinger-Ellison syndrome (ZES). They occur primarily in the pancreas and duodenum (beginning of the small intestine) and secrete large quantities of the hormone

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gastrin, triggering gastric acid production that produces ulcers. They may be malignant (cancerous) or benign.

Description

Gastrinomas are an integral part of the Zollinger-Ellison syndrome (ZES). In fact, ZES is also known as gastrinoma. This syndrome consists of ulcer disease in the upper gastrointestinal tract, marked increases in the secretion of gastric acid in the stomach, and tumors of the islet cells in the pancreas. The tumors produce large amounts of gastrin that are responsible for the characteristics of Zollinger-Ellison syndrome, namely severe ulcer disease. Although usually located within the pancreas, they may occur in other organs.

Gastrinomas may occur randomly and sporadically, or they may be inherited as part of a genetic condition called multiple endocrine neoplasia type 1 (MEN-1) syndrome. About half of persons with MEN-1 have gastrinomas, which tend to be more numerous and smaller than tumors in sporadic cases.

About half of ZES patients have multiple gastrinomas, which can vary in size from 1–20 mm. Gastrinomas found in the pancreas are usually much larger than duodenal gastrinomas. About two thirds of gastrinomas are malignant (cancerous). These usually grow slowly, but some may invade surrounding sites rapidly and metastasize (spread) widely. Sometimes, gastrinomas are found only in the lymph nodes, and it is uncertain whether these malignancies have originated in the lymph nodes or have metastasized from a tumor not visible in the pancreas or duodenum.

There is some evidence that the more malignant form of gastrinomas is more frequent in larger pancreatic tumors, especially in females and in persons with a shorter disease symptom duration and higher serum gastrin levels.

Causes and symptoms

Most persons with gastrinomas secrete profound amounts of gastric acid, and almost all develop ulcers, mostly in the duodenum or stomach. Early in the course of the disease, symptoms are typical of peptic ulcers, however once the disease is established, the ulcers become more persistent and symptomatic, and may respond poorly to standard anti-ulcer therapy. Abdominal pain is the predominant symptom of ulcer disease. About 40% of patients have **diarrhea** as well. In some patients, diarrhea is the primary symptom of gastrinoma.

Diagnosis

Persons with gastrinomas have many of the same symptoms as persons with ulcers. Their levels of gastric acid, however, are usually far greater than those in common ulcer disease. Gastrinomas are usually diagnosed by a blood test that measures the level of gastrin in the blood. Patients with gastrinomas often have gastrin levels more than 200 pg/mL, which is 4–10 times higher than normal. Serum gastrin levels as high as 450,000 pg/mL have occurred.

When the serum gastrin test does not show these extremely high levels of gastrin, patients may be given certain foods or injections in an attempt to provoke a response that will help diagnose the condition. The most useful of these provocative tests is the secretin injection test (or secretin stimulation or provocative test), which will almost always produce a positive response in persons with gastrinomas but seldom in persons without them.

Surgically, gastrinomas are often difficult to locate, even with careful inspection. They may be missed in at least 10–20% of patients with ZES. Gastrinomas are sometimes found only because they have metastasized and produced symptoms related to the spread of malignancy. Such metastasis may be the most reliable indication of whether the gastrinoma is malignant or benign.

Diagnostic imaging techniques help locate the gastrinomas. The most sophisticated is an x-ray test called radionuclide octreotide scanning (also known as somatostatin receptor scintigraphy or 111In pentetreotide SPECT). A study by the National Institutes of Health (NIH) found this test to be superior to other imaging methods, such as computed tomography scan (CT) or **magnetic resonance imaging** (MRI), in pinpointing the location of tumors and guiding physicians in treatment.

Approximately half of all gastrinomas do not show up on imaging studies. Therefore, exploratory surgery is often recommended to try to locate and remove the tumors.

Treatment

Therapy for gastrinomas should be individualized, since patients tend to have varying degrees of disease and symptoms. Treatment is aimed at eliminating the overproduction of gastric acid and removing the gastrin-producing tumors.

Drugs

Gastrinomas may not be easily treated by the standard anti-ulcer approaches. The medical treatment

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KEY TERMS

Gastrin—A hormone secreted in the stomach that is involved in the production of gastric acid. Overproduction of gastric acid contributes to peptic ulcer formation.

Multiple endocrine neoplasia type 1 (MEN-1)—An inherited condition marked by multiple malignancies of the pituitary gland, parathyroid gland, and islet cells of the pancreas. About half of MEN-1 patients with pancreatic islet cell tumors will have gastrinomas, gastrin-producing tumors that lead to ulcer disease.

Peptic ulcer—An eroded area in the stomach lining or in the first part of the duodenum (beginning of the small intestine).

Serum gastrin test—A laboratory test that is performed on a blood sample to determine that level of the hormone gastrin. High levels of gastrin indicate the presence a duodenal ulcer or a gastrinoma.

Sporadic—Occurring at random or by chance, and not as a result of a genetically determined, or inherited, trait.

of choice is with drugs called **proton pump inhibitors**, such as omeprazole or lansoprazole, daily. These drugs are potent inhibitors of gastric acid. High doses of H-2 receptor antagonists may also reduce gastric acid secretion, improve symptoms, and induce ulcer healing. These drugs must be continued indefinitely, since even a brief discontinuation will cause ulcer recurrence. **Antacids** may provide some relief, but it is usually not longlasting or healing.

Surgery

Because of the likelihood that gastrinomas may be malignant, in both sporadic tumors and those associated with the inherited MEN-1 syndrome, surgery to locate and remove gastrinomas is frequently advised. It is now known that complete surgical removal of gastrinomas can cure the overproduction of gastrin, even in patients who have metastases to the lymph nodes. Surgery in patients with MEN-1 and ZES, however, remains controversial since the benefit is less clear.

Freedom from disease after surgery is judged by improved symptoms, reduced gastric acid production, reduced need for drug therapy, normalization of serum gastrin levels, and normalization of results from the secretin stimulation test and imaging studies.

Prognosis

Medical therapy often controls symptoms, and surgery may or may not cure gastrinoma. About 50% of ZES patients in whom gastrinomas are not removed will die from malignant spread of the tumor. In patients with gastrinomas as part of MEN-1 syndrome, the cure rate is extremely low.

A NIH study of patients who had surgical removal of gastrinomas found that 42% were disease-free one year after surgery and 35% were disease-free at five years. Disease recurrences can often be detected with a serum gastrin test or secretin stimulation test.

When gastrinomas are malignant, they often grow slowly. The principal sites of metastasis are the regional lymph nodes and liver, but they may also spread to other structures. About one quarter of patients with gastrinomas have liver metastases at the time of diagnosis. This appears to be more frequent with pancreatic gastrinomas than duodenal gastrinomas.

Metastases of malignant gastrinomas to the liver is very serious. Survival five years after diagnosis is 20–30%, however patients with gastrinomas found only in the lymph nodes have been known to live as long as 25 years after diagnosis, without evidence of further tumor spread. In fact, the life expectancy of patients with gastrinomas that have spread to the lymph nodes is no different from that of patients with gastrinomas that cannot even be found at surgery for about 90%, five years after diagnosis.

ORGANIZATIONS

National Digestive Diseases Information Clearinghouse (NDDIC), 2 Information Way, Bethesda, MD, 20892-3570, (703) 738-4929, (800) 891-5389, http://digestive.niddk.nih.gov.

Caroline A. Helwick

Gastritis

Definition

Gastritis commonly refers to inflammation of the lining of the stomach, but the term is often used to cover a variety of symptoms resulting from stomach lining

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inflammation and symptoms of burning or discomfort. True gastritis comes in several forms and is diagnosed using a combination of tests. In the 1990s, scientists discovered that the main cause of true gastritis is infection from a bacterium called *Helicobacter pylori* (*H. pylori*).

Description

Gastritis should not be confused with common symptoms of upper abdominal discomfort. It has been associated with resulting ulcers, particularly peptic ulcers. And in some cases, chronic gastritis can lead to more serious complications.

Nonerosive H. pylori gastritis

The main cause of true gastritis is *H. pylori* infection. *H. pylori* is indicated in an average of 90% of patients with chronic gastritis. This form of nonerosive gastritis is the result of infection with *Helicobacter pylori* bacterium, a microorganism whose outer layer is resistant to the normal effects of stomach acid in breaking down bacteria.

The resistance of *H. pylori* means that the bacterium may rest in the stomach for long periods of times, even years, and eventually cause symptoms of gastritis or ulcers when other factors are introduced, such as the presence of specific genes or ingestion of **nonsteroidal anti-inflammatory drugs** (NSAIDS). Study of the role of *H. pylori* in development of gastritis and peptic ulcers has disproved the former belief that **stress** lead to most stomach and duodenal ulcers and has resulted in improved treatment and reduction of stomach ulcers. *H. pylori* is most likely transmitted between humans, although the specific routes of transmission are continuously under study.

Erosive and hemorrhagic gastritis

After *H. pylori*, the second most common cause of chronic gastritis is use of nonsteroidal anti-inflammatory drugs. These commonly used **pain** killers, including **aspirin**, fenoprofen, ibuprofen and naproxen, among others, can lead to gastritis and peptic ulcers. Other forms of erosive gastritis are those due to alcohol and corrosive agents or due to trauma such as ingestion of foreign bodies.

Other forms of gastritis

Clinicians differ on the classification of the less common and specific forms of gastritis, particularly since there is so much overlap with *H. pylori* in development of chronic gastritis and complications of gastritis. Other types of gastritis that may be diagnosed include:

- Acute stress gastritis–the most serious form of gastritis which usually occurs in critically ill patients, such as those in intensive care. Stress erosions may develop suddenly as a result of severe trauma or stress to the stomach lining.
- Atrophic gastritis is the result of chronic gastritis which is leading to atrophy, or decrease in size and wasting away, of the gastric lining. Gastric atrophy is the final stage of chronic gastritis and may be a precursor to gastric cancer.
- Superficial gastritis is a term often used to describe the initial stages of chronic gastritis.
- Uncommon specific forms of gastritis include granulomatous, eosiniphilic and lymphocytic gastritis.

Causes and symptoms

Nonerosive H. pylori gastritis

H. pylori gastritis is caused by infection from the *H. pylori* bacterium. The route of its transmission is under study as clinicians believe there are numerous routes for the bacterium. Its prevalence and distribution differs in nations around the world. The presence of *H. pylori* has been detected in 86–99% of patients with chronic superficial gastritis. However, physicians are still learning about the link of *H. pylori* to chronic gastritis and peptic ulcers, since many patients with *H. pylori* infection do not develop symptoms or peptic ulcers. *H. pylori* is also seen in 90–100% of patients with duodenal ulcers.

Symptoms of *H. pylori* gastritis include abdominal pain and reduced acid secretion in the stomach. However, the majority of patients with *H. pylori* infection suffer no symptoms, even though the infection may lead to ulcers and resulting symptoms. Ulcer symptoms include dull, gnawing pain, often two to three hours after meals and pain in the middle of the night when the stomach is empty.

Erosive and hemorrhagic gastritis

The most common cause of this form of gastritis is use of NSAIDS. Other causes may be **alcoholism** or stress from surgery or critical illness. The role of NSAIDS in development of gastritis and peptic ulcers depends on the dose level. Although even low doses of aspirin or other nonsteroidal anti-inflammatory drugs may cause some gastric upset, low doses generally will not lead to gastritis. However, as many as 10–30% of

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patients on higher and more frequent doses of NSAIDS, such as those with chronic arthritis, may develop gastric ulcers. Studies were underway to understand the role of *H. pylori* in gastritis and ulcers among patients using NSAIDS.

Patients with erosive gastritis may also show no symptoms. When symptoms do occur, they may include **anorexia nervosa**, gastric pain, **nausea and vomiting**.

Other Forms of Gastritis

Less common forms of gastritis may result from a number of generalized diseases or from complications of chronic gastritis. Any number of mechanisms may cause various less common forms of gastritis and they may differ slightly in their symptoms and clinical signs. However, they all have in common inflammation of the gastric mucosa.

Diagnosis

Nonerosive H. pylori gastritis

H. pylori gastritis is easily diagnosed through the use of the urea breath test. This test detects active presence of *H. pylori* infection. Other serological tests, which may be readily available in a physician's office, may be used to detect *H. pylori* infection. Newly developed versions offer rapid diagnosis. The choice of test will depend on cost, availability and the physician's experience, since nearly all of the available tests have an accuracy rate of 90% or better. **Endoscopy**, or the examination of the stomach area using a hollow tube inserted through the mouth, may be ordered to confirm diagnosis. A biopsy of the gastric lining may also be ordered.

Erosive or hemorrhagic gastritis

Clinical history of the patient may be particularly important in the diagnosis of this type of gastritis, since its cause is most often the result of chronic use of NSAIDS, alcoholism, or other substances.

Other forms of gastritis

Gastritis that has developed to the stage of duodenal or gastric ulcers usually requires endoscopy for diagnosis. It allows the physician to perform a biopsy for possible malignancy and for *H. pylori*. Sometimes, an upper gastrointestinal x-ray study with barium is ordered. Some diseases such as Zollinger-Ellison syndrome, an ulcer disease of the upper gastrointestinal tract, may show large mucosal folds in the stomach and duodenum on radiographs or in endoscopy. Other tests check for changes in gastric function.

Treatment

H. pylori gastritis

The discovery of *H. pylori's* role in development of gastritis and ulcers has led to improved treatment of chronic gastritis. In particular, relapse rates for duodenal and gastric ulcers has been reduced with successful treatment of *H. pylori* infection. Since the infection can be treated with **antibiotics**, the bacterium can be completely eliminated up to 90% of the time.

Although *H. pylori* can be successfully treated, the treatment may be uncomfortable for patients and relies heavily on patient compliance. Clinicians are attempting to identify the best treatment method based on simplicity, patient cooperation and results. As of 2010, no single antibiotic had been found which would eliminate *H. pylori* on its own, so a combination of antibiotics has been prescribed to treat the infection.

DUAL THERAPY. Dual therapy involves the use of an antibiotic and a proton pump inhibitor. **Proton pump inhibitors** help reduce stomach acid by halting the mechanism that pumps acid into the stomach. This also helps promote healing of ulcers or inflammation. Dual therapy has not been proven to be as effective as triple therapy, but may be ordered for some patients who can more comfortably handle the use of less drugs and will therefore more likely follow the two-week course of therapy.

TRIPLE THERAPY. As of early 1998, triple therapy was the preferred treatment for patients with *H. pylori* gastritis. It is estimated that triple therapy successfully eliminates 80–95% of *H. pylori* cases. This treatment regimen usually involves a two-week course of three drugs. An antibiotic such as amoxicillin or tetracycline, and another antibiotic such as clarithomycin or metronidazole are used in combination with bismuth subsalicylate, a substance found in the over-the-counter medication, Pepto-Bismol, which helps protect the lining of the stomach from acid. Physicians were experimenting with various combinations of drugs and time of treatment to balance side effects with effectiveness. Side effects of triple therapy are not serious, but may cause enough discomfort that patients are not inclined to follow the treatment.

OTHER TREATMENT THERAPIES. Scientists have experimented with quadruple therapy, which adds an antisecretory drug, or one which suppresses gastric secretion, to the standard triple therapy. One study showed this therapy to be effective with only a week's

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KEY TERMS

Duodenal—Refers to the duodenum, or the first part of the small intestine.

Gastric—Relating to the stomach.

Mucosa—The mucous membrane, or the thin layer which lines body cavities and passages.

Ulcer—A break in the skin or mucous membrane. It can fester and pus like a sore.

course of treatment in more than 90% of patients. Short course therapy was attempted with triple therapy involving antibiotics and a proton pump inhibitor and seemed effective in eliminating *H. pylori* in one week for more than 90% of patients. The goal is to develop the most effective therapy combination that can work in one week of treatment or less.

MEASURING H. PYLORI TREATMENT EFFECTIVENESS. In order to ensure that *H. pylori* has been eradicated, physicians will test patients following treatment. The breath test is the preferred method to check for remaining signs of *H. pylori*.

Treatment of erosive gastritis

Since few patients with this form of gastritis show symptoms, treatment may depend on severity of symptoms. When symptoms do occur, patients may be treated with therapy similar to that for *H. pylori*, especially since some studies have demonstrated a link between *H. pylori* and NSAIDS in causing ulcers. Avoidance of NSAIDS will most likely be prescribed.

Other forms of gastritis

Specific treatment will depend on the cause and type of gastritis. These may include prednisone or antibiotics. Critically ill patients at high risk for bleeding may be treated with preventive drugs to reduce risk of acute stress gastritis. If stress gastritis does occur, the patient is treated with constant infusion of a drug to stop bleeding. Sometimes surgery is recommended, but is weighed with the possibility of surgical complications or **death**. Once torrential bleeding occurs in acute stress gastritis, mortality is as high as greater than 60%.

Alternative treatment

Alternative forms of treatment for gastritis and ulcers should be used cautiously and in conjunction with conventional medical care, particularly now that scientists have confirmed the role of *H. pylori* in gastritis and ulcers. Alternative treatments can help address gastritis symptoms with diet and **nutritional supplements**, herbal medicine and **ayurvedic medicine**. It is believed that zinc, vitamin A and beta-carotene aid in the stomach lining's ability to repair and regenerate itself. Herbs thought to stimulate the immune system and reduce inflammation include **echinacea** (*Echinacea* spp.) and goldenseal (*Hydrastis canadensis*). Ayurvedic medicine involves **meditation**. There are also certain herbs and nutritional supplements aimed at helping to treat ulcers.

Prognosis

The discovery of *H. pylori* has improved the prognosis for patients with gastritis and ulcers. Since treatment exists to eradicate the infection, recurrence is much less common. The only patients requiring treatment for *H. pylori* are those at high risk because of factors such as NSAIDS use or for those with ulcers and other complicating factors or symptoms. Research will continue into the most effective treatment of *H. pylori*, especially in light of the bacterium's resistance to certain antibiotics. Regular treatment of patients with gastric and duodenal ulcers has been recommended, since H. pylori plays such a consistently high role in development of ulcers. It is believed that *H. pylori* also plays a role in the eventual development of serious gastritis complications and cancer. Detection and treatment of *H. pylori* infection may help reduce occurrence of these diseases. The prognosis for patients with acute stress gastritis is much poorer, with a 60 percent or higher mortality rate among those bleeding heavily.

Prevention

The widespread detection and treatment of *H. pylori* as a preventive measure in gastritis has been discussed but not resolved. Until more is known about the routes through which *H. pylori* is spread, specific prevention recommendations are not available. Erosive gastritis from NSAIDS can be prevented with cessation of use of these drugs. An education campaign was launched in 1998 to educate patients, particularly an **aging** population of arthritis sufferers, about risk for ulcers from NSAIDS and alternative drugs.

Resources

PERIODICALS

Podolski, J. L. "Recent Advances in Peptic Ulcer Disease: H. pylori Infection and Its Treatement." *Gastroenterology Nursing* 19, no. 4: 128–136.

OTHER

American College of Gastroenterology Page. http://www.acg.org.

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ORGANIZATIONS

National Digestive Diseases Information Clearinghouse (NDDIC), 2 Information Way, Bethesda, MD, 20892-3570, (703) 738-4929, (800) 891-5389, http://digestive.niddk.nih.gov.

Teresa Odle,

Gastroduodenostomy (Billroth I) *see* **Ulcer surgery**

Gastroenteritis

Definition

Gastroenteritis is a catchall term for infection or irritation of the digestive tract, particularly the stomach and intestine. It is frequently referred to as the stomach or intestinal flu, although the **influenza** virus is not associated with this illness. Major symptoms include **nausea and vomiting**, **diarrhea**, and abdominal cramps. These symptoms are sometimes also accompanied by **fever** and overall weakness. Gastroenteritis typically lasts about three days. Adults usually recover without problem, but children, the elderly, and anyone with an underlying disease are more vulnerable to complications such as **dehydration**.

Demographics

Gastroenteritis is an uncomfortable and inconvenient ailment, but it is rarely life-threatening in the United States and other developed nations. However, an estimated 220,000 children younger than age five are hospitalized with gastroenteritis symptoms in the United States annually. Of these children, 300 die as a result of severe diarrhea and dehydration. In developing nations, diarrheal illnesses are a major source of mortality. Worldwide, inadequate treatment of gastroenteritis kills 5 to 8 million people per year, and is a leading cause of **death** among infants and children under the age of 5. Annually, worldwide, rotaviruses are estimated to cause 800,000 deaths in children below age five.

Description

Typically, children are more vulnerable to rotaviruses, the most significant cause of acute watery diarrhea. For this reason, much research has gone into developing a vaccine to protect children from this virus. Adults can be infected with rotaviruses, but these infections typically have minimal or no symptoms. Children are also susceptible to adenoviruses and astroviruses, which are minor causes of childhood gastroenteritis. Adults experience illness from astroviruses as well, but the major causes of adult viral gastroenteritis are the caliciviruses and SRSVs. These viruses also cause illness in children. The SRSVs are a type of calicivirus and include the Norwalk, Southhampton, and Lonsdale viruses. These viruses are the most likely to produce **vomiting** as a major symptom.

Bacterial gastroenteritis is frequently a result of poor sanitation, the lack of safe drinking water, or contaminated food–conditions common in developing nations. Natural or man-made disasters can make underlying problems in sanitation and food safety worse. In developed nations, the modern food production system potentially exposes millions of people to disease-causing bacteria through its intensive production and distribution methods. Common types of bacterial gastroenteritis can be linked to *Salmonella* and *Campylobacter* bacteria; however, ***Escherichia coli*** 0157 and *Listeria monocytogenes* are creating increased concern in developed nations. **Cholera** and Shigella remain two diseases of great concern in developing countries, and research to develop long-term vaccines against them is underway.

Causes and symptoms

Gastroenteritis arises from ingestion of viruses, certain bacteria, or parasites. Food that has spoiled may also cause illness. Certain medications and excessive alcohol can irritate the digestive tract to the point of inducing gastroenteritis. Regardless of the cause, the symptoms of gastroenteritis include diarrhea, **nausea** and **vomiting**, and abdominal pain and cramps. Sufferers may also experience bloating, low fever, and overall tiredness. Typically, the symptoms last only two to three days, but some viruses may last up to a week.

A usual bout of gastroenteritis shouldn't require a visit to the doctor. However, medical treatment is essential if symptoms worsen or if there are complications. Infants, young children, the elderly, and persons with underlying disease require special attention in this regard.

The greatest danger presented by gastroenteritis is dehydration. The loss of fluids through diarrhea and vomiting can upset the body's electrolyte balance, leading to potentially life-threatening problems such as heart beat abnormalities (arrhythmia). The risk of dehydration increases as symptoms are prolonged. Dehydration should be suspected if a dry mouth, increased or excessive thirst, or scanty urination is experienced.

If symptoms do not resolve within a week, an infection or disorder more serious than gastroenteritis may be involved. Symptoms of great concern include a high fever (102° F [38.9°C] or above), blood or mucus

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KEY TERMS

Dehydration—A condition in which the body lacks the normal level of fluids, potentially impairing normal body functions.

Electrolyte—An ion, or weakly charged element, that conducts reactions and signals in the body. Examples of electrolytes are sodium and potassium ions.

Glucose—A sugar that serves as the body's primary source of fuel.

Influenza—A virus that affects the respiratory system, causing fever, congestion, muscle aches, and headaches.

Intravenous (IV) therapy—Administration of intravenous fluids.

Microflora—The bacterial population in the intestine.

Pathogenic bacteria—Bacteria that produce illness.

Probiotics—Bacteria that are beneficial to a person's health, either through protecting the body against pathogenic bacteria or assisting in recovery from an illness.

in the diarrhea, blood in the vomit, and severe abdominal pain or swelling. These symptoms require prompt medical attention.

Diagnosis

The symptoms of gastroenteritis are usually enough to identify the illness. Unless there is an outbreak affecting several people or complications are encountered in a particular case, identifying the specific cause of the illness is not a priority. However, if identification of the infectious agent is required, a stool sample will be collected and analyzed for the presence of viruses, disease-causing (pathogenic) bacteria, or parasites.

Treatment

Gastroenteritis is a self-limiting illness which will resolve by itself. However, for comfort and convenience, a person may use over-the-counter medications such as Pepto Bismol to relieve the symptoms. These medications work by altering the ability of the intestine to move or secrete spontaneously, absorbing toxins and water, or altering intestinal microflora. Some over-the-counter medicines use more than one element to treat symptoms.

If over-the-counter medications are ineffective and medical treatment is sought, a doctor may prescribe a more powerful anti-diarrheal drug, such as motofen or lomotil. Should pathogenic bacteria or parasites be identified in the patient's stool sample, medications such as **antibiotics** will be prescribed.

It is important to stay hydrated and nourished during a bout of gastroenteritis. If dehydration is absent, the drinking of generous amounts of nonalcoholic fluids, such as water or juice, is adequate. **Caffeine**, since it increases urine output, should be avoided. The traditional BRAT diet–bananas, rice, applesauce, and toast–is tolerated by the tender gastrointestinal system, but it is not particularly nutritious. Many, but not all, medical researchers recommend a diet that includes complex carbohydrates (e.g., rice, wheat, potatoes, bread, and cereal), lean meats, yogurt, fruit, and vegetables. Milk and other dairy products shouldn't create problems if they are part of the normal diet. Fatty foods or foods with a lot of sugar should be avoided. These recommendations are based on clinical experience and controlled trials, but are not universally accepted.

Minimal to moderate dehydration is treated with oral rehydrating solutions that contain glucose and electrolytes. These solutions are commercially available under names such as Naturalyte, Pedialyte, Infalyte, and Rehydralyte. Oral rehydrating solutions are formulated based on physiological properties. Fluids that are not based on these properties–such as cola, apple juice, broth, and sports beverages–are not recommended to treat dehydration. If vomiting interferes with oral rehydration, small frequent fluid intake may be better tolerated. Should oral rehydration fail or severe dehydration occur, medical treatment in the form of intravenous (IV) therapy is required. IV therapy can be followed with oral rehydration as the patient's condition improves. Once normal hydration is achieved, the patient can return to a regular diet.

Alternative treatment

Symptoms of uncomplicated gastroenteritis can be relieved with adjustments in diet, herbal remedies, and homeopathy. An infusion of meadowsweet (*Filipendula ulmaria*) may be effective in reducing nausea and stomach acidity. Once the worst symptoms are relieved, slippery elm (*Ulmus fulva*) can help calm the digestive tract. Of the homeopathic remedies available, *Arsenicum album*, **ipecac**, or *Nux vomica* are three said to relieve the symptoms of gastroenteritis.

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Probiotics, bacteria that are beneficial to a person's health, are recommended during the recovery phase of gastroenteritis. Specifically, live cultures of *Lactobacillus acidophilus* are said to be effective in soothing the digestive tract and returning the intestinal flora to normal. *L. acidophilus* is found in live-culture yogurt, as well as in capsule or powder form at health food stores. The use of probiotics is found in folk remedies and has some support in the medical literature. Castor oil packs to the abdomen can reduce inflammation and also reduce spasms or discomfort.

Prognosis

Gastroenteritis is usually resolved within two to three days and there are no long-term effects. If dehydration occurs, recovery is extended by a few days.

Prevention

There are few steps that can be taken to avoid gastroenteritis. Ensuring that food is well-cooked and unspoiled can prevent bacterial gastroenteritis, but may not be effective against viral gastroenteritis.

Resources

BOOKS

Craig SA, Zich DK. Gastroenteritis. In: Marx JA, ed. *Rosen's Emergency Medicine: Concepts and Clinical Practice, 7th ed.* Philadelphia, Pa: Mosby Elsevier; 2009: chap 92.

Sodha SV, Griffin PM, Hughes JM. Foodborne disease. In: Mandell GL, Bennett JE, Dolin R, eds. *Principles and Practice of Infectious Diseases, 7th ed.* Philadelphia, Pa: Elsevier Churchill Livingstone; 2009: chap 99.

Julia Barrett
Karl Finley

Gastroesophageal reflux disease

Definition

Gastroesophageal reflux disease (GERD) is a condition in which stomach acids and other stomach contents backflow into the esophagus, the tube leading from the mouth to the stomach, causing a burning sensation in the middle of the chest known as **heartburn**.

Gastroesophageal reflux disease (GERD) relief

Diet and lifestyle modifications:

- Eat smaller but more frequent meals
- Avoid common triggers (including tomato sauces, fried or spicy foods, alcohol, and caffeinated beverages)
- Lose excess weight
- Sleep with the head elevated
- Avoid eating before bed

Over-the-counter medications:

- Antacids (Tums*, Rolaids)
- OTC acid blockers (Pepcid AC, Prilosec OTC)

Prescription medications:

- Proton pump inhibitors (Nexium, Prevacid)
- Pro-motility drugs (Propulsid)
- Prescription-strength antacids (Carafate)
- Prescription-strength H2 blockers (Zantac, Tagamet)

*Drug names are provided as examples but are not meant to be recommendations or wholly representative of the treatments available.

SOURCE: The American College of Gastroenterology, "Heartburn or Gastroesophageal Reflux Disease (GERD)." Available online at: http://www.acg.gi.org/patients/women/whatisgerd.asp (accessed August 19, 2010).

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Demographics

Estimates of the number of people in the United States with GERD may be significantly underreported because some people who experience heartburn self-treat through over-the-counter medications and are never officially diagnosed with GERD unless a more serious condition occurs. The American College of Gastroenterology estimates that about 60 million Americans experience heartburn at least once a month; of these, 15 million experience the condition daily. Other estimates suggest that 7% of the population has heartburn daily, and of these individuals, 20–40% have GERD, while heartburn in the remaining individuals arises from other causes. GERD occurs in all races and at all ages but is most common in people over age 40 years. Men and women are equally affected, although white men are ten times more likely to develop Barrett's esophagus (a precursor of **esophageal cancer**) than women.

Description

The mechanism behind GERD is a weakness in the lower esophageal sphincter (LES), causing stomach acids to back into the esophagus. The LES is a muscle located at the bottom of the esophagus that acts as a doorkeeper to the stomach. Normally, when food is

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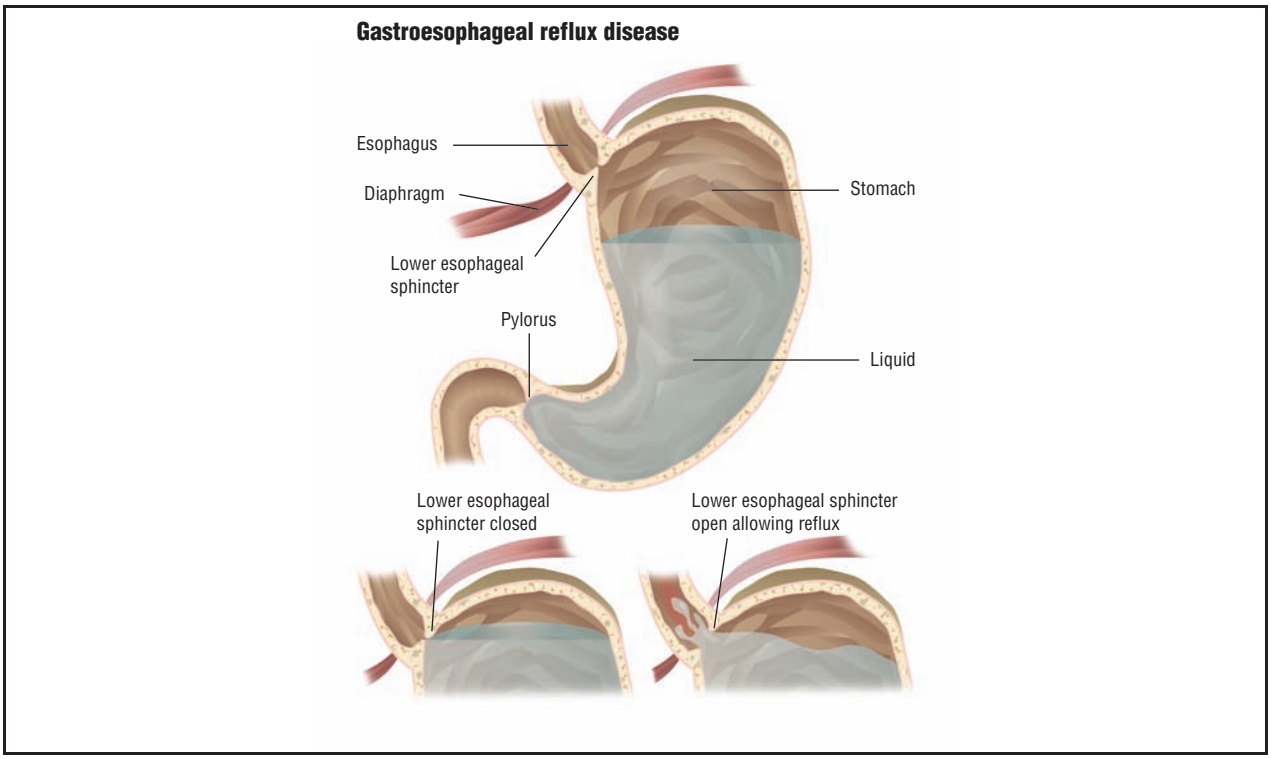

Normally, the lower esophageal sphincter keeps the stomach contents contained with the stomach (top). However, with gastroesophageal reflux disease, the sphincter opens, allowing the acidic contents to flow up the esophagus. *(Illustration by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)*

eaten, it passes through the esophagus into the stomach, and the LES closes to keep the highly acidic stomach contents from washing back into the esophagus. Although a malfunctioning LES can be present from birth and can cause infants and children to complain of stomachaches and have frequent bouts of **vomiting**, GERD is most often seen in adults.

The esophagus risks being damaged every time stomach acids wash into it. Constant irritation by stomach acids can cause esophagitis, a condition in which the esophagus becomes red and irritated. Because the lining of the esophagus is thinner and less acid-resistant than the stomach or the intestines, untreated GERD over many years can cause ulcers to develop in the esophagus. These can bleed and can, in turn, result in anemia. Scar tissue can also build up.

The body may try to protect the esophagus by developing a thick lining made up of cells like those in the stomach and intestine. This is known as Barrett's esophagus and is a pre-cancerous condition that can lead to **cancer** of the esophagus.

Some people have trouble eating because there is a feeling that something is in their throats or that their food keeps getting stuck when they eat. This may be a serious condition called dysphagia, which develops from long-term GERD. It is a narrowing of the esophagus, caused by a thickening of the lining in response to acids from the stomach. When swallowing hurts, the condition is called odynophagia. This type of GERD often is referred to as silent reflux because no other symptoms are reported.

Everyone experiences heartburn occasionally, especially after overeating or eating fatty foods. Continued heartburn, though, can disrupt sleep. Moreover, if stomach acids keep bathing the esophagus, chronic inflammation of the lower esophagus can occur. In addition, if stomach material from the esophagus finds its way into the windpipe (trachea), it can enter the lungs, leading to **asthma** and **pneumonia**. For elderly individuals who are bedridden, aspiration of stomach contents can cause **choking**, infection, and even suffocation and **death**.

Causes and symptoms

Causes

Often, a structural abnormality called a **hiatal hernia** is the cause of constant reflux and GERD. In a

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hiatal hernia, a part of the stomach protrudes through a whole in the diaphragm (a sheet of muscle that separates the abdominal cavity from the chest cavity). This condition is more common in older individuals. Impaired motility in the stomach also can be a factor in GERD. In this case, the stomach nerves or muscles do not allow the stomach and the esophagus to contract normally, thereby allowing acid to build up in the esophagus. **Scleroderma**, a disease that causes muscular tissue to thicken, can affect digestive muscles and keep the LES open.

Lifestyle factors affect the development of GERD. Being overweight or pregnant increases abdominal pressure, and can cause the LES to remain open, thus allowing the stomach contents to squeeze into the esophagus. Wearing tight clothing around the abdomen, eating large meals, and lying down after eating can keep the LES open. Some foods may act as triggers for GERD, including chocolate, peppermint, high fat foods, citrus foods, tomato products, and onions. Smoking can stimulate acid production in the stomach and also can relax the LES. Consuming alcoholic, caffeinated, and carbonated drinks also can contribute to GERD.

Some medications have been linked to the development of GERD. They include high blood pressure medications such as **calcium channel blockers**, nitrate heart medications, asthma drugs such as theophylline, antidepressants, sedatives such as diazepam (Valium), and corticosteroid drugs. Nitrates in foods also may trigger GERD. Non-steroidal anti-inflammatory drugs (NSAIDs) such as **aspirin**, ibuprofen, and naproxen can irritate the stomach and lead to GERD.

Symptoms

Although heartburn is the characteristic symptom of GERD, people with this condition also may experience other symptoms. Regurgitation of stomach acid into the mouth (sometimes called water brash) is often present. Some individuals report abdominal pain, difficulty in swallowing, **nausea**, morning hoarseness, **sore throat**, coughing, **wheezing**, or a need to repeatedly clear the throat. Others experience **vomiting** or frequent burping or **hiccups**. A few note weight loss or **snoring**.

Some people do not experience noticeable symptoms. This is or milder forms of common GERD symptoms, but they experienced more instances of difficulty swallowing, vomiting, anemia, and weight loss. The study also found that abdominal pain and heartburn seemed to decrease with age and that GERD in the elderly most often was related to nonsteroidal anti-inflammatory drug (NSAID) use.

Having heartburn several times a week or waking up with heartburn at night is a good indicators that an appointment should be made for evaluation by a physician. If symptoms disturb sleep or interfere with work or leisure activities, a doctor should be consulted. Losing weight, breathing difficulties, vomiting blood, or has producing black, tarry stool, indicate that a doctor should be seen immediately. In addition, if an individual has been treated by a family physician for GERD for more than two years, a consultation with a gastroenterologist (a doctor specializing in diseases of the digestive system) usually is recommended.

Diagnosis

Examination

Because GERD is common, it often will be diagnosed after the doctor takes a thorough medical history, listens carefully for GERD symptoms, and does a **physical examination**. If the patient responds positively to treatment, no further tests are ordered. However, if the patient has serious symptoms such as intense pain, vomiting blood, or rapid weight loss, the doctor will investigate these through a series of tests. In addition, if the patient has been complaining of heartburn for a long time or has been treated for GERD for more than two years, other tests will likely be ordered to gauge the extent of damage done to the esophagus.

Procedures

The most common procedures are the upper gastrointestinal (GI) series and the upper GI **endoscopy**. The upper GI series examines the esophagus, stomach, and the duodenum (the first section of the small intestine). The patient drinks a cup of barium (barium swallow), a metallic, chalky liquid that coats the digestive track and makes it show up on x rays. X rays or images are then taken as the barium flows down the esophagus, into the stomach, and into the duodenum. The patient may be asked to turn to the side so that the technician can gently massage the stomach to move the barium into the duodenum. Images are sent to a video monitor where the doctors and technicians observe the behavior of the upper digestive tract and snap still images from the monitor.

The upper GI series can reveal anatomical changes in the esophagus, such as a hiatal hernia or esophageal narrowing. It also can assess damage to the esophagus, detect stomach ulcers or ulcers in the duodenum, and determine whether an intestinal blockage is present.

The upper GI endoscopy, also called the **esophagogastroduodenoscopy** (EGD), offers a more complete picture of what is happening in the upper digestive tract. It is the test of choice for many gastroenterologists.

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Before the endoscopy, the patient receives a mild sedative, and then the doctor inserts a small, flexible tube down the patient's throat. At the end of the tube is a light, a tiny camera, and a small instrument used to take tissue samples (biopsies). The camera broadcasts live images from the esophagus and stomach to a video monitor. Using these tools, the doctor can capture still images for further diagnosis and can examine suspicious areas more closely with the camera or by taking tissue samples. The EGD allows the doctor to determine the extent of damage to the esophagus and to rule out serious complications such as Barrett's esophagus. Mild GERD may show no damage to the esophagus at all.

Another test, esophageal manometry, measures pressure within the esophagus and how well the LES functions. A thin tube is inserted through the nose and down the throat. Coupled with the 24-hour pH probe study, esophageal manometry becomes the best determinant of GERD because it monitors how often the patient has reflux into the esophagus during a full day. One episode of acid reflux is considered having a pH of less than 4.0 for at least 15–30 seconds. This test can determine if there is a correlation between episodes of acid reflux and other symptoms, such as chronic **cough**, wheezing, or **sleep apnea**.

To do a pH probe study, a small computer is attached to the outside end of the thin tube in the patient's nose, and the computer is worn around the waist or over the shoulder. The patient goes home, carries on a normal routine, then comes back to have the probe removed and the results analyzed.

A more comfortable form of the 24-hour pH probe study is the Bravo pH probe that is placed in the esophagus during endoscopy. This tiny probe transmits data to a miniature recorder the size of a paper clip that is worn around the waist. Eventually, the probe makes its way through the digestive system and is passed in the patient's stool in a week to ten days.

Sometimes, chest x rays are ordered to check for pneumonia or lung damage due to aspiration of stomach contents.

Treatment

The preferred treatments for GERD are lifestyle changes and drugs.

Lifestyle changes

Either prescribed alone or in combination with drug therapy, lifestyle changes can ease many GERD symptoms. Food choices, the timing of meals, and the size of meals are key lifestyle factors. Individuals should avoid foods that trigger GERD and eat smaller, more frequent meals. Doing so helps to control the amount of acid in the stomach. Individuals also should stop eating three hours before lying down. Lying down after eating can cause stomach contents to backflow into the esophagus. In addition, elevating the head of the bed about six inches may help keep acid within the stomach. Losing weight and avoiding slumping will reduce pressure on the stomach.

Drugs

Drugs often are prescribed along with lifestyle changes, even in the early stages of the disease. Commonly, the first medications prescribed are over-the-counter **antacids** and/or histamine-2 receptor blockers (H2 blockers). Antacids, such as Gaviscon, Tums, Maalox, and Mylanta, help neutralize acid already in the stomach or esophagus but do nothing to heal inflammation. Some have a foaming agent that helps prevent acid from backflowing into the esophagus. Unless otherwise instructed by a doctor, antacids can be used every day for three weeks. If taken longer, they can produce **diarrhea**, interfere with **calcium** absorption in the body, and increase levels of magnesium, which can damage the kidneys. Antacids are not recommended for individuals taking drugs to correct **hypothyroidism**.

Common H2 blockers are nizatidine (Axid), ranitidine (Zantac), famotidine (Pecid), and cimetidine (Tagamet). At half the strength of their prescription counterparts, these over-the-counter medications block acid production, but they have no effect on acid already present in the stomach. These drugs should be taken thirty minutes to one hour before meals. H2 blockers do not work as quickly as antacids, but they produce longer relief and are effective in reducing acid reflux at night. These drugs can heal mild esophageal damage but are not strong enough to heal serious injury. Standard dosage for 6–12 weeks has been found to relieve symptoms in half of GERD patients using H2 blockers.

If symptoms do not improve, proton-pump inhibitors (PPIs) may be given. PPIs can be bought without a prescription and, like H2 blockers, are also available in stronger strengths with a prescription. PPIs include esomeprazole (Nexium), omeprazole (Prilosec), lansoprazole (Prevacid), and rabeprazole (Aciphex). These drugs block the production of an enzyme that aids in acid formation. PPIs can reduce stomach acid by more than 95%. They are used to treat GERD and can heal some gastric and duodenal ulcers and prevent upper GI tract bleeding. PPIs are contraindicated for people with **liver disease** and may make the intestinal tract more susceptible to bacterial infections.

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KEY TERMS

Calcium channel blocker—A drug that lowers blood pressure by regulating calcium-related electrical activity in the heart.

Dysphagia—Difficulty in swallowing, as if something is stuck in the throat.

Esophagogastroduodenoscopy (EGD)—A test that involves visually examining the lining of the esophagus, stomach, and upper duodenum with a flexible fiber-optic endoscope.

Esophagus—The muscular tube that leads from the back of the throat to the stomach. Coated with mucus and surrounded by muscles, it pushes food to the stomach by contraction.

Fundoplication—A surgical procedure that tightens the lower esophageal sphincter by stretching and wrapping the upper part of the stomach around the sphincter.

Gastroenterologist—A physician who specializes in diseases of the digestive system.

H2 Blockers—Medications used to treat some GERD symptoms, for example, Tagamet, Pepcid, Axid.

Heartburn—A burning sensation in the chest that can sometimes also be felt in the neck, throat, and face. It is the primary symptom of GERD.

Hiatal hernia—A condition in which part of the stomach protrudes above the diaphragm next to the esophagus.

Laparoscopic surgery—A minimally invasive surgery in which a camera and surgical instruments are inserted through a small incision.

Lower esophageal sphincter (LES)—A muscular ring at the base of the esophagus that keeps stomach contents from entering back into the esophagus.

Odynophagia—Pain felt when swallowing.

pH—A measure of the acidity of a fluid. On a scale of 1–14, a pH of 7 is neutral. Higher pH readings are alkaline and lower pH readings are acidic.

Silent reflux—An acid reflux problem that does not have marked symptoms but can cause chronic, recurrent respiratory symptoms much like asthma.

Sleep apnea—A sleep disorder in which breathing stop briefly then resumes on its own. These pauses can occur many times each night, resulting in poor quality sleep.

Water brash—The flow of saliva and stomach acid back up the esophagus and into the throat or lungs.

In addition to PPIs, the doctor may prescribe coating agents, such as sucralfate (Carfate), to cover the sores and mucous membranes of the esophagus and stomach. This acts as a protective barrier.

Some doctors also a prokinetic agent to tighten the LES and promote faster emptying of the stomach. Metaclopramide (Reglan) is the only prokinetic drug approved for use in the United States. Many doctors are reluctant to use prokinetic drugs because they have serious side effects.

Surgery

If all other treatments fail, surgery is a final option. A surgical procedure called fundoplication creates a one-way valve into the stomach. During surgery, the doctor wraps a part of the stomach around the esophagus and sews it down. This procedure can be done laparoscopically, a less invasive surgical method in which the doctor makes small cuts into the abdomen to insert a camera and the surgical instruments. Laparoscopic surgery produces very little scarring and has a faster recovery rate than traditional open surgery. However, the benefits of fundoplication have been challenged in some studies.

Certain endoscopy treatments can be used to repair the upper digestive tract instead of using surgery. Plication allows the doctor to stitch tears in the esophagus or narrow the LES. The Stretta procedure uses radiofrequency energy to cause the LES sphincter to tighten. The Enteryx procedure lets the doctor inject a bulking material into the LES to narrow it. As of 2010, these procedures were not widely available but were being used at some larger medical centers.

Alternative treatments

Alternative remedies include eating bananas or drinking chamomile or ginger tea. Chamomile should be avoided by people who have ragweed **allergies**. Some people eat licorice to balance the acid output in the stomach and to increase the mucous coating of the esophagus, but this is contraindicated for people with high blood pressure. Teas made from marsh mallow root, papaya, fennel, and catnip are also suggested treatments for heartburn, as well as eating papayas.

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Homeopathic remedies most recommended are Nux vomica, Carbo vegetabilis, and Srsenicum album. **Acupuncture** and **acupressure** have also been used to treat heartburn.

Home Remedies

In addition to the lifestyle changes listed above, a common home remedy offering temporary relief is drinking water with sodium bicarbonate (baking soda) in it. However, this remedy can also add uncomfortable gas to the stomach, more sodium to the diet, which can increase blood pressure, and the excessive bicarbonate can produce rebound hyperacidity with worsening symptoms.

Prognosis

In most cases, GERD is easily managed. Between 80% and 90% of individuals improve with drug therapy. However, the length of treatment varies. Some patients may not see improvement for several weeks or months. Some patients can experience relief after two to three months of treatment and are able to modify their lifestyle to minimize symptoms so that medications are reduced or discontinued. Many patients with serious, persistent GERD may need to take medications for the rest of their lives.

Even with successful treatment, some patients experience acid breakthrough. This response occurs when symptoms appear even though the patient has faithfully taken medications. Some patients on PPIs may be symptom free during the day but wake up at night with heartburn. Sometimes, an H2 blocker is given to the patient at night in addition to PPI medications. Some patients on H2 blockers may benefit from a combination pill that contains an antacid and an H2 blocker.

Untreated GERD can lead to the development of Barrett's esophagus. Barrett's is a pre-cancerous condition. Many times it can be reversed with proper treatment of GERD.

Prevention

Symptoms of GERD can be prevented by taking drugs as prescribed, avoiding alcohol, not **smoking**, eating smaller meals, limiting fatty foods, and eliminating trigger foods. Individuals should avoid belts and tight clothing around the waist and try to lose excess weight. Individuals may chew gum or suck on hard candies to increase saliva production, which can sooth the esophagus and wash the acid back to the stomach. People with heartburn should wait two hours after eating before exercising and plan not to eat anything at least three hours before lying down. Finally, elevating the head of the bed at least six inches and sleeping on the left side may reduce nighttime heartburn.

Resources

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The Word on GERD. American College of Gastroenterology. Undated [accessed February 7, 2010]. http://www.acg.gi.org/patients/gerd/word.asp

ORGANIZATIONS

American College of Gastrolenterology (ACG), P.O. Box 34226, Bethesda, MD, 20827-2260, (301) 263-9000, http://www.acg.gi.org.

American Gastroenterological Association (AGA), 4930 Del Ray Avenue, Bethesda, MD, 20814, (310) 654-2055, (301) 654-5920, www.gastro.org.

International Foundation for Functional Gastrointestinal Disorders, P. O. Box 170864, MilwaukeeWI, USA, 53217-8076, (414) 964-1799, (USA only) (888) 964-2001, (414) 964-7176, iffgdiffgd.org, http://www.iffgd.org.

National Digestive Diseases Information Clearinghouse (NDDIC)., 2 Information Way, Bethesda, MD, 20892-3570, (800) 891-5389; TTY (866) 569-1162 , (703) 738-4929, info@niddk.nih.gov, http://digestive.niddk.nih.gov.

Janie F. Franz
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Gastrointestinal bleeding studies *see* **GI bleeding studies**

Gastrointestinal study *see* **Liver nuclear medicine scan**

Gastrojejunostomy *see* **Ulcer surgery**

Gastroschisis *see* **Abdominal wall defects**

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Gastrostomy

Definition

Gastrostomy is a surgical procedure for inserting a tube through the abdomen wall and into the stomach. The tube is used for feeding or drainage.

Purpose

Gastrostomy is performed because a patient temporarily or permanently needs to be fed directly through a tube in the stomach. Reasons for feeding by gastrostomy include **birth defects** of the mouth, esophagus, or stomach, and problems sucking or swallowing.

Gastrostomy is also performed to provide drainage for the stomach when it is necessary to bypass a long-standing obstruction of the stomach outlet into the small intestine. Obstructions may be caused by peptic ulcer scarring or a tumor.

Precautions

Gastrostomy is a relatively simple procedure. As with any surgery, patients are more likely to experience complications if they are smokers, obese, use alcohol heavily, or use illicit drugs. In addition, some prescription medications may increase risks associated with anesthesia.

Description

Gastrostomy, also called gastrostomy tube insertion, is surgery performed by a general surgeon to give an external opening into the stomach. Surgery is performed either when the patient is under general anesthesia–where the patient feels as if he is in a deep sleep and has no awareness of what is happening–or under **local anesthesia**. With local anesthesia, the patient is awake, but the part of the body cut during the operation is numbed.

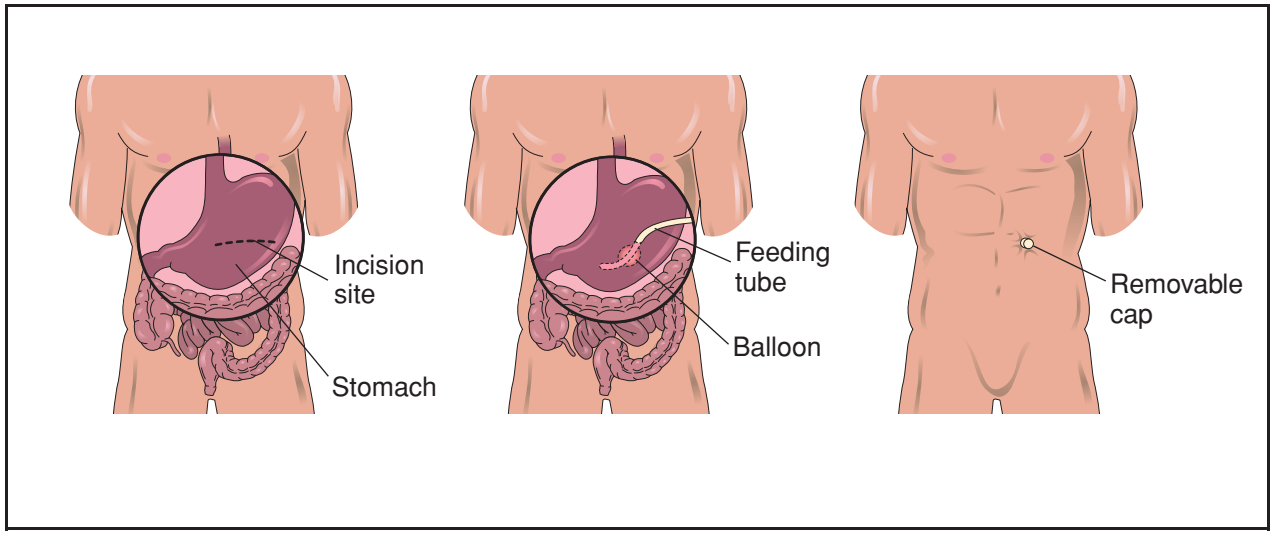
A small incision is made on the left side of the abdomen; then, an incision is made through the stomach. A small, flexible, hollow tube, usually made of polyvinylchloride or rubber, is inserted into the stomach. The stomach is stitched closed around the tube, and the incision is closed. The procedure is performed at a hospital or free-standing surgery center.

The length of time the patient needs to remain in the hospital depends on the age of the patient and the patient's general health. In some cases, the hospital stay can be as short as one day, but often is longer. Normally, the stomach and abdomen heal in five to seven days.

The cost of the surgery varies, depending on the age and health of the patient. Younger, sicker patients require more intensive, thus more expensive, care.

Preparation

Prior to the operation, the doctor will perform **endoscopy** and take x rays of the gastrointestinal tract. Blood and urine tests will also be performed, and the patient may meet with the anesthesiologist to evaluate any special conditions that might affect the administration of anesthesia.



Gastrostomy is a procedure in which the surgeon makes an opening into the stomach and inserts a feeding tube for feeding or for drainage. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

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KEY TERMS

Endoscopy—A procedure in which an instrument containing a camera is inserted into the gastrointestinal tract so that the doctor can visually inspect the gastrointestinal system.

Aftercare

Immediately after the operation, the patient is fed intravenously for at least 24 hours. Once bowel sounds are heard, indicating that the gastrointestinal system is working, the patient can begin clear liquid feedings through the tube. Gradually feedings are increased.

Patient education concerning use and care of the gastrostomy tube is very important. Patients and their families are taught how to recognize and prevent infection around the tube, how to feed through the tube, how to handle tube blockage, what to do if the tube pulls out, and what normal activities can be continued.

Risks

There are few risks associated with this surgery. The main complications are infection, bleeding, dislodgment of the tube, stomach bloating, **nausea**, and **diarrhea**.

Normal results

The patient is able to eat through the gastrostomy tube, or the stomach can be drained through the tube.

Resources

OTHER

"Stomach Tube Insertion." HealthAnswers.com. www.healthanswers.com.

Tish Davidson, A.M.

Gaucher disease

Definition

Gaucher disease is a rare genetic disorder that results in accumulation of fatty molecules called cerebrosides. It can have serious effects on numerous body organs including the liver, spleen, bones and central nervous system. Treatments based on molecular biology are becoming available, but are very expensive.

Description

Gaucher disease was first described by the French physician Philippe Gaucher in 1882. It is the most common of a class of diseases called lysosomal storage diseases, each of which is characterized by the accumulation of a specific chemical substance (a different substance depending on the exact disease). Gaucher disease is characterized by a wide array of different symptoms and the severity of the disease ranges from undetectable to lethal.

Three forms of the disease are recognized: Types I, II and III. Type I is by far the most common and shows the mildest symptoms. It is non-neuronopathic, meaning that the nervous system is not attacked. The onset of Type I can occur at any age in childhood or adult life with the average age of onset at about 21 years. Some affected individuals are have no symptoms throughout adult life. Type II, the infantile form, accounts for less than 1% of patients with Gaucher disease. It is neuronopathic (attacks the nervous system); nervous system effects are severe, and victims often die within the first year of life. Type III most often has its onset during childhood and has some of the features of both the adult and infantile forms. This affects less than 5% of persons with Gaucher disease.

Gaucher disease is caused by the absence, or near absence, of activity of an enzyme called glucocerebrosidase (GC). The normal action of GC is to break down a common molecule called glucocerebroside. If not broken down, glucocerebroside accumulates in certain cells to levels that can cause damage, especially in the spleen, liver, and bone. The common link among these organs is that they house a cell type called a macrophage. A macrophage is a large cell that surrounds and consumes a foreign substance (such as bacteria) in the body. The cellular structures in which glucocerebroside accumulates are called lysosomes.

The three forms of Gaucher disease also differ in their population genetics. Type I is most common in persons of eastern European (Ashkenazi) Jewish descent. Among this population, the disease occurs at a rate of one in 450 live births and about one in 10 to 15 persons are carriers, making it the most common genetic disease affecting Jewish people. The other two types are equally frequent in all ethnic groups. Type II occurs at a rate of one in 100,000 live births, while Type III is estimated to occur in one in 50,000 live births.

Causes and symptoms

Lack of the GC enzyme is caused by a mutation in the glucocerebrosidase gene. The gene is located on chromosome 1. There have been more than 100

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mutations described in this gene that causes Gaucher disease. Gaucher disease is inherited in an autosomal recessive pattern. This means that two defective gene copies must be inherited, one from each parent, for the disease to manifest itself. Persons with only one gene mutation are carriers for the disorder. A person who is a carrier for Gaucher disease does not have any symptoms and does not know he or she is a carrier unless he or she has had specific testing. When both parents are carriers for Gaucher disease, there is a one in four chance (25%) in each **pregnancy** for a child to have Gaucher disease. There is a two in three chance that a healthy sibling of an affected child is a carrier.

The results of Gaucher disease are widespread in the body and include excessive growth of the liver and spleen (hepatosplenomegaly), weakening of bones, and, in acute cases, severe nervous system damage. Many patients experience "bone crises," which are episodes of extreme **pain** in their bones.

There is a wide array of other problems that occur with Gaucher disease, such as anemia (fewer than normal red blood cells). Just how these other symptoms are caused is not known. Nor is it known why some patients have very mild disease and others have much more significant problems. Even identical twins with the disease can have differing symptoms.

Diagnosis

Diagnosis of Gaucher disease, based initially on the symptoms described above, can be confirmed by microscopic, enzymatic, and molecular tests. Biopsy (surgical removal of tissue from a problem area) of tissue is helpful for microscopic diagnosis. When biopsy tissue is examined under the microscope, cells will appear swollen and will show characteristic features of the cytoplasm (part of the cell body along with the nucleus) and nucleus. Enzyme tests will show deficiency (<30% of normal levels) of the enzyme GC. Molecular analysis of DNA samples looking at four of the more common mutations will show defects in the gene for GC in 95% of Ashkenazi Jewish individuals and in 75% of non-Jewish people. Diagnosis can be performed prenatally (before birth) if the parents' mutations are known using **amniocentesis** or **chorionic villus sampling**.

Diagnosis as to which of the three types of Gaucher disease an individual has is based on the symptoms, rather than on test results.

Treatment

Until the 1990s, only supportive therapy could be offered. **Analgesics** are used to control pain. Orthopedic treatment is used for bone **fractures**. In some cases, surgical removal of the spleen may be necessary. Several treatments for anemia have been used, including vitamin and iron supplements, blood transfusions, and bone marrow transplants.

KEY TERMS

Cerebrosides—Fatty carbohydrates that occur in the brain and nervous system.

Enzymatic replacement therapy—A treatment method used to replace missing enzymes. It is possible to synthesize enzymes and then inject them intravenously into patients.

Glucocerebroside—A cerebroside that contains glucose in the molecule.

The newest form of treatment for Gaucher disease is enzyme replacement therapy, in which GC can be administered intravenously. The enzyme can be prepared either by purification from placentas (alglucerase) or by recombinant DNA manufacturing techniques (imiglucerase). Either way, the cost of treatment ranges from $100,000 to $400,000 per year, which can prevent many from obtaining treatment.

Enzyme replacement is effective at reducing most Gaucher symptoms. The notable exception is neurologic damage in Type II disease, which remains unimproved by this treatment. This treatment is not recommended for individuals who are asymptomatic. The efficacy for the treatment of Type III Gaucher disease is not known. Many questions remain about enzyme replacement therapy in regard to dosage, and method and frequency of administration. The treatment program should be individualized for each patient.

Prognosis

A patient's expected lifespan varies greatly with the type of Gaucher disease. Infants with Type II disease have a life span of one to four years. Patients with Types I and III of the disease have highly variable outcomes with some patients dying in childhood and others living full lives. Little is known about the reasons for this variability.

Prevention

Genetic counseling is advised for individuals with Gaucher disease and for their relatives to accurately assess risk and discuss testing options. For couples who previously had a child with Gaucher or in situations

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where both parents are carriers for known Gaucher mutations, prenatal diagnosis is available to determine whether a pregnancy is affected. Families in which a person has been diagnosed with Gaucher disease can have DNA testing, which enables other relatives to determine their carrier status. Prospective parents can then use that information to conduct family planning or to prepare for a child who may have special circumstances.

Families in which both parents are known to be a carrier of a mutation for Gaucher disease could consider preimplantation genetic diagnosis. This relatively new procedure can select an embryo without both Gaucher disease mutations prior to implantation of the embryo into the uterus. This technique is only available at selected genetics centers.

As of the early 2000s, population screening for Gaucher disease is not standard of care.

Resources

OTHER

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"Gaucher Disease: Current Issues in Diagnosis and Treatment." http://text.nlm.nih.gov/nih/ta/www/16.html.

National Foundation for Jewish Genetic Diseases (NFJGD). http://www.nfjgd.org.

ORGANIZATIONS

Children's Gaucher Research Fund, 8110 Warren Court, Granite Bay, CA, 95746, (916) 797-3700, (916) 797-3707, research@childrensgaucher.org, http://www.childrensgaucher.org.

Genetic Alliance, Inc., 4301 Connecticut Ave., NW, Suite 404, Washington, DC, 20008-2369, (202) 966-5557, (202) 966-8553, info@geneticalliance.org, http://www.geneticalliance.org.

National Gaucher Foundation, 2227 Idlewood Road, Suite 6, Tucker, GA, 30084, (770) 934-2911, (800) 504-3189, ngf@gaucherdisease.org, http://www.gaucherdisease.org.

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923, (800) 999-6673, http://www.rarediseases.org.

Amy Vance, MS, CGC

Gay and lesbian health

Definition

Lesbian, gay, bisexual, and transgender (LGBT) individuals are as diverse as the general population in terms of race, ethnicity, age, religion, education, income, and family history. A number of health concerns are unique to or shared by the LGBT community, however, including an increased risk of certain cancers, infectious and **sexually transmitted diseases** (STDs), and mental health disorders, issues relating to **nutrition** and weight, tobacco use, and **substance abuse**, and discrimination by health care and insurance providers.

Description

The definitions of different sexual identities have shifted over the years, as have the perceptions and stereotypes of the general population. Because of the wide range of behaviors and identities that exist in the LGBT community, it is difficult to develop an inclusive definition. It is generally accepted, however, that gay men and lesbians are sexually attracted to or participate in sexual behaviors with individuals of the same gender, while bisexual men and women are sexually attracted to or participate in sexual behaviors with individuals of both genders. Transgender individuals live part or full-time in a gender role opposite to their genetic sex.

Estimates suggest that approximately 2.8% of men and 1.4% of women identify as being gay, lesbian, or bisexual while 9.1% of men and 4.3% of women have participated in sexual behavior with someone of the same gender at least once. The true extent of the transgender community has not been well researched in the United States. Note that estimates of the LGBT community are based on self-reported information and actual rates may be higher.

Certain issues arise when trying to define sexual orientation. Many gay men and lesbians have participated in or continue to participate in sexual activities with members of the opposite sex but choose not to identify as heterosexuals or bisexuals. Others have never participated in sexual activities at all yet still identify as gay, lesbian, or bisexual. Some men and women identifying as bisexuals are in long-term, monogamous relationships with individuals of the same or opposite sex. Male-to-female (MTF) or female-to-male (FTM) transgender individuals may or may not identify themselves as gay or lesbian.

The implications of these identity issues are far-reaching. Misdiagnoses or improper medical recommendations might be made by health care providers who have mistakenly assumed sexual behaviors or risks from the patient's stated identity. For example, a provider might incorrectly assume that a lesbian patient has never had sexual intercourse with a male and therefore would not have contracted STDs. It has

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been difficult to closely estimate the numbers of LGBT individuals in the United States because of varying definitions. Likewise, the statistics in medical or social studies and surveys on LGBT issues might vary widely depending on what definitions were provided for the respondents. Because of this, many researchers have opted for the more inclusive terms of "men who have sex with men" (MSM) and "women who have sex with women" (WSW) to categorize gay, lesbian, and bisexual respondents.

Important health care issues

Many LGBT individuals have difficulty revealing their sexual identity ("coming out") to their health care providers. They may fear discrimination from providers or believe that their confidentiality might be breached. In some cases health care workers have been poorly trained to address the needs of LGBT individuals, have difficulty communicating with their LGBT patient, or feel uncomfortable providing care for LGBT patients. In addition, many questions posed in questionnaires or examinations are heterosexually biased (e.g., asking a lesbian which birth control methods she uses).

Other reasons why LGBT individuals are often hesitant to share their sexual identity are more logistical. Many insurance companies deny benefits to long-term partners on the basis that they are not married. LGBT patients may have inadequate access to health care, either because they live in a remote rural area or in the crowded inner city. Some same-sex partners encounter discrimination in hospitals and clinics when they are denied the rights usually given to spouses of a patient such as visiting, making medical decisions, and participating in consultations with physicians.

Some of the health concerns and risk factors that are relevant to LGBT individuals may be shared by the general population, while others are more specific to the LGBT community, and still others are specific to different subgroups of LGBT individuals. These health concerns may be grouped into the following areas of concern:

- Sexual behavior issues: STDs such as human immunodeficiency virus (HIV) and acquired immune deficiency syndrome (AIDS), hepatitis A virus (HAV), hepatitis B virus (HBV), bacterial vaginosis, gonorrhea, chlamydia, and genital warts (human papillomavirus or HPV); anal, ovarian, and cervical cancer.
- Cultural issues: body image, nutrition, weight, and eating disorders; drug and alcohol abuse; tobacco use; parenting and family planning.
- Discrimination issues: inadequate medical care; harassment at work, school, or home; difficulty in obtaining housing, insurance coverage, or child custody; violence.
- Sexual identity issues: conflicts with family, friends, and work mates; psychological issues such as anxiety, depression, and suicide; economic hardship.

CANCER. Cancer is the second leading cause of **death** (after heart disease) in the United States. In 2008, it was estimated that about 1.4 million individuals were diagnosed with cancer and about 565,600 lost their lives as a result. LGBT individuals are at an increased risk for certain types of cancers.

Several studies indicated that lesbians appear to have a higher risk for developing uterine, breast, cervical, endometrial, and ovarian cancers This is partially related to higher rates of risk factors such as **obesity**, alcohol use, tobacco use, and nulliparity (not bearing children). Lesbians are less likely than heterosexual women to visit a doctor for routine Pap screening that can detect **cervical cancer**. Lesbians also have additional risk of developing **ovarian cancer**, due to inadequate access to health care, nulliparity, and not using **oral contraceptives** (use of oral contraceptives has been shown to decrease the risk of getting ovarian cancer).

Gay and bisexual men (or more generally, men who have sex with men [MSM]) are at higher risk of developing non-Hodgkin's lymphoma, Hodgkin's disease, and **anal cancer**. **Kaposi's sarcoma**, an AIDS-associated cancer, are also found in the gay community at rates higher than the general population. Anal cancer is associated with transmission of human papillomavirus (HPV), and the risk factors associated with MSM are also associated with increased rates of anal cancer (i.e. **smoking**, having many sexual partners, and receiving anal intercourse).

AIDS. The United States Centers for Disease Control and Prevention (CDC) estimated that in 2006, 944,000 people in the United States had been diagnosed with **AIDS** since the disease was identified in 1981. In 2006, an additional 1–1.2 million Americans were diagnosed as infected with HIV but not yet showing symptoms (HIV positive). However, in early 2009, the CDC issued a statement that they now thought that earlier the HIV-positive estimates were too low, as many more people than were originally estimated are living with unreported or undiagnosed HIV infection. More than 70% of HIV infections are transmitted through sexual contact. Traditionally in the United States, the majority of cases were found in homosexual

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KEY TERM

Nulliparity—The condition of being nulliparous, or not bearing offspring.

or bisexual men. In 2007, about half of new HIV cases were acquired by men having sex with other men.

PSYCHIATRIC DISORDERS. In 1973, the American Psychiatric Association removed homosexuality from their list of mental disorders. Nevertheless, American society has been slow to fully accept of members of the LGBT community. As a result, members of this community often find themselves rejected by their families, socially stigmatized for their sexual orientation, treated unequally by laws and the justice system, and subject to physical and emotional **abuse** for their lifestyles. These pressures, plus the continuing **stress** caused by the need some LGBT individuals feel to conceal their sexual orientation from family, LGBT employers, and larger society lead to an increased occurrence of depressive illness, **anxiety disorders**, and drug and alcohol abuse.

NUTRITION AND BODY IMAGE. Diet and nutritional factors are associated with a number of diseases including cancer, **stroke**, diabetes, heart disease, and **osteoporosis**. It has been shown that lesbians are more likely than heterosexual women to be obese, have a higher body mass index (BMI), have a nutritionally poorer diet, and have higher rates of smoking and alcohol use, but they are also more likely to have a healthier body image than heterosexual women. Gay men and adolescents, on the other hand, have been shown to have increased rates of eating disorder behaviors than heterosexual men (e.g. **anorexia nervosa**, bulimia, and **binge eating**) and a poorer body image.

DRUG, ALCOHOL, AND TOBACCO USE. **Marijuana** and **cocaine** use has been shown to be higher among lesbians than heterosexual women. The incidence of the use of some drugs is higher in gay men than heterosexual men; these include marijuana, psychedelic drugs, ecstasy, **barbiturates**, and stimulants such as amyl or butyl nitrate ("poppers"). Although alcohol use has declined in the LGBT community since the 1990s, the rate is still higher among young LGBT individuals.

Cigarette smoking is responsible for 430,000 deaths a year in the United States, with an estimated 3,000 nonsmokers dying as a result of exposure to secondhand smoke. In 2004 the rate of smoking among all adults was 28%. In contrast, 50% of gay men, lesbians and bisexuals were noted to be smokers. Lesbians are more than two times as likely to become heavy smokers than heterosexual women.

Prevention

There are numerous ways that health care providers can improve the access to and experience of health care services for LGBT individuals. These include:

- rewording questionnaires and examinations to be inclusive of LGBT patients
- providing referrals to social service agencies and counseling services that are LGBT-friendly
- taking educational courses that are sensitive to the needs of LGBT patients
- treating the families of LGBT patients as one would the families of heterosexual patients
- maintaining the strictest code of confidentiality
- developing and maintaining health care centers or clinics that address LGBT-specific needs
- asking non-threatening questions to determine if a person is at risk of an STD
- educating patients of risk factors associated with STDs, possible vaccines, and treatments available
- providing services to individuals in the process of disclosing their sexual identity and, if applicable, their families

Resources

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"Sexual Orientation." *American Psychiatric Association*. [cited October 18, 2010]. http://healthyminds.org/More-Info-For/GayLesbianBisexuals.aspx

ORGANIZATIONS

Gay and Lesbian Medical Association, 459 Fulton Street, Suite 107, San Francisco, CA, (415) 255-4547, (415) 255-4784, info@glma.org, http://www.glma.org.

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Parents, Familes and Friends of Lesbians and Gays (PFLAG), 1726 M Street NW, Suite 400, Washington, DC, 20036, (202) 467-8180, (202) 467-8194, info@pflag.org, http://community.pflag.org.

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KEY TERMS

Cross-dressing—Dressing in clothing that is stereotypical of the opposite sex.

Gender identity disorder (GID)—A strong and lasting cross-gender identification and persistent discomfort with one's biological gender (sex) role. This discomfort must cause a significant amount of distress or impairment in the functioning of the individual.

Transsexual—A person with gender identity disorder who has an overwhelming desire to change anatomic sex; one who seeks hormonal or surgical treatment to change sex.

Gender identity disorder

Definition

The psychological diagnosis gender identity disorder (GID) is used to describe a male or female that feels a strong identification with the opposite sex and experiences considerable distress because of their actual sex.

Description

Gender identity disorder can affect children, adolescents, and adults. Individuals with gender identity disorder have strong cross-gender identification. They believe that they are, or should be, the opposite sex. They are uncomfortable with their sexual role and organs and may express a desire to alter their bodies. While not all persons with GID are labeled as transsexuals, there are those who are determined to undergo sex change procedures or have done so, and, therefore, are classified as transsexual. They often attempt to pass socially as the opposite sex. Transsexuals alter their physical appearance cosmetically and hormonally, and may eventually undergo a sex-change operation.

Children with gender identity disorder refuse to dress and act in sex-stereotypical ways. It is important to remember that many emotionally healthy children experience fantasies about being a member of the opposite sex. The distinction between these children and gender identity disordered children is that the latter experience significant interference in functioning because of their cross-gender identification. They may become severely depressed, anxious, or socially withdrawn.

Causes and symptoms

The cause of gender identity disorder is not known. It has been theorized that a prenatal hormonal imbalance may predispose individuals to the disorder. Problems in the individual's family interactions or family dynamics have also been postulated as having some causal impact.

The *Diagnostic and Statistical Manual of Mental Disorders*, Fourth Edition (*DSM-IV*), the diagnostic reference standard for United States mental health professionals, describes the criteria for gender identity disorder as an individual's strong and lasting cross-gender identification and their persistent discomfort with their biological gender role. This discomfort must cause a significant amount of distress or impairment in the functioning of the individual.

DSM-IV specifies that children must display at least four of the following symptoms of cross-gender identification for a diagnosis of gender identity disorder:

- a repeatedly stated desire to be, or insistence that he or she is, the opposite sex
- a preference for cross-dressing
- a strong and lasting preference to play make-believe and role-playing games as a member of the opposite sex or persistent fantasies that he or she is the opposite sex
- a strong desire to participate in the stereotypical games of the opposite sex
- a strong preference for friends and playmates of the opposite sex

Diagnosis

Gender identity disorder is typically diagnosed by a psychiatrist or psychologist, who conducts an interview with the patient and takes a detailed social history. Family members may also be interviewed during the assessment process. This evaluation usually takes place in an outpatient setting.

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Treatment

Treatment for children with gender identity disorder focuses on treating secondary problems such as depression and **anxiety**, and improving self-esteem. Treatment may also work on instilling positive identifications with the child's biological gender. Children typically undergo psychosocial therapy sessions; their parents may also be referred for family or individual therapy.

Transsexual adults often request hormone and surgical treatments to suppress their biological sex characteristics and acquire those of the opposite sex. A team of health professionals, including the treating psychologist or psychiatrist, medical doctors, and several surgical specialists, oversee this transitioning process. Because of the irreversible nature of the surgery, candidates for sex-change surgery are evaluated extensively and are often required to spend a period of time integrating themselves into the cross-gender role before the procedure begins. Counseling and peer support are also invaluable to transsexual individuals.

Prognosis

Long-term follow up studies have shown positive results for many transsexuals who have undergone sex-change surgery. However, significant social, personal, and occupational issues may result from surgical sex changes, and the patient may require **psychotherapy** or counseling.

Resources

OTHER

The National Transgender Guide. http://www.tgguide.com.

ORGANIZATIONS

American Academy of Child and Adolescent Psychiatry (AACAP), 3615 Wisconsin Ave. NW, Washington, DC, 20013-3007, (202) 966-7300, (202) 966-2891, communications@aacap.org, http://www.aacap.org.

Paula Anne Ford-Martin

Gender reassignment surgery *see* **Sex reassignment surgery**

Gene therapy

Gene therapy is a rapidly growing field of medicine in which genes are introduced into the body to treat diseases. Genes control heredity and provide the basic biological code for determining a cell's specific functions. Gene therapy seeks to provide genes that correct or supplant the disease-controlling functions of cells that are not, in essence, doing their job. Somatic gene therapy introduces therapeutic genes at the tissue or cellular level to treat a specific individual. Germ-line gene therapy inserts genes into reproductive cells or possibly into embryos to correct genetic defects that could be passed on to future generations. Initially conceived as an approach for treating inherited diseases, like **cystic fibrosis** and Huntington's disease, the scope of potential gene therapies has grown to include treatments for cancers, arthritis, and infectious diseases. Although gene therapy testing in humans has advanced rapidly, many questions surround its use. For example, some scientists are concerned that the therapeutic genes themselves may cause disease. Others fear that germ-line gene therapy may be used to control human development in ways not connected with disease, like intelligence or appearance.

The biological basis of gene therapy

Gene therapy has grown out of the science of genetics or how heredity works. Scientists know that life begins in a cell, the basic building block of all multicellular organisms. Humans, for instance, are made up of trillions of cells, each performing a specific function. Within the cell's nucleus (the center part of a cell that regulates its chemical functions) are pairs of chromosomes. These threadlike structures are made up of a single molecule of DNA (deoxyribonucleic acid), which carries the blueprint of life in the form of codes, or genes, that determine inherited characteristics.

A DNA molecule looks like two ladders with one of the sides taken off both and then twisted around each other. The rungs of these ladders meet (resulting in a spiral staircase-like structure) and are called base pairs. Base pairs are made up of nitrogen molecules and arranged in specific sequences. Millions of these base pairs, or sequences, can make up a single gene, specifically defined as a segment of the chromosome and DNA that contains certain hereditary information. The gene, or combination of genes formed by these base pairs ultimately direct an organism's growth and characteristics through the production of certain chemicals, primarily proteins, which carry out most of the body's chemical functions and biological reactions.

Scientists have long known that alterations in genes present within cells can cause inherited diseases like cystic fibrosis, sickle-cell anemia, and **hemophilia**. Similarly, errors in the total number of chromosomes can cause conditions such as **Down syndrome** or **Turner syndrome**. As the study of genetics advanced, however, scientists learned that an altered genetic sequence can

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Early detection of cancer. The researcher's pen marks a band on a DNA sequencing autogradiogram confirming a bladder cancer. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

also make people more susceptible to diseases, like **atherosclerosis**, **cancer**, and even **schizophrenia**. These diseases have a genetic component, but are also influenced by environmental factors (such as diet and lifestyle). The objective of gene therapy is to treat diseases by introducing functional genes into the body to alter the cells involved in the disease process by either replacing missing genes or providing copies of functioning genes to replace nonfunctioning ones. The inserted genes can be naturally occurring genes that produce the desired effect or may be genetically engineered (or altered) genes.

Scientists have known how to manipulate a gene's structure in the laboratory since the early 1970s through a process called gene splicing. The process involves removing a fragment of DNA containing the specific genetic sequence desired then inserting it into the DNA of another gene. The resultant product is called recombinant DNA and the process is genetic engineering.

There are basically two types of gene therapy. Germ-line gene therapy introduces genes into reproductive cells (sperm and eggs) or someday possibly into embryos in hopes of correcting genetic abnormalities that could be passed on to future generations. Most of the current work in applying gene therapy, however, has been in the realm of somatic gene therapy. In this type of gene therapy, therapeutic genes are inserted into tissue or cells to produce a naturally occurring protein or substance that is lacking or not functioning correctly in an individual patient.

Viral vectors

In both types of therapy, scientists need something to transport either the entire gene or a recombinant DNA to the cell's nucleus, where the chromosomes and DNA reside. In essence, vectors are molecular delivery trucks. One of the first and most popular vectors developed were viruses because they invade cells as part of the natural infection process. Viruses have the potential to be excellent vectors because they have a specific relationship with the host in that they colonize certain cell types and tissues in specific organs. As a result, vectors are chosen according to their attraction to certain cells and areas of the body.

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One of the first vectors used was the retrovirus. Because these viruses are easily cloned (artificially reproduced) in the laboratory, scientists have studied them extensively and learned a great deal about their biological action. They have also learned how to remove the genetic information which governs viral replication, thus reducing the chances of infection.

Retroviruses work best in actively dividing cells, but cells in the body are relatively stable and do not divide often. As a result, these cells are used primarily for *ex vivo* (outside the body) manipulation. First, the cells are removed from the patient's body, and the virus, or vector, carrying the gene is inserted into them. Next, the cells are placed into a nutrient culture where they grow and replicate. Once enough cells are gathered, they are returned to the body, usually by injection into the blood stream. Theoretically, as long as these cells survive, they will provide the desired therapy.

Another class of viruses, called the adenoviruses, may also prove to be good gene vectors. These viruses can effectively infect nondividing cells in the body, where the desired gene product is then expressed naturally. In addition to being a more efficient approach to gene transportation, these viruses, which cause respiratory infections, are more easily purified and made stable than retroviruses, resulting in less chance of an unwanted viral infection. However, these viruses live for several days in the body, and some concern surrounds the possibility of infecting others with the viruses through sneezing or coughing. Other viral vectors include **influenza** viruses, Sindbis virus, and a herpes virus that infects nerve cells.

Scientists have also delved into nonviral vectors. These vectors rely on the natural biological process in which cells uptake (or gather) macromolecules. One approach is to use liposomes, globules of fat produced by the body and taken up by cells. Scientists are also investigating the introduction of raw recombinant DNA by injecting it into the bloodstream or placing it on microscopic beads of gold shot into the skin with a "gene-gun." Another possible vector under development is based on dendrimer molecules. A class of polymers (naturally occurring or artificial substances that have a high molecular weight and formed by smaller molecules of the same or similar substances), is "constructed" in the laboratory by combining these smaller molecules. They have been used in manufacturing Styrofoam, polyethylene cartons, and Plexiglass. In the laboratory, dendrimers have shown the ability to transport genetic material into human cells. They can also be designed to form an affinity for particular cell membranes by attaching to certain sugars and protein groups.

History of gene therapy

In the early 1970s, scientists proposed "gene surgery" for treating inherited diseases caused by faulty genes. The idea was to take out the disease-causing gene and surgically implant a gene that functioned properly. Although sound in theory, scientists, then and now, lack the biological knowledge or technical expertise needed to perform such a precise surgery in the human body.

However, in 1983, a group of scientists from Baylor College of Medicine in Houston, Texas, proposed that gene therapy could one day be a viable approach for treating Lesch-Nyhan disease, a rare neurological disorder. The scientists conducted experiments in which an enzyme-producing gene (a specific type of protein) for correcting the disease was injected into a group of cells for replication. The scientists theorized the cells could then be injected into people with Lesch-Nyhan disease, thus correcting the genetic defect that caused the disease.

As the science of genetics advanced throughout the 1980s, gene therapy gained an established foothold in the minds of medical scientists as a promising approach to treatments for specific diseases. One of the major reasons for the growth of gene therapy was scientists' increasing ability to identify the specific genetic malfunctions that caused inherited diseases. Interest grew as further studies of DNA and chromosomes (where genes reside) showed that specific genetic abnormalities in one or more genes occurred in successive generations of certain family members who suffered from diseases like intestinal cancer, manic-depression, **Alzheimer's disease**, heart disease, diabetes, and many more. Although the genes may not be the only cause of the disease in all cases, they may make certain individuals more susceptible to developing the disease because of environmental influences, like **smoking**, pollution, and **stress**. In fact, some scientists theorize that all diseases may have a genetic component.

On September 14, 1990, a four-year-old girl with a genetic disorder that prevented her body from producing a crucial enzyme became the first person to undergo gene therapy in the United States. Because her body could not produce adenosine deaminase (ADA), she had a weakened immune system, making her extremely susceptible to severe, life-threatening infections. W. French Anderson and colleagues at the National Institutes of Health's Clinical Center in Bethesda, Maryland, took white blood cells (which are crucial to proper immune system functioning) from the girl, inserted ADA producing genes into them, and then transfused the cells back into the patient. Although

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the young girl continued to show an increased ability to produce ADA, debate arose as to whether the improvement resulted from the gene therapy or from an additional drug treatment she received.

Nevertheless, a new era of gene therapy began as more and more scientists sought to conduct clinical trial (testing in humans) research in this area. In that same year, gene therapy was tested on patients with melanoma (skin cancer). The goal was to help them produce antibodies (disease fighting substances in the immune system) to battle the cancer.

These experiments have spawned an ever-growing number of attempts at gene therapies designed to perform a variety of functions in the body. For example, a gene therapy for cystic fibrosis aims to supply a gene that alters cells, enabling them to produce a specific protein to battle the disease. Another approach was used for brain cancer patients, in which the inserted gene was designed to make the cancer cells more likely to respond to drug treatment. Gene therapy for patients who have artery blockage, which can lead to strokes, induces the growth of new blood vessels near clogged arteries, thus ensuring normal blood circulation.

Currently, there are a host of new gene therapy agents in clinical trials. In the United States, both nucleic acid-based (*in vivo*) treatments and cell-based (*ex vivo*) treatments are being investigated. Nucleic acid-based gene therapy uses vectors (like viruses) to deliver modified genes to target cells. Cell-based gene therapy techniques remove cells from the patient in order to genetically alter them then reintroduce them to the patient's body. Presently, gene therapies for the following diseases are being developed: cystic fibrosis (using adenoviral vector), HIV infection (cell-based), **malignant melanoma** (cell-based), Duchenne **muscular dystrophy** (cell-based), hemophilia B (cell-based), **kidney cancer** (cell-based), **Gaucher disease** (retroviral vector), **breast cancer** (retroviral vector), and lung cancer (retroviral vector). When a cell or individual is treated using gene therapy and successful incorporation of engineered genes has occurred, the cell or individual is said to be *transgenic*.

The medical establishment's contribution to transgenic research has been supported by increased government funding. In 1991, the U.S. government provided $58 million for gene therapy research, with increases in funding of $15–40 million dollars a year over the following four years. With fierce competition over the promise of societal benefit in addition to huge profits, large pharmaceutical corporations have moved to the forefront of transgenic research. In an effort to be first in developing new therapies, and armed with billions of dollars of research funds, such corporations are making impressive strides toward making gene therapy a viable reality in the treatment of once elusive diseases.

Diseases targeted for treatment by gene therapy

The potential scope of gene therapy is enormous. More than 5,000 diseases have been identified as resulting directly from abnormal genes, and countless others that may be partially influenced by a person's genetic makeup. Initial research has concentrated on developing gene therapies for diseases whose genetic origins have been established and for other diseases that can be cured or ameliorated by substances genes produce.

The following are examples of potential gene therapies. People suffering from cystic fibrosis lack a gene needed to produce a salt-regulating protein. This protein regulates the flow of chloride into epithelial cells, (the cells that line the inner and outer skin layers) which cover the air passages of the nose and lungs. Without this regulation, patients with cystic fibrosis build up a thick mucus that makes them prone to lung infections. A gene therapy technique to correct this abnormality might employ an adenovirus to transfer a normal copy of what scientists call the cystic fibrosis transmembrane conductance regulator, or CTRF, gene. The gene is introduced into the patient by spraying it into the nose or lungs.

Familial **hypercholesterolemia** (FH) is also an inherited disease, resulting in the inability to process cholesterol properly, which leads to high levels of artery-clogging fat in the blood stream. Patients with FH often suffer heart attacks and strokes because of blocked arteries. A gene therapy approach used to battle FH is much more intricate than most gene therapies because it involves partial surgical removal of patients' livers (*ex vivo* transgene therapy). Corrected copies of a gene that serve to reduce cholesterol build-up are inserted into the liver sections, which are then transplanted back into the patients.

Gene therapy has also been tested on patients with **AIDS**. AIDS is caused by the human **immunodeficiency** virus (HIV), which weakens the body's immune system to the point that sufferers are unable to fight off diseases like pneumonias and cancer. In one approach, genes that produce specific HIV proteins have been altered to stimulate immune system functioning without causing the negative effects that a complete HIV molecule has on the immune system. These genes are then injected in the patient's blood stream. Another approach to treating AIDS is to insert, via white

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blood cells, genes that have been genetically engineered to produce a receptor that would attract HIV and reduce its chances of replicating.

Several cancers also have the potential to be treated with gene therapy. A therapy tested for melanoma, or skin cancer, involves introducing a gene with an anti-cancer protein called tumor necrosis factor (TNF) into test tube samples of the patient's own cancer cells, which are then reintroduced into the patient. In brain cancer, the approach is to insert a specific gene that increases the cancer cells' susceptibility to a common drug used in fighting the disease.

Gaucher disease is an inherited disease caused by a mutant gene that inhibits the production of an enzyme called glucocerebrosidase. Patients with Gaucher disease have enlarged livers and spleens and eventually their bones deteriorate. Clinical gene therapy trials focus on inserting the gene for producing this enzyme.

Gene therapy is also being considered as an approach to solving a problem associated with a surgical procedure known as balloon **angioplasty**. In this procedure, a stent (in this case, a type of tubular scaffolding) is used to open the clogged artery. However, in response to the trauma of the stent insertion, the body initiates a natural healing process that produces too many cells in the artery and results in restenosis, or reclosing of the artery. The gene therapy approach to preventing this unwanted side effect is to cover the outside of the stents with a soluble gel. This gel contains vectors for genes that reduce this overactive healing response.

The Human Genome Project

Although great strides have been made in gene therapy in a relatively short time, its potential usefulness has been limited by lack of scientific data concerning the multitude of functions that genes control in the human body. For instance, it is now known that the vast majority of genetic material does not store information for the creation of proteins, rather, it is involved in the control and regulation of gene expression, and is therefore much more difficult to interpret. Even so, each individual cell in the body carries thousands of genes coding for proteins, with some estimates as high as 150,000 genes. For gene therapy to advance to its full potential, scientists must discover the biological role of each of these individual genes and where the base pairs that make them up are located on DNA.

To address this issue, the National Institutes of Health initiated the Human Genome Project in 1990. Led initially by James D. Watson, one of the co-discoverers of the chemical makeup of DNA, the project's 15-year goal was to map the entire human genome (a combination of the words gene and chromosomes). Watson was replaced in 1993 by Dr. Francis Collins, and the name of the project's center was officially changed to the National Human Genome Research Institute (NHGRI) in 1997. A genome map would clearly identify the location of all genes as well as the more than three billion base pairs that make them up. With a precise knowledge of gene locations and functions, scientists may one day be able to conquer or control diseases that have plagued humanity for centuries.

Scientists working at NHGRI have identified an average of one new gene a day, but many expect this rate of discovery to increase. Their goal was to determine the exact location of all the genes on human DNA and the exact sequence of the base pairs that make them up by 2005. A "rough draft" of the genome was finished in 2000, with the complete genome essentially sequenced by April 2003, two years earlier than planned. A number of regions of the genome, however, remain incompletely sequenced as of 2010. These include the central regions of the chromosomes, known as centromeres, and the end regions of the chromosomes, the telomeres. Both these regions are highly repetitive DNA sequences millions of base pairs in length that are difficult to sequence given the limits of current technology. The best current estimate is that about 93% of the genome has been completely sequenced as of early 2010.

Some of the genes already identified through the Human Genome Project include a gene that predisposes people to **obesity**, one associated with programmed cell death (apoptosis), a gene that guides HIV viral reproduction, and the genes of inherited disorders like **Huntington disease**, Lou Gehrig's disease, and some colon and breast cancers. As the human genome is completed, there will be more information available for gene therapy research and implementation.

Future of gene therapy

Gene therapy seems elegantly simple in its concept: supply the human body with a gene that can correct a biological malfunction that causes a disease. However, there are many obstacles and some distinct questions concerning the viability of gene therapy. For example, viral vectors must be carefully controlled lest they infect the patient with a viral disease. Some vectors, like retroviruses, can also enter cells functioning properly and interfere with the natural biological processes, possibly leading to other diseases. Other viral vectors, like the adenoviruses, are often recognized and destroyed by the immune system so their therapeutic effects are short-lived. Maintaining gene

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expression so that the gene will perform its role properly after vector delivery is difficult. As a result, some therapies need to be repeated often to provide long-lasting benefits.

One of the most pressing issues, however, is gene regulation. Genes work in concert to regulate their functioning. In other words, several genes may play a part in turning other genes on and off. For example, certain genes work together to stimulate cell division and growth, but if these are not regulated, the inserted genes could cause tumor formation and cancer. Another difficulty is learning how to make the gene go into action only when needed. For the best and safest therapeutic effort, a specific gene should turn on, for example, when certain levels of a protein or enzyme are low and must be replaced. But the gene should also remain dormant when not needed to ensure it does not oversupply a substance and disturb the body's delicate chemical makeup.

One approach to gene regulation is to attach other genes that detect certain biological activities and then react as a type of automatic off-and-on switch that regulates the activity of the other genes according to biological cues. Although still in the rudimentary stages, researchers are making headway in inhibiting some gene functioning by using a synthetic DNA to block gene transcriptions (the copying of genetic information). This approach may have implications for gene therapy.

Ethics of gene therapy

While gene therapy holds promise as a revolutionary approach to treating disease, ethical concerns over its use and ramifications have been expressed by scientists and lay people alike. For example, since much needs to be learned about how these genes actually work and their long-term effect, is it ethical to test these therapies on humans, where they could have a disastrous result? As with most clinical trials concerning new therapies, including many drugs, the patients participating in these studies have usually not responded to more established therapies and are often so ill the novel therapy is their only hope for long-term survival.

Another questionable outgrowth of gene therapy is that scientists could possibly manipulate genes to genetically control traits in human offspring that are not health-related. For example, perhaps a gene could be inserted to ensure that a child would not be bald, a seemingly harmless goal. However, what if genetic manipulation was used to alter skin color, prevent homosexuality, or ensure good looks? If a gene is found that can enhance intelligence of children who are not yet born, will everyone in society, the rich and the poor, have access to the technology or will it be so expensive only the elite can afford it?

The Human Genome Project, which plays such an integral role for the future of gene therapy, also has social repercussions. If individual genetic codes can be determined, will such information be used against people? For example, will someone more susceptible to a disease have to pay higher insurance premiums or be denied health insurance altogether? Will employers discriminate between two potential employees, one with a "healthy" genome and the other with genetic abnormalities?

Some of these concerns can be traced back to the eugenics movement popular in the first half of the twentieth century. This genetic "philosophy" was a societal movement that encouraged people with "positive" traits to reproduce while those with less desirable traits were sanctioned from having children. Eugenics was used to pass strict immigration laws in the United States, barring less suitable people from entering the country lest they reduce the quality of the country's collective gene pool. Probably the most notorious example of eugenics in action was the rise of Nazism in Germany, which resulted in the Eugenic Sterilization Law of 1933. The law required sterilization for those suffering from certain disabilities and even for some who were simply deemed "ugly." To ensure that this novel science is not abused, many governments have established organizations specifically for overseeing the development of gene therapy. In the United States, the Food and Drug Administration (FDA) and the National Institutes of Health (NIH) require scientists to take a precise series of steps and meet stringent requirements before approving clinical trials.

In fact, gene therapy has been immersed in more controversy and surrounded by more scrutiny in both the health and ethical arena than most other technologies (except, perhaps, for cloning) that promise to substantially change society. Despite the health and ethical questions surrounding gene therapy, the field will continue to grow and is likely to change medicine faster than any previous medical advancement.

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General adaptation syndrome

Definition

General adaptation syndrome, or GAS, is a term used to describe the body's short-term and long-term reactions to **stress**.

Stressors in humans include such physical stressors as **starvation**, being hit by a car, or suffering through severe weather. Additionally, humans can suffer such emotional or mental stressors as the loss of a loved one, the inability to solve a problem, or even having a difficult day at work.

Description

Originally described by Hans Selye (1907–1982), an Austrian-born physician who emigrated to Canada in 1939, the general adaptation syndrome represents a three-stage reaction to stress. Selye explained his choice of terminology as follows: "I call this syndrome *general* because it is produced only by agents which have a general effect upon large portions of the body. I call it *adaptive* because it stimulates defense. . .I call it a *syndrome* because its individual manifestations are coordinated and even partly dependent upon each other."

Selye thought that the general adaptation syndrome involved two major systems of the body, the nervous system and the endocrine (or hormonal) system. He then went on to outline what he considered as three distinctive stages in the syndrome's evolution. He called these stages the alarm reaction (AR), the stage of resistance (SR), and the stage of exhaustion (SE).

Stage 1: Alarm reaction (AR)

The first stage of the general adaptation stage, the alarm reaction, is the immediate reaction to a stressor. In the initial phase of stress, humans exhibit a "fight or flight" response, which prepares the body for physical activity. However, this initial response can also decrease the effectiveness of the immune system, making persons more susceptible to illness during this phase.

Stage 2: Stage of resistance (SR)

Stage 2 might also be named the stage of adaptation, instead of the stage of resistance. During this phase, if the stress continues, the body adapts to the stressors it is exposed to. Changes at many levels take place in order to reduce the effect of the stressor. For example, if the stressor is starvation (possibly due to anorexia), the person might experienced a reduced desire for physical activity to conserve energy, and the absorption of nutrients from food might be maximized.

Stage 3: Stage of exhaustion (SE)

At this stage, the stress has continued for some time. The body's resistance to the stress may gradually be reduced, or may collapse quickly. Generally, this means the immune system, and the body's ability to resist disease, may be almost totally eliminated. Patients who experience long-term stress may succumb to heart attacks or severe infection due to their reduced immunity. For example, a person with a stressful job may experience long-term stress that might lead to high blood pressure and an eventual **heart attack**.

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KEY TERMS

Adjustment disorder—A disorder defined by the development of significant emotional or behavioral symptoms in response to a stressful event or series of events within the normal range of human experience.

Cortisol—A steroid hormone released by the cortex (outer portion) of the adrenal gland when a person is under stress.

Eustress—A term that is sometimes used to refer to positive stress.

Stress management—A set of techniques and programs intended to help people deal more effectively with stress in their lives by analyzing the specific stressors and taking positive actions to minimize their effects. Most stress management programs deal with job stress and workplace issues.

Stressor—A stimulus or event that provokes a stress response in an organism. Stressors can be categorized as acute or chronic, and as external or internal to the organism.

Stress, a useful reaction?

The reader should note that Dr. Selye did not regard stress as a purely negative phenomenon; in fact, he frequently pointed out that stress is not only an inevitable part of life but results from intense joy or pleasure as well as fear or **anxiety**. "Stress is not even necessarily bad for you; it is also the spice of life, for any emotion, any activity, causes stress." Some later researchers have coined the term "eustress" or pleasant stress, to reflect the fact that such positive experiences as a job promotion, completing a degree or training program, marriage, travel, and many others are also stressful.

Selye also pointed out that human perception of and response to stress is highly individualized; a job or sport that one person finds anxiety-provoking or exhausting might be quite appealing and enjoyable to someone else. Looking at one's responses to specific stressors can contribute to better understanding of one's particular physical, emotional, and mental resources and limits.

Causes and symptoms

Stress is one cause of general adaptation syndrome. The results of unrelieved stress can manifest as **fatigue**, irritability, difficulty concentrating, and difficulty sleeping. Persons may also experience other symptoms that are signs of stress. Persons experiencing unusual symptoms, such as hair loss, without another medical explanation might consider stress as the cause.

The general adaptation syndrome is also influenced by such universal human variables as overall health and nutritional status, sex, age, ethnic or racial background, level of education, socioeconomic status (SES), genetic makeup, etc. Some of these variables are biologically based and difficult or impossible to change. For example, recent research indicates that men and women respond somewhat differently to stress, with women being more likely to use what is called the "tend and befriend" response rather than the classical "fight or flight" pattern. These researchers note that most of the early studies of the effects of stress on the body were conducted with only male subjects.

Selye's observation that people vary in their perceptions of stressors was reflected in his belief that the stressors themselves are less dangerous to health than people's maladaptive responses to them. He categorized certain diseases, ranging from cardiovascular disorders to inflammatory diseases and mental disorders as "diseases of adaptation," regarding them as "largely due to errors in our adaptaive response to stress" rather than the direct result of such outside factors as germs, toxic substances, etc.

Diagnosis

GAS by itself is not an official diagnostic category but rather a descriptive term. A person who consults a doctor for a stress-related physical illness may be scheduled for blood or urine tests to measure the level of cortisol or other stress-related hormones in their body, or imaging studies to evaluate possible abnormalities in their endocrine glands if the doctor thinks that these tests may help to establish or confirm a diagnosis.

The American Psychiatric Association (APA) recognizes stress as a factor in **anxiety disorders**, particularly **post-traumatic stress disorder** (PTSD) and **acute stress disorder** (ASD). These two disorders are defined as symptomatic reactions to extreme traumatic stressors (war, natural or transportation

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disasters, criminal assault, **abuse**, hostage situations, etc.) and differ chiefly in the time frame in which the symptoms develop. The APA also has a diagnostic category of **adjustment disorders**, which are characterized either by excessive reactions to stressors within the normal range of experience (e.g., academic examinations, relationship breakups, being fired from a job) or by significant impairment in the person's occupational or social functioning.

Treatment

Treatment of stress-related illnesses typically involves one or more **stress reduction** strategies. Stress reduction strategies generally fall into one of three categories: avoiding stressors; changing one's reaction to the stressor(s); or relieving stress after the reaction to the stressor(s). Many mainstream as well as complementary or alternative (CAM) strategies for stress reduction, such as exercising, listening to music, **aromatherapy**, and massage relieve stress after it occurs.

Many psychotherapeutic approaches attempt to modify the patient's reactions to stressors. These approaches often include an analysis of the patient's individual patterns of response to stress; for example, one commonly used set of categories describes people as "speed freaks," "worry warts," "cliff walkers," "loners," "basket cases," and "drifters." Each pattern has a recommended set of skills that the patient is encouraged to work on; for example, worry warts are advised to reframe their anxieties and then identify their core values and goals in order to take concrete action about their worries. In general, persons wishing to improve their management of stress should begin by consulting a medical professional with whom they feel comfortable to discuss which option, or combination of options, they can use.

Selye himself recommended an approach to stress that he described as "living wisely in accordance with natural laws." In his now-classic book *The Stress of Life* (1956), he discussed the following as important dimensions of living wisely:

- Adopting an attitude of gratitude toward life rather than seeking revenge for injuries or slights.
- Acting toward others from altruistic rather than self-centered motives.
- Retaining a capacity for wonder and delight in the genuinely good and beautiful things in life.
- Finding a purpose for one's life and expressing one's individuality in fulfilling that purpose.
- Keeping a healthy sense of modesty about one's goals or achievements.

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ORGANIZATIONS

American Psychiatric Association (APA), 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209, (888) 357-7924, apa@psych.org, http://www.psych.org.

Canadian Institute of Stress, Hans Selye Foundation, Medcan Clinic Office, Suite 1500, 150 York Street, Toronto, ON, Canada, M5H 3S5, (416) 236-4218, info@stresscanada.org, http://www.stresscanada.org.

National Institute of Mental Health (NIMH), 6001 Executive Boulevard, Bethesda, MD, 20892, (301) 443-4513, (301) 443-4279, (866) 615-6464, nimhinfo@nih.gov, http://www.nimh.nih.gov.

The American Institute of Stress, 124 Park Avenue, Yonkers, NY, 10703, (914) 963-1200, (914) 965-6267, Stress125@optonline.net, http://www.stress.org.

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General anesthetic *see* **Anesthesia, general**

General surgery

Definition

General surgery is the treatment of injury, deformity, and disease using operative procedures.

Purpose

General surgery is frequently performed to alleviate suffering when a cure is unlikely through medication alone. It can be used for routine procedures performed in a physician's office, such as **vasectomy**, or for more complicated operations requiring a medical

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team in a hospital setting, such as laparoscopic **cholecystectomy** (removal of the gallbladder). Areas of the body treated by general surgery include the stomach, liver, intestines, appendix, breasts, thyroid gland, salivary glands, some arteries and veins, and the skin. The brain, heart, eyes, and feet, to name only a few, are areas that require specialized surgical repair.

New methods and techniques are less invasive than previous practices, permitting procedures that were considered impossible in the past. For example, microsurgery has been used in reattaching severed body parts by successfully reconnecting small blood vessels and nerves.

Precautions

Patients who are obese, smoke, have bleeding tendencies, or are over 60, need to follow special precautions, as do patients who have recently experienced an illness such as **pneumonia** or a **heart attack**. Patients on medications such as heart and blood pressure medicine, blood thinners, **muscle relaxants**, tranquilizers, insulin, or sedatives, may require special lab tests prior to surgery and special monitoring during surgery. Special precautions may be necessary for patients using mind-altering drugs such as **narcotics**, psychedelics, hallucinogens, **marijuana**, sedatives, or **cocaine** since these drugs may interact with the anesthetic agents used during surgery.

Description

In earlier times, surgery was a dangerous and dirty practice. Until the middle of the 19th century, as many patients died of surgery as were cured. With the discovery and development of **general anesthesia** in the mid-1800s, surgery became more humane. And as knowledge about infections grew, surgery became more successful as sterile practices were introduced into the operating room. The last 50 years of the 20th century have seen continued advancements.

Types of general surgery

General surgery experienced major advances with the introduction of the endoscope. This is an instrument for visualizing the interior of a body canal or a hollow organ. Endoscopic surgery relies on this pencil-thin instrument, capable of its own lighting system and small video camera. The endoscope is inserted through tiny incisions called portals. While viewing the procedure on a video screen, the surgeon then operates with various other small, precise instruments inserted through one or more of the portals. The specific area of the body treated determines the type of endoscopic surgery performed. For example, **colonoscopy** uses an endoscope, which can be equipped with a device for obtaining tissue samples for visual examination of the colon. Gastroscopy uses an endoscope inserted through the mouth to examine the interior of the stomach. **Arthroscopy** refers to joint surgery, and abdominal procedures are called laparoscopies.

Endoscopy is used in both treatment and diagnosis especially involving the digestive and female reproductive systems. Endoscopy has advantages over many other surgical procedures, resulting in a quicker recovery and shorter hospital stay. This non-invasive technique is being used for appendectomies, gallbladder surgery, hysterectomies and the repair of shoulder and knee ligaments. However, endoscopy does not come without limitations such as complications and high operating expense. Also, endoscopy doesn't offer advantages over conventional surgery in all procedures. Some literature states that as general surgeons become more experienced in their prospective fields, additional non-invasive surgery will be a more common option to patients.

ONE-DAY SURGERY. One-day surgery is also termed same-day, or outpatient surgery. Surgical procedures usually take two hours or less and involve minimal blood loss and a short recovery time. In the majority of surgical cases, oral medications control postoperative **pain**. Cataract removal, **laparoscopy**, **tonsillectomy**, repair of broken bones, **hernia repair**, and a wide range of cosmetic procedures are common same-day surgical procedures. Many individuals prefer the convenience and atmosphere of one-day surgery centers, as there is less competition for attention with more serious surgical cases. These centers are accredited by the Joint Commission on Accreditation of Healthcare Organizations or the Accreditation Association for Ambulatory Health Care.

Preparation

The preparation of patients has advanced significantly with improved diagnostic techniques and procedures. Before surgery the patient may be asked to undergo a series of tests including blood and urine studies, x rays and specific heart studies if the patient's past medical history and/or physical exam warrants this testing. Before any general surgery the physician will explain the nature of the surgery needed, the reason for the procedure, and the anticipated outcome. The risks involved will be discussed along with the types of anesthesia utilized. The expected length of recovery and limitations imposed during the recovery period are also explained in detail before any general surgical procedure.

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KEY TERMS

Appendectomy—Removal of the appendix.

Endoscope—Instrument for examining visually the inside of a body canal or a hollow organ such as the stomach, colon, or bladder.

Hysterectomy—Surgical removal of part or all of the uterus.

Laparoscopic cholecystectomy—Removal of the gallbladder using a laparoscope, a fiberoptical instrument inserted through the abdomen.

Microsurgery—Surgery on small body structures or cells performed with the aid of a microscope and other specialized instruments.

Portal—An entrance or a means of entrance.

Surgical procedures most often require some type of anesthetic. Some procedures require only **local anesthesia**, produced by injecting the anesthetic agent into the skin near the site of the operation. The patient remains awake with this form of medication. Injecting anesthetic agents into a primary nerve located near the surgical site produces block anesthesia (also known as regional anesthesia), which is a more extensive local anesthesia. The patient remains conscious, but is usually sedated. General anesthesia involves injecting anesthetic agents into the blood stream and/or inhaling medicines through a mask placed over the patient's face. During general anesthesia, the patient is asleep and an airway tube is usually placed into the windpipe to help keep the airway open.

As part of the preoperative preparation, the patient will receive printed educational material and may be asked to review audio or videotapes. The patient will be instructed to shower or bathe the evening before or morning of surgery and may be asked to scrub the operative site with a special antibacterial soap. Instructions will also be given to the patient to ingest nothing by mouth for a determined period of time prior to the surgical procedure.

Aftercare

After surgery, blood studies and a laboratory examination of removed fluid or tissue are often performed especially in the case of **cancer** surgery. After the operation, the patient is brought to a recovery room and vital signs, fluid status, **dressings** and surgical drains are monitored. Pain medications are offered and used as necessary. Breathing exercises are encouraged to maximize respiratory function and leg exercises are encouraged to promote adequate circulation and prevent pooling of blood in the lower extremities. Patients must have a responsible adult accompany them home if leaving the same day as the surgery was performed.

Risks

One of the risks involved with general surgery is the potential for postoperative complications. These complications include—but are not limited to—pneumonia, internal bleeding, and wound infection as well as adverse reactions to anesthesia.

Normal results

Advances in diagnostic and surgical techniques have increased the success rate of general surgery by many times compared to the past. Today's less invasive surgical procedures have reduced the length of hospital stays, shortened recovery time, decreased postoperative pain and decreased the size of surgical incision. On the average, a conventional abdominal surgery requires a three to six-day hospital stay and three to six-week recovery time.

Abnormal results

Abnormal results from general surgery include persistent pain, swelling, redness, drainage or bleeding in the surgical area and surgical wound infection resulting in slow healing.

ORGANIZATIONS

American Medical Association, 515 N. State St., Chicago, IL, 60654, (800) 621-8335, http://www.ama-assn.org.

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Generalized anxiety disorder

Definition

Generalized **anxiety** disorder is a condition characterized by "free floating" anxiety or apprehension not linked to a specific cause or situation.

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Description

Some degree of fear and anxiety is perfectly normal. In the face of real danger, fear makes people more alert and prepares the body to fight or flee (the "fight or flight" response). When people are afraid, their hearts beat faster and they breathe faster in anticipation of the physical activity that will be required of them. Sometimes people can become anxious even when there is no identifiable cause, and this anxiety can become overwhelming and very unpleasant, interfering with their daily lives. People with debilitating anxiety are said to be suffering from **anxiety disorders**, such as **phobias**, panic disorders, and generalized anxiety disorder. The person with generalized anxiety disorder generally has chronic (officially, having more days with anxiety than not for at least six months), recurrent episodes of anxiety that can last days, weeks, or even months.

Causes and symptoms

Generalized anxiety disorder afflicts between 2–3% of the general population, and is slightly more common in women than in men. It accounts for almost one-third of cases referred to psychiatrists by general practitioners.

Generalized anxiety disorder may result from a combination of causes. Some people are genetically predisposed to developing it. Psychological traumas that occur during childhood, such as prolonged separation from parents, may make people more vulnerable as well. Stressful life events, such as a move, a major job change, the loss of a loved one, or a divorce, can trigger or contribute to the anxiety.

Psychologically, the person with generalized anxiety disorder may develop a sense of dread for no apparent reason—the irrational feeling that some nameless catastrophe is about to happen. Physical symptoms similar to those found with **panic disorder** may be present, although not as severe. They may include trembling, sweating, heart **palpitations** (the feeling of the heart pounding in the chest), **nausea**, and "butterflies in the stomach."

According to the *Diagnostic and Statistical Manual of Mental Disorders,* 4th edition, a person must have at least three of the following symptoms, with some being present more days than not for at least six months, in order to be diagnosed with generalized anxiety disorder:

- restlessness or feeling on edge
- easily fatigued
- difficulty concentrating
- irritability
- muscle tension
- sleep disturbance

While generalized anxiety disorder is not completely debilitating, it can compromise a person's effectiveness and quality of life.

KEY TERMS

Cognitive behavioral therapy—A psychotherapeutic approach that aims at altering cognitions—including thoughts, beliefs, and images—as a way of altering behavior.

Panic attack—A time-limited period of intense fear accompanied by physical and cognitive symptoms. Panic attacks may be unexpected or triggered by specific internal or external cues.

Diagnosis

Anyone with chronic anxiety for no apparent reason should see a physician. The physician may diagnose the condition based on the patient's description of the physical and emotional symptoms. The doctor will also try to rule out other medical conditions that may be causing the symptoms, such as excessive **caffeine** use, thyroid disease, **hypoglycemia**, cardiac problems, or drug or alcohol withdrawal. Psychological conditions, such as depressive disorder with anxiety, will also need to be ruled out.

In June 2004, the Anxiety Disorders Association of America released follow-up guidelines to help primary care physicians better diagnose and manage patients with generalized anxiety disorder. They include considering the disorder when medical causes for general, vague physical complaints cannot be ruled out. Since generalized anxiety disorder often co-occurs with **mood disorders** and **substance abuse**, the clinician may have to treat these conditions as well, and, therefore, must consider them in making the diagnosis.

Treatment

Drugs

Over the short term, a group of tranquilizers called **benzodiazepines**, such as clonazepam (Klonipin), may help ease the symptoms of generalized anxiety disorder. Sometimes **antidepressant drugs**, such as amitryptiline (Elavil), or **selective serotonin reuptake inhibitors** (SSRIs), such as paroxetine (Paxil), escitalopram (Lexapro), and venlafaxine (Effexor), which also has

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norepinephrine, may be preferred. Other SSRIs are fluoxetine (Prozac) and sertraline (Zoloft).

Alternative

Psychotherapy can be effective in treating generalized anxiety disorder. The therapy may take many forms. In some cases, psychodynamically-oriented psychotherapy can help patients work through this anxiety and solve problems in their lives. Cognitive behavioral therapy aims to reshape the way people perceive and react to potential stressors in their lives. Relaxation techniques have also been used in treatment, as well as in prevention efforts.

Prognosis

When properly treated, most patients with generalized anxiety disorder experience improvement in their symptoms.

Prevention

While preventive measures have not been established, a number of techniques may help manage anxiety, such as relaxation techniques, breathing exercises, and distraction—putting the anxiety out of one's mind by focusing thoughts on something else.

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ORGANIZATIONS

American Psychiatric Association, 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209, (703) 907-7300, http://www.psych.org.

Anxiety Disorders Association of America, 8730 Georgia Ave., Suite 600, Silver Spring, MD, 20910, (240) 485-1001, http://www.adaa.org.

National Institute of Mental Health (NIMH, Mental Health Public Inquiries, 6001 Executive Boulevard Room 8184, MSC 9663, Bethesda, MD, 20892-9663, (668) 227-6464, http://www.nimh.nih.gov.

National Alliance on Mental Illness (NAMI), 3803 N. Fairfax Dr., Ste. 100, Arlington, VA, 22201, (703) 524-7600, (800) 950-NAMI (6264), (703) 524-9094, http://www.nami.org.

National Mental Health Association (NMHA), 2000 N. Beauregard Street, 6th Floor, Alexandria, VA, 22311, (703) 684-7722, (800) 969-NMHA, (703) 684-5968, http://www1.nmha.org.

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Genetic counseling

Definition

Genetic counseling is a communication process by which personal genetic risk information is translated into practical information for families. Genetic counselors are commonly health care professionals with specialized training and experience in the areas of medical genetics and counseling. They work as members of a healthcare team, providing individuals and families with information on the nature, inheritance, and implications of genetic disorders to help them make informed medical and personal decisions.

Purpose

Specifically, the process of genetic counseling assists families by:

- Helping families understand information about birth defects or genetic disorders. This includes explaining patterns of inheritance, recurrence risks, natural history of diseases, and genetic testing options.
- Providing nondirective supportive counseling regarding emotional issues related to a diagnosis or testing options.
- Helping individuals or families make decisions that they are comfortable with based on their personal ethical and religious standards.
- Connecting families with appropriate resources, such as support groups or specific types of medical clinics, locally and nationally.

As of 2008, 25 universities were offering genetic counseling study programs in the United States and Canada meeting the rigorous accreditation criteria established by the American Board of Genetic

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Counseling (ABGC). Most genetic counseling programs are two-year programs that include course work, clinical rotations and an independent research project. Most applicants enter the field from variety of disciplines, including biology, genetics, psychology, and nursing.

Description

Genetic counselors work with people concerned about the risk of an inherited disease. These patients represent several different patient populations. Prenatal genetic counseling is provided to couples that have an increased risk for **birth defects** or inherited conditions and are expecting a child or planning a **pregnancy**. Pediatric genetic counseling is provided to families with children suspected of having a genetic disorder or with children previously diagnosed with a genetic disorder. Adult genetic counseling is provided to adults with clinical features of an inherited disease or a family history of an inherited disease. **Cancer** genetic counseling is provided to those with a strong family history of certain types of cancer.

Prenatal genetic counseling

There are several different reasons a person or couple may seek prenatal genetic counseling. If a woman is age 35 or older and pregnant, there is an increased chance that the fetus may have a change in the number of chromosomes present. Changes in chromosome number may lead to **mental retardation** and birth defects. **Down syndrome** is the most common change in chromosome number that occurs more often in the fetuses of older women. Couples may seek prenatal genetic counseling because of abnormal results of screening tests performed during pregnancy. A blood test called the alpha fetal protein (AFP) test is offered to all pregnant women. This blood test screens for Down syndrome, open spine defects (**spina bifida**) and another type of mental retardation caused by a change in chromosome number called Trisomy 18. When this test is abnormal, further tests are offered to get more information about the chance of these conditions in the fetus. Another reason that people seek prenatal genetic counseling is a family history of birth defects or inherited diseases. In some cases, blood tests on the parents may be available to indicate if their children would be at risk of being affected. Genetic counselors assess risk in each case, help patients understand their risks and explore how patients feel about or cope with these risks.

Prenatal tests that are offered during genetic counseling include level II ultrasounds, maternal serum AFP screening, **chorionic villus sampling** (CVS), and **amniocentesis**. Level II ultrasound is a detailed ultrasound surveying fetal anatomy for birth defects. Ultrasound is limited to detection of structural changes in anatomy and cannot detect changes in chromosome number. The maternal serum AFP screening is used to indicate if a pregnant woman has a higher or lower chance of certain birth defects. This test can only change the chances for a birth defect. The screening cannot diagnose a birth defect. CVS is a way of learning how many chromosomes is present in a fetus. A small piece of placental tissue is obtained for these studies during the tenth to twelfth weeks of pregnancy. Amniocentesis is also a way of learning how many chromosomes are present in a fetus. Amniotic fluid is obtained for these studies, usually between 16 and 18 weeks of pregnancy. There is a small risk for **miscarriage** with both of these tests. Genetic counseling regarding these procedures involves the careful explanation of benefits and limitations of each testing option. The counselor also tries to explore how patients feel about prenatal testing and the impact of such testing on the pregnancy. Genetic counselors are supportive of any decision a patient makes about whether or not to have prenatal tests performed.

Pediatric genetic counseling

Families or pediatricians seek genetic counseling when a child has features of an inherited condition. Any child who is born with more than one birth defect, mental retardation, or dysmorphic features has an increased chance of having a genetic syndrome. A common type of mental retardation in males for which **genetic testing** is available is **fragile X syndrome**. Genetic testing is also available for many other childhood illnesses such as **hemophilia** and **muscular dystrophy**. Genetic counselors work with medical geneticists to determine if a genetic syndrome is present. This process includes a careful examination of family history, medical history of the child, review of pertinent medical records in the family, a **physical examination** of the child, and sometimes blood work or other diagnostic tests. If a diagnosis is made, then the medical geneticist and genetic counselor review what is known about the inheritance of the condition, the natural history of the condition, treatment options, further examinations that may be needed for health problems common in the diagnosed syndrome and resources for helping the family. The genetic counselor also helps the family adjust to the diagnosis by emotional support and counseling. Many families are devastated by receiving a diagnosis, learning of the likely outcome for the child, and by the loss of the

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hoped–for healthy child. There would also be a discussion about recurrence risks in the family and who else in the family may be at risk.

Adult genetic counseling

Adults seek genetic counseling when a person in the family decides to be tested for a known genetic condition in the family, when an adult begins exhibiting symptoms of an inherited condition or when there is a new diagnosis of someone with an adult onset disorder in the family. In addition, sometimes the birth of a child with obvious features of a genetic disease leads to diagnosis of a parent who is affected more mildly. Genetic counseling for adults may lead to the consideration of presymptomatic genetic testing. Testing a person to determine if they will be symptomatic for a condition before the symptoms occur is an area of controversy. **Huntington disease** is an example of a genetic disease for which presymptomatic testing is available. Huntington disease is a neurological disease resulting in **dementia**. Onset of the condition is between 30 to 50 years of age. Huntington disease is inherited in an autosomal dominant pattern. If a person has a parent with the disease, their risk of being affected is 50%. Would presymptomatic testing relieve or create **anxiety**? Would a person benefit from removal of doubt about being affected? Would knowing help a person with life planning? Genetic counselors help patients sort through their feelings about such testing and whether or not the results would be helpful to them.

Cancer genetic counseling

A family history of early onset breast, ovarian, or **colon cancer** in multiple generations of a family is a common reason a person would seek a genetic counselor that works with cancer patients. While most cancer is not inherited, there are some families in which a dominant gene is present and causing the disease. The genetic counselor is able to discuss with a patient the chance that the cancer in the family is related to a dominantly inherited gene. The counselor can also discuss the option of testing for the breast and **ovarian cancer** genes, BRCA1 and BRCA2. In some cases the person seeking testing has already had cancer, and in others they have not. Therefore, presymptomatic testing is also an issue in cancer genetics. Emotional support is important for these patients as they have often lost close relatives from cancer and are fearful of their own risks. For families in which a dominant form of cancer is detected through genetic testing, a plan for increased surveillance for the disease can be made.

KEY TERMS

Carrier—An individual who possesses a genetic mutation associated with a recessive disorder, but who usually does not display symptoms of that disease. Carriers are able to pass the mutation on to their offspring.

Consanguinity—Related from a common ancestor; blood relative.

Dominant inheritance—A pattern of inheritance in which a trait or disease is conferred by one gene or allele. A parent with a disorder caused by a dominant allele has a 50% chance of passing the trait for disease to their offspring.

Recessive inheritance—A pattern of inheritance where both parents carry the gene responsible for a trait or disease (although they seldom show symptoms). Their offspring will have a 25% chance of having the trait or disease. Recessive inheritance is also responsible for disorders such as hemophilia, where the mother carries the affected gene on the X chromosome and passes it to her son.

Pedigree

In all types of genetic counseling, an important aspect of the genetic counseling session is information gathering about family and medical history. Information gathering is performed by drawing a chart called a pedigree. A pedigree is made of symbols and lines that represent the family history. To accurately assess the risk of inherited diseases, information about three generations of the family, including health status and/or cause of **death**, is usually needed. If the family history is complicated, information from more distant relatives may be helpful, and medical records may be requested for any family members who have had a genetic disorder. Through an examination of the family history a counselor may be able to discuss the probability of future occurrence of genetic disorders.

ETHNICITY. In taking a family history, a genetic counselor asks for the patient's ethnicity or ancestral origin. There are some ethnic groups that have a higher chance of being carriers of specific genetic diseases. For instance, the chance that an African American is a carrier of a gene for **sickle cell disease** is 1 in 10 individuals. People of Jewish ancestry are more likely to be carriers of several conditions including **Tay–Sachs disease**, Canavan disease and **cystic fibrosis**. People of Mediterranean ancestry are more likely to be carriers of a type of anemia

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called **thalassemia**. Genetic counselors discuss inheritance patterns of these diseases, carrier risks, and genetic screening or testing options.

CONSANGUNITY. Another question a genetic counselor asks in taking a family history is if the couple is related to one another by blood. The practice of marrying or having children with relatives is infrequent in the United States, but is more common in some countries. When two people are related by blood, there is an increased chance for their children to be affected with conditions inherited in a recessive pattern. In recessive inheritance, each parent of a child affected with a disease carries a single gene for the disease. The child gets two copies, one from each parent, and is affected. People who have a common ancestor are more likely than unrelated people to be carriers of genes for the same recessively inherited genes. Depending on family history and ethnic background, blood tests can be offered to couples to get more information about the chance for these conditions to occur.

EXPOSURES DURING PREGNANCY. During prenatal genetic counseling, the counselor will ask about pregnancy history. If the patient has taken a medication or has had a harmful exposure (like radiation), the genetic counselor can discuss the possibility of harmful effects. Ultrasound is often a useful tool to look for some affects of exposures.

Ethical issues in genetic counseling

Prenatal diagnosis of anomalies or chromosomal abnormalities leads to a decision about whether or not a couple wishes to continue a pregnancy. Some couples chose to continue a pregnancy. Prenatal gives them additional time to emotionally prepare for the birth of the child and to gather resources. Others choose not to continue a pregnancy in which problems have been diagnosed. These couples have unique emotional needs. Often the child is very much a desired addition to the family and parents are devastated that the child is not healthy. Presymptomatic testing for adult onset disorders and cancer raise difficult issues regarding the need to know and the reality of dealing with abnormal results before symptoms. The National Society of Genetic Counselors (NSGC) has established a Code of Ethics to guide genetic counselors in caring for patients. The NSGC Code of Ethics, last updated in 2006, is based on four ethical principles:

- Beneficience is the promotion of personal well being in others. The genetic counselor is an advocate for the patient.
- Nonmaleficience is the idea of doing no harm to a patient.
- Autonomy is recognizing the value of the individual, the person's abilities and their point of view. Important aspects of autonomy are truthfulness with patients, respecting confidentiality, and practicing informed consent.
- Justice is providing equal care for all, freedom of choice, and providing a high quality of care.

Perhaps the main ethical principle of genetic counseling is the attempt to provide nondirective counseling. This requires a patient–centered approach by providing care focused on the thoughts and feelings of the patient. Five percent of the Human Genome Project budget is assigned to research involving the best way to deal with ethical issues that arise as new genetic tests become available. Genetic counselors can help patients navigate through the unfamiliar territory of genetic testing.

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ORGANIZATIONS

March of Dimes Foundation, 1275 Mamaroneck Avenue, White Plains, NY, 10605, (914) 428–7100, (888) MODIMES (663–4637), (914) 428–8203, askus@marchofdimes.com, http://www.marchofdimes.com.
National Office of Public Health Genomics, 4770 Buford Highway Mailstop K–89, White Plains, Atlanta, GA, (770) 488–8510, (888) MODIMES (663–4637), (770) 488–8355, genetics@cdc.gov, http://www.cdc.gov/genomics.
National Society of Genetic Counselors, 401 N. Michigan Ave., Chicago, IL, 60611, (312) 321–6834, (312) 673–6972, nsgc@nsgc.org, http://www.nsgc.org.

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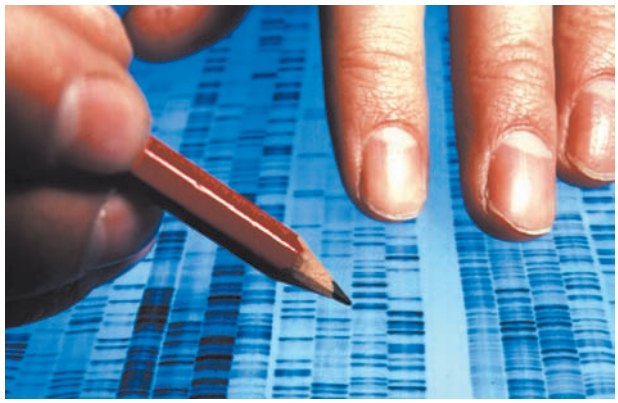
Genetic studies *see* **Genetic testing**

Genetic testing

Definition

A genetic test seeks to identify changes in a person's chromosomes, genes, or proteins, that are associated with inherited disorders. Genetic testing is performed to determine if a person has or will develop a certain disease or could pass a disease to his or her offspring. Genetic tests also determine whether or not couples are at a higher risk than the general population for having a child affected with a genetic disorder.



A scientist examines a DNA sequencing autogradiogram on a light box. *(Photo Researchers, Inc.)*

Purpose

Some families or ethnic groups have a higher incidence of a certain disease than does the population as a whole. For example, individuals from Eastern European, Ashkenazi Jewish descent are at higher risk for carrying genes for rare conditions that occur much less frequently in populations from other parts of the world. Before having a child, a couple from such a family or ethnic group may want to know if their child would be at risk of having that disease. Genetic testing for this type of purpose is called genetic screening.

During **pregnancy**, the baby's cells can be studied for certain genetic disorders or chromosomal problems such as **Down syndrome**. Chromosome testing is most commonly offered when the mother is 35 years or older at the time of delivery. When there is a family medical history of a genetic disease or there are individuals in a family affected with developmental and physical delays, genetic testing may also be offered during pregnancy. Genetic testing during pregnancy is called prenatal diagnosis.

Prior to becoming pregnant, couples who are having difficulty conceiving a child or who have suffered multiple miscarriages may be tested to see if a genetic cause can be identified.

A genetic disease may be diagnosed at birth by doing a physical evaluation of the baby and observing characteristics of the disorder. Genetic testing can help to confirm the diagnosis made by the physical

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evaluation. In addition, genetic testing is used routinely on all newborns to screen for certain genetic diseases which can affect a newborn baby's health shortly after birth.

There are several genetic diseases and conditions in which the symptoms do not occur until adulthood. One such example is Huntington's disease. This is a serious disorder affecting the way in which individuals walk, talk and function on a daily basis. Genetic testing may be able to determine if someone at risk for the disease will in fact develop the disease.

Some genetic defects may make a person more susceptible to certain types of **cancer**. Testing for these defects can help predict a person's risk. Other types of genetic tests help diagnose and predict and monitor the course of certain kinds of cancer, particularly leukemia and lymphoma.

Description

Gene tests

Gene tests look for signs of a disease by examining DNA taken from a person's blood, body fluids or tissues. The tests can look for large changes, such as a gene that has a section missing or added, or small changes, such as a missing, added, or altered chemical base within the DNA strand. Other important changes can be genes with too many copies, genes that are too active, genes that are turned off, or those that are lost entirely.

Various techniques are used for gene tests. Direct DNA sequencing examines the direct base pair sequence of a gene for specific gene mutations. Some genes contain more than 100,000 bases; a mutation of any one base can make the gene nonfunctional and cause disease. The more mutations possible, the less likely it is for a test to detect all of them. This test is usually done on white blood cells from a person's blood, but can also be performed on other tissues. There are different ways in which to perform direct DNA mutation analysis. When the specific genetic mutation is known, it is possible to perform a complete analysis of the genetic code, also called direct sequencing. There are several different lab techniques used to test for a direct mutation. One common approach begins by using chemicals to separate DNA from the rest of the cell. Next, the two strands of DNA are separated by heating. Special enzymes (called restriction enzymes) are added to the single strands of DNA; they then act like scissors and cut the strands in specific places. The DNA fragments are then sorted by size through a process called electrophoresis. A special piece of DNA, called a probe, is added to the fragments. The probe is designed to bind to specific mutated portions of the gene. When bound to the probe, the mutated portions appear on x–ray film with a distinct banding pattern.

Another gene test technique is indirect DNA testing. Family linkage studies are done to study a disease when the exact type and location of the genetic alteration is not known, but the general location on the chromosome has been identified. These studies are possible when a chromosome marker has been found associated with a disease. Chromosomes contain certain regions that vary in appearance between individuals. These regions are called polymorphisms and do not cause a genetic disease to occur. If a polymorphism is always present in family members with the same genetic disease, and absent in family members without the disease, it is likely that the gene responsible for the disease is near that polymorphism. The gene mutation can be indirectly detected in family members by looking for the polymorphism.

To look for the polymorphism, DNA is isolated from cells in the same way it is for direct DNA mutation analysis. A probe is added that will detect the large polymorphism on the chromosome. When bound to the probe, this region will appear on x–ray film with a distinct banding pattern. The pattern of banding of a person being tested for the disease is compared to the pattern from a family member affected by the disease.

Linkage studies have disadvantages not found in direct DNA mutation analysis. These studies require multiple family members to participate in the testing. If key family members choose not to participate, the incomplete family history may make testing other members useless. The indirect method of detecting a mutated gene also causes more opportunity for error.

Chromosome tests

Various genetic syndromes are caused by structural chromosome abnormalities. To analyze a person's chromosomes, his or her cells are allowed to grow and multiply in the laboratory until they reach a certain stage of growth. The length of growing time varies with the type of cells. Cells from blood and bone marrow take one to two days; fetal cells from amniotic fluid take 7–10 days.

When the cells are ready, they are placed on a microscope slide using a technique to make them burst open, spreading their chromosomes. The slides are stained: the stain creates a banding pattern unique to each chromosome. Under a microscope, the chromosomes are counted, identified, and analyzed based on their size, shape, and stained appearance.

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Types of chromosome tests include the karyotype test and the FISH (fluorescent in situ hybridization) test. In a karyotype test, the chromosomes are counted, and a photograph is taken of the chromosomes from one or more cells as seen through the microscope. Then the chromosomes are cut out and arranged side-by-side with their partner in ascending numerical order, from largest to smallest. The karyotype is done either manually or using a computer attached to the microscope. The FISH test identifies specific regions on chromosomes using fluorescent DNA probes. FISH analysis can find small pieces of chromosomes that are missing or have extra copies and that can be missed by the karyotype test.

Biochemical tests

Genes contain instructions for making proteins and abnormal protein levels can be indicative of a genetic disorder. Biochemical tests look at the level of key proteins. This level can identify genes that are not working normally. These types of tests are typically used for newborn screening. For example, this screening can detect infants who have metabolic conditions such as **phenylketonuria** (PKU).

Applications of genetic testing

Newborn screening

In the United States, genetic testing is used most often for newborn screening, a major public health program which can find disorders in newborns that have long-term health effects. Newborn screening tests infant blood samples for abnormal or missing gene products. Every year, millions of newborn babies have their blood samples tested for potentially serious genetic diseases. As of 2009, newborn screening programs were testing for disorders that can cause **infectious disease**, premature **death**, hearing disorders, and heart problems. A new technology called tandem mass spectrometry allows screening of up to 30 other metabolic disorders.

Carrier testing

An individual who has a gene associated with a disease but never exhibits any symptoms of the disease is called a carrier. A carrier is a person who is not affected by the mutated gene he or she possesses, but can pass the gene to an offspring. Genetic tests have been developed that tell prospective parents whether or not they are carriers of certain diseases. If one or both parents are a carrier, the risk of passing the disease to a child can be predicted.

To predict the risk, it is necessary to know if the gene in question is autosomal or sex–linked. If the gene is carried on any one of chromosomes 1–22, the resulting disease is called an autosomal disease. If the gene is carried on the X or Y chromosome, it is called a sex–linked disease.

Sex–linked diseases, such as the bleeding condition **hemophilia**, are usually carried on the X chromosome. A woman who carries a disease–associated gene on one of her X chromosomes has a 50% chance of passing that gene to her son. A son who inherits that gene will develop the disease because he does not have another normal copy of the gene on a second X chromosome to compensate for the abnormal copy. A daughter who inherits the disease–associated gene from her mother will be at risk for having a son affected with the disease.

The risk of passing an autosomal disease to a child depends on whether the gene is dominant or recessive. A prospective parent carrying a dominant gene has a 50% chance of passing the gene to a child. A child needs to receive only one copy of the mutated gene to be affected by the disease.

If the gene is recessive, a child needs to receive two copies of the mutated gene, one from each parent, to be affected by the disease. When both parents are carriers, their child has a 25% chance of inheriting two copies of the mutated gene and being affected by the disease; a 50% chance of inheriting one copy of the mutated gene, and being a carrier of the disease but not affected; and a 25% chance of inheriting two normal genes. When only one parent is a carrier, a child has a 50% chance of inheriting one mutated gene and being an unaffected carrier of the disease, and a 50% chance of inheriting two normal genes.

Cystic fibrosis is a disease that affects the lungs and pancreas and is discovered in early childhood. It is the most common autosomal recessive genetic disease found in the Caucasian population: one in 25 people of Northern European ancestry are carriers of a mutated cystic fibrosis gene. The gene, located on chromosome 7, was identified in 1989.

The gene mutation for cystic fibrosis is detected by a direct DNA test. Over 600 mutations of the cystic fibrosis gene have been found; each of these mutations cause the same disease. Tests are available for the most common mutations. Tests that check for the 86 of the most common mutations in the Caucasian population will detect 90% of carriers for cystic fibrosis. (The percentage of mutations detected varies according to the individual's ethnic background). If a person tests negative, it is likely, but not guaranteed that he or she

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does not have the gene. Both parents must be carriers of the gene to have a child with cystic fibrosis.

Tay–Sachs disease, also autosomal recessive, affects children primarily of Ashkenazi Jewish descent. Children with this disease usually die between the ages of two and five. This disease was previously detected by looking for a missing enzyme. The mutated gene has now been identified and can be detected using direct DNA mutation analysis.

Presymptomatic testing

Not all genetic diseases show their effect immediately at birth or early in childhood. Although the gene mutation is present at birth, some diseases do not appear until adulthood. If a specific mutated gene responsible for a late–onset disease has been identified, a person from an affected family can be tested before symptoms appear.

Huntington disease is one example of a late–onset autosomal dominant disease. Its symptoms of mental confusion and abnormal body movements do not appear until middle to late adulthood. The chromosome location of the gene responsible for Huntington chorea was located in 1983 after studying the DNA from a large Venezuelan family affected by the disease. Ten years later the gene was identified. A test is now available to detect the presence of the expanded base pair sequence responsible for causing the disease. The presence of this expanded sequence means the person will develop the disease.

Another late onset disease, Alzheimer's, does not have as well a understood genetic cause as Huntington disease. The specific genetic cause of Alzheimer disease is not as clear. Although many cases appear to be inherited in an autosomal dominant pattern, many cases exist as single incidents in a family. Like Huntington, symptoms of mental deterioration first appear in adulthood. Genetic research has found an association between this disease and genes on four different chromosomes. The validity of looking for these genes in a person without symptoms or without family history of the disease is still being studied.

CANCER SUSCEPTIBILITY TESTING. Cancer can result from an inherited (germline) mutated gene or a gene that mutated sometime during a person's lifetime (acquired mutation). Some genes, called tumor suppressor genes, produce proteins that protect the body from cancer. If one of these genes develops a mutation, it is unable to produce the protective protein. If the second copy of the gene is normal, its action may be sufficient to continue production, but if that gene later also develops a mutation, the person is vulnerable to cancer. Other genes, called oncogenes, are involved in the normal growth of cells. A mutation in an oncogene can cause too much growth, which is the beginning of cancer.

Direct DNA tests are currently available to look for gene mutations identified and linked to several kinds of cancer. People with a family history of these cancers are those most likely to be tested. If one of these mutated genes is found, the person is more susceptible to developing the cancer. The likelihood that the person will develop the cancer, even with the mutated gene, is not always known because other genetic and environmental factors are also involved in the development of cancer.

Cancer susceptibility tests are most useful when a positive test result can be followed with clear treatment options. In families with **familial polyposis** of the colon, testing a child for a mutated APC gene can reveal whether or not the child needs frequent monitoring for the disease. In families with potentially fatal familial medullary **thyroid cancer** or multiple endocrine neoplasia type 2, finding a mutated RET gene in a child provides the opportunity for that child to have preventive removal of the thyroid gland. In the same way, MSH1 and MSH2 mutations can reveal which members in an affected family are vulnerable to familiar colorectal cancer and would benefit from aggressive monitoring.

In 1994, a mutation linked to early–onset familial breast and **ovarian cancer** was identified. BRCA1 is located on chromosome 17. Women with a mutated form of this gene have an increased risk of developing breast and ovarian cancer. A second related gene, BRCA2, was later discovered. Located on chromosome 13, it also carries increased risk of breast and ovarian cancer. Although both genes are rare in the general population, they are slightly more common in women of Ashkenazi Jewish descent.

When a woman is found to have a mutation in one of these genes, the likelihood that she will get breast or ovarian cancer increases, but not to 100%. Other genetic and environmental factors influence the outcome.

Testing for these genes is most valuable in families where a mutation has already been found. BRCA1 and BRCA2 are large genes; BRCA1 includes 100,000 bases. More than 120 mutations to this gene have been discovered, but a mutation could occur in any one of the bases. Studies show tests for these genes may miss 30% of existing mutations. The rate of missed mutations, the unknown disease likelihood in spite of a positive result and the lack of a clear preventive

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response to a positive result, make the value of this test for the general population uncertain.

Prenatal and postnatal chromosome analysis

Chromosome analysis is performed on fetal cells primarily when the mother is age 35 or older at the time of delivery, has experienced multiple miscarriages, or reports a family history of a genetic abnormality. Prenatal testing is done on the fetal cells from a **chorionic villus sampling** (from the baby's developing placenta) at 10–12 weeks or from the amniotic fluid (the fluid surrounding the baby) at 16–18 weeks of pregnancy. Cells from amniotic fluid grow for 7–10 days before they are ready to be analyzed. Chorionic villi cells have the potential to grow faster and can be analyzed sooner.

Chromosome analysis using blood cells is done on a child who is born with or later develops signs of **mental retardation** or physical malformation. In the older child, chromosome analysis may be done to investigate developmental delays.

Extra or missing chromosomes cause mental and physical abnormalities. A child born with an extra chromosome 21 (trisomy 21) has Down syndrome. An extra chromosome 13 or 18 also produce well known syndromes. A missing X chromosome causes **Turner syndrome** and an extra X in a male causes **Klinefelter syndrome**. Other abnormalities are caused by extra or missing pieces of chromosomes. **Fragile X syndrome** is a sex–linked disease that causes mental retardation in males.

Chromosome material may also be rearranged, such as the end of chromosome 1 moving to the end of chromosome 3. This is called a chromosomal translocation. If no material is added or deleted in the exchange, the person may not be affected. Such an exchange, however, can cause **infertility** or abnormalities if passed to children.

Evaluation of a man and woman's infertility or repeated miscarriages will include blood studies of both to check for a chromosome translocation. Many chromosome abnormalities are incompatible with life; babies with these abnormalities often miscarrry during the first trimester. Cells from a baby that died before birth can be studied to look for chromosome abnormalities that may have caused the death.

Diagnostic testing

This type of genetic testing is used to confirm a diagnosis when a person has signs or symptoms of a genetic disease. The genetic test used depends on the disease for which a person is tested. For example, if a patient has physical features indicative of Down syndrome, a chromosomal test is used. To test for Duchenne **muscular dystrophy**, a gene test is done to look for missing sections in the dystrophin gene.

Chromosome tests are also used to diagnose certain cancers, particularly leukemia and lymphoma, which are associated with changes in chromosomes: extra or missing complete chromosomes, extra or missing portions of chromosomes, or exchanges of material (translocations) between chromosomes. Studies show that the locations of the chromosome breaks are at locations of tumor suppressor genes or oncogenes.

Chromosome analysis on cells from blood, bone marrow, or solid tumor helps diagnose certain kinds of leukemia and lymphoma and often helps predict how well the person will respond to treatment. After treatment has begun, periodic monitoring of these chromosome changes in the blood and bone marrow gives the physician information as to the effectiveness of the treatment.

A well-known chromosome rearrangement is found in chronic myelogenous leukemia. This leukemia is associated with an exchange of material between chromosomes 9 and 22. The resulting smaller chromosome 22 is called the Philadelphia chromosome.

Pharmacogenetic testing

Among the latest types of genetic testing is pharmacogenetic testing. This test examines a person's genes to gain information on how drugs would be broken down by the body. Pharmacogenetic testing aims to design drug treatments that are specific to each person. For example, a test used in patients who have chronic myelogenous leukemia can show which patients would benefit from a medicine called Gleevac. Another test looks at a liver enzyme called cytochrome P450, which breaks down certain types of drugs. Gene mutations can affect the ability of the body to break down certain drugs and people with a less active form of P450 might be taking excessive levels of a drug. Pharmacogenetic testing seeks to help patients obtain the right amount of a medication.

Precautions

Because genetic testing is not always accurate and because there are privacy concerns for the individual receiving a genetic test, **genetic counseling** should always be performed prior to genetic testing. A genetic counselor is an individual with a master's degree in genetic counseling. A medical geneticist is a physician specializing and board certified in genetics.

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KEY TERMS

Autosomal disease—A disease caused by a gene mutation located on a chromosome other than a sex chromosome.

Karyotype—A photomicrograph (picture taken through a microscope) of a person's 46 chromosomes, lined up in 23 pairs, that is used to identify some types of genetic disorders.

Oncogene—A gene that causes normal cell growth, but if mutated or expressed at high levels, encourages normal cells to change into cancerous cells.

Sex-linked genetic disorder—A disease or disorder caused by a gene mutation located on the X (female) or Y (male) chromosome.

Translocation—The rearrangement or exchange of segments of chromosomes that does not alter the total number of chromosomes, but sometimes results in a genetic disorder or disease.

A genetic counselor reviews the person's family history and medical records and the reason for the test. The counselor explains the likelihood that the test will detect all possible causes of the disease in question (known as the sensitivity of the test), and the likelihood that the disease will develop if the test is positive (known as the positive predictive value of the test).

Learning about the disease in question, the benefits and risks of both a positive and a negative result, and what treatment choices are available if the result is positive, will help prepare the person undergoing testing. During the genetic counseling session, the individual interested in genetic testing will be asked to consider how the test results will affect his or her life, family, and future decisions.

After this discussion, the person should have the opportunity to indicate in writing that he or she gave informed consent to have the test performed, verifying that the counselor provided complete and understandable information.

A variety of genetic tests are now increasingly being offered directly to consumers, usually over the Internet. Such genetic testing usually involves scraping a few cells from inside the cheek and mailing the sample to a test laboratory, where the test is performed. People considering such genetic tests, should discuss the issue with their health-care provider or a genetic counselor.

Preparation

Most tests for genetic diseases of children and adults are done on blood. To collect the 5–10 mL of blood needed, a healthcare worker draws blood from a vein in the inner elbow region. Collection of the sample takes only a few minutes.

Prenatal testing is done either on amniotic fluid or a chorionic villus sampling. To collect amniotic fluid, a physician performs a procedure called **amniocentesis**. An ultrasound is done to find the baby's position and an area filled with amniotic fluid. The physician inserts a needle through the woman's skin and the wall of her uterus and withdraws 5–10 mL of amniotic fluid. Placental tissue for a chorionic villus sampling is taken through the cervix. Each procedure takes approximately 30 minutes.

Bone marrow is used for chromosome analysis in a person with leukemia or lymphoma. The person is given **local anesthesia**. Then the physician inserts a needle through the skin and into the bone (usually the sternum or hip bone). One–half to 2 mL of bone marrow is withdrawn. This procedure takes approximately 30 minutes.

Aftercare

After blood collection the person can feel discomfort or bruising at the puncture site or may become dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Warm packs to the puncture site relieve discomfort.

The chorionic villus sampling, amniocentesis and bone marrow procedures are all done under a physician's supervision. The person is asked to rest after the procedure and is watched for weakness and signs of bleeding.

Risks

Collection of amniotic fluid and chorionic villus sampling have the risk of **miscarriage**, infection, and bleeding; the risks are higher for the chorionic villus sampling. Because of the potential risks for miscarriage, 0.5% following the amniocentesis and 1% following the chorionic villus sampling procedure, both of these prenatal tests are offered to couples, but not required. A woman should tell her physician immediately if she has cramping, bleeding, fluid loss, an increased temperature,

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or a change in the baby's movement following either of these procedures.

After bone marrow collection, the puncture site may become tender and the person's temperature may rise. These are signs of a possible infection.

Genetic testing involves other nonphysical risks. Many people fear the possible loss of privacy about personal health information. Other family members may be affected by the results of a person's genetic test. Privacy of the person tested and the family members affected is a consideration when deciding to have a test and to share the results.

A positive result carries a psychological burden, especially if the test indicates the person will develop a disease later in life, such as Huntington's chorea. The news that a person may be susceptible to a specific kind of cancer, while it may encourage positive preventive measures, may also negatively shadow many decisions and activities.

A genetic test result may also be inconclusive meaning no definitive result can be given to the individual or family. This may cause the individual to feel more anxious and frustrated and experience psychological difficulties.

Prior to undergoing genetic testing, individuals need to learn from the genetic counselor the likelihood that the test could miss a mutation or abnormality.

Results

A normal result for chromosome analysis is 46, XX or 46, XY. This means there are 46 chromosomes (including two X chromosomes for a female or one X and one Y for a male) with no structural abnormalities. A normal result for a direct DNA mutation analysis or linkage study includes no gene mutations found.

There can be some benefits from genetic testing when the individual tested is not found to carry a genetic mutation. Those who learn with great certainty they are no longer at risk for a genetic disease may choose not to undergo prophylactic therapies and may feel less anxious and relieved.

An abnormal chromosome analysis report will include the total number of chromosomes and will identify the abnormality found. Tests for gene mutations will report the mutations found.

There are many ethical issues to consider with an abnormal prenatal test result. Many of the diseases tested for during a pregnancy, cannot be treated or cured. In addition, some diseases tested for during pregnancy, may have a late-onset of symptoms or have minimal effects on the affected individual.

Before making decisions based on an abnormal test result, the person should meet again with a genetic counselor to fully understand the meaning of the results, learn what options are available based on the test result, and what are the risks and benefits of each of those options.

Resources

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EuroGentest, Gasthuisberg O&N, Herestraat 49, Box 602, Leuven, Belgium, 3000, (+32)16 345860, (+32) 16 34599, http://www.eurogentest.org.

March of Dimes Foundation, 1275 Mamaroneck Avenue, White Plains, NY, 10605, (914) 428–7100, (888) MODIMES (663–4637), (914) 428–8203, askus@marchofdimes.com, http://www.marchofdimes.com.

National Office of Public Health Genomics, 4770 Buford Highway Mailstop K–89, White Plains, Atlanta, GA, (770) 488–8510, (888) MODIMES (663–4637), (770) 488–8355, genetics@cdc.gov, http://www.cdc.gov/genomics.

National Society of Genetic Counselors, 401 N. Michigan Ave., Chicago, IL, 60611, (312) 321–6834, (312) 673–6972, nsgc@nsgc.org, http://www.nsgc.org.

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Genital herpes

Definition

Genital herpes is a sexually transmitted disease caused by a herpes virus. The disease is characterized by the formation of fluid–filled, painful blisters in the genital area. However, many people who are infected with the virus may not have symptoms and may be unaware they are infected.

A close-up view of a man's penis with a blister (center of image) caused by the herpes simplex virus. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Demographics

It is estimated that almost 536 million people world–wide between the ages of 15–49 years are living with the herpes simplex type 2 virus (HSV–2). The lowest prevalence of the infection is in Western Europe. Approximately 30 million people in North America are infected with genital herpes. About 17% of the adult population in the United States have antibodies to HSV–2 while almost 60% have antibodies to HSV–1. Newly diagnosed cases of primary genital herpes are increasingly caused by the herpes simplex virus type 1 (HSV–1).

More women (one out of four) than men (one out of eight) have antibodies to the herpes simplex virus. The racial differences for herpes type 2 antibodies are whites, 17.6%; blacks, 45.9%; and Mexican Americans, 22.3%. The occurrence of antibodies to herpes type 1 is higher in blacks.

Interestingly, only 2.6% of adults report that they have had genital herpes.

Description

Genital herpes (herpes genitalis, herpes progenitalis) is characterized by the formation of fluid–filled blisters on the genital organs of men and women. The word "herpes" comes from the Greek adjective *herpestes,* meaning *creeping,* which refers to the serpent–like pattern

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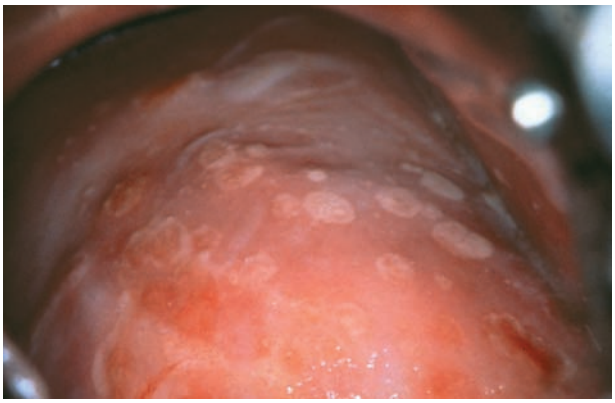

Female cervix covered with herpes lesions.
(Photo Researchers, Inc.)

that the blisters may form. Genital herpes is considered to be a sexually transmitted disease which means that it can be spread from person–to–person by sexual contact. Herpes may be spread by vaginal, anal, or oral sexual activity. In addition, genital herpes may be spread by an infected mother to a baby when the baby passes through the birth canal during the delivery process. It is not spread by objects (such as a toilet seat or doorknob), swimming pools, hot tubs, or through the air.

Genital herpes is a disease resulting from an infection by a herpes simplex virus. There are eight different kinds of human herpes viruses. Only two of these, herpes simplex types 1 and 2, can cause genital herpes. It has been commonly believed that herpes simplex virus type 1 infects above the waist (causing **cold sores**) and herpes simplex virus type 2 infects below the waist (causing genital sores). This generalization is not completely true. Both herpes virus type 1 and type 2 can cause herpes lesions on the lips or genitals, but recurrent cold sores are almost always type 1. The two viruses seem to have evolved to more likely infect at one site or the other, especially with regard to recurrent disease.

Viruses are different from bacteria. While bacteria are independent and can reproduce on their own, viruses cannot reproduce without the help of a cell. Viruses enter human cells and modify them in such as way as to make more virus. A human cell infected with herpes virus releases thousands of new viruses before it is killed by the virus. The cell death and resulting tissue damage causes the actual sores. The highest risk for spreading the virus is the time period beginning with the appearance of blisters and ending with scab formation.

Herpes virus can also infect a cell and instead of making the cell produce new viruses, it hides inside the cell and waits. Herpes virus hides in cells of the nervous system called "neurons." This period is called "latency." A latent virus can remain inside neurons for days, months, or even years. At some future time, the virus "awakens" and causes the cell to produce thousands of new viruses, which causes an active infection. Sometimes an active infection occurs without visible sores. Therefore, an infected person can spread herpes virus to other people even in the absence of sores.

This process of latency and active infection is best understood by considering the genital sore cycle. An active infection is obvious because sores are present. The first infection is called the "primary" infection. This active infection is then controlled by the body's immune system and the sores heal. In between active infections, the virus is latent. At some point in the future, latent viruses become activated and once again cause sores. These episodes are called "recurrent infections" or "outbreaks." Genital sores caused by herpes type 1 recur much less frequently than sores caused by herpes type 2.

Although the factors that trigger latent viruses to activate are not known, several conditions seem to bring on infections. These factors include illness, tiredness, exposure to ultraviolet light (sunlight, **tanning** beds), menstruation, **stress**, immunosuppression, sexual intercourse, and genital trauma.

In the United States, approximately 22% of pregnant women are infected with HSV–2. Newborn babies who are infected with herpes virus experience a very severe, and possibly fatal disease. This disease is called "neonatal herpes infection."

The risk to the neonate varies depending on the time the mother was infected. If the mother was infected prior to the **pregnancy** or during early pregnancy, the risk for infection to the neonate is about one percent. If a woman becomes infected in the last trimester, the risk of neonatal infection is as high as 30 to 50%. The higher risk for infection in late pregnancy is attributed to an inadequate time to develop the antibodies needed to suppress replication of the virus before labor begins.

In the United States, one in 3,000–5,000 babies born will be infected with the herpes virus. Babies can become infected during passage through the birth canal, but can also become infected during the pregnancy if the mother's membranes rupture early. Doctors will perform a **Cesarean section** on women who go into labor with active genital herpes.

Causes and symptoms

While anyone can be infected by herpes virus, not everyone will show symptoms. Risk factors for genital herpes include: early age at first sexual activity, multiple

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sexual partners, history of unprotected sexual intercourse, and a medical history of other sexually–transmitted diseases.

Most patients with genital herpes experience a prodrome (symptoms of oncoming disease) of **pain**, burning, **itching**, or **tingling** at the site where blisters will form. This prodrome stage may last anywhere from a few hours, to one to two days. The herpes infection prodrome can occur for both the primary infection and recurrent infections. The prodrome for recurrent infections may be severe and cause a severe burning or stabbing pain in the genital area, legs, or buttocks.

Primary genital herpes

The first symptoms of herpes usually occur within three to seven days after contact with an infected person, but may take up to two weeks. Symptoms of the primary infection are usually more severe than those of recurrent infections. For up to 70% of patients, the primary infection causes symptoms which affect the whole body (called "constitutional symptoms") including tiredness, **headache**, **fever**, chills, muscle aches, loss of appetite, as well as painful, swollen lymph nodes in the groin. These symptoms are greatest during the first three to four days of the infection and disappear within one week. The primary infection is more severe in women than in men.

Following the prodrome herpes pimples which turn into blisters, which are similar on men and women, begin to appear. First, small red bumps appear. These bumps quickly become fluid–filled blisters. In dry areas, the blisters become filled with pus and take on a white to gray appearance, become covered with a scab, and heal within two to three weeks. In moist areas, the fluid–filled blisters burst and form painful ulcers which drain before healing. New blisters may appear over a period of one week or longer and may join together to form very large ulcers. The pain is relieved within two weeks and the blisters and ulcers heal without scarring by two to six weeks.

Women can experience a very severe and painful primary infection. Herpes blisters first appear on the labia majora (outer lips), labia minora (inner lips), and entrance to the vagina. Blisters often appear on the clitoris, at the urinary opening, around the anal opening, and on the buttocks and thighs. In addition, women may get herpes blisters on the lips, breasts, fingers, and eyes. The vagina and cervix are almost always involved, which causes a watery discharge. Other symptoms that occur in women are: painful or difficult urination (83%), swelling of the urinary tube (85%), **meningitis** (36%), and throat infection (13%).

KEY TERMS

Groin—The region of the body that lies between the abdomen and the thighs.

Latent virus—An inactive virus which is in a dormant state within a cell. Herpes virus is latent in cells of the nervous system.

Prodrome—Symptoms which warn of the beginning of disease. The herpes prodrome consists of pain, burning, tingling, or itching at a site before blisters are visible.

Recurrence—The return of an active herpes infection following a period of latency.

Ulcer—A painful, pus–draining, depression in the skin caused by an infection.

Most women develop painful, swollen lymph nodes (lymphadenopathy) in the groin and pelvis. About one in ten women get a vaginal yeast infection as a complication of the primary herpes infection.

In men, the herpes blisters usually form on the penis but can also appear on the scrotum, thighs, and buttocks. Fewer than half of the men with primary herpes experience constitutional symptoms. Thirty to forty percent of men have a discharge from the urinary tube. Some men develop painful swollen lymph nodes (lymphadenopathy) in the groin and pelvis. Although less frequently than women, men too may experience painful or difficult urination (44%), swelling of the urinary tube (27%), meningitis (13%), and throat infection (7%).

Recurrent genital herpes

Several (five to eight) outbreaks of genital herpes per year occur in 60–90% of those infected with the herpes virus. About 40% of the persons infected with herpes simplex virus type 2 will experience six or more outbreaks each year. Genital herpes recurrences are less severe than the primary infection; however, women still experience more severe symptoms and pain than men. Constitutional symptoms are not usually present. Blisters will appear at the same sites during each outbreak. Usually there are fewer blisters, less pain, and the time period from the beginning of symptoms to healing is shorter than the primary infection. One out of every four women experience painful or difficult urination during recurrent infection. Both men and women may develop lymphadenopathy.

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Diagnosis

Because genital herpes is so common, it is diagnosed primarily by symptoms. It can be diagnosed and treated by the family doctor or nurse practitioner, dermatologists (doctors who specialize in skin diseases), urologists (doctors who specialize in the urinary tract diseases of men and women and the genital organs of men), gynecologists (doctors who specialize in the diseases of women's genital organs) and **infectious disease** specialists. The diagnosis and treatment of this infectious disease should be covered by most insurance providers.

Examination

The health care practitioner will examine the patient for typical signs of genital herpes such as shallow, painful ulcers, and swelling in areas where herpes lesions are present. The lymph nodes in the groin will be palpated during the **physical examination**. These lymph nodes are often tender and painful to the touch.

Because newborns who are infected with herpes virus may be born to mothers who have no symptoms of infection it is important to check all newborn babies for symptoms. Any skin sore should be sampled to determine if it is caused by herpes simplex. Babies should be checked for sores in their mouth and for signs of herpes infection in their eyes.

Tests

Laboratory tests may be performed to look for the virus. Because healing sores do not shed much virus, a sample from an open sore would be taken for viral culture. A sterile cotton swab is wiped over open sores and the sample used to infect human cells in culture. Cells which are killed by herpes virus have a certain appearance under microscopic examination. The results of this test are available within two to ten days. Other areas which may be sampled, depending upon the disease symptoms in a particular patient, include the urinary tract, vagina, cervix, throat, eye tissues, and cerebrospinal fluid.

Direct staining and microscopic examination of the lesion sample may also be used. A blood test may be performed to see if the patient has antibodies to herpes virus. The results of blood testing are available within one day. The disadvantage of this blood test is that it usually does not distinguish between herpes type 1 and 2, and only determines that the patient has had a herpes infection at some point in his or her life. Therefore, the viral culture test must be performed to be absolutely certain that the sores are caused by herpes virus.

Because genital sores can be symptoms of many other diseases, the doctor must determine the exact cause of the sores. The above mentioned tests are performed to determine that herpes virus is causing the genital sores. Other diseases which may cause genital sores are **syphilis**, **chancroid**, **lymphogranuloma venereum**, **granuloma inguinale**, herpes zoster, erythema multiform, Behçet's syndrome, inflammatory bowel disease, **contact dermatitis**, **candidiasis**, and **impetigo**.

Treatment

Traditional

There is no cure for herpes virus infections. There are **antiviral drugs** available which have some effect in lessening the symptoms and decreasing the length of herpes outbreaks. There is evidence that some may also prevent future outbreaks. These antiviral drugs work by interfering with the replication of the virus and are most effective when taken as early in the infection process as possible. For the best results, drug treatment should begin during the prodrome stage before blisters are visible. Depending on the length of the outbreak, drug treatment can continue for up to 10 days.

Drugs

Antiviral agents such as acyclovir (Zovirax), famciclovir (Famvir), and valacyclovir (Valtrex) appear to be equally effective as treatment agents for primary genital HSV infection although treatment with acyclovir is typically less expensive. The drugs, which are most frequently given orally to treat uncomplicated cases of genital herpes, should be started within 72 hours of the appearance of lesions to be most effective. Beginning treatment within this time frame appears to decrease the duration of the outbreak and often lessens the severity of the infection.

Currently, recommended doses and treatment schedules for these drugs are:

- acyclovir, 400 mg by mouth three times per day
- famciclovir, 250 mg by mouth three times per day
- valacyclovir, 1000 mg by mouth two times per day

Duration of treatment is usually seven to ten days.

Treatment of recurrent episodes

Treatment strategies for recurrent episodes of genital herpes depend on the frequency of the episodes and the severity of the outbreaks among other considerations. These strategies include:

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- No treatment may be recommended for individuals who experience infrequent outbreaks and/or minimal symptoms with outbreaks.
- Chronic suppressive therapy is recommended for people with very frequent recurrences and for individuals who are HSV–seropositive with uninfected sexual partners. This strategy involves daily antiviral therapy.
- Episodic therapy may be used by individuals to treat outbreaks of the infection as they occur. Patients should be counseled to begin treatment with antivirals when prodromal symptoms (tingling, itching, burning, pain) begin and before herpes pimples and blisters occur.

Treatment for complicated genital herpes infection

Complicated genital herpes includes those cases in which there is involvement of the central nervous system such as in cases of aseptic meningitis, **encephalitis**, or tranverse myelitis associated with the herpes infection. Other complications can include hepatitis, pneumonitis, and HSV infection which is wide–spread. The Centers for Disease Control (CDC) recommends treatment with intravenous acyclovir at a dose of five to 10 mg/kg every eight hours for two to seven days or longer as the treatment for complicated cases of genital herpes. Treatment is continued until clinical improvement is noted. Following conclusion of intravenous antiviral therapy, the patient is started on oral antiviral therapy for at least an additional 10 days. Some patients may require longer duration of treatment.

Neonatal herpes

Newborn babies with herpes virus infections are treated with intravenous acyclovir. The duration of treatment, which may last 21 days or longer, depends on the extent of the infection and on the baby's response to therapy. Treatment with antivirals and other supportive measures has greatly reduced deaths and increased the number of babies who appear normal at one year of age. However, because neonatal herpes infection is so serious, even with treatment babies may not survive, or may suffer nervous system damage.

Alternative

An imbalance in the amino acids lysine and arginine is thought to be one contributing factor in herpes virus outbreaks. A ratio of lysine to arginine that is in balance (that is more lysine than arginine is present) seems to help the immune system work optimally. Thus, a diet that is rich in lysine may help prevent recurrences of genital herpes. Foods that contain high levels of lysine include most vegetables, legumes, fish, turkey, beef, lamb, cheese, and chicken. Patients may take 500 mg of lysine daily and increase to 1,000 mg three times a day during an outbreak. Intake of the amino acid arginine should be reduced. Foods rich in arginine that should be avoided are chocolate, peanuts, almonds, and other nuts and seeds.

Clinical experience indicates a connection between high stress and herpes outbreaks. Some patients respond well to **stress reduction** and relaxation techniques. **Acupressure** and massage may relieve tiredness and stress. **Meditation**, **yoga**, **tai chi**, and **hypnotherapy** can also help relieve stress and promote relaxation.

Some herbs, including **echinacea** (*Echinacea* spp.) and garlic (*Allium sativum*), are believed to strengthen the body's defenses against viral infections. Red marine algae (family Dumontiaceae), both taken internally and applied topically, is thought to be effective in treating herpes type I and type II infections. Other topical treatments may be helpful in inhibiting the growth of the herpes virus, in minimizing the damage it causes, or in helping the sores heal. Zinc sulphate ointment seems to help sores heal and to fight recurrence. Lithium succinate ointment may interfere with viral replication. An ointment made with glycyrrhizinic acid, a component of licorice (*Glycyrrhiza glabra*), seems to inactivate the virus. Topical applications of vitamin E or tea tree oil (*Melaleuca* spp.) help dry up herpes sores. Results of one study indicated that using an ointment containing propolis, a waxy substance made by bees, helped in healing herpes lesions. Individuals using the ointment four times a day for 10 days reported improvement in the lesions. Other research seems to indicate that the herb Prunella vulgaris and an edible mushroom, Rozites caperata (also known as gypsy mushroom) contain chemicals that may be helpful in fighting the effects of HSV–1 and HSV–2. Specific combinations of homeopathic remedies may also be helpful treatments for genital herpes.

Home remedies

There are several things that a patient may do to lessen the pain of genital sores. Over–the–counter pain relievers such as **aspirin**, **acetaminophen**, or ibuprofen may help to reduce the pain associated with a herpes outbreak. Wearing loose fitting clothing and cotton underwear is helpful. Removing clothing or wearing loose pajamas while at home may reduce pain. Soaking in a tub of warm water and using a blow dryer on the "cool" setting to dry the infected area is helpful however, most clinicians recommend keeping infected

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areas dry most of the time. Putting an ice pack on the affected area for 10 minutes, followed by five minutes off and then repeating this procedure may relieve pain. Application of a baking soda compress to sores may be soothing.

Prognosis

Although physically and emotionally painful, genital herpes is usually not a serious disease. The primary infection can be severe and may require hospitalization for treatment. Complications of the primary infection may involve the cervix, urinary system, anal opening, and the nervous system. Persons who have a decreased ability to produce an immune response to infection (called "immunocompromised") due to disease or medication are at risk for a very severe, and possibly fatal, herpes infection. Even with antiviral treatment, neonatal herpes infections can be fatal or cause permanent nervous system damage.

Prevention

The only way to prevent genital herpes is to avoid contact with infected persons. This is not an easy solution because many people are not aware that they are infected and can easily spread the virus to others. Avoid all sexual contact with an infected person during a herpes outbreak. Because herpes virus can be spread at any time, condom use is recommended to prevent the spread of virus to uninfected partners. At this time, there is no vaccine available to prevent genital herpes.

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ORGANIZATIONS

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Genital warts

Definition

Genital **warts**, which are also called condylomata acuminata or venereal warts, are growths in the genital area caused by a sexually transmitted papillomavirus. A papillomavirus is a virus that produces papillomas, or benign growths on the skin and mucous membranes.

Description

Genital warts are the most common sexually transmitted disease (STD) in the general population. It is estimated that 1% of sexually active people between the ages of 18 and 45 have genital warts; however, polymerase chain reaction (PCR) testing indicates that as many as 40% of sexually active adults carry the human papillomavirus (HPV) that causes genital warts.

Genital warts vary somewhat in appearance. They may be either flat or resemble raspberries or cauliflower in appearance. The warts begin as small red or pink

Man with genital warts. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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growths and grow as large as four inches across, interfering with intercourse and **childbirth**. The warts grow in the moist tissues of the genital areas. In women, they occur on the external genitals and on the walls of the vagina and cervix; in men, they develop in the urethra and on the shaft of the penis. The warts then spread to the area behind the genitals surrounding the anus.

Risk factors for genital warts include:

- multiple sexual partners
- infection with another STD
- pregnancy
- anal intercourse
- poor personal hygiene
- heavy perspiration

Causes and symptoms

There are about 80 types of human papillomavirus. Genital warts are caused by HPV types 1, 2, 6, 11, 16, and 18. HPV is transmitted by sexual contact. The incubation period varies from one to six months.

The symptoms include bleeding, **pain**, and odor as well as the visible warts.

Diagnosis

The diagnosis is usually made by examining scrapings from the warts under a darkfield microscope. If the warts are caused by HPV, they will turn white when a 5% solution of white vinegar is added. If the warts reappear, the doctor may order a biopsy to rule out **cancer**.

Treatment

No treatment for genital warts is completely effective because therapy depends on destroying skin infected by the virus. There are no drugs that will kill the virus directly.

Medications

Genital warts were treated until recently with applications of podophyllum resin, a corrosive substance that cannot be given to pregnant patients. A milder form of podophyllum, podofilox (Condylox), has been introduced. Women are also treated with 5-fluorouracil cream, bichloroacetic acid, or trichloroacetic acid. All of these substances irritate the skin and require weeks of treatment.

Genital warts can also be treated with injections of interferon. Interferon works best in combination with podofilox applications.

KEY TERMS

Condylomata acuminata—Another name for genital warts.

Papilloma—A benign growth on the skin or mucous membrane. Viruses that cause these growths are called human papillomaviruses (HPVs).

Podophyllum resin—A medication derived from the May apple or mandrake and used to treat genital warts.

Surgery

Surgery may be necessary to remove warts blocking the patient's vagina, urethra, or anus. Surgical techniques include the use of liquid nitrogen, electrosurgery, and **laser surgery**.

Prognosis

Genital warts are benign growths and are not cancerous by themselves. Repeated HPV infection in women, however, appears to increase the risk of later **cervical cancer**. Women infected with HPV types 16 and 18 should have yearly cervical smears. Recurrence is common with all present methods of treatment—including surgery—because HPV can remain latent in apparently normal surrounding skin.

Prevention

The only reliable method of prevention is sexual abstinence. The use of **condoms** minimizes but does not eliminate the risk of HPV transmission. The patient's sexual contacts should be notified and examined.

Resources

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Rebecca J. Frey, PhD

Gentamicin *see* **Aminoglycosides**

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Germ cell tumors

Definition

Germ cell tumors (GCTs) are solid tumors which are diagnosed in children, adolescents, and less frequently, in adults. The term germ cell tumor alludes to the term "germinate" rather than to the term "germ" as it relates to bacterial or other related organisms that are capable of causing disease. These tumors arise from germ cells that develop into reproductive tissue such as testicular and ovarian cells. GCTs can be benign tumors or malignant (cancerous) tumors.

Demographics

The incidence of GCTs appears to be increasing. Malignant germ cell tumors account for about 3% of all cases of **cancer** occurring in children and adolescents prior to age 20 years. Malignant GCTs are more commonly diagnosed in adolescents between the ages of 15 and 19 years and account for about 14% of all cancers which occur in this age group.

Description

GCTs appear to arise from primitive germs cells. During embryo development, these germ cells migrate from the yolk sac down the midline of the body to the pelvis and eventually to the gonads, or reproductive organs. During fetal development, some of the cells may migrate to abnormal sites other than the gonads, however. Therefore, GCTs are classified as gonadal GCTs or extragonadal GCTs, meaning they occur in tissues that are not reproductive tissue. About 90% of GCTs are gonadal in origin.

Malignant GCTs can be further histologically classified according to the origin of the tumor. In young children, GCTs are classified as yolk sac tumors, which can arise from extragonadal, ovarian, or testicular tissue, or dysgerminoma, which arises from ovarian tissue and is rarely diagnosed in young children. In adolescents and in young adults, malignant GCTs can be classified as follows:

- seminoma – germinomas which arise from testicular tissue
- dysgerminoma – germinomas which arise from ovarian tissue
- germinoma –extagonadal origin
- yolk sac tumor –extragonadal, ovarian and testicular origin; also termed endodermal sinus tumors
- choriocarcinoma –extragonadal, ovarian, and testicular origin; a rare tumor type
- embryonal carcinoma –arises from testicular tissue
- mixed germ cell tumors – arises from extragonadal and ovarian tissue

Testicular and mediastinal seminomas are most likely to be diagnosed in adolescent and young adult males while ovarian dysgerminomas are more likely to be diagnosed in adolescent and young adult females. Most children who are diagnosed with a malignant GCT are most likely to have a yolk sac component to their tumors.

Some of the malignant GSTs secrete abnormal proteins such as alpha–fetaprotein (AFP) and beta–human chorionic gonadotropin (b–HCG) which are considered to be **tumor markers**. For example, yolk sac tumors secrete AFP while germinomas (such as seminoma and dysgerminoma) and choriocarcinomas produce b–HCG. Serum levels of these tumor markers can be monitored during treatment to determine the response of the tumor to the treatment.

Risk factors

Specific risk factors related to the development of GCTs have not been identified. However, patients diagnosed with certain genetic or hereditary syndromes or disorders appear to be at higher risk for the development of some types of GCTs. For example, individuals with **Klinefelter syndrome** appear to be at increased risk for the development of extragonadal GCT and patients with Swyer syndrome may be at increased risk for the development of germinomas.

KEY TERMS

Embryo—The human organism in the earliest stages of development.

Extragonadal—Occurring outside of the gonads or outside of the reproductive organs.

Gonads—The reproductive organs; testes in males and ovaries in females.

Histology—The study of the structure, composition, and function of tissues of organs.

Tumor marker—A biochemical substance produced and released or secreted by a tumor.

Yolk sac—A sac made of membranous tissue that is attached to the embryo and provides nutrition to the embryo.

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Causes and symptoms

The specific cause of most cases of GCTs is unknown at this time. Some individuals with certain genetic or hereditary syndromes and disorders appear to be at higher risk for the development of some types of GCTs. In addition, several chromosomal abnormalities are being studied to determine their exact role in causing GCTs.

Symptoms of GCTs are linked to the size and location of the tumor. Symptoms may include:

- a swelling or mass of tissue that can be palpated
- abnormal shape or size of the testicle
- excessive hair growth
- early puberty
- hormonal abnormalities such as diabetes
- headache
- weakness in the lower extremities
- constipation

Diagnosis

Examination

A complete history and **physical examination** will be conducted. The suspected tumor mass will be examined and palpated. A focused assessment and examination will be conducted based on the location of the suspected tumor.

Tests

Levels of tumor markers such as AFP and b–HCG should be assessed prior to surgical intervention. Lactate dehydrogenase levels will also be determined. Tests which should be conducted prior to **chemotherapy** administration include a **complete blood count** (CBC) with differential and **platelet count**, tests to determine baseline kidney function such as the glomerular filtration rate and creatinine clearance rate, uric acid levels, **liver function tests**, and electrolyte levels as well as the levels of **calcium** and magnesium in the body.

Radiologic procedures which may be utilized include chest xray and magnetic imaging scanning (MRI) to evaluate for metastasis to the lungs, computed tomography (CT) and/or MRI scanning of the abdomen and/or pelvis if tumor is suspected in those locations, and bone scans to further determine extent of metastasis. Other tests which may be done, depending on the location of the tumor, include CT or MRI scans of the brain, ultrasounds of the abdomen and pelvis, testicular ultrasounds, and **positron emission tomography (PET)** scans to detect relapse of tumor. In addition, **pulmonary function tests** may be done to establish baseline pulmonary function prior to the start of chemotherapy administration.

Treatment

Treatment for these relatively rare types of cancer should be conducted at pediatric cancer centers experienced in treating GCTs. Factors which play a role in determining optimum treatment for GCTs include the histology of the tumor, tumor stage, the location of the primary tumor and the patient's age. Clinicians treating these children and adolescents will attempt to maximize the potential for survival while attempting to minimize the risk for adverse long–term side effects such as the development of second cancers, and other serious physical and cognitive impairments.

Currently, multimodality therapy is utilized including surgery and administration of chemotherapy. Based on the factors described above, treatment options may include:

- surgical removal of the tumor followed by strict surveillance for tumor relapse
- biopsy of the tumor to obtain a definitive diagnosis, followed by preoperative chemotherapy administration which includes a platinum–based chemotherapy drug, followed by surgical removal of all remaining tumor
- surgical removal of the tumor followed by platinum–based chemotherapy administration.

Currently, the standard chemotherapy regimen for children and adults diagnosed with malignant non-seminomatous GCTs includes the drugs cisplatin, etoposide and bleomycin. However, children are given fewer doses of bleomycin than adults.

There are different treatment options for malignant testicular GCTs in boys than for adolescents and young adult males which vary by stage of disease at the time of diagnosis and age of the patient. Treatment options for childhood ovarian GCT includes a multimodality approach which may utilize surgery, observation, and chemotherapy. Current standard treatment options for childhood malignant extragonadal GCTs varies by patient age, tumor location, tumor histology, and stage at time of diagnosis and may include surgery and chemotherapy administration.

Prognosis

The 5–year survival rate for gonadal GCTs increased from 89% to 98% in children younger than age 15 years between 1975 and 2002 according to the National Cancer Institute. The 5–year survival rate for adolescents diagnosed with gonadal GCTs between

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the ages of 15 and 19 years increased from 70% to 95% during that same time period.

The 5–year survival rate for extragonadal GCTs increased from 42% to 83% in children younger than age 15 years between 1979 and 2002. The 5–year survival rate for adolescents between the ages of 15 and 19 years increased from 80% to 95% during that same time period.

Prevention

As the cause of most cases of childhood GCTs is not currently known, there are no ways to prevent development of GCTs. Children diagnosed with specific congenital or hereditary syndromes or disorders which increase their risk of developing GCTs should be screened for GCTs.

Resources

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"Childhood Extracranial Germ Cell Tumors Treatment (PDQ)." National Cancer Institute. June 24, 2010 [cited September 5, 2010]. http://www.cancer.gov

ORGANIZATIONS

Candlelighters Childhood Cancer Family Alliance. , 8323 Southwest Freeway, Suite 435, Houston, Texas, 77074, (713) 270-4700, (713) 270-9802, http//www.candle.org.

CureSearch for Children's Cancer, National Childhood Cancer Foundation, 4600 East West Highway, Suite 600, Bethesda, Maryland, 20814-3457, (800) 458–6223 (U.S. and Canada), info@curesearch.org, http://www.curesearch.org.

Genetic and Rare Disease Information Center (GARD), P.O. Box 8126, Gaithersburg, Maryland, 20898-8126, (888) 205-2311, (301) 251-4911, http://www.rarediseases.info.nih.gov/GARD.

St. Jude's Children's Research Hospital, 262 Danny Thomas Place, Memphis, Tennessee, 38105, (901) 595-3300, http://www.stjude.org.

Melinda Granger Oberleitner, RN, DNS, APRN, CNS

German measles *see* **Rubella**

Gestalt therapy

Definition

Gestalt therapy is a humanistic therapy technique that focuses on gaining an awareness of emotions and behaviors in the present rather than in the past. The therapist does not interpret experiences for the patient. Instead, the therapist and patient work together to help the patient understand him/herself. This type of therapy focuses on experiencing the present situation rather than talking about what occurred in the past. Patients are encouraged to become aware of immediate needs, meet them, and let them recede into the background. The well-adjusted person is seen as someone who has a constant flow of needs and is able to satisfy those needs.

Purpose

In Gestalt therapy (from the German word meaning *form*), the major goal is self-awareness. Patients work on uncovering and resolving interpersonal issues during therapy. Unresolved issues are unable to fade into the background of consciousness because the needs they represent are never met. In Gestalt therapy, the goal is to discover people connected with a patient's unresolved issues and try to engage those people (or images of those people) in interactions that can lead to a resolution. Gestalt therapy is most useful for patients open to working on self-awareness.

Precautions

The choice of a therapist is crucial. Some people who call themselves "therapists" have limited training in Gestalt therapy. It is important that the therapist be a licensed mental health professional. Additionally, some individuals may not be able to tolerate the intensity of this type of therapy.

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Description

Gestalt therapy has developed into a form of therapy that emphasizes medium to large groups, although many Gestalt techniques can be used in one-on-one therapy. Gestalt therapy probably has a greater range of formats than any other therapy technique. It is practiced in individual, couples, and family therapies, as well as in therapy with children.

Ideally, the patient identifies current sensations and emotions, particularly ones that are painful or disruptive. Patients are confronted with their unconscious feelings and needs, and are assisted to accept and assert those repressed parts of themselves.

The most powerful techniques involve role-playing. For example, the patient talks to an empty chair as they imagine that a person associated with an unresolved issue is sitting in the chair. As the patient talks to the "person" in the chair, the patient imagines that the person responds to the expressed feelings. Although this technique may sound artificial and might make some people feel self-conscious, it can be a powerful way to approach buried feelings and gain new insight into them.

Sometimes patients use battacca bats, padded sticks that can be used to hit chairs or sofas. Using a battacca bat can help a patient safely express anger. A patient may also experience a Gestalt therapy marathon, where the participants and one or more facilitators have nonstop **group therapy** over a weekend. The effects of the intense emotion and the lack of sleep can eliminate many psychological defenses and allow significant progress to be made in a short time. This is true only if the patient has adequate psychological strength for a marathon and is carefully monitored by the therapist.

Preparation

Gestalt therapy begins with the first contact. There is no separate diagnostic or assessment period. Instead, assessment and screening are done as part of the ongoing relationship between patient and therapist. This assessment includes determining the patient's willingness and support for work using Gestalt methods, as well as determining the compatibility between the patient and the therapist. Unfortunately, some "encounter groups" led by poorly trained individuals do not provide adequate pre-therapy screening and assessment.

Aftercare

Sessions are usually held once a week. Frequency of sessions held is based on how long the patient can go between sessions without losing the momentum from the previous session. Patients and therapists discuss when to start sessions, when to stop sessions, and what kind of activities to use during a session. However, the patient is encouraged and required to make choices.

Risks

Disturbed people with severe mental illness may not be suitable candidates for Gestalt therapy. Facilities that provide Gestalt therapy and train Gestalt therapists vary. Since there are no national standards for these Gestalt facilities, there are no set national standards for Gestalt therapy or Gestalt therapists.

Normal results

Scientific documentation on the effectiveness of Gestalt therapy is limited. Evidence suggests that this type of therapy may not be reliably effective.

Abnormal results

This approach can be anti-intellectual and can discount thoughts, thought patterns, and beliefs. In the hands of an ineffective therapist, Gestalt procedures can become a series of mechanical exercises, allowing the therapist as a person to stay hidden. Moreover, there is a potential for the therapist to manipulate the patient with powerful techniques, especially in therapy marathons where **fatigue** may make a patient vulnerable.

ORGANIZATIONS

Association for the Advancement of Gestalt Therapy, 400 East 58th St, New York, NY, 10022, (212) 486-1581, http://www.aagt.org.

David James Doermann

Gestational diabetes

Definition

Gestational diabetes is an abnormal increase blood sugar (glucose) levels that occurs during **pregnancy** in some women. Unlike other types of diabetes, gestational diabetes first appears during pregnancy and then disappears after the woman gives birth.

Demographics

Studies have found that in the United States between 3% and 10% of women experience diabetes

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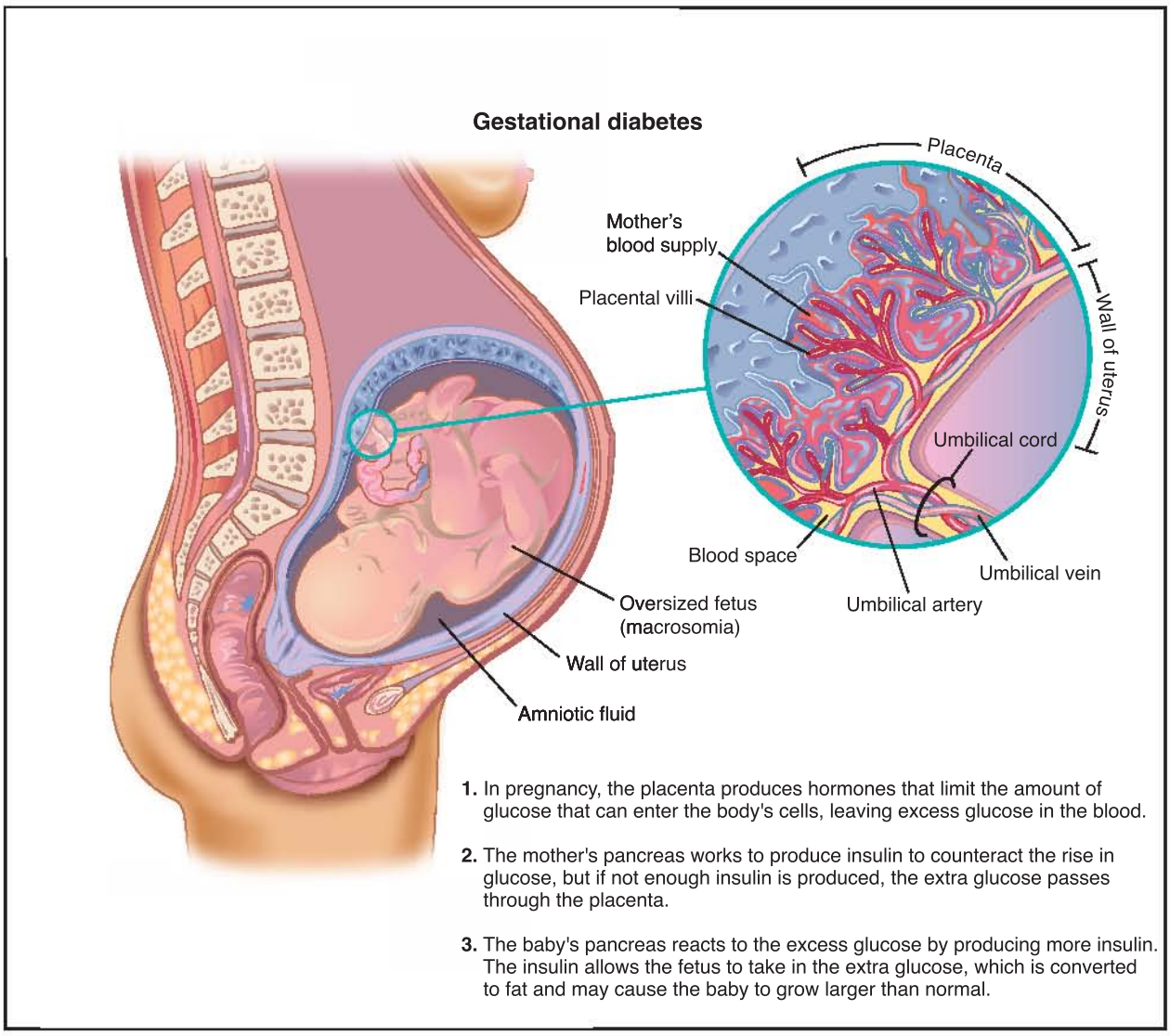

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during pregnancy. Ninety percent of these women develop gestational diabetes, about 8% have pre-existing type 2 (insulin resistant) diabetes, while about 1% have pre-existing type 1 (insulin deficiency) diabetes.

Race and ethnicity strongly affect the rate of development of gestational diabetes. Only about 1.4–2% of Caucasian women develop gestational diabetes, while as many as 15% of Native American women from tribes in the Southwest United States develop the disorder. Between 5% and 8% of Hispanic Americans, African Americans, and Asian Americans develop gestational diabetes. If a woman experiences gestational diabetes, the chance of her developing it again in future pregnancies is as high as 68%.

Description

Carbohydrates (sugars and starches) found in foods such as sweets, potatoes, pasta, and breads, are broken down during digestion into glucose, a simple sugar that circulates in the blood and is used by cells for energy. The level of glucose changes depending on what food and how much of it a person eats. The level usually is highest about two hours after a meal. However, in order for the body to remain healthy, blood glucose levels must stay stable with certain narrow limits. In healthy people, the hormone insulin regulates the blood glucose level by controlling how much glucose enters cells. Once in cells, glucose either is used

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to meet the immediate energy needs of the cell or stored in liver, muscle, or fat cells for later release when blood glucose levels are low. In people with diabetes, this regulatory mechanism does not function correctly, and glucose builds up in the blood, a condition called hyperglycemia.

There are three types of diabetes. In type 1 diabetes, the pancreas, a digestive system organ, does not make any insulin or does not make enough insulin to properly regulate blood glucose levels. People with type 1 diabetes must control their blood glucose through diet, **exercise**, and most importantly, through the regular injection of synthetic or animal insulin.

In type 2 diabetes, the pancreas makes enough insulin, but cells become unresponsive to it, a condition called **insulin resistance**. As a result, adequate amounts of glucose cannot enter these cells, and glucose builds up in the blood. Many people with type 2 diabetes can control their blood glucose level through diet and exercise. Others must take supplemental insulin either by mouth (orally) or by injection.

In gestational diabetes, the pancreas makes insulin, but the placenta, which allows the fetus to obtain nourishment, produces hormones (e.g., estrogens, progesterone, and chorionic somatomammotropin) that increase the insulin resistance of cells. These hormones are at their highest levels during the third trimester of pregnancy. Their presence reduces the amount of glucose that can enter cells, so that more remains in the blood and hyperglycemia occurs. Most pregnant women do not develop gestational diabetes because the pancreas produces additional quantities of insulin (as much as 50% more than normal in the third trimester) in order to compensate for insulin resistance caused by pregnancy hormones. However, when a woman's pancreas cannot produce enough extra insulin, blood levels of glucose stay abnormally high, and the woman develops gestational diabetes.

Risk factors

Women at risk for gestational diabetes include those who:

- are overweight
- have a family history of diabetes
- have previously given birth to a very large, heavy baby
- have previously had a baby who was stillborn, or born with a birth defect
- have an unusually large amount of amniotic fluid (the cushioning fluid within the uterus that surrounds the developing fetus)
- are over 30 years of age
- belong to an ethnic group known to experience higher rates of gestational diabetes
- have a history of gestational diabetes during a pregnancy

Causes and symptoms

Since increasing levels of pregnancy hormones cause gestational diabetes, it develops in late in pregnancy when pregnancy hormones are at their highest levels. Often women with gestational diabetes have few symptoms. However, leaving gestational diabetes undiagnosed and untreated is risky to the developing fetus. Left untreated, the mother's blood glucose levels will remain consistently high, and these same high levels will occur in the blood of the fetus. The fetal pancreas responds to the high level glucose by secreting large amounts of insulin. This insulin allows the fetal cells to take in excess glucose that is converted into fat and stored. This conversion process uses oxygen that may be needed for other fetal processes. Low oxygen levels can lead to an increased risk of heart, breathing, and vision problems. Increased fat storage causes many babies born to women with gestational diabetes to be unusually large, often large enough to cause more difficult deliveries that may require the use of forceps, suction, or **cesarean section**.

Furthermore, when the baby is born, it will have an abnormally high level of insulin in the blood. After birth, when the mother and baby are no longer attached to each other via the placenta and umbilical cord, the baby will no longer be receiving the mother's high level of blood glucose. The infant's high level of insulin, however, will quickly use up the glucose circulating in the infant's bloodstream. The baby is then at risk for having a dangerously low level of blood glucose, a condition called **hypoglycemia**. When this occurs, it is easily resolved by giving the baby glucose from an external source.

Diagnosis

Since gestational diabetes often exists with no symptoms detectable by the mother, and since its existence puts the developing baby at risk for developmental abnormalities, screening for the disorder is a routine part of pregnancy care. This screening usually is done between the 26th and 28th week of pregnancy. At this point in the pregnancy, the placental hormones have reached a sufficient level to cause insulin

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KEY TERMS

Glucose—A simple sugar that is the final product of the breakdown of carbohydrates.

Glycemic index—A ranking from 1–100 of how much carbohydrate-containing foods raise blood sugar levels within two hours after being eaten. Foods with a glycemic index of 50 or lower are considered "good."

Hormone—A chemical messenger that is produced by one type of cell and travels through the bloodstream to change the metabolism of a different type of cell.

Insulin—A hormone produced by the pancreas that is central to the processing of sugars and carbohydrates in the diet.

Placenta—An organ that is attached to the inside wall of the mother's uterus and to the fetus via the umbilical cord. The placenta allows oxygen and nutrients from the mother's bloodstream to pass into the unborn baby.

Type 1 diabetes—A chronic immune system disorder in which the pancreas does not produce sufficient amounts of insulin, a hormone that enables cells to use glucose for energy. Also called juvenile diabetes, it must be treated with insulin injections.

Type 2 diabetes—Formerly called adult-onset diabetes. In this form of diabetes, the pancreas either does not make enough insulin or cells become insulin resistant and do not use insulin efficiently.

resistance. Screening for gestational diabetes involves the pregnant woman drinking a special solution that contains exactly 50 grams of glucose. An hour later, the woman's blood is drawn and tested for its glucose level. A level less than 140 mg/dL is considered normal.

When the screening glucose level is over 140 mg/dL, a special three-hour glucose tolerance test is performed. This involves following a special diet for three days before the test. This diet is set up to contain at least 150 grams of carbohydrates each day. Just before the test, the woman is instructed to eat and drink nothing except water for 10–14 hours. A blood sample is then tested to determine the fasting glucose level. The woman then drinks a special solution containing exactly 100 grams of glucose, and her blood is tested every hour for the next three hours. If two or more of these levels are elevated over normal, then the woman is considered to have gestational diabetes.

Treatment

Treatment for gestational diabetes depends on the severity of the diabetes. Mild forms can be treated with changes in diet. Women may be put on strict, detailed **diets**, and instructed to stay within a certain range of calorie intake. Exercise sometimes is used to help reduce blood glucose levels. Women often are asked to regularly measure their blood glucose level. This is done by poking a finger with a needle called a lancet, putting a drop of blood on a special type of paper, and feeding the paper into a meter that analyzes and reports the blood glucose level. Self-monitoring of blood glucose helps to manage gestational diabetes and prevent complications. When diet and exercise do not keep blood glucose levels within an acceptable range, a woman may need to take regular shots of insulin.

Prognosis

Prognosis for women with gestational diabetes and their infants is generally good. Almost all such women have blood glucose levels that return to normal after the birth of their baby. However, research has shown that nearly half of these women who have gestational diabetes will develop type 2 diabetes within 15 years.

Pregnant women who have type 1 or type 2 diabetes that is poorly controlled have 4–8 times the chance of having a baby born with a birth defect than women who do not have diabetes. The risk is much lower for babies born to women who develop gestational diabetes because their fetus is exposed to high glucose levels for a much shorter time and only near the end of pregnancy after most organs are already formed. However, the child of a mother with gestational diabetes has a greater-than-normal chance of developing diabetes sometime in adulthood. A woman who has had gestational diabetes during one pregnancy has about a 68% chance of having it again during any subsequent pregnancies. Women who had gestational diabetes usually have their blood glucose levels tested at the post-partum checkup or after stopping **breastfeeding**.

Prevention

There is no known way to prevent gestational diabetes since it is caused by the effects of normal

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hormones of pregnancy. However, the effects of insulin resistance can be best handled through careful attention to diet, avoiding becoming overweight throughout life, and participating in reasonable exercise and avoiding **smoking**.

Resources

BOOKS

American College of Obstetricians and Gynecologists, Women's, Health Care Physicians. *Your Pregnancy and Childbirth: Month to Month,* 5th ed. Washington, DC: American College of Obstetricians and Gynecologists, 2010.

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Diabetes and Pregnancy Frequently Asked Questions. United States Centers for Disease Control and Prevention. October 5, 2005. http://www.cdc.gov/ncbddd/bd/diabetespregnancyfaqs.htm

Prenatal Care. National Women's Health Information Center March 6, 2009. http://www.womenshealth.gov/faq/prenatal-care.cfm

Routine Tests in Pregnancy. American College of Obstetri cians and Gynecologists January 2009. http://www. acog.org/publications/patient_education/bp133.cfm

ORGANIZATIONS

American College of Obstetricians and Gynecologists, P.O. Box 96920, Washington, DC, 20090-6920, (202) 638-5577, http://www.acog.org.

American Diabetes Association, 1701 North Beauregard Street, Alexandria, VA, 22311, (800) DIABETES (342-2383), askADA@diabetes.org, http://www.diabetes.org.

American Pregnancy Association, 431 Greenway Drive, Suite 800, Irving, TX, 75038, (972) 550-0140, (972) 550-0800, Questions@AmericanPregnancy.org, http://www.americanpregnancy.org.

National Diabetes Education Program, One Diabetes Way, Bethesda, MD, 20814-9692, (301) 496-3583, http://www.ndep.nih.gov.

Rosalyn Carson-DeWitt, MD
Tish Davidson, AM

GI bleeding studies

Definition

GI bleeding studies uses radioactive materials in the investigation of bleeding from the gastrointestinal (GI) tract. These studies go under various names such as "GI bleeding scans" or "Tagged red blood cell scans." They are performed and interpreted by radiologists (physicians who specialize in diagnosis and treatment of diseases by means of x rays or related substances).

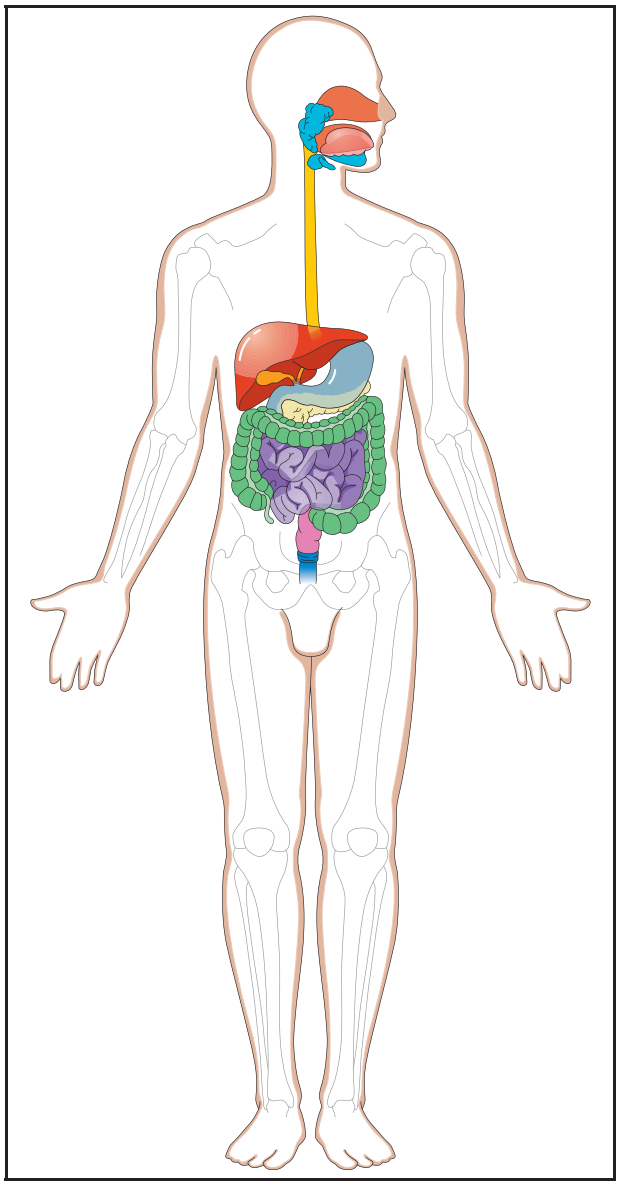

Diagram of the human digestive system. *(Illustration by Argosy, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

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KEY TERMS

Endoscope, Endoscopy—An endoscope as used in the field of gastroenterology is a thin flexible tube which uses a lens or miniature camera to view various areas of the gastrointestinal tract. The performance of an exam using an endoscope is referred by the general term endoscopy. Diagnosis through biopsies or other means and therapeutic procedures can be done with these instruments.

Purpose

These studies are designed to find the source of blood loss from the GI tract; that is the stomach, small bowel, or colon. They work best when bleeding is either too slow, intermittent, or too rapid to be identified by other means, such as **endoscopy**, upper GI series, or **barium enema**.

They are particularly useful when other methods have not been able to determine the site or cause of bleeding.

Precautions

Because of the use of radioactive materials, these studies are best avoided in pregnant patients. Another important relates to the interpretation of these tests, whether normal or abnormal. Since these studies are far from perfect, they can only be used as "guides" as to the cause or site of bleeding. In most instances, further studies must be performed to confirm their findings.

Description

Bleeding scans are based on the accumulation of radioactive material as it exits from the vessels during a bleeding episode. Blood is first withdrawn from the patient. Then, the blood, along with a radioactive substance is injected into a vein and over several hours scans measuring radioactivity are performed. The studies were initially reported to be very sensitive and accurate; however, critical evaluation of these tests have shown them to be less accurate than originally believed.

Preparation

No preparation is needed for these tests. They are often done on an "emergency" basis.

Aftercare

No special care is needed after the exam.

Risks

Bleeding scans are free of any risks or side-effects, aside from the fact that they should best be avoided in **pregnancy**.

Normal results

A normal exam would fail to show any evidence of accumulation of radioactive material on the scan. However, scans may be normal in as many as 70% of patients who later turn out to have significant causes of bleeding. This is known as a false-negative result. A patient must be bleeding at the same time the scan is performed for it to be seen. Therefore, not finding evidence of a bleeding source during the study, can be misleading.

Abnormal results

The accumulation of radioactive material indicating a "leakage" of blood from the vessels is abnormal. The scan gives a rough, though not exact, guide as to the location of the bleeding. It can tell where the bleeding may be, but usually not the cause. Thus, extreme caution and skill is needed in interpreting these scans, and decisions involving surgery or other treatment should await more definitive tests.

Resources

BOOKS

Sleisenger, Marvin H., et al. *Sleisenger & Fordtran's Gastrointestinal and Liver Disease: Pathophysiology, Diagnosis, Management*. St. Louis, Mo.: MD Consult, 2009.

David Kaminstein, MD

Giant-cell arteritis *see* **Temporal arteritis**

Giardia lamblia infection *see* **Giardiasis**

Giardiasis

Definition

Giardiasis is a common intestinal infection spread by eating contaminated food, drinking contaminated water, or through direct contact with the organism that causes the disease, *Giardia lamblia*. Giardiasis is found throughout the world and is a common cause

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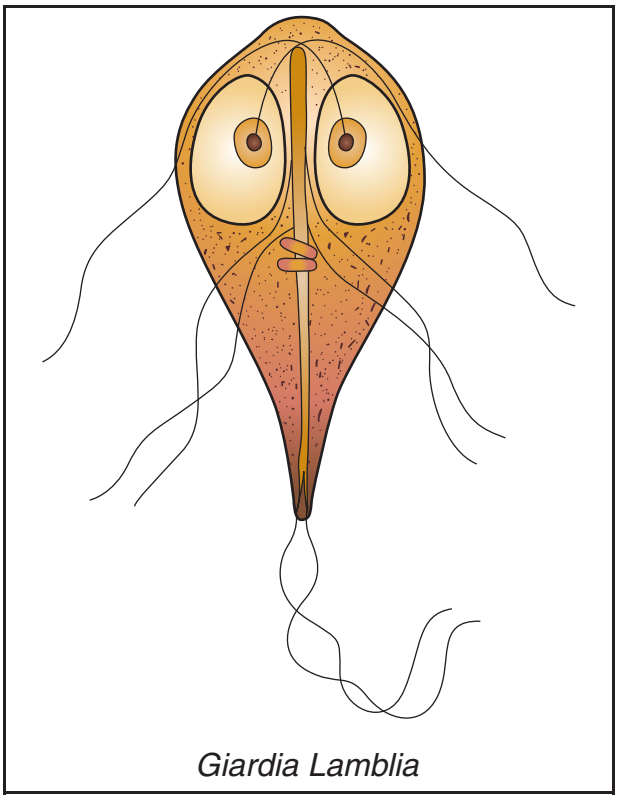

Infection with the protozoon *Giardia lamblia*, shown above, causes diarrhea in humans. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

of traveller's **diarrhea**. In the United States it is a growing problem, especially among children in child-care centers.

Giardiasis case reports in the United States[1] (including Guam and Puerto Rico), 2006–2008

Year	Number of cases	Number of outbreak cases[2]
2006	19,239	393
2007	19,794	346
2008	19,140	189

[1] *Giardia* is not a reputable condition in five states (IN, KY, MS, NC, TX).
[2] Number of cases linked to a known outbreak.

SOURCE: Centers for Disease Control and Prevention, "Giardiasis Surveillance—United States, 2006–2008," *MMWR Surveillance Summaries* 59, no. SS—6 (June 11, 2010):15–25. Available online at: http://www.cdc.gov/mmwr/preview/mmwrhtml/ss5906a2.htm (accessed September 20, 2010).

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Description

Giardia is one of the most common intestinal parasites in the world, infecting as much as 20% of the entire population of the earth. It is common in overcrowded developing countries with poor sanitation and a lack of clean water. Recent tests have found *Giardia* in 7% of all stool samples tested nationwide, indicating that this disease is much more widespread than was originally believed. It has been found not only in humans, but also in wild and domestic animals.

Giardiasis is becoming a growing problem in the United States, where it affects three times more children than adults. In recent years, giardiasis outbreaks have been common among people in schools or daycare centers and at catered affairs and large public picnic areas. Children can easily pass on the infection by touching contaminated toys, changing tables, utensils, or their own feces, and then touching other people. For this reason, infection spreads quickly through a daycare center or institution for the developmentally disabled.

Unfiltered streams or lakes that may be contaminated by human or animal wastes are a common source of infection. Outbreaks can occur among campers and hikers who drink untreated water from mountain streams. While 20 million Americans drink unfiltered city water from streams or rivers, giardiasis outbreaks from tainted city water have been rare. Most of these problems have occurred not due to the absence of filters, but because of malfunctions in city water treatment plants, such as a temporary drop in chlorine levels. It is possible to become infected in a public swimming pool, however, since *Giardia* can survive in chlorinated water for about 15 minutes. During that time, it is possible for an individual to swallow contaminated pool water and become infected.

Causes and symptoms

Giardiasis is spread by food or water contaminated by the *Giardia lamblia* protozoan organism found in the human intestinal tract and feces. When the cysts are ingested, the stomach acid degrades the cysts and releases the active parasite into the body. Once within the body, the parasites cling to the lining of the small intestine, reproduce, and are swept into the fecal stream. As the liquid content of the bowel dries up, the parasites form cysts, which are then passed in the feces. Once excreted, the cysts can survive in water for more than three months. The parasite is spread further by direct fecal-oral contamination, such as can occur if food is prepared without adequate hand-washing, or by ingesting the cysts in water or food.

Giardiasis is not fatal, and about two-thirds of infected people exhibit no symptoms. Symptoms will

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not occur until between one and two weeks after infection. When present, symptoms include explosive, watery diarrhea that can last for a week or more and, in chronic cases, may persist for months. Because the infection interferes with the body's ability to absorb fats from the intestinal tract, the stool is filled with fat. Other symptoms include foul-smelling and greasy feces, stomach pains, gas and bloating, loss of appetite, **nausea and vomiting**. In cases in which the infection becomeschronic, lasting for months or years, symptoms might include poor digestion, problems digesting milk, intermittent diarrhea, **fatigue**, weakness, and significant weight loss.

Diagnosis

Diagnosis can be difficult because it can be easy to overlook the presence of the giardia cysts during a routine inspection of a stool specimen. In the past, the condition has been diagnosed by examining three stool samples for the presence of the parasites. However, because the organism is shed in some stool samples and not others, the infection may not be discovered using this method.

A newer, more accurate method of diagnosing the condition is the enzyme-linked immunosorbent assay (ELISA) that detects cysts and antigen in stool, and is approximately 90% accurate. While slightly more expensive, it only needs to be done once and is therefore less expensive overall than the earlier test.

Treatment

Acute giardiasis can usually be allowed to run its natural course and tends to clear up on its own. **Antibiotics** are helpful, however, in easing symptoms and preventing the spread of infection. Medications include metronidazole, furazolidone and paromomycin. Healthy carriers with no symptoms do not need antibiotic treatment. If treatment should fail, the patient should wait two weeks and repeat the drug course. Anyone with an impaired immune system (immunocompromised), such as a person with **AIDS**, may need to be treated with a combination of medications.

Prognosis

Giardiasis is rarely fatal, and when treated promptly, antibiotics usually cure the infection. While most people respond quickly to treatment, some have lingering symptoms and suffer with diarrhea and cramps for long periods, losing weight and not growing well. Those most at-risk for a course like this are the elderly, people with a weakened immune system, malnourished children, and anyone with low stomach acid.

KEY TERMS

Antibody—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

Antigen—A substance (usually a protein) identified as foreign by the body's immune system, triggering the release of antibodies as part of the body's defense mechanism.

Enzyme-linked immunosorbent assay (ELISA)—A laboratory technique used to detect specific antigens or antibodies. It can be used to diagnose giardiasis.

Giardia lamblia—A type of protozoa with a whip-like tail that infects the human intestinal tract, causing giardiasis. The protozoa will not spread to other parts of the body.

Immunocompromised—A state in which the immune system is suppressed or not functioning properly.

Prevention

The best way to avoid giardiasis is to avoid drinking untreated surface water, especially from mountain streams. The condition also can be minimized by practicing the following preventive measures:

- thoroughly washing hands before handling food
- maintaining good personal cleanliness
- boiling any untreated water for at least three minutes
- properly disposing of fecal material

Children with severe diarrhea (and others who are unable to control their bowel habits) should be kept at home until the stool returns to normal. If an outbreak occurs in a daycare center, the director should notify the local health department. Some local health departments require a follow-up stool testing to confirm that the person is no longer contagious. People not in high-risk settings can return to their routine activities after recovery.

Resources

OTHER

Centers for Disease Control. http://www.cdc.gov/ncidod/EID/eidtext.htm.

International Society of Travel Medicine. http://www.istm.org.

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ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

Carol A. Turkington

Gigantism *see* **Acromegaly and gigantism**

Gilchrist's disease *see* **Blastomycosis**

Gilles de la Tourette's syndrome *see* **Tourette syndrome**

Gingivitis *see* **Periodontal disease**

Ginkgo biloba

Definition

Ginkgo biloba, known as the kew tree, ginkyo, or duck-foot tree, is one of the oldest trees on Earth. Known for its heartiness and resilience, Ginkos survived the Atom Bomb attack on Hiroshima, Japan in 1945.

The Ginkgo is indigenous to China, Japan, and Korea and, when planted, thrives in North America and Europe.

Description

Ginkgo trees may grow to 122 ft (37.2 m) tall and measure 4 ft (1.2 m) in girth. They are grown on plantations in the United States, France, South Korea, and Japan.

Ginkgo biloba leaves. *(© iStockPhoto/Ma Sai.)*

Purpose

In Chinese medicine, leaf extracts have been traditionally used to treat **asthma**, **allergies**, **premenstrual syndrome**, ringing in the ears, age-related **memory loss** and **dementia**. Standardized leaf extracts are currently used to treat memory loss and early Alzheimer's and circulation problems in the hands and legs.

Preparations

There are more than 40 chemical compounds extractable from Ginkgo leaves. The compounds have complex interactions, making precise cause and effect relationships between them difficult to asses.

Ginkgo acts to dilate blood vessels and increase blood flow in the brain, hands and legs and can relax smooth muscles in the lungs. It also acts as a blood thinner by interfering with platelet aggregation.

Precautions

Though used as medicines, herbal products like Ginko are regulated like dietary supplements in the United States. Thus, manufacturers are responsible only for their production processes. Imported herbals may not have met our manufacturing standards. Approval of herbals is based on traditional use, not demonstrated safety and effectiveness. Before an herbal can be withdrawn from the market, the FDA must prove that it is unsafe.

In therapeutic doses of 120-240mg per day, Ginkgo is generally safe and non-toxic. Approximately 2% of people taking Ginko may experience **headache**, restlessness, mild abdominal discomfort and **diarrhea**.

Ginko interferes with platelets, crucial components in blood clotting, and should not be taken for at least two days prior to having surgery or dental work.

Ginko may increase the blood-thinning effects of warfarin.

Drug-herbal and herbal-herbal interactions are not well understood and have not been thoroughly tested. Patients must be careful observers of themselves as they take new drugs or herbs, or as they take these products regularly over many months.

Side effects

Plum-like fruits of female Ginko trees may cause **contact dermatitis**. Taken internally, seeds may cause headache, **nausea**, diarrhea, and even seizures when taken in large amounts.

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Resources

OTHER

"Gingko (Gingko biloba L)." National Standard. Mayo Clinic online. http://www.mayoclinic/health/gingko-biloba/NS_patient-ginkgo.

James Waun, MD, RPh

Ginseng

Definition

Ginseng is an herb derived from the roots of different plants in the Araliacea family that is native to Asia and North America. It is also called Asian ginseng, Asiatic ginseng, Chinese ginseng, and Korean ginseng. Russian ginseng is not a true member of the ginseng family.

Description

Highest quality ginseng root is harvested in the fall from three to six-year-old plants.

Dried Korean ginseng. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Purpose

Evidence suggests that ginseng boosts immune systems and increases the effectiveness of **antibiotics** during treatment for respiratory infections.

Ginseng has some antioxidant effects that may protect the heart and lower low density lipoproteins, bad cholesterol.

Ginseng may lower blood sugar. Long term effects of the herb on type II diabetes are unknown and safe, effective doses for use in this condition have not been established.

Ginseng is used to improve the overall sense of well being during recovery from illness and to boost stamina and mental and physical performance.

It is sometimes used to treat **erectile dysfunction** and relieve symptoms of **menopause**.

preparations

Carefully cleansed, dried and ground ginseng root is available as teas and in tablets, capsules, liquid extracts and as topical creams.

Precautions

Though used as medicines, herbal products are regulated like dietary supplements in the United States. Manufacturers are responsible only for their production processes. Manufacturing standards, and combinations of herbs within herbal products, may vary.

The potency of many herbal products sold in stores varies from what is stated on their labels.

There is no reliable evidence on the long-term side effects of taking ginseng; some advocates for the herb recommend limiting its use to three months.

Side effects

Some people are allergic to ginseng.

Side effects include **headache**, intestinal and sleep disturbances

Long-term use of ginseng may result in skin **rashes**, **itching**, loss of appetite, **diarrhea**, **anxiety**, excitability, depression and **insomnia**.

Occasionally, headaches, **dizziness**, rapid heart rate or **palpitations** (pounding sensation in the chest) occur.

Some people taking ginseng experience an estrogen-like effect with swelling and tenderness in the breasts, or post-menopausal bleeding.

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Because of the possible estrogen effect, ginseng should not be used by people with hormone-related conditions like breast or uterine **cancer** or **endometriosis**.

Ginseng effects the liver enzyme that decomposes many drugs, and can alter their effects. For instance, it may reduce the effects of the blood thinner warfarin and increase the effects of drugs taken to reduce blood pressure.

Interactions

Ginseng may reduce the effectiveness of the blood-thinner warfarin and increase the likelihood **blood clots**.

Ginseng may increase the potential for bleeding for people taking blood thinners like **aspirin**, Plavix, and nonsteroidal anti inflammatory drugs like ibuprofen.

People who take ginseng and monoamine oxidase inhibitor antidepressants (MAOI) are more likely to experience headaches and insomnia.

Ginseng may either increase or decrease the effects drugs taken for heart disease and high blood pressure.

Resources

OTHER

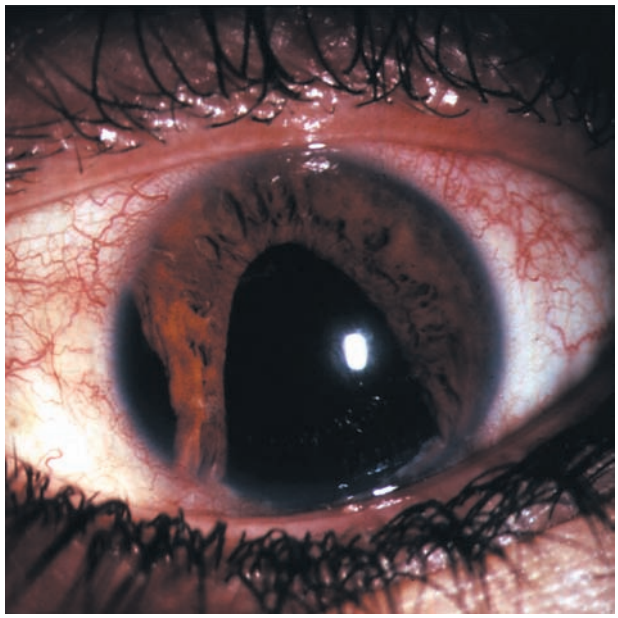
"Asian ginseng." National Center for Complementary and Alternative Medicine. http://nccam.nih.gov/health/asianginseng.

James Waun, MD, RPh

Glaucoma

Definition

Glaucoma is a condition in which the optic nerve is subject to damage—usually, but not always, because of excessively high intraocular pressure (pressure within the eye, also called IOP). If untreated, the optic nerve damage results in progressive, permanent vision loss, starting with unnoticeable blind spots in the field of vision, progressing to tunnel vision, and then to blindness. Glaucoma can result in irreversible damage to the optic nerve. It is one of the leading causes of irreversible blindness in the United States and world-wide, and is the leading cause of blindness among African Americans and older adults in the United States. Because there are usually no symptoms early on in the disease, about half of the people with glaucoma do not even know they have the condition.



A close-up view of an inflamed eye with acute glaucoma and an irregularly enlarged pupil. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Description

More than two million people in the United States have glaucoma, and 80,000 of those are legally blind as a result of the disease. Glaucoma can strike any age group, even newborn infants. Susceptibility to the disease, however, increases with age. African Americans are at a three times higher risk of glaucoma than the rest of the population.

Glaucoma is a class of diseases. There are at least 20 different forms that can be divided into two categories: open-angle glaucoma and narrow-angle glaucoma. To understand what glaucoma is and what these terms mean, it is useful to understand eye structure.

Eyes are sphere-shaped. A tough, non-leaky protective sheath (the sclera) covers the entire eye, except for the clear cornea at the front and the optic nerve at the back. Light comes into the eye through the cornea, then passes through the lens, which focuses it onto the retina (the innermost surface at the back of the eye). The rods and cones of the retina transform the light energy into electrical messages, which are transmitted to the brain by the bundle of nerves known as the optic nerve.

The iris, the colored part of the eye shaped like a round picture frame, is between the dome-shaped cornea and the lens. It controls the amount of light that enters the eye by opening and closing its central hole (pupil) like the diaphragm in a camera. The iris, cornea,

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and lens are bathed in a liquid called the aqueous humor, which is somewhat similar to plasma. This liquid is continually produced by nearby ciliary tissues and moved out of the eye into the bloodstream by a system of drainage canals (called the trabecular meshwork). The drainage area is located in front of the iris, in the angle formed between the iris and the point at which the iris appears to meet the inside of the cornea.

Glaucoma occurs if the aqueous humor is not removed rapidly enough or if it is made too rapidly, causing pressure to build-up. The high pressure distorts the shape of the optic nerve and destroys the nerve. Destroyed nerve cells result in blind spots in places where the image from the retina is not being transmitted to the brain.

Open-angle glaucoma accounts for over 90% of all cases. It is called "open-angle" because the angle between the iris and the cornea is open, allowing drainage of the aqueous humor. It is usually chronic and progresses slowly. In narrow-angle glaucoma, the angle where aqueous fluid drainage occurs is narrow, and therefore may drain slowly or may be at risk of becoming closed. A closed-angle glaucoma attack is usually acute, occurring when the drainage area is blocked. This can occur, for example, if the iris and lens suddenly adhere to each other and the iris is pushed forward. In patients with very narrow angles, this can occur when the eyes dilate (e.g., when entering a dark room, or if taking certain medications).

Congenital glaucoma occurs in babies and is the result of incomplete development of the eye's drainage canals during embryonic development. An infant with congenital glaucoma may have enlarged, hazy corneas; show signs of being extremely sensitive to light; and have very teary eyes. The eye may also seem enlarged or bulging. The best way to detect childhood glaucoma is for children to have a regular and complete **eye examination**. Microsurgery can often correct the defects or they can be treated with a combination of medicine and surgery.

One rare form of open-angle glaucoma, normal tension glaucoma, is different. People with normal-tension glaucoma have optic nerve damage in the presence of normal IOP. The mechanism of this disease is a mystery but is generally detected after an examination of the optic nerve. Those at higher risk for this form of glaucoma are people with a familial history of normal tension glaucoma, people of Japanese ancestry, and people with a history of systemic heart disease such as irregular heart rhythm.

Glaucoma is also a secondary condition of over 60 widely diverse diseases and can also result from injury, inflammation, tumor, or in advanced cases of cataract or diabetes.

Causes

Glaucoma is the result of disruptions of normal processes to maintain pressure within the eye tissue. The iris, cornea, and lens of the eye are bathed in a nutritive liquid called the aqueous humor, which is made by cells within the eye. Excess fluid is continually removed by a spongy meshwork of drainage canals. Glaucoma occurs if there is a build up of the aqueous humor due to poor drainage or overproduction. As the fluid builds up there is increased pressure on the retina at the back of the eye. This increased pressure reduces the blood supply to the nerves of the retina and causes the nerves to die, which may distort and destroy the optic nerve. As nerve cells are destroyed, blind spots develop, and there is a progressive loss of vision. A change in the production and strength of collagen may also contribute to the onset of the disease. Collagen is a protein that helps maintain the structure and function of eye tissue. **Stress** and **allergies** may aggravate glaucoma symptoms.

It is probable that most cases of glaucoma are partially due to a genetic predisposition. At least 10 defective genes have been identified that may cause glaucoma. Although in the late 2000s there were still many unknown factors that trigger the disease, a number of processes have been implicated. They include age-related changes, congenital abnormalities, injuries to the eye tissue, and problems related to other eye diseases. Vision loss in all forms of glaucoma is caused by damage to the optic nerve, the retina, and the collagen protein that makes up eye tissue. Use of certain medications, including antihypertensives, **antihistamines**, anticholinergics, and antidepressants may also contribute to the development of glaucoma. Corticosteroid eye drops, which are often used for other eye disorders, may destroy the integrity of eye tissue. Other types of eye drops may cause the pupils to dilate, increasing intraocular eye pressure (IOP), which may also lead to glaucoma in those who have a tendency to the disease.

Symptoms

Chronic open-angle glaucoma at first develops without noticeable symptoms. The pressure buildup is gradual, and it does not bring on discomfort. Moreover, the vision loss is too gradual to be noticed at first, and the brain compensates for blind spots. Over an extended period of time, though, the elevated pressure pushes against and damages the optic nerve and the

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retina. If glaucoma is left untreated, vision loss becomes evident, and the condition becomes painful.

Acute closed-angle glaucoma is obvious from the beginning. The symptoms are blurred vision, severe eye **pain**, sensitivity to light, **nausea and vomiting**, dilated pupils, reddened eyes, and halos visualized around lights. The corneas may become hazy in appearance. Acute closed-angle glaucoma is an emergency situation. It needs to be treated immediately. Congenital glaucoma is evident at birth. Symptoms are bulging eyes, cloudy corneas, enlarged corneas, excessive teariness, and sensitivity to light.

Risk factors that increase the probability of developing glaucoma include:

- ocular hypertension, a slightly increased IOP
- age over 40
- diabetic conditions
- high blood pressure
- migraine headaches
- nearsightedness, farsightedness, and other visual disturbances
- a family history of glaucoma
- being of African American or Hispanic ethnicity

Diagnosis

Sometimes glaucoma can be diagnosed with a routine eye exam by an ophthalmologist, who can make a definitive diagnosis of glaucoma. IOP, defects in the field of vision, and the appearance of the optic nerve, are all considered in the diagnosis of glaucoma. Visual field tests (perimetry) can detect blind spots in a patient's field of vision before the patient is aware of them. An instrument, known as a tonometer, is used to measure eye pressure. Since IOP can vary throughout the day, a person may have to return for several visits to measure eye pressure at different times of the day. An ophthalmoscope is used to examine the inner aspects and the back of the eyes, including the optic nerve, for changes and damage. A slit lamp may be used to allow the doctor further examination of the eye. Another test, gonioscopy, can distinguish between narrow-angle and open-angle glaucoma. A gonioscope allows visualization of the angle between the iris and the cornea. A subsequent technology is optical coherence tomography (OCT) that produces high-resolution images of the anterior segment of the eye and is a non-invasive procedure. As of 2007, it was primarily used in conjunction with gonioscopy in diagnosing and assessing glaucoma.

Intraocular pressure can vary throughout the day. For that reason, the doctor may have a patient return for several visits to measure the IOP at different times of the day.

Treatment

The first line of glaucoma treatment is the use of prescription eyedrops. Several classes of medications are effective at lowering IOP and thus preventing optic nerve damage in chronic and neonatal glaucoma. **Beta blockers** (e.g., timolol), carbonic anhydrase inhibitors (e.g., acetazolamide), and alpha-2 agonists (e.g., brimonidine tartrate) inhibit aqueous humor production. Miotics (e.g., pilocarpine) and prostaglandin analogues (e.g., latanoprost) increase the outflow of aqueous humor.

It is important for patients to inform their doctors of any health conditions they have or any medications they take, including over-the counter drugs. Certain drugs used to treat glaucoma are not prescribed for patients with pre-existing conditions. The drugs prescribed to treat glaucoma all have side effects, so patients taking them should be monitored closely, especially for cardiovascular, pulmonary, and behavioral symptoms. Each medication lowers IOP by a different amount, and a combination of medications may be necessary. To ensure that IOP is lowered sufficiently, it is important that patients take their medications and be monitored regularly. IOP should be measured three to four times per year.

Normal-tension glaucoma is treated by reducing IOP to less-than-normal levels, on the theory that overly susceptible optic nerves are less likely to be damaged at lower pressures. Research underway may point to better treatments for this form of glaucoma.

Attacks of acute closed-angle glaucoma are medical emergencies. IOP is rapidly lowered by successive deployment of acetazolamide, hyperosmotic agents, a topical beta-blocker, and pilocarpine. Epinephrine should not be used because it exacerbates angle closure.

Trabeculectomy, to open the drainage canals or make an opening in the iris, can be effective in increasing the outflow of aqueous humor. This surgery is usually successful, but the effects often last less than one year. Nevertheless, this is an effective treatment for patients whose IOP is not sufficiently lowered by drugs and for those who can't tolerate the drugs.

Laser peripheral iridotomy is a procedure used almost exclusively to treat narrow angle glaucoma. It involves creating a small opening in the peripherial iris that allows aqueous fluid to drain from behind the iris

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KEY TERMS

Agonist—A drug that mimics one of the body's own molecules.

Alpha-2 agonist—A class of drugs that bind to and stimulate alpha-2 adrenergic receptors, causing responses similar to those of adrenaline and noradrenaline, by inhibiting aqueous humor production.

Aqueous humor—A transparent liquid, contained within the eye, that is composed of water, sugars, vitamins, proteins, and other nutrients.

Beta-blocker—A class of drugs that bind beta-adrenergic receptors and thereby decrease the ability of the body's own natural epinephrine to bind to those receptors, leading to the reduction of aqueous humor secretion.

Carbonic anhydrase inhibitor—A class of diuretic drugs that inhibit the enzyme carbonic anhydrase, an enzyme involved in producing bicarbonate, which is required for aqueous humor production by the ciliary tissues in the eye. Thus, inhibitors of this enzyme inhibit aqueous humor production. Some side effects are urinary frequency, kidney stones, loss of the sense of taste, depression, and anemia.

Cornea—The clear, bowl-shaped structure at the front of the eye located in front of the colored part of the eye. The cornea lets light into the eye and partially focuses it.

Gonioscope—An instrument that consists of a magnifier and a lens equipped with mirrors and sits on the patient's cornea.

Hyperosmotic drugs—Refers to a class of drugs for glaucoma that increase the osmotic pressure in the blood, which then pulls water from the eye into the blood.

Iris—The colored part of the eye just behind the cornea and in front of the lens that controls the amount of light sent to the retina.

Laser cyclophotocoagulation—A procedure used for severe glaucoma in patients who have not responded well to previous treatments. The laser partially destroys the tissues that make the fluid of the eye.

Laser peripheral iridotomy—This procedure makes a drainage hole in the iris allowing the fluid to drain from the eye.

Laser trabeculoplasty—In this procedure the laser attempts to open the normal drainage channels of the eye so fluid can drain more effectively.

Lens (the crystalline lens)—A transparent structure in the eye that focuses light onto the retina.

Miotic—A drug that causes pupils to contract.

Ophthalmoscope—An instrument, with special lighting, designed to view structures in the eye.

Optic nerve—The nerve that carries visual messages from the retina to the brain.

Prostaglandin—A group of molecules that exert local effects on a variety of processes including fluid balance, blood flow, and gastrointestinal function.

Prostaglandin analogue—A class of drugs that are similar in structure and function to prostaglandin.

Retina—The light-sensitive layer of the eye.

Sclera—The tough, fibrous, white outer protective covering that surrounds the eye.

Tonometry—The measurement of pressure.

Trabecular meshwork—A sponge-like tissue located near the cornea and iris that functions to drain the aqueous humor from the eye into the blood.

directly to the anterior chamber. This procedure typically result in "opening up" the narrow angle between the iris and the cornea, in essence converting a narrow angle into an open angle.

Argon laser trabeculoplasty is usually recommended when medications have not been able to sufficiently control IOP, although it is increasingly advocated as primary therapy for patients who are not good candidates for the use of glaucoma medications or who cannot use eyedrops. In this procedure, the beam of an argon laser is directed at the trabecular meshwork. Typically about 180° of the trabecular meshwork is treated with laser spots. As a result of this procedure, the drainage of aqueous fluid out of the eye increases, thus lowering IOP.

Gene therapy may also be part of future treatments. A mutation in the gene myocilin is believed to cause most cases of juvenile glaucoma, and 3–4% of adult glaucoma. Researchers are investigating drugs that inhibit myocilin production. The drug therapy would not just treat IOP, but also could be used before glaucoma's onset.

Vitamin C, vitamin B_1 (thiamine), chromium, zinc, and rutin may reduce IOP.

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Patients using alternative methods to attempt to prevent optic nerve damage should be advised they also need the care of a traditionally trained ophthalmologist or optometrist who is licensed to treat glaucoma, so that IOP and optic nerve damage can be monitored.

Since the early 1970s, a number of scientific studies reported that the active agents in **marijuana** *Cannabis sativa* are effective in lowering intraocular pressure (IOP) in people with glaucoma. One study reported that people with glaucoma who smoked marijuana had a 25% to 30% drop in IOP that lasted three to four hours. Under federal law, the use, possession, or sale of marijuana is illegal in the United States. However, as of 2007, twelve states had legalized the medical use of marijuana. In 2005, the U.S. Supreme Court ruled that federal laws against medical marijuana take precedence over state laws, allowing for continued federal prosecution against people who use marijuana for medical purposes. Despite the ruling, medical marijuana programs continue in several states, including California. The active agents in marijuana are cannabinol, cannabidiol, and delta-9-tetrahydrocannabinol (THC). A synthetic version of THC, dronabinol (Marinol), is available in the United States and can be legally prescribed for a number of conditions, including glaucoma.

Expected results

If glaucoma is left untreated, optic nerve damage will result in a progressive loss of vision. Once blindness develops due to glaucoma, it cannot be reversed. With early treatment and monitoring, however, serious vision loss can usually be prevented.

Prevention

While glaucoma is not preventable, early detection and treatment can help to prevent serious damage to vision. Those with risk factors should have regular eye exams and avoid medicines that tend to be implicated in the development of glaucoma, including some over-the-counter cold and allergy medications. All medications should be checked for their ingredients. Alternatives for drugs that aggravate glaucoma should be discussed with a healthcare provider.

Patients with narrow angles should avoid certain medications (even over-the-counter medications, such as some cold or allergy medications).Any person who is glaucoma-susceptible (i.e. narrow angles and borderline IOPs) should read the warning labels on over-the-counter medicines and inform their physicians of products they are considering taking. **Steroids** may also raise IOP, so patients may need to be monitored more frequently if it is necessary to use steroids for another medical condition.

Health care team roles

Nursing and allied health professionals play an important part in the diagnosis and treatment of glaucoma. Skilled ophthalmic technicians and assistants record the patient history and perform many of the preliminary tests. Depending on skill level, these ophthalmic assistants may perform measurement of visual acuity under both low and high illumination, assessment of ocular motility and binocularity, visual fields, measurement of IOPs with tonometers, evaluation of pupillary responses, and refraction.

Before surgical procedures, nurses and assistants also prepare the operating room (OR). Many ophthalmologists now have their own ambulatory surgery centers where skilled technicians and ophthalmic nurses play a critical role in preparing the OR and patients for the surgery. Ophthalmic nurses also assist the ophthalmologists during surgery and discuss outcomes with patients post-operatively.

Nurses and assistants assist patients by explaining the sometimes difficult regimen of glaucoma medication. In some cases, patients require several doses of a combination of medications. Ophthalmic nurses and assistants show patients the correct technique for inserting eyedrops, and reinforce the physician's instructions for medication compliance.

Patient education

Ophthalmic assistants and nurses help to ensure that patients return to the physician's office in a timely manner so that IOPs can be monitored. Nurses and assistants also emphasize the importance of adhering to the eyedrop schedule to keep IOPs at a lower level, and answer any questions concerning proper eyedrop instillation.

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ORGANIZATIONS

American Academy of Ophthalmology., PO Box 7424, San Francisco, CA, 94120-7424, (415) 561-8500, http://www.aao.org.
Glaucoma Foundation., 80 Maiden Lane, Suite 1206, New York, NY, 10038, (212) 285-0080, http://www.glaucomafoundation.org.
National Eye Institute., 31 Center Dr., MSC 2510, Bethesda, MD, 20892-2510, (301) 496-5248, http://www. nei.nih.gov.
Optometric Glaucoma Society., 5553 Taft Ave., Oakland, CA, 94618, (925) 557-4181, http://www.optometricglaucomasociety.org.

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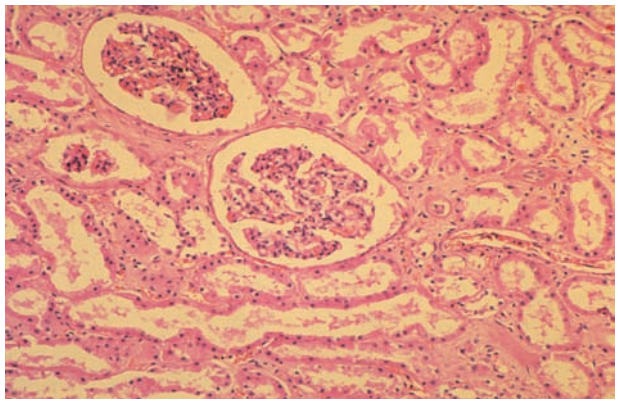
Glaucoma surgery *see* **Trabeculectomy**
Glioma *see* **Brain tumor**
Glipizide *see* **Antidiabetic drugs**

Glomerulonephritis

Definition

Acute glomerulonephritis is an inflammatory disease of both kidneys predominantly affecting children from ages two to 12. Chronic glomerulonephritis can develop over a period of 10–20 years and is most often associated with other systemic disease, including diabetes, **malaria**, hepatitis, or **systemic lupus erythematosus**.



A close-up view of glomerulonephritis affecting the kidney. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Description

Acute glomerulonephritis is an inflammation of the glomeruli, bundles of tiny vessels inside the kidneys. The damaged glomeruli cannot effectively filter waste products and excess water from the bloodstream to make urine. The kidneys appear enlarged, fatty, and congested.

Causes and symptoms

Acute glomerulonephritis most often follows a streptococcal infection of the throat or skin. In children, it is most often associated with an upper respiratory infection, **tonsillitis**, or **scarlet fever**. Kidney symptoms usually begin two to three weeks after the initial infection. Exposure to certain paints, glue or other organic solvents may also be the causative agent. It is thought that the kidney is damaged with exposure to the toxins that are excreted into the urine.

Mild glomerulonephritis may produce no symptoms, and diagnosis is made with laboratory studies of the urine and blood. Individuals with more severe cases of the disease may exhibit:

- fatigue
- nausea and vomiting
- shortness of breath
- disturbed vision
- high blood pressure
- swelling, especially noted in the face, hands, feet, and ankles
- blood and protein in the urine, resulting in a smoky or slightly red appearance

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KEY TERMS

Dialysis—A process of filtering and removing waste products from the bloodstream. Two main types are hemodialysis and peritoneal dialysis. In hemodialysis, the blood flows out of the body into a machine that filters out the waste products and routes the cleansed blood back into the body. In peritoneal dialysis, the cleansing occurs inside the body. Dialysis fluid is injected into the peritoneal cavity and wastes are filtered through the peritoneum, the thin membrane that surrounds the abdominal organs.

Glomeruli—Groups of tiny blood vessels with very thin walls that function as filters in the kidney. Glomeruli become inflamed and are destroyed in the disease process of glomerulonephritis.

Renal—Relating to the kidneys, from the Latin word *renes*.

The individual with chronic glomerulonephritis may discover their condition with a routine physical exam revealing high blood pressure, or an eye exam showing vascular or hemorrhagic changes. The kidneys may be reduced to as little as one-fifth their normal size, consisting largely of fibrous tissues.

Diagnosis

Diagnosis of glomerulonephritis is established based on medical history, combined with laboratory studies. A "dipstick" test of urine will reveal increased protein levels. A 24 hour urine collection allows measurement of the excretion of proteins and creatinine. Creatinine clearance from the bloodstream by the kidneys is considered an index of the glomerular filtration rate. Blood studies may reveal a low blood count, and may also be checked for the presence of a streptococcal antibody titer(a sophisticated blood test indicating presence of streptococcal infection). A **kidney biopsy** may also be performed, using ultrasound to guide the needle for obtaining the specimen.

Treatment

The main objectives in the treatment of acute glomerulonephritis are to:

- decrease the damage to the glomeruli
- decrease the metabolic demands on the kidneys
- improve kidney function

Bedrest helps in maintaining adequate blood flow to the kidney. If residual infection is suspected, antibiotic therapy may be needed. In the presence of fluid overload, **diuretics** may be used to increase output with urination. Iron and vitamin supplements may be ordered if anemia develops, and antihypertensives, if high blood pressure accompanies the illness. In order to rest the kidney during the acute phase, decreased **sodium** and protein intake may be recommended. The amount of protein allowed is dependent upon the amount lost in the urine, and the requirements of the individual patient. Sodium limitations depend on the amount of **edema** present. Fluid restrictions are adjusted according to the patient's urinary output and body weight.

An accurate daily record of the patient's weight, fluid intake and urinary output assist in estimating kidney function. The patient must be watched for signs of complications and recurrent infection. As edema is reduced and the urine becomes free of protein and red blood cells, the patient is allowed to increase activity. A woman who has had glomerulonephritis requires special medical attention during **pregnancy**.

Prognosis

In acute glomerulonephritis, symptoms usually subside in two weeks to several months, with 90% of children recovering without complications and adults recovering more slowly. Chronic glomerulonephritis is a disease that tends to progress slowly, so that there are no symptoms until the kidneys can no longer function. The resultant renal failure may require dialysis or kidney transplant.

Prevention

Prevention of glomerulonephritis is best accomplished by avoiding upper respiratory infections, as well as other acute and chronic infections, especially those of a streptococcal origin. Cultures of the infection site, usually the throat, should be obtained and antibiotic sensibility of the offending organism determined. Prompt medical assessment for necessary antibiotic therapy should be sought when infection is suspected. The use of prophylactic immunizations is recommended as appropriate.

ORGANIZATIONS

American Association of Kidney Patients, 3505 E. Frontage Road, Suite 315, Tampa, FL, 33607, (813) 636-8122, (800) 749-2257, info@aakp.org, http://www.aakp.org.

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American Kidney Fund (AKF), 6110 Executive Boulevard, Suite 1010, Rockville, MD, 20852, (800) 638-8299, http://www.kidneyfund.org.

National Institute of Diabetes and Digestive and Kidney Diseases, NIDDK, NIH Bldg 31, Rm 9A06 31 Center Drive, MSC 2560, Bethesda, MD, 20892-2560, (301) 496.3583, http://www2.niddk.nih.gov.

National Kidney Foundation, Inc. , 30 East 33rd Street, New York, NY, 10016, (212) 889-2210, (212) 689-9261, (800) 622-9010, http://www.kidney.org.

Kathleen D. Wright, RN

Glossopharyngeal neuralgia *see* **Neuralgia**

Glucose-6-phosphate dehydrogenase deficiency

Definition

Glucose-6-phosphate dehydrogenase deficiency is an inherited condition caused by a defect or defects in the gene that codes for the enzyme, glucose-6-phosphate dehydrogenase (G6PD). It can cause **hemolytic anemia**, varying in severity from life-long anemia, to rare bouts of anemia to total unawareness of the condition. The episodes of hemolytic anemia are usually triggered by oxidants, infection, or by eating fava beans.

Description

G6PD deficiency is the most common enzyme deficiency in the world, with about 400 million people living with it. It is most prevalent in people of African, Mediterranean, and Asian ancestry. The incidence in different populations varies from zero in South American Indians to less than 0.1% of Northern Europeans to about 50% of Kurdish males. In the United States, it is most common among African American males; about 11 to 14% are G6PD-deficient.

G6PD deficiency is a recessive sex-linked trait. Thus, males have only one copy of the G6PD gene, but females have two copies. Recessive genes are masked in the presence of a gene that encodes normal G6PD. Accordingly, females with one copy of the gene for G6PD deficiency are usually normal, while males with one copy have the trait.

G6PD is present in all human cells but is particularly important to red blood cells. It is required to make NADPH in red blood cells but not in other cells. It is also required to make glutathione. Glutathione and NADPH both help protect red blood cells against oxidative damage. Thus, when G6PD is defective, oxidative damage to red blood cells readily occurs, and they break open as a result. This event is called hemolysis, and multiple hemolyses in a short time span constitute an episode of hemolytic anemia.

There are almost 100 different known forms of G6PD enzyme molecules encoded by defective G6PD genes, yet not one of them is completely inactive. This suggests that G6PD is indispensable. Many G6PD defective enzymes are deficient in their stability rather than their initial ability to function. Since red blood cells lack nuclei, they, unlike other cells, cannot synthesize new enzyme molecules to replace defective ones. Hence, we expect young red blood cells to have new, functional G6PD and older cells to have nonfunctioning G6PD. This explains why episodes of hemolytic anemia are frequently self-limiting; new red blood cells are generated with enzymes able to afford protection from oxidation.

The geographic distribution of G6PD deficiency, allowing for migration, coincides with the geographic distribution of **malaria**. This fact and survival statistics suggest that G6PD deficiency protects against malaria.

Glucose-6-phosphate dehydrogenase deficiency is also known as G6PD deficiency, favism, and primaquine sensitivity.

Causes and symptoms

Causes

G6PD deficiency is caused by one copy of a defective G6PD gene in males or two copies of a defective G6PD gene in females. Hemolytic anemic attacks can be caused by oxidants, infection, and or by eating fava beans.

Symptoms

The most significant consequence of this disorder is hemolytic anemia, which is usually episodic, but the vast majority of people with G6PD deficiency have no symptoms.

The many different forms of G6PD deficiency have been divided into five classes according to severity.

- Class 1–enzyme deficiency with chronic hemolytic anemia
- Class 2–severe enzyme deficiency with less than 10% of normal activity
- Class 3–moderate to mild enzyme deficiency with 10–60% of normal activity
- Class 4–very mild or no enzyme deficiency
- Class 5–increased enzyme activity

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KEY TERMS

Bilirubin—A breakdown product derived from hemoglobin; removed from the blood by the liver.

Enzyme—A protein catalyst; one of the two kinds of biological catalysts, which are exceedingly specific; each different enzyme only catalyzes one or two specific reactions.

Enzyme activity—A measure of the ability of an enzyme to catalyze a specific reaction.

Glutathione—A molecule that acts as a co-enzyme in cellular oxidation-reduction reactions.

Hemolysis—Lysis (opening) of red blood cells, with concomitant leakage of cell contents from the cells.

Hemolytic anemia—Anemia due to hemolysis.

Jaundice—Yellowish skin color due to liver disease.

Neonatal—Describes babies just after they are born.

Recessive trait—An inherited trait that is outwardly obvious only when two copies of the gene for that trait are present–as opposed to a dominant trait where one copy of the gene for the dominant trait is sufficient to display the trait. The recessive condition is said to be masked by the presence of the dominant gene when both are present; i.e., the recessive condition is seen only in the absence of the dominant gene.

Sex-linked—Refers to genes or traits carried on one of the sex chromosomes, usually the X.

X chromosome—One of the two types of sex chromosomes, present twice in female cells and once in male cells.

The major symptoms of hemolytic anemia are **jaundice**, dark urine, abdominal **pain**, back pain, lowered red blood cell count, and elevated bilirubin. People who suffer from severe and chronic forms of G6PD deficiency in addition may have **gallstones**, enlarged spleens, defective white blood cells, and **cataracts**.

Attacks of hemolytic anemia are serious for infants. Brain damage and **death** are possible but preventable outcomes. Newborns with G6PD deficiency are about 1.5 times as likely to get **neonatal jaundice** than newborns without G6PD deficiency.

Diagnosis

Blood tests can detect G6PD deficiency, either by measuring the G6PD enzyme activity between episodes or by measuring bilirubin during an episode. Such tests cost about $50.00. Family histories are helpful, too.

Treatment

In a typical attack of hemolytic anemia, no treatment is needed; the patient will recover in about eight days. However, blood transfusions are necessary in severe cases. Recent success treating elevated bilirubin in newborns by exposing them to bright light has decreased the need for neonatal transfusions.

Alternative treatment

Vitamin E and **folic acid** (both anti-oxidants) may help decrease hemolysis in G6PD-deficient individuals.

Prognosis

The prognosis for almost everyone with G6PD deficiency is excellent. Large studies have shown that G6PD-deficient individuals do not acquire any illnesses more frequently than the rest of the population. In fact the opposite may be true for some diseases like ischemic heart disease and cerebrovascular disease.

Prevention

Most episodes of hemolytic anemia can be prevented by avoiding fava beans, oxidant drugs, and oxidant chemicals. All of the following oxidants can trigger attacks: acetanilid, dapsone, doxorubicin, furazolidone, methylene blue, nalidixic acid, napthalene, niridazole, nitrofurantoin, phenazopyridine, phenylhydrazine, primaquine, quinidine, quinine, sulfacetamide, sulfamethoxazole, sulfonamide, sulfapyridine, thiazolesulfone, toluidine blue, and trinitrotoluene. Since infections also trigger hemolytic attacks and have other dire consequences, sometimes it is advisable to use one of the listed drugs.

It is especially important to screen newborns who are likely to have G6PD deficiency to ensure that G6PD-deficient babies won't be subjected to any of the triggers of hemolytic anemia. Pregnant women, especially in areas where G6PD deficiency is prevalent, should avoid eating fava beans.

Resources

OTHER

G6PD Deficiency Favism Association. http://www.g6pd.org/favism/english/index.mvc.

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ORGANIZATIONS

Genetic Alliance, Inc., 4301 Connecticut Ave., NW, Suite 404, Washington, DC, 20008-2369, (202) 966-5557, (202) 966-8553, info@geneticalliance.org, http://www.geneticalliance.org.

Lorraine Lica, PhD

Glucosylcerebroside lipidosis *see* **Gaucher disease**

Gluten-free diet

Definition

A gluten-free diet is a diet that is completely free of gluten, which is a generic name for storage protein found in certain grains. In **celiac disease** (also referred to as celiac sprue), individuals develop an inflammatory immune system response to gluten that results in damage to the small intestine. This damage inhibits absorption of nutrients. Some individuals also develop **dermatitis** herpetiformis, an itchy and blistering skin condition. To control symptoms of gluten intolerance, affected individuals must completely avoid foods that contain gluten.

Origins

Guidelines for this diet have been developed by dietitians for several organizations associated with celiac disease and dermatitis herpetiformis, including the Gluten Intolerance Group, the Celiac Sprue Association, and the Celiac Disease Foundation. The American Dietetic Association also sponsored the development of a gluten-free diet through a cooperative effort of

Gluten-free diet

Ingredients/foods to avoid	May contain gluten	Foods allowed
Barley	Baking powder	Amaranth
Bran (wheat or oat)	Beans, baked	Beans, dried, unprocessed
Bulgur	Bouillon cubes	Buckwheat
Cake meal	Candy	Cassava
Couscous	Cheese sauces and spreads	Cheese, aged
Emulsifier	Chips, potato and tortilla	Corn
Farina	Chocolate drinks and mixes	Eggs, unprocessed
Flavoring	Coffee substitutes	Fish, unprocessed
Flour, enriched, durum, graham, semolina	Cold cuts	Flax
Gluten	Communion wafers	Fruits and juices, fresh, frozen or canned
Hydrolyzed plant protein	Corn cakes, popped	Herbs and spices, pure
Kamut	Egg substitutes, dried eggs	Ketchup
Malt and malt flavoring	French fries	Legumes
Matzo meal	Fruits, dried	Meats, unprocessed
Oatmeal and oat bran	Fruit-flavored drinks	Milk
Oats, rolled	Fruit pie fillings	Millet
Rye	Gravy	Mustard
Semolina	Hot dogs and other processed meats	Nuts, unprocessed, and nut flours
Seitan	Matzo	Olives
Soy sauce or soy sauce solids	Mayonnaise	Pickles, plain
Soy	Milk drinks	Potatoes and sweet potatoes
Spelt	Nuts, dry roasted	Quinoa
Stablizer	Peanut butter	Rice, wild rice, Indian rice
Starch, modified, or modified food starch	Pudding mixes	Sago
Triticale	Rice, brown	Seeds, unprocessed
Vegetable gum	Rice crackers and cakes	Soy flour
Vegetable protein	Rice mixes	Soy sauce, gluten-free
Vinegar, malt	Salad dressings	Sorghum
Wheat	Sauces	Tapioca
Wheat berries	Seasoning mixes	Tomato paste
Wheat bran	Sour cream	Vegetables without gluten-containing additives
Wheat, cracked	Soy nuts	Vinegar, apple, cider, and distilled white
Wheat germ	Syrup	Yucca
Wheat protein and hydrolyzed wheat protein	Teas, flavored and herbal	
Wheat starch	Turkey, self-basting	
Whole wheat	Vegetables in sauces	
	Yogurt, flavored or frozen	

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dietitian experts in celiac disease in Canada and the United States. This diet was published in October 2000.

Description

The gluten-free diet is the prescribed medical treatment for gluten intolerance diseases, including celiac disease and dermatitis herpetiformis. Celiac disease is a genetically inherited, chronic digestive disease that results in damage to parts of the small intestine that are responsible for absorption of nutrients. Celiac disease affects almost three million people in the United States, about one percent of the population. Another 3 million Europeans are affected. Celiac disease is found among North American and European populations where wheat is a staple food, but it is found infrequently among people of Chinese and Japanese heritage and individuals with an African-Caribbean background, where wheat is not as widely consumed.

In addition, dermatitis herpetiformis is an important disorder or complication of gluten-sensitivity. It manifests in the form of a skin rash. Approximately 10% of individuals with celiac disease have dermatitis herpetiformis, but about 85% of individuals with dermatitis herpetiformis also have celiac disease.

When a person with celiac disease consumes gluten, the villi of the small intestine, where absorption of key nutrients takes place, become damaged, resulting in nutrients passing through the digestive system without being absorbed. The person exhibits gastrointestinal distress and eventually **malnutrition**. In infancy, celiac disease can manifest as **failure to thrive**, **diarrhea**, abdominal distention, developmental delay, and in some infants, as severe malnutrition.

After infancy, the symptoms of celiac disease are less dramatic. Older children may be short or exhibit dental enamel defects. Women comprise about 75% of newly diagnosed adult cases of celiac disease. Symptoms of celiac disease include diarrhea, **constipation** alternating with diarrhea, intestinal gas, fatty, greasy, foul-smelling stools, bloating, **nausea**, **vomiting**, skin irritation, weight loss, anemia, neurological effects (including seizures, and possibly migraine headaches), **fatigue**, concentration and memory problems. In some cases, there may be intestinal damage without significant gastrointestinal symptoms. Celiac disease is diagnosed by blood tests for certain antibodies and a **small intestine biopsy**. A positive small intestine biopsy, followed by an improvement in health after following a gluten-free diet, is confirmation of celiac disease. A gluten-free diet should not be started before diagnosis is confirmed.

Some individuals may exhibit gluten intolerance, with gastrointestinal symptoms similar to those seen with celiac disease, but without its resulting intestinal damage. Gluten intolerance is diagnosed by following a gluten-free diet, followed by reintroduction of gluten-containing foods, to evaluate health improvement associated with elimination or reduction of gluten from the diet. Some individuals with gluten intolerance may be able to tolerate a low-gluten diet under the supervision of a physician or dietitian.

A gluten-free diet also may be helpful for individuals with **multiple sclerosis** and other **autoimmune disorders**, as well as for individuals with **autism** spectrum disorders, **attention deficit hyperactivity disorder (ADHD)**, and some behavioral problems.

The foods of concern for individuals with, or susceptible to, celiac disease are the cereal grains that contain the storage proteins prolamin and glutelin (commonly referred to as glutens in wheat), including all varieties of wheat (e.g., durum, spelt, kamut), barley (where the storage proteins are called hordiens), rye (where the storage proteins are called secalins), and their cross-bred hybrids (e.g., triticale).

Grains and starches that are allowed in a gluten-free diet include: rice, corn, soy, potato, sweet potato, tapioca, beans, garfava, sorghum, quinoa, millet, arrowroot, amaranth, tef, nut flours, and buckwheat. However, some commercial buckwheat products are mixtures of wheat and buckwheat flours and should be avoided. Other foods that are allowed (only a partial list) include fresh, canned, and frozen fruit or fruit juices, fresh vegetables, canned and frozen vegetables without gluten-containing additives, milk, aged cheese, all unprocessed meats, poultry, fish, eggs, dried beans, nuts, and seeds. A dietitian should be consulted to develop and monitor a gluten-free diet.

Gluten-free foods can be found in health food stores, through mail order sources, and in some supermarkets. Cookbooks are available to help in food preparation. Many food manufacturers maintain lists of gluten-free products. The Gluten-Free Certification Organization (GFCO) of the Gluten Intolerance Group, in cooperation with the Food Services, Inc., a subsidiary of the Orthodox Union, a kosher certification agency, has developed a gluten-free certification program. This program benefits consumers by giving them confidence that a product is gluten-free through a process whereby products have been tested and the manufacturing site inspected. The program also saves the consumer time that would have been spent calling the manufacturer for the gluten-free status of the product. Certification is a yearly process based on ingredient review, on-site

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KEY TERMS

Anemia—A condition in which there are too few red blood cells, too many abnormal red blood cells, or too little iron-containing hemoglobin for normal oxygen transport in the body.

Attention deficit hyperactivity disorder (ADHD)—A learning and behavioral disorder characterized by difficulty in sustaining attention, impulsive behavior, and excessive activity.

Autoimmunity—A condition in which the body's immune system produces antibodies in response to its own tissues or blood components instead of foreign particles or microorganisms.

Corticosteroids —Medication that acts like a type of hormone (cortisol) produced by the adrenal gland of the body. Corticosteroids produced by the body stimulate specific types of functional activity. As a drug, a corticosteroid (sometimes just called steroid) provides extra cortisol, which helps treat infection or trauma to the body.

Immunosuppressant—Any agent that decreases the response of the immune response of an individual.

Kosher—Conforming to Jewish dietary laws.

Osteomalacia—A softening of bones caused by lack of vitamin D and/or calcium in the diet.

Osteoporosis—A condition found in older individuals in which bones decrease in density and become fragile and more likely to break. It can be caused by lack of vitamin D and/or calcium in the diet.

Type 1 diabetes—A chronic immune system disorder in which the pancreas does not produce sufficient amounts of insulin, a hormone that enables cells to use glucose for energy. Also called juvenile diabetes, it must be treated with insulin injections.

inspection, and product testing. The Celiac Sprue Association (CSA) also has the CSA Recognition Seal Program that certifies gluten-free products. Requirements for obtaining the CSA Seal for products include:

- Ingredient review and verification by testing to assure products are free of wheat, barley, rye and oats
- Provision of written facility procedures and on-site facility audits to assure that procedures are in place to control any cross or outside contamination in processing and packaging

Foods may contain gluten, although gluten will not be indicated on the ingredient list, because it was not included in the formulation of the product. For example, a conveyer belt may be dusted with a gluten-containing material to prevent foods from sticking and may contaminate the finished food product.

Function

The gluten-free diet is used by individuals who are gluten-sensitive to prevent damage to their small intestines and to prevent serious complications such as gastrointestinal cancers, iron-deficiency anemia, and decreased bone mineral density.

Benefits

A gluten-free diet has been shown to greatly reduce the risk for **cancer** and overall mortality for individuals with symptomatic celiac disease.

For many people with celiac disease, following a gluten-free diet will stop the symptoms of the disease and result in improved health, usually within several months, although for some individuals, recovery may take up to one year. However, the health of some people with extensive damage to their small intestine may not improve. Refractory celiac disease (RCD), that is celiac disease that fails to respond to treatment, is a rare syndrome with a poor prognosis, defined by malabsorption due to gluten-related intestinal damage after initial or subsequent failure of a strict gluten-free diet and after exclusion of any other disease or disorder mimicking celiac disease. Other treatments may be necessary to treat the RCD, such as the use of **corticosteroids** and **immunosuppressant drugs**, but data on their effectiveness is lacking.

Precautions

In addition to gluten-containing grains, gluten can be found in a large variety of foods including soups, salad **dressings**, processed foods, candy, imitation bacon and seafood, marinades, processed luncheon meats, sauces and gravies, self-basting poultry, soy sauce or soy sauce solids, thickeners, communion wafers, and natural flavorings. Unidentified starch, binders, and fillers in medications, supplements, or **vitamins** and adhesives in stamps and stickers can also be unsuspected sources of gluten. Play dough, which contains wheat, can be harmful if hands are put on or in the mouth after contact or hands are not washed after play.

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An individual following a gluten-free diet must read labels every time a food item purchased or consumed. Ingredients that may contain hidden sources of gluten include unidentified starch, modified food starch, hydrolyzed vegetable or plant protein (HVP or HPP), texturized vegetable protein (TVP), and binders, fillers, and extenders. In addition, manufacturers can change ingredients at any time, and a product may no longer be gluten-free. Ingredients may be verified by contacting a manufacturer and specifying the ingredient and lot number of a food item. If a person cannot verify ingredients in a food product or if the ingredient list is unavailable, the food should not be eaten, to avoid damage to the small intestine that occurs every time gluten is consumed.

Gluten-free recommendations can be difficult to follow. It is recommended that an affected person keeps the diet simple at the beginning by eating fresh fruits and vegetables, milk, unprocessed protein foods such as fresh beef, pork, poultry, fish, and eggs, natural nuts, seeds, and vegetable oils without additives.

Pure, uncontaminated oats eaten in moderation (about one cup cooked daily) may be safe for individuals with celiac disease. However, in many cases oats can become cross contaminated with grains containing gluten during growth, harvest, transport, storage, or processing. Some individuals with celiac disease who introduce oats to their diet may experience abdominal discomfort, gas, and stool changes until they become accustomed to the increased fiber levels from the oats. Others with celiac disease may exhibit a hypersensitivity to oats and should avoid their consumption. Research published in the early 2000s (2000 to 2004) indicated that oats may contain a protein similar to gluten that causes intestinal inflammation in some individuals with celiac disease. Individuals with celiac disease should consult their health care provider or dietitian before including oats in their diet and should have their antibody levels monitored regularly.

Most all beers are brewed with barley and some are brewed with wheat, and thus should not be consumed by a person following a gluten-free diet. Sorghum and buckwheat beers are available but are a specialty product. Most distilled forms of alcohol are gluten-free unless additives and colorings containing gluten have been added. Wines also usually are gluten-free.

Since celiac disease is an inherited autoimmune disease, screening of family members is recommended. The chances of developing symptoms of gluten-sensitivity increases to 10–20% in individuals who have a first-degree relative (parent, sibling, child) with celiac disease. Celiac disease is also associated with other autoimmune syndromes such as Type 1 diabetes.

Risks

A gluten-free diet is difficult to follow, and continued health problems usually are associated with problems with adhering to the diet. A person can exhibit celiac-related symptoms for months after a single intake of gluten. Individuals with gluten-sensitivity who do not treat their disease are at a higher risk for gastrointestinal T-cell lymphoma and other gastrointestinal cancers. However, the maintenance of a long-term gluten-free state reduces the risk of lymphoma to the level seen in the general population. Other complications of gluten-sensitivity include decreased mineral bone density and iron-deficiency. Individuals with celiac disease and dermatitis herpetiformis must maintain a gluten-free diet for the rest of their lives, for these diseases cannot be cured.

Individuals are more likely to adhere to the diet if a dietitian and support groups are involved. If a person is not responding well to a gluten-free diet, the doctor may:

- Investigate whether the initial diagnosis of celiac disease was correct
- Check for other conditions that can be causing symptoms, such as pancreatic insufficiency, irritable bowel syndrome, bacterial overgrowth, lymphocytic colitis, T-cell lymphoma, fructose intolerance, or tropical sprue
- Refer the person to a dietician to check for errors in the diet or for compliance with the diet

To monitor dietary adherence to the gluten-free diet, the dietitian will examine the person's dietary history and habits. Blood tests will be conducted to see if gluten antibody levels have returned to normal levels. If there is clinical concern that a person is not adhering to the gluten-free diet or that the diet is not effective, a biopsy of the small intestine may be conducted.

The gluten-free diet is complex, and it cannot be assumed that chefs in restaurants or others who prepare food (including friends and family) are aware of potential sources of gluten contamination. Education of family and friends is important in accomplishing a lifestyle change. In restaurants simple dishes without sauces should be ordered, and the person should inquire whether grain products are prepared with the same equipment or utensils used to prepare other foods. Although a food may meet labeling standards to be called gluten-free, it may be gluten-contaminated by the way in which it is prepared or stored. Other

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difficulties associated with following a gluten-free diet include lifestyle changes such as avoiding travel, finding gluten-free foods, especially those of good quality, determining whether foods are gluten-free, not being invited out because of the diet, with resulting social isolation, and maintaining a gluten-free diet when in the hospital.

As with any restrictive diet, the gluten-free diet has potential for nutritional inadequacy. Individuals who are sensitive to gluten are at increased risk for **osteoporosis** and osteomalacia due to malabsorption of **calcium** and vitamin D. Most individuals with celiac disease have some degree of osteopenia or osteoporosis. Calcium and vitamin D supplementation along with strict adherence to a gluten-free diet usually results in remineralization of the skeleton. Iron or other vitamin deficiencies may also be present and must be treated appropriately. The consumption of gluten-free fiber-rich foods (for example, brown rice, fruits, and vegetables) and adequate fluid intake is recommended to assist in the prevention of constipation.

Women with untreated celiac disease often exhibit a history of miscarriages, anemia, low birth weight babies, and unfavorable outcome of **pregnancy**. It is suggested that testing for celiac disease be included in the battery of tests prescribed for pregnant women. Celiac disease is considerably more common than most of the diseases for which pregnant women are routinely screened. Unfavorable events associated with celiac disease may be prevented by a gluten-free diet.

Research and general acceptance

The gluten-free diet is recognized by the medical community as the required treatment for individuals exhibiting gluten-sensitivity.

The National Institutes of Health has noted that the strict definition of a gluten-free diet remains controversial due to the lack of an accurate method to detect gluten in food products and the lack of scientific evidence for what constitutes a safe amount of gluten ingestion. No international agreement has yet been developed on how much gluten a person with gluten-sensitivity can tolerate. Research is on going to better identify levels that are acceptable, and health professionals involved in the therapy of celiac disease should keep up-to-date on the latest research. On January 23, 2007, the United States Food and Drug Administration proposed to set a standard of 20 part per million as the maximum acceptable level of gluten allowed for a product to be labeled as gluten-free. Labeling is voluntary. European standards for labeling a food gluten-free are more strict than those in the United States.

Research continues on the benefits of a gluten-free diet for individuals with multiple sclerosis and other autoimmune disorders, as well as for individuals with autism spectrum disorders, **ADHD**, and some behavioral problems.

In addition, a new enzyme that was being developed for commercial food processing has been found to break down gluten molecules quickly and almost completely. The enzyme is made from *Aspergillis niger*, a common fungus that is the source of other food grade enzymes already being manufactured for human consumption. Fritz Koning of Leiden University Medical Center in the Netherlands is leading the research. He stated that if the enzyme proves itself in clinical trials to eliminate the need for a gluten-free diet, it could be mass produced at a reasonable cost.

Resources

BOOKS

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ORGANIZATIONS

American Dietetic Association, 120 South Riverside Plaza, Suite 2000, Chicago, IL, 60606-6995, (800) 877-1600, http://www.eatright.org.

Gluten Intolerance Group, 31214 124th Ave SE, Auburn, WA, 98092, 253-833-6655, 253-833-6675, info@gluten.net, http://www.gluten.net.

Celiac Sprue Association, P.O. Box 31700, Omaha, NE, (402) 558-0600, (877) 272-4272, celiacs@csaceliacs.org, http://www.csaceliacs.org.

Celiac Disease Foundation, 13251 Ventura Boulevard, Studio City , CA, 91604-1838, (818) 990-2354, (818) 990-2379, cdf@celiac.org, http://www.celiac.org.

Judith L. Sims
Tish Davidson, AM

Gluten enteropathy *see* **Celiac disease**

Glyburide *see* **Antidiabetic drugs**

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Glycogen storage diseases

Definition

Glycogen serves as the primary fuel reserve for the body's energy needs. Glycogen storage diseases, also known as glycogenoses, are genetically linked metabolic disorders that involve the enzymes regulating glycogen metabolism. Symptoms vary by the glycogen storage disease (GSD) type and can include **muscle cramps** and wasting, enlarged liver, and low blood sugar. Disruption of glycogen metabolism also affects other biochemical pathways as the body seeks alternative fuel sources. Accumulation of abnormal metabolic by-products can damage the kidneys and other organs. GSD can be fatal, but the risk hinges on the type of GSD.

Description

Most of the body's cells rely on glucose as an energy source. Glucose levels in the blood are very stringently controlled within a range or 70–100 mg/dL, primarily by hormones such as insulin and glucagon. Immediately after a meal, blood glucose levels rise and exceed the body's immediate energy requirements. In a process analogous to putting money in the bank, the body bundles up the extra glucose and stores it as glycogen in the liver and muscles. Later, as the blood glucose levels begin to dip, the body makes a withdrawal from its glycogen savings.

The system for glycogen metabolism relies on a complex system of enzymes. These enzymes are responsible for creating glycogen from glucose, transporting the glycogen to and from storage areas within cells, and extracting glucose from the glycogen as needed. Both creating and tearing down the glycogen macromolecule are multistep processes requiring a different enzyme at each step. If one of these enzymes is defective and fails to complete its step, the process halts. Such enzyme defects are the underlying cause of GSDs.

The enzyme defect arises from an error in its gene. Since the error is in the genetic code, GSDs can be passed down from generation-to-generation. However, all but one GSD are linked to autosomal genes, which means a person inherits one copy of the gene from each parent. Following a Mendelian inheritance pattern, the normal gene is dominant and the defective gene is recessive. As long as a child receives at least one normal gene, there is no risk for a GSD. GSDs appear only if a person inherits a defective gene from both parents.

The most common forms of GSD are Types I, II, III, and IV, which may account for more than 90% of all cases. The most common form is Type I, or von Gierke's disease, which occurs in one out of every 100,000 births. Other forms, such as Types VI and IX, are so rare that reliable statistics are not available. The overall frequency of all forms of glycogen storage disease is approximately one in 20,000–25,000 live births.

Causes and symptoms

GSD symptoms depend on the enzyme affected. Since glycogen storage occurs mainly in muscles and the liver, those sites display the most prominent symptoms.

There are at least 10 different types of GSDs which are classified according to the enzyme affected:

- Type Ia, or von Gierke's disease, is caused by glucose-6-phosphatase deficiency in the liver, kidney, and small intestine. The last step in glycogenolysis, the breaking down of glycogen to glucose, is the transformation of glucose-6-phosphate to glucose. In GSD I, that step does not occur. As a result, the liver is clogged with excess glycogen and becomes enlarged and fatty. Other symptoms include low blood sugar and elevated levels of lactate, lipids, and uric acid in the blood. Growth is impaired, puberty is often delayed, and bones may be weakened by osteoporosis. Blood platelets are also affected and frequent nosebleeds and easy bruising are common. Primary symptoms improve with age, but after age 20–30, liver tumors, liver cancer, chronic renal disease, and gout may appear.
- Type Ib is caused by glucose-6-phosphatase translocase deficiency. In order to carry out the final step of glycogenolysis, glucose-6-phosphate has to be transported into a cell's endoplasmic reticulum. If translocase, the enzyme responsible for that movement, is missing or defective, the same symptoms occur as in Type Ia. Additionally, the immune system is weakened and victims are susceptible to bacterial infections, such as pneumonia, mouth and gum infections, and inflammatory bowel disease. Types Ic and Id are also caused by defects in the translocase system.
- Type II, or Pompe's disease or acid maltase deficiency, is caused by lysosomal alpha-D-glucosidase deficiency in skeletal and heart muscles. GSD II is subdivided according to the age of onset. In the infantile form, infants seem normal at birth, but within a few months they develop muscle weakness, trouble breathing, and an enlarged heart. Cardiac failure and death usually occur before age 2, despite medical treatment. The juvenile and adult forms of GSD II affect mainly the skeletal muscles in the body's limbs and torso. Unlike the infantile form, treatment can extend life, but there is no cure. Respiratory failure is the primary cause of death.

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- Type III, or Cori's disease, is caused by glycogen debrancher enzyme deficiency in the liver, muscles, and some blood cells, such as leukocytes and erythrocytes. About 15% of GSD III cases only involve the liver. The glycogen molecule is not a simple straight chain of linked glucose molecules, but rather an intricate network of short chains that branch off from one another. In glycogenolysis, a particular enzyme is required to unlink the branch points. When that enzyme fails, symptoms similar to GSD I occur; in childhood, it may be difficult to distinguish the two GSDs by symptoms alone. In addition to the low blood sugar, retarded growth, and enlarged liver causing a swollen abdomen, GSD III also causes muscles prone to wasting, an enlarged heart, and heightened levels of lipids in the blood. The muscle wasting increases with age, but the other symptoms become less severe.
- Type IV, or Andersen's disease, is caused by glycogen brancher enzyme deficiency in the liver, brain, heart, skeletal muscles, and skin fibroblasts. The glycogen constructed in GSD IV is abnormal and insoluble. As it accumulates in the cells, cell death leads to organ damage. Infants born with GSD IV appear normal at birth, but are diagnosed with enlarged livers and failure to thrive within their first year. Infants who survive beyond their first birthday develop cirrhosis of the liver by age 3–5 and die as a result of chronic liver failure.
- Type V, or McArdle's disease, is caused by glycogen phosphorylase deficiency in skeletal muscles. Under normal circumstances, muscles cells rely on oxidation of fatty acids during rest or light activity. More demanding activity requires that they draw on their glycogen stockpile. In GSD V, this form of glycogenolysis is disabled and glucose is not available. The main symptoms are muscle weakness and cramping brought on by exercise, as well as burgundy-colored urine after exercise due to myoglobin (a breakdown product of muscle) in the urine.
- Type VI, or Hers' disease, is caused by liver phosphorylase deficiency, which blocks the first step of glycogenolysis. In contrast to other GSDs, Type VI seems to be linked to the X chromosome. Low blood sugar is one of the key symptoms, but it is not as severe as in some other forms of GSD. An enlarged liver and mildly retarded growth also occur.
- Type VII, or Tarui's disease, is caused by muscle phosphofructokinase deficiency. Although glucose may be available as a fuel in muscles, the cells cannot metabolize it. Therefore, abnormally high levels of glycogen are stockpiled in the muscle cells. The symptoms are similar to GSD V, but also include anemia and increased levels of uric acid.
- Types VIII and XI are caused by defects of enzymes in the liver phosphorylase activating-deactivating cascade and have symptoms similar to GSD VI.
- Type IX is caused by liver glycogen phosphorylase kinase deficiency and, symptom-wise, is very similar to GSD VI. The main differences are that the symptoms may not be as severe and may also include exercise-related problems in the muscles, such as pain and cramps. The symptoms abate after puberty with proper treatment. Most cases of GSD IX are linked to the X chromosome and therefore affect males.
- Type X is caused by a defect in the cyclic adenosine monophosphate-dependent (AMP) kinase enzyme and presents symptoms similar to GSDs VI and IX.

Diagnosis

Diagnosis usually occurs in infancy or childhood, although some milder types of GSD go unnoticed well into adulthood and old age. It is even conceivable that some of the milder GSDs are never diagnosed.

The four major symptoms that typically lead a doctor to suspect GSDs are low blood sugar, enlarged liver, retarded growth, and an abnormal blood biochemistry profile. A definitive diagnosis is obtained by biopsy of the affected organ or organs. The biopsy sample is tested for its glycogen content and assayed for enzyme activity. There are DNA-based techniques for diagnosing some GSDs from more easily available samples, such as blood or skin. These DNA techniques can also be used for prenatal testing.

Treatment

Some GSD types cannot be treated, while others are relatively easy to control through symptom management. In more severe cases, receiving an organ transplant is the only option. In the most severe cases, there are no available treatments and the victim dies within the first few years of life.

Of the treatable types of GSD, many are treated by manipulating the diet. The key to managing GSD I is to maintain consistent levels of blood glucose through a combination of nocturnal intragastric feeding (usually for infants and children), frequent high-carbohydrate meals during the day, and regular oral doses of cornstarch (people over age 2). Juvenile and adult forms of GSD II can be managed somewhat by a high protein diet, which also helps in cases of GSD III, GSD VI, and GSD IX. GSD V and GSD VII can also be managed with a high protein diet and by avoiding strenuous **exercise**.

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KEY TERMS

Amniocentesis—A medical test done during pregnancy in which a small sample of the amniotic fluid is taken from around the fetus. The fluid contains fetal cells that can be examined for genetic abnormalities.

Autosomal gene—A gene found on one of the 22 autosomal chromosome pairs; i.e., not on a sex (X or Y) chromosome.

Chorionic villus sampling—A medical test done during pregnancy in which a sample of the membrane surrounding the fetus is removed for examination. This examination can reveal genetic fetal abnormalities.

Glucose—A form of sugar that serves as the body's main energy source.

Glycogen—A macromolecule composed mainly of glucose that serves as the storage form of glucose that is not immediately needed by the body.

Glycogenolysis—The process of tearing-down a glycogen molecule to free up glucose.

Glycogenosis—An alternate term for glycogen storage disease. The plural form is glycogenoses.

Gout—A painful condition in which uric acid precipitates from the blood and accumulates in joints and connective tissues.

Mendelian inheritance—An inheritance pattern for autosomal gene pairs. The genetic trait displayed results from one parent's gene dominating over the gene inherited from the other parent.

Osteoporosis—A disease in which the bones become weak and brittle.

Renal disease—Kidney disease.

Transgenic animal—Animals that have had genes from other species inserted into their genetic code.

For GSD cases in which dietary therapy is ineffective, organ transplantation may be the only viable alternative. Liver transplants have been effective in reversing the symptoms of GSD IV.

Advances in genetic therapy offer hope for effective treatment in the future. This therapy involves using viruses to deliver a correct form of the gene to affected cells.

Prognosis

People with well-managed, treatable types of GSD can lead long, relatively normal lives. This goal is accomplished with the milder types of GSD, such as Types VI, IX, and X. As the GSD type becomes more severe, a greater level of vigilance against infections and other complications is required. Given current treatment options, complications such as **liver disease**, **heart failure**, and **respiratory failure** may not be warded-off indefinitely. Quality of life and life expectancy are substantially decreased.

Prevention

Because GSD is an inherited condition, it is not preventable. If both parents carry the defective gene, there is a one-in-four chance that their offspring will inherit the disorder. Other children may be carriers or they may miss inheriting the gene altogether.

Through chorionic villi sampling and **amniocentesis**, the disorder can be detected prior to birth. Some types of GSD can be detected even before conception occurs, if both parents are tested for the presence of the defective gene. Before undergoing such testing, the prospective parents should meet with a genetic counselor and other professionals in order to make an informed decision.

ORGANIZATIONS

Acid Maltase Deficiency Association, PO Box 700248, San Antonio, TX, 8270-0248, (210) 494-6144, tianrama@aol.com, http://www.amda-pompe.org.

American Liver Foundation, 75 Maiden Lane, Suite 603, New York, NY, 10038, (212) 668-1000, (212) 483-8179, http://www.liverfoundation.org.

Association for Glycogen Storage Disease, PO Box 896, Durant, IA, 52747-9769, (563) 514-4022, maryc@agsdus.org, http://www.agsdus.org.

Julia Barrett

Glycosylated hemoglobin test

Definition

Glycosylated hemoglobin is a test that indicates how much sugar has been in a person's blood during the past two to four months. It is used to monitor the effectiveness of diabetes treatment.

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Purpose

Diabetes is a disease in which a person cannot effectively use sugar in the blood. Left untreated, blood sugar levels can be very high. High sugar levels increase risk of complications, such as damage to eyes, kidneys, heart, nerves, blood vessels, and other organs.

A routine blood sugar test reveals how close to normal a sugar level is at the time of the test. The glycosylated **hemoglobin test** reveals how close to normal it has been during the past several months.

This information helps a physician evaluate how well a person is responding to diabetes treatment and to determine how long sugar levels have been high in a person newly diagnosed with diabetes.

Description

The Diabetes Control and Complications Trial (DCCT) demonstrated that people with diabetes who maintained blood glucose (sugar) and total fasting hemoglobin levels at or close to a normal range decreased their risk of complications by 50–75%. Based on results of this study, the American Diabetes Association (ADA) recommends routine glycosylated hemoglobin testing to measure long-term control of blood sugar.

Glycosylated hemoglobin measures the percentage of hemoglobin bound to glucose. Hemoglobin is a protein found in every red blood cell. As hemoglobin and glucose are together in the red blood cell, the glucose gradually binds to the A1c form of hemoglobin in a process called glycosylation. The amount bound reflects how much glucose has been in the blood during the past average 120-day lifespan of red cells.

Several methods are used to measure the amount of bound hemoglobin and glucose. They are electrophoresis, chromatography, and immunoassay. All are based on the separation of hemoglobin bound to glucose from that without glucose.

The ADA recommends glycosylated hemoglobin be done during a person's first diabetes evaluation, again after treatment is begun and sugar levels are stabilized, then repeated at least semiannually. If the person does not meet treatment goals or sugar levels have not stabilized, the test should be repeated quarterly.

Other names for the test include: Hemoglobin A1c, HbA1c, Diabetic control index, GHb, glycosylated hemoglobin, and glycated hemoglobin. The test is covered by insurance. Results usually are available the following day.

KEY TERMS

Diabetes mellitus—A disease in which a person can't effectively use sugar in the blood to meet the needs of the body. It is caused by a lack of the hormone insulin.

Glucose—The main form of sugar used by the body for energy.

Glycosylated hemoglobin—A test that measures the amount of hemoglobin bound to glucose. It is a measure of how much glucose has been in the blood during the past two to four months.

Preparation

A person does not need to fast before this test. A healthcare worker ties a tourniquet on the person's upper arm, locates a vein in the inner elbow region, and inserts a needle into the vein. Vacuum action draws the blood through the needle into an attached tube. Collection of the sample takes only a few minutes. This test requires 5 mL of blood.

While home HbA1c tests are available, they should only be used with a doctor's guidance.

Aftercare

Discomfort or bruising may occur at the puncture site, or the person may feel dizzy or faint. Pressure to the puncture site until bleeding stops reduces bruising. Warm packs relieve discomfort.

Normal results

Diabetes treatment should achieve glycosylated hemoglobin levels of less than 7.0%. Normal value for a non-diabetic person is 4.0–6.0%.

Because laboratories use different methods, results from different laboratories can not always be compared. The National Glycosylation Standardization Program gives a certification to laboratories using tests standardized to those used in the DCCT study.

Abnormal results

Results require interpretation by a physician with knowledge of the person's clinical condition, as well as the test method used. Some methods give false high or low results if the person has an abnormal hemoglobin, such as hemoglobin S or F.

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Conditions that increase the lifespan of red cells, such as a **splenectomy** (removal of the spleen), falsely increase levels. Conditions that decrease the lifespan, such as hemolysis (disruption of the red blood cell membrane), falsely decrease levels.

Resources

PERIODICALS

"Simple Choice A1c." *Diabetes Forecast* January 2004: RG7.

ORGANIZATIONS

American Diabetes Association, 1701 North Beauregard Street, Alexandria, VA, 22311, (800) 342-2383, Ask ADA@diabetes.org, http://www.diabetes.org.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

National Diabetes Information Clearinghouse (NDIC), 1 Information Way, Bethesda, MD, 20892-3560, (703) 738-4929, (800) 860-8747, ndic@info.niddk.nih.gov, http://diabetes.niddk.nih.gov.

Nancy J. Nordenson
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This woman's goiter may have been caused by an insufficient intake of iodine. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Goiter

Definition

Goiter refers to any visible enlargement of the thyroid gland.

Description

The thyroid gland sits astride the trachea (windpipe) and is shaped like a butterfly. It makes thyroxin, a hormone that regulates the metabolic activity of the body, rather like the gas pedal on a car. Too much thyroxin increases the metabolism, causing weight loss, temperature elevation, nervousness, and irritability. Too little thyroxin slows the metabolism down, deepens the voice, causes weight gain and water retention, and retards growth and mental development in children. Both conditions also alter hair and skin growth, bowel function, and menstrual flow.

Curiously, the thyroid gland is often enlarged whether it is making too much hormone, too little, or sometimes even when it is functioning normally. The thyroid is controlled by the pituitary gland, which secretes thyroid stimulating hormone (TSH) in response to the amount of thyroxin it finds in the blood. TSH increases the amount of thyroxin secreted by the thyroid and also causes the thyroid gland to grow.

- Hyperthyroid goiter–If the amount of stimulating hormone is excessive, the thyroid will both enlarge and secrete too much thyroxin. The result–hyperthyroidism with a goiter. Graves' disease is the most common form of this disorder.
- Euthyroid goiter–The thyroid is the only organ in the body to use iodine. If dietary iodine is slightly inadequate, too little thyroxin will be secreted, and the pituitary will sense the deficiency and produce more TSH. The thyroid gland will enlarge enough to make sufficient thyroxin.
- Hypothyroid goiter–If dietary iodine is severely reduced, even an enlarged gland will not be able to make enough thyroxin. The gland will keep growing under the influence of TSH, but it may never be able to make enough thyroxin.

Causes and symptoms

Excess TSH (or similar hormones), cysts, and tumors will enlarge the thyroid gland. Of these, TSH enlarges the entire gland while cysts and tumors enlarge only a part of it.

The only symptom from a goiter is the large swelling just above the breast bone. Rarely, it may constrict the trachea (windpipe) or esophagus and cause

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KEY TERMS

Cyst—A liquid-filled structure developing abnormally in the body.

Euthyroid—Having the right amount of thyroxin stimulation.

Hyperthyroid—Having too much thyroxin stimulation.

Hypothyroid—Having too little thyroxin stimulation.

Pituitary gland—The master gland, located in the middle of the head, that controls most of the other glandss by secreting stimulating hormones.

Radiotherapy—The use of ionizing radiation, either as x rays or radioactive isotopes, to treat disease.

Thyroxin—The hormone secreted by the thyroid gland.

difficulty breathing or swallowing. The rest of the symptoms come from thyroxin or the lack of it.

Diagnosis

The size, shape, and texture of the thyroid gland help the physician determine the cause. A battery of blood tests are required to verify the specific thyroid disease. Functional imaging studies using radioactive iodine determine how active the gland is and what it looks like.

Treatment

Goiters of all types will regress with treatment of the underlying condition. Dietary iodine may be all that is needed. However, if an iodine deficient thyroid that has grown in size to accommodate its deficiency is suddenly supplied an adequate amount of iodine, it could suddenly make large amounts of thyroxin and cause a thyroid storm, the equivalent of racing your car motor at top speed.

Hyperthyroidism can be treated with medications, therapeutic doses of radioactive iodine, or surgical reduction. Surgery is much less common now than it used to be because of progress in drugs and radiotherapy.

Prognosis

Although goiters diminish in size, the thyroid may not return to normal. Sometimes thyroid function does not return after treatment, but thyroxin is easy to take as a pill.

Prevention

Euthyroid goiter and hypothyroid goiter are common around the world because many regions have inadequate dietary iodine, including some places in the United States. International relief groups are providing iodized salt to many of these populations. Because **mental retardation** is a common result of **hypothyroidism** in children, this is an extremely important project.

ORGANIZATIONS

International Council for the Control of Iodine Deficiency Disorders, P.O. Box 51030, 375 des Epinettes, Ottawa, Ontario, Canada, K1E 3E), http://www.iccidd.org.

J. Ricker Polsdorfer, MD

Gonadal dysgenesis *see* **Turner syndrome**

Gonorrhea

Definition

Gonorrhea is a highly contagious sexually transmitted infection (STI) or disease (STD) caused by the bacterium *Neisseria gonorrhoeae*. These bacteria grow in the urethra and in warm, moist parts of the reproductive tract, including the cervix, uterus, and fallopian tubes of women. The bacteria also can infect the anus, mouth, throat, and eyes. Untreated gonorrhea can cause serious medical complications.

Demographics

For most of the twentieth century gonorrhea was the most common STD worldwide. The incidence of gonorrhea has declined steadily in the developed world since the mid-1970s, reaching an all-time low in 2004. This decline is largely due to increased public awareness of the risks and prevention of STDs such as herpes and HIV/AIDS. However there are still about 200 million new cases of gonorrhea annually throughout the world and gonorrhea rates in certain urban areas of the United States are once again on the rise.

Gonorrhea is the second most common reportable disease in the United States. More than 350,000 newly

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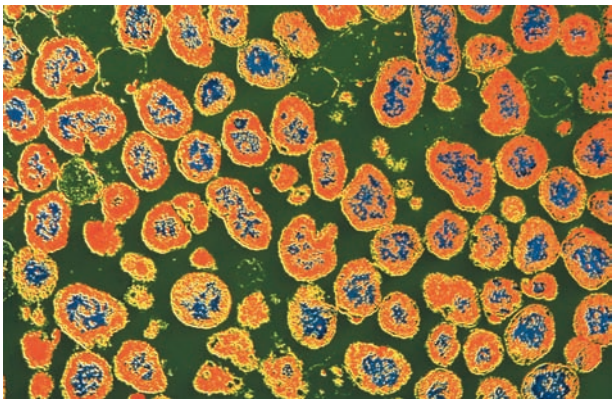

A transmission electron microscopy (TEM) image of *Neisseria gonorrhoeae.* *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

diagnosed cases were reported in 2007. Experts believe that the actual number is much higher since gonorrhea tends to be both under-diagnosed and underreported. Estimates of the actual number of annual cases in the United States range from 400,000 to one million. An estimated 40,000 pregnant women are infected with gonorrhea each year in the United States. **Pelvic inflammatory disease** (PID), the most common complication of gonorrhea, affects one million American women annually.

Although gonorrhea affects people of all ages, races, and socioeconomic levels, adolescents and young adults are at the highest risk. More than 80% of cases occur in those aged 15 to 29. Gonorrhea is most common among females aged 15–19 and males aged 20–24. Infection rates are higher in men than in women and highest in men who have sex with other men. African Americans and those living in urban areas and having multiple sex partners are at the greatest risk for infection.

Description

Commonly called "the clap," gonorrhea is transmitted through sexual contact, including oral, anal, and vaginal intercourse. The risk of contracting gonorrhea from a single sexual encounter with an infected partner is 60–90%. Gonorrhea also can be spread through contact with the bodily fluids of an infected person. There is some evidence for transmission of gonorrhea among children and from adults to children via unclean hands. However gonorrhea infection in children is considered a warning flag for **sexual abuse**.

Gonorrhea usually affects the genitourinary tract, but can also spread to the rectum, throat, and eyes. Left untreated, gonorrhea can spread through the bloodstream and infect the reproductive system, joints, heart valves, skin, liver, and brain. As many as 10% of women infected with gonorrhea experience a **pregnancy** in a fallopian tube (**ectopic pregnancy**) or become infertile as a result of PID. Gonorrhea also increases the risk of contracting and transmitting HIV/AIDS. Being cured of gonorrhea does not protect a person against re-infection.

Pregnant women with untreated gonorrhea are at increased risk for **miscarriage**, preterm birth, or membranes that rupture prematurely. An infected mother can transmit the disease to her infant as it passes through the birth canal during delivery, causing newborn conjunctivitis—an eye infection that can lead to blindness. The infant also is at risk for joint infection or a life-threatening blood infection.

Risk factors

Risk factors for gonorrhea are similar to those for other STDs. The primary risk factors are unprotected sex (without a condom) with multiple partners.

Causes and symptoms

Gonnorrhea is caused by the bacterium *N. gonorrhoeae*, which is transmitted through sexual contact. It can be transmitted to the eyes by touching an infected organ and then touching the eyes. *N. gonorrhoeae* cannot survive for any length of time outside of the human body. It cannot be transmitted via a toilet seat or by shaking hands.

Although most gonorrhea-infected males have symptoms, as many as 80% of infected females do not. Symptoms usually appear between one and 14 days following infection, but the incubation period can be as long as 30 days. Often the only symptom of gonorrhea is inflammation of mucous membranes in the genital region. Some people experience **nausea**, **vomiting**, **fever**, and chills, and **pain** during intercourse.

In males the infection usually appears first in the urethra—the tube that carries urine and sperm to the outside of the body. About 95% of infected men have thick, cloudy, white, yellowish, green, or bloody discharge from the penis. Other common symptoms in males include frequent urination and burning or pain during urination. Complications of gonorrhea in males can affect the prostate, testicles, and surrounding glands. **Epididymitis** is a painful condition of the testicles that can lead to sterility if untreated.

In females gonorrhea usually infects the cervix—the lower narrow portion of the uterus that opens to

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KEY TERMS

Cervix—The lower, narrow part—or neck—of the uterus.

Chlamydia—The most common sexually transmitted bacterial infection in the United States. It often occurs along with gonorrhea. The majority of infected women have no symptoms.

Conjunctivitis—An inflammation of the eye that can be caused by gonorrhea or chlamydia.

Ectopic pregnancy—A pregnancy that develops outside of the uterus, such as in the fallopian tubes. The fetus dies and the mother's life may be threatened.

ELISA—Enzyme-linked immunosorbent assay; a screening test that uses antibodies to detect infections such as gonorrhea and HIV.

HIV/AIDS—Human immunodeficiency virus/acquired immunodeficiency syndrome; a sexually transmitted viral disease that is more likely to be transmitted or acquired in the presence of gonorrhea or another STD.

Neisseria gonorrhoeae—The bacterium that causes gonorrhea.

Nucleic acid amplification test (NAAT)—A screening test for gonorrhea that detects bacterial DNA in a urine sample or cervical swab.

Pelvic inflammatory disease (PID)—An infection of the female upper genital tract that can be a complication of gonorrhea. At least 25% of women with PID suffer long-term consequences such as infertility or an ectopic pregnancy.

Sexually transmitted disease (STD)—A disease that is transmitted by sexual contact, including gonorrhea, chlamydia, HIV/AIDS, genital herpes, syphilis, and genital warts.

Sexually transmitted infection (STI)—An infectious disease, such as gonorrhea, that is transmitted through sexual activity.

Sterility—Inability to conceive a child.

Urethra—The urine channel leading from the bladder to the outside of the body and, in men, the channel for semen.

Urethritis—Inflammation of the urethra.

the vagina—as well as the uterus and fallopian tubes. Symptoms can include:

- vaginal discharge that may be cloudy and yellow
- frequent, painful, or burning urination
- bleeding between menstrual periods
- pain or bleeding during vaginal intercourse
- heavy bleeding during menstrual periods
- chronic abdominal pain

Women are more likely than men to suffer from complications of gonorrhea because the disease often progresses without symptoms. The most common complication of untreated gonorrhea is PID, which can occur in as many as 40% of infected women. PID can damage the ovaries and fallopian tubes, resulting in a pregnancy developing outside of the uterus or sterility. A less common complication is disseminated gonococcal infection (DGI), in which the bacteria travels through the blood to distant sites such as the skin or joints.

Newborn **conjunctivitis** caused by gonorrhea usually appears two–seven days after birth. Symptoms of eye infection include redness, **itching**, or discharge from the eye. Other symptoms of gonorrhea in infants and children include irritation, redness, swelling, or a pus-like discharge from the urethra and possibly painful urination.

Anal gonorrheal infection may cause rectal itching, discharge, a constant urge to move the bowels, painful bowel movements, or blood in the stool. However about 90% of anal infections are without symptoms. Oral gonorrheal infection may cause a **sore throat** or painful swallowing.

Diagnosis

Examination

An initial diagnosis of gonorrhea is based on symptoms, sexual history, and at-risk behavior. The diagnosis may be made by a family physician or STD specialist or at a public health clinic. Women may be diagnosed by an obstetrician/gynecologist, particularly if there are gynecological complications. Men may be diagnosed by a urologist. Physicians are required to report cases of gonorrhea to public health officials. Patients are asked to provide the names of all sexual partners who may have been exposed to the infection, so that they can be notified and tested for gonorrhea.

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Tests

Many physicians use more than one test to confirm a diagnosis of gonorrhea:

- A nucleic acid amplifications test (NAAT) that detects bacterial DNA in a urine or cervical sample is the fastest and most accurate diagnostic test.
- An enzyme-linked immunosorbent assay (ELISA) that uses antibodies specific for *N. gonorrhoeae* is also fast and sensitive.
- Culturing bacteria from a discharge or sample obtained with a cotton swab can diagnose gonorrhea and determine whether the bacteria are drug resistant. Culturing takes for up to two days.
- Discharge from an infected area can Gram stained and examined under a microscope for the presence of *N. gonorrhoeae*; however this test is only about 70% accurate in men and about 50% accurate in women.
- Since other STDs, such as chlamydia and syphilis, often occur along with gonorrhea, patients also may be tested for these infections.

Treatment

Traditional

Gonorrhea is treated with **antibiotics**. Patients should refrain from sexual intercourse until they and their partners have completed treatment and had follow-up testing to ensure that the infection has been completely eradicated.

Drugs

In the past gonorrhea was usually treated with penicillin, a penicillin derivative, or tetracycline. However since the 1940s *N. gonorrhoeae* has become increasingly resistant to these antibiotics. Resistance to fluoroquinolone antibiotics also has increased rapidly over the past decade. Therefore as of 2009, the recommended treatments for gonorrhea are:

- a single 125-mg injection of ceftriaxone
- a single 400-mg dose of oral cefixime
- another single-dose cephalosporin antibiotic

Infants born to gonorrhea-infected mothers may be treated with intravenous ceftriaxone or another antibiotic. Infant conjunctivitis caused by gonorrhea is treated with an eye ointment containing polymyxin and bacitracin, erythromycin, or tetracycline.

If chlamydial infection is also present, a combination of antibiotics—such as ceftriaxone and doxycycline or azithromycin—is used to treat both infections simultaneously. Erythromycin is used to treat chlamydia in pregnant women.

Alternative

Antibiotic treatment for gonorrhea may be complemented with various alternative therapies:

- *Lactobacillus acidophilus* or live-culture yogurt can help replace gastrointestinal flora that are killed by the antibiotics.
- Zinc, multivitamin/mineral complexes, vitamin C, and garlic (*Allium sativum*) may help improve immune system function.
- Kelp (*Macrocystis pyrifera* and related species) can supply vitamins and minerals.
- Teas or douches made with calendula (*Calendula officinalis*), myrrh (*Commiphora molmol*), and thuja (*Thuja occidentalis*) may reduce discharge and inflammation.
- The Chinese herb *Coptis chinensis*, used for "damp-heat;" infections, can be helpful for treating the genitourinary tract, especially if PID develops.
- Various other herbs can help treat reproductive and urinary system symptoms.
- With physician approval, a three-day juice fast may help cleanse the urinary and gastrointestinal systems and support healing.
- Acupuncture or acupressure can help cleanse body systems.

Home remedies

Antibiotic treatment is absolutely essential for gonorrhea. Hot baths can help reduce pain and inflammation.

Prognosis

Gonorrhea is curable with cephalosporin antibiotics and the prognosis is excellent with prompt treatment. However many people, especially women, have no symptoms of the disease and are unaware that they are infected. Adolescent girls are at particular risk for untreated gonorrhea. Up to 40% of women who do not receive early treatment may develop PID, which can damage the fallopian tubes and result in sterility. Women who have had PID are six–ten times more likely to have an ectopic pregnancy. Although the risk of **infertility** is higher for women than for men, men also can become sterile if untreated gonorrhea causes inflammation of the urethra (**urethritis**).

Untreated gonorrhea can cause inflammation, abscesses, and scarring. In about 2% of patients with untreated gonorrhea, the infection spreads throughout the body, causing fever, arthritis-like joint pain, and **skin lesions**. The bacterium also can infect the heart

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valves and brain. In men, untreated gonorrhea can affect the prostate, testicles, and surrounding glands.

Prevention

The best prevention for gonorrhea is sexual abstinence or sexual activity that is confined to a mutually monogamous relationship in which both partners have been tested for gonorrhea and other STDs. If used properly and consistently for vaginal and anal sex, latex male **condoms** and polyurethane female condoms can reduce the risk of *N. gonorrhoeae* transmission. A dental dam may reduce the risk of transmission during oral sex. However anyone who has multiple sexual partners should be tested regularly for gonorrhea and other STDs. It is recommended that all sexually active teenagers and young adults be screened regularly for gonorrhea. All pregnant women should be screened at their first prenatal visit.

All newborns are treated under the eyelids with an antibiotic ointment, such as silver nitrate or erythromycin, to prevent gonorrhea. Infants born to mothers with untreated gonorrhea are given a prophylactic dose of ceftriaxone.

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American Social Health Association, P.O. Box 13827, Research Triangle Park, NC, 27709, (919) 361-8400, (800) 227-8922, (919) 361-8425, info@ashastd.org, http://www.ashastd.org.

National Institute of Allergy and Infectious Diseases (NIAID), Office of Communications and Public Liaison, 6610 Rockledge Drive, Bethesda, MD, 20892-66123, (866) 284-4107, http://www3.niaid.nih.gov.

U.S. Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, 800-CDC-INFO (232-4636), cdcinfo@cdc.gov, http://www.cdc.gov.

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Goodpasture's syndrome

Definition

An uncommon and life-threatening hypersensitivity disorder believed to be an autoimmune process related to antibody formation in the body. Goodpasture's syndrome is characterized by renal (kidney) disease and lung hemorrhage.

Demographics

Goodpasture's syndrome is a rare autoimmune disorder, with a predominance in young males typically between the ages of 20 and 30 years. It occurs more often in African Americans than Caucasians, and has also been observed in the Maori ethnic group of New Zealand.

Risk factors

There are no known risk factors for Goodpasture's syndrome however in some cases, affected individuals have been known to be ill with an upper respiratory

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tract infection before the development of the disorder. There may also be a connection between substances such as hydrocarbon solvents and some chemicals found in certain weed killers, however, the exact cause of Goodpasture's syndrome remains unknown.

Description

The disorder is characterized by an autoimmune reaction which deposits antibodies in the membranes of both the lung and kidneys, causing both inflammation of kidney (**glomerulonephritis**) and lung bleeding.

Causes and symptoms

The exact cause is unknown. It is an autoimmune disorder; that is, the immune system is fighting the body's own normal tissues through creating antibodies that attack the lungs and kidneys. Sometimes the disorder is triggered by a viral infection, or by the inhalation of gasoline or other hydrocarbon solvents. An association also exists between cigarette **smoking** and the syndrome. The target antigen of the Goodpasture's antibodies has been localized to a protein chain (type IV collagen).

Symptoms include foamy, bloody, or dark colored urine, decreased urine output, **cough** with bloody sputum, difficulty breathing after exertion, weakness, **fatigue**, **nausea** or **vomiting**, weight loss, nonspecific chest **pain** and/or pale skin.

Diagnosis

The clinician will perform a battery of tests to confirm a diagnosis. These tests include a **complete blood count** (CBC) to confirm anemia, iron levels to check for blood loss and blood urea nitrogen (BUN) and creatinine levels to test the kidney function. A **urinalysis** will be done to check for damage to the kidneys. A sputum test will be done to look for specific antibodies. A **chest x ray** will be done to assess the amount of fluid in the lung tissues. A lung needle biopsy and a **kidney biopsy** will show immune system deposits. The kidney biopsy can also show the presence of the harmful antibodies that attack the lungs and kidneys.

Treatment

Treatment is focused on slowing the progression of the disease. Treatment is most effective when begun early, before kidney function has deteriorated to a point where the kidney is permanently damaged, and dialysis is necessary. **Corticosteroids**, such as prednisone, or other anti-inflammatory medications may be used to reduce the immune response. Immune suppressants such as cyclophosphamide or azathioprine are used aggressively to reduce immune system effects.

A procedure whereby blood plasma, which contains antibodies, is removed from the body and replaced with fluids or donated plasma (**plasmapheresis**) may be performed daily for two or more weeks to remove circulating antibodies. It is fairly effective in slowing or reversing the disorder. Dialysis to clean the blood of wastes may be required if kidney function is poor. A kidney transplant may be successful, especially if performed after circulating antibodies have been absent for several months.

KEY TERMS

Antibody—A protein molecule produced by the immune system in response to a protein that is not recognized as belonging in the body.

Antigen—Any substance that, as a result of coming in contact with appropriate cells, induces a state of sensitivity and/or immune responsiveness after a period of time and that reacts in a demonstrable way with antibodies.

Autoimmune disorder—An abnormality within the body whereby the immune system incorrectly attacks the body's normal tissues, thereby causing disease or organ dysfunction.

Blood urea nitrogen (BUN)—A test used to measure the blood level of urea nitrogen, a waste that is normally filtered from the kidneys.

Creatinine—A test used to measure the blood level of creatinine, a waste product filtered out of the blood by the kidneys. Higher than usual levels of this substance may indicate kidney disease.

Glomerulus (glomeruli)—A small tuft of blood capillaries in the kidney, responsible for filtering out waste products.

Prognosis

The probable outcome is variable. Most cases progress to severe renal failure and end-stage renal disease within months. Early diagnosis and treatment makes the probable outcome more favorable.

Prevention

No known prevention of Goodpasture's syndrome exists. Smoking cessation can reduce further

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damage to the lungs. Early diagnosis and treatment may slow progression of the disorder.

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ORGANIZATIONS

American Association of Kidney Patients, 100 S. Ashley Dr., #280, Tampa, FL, 33602, (800) 749-2257, http://www.aakp.org.

American Kidney Fund (AKF), Suite 1010, 6110 Executive Boulevard, Rockville, MD, 20852, (800) 638-8299, http://www.kidneyfund.org.

National Kidney Foundation, 30 East 33rd St., New York, NY, 10016, (800) 622-9010, http://www.kidney.org.

National Organization for Rare Diseases, P.O. Box 8923, Fairfield, CT, 06812, (213) 745-6518, http://www.rarediseases.org.

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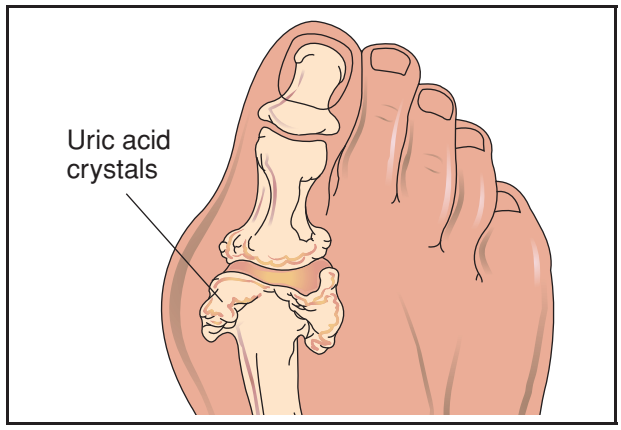
Gout

Definition

Gout is a form of acute arthritis that causes severe **pain** and swelling in the joints. It most commonly affects the big toe, but may also affect the heel, ankle, hand, wrist, or elbow. It affects the spine often enough to be a factor in back pain. Gout usually comes on suddenly, goes away after 5–10 days, and can keep recurring. Gout is different from other forms of arthritis because it occurs when there are high levels of uric acid circulating in the blood, which can cause urate crystals to settle in the tissues of the joints.

Description

Uric acid, which is found naturally in the bloodstream, is formed as the body breaks down waste products, mainly those containing purine, a substance that is produced by the body and is also found in high concentrations in some foods, including brains, liver, sardines, anchovies, and dried peas and beans. Normally, the kidneys filter uric acid out of the blood and excrete it in the urine. Sometimes, however, the body produces too much uric acid or the kidneys aren't efficient enough at filtering it from the blood, and it builds up in the blood stream, a condition known as hyperuricemia. A person's susceptibility to gout may increase because of the inheritance of certain genes or from being overweight and eating a rich diet. In some cases, another disease (such as lymphoma, leukemia, or **hemolytic anemia**) may be the underlying cause of the uric acid buildup that results in gout. An additional factor is occupational or environmental; it is now known that chronic exposure to high levels of lead decreases the body's excretion of urates, allowing uric acid to accumulate in the blood.



Gout, a form of acute arthritis, most commonly occurs in the big toe. It is caused by high levels of uric acid in the blood, in which urate crystals settle in the tissues of the joints and produce severe pain and swelling. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Hyperuricemia does not always cause gout. Over the course of years, however, sharp urate crystals build up in the synovial fluid of the joints. Often, some precipitating event, such as an infection, surgery, the **stress** of hospitalization, a stubbed toe, or even a heavy drinking binge can cause inflammation. White blood cells, mistaking the urate crystals for a foreign invader, flood into the joint and surround the crystals, causing inflammation—in other words, the redness, swelling, and pain that are the hallmarks of a gout attack.

Causes and symptoms

As a result of high levels of uric acid in the blood, needle-like urate crystals gradually accumulate in the joints. Urate crystals may be present in the joint for a long time without causing symptoms. Infection, injury

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KEY TERMS

Allopurinol—A drug that corrects hyperuricemia by inhibiting urate production.

Colchicine—A drug used to treat painful flare-ups of gout.

Corticosteroids—Medications related to a natural body hormone called hydrocortisone, which are used to treat inflammation.

Hyperuricemia—High levels of a waste product called uric acid in the blood.

Probenecid—A drug that corrects hyperuricemia by increasing the urinary excretion of urate.

Purine—A substance found in foods that is broken down into urate and may contribute to hyperuricemia and gout.

Sulfinpyrazone—A drug that corrects hyperuricemia by increasing the urinary excretion of urate.

Synovial fluid—Fluid surrounding the joints which acts as a lubricant, reducing the friction between the joints.

Tophus (plural, tophi)—A chalky deposit of a uric acid compound found in gout. Tophi occur most frequently around joints and in the external ear.

Urate crystals—Crystals formed by high levels of uric acid in the blood.

to the joint, surgery, drinking too much, or eating the wrong kinds of foods may suddenly bring on the symptoms, which include pain, tenderness, redness, warmth, and swelling of the joint. In many cases, the gout attack begins in the middle of the night. The pain is often so excruciating that the sufferer cannot bear weight on the joint or tolerate the pressure of bedcovers. The inflamed skin over the joint may be red, shiny, and dry, and the inflammation may be accompanied by a mild **fever**. These symptoms may go away in about a week and disappear for months or years at a time. However, over the course of time, attacks of gout recur more and more frequently, last longer, and affect more joints. Eventually, stone-like deposits known as tophi may build up in the joints, ligaments, and tendons, leading to permanent joint deformity and decreased motion. (In addition to causing the tophi associated with gout, hyperuricemia can also cause **kidney stones**, also called renal calculi or uroliths.)

Gout affects an estimated one million Americans; according to the National Institutes of Health, it accounts for about 5% of all cases of arthritis. It occurs more often in men than in women; the sex ratio is about 4:1. Uric-acid levels tend to increase in men at **puberty**, and, because it takes 20 years of hyperuricemia to cause gout symptoms, men commonly develop gout in their late 30s or early 40s. Women more typically develop gout later in life, starting in their 60s. According to some medical experts, estrogen protects against hyperuricemia, and when estrogen levels fall during **menopause**, urate crystals can begin to build up in the joints. Excess body weight, regular excessive alcohol intake, the use of blood pressure medications called **diuretics**, and high levels of certain fatty substances in the blood (serum **triglycerides**) associated with an increased risk of heart disease can all increase a person's risk of developing gout.

Gout appears to be on the increase in the American population. According to a study published in November 2002, there was a twofold increase in the incidence of gout over the 20 years between 1977 and 1997. It is not yet known whether this increase is the result of improved diagnosis or whether it is associated with risk factors that have not yet been identified.

Diagnosis

Usually, physicians can diagnose gout based on the **physical examination** and medical history (the patient's description of symptoms and other information). Doctors can also administer a test that measures the level of uric acid in the blood. While normal uric acid levels don't necessarily rule out gout and high levels don't confirm it, the presence of hyperuricemia increases the likelihood of gout. The development of a tophus can confirm the diagnosis of gout. The most definitive way to diagnose gout is to take a sample of fluid from the joint and test it for urate crystals.

Treatment

The goals of treatment for gout consist of alleviating pain, avoiding severe attacks in the future, and preventing long-term joint damage. In addition to taking pain medications as prescribed by their doctors, people having gout attacks are encouraged to rest and to increase the amount of fluids that they drink.

Acute attacks of gout can be treated with nonaspirin, **nonsteroidal anti-inflammatory drugs** (NSAIDs) such as naproxen **sodium** (Aleve), ibuprofen (Advil), or indomethacin (Indocin). In some cases, these drugs can

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aggravate a peptic ulcer or existing **kidney disease** and cannot be used. Doctors may also use colchicine (Colbenemid), especially in cases where nonsteroidal anti-inflammatory drugs cannot be used. Colchicine may cause **diarrhea**, which tends to go away once the patient stops taking it. **Corticosteroids** such as prednisone (Deltasone) and adrenocorticotropic hormone (Acthar) may be given orally or may be injected directly into the joint for a more concentrated effect. While all of these drugs have the potential to cause side effects, they are used for only about 48 hours and are not likely to cause major problems. However, **aspirin** and closely related drugs (salicylates) should be avoided because they can ultimately worsen gout.

Once an acute attack has been successfully treated, doctors try to prevent future attacks of gout and long-term joint damage by lowering uric acid levels in the blood. There are two types of drugs for correcting hyperuricemia. Such uricosuric drugs as probenecid (Benemid) and sulfinpyrazone (Anturane) lower the levels of urate in the blood by increasing its removal from the body (excretion) through the urine. These drugs may promote the formation of kidney stones, however, and they may not work for all patients, especially those with kidney disease. Allopurinol (Zyloprim), a type of drug called a xanthine-oxidase inhibitor, blocks the production of urate in the body, and can dissolve kidney stones as well as treating gout. The potential side effects of allopurinol include rash, a skin condition known as **dermatitis**, and liver dysfunction. In 2004, the FDA was seeking trial data on a new drug called oxypurinol (Oxyprim) for treating chronic gout. These medications may have to be taken for life to prevent further gout attacks.

Alternative treatment

Alternative approaches to gout focus on correcting hyperuricemia by encouraging weight loss and limiting the intake of alcohol and purine-rich foods. In addition, consuming garlic (*Allium sativum*) has been recommended to help prevent gout. Increasing fluid intake, especially by drinking water, is also recommended. During an acute attack, contrast **hydrotherapy** (alternating three-minute hot compresses with 30–second cold compresses) can help dissolve the crystals and resolve the pain faster.

Prognosis

Gout cannot be cured but usually it can be managed successfully. As tophi dissolve, joint mobility generally improves. (In some cases, however, medicines alone do not dissolve the tophi and they must be removed surgically.) Lowering uric acid in the blood also helps to prevent or improve the kidney problems that may accompany gout.

Prevention

For centuries, gout has been known as a "rich man's disease" or a disease caused by overindulgence in food and drink. While this view is perhaps a little overstated and oversimplified, lifestyle factors clearly influence a person's risk of developing gout. Since **obesity** and excessive alcohol intake are associated with hyperuricemia and gout, losing weight and limiting alcohol intake can help ward off gout. **Dehydration** may also promote the formation of urate crystals, so people taking diuretics or "water pills" may be better off switching to another type of blood pressure medication. Everyone should be sure to drink at least six to eight glasses of water each day. Since purine is broken down in the body into urate, it may also be helpful to avoid foods high in purine, such as organ meats, sardines, anchovies, red meat, gravies, beans, beer, and wine. A 2004 study revealed that eating more low-fat dairy products could reduce risk of developing gout.

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Gout drugs

Definition

Gout drugs are medicines that prevent or relieve the symptoms of gout, a disease that affects the joints and kidneys.

Purpose

Gout is a disease in which uric acid, a waste product that normally passes out of the body in urine, collects and forms crystals in the joints and the kidneys. When uric acid crystals build up in the joints, the tissue around the joint becomes inflamed, and nerve endings in the area become irritated, causing extreme **pain**. Uric acid crystals in the kidneys can lead to **kidney stones** and eventually to kidney failure.

The symptoms of gout–severe pain, usually in the hand or foot (often at the base of the big toe), but sometimes in the elbow or knee–should be reported to a health care professional. If not treated, gout can lead to high blood presssure, deformed joints, and even **death** from kidney failure. Fortunately, the condition is easily treated. For patients who have just had their first attack, physicians may prescribe only medicine to reduce the pain and inflammatin, such as **nonsteroidal anti-inflammatory drugs**, **corticosteroids**, or colchicine. Patients may also be advised to change their eating and drinking habits, avoiding organ meats and other protein-rich foods, cutting out alcoholic beverages, and drinking more water. Some people never have another gout attack after the first. For those who do, physicians may prescribe additional drugs that either help the body get rid of uric acid or reduce the amount of uric acid the body produces. These drugs will not relieve gout attacks that already have started, but will help prevent attacks when taken regularly.

Description

Three main types of drugs are used in treating gout. Colchicine helps relieve the symptoms of gout by reducing inflammation. Allopurinol (Lopurin, Zyloprim) reduces the amount of uric acid produced in the body. Probenecid (Benemid, Probalan) and sulfinpyrazone (Anturane) help the body get rid of excess uric acid. Physicians may recommend that patients take more than one type of gout drug at the same time. Some of these medicines may also be prescribed for other medical conditions that are caused by too much uric acid in the body.

Recommended dosage

The recommended dosage depends on the type of gout drug. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

Always take gout drugs exactly as directed. Never take larger or more frequent doses than recommended. Patients who are told to take more than one gout drug should carefully follow the physician's directions for taking all medicines.

Gout drugs such as allopurinol, probenecid, and sulfinpyrazone must be taken regularly to prevent gout attacks. The medicine may take some time to begin working, so gout attacks may continuee for awhile after starting to take the drug. Continuing to take the drug is important, even if it does not seem to be working at first.

Colchicine may be taken regularly in low doses to help prevent gout attacks or in high doses for only a few hours at a time to relieve an attack. The chance of serious side effects is greater when this medicine is taken in high doses for short periods.

Precautions

Seeing a physician regularly while taking gout drugs is important. The physician will check to make sure the medicine is working as it should and will watch for unwanted side effects. Blood tests may be ordered to help the physician monitor how well the drug is working.

Drinking alcohol, including beer and wine, may increase the amount of uric acid in the body and may interfere with the effects of gout medicine. People with gout (or other conditions that result from excess uric acid) may need to limit the amount of alcohol they drink or stop drinking alcohol altogether.

Some people feel drowsy or less alert when taking gout drugs. Anyone who takes this type of medicine should not drive, use machines or do anything else that might be dangerous until they have found out how the drugs affect them.

Some gout drugs may change the results of certain medical tests. Before having medical tests, anyone taking this medicine should alert the health care professional in charge.

Older people may be especially sensitive to the effects of colchicine. The drug may also stay in their bodies longer than it does in younger people. Both the increased sensitivity to the drug and the longer time

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for the drug to leave the body may increase the chance of side effects.

Special conditions

People who have certain medical conditions or who are taking certain other medicines can have problems if they take gout drugs. Before taking these drugs, be sure to let the physician know about any of these conditions:

ALLERGIES. Anyone who has ever had unusual reactions to gout drugs or to medicines used to relieve pain or inflammation should let his or her physician know before taking gout drugs. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

DIABETES. Some gout drugs may cause false results on certain urine sugar tests, but not on others. Diabetic patients who take gout drugs should check with their physicians to find out if their medicine will affect the results of their urine sugar tests.

PREGNANCY. The effects of taking gout drugs during **pregnancy** are not fully understood. Women who are pregnant or who may become pregnant should check with their physicians before using gout drugs.

BREASTFEEDING. Gout drugs may pass into breast milk. Women who are taking this medicine and want to breastfeed their babies should check with their physicians.

OTHER MEDICAL CONDITIONS. Gout drugs may cause problems for people with certain medical conditions. For example, the risk of severe allergic reactions or other serious side effects is greater when people with these medical conditions take certain gout drugs:

- congestive heart disease
- high blood pressure
- blood disease
- diabetes
- kidney disease or kidney stones
- cancer being treated with drugs or radiation
- stomach or intestinal problems, including stomach ulcer (now or in the past)

Before using gout drugs, people with any of medical problems listed above should make sure their physicians are aware of their conditions.

USE OF CERTAIN MEDICINES. Taking gout drugs with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Side effects

A skin rash that develops during treatment with gout drugs may be a sign of a serious and possibly life-threatening reaction. If any of these symptoms occur, stop taking the medicine and check with a physician immediately:

- skin rash, itching, or hives
- scaly or peeling skin
- chills, fever, sore throat, nausea and vomiting, yellow skin or eyes, joint pain, muscle aches or pains–especially if these symptoms occur at the same time or shortly after a skin rash

Patients taking colchicine should stop taking it immediately if they have **diarrhea**, stomach pain, **nausea**, or **vomiting**. If these symptoms continue for 3 hours or more after the medicine is stopped, check with a physician.

Other side effects may also need medical attention. If any of the following symptoms occur while taking gout drugs, check with the physician who prescribed the medicine as soon as possible:

- pain in the side or lower back
- painful urination
- blood in the urine

Less serious side effects, such as **headache**, loss of appetite, and joint pain and inflammation usually go away as the body adjusts to the drug and do not need medical treatment.

Other side effects may occur. Anyone who has unusual symptoms while taking gout drugs should get in touch with his or her physician.

INTERACTIONS. Gout drugs may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes gout drugs should let the physician know all other medicines he or she is taking. Among the drugs that may interact with gout drugs are:

- **Aspirin** or other salicylates. These drugs may keep gout drugs from working properly.
- Nonsteroidal anti-inflammatory drugs such as indomethacin (Indocin) and ketoprofen (Orudis). Taking these medicines with probenecid may increase the chance of side effects from the nonsteroidal anti-inflammatory drugs.
- Blood thinners. When taken with blood thinners, such as warfarin (Coumadin), gout drugs may increase the chance of bleeding. A lower blood thinner dose may be necessary.

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- Blood viscosity reducing medicines such as pentoxifylline (Trental). Taking this medicine with blood thinners may increase the chance of bleeding.
- Medicine for infections. Probenecid may increase the levels of these medicines in the blood. This may make the other medicine work better, but may also increase the risk of side effects.
- The immunosuppressant drug azathioprine (Imuran), used to prevent organ rejection in transplant patients and to treat **rheumatoid arthritis**. Taking this medicine with allopurinol can increase the risk of side effects from the azathioprine.
- Anticancer drugs such as mercaptopurine (Purinethol), plicamycin (Mithracin), and methotrexate (Rheumatrex). Taking this medicine with gout drugs may increase the risk of side effects from the anticancer drug.
- Antiretroviral drugs such as zidovudine (Retrovir). Probenecid may increase the level of this medicine in the blood. This may make side effects more likely.
- Antiseizure medicines such as Depakote (divalproex) and Depakene (valproic acid). Using these medicines with sulfinpyrazone may increase the chance of bleeding.

The list above does not include every drug that may interact with gout drugs. Be sure to check with a physician or pharmacist before combining gout drugs with any other prescription or nonprescription (over-the-counter) medicine.

Nancy Ross-Flanigan

Gouty arthritis *see* **Gout**

Graft-vs.-host disease

Definition

Graft-vs.-host disease is an immune attack on the recipient by cells from a donor.

Description

The main problem with transplanting organs and tissues is that the recipient host does not recognize the new tissue as its own. Instead, it attacks it as foreign in the same way it attacks germs, to destroy it.

If immunogenic cells from the donor are transplanted along with the organ or tissue, they will attack the host, causing graft vs. host disease.

The only transplanted tissues that house enough immune cells to cause graft vs. host disease are the blood and the bone marrow. Blood transfusions are used every day in hospitals for many reasons. Bone marrow transplants are used to replace blood forming cells and immune cells. This is necessary for patients whose **cancer** treatment has destroyed their own bone marrow. Because bone marrow cells are among the most sensitive to radiation and **chemotherapy**, it often must be destroyed along with the cancer. This is true primarily of leukemias, but some other cancers have also been treated this way.

Causes and symptoms

Even if the donor and recipient are well matched, graft-vs.-host disease can still occur. There are many different elements involved in generating immune reactions, and each person is different, unless they are identical twins. Testing can often find donors who match all the major elements, but there are many minor ones that will always be different. How good a match is found also depends upon the urgency of the need and some good luck.

Blood **transfusion** graft-vs.-host disease affects mostly the blood. Blood cells perform three functions: carrying oxygen, fighting infections, and clotting. All of these cell types are decreased in a transfusion graft-vs.-host reaction, leading to anemia (lack of red blood cells in the blood), a decrease in resistance to infections, and an increase in bleeding. The reaction occurs between four to 30 days after the transfusion.

The tissues most affected by bone marrow graft-vs.-host disease are the skin, the liver, and the intestines. One form or the other occurs in close to half of the patients who receive bone marrow transplants.

Bone marrow graft-vs.-host disease comes in an acute and a chronic form. The acute form appears within two months of the transplant; the chronic form usually appears within three months. The acute disease produces a skin rash, liver abnormalities, and **diarrhea** that can be bloody. The skin rash is primarily a patchy thickening of the skin. Chronic disease can produce a similar skin rash, a tightening or an inflammation of the skin, lesions in the mouth, drying of the eyes and mouth, hair loss, liver damage, lung damage, and **indigestion**. The symptoms are similar to an autoimmune disease called **scleroderma**.

Both forms of graft-vs.-host disease bring with them an increased risk of infections, either because of the process itself or its treatment with cortisone-like drugs and immunosuppressives. Patients can die of liver failure, infection, or other severe disturbances of their system.

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KEY TERMS

Anemia—Too few red blood cells, or too little hemoglobin in them.

Immunoglobulin—Chemicals in the blood that defend against infections.

Immunosuppressive—A chemical which suppresses an immune response.

Inflammation—The body's immune reaction to presumed foreign substances like germs. Inflammation is characterized by increased blood supply and activation of defense mechanisms. It produces redness, swelling, heat, and pain.

Lesion—Localized disease or damage.

Scleroderma—Progressive disease of the connective tissue of the skin and internal organs.

Treatment

Both the acute and the chronic disease are treated with cortisone-like drugs, immunosuppressive agents like cyclosporine, or with **antibiotics** and immune chemicals from donated blood (**gamma globulin**). Infection with one particular virus, called cytomegalovirus (CMV) is so likely a complication that some experts recommend treating it ahead of time.

Prognosis

Children with **acute leukemias** have greatly benefited from the treatment made possible by **bone marrow transplantation**. Survival rates have climbed by 15–50%. It is an interesting observation that patients who develop graft-vs.-host disease are less likely to have a recurrence of the leukemia that was being treated. This phenomenon is called graft-vs.-leukemia.

Bone marrow transplant patients who do not have a graft-vs.-host reaction gradually return to normal immune function in a year. A graft-vs.-host reaction may prolong the diminished immune capacity indefinitely, requiring supplemental treatment with immunoglobulins (gamma globulin).

Somehow the grafted cells develop a tolerance to their new home after six to 12 months, and the medications can be gradually withdrawn. Graft-vs.-host disease is not the only complication of blood transfusion or bone marrow transplantation. Host-vs.-graft or rejection is also common and may require a repeat transplant with another donor organ. Infections are a constant threat in bone marrow transplant because of the disease being treated, the prior radiation or chemotherapy and the medications used to treat the transplant.

Prevention

For recipients of blood transfusions who are especially likely to have graft-vs.-host reactions, the red blood cells can safely be irradiated (using x rays) to kill all the immune cells. The red blood cells are less sensitive to radiation and are not harmed by this treatment.

Much current research is directed towards solving the problem of graft-vs.-host disease. There are efforts to remove the immunogenic cells from the donor tissue, and there are also attempts to extract and purify bone marrow cells from the patient before treating the cancer. These cells are then given back to the patient after treatment has destroyed all that were left behind.

Resources

BOOKS

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J. Ricker Polsdorfer, MD

Grafts and grafting *see* **Bone grafting; Coronary artery bypass graft surgery; Graft-vs.-host disease; Skin grafting**

Granular conjunctivitis *see* **Trachoma**

Granulocytic ehrlichiosis *see* **Ehrlichiosis**

Granulocytopenia *see* **Neutropenia**

Granuloma inguinale

Definition

Granuloma inguinale is a sexually transmitted infection that affects the skin and mucous membranes of the anal and genital areas. Its name is derived from granuloma, a medical term for a mass or growth of granulation tissue, and *inguinale*, a Latin word that means located in the groin. Granulation tissue is tissue formed during wound healing that is rich in blood capillaries and has a rough or lumpy surface.

Description

Granuloma inguinale is a chronic infection with frequent relapses caused by a rod-shaped bacterium. It occurs worldwide but is most common in tropical or

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KEY TERMS

Donovan bodies—Rod-shaped oval organisms found in tissue samples from patients with granuloma inguinale. Donovan bodies appear deep purple when stained with Wright's stain.

Granulation tissue—A kind of tissue formed during wound healing, with a rough or irregular surface and a rich supply of blood capillaries.

Granuloma—An inflammatory swelling or growth composed of granulation tissue, as in granuloma inguinale.

Keloid—An unusual or abnormal growth of scar tissue, as in the third stage of granuloma inguinale.

Punch biopsy—A method of obtaining skin samples under local anesthesia using a surgical skin punch.

Superinfection—A condition in which a patient with a contagious disease acquires a second infection, as when a patient with granuloma inguinale is also infected with syphilis.

Wright's stain—A chemical used to stain tissue samples for laboratory analysis.

subtropical countries, where it is associated with poverty and poor hygiene. As many as 20% of male patients with **sexually transmitted diseases** (STDs) in tropical countries have granuloma inguinale. The disease is less common in the United States, with fewer than 100 reported cases per year. Most patients are between the ages of 20 and 40 years, with a 2:1 male-to-female ratio.

Although granuloma inguinale is relatively uncommon in the United States in comparison with other STDs, it is still a significant public health problem. It can be acquired through casual sexual contacts when traveling abroad. Moreover, patients with granuloma inguinale are vulnerable to superinfection (infection by other disease agents) with other STDs, especially **syphilis**. Patients with granuloma inguinale are also a high-risk group for Acquired Immune Deficiency Syndrome (**AIDS**) transmission, because the disease causes open genital ulcers that can be easily invaded by the AIDS virus.

Granuloma inguinale is spread primarily through heterosexual and male homosexual contact; however, its occurrence in children and sexually inactive adults indicates that it may also be spread by contact with human feces. Granuloma inguinale is not highly contagious; however, persons with weakened immune systems are at greater risk of infection.

Causes and symptoms

Granuloma inguinale, which is sometimes called donovanosis, is caused by *Calymmatobacterium granulomatis*, a rod-shaped bacterium formerly called *Donovania granulomatis*. The bacterium has an incubation period ranging from eight days to 12 weeks, with an average of two to four weeks. The disease has a slow and gradual onset, beginning with an inconspicuous pimple or lumpy eruption on the skin. In 90% of patients, the initial sign of infection is in the genital region, but a minority of patients will develop the sore in their mouth or anal area if their sexual contact involved those parts of the body. Many patients do not notice the sore because it is small and not usually painful. In some women, the first symptom of granuloma inguinale is bleeding from the genitals.

The initial pimple or sore is typically followed by three stages of disease. In the first stage, the patient develops a mass of pink or dull red granulation tissue in the area around the anus. In the second stage, the bacteria erode the skin to form shallow, foul-smelling ulcers which spread from the genital and anal areas to the thighs and lower abdomen. The edges of the ulcers are marked by granulation tissue. In the third stage, the ulcerated areas form deep masses of keloid or scar tissue that may spread slowly for many years.

Patients with long-term infections are at risk for serious complications. The ulcers in second-stage granuloma inguinale often become superinfected with syphilis or other STD organisms. Superinfected ulcers become painful to touch, filled with pus and dead tissue, and are much more difficult to treat. There may be sizable areas of tissue destruction in superinfected patients. In addition, the scar tissue produced by third-stage infection can grow until it closes off parts of the patient's urinary tract. It is also associated with a higher risk of genital **cancer**.

Diagnosis

The most important aspect of diagnosis is distinguishing between granuloma inguinale and other STDs, particularly since many patients will be infected with more than one STD. Public health officials recommend that patients tested for granuloma inguinale be given a blood test for syphilis as well. In addition, the doctor will need to distinguish between granuloma

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inguinale and certain types of skin cancer, **amebiasis**, fungal infections, and other bacterial ulcers. The most significant distinguishing characteristic of granuloma inguinale is the skin ulcer, which is larger than in most other diseases, painless, irregular in shape, and likely to bleed when touched.

The diagnosis of granuloma inguinale is made by finding Donovan bodies in samples of the patient's skin tissue. Donovan bodies are oval rod-shaped organisms that appear inside infected tissue cells under a microscope. The doctor obtains a tissue sample either by cutting a piece of tissue from the edge of an skin ulcer with a scalpel or by taking a punch biopsy. To make a punch biopsy, the doctor will inject a local anesthetic into an ulcerated area and remove a piece of skin about 1/16 of an inch in size with a surgical skin punch. The tissue sample is then air-dried and stained with Wright's stain, a chemical that will cause the Donovan bodies to show up as dark purple safety pin-shaped objects inside lighter-staining capsules.

Treatment

Granuloma inguinale is treated with oral **antibiotics**. Three weeks of treatment with erythromycin, streptomycin, or tetracycline, or 12 weeks of treatment with ampicillin are standard forms of therapy. Although the skin ulcers will start to show signs of healing in about a week, the patient must take the full course of medication to minimize the possibility of relapse.

Prognosis

Most patients with granuloma inguinale recover completely, although superinfected ulcers may require lengthy courses of medication. Early treatment prevents the complications associated with second- and third-stage infection.

Prevention

Prevention of granuloma inguinale has three important aspects:

- Avoidance of casual sexual contacts, particularly among homosexual males, in countries with high rates of the disease
- Tracing and examination of an infected person's recent sexual contacts
- Monitoring the patient's ulcers or scar tissue for signs of reinfection for a period of six months after antibiotic treatment

Resources

BOOKS

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Rebecca J. Frey, PhD

Granulomatous ileitis *see* **Crohn's disease**

Graves' disease *see* **Hyperthyroidism**

Greenfield filter *see* **Vena cava**

Grippe *see* **Influenza**

Group A streptococcus infection *see* **Streptococcal infections**

Group B streptococcus infection *see* **Streptococcal infections**

Group therapy

Definition

Group therapy is a form of psychosocial treatment where a small group of patients meet regularly to talk, interact, and discuss problems with each other and the group leader (therapist).

Purpose

Group therapy attempts to give individuals a safe and comfortable place where they can work out problems and emotional issues. Patients gain insight into their own thoughts and behavior, and offer suggestions and support to others. In addition, patients who have a difficult time with interpersonal relationships can benefit from the social interactions that are a basic part of the group therapy experience.

Precautions

Patients who are suicidal, homicidal, psychotic, or in the midst of a major acute crisis are typically not referred for group therapy until their behavior and emotional state have stabilized. Depending on their level of functioning, cognitively impaired patients (like patients with organic brain disease or a traumatic brain injury) may also be unsuitable for group therapy intervention. Some patients with sociopathic traits are not suitable for most groups.

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Description

A psychologist, psychiatrist, social worker, or other healthcare professional typically arranges and conducts group therapy sessions. In some therapy groups, two co-therapists share the responsibility of group leadership. Patients are selected on the basis of what they might gain from group therapy interaction and what they can contribute to the group as a whole.

Therapy groups may be homogeneous or heterogeneous. Homogeneous groups have members with similar diagnostic backgrounds (for example, they may all suffer from depression). Heterogeneous groups have a mix of individuals with different emotional issues. The number of group members varies widely, but is typically no more than 12. Groups may be time limited (with a predetermined number of sessions) or indefinite (where the group determines when therapy ends). Membership may be closed or open to new members once sessions begin.

The number of sessions in group therapy depends on the makeup, goals, and setting of the group. For example, a therapy group that is part of a **substance abuse** program to rehabilitate inpatients would be called short-term group therapy. This term is used because, as patients, the group members will only be in the hospital for a relatively short period of time. Long-term therapy groups may meet for six months, a year, or longer. The therapeutic approach used in therapy depends on the focus of the group and the psychological training of the therapist. Some common techniques include psychodynamic, cognitive-behavioral, and **Gestalt therapy**.

In a group therapy session, group members are encouraged to openly and honestly discuss the issues that brought them to therapy. They try to help other group members by offering their own suggestions, insights, and empathy regarding their problems. There are no definite rules for group therapy, only that members participate to the best of their ability. However, most therapy groups do have some basic ground rules that are usually discussed during the first session. Patients are asked not to share what goes on in therapy sessions with anyone outside of the group. This protects the confidentiality of the other members. They may also be asked not to see other group members socially outside of therapy because of the harmful effect it might have on the dynamics of the group.

The therapist's main task is to guide the group in self-discovery. Depending on the goals of the group and the training and style of the therapist, he or she may lead the group interaction or allow the group to take their own direction. Typically, the group leader does some of both, providing direction when the group gets off track while letting them set their own agenda. The therapist may guide the group by simply reinforcing the positive behaviors they engage in. For example, if a group member shows empathy to another member, or offers a constructive suggestion, the therapist will point this out and explain the value of these actions to the group. In almost all group therapy situations, the therapist will attempt to emphasize the common traits among group members so that members can gain a sense of group identity. Group members realize that others share the same issues they do.

The main benefit group therapy may have over individual **psychotherapy** is that some patients behave and react more like themselves in a group setting than they would one-on-one with a therapist. The group therapy patient gains a certain sense of identity and social acceptance from their membership in the group. Suddenly, they are not alone. They are surrounded by others who have the same anxieties and emotional issues that they have. Seeing how others deal with these issues may give them new solutions to their problems. Feedback from group members also offers them a unique insight into their own behavior, and the group provides a safe forum in which to practice new behaviors. Lastly, by helping others in the group work through their problems, group therapy members can gain more self-esteem. Group therapy may also simulate family experiences of patients and will allow family dynamic issues to emerge.

Self-help groups like Alcoholics Anonymous and Weight Watchers fall outside of the psychotherapy realm. These self-help groups do offer many of the same benefits of social support, identity, and belonging that make group therapy effective for many. Self-help group members meet to discuss a common area of concern (like **alcoholism**, **eating disorders**, **bereavement**, parenting). Group sessions are not run by a therapist, but by a nonprofessional leader, group member, or the group as a whole. Self-help groups are sometimes used in addition to psychotherapy or regular group therapy.

Preparation

Patients are typically referred for group therapy by a psychologist or psychiatrist. Some patients may need individual therapy first. Before group sessions begin, the therapist leading the session may conduct a short intake interview with the patient to determine if the group is right for the patient. This interview will also allow the therapist to determine if the addition of the patient will benefit the group. The patient may be

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KEY TERMS

Cognitive-behavioral—A therapy technique that focuses on changing beliefs, images, and thoughts in order to change maladjusted behaviors.

Gestalt—A humanistic therapy technique that focuses on gaining an awareness of emotions and behaviors in the present rather than in the past.

Psychodynamic—A therapy technique that assumes improper or unwanted behavior is caused by unconscious, internal conflicts and focuses on gaining insight into these motivations.

given some preliminary information on the group before sessions begin. This may include guidelines for success (like being open, listening to others, taking risks), rules of the group (like maintaining confidentiality), and educational information on what group therapy is about.

Aftercare

The end of long-term group therapy may cause feelings of grief, loss, abandonment, anger, or rejection in some members. The group therapist will attempt to foster a sense of closure by encouraging members to explore their feelings and use newly acquired coping techniques to deal with them. Working through this termination phase of group therapy is an important part of the treatment process.

Risks

Some very fragile patients may not be able to tolerate aggressive or hostile comments from group members. Patients who have trouble communicating in group situations may be at risk for dropping out of group therapy. If no one comments on their silence or makes an attempt to interact with them, they may begin to feel even more isolated and alone instead of identifying with the group. Therefore, the therapist usually attempts to encourage silent members to participate early on in treatment.

Normal results

Studies have shown that both group and individual psychotherapy benefit about 85% of the patients that participate in them. Optimally, patients gain a better understanding of themselves, and perhaps a stronger set of interpersonal and coping skills through the group therapy process. Some patients may continue therapy after group therapy ends, either individually or in another group setting.

Resources

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ORGANIZATIONS

American Psychiatric Association, 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209-3901, (703) 907-7300, apa@psych.org, http://www.psych.org.

American Psychological Association (APA), 750 First Street NE, Washington, DC, 20002-4242, (202) 336-5500, (800) 374-2721, http://www.apa.org.

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Growth hormone suppression test *see* **Growth hormone tests**

Growth hormone tests

Definition

Growth hormone (hGH), or somatotropin, is a hormone responsible for normal body growth and development by stimulating protein production in muscle cells and energy release from the breakdown of fats. Tests for growth hormone include Somatotropin hormone test, Somatomedin C, Growth hormone suppression test (glucose loading test), and Growth hormone stimulation test (Arginine test or Insulin tolerance test).

Purpose

Growth hormone tests are ordered for the following reasons:

- to identify growth deficiencies, including delayed puberty and small stature in adolescents that result from pituitary or thyroid malfunction
- to aid in the diagnosis of hyperpituitarism that is evident in gigantism or acromegaly
- to screen for inadequate or reduced pituitary gland function

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- to assist in the diagnosis of pituitary tumors or tumors related to the hypothalamus, an area of the brain
- to evaluate hGH therapy

Precautions

Taking certain drugs such as amphetamines, dopamine, **corticosteroids**, and phenothiazines may increase and decrease growth hormone secretion, respectively. Other factors influencing hGH secretion include **stress**, **exercise**, diet, and abnormal glucose levels. These tests should not be done within a week of any radioactive scan.

Description

Several hormones play important roles in human growth. The major human growth hormone (hGH), or somatotropin, is a protein made up of 191 amino acids that is secreted by the anterior pituitary gland and coordinates normal growth and development. Human growth is characterized by two spurts, one at birth and the other at **puberty**. hGH plays an important role at both of these times. Normal individuals have measurable levels of hGH throughout life. Yet levels of hGH fluctuate during the day and are affected by eating and exercise. Receptors that respond to hGH exist on cells and tissues throughout the body. The most obvious effect of hGH is on linear skeletal development. But the metabolic effects of hGH on muscle, the liver, and fat cells are critical to its function. Surprisingly, a 2004 study reported that obese people have lower-than-normal levels of human growth hormone in their bodies. Humans have two forms of hGH, and the functional difference between the two is unclear. They are both formed from the same gene, but one lacks the amino acids in positions 32–46.

GH is produced in the anterior portion of the pituitary gland by somatotrophs under the control of hormonal signals in the hypothalamus. Two hypothalamic hormones regulate hGH; they are growth hormone-releasing hormone (GHRH) and growth hormone—inhibiting hormone (GHIH). When blood glucose levels fall, GHRH triggers the secretion of stored hGH. As blood glucose levels rise, GHRH release is turned off. Increases in blood protein levels trigger a similar response. As a result of this hypothalamic feedback loop, hGH levels fluctuate throughout the day. Normal plasma hGH levels average 1–3 ng/ML with peaks as high as 60 ng/ML. In addition, plasma glucose and amino acid availability for growth is also regulated by the hormones adrenaline, glucagon, and insulin.

Most hGH is released at night. Peak spikes of hGH release occur around 10 p.m., midnight, and 2 a.m. The logic behind this night-time release is that most of hGH's effects are controlled by other hormones, including the somatomedins, IGH-I and IGH-II. As a result, the effects of hGH are spread out more evenly during the day.

A number of hormonal conditions can lead to excessive or diminished growth. Because of its critical role in producing hGH and other hormones, an abnormal pituitary gland will often yield altered growth. Dwarfism (very small stature) can be due to underproduction of hGH, lack of IGH-I, or a flaw in target tissue response to either of these growth hormones. Overproduction of hGH or IGH-I, or an exaggerated response to these hormones can lead to **gigantism** or acromegaly, both of which are characterized by a very large stature.

Gigantism is the result of hGH overproduction in early childhood leading to a skeletal height up to 8 feet (2.5m) or more. Acromegaly results when hGH is overproduced after the onset of puberty. In this condition, the epiphyseal plates of the long bone of the body do not close, and they remain responsive to additional stimulated growth by hGH. This disorder is characterized by an enlarged skull, hands and feet, nose, neck, and tongue.

Somatotropin

Somatotropin is used to identify hGH deficiency in adolescents with short stature, delayed sexual maturity, and other growth deficiencies. It also aids in documenting excess hGH production that is responsible for gigantism or acromegaly, and confirms underactivity or overproduction of the pituitary gland (**hypopituitarism** or hyperpituitarism). However, due to the episodic secretion of hGH, as well as hGH production in response to stress, exercise, or other factors, random assays are not an adequate determination of hGH deficiency. To negate these variables and obtain more accurate readings, a blood sample can be drawn one to 1.5 hours after sleep (hGH levels increase during sleep), or strenuous exercise can be performed for 30 minutes before blood is drawn (hGH levels increase after exercise). The hGH levels at the end of an exercise period are expected to be maximal.

Somatomedin C

The somatomedin C test is usually ordered to detect pituitary abnormalities, hGH deficiency, and acromegaly. Also called insulin-like growth factor (IGF-1), somatomedin C is considered a more accurate reflection of the blood concentration of hGH because

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such variables as time of day, activity levels, or diet do not influence the results. Somatomedin C is part of a group of peptides, called somatomedins, through which hGH exerts its effects. Because it circulates in the bloodstream bound to long-lasting proteins, it is more stable than hGH. Levels of somatomedin C depend on hGH levels, however. As a result, somatomedin C levels are low when hGH levels are deficient. Abnormally low test results of somatomedin C require an abnormally reduced or absent hGH during an hGH stimulation test in order to diagnose hGH deficiency. Nonpituitary causes of reduced somatomedin C include **malnutrition**, severe chronic illness, severe **liver disease**, **hypothyroidism**, and Laron's dwarfism.

Growth hormone stimulation test

The hGH stimulation test, also called hGH Provocation test, Insulin Tolerance, or Arginine test, is performed to test the body's ability to produce human growth hormone, and to identify suspected hGH deficiency. A normal patient can have low hGH levels, but if hGH is still low after stimulation, a diagnosis can be more accurately made.

Insulin-induced **hypoglycemia** (via intravenous injection of insulin) stimulates hGH and corticotropin secretion as well. If such stimulation is unsuccessful, then there is a malfunction of the anterior pituitary gland. Blood samples may be obtained following an energetic exercise session lasting 20 minutes.

A substance called hGH-releasing factor has recently been used for hGH stimulation. This approach promises to be more accurate and specific for hGH deficiency caused by the pituitary. Growth hormone deficiency is also suspected when x-ray determination of bone age indicates retarded growth in comparison to chronologic age. At present, the best method to identify hGH-deficient patients is a positive stimulation test followed by a positive response to a therapeutic trial of hGH.

Growth hormone suppression test

Also called the glucose loading test, this procedure is used to evaluate excessive baseline levels of human growth hormone, and to confirm diagnosis of gigantism in children and acromegaly in adults. The procedure requires two different blood samples, one drawn before the administration of 100 g of glucose (by mouth), and a second sample two hours after glucose ingestion.

Normally, a glucose load suppresses hGH secretion. In a patient with excessive hGH levels, failure of suppression indicates anterior pituitary dysfunction and confirms a diagnosis of **acromegaly and gigantism**.

Preparation

Somatotropin: This test requires a blood sample. The patient should be **fasting** (nothing to eat or drink from midnight the night before the test). Stress and/or exercise increases hGH levels, so the patient should be at complete rest for 30 minutes before the blood sample is drawn. If the physician has requested two samples, they should be drawn on consecutive days at approximately the same time on both days, preferably between 6 a.m. and 8 a.m.

Somatomedin C: This test requires a blood sample. The patient should have nothing to eat or drink from midnight the night before the test.

Growth hormone stimulation: This test requires intravenous administration of medications and the withdrawal of frequent blood samples, which are obtained at 0, 60, and 90 minutes after injection of arginine and/or insulin. The patient should have nothing to eat or drink after midnight the night before the test.

Growth hormone suppression: This test requires two blood samples, one before the test and another two hours after administration of 100 g of glucose solution by mouth. The patient should have nothing to eat or drink after midnight, and physical activity should be limited for 10–12 hours before the test.

Risks

Growth hormone stimulation: Only minor discomfort is associated with this test, and results from the insertion of the IV line and the low blood sugar (hypoglycemia) induced by the insulin injection. Some patients may experience sleepiness, sweating and/or nervousness, all of which can be corrected after the test by ingestion of cookies, juice, or a glucose infusion. Severe cases of hypoglycemia may cause ketosis (excessive amounts of fatty acid byproducts in the body), acidosis (a disturbance of the body's acid-base balance), or **shock**. With the close observation required for the test, these are unlikely.

Growth hormone suppression: Some patients experience **nausea** after the administration of this amount of glucose. Ice chips can alleviate this symptom.

Normal results

Normal results may vary from laboratory to laboratory but are usually within the following ranges:

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KEY TERMS

Acromegaly—A rare disease resulting from excessive growth hormone caused by a benign tumor. If such a tumor develops within the first 10 years of life, the result is gigantism (in which growth is accelerated) and not acromegaly. Symptoms include coarsening of the facial features, enlargement of the hands, feet, ears, and nose, jutting of the jaw, and a long face.

Dwarfism, pituitary—Short stature. When caused by inadequate amounts of growth hormone (as opposed to late growth spurt or genetics), hGH deficiency results in abnormally slow growth and short stature with normal proportions.

Gigantism—Excessive growth, especially in height, resulting from overproduction during childhood or adolescence of growth hormone by a pituitary tumor. Untreated, the tumor eventually destroys the pituitary gland, resulting in death during early adulthood. If the tumor develops after growth has stopped, the result is acromegaly, not gigantism.

Pituitary gland—The pituitary is the most important of the endocrine glands (glands that release hormones directly into the bloodstream). Sometimes referred to as the "master gland," the pituitary regulates and controls the activities of other endocrine glands and many body processes.

Somatotropin:

- men: 5 ng/mL
- women: less than 10 ng/mL
- children: 0–10 ng/mL
- newborn: 10–40 ng/mL

Somatomedin C:

- adult: 42–110 ng/mL
- Child:
- 0–8 years: Girls 7–110 ng/ml; Boys 4–87 ng/mL
- 9–10 years: Girls 39–186 ng/ml; Boys 26–98 ng/mL
- 11–13 years: Girls 66–215 ng/ml; Boys 44–207 ng/mL
- 14–16 years: Girls 96–256 ng/ml; Boys 48 255 ng/mL

Growth hormone stimulation: greater than 10 ng/mL.

Growth hormone suppression: Normally, glucose suppresses hGH to levels of undetectable to 3 ng/mL in 30 minutes to two hours. In children, rebound stimulation may occur after two to five hours.

Abnormal results

Somatotropin hormone: Excess hGH is responsible for the syndromes of gigantism and acromegaly. Excess secretion is stimulated by **anorexia nervosa**, stress, hypoglycemia, and exercise. Decreased levels are seen in hGH deficiency, dwarfism, hyperglycemia, **failure to thrive**, and delayed sexual maturity.

Somatomedin C: Increased levels contribute to the syndromes of gigantism and acromegaly. Stress, major surgery, hypoglycemia, **starvation**, and exercise stimulate hGH secretion, which in turn stimulates somatomedin C.

Growth hormone stimulation: Decreased levels are seen in pituitary deficiency and hGH deficiency. Diseases of the pituitary can result in failure of the pituitary to secrete hGH and/or all the pituitary hormones. As a result, the hGH stimulation test will fail to stimulate hGH secretion.

Growth hormone suppression: The acromegaly syndrome elevates base hGH levels to 75 ng/mL, which in turn are not suppressed to less than 5 ng/mL during the test. Excess hGH secretion may cause unchanged or rising hGH levels in response to glucose loading, confirming a diagnosis of acromegaly or gigantism. In such cases, verification of results is required by repeating the test after a one-day rest.

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Guaifenesin *see* **Expectorants**

Guided imagery

Definition

Guided imagery is the use of relaxation and mental visualization to improve mood and/or physical well-being.

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Purpose

The connection between the mind and physical health has been well documented and extensively studied. Positive mental imagery can promote relaxation and reduce **stress**, improve mood, control high blood pressure, alleviate **pain**, boost the immune system, and lower cholesterol and blood sugar levels. Through guided imagery techniques, patients can learn to control functions normally controlled by the autonomic nervous system, such as heart rate, blood pressure, respiratory rate, and body temperature.

One of the biggest benefits of using guided imagery as a therapeutic tool is its availability. Imagery can be used virtually anywhere, anytime. It is also an equal opportunity therapy. Although some initial training in the technique may be required, guided imagery is accessible to virtually everyone regardless of economic status, education, or geographical location.

Guided imagery also gives individuals a sense of empowerment, or control. The technique is induced by a therapist who guides the patient. The resulting mental imagery used is solely a product of the individual's imagination. Some individuals have difficulty imagining. They may not get actual clear images but perhaps vague feelings about the guided journey. However these individuals' brains and nervous systems responses seem to be the same as those with more detailed imaginings.

Patients who feel uncomfortable "opening up" in a traditional therapist-patient session may feel more at ease with a self-directed therapy like guided imagery.

Description

Guided imagery is simply the use of one's imagination to promote mental and physical health. It can be self-directed, where the individual puts himself into a relaxed state and creates his own images, or directed by others. When directed by others, an individual listens to a therapist, video, or audiotaped exercise that leads him through a relaxation and imagery exercise. Some therapists also use guided imagery in group settings.

Guided imagery is a two-part process. The first component involves reaching a state of deep relaxation through breathing and muscle relaxation techniques. During the relaxation phase, the person closes her eyes and focuses on the slow, in and out sensation of breathing. Or, she might focus on releasing the feelings of tension from her muscles, starting with the toes and working up to the top of the head. Relaxation tapes often feature soft music or tranquil, natural sounds such as rolling waves and chirping birds in order to promote feelings of relaxation.

Once complete relaxation is achieved, the second component of the exercise is the imagery, or visualization, itself. There are a number of different types of guided imagery techniques, limited only by the imagination. Some commonly used types include relaxation imagery, healing imagery, pain control imagery, and mental rehearsal.

Relaxation imagery

Relaxation imagery involves conjuring up pleasant, relaxing images that rest the mind and body. These may be experiences that have already happened, or new situations.

Healing imagery

Patients coping with diseases and injuries can imagine **cancer** cells dying, **wounds** healing, and the body mending itself. Or, patients may picture themselves healthy, happy, and symptom-free. Another healing imagery technique is based on the idea of *qi*, or energy flow, an idea borrowed from **traditional Chinese medicine**. Chinese medicine practitioners believe that illness is the result of a blockage or slowing of energy flow in the body. Individuals may use guided imagery to imagine energy moving freely throughout the body as a metaphor for good health.

Pain control imagery

Individuals can control pain through several imagery techniques. One method is to produce a mental image of the pain and then transform that image into something less frightening and more manageable. Another is to imagine the pain disappearing, and the patient as completely pain-free. Or, one may imagine the pain as something over which he has complete control. For example, patients with back problems may imagine their pain as a high voltage electric current surging through their spine. As they use guided imagery techniques, they can picture themselves reaching for an electrical switch and turning down the power on the current to alleviate the pain.

Mental rehearsal

Mental rehearsal involves imagining a situation or scenario and its ideal outcome. It can be used to reduce **anxiety** about an upcoming situation, such as labor and delivery, surgery, or even a critical life event such as an important competition or a job interview. Individuals picture themselves going through each step of the anxiety-producing event and then successfully completing it.

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KEY TERMS

Aromatherapy—The therapeutic use of plant-derived, aromatic essential oils to promote physical and psychological well-being.

Autonomic nervous system—The part of the nervous system that controls so-called involuntary functions such as heart rate, salivary gland secretion, respiratory function, and pupil dilation.

Preparations

For a successful guided imagery session, individuals should select a quiet, relaxing location where there is a comfortable place to sit or recline. If the guided imagery session is to be prompted with an audiotape or videotape, a stereo, VCR, or portable tape player should be available. Some people find that quiet background music improves their imagery sessions.

The session, which can last anywhere from a few minutes to an hour, should be uninterrupted. Taking the phone off the hook and asking family members for solitude can ensure a more successful and relaxing session.

Imagery combined with other relaxation techniques such as **yoga**, massage, or **aromatherapy** can greatly enhance the effects of these therapies. It can be done virtually anywhere.

Precautions

Because of the state of extreme relaxation involved in guided imagery, individuals should never attempt to use guided imagery while driving or operating heavy machinery.

Side effects

Guided imagery can induce sleepiness, and some individuals may fall asleep during a session. Other than this, there are no known adverse side effects to guided imagery.

Research and general acceptance

Use of guided imagery is a widely accepted practice among mental healthcare providers and is gaining acceptance as a powerful pain control tool across a number of medical disciplines. Results of a study conducted at The Cleveland Clinic Foundation and published in 1999 found that cardiac surgery patients who used a guided imagery tape prior to surgery experienced less pain and anxiety. These patients also left the hospital earlier following surgery than patients who used pain medication only.

Another study conducted by Harvard Medical School researchers found that for more than 200 patients undergoing invasive vascular or renal surgery, guided imagery controlled pain and anxiety more effectively than medication alone.

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ORGANIZATIONS

The Academy for Guided Imagery, 30765 Pacific Coast Highway, Suite 359, Malibu, CA, 90265, (800) 727-2070, (800) 726-2070, info@acadgi.com, http://www.academyforguidedimagery.com.

Paula Anne Ford-Martin

Guillain-Barré syndrome

Definition

Guillain-Barré syndrome (GBS), also called acute idiopathic polyneuritis, acute inflammatory polyneuropathy, infectious polyneuritis, and Landry-Guillain-Barré syndrome, causes progressive muscle weakness and **paralysis**, which develops over days or up to four weeks and lasts several weeks to several months.

Demographics

Guillain-Barré syndrome is found worldwide in all races. It is a rare disorder. In the United States, there are about 3 cases per 100,000 population. Risk increases with age, with infant at least risk, young adults accounting for about 1.5 cases per 100,000 population, and people over age 70 for 8.6 cases per 100,000 population.

Description

Guillain-Barré syndrome is a disorder characterized by progressive symmetrical paralysis and loss of reflexes, usually beginning in the legs. The paralysis characteristically involves more than one limb, is

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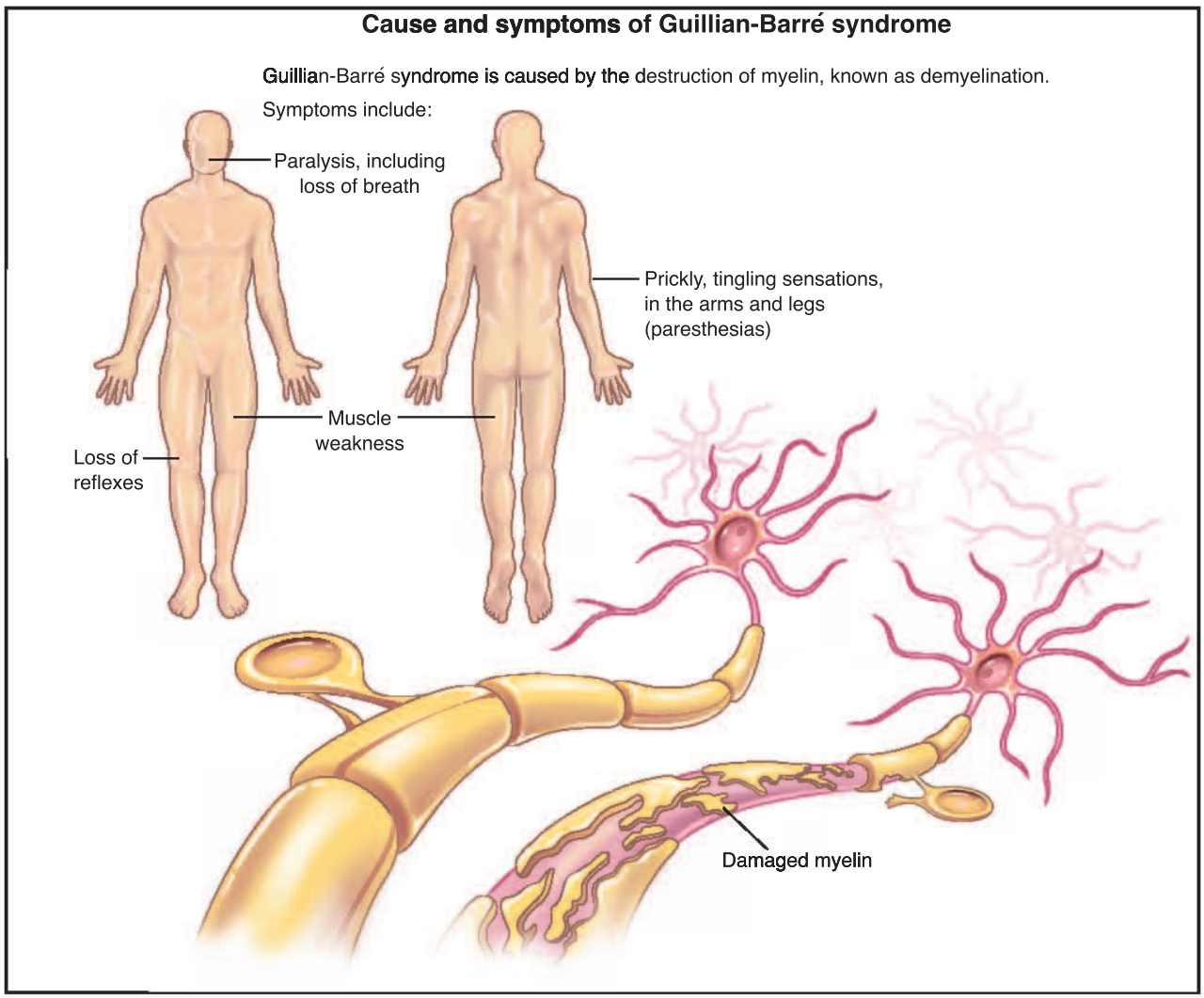

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progressive, and usually proceeds from the end of an extremity toward the torso. The classic scenario in GBS involves a patient who has just recovered from a typical, seemingly uncomplicated viral infection. Symptoms of muscle weakness appear one to four weeks later. The most common preceding infections are cytomegalovirus, herpes, **Epstein-Barr virus**, and viral hepatitis. A gastrointestinal infection with the bacteria *Campylobacter jejuni* is also common and may cause a severe type of GBS from which it is particularly difficult to recover. About 5% of GBS patients have a surgical procedure as a preceding event. GBS appears to be an autoimmune disorder, apparently caused by a misdirected immune response that results in the direct destruction of the myelin sheath surrounding the peripheral nerves or of the axon of the nerve itself.

Patients with lymphoma, **systemic lupus erythematosus**, or **AIDS** have a higher than normal risk of GBS. Other GBS patients have recently received an immunization, while still others have no known preceding event. In 1976–77, there was a vastly increased number of GBS cases among people who had been recently vaccinated against the Swine flu. The reason for this phenomenon has never been identified, and no other flu vaccine has caused such an increase in GBS cases.

Causes and symptoms

The cause of the weakness and paralysis of GBS is the loss of myelin, which is the material that coats nerve cells. (The loss of myelin is called demyelination.) Myelin is an insulating substance that is wrapped around all nerves in the body. Its function is to speed conduction

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KEY TERMS

Autoimmune disorder—A disorder in which the body's immune system produces antibodies that attack its own healthy tissues or blood components.

Demyelination—Disruption or destruction of the myelin sheath, leaving a bare nerve. Results in a slowing or stopping of impulses traveling along that nerve.

Idiopathic—Of unknown origin; without a known cause.

Inflammation—The body's response to tissue damage. Includes warmth, swelling, redness, and pain in the affected part.

Myelin—The substance that is wrapped around nerves. Myelin is responsible for speed and efficiency of impulses traveling through those nerves. When the myelin sheath is damaged, nerve communication is disrupted.

Peripheral nervous system—Nerves that are not part of the brain of spinal cord.

Systemic lupus erythematosus (SLE)—A chronic, inflammatory, autoimmune disorder in which the individual's immune system attacks, injures, and destroys the body's own organs and tissues. It may affect many organ systems including the skin, joints, lungs, heart, and kidneys.

of nerve impulses. Without myelin, nerve conduction slows or stops. GBS has a short, severe course. It causes inflammation and destruction of the myelin sheath, and it disturbs multiple nerves. Therefore, it is considered an acute inflammatory demyelinating polyneuropathy.

The reason for the destruction of myelin in GBS is not completely understood, although it is thought that the underlying problem is autoimmune in nature and is triggered in most cases by infection. An autoimmune disorder is one in which the body's immune system, trained to fight against such foreign invaders as viruses and bacteria, somehow becomes improperly programmed. The immune system becomes confused and is not able to distinguish between foreign invaders and the body itself. Elements of the immune system are unleashed against areas of the body, resulting in damage and destruction. For some reason, in the case of GBS, the myelin sheath appears to become a target for the body's own immune system.

The first symptoms of GBS consist of muscle weakness (legs first, then arms, then face), accompanied by prickly, **tingling** sensations (paresthesias). Symptoms affect both sides of the body simultaneously, a characteristic that helps distinguish GBS from other causes of weakness and paresthesias. Normal reflexes are first diminished, then lost. The weakness eventually affects all the voluntary muscles, resulting in paralysis. When those muscles necessary for breathing become paralyzed, the patient must be placed on a mechanical ventilator, which takes over the function of breathing. This occurs about 30% of the time. Very severely ill GBS patients may have complications stemming from other nervous system abnormalities that can result in problems with fluid balance in the body, severely fluctuating blood pressure, and heart rhythm irregularities.

Diagnosis

Diagnosis of GBS is made by looking for a particular cluster of symptoms (progressively worse muscle weakness and then paralysis), and by analyzing the cerebrospinal fluid (CSF) that bathes the brain and spinal canal. This fluid is obtained by a **lumbar puncture**, which consists of inserting a needle into the lower back (lumbar region) and withdrawing a small amount of CSF. When examined in a laboratory, the CSF of a person with GBS will reveal a greater-than-normal quantity of protein, normal numbers of white blood cells, and a normal amount of sugar. Electrodiagnostic studies may show slowing or block of conduction in nerve endings in parts of the body other than the brain. Minor abnormalities will be present in 90% of patients.

Treatment

There is no direct treatment for GBS. Instead, treatments are used that support the patient with the disabilities caused by the disease. The progress of paralysis must be carefully monitored, in order to provide mechanical assistance for breathing if it becomes necessary. Careful attention must also be paid to the amount of fluid the patient is taking in by drinking and eliminating by urinating. Blood pressure, heart rate, and heart rhythm also must be monitored.

A procedure called **plasmapheresis**, performed early in the course of GBS, has been shown to shorten the course and severity of GBS. Plasmapheresis consists of withdrawing the patient's blood, passing it through

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an instrument that separates the different types of blood cells, and returning all the cellular components (red and white blood cells and platelets) along with either donor plasma or a manufactured replacement solution. This is thought to rid the blood of the substances that are attacking the patient's myelin.

It has also been shown that the use of high doses of immunoglobulin given intravenously (by drip through a needle in a vein) may be just as helpful as plasmapheresis. Immunoglobulin is a substance naturally manufactured by the body's immune system in response to various threats. It is interesting to note that corticosteroid drugs (such as prednisone), often the mainstay of anti-autoimmune disease treatment, are not only unhelpful, but may in fact be harmful to patients with GBS.

Physical therapy and **occupational therapy** may be used to help restore function as the patient begins to recover.

Prognosis

About 85% of GBS patients make reasonably good recoveries. However, 30% of adult patients, and a greater percentage of children, never fully regain their previous level of muscle strength. Some of these patients suffer from residual weakness, others from permanent paralysis. About 10% of GBS patients begin to improve, then experience a relapse; these patients suffer chronic GBS symptoms. Between 2% and 12% of all GBS patients die from complications of the disorder, with patients over age 60 most at risk for **death**. Cause of death most often is either from cardiac rhythm disturbances or from ventilator-related complications such as **pneumonia**.

Patients with certain characteristics tend to have a worse outcome. These include people of older age, those who required breathing support with a mechanical ventilator, and those who had their worst symptoms within the first seven days.

Prevention

Because so little is known about what causes GBS to develop, there are no known methods of prevention.

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ORGANIZATIONS

American Autoimmune Diseases Association, 22100 Gratiot Avenue, East Detroit, MI, 48021, (586) 776-3900, (800) 598-4668, (586) 776-3903, http://www.aarda.org.

GBS/CIDP Foundation International, 04 1/2 Forrest Avenue, NarberthPA, USA, 19079, (610) 667-0131, (866) 224-3301, (610) 667-7036, http://gbs-cidp.org.

National Institute of Neurological Disorders and Stroke (NINDS), P.O. Box 5801, Bethesda, MD, 20828, (301) 496-5751. TTY: (301) 468-5981, (800) 352-9424, http://www.ninds.nih.gov.

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Guinea worm infection

Definition

Infection occurs when the parasitic guinea worm resides within the body. Infection is not apparent until a pregnant female worm prepares to expel embryos. The infection is rarely fatal, but the latter stage is painful. The infection is also referred to as dracunculiasis, and less commonly as dracontiasis.

Description

Before the early 1980s, guinea worms infected 10–15 million people annually in central Africa and parts of Asia. By 1996, worldwide incidence of infection fell to fewer than 153,000 cases per year. Complete eradication of guinea worm infection is a goal of international water safety programs.

To survive, guinea worms require three things: water during the embryo stage, an intermediate host during early maturation, and a human host during adulthood. In bodies of water, such as ponds, guinea worm embryos are eaten by tiny, lobster-like water fleas. Once ingested, the embryos mature into larvae.

Humans become hosts by consuming water containing infected water fleas. Once in the human intestine, larvae burrow into surrounding tissue. After three to

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KEY TERMS

Guinea worm embryo—The guinea worm at its earliest life stage prior to or shortly after being expelled from an adult female worm.

Guinea worm larvae—The guinea worm during its middle life stage as it matures within a water flea. The larvae can only grow to adulthood within a human host.

Host—With regard to guinea worm infection, either the water flea or human from which the worm gets nourishment and shelter as it matures.

Secondary infection—An illness–typically caused by bacteria–that follows from a guinea worm infection.

four, the worms mate. Males die soon after, but pregnant females continue to grow. As adults, each thread-like worm can be three feet long and harbor three million embryos. More than one guinea worm can infect a person at the same time.

About eight months later, the female prepares to expel mature embryos by migrating toward the skin surface. Until this point, most people are unaware that they are infected. Extreme **pain** occurs as the worm emerges from under the skin, often around the infected person's ankle. The pain is temporarily relieved by immersing the area in water, an act that contaminates the water and starts the cycle again.

Causes and symptoms

Dracunculus medinensis, or guinea worm, causes infection. Symptoms are commonly absent until a pregnant worm prepares to expel embryos. By secreting an irritating chemical, the worm causes a blister to form on the skin surface. This chemical also causes **nausea**, **vomiting**, **dizziness**, and **diarrhea**. The blister is accompanied by a burning, stabbing pain and can form anywhere on the body; but, the usual site is the lower leg or foot. Once the blister breaks, an open sore remains until the worm has expelled all the embryos.

Diagnosis

Guinea worm infection is identified by the symptoms.

Treatment

Most people infected with guinea worm rely on traditional medicine. The worm is extracted by gently and gradually pulling the worm out and winding it around a small strip of wood. Surgical removal is possible, but rarely done in rural areas. Extraction is complemented by herbs and oils to treat the wound site. Such treatment can ease extraction and may help prevent secondary infections.

Modern medicine offers safe surgical removal of the guinea worm, and drug therapy can prevent infection and pain. Using drugs to combat the worms has had mixed results.

Prognosis

If the worm is completely removed, the wound heals in approximately two to four weeks. However, if a worm emerges from a sensitive area, such as the sole of a foot, or if several worms are involved, healing requires more time. Recovery is also complicated if the worm breaks during extraction. Serious secondary infections frequently occur in such situations. There is the risk of permanent disability in some cases, and having one guinea worm infection does not confer immunity against future infections.

Prevention

Guinea worm infection is prevented by disrupting transmission. Wells and other protected water sources are usually safe from being contaminated with worm embryos. In open water sources, poisons may be used to kill water fleas. Otherwise, water must be boiled or filtered.

Resources

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Julia Barrett

Gulf War syndrome

Definition

Gulf War syndrome describes a wide spectrum of illnesses and symptoms ranging from **asthma** to **sexual dysfunction** that have been reported by U.S. and U.S. allied soldiers who served in the Persian Gulf War in 1990–1991.

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Description

Between 1994 and 1999, 145 federally funded research studies on Gulf War-related illnesses were undertaken at a cost of over $133 million. Despite this investment and the data collected from over 100,000 veterans who have registered with the Department of Defense (DOD) and/or Veterans Administration (VA) as having Gulf War-related illnesses, there is still much debate over the origin and nature of Gulf War syndrome. A 2006 study for the U.S. Department of Veterans Affairs concluded Gulf War Syndrome does not constitute a single illness and as of 2007, the DOD has failed to establish a definite cause for the disorder. Veterans who have the illness experience a wide range of debilitating symptoms that elude a single diagnosis. Common symptoms include **fatigue**, trouble breathing, headaches, disturbed sleep, **memory loss**, and lack of concentration. Similar experiences among Gulf War veterans have been reported in the United Kingdom and Canada.

Causes and symptoms

There is much current debate over a possible causative agent for Gulf War syndrome other than the **stress** of warfare. Intensive efforts by the Veterans Administration and other public and private institutions have investigated a wide range of potential factors. These include chemical and biological weapons, the immunizations and preventive treatments used to protect against them, smoke from oil well fires, exposure to depleted uranium, and diseases endemic to the Arabian peninsula. So far investigators have not approached a consensus. In its final report released in December 2000, the Presidential Special Oversight Board for Department of Defense Investigations of Gulf War Chemical and Biological Incidents cited combat stress as a possible causative factor, but called for further research. There is also a likelihood that U.S. and allied forces were exposed to low levels of sarin and/or cyclosarin (nerve gases) released during the destruction of Iraqi munitions at Kharnisiyah, Iraq, and that these chemicals might be linked to the syndrome. In July 1997, the VA informed approximately 100,000 U.S. servicemen of their possible exposure to the nerve agents.

In October 1999, the U.S. Pentagon released a report that hypothesized that an experimental drug known as pyriostigmine bromide (PB) might be linked to the physical symptoms manifested in Gulf War Syndrome. The experimental drug was given to U.S. and Canadian troops during the war to protect soldiers against the effects of the chemical nerve agent soman. It has also been suggested that botulinum toxoid and **anthrax** vaccinations administered to soldiers during the conflict may be responsible for some manifestations of the syndrome.

Some studies have shown that Gulf War veterans have a higher incidence of positive tests for *Mycoplasma fermentans*, a bacteria, in their bloodstream. However, other clinical studies have not found a link between the bacterial infection and Gulf War-related illnesses.

Statistical analysis tells us that the following symptoms are about twice as likely to appear in Gulf War veterans than in their non-combat peers: depression, posttraumatic stress disorder (PTSD), chronic fatigue, cognitive dysfunction (diminished ability to calculate, order thoughts, evaluate, learn, and remember), **bronchitis**, asthma, fibromyalgia, alcohol **abuse**, **anxiety**, and sexual discomfort. PTSD is the modern equivalent of shell shock (World War I) and battle fatigue (World War II). It encompasses most of the psychological symptoms of war veterans, including nightmares, panic at sudden loud noises, and inability to adjust to peacetime living. **Chronic fatigue syndrome** has a specific medical definition that attempts to separate common fatigue from a more disabling illness in hope of finding a specific cause. Fibromyalgia is another newly defined syndrome, and as such it has arbitrarily rigid defining characteristics. These include a certain duration of illness, a specified minimum number of joint and muscle **pain** located in designated areas of the body, sleep disturbances, and other associated symptoms and signs.

Researchers have identified three distinct syndromes and several variations in Gulf War veterans. Type one patients suffer primarily from impaired thinking. Type two patients have a greater degree of confusion and ataxia (loss of coordination). Type three patients were the most affected by joint pains, muscle pains, and extremity paresthesias (unnatural sensations like burning or **tingling** in the arms and legs). In each of the three types, researchers found different but measurable impairments on objective testing of neurological function. The business of the nervous system is much more complex and subtle than other body functions. Measuring it requires equally complex effort. The tests used in this study carefully measured and compared localized nerve performance at several different tasks against the same values in normal subjects. Brain wave response to noise and touch, eye muscle response to spinning, and caloric testing (stimulation of the ear with warm and cold water, which causes vertigo) were clearly different between the normal and the test subjects. The researchers concluded that there was "a generalized injury to the

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KEY TERMS

Ataxia—Lack of coordination.

Caloric testing—Flushing warm and cold water into the ear stimulates the labyrinth and causes vertigo and nystagmus if all the nerve pathways are intact.

Endemic—Always there.

Paresthesia—An altered sensation often described as burning, tingling, or pin pricks.

Syndrome—Common features of a disease or features that appear together often enough to suggest they may represent a single, as yet unknown, disease entity. When a syndrome is first identified, an attempt is made to define it as strictly as possible, even to the exclusion of some cases, in order to separate out a pure enough sample to study. This process is most likely to identify a cause, a positive method of diagnosis, and a treatment. Later on, less typical cases can be considered.

nervous system." Another research group concluded their study by stating that there was "a spectrum of neurologic injury involving the central, peripheral, and autonomic nervous systems."

Diagnosis

Until there is a clear definition of the disease, diagnosis is primarily an exercise in identifying those Gulf War veterans who have undefined illness in an effort to learn more about them and their symptoms. Both the Department of Defense and the Veterans Administration currently have programs devoted to this problem. Both the DOD's Comprehensive Clinical Evaluation Program and the VA's Persian Gulf Registry provide free, in-depth medical evaluations to Gulf War veterans and their families. In addition to providing individual veterans with critical medical care, these organizations use the cumulative data from these programs to advance research on Gulf War Syndrome itself.

Treatment

Specific treatment awaits specific diagnosis and identification of a causative agent. Meanwhile, veterans can benefit from the wide variety of supportive and non-specific approaches to this and similar problems. There are many drugs available for symptomatic relief. Psychological counseling by those specializing in this area can be immensely beneficial, even life-saving for those contemplating **suicide**. Veterans' benefits are available for those who are impaired by their symptoms.

Alternative treatment

The symptoms can be worked with using many modalities of alternative health care. The key to working successfully with people living their lives with Gulf War syndrome is long-term, ongoing care, whether it be **hypnotherapy**, **acupuncture**, homeopathy, **nutrition**, vitamin/mineral therapy, or bodywork.

Experimental treatment with **antibiotics** is advocated by some healthcare professionals who believe that Gulf War illness is related to a *Mycoplasma fermentans* bacterial infection. However, a conclusive link has not been clinically proven.

Prognosis

The outlook for Persian Gulf War veterans is unclear, but will hopefully improve as more information is gathered about the illness. Gradual return to a functioning life may take many years of work and much help. It is important to note that even in the absence of an identifiable and curable cause, recovery is possible.

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Office of the Special Assistant for Gulf War Illnesses, Force Health Protection & Readiness Policy & Programs Four Skyline Place, 5113 Leesburg Pike, Suite 901, Falls Church, VA, 22041, (800) 497-6261, http://www.gulflink.osd.mil.

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The American Legion, 700 North Pennsylvania St., Indianapolis, IN, 46206, (800) 433-3318, http://www.legion.org.

Veterans Administration. Persian Gulf Medical Information Helpline, 400 South 18th Street, St. Louis, MO, 63103-2271, http://www.publichealth.va.gov/exposures/gulfwar.

Paula Anne Ford-Martin
Ken R. Wells

Gum disease *see* **Periodontal disease**
Günther's disease *see* **Porphyrias**

Gynecomastia (male breast enlargement)

Definition

Gynecomastia is a benign (noncancerous) condition caused by the development of unusually large mammary glands in the male resulting in enlargement of the male breast. The English word comes from two Greek words meaning "woman" and "breast." Enlargement of the male breast caused solely by deposits of fat associated with **obesity** is called pseudogynecomastia or lipomastia.

Demographics

Gynecomastia by definition is a condition found only in males. It occurs in three different age groups: infants, adolescents, and older men. Between 60% and 90% of male infants have temporary gynecomastia resulting from exposure to the mother's high estrogen levels during **pregnancy**. Various studies report the rate of gynecomastia in male adolescents as being between four and 69%.

In older men, the rate of gynecomastia is between 24% and 65%. The condition is thought to be equally common in all races and ethnic groups.

Description

The enlargement of the male breast that characterizes gynecomastia is caused by the growth of glandular tissue directly under the areola (the pigmented skin surrounding the nipple), usually in a symmetrical fashion just below the nipple. In most cases the extra glandular tissue is less than two inches across. In older men there may be extra fibrous tissue accumulating below the areola along with the increased growth of glandular tissue. Mild gynecomastia may take the form of puffy nipples, while severe gynecomastia—particularly in older men— may take the form of large sagging breasts, often referred to informally as "man boobs." The enlarged lump of glandular tissue under the nipple typically feels rubbery in texture.

In most cases the swelling of the breast is bilateral (affects both breasts) but it may also be unilateral, occurring in only one breast. In some cases the gynecomastia affects both breasts but not to the same extent, so that one is noticeably larger than the other.

Doctors divide gynecomastia into two major categories: physiologic and pathologic. Physiologic gynecomastia is caused by an imbalance in the amounts of estrogen and androgen in the man's body in favor of estrogen. Although estrogen is usually thought of as a female sex hormone, men's bodies also produce small amounts of it. Normally, the male body produces much more testosterone, a male sex hormone, than estrogen; the usual ratio is 100:1. But if the testosterone level in the male body is low for some reason or the estrogen level unusually high, gynecomastia can occur. In male infants, the imbalance between estrogen and testosterone results from exposure to the estrogen in the mother's circulation before birth; gynecomastia in infants typically goes away between two and three weeks after birth. In adolescent boys, the imbalance between the two sex hormones leads to gynecomastia lasting anywhere from six months to two or three years. Gynecomastia in older males typically results from a combination of causes: lowered levels of testosterone secretion; the conversion of some of the testosterone that is produced to estradiol, a female sex hormone; and the side effects of certain drugs that are frequently prescribed for older men.

Pathologic gynecomastia differs from physiologic gynecomastia in that it is associated with other diseases and disorders. These may include diseases that result in lowered testosterone production or increased estrogen production. Disorders associated with low testosterone production include genetic disorders like **Klinefelter syndrome** and Kallmann syndrome; trauma to or viral infection of the testicles; tumors of the pituitary gland; **hyperthyroidism**; kidney failure; malnutrition; or **small cell lung cancer**, gastric carcinoma, renal cell carcinoma, or kidney failure. Disorders associated with increased production of estrogen or increased conversion of testosterone to estradiol include cancers of the lung, kidney, and digestive tract; and chronic **liver disease**, malnutrition, hyperthyroidism, and tumors of the adrenal glands.

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KEY TERMS

Areola—The area of pigmented skin surrounding the human nipple in both males and females. It is roughly circular in shape.

Bilateral—Located on or affecting both sides of the body.

Hyperthyroidism—A condition in which the thyroid gland in the throat is overactive and produces too much thyroid hormone.

Idiopathic—Of unknown cause or spontaneous origin.

Kallmann syndrome—A rare genetic disorder in which the hypothalamus does not produce enough gonadotropin–releasing hormone, leading to underfunctioning of the testes in males and the ovaries in females.

Klinefelter syndrome—A genetic disorder in which a male has an extra X chromosome, making his genetic sex classification 47, XXY. About a third of males with Klinefelter syndrome develop gynecomastia.

Liposuction—A cosmetic surgery technique for removing unwanted fat cells from the abdomen, hips, thighs, or male breast while doing as little damage as possible to nearby connective tissue and blood vessels.

Pseudogynecomastia—Enlargement of the male breast caused solely by fat accumulation. It is also called lipomastia.

Unilateral—Located on or affecting only one side of the body.

Risk factors

Risk factors for gynecomastia include:

- Age. Infants, boys undergoing puberty, and men over 50 are at increased of gynecomastia.
- Family history of gynecomastia.
- Use of anabolic steroids or injected androgens to improve athletic performance.
- Diagnosis with Klinefelter syndrome, Kallmann syndrome, or other genetic disorders that affect the size of the testes or their ability to produce testosterone.
- Kidney disease, liver disease, or thyroid disease.
- Cancers that are hormonally active, including cancers of the kidneys, digestive tract, and lungs.
- Having to take prescription drugs that stimulate estrogen synthesis, lower testosterone production, or are otherwise known to cause gynecomastia as a side effect.

Causes and symptoms

Causes

As has been noted, gynecomastia can be caused by a number of conditions, ranging from normal shifts in hormone balance at certain points in the male life cycle to genetic conditions, medication side effects, and **cancer**. The causes for which males seek help with gynecomastia are as follows in order of frequency:

- Persistent (two years or longer) gynecomastia of puberty: 25%
- Drug–related gynecomastia: 10% to 25%
- Idiopathic (no detectable disease or disorder): 25%
- Cirrhosis of the liver or malnutrition: 8%
- Underdeveloped testicles: 8%
- Testicular tumors: 3%
- Hyperthyroidism: 1.5%
- Kidney disease: 1%

Symptoms

The symptoms of gynecomastia are visible enlargement of the breast. Most boys and men will also feel some **pain** or tenderness around the areola. A discharge from the nipple is not normal with gynecomastia, however, and may indicate **breast cancer**, as one percent of all cancers of the breast occur in males.

Diagnosis

A formal diagnosis is not usually necessary for male infants as the condition is temporary in infancy and does not require treatment.

In adolescent boys and older men, diagnosis is based on a combination of patient and family history, an office examination, imaging studies, and a blood test. In terms of patient history, the doctor will ask the patient's age at the time the gynecomastia first appeared, how long it has been present, whether the patient is using **steroids**, whether the patient is consuming alcohol or drugs of **abuse**, what prescription medications the patient is taking, and whether there is a family history of gynecomastia.

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Examination

The office examination is intended to check for abnormally small testicles, testicular tumors, and other abnormalities of the male genitals, and to distinguish between gynecomastia and pseudogynecomastia. To tell whether the breast is enlarged by glandular tissue or only by fat, the doctor will ask the patient to lie flat on the examination table with arms raised above the head. The doctor will then place his or her thumbs on either side of the nipple and slowly bring the thumbs together. If the patient has gynecomastia, the doctor will feel a ridge of glandular tissue. If only fat is present, no such ridge will be felt.

The doctor will also check to see whether there is any discharge from the patient's nipple, and for signs of thyroid, kidney, or liver disease.

Tests

The tests most commonly performed are a mammogram and a blood test to check for abnormalities in thyroid, liver, or kidney function. If the doctor suspects an underlying cancer, the patient may also be given an MRI, ultrasound of the testicles, a chest x ray, or a tissue biopsy.

Treatment

Treatment for gynecomastia ranges from none at all to drugs or surgery. Adolescents may also be referred to **psychotherapy** to help them cope with the social embarrassment caused by the disorder and their psychological reactions to it.

Traditional

Gynecomastia by itself is not a danger to health, although its underlying cause may require treatment. In many cases, treatment of that cause relieves the gynecomastia as well. In the case of adolescents, most doctors recommend simple observation of the condition (a checkup every three to six months), as it usually goes away by itself in two to three years. If the adolescent is having significant pain in the enlarged breasts, if the condition persists beyond three years, or if the teenager is having serious psychological problems related to the gynecomastia, the doctor may recommend breast surgery. Surgical treatment may consist either of **mastectomy** (surgical removal of the glandular tissue in the breast) or **liposuction** (removal of the fat surrounding the glandular tissue while leaving the glandular tissue intact).

Pseudogynecomastia can be helped somewhat by encouraging the patient to lose weight; however, it is not possible as of 2010 to target a specific area of the body for fat loss, and the patient may still have larger breasts than he would like. Liposuction can also be used successfully to treat pseudogynecomastia.

Drugs

Some older men can be treated with tamoxifen or raloxifene, drugs used to treat breast cancer in women; between 70% and 80% report complete reduction of the gynecomastia after taking these drugs. In addition, men whose gynecomastia is caused by prescription medications for other conditions may be helped by having their doctor switch them to another drug. Drugs known to cause gynecomastia as a side effect include methyldopa, busulfan, tricyclic antidepressants, diazepam, penicillamine, omeprazole, phenothiazines, calcium channel blockers, angiotensin–converting enzyme (ACE) inhibitors, ketoconazole, metronidazole, alkylating agents, cisplatin, spironolactone, cimetidine, flutamide, **finasteride**, and etomidate.

Patients abusing alcohol, heroin, or **marijuana** may be helped by stopping their use of these substances, as all three are known to cause gynecomastia.

Prognosis

In 90% of cases, gynecomastia will eventually go away by itself. For those patients with persistent gynecomastia, drug therapy or **plastic surgery** will usually relieve the condition. Men with Klinefelter syndrome, however, have a 10– to 20–fold increased risk of breast cancer, and should be checked for any abnormalities in their breasts during every routine office physical.

Prevention

There is no known way to prevent gynecomastia in male infants as of 2010, whether physiologic or pathologic. Male adolescents can lower their risk of gynecomastia by avoiding steroids for muscle building, illicit drugs, and heavy alcohol consumption. Older men should ask their doctor whether any of the medications currently prescribed for them are known to cause gynecomastia, and if so, whether other drugs can be substituted.

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American Academy of Child and Adolescent Psychiatry (AACAP), 3615 Wisconsin Avenue, NW, Washington, DC, 20016–3007, (202) 966-7300, (202) 966-2891, http://www.aacap.org.

American Association of Clinical Endocrinologists (AACE), 245 Riverside Ave., Suite 200, Jacksonville, FL, 32202, (904) 353-7878, http://www.aace.com/college.

American Society of Plastic Surgeons (ASPS), 444 East Algonquin Rd., Arlington Heights, IL, 60005, (847) 228-9900, http://www.plasticsurgery.org.

National Adolescent Health Information Center (NAHIC), LHTS Suite 245, Box 0503, San Francisco, CA, 94143, (415) 502-4856, (415) 502-4858, nahic@ucsf.edu, http://nahic.ucsf.edu.

Society for Adolescent Health and Medicine (SAHM), 111 Deer Lake Rd., Suite 100, Deerfield, IL, 60015, (847) 753-5226, (847) 480-9282, info@adolescenthealth.org, http://www.adolescenthealth.org/AM/Template.cfm?Section = Home.

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H

H1N1 influenza

Definition

Pandemic 2009 H1N1 **influenza**, initially termed a swine flu, is an infectious respiratory disease caused by a subtype of the influenza A virus first identified in April 2009. The virus and associated influenza spread rapidly around the globe, and on June 11, 2009, World Health Organization (WHO) officials declared H1N1 influenza to be a global pandemic, the first new pandemic of the twenty-first century. According to the Centers for Disease Control (CDC), the U.S. Public Health Emergency for 2009 H1N1 Influenza expired on June 23, 2010.

Demographics

As of July 2009, the World Health Organization (WHO) offices reported more than 94,000 laboratory-confirmed cases of 2009 H1N1 influenza in 135 countries. At least 700 deaths were already attributed to the novel virus, and WHO officials characterized the 2009 H1N1 flu as the fastest spreading pandemic on record.

Despite high initial estimates, by June 24, 2009, Mexico had reported 7,847 confirmed cases and 115 laboratory-confirmed deaths. The United States reported 21,449 confirmed cases and 87 deaths, and Canada reported 6,457 cases and 15 deaths. Deaths were also reported in Colombia Costa Rica, Dominican Republic, Guatemala, the Philippines, and the United Kingdom. The spread of the virus into the Southern Hemisphere was evidenced by Australia's reporting of 2,857 cases including 2 deaths, Argentina's reporting of 1,213 cases including 7 deaths, and Chile's reporting 4,315 cases including 4 deaths. As with all reports related to a developing outbreak, daily reports of cases and deaths are simply considered by experts to be a snapshot of data; both the number of countries reporting and cases confirmed will increase until the pandemic subsides. In July 2009, with the pandemic well established in both the Northern and Southern Hemispheres, WHO officials stopped accumulating individual case counts in favor of concentrating on pandemic flu mitigation strategies such as vaccine and anti-viral medication development and delivery. Especially in developing countries with established outbreaks, data would be difficult to collect and prone to error. Counting individual cases is also difficult because many are mild and go unreported.

Newswires are often filled with unverified reports, and even the time difference between offices reporting laboratory-confirmed results can seemingly swing figures rapidly. In addition, there is often a delay or backlog in such reporting. Uncertainties in the number of cases and confirmed deaths create a degree of uncertainty in assessments of the lethality of the virus and course of the outbreak. As of August 2009, there was no evidence that the H1N1 pandemic would be more lethal on a case-by-case basis than a typical seasonal flu. However, pandemic flu viruses often cause significant global deaths because so many more people are infected than in normal influenza seasons.

Common seasonal influenza (the type for which vaccinations are offered each year) normally accounts for about 200,000 hospitalizations and 36,000 deaths annually in the United States. Globally, WHO officials estimate that between 300,000 and 500,000 people die from flu complications each year. Although people of all ages can contract influenza, young children and the elderly, along with those with compromised immune systems (e.g., **cancer** patients or those with HIV/AIDS) are most at risk during a normal seasonal flu. Most deaths are caused by **pneumonia**, a common complication of seasonal flu. During the initial outbreak of 2009 H1N1 flu in Mexico, reports indicated that otherwise healthy adults aged 20 to 44 years were dying of the disease in higher than expected numbers. By the end of July 2009, in the United States, approximately 50 percent of the reported cases of pandemic H1N1 flu occurred in young people from 5 to 24 years old, and the highest rate

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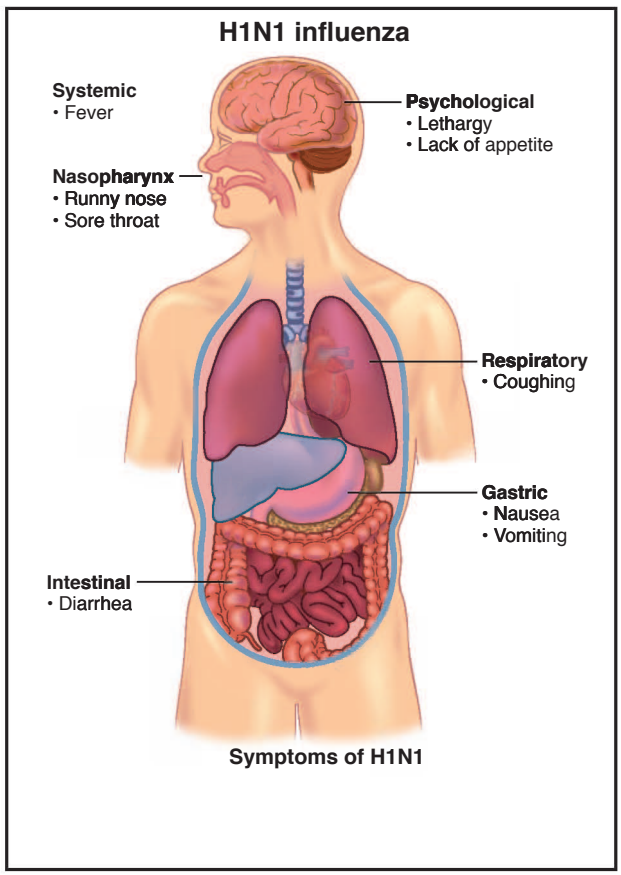

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of hospitalization was among infants and young children under four years of age. Although there is no definitive cause, the pattern of illness differs from normal seasonal flu, which usually results in a greater number of cases in the elderly. A report published in the medical journal *The Lancet* showed that early in the pandemic, pregnant women were four times as likely as other people who contract swine flu to require hospitalization. The physiological reasons remain under study.

Description

In April 2009, scientists at the U.S. Centers for Disease Control and Prevention (CDC) and at a research laboratory in Winnipeg, Canada, confirmed that a new strain of influenza was causing illness in humans. Genetic analysis showed that although the H1N1 virus is a novel genetic reassortment of genes of swine, human, and avian origin, the majority of the H1N1 genome is traceable and comparable to other viruses that cause seasonal influenza.

It remains a subject of intense research as to when and where the 2009 H1N1 flu virus may have entered the human population. Although the first cases erupted in Mexico and the United States in March and April 2009, this does not mean that the genetic reassortment of the virus took place in Mexico or the United States, or that the virus entered the human population in either country.

The 2009 H1N1 influenza virus was initially classified as a swine flu because it contains swine flu genes. This means only that the virus passed through swine at some point in its evolution. When and where the virus passed through swine is a subject of continued investigation. Although probable, it is not a certainty that the virus was most recently transmitted from swine to humans. Based on preliminary genetic analysis, experts conjecture such a transfer might have taken place in late 2008. As of June 12, 2009, however, none of the cases encountered in the 2009 H1N1 flu outbreak could be definitively traced to contact with pigs. In fact, the first confirmed outbreak of H1N1 recorded in swine was on a Canadian farm. Experts strongly suspect that a human farm worker who had traveled from Mexico infected the swine.

H1N1 strains of influenza are common in pigs, and swine flu viruses can be transmitted from pigs to humans who are in close contact with infected animals. However, before the 2009 H1N1 outbreak, documented transmission of recent swine flu viruses from person to person was extremely limited and had not resulted in documented outbreaks of human disease.

What made health experts in 2009 so concerned about the new H1N1 virus was that it was a novel virus of unknown lethality that had gained the ability to efficiently pass from person to person (human transmission). Because 2009 H1N1 flu was new, humans had no immunity to it. As a result, the resources of the WHO, the CDC, state public health departments, and various international organizations charged with protecting public health were mobilized to attempt to mitigate a worldwide influenza pandemic.

Understanding the influenza virus

Viruses are simple organisms consisting of a protein matrix containing genetic information. They are so small that they can be seen only with an electron microscope. Because they are metabolically inert outside of a host cell, viruses cannot reproduce on their own. They are parasites and must enter a host cell and take over the host cell's resources in order to make millions of new virus particles.

Influenza is caused by a hardy group of viruses belonging to the Orthomyxoviridae family. There are three types of influenza viruses: types A, B, and C. Type A influenza virus is the most threatening to humans. The type B virus is stable, changing little from year to year, and

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can be effectively controlled through **vaccination**. Type C influenza viruses cause only mild illness in humans. The type A virus, however, easily changes, or mutates, into new strains or subtypes. Each strain contains slightly different genetic information. Because of this, no single vaccine is completely effective against all type A viruses, and whenever a new strain arises, as in the case of the 2009 H1N1, the body's immune system treats the virus as a completely new antigen.

How new strains develop

Humans are not the only animals vulnerable to influenza A infections. Different strains of influenza A cause disease in other animals, including wild birds, chickens, ducks, and turkeys (collectively called avian or bird flu), pigs, horses, ferrets, whales, seals, and dogs. Pigs and birds are the critical species in the development of new flu strains that can infect humans. Wild birds serve as a reservoir for the influenza A viruses; some strain of **avian flu** is always present in the world bird population. Birds shed live virus in their droppings (feces), and because many species of bird migrate long distances, they can infect large areas. Pigs carry their own strains of influenza A, but they also can become infected with avian influenza if they are exposed to infected bird droppings or contaminated water. If a pig simultaneously becomes infected with a strain of swine influenza and a strain of avian influenza, when the virus reproduces, genetic information can be exchanged so that new strains of influenza A develop that incorporate some genetic material from the avian virus and some genetic material from the swine virus.

Most new strains of influenza that result from a recombination or reassortment of avian and swine flu viruses do not survive, cannot infect humans, or die out quickly. Occasionally, however, a strain develops that can infect humans and that has the ability not only to pass from pig to human, but also from person to person. Because the virus is new to humans, the body has few defenses against it, and the vaccines included in seasonal flu shots are ineffective against it. When a new strain of flu arises that can pass easily from person to person, it has the potential to cause a pandemic, rapidly infecting and sometimes killing millions of people across the world.

Influenza pandemics have occurred during thousands of years of recorded history. The worst influenza pandemic in modern history occurred in 1918–1919 and killed an estimated 20 to 40 million people. In 1957, another pandemic known as the Asian flu killed about 70,000 Americans. This was followed by the pandemic Hong Kong flu in 1968. Then in 1976, Americans experienced a swine flu scare. During February 1976, several recruits at the Army Fort Dix in New Jersey developed unusually severe flu symptoms. When samples from some of the sick men were sent to the CDC for analysis, four samples showed a previously unknown flu virus that appeared to be similar to the virus that caused the 1918–1919 pandemic. After one soldier died of the flu, the United States began a $135 million emergency immunization program. However, the virus 1976 proved to be much less dangerous than the 1918 virus. In the end, the 1976 swine flu never spread beyond Fort Dix. About 500 people became sick and only one person died.

People who are most likely to become infected with the H1N1 influenza are those who are in close contact with someone who is infected. The incubation period is uncertain, although it is most likely less than seven days. The disease is passed to others through infected droplets that are spread by coughing, sneezing, kissing, and close physical contact. The virus can also spread indirectly. Tests of other viral strains typically show that Type A viruses can live up to two hours on hard surfaces such as door knobs, telephones, or children's toys. This means that an infected person can leave the flu virus on objects where it can be picked up by another person who then touches his or her own mouth, nose, or eyes and becomes infected. People are contagious for about one day before symptoms appear. Adults remain contagious for about seven days after they begin to show symptoms; children can remain contagious for up to 10 days.

Causes and symptoms

The H1N1 flu is caused by a newly identified strain of influenza virus. Genetic tests established that H1N1 strains encountered thus far are consistent (nearing 99 percent genetic matches among viruses examined from patient samples taken from six countries). Of particular interest to **infectious disease** research are the genes that control hemagglutinin (H), neuraminidase (N), two surface proteins with subtypes that are numbered, hence H1N1 flu or H5N1 avian flu virus, genes that control the nucleoprotein, the surrounding matrix, and three key polymerase enzymes (designated PA, PB1, and PB2) that the virus must have to reproduce. Genetically, the 2009 H1N1 presents a mixed background, with these key genes derived from human, swine, and avian sources (a triple reassortment). The hemagglutinin [H] produced is equidistant to the swine flu sequences found in the North America, Europe, and Asia. The neuraminidase and matrix genes sequences are close to genes found in swine flu strains found in Asia. Early evidence indicates similarities to influenza strains where the PB1 gene is of human origin and the PA and PB2 genes are from avian sources.

Symptoms of H1N1 flu are similar to the symptoms of seasonal influenza. These include **fever**, **cough**, **sore**

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KEY TERMS

Incubation period—The time between when an individual becomes infected with a disease-causing agent and when symptoms begin to appear.

Pandemic—The occurrence of a disease that in a short time infects a large percentage of the population over a wide geographical area.

Parasite—An organism that lives in or with another organism, called the host, in parasitism, a type of association characterized by the parasite obtaining benefits from the host, such as food, and the host being injured as a result.

throat, runny nose, body aches, **headaches**, chills, loss of appetite, and exhaustion. Some people experience **nausea**, **vomiting**, and **diarrhea**. Although most cases of H1N1 flu are mild to moderate, complications such as severe pneumonia can result in **respiratory failure** and **death**. Neurological complications including seizures have also been linked to H1N1 flu in children.

Diagnosis

Normally influenza is diagnosed on the basis of symptoms and the health care provider's knowledge of whether influenza is prevalent in the local area. An influenza test can be performed in the doctor's office that is about 75% accurate. However, this test cannot distinguish between strains of influenza A and, therefore, is not useful in determining if the patient has H1N1. To make this determination, a mucus sample must be sent to laboratory capable of rapid PCR analysis. Prior to May 1, 2009, only two laboratories in North America, the CDC laboratories in Atlanta and Canadian research laboratories in Winnipeg, were capable of definitively diagnosing the 2009 H1N1 flu. However, PCR machines are being installed in labs in Mexico that will allow rapid definitive diagnosis.

Tests

The most accurate test for influenza is done by taking a mucus sample from the throat of an infected person. Because of the time delay involved in testing, knowing the strain of flu does not provide much help to the patient, but this information helps the CDC and WHO understand how and where flu is spreading. During an influenza pandemic, physicians often forgo laboratory confirmation of influenza, relying on signs and symptoms for diagnosis. In the United Kingdom, persons with flu symptoms are given access to **antiviral drugs** after answering questions that indicate an influenza diagnosis on a government-sponsored public health website. This saves physician resources for handling severe or emergent cases, provides quick access to treatment, and helps the person with symptoms to stay home, thereby reducing the pool of infected persons in public available to infect others.

Treatment

Supportive treatment for H1N1 appears to be the same as for all influenza viruses and includes drinking plenty of fluids, extended bed rest, and use of **acetaminophen** to treat aches and fever. H1N1 influenza A virus also responds to two antiviral drugs, oseltamivir (Tamiflu) and zanamivir (Relenza). These drugs do not prevent or cure flu, but if taken within 48 hours of the start of symptoms, they reduce the severity and duration of the disease. In late April 2009, the United States government released stockpiled supplies of these antiviral drugs to combat H1N1 flu. Initial tests show that H1N1 is resistant to two other antiviral drugs, amantadine (Symmetrel, Symadine) and rimantadine (Flumandine), making these drugs ineffective. **Antibiotics** also are ineffective against all viruses, including H1N1, but can be used to treat bacterial complications of influenza, such as pneumonia.

In late June 2009, public health officials in Denmark reported the first case of A/H1N1 influenza that was resistant to oseltamivir. Although some cases of resistance normally occur and develop with seasonal influenzas, any emergence of Tamiflu-resistant 2009 A/H1N1 influenza virus puts public health officials on alert for appearance of the resistant virus elsewhere. Isolated cases of Tamiflu-resistant H1N1 have also been identified in Japan, Hong Kong (Special Administrative Region of China), and Canada. Thus far, the Tamiflu-resistant viral influenza remains treatable with zanamivir (Relenza), the other antiviral drug usually effective against the A/H1N1 virus.

Alternative treatment

No scientific testing exists to validate any claim of effectiveness of any alternative medical treatments specific to H1N1 flu. Although claims of effectiveness (and/or potential harm) for any alternative medical treatment should be carefully scrutinized for supporting scientific evidence, there are a number of alternative treatments commonly used to support relief of symptoms. Because there is no scientifically validated antiviral treatment, if flu is suspected, persons should consult with a physician to determine if they are in need of antiviral medicines.

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Alternative practitioners recommend herbal teas to soothe the throat and allegedly "boost" the immune system. Other herbal treatments recommended by alternative practitioners for seasonal flu routinely include:

- Ginger (*Zingiber officinalis*) to reduce fever and pain, settle the stomach, and suppress cough
- Echinacea (*Echinacea purpurea* or *angustifolia*) to reduce flu symptoms, including sore throat, chills, sweating, fatigue, weakness, body aches, and headaches
- Cordyceps (*Cordyceps sinensis*) to modulate and allegedly "boost" the immune system and improve respiration
- Eucalyptus (*Eucalyptus globulus*) or peppermint (*Mentha piperita*) essential oils added to a steam vaporizer to help clear chest and nasal congestion

Prognosis

Because 2009 H1N1 is a new strain of influenza, it is difficult to predict the course of the disease. Generally cases have been mild, but as with all flu, cases can be life-threatening if complications develop. Underlying health conditions may be worsened by the disease, and pneumonia, a common and sometimes fatal complication of seasonal flu, may develop.

Prevention

The best ways to prevent H1N1 infection include the following:

- Wash hands well and often. Hands should be washed with soap and warm water to above the wrists for 15–20 seconds or about the time it takes to sing the happy birthday song slowly. If soap and water are not available, use an alcohol-based hand sanitizer.
- Cover the mouth when coughing; dispose of used tissues in a covered container.
- Avoid touching the nose, mouth, and eyes.
- Stay home if flu symptoms appear.
- Avoid crowded places such as movie theaters.

Note that surgical masks are unlikely to protect against the influenza virus, but are effective in reducing dissemination of droplets that can contain viral particles. Also, antiviral medications do not prevent influenza; they simply help shorten the intensity and duration of the illness.

Vaccination

World public health officials have recommended prioritizing vaccine recipients according to individual risk, as well as to ensure the greatest benefit for overall public health. Pregnant women and people caring for infants, children, young people under 25 years of age, and persons with underlying health conditions such as **asthma** or diabetes are recommended to receive priority vaccination against pandemic H1N1 influenza. In addition, healthcare workers are suggested to be among the first immunized in order to keep hospitals, doctors' offices, and other critical healthcare infrastructure functional during a pandemic flu.

Public health officials acknowledged that production of the H1N1 vaccine fell far short of global demand. At current rates of production, 900 million doses of the new H1N1 vaccine can be produced each year (as two doses are required per person, enough to vaccinate 450 million people). The vaccine is produced in only a handful of countries and there are concerns these countries, along with wealthier nations will obtain the vast majority of vaccine produced. The shortages may also hinder WHO efforts to secure donations of vaccine or agreements that will enable poorer countries to purchase vaccine at a lower price. The current seasonal influenza vaccine protects against an H3N2 virus, an influenza B virus, and the H1N1 virus.

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United States Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (779) 488-7100, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.
World Health Organization. Regional Office for the Americas, 525 23rd Street N.W., Washington, DC, 20037, (202) 974-3000, postmaster@paho.org, http://new.paho.org/hq/.

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H-2 blockers

Definition

Histamine H-2 receptor blockers act by stopping the pathway that leads to the secretion of stomach acid. There are two kinds of pathways that react to stimulation by histamine. Histamine is produced in the body and released by mast cells in response to some types of injury or to the presence of an antigen. When histamine reaches the H-1 receptors, the reaction results in dilation of capillaries, leading to redness and swelling, along with **itching**. These reactions can be controlled with traditional **antihistamines**.

Histamine that reaches the H-2 receptors causes increased secretion of stomach acid.

Purpose

H2 receptor blockers are used to treat conditions associated with excess amounts of stomach acid, although in some cases they have been replaced by the **proton pump inhibitors**, which have a greater effect on reducing acid secretions.

H2 receptor blockers are used to treat the following conditions:

- duodenal ulcer, as short term therapy and maintenance
- gastric ulcer, as short term therapy and maintenance
- gastroesophageal reflux disease (GERD), including endoscopically diagnosed erosive esophagitis
- pathological hypersecretory conditions such as Zollinger-Ellison syndrome, systemic mastocytosis, and multiple endocrine adenomas
- upper GI bleeding
- heartburn, acid indigestion, and sour stomach

None of the drugs in this class has been approved for use by children under the age of 12 years. However, standard pediatric texts have reported use by infants and children.

Description

There are four H2 receptor blockers on the market. Although they all work in the same manner and have similar effects, they are not all approved for the same uses.

Cimetidine (Tagamet) is available in both prescription and over-the-counter forms. The oldest of the group and the most studied, this drug is the least potent of the H2 receptor blockers, which means that higher dosages are required to provide comparable effects. There is no evidence that higher potency improves therapeutic results.

Cimetidine is the only drug in its class which is approved for prevention of upper gastro-intestinal bleeding. It has been reported on for a number of uses, with varying degrees of success. Cimetidine, like ranitidine, has shown some benefit in treatment of colorectal **cancer**. Although some claims have been made that cimetidine is useful in treatment of **acetaminophen** overdose, the evidence for this use is lacking, and cimetidine should not be used. Because cimetidine is a mild antiandrogen, it has been of some use in treatment of **hirsutism** (abnormal growth of hair on a woman's face and body).

The three other H2 receptor blockers, famotidine (Pepcid, Pepcid AC), nizatidine (Axid), and ranitidine (Zantac), are similar in their uses. All are approved for treatment of duodenal ulcer both acute treatment and maintenance therapy, gastro-esophageal reflux disease, including erosive esophagitis and gastric ulcer short term treatment, although in this group ranitidine alone is approved for maintenance treatment.

In their over-the-counter (non-prescription) forms, cimetidine and famotidine are approved for treatment of **heartburn**, acid **indigestion**, and sour stomach.

Drugs in this class are similar in other respects as well. Although study results vary, cimetidine will usually

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show its effects within one hour and last for about five hours after a single dose; famotidine and nizatidine also show effects within one hour but may act for up to 12 hours at maximum dosing. Ranitidine has a comparable onset of action and duration in adults but may be slower in the elderly. Onset and duration of action will vary with the individual, the dose of medication, and the presence or absence of food or **antacids** in the stomach.

When *Facts and Comparisons*, a widely used on-line drug information resource, compared the published reports on cure rates for duodenal ulcers, it found that after eight weeks of treatment, all drugs showed healing rates in the range of 82% to 95%. These results were based on comparing separate studies and did not represent comparative trials of the drugs against each other.

Recommended dosage

Cimetidine doses for patients over the age of 12 years, for oral administration.

- Short-term treatment of active duodenal ulcer: 800 mg at bedtime. Other dose regimens are sometimes used.
- Heartburn, acid indigestion, and sour stomach using the over-the-counter product: 100 to 200 mg with water when symptoms start. The dose may be repeated once in 24 hours.
- Prevention of heartburn, acid indigestion, and sour stomach using the over-the-counter product: 100 to 200 mg with water up to one hour before eating food or drinking beverages expected to cause symptoms. Dose should not exceed 400 mg in 24 hours.
- Treatment of hypersecretory conditions: 300 mg four times a day, with meals and at bedtime.
- Gastroesophageal reflux disease: 800 to 1600 mg a day, divided into smaller doses. Treatment usually lasts 12 weeks.

Famotidine doses for patients over the age of 12 years, for oral administration.

- Treatment of duodenal ulcers: 40 mg once a day at bedtime. If necessary, 20 milligrams two times a day may be used.
- Prevention of duodenal ulcers: 20 mg once a day at bedtime.
- Gastric ulcers: 40 mg once a day at bedtime.
- To treat heartburn, acid indigestion, and sour stomach using the over-the-counter product: 10 mg with water when symptoms start. The dose may be repeated once in 24 hours.
- Hypersecretory conditions: 20 mg every six hours.
- Gastroesophageal reflux disease: 20 mg two times a day, usually for up to six weeks.

Nizatidine doses for patients over the age of 12 years, for oral administration.

- Treatment of duodenal or gastric ulcers: 300 mg once a day at bedtime. Alternately, 150 mg two times a day.
- Prevention of duodenal ulcers: 150 mg once a day at bedtime.
- Prevention of heartburn, acid indigestion, and sour stomach: 75 mg taken 30 to 60 minutes before meals which may cause symptoms. The dose may be repeated once in 24 hours.
- Gastroesophageal reflux disease: 150 mg two times a day.

Ranitidine doses for patients over the age of 12 years, for oral administration.

- Duodenal ulcers, treatment: 150 mg two times a day. Alternately, 300 mg once a day at bedtime.
- Duodenal ulcers, prevention: 150 mg at bedtime.
- Gastric ulcers, treatment: 150 mg two times a day.
- Heartburn, acid indigestion, and sour stomach, treatment: 75 mg with water when symptoms start. The dose may be repeated once in 24 hours.
- Heartburn, acid indigestion, and sour stomach, prevention: 75 mg with water taken 30 to 60 minutes before meals or beverages which may cause symptoms. The dose may be repeated once in 24 hours.
- Hypersecretory conditions: 150 mg two times a day.
- Gastroesophageal reflux disease: 150 mg two times a day. The dose may be increased as needed.

Precautions

Overall, the histamine H2 receptor blockers are a safe class of drugs. However, some patients may be particularly susceptible to adverse effects of these drugs. H2 receptor blockers are metabolized in the liver and excreted through the kidneys. Therefore, patients with kidney or liver problems may require reduced doses in order to maintain safe blood levels of the drugs.

Although the safety and effectiveness of H2 receptor blockers in patients over the age of 65 appears to be similar to that seen in younger patients, age-associated reductions in kidney function may lead to elevated blood levels.

Allergic reactions to these drugs are rare but have been reported.

The histamine H2 receptor blockers are **Pregnancy** category B. There are no adequate and well-controlled studies with these agents in pregnant women. Women should use them only when clearly needed and when the

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potential benefits outweigh the potential hazards to the fetus. Cimetidine is known to cross the placenta.

All drugs in this class are excreted into breast milk and should not be taken by nursing women. Decide whether to discontinue nursing, or discontinue the drug, taking into account the importance of the drug to the mother.

These drugs may mask the symptoms of **stomach cancer**.

Side effects

Although side effects due to the H2 receptor blockers are relatively rare and usually mild, a large number of adverse effects have been reported, in part because of the high use of these drugs. For example, the most common single adverse effect of cimetidine has been a 4% incidence of breast enlargement among males taking the drug in high doses for hypersecretory conditions. Similarly, the incidence of **headache** among high-dose cimetidine patients was 3.5%. Among patients taking lower doses, the frequency of headache was 2.1% compared to 2.3% in a placebo control group. Decreased **white blood cell count** was reported in 1 in 1,000,000 patients.

The reported side effects from the H2 receptor blocks are:

- abdominal pain
- back, leg, or stomach pain
- bleeding or crusting sores on lips
- blistering, burning, redness, scaling, or tenderness of skin
- blisters on palms of hands and soles of feet
- changes in vision or blurred vision
- coughing or difficulty in swallowing
- dark-colored urine
- dizziness
- fainting
- fast, pounding, or irregular heartbeat
- fever and/or chills
- flu-like symptoms
- general feeling of discomfort or illness
- hives
- inflammation of blood vessels
- joint pain
- light-colored stools
- mood or mental changes, including anxiety, agitation, confusion, hallucinations (seeing, hearing, or feeling things that are not there), mental depression, nervousness, or severe mental illness
- muscle cramps or aches
- nausea, vomiting, or loss of appetite
- pain
- peeling or sloughing of skin
- red or irritated eyes
- shortness of breath
- skin rash or itching
- slow heartbeat
- sore throat
- sores, ulcers, or white spots on lips, in mouth, or on genitals
- sudden difficult breathing
- swelling of face, lips, mouth, tongue, or eyelids
- swelling of hands or feet
- swollen or painful glands
- tightness in chest
- troubled breathing, unusually slow or irregular breathing
- unusual bleeding or bruising
- unusual tiredness or weakness
- wheezing
- yellow eyes or skin

Less frequently reported are

- constipation
- decreased sexual ability (especially in patients with Zollinger-Ellison disease who have received high doses of cimetidine for at least 1 year)
- decrease in sexual desire
- diarrhea
- difficult urination
- dizziness
- drowsiness
- dryness of mouth or skin
- headache
- increased or decreased urination
- increased sweating
- loss of hair
- ringing or buzzing in ears
- runny nose
- swelling of breasts or breast soreness in females and males
- trouble in sleeping

Not all of these adverse effects have been reported with all of the H2 receptor blockers, and some of the adverse effects may not have been drug related. However, because of the high similarity between drugs in this class, any of the reported adverse effects may be considered a possible result of therapy.

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KEY TERMS

Duodenal—Pertaining to the first part of the small intestine.

Gastric—Pertaining to the stomach.

Hirsutism—Abnormal growth of hair on a woman's face and body.

Histamine—A physiologically active compound found in plant and animal tissue and released from mast cells as part of an allergic reaction in humans. It stimulates gastric secretion and causes dilation of capillaries, constriction of bronchial smooth muscle, and decreased blood pressure.

Hypersecretory—Excessive secretions, overproduction of stomach acid.

Mast cell—A cell found in connective tissue that releases substances such as heparin and histamine in response to injury or inflammation of bodily tissues.

Peptic—Induced by or associated with the action of digestive secretions.

Ulcer—A slow-healing sore on the surface of a mucous membrane, especially the membrane lining the stomach or other part of the digestive tract.

Zollinger-Ellizon syndrome—Severe peptic ulceration from excessive stomach acid production stimulated by one or more tumors that produce a powerful acid secretion.

Interactions

Cimetidine and ranitidine are both metabolized in the liver using the cytochrome P450 oxidase enzyme system. Since the same enzymes metabolize many drugs, taking two or more drugs that affect the same group of enzymes may cause one of the drugs to be retained in the body longer than would have been expected. The following is a partial list of drugs which may interact with cimetidine, or to a lesser extent with ranitidine.

- benzodiazepines, including Valium, Librium and Xanax
- caffeine
- calcium channel blockers, including Adalat, Calan, Procadia, and others
- carbamazepine
- chloroquine
- labetolol
- lidocaine
- metoprolol
- metronidazole
- phenytoin
- propranolol
- quinidine
- quinine
- sulfonylureas (includes many of the drugs used to treat diabetes)
- theophyllines (used to treat asthma; Dyphylline, a member of this group, does not interact with cimetidine)
- triamterene (a diuretic drug rarely used alone but may be found in fixed combinations, including Dyazide and Maxzide)
- tricyclic antidepressants (a group that includes amitriptyline, imipramine, and others)
- valproic acid
- warfarin

Additional drugs may also interact with the H2 receptor blockers, particularly those which might have a similar mechanism or action or adverse effects.

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American College of Gastroenterology, PO Box 342260, Bethesda, MD, 20827-2260, (301) 263-9000, http://www.acg.gi.org.

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American Gastroenterological Association (AGA), 4930 Del Ray Avenue, Bethesda, MD, 20814, (301) 654-2055, (301) 654-5920, member@gastro.org, http://www.gastro.org.

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Habitual abortion *see* **Recurrent miscarriage**

Hair transplantation

Definition

Hair transplantation is a surgical procedure used to treat baldness or hair loss. Typically, tiny patches of scalp are removed from the back and sides of the head and implanted in the bald spots in the front and top of the head.

Purpose

Hair transplantation is a cosmetic procedure performed on men (and occasionally on women) who have significant hair loss, thinning hair, or bald spots where hair no longer grows. In men, hair loss and baldness are most commonly due to genetic factors (a tendency passed on in families) and age. Male pattern baldness, in which the hairline gradually recedes to expose more and more of the forehead, is the most common form. Men may also experience a gradual thinning of hair at the crown or very top of the skull. For women, hair loss is more commonly due to hormonal changes and is more likely to be a thinning of hair from the entire head. An estimated 50,000 men get transplants each year. Transplants can also be done to replace hair lost due to **burns**, injury, or diseases of the scalp.

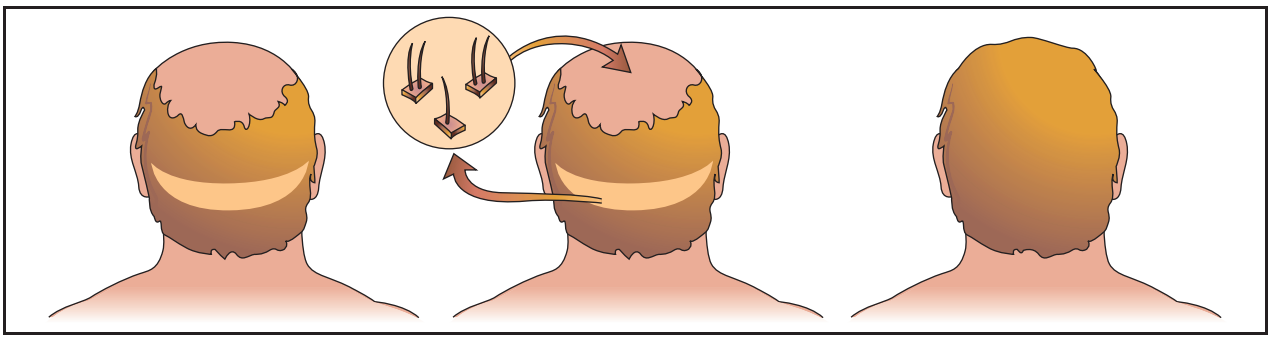
Precautions

Although hair transplantation is a fairly simple procedure, some risks are associated with any surgery. It is important to inform the physician about any medications currently being used and about previous allergic reactions to drugs or anesthetic agents. Patients with blood clotting disorders also need to inform their physician before the procedure is performed.

Description

Hair transplantation surgery is performed by a physician in an office, clinic, or hospital setting. Each surgery lasts two to three hours during which approximately 250 grafts will be transplanted. A moderately balding man may require up to 1,000 grafts to get good coverage of a bald area, so a series of surgeries scheduled three to four months apart is usually required. The patient may be completely awake during the procedure with just a local anesthetic drug applied to numb the areas of the scalp. Some patients may be given a drug to help them relax or may be given an anesthetic drug that puts them to sleep.

The most common transplant procedure uses a thin strip of hair and scalp from the back of the head. This strip is cut into smaller clumps of five or six hairs. Tiny cuts are made in the balding area of the scalp and a clump is implanted into each slit. The doctor performing the surgery will attempt to recreate a natural looking hairline along the forehead. Minigrafts, micrografts, or implants of single hair follicles can be used to fill in between larger implant sites and can provide a more natural-looking hairline. The implants will also be arranged so that thick and thin hairs are interspersed and the hair will grow in the same direction.



The most common hair transplant procedure involves taking small strips of scalp containing hair follicles from the donor area, usually at the sides or back of the head. These strips are then divided into several hundred smaller grafts. The surgeon relocates these grafts containing skin, follicle, and hair to tiny holes in the balding area by using microsurgical instruments or lasers.
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KEY TERMS

Anesthetic agents—Medication or drugs that can be injected with a needle or rubbed onto and area to make it numb before a surgical procedure. Anesthesia drugs may also be given by mouth, breathed in as a gas, or injected into a vein or muscle to make a patient relaxed or unconscious.

Hair follicle—A tube-like indentation in the skin from which a single hair grows.

Minigraft or micrograft—Transplantation of a small number of hair follicles, as few as one to three hairs, into a transplant site.

Transplantation—Surgically cutting out hair follicles and replanting them in a different spot on the head.

Another type of hair replacement surgery is called scalp reduction. This involves removing some of the skin from the hairless area and "stretching" some of the nearby hair-covered scalp over the cut-away area.

Health insurance will not pay for hair transplants that are done for cosmetic reasons. Insurance may pay for hair replacement surgery to correct hair loss due to accident, burn, or disease.

It is important to be realistic about what the final result of a hair transplant will look like. This procedure does not create new hair, it simply redistributes the hair that the patient still has. Some research has been conducted where chest hair has been transplanted to the balding scalp, but this procedure is not widely practiced.

Preparation

It is important to find a respected, well-established, experienced surgeon and discuss the expected results prior to the surgery. The patient may need blood tests to check for bleeding or clotting problems and may be asked not to take **aspirin** products before the surgery. The type of anesthesia used will depend on how extensive the surgery will be and where it will be performed. The patient may be awake during the procedure, but may be given medication to help them relax. A local anesthetic drug which numbs the area will be applied or injected into the skin at the surgery sites.

Aftercare

The area may need to be bandaged overnight. The patient can return to normal activities; however, strenuous activities should be avoided in the first few days after the surgery. On rare occasions, the implants can be "ejected" from the scalp during vigorous **exercise**. There may be some swelling, bruising, **headache**, and discomfort around the graft areas and around the eyes. These symptoms can usually be controlled with a mild **pain** reliever like aspirin. Scabs may form at the graft sites and should not be scraped off. There may be some **numbness** at the sites, but it will diminish within two to three months.

Risks

Although there are rare cases of infection or scarring, the major risk is probably that the grafted area does not look the way the patient expected it to look.

Normal results

The transplanted hair will fall out within a few weeks, however, new hair will start to grow in the graft sites within about three months. A normal rate of hair growth is about 0.25–0.5 in (6–13 mm) per month.

Abnormal results

Major complications as a result of hair transplantation are extremely rare. Occasionally, a patient may have problems with delayed healing, infection, scarring, or rejection of the graft, but this is uncommon.

Resources

OTHER

"Hair Transplant." Ienhance. http://www.ienhance.com.

"Transplants; Flap Surgery; and The Perfect Candidate." Transplant Network. http://www.hair-transplants.net.

ORGANIZATIONS

American Academy of Cosmetic Surgery, 737 North Michigan Ave., Suite 2100, Chicago, IL, 60611-5641, (312) 981-6760, (312) 981-6787, info@cosmeticsurgery.org, http://www.cosmeticsurgery.org.

American Academy of Facial Plastic and Reconstructive Surgery (AAFPRS), 310 South Henry Street, Alexandria, VA, 22314, (703) 299-9291, info@aafprs.org, http://www.aafprs.org/.

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Hairy cell leukemia

Definition

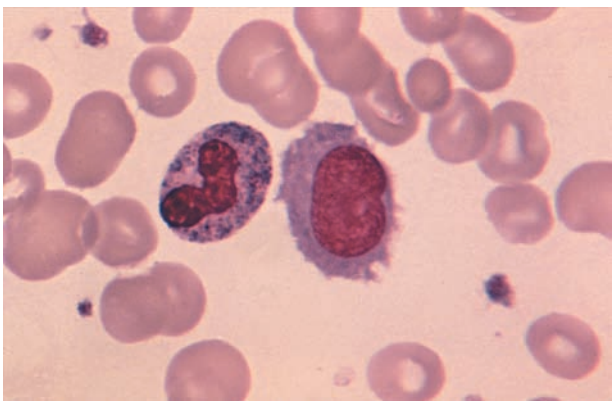
Hairy cell leukemia is a disease in which a type of white blood cell called the lymphocyte, present in the blood and bone marrow, becomes malignant and proliferates. It is called hairy cell leukemia because the cells have tiny hair-like projections when viewed under the microscope.

Description

Hairy cell leukemia (HCL) is a rare **cancer**. It was first described in 1958 as *leukemic reticuloendotheliosis*, erroneously referring to a red blood cell because researchers were unsure of the cell of origin. It became more easily identifiable in the 1970s. There are approximately 600 new cases diagnosed every year in the United States, making up about 2% of the adult cases of leukemia each year.

HCL is found in cells located in the blood. There are three types of cells found in the blood: the red blood cells that carry oxygen to all the parts of the body; the white blood cells that are responsible for fighting infection and protecting the body from diseases; and the platelets that help in the clotting of blood. Hairy cell leukemia affects a type of white blood cell called the lymphocyte. Lymphocytes are made in the bone marrow, spleen, lymph nodes, and other organs. It specifically affects B-lymphocytes, which mature in the bone marrow. However, extremely rare variants of HCL have been discovered developing from T-lymphocytes, which mature in the thymus.

When hairy cell leukemia develops, the white blood cells become abnormal both in the way they appear (by acquiring hairy projections) and in the way they act (by proliferating without the normal control mechanisms).



A magnified image of white blood cells with "hairy" projections. *(M. Abbey/Photo Researchers, Inc.)*

Further, the cells tend to accumulate in the spleen, causing it to become enlarged. The cells may also collect in the bone marrow and prevent it from producing normal blood cells. As a result, there may not be enough normal white blood cells in the blood to fight infection.

The median age at which people develop HCL is 52 years. Though it occurs in all ages, HCL more commonly develops in the older population. Men are four times more likely to develop HCL than women. There have been reports of familial aggregation of disease, with higher occurrences in Ashkenazi Jewish men. A potential genetic link is undergoing further investigation.

Causes and symptoms

The cause of hairy cell leukemia is not specifically known. However, exposure to radiation is a known cause of leukemia in general. Familial involvement is another theory, suggesting that there is a genetic component associated with this disease.

HCL is a chronic (slowly progressing) disease, and the patients may not show any symptoms for many years. As the disease advances, the patients may suffer from one or more of the following symptoms:

- weakness
- fatigue
- recurrent infections
- fever
- anemia
- bruising
- pain or discomfort in the abdominal area
- weight loss (uncommon)
- night sweats (uncommon)

Pain and discomfort are caused by an enlarged spleen, which results from the accumulation of the abnormal hairy cells in the spleen. Blood tests may show abnormal counts of all the different types of cells. This happens because the cancerous cells invade the bone marrow as well and prevent it from producing normal blood cells. Because of the low white cell count in the blood, the patient may have frequent infections. **Fever** often accompanies the infections. The patient is most susceptible to bacterial infections, but infections of any kind are the major cause of **death**. The low red cell count may cause anemia, **fatigue**, and weakness, and the low **platelet count** may cause the person to bruise and bleed easily.

Diagnosis

When a patient suffers from the above symptoms, the doctor will palpate the abdomen and may order

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KEY TERMS

Anemia—A condition in which there is low iron in the blood due to a deficiency of red blood cells.

Bone marrow—The spongy tissue inside the large bones in the body that is responsible for making the red blood cells, white blood cells, and platelets.

Bone marrow aspiration and biopsy—A procedure in which a needle is inserted into the large bones of the hip or spine and a small piece of marrow is removed for microscopic examination.

Immunotherapy—A mode of cancer treatment in which the immune system is stimulated to fight the cancer.

Leukemia—A disease in which the cells that constitute the blood become cancerous or abnormal.

Lymph nodes—Oval-shaped organs that are the size of peas, located throughout the body, and contain clusters of cells called lymphocytes. They filter out and destroy the bacteria, foreign particles, and cancerous cells from the blood.

Malignant—Cells that have the ability to invade locally, cause destruction of surrounding tissue, and travel to other sites in the body.

Keratoconjunctivitis—Inflammation of the conjunctiva and cornea of the eye.

Spleen—An organ that lies next to the stomach. Its function is to remove the worn-out blood cells and foreign materials from the blood stream.

Splenectomy—A surgical procedure that involves the surgical removal of the spleen.

scans to see if the spleen is enlarged (splenomegaly). An enlarged spleen is present in 80% of patients. An enlarged liver is less common, but can occur.

If the spleen is enlarged, the doctor may order several blood tests. In these tests, the total numbers of each of the different types of blood cells (CBC) are reported. Sixty to eighty percent of patients suffer from pancytopenia, which is a dramatic reduction in the number of red blood cells, white blood cells, and platelets circulating in the blood.

If the blood tests are abnormal, the doctor may order a **bone marrow aspiration and biopsy**. In order to establish a diagnosis, hairy cells must be present in the bone marrow.

Treatment

When physicians perform blood tests, they will determine the level of hemoglobin (the oxygen-transporting molecule of red blood cells). Serum hemoglobin levels and the size of the spleen, which can be measured on exam and by using an x ray, are proposed criteria for determining the stage of HCL. The following are the three proposed stages and their criteria:

- Stage I: Hemoglobin greater than 12 g/dL (1 g = approximately 0.02 pint and 1 dL = approximately 0.33 ounce) and spleen less than or equal to 10 cm (3.9 inches).
- Stage II: Hemoglobin between 8.5 and 12 g/dL and spleen greater than 10 cm (3.9 inches).
- Stage III: Hemoglobin less than 8.5 g/dL and spleen greater than 10 cm (3.9 inches).

Since there is generally no accepted staging system, another method for evaluating the progression of HCL is to group patients into two categories: untreated HCL and progressive HCL, in which hairy cells are present after therapy has been administered.

Some people with hairy cell leukemia have very few or no symptoms at all, and it is reasonable to expect that 10% of patients may not need any treatment. However, if the patient is symptomatic and needs intervention, HCL is especially responsive to treatment.

There are three main courses of treatment: **chemotherapy**, **splenectomy** (surgical removal of the spleen), and immunotherapy. Once a patient meets treatment criteria, purine analogues, particularly the drugs pentostatin and cladribine, are the first-line therapy. Pentostatin is administered at 5mg/m^2 for two days every other week until total remission is achieved. Patients may experience side effects such as fever, **nausea**, **vomiting**, **photosensitivity**, and keratoconjuctivitis. However, follow-up studies estimate a relapse-free survival rate at 76%. Cladribine (2-CdA) taken at 0.1mg/kg/day for seven days also has an impressive response. Eighty-six percent of patients experience complete remission after treatment, while 16% experience partial remission. Fever is the principal side effect of 2-CdA.

Biological therapy or immunotherapy, where the body's own immune cells are used to fight cancer, is also being investigated in clinical trials for hairy cell leukemia. A substance called interferon that is produced by the white blood cells of the body was the first systemic treatment that showed consistent results in fighting

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HCL. The FDA approved interferon-alpha (INF-alpha) to fight HCL. The mechanism by which INF-alpha works is not clearly understood. However, it is known that interferon stimulates the body's natural killer cells that are suppressed during HCL. The standard dosage is 2 MU/m^2 three times a week for 12 months. Side effects include fever, myalgia, malaise, **rashes**, and gastrointestinal complaints.

If the spleen is enlarged, it may be removed in a surgical procedure known as splenectomy. This usually causes a remission of the disease. However, 50% of patients that undergo splenectomy require some type of systemic treatment such as chemotherapy or immunotherapy. Splenectomy is not the most widely used course of treatment as it was many years ago. Although the spleen is not an indispensable organ, it is responsible for helping the body fight infection. Therefore, other therapies are preferred in order to salvage the spleen and its functions.

Most patients have excellent prognosis and can expect to live 10 years or longer. The disease may remain silent for years with treatment. Continual follow-up is necessary to monitor the patient for relapse and determine true cure rates.

Alternative treatment

Many individuals choose to supplement traditional therapy with complementary methods. Often, these methods improve the tolerance of side effects and symptoms as well as enrich the quality of life. The American Cancer Society recommends that patients talk to their doctor to ensure that the methods they are using are safely supplementing traditional therapy. Some complementary treatments include the following:

- yoga
- meditation
- religious practices and prayer
- music therapy
- art therapy
- massage therapy
- aromatherapy

Prevention

Since the cause for the disease is unknown and there are no specific risk factors, there is no known prevention.

Resources

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NCI/PDQ Patient Statement, "Hairy cell leukemia." National Cancer Institute, 2001.

ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (800) 227-2345, http://www.cancer.org.

Cancer Research Institute (National Headquarters), One Exchange Plaza, 55 Broadway, Suite 1802, New York, NY, (212) 688-7515, (212) 832-9376, (800) 992-2623, http://www.cancerresearch.org/.

Hairy Cell Leukemia Research Foundation, 790 Estate Drive, Suite 180, Deerfield, IL, 60015, (866) 376-0046, hairycellpatientservices@hotmail.com, http://www.hairycellleukemia.org/.

Leukemia and Lymphoma Society, 1311 Mamaroneck Avenue, Suite 310, White Plains, NY, 10605, (800) 955-4572, http://www.leukemia-lymphoma.org.

National Cancer Institute (National Institutes of Health), NCI Office of Communications and Education, 6116 Executive Blvd., Suite 300, Bethesda, MD, 20892-8322, (800) 4-CANCER (422-6237), cancergovstaff@mail.nih.gov, http://www.cancer.gov/.

Oncolink. University of Pennsylvania Cancer Center, 3400 Spruce Street, 2 Donner, Philadelphia, PA, 19104, (215) 349-8895, (215) 349-5445, hampshire@uphs.upenn.edu, http://oncolink.org.

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Halitosis *see* **Bad breath**

Hallucinations

Definition

Hallucinations are false or distorted sensory experiences that appear to be real perceptions. These sensory impressions are generated by the mind rather than by any external stimuli, and may be seen, heard, felt, and even smelled or tasted.

Description

A hallucination occurs when environmental, emotional, or physical factors such as **stress**, medication, extreme **fatigue**, or mental illness cause the mechanism within the brain that helps to distinguish conscious perceptions from internal, memory-based perceptions to

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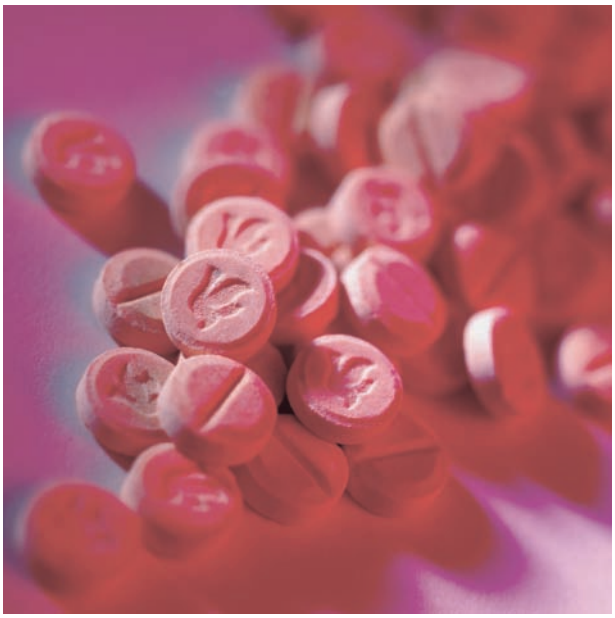

Ecstasy tablets. *(© Andrew Brookes/Corbis.)*

misfire. As a result, hallucinations occur during periods of consciousness. They can appear in the form of visions, voices or sounds, tactile feelings (known as haptic hallucinations), smells, or tastes.

Patients suffering from **dementia** and psychotic disorders such as **schizophrenia** frequently experience hallucinations. Hallucinations can also occur in patients who are not mentally ill as a result of stress overload or exhaustion, or may be intentionally induced through the use of drugs, **meditation**, or sensory deprivation. A 1996 report published in the *British Journal of Psychiatry* noted that 37% of 4,972 people surveyed experienced hypnagogic hallucinations (hallucinations that occur as a person is falling to sleep). Hypnopomic hallucinations (hallucinations that occur just upon waking) were reported by 12% of the sample.

Causes and symptoms

Common causes of hallucinations include:

- Drugs. Hallucinogenics such as ecstasy (3,4-methylenedioxymethamphetamine, or MDMA), LSD (lysergic acid diethylamide, or acid), mescaline (3,4,5-trimethoxyphenethylamine, or peyote), and psilocybin (4-phosphoryloxy-N, N-dimethyltryptamine, or mushrooms) trigger hallucinations. Other drugs, such as marijuana and PCP, have hallucinatory effects. Certain prescription medications may also cause hallucinations. In addition, drug withdrawal may induce tactile and visual hallucinations as in an alcoholic suffering from delirium tremens (DTs).
- Stress. Prolonged or extreme stress can impede thought processes and trigger hallucinations.
- Sleep deprivation and/or exhaustion. Physical and emotional exhaustion can induce hallucinations by blurring the line between sleep and wakefulness.
- Meditation and/or sensory deprivation. When the brain lacks external stimulation to form perceptions, it may compensate by referencing the memory and form hallucinatory perceptions. This condition is commonly found in blind and deaf individuals.
- Electrical or neurochemical activity in the brain. A hallucinatory sensation—usually involving touch—called an aura, often appears before, and gives warning of, a migraine. Also, auras involving smell and touch (tactile) are known to warn of the onset of an epileptic attack.
- Mental illness. Up to 75% of schizophrenic patients admitted for treatment report hallucinations.
- Brain damage or disease. Lesions or injuries to the brain may alter brain function and produce hallucinations.

Diagnosis

Aside from hypnogogic and hypnopompic hallucinations, more than one event suggests a person should seek evaluation. A general physician, psychologist, or psychiatrist will try to rule out possible organic, environmental, or psychological causes through a detailed medical examination and social history. If a psychological cause such as schizophrenia is suspected, a psychologist will typically conduct an interview with the patient and his family and administer one of several clinical inventories, or tests, to evaluate the mental status of the patient.

Occasionally, people who are in good mental health will experience a hallucination. If hallucinations are infrequent and transitory and can be accounted for by short-term environmental factors such as **sleep deprivation** or meditation, no treatment may be necessary. However, if hallucinations are hampering an individual's ability to function, a general physician, psychologist, or psychiatrist should be consulted to pinpoint their source and recommend a treatment plan.

Treatment

Hallucinations that are symptomatic of a mental illness such as schizophrenia should be treated by a psychologist or psychiatrist. Antipsychotic medication

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KEY TERMS

Aura—A subjective sensation or motor phenomenon that precedes and indicates the onset of a neurological episode, such as a migraine or an epileptic seizure.

Hypnogogic hallucination—A hallucination, such as the sensation of falling, that occurs at the onset of sleep.

Hypnopompic hallucination—A hallucination that occurs as a person is waking from sleep.

Sensory deprivation—A situation where an individual finds himself in an environment without sensory cues. Also, (used here) the act of shutting one's senses off to outside sensory stimuli to achieve hallucinatory experiences and/or to observe the psychological results.

such as thioridazine (Mellaril), haloperidol (Haldol), chlorpromazine (Thorazine), clozapine (Clozaril), or risperidone (Risperdal) may be prescribed.

Prognosis

In many cases, chronic hallucinations caused by schizophrenia or some other mental illness can be controlled by medication. If hallucinations persist, psychosocial therapy can be helpful in teaching the patient the coping skills to deal with them. Hallucinations due to sleep deprivation or extreme stress generally stop after the cause is removed.

ORGANIZATIONS

American Psychological Association (APA), 750 First St. NE, Washington, DC, 20002-4242, (202) 336-5500, (800) 374-2721, http://www.apa.org/.

National Alliance for the Mentally Ill (NAMI), 3803 N. Fairfax Dr., Ste. 100, Arlington, VA, 22203, (703) 524-7600, (703) 524-9094, (800) 950-6264, http://www.nami.org.

Paula Anne Ford-Martin

Hallucinogen *see* **Lysergic acid diethylamide**

Hallux valgus *see* **Bunion**

Haloperidol *see* **Antipsychotic drugs**

Hammertoe

Definition

Hammertoe is a condition in which the toe is bent in a claw-like position. It can be present in more than one toe but is most common in the second toe.

Description

Hammertoe is described as a deformity in which the toes bend downward with the toe joint usually enlarged. Over time, the joint enlarges and stiffens as it rubs against shoes. Other foot structures involved include the overlying skin and blood vessels and nerves connected to the involved toes.

Causes and symptoms

The shortening of tendons responsible for the control and movement of the affected toe or toes cause hammertoe. Top portions of the toes become callused from the friction produced against the inside of shoes. This common foot problem often results from improper fit of footwear. This is especially the case with high-heeled shoes placing pressure on the front part of the foot that compresses the smaller toes tightly together. The condition frequently stems from muscle imbalance, and usually leaves the affected individual with impaired balance.

Hammertoe most commonly affects the second toe which, as shown, often develops a corn over the deformity. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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Diagnosis

A thorough medical history and physical exam by a physician is always necessary for the proper diagnosis of hammertoe and other foot conditions. Because the condition involves bony deformity, x rays can help to confirm the diagnosis.

Treatment

Conservative

Wearing proper footwear and stockings with plenty of room in the toe region can provide treatment for hammertoe. Stretching exercises may be helpful in lengthening the excessively tight tendons.

Surgery

In advanced cases where conservative treatment is unsuccessful, surgery may be recommended. The tendons that attach to the involved toes are located and an incision is made to free the connective tissue to the foot bones. Additional incisions are made so the toes no longer bend in a downward fashion. The middle joints of the affected toes are connected permanently with surgical hardware such as pins and wire sutures. The incision is then closed with fine sutures. These sutures are removed approximately 7 to 10 days after surgery.

Alternative treatment

Various soft tissue and joint treatments offered by **chiropractic** and **massage therapy** may be useful to decrease the tightness of the affected structures.

Prognosis

If detected early, hammertoe can be treated non-surgically. If surgery becomes necessary, surgical risks are minimal with the overall outcome providing good results.

Prevention

Wearing comfortable shoes that fit well can prevent many foot ailments. Foot width may increase with age. Feet should always be measured before buying shoes. The upper part of the shoes should be made of a soft, flexible material to match the shape of the foot. Shoes made of leather can reduce the possibility of skin irritations. Soles should provide solid footing and not be slippery. Thick soles lessen pressure when walking on hard surfaces. Low-heeled shoes are more comfortable, safer, and less damaging than high-heeled shoes.

ORGANIZATIONS

American Orthopaedic Foot and Ankle Society, 6300 N. River Road, Suite 510, Rosemont, IL, 60018, (847) 698-4654, (800) 235-4855.

American Podiatric Medical Association, 9312 Old George town Road, Bethesda, MD, 20814-1621, (301) 581-9200, http://www.apma.org.

Jeffrey P. Larson, RPT

Hand–foot–and–mouth disease

Definition

Hand–foot–and–mouth disease is an infection of young children in which characteristic fluid–filled blisters appear on the hands, feet, and inside the mouth.

Demographics

Hand–foot–and-mouth disease is very common among young children and often occurs in clusters of children who are in daycare together.

An outbreak of hand–foot–and–mouth disease occurred in Singapore in 2000, with more than 1,000 diagnosed cases, all in children, resulting in four deaths. A smaller outbreak occurred in Malaysia in 2000. In 1998, a serious outbreak of enterovirus 71 in Taiwan resulted in more than one million cases of hand–foot–and–mouth disease. Of these, there were 405 severe cases

Skin lesions on the tongue and around the mouth of a five-year-old boy due to hand-foot-mouth disease. *(Dr. P. Marazzi/ Photo Researchers, Inc.)*

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and 78 deaths, 71 of which were children younger than five years of age.

Hand–foot–and–mouth should not be confused with foot and mouth disease, which infects cattle but is extremely rare in humans. An outbreak of foot and mouth disease swept through Great Britain and into other parts of Europe and South America in 2001.

Description

Coxsackie viruses belong to a family of viruses called enteroviruses. These viruses live in the gastrointestinal tract and are therefore present in feces. They can be spread easily from one person to another when poor hygiene allows the virus within the feces to be passed from person to person. After exposure to the virus, development of symptoms takes only four to six days. Hand–foot–and–mouth disease can occur year–round, although the largest number of cases are in summer and fall months.

Causes and symptoms

Hand–foot–and–mouth disease is very common among young children and often occurs in clusters of children who are in daycare together. It is spread when poor hand–washing after a diaper change or contact with saliva (drool) allows the virus to be passed from one child to another.

Within about four to six days of acquiring the virus, an infected child may develop a relatively low–grade **fever**, ranging from 99–102°F (37–38.9°C). Other symptoms include **fatigue**, loss of energy, decreased appetite, and a sore sensation in the mouth that may interfere with feeding. After one to two days, fluid–filled bumps (vesicles) appear on the inside of the mouth, along the surface of the tongue, on the roof of the mouth, and on the insides of the cheeks. These are tiny blisters, about three to seven millimeters in diameter. Eventually, they may appear on the palms of the hands and on the soles of the feet. Occasionally, these vesicles may occur in the diaper region.

The vesicles in the mouth cause the majority of discomfort, and the child may refuse to eat or drink due to **pain**. This phase usually lasts for an average of a week. As long as the bumps have clear fluid within them, the disease is at its most contagious. The fluid within the vesicles contains large quantities of the causative viruses. Extra care should be taken to avoid contact with this fluid.

KEY TERMS

Enteroviruses—Viruses which live in the gastrointestinal tract. Coxsackie viruses, viruses that cause hand–foot–mouth disease, are an enterovirus.

Vesicle—A bump on the skin filled with fluid.

Diagnosis

Diagnosis is made by most practitioners solely on the basis of the unique appearance of blisters of the mouth, hands, and feet in a child not appearing very ill.

Treatment

There are no treatments available to cure or decrease the duration of the disease. Medications like **acetaminophen** or ibuprofen may be helpful for decreasing pain, and allowing the child to eat and drink. It is important to try to encourage the child to take in adequate amounts of fluids, in the form of ice chips or popsicles if other foods or liquids are too uncomfortable.

Alternative treatment

There are no effective alternative treatments for hand–foot–and–mouth disease.

Prognosis

The prognosis for a child with hand–foot–and–mouth disease is excellent. The child is usually completely better within about a week of the start of the illness.

Prevention

Prevention involves careful attention to hygiene. Thorough, consistent hand–washing practices and discouraging the sharing of clothes, towels, and stuffed toys are all helpful. The virus continues to be passed in the feces for several weeks after infection, so good hygiene should be practiced long after all signs of infection have passed.

Resources

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Hand-Schüller-Christian syndrome *see* **Histiocytosis X**

Hansen's disease *see* **Leprosy**

Hantavirus infections

Definition

Hantavirus infection is caused by a group of viruses that can infect humans with two serious illnesses: hemorrhagic **fever** with renal syndrome (HFRS), and Hantavirus pulmonary syndrome (HPS).

Description

Hantaviruses are found without causing symptoms within various species of rodents and are passed to humans by exposure to the urine, feces, or saliva of those infected rodents. Ten different hantaviruses have been identified as important in humans. Each is found in specific geographic regions and therefore is spread by different rodent carriers. Further, each type of virus causes a slightly different form of illness in its human hosts:

- Hantaan virus is carried by the striped field mouse and exists in Korea, China, Eastern Russia, and the Balkans. Hantaan virus causes a severe form of hemorrhagic fever with renal syndrome (HFRS).
- Puumula virus is carried by bank voles and exists in Scandinavia, western Russia, and Europe. Puumula virus causes a milder form of HFRS, usually termed *nephropathia epidemica*.
- Seoul virus is carried by a type of rat called the Norway rat and exists worldwide, but causes disease almost exclusively in Asia. Seoul virus causes a form of HFRS that is slightly milder than that caused by Hantaan virus, but results in liver complications.
- Prospect Hill virus is carried by meadow voles and exists in the United States, but has not been found to cause human disease.
- Sin Nombre virus, the most predominant strain in the United States, is carried by the deer mouse. This virus was responsible for severe cases of HPS that occurred in the southwestern United States in 1993.
- Black Creek Canal virus has been found in Florida. It is predominantly carried by cotton rats.
- New York virus strain has been documented in New York State. The vectors for this virus seem to be deer mice and white-footed mice.
- Bayou virus has been reported in Louisiana and Texas and is carried by the marsh rice rat.
- Blue River virus has been found in Indiana and Oklahoma and seems to be associated with the white-footed mouse.
- Monongahela virus, discovered in 2000, has been found in Pennsylvania and is transmitted by the white-footed mouse.

Causes and symptoms

Hemorrhagic fever with renal syndrome (HFRS)

Hantaviruses that produce forms of hemorrhagic fever with renal syndrome (HFRS) cause a classic group of symptoms, including fever, malfunction of the kidneys, and low **platelet count**. Because platelets are blood cells important in proper clotting, low numbers of circulating platelets can result in spontaneous bleeding, or hemorrhage.

Patients with HFRS have **pain** in the head, abdomen, and lower back and may report bloodshot eyes and blurry vision. Tiny pinpoint hemorrhages, called petechiae, may appear on the upper body and the soft palate in the mouth. The patient's face, chest, abdomen, and back often appear flushed and red, as if sunburned.

After about five days, the patient may have a sudden drop in blood pressure; often it drops low enough to cause the clinical syndrome called **shock**. Shock is a state in which blood circulation throughout the body is insufficient to deliver proper quantities of oxygen. Lengthy shock can result in permanent damage to the body's organs, particularly the brain, which is very sensitive to oxygen deprivation.

Around day eight of HFRS, kidney involvement results in multiple derangements of the body chemistry. Simultaneously, the hemorrhagic features of the illness begin to cause spontaneous bleeding, as demonstrated by bloody urine, bloody vomit, and in very serious cases, brain hemorrhages with resulting changes in consciousness.

Day 11 often brings further chemical derangements, with associated confusion, **hallucinations**, seizures, and lung complications. Those who survive this final phase usually begin to turn the corner toward recovery at this time, although recovery takes approximately six weeks.

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KEY TERMS

Hemodialysis—A method of mechanically cleansing the blood outside of the body, in order to remove various substances that would normally be cleared by the kidneys. Hemodialysis is used when an individual is in relative, or complete, kidney failure.

Hemorrhagic—A condition resulting in massive, difficult-to-control bleeding.

Petechiae—Pinpoint size red spots caused by hemorrhaging under the skin.

Platelets—Circulating blood cells that are crucial to the mechanism of clotting.

Prodrome—Early symptoms or warning signs

Pulmonary—Referring to the lungs.

Renal—Referring to the kidneys.

Shock—Shock is a state in which blood circulation is insufficient to deliver adequate oxygen to vital organs.

Hantavirus pulmonary syndrome (HPS)

Hantavirus pulmonary syndrome (HPS) develops in four stages. They are:

- The incubation period. This lasts from one to five weeks from exposure. Here, the patient may exhibit no symptoms.
- The prodrome, or warning signs, stage. Symptoms begin with a fever, muscle aches, headache, dizziness, and abdominal pain and upset. Sometimes there is vomiting and diarrhea.
- The cardiopulmonary stage. The patient slips into this stage rapidly, sometimes within a day or two of initial symptoms, sometimes as long as 10 days later. There is a drop in blood pressure, shock, and leaking of the blood vessels of the lungs, which results in fluid accumulation in the lungs, and subsequent shortness of breath. The fluid accumulation can be so rapid and so severe as to put the patient in respiratory failure within only a few hours. Some patients experience severe abdominal tenderness.
- The convalescent stage. If the patient survives the respiratory complications of the previous stage, there is a rapid recovery, usually within a day or two. However, abnormal liver and lung functioning may persist for six months.

Diagnosis

Serologic techniques help diagnose a hantavirus infection. The patient's blood is drawn, and the ELISA (enzyme-linked immunosorbent assay) is done in a laboratory to identify the presence of specific immune substances (antibodies)—substances which an individual's body would only produce in response to the hantavirus.

It is very difficult to demonstrate the actual virus in human tissue or to grow cultures of the virus within the laboratory, so the majority of diagnostic tests use indirect means to demonstrate the presence of the virus.

Treatment

Treatment of hantavirus infections is primarily supportive because there are no agents available to kill the viruses and interrupt the infection. Broad-spectrum **antibiotics** are given until the diagnosis is confirmed. Supportive care consists of providing treatment in response to the patient's symptoms. Because both HFRS and HPS progress so rapidly, patients must be closely monitored so that treatment may be started at the first sign of a particular problem. Low blood pressure is treated with medications. Blood transfusions are given for both hemorrhage and shock states. Hemodialysis is used in kidney failure. (Hemodialysis involves mechanically cleansing the blood outside of the body, to replace the kidney's normal function of removing various toxins form the blood.) Rapid respiratory assistance is critical, often requiring intubation.

The anti-viral agent ribavirin has been approved for use in early treatment of hantavirus infections.

Prognosis

The diseases caused by hantaviruses are extraordinarily lethal. About 6–15% of people who contract HFRS have died. Almost half of all people who contract HPS will die. This gives HPS one of the highest fatality rates of any acute viral disease. It is essential that people living in areas where the hantaviruses exist seek quick medical treatment should they begin to develop an illness that might be due to a hantavirus.

Prevention

There are no immunizations currently available against any of the hantaviruses. In 2003, developments in genetic science were helping researchers work on a possible **vaccination** and therapy for several versions of hantavirus, including the Sin Nombre virus that causes HPS. With further work, a gene-based vaccine

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could become available in the future. However, the only known forms of hantavirus prevention involve rodent control within the community and within individual households. The following is a list of preventive measures:

- Avoiding areas known to be infested by rodents is essential.
- Keeping a clean home and keeping food in rodent-proof containers.
- Disposing of garbage and emptying pet food dishes at night.
- Setting rodent traps around baseboards and in tight places. Disposing of dead animals with gloves and disinfecting the area with bleach.
- Using rodenticide as necessary.
- Sealing any entry holes 0.25 inch wide or wider around foundations with screen, cement, or metal flashing.
- Clearing brush and junk from house foundations.
- Putting metal flashing around house foundations.
- Elevating hay, woodpiles, and refuse containers.
- Airing out all sealed outbuildings or cabins 30 minutes before cleaning for the season.
- When camping, avoiding sleeping on the bare ground. It is advised to sleep on a cot or in a tent with a floor.

Resources

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"DNA Vaccine Protects Against Hantavirus Pulmonary Syndrome." *Heart Disease Weekly*. November 2, 2003: 31.

Janie F. Franz
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Haptoglobin test

Definition

This test is done to help evaluate a person for **hemolytic anemia**.

Purpose

Haptoglobin is a blood protein made by the liver. The haptoglobin levels decrease in hemolytic anemia. Hemolytic **anemias** include a variety of conditions that result in hemolyzed, or burst, red blood cells.

Decreased values can also indicate a slower type of red cell destruction unrelated to anemia. For example, destruction can be caused by mechanical heart valves or abnormal hemoglobin, such as **sickle cell disease** or **thalassemia**.

Haptoglobin is known as an acute phase reactant. Its level increases during acute conditions such as infection, injury, tissue destruction, some cancers, **burns**, surgery, or trauma. Its purpose is to remove damaged cells and debris and rescue important material such as iron. Haptoglobin levels can be used to monitor the course of these conditions.

Description

Hemoglobin is the protein in the red blood cell that carries oxygen throughout the body. Iron is an essential part of hemoglobin; without iron, hemoglobin can not function. Haptoglobin's main role is to save iron by attaching itself to any hemoglobin released from a red cell.

When red blood cells are destroyed, the hemoglobin is released. Haptoglobin is always present in the blood waiting to bind to released hemoglobin. White blood cells (called macrophages) bring the haptoglobin-hemoglobin complex to the liver, where the haptoglobin and hemoglobin are separated and the iron is recycled.

In hemolytic anemia, so many red cells are destroyed that most of the available haptoglobin is needed to bind the released hemoglobin. The more severe the hemolysis, the less haptoglobin remains in the blood.

Haptoglobin is measured in several different ways. One way is called rate nephelometry. A person's serum is mixed with a substance that will bind to haptoglobin. The amount of bound haptoglobin is measured using a rate nephelometer, which measures the amount of light scattered by the bound haptoglobin. Another way of measuring haptoglobin is to measure it according to how much hemoglobin it can bind.

Preparation

This test requires 5 mL of blood. The person being tested should avoid taking **oral contraceptives** or androgens before this test. A healthcare worker ties a tourniquet on the person's upper arm, locates a vein in the inner elbow region, and inserts a needle into that vein. Vacuum action draws the blood through the needle into an attached tube. Collection of the sample takes only a few minutes.

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KEY TERMS

Acute phase reactant—A substance in the blood that increases as a response to an acute condition such as infection, injury, tissue destruction, some cancers, burns, surgery, or trauma.

Haptoglobin—A blood protein made by the liver. Its main role is to save iron by attaching itself to any hemoglobin released from a red cell.

Hemoglobin—The protein in the red blood cell that carries oxygen.

Hemolytic anemia—A variety of conditions that result in hemolyzed, or burst, red blood cells.

Aftercare

Discomfort or bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Warm packs to the puncture site relieve discomfort.

Normal results

Normal results vary based on the laboratory and test method used. Haptoglobin is not present in newborns at birth, but develop adult levels by six months.

Abnormal results

Decreased haptoglobin levels usually indicates hemolytic anemia. Other causes of red cell destruction also decrease haptoglobin: a blood **transfusion** reaction; mechanical heart valve; abnormally shaped red cells; or abnormal hemoglobin, such as thalassemia or sickle cell anemia.

Haptoglobin levels are low in **liver disease**, because the liver can not manufacture normal amounts of haptoglobin. Low levels may also indicate an inherited lack of haptoglobin, a condition found particularly in African Americans.

Haptoglobin increases as a reaction to illness, trauma, or rheumatoid disease. High haptoglobin values should be followedup with additional tests. Drugs can also effect haptoglobin levels.

Normal results vary widely from person to person. Unless the level is very high or very low, haptoglobin levels are most valuable when the results of several tests done on different days are compared.

Nancy J. Nordenson

Hardening of the arteries *see* **Atherosclerosis**

Harelip *see* **Cleft lip and palate**

Hartnup disease

Definition

Hartnup disease is an inherited nutritional disorder with primary symptoms including a red, scaly rash and sensitivity to sunlight.

Description

Hartnup disease was first identified in the 1950s in the Hartnup family in London. A defect in intestines and kidneys makes it difficult to break down and absorb protein in the diet. This causes a condition very similar to pellegra (niacin deficiency). The condition occurs in about one of every 26,000 live births.

Causes and symptoms

Hartnup disease is an in-born error of metabolism, that is, a condition where certain nutrients cannot be digested and absorbed properly. The condition is passed on genetically in families. It occurs when a person inherits two recessive genes for the disease, one from each parent. People with Hartnup disease are not able to absorb some of the amino acids (the smaller building blocks that make up proteins) in their intestines. One of the amino acids that is not well absorbed is tryptophan, which the body uses to make its own form of niacin.

The majority of people with this disorder do not show any symptoms. About 10–20% of people with Hartnup disease do have symptoms. The most prominent symptom is a red, scaly rash that gets worse when the patient is exposed to sunlight. **Headache**, **fainting**, and **diarrhea** may also occur. **Mental retardation**, cerebral ataxia (muscle weakness), and **delirium** (a confused, agitated, delusional state) are some of the more serious complications that can occur. Short stature has also been noted in some patients. Although this is an inherited disease, the development of symptoms depends on a variety of factors including diet, environment, and other genetic traits controlling amino acid levels in the body. Symptoms can be brought on by exposure to sunlight, **fever**, drugs, or other stresses. Poor **nutrition** frequently precedes an attack of symptoms. The frequency of attacks usually decreases as the patient gets older.

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KEY TERMS

Amino acids—Proteins are made up of organic compounds called amino acids. The human body uses amino acids to build and repair body tissue. The body can make some of its own amino acids from other nutrients in the diet; these are called nonessential amino acids. Essential amino acids are those that cannot be made by the body but must be consumed in the diet. Animal proteins (like meat, eggs, fish, and milk) provide all of the amino acids.

Aminoaciduria—A condition confirmed by laboratory tests where high levels of amino acids are found in the urine.

Pellegra—A condition caused by a dietary deficiency of one of the B vitamins called niacin.

Tryptophan—An essential amino acid that has to consumed in the diet because it cannot be manufactured by the body. Tryptophan is converted by the body to niacin, one of the B vitamins.

Diagnosis

The symptoms of this disease suggest a deficiency of a B vitamin called niacin. A detailed diet history can be used to assess if there is adequate protein and **vitamins** in the diet. The diagnosis of Hartnup disease is confirmed by a laboratory test of the urine which will contain an abnormally high amount of amino acids (aminoaciduria).

Treatment

The vitamin niacin is given as a treatment for Hartnup disease. The typical dosage ranges from 40–200 mg of nicotinamide (a form of niacin) per day to prevent pellagra-like symptoms. Some patients may require dietary supplements of tryptophan.

Eating a healthy, high protein diet can relieve the symptoms and prevent them from recurring.

Prognosis

The prognosis for a healthy life is good once the condition has been identified and treated.

Prevention

Hartnup disease is an inherited condition. Parents may not have the disease themselves, but may pass the genes responsible for it on to their children. **Genetic testing** can be used to identify carriers of the genes. Symptoms can usually be controlled with a high protein diet, vitamin supplements of niacin, and by avoiding the stresses that contribute to attacks of symptoms.

Resources

OTHER

"Hartnup disorder." OMIM Homepage, Online Mendelian Inheritance in Man. http://www.ncbi.nlm.nih.gov/Omim.

"Nephrology: Hartnup disease." Medstudents.com. http://www.medstudents.com.

ORGANIZATIONS

National Institute of Diabetes and Digestive and Kidney Diseases, NIDDK, NIH Bldg 31, Rm 9A06 31 Center Drive, MSC 2560, Bethesda, MD, 20892-2560, (301) 496-3583, http://www2.niddk.nih.gov.

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923, (800) 999-6673, http://www.rarediseases.org.

Altha Roberts Edgren

Hashimoto's disease *see* **Thyroiditis**

Hatha yoga

Definition

Hatha **yoga** is the most widely practiced form of yoga in the United States. It is the branch of yoga which concentrates on physical health and mental well-being. Hatha yoga uses bodily postures (*asanas*), breathing techniques (*pranayama*), and **meditation** (*dyana*) with the goal of bringing about a sound, healthy body and a clear, peaceful mind. There are nearly 200 hatha yoga postures, with hundreds of variations, which work to make the spine supple and to promote circulation in all the organs, glands, and tissues. Hatha yoga postures also stretch and align the body, promoting balance and flexibility.

Purpose

In a celebrated 1990 study, *Dr. Dean Ornish's Program for Reversing Heart Disease* (Random House), a cardiologist showed that yoga and meditation combined

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with a low-fat diet and group support could significantly reduce the blockage of coronary arteries. Other studies have shown yoga's benefit in reducing stress-related problems such as high blood pressure and cholesterol. Meditation has been adopted by medical schools and clinics as an effective **stress** management technique. Hatha yoga is also used by physical therapists to improve many injuries and disabilities, as the gentleness and adaptability of yoga make it an excellent **rehabilitation** program.

Yoga has been touted for its ability to reduce problems with such varying conditions as **asthma**, backaches, diabetes, **constipation**, **menopause**, **multiple sclerosis**, **varicose veins**, and **carpal tunnel syndrome**. A vegetarian diet is the dietary goal of yoga, and this change of lifestyle has been shown to significantly increase longevity and reduce heart disease.

Yoga as a daily **exercise** program can improve fitness, strength, and flexibility. People who practice yoga correctly every day report that it can promote high levels of overall health and energy. The mental component of yoga can clarify and discipline the mind, and yoga practitioners say its benefits can permeate all facets of a person's life and attitude, raising self-esteem and self-understanding.

Description

Origins

Yoga was developed in ancient India as far back as 5,000 years ago; sculptures detailing yoga positions have been found in India which date back to 3000 B.C. Yoga is derived from a Sanskrit word which means "union." The goal of classical yoga is to bring self-transcendence, or enlightenment, through physical, mental and spiritual health. Many people in the West mistakenly believe yoga to be a religion, but its teachers point out that it is a system of living designed to promote health, peace of mind, and deeper awareness of ourselves. There are several branches of yoga, each of which is a different path and philosophy toward self-improvement. Some of these paths include service to others, pursuit of wisdom, non-violence, devotion to God, and observance of spiritual rituals. Hatha yoga is the path which has physical health and balance as a primary goal, for its practitioners believe that greater mental and spiritual awareness can be brought about with a healthy and pure body.

The origins of hatha yoga have been traced back to the eleventh century A.D. The Sanskrit word *ha* means "sun" and *tha* means "moon," and thus hatha, or literally sun-moon yoga, strives to balance opposing parts of the physical body, the front and back, left and right, top and bottom. Some yoga masters (*yogis*) claim that hatha yoga was originally developed by enlightened teachers to help people survive during the Age of Kali, or the spiritual dark ages, in which Hindus believe we are now living.

The original philosophers of yoga developed it as an eight-fold path to complete health. These eight steps include moral and ethical considerations (such as honesty, non-aggression, peacefulness, non-stealing, generosity, and sexual propriety), self-discipline (including purity, simplicity, devotion to God, and self-knowledge), posture, breath control, control of desires, concentration, meditation, and happiness. According to yogis, if these steps are followed diligently, a person can reach high levels of health and mental awareness.

As it has subsequently developed, hatha yoga has concentrated mainly on two of the eight paths, breathing and posture. Yogis believe breathing to be the most important metabolic function; we breathe roughly 23,000 times per day and use about 4,500 gallons of air, which increases during exercise. Thus, breathing is extremely important to health, and *prana*, or life-force, is found most abundantly in the air and in the breath. If we are breathing incorrectly, we are hampering our potential for optimal health. *Pranayama*, literally the "science of breathing" or "control of life force," is the yogic practice of breathing correctly and deeply.

In addition to breathing, hatha yoga utilizes asanas, or physical postures, to bring about flexibility, balance and strength in the body. Each of these postures has a definite form and precise steps for achieving the desired position and for exiting it. These postures, yogis maintain, have been scientifically developed to increase circulation and health in all parts of the body, from the muscular tissues to the glands and internal organs. Yogis claim that although hatha yoga can make the body as strong and fit as any exercise program, its real benefits come about because it is a system of maintenance and balance for the whole body.

Yoga was brought to the United States in the late 1800s, when Swami Vivekananda, an Indian yogi, presented a lecture on yoga in Chicago. Hatha yoga captured the imagination of the Western mind, because accomplished yogis could demonstrate incredible levels of fitness, flexibility, and control over their bodies and metabolism. Yoga has flourished in the West. Americans have brought to yoga their energy and zest for innovation, which troubles some Indian yogis and encourages others, as new variations and schools of yoga have developed. For instance, power yoga is a recent Americanized version of yoga which takes hatha yoga principles and speeds them up into an

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extremely rigorous aerobic workout, and many strict hatha yoga teachers oppose this sort of change to their philosophy. Other variations of hatha yoga in the United States now include Iyengar, Ashtanga, Kripalu, Integral, Viniyoga, Hidden Language, and Bikram yoga, to name a few. Sivananda yoga was practiced by Lilias Folen, who was responsible for introducing many Americans to yoga through public television.

Iyengar yoga was developed by B.K.S. Iyengar, who is widely accepted as one of the great living yogis. Iyengar uses classical hatha yoga asanas and breathing techniques, but emphasizes great precision and strict form in the poses and uses many variations on a few postures. Iyengar allows the use of props such as belts, ropes, chairs, and blocks to enable students to get into postures they otherwise couldn't. In this respect, Iyengar yoga is good for **physical therapy** because it assists in the manipulation of inflexible or injured areas.

Ashtanga yoga, made popular by yogi K. Patabhi Jois, also uses hatha yoga asanas, but places an emphasis on the sequences in which these postures are performed. Ashtanga routines often unfold like long dances with many positions done quickly one after the other. Ashtanga is thus a rigorous form of hatha yoga, and sometimes can resemble a difficult aerobic workout. Ashtanga teachers claim that this form of yoga uses body heat, sweating, and deep breathing to purify the body.

Kripalu yoga uses hatha yoga positions but emphasizes the mental and emotional components of each asana. Its teachers believe that tension and long-held emotional problems can be released from the body by a deep and meditative approach to the yoga positions. Integral yoga seeks to combine all the paths of yoga and is generally more meditative than physical, emphasizing spirituality and awareness in everyday life. Viniyoga tries to adapt hatha yoga techniques to each individual body and medical problem. Hidden Language yoga was developed by Swami Sivananda Radha, a Western man influenced by Jungian psychology. It emphasizes the symbolic and psychological parts of yoga postures and techniques. Its students are encouraged to write journals and participate in group discussions as part of their practice. Bikram yoga has became very popular in the late 1990s, as its popular teacher, Bikram Choudury, began teaching in Beverly Hills and has been endorsed by many famous celebrities. Bikram yoga uses the repetition of 26 specific poses and two breathing techniques to stretch and tone the whole body.

A hatha yoga routine consists of a series of physical postures and breathing techniques. Routines can take anywhere from 20 minutes to two hours, depending on the needs and ability of the practitioner. Yoga should always be adapted to one's state of health; that is, a shorter and easier routine should be used when a person is fatigued. Yoga is ideally practiced at the same time every day, to encourage the discipline of the practice. It can be done at any time of day; some prefer it in the morning as a wake-up routine, while others like to wind down and de-stress with yoga at the end of the day.

Yoga asanas consist of three basic movements: backward bends, forward bends, and twisting movements. These postures are always balanced; a back bend should be followed with a forward bend, and a leftward movement should be followed by one to the right. Diaphragm breathing is important during the poses, where the breath begins at the bottom of the lungs. The stomach should move outward with the inhalation and relax inward during exhalation. The breath should be through the nose at all times during hatha asanas. Typically, one inhales during backward bends and exhales during forward bending movements.

The mental component in yoga is as important as the physical movements. Yoga is not a competitive sport, but a means to self-awareness and self-improvement. An attitude of attention, care, and non-criticism is important; limitations should be acknowledged and calmly improved. Patience is important, and yoga stretches should be slow and worked up to gradually. The body should be worked with, and never against, and a person should never overexert. A yoga stretch should be done only so far as proper form and alignment of the whole body can be maintained. Some yoga stretches can be uncomfortable for beginners, and part of yoga is learning to distinguish between sensations that are beneficial and those that can signal potential injury. A good rule is that positions should be stopped when there is sharp **pain** in the joints, muscles, or tendons.

Preparations

All that is needed to perform hatha yoga is a flat floor and adequate space for stretching out. A well-ventilated space is preferable, for facilitating proper breathing technique. Yoga mats are available which provide non-slip surfaces for standing poses. Loose, comfortable clothing should be worn. Yoga should be done on an empty stomach; a general rule is to wait three hours after a meal.

Yoga is an exercise that can be done anywhere and requires no special equipment. Yoga uses only gravity and the body itself as resistance, so it is a low-impact activity excellent for those who don't do well with other types of exercise. The mental component of yoga can

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KEY TERMS

Asana—Yoga posture or stance.

Diaphragm breathing—Method of deep breathing using the entire lungs.

Dyana—Yoga meditation.

Meditation—Technique of mental relaxation.

Prana—Yoga term for life-enhancing nutrient found in air, food, and water.

Pranayama—Yoga method of breathing.

appeal to those who get bored easily with exercise. By the same token, yoga can be a good stress management tool for those who prefer movement to sitting meditation.

Precautions

As with any exercise program, people should check with their doctors before starting yoga practice for the first time. Those with medical conditions, injuries, or spinal problems should find a yoga teacher familiar with their conditions before beginning yoga. Pregnant women, particularly after the third month of **pregnancy**, should only perform a few yoga positions with the supervision of an experienced teacher. Some yoga asanas can be very difficult, and potentially injurious, for beginners, so teachers should always be consulted as preparation for advanced yoga positions. Certain yoga positions should not be performed by those with fevers or during menstruation.

Side effects

Those just beginning hatha yoga programs often report **fatigue** and soreness throughout the body, as yoga stretches and exercises muscles and tendons which are often long-neglected. Some yogic breathing and meditation techniques can be difficult for beginners and can cause **dizziness** or disorientation; these are best performed under the guidance of a teacher.

Resources

BOOKS

Feuerstein, Georg, and Larry Payne. *Yoga for Dummies*. New York: For Dummies, 2010.

ORGANIZATIONS

International Association of Yoga Therapists (IAYT), P.O. Box 12890, Prescott, AZ, 86304, (928) 541-0004, http://www.iayt.org/.

Douglas Dupler, MA

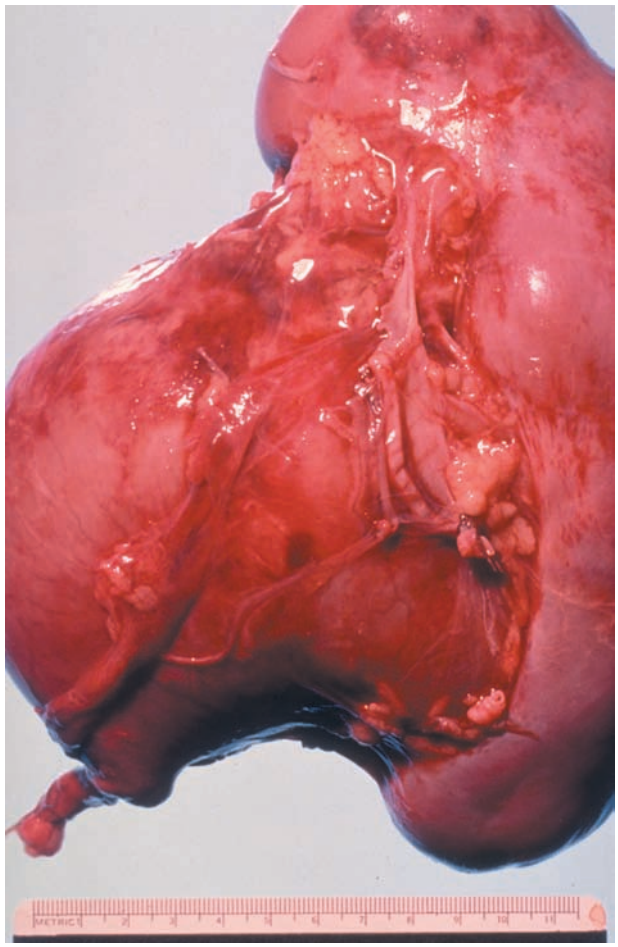
Haverhill fever *see* **Rat-bite fever**
Hay fever *see* **Allergic rhinitis**
HBF test *see* **Fetal hemoglobin test**
HCG *see* **Infertility drugs**

Head and neck cancer

Definition

The term head and neck cancers refers to a group of cancers found in the head and neck region. This includes tumors found in:

- The oral cavity (mouth). The lips, the tongue, the teeth, the gums, the lining inside the lips and cheeks, the floor of the mouth (under the tongue), the roof of



A specimen of a squamous cell carcinoma of the tongue and jaw. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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the mouth and the small area behind the wisdom teeth are all included in the oral cavity.

- The oropharynx (which includes the back one-third of the tongue, the back of the throat and the tonsils).
- Nasopharynx (which includes the area behind the nose).
- Hypopharynx (lower part of the throat).
- The larynx (voice box, located in front of the neck, in the region of the Adam's apple). In the larynx, the cancer can occur in any of the three regions: the glottis (where the vocal cords are); the supraglottis (the area above the glottis); and the subglottis (the area that connects the glottis to the windpipe).

The most frequently occurring cancers of the head and neck area are oral cancers and laryngeal cancers. Almost half of all the head and neck cancers occur in the oral cavity, and a third of the cancers are found in the larynx. By definition, the term "head and neck cancers" usually excludes tumors that occur in the brain.

Description

Head and neck cancers involve the respiratory tract and the digestive tract; and they interfere with the functions of eating and breathing. Laryngeal cancers affect speech. Loss of any of these functions is significant. Hence, early detection and appropriate treatment of head and neck cancers is of utmost importance.

Roughly 10% of all cancers are related to the head and the neck. In 2005, 39,000 men and women developed head and neck cancers and nearly 13,000 die each year from the disease. The American Cancer Society estimates that approximately, 12,100 new cases of laryngeal cancer alone will be diagnosed yearly and 3,600 people (2,870 men and 730 women) will die from this disease. Oral cancer is the sixth most common cancer in the United States. Approximately 35,000 new cases are diagnosed each year, and it causes at least 7.600 deaths. Among the major cancers, the survival rate for head and neck cancers is one of the poorest. Less than 50% of patients survive five years or more after initial diagnosis. This is because the early signs of head and neck cancers are frequently ignored. Hence, when it is first diagnosed, it is often in an advanced stage and not very amenable to treatment.

The risk for both oral cancer and laryngeal cancer seems to increase with age. Most of the cases occur in individuals over 40 years of age, the average age at diagnosis being 60. While oral cancer strikes men twice as often as it does women, laryngeal cancer is four times more common in men than in women. Both diseases are more common in African Americans than among whites.

Causes and symptoms

Although the exact cause for these cancers is unknown, tobacco is regarded as the single greatest risk factor: 75-80% of the oral and laryngeal cancer cases occur among smokers. Heavy alcohol use has also been included as a risk factor. A combination of tobacco and alcohol use increases the risk for oral cancer by 6–15 times more than for users of either substance alone. In rare cases, irritation to the lining of the mouth, due to jagged teeth or ill-fitting dentures, has been known to cause oral cancer. Exposure to asbestos appears to increase the risk of developing laryngeal cancer.

In the case of lip cancer, just like skin cancer, exposure to sun over a prolonged period has been shown to increase the risk. In Southeast Asian countries (India and Sri Lanka), chewing of betel nuts has been associated with cancer of the lining of the cheek. An increased incidence of nasal cavity cancer has been observed among furniture workers, probably due to the inhalation of wood dust. A virus (Epstein-Barr) has been shown to cause nasopharyngeal cancer.

Head and neck cancers are one of the easiest to detect. The early signs can be both seen and felt. The signs and symptoms depend on the location of the cancer:

- Mouth and oral cavity: a sore that does not heal within two weeks, unusual bleeding from the teeth or gums, a white or red patch in the mouth, a lump or thickening in the mouth, throat, or tongue.
- Larynx: persistent hoarseness or sore throat, difficulty breathing, or pain.
- Hypopharynx and oropharynx: difficulty in swallowing or chewing food, ear pain.
- Nose, sinuses, and nasopharyngeal cavity: pain, bloody discharges from the nose, blocked nose, and frequent sinus infections that do not respond to standard antibiotics.

When detected early and treated appropriately, head and neck cancers have an excellent chance of being cured completely.

Diagnosis

Specific diagnostic tests used depend on the location of the cancer. The standard tests are:

Physical examination

The first step in diagnosis is a complete and thorough examination of the oral and nasal cavity, using

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mirrors and other visual aids. The tongue and the back of the throat are examined as well. Any suspicious looking lumps or lesions are examined with fingers (palpation). In order to look inside the larynx, the doctor may sometimes perform a procedure known as **laryngoscopy**. In indirect laryngoscopy, the doctor looks down the throat with a small, long handled mirror. Sometimes the doctor inserts a lighted tube (laryngoscope or a fiberoptic scope) through the patient's nose or mouth. As the tube goes down the throat, the doctor can observe areas that cannot be seen by a simple mirror. This procedure is called a direct laryngoscopy. Some-times patients may be given a mild sedative to help them relax, and a local anesthetic to ease any discomfort.

Blood tests

The doctor may order blood or other immunological tests. These tests are aimed at detecting antibodies to the **Epstein-Barr virus**, which has been known to cause cancer of the nasopharynx.

Imaging tests

X rays of the mouth, the sinuses, the skull, and the chest region may be required. A computed tomography scan (CT scan), a procedure in which a computer takes a series of x ray pictures of areas inside the body, may be done. Ultrasonograms (images generated using sound waves) or an MRI (**magnetic resonance imaging**, a procedure in which a picture is created using magnets linked to a computer), are alternate procedures which a doctor may have done to get detailed pictures of the areas inside the body.

Biopsy

When a sore does not heal or a suspicious patch or lump is seen in the mouth, larynx, nasopharynx, or throat, a biopsy may be performed to rule out the possibility of cancer. The biopsy is the most definitive diagnostic tool for detecting the cancer. If cancerous cells are detected in the biopsied sample, the doctor may perform more extensive tests in order to find whether, and to where, the cancer may have spread.

Treatment

The cancers can be treated successfully if diagnosed early. The choice of treatment depends on the size of the tumor, its location, and whether it has spread to other parts of the body.

In the case of lip and mouth cancers, sometimes surgery is performed to remove the cancer. **Radiation therapy**, which destroys the cancerous cells, is also one of the primary modes of treatment and may be used alone or in combination with surgery. If lip surgery is drastic, **rehabilitation** cosmetic or **reconstructive surgery** may have to be considered.

Cancers of the nasal cavity are often diagnosed late because they have no specific symptoms in their early stages or the symptoms may just resemble chronic **sinusitis**. Hence, treatment is often complex, involving a combination of radiotherapy and surgery. Surgery is generally recommended for small tumors. If the cancer cannot be removed by surgery, radiotherapy is used alone.

Treatment of oropharynx cancers (cancers that are either in the back of the tongue, the throat, or the tonsils) generally involves radiation therapy and/or surgery. After aggressive surgery and radiation, rehabilitation is often necessary and is an essential part of the treatment. The patient may experience difficulties with swallowing, chewing, and speech and may require a team of health care workers, including speech therapists, prosthodontists, occupational therapists, etc.

Cancers of the nasopharynx are different from the other head and neck cancers in that there does not appear to be any association between alcohol and tobacco use and the development of the cancer. In addition, the incidence is seen primarily in two age groups: young adults and 50–70 year-olds. The Epstein-Barr virus has been implicated as the causative agent in most patients. While 80–90% of small tumors are curable by radiation therapy, advanced tumors that have spread to the bone and cranial nerves are difficult to control. Surgery is not very helpful and, hence, is rarely attempted. Radiation remains the only treatment of choice to treat the cancer that has metastasized (traveled) to the lymph nodes in the neck.

In the case of cancer of the larynx, radiotherapy is the first choice to treat small lesions. This is done in an attempt to preserve the voice. If the cancer recurs later, surgery may be attempted. If the cancer is limited to one of the two vocal cords, laser excision surgery is used. In order to treat advanced cancers, a combination of surgery and radiation therapy is often used. Because the chances of a cure in the case of advanced laryngeal cancers are rather low with current therapies, the patient may be advised to participate in clinical trials so they may get access to new experimental drugs and procedures, such as **chemotherapy**, that are being evaluated.

When only part of the larynx is removed, a relatively slight change in the voice may occur—the patient may sound slightly hoarse. However, in a total **laryngectomy**, the entire voice box is removed. The patients then have to

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KEY TERMS

Biopsy—The surgical removal and microscopic examination of living tissue for diagnostic purposes.

Chemotherapy—Treatment of cancer with synthetic drugs that destroy the tumor either by inhibiting the growth of the cancerous cells or by killing the cancer cells.

Clinical trials—Highly regulated and carefully controlled patient studies, where either new drugs to treat cancer or novel methods of treatment are investigated.

Computerized tomography scan (CT scan)—A medical procedure where a series of X-rays are taken and put together by a computer in order to form detailed pictures of areas inside the body.

Laryngoscopy—A medical procedure that uses flexible, lighted, narrow tubes inserted through the mouth or nose to examine the larynx and other areas deep inside the neck.

Magnetic resonance imaging (MRI)—A medical procedure used for diagnostic purposes where pictures of areas inside the body can be created using a magnet linked to a computer.

Radiation therapy—Treatment using high energy radiation from x-ray machines, cobalt, radium, or other sources.

Stoma—When the entire larynx must be surgically removed, an opening is surgically created in the neck so that the windpipe can be brought out to the neck. This opening is called the stoma.

Ultrasonogram—A procedure where high-frequency sound waves that cannot be heard by human ears are bounced off internal organs and tissues. These sound waves produce a pattern of echoes which are then used by the computer to create sonograms, or pictures, of areas inside the body.

X rays—High energy radiation used in high doses, either to diagnose or treat disease.

re-learn to speak using different approaches, such as esophageal speech, tracheo-esophageal (TE) speech, or by means of an artificial larynx.

In esophageal speech, the patients are taught how to create a new type of voice by forcing air through the esophagus (food pipe) into the mouth. This method has a high success rate of approximately 65% and patients are even able to go back to jobs that require a high level of verbal communication, such as telephone operators and salespersons.

In the second approach, TE speech, a small opening, called a **fistula**, is created surgically between the trachea (breathing tube to the lungs) and the esophagus (tube into the stomach) to carry air into the throat. A small tube, known as the "voice prosthesis," is placed in the opening of the fistula to keep it open and to prevent food and liquid from going down into the trachea. In order to talk, the stoma (or the opening made at the base of the neck) must be covered with one's thumb during exhalation. As the air is forced out from the trachea into the esophagus, it vibrates the walls of the esophagus. This produces a sound that is then modified by the lips and tongue to produce normal sounding speech.

In the third approach, an artificial larynx, a battery driven vibrator, is placed on the outside of the throat. Sound is created as air passes through the stoma (opening made at the base of the neck) and the mouth forms words.

Prognosis

Oral cavity

With early detection and immediate treatment, survival rates can be dramatically improved. For lip and oral cancer, if detected at its early stages, almost 80% of the patients survive five years or more. However, when diagnosed at the advanced stages, the five year survival rate drops to a mere 18%.

Nose and sinuses

Cancers of the nasal cavity often go undetected until they reach an advanced stage. If diagnosed at the early stages, the five-year survival rates are 60–70%. However, if cancers are more advanced, only 10–30% of the patients survive five years or more.

Oropharynx

In cancer of the oropharynx, 60–80% of the patients survive five years or more if the cancer is detected in the early stages. As the cancer advances, the survival rate drops to 15–30%.

Nasopharynx

Patients who are diagnosed with early stage cancers that have originated in the nasopharynx have an excellent chance of a complete cure (almost 95%).

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Unfortunately, most of the time, the patients are in an advanced stage at the time of initial diagnosis. With the new chemotherapy drugs, the five year survival rate has improved and 5–40% of the patients survive five years or longer.

Larynx

Small cancers of the larynx have an excellent five-year survival rate of 75–95%. However, as with most of the head and neck cancers, the survival rates drop dramatically as the cancer advances. Only 15–25% of the patients survive five years or more after being initially diagnosed with advanced laryngeal cancer.

Prevention

Refraining from the use of all tobacco products (cigarettes, cigars, pipe tobacco, chewing tobacco), consuming alcohol in moderation, and practicing good **oral hygiene** are some of the measures that one can take to prevent head and neck cancers. Since there is an association between excessive exposure to the sun and lip cancer, people who spend a lot of time outdoors in the sun should protect themselves from the sun's harmful rays. Regular physical examinations, or mouth examination by the patient himself, or by the patient's doctor or dentist, can help detect oral cancer in its very early stages.

Since working with asbestos has been shown to increase one's risk of getting cancer of the larynx, asbestos workers should follow safety rules to avoid inhaling asbestos fibers. Also, **malnutrition** and vitamin deficiencies have been shown to have some association with an increased incidence of head and neck cancers. The American Cancer Society, therefore, recommends eating a healthy diet, consisting of at least five servings of fruits and vegetables every day, and six servings of food from other plant sources such as cereals, breads, grain products, rice, pasta, and beans. Reducing one's intake of high-fat food from animal sources is advised.

ORGANIZATIONS

American Association of Oral & Maxillofacial Surgeons, 9700 West Bryn Mawr Avenue, Rosemont, IL, 60018-5701, (847) 678-6200, (847) 678-6286, (800) 822-6637, http://www.aaoms.org.

National Cancer Institute (National Institutes of Health), NCI Office of Communications and Education, 6116 Executive Blvd. Suite 300, Bethesda, MD, 20892-8322, (800) 4-CANCER (422-6237), cancergovstaff@mail.nih.gov, http://www.cancer.gov/.

National Institute of Dental and Craniofacial Research, National Institutes of Health, Bethesda, MD, (301) 470-4098, (866) 232-4528, nidcrinfo@mail.nih.gov, http://www.nidcr.nih.gov.

The International Association of Laryngectomees (IAL), 925B Peachtree Street - NE Suite 316 , Atlanta, GA, 30309, (866) 425-3678, http://www.theial.com/ial/.

Thyroid, Head and Neck Cancer Foundation, 10 Union Square East, Suite 5B, New York, NY, 10003, (212) 844-6832, (212) 844-8465, info@thancfoundation.org, http://www.thancfoundation.org.

Lata Cherath, PhD

Head injury

Definition

Injury to the head may damage the scalp, skull, or brain. The most important consequence of head trauma is traumatic brain injury. Head injury may occur either as a closed head injury, such as the head hitting a car's windshield, or as a penetrating head injury, as when a bullet pierces the skull. Both may cause damage that ranges from mild to profound. Very severe injury can be fatal because of profound brain damage.

Description

External trauma to the head is capable of damaging the brain, even if there is no external evidence of damage. More serious injuries can cause skull fracture, **blood clots** between the skull and the brain, or bruising and tearing of the brain tissue itself.

Injuries to the head can be caused by traffic accidents, **sports injuries**, falls, workplace accidents, assaults, or bullets. Most people have had some type of head injury at least once in their lives, but rarely do they require a hospital visit.

Each year about two million people have a serious head injury and up to 750,000 of them are severe enough to require hospitalization. Brain injury is most likely to occur in males between ages 15 and 24, usually as a result of car and motorcycle accidents. About 70% of all accidental deaths are due to head injuries, as are most of the disabilities that occur after trauma.

A person who has had a head injury and who is experiencing the following symptoms should seek medical care immediately:

- serious bleeding from the head or face
- loss of consciousness, however brief
- confusion and lethargy
- lack of pulse or breathing
- clear fluid drainage from the nose or ear

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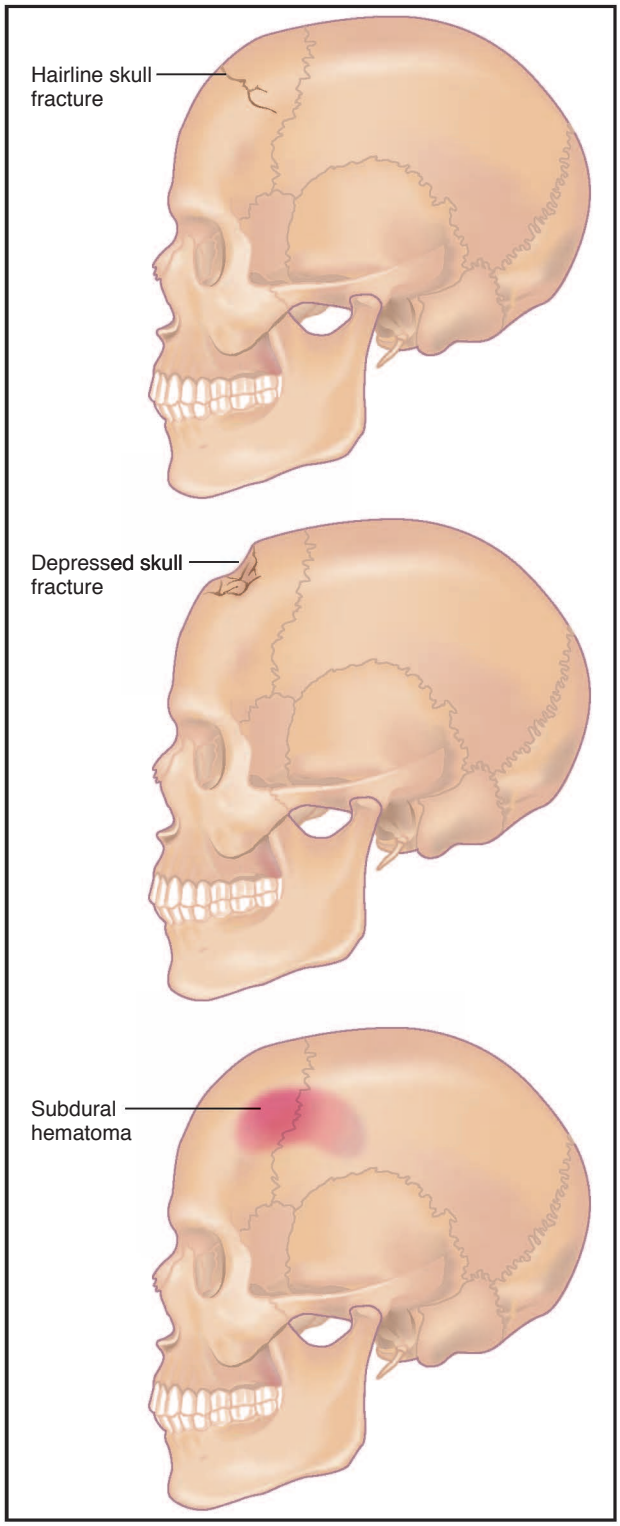

Illustration depicting three types of head injury: hairline fracture, depressed fracture, and subdural hematoma. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Causes and symptoms

A head injury may cause damage both from the direct physical injury to the brain and from secondary factors, such as lack of oxygen, brain swelling, and disturbance of blood flow. Both closed and penetrating head injuries can cause swirling movements throughout the brain, tearing nerve fibers and causing widespread bleeding or a blood clot in or around the brain. Swelling may raise pressure within the skull (intracranial pressure) and may block the flow of oxygen to the brain.

Head trauma may cause a **concussion**, in which there is a brief loss of consciousness without visible structural damage to the brain. In addition to loss of consciousness, initial symptoms of brain injury may include:

- memory loss and confusion
- vomiting
- dizziness
- partial paralysis or numbness
- shock
- anxiety

After a head injury, there may be a period of impaired consciousness followed by a period of confusion and impaired memory with disorientation and a breakdown in the ability to store and retrieve new information. Others experience temporary **amnesia** following head injury that begins with **memory loss** over a period of weeks, months, or years before the injury (retrograde amnesia). As the patient recovers, memory slowly returns. Post-traumatic amnesia refers to loss of memory for events during and after the accident.

Epilepsy occurs in 2–5% of people who have had a head injury; it is much more common in people who have had severe or penetrating injuries. Most cases of epilepsy appear right after the accident or within the first year and become less likely with increased time following the accident.

Closed head injury

Closed head injury refers to brain injury without any penetrating injury to the brain. It may be the result of a direct blow to the head; of the moving head being rapidly stopped, such as when a person's head hits a windshield in a car accident; or by the sudden deceleration of the head without its striking another object. The kind of injury the brain receives in a closed head injury is determined by whether or not the head was unrestrained upon impact and the direction, force, and velocity of the blow. If the head is resting on impact, the maximum damage will be found at the impact site. A moving head will cause a "contrecoup injury" where

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A three-dimensional computed tomography (CT) scan of a human skull showing a depressed skull fracture above the right eye. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

the brain damage occurs on the side opposite the point of impact, as a result of the brain slamming into that side of the skull. A closed head injury also may occur without the head being struck, such as when a person experiences **whiplash**. This type of injury occurs because the brain is of a different density than the skull and can be injured when delicate brain tissues hit against the rough, jagged inner surface of the skull.

Penetrating head injury

If the skull is fractured, bone fragments may be driven into the brain. Any object that penetrates the skull may implant foreign material and dirt into the brain, leading to an infection.

Skull fracture

A skull fracture is a medical emergency that must be treated promptly to prevent possible brain damage. Such an injury may be obvious if blood or bone fragments are visible, but it is possible for a fracture to have occurred without any apparent damage. A skull fracture should be suspected if there is:

- blood or clear fluid leaking from the nose or ears
- unequal pupil size
- bruises or discoloration around the eyes or behind the ears
- swelling or depression of part of the head

Intracranial hemorrhage

Bleeding (hemorrhage) inside the skull may accompany a head injury and cause additional damage to the brain. A blood clot (hematoma) may occur if a blood vessel between the skull and the brain ruptures; when the blood leaks out and forms a clot, it can press against brain tissue, causing symptoms from a few hours to a few weeks after the injury. If the clot is located between the bones of the skull and the covering of the brain (dura), it is called an epidural hematoma. If the clot is between the dura and the brain tissue itself, the condition is called a **subdural hematoma**. In other cases, bleeding may occur deeper inside the brain. This condition is called intracerebral hemorrhage or intracerebral contusion (from the word for bruising).

In any case, if the blood flow is not stopped, it can lead to unconsciousness and **death**. The symptoms of bleeding within the skull include:

- nausea and vomiting
- headache
- loss of consciousness
- unequal pupil size
- lethargy

Post-concussion syndrome

If the head injury is mild, there may be no symptoms other than a slight **headache**. There also may be confusion, **dizziness**, and blurred vision. While the head injury may seem to have been quite mild, in many cases symptoms persist for days or weeks. Up to 60% of patients who sustain a mild brain injury continue to experience a range of symptoms called "post-concussion syndrome," as long as six months or a year after the injury.

The symptoms of **post-concussion syndrome** can result in a puzzling interplay of behavioral, cognitive, and emotional complaints that can be difficult to diagnose, including:

- headache
- dizziness
- mental confusion

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- behavior changes
- memory loss
- cognitive deficits
- depression
- emotional outbursts

Diagnosis

The extent of damage in a severe head injury can be assessed with computed tomography (CT) scan, **magnetic resonance imaging** (MRI), **positron emission tomography (PET)** scans, electroencephalograms (EEG), and routine neurological and neuropsychological evaluations.

Doctors use the Glasgow **Coma** Scale to evaluate the extent of brain damage based on observing a patient's ability to open his or her eyes, respond verbally, and respond to stimulation by moving (motor response). Patients can score from 3 to 15 points on this scale. People who score below eight when they are admitted usually have suffered a severe brain injury and will need rehabilitative therapy as they recover. In general, higher scores on the Glasgow Coma Scale indicate less severe brain injury and a better prognosis for recovery.

Patients with a mild head injury who experience symptoms are advised to seek out the care of a specialist; unless a family physician is thoroughly familiar with medical literature in this newly emerging area, experts warn that there is a good chance that patient complaints after a mild head injury will be downplayed or dismissed. In the case of mild head injury or post-concussion syndrome, CT and MRI scans, electroencephalograms (EEG), and routine neurological evaluations all may be normal because the damage is so subtle. In many cases, these tests cannot detect the microscopic damage that occurs when fibers are stretched in a mild, diffuse injury. In this type of injury, the axons lose some of their covering and become less efficient. This mild injury to the white matter reduces the quality of communication between different parts or the brain. A **PET** scan, which evaluates cerebral blood flow and brain metabolism, may be of help in diagnosing mild head injury.

Patients with continuing symptoms after a mild head injury should call a local chapter of a head-injury foundation that can refer patients to the best nearby expert.

Treatment

If a concussion, bleeding inside the skull, or skull fracture is suspected, the patient should be kept quiet in a darkened room, with head and shoulders raised slightly on a pillow or blanket.

After initial emergency treatment, a team of specialists may be needed to evaluate and treat the problems that result. A penetrating wound may require surgery. Those with severe injuries or with a deteriorating level of consciousness may be kept hospitalized for observation. If there is bleeding inside the skull, the blood may need to be surgically drained; if a clot has formed, it may need to be removed. Severe skull **fractures** also require surgery.

Supportive care and specific treatments may be required if the patient experiences further complications. People who experience seizures, for example, may be given **anticonvulsant drugs**, and people who develop fluid on the brain (**hydrocephalus**) may have a shunt inserted to drain the fluid.

In the event of long-term disability as a result of head injury, there are a variety of treatment programs available, including long-term **rehabilitation**, coma treatment centers, transitional living programs, behavior management programs, life-long residential or day treatment programs and independent living programs.

Prognosis

Prompt, proper diagnosis and treatment can help alleviate some of the problems after a head injury. It usually is difficult to predict the outcome of a brain injury in the first few hours or days; a patient's prognosis may not be known for many months or even years.

The outlook for someone with a minor head injury generally is good, although recovery may be delayed and symptoms such as headache, dizziness, and cognitive problems can persist for up to a year or longer after an accident. This can limit a person's ability to work and cause strain in personal relationships.

Serious head injuries can be devastating, producing permanent mental and physical disability. Epileptic seizures may occur after a severe head injury, especially a penetrating brain injury, a severe skull fracture, or a serious brain hemorrhage. Recovery from a severe head injury can be very slow, and it may take five years or longer to heal completely. Risk factors associated with an increased likelihood of memory problems or seizures after head injury include age, length and depth of coma, duration of post-traumatic and retrograde amnesia, presence of focal brain injuries, and initial Glasgow Coma Scale score.

As researchers learn more about the long-term effects of head injuries, they have started to uncover links to later conditions. A 2003 report found that mild

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KEY TERMS

Computed tomography scan (CT)—A diagnostic technique in which the combined use of a computer and x rays produce clear cross-sectional images of tissue. It provides clearer, more detailed information than x rays alone.

Electroencephalogram (EEG)—A record of the tiny electrical impulses produced by the brain's activity. By measuring characteristic wave patterns, the EEG can help diagnose certain conditions of the brain.

Magnetic resonance imaging (MRI)—A diagnostic technique that provides high quality cross-sectional images of organs within the body without x rays or other radiation.

Positron emission tomography (PET) scan—A computerized diagnostic technique that uses radioactive substances to examine structures of the body. When used to assess the brain, it produces a three-dimensional image that reflects the metabolic and chemical activity of the brain.

brain injury during childhood could speed up expression of **schizophrenia** in those who were already likely to get the disorder because of genetics. Those with a history of a childhood brain injury, even a minor one, were more likely to get familial schizophrenia than a sibling and to have earlier onset. Another study in 2003 found that people who had a history of a severe head injury were four times more likely to develop Parkinson's disease than the average population. Those requiring hospitalization for their head injuries were 11 times as likely. The risk did not increase for people receiving mild head injuries.

Prevention

Many severe head injuries could be prevented by wearing protective helmets during certain sports or when riding a bike or motorcycle. Seat belts and airbags can prevent many head injuries that result from car accidents. Appropriate protective headgear always should be worn on the job where head injuries are a possibility.

Resources

BOOKS

Daisley, Audrey, Rachel Tams, and Udo Kischka. *Head Injury*. New York: Oxford University Press, 2009.

Huff, Eane. *Heads Up: Finding Possibility and Purpose with Head Injury*. Parker, CO: Outskirts Press, 2009.

Mason, Michael Paul. *Head Cases: Stories of Brain Injury and Its Aftermath*. New York: Farrar, Straus and Giroux, 2009.

Smith, Terry. *Surviving Head Trauma: A Guide to Recovery Written by a Traumatic Brain Injury Patient*. Bloomington, IN: iUniverse, 2009.

PERIODICALS

"Childhood Head Injury Tied to Later Schizophrenia." *The Brown University Child and Adolescent Behavior Letter* (June 2003): 5.

"Link to Head Injury Found." *Pain & Central Nervous System Week* (June 9, 2003): 3.

ORGANIZATIONS

American Epilepsy Society, 342 N. Main St., West Hartford, CT, 06117-2507, (860) 586-7505, http://www.aesnet.org.

Brain Injury Association of America, 1608 Spring Hill Road, Suite 110, Vienna, VA, 22182, (703) 761-0750, http://www.biausa.org.

Brain Injury Resource Center, P.O. Box 84151, Seattle, WA, 98124, (206) 621-8558, http://www.headinjury.com.

Family Caregiver Alliance, 425 Bush St., Ste. 500, San Francisco, CA, 94108, (800) 445-8106, http://www.caregiver. org.

Head Trauma Support Project, Inc, 2500 Marconi Ave., Ste. 203, Sacramento, CA, 95821, (916) 482-5770

National Head Injury Foundation, 333 Turnpike Rd., Southboro, MA, 01722, (617) 485-9950

National Institute of Neurological Disorders and Stroke (NINDS), P.O. Box 5801, Bethesda, MD, 20824, (301) 496-5751, (800) 352-9424, http://www.ninds.nih.gov.

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Laura Jean Cataldo, RN, EdD

Head lice *see* **Lice infestation**
Head trauma *see* **Head injury**

Headache

Definition

A headache involves **pain** in the head which can arise from many disorders or may be a disorder in and of itself.

Description

There are three types of primary headaches: tension-type (muscular contraction headache), migraine

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(vascular headaches), and cluster. Virtually everyone experiences a tension-type headache at some point. An estimated 18% of American women suffer migraines, compared to 6% of men. Cluster headaches affect fewer than 0.5% of the population, and men account for approximately 80% of all cases. Headaches caused by illness are secondary headaches and are not included in these numbers.

Approximately 40–45 million people in the United States suffer chronic headaches. Headaches have an enormous impact on society due to missed workdays and productivity losses.

Causes and symptoms

Traditional theories about headaches link tension-type headaches to muscle contraction, and migraine and cluster headaches to blood vessel dilation (swelling). Pain-sensitive structures in the head include blood vessel walls, membranous coverings of the brain, and scalp and neck muscles. Brain tissue itself has no sensitivity to pain. Therefore, headaches may result from contraction of the muscles of the scalp, face or neck; dilation of the blood vessels in the head; or brain swelling that stretches the brain's coverings. Involvement of specific nerves of the face and head may also cause characteristic headaches. Sinus inflammation is a common cause of headache. Keeping a headache diary may help link headaches to stressful occurrences, menstrual phases, food triggers, or medication.

Tension-type headaches are often brought on by **stress**, overexertion, loud noise, and other external factors. The typical tension-type headache is described as a tightening around the head and neck, and an accompanying dull ache.

Migraines are intense throbbing headaches occurring on one or both sides of the head, usually on one side. The pain is accompanied by other symptoms such as **nausea**, **vomiting**, blurred vision, and aversion to light, sound, and movement. Migraines often are triggered by food items, such as red wine, chocolate, and aged cheeses. For women, a hormonal connection is likely, since headaches occur at specific points in the menstrual cycle, with use of **oral contraceptives**, or the use of **hormone replacement therapy** after **menopause**. Research shows that a complex interaction of nerves and neurotransmitters in the brain act to cause migraine headaches.

Cluster headaches cause excruciating pain. The severe, stabbing pain centers around one eye, and eye tearing and nasal congestion occur on the same side. The headache lasts from 15 minutes to four hours and may recur several times in a day. Heavy smokers are more likely to suffer cluster headaches, which also are associated with alcohol consumption.

Diagnosis

Since headaches arise from many causes, a physical exam assesses general health and a neurologic exam evaluates the possibility of neurologic disease as a cause for the headache. If the headache is the primary illness, the doctor asks for a thorough history of the headache. Questions revolve around its frequency and duration, when it occurs, pain intensity and location, possible triggers, and any prior symptoms. This information aids in classifying the headache.

Warning signs that should point out the need for prompt medical intervention include:

- "Worst headache of my life." This may indicate subarachnoid hemorrhage from a ruptured aneurysm (swollen blood vessel) in the head or other neurological emergency.
- Headache accompanied by one-sided weakness, numbness, visual loss, speech difficulty, or other signs. This may indicate a stroke. Migraines may include neurological symptoms.
- Headache that becomes worse over a period of six months, especially if most prominent in the morning or if accompanied by neurological symptoms. This may indicate a brain tumor.
- Sudden onset of headache. If accompanied by fever and stiff neck, this can indicate meningitis.

Headache diagnosis may include neurological imaging tests such as computed tomography scan (CT scan) or **magnetic resonance imaging** (MRI).

Treatment

Headache treatment is divided into two forms: abortive and prophylactic. Abortive treatment addresses a headache in progress, and prophylactic treatment prevents headache occurrence.

Tension-type headaches can be treated with **aspirin**, **acetaminophen**, ibuprofen, or naproxen. In early 1998, the FDA approved extra-strength Excedrin, which includes **caffeine**, for mild migraines. Physicians continue to investigate and monitor the best treatment for migraines and generally prefer a stepped approach, depending on headache severity, frequency, and impact on the patient's quality of life. A group of drugs called triptans are usually preferred for abortive treatment. About seven triptans are available in the United States, and the pill forms are considered most effective. They should be taken as early as possible during the typical migraine attack. The most common prophylactic

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KEY TERMS

Abortive—Referring to treatment that relieves symptoms of a disorder.

Analgesics—A class of pain-relieving medicines, including aspirin and Tylenol.

Biofeedback—A technique in which a person is taught to consciously control the body's response to a stimulus.

Chronic—Referring to a condition that occurs frequently or continuously or on a regular basis.

Prophylactic—Referring to treatment that prevents symptoms of a disorder from appearing.

Transcutaneous electrical nerve stimulation—A method that electrically stimulates nerve and blocks the transmission of pain signals, called TENS.

therapies include antidepressants, **beta blockers**, **calcium channel blockers**, and antiseizure medications. Antiseizure medications have proven particularly effective at blocking the actions of neurotransmitters that start migraine attacks. Topiramate (Topamax) was shown effective in several combined clinical trials in 2004 at 50 to 200 mg per day.

In 2004, a new, large study added evidence to show the effectiveness of botulinum toxin type A (Botox) treatment to prevent headache pain for those with frequent, untreatable tension and migraine headaches. Patients were treated every three months, with two to five injections each time. They typically received relief within two to three weeks.

Cluster headaches may also be treated with ergotamine and sumatriptan, as well as by inhaling pure oxygen. Prophylactic treatments include prednisone, **calcium** channel blockers, and methysergide.

Alternative treatment

Alternative headache treatments include:

- acupuncture or acupressure
- biofeedback
- chiropractic
- herbal remedies using feverfew (*Chrysanthemum parthenium*), valerian (*Valeriana officinalis*), white willow (*Salix alba*), or skullcap (*Scutellaria lateriflora*), among others
- homeopathic remedies chosen specifically for the individual and his/her type of headache
- hydrotherapy
- massage
- magnesium supplements
- regular physical exercise
- relaxation techniques, such as meditation and yoga
- transcutaneous electrical nerve stimulation (TENS) (A procedure that electrically stimulates nerves and blocks the signals of pain transmission.)

Prognosis

Headaches are typically resolved through the use of **analgesics** and other treatments. Research in 2004 showed that people who have migraine headaches more often than once a month may be at increased risk for **stroke**.

Prevention

Some headaches may be prevented by avoiding triggering substances and situations, or by employing alternative therapies, such as **yoga** and regular **exercise**. Since **food allergies** often are linked with headaches, especially cluster headaches, identification and elimination of the allergy-causing food(s) from the diet can be an important preventive measure.

Resources

PERIODICALS

Kruit, Mark C., et al. "Migraine as a Risk Factor for Subclinical Brain Lesions." *JAMA, Journal of the American Medical Association*. January 28, 2004: 427–435.

Norton, Patrice G. W. "Botox Stops Headache Pain in Recalcitrant Cases." *Clinical Psychiatry News*. March 2004: 72.

Taylor, Frederick, et al. "Diagnosis and Management of Migraine in Family Practice." *Journal of Family Practice*. January 2004: S3–S25.

ORGANIZATIONS

American Council for Headache Education (ACHE), 19 Mantua Road, Mount Royal, NJ, 08061, (856) 423-0043, (858) 423-0082, achehq@talley.com, http://www.achenet.org.

National Headache Foundation, 820 N. Orleans, Suite 217, Chicago, IL, 60610, (312) 274-2650, (888) NHF-5552, info@headaches.org, http://www.headaches.org.

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Hearing aids

Definition

A hearing aid is a device that can amplify sound waves in order to help a deaf or hard-of-hearing person hear sounds more clearly.

Purpose

Recent technology can help most people with **hearing loss** understand speech better and achieve better communication.

Precautions

It's important that a person being fitted for a hearing aid understand what an aid can and can't do. An aid can help a person hear better, but it won't return hearing to normal levels. Hearing aids boost all sounds, not just those the person wishes to hear. Especially when the source of sound is far away (such as up on a stage), environmental noise can interfere with good speech perception. In addition, while the aid amplifies sound, it doesn't necessarily improve the clarity of the sound. A hearing aid is a machine and can never duplicate the true sound that people with normal hearing experience, but it will help the person take advantage of the hearing that remains.

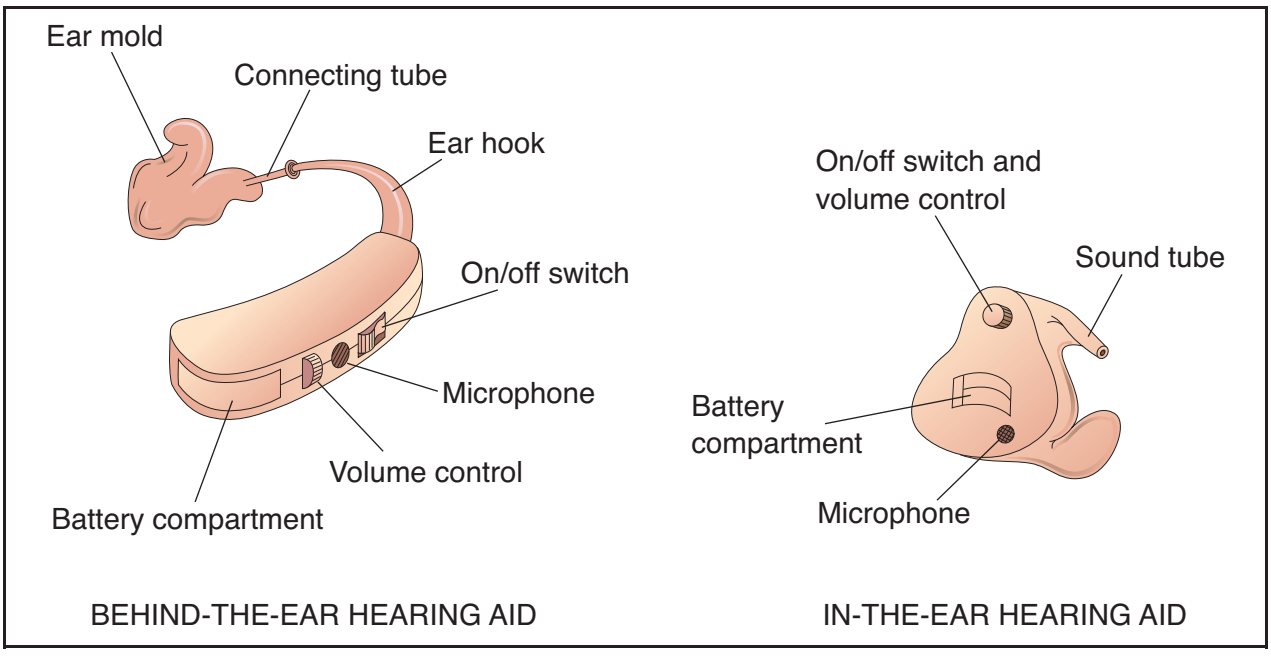
Description

More than 1,000 different models are available in the United States. All of them include a microphone (to pick up sound), amplifier (to boost sound strength), a receiver or speaker (to deliver sound to the ear), and are powered by a battery. Depending on the style, it's possible to add features to filter or block out background noise, minimize feedback, lower sound in noisy settings, or boost power when needed.

Hearing aids are either "monaural" (a hearing aid for one ear), or "binaural" (for two ears); more than 65% of all users have binaural aids. Hearing aids are divided into several different types:

- digital
- in-the-ear
- in-the-canal
- behind-the-ear
- on-the-body

Digital aids are sophisticated, very expensive aids that borrow computer technology to allow a person to tailor an aid to a specific hearing loss pattern. Using miniature computer chips, the aids can selectively boost certain frequencies while leaving others alone. This means a person could wear such an aid to a loud party and screen out unwanted background noise, while tuning in on one-on-one conversations. The aid is programmed by the dealer to conform to the patient's



Hearing aids are devices that can amplify sound waves to help a deaf or hard-of-hearing person hear sounds more clearly.
(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)

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specific hearing loss. Some models can be programmed to allow the wearer to choose different settings depending on the noise of the environment.

In-the-ear aids are lightweight devices whose custom-made housings contain all the components; this device fits into the ear canal with no visible wires or tubes. It's possible to control tone but not volume with these aids, so they are helpful only for people with mild hearing loss. Some people find these aids are easier to put on and take off than behind-the-ear aids. However, because they are custom-fit to a person's ear, it is not possible to try on before ordering. Some people find them uncomfortable in hot weather.

In-the-canal aids fit far into the ear canal, with only a small bit extending into the external ear. The smallest is the MicroCanal, which fits out of sight down next to the eardrum and is removed with a small transparent wire. These are extremely expensive, but they are not visible, offer better acoustics, and are easier to maintain. They can more closely mimic natural sound because of the position of the microphone, this position also cuts down on wind noise. However, their small size makes them harder to handle, and their battery is especially small and difficult to insert. Adjusting the volume may be hard, since a person must stick a finger down into the ear to adjust volume, and this very tiny aid doesn't have the power of other, larger aids.

Behind-the-ear aids include a microphone, amplifier, and receiver inside a small curved case worn behind the ear; the case is connected to the earmold by a short plastic tube. The earmold extends into the ear canal. Some models have both tone and volume control plus a telephone pickup device. However, many users think them unattractive and out of date, and people who wear glasses find that the glasses interfere with the aid's fit. Others don't have space behind the ear for the mold to fit comfortably. However, they do offer a few advantages.

Behind-the-ear aids:

- don't require as much maintenance
- are easily interchangeable if they need to be serviced
- are more powerful
- are easier to handle than smaller aids
- can provide better sound quality
- tend to be more reliable

Eyeglass models are the same as behind-the-ear devices, except that the case fits into an eyeglass frame instead of resting behind the ears. Not many people buy this type of aid, but those who do believe it's less obvious, although there is a tube that travels from the temple of the glasses to the earmold. However, it can be hard to fit this type of aid, and repairs can be problematic. Also, if the aid breaks, the person also loses the benefit of the glasses.

CROS or the crossover system type of hearing aid is often used in conjunction with the eyeglass model. The CROS (contralateral routing of signal) system features a microphone behind the ear that feeds the amplified signal to the better ear, eliminating "head shadow," which occurs when the head blocks sound from the better ear. This type may help make speech easier to understand for people with a high-frequency loss in both ears.

A BI-CROS system uses two microphones (one above each ear) that send signals to a single amplifier. Sound then travels to a single receiver, which transfers it to the better ear via a conventional earmold.

On-the-body aids feature a larger microphone, amplifier, and power supply inside a case carried inside the pocket, or attached to clothing. The receiver attaches directly to the earmold; its power comes through a flexible wire from the amplifier. Although larger than other aids, the on-the-body aids are more powerful and easier to adjust than other devices. While not popular for everyone, they are often used by those with a profound hearing loss, or by very young children. Some people who are almost totally deaf find they need the extra power boost available only from a body aid.

The latest aids on the market may eliminate the amplifier and speaker in favor of a tiny magnet mounted on a silicone disk, similar to a contact lens, which rests right on the eardrum. Called the Earlens, it is designed to be held in place by a thin film of oil. Users wear a wireless microphone, either in the ear or on a necklace, that picks up sounds and converts them into magnetic signals, making the magnet vibrate. As the Earlens vibrates, so does the eardrum, transmitting normal-sounding tones to the middle and inner ears.

Other researchers are bypassing the middle ear completely; they surgically implant a tiny magnet in the inner ear. By attaching a magnet to the round window, they open a second pathway to the inner ear. An electromagnetic coil implanted in bone behind the ear vibrates the implanted magnet. Unlike the Earlens, this magnetic implant would not block the normal hearing pathway.

Preparation

The fist step in getting a hearing aid is to have a medical exam and a hearing evaluation. (Most states prohibit anyone selling a hearing aid until the patient has been examined by a physician to rule out medical problems.) After performing a hearing evaluation, an audiologist should be able to determine whether a

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KEY TERMS

Audiologist—A person with a degree and/or certification in the areas of identification and measurement of hearing impairments and rehabilitation of those with hearing problems.

Eardrum—A paper-thin covering stretching across the ear canal that separates the middle and outer ears.

Middle ear—The small cavity between the eardrum and the oval window that houses the three tiny bones of hearing.

Oval window—A tiny opening at the entrance to the inner ear.

hearing aid will help, and which one will do the most good. This is especially important because aids can be very expensive (between $500 and $4,000) and are often not covered by health insurance. Hearing aids come in a wide range of styles and types, requiring careful testing to make sure the aid is the best choice for a particular hearing loss.

Some audiologists sell aids; others can make a recommendation, or give one a list of competent dealers in one's area. Patients should shop around and compare prices. In all but three states, hearing aids must be fitted and sold only by licensed specialists called dealers, specialists, dispensers, or dispensing audiologists.

The hearing aid dealer will make an impression of the consumer's ears using a putty-like material, from which a personalized earmold will be created. It's the dealer's job to make sure the aid fits properly. The person may need several visits to find the right hearing aid and learn how to use it. The dealer will help the consumer learn how to put the aid on, adjust the controls, and maintain the device. The dealer should be willing to service the aid and provide information about what to do if sensitivity to the earmold develops. (Some people are allergic to the materials in the mold.)

Aftercare

Within several weeks, the wearer should return to the dealer to have the aid checked, and to discuss the progress in wearing the aid. About 40% of all aids need some modification or adjustment in the beginning.

Within the first month of getting an aid, the patient should make an appointment for a full hearing examination to determine if the aid is functioning properly.

Risks

While there are no medical risks to hearing aids, there is a risk associated with hearing aids: many people end up not wearing their aids because they say everything seems loud when wearing them. This is because they have lived for so long with a hearing problem that they have forgotten how loud "normal" sound can be. Other potential problems with hearing aids include earmold discomfort and a build up of excess ear wax after getting a hearing aid.

Normal results

A hearing aid will boost the loudness of sound, which can improve a person's ability to understand speech.

ORGANIZATIONS

American Academy of Otolaryngology—Head and Neck Surgery, 1650 Diagonal Road, Alexandria, VA, 22314-2857, (703) 836-4444, http://www.entnet.org.

Better Hearing Institute, 1444 I Street, NW, Suite 700, Washington, DC, 20005, (202) 449-1100, (800) 327-9355, mail@betterhearing.org, http://www.betterhearing.org/, http://www.betterhearing.org/

Hearing Industries Association, 1444 I Street, N.W., Suite 700, Washington, DC, 20005, (202))449-1090, (202) 216-9646, mspangler@bostrom.com, http://www.hearing.org.

Hearing Loss Association of America, 7910 Woodmont Ave., Suite 1200, Behtesda, MD, 20814, (301) 657-2248, http://www.hearingloss.org.

National Institute on Deafness and Other Communication Disorders, 31 Center Drive, MSC 2320, Bethesda, MD, 20892-2320, (800) 241-1044 , nidcdinfo@nidcd.nih.gov, http://www.nidcd.nih.gov.

Starkeu Hearing Foundation, 6700 Washington Ave South, Eden Prairie, MN, 55344, (866) 354-3254 , http://www.starkeyhearingfoundation.org.

Carol A. Turkington

Hearing loss

Definition

Hearing loss is any degree of impairment of the ability to apprehend sound. Such impairment occurs primarily due to natural causes (heredity) and environmental factors (extended exposure to loud sounds). Secondary factors of hearing loss include obstructions

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Decibel ratings and hazardous levels of noise

Decibel level	Examples of sounds
30	Soft whisper
35	Noise may prevent listener from falling asleep
40	Quiet office noise level
50	Quiet conversation
60	Average television volume, sewing machine, lively conversation
70	Busy traffic, noisy restaurant
80	Heavy city traffic, factory noise, alarm clock
90	Cocktail party, lawn mower
100	Pneumatic drill
120	Sandblasting, thunder
140	Jet airplane
180	Rocket launching pad

At volumes above 110 decibels, hearing may become painful.
A volume above 120 decibels is considered deafening.
At volumes above 135 decibels, hearing will become extremely painful and hearing loss may result if exposure is prolonged.
At volumes above 180 decibels, hearing loss is almost certain with any exposure.

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within the ear canal, primarily ear wax but sometimes also other natural or foreign materials.

Demographics

Generally, some hearing loss occurs gradually as humans get older. According to the National Institutes of Health, about one out of three older Americans between the ages of 65 and 75 years has hearing loss. Over the age of 75 years, hearing loss occurs in about one out two people in the United States. However, hearing loss can happen to any person regardless of age.

Description

Sound can be measured accurately. The term decibel (dB) refers to an amount of energy moving sound from its source to one's ears or to a microphone. For instance, a whisper is equivalent to about 30 dB and a washing machine is around 70 dB, both well within the range that will not produce hearing loss. However, heavy traffic and a hair dryer each produce about 85 to 90 dB, which is within the range that is considered risky for producing a loss of hearing. Even worse, a jet taking off and a shotgun blast each produce between 140 and 165 dB, which is within the range that can cause considerable degradation to one's hearing. In fact, a drop of more than 10 dB in the level of sound a person can hear is significant.

Sound travels through a medium like air or water as waves of compression and rarefaction. These waves are collected by the external ear and cause the tympanic membrane (ear drum) to vibrate. The chain of ossicles connected to the ear drum—the incus, malleus, and stapes—carry the vibration to the oval window, increasing its amplitude 20 times on the way. There the energy causes a standing wave in the watery liquid (endolymph) inside the Organ of Corti. (A standing wave is one that does not move. A vibrating cup of coffee, for instance, will demonstrate standing waves.) The configuration of the standing wave is determined by the frequency of the sound. Many thousands of tiny nerve fibers detect the highs and lows of the standing wave and transmit their findings to the brain, which interprets the signals as sound.

To summarize, sound energy passes through the air of the external ear, the bones of the middle ear and the liquid of the inner ear. It is then translated into nerve impulses, sent to the brain through nerves and understood there as sound. It follows that there are five steps in the hearing process:

- air conduction through the external ear to the ear drum
- bone conduction through the middle ear to the inner ear
- water conduction to the Organ of Corti
- nerve conduction into the brain
- interpretation by the brain.

Hearing can be interrupted (that is, hearing loss can result) in several ways at each of the five steps.

Risk factors

Some of the risk factors that can lead to hearing loss include:

- Age: Exposure to loud sounds over many years
- Heredity: Being born within a family that is prone to hearing loss
- Occupation: A person's place of work or employment—one that involves loud noises on a regular basis (such as construction workers using pneumatic hammers or loggers using chain saws)
- Recreation: Exposure to loud noises during recreational activities, such as rock concerts, snowmobiling, and automobile races, along with the use of musical and other sound-generating devices hooked up directly to the ear
- Illnesses: Medical conditions that involve exceptionally high fevers, such as meningitis
- Medications: Continual use of drugs, such as pain relievers and nonsteroidal anti-inflammatory drugs

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An Oto-Acoustic Emission (OAE) hearing test being performed on a newborn baby. The probe emits harmless sound into the baby's ear, and the response of the inner ear is detected and registered on a computer. Early diagnosis of a hearing disorder is important in young children, who may experience difficulties in speech and language development. *(James King-Holmes/Photo Researchers, Inc.)*

Causes and Symptoms

The external ear canal can be blocked with ear wax, **foreign objects**, infection, and tumors. Wax build-up can cause hearing loss in people of any age. Overgrowth of the bone, a condition that occurs when the ear canal has been flushed with cold water repeatedly for years, can also narrow the passageway, making blockage and infection more likely. This condition occurs often in Northern Californian surfers and is therefore called "surfer's ear."

The ear drum is so thin a physician can see through it into the middle ear. Sharp objects, pressure from an infection in the middle ear, or even a firm cuffing or slapping of the ear, can rupture it. It is also susceptible to pressure changes during scuba diving.

Several conditions can diminish the mobility of the ossicles (small bones) in the middle ear. **Otitis media** (an infection in the middle ear) occurs when fluid cannot escape into the throat because of blockage of the eustachian tube. The fluid then accumulates—whether it is pus or just mucus—which dampens the motion of the ossicles. A disease called **otosclerosis** can bind the stapes in the oval window and thereby cause deafness.

All of the conditions mentioned so far that occur in the external and middle ear are causes of conductive hearing loss.

The second category, sensory hearing loss, refers to damage to the Organ of Corti and the acoustic nerve. Prolonged exposure to loud noise is the leading cause of sensory hearing loss. At least one million people have this condition in the United States, many of whom were identified during the military draft and rejected as being unfit for duty. The cause is often believed to be prolonged exposure to rock music. Occupational noise exposure is the other leading cause of noise induced hearing loss (NIHL) and is ample reason for wearing ear protection on the job. A third of people over 65 years of age have presbycusis—sensory hearing loss due to **aging**. Both NIHL and presbycusis are primarily high frequency losses. In most languages, the high frequency sounds define speech, so these people hear

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plenty of noise. They just cannot easily make out what it means. They have particular trouble selecting out speech from background noise.

Brain infections like **meningitis**, drugs such as the aminoglycoside **antibiotics** (streptomycin, gentamycin, kanamycin, tobramycin), and Meniere's disease also cause permanent sensory hearing loss. Meniere's disease combines attacks of hearing loss with attacks of vertigo. The symptoms may occur together or separately. High doses of salicylates like **aspirin** and quinine can cause a temporary high-frequency loss. Prolonged high doses can lead to permanent deafness. There is an hereditary form of sensory deafness and a congenital form most often caused by **rubella** (German **measles**).

The general symptoms of hearing loss include the following:

- Unclear (muffled) voices and noises
- Difficulty with the understanding of spoken words, especially when background noises are present
- Requests for people to talk slowly or more distinctly
- Inability to participate in conversations
- Reluctance to attend social events.

Sudden hearing loss—at least 30dB in less than three days—is most commonly caused by cochleitis, a mysterious viral infection.

The final category of hearing loss is neural. Damage to the acoustic nerve and the parts of the brain that perform hearing are the most likely to produce permanent hearing loss. Strokes, **multiple sclerosis**, and acoustic neuromas are all possible causes of neural hearing loss.

Hearing can also be diminished by extra sounds generated by the ear, most of them from the same kinds of disorders that cause diminished hearing. These sounds are referred to as **tinnitus** and can be ringing, blowing, clicking, or anything else that no one but the patient hears.

Diagnosis

An examination of the ears and nose combined with simple hearing tests done in the physician's office can detect many common causes of hearing loss. An audiogram often concludes the evaluation, since this simple means often produces a diagnosis. If the defect is in the brain or the acoustic nerve, further neurological testing and imaging will be required.

The audiogram has many uses in diagnosing hearing deficits. The pattern of hearing loss across the audible frequencies gives clues to the cause. Several alterations in the testing procedure can give additional information. For example, speech is perceived differently than pure tones. Adequate perception of sound combined with inability to recognize words points to a brain problem rather than a sensory or conductive deficit. Loudness perception is distorted by disease in certain areas but not in others. Acoustic neuromas often distort the perception of loudness.

Treatment

Conductive hearing loss can almost always be restored to some degree, if not completely. Some ways to restore hearing loss are:

- matter in the ear canal can be easily removed with a dramatic improvement in hearing.
- surfer's ear gradually regresses if cold water is avoided or a special ear plug is used. In advanced cases, surgeons can grind away the excess bone.
- middle ear infection with fluid is also simple to treat. If medications do not work, surgical drainage of the ear is accomplished through the ear drum, which heals completely after treatment.
- traumatically damaged ear drums can be repaired with a tiny skin graft.
- surgical repair of otosclerosis through an operating microscope is one of the most intricate of procedures, substituting tiny artificial parts for the original ossicles.

Sensory and neural hearing loss, on the other hand, cannot readily be cured. Fortunately the loss is not often complete, so that **hearing aids** can fill the deficit.

In-the-ear hearing aids can boost the volume of sound by up to 70 dB. (Normal speech is about 60 dB.) Federal law now requires that they be dispensed only with a physician's prescription. For complete conduction hearing loss there are now available bone conduction hearing aids and even devices that can be surgically implanted in the cochlea.

Tinnitus can sometimes be relieved by adding white noise (like the sound of wind or waves crashing on the shore) to the environment.

Decreased hearing is such a common problem that there are legions of organizations to provide assistance. Special language training, both in lip reading and signing, special schools, and special camps for children are all available in most regions of the United States.

Alternative treatment

Conductive hearing loss can be treated with alternative therapies that are specific to the particular condition. Sensory hearing loss may be helped by homeopathic therapies. Oral supplementation with essential fatty

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KEY TERMS

Decibel—A unit of the intensity of sound, a measure of loudness.

Meniere's disease—The combination of vertigo and decreased hearing caused by abnormalities in the inner ear.

Multiple sclerosis—A progressive disease of brain and nerve tissue.

Otosclerosis—A disease that scars and limits the motion of the small conducting bones in the middle ear.

Stroke—Sudden loss of blood supply to part of the brain.

acids such as flax oil and omega 3 oil can help alleviate the accumulation of wax in the ear.

Prognosis

The prognosis for reducing or eliminating hearing loss widely varies. Whether hearing loss can be solved is generally dependent on the cause. Conductive hearing loss is usually able to be cured. However, sensory hearing loss is more complicated to treat and is usually not curable. People can regain a majority of their hearing with the use of hearing aids.

Prevention

Prompt treatment and attentive follow-up of middle ear infections in children will prevent this cause of conductive hearing loss. Control of infectious childhood diseases, such as measles, has greatly reduced sensory hearing loss as a complication of epidemic diseases. Laws that require protection from loud noise in the workplace have achieved substantial reduction in noise induced hearing loss. Surfers should use the right kind of ear plugs.

Resources

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Hearing Loss. Mayo Clinic. (August 22, 2009), http://www.mayoclinic.com/health/hearing-loss/DS00172 (accessed September 14, 2010).

ORGANIZATIONS

Alexander Graham Bell Academy for Listening and Spoken Language, 3417 Volta Place NW, Washington, DC, 20007, (202) 204-4700, (202) 337-8314, academy@agbell.org, http://agbell.org/NetCommunity/Page.aspx?pid=330.

Alexander Graham Bell Association for the Deaf and Hard of Hearing, 3417 Volta Place NW, Washington, DC, 20007, (202) 337-5220, http://nc.agbell.org/.

Better Hearing Institute, 1444 I Street NW; Suite 700, Washington, DC, 20005, (202) 449-1100, mail@betterhearing.org, http://www.betterhearing.org/.

Center for Hearing and Communications, 50 Broadway, Sixth Floor, New York City, NY, 10004, (917) 305-7700, http://www.chchearing.org/.

Central Institute for the Deaf, 825 South Taylor Avenue, St. Louis, MO, 63110, (314) 977-0132, (877) 444-4574, (314) 977-0023, http://www.cid.edu/home.aspx.

Hearing Loss Association of America, 7910 Woodmont Avenue, Suite 1200, Bethesda, MD, 20814, (301) 657-2248, http://www.hearingloss.org/.

National Association of the Deaf, 8630 Fenton Street, Suite 820, Silver Spring, MD, 20910-3819, (301) 587-1788, (301) 587-1791, http://www.nad.org/.

The Sight & Hearing Association, 1246 University Avenue West, Suite 226, St. Paul, MN, 55104-4125, (651) 645-2546, (800) 992-0424, (651) 645-2742, mail@sightandhearing.org, http://www.sightandhearing.org/.

World Recreation Association of the Deaf, Post Office Box 3211, Quartz Hill, CA, 93586, (661) 952-7752, wradceo@aol.com, http://www.wrad.org/.

J. Ricker Polsdorfer, MD

Hearing test with an audiometer *see* **Audiometry**

Hearing tests with a tuning fork

Definition

A tuning fork is a metal instrument with a handle and two prongs or tines. Tuning forks, made of steel, aluminum, or magnesium-alloy will vibrate at a set frequency to produce a musical tone when struck. The vibrations produced can be used to assess a person's ability to hear various sound frequencies.

Purpose

A vibrating tuning fork held next to the ear or placed against the skull will stimulate the inner ear to vibrate and can help determine if there is **hearing loss**.

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KEY TERMS

Mastoid process—The protrusions of bone behind the ears at the base of the skull.

Rinne test—A hearing test using a vibrating tuning fork which is held near the ear and held at the back of the skull.

Weber test—A hearing test using a vibrating tuning fork which is held at various points along the midline of the skull and face.

Precautions

No special precautions are necessary when tuning forks are used to conduct a hearing test.

Description

Two types of hearing tests with tuning forks are typically conducted. In the Rinne test, the vibrating tuning fork is held against the skull, usually on the bone behind the ear (mastoid process) to cause vibrations through the bones of the skull and inner ear. It is also held next to, but not touching, the ear, to cause vibrations in the air next to the ear. The patient is asked to determine which sound is louder, the sound heard through the bone or through the air. A second hearing test using a tuning fork is the Weber test. For this test, the stem or handle of the vibrating tuning fork is placed at various points along the midline of the skull and face. The patient is then asked to identify which ear hears the sound created by the vibrations. Tuning forks of different sizes produce different frequencies of vibrations and can be used to establish the range of hearing for an individual patient.

Preparation

No special preparation is required for a hearing test with tuning forks.

Aftercare

No special aftercare is required. If hearing loss is revealed during testing with tuning forks, the patient may require further testing to determine the extent of the hearing loss.

Risks

There are no risks associated with the use of tuning forks to screen for hearing loss.

Normal results

With the Rinne test, a person will hear the tone of the vibration longer and louder when the tuning fork is held next to the ear, rather than when it is held against the mastoid bone. For the Weber test, the tone produced when the tuning fork is placed along the center of the skull, or face, sounds about the same volume in each ear.

Abnormal results

The Rinne test detects a hearing loss when a patient hears a louder and longer tone when the vibrating tuning fork is held against the mastoid bone than when it is held next to the ear. The volume of sound vibrations conducted through parts of the skull and face in the Weber test can indicate which ear may have a hearing loss.

ORGANIZATIONS

American Academy of Otolaryngology—Head and Neck Surgery, 1650 Diagonal Road, Alexandria, VA, 22314-2857, (703) 836-4444, http://www.entnet.org.

EAR Foundation of Arizona, 668 North 44th Street, Suite 300, Phoenix, AZ, 85008 (602) 685-1050, (602) 239-5117, melissa@earfoundationaz.com, http://www.earfoundationaz.com.

Altha Roberts Edgren

Heart arrest *see* **Sudden cardiac death**

Heart arrhythmias *see* **Arrhythmias**

Heart attack

Definition

A heart attack is the **death** of or damage to heart muscle because the supply of blood to the heart is severely restricted or blocked. Heart attacks also are called myocardial infarctions (MIs).

Demographics

Heart attack is the leading cause of death in the United States. More than 1.5 million Americans experience a heart attack every year and between 500,000 and 700,000 die. Worldwide, heart attacks cause 12 million deaths each year. Most heart attacks are the result of years of silent but progressive **coronary artery disease** (CAD); a heart attack may be the first symptom of the disease. According to the American Heart Association,

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63% of women and 48% of men who died suddenly of coronary artery disease had no previous symptoms.

Description

A heart attack occurs when one or more of the coronary arteries that supply blood to the heart are completely or substantially blocked and not enough oxygen reaches the heart (a condition called **ischemia**). The blockage usually is caused by **atherosclerosis**, the build-up of plaque in the artery walls, and/or by a blood clot in a coronary artery. Much less often, a healthy coronary artery has a spasm, and blood flow to part of the heart suddenly decreases or stops. Coronary artery spasm in young, healthy individuals is most often brought on by **methamphetamine** or **cocaine** use.

About half of all people who have heart attacks wait at least two hours before seeking help. This increases their chance of death or permanently disabled. The longer an artery remains blocked during a heart attack, the more damage will be done to the heart. Therefore, it is important to recognize the signs of a heart attack and seek prompt medical attention at the nearest hospital with 24-hour emergency cardiac care.

About one-fifth of all heart attacks are silent, that is, the individual does not know one has occurred. Although the person feels no **pain**, silent heart attacks still damage the heart.

The outcome of a heart attack depends on where the blockage is, whether heart rhythm is disturbed, and whether another coronary artery supplies blood to that part of the heart. Blockages in the left coronary artery usually are more serious than in the right coronary artery. Blockages that cause an arrhythmia, an irregular heartbeat, can cause sudden death.

Major risk factors

Major risk factors significantly increase the risk of coronary artery disease. Those which cannot be changed include:

- Heredity. People whose parents have coronary artery disease are more likely to develop it. The risk of heart attack is highest for those who have a male parent or sibling who has had a heart attack before age 45 or a female parent or sibling who has had a heart attack before age 55.
- Gender. Men under 60 years of age are more likely to have heart attacks than women of the same age.
- Age. Men over the age of 45 and women over the age of 55 are considered at risk. Older people (those over 65) are at increased risk of dying from a heart attack. Older women are twice as likely to die within a few weeks of a heart attack as men of the same age.

Major risk factors that can be modified through lifestyle changes include:

- Smoking. Smoking greatly increases both the chance of developing coronary artery disease and the change of dying from it. Smokers are more than twice as likely to have a heart attack and have two to four times the risk of non-smokers of sudden cardiac death. They also are more likely to die within an hour of a heart attack. Exposure to second-hand smoke also increases risk.
- High cholesterol. Cholesterol is a soft, waxy substance that is produced by the liver, as well as obtained from eating cholesterol-containing food, such as meat, eggs, and other animal products. Cholesterol level is affected by age, sex, heredity, and diet.
- Cholesterol does not dissolve in blood. Instead, it moves through the circulatory system in combination with carrier substances called lipoproteins. There are two types of carrier-cholesterol combinations, low-density lipoprotein (LDL) or "bad" cholesterol and high-density lipoprotein (HDL) or "good" cholesterol.
- LDL picks up cholesterol in the liver and carries it through the circulatory system. Most of the cholesterol in the body is LDL cholesterol. When too much LDL cholesterol is present, it begins to drop out of the blood and stick to the walls of the arteries. The sticky material on the artery walls is called cholesterol plaque. Plaque can reduce the amount of blood flowing through the arteries and encourage blood clots to form. Total cholesterol of 240 mg/dL and over poses a high risk, and 200–239 mg/dL a borderline high risk. For LDL cholesterol, high risk starts at 130–159 mg/dL, depending on other risk factors.
- Researchers believe that HDL works opposite LDL. HDL picks up cholesterol off the walls of the arteries and takes it back to the liver where it can be broken down and removed from the body. This helps to keep the blood vessels open. Cholesterol can be measured by a simple blood test. To reduce the risk of cardiovascular disease, adults should keep their HDL cholesterol above 40 mg/dL.
- High blood pressure (hypertension). High blood pressure makes the heart work harder and over time weakens it. It increases the risk of heart attack, stroke, kidney failure, and congestive heart failure. A blood pressure of 140 over 90 or above is considered high. As the numbers increase, high blood pressure goes from being categorized as Stage 1 (mild) to Stage 4 (very severe). African Americans are at increased risk of developing severe hypertension.

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KEY TERMS

Angina—Chest pain that happens when diseased blood vessels restrict the flow of blood to the heart. Angina often is the first symptom of coronary artery disease.

Atherosclerosis—A process in which the walls of the coronary arteries thicken due to the accumulation of plaque in the blood vessels. Atherosclerosis is the cause of coronary artery disease.

Coronary arteries—The arteries that provide blood to the heart. The coronary arteries surround the heart like a crown, coming out of the aorta, arching down over the top of the heart and dividing into two branches. These are the arteries where coronary artery disease occurs.

Myocardial infarction—The technical term for heart attack. Myocardial means heart muscle and infarction means death of tissue from lack of oxygen.

Plaque—A deposit of fatty and other substances that accumulate in the lining of the artery wall.

- Obesity and lack of physical activity. The heart of an obese individual must work harder, while lack of physical activity increases the risk of coronary artery disease. Even modest physical activity is beneficial if done regularly.
- Use of certain drugs or supplements. In the late twentieth century, ephedra (ma huang) gained popularity as a weight-loss supplement. The herb can cause life-threatening side effects, including heart attack, stroke, and seizures. Since April 2004, sale of products containing ephedra have been banned in the United States, although it may still be obtained illegally over the Internet. Hormone replacement therapy (HRT) was once believed to help prevent heart disease in postmenopausal women. However, the Women's Health Initiative, a very large clinical trial, found the opposite to be true. Potential adverse effects of HRT include increased risk of heart attack, stroke and blood clots, and an increased risk of breast cancer.

Contributing risk factors

Contributing risk factors have been linked to coronary artery disease, but their significance or prevalence cannot always be demonstrated or quantified. Contributing risk factors include:

- Diabetes mellitus. The risk of developing coronary artery disease is seriously increased for individuals with diabetes. More than 80% of diabetics die of some type of heart or blood vessel disease.
- Emotional factors. Long-term stress, anger, and guilt are thought to contribute to the development of coronary artery disease. Stress, the mental and physical reaction to life's irritations and challenges, increases the heart rate and blood pressure and can injure the lining of the arteries. Evidence shows that anger increases the risk of dying from heart disease and more than doubles the risk of having a heart attack right after an episode of anger.

Causes and symptoms

Heart attacks generally are the result of severe coronary artery disease. Most heart attacks are caused by **blood clots** that form on atherosclerotic plaque. These may break lose and travel through the circulatory system causing heart attack or **stroke** (blockage of an artery to the brain). Certain major risk factors increase the chance of developing coronary artery disease. Some of these can be modified and some cannot. People with a greater number of risk factors are more likely to develop coronary artery disease.

More than 60% of people who have a heart attack experience symptoms before the heart attack occurs. These symptoms sometimes occur days or weeks before the heart attack. Sometimes, people do not recognize the symptoms of a heart attack or are in denial that they are having one. Typical symptoms include:

- Uncomfortable pressure, fullness, squeezing, or pain in the center of the chest (angina) that lasts more than 30 minutes. Warning pains before a heart attack may last a shorter time or may go away with rest and then return.
- Pain that spreads to the shoulders, neck, arms, or jaw.
- Chest discomfort accompanied by lightheadedness, fainting, sweating, nausea, or shortness of breath.

All of these symptoms do not occur with every heart attack, and most have other common causes. Nevertheless, person with any of these symptoms should immediately call an emergency rescue service (recommended) or be driven (but not drive themselves) to the nearest hospital with a 24-hour cardiac care unit. The advantage of calling an emergency rescue service is

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that life-saving treatment may begin while the individual is in transit to the hospital.

Diagnosis

Experienced emergency care personnel usually can diagnose a heart attack simply by looking at the patient.

Tests

To confirm this diagnosis, they talk with the patient, check heart rate and blood pressure, perform an electrocardiogram, and take a blood sample. The electrocardiogram shows whether damage has occurred to the heart. Electrodes covered with conducting jelly are placed on the patient's chest, arms, and legs. They send impulses of the heart's electrical activity through an oscilloscope (a monitor) to a recorder, which traces them on paper. Damaged hearts produce a different electrical pattern from healthy hearts. The blood test shows the leak of cardiac enzymes or other biochemical markers from damaged cells in the bloodstream.

Treatment

The goal of treatment is to restore adequate blood flow and oxygen delivery to the heart, relieve pain, and prevent complications. Heart attacks are treated with **cardiopulmonary resuscitation** (CPR) when necessary to start and keep the patient breathing and the heart beating. Beta-blocker drugs may be given to help control heart rate. Other drugs may be used to relieve pain and **anxiety**. These treatments may be started by trained emergency medical service personnel in the ambulance on the way to the hospital.

Traditional

Once at the hospital, certain patients may receive intravenous drug therapy to dissolve blood clots (**thrombolytic therapy**). If started within six hours after the start of the heart attack, these drugs are successful in dissolving blood clots in about 80% of patients. If these drugs are given in a window 6–12 hours after the start of pain, the success rate drops to 50%. Thrombolytic therapy is not used if more than 12 hours has passed since chest pain started. Throughout treatment, the patient is monitored closely.

Additional treatment can include, electric shock, additional drug therapy, revascularization procedures, percutaneous transluminal coronary **angioplasty**, and coronary artery bypass surgery. An electrical-shock device (defibrillator), may be used to restore a normal rhythm if the heart is fluttering and contracting uncontrollably (arrhythmia). Supplemental oxygen often is used to ease the heart's workload. If oxygen is used within hours of the heart attack, it may help limit damage to the heart. Additional drugs may be used to stabilize the patient and limit damage to the heart, including **aspirin**, anticoagulants, painkillers, tranquilizers, beta-blockers, ace-inhibitors, nitrates, rhythm-stabilizing drugs, and **diuretics**. Once the patient has been stabilized, he or she is usually moved to the cardiac care unit (CCU) for special monitoring.

Drugs

To prevent additional heart attacks, aspirin and an anticoagulant drug often follow the thrombolytic drug. These help to prevent new blood clots from forming and existing blood clots from growing. **Anticoagulant drugs** help prevent the blood from clotting. The most common anticoagulants are heparin and warfarin. Heparin, an anticoagulant, often is given intravenously while the patient is in the hospital. Warfarin (Coumadin), taken orally, often is given later, and sometimes must be taken for life. Aspirin helps to prevent the dissolved blood clots from reforming.

To relieve pain, a nitroglycerine tablet taken under the tongue may be given. If the pain continues, morphine sulfate may be prescribed. Tranquilizers such as diazepam (Valium) and alprazolam (Ativan) may be prescribed to lessen the trauma of a heart attack.

To slow the heart rate and give the heart a chance to heal, beta-blockers often are given intravenously right after the heart attack. These can also help prevent sometimes-fatal **ventricular fibrillation**. Beta-blockers include atenolol (Tenormin), metoprolol (Lopressor), nadolol, pindolol (Visken), propranolol (Inderal), and timolol (Blocadren).

Nitrates, a type of vasodilator, also are given right after a heart attack to help improve the delivery of blood to the heart and ease **heart failure** symptoms. Nitrates include isosorbide mononitrate (Imdur), isosorbide dinitrate (Isordil, Sorbitrate), and nitroglycerin (Nitrostat).

When a heart attack causes an abnormal heartbeat, arrhythmia drugs may be given to restore and maintain the heart's normal rhythm. These include amiodarone (Cordarone), atropine, bretylium, disopyramide (Nor Pace), lidocaine (Xylocaine), procainamide (Procan), propafenone (Rythmol), propranolol (Inderal), quinidine, and sotalol (Betapace).

Angiotensin-converting enzyme (ACE) inhibitors reduce the resistance against which the heart beats and are used to manage and prevent heart failure. They are used to treat heart attack patients whose hearts do not pump well or who have symptoms of heart failure.

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Taken orally, they include Altace, Capoten, Lotensin, Monopril, Prinivil, Vasotec, and Zestril. Angiotensin receptor blockers, such as losartan (Cozaar), may be substituted.

Diuretics can help get rid of excess fluids that sometimes accumulate when the heart is not pumping effectively. They also help reduce **hypertension**. Usually taken orally, they cause the body to increase urine output. Common diuretics include: bumetanide (Bumex), chlorthalidone (Hygroton), chlorothiazide (Diuril), furosemide (Lasix), hydrochlorothiazide (HydroDIRUIL, Esidrix), spironolactone (Aldactone), and triamterene (Dyrenium).

Surgery

Percutaneous transluminal coronary angioplasty and coronary artery bypass surgery are invasive revascularization procedures that open blocked coronary arteries and improve blood flow. They usually are performed only on patients for whom clot-dissolving drugs do not work, who have poor **exercise** stress tests, poor left ventricular function, or ischemia. Generally, angioplasty is tried before coronary artery bypass surgery is attempted.

Percutaneous transluminal coronary angioplasty, usually called coronary angioplasty, is a procedure in which a catheter (a tiny plastic tube) tipped with a balloon is threaded from a blood vessel in the thigh or arm into the blocked artery. The balloon is inflated and compresses the plaque to enlarge the blood vessel and open the blocked artery. The balloon is then deflated and the catheter is removed. Coronary angioplasty is performed in a hospital and generally requires a two-day stay. It is successful about 90% of the time. For one-third of patients, the artery narrows again within six months after the procedure. The procedure can be repeated. It is less invasive and less expensive than coronary artery bypass surgery.

In coronary artery bypass surgery, a detour is built around the coronary artery blockage using a healthy leg or chest wall artery or vein. The healthy vein then supplies oxygen-rich blood to the heart. Bypass surgery is major surgery done most often only when patients have blockages in two or three coronary arteries or a severely narrowed left main coronary arteries, or who have not responded to other treatments. It is performed in a hospital under **general anesthesia** using a heart-lung machine to support the patient while the heart is stopped and a healthy vein is attached to the coronary artery. About 70% of patients who have bypass surgery experience full relief from **angina**; about 20% experience partial relief. Long term, symptoms recur in only about 3 or 4% of patients per year. Five years after bypass surgery, survival expectancy is 90%, at 10 years it is about 80%, at 15 years it is about 55%, and at 20 years it is about 40%.

There are several other surgical procedures for unblocking coronary arteries including: **atherectomy**, where the surgeon grinds out and removes strips of plaque from the blocked artery and laser angioplasty, where a catheter with a laser tip is inserted to burn or break down the plaque. After the artery is opened, a tiny metal tube called a stent may be implanted permanently to help the artery remain open.

Alternative

Alternative therapies aim at preventing the progression of heart disease that leads to a heart attack. Changes in lifestyle can also prevent second heart attacks.

Herbal medicine offers a variety of remedies that may have a beneficial effect on coronary artery disease. Oats *(Avena sativa)*, garlic *(Allium sativum)*, and guggul *(Commiphora mukul)*, may help reduce cholesterol; linden *(Tilia europaea)* and hawthorn *(Crataegus spp.)* are sometimes recommended to control high blood pressure, a risk factor for heart disease. Tea *(Camellia sinensis)*, especially green tea, is high in **antioxidants**, which studies have shown may have a preventive effect against atherosclerosis.

Nutritional therapies have been shown to prevent coronary artery disease and stop, or even reverse, the progression of atherosclerosis. A low-fat, high-fiber diet is often recommended. It is essential to reduce the amount of meat and animal products consumed, as they are high in saturated fats. Whole grains, fresh fruits and vegetables, legumes, and nuts are recommended. Vitamin and mineral supplements that reduce, reverse, or protect against coronary artery disease include chromium; **calcium** and magnesium; B complex **vitamins**; the antioxidant vitamins B and E; L-carnitine; and zinc.

Yoga and other bodywork, massage, relaxation therapies, **aromatherapy**, and **music therapy** may also help by reducing stress and promoting physical and mental well being. By evoking the body's relaxation response through **meditation** and deep breathing, blood pressure, metabolic rate, and heart rate can all be reduced.

Rehabilitation

Successful recovery from a heart attack requires a substantial amount of **rehabilitation**. Most patients follow a three-stage rehabilitation program. Phase 1 begins in the hospital with low-level exercise to prevent complications from prolonged bed rest. Phase 2 begins

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after hospital discharge and usually takes place in an outpatient rehabilitation setting. The goals of phase 2 are to increase physical endurance and to promote return to normal daily activities. Phase 3 continues in an outpatient setting, It begins 3–6 months after the heart attack and may last up to one year. In phase 3, the level of exercise is gradually increased, ideally to the point where swimming, light jogging, or bicycling is possible. The effectiveness of rehabilitation, however, may be limited by other medical conditions.

Prognosis

Early recognition of a heart attack substantially improves survival. More than half or all people who have heart attacks die before they reach the hospital. Another 10% die in the hospital. Of people who leave the hospital after a heart attack, 27% of men and 44% of women die within one year. Within six years, 23% of men and 31% of women have another heart attack, 13% of men and 6% of women experience sudden death, and about 20% have heart failure. People who survive a heart attack have a chance of sudden death that is four to six times greater than others and a chance of illness and death that is two to nine times greater.

Prevention

Many heart attacks can be prevented through a healthy lifestyle that reduces risk factors for developing coronary artery disease. For patients who have already had a heart attack, a healthy lifestyle, participation in a **cardiac rehabilitation** program, and carefully following doctor's orders may prevent another heart attack. A heart-healthy lifestyle includes eating a heart-healthy diet, regular exercise, maintaining a healthy weight, no **smoking**, moderate drinking, no illegal drugs, controlling high blood pressure, and managing stress.

A heart-healthy diet includes a variety of foods that are low in fat (especially saturated fat), low in cholesterol, and high in fiber; plenty of fruits and vegetables; and limited **sodium** (salt). Saturated fat raises cholesterol. Polyunsaturated and monounsaturated fats are relatively better for the heart. Fat should comprise no more than 30 percent of total daily calories. The American Heart Association has information on heart-healthy living on its Web site and publishes several heart-healthy cookbooks.

Cholesterol comes from eating foods such as meat, eggs, and other animal products. It also is produced in the liver. Soluble dietary fiber can help lower cholesterol. Cholesterol intake should be limited to about 300 mg per day. Many lipid-lowering drugs can reduce LDL-cholesterol by an average of 25–30% when combined with a low-fat, low-cholesterol diet. Fruits and vegetables are rich in fiber, vitamins, and **minerals**. They are also low in calories and nearly fat free. Vitamin C and beta-carotene, found in many fruits and vegetables, also are beneficial. Excess sodium increases the risk of high blood pressure. Many processed foods contain large amounts of sodium, which should be limited to a daily intake of 2,400 mg—about the amount in a teaspoon of salt. In the United States, cholesterol, fats, fiber, sodium, and calories are listed on nutritional labels of all processed foods.

Regular aerobic exercise can lower blood pressure, help control weight, increase HDL ("good") cholesterol, and reduce stress. Moderate intensity aerobic exercise lasting about 30 minutes four or more times per week is recommended for maximum heart health. Three 10-minute exercise periods also are beneficial. Aerobic exercise—activities such as walking, jogging, and cycling—uses the large muscle groups and forces the body to use oxygen more efficiently. It also can include everyday activities, such as active gardening, climbing stairs, or brisk housework. However, any regular exercise, no matter how mild, is better than not exercising.

Maintaining a desirable body weight also is important in preventing heart attacks. In 2009, about one-third of all adult Americans were overweight or obese. People who are 20% or more over their ideal body weight have an increased risk of developing coronary artery disease. Losing weight can help reduce total and LDL cholesterol, reduce **triglycerides**, and boost relative levels of HDL cholesterol. It also may reduce blood pressure.

Smoking has many adverse effects on the heart. It increases the heart rate, constricts major arteries, and can create irregular heartbeats. It also raises blood pressure, contributes to the development of plaque, increases the formation of blood clots, and causes blood platelets to cluster and impede blood flow. Quitting can repair heart damage caused by smoking; even heavy smokers can return to heart health, and the health of their lungs also improves. Several studies have shown that ex-smokers face the same risk of heart disease as non-smokers within 5 to 10 years of quitting.

Drinking alcohol should always be done in moderation. Modest consumption of alcohol may protect against coronary artery disease; however, even small amounts of alcohol may have other negative effects depending on the individual's health status and medications being taken. The American Heart Association defines moderate consumption as one ounce of alcohol per day—roughly one cocktail, one 8-ounce glass of

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wine, or two 12-ounce glasses of beer. Excessive alcohol use is always bad for the heart, and illegal drugs, such as methamphetamines and cocaine, can seriously harm the heart and cause a fatal heart attack.

High blood pressure, one of the most common and serious risk factors for coronary artery disease, can be controlled through lifestyle changes and medication. People with moderate hypertension may be able to lower it through dietary changes, such as reducing sodium intake combined with exercising regularly, managing stress, quitting smoking, and drinking alcohol in moderation. If these changes do not work, or if hypertension is severe, drugs that lower blood pressure may be prescribed.

Stress management means controlling mental and physical reactions to life's irritations and challenges. Techniques for controlling stress include taking life more slowly, spending time with family and friends, thinking positively, getting enough sleep, exercising, and practicing relaxation techniques.

Daily aspirin therapy has been proven to help reduce blood clots associated with atherosclerosis. It also can lower the risk of strokes.

Resources

BOOKS

American Heart Association. *American Heart Association Low-fat, Low-cholesterol Cookbook: Delicious Recipes to Help Lower your Cholesterol*. New York, NY: Clarkson Potter, 2004.

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ORGANIZATIONS

American Association of Cardiovascular and Pulmonary Rehabilitation, 401 North Michigan Avenue, Suite 2200, Chicago, IL, 60611, (312) 321-5146, (312) 673-6924, aacvpr@aacvpr.org, http://www.aacvpr.org.

American College of Cardiology, Heart House, 2400 N Street, NW, Washington, DC, 20037, (202) 375-6000, (800) 253-4636 x8603, (202) 375-7000, resource@acc.org, http://www.acc.org.

American Heart Association, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, http://www.americanheart.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573; TTY: (240) 629-3255, (240) 629-3246, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi.nih.gov.

Tish Davidson, A.M.

Heart block

Definition

Heart block refers to a delay in the normal flow of electrical impulses that cause the heart to beat. They are further classified as first-, second-, or third-degree block.

Description

The muscles of the heart contract in a rhythmic order for each heart beat, because electrical impulses travel along a specific route called the conduction system. The main junction of this system is called the atrioventricular node (AV node). Just as on a highway, there are occasionally some delays getting the impulse from one point to another. These delays are classified according to their severity.

In first-degree heart block, the signal is just slowed down a little as it travels along the defective part of the conduction system so that it arrives late traveling from the atrium to the ventricle.

In second-degree heart block, not every impulse reaches its destination. The block may affect every other beat, every second or third beat, or be very rare. If the blockage is frequent, it results in an overall slowing of the heart called bradycardia.

Third-degree block, also called complete heart block, is the most serious. When no signals can travel through the AV node, the heart uses its backup impulse generator in the lower portion of the heart. Though this impulse usually keeps the heart from stopping entirely, it is too slow to be an effective pump.

Causes and symptoms

First-degree heart block is fairly common. It is seen in teenagers, in young adults, and in well-trained athletes. The condition may be caused by **rheumatic fever**, some types of heart disease, and by some drugs. First-degree heart block produces no symptoms.

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KEY TERMS

Atrioventricular node (AV node)—Highly specialized area of the heart muscle which transmits electrical impulses.

Bradycardia—A slow heart rate, usually under 60 beats per minute.

Some cases of second-degree heart block may benefit from an artificial pace-maker. Second-degree block can occasionally progress to third-degree.

Third-degree heart block is a serious condition that affects the heart's ability to pump blood effectively. Symptoms include **fainting**, **dizziness**, and sudden **heart failure**. If the ventricles beat more than 40 times per minute, symptoms are not as severe, but include tiredness, low blood pressure on standing, and **shortness of breath**.

Young children who have received a forceful blunt chest injury, can experience first- or second-degree heart block.

Diagnosis

Diagnosis of first- and second-degree heart block is made by observing it on an electrocardiograph (ECG).

Third-degree heart block usually results in symptoms, such as fainting, dizziness, and sudden heart failure, which require immediate medical care. A physical exam and ECG confirm the presence of heart block.

Treatment

Some second- and almost all third-degree heart blocks require an artificial pacemaker. In an emergency, a temporary pacemaker can be used until an implanted device is advisable. Most people need the pacemaker for the rest of their lives.

Prognosis

Most people with first- and second-degree heart block don't even know they have it. For people with third-degree block, once the heart has been restored to its normal, dependable rhythm, most people live full and comfortable lives.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

Dorothy Elinor Stonely

Heart catheterization *see* **Cardiac catheterization**

Heart disease

Definition

Heart disease is a group of conditions affecting the structure and functions of the heart. The four primary conditions that make up heart disease are **coronary artery disease**, **heart attack**, **congenital heart disease**, and rheumatic heart disease. Other diseases include **angina** (chest **pain**) and arrhythmia (irregular heartbeat).

Description

The heart is a muscle that gets energy from blood carrying oxygen and nutrients. Having a constant supply of blood keeps the heart working properly. Most people think of heart disease as one condition. However, heart disease is a group of conditions affecting the structure and functions of the heart and has many root causes. Coronary artery disease (CAD) is the most common of these conditions and occurs when blood vessels in the heart become blocked or narrowed. This blockage limits the flow of blood through the coronary arteries, the major arteries supplying oxygen-rich blood to the heart. The coronary arteries expand when the heart is working harder and needs more oxygen. If the arteries are unable to expand, the heart is deprived of oxygen (myocardial **ischemia**). When the blockage is limited, chest pain or pressure called angina may occur. When the blockage cuts off the blood flow, the result is heart attack (myocardial infarction or heart muscle death).

A normal heart is a strong muscular pump. It weighs between 200 and 425 grams (7–15 ounces) and is a little larger than the size of an adult fist. During an average lifetime, the human heart will beat more than 2.5 billion times. The average heart beats about 100,000 times each day and pumps about 7,200 liters (1,900 gallons) of blood. The heart sits between the lungs in the middle of the chest, behind and slightly to the left of the breastbone. A double-layered membrane called the pericardium surrounds the heart like a sac. Blood loaded with oxygen comes from the lungs and enters the heart. To function, the heart needs a continuous supply of oxygen and nutrients, which it gets from the blood that is pumped through the coronary arteries. The heart and circulatory system make up the cardiovascular system. The heart pumps blood to the organs, tissues, and cells of the body, delivering oxygen and nutrients to every cell

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Prevalence of heart disease in the United States[1]

	African American		Caucasian	
	Females	Males	Females	Males
Coronary heart disease	8.8%	7.8%	6.9%	9.4%
Heart attack	2.9%	3.6%	2.6%	5.1%
Angina pectoris	5.4%	4.0%	4.5%	4.7%
Total cardiovascular disease	**46.9%**	**44.6%**	**34.4%**	**38.1%**

[1]All statistics are from 2006, the most recent year for which data was available.

SOURCE: American Heart Association, *Heart Disease and Stroke Statistics—2010 Update*. Available online at: http://www.americanheart.org (accessed September 23, 2010).

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and removing carbon dioxide and waste products made by those cells. Oxygen-rich blood is carried from the heart to the rest of the body through a complex network of arteries, arterioles, and capillaries. Oxygen-poor blood is carried back to the heart through veins.

Coronary artery disease

Healthy coronary arteries are open, elastic, smooth, and slick. The artery walls are flexible and expand to let more blood through when the heart needs to work harder. The disease process is thought to begin with an injury to the linings and walls of the arteries. This injury makes them susceptible to **atherosclerosis** and production of **blood clots** (thrombosis).

Coronary artery disease (CAD) is a condition in which plaque builds up inside the coronary arteries. These arteries supply the heart muscle with oxygen-rich blood. Plaque is made up of fat, cholesterol, **calcium**, and other substances found in the blood. When plaque builds up in the arteries, the condition is called atherosclerosis, commonly called hardening of the arteries. Plaque narrows the arteries and reduces blood flow to the heart. It also makes it more likely that blood clots will form in arteries. Blood clots can partially or completely block blood flow. When coronary arteries are narrowed or blocked, oxygen-rich blood can't reach the heart. This can cause angina or a heart attack. Angina is chest pain or discomfort that occurs when not enough oxygen-rich blood is flowing to an area of the heart. Angina may feel like pressure or squeezing in the chest. The pain also may occur in the shoulders, arms, neck, jaw, or back. A heart attack occurs when blood flow to an area of the heart is completely blocked. This prevents oxygen-rich blood from reaching that area of heart and causes it to die. Without quick treatment, a heart attack can lead to serious problems and even death. Over time, CAD can weaken the heart and lead to **heart failure** and **arrhythmias**. Heart failure is a condition in which the heart can't pump enough blood throughout the body. Arrhythmias are irregularities with the speed or rhythm of the heartbeat.

Heart attack (myocardial infarction)

A heart attack (myocardial infarction) occurs when the blood supply to the heart is slowed or stopped because of a blockage. Atherosclerosis, the narrowing of coronary arteries due to plaque buildup, causes more than 90% of heart attacks. A heart attack may also occur when a coronary artery temporarily contracts or goes into a severe spasm, effectively shutting off the flow of blood to the heart. The length of time the blood supply is cut off will determine the amount of damage to the heart.

Congenital heart disease

Congenital means existing at birth. A congenital heart defect happens when the heart or the blood vessels near the heart don't develop normally before birth. Congenital heart defects are present in about 1% of live births and are the most frequent congenital malformations in newborns. In most cases, researchers don't know why they happen. Some causes include viral infections, certain conditions such as **Down Syndrome**, and drug **abuse** during **pregnancy**, especially of alcohol, **cocaine**, and methamphetamines.

Rheumatic heart disease

Rheumatic heart disease describes a group of acute (short-term) and chronic (long-term) heart disorders that can occur as a result of **rheumatic fever**. One common result of rheumatic **fever** is heart valve damage. Due to the control of rheumatic fever in the

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United States and most developed countries, it is relatively rare in these regions but is still a significant heart disease in parts of Africa, Asia, and South America. Rheumatic fever is an inflammatory disease that may affect many connective tissues of the body, especially those of the heart, joints, brain or skin. It usually starts out as a **strep throat** (streptococcal) infection. Anyone can get acute rheumatic fever, but it usually occurs in children between the ages of 5 and 15 years. About 60% of people with rheumatic fever develop some degree of subsequent heart disease.

Demographics

Heart disease is the leading cause of death in the United States, and it is a major cause of disability. Almost 700,000 people die of heart disease in the United States each year, about 29% of all U.S. deaths. Statistics from the Centers for Disease Control (CDC) report that coronary heart disease is the principal type of heart disease, reponsible for about 68.3% of all heart disease deaths. In 2005, coronary heart disease killed more than 7.6 million people. Worldwide, heart disease and **stroke** kill 17 million people a year, almost one-third of all deaths globally, according to the World Health Organization (WHO). By 2020, heart disease and stroke will become the leading cause of both death and disability worldwide, with the number of fatalities projected to increase to over 20 million a year and by 2030 to over 24 million a year. Men are slightly more likely to develop heart disease than women. An increasing number of women are experiencing heart disease but they are under-diagnosed. For both sexes, the risk of heart disease increases with age. In the United States, the number of heart disease deaths per 100,000 people by race is: Hispanics, 72; Asians and Pacific Islanders, 78; Native Americans, 80; African Americans, 206; and Caucasians, 259. However, when adjusted for differences in age distributions, the death rate from heart disease was 30% higher among African Americans than whites. In 2004, the number of deaths per 100,000 people in the U.S. by age groups was: 55–64, 218.8; 65–74, 541.6; 75–84, 1,506; and 85 and older, 4,896.

Causes and symptoms

Coronary artery disease

Over many years, plaque builds up on artery walls. Plaque is a sticky, yellow substance made of fatty substances like cholesterol, as well as calcium and waste products from cells. It narrows and clogs the arteries, slowing the flow of blood. The process is called atherosclerosis. Atherosclerosis is a slow, progressive condition that may begin as early as childhood and occur anywhere in the body but it usually affects large and medium sized arteries. Atherosclerotic plaques often form blood clots that can also block the coronary arteries (coronary thrombosis). Sometimes plaque in an artery can rupture. The body's repair system in turn creates a blood clot to heal the wound. The clot, however, can block the artery, leading to a heart attack or stroke.

Congenital defects and **muscle spasms** of arteries or heart muscles also block blood flow. Some research indicates that infection from organisms such as chlamydia bacteria may be responsible for some cases of heart disease.

Early warning signs may include: **fatigue**, pain, and **dizziness**, as well as the symptoms associated with angina: a squeezing, suffocating, or burning feeling in the chest that tends to start in the center of the chest but may move to the arm, neck, back, throat, or jaw. Women are more likely to experience atypical symptoms, such as vague chest discomfort.

Heart attack (myocardial infarction)

A heart attack occurs when the blood supply to the heart is partially or completely blocked. Symptoms include pain in the chest, neck, jaw, shoulder, arms or back, sudden discomfort or pain (especially in the chest) that does not go away, difficulty breathing, **nausea**, sweating, and **anxiety**.

Congenital heart disease

Congenital heart disease is caused by a defect in the heart at birth. The most common symptoms of congenital heart defects are a heart murmur, a bluish tint to the skin, lips, or fingernails, fast breathing, **shortness of breath**, and fatigue, especially during **exercise** or physical activity.

Rheumatic heart disease

It may take several years after an episode of rheumatic fever for valve damage to develop or symptoms to appear. **Antibiotics** can prevent streptococcal infection from developing into rheumatic fever. Any child with a persistent **sore throat** should have a **throat culture** to check for strep infection. Penicillin or another antibiotic will usually prevent strep throat from developing into rheumatic fever. Symptoms of heart valve problems, which are often the result of rheumatic heart disease, can include chest pain, excessive fatigue, heart **palpitations** (when the heart flutters or misses beats), a thumping sensation in the chest, shortness of breath, and swollen ankles, wrists or stomach.

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Major risk factors

A number of major contributing risk factors increase the chance of developing heart disease. Some of these can be changed and some cannot. The greater the number of risk factors, the greater the chance of developing heart disease. Major risk factors significantly increase the chance of developing heart disease. These include:

- Heredity. People whose parents have heart disease are more likely to develop it. African Americans are also at increased risk because they experience a high rate of severe hypertension.
- Gender. Men are more likely to have heart attacks than women and have them at a younger age. Above the age of 60, however, women have heart disease at a rate equal to that of men.
- Age. Men who are 45 years of age and older and women who are 55 years of age and older are more likely to have heart disease. Occasionally, heart disease may strike men or women in their 30s. People more than 65 years old are more likely to die from a heart attack. Older women are twice as likely as older men to die within a few weeks of a heart attack.
- Smoking. Smoking increases both the chance of developing heart disease and the chance of dying from it. Smokers are more than twice as likely as non-smokers to have a heart attack and are two to four times more likely die from it.
- High cholesterol levels. Dietary sources of cholesterol are meat, dairy food, eggs, and other animal-fat products. Cholesterol is also produced by the body. Age, body fat, diet, exercise, heredity, and sex affect one's blood cholesterol. For typical, healthy patients, the American Heart Association recommends a total blood cholesterol below 200 mg/dL, which puts the person at a comparatively low risk for coronary heart disease. For these individuals, a total cholesterol level of 200–239 mg/dL is considered borderline high-risk, and a level of 240 mg/dL or above is considered high risk and doubles the risk for coronary heart disease. Persons with such risk factors as elevated low-density lipoprotein (LDL cholesterol, or "bad" cholesterol) levels, low high-density lipoprotein (HDL or "good" cholesterol) levels, or high triglyceride levels should consult with their doctor about what their target cholesterol level should be.
- High blood pressure. High blood pressure makes the heart work harder and weakens it over time. It increases the risk of heart attack, stroke, kidney failure, and congestive heart failure. A blood pressure of 140 over 90 or above is considered high. The risk of heart attack or stroke is raised several times for people with high blood pressure combined with obesity, smoking, high cholesterol levels, or diabetes. Nearly one-third of American adults have high blood pressure.
- Lack of physical activity. Lack of exercise increases the risk of heart disease. Even modest physical activity, such as walking, is beneficial if done regularly.
- Diabetes mellitus. The risk of developing heart disease is seriously increased for diabetics. About two-thirds of people who have type I or type II diabetes die as the result of a heart attack or stroke.

Contributing risk factors

Contributing risk factors have been linked to heart disease. These include:

- Obesity. Excess weight increases the strain on the heart and increases the risk of developing heart disease even if no other risk factors are present. Obesity increases blood pressure and blood cholesterol and can lead to diabetes.
- Hormone replacement therapy (HRT). Even though physicians once believed that HRT could help prevent heart disease in women, the Women's Health Initiative (WHI) released information in 2002 and 2003 showing that use of combined hormones (estrogen and progestin) is harmful in women who already have coronary artery disease. As of 2007, it continued to be debated if HRT, and estrogen in particular, can provide some protection against heart disease when a woman takes it soon after going through menopause.
- Stress and anger. Some scientists believe that poorly managed stress and anger can contribute to the development of heart disease and increase the blood's tendency to form clots (thrombosis). Stress increases the heart rate and blood pressure and can injure the lining of the arteries.
- Chest pain (angina). Angina is the main symptom of coronary heart disease, but it is not always present. Other symptoms include shortness of breath, chest heaviness, tightness, pain, a burning sensation, squeezing, or pressure either behind the breastbone or in the left arm, neck, or jaws. According to the American Heart Association, 64 percent of women and 50 percent of men who died suddenly of heart disease had no previous symptoms of the disease.

Diagnosis

Diagnosis begins with a doctor's review of the medical history, discussion of symptoms, listening to the heart, and performing basic screening tests. These tests measure blood lipid levels, blood pressure, fasting blood-glucose levels, weight, and other indicators. Other diagnostic tests include resting and exercise electrocardiograms,

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echocardiography, radionuclide scans, and coronary **angiography**. The treadmill exercise (stress) test is an appropriate screening test for those with high risk factors even though they feel well.

Angiogram

Coronary angiography is considered the most accurate method for making a diagnosis of heart disease, but it is also the most invasive. This test involves taking x ray pictures of the coronary arteries and the vessels that supply blood to the heart. During coronary angiography the patient is awake but sedated. The cardiologist inserts a catheter into a blood vessel and guides it into the heart. A contrast dye (a radiopaque substance that is visible on x ray) is injected into the catheter and x rays are taken. This dye makes the blood vessels visible when an X-ray is taken of them. Angiography allows doctors to clearly see how blood flows into the heart. This helps them to pinpoint problems with the coronary arteries. Angiography may be recommended for patients with angina or those with suspected coronary artery disease. The test gives doctors valuable information on the condition of the coronary arteries, such as atherosclerosis, regurgitation (blood flowing backwards through the heart valves), or pooling of blood in a chamber because of a valve malfunction. Coronary angiography is performed in a **cardiac catheterization** laboratory in either an outpatient or an inpatient surgery unit.

Radionuclide angiography enables physicians to see the blood flow of the coronary arteries. Nuclear scans are performed by injecting a small amount of radiopharmaceutical, such as thallium, into the bloodstream. As the patient lies on a table, a camera that uses gamma rays to produce an image of the radioactive material passes over the patient and records pictures of the heart. Radionuclide angiography is usually performed in a hospital's nuclear medicine department. The radiation exposure is about the same as that in a **chest x ray**.

Echocardiogram

An echocardiogram uses sound waves (ultrasound) to create a picture of the heart. The recorded waves show the shape, texture, and movement of the heart valves, as well as the size of the heart chambers and how well they are working. A technician applies gel to a hand-held transducer and then presses it against the patient's chest. The heart's sound waves are converted into an image that can be displayed on a monitor. An echocardiogram may be done to determine whether a stroke was caused by a heart condition and can also help determine if there is a risk of blood clots forming in the heart. It may also be recommended if the patient is experiencing abnormal heart sounds, shortness of breath, palpitations, angina, or has a history of stroke. It is very useful in diagnosing heart valve problems. It does not reveal the coronary arteries themselves but can detect abnormalities in the heart wall caused by heart disease. Typically performed in a doctor's office or outpatient facility, the test takes 30 to 60 minutes.

Electrocardiogram

An electrocardiogram (ECG or EKG) is a test that checks how the heart is functioning by measuring the electrical activity of the heart. Electrodes are placed on the patient's chest, arms, and legs. They send impulses of the heart's activity through an oscilloscope (a monitor) to a recorder that traces them on paper. With each heart beat, an electrical impulse (wave) travels through the heart. This wave causes the muscle to squeeze and pump blood from the heart. By measuring how long the electrical wave takes to pass through the heart, a cardiologist can determine if the electrical activity is normal, fast, or irregular. The cardiologist may also be able to determine if the heart is enlarged or overworked. It may be recommended if the patient is experiencing arrhythmia, palpitations, dizziness, excessive fatigue, or angina. An ECG is used to:

- Detect abnormal heart rhythms that may have caused blood clots to form.
- Detect heart problems, including a recent or ongoing heart attack, abnormal heart rhythms (arrhythmias), coronary artery blockage, areas of damaged heart muscle (from a prior heart attack), enlargement of the heart, and inflammation of the sac surrounding the heart (pericarditis).
- Detect non-heart conditions such as electrolyte imbalances and lung diseases.
- Monitor recovery from a heart attack, progression of heart disease, or the effectiveness of certain heart medications or a pacemaker.
- Rule out hidden heart disease in patients about to undergo surgery.

Exercise stress test

This test measures how the heart and blood vessels respond to exertion when the patient is exercising on a treadmill or a stationary bike. It can be performed in a physician's office or outpatient facility.

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Treatment

Heart disease can be treated many ways. The choice of treatment depends on the patient and the severity of the disease. Treatments include lifestyle changes, drug therapy, and coronary artery bypass surgery. (Recommendations for persons with coronary artery disease are available through the American Heart Association Web site at http://www.americanheart.org/presenter.jhtml?identifier=3039477.) These, however, are not a cure. Heart disease is a chronic disease requiring lifelong care.

There is no cure for heart disease, but there are many treatments, such as medications, surgery, and lifestyle changes, that can slow down its progression.

Medications

People with moderate heart disease may gain adequate control through lifestyle changes and drug therapy. Drugs such as nitrates, beta-blockers, and **calcium channel blockers** relieve chest pain and complications of heart disease, but they cannot clear blocked arteries. Nitrates improve blood flow to the heart, and beta-blockers reduce the amount of oxygen required by the heart during stress. Calcium channel blockers help keep the arteries open and reduce blood pressure. **Aspirin** helps prevent blood clots from forming on plaques, reducing the likelihood of a heart attack and stroke. Cholesterol-lowering medications are also indicated in many cases.

ANTIPLATELETS. Antiplatelets help prevent dangerous blood clots from forming. They may be used to reduce the risk of clot-induced heart attack or stroke, which is called preventive or prophylactic treatment. One of the most common antiplatelets is aspirin. Ticlopidine (Ticlid) may be prescribed to stroke survivors or those who are at high risk of stroke, particularly if they are not able to take aspirin. Clopidogrel (Plavix) is an antiplatelet drug that is effective in preventing strokes and heart attacks and is often prescribed for patients who receive a coronary stent. Dipyridmalole (Persantine) may also be given with other antiplatelet or anticoagulant medications. It can also be given by injection during tests on the heart.

ACE INHIBITORS. Angiotensin converting enzyme (ACE) inhibitors are usually given to people with high blood pressure, congestive heart failure, or people with a high likelihood of developing coronary artery disease. They may also be given after a heart attack to prevent more complications and to people living with congestive heart failure. They help control blood pressure to make it easier for the heart to pump. ACE inhibitors may also make people with CAD feel less tired and short of breath, reduce the time they spend in a hospital, and help them live longer. ACE inhibitors have been shown to reduce the risk of heart attack, stroke, and death in people with a history of coronary artery disease. Since ACE inhibitors are used to control and prevent conditions of the heart, they are usually prescribed for the long term.

BETA BLOCKERS. **Beta blockers** are used to treat high blood pressure, congestive heart failure, abnormal heart rhythms, and chest pain. They are sometimes used to prevent future heart attacks in someone who has had a heart attack and to treat **tremors** caused by an overactive thyroid, as well as anxiety or migraines. Beta blocker is short for beta-adrenergic blocking drugs. Beta blockers block the responses from the beta nerve receptors. This slows the heart rate and lowers blood pressure to reduce the workload on the heart.

CALCIUM CHANNEL BLOCKERS. Calcium channel blockers, sometimes called calcium channel antagonists, are used to control high blood pressure, chest pain caused by coronary artery disease, and irregular heartbeats. Calcium channel blockers are often taken in combination with beta blockers or **diuretics** to help reduce blood pressure. Calcium channel blockers are **vasodilators**, which means they widen (dilate) blood vessels, letting blood flow through more easily. By relaxing blood vessels, the blood pressure drops and the heart doesn't have to work as hard.

NITRATES. Nitrates are vasodilators and can be used to prevent chest pain, limit the number of angina attacks, relieve the pain of a current attack, or treat the symptoms of congestive heart failure. Nitroglycerin is a type of nitrate.

Medical procedures

ANGIOPLASTY WITH STENT. Percutaneous Coronary Intervention (PCI), commonly called **angioplasty** with a stent, is a non-surgical procedure that uses a catheter (a thin flexible tube) to place a small structure called a stent (a small tubular structure made of stainless steel or plastic) to open up blood vessels in the heart that have been narrowed by plaque buildup. PCI improves blood flow, thus decreasing heart-related chest pain, making the patient feel better and increasing his or her ability to be physically active. During the procedure, a catheter is inserted into the blood vessels either in the groin or in the arm. Using a special type of X-ray called fluoroscopy, the catheter is threaded through the blood vessels into the heart where the coronary artery is narrowed. When the tip is in place, a balloon tip covered with a stent is inflated. The balloon tip compresses the

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plaque and expands the stent. Once the plaque is compressed and the stent is in place, the balloon is deflated and withdrawn. The stent stays in the artery, holding it open. The doctor may use a coated stent or a bare metal stent. A coated stent has medicine on its outside that slows the regrowth of the artery wall and blocking the stent. If a coated stent is used, the patient will need to take Plavix for at least two years, perhaps for life.

CORONARY ARTERY BYPASS SURGERY. Coronary artery bypass surgery improves the blood flow to the heart muscle. It is commonly referred to as bypass surgery or Coronary Artery Bypass Graft (CABG, pronounced like cabbage) surgery. Bypass surgery is performed to improve blood flow problems to the heart muscle caused by the buildup of plaque in the coronary arteries. The surgery involves using a piece of blood vessel (artery, vein) taken from elsewhere in the body to create a detour or bypass around the blocked portion of the coronary artery. By improving blood flow, bypass surgery may decrease heart-related chest pain, making patients feel better and increasing their ability for physical activity.

In coronary artery bypass surgery, a piece of a healthy blood vessel from the patient's leg, arm, or chest will be removed to be used as the bypass. Unless a patient is undergoing one of the newer procedures (minimally-invasive bypass or off-pump or beating-heart surgery), the heart is stopped so the surgeons can work on it. A machine called the heart-lung machine will take over the work of the heart and lungs while the surgeon is operating on the heart. The section of healthy blood vessel is attached above and below the blocked artery. When the heart is restarted, blood flow is diverted through the bypass around the narrowed portion of the diseased artery. Depending upon the number of blockages, one to five bypasses may be created.

COUNTER PULSATION. Another medical procedure that can help with CAD is counter pulsation. In this procedure, inflatable cuffs are placed on the legs and lower abdomen. When the heart relaxes, the cuffs inflate and push blood into the blood vessels of the heart. This procedure is repeated over a few days and it stimulates improved blood flow to the heart. Counter pulsation can't be done in people with dilated aortas or who have severe **peripheral vascular disease**.

Heart attack (myocardial infarction)

When someone is experiencing a heart attack or believes they are, they should seek immediate emergency help. In the United States, call or have someone else call 911 and request paramedics or emergency medical technicians (EMTs). Most fire departments in the United States and Canada have paramedics and/or EMTs. Doctors also recommend that at the first sign of a heart attack, the patient chew and swallow an adult (325 mg) aspirin, which can help improve blood flow to the heart. Only aspirin can improve blood flow, no other pain medications, such as **acetaminophen** (Tylenol) or ibuprofen (Advil), will work. Until medical help arrives, the patient should sit or lie down. If the patient is on the drug nitroglycerine, they should take a normal dose. Following a heart attack, patients may be put on nitrates, ACE inhibitors, beta-blockers, and antiplatelets (all described under coronary artery disease medications). Other drugs used include thrombolytic drugs, used to dissolve blood clots that are blocking the coronary arteries, and anticoagulants, used to thin the blood and prevent clots from forming in the arteries. Surgical treatments include angioplasty and coronary bypass (both described under coronary artery disease medical procedures).

Congenital heart disease

The heart defects of congenital heart disease are treated with several medications, including ACE inhibitors, beta blockers, diuretics, and **digoxin**. Diuretics act on the kidneys to produce more urine and remove excess salt and water from the body. By decreasing water and salt, diuretics lower blood pressure and help reduce the workload on the heart. This may make it easier for the heart to pump, improve shortness of breath, reduce swelling and bloating, reduce the time spent in a hospital, and help patients live longer. Digoxin helps the heart pump stronger and slows down the heart rate to improve its pumping action.

In many cases, the strain to the heart requires procedures that either fix holes between the chambers, replace valves, or repair or reconnect major blood vessels. In severe cases, heart **transplant surgery** may be needed. Several other surgical procedures can be used to repair and correct congenital heart defects They include:

- Cardiac catheterization is often used to repair simple holes in the heart. A catheter (thin tube) is inserted into a blood vessel in the groin or arm and guided to the heart so that a surgeon can insert a plug inside the hole to repair it.
- Angioplasty is used to repair defective cardiac valves that can be either too narrow or leaky. A tiny balloon is guided to the heart inside a catheter (a thin tube). When the balloon is inflated, it can stretch the opening of a narrowed heart valve and restore normal blood flow. It is removed once blood flow returns.

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Rheumatic heart disease

If heart damage from rheumatic fever is identified in childhood or young adulthood, daily antibiotics may be required until the age of 25 or 30 to help prevent recurrence of rheumatic fever and avoid the development of infective bacterial **endocarditis**, an infection of the heart valves or lining of the heart. Additional treatment will depend on the type of heart damage. Surgery may be required to repair or replace damaged heart valves. In rare cases, heart transplant surgery may be recommended.

Other treatment options

Herbal-medicine practitioners recommend a variety of remedies that may have a beneficial effect on heart disease. They may suggest garlic (*Allium sativum*), myrrh (*Commiphora molmol*), and oats (*Avena sativa*) to help reduce cholesterol, and hawthorn (*Crataegus* spp.), linden (*Tilia europaea*), and yarrow (*Achillea millefolium*) to control high blood pressure, a risk factor for heart disease. Tea, especially green tea (*Camellia sinensis*), is high in **antioxidants**, and studies have shown that it may have a preventive effect against atherosclerosis. Coenzyme Q10 has been shown to be beneficial for patients with congestive heart failure. Taurine, an amino acid found in meat and fish proteins, has also been suggested as a way to treat heart arrhythmia.

Some alternative-medicine practitioners believe that **yoga** and other bodywork, massage, relaxation, **aromatherapy**, and music therapies may also help prevent heart disease and stop, or even reverse, the progression of atherosclerosis. Vitamin and mineral supplements that are believed to reduce, reverse, or protect against heart disease include B-complex **vitamins**, calcium, chromium, magnesium, L-carnitine, zinc, and the antioxidant vitamins C and E. Notably, a study in 2004 showed a relationship between high doses of supplemental vitamin C and reduced coronary heart disease but found little risk reduction with supplemental vitamin E.

Traditional Chinese medicine (TCM) may recommend herbal remedies, massage, **acupuncture**, and dietary modification. A healthy diet (including cold water fish as a source of essential fatty acids) and exercise are important components of both alternative and conventional prevention and treatment strategies.

Nutrition and diet concerns

A healthy diet includes a variety of foods that are low in fat, especially saturated fat; low in cholesterol; and high in fiber. It includes plenty of fruits and vegetables and limits salt. According to the American Heart Association, fats should comprise no more than 25 to 35 percent of total daily calories and should total less than 7 percent saturated fats, less than 1 percent trans fats, and the remainder as monounsaturated and polyunsaturated fats from such sources as nuts, seeds, fish, and vegetable oils. Cholesterol intake should be limited to 300 mg per day for the average person. Those individuals who have coronary heart disease or who have an LDL cholesterol level of 100 mg/dL or more should lower their daily cholesterol intake to less than 200 mg per day. Eating cold-water fish or taking comparable omega-3 polyunsaturated fatty acid supplements can help prevent cardiac death. The American Heart Association advocates eating fish (particularly fatty fish) at least twice a week. It also recommends adding soybeans (including tofu), canola, walnut, and flaxseed, and their oils to the diet because these contain alpha-linolenic acid than can transform into omega-3 fatty acid in the body. The association also notes that individuals consult with their doctor before taking omega-3 fatty acid supplements in excess of 3 grams per day because of the potential for bleeding.

Cholesterol, a waxy substance containing fats, is found in foods such as meat, dairy, eggs, and other animal products. It is also produced in the liver. Soluble fiber can help lower cholesterol. Dietary cholesterol should be below 300 milligrams per day. Many popular lipid-lowering drugs can reduce LDL cholesterol by an average of 25 to 30 percent or more when used with a low-fat, low-cholesterol diet.

Antioxidants are chemical compounds in plant foods. When people eat antioxidant-rich foods, they may improve the function of the arteries and prevent arterial plaque formation and reduce their risk of **cancer**. Colorful vegetables and fruits are sources of antioxidants and are rich in fiber, vitamins, and **minerals**. They are low in calories and nearly fat-free. Vitamin C and beta-carotene, found in many fruits and vegetables, keep LDL-cholesterol from turning into a form that damages coronary arteries. Whole grains, especially whole oats and oat bran, reduce cholesterol.

Excess **sodium** can increase the risk of high blood pressure. Many processed foods contain large amounts of sodium. Daily intake should be limited to about 2,300 milligrams, about the amount in a teaspoon of salt.

New reports on diet and heart disease have answered some questions, but others remain unclear. While one study concludes that four servings per day of fruit and vegetables are associated with a slight drop in risk of heart disease, eight or more servings per day can produce a significant drop in risk. Another study showed that consuming legumes at least four times per week lowered

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risk of heart disease from 11 percent to 22 percent compared with consuming legumes less than once a week. Research on antioxidants continues to produce mixed findings, with some reports showing that vitamins E, C, and other antioxidants can help prevent heart disease and other studies showing they have no effect. Although scientists and medical professionals had not reached a consensus about the benefits of antioxidants as of 2008, the American Heart Association reported that up to 30 percent of Americans take antioxidant supplements. As of 2008, however, the association did not recommend supplements. Instead, it advised a diet containing a variety of nutrient-rich foods, including fruits, vegetables, whole grains, and nuts.

The Food Guide Pyramid developed by the Center for Nutrition Policy and Promotion, an organization of the U.S. Department of Agriculture, provides easy-to-follow guidelines for daily heart-healthy eating.

Exercising regularly

Regular aerobic exercise can lower blood pressure, help control weight, and increase HDL (good) cholesterol. It also may keep the blood vessels more flexible. The American Heart Association recommends moderate-to-vigorous intensity aerobic activity (50 to 85 percent of the maximum heart rate) for at least 30 minutes on most days of the week. Those 30 minutes can be divided into two 15-minute or three 10-minute sessions throughout the day. Aerobic exercise—activities such as walking, jogging, and cycling—uses the large muscle groups and forces the body to use oxygen more efficiently. It also can include everyday activities such as active gardening, climbing stairs, or brisk housework. People with heart disease or risk factors should consult a doctor before beginning an exercise program.

Maintaining a desirable body weight

People who are 20 percent or more above their ideal body weight have an increased risk of developing heart disease. Losing weight can help decrease total and LDL cholesterol, reduce **triglycerides**, and boost HDL cholesterol. It may also reduce blood pressure. Eating right and exercising are two essential components of losing weight.

Quitting smoking

Smoking has many adverse effects on the heart. It increases the heart rate, constricts major arteries, and can create irregular heartbeats. It also raises blood pressure, contributes to the development of plaque, increases the formation of blood clots, and causes blood platelets to cluster and impede blood flow. When smokers quit the habit, heart damage can be repaired. Several studies have shown that ex-smokers face the same risk of heart disease as non-smokers within 5 to 10 years after they quit.

Drinking in moderation

Modest consumption of alcohol may actually protect against heart disease because alcohol appears to raise levels of HDL cholesterol. The American Heart Association defines moderate consumption as one to two daily drinks for men and one daily drink for women, or one ounce of alcohol per day. The association defines one drink as 4 ounces of wine, 12 ounces of beer, 1.5 ounces of 80-proof spirits, or 1 ounce of 100-proof spirits.

Seeking diagnosis and treatment for hypertension

High blood pressure, one of the most common and serious risk factors for heart disease, can be completely controlled through lifestyle changes and medication. Seeking diagnosis and treatment is critical because **hypertension** often exhibits no symptoms, so many people do not know they have it. Moderate hypertension can be controlled by reducing dietary intake of sodium and fat, exercising regularly, managing stress, abstaining from smoking, and drinking alcohol in moderation.

Managing stress

Everyone experiences stress. Stress can sometimes be avoided and, when it is inevitable, it can be managed through relaxation techniques, exercise, and other methods.

Prevention

The only way to prevent rheumatic heart disease is to prevent rheumatic fever or successfully treat rheumatic fever before it can damage heart valves. There is no way to prevent congenital heart disease, since it is an inherited (genetic) disorder that develops in the womb.

People can lower their risk of coronary artery disease and heart attack by knowing and controlling their blood pressure, diabetes, and cholesterol. It is also important to lead a healthy lifestyle by not smoking and being physically active (exercising regularly), eating a healthy diet that is lower in fat, especially saturated and trans fat, achieving and maintaining a healthy weight, limiting alcohol use, and reducing stress. Seniors can reduce stress by regularly socializing with friends and family and with such activities as yoga and **meditation**. Many doctors also recommend taking a low-dose (81mg) of aspirin daily.

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KEY TERMS

Angina—Chest pain.

Angiogram—An X-ray photograph of one or more blood vessels.

Angioplasty—A surgical operation to clear a narrowed or blocked artery.

Arrhythmia—An irregular heartbeat.

Atherosclerosis—A buildup of plaque in the arteries, also called hardening of the arteries.

Beta-blocker—A drug that blocks some of the effects of fight-or-flight hormone adrenaline (epinephrine and norepinephrine), slowing the heart rate and lowering the blood pressure.

Calcium channel blocker—A drug that blocks the entry of calcium into the muscle cells of small blood vessels (arterioles) and keeps them from narrowing.

Coronary arteries—The main arteries that provide blood to the heart. The coronary arteries surround the heart like a crown, coming out of the aorta, arching down over the top of the heart, and dividing into two branches. These are the arteries in which heart disease occurs.

Echocardiogram—An image of the heart created by ultrasound waves.

Electrocardiogram—A test that measures the electrical activity of the heart. Also called an ECG or EKG.

HDL cholesterol—High-density lipoprotein cholesterol is a component of cholesterol that helps protect against heart disease. HDL is nicknamed "good cholesterol."

LDL cholesterol—Low-density lipoprotein cholesterol is the primary cholesterol molecule. High levels of LDL increase the risk of coronary heart disease. LDL is nicknamed "bad cholesterol."

Plaque—A compound made up of fat, cholesterol, calcium, and other substances found in the blood. It can stick to the walls of arteries, partially or totally blocking blood flow.

Triglyceride—A fat that comes from food or is made from other energy sources in the body. Elevated triglyceride levels contribute to the development of atherosclerosis.

Ultrasound—A technique that uses high-frequency sound waves for medical diagnosis and treatment by creating images of internal organs.

Vasodilator—A class of drugs that widen the blood vessels, that in turn decreases resistance to blood flow and lowers blood pressure.

A healthy lifestyle can help prevent heart disease and slow its progress. A heart-healthy lifestyle includes maintaining a healthy diet and weight, performing regular exercise, refraining from smoking, engaging in moderate drinking, controlling hypertension, and managing stress. **Cardiac rehabilitation** programs are excellent ways to help prevent recurring coronary problems for people who are at risk and who have had coronary events and procedures.

Caregiver concerns

Patients with heart disease may have as many as five (or more) medications that need to be taken daily. Caregivers should have a system to make sure that the patient takes the medications when and how they are prescribed. Alarms or timers can be used to remind the patient when to take each pill. Also, weekly pill dispensers can help to insure patients only take the dose that is prescribed. Caregivers may want to keep a medicine calendar and note every time the patient takes a dose, or have the patient do it themselves. It is vital that the caregiver makes sure that prescriptions are refilled before they run out. Make sure that the patient is not taking anything that is contraindicated by their condition or that may interact with their medication. Examples include such things as herbal supplements, **antihistamines**, and **analgesics**. Check with the patient's doctor or pharmacist for possible **drug interactions**. Also, people who take nitrates (such as nitroglycerine) should not take medications for **erectile dysfunction** (ED), including sildenafil (Viagra), vardenafil (Levitra), and tadalafil (Cialis).

Helping a patient stick to their diet and exercise routine is critical to their overall health. One way to ensure adherence to a restricted diet is to prepare meals for the patient. If this is not feasible, the caregiver can try to limit the amount of forbidden foods that are present in the patient's home. The level of exercise required of a patient will depend on their overall health, but for most patients, frequent walks are beneficial. If the caregiver can accompany them on their walks it will make the experience more enjoyable and increase adherence. Perhaps the most important role of a caregiver is providing emotional support. Simply being there to listen to the patient's concerns and to provide encouragement can keep them on the path toward better health. In some

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cases, the patient may require at-home **oxygen therapy**. The caregiver should learn how the oxygen equipment is used and to make sure more oxygen is ordered well before the patient's current supply runs out.

Prognosis

Advances in medicine and the adoption of healthier lifestyles have caused a substantial decline in death rates from heart disease since the mid-1980s. New diagnostic techniques enable doctors to identify and treat heart disease in its earliest stages. New technologies and surgical procedures have extended the lives of many patients who would have otherwise died. Research continues, and valuable organizations continue to educate clinicians, patients, and healthy individuals alike, in the fight against heart disease

Resources

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ORGANIZATIONS

Adult Congenital Heart Association, 6757 Greene St., Suite 335, Philadelphia, PA, 19119-3508, (215) 849-1260, (888) 921-2242, (215) 849-1261, info@achaheart.org, http://www.achaheart.org.

American Heart Association, 7272 Greenville Ave., Dallas, TX, 75231, (301) 223-2307, (800) 242-8721, http://www.americanheart.org.

Association of Black Cardiologists, 5355 Hunter Road, Atlanta, GA, 30349, (404) 201-6600, (800) 753-9222, (404) 201-6601, abcardio@abcardio.org, http://www.abcardio.org.

European Society of Cardiology, The European Heart House, 2035 Route des Colles, B.P. 179-Les Templiers, Sophia-Antipolis, France, 06903, 33 4 9294 7600, 33 4 9294 7601, http://www.escardio.org.

Heart Foundation, 80 William St., Level 3, SydneyNSW, Australia, 2011, 02 9219 2444, 300 36 27 87, http://www.heartfoundation.org.au.

National Heart, Lung, and Blood Institute, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (204) 629-3246, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi.nih.gov.

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Heart failure

Definition

Heart failure is a condition in which the heart has lost the ability to pump enough blood to the body's tissues. With too little blood being delivered, the organs and other tissues do not receive enough oxygen and nutrients to function properly.

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Description

According to the American Heart Association, about 5 million Americans are living with congestive heart failure. Ten of every 1,000 people over age 65 have this condition. There are about 550,000 new cases each year.

Heart failure happens when a disease affects the heart's ability to deliver enough blood to the body's tissues. Often, a person with heart failure may have a buildup of fluid in the tissues, called **edema**. Heart failure with this kind of fluid buildup is called congestive heart failure. Where edema occurs in the body depends on the part of the heart that is affected by heart failure. Heart failure caused by abnormality of the lower left chamber of the heart (left ventricle) means that the left ventricle cannot pump blood out to the body as fast as it returns from the lungs. Because blood cannot get back to the heart, it begins to back up in the blood vessels of the lungs. Some of the fluid in the blood is forced into the breathing space of the lungs, causing **pulmonary edema**. A person with pulmonary edema has **shortness of breath**, which may be acute, severe and life threatening. A person with congestive heart failure feels tired because not enough blood circulates to supply the body's tissues with the oxygen and nutrients they need. Abnormalities of the heart structure and rhythm also can be responsible for left ventricular congestive heart failure.

In right-sided heart failure, the lower right chamber of the heart (right ventricle) cannot pump blood to the lungs as fast as it returns from the body through the veins. Blood then engorges the right side of the heart and the veins. Fluid backed up in the veins is forced out into the tissues, causing swelling (edema), usually in the feet and legs. Congestive heart failure of the right ventricle often is caused by abnormalities of the heart valves and lung disorders.

When the heart cannot pump enough blood, it tries to make up for this by becoming larger. By becoming enlarged (hypertrophic) the ventricle can contract more strongly and pump more blood. When this happens, the heart chamber becomes larger and the muscle in the heart wall becomes thicker. The heart also compensates by pumping more often to improve blood output and circulation. The kidneys try to compensate for a failing heart by retaining more salt and water to increase the volume of blood. This extra fluid also can cause edema. Eventually, as the condition worsens over time these measures are not enough to keep the heart pumping enough blood needed by the body. Kidneys often weaken under these circumstances, further aggravating the situation and making therapy more difficult.

For most people, heart failure is a chronic disease with no cure. However, it can be managed and treated with medicines and changes in diet, **exercise**, and lifestyle habits. **Heart transplantation** is considered in some cases.

Causes and symptoms

The most common causes of heart failure are:

- coronary artery disease and heart attack (which may be "silent")
- cardiomyopathy
- high blood pressure (hypertension)
- heart valve disease
- congenital heart disease
- alcoholism and drug abuse

The most common cause of heart failure is **coronary artery disease**. In coronary artery disease, the arteries supplying blood to the heart become narrowed or blocked. When blood flow to an area of the heart is completely blocked, the person has a **heart attack**. Some heart attacks go unrecognized. The heart muscle suffers damage when its blood supply is reduced or blocked. If the damage affects the heart's ability to pump blood, heart failure develops.

Cardiomyopathy is a general term for disease of the heart muscle. Cardiomyopathy may be caused by coronary artery disease and various other heart problems. Sometimes the cause of cardiomyopathy cannot be found. In these cases the heart muscle disease is called idiopathic cardiomyopathy. Whatever the cause, cardiomyopathy can weaken the heart, leading to heart failure.

High blood pressure is another common cause of heart failure. High blood pressure makes the heart work harder to pump blood. After a while, the heart cannot keep up and the symptoms of heart failure develop.

Defects of the heart valves, congenital heart diseases, **alcoholism**, and drug **abuse** cause damage to the heart that can all lead to heart failure.

A person with heart failure may experience the following:

- shortness of breath
- frequent coughing, especially when lying down
- swollen feet, ankles, and legs
- abdominal swelling and pain
- fatigue
- dizziness or fainting
- sudden death

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A person with left-sided heart failure may have shortness of breath and coughing caused by the fluid buildup in the lungs. Pulmonary edema may cause the person to **cough** up bubbly phlegm that contains blood. With right-sided heart failure, fluid build-up in the veins and body tissues causes swelling in the feet, legs, and abdomen. When body tissues, such as organs and muscles, do not receive enough oxygen and nutrients they cannot function as well, leading to tiredness and **dizziness**.

Diagnosis

Diagnosis of heart failure is based on:

- symptoms
- medical history
- physical examination
- chest x ray
- electrocardiogram (ECG; also called EKG)
- other imaging tests
- cardiac catheterization

A person's symptoms can provide important clues to the presence of heart failure. Shortness of breath while engaging in activities and episodes of shortness of breath that wake a person from sleep are classic symptoms of heart failure. During the **physical examination**, the physician listens to the heart and lungs with a stethoscope for telltale signs of heart failure. Irregular heart sounds, "gallops," a rapid heart rate, and murmurs of the heart valves may be heard. If there is fluid in the lungs a crackling sound may be heard. Rapid breathing or other changes in breathing may also be present. Patients with heart failure also may have a rapid pulse.

By pressing on the abdomen, the physician can feel if the liver is enlarged. The skin of the fingers and toes may have a bluish tint and feel cool if not enough oxygen is reaching them.

A **chest x ray** can show if there is fluid in the lungs and if the heart is enlarged. Abnormalities of heart valves and other structures also may be seen on chest x ray.

An electrocardiogram gives information on the heart rhythm and the size of the heart. It can show if the heart chamber is enlarged and if there is damage to the heart muscle from blocked arteries.

Besides chest x ray, other imaging tests may help make a diagnosis. **Echocardiography** uses sound waves to make images of the heart. These images can show if the heart wall or chambers are enlarged and if there are any abnormalities of the heart valves. An echocardiogram also can be used to find out how much blood the heart is pumping. It determines the amount of blood in the ventricle (ventricular volume) and the amount of blood the ventricle pumps each time it beats (called the ejection fraction). A healthy heart pumps at least one-half the amount of blood in the left ventricle with each heartbeat. Radionuclide ventriculography also measures the ejection fraction by imaging with very low doses of an injected radioactive substance as it travels through the heart.

A new test that measures the level of a particular hormone in the blood was introduced in 2003 and researchers said the test may be useful for testing for heart failure in physicians' offices because it could provide results in 15 minutes.

Cardiac catheterization involves using a small tube (catheter) that is inserted through a blood vessel into the heart. It is used to measure pressure in the heart and the amount of blood pumped by the heart. This test can help find abnormalities of the coronary arteries, heart valves, and heart muscle, and other blood vessels. Combined with echocardiography and other tests, cardiac catheterization can help find the cause of heart failure. It is not always necessary, however.

Treatment

Heart failure usually is treated with lifestyle changes and medicines. Sometimes surgery is needed to correct abnormalities of the heart or heart valves. Heart transplantation is a last resort to be considered in certain cases.

Dietary changes to maintain proper weight and reduce salt intake may be needed. Reducing salt intake helps to lessen swelling in the legs, feet, and abdomen. Appropriate exercise also may be recommended, but it is important that heart failure patients only begin an exercise program with the advice of their doctors. Walking, bicycling, swimming, or low-impact aerobic exercises may be recommended. There are good heart **rehabilitation** programs at most large hospitals.

Other lifestyle changes that may reduce the symptoms of heart failure include stopping **smoking** or other tobacco use, eliminating or reducing alcohol consumption, and not using harmful drugs.

One or more of the following types of medicines may be prescribed for heart failure:

- diuretics
- digitalis
- vasodilators
- beta blockers
- angiotensin converting enzyme inhibitors (ACE inhibitors)
- angiotensin II receptor blockers (ARBs)

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KEY TERMS

Angioplasty—A technique for treating blocked coronary arteries by inserting a catheter with a tiny balloon at the tip into the artery and inflating it.

Angiotensin-converting enzyme (ACE) inhibitor—A drug that relaxes blood vessel walls and lowers blood pressure.

Arrhythmias—Abnormal heartbeat.

Atherosclerosis—Buildup of a fatty substance called a plaque inside blood vessels.

Calcium channel blocker—A drug that relaxes blood vessels and lowers blood pressure.

Cardiac catheterization—A diagnostic test for evaluating heart disease; a catheter is inserted into an artery and passed into the heart.

Cardiomyopathy—Disease of the heart muscle.

Catheter—A thin, hollow tube.

Congenital heart defects—Abnormal formation of structures of the heart or of its major blood vessels present at birth.

Congestive heart failure—A condition in which the heart cannot pump enough blood to supply the body's tissues with sufficient oxygen and nutrients; back up of blood in vessels and the lungs causes buildup of fluid (congestion) in the tissues.

Coronary arteries—Arteries that supply blood to the heart muscle.

Coronary artery bypass—Surgical procedure to reroute blood around a blocked coronary artery.

Coronary artery disease—Narrowing or blockage of coronary arteries by atherosclerosis.

Digitalis—A drug that helps the heart muscle to have stronger pumping action.

Diuretic—A type of drug that helps the kidneys eliminate excess salt and water.

Edema—Swelling caused by fluid buildup in tissues.

Ejection fraction—A measure of the portion of blood that is pumped out of a filled ventricle.

Heart valves—Valves that regulate blood flow into and out of the heart chambers.

Hypertension—High blood pressure.

Hypertrophic—Enlarged.

Idiopathic cardiomyopathy—Cardiomyopathy without a known cause.

Pulmonary edema—Buildup of fluid in the tissue of the lungs.

Vasodilator—Any drug that relaxes blood vessel walls.

Ventricles—The two lower chambers of the heart.

- calcium channel blockers
- blood thinners
- potassium

Diuretics help eliminate excess salt and water from the kidneys by making patients urinate more often. This helps reduce the swelling caused by fluid buildup in the tissues. Digitalis helps the heart muscle to have stronger pumping action. **Vasodilators**, ACE inhibitors, ARBs, and **calcium channel blockers** lower blood pressure and expand the blood vessels so blood can move more easily through them. This action makes it easier for the heart to pump blood through the vessels. Cholesterol-lowering drugs called statins can help prevent **death** from heart failure. A 2003 study showed a 62% drop in the mortality rate among patients with severe heart failure who took statin therapy.

In 2005, the U.S. Food and Drug Administration (FDA) approved a new noninvasive procedure for patients with congestive heart failure. Called **enhanced external counterpulsation** (EECP), it consists of inflating three sets of pneumatic cuffs attached to the patient's legs. The therapy had positive effects on the blood pressure and reduced frequency of episodes of **angina** (**pain**) in a clinical trial by as much as 70%.

Surgery is used to correct certain heart conditions that cause heart failure. Congenital heart defects and abnormal heart valves can be repaired with surgery. Blocked coronary arteries usually can be treated with **angioplasty** or coronary artery bypass surgery.

With severe heart failure, the heart muscle may become so damaged that available treatments do not help. Patients with this stage of heart failure are said to have end-stage heart failure. Heart transplant usually is considered for patients with end-stage heart failure when all other treatments have stopped working.

Prognosis

Most patients with mild or moderate heart failure can be successfully treated with dietary and exercise programs and the right medications. In fact, in 2003,

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the American Heart Association said that even those awaiting heart transplants could benefit from exercise. Many people are able to participate in normal daily activities and lead relatively active lives.

Patients with severe heart failure may eventually have to consider heart transplantation. Approximately 50% of patients diagnosed with congestive heart failure live for five years with the condition. Women with heart failure usually live longer than men with heart failure.

Prevention

Heart failure usually is caused by the effects of some type of heart disease. The best way to try to prevent heart failure is to eat a healthy diet and get regular exercise, but many causes of heart failure cannot be prevented. People with risk factors for coronary disease (such as high blood pressure and high cholesterol levels) should work closely with their physician to reduce likelihood of heart attack and heart failure.

Heart failure sometimes can be avoided by identifying and treating any conditions that might lead to heart disease. These include high blood pressure, alcoholism, and coronary artery disease. Regular blood pressure checks and obtaining immediate medical care for symptoms of coronary artery disease, such as chest pain, will help to get these conditions diagnosed and treated early, before they can damage the heart muscle.

A 2003 initiative called OPTIMIZE H-F was aimed at preventing severe heart failure and deaths among patients discharge from hospitals. The project created a registry or database of patients with heart failure that could be shared among hospitals. Finally, diagnosing and treating heart failure before the heart becomes severely damaged can improve the prognosis. With proper treatment, many patients may continue to lead active lives for a number of years.

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ORGANIZATIONS

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American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

Heart and Stroke Foundation of Canada, 222 Queen Street, Suite 1402, Ottawa, CanadaON, K1P 5V9, (613) 569-4361, (613) 569-3278, http://www.heartandstroke.com.

Heart Association of Australia, Level 3, 80 William Street, Sydney, Australia, NSW 2011, (02) 02)9219 2444, reception.sydney@heartfoundation.org.au, http://www.heartfoundation.org.au.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

Toni Rizzo
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Heart murmurs

Definition

A heart murmur is an abnormal extra sound during the heartbeat cycle made by blood moving through the heart and its valves. It is detected by the physician's examination using a stethoscope and may sound like a swishing or whooshing noise. Some heart murmurs are congenital (present at birth) while others develop later in life. In adults, most abnormal heart murmurs are caused by infections, other diseases, or **aging**.

Demographics

Innocent heart murmurs are quite common in the general population. Exact statistics are difficult to

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obtain; however, one Dutch study reported in the mid-1990s that 41% of schoolchildren between the ages of 5 and 14 years had grade 1 (barely audible) innocent heart murmurs, while 14% had grade 2 or grade 3 murmurs.

Description

A heart which is beating normally makes two sounds, "lubb," which is heard when the valves between the atria and ventricles close; and "dupp," which is heard when when the valves between the ventricles and the major arteries close. The first sound (lubb) is known as S1 in medical shorthand, and the second heart sound (dupp or dub) is known as S2. A heart murmur is a series of vibratory sounds made by turbulent blood flow. The sounds are longer than normal heart sounds and can be heard between the normal sounds of the heart.

Heart murmurs are common in children and can also result from heart or valve defects. Nearly two-thirds of heart murmurs in children are produced by normal hearts and are harmless. This type of heart murmur is usually called an "innocent" heart murmur. It can also be called "functional" or "physiologic." Innocent heart murmurs are usually very faint, intermittent, and occur in a small area of the chest. Pathologic heart murmurs may indicate the presence of a serious heart defect. They are louder, continual, and may be accompanied by a click or gallop.

Some heart murmurs are continually present; others occur only when the heart is working harder than usual, including during **exercise** or certain types of illness. Heart murmurs can be diastolic or systolic. Those that occur during relaxation of the heart between beats are called diastolic murmurs. Those that occur during contraction of the heart muscle are called systolic murmurs. Murmurs that can be heard throughout the heartbeat cycle are called continuous murmurs. The characteristics of the murmur may suggest specific alterations in the heart or its valves.

Heart murmurs are evaluated according to several characteristics:

- Timing. Timing refers to whether the murmur is systolic, diastolic, or continuous.
- Shape. Shape refers to the loudness of the murmur over time. Some grow louder (crescendo); some grow softer (decrescendo); and some grow louder and then softer (crescendo/decrescendo).
- Location. This characteristic refers to the place on the front of the chest where the doctor can best hear the murmur.
- Radiation. Radiation refers to the direction of the movement of the sound of the murmur. In general, heart murmurs radiate in the direction of the blood flow.
- Intensity. Intensity refers to the loudness of the murmur and is graded on a scale of 1 to 6. A grade 1 murmur is difficult to hear at all; grade 3 can be heard all over the portion of the chest over the heart; grade 5 can be heard with the stethoscope partly off the chest; and grade 6 is loud enough to be heard with the stethoscope completely off the chest.
- Pitch. The pitch of a murmur can be low, medium, or high.
- Quality. This characteristic refers to unusual aspects of the murmur's sound. Some murmurs can be described as harsh, rumbling, blowing, or even musical.

Risk factors

Risk factors for heart murmurs in an unborn child include:

- Family history of heart murmurs or heart defects-
- Illnesses during pregnancy, particularly poorly controlled diabetes and rubella (German measles)-
- Using alcohol or illegal drugs during pregnancy-

There are no known risk factors for innocent heart murmurs in the general population as of 2010.

Causes and symptoms

Heart murmurs in general are caused by the turbulence of blood flowing through the chambers and valves of the heart or the blood vessels near the heart strongly enough to produce audible sounds. Sometimes **anxiety**, **stress**, **fever**, anemia, an overactive thyroid gland, and **pregnancy** will cause innocent murmurs that can be heard by a physician using a stethoscope. Pathologic heart murmurs, however, are caused by structural abnormalities of the heart. These include defective heart valves or holes in the walls of the heart. Valve problems are more common. Valves that do not open completely cause blood to flow through a smaller opening than normal, while those that do not close properly may cause blood to go back through the valve. A hole in the wall between the left and right sides of the heart, called a septal defect, can cause heart murmurs. Some septal defects close on their own; others require surgery to prevent progressive damage to the heart.

The symptoms of heart murmurs differ depending on the cause of the heart murmur. Innocent heart murmurs and those which do not impair the function of the heart have no symptoms. Murmurs that are due to severe abnormalities of a heart valve may cause **shortness of breath**, **dizziness**, chest pains, faintness,

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a bluish discoloration of the skin of the fingertips and lips, swollen veins in the neck, heavy sweating with little exertion, **palpitations**, and lung congestion.

Diagnosis

The diagnosis of a heart murmur begins with taking a careful patient history. The doctor may ask about a family history of heart murmurs or heart disease. The doctor may also ask about symptoms that may be associated with heart disorders, such as **fainting**, chest **pain**, a bluish tinge to the complexion, shortness of breath, weight gain, and swelling. The doctor will also check the size of the patient's liver by feeling the abdomen, and look for swollen neck veins.

Examination

Heart murmurs can be heard during an office examination when a pediatrician or primary care physician listens to the heart through a stethoscope during a regular checkup. The doctor's listening to heart or other body sounds is called auscultation. After listening to the heart sounds, the doctor will also check for any unusual sounds in the lungs. Very loud heart murmurs and those with clicks or extra heart sounds should be evaluated further. The doctor may ask the patient to stand, squat, hold the breath while bearing down, or squeeze an object in the hand during auscultation. These maneuvers help the doctor to evaluate the location and possible cause of the murmur.

Infants with heart murmurs who do not thrive, eat, or breathe properly, and older children who lose consciousness suddenly or are intolerant of exercise should also be evaluated. If the murmur sounds suspicious, the physician may order a **chest x ray**, an electrocardiogram, and an echocardiogram. A primary care physician may refer the patient to a cardiologist, who is a doctor who specializes in diagnosing and treating heart disorders.

Tests

An electrocardiogram (ECG) displays the heart's activity and may reveal muscle thickening, damage, or a lack of oxygen. Electrodes covered with conducting jelly are placed on the patient's chest, arms, and legs. They send impulses of the heart's activity through a monitor (oscilloscope) to a recorder which traces them on paper. The test takes about 10 minutes and is commonly performed in a physician's office. An exercise ECG can reveal additional information.

An echocardiogram (cardiac ultrasound), may be ordered to identify a structural problem that is causing the heart murmur. An echocardiogram uses sound waves to create an image of the heart's chambers and valves. The technician applies gel to a hand-held transducer, then presses it against the patient's chest. The sound waves are converted into an image that can be displayed on a monitor. Performed in a cardiology outpatient diagnostic laboratory, the test takes 30 minutes to an hour.

In some cases the doctor may administer a drug to further evaluate a murmur. The two compounds used most often for such tests are amyl nitrite, which expands blood vessels and lowers blood pressure, and methoxamine, which has the opposite effect, namely constricting blood vessels and raising blood pressure.

Procedures

In some cases the doctor may recommend **cardiac catheterization** to evaluate the condition of the patient's heart. This procedure involves the use of x-ray and ultrasound imaging to guide a long thin tube called a catheter through a major blood vessel into the heart. The doctor can inject a dye visible on x ray through the catheter and trace its flow through the

KEY TERMS

Atria (singular, atrium)—The upper two chambers of the heart.

Auscultation—The medical term for listening to the sounds of the heart or other body organs.

Cardiologist—A doctor who specializes in diagnosing and treating disorders of the heart.

Congenital—Present at birth.

Echocardiogram—A non-invasive ultrasound test that shows an image of the inside of the heart. An echocardiogram can be performed to identify any structural problems which cause a heart murmur.

Electrocardiogram—A test that shows the electrical activity of the heart by placing electronic sensors on the patient. This test can be used to confirm the presence of a heart murmur.

Innocent—The medical term for a harmless heart murmur.

Pathologic—Characterized by disease or the structural and functional changes due to disease. Pathologic heart murmurs may indicate a heart defect.

Ventricles—The lower two chambers of the heart.

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chambers of the heart in order to identify problems in the valves or other structures of the heart.

Treatment

Traditional

Innocent heart murmurs do not affect the patient's health and require no treatment. Treatment when needed is directed toward the cause of the heart murmur. Heart murmurs due to septal defects may require surgery. Those due to valvular defects may require **antibiotics** to prevent infection during certain surgical or dental procedures. Severely damaged or diseased valves can be repaired or replaced through surgery.

Drugs

Some heart murmurs can be managed with various medications. Depending on the specific cause of the murmur, the doctor might prescribe one or more of the following types of drugs:

- Diuretics. Diuretics, sometimes called water pills, are drugs that remove fluid from the blood by increasing urinary output. They can be used to lower blood pressure, as high blood pressure can worsen a heart murmur.
- Angiotensin-converting enzyme (ACE) inhibitors. These are another class of drugs often prescribed to lower high blood pressure.
- Statins. Statins are a group of drugs given to control blood cholesterol levels. High blood cholesterol is a risk factor for making some heart valve problems worse.
- Digoxin (Lanoxin). Also known as digitalis, digoxin is a drug that increases the strength of the heart muscle's contractions, making the heart pump blood more efficiently.
- Aspirin or other anticoagulants. Anticoagulants, sometimes called blood thinners, are drugs that prevent blood clots from forming in the heart, thus lowering the risk of a stroke or heart attack.

Alternative

There are no alternative treatments for heart murmurs that require surgical treatment, although there are alternative therapies that are helpful for pre- and post-surgical support of the patient. If the heart murmur is innocent, heart activity can be supported using the herb hawthorn (*Crataegus laevigata* or *C. oxyacantha*) or coenzyme Q10. These remedies improve heart contractility and the heart's ability to use oxygen. If the murmur is valvular in origin, herbs that act like antibiotics as well as options that build resistance to infection in the valve areas may be considered.

Prognosis

The prognosis of a heart murmur depends on its cause. Most children with innocent heart murmurs grow out of them by the time they reach adulthood. Severe causes of heart murmurs may progress to severe symptoms and **death**.

Prevention

Apart from keeping diabetes under control and avoiding drug or alcohol **abuse** during pregnancy, there is no known way to prevent heart murmurs as of 2010.

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ORGANIZATIONS

American College of Cardiology (ACC), Heart House, 2400 N Street NW, Washington, DC, 20037, 202-375-6000, 202-375-7000, http://www.acc.org/.
American Heart Association, 7272 Greenville Avenue, Dallas, TX, 75231, 301-592-8573, 800-242-8721, 301-592-8563, www.americanheart.org.
Center for Adults with Congenital Heart Disease, University of Chicago Medical Center, 5841 S. Maryland Avenue, Chicago, IL, 60637, 888-UCH-0200, http://www.uchospitals.edu/specialties/heart/services/adult-congenital-heart/.
National Heart, Lung, and Blood Institute (NHLBI), Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, 301-592-8573, 240-629-3246, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi.nih.gov/.

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Heart muscle infection *see* **Myocarditis**
Heart scan *see* **Echocardiography**
Heart septal defect *see* **Atrial septal defect**
Heart sonogram *see* **Echocardiography**

Heart surgery for congenital defects

Definition

A variety of surgical procedures that are performed to repair the many types of heart defects that may be present at birth.

Purpose

Heart surgery for congenital defects is performed to repair a defect as much as possible and improve the flow of blood and oxygen to the body. While congenital heart defects vary in their severity, most require surgery. Surgery is recommended for congenital heart defects that result in a lack of oxygen, a poor quality of life, or a patient who does not thrive. Some types of congenital heart defects that don't cause symptoms are treated surgically because they can lead to serious complications.

Precautions

There are many types of surgery for congenital heart defects and many considerations in the decision to operate. The patient's cardiologist or surgeon will discuss these issues on an individual basis.

Description

There are many types of congenital heart defects. Most obstruct the flow of blood in the heart, or the vessels near it, or cause an abnormal flow of blood through the heart. Rarer types include newborns born with one ventricle, one side of the heart that is not completely formed, or the pulmonary artery and the aorta coming out of the same ventricle. Most congenital heart defects require surgery during infancy or childhood. Recommended ages for surgery for the most common congenital heart defects are:

- atrial septal defects: during the preschool years
- patent ductus arteriosus: between ages one and two
- coarctation of the aorta: in infancy, if it's symptomatic, at age four otherwise
- Tetralogy of Fallot: age varies, depending on the patient's signs and symptoms
- transposition of the great arteries: often in the first weeks after birth, but before the patient is 12 months old

Surgical procedures seek to repair the defect as much as possible and restore circulation to as close to normal as possible. Sometimes, multiple, serial, surgical procedures are necessary. Smaller congenital heart defects can now be repaired in a **cardiac catheterization** lab instead of an operating room. Catheterization procedures include balloon atrial septostomy and **balloon valvuloplasty**. Surgical procedures include arterial switch, Damus-Kaye-Stansel procedure, Fontan procedure, Ross procedure, shunt procedure, and venous switch or intra-atrial baffle.

Catheterization procedures

Balloon atrial septostomy and balloon valvuloplasty are cardiac catheterization procedures. Cardiac catheterization procedures can save the lives of critically ill neonates and in some cases eliminate or delay more invasive surgical procedures. It is expected that catheterization procedures will continue to replace more types of surgery for congenital heart defects in the future. A thin tube called a catheter is inserted into

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KEY TERMS

Atresia—A congenital defect in which the blood pumped through the body has too little oxygen. In tricuspid atresia, the baby lacks a triscupid valve. In pulmonary atresia, a pulmonary valve is missing.

Coarctation of the aorta—A congenital defect in which severe narrowing or constriction of the aorta obstructs the flow of blood.

Congenital heart defects—Congenital means conditions which are present at birth. Congenital heart disease includes a variety of defects that babies are born with.

Patent ductus arteriosus—A congenital defect in which the temporary blood vessel connecting the left pulmonary artery to the aorta in the fetus doesn't close in the newborn.

Septal defects—These are holes in the septum, the muscle wall separating the right and left sides of the heart. Atrial septal defects are openings between the two upper heart chambers and ventricular septal defects are openings between the two lower heart chambers.

Stenosis—A narrowing of the heart's valves. This congenital defect can occur in the pulmonary (lung) or aortic (the main heart artery) valve.

Tetralogy of Fallot—A cyanotic defect in which the blood pumped through the body has too little oxygen. Tetralogy of Fallot includes four defects: a large hole between the ventricles, narrowing at or beneath the pulmonary valve, an overly muscular right ventricle, and an aorta over the large hole.

Transposition of the great arteries—A cyanotic defect in which the blood pumped through the body has too little oxygen. The pulmonary artery and the aorta are reversed.

an artery or vein in the leg, groin, or arm and threaded into the area of the heart that needs repair. The patient receives a local anesthetic at the insertion site and is awake but sedated during the procedure.

BALLOON ATRIAL SEPTOSTOMY. Balloon atrial septostomy is the standard procedure for correcting **transposition of the great arteries**; it is sometimes used in patients with mitral, pulmonary, or tricupsid atresia (atresia is a defect that causes the blood to carry too little oxygen to the body). Balloon atrial septostomy enlarges the atrial opening. A special balloon-tipped catheter is inserted into the right atrium and inflated to create a large opening in the atrial septum.

BALLOON VALVULOPLASTY. Balloon valvuloplasty uses a balloon-tipped catheter to open a narrowed heart valve, improving the flow of blood. It is the procedure of choice in pulmonary stenosis and is sometimes used in aortic stenosis. Balloons made of plastic polymers are placed at the end of the catheter and inflated to relieve the obstruction in the heart valve. Long-terms results are excellent in most cases. The operative **death** rate is 2–4%.

Surgical procedures

These procedures are performed under **general anesthesia**. Some require the use of a heart-lung machine, which cools the body to reduce the need for oxygen and takes over for the heart and lungs during the procedure.

ARTERIAL SWITCH. Arterial switch is performed to correct transposition of the great arteries, where the position of the pulmonary artery and the aorta are reversed. The procedure involves connecting the aorta to the left ventricle and the pulmonary artery to the right ventricle.

DAMUS-KAYE-STANSEL PROCEDURE. Transposition of the great arteries can also be corrected by the Damus-Kaye-Stansel procedure, in which the pulmonary artery is cut in two and connected to the ascending aorta and right ventricle.

FONTAN PROCEDURE. For tricuspid atresia and pulmonary atresia, the Fontan procedure connects the right atrium to the pulmonary artery directly or with a conduit, and the atrial defect is closed. Survival is over 90%.

PULMONARY ARTERY BANDING. Pulmonary artery banding is narrowing the pulmonary artery with a band to reduce blood flow and pressure in the lungs. It is used for **ventricular septal defect**, atrioventricular canal defect, and tricuspid atresia. Later, the band can be removed and the defect corrected with open heart surgery.

ROSS PROCEDURE. To correct aortic stenosis, the Ross procedure grafts the pulmonary artery to the aorta.

SHUNT PROCEDURE. For **Tetralogy of Fallot**, tricuspid atresia, or pulmonary atresia, the shunt procedure creates a passage between blood vessels, sending blood into parts of the body that need it.

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VENOUS SWITCH. For transposition of the great arteries, venous switch creates a tunnel inside the atria to re-direct oxygen-rich blood to the right ventricle and aorta and venous blood to the left ventricle and pulmonary artery.

OTHER TYPES OF SURGERY. These surgical procedures are also used to treat common congenital heart defects. A medium to large ventricular or **atrial septal defect** can be closed by suturing it or covering it with a Dacron patch. For **patent ductus arteriosus**, surgery consists of dividing the ductus into two and tying off the ends. If performed within the patient's first few years, there is practically no risk associated with this operation. Surgery for **coarctation of the aorta** involves opening the chest wall, removing the defect, and reconnecting the ends of the aorta. If the defect is too long to be reconnected, a Dacron graft is used to replace the missing piece. In uncomplicated cases, the risk of the operation is 1–2%.

Preparation

Before surgery for congenital heart defects, the patient will receive a complete evaluation, which includes a physical exam, a detailed family history, a **chest x ray**, an electrocardiogram, an echocardiogram, and usually cardiac catheterization. For six to eight hours before the surgery, the patient cannot eat or drink anything. An electrocardiogram shows the heart's activity and may reveal a lack of oxygen. Electrodes covered with conducting jelly are placed on the patient's chest, arms, and legs and the heart's impulses are traced on paper. An echocardiogram uses sound waves to create an image of the heart's chambers and valves. Gel is applied to a hand-held transducer and then pressed against the patient's chest. Cardiac catheterization is an invasive diagnostic technique used to evaluate the heart in which a long tube is inserted into a blood vessel and guided into the heart. A contrast solution is injected to make the heart visible on x rays.

Aftercare

After heart surgery for congenital defects, the patient goes to an intensive care ward where he or she is connected to a variety of tubes and monitors, including a ventilator. Patients are monitored every 15 minutes until vital signs are stable. Heart sounds, oxygenation, and the electrocardiogram are monitored. Chest tubes will be checked to ensure that they're draining properly and there is no hemorrhage. **Pain** medications will be administered. Complications such as **stroke**, lung **blood clots**, and reduced blood flow to the kidneys will be monitored. After the ventilator and breathing tube are removed, **chest physical therapy** and exercises to improve circulation will be started.

Risks

Complications from heart surgery for congenital defects can be severe. They include **shock**, congestive **heart failure**, lack of oxygen or too much carbon dioxide in the blood, irregular heartbeat, stroke, infection, kidney damage, lung blood clot, low blood pressure, hemorrhage, cardiac arrest, and death.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

Congenital Heart Information Network (C.H.I.N.), 101 N. Washington Ave., Suite 1A, Margate City, NJ, 08402-1195, (609) 882-1572, (609) 822-1574, mb@tchin.org, http://tchin.org/.

Texas Heart Institute. Heart Information Service, MC 3-116, PO Box 20345, Houston, TX, 77225, (832) 355-4011, (800) 292-2221, http://www.texasheart.org.

Lori De Milto

Heart transplantation

Definition

Heart transplantation, also called cardiac transplantation, is the replacement of a patient's diseased or injured heart with a healthy donor heart.

Purpose

Heart transplantation is performed on patients with end-stage **heart failure** or some other life-threatening heart disease. Before a doctor recommends heart transplantation for a patient, all other possible treatments for his or her disease must have been tried. The purpose of heart transplantation is to extend and improve the life of a person who would otherwise die from heart failure. Most patients who receive a new heart were so sick before transplantation that they could not live a normal life. Replacing a patient's diseased heart with a healthy, functioning donor heart often allows the recipient to return to normal daily activities.

Precautions

Because healthy donor hearts are in short supply, strict rules dictate who should or should not get a heart transplant. Patients who have conditions that might

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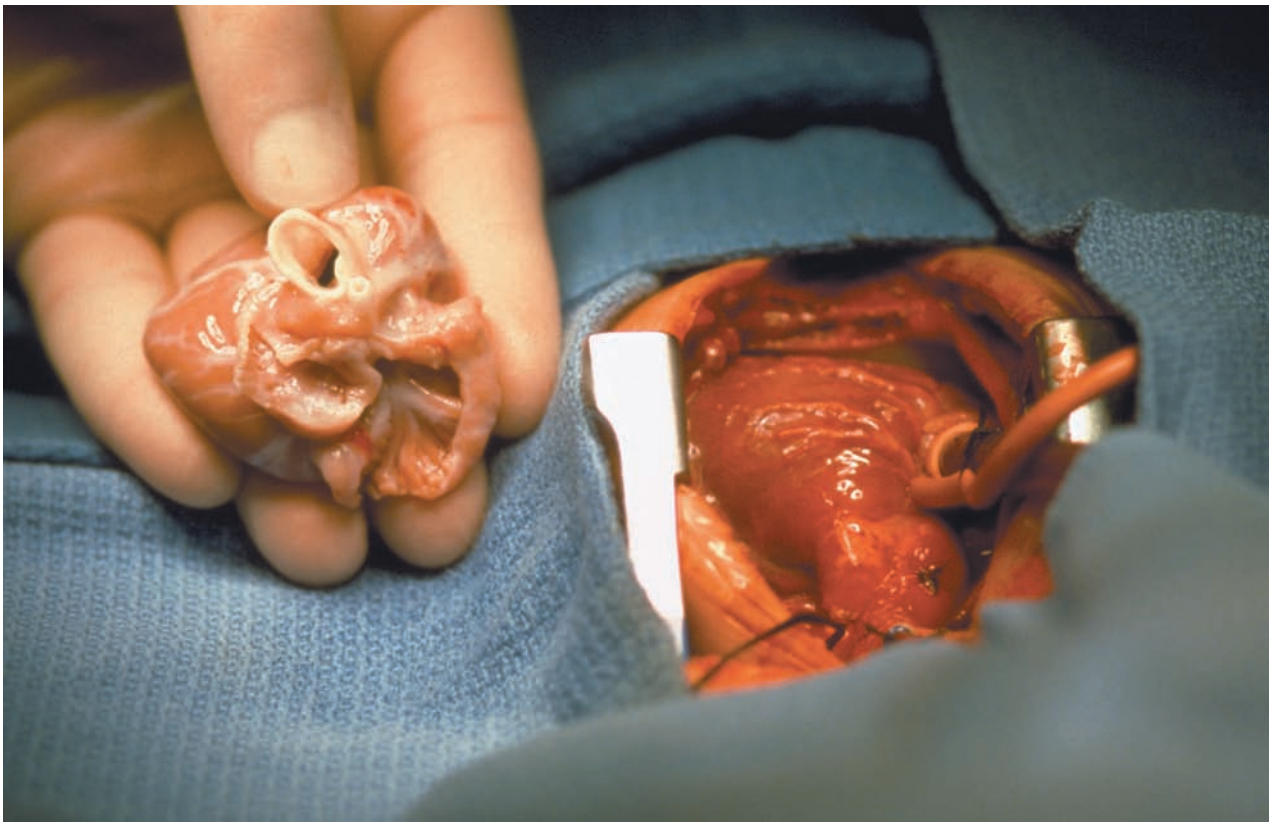

A comparison of the old and new hearts of Dylan Stork. At the time, he was the smallest heart transplant recipient in the world. Dylan was seven weeks old and weighed 5.5 pounds (2.5 kg) at the time of the operation. *(Alexander Tsiaras/Photo Researchers, Inc.)*

cause the new heart to fail should not have a heart transplant. Similarly, patients who may be too sick to survive the surgery or the side effects of the drugs they must take to keep their new heart working would not be good transplant candidates.

Patients who have any of the following conditions may not be eligible for heart transplantation:

- active infection
- pulmonary hypertension
- chronic lung disease with loss of more than 40% of lung function
- untreatable liver or kidney disease
- diabetes that has caused serious damage to vital organs
- disease of the blood vessels in the brain, such as a stroke
- serious disease of the arteries
- mental illness or any condition that would make a patient unable to take the necessary medicines on schedule
- continuing alcohol or drug abuse

Description

Patients with end-stage heart disease that threatens their life even after medical treatment may be considered for heart transplantation. Potential candidates must have a complete medical examination before they can be put on the transplant waiting list. Many types of tests are done, including blood tests, x rays, and tests of heart, lung, and other organ function. The results of these tests indicate to doctors how serious the heart disease is and whether or not a patient is healthy enough to survive the **transplant surgery**.

Organ waiting list

A person approved for heart transplantation is placed on the heart transplant waiting list of a heart transplant center. All patients on a waiting list are registered with the United Network for Organ Sharing (UNOS). UNOS has organ transplant specialists who run a national computer network that connects all the transplant centers and organ-donation organizations.

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National transplant waiting list by organ type (June 2010)

Organ needed	Persons waiting
Kidney	85,296
Liver	16,031
Heart	3,141
Kidney/Pancreas	2,199
Lung	1,802
Pancreas	1,450
Intestine	242
Heart/Lung	79

SOURCE: U.S. Department of Health and Human Services, Organ Procurement and Transplantation Network. Available online at: http://optn.transplant.hrsa.gov/data/default.asp (accessed June 8, 2010).

(Table by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)

When a donor heart becomes available, information about it is entered into the UNOS computer and compared to information from patients on the waiting list. The computer program produces a list of patients ranked according to blood type, size of the heart, and how urgently they need a heart. Because the heart must be transplanted as quickly as possible, the list of local patients is checked first for a good match. After that, a regional list and then a national list are checked. The patient's transplant team of heart and transplant specialists makes the final decision as to whether a donor heart is suitable for the patient.

The transplant procedure

When a heart becomes available and is approved for a patient, it is packed in a sterile cold solution and rushed to the hospital where the recipient is waiting.

Heart transplant surgery involves the following basic steps:

- A specialist in cardiovascular anesthesia gives the patient general anesthesia.
- Intravenous antibiotics are usually given to prevent bacterial wound infections.
- The patient is put on a heart/lung machine, which performs the functions of the heart and lungs and pumps the blood to the rest of the body during surgery. This procedure is called cardiopulmonary bypass.
- After adequate blood circulation is established, the patient's diseased heart is removed.
- The donor heart is attached to the patient's blood vessels.
- After the blood vessels are connected, the new heart is warmed up and begins beating. If the heart does not begin to beat immediately, the surgeon may start it with an electrical shock.
- The patient is taken off the heart/lung machine.
- The new heart is stimulated to maintain a regular beat with medications for two to five days after surgery, until the new heart functions normally on its own.

Heart transplant recipients are given immunosuppressive drugs to prevent the body from rejecting the new heart. These drugs are usually started before or during the heart transplant surgery. Immunosuppressive drugs keep the body's immune system from recognizing and attacking the new heart as foreign tissue. Normally, immune system cells recognize and attack foreign or abnormal cells, such as bacteria, **cancer** cells, and cells from a transplanted organ. The drugs suppress the immune cells and allow the new heart to function properly. However, they can also allow infections and other adverse effects to occur to the patient.

Because the chance of rejection is highest during the first few months after the transplantation, recipients are usually given a combination of three or four immunosuppressive drugs in high doses during this time. Afterwards, they must take maintenance doses of immunosuppressive drugs for the rest of their lives.

Cost and insurance coverage

The total cost for heart transplantation varies, depending on where it is performed, whether transportation and lodging are needed, and on whether there are any complications. The costs for the surgery and first year of care are estimated to be about $250,000. The medical tests and medications after the first year cost about $21,000 per year.

Insurance coverage for heart transplantation varies depending on the policy. Most commercial insurance companies pay a certain percentage of heart transplant costs. Medicare pays for heart transplants if the surgery is performed at Medicare-approved centers. Medicaid pays for heart transplants in 33 states and in the District of Columbia.

Preparation

Before patients are put on the transplant waiting list, their blood type is determined so a compatible donor heart can be found. The heart must come from a person with the same blood type as the patient, unless it is blood type O. A blood type O heart can be transplanted into a person with any type of blood.

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A panel reactive antibodies (PRA) test is also done before heart transplantation. This test tells doctors whether or not the patient is at high risk for having a hyperacute reaction against a donor heart. A hyperacute reaction is a strong immune response against the new heart that happens within minutes to hours after the new heart is transplanted. If the PRA shows that a patient has a high risk for this kind of reaction, then a crossmatch is done between a patient and a donor heart before transplant surgery. A crossmatch checks how close the match is between the patient's tissue type and the tissue type of the donor heart.

Most people are not high risk, and a crossmatch usually is not done before the transplant because the surgery must be done as quickly as possible after a donor heart is found.

While waiting for heart transplantation, patients are given treatment to keep the heart as healthy as possible. They are regularly checked to make sure the heart is pumping enough blood. Intravenous medications may be used to improve cardiac output. If these drugs are not effective, a mechanical pump can help keep the heart functioning until a donor heart becomes available. Inserted through an artery into the aorta, the pump assists the heart in pumping blood.

Aftercare

Immediately following surgery, patients are monitored closely in the intensive care unit (ICU) of the hospital for 24–72 hours. Most patients need to receive oxygen for 4 to 24 hours following surgery. Blood pressure, heart function, and other organ functions are carefully monitored during this time.

Heart transplant patients start taking immunosuppressive drugs before or during surgery to prevent immune rejection of the heart. High doses of immunosuppressive drugs are given at this time, because rejection is most likely to happen within the first few months after the surgery. A few months after surgery, lower doses of immunosuppressive drugs usually are given and must be taken for the rest of the patient's life.

For six to eight weeks after the transplant surgery, patients usually come back to the transplant center twice a week for physical examinations and medical tests. These tests check for any signs of infection, rejection of the new heart, or other complications.

In addition to a **physical examination**, the following tests may be done during these visits:

- laboratory tests to check for infection
- chest x ray to check for early signs of lung infection
- electrocardiogram (ECG) to check heart function
- echocardiogram to check the function of the ventricles in the heart
- blood tests to check liver and kidney function
- complete blood counts (CBC) to check the numbers of blood cells
- taking of a small tissue sample from the donor heart (endomyocardial biopsy) to check for signs of rejection

During the physical examination, the blood pressure is checked and the heart sounds are listened to with a stethoscope to determine if the heart is beating properly and pumping enough blood. Kidney and liver function are checked because these organs may lose function if the heart is being rejected.

An endomyocardial biopsy is the removal of a small sample of the heart muscle. This is done with a very small instrument that is inserted through an artery or vein and into the heart. The heart muscle tissue is examined under a microscope for signs that the heart is being rejected. Endomyocardial biopsy is usually done weekly for the first four to eight weeks after transplant surgery and then at longer intervals after that.

Risks

The most common and dangerous complications of heart transplant surgery are organ rejection and infection. Immunosuppressive drugs are given to prevent rejection of the heart. Most heart transplant patients have a rejection episode soon after transplantation, but doctors usually diagnose it immediately when it will respond readily to treatment. Rejection is treated with combinations of immunosuppressive drugs given in higher doses than maintenance immunosuppression. Most of these rejection situations are successfully treated.

Infection can result from the surgery, but most infections are a side effect of the immunosuppressive drugs. Immunosuppressive drugs keep the immune system from attacking the foreign cells of the donor heart. However, the suppressed immune cells are also unable to adequately fight bacteria, viruses, and other microorganisms. Microorganisms that normally do not affect persons with healthy immune systems can cause dangerous infections in transplant patients taking immunosuppressive drugs.

Patients are given **antibiotics** during surgery to prevent bacterial infection. Patients may also be given an antiviral drug to prevent virus infections. Patients who develop infections may need to have their immunosuppressive drugs changed or the dose adjusted. Infections are treated with antibiotics or other drugs, depending on the type of infection.

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KEY TERMS

Anesthesia—Loss of the ability to feel pain, caused by administration of an anesthetic drug.

Angina—Characteristic chest pain which occurs during exercise or stress in certain kinds of heart disease.

Cardiopulmonary bypass—Mechanically circulating the blood with a heart/lung machine that bypasses the heart and lungs.

Cardiovascular—Having to do with the heart and blood vessels.

Complete blood count (CBC)—A blood test to check the numbers of red blood cells, white blood cells, and platelets in the blood.

Coronary artery disease—Blockage of the arteries leading to the heart.

Crossmatch—A test to determine if patient and donor tissues are compatible.

Donor—A person who donates an organ for transplantation.

Echocardiogram—A test that visualizes and records the position and motion of the walls of the heart using ultrasound waves.

Electrocardiogram (ECG)—A test that measures electrical conduction of the heart.

End-stage heart failure—Severe heart disease that does not respond adequately to medical or surgical treatment.

Endomyocardial biopsy—Removal of a small sample of heart tissue to check it for signs of damage caused by organ rejection.

Fatigue—Loss of energy; tiredness.

Graft—A transplanted organ or other tissue.

Immunosuppressive drug—Medication used to suppress the immune system.

Inotropic drugs—Medications used to stimulate the heart beat.

Pulmonary hypertension—An increase in the pressure in the blood vessels of the lungs.

Recipient—A person who receives an organ transplant.

Other complications that can happen immediately after surgery are:

- bleeding
- pressure on the heart caused by fluid in the space surrounding the heart (pericardial tamponade)
- irregular heart beats
- reduced cardiac output
- increased amount of blood in the circulatory system
- decreased amount of blood in the circulatory system

About half of all heart transplant patients develop **coronary artery disease** 1–5 years after the transplant. The coronary arteries supply blood to the heart. Patients with this problem develop chest pains called **angina**. Other names for this complication are coronary allograft **vascular disease** and chronic rejection.

Outcomes

Heart transplantation is an appropriate treatment for many patients with end-stage heart failure. The outcomes of heart transplantation depend on the patient's age, health, and other factors. About 73% of heart transplant patients are alive four years after surgery.

After transplant, most patients regain normal heart function, meaning the heart pumps a normal amount of blood. A transplanted heart usually beats slightly faster than normal because the heart nerves are cut during surgery. The new heart also does not increase its rate as quickly during **exercise**. Even so, most patients feel much better and their capacity for exercise is dramatically improved from before they received the new heart. About 85% of patients return to work and other daily activities. Many are able to participate in sports.

Resources

OTHER

"What Every Patient Needs to Know." *United Network for Organ Sharing (UNOS)*. http://www.unos.org/docs/WEPNTK.pdf.

ORGANIZATIONS

American Society of Transplantation, 15000 Commerce Parkway, Suite C, Mt. Laurel, NJ, 08054, (856) 439-9986, (856) 439-9982, info@a-s-t.org, http://www.a-s-t.org/.

Health Services and Resources Administration, Division of Organ Transplantation, 5600 Fishers Lane, Rockville, MD, 20857, (888) 275-4772, ask@hrsa.gov, http://organdonor.gov.

United Network for Organ Sharing (UNOS), 700 N. 4th Street, PO Box 2484, Richmond, VA, 23218, (804) 782-4800, (804) 782-4817, (888) 894-6361, http://www. unos.org.

Toni Rizzo

Heart tumors *see* **Myxoma**

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Heart valve repair

Definition

Heart valve repair is a surgical procedure used to correct a malfunctioning heart valve. Repair usually involves separating the valve leaflets (the one-way "doors" of the heart valve which open and close to pump blood through the heart) or forcing them open with a balloon catheter, a technique known as *balloon valvuloplasty*.

Purpose

To correct damage to the mitral, aortic, pulmonary, or tricuspid heart valves caused by a systemic infection, **endocarditis**, rheumatic heart disease, a congenital heart defect, or mitral and/or aortic valve disease. Damaged valves may not open properly (stenosis) or they may not close adequately (valve regurgitation, insufficiency, or incompetence).

Precautions

Patients who have a diseased heart valve that is badly scarred or calcified may be better candidates for valve replacement surgery.

Description

Heart valve repair is performed in a hospital setting by a cardiac surgeon. During valve repair surgery, the patient's heart is stopped, and his/her blood is circulated outside of the body through an *extracorporeal bypass circuit*, also called heart-lung machine or just "the pump." The extracorporeal circuit consists of tubing and medical devices that take over the function of the patient's heart and lungs during the procedure. As blood passes through the circuit, carbon dioxide is removed from the bloodstream and replaced with oxygen. The oxygenated blood is then returned to the body. Other components may also be added to the circuit to filter fluids from the blood or concentrate red blood cells.

In cases of valve disease where the leaflets have become fused together, a procedure known as a valvulotomy is performed. In valvulotomy, the leaflets of the valves are surgically separated, or partially resected, with an incision to increase the size of the valve opening. The surgeon may also make adjustments to the chordae, the cord-like tissue that connects the valve leaflets to the ventricle muscles, to improve valve function.

KEY TERMS

Angiogram—An angiogram uses a radiopaque substance, or dye, to make the blood vessels or arteries visible under x ray.

Calcified—Hardened by calcium deposits.

Catheter—A long, thin, flexible tube used in valvuloplasty to widen the valve opening.

Echocardiogram—Ultrasound of the heart; generates a picture of the heart through the use of soundwaves.

Edema—Fluid accumulation in the body.

Scintigram—A nuclear angiogram; a scintigram involves injection of a radioactive substance into the patient's circulatory system. As the substance travels through the body, a special scanning camera takes pictures.

Stenosis—Narrowing of the heart valve opening.

Another valve repair technique, **balloon valvuloplasty**, is used in patients with pulmonary, aortic, and **mitral valve stenosis** to force open the valve. Valvuloplasty is similar to a cardiac **angioplasty** procedure in that it involves the placement of a balloon-tipped catheter into the heart. Once inserted into the valve, the balloon is inflated and the valve dilates, or opens. Valvuloplasty does not require a bypass circuit.

Preparation

A number of diagnostic tests may be administered prior to valve repair surgery. **Magnetic resonance imaging** (MRI), echocardiogram, angiogram, and/or scintigram are used to help the surgeon get an accurate picture of the extent of damage to the heart valve and the status of the coronary arteries.

Aftercare

The patient's blood pressure and vital signs will be carefully monitored following a valve repair procedure, and he or she watched closely for signs of **edema** or congestive **heart failure**.

Echocardiography or other diagnostic tests are ordered for the patient at some point during or after surgery to evaluate valvular function. A **cardiac rehabilitation** program may also be recommended to assist the patient in improving **exercise** tolerance after the procedure.

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Risks

As with any invasive surgical procedure, hemorrhage, infarction, **stroke**, **heart attack**, and infection are all possible complications of heart valve repair. The overall risks involved with the surgery depend largely on the complexity of the procedure and physical condition of the patient.

Normal results

Ideally, a successful heart valve repair procedure will return heart function to age-appropriate levels. If valvuloplasty is performed, a follow-up valve repair or replacement surgery may be necessary at a later date.

Resources

BOOKS

Surhone, Lambert M., Mariam T. Tennoe, and Susan F. Henssonow, eds. *Heart Valve Repair*. Beau Bassin, Mauritius: Betascript, 2010.

Paula Anne Ford-Martin

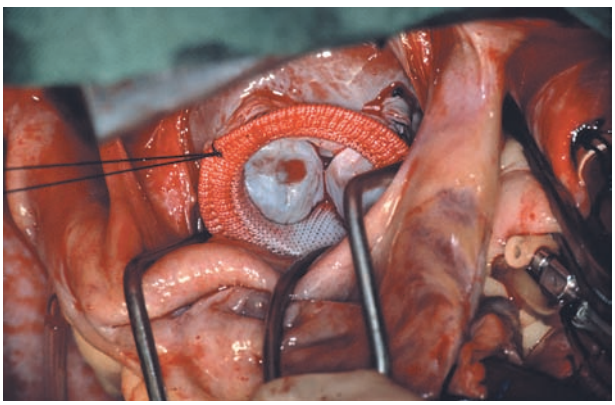
Heart valve replacement

Definition

Heart valve replacement is a surgical procedure during which surgeons remove a damaged valve from the heart and substitute a healthy one.

Purpose

Four valves direct blood to and from the body through the heart: the aortic valve, the pulmonic valve, the tricuspid valve, and the mitral valve. Any of these valves may malfunction because of a birth defect, infection, disease, or trauma. When the malfunction is so severe that it interferes with blood flow, an individual will have heart **palpitations**, **fainting** spells, and/or difficulty breathing. These symptoms will progressively worsen and cause **death** unless the damaged valve is replaced surgically.



Open heart surgery showing replacement of a valve. *(David Leah/Photo Researchers, Inc.)*

Precautions

Abnormal tricuspid valves usually are not replaced because they do not cause serious symptoms. Mildly or even moderately diseased mitral valves may not need to be replaced because their symptoms are tolerable or they can be treated with such drugs as **beta blockers** or **calcium** antagonists, which slow the heart rate. However, a severely diseased mitral valve should be repaired or replaced unless the person is too ill to tolerate the operation because of another condition or illness.

Description

After cutting through and separating the breastbone and ribs, surgeons place the patient on a cardiopulmonary bypass machine, which will perform the functions of the heart and lungs during the operation. They then open the heart and locate the faulty valve. Slicing around the edges of the valve, they loosen it from the tendons that connect it to the rest of the heart and withdraw it. The new valve is inserted and sutured into place. The patient is then taken off the bypass machine and the chest is closed. The surgery takes three to five hours and is covered by most insurance plans.

There are three types of replacement valves. One class is made from animal tissue, usually a pig's aortic valve. Another is mechanical and is made of metal and plastic. The third, includes human valves that have been removed from an organ donor or that, rarely, are the patient's own pulmonic valve.

There is no single ideal replacement valve. The choice between an animal valve or a mechanical valve depends largely on the age of the patient. Because valves obtained from animals have a life expectancy of 7–15 years, they usually are given to older patients. Mechanical valves are used in younger patients because they are more durable. Because mechanical valves are made of foreign material, however, **blood clots** can form on their surface. Therefore, patients who receive these valves must take anticoagulants the rest of their lives.

Donor or pulmonic valves are given only to those patients who will deteriorate rapidly because of a narrowing of the passageway between the aorta and the

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KEY TERMS

Anticoagulants—Drugs that prevent blood clots from forming.

Aortic valve—A fold in the channel leading from the aorta to the left ventricle of the heart. The aortic valve directs blood flow that has received oxygen from the lungs to the aorta which transmits blood to the rest of the body.

Cardiac catheterization—A thin tube called a catheter is inserted into an artery or vein in the leg, groin or arm. The catheter tube is carefully threaded into the area of the heart needing surgical repair. A local anaesthesia is used at the insertion sites.

Cardiopulmonary bypass machine—A mechanical instrument that takes over the circulation of the body while heart surgery is taking place.

Echocardiography—A diagnostic instrument that assesses the structure of the heart using sound waves.

Electrocardiography—A diagnostic instrument that evaluates the function of the heart by measuring the electrical activity generated by the beating of the heart.

Mitral valve—A fold in between the left atrium and the left ventricle of the heart that directs blood that has received oxygen from the lungs to the aortic valve and the aorta.

Pulmonic valve—A fold in the pulmonary artery that directs blood to the lungs. It may be transferred to replace a severely diseased aortic valve during heart valve replacement surgery for aortic stenosis.

Tricuspid valve—A fold in between the right atrium and the right ventricle of the heart that directs blood that needs oxygen to the lungs.

left ventrical (aortic stenosis). These valves are limited in their use because of the small supply available from donors and the strain that could be caused by removing and transferring a patient's own pulmonic valve.

Preparation

Before patients undergo heart valve replacement, they must be evaluated carefully for any signs that they may not tolerate the surgery.

Preoperative tests include:

- electrocardiography, which assesses the electrical activity of the heart
- echocardiography, which uses sound waves to show the extent of the obstruction of blood flow through the heart and determine the degree of loss of heart function due to the malfunctioning valve
- chest x ray, which provides an overall view of the anatomy of the heart and the lungs

Cardiac catheterization may also be performed to further asses the valve and to determine if coronary bypass surgery should also be done.

Aftercare

A patient usually spends one to three days in the hospital intensive care unit (ICU) after heart valve replacement so that the working of his or her heart and circulation can be monitored closely. When first brought to the ICU after surgery, the patient undergoes a neurological examination to be sure he or she has not suffered a **stroke**. The patient continues to breathe by means of a tube inserted in the trachea at the time of surgery. This mechanical ventilation is not withdrawn until the patient is fully awake from anesthesia, shows signs that he or she can breathe satisfactorily without mechanical support, and has steadfast circulation.

Once stablilized, the patient is transferred to a standard medical/surgical unit where he or she receives drugs that will prevent excess fluid from building up around the heart. As soon as possible, the patient begins walking and exercising to regain strength. He or she is also placed on a diet that is low in salt and cholesterol.

After being released from the hospital, the patient continues a daily **exercise** program that includes vigorous walking, and he or she may also join a recommended **cardiac rehabilitation** program. He or she usually can return to work or other normal activities within two months of the surgery.

Risks

Complications following heart valve replacement are not common, but can be serious. All valves made from animal tissue will develop calcium deposits over time. If these deposits hamper the function of the valve, it must be replaced. Valves may become dislodged. Blood clots may form on the surface of the substitute valve, break off into the general circulation, and become wedged in an artery supplying blood to the brain, kidneys, or legs. These blood clots may cause fainting spells,

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stroke, kidney failure, or loss of circulation to the legs. These blood clots can be treated with drugs or surgery.

Infection of heart muscle affects up to 2% of patients who have heart valve replacement. Such an infection is treated with intravenous **antibiotics**. If the infection persists, the new valve may have to be replaced.

Normal results

Few patients die as a result of the surgery. Approximately 3% of all patients die during or immediately after heart valve replacement, and less than 1% of patients below the age of 65 die because of the operation. The vast majority of patients who have heart valve replacement return to normal activity after the surgery. Depending on the type of valve they receive, these patients will have no symptoms of valve abnormality for at least seven years. Also, their quality of life will improve because they may no longer have difficulty breathing, fainting spells, or palpitations.

Resources

BOOKS

Pick, Adam. *The Patient's Guide To Heart Valve Surgery*. El Segundo, CA: Adam Pick, 2006.

ORGANIZATIONS

American College of Cardiology, Heart House, 2400 N Street NW, Washington, DC, 20037, (202) 375-6000, ext 5603, (202) 375-7000, (800) 223-4636, ext. 5603, resource@acc.org, http://www.acc.org.

American College of Surgeons, 633 North St. Clair St., Chicago, IL, 60611-3211, (212) 202-5000, (312) 202-5001, (800) 621-4111, postmaster@facs.org, http://www.facs.org.

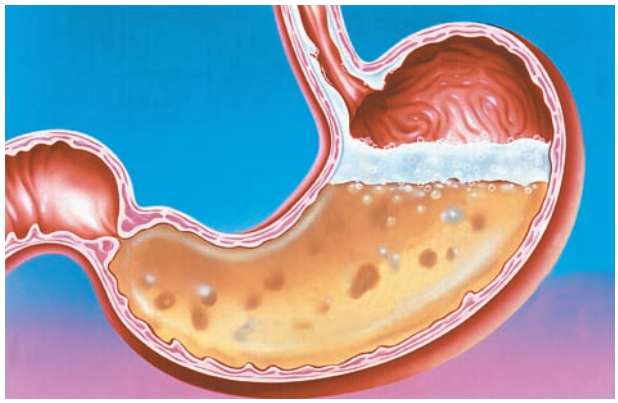
American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

Karen Marie Sandrick

Heartburn

Definition

Heartburn is a burning sensation in the chest that can extend to the neck, throat, and face; it is worsened by bending or lying down. It is the primary symptom of gastroesophageal reflux, which is the movement of stomach acid into the esophagus. On rare occasions, it is due to **gastritis** (stomach lining inflammation).



An illustration of foaming antacid on top of the contents of a human stomach. Heartburn is caused by a backflow of the stomach's acidic contents into the esophagus, causing inflammation and a sense of pain that can rise to the throat. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Demographics

Heartburn is extremely common. More than one-third of the population is afflicted by heartburn, with about one-tenth afflicted daily. Infrequent heartburn is usually without serious consequences, but chronic or frequent heartburn (recurring more than twice per week) can have severe consequences. Accordingly, early management is important.

Description

Understanding heartburn depends on understanding the structure and action of the esophagus. The esophagus is a tube connecting the throat to the stomach. It is about 10 in (25 cm) long in adults, lined with squamous (plate-like) epithelial cells, coated with mucus, and surrounded by muscles that push food to the stomach by sequential waves of contraction (peristalsis). The lower esophageal sphincter (LES) is a thick band of muscles that encircles the esophagus just above the uppermost part of the stomach. This sphincter is usually tightly closed and normally opens only when food passes from the esophagus into the stomach. Thus, the contents of the stomach are normally kept from moving back into the esophagus.

The stomach has a thick mucous coating that protects it from the strong acid it secretes into its interior when food is present, but the much thinner esophageal coating doesn't provide protection against acid. Thus, if the LES opens inappropriately or fails to close completely, and stomach contents leak into the esophagus, the esophagus can be burned by acid. The resulting burning sensation is called heartburn.

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Occasional heartburn has no serious long-lasting effects, but repeated episodes of gastroesophageal reflux can ultimately lead to esophageal inflammation (esophagitis) and other damage. If episodes occur more frequently than twice a week, and the esophagus is repeatedly subjected to acid and digestive enzymes from the stomach, ulcerations, scarring, and thickening of the esophagus walls can result. This thickening of the esophagus wall causes a narrowing of the interior of the esophagus. Such narrowing affects swallowing and peristaltic movements. Repeated irritation can also result in changes in the types of cells that line the esophagus. The condition associated with these changes is termed Barrett's syndrome and can lead to **esophageal cancer**.

Causes and symptoms

Causes

A number of different factors may contribute to LES malfunction with its consequent gastroesophageal acid reflux:

- The eating of large meals that distend the stomach can cause the LES to open inappropriately.
- Lying down within two to three hours of eating can cause the LES to open.
- Obesity, pregnancy, and tight clothing can impair the ability of the LES to stay closed by putting pressure on the abdomen.
- Certain drugs, notably nicotine, alcohol, diazepam (Valium), meperidine (Demerol), theophylline, morphine, prostaglandins, calcium channel blockers, nitrate heart medications, anticholinergic and adrenergic drugs (drugs that limit nerve reactions), including dopamine, can relax the LES.
- Progesterone is thought to relax the LES.
- Greasy foods and some other foods such as chocolate, coffee, and peppermint can relax the LES.
- Paralysis and scleroderma can cause the LES to malfunction.
- Hiatus hernia may also cause heartburn according to some gastroenterologists. (Hiatus hernia is a protrusion of part of the stomach through the diaphragm to a position next to the esophagus.)

Symptoms

Heartburn itself is a symptom. Other symptoms also caused by gastroesophageal reflux can be associated with heartburn. Often heartburn sufferers salivate excessively or regurgitate stomach contents into their mouths, leaving a sour or bitter taste. Frequent gastroesophageal reflux leads to additional complications including difficult or painful swallowing, **sore throat**, hoarseness, coughing, **laryngitis**, **wheezing**, **asthma**, **pneumonia**, gingivitis, **bad breath**, and earache.

Diagnosis

Gastroenterologists and internists are best equipped to diagnose and treat gastroesophageal reflux. Diagnosis is usually based solely on patient histories that report heartburn and other related symptoms. Additional diagnostic procedures can confirm the diagnosis and assess damage to the esophagus, as well as monitor healing progress. The following diagnostic procedures are appropriate for anyone who has frequent, chronic, or difficult-to-treat heartburn or any of the complicating symptoms noted in the previous paragraph.

X rays taken after a patient swallows a barium suspension can reveal esophageal narrowing, ulcerations or a reflux episode as it occurs. However, this procedure cannot detect the structural changes associated with different degrees of esophagitis. This diagnostic procedure has traditionally been called the "upper GI series" or "barium swallow."

Esophagoscopy is a procedure that uses a thin flexible tube to view the inside of the esophagus directly. It should be done by a gastroenterologist or gastrointestinal endoscopist. It gives an accurate picture of any damage present and gives the physician the ability to distinguish between different degrees of esophagitis.

Other tests may also be used. They include pressure measurements of the LES; measurements of esophageal acidity (pH), usually throughout a 24-hour period; and microscopic examination of biopsied tissue from the esophageal wall (to inspect esophageal cell structure for Barrett's syndrome and malignancies).

Recent technology allows for continuous monitoring of pH levels to help determine the cause. A tiny wireless capsule can be delivered to the lining of the esophagus through a catheter and data recorder on a device the size of a pager that is clipped to the patient's belt or purse for 48 hours. The capsule eventually sloughs off and passes harmlessly through the gastrointestinal tract in 7 to 10 days.

Note: A burning sensation in the chest is usually heartburn and is not associated with the heart. However, chest **pain** that radiates into the arms and is not accompanied by regurgitation is a warning of a possible serious heart problem. Anyone with these symptoms should contact a doctor immediately.

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KEY TERMS

Barrett's syndrome—Also called Barrett's esophagus or Barrett's epithelia, this is a condition where the squamous epithelial cells that normally line the esophagus are replaced by thicker columnar epithelial cells.

Digestive enzymes—Molecules that catalyze the breakdown of large molecules (usually food) into smaller molecules.

Esophagitis—Inflammation of the esophagus.

Fundoplication—A surgical procedure that increases pressure on the LES by stretching and wrapping the upper part of the stomach around the sphincter.

Gastroesophageal reflux—The flow of stomach contents into the esophagus.

Hiatus hernia—A protrusion of part of the stomach through the diaphragm to a position next to the esophagus.

Metabolic—Refers to the chemical reactions in living things.

Mucus—Thick, viscous, gel-like material that functions to moisten and protect inner body surfaces.

Peristalsis—A sequence of muscle contractions that progressively squeeze one small section of the digestive tract and then the next to push food along the tract, something like pushing toothpaste out of its tube.

Scleroderma—An autoimmune disease with many consequences, including esophageal wall thickening.

Squamous epithelial cells—Thin, flat cells found in layers or sheets covering surfaces such as skin and the linings of blood vessels and esophagus.

Ulceration—An open break in surface tissue.

Treatment

Drugs

Occasional heartburn is probably best treated with over-the-counter **antacids**. These products go straight to the esophagus and immediately begin to decrease acidity. However, they should not be used as the sole treatment for heartburn sufferers who either have two or more episodes per week or who suffer for periods of more than three weeks. There is a risk of kidney damage and other metabolic changes.

H2 blockers (histamine receptor blockers, such as Pepsid AC, Zantac, Tagamet) decrease stomach acid production and are effective against heartburn. H2 blocker treatment also allows healing of esophageal damage but is not very effective when there is a high degree of damage. It takes 30–45 minutes for these drugs to take effect, so they must be taken prior to an episode. Thus, they should be taken daily, usually two to four times per day for several weeks. Six to twelve weeks of standard-dose treatment relieves symptoms in about one-half the patients. Higher doses relieve symptoms in a greater fraction of the population, but at least 25% of heartburn sufferers are not helped by H2 blockers.

Proton-pump inhibitors also inhibit acid production by the stomach, but are much more effective than H2 blockers for some people. They are also more effective in aiding the healing process. Esophagitis is healed in about 90% of the patients undergoing proton-pump inhibitor treatment.

The long-term effects of inhibiting stomach acid production are unknown. Without the antiseptic effects of a consistently very acidic stomach environment, users of H2 blockers or proton-pump inhibitors may become more susceptible to bacterial and viral infection. Absorption of some drugs is also lowered by this less-acidic environment.

Prokinetic agents (also known as motility drugs) act on the LES, stimulating it to close more tightly, thereby keeping stomach contents out of the esophagus. It is not known how effectively these drugs promote healing. Some of the early motility drugs had serious neurological side effects, but a newer drug, cisapride, seems to act only on digestive system nerve connections.

Surgery

Fundoplication, a surgical procedure to increase pressure on the LES by stretching and wrapping the upper part of the stomach around the sphincter, is a treatment of last resort. About 10% of heartburn sufferers undergo this procedure. It is not always effective and its effectiveness may decrease over time, especially several years after surgery. Dr. Robert Marks and his colleagues at the University of Alabama reported in 1997 on the long-term outcome of this procedure. They found that 64% of the patients in their study who had

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fundoplication between 1992 and 1995 still suffered from heartburn and reported an impaired quality of life after the surgery.

However, **laparoscopy** (an examination of the interior of the abdomen by means of the laparoscope) now provides hope for better outcomes. Fundoplication performed with a laparoscope is less invasive. Five small incisions are required instead of one large incision. Patients recover faster, and it is likely that studies will show they suffer from fewer surgical complications.

Alternative treatment

Prevention, as outlined below, is a primary feature for heartburn management in alternative medicine and traditional medicine. Dietary adjustments can eliminate many causes of heartburn.

Herbal remedies include bananas, aloe vera gel, chamomile (*Matricaria recutita*), ginger (*Zingiber officinale*), and citrus juices, but there is little agreement here. For example, ginger, which seems to help some people, is claimed by other practitioners to *cause* heartburn and is thought to relax the LES. There are also many recommendations to *avoid* citrus juices, which are themselves acidic. Licorice (*Glycyrrhiza uralensis*) can help relieve the symptoms of heartburn by reestablishing balance in the acid output of the stomach.

Several homeopathic remedies are useful in treating heartburn symptoms. Among those most often recommended are *Nux vomica, Carbo vegetabilis*, and *Arsenicum album*. **Acupressure** and **acupuncture** may also be helpful in treating heartburn.

Sodium bicarbonate (baking soda) is an inexpensive alternative to use as an antacid. It reduces esophageal acidity immediately, but its effect is not long-lasting and should not be used by people on sodium-restricted **diets**.

Moderate **exercise** can also help relieve heartburn symptoms, but intense activity may exacerbate the condition.

Prognosis

The prognosis for people who get heartburn only occasionally or people without esophageal damage is excellent. The prognosis for people with esophageal damage who become involved in a treatment program that promotes healing is also excellent. The prognosis for anyone with esophageal **cancer** is very poor. There is a strong likelihood of a painful illness and a less than 5% chance of surviving more than five years.

Prevention

Given the lack of completely satisfactory treatments for heartburn or its consequences and the lack of a cure for esophageal cancer, prevention is of the utmost importance. Proponents of traditional *and* alternative medicine agree that people disposed to heartburn should:

- avoid eating large meals
- avoid alcohol, caffeine, fatty foods, fried foods, hot or spicy foods, chocolate, peppermint, and nicotine
- avoid drugs known to contribute to heartburn, such as nitrates (heart medications such as Isonate and Nitrocap), calcium channel blockers (e.g., Cardizem and Procardia), and anticholinergic drugs (e.g., Probanthine and Bentyl), and check with their doctors about any drugs they are taking
- avoid clothing that fits tightly around the abdomen
- control body weight
- wait about three hours after eating before going to bed or lying down
- elevate the head of the bed 6–9 inches to alleviate heartburn at night. This can be done with bricks under the bed or with a wedge designed for this purpose.

Preventing heartburn's switch to cancer begins with preventing heartburn in the first place. A study in Great Britain in 2004 also looked at using a combination of **aspirin** and an anti-ulcer drug to try to prevent Barrett's esophagus from forming in patients with long-term heartburn. Aspirin has been found in previous studies to reduce cases of esophageal cancer. However, since one of its side effects is an increased risk of stomach ulcers, the researchers were including an effective anti-ulcer drug for participants.

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ORGANIZATIONS

The American College of Gastroenterology (ACG), PO Box 3099, Alexandria, VA, 22302, (800) HRT-BURN, https://www.healthtouch.com.

The American Gastroenterological Association (AGA), 7910 Woodmont Ave., 7th Floor, Bethesda, MD, 20814, (310) 654-2055, http://www.gastro.org/index.html.

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American Society for Gastrointestinal Endoscopy, 13 Elm St, Manchester, MA, 01944, (508) 526-8330, http://www.asge.org.

National Digestive Diseases Information Clearinghouse, 2 Information Way, Bethesda, MD, 20892-3570, (800) 891-5389, www.niddk.nih.gov/health/digest/nddic.htm.

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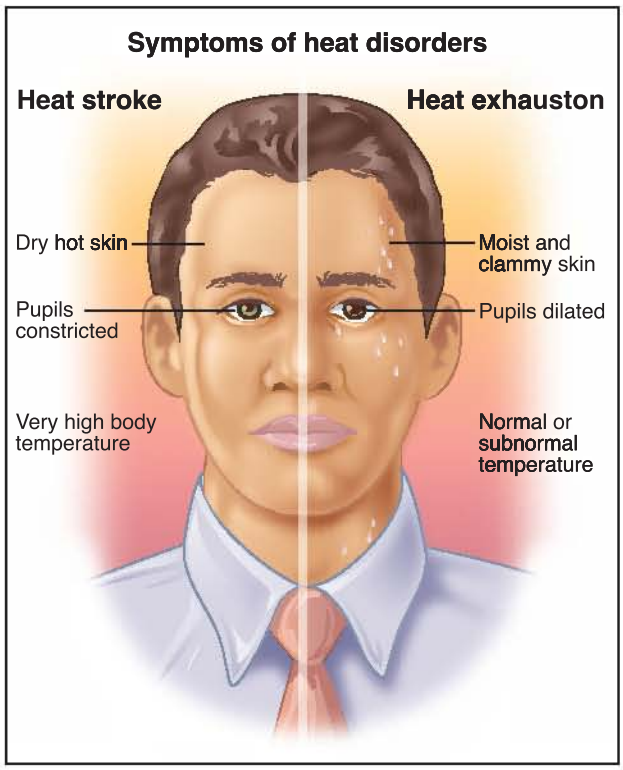
Heat cramps *see* **Heat disorders**

Heat disorders

Definition

Heat disorders are a group of physically related illnesses caused by prolonged exposure to hot temperatures, restricted fluid intake, or failure of the body's temperature regulation mechanisms. Disorders of heat exposure include heat cramps, heat exhaustion, and heat **stroke** (also called sunstroke). Hyperthermia is the general name given to heat-related illnesses. The two most common forms of hyperthermia are heat exhaustion and heat stroke, which is especially dangerous and requires immediate medical attention.



Symptoms of heat stroke and heat exhaustion. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Demographics

Anyone can develop hyperthermia. However, seniors and young children are more likely to be affected than young or middle-aged adults. The United States Centers for Disease Control and Prevention (CDC) report that more than 330 individuals die of heat-related causes each year. More deaths occur in years that have significant heat waves, and more individuals die of heat-related illness during the summer months. More than 40% of the individuals who die of heat-related causes each year are over the age of 65.

Description

Heat disorders are harmful to people of all ages, but their severity is likely to increase as people age. Heat cramps in a 16-year-old may be heat exhaustion in a 45-year-old and heat stroke in a 65-year-old.

Regardless of extreme weather conditions, the healthy human body keeps a steady temperature of approximately 98.6°F (37°C). The body's temperature regulating mechanisms rely on the thermal regulating centers in the brain. Through these complex centers, the body tries to adapt to high temperatures by adjusting the amount of salt in the perspiration. Salt helps the cells in body tissues retain water. In hot weather, a healthy body will lose enough water to cool the body while creating the lowest level of chemical imbalance. In hot weather, or during vigorous activity, the body perspires. As perspiration evaporates from the skin, the body is cooled. If the body loses too much salt and fluids, the symptoms of **dehydration** can occur.

Risk factors

The very young, very old, obese individuals and those with cardiovascular problems are at increased risk of experiencing a heat disorder. Alcohol and diseases that impair the ability to sweat are associated with a higher risk of heat-related illness.

Individuals taking certain medications are more likely to be affected because the medications can interfere with the body's normal cooling mechanisms. Individuals taking some blood pressure and heart medications, allergy medications, diet pills, water pills, cold medicines, medicines to prevent seizures, **laxatives**, and thyroid pills are at increased risk for hyperthermia.

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Heat cramps

Heat cramps are the least severe of the heat-related illnesses. This heat disorder is often the first signal that the body is having difficulty with increased temperature. Individuals exposed to excessive heat should think of heat cramps as a warning sign to a potential heat-related emergency.

Heat exhaustion

Heat exhaustion is a more serious and complex condition than heat cramps. Heat exhaustion can result from prolonged exposure to hot temperatures, restricted fluid intake, or failure of temperature regulation mechanisms of the body. It often affects athletes, firefighters, construction workers, factory workers, and anyone who wears heavy clothing in hot humid weather.

Heatstroke

Heat exhaustion can develop rapidly into heatstroke. Heatstroke can be life threatening. Because of its seriousness and its high potential for causing **death**, immediate medical attention is critical when problems first begin. Heat stroke, like heat exhaustion, is also a result of prolonged exposure to hot temperatures, restricted fluid intake, or failure of temperature regulation mechanisms of the body. However, the severity of impact on the body is much greater with heatstroke.

Causes and symptoms

Heat cramps

Heat cramps are painful **muscle spasms** caused by the excessive loss of salts (electrolytes) due to heavy perspiration. The muscle tissue becomes less flexible, causing **pain**, difficult movement, and involuntary tightness. Heavy exertion in extreme heat, restricted fluid intake, or failure of temperature regulation mechanisms of the body may lead to heat cramps. This disorder occurs more often in the legs and abdomen than in other areas of the body. Individuals at higher risk are those working in extreme heat, elderly people, young children, people with health problems, and those who are unable to naturally and properly cool their bodies. Individuals with poor circulation and who take medications to reduce excess body fluids (**diuretics**) can be at risk when conditions are hot and humid.

Heat exhaustion

Heat exhaustion is caused by exposure to high heat and humidity for many hours, resulting in excessive loss of fluids and salts through heavy perspiration. The skin may appear cool, moist, and pale. The individual may complain of **headache** and **nausea** with a feeling of overall weakness and exhaustion. **Dizziness**, faintness, and mental confusion are often present, as is rapid and weak pulse. Breathing becomes fast and shallow. Fluid loss reduces blood volume and lowers blood pressure. Yellow or orange urine often is a result of inadequate fluid intake, along with associated intense thirst. Insufficient water and salt intake or a deficiency in the production of sweat place an individual at high risk for heat exhaustion.

Heatstroke

Heatstroke is caused by overexposure to extreme heat, resulting in a breakdown in the body's heat regulating mechanisms. The body's temperature reaches a dangerous level, as high as 106°F (41.1°C). An individual with heat stroke has a body temperature higher than 104°F (40°C). Other symptoms include mental confusion with possible combativeness and bizarre behavior, staggering, and faintness.

The pulse becomes strong and rapid (160–180 beats per minute) with the skin taking on a dry and flushed appearance. There is often very little perspiration. The individual can quickly lose consciousness or have convulsions. Before heat stroke, an individual experiences heat exhaustion and the associated symptoms. When the body can no longer maintain a normal temperature, heat exhaustion becomes heatstroke. Heatstroke is a life-threatening medical emergency that requires immediate initiation of life-saving measures.

KEY TERMS

Convulsions—Also termed seizures; a sudden violent contraction of a group of muscles.

Electrolyte—Ions in the body that participate in metabolic reactions. The major human electrolytes are sodium (Na+), potassium (K+), calcium (Ca 2+), magnesium (Mg2+), chloride (Cl-), phosphate (HPO4 2-), bicarbonate (HCO3-), and sulfate (SO4 2-). Careful and regular monitoring of electrolytes and intravenous replacement of fluid and electrolytes are part of the acute care in many illnesses.

Intravenous (IV)—The process of giving a liquid through a vein.

Rehydration—The restoration of water or fluid to a body that has become dehydrated.

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Diagnosis

The diagnosis of heat cramps usually involves observation of symptoms such as muscle cramping and thirst. Diagnosis of heat exhaustion or heatstroke, however, may require a physician to review the medical history, document symptoms, and obtain a blood pressure and temperature reading. The physician also may take blood and urine samples for further laboratory testing. A test to measure the body's electrolytes also can give valuable information about chemical imbalances caused by the heat-related illness.

Treatment

Heat cramps

The care of heat cramps includes placing the individual at rest in a cool environment, while giving cool water with one teaspoon of salt per quart of water or giving a commercial sports drink (e.g., Gatorade). Usually rest and liquids are all that is needed for the patient to recover. Mild stretching and massaging of the muscle area follows once the condition improves. The individual should not take salt tablets since this may actually worsen the condition. When the cramps stop, the person usually can start activity again if there are no other signs of illness. The individual needs to continue drinking fluids and should be watched carefully for further signs of heat-related illnesses.

Heat exhaustion

An individual who shows signs of heat exhaustion should stop all physical activity and immediately be moved to a cool place out of the sun, preferably a cool, air-conditioned location. She or he should then lay down with feet slightly elevated, remove or loosen clothing, and drink cold (but not iced), slightly salty water or a commercial sports drink. Rest and replacement of fluids and salt is usually all the treatment that is needed, and hospitalization is rarely required. Following rehydration, the person usually recovers rapidly.

Heatstroke

Simply moving the individual afflicted with heatstroke to a cooler place is not enough to reverse internal overheating. Emergency medical assistance should be called immediately. While waiting for help to arrive, quick action to lower body temperature must take place. Treatment involves getting the victim to a cool place, loosening clothes or undressing the heat stroke victim, and allowing air to circulate around the body. The next important step is wrapping the individual in wet towels or clothing, and placing ice packs in areas with the greatest blood supply. These areas include the neck, under the arm and knees, and in the groin. The individual can even be placed into a bathtub full of cool water to help speed cooling. A fan can be used to circulate air over dampened skin to simulate sweating and help the cooling process. Once the patient is under medical care, **cooling treatments** may continue as appropriate. The individual's body temperature will be monitored constantly to guard against overcooling. Breathing and heart rate will be monitored closely, and fluids and electrolytes will be replaced intravenously. **Anticonvulsant drugs** may be given to help reduce shivering, which warms the body up. After severe heat stroke, bed rest may be recommended for several days.

Prognosis

Prompt treatment for heat cramps is usually very effective with the individual returning to activity thereafter. Treatment of heat exhaustion usually brings full recovery in one to two days. Heatstroke is a very serious condition and its outcome depends upon general health and age. Due to the high internal temperature of heatstroke, permanent damage to internal organs is possible.

Prevention

Because heat cramps, heat exhaustion, and heatstroke are all essentially different levels of severity of the same disorder, the prevention of the onset of all heat disorders is similar. Strenuous **exercise** should be avoided when it is very hot or humid. Individuals exposed to extreme heat conditions should drink plenty of fluids. Wearing light and loose-fitting clothing in hot weather is important, regardless of the activity. It is important to consume water often and not to wait until thirst develops. If perspiration is excessive, fluid intake should be increased. When urine output decreases, fluid intake should also increase. Eating lightly salted foods can help replace salts lost through perspiration. Ventilation in any working areas in warm weather must be adequate. This can be achieved as simply as opening a window or using an electric fan. Proper ventilation will promote adequate sweat evaporation to cool the skin.

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Heat exhaustion *see* **Heat disorders**

Heat treatments

Definition

Heat treatments are applications of therapeutic thermal agents to specific body areas experiencing injury or dysfunction.

Purpose

The general purpose of a heat treatment is to increase the extensibility of soft tissues, remove toxins from cells, enhance blood flow, increase function of the tissue cells, encourage muscle relaxation, and help relieve **pain**. There are two types of heat treatments: superficial and deep. Superficial heat treatments apply heat to the outside of the body. Deep heat treatments direct heat toward specific inner tissues through ultrasound or by electric current. Heat treatments are beneficial prior to **exercise**, providing a warm-up effect to the soft tissues involved.

Precautions

Heat treatments should not be used on individuals with circulation problems, heat intolerance, or lack of sensation in the affected area. Low blood circulation may contribute to heat-related injuries. Heat treatments also should not be used on individuals afflicted with heart, lung, or kidney diseases. Deep heat treatments should not be used on areas above the eye, heart, or on a pregnant patient. Deep heat treatments over areas with metal surgical implants should be avoided in case of rapid temperature increase and subsequent injury.

Description

There are four different ways to convey heat:

- Conduction is the transfer of heat between two objects in direct contact with each other.
- Conversion is the transition of one form of energy to heat.
- Radiation involves the transmission and absorption of electromagnetic waves to produce a heating effect.
- Convection occurs when a liquid or gas moves past a body part creating heat.

Hot packs, water bottles, and heating pads

Hot packs are a very common form of heat treatment utilizing conduction as a form of heat transfer. Moist heat packs are readily available in most hospitals, **physical therapy** centers, and athletic training rooms. Treatment temperature should not exceed 131°F (55°C). The pack is used over multiple layers of toweling to achieve a comfortable warming effect for approximately 30 minutes. More recently, several manufacturers have developed packs that may be warmed in a microwave over a specified amount of time prior to use.

Hot-water bottles are another form of superficial heat treatment. The bottles are filled half way with hot water between 115–125°F (46.1–52°C). Covered by protective toweling, the hot-water bottle is placed on the treatment area and left until the water has cooled off.

Electrical heating pads continue to be used, however, because of the need for an electrical outlet, safety and convenience become an issue.

Paraffin

Paraffin, a conductive form of superficial heat, is often used for heating uneven surfaces of the body such as the hands. It consists of melted paraffin wax and mineral oil. Paraffin placed in a small bath unit becomes solid at room temperature and is used as a liquid heat treatment when heated at 126–127.4°F (52–53°C). The most common form of paraffin application is called the dip and wax method. In this technique, the patient will dip 8 to 12 times and then the extremity will be covered with a plastic bag and a towel for insulation. Most treatment sessions are about 20 minutes.

Hydrotherapy

Hydrotherapy is used in a form of heat treatment for many musculoskeletal disorders. The hydrotherapy tanks and pools are all generally set at warm

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temperatures, never exceeding 150°F (65.6°C). Because the patient often performs resistance exercises while in the water, higher water temperatures become a concern as the treatment becomes more physically draining. Because of this, many hydrotherapy baths are now being set at 95–110°F (35–43.3°C). There are also units available with moveable turbine jets, which provide a light massage effect. Hydrotherapy is helpful as a warm-up prior to exercise.

Fluidotherapy

Fluidotherapy is a form of heat treatment developed in the 1970s. It is a dry heat modality consisting of cellulose particles suspended in air. Units come in different sizes and some are restricted to only treating a hand or foot. The turbulence of the gas-solid mixture provides thermal contact with objects that are immersed in the medium. Temperatures of this treatment range from 110–123°F (43.3–50.5°C). Fluidotherapy allows the patient to exercise the limb during the treatment, and also massages the limb, increasing blood flow.

Ultrasound

Ultrasound heat treatments penetrate the body to provide relief to inner tissue. Ultrasound energy comes from the acoustic or sound spectrum and is undetectable to the human ear. By using conducting agents such as gel or mineral oil, the ultrasound transducer warms areas of the musculoskeletal system Some areas of the musculoskeletal system absorb ultrasound better that others. Muscle tissue and other connective tissue such as ligaments and tendons absorb this form of energy very well. However, fat absorbs to a much lesser degree. Ultrasound has a relatively long-lasting effect, continuing up to one hour.

Diathermy

Diathermy is another deep heat treatment. An electrode drum is used to apply heat to an affected area. It consists of a wire coil surrounded by dead space and other insulators such as a plastic housing. Plenty of toweling must be layered between the unit and the patient. This device is unique in that it utilizes the basis of a magnetic field on connective tissues. One advantage of diathermy over various other heat treatments is that fat does resist an electrical field, which is not the case with a magnetic field. It is found to be helpful with those experiencing chronic **low back pain** and **muscle spasms**. Prior to ultrasound technology, diathermy was a popular heat therapy of the 1940s–1960s.

Preparation

Before administering any form of heat treatment, heat sensitivity is accessed and the skin over the affected area is cleansed. When a patient is undergoing any form of heat treatment, supervision should always be present especially in the treatment of hydrotherapy.

Aftercare

Once the heat treatment has been completed, any symptoms of **dizziness** and **nausea** should be noted and documented along with any skin irritations or discoloring not present prior to the heat treatment. A one hour interval between treatments should be adhered to in order to avoid restriction of blood flow.

Risks

All heat treatments have the potential of tissue damage resulting from excessive temperatures. Proper insulation and treatment duration should be carefully administered for each method. Overexposure during a superficial heat treatment may result in redness, blisters, **burns**, or reduced blood circulation. During ultrasound therapy, excessive treatment over bony areas with little soft tissue (such as hand, feet, and elbow) can cause excessive heat resulting in pain and possible tissue damage. Exposure to the electrode drum during diathermy may produce hot spots.

ORGANIZATIONS

American Physical Therapy Association, 1111 North Fairfax St., Alexandria, VA, 22314-1488, (703) 684-2782, (703) 684-7343, (800) 999-2782, http://www.apta.org/.

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Heatstroke *see* **Heat disorders**

Heavy menstruation *see* **Dysfunctional uterine bleeding**

Heavy metal poisoning

Definition

Heavy metal **poisoning** is the toxic accumulation of heavy metals in the soft tissues of the body.

Description

Heavy metals are chemical elements that have a specific gravity (a measure of density) at least five times that of water. The heavy metals most often implicated in accidental human poisoning are lead, mercury,

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arsenic, and cadmium. More recently, thallium has gained some attention in the media as the poison used in several murder cases in the 1990s. Some heavy metals, such as zinc, copper, chromium, iron, and manganese, are required by the body in small amounts, but these same elements can be toxic in larger quantities.

Heavy metals may enter the body in food, water, or air, or by absorption through the skin. Once in the body, they compete with and displace essential **minerals**, such as zinc, copper, magnesium, and **calcium**, and interfere with organ system function. People may come in contact with heavy metals in industrial work, pharmaceutical manufacturing, and agriculture. Children may be poisoned as a result of playing in contaminated soil. **Lead poisoning** in adults has been traced to the use of lead-based glazes on pottery vessels intended for use with food, and contamination of Ayurvedic and other imported herbal remedies. Arsenic and thallium have been mixed with food or beverages to attempt **suicide** or poison others.

Another form of **mercury poisoning** that is seen more and more frequently in the United States is self-injected mercury under the skin. Some boxers inject themselves with mercury in the belief that it adds muscle bulk. Metallic mercury is also used in folk medicine or religious rituals in various cultures. These practices increase the risk of mercury poisoning of children in these ethnic groups or subcultures.

Causes and symptoms

Symptoms will vary, depending on the nature and the quantity of the heavy metal ingested. Patients may complain of **nausea**, **vomiting**, **diarrhea**, stomach **pain**, **headache**, sweating, and a metallic taste in the mouth. Depending on the metal, there may be blue-black lines in the gum tissues. In severe cases, patients exhibit obvious impairment of cognitive, motor, and language skills. The expression "mad as a hatter" comes from the mercury poisoning prevalent in 17th-century France among hatmakers who soaked animal hides in a solution of mercuric nitrate to soften the hair.

Diagnosis

Heavy metal poisoning may be detected using blood and urine tests, hair and tissue analysis, or x ray. The diagnosis is often overlooked, however, because many of the early symptoms of heavy metal poisoning are nonspecific. The doctor should take a thorough patient history with particular emphasis on the patient's occupation.

In childhood, blood lead levels above 80 ug/dL generally indicate lead poisoning, however, significantly lower levels (>30 ug/dL) can cause **mental retardation** and other cognitive and behavioral problems in affected children. The Centers for Disease Control and Prevention considers a blood lead level of 10 ug/dL or higher in children a cause for concern. In adults, symptoms of lead poisoning are usually seen when blood lead levels exceed 80 ug/dL for a number of weeks.

Blood levels of mercury should not exceed 3.6 ug/dL, while urine levels should not exceed 15 ug/dL. Symptoms of mercury poisoning may be seen when mercury levels exceed 20 ug/dL in blood and 60 ug/dL in urine. Mercury levels in hair may be used to gauge the severity of chronic mercury exposure.

Since arsenic is rapidly cleared from the blood, blood arsenic levels may not be very useful in diagnosis. Arsenic in the urine (measured in a 24-hour collection following 48 hours without eating seafood) may exceed 50 ug/dL in people with arsenic poisoning. If acute arsenic or thallium poisoning is suspected, an x ray may reveal these substances in the abdomen (since both metals are opaque to x rays). Arsenic may also be detected in the hair and nails for months following exposure.

Cadmium toxicity is generally indicated when urine levels exceed 10 ug/dL of creatinine and blood levels exceed 5 ug/dL.

Thallium poisoning often causes hair loss (**alopecia**), **numbness**, and a burning sensation in the skin as well as nausea, **vomiting**, and **dizziness**. As little as 15–20 mg of thallium per kilogram of body weight is fatal in humans; however, smaller amounts can cause severe damage to the nervous system.

Treatment

When heavy metal poisoning is suspected, it is important to begin treatment as soon as possible to minimize long-term damage to the patient's nervous system and digestive tract. Heavy metal poisoning is considered a medical emergency, and the patient should be taken to a hospital emergency room.

The treatment for most heavy metal poisoning is **chelation therapy**. A chelating agent specific to the metal involved is given either orally, intramuscularly, or intravenously. The three most common chelating agents are calcium disodium edetate, dimercaprol (BAL), and penicillamine. The chelating agent encircles and binds to the metal in the body's tissues, forming a complex; that complex is then released from the tissue to travel in the bloodstream. The complex is filtered out of the blood by the kidneys and excreted in the urine. This process may be lengthy and painful, and typically requires hospitalization. Chelation therapy is effective in treating lead, mercury, and arsenic

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KEY TERMS

Alopecia—Loss of hair.

Chelation—The process by which a molecule encircles and binds to a metal and removes it from tissue.

Heavy metal—One of 23 chemical elements that has a specific gravity (a measure of density) at least five times that of water.

Prussian blue—The common name of potassium ferric hexacyanoferrate, a compound approved in the United States for treatment of thallium poisoning. Prussian blue gets its name from the fact that it was first used by artists in 1704 as a dark blue pigment for oil paints. It has also been used in laundry bluing and fabric printing.

poisoning, but is not useful in treating cadmium poisoning. To date, no treatment has been proven effective for cadmium poisoning. Thallium poisoning is treated with a combination of Prussian blue (potassium ferric hexacyanoferrate) and a diuretic because about 35% of it is excreted in the urine; however, if treatment is not started within 72 hours of ingesting the poisoning, damage to the patient's nervous system may be permanent.

In cases of acute mercury, arsenic, or thallium ingestion, vomiting may be induced. **Activated charcoal** may be given in cases of thallium poisoning. Washing out the stomach (gastric lavage) may also be useful. The patient may also require treatment such as intravenous fluids for such complications of poisoning as **shock**, anemia, and kidney failure.

Patients who have taken arsenic, thallium, or mercury in a suicide attempt will be seen by a psychiatrist as part of emergency treatment.

Prognosis

The chelation process can only halt further effects of the poisoning; it cannot reverse neurological damage already sustained.

Prevention

Because arsenic and thallium were commonly used in rat and insect poisons at one time, many countries have tried to lower the rate of accidental poisonings by banning the use of heavy metals in pest control products. Thallium was banned in the United States as a rodent poison in 1984. As a result, almost all recent cases of arsenic and thallium poisoning in the United States were deliberate rather than accidental.

Because exposure to heavy metals is often an occupational hazard, protective clothing and respirators should be provided and worn on the job. Protective clothing should then be left at the work site and not worn home, where it could carry toxic dust to family members. Industries are urged to reduce or replace the heavy metals in their processes wherever possible. Exposure to environmental sources of lead, including lead-based paints, plumbing fixtures, vehicle exhaust, and contaminated soil, should be reduced or eliminated.

People who use Ayurvedic or traditional Chinese herbal preparations as alternative treatments for various illnesses should purchase them only from reliable manufacturers.

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ORGANIZATIONS

American Society of Health-System Pharmacists (ASHP), 7272 Wisconsin Avenue, Bethesda, MD, 20814, (301) 657-3000, (866) 279-0681, http://www.ashp.org.

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Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.
Food and Drug Administration. Consumer Information. , HFI-40, 5600 Fishers La.,-Rockville, MD, 20857, (888) 463-6332, ConsumerInfo@fda.hhs.gov, http://www.fda.gov.
National Center for Environmental Health, 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov/nceh.

Bethany Thivierge
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Heel spurs

Definition

A heel spur is a bony projection on the sole (plantar) region of the heel bone (also known as the calcaneous). This condition may accompany or result from severe cases of inflammation to the structure called plantar fascia. This associated plantar fascia is a fibrous band of connective tissue on the sole of the foot, extending from the heel to the toes.

Description

Heel spurs are a common foot problem resulting from excess bone growth on the heel bone. The bone growth is usually located on the underside of the heel bone, extending forward to the toes. One explanation for this excess production of bone is a painful tearing of the plantar fascia connected between the toes and heel. This can result in either a heel spur or an inflammation of the plantar fascia, medically termed plantar fascitis. Because this condition is often correlated to a decrease in the arch of the foot, it is more prevalent after the age of six to eight years, when the arch is fully developed.

Causes and symptoms

One frequent cause of heel spurs is an abnormal motion and mal-alignment of the foot called pronation. For the foot to function properly, a certain degree of pronation is required. This motion is defined as an inward action of the foot, with dropping of the inside arch as one plants the heel and advances the weight distribution to the toes during walking. When foot pronation becomes extreme from the foot turning in and dropping beyond the normal limit, a condition known as excessive pronation creates a mechanical problem in the foot. In some cases the sole or bottom of the foot flattens and becomes unstable because of this excess pronation, especially during critical times of walking and athletic activities. The portion of the plantar fascia attached into the heel bone or calcaneous begins to stretch and pull away from the heel bone.

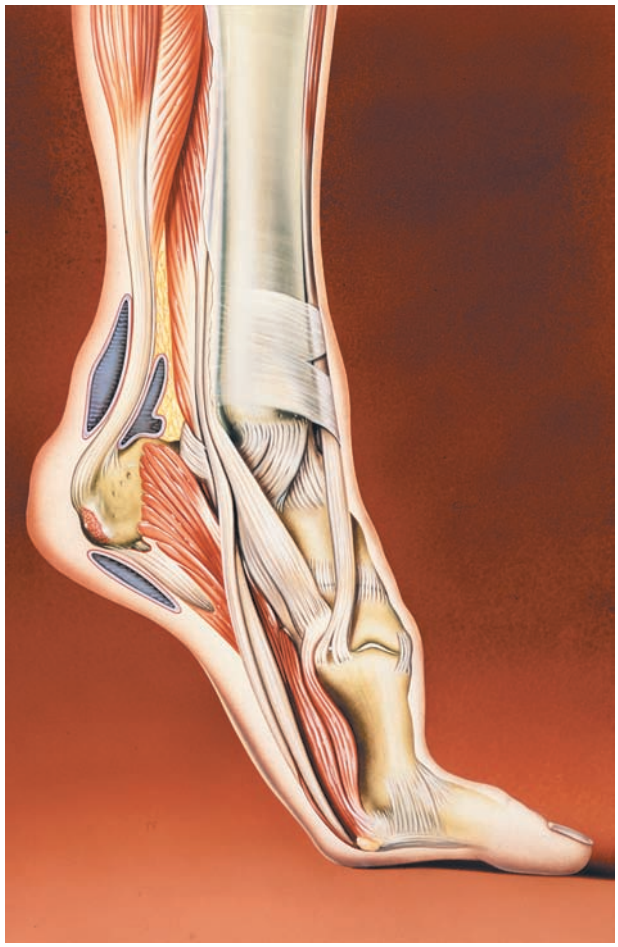

Illustration of a bony projection, a spur, which developed from chronic irritation. *(Photo Researchers, Inc.)*

At the onset of this condition, **pain** and swelling become present, with discomfort particularly noted as pushing off with the toes occurs during walking. This movement of the foot stretches the fascia that is already irritated and inflamed. If this condition is allowed to continue, pain is noticed around the heel region because of the newly formed bone, in response to the **stress**. This results in the development of the heel spur. It is common among athletes and others who run and jump a significant amount.

An individual with the lower legs angulating inward, a condition called genu valgum or "knock knees," can have a tendency toward excessive pronation. As a result,

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this too can lead to a fallen arch resulting in plantar fascitis and heel spurs. Women tend to have more genu valgum than men do. Heel spurs can also result from an abnormally high arch.

Other factors leading to heel spurs include a sudden increase in daily activities, an increase in weight, or a change of shoes. Dramatic increase in training intensity or duration may cause plantar fascitis. Shoes that are too flexible in the middle of the arch or shoes that bend before the toe joints will cause an increase in tension in the plantar fascia and possibly lead to heel spurs.

The pain this condition causes forces an individual to attempt walking on his or her toes or ball of the foot to avoid pressure on the heel spur. This can lead to other compensations during walking or running that in turn cause additional problems to the ankle, knee, hip, or back.

KEY TERMS

Calcaneous—The heel bone.

Genu valgum—Deformity in which the legs are curved inward so that the knees are close together, nearly or actually knocking as a person walks with ankles widely apart of each other.

Plantar fascia—A tough fibrous band of tissue surrounding the muscles of the sole of the foot. Also called plantar aponeurosis.

Pronation—The lowering or descending of the inner edge of the foot by turning the entire foot outwards.

Diagnosis

A thorough medical history and physical exam by a physician is always necessary for the proper diagnosis of heel spurs and other foot conditions. X rays of the heel area are helpful, as excess bone production will be visible.

Treatment

Conservative

Heel spurs and plantar fascitis are usually controlled with conservative treatment. Early intervention includes stretching the calf muscles while avoiding re-injuring the plantar fascia. Decreasing or changing activities, losing excess weight, and improving the proper fitting of shoes are all important measures to decrease this common source of foot pain. Modification of footwear includes shoes with a raised heel and better arch support. Shoe orthotics recommended by a healthcare professional are often very helpful in conjunction with exercises to increase strength of the foot muscles and arch. The orthotic prevents excess pronation and lengthening of the plantar fascia and continued tearing of this structure. To aid in this reduction of inflammation, applying ice for 10–15 minutes after activities and use of anti-inflammatory medication can be helpful. **Physical therapy** can be beneficial with the use of heat modalities, such as ultrasound that creates a deep heat and reduces inflammation. If the pain caused by inflammation is constant, keeping the foot raised above the heart and/or compressed by wrapping with an ace bandage will help.

Corticosteroid injections are also frequently used to reduce pain and inflammation. Taping can help speed the healing process by protecting the fascia from reinjury, especially during stretching and walking.

Heel surgery

When chronic heel pain fails to respond to conservative treatment, surgical treatment may be necessary. Heel surgery can provide relief of pain and restore mobility. The type of procedure used is based on examination and usually consists of releasing the excessive tightness of the plantar fascia, called a plantar fascia release. Depending on the presence of excess bony build up, the procedure may or may not include removal of heel spurs. Similar to other surgical interventions, there are various modifications and surgical enhancements regarding surgery of the heel.

Alternative treatment

Acupuncture and accupressure have been used to address the pain of heel spurs, in addition to using friction massage to help break up scar tissue and delay onset of bony formations.

Prognosis

Usually, heel spurs are curable with conservative treatment. If not, heel spurs are curable with surgery. About 10% of those that continue to see a physician for plantar fascitis have it for more than a year. If there is limited success after approximately one year of conservative treatment, patients are often advised to have surgery.

Prevention

To prevent this condition, wearing shoes with proper arches and support is very important. Proper stretching is always a necessity, especially when there is an increase in activities or a change in running

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technique. It is not recommended to attempt working through the pain, as this can change a mild case of heel spurs and plantar fascitis into a long lasting and painful episode of this condition.

ORGANIZATIONS

American Orthopaedic Foot and Ankle Society, 6300 N. River Road, Suite 510, Rosemont, IL, 60018, (847) 698-4654, (800) 235-4855.

American Podiatric Medical Association, 9312 Old Geor getown Road, Bethesda, MD, 20814-1621, (301) 581-9200, http://www.apma.org.

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Heimlich maneuver

Definition

The Heimlich maneuver is an emergency procedure for removing a foreign object lodged in the airway that is preventing a person from breathing. It is also known as abdominal thrusts.

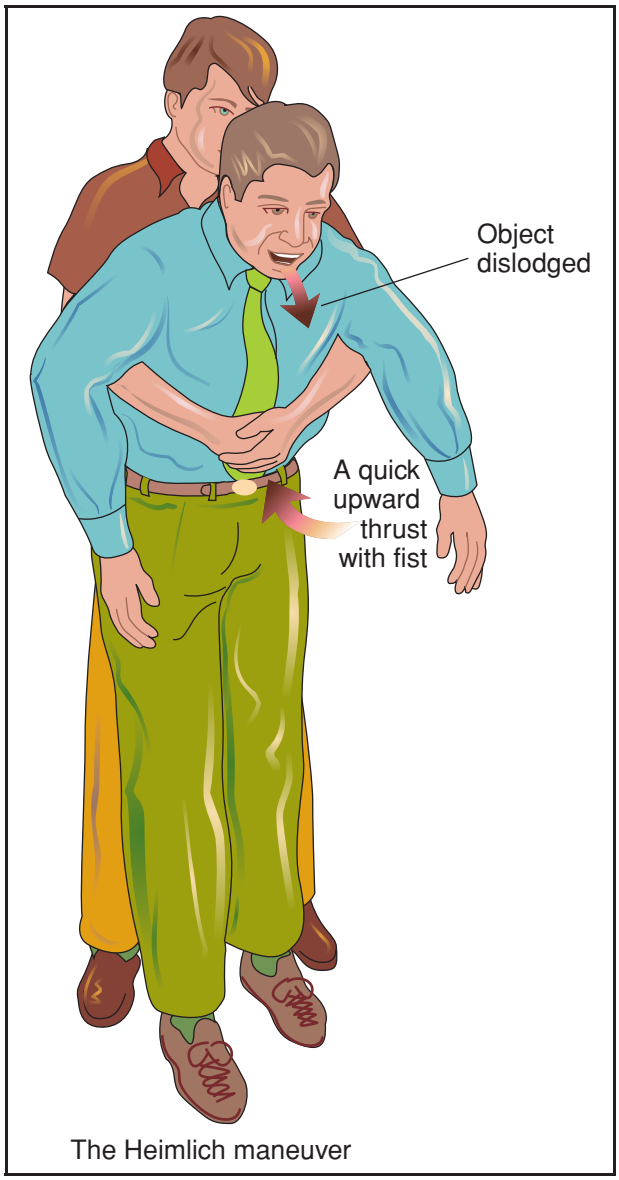
Purpose

Each year, between 2,800 and 4,000 adults die in the United States because they accidentally inhale rather than swallow food. The food gets stuck and blocks their trachea (windpipe), making breathing impossible. **Death** follows rapidly unless the food or other foreign material can be displaced from the airway. This condition is so common it has been nicknamed the "café coronary."

In 1974, Dr. Henry Heimlich first described an emergency technique for expelling foreign material blocking the trachea. This technique, now called the Heimlich maneuver or abdominal thrust, is simple enough that it can be performed immediately by anyone trained in the maneuver. The Heimlich maneuver is a standard part of all **first aid** courses.

The theory behind the Heimlich maneuver is that by compressing the abdomen below the level of the diaphragm, air is forced out of the lungs under pressure. This air dislodges the obstruction in the trachea and brings the foreign material back up into the mouth.

The Heimlich maneuver is used mainly when such solid materials as food, coins, vomit, or small toys are blocking the airway. There has been some controversy about whether the Heimlich maneuver is appropriate to use routinely on **near-drowning** victims. After several studies of the effectiveness of the Heimlich maneuver on reestablishing breathing in near-drowning victims, the American Red Cross and the American Heart Association both recommend that the Heimlich maneuver be used only as a last resort after traditional airway clearance techniques and **cardiopulmonary resuscitation** (CPR) have been tried repeatedly and failed; or if it is clear that a solid foreign object is blocking the airway.



To perform the Heimlich maneuver on a conscious adult (as illustrated above), the rescuer stands behind the victim and encircles his waist. The rescuer makes a fist with one hand and places the other hand on top, positioned below the rib cage and above the waist. The rescuer then applies pressure by a series of upward and inward thrusts to force the foreign object back up the victim's trachea. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

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Demographics

There are no exact statistics on the number of times the Heimlich maneuver is performed in an average year, or the circumstances or age groups of the persons treated, although one study done in California stated that 4% of 513 patients treated for a foreign body in the airway died and that the average age of patients treated was 65. The Heimlich maneuver was the most commonly used intervention, with an 86% success rate.

Description

The Heimlich maneuver can be performed on all people. Modifications are necessary if the person **choking** is very obese, pregnant, a child, or an infant. Indications that a person's airway is blocked include:

- inability to speak or cry out
- face turning blue from lack of oxygen
- desperate grabbing at the throat
- weak cough with labored breathing producing a high-pitched noise
- all of the above, followed by unconsciousness

Performing the Heimlich maneuver on adults

To perform the Heimlich maneuver on a conscious adult, the rescuer stands behind the affected person, who may be either sitting or standing. The rescuer makes a fist with one hand and places it, thumb toward the person choking, below the rib cage and above the waist. The rescuer encircles the other person's waist, placing the other hand on top of the fist.

In a series of 6 to 10 sharp and distinct thrusts upward and inward, the rescuer attempts to develop enough pressure to force the foreign object back up the trachea. If the maneuver fails, it is repeated. It is important not to give up if the first attempt fails. As the choking person is deprived of oxygen, the muscles of the trachea relax slightly. Because of this loosening, it is possible that a foreign object may be expelled on a second or third attempt.

If the individual choking is unconscious, the rescuer should place the person supine on the floor; bend the chin forward; make sure the tongue is not blocking the airway; and feel in the mouth for any **foreign objects**, being careful not to push them further into the airway. The rescuer kneels astride the choking person's thighs and places the fists between the bottom of the choking person's breastbone and navel. The rescuer then executes a series of 6 to 10 sharp compressions by pushing inward and upward.

After the abdominal thrusts, the rescuer repeats the process of lifting the chin, moving the tongue, feeling for and possibly removing any foreign material. If the airway is not clear, the rescuer repeats the abdominal thrusts as often as necessary. If the foreign object has been removed, but the victim is not breathing, the rescuer starts CPR.

Performing the Heimlich maneuver under special circumstances

OBVIOUSLY PREGNANT OR VERY OBESE PEOPLE. The main difference in performing the Heimlich maneuver on this group of people is in the placement of the fists. Instead of using abdominal thrusts, chest thrusts are used. The rescuer's fists are placed against the middle of the breastbone (sternum), and the motion of the chest thrust is in and downward, rather than upward. If the person choking is unconscious, the chest thrusts are similar to those used in CPR.

CHILDREN. The technique in children over one year of age is the same as in adults, except that the amount of force used is less than that used with adults, in order to avoid damaging a child's ribs, breastbone, and internal organs.

INFANTS UNDER ONE YEAR OLD. The rescuer sits down and positions the infant along the rescuer's forearm with the infant's face pointed toward the floor and at a lower level than the infant's chest. The rescuer's hand supports the infant's head. The forearm rests on the rescuer's own thigh for additional support. Using the heel of the other hand, the rescuer administers four or five rapid blows to the infant's back between the shoulder blades.

After administering the back blows, the rescuer sandwiches the infant between both arms. The infant is turned over so that it lies face up, supported by the rescuer's opposite arm. Using the free hand, the rescuer places the index and middle finger on the center of the breastbone and makes four sharp chest thrusts. This series of back blows and chest thrusts is alternated until the foreign object is expelled.

SELF-ADMINISTRATION OF THE HEIMLICH MANEUVER. To apply the Heimlich maneuver to oneself, a choking person should make a fist with one hand and place it in the middle of the body at a spot above the navel and below the breastbone, then grasp the fist with the other hand and push sharply inward and upward. If this fails, the choking person should press the upper abdomen over the back of a chair, edge of a table, porch railing or something similar, and thrust up and inward until the object is dislodged.

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KEY TERMS

Aspiration—The entry of body secretions or foreign material into the trachea and lungs.

Diaphragm—The thin layer of muscle that separates the chest cavity, which contains the lungs and heart, from the abdominal cavity, which contains the intestines and digestive organs.

Sternum—The breastbone. The sternum is located over the heart, is the point of attachment for ribs at the front of the body and provides protection to the heart beneath it.

Trachea—The windpipe. A tube extending from below the voice box into the chest where it splits into two branches, the bronchi, that lead to each lung.

Benefits

The Heimlich maneuver usually results in the expulsion and removal of an obstruction in the throat; in many situations, the person's life is saved. The choking person suffers no permanent effects from the episode.

Precautions

If possible, have someone nearby call 911 while the rescuer performs the Heimlich maneuver.

It is important to have training and practice in the correct use of the maneuver. Incorrect application of the Heimlich maneuver can damage the chest, ribs, heart, or internal organs of the person on whom it is performed. People may also vomit after being treated with the Heimlich maneuver. It is important to prevent aspiration of the vomitus.

Preparation

Any adult, adolescent, or responsible older child can be trained to perform the Heimlich maneuver. Knowing how to perform it may save someone's life. Before doing the maneuver, it is important to determine whether the airway is completely blocked. If the choking person can talk or cry, the Heimlich maneuver is not appropriate. If the airway is not completely blocked, the choking person should be allowed to try to **cough** up the foreign object without assistance.

Aftercare

Once the obstruction is removed, most persons who experience an episode of choking recover without any further care. Persons who have an obstruction that cannot be dislodged but are able to breathe should be taken to an emergency room for treatment.

Risks

Many people vomit after being treated with the Heimlich maneuver. Depending on the length and severity of the choking episode, the person may need to be taken to a hospital emergency room. In addition, even when the maneuver is performed correctly, the person being treated often suffers **bruises** in the abdominal area. Occasionally, one or more ribs of the choking person may be broken during administration of the Heimlich maneuver. The elderly are more likely to suffer bruises or broken ribs during the maneuver than younger adults.

Applying the Heimlich maneuver too vigorously may result in an injury to the internal organs of the choking person. There may be some local **pain** and tenderness at the point where the rescuer's fist was placed. In infants, a rescuer should never attempt to sweep the baby's mouth without looking to remove foreign material. This is likely to push the material farther down the trachea. If the foreign material is not removed, the person choking will die from lack of oxygen.

Health care team roles

Anyone can be trained to successfully apply the Heimlich maneuver. Most of the applications each year are provided by trained volunteers. Health professionals may become involved. Paramedics may apply the Heimlich maneuver to a choking person. Physicians, physician assistants and nurses may provide additional treatment in a hospital emergency room. Nurses may provide some follow-up care.

Research and general acceptance

There is some debate as of 2010 over the benefit of slapping the person's upper back to help dislodge the material in the windpipe. Dr. Heimlich has long maintained that back slaps should not be done because they drive the material deeper into the windpipe. However, the American Red Cross and the American Heart Association presently recommend the use of hard blows with the heel of the rescuer's hand on the upper back of the victim. The number to be used varies by training organization, but is usually between 5 and 20. The back slap is designed to create pressure behind the blockage, assisting the patient in dislodging the article in the airway. The Mayo Clinic article listed in the Resources section of this article recommends five back slaps before

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beginning the abdominal thrusts of the Heimlich maneuver, and alternating between five back blows and five abdominal thrusts until the food or other object is dislodged.

Resources

BOOKS

American Academy of Orthopaedic Surgeons. *First Aid, CPR, and AED Standard*. Sudbury, MA: Jones and Bartlett Publishers, 2010.

Dvorchak, George E., Jr. *The Pocket First Aid Field Guide: Treatment of Outdoor Emergencies*. New York: Skyhorse Publishing, 2010.

National Safety Council. *Basic Pediatric First Aid, CPR, and AED*. Boston: McGraw-Hill Higher Education, 2008.

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Soroudi, A., et al. "Adult Foreign Body Airway Obstruction in the Prehospital Setting." *Prehospital Emergency Care* 11 (January-March 2007): 25–29.

OTHER

American Heart Association. *Heimlich Maneuver*. http://www.americanheart.org/presenter.jhtml?identifier=4605.

Broomfield, James, MD. "Heimlich Maneuver on Self." *Discovery Health*, January 4, 2007. http://health.discovery.com/encyclopedias/illnesses.html?article=671.

Heimlich Institute. *How to Do the Heimlich Maneuver*. http://www.heimlichinstitute.org/page.php?id=34.

Howcast. *How to Perform the Heimlich Maneuver*. This is a video demonstration of the maneuver that takes about 2-1/2 minutes to watch. http://www.youtube.com/watch?v=tEIiEAn7b-U.

Mayo Clinic. *Choking: First Aid*. http://www.mayoclinic.com/health/first-aid-choking/FA00025.

MedlinePlus Medical Encyclopedia. *Heimlich Maneuver*. http://www.nlm.nih.gov/medlineplus/ency/article/000047.htm.

Nathan, Joan. "A Heimlich in Every Pot." *New York Times*, February 3, 2009. http://www.nytimes.com/2009/02/04/opinion/04nathan.html?ref=opinion.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, 800-AHA-USA-1, http://www.americanheart.org/presenter.jhtml?identifier=1200000.

American Red Cross National Headquarters, 2025 E Street, NW, Washington, DC, 20006, 202-303-5000, http://www.redcross.org/.

Heimlich Institute, 311 Straight Street, Cincinnati, OH, 45219, 513-559-2100, http://www.heimlichinstitute.org/default.php.

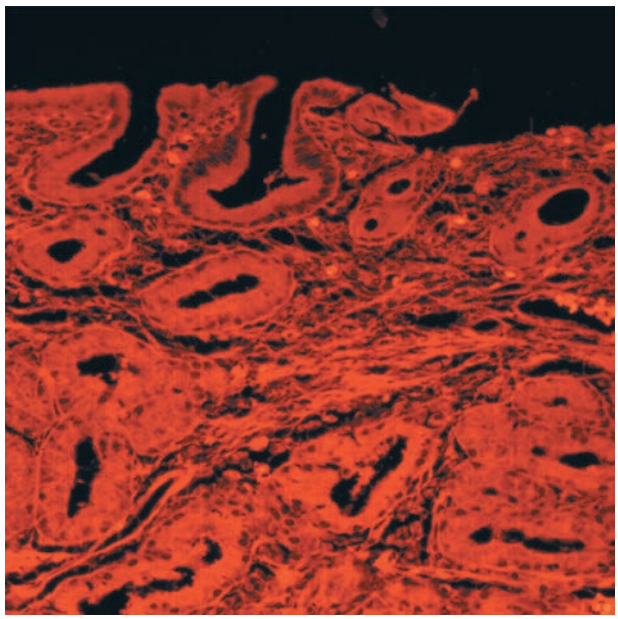
L. Fleming Fallon, Jr., MD, PhD, DrPH
Rebecca J. Frey, PhD

Helicobacter pylori infection *see* **Helicobacteriosis**

Helicobacteriosis

Definition

Helicobacteriosis refers to infection of the gastrointestinal tract with the bacteria, *Helicobacter pylori* (*H. pylori*). While there are other, more rare strains of *Helicobacter* species that can infect humans, only *H. pylori* has been convincingly shown to be a cause of disease in humans. The organism was first documented to cause injury to the stomach in 1983 by two researchers in Australia, who ingested the organism to prove their theory. Since then, *H. pylori* has been



A light microscopic image of a stomach ulcer. Gastric and duodenal ulcers are usually caused by infection with the bacteria Helicobacter pylori. This bacterium is also believed to be a cause of various cancers of the stomach. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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shown to be the main cause of ulcer disease, and has revolutionized the treatment of peptic ulcer disease. It also is believed to be linked to various cancers of the stomach.

Description

H. pylori is a gram-negative, spiral-shaped organism, that contains flagella (tail-like structures) and other properties. In addition to flagella, which help the organism to move around in the liquid mucous layer of the stomach, *H. pylori* also produces an enzyme called urease, that protects it from gastric acid present in the stomach. As the production of this enzyme is relatively unusual, new diagnostic tests have enabled rapid identification of the bacteria.

H. pylori also produces two other chemicals: a cytotoxin called vacA and a protein known as cagA. Patients with ulcer disease are more likely to produce the cytotoxin (vacA). The cagA protein not only occurs frequently in ulcer disease but also in **cancer**. It is still not known how these substances enable *H. pylori* to cause disease.

Causes and symptoms

Infection with *H. pylori* is largely dependent on two factors; age and income status. The bacteria is acquired mainly in childhood, especially in areas of poor hygiene or overcrowding. *H. pylori* is two to three times more prevalent in developing, non-industrialized countries. In the United States for example, the organism is believed to be present in about one-third of the population.

The exact way in which *H. pylori* gets passed from one individual to another is uncertain, but person to person transmission is most likely. In most cases, children are felt to be the source of spread. Reinfection of those who have been cured has been documented, especially in areas of overcrowding.

The bacteria is well adapted to survival within the stomach. Not only does it survive there for years, but once infection begins, a form of chronic inflammation (chronic **gastritis**) always develops. In most individuals, initial infection causes little or no symptoms; however, some individuals, such as the original researchers who ingested the bacteria, wind up with abdominal **pain** and **nausea**.

In about 15% of infected persons, ulcer disease develops either in the stomach or duodenum. Why some develop ulcer disease and others do not remains unclear. Ulcer symptoms are characterized by upper abdominal pain that is typically of a burning or "gnawing" type and usually is rapidly relieved by **antacids** or food.

Acid secretion increases in most patients with duodenal ulcers. This increase returns to normal once *H. pylori* is eliminated. It is now known that elimination of the bacteria will substantially decrease the risk of recurrent bouts of ulcer disease in the vast majority of patients. In fact, a 2003 report showed that by eradicating H. pylori, ulcer bleeding rarely recurs.

In the last decade it has been shown that *H. pylori* is not only the prime cause of ulcer disease of the stomach and duodenum, but is also strongly associated with various tumors of the stomach. Bacterial infection is nine times more common in patients with cancer of the stomach, and seven times more common in those with lymphoma of the stomach (tumor of the lymphatic tissue), called a MALT tumor. It is believed that the prolonged inflammation leads to changes in cell growth and tumors. Eliminating *H. pylori* can lead to regression of some tumors.

In addition to the above damage caused by *H. pylori*, some individuals lose normal gastric function, such as the ability to absorb vitamin B_{12}.

Diagnosis

There are basically two types of tests to identify infection: one group is "invasive" in that it involves the use of an **endoscopy** to obtain biopsy specimens for evaluation, while the other "noninvasive" methods depend on blood or breath samples. Invasive tests can be less accurate because of technical limitations: the biopsy may miss the area where the bacteria hides.

Invasive studies make use of tissue obtained by endoscopic biopsy to identify the organism. The bacteria can be searched for in pieces of biopsy tissue or grown (cultured) from the specimen. However, *H. pylori* is not easy to culture. Another method uses the bacteria's production of the enzyme urease. Biopsy specimens are placed on a card that changes color if urease is present. Results often are available within a few minutes, but can take up to 24 hours.

Noninvasive tests are of two types: blood tests and breath test. Blood tests measure antibodies to make a diagnosis accurately within minutes. This can be done immediately in the doctor's office. In addition, antibody levels can be measured several months after treatment, to see if *H. pylori* has been eradicated.

The breath test uses radioactive or non-radioactive forms of a compound called urea, which the patient drinks. The method that uses a radioactive form of urea is easier to perform, as the equipment is commonly

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KEY TERMS

Antibiotic—A medication that is designed to kill or weaken bacteria.

Endoscope, Endoscopy—An endoscope as used in the field of gastroenterology is a thin flexible tube that uses a lens or miniature camera to view various areas of the gastrointestinal tract. When the procedure is performed to examine certain organs, such as the bile ducts or pancreas, the organs are not viewed directly, but indirectly through the injection of x ray. The performance of an exam using an endoscope is referred by the general term endoscopy. Diagnosis through biopsies or other means and therapeutic procedures can be done with these instruments.

Gram-negative—Refers to the property of many bacteria in which they do not take or color with Gram's stain, a method which is used to identify bacteria. Gram-positive bacteria that take up the stain turn purple, while Gram-negative bacteria which do not take up the stain turn red.

available in x ray departments. Radiation exposure is less than that of a **chest x ray**. The test that uses nonradioactive urea is safer for children. A 2003 study in Brazil showed that the urea breath test and H. pylori stool antigen test also worked well to detect the bacteria in children. The breath test is the best way to be sure of elimination of *H. pylori*. The test can be used within 30 days after treatment. This is an advantage over following antibody levels that take six months or longer to diminish.

Treatment

H. pylori peptic ulcers are treated with drugs to kill the bacteria, drugs to reduce stomach acid, and drugs to protect the lining of the stomach. The **antibiotics** most commonly used to kill the bacteria are amoxicillin, clarithromycin, metronidazole, and tetracycline. Drugs used to reduce stomach acid may be histamine blockers or **proton pump inhibitors**. The most commonly used histamine blockers are cimetidine, famotidine, nizatidine, and ranitidine. The most commonly used proton pump inhibitors are lansoprazole and omeprazole. The drug bismuth subsalicylate (a component of Pepto-Bismol) is used to protect the stomach lining.

The most common drug treatment is a two-week course of treatment called triple therapy. This treatment regimen involves taking two antibiotics to kill the bacteria and either an acid reducer or a stomach-lining shield. This therapy has been shown to kill the bacteria, reduce ulcer symptoms, and prevent ulcer recurrence in over 90% of patients.

The main drawback of triple therapy is that some patients find it difficult to follow because it often requires taking as many as 20 pills a day. The antibiotics also may cause unpleasant side effects that may make certain patients less likely to follow the treatment protocol. These side effects include dark stools, **diarrhea**, **dizziness**, **headache**, a metallic taste in the mouth, nausea, **vomiting**, and yeast infections in women.

Prognosis

The elimination of *H. pylori* and cure of ulcer disease is now possible in more than 90% of those infected. The finding that most ulcers are due to an infectious agent has brought a dramatic change in treatment and outlook for those suffering from the disease. Some patients will wind up with repeated infection, but this is most common in overcrowded areas.

Prevention

Attempts to develop a vaccine to protect against infection may be worthwhile in areas where the *H. pylori* infection rate and occurrence of cancer of the stomach is high. Research has shown such a vaccine would likely be safe in humans, but a vaccine has yet to be fully identified and developed as of mid-2003.

Resources

PERIODICALS

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"Management Strategies for Helicobacter pylori Seropositive Patients with Dyspepsia." http://www.acponline.org/journals/annals/15feb97/treatcounsel.htm.

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"Treating Stomach Ulcers and H. pylori Infection." http://www.aafp.org/patientinfo/ulcers.html.
"What Is Helicobacter pylori Infection?" Centers for Disease Control. http://www.cdc.gov/ncidod/aip/research/hp.html#what_is_hp.

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Teresa G. Odle

Hellerwork

Definition

Hellerwork is a system of bodywork that combines deep tissue massage, body movement education, and verbal dialogue. It is designed to realign the body's structure for overall health, improvement of posture, and reduction of physical and mental **stress**.

Purpose

Hellerwork improves posture and brings the body's natural structure into proper balance and alignment. This realignment can bring relief from general aches and pains, improve breathing, and relieve physical and mental stress. Hellerwork has been used to treat such specific physical problems as chronic back, neck, shoulder, and joint **pain** as well as repetitive stress injuries, including **carpal tunnel syndrome**. Hellerwork is also used to treat and prevent athletic injuries.

Description

Origins

Joseph Heller (1940–) developed Hellerwork, a system of structural integration patterned after **Rolfing**. Heller received a degree in engineering and worked for NASA's Jet Propulsion Laboratory in Pasadena, California, before he became interested in humanistic psychology in the 1970s. He spent two years studying bioenergetics and **Gestalt therapy** as well as studying under architect and futurist Buckminster Fuller (1895–1983), flotation tank therapy developer John Lilly, family therapist Virginia Satir, and body movement pioneer Judith Aston.

During this period, he trained for six years with Dr. Ida P. Rolf (1896-1979), the founder of Rolfing, and became a certified Rolfer in 1972. After Heller developed his own system of bodywork, he founded Hellerwork in 1979 and established a training facility in Mt. Shasta, California, where he continues his work.

Hellerwork is based largely on the principles of Rolfing, in which the body's connective tissue is manipulated or massaged to realign and balance the body's structure. Because Heller believes that physical realignment is insufficient, he expanded his system to include movement education and verbal dialogue as well as deep tissue massage.

Connective tissue massage

The **massage therapy** aspect of Hellerwork is designed to release the tension that exists in the deep connective tissue, called fascia, and return it to a normal alignment. The fascia is plastic and highly adaptable. It can tighten and harden in response to the general effects of gravity on the body, other ongoing physical stresses, negative attitudes and emotions, and periodic physical traumas. One example of ongoing physical stress is carrying a briefcase, which pulls down the shoulder on one side of the body. Over time, the connective tissue becomes hard and stiff; the body becomes adapted to that position even when the person is not carrying a briefcase. In trying to adjust to the uneven weight distribution, the rest of the body becomes unbalanced and out of proper alignment.

Heller believes that as people age, more of these stress and trauma patterns become ingrained in the connective tissue, further throwing the body out of alignment. As stress accumulates, the body shortens and stiffens, a process commonly attributed to **aging**. Hellerwork seeks to recondition the body and make the connective tissue less rigid.

Movement education

The second component of Hellerwork, movement education, trains patients in the proper physical movements needed to keep the body balanced and correctly aligned. Movement education focuses on common actions, such as sitting, standing, and walking. Hellerwork practitioners also teach better patterns of movement for activities that are specific to each individual, such as their job and favorite sports or social activities.

Verbal dialogue

Verbal dialogue is the third aspect of Hellerwork. It is designed to teach awareness of the relationships among emotions, life attitudes, and the body. Hellerwork practitioners believe that as patients become responsible for their attitudes, their body movements and patterns of self-expression improve. Dialogue focuses on the theme of each session and the area of the body that is worked on during that session.

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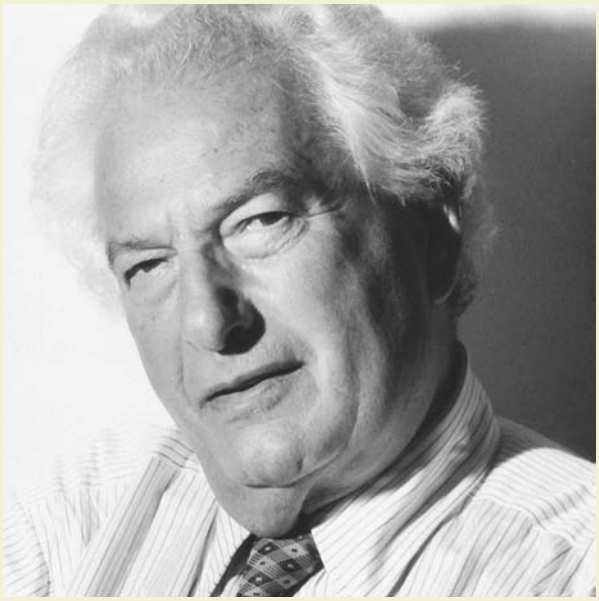
JOSEPH HELLER (1940–)



(AP Images.)

Born in Poland, Joseph Heller attended school in Europe until age 16, when he immigrated to the United States. Living in Los Angeles, he attended the California Institute of Technology in Pasadena and graduated in 1962 with a degree in engineering. He worked for 10 years at the National Aeronautics and Space Administration's Jet Propulsion Laboratory (JPL) in Pasadena as an aerospace engineer. During his service at JPL, Heller became interested in humanistic psychology. After leaving JPL in 1972, he became director of Kairos, a center for human development in Los Angeles. He spent two years studying bioenergetics and gestalt. He also trained under Buckminster Fuller, flotation tank therapy developer John Lilly, self-esteem trainer Virginia Satir, and body movement pioneer Judith Aston.

He became a certified Rolfer in 1972 and spent the next six years studying structural integration under Rolfing founder Ida P. Rolf. He became the first president of the Rolf Institute in 1975. During his training with Rolf, Heller began developing his own system of bodywork. He left the institute in 1978 and moved to Northern California where he founded Hellerwork, which he continues to operate today. According to Hellerwork's website (http://www.hellerwork.com/), his program is a unique and powerful combination of deep-tissue structural integration bodywork, movement education and dialogue. The 11 section series is designed to transform a person's relationship with his body and with the experience of being alive.

Hellerwork consists of 11 90-minute sessions costing about $90–100 each. The first three sessions focus on the surface layers of the fascia and on developmental issues of infancy and childhood. The next four sessions are the core sessions and work on the deep layers and on adolescent developmental issues. The final four treatments are the integrative sessions, and build upon all the previous ones, while also looking at questions of maturity.

Preparations

No advance preparations are required to begin Hellerwork treatment. The treatment is usually done on a massage table with the patient wearing only undergarments.

Precautions

Since Hellerwork involves vigorous deep tissue massage, it is often described as uncomfortable and sometimes painful, especially during the first several sessions. As it requires the use of hands, it may be a problem for people who do not like or are afraid of being touched. It is not recommended as a treatment for any disease or a chronic inflammatory condition such as arthritis, and can worsen such a condition. Anyone with a serious medical condition, including heart disease, diabetes, or respiratory problems, should consult a medical practitioner before undergoing Hellerwork.

Side effects

There are no reported serious side effects associated with Hellerwork when delivered by a certified practitioner to adults and juveniles.

Research and general acceptance

As with many alternative or holistic treatments, there is little mainstream scientific research documenting the effectiveness of Hellerwork therapy. Since the deep tissue massage aspect of Hellerwork is similar to Rolfing, scientific studies of Rolfing may be useful in evaluating Hellerwork. A 1988 study published in the *Journal of the American Physical Therapy Association* indicated that Rolfing stimulates the parasympathetic

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KEY TERMS

Bioenergetics—A system of therapy that combines breathing and body exercises, psychological therapy, and the free expression of emotions to release blocked physical and psychic energy.

Bodywork—A term that covers a variety of therapies that include massage, realignment of the body, and similar techniques to treat deeply ingrained stresses and traumas carried in the tissues of the body.

Chronic—A disease or condition that progresses slowly but persists or reoccurs over time.

Fascia—The sheet of connective tissue that covers the body under the skin and envelops the muscles and various organs.

Gestalt therapy—A form of therapy that focuses on helping patients reconnect with their bodies and their feelings directly, as contrasted with verbal intellectual analysis.

Kinesiology—The study of the anatomy and physiology of body movement, particularly in relation to therapy.

Rolfing—A deep-tissue therapy that involves manipulating the body's fascia to realign and balance the body's structure.

nervous system, which can help speed the recovery of damaged tissue. An article in *The Journal of Orthopaedic and Sports Physical Therapy* reported that Rolfing can provide effective and sustained pain relief from lower back problems.

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ORGANIZATIONS

American Massage Therapy Association, 500 Davis St., Evanston, IL, 60201, (877) 905-2700, http://www.amtamassage.org.

Hellerwork, 406 Berry St., Mt. Shasta, CA, 96067, (530) 926-2500, http://www.hellerwork.com.

The Center for Mindfulness in Medicine, Health Care and Society. University of Massachusetts Medical School., 55 Lake Avenue North, Worcester, MA, 01655, (508) 856-2656, (508) 856-1977, mindfulness@umassmed.edu, http://www.umassmed.edu/cfm/.

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HELLP syndrome *see* **Preeclampsia and eclampsia**

Hemangiomas *see* **Birthmarks**

Hematocrit

Definition

The hematocrit measures how much space in the blood is occupied by red blood cells. It is useful when evaluating a person for anemia.

Purpose

Blood is made up of red and white blood cells, and plasma. A decrease in the number or size of red cells also decreases the amount of space they occupy, resulting in a lower hematocrit. An increase in the number or size of red cells increases the amount of space they occupy, resulting in a higher hematocrit. **Thalassemia** is a condition which can cause an increased number of red blood cells but a decreased size and hematocrit.

The hematocrit is usually done on a person with symptoms of anemia. An anemic person has fewer or smaller than normal red cells. A low hematocrit, combined with other abnormal blood tests, confirms the diagnosis.

Some conditions, such as polycythemia, cause an overproduction of red blood cells, resulting in an increased hematocrit.

Transfusion decisions are based on the results of laboratory tests, including hematocrit. Transfusion is not considered if the hematocrit level is reasonable. The level differs for each person, depending on his or her clinical condition.

Description

Blood drawn from a fingerstick is often used for hematocrit testing. The blood fills a small tube, which is

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KEY TERMS

Anemia—A condition where a person has fewer or smaller than normal red blood cells.

Hemoglobin—The percentage of space in blood occupied by red blood cells.

then spun in a small centrifuge. As the tube spins, the red blood cells go to the bottom of the tube, the white blood cells cover the red in a thin layer called the buffy coat, and the liquid plasma rises to the top. The spun tube is examined for the line that divides the red cells from the buffy coat and plasma. The height of the red cell column is measured as a percent of the total blood column. The higher the column of red cells, the higher the hematocrit.

The hematocrit test can also be done on an automated instrument as part of a **complete blood count**. It is also called Packed Red Cell Volume or Packed Cell Volume, or abbreviated as Hct or Crit. The test is covered by insurance when medically necessary. Results are usually available the same or following day.

Preparation

To collect the blood by fingerstick, a healthcare worker punctures a finger with a lancet and allows the blood to fill a small tube held to the puncture site.

Tests done on an automated instrument require 5–7 mL of blood. A healthcare worker ties a tourniquet on the person's upper arm, locates a vein in the inner elbow region, and inserts a needle into that vein. Vacuum action draws the blood through the needle into an attached tube. Collection of the sample takes only a few minutes.

Aftercare

Discomfort or bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Warm packs to the puncture site relieve discomfort.

Normal results

Normal values vary with age and sex. Adult male range is 42–52%, adult female 36–48%.

Abnormal results

Hematocrit values decrease when the size or number of red cells decrease. This is most common in anemia, but other conditions have similar effects: excessive bleeding, damaged cells due to a mechanical heart valve, **liver disease**, and cancers affecting the bone marrow. Additional tests and the person's symptoms and medical history help distinguish these conditions or diagnose a specific type of anemia. Hematocrit values increase when the size or number of red cells increase, such as in polycythemia.

Fluid volume in the blood affects the hematocrit. Pregnant women have extra fluid, which dilutes the blood, decreasing the hematocrit. **Dehydration** concentrates the blood, increasing the hematocrit.

Resources

OTHER

"Hemocrit." *Medline Plus*. http://www.nlm.nih.gov/medlineplus/ency/article/003646.htm.

Nancy J. Nordenson

Hemiplegia *see* **Paralysis**

Hemochromatosis

Definition

Hemochromatosis is an inherited blood disorder that causes the body to retain excessive amounts of iron. This iron overload can lead to serious health consequences, most notably **cirrhosis** of the liver.

Description

Hemochromatosis is also known as iron overload, bronze diabetes, hereditary hemochromatosis and familial hemochromatosis. The inherited disorder causes increased absorption of intestinal iron, well beyond that needed to replace the body's loss of iron. Iron overload diseases afflict as many as 1.5 million persons in the United States. The most common of these, as well as one of the most common genetic disorders in the United States, is hereditary hemochromatosis. Men and women are equally affected by hemochromatosis, but women are diagnosed later in life because of blood loss from menstruation and **childbirth**. It most commonly appears in patients between the ages of 40–60 years, since it takes many years for the body to accumulate excessive iron. Symptoms appear later in females than in males—usually after **menopause**.

Hemochromatosis causes excess iron storage in several organs of the body including the liver, pancreas, endocrine glands, heart, skin, joints, and intestinal lining. The buildup of iron in these organs can

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lead to serious complications, including **heart failure**, **liver cancer**, and cirrhosis of the liver. It is estimated that about 5% of cirrhosis cases are caused by hereditary hemochromatosis.

Idiopathic pulmonary hemosiderosis, a disorder afflicting children and young adults, is a similar overload disorder characterized by abnormal accumulation of hemosiderin. Hemosiderin is a protein found in most tissues, especially the liver. It is produced by digestion of hematin, an iron-related substance.

Hemochromatosis is one of the most common genetic disorders in the United States. Approximately one in nine individuals have one abnormal hemochromatosis gene (11% of the population). Since everyone has two copies of each gene, these individuals have an abnormal *HFE* gene and a normal gene. They are called carriers. Between 1/200 and 1/400 individuals have two abnormal genes for hemochromatosis and no normal gene.

With most autosomal recessive conditions, an affected person's parents are carriers. If more than one family member has the condition, they are siblings. Hemochromatosis is so common, however, that families are seen in which both parents are affected, or one parent is affected and the other parent is a carrier. More than one generation may be affected, which is not usually seen in rare autosomal recessive conditions.

Causes and symptoms

Hereditary hemochromatosis is an autosomal recessive condition. This means that individuals with hemochromatosis have inherited an altered (mutated) gene from both of their parents. Affected individuals have two abnormal hemochromatosis genes and no normal hemochromatosis gene.

The gene that causes hemochromatosis has been identified, and the most common abnormalities of the gene have been described. The gene is on chromosome 6; it is called *HFE*. Scientists have not confirmed the function of the normal gene product; they do know that it interacts with the cell receptor for transferrin. Transferrin binds and transports iron in the blood.

Because it is an autosomal recessive condition, siblings of individuals who have hemochromatosis are at a 25% risk to also be affected. However, the likelihood that an individual will develop symptoms depends on which gene mutation he or she has as well as environmental factors. The two most common changes in the *HFE* gene are *C282Y* and *H63D*. The age at which symptoms begin is variable, even within the same family.

The symptoms of hemochromatosis include **fatigue**, weight loss, weakness, **shortness of breath**, heart **palpitations**, chronic abdominal **pain**, and impaired sexual performance. The patient may also show symptoms commonly connected with heart failure, diabetes, or cirrhosis of the liver. Changes in the pigment of the skin may appear, such as grayness in certain areas or a tanned or yellow (**jaundice**) appearance. The age of onset and initial symptoms vary.

Idiopathic pulmonary hemosiderosis may first, and only, appear as paleness of the skin. Sometimes the patient will experience spitting of blood from the lungs or bronchial tubes.

Diagnosis

The most common diagnostic methods for hemochromatosis are blood studies of iron, genetic blood studies, **magnetic resonance imaging** (MRI), and **liver biopsy**. Blood studies of transferrin–iron saturation and ferritin concentration are often used to screen for iron overload. Ferritin is a protein that transports iron and liver enzymes. Additional studies are performed to confirm the diagnosis.

Blood studies used to confirm the diagnosis include additional iron studies and/or genetic blood studies. Genetic blood studies became available in the late 1990s. **Genetic testing** is a reliable method of diagnosis. However, in the year 2001 scientists and physicians began to study how accurately having a hemochromatosis mutation predicts whether a person will develop symptoms. Most individuals affected with hemochromatosis (87%) have two identifiable gene mutations; that is, genetic testing will confirm the diagnosis in most individuals. Genetic studies are also be used to determine whether the affected person's family members are at risk for hemochromatosis. The results of genetic testing are the same whether or not a person has developed symptoms.

MRI scans and/or liver biopsy may be necessary to confirm the diagnosis. MRI studies of the liver (or other iron absorbing organs), with quantitative assessment of iron concentration, may reveal abnormal iron deposits. For the liver biopsy, a thin needle is inserted into the liver while the patient is under **local anesthesia**. The needle will extract a small amount of liver tissue, which can be analyzed microscopically to measure its iron content and other signs of hemochromatosis. Diagnosis of idiopathic pulmonary hemosiderosis begins with blood tests and x ray studies of the chest.

Treatment

Patients who show signs of iron overload will often be treated with **phlebotomy**. Phlebotomy is a procedure that involves drawing blood from the patient, just like **blood donation**. Its purpose as a treatment is to rid the

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KEY TERMS

Autosomal—Relating to any chromosome besides the X and Y sex chromosomes. Human cells contain 22 pairs of autosomes and one pair of sex chromosomes.

Cirrhosis—A chronic degenerative disease of the liver, in which normal cells are replaced by fibrous tissue. Cirrhosis is a major risk factor for the later development of liver cancer.

Diabetes mellitus—The clinical name for common diabetes. It is a chronic disease characterized by inadequate production or use of insulin.

Phlebotomy—The taking of blood from the body through an incision in the vein, usually in the treatment of disease.

body of excess iron storage. Patients may need these procedures one or two times a week for a year or more. Less frequent phlebotomy may be continued in subsequent years to keep excess iron from accumulating. Patients who cannot tolerate phlebotomy due to other medical problems can be treated with Desferal (desferrioxamine). Diet restrictions may also be prescribed to limit the amount of iron ingested. Complications from hemochromatosis, such as cirrhosis or diabetes, may also require treatment. Treatment for idiopathic pulmonary hemosiderosis is based on symptoms.

Diet restrictions may help lower the amount of iron in the body, but do not prevent or treat hemochromatosis. Individuals who are affected or who know they have two *C282Y* and/or *H63D* genes may reduce iron intake by avoiding iron and mineral supplements, excess vitamin C, and uncooked seafood. If a patient is symptomatic, he/she may be advised to abstain from drinking alcohol.

Prognosis

With early detection and treatment, the prognosis is usually good. All potential symptoms are prevented if iron levels are kept within the normal range, which is possible if the diagnosis is made before an individual is symptomatic. If a patient is symptomatic but treated successfully before he/she develops liver cirrhosis, the patient's life expectancy is near normal. However, if left untreated, complications may arise which can be fatal. These include liver **cancer**, liver cirrhosis, **diabetes mellitus**, congestive heart failure, and difficulty depleting iron overload through phlebotomy. Liver biopsy can be helpful in determining prognosis of more severely affected individuals. Genetic testing may also be helpful, as variable severity has been noted in patients who have two *C282Y* genes compared to patients with two *H63D* genes or one of each. Men are two times more likely than women to develop severe complications. The prognosis for patients with idiopathic pulmonary hemosiderosis is fair, depending on detection and complications.

Prevention

Screening for hemochromatosis is cost effective, particularly for certain groups of people. Relatives of patients with hemochromatosis—including children, siblings, and parents—should be tested by the most appropriate method. The best screening method may be iron and ferritin studies or genetic testing. If the affected person's diagnosis has been confirmed by genetic testing, relatives may have genetic testing to determine whether or not they have the genetic changes present in the affected individual. Many medical groups oppose genetic testing of children. Relatives who are affected but do not have symptoms can reduce iron intake and/or begin phlebotomy prior to the onset of symptoms, possibly preventing ever becoming symptomatic.

In the winter of 2000, population screening for hereditary hemochromatosis was widely debated. Many doctors and scientists wanted population screening because hemochromatosis is easily and cheaply treated, and quite common. Arguments against treatment include the range of symptoms seen (and not seen) with certain gene mutations, and the risk of discrimination in health and life insurance. Whether or not population screening becomes favored by a majority, the publicity is beneficial. Hemochromatisis is a common, easily and effectively treated condition. However, diagnosis may be difficult because the presenting symptoms are the same as those seen with many other medical problems. The screening debate has the positive effect of increasing awareness and suspicion of hemochromatisis. Increased knowledge leads to earlier diagnosis and treatment of symptomatic individuals, and increased testing of their asymptomatic at-risk relatives.

Resources

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ORGANIZATIONS

American Liver Foundation, 75 Maiden Lane, Suite 603, New York, NY, 10038, (212) 668-1000, (212) 483-8179, http://www.liverfoundation.org/.

Hemochromatosis Foundation, PO Box 675, Taylor, SC, 29687, (864) 292-1878, (888) 565-4766 , patientservices@irondisorders.org, http://www.hemochromatosis.org.

Iron Disorders Institute, P.O. Box 675, Taylors, SC, 29687, (864) 292-1175, (864) 292-1878, (888) 565-IRON (4766), http://www.irondisorders.org.

Iron Overload Diseases Association, Inc., West Palm Beach, FL, 33405, (561) 586-8246, iod@ironoverload.org, http://www.ironoverload.org/.

The Hemochromatosis Information Center, P.O. Box 675, Taylors, SC, 29687, (864) 292-1175, (864) 292-1878, (888) 565-4766, patientservices@irondisorders.org, http://www.hemochromatosis.org/.

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Hemodialysis *see* **Dialysis, kidney**

Hemoglobin electrophoresis

Definition

Hemoglobin electrophoresis (also called Hgb electrophoresis), is a test that measures the different types of hemoglobin in the blood. The method used is called electrophoresis, a process that causes movement of particles in an electric field, resulting in formation of "bands" that separate toward one end or the other in the field.

Purpose

Hgb electrophoresis is performed when a disorder associated with abnormal hemoglobin (hemoglobinopathy) is suspected. The test is used primarily to diagnose diseases involving these abnormal forms of hemoglobin, such as sickle cell anemia and **thalassemia**.

Precautions

Blood transfusions within the previous 12 weeks may alter test results.

Description

Hemoglobin (Hgb) is comprised of many different types, the most common being A_1, A_2, F, S, and C.

Hgb A_1 is the major component of hemoglobin in the normal red blood cell. Hgb A_2 is a minor component of normal hemoglobin, comprising approximately 2–3% of the total.

Hgb F is the major hemoglobin component in the fetus, but usually exists only in minimal quantities in the normal adult. Levels of Hgb F greater than 2% in patients over three years of age are considered abnormal.

Hgb S is an abnormal form of hemoglobin associated with the disease of sickle cell anemia, which occurs predominantly in African Americans. A distinguishing characteristic of **sickle cell disease** is the crescent-shaped red blood cell. Because the survival rate of this type of cell is limited, patients with sickle cell disease also have anemia.

Hgb C is another hemoglobin variant found in African Americans. Red blood cells containing Hgb C have a decreased life span and are more readily destroyed than normal red blood cells, resulting in mild to severe **hemolytic anemia**.

Each of the major hemoglobin types has an electrical charge of a different degree, so the most useful method for separating and measuring normal and abnormal hemoglobins is electrophoresis. This process involves subjecting hemoglobin components from dissolved red blood cells to an electric field. The components then move away from each other at different rates, and when separated form a series of distinctly pigmented bands. The bands are then compared with those of a normal sample. Each band can be further assessed as a percentage of the total hemoglobin, thus indicating the severity of any abnormality.

Preparation

This test requires a blood sample. No special preparation is needed before the test.

Risks

Risks for this test are minimal, but may include slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after venipuncture, or hematoma (blood accumulating under the puncture site).

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KEY TERMS

Hemoglobin C disease—A disease of abnormal hemoglobin, occurring in 2–3% of African Americans. Only those who have two genes for the disease develop anemia, which varies in severity. Symptoms include episodes of abdominal and joint pain, an enlarged spleen and mild jaundice.

Hemoglobin H disease—A thalassemia-like syndrome causing moderate anemia and red blood cell abnormalities.

Heterozygous—Two different genes controlling a specified inherited trait.

Homozygous—Identical genes controlling a specified inherited trait.

Thalassemias—The name for a group of inherited disorders resulting from an imbalance in the production of one of the four chains of amino acids that make up hemoglobin. Thalassemias are categorized according to the amino acid chain affected. The two main types are alpha-thalassemia and beta-thalassemia. The disorders are further characterized by the presence of one defective gene (thalassemia minor) or two defective genes (thalassemia major). Symptoms vary, but include anemia, jaundice, skin ulcers, gallstones, and an enlarged spleen.

Normal results

Normal reference values can vary by laboratory, but are generally within the following ranges.

Adults:

- Hgb A_1: 95–98%
- Hgb A_2: 2–3%
- Hgb F: 0.8–2%
- Hgb S: 0%
- Hgb C: 0%.

Child (Hgb F):

- 6 months: 8%
- greater than 6 months: 1–2%
- newborn (Hgb F): 50–80%

Abnormal results

Abnormal reference values can vary by laboratory, but when they appear within these ranges, results are usually associated with the conditions that follow in parentheses.

Hgb A_2:

- 4–5.8% (β-thalassemia minor)
- under 2% (Hgb H disease)

Hgb F:

- 2–5% (β-thalassemia minor)
- 10–90% (β-thalassemia major)
- 5–35% (Heterozygous hereditary persistence of fetal hemoglobin, or HPFH)
- 100% (Homozygous HPFH)
- 15% (Homozygous Hgb S)

Homozygous Hgb S:

- 70–98% (Sickle cell disease).

Homozygous Hgb C:

- 90–98% (Hgb C disease)

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Janis O. Flores

Hemoglobin F test *see* **Fetal hemoglobin test**

Hemoglobin test

Definition

Hemoglobin is a protein inside red blood cells that carries oxygen throughout the body. A hemoglobin test reveals how much hemoglobin is in a person's blood, helping to diagnose and monitor anemia and **polycythemia vera**.

Purpose

A hemoglobin test is done when a person is ill or during a general **physical examination**. Good health requires an adequate amount of hemoglobin. The amount of oxygen in the body tissues depends on how much hemoglobin is in the red cells. Without enough hemoglobin, the tissues lack oxygen and the heart and lungs must work harder to try to compensate.

If the test indicates a "less than" or "greater than" normal amount of hemoglobin, the cause of the decrease

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or increase must be discovered. A low hemoglobin usually means the person has anemia. Anemia results from conditions that decrease the number or size of red cells, such as excessive bleeding, a dietary deficiency, destruction of cells because of a **transfusion** reaction or mechanical heart valve, or an abnormally formed hemoglobin.

A high hemoglobin may be caused by polycythemia vera, a disease in which too many red blood cells are made.

Hemoglobin levels also help determine if a person needs a blood transfusion. Usually a person's hemoglobin must be below 8 gm/dL before a transfusion is considered.

Description

Hemoglobin is made of heme, an iron compound, and globin, a protein. The iron gives blood its red color. Hemoglobin tests make use of this red color. A chemical is added to a sample of blood to make the red blood cells burst. When they burst, the red cells release hemoglobin into the surrounding fluid, coloring it clear red. By measuring the color using an instrument called a spectrophotometer, the amount of hemoglobin is determined.

Hemoglobin is often ordered as part of a **complete blood count** (CBC), a test that includes other blood cell measurements.

Some people inherit hemoglobin with an abnormal structure. These abnormal hemoglobins cause diseases, such as sickle cell or Hemoglobin C disease. Special tests, using a process called **hemoglobin electrophoresis**, identify abnormal hemoglobins.

Preparation

This test requires 5 mL of blood. A healthcare worker ties a tourniquet on the person's upper arm, locates a vein in the inner elbow region, and inserts a needle into that vein. Vacuum action draws the blood through the needle into an attached tube. Collection of the sample takes only a few minutes.

The person should avoid **smoking** before this test as smoking can increase hemoglobin levels.

Aftercare

Discomfort or bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Warm packs to the puncture site relieve discomfort.

KEY TERMS

Anemia—A condition characterized by a decrease in the size or number of red blood cells.

Hemoglobin—A protein inside red blood cells that carries oxygen to body tissues.

Polycythemia vera—A disease in which the bone marrow makes too many red blood cells.

Normal results

Normal values vary with age and sex. Women generally have lower hemoglobin values than men. Men have 14.0–18.0 g/dL, while women have levels of 12.0–16.0 g/dL.

Abnormal results

A low hemoglobin usually indicates the person has anemia. Further tests are done to discover the cause and type of anemia. Dangerously low hemoglobin levels put a person at risk of a **heart attack**, congestive **heart failure**, or **stroke**.

A high hemoglobin indicates the body is making too many red cells. Further tests are done to see if this is caused by polycythemia vera or as a reaction to illness, high altitudes, heart failure, or lung disease.

Fluid volume in the blood affects hemoglobin values. Pregnant women and people with **cirrhosis** have extra fluid, which dilutes the blood, decreasing the hemoglobin. **Dehydration** concentrates the blood, increasing the hemoglobin.

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Nancy J. Nordenson

Hemoglobinopathies

Definition

Hemoglobinopathies are genetic (inherited) disorders of hemoglobin, the oxygen-carrying protein of the red blood cells.

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Description

The hemoglobin molecule is composed of four separate polypeptide chains of amino acids, two alpha chains, and two beta chains, as well as four iron-bearing heme groups that bind oxygen. The alpha chains are coded for by two similar genes on chromosome 16; the beta chains by a single gene on chromosome 11. Mutations and deletions in these genes cause one of the many hemoglobinopathies.

In general, hemoglobinopathies are divided into those in which the gene abnormality results in a qualitative change in the hemoglobin molecule and those in which the change is quantitative. Sickle cell anemia (**sickle cell disease**) is the prime example of the former, and the group of disorders known as the **thalassemias** constitute the latter. It has been estimated that one-third of a million people worldwide are seriously affected by one of these genetic disorders.

Causes and symptoms

Sickle cell anemia (SSA), an autosomal recessive disorder more common in the Black population, is caused by a single mutation in the gene that codes for the beta polypeptide. Approximately 1/400 to 1/600 African Americans are born with the disorder, and, one in 10 is a carrier of one copy of the mutation. In certain parts of the African continent, the prevalence of the disease reaches 1 in 50 individuals.

The sickle cell mutation results in the substitution of the amino acid valine for glutamic acid in the sixth position of the beta polypeptide. In turn, this alters the conformation of the hemoglobin molecule and causes the red blood cells to assume a characteristic sickle shape under certain conditions. These sickle-shaped cells, no longer able to pass smoothly through small capillaries, can block the flow of blood. This obstruction results in symptoms including growth retardation, severe **pain** crises, tissue and organ damage, splenomegaly, and strokes. Individuals with SSA are anemic and prone to infections, particularly **pneumonia**, a significant cause of **death** in this group. Some or all of these symptoms are found in individuals who have the sickle mutation in both copies of their beta-globin gene. Persons with one abnormal gene and one normal gene are said to be carriers of the sickle cell trait. Carriers are unaffected because of the remaining normal copy of the gene.

The thalassemias are a diverse group of disorders characterized by the fact that the causative mutations result in a decrease in the amount of normal hemoglobin. Thalassemias are common in Mediterranean populations as well as in Africa, India, the Mideast, and Southeast Asia. The two main types of thalassemias are alpha-thalassemia due to mutations in the alpha polypeptide and beta-thalassemia resulting from beta chain mutations.

Since individuals possess a total of four genes for the alpha polypeptide (two genes on each of their two chromosomes 16), disease severity depends on how many of the four genes are abnormal. A defect in one or two of the genes has no clinical effect. Abnormalities of three results in a mild to moderately severe anemia (hemoglobin H disease) and splenomegaly. Loss of function of all four genes usually causes such severe oxygen deprivation that the affected fetus does not survive. A massive accumulation of fluid in the fetus (hydrops fetalis) results in **stillbirth** or neonatal death.

Beta thalassemias can range from mild and clinically insignificant (beta **thalassemia** minor) to severe and life-threatening (beta thalassemia major, also known as Cooley's anemia), depending on the exact nature of the gene mutation and whether one or both copies of the beta gene are affected. While the milder forms may only cause slight anemia, the more severe types result in growth retardation, skeletal changes, splenomegaly, vulnerability to infections, and death as early as the first decade of life.

Diagnosis

Many countries, including the United States, have made concerted efforts to screen for sickle cell anemia at birth because of the potential for beginning early treatment and counseling parents about their carrier status. Diagnosis is traditionally made by blood tests, including **hemoglobin electrophoresis**. Similar tests are used to determine whether an individual is a sickle cell or thalassemia carrier. In certain populations with a high prevalence of one of the mutations, carrier testing is common. If both members of a couple are carriers of one of these conditions, it is possible through prenatal **genetic testing** to determine if the fetus will be affected, although the severity of the disease cannot always be predicted.

Treatment

Treatment of SSA has improved greatly in recent years with a resulting increase in life expectancy. The use of prophylactic (preventative) antibiotic therapy has been particularly successful. Other treatments include fluid therapy to prevent **dehydration**, oxygen supplementation, pain relievers, blood transfusions,

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KEY TERMS

Amino acids—Organic compounds that form the building blocks of protein. There are 20 different amino acids.

Autosomal recessive—A pattern of inheritance in which both copies of an autosomal gene must be abnormal for a genetic condition or disease to occur. An autosomal gene is a gene that is located on one of the autosomes or non-sex chromosomes. When both parents have one abnormal copy of the same gene, they have a 25% chance with each pregnancy that their offspring will have the disorder.

Hemoglobin—Protein-iron compound in the blood that carries oxygen to the cells and carries carbon dioxide away from the cells.

Hydroxyurea—A drug that has been shown to induce production of fetal hemoglobin. Fetal hemoglobin has a pair of gamma-globin molecules in place of the typical beta-globins of adult hemoglobin. Higher-than-normal levels of fetal hemoglobin can prevent sickling from occurring.

Phlebotomy—Drawing blood from a vein for diagnosis or treatment. Phlebotomy is sometimes used in the treatment of hemoglobinopathies to lower the iron concentration of the blood.

Sickle cell—A red blood cell that has assumed an elongated shape due to the presence of hemoglobin S.

Splenomegaly—Enlargement of the spleen.

and several different types of medications. Recent interest has focused on **bone marrow transplantation**, which has been successful in selected patients.

Since the clinically important thalassemias are characterized by severe anemia, the traditional treatment has been blood **transfusion**, but the multiple transfusions needed to sustain life lead to an iron overload throughout the tissues of the body and eventual destruction of the heart and other organs. For this reason, transfusion therapy must also include infusions of medications such as deferoxamine (desferroxamine) to rid the body of excess iron. **Phlebotomy** is another technique that has been used with some success to lower the concentration of iron in the patient's blood. As with sickle cell anemia, bone marrow therapy has been successful in some cases.

Until very recently, patients being treated with bone marrow transplants had to find a sibling or other closely related donor in order to avoid rejection of the transplant. Advances in the preparation of the transplanted cells, however, have made the use of bone marrow from unrelated donors (URD) an option for patients with hemoglobinopathies. The National Marrow Donor Program reports that about 40% of bone marrow transplants involve a patient in the United States receiving marrow from an international donor or an international patient receiving marrow from a donor in the United States.

Emphasis is also being placed on developing drugs that treat sickle cell anemia directly. The most promising of these drugs in the late 1990s was hydroxyurea, a drug that was originally designed for anticancer treatment. Hydroxyurea has been shown to reduce the frequency of painful crises and acute chest syndrome in adults, and to lessen the need for blood transfusions. Hydroxyurea seems to work by inducing a higher production of fetal hemoglobin. The major side effects of the drug include decreased production of platelets, red blood cells, and certain white blood cells. The effects of long-term hydroxyurea treatment are unknown; however, a nine-year follow-up study of 299 adults with frequent painful crises reported in 2003 that taking hydroxyurea was associated with a 40% reduction in mortality.

Another promising development for the treatment of hemoglobinopathies is **gene therapy**, which has interested researchers since the early 1990s. In late 2001, genetic scientists reported that they had designed a gene that might lead to a future treatment of sickle cell anemia. Although the gene had not been tested in humans, early results showed that the injected gene protected cells from sickling. Experiments in gene therapy for sickle cell disease have been carried out in mice, using lentiviral vectors to transfer the corrective gene into the mouse's stem cells. This technique, however, has not yet been attempted in human subjects.

Prognosis

Hemoglobinopathies are life-long disorders. The prognosis depends upon the exact nature of the mutation and the availability of effective treatment, as well as the individual's compliance with therapies. Hemoglobinopathies significantly complicate **pregnancy** and increase the risk of infant mortality.

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Prevention

Because the hemoglobinopathies are inherited diseases, primary prevention involves carriers making reproductive decisions to prevent passage of the abnormal gene to their offspring. At present, most prevention is targeted toward the symptoms using treatments such as those described above.

Resources

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ORGANIZATIONS

American Sickle Cell Anemia Association, Cleavand Clinic, 10681 Carnegie Avenue, Cleveland, OH, 44106, (216) 229-8600, (216) 229-4500, http://www.ascaa.org/.

National Marrow Donor Program, 3001 Broadway Street Northeast, Suite 100, Minneapolis, MN, 55413-1753, (800) 627-7692, patientinfo@nmdp.org, https://www.marrow-donor.org.

Sickle Cell Disease Association of America, Inc., 231 East Baltimore Street, STE 800, Baltimore, MD, 21202, (800)421-8453, scdaa@sicklecelldisease.org, http://sicklecelldisease.org.

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Hemolytic-uremic syndrome

Definition

Hemolytic-uremic syndrome (HUS) is a rare condition that affects mostly children under the age of 10, but also may affect the elderly as well as persons with other illnesses. HUS, which most commonly develops after a severe bowel infection with certain toxic strains of a bacteria, is characterized by destruction of red blood cells, damage to the lining of blood vessel walls, and in severe cases, kidney failure.

Description

Most cases of HUS occur after an infection in the digestive system that has been caused by toxin-producing strains of the bacterium ***Escherichia coli***. About 75% of HUS cases in the United States are caused by the strain referred to as *E. coli* O157:H7, which is found in the intestinal tract of cattle, while the remaining cases are caused by non-O157 strains. Some children infected with *E. coli* O157:H7 will develop HUS. HUS also can follow respiratory infection episodes in young children. In the United States, there are about 20,000 infections and 250 deaths annually that are caused by *E. coli* O157:H7. HUS has also been known to occur in persons using drugs such as **oral contraceptives**, immunosuppressors, and antineoplastics and in women during the postpartum period.

E. coli. O157:H7, first identified in 1982 and isolated with increasing frequency since then, is found in contaminated foods such as meat, dairy products, and juices. Infection with *E. coli*. O157:H7 causes severe **gastroenteritis**, which can include abdominal **pain**, **vomiting**, and bloody **diarrhea**. For most children, the vomiting and diarrhea stop within two to three days. However, about 5 to 10% of the children will develop HUS and will become pale, tired, and irritable. Toxins produced by the bacteria enter the blood stream, where they destroy red blood cells and platelets, which contribute to the clotting of blood. The damaged red blood cells and platelets clog tiny blood vessels in the kidneys, or form lesions in the kidneys, making it difficult for the kidneys to remove wastes and extra fluid from the body, resulting in **hypertension**, fluid accumulation, and reduced production of urine.

Causes and symptoms

The most common way an *E. coli* O157:H7 infection is contracted is through the consumption of undercooked ground beef (e.g., eating hamburgers that are

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still pink inside). Healthy cattle carry *E. coli* within their intestines. During the slaughtering process, the meat can become contaminated with the *E. coli* from the intestines. When contaminated beef is ground up, the *E. coli* bacteria are spread throughout the meat. Additional ways to contract an *E. coli* infection include drinking contaminated water and unpasteurized milk and juices, eating contaminated fruits and vegetables, and working with cattle. The infection is also easily transmitted from an infected person to others in settings such as day care centers and nursing homes when improper sanitary practices are used.

Symptoms of an *E. coli* O157:H7 infection start about seven days after infection with the bacteria. The first symptom is sudden onset of severe abdominal cramps. After a few hours, watery diarrhea starts, causing loss of fluids and electrolytes (**dehydration**), which causes the person to feel tired and ill. The watery diarrhea lasts for about a day, and then changes to bright red bloody stools, as the infection causes sores to form in the intestines. The bloody diarrhea lasts for two to five days, with as many as 10 bowel movements a day. Additional symptoms may include **nausea** and vomiting, without a **fever**, or with only a mild fever. After about 5 to 10 days, HUS can develop, which is characterized by paleness, irritability, and **fatigue**, as well as reduced urine production.

Diagnosis

The diagnosis of an *E. coli* infection is made through a **stool culture**. The culture must be taken within the first 48 hours after the start of the bloody diarrhea. If a positive culture is obtained, the patient should be monitored for the development of HUS, with treatment initiated as required.

Children should not go to day care until they have had two negative stool cultures. Older people in nursing homes should stay in bed until two stool cultures are negative.

Treatment

Treatment of HUS is supportive, with particular attention to management of fluids and electrolytes. Treatment generally is provided in a hospital setting. Blood transfusions may be required. In about 50% of the cases, short term replacement of kidney function is required in the form of dialysis. Most patients will recover kidney function and be able to discontinue dialysis.

Some studies have shown that the use of **antibiotics** and antimotility agents during an *E. coli* infection may worsen the course of the infection and should be avoided. However, other studies have been less definitive. Physicians should stay informed so that clinical practices matches medical advances on this aspect of treatment.

KEY TERMS

Antineoplastics—Agents that inhibit or prevent the development, maturation, and proliferation of malignant cells.

Gastroenteritis—An acute inflammation of the lining of the stomach and intestines, characterized by nausea, diarrhea, abdominal pain and weakness, which has various causes, including food poisoning due to infection with such organisms as *Escherichia coli*, *Staphylococcus aureus*, and *Salmonella* species, consumption of irritating food or drink, or psychological factors, such as anger, stress and fear.

Alternative treatment

Persons with HUS must be under the care of health care professionals skilled in the treatment of HUS.

Prognosis

Ninety percent of children with HUS who receive careful supportive care survive the initial acute stages of the condition, with most having no long-term effects. However, between 10 and 30% of survivors will have kidney damage that will lead to kidney failure immediately or within several years. The children with kidney failure require on-going dialysis to remove waste and extra fluids from their bodies, or may require a kidney transplant.

Prevention

Prevention of HUS caused by ingestion of foods contaminated with *E. coli* O157:H7 and other toxin-producing bacteria is accomplished through practicing hygienic food preparation techniques, including adequate handwashing, cooking of meat thoroughly, defrosting meats safely, vigorous washing of fruits and vegetables, and handling leftovers properly. Irradiation of meat has been approved by the United States Food and Drug Administration and the United States Department of Agriculture in order to decrease bacterial contamination of consumer meat supplies.

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Judith Sims

Hemolytic anemia

Definition

Red blood cells have a normal life span of approximately 90–120 days, at which time the old cells are destroyed and replaced by the body's natural processes. Hemolytic anemia is a disorder in which the red blood cells are destroyed prematurely. The cells are broken down at a faster rate than the bone marrow can produce new cells. Hemoglobin, the component of red blood cells that carries oxygen, is released when these cells are destroyed.

Description

As a group, **anemias** (conditions in which the number of red blood cells or the amount of hemoglobin in them is below normal) are the most common blood disorders. Hemolytic anemias, which result from the increased destruction of red blood cells, are less common than anemias caused by excessive blood loss or by decreased hemoglobin or red cell production.

Since a number of factors can increase red blood cell destruction, hemolytic anemias are generally identified by the disorder that brings about the premature destruction. Those disorders are classified as either inherited or acquired. Inherited hemolytic anemias are caused by inborn defects in components of the red blood cells—the cell membrane, the enzymes, or the hemoglobin. Acquired hemolytic anemias are those that result from various other causes. With this type, red cells are produced normally, but are prematurely destroyed because of damage that occurs to them in the circulation.

Causes and symptoms

Inherited hemolytic anemias involve conditions that interfere with normal red blood cell production. Disorders that affect the red blood cell membrane include hereditary spherocytosis, in which the normally disk-shaped red cells become spherical, and hereditary elliptocytosis, in which the cells are oval, rather than disk-shaped. Other hereditary conditions that cause hemolytic anemia include disorders of the hemoglobin, such as sickle cell anemia and **thalassemia**, and red blood cell enzyme deficiencies, such as G6PD deficiency.

The causes of acquired hemolytic anemias vary, but the most common are responses to certain medications and infections. Medications may cause the body to develop antibodies that bind to the red blood cells and cause their destruction in the spleen. Immune hemolytic anemia most commonly involves antibodies that react against the red blood cells at body temperature (warm-antibody hemolytic anemia), which can cause premature destruction of the cells. About 20% of hemolytic anemias caused by warm antibodies come from diseases such as lymphocytic leukemia, 10% from an autoimmune disease, and others are drug-induced. Cold-antibody hemolytic anemia is a condition in which the antibodies react with the red blood cells at a temperature below that of normal body temperature. Red blood cells can also receive mechanical damage as they circulate through the blood vessels. Aneurysms, artificial heart valves, or very high blood pressure can cause the red cells to break up and release their contents. In addition, hemolytic anemia may be caused by a condition called **hypersplenism**, in which a large, overactive spleen rapidly destroys red blood cells.

Major symptoms of hemolytic anemias are similar to those for all anemias, including **shortness of breath**; noticeable increase in heart rate, especially with exertion; **fatigue**; pale appearance; and dark urine. A yellow tint, or **jaundice**, may be seen in the skin or eyes of hemolytic anemia patients. Examination may also show an enlarged spleen. A more emergent symptom of hemolytic anemia is **pain** in the upper abdomen. Severe anemia is indicated if there are signs of **heart failure** or an enlarged liver.

Diagnosis

In order to differentiate hemolytic anemia from others, physicians will examine the blood for the number of young red blood cells, since the number of young cells is increased in hemolytic anemia. The physician will also examine the abdominal area to check for spleen or liver enlargement. If the physician knows the duration of hemolysis, it may also help differentiate between types of anemia. There are a number of other indications that can be obtained from blood samples

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KEY TERMS

Antibody—Antibodies are parts of the immune system which counteract or eliminate foreign substances or antigens.

Erythrocyte—The name for red blood cells or red blood corpuscles. These components of the blood are responsible for carrying oxygen to tissues and removing carbon dioxide from tissues.

Hemolysis—The process of breaking down red blood cells. As the cells are destroyed, hemoglobin, the component of red blood cells which carries the oxygen, is liberated.

Thalassemia—One of a group of inherited blood disorders characterized by a defect in the metabolism of hemoglobin, or the portion of the red blood cells that transports oxygen throughout the blood stream.

that will help a physician screen for hemolytic anemia. An antiglobulin (Coomb's) test may be performed as the initial screening exam after determining hemolysis. In the case of immune hemolytic anemia, a direct Coomb's test is almost always positive.

Treatment

Treatment will depend on the cause of the anemia and may involve treatment of the underlying cause. If the hemolytic anemia was brought on by hereditary spherocytosis, the spleen may be removed. Corticosteroid medications, or adrenal **steroids**, may be effective, especially in hemolytic anemia due to antibodies. If the cause of the disorder is a medication, the medication should be stopped. When anemia is severe in conditions such as sickle cell anemia and thalassemia, blood transfusions may be indicated.

Prognosis

Hemolytic anemias are seldom fatal. However, if left untreated, hemolytic anemia can lead to heart failure or liver complications.

Prevention

Hemolytic anemia due to inherited disorders can not be prevented. Acquired hemolytic anemia may be prevented if the underlying disorder is managed properly.

ORGANIZATIONS

American Autoimmune Related Diseases Association, Inc., 22100 Gratiot Avenue, Eastpointe, MI, 48021, (586) 776-3900, (586) 776-3903, http://www.aarda.org.

American Society of Hematology, 2021 L St. NW, Suite 900, Washington, DC, 20036, (202) 776-0544, (202) 776-0545, http://www.hematology.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

Teresa Odle

Hemophilia

Definition

Hemophilia is a coagulation disorder arising from a genetic defect of the X chromosome; the defect can either be inherited or result from spontaneous gene mutation. In each type of hemophilia (hemophilias A, B, and C), a critical coagulation protein is missing, causing individuals to bleed for long periods of time before clotting occurs. Depending on the degree of the disorder in the affected individual, uncontrolled bleeding may occur spontaneously with no known initiating event or occur after specific events, such as surgery, dental procedures, immunizations, or injury.

Demographics

According to the National Heart, Lung, and Blood Institute (NHLBI), hemophilia affects about 18,000 people in the United States, and each year about 400 babies are born with the disorder, which usually occurs only in males with very rare exceptions. Worldwide, hemophilia A is the most common type of the disorder with about 1 in 4,000 males born with the disorder. As for hemophilia B, it occurs approximately in 1 of 20,000 newborn males. In 2008, an Orphanet report estimated the European prevalence of hemophilia at 7.7 per 100,000 persons. The mortality rate for patients with hemophilia is twice that of the healthy male population. For severe hemophilia, the rate is increased 4–6 times.

Hemophilia A and B are observed in all ethnic and racial groups, with some prevalence reported in Chinese populations.

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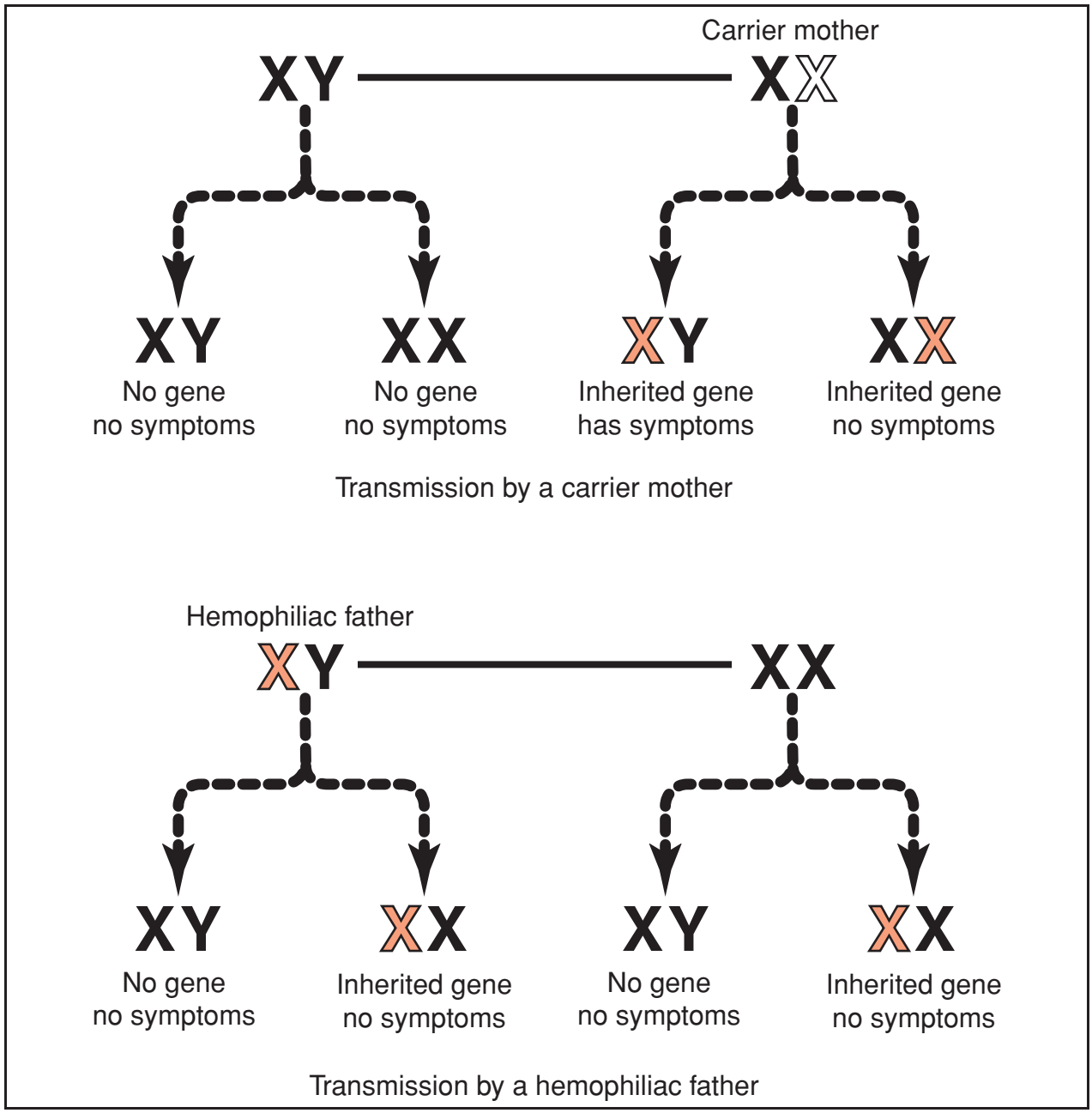

Hemophilia A and B are both caused by a genetic defect present on the X chromosome. Approximately 70% of people with hemophilia A or B inherited the disease, while the remaining 30% have hemophilia due to a spontaneous genetic mutation. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Description

The normal mechanism for blood clotting is a complex series of events (coagulation cascade) involving interaction between the injured blood vessel, blood cells called platelets, 13 specific coagulation factors (designated by Roman numerals I through XIII), and other substances that circulate in the blood.

When a blood vessel is injured in a way that causes bleeding, platelets collect over the injured area, and form a temporary plug to prevent further bleeding. This temporary plug, however, is too disorganized to serve as a long–term solution, so a series of chemical events occur, resulting in the formation of a more reliable plug. The final plug involves tightly woven fibers of a material called fibrin. The production of fibrin

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requires the interaction of several chemicals, in particular a series of proteins called clotting factors. At least 13 different clotting factors have been identified.

The clotting cascade, as it is usually called, is the series of events required to form the final fibrin clot. The cascade uses a technique called amplification to rapidly produce the proper sized fibrin clot from the small number of molecules initially activated by the injury.

In hemophilia, certain clotting factors are either decreased in quantity, absent, or improperly formed. Because the clotting cascade uses amplification to rapidly plug up a bleeding area, absence or inactivity of just one clotting factor can greatly increase **bleeding time**.

Hemophilia A is the most common type of bleeding disorder and involves decreased activity of factor VIII. There are three levels of factor VIII deficiency: severe, moderate, and mild. This classification is based on the percentage of normal factor VIII activity present:

- Individuals with less than 1% of normal factor VIII activity level have severe hemophilia. Half of all people with hemophilia A fall into this category. Such individuals frequently experience spontaneous bleeding, most frequently into their joints, skin, and muscles. Surgery or trauma can result in life–threatening hemorrhage and must be carefully managed.
- Individuals with 1–5% of normal factor VIII activity level have moderate hemophilia and are at risk for heavy bleeding after seemingly minor traumatic injury.
- Individuals with 5–40% of normal factor VIII activity level have mild hemophilia, and must prepare carefully for any surgery or dental procedures.

Individuals with hemophilia B have symptoms very similar to those of hemophilia A, but the deficient factor is factor IX. This type of hemophilia is also known as Christmas disease.

Hemophilia C is very rare and is much more mild than hemophilia A or B; it involves factor XI.

Risk factors

Hemophilia is a genetic disorder, which is usually inherited. The hemophilia gene is passed down from a parent to a child. Individuals with a family history of the condition are accordingly at higher risk for hemophilia.

Causes and symptoms

Hemophilia A and B are both caused by a genetic defect present on the X chromosome. (Hemophilia C is inherited in a different fashion.) About 70% of all people with hemophilia A or B inherited the disease. The other 30% develop from a spontaneous genetic mutation.

The following concepts are important to understanding the inheritance of these diseases. All humans have two chromosomes determining their gender: females have XX, males have XY. Because the trait is carried only on the X chromosome, it is called "sex–linked." The chromosome's flawed unit is referred to as the gene.

Both factors VIII and IX are produced by a genetic defect of the X chromosome, so hemophilia A and B are both sex–linked diseases. Because a female child always receives two X chromosomes, she nearly always will receive at least one normal X chromosome. Therefore, even if she receives one flawed X chromosome, she will still be capable of producing a sufficient quantity of factors VIII and IX to avoid the symptoms of hemophilia. Such a person who has one flawed chromosome, but does not actually suffer from the disease, is called a carrier. She carries the flaw that causes hemophilia and can pass it on to her offspring. If, however, she has a son who receives her flawed X chromosome, he will be unable to produce the right quantity of factors VIII or IX, and he will suffer some degree of hemophilia. (Males inherit one X and one Y chromosome, and therefore have only one X chromosome.)

In rare cases, a hemophiliac father and a carrier mother can pass on the right combination of parental chromosomes to result in a hemophiliac female child. This situation, however, is rare. The vast majority of people with either hemophilia A or B are male.

About 30% of all people with hemophilia A or B are the first member of their family to ever have the disease. These individuals have had the unfortunate occurrence of a spontaneous mutation, meaning that in their early development, some random genetic accident befell their X chromosome, resulting in the defect causing hemophilia A or B. Once such a spontaneous genetic mutation takes place, offspring of the affected person can inherit the newly–created, flawed chromosome.

In the case of severe hemophilia, the first bleeding event usually occurs prior to 18 months of age. In some babies, hemophilia is suspected immediately, when a routine **circumcision** (removal of the foreskin of the penis) results in unusually heavy bleeding. Toddlers are at particular risk, because they fall frequently and may bleed into the soft tissue of their arms and legs. These small bleeds result in bruising and noticeable lumps, but don't usually need treatment. As a child becomes more active, bleeding may occur

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KEY TERMS

Amplification—A process by which something is made larger. In clotting, only a very few chemicals are released by the initial injury; they result in a cascade of chemical reactions which produces increasingly larger quantities of different chemicals, resulting in an appropriately–sized, strong fibrin clot.

Coagulation—Blood clotting.

Coagulation factors—Specific coagulation proteins in the blood required for clotting. Coagulation proteins are designated with roman numerals I through XIII.

Factors—Coagulation factors are substances in the blood, such as proteins and minerals, that are necessary for clotting. Each clotting substance is designated with roman numerals I through XIII.

Fibrin—The final substance created through the clotting cascade, which provides a strong, reliable plug to prevent further bleeding from the initial injury.

Hemorrhage—Very severe, massive bleeding that is difficult to control. Hemorrhage can occur in hemophiliacs after what would be a relatively minor injury to a person with normal clotting factors.

Mutation—A permanent change in the genetic material that may alter a trait or characteristic of an individual, or manifest as disease, and can be transmitted to offspring.

Platelets—Small disc–shaped structures that circulate in the blood stream and participate in blood clotting.

Trauma—Injury.

into the muscles, which is a much more painful and debilitating problem. These muscle bleeds result in **pain** and pressure on the nerves in the area of the bleed. Damage to nerves can cause **numbness** and decreased ability to use the injured limb.

Some of the most problematic and frequent bleeds occur into the joints, particularly into the knees and elbows. Repeated bleeding into joints can result in scarring within the joints and permanent deformities. Individuals may develop arthritis in joints that have suffered continued irritation from the presence of blood. Mouth injuries can result in compression of the airway, and, therefore, can be life–threatening. A blow to the head, which might be totally insignificant in a normal individual, can result in bleeding into the skull and brain. Because the skull has no room for expansion, the hemophiliac is at risk for brain damage due to blood taking up space and exerting pressure on the delicate brain tissue.

People with hemophilia are at very high risk of hemorrhage (severe, heavy, uncontrollable bleeding) from injuries, such as motor vehicle accidents, and also from surgery.

Some other rare clotting disorders such as **Von Willebrand disease** present similar symptoms but are not usually called hemophilia.

Diagnosis

Examination

If hemophilia is suspected, or if a person has a bleeding problem, a physician typically takes personal and family medical histories to establish whether the family has a history of frequent or heavy bleeding and bruising.

Tests

Various tests are available to measure, under very carefully controlled conditions, the length of time it takes to produce certain components of the final fibrin clot. The activated **partial thromboplastin time** (APTT) is performed and will typically be prolonged while a **prothrombin time** (PT) will likely be normal. Factor assays, which are measurement methods performed by the clinical laboratory, can determine the percentage of factors VIII and IX present compared to normal percentages. This information helps to confirm a diagnosis of hemophilia and identifies the type and severity of hemophilia present.

Hemophilia A and B are classified as mild, moderate, or severe, depending on the amount of clotting factor VIII or IX in the blood. Mild hemophilia is diagnosed if 5–30% of the normal clotting factors are present. With 1–5% of the normal clotting factors present, the haemophilia is diagnosed as moderate, and as severe when less than 1% of the normal clotting factors are present.

Procedures

Individuals with a family history of hemophilia may benefit from **genetic counseling** before deciding to have a baby. Families with a positive history of hemophilia can also have tests done during a

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pregnancy to determine whether the fetus is a hemophiliac. A test called chorionic villius sampling examines proteins for the defects that lead to hemophilia. This test, which is associated with a 1% risk of **miscarriage**, can be performed at 10–12 weeks. A test called **amniocentesis** examines the DNA of fetal cells shed into the amniotic fluid for genetic mutations. Amniocentesis, which is associated with a 1 in 200 risk of miscarriage, is performed at 16–18 weeks gestation.

Treatment

Traditional

The most important thing that individuals with hemophilia can do to prevent complications of his disease is to avoid injury. This is accomplished with replacement therapy to replace the clotting factor that is missing or present in low amounts. Hemophiliacs are also typically vaccinated against hepatitis.

In replacement therapy, various types of factors VIII and IX are available to replace a patient's missing factors. These are administered intravenously (directly into the patient's veins by needle). Cryoprecipitate, for example, is a single– or multiple–donor human plasma preparation rich in coagulation factors; it is available as a frozen concentrate. Fresh frozen plasma is a single–donor preparation of factor–rich plasma; it is used primarily for replacing factor XI in individuals with hemophilia C. Concentrated factor preparations may be obtained from a single donor by pooling the donations of as many as thousands of donors or by laboratory creation through highly advanced genetic techniques. These preparations are administered directly into the individual's veins (intravenous administration). In 2008, the United States Food and Drug Administration (FDA) approved a new formulation of the genetically engineered version of Factor VIIa that can be stored at room temperature for up to two years.

The frequency of treatment with factors depends on the severity of the individual patient's disease. Patients with relatively mild disease will only require treatment in the event of injury, or to prepare for scheduled surgical or dental procedures. Patients with more severe disease will require regular treatment to avoid spontaneous bleeding.

While appropriate treatment of hemophilia can both decrease suffering and be life–saving, complications associated with treatment can also be quite serious. About 20% of all patients with hemophilia A begin to produce chemicals in their bodies which rapidly destroy infused factor VIII. The presence of such a chemical may greatly hamper efforts to prevent or stop a major hemorrhage.

Individuals who receive factor prepared from pooled donor blood are at risk for serious infections that may be passed through blood. Hepatitis, a severe and potentially fatal viral liver infection, may be contracted from pooled factor preparations. Recently, a good deal of concern has been raised about the possibility of hemophiliacs contracting a fatal slow virus infection of the brain (Creutzfeldt–Jakob disease) from blood products. Unfortunately, pooled factor preparations in the early 1980s were contaminated with human **immunodeficiency** virus (HIV), the virus which causes **AIDS**. A large number of hemophiliacs were infected with HIV and some statistics show that HIV is still the leading cause of **death** among hemophiliacs. Currently, careful methods of donor testing, as well as methods of inactivating viruses present in donated blood, have greatly lowered this risk.

Drugs

Desmopressin (DDAVP) is a synthetic hormone used in the treatment of mild to moderate hemophilia A. DDAVP is not used to treat hemophilia B or severe hemophilia A. DDAVP usually is given by injection or as nasal spray. Since it wears off when used often, DDAVP is given only in specific situations. For example, before dental work or before certain physical activities to prevent or reduce bleeding. Antifibrinolytic medicines, such as tranexamic acid and aminocaproic acid, may also be used with replacement therapy. These medications are typically used before dental work or to treat bleeding from the mouth or nose or mild intestinal bleeding.

Medications or drugs that promote bleeding, such as **aspirin**, should be avoided.

Alternative

The most exciting new treatments currently being researched involve efforts to transfer new genes to hemophiliacs. These new genes would have the ability to produce the missing factors. As yet, these techniques are not being performed on humans, but there is great hope that eventually this type of **gene therapy** will be available.

Clinical trials for the treatment of hemophilia are currently sponsored by the National Institutes of Health (NIH) and other agencies. In 2009, NIH reported 196 on–going or recently completed studies. Some examples include the following:

- The evaluation of the safety of gene transfer for the treatment of severe hemophilia B. (NCT00076557)

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- The study of musculoskeletal function in people with hemophilia in developing countries. (NCT00324493)
- The study of allergic reactions to factor IX in patients with hemophilia B. (NCT00195221)
- A study evaluating inhibitor specificity in hemophilia A. (NCT00151385)

Clinical trial information is constantly updated by NIH and the most recent information on hemophilia trials can be found at: http://clinicaltrials.gov/ct2/results?term=hemophilia

Home remedies

At home, certain steps can help avoid excessive bleeding. They include regular **exercise** to build up muscles and protect joints, avoiding aspirin and nonsteroidal anti–inflammatory drugs (Advil, Motrin, others) that can aggravate bleeding, practising good dental hygiene to avoid having teeth pulled out, and using protective equipment in sports and physical activities to minimize injuries.

Prognosis

Prognosis is very difficult to generalize. Because there are so many variations in the severity of hemophilia and because much of what befalls a hemophiliac patient will depend on issues such as physical activity level and accidental injuries, statistics on prognosis are not generally available.

Prevention

Because of its genetic origins, hemophilia cannot be prevented in those born with the inherited defects or factor deficiencies. However, individuals who have a family history of hemophilia may benefit from **genetic testing** and counseling before deciding to have a baby. The most important way for individuals with hemophilia to prevent complications of the disease is to avoid activities that may lead to injury. Those individuals who require dental work or any type of surgery may need to be pre–treated with an infusion of factor VIII to avoid hemorrhage. Hemophiliacs should also avoid medications or drugs that promote bleeding; aspirin is one such medication, and many prescription drugs have anticoagulant properties.

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American Society of Pediatric Hematology and Oncology (ASPHO), 4700 W. Lake Ave., Glenview, IL, 60025, (847) 375-4716, info@aspho.org, http://www.aspho.org.

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National Heart, Lung, and Blood Institute (NHLBI), P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi.nih.gov.

National Hemophilia Foundation, 116 West 32nd St., 11th Floor, New York, NY, 10001, (212) 328-3700, (212) 328-3777, handi@hemophilia.org, http://www.hemophilia.org.

World Federation of Hemophilia, 1425 René Lévesque Blvd. W., Suite 1010, MontréalQC, Canada, H3G 1T7, (514) 875-7944, (514) 875-8916, wfh@wfh.org, http://www.wfh.org.

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Hemophilus ducreyi infection *see* **Chancroid**

Hemophilus infections

Definition

Hemophilus infections, most of which are due to *Haemophilus influenzae* infections, are a group of contagious diseases that are caused by a gram-negative bacterium and affect only humans. Some hemophilus infections are potentially fatal.

Description

H. influenzae is a common organism worldwide; it has been found in the nasal secretions of as many as 90% of healthy individuals in the general population. Hemophilus infections are characterized by acute inflammation with a discharge (exudate). They may affect almost any organ system, but are most common in the respiratory tract. The organism can be transmitted by person-to-person contact or by contact with nasal discharges and other body fluids. Hemophilus infections in the United States are most likely to spread in the late winter or early spring.

The primary factor influencing the rate of infection is age; children between the ages of six months and four years are most vulnerable to *H. influenzae*. In previous years, about 50% of children would acquire a hemophilus infection before reaching one year of age; almost all children would develop one before age three. These figures are declining, however, as a result of the increasing use of hemophilus vaccines for children.

Adults are also susceptible to hemophilus diseases. *H. influenzae*pneumonia is a common nosocomial infection (illnesses contracted in hospitals). The rate of hemophilus infections in the adult population has increased over the past 40 years. The reasons for this change are unclear, but some researchers speculate that the overuse of **antibiotics** has led to the development of drug-resistant strains of *H. influenzae*. The risk factors for hemophilus infections among adults include:

- smoking
- alcoholism
- chronic lung disease
- old age
- living in a city or institutional housing with a large group of people
- poor nutrition and hygiene
- hIV infection or other immune system disorder

Causes and symptoms

Hemophilus infections are primarily caused by *Haemophilus influenzae*, a gram-negative bacterium that is capable of spreading from the nasal tissues and upper airway, where it is usually found, to the chest, throat, or middle ear. The organism sometimes invades localized areas of tissue, producing **meningitis**, **infectious arthritis**, **conjunctivitis**, **cellulitis**, **epiglottitis**, or inflammation of the membrane surrounding the heart. The most serious infections are caused by a strain called *H. influenzae* b (Hib). Before routine **vaccination**, Hib was the most common cause of bacterial meningitis and was responsible for most of the cases of acquired **mental retardation** in the United States.

Hemophilus infections in children

BACTERIAL SEPSIS IN THE NEWBORN. Bacterial **sepsis** (the presence of illness-causing microorganisms, or their poisons, in the blood) is a potentially fatal illness in newborn infants. The child may acquire the disease organism as it passes through the mother's birth canal or from the hospital environment. *H. influenzae* can also produce inflammations of the eye (conjunctivitis) in newborn children. The signs of sepsis may include **fever**, crankiness, feeding problems, breathing difficulties, pale or mottled skin, or drowsiness. Premature birth is the most significant risk factor for hemophilus infections in newborns.

EPIGLOTTITIS. Epiglottitis is a potentially fatal hemophilus infection. Although children are more likely to develop epiglottitis, it can occur in adults as well. When the epiglottis (a piece of cartilage behind the tongue which protects the opening to the windpipe by opening and closing) is infected, it can swell to the point where it blocks the windpipe. The symptoms of

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epiglottitis include a sudden high fever, drooling, the feeling of an object stuck in the throat, and **stridor**. The epiglottis will look swollen and bright red if the doctor examines the patient's throat with a laryngoscope (a viewing device).

MENINGITIS. Meningitis caused by Hib is most common in children between nine months and four years of age. The child usually develops upper respiratory symptoms followed by fever, loss of appetite, **vomiting**, **headache**, and a stiff or sore neck or back. In severe cases, the child may have convulsions or go into **shock** or **coma**.

OTHER INFECTIONS. Hib is the second most common cause of middle ear infection and **sinusitis** in children. The symptoms of sinusitis include fever, **pain**, **bad breath**, and coughing. Children may also develop infectious arthritis from Hib. The joints most frequently affected are the large weight-bearing joints.

Hemophilus infections in adults

PNEUMONIA. Hib **pneumonia** is the most common hemophilus infection in adults. The symptoms include **empyema** (sputum containing pus) and fever. The hemophilus organism can usually be identified from sputum samples. Hib pneumonia is increasingly common in the elderly.

MENINGITIS. Meningitis caused by Hib can develop in adults as a complication of an ear infection or sinusitis. The symptoms are similar to those in children but are usually less severe in adults.

Diagnosis

The diagnosis is usually based on a combination of the patient's symptoms and the results of blood counts, cultures, or antigen detection tests.

Laboratory tests

Laboratory tests can be used to confirm the diagnosis of hemophilus infections. The bacterium can be grown on chocolate agar or identified by blood cultures or Gram stain of body fluids. Antigen detection tests can be used to identify hemophilus infections in children. These tests include latex agglutination and electrophoresis.

Other laboratory findings that are associated with hemophilus infections include anemia (low red blood cell count) and a drop in the number of white blood cells in children with severe infections. Adults often show an abnormally high level of white blood cells; cell counts of 15,000–30,000/mm^3 are not unusual.

Treatment

Because some hemophilus infections are potentially fatal, treatment is started without waiting for the results of laboratory tests.

Medications

Hemophilus infections are treated with antibiotics. Patients who are severely ill are given ampicillin or a third-generation cephalosporin, such as cefotaxime or ceftriaxone, intravenously. Patients with milder infections are given oral antibiotics, including amoxicillin, cefaclor, erythromycin, or trimethoprim-sulfamethoxazole. Patients who are allergic to penicillin are usually given cefaclor or trimethoprim-sulfamethoxazole.

Patients with Hib strains that are resistant to ampicillin may be given chloramphenicol. Chloramphenicol is not a first-choice drug because of its side effects, including interference with bone marrow production of blood cells.

The duration of antibiotic treatment depends on the location and severity of the hemophilus infection. Adults with respiratory tract infections, or Hib pneumonia, are usually given a 10–14 day course of antibiotics. Meningitis is usually treated for 10–14 days, but a seven-day course of treatment with ceftriaxone appears to be sufficient for infants and children. Ear infections are treated for 7 to 10 days.

Supportive care

Patients with serious hemophilus infections require bed rest and a humidified environment (such as a **croup** tent) if the respiratory tract is affected. Patients with epiglottitis frequently require intubation (insertion of a breathing tube) or a **tracheotomy** to keep the airway open. Patients with inflammation of the heart membrane, pneumonia, or arthritis may need surgical treatment to drain infected fluid from the chest cavity or inflamed joints.

Supportive care also includes monitoring of blood cell counts for patients using chloramphenicol, ampicillin, or other drugs that may affect production of blood cells by the bone marrow.

Prognosis

The most important factors in the prognosis are the severity of the infection and promptness of treatment. Untreated hemophilus infections—particularly meningitis, sepsis, and epiglottitis—have a high mortality rate. Bacterial sepsis of the newborn has a mortality rate between 13 and 50%. The prognosis is usually good for patients with mild infections who are treated

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KEY TERMS

Bacterium—A microscopic one-celled organism. *Haemophilus influenzae* is a specific bacterium.

Epiglottitis—Inflammation of the epiglottis. The epiglottis is a piece of cartilage behind the tongue that closes the opening to the windpipe when a person swallows. An inflamed epiglottis can swell and close off the windpipe, thus causing the patient to suffocate.

Exudate—A discharge produced by the body. Some exudates are caused by infections.

Gram-negative—A term that means that a bacterium will not retain the violet color when stained with Gram's dye. *Haemophilus influenzae* is a gram-negative bacterium.

Intubation—The insertion of a tube into the patient's airway to protect the airway from collapsing. Intubation is sometimes done as an emergency procedure for patients with epiglottitis.

Nosocomial—Contracted in a hospital. Pneumonia caused by *H. influenzae* is an example of a nosocomial infection.

Sepsis—Invasion of body tissues by disease organisms or their toxins. Sepsis may be either localized or generalized. *Haemophilus influenzae* can cause bacterial sepsis in newborns.

Stridor—A harsh or crowing breath sound caused by partial blockage of the patient's upper airway.

Tracheotomy—An emergency procedure in which the surgeon cuts directly through the patient's neck into the windpipe in order to keep the airway open.

without delay. Children who develop Hib arthritis sometimes have lasting problems with joint function.

Prevention

Hemophilus vaccines

There are three different vaccines for hemophilus infections used to immunize children in the United States: PRP-D, HBOC, and PRP-OMP. PRP-D is used only in children older than 15 months. HBOC is administered to infants at two, four, and six months after birth, with a booster dose at 15–18 months. PRP-OMP is administered to infants at two and four months, with the third dose at the child's first birthday. All three vaccines are given by intramuscular injection. About 5% of children may develop a fever or soreness in the area of the injection.

Other measures

Other preventive measures include isolating patients with respiratory hemophilus infections; treating appropriate contacts of infected patients with rifampin; maintaining careful standards of cleanliness in hospitals, including proper disposal of soiled tissues; and washing hands properly.

Resources

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Rebecca J. Frey, PhD

Hemophilus influenzae infections *see* **Hemophilus infections**

Hemoptysis

Definition

Hemoptysis is the coughing up of blood or bloody sputum from the lungs or airway. It may be either self-limiting or recurrent. Massive hemoptysis is defined as 200–600 mL of blood coughed up within a period of 24 hours or less.

Description

Hemoptysis can range from small quantities of bloody sputum to life-threatening amounts of blood. The patient may or may not have chest **pain**.

Causes and symptoms

Hemoptysis can be caused by a range of disorders:

- Infections. These include pneumonia; tuberculosis; aspergillosis; and parasitic diseases, including ascariasis, amebiasis, and paragonimiasis.
- Tumors that erode blood vessel walls.
- Drug abuse. Cocaine can cause massive hemoptysis.
- Trauma. Chest injuries can cause bleeding into the lungs.
- Vascular disorders, including aneurysms, pulmonary embolism, and malformations of the blood vessels.
- Bronchitis. Its most common cause is long-term smoking.
- Foreign object(s) in the airway.
- Blood clotting disorders.

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- Bleeding following such surgical procedures as bronchial biopsies and heart catheterization.

Diagnosis

The diagnosis of hemoptysis is complicated by the number of possible causes.

Patient history

It is important for the doctor to distinguish between blood from the lungs and blood coming from the nose, mouth, or digestive tract. Patients may aspirate, or breathe, blood from the nose or stomach into their lungs and **cough** it up. They may also swallow blood from the chest area and then vomit. The doctor will ask about stomach ulcers, repeated **vomiting**, **liver disease**, **alcoholism**, **smoking**, **tuberculosis**, mitral valve disease, or treatment with anticoagulant medications.

Physical examination

The doctor will examine the patient's nose, throat, mouth, and chest for bleeding from these areas and for signs of chest trauma. The doctor also listens to the patient's breathing and heartbeat for indications of heart abnormalities or lung disease.

Laboratory tests

Laboratory tests include blood tests to rule out clotting disorders, and to look for food particles or other evidence of blood from the stomach. Sputum can be tested for fungi, bacteria, or parasites.

X ray and bronchoscopy

Chest x rays and **bronchoscopy** are the most important studies for evaluating hemoptysis. They are used to evaluate the cause, location, and extent of the bleeding. The bronchoscope is a long, flexible tube used to identify tumors or remove **foreign objects**.

Imaging and other tests

Computed tomography scans (CT scans) are used to detect aneurysms and to confirm x-ray results. Ventilation-perfusion scanning is used to rule out **pulmonary embolism**. The doctor may also order an angiogram to rule out pulmonary **embolism**, or to locate a source of bleeding that could not be seen with the bronchoscope.

In spite of the number of diagnostic tests, the cause of hemoptysis cannot be determined in 20–30% of cases.

KEY TERMS

Aneurysm—A sac formed by the dilation of the wall of an artery, vein, or heart; it is filled with clotted blood or fluid.

Angiography—A technique for imaging the blood vessels by injecting a substance that is opaque to x rays.

Aspergillosis—A lung infection caused by the mold *Aspergillus fumigatus*.

Intubation—The insertion of a tube into a body canal or hollow organ, as into the trachea or stomach.

Pulmonary embolism—The blocking of an artery in the lung by a blood clot.

Treatment

Massive hemoptysis is a life-threatening emergency that requires treatment in an intensive care unit. The patient will be intubated (the insertion of a tube to help breathing) to protect the airway, and to allow evaluation of the source of the bleeding. Patients with lung **cancer**, bleeding from an aneurysm (blood clot), or persistent traumatic bleeding require chest surgery.

Patients with tuberculosis, **aspergillosis**, or bacterial **pneumonia** are given **antibiotics**.

Foreign objects are removed with a bronchoscope.

If the cause cannot be determined, the patient is monitored for further developments.

Prognosis

The prognosis depends on the underlying cause. In cases of massive hemoptysis, the mortality rate is about 15%. The rate of bleeding, however, is not a useful predictor of the patient's chances for recovery.

Resources

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Hemorrhagic colitis *see Escherichia* **coli**

Hemorrhagic fever with renal syndrome *see* **Hantavirus infections**

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Hemorrhagic fevers

Definition

Hemorrhagic fevers are caused by viruses that exist throughout the world. However, they are most common in tropical areas. Early symptoms, such as muscle aches and **fever**, can progress to a mild illness or to a more debilitating, potentially fatal disease. In severe cases, a prominent symptom is bleeding, or hemorrhaging, from orifices and internal organs.

Description

Although hemorrhagic fevers are regarded as emerging diseases, they probably have existed for many years. This designation isn't meant to imply that they are newly developing, but rather that human exposure to the causative viruses is increasing to the point of concern.

These viruses are maintained in nature in arthropod (insects, spiders and other invertebrates with external hard skeletons) or animal populations—so-called disease reservoirs. Individuals within these populations become infected with a virus but do not die from it. In many cases, they don't even develop symptoms. Then the viruses are transmitted from a reservoir population to humans by vectors—either members of the reservoir population or an intervening species, such as mosquitoes.

Hemorrhagic fevers are generally either endemic or linked to specific locations. If many people reside in an endemic area, the number of cases may soar. For example, **dengue fever**, a type of hemorrhagic fever, affects approximately 100 million people annually. A large percentage of those infected live in densely populated Southeast Asia, an area in which the disease vector, a mosquito, thrives. Some hemorrhagic fevers are exceedingly rare because people very infrequently encounter the virus. Marburg hemorrhagic fever, which has affected fewer than 40 people since its discovery in 1967, provides one such example. Fatality rates are also variable. In cases of dengue hemorrhagic fever–dengue **shock** syndrome, 1–5% of the victims perish. On the other end of the spectrum is Ebola, an African hemorrhagic fever, that kills 30–90% of those infected.

The onset of hemorrhagic fevers may be sudden or gradual, but all of them are linked by the potential for hemorrhaging. However, not all cases progress to this very serious symptom. Hemorrhaging may be attributable to the destruction of blood coagulating factors or to increased permeability of body tissues. The severity of bleeding ranges from petechiae, which are pinpoint hemorrhages under the skin surface, to distinct bleeding from such body orifices as the nose or vagina.

Causes and symptoms

The viruses that cause hemorrhagic fevers are found most commonly in tropical locations; however, some are found in cooler climates. Typical disease vectors include rodents, ticks, or mosquitoes, but person-to-person transmission in health care settings or through sexual contact can also occur.

Filoviruses

Ebola is the most famous of the Filoviridae, a virus family that also includes the Marburg virus. Ebola is endemic to Africa, particularly the Republic of the Congo and Sudan; the Marburg virus is found in sub-Saharan Africa. The natural reservoir of filoviruses is unknown. The incubation period, or time between infection and appearance of symptoms, is thought to last three to eight days, possibly longer.

Symptoms appear suddenly, and include severe **headache**, fever, chills, muscle aches, malaise, and appetite loss. These symptoms may be accompanied by **nausea**, **vomiting**, **diarrhea**, and abdominal **pain**. Victims become apathetic and disoriented. Severe bleeding commonly occurs from the gastrointestinal tract, nose and throat, and vagina. Other bleeding symptoms include petechiae and oozing from injection sites. Ebola is fatal in 30–90% of cases.

Arenaviruses

Viruses of the Arenaviridae family cause Argentinian, Brazilian, Bolivian, and Venezuelan hemorrhagic fevers. Lassa fever, which occurs in west Africa, also arises from an arenavirus. Infected rodents, the natural reservoir, shed virus particles in their urine and saliva, which humans may inhale or otherwise come in contact with.

Fever, muscle aches, malaise, and appetite loss gradually appear one to two weeks after infection with the South American viruses. Initial symptoms are followed by headache, back pain, **dizziness**, and gastrointestinal upset. The face and chest appear flushed and the gums begin to bleed. In about 30% of cases, the disease progresses to bleeding under the skin and from the mucous membranes and/or to effects on the nervous system, such as **delirium**, **coma**, and convulsions. Untreated, South American hemorrhagic fevers have a 10–30% fatality rate.

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Lassa fever also begins gradually, following an 8–14 day incubation. Initial symptoms resemble those of the South American hemorrhagic fevers, followed by a **sore throat**, muscle and joint pain, severe headache, pain above the stomach, and a dry **cough**. The face and neck become swollen, and fluid may accumulate in the lungs. Bleeding occurs in 15–20% of infected individuals, mostly from the gums and nose. Overall, the fatality rate is lower than 2%, but hospitals may encounter 20% fatality rates, treating typically the most serious of cases.

Flaviviruses

The Flaviviridae family includes the viruses that cause yellow and dengue fevers.

Yellow fever occurs in tropical areas of the Americas and Africa and is transmitted from monkeys to humans by mosquitoes. The virus may produce a mild, possibly unnoticed illness, but some individuals are suddenly stricken with a fever, weakness, **low back pain**, muscle pain, nausea, and **vomiting**. This phase lasts one to seven days, after which the symptoms recede for one to two days. Symptoms then return with greater intensity, along with **jaundice**, delirium, seizures, stupor, and coma. Bleeding occurs from the mucous membranes and under the skin surface, and dark blood appears in stools and vomit.

Mosquitoes also transmit the dengue virus. Dengue fever is endemic in Southeast Asia and areas of the Americas. Cases have also been reported in the Caribbean, Saudi Arabia, and northern Australia. In 2004 several cases were reported along the border between Texas and Mexico in the southwestern United States. This virus causes either the mild dengue fever or the more serious dengue hemorrhagic fever–dengue shock syndrome (DHF-DSS).

In children, dengue fever is characterized by a sore throat, runny nose, slight cough, and a fever lasting for a week or less. Older children and adults experience more severe symptoms: fever, headache, muscle and joint pain, loss of appetite, and a rash. The skin appears flushed, and intense pain occurs in the bones and limbs. After nearly a week, the fever subsides for one to two days before returning. Minor hemorrhaging, such as from the gums, or more serious gastrointestinal bleeding may occur.

DHF-DSS primarily affects children younger than 15 years. The symptoms initially resemble those of dengue fever in adults, without the bone and limb pain. As the fever begins to abate, the individual's condition worsens and hemorrhaging occurs from the nose, gums, and injection sites. Bleeding is also seen from the gastrointestinal, genitourinary, and respiratory tracts.

Bunyaviruses

The Bunyaviridae family includes several hundred viruses but only a few are responsible for hemorrhagic fevers in humans.

Rift Valley fever is caused by the phlebovirus, found in sub-Saharan Africa and the Nile Delta. Natural reservoirs are wild and domestic animals, and transmission occurs through contact with infected animals or through mosquito **bites**. The incubation period lasts 3–12 days. Most cases of Rift Valley fever are mild and may be symptomless. If symptoms develop, they include fever, backache, muscle and joint pain, and headache. Hemorrhagic symptoms occur rarely, while **death**, which occurs in fewer than 3% of cases, is attributable to massive liver damage.

Crimean-Congo hemorrhagic fever is caused by nairovirus and occurs in central and southern Africa, Asia, Eurasia, and the Middle East. The virus is found in hares, birds, ticks, and domestic animals and may be transmitted by ticks or by contact with infected animals. The nairovirus incubation period is 3 to 12 days, after which an individual experiences fever, chills, headache, severe muscle pain, pain above the stomach, nausea, vomiting, and appetite loss. Bleeding under the skin and gastrointestinal and vaginal bleeding may develop in the most severe cases. Death rates range from 10% in southern Russia to 50% in parts of Asia.

Hemorrhagic fever with renal (kidney) syndrome is caused by the hantaviruses: Hantaan, Seoul, Puumala, and Dobrava. Hantaan virus occurs in northern Asia, the Far East, and the Balkans; Seoul virus is found worldwide; Puumala virus is found in Scandinavia and northern Europe; while Dobrava virus occurs in the Balkans. Wild rodents are the natural reservoirs and transmit the virus via their excrement or body fluids or through direct contact. Initial symptoms develop within 10–40 days and include fever, headache, muscle pain, and dizziness. Other symptoms are blurry vision, abdominal and back pain, nausea, and vomiting. High levels of protein in the urine signal kidney damage; hemorrhaging may also occur. Death rates range from 0–10%.

Diagnosis

Since the hemorrhagic fevers share symptoms with many other diseases, positive identification of the disease relies on evidence of the viruses in the bloodstream—such as detection of antigens and antibodies—or **isolation** of the virus from the body. Disruptions in the

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normal levels of bloodstream components may be helpful in determining some, but not all, hemorrhagic fevers.

Treatment

Lassa fever, and possibly other hemorrhagic fevers, respond to ribavirin, an antiviral medication. However, most of the hemorrhagic fever viruses can only be treated with supportive care. Interferon is not useful and may in fact complicate management. Such care centers around maintaining correct fluid and electrolyte balances in the body and protecting the patient against secondary infections. Heparin and vitamin K administration, coagulation factor replacement, and blood transfusions may be effective in lessening or stopping hemorrhage in some cases.

Some researchers are investigating the possibility of targeting tissue factor (TF) as a way of treating viral hemorrhagic fevers. TF is a protein that activates the coagulation process in these illnesses, and experimental models suggest that a blockade of tissue factor assists the body's immune response to hemorrhagic fever viruses.

Prognosis

Recovery from some hemorrhagic fevers is more certain than from others. The filoviruses are among the most lethal; fatality rates for Ebola range from 30–90%, while DHF-DSS cases result in a 1–5% fatality rate. Whether a case occurs during an epidemic or as an isolated case also has a bearing on the outcome. For example, isolated cases of yellow fever have a 5% mortality rate, but 20–50% of epidemic cases may be fatal.

Permanent disability can occur with some types of hemorrhagic fever. About 10% of severely ill Rift Valley fever victims suffer retina damage and may be permanently blind, and 25% of South American hemorrhagic fever victims suffer potentially permanent deafness.

Proper treatment is vital. In cases of DHF-DSS, fatality can be reduced from 40–50% to less than 2% with adequate medical care. For individuals who survive hemorrhagic fevers, prolonged convalescence is usually inevitable. However, survivors seem to gain lifelong immunity against the virus that made them ill.

Prevention

Hemorrhagic fevers can be prevented through vector control and personal protection measures. Attempts have been made in urban and settled areas to destroy mosquito and rodent populations. In areas where such measures are impossible, individuals can use insect repellents, mosquito netting, and other methods to minimize exposure.

Vaccines have been developed against yellow fever, Argentinian hemorrhagic fever, and Crimean-Congo hemorrhagic fever. Vaccines against other hemorrhagic fevers are being researched. Another possible preventive measure is increasing the number of natural killer (NK) cells in the body. These cells appear to be an important innate source of protection against Ebola and other filoviruses.

Prevention of epidemics of hemorrhagic fevers has acquired a new importance in the early 2000s from concern that the causative viruses might be used as weapons of bioterrorism. These viruses can be

KEY TERMS

Antibody—A molecule created by the body's immune system to combat a specific infectious agent, such as a virus or bacteria.

Antigen—A specific feature, such as a protein, on an infectious agent. Antibodies use this feature as a means of identifying infectious intruders.

Coagulating factors—Components within the blood that help form clots.

Endemic—Referring to a specific geographic area in which a disease may occur.

Hemorrhage—As a noun, this refers to the point at which blood is released. As a verb, this refers to bleeding.

Incubation—The time period between exposure to an infectious agent, such as a virus or bacteria, and the appearance of symptoms of illness.

Petechiae—Pinpoint hemorrhages that appear as reddish dots beneath the surface of the skin.

Reservoir—A population in which a virus is maintained without causing serious illness to the infected individuals.

Ribavirin—A drug that is used to combat viral infections.

Tissue factor—A glycoprotein involved in blood coagulation.

Vector—A member of the reservoir population or an intervening species that can transmit a virus to a susceptible victim. Mosquitoes are common vectors, as are ticks and rodents.

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transmitted in aerosol form as well as having a high mortality rate.

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Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

Infectious Diseases Society of America (IDSA), 1300 Wilson Blvd., Suite 300, Arlington, VA, 22209, (703) 299-0200, (703) 299-0204, http://www.idsociety.org/.

World Health Organization (WHO), Avenue Appia 201211, Geneva, Switzerland, 27, 4122791-2111, info@who.int, http://www.who.int.

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Hemorrhoids

Definition

Hemorrhoids are enlarged veins in the anus or lower rectum. They often go unnoticed and usually clear up after a few days, but can cause long-lasting discomfort, bleeding and excruciatingly pain. Effective medical treatments are available, however.

Demographics

Hemorrhoids are a very common medical complaint. More than 75% of Americans have hemorrhoids at some point in their lives, typically after age 30. Pregnant women often develop hemorrhoids, but the condition usually clears up after **childbirth**. Men are more likely than women to suffer from hemorrhoids that require professional medical treatment.

Description

Hemorrhoids (also called piles) can be divided into two kinds, internal and external. Internal hemorrhoids lie inside the anus or lower rectum, beneath the anal or rectal lining. External hemorrhoids lie outside the anal opening. Both kinds can be present at the same time.

Causes and symptoms

Precisely why hemorrhoids develop is unknown. Researchers have identified a number of reasons to explain hemorrhoidal swelling, including the simple fact that people's upright posture places a lot of pressure on the anal and rectal veins. **Aging**, **obesity**, **pregnancy**, chronic **constipation** or **diarrhea**, excessive use of **enemas** or **laxatives**, straining during bowel

Clinical photo of a thrombosed external hemorrhoid. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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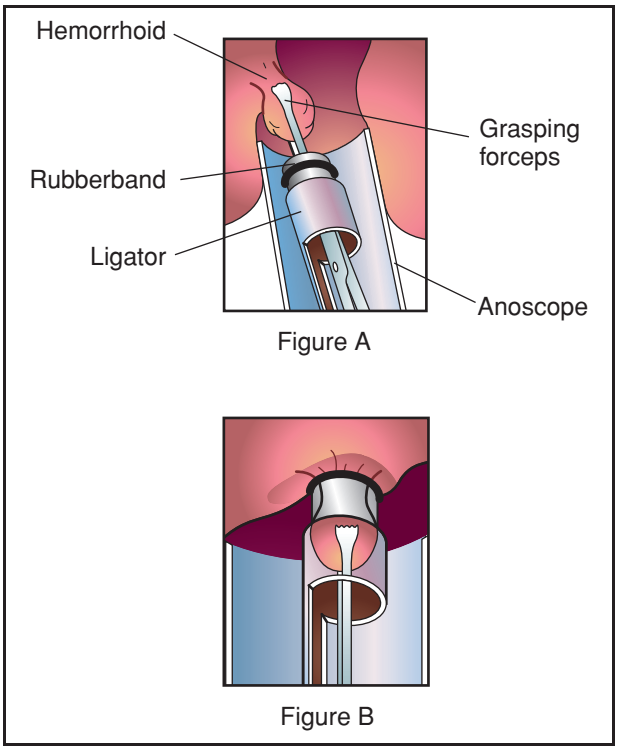

Rubber band ligation is probably the most widely used treatment for internal hemorrhoids. An applicator is used to place one or two small rubber bands around the base of the hemorrhoid, cutting off its blood supply (figures A and B). After 3-10 days, the rubber bands and the hemorrhoid fall off, leaving a scab which disappears within a week or two. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

movements, and spending too much time on the toilet are considered contributing factors. Heredity may also play a part in some cases. There is no reason to believe that hemorrhoids are caused by jobs requiring, for instance, heavy lifting or long hours of sitting, although activities of that kind may make existing hemorrhoids worse.

The most common symptom of internal hemorrhoids is bright red blood in the toilet bowl or on one's feces or toilet paper. When hemorrhoids remain inside the anus they are almost never painful, but they can prolapse (protrude outside the anus) and become irritated and sore. Sometimes, prolapsed hemorrhoids move back into the anal canal on their own or can be pushed back in, but at other times they remain permanently outside the anus until treated by a doctor.

Small external hemorrhoids usually do not produce symptoms. Larger ones, however, can be painful and interfere with cleaning the anal area after a bowel movement. When, as sometimes happens, a blood clot forms in an external hemorrhoid (creating what is called a thrombosed hemorrhoid), the skin around the anus becomes inflamed and a very painful lump develops. On rare occasions the clot will begin to bleed after a few days and leave blood on the underwear. A thrombosed hemorrhoid will not cause an **embolism**.

Diagnosis

Diagnosis begins with a visual examination of the anus, followed by an internal examination during which the doctor carefully inserts a gloved and lubricated finger into the anus. The doctor may also use an anoscope, a small tube that allows him or her to see into the anal canal. Under some circumstances the doctor may wish to check for other problems by using a sigmoidoscope or colonoscope, a flexible instrument that allows inspection of the lower colon (in the case of the sigmoidoscope) or the entire colon (in the case of the colonoscope).

Treatment

Hemorrhoids can often be effectively dealt with by dietary and lifestyle changes. Softening the feces and avoiding constipation by adding fiber to one's diet is important because hard feces lead to straining during defecation. Fruit, leafy vegetables, and whole-grain breads and cereals are good sources of fiber, as are bulk laxatives and fiber supplements, such as Metamucil or Citrucel. Exercising, losing excess weight, and drinking six to eight glasses a day of water or another liquid (not alcohol) also helps. Soap or toilet paper that is perfumed may irritate the anal area and should be avoided, as should excessive cleaning, rubbing, or wiping of that area. Reading in the bathroom is also considered a bad idea, because it adds to the time one spends on the toilet and may increase the strain placed on the anal and rectal veins. After each bowel movement, wiping with a moistened tissue or pad sold for that purpose helps lessen irritation. Hemorrhoid **pain** is often eased by sitting in a tub of warm water for about 10 or 15 minutes two to four times a day (**sitz bath**). A cool compress or ice pack to reduce swelling is also recommended (the ice pack should be wrapped in a cloth or towel to prevent direct contact with the skin). Many people find that over-the-counter hemorrhoid creams and foams bring relief, but these medications do not make hemorrhoids disappear.

When painful hemorrhoids do not respond to home-based remedies, professional medical treatment is necessary. The choice of treatment depends on the type of hemorrhoid, what medical equipment is available, and other considerations.

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KEY TERMS

Anus—The opening at the lower end of the rectum. The anus and rectum are both part of the large intestine, a digestive system organ.

Colon—The major part of the large intestine, a digestive system organ.

Defecation—Passage of feces through the anus.

Embolism—Obstruction of blood flow in an artery by a blood clot or other substance arising from another site. An untreated embolism can endanger health and even cause death.

Enema—The introduction of water or another liquid into the bowels through a tube inserted into the anus. Enemas are used to treat constipation and for other purposes.

Feces—Undigested food and other waste that is eliminated through the anus; also called stools.

Rectum—The lower section of the large intestine, a digestive system organ. After food has passed through the stomach and intestines and been digested, the leftover material, in the form of feces, enters the rectum, where it stays until defecation.

Suppository—A medicinal substance that slowly dissolves after being inserted into the rectum (or other body cavity).

Rubber band ligation is probably the most widely used of the many treatments for internal hemorrhoids (and the least costly for the patient). This procedure is performed in the office of a family doctor or specialist or in a hospital on an outpatient basis. An applicator is used to place one or two small rubber bands around the base of the hemorrhoid, cutting off its blood supply. After 3 to 10 days in the bands, the hemorrhoid falls off, leaving a sore that heals in a week or two. Because internal hemorrhoids are located in a part of the anus that does not sense pain, anesthetic is unnecessary and the procedure is painless in most cases. Although there can be minor discomfort and bleeding for a few days after the bands are applied, complications are rare and most people are soon able to return to work and other activities. If more than one hemorrhoid exists or if banding is not entirely effective the first time (as occasionally happens), the procedure may need to be repeated a few weeks later. After five years, 15–20% of patients experience a recurrence of internal hemorrhoids, but in most cases all that is needed is another banding.

External hemorrhoids, and some prolapsed internal hemorrhoids, are removed by conventional surgery in a hospital. Depending on the circumstances, this requires a local, regional, or general anesthetic. Surgery does cause a fair amount of discomfort, but an overnight hospital stay is usually not necessary. Full healing takes two to four weeks, but most people are able to resume normal activities at the end of a week. Hemorrhoids rarely return after surgery.

Alternative treatment

Like mainstream practitioners, alternative practitioners stress the importance of a high-fiber diet. To prevent hemorrhoids by strengthening the veins of the anus, rectum, and colon, they recommend blackberries, blueberries, cherries, vitamin C, butcher's broom (*Ruscus aculeatus*), and flavonoids (plant pigments found in fruit and fruit products, tea, and soy). Herbal teas, ointments, and suppositories, and other kinds of herbal preparations, are suggested for reducing discomfort and eliminating hemorrhoids. In particular, pilewort (*Ranunculusficaria*), applied in an ointment or taken as a tea, can reduce the pain of external hemorrhoids. **Acupuncture**, **acupressure**, **aromatherapy**, and homeopathy are also used to treat hemorrhoids.

Prognosis

Hemorrhoids do not cause **cancer** and are rarely dangerous or life threatening. Most clear up after a few days without professional medical treatment. However, because colorectal cancer and other digestive system diseases can cause anal bleeding and other hemorrhoid-like symptoms, people should always consult a doctor when those symptoms occur.

Prevention

A high-fiber diet and the other lifestyle changes recommended for coping with existing hemorrhoids also help to prevent hemorrhoids. Not straining during bowel movements is essential.

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National Digestive Diseases Information Clearinghouse, 2 Information Way, Bethesda, MD, 20892-3570, (800) 891-5389, http://www.niddk.nih.gov/health/digest/nddic.htm.

Howard Baker
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Henoch-Schönlein purpura *see* **Allergic purpura**
Hepatic carcinoma *see* **Liver cancer, primary**
Hepatic encephalopathy *see* **Liver encephalopathy**
Hepatitis-associated antigen (HAA) test *see* **Hepatitis virus tests**

Hepatitis A

Definition

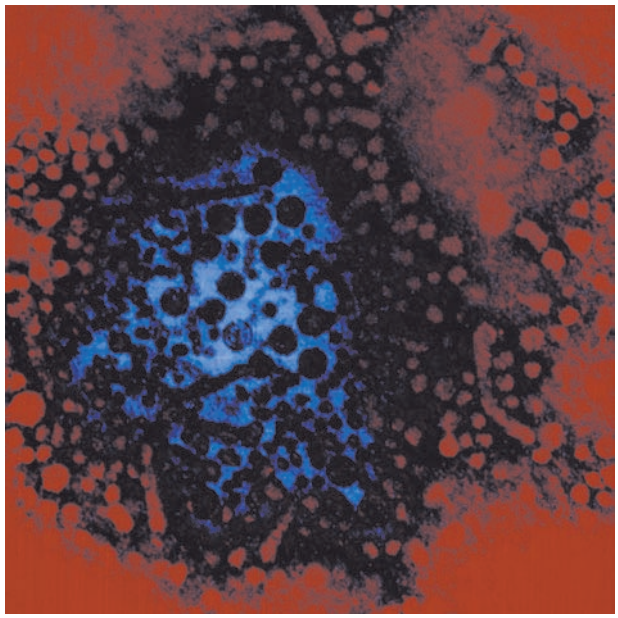
Hepatitis A is an **infectious disease** of the liver caused by the HAV virus. The disease is usually transmitted by food or water contaminated by human wastes containing the virus or by close human contact. As far as is known, only humans can get hepatitis A; it is not carried by other animals.

Hepatitis A was previously known as infectious hepatitis because it spread relatively easily from those infected to close household contacts.

Demographics

Hepatitis A is much more common in Africa, Asia, and South America than in the United States. The rates of hepatitis A in North America have been steadily dropping since the 1980s due to improvements in public health policies and sanitation; on the other hand, the rates of hepatitis A among frequent travelers have been rising during the same time period.

In 1988 the Centers for Disease Control and Prevention (CDC) reported 32,000 cases in the United States; in 2003, 7653 cases were reported. The CDC estimates that nearly 25,000 people contracted hepatitis A in the United States in 2007, although the number of reported cases is much lower because many people do not show symptoms of the disease. In developing countries, children below the age of 2 account for most new cases of hepatitis A; in the United States, the age group most often affected is children between the ages of 5 and 14.



Hepatitis A virus magnified 225,000 times. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

The states with the highest incidence of hepatitis A account for 50 percent of the reported cases. According to the American Academy of Pediatrics, 11 states have a rate of HAV infection that is at least twice the national average, or 20 cases per every 100,000 people. The states are Arizona, Alaska, California, Idaho, Nevada, New Mexico, Oklahoma, Oregon, South Dakota, Utah, and Washington.

Males and females are equally likely to get hepatitis A, as are people from all races and ethnic groups in the United States.

Description

Hepatitis A is an inflammation of the liver caused by the HAV virus, also called enterovirus 72, which was first identified in 1973. It differs from **hepatitis B** and **hepatitis C** in that it does not cause long-term liver damage. Even though people can take several weeks or months to recover completely from hepatitis A, they have lifelong immunity afterward. Complications from hepatitis A are rare and usually limited to people with chronic **liver disease** or those who have received a liver transplant.

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Hepatitis A varies in severity, running an acute course, generally starting within two to six weeks after contact with the virus, and lasting no longer than two or three months. Children and younger adults may have no symptoms at all, although they can still spread the disease. In general, adults are more likely to have noticeable symptoms than children or teenagers. The most common symptom is loss of energy and overall tiredness.

Some people develop a mild flu-like illness with **diarrhea**, low-grade **fever**, **nausea**, **vomiting**, and **muscle cramps**. People with more severe symptoms may have **pain** in the abdomen in the area of the liver (below the rib cage on the right side of the body); they may notice that their urine has turned dark brown or that they have jaundice—yellowing of the skin and the whites of the eyes. Some have an itchy skin rash.

HAV may occur in single cases after contact with an infected relative or sex partner. Alternately, epidemics may develop when food or drinking water is contaminated by the feces of an infected person. In the public's mind, outbreaks of hepatitis A usually are linked with the eating of contaminated food at a restaurant. It is true that food-handlers, who may themselves have no symptoms, can start an alarming, widespread epidemic. Many types of food can be infected by sewage containing HAV, but such shellfish as clams and oysters are common culprits.

Most people diagnosed with hepatitis A feel better within four to six weeks after the symptoms begin, although about 15 percent of patients may take up to 9 months to regain their energy and feel normal again.

Risk factors

Some people are at increased risk of hepatitis A, including:

- People who travel to parts of the world with high rates of the disease and poor sanitation, including the Middle East, South America, Eastern Europe, Mexico and Central America, Africa, Southeast Asia, and the Caribbean.
- Male homosexuals.
- People who use illicit drugs, whether injected or taken by mouth.
- Medical researchers and laboratory workers who may be exposed to HAV.
- Child care workers and children in day care centers. Children at day care centers make up an estimated 14–40% of all cases of HAV infection in the United States. Changing diapers transmits infection through fecal-oral contact. Toys and other objects may remain contaminated for some time. Often a child without symptoms brings the infection home to siblings and parents.
- Troops living under crowded conditions at military camps or in the field.
- Homeless people.

Causes and symptoms

Causes

Hepatitis A is caused by a virus that is transmitted by close personal contact with an infected person, by needle sharing, and by eating food or drinking water contaminated by fecal matter. After the virus enters the body, it multiplies in the cells of the liver, causing inflammation of the liver and a general response from the immune system that leads to most of the symptoms of the illness.

The HAV virus is shed from the liver into the bile (a digestive fluid secreted by the liver) and then into the person's stools between 15 and 45 days before symptoms appear. That means that people can spread the virus through their feces before they know that they are sick. In the United States, hepatitis A is most commonly spread by food handlers who do not wash their hands properly after using the bathroom; by childcare workers who do not wash their hands after changing a baby's diaper; by anal sex; and by eating raw shellfish harvested from sewage-polluted waters. In very rare cases the virus can be transmitted through blood transfusions.

Symptoms

Often the first symptoms to appear are **fatigue** and general achiness. Those who like to drink coffee or smoke cigarettes may lose their taste for them. The liver often enlarges, causing pain or tenderness in the right upper part of the abdomen. As many as three out of four children have no symptoms of HAV infection, but about 85% of adults will have symptoms.

In addition to fatigue, the most common symptoms of hepatitis A include:

- Low-grade fever (101°F)
- Nausea, vomiting, and diarrhea
- Loss of appetite and weight loss
- Swelling of the liver and pain in the area of the abdomen over the liver
- Tea- or coffee-colored urine
- Jaundice
- An itchy rash or a generalized sensation of itching
- Pale or clay-colored stools
- Muscle pains

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KEY TERMS

Antibody—A substance made by the body in response to a foreign body, such as a virus, which is able to attack and destroy the invading virus.

Antiemetic—A type of drug given to control nausea and vomiting.

Bile—A yellow-green fluid secreted by the liver that aids in the digestion of fats.

Contamination—The process by which an object or body part becomes exposed to an infectious agent such as a virus.

Epidemic—A situation where a large number of infections by a particular agent, such as a virus, develops in a short time. The agent is rapidly transmitted to many individuals.

Hepatitis—The medical term for inflammation of the liver. It can be caused by toxic substances or alcohol as well as infections.

Immune globulin—A preparation of antibodies that can be given before exposure for short-term protection against hepatitis A and for persons who have already been exposed to hepatitis A virus. Immune globulin must be given within two weeks after exposure to hepatitis A virus for maximum protection.

Incubation period—The interval from initial exposure to an infectious agent, such as a virus, and the first symptoms of illness.

Jaundice—A yellowish discoloration of the skin and whites of the eyes caused by increased levels of bile pigments from the liver in the patient's blood.

Relapse—A temporary recurrence of the symptoms of a disease.

Vaccine—A substance prepared from a weakened or killed microorganism which, when injected, helps the body to form antibodies that will prevent infection by the natural microorganism.

Diagnosis

Diagnosis of hepatitis A is made on the basis of the patient's history, findings during an office examination, and a blood test for HAV.

Examination

The doctor may suspect that a patient has hepatitis A during a **physical examination** in the office by feeling the area over the liver for signs of swelling and pain; taking the patient's temperature; and checking the skin and eyes for signs of **jaundice**.

Tests

A definite diagnosis is provided by a blood test for antibodies to the HAV virus. There is a specific antibody called hepatitis A IgM antibody that develops when HAV is present in the body. This test always registers positive when a patient has symptoms and should continue to register positive for four to six months. However, hepatitis A IgM antibody will persist lifelong in the blood and is protective against reinfection.

In some cases the doctor may also have the sample of blood checked for abnormally high levels of liver enzymes.

Treatment

Traditional

There is no specific drug treatment for hepatitis A, as **antibiotics** cannot be used to treat virus infections. Most people can care for themselves at home by making sure they get plenty of fluids and adequate **nutrition**. People whose appetite has been affected may benefit from eating small snacks throughout the day rather than three main meals and by eating soft and easily digested foods.

Patients with hepatitis A should avoid drinking alcohol, which makes it harder for the liver to recover from inflammation. Patients should also tell their doctor about any over-the-counter or prescription drugs they are taking because the drugs may need to be stopped temporarily or have the dosages changed.

Drugs

Patients with hepatitis A may take **acetaminophen** to reduce fever and relieve pain. Patients with mild **vomiting** may be prescribed antiemetics (drugs to control nausea); the drug most commonly prescribed for hepatitis patients is metoclopramide (Reglan). Those with severe vomiting may need to be hospitalized in order to receive intravenous fluids.

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Prognosis

Most people recover fully from hepatitis A within a few weeks or months. Between 3 and 20% have relapses (temporary recurrences of symptoms) for as long as six to nine months after infection. In the United States, serious complications are infrequent and deaths are very rare. As many as 75% of adults over 50 years of age in North America will have blood test evidence of previous hepatitis A.

About 1 percent of patients develop liver failure following HAV infection, mostly those over 60 or those with chronic liver disease. In these cases **liver transplantation** may be necessary for the patient's survival. There are about 100 deaths from hepatitis A reported each year in the United States.

Prevention

Hepatitis A can be prevented by a vaccine called Havrix that is given before exposure to the HAV virus. The vaccine is given in two shots, the second given between 6 and 18 months after the first. It confers immunity against hepatitis A for at least 20 years. Those who should receive the vaccine include people in the military and those who travel abroad frequently; men who have sex with other men; people who use intravenous drugs; people with **hemophilia** who must receive human blood products; and people who have chronic hepatitis B or C infection.

People who have been exposed to the HAV virus should be given immune globulin to protect them against getting sick, because Havrix is not effective in people who have already been exposed to HAV. Children under the age of 2 should be given immune globulin or a vaccine called Epaxal that was introduced in 2007 rather than Havrix to protect them against HAV.

A vaccine against hepatitis A introduced in 2007 is called Epaxal; there is a version for children called Epaxal Junior that appears to be a good choice for mass **vaccination** programs. Unlike Havrix, Epaxal Junior can be given to children above the age of one year.

Everyone can reduce their risk of hepatitis A by observing the following precautions:

- Practice good personal hygiene; wash hands frequently, especially after using the toilet or changing a child's diaper.
- When traveling, drink only bottled water; avoid raw or undercooked meat or shellfish; and avoid eating fresh fruits or vegetables unless you have washed and peeled them yourself.
- Avoid sharing drinking glasses and eating utensils. If someone in the family has hepatitis A, wash their glasses and utensils separately in hot, soapy water.
- Avoid sexual contact with anyone who has hepatitis A.

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American College of Gastroenterology (ACG), P.O. Box 342260, Bethesda, MD, 20827-2260, (301)263-9000, http://www.acg.gi.org/.

American Liver Foundation (ALF), 75 Maiden Lane, Suite 603, New York, NY, 10038, (212)668-1000, (212)483-8179, http://www.liverfoundation.org/.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800)232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

National Institute of Allergy and Infectious Diseases (NIAID), 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-6612, (301)496-5717, (866)284-4107, (301)402-3573, http://www3.niaid.nih.gov.

World Health Organization (WHO), Avenue Appia 20, 1211 Geneva 27, Switzerland, + 41 22 791 21 11, + 41 22 791 31 11, info@who.int, http://www.who.int/en/.

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Hepatitis, alcoholic

Definition

Alcoholic hepatitis is an inflammation of the liver caused by alcohol.

Description

Irritation, whether from toxins or infections, causes a similar response in body organs. The response is known as inflammation and consists of:

- an increase in the blood to the affected organ
- redness and swelling of the organ
- influx of immune agents like white blood cells and their arsenal of chemical weapons
- pain

As the acute process subsides, there is either healing or lingering activity. Lingering activity—chronic disease—has a milder presentation with similar ingredients. Healing often takes the form of scarring, wherein normal functioning tissue is replaced by tough, fibrous, and non-productive scar. Both chronic disease and healing can happen simultaneously, so that scar tissue progressively replaces normal tissue. This leads to **cirrhosis**, a liver so scarred it is unable to do its job adequately.

KEY TERMS

Cirrhosis—Disruption of normal liver structure and function caused by any type of chronic disease such as hepatitis and alcohol abuse.

Fatty liver—An abnormal amount of fat tissue in the liver caused by alcohol abuse.

Hemolysis—Disintegration of red blood cells.

Protozoa—One-celled microscopic organisms like amoeba.

Alcohol can cause either an acute or a chronic disease in the liver. The acute disease can be severe, even fatal, and can bring with it hemolysis–blood cell destruction. Alcohol can also cause a third type of **liver disease**, **fatty liver**, in which the continuous action of alcohol turns the liver to useless fat. This condition eventually progresses to cirrhosis if the poisoningcontinues.

Causes and symptoms

Inflammation of the liver can be caused by a great variety of agents—poisons, drugs, viruses, bacteria, protozoa, and even larger organisms like worms. Alcohol is a poison if taken in more than modest amounts. It favors destroying stomach lining, liver, heart muscle, and brain tissue. The liver is a primary target because alcohol travels to the liver after leaving the intestines. Those who drink enough to get alcohol **poisoning** have a tendency to be undernourished, since alcohol provides ample calories but little **nutrition**. It is suspected that both the alcohol and the poor nutrition produce alcoholic hepatitis.

Diagnosis

Hepatitis of all kinds causes notable discomfort, loss of appetite, **nausea**, **pain** in the liver, and usually **jaundice** (turning yellow). Blood test abnormalities are unmistakably those of hepatitis, but selecting from so many the precise cause may take additional diagnostic work.

Treatment

As with all poisonings, removal of the offending agent is primary. There is no specific treatment for alcohol poisoning. General supportive measures must see the patient through until the liver has healed by itself. In the case of fulminant (sudden and severe)

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disease, the liver may be completely destroyed and have to be replaced by a transplant.

Prognosis

The liver is robust. It can heal without scarring after one or a few episodes of hepatitis that resolve without lingering. It can, moreover, regrow from a fragment of its former self, provided there is not disease or poison still inhibiting it.

Prevention

Alcohol is lethal in many ways when ingested in excess. Research suggests that the maximum healthy dose of alcohol per day is roughly one pure ounce—the amount in two cocktails, two glasses of wine, or two beers.

ORGANIZATIONS

Alcoholics Anonymous, World Services, P.O. Box 459, New York, NY, 10163, (212) 870-3400, http://www. aa.org.

American Liver Foundation, 75 Maiden Lane, Suite 603, New York, NY, 10038, (212) 668-1000, (212) 483-8179, http://www.liverfoundation.org/.

J. Ricker Polsdorfer, MD

Hepatitis, autoimmune

Definition

A form of liver inflammation in which the body's immune system attacks liver cells.

Description

Autoimmunity causes the body's defense mechanisms to turn against itself. Many of the tissues in the body can be the target of such an attack. While one tissue type predominates, others may be involved in a general misdirection of immune activity, perhaps because the specific target antigen is present in differing quantities in each of the affected tissues. There seem to be hereditary causes for autoimmunity, since these diseases tend to run in families and have genetic markers. Among the more common diseases believed to fall within this category are **rheumatoid arthritis**, **systemic lupus erythematosus**, **multiple sclerosis**, and **psoriasis**.

The process of autoimmune disease is very similar to **infectious disease** and allergy, so that great caution is observed in placing a disorder in this class. Germs were found to cause several diseases originally thought to be autoimmune. Allergens cause others. Many more may be uncovered. Autoimmunity is often believed to originate with a virus infection. A chemical in the virus resembles a body chemical so closely that the immune system attacks both.

KEY TERMS

Allergen—Any chemical that causes an immune reaction only in people sensitive to it.

Antigen—Any chemical that can be the target of an immune response.

Biopsy—Surgical removal of a piece of tissue for examination.

Jaundice—A yellow color to the skin from bile that backs up into the circulation.

Autoimmune hepatitis is similiar to viral hepatitis, a disease of the liver. It can be an acute disease that kills over a third of its victims within six months, can persist for years, or can return periodically. Some patients develop **cirrhosis** of the liver which, over time, causes the liver to cease functioning.

Causes and symptoms

Symptoms of autoimmune hepatitis resemble those of other types of hepatitis. Patients who develop autoimmune hepatitis experience **pain** under the right ribs, **fatigue** and general discomfort, loss of appetite, **nausea**, and sometimes **vomiting** and **jaundice**. In addition, other parts of the body may be involved and contribute their own symptoms.

Diagnosis

Extensive laboratory testing may be required to differentiate this disease from viral hepatitis. The distinction may not even be made during the initial episode. There are certain markers of autoimmune disease in the blood that can lead to the correct diagnosis if they are sought. In advanced or chronic cases a **liver biopsy** may be necessary.

Treatment

Autoimmune hepatitis is among the few types of hepatitis that can be treated effectively. Since treatment itself introduces problems in at least 20% of patients, it is reserved for the more severe cases. Up to 80% of patients improve with cortisone treatment,

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although a cure is unlikely. Another drug—azathioprine—is sometimes used concurrently. Treatment continues for over a year and may be restarted during a relapse. At least half the patients relapse at some point, and most will still continue to have progressive liver scarring.

If the liver fails, transplant is the only recourse.

Prognosis

In spite of treatment, autoimmune hepatitis can re-erupt at any time and may continue to damage and scar the liver. The rate of progression varies considerably from patient to patient.

ORGANIZATIONS

American Liver Foundation, 75 Maiden Lane, Suite 603, New York, NY, 10038, (212) 668-1000, (212) 483-8179, http://www.liverfoundation.org/.

J. Ricker Polsdorfer, MD

Hepatitis B

Definition

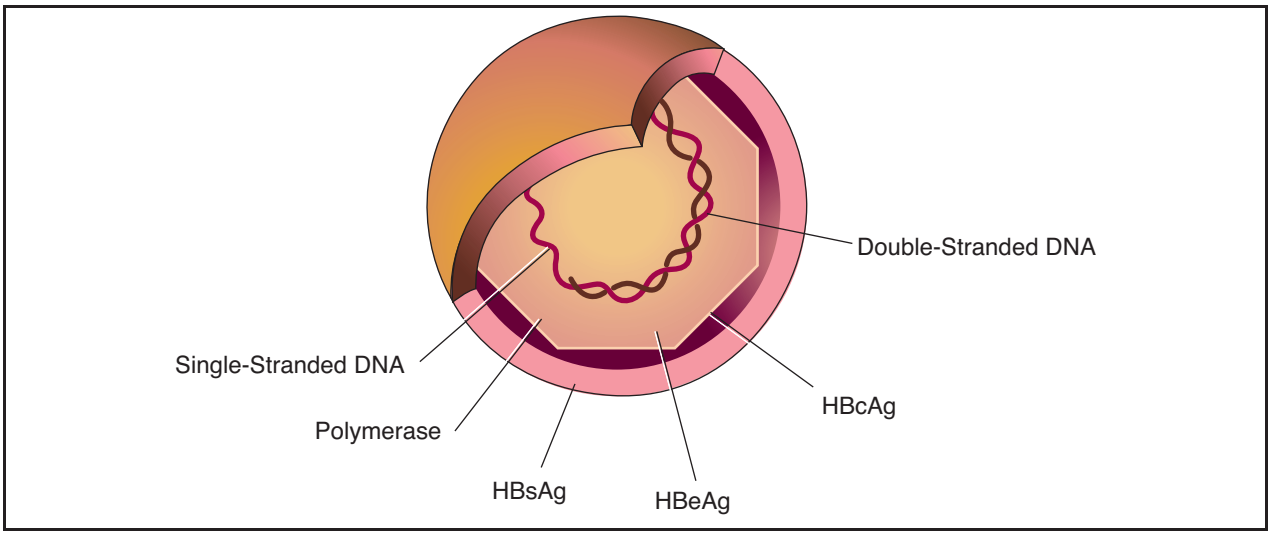
Hepatitis B is a viral infection of the liver transmitted through the blood or body fluids of someone who is infected. It is also called serum hepatitis because it can be transmitted through blood serum, the liquid portion of blood.

Hepatitis B is the most common serious liver infection worldwide. The disease has two forms: an acute form that lasts a few weeks, and a chronic form that can last for years, leading to **cirrhosis**, liver failure, **liver cancer**, and even **death**. Acute hepatitis B has a 5 percent chance of leading to the chronic form of the infection in adults. However, infants infected during the mother's **pregnancy** have a 90 percent chance of developing chronic hepatitis B, and children have a 25–50 percent chance.

Demographics

There are about 100,000 new cases of hepatitis B in the United States each year; it is estimated that 1–1.4 million people carry the disease and that 12 million Americans (1 in 20) have been infected by the disease. Hepatitis B causes about 5100 deaths in the United States each year; on average, one American health care worker dies each day from hepatitis B. In the rest of the world, as many as a third of the population (2 billion people) are chronic carriers of the disease. Chronic hepatitis B affects approximately 400 million people around the world as of 2009 and contributes to an estimated 1 million deaths worldwide each year.

The age group most commonly affected by hepatitis B in the United States is adults between the ages of 20 and 50. The routine immunization of children



Hepatitis B virus (HBV) is composed of an inner protein core and an outer protein capsule. The outer capsule contains the hepatitis B surface antigen (HBsAg). The inner core contains HBV core antigen (HBcAg) and hepatitis B e-antigen (HBeAg). This cell also contains polymerase, which catalyzes the formation of the cell's DNA. HBV is the only hepatitis-causing virus that has DNA, instead of RNA. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

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against the disease since 1990 has led to a decline in the rate of acute hepatitis in North America for the past two decades. African Americans are more likely to be infected than either Hispanics or Caucasians; however, Alaskan Eskimos and Pacific Islanders have higher rates of carrier status than members of other racial groups. Asian Americans are at increased risk of severe liver damage from hepatitis B compared to members of other racial groups. More males than females are infected with hepatitis B in all races and age groups.

Description

Hepatitis B has an incubation period of 1–6 months. About 50 percent of people with the acute form of the disease have no symptoms at all; the others experience loss of appetite, **nausea** and **vomiting**, and **jaundice** around 12 weeks after getting infected. Some patients may also have joint **pain**, itchy skin, or abdominal pain. Many of these patients assume that they have **influenza**.

Patients with chronic hepatitis may have no symptoms at all. The one-third who do eventually fall ill have the same symptoms as patients with the acute form of the disease. About two-thirds of people with chronic HBV are carriers of the virus. They may never get sick themselves but they can transmit the infection to others. The remaining one-third of people with chronic hepatitis B develop **liver disease** that can lead to permanent scarring of the liver. Between 15 and 25 percent of people with chronic hepatitis B eventually die of liver disease.

Although there are many ways of passing on HBV, the virus is not very easily transmitted by indirect contact because it is a bloodborne pathogen. There is no need to worry that such casual contact as shaking hands will expose one to hepatitis B, and there is no reason not to share a workplace or even a restroom with an infected person. On the other hand, hepatitis B virus is a durable virus that can survive outside the body for at least seven days. During that time, the virus can still cause disease if it enters the body of a person who is not infected. For that reason it is necessary to clean any surface contaminated by blood spills (including those that have dried) carefully with a mixture of chlorine bleach and water. Medical or dental instruments must be sterilized with particular care.

People who have been infected by HBV and have recovered from the infection are protected against hepatitis B for the rest of their lives. People can also be protected by receiving a vaccine against the disease but must have a repeat **vaccination** every 5–10 years.

Risk factors

Risk factors for hepatitis B include:

- Having unprotected sex with a partner regardless of sexual orientation.
- Having a large number of sexual partners.
- Being infected with another sexually transmitted disease (STD), particularly gonorrhea or chlamydia.
- Sharing needles with other intravenous drug users.
- Having a family member with chronic HBV infection.
- Having had a blood transfusion or use of blood products before 1972.
- Needing hemodialysis for kidney disease.
- Frequent travels to parts of the world with high rates of hepatitis B. These include the Middle East, southern Africa, China, Southeast Asia, Brazil, and the Pacific Islands.
- Emigrating from or adopting a child from any of the countries listed above.
- Working in a hospital, clinic, or other facility requiring frequent exposure to blood, open wounds, or other body secretions. Health care workers at risk include dentists and dental hygienists as well as physicians, nurses, and laboratory technicians.
- Working as a police officer, firefighter, or other emergency first responder.
- Being a prison inmate.
- Living or working in a facility for the developmentally disabled.

Causes and symptoms

Causes

Hepatitis B is caused by a virus known as HBV. With the exception of HBV, all the common viruses that cause hepatitis are known as RNA viruses because they contain ribonucleic acid or RNA as their genetic material. HBV is the only deoxyribonucleic acid or DNA virus that is a major cause of hepatitis. HBV is made up of several fragments called antigens that stimulate the body's immune system to produce the antibodies that can neutralize or even destroy the infecting virus. It is in fact the immune reaction, not the virus, that seems to cause the liver inflammation associated with hepatitis B.

Hepatitis B is primarily a bloodborne infection but can also be transmitted through contact with the semen, vaginal secretions, or saliva of an infected person. The virus enters the body through injection, a

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KEY TERMS

Antibody—A substance formed in the body in response to a foreign body, such as a virus, which can then attack and destroy the invading virus.

Antigen—Part of an invading microorganism, such as a virus, that causes tissue damage (in hepatitis, to the liver), and that also stimulates the body's immune system to produce antibodies.

Carrier—A person who is infected with a virus or other disease organism but does not develop the symptoms of the disease.

Chronic—Long-term or recurrent.

Cirrhosis—Disruption of normal liver function by the formation of scar tissue and nodules in the liver.

Fulminant—Referring to a disease that comes on suddenly with great severity.

Hepatitis—A general term for inflammation of the liver. It can be caused by toxic substances or alcohol as well as infections.

Jaundice—A yellowish discoloration of the skin and whites of the eyes caused by increased levels of bile pigments from the liver in the patient's blood.

Pathogen—Any biological agent that causes illness or disease in its host. A pathogen may be a virus, bacterium, fungus, or prion.

Vaccine—A substance prepared from a weakened or killed virus which, when injected, helps the body to form antibodies that will attack an invading virus and may prevent infection altogether.

break in the skin, or contact with the mucous membranes that line the mouth, genitals, and rectum. People cannot get hepatitis B from food or from shaking hands, sneezing or coughing, **breastfeeding**, or casual contact with an infected person.

Symptoms

ACUTE HEPATITIS B. In the United States, a majority of acute HBV infections occur in teenagers and young adults. Half of these youth never develop symptoms, and only about 20%—or one in five infected patients—develop severe symptoms and yellowing of the skin (jaundice). Jaundice occurs when the infected liver is unable to get rid of certain colored substances, or pigments, as it normally does. The remaining 30% of patients have only "flu-like" symptoms and will probably not even be diagnosed as having hepatitis unless certain blood tests are performed.

The most commom symptoms of acute hepatitis B are loss of appetite, **nausea**, generally feeling poorly, and pain or tenderness in the right upper part of the abdomen (where the liver is located). Compared to patients with **hepatitis A** or C, those with HBV infection are less able to continue their usual activities and require more time resting in bed.

Occasionally patients with HBV infection will develop joint swelling and pain (arthritis), as well as **hives** or a skin rash before jaundice appears. The joint symptoms usually last no longer than three to seven days.

Typically the symptoms of acute hepatitis B do not persist longer than two or three months. If they continue for four months, the patient has an abnormally long-lasting acute infection. In a small number of patients—probably fewer than 3%—the infection keeps getting worse as the liver cells die off. Jaundice deepens, and patients may bleed easily when the levels of coagulation factors (normally made by the liver) decrease. Large amounts of fluid collect in the abdomen and beneath the skin (**edema**).

A few people (less than 1% of patients) develop a severe form of hepatitis B known as fulminant hepatitis. This form of the disease appears rapidly and can cause death if not treated at once. Its symptoms include:

- Sudden collapse
- Mental confusion, hallucinations, or extreme sleepiness
- Jaundice
- Noticeable swelling of the abdomen

CHRONIC HEPATITIS B. HBV infection lasting longer than six months is said to be chronic. After this time it is much less likely that the infection will disappear. Most infants infected with HBV at birth and many children infected between 1 and 5 years of age become chronically infected. Not all carriers of the virus develop chronic liver disease; in fact, a majority of carriers have no symptoms. About one in every four HBV carriers, however, develops liver disease that gets worse over time as the liver becomes more and more scarred and less able to carry out its normal functions. The hepatitis B virus accounts for 5–10% of cases of chronic end-stage liver disease in the United States. A badly scarred liver is called cirrhosis. Patients are likely to have an enlarged liver and spleen, as

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well as tiny clusters of abnormal blood vessels in the skin that resemble spiders.

The most serious complication of chronic HBV infection is liver **cancer**. Worldwide this is the most common cancer to occur in men. Nevertheless, the overall chance that liver cancer will develop at any time in a patient's life is probably much lower than 10%. Patients with chronic hepatitis B who drink or smoke are more likely to develop liver cancer. It is not unusual for a person to simultaneously have HBV infection and infection by HIV (human **immunodeficiency** virus, the cause of **AIDS**). One study reported that men infected with both HIV and HBV were more likely to die from liver disease than people infected with just one of the diseases.

Diagnosis

Hepatitis B is diagnosed by one or more blood tests, since patients may not have any apparent symptoms. In a number of cases, the person is diagnosed following a routine blood test given as part of an annual health checkup. The most common clue is abnormal liver function results.

Examination

Many patients infected with hepatitis B will not have any visible symptoms during a routine office examination. In some cases, however, the doctor may observe swelling or tenderness in the right upper quadrant of the patient's abdomen; enlargement of the spleen; a low-grade **fever**; reddening of the palms of the hands; and signs of jaundice. If the disease has progressed to cirrhosis, the doctor may be able to detect the presence of fluid in the abdomen.

Tests

To confirm the diagnosis of hepatitis B, the doctor will take one or more blood samples for testing:

- A test of the patient's liver function, if this has not already been done.
- Tests for antibodies to the hepatitis B virus. A positive result means that the person has either been effectively vaccinated against HBV or has been infected at some point in the past and has recovered.
- Tests for the surface antigen of the hepatitis B virus (HBsAg). The surface antigen is the outer coating of the virus. A positive HBsAg test means that the patient is currently infected and can pass on the virus to others.
- Hepatitis B DNA test. This blood test measures the levels of virus in the patient's blood.

Procedures

Patients with chronic active hepatitis B may be given a computed tomography (CT) scan or ultrasound imaging of the liver to see whether the liver has been damaged by the infection. The doctor may also perform a **liver biopsy**. This test involves inserting a long hollow needle into the patient's liver through the abdomen and withdrawing a small amount of tissue for examination under a microscope.

Treatment

Traditional

There are few treatment options for chronic hepatitis B. If the patient has no symptoms and little sign of liver damage, the doctor may suggest monitoring the levels of HBV in the patient's blood periodically rather than starting drug treatment right away.

If the patient develops fulminant hepatitis B or their liver is otherwise severely damaged by HBV, the only option is a liver transplant. This is a serious operation with a lengthy recovery period; its success also depends on finding a suitable donor liver.

Drugs

Patients who know that they have been exposed to the hepatitis B virus can be treated by administering three shots of the HBV vaccine to prevent them from developing an active infection. Those who have already developed symptoms of the acute form of the disease may be given intravenous fluids to prevent **dehydration** or antinausea medications to stop **vomiting**. There is no medication as of late 2009 that can prevent acute hepatitis B from becoming chronic once the symptoms begin.

There are seven different drugs approved in the United States to treat chronic hepatitis B in adults as of 2009, but they do not work in all patients and may produce severe side effects. These drugs include adefovir dipivoxil (Hepsera), alpha interferon (Intron A), pegylated interferon (Pegasys), entecavir (Baraclude), telbivudine (Telzeka), tenofovir (Viread), and lamivudine (Zeffix or Epivir-HBV). The two interferons are given by injection; the other five drugs are taken by mouth in pill form once a day. Most doctors will wait until the patient's liver function begins to worsen before administering these drugs. The drugs do not cure the infection; what they do is lower the patient's risk of severe liver damage by slowing or preventing the hepatitis B virus from reproducing further.

The only drugs approved as of 2009 for treating chronic hepatitis B in children are alpha interferon (Intron A) and lamivudine (Zeffix or Epivir-HBV).

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Alternative

There are no alternative or complementary therapies that are definitely known to be useful in treating or preventing hepatitis B. One herbal remedy, milk thistle (*Silybum marianum*), has been recommended by some alternative practitioners as beneficial to liver function and as a treatment for cirrhosis and viral hepatitis. The seeds of the plant are used to make capsules, extracts, and herbal teas to be taken by mouth.

Several studies have been done on the benefits of milk thistle; however, the studies are of uneven quality and the findings inconclusive as of 2009. The only major side effects of milk thistle are headaches and mild gastrointestinal upset (**diarrhea**, laxative effect, and nausea). While milk thistle is not known to be harmful, patients diagnosed with hepatitis B who wish to try this herb should consult their doctor first.

Prognosis

Each year an estimated 150,000 persons in the United States get hepatitis B. More than 10,000 will require hospital care, and as many as 5,000 will eventually die from complications of the infection. About 90% of all those infected will have acute disease only. It is the remaining 10% with chronic infection who account for most serious complications and deaths from HBV infection. Even when no symptoms of liver disease develop, chronic carriers remain a threat to others by serving as a source of infection.

Patients with acute hepatitis B usually recover; the symptoms go away in 2–3 weeks, and the liver itself returns to normal in about 4 months. Other patients have a longer period of illness with very slow improvement. The course of chronic HBV infection in any particular patient is unpredictable. Some patients who do well at first may later develop serious complications. Chronic hepatitis leads to an increased risk of cirrhosis and liver cancer, and eventual death in about 1 percent of cases.

Prevention

Hepatitis B can be prevented by vaccination with a vaccine called Engerix-B. An adult patient is given the first two doses of the vaccine a month apart and the third dose 6 months later. The vaccine is recommended for all persons under the age of 20; it can be given to newborns and infants as part of their regular vaccination series. Children usually receive the first vaccine between birth and two months of age, the second shot at one to four months, and the third at 6 to 18 months. The vaccine is generally required for all children born on or after January 1, 1992, before they enter school. The vaccine is available for older children who may have not been immunized before 1992 and is recommended to be given before age 11 or 12.

Others who should be vaccinated include health care workers, military personnel, firefighters and police, people who travel frequently to countries with high rates of hepatitis B, people with **hemophilia**, people who must be treated for **kidney disease**, people who inject illegal drugs, and men who have sex with men. A study published in 2009 reported that the immunity conferred by the vaccine lasts for at least 22 years.

Other preventive measures include:

- Practicing safe sex
- Not sharing needles, razors, toothbrushes, or any other personal item that might have blood on it
- Avoiding getting a tattoo or body piercing, as some people who perform these procedures do not sterilize their needles and other equipment properly
- Getting tested for HBV infection if pregnant, as the virus can be transmitted from a mother to her unborn baby
- Consulting a doctor before taking an extended trip to any country with high rates of hepatitis B.
- Carefully disinfecting any bloodstained surface or material with a mixture of chlorine bleach and water

Resources

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Hepatitis C

Definition

Hepatitis C infection is an inflammatory disease of the liver caused by the hepatitis C virus or HCV. The virus is most commonly transmitted from person to person through contaminated blood. It is sometimes called non-A non-B hepatitis.

Demographics

Hepatitis C is the major source of chronic liver infection in North America; it accounts for about 15 percent of cases of acute viral hepatitis, 60 to 70 percent of cases of chronic hepatitis, and up to 50 percent of cases of **cirrhosis**, end-stage **liver disease**, and **liver cancer**. There are approximately 20,000–30,000 new infections and 8,000–10,000 deaths from hepatitis C each year in the United States. It is estimated that 4 million persons in the United States have been infected by the virus and 3.2 million of these have the chronic form of the infection as of 2009. HCV infection presently accounts for 40 percent of referrals to liver clinics. The cost of treating hepatitis C in the United States is estimated to be more than $600 million a year.

Hepatitis C is more common among Hispanics and African Americans than among Caucasians, Asian Americans, or Native Americans. In terms of age groups, 65 percent of persons with HCV infection are between the ages of 30 and 49 years. According to the Centers for Disease Control and Prevention (CDC), the rates of hepatitis C infection are highest among people born between 1945 and 1965. Most of these persons were likely

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infected during the 1970s and 1980s, when rates of hepatitis C in North America were at their peak.

The World Health Organization (WHO) estimates that 170 million individuals worldwide are infected with the hepatitis C virus. The rates vary considerably from country to country, however, from 0.02% of the population in the United Kingdom to 6.5% in Africa to 22% in Egypt.

Description

Hepatitis C is an infection that often goes undetected until it has done significant damage to a patient's liver. The infection is divided into two phases, an acute phase (the first six months) and a chronic phase (after the first six months). A minority of patients clear the virus from their bodies during the acute phase, but 60–85 percent have a chronic HCV infection.

People may have no symptoms of illness at all during the acute phase of HCV infection and possibly only a mild flu-like syndrome later. Such symptoms of severe liver damage as **nausea**, **vomiting**, collection of fluid in the abdomen, and mental changes or severe psychiatric disturbances may not develop for 10 or 20 years after the initial infection with the virus.

Risk factors

People who are at increased risk of hepatitis C include:

- Those who abuse intravenous drugs (60 percent of new cases)
- People who use any form of cocaine, including non-injected (smoked or snorted) cocaine
- People who have unprotected sex with a large number of partners
- People who require hemodialysis for kidney disorders
- People who need frequent blood transfusions
- People who received clotting factor concentrates made before 1987
- Children born to mothers with hepatitis C
- People who are HIV-positive (about 25% of HIV-positive patients in North America are also infected with hepatitis C)
- Health care workers who may get needlestick injuries

There have been several notorious cases of hepatitis C transmission in healthcare settings when syringes, other injectable medications, or intravenous solutions were mishandled and became contaminated. In 2000–2001, there was an outbreak of HCV infection in Nebraska that affected almost a hundred patients at a **cancer** clinic. A physician's wife who began treatment for **breast cancer** at the clinic in 2001 was surprised to find out in 2002 that she was infected with hepatitis C. Her husband discovered on checking his records that several of his patients were also infected; what they had in common was undergoing cancer therapy at the same clinic.

An investigation of the clinic found that the HCV virus had been transmitted to patients through contamination of the saline solution used to cleanse **chemotherapy** equipment. In March 2000, a patient known to have hepatitis C began treatment at the cancer clinic. The clinic nurse used a syringe to rinse the patient's chemotherapy port with saline solution and then used the same syringe to draw more saline from a large common container. In the process, HCV virus was transferred from the infected patient's chemotherapy port to the large container of saline. From there the virus was transmitted to other patients via the saline solution and repeated use of other contaminated syringes.

Causes and symptoms

Causes

Hepatitis C is caused by the HCV virus, which is a spherical, single-stranded RNA virus belonging to the family Flaviviridae. HCV is most often transmitted from one person to another through infected blood or blood products, but it can also be transmitted from mother to child during **childbirth** or through sexual intercourse. Before 1992, the virus was sometimes transmitted through blood transfusions, hemodialysis, or transplanted organs from infected donors, but these are now rare events. In 1992, researchers invented a new test for checking blood products for HCV; as a result, new infections per year in the United States declined from 240,000 in the 1980s to about 20,000–30,000 per year as of 2009. The most common cause of HCV transmission at present is intravenous drug use; transfusion-related cases of hepatitis C now occur only once in every 2 million transfused units of blood.

Hepatitis C infection is sometimes divided into an early phase called the acute stage and a later phase called the chronic stage. The acute stage begins when the virus enters the body; it lasts for about six months. Antibodies to the virus can usually be detected between 3 and 12 weeks after infection. About 15–25 percent of people who are infected clear the virus from their bodies during this phase, while the other 75–85 percent go on to develop chronic hepatitis C infection. Doctors do not yet know why some patients clear the virus without treatment and others do not. It is this second

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KEY TERMS

Antibody—A substance made by the body in response to a foreign body, such as a virus, which is able to attack and destroy the invading virus.

Ascites—Accumulation of fluid in the abdomen.

Chronic—Recurrent or long-term. Chronic hepatitis C refers to an infection that has lasted longer than 6 months and has not been cleared by the patient's body.

Cirrhosis—Disruption of normal liver function by the formation of scar tissue and nodules in the liver. It is most commonly caused by alcoholism or hepatitis C.

Contamination—The process by which an object or body part becomes exposed to an infectious agent such as a virus.

Genotype—The genetic makeup of a cell or organism. There are six genotypes of the virus that causes hepatitis C.

Hepatitis—Inflammation of the liver. It can be caused by toxic substances or alcohol as well as infections.

Jaundice—A yellowish discoloration of the skin and whites of the eyes caused by increased levels of bile pigments from the liver in the patient's blood.

Relapse—A temporary recurrence of the symptoms of a disease.

group of patients who run the risk of suffering cirrhosis or other forms of liver or kidney damage years later.

Symptoms

Eighty percent of patients infected by the hepatitis C virus in its early stage do not have any symptoms, or have mild and nonspecific symptoms like **fatigue**. In patients who do develop symptoms, the average time period from exposure to symptom onset is 4–12 weeks, although some feel sick in as little as two weeks after exposure. Others have a flu-like syndrome marked by poor appetite or nausea, soreness in the area of the abdomen over the liver, or pains in the joints and muscles. Some may notice that their urine is darker than normal and looks like tea or cola.

If chronic HCV infection leads to liver disease 10–20 years later, the patient may have the following symptoms:

- Severe loss of appetite
- Nausea and vomiting, with blood in the vomit
- Low-grade fever
- Itchy skin
- Jaundice. This is a yellowish discoloration of the whites of the eyes and the skin caused by an increase in the amount of bile pigments from the liver in the patient's blood.
- Sleep disturbances
- Swelling of the abdomen caused by fluid retention
- Diarrhea
- Clay-colored stools
- Difficulty urinating
- Confusion, hallucinations, difficulty concentrating, or other mental disturbances

Diagnosis

The diagnosis of hepatitis C infection is often delayed for years because many patients with chronic HCV infection do not have noticeable or troublesome symptoms until damage to the liver has already occurred. In some cases a person with chronic hepatitis C is detected through routine blood testing for abnormal liver function or because they have a history of intravenous drug **abuse**, organ transplantation, hemodialysis treatment, or HIV infection. The diagnosis is based on a combination of the patient's history and the results of blood tests.

Examination

Many patients infected with hepatitis C will not have any visible symptoms during a routine office examination. In some cases, however, the doctor may observe swelling or tenderness in the right upper quadrant of the patient's abdomen; enlargement of the spleen; signs of **jaundice**; scratches or abrasions on the skin; swollen ankles; and evidence of muscle wasting. The doctor may also be able to detect the presence of fluid in the patient's abdomen (**ascites**).

Tests

Testing for chronic HCV infection begins with blood tests that indicate the presence of antibodies to the hepatitis C virus. Since antibody tests cannot tell whether the person is currently infected, however, a second blood test that looks for the virus's characteristic RNA is performed.

If the results are positive for both tests, the doctor will order a third blood test that determines the virus's specific genotype or genetic makeup. There are six

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known genotypes of the HCV virus as of 2009, and more than 50 subtypes have been identified. Knowing which type is involved helps to guide the patient's treatment. The most common HCV genotype in patients in North America is genotype 1, found in 75% of patients diagnosed with chronic hepatitis C. Unfortunately, this genotype is less responsive to therapy than the others. Genotype 1 also may be associated with more severe liver disease and a higher risk of liver cancer.

Genotypes 1 and 2 are found worldwide whereas the others are limited to specific geographical regions. Genotype 3 is found in Australia, India, and Thailand. Genotype 4 is the most common HCV genotype in Egypt and the Middle East. Genotype 5 is found in South Africa, while genotype 6 is more common in Southeast Asia, particularly in Hong Kong, Macao, and Vietnam.

Other tests that are performed to guide treatment and monitor the effects of the drugs used to treat hepatitis C include a **complete blood count** (CBC); **liver function tests**; screening for co-infection with HIV or **hepatitis B**; and screening for alcohol and drug abuse.

Procedures

To determine the extent of damage to the patient's liver, the doctor may order a **liver biopsy**. In this procedure, a needle is inserted into the patient's liver through the abdomen in order to remove a small sample of tissue for analysis.

The doctor may also order an ultrasound of the liver. Other imaging studies are not particularly useful in diagnosing hepatitis C.

Treatment

Traditional

The goals of treatment for hepatitis C are 1) to achieve persistent absence of HCV RNA in the patient's blood six months and longer after the end of drug therapy; and 2) prevent the disease from progressing to cirrhosis and liver cancer.

Drugs

The first line of treatment in hepatitis C is two medications known as Intron A, a drug that resembles the antibodies that the body makes naturally to fight viruses; and Virazole, which is an antiviral drug. The combination of these drugs works better than Intron A alone. Intron A is given as a shot once a week and Virazole is taken as a pill twice a day. The length of treatment depends on the genotype of the HCV virus; patients with genotype 2 and 3 are treated for 24 weeks whereas patients with genotypes 1 or 4 must undergo 48 weeks of treatment. The cure rates for genotypes 1 and 3 are between 60 and 75 percent; the cure rate for genotype 1 is 50 percent and for genotype 4, 65 percent. Unfortunately, Intron A and Virazole produce unpleasant side effects for patients that range from depression and irritability to weight loss, nausea, and muscle pains. In addition to side effects in adult patients, Virazole cannot be given at all to pregnant women because it can harm the unborn child. In rare cases, patients treated with Intron A for hepatitis C have had psychotic episodes.

Combination therapy with these drugs is not recommended for patients who have already developed cirrhosis due to hepatitis C, or for patients who have received kidney, liver, or heart transplants. Other patients who should not be given these drugs include those with lupus or other autoimmune diseases; severe psychiatric disorders; **coronary artery disease**; inability to practice birth control; and active alcohol or **substance abuse**.

Patients treated for hepatitis C are monitored for levels of HCV RNA in their blood during treatment, usually at the 12-week mark; at the completion of therapy; and six months after the completion of therapy. If the patient has a detectable level of HCV RNA at this point, they are considered to have a relapse. There are few treatment options for patients who do not respond to drug therapy or have a relapse as of 2009.

Surgery

The only treatment for cirrhosis or severe liver disease as of 2009 is **liver transplantation**. Chronic HCV infection, in fact, is the leading indication for liver transplants in the United States. The problem, however, is that there are many more patients waiting for donated livers than there are suitable organs available. In addition, liver transplantation does not cure HCV infection; most people who receive transplanted livers will develop a recurrence of the virus. About 30% of recipients die, develop cirrhosis, or have the transplanted liver fail within five years of surgery, with the rate of failure increasing with each year of follow-up. The effectiveness of medication treatment of hepatitis C following a liver transplant is unclear as of 2009.

Patients with chronic hepatitis C should stop drinking alcohol, as even small amounts can speed up the rate of liver damage. They should also be vaccinated against **hepatitis A** and hepatitis B.

Prognosis

The prognosis of hepatitis C is guarded for most patients. The **antiviral drugs** presently used to treat the

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infection cure only about 60% of patients. According to the CDC, between 75 and 85 percent of people infected with HCV will develop chronic HCV infection, and 60–70 percent will develop some form of chronic liver disease. Twenty percent of these chronically infected persons will develop cirrhosis of the liver within 20 years of infection; 1–5 percent of chronically infected people will eventually die of liver disease.

Women with chronic hepatitis C have better outcomes than men, and patients infected at younger ages have better outcomes than those infected in middle age. The reason for these differences is not clear as of 2009.

A small percentage of patients with hepatitis C develop medical conditions that are not related to the liver. It is thought that these conditions result from the body's immune response to the HCV virus. These conditions include **diabetes mellitus**; skin **rashes**; inflammation of the kidney (**glomerulonephritis**); non-Hodgkin lymphoma; and essential mixed cryoglobulinemia, a condition marked by the presence of abnormal proteins in the blood.

Prevention

There is no vaccine that can prevent hepatitis C infection as of 2009, and there is no treatment that can prevent someone who recovered from one genotype of the virus from contracting a different genotype. Prevention depends on careful observation of good health practices in hospitals and clinics, and on individual lifestyle changes. The CDC recommends the following ways that individuals can lower their risk of getting hepatitis C:

- Do not use intravenous drugs. People who cannot quit should never share their needles, syringes, water, or other materials used to inject drugs. They should also get vaccinated against hepatitis A and hepatitis B.
- Do not share personal items (razors, toothbrushes, nail clippers, etc.) that might have blood on them.
- Avoid getting tattoos or body piercing. People who do get a tattoo, however, should at least make sure that the operator who performs the tattoo is using proper sterile procedure.
- Use latex condoms when having sex. Although it is rare for hepatitis C to be transmitted through sexual intercourse, it can happen.
- People who discover that they are infected with hepatitis C should not donate blood, organs, or tissues.
- Health care personnel must take special precautions when performing or assisting with surgical or dental procedures on patients with hepatitis C.

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ORGANIZATIONS

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National Institute of Allergy and Infectious Diseases (NIAID), 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-6612, (301) 496-5717, (866) 284-4107, (301) 402-3573, http://www3.niaid.nih.gov.
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Rebecca J. Frey, PhD

Hepatitis D

Definition

Hepatitis D (or delta, the Greek letter "D"), is a form of liver inflammation that occurs only in patients who also are infected by the **hepatitis B** virus. Infection by the hepatitis delta virus (HDV) either occurs at the same time as hepatitis B develops or develops later when infection by hepatitis B virus (HBV) has entered the chronic (long-lasting) stage.

Description

Delta hepatitis can be quite severe, but it is seen only in patients already infected by HBV. In the late 1970s, Italian physicians discovered that some patients with hepatitis B had another type of infectious agent in their liver cells. Later the new virus—HDV—was confirmed by experimentally infecting chimpanzees. When both viruses are present, acute infection tends to be more severe. Furthermore, patients with both infections are more likely than those with HBV alone to develop chronic **liver disease**, and, when it occurs, it is more severe.

About 300 million persons worldwide carry HBV. Of them, at least 5% probably also have delta hepatitis. In North America HDV infection appears to be less frequent: 4% of all patients with acute hepatitis B have HDV infection. The delta virus causes an estimated 2% of all cases of acute viral hepatitis in the United States. The rate of HDV infection varies widely in different parts of the world; it is a very serious infection in some countries and quite mild in others. Chronic delta hepatitis is a more serious disease than either chronic hepatitis B alone or **hepatitis C**.

Certain individuals—the same ones who are at increased risk of developing hepatitis B—are the prime candidates to be infected by HDV. For example:

- Not infrequently, HDV infection occurs in patients with chronic HBV infection who also have hemophilia, a bleeding disease. These patients are at risk because they require large amounts of transfused blood and blood products that may contain HDV.
- In some areas, one-fourth to one-half of patients with chronic HBV infection who inject themselves with illicit drugs become infected by HDV as well. Drug abusers who share contaminated needles are likely to infect one another.
- Patients who get HBV infection by sexual contact may also be infected by HDV, although the delta virus is less often spread in this way than is HBV itself. Between 10–25% of homosexual men with chronic HBV infection harbor the delta virus.
- Like hepatitis B, HDV infection may develop in healthcare workers who are victims of a needle stick, and it also can be spread within households when personal items such as a razor or toothbrush are shared.

Causes and symptoms

The delta virus is a small and incomplete viral particle. Perhaps this is why it cannot cause infection

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KEY TERMS

Alpha-interferon—A natural body substance that now can be made in large quantities and is an effective treatment for some types of viral inflammatory disease, including hepatitis C.

Antibody—A substance formed in the body in response to an invading microorganism, such as a virus, which can attack and destroy the invading virus.

Coinfection—Invasion of the body by two viruses at about the same time.

Hemophilia—A bleeding disease that may call for the transfusion of large amounts of blood and blood products.

Superinfection—Infection by a second virus after a previous infection by a different virus has become well established.

on its own. Its companion virus, HBV, actually forms a covering over the HDV particle. In chronically ill patients (those whose virus persists longer than six months), the combined viruses cause inflammation throughout the liver and eventually destroy the liver cells, which are then replaced by scar tissue. This scarring is called **cirrhosis**.

When HBV and HDV infections develop at the same time, a condition called coinfection, recovery is the rule. Only 2–5% of patients become chronic carriers (have the virus remain in their blood more than six months after infection). It may be that HDV actually keeps HBV from reproducing as rapidly as it would if it were alone, so chronic infection is less likely.

When HBV infection occurs first and is followed by HDV infection, the condition is called superinfection. This is a more serious situation. Between half and two-thirds of patients with superinfection develop severe acute hepatitis. Once the liver cells contain large numbers of HBV viruses, HDV tends to reproduce more actively. Massive infection and liver failure are more common in superinfection. The risk of **liver cancer**, however, is no greater than from hepatitis B alone.

As with other forms of hepatitis, the earliest symptoms are **nausea**, loss of appetite, joint pains, and tiredness. There may be **fever** (not marked), and an enlarged liver may cause discomfort or actual **pain** in the right upper part of the abdomen. Later, **jaundice** (a yellowing of the skin and whites of the eyes that occurs when the liver is no longer able to eliminate certain pigmented substances) may develop.

Diagnosis

HDV infection may be diagnosed by detecting the antibody against the virus. Unfortunately this test cannot detect acute coinfection or superinfection as early as when symptoms first develop. Antibody against HDV usually is found no sooner than 30 days after symptoms appear. Until recently, the virus itself could only be identified by testing a small sample of liver tissue. Scientists now are developing a blood test for HDV that should make diagnosis faster and easier. When HDV is present, liver enzymes (proteins made by the liver) are present in abnormally high amounts. In some patients with coinfection, the enzyme levels peak twice, once when HBV infection starts and again at the time of HDV infection.

Treatment

As in any form of hepatitis, patients in the acute stage should rest in bed as needed, eat a balanced diet, and avoid alcohol. Alpha-interferon, the natural body substance which helps control hepatitis C, has generally not been found helpful in treating hepatitis D. If the liver is largely destroyed and has stopped functioning, **liver transplantation** is an option. Even when the procedure is successful, the disease often recurs and cirrhosis may actually develop more rapidly than before.

Prognosis

A large majority of patients with coinfection of HBV and HDV recover from an episode of acute hepatitis. However, about two-thirds of patients chronically infected by HDV go on to develop cirrhosis of the liver. In one long-term study, just over half of patients who became carriers of HDV had moderate or severe liver disease, and one-fourth of them died. If very severe liver failure develops, the chance of a patient surviving is no better than 50%. A liver transplant may improve this figure to 70%. When transplantation is done for cirrhosis, rather than for liver failure, nearly 90% of patients live five years or longer. The major concern with transplantation is infection of the transplanted liver; this may occur in as many as 40% of transplant patients.

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When a child with viral hepatitis develops cirrhosis, HDV infection is commonly responsible. A woman who develops delta hepatitis while pregnant will do as well as if she were not pregnant, and there is no increased risk that the newborn will be malformed in any way.

Prevention

The vaccine against hepatitis B also prevents delta hepatitis, since it cannot occur unless HBV infection is present. Hopefully, a vaccine can be developed that will keep delta infection from developing in chronic HBV carriers. However, if a person already has HBV infection, any exposure to blood should be strictly avoided. A high level of sexual activity with multiple partners is also a risk factor for delta hepatitis.

ORGANIZATIONS

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Hepatitis, drug-induced

Definition

Inflammation of the liver due to an adverse reaction with a drug.

Description

The liver is a very important organ to the body. It is a large internal organ weighing more than three pounds in the average adult. It performs over 100 functions including formation of bile; **detoxification** of harmful substances; vitamin storage; and metabolism of carbohydrates, fats, and proteins. Serious complications could arise when the liver becomes inflamed due to hepatitis when it is not able to perform these tasks. A virus most often causes hepatitis but certain drugs can also induce it.

Drug-induced hepatitis (also called toxic hepatitis) occurs in eight in every 10,000 people because the liver reacts abnormally during drug exposure, leading to liver damage. This pathology causes the liver not to function properly and the symptoms can begin to be seen. Women tend to be affected almost twice as often as men. Older people are more prone to this type of hepatitis because their bodies aren't able to repair themselves as fast as younger people. Drugs that can be associated with drug-induced hepatitis include **acetaminophen**, vitamin A, and PTU (a drug treatment for **tuberculosis**).

Causes and symptoms

There are three general types of drug-induced hepatitis: toxic, metabolic idiosyncrasy, and immunologic idiosyncrasy. With toxic hepatitis liver damage as the result of a drug complication with hepatotoxins happens to everyone who takes that particular drug. On the other hand, hepatitis resulting from a metabolic or immunologic idiosyncrasy only happens to certain people, those predisposed to particular idiosyncrasy.

In patients with a metabolic idiosyncrasy the person metabolizes the drug differently than most people causing a harmful by-product that damages the liver. A metabolic idiosyncrasy is seen in 0.1-2% of people and it is complicated by use of alcohol.

With an immunologic idiosyncrasy the patient's body recognizes the metabolized drug by-products as foreign. This leads to the destruction of liver cells containing the by-product via the immune system resulting in hepatitis. An immunologic idiosyncrasy is seen in less than one person per 10,000 (0.01%) people and is more than twice as common in women.

The symptoms of drug-induced hepatitis are similar to viral hepatitis. Drug induced hepatitis tends to be acute. If it is not caught soon enough the damage could be permanent resulting in chronic hepatitis. Some of the common symptoms are:

- nausea
- vomiting
- headache
- anorexia
- jaundice
- clay color stools
- dark urine
- hepatomegaly

Diagnosis

Diagnosis is typically made through a physical exam along with a patient history to identify any possible hepatotoxins. Blood tests are usually done as well. An increased **white blood cell count** is typical.

Treatment

There isn't any specific treatment other than immediate discontinuance of the causative agent. Rest

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KEY TERMS

Hepatitis—General inflammation of the liver.

Hepatomegaly—General swelling of the liver.

Hepatotoxin—A substance that is toxic to the liver.

Idiosyncrasy—A defect in that particular pathway resulting in an abnormality.

during the acute phase of the disease is vital along with the intake of fluids to maintain hydration.

Prognosis

Usually the symptoms will go away after the drug has been eliminated due to the liver repairing itself. A full recovery is typically expected unless it wasn't treated quickly resulting in more liver damage being done than normal.

Prevention

If there is a history of liver damage certain medications should not be taken. Doctors will be familiar with these.

Resources

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Thomas Scott Eagan
Ronald Watson, PhD

Hepatitis E

Definition

The hepatitis E virus (HEV) is a common cause of hepatitis that is transmitted via the intestinal tract, and is not caused by the **hepatitis A** virus. Spread most often by contaminated drinking water, HEV infection occurs mainly in developing countries.

Description

Hepatitis E is also known as epidemic non-A, non-B hepatitis. Like hepatitis A, it is an acute and short-lived illness that can sometimes cause liver failure. HEV, discovered in 1987, is spread by the fecal-oral route. It is constantly present (endemic) in countries where human waste is allowed to get into drinking water without first being purified. Large outbreaks (epidemics) have occurred in Asian and South American countries where there is poor sanitation. In the United States and Canada no outbreaks have been reported, but persons traveling to an endemic region may return with HEV.

Causes and symptoms

There are at least two strains of HEV, one found in Asia and another in Mexico. The virus may start dividing in the gastrointestinal tract, but it grows mostly in the liver. After an incubation period (the time from when a person is first infected by a virus until the appearance of the earliest symptoms) of two to eight weeks, infected persons develop a **fever**, may feel nauseous, lose their appetite, and often have discomfort or actual **pain** in the right upper part of the abdomen where the liver is located. Some develop yellowing of the skin and the whites of the eyes (**jaundice**). Most often the illness is mild and disappears within a few weeks with no lasting effects. Children younger than 14 years and persons over age 50 seldom have jaundice or show other clinical signs of hepatitis.

Hepatitis E never becomes a chronic (long-lasting) illness, but on rare occasions the acute illness damages and destroys so many liver cells that the liver can no longer function. This is called fulminant liver failure and may cause **death**. Pregnant women are at much higher risk of dying from fulminant liver failure; this increased risk is not true of any other type of viral hepatitis. The great majority of patients who recover from acute infection do not continue to carry HEV and cannot pass on the infection to others.

Diagnosis

HEV can be found by microscopically examining a stool sample, but this is not a reliable test, as the virus often dies when stored for a short time. Like other hepatitis viruses, HEV stimulates the body's immune system to produce a substance called an antibody, which can swallow up and destroy the virus. Blood tests can determine elevated antibody levels, which indicate the presence of HEV virus in the body. Unfortunately, such antibody blood tests are not widely available.

Treatment

There is no way of effectively treating the symptoms of any acute hepatitis, including hepatitis E.

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KEY TERMS

Antibody—A substance made by the body's immune system in response to an invading virus, the antibodies then attack and destroy the virus.

Incubation period—The time from when a person is first infected by a virus until the appearance of the earliest symptoms.

Jaundice—Yellowing of the skin that occurs when pigments normally eliminated by the liver collect in high amounts in the blood.

Sanitation—The process of keeping drinking water, foods, or any anything else with which people come into contact free of microorganisms such as viruses.

Vaccine—A substance prepared from a weakened or killed virus which, when injected, stimulates the immune system to produce antibodies that can prevent infection by the natural virus.

During acute infection, a patient should eat a balanced diet and rest in bed as needed.

Prognosis

In the United States hepatitis E is not a fatal illness, but elsewhere about 1–2% of those infected die of advanced liver failure. In pregnant women the death rate is as high as 20%. It is not clear whether having hepatitis E once guarantees against future HEV infection.

Prevention

Most attempts to use blood serum containing HEV antibody to prevent hepatitis in those exposed to HEV have failed. Hopefully, this approach can be made to work so that pregnant women living in endemic areas can be protected. No vaccine is available, though several are being tested. It also is possible that effective anti-viral drugs will be found. The best ways to prevent hepatitis E are to provide safe drinking water and take precautions to use sterilized water and beverages when traveling.

ORGANIZATIONS

American Liver Foundation, 75 Maiden Lane, Suite 603, New York, NY, 10038, (212) 668-1000, (212) 483-8179, http://www.liverfoundation.org/.

David A. Cramer, MD

Hepatitis G

Definition

Hepatitis G is a newly discovered form of liver inflammation caused by hepatitis G virus (HGV), a distant relative of the **hepatitis C** virus.

Description

HGV, also called hepatitis GB virus, was first described early in 1996. Little is known about the frequency of HGV infection, the nature of the illness, or how to prevent it. What is known is that transfused blood containing HGV has caused some cases of hepatitis. For this reason, patients with **hemophilia** and other bleeding conditions who require large amounts of blood or blood products are at risk of hepatitis G. HGV has been identified in between 1–2% of blood donors in the United States. Also at risk are patients with **kidney disease** who have blood exchange by hemodialysis and those who inject drugs into their veins. It is possible that an infected mother can pass on the virus to her newborn infant. Sexual transmission also is a possibility.

Often patients with hepatitis G are infected at the same time by the **hepatitis B** or C virus, or both. In about three of every thousand patients with acute viral hepatitis, HGV is the only virus present. There is some indication that patients with hepatitis G may continue to carry the virus in their blood for many years, and so might be a source of infection in others.

Causes and symptoms

Some researchers believe that there may be a group of GB viruses, rather than just one. Others remain doubtful that HGV actually causes illness. If it does, the type of acute or chronic (long-lasting) illness that results is not clear. When diagnosed, acute HGV infection has usually been mild and brief. There is no evidence of serious complications, but it is possible that, like other hepatitis viruses, HGV can cause severe liver damage resulting in liver failure. The virus has been identified in as many as 20% of patients with long-lasting viral hepatitis, some of whom also have hepatitis C.

Diagnosis

The only method of detecting HGV is a complex and costly DNA test that is not widely available. Efforts are under way, however, to develop a test for the HGV antibody, which is formed in response to invasion by the virus. Once antibody is present,

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KEY TERMS

Antibody—A substance made by the body's immune system in response to an invading virus; antibodies then attack and destroy the virus.

Hemophilia—A bleeding disorder that often makes it necessary to give patients dozens or even hundreds of units of blood and blood products over time.

however, the virus itself generally has disappeared, making the test too late to be of use.

Treatment

There is no specific treatment for any form of acute hepatitis. Patients should rest in bed as needed, avoid alcohol, and be sure to eat a balanced diet.

Prognosis

What little is known about the course of hepatitis G suggests that illness is mild and does not last long. When more patients have been followed up after the acute phase, it will become clear whether HGV can cause severe liver damage.

Prevention

Since hepatitis G is a blood-borne infection, prevention relies on avoiding any possible contact with contaminated blood. Drug users should not share needles, syringes, or other equipment.

ORGANIZATIONS

American Liver Foundation, 75 Maiden Lane, Suite 603, New York, NY, 10038, (212) 668-1000, (212) 483-8179, http://www.liverfoundation.org/.

David A. Cramer, MD

Hepatitis virus studies *see* **Hepatitis virus tests**

Hepatitis virus tests

Definition

Viral hepatitis is any type of liver inflammation caused by a viral infection. The three most common viruses now recognized to cause **liver disease** are **hepatitis A**, **hepatitis B**, and hepatitis non-A, non-B (also called **hepatitis C**). Several other types have been recognized: **hepatitis D**, **hepatitis E**, and the recently identified **hepatitis G**. A seventh type (hepatitis F) is suspected but not yet confirmed.

Purpose

The different types of viral hepatitis produce similar symptoms, but they differ in terms of transmission, course of treatment, prognosis, and carrier status. When the clinical history of a patient is insufficient for differentiation, hepatitis virus tests are used as an aid in diagnosis and in monitoring the course of the disease. These tests are based primarily on antigen-antibody reactions—an antigen being a protein foreign to the body, and an antibody another type of protein manufactured by lymphocytes (a type of white blood cell) to neutralize the antigen.

Description

There are five major types of viral hepatitis. The diseases, along with the antigen-antibody tests available to aid in diagnosis, are

Hepatitis A

Commonly called infectious hepatitis, this is caused by the hepatitis A virus (HAV). It is usually a mild disease, most often spread by food and water contamination, but sometimes through sexual contact. Immunologic tests are not commercially available for the HAV antigen, but two types of antibodies to HAV can be detected. IgM antibody (anti-HAV/IgM), appears approximately three to four weeks after exposure and returns to normal within several months. IgG (anti-HAV/IgG) appears approximately two weeks after the IgM begins to increase and remains positive. Acute hepatitis is suspected if IgM is elevated; conversely, if IgG is elevated without IgM, a convalescent stage of HAV is presumed. IgG antibody can remain detectable for decades after infection.

Hepatitis B

Commonly known as serum hepatitis, this is caused by the hepatitis B virus (HBV). The disease can be mild or severe, and it can be acute (of limited duration) or chronic (ongoing). It is usually spread by sexual contact with another infected person, through contact with infected blood, by intravenous drug use, or from mother to child at birth.

HBV, also called the Dane particle, is composed of an inner protein core surrounded by an outer protein capsule. The outer capsule contains the hepatitis B surface antigen (HBsAg), formerly called the Australia antigen. The inner

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core contains HBV core antigen (HBcAg), and the hepatitis B e-antigen (HBeAg). Antibodies to these antigens are called anti-HBs, anti-HBc, and anti-HBe. Testing for these antigens and antibodies is as follows:

- Hepatitis B surface antigen (HBsAg). This is the first test for hepatitis B to become abnormal. HBsAg begins to elevate before the onset of clinical symptoms, peaks during the first week of symptoms, and usually disappears by the time the accompanying jaundice (yellowing of the skin and other tissues) begins to subside. HBsAg indicates an active HBV infection. A person is considered to be a carrier if this antigen persists in the blood for six or more months.
- Hepatitis B surface antibody (anti-HBs). This appears approximately one month after the disappearance of the HBsAg, signaling the end of the acute infection period. Anti-HBs is the antibody that demonstrates immunity after administration of the hepatitis B vaccine. Its presence also indicates immunity to subsequent infection.
- Hepatitis B core antigen (HBcAg). No tests are commercially available to detect this antigen.
- Hepatitis B core antibody (anti-HBc). This appears just before acute hepatitis develops and remains elevated (although it slowly declines) for years. It is also present in chronic hepatitis. The hepatitis B core antibody is elevated during the time lag between the disappearance of the hepatitis B surface antigen and the appearance of the hepatitis B surface antibody in an interval called the "window." During this time, the hepatitis B core antibody is the only detectable marker of a recent hepatitis B infection.
- Hepatitis B e-antigen (HBeAg). This is more useful as an index of infection than for diagnostic purposes. The presence of this antigen correlates with early and active disease, as well as with high infectivity in patients with acute HBV infection. When HBeAg levels persist in the blood, the development of chronic HBV infection is suspected.
- Hepatitis B e-antibody (anti-HBe). In the bloodstream, this indicates a reduced risk of infectivity in patients who have previously been HBeAg positive. Chronic hepatitis B surface antigen carriers can be positive for either HBeAg or anti-HBe, but are less infectious when anti-HBe is present. Antibody to e antigen can persist for years, but usually disappears earlier than anti-HBs or anti-HBc.

Hepatitis C

Previously known as non-A non-B hepatitis, this disease is primarily caused by the hepatitis C virus (HCV). It is generally mild, but more likely than hepatitis B to lead to chronic liver disease, possible liver failure, and the eventual need for transplant. Chronic carrier states develop in more than 80% of patients, and chronic liver disease is a major problem. As many as 20% of patients with chronic hepatitis C will develop liver failure or **liver cancer**. HCV is spread through sexual contact, as well as through sharing drug needles, although nearly half of infections can't be traced as to origin.

Hepatitis C is detected by HCV serology (tests on blood sera). A specific type of assay called enzyme-linked immunosorbent assay (ELISA) was developed to detect antibody to hepatitis C for diagnostic purposes, as well as for screening blood donors. Most cases of post-transfusion non-A, non-B hepatitis are caused by HCV, but application of this test has virtually eliminated post-transfusion hepatitis. An HCV viral titer to detect HCV RNA in the blood is now available, and recently, IgM anti-HCV core is proving to be a useful acute marker for HCV infection.

Hepatitis D

Also called delta hepatitis, this is caused by the hepatitis D virus (HDV). The disease occurs only in those who have HBV in the blood from a past or simultaneously occurring infection. Experts believe transmission may occur through sexual contact, but further research is needed to confirm that. Most cases occur among those who are frequently exposed to blood and blood products. Many cases also occur among drug users who share contaminated needles. Hepatitis D virus (HDV) antigen can be detected by radioimmunoassay within a few days after infection, together with IgM and total antibodies to HDV.

Hepatitis E

Caused by the hepatitis E virus (HEV), this is actually another type of non-A non-B hepatitis. The virus is most often spread through fecally contaminated water, but the role of person-to-person transmission is unclear. This form of hepatitis is quite rare in the United States. There are currently no antigen or antibody tests widely available to accurately detect HEV.

Preparation

Hepatitis virus tests require a blood sample. It is not necessary for the patient to withhold food or fluids before any of these tests, unless requested to do so by the physician.

Risks

Risks for these tests are minimal for the patient, but may include slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after

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venipuncture, or hematoma (blood accumulating under the puncture site).

Normal results

Reference ranges for the antigen/antibody tests are as follows:

- hepatitis A antibody, IgM: Negative
- hepatitis B core antibody: Negative
- hepatitis B e antibody: Negative
- hepatitis B e-antigen: Negative
- hepatitis B surface antibody: Varies with clinical circumstance (Note: As the presence of anti-HBs indicates past infection with resolution of previous hepatitis B infection, or vaccination against hepatitis B, additional patient history may be necessary for diagnosis.)
- hepatitis B surface antigen: Negative
- hepatitis C serology: Negative
- hepatitis D serology: Negative.

Abnormal results

Hepatitis A: A single positive anti-HAV test may indicate previous exposure to the virus, but due to the antibody persisting so long in the bloodstream, only evidence of a rising anti-HAV titer confirms hepatitis A. Determining recent infection rests on identifying the antibody as IgM (associated with recent infection). A negative anti-HAV test rules out hepatitis A.

Hepatitis B: High levels of HBsAg that continue for three or more months after onset of acute infection suggest development of chronic hepatitis or carrier status. Detection of anti-HBs signals late convalescence or recovery from infection. This antibody remains in the blood to provide immunity to reinfection.

Hepatitis C (non-A non-B hepatitis): Anti-HBc develops after exposure to hepatitis B. As an early indicator of acute infection, antibody (IgM) to core antigen (anti-HBc IgM) is rarely detected in chronic infection, so it is useful in distinguishing acute from chronic infection, and hepatitis B from non-A, non-B.

Resources

BOOKS

Pagana, Kathleen Deska, and Timothy J. Pagana. *Mosby's Manual of Diagnostic and Laboratory Tests*. 4th ed. St. Louis: Mosby, 2009.

Janis O. Flores

Hepatobiliary scan *see* **Gallbladder nuclear medicine scan**

Hepatocellular carcinoma *see* **Liver cancer, primary**

Hepatolenticular degeneration *see* **Wilson's disease**

Hepatoma *see* **Liver cancer, primary**

Herbal medicine *see* **Herbalism, western**

Herbalism, traditional Chinese

Definition

Chinese herbalism is one of the major components of **traditional Chinese medicine** (TCM), or Oriental medicine (OM). In TCM, herbs are often used in conjunction with other techniques, such as **acupuncture** or massage. Chinese herbalism is a holistic medical system, meaning that it looks at treating a patient as a whole person, looking at the mental and spiritual health, as well as the physical health, of the individual. Illness is seen as a disharmony or imbalance among these aspects of the individual. Chinese herbalism has been practiced for over 4,000 years.

One of the earliest and certainly the most important Chinese herbal text is the *Huang Ti Nei Ching*, or *Yellow Emperor's Classic of Internal Medicine*. It is believed to be authored by Huang Ti during his reign over China, which started about 2697 B.C. Since that time, herbal practices have been more extensively documented and refined. In modern China, traditional Chinese

Five popular Chinese herbs used in the United States

Herb	Purpose
Astragalus (huang qi)	Builds immune system; offsets side effects of chemotherapy and radiation treatments
Dong quai (dang gui)	Stimulates the production of red blood cells and bone marrow; increases cardiovascular endurance; regulates menstrual disorders
Ginseng (ren shen)	Increases physical stamina; general tonic
Reishi mushroom (ling zhi)	Eliminates toxins; increases physical stamina
Schisandra (wu wei zu)	Prevents fluid loss (e.g., excessive sweating, runny nose, incontinence)

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herbalism is taught alongside conventional Western pharmacology. Chinese herbal remedies have been used in the West only relatively recently, over the past two decades. These remedies are more gentle and natural that conventional medicines. In addition, they have fewer unpleasant side effects. Individuals with chronic disorders in particular are increasingly drawn to the holistic aspect of Chinese herbalism and TCM in general.

Purpose

Because it is a safe, inexpensive solution to health problems of all kinds, Chinese herbalism is very popular in China. In recent years, herbalism has been modernized with the introduction of quality control. For example, herbs are subjected to absorption spectrometry to determine levels of heavy metals found in some. Because they are standardized, Chinese herbs are safer for self-treatment. This puts the individual, not the physician, in charge of the individual's health; that is a basic goal of Chinese herbalism.

Chinese herbalism offers unique advice regarding what foods can help and what can hinder, and an herbalist can help an individual discover foods that might cause an allergic reaction. In addition, Chinese herbs stimulate the immune system and provide beneficial nutrients, aside from their role in curing illness.

At M.D. Anderson Hospital in Texas, medical research has confirmed that patients undergoing **chemotherapy** were shown to have an improved degree of immune function when they took the tonic herb astragulus (*huang qi*). (It is well known that chemotherapy suppresses the immune system.) Research also showed that T-cell and macrophage activity and interferon production was increased in patients using the Chinese herbs ganoderma, lentinus, and polyporous, helping the body fight **cancer** cells. Agents also found in ganoderma were found to inhibit platelet aggregation and thrombocyte formation, which would be helpful to counter circulation and heart problems.

An ingredient of **ginseng** was found to promote adrenal function, which would give the herb properties of enhancing many hormone functions in the body.

Description

Origins

HISTORICAL BACKGROUND. Traditional Chinese medicine originated in the region of eastern Asia that today includes China, Tibet, Vietnam, Korea, and Japan. Tribal shamans and holy men who lived as hermits in the mountains of China as early as 3500 B.C. practiced what was called the "Way of Long Life." This regimen included a diet based on herbs and other plants; kung-fu exercises; and special breathing techniques that were thought to improve vitality and life expectancy.

After the Han dynasty, the next great age of Chinese medicine was under the Tang emperors, who ruled from A.D. 608 to 906. The first Tang emperor established China's first medical school in A.D. 629 Under the Song (A.D. 960–1279) and Ming (A.D. 1368–1644) dynasties, new medical schools were established, their curricula and qualifying examinations were standardized, and the traditional herbal prescriptions were written down and collected in encyclopedias. One important difference between the development of medicine in China and in the West is the greater interest in the West in surgical procedures and techniques.

PHILOSOPHICAL BACKGROUND: THE COSMIC AND NATURAL ORDER. In Taoist thought, the Tao, or universal first principle, generated a duality of opposing principles that underlie all the patterns of nature. These principles, yin and yang, are mutually dependent as well as polar opposites. They are basic concepts in traditional Chinese medicine. Yin represents everything that is cold, moist, dim, passive, slow, heavy, and moving downward or inward; while yang represents heat, dryness, brightness, activity, rapidity, lightness, and upward or outward motion. Both forces are equally necessary in nature and in human well-being, and neither force can exist without the other. The dynamic interaction of these two principles is reflected in the cycles of the seasons, the human life cycle, and other natural phenomena. One objective of traditional Chinese medicine is to keep yin and yang in harmonious balance within a person.

In addition to yin and yang, Taoist teachers also believed that the Tao produced a third force, primordial energy or qi (also spelled chi or ki). The interplay between yin, yang, and qi gave rise to the Five Elements of water, metal, earth, wood, and fire. These entities are all reflected in the structure and functioning of the human body.

THE HUMAN BEING. Traditional Chinese physicians did not learn about the structures of the human body from dissection because they thought that cutting open a body insulted the person's ancestors. Instead they built up an understanding of the location and functions of the major organs over centuries of observation, and then correlated them with the principles of yin, yang, qi, and the Five Elements. Thus wood is related to the liver (yin) and the gall bladder (yang); fire to the heart (yin) and the small intestine (yang); earth to the spleen (yin) and the stomach (yang); metal to the lungs (yin) and the large

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intestine (yang); and water to the kidneys (yin) and the bladder (yang). The Chinese also believed that the body contains Five Essential Substances, which include blood, spirit, vital essence (a principle of growth and development produced by the body from qi and blood), fluids (all body fluids other than blood, such as saliva, spinal fluid, sweat, etc.), and qi.

Chinese herbal treatment differs from **Western herbalism** in several respects. In Chinese practice, several different herbs may be used, according to each plant's effect on the individual's Qi and the Five Elements. There are many formulas used within traditional Chinese medicine to treat certain common imbalance patterns. These formulas can be modified to fit specific individuals more closely.

A traditional Chinese herbal formula typically contains four classes of ingredients, arranged in a hierarchical order: a chief (the principal ingredient, chosen for the patient's specific illness); a deputy (to reinforce the chief's action or treat a coexisting condition); an assistant (to counteract side effects of the first two ingredients); and an envoy (to harmonize all the other ingredients and convey them to the parts of the body that they are to treat).

Methods of diagnosis

A Chinese herbalist will not prescribe a particular herb on the strength of symptoms only, but will take into consideration the physical condition, emotional health, and mental state of the patient. He or she may look at the condition of the patient's hair, skin, and tongue, as well as the appearance of the eyes, lips, and general complexion. The practitioner then listens to the sounds the body makes when breathing. He or she may smell the breath, body odor, or sputum in diagnosis.

TCM practitioners take an extensive medical history of a patient. He or she may ask about dietary habits, lifestyle, and sleep patterns. The patient will be questioned about chief medical complaints, as well as on his or her particular emotional state and sexual practices.

Chinese herbalists employ touch as a diagnostic tool. They may palpate the body or use light massage to assess the patient's physical health. Another chief component of Chinese medical diagnosis is pulse diagnosis, or sphygmology. This is a very refined art that takes practitioners years to master. Some practitioners can detect 12 different pulse points that correspond to the 12 major organs in Chinese medicine. There are over 30 pulse qualities that practitioners are able to detect on each point. The strength, speed, quality, and rhythm of the pulse, to name a few, will be determined before a diagnosis is given.

Herbs

Chinese herbs may be used alone or in combination. Relatively few are used alone for medicinal purposes. Practitioners believe that illness can be effectively treated by combining herbs based on their various characteristics and the patient's overall health. Every herb has four basic healing properties: nature, taste, affinity, and effect.

An herb's nature is described according to its yin or yang characteristics. Yang, or warming, herbs treat cold deficiencies. They are frequently used in the treatment of the upper respiratory tract, skin, or extremities. Yin, or cooling, herbs, treat hot excess conditions. They are most often used to treat internal conditions and problems with organs. Herbs can also be neutral in nature.

An herb's taste does not refer to its flavor, but to its effect on qi, blood, fluids, and phlegm. Sour herbs have a concentrating action. They are prescribed to treat bodily excess conditions, such as **diarrhea**, and concentrate qi. Bitter herbs have an eliminating or moving downward action. They are used to treat coughs, **constipation**, and heart problems. Sweet or bland herbs have a harmonizing action. They are used as restorative herbs and to treat **pain**. Spicy herbs have a stimulating action. They are prescribed to improve blood and qi circulation. Salty herbs have a softening action. They are used to treat constipation and other digestion problems.

An herb's affinity describes its action on a specific bodily Organ. (Note that Chinese medicine does not have the anatomical correlation for organ names. They correspond more closely to the organ's function.) Sour herbs have an affinity for the Liver and Gallbladder. Bitter herbs act on the Heart and Small Intestine. Sweet and bland herbs affect the Stomach and Spleen. Spicy herbs have an affinity for Lungs and Large Intestine, whereas salty herbs act on the Kidneys and Bladder.

Chinese herbs are lastly classified according to their specific actions, which are divided into four effects. Herbs that dispel are used to treat an accumulation, sluggishness, or spasm by relaxing or redistributing. Herbs with an astringent action are used to consolidate or restrain a condition characterized by discharge or excessive elimination. Herbs that purge treat an obstruction or "poison" by encouraging elimination and **detoxification**. Tonifying herbs nourish, support, and calm where there is a deficiency.

Treatment of diabetes

The incidence of diabetes has increased quite dramatically in recent years, especially in the United States, where in general people take less **exercise**, and food is

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KEY TERMS

Absorption spectrometry—A scientific procedure to determine chemical makeup of samples.

Interferon—A substance proved to be necessary in the body to help fight cancer cells.

Immune function—The body's defense system against bacteria, viruses and fungi, and any malfunction of the organism.

Pharmaco-dynamics—The study of the relationships and interactions of herbs.

Platelet aggregation—The clumping together of blood cells, possibly forming a clot.

Thrombocyte—Another name for platelet.

taken in greater quantity with a general reduction in quality. This has lead to a scramble to find new solutions to the problem, and many researchers have focused their interest on Chinese herbal remedies. In the search for more effective and more convenient treatments, the alkaloid berberine has come under close scrutiny for its many uses, including the treatment of diabetes. In trials, rats given a mixture of berberine and alloxan showed less likelihood of incurring a rise in blood sugar. Patients suffering from type II diabetes who were given between 300 and 600 mg of berberine daily for between one and three months, showed a reduction in blood sugar levels, when taken in conjunction with a controlled diet.

Treatment of AIDS and cancer

Independent researchers are investigating indications that Chinese herbalism can reduce the toxicity of chemotherapy and other medications, in addition to stimulating immune responses.

Preparations

Those who are unfamiliar with Chinese herbs and their uses should consult a practitioner before starting any treatment. Once a remedy is prescribed, it may be found at Oriental markets or health food stores. The remedies used in Chinese herbalism are standardized and sold prepared for use, with instructions for dosage. A Chinese herbalist may prescribe herbs to be made into tea, or taken as capsules.

Precautions

When treating a patient, the herbalist will aim to gently "nudge" the system into shape, rather than producing any immediate reaction. A return to health, therefore, may take time, and it is important that the patient realizes the principle of the treatment. Some practitioners estimate that treatment will take a month for every year that a chronic condition has existed. The advantage of the slow pace is that if there is a bad reaction to any herb, which is rare, it will be mild because the treatment itself is gentle.

As with most naturopathic therapies, Chinese herbal remedies work best when taken in conjunction with a healthy lifestyle and program of exercise.

Side effects

Some Chinese herbs are incompatible with certain prescription drugs, certain foods, or should not be taken during **pregnancy**. To be certain, a Chinese herbalist should be consulted.

Research and general acceptance

At present, there is renewed interest in the West in traditional Chinese medicine and Chinese herbalism. Of the 700 herbal remedies used by traditional Chinese practitioners, over 100 have been tested and found effective by the standards of Western science. Several United States agencies, including the National Institutes of Health, the Office of Alternative Medicine, and the Food and Drug Administration are currently investigating Chinese herbal medicine as well as acupuncture and *Tui na* massage. In general, however, Western studies of Chinese medicine focus on the effects of traditional treatments and the reasons for those effects, thus attempting to fit traditional Chinese medicine within the Western framework of precise physical measurements and scientific hypotheses.

ORGANIZATIONS

California State Oriental Medial Association, 703 Market Street, Suite 250, San Francisco, CA, 94103-2100, (800) 477-4564, info@csomaonline.org, http://www.csomaonline.org.

Crane Herb Company, 745 Falmouth Road, Mashpee, MA, 02649, (508) 539-1700, (508) 539-2369, info@craneherb.com, https://www.craneherb.com.

National Center for Complementary and Alternative Medicine (NCCAM), P.O. Box 7923, Gaitherburg, MD, 20898, (866) 464-3616, (888) 644-6226, info@nccam.nih.gov, http://nccam.nih.gov/.

Traditional Chinese Medicine Association and Alumni, Inc. (TCMAA), 108-A East 38th Street, New York, NY, 10016, (212) 889-4802, (643) 309-7633, peng8@verizon.net, http://www.tcmaa.org/.

Patricia Skinner

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Herbalism, Western

Definition

Western herbalism is a form of the healing arts that draws from herbal traditions of Europe and the Americas and that emphasizes the study and use of European and Native American herbs in the treatment and prevention of illness. Western herbalism is based on physicians' and herbalists' clinical experience and traditional knowledge of medicinal plant remedies preserved by oral tradition and in written records over thousands of years. Western herbalism, like the much older system of **traditional Chinese medicine**, relies on the synergistic and curative properties of the plant to treat symptoms and disease and maintain health.

Western herbalism is based upon pharmocognosy, the study of natural products. Pharmocognosy includes the identification, extraction methods, and applications of specific plant constituents responsible for specific therapeutic actions, such as the use of **digoxin** from Digitalis leaf for **heart failure**. These constituents are extracted, purified and studied in vitro, in vivo, and in clinical research. They may be concentrated to deliver standardized, set doses. Sometimes, the natural constituent can be synthesized in the lab, or changed and patented. Practitioners may choose to use fresh medicinal plants, simple extracts, or standardized extracts.

In standardized extracts, a specific quantity of a constituent is called a marker compound, and it may or may not be the active constituent(s) in the plant medicine. There are preparations with standardized active constituent quantities and preparations with greater emphasis on quality of crude plant material and traditional preparation methodology than on finalized total quantity of marker compounds. The preference between the two for precision dosing is philosophical, practical and variable. When using plant extracts in which the active constituents and their cofactors are well established, or the therapeutic and lethal dose are close, standardized products are often preferred. When using plant extracts whose active constituents remain obscure, or the active constituents when purified produce weaker therapeutic results or more undesirable side effects, the products produced under good manufacturing processes and according to the traditional *National Formulary U. S. Dispensatory* or *U. S. Pharmacopeia* are preferred.

A selection of Western herbal medical equipment and traditional herbs, including foxglove (upper right), ginger (center right), and periwinkle (lower left). *(Photo Researchers, Inc.)*

Purpose

The benefits of botanical medicine may be subtle or dramatic, depending on the remedy used and the symptom or problem being addressed. Herbal remedies usually have a much slower effect than pharmaceutical drugs. Some herbal remedies have a cumulative effect and work slowly over time to restore balance, and others are indicated for short-term treatment of acute symptoms. When compared to the pharmaceutical drugs, herbal remedies prepared from the whole plant have relatively few side effects. This is due to the complex chemistry and synergistic action of the full range of phytochemicals present in the whole plant and the relatively lower concentrations. They are generally safe when used in properly designated therapeutic dosages and less costly than the isolated chemicals or synthetic prescription drugs available from western pharmaceutical corporations.

Description

Origins

More than 2,500 years ago Hippocrates wrote, "In medicine one must pay attention not to plausible theorizing but to experience and reason together." This Greek physician and herbalist from the fourth century B.C. is considered the father of Western medicine. He stressed the importance of diet, water quality, climate, and social environment in the development of disease. Hippocrates believed in treating the whole person, rather than merely isolating and treating symptoms. He recognized the innate capacity of the body to heal itself, and emphasized the importance of keen observation in the medical practice. He recommended simple herbal remedies to assist the body in restoring health.

Ancient Greek medicine around the fifth century B.C. was a fertile ground for contrasting philosophies and

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religions. Greek physicians were influenced by the accumulated medical knowledge from Egypt, Persia, and Babylon. Medical advances flourished and practitioners and scholars were free to study and practice without religious and secular constraints. In the fourth century B.C., Theophrastus wrote the *Historia Plantarum*, considered to be the founding text in the science of botany.

During the first century A.D. Dioscorides, a Greek physician who traveled with the Roman legions, produced five medical texts. His herbal text, known as the *De Materia Medica* is considered to be among the most influential of all western herbal texts. It became a standard reference for practitioners for the next 1,500 years. This influential book also included information on medicinal herbs and treatments that had been used for centuries in Indian **Ayurvedic medicine**. Galen of Pergamon, who also lived in the first century A.D., was a Roman physician and student of anatomy and physiology. He authored a recipe book containing 130 antidotes and medicinal preparations. These elaborate mixtures, known as galenicals, sometimes included up to one hundred herbs and other substances. This complex approach to herbal medicine was a dramatic change from the simple remedies recommended by Hippocrates and employed by traditional folk healers. Galen developed a rigid system of medicine in which the physician, with his specialized knowledge of complex medical formulas, was considered the ultimate authority in matters of health care. The Galenic system, relying on theory and scholarship rather than observation, persisted throughout the Middle Ages. The Galenical compounds, along with bloodletting and purging, were among the drastic techniques practiced by the medical professionals during those times; however, traditional herbal healers persisted outside the mainstream medical system.

During the eighth century a medical school was established in Salerno, Italy, where the herbal knowledge accumulated by Arab physicians was preserved. The Arabian Muslims conducted extensive research on medicinal herbs found in Europe, Persia, India, and the Far East. Arab businessmen opened the first herbal pharmacies early in the ninth century. The *Leech Book of Bald*, the work of a Christian monk, was compiled in the tenth century. It preserved important medical writings that had survived from the work of physicians in ancient Greece and Rome.

The Middle Ages in Europe was a time of widespread **death** from plagues and pestilence. The Black **Plague** of 1348, particularly, and other health catastrophes in later years, claimed so many lives that survivors began to lose faith in the dominant Galenic medical system. Fortunately, the knowledge of traditional herbal medicine had not been lost. Medieval monks who cultivated extensive medicinal gardens on the monastery grounds, also patiently copied the ancient herbal and medical texts. Folk medicine as practiced in Europe by traditional healers persisted, even though many women herbalists were persecuted as witches and enemies of the Catholic church and their herbal arts were suppressed.

The growing spice trade and explorations to the New World introduced exotic plants, and a whole new realm of botanical medicines became available to Europeans. Following the invention of the printing press in the fifteenth century, a large number of herbal texts, also simply called herbals, became available for popular use. Among them were the beautifully illustrated works of the German botanists Otto Brunfels and Leonhard Fuchs published in 1530 and the Dutch herbal of Belgian physician Rembert Dodoens, a popular work that was later reproduced in English. In 1597, the physician and gardener John Gerard published one of the most famous of the English herbal, still in print today. Gerard's herbal, known as *The Herball or General Historie of Plantes* was not an original work. Much of the content was taken from the translated text of his Belgian predecessor Dodoens. Gerard did, however, include descriptions of some of the more than 1,000 species of rare and exotic plants and English flora from his own garden.

The correspondence of astrology with herbs was taught by Arab physicians who regarded astrology as a science helpful in the selection of medicines and in the treatment of diseases. This approach to western herbalism was particularly evident in the herbal texts published in the sixteenth and seventeenth centuries. One of the most popular and controversial English herbals is *The English Physician Enlarged* published in 1653. The author, Nicholas Culpeper, was an apothecary by trade. He also published a translation of the Latin language *London Pharmacopoeia* into English. Culpeper was a nonconformist in loyalist England, and was determined to make medical knowledge more accessible to the apothecaries, the tradesmen who prescribed most of the herbal remedies. Culpeper's herbal was criticized by the medical establishment for its mix of magic and astrology with botanical medicine, but it became one of the most popular compendiums of botanical medicine of its day. Culpeper also accepted the so-called "Doctrine of Signatures," practiced by medieval monks in their medicinal gardens. This theory teaches that the appearance of plants is the clue to their curative powers. Plants were chosen for treatment of particular medical conditions based on their associations with the four natural elements and with a planet or sign. The place where the plant grows, its dominant physical feature, and the smell and taste of an herb determined the plant's signature. Culpeper's herbal is still in print in facsimile

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copies, and some pharmocognosists and herbalists in the twenty-first century voice the same criticisms that Culpeper's early critics did.

European colonists brought their herbal knowledge and plant specimens to settlements in North America where they learned from the indigenous Americans how to make use of numerous nutritive and medicinal plants, native to the New World. Many European medicinal plants escaped cultivation from the early settlements and have become naturalized throughout North America. The first record of Native American herbalism is found in the manuscript of the native Mexican Indian physician, Juan Badianus published in 1552. The American Folk tradition of herbalism developed as a blend of traditional European medicine and Native American herbalism. The pioneer necessity for self-reliance contributed to the perseverance of folk medicine well into the twentieth century.

In Europe in the seventeenth century, the alchemist Paracelsus changed the direction of western medicine with the introduction of chemical and mineral medicines. He was the son of a Swiss chemist and physician. Paracelsus began to apply chemicals, such as arsenic, mercury, sulfur, iron, and copper sulfate to treat disease. His chemical approach to the treatment of disease was a forerunner to the reliance in the twentieth century on chemical medicine as the orthodox treatment prescribed in mainstream medical practice.

The nineteenth and twentieth centuries brought a renewed interest in the practice of Western herbalism and the development of natural therapies and health care systems that ran counter to the mainstream methods of combating disease symptoms with synthetic pharmaceuticals.

In the late eighteenth century, the German physician Samuel Hahnemann developed a system of medicine known as homeopathy. This approach to healing embraces the philosophy of "like cures like." Homeopathy uses extremely diluted solutions of herbs, animal products, and chemicals that are believed to hold a "trace memory" or energetic imprint of the substance used. Homeopathic remedies are used to amplify the patient's symptoms with remedies that would act to produce the same symptom in a healthy person. Homeopathy holds that the symptoms of illness are evidence of the body's natural process of healing and eliminating the cause of the disease.

In 1895, the European medical system known as Naturopathy was introduced to the North America. Like homeopathy, this medical approach is based on the Hippocratic idea of eliminating disease by assisting the body's natural healing abilities. The naturopath uses nontoxic methods to assist the body's natural healing processes, including **nutritional supplements**, herbal remedies, proper diet, and **exercise** to restore health.

Western herbalism is regaining popularity at a time when the world is assaulted by the **stress** of overpopulation and development that threatens the natural biodiversity necessary for these valuable medicinal plants to survive. The American herb market is growing rapidly and increasing numbers of individuals are choosing alternative therapies over the mainstream allopathic Western medicine. Consumers spend more than $7 billion a year on herbal products. An estimated 2,400 acres of native plant habitat are lost to development every day. As much as 29% of all plant life in North America is in danger of extinction, including some of the most important native medicinal plants, according to the 1997 World Conservation Union Red List of Threatened Plants.

Though research into the efficacy and safety of traditional herbal remedies is increasing, it has been limited by the high costs of clinical studies and laboratory research, and by the fact that whole plants and their constituents are not generally patentable (therefore, there is no drug profit after market introduction). Outside the United States, herbalism has successfully combined with conventional medicine and in some countries is fully integrated into the nation's health care systems. At the beginning of the twenty-first century, 80% of the world's population continues to rely on herbal treatments. The World Health Organization, an agency of the United Nations, promotes traditional herbal medicine for treatment of many local health problems, particularly in the third world where it is affordable and already well-integrated into the cultural fabric.

In the United States, the re-emergence of interest in holistic approaches to health care is evident. Citizens are demanding access to effective, safe, low-cost, natural medicine. Legislative and societal change is needed, however, before natural therapies can be fully integrated into the orthodox allopathic health care system and provide citizens with a wide range of choices for treatment. If the current trend continues, U. S. citizens will benefit from a choice among a variety of safe and effective medical treatments.

Herbs are generally defined as any plant or plant part that may be used for medicinal, nutritional, culinary, or other beneficial purposes. The active constituents of plants (if known) may be found in varying amounts in the root, stem, leaf, flower, and fruit, etc. of the plant. Herbs may be classified into many different categories. Some western herbalists categorize herbal remedies according to their strength, action, and

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characteristics. Categories may include sedatives, stimulants, **laxatives**, febrifuges (to reduce **fever**), and many others. One system of classification is based on a principle in traditional Chinese medicine that categorizes herbs into four classes: tonics, specifics, heroics, and cleansers and protectors. Within these broad classifications are the numerous medicinal actions of the whole herb which may be due to a specific chemical or combination of chemicals in the plant.

- Tonics. Herbs in this classification are also known as alteratives in western herbalism. They are generally mild in their action and act slowly in the body, providing gentle stimulation and nutrition to specific organs and systems. Tonic herbs act over time to strengthen and nourish the whole body. These herbs are generally safe and may be used regularly, even in large quantities. These tonic herbs are known as "superior" remedies in traditional Chinese medicine. The therapeutic dose of tonic remedies is far removed from the possible toxic dose. American ginseng is an example of a tonic herb.
- Specifics. Herbs in this classification are strong and specific in their therapeutic action. They are generally used for short periods of time in smaller dosages to treat acute conditions. Herbs classified as specifics are not used beyond the therapeutic treatment period. Echinacea is a specific herb.
- Heroic. These herbs offer high potency but are potentially toxic and should not be used in self-treatment. Because the therapeutic dosage may be close to the lethal dosage, these herbs are presented cautiously and closely monitored or avoided by trained clinicians. They should not be used continuously or without expert supervision. Poke (*Phytolacca americana*) is an example of a heroic remedy.
- Cleansers and protectors. These herbs, plants, and plant tissues remove wastes and pollutants, while minimally affecting regular body processes. An example of a cleanser is pectin. Pectins are the water soluble substances that bind cell walls in plant tissues, and some believe that they help remove heavy metals and environmental toxins from the body.

Preparations

Herbal preparations are commercially available in a variety of forms, including tablets or capsules, tinctures, teas, fluid extracts, douches, washes, suppositories, dried herbs, and many other forms. The medicinal properties of herbs are extracted from the fresh or dried plant parts by the use of solvents appropriate to the particular herb. Alcohol, oil, water, vinegar, glycerin, and propylene glycol are some of the solvents used to extract and concentrate the medicinal properties. Steam distillation and cold-pressing techniques are used to extract the essential oils. The quality of any herbal remedy and the potency of the phytochemicals found in the herb depends greatly on the conditions of weather and soil where the herb was grown, the timing and care in harvesting, and the manner of preparation and storage.

KEY TERMS

In vitro—A biological reaction occurring in a laboratory apparatus.

In vivo—Occurring in a living organism.

Phyto-, as in phytochemical, phytomedicinal, and phytotherapy—Meaning, or pertaining to, a plant or plants.

Wildcrafting—Gathering of herbs or other natural materials.

Precautions

Herbal remedies prepared by infusion, decoction, or alcohol tincture from the appropriate plant part, such as the leaf, root, or flower, are generally safe when ingested in properly designated therapeutic dosages. However, many herbs have specific contraindications for use when certain medical conditions are present. Not all herbal remedies may be safely administered to infants or small children. Many herbs are not safe for use by pregnant or lactating women. Some herbs are toxic, even deadly, in large amounts, and there is little research on the chronic toxicity that may result from prolonged use. Herbal remedies are sold in the United States as dietary supplements and are not regulated for content or efficacy. Self-diagnosis and treatment with botanical medicinals may be risky. A consultation with a clinical herbalist, Naturopathic physician, or certified clinical herbalist is prudent before undertaking a course of treatment.

Essential oils are highly concentrated and should not be ingested as a general rule. They should also be diluted in water or in a non-toxic carrier oil before application to the skin to prevent **contact dermatitis** or photo-sensitization. The toxicity of the concentrated essential oil varies depending on the chemical constituents of the herb.

The American Professor of Pharmacognosy, Varro E. Tyler, believes that "herbal chaos" prevails in the United States with regard to herbs and phytomedicinals. In part he blames the herb producers and marketers of

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crude herbs and remedies for what he terms unproven hyperbolic, poor quality control, deceptive labeling, resistance to standardization of dosage forms, and continued sale of herbs determined to be harmful.

Side effects

Herbs have a variety of complex phytochemicals that act on the body as a whole or on specific organs and systems. Some of these chemical constituents are mild and safe, even in large doses. Other herbs contain chemicals that act more strongly and may be toxic in large doses or when taken continuously. **Drug interactions** are possible with certain herbs when combined with certain pharmaceutical drugs. Some herbs are tonic in a small amount and toxic in larger dosages.

Research and general acceptance

Western herbalism is experiencing a revival of popular and professional interest. The number of training schools and qualified herbal practitioners is growing to meet the demand. Western herbalism is incorporated into the medical practice of licensed Naturopathic doctors, who receive special training in clinical herbalism. Folk herbalists, heir to the continuing oral traditions passed from generation to generation in many rural areas, as well as amateur, self-taught herbalists, keep the practice of botanical medicine alive at the grassroots level. Traditional western herbalism relies on traditional use and *materia medica*, folk wisdom, and recent clinical research and advances in the extraction processes. These advances provide increased quality control on the concentration and potency of the active ingredients. Western physicians, educated in allopathic medicine, typically receive no training in the use of herbs. These doctors rely on pharmaceutical drugs for their patients, and some cite the following reasons for continuing to do so: lack of standardized dosages, lack of quality control in the preparation of herbal medicinals, and the dearth of clinical research verifying the safety and effectiveness of many traditional herbal remedies.

Herbalism is widely practiced throughout Europe, particularly in England, France, Italy, and Germany, where phytomedicinals are available in prescription form and as over-the-counter remedies. In Germany, plant medicines are regulated by a special government body known as the Commission E. In the United States, however, despite increasing popularity, traditional herbalism is not integrated into the allopathic medical system. Phytomedicinals are sold as dietary supplements rather than being adequately researched and recognized as safe and effective drugs. The Dietary Supplement Health and Education Act of 1994 circumvented a U. S. Food and Drug Administration (FDA) effort to effectively remove botanicals from the marketplace and implement regulations restricting sale. Massive popular outcry against the proposed regulations on the sale of herbs and phytomedicinals resulted in this Congressional action. In 2000, U.S. President Bill Clinton, by executive order, created the White House Commission on Alternative Medicine in an effort to hold alternative medicine therapies "to the same standard of scientific rigor as more traditional health care interventions." That Commission is charged with recommending federal guidelines and legislation regarding the use of alternative medical therapies in the twenty-first century.

Resources

OTHER

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Oracle Tree New Age Mall. "Western Medical Astrology: A Brief History." http://ww.oracletree.com/avalonphysics/wesmedas.html.

Wicke, Roger, Ph.D. "A World History of Herbology and Herbalism: Oppressed Arts." Rocky Mountain Herbal Institute. http://www.rmhiherbal.org/a/f.ahr1.hist.html.

ORGANIZATIONS

American Herbalists Guild, PO Box 230741, Boston, MA, 02123, (857) 350-3128, ahgoffice@earthlink.net, http://americanherbalistsguild.com.

Clare Hanrahan

Herbs *see* **Echinacea; Ginkgo biloba; Ginseng; Saw palmetto; St. John's wort**

Hereditary cerebral hemorrhage with amyloidosis *see* **Cerebral amyloid angiopathy**

Hereditary chorea *see* **Huntington's disease**

Hereditary fructose intolerance

Definition

Hereditary fructose intolerance is an inherited condition where the body does not produce the chemical needed to break down fructose (fruit sugar).

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KEY TERMS

Aldolase B—Also called fructose 1-phosphate aldolase, this chemical is produced in the liver, kidneys, and brain. It is needed for the breakdown of fructose, a sugar found in fruits, vegetables, honey, and other sweeteners.

Hyperbilirubinemia—A condition where there is a high level of bilirubin in the blood. Bilirubin is a natural by-product of the breakdown of red blood cells, however, a high level of bilirubin may indicate a problem with the liver.

Liver biopsy—A surgical procedure where a small piece of the liver is cut out for examination. A needle or narrow tube may be inserted either directly through the skin and muscle or through a small incision and passed into the liver for collection of a sample of liver tissue.

Description

Fructose is a sugar found naturally in fruits, vegetables, honey, and table sugar. Fructose intolerance is a disorder caused by the body's inability to produce an enzyme called aldolase B (also called fructose 1-phosphate aldolase) that is necessary for absorption of fructose. The undigested fructose collects in the liver and kidneys, eventually causing liver and kidney failure. One person in about 20,000 is born with this disorder. It is reported more frequently in the United States and Northern European countries than in other parts of the world. It occurs with equal frequency in males and females.

Causes and symptoms

Fructose intolerance is an inherited disorder passed on to children through their parents' genes. Both the mother and father have the gene that causes the condition, but may not have symptoms of fructose intolerance themselves. (This is called an autosomal recessive pattern of inheritance.) The disorder will not be apparent until the infant is fed formula, juice, fruits, or baby foods that contain fructose. Initial symptoms include **vomiting**, **dehydration**, and unexplained **fever**. Other symptoms include extreme thirst and excessive urination and sweating. There will also be a loss of appetite and a failure to grow. **Tremors** and seizures caused by low blood sugar can occur. The liver becomes swollen and the patient becomes jaundiced with yellowing of the eyes and skin. Left untreated, this condition can lead to **coma** and **death**.

Diagnosis

Urine tests can be used to detect fructose sugar in the urine. Blood tests can also be used to detect *hyperbilirubinemia* and high levels of liver enzymes in the blood. A **liver biopsy** may be performed to test for levels of enzymes present and to evaluate the extent of damage to the liver. A fructose-loading test where a dose of fructose is given to the patient in a well-controlled hospital or clinical setting may also be used to confirm fructose intolerance. Both the biopsy and the loading test can be very risky, particularly in infants that are already sick.

Treatment

Once diagnosed, fructose intolerance can be successfully treated by eliminating fructose from the diet. Patients usually respond within three to four weeks and can make a complete recovery if fructose-containing foods are avoided. Early recognition and treatment of the disease is important to avoid damage to the liver, kidneys, and small intestine.

Prognosis

If the condition is not recognized and the diet is not well controlled, death can occur in infants or young children. With a well-controlled diet, the child can develop normally.

Prevention

Carriers of the gene for hereditary fructose intolerance can be identified through DNA analysis. Anyone who is known to carry the disease or who has the disease in his or her family can benefit from **genetic counseling**. Since this is a hereditary disorder, there is currently no known way to prevent it other than assisting at-risk individuals with family planning and reproductive decisions.

Resources

OTHER

"What Is Hereditary Fructose Intolerance?" Hereditary Fructose Intolerance & Aldolase Homepage. http://www.bu.edu/aldolase.

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ORGANIZATIONS

National Institute of Diabetes and Digestive and Kidney Diseases, NIDDK, NIH Bldg 31, Rm 9A06 31 Center Drive, MSC 2560, Bethesda, MD, 20892-2560, (301) 496.3583, http://www2.niddk.nih.gov.

Altha Roberts Edgren

Hereditary hemorrhagic telangiectasia

Definition

Hereditary hemorrhagic telangiectasia is an inherited condition characterized by abnormal blood vessels which are delicate and prone to bleeding. Hereditary hemorrhagic telangiectasia is also known as Rendu-Osler-Weber disease.

Description

The term telangiectasia refers to a spot formed, usually on the skin, by a dilated capillary or terminal artery. In hereditary hemorrhagic telangiectasia these spots occur because the blood vessel is fragile and bleeds easily. The bleeding may appear as small, red or reddish-violet spots on the face, lips, inside the mouth and nose or the tips of the fingers and toes. Other small telangiectasias may occur in the digestive tract.

Unlike **hemophilia**, where bleeding is caused by an ineffective clotting mechanism in the blood, bleeding in hereditary hemorrhagic telangiectasia is caused by fragile blood vessels. However, like hemophilia, bleeding may be extensive and can occur without warning.

Causes and symptoms

Hereditary hemorrhagic telangiectasia, an autosomal dominant inherited disorder, occurs in one in 50,000 people.

Recurrent nosebleeds are a nearly universal symptom of this condition. Usually the nosebleeds begin in childhood and become worse with age. The skin changes begin at **puberty**, and the condition becomes progressively worse until about 40 years of age, when it stabilizes.

Diagnosis

The physician will look for red spots on all areas of the skin, but especially on the upper half of the body, and in the mouth and nose and under the tongue.

KEY TERMS

Autosomal dominant—A pattern of inheritance in which the dominant gene on any non-sex chromosome carries the defect.

Chromosome—A threadlike structure in the cell which transmits genetic information.

Treatment

There is no specific treatment for hereditary hemorrhagic telangiectasia. The bleeding resulting from the condition can be stopped by applying compresses or direct pressure to the area. If necessary, a laser can be used to destroy the vessel. In severe cases, the leaking artery can be plugged or covered with a graft from normal tissue.

Prognosis

In most people, recurrent bleeding results in an iron deficiency. It is usually necessary to take iron supplements.

Prevention

Hereditary hemorrhagic telangiectasia is an inherited disorder and cannot be prevented.

ORGANIZATIONS

American Medical Association, 515 N. State St., Chicago, IL, 60654, (800) 621-8335, http://www.ama-assn.org/.

Association of Birth Defect Children, 3526 Emerywood Lane, Orlando, FL, 32806, (305) 859-2821.

Dorothy Elinor Stonely

Hereditary hyperuricemia *see* **Lesch-Nyhan syndrome**

Hereditary spinocerebellar ataxia *see* **Friedreich's ataxia**

Hermaphroditism *see* **Intersex states**

Hernia

Definition

Hernia is a general term used to describe a bulge or protrusion of an organ through the structure or muscle that normally contains it.

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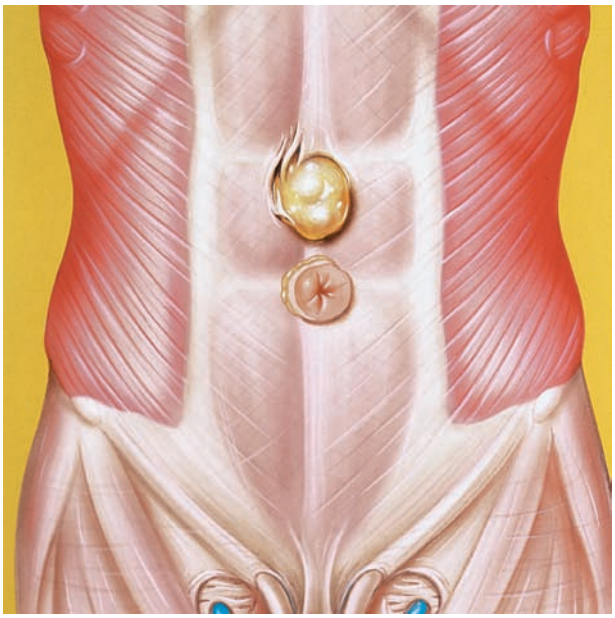

An illustration of an epigastric (abdominal) hernia in an adult male. The torso is shown with its skin removed. Epigastric hernia is caused commonly by a congenital weakness in muscles of the central upper abdomen; the intestine bulges out through the muscle at a point between the navel and breastbone. *(John Bavosi/Photo Researchers, Inc.)*

Demographics

The frequency of hernias varies greatly depending on the type of hernia. Hernias tend to be more common in the elderly than in younger individuals. Hernias also are more common in infants and children, often caused by the abdominal wall not closing completely after birth.

Hiatal hernias are very common, although most do not produce serious symptoms and many individuals never even know they have one. About 10% of individuals under the age of 40 have hiatal hernias. This number increases with age, with about 70% of individuals over age 70 having this type of hernia.

Abdominal hernias are more common in males than in females. About 25% of men have an inguinal hernia at some time in their lives, and only about 2% of women ever have one. Over 1 million surgeries are performed each year to repair abdominal hernias.

Description

There are many different types of hernias. The most familiar type is that which occur in the abdomen when part of the intestine protrudes through the abdominal wall. This may occur in different areas and, depending on the location, the hernia is given a different name.

An inguinal hernia appears as a bulge in the groin and may come and go depending on the position of the person or their level of physical activity. It can occur with or without **pain**. In men, the protrusion may descend into the scrotum. Inguinal hernias account for 80% of all hernias and are more common in men.

Femoral hernias are similar to inguinal hernias but appear as a bulge slightly lower. They are more common in women and are often caused by the strain that **pregnancy** puts on the abdominal area.

A ventral hernia is also called an incision hernia because it generally occurs as a bulge in the abdomen at the site of an old surgical scar. It is caused by thinning or stretching of scar tissue It occurs more frequently in people who are obese or pregnant.

An umbilical hernia appears as a soft bulge at the navel (umbilicus). It is caused by a weakening of the area or an imperfect closure of the area in infants. This type of hernia is more common in women due to pregnancy and in Chinese and African American infants. Some umbilical hernias in infants disappear without treatment within the first year.

A hiatal or diaphragmatic hernia is different from abdominal hernias in that it is not visible on the outside of the body. With a **hiatal hernia**, the stomach bulges upward through the muscle that separates the chest from the abdomen (the diaphragm). This type of hernia occurs more often in women than in men, and it is treated differently from other types of hernias.

Causes and symptoms

Most hernias result from a weakness in the abdominal wall. In many cases an infant is born with this weakness (congenital), and in other cases weakness can develop later in life. Any increase in pressure in the abdomen, such as recurring coughing, straining, heavy lifting, or pregnancy, can be a considered a causative factor in developing an abdominal hernia. **Obesity** or recent excessive weight loss, as well as **aging** and previous surgery, are also risk factors.

Most abdominal hernias appear suddenly when the abdominal muscles are strained. The individual may feel tenderness, a slight burning sensation, or a feeling of heaviness in the bulge. It may be possible for the individual to push the hernia back into place with gentle pressure, or the hernia may disappear by itself when the person reclines. Being able to push the hernia back is called reducing it. On the other hand, some hernias cannot be pushed back into place and are termed incarcerated or irreducible.

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KEY TERMS

Endoscopy—A diagnostic procedure in which a tube is inserted through the mouth, into the esophagus and stomach. It is used to visualize various digestive disorders, including hiatal hernias.

Herniorrhaphy—Surgical repair of a hernia.

Incarcerated hernia—A hernia that cannot be reduced, or pushed back into place inside the abdominal wall.

Laparoscopic surgery—A minimally invasive surgery in which a camera and surgical instruments are inserted through a small incision.

Reducible hernia—A hernia that can be gently pushed back into place or that disappears when the person lies down.

Strangulated hernia—A hernia that is so tightly incarcerated outside the abdominal wall that the intestine is blocked and the blood supply to that part of the intestine is cut off.

A hiatal hernia may also be caused by obesity, pregnancy, aging, or previous surgery. About 50% of all people with hiatal hernias do not have any symptoms. If symptoms exist they usually include **heartburn**, usually 30–60 minutes following a meal. There may be some mid chest pain due to gastric acid from the stomach being pushed up into the esophagus (gastric reflux). The pain and heartburn usually are worse when lying down. Frequent belching and feelings of abdominal fullness may also be present.

Diagnosis

Generally, abdominal hernias need to be seen and felt to be diagnosed. Usually the hernia will increase in size with an increase in abdominal pressure, so the doctor may ask the person to **cough** while he or she feels the area. Once a diagnosis of an abdominal hernia is made, the doctor usually will refer the individual to a surgeon for a consultation. Surgery provides the only cure for a hernia through the abdominal wall.

With a hiatal hernia, the preliminary diagnosis is based on the symptoms reported by the person. The doctor may then order tests to confirm the diagnosis. One possible test is called a barium swallow test. During this procedure, the individual drinks a chalky white barium solution and then undergoes an abdominal x ray. The barium causes any protrusion through the diaphragm show up more clearly on the x ray. Hiatal hernias often are diagnosed using **endoscopy**. This procedure is done by a gastroenterologist (a specialist in digestive diseases). During an endoscopy the person is given an intravenous sedative and a small tube is inserted through the mouth, then into the esophagus and stomach where the doctor can look at the hernia using a small tube or camera. The procedure takes about 30 minutes and usually causes no discomfort. It is done on an outpatient basis.

Treatment

Once an abdominal hernia occurs it tends to increase in size. Some patients with abdominal hernias take a watch and wait approach before deciding on surgery. In these cases, they must avoid strenuous physical activity such as heavy lifting or straining with **constipation**. They may also wear a truss, which is a support worn like a belt to keep a small hernia from protruding. People can tell if their hernia is getting worse if they develop severe constant pain, **nausea and vomiting**, or if the bulge does not return to normal when lying down or when they try to gently push it back in place. In these cases they, should consult their doctor immediately. In most cases, surgery is eventually required to correct the hernia.

Surgery

There are risks to not surgically repairing a hernia. Left untreated, a hernia may become incarcerated, which means it can no longer be reduced or pushed back into place. With an incarcerated hernia, the intestine become trapped, or strangulated, outside the abdomen. This can lead to a blockage in the intestine. If strangulation is severe, it may cut off the blood supply to the intestine and part of the intestine will die. Because of the risk of tissue **death** (necrosis) and **gangrene**, and because the hernia can block food from moving through the bowel, a strangulated hernia is a medical emergency requiring immediate surgery. Repairing a hernia before it becomes incarcerated or strangulated is much safer than waiting until complications develop.

Surgical repair of a hernia is called a herniorrhaphy. The surgeon will push the bulging part of the intestine back into place and sew the overlying muscle back together. When the muscle is not strong enough, the surgeon may reinforce it with a synthetic mesh.

Surgery can be done on an outpatient basis. It usually takes 30 minutes in children and 60 minutes in adults. It can be done under either local or **general anesthesia** and is frequently done laparoscopically. In this type of surgery, a tube that allows visualization of the abdominal cavity is inserted through a small

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puncture wound. Several small punctures are made to allow surgical instruments to be inserted. This type of surgery avoids a larger incision and significantly reduces the time required for recovery.

Hiatal hernias normally are treated without surgery. The focus of the treatment is to reduce the symptoms associated with **gastroesophageal reflux disease** (GERD) associated with the hernia. Treatments include:

- avoiding reclining after meals
- avoiding spicy foods, acidic foods, alcohol, and tobacco
- eating small, frequent, bland meals
- eating a high-fiber diet

Several types of medications can help manage the symptoms of gastric reflux and heartburn a hiatal hernia. **Antacids** are used to neutralize gastric acid and decrease heartburn. Drugs that reduce the amount of acid produced in the stomach (H2 blockers) are also used. This class of drugs includes famotidine (Pepcid), cimetidine (Tagamet), and ranitidine (Zantac). Omeprazole (Prilosec) is a proton pump inhibitor (PPI) drug, which is another class of drugs that suppress gastric acid secretion and are used for symptoms associated with hiatal hernias. Another option may be metoclopramide (Reglan), a drug that increases the tone of the muscle around the esophagus and causes the stomach to empty more quickly. This drug, however, can have serious side effects.

Alternative treatment

Visceral manipulation, done by a trained therapist, can help replace the stomach to its proper positioning. An alternative to H2 blocker and PPI drugs is deglycyrrhizinated licorice (DGL). This helps balance stomach acid by improving the protective substances that line the stomach and intestines and by improving blood supply to these tissues. DGL does not interrupt the normal function of stomach acid.

As with traditional therapy, dietary modifications are important. Small, frequent meals will keep pressure down on the esophageal sphincter. Also, raising the head of the bed several inches with blocks or books can help with both the quality and quantity of sleep.

Prognosis

Abdominal hernias generally do not recur in children but can recur in up to 10% of adult patients. Surgery is considered the only cure, and the prognosis is excellent if the hernia is corrected before it becomes strangulated.

Hiatal hernias are treated successfully with medication and diet modifications 85% of the time.

Prevention

Some hernias can be prevented by maintaining a reasonable weight, not **smoking**, avoiding heavy lifting, preventing constipation, and following a moderate **exercise** program to maintain good abdominal muscle tone.

Resources

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Medline Plus. Hernia. February 8, 2010. http://www.nlm.nih.gov/medlineplus/hernia.html.

ORGANIZATIONS

The British Hernia Centre, 87 Watford Way, London, England, United Kingdom, NW4 4RS, + 44-20 8201 7000, +44 20 8202 6714, experts@hernia.org, http://www.hernia.org/.

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Hernia repair

Definition

Hernia repair is a surgical procedure to return an organ that protrudes through a weak area of muscle to its original position.

Purpose

Hernias occur when a weakness in the wall of the abdomen allows an organ, usually the intestines, to bulge out of place. Hernias may result from a genetic predisposition toward this weakness. They can also be the result of weakening the muscle through improper **exercise** or poor lifting techniques. Both children and adults get hernias. Some are painful, while others are not.

There are three levels of hernias. An uncomplicated hernia is one where the intestines bulge into the peritoneum (the membrane lining the abdomen), but they can still be manipulated back into the body (although they

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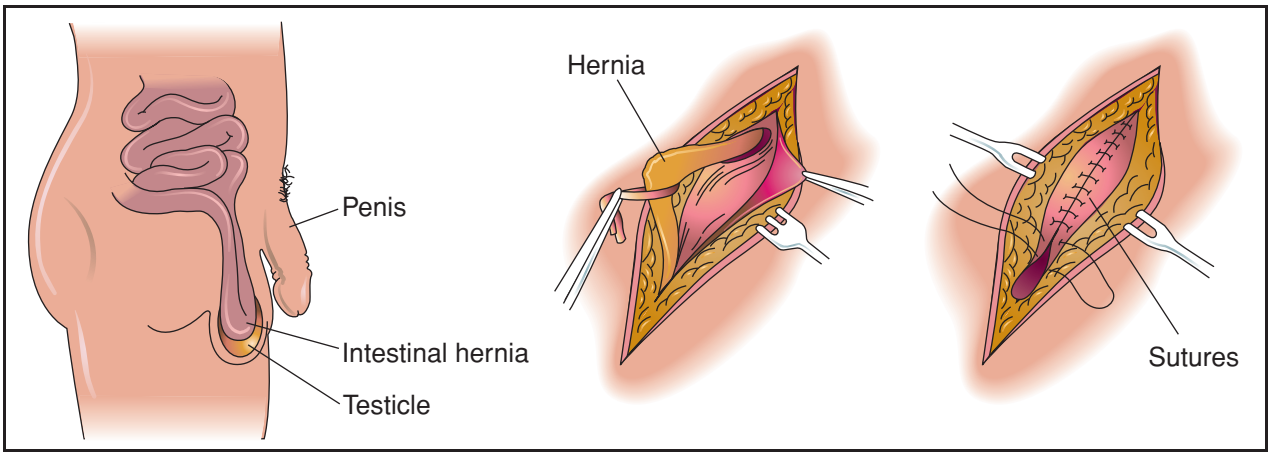

In this inguinal hernia repair, an incision is made in the abdomen. The hernia is located, and the intestines are returned to the abdomen. The abdominal wall is then sutured together to close any space and reinforce the weak area. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

don't stay in place without corrective surgery). This is termed a reducible hernia.

If the intestines bulge through the hernia defect and become trapped, this is called an incarcerated hernia. If the blood supply to an incarcerated hernia is shut off, the hernia is called a strangulated hernia. Strangulated hernias can result in **gangrene**.

Both incarcerated and strangulated hernias are medical emergencies and require emergency surgery to correct. For this reason, doctors generally recommend the repair of an uncomplicated hernia, even if it causes no discomfort to the patient.

Precautions

Hernia repair can be performed under local, regional, or **general anesthesia**. The choice depends on the age and health of the patient and the type of hernia. Generally hernia repair is very safe surgery, but—as with any surgery—the risk of complications increases if the patient smokes, is obese, is very young or very old, uses alcohol heavily, or uses illicit drugs.

Description

Hernia repairs are performed in a hospital or outpatient surgical facility by a general surgeon. Depending on the patient's age, health, and the type of hernia, he or she may be able to go home the same day or may remain hospitalized for up to three to five days.

There are two types of hernia repair. A herniorrhaphy is used for simpler hernias. The intestines are returned to their proper place and the defect in the abdominal wall is mended. A hernioplasty is used for larger hernias. In this procedure, plastic or steel mesh is added to the abdominal wall to repair and reinforce the weak spot.

There are five kinds of common hernia repairs. They are named for the part of the body closest to the hernia, or bulge.

Femoral hernia repair

This procedure repairs a hernia that occurs in the groin where the thigh meets the abdomen. It is called a femoral hernia repair because it is near the spot where the femoral artery and vein pass from the leg into the trunk of the body. Sometimes this type of hernia creates a noticeable bulge.

An incision is made in the groin area. The tissues are separated from the hernia sac, and the intestines are returned to the abdomen. The area is often reinforced with webbing before it is sewn shut. The skin is closed with sutures or metal clips that can be removed in about one week.

Inguinal hernia repair

Inguinal hernia repair closes a weakness in the abdominal wall that is near the inguinal canal, the spot where the testes descend from the body into the scrotum. This type of hernia occurs in about 2 percent of adult males.

An incision is made in the abdomen, then the hernia is located and repaired. The surgeon must be alert not to injure the spermatic cord, the testes, or the blood supply to the testes. If the hernia is small, it is simply repaired. If it is large, the area is reinforced with mesh to prevent a recurrence. External skin sutures can be removed in

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about a week. Patients should not resume sexual activity until being cleared by their doctor.

Umbilical hernia repair

This procedure repairs a hernia that occurs when the intestines bulge through the abdomen wall near the navel. Umbilical hernias are most common in infants.

An incision is made near the navel. The hernia is located and the intestines are returned to the abdomen. The peritoneum is closed, then the large abdominal muscle is pulled over the weak spot in such a way as to reinforce the area. External sutures or skin clips can be removed in about 10 days.

Incisional hernia repair

Incisional hernias occur most frequently at the site of a scar from earlier abdominal surgery. Once again, the abdomen is opened and the intestines returned to their proper place. The area is reinforced with mesh, and the abdominal wall is reconstructed to prevent another hernia from developing. External sutures can be removed in about a week.

Hiatal hernia

A **hiatal hernia** repair is slightly different from the other hernias described here, because it corrects a weakness or opening in the diaphragm, the muscle that separates the chest cavity from the abdominal cavity. This surgery is done to prevent the stomach from shifting up into the chest cavity and to prevent the stomach from spilling gastric juices into the esophagus, causing **pain** and scarring.

An incision is made in the abdomen or chest, and the hole or weakness in the diaphragm is located and repaired. The top of the stomach is wrapped around the bottom of the esophagus, and they are sutured together to hold the stomach in place. Sometimes the vagus nerve is cut in order to decrease the amount of acid the stomach produces. External sutures can be removed in about one week. This type of hernia repair often requires a longer hospital stay than the other types, although techniques are being improved that reduce invasiveness of the surgery and the length of the hospital stay.

Preparation

Before the operation, the patient will have blood and urine collected for testing. X rays are taken of the affected area. In a hiatal hernia, an **endoscopy** (a visual inspection of the organs) is done.

KEY TERMS

Endoscopy—A procedure in which an instrument containing a camera is inserted into the gastrointestinal tract so that the doctor can visually inspect the gastrointestinal system.

Gangrene—Death and decay of body tissue because the blood supply is cut off. Tissues that have died in this way must be surgically removed.

Peritoneum—The transparent membrane lining the abdominal cavity that holds organs such as the intestines in place.

Patients should meet with the anesthesiologist before the operation to discuss any medications or conditions that might affect the administration of anesthesia. Patients may be asked to temporarily discontinue certain medications. The day of the operation, patients should not eat or drink anything. They may be given an enema to clear the bowels.

Aftercare

Patients should eat a clear liquid diet until the gastrointestinal tract begins functioning again. Normally this is a short period of time. After that, they are free to eat a healthy, well-balanced diet of their choice. They may bathe normally, using a gentle, unscented soap. An antibiotic ointment may be prescribed for the incision. After the operation, a hard ridge will form along the incision line. With time, this ridge softens and becomes less noticeable. Patients who remain in the hospital will have blood drawn for follow-up studies.

Patients should begin easy activities, such as walking, as soon as they are comfortable, but should avoid strenuous exercise for four to six weeks, and especially avoid heavy lifting. Learning and practicing proper lifting techniques is an important part of patient education after the operation. Patients may be given a laxative or stool softener so that they will not strain to have bowel movements. They should discuss with their doctor when to resume driving and sexual activity.

Risks

As with any surgery, there exists the possibility of excessive bleeding and infection after the surgery. In inguinal and femoral hernia repair, a slight risk of damage to the testicles or their blood supply exists for male patients. Accidental damage may be caused to the intestinal tract, but generally complications are few.

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Normal results

The outcome of surgery depends on the age and health of the patient and on the type of hernia. Although most hernias can be repaired without complications, hernias recur in 10–20% of people who have had hernia surgery.

Resources

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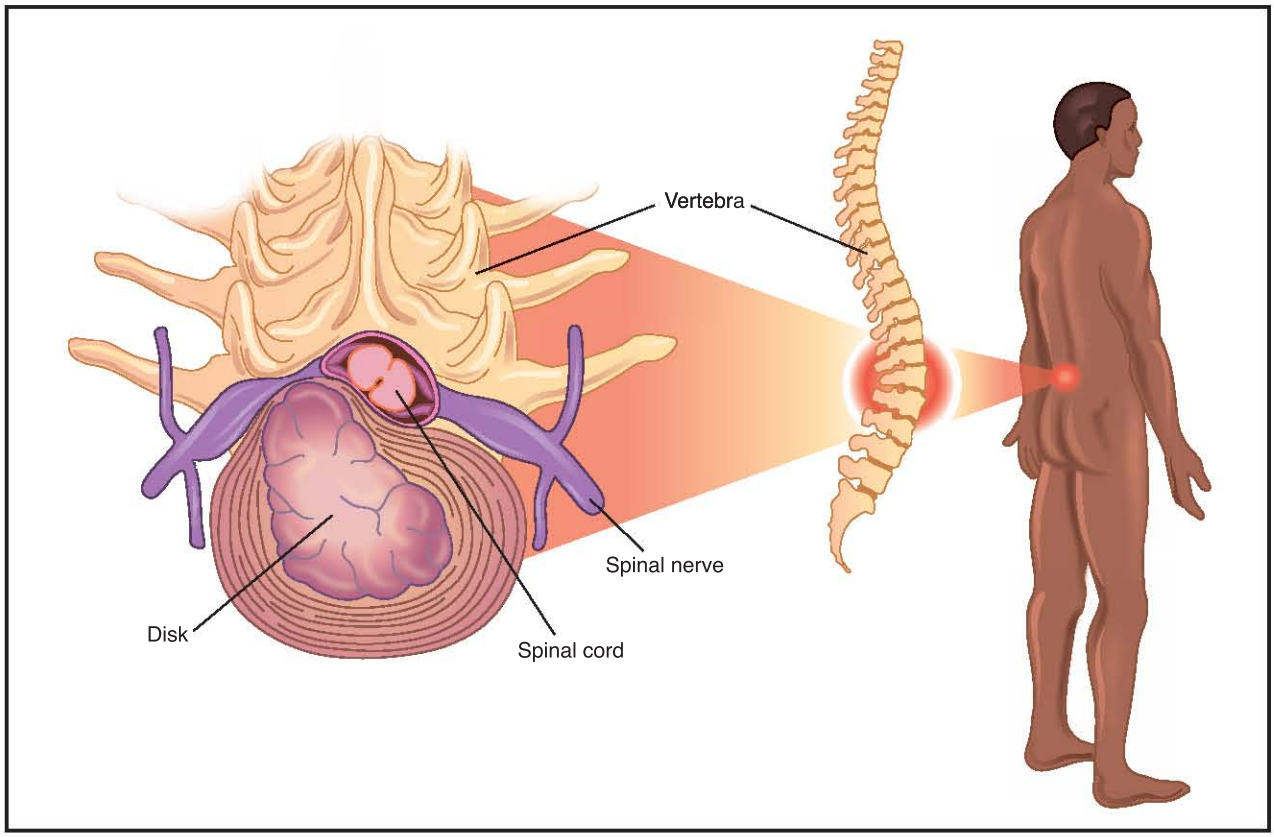
Herniated disk

Definition

Disk herniation is a rupture of fibrocartilagenous material (annulus fibrosis) that surrounds the intervertebral disk. This rupture involves the release of the disk's center portion containing a gelatinous substance called the nucleus pulposus. Pressure from the vertebrae above and below may cause the nucleus pulposus to be forced outward, placing pressure on a spinal nerve and causing considerable **pain** and damage to the nerve. This condition most frequently occurs in the lumbar region and is also commonly called herniated nucleus pulposus, prolapsed disk, ruptured intervertebral disk, or slipped disk.

Description

The spinal column is made up of 26 vertebrae that are joined together and permit forward and backward bending, side bending, and rotation of the spine. Five distinct regions comprise the spinal column, including the cervical (neck) region, thoracic (chest) region, lumbar (low back) region, sacral, and coccygeal (tailbone) region. The cervical region consists of seven vertebrae, the thoracic region includes 12 vertebrae, and the lumbar region contains five vertebrae. The sacrum is



A herniated disk refers to the rupture of fibrocartilagenous material, called the annulus fibrosis, that surrounds the intervertebral disk. When this occurs, pressure from the vertebrae above and below may force the disk's center portion, a gel-like substance, outward, placing additional pressure on the spinal nerve and causing pain and damage to the nerve. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

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composed of five fused vertebrae, which are connected to four fused vertebrae forming the coccyx. Intervertebral disks lie between each adjacent vertebra.

Each disk is composed of a gelatinous material in the center, called the nucleus pulposus, surrounded by rings of a fiberous tissue (annulus fibrosus). In disk herniation, an intervertebral disk's central portion herniates or slips through the surrounding annulus fibrosus into the spinal canal, putting pressure on a nerve root. Disk herniation most commonly affects the lumbar region between the fifth lumbar vertebra and the first sacral vertebra. However, disk herniation can also occur in the cervical spine. The incidence of cervical disk herniation is most common between the fifth and sixth cervical vertebrae. The second most common area for cervical disk herniation occurs between the sixth and seventh cervical vertebrae. Disk herniation is less common in the thoracic region.

Predisposing factors associated with disk herniation include age, gender, and work environment. The peak age for occurrence of disk herniation is between 20–45 years of age. Studies have shown that males are more commonly affected than females in lumbar disk herniation by a 3:2 ratio. Prolonged exposure to a bent-forward work posture is correlated with an increased incidence of disk herniation.

There are four classifications of disk pathology:

- A protrusion may occur where a disk bulges without rupturing the annulus fibrosis.
- The disk may prolapse where the nucleus pulposus migrates to the outermost fibers of the annulus fibrosis.
- There may be a disk extrusion, which is the case if the annulus fibrosis perforates and material of the nucleus moves into the epidural space.
- The sequestrated disk may occur as fragments from the annulus fibrosis and nucleus pulposus are outside the disk proper.

Causes and symptoms

Any direct, forceful, and vertical pressure on the lumbar disks can cause the disk to push its fluid contents into the vertebral body. Herniated nucleus pulposus may occur suddenly from lifting, twisting, or direct injury, or it can occur gradually from degenerative changes with episodes of intensifying symptoms. The annulus may also become weakened over time, allowing stretching or tearing and leading to a disk herniation. Depending on the location of the herniation, the herniated material can also press directly on nerve roots or on the spinal cord, causing a shock-like pain (**sciatica**) down the legs, weakness, **numbness**, or problems with bowels, bladder, or sexual function.

Diagnosis

Several radiographic tests are useful for confirming a diagnosis of disk herniation and locating the source of pain. These tests also help the surgeon indicate the extent of the surgery needed to fully decompress the nerve. X rays show structural changes of the lumbar spine. **Myelography** is a special x ray of the spine in which a dye or air is injected into the patient's spinal canal. The patient lies strapped to a table as the table tilts in various directions and spot x rays are taken. X rays showing a narrowed dye column in the intervertebral disk area indicate possible disk herniation.

A computed tomography scan (CT or CAT scan) exhibits the details of pathology necessary to obtain consistently good surgical results. **Magnetic resonance imaging** (MRI) analysis of the disks can accurately detect the early stages of disk **aging** and degeneration. Electomyograms (EMGs) measure the electrical activity of the muscle contractions and possibly show evidence of nerve damage. An EMG is a powerful tool for assessing muscle **fatigue** associated with muscle impairment with **low back pain**.

Treatment

Drugs

Unless serious neurologic symptoms occur, herniated disks can initially be treated with pain medication and up to 48 hours of bed rest. There is no proven benefit from resting more than 48 hours. Patients are then encouraged to gradually increase their activity. Pain medications, including antiinflammatories, muscle relaxers, or in severe cases, **narcotics**, may be continued if needed.

Epidural steroid injections have been used to decrease pain by injecting an antiinflammatory drug, usually a corticosteroid, around the nerve root to reduce inflammation and **edema** (swelling). This partly relieves the pressure on the nerve root as well as resolves the inflammation.

Physical therapy

Physical therapists are skilled in treating acute back pain caused by the disk herniation. The physical therapist can provide noninvasive therapies, such as ultrasound or diathermy to project heat deep into the tissues of the back or administer manual therapy, if mobility of the spine is impaired. They may help improve posture and develop an **exercise** program for

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recovery and long-term protection. Appropriate exercise can help take pressure off inflamed nerve structures, while improving overall posture and flexibility. **Traction** can be used to try to decrease pressure on the disk. A lumbar support can be helpful for a herniated disk at this level as a temporary measure to reduce pain and improve posture.

Surgery

Surgery is often appropriate for conditions that do not improve with the usual treatment. In this event, a strong, flexible spine is important for a quick recovery after surgery. There are several surgical approaches to treating a herniated disk, including the classic discectomy, microdiscectomy, or percutaneous discectomy. The basic differences among these procedures are the size of the incision, how the disk is reached surgically, and how much of the disk is removed.

Discectomy is the surgical removal of the portion of the disk that is putting pressure on a nerve causing the back pain. In the classic disectomy, the surgeon first enters through the skin and then removes a bony portion of the vertebra called the lamina, hence the term **laminectomy**. The surgeon removes the disk material that is pressing on a nerve. Rarely is the entire lamina or disk entirely removed. Often, only one side is removed and the surgical procedure is termed hemilaminectomy.

In microdiscectomy, through the use of an operating microscope, the surgeon removes the offending bone or disk tissue until the nerve is free from compression or stretch. This procedure is possible using **local anesthesia**. Microsurgery techniques vary and have several advantages over the standard discectomy, such as a smaller incision, less trauma to the musculature and nerves, and easier identification of structures by viewing into the disk space through microscope magnification.

Percutaneous disk excision is performed on an outpatient basis, is less expensive than other surgical procedures, and does not require a **general anesthesia**. The purpose of percutaneous disk excision is to reduce the volume of the affected disk indirectly by partial removal of the nucleus pulposus, leaving all the structures important to stability practically unaffected. In this procedure, large incisions are avoided by inserting devices that have cutting and suction capability. Suction is applied and the disk is sliced and aspirated.

Arthroscopic microdiscectomy is similar to percutaneous discectomy, however it incorporates modified arthroscopic instruments, including scopes and suction devices. A suction irrigation of saline solution is established through two entry sites. A video discoscope is introduced from one site and the deflecting instruments from the opposite side. In this way, the surgeon is able to search and extract the nuclear fragments under direct visualization.

Laser disk decompression is performed using similar means as percutaneous excision and arthroscopic microdiscectomy, but laser energy is used to remove the disk tissue. Here, laser energy is percutaneously introduced through a needle to vaporize a small volume of nucleus pulposus, thereby dropping the pressure of the disk and decompressing the involved neural tissues. One disadvantage of this procedure is the high initial cost of the laser equipment. It is important to realize that only a very small percentage of people with herniated lumbar disks go on to require surgery. Further, surgery should be followed by appropriate **rehabilitation** to decrease the chance of reinjury.

Chemonucleolysis

Chemonucleolysis is an alternative to surgical excision. Chymopapain, a purified enzyme derived from the papaya plant, is injected percutaneously into the disk space to reduce the size of the herniated disks. It hydrolyses proteins, thereby decreasing water-binding capacity, when injected into the nucleus pulposus inner disk material. The reduction in size of the disk relieves pressure on the nerve root.

Spinal fusion

Spinal fusion is the process by which bone grafts harvested from the iliac crest (thick border of the ilium located on the pelvis) are placed between the intervertebral bodies after the disk material is removed. This approach is used when there is a need to reestablish the normal bony relationship between the vertebrae. A total discectomy may be needed in some cases because lumbar spinal fusion can help prevent recurrent lumbar disk herniation at a particular level.

Alternative treatment

Acupuncture involves the use of fine needles inserted along the pathway of the pain to move energy locally and relieve the pain. An acupuncturist determines the location of the nerves affected by the herniated disk and positions the needles appropriately. Massage therapists may also provide short-term relief from a herniated disk. Following manual examination and x-ray diagnosis, **chiropractic** treatment usually includes manipulation to correct muscle and joint malfunctions, while care is taken not to place an additional strain on the injured disk. If a full trial of conservative therapy fails, or if neurologic problems (weakness, bowel or bladder

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problems, and sensory loss) develop, the next step is usually evaluation by an orthopedic surgeon.

Prognosis

Only 5–10% of patients with unrelenting sciatica and neurological involvement, leading to chronic pain of the lumbar spine, need to have a surgical procedure performed. This strongly suggests that many patients with herniated disks at the lumbar level respond well to conservative treatment. For those patients who do require surgery for lumbar disk herniation, the reviewed procedures of nerve root decompression caused by disk herniation is favorable. Results of studies varied from 60–90% success rates. Disk surgery has progressively evolved in the direction of decreasing invasiveness. Each surgical procedure is not without possible complications, which can lead to chronic low back pain and restricted lifestyle.

Prevention

Proper exercises to strengthen the lower back and abdominal muscles are key in preventing excess **stress** and compressive forces on lumbar disks. Good posture will help prevent problems on cervical, thoracic, and lumbar disks. A good flexibility program is critical for prevention of muscle and spasm that can cause an increase in compressive forces on disks at any level. Proper lifting of heavy objects is important for all muscles and levels of the individual disks. Good posture in sitting, standing, and lying down is helpful for the spine. Losing weight, if needed, can prevent weakness and unnecessary stress on the disks caused by **obesity**. Choosing proper footwear may also be helpful to reduce the impact forces to the lumbar disks while walking on hard surfaces. Wearing special back support devices may be helpful if heavy lifting is required with combinations of twisting.

Resources

OTHER

"Back Pain." Healthtouch Online Page. http://www.healthtouch.com.

Jeffrey P. Larson, RPT

Hernioplasty *see* **Hernia repair**

Herniorrhaphy *see* **Hernia repair**

Herpes *see* **Cold sore**

Herpes encephalitis *see* **Encephalitis**

Herpes genitalis *see* **Genital herpes**

Herpes simplex *see* **Cold sore**

Herpes simplex type 2 *see* **Genital herpes**

Herpes type 2 *see* **Genital herpes**

Herpes zoster infection *see* **Shingles**

Heterotopic transplant *see* **Liver transplantation**

Heterotropia *see* **Strabismus**

HFRS *see* **Hantavirus infections**

Hiatal hernia

Definition

A hiatal hernia is a condition in which a weakness or actual gap or tear in the large muscle of the diaphragm serves as an opening through which the stomach can enter the chest. Hiatal hernias can exist at birth (congenital hiatal hernia) or can develop later in life.

The diaphragm is a large dome-shaped sheet of muscle tissue that spans from the left to the right ribcage. It divides the chest area (thoracic cavity) from the abdominal cavity. The esophageal hiatus is the area of the diagphragm where the esophagus penetrates, joining the stomach below.

Along with other muscles of the abdomen and thoracic cavity, the diaphragm plays an important role in the process of respiration (breathing). During inspiration (breathing in), the muscle of the diaphragm contracts. This increases the volume of the thoracic cavity, and suction allows air to enter the lungs. During expiration, the diaphragm relaxes, and air is expelled from the lungs. The esophagus passes through an area of the diaphragm (the hiatus) on the way to the stomach, which helps prevent the backflow of stomach acid up the esophagus. The diaphragm plays a role in other functions, by virtue of its ability to increase pressure within the abdomen (intra-abdominal pressure)—in this capacity, it is crucial to the acts of **vomiting**, defecation, and urination.

Demographics

A hiatal hernia can occur due to an injury, or can develop over time due to some inherent weakness in the muscle fibers. Greatly increased intra-abdominal pressure, as may occur during **pregnancy**, can also induce a hiatal hernia. The following factors may contribute to the development of a hiatal hernia:

- Obesity
- Family history of hiatal hernia

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- Repeated straining due to constipation
- Smoking
- Heavy lifting
- Chronic cough
- Extreme bouts of violent vomiting
- Age (about 60% of people develop some degree of hiatal hernia by the time they reach the age of 60)

Description

A hiatal hernia occurs when the stomach enters the chest cavity through a weakness or tear in the area of the diaphragm where the esophagus passes through. The most common form of hiatal hernia occurs when the gastroesophageal junction (the area where the esophagus enters the stomach) slides upward through the hernia opening. This is referred to as a sliding hiatal hernia. A rolling or paraesophageal hiatal hernia is much more rare. In this instance, the gastroesophageal junction doesn't protrude up into the thoracic cavity; instead, a portion of the stomach slides up alongside the esophagus, and protrudes into the chest cavity through the hiatal opening. This type of hiatal hernia is more dangerous, since there is a risk that the narrow confines through which the stomach protrudes will prevent proper blood circulation into this area of the stomach, causing its tissue to become oxygen deprived (strangulated).

While some people can have a hiatal hernia without any recognizable symptoms, other people have clear-cut discomfort related to the condition. Symptoms of a hiatal hernia are very similar to symptoms of gastric acid reflux, and include

- heartburn
- chest pain
- nausea
- frequent belching

Symptoms often get worse based on position (lying down, leaning forward) and activity (lifting heavy objects, straining for any reason). Over time, symptoms can worsen and cause coughing and asthma-like symptoms, **sore throat**, and swallowing problems (dysphagia). Anemia can develop when chronic acid reflux causes esophagitis with erosions of the esophagus or upper stomach.

Diagnosis/Preparations

Hiatal hernia is sometimes diagnosed when a **chest x ray** is performed for some other reason. In other instances, tests such as a barium swallow (upper GI series) or upper **endoscopy** may be performed specifically to look for the presence of a hiatal hernia.

Treatment

Treatment of a hiatal hernia often starts with treatment of the symptoms of gastroesophageal reflux that it induces, including medications such as **antacids**, **H-2 blockers**, and **proton pump inhibitors**. Practical recommendations include weight loss, stopping **smoking**, elevating the head of the bed at night, so that gravity discourages acid reflux, adjusting the diet to avoid **constipation** (and therefore straining at stool), and avoiding activities that cause straining (such as heavy lifting).

In some cases, surgical interventions will be required, particularly with very large hiatal hernias or with the rolling or paraesophageal form of hiatal hernia. Several surgical approaches may be utilized, all with the purpose of pulling the stomach back down into the abdomen, and decreasing the size of the hiatal opening. The surgery may be performed through an incision in the chest (thoracic access), abdomen (abdominal access), or using minimally invasive, laparoscopic techniques. Some of the surgeries used include Nissen fundoplication, Belsey (Mark IV) fundoplication, and Hill repair.

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Rosalyn Carson-DeWitt, MD

Hiccups

Definition

Hiccups are the result of an involuntary, spasmodic contraction of the diaphragm followed by the closing of the throat.

Demographics

A hiccup bout is an episode lasting more than a few minutes. If hiccups last longer than 48 hours, they are considered persistent or protracted. Hiccups lasting longer than one month are termed intractable. The longest recorded attack is six decades.

Hiccups can occur at any age and in utero. Preterm infants spend up to 2.5% of their time hiccupping.

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Although hiccups occur less frequently with age, intractable hiccups are more common in adult life. Females develop hiccups more frequently during early adulthood than males of the same age.

Hiccups are one of the most common, but thankfully mildest, disorders to which humans are prey. Virtually everyone experiences them at some point, but they rarely last long or require a doctor's care. Occasionally, a bout of hiccups will last longer than two days, earning it the name "persistent hiccups." Very few people will experience intractable hiccups, in which hiccups last longer than one month.

Description

A hiccup involves the coordinated action of the diaphragm and the muscles that close off the windpipe (trachea). The diaphragm is a dome-shaped muscle separating the chest and abdomen, normally responsible for expanding the chest cavity for inhalation. Sensation from the diaphragm travels to the spinal cord through the phrenic nerve and the vagus nerve, which pass through the chest cavity and the neck. Within the spinal cord, nerve fibers from the brain monitor sensory information and adjust the outgoing messages that control contraction. These messages travel along the phrenic nerve.

Irritation of any of the nerves involved in this loop can cause the diaphragm to undergo involuntary contraction, or spasm, pulling air into the lungs. When this occurs, it triggers a reflex in the throat muscles. Less than a tenth of a second afterward, the trachea is closed off, making the characteristic "hic" sound.

Causes and symptoms

Hiccups can be caused by central nervous system disorders, injury or irritation to the phrenic and vagus nerves, and toxic or metabolic disorders affecting the central or peripheral nervous systems. They may be of unknown cause or may be a symptom of psychological **stress**. Hiccups often occur after drinking carbonated beverages or alcohol. They may also follow overeating or rapid temperature changes. Persistent or intractable hiccups may be caused by any condition which irritates or damages the relevant nerves, including:

- overstretching of the neck
- laryngitis
- heartburn (gastroesophageal reflux)
- irritation of the eardrum (which is innervated by the vagus nerve)
- general anesthesia
- surgery
- bloating
- tumor
- infection
- diabetes

Diagnosis

Hiccups are diagnosed by observation, and by hearing the characteristic sound. Diagnosing the cause of intractable hiccups may require imaging studies, blood tests, pH monitoring in the esophagus, and other tests.

Treatment

Most cases of hiccups will disappear on their own. Home remedies that interrupt or override the spasmodic nerve circuitry are often effective. Such remedies include:

- holding one's breath for as long as possible
- breathing into a paper bag
- swallowing a spoonful of sugar
- bending forward from the waist and drinking water from the wrong side of a glass

Treating any underlying disorder will usually cure the associated hiccups. Chlorpromazine (Thorazine) relieves intractable hiccups in 80% of cases. Metoclopramide (Reglan), carbamazepam, valproic acid (Depakene), and phenobarbital are also used. As a last resort, surgery to block the phrenic nerve may be performed, although it may lead to significant impairment of respiration.

Prognosis

Most cases of hiccups last no longer than several hours, with or without treatment.

Prevention

Some cases of hiccups can be avoided by drinking in moderation, avoiding very hot or very cold food, and avoiding cold showers. Carbonated beverages when drunk through a straw deliver more gas to the stomach than when sipped from a container; therefore, avoid using straws.

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Richard Robinson
Karl Finley

High-altitude sickness *see* **Altitude sickness**

High-risk pregnancy

Definition

A **pregnancy** that has maternal or fetal complications requiring special medical attention or bed rest is considered high-risk. Complications, as used here, mean that the risk of illness or **death** before or after delivery is greater than normal for the mother or baby.

Demographics

According to the U.S. Centers for Disease Control and Prevention (CDC) there were 13.1 maternal deaths for every 100,000 live births in the United States in 2004. There was a large racial disparity in maternal deaths, with African American women experiencing 36.1 deaths per 100,00 live births in 2004 and white women experiencing 9.8 deaths per 100,000 live births the same year. The rate for Hispanic women was 8.5 per 100,000 live births. Over the past 100 years deaths due to pregnancy and **childbirth** have declined hugely. In the early 1900s, giving birth was one of the most dangerous things a woman could do, with more than 600 women dying for every 100,000 live births in the year 1915.

Other statistics provide maternal mortality information by total female population, instead of per number of live births. In 2006, there were 115 deaths per 100,000 population due to pregnancy and childbirth among African American women, 70 deaths per 100,000 population among Hispanic and Latino women, 113 deaths per 100,000 population among white women, and 20 deaths per 100,000 population among Asian women. Common causes of death in women of childbearing age are problems related to pregnancy and delivery, including **blood clots** that travel to the lungs, anesthesia complications, bleeding, infection, and high blood pressure complications (pre-eclampsia and **eclampsia**).

A baby dies before, during, or shortly after birth in 16 out of 1,000 deliveries in the United States. Almost 50% of these deaths are stillbirths, which are sometimes unexplained. In 2005 there were 4.54 deaths in newborns before age 28 days per 1,000 live births, a total of 18,782 neonatal deaths. Risk factors for **stillbirth** and neonatal can be present before pregnancy occurs or develop during the course of the pregnancy.

Description

Risk factors in pregnancy are those findings discovered during prenatal assessment that are known to have a potentially negative effect on the outcome of the pregnancy, either for the woman or the fetus. This evaluation determines whether the mother has characteristics or conditions that make her or her baby more likely to become sick or die during the pregnancy.

The pregnant woman's interview at her first visit to the health care provider is conducted by the nurse, who obtains the data necessary to begin the high-risk screening. The physician or midwife caring for the pregnant woman will review the prenatal assessment sheet, order lab data, and obtain ultrasounds to determine if any risk factors are present. If it is determined that a woman has a high-risk pregnancy, she should be referred to a perinatologist for advanced care. This is the specialist who establishes and implements the medical regimen needed for the particular maternal/fetal complications likely to occur and the interdisciplinary team associated with the perinatal center works in its management. The perinatal team usually comprises a nutritionist, social worker, nurse educators, geneticists, ultrasonographers, and additional nursing staff who are responsible for the monitoring and supervising of ongoing team care of the patient.

Causes and symptoms

All risk factors do not threaten pregnancy to the same extent. The risk of complications is increased by **smoking**, poor nutritional habits, drug and alcohol **abuse**, domestic violence, prepregnancy maternal health status, psychosocial factors, prior health care, the presence of chronic medical problems in the mother, past history of repeated preterm delivery, multiple gestation, and abnormalities of the fetus or placenta. A woman with a high-risk pregnancy may have an earlier labor and delivery depending upon the fetal or maternal complication present and, likewise, present with symptoms dependent on the condition. Since the placenta supplies the baby with its nutrients and oxygen, any condition that threatens the blood supply to it threatens fetal development.

The threat of a preterm delivery is the most common reason for a referral to a perinatal center, which is linked to obstetric and newborn services that provide

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KEY TERMS

Amniocentesis—A procedure that uses ultrasound to guide a needle into the amniotic sac (bag of waters) surrounding the baby and obtain fluid to analyze for genetic abnormalities.

Antepartum—This refers to the time period of the woman's pregnancy from conception and onset of labor.

Down syndrome—The most prevalent of a class of genetic defects known as trisomies, in which cells contain three copies of certain chromosomes rather than the usual two. Down syndrome, or trisomy 21, usually results from three copies of chromosome 21.

Perinatal—Refers to the period shortly before and after birth, generally from around the 20th week of pregnancy to one to four weeks after birth.

Perinatologist—A specialist in the branch of obstetrics that deals with the high-risk pregnant woman and her fetus.

Preconceptional—This refers to the time period before pregnancy, i.e., conception, occurs.

Ultrasonographer—The person who performs the radiologic technique of ultrasound in which deep structures of the body are visualized.

the highest level of care for a pregnant woman and her baby. A preterm delivery may occur because of a **premature rupture of membranes** (the bag of water surrounding the baby breaks) or preterm labor. There is a strong correlation of vaginal or uterine infection with the pregnant woman's water breaking, and there are laboratory tests that are predictive of a woman's risk of experiencing preterm labor.

Diagnosis

A risk-scoring sheet is used by many health care agencies during the prenatal assessment to establish if a woman may be at risk for complications during her pregnancy. This score sheet is implemented at the first prenatal visit, becomes a part of the woman's record, and is updated throughout the pregnancy as necessary. A woman's age affects pregnancy risk, as girls 15 years old and under are more likely to develop high blood pressure, protein in the urine and fluid accumulation, or seizures. They also are more likely to have underweight or undernourished babies. A woman 35 or older has a greater risk of developing high blood pressure or diabetes, as well as a much higher risk of having a chromosomal abnormality such as **Down syndrome**. A woman shorter than five feet or a woman weighing less than 100 pounds before pregnancy has a greater risk of having a small or preterm baby.

Laboratory data and ultrasound also are used to determine high-risk pregnancies by specific blood tests and imaging of the baby. A pregnancy may begin classified as low risk but be changed to a classification of high risk secondary to complications determined from the ongoing assessment of the pregnant woman. Since many of these complications can be managed with proper treatment, it is essential that a pregnant woman make and keep regular obstetric appointments.

Treatment

Treatment will vary, depending upon the maternal or fetal complication present. Generally, a woman with severe high-risk factors in pregnancy should be referred to a perinatal center to obtain the highest level of care for herself and her baby. Interventions to improve health status might include nutritional assessment; **physical examination**; teaching modalities for smoking cessation, drug and alcohol programs; prescribing medications related to the condition or changing pre-pregnancy medications (known to cause problems in the fetus); serial ultrasounds to learn fetal status; **amniocentesis**; fetal transfusions; fetal surgery; **antepartum testing**; bed rest; home health care; hospitalization; and early delivery. In a post-term pregnancy (greater than 42 weeks), the death of a baby is three times more likely than that of a normal term pregnancy (37–40 weeks). The treatment in this case would be to induce labor or perform a **cesarean section** before problems start to occur.

Prognosis

Advances in the management of complications in high-risk pregnancies have provided women with a means of controlling their risks, which substantially increases the potential for a successful outcome. Since it is impossible to guarantee a good outcome in a normal pregnancy, it is even more difficult to ensure that a high-risk pregnancy will result in a healthy infant and mother. A woman who strictly adheres to the medical regimen established for her, however, will greatly increase her chances of a positive result.

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Prevention

The early weeks of pregnancy are the most crucial ones for the fetus. Many women do not know they are pregnant until several weeks after conception, so education about the need for preconceptional care is essential. Preconception counseling guides a woman in planning a healthy pregnancy. These are some of the factors to which attention must be paid:

- family history
- medical history
- past pregnancies
- current medications
- lifestyle
- environment
- infections

The number one preventable cause of **mental retardation** in infants is the alcohol use during pregnancy. Alcohol can cause problems ranging from **miscarriage** to severe behavioral problems in the baby or developing child even if no obvious physical **birth defects** are apparent. **Fetal alcohol syndrome** is seen in about 2 out of 1,000 live births.

Cigarette smoking is the most common **addiction** among pregnant women in the United States, and despite the health hazards of smoking being well known, only about 20% of these women actually quit during pregnancy. One risk of smoking during pregnancy is having a baby who may die from **sudden infant death syndrome** (SIDS).

Drugs known to cause birth defects when taken during pregnancy include: alcohol, dilantin (phenytoin), any drug that interferes with the actions of **folic acid**, lithium, streptomycin, tetracycline, thalidomide, warfarin (Coumadin), and isotretinoin (Accutane), which is prescribed for **acne**.

Infections that may cause birth defects include: herpes simplex, viral hepatitis, the flu, **mumps**, German **measles** (**rubella**), **chickenpox** (varicella), **syphilis**, **toxoplasmosis** (occurs from eating undercooked meat and handling kitty litter), **listeriosis**, and infections from the coxsackievirus or cytomegalovirus (CMV). Many adults have been exposed to coxsackievirus and CMV when they were younger, but many have not. Those who have not been exposed should pay careful attention to any illnesses they have early in their pregnancy, noting the onset, presence of **fever**, muscle aches and pains, and duration of illness to report to their physician.

Hemolytic disease of the newborn (destruction of the red blood cells) can occur when Rh incompatibility exists between child and mother. The most common cause of incompatible blood types is Rh incompatibility, such as when the mother has Rh-negative blood and the father has Rh-positive blood. The baby may have Rh-positive blood, in which case the mother's body produces antibodies against the baby's blood. Fortunately, the mother can be treated with Rhogham [Rh0(D)immune globulin], which can be given to the mother in the first 72 hours after delivery and at the twenty-eighth week of pregnancy; it will destroy any antibodies produced by her blood and significantly decrease the risk associated with pregnancies with Rh-factor incompatibilities.

There are, however, other incompatible blood factors during the prenatal assessment period that can cause anemia in the fetus and require ongoing monitoring. The greatest gift a woman can give to herself and her baby is to plan her pregnancy with preconceptional counseling. Many women are frequently deficient in folic acid, a B vitamin used in the synthesis of ribonucleic acid (RNA) and essential, in large quantities, for optimal protein synthesis in the fetus. This is especially true in the early weeks of pregnancy, when all cell division and organ development is occurring. Thus, the best prevention for a high risk pregnancy is good planning.

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American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, IL, 60007-1098, (847) 434-4000, (847) 434-8000, http://www.aap.org.

American College of Obstetricians and Gynecologists, P.O. Box 96920, Washington, DC, 20090-6920, (202)638-5577, http://www.acog.org.

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American Pregnancy Association, 431 Greenway Drive, Suite 800, Irving, TX, 75038, (972) 550-0140, (972) 550-0800, Questions@AmericanPregnancy.org, http://www.americanpregnancy.org.

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High blood phosphate level *see* **Phosphorus imbalance**

High blood pressure *see* **Pulmonary hypertension**

High calcium blood level *see* **Hypercalcemia**

High cholesterol *see* **Cholesterol, high**

High potassium blood level *see* **Hyperkalemia**

High sodium blood level *see* **Hypernatremia**

Hindu medicine *see* **Ayurvedic medicine**

Hip bath *see* **Sitz bath**

Hip replacement *see* **Joint replacement**

Hirschsprung's disease

Definition

Hirschsprung's disease, also known as congenital megacolon or aganglionic megacolon, is an abnormality in which certain nerve fibers are absent in segments of the bowel, resulting in severe bowel obstruction. It was first identified in 1886 by a physician named Harold Hirschsprung.

Description

Hirschsprung's disease is caused when certain nerve cells (called parasympathetic **ganglion** cells) in the wall of the large intestine (colon) do not develop before birth. Without these nerves, the affected segment of the colon lacks the ability to relax and move bowel contents along. This causes a constriction and as a result, the bowel above the constricted area dilates due to stool becoming trapped, producing megacolon (dilation of the colon). The disease can affect varying lengths of bowel segment, most often involving the region around the rectum. In up to 10% of children, however, the entire colon and part of the small intestine are involved. This condition is known as total colonic aganglionosis, or TCA.

Hirschprung's disease occurs once in every 5,000 live births, and it is about four times more common in males than females. Between 4% and 50% of siblings are also afflicted. The wide range for recurrence is due to the fact that the recurrence risk depends on the gender of the affected individual in the family (i.e., if a female is affected, the recurrence risk is higher) and the length of the aganglionic segment of the colon (i.e., the longer the segment that is affected, the higher the recurrence risk).

Causes and symptoms

Hirschsprung's disease occurs early in fetal development when, for unknown reasons, there is either failure of nerve cell development, failure of nerve cell migration, or arrest in nerve cell development in a segment of the bowel. The absence of these nerve fibers, which help control the movement of bowel contents, is what results in intestinal obstruction accompanied by other symptoms.

There is a genetic basis to Hirschsprung's disease, and it is believed that it may be caused by different genetic factors in different subsets of families. Proof that genetic factors contribute to Hirschprung's disease is that it is known to run in families, and it has been seen in association with some chromosome abnormalities. For example, about 10% of children with the disease have **Down syndrome** (the most common chromosomal abnormality). Molecular diagnostic techniques have identified many genes that cause susceptibility to Hirschprung's disease. As of the early 2000s, a total of six genes have been identified: the RET gene, the glial cell line-derived neurotrophic factor gene, the endothelin-B receptor gene, endothelin converting enzyme, the endothelin-3 gene, and the Sry-related transcription factor SOX10. Mutations that inactivate the RET gene are the most frequent, occurring in 50% of familial cases (cases which run in families) and 15–20% of sporadic (non-familial) cases. Mutations in these genes do not cause the disease, but they make the chance of developing it more likely. Mutations in other genes or environmental factors are required to develop the disease, and these other factors are not understood. At least three chromosomes are known to be involved: 13q22, 21q22, and 10q. Hirschsprung's disease has also been reported in association with abnormal forms of chromosome 18.

For persons with a ganglion growth beyond the sigmoid segment of the colon, the inheritance pattern is autosomal dominant with reduced penetrance (risk closer to 50%). For persons with smaller segments involved, the inheritance pattern is multifactorial (caused by an interaction of more than one gene and environmental factors, risk lower than 50%) or autosomal

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recessive (one disease gene inherited from each parent, risk closer to 25%) with low penetrance.

The initial symptom is usually severe, continuous **constipation**. A newborn may fail to pass meconium (the first stool) within 24 hours of birth, may repeatedly vomit yellow- or green-colored bile and may have a distended (swollen, uncomfortable) abdomen. Occasionally, infants may have only mild or intermittent constipation, often with **diarrhea**.

While two-thirds of cases are diagnosed in the first three months of life, Hirschsprung's disease may also be diagnosed later in infancy or childhood. Occasionally, even adults are diagnosed with a variation of the disease. In older infants, symptoms and signs may include anorexia (lack of appetite or inability to eat), lack of the urge to move the bowels or empty the rectum on **physical examination**, distended abdomen, and a mass in the colon that can be felt by the physician during examination. It should be suspected in older children with abnormal bowel habits, especially a history of constipation dating back to infancy and ribbon-like stools.

Occasionally, the presenting symptom may be a severe intestinal infection called enterocolitis, which is life-threatening. The symptoms are usually explosive, watery stools and **fever** in a very ill-appearing infant. It is important to diagnose the condition before the intestinal obstruction causes an overgrowth of bacteria that evolves into a medical emergency. Enterocolitis can lead to severe diarrhea and massive fluid loss, which can cause **death** from **dehydration** unless surgery is done immediately to relieve the obstruction.

Hirschsprung's disease sometimes occurs in children with other disorders of the autonomic nervous system, such as congenital central hypoventilation syndrome, a breathing disorder. Other syndromes associated with Hirschsprung disease include congenital deafness and Waardenburg syndrome, a genetic disorder characterized by facial abnormalities and the loss of normal pigmentation in the hair, skin, and the iris of the eye.

Diagnosis

Hirschsprung's disease in the newborn must be distinguished from other causes of intestinal obstruction. The diagnosis is suspected by the child's medical history and physical examination, especially the rectal exam. The diagnosis is confirmed by a **barium enema** x ray, which shows a picture of the bowel. The x ray will indicate if a segment of bowel is constricted, causing dilation and obstruction. A biopsy of rectal tissue will reveal the absence of the nerve fibers. Adults may also undergo manometry, a balloon study (device used to enlarge the anus for the procedure) of internal anal sphincter pressure and relaxation.

Treatment

Hirschsprung's disease is treated surgically. The goal is to remove the diseased, nonfunctioning segment of the bowel and restore bowel function. This is often done in two stages. The first stage relieves the intestinal obstruction by performing a **colostomy**. This is the creation of an opening in the abdomen (stoma) through which bowel contents can be discharged into a waste bag. When the child's weight, age, or condition is deemed appropriate, surgeons close the stoma, remove the diseased portion of bowel, and perform a "pull-through" procedure, which repairs the colon by connecting functional bowel to the anus. The pull-through operation usually establishes fairly normal bowel function.

Children with total colonic aganglionosis occasionally fail to benefit from a pull-through procedure. One option in treating these patients is the construction of an ileoanal S-pouch.

The surgeon may recommend a permanent **ostomy** if the child has Down syndrome in addition to Hirschsprung disease, as these children usually have more difficulty with bowel control.

Prognosis

Overall, prognosis is very good. Most infants with Hirschsprung's disease achieve good bowel control after surgery, but a small percentage of children may have lingering problems with soilage or constipation. These infants are also at higher risk for an overgrowth of bacteria in the intestines, including subsequent episodes of enterocolitis, and should be closely followed by a physician. Mortality from enterocolitis or surgical complications in infancy is 25–30%.

Prevention

Hirschsprung's disease is a congenital abnormality that has no known means of prevention. It is important to diagnose the condition early in order to prevent the development of enterocolitis. **Genetic counseling** can be offered to a couple with a previous child with the disease or to an affected individual considering **pregnancy** to discuss recurrence risks and treatment options. Prenatal diagnosis is not available as of the early 2000s.

Resources

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ORGANIZATIONS

American Pseudo-Obstruction & Hirschsprung's Society, 158 Pleasant St., North Andover, MA, 01845-2797, (978) 685-4477, (978) 685-4488, aphs@tiac.net.

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923, (800) 999-6673, http://www.rarediseases.org.

Pull-thru Network, 2312 Savoy Street, Hoover, AL, 35226-1528, (205) 978-2930, PTNmail@charter.net, http://www.pullthrunetwork.org.

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Hirsutism

Definition

Excessive growth of facial or body hair in women is called hirsutism.

Description

Hirsutism is not a disease. The condition usually develops during **puberty** and becomes more pronounced as the years go by. However, an inherited tendency, overproduction of male hormones (androgens), medication, or disease, can cause it to appear at any age.

Women who have hirsutism usually have irregular menstrual cycles. They sometimes have small breasts and deep voices, and their muscles and genitals may become larger than women without the condition.

Types of hirsutism

Idiopathic hirsutism is probably hereditary, because there is usually a family history of the disorder. Women with idiopathic hirsutism have normal menstrual cycles and no evidence of any of the conditions associated with secondary hirsutism.

Secondary hirsutism is most often associated with **polycystic ovary syndrome** (an inherited hormonal disorder characterized by menstrual irregularities, biochemical abnormalities, and **obesity**). This type of hirsutism may also be caused by:

- malfunctions of the pituitary or adrenal glands
- use of male hormones or minoxidil (Loniten), a drug used to widen blood vessels
- adrenal or ovarian tumors.

Causes and symptoms

Hirsutism is rarely caused by a serious underlying disorder. **Pregnancy** occasionally stimulates its development. Hirsutism triggered by tumors is very unusual.

Hair follicles usually become enlarged, and the hairs themselves become larger and darker. A woman whose hirsutism is caused by an increase in male hormones has a pattern of hair growth similar to that of a man. A woman whose hirsutism is not hormone-related has long, fine hairs on her face, arms, chest, and back.

Diagnosis

Diagnosis is based on a family history of hirsutism, a personal history of menstrual irregularities, and masculine traits. Laboratory tests are not needed to assess the status of patients whose menstrual cycles are normal and who have mild, gradually progressing hirsutism.

A family physician or endocrinologist may order blood tests to measure hormone levels in women with long-standing menstrual problems or more severe hirsutism. **Computed tomography scans** (CT scans) are sometimes performed to evaluate diseases of the adrenal glands. Additional diagnostic procedures may be used to confirm or rule out underlying diseases or disorders.

Treatment

Primary hirsutism can be treated mechanically. Mechanical treatment involves bleaching or physically removing unwanted hair by:

- cutting
- electrolysis
- shaving
- tweezing
- waxing
- using hair-removing creams (depilatories)

Low-dose dexamethasone (a synthetic adrenocortical steroid), birth-control pills, or medications that suppress male hormones (for example, spironolactone)

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may be prescribed for patients whose condition stems from high androgen levels.

Treatment of secondary hirsutism is determined by the underlying cause of the condition.

Prognosis

Birth-control pills alone cause this condition to stabilize in one of every two patients and to improve in 1 of every 10.

When spironolactone (Aldactone) is prescribed to suppress hair growth, 70% of patients experience improvement within six months. When women also take birth-control pills, menstrual cycles become regular and hair growth is suppressed even more.

ORGANIZATIONS

American Society for Reproductive Medicine, 1209 Montg omery Highway, Birmingham, AL, 35216-2809, (205) 978-5000, (205) 978-5005, asrm@asrm.org, http://www.asrm.org.

Maureen Haggerty

Hispanic American health *see* **Minority health**
Histamine *see* **Antiulcer drugs**
Histamine headache *see* **Cluster headache**

Histiocytosis X

Definition

Histiocytosis X is a generic term that refers to an increase in the number of histiocytes, a type of white blood cell, that act as scavengers to remove foreign material from the blood and tissues. Since recent research demonstrated Langerhan cell involvement as well as histiocytes, this led to a proposal that the term Langerhans Cell Histiocytosis (LCH) be used in place of histiocytosis X. Either term refers to three separate illnesses (listed in order of increasing severity): eosinophilic granuloma, Hand-Schuller-Christian disease, and Letterer-Siwe disease.

Description

Epidermal (skin) Langerhans cells (a form of dendritic cell) accumulate with other immune cells in various parts of the body and cause damage by the release of chemicals. Normally, Langerhans cells recognize foreign material, including bacteria, and stimulate the immune system to react to them. Langerhans cells are usually found in skin, lymph nodes, lungs, and the gastrointestinal tract. Under abnormal conditions these cells affect skin, bone, and the pituitary gland as well as the lungs, intestines, liver, spleen, bone marrow, and brain. Therefore, the disease is not confined to areas where Langerhans cells are normally found. The disease is more common in children than adults and tends to be most severe in very young children.

Histiocytosis X or LCH is a family of related conditions characterized by a distinct inflammatory and proliferative process but differs from each other in which parts of the body are involved. The least severe of the histiocytosis X/LCH family is eosinophilic granuloma. Approximately 60–80% of all diagnosed cases are in this classification, which usually occurs in children aged 5–10 years. The bones are involved 50–75% of the time, which includes the skull or mandible, and the long bones. If the bone marrow is involved, anemia can result. With skull involvement, growths can occur behind the eyes, bulging them forward. One case study involved swelling of the eyes caused by histiocytosis in a three-year-old girl. The lungs are involved less than 10% of the time, and this involvement signals the worst prognosis.

Next in severity is Hand-Schuller-Christian disease, a chronic, scattered form of histiocytosis. It occurs most commonly from the age of one to three years and is a slowly progressive disease that affects the softened areas of the skull, other flat bones, the eyes, and skin. Letterer-Siwe disease is the acute form of this series of diseases. It is generally found from the time of birth to one year of age. It causes an enlarged liver, bruising and **skin lesions**, anemia, enlarged lymph glands, other organ involvement, and extensive skull lesions.

Causes and symptoms

This is a rare disorder affecting approximately 1 in 200,000 children or adults each year. The International Histiocyte Society formed a registry in 2000 that has registered a total of about 300 adults from 13 countries. Because histiocytic disorders are so rare, little research has been done to determine their cause. Over time, histiocytosis may lessen in its assault on the body but there are still problems from damage to the tissues. There are no apparent inheritance patterns in these diseases with the exception of a form involving the lymphatic system; of the 274 adults in the international registry, only one came from a family with a history of the disease.

The symptoms of histiocytosis are caused by substances called cytokines and prostaglandins, which are normally produced by histiocytes and act as messengers

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between cells. When these chemicals are produced in excess amounts and in the wrong places, they cause tissue swelling and abnormal growth. Thus, symptoms may include painful lumps in the skull and limbs as well as **rashes** on the skin. General symptoms may include: poor appetite, failure to gain weight, recurrent **fever**, and irritability. Symptoms from other possible sites of involvement include:

- gums: swelling, usually without significant discomfort
- ear: chronic discharge
- liver or spleen: abdominal discomfort or swelling
- pituitary: This gland at the base of the brain is affected at some stage in approximately 20%–30% of children causing a disturbance in water balance to produce thirst and frequent urination.
- eyes: Due to the bony disease, behind-the-eye bulging may occur (exophthalmos).
- lungs: breathing problems

Diagnosis

The diagnosis can be made only by performing a biopsy, that is, taking a tissue sample under anesthesia from a site in the patient thought to be involved. Blood and urine tests, chest and other x rays, **magnetic resonance imaging** (MRI) and **computed tomography scans** (CT scans) (to check the extent of involvement), and possibly bone marrow or breathing tests may be required to confirm the diagnosis.

Treatment

Although this disease is not **cancer**, most patients diagnosed with it are treated in cancer clinics. There are two reasons for this:

- Historically, cancer specialists treated it before the cause was known.
- The treatment requires the use of drugs typically required to treat cancer.

Any cancer drugs utilized are usually given in smaller doses, which diminishes the severity of their side effects. **Radiation therapy** is rarely used, and special drugs may be prescribed for skin symptoms. If there is only one organ affected, **steroids** may be injected locally, or a drug called indomethacin may be used. Indomethacin is an anti-inflammatory medication that may achieve a similar response with less severe side effects.

Prognosis

The disease fluctuates markedly. If only one system is involved, the disease often resolves by itself. Multisystem disease usually needs treatment although it may disappear spontaneously. The disease is not normally fatal unless organs vital to life are damaged. In general, the younger the child at diagnosis and the more organs involved, the poorer the outlook. If the condition resolves, there could still be long-term complications because of the damage done while the disease was active.

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ORGANIZATIONS

Histiocytosis Association of America, 332 North Broadway, Pittman, NJ, 08071, (856) 589-6614, (800) 548-2758, Association@histio.org, http://www.histio.org.

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Histoplasmosis

Definition

Histoplasmosis is an **infectious disease** caused by inhaling the microscopic spores of the fungus *Histoplasma capsulatum*. The disease exists in three forms. Acute or primary histoplasmosis causes flu-like symptoms. Most people who are infected recover without medical intervention. Chronic histoplasmosis affects the lungs and can be fatal. Disseminated histoplasmosis affects many organ systems in the body and is often

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fatal, especially to people with acquired **immunodeficiency** syndrome (**AIDS**).

Description

Histoplasmosis is an airborne infection. The spores that cause this disease are found in soil that has been contaminated with bird or bat droppings. In the United States, the disease is most common in eastern and midwestern states and is widespread in the upper Mississippi, Ohio, Missouri, and St. Lawrence river valleys. Sometimes histoplasmosis is called Ohio Valley disease, Central Mississippi River Valley disease, Appalachian Mountain disease, Darling's disease, or *Histoplasma capsulatum* infection.

Anyone can get histoplasmosis, but people who come in contact with bird and bat excrement are more likely to be infected. This includes farmers, gardeners, bridge inspectors and painters, roofers, chimney cleaners, demolition and construction workers, people installing or servicing heating and air conditioning units, people restoring old or abandoned buildings, and people who explore caves.

The very young and the elderly, especially if they have a pre-existing lung disease or are heavy smokers, are more likely to develop symptoms that are more severe. People who have a weakened immune system, either from diseases, such as AIDS or leukemia, or as the result of medications they take (**corticosteroids**, **chemotherapy** drugs), are more likely to develop chronic or disseminated histoplasmosis.

Causes and symptoms

When the spores of *H. capsulatum* are inhaled, they lodge in the lungs where they divide and cause lesions. This is known as acute or primary histoplasmosis. It is not contagious.

Many otherwise healthy people show no symptoms of infection at all. When symptoms do occur, they appear 3–17 days after exposure (average time is 10 days). The symptoms are usually mild and resemble those of a cold or flu: **fever**, dry **cough**, enlarged lymph glands, tiredness, and a general feeling of ill health. A small number of people develop bronchopneumonia. About 95% of people who are infected either experience no symptoms or have symptoms that clear up spontaneously. These people then have partial immunity to re-infection.

In some people, the spores that cause the disease continue to live in the lungs. In about 5% of people who are infected, usually those with chronic lung disease, diabetes mellitis, or weakened immune systems, the disease progresses to chronic histoplasmosis. This can take months or years. Symptoms of chronic histoplasmosis resemble those of **tuberculosis**. Cavities form in the lung tissue, parts of the lung may collapse, and the lungs fill with fluid. Chronic histoplasmosis is a serious disease that can result in **death**.

The most rare form of histoplasmosis is disseminated histoplasmosis. Disseminated histoplasmosis is seen almost exclusively in patients with AIDS or other immune defects. In disseminated histoplasmosis the infection may move to the spleen, liver, bone marrow, or adrenal glands. Symptoms include a worsening of those found in chronic histoplasmosis, as well as weight loss, **diarrhea**, the development of open sores in the mouth and nose, and enlargement of the spleen, liver, and adrenal gland.

Diagnosis

A simple skin test similar to that given for tuberculosis will tell if a person has previously been infected by the fungus *H. capsulatum*. Chest x rays often show lung damage caused by the fungus, but do not lead to a definitive diagnosis because the damage caused by other diseases has a similar appearance on the x ray. Diagnosis of chronic or disseminated histoplasmosis can be made by culturing a sample of sputum or other body fluids in the laboratory to isolate the fungus. The urine, blood serum, washings from the lungs, or cerebrospinal fluid can all be tested for the presence of an antigen produced in response to the infection. Most cases of primary histoplasmosis go undiagnosed.

Treatment

Acute primary histoplasmosis generally requires no treatment other than rest. Non-prescription drugs such as **acetaminophen** (Tylenol) may be used to treat **pain** and relieve fever. Avoiding smoke and using a cool air humidifier may ease chest pain.

Patients with an intact immune system who develop chronic histoplasmosis are treated with the drug ketoconazole (Nizoral) or amphotericin B (Fungizone). Patients with suppressed immune systems are treated with amphotericin B, which is given intravenously. Because of its potentially toxic side effects, hospitalization is often required. The patient may also receive other drugs to minimize the side effects of the amphotericin B.

Patients with AIDS must continue to take the drug itraconazole (Sporonox) orally for the rest of their lives in order to prevent a relapse. If the patient can not tolerate itraconazole, the drug fluconazole (Diflucan) can be substituted.

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Alternative treatment

In non-immunocompromised patients, alternative therapies can be very successful. Alternative treatment for fungal infections focuses on creating an environment where the fungus cannot survive. This is accomplished by maintaining good health and eating a diet low in dairy products; sugars, including honey and fruit juice; and foods like beer that contain yeast. This is complemented by a diet high in raw food. Supplements of antioxidant **vitamins** C, E, and A, along with B complex, may also be added to the diet. *Lactobacillus acidophilus* and *Bifodobacteria* will replenish the good bacteria in the intestines. Antifungal herbs, like garlic, can be consumed in relatively large doses and for an extended period of time in order to be most effective.

Prognosis

Most people recover from primary histoplasmosis in a few weeks without medical intervention. Patients with chronic histoplasmosis who are treated with antifungal drugs generally recover rapidly if they do not have an underlying serious disease. When left untreated, or if serious disease is present, histoplasmosis can be fatal.

AIDS patients with disseminated histoplasmosis vary in their response to amphotericin B, depending on their general health and how well they tolerate the side effects of the drug. Treatment often suppresses the infection temporarily, but patients with AIDS are always in danger of a relapse and must continue to take medication for the rest of their lives to keep the infection at bay. New combinations of therapies and new drugs are constantly being evaluated, making hard statistics on prognosis difficult to ascertain. AIDS patients have problems with multiple opportunistic infections, making it difficult to isolate death rates due to any one particular fungal infection.

Prevention

Since the spores of *H. capsulatum* are so widespread, it is almost impossible to prevent exposure in endemic areas. Dust suppression measures when working with contaminated soil may help limit exposure. Individuals who are at risk of developing the more severe forms of the disease should avoid situations where they will be exposed to bat and bird droppings.

Resources

OTHER

Histoplasmosis: Protecting Workers at Risk. Centers for Disease Control and Prevention. http://www.cdc.gov/niosh/97146eng.html.

ORGANIZATIONS

American Lung Association, 1301 Pennsylvania Ave. NW, Suite 800, Washington, DC, 20001, (202) 758-3355, (202) 452-1805, (800) 548-8252, info@lungusa.org, http://www.lungusa.org/.

National Center for Preparedness, Detection, and Control of Infectious Diseases, 1600 Clifton Road, Atlanta, GA, 30333, (888) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov/ncpdcid.

National Institute for Occupational Safety and Health, 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov/niosh.

Tish Davidson, A.M.

HIV infection *see* **AIDS**

Hives

Definition

Hives are due to an allergic skin reaction and cause localized redness, swelling, and **itching**.

Hives on the back of a young woman's legs. The accompanying inflammation develops as an allergic reaction which ranges in size from small spots to patches measuring several inches across. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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Description

Hives are a reaction of the body's immune system that causes areas of the skin to swell, itch, and become reddened (wheals). When the reaction is limited to small areas of the skin, it is called "urticaria." Involvement of larger areas, such as whole sections of a limb, is called "angioedema." Hives can be round or they can form rings or large patches. Hives can also form wheals or welts, which are red lesions with a red flare at the borders.

Demographics

It is estimated that 5 percent of all people will develop urticaria at some point in their lives. Hives are more common in women than in men. Of those with chronic hives, lasting six weeks or more, about 80% are idiopathic, meaning no cause, allergic or otherwise, can be found.

Causes and symptoms

Causes

Hives occur due to an allergic reaction. The body's immune system is normally responsible for protection from foreign invaders. When it becomes sensitized to normally harmless substances, the resulting reaction is called an allergy. An attack of hives is set off when such a substance, called an allergen, is ingested, inhaled, or otherwise contacted. The allergen interacts with immune cells called mast cells, which reside in the skin, airways, and digestive system. When mast cells encounter an allergen, they release histamine and otherchemicals, both locally and into the bloodstream. These chemicals cause blood vessels to become more porous, allowing fluid to accumulate in tissue and leading to the swollen and reddish appearance of hives. Some of the chemicals released sensitize **pain** nerve endings, causing the affected area to become itchy and sensitive.

A wide variety of substances may cause hives in sensitive people, including foods, drugs, and insect **bites** or **stings**. Common culprits include:

- nuts, especially peanuts, walnuts, and Brazil nuts
- fish, mollusks, and shellfish
- eggs
- wheat
- milk
- strawberries
- food additives and preservatives
- penicillin or other antibiotics
- flu vaccines
- tetanus toxoid vaccine
- gamma globulin
- bee, wasp, and hornet stings
- bites of mosquitoes, fleas, and scabies

Symptoms

Urticaria is characterized by redness, swelling, and itching of small areas of the skin. These patches usually grow and recede in less than a day, but may be replaced by hives in other locations. Angioedema is characterized by more diffuse swelling. Swelling of the airways may cause **wheezing** and respiratory distress. In severe cases, airway obstruction may occur.

Diagnosis

Hives are easily diagnosed by visual inspection. The cause of hives is usually apparent, but may require a careful medical history in some cases.

Treatment

Mild cases of hives are treated with **antihistamines**, such asdiphenhydramine (Benadryl) or desloratadine (Clarinex). Clarinex is non-sedating, meaning it will not make patients drowsy. More severe cases may require oral **corticosteroids**, such as prednisone. Topical corticosteroids are not effective. Airway swelling may require emergency injection of epinephrine (adrenaline).

Alternative treatment

An alternative practitioner will try to determine what allergic substance is causing the reaction and help the patient eliminate or minimize its effects.To deal with the symptoms of hives, an oatmeal bath may help to relieve itching. Chickweed (*Stellaria media*), applied as a poultice (crushed or chopped herbs applied directly to the skin) or added to bath water, may also help relieve itching. Several homeopathic remedies, including *Urtica urens* and *Apis* (*Apis mellifica*), may help relieve the itch, redness, or swelling associated with hives.

Prognosis

Most cases of hives clear up within one to seven days without treatment, providing the cause (allergen) is found and avoided.

Prevention

Preventing hives depends on avoiding the allergen causing them. Analysis of new items in the diet or new drugs taken may reveal the likely source of their action. Chronic hives may be aggravated by **stress**, **caffeine**, alcohol, or tobacco; avoiding these may reduce the frequency of reactions.

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ORGANIZATIONS

American Academy of Dermatology (AAD), 930 E. Wood field Rd., Schaumburg, IL, 60173, http://www.aad.org.

American Podiatric Medical Association (APMA), 9312 Old Georgetown Rd., Bethesda, MD, 20814–1698, (301) 571–9200, http://www.apma.org.

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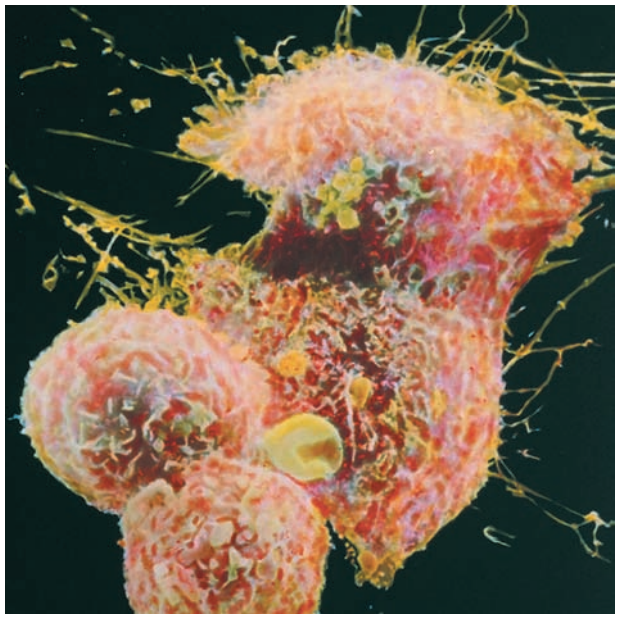
HLA-B27 antigen test *see* **Tissue typing**

HLA test *see* **Human leukocyte antigen test**

HMG-CoA reductase inhibitors *see* **Cholesterol-reducing drugs**



A scanning electron micrograph (SEM) image of dividing Hodgkin's cells from the pleural effusions (abnormal accumulations of fluid in the lungs) of a 55-year-old male patient. *(Dr. Andrejs Liepins/Photo Researchers, Inc.)*

Hodgkin's lymphoma

Definition

Hodgkin's lymphoma is a rare lymphoma, a **cancer** of the lymphatic system.

Demographics

The American Cancer Society estimated there were 8,510 new cases of Hodgkin's lymphoma in the United States in 2009—3,870 in females and 4,640 in males. It is estimated that 800 men and 490 women in the United States died of the disease in 2009.

Hodgkin's lymphoma can occur at any age. However, the majority of cases develop in early adulthood (ages 15–40) and late adulthood (after age 55). Approximately 10–15% of cases are in children under age 17. It is more common in boys than in girls under the age of 10. The disease is very rare in children under age five.

Description

Hodgkin's lymphoma, or Hodgkin's disease, was first described in 1832 by British physician Thomas Hodgkin's. Hodgkin's clearly differentiated between this disease and the much more common non-Hodgkin's lymphomas. Prior to 1970, few individuals survived Hodgkin's lymphoma. Due to significant treatment advancements, the majority of individuals with this cancer can be cured.

The lymphatic system is part of the body's immune system, for fighting disease, and a part of the blood-producing system. It includes the lymph vessels and nodes, the spleen, bone marrow, and thymus. The narrow lymphatic vessels carry lymphatic fluid throughout the body. The lymph nodes are small organs that filter the lymphatic fluid and trap foreign substances, including viruses, bacteria, and cancer cells. The spleen, in the upper left abdomen, removes old cells and debris from the blood. The bone marrow, the tissue inside the bones, produces new red and white blood cells.

Lymphocytes are white blood cells that recognize and destroy disease-causing organisms. Lymphocytes are produced in the lymph nodes, spleen, and bone marrow. They circulate throughout the body in the blood and lymphatic fluid. Clusters of immune cells also exist in major organs.

Hodgkin's lymphoma is a type of lymphoma in which antibody-producing cells of the lymphatic system begin to grow abnormally. It usually begins in a lymph node and progresses slowly, in a fairly predictable way, spreading via the lymphatic vessels from one group of lymph nodes to the next. Sometimes it invades organs that are adjacent to the lymph nodes. If the cancer cells spread to the blood, the disease can reach

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almost any site in the body. Advanced cases of Hodgkin's lymphoma may involve the spleen, liver, bone marrow, and lungs.

There are different subtypes of Hodgkin's lymphoma:

- nodular sclerosis (60–80% of cases); most common subtype affecting younger patients
- mixed cellularity (15–30% of cases) most common subtypes in patients diagnosed after age 55
- lymphocyte predominant or lymphocyte rich (5% of cases)
- lymphocyte depleted (less than 1% of cases)

These four subtypes are referred to as classic Hodgkin's lymphoma. A fifth subtype, nodular lymphocyte predominant Hodgkin's lymphoma (NLPHD), which accounts for about 5% of cases, is a subtype that is clinically unique from the other subtypes and is treated differently.

Risk factors

Although the exact cause of Hodgkin's lymphoma is not yet known, several risk factors related to the disease have been identified including:

- Previous infection with the Epstein Barr virus/infectious mononucleosis (mono). The overall risk of developing Hodgkin's lymphoma after this infection is small. According to a study conducted in Denmark and Sweden, the average time between illness with infectious mononucleosis and diagnosis of Hodgkin's lymphoma was about three years.
- Age—Individuals in their twenties and adults over the age of 55 are more likely to be diagnosed with Hodgkin's lymphoma.
- Gender—Males are more likely to be diagnosed with this type of lymphoma. In children, up to 85% of cases are diagnosed in boys.
- Family history—Siblings of patients who have been diagnosed with Hodgkin's lymphoma are at higher risk than the general population. An identical twin of an individual who has been diagnosed with Hodgkin's is at even higher risk. However, less than 5% of cases are diagnosed in family members.
- Patients with human immunodeficiency virus (HIV) infection are more likely to develop Hodgkin's lymphoma than those not diagnosed with HIV.

Causes and symptoms

The cause of Hodgkin's lymphoma is not known. It is suspected that some interaction between an individual's genetic makeup, environmental exposures, and infectious agents may be responsible. Immune system deficiencies may be involved.

Early symptoms of Hodgkin's lymphoma are similar to those of the flu:

- fevers, night sweats, chills
- fatigue
- itching
- swelling of one or more lymph nodes
- loss of appetite
- weight loss
- pain after drinking alcoholic beverages (occurs in less than 10% of patients)

Sudden or emergency symptoms of Hodgkin's lymphoma include:

- sudden high fever
- loss of bladder and/or bowel control
- numbness in the arms and legs and a loss of strength

As lymph nodes swell, they may push on other structures, causing a variety of symptoms:

- pain due to pressure on nerve roots
- loss of function in muscle groups served by compressed nerves
- coughing or shortness of breath due to compression of the windpipe and/or airways by swollen lymph nodes in the chest
- kidney failure from compression of the ureters, the tubes that carry urine from the kidneys to the bladder
- swelling in the face, neck, or legs, due to pressure on veins
- paralysis in the legs due to pressure on the spinal cord

As Hodgkin's lymphoma progresses, the immune system becomes less effective at fighting infection. Thus, patients with Hodgkin's lymphoma become more susceptible to both common infections caused by bacteria and opportunistic infections.

As many as 75% of individuals with Hodgkin's lymphoma do not have any typical symptoms.

Diagnosis

As with many forms of cancer, diagnosis of Hodgkin's lymphoma has two major components.

- Identification of Hodgkin's lymphoma as the cause of the patient's disease.
- Staging of the disease to determine how far the cancer has spread.

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KEY TERMS

Excisional biopsy—Removal of an entire lymph node; often the most suspicious-looking node is removed for testing.

Incisional biopsy—Removal of a part of a lymph node for diagnostic purposes.

Lymph node—Small, round-shaped organs of the lymph system found throughout the body that are connected by lymph vessels.

Lymphatic system—A system of the body that includes lymph vessels and nodes, the spleen, bone marrow, and the thymus.

Lymphoma—Cancer originating in a lymph node or in the lymph system.

Reed-Sternberg cells—Cancerous cells that, when present in the body, are indicative of Hodgkin's lymphoma

Examination

The initial diagnosis of Hodgkin's lymphoma often results from abnormalities in a chest x-ray that was performed because of nonspecific symptoms. The physician then takes a medical history to check for the presence of symptoms and conducts a complete **physical examination**.

The size, tenderness, firmness, and location of swollen lymph nodes are determined and correlated with any signs of infection. In particular, lymph nodes that do not shrink after treatment with **antibiotics** may be a cause for concern. The lymph nodes that are most often affected by Hodgkin's lymphoma include those of the neck, above the collarbone, under the arms, and in the chest above the diaphragm.

Tests

Laboratory tests that may be ordered as part of the diagnostic workup for Hodgkin's lymphoma include:

- Lactate dehydrogenase (LDH) level—High levels of LDH may be indicative of more extensive disease.
- Complete blood count (CBC)—Anemia may be present if there is disease in the bone marrow. The platelet count may be increased or decreased.
- Alkaline phosphatase (ALP) levels—ALP may be increased if there is disease in the liver and/or bone.
- An HIV test should be done if HIV infection is suspected. Antiviral therapies to treat HIV should be initiated because they have a positive impact in HIV-positive patients diagnosed with Hodgkin's lymphoma

Procedures

Diagnosis of Hodgkin's lymphoma requires either the removal of an entire enlarged lymph node (an excisional biopsy) or an incisional biopsy (the recommended procedure), in which only a small part of a large tumor is removed. If the node is near the skin, the biopsy is performed with a local anesthetic. If it is inside the chest or abdomen, **general anesthesia** is required.

The sample of biopsied tissue is examined under a microscope. Giant cells called Reed-Sternberg cells must be present to confirm a diagnosis of Hodgkin's lymphoma. These cells, which usually contain two or more nuclei, are named for the two pathologists who discovered them. Normal cells have only one nucleus (the organelle within the cell that contains the genetic material). Affected lymph nodes may contain only a few Reed-Sternberg cells and they may be difficult to recognize. Characteristics of other types of cells in the biopsied tissue help to diagnose the subtype of Hodgkin's lymphoma.

A fine needle aspiration (FNA) biopsy, in which a thin needle and syringe are used to remove a small amount of fluid and bits of tissue from a tumor, has the advantage of not requiring surgery. An FNA may be performed prior to an excisional or incisional biopsy, to check for infection or for the spread of cancer from another organ. However, an FNA biopsy does not provide enough tissue to diagnose Hodgkin's lymphoma. FNA is generally indicated only when a **head and neck cancer** is suspected.

Occasionally, additional biopsies are required to diagnose Hodgkin's lymphoma. In rare instances, other tests that detect certain substances on the surfaces of cancer cells or changes in the DNA of cells are used to distinguish Hodgkin's lymphoma from non-Hodgkin's's lymphoma.

Staging is very important in Hodgkin's lymphoma. This is because the cancer usually spreads in a predictable pattern, without skipping sets of lymph nodes until late in the progression of the disease.

Tests

Imaging of the abdomen, chest, and pelvis is used to identify areas of enlarged lymph nodes and abnormalities

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DOROTHY MENDENHALL (1874–1964)

Dorothy Reed Mendenhall, the last of three children, was born September 22, 1874, in Columbus, Ohio, to William Pratt Reed, a shoe manufacturer, and Grace Kimball Reed, both of whom had descended from English settlers who came to America in the seventeenth century. Mendenhall attended Smith College and obtained a baccalaureate degree. Although she initially contemplated a career in journalism, Mendenhall's interest in medicine was inspired by a biology course she attended.

Dorothy Reed Mendenhall was a well-respected researcher, obstetrician, and pioneer in methods of childbirth. She was the first to discover that Hodgkin's lymphoma was not a form of tuberculosis, as had been thought. This finding received international acclaim. As a result of her work, the cell type characteristic of Hodgkin's lymphoma bears her name. The loss of her first child due to poor obstetrics changed her research career to a lifelong effort to reduce infant mortality rates. Mendenhall's efforts paid off with standards being set for weight and height for children ages birth to six and also in programs that stressed the health of both the mother and child in the birthing process.

in the spleen or other organs. Computerized axial tomography (CT or CAT) scans use a rotating x ray beam to obtain pictures. Chest x rays also may be taken. These images reveal rounded lumps called nodules in the affected lymph nodes and other organs.

Positron emission tomography (PET) scan, considered to be an essential diagnostic tool in Hodgkin's lymphoma, is an extremely accurate method for staging Hodgkin's lymphoma. A very low dose of radioactive glucose, a sugar, is injected into the body. The glucose travels to metabolically active sites, including cancerous regions that require large amounts of glucose. The **PET** scan detects the radioactivity and produces images of the entire body that distinguish between cancerous and non-cancerous tissues.

Anemia (a low red-blood-cell count), fevers, or night sweats are indications that Hodgkin's lymphoma may be in the bone marrow. In these cases, a bone-marrow biopsy, in which a large needle is used to remove a narrow, cylindrical piece of bone, may be necessary to determine the spread of the cancer. Alternatively, an aspiration, in which a needle is used to remove small bits of bone marrow, may be used. The marrow usually is removed from the back of the hip or other large bone.

Rarely, further staging, called pathological staging or a staging laparotomy, is used for Hodgkin's lymphoma. In this operation, a surgeon checks the abdominal lymph nodes and other organs for cancer and removes small pieces of tissue. A pathologist examines the tissue samples for Hodgkin's lymphoma cells. Usually the spleen is removed (a **splenectomy**) during the laparotomy. The splenectomy helps with staging Hodgkin's lymphoma, as well as removing a disease site. The staging laparotomy is infrequently used.

Treatment

All of the available treatments for Hodgkin's lymphoma have serious side effects, both short and long-term. Goals of treatment include minimizing treatment for patients who have been diagnosed with low-risk disease in early stages. With accurate staging, physicians and patients often can choose the minimum treatment that will cure the disease. The staging system used most often to stage Hodgkin's lymphoma is the Ann Arbor Staging Classification System.

Hodgkin's lymphoma is divided into four stages, with additional substages:

- Stage I: The disease is confined to one lymph node area or to one site outside of a lymph node.
- Stage II: The disease is in two or more lymph node areas on one side of the diaphragm (the muscle below the lungs).
- Stage III: The disease is in lymph node areas on both sides of the diaphragm.
- Stage IV: The disease has spread from the lymphatic system to one or more other organs, such as the bone marrow or liver.

Treatment for Hodgkin's lymphoma depends both on the stage of the disease and whether or not symptoms are present. Stages are labeled with an A if no symptoms are present. If symptoms are present, the stage is labeled with a B. These symptoms include:

- unexplained or unintended loss of more than 10% of body weight over the previous six months
- fevers above 100°F (37.7°C)
- drenching night sweats

Drugs

Combined modality treatment incorporating **radiation therapy** and/or **chemotherapy** (drug therapy) are the standard treatments for Hodgkin's lymphoma. If the disease is confined to one area of the body, radiotherapy is usually used. This treatment, with x rays or other high-energy rays, is used when the disease is in bulky areas such as the chest, where chemotherapeutic drugs cannot

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reach all of the cancer. External-beam radiation, a focused beam from an external machine, is used to irradiate only the affected lymph nodes. This procedure is called involved field radiation. Chemotherapy is also used to treat early stage disease to enhance the effects of the radiation therapy; this is called a synergistic effect.

Involved field radiation may also be used in patients with advanced disease who have disease remaining after treatment with chemotherapy.

Since external-beam radiation damages healthy tissue near the cancer cells, the temporary side effects of radiotherapy can include sunburn-like skin damage, **fatigue**, **nausea**, and **diarrhea**. Other temporary side effects may include a **sore throat** and difficulty swallowing. Long-term side effects depend on the dose and the location of the radiation and the age of the patient. Since radiation of the ovaries causes permanent sterility (the inability to have offspring), the ovaries of girls and young women are protected during radiotherapy. Sometimes the ovaries are surgically moved from the region to be irradiated. The testes should also be shielded if they are in a radiation field.

Chemotherapy utilizes a combination of drugs, each of which kills cancer cells in a different way. The most common chemotherapy regimens for Hodgkin's lymphoma are MOPP (either mechlorethamine or methotrexate with oncovin, procarbazine, and prednisone) and ABVD (adriamycin or doxorubicin, bleomycin, vincristine, dacarbazine). Each of these consists of four different drugs. ABVD, now considered the standard regimen to treat Hodgkin's lymphoma, is used more frequently than MOPP because it has fewer severe side effects such as sterility and because ABVD has been proven to be superior in terms of outcomes. Use of ABVD also reduces the risk of development of a secondary leukemia. MOPP may be used for individuals who are at risk for **heart failure**. The chemotherapeutic drugs may be injected into a vein or taken orally (prednisone).

Children who are sexually mature when they develop Hodgkin's lymphoma, and whose muscle and bone mass are almost completely developed, usually receive the same treatment as adults. Younger children usually are treated with chemotherapy, since radiation will adversely affect bone and muscle growth. However, radiation may be used in low dosages in combination with chemotherapy. Chemotherapy for children with Hodgkin's lymphoma usually includes more drugs than ABVD and MOPP.

The side effects of chemotherapy for Hodgkin's lymphoma depend on the dose of drugs and the length of time they are taken. Since these drugs target rapidly dividing cancer cells, they also affect normal cells that grow rapidly. These include the cells of the bone marrow, the linings of the mouth and intestines, and hair follicles. Damage to bone marrow leads to lower white blood cell counts and lower resistance to infection. It also leads to lower red blood cell counts, which can result in fatigue and easy bleeding and bruising. Damage to intestinal cells leads to a loss of appetite, nausea, and **vomiting**. Mouth sores and hair loss also are common side effects of chemotherapy. These side effects disappear when the chemotherapy is discontinued. Some drugs can reduce or prevent the **nausea and vomiting**.

Chemotherapy for Hodgkin's lymphoma may lead to long-term complications. The drugs may damage the heart, lungs, kidneys, and liver. In children, growth may be impeded. Some chemotherapy can cause sterility, so men may choose to have their sperm frozen prior to treatment. Women may stop ovulating and menstruating during chemotherapy. This may or may not be permanent.

The development of a second type of cancer is the most serious risk from radiation and chemotherapy treatment for Hodgkin's lymphoma. In particular, there is a risk of developing leukemia, **breast cancer**, bone cancer, or **thyroid cancer**. Chemotherapy, particularly MOPP, or chemotherapy in conjunction with radiotherapy, significantly increases the risk for leukemia.

Following treatment, the original diagnostic tests for Hodgkin's lymphoma are repeated, to determine whether all traces of the cancer have been eliminated and to check for long-term side effects of treatment. In resistant Hodgkin's lymphoma, some cancer cells remain following treatment. If the cancer continues to spread during treatment, it is called progressive Hodgkin's lymphoma. If the disease returns after treatment, it is known as recurrent Hodgkin's lymphoma. It may recur in the area where it first started or elsewhere in the body. It may recur immediately after treatment or many years later.

Additional treatment is necessary with these types of Hodgkin's lymphoma. Salvage therapy for refractory or recurrent Hodgkin's lymphoma includes the chemotherapy regimens ICE (ifosfamide, mesna, carboplatin, and etoposide), the DHAP regimen (cisplatin, cytarabine, and dexamethasone), and the EPOCH regimen (etoposide, vincristine, doxorubicin, cyclophosphamide, and prednisone).

An autologous bone marrow and/or a peripheral blood **stem cell transplantation** (PBSCT) often is recommended for treating resistant or recurrent Hodgkin's lymphoma, particularly if the disease recurs within a few months of a chemotherapy-induced remission. These transplants are autologous because they utilize the individual's own cells. The patient's bone marrow cells or

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peripheral blood stem cells (immature bone marrow cells found in the blood) are collected and frozen prior to high-dosage chemotherapy, which destroys bone marrow cells. A procedure called leukapheresis is used to collect the stem cells. Following the high-dosage chemotherapy, and possibly radiation, the bone marrow cells or stem cells are reinjected into the individual.

Most complementary therapies for Hodgkin's lymphoma are designed to stimulate the immune system to destroy cancer cells and repair normal cells that have been damaged by treatment. These therapies are used in conjunction with standard treatment.

Targeted **immunologic therapies**, also known as immunotherapies, biological therapies, or biological response modifier therapies, utilize substances that are produced by the immune system. These include interferon (an immune system protein), monoclonal antibodies (specially engineered antibodies), colony-stimulating (growth) factors (such as filgrastim), and vaccines. Many immunotherapies for Hodgkin's lymphoma are being evaluated and most are available only through clinical trials. As of 2010, targeted immunotherapy agents have shown modest effects when used to treat refractory or recurrent Hodgkin's lymphoma.

Prognosis

Hodgkin's lymphoma, particularly in children, is one of the most curable forms of cancer. Approximately 90% of individuals are cured of the disease with chemotherapy and/or radiation.

The one-year relative survival rate following treatment for Hodgkin's lymphoma is 93%. Relative survival rates do not include individuals who die of causes other than Hodgkin's lymphoma. The percentage of individuals who have not died of Hodgkin's lymphoma within five years of diagnosis is 90–95% for those with stage I or stage II disease. The figure is 85–90% for those diagnosed with stage III Hodgkin's and approximately 65% for those diagnosed with stage IV disease. The 15-year relative survival rate is 63%. Approximately 75% of children are alive and cancer free 20 years after the original diagnosis of Hodgkin's's.

Acute myelocytic leukemia, a very serious cancer, may develop in as many as 2–6% of individuals receiving certain types of treatment for Hodgkin's lymphoma. Women under the age of 30 who are treated with radiation to the chest have a much higher risk for developing breast cancer. Both men and women are at higher risk for developing lung or thyroid cancers as a result of chest irradiation.

Individuals with the type of Hodgkin's lymphoma known as nodular lymphocytic predominance have a 2% chance of developing non-Hodgkin's lymphoma. This appears to be a result of the Hodgkin's lymphoma itself and not the treatment.

Prevention

As it is not known exactly what causes Hodgkin's lymphoma, it is not possible to prevent the occurrence of this type of cancer.

Most relapses of disease after treatment with Hodgkin's lymphoma occur within the first three years after treatment has been completed. Therefore, compliance with scheduled follow-up visits is extremely important. A typical schedule for follow-up after completion of treatment of Hodgkin's lymphoma is as follows:

- every two to four months during the first two years
- every three to six months during the next three to five years

Resources

PERIODICALS

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ORGANIZATIONS

American Cancer Society, (800) 227-2345, http://www.cancer.org.

The Leukemia and Lymphoma Society, 1311 Mamaroneck Ave., White Plains, NY, 10605, (800) 955-4572, http://www.leukemia-lymphoma.org.

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Holistic medicine

Definition

Holistic medicine is a term used to describe therapies that attempt to treat the patient as a whole person. That is, instead of treating an illness, as in orthodox allopathy, holistic medicine looks at an individual's overall physical, mental, spiritual, and emotional well-being before recommending treatment. A practitioner with a holistic approach treats the symptoms of illness as well as looking for the underlying cause of the illness. Holistic medicine also attempts to prevent illness by placing a greater emphasis on optimizing health. The body's systems are seen as interdependent parts of the person's whole being. Its natural state is one of health, and an illness or disease is an imbalance in the body's systems. Holistic therapies tend to emphasize proper **nutrition** and avoidance of substances—such as chemicals—that pollute the body. Their techniques are non-invasive.

Some of the world's health systems that are holistic in nature include **naturopathic medicine**, homeopathy, and **traditional Chinese medicine**. Many alternative or natural therapies have a holistic approach, although that is not always the case. The term complementary medicine is used to refer to the use of both allopathic and holistic treatments. It is more often used in Great Britain, but is gaining acceptance in the United States.

There are no limits to the range of diseases and disorders that can be treated in a holistic way, as the principle of holistic healing is to balance the body, mind, spirit, and emotions so that the person's whole being functions smoothly. When an individual seeks holistic treatment for a particular illness or condition, other health problems improve without direct treatment, due to improvement in the performance of the immune system, which is one of the goals of holistic medicine.

Origins

The concept of holistic medicine is not new. In the 4th century B.C., Socrates warned that treating one part of the body only would not have good results. Hippocrates considered that many factors contribute to the health of a human being, including weather, nutrition, emotional factors, and in our time, a host of different sources of pollution can interfere with health. Of course, holistic medicine existed even before ancient Greece in some ancient healing traditions, such as those from India and China, which date back over 5,000 years. However, the term "holistic" only became part of everyday language in the 1970s, when Westerners began seeking an alternative to allopathic medicine.

Interestingly, it was only at the beginning of the twentieth century that the principles of holistic medicine fell out of favor in Western societies, with the advent of major advances in what we now call allopathic medicine. Paradoxically, many discoveries of the twentieth century have only served to confirm many natural medicine theories. In many cases, researchers have set out to debunk holistic medicine, only to find that their research confirms it, as has been the case, for example, with many herbal remedies.

Purpose

Many people are now turning to holistic medicine, often when suffering from chronic ailments that have not been successfully treated by allopathic means. Although many wonderful advances and discoveries have been made in modern medicine, surgery and drugs alone have a very poor record for producing optimal health because they are designed to attack illness. Holistic medicine is particularly helpful in treating chronic illnesses and maintaining health through proper nutrition and **stress** management.

Description

There are a number of therapies that come under the umbrella of "holistic medicine." They all use basically the same principles, promoting not only physical health, but also mental, emotional, and spiritual health. Most emphasize quality nutrition. Refined foods typically eaten in the twenty-first century United States contain chemical additives and preservatives, are high in fat, cholesterol, and sugars, and promote disease. Alternative nutritionists counter that by recommending whole foods whenever possible and minimizing the amount of meat—especially red meat—that is consumed. Many alternative therapies promote **vegetarianism** as a method of **detoxification**.

The aim of holistic medicine is to bring all areas of an individual's life, and most particularly the energy flowing through the body, back into harmony. Ultimately, of course, only the patient can be responsible for this, for no practitioner can make the necessary adjustments to diet and lifestyle to achieve health. The practice of holistic medicine does not rule out the practice of allopathic medicine; the two can complement each other.

A properly balanced holistic health regimen, which takes into consideration all aspects of human health and includes noninvasive and nonpharmaceutical healing

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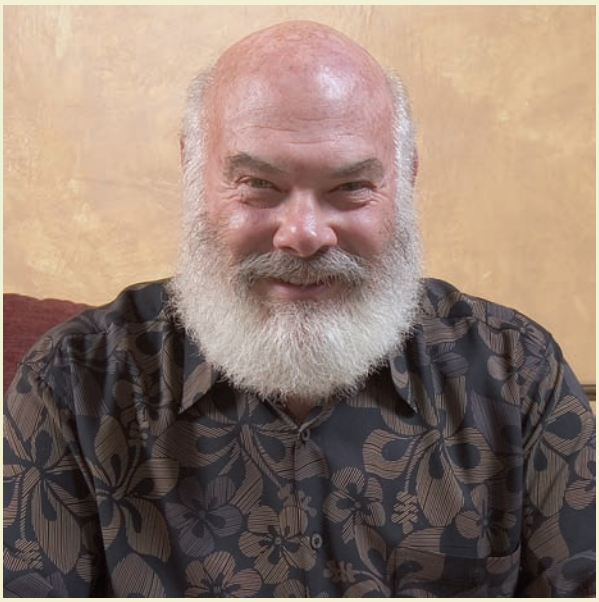
ANDREW WEIL (1942–)



(AP Images.)

Dr. Andrew Weil, a Harvard-educated physician, adds credibility and expertise to the natural healing methods he espouses in his best-selling books, on his website, in his talk show appearances, and in his popular audio CD of music and meditation. Weil's *Spontaneous Healing* spent more than a year on the best-seller list, and his 1997 book, *Eight Weeks to Optimum Health*, also was a runaway best-seller. Perhaps the best-known proponent of naturalistic healing methods, Weil established a field he calls integrative medicine. He is director of Tucson's Center for Integrative Medicine (http://integrativemedicine.arizona.edu/), which he founded in 1993. In 1997, he began training doctors in the discipline at the University of Arizona, where he teaches.

After getting his bachelor's degree in botany from Harvard University, Weil applied for admission to Harvard Medical School in 1964. During his second year, he led a group of students who argued they could succeed better studying on their own than going to classes; in fact, the group got higher scores on their final exams than their classmates. After graduating from Harvard Medical School, he volunteered at the notorious counter-cultural Haight-Asbury Free Clinic in San Francisco, CA. Later in 1969, Weil got a job in Washington, DC, with the National Institute of Mental Health's Drug Studies Division. From 1971 to 1975, he traveled extensively in South America and Africa, soaking up information about medicinal plants, shamanism, and natural healing techniques. He never returned to the practice of conventional medicine.

His approach to alternative medicine is eclectic, mingling traditional medicine with herbal therapy, acupuncture, homeopathy, chiropractic, hypnotism, cranial manipulation, and other alternative healing methods. Though his books discuss the benefits of everything from healing touch to herbal cures, Weil doesn't dismiss the benefits of standard Western medicine when appropriate.

Today, Weil continues to teach and practice alternative medicine, news about which can be found on http://www.drweil.com. He also started the Weil Foundation, a nonprofit organization dedicated to supporting integrative medicine through training, education, and research.

methods, can often completely eradicate even acute health conditions safely. If a patient is being treated with allopathic medicine, holistic therapies may at least support the body during treatment, and alleviate the symptoms that often come with drug treatments and surgery. In addition, holistic therapies aim at the underlying source of the illness, to prevent recurrence.

Here are some of the major holistic therapies:

- herbal medicine
- homeopathy
- naturopathic medicine
- traditional Chinese medicine
- Ayurvedic medicine
- nutritional therapies
- chiropractic
- stress reduction
- psychotherapy
- massage

Because holistic medicine aims to treat the whole person, holistic practitioners sometimes may advise treatment from more than one type of practitioner. This is to ensure that all aspects of health are addressed. Some practitioners also specialize in more than one therapy, and so may be able to offer more comprehensive assistance.

Preparations

How to choose a holistic practitioner:

- How did you hear of this therapist? A personal referral can sometimes be more reliable than a professional one. What do other professionals say about this therapist? What qualifications, board certification, or affiliations does this practitioner have?

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- How do you feel personally about this practitioner? Do you feel comfortable in his/her office and with his/her staff? Is your sense of well being increased? Are you kept waiting for appointments?
- Do you have confidence in this practitioner, does he/she respect you as a person? Does he/she show an interest in your family, lifestyle, and diet? Are various treatment options explained to you?
- Is your personal dignity respected?
- Do you feel that this practitioner is sensitive to your feelings and fears regarding treatment?
- Is this practitioner a good advertisement for his/her profession? Signs of stress or ill health may mean that you would be better off choosing another practitioner.
- Do you feel that you are rushed into decisions, or do you feel that you are allowed time to make an informed choice regarding treatment?
- Are future health goals outlined for you? And do you feel that the practitioner is taking your progress seriously?
- Do you feel unconditionally accepted by this practitioner?
- Would you send your loved ones to this practitioner?

If you answered yes to all the above, then you have found a suitable practitioner. The cost of treatment by a holistic therapist varies widely, depending on the level of qualification and the discipline, so it is best to discuss how much treatment can be expected to cost with a practitioner before beginning a course. Some forms of holistic treatment may be covered by health insurance.

Precautions

Many people who try holistic therapies focus on one area of their health only, often detoxification and nutrition. However, practitioners stress that it is only when all areas of a person's potential well being are tackled that total health and happiness can be achieved. They stress that the spiritual and emotional health contribute just as much as physical and mental health to a person's overall state of well-being.

When seeking treatment from a holistic practitioner, it is important to ensure that they are properly qualified. Credentials and reputation should always be checked. In addition, it is important that allopathic physicians and alternative physicians communicate about a patient's care.

Side effects

One of the main advantages of holistic therapies is that they have few side effects when used correctly. If a reputable practitioner is chosen and guidelines are adhered to, the worst that typically happens is that when lifestyle is changed and fresh nutrients are provided, the body begins to eliminate toxins that may have accumulated in the cells over a lifetime.

Often this results in what is known in alternative medicine circles as a "healing crisis." This comes about when the cells eliminate poisons into the blood stream all at the same time, throwing the system into a state of toxic overload until it can clear the "backlog." Symptoms such as **nausea**, headaches, or sensitivities to noise and other stimulations may be experienced.

The answer to most otherwise healthy patients is often just to lie quietly in a darkened room and take herbal teas. However, in the case of someone who has a serious illness, such as arthritis, **colitis**, diabetes, or **cancer**, (the list is much longer than this), it is strongly advised that they seek the help of a qualified practitioner. Therapists can help patients achieve detoxification in a way that causes the least stress to their bodies.

Research and general acceptance

Traditionally, holistic medicine, in all its different forms, has been regarded with mistrust and skepticism on the part of the allopathic medical profession. This situation is gradually changing. As of the year 2000, many insurance companies will provide for some form of alternative, or complementary, treatment.

In addition, many allopathic physicians, recognizing the role alternative medicine can play in overall health and well being, are actually referring patients to reputable practitioners, particularly **chiropractic** and relaxation therapists, for help with a varied range of complaints.

Training and certification

Holistic or alternative medicine practitioners are usually affiliated with an organization in their field. Training varies tremendously with the category, and ranges from no qualifications at all—experience only—to holding a Ph.D. from an accredited university. Again, credentials and memberships should be checked by prospective patients.

An excellent source for qualified practitioners is the American Board of Holistic Medicine, (AHBM), which was incorporated in 1996. Also, the American Holistic Medicine Association has a comprehensive list of practitioners in all types of therapies across the United States, which they call "the holistic doctor finder." However, they stress that it is the responsibility of the patient to check each practitioner's credentials prior to treatment.

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The ABHM has established the core curriculum upon which board certification for holistic medicine will be based. It includes the following 12 categories:

Body

Physical and environmental health

- nutritional medicine
- exercise medicine
- environmental medicine

Mind

Mental and emotional health

- behavioral medicine

Spirit

Spiritual health

- spiritual attunement
- social health

The six specialized areas:

- biomolecular diagnosis and therapy
- botanical medicine
- energy medicine
- ethno-medicine—including traditional Chinese medicine, Ayurveda, and Native American medicine
- homeopathy
- manual medicine

Founded in 1978 for the purpose of uniting practitioners of holistic medicine, membership of the AHMA is open to licensed medical doctors (MDs) and doctors of osteopathic medicine (DOs) from every specialty and to medical students studying for those degrees. Associate membership is open to health care practitioners who are certified, registered or licensed in the state in which they practice. The mission of the AHMA is to support practitioners in their personal and professional development as healers, and to educate physicians about holistic medicine.

ORGANIZATIONS

American Holistic Medical Association, 23366 Commerce Park, Suite 101B, Beachwood, OH, 44122, (216) 292-6644, (216) 292-6688, info@holisticmedicine.org, http://www.holisticmedicine.org.

Holistic Medicine, http://www.holisticmed.com/whatis. html.

Patricia Skinner

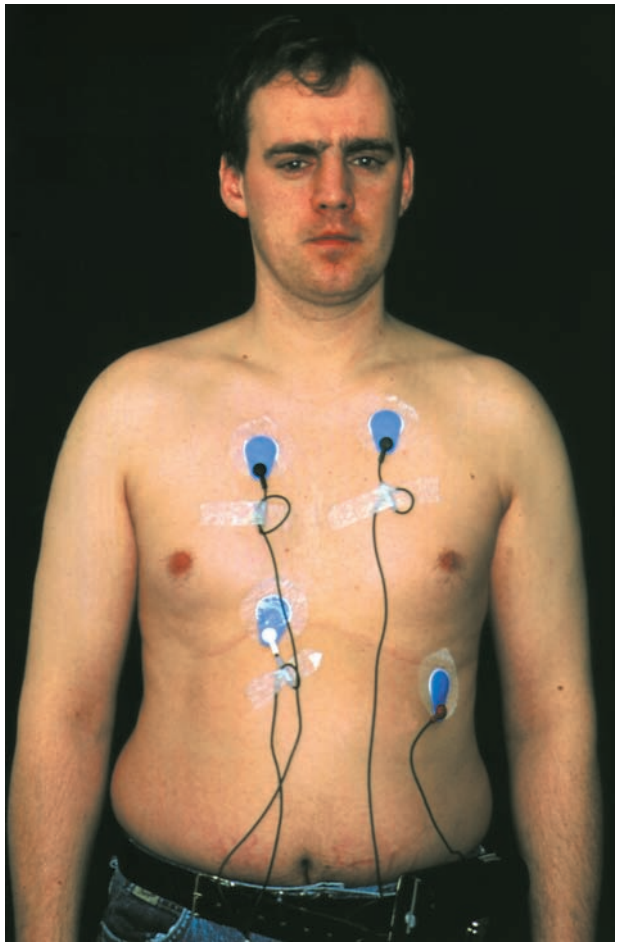
Holter monitoring

Definition

Holter monitoring is continuous monitoring of the electrical activity of a patient's heart muscle (**electrocardiography**) for 24 hours, using a special portable device called a Holter monitor. Patients wear the Holter monitor while carrying out their usual daily activities.

Purpose

Holter monitoring is used to help determine whether someone has an otherwise undetected heart disease, such as abnormal heart rhythm (cardiac arrhythmia), or inadequate blood flow through the heart. Specifically, it can detect abnormal electrical activity in the heart that may occur randomly or only under certain circumstances, such as during sleep or periods of physical activity or **stress**,



A male patient wears electrodes attached to his chest, which is connected to a Holter monitor at his waist. *(Dr. P. Marazzi/ Photo Researchers, Inc.)*

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which may or may not be picked up by standard, short-term electrocardiography performed in a doctor's office.

Traditionally, an exercise **stress test** has been used to screen people for "silent" heart disease (heart disease with none of the usual symptoms). However, an exercise stress test is not completely foolproof, often producing false negative results (indicating no heart disease when heart disease is actually present) and false positives (indicating heart disease when there is none). Furthermore, some people cannot undergo exercise stress testing because of other medical conditions, such as arthritis.

Holter monitoring, also known as ambulatory or 24-hour electrocardiography, offers an alternate means of testing people for heart disease. By monitoring electrocardiographic activity throughout the day, Holter monitoring can uncover heart problems that occur during the patient's everyday activities. It can also help to recognize any activities that may be causing the heart problems. And it can define and correlate symptoms that may be caused by irregularities of the heart.

Precautions

Holter monitoring is an extremely safe procedure and no special precautions are required.

Description

The technician affixes electrodes on the surface of the skin at specific areas of the patient's chest, using adhesive patches with special gel that conducts electrical impulses. Typically, electrodes are placed under each collarbone and each bottom rib, and several electrodes are placed across the chest in a rough outline of the heart. The electrodes are attached to a portable electrocardiographic device called a Holter monitor, which records the electrical activity of the heart over 24–48 hours. The device is worn over the patient's shoulder or attached to a belt around the waist.

The Holter monitor records the continuous electrical activity throughout the course of the day, while the patient carries out his or her daily activities. During this time, the patient also keeps a detailed log or diary, recording his or her various activities, such as exercise, eating, sleeping, straining, breathing too hard (hyperventilating), and any stressful situations. The patient also notes the time and circumstances of any symptoms–especially chest **pain**, **dizziness**, **shortness of breath**, heart **palpitations**, and any other signs of heart trouble. Some Holter monitors allow patients to record their symptoms electronically, highlighting the portion of the electrocardiogram recorded while the symptoms are occurring.

After 24–48 hours, the Holter monitor is removed. A computer-assisted analysis is performed on the electrocardiographic recording, and the doctor compares the recording against the patient's log to see if there is any correlation between electrocardiographic abnormalities and any of the patient's activities or symptoms. The physician makes a final interpretation.

Preparation

In the doctor's office, electrodes are attached to the patient's chest. In some cases, the patient's chest hair may have to be shaved to facilitate attaching the electrodes. The patient then begins carrying the monitor on a shoulder harness, in a pocket, or on the belt while carrying out his or her usual daily routine. The patient should inform the doctor of any drugs he or she may be taking, because certain drugs can alter heart rhythms and may affect the results of the test.

Aftercare

The patient returns to the doctor's office to have the monitor and electrodes removed. No special measures need to be taken following Holter monitoring. The test results are usually available within a few days after the monitor is removed.

Risks

There are no known risks associated with Holter monitoring. The main complaint that people have with Holter monitoring is that the monitor may be cumbersome and interfere with certain activities, especially sleeping. Bathing and showering are not allowed during the study.

Normal results

A normal Holter monitoring test shows relatively normal electrical activity in the heart around the clock and no evidence of silent **ischemia** (deprivation of oxygen-rich blood).

Abnormal results

An abnormal result on Holter monitoring may indicate ischemia to the heart muscle or heart rhythm disturbances. Abnormalities are especially likely to show up during periods of stress or heavy activity, but sometimes serious abnormalities are recorded while the patient is sleeping.

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ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

National Heart Lung and Blood Institute Health Informa tion Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi. nih.gov.

Robert Scott Dinsmoor

Holtzman ink blot test

Definition

The Holtzman Inkblot Technique (HIT) is a projective personality assessment test for persons ages five and up.

Purpose

The HIT is used to assess the personality structure of a test subject. It is sometimes used as a diagnostic tool in assessing **schizophrenia**, depression, **addiction**, and character disorders.

Precautions

Psychometric testing requires a clinically trained examiner. The HIT should be administered and interpreted by a trained psychologist, psychiatrist, or appropriately trained mental health professional.

Some consider projective tests to be less reliable than objective personality tests. If the examiner is not well-trained in psychometric evaluation, subjective interpretations may affect the outcome of the test.

Description

The HIT, developed by psychologist Wayne Holtzman and colleagues, was introduced in 1961. The test was designed to overcome some of the deficiencies of its famous predecessor, the Rorschach Inkblot Test.

Unlike the Rorschach, the Holtzman is a standardized measurement with clearly defined objective scoring criteria. The HIT consists of 45 inkblots. The test administrator, or examiner, has a stack of 47 cards with inkblots (45 test cards and 2 practice cards) face down in front of him or her. The examiner hands each card to the subject and asks the test subject what he or she sees in the inkblot. Only one response per inkblot is requested. Occasionally, the examiner may ask the test subject to clarify or elaborate on a response. The administration of the HIT typically takes 50–80 minutes. The HIT is then scored against 22 personality-related characteristics.

The HIT can also be administered in a group setting. In group testing, 30–45 inkblots are projected onto a screen and test subjects provide written responses to each inkblot.

Medicare reimbursement rates for psychological and neuropsychological testing is $58.35 an hour. Billing time typically includes test administration, scoring and interpretation, and reporting. Many insurance plans cover all or a portion of diagnostic psychological testing.

Normal results

Because of the complexity of the scoring process and the projective nature of the test, results for the HIT should only be interpreted by a clinically trained psychologist, psychiatrist, or appropriately trained mental health professional.

ORGANIZATIONS

American Psychological Association (APA), 750 First St. NE, Washington, DC, 20002-4242, (202) 336-5500, (800) 374-2721, http://www.apa.org/.

Paula Anne Ford-Martin

Homeopathic medicine

Definition

Homeopathy, or homeopathic medicine, is a holistic system of treatment that originated in the late eighteenth century. The name homeopathy is derived from two Greek words that mean "like disease." The system is based on the idea that substances that produce symptoms of sickness in healthy people will have a curative effect when given in very diluted quantities to sick people who exhibit those same symptoms. Homeopathic remedies are believed to stimulate the body's own healing processes. Homeopaths use the term "allopathy," or "different than disease," to describe the use of drugs used in conventional medicine to oppose or counteract the symptom being treated.

Purpose

Homeopathic physicians seek to cure their patients on the physical, mental and emotional levels, and each treatment is tailored to a patient's individual needs. Homeopathy is generally a safe treatment, as it uses medicines in extremely diluted quantities, and there are usually minimal side effects. Its non-toxicity makes it a

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Examples of popular homeopathic remedies

Aconite	Commonly known as monkshood, aconite is highly toxic. A nontoxic, diluted extract is used in homeopathy to treat symptoms similar to that of poison.
Allium cepa	Commonly known as red onion, homeopathic physicians use a diluted extract of red onion to treat symptoms similar to that of red onion—watery eyes, burning, etc.
Apis	Commonly known as the honey bee, apis as a homeopathic remedy is made from the body of the bee. It is used to treat symptoms similar to that of a bee sting—redness, swelling, etc.
Arnica	Commonly known as the mountain daisy, arnica is used by homeopaths to treat bruises, sprains, and strains.
Arsenicum album	Also known as ars alb, arsenicum album is a diluted form of arsenic, a metallic poison. It is used by homeopathic physicians to treat symptoms similar to the effects of arsenic poisoning—dehydration, burning pain, etc.
Belladonna	Commonly known as deadly nightshade, belladonna is used in homeopathy to treat symptoms of dry mouth, nausea, delirium, etc.
Bryonia	Commonly known as wild hops, bryonia is used in homeopathy to treat vomiting, diarrhea, inflammation, etc.
Calcarea carbonica	Also known as calcium carbonate or calc carb, calcarea carbonica is used in homeopathy to treat symptoms of exhaustion, depression, and anxiety.
Cantharis	Commonly known as Spanish fly, cantharis is used in homeopathy to treat conditions with symptoms of abdominal cramps, vomiting, diarrhea, convulsions, etc.
Chamomilla	Derived from German chamomile, chamomilla is used in homeopathy to treat irritability, impatience, etc. It is most often prescribed to children.
Ferrum phosphoricum	Also known as ferrum phos or iron phosphate, it is used to treat symptoms of low energy and anemia.
Gelsemium	Also known as yellow jasmine, gelsemium is used to treat conditions that affect vision, balance, thought, and locomotion.
Hepar sulphuris	Derived from the inner layer of oyster shells, hepar sulphuris is used to treat infection.
Hypericum perforatum	Commonly known as St. John's wort, hypericum is used to treated nerve damage.
Ignatia	Derived from the bean of a small tree, this homeopathic remedy is prescribed to treat conditions with symptoms such as headache, cramping, and tremors.
Ipecac	Ipecac induces vomiting and causes gastrointestinal distress. Homeopaths prescribe it to treat similar symptoms.
Kali bichromicum	Commonly known as potassium bichromate, kali bichromicum is a poison used also in textile dyes, wood stain, etc. Homeopaths use it to treat localized pain.
Lachesis	Derived from the venom of the bushmaster snake, this homeopathic remedy is used to treat conditions that cause the same symptoms as the venom.
Ledum	Also known as marsh tea, ledum is used to treat infections, most often from animal bites, stings, cuts, etc.
Lycopodium	Commonly known as club moss, lycopodium is used to treat diarrhea, stomach upset, etc.

continued

Examples of popular homeopathic remedies [CONTINUED]

Mercurius vivus	Also known as quicksilver, it is used to treat symptoms of sweats, shaking, nausea, etc.
Natrum muriaticum	Commonly known as salt, it is used to treat conditions that cause excessive thirst and salt cravings.
Phosphorus	Phosphorus is used to treat symptoms of excessive thirst, fatigue, and nervousness.
Pulsatilla	Pulsatilla is used to treat conditions that are accompanied by discharge, such as bedwetting, sinusitis, etc.
Rhus toxicodendron	Commonly known as poison ivy, homeopaths use it to treat conditions with symptoms of fever, swollen glands, and restlessness.
Ruta	Ruta, or rue, is used to treat conditions associated with pain and strain, such as tennis elbow, sciatica, etc.
Sepia	Sepia is the discharge used by the cuttlefish to disappear from a predator. Homeopaths use sepia to treat symptoms of apathy and weakness.
Silica	Also called flint, silica is used by homeopaths to treat conditions that cause weakness, sweating, and sensitivity to cold.
Sulphur	Sulphur is used to treat conditions with symptoms of itching, burning pains, and odor.

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good choice for the treatment of children. Another benefit of homeopathy is the cost of treatments; homeopathic remedies are inexpensive, often a fraction of the cost of conventional drugs.

Homeopathic treatment has been shown effective in treating many conditions. Colds and flu may be effectively treated with aconite and bryonia. **Influenza** suffers in a double-blind study found that they were twice as likely to recover in 48 hours when they took homeopathic remedies. Studies have been published in British medical journals confirming the efficacy of homeopathic treatment for **rheumatoid arthritis**. Homeopathic remedies are effective in treating infections, circulatory problems, respiratory problems, heart disease, depression and nervous disorders, migraine headaches, **allergies**, arthritis, and diabetes. Homeopathy is a good treatment to explore for acute and chronic illnesses, particularly if these are found in the early stages and where there is not severe damage. Homeopathy can be used to assist the healing process after surgery or **chemotherapy**.

Description

Origins

Homeopathy was founded by German physician Samuel Hahnemann (1755–1843), who was much

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disturbed by the medical system of his time, believing that its cures were crude and some of its strong drugs and treatments did more harm than good to patients. Hahnemann performed experiments on himself using Peruvian bark, which contains quinine, a **malaria** remedy. He concluded that in a healthy person, quinine creates the same symptoms as malaria, including fevers and chills, which is the reason why it is effective as a remedy. He then began to analyze the remedies available in nature by what he called provings. Provings of homeopathic remedies are still compiled by dosing healthy adults with various substances and documenting the results, in terms of the dose needed to produce the symptoms and the length of the dose's effectiveness. The provings are collected in large homeopathic references called *materia medica* or materials of medicine.

Hahnemann formulated these principles of homeopathy:

- Law of Similars (like cures like)
- Law of the Infinitesimal Dose (The more diluted a remedy is, the more potent it is.)
- illness is specific to the individual

Hahnemann's Law of Similars was based on thinking that dated back to Hippocrates in the fourth century B.C. It is the same thinking that provided the basis for vaccines created by Edward Jenner (1749–1823) and Louis Pasteur (1822–1895). These vaccines provoke a reaction in the individual that protects against the actual disease. Allergy treatments work the same way. By exposing a person to minute quantities of the allergen, the person's tolerance levels are elevated.

The Law of the Infinitesimal Dose has always caused controversy among those outside the field of homeopathy. Hahnemann contended that as he diluted his remedies with water and alcohol and succussed, or shook, them, the remedies actually worked more effectively. In fact, diluted homeopathic remedies may have no chemical trace of the original substance. Practitioners believe that the electromagnetic energy of the original substance is retained in the dilution, but toxic side effects of the remedy are not. It is this electrochemical "message" that stimulates the body to heal itself, although there is no scientific proof of this.

Homeopathic practitioners believe that illness is specific to an individual. In other words, two people with severe headaches may not receive the same remedies. The practitioner will ask the patient questions about lifestyle, dietary habits, and personality traits, as well as specific questions about the nature of the **headache** and when it occurs. This information gathering is called profiling or case-taking.

In the early 1900s, homeopathy was popular in the United States, with over 15% of all doctors being homeopathic. There were 22 major homeopathic medical schools, including Boston University and the University of Michigan. However, with the formation of the American Medical Association, which restricted and closed down alternative practices, homeopathy declined for half a century. When the 1960s invigorated back-to-nature trends and distrust of artificial drugs and treatments, homeopathy began to grow again dramatically through the next decades. In 1993, *The New England Journal of Medicine* reported that 2.5 million Americans used homeopathic remedies and 800,000 patients visited homeopaths in 1990, and it has continued to grow. Homeopathy is much more popular in Europe than in the United States. French pharmacies are required to make homeopathic remedies available along with conventional medications. Homeopathic hospitals and clinics are part of the national health system in Britain. It is also practiced in India and Israel, among other countries.

A visit to a homeopath can be a different experience than a visit to a regular physician. The initial visit often includes a long questionnaire about a patient's medical and family history, and then a long interview with the practitioner, who prompts the patient with many questions. Sometimes a homeopathic practitioner will use lab tests to establish a patient's general level of health. The initial interview usually lasts between one and two hours.

The purpose of homeopathy is the restoration of the body to homeostasis, or healthy balance, which is its natural state. The symptoms of a disease are regarded as the body's own defensive attempt to correct its imbalance, rather than as enemies to be defeated. Because a homeopath regards symptoms as positive evidence of the body's inner intelligence, he or she will prescribe a remedy designed to stimulate this internal curative process, rather than suppress the symptoms.

In homeopathy, the curative process extends beyond the relief of immediate symptoms of illness. Healing may come in stages, as the practitioner treats layers of symptoms that are remnants of traumas or chronic disease in the patient's past. This is part of Hering's Laws of Cure, named for Constantine Hering, the father of homeopathy in the United States. Hering believed that healing starts from the deepest parts of the body to the extremities, and from the upper parts of the body to the lower parts. Hering's Laws also state that homeopaths should treat disease symptoms in reverse chronological order, from the most recent to the oldest, restoring health in stages. Sometimes, the patient may feel worse before feeling better. This is called a healing crisis.

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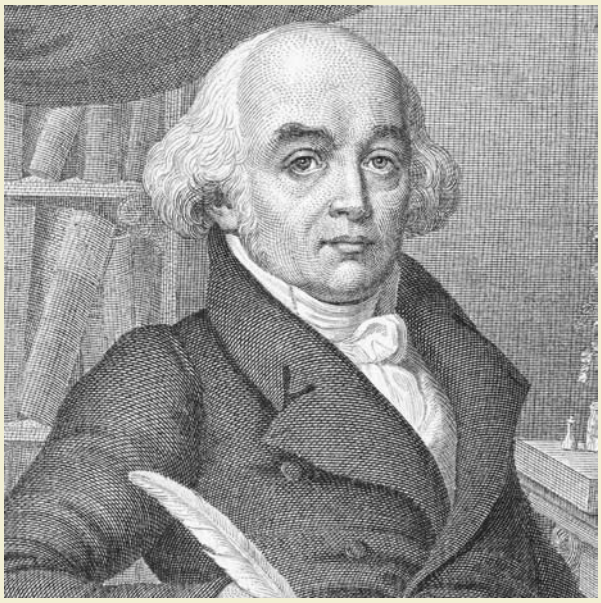
SAMUEL HAHNEMANN (1755–1843)



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Samuel Christian Hahnemann created and developed the system called homeopathy. It is also known as *similia similibus curentor* or like cures like. Although his new methods initially met with ridicule and criticism, by the time of his death they were accepted the world over as a result of the great success he had with his new cure.

Hahnemann was born in Meissen, Saxony (now part of Germany) into a financially challenged middle class family. His parents initially educated him at home, where his father taught him never to accept anything he learned without first questioning it. He graduated as a physician at Erlangen in 1779 after studying at Leipzig and Vienna. He was also fluent in English, German, Italian, French, Greek, Arabic, Latin, and Hebrew.

At age 27 he married his first wife, Johanna Henriette Kuchler, the daughter of an apothecary, with whom he had 11 children.

Living in poverty, Hahnemann began practicing medicine in 1781 and translating scientific texts to supplement his income. However, disillusioned with medicine, he eventually gave it up entirely.

He discovered the concept of homeopathy when considering the effect of quinine on malaria, and went on to cure soldiers and then sufferers of a typhus epidemic with astounding success. He documented his discoveries in the *Organon*, a treatise on his work. Homeopathy also proved its worth in 1831 when there was an outbreak of cholera. Hahnemann used homeopathic treatment with a 96% success rate, compared to the 41% of allopathic medicine. He also wrote his *Materia Medica Pura.*

In 1834, Hahnemann met his second wife, Marie Melanie d'Hervilly. Despite a great difference in age, they were happily married until his death in Paris on July 2, 1843, at the age of 88.

When prescribing a remedy, homeopaths will match a patient's symptoms with the proper remedy in a repertory or *materia medica* that has been compiled throughout the history of homeopathy. Classical homeopaths prescribe only one remedy at a time. However, it is becoming more common, especially in Europe, to use combination formulas of several remedies for the treatment of some combinations of symptoms.

The cost of homeopathic care can vary. The cost of visits will be comparable to conventional medicine, with initial visits ranging from $50 to $300. Non-M.D. homeopaths can charge from $50 to $250. Follow-up visits are less, at about $35 to $100. Homeopathic medicine is significantly cheaper than pharmaceuticals, and most remedies cost between $2 and $10. Homeopaths rarely use lab tests, which reduces the cost of treatment further. In general, homeopathy is much more economical than conventional medicine. In 1991, the French government did a study on the cost of homeopathic medicine, and found that it costs half as much to treat patients, considering all costs involved. The study did not look at the effectiveness of homeopathy treatment versus conventional treatment.

When homeopaths are licensed professionals, most insurance companies will pay for their fees. Consumers should consult their insurance policies to determine individual regulations. Insurance usually will not cover visits to homeopathic practitioners or homeopathic medicine.

Precautions

Although homeopathic remedies sometimes use substances that are toxic, they are diluted and prescribed in non-toxic doses. Remedies should be prescribed by a homeopathic practitioner. Those preparing to take homeopathic remedies should also avoid taking *antidotes*, substances which homeopathic doctors believe cancel the effects of their remedies. These substances include alcohol, coffee, peppermint (in toothpaste and mouthwash), camphor (in salves and lotions), and very spicy foods. Homeopathic medicine should also be

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KEY TERMS

Acute prescribing—Homeopathic treatment for self-limiting illnesses with abrupt onset.

Allopathy—Conventional medical treatment of disease symptoms that uses substances or techniques to oppose or suppress the symptoms.

Law of similars—The basic principle of homeopathic medicine that governs the selection of a specific remedy. It holds that a substance of natural origin that produces certain symptoms in a healthy person will cure those same symptoms in a sick person.

Modalities—The factors and circumstances that cause a patient's symptoms to improve or worsen.

Mother tincture—The first stage in the preparation of a homeopathic remedy, made by soaking a plant, animal, or mineral product in a solution of alcohol.

Potentization—The process of increasing the power of homeopathic preparations by successive dilutions and succussions of a mother tincture.

Succussion—The act of shaking diluted homeopathic remedies as part of the process of potentization.

Trituration—The process of diluting a nonsoluble substance for homeopathic use by grinding it to a fine powder and mixing it with lactose powder.

handled with care, and should not be touched with the hands or fingers, which can contaminate it.

Side effects

A homeopathic *aggravation* sometimes occurs during initial treatment with homeopathic remedies. This means that symptoms can temporarily worsen during the process of healing. Although this is usually mild, the aggravation can sometimes be severe. Homeopaths see aggravation as a positive sign that the remedy is a good match for the patient's symptoms. The healing crisis, which happens when the patient is undergoing treatment for layers of symptoms, may also cause the patient to feel worse before feeling better. Some patients can experience emotional disturbances like weeping or depression, if suppressed emotional problems led to the illness in the first place.

Research and general acceptance

Since the early 1900s, when the American Medical Association and pharmacists waged a battle against it, homeopaths believe that homeopathy has been neglected and sometimes ridiculed by mainstream medicine. Much of this is because there are few controlled scientific studies of homeopathy that would meet the criteria for approval by the U.S. Food and Drug Administration (FDA), or for acceptance for publication in the major reputable medical journals in the United States. Aside from politics, part of the reason for this skepticism is that there are some aspects of homeopathy which have not been completely explained scientifically. For instance, homeopaths have found that the more they dilute and succuss a remedy, the greater effect it seems to have on the body. Some homeopathic remedies are so diluted that not even a single molecule of the active agent remains in a solution. Also, homeopathy puts an emphasis on analyzing symptoms and then applying remedies to these symptoms, rather than working by classifying diseases. Thus, some people with the same disease may require different homeopathic medicines and treatments. Furthermore, conventional medicine strives to find out how medicines work in the body before they use them; homeopathy is less concerned with the intricate biochemistry involved than with whether a remedy ultimately works and heals holistically. For all these reasons, conventional medicine claims that homeopathy is not scientific.

There continue to be many studies that homeopaths believe affirm the effectiveness of homeopathic treatments. Among the most celebrated, the *British Medical Journal* in 1991 published a large analysis of homeopathic treatments that were given over the course of 25 years. This project involved over 100 studies of patients with problems ranging from vascular diseases, respiratory problems, infections, stomach problems, allergies, recovery from surgeries, arthritis, trauma, psychological problems, diabetes, and others. The study found improvement with homeopathic treatment in most categories of problems, and concluded that the evidence was "sufficient for establishing homeopathy as a regular treatment for certain indications."

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American Institute of Homeopathy, 801 N. Fairfax St., Suite 306, Alexandria, VA, 22314, (888) 445-9988, http://www.homeopathyusa.org.
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Ken R. Wells

Homeopathic medicine, acute prescribing

Definition

Acute homeopathic prescribing is that part of homeopathy that treats illness which has an abrupt onset and needs immediate attention. In **homeopathic medicine**, acute refers primarily to the speed of onset and self-limiting character of the disorder rather than its seriousness. Colds, **influenza**, sore throats, insect **stings**, cuts, **bruises**, **vomiting**, **diarrhea**, **fever**, muscle aches, and short-term **insomnia** are all examples of conditions that are treated by acute prescribing. The remedies given in acute homeopathic prescribing are intended to stimulate the body's internal ability to heal itself; they do not kill germs or suppress symptoms. Acute prescribing can be done—within limits—by patients at home, as well as by homeopathic practitioners. Study courses, self-treatment guides, and homeopathic home medicine kits are now available by mail order from homeopathic pharmacies and educational services.

Purpose

Homeopathic physicians seek to cure their patients on physical, mental, and emotional levels, and each treatment is tailored to a patient's individual needs. Homeopathy is generally a safe treatment, as it uses medicines in extremely diluted quantities, and there are usually minimal side effects. Its non-toxicity makes it a choice for the treatment of children. Another benefit of homeopathy is the cost of treatments; homeopathic remedies are inexpensive, often a fraction of the cost of conventional drugs.

Acute homeopathic prescribing is thought to benefit a wide range of ailments. These include **altitude sickness**, Bell's palsy, the **common cold**, **allergies**, coughing, **dengue fever**, **dysentery**, earaches, migraine headaches, fever, **food poisoning**, grief, influenza, **motion sickness**, **shock**, **sore throat**, surgical complications, and reactions to vaccinations and drug therapy. Acute remedies may also be prescribed to treat insect stings, animal **bites**, and problems related to **poison oak** and **poison ivy**. It may be further employed in treating injuries including black eyes, **burns**, bruises, concussions, cuts, damaged tendons and ligaments, **dislocations**, **fractures**, herniated discs, nosebleeds, puncture **wounds**, sprains, and strains.

Description

Origins

Homeopathy is a gentle, painless, holistic system of healing developed during the 1790s by Samuel Hahnemann, a German physician. Experimenting on himself with the anti-malarial drug quinine, Hahnemann noticed that large doses of the medicine actually caused malaria-like symptoms, while smaller doses cured the symptoms. From this, he advanced his concept of *Similia similibus curentur*, or "let like be cured with like." Hahnemann then developed an extensive system of medicine based on this concept. He named it homeopathy, from the Greek words *homoios* (the same) and *pathos* (suffering).

Homeopathic remedies are almost always made from natural materials—plant, animal, or mineral substances—that have been treated to form base tinctures or nonsoluble powders. Liquid extracts are then potentized, or increased in power, by a series of dilutions and succussions, or shakings. It is thought that succussion is necessary to transfer the energy of the natural substance to the solution. In addition, the potency of the remedy is regarded as increasing with each dilution. After the tincture has been diluted to the prescribed potency, the resulting solution is added to a bottle of sucrose/lactose tablets, which are stored in a cool, dark place. If the remedy is not soluble in water, it is ground to a fine powder and triturated with powdered lactose to achieve the desired potency.

Proponents of homeopathy over the years have included Louisa May Alcott, Charles Dickens, Benjamin

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Disraeli, Johann Wolfgang Goethe, Nathaniel Hawthorne, William James, Henry Wadsworth Longfellow, Pope Pius X, John D. Rockefeller, Harriet Beecher Stowe, William Thackeray, Daniel Webster, and W. B. Yeats. England's Royal Family has employed homeopathic practitioners since the 1830s.

Homeopathic prescribing differs in general from allopathic medicine in its tailoring of remedies to the patient's overall personality type and totality of symptoms, rather than to the disease. Whereas a conventional physician would prescribe the same medication or treatment regimen to all patients with the common cold, for example, a homeopathic practitioner would ask detailed questions about each patient's symptoms and the modalities, or factors, that make them better or worse. As a result, the homeopath might prescribe six different remedies for six different patients with the same illness. In acute prescribing homeopathy, consultations are more brief compared to constitutional homeopathic prescribing. A typical patient might spend just 10–15 minutes with the practitioner, compared to more than an hour for constitutional prescribing.

Homeopathic classification of symptoms

Homeopathic practitioners use the word symptom in a more inclusive fashion than traditional medicine. In homeopathy, symptoms include any change that the patient experiences during the illness, including changes in emotional or mental patterns.

Homeopaths classify symptoms according to a hierarchy of four categories for purposes of acute prescribing:

- Peculiar symptoms. These are symptoms unique to the individual that do not occur in most persons with the acute disease. Homeopaths make note of peculiar symptoms because they often help to determine the remedy.
- Mental and emotional symptoms. These are important general symptoms that inform the homeopath about the patient's total experience of the disorder.
- Other general symptoms. These are physical symptoms felt throughout the patient's body, such as tiredness, changes in appetite, or restlessness.
- Particular symptoms. Particular symptoms are localized in the body; they include such symptoms as nausea, skin rashes, headache, etc.

During homeopathic case-taking, the practitioner will evaluate the intensity of the patient's symptoms, assess their depth within the patient's body, note any peculiar symptoms, evaluate the modalities of each symptom, and make a list of key symptoms to guide the selection of the proper medicine.

Homeopathic remedies

There are several hundred homeopathic remedies. Homeopathic medicines are usually formulated from diluted or triturated natural substances, including plants, **minerals**, or even venom from snakes or stinging insects. Some remedies may be given in a spray, ointment, or cream, but the most common forms of administration are liquid dilutions and two sizes of pellets, or cylindrical tablets (for triturated remedies). A dose consists of one drop of liquid; 10–20 small pellets; or 1–3 large pellets. Since the remedies are so dilute, the exact size of the dose is not of primary importance. The frequency of dosing is considered critical, however; patients are advised not to take further doses until the first has completed its effect.

Homeopathic remedies can be kept indefinitely with proper handling. Proper handling includes storing the remedies in the original bottles and discarding them if they become contaminated by sunlight or other intense light; temperatures over 100°F (37.8°C); vapors from camphor, mothballs, or perfume; or from other homeopathic remedies being opened in the same room at the same time.

Preparations

Case-taking

The first step in acute prescribing is a lengthy interview with the patient, known as case-taking. In addition to noting the character, location, and severity of the patient's symptoms, the homeopath will ask about their modalities. The modalities are the circumstances or factors (e.g., weather, time of day, body position, behavior or activity, etc.) that make the symptoms either better or worse. Case-taking can be done by the patient or a family member as well as by a homeopath.

Selection and administration of a remedy

The choice of a specific remedy is guided by the patient's total symptom profile rather than by the illness. Homeopathic remedies are prescribed according to the law of similars, which holds that a substance that produces specific symptoms in healthy people cures those symptoms in sick people when given in highly diluted forms. For example, a patient with influenza who is irritable, headachy, and suffering from joint or muscle pains is likely to be given *bryonia* (wild hops), because this plant extract would cause this symptom cluster in a healthy individual.

Patients are instructed to avoid touching homeopathic medicines with their fingers. The dose can be

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poured onto a piece of white paper or the bottle's cap and tipped directly into the mouth. Homeopathic remedies are not taken with water; patients should not eat or drink anything for 15–20 minutes before or after taking the dose.

Precautions

Homeopathic acute prescribing is not recommended for the treatment of chronic conditions requiring constitutional prescribing, for severe infections requiring antibiotic treatment, or for conditions requiring major surgery. It is also not recommended for the treatment of mental health problems.

Persons who are treating themselves with homeopathic remedies should follow professional guidelines regarding the limitations of home treatment. Most homeopathic home treatment guides include necessary information regarding symptoms and disorders that require professional attention.

Homeopathic remedies may lose their potency if used at the same time as other products. Some homeopathic practitioners recommend the avoidance of mint and mentholated products (toothpastes, candies, chewing gum, mouth rinses), as well as camphor and camphorated products (including eucalyptus and Tiger Balm), patchouli and other essential oils, moth balls, strong perfumes, aftershaves, scented soaps, **stress**, x rays, coffee, nicotine, recreational drugs (**marijuana**), and certain therapeutic drugs (most notably cortisone and prednisone) during treatment. Patients are also advised to avoid electric blankets and dental work, as these are thought to adversely affect homeopathic therapy. Homeopathic remedies should never be placed near magnets.

Practitioners caution that high-potency preparations should be used only under the supervision of a homeopathic practitioner.

Side effects

Homeopathic medicines are so diluted that sometimes no trace of the original substance can be detected. These medicines are therefore considered non-toxic and generally free of harmful side effects. There may, however, be individual reactions to homeopathic medicine.

An intensified healing response may occur as treatment begins, which causes symptoms to worsen, but the phenomenon is usually temporary. In some patients, old symptoms may re-appear from past conditions from which recovery was not complete. Such phenomena are taken as positive indications that the healing process has started.

Research and general acceptance

As Samuel Hahnemann's healing system grew in popularity during the 1800s, it quickly attracted vehement opposition from the medical and apothecary professions. Since the early 1900s, when the American Medical Association and pharmacists waged a battle against it, homeopaths believe that homeopathy has been neglected and sometimes ridiculed by mainstream medicine. Much of this skepticism is because there are few controlled scientific studies of homeopathy that would meet the criteria of the U.S. Food and Drug Administration (FDA), or for acceptance for publication in the major reputable medical journals in the United States. Aside from politics, part of the reason for this skepticism is that there are some aspects of homeopathy which have not been completely explained scientifically. For instance, homeopaths have found that the more they dilute and succuss a remedy, the greater effect it seems to have on the body. Some homeopathic remedies are so diluted that not even a single molecule of the active agent remains in a solution, yet homeopaths maintain it still works; some studies have demonstrated this paradox, yet cannot explain it. Also, homeopathy puts an emphasis on analyzing symptoms and then applying remedies to these symptoms, rather than working by classifying diseases. Thus, some people with the same disease may require different homeopathic medicines and treatments. Furthermore, conventional medicine strives to find out how medicines work in the body before they use them; homeopathy is less concerned with the intricate biochemistry involved than with whether a remedy ultimately works and heals holistically. For all these reasons, conventional medicine claims that homeopathy is not scientific, but homeopaths reply that homeopathy has been developed and studied for centuries, with much documentation and success.

There continue to be many studies that homeopaths believe affirm the effectiveness of homeopathic treatments. Among the most celebrated, the *British Medical Journal* in 1991 published a large analysis of homeopathic treatments that were given over the course of 25 years. This project involved over 100 studies of patients with problems ranging from vascular diseases, respiratory problems, infections, stomach problems, allergies, recovery from surgeries, arthritis, trauma, psychological problems, diabetes, and others. The study found improvement with homeopathic treatment in most categories of problems, and concluded that the

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evidence was "sufficient for establishing homeopathy as a regular treatment for certain indications."

In the United Kingdom and other countries where homeopathy is especially popular, some medical doctors incorporate aspects of acute prescribing homeopathy into their practices. Countries in which homeopathy is popular include France, India, Pakistan, Sri Lanka, Brazil, and Argentina. Large homeopathic hospitals exist in London and Glasgow, and homeopathic medical centers can be found in India and South America.

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American Institute of Homeopathy, 101 South Whiting Street, Suite 16, Alexandria, VA, 22304, (888) 445-9988, admin@homeopathyusa.org, http://www.homeopathyusa.org.

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Ken R. Wells

Homeopathic medicine, constitutional prescribing

Definition

Constitutional homeopathic prescribing, also called classical prescribing, is a holistic system of medicine that has been practiced for more than 200 years. Unlike acute homeopathic prescribing, constitutional prescribing refers to the selection and administration of homeopathic preparations over a period of time for treatment related to what practitioners call miasmic disorders, those caused by an inherited predisposition to a disease. The term miasm comes from a Greek word meaning stain or pollution. As in acute prescribing, constitutional prescribing is holistic in that it is intended to treat the patient on the emotional and spiritual levels of his or her being as well as the physical. Constitutional prescribing is also aimed at eventual cure of the patient, not just suppression or relief of immediate symptoms.

Purpose

Homeopathic physicians seek to treat their patients on physical, mental, and emotional levels, and each treatment is tailored to a patient's individual needs. Homeopathy is generally a safe treatment, as it uses medicines in extremely diluted quantities, and there are usually minimal side effects. Its non-toxicity makes it a choice for treating children. Another benefit of homeopathy is the cost of treatments; homeopathic remedies are inexpensive, often a fraction of the cost of conventional drugs.

Classical homeopathy has been used to treat a wide range of diseases and conditions, most of which tend to be long-term. These include: **alcoholism**, **allergies**, **anxiety**, arthritis, **asthma**, bladder conditions, **chronic fatigue syndrome**, depression, drug dependencies, gastrointestinal problems, Gulf War sickness, **headache**, hearing problems, herpes, hypersensitivity, immune disorders, **insomnia**, joint problems, kidney conditions, liver problems, **Lyme disease**, lower back problems, **malaria**, **menopause**, menstrual problems, migraine, **multiple sclerosis**, **paralysis**, **phobias**, **shingles**, sinus problems, skin disorders, repetitive stress injury, rheumatism, vertigo, vision problems, and yeast infections.

Description

Origins

Homeopathy was developed during the 1790s by Samuel Hahnemann, a German physician. Experimenting on himself with the anti-malarial drug quinine, Hahnemann noticed that large doses of the medicine

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actually caused malaria-like symptoms, while smaller doses cured the symptoms. From this, he advanced his concept of *Similia similibus curentur*, or "let like be cured with like." Hahnemann then developed an extensive system of medicine based on this concept. He named it homeopathy, from the Greek words *homoios* (the same) and *pathos* (suffering).

There are several hundred homeopathic remedies. They are almost always made from natural materials—plant, animal, or mineral substances—that have been treated to form base tinctures or nonsoluble powders. Liquid extracts are then potentized, or increased in power, by a series of dilutions and succussions, or shakings. It is thought that succussion is necessary to transfer the energy of the natural substance to the solution. In addition, the potency of the remedy is regarded as increasing with each dilution. After the tincture has been diluted to the prescribed potency, the resulting solution is added to a bottle of sucrose/lactose tablets, which are stored in a cool, dark place. If the remedy is not soluble in water, it is ground to a fine powder and triturated with powdered lactose to achieve the desired potency.

Proponents of homeopathy over the years have included Louisa May Alcott, Charles Dickens, Benjamin Disraeli, Johann Wolfgang Goethe, Nathaniel Hawthorne, William James, Henry Wadsworth Longfellow, Pope Pius X, John D. Rockefeller, Harriet Beecher Stowe, William Thackeray, Daniel Webster, and W. B. Yeats. England's Royal Family has employed homeopathic practitioners since the 1830s.

Constitutional prescribing is based on the patient's symptom profile and specific aspects of homeopathic theory.

Homeopathic classification of symptoms

Homeopathic practitioners use the word symptom in a more inclusive fashion than traditional medicine. In homeopathy, symptoms include any change that the patient experiences during the illness, including changes in emotional or mental patterns.

Homeopaths classify symptoms according to a hierarchy of four categories:

- Peculiar symptoms. These are symptoms unique to the individual that do not occur in most persons. Homeopaths make note of peculiar symptoms because they often help to determine the remedy.
- Mental and emotional symptoms. These are important general symptoms that inform the homeopath about the patient's total experience of the disorder.
- Other general symptoms. These are physical symptoms felt throughout the patient's body, such as tiredness, changes in appetite, or restlessness.
- Particular symptoms. Particular symptoms are localized in the body; they include such symptoms as nausea, skin rashes, or headaches.

Miasms

Homeopaths regard the patient's symptom profile as a systemic manifestation of an underlying chronic disorder called a miasm. Miasms are serious disturbances of what homeopaths call the patient's vital force that are inherited from parents at the time of conception. Hahnemann believed that the parents' basic lifestyle, their emotional condition, and habitual diet, and even the atmospheric conditions at the time of conception would affect the number and severity of miasms passed on to the child. Hahnemann himself distinguished three miasms: the psoric, which he considered the most universal source of chronic disease in humans; the syphilitic; and the sycotic, which he attributed to **gonorrhea**. Later homeopaths identified two additional miasms, the cancernic and the tuberculinic. The remaining major source of miasms is allopathic medicine. It is thought that specific allopathic treatments—particularly **smallpox** vaccinations, cortisone preparations, major tranquilizers, and antibiotics—can produce additional layers of miasms in the patient's constitution. There are no credible, mainstream scientific studies that support this. Constitutional prescribing evaluates the person's current state or miasmic picture, and selects a remedy intended to correct or balance that state. The homeopath may prescribe a different remedy for each miasmic layer over time, but gives only one remedy at a time directed at the person's current state. The basic principle governing the prescription of each successive remedy is the law of similars, or "like cures like."

Hering's laws of cure

The homeopathic laws of cure were outlined by Constantine Hering, a student of Hahnemann who came to the United States in the 1830s. Hering enunciated three laws or principles of the patterns of healing that are used by homeopaths to evaluate the effectiveness of specific remedies and the overall progress of constitutional prescribing:

- Healing progresses from the deepest parts of the organism to the external parts. Homeopaths consider the person's mental and emotional dimensions, together with the brain, heart, and other vital organs, as a person's deepest parts. The skin, hands, and feet are considered the external parts.
- Symptoms appear or disappear in the reverse of their chronological order of appearance. In terms of

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constitutional treatment, this law means that miasms acquired later in life will resolve before earlier ones.

- Healing proceeds from the upper to the lower parts of the body.

Healing crises

Homeopaths use Hering's laws to explain the appearance of so-called healing crises, or aggravations, in the course of homeopathic treatment. It is not unusual for patients to experience temporary worsening of certain symptoms after taking their first doses of homeopathic treatment. For example, a person might notice that arthritic pains in the shoulders are better but that the hands feel worse. Hering's third law would indicate that the remedy is working because the symptoms are moving downward in the body. In constitutional prescribing, a remedy that removes one of the patient's miasmic layers will then allow the symptoms of an older miasm to emerge. Thus the patient may find that a physical disease is followed by a different set of physical problems or by emotional symptoms.

Preparations

The most important aspects of preparation for constitutional prescribing are the taking of a complete patient history and careful patient education.

Case-taking

Homeopathic case-taking for constitutional prescribing is similar to that for acute prescribing, but more in-depth. The initial interview generally takes one to two hours. The practitioner is concerned with recording the totality of the patient's symptoms and the modalities that influence their severity. Also included are general characteristics about the patient and his or her lifestyle choices. For example, a practitioner might ask the patient if he or she likes being outside or is generally hot or cold. There is also an emphasis on the patient's lifetime medical history, particularly records of allopathic treatments.

Patient education

Homeopaths regard patients as equal partners in the process of recovery. They will take the time to explain the theories underlying constitutional prescribing to the patient as well as taking the history. Patient education is especially important in constitutional prescribing in order to emphasize the need for patience with the slowness of results and length of treatment, and to minimize the possibility of self-treatment with allopathic drugs if the patient has a healing crisis.

Homeopathic remedies

In constitutional prescribing, one dose of the selected remedy is given. Patients then wait two to six weeks before following up with the homeopath, while the body begins the healing process. At the follow-up visit, the remedy may be repeated, or a different remedy prescribed. The preparation, selection, administration, and storage of remedies for constitutional prescribing are the same as for acute prescribing. These procedures are described more fully in the article on acute prescribing.

Precautions

Constitutional homeopathic prescribing is not appropriate for diseases or health crises requiring emergency treatment, whether medical, surgical, or psychiatric. In addition, constitutional prescribing should not be self-administered. Although home treatment kits of homeopathic remedies are available for acute self-limited disorders, the knowledge of homeopathic theory and practice required for constitutional evaluation is beyond the scope of most patients. Patients who are also seeing an allopathic doctor should make sure the physician is aware of the homeopathic treatment.

Patients are instructed to avoid touching homeopathic medicines with their fingers. The dose can be poured onto a piece of white paper or the bottle's cap and tipped directly into the mouth. Homeopathic remedies are not taken with water; patients should not eat or drink anything for 15–20 minutes before or after taking the dose.

Homeopathic remedies may lose their potency if used at the same time as other products. Some homeopathic practitioners recommend the avoidance of mint and mentholated products (toothpastes, candies, chewing gum, mouth rinses), as well as camphor and camphorated products (including eucalyptus and Tiger Balm), patchouli and other essential oils, moth balls, strong perfumes, aftershaves, scented soaps, stress, x rays, coffee, nicotine, recreational drugs (**marijuana**), and certain therapeutic drugs (most notably cortisone and prednisone) during treatment. Patients are also advised to avoid electric blankets and dental work, as these are thought to adversely affect homeopathic therapy. Homeopathic remedies should never be placed near magnets.

Side effects

Homeopathic medicines are so diluted that sometimes no trace of the original substance can be detected. These medicines are therefore considered by homeopathic practitioners as non-toxic and generally free of harmful side effects. The primary risks to the patient

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from constitutional homeopathic treatment are the symptoms of the healing crisis and individual reactions to **homeopathic medicine**. The complexity of constitutional prescribing requires homeopaths to have detailed knowledge of the *materia medica* and the repertories, and to take careful and extensive case notes.

An intensified healing response may occur as treatment begins, which causes symptoms to worsen, but the phenomenon is temporary. In some patients, old symptoms may re-appear from past conditions from which recovery was not complete. Such phenomena are taken as positive indications that the healing process has commenced.

Research and general acceptance

As Samuel Hahnemann's healing system grew in popularity during the 1800s, it quickly attracted vehement opposition from the medical and apothecary professions. Since the early 1900s, when the American Medical Association and pharmacists waged a battle against it, homeopathy has been neglected and sometimes ridiculed by mainstream medicine. Much of this is because there are few controlled scientific studies of homeopathy that would meet criteria of the U.S. Food and Drug Administration, or would be accepted for publication in the major reputable medical journals in the United States. Aside from politics, part of the reason for this is that there are some aspects of homeopathy which have not been completely explained scientifically. For instance, homeopaths have found that the more they dilute and succuss a remedy, the greater effect it seems to have on the body. Some homeopathic remedies are so diluted that not even a single molecule of the active agent remains in a solution, yet homeopaths maintain it still works; some studies have demonstrated this paradox, yet cannot explain it. Also, homeopathy puts an emphasis on analyzing symptoms and then applying remedies to these symptoms, rather than working by classifying diseases. Thus, some people with the same disease may require different homeopathic medicines and treatments. Furthermore, conventional medicine strives to find out how medicines work in the body before they use them; homeopathy is less concerned with the intricate biochemistry involved than with whether a remedy ultimately works and heals holistically. For all these reasons, conventional medicine claims that homeopathy is not scientific, but homeopaths reply that homeopathy has been developed and studied for centuries, with much documentation and success.

There continue to be many studies that affirm the effectiveness of homeopathic treatments. Among the most celebrated, the *British Medical Journal* in 1991 published a large analysis of homeopathic treatments that were given over the course of 25 years. This project involved over 100 studies of patients with problems ranging from vascular diseases, respiratory problems, infections, stomach problems, allergies, recovery from surgeries, arthritis, trauma, psychological problems, diabetes, and others. The study found improvement with homeopathic treatment in most categories of problems, and concluded that the evidence was "sufficient for establishing homeopathy as a regular treatment for certain indications."

In the United Kingdom and other countries where homeopathy is especially popular, some medical doctors incorporate aspects of acute prescribing homeopathy into their practices. Countries in which homeopathy is popular include France, India, Pakistan, Sri Lanka, Brazil, and Argentina. Large homeopathic hospitals exist in London and Glasgow, and homeopathic medical centers can be found in India and South America.

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American Institute of Homeopathy, 101 South Whiting Street, Suite 16, Alexandria, VA, 22304, (888) 445-9988, admin@homeopathyusa.org, http://www.homeopathyusa.org.

Australian Homeopathic Association, PO Box7108, Toowoomba, Australia, (07) 4646 4380, (07) 4646 4393, admin@homeopathyoz.org, http://www.homeopathyoz.org.

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Council for Homeopathic Certification, PMB 187, 16915 SE 272nd St., Suite 100, Covington, WA, 98042, (815) 366-7622, (866) 242-3399, http://www.homeopathicdirectory.com.

Homeopathic Medical Council of Canada, 31 Adelaide Street East, Box 605, Toronto, Ontario, M5C 2J8, Canada, (416) 788-4622, Ontario@HMCC.ca, http://www.hmcc.ca.

Ken R. Wells

Homocysteine

Definition

Homocysteine is a naturally occurring amino acid found in blood plasma. High levels of homocysteine in the blood are believed to increase the chance of heart disease, **stroke**, **Alzheimer's disease**, and **osteoporosis**.

Description

Homocysteine is a sulfur-containing amino acid that occurs naturally in all humans. It is broken down in the body through two metabolic pathways. The chemical changes that must occur to break down homocysteine require the presence of **folic acid** (also called folate) and **vitamins** B^6 and B^{12}. The level of homocysteine in the blood is influenced by the presence of these substances.

Homocystinuria is a rare genetic disorder that occurs in about one in every 200,000 individuals. This congenital metabolic disorder causes large amounts of homocysteine to be excreted in the urine. Homocystinuria is associated **mental retardation** and the development of heart disease before age 30.

In the late 1960s, doctors documented that individuals with homocystinuria developed narrowing of the arteries at a very early age, sometimes even in childhood. Although homocystinuria is rare, this finding stimulated research on whether people who did not have homocystinuria but who did have unusually high levels of homocysteine in their blood were at greater risk of developing heart disease or stroke.

Many risk factors, including family history of heart disease, **smoking**, **obesity**, lack of **exercise**, diabetes, high levels of low-density lipoprotein cholesterol (LDL or "bad" cholesterol), low levels of high-density lipoprotein cholesterol (HDL or "good" cholesterol), and high blood pressure have been documented to increase the risk of stroke and heart disease. With so many other risk factors, it has been difficult to determine whether high levels of homocysteine are an independent risk factor for the development these diseases. However, a substantial number of controlled, well-designed, and well-documented studies have shown that individuals who have high levels of homocysteine in the blood are at increased risk of developing blocked blood vessels, a condition known as occlusive arterial disease or at risk to worsen **atherosclerosis** ("hardening of the arteries").

In the 2000s, studies also suggested that high levels of homocysteine were associated with poorer mental functioning, leading to ongoing investigations into the role of homocysteine in Alzheimer's disease. Additional studies have also suggested that high levels of homocysteine can lead to osteoporosis and an increased risk of broken bones in the elderly. Homocysteine was being tested in half a dozen clinical trials to determine its role in these and several other conditions. Information on clinical trials that are enrolling patients can be found online at www.clinicaltrials.gov.

Causes and symptoms

Homocysteine is thought to irritate the lining of the blood vessels, causing them to become scarred, hardened, and narrowed. This increases the work the heart must do, leading to heart disease. High levels of homocysteine also cause increased blood clotting. **Blood clots** can decrease or block the flow of blood through blood vessels, resulting in strokes and heart attacks. If and how homocysteine directly plays a role in osteoporosis and Alzheimer's disease is not clear.

The level of homocysteine in the blood naturally varies with age, gender, diet, hereditary factors, and general health, but it is estimated that 5–10% of the population has homocysteine levels that are considered high. With the exception of rare individuals who have congenital homocystinuria, people with high blood levels of homocysteine do not have any obvious signs or symptoms.

Diagnosis

The American Heart Association and the American College of Cardiology do not recommend routine screening of homocysteine levels, but they do recommend screening as part of a cardiac risk assessment for individuals who have a family history of **coronary artery disease** but no obvious symptoms of heart disease. The level of homocysteine in the blood can be measured with a simple blood test that is often, but not always, done after **fasting**. Homocysteine levels of 12 mmol/L are considered normal and levels below 10 mmol/L are considered desirable.

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Treatment

Lowering homocysteine blood levels is linked to increasing the intake of folic acid and vitamins B_6 and B_{12}. The healthiest way to increase intake is by eating more foods that are high in these substances. Good sources of folic acid, vitamin B_6, and vitamin B_{12} include green leafy vegetables, fortified breakfast cereals, lentils, chickpeas, asparagus, spinach, and most beans. Taking a daily multivitamin is also a way to increase the levels of these substances. However, megadoses of folic acid, vitamin B_6, and vitamin B_{12} are not recommended. Individuals should discuss dosage with their doctor before beginning any supplements. It is important to note that a direct link between increased intake of folic acid, vitamin B_6, and vitamin B_{12} and decreased incidence stroke and **heart attack** has not been proven. However, one study published in the *Journal of the American Medical Association* found that women whose folic acid levels were in the lowest 25% were 69% more likely to die of coronary problems than women whose folic acid levels were in the top 25%.

Individuals with homocystinuria are treated with the drug betaine (Cystadane). This is a powder dissolved in water, juice, or milk and drunk usually twice a day with meals. This drug is not normally used simply to lower high levels of homocysteine in the absence of congenital disease.

Prognosis

Individuals who increase the folic acid, vitamin B_6, and vitamin B_{12} in their diet are expected to see a decrease in blood levels of homocysteine and as a result decrease their risk of heart disease and stroke.

Prevention

Certain drugs are suspected of increasing the level of homocysteine in the blood. People using these drugs should discuss with their doctor the advisability of increasing their intake of folic acid, vitamin B_6, and vitamin B_{12}. These drugs include:

- lipid-lowering drugs such as fenofibrate (Tricor) and bezafibrate (Bezalip)
- metformin (Glucophage), a drug to modify insulin resistance
- anti-epileptic drugs such as phenobarbital, phenytoin (Dilantin), primidone (Mysoline) and carbamazepine (Tegretol)
- levadopa (Sinemet) for treatment of Parkinson's disease
- methotrexate (Rheumatrex, Trexall) for treatment of cancer, psoriasis, rheumatoid arthritis, and systemic lupus erythematosus
- androgen treatment
- nitrous oxide ("laughing gas"), a mild anesthetic

Resources

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American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org, http://www.heart.org.

Tish Davidson, A.M.

Hong Kong flu *see* **Influenza**

Hookworm disease

Definition

Hookworm disease is an illness caused by one of two types of S-shaped worms that infect the intestine of humans (the worm's host).

Description

Two types of hookworm are responsible for hookworm disease in humans. *Necator americanus* and *Ancylostoma duodenale* have similar life cycles and similar methods of causing illness. The adult worm of both *Necator americanus* and *Ancylostoma duodenale* is about 10 mm long, pinkish-white in color and curved into an S-shape or double hook.

Both types of hookworm have similar life cycles. The females produce about 10,000–20,000 eggs per day. These eggs are passed out of the host's body in feces. The eggs enter the soil, where they incubate. After about 48 hours, the immature larval form hatches out of the eggs. These larvae take about six weeks to develop into the mature larval form that is capable of causing human infection. If exposed to human skin at this point (usually bare feet walking in the dirt or bare hands digging in the dirt), the larvae will bore through the skin and ride through the lymph circulation to the right side of the heart. The larvae are then pumped into the lungs. There

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A micrograph image of the head of the hookworm *Ancylostoma spp.* *(Photo Researchers, Inc.)*

they bore into the tiny air sacs (alveoli) of the lungs. Their presence within the lungs usually causes enough irritation to produce coughing. The larvae are coughed up into the throat and mouth, and are then swallowed and passed into the small intestine. It is within the intestine that they develop into the adult worm, producing illness in their human host.

Ancylostoma duodenale is found primarily in the Mediterranean, the Middle East, and throughout Asia. *Necator americanus* is common in tropical areas including Asia, parts of the Americas, and throughout Africa. Research suggests that at least 25% of all people in the world have hookworm disease. In the United States, 700,000 people are believed to be infected with hookworms at any given time.

Causes and symptoms

Hookworms cause trouble for their human host when the worms attach their mouths to the lining of the small intestine and suck the person's blood.

An itchy, slightly raised rash called "ground itch" may appear around the area where the larvae first bored through the skin. The skin in this area may become red and swollen. This lasts for several days and commonly occurs between the toes.

When the larvae are in the lungs, the patient may have a **fever**, **cough**, and some **wheezing**. Some people, however, have none of these symptoms.

Once established within the intestine, the adult worms can cause abdominal **pain**, decreased appetite, **diarrhea**, and weight loss. Most importantly, the worms suck between 0.03–0.2 mL of blood per day. When a worm moves from one area of the intestine to another, it detaches its mouth from the intestinal lining, leaving an irritated area that may continue to bleed for some time. This results in even further blood loss. A single adult worm can live for up to 14 years in a patient's intestine. Over time, the patient's blood loss may be very significant. Anemia is the most serious complication of hookworm disease, progressing over months or years. Children are particularly harmed by such anemia, and can suffer from heart problems, **mental retardation**, slowed growth, and delayed sexual development. In infants, hookworm disease can be deadly.

Diagnosis

Diagnosis of hookworm disease involves collecting a stool sample for examination under a microscope. Hookworm eggs have a characteristic appearance. Counting the eggs in a specific amount of feces allows the healthcare provider to estimate the severity of the infection.

Treatment

Minor infections are often left untreated, especially in areas where hookworm is very common. If treatment is required, the doctor will prescribe a three-day dose of medication. One to two weeks later, another stool sample will be taken to see if the infection is still present.

Anemia is treated with iron supplements. In severe cases, blood **transfusion** may be necessary. Two medications, pyrantel pamoate and mebendazole, are frequently used with good results.

Prognosis

The prognosis for patients with hookworm disease is generally good. However, reinfection rates are extremely high in countries with poor sanitation.

Prevention

Prevention of hookworm disease involves improving sanitation and avoiding contact with soil in areas with high rates of hookworm infection. Children should be required to wear shoes when playing outside in such areas, and people who are gardening should wear gloves.

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ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

Rosalyn Carson-DeWitt, MD

Hormone replacement therapy

Definition

Hormone replacement therapy (HRT)—now more commonly called menopausal hormone therapy (MRT)—is the use of synthetic or natural females hormones to compensate for the decline in the body's hormone production that occurs when a woman enters **menopause**.

Purpose

HRT is used relieve physical symptoms associated with menopause—the stage of midlife development when a woman's menstrual periods become irregular and eventually cease. Women usually begin the earliest stages of menopause—known as perimenopause—in their mid-30s. Over time the ovaries decrease their production of the sex hormones estrogen and progesterone. Women undergo natural menopause when they have their last menstrual period. Menopause is considered to be complete one year after the last menstruation. This most often occurs between the ages of 45 and 55. Women who have their ovaries removed undergo immediate surgical menopause.

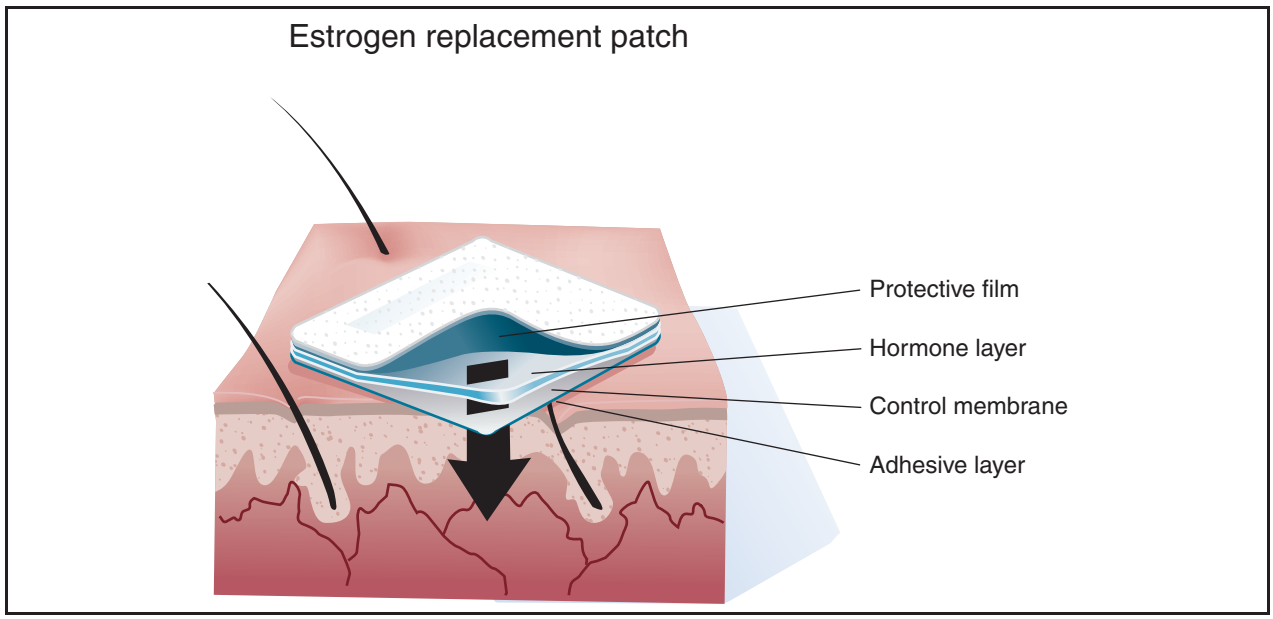
In the years before and during menopause the levels of estrogen and progesterone fluctuate irregularly. Following menopause, estrogen levels are about one-tenth of premenopausal levels and progesterone is almost completely absent. Menopausal symptoms resulting from low estrogen that may be treated with HRT include:

- hot flashes
- vaginal dryness
- night sweats
- sleep disturbances
- mood swings
- frequent urination
- loss of sexual interest

HRT is also used to help prevent osteoporosis—a decrease in bone mass and density that causes the bones to become more fragile and can lead to **fractures**.

Demographics

At the turn of the twenty-first century, about 6 million American women were taking estrogen and



Estrogen replacement patches adhere to a patient's skin and slowly administer estrogen to the body. *(Illustration by Argosy, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

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progestin (a synthetic progesterone) as HRT. Although many women used HRT for only a couple of years to treat menopausal symptoms, some women used HRT indefinitely. Then, in 2002 and 2004, early results from the **Women's Health** Initiative (WHI) Hormone Program—a very large clinical study of HRT by the U.S. National Institutes of Health—indicated that postmenopausal women on HRT were at increased risk for **heart attack**, **stroke**, **blood clots**, and **breast cancer**. Since then millions of women have stopped taking the hormones. Recent decreases in the incidence of breast **cancer** in the United States have been attributed, in part, to this reduction in HRT.

Description

Estrogen relieves menopausal symptoms and may help prevent **osteoporosis**. Women who have had their uterus removed can use estrogen alone for HRT. Otherwise women must take progesterone or progestin along with the estrogen to reduce the risk of thickening of the lining of the uterus and uterine cancer.

Estrogen for HRT is available in many forms including:

- oral pills
- transdermal skin patches
- implants
- injections
- vaginal ring inserts
- vaginal tablets
- vaginal creams
- gels
- emulsions
- sprays

Estrogen patches and pills can relieve hot flashes, night sweats, and vaginal dryness. Vaginal rings, tablets, and creams are used to treat vaginal dryness, although vaginal ring inserts may help relieve some urinary tract symptoms.

There are different types of estrogens. Estradiol is the most important type in premenopausal women. If synthetic estradiol is injected or applied to the skin—rather than taken by mouth—it appears to work in the same way as estradiol made in the body. Estrone is the form of estrogen that is produced by the body in postmenopausal women. Conjugated estrogen is a mixture of estrone and other estrogens. Estriol is a weaker form of estrogen produced by the breakdown of other estrogens in the body and is the type most commonly used in Europe for HRT. Estrogen taken as a pill is chemically changed in the liver. Some studies have suggested that estrogen that enters through the skin, bypassing the liver, may present less risk for serious blood clots, stroke, and possibly gallbladder disease. Non-oral forms of estrogen also may relieve symptoms at a lower dosage than oral estrogen.

Progesterone or progestin is available in various forms including:

- pills
- combined with estrogen in pills
- combined with estrogen in skin patches
- injections
- as an intrauterine device (IUD)
- gels
- vaginal suppositories

HRT doses and timing of the doses vary. Sometimes estrogen and progesterone are taken daily. Sometimes estrogen is taken daily, whereas progesterone or progestin is taken for 10–14 days every four weeks to mimic premenopausal hormone production. This approach can cause some spotting or bleeding. Various other dosing regimes are also used.

Common types of HRT include:

- generic estradiol pills
- Gynodiol (estradiol pill)
- Menest (esterified estrogen pill)
- generic estropipate pills
- generic estradiol skin patches
- Estraderm (estradiol skin patch)
- FemRing (estradiol vaginal ring)
- Estring (estradiol vaginal ring)
- Premarin vaginal cream (conjugated equine estrogen)
- generic medroxyprogesterone pills
- Prempro (estrogen-progestin combination pill)
- Prefest (estrogen-progestin combination pill)
- Climara Pro (estrogen-progestin skin patch)
- Combipatch (estrogen-progestin skin patch)

Some women prefer natural progesterone because they find that it lacks the side effects of synthetic progestin. Natural progesterone is also available as an over-the-counter vitamin E oil suspension that is absorbed through the skin.

"Natural" or bio-identical estrogens and progesterones are made from plants such as soy or yams. Some of these hormones are chemically identical to those made by the female body. Sometimes these hormones are formulated by a physician according to the requirements of individual women and are

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put together or compounded by a compounding pharmacist.

Women's ovaries secrete small amounts of the male sex hormone testosterone throughout their lives. Women who have had both ovaries surgically removed are sometimes given testosterone along with estrogen for HRT. Women also sometimes use 1% testosterone cream to relieve vaginal soreness.

Origins

Physicians began prescribing estrogen to menopausal women during the 1960s, when it was referred to as estrogen replacement therapy (ERT). The use of HRT grew rapidly, in part because—until the results of the WHI—it was widely believed that HRT reduced the risk of heart disease, stroke, and cancer in postmenopausal women.

Benefits

HRT can significantly improve quality of life for some women. The WHI and other studies have found that 70–90% of menopausal women who take estrogen have an average reduction of 75% in the frequency of hot flashes and night sweats. Estrogen supplementation also reduces vaginal dryness and urinary symptoms associated with menopause. Estrogen appears to improve cholesterol levels, lowering LDL ("bad" cholesterol) and raising HDL ("good" cholesterol), although estrogen in pill form can cause increased triglycerides—fats in the blood. The estrogen patch does not seem to have this effect, but it also does not improve cholesterol levels to the same degree as the pill.

The WHI found that both estrogen-alone and estrogen-plus-progestin HRT lowered the risk of bone fractures. Estrogen-plus-progestin HRT also lowered the risk of colorectal cancer.

Precautions

Women aged 50–59 who have become menopausal within the past five years and are at low risk for heart disease can use HRT without increasing their risk for heart disease. However they will have an increased risk of breast cancer, blood clots, and stroke:

- Women should take the lowest dose of HRT that relieves symptoms and for the shortest possible time.
- HRT should be re-evaluated every six months.
- Women should not use HRT if their symptoms are mild and can be managed with lifestyle and habit changes, such as quitting smoking, sleeping in a cooler room, reducing stress, exercising regularly, and limiting caffeine and alcohol.
- Women should not use HRT after the first five to 10 years post-menopause.
- HRT is ineffective for—and can even worsen—conditions such as mood swings, irritability, depression, anxiety, cognitive difficulties, reduced libido, urinary incontinence, back or joint pain, chronic pain, stiffness, or fatigue.
- Bio-identical hormones compounded in pharmacies are not regulated by the U.S. Food and Drug Administration (FDA) and have not been shown to be more effective or safer than other HRTs.

Common side effects of HRT include:

- fluid retention
- bloating
- weight gain
- breast tenderness or soreness
- spotting or a return of monthly periods
- cramping
- leg cramps
- vaginal discharge
- severe headaches
- hair loss
- nausea and vomiting
- acne
- moodiness
- depression
- shortness of breath
- dizziness

Potentially serious side effects of HRT include:

- tissues growth in the uterus (fibroids)
- abnormal growth (hyperplasia) of uterine tissue
- gallstones
- thrombophlebitis
- hypoglycemia
- thyroid disorders
- high blood pressure

HRT can interact with other medications, including:

- corticosteroids
- anticoagulants
- rifampin

Drugs that can cause liver damage when combined with estrogens include:

- acetaminophen (Tylenol), when used in high doses over long periods
- anabolic steroids such as nandrolone (Anabolin) or oxymetholone (Anadrol)
- medicine for infections

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KEY TERMS

Estrodiol—The most physiologically active form of estrogen.

Estrogen—Any of several naturally occurring or synthetic steroid hormones that promote the growth and maintenance of the female reproductive system.

Menopause—The female developmental stage at which menstruation ceases.

Osteoporosis—A disease characterized by low bone mass and structural deterioration of bone tissue, leading to bone fragility.

Progesterone—A female steroid sex hormone that is secreted after ovulation to prepare the lining of the uterus for implantation with a fertilized egg and secreted by the placenta to maintain pregnancy.

Progestin—Any natural or synthetic hormone that causes the effects of progesterone.

Testosterone—The primary male sex hormone.

Women's Health Initiative (WHI)—A very large clinical study supported by the National Heart, Lung, and Blood Institute and the National Cancer Institute of the U.S. National Institutes of Health that is examining a wide range of women's health issues including HRT.

- antiseizure medicines such as divalproex (Depakote), valproic acid (Depakene), or phenytoin (Dilantin)
- antianxiety drugs, including chlorpromazine (Thorazine), prochlorperazine (Compazine), and thioridazine (Mellaril)

Estrogens can interfere with the effects of bromocriptine (Parlodel) used to treat Parkinson's disease and other conditions. Estrogens can increase the chance of toxic side effects from cyclosporine (Sandimmune).

Other conditions and allergies

HRT should not be used by women with:

- heart disease
- diabetes, high cholesterol, high blood pressure, family history of heart disease, or other risk factors for heart disease
- breast cancer
- cancer of the ovaries or uterus
- history of stroke
- abnormal undiagnosed vaginal bleeding
- liver disease
- gallstones or gallbladder disease

Preparation

Women who are considering HRT should carefully discuss the benefits and risks with their doctor. They should have a variety of tests including:

- a Pap smear
- breast examination and mammogram
- urinalysis
- bone density
- red blood cell count
- blood sugar levels
- cholesterol levels
- liver and thyroid function

Before prescribing HRT many doctors administer a progesterone challenge test to determine whether a woman is still producing estrogen. Bleeding after taking progesterone for 10 days indicates that a woman's ovaries are still making estrogen.

Aftercare

Women on HRT should have their blood pressure tested and breasts examined at least twice a year. They should have a complete physical on a yearly basis. Any abnormal bleeding may require a tissue biopsy or dilatation and curettage to rule out uterine cancer.

The HRT dosage should be tapered off over a period of several months rather than discontinued abruptly. The gradual reduction minimizes the possibility of hot flashes and other side effects.

Risks

The WHI Estrogen-plus-Progestin Study was halted prematurely in July of 2002, when early results showed that the overall risks of Prempro outweighed the benefits, increasing the risk of breast cancer, heart disease, heart attack, stroke, serious blood clots in the legs and lungs, and **urinary incontinence**. Furthermore, the WHI Memory Study found that, in postmenopausal women aged 65 and older, estrogen-plus-progestin HRT doubled the risk for developing all types of **dementia**, including **Alzheimer's disease**.

The WHI Estrogen-Alone Study was halted prematurely in 2004, when researchers found an increased

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risk of stroke, blood clots, and urinary incontinence. It was also found that estrogen alone did not reduce the risk of heart disease.

It is unclear whether the results of the WHI Hormone Therapy Study apply to all forms of HRT. The study used only oral HRT, rather than patches or other forms of delivery, and only specific forms of estrogen and progestin at specific doses. Furthermore, the increased risk for heart disease and dementia applied only to women over age 60.

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American College of Obstetricians and Gynecologists, PO Box 96920, Washington, DC, 20090-6920, (202) 638-5577, (800) 673-8444, resources@acog.org, http://www.acog.org.

National Cancer Institute, NCI Public Inquiries Office, 6116 Executive Boulevard, Room 3036A, Bethesda, MD, 20006, (800) 4-CANCER, http://www.cancer.gov.

National Heart, Lung and Blood Institute, NHLBI Health Information Center, PO Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi.nih.gov.

National Institute on Aging, Information Center, P.O. Box 8057, Gaithersburg, MD, 20898-8057, (301) 496-1752, (301) 496-1072, http://www.nia.nih.gov.

North American Menopause Society, 5900 Landerbrook Drive, Suite 390, Mayfield Heights, OH, 44124, (440) 442-7550, (800) 774-5342, (440) 442-2660, info@menopause.org, http://www.menopause.org/.

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Hospital–acquired infections

Definition

A hospital–acquired infection, also called a nosocomial infection, is one that is unrelated to the patient's original condition and first appears after the patient is admitted to a hospital, nursing home, or other health care facility. Hospital–acquired infections can be bacterial, viral, or fungal.

Description

In the United States, the National Nosocomial Infections Surveillance (NNIS) System of the Centers for Disease Control and Prevention (CDC) tracks hospital–acquired infections. The CDC has estimated that about 10% of patients admitted to hospitals develop a nosocomial infection. In 2006, this amounted to close to 1.7 million patients and accounted for about 90,000 deaths.

Bacteria, viruses, fungi, or parasites can cause hospital–acquired infections. These microorganisms may already be present in the patient's body or may come from the environment, contaminated hospital equipment, health care workers, or other patients. Depending on the

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causal agents involved, an infection may start in any part of the body. A localized infection is limited to a specific part of the body and has local symptoms. For example, if a surgical wound in the abdomen becomes infected, the area of the wound becomes red, hot, and painful. A generalized infection is one that enters the bloodstream and causes general systemic symptoms such as **fever**, chills, low blood pressure, or mental confusion.

Hospital–acquired infections may develop from surgical procedures, catheters placed in the urinary tract or blood vessels, or from material from the nose or mouth that is inhaled into the lungs. The most common types of hospital–acquired infections are urinary tract infections (UTIs), pneumonia, and surgical wound infections.

Causes and symptoms

All hospitalized patients are susceptible to contracting a nosocomial infection. Some patients are at greater risk than others. Newborns, the elderly, and persons with compromised immune systems are more likely to get an infection. Other risk factors for getting a hospital–acquired infection are a long hospital stay, the use of indwelling catheters, failure of health care workers to wash their hands, and overuse of **antibiotics**.

Any type of invasive procedure can expose a patient to the possibility of infection. Common causes of hospital–acquired infections include:

- urinary bladder catheterization
- respiratory procedures
- surgery and wounds
- intravenous (IV) procedures

Urinary tract infection (UTI) is the most common type of hospital–acquired infection accounting for 32% of reported cases. Most hospital–acquired UTIs happen after urinary catheterization. Catheterization is the placement of a catheter through the urethra into the urinary bladder. This procedure is done to empty urine from the bladder, relieve pressure in the bladder, measure urine in the bladder, put medicine into the bladder, or for other medical reasons.

The healthy urinary bladder is sterile, which means it does not have any harmful bacteria or other microorganisms in it. There may be bacteria in or around the urethra but they normally cannot enter the bladder. A catheter can pick up bacteria from the urethra and allow them into the bladder, causing an infection to start.

Bacteria from the intestinal tract are the most common type to cause UTIs. Patients with poorly functioning immune systems, such as those with **AIDS** or who are taking antibiotics, are also at risk for infection by a fungus called *Candida*.

Pneumonia accounts for about 15% of hospital–acquired infections. Bacteria and other microorganisms are easily brought into the throat by respiratory procedures commonly done in the hospital. The microorganisms come from contaminated equipment or the hands of health care workers. Some of these procedures are respiratory intubation, suctioning of material from the throat and mouth, and mechanical ventilation. The introduced microorganisms quickly colonize the throat area. This means that they grow and form a colony, but do not yet cause an infection. Once the throat is colonized, it is easy for a patient to inhale the microorganisms into the lungs.

Patients who cannot **cough** or gag very well are most likely to inhale colonized microorganisms into their lungs. Some respiratory procedures can keep patients from gagging or coughing. Patients who are sedated or who lose consciousness may also be unable to cough or gag. The inhaled microorganisms grow in the lungs and cause an infection that can lead to pneumonia.

Surgical procedures increase a patient's risk of getting an infection in the hospital and account for about 22% of nosocomial infections. Surgery directly invades the patient's body, giving bacteria a way into normally sterile parts of the body. An infection can be acquired from contaminated surgical equipment or from health care workers. Following surgery, the surgical wound can become infected. Other **wounds** from trauma, **burns**, and ulcers may also become infected.

Many hospitalized patients need a steady supply of medications or nutrients delivered to their bloodstream. An intravenous (IV) catheter is placed in a vein and the medication or other substance is infused into the vein. Bacteria transmitted from the surroundings, contaminated equipment, or health care workers' hands can invade the site where the catheter is inserted. A local infection may develop in the skin around the catheter. Bacteria also can enter the blood through the vein and cause a generalized infection. Infections of the bloodstream account for about 14% of hospital–acquired infections. The longer a catheter is in place, the greater the risk of infection.

Other hospital procedures that put patients at risk for nosocomial infection are gastrointestinal procedures, obstetric procedures, and kidney dialysis.

In the 2000s, hospitals have had increasingly to contend with the development of antibiotic–resistant strains of bacteria. In fact, some organisms may be resistant to *multiple* antimicrobial agents (MDROs). Years of overprescribing and misuse of antibiotics and

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KEY TERMS

Abscess—Localized collection of pus in any part of the body that is surrounded by swelling.

Antibiotic—A drug used to treat infections caused by bacteria and other microorganisms.

Antibiotic–resistant—Microorganisms that continue to multiply although exposed to antibiotics.

Antimicrobial agent—A substance that kills microorganisms such as bacteria or mold, or stops them from growing and causing disease.

Bacterium—A single–celled microorganism that can be seen only through a microscope. Many bacteria cause disease.

Immune system—The integrated body system of organs, tissues, cells, and cell products such as antibodies that protects the body from foreign organisms or substances.

Multidrug–resistant organisms (MDROs)—Bacteria that are resistant to one or more classes of antimicrobial agents and usually are resistant to all but one or two commercially available antimicrobial agents.

Pus—A generally viscous, yellowish–white fluid formed in infected tissue, consisting of white blood cells, cellular debris, and dead tissue.

the increased use of antibiotics in the production of meat and milk have resulted in the emergence of strains of bacteria that are resistant to many antibiotics. A bacterium is considered resistant when it can no longer be treated effectively using antibiotics that are commonly prescribed for that type of infection.

Methicillin–resistant *S. aureus*. is a strain of staph bacteria that is resistant to the antibiotic methicillin and other common antibiotics that normally control staph infections. Although this strain of staph has existed in hospitals for years, in the 1990s, MRSA began appearing in places other than hospitals. By 2007, two forms of MRSA were recognized, hospital–acquired MRSA (HA–MRSA) and community–acquired MRSA (CA–MRSA). Symptoms of a MRSA infection are similar to other staph infection symptoms, only MRSA is much more dangerous and has a much higher mortality rate because treatment with common antibiotics does not kill the bacterium.

Risk factors for acquiring HA–MRSA include hospitalization, especially in patients who need intravenous lines, feeding tubes, and catheters, residence in a nursing home, and recent treatment with certain antibiotics including the fluoroquinolone antibiotics ciprofloxacin (Cipro), ofloxacin (Floxin, Tarivid), levofloxacin (Levaquin, Elequine), and cephalosporin (Keflex). The Association of Professionals in **Infection Control** and Epidemiology estimates that in 2007 1.2 million hospital patients were infected with MRSA and about 423,000 were healthy carriers (i.e., they showed no symptoms) of the bacteria.

Fever is often the first sign of infection. Other symptoms and signs of infection are rapid breathing, mental confusion, low blood pressure, reduced urine output, and a high **white blood cell count**.

Patients with a UTI may have **pain** when urinating and blood in the urine. Symptoms of pneumonia may include difficulty breathing and coughing. A localized infection causes swelling, redness, and tenderness at the site of infection.

Diagnosis

An infection is suspected any time a hospitalized patient develops a fever that cannot be explained by a known illness. Some patients, especially the elderly, may not develop a fever. In these patients, the first signs of infection may be rapid breathing or mental confusion.

Diagnosis of a hospital–acquired infection is based on:

- symptoms and signs of infection
- examination of wounds and catheter entry sites
- review of procedures that might have led to infection
- laboratory test results

A complete **physical examination** is conducted in order to locate symptoms and signs of infection. Wounds and the skin where catheters have been placed are examined for redness, swelling, or the presence of pus or an **abscess**. The physician reviews the patient's record of procedures performed in the hospital to determine if any posed a risk for infection.

Laboratory tests are done to look for signs of infection. A complete blood count can reveal if the white blood cell count is high. White blood cells are immune system cells that increase in numbers in response to an infection. White blood cells or blood may be present in the urine when there is a UTI.

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Cultures of blood, urine, sputum, other body fluids, or tissue are done to look for infectious microorganisms. If an infection is present, it is necessary to identify the microorganism so the patient can be treated with the correct medication. A sample of the fluid or tissue is placed in a special medium that bacteria grow in. Other tests can also be done on blood and body fluids to look for and identify bacteria, fungi, viruses, or other microorganisms responsible for an infection.

If a patient has symptoms suggestive of pneumonia, a **chest x ray** is done to look for infiltrates of white blood cells and other inflammatory substances in the lung tissue. Samples of sputum can be studied with a microscope or cultured to look for bacteria or fungi.

Treatment

Once the source of infection is identified, the patient is treated with antibiotics or other medication that kills the responsible microorganism. Many different antibiotics are available that are effective against different bacteria. Some common antibiotics are penicillin, **cephalosporins**, tetracyclines, and erythromycin. More and more commonly, some types of bacteria are becoming resistant to the standard antibiotic treatments. When this happens, a different, more powerful antibiotic must be used. Two strong antibiotics that have been effective against resistant bacteria are vancomycin and imipenem, although some bacteria are developing resistance to these antibiotics as well.

Fungal infections are treated with antifungal medications. Examples of these medications are amphotericin B, nystatin, ketoconazole, itraconazole, and fluconazole.

A number of **antiviral drugs** have been developed that slow the growth or reproduction of viruses. Acyclovir, ganciclovir, foscarnet, and amantadine are examples of antiviral medications.

Prognosis

Hospital–acquired infections are serious illnesses that cause death in about 1% of cases. Rapid diagnosis and identification of the responsible microorganism is necessary, so treatment can be started as soon as possible.

Prevention

Hospitals and other health care facilities have developed extensive infection control programs to prevent nosocomial infections. These programs focus on identifying high–risk procedures and other possible sources of infection. High–risk procedures such as **urinary catheterization** should be performed only when necessary and catheters should be left in for as little time as possible. Medical instruments and equipment must be properly sterilized to ensure they are not contaminated. Frequent hand washing by health care workers and visitors is necessary to avoid passing infectious microorganisms to hospitalized patients. In 2003, the Joint Commission on Accreditation of Health care Organizations (JCAHO) announced it would make prevention of nosocomial infections a major goal future years. JCAHO, the body that inspects hospitals for quality and accredits them accordingly, issued an alert stating that hospital–acquired infections are seriously underreported. In 2005, Pennsylvania and Florida became the first states to require hospitals to report data on hospital–acquired infections. Since then, many other states have passed similar legislation. Increasingly, lawsuits have been brought against hospitals by families of patients that have died from nosocomial infections. The problem of nosocomial infections has become more serious for hospitals to address as many bacteria are becoming resistant to antibiotics.

Antibiotics should be used only when necessary. Use of antibiotics creates favorable conditions for infection with the fungal organism *Candida*. Overuse of antibiotics is also responsible for the development of bacteria that are resistant to antibiotics.

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Centers for Disease Control and Prevention (CDC), 1600 Clifton Rd., Atlanta, GA, 30333, (404) 498–1515, (800)311–3435, http://www.cdc.gov.

Hospital Infection Society, 162 Kings Cross Rd., London, England, WC1X 9DH, 020 7713 0273, http://www. his.org.uk.

National Heart, Lung, and Blood Institute, PO Box 30105, Bethesda, MD, 20824–0105, (301) 592–8573, (204) 629–3246, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi. nih.gov.

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National Institute of Allergy and Infectious Diseases (NIAID), 6610 Rockledge Dr., MSC 6612, Bethesda, MD, 20892–6612, (301) 496–5717, (866) 284–4107, http://www3.niaid.nih.gov.

National Institutes of Health (NIH), 9000 Rockville Pike, Bethesda, MD, 20892, 301-496-4000, http://www.nih.gov/index.html.

World Health Organization (WHO), Avenue Appia 20, CH – 1211 Geneva 27, Switzerland, +41 22 791 2111, http://www.who.int/en.

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Hot-spot imaging *see* **Technetium heart scan**

HPV vaccination

Definition

HPV **vaccination** refers to the administration of a vaccine to protect against human papillovirus (HPV) infection.

Purpose

Human papillomavirus (HPV) is the most common sexually transmitted virus in the United States. Most HPV infections do not cause any symptoms and disappear on their own, but it is now known that HPV can cause **cervical cancer** in women. Every year in the United States, approximately 11,000 women are diagnosed with cervical **cancer** and 4,000 die from it. Cervical cancer is the second leading cause of cancer deaths among women around the world. It is estimated that as much as two-thirds of the cervical cancer deaths around the world could be eliminated if all women were immunized with the HPV vaccine prior to infection with HPV.

There are approximately 40 types of genital HPV. In the United States, about 20 million people are infected, with about 6.2 million new cases of genital HPV infection reported each year. Some HPV types can cause cervical cancer in women and can also cause other kinds of cancer in both men and women. HPV infection has been linked to oropharyngeal cancer and cancers of the anus, vulva, vagina, and penis. Other types of HPV can cause **genital warts** in both males and females or **warts** in the upper respiratory tract. The HPV vaccines work by preventing the most common types of HPV that cause cervical cancer and genital warts.

Description

In June 2006, the Advisory Committee on Immunization Practices (ACIP) voted to recommend the first vaccine developed to prevent cervical cancer and other diseases in females caused by certain types of genital human papillomavirus (HPV). This vaccine, Gardasil®, manufactured by the pharmaceutical company Merck, is a quadrivalent vaccine that protects against four HPV types (types 6, 11, 16, and 18), which together cause 70% of cervical cancers and 90% of genital warts. The Food and Drug Administration (FDA) licensed this vaccine for use in girls and women, between the ages of 9–26 years. Gardasil has also been approved by the FDA for use in males ages 9 to 26 years to prevent genital warts caused by HPV types 6 and 11.

In 2009, drug manufacturer GlaxoSmithKline released a second HPV vaccine, Cervarix. Cervarix is a bivalent vaccine, meaning it protects against HPV infection from two HPV types (types 16 and 18) that can cause precancerous and cancerous tumors of the cervix. Cervarix does not protect against genital warts (caused by HPV types 6 and 11). Cervarix has been approved by the FDA for use in females ages 10 to 25 years for the prevention of cervical cancer caused by HPV types 16 and 18.

Recommended dosage

The HPV vaccine is routinely administered to girls 11 and 12 years of age and is given in a series of three injections over a six–month period. The second and third doses are given one and six months after the first dose. Each dose of quadrivalent HPV vaccine is 0.5 mL, administered intramuscularly. It is important for girls to get vaccinated before their first sexual contact, i.e., before they can be exposed to HPV. For immunized girls, the vaccine can prevent almost 100% of the diseases caused by the types of HPVs targeted by the vaccine. Girls as young as 9 years old can receive the vaccine. The vaccine is also recommended for girls and women 13 through 26 years of age who did not receive it when they were younger. Additional (booster) doses are not recommended at this time. Studies are underway to determine whether booster vaccinations are necessary. HPV vaccine may be given at the same time as other vaccines.

Precautions

Vaccines can cause severe allergic reactions, like all medications. The risk of a vaccine causing serious harm, or **death**, is extremely small. Overwhelmingly, health practitioners recommend vaccination over the risk of suffering the disease against which it protects.

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KEY TERMS

Cervical cancer—Cancer of the entrance to the womb (uterus). The cervix is the lower, narrow part of the uterus (womb).

Cervical cancer screening—Use of the Papanicolaou (Pap) smear test to detect cervical cancer in the early curable stage.

Intramuscularly—A medication given by needle into a muscle.

Pathogen—A disease-causing microorganism.

Quadrivalent vaccine—A vaccine that protects against four pathogens.

Virus—A microorganism smaller than a bacteria, which cannot grow or reproduce apart from a living cell. Viruses cause many common human infections, and are also responsible for many rare diseases.

Wart—A raised growth on the surface of the skin or other organ.

However, some girls should not get the HPV vaccine. They include:

- Any girl who has ever had a life–threatening allergic reaction to yeast, to any other component of HPV vaccine, or to a previous dose of HPV vaccine.
- Pregnant women should not get vaccinated since no data is yet available on its safety in mothers and the unborn baby. Women who are breast feeding may safely get the vaccine.
- Girls with moderate or severe illnesses should wait until they recover.

Protection from HPV vaccine is expected to be long–lasting. However, vaccinated women still need cervical cancer screening because the vaccine does not protect against all HPV types that cause cervical cancer.

Side effects

According to the CDC, the following problems may follow HPV vaccination:

- Pain at the injection site (8 people in 10)
- Redness or swelling at the injection site (1 person in 4)
- Mild fever (100°F/37.8°C) (1 person in 10)
- Itching at the injection site (1 person in 30)
- Moderate fever (102°F/38.9°C) (1 person in 65)

A small number of patients receiving the HPV vaccine have experienced syncope (**fainting**) or seizures. Patients receiving the vaccine should be observed for 15 minutes after receiving each dose.

Interactions

The FDA has licensed the HPV vaccine as safe and effective. This vaccine has been tested in thousands of females (9 to 26 years of age) around the world no serious interactions or side effects.

Some medicines may interact with HPV vaccine. Alkylating agents (eg, cyclophosphamide), antimetabolites (eg, fluorouracil, methotrexate), cytotoxics (eg, cisplatin), or **corticosteroids** (eg, prednisone) may decrease the HPV vaccine's effectiveness.

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Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

National Institute of Allergies and Infectious Diseases, 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-6612, (301) 496-5717, (301) 402-3573, (866) 284-4107, ocpostoffice@niaid.nih.gov, http://www.niaid.nih.gov.

National Network for Immunization Information, 301 University Blvd, Galveston, TX, 77555-0350, (409) 772-0199, (409) 772-5208, nnii@i4ph.org, http://www.immunizationinfo.org.

National Vaccine Program Office. U.S. Department of Health & Human Services, Room 715-H 200 Independence Avenue, SW, Washington, DC, 20201, (202) 690-5566, nvpo@hhs.gov, http://www.hhs.gov/nvpo.

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HRT *see* **Hormone replacement therapy**

HTLV-1 associated myelopathy *see* **Tropical spastic paraparesis**

HTLV-1 infection *see* **Tropical spastic paraparesis**

Huffing *see* **Inhalants and related disorders**

Human-potential movement

Definition

The human-potential movement is a term used for humanistic psychotherapies that first became popular in the 1960s and early 1970s. The movement emphasized the development of individuals through such techniques as encounter groups, sensitivity training, and primal therapy. Although the human-potential movement and humanistic therapy are sometimes used as synonyms, in reality, humanistic therapy preceded the human-potential movement and provided the movement's theoretical base. Humanistic therapy flourished in the 1940s and 1950s. Its theorists were mostly psychologists rather than medical doctors. They included Gordon Allport, Abraham Maslow, Everett Shostrom, Carl Rogers, and Fritz Perls.

The human-potential movement and humanistic therapy is distinguished by the following emphases:

- A concern for what is uniquely human rather than what humans share with other animals.
- A focus on each person's open-ended growth rather than reshaping individuals to fit society's demands.
- An interest in the here-and-now rather than in a person's childhood history or supposed unconscious conflicts.
- A holistic approach concerned with all levels of human being and functioning—not just the intellectual—including creative and spiritual functioning.
- A focus on psychological health rather than disturbance.

Purpose

The purpose of humanistic therapy is to allow a person to make full use of his or her personal capacities leading to self-actualization. Self-actualization requires the integration of all the components of one's unique personality. These elements or components of personality include the physical, emotional, intellectual, behavioral, and spiritual. The marks of a self-actualized person are maturity, self-awareness, and authenticity. Humanistic therapists think that most people—not only those with obvious problems—can benefit from opportunities for self-development. Humanistic therapy uses both individual and group approaches.

Precautions

Psychotic patients, substance abusers, and persons with severe **personality disorders** or disorders of impulse control may not be appropriate for treatment with humanistic methods.

Description

Humanistic approaches to individual treatment usually follow the same format as other forms of outpatient counseling. Therapists may be medical doctors, nurses, psychologists, social workers, or clergy. Humanistic group treatment formats are flexible, and a wide range of treatment methods are used, ranging from encounter groups and therapy groups to assertiveness training and consciousness-raising groups. In addition, the humanistic tradition has fostered the publication of self-help books for people interested in psychological self-improvement.

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Risks

The chief risks include the reinforcement of self-centered tendencies in some patients and the dangers resulting from encounter groups led by persons without adequate training. Poorly led encounter groups can be traumatic to persons with low tolerance for confrontation or "uncovering" of private issues.

Normal results

The anticipated outcome of humanistic therapy is a greater degree of personal wholeness, self-acceptance, and exploration of one's potential. In group treatment, participants are expected to grow in interpersonal empathy and relationship skills. However, there have been few controlled studies to determine the reasonableness of these expectations.

Resources

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Rebecca J. Frey, PhD

Human bite infections

Definition

Human bite infections are potentially serious infections caused by rapid growth of bacteria in broken skin.

Description

Bites—animal and human—are responsible for about 1% of visits to emergency rooms. Bite injuries are more common during the summer months.

Closed–fist injury

In adults, the most common form of human bite is the closed–fist injury, sometimes called the "fight bite." These injuries result from the breaking of the skin over the knuckle joint when a person's fist strikes someone's teeth during a fight.

Causes and symptoms

In children, bite infections result either from accidents during play or from fighting. Most infected bites in adults result from fighting.

KEY TERMS

Antibiotic—A drug used to treat infections caused by bacteria and other microorganisms.

Bacteria—Single–celled microorganisms that can be seen only through a microscope. Many bacteria cause disease.

The infection itself can be caused by a number of bacteria that live in the human mouth. These include streptococci, staphylococci, anaerobic organisms, and *Eikenella corrodens*. Infections that begin less than 24 hours after the injury are usually produced by a mixture of organisms and can cause a necrotizing infection (causing the **death** of a specific area of tissue), in which tissue is rapidly destroyed. If a bite is infected, the skin will be sore, red, swollen, and warm to the touch.

Diagnosis

In most cases the diagnosis is made by an emergency room physician on the basis of the patient's history.

Because the human mouth contains a variety of bacteria, the physician will order a laboratory culture to choose the most effective antibiotic.

Treatment

Treatment involves surgical attention as well as medications. Because bites cause puncturing and tearing of skin rather than clean-edged cuts, they must be carefully cleansed. The doctor will wash the wound with water under high pressure and debride it. **Debridement** is the removal of dead tissue and **foreign objects** from a wound to prevent infection. If the bite is a closed–fist injury, the doctor will look for torn tendons or damage to the spaces between the joints. Examination includes x rays to check for bone **fractures** or foreign objects in the wound.

Doctors do not usually suture a bite wound because the connective tissues and other structures in the hand form many small closed spaces that make it easy for infection to spread. Emergency room doctors often consult surgical specialists if a patient has a deep closed–fist injury or one that appears already infected.

The doctor will make sure that the patient is immunized against **tetanus**, which is routine procedure for any open wound. A study released in June 2004 showed that routine use of **antibiotics** for human bites may not be necessary, as physicians try to

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minimize overuse of antibiotics. Superficial **wounds** in low-risk areas may no longer need antibiotic treatment, but more serious human bites to high-risk areas such as the hands should be treated with antibiotics to prevent serious infection. Patients with closed–fist injuries may need inpatient treatment in addition to an intravenous antibiotic.

Prognosis

The prognosis depends on the location of the bite and whether it was caused by a child or an adult. Bites caused by children rarely become infected because they are usually shallow. Between 15–30% of bites caused by adults become infected, with a higher rate for closed–fist injuries.

Prevention

Prevention of human bite infections depends upon prompt treatment of any bite caused by a human being, particularly a closed–fist injury.

Resources

PERIODICALS

"Do All Human Bite Wounds Need Antibiotics?" *Emergency Medicine Alert*. June 2004: 3.

ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Rd., Atlanta, GA, 30333, 800-311-3435, http://www.cdc.gov.

National Institutes of Health (NIH), 9000 Rockville Pike, Bethesda, MD, 20892, 301-496-4000, http://www.nih.gov/index.html.

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Human chorionic gonadotropin *see* **Infertility drugs**

Human chorionic gonadotropin pregnancy test

Definition

The most common test of **pregnancy** involves the detection of a hormone known as human chorionic gonadotropin (hCG) in a sample of blood or urine.

Purpose

To determine whether or not a woman is pregnant.

Description

Shortly after a woman's egg is fertilized by her male partner's sperm and is implanted in the lining or the womb (uterus), a placenta begins to form. This organ will help nourish the developing new life. The placenta produces hCG, whose presence, along with other hormones, helps maintain the early stages of pregnancy. Because hCG is produced only by placental tissue and the hormone can be found in the blood or urine of a pregnant woman, it has become a convenient chemical test of pregnancy.

After implantation, the level of detectable hCG rises very rapidly, approximately doubling in quantity every two days until a peak is reached between the sixth and eighth week. Over the next 10 or more weeks, the quantity of hCG slowly decreases. After this point, a much lower level is sustained for the duration of the pregnancy. Detectable levels of this hormone may even persist for a month or two after delivery.

Blood tests for hCG are the most sensitive and can detect a pregnancy earlier than urine tests. Blood tests for hCG can also distinguish normal pregnancies from impending miscarriages or pregnancies that occur outside of the uterus (ectopic pregnancies).

If a woman misses her menstrual period and wants to know if she may be pregnant, she can purchase one of many home pregnancy test kits that are available. Although each of these products may look slightly different and provide a different set of directions for use, each one detects the presence of hCG. This indicator contains chemical components called antibodies that are sensitive to a certain quantity of this hormone.

Precautions

Although home pregnancy tests may be advertised as having an accuracy of 97% or better, studies indicate that, in practice, pregnancy tests performed in the home may incorrectly indicate that a woman is not pregnant (a false positive result) between 25–50% of the time. Studies also indicate that the false negative results usually result from failing to follow the package directions or testing too soon after a missed menstrual period. Waiting a few days after the missed period was expected can increase the accuracy of the test. Blood and urine tests performed by a laboratory are from 97–100% accurate in detecting pregnancy.

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Preparation

Generally, no preparation is required for a pregnancy test given in a doctor's office.

Home pregnancy test kits can be divided into two basic types. One type involves the use of a wand-like device that a woman must place into her urine stream for a brief period of time. The other type of kit involves the use of a cup, a dropper, and a wand or stick with a small well. The cup is used to collect the urine, and the dropper is used to transfer a specific number of drops into the well. Results are displayed by a color change. It's important to follow the package directions very carefully (the techniques vary from brand to brand) and to read the results in the time specified.

Aftercare

No special care is required after a urine test for hCG. Women who feel faint or who continue to bleed after a blood test should be observed until the condition goes away.

Risks

Tests for hCG levels pose no direct risk to a woman's health. The main risk with a home pregnancy test is a false negative result, which may be lessened by following the manufacturer's instructions carefully and waiting at least several days after the expected menstrual period to test. A false negative result can cause a delay in seeking prenatal care, which can pose a risk to both the woman and the baby.

Abnormal results

In most cases, a positive result is an indication of pregnancy. However, false positive results may also occur. If a pregnancy test is performed within a month or two of a recent birth or **miscarriage**, it is possible to test positive for pregnancy since hCG may still be detected in a woman's urine. Sometimes positive pregnancy tests provide clues of an early miscarriage that might have otherwise gone unrecognized because it occurred before or just after a missed period. An **ectopic pregnancy** (one in which an embryo implants outside the uterus), certain types of masses (such as an ovarian tumor or a **hydatidiform mole**), and the use of some fertility drugs that contain hCG are among other possibilities behind false positive results.

Normal results

A woman should notify her physician immediately if her home pregnancy test is positive. Pregnancy can then be confirmed with hCG urine or blood tests taken in the doctor's office and evaluated by laboratory personnel. If performed accurately, home pregnancy tests have been found to be highly reliable. However, the versions of these tests performed by qualified laboratory technologists are considered to be definitive. Often, such a test will produce positive results before a woman experiences symptoms or before a doctor's exam reveals signs of pregnancy.

Resources

PERIODICALS

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Betty Mishkin

Human herpes *see* **Roseola**

Human leukocyte antigen test

Definition

The human leukocyte antigen test, also known as HLA, is a test that detects antigens (genetic markers) on white blood cells. There are four types of human leukocyte antigens: HLA-A, HLA-B, HLA-C, and HLA-D.

Purpose

The HLA test is used to provide evidence of tissue compatibility typing of tissue recipients and donors. It is also an aid in **genetic counseling** and in paternity testing.

Precautions

This test may have to be postponed if the patient has recently undergone a **transfusion**.

Description

Human leukocyte antigen (leukocyte is the name for white blood cell, while antigen refers to a genetic marker) is a substance that is located on the surface of white blood cells. This substance plays an important role in the body's immune response.

Because the HLA antigens are essential to immunity, identification aids in determination of the degree of tissue compatibility between transplant recipients and donors. Testing is done to diminish the likelihood of rejection after transplant, and to avoid graft-versus-

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host disease (GVHD) following major organ or **bone marrow transplantation**. It should be noted that risk of GVHD exists even when the donor and recipient share major antigens. As an example, it was recently discovered that a mismatch of HA-1 (a minor antigen) was a cause of GVHD in bone marrow grafts from otherwise HLA-identical donors.

HLA can aid in paternity exclusion testing, a highly specialized area of forensic medicine. To resolve cases of disputed paternity, a man who demonstrates a phenotype (two haplotypes: one from the father and one from the mother) with no haplotype or antigen pair identical to one of the child's is excluded as the father. Conversely, a man who has one haplotype identical to one of the child's may be the father (the probability varies with the appearance of that particular haplotype in the population). Because of the issues involved, this type of testing is referred to experts.

Certain HLA types have been linked to diseases, such as **rheumatoid arthritis**, **multiple sclerosis**, serum lupus erythematosus, and other **autoimmune disorders**. By themselves, however, none of the HLA types are considered definitive. Because the clinical significance of many of the marker antigens has not yet been well defined, definitive diagnosis of disease is obtained by the use of more specific tests.

Preparation

The HLA test requires a blood sample. There is no need for the patient to be **fasting** (having nothing to eat or drink) before the test.

Risks

Risks for this test are minimal, but may include slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after venipuncture, or hematoma (blood accumulating under the puncture site).

Normal results

Identification of specific leukocyte antigens, HLA-A, HLA-B, HLA-C and HLA-D.

Abnormal results

Incompatible groups between organ donors and recipients may cause unsuccessful tissue transplantation.

Certain diseases have a strong association with certain types of HLAs, which may aid in genetic counseling. For example, Hashimoto's **thyroiditis** (an autoimmune disorder involving underproduction by the thyroid gland) is associated with HLA-DR5, while B8 and Dw3 are allied with Graves' disease (another autoimmune disorder, but with overproduction by the thyroid gland). Hereditary **hemochromatosis** (too much iron in the blood) is associated with HLA-A3, B7, and B14. HLA-A3 is found in approximately 70% of patients with hemochromatosis, but as is the case with other HLA-associated disorders, the expense of HLA typing favors use of other tests. In cases of suspected hemochromatosis, for example, diagnosis is better aided by two tests called transferrin saturation and serum ferritin.

Resources

BOOKS

Pagana, Kathleen Deska, and Timothy J. Pagana. *Mosby's Manual of Diagnostic and Laboratory Tests*. 4th ed. St. Louis: Mosby, 2009.

Janis O. Flores

Human papilloma virus

Definition

HPV infection is a sexually transmitted disease (STD) caused by 30–40 of the 130 or so known strains of human papillomavirus, the name of a group of viruses that infect the skin and mucous membranes of humans and some animals. In humans these sexually transmitted strains can cause **genital warts**, precancerous changes in the tissues of the female vagina, or **cervical cancer**. Other strains of HPV are responsible for **warts** on the soles of the feet (plantar warts), common warts on the hands, and flat warts on the face or legs.

Demographics

In recent years HPV infection has become the most common STD in the United States. Approximately 20 million Americans are infected with HPV as of 2009, and another 6.2 million people become newly infected each year. According to one study, 27 percent of women between the ages of 14 and 59 are infected with one or more types of HPV, and 35% of homosexual men. The Centers for Disease Control and Prevention (CDC) estimates that more than 80 percent of American women will contract at least one strain of genital HPV by age 50. About 75–80 percent of sexually active Americans of either sex will be infected with HPV at some point in their lifetime.

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Prevalence of HPV and related diseases

Human papillomavirus (HPV): Approximately 20 million Americans are currently infected with HPV and another 6 million become infected each year. HPV is so prevalent that half of all sexually active men and women contract it at some point in their lives.

Genital warts: About 1% of sexually active adults in the United States have genital warts.

Cervical cancer: On average, 12,000 women in the United States are diagnosed with cervical cancer each year.

Other cancers that can be caused by HPV:

- Vulvar cancer (3,700 women per year)
- Vaginal cancer (1,000 women per year)
- Penile cancer (1,000 men per year)
- Anal cancer (2,700 women and 1,700 men per year)

SOURCE: Centers for Disease Control and Prevention, "Genital HPV Infection Fact Sheet." Available online at: http://www.cdc.gov/std/hpv/stdfact-hpv.htm (accessed August 17, 2010).

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As far as is known, men and women are at equal risk of being infected with HPV, as are members of all races and ethnic groups.

In terms of specific illnesses associated with HPV, 11,000 women are diagnosed with cervical **cancer** each year in the United States and 3,900 women die of the disease. Another 5,800 women are diagnosed with cancers of the vagina and the external female genitals, while 3,300 men are diagnosed with cancer of the penis or the anal area. The risk of **anal cancer** is 17 to 31 times higher among gay and bisexual men than among heterosexual men.

Description

The family of human papilloma viruses includes a large number of genetically related viruses. Many of these cause warts, including the warts commonly found on the skin. Another group of HPV preferentially infect the mucosal surfaces of the genitals, including the penis, vagina, vulva, and cervix. These are spread among adults by sexual contact. One group of HPV that infect the genitals causes soft warts, often designated condylomata acuminata. These genital warts are quite common and rarely if ever become cancerous. The most common of these low-risk HPV types are designated HPV 6 and 11.

The second group of viruses, termed high-risk HPV types, is associated with the development of cervical cancer. Individuals infected with these viruses are at higher risk for the development of precancerous lesions. Typically, infection with these viruses is common in adolescents and women in their twenties and usually do not result in cancerous growth. The most common high-risk HPV is type 16. The appearance of abnormal cells containing high-risk HPV types is seen most frequently in women over the age of 30 who have abnormal Pap smears.

It is possible that other viruses work together with human papilloma viruses to produce precancerous changes in tissue. Cases of tongue cancer have been reported in which HPV was found together with **Epstein-Barr virus**, or EBV. **Smoking**, the use of **oral contraceptives** for birth control for longer than five years, and suppression of the immune system are also thought to be factors that combine with HPV infection to lead to precancerous lesions in tissue.

Risk factors

Some people are at greater risk of sexually transmitted HPV than others:

- Gay and bisexual men.
- People with HIV or other diseases that weaken the immune system.
- Males or females below age 25. Younger people appear to be more biologically vulnerable to the HPV virus.
- People who have large numbers of sexual partners.
- People in relationships with partners who have sex with many other people.
- People who must take drugs that suppress the immune system.

Causes and symptoms

Causes

The cause of sexually transmitted HPV infection is one or more strains of the human papillomavirus. The virus enters the body through small breaks in the skin surface or in the mucous membranes lining the genitals. In most cases the body fights off the virus within a few weeks. In some people, however, HPV remains dormant for a period ranging from a few weeks to three years in one of the lower layers of skin cells. The virus then begins to replicate (copy itself) when these cells mature and move upward to the surface of the skin. The virus affects the shape of the cells, leading to the formation of noticeable warts, precancerous changes in skin cells, or cervical cancer. About 1 percent of sexually active adults in the United States have genital warts at any one time; about 10 percent of women with high-risk HPV in the tissues of their cervix will develop long-lasting HPV infections that put them at risk for cervical cancer.

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The percentages of cancers caused by high-risk types of HPV are as follows:

- Cervical cancer: 100%
- Anal cancer: 90%
- Cancer of the vulva: 40%
- Vaginal cancer: 40%
- Oropharyngeal cancer: 12%
- Oral cancer: 3%

Symptoms in adults

Symptoms of sexually transmitted HPV infection may include:

- Genital warts. These appear as bumps or clusters of fleshy outgrowths around the anus or on the genitals. Some may grow into large cauliflower-shaped masses. Genital warts usually appear within weeks or months after sexual contact with an infected person. If left untreated, genital warts may go away, remain unchanged, or increase in size or number but will not turn into cancers. It is possible, however, for a person to be infected with a high-risk strain of HPV as well as one of the strains that cause genital warts; therefore the appearance of genital warts does not necessarily mean that the person is not at risk of cancer.
- Precancerous changes in the tissues of the female cervix. These are flat growths on the cervix that cannot be seen or felt by the infected woman.
- Cancer. High-risk strains of HPV can cause cancers of the mouth and throat as well as cancers of the anal area and the male and female genitals. These typically take years to develop after infection. In men, symptoms of anal cancer may include bleeding, pain, or a discharge from the anus, or changes in bowel habits. Early signs of cancer of the penis may include thickening of the skin, tissue growths, or sores.

It was not fully understood as of 2009 why most infections with high-risk HPV are of short duration, while a small percentage persist and eventually transform cervical cells to a state of cancerous growth.

Symptoms in children

In addition to producing precancerous lesions in some patients, HPV infections in women are a health concern because they can be transmitted to the respiratory tract of a baby during **childbirth**. This type of HPV infection may lead to a rare disorder known as juvenile-onset recurrent respiratory papillomatosis (JO-RRP) or laryngeal papillomatosis, in which papillomas or warts form in the child's airway, producing hoarseness or partial blockage of the windpipe. Although laryngeal papillomatosis can occur in HPV-infected adults, 60–80% of cases occur in children, most of them younger than three years.

Laryngeal papillomatosis is usually diagnosed by **laryngoscopy**. Surgery, whether traditional or **laser surgery**, is the usual treatment for JO-RRP, but the warts often recur and require additional surgery to remove them. In extreme cases, the patient may be given a **tracheotomy**, a procedure in which a hole is cut through the throat into the windpipe and a tube is inserted to keep the breathing hole open. A new treatment for the disorder is **photodynamic therapy** or PDT. In PDT, a special light-sensitive dye is injected into the patient's blood. The dye collects in the tumors rather than in healthy tissue. When bright light of a specific wavelength is shined on the throat, it destroys the tumors containing the dye.

Cidofovir and interferon are often given as adjuvant treatments for this disease as of the early 2000s. JO-RRP is a serious illness, leading to **death** in a significant number of affected children. In a very few cases, respiratory papillomatosis can lead to cancer as well as breathing difficulties.

Diagnosis

There is no general blood, urine, or imaging test for HPV infection. The diagnosis of genital warts is obvious based on their location and appearance. The doctor may, however, use a vinegar solution to identify HPV-infected areas on the skin of the genitals. The vinegar solution will turn white if HPV is present. Since genital warts are caused by low-risk strains of HPV, the doctor does not need to identify the specific strain of the virus that is present.

Sexually active women should be screened periodically for the presence of changes in the tissues of the cervix. The most common test is the Papanikolaou test or Pap smear, invented by a Greek physician in the 1940s. To perform a Pap smear, the doctor takes a small spatula to obtain cells from the outer surface of the cervix and smears the collected cells on a slide that is then examined in a laboratory for signs of any abnormal cells. If abnormal or questionable cells are found, the doctor may order an HPV DNA test, which can identify the DNA of 13 high-risk types of HPV in cells taken from the cervix.

There were no HPV screening tests for men as of 2009; however, some doctors suggested that anal Pap smears for men who have sex with men would be useful in early detection of anal cancer.

Tests

The relationship among HPV, precancerous cellular changes, and cervical cancer have led to the suggestion

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KEY TERMS

Ablative—Also known as "ablation" and referring to the surgical removal of lesions associated with HPV.

Biopsy—The removal of a small bit of tissue for diagnostic examination.

Cervical intra-epithelial neoplasia (CIN)—A precancerous condition in which a group of cells grow abnormally on the cervix but do not extend into the deeper layers of this tissue.

Cervix—The narrow neck or outlet of a woman's uterus.

Colposcopy—Procedure in which the cervix is examined using a special microscope.

Condylomata acuminata (singular, condyloma acuminatum)—The medical term for infectious warts on the genitals caused by HPV.

Cryotherapy—The use of liquid nitrogen or other forms of extreme cold to destroy tissue.

Epithelial—Referring to the epithelium, the layer of cells forming the epidermis of the skin and the surface layer of mucous membranes.

High-risk HPV type—A member of the HPV family of viruses that is associated with the development of cervical cancer and precancerous growths.

Pap test—A screening test for cervical cancer devised by Giorgios Papanikolaou (1883–1962) in the 1940s.

Photodynamic therapy (PDT)—A treatment for tumors in which a light-sensitive dye is injected into the blood (or skin) to be taken up selectively by the tumors. Light of a specific wavelength is then applied to the affected area to kill the tumors.

Topical—Referring to a type of medication applied directly to the skin or outside of the body.

Tracheotomy—A surgical procedure in which a hole is cut through the neck to open a direct airway through an incision in the trachea (windpipe).

that testing for the presence of HPV can be a useful addition to Pap smears. Pap smears involve microscopic analysis of cells removed from the cervix. The results of these tests are generally reported as either normal or consistent with the presence of cancer or a precancerous condition. Patients receiving the latter diagnosis usually are treated either by excisional or ablative therapy surgery or some other means in order to remove the tumor or precancerous lesion.

In some cases the cytologist or pathologist examining a Pap smear reports a "borderline" result when abnormal cells are observed, but it is not possible to distinguish whether the changes seen are due to early precancerous changes or to inflammation caused by some infectious agent or irritant. In these cases, some physicians and scientists believe that testing for the presence of HPV can help to identify those women who should be closely followed for the development of early cancerous lesions, or who should undergo **colposcopy**, a procedure to examine the cervix for precancerous lesions. These cancer precursors, termed cervical intraepithelial neoplasia (CIN) when identified early, before they have become invasive, can almost always be completely removed by minor surgery, essentially curing the patient before the cancer has had a chance to develop. The cervical tissue removed, which includes the precancerous tissue, is examined as part of a biopsy to confirm the diagnosis, and if requested by a doctor, can be tested for the presence of high-risk HPV types.

Treatment

Traditional

Patients with genital warts should *never* use over-the counter-preparations designed to remove common or flat warts from the hands or face. Doctors can treat genital warts with various medical or surgical techniques:

- Cryotherapy. Cryotherapy uses liquid nitrogen to freeze the warts. The dead tissue in the wart falls away from the skin beneath in about a week.
- Imiquimod. Imiquimod (Aldara) is a topical cream that gets rid of genital warts by stimulating the body's immune system to fight the virus that causes the warts.
- Podofilox. Podofilox (Condylox) is a topical medication available in liquid or gel form that destroys the wart tissue.
- Surgery. The doctor can remove the wart by drying it out with an electric needle and then scraping the tissue with a sharp instrument called a curette. Lasers can also be used to remove genital warts.

Low-grade precancerous changes in the tissue of the female cervix are not usually treated directly because most of them will eventually go away on their own without developing into cancer. The patient should, however, see the doctor for follow-up Pap smears to make sure that the tissues are returning to normal. High-risk

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precancerous lesions are removed, usually by surgery, **cryotherapy**, electrocauterization, or laser surgery.

Since the incidence of latent and recurrent infections is high, the eradication of HPV is not always 100% effective. It is essential to be aware that HPV is a sexually transmitted disease and women must engage in safe sex practices to decrease the risk of spreading the virus or becoming reinfected. A vaccine effective against four of the HPV types most likely to cause genital warts or cervical cancer was approved for use in 2006; it is described more fully in the Prevention section of this article. As of 2009, researchers were working on developing vaccines to protect against additional types of the HPV virus.

Prognosis

The prognosis of sexually transmitted HPV infections depends on the patient's age, number of sexual partners, gender, and the condition of his or her immune system. Women are significantly more likely than men to develop cancers following HPV infection. However, most people of either sex with normally functioning immune systems who are infected with HPV will clear the infection from their bodies within two years.

Prevention

Preventive measures that people can take to lower their risk of HPV infection include:

- Abstaining from sex or having sex only with an uninfected partner who is faithful.
- Reducing the number of sexual partners.
- Using condoms regularly during sexual intercourse.
- For women, using a vaccine called Gardasil. Approved by the Food and Drug Administration (FDA) in 2006, Gardasil is protects against the four types of HPV that cause most cervical cancers and genital warts. The vaccine is recommended for 11- and 12-year-old girls. It is also recommended for girls and women age 13 through 26 who have not yet been vaccinated or completed the vaccine series. Gardasil works best in girls who have not yet been sexually active. It is given as a series of three shots over a six-month period.

A second human papillomavirus vaccine, Cervarix, was approved in Europe, Australia, and the Philippines in 2007. It received FDA approval for use in the United States in October 2009.

In addition to giving the available preventive vaccines to women, some doctors think it might be a useful preventive measure to vaccinate men as well to protect their female partners against infection. As of 2009, however, male **vaccination** for HPV is still under discussion rather than being put into clinical practice.

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American College of Obstetricians and Gynecologists (ACOG), 409 12th St., S.W., P.O. Box 96920, Wash ington, DC, 20090-6920, 202-638-5577, resources@acog.org, http://www.acog.org/.
American Social Health Association (ASHA), P.O. Box 13827, Research Triangle Park, NC, 27709, 919-361-8400, 800-227-8922, 919-361-8425, http://www.ashastd.org/index.cfm.
Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, 800-232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.
National Cancer Institute, 6116 Executive Blvd., Room 3036A, Bethesda, MD, 20892-8322, 800-422-6237, cancergovstaff@mail.nih.gov, http://www.cancer.gov.
National Institute of Allergy and Infectious Diseases (NIAID), 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-6612, 301-496-5717, 866-284-4107, 301-402-3573, http://www3.niaid.nih.gov.
National Institute on Deafness and Other Communication Disorders (NIDCD), 31 Center Drive, MSC 2320, Bethesda, MD, 20892-2320, 800 241-1044, 301 770-8977, nidcdinfo@nidcd.nih.gov, http://www.nidcd.nih.gov/index.asp.

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Humanistic therapy *see* **Gestalt therapy; Human-potential movement**
Humpback *see* **Kyphosis**
Hunchback *see* **Kyphosis**
Hunter's syndrome *see* **Mucopolysaccharidoses**

Huntington's disease

Definition

Huntington's disease (HD) is an inherited, progressive, neurodegenerative disease causing uncontrolled physical movements and mental deterioration. The disease was discovered by George Huntington of Pomeroy, Ohio, who first described a hereditary movement disorder.

Demographics

HD is estimated to occur in the United States at a rate of 4.1–8.4 cases per 100,000 people. In most European countries, prevalence ranges from 1.63–9.95 per 100,000 people. It is lower in Finland and Japan (less than 1 case per 100,000 people). Pockets of isolated populations with western European ancestors exist where the prevalence is higher. For example, these include the region of lake Maracaibo in Venezuela (700 per 100,000 people), the island of Mauritius (46 per 100,000 people), and Tasmania (17.4 per 100,000 people). HD is a disease that affects males and females equally.

The mean age at HD onset ranges from 35–44 years. HD onset in patients younger than 10 years and older than 70 years is rare. Modifying genes and environmental factors are thought to influence the age of onset. Fpr example, the Venezuelan age of onset (34.35 y) is on average higher than that of Americans (37.47 y) and Canadians (40.36 y).

Description

Huntington's disease is also called Huntington chorea, from the Greek word for "dance," referring to the involuntary movements that develop as the disease progresses. It is occasionally referred to as "Woody Guthrie disease" for the U.S. folk singer who died from it. Huntington's disease causes progressive loss of cells in areas of the brain responsible for some aspects of movement control and mental abilities. A person with HD gradually develops abnormal movements and changes in cognition (thinking), behavior and personality.

Risk factors

Children of a parent who carries the gene responsible for HD have a 50% chance of inheriting the abnormal gene.

Causes and symptoms

Mutations in the HTT gene cause Huntington's disease. This gene provides instructions for making a protein called huntingtin, a protein that is believed to play an important role in the development of brain neurons. The HTT mutation involves lengthening a DNA segment known as a CAG trinucleotide repeat. The extra building blocks in the huntingtin gene cause the protein that is made from it to contain an extra section. It is currently thought that this extra protein section interacts with

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KEY TERMS

Chorea—Involuntary writhing movements.

Cognition—The mental activities associated with thinking, learning, and memory.

Computed tomography (CT) scan—An imaging procedure that produces a three–dimensional picture of organs or structures inside the body, such as the brain.

Deoxyribonucleic acid (DNA)—The genetic material in cells that holds the inherited instructions for growth, development, and cellular functioning.

Heimlich maneuver—An action designed to expel an obstructing piece of food from the throat. It is performed by placing the fist on the abdomen, underneath the breastbone, grasping the fist with the other hand (from behind), and thrusting it inward and upward.

Neurodegenerative—Relating to degeneration of nerve tissues.

Neuron—A cell that is specialized to conduct nerve impulses.

other proteins in brain cells where it occurs, and that this interaction ultimately leads to cell **death**.

The HD gene is a dominant gene, meaning that only one copy of it is needed to develop the disease. HD affects both males and females. The gene may be inherited from either parent, who will also be affected by the disease. A parent with the HD gene has a 50% chance of passing it on to each offspring. The chances of passing on the HD gene are not affected by the results of previous pregnancies.

The symptoms of HD fall into three categories: motor or movement symptoms, personality and behavioral changes, and cognitive decline. The severity and rate of progression of each type of symptom can vary from person to person.

Early motor symptoms include restlessness, twitching and a desire to move about. Handwriting may become less controlled, and coordination may decline. Later symptoms include:

- Dystonia, or sustained abnormal postures, including facial grimaces, a twisted neck, or an arched back.
- Chorea, in which involuntary jerking, twisting or writhing motions become pronounced.
- Slowness of voluntary movements, inability to regulate the speed or force of movements, inability to initiate movement, and slowed reactions.
- Difficulty speaking and swallowing due to involvement of the throat muscles.
- Localized or generalized weakness and impaired balance ability.
- Rigidity, especially in late–stage disease.

Personality and behavioral changes include depression, irritability, **anxiety**, and apathy. The person with HD may become impulsive, aggressive, or socially withdrawn.

Cognitive changes include loss of ability to plan and execute routine tasks, slowed thought, and impaired or inappropriate judgment. Short–term **memory loss** usually occurs, although long–term memory is usually not affected. The person with late–stage HD usually retains knowledge of his environment and recognizes family members or other loved ones, despite severe cognitive decline.

Diagnosis

Examination

Diagnosis of HD begins with a detailed medical history, and a thorough physical and **neurological exam**. Family medical history is very important as HD is inherited.

Tests

Magnetic resonance imaging (MRI) or computed tomography scan (CT scan) imaging may be performed to look for degeneration in the basal ganglia and cortex, the brain regions most affected in HD.

A genetic test is available for confirmation of the clinical diagnosis. In this test, a small blood sample is taken, and DNA from it is analyzed to determine the CAG repeat number. A person with a repeat number of 30 or below will not develop HD. A person with a repeat number between 35 and 40 may not develop the disease within their normal life span. A person with a very high number of repeats (70 or above) is likely to develop the juvenile–onset form. An important component of **genetic testing** is extensive **genetic counseling**

Prenatal testing is also available. A person at risk for HD may obtain fetal testing without determining whether she herself carries the gene. This test, also called a linkage test, examines the pattern of DNA near the gene in both parent and fetus, but does not

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analyze for the triple nucleotide repeat (CAG). If the DNA patterns do not match, the fetus can be assumed not to have inherited the HD gene, even if present in the parent. A pattern match indicates the fetus probably has the same genetic makeup of the at–risk parent.

Treatment

Traditional

There is no cure for HD, nor any treatment that can slow the rate of progression. Treatment is aimed at reducing the disability caused by the motor impairments, and treating behavioral and emotional symptoms.

Physical therapy is used to maintain strength and compensate for lost strength and balance. Stretching and range of motion exercises help minimize contracture, or muscle shortening, a result of weakness and disuse. The physical therapist also advises on the use of mobility aids such as walkers or wheelchairs.

Occupational therapy is used to design compensatory strategies for lost abilities in the activities of daily living, such as eating, dressing, and grooming. The occupational therapist advises on modifications to the home that improve safety, accessibility, and comfort.

Difficulty swallowing may be lessened by preparation of softer foods, blending food in an electric blender, and taking care to eat slowly and carefully. Use of a straw for all liquids can help. The potential for **choking** on food is a concern, especially late in the disease progression. Caregivers should learn the use of the **Heimlich maneuver**. In addition, passage of food into the airways increases the risk for **pneumonia**. A gastric feeding tube may be needed, if swallowing becomes too difficult or dangerous.

Speech difficulties may be partially compensated by using picture boards or other augmentative communication devices. Loss of cognitive ability affects both speech production and understanding. A speech–language pathologist can work with the family to develop simplified and more directed communication strategies, including speaking slowly, using simple words, and repeating sentences exactly.

Drugs

Motor symptoms may be treated with drugs, although some studies suggest that anti–chorea treatment rarely improves function. Chorea (movements caused by abnormal muscle contractions) can be suppressed with drugs that deplete dopamine, an important brain chemical regulating movement. As HD progresses, natural dopamine levels fall, leading to loss of chorea and an increase in rigidity and movement slowness. Treatment with L–dopa (which resupplies dopamine) may be of some value. Frequent reassessment of the effectiveness and appropriateness of any drug therapy is necessary. In August 2008 the Food and Drug Administration (FDA) approved tetrabenazine to treat Huntington's chorea, making it the first drug approved for use in the United States to treat HD.

Early behavioral changes, including depression and anxiety, may respond to drug therapy. Maintaining a calm, familiar, and secure environment is useful as the disease progresses. Support groups for both patients and caregivers form an important part of treatment.

Alternative

As of 2009, 548 clinical trials for the treatment of Huntington's disease were being sponsored by the National Institutes of Health (NIH)and other agencies. A few examples include:

- The study of early brain and behavioral changes in people who have the gene expansion for HD, but are currently healthy and have no symptoms. (NCT00051324)
- The evaluation of the effect of atomoxetine on daily activities such as attention and focus, thinking ability and muscle movements in subjects with early HD. (NCT00368849)
- The collection of prospective data from individuals who are part of HD family to learn more about HD, develop potential treatments for HD, and to plan for future research studies of experimental drugs aimed at slowing or postponing the onset and progression of HD. (NCT00313495)
- The evaluation of the safety of the drug ursodiol in people with HD and the study of how the compound is processed by the body. (NCT00514774)
- The evaluation of the safety and tolerability of dimebon in people with HD. (NCT00387270)
- The effectiveness of a music therapy program to improve holistically the psychological, somatic, and social symptoms of patients with HD. (NCT00178360)
- The assessment of the impact of minocycline on the progression of symptoms of HD. (NCT00277355)

Clinical trial information is constantly updated by NIH and the most recent information on Huntington's disease trials can be found at http://clinicaltrials.gov/search/term=Huntington%27s%20Disease

Prognosis

The person with Huntington's disease may be able to maintain a job for several years after diagnosis, despite the increase in disability. Loss of cognitive functions and increase in motor and behavioral symptoms

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eventually prevent the person with HD from continuing employment. Ultimately, severe motor symptoms prevent mobility. Death usually occurs 15–20 years after disease onset. Progressive weakness of respiratory and swallowing muscles leads to increased risk of respiratory infection and choking, the most common causes of death. Future research in this area is focusing on nerve cell transplantation.

Prevention

Genetic testing is available for HD and should be considered if there is a family history of the disease. The Huntington's Disease Society of America has reputable pre–test and post–test counseling information.

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ORGANIZATIONS

Hereditary Disease Foundation., 3960 Broadway, 6th Floor, New York, NY, 10032, (212) 928-2121, (212) 928-2172, cures@hdfoundation.org, http://www.hdfoundation.org.

Huntington's Disease Society of America (HDSA), 505 Eighth Avenue, Suite 902, New York, NY, 10018, (212) 242-1968, (800) 345-4372, (212) 239-3430, hdsainfo@hdsa.org, http://www.hdsa.org.

Huntington Society of Canada, 151 Frederick Street, Suite 400, Kitchener, Ontario, NH2 2M2, Canada, (519) 749-7063, (800) 998-7398, (519) 749-8965, info@huntingtonsociety.ca, http://www.huntingtonsociety.ca.

International Huntington Association (IHA), Callunahof 8, St Harfsen, The Netherlands, 7217, + 31-573-431595, + 31-573-431719, iha@huntington-assoc.com, http://www.huntington-assoc.com.

National Institute of Neurological Disorders and Stroke (NINDS), PO Box 5801, Bethesda, MD, 20824, (301) 496-5751, (800) 352-9424, http://www.ninds.nih.gov.

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Hurler's syndrome *see* **Mucopolysaccharidoses**

HUS *see* **Hemolytic-uremic syndrome**

Hyaline *see* **Respiratory distress syndrome**

Hydatid *see* **Echinococcosis**

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Hydatidiform mole

Definition

A hydatidiform mole is a relatively rare condition in which tissue around a fertilized egg that normally would have developed into the placenta instead develops as an abnormal cluster of cells. (This is also called a molar pregnancy.) This grapelike mass forms inside of the uterus after fertilization instead of a normal embryo. A hydatidiform mole triggers a positive **pregnancy** test and in some cases can become cancerous.

Description

A hydatidiform mole ("hydatid" means "drop of water" and "mole" means "spot") occurs in about 1 out of every 1,500 (1/1,500) pregnancies in the United States. In some parts of Asia, however, the incidence may be as high as 1 in 200 (1/200). Molar pregnancies are most likely to occur in younger and older women (especially over age 45) than in those between ages 20–40. About 1–2% of the time a woman who has had a molar pregnancy will have a second one.

A molar pregnancy occurs when cells of the chorionic villi (tiny projections that attach the placenta to the lining of the uterus) don't develop correctly. Instead, they turn into watery clusters that can't support a growing baby. A partial molar pregnancy includes an abnormal embryo (a fertilized egg that has begun to grow) that does not survive. In a complete molar pregnancy there is a small cluster of clear blisters or pouches that don't contain an embryo.

If not removed, about 15% of **moles** can become cancerous. They burrow into the wall of the uterus and cause serious bleeding. Another 5% will develop into fast-growing cancers called choriocarcinomas. Some of these tumors spread very quickly outside the uterus in other parts of the body. Fortunately, **cancer** developing from these moles is rare and highly curable.

Causes and symptoms

The cause of hydatidiform mole is unclear; some experts believe it is caused by problems with the chromosomes (the structures inside cells that contain genetic information) in either the egg or sperm, or both. It may be associated with poor **nutrition** or a problem with the ovaries or the uterus. A mole sometimes can develop from placental tissue that is left behind in the uterus after a **miscarriage** or **childbirth**.

Women with a hydatidiform mole will have a positive pregnancy test and often believe they have a normal pregnancy for the first three or four months. However, in these cases the uterus will grow abnormally fast. By the end of the third month, if not earlier, the woman will experience vaginal bleeding ranging from scant spotting to excessive bleeding. She may have **hyperthyroidism** (overproduction of **thyroid hormones** causing symptoms such as weight loss, increased appetite, and intolerance to heat). Sometimes, the grapelike cluster of cells itself will be shed with the blood during this time. Other symptoms may include severe **nausea and vomiting** and high blood pressure. As the pregnancy progresses, the fetus will not move and there will be no fetal heartbeat.

Diagnosis

The physician may not suspect a molar pregnancy until after the third month or later, when the absence of a fetal heartbeat together with bleeding and severe nausea and vomiting indicates something is amiss.

First, the physician will examine the woman's abdomen, feeling for any strange lumps or abnormalities in the uterus. A tubal pregnancy, which can be life threatening if not treated, will be ruled out. Then the physician will check the levels of human chorionic gonadotropin (hCG), a hormone that is normally produced by a placenta or a mole. Abnormally high levels of hCG together with the symptoms of vaginal bleeding, lack of fetal heartbeat, and an unusually large uterus all indicate a molar pregnancy. An ultrasound of the uterus to make sure there is no living fetus will confirm the diagnosis.

Treatment

It is extremely important to make sure that all of the mole is removed from the uterus, since it is possible that the tissue is potentially cancerous. Often, the tissue is naturally expelled by the fourth month of pregnancy. In some instances, the physician will give the woman a drug called oxytocin to trigger the release of the mole that is not spontaneously aborted.

If this does not happen, however, a vacuum aspiration can be performed to remove the mole. In a procedure similar to a **dilatation and curettage** (D & C), a woman is given an anesthetic (to deaden feeling during the procedure), her cervix (the structure at the bottom of the uterus) is dilated and the contents of the uterus is gently suctioned out. After the mole has been mostly removed, gentle scraping of the uterus lining is usually performed.

If the woman is older and does not want any more children, the uterus can be surgically removed (**hysterectomy**) instead of a vacuum aspiration because of the higher risk of cancerous moles in this age group.

Because of the cancer risk, the physician will continue to monitor the patient for at least two months

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after the end of a molar pregnancy. Since invasive disease is usually signaled by high levels of hCG that don't go down after the pregnancy has ended, the woman's hCG levels will be checked every two weeks. If the levels don't return to normal by that time, the mole may have become cancerous.

If the hCG level is normal, the woman's hCG will be tested each month for six months, and then every two months for a year.

If the mole has become cancerous, treatment includes removal of the cancerous issue and **chemotherapy**. If the cancer has spread to other parts of the body, radiation will be added. Specific treatment depends on how advanced the cancer is.

Women should make sure not to become pregnant within a year after hCG levels have returned to normal. If a woman were to become pregnant sooner than that, it would be difficult to tell whether the resulting high levels of hCG were caused by the pregnancy or a cancer from the mole.

Prognosis

A woman with a molar pregnancy often goes through the same emotions and sense of loss as does a woman who has a miscarriage. Most of the time, she truly believed she was pregnant and now has suffered a loss of the baby she thought she was carrying. In addition, there is the added worry that the tissue left behind could become cancerous.

In the unlikely case that the mole is cancerous the cure rate is almost 100%. As long as the uterus was not removed, it would still be possible to have a child at a later time.

Resources

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Hydrocelectomy

Definition

Hydrocelectomy, also called hydrocele repair, is the surgical removal of a hydrocele. A hydrocele is a fluid-filled sac along the spermatic cord within a testicle. It forms from a backup of peritoneal (abdominal) fluid in a membrane called the tunica vaginalis, which covers the front and sides of the male testes.

Purpose

A hydrocelectomy is performed to remove a hydrocele and prevent its recurrence. In babies a hydrocelectomy is used to remove a congenital (present at birth) hydrocele that has not resolved on its own by the age of two. In adults hydrocelectomies are used to repair hydroceles that:

- are large, painful, or embarrassing
- cause swelling of the scrotum
- reoccur following aspiration of the hydrocele
- interfere with the blood supply in the testicle
- are associated with an inguinal hernia

Demographics

Hydroceles occur in at least 80% of male infants, but almost always disappear on their own by the age of two. They also can occur in older boys and men. About 1% of adult males over age 40 develop hydroceles.

Description

During development of the male fetus the testicles descend down a tube from the abdomen into the scrotum. Congenital hydroceles are most often caused by a failure of a portion of the testicular membrane—the processus vaginalis that descends with the testicles—to close normally. This failure to close allows peritoneal fluid to flow into the scrotum and becomes trapped. However the processus vaginalis usually closes spontaneously within the first year of life and the hydrocele disappears. The processus does not usually close spontaneously after the age of 18 months.

In adults hydroceles develop slowly and increase and decrease in size over time. They are usually a result either of a defect in the tunica vaginalis that causes overproduction of fluid or a blocked lymphatic flow that may be related to an obstruction in the spermatic cord. The latter type of hydrocele is more common in older men. Hydroceles can also develop from inflammation, injury, or infection of the epididymis or testicle, trauma to the scrotal area, or in association with an inguinal **hernia** or cancerous tumors in the groin.

Hydroceles usually appear as a soft swelling in the membrane surrounding the testes. Hydroceles typically occur in one testis—only 7–10% occur on both sides of the scrotum. They are not usually painful and do not damage the testes; however as the hydrocele fills with fluid some men may experience discomfort or **pain** from the increased size of the scrotum. If a hydrocele occurs in conjunction with **epididymitis** (inflammation of the epididymis), the testis may become painful and inflamed.

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KEY TERMS

Aspiration—The process of removing fluids or gases from the body by suction.

Epididymis—A coiled segment of spermatic duct within the scrotum, attached to the back of the testis.

Epididymitis—Inflammation of the epididymis.

Hydrocele—An accumulation of fluid in the membrane that surrounds the testis.

Inguinal hernia—An opening, weakness, or bulge in the lining of the abdominal wall in the groin area, with protrusion of the large intestine.

Peritoneal fluid—Fluid from the abdominal cavity.

Processus vaginalis—A pouch of the peritoneum (lining of the abdominal cavity) that is carried into the scrotum with the descent of the testicles to become the tunica vaginalis.

Scrotum—The pouch of skin containing the testes, epididymis, and portions of the spermatic cords.

Testis (plural: testes)—The male sex gland, held within the scrotum.

Transillumination—A technique by which a strong light is shone through body tissues to examine an organ or structure.

Tunica vaginalis—A sac-like membrane covering the outer surface of the testis.

Hydroceles can sometimes be diagnosed in a doctor's office by visual examination and palpation (touch). Hydroceles are distinguished from other testicular problems by transillumination (shining a light source through the hydrocele so that the tissue lights up) and ultrasound examinations of the area around the groin and scrotum.

Although the fluid from a hydrocele can be removed through a needle by aspiration, this is usually a temporary measure because the hydrocele often recurs. Aspiration may have longer-term success when certain medications are injected during the procedure (sclerotherapy). However there also is a higher risk of infection with aspiration than with hydrocelectomy.

A hydrocelectomy is performed by a general surgeon or a urologist on an outpatient basis in a clinic, one-day surgery center, or hospital operating room, with no special precautions. Patients are given **general anesthesia**. The extent of the surgery depends on the presence of other problems:

- For a hydrocelectomy in a child, a small incision is made in the fold of the groin, the fluid is drained, and the hydrocele sac is removed. The muscle wall is then strengthened with stitches.
- For an uncomplicated hydrocele in an adult, an incision is made directly into the scrotum. The canal between the abdominal cavity and the scrotum is repaired, the hydrocele sac is removed, the fluid is drained from the scrotum, and the incision is closed with sutures.
- For more complicated hydrocelectomies, such as those associated with an inguinal hernia, the incision is made in the groin area and the hernia or other complicating factor is repaired along with hydrocele removal.
- Sometimes a hydrocelectomy is performed by minimally invasive laparoscopic surgery. A lighted, camera-tipped, tube-like instrument called a laparoscope is inserted through a tiny incision. Instruments can be passed through the laparoscope or inserted through other small incisions. The repair completed by visualizing images on a monitor in the operating room.

Benefits

Hydrocelectomy usually eliminates the hydrocele and completely corrects any underlying defect. Recurrence of hydroceles are rare and the long-term prognosis is excellent.

Precautions

Children can resume normal activities in four to seven days following a hydrocelectomy. Adults can resume most activities within 7 to 10 days, although heavy lifting and sexual activities may be delayed for up to six weeks. There may be swelling of the scrotum for a month or more after the procedure; however prolonged swelling, **fever**, or redness in the incision area should be reported to the surgeon immediately. There have been no reports of **death** following a hydrocele repair.

Preparation

Prior to the hydrocelectomy standard pre-operative blood and urine tests will be performed. Several days before the surgery adults may be asked to stop taking any drugs that affect blood clotting. These include **aspirin**, ibuprofen (Motrin, Advil), naproxen (Naprosyn, Aleve), and some herbal supplements. The patient may be asked to not eat or drink for at least six

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hours before the surgery. An anesthesiologist will discuss the patient's medical history to select the correct type and amount of anesthesia. The physician or nurse will explain the surgical procedure, the type of anesthesia, and, in some cases, the need to insert a temporary drain during surgery to reduce the risk of postoperative infection and fluid accumulation.

Aftercare

Immediately following the hydrocelectomy the patient will be moved to a recovery area and checked for any undue bleeding from the incision. Body temperature and blood pressure will be monitored. Patients usually return home within a few hours. A follow-up visit is usually required several weeks after the surgery to examine the incision for proper healing and any signs infection.

Risks

Hydrocelectomy is considered a very safe surgery, with only a 2% risk of infection or complications. It is possible for a hydrocelectomy to cause injury to spermatic vessels that can affect fertility. Most surgical procedures carry some risk of problems related to anesthesia, including allergic reactions or breathing difficulties. Most surgeries also carry some risk of bleeding from the incision, internal bleeding, **blood clots**, or infection.

Resources

BOOKS

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National Kidney and Urologic Diseases Information Clearinghouse, 3 Information Way, Bethesda, MD, 20892-3580, (703) 738-4929, (800) 891-5390, (703) 738–4929, nkudic@info.niddk.nih.gov, http://kidney.niddk.nih.gov.

L. Lee Culvert
Margaret Alic, PhD

Hydrocephalus

Definition

Hydrocephalus is an abnormal expansion of cavities (ventricles) within the brain that is caused by the accumulation of cerebrospinal fluid. Hydrocephalus comes from two Greek words: *hydros* means water and *cephalus* means head.

There are two main varieties of hydrocephalus: congenital and acquired. An obstruction of the cerebral aqueduct (aqueductal stenosis) is the most frequent cause of congenital hydrocephalus. Acquired hydrocephalus may result from **spina bifida**, intraventricular hemorrhage, **meningitis**, head trauma, tumors, and cysts.

Description

Hydrocephalus is the result of an imbalance between the formation and drainage of cerebrospinal fluid (CSF). Approximately 500 milliliters (about a pint) of CSF is formed within the brain each day, by epidermal cells in structures collectively called the choroid plexus. These cells line chambers called ventricles that are located within the brain. There are four ventricles in a human brain. Once formed, CSF usually circulates among all the ventricles before it is absorbed and returned to the circulatory system. The normal adult volume of circulating CSF is 150 mL. The CSF turn-over rate is more than three times per day. Because production is independent of absorption, reduced absorption causes CSF to accumulate within the ventricles.

There are three different types of hydrocephalus. In the most common variety, reduced absorption occurs when one or more passages connecting the ventricles become blocked. This prevents the movement of CSF to its drainage sites in the subarachnoid space just inside the skull. This type of hydrocephalus is called "noncommunicating." In a second type, a reduction in the absorption rate is caused by damage to the absorptive tissue. This variety is called "communicating hydrocephalus."

Both of these types lead to an elevation of the CSF pressure within the brain. This increased pressure pushes aside the soft tissues of the brain. This squeezes and distorts them. This process also results in damage to these tissues. In infants whose skull bones have not yet fused, the intracranial pressure is partly relieved by expansion of the skull, so that symptoms may not be as dramatic. Both types of elevated-pressure hydrocephalus may occur from infancy to adulthood.

A third type of hydrocephalus, called "normal pressure hydrocephalus," is marked by ventricle enlargement

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without an apparent increase in CSF pressure. This type affects mainly the elderly.

Hydrocephalus has a variety of causes including:

- congenital brain defects
- hemorrhage, either into the ventricles or the subarachnoid space
- infection of the central nervous system (syphilis, herpes, meningitis, encephalitis, or mumps)
- tumor

Hydrocephalus is believed to occur in approximately one to two of every 1,000 live births. The incidence of adult onset hydrocephalus is not known. There is no known way to prevent hydrocephalus.

Causes and symptoms

Hydrocephalus that is congenital (present at birth) is thought to be caused by a complex interaction of genetic and environmental factors. Aqueductal stenosis, an obstruction of the cerebral aqueduct, is the most frequent cause of congenital hydrocephalus. The genetic factors are not well understood. According to the British Association for Spina Bifida and Hydrocephalus, in very rare circumstances, hydrocephalus is due to hereditary factors, which might affect future generations.

Signs and symptoms of elevated-pressure hydrocephalus include:

- headache
- nausea and vomiting, especially in the morning
- lethargy
- disturbances in walking (gait)
- double vision
- subtle difficulties in learning and memory
- delay in children achieving developmental milestones

Irritability is the most common sign of hydrocephalus in infants. If this is not treated, it may lead to lethargy. Bulging of the fontanelles, or the soft spots between the skull bones, may also be an early sign. When hydrocephalus occurs in infants, fusion of the skull bones is prevented. This leads to abnormal expansion of the skull.

Symptoms of normal pressure hydrocephalus include **dementia**, gait abnormalities, and incontinence (involuntary urination or bowel movements).

Diagnosis

Imaging studies—x ray, computed tomography scan (CT scan), ultrasound, and especially **magnetic resonance imaging** (MRI)—are used to assess the presence and location of obstructions, as well as changes in brain tissue that have occurred as a result of the hydrocephalus. **Lumbar puncture** (spinal tap) may be performed to aid in determining the cause when infection is suspected.

Treatment

The primary method of treatment for both elevated and normal pressure hydrocephalus is surgical installation of a shunt. A shunt is a tube connecting the ventricles of the brain to an alternative drainage site, usually the abdominal cavity. A shunt contains a one-way valve to prevent reverse flow of fluid. In some cases of non-communicating hydrocephalus, a direct connection can be made between one of the ventricles and the subarachnoid space, allowing drainage without a shunt.

Installation of a shunt requires lifelong monitoring by the recipient or family members for signs of recurring hydrocephalus due to obstruction or failure of the shunt. Other than monitoring, no other management activity is usually required.

Some drugs may postpone the need for surgery by inhibiting the production of CSF. These include acetazolamide and furosemide. Other drugs that are used to delay surgery include glycerol, **digoxin**, and isosorbide.

Some cases of elevated pressure hydrocephalus may be avoided by preventing or treating the infectious diseases which precede them. Prenatal diagnosis of congenital brain malformation is often possible, offering the option of family planning.

Prognosis

The prognosis for elevated-pressure hydrocephalus depends on a wide variety of factors, including the cause, age of onset, and the timing of surgery. Studies indicate that about half of all children who receive appropriate treatment and follow-up will develop IQs greater than 85. Those with hydrocephalus at birth do better than those with later onset due to meningitis. For individuals with normal pressure hydrocephalus, approximately half will benefit by the installation of a shunt.

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ORGANIZATIONS

Association for Spina Bifida and Hydrocephalus, 42 Park Rd, Peterborough, UK, PE1 2UQ, 44(0173) 355 5988, 44(017) 3355 5985, helpline@asbah.org, http://www.asbah.org.

The Hydrocephalus Foundation, Inc., (HyFI), 910 Rear Broadway, Saugus, MA, 01906, (781) 942-1161, HyFII@netscape.net, http://www.hydrocephalus.org/.

L. Fleming Fallon, MD, PhD, DrPH

Hydrochlorothiazide *see* **Diuretics**
Hydrocodone *see* **Analgesics, opioid**
Hydrogen peroxide *see* **Antiseptics**

Hydronephrosis

Definition

Hydronephrosis is the swelling of the kidneys when urine flow is obstructed in any of part of the urinary tract. Swelling of the ureter, which always accompanies hydronephrosis, is called hydroureter. Hydronephrosis implies that a ureter and the renal pelvis (the connection of the ureter to the kidney) are overfilled with urine.

Description

The kidneys filter urine out of the blood as a waste product. It collects in the renal pelvis and flows down the ureters into the bladder. The ureters are not simple tubes, but muscular passages that actively propel urine into the bladder. At their lower end is a valve (the ureterovesical junction) that prevents urine from flowing backward into the ureter. The bladder stores urine. The prostate gland surrounds the bladder outlet in males. Urine then flows through the urethra and out of the body as a waste product.

Because the urinary tract is closed save for the one opening at the bottom, urine cannot escape. Instead, the parts distend. Rupture is rare unless there is violent trauma like an automobile accident.

Obstructed flow anywhere along the drainage route can cause swelling of the upper urinary tract, but if the obstruction is below the bladder, the ureterovesical valve will protect the upper tract to a certain extent. Even then, with no place to go, the urine will back up all the way to its source. Eventually, the back pressure causes kidney function to deteriorate.

Obstruction need not be complete for problems to arise. Intermittent or partial obstruction is far more common than complete blockage, allowing time for the parts to enlarge gradually. Furthermore, if a ureterovesical valve is absent or incompetent, the pressure generated by bladder emptying will force urine backward into the ureter and kidney, causing dilation even without mechanical obstruction.

Causes and symptoms

Causes are numerous. Various congenital deformities of the ureter may sooner or later produce back pressure. **Kidney stones** are a common cause. They form in the renal pelvis and become lodged in the kidney, usually at the ureterovesical junction. In older men, the continued growth of the prostate gland leads commonly to restricted urine flow out of the bladder. **Prostate cancer**, and **cancer** anywhere else along the urine pathways, can obstruct flow. **Pregnancy** normally causes ureteral obstruction from the pressure of the enlarged uterus (womb) on the ureters.

Symptoms relate to the passage of urine. Sometimes, urine may be difficult to pass, irregular, or uncontrolled. **Pain** from distension of the structures is present. Blood in the urine may be visible, but it is usually microscopic.

In all cases where bodily fluids cannot flow freely, infection is inevitable. Symptoms of urinary infection may include:

- painful, burning urine
- cloudy urine
- pain in the back, flank, or groin
- fever, sweats, chills, and generalized discomfort

Patients often mistake a serious urinary infection for the flu.

Diagnosis

If the bladder is significantly distended, it can be felt through the abdomen. An analysis of the urine may reveal blood (if there is a stone), infection, or chemical changes suggesting kidney damage. Blood tests may also detect a decrease in kidney function.

All urinary obstructions will undergo imaging of some sort. Beginning with standard x rays to look for stones, radiologists, physicians specializing in the use of radiant energy for diagnostic purposes, will select from a wide array of tests. Ultrasound is simple, inexpensive, and very useful for these conditions. Standard x rays can be enhanced with contrast agents in several ways. If the kidneys are functioning, they will filter an x ray dye out of the blood and concentrate it in the urine, giving excellent pictures and also an assessment of kidney function. For better images of the lower urinary tract,

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contrast agents can be instilled from below. This is usually done with a cystoscope placed in the bladder. Through the cystoscope, a small tube can be threaded into the ureter through the ureterovesical valve, allowing dye to be injected all the way up to the kidney. CT and MRI scanning provide miraculous detail, more than is often needed for this condition.

Treatment

The obstruction must be relieved, even if it is partial or functional, as in the case of reflux from the bladder. If not, the kidney will ultimately be damaged, infection will appear, or both. The task may be as simple as placing a catheter through a restricting prostate or as complicated as removing a cancerous bladder and rebuilding a new one with a piece of bowel. In some cases, a badly damaged kidney may have to be removed.

Alternative treatment

Catheters or other urinary diversions may be better for weak or ill patients who cannot tolerate more extensive procedures. There is support using botanical medicine that can help the patient using a catheter avoid infections. Consultation with a trained health care practitioner is necessary.

Prognosis

After relief of the obstruction, a kidney may react with a brief flood of urine, but if the obstruction has been of short duration, normal kidney function will return. If one kidney is destroyed, the other will compensate for the lost organ.

Prevention

Kidney stones can be prevented by dietary changes and medication. Prompt evaluation of infections and urinary complaints will usually detect problems early enough to prevent long-term complications.

ORGANIZATIONS

American Association of Kidney Patients, 3505 E. Frontage Road, Suite 315, Tampa, FL, 33607, (813) 636-8122, (800) 749-2257, info@aakp.org, http://www.aakp.org.

American Kidney Fund (AKF), 6110 Executive Boulevard, Suite 1010, Rockville, MD, 20852, (800) 638-8299, http://www.kidneyfund.org.

National Kidney Foundation, Inc. , 30 East 33rd Street, New York, NY, 10016, (212) 889-2210, (212) 689-9261, (800) 622-9010, http://www.kidney.org/.

J. Ricker Polsdorfer, MD

Hydrotherapy

Definition

Hydrotherapy, or water therapy, is the use of water (hot, cold, steam, or ice) to relieve discomfort and promote physical well-being.

Purpose

Hydrotherapy can soothe sore or inflamed muscles and joints, rehabilitate injured limbs, lower fevers, soothe headaches, promote relaxation, treat **burns** and **frostbite**, ease labor pains, and clear up skin problems. The temperature of water used affects the therapeutic properties of the treatment. Hot water is chosen for its relaxing properties. It is also thought to stimulate the immune system. Tepid water can also be used for **stress reduction**, and may be particularly relaxing in hot weather. Cold water is selected to reduce inflammation. Alternating hot and cold water can stimulate the circulatory system and improve the immune system. Adding herbs and essential oils to water can enhance its therapeutic value. Steam is frequently used as a carrier for essential oils that are inhaled to treat respiratory problems.

Since the late 1990s, hydrotherapy has been used in critical care units to treat a variety of serious conditions, including such disorders of the nervous system as **Guillain-Barré syndrome**.

Description

Origins

The therapeutic use of water has a long history. Ruins of an ancient bath were unearthed in Pakistan and date as far back as 4500 B.C. Bathhouses were an essential part of ancient Roman culture. The use of steam, baths, and aromatic massage to promote well being is documented since the first century. Roman physicians Galen and Celsus wrote of treating patients with warm and cold baths in order to prevent disease.

By the seventeenth and eighteenth centuries, bathhouses were extremely popular with the public throughout Europe. Public bathhouses made their first American appearance in the mid 1700s.

In the early nineteenth century, Sebastien Kneipp, a Bavarian priest and proponent of water healing, began treating his parishioners with cold water applications after he himself was cured of **tuberculosis** through the same methods. Kneipp wrote extensively on the subject, and opened a series of hydrotherapy clinics known as the Kneipp clinics, which are still in operation today.

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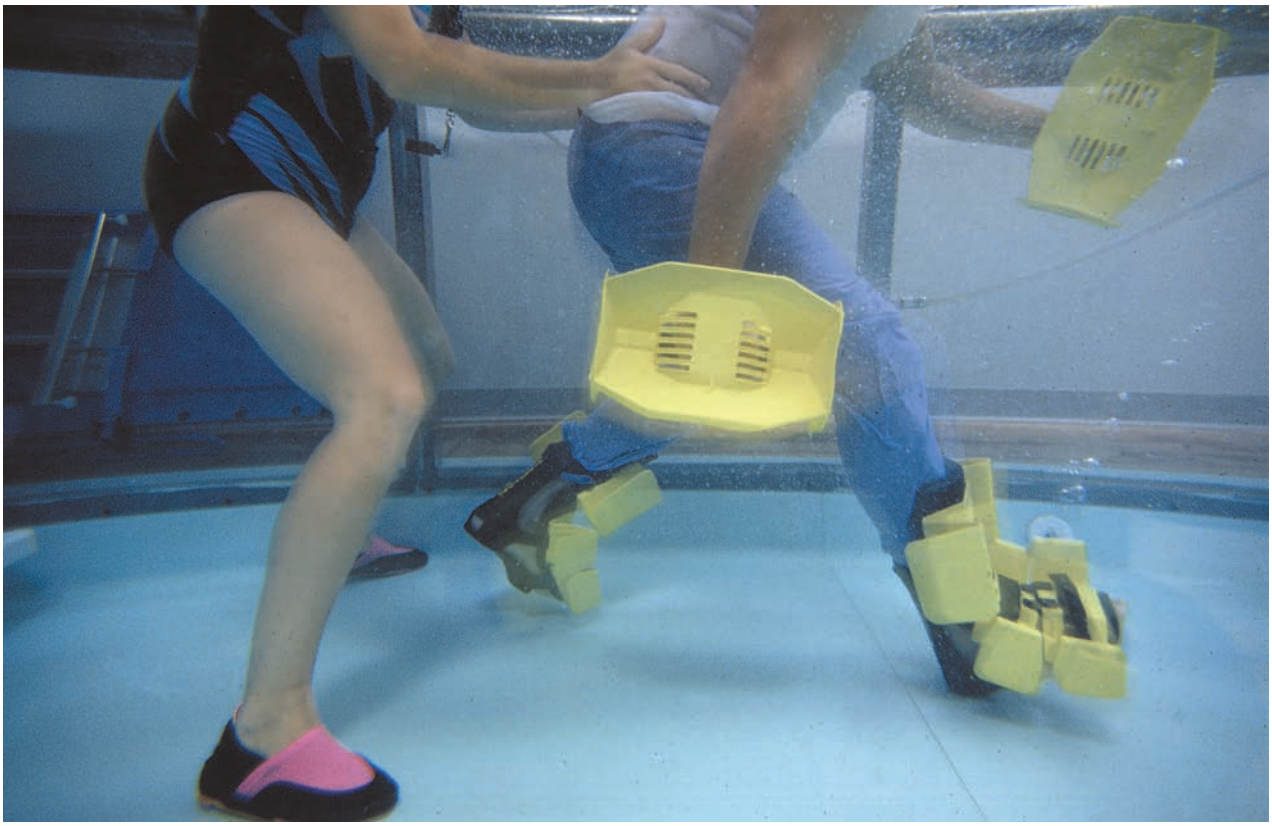

A patient (holding paddles) is undergoing a hydrotherapy treatment. *(Will & Deni McIntyre/Photo Researchers, Inc.)*

Around the same time in Austria, Vincenz Priessnitz was treating patients with baths, packs, and showers of cold spring water. Priessnitz also opened a spa that treated over 1,500 patients in its first year of operation, and became a model for physicians and other specialists to learn the techniques of hydrotherapy.

Water can be used therapeutically in a number of ways. Common forms of hydrotherapy include:

- Whirlpools, jacuzzis, and hot tubs. These soaking tubs use jet streams to massage the body. They are frequently used by physical therapists to help injured patients regain muscle strength and to soothe joint and muscle pain. Some midwives and obstetricians also approve of the use of hot tubs to soothe the pain of labor.
- Pools and Hubbard tanks. Physical therapists and rehabilitation specialists may prescribe underwater pool exercises as a low-impact method of rebuilding muscle strength in injured patients. The buoyancy experienced during pool immersion also helps ease pain in conditions such as arthritis.
- Baths. Tepid baths are prescribed to reduce a fever. Baths are also one of the oldest forms of relaxation therapy. Aromatherapists often recommend adding essential oils of lavender (*Lavandula angustifolia*) to a warm to hot bath to promote relaxation and stress reduction. Adding Epsom salts (magnesium sulfate) or Dead Sea salts to a bath can also promote relaxation and soothe rheumatism and arthritis.
- Showers. Showers are often prescribed to stimulate the circulation. Water jets from a shower head are also used to massage sore muscles. In addition, showering hydrotherapy has been shown to be preferable to immersion hydrotherapy for treating burn patients.
- Moist compresses. Cold, moist compresses can reduce swelling and inflammation of an injury. They can also be used to cool a fever and treat a headache. Hot or warm compresses are useful for soothing muscle aches and treating abscesses.
- Steam treatments and saunas. Steam rooms and saunas are recommended to open the skin pores and cleanse the body of toxins. Steam inhalation is prescribed to treat respiratory infections. Adding botanicals to the steam bath can increase its therapeutic value.
- Internal hydrotherapy. Colonic irrigation is an enema that is designed to cleanse the entire bowel. Proponents of the therapy say it can cure a number of

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VINZENZ PRIESSNITZ (1799–1851)

Hydrotherapy inventor Vinzenz Priessnitz was the son of a Silesian farmer from a remote Austrian territory in the Jeseniky Mountains. From the age of 12, Priessnitz dutifully provided for his blind father, his elderly mother, and his sister. His formal education was sporadic at best. However, Priessnitz possessed a level head and a high degree of intelligence along with a keen and active mind. As he matured he became extremely aware of his surroundings in nature.

At age 16, Priessnitz fell from a horse and was seriously hoofed by the animal. He received the morbid prognosis that he might be crippled at best, or might die at worst. He set to treating his own chest wound with cold packs, in emulation of a doe that he had once observed bathing a wound in a cool mountain stream. The hydrotherapy regimen proved highly effective and drew considerable attention to his small hometown of Gräfenberg. In 1822 he rebuilt the family home, renovating its wooden frame into a solid brick spa structure. The spa, known as the castle, housed as many as 1,500 guests each year by 1939. Among the guests were medical professionals who were intent upon exposing the therapy as a sham.

Detractors notwithstanding, word of the simple and effective treatment spread to Vienna, where Priessnitz traveled on occasion to provide counsel at the emperor's court. Priessnitz, for his remarkable discovery, received the Austrian Gold Civil Merit Medal First Class, the highest civilian honor of the Austrian government.

Priessnitz died on November 28, 1851. He was survived by a wife, Zofie Priessnitz, and a young son, Vinzenz Pavel. Joseph Schindler took over the operation of the spa at Gräfenberg following the death of its founder.

digestive problems. Douching, another form of internal hydrotherapy, directs a stream of water into the vagina for cleansing purposes. The water may or may not contain medications or other substances. Douches can be self-administered with kits available at most drug stores.

Preparations

Because of the expense of the equipment and the expertise required to administer effective treatment, hydrotherapy with pools, whirlpools, Hubbard tanks, and saunas is best taken in a professional healthcare facility, and/or under the supervision of a healthcare professional. However, baths, steam inhalation treatments, and compresses can be easily administered at home.

Bath preparations

Warm to hot bath water should be used for relaxation purposes, and a tepid bath is recommended for reducing fevers. Herbs can greatly enhance the therapeutic value of the bath for a variety of illnesses and minor discomforts.

Herbs for the bath can be added to the bath in two ways—as essential oils or whole herbs and flowers. Whole herbs and flowers can be placed in a muslin or cheesecloth bag that is tied at the top to make an herbal bath bag. The herbal bath bag is then soaked in the warm tub, and can remain there throughout the bath. When using essential oils, add five to 10 drops of oil to a full tub. Oils can be combined to enhance their therapeutic value. Marjoram (*Origanum marjorana*) is good for relieving sore muscles; juniper (*Juniperus communis*) is recommended as a detoxifying agent for the treatment of arthritis; lavender, ylang ylang (*Cananga odorata*), and chamomile (*Chamaemelum nobilis*) are recommended for **stress** relief; cypress (*Cupressus sempervirens*), yarrow (*Achillea millefolium*), geranium (*Pelargonium graveolens*), clary sage (*Savlia sclaria*), and myrtle (*Myrtus communis*) can promote healing of **hemorrhoids**; and spike lavender and juniper (*Juniperus communis*) are recommended for rheumatism.

To prepare salts for the bath, add one or two handfuls of epsom salts or Dead Sea salts to boiling water until they are dissolved, and then add them to the tub.

A **sitz bath**, or hip bath, can also be taken at home to treat hemorrhoids and promote healing of an **episiotomy**. There is special apparatus available for taking a seated sitz bath, but it can also be taken in a regular tub partially filled with warm water.

Steam inhalation

Steam inhalation treatments can be easily administered with a bowl of steaming water and a large towel. For colds and other conditions with nasal congestion, aromatherapists recommend adding five drops of an essential oil that has decongestant properties, such as peppermint (*Mentha piperita*) and eucalyptus blue gum (*Eucalyptus globulus*). Oils that act as **expectorants**, such as myrtle (*Myrtus communis*) or rosemary (*Rosmarinus officinalis*), can also be used. After the oil is added, the individual should lean over the bowl of water and place the towel over head to trap the steam. After approximately three minutes of inhaling the steam, with eyes closed, the towel can be removed.

Other herbs and essential oils that can be beneficial in steam inhalation include:

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- tea tree oil (*Melaleuca alternaifolia*) for bronchitis and sinus infections
- sandalwood (*Santalum album*), virginian cedarwood (*Juniperus virginiana*), and frankincense (*Boswellia carteri*) for sore throat
- lavender (*Lavandula angustifolia*) and thyme (*Thymus vulgaris*) for cough

Compresses

A cold compress is prepared by soaking a cloth or cotton pad in cold water and then applying it to the area of injury or distress. When the cloth reaches room temperature, it should be resoaked and reapplied. Applying gentle pressure to the compress with the hand may be useful. Cold compresses are generally used to reduce swelling, minimize bruising, and to treat headaches and sprains.

Warm or hot compresses are used to treat abscesses and muscle aches. A warm compress is prepared in the same manner as a cold compress, except steaming water is used to wet the cloth instead of cold water. Warm compresses should be refreshed and reapplied after they cool to room temperature.

Essential oils may be added to moist compresses to increase the therapeutic value of the treatment. Peppermint, a cooling oil, is especially effective when added to cold compresses. To add oils to compresses, place five drops of the oil into the bowl of water the compress is to be soaked in. Never apply essential oils directly to a cloth, as they may irritate the skin in undiluted form.

Precautions

Individuals with **paralysis**, frostbite, or other conditions that impair the nerve endings and cause reduced sensation should only take hydrotherapy treatments under the guidance of a trained hydrotherapist, physical therapist, or other appropriate healthcare professional. Because these individuals cannot accurately sense temperature changes in the water, they run the risk of being seriously burned without proper supervision. Diabetics and people with **hypertension** should also consult their healthcare professional before using hot tubs or other heat hydrotherapies.

Hot tubs, jacuzzis, and pools can become breeding grounds for bacteria and other infectious organisms if they are not cleaned regularly, maintained properly, kept at the appropriate temperatures, and treated with the proper chemicals. Individuals should check with their healthcare provider to ensure that the hydrotherapy equipment they are using is sanitary. Those who are using hot tubs and other hydrotherapy equipment in their homes should follow the directions for use and maintenance provided by the original equipment manufacturer.

Certain essential oils should not be used by pregnant or nursing women or by people with specific illnesses or physical conditions. Individuals suffering from any chronic or acute health condition should inform their healthcare provider before starting treatment with any essential oil.

Essential oils such as cinnamon leaf, juniper, lemon, eucalyptus blue gum, peppermint, and thyme can be extremely irritating to the skin if applied in full concentration. Oils used in hydrotherapy should always be diluted in water before they are applied to the skin. Individuals should never apply essential oils directly to the skin unless directed to do so by a trained healthcare professional and/or aromatherapist.

Colonic irrigation should only be performed by a healthcare professional. Pregnant women should never douche, as the practice can introduce bacteria into the vagina and uterus. They should also avoid using hot tubs without the consent of their healthcare provider.

The vagina is self-cleansing, and douches have been known to upset the balance of vaginal pH and flora, promoting vaginitis and other infections. Some studies have linked excessive vaginal douching to increased incidence of **pelvic inflammatory disease** (PID).

Side effects

Most forms of hydrotherapy are well tolerated. There is a risk of allergic reaction (also known as **contact dermatitis**) for some patients using essential oils and herbs in their bath water. These individuals may want to test for allergic sensitization to herbs by performing a skin patch test (i.e., rubbing a small amount of diluted herb on the inside of their elbow and observing the spot for redness and irritation). People who experience an allergic reaction to an essential oil should discontinue its use and contact their healthcare professional for further guidance.

The most serious possible side effect of hydrotherapy is overheating, which may occur when an individual spends too much time in a hot tub or jacuzzi. However, when properly supervised, this is a minimal risk.

Research and general acceptance

Hydrotherapy treatments are used by both allopathic and complementary medicine to treat a wide variety of discomforts and disorders. Not as well accepted are invasive hydrotherapy techniques, such as colonic irrigation, **enemas**, and douching. These internal cleansing techniques can actually harm an individual by upsetting the

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natural balance of the digestive tract and the vagina. Most conventional medical professionals agree that vaginal douches are not necessary to promote hygiene in most women, and can actually do more harm than good.

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American Association of Naturopathic Physicians, 4435 Wisconsin Avenue, NW, Suite 403 , Washington, DC, 20016, (202) 237-8150, (202) 237-8152, (866) 538-2267, mem ber.services@naturopathic.org, http://naturopathic.org/.

Canadian Association of Naturopathic Doctors, 20 Holly St., Ste. 200, Toronto, Ontario, M4S 3B1, Canada, (416) 496-8633, (416) 496-8634, (800) 551-4381, http://www.cand.ca.

Paula Anne Ford-Martin
Rebecca J. Frey, PhD

Hydroxzine *see* **Anti-itch drugs**

Hyperactivity *see* **Attention deficit hyperactivity disorder (ADHD)**

Hyperaldosteronism

Definition

Hyperaldosteronism is a disorder which is defined by the body's overproduction of aldosterone, a hormone that controls **sodium** and potassium levels in the blood. Its overproduction leads to retention of salt and loss of potassium, which leads to **hypertension** (high blood pressure).

Description

Also known as Conn's syndrome, primary aldosteronism, and secondary aldosteronism, this disorder takes several forms. It often begins with a tumor that produces aldosterone. In fact, approximately 60–70% of the cases of primary aldosteronism result from tumors in the adrenal gland area. Aldosterone is normally produced by the adrenal cortex, or the outer portion of the gland that rests on top of each kidney. Primary aldosteronism is due to adenoma, a typically benign tumor in which the cells form to act as glands or cause the glands on which they rest to overproduce. It can cause a number of problems, most notably hypertension. In secondary aldosteronism, factors outside the adrenal gland may cause overproduction of aldosterone, or overproduction of renin, an enzyme stored in the kidney area that stimulates aldosterone and raises blood pressure. Obstructive renal artery disease may also cause hypertension from elevated renin stimulating aldosterone. **Oral contraceptives** have been known to increase the secretion of aldosterone in some patients. This disorder is more common in women.

Causes and symptoms

Hyperaldosteronism is most often caused by the invasion of adenoma. Other adrenal cancers and hyperplasia, or the increase in the bulk of an organ due to increased cell production, may also cause hyperaldosteronism. Those diseases and factors influencing the adrenal and kidney functions may lead to secondary aldosteronism. The primary symptom of hyperaldosteronism is moderate hypertension, or high blood pressure. In addition, a patient may experience **orthostatic hypotension**, or reduced blood pressure when a person stands after lying down. **Constipation**, muscle weakness (sometimes to the point of **periodic paralysis**), excessive urination, excessive thirst, **headache**, and personality changes are also possible symptoms. Some patients will show no obvious symptoms.

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Diagnosis

Screening tests can be conducted to pinpoint a diagnosis of hyperaldosteronism. If a patient is taking drugs to reduce high blood pressure, the physician may order these drugs stopped for a time period before conducting tests, since these drugs will affect results. Blood and urine tests may be conducted to check for levels of aldosterone, potassium levels, or renin activity. A computed tomography scan (CT scan) may be ordered to detect tumors as small as 5–7 mm. These combined tests approach 95% accuracy for detecting aldosterone-producing adenoma. Laboratory findings recording blood pressure, **edema**, and aldosterone and **plasma renin activity** can help the physician differentiate between primary aldosteronism and secondary aldosteronism.

Treatment

Once the physician has made a diagnosis of hyperaldosteronism, the adrenal glands should be checked for possible adenomas. This can be done through imaging or with a surgical dissection of the gland. Surgical or ablative treatment will vary depending on the number of tumors found. Since more than 60% of hyperaldosteronism cases are caused by these tumors, treatment of the tumors will help eliminate the resulting high blood pressure in many patients. Some patients will receive **antihypertensive drugs**, like **calcium channel blockers**, to control high blood pressure. The use of **diuretics** can help control hypertension by reducing volume. Potassium levels should be considered in the type of diuretic ordered and the levels should be checked throughout treatment. The most widely used drug for treatment of hyperaldosteronism is spironolactone. This drug helps control aldosterone, but should not be prescribed for some patients, especially those with certain kidney diseases. Spironolactone has several possible adverse effects, depending on the dosage. In all cases of hyperaldosteronism, the treatment should be carefully based on the specific type or underlying cause of the disorder.

Alternative treatment

Patients may choose to work with their physician or alternative provider to control hypertension with diet, **stress reduction** (including massage, **meditation**, **biofeedback**, and **yoga**), and other remedies. Blood pressure elevation needs to be controlled and monitored by frequent blood pressure measurements. There is no alternative treatment known for the underlying adenoma.

Prognosis

Hyperaldosteronism carries with it all the possible complications of high blood pressure, including thickening of arterial walls and a higher risk of **angina**, kidney failure, **stroke**, or **heart attack**. Another possible, and less reversible complication than hypertension, is kidney damage. When primary aldosteronism is caused by a solitary adenoma, the prognosis is good. Once this tumor is removed, blood pressure will drop, and 70% of these patients have full remission. Patients whose hyperaldosteronism results from adrenal hyperplasia will remain hypertensive. However, in up to 70% of patients, blood pressure can be reduced somewhat with drug therapy. Many patients will be faced with the prospect of controlling their hypertension for the remainder of their lives.

Prevention

There is no known prevention for most causes of hyperaldosteronism.

Resources

OTHER

Hypertension Network. http://www.bloodpressure.com.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

American Society of Hypertension, 148 Madison Avenue, Fifth Floor, New York, NY, 10016, (212) 696-9099, (212) 696-0711, ash@ash-us.org, http://www.ash-us. org/.

National Heart Lung and Blood Institute Health Informa tion Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

Teresa Odle

Hyperbaric chamber

Definition

A hyperbaric chamber is a room that allows an individual to breathe 100% pure oxygen at greater than 1 standard atmosphere of pressure.

Purpose

Hyperbaric chambers are used to deliver hyperbaric **oxygen therapy** (HBOT). HBOT was developed

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Patient lying in a hyperbaric chamber. *(© Chuck Mason/ Alamy.)*

to treat underwater divers suffering from **decompression sickness** (the bends). It has since been approved by the Undersea and Hyperbaric Medical Society for 13 conditions including:

- air or gas embolism
- carbon monoxide (CO) poisoning
- smoke inhalation
- gas gangrene caused by certain bacteria
- decompression sickness
- radiation tissue damage
- thermal burns
- non-healing skin grafts
- crush injuries
- wounds that fail to heal through conventional treatment
- serious blood loss
- intracranial abscess

Although hyperbaric therapy has become increasingly popular for other uses, especially in sports medicine, its use is controversial. Terrell Owens of the Philadelphia Eagles used HBOT for an ankle injury prior to playing in the Super Bowl in 2005, but medical professionals questioned the appropriateness of this treatment.

Precautions

Individuals who have lung disease, including **asthma**, **emphysema**, obstructive lung disease, or any condition in which air is trapped in the lungs, are poor candidates for this therapy and should discuss the relative benefits and drawbacks of HBOT with their doctor. Individuals who have had chest surgery or who have had a central venous catheter implanted are also at higher risk for complications. People with seizure disorders should be carefully monitored, as this treatment may increase the risk and severity of seizures. People with colds or clogged ears may want to wait to undergo HBOT, as they may experience difficulties with pressure equalization that can cause damage to the middle or inner ear. HBOT in **pregnancy** is controversial. Individuals with diabetes may need to adjust their glucose and insulin balance, since HBOT slows the absorption of insulin.

Description

At normal atmospheric pressure, oxygen binds with a molecule in red blood cells called hemoglobin. The oxygen is carried through the body to tissues where it is needed as the blood circulates. Under normal conditions, almost all (about 97%) of the available hemoglobin carries oxygen. Increasing the atmospheric pressure does little to increase the oxygen-carrying capacity of the blood. However, under normal conditions, only a small amount of oxygen is dissolved in the fluid that carries the red blood cells (blood plasma). Increasing the atmospheric pressure to two to three times normal and breathing 100% oxygen forces more oxygen to dissolve into the blood plasma. In this way, hyperbaric chambers increase the amount of oxygen circulating in the body. This can promote healing in areas that are not receiving adequate oxygen. The extra oxygen can also help to cure certain infections caused by anerobic bacteria that can live only in the absence of oxygen.

There are two types of hyperbaric chambers—monoplace and multiplace. Monoplace chambers accommodate a single person. The patient enters the chamber, then it is closed and the pressure is increased. The advantages of a monoplace chamber are that the patient does not have to wear a mask or a hood to receive the oxygen and the treatment regimen is designed specifically for each individual. The major disadvantages are that the patient is inaccessible to the staff during treatment should an emergency arise, and the pure oxygen atmosphere creates an increased fire hazard. In multiplace chambers, several patients use the same chamber simultaneously. Each person is given oxygen through a face mask or hood, but all patients receive the same treatment. A staff member remains in the chamber throughout the procedure.

Hyperbaric chambers can be associated with hospitals, but are increasingly part of free-standing clinics. Insurance may cover the cost of treatment for approved indications such as **carbon monoxide poisoning**, but may reject payment for uses that are considered experimental or controversial. The American Board of Medical Specialists certifies physician competency in the undersea medicine, including the use of hyperbaric chambers. The Baromedical Nurses Association offers three levels of certification for

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hyperbaric nurses, and the National Board of Hyperbaric Medicine Technology certifies hyperbaric technicians. Individuals considering hyperbaric therapy should seek facilities run by health care providers credentialed by these organizations.

Preparation

No special preparation is needed to use a hyperbaric chamber other than educating patients about what to expect during treatment.

Aftercare

After HBOT is complete, a period of decompression in the chamber is required until the pressure in the chamber is equal to the pressure outside. Serious complications can occur if decompression occurs suddenly.

Risks

Hyperbaric chambers, because of their use of 100% oxygen, present a potential fire risk. In addition, although hyperbaric oxygen therapy is very safe when used correctly, complications can occur. Oxygen **poisoning**, also called oxygen toxicity, can occur when an individual is exposed to high doses of oxygen for a prolonged period. Excess oxygen causes chemical changes in the body that negatively affect cells and metabolic processes. Symptoms of oxygen poisoning include **nausea**, **vomiting**, dry **cough**, seizures, chest **pain**, sweating, muscle twitching, ringing of the ears, **hallucinations**, **dizziness**, **shortness of breath** and a decreased level of consciousness.

Other complications can occur as the result of increased pressure within the chamber. These include pain and bloody discharge from congested sinuses, ear pain, rupture of the eardrum, and bleeding from the ear if the Eustachian tube that connects the ear to the back of the throat is clogged and pressure on either side of the eardrum is not equalized. Teeth that are infected or have been repaired may become painful or explode if gas is trapped within them. A few individuals develop **pneumothorax**. This is a serious condition where air is trapped between the lungs and the chest cavity.

Normal results

HBOT is expected to promote healing and improve the health of individuals with conditions for which it is approved.

Abnormal results

Under some conditions HBOT fails to cause improvement or complications occur.

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ORGANIZATIONS

Undersea and Hyperbaric Medical Society, 21 West Colony Place, Suite 280, Durham, NC, 27705, (919) 490-5140, (919) 490-5149, (877) 533-UHMS (8467), uhms@uhms@org, http://www.uhms.org.

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Hyperbaric oxygenation *see* **Oxygen/ozone therapy**

Hyperbilirubinemia *see* **Neonatal jaundice**

Hypercalcemia

Definition

Hypercalcemia is an abnormally high level of **calcium** in the blood, usually more than 10.5 milligrams per deciliter of blood.

Description

Calcium plays an important role in the development and maintenance of bones in the body. It is also needed in tooth formation and is important in other body functions. Normally, the body maintains a balance between the amount of calcium in food sources and the calcium already available in the body's tissues. The balance can be upset if excess amounts of calcium are eaten or if the body is unable to process the mineral because of disease.

Calcium is one of the most important and most abundant **minerals** in the human body. Dairy products are the major source of calcium. Eggs, green leafy vegetables, broccoli, legumes, nuts, and whole grains provide

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smaller amounts. Only about 10–30% of the calcium in food is absorbed into the body. Most calcium is found in combination with other dietary components and must be broken down by the digestive system before it can be used. Calcium is absorbed into the body in the small intestine. Its absorption is influenced by such factors as the amount of vitamin D hormone available to aid the process and the levels of calcium already present in the body. As much as 99% of the body's calcium is stored in bone tissue. A healthy person experiences a constant turnover of calcium as bone tissue is built and reshaped. The remaining 1% of the body's calcium circulates in the blood and other body fluids. Circulating calcium plays an important role in the control of many body functions, such as blood clotting, transmission of nerve impulses, muscle contraction, and other metabolic activities. In the bloodstream, calcium maintains a constant balance with another mineral, phosphate.

Two main control agents are vital in maintaining calcium levels, vitamin D hormone and parathyroid hormone. A hormone is a chemical substance that is formed in one organ or part of the body and carried in the blood to another organ. It can alter the function, and sometimes the structure, of one or more organs.

- Parathyroid hormone (PTH). The four parathyroid glands are endocrine glands located next to the thyroid gland in the neck. A gland is a cell or group of cells that produces a material substance (secretion). When the level of calcium circulating in the blood drops, the parathyroid gland releases its hormone. PTH then acts in three ways to restore the normal blood calcium level. It stimulates the absorption of more calcium in the intestine; it takes more calcium from the bone tissue, and it causes the kidneys to excrete more phosphate.
- Vitamin D hormone. This hormone works with parathyroid hormone to control calcium absorption and affects the deposit of calcium and phosphate in the bone tissue.

The kidneys also help to control calcium levels. Healthy kidneys can increase calcium excretion almost fivefold to maintain normal concentrations in the body. Hypercalcemia can occur when the concentration of calcium overwhelms the ability of the kidneys to maintain balance.

Causes and symptoms

Causes of hypercalcemia

Many different conditions can cause hypercalcemia; the most common are **hyperparathyroidism** and **cancer**.

PRIMARY HYPERPARATHYROIDISM. Primary hyperparathyroidism is the excessive secretion of parathyroid hormone by one or more of the parathyroid glands. It is the most common cause of hypercalcemia in the general population. Women have this condition more frequently than men do, and it is more common in older people. It can appear 30 or more years after radiation treatments to the neck. Ninety percent of the cases of primary hyperparathyroidism are caused by a nonmalignant growth on the gland.

Hyperparathyroidism can also occur as part of a rare hereditary disease called multiple endocrine neoplasia. In this disease, tumors develop on the parathyroid gland.

CANCER. People with cancer often have hypercalcemia. In fact, it is the most common life-threatening metabolic disorder associated with cancer. Ten to 20 percent of all persons with cancer have hypercalcemia. Cancers of the breast, lung, head and neck, and kidney are frequently associated with hypercalcemia. It also occurs frequently in association with certain cancers of the blood, particularly malignant myeloma. It is seen most often in patients with tumors of the lung (25–35%) and breast (20–40%), according to the National Cancer Institute. Cancer causes hypercalcemia in two ways. When a tumor grows into the bone, it destroys bony tissue (osteolysis). When the bone is not involved, factors secreted by cancer cells can increase calcium levels (humoral hypercalcemia of malignancy). The two mechanisms may operate at the same time.

Because immobility causes an increase in the loss of calcium from bone, cancer patients who are weak and spend most of their time in bed are more prone to hypercalcemia. Cancer patients are often dehydrated because they take in inadequate amounts of food and fluids and often suffer from **nausea and vomiting**. **Dehydration** reduces the ability of the kidneys to remove excess calcium from the body. Hormones and **diuretics** that increase the amount of fluid released by the body can also trigger hypercalcemia.

OTHER CAUSES. Other conditions can cause hypercalcemia. Excessive intake of vitamin D increases intestinal absorption of calcium. During therapy for peptic ulcers, abnormally high amounts of calcium **antacids** are sometimes taken. Over use of antacids can cause milk-alkali syndrome and hypercalcemia. Diseases such as Paget's, in which bone is destroyed or reabsorbed, can also cause hypercalcemia. As in cancer or **paralysis** of the arms and legs, any condition

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in which the patient is immobilized for long periods of time can lead to hypercalcemia due to bone loss.

Common symptoms

Many patients with mild hypercalcemia have no symptoms and the condition is discovered during routine laboratory screening. Gastrointestinal symptoms include loss of appetite, **nausea**, **vomiting**, **constipation**, and abdominal **pain**. There may be a blockage in the bowel. If the kidneys are involved, the individual will have to urinate frequently during both the day and night and will be very thirsty. As the calcium levels rise, the symptoms become more serious. Stones may form in the kidneys and waste products can build up. Blood pressure rises. The heart rhythm may change. Muscles become increasingly weak. The individual may experience mood swings, confusion, **psychosis**, and eventually, **coma** and **death**.

Diagnosis

High levels of calcium in the blood are a good indication of hypercalcemia, but these levels may fluctuate. Calcium levels are influenced by other compounds in the blood that may combine with calcium. Higher calcium and lower phosphate levels may suggest primary hyperparathyroidism. The blood levels of protein (serum albumin) and parathyroid hormone (PTH) are also measured in the diagnosis of hypercalcemia. Too much PTH in the blood may indicate primary hyperparathyroidism. Levels of calcium and phosphate in the urine should also be measured. The medical history and physical condition of the individual must be taken into consideration, especially in the early stages of hypercalcemia when symptoms are mild.

Treatment

The treatment of hypercalcemia depends on how high the calcium level is and what is causing the elevation. Hypercalcemia can be life-threatening and rapid reduction may be necessary. If the patient has normal kidney function, fluids can be given by vein (intravenously) to clear the excess calcium. The amount of fluid taken in and eliminated must be carefully monitored. If the patient's kidneys are not working well, acute hemodyalysis is probably the safest and most effective method to reduce dangerous calcium levels. In this procedure, blood is circulated through tubes made of semi-permeable membranes against a special solution that filters out unwanted substances before returning the blood to the body.

Drugs such as furosemide, called loop diuretics, can be given after adequate fluid intake is established. These drugs inhibit calcium reabsorption in the kidneys and promote urine production. Drugs that inhibit bone loss, such as calcitonin, biphosphates, and plicamycin, are helpful in achieving long-term control. Phosphate pills help lower high calcium levels caused by a deficiency in phosphate. Anti-inflammatory agents such as **steroids** are helpful with some cancers and toxic levels of vitamin D.

Treatment of the underlying cause of the hypercalcemia will also correct the imbalance. Hyperparathyroidism is usually treated by surgical removal of one or more of the parathyroid glands and any tissue, other than the glands themselves, that is producing excessive amounts of the hormone.

The hypercalcemia caused by cancer is difficult to treat without controlling the cancer. Symptoms can be alleviated with fluids and drug therapy as outlined above.

Prognosis

Surgery to remove the parathyroid glands and any misplaced tissue that is producing excessive amounts of hormone succeeds in about 90% of all cases. Outcome is also influenced by whether any damage to the kidneys can be reversed.

Mild hypercalcemia can be controlled through good fluid intake and the use of effective drugs.

Hypercalcemia generally develops as a late complication of cancer and the expected outlook is grim without effective anticancer therapy.

Prevention

People with cancer who are at risk of developing hypercalcemia should be familiar with early symptoms and know when to see a doctor. Good fluid intake (up to four quarts of liquid a day if possible), controlling nausea and vomiting, paying attention to fevers, and keeping physically active as much as possible can help prevent problems. Dietary calcium restriction is not necessary because hypercalcemia reduces absorption of calcium in the intestine.

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Hypercholesterolemia

Definition

Hypercholesterolemia refers to levels of cholesterol in the blood that are higher than normal.

Description

Cholesterol circulates in the blood stream. It is an essential molecule for the human body. Cholesterol is a molecule from which hormones and **steroids** are made. It is also used to maintain nerve cells. Between 75 and 80% of the cholesterol that circulates in a person's bloodstream is made in that person's liver. The remainder is acquired from outside sources. Cholesterol is found in animal sources of food. It is not found in plants.

Normal blood cholesterol level is a number derived by laboratory analysis. A normal or desirable cholesterol level is defined as less than 200 mg of cholesterol per deciliter of blood (mg/dL). Blood cholesterol is considered to be borderline when it is in the range of 200 to 239 mg/dL. Elevated cholesterol level is 240 mg/dL or above. Elevated blood cholesterol is considered to be hypercholesterolemia.

Cholesterol has been divided into two major categories: low-density lipoprotein (LDL), the so-called "bad" cholesterol, and high-density lipoprotein (HDL), the so-called "good" cholesterol. Diet, **exercise**, **smoking**, alcohol, and certain illnesses can affect the levels of both types of cholesterol. Eating a high fat diet will increase one's level of LDL cholesterol. Exercising and reducing one's weight will both increase HDL cholesterol and lower LDL cholesterol.

The most common cause of elevated serum cholesterol is eating foods that are rich in saturated fats or contain high levels of cholesterol. Elevated cholesterol also can be caused by an underlying disease that raises blood cholesterol levels such as **diabetes mellitus**, **kidney disease**, **liver disease**, or **hypothyroidism**. It also can be caused by an inherited disorder in which cholesterol is not metabolized properly by the body. **Obesity**, which generally results from eating a diet high in fat, also can lead to elevated cholesterol levels in the blood. This is because obesity itself leads the body to produce excessive amounts of cholesterol.

Hypercholesterolemia increases the risk of heart disease. Elevated levels of circulating cholesterol cause deposits to form inside blood vessels. These deposits, called plaque, are composed of fats deposited from the bloodstream. When the deposits become sufficiently large, they block blood vessels and decrease the flow of blood. These deposits result in a disease process called **atherosclerosis**, which can cause **blood clots** to form that will ultimately stop blood flow. If this happens in the arteries supplying the heart, a **heart attack** will occur. If it happens in the brain, the result is a **stroke** where a portion of brain tissue dies. Atherosclerosis causes more deaths from heart disease than any other single condition. Heart disease has been the leading cause of **death** in the United States for the past half century.

There is a syndrome called familial hypercholesterolemia. Affected persons have consistently high levels of LDL. This leads to early clogging of the coronary arteries. In turn this leads to a heart attack. Among affected males, a first heart attack typically occurs in their 40s to 50s. Approximately 85% of men with this disorder have experienced a heart attack by the time they reach 60 years of age. The incidence of heart attacks among women with this disorder also is increased. However, it is delayed 10 years compared to men. The incidence of familial hypercholesterolemia is seven out of 1,000 people.

Causes and symptoms

Hypercholesterolemia is silent. There are no symptoms that are obvious to the naked eye. It is diagnosed by a blood test or after a heart attack or stroke occurs.

Diagnosis

Hypercholesterolemia is diagnosed by using a blood test. A blood specimen is obtained after the patient does not eat or drink anything (except water) for 12 hours. The **fasting** is done to measure the LDL and HDL cholesterol, which can only be determined accurately in a fasting state. Some experts agree that an acceptable limit for LDL cholesterol as 130 mg/dL, though the National Cholesterol Education Program Adult Treatment Panel III recommended a goal of less than 100mg/dL. Total cholesterol of under 200 mg/dL is thought to be an acceptable range.

Treatment

If an individual's cholesterol is elevated, discussions with a physician should be scheduled to determine what course of treatment may be needed. Initial treatment for hypercholesterolemia usually requires dietary changes to reduce the intake of total fat, saturated fat, and cholesterol. Most health care professionals will recommend that a person's weight and height

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be proportionate. In addition to diet, guidelines recommend exercise to help bring weight and cholesterol to acceptable levels. Further, experts counsel persons with elevated blood cholesterol levels to increase their intake of soluble fiber. Sources of soluble fiber include bran, foods containing whole grains and other sources of indigestible fiber such as lignin. Physicians also recommend that patients with high cholesterol stop smoking as part of first-line therapy for hypercholesterolemia.

The reason for treating elevated cholesterol is to reduce an individual's risk of complications. If a diet low in cholesterol and saturated fats doesn't significantly reduce a person's cholesterol level, medication may be required. For every 1 percent reduction in cholesterol level, the risk of heart disease is reduced by 2 percent. It also is possible to partially reverse atherosclerosis that has already occurred by aggressively lowering cholesterol levels with diet and medications.

Prescription drugs are available to help lower cholesterol levels in the blood. These may be used as first-line therapy in high-risk patients or after about three months of dietary and lifestyle therapy. Cholestyramine, cholestipol, lovastatin, simvastatin, pravastatin, fluvaststin, rosuvastatin, and gemfibrazol are some of the drugs approved for use in the United States. The most often prescribed group of drugs are the statins, which also have been shown in some studies to reduce risk of depression and **dementia**.

Alternative treatment

There are advocates of treatment using **vitamins**, **minerals** and antioxidant substances in relatively high amounts. These amounts generally exceed those provided by the Food and Drug Administration in its Minimum Daily Requirements (MDR). Advocates of such therapies also emphasize increased levels of exercise, attaining an ideal body weight and increasing levels of fiber in one's diet.

Some people have advocated the use of garlic, soy and isoflavones to lower serum cholesterol levels. In 2003, enriched green tea was found to be an effective addition to a low-fat diet for lowering LDL cholesterol in adults.

Prognosis

The prognos is in direct proportion to serum cholesterol levels. People with hypercholesterolemia are at high risk of dying from heart disease.

Many studies have looked at the relationship between elevated cholesterol levels, increased risk for heart attack and death. In one investigation of relatively young males who had no known heart disease, cholesterol levels were measured and participants were followed for six years. During this time, all heart attacks and deaths that occurred among participants were recorded. As serum cholesterol levels increased, so did the risk of experiencing a fatal heart attack. The risk of a fatal heart attack was approximately five times higher among persons having cholesterol levels of 300 mg/dL or more compared to those with cholesterol levels below 200 mg/dL.

The Framingham Heart Study is an ongoing research effort. Cholesterol levels, smoking habits, heart attack rates, and deaths in the population of an entire town have been recorded for over 40 years. After 30 years, more than 85% of persons with cholesterol levels of 180 mg/dL or less were still alive; almost a third of those with cholesterol levels greater than 260 mg/dL had died.

Prevention

Experts suggest the following steps to maintain serum cholesterol within normal limits: an important component is to maintain a normal weight for height and to reduce one's weight if it is inappropriate for height. Changing dietary habits by reducing the amount of fat and cholesterol consumed is advised. Doctors recommend avoiding smoking by not starting or quitting if currently a smoker. Increasing levels of fiber in the diet by including foods such as beans, raw fruits, whole grains and vegetables is receommended. It is important to exercise on a regular basis. Aerobic exercise is especially helpful in reducing serum cholesterol levels.

People from families with a strong history of early heart attacks should be evaluated with a lipid screen. Proper diet, exercise and the use of effective drugs can reduce serum lipid levels.

Nutrition and cardiac experts offer the following suggestions:

- purchasing low-fat or fat-free dairy products such as milk, cheese, sour cream, and yogurt
- eating lean red meats, chicken without skin, and fish
- reducing consumption of foods high in saturated fat such as french fries
- avoiding foods that are rich sources of cholesterol such as eggs, liver, cheese, and bacon
- eating smaller servings

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- keeping a food journal and writing down everything eaten each day
- preparing food by microwaving, boiling, broiling, or baking food instead of frying
- trimming the fat from meat before cooking it.

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ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

American Medical Association, 515 N. State St., Chicago, IL, 60654, (800) 621-8335, http://www.ama-assn.org/.

American Society of Nuclear Cardiology, 4550 Montgomery Ave., Suite 780 North, Bethesda, MD, 20814-3304, (301) 215-7575, (301) 215-7113, info@asnc.org, http://www.asnc.org.

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Hypercoagulation disorders

Definition

Hypercoagulation disorders (or hypercoagulable states or disorders) have the opposite effect of the more common **coagulation disorders**. In hypercoagulation, there is an increased tendency for clotting of the blood, which may put a patient at risk for obstruction of veins and arteries (phlebitis or **pulmonary embolism**).

Description

In normal hemostasis, or the stoppage of bleeding, clots form at the site of the blood vessel's injury. The difference between that sort of clotting and the clotting present in hypercoagulation is that these clots develop in circulating blood.

This disorder can cause clots throughout the body's blood vessels, sometimes creating a condition known as thrombosis. Thrombosis can lead to infarction, or **death** of tissue, as a result of blocked blood supply to the tissue. However, hypercoagulability does not always lead to thrombosis. In **pregnancy** and other hypercoagulable states, the incidence of thrombosis is higher than that of the general population, but is still under 10%. In association with certain genetic disorders, hypercoagulation disorders may be more likely to lead to thrombosis. Hypercoagulation disorders are also known as hyperhomocystinemia, antithrombin III deficiency, factor V leyden, and protein C or protein S deficiency.

Causes and symptoms

Hypercoagulation disorders may be acquired or hereditary. Some of the genetic disorders that lead to hypercoagulation are abnormal clotting factor V, variations in fibrinogen, and deficiencies in proteins C and S. Other body system diseases may lead to these disorders, including diabetes, sickle cell anemia, **congenital heart disease**, lupus, **thalassemia**, polycythemia rubra vera, and others.

Antithrombin III deficiency is a hereditary hypercoagulation disorder that affects both sexes. Symptoms include obstruction of a blood vessel by a clot (thromboembolic disease), vein inflammation (phlebitis), and ulcers of the lower parts of the legs.

The role of proteins C and S is a complex one. In order for coagulation to occur, platelets (small, round fragments in the blood) help contract blood vessels to

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KEY TERMS

Blood clot—A thickening of the blood into a jelly-like substance that helps stop bleeding. Clotting of the blood within a blood vessel can lead to blockage of blood flow.

Embolism—The blockage of a blood vessel by air, blood clot, or other foreign body.

Embolus—An embolus is a clot that has formed in a blood vessel somewhere in the body, often in the heart. It can break away from the wall of the vessel where it was formed, travel through the circulatory system, and become wedged in the brain, causing an embolic stroke. Ischemic strokes can be caused by the formation of a blood clot in one of the cerebral arteries (arteries supplying blood to the brain). If the clot grows large enough it will block blood flow.

Plaque—A deposit, usually of fatty material, on the inside wall of a blood vessel.

Thrombosis—The formation or development of a blood clot or thrombus.

lessen blood loss and to help plug damaged blood vessels. The conversion of platelets into actual clots is a complicated web involving proteins that are identified clotting factors. The factors are carried in the plasma, or liquid portion of the blood. Proteins C and S are two of the clotting factors present in the plasma to help regulate or activate parts of the clotting process. Protein C is considered an anticoagulant. Mutation defects in the proteins may decrease their concentrations in the blood, and may or may not affect their resulting anticoagulant activity.

Factor V is an unstable clotting factor present in plasma. Abnormal factor V resists the changes that normally occur through the influence of protein C, which can also lead to hypercoagulability. Prothrombin, a glycoprotein that converts to thrombin in the early stage of the clotting process, is affected by the presence of these proteins, as well as other clotting factors.

Diagnosis

Examination

The diagnosis of hypercoagulation disorders is completed with a combination of **physical examination**, medical history, and blood tests. An accurate medical history is important to determine possible symptoms and causes of hypercoagulation disorders.

Tests

There are a number of blood tests that can determine the presence or absence of proteins, clotting factors, and platelet counts in the blood. Among the tests used to detect hypercoagulation is the Antithrombin III assay. Protein C and Protein S concentrations can be diagnosed with immunoassay or plasma antigen level tests.

Treatment

Warfarin (Coumadin) and heparin anticoagulants may be administered to reduce the clotting effects and maintain fluidity in the blood. Heparin is an anticoagulant that prevents thrombus formation and is used primarily for liver and lung clots. Heparin works right away, keeping **blood clots** from growing. It usually is injected. In recent years, more physicians have been prescribing low-molecular weight heparin, purified versions of the drug that can be given with less monitoring such as enoxaparin (Lovenox). Warfarin often is used for long-term treatment of blood clots and is taken orally. Patients must work closely with their physicians to constantly monitor its effects and adjust dose if necessary. Too little warfarin can lead to clotting, but too much can thin the blood so much that life-threatening bleeding can occur. The same can be true of low-molecular weight heparin when used on a long-term, at-home basis.

Prognosis

The prognosis for patients with hypercoagulation disorders varies depending on the severity of the clotting and thrombosis. If undetected and untreated, thrombosis could lead to recurrent thrombosis and pulmonary **embolism**, a potentially fatal problem.

Prevention

Hereditary hypercoagulation disorders may not be prevented. Genetic and blood testing may help determine a person's tendency to develop these disorders.

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National Heart, Lung, and Blood Institute, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (204) 629-3246, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi.nih.gov.
National Hemophilia Foundation, 116 West 32nd St., 11th Floor, New York, NY, 10001, (800) 424-2634, http://www.hemophilia.org.

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Hyperemesis gravidarum

Definition

Hyperemesis gravidarum means excessive **vomiting** during **pregnancy**.

Description

In pregnant women, **nausea and vomiting** (morning sickness) are common, affecting up to 80% of pregnancies. Hyperemesis, or extreme nausea and excessive vomiting, occur in about 1% of pregnancies. This condition causes uncontrollable vomiting, severe **dehydration**, and weight loss for the mother. However, hyperemesis gravidarum rarely causes problems for the unborn baby.

Causes and symptoms

The cause of nausea and vomiting during pregnancy is unknown but may be related to the level of certain hormones produced during pregnancy. Hyperemesis is seen more often in first pregnancies and multiple pregnancies (twins, triplets, etc.). The main symptom of hyperemesis is severe vomiting, which causes dehydration and weight loss.

Diagnosis

Although many women with morning sickness feel like they are vomiting everything they eat, they continue to gain weight and are not dehydrated; they do not have hyperemesis gravidarum. Women with this condition will start to show signs of **starvation**, including weight loss. **Physical examination** and laboratory tests of blood and urine samples will be used to help diagnose the condition. One of the most common tests used to help diagnosis and monitor hyperemesis gravidarum is a test for ketones in the urine. Excessive ketones in the urine (ketonuria) indicate that the body is not using carbohydrates from food as fuel and is inadequately trying to break down fat as fuel. Ketonuria is a sign that the body is beginning to operate in starvation mode.

Treatment

Hospitalization is often required. Intravenous fluids with substances that help the body conduct nerve signals (electrolytes) may be given to correct the dehydration and excessive acid in the blood (acidosis). Anti-nausea or sedative medications may be given by injection to stop the vomiting. In some cases, oral medication may be prescribed to control the nausea and vomiting while food is reintroduced. If food cannot be tolerated at all, intravenous **nutritional supplements** may be necessary. Injections of vitamin B_6, in particular, may help overcome nutritional deficiencies that often occur.

Alternative treatment

The severe vomiting associated with hyperemesis gravidarum requires medical attention. Milder episodes of nausea or vomiting may be reduced with deep breathing and relaxation exercises. The use of herbal remedies should be done with extreme caution during pregnancy, especially in the first trimester. Natural remedies to reduce nausea include a teaspoon of cider vinegar in a cup of warm water, or tea made from anise (*Pinpinella anisum*), fennel seed (*Foeniculum vulgare*), red raspberry (*Rubus idaeus*), or ginger (*Zingiber officinale*). Wristbands can be positioned over **acupressure** points on both wrists. **Aromatherapy** with lavender, rose, or chamomile can be soothing, as can smelling ground ginger. Homeopathic remedies—which use extremely diluted solutions as treatments—can be safe and effective for controlling symptoms in some women.

Prognosis

In virtually all cases, the pregnancy can continue to the successful delivery of a healthy baby.

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Prevention

Although there is no evidence that hyperemesis gravidarum can be prevented, vomiting during pregnancy sometimes may be lessened. Maintaining a healthy diet, getting adequate sleep, and controlling **stress** may contribute to prevention or improvement of symptoms. Several strategies may help lessen the nausea and vomiting. Eating dry foods and limiting fluid intake may also be helpful. Small meals should be eaten frequently throughout the day, with a protein snack at night. Eating soda crackers before rising from bed in the morning may help prevent early morning nausea. Iron supplements may cause nausea and can be eliminated until the nausea is controlled. Sitting upright for 45 minutes after meals may also help.

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Hyperhidrosis

Definition

Hyperhidrosis is a disorder marked by excessive sweating. It usually begins at **puberty** and affects the palms, soles, and armpits.

Description

Sweating is the body's way of cooling itself and is a normal response to a hot environment or intense **exercise**. Excessive sweating unrelated to these conditions can be a problem for some people. Those with constantly moist hands may feel uncomfortable shaking hands or touching, while others with sweaty armpits and feet may have to contend with the unpleasant odor that results from the bacterial breakdown of sweat and cellular debris (bromhidrosis). People with hyperhidrosis often must change their clothes at least once a day, and their shoes can be ruined by the excess moisture. Hyperhidrosis may contribute to such skin diseases as **athlete's foot** (tinea pedis) and **contact dermatitis**.

In addition to excessive sweat production, the texture and color of the skin itself may be affected by hyperhidrosis. The skin may turn pink or bluish white. Severe hyperhidrosis of the soles of the feet may produce cracks, fissures, and scaling of the skin.

Hyperhidrosis in general and axillary hyperhidrosis (excessive sweating in the armpits) in particular are more common in the general population than was previously thought. A group of dermatologists in Virginia reported in 2004 that 2.8% of the United States population, or about 7.8 million persons, have hyperhidrosis. Of this group, slightly more than half (4 million persons) have axillary hyperhidrosis. One-third of the latter group, or about 1.3 million persons, find that the condition significantly interferes with daily activities and is barely tolerable. Only 38% had ever discussed their excessive sweating with their doctor.

Causes and symptoms

There are three basic forms of hyperhidrosis: emotionally induced; localized; and generalized. Emotionally induced hyperhidrosis typically affects the palms of the hands, soles of the feet, and the armpits. Localized hyperhidrosis typically affects the palms, armpits, groin, face, and the area below the breasts in women, while generalized hyperhidrosis may affect the entire body.

Hyperhidrosis may be either idiopathic (of unknown cause) or secondary to **fever**, metabolic disorders, **alcoholism**, **menopause**, **Hodgkin's lymphoma**, **tuberculosis**, various types of **cancer**, or the use of certain medications. The medications most commonly associated with hyperhidrosis are propranolol, venlafaxine, **tricyclic antidepressants**, pilocarpine, and physostigmine.

Most cases of hyperhidrosis begin during childhood or adolescence. Hyperhidrosis that begins in adult life should prompt the doctor to look for a systemic illness, medication side effect, or metabolic disorder.

Hyperhidrosis affects both sexes equally and may occur in any age group. People of any race may be affected; however, for some unknown reason, Japanese are affected 20 times more frequently than members of other ethnic groups.

Diagnosis

Hyperhidrosis is diagnosed by patient report and a **physical examination**. In many cases the physician can directly observe the excessive sweating.

Tests

The doctor may perform an iodine starch test, which involves spraying the affected areas of the patient's body with a mixture of 500 g of water-soluble

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KEY TERMS

Dermatitis—A skin condition characterized by a red, itchy rash. It may occur when the skin comes in contact with something to which it is sensitive.

starch and 1 g iodine crystals. Areas of the skin producing sweat turn black.

The doctor will order other laboratory or imaging tests if he or she suspects that the sweating is associated with another disease or disorder.

Treatment

Most over-the-counter antiperspirants are not strong enough to effectively prevent hyperhidrosis. To treat the disorder, doctors prescribe 20% aluminum chloride hexahydrate solution (Drysol). It is applied at night to the affected areas and then wrapped in a plastic film until morning. Drysol works by blocking the sweat pores. Formaldehyde and glutaraldehyde-based solutions can also be prescribed; however, formaldehyde may trigger an allergic reaction and glutaraldehyde can stain the skin (for this reason it is primarily applied to the soles).

Drugs

Anticholinergic drugs may be given. These drugs include such medications as propantheline, oxybutynin, and benztropine.

Injections of botulinum toxin (Botox) under the skin work well for some patients. Botox works to stop the excessive sweating by preventing the transmission of nerve impulses to the sweat glands. These injections must be repeated every 4–12 months.

Alternative

An electrical device that emits low-voltage current can be held against the skin to reduce sweating. These treatments are usually conducted in a doctor's office on a daily basis for several weeks, followed by weekly visits. Dermatologists recommend that patients wear clothing made of natural or absorbent fabrics, avoid high-buttoned collars, use talc or cornstarch, and keep underarms shaved.

The only permanent cure for hyperhidrosis of the palms is a surgical procedure known as a **sympathectomy**. To treat severe excessive sweating, a surgeon can remove a portion of the nerve near the top of the spine that controls palm sweat. Few neurosurgeons in the United States will perform the procedure because it often results in compensatory sweating in other regions of the body. Alternatively, it is possible to surgically remove the sweat gland-bearing skin of the armpits, but this is a major procedure that may require skin grafts.

More recently, **liposuction** under the armpits has been successfully used to treat hyperhidrosis in this region of the body. The liposuction removes some of the excess sweat glands responsible for axillary hyperhidrosis. The procedure also has the advantage of leaving smaller **scars** and being less disruptive to the overlying skin.

Prognosis

Hyperhidrosis is not associated with increased mortality; it primarily affects the patient's quality of life rather than longevity. While the condition cannot be cured without radical surgery, it can usually be controlled effectively.

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Hyperhomocystinemia *see* **Hypercoagulation disorders**

Hypericum perforatum see **St. Johns wort**

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Hyperkalemia

Definition

Hyperkalemia refers to serum or plasma levels of potassium ions above 5.5 mEq/L. The concentration of potassium is often expressed in units of milliequivalents per liter (mEq/L). The normal concentration of potassium in the serum is in the range of 3.5–5.0 mEq/L.

Description

A normal adult who weighs about 150 lb (70 kg) contains a total of about 3,500 mEq of potassium stores in the body. Most of this potassium (about 98%) occurs inside various cells (intracellular) and organs, where its concentration is about 150 mEq/L. This level is in contrast to the much lower concentration found in the blood serum, where only about 0.4% of the body's potassium resides. Hyperkalemia can be caused by an overall excess of body potassium, or by a shift from inside to outside cells. For example, hyperkalemia can be caused by the sudden release of potassium ions from muscle into the surrounding fluids.

In a normal person, hyperkalemia from too much potassium in the diet is prevented by at least three types of regulatory processes. First, various cells and organs act to prevent hyperkalemia by taking up potassium from the blood. It is also prevented by the action of the kidneys, which excrete potassium into the urine. A third protective mechanism is **vomiting**. Consumption of a large dose of potassium ions, such as potassium chloride, induces a vomiting reflex to expel most of the potassium before it can be absorbed.

Causes and symptoms

Hyperkalemia can occur from a variety of causes, including the consumption of too much of a potassium salt; failure of the kidneys to normally excrete potassium ions into the urine; leakage of potassium from cells and tissues into the bloodstream; and from acidosis. The most common cause of hyperkalemia is kidney (or renal) disease, which accounts for about three-quarters of all cases. Kidney function is measured by the glomerular filtration rate, the rate at which each kidney performs its continual processing and cleansing of blood. The normal glomerular filtration rate is about 100 mL/min. If the kidney is damaged so that the glomerular filtration rate is only 5 mL/min or less, hyperkalemia may result, especially if high-potassium foods are consumed. The elderly are at particular risk, since many regulatory functions of the body may not work as efficiently in this population. Elderly patients who are being treated with certain drugs for high blood pressure, such as spironolactone (Aldactone) and triamterene (Dyazide), must be monitored for possible hyperkalemia as these medications promote the retention of potassium by the kidneys.

Hyperkalemia can also be caused by a disease of the adrenal gland called **Addison's disease**. The adrenal gland produces the hormone aldosterone that promotes the excretion of potassium into the urine by the kidney.

Injury to muscle or other tissues, including severe **burns** or infections, can also lead to hyperkalemia. Since most of the potassium in the body is contained in muscle, a severe trauma that crushes muscle cells results in an immediate increase in the concentration of potassium in the blood.

Acidic blood plasma, or acidosis, is an occasional cause of hyperkalemia. Acidosis, which occurs in a number of diseases, is defined as an increase in the concentration of hydrogen ions in the bloodstream. In the body's attempt to correct the situation, hydrogen is taken up by muscle cells out of the blood in an exchange mechanism involving the transfer of potassium ions into the bloodstream. This can abnormally elevate the plasma's concentration of potassium ions. When acidosis is the cause of hyperkalemia, treating the patient for acidosis has two benefits: a reversal of both the acidosis and the hyperkalemia.

Symptoms of mild to moderate hyperkalemia are often vague. Many cases of hyperkalemia are discovered incidentally as a result of routine blood laboratory testing. Heart abnormalities of mild hyperkalemia (5.5 to 6.0 mEq/L potassium) can be detected by an electrocardiogram (ECG or EKG). With severe hyperkalemia (over 7.0 mEq/L potassium), the heart may beat at a dangerously rapid rate (fibrillation) or stop beating entirely (cardiac arrest). Patients with moderate or severe hyperkalemia may also develop nervous system symptoms such as **tingling** of the skin, **numbness** of the hands or feet, weakness, or a flaccid **paralysis**, which is characteristic of both hyperkalemia and **hypokalemia** (low plasma potassium).

Diagnosis

The patient's medical history is often an invaluable tool in helping to diagnose hyperkalemia. A history of kidney problems, trauma that involves crushing injuries, burns, consumption of medications that cause the body to retain potassium, and/or consumption of high potassium foods, particularly if kidney function is impaired, may prompt a diagnosis of hyperkalemia.

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KEY TERMS

Acidosis—A medical condition caused by an increase in the concentration of hydrogen ions in the blood. The result of this increase is a lowered (acidic) blood pH level.

Potassium—A chemical element; also referred to as an electrolyte, which is predominantly found inside cells of the body (intracellular). Small changes in potassium levels can have pronounced effects on the cardiovascular and neuromuscular systems.

Tests

Hyperkalemia can be measured by acquiring a sample of blood to measure the concentration of potassium ions in the bloodstream.

Procedures

Since high or low potassium levels result in abnormalities in heart function, an electrocardiogram is usually the method of choice for the diagnosis of both hyperkalemia and hypokalemia. Specific EKG changes often correlate with the level of hyperkalemia.

Treatment

Traditional

Patients with severe or symptomatic hyperkalemia should be have intravenous access initiated, should be placed on a cardiac monitor for observation of EKG changes, and should be admitted to an intensive care unit (ICU) for continuous observation and treatment to quickly lower potassium levels.

Drugs

If life-threatening EKG abnormalities are noted, a rapid reduction in potassium levels can be achieved by treatment with **electrolyte supplementscalcium** chloride or calcium gluconate. Onset of action is typically within five minutes. Patients receiving this treatment should be monitored continually by means of a cardiac monitor.

Insulin injections are used to treat hyperkalemia in emergency situations. Insulin is a hormone well-known for its ability to stimulate the entry of sugar (glucose) into cells. It also provokes the uptake of potassium ions by cells, decreasing potassium ion concentration in the blood. When insulin is used to treat hyperkalemia, glucose is also injected. Serum potassium levels begin to decline within 30 to 60 minutes and remain low for several hours.

In non-emergency situations, hyperkalemia can be treated with a low potassium diet in some individuals. If this does not succeed, the patient can be given a special resin to bind potassium ions. One such resin, **sodium** polystyrene sulfonate (Kayexalate), remains in the intestines where it absorbs potassium and forms a complex of resin and potassium. This complex is excreted in the feces. A typical dose of resin is 15 g, taken one to four times per day. The correction of hyperkalemia with resin treatment takes at least 24 hours. However, recent research seems to indicate that use of sodium polystyrene sulfonate to treat hyperkalemia may not as effective as once thought in lowering potassium levels and may increase risk for necrosis in the large intestine.

Prognosis

The prognosis for specifically correcting hyperkalemia is excellent. However, hyperkalemia is usually caused by kidney failure, an often irreversible and eventually fatal condition.

Prevention

Most healthy people are not at risk for hyperkalemia. Patients with renal disease and those on certain diuretic medications must be monitored to prevent its occurrence.

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Hyperkinetic disorder *see* **Attention-deficit/ Hyperactivity disorder (ADHD)**

Hyperlipemia *see* **Hyperlipoproteinemia**

Hyperlipidemia *see* **Hyperlipoproteinemia**

Hyperlipoproteinemia

Definition

Hyperlipoproteinemia occurs when there is too much lipid (fat) in the blood. Shorter terms that mean the same thing are hyperlipidemia and hyperlipemia. Dyslipidemia refers to a redistribution of cholesterol from one place to another that increases the risk of **vascular disease** without increasing the total amount of cholesterol. When more precise terms are needed, **hypercholesterolemia** and hypertriglyceridemia are used.

Description

It is commonly known that oil and water do not mix unless another substance like a detergent is added. Yet the body needs to transport both lipids (fats) and water-based blood within a single circulatory system. There must be a way to mix the two so that essential fatty nutrients can be transported in the blood and so that fatty waste products can be carried away from tissues. The solution is to combine the lipids with protein to form water-soluble packages that can be transported in the blood.

These packages of fats are called lipoproteins. They are a complex mixture of **triglycerides**, cholesterol, phospholipids, and special proteins. Some of these chemicals are fatty nutrients absorbed from the intestines on their way to being made part of the body. Cholesterol is a waste product on its way out of the body through the liver, the bile, and ultimately the bowel for excretion. The proteins and phospholipids make the packages water-soluble.

There are five different sizes of these chemical packages. Each package needs all four chemicals in it to hold everything in solution. They differ in how much of each they contain. If blood serum is spun very rapidly in an ultracentrifuge, these five packages will layer out according to their density. They have, therefore, been named according to their densities—high-density lipoproteins (HDL), low-density lipoproteins (LDL), intermediate-density lipoproteins (IDL), very low density lipoproteins (VLDL), and chylomicrons. Only the HDLs and the LDLs will be discussed in the rest of this article.

If there is not enough detergent in the laundry, the oily stains will remain in the clothes. In the same way, if the balance of chemicals in these packages is not right, cholesterol will stay in tissues rather than being excreted from the body. What is even worse, if the chemical composition of these packages changes, the cholesterol can fall out of the blood and stay where it lands. On the other hand, a different change in the balance can remove cholesterol from tissues where there is too much. This appears to be exactly what is going on in **atherosclerosis**. The lesions contain lots of cholesterol.

The LDLs are overloaded with cholesterol. A minor change in the other chemicals in this package will leave cholesterol behind. The HDLs have a third to a half as much cholesterol. They seem to be able to pick up cholesterol left behind by the LDLs. It seems that atherosclerosis begins with tiny tears at stressed places in the walls of the arteries. Low density lipoproteins from the blood enter these tears, where their chemistry changes enough to leave cholesterol behind. The cholesterol causes irritation; the body responds with inflammation; damage and scarring follow. Eventually the artery gets so diseased blood cannot flow through it. Strokes and heart attacks are the result.

However, if there are lots of HDLs in the blood, the cholesterol is rapidly picked up and not allowed to cause problems. Women before **menopause** have estrogen (the female hormone), which encourages the formation of HDLs. This is the reason they have so little vascular disease and why they rapidly catch up to men after menopause, when estrogen levels fall. Replacement of estrogen after menopause has been prescribed for protection through the later years. However, in 2003, the Women's Health Initiative, a large clinical trial involving postmenopausal women, was halted in July 2002 because of the many detrimental effects of combined estrogen and progesterone therapy (called **hormone replacement therapy**). Among the effects was increased risk of heart disease, sometimes within the first year of use.

Cholesterol is the root of the problem, but like any other root it cannot just be eliminated. Ninety percent of the cholesterol in the body is created there as a waste product of necessary processes. The solution lies in getting it out to the body without clogging the arteries.

Of course the story is much more complex. The body has dozens of chemical processes that make up, break down, and reconfigure all these chemicals. It is these processes that are the targets of intervention in the effort to cure vascular disease.

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Diseases

Near the dawn of concern over cholesterol and vascular disease a family of hereditary diseases was identified, all of which produced abnormal quantities of blood fats. These diseases were called dyslipoproteinemias and came in both too many and too little varieties. The hyperlipoproteinemias found their way into five categories, depending on which chemical was in excess.

- Type 1 has a pure elevation of triglycerides in the chylomicron fraction. These people sometimes get pancreatitis and abdominal pains, but they do not seem to have an increase in vascular disease.
- Type 2 appears in two distinct genetic patterns and a third category, which is by far the most important kind, because everyone is at risk for it. All Type 2s have elevated cholesterol. Some have elevated triglycerides also. The familial (genetic) versions of Type 2 often develop xanthomas, which are yellow fatty deposits under the skin of the knuckles, elbows, buttocks or heels. They also may have xanthelasmas, smaller yellow patches on the eyelids.
- Type 3 appears in one in 10,000 people and elevates both triglycerides and cholesterol with consequent vascular disease. In 2003, researchers discovered the molecular mechanism that contributes to high triglycerides in those with this type of hyperlipopoproteinemia.
- Type 4 elevates only triglycerides and does not increase the risk of vascular disease.
- Type 5 is similar to Type 1.
- Dyslipidemia refers to a normal amount of cholesterol that is mostly in LDLs, where it causes problems.

All but Type 2 are rare and of interest primarily because they give insight into the chemistry of blood fats.

In addition to the above genetic causes of blood fat disorders, a number of acquired conditions can raise lipoprotein levels:

- Diabetes mellitus, because it alters the way the body handles its energy needs, and also affects the way it handles fats. The result is elevated triglycerides and reduced HDL cholesterol. This effect is amplified by obesity.
- Hypothyroidism is a common cause of lipid abnormalities. The thyroid hormone affects the rate of many chemical processes in the body, including the clearing of fats from the blood. The consequence usually is an elevation of cholesterol.
- Kidney disease affects the blood's proteins and consequently the composition of the fat packages. It usually raises the LDLs.
- Liver disease, depending on its stage and severity, can raise or lower any of the blood fats.
- Alcohol raises triglycerides. In moderate amounts (if they are very moderate) it raises HDLs and can be beneficial.
- Cigarette smoking lowers HDL cholesterol, as does malnutrition and obesity.

Certain medications elevate blood fat levels. Because some of these medications are used to treat heart disease, it has been necessary to reevaluate their usefulness:

- Thiazides, water pills used to treat high blood pressure, can raise both cholesterol and triglycerides.
- Beta-blockers, another class of medication used to treat high blood pressure, cortisone-like drugs, and estrogen can raise triglycerides.
- Progesterone, the pregnancy hormone, raises cholesterol.

Not all of these effects are necessarily bad, nor are they necessarily even significant. For instance, estrogen is clearly beneficial. Each effect must be considered in the overall goal of treatment.

Causes and symptoms

A combination of heredity and diet is responsible for the majority of fat disorders. It is not so much the cholesterol in the diet that is the problem, because that accounts for only 10% of the body's store. It is the other fats in the diet that alter the way the body handles its cholesterol. There is a convincing relation between fats in the diet and the incidence of atherosclerosis. The guilty fats are mostly the animal fats, but palm and coconut oil also are harmful. These fats are called saturated fats for the chemical reason that most of their carbon atoms have as many hydrogen atoms attached as they can accommodate. More important than the kind of fat is the amount of fat. For many people, fat is half of their diet. One-fifth to one-fourth is a much healthier fraction, the rest of the diet being made up of complex carbohydrates and protein.

This disease is silent for decades, until the first episode of heart disease or **stroke**.

Diagnosis

It would be easier if simple cholesterol and triglyceride tests were all it took to assess the risk of atherosclerosis. However, the important information is which package the cholesterol is in—the LDLs or the HDLs. That takes a more elaborate testing process. To complicate matters further, the amount of fats in the blood varies greatly in relation to the last meal—how long ago

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it was and what kind of food was eaten. A true estimate of the risk comes from several tests several weeks apart, each done after at least 12 hours of **fasting**.

Treatment

Diet and lifestyle change are the primary focus for most cholesterol problems. It is a mistake to think that a pill will reverse the effects of a bad diet, **obesity**, **smoking**, excess alcohol, **stress**, and inactivity. Reducing the amount of fat in the diet by at least half is the most important move to make. Much of the food eaten to satisfy a "sweet tooth" is higher in fat than in sugar. A switch away from saturated fats is the next step, but the rush to polyunsaturated fats was ill-conceived. These, particularly the hydrogenated fats in margarine, have problems of their own. They raise the risk of **cancer** and are considered more dangerous than animal fat by many experts. Theory supports population studies that suggest monounsaturated olive oil may be the healthiest of all.

There was a tremendous push at the end of the 20th century to use lipid-lowering medications. The most popular and most expensive agents, the "statins," hinder the body's production of cholesterol and sometimes damage the liver as a side effect. Their full name is 3-hydroxy-3-methylglutaryl-coemzyme A *(HMG-CoA)* reductase inhibitors. Their generic names are cervistatin, fluvastatin, lovastatin, pravastatin, simvastatin, and the newest and most powerful as of 2010, rosuvastatin. Studies show that these drugs lower cholesterol. Only recently, though, has any evidence appeared that this affects health and longevity. Earlier studies showed, in fact, an increased **death** rate among users of the first class of lipid-altering agents—the fibric acid derivatives. The chain of events connecting raised HDL and lowered LDL cholesterol to longer, healthier lives is still to be forged.

High-tech methods of rapidly reducing very high blood fat levels are performed for those rare disorders that require it. There are resins that bind cholesterol in the intestines. They taste awful, feel like glue and routinely cause gas, bloating, and **constipation**. For acute cases, there is a filtering system that takes fats directly out of the blood.

Niacin (nicotinic acid) lowers cholesterol effectively and was the first medication proven to improve overall life expectancy. It also can be liver toxic, and the usual formulation causes a hot flash in many people. This can be overcome by taking a couple of aspirins 30 minutes before the niacin, or by taking a special preparation called "flush free," "inositol-bound" or inositol hexanicotinate.

Alternative treatment

Omega-3 oil is a special kind found mostly in certain kinds of fish. It is beneficial in lowering cholesterol. An herbal alternative called guggulipid, *Commiphora mukul*, an extract of an Indian plant, has been touted as working the same way as the expensive and liver toxic cholesterol-lowering medications. However, a 2003 clinical trial found that the supplement did not meet these claims. In fact, guggul did not lower total cholesterol, LDL cholesterol, or triglycerides. Most patients tolerated the supplement, but some developed a hypersensitivity rash.

To lower cholesterol, **naturopathic medicine**, **traditional Chinese medicine**, and **ayurvedic medicine** may be considered. Some herbal therapies include alfalfa (*Medicago sativa*), Asian **ginseng** (*Panax ginseng*), and fenugreek (*Trigonella foenum-graecum*). Garlic (*Allium sativum*) and onions are also reported to have cholesterol-lowering effects. In naturopathic medicine, the liver is considered to be an organ that needs cleansing and rebalancing. The liver often is treated with a botanical formula that will act as a bitter to stimulate bile flow in the liver. Before initiating alternative therapies, medical consultation is strongly advised.

Prognosis

The prognosis is good for Type 1 hyperlipoproteinemia with treatment; without treatment, death may result. For Type 2 the prognosis is poor even with treatment. The prognosis for Type 3 is good when the prescribed diet is strictly followed. For Types 4 and 5 the prognosis is uncertain, due to the risk of developing premature **coronary artery disease** and **pancreatitis**, respectively.

Prevention

Genetic inheritance cannot be changed, but its effects may be modified with proper treatment. Family members of an individual with hyperlipoproteinemia should consider having their blood lipids assessed. The sooner any problems are identified, the better the chances of limiting or preventing the associated health risks. Anyone with a family history of disorders leading to hyperlipoproteinemia also may benefit from **genetic testing** and counseling to assist them in making reproductive decisions.

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J. Ricker Polsdorfer, MD
Teresa G. Odle

Hypermagnesemia *see* **Magnesium imbalance**

Hypermenorrhea *see* **Dysfunctional uterine bleeding**

Hypermetropia *see* **Hyperopia**

Hypernatremia

Definition

The normal concentration of **sodium** in the blood plasma is 136–145 mEq/L. Hypernatremia is defined as a serum sodium level over 145 mEq/L. Severe hypernatremia, with serum sodium above 152 mEq/L, is a rare disorder in patients with an intact thirst response that can result in seizures and **death** if left untreated.

Description

Sodium is an atom, or ion, that carries a single positive charge. The sodium ion may be abbreviated as Na^+ or as simply Na. Sodium can occur as a salt in a crystalline solid. Sodium chloride (NaCl), sodium phosphate (Na_2HPO_4) and sodium bicarbonate ($NaHCO_3$) are commonly occurring salts. These salts can be dissolved in water or in juices of various foods. Dissolving involves the complete separation of ions, such as sodium and chloride, in common table salt (NaCl).

About 40% of the body's sodium is contained in bone. Approximately 2–5% occurs within organs and cells and the remaining 55% is in blood plasma and other extracellular fluids. The amount of sodium in blood plasma is typically 140 mEq/L, a much higher amount than is found in intracellular sodium (about 5 mEq/L). This asymmetric distribution of sodium ions is essential for human life. It makes possible proper nerve conduction, the passage of various nutrients into cells, and the maintenance of blood pressure.

The body continually regulates its handling of sodium. When dietary sodium is too high or low, the intestines and kidneys respond to adjust concentrations to normal. During the course of a day, the intestines absorb dietary sodium while the kidneys excrete a nearly equal amount of sodium into the urine. If a low sodium diet is consumed, the intestines increase their efficiency of sodium absorption, and the kidneys reduce its release into urine.

The concentration of sodium in the blood plasma depends on two things: the total amount of sodium and water in arteries, veins, and capillaries (the circulatory system). The body uses separate mechanisms to regulate sodium and water, but they work together to correct blood pressure when it is too high or too low. Too high a concentration of sodium, or hypernatremia, can be corrected either by decreasing sodium or by increasing body water. The existence of separate mechanisms that regulate sodium concentration account for the fact that there are numerous diseases that can cause hypernatremia, including diseases of the kidney, pituitary gland, and hypothalamus.

Causes and symptoms

Vasopressin, also called anti-diuretic hormone, is made by the hypothalamus and released by the pituitary gland into the bloodstream. There it travels to the kidney where it reduces the release of water into the urine. With less vasopressin production, the body fails to conserve water, and the result is a trend toward higher plasma sodium concentrations. Hypernatremia may occur in **diabetes insipidus**, a disease that causes excessive urine production. (It is not the same disease as **diabetes mellitus**, a disease resulting from impaired insulin production.) The defect involves either the failure of the hypothalamus to make vasopressin or the failure of the kidney to respond to vasopressin. In either case, the kidney is able to conserve and regulate the body's sodium levels, but is unable to conserve and retain the body's water. Hypernatremia does not occur in diabetes insipidus if the patient is able to drink enough water to keep up with urinary loss, which may be as high as 10 L per day.

Hypernatremia may occur in unconscious (or comatose) patients due to the inability to drink water. Water is continually lost by evaporation from the lungs and in the urine. If the patient is not given

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KEY TERMS

Acidosis—A medical condition caused by an increase in the concentration of hydrogen ions in the blood. The result of this increase is a lowered (acidic) blood pH level.

mEq/L—Abbreviation for milliequivalents per liter. Some medical tests results are reported in mEq/L.

Plasma—Clear, yellow- or straw-colored fluid that is the liquid component of blood and lymphatic fluid.

water via infusion, the sodium concentration in the blood may increase and hypernatremia could develop.

Hypernatremia can occur in individuals in which the thirst impulse is impaired or who cannot satisfy the thirst impulse on their own. Hypernatremia induced by these mechanisms is most likely to occur in infants, in psychiatric patients, and in elderly patients, especially those confined to institutionalized care settings.

Hypernatremia can occur accidentally in the hospital when patients are infused with solutions containing sodium, such as sodium bicarbonate for the treatment of acidosis (acidic blood). It can also be accidentally induced with sodium chloride infusions, especially in elderly patients with impaired kidney function.

Hypernatremia can cause neurological damage due to shrinkage of brain cells. Neurological symptoms include confusion, **coma**, **paralysis** of the lung muscles, and death. The severity of the symptoms is related to how rapidly the hypernatremia developed. Hypernatremia that comes on rapidly does not allow the cells of the brain time to adapt to their new high-sodium environment. Hypernatremia is especially dangerous for children and the elderly.

Diagnosis

Tests

Hypernatremia is diagnosed by acquiring a blood sample and then measuring the concentration of sodium ions in the blood. Other tests that may be ordered in the diagnosis of hypernatremia include urine osmolality, urine sodium, and serum glucose tests. A head CT scan or **magnetic resonance imaging** test (MRI) may be ordered in patients with severe hypernatremia. Less frequently ordered tests that may be utilized include a water deprivation test and an antidiuretic hormone (ADH) simulation test.

Treatment

Hypernatremia is treated with infusions of a solution of water containing 0.9% sodium chloride (0.9 g NaCl/100 mL water), which is the normal concentration of sodium chloride in the blood plasma. The infusion is performed over many hours or days to prevent abrupt and dangerous changes in brain cell volume. When possible, patients should be encouraged to drink water unless contraindicated for other medical reasons. In emergencies, such as when hypernatremia is causing neurological symptoms, infusions may be conducted with salt solutions containing 0.45% sodium chloride, which is half the normal physiologic level.

Prognosis

The prognosis for treating hypernatremia is excellent, except if neurological symptoms are severe or if overly rapid attempts are made to treat and reverse the condition. Some patients may be left with permanent neurological damage despite treatment.

Prevention

Hypernatremia occurs only in unusual circumstances that are not normally under a person's control. Monitoring the fluid consumption of vulnerable individuals, particularly those in institutionalized care settings, is strongly recommended. As hypernatremia in infants is most often caused by not receiving enough breast milk from the mother or from inaccurate formula preparation, educating new parents to these possibilities is important before the infant leaves the hospital.

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Hypernephroma *see* **Kidney cancer**

Hyperopia

Definition

Hyperopia (farsightedness) is the condition of the eye where incoming rays of light reach the retina before they converge into a focused image.

Description

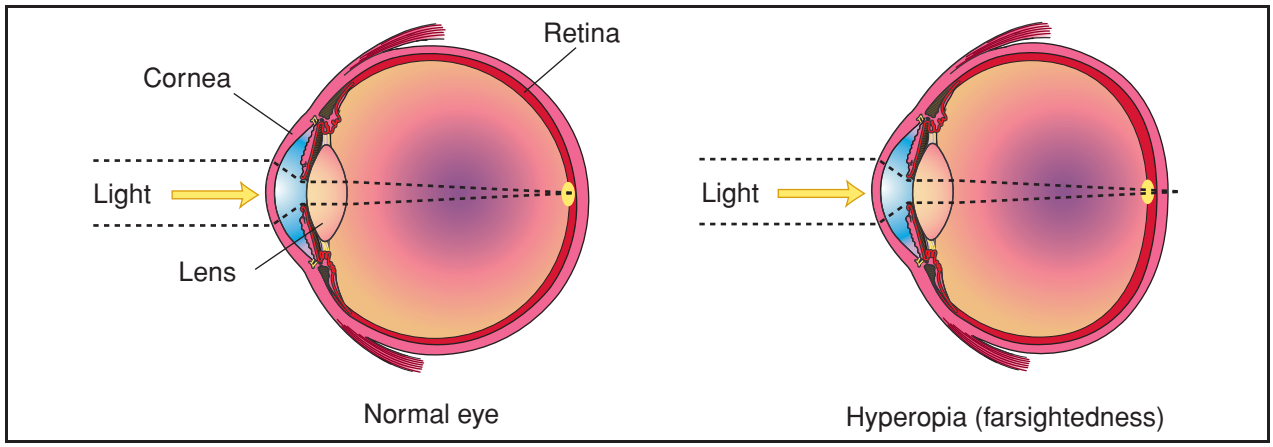
When light goes through transparent but dense material like the materials of the eye's lens system (the lens and cornea), its velocity decreases. If the surface of the dense material is not perpendicular to the incoming light, as is the case with the curved surfaces on lenses and corneas, the direction of the light changes. The greater the curvature of the lens system, the greater the change in the direction of the light.

When parallel light rays from an object go through the lens system of the eye, they are bent so they converge at a point some distance behind the lens. With perfect vision this point of convergence, where the light rays are focused, is on the retina. This happens when the cumulative curvature of the lens plus cornea and the distance from the lens to the retina are just right for each other. The condition where the point of focus of parallel light rays from an object is behind the retina is called hyperopia. This condition exists when the combined curvature of the lens and cornea is insufficient (e.g., flatter than needed for the length of the eyeball). This condition can be equivalently described by saying hyperopia exists when the eyeball is too short for the curvature of its lens system.

There is a connection between the focusing of the lens of the eye (accommodation) and convergence of the eyes (the two eyes turning in to point at a close object). The best example is during reading. The lens accommodates to make the close-up material clear and the eyes turn in to look at the print and keep it single. Because of this connection between accommodation and convergence, if the lens needs to accommodate to focus for distance (to bring the image back onto the retina) the eyes may appear to turn in even when looking at the distance. This can cause a condition known as accommodative esotropia in children. The eyes turn in and the cause is accommodation because of hyperopia.

Causes and symptoms

Babies are generally born slightly hyperopic. This tends to decrease with age. There is normal variation in eyeball length and curvature of the lens and cornea. Some combinations of these variables give rise to eyes where the cornea is too flat for the distance between



Hyperopia, or farsightedness, is a condition of the eye where incoming rays of light impinge on the retina before converging into a focused image, resulting in difficulty seeing nearby objects clearly. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

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the cornea and the retina. If the hyperopia is not too severe the lens may be able to accommodate and bring the image back onto the retina. This would result in clear distance vision, but the constant focusing might result in headaches or eyestrain. If the lens cannot accommodate for the full amount of the hyperopia the distance image would be blurry.

If the eyes are focusing for distance and now the person is looking at a near object, the eyes need to accommodate further. This may result in blurry near by objects or headaches during close work.

Depending upon the amount of hyperopia, symptoms can range from none to clear distance vision but blurry near vision, to blurry distance and near vision. Headaches and eyestrain may also occur, particularly when doing near tasks. An eye turned in (esotropia) may be a result of hyperopia, particularly in children. However, because a turned eye may be a result of more serious causes it is very important to have it checked out.

Diagnosis

Because it is possible to have good visual acuity with some degree of hyperopia it is important to relax accommodation before the eye exam. This is done with the use of eyedrops and is called a cycloplegic exam or cycloplegic refraction. The drops relax the accommodation (thus making reading blurry until the drops wear off). Patients will usually be asked to have someone drive them home because of the blurriness. The doctor can then determine the patient's visual status with a hand-held instrument called a retinoscope and/or have the patient read from an eye chart while placing different lenses in front of the patient's eyes. Refractive error is measured in units called diopters (D).

Treatment

The usual treatment for hyperopia is corrective lenses (spectacles or **contact lenses**).

Different surgical methods to correct hyperopia are under investigation. One approach is to implant corrective contact lenses behind the patient's iris. The first experimental implantable contact lenses were implanted in 1997. Another approach is to surgically increase the curvature of the eye's existing cornea or lens. Although there have been many reports of success using different kinds of lasers to increase corneal curvature, there are still problems with stability and predictability. The introduction of light-activated biologic tissue glue in 1997 holds promise for improvements in those areas.

Prognosis

The prognosis for fully corrected vision is excellent for patients with low to moderate amounts of hyperopia. Patients with very high hyperopia (+10.00D or more) may not achieve full correction. Moreover, surgery to correct hyperopia will probably be perfected and approved in the near future.

Hyperopia increases the chances of chronic glaucoma, but vision loss from glaucoma is preventable.

Prevention

Hyperopia is usually present at birth, and there is no known way to prevent it.

ORGANIZATIONS

American Academy of Ophthalmology (AAO), P. O. Box 7424, San Francisco, CA, 94120-7424, (415) 561-8500, (415) 561-8500, http://www.aao.org.

American Optometric Association, 243 North Lindbergh Blvd., St. Louis, MO, 63141, (314) 991-4100, (314) 991-4101, (800) 365-2219, http://www.aoa.org/.

Lorraine Lica, PhD

Hyperparathyroidism

Definition

Parathyroid glands are four pea-sized glands located just behind the thyroid gland in the front of the neck. The function of parathyroid glands is to produce a hormone called parathyroid hormone (parathormone), which helps regulate **calcium** and phosphate in the body. Hyperparathyroidism is the overproduction of this hormone.

Description

Thyroid glands and parathyroid glands, despite their similar name and proximity, are entirely separate, and each produces hormones with different functions. Hyperparathyroidism may be primary or secondary. It most often occurs in those over age 30, and most commonly in patients 50 to 60 years old. It rarely occurs in children or the elderly. Women are affected by the disease up to three times more often than men. It is estimated that 28 of every 100,000 people in the United States will develop hyperparathyroidism each year.

Normally, parathyroid glands produce the parathormone as calcium levels drop and lower to meet the demands of a growing skeleton, **pregnancy**, or

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lactation. However, when one or more parathyroid glands malfunctions, it can lead to overproduction of the hormone and elevated calcium level in the blood. Therefore, a common result of hyperparathyroidism is **hypercalcemia**, or an abnormally high level of calcium in the blood. Primary hyperparathyroidism occurs as a malfunction of one of the glands, usually as a result of a benign tumor called an adenoma. Secondary hyperparathyroidism occurs as the result of a metabolic abnormality outside the parathyroid glands, which causes a resistance to the function of the parathyroid hormones. Primary hyperparathyroidism is one of the most common endocrine disorders, led only by diabetes and **hyperthyroidism**.

Causes and symptoms

Often, there are no obvious symptoms or suspicion of hyperparathyroidism, and it is first diagnosed when a patient is discovered to be hypercalcemic during a routine blood chemistry profile. Patients may believe they have felt fine, but realize improvements in sleep, irritability, and memory following treatment. When symptoms are present, they may include development of gastric ulcers or **pancreatitis** because high calcium levels can cause inflammation and **pain** in the linings of the stomach and pancreas.

Most of the symptoms of hyperparathyroidism are those present as a result of hypercalcemia, such as **kidney stones**, **osteoporosis**, or bone degradation resulting from the bones giving up calcium. Muscle weakness, central nervous system disturbances such as depression, psychomotor and personality disturbances, and rarely, even **coma** can occur. Patients may also experience **heartburn**, **nausea**, **constipation**, or abdominal pain. In secondary hyperparathyroidism, patients may show signs of calcium imbalance such as deformities of the long bones. Symptoms of the underlying disease may also be present.

Most commonly, hyperparathyroidism occurs as the result of a single adenoma, or benign tumor, in one of the parathyroid glands. About 90% of all cases of hyperparathyroidism are caused by an adenoma. The tumors are seldom cancerous. They will grow to a much larger size than the parathyroid glands, often to the size of a walnut. Genetic disorders or multiple endocrine tumors can also cause a parathyroid gland to enlarge and oversecrete hormone. In 10% or fewer of patients with primary hyperparathyroidism, there is enlargement of all four parathyroid glands. This condition is called parathyroid hyperplasia.

Diagnosis

Diagnosis of hyperparathyroidism is most often made when a blood test (radioimmunoassay) reveals high levels of parathyroid hormone and calcium. A blood test that specifically measures the amount of parathyroid hormone has made diagnosis simpler. X ray examinations may be performed to look for areas of diffuse bone demineralization, bone cysts, outer bone absorption and erosion of the long bones of the fingers and toes. Hypercalcemia is mild or intermittent in some patients, but is an excellent indicator of primary hyperparathyroidism. Dual energy x ray absorptiometry (DEXA or DXA), a tool used to diagnose and measure osteoporosis, is used to show reduction in bone mass for primary hyperparathryroidism patients. Once a diagnosis of hyperparathyroidism is reached, the physician will probably order further tests to evaluate complications. For example, abdominal radiographs might reveal kidney stones.

For secondary hyperparathyroidism, normal or slightly decreased calcium levels in the blood and variable phosphorous levels may be visible. Patient history of familial **kidney disease** or convulsive disorders may suggest a diagnosis of secondary hyperparathyroidism. Other tests may reveal a disease or disorder, which is causing the secondary hyperparathyroidism.

Treatment

Hyperparathyroidism cases will usually be referred to an endocrinologist, a physician specializing in hormonal problems, or a nephrologist, who specializes in kidney and mineral disorders.

Patients with mild cases of hyperparathyroidism may not need immediate treatment if they have only slight elevations in blood calcium level and normal kidneys and bones. These patients should be regularly checked, probably as often as every six months, by **physical examination** and measurement of kidney function and calcium levels. A bone densitometry measurement should be performed every one or two years. After several years with no worsened symptoms, the length of time between exams may be increased.

Patients with more advanced hyperparathyroidism will usually have all or half of the affected parathyroid gland or glands surgically removed. This surgery is relatively safe and effective. The primary risks are those associated with **general anesthesia**. There are some instances when the surgery can be performed with the patient under regional, or cervical block, anesthesia. Often studies such as ultrasonography prior to surgery help pinpoint the affected areas.

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Alternative treatment

Forcing fluids and reducing intake of calcium-rich foods can help decrease calcium levels prior to surgery or if surgery is not necessary.

Prognosis

Removal of the enlarged parathyroid gland or glands cures the disease 95% of the time and relief of bone pain may occur in as few as three days. In up to 5% of patients undergoing surgery, chronically low calcium levels may result, and these patients will require a calcium supplement or vitamin D treatment. Damage to the kidneys as a result of hyperparathyroidism is often irreversible. Prognosis is generally good, however complications of hyperparathyroidism such as osteoporosis, bone **fractures**, kidney stones, peptic ulcers, pancreatitis, and nervous system difficulties may worsen the prognosis.

Prevention

Secondary hyperparathyroidism may be prevented by early treatment of the disease causing it. Early recognition and treatment of hyperparathyroidism may prevent hypercalcemia. Since the cause of primary hyperparathyroidism, or the adenoma which causes parathyroid enlargement, is largely unknown, there are no prescribed prevention methods.

Resources

OTHER

"Endocrine Disorder and Endocrine Surgery." Endocrine Web Page. http://www.endocrineweb.com.

ORGANIZATIONS

Osteoporosis and Related Bone Diseases—National Resource Center, 2 AMS Circle, Bethesda, MD, 20892-3676, (202) 223-0344, (202) 293-2356, NIAMSBoneInfo@mail.nih.gov, http://www.niams.nih.gov/Health _Info/bone/default.asp.

Paget Foundation, 120 Wall Street, Ste. 1602, New York, NY, 10005-4035, (212) 509-5335, (212) 509-8492, (800) 237-2438, Pagetfdn@aol.com, http://www.paget.org.

Teresa Odle

Hyperpigmentation

Definition

Hyperpigmentation is the increase in the natural color of the skin.

Description

Melanin, a brown pigment manufactured by certain cells in the skin called melanocytes, is responsible for skin color. Mela1nin production is stimulated by a pituitary hormone called melanocyte stimulating hormone (MSH). Other pigments appear in the skin much less often.

Causes and symptoms

Darkened spots on the skin come in several varieties. The most ominous is **malignant melanoma**, a very aggressive **cancer** that begins as an innocent mole. The majority of **moles** (nevus), however, are and remain benign (harmless). The average person has several dozen, and certain people with a hereditary excess may have hundreds. Freckles, age spots, and cafe au lait spots, known as ephelides, are always flat and not as dark. Cafe au lait spots are seen mostly in people with another hereditary disorder called **neurofibromatosis**. "Port wine stains" are congenital dark red blotches on the skin. Other common dark colorations on the skin are called keratosis and consist of locally overgrown layers of skin that are dark primarily because there is more tissue than normal. A few of these turn into skin cancers of a much less dangerous kind than melanoma.

Darkened regions of the skin occur as a result of abnormal **tanning** when the skin is sensitive to sunlight. Several diseases and many drugs can cause **photosensitivity**. Among the common drugs responsible for this uncommon reaction are birth control pills, **antibiotics** (**sulfonamides** and **tetracyclines**), **diuretics**, **nonsteroidal anti-inflammatory drugs** (NSAID), **pain** relievers, and some psychoactive medications. Some of the same drugs may also cause patches of discolored skin known as localized drug reactions and representing an allergy to that drug. Sunlight darkens an abnormal chemical in the skin of patients with porphyria cutanea tarda. Several endocrine diseases, some cancers, and several drugs abnormally stimulate melanocytes, usually through an overproduction of MSH. Arsenic **poisoning** and **Addison's disease** are among these causes. A condition known as acanthosis nigricans is a velvety darkening of skin in folded areas (arm pits, groin, and neck) that can signal a cancer or hormone imbalance.

Of particular note is a condition called melasma (dark pigmentation of the skin), caused by the female hormone estrogen. Normal in **pregnancy**, this brownish discoloration of the face can also happen with birth control pills that contain estrogen.

Overall darkening of the skin may be due to pigmented chemicals in the skin. Silver, gold, and iron

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each have a characteristic color when visible in the skin. Several drugs and body chemicals, like bilirubin, can end up as deposits in the skin and discolor it.

There are a number of other rare entities that color the skin, each in its own peculiar way. Among these are strange syndromes that seem to be **birth defects** and vitamin and nutritional deficiencies.

Diagnosis

The pattern of discoloration is immediately visible to the trained dermatologist, a physician specializing in skin diseases, and may be all that is required to name and characterize the discoloration. Many of these pigment changes are signs of internal disease that must be identified. Pigmentation changes may also be caused by medication, and the drug responsible for the reaction must be identified and removed.

Treatment

Skin sensitive to sunlight must be protected by shade or **sunscreens** with an SPF of 15 or greater. Skin cancers must be, and unsightly benign lesions may be, surgically removed. **Laser surgery** is an effective removal technique for many localized lesions. Because it spreads so rapidly, melanoma should be immediately removed, as well as some of the surrounding tissue to prevent regrowth.

Prevention

Sunlight is the leading cause of dark spots on the skin, so shade and sunscreens are necessary preventive strategies, especially in people who burn easily.

Resources

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Hyperprolactation *see* **Galactorrhea**

Hypersensitivity pneumonitis

Definition

Hypersensitivity pneumonitis refers to an inflammation of the lungs caused by repeated breathing in of a foreign substance, such an organic dust, a fungus, or a mold. The body's immune system reacts to these substances, called antigens, by forming antibodies, molecules that attack the invading antigen and try to destroy it. The combination of antigen and antibody produces acute inflammation, or pneumonitis (a hypersensitivity reaction), which later can develop into chronic lung disease that impairs the lungs' ability to take oxygen from the air and eliminate carbon dioxide.

Description

Hypersensitivity pneumonitis (HP) is sometimes called "allergic alveolitis." "Allergic" refers to the antigen-antibody reaction, and "alveolitis" means an inflammation of the tiny air sacs in the lungs where oxygen and CO_2 are exchanged, the alveoli. It also is known as "extrinsic" allergic alveolitis, meaning that the antigen that sets up the allergic reaction (also called an allergen) comes from the outside. Most of the antigens that cause this disease come from plant or animal proteins or microorganisms, and many of those affected are exposed either at work or in the course of some hobby or other activity. The first known type of HP, farmer's lung, is caused by antigens from tiny microorganisms living on moldy hay. An example of disease connected with a hobby is pigeon breeder's lung, caused by inhaling protein material from bird droppings or feathers. After a time, very little of the allergenic material is needed to set off a reaction in the lungs.

Roughly one in every 10,000 persons develops some form of HP. A mysterious aspect of this condition is that, even though many persons may be exposed to a particular antigen, only a small number of them will develop the disease. Genetic differences may determine who becomes ill; this remains unclear. Probably between 5% and 15% of all persons who are regularly exposed to organic materials develop HP. Most of those who do get it do *not* smoke (**smoking** may create the type of cells that take up antigens and neutralize them). The amount of antigen is an important factor in whether HP will develop and what form it will take. Sudden heavy exposure can produce symptoms in a matter of hours, whereas mild but frequent exposures tend to produce a long-lasting, "smoldering" illness. HP may be more likely to develop in persons exposed to polluted air or industrial fumes.

Typical changes occur in the lungs of persons with HP. In the acute stage, large numbers of inflammatory cells are found throughout the lungs and the air sacs may be filled by a thick fluid mixed with these cells. In the subacute stage, disease extends into the small breathing tubes, or bronchioles, and the inflammatory cells collect into tiny granules called granulomas. Finally, in the chronic stage of HP, the previously

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inflamed parts of the lungs become scarred and unable to function, as in **pulmonary fibrosis**.

Causes and symptoms

A number of different types of HP are known, since a wide range of allergens may produce an allergic reaction in the lungs. Many of them produce similar symptoms and abnormal physical findings, but some have their own typical features. Some of the more common forms are:

- Farmer's lung. This can affect any farmer who works with wet hay or other moldy dust. Small farmers who have to directly thresh and handle their hay are most at risk, as are those living in cold and humid areas where damp weather is common.
- Pigeon breeder's lung. Also called "bird fancier's lung," it is second to farmer's lung as the best known type of HP. A substance has been found in pigeon droppings that may cause the allergic reaction, but there may be more than one such substance. Besides pigeons, the disorder may follow exposure to ducks, geese, pheasants, and even canaries. Parakeets produce an especially severe form of disease. Most patients are middle-aged women, who usually care for birds either at home or on bird breeding farms.
- Bagassosis. Caused by bagasse, a substance produced when juice is extracted from sugar cane and is used in making paper and explosives. A fungus is probably responsible. Young and middle-aged men who work in the sugar industry are at risk.
- Byssinosis. A similar condition affecting workers who inhale dust from cotton, flax, or hemp.
- Humidifier lung. An acute form of HP caused by inhaling actinomycetes, the same organisms that cause farmer's lung, which grow in contaminated humidifier vents, air conditioners, heating systems, and even saunas.
- Other antigens. HP has been seen in persons working with detergents, silicone, mushrooms, cheese, wood dust, maple bark, coffee, and furs.

In the acute stage, patients with HP begin coughing, develop **fever**, and note tightness in the chest as well as extreme tiredness and aching, four to eight hours after the most recent exposure. Most patients are well aware of the connection between their work (or an activity) and their symptoms. After a time, patients may have trouble breathing. They also may lose their appetite, lose weight, and generally feel ill. Finally, in the chronic stage, the patient will have increasing trouble breathing and may sometimes wheeze. With advanced disease, the skin may appear bluish (because too little oxygen is getting into the blood). When a physician listens to the patient's chest with a stethoscope, there may be crackling sounds or loud **wheezing**. In the late stages, club-shaped fingertips are a sign that the patient has not been getting enough oxygen for an extended period of time.

Diagnosis

No single test can make a definite diagnosis of HP. The key is to relate some specific exposure or activity to episodes of symptoms. A **chest x ray** may be normal in the acute stage, but later may show a hazy appearance that looks like "ground glass." There may be linear or rounded shadows in the central parts of the lungs. Studies of lung function in the acute stage typically show abnormally small lung volume. The ability to breathe at a fast rate is impaired. Blood from an artery typically has a low level of oxygen. Later, when the lungs have begun to scar, the airways (breathing tubes) are obstructed and the rate of air flow is reduced.

Some experts believe that skin testing can help diagnose HP and show which particular antigen is causing the symptoms. Small amounts of several suspect antigens are injected just beneath the surface of the skin, usually on the arm or back, and the reactions compared to that caused by injecting a harmless salt solution. Another diagnostic test is to place a thin tube into the airways, inject a small amount of fluid, and draw it back up (bronchoalveolar lavage). A very large number of cells called lymphocytes is typical of HP, and mast cells, which are part of the immune system, may also be seen. Rarely, a tissue sample (biopsy) of lung tissue may be taken through a tube placed in the airways and examined under a microscope. Finally, a patient may be "challenged" by actually inhaling a particular antigen in the form of an aerosol and noting whether lung function suddenly becomes worse. This test is usually not necessary.

Treatment

Treatment of HP requires identifying the offending antigen and avoiding further exposure. Although it may sometimes be necessary for a patient to find a totally different type of work, often it is possible to simply perform different duties or switch to a work site where exposure is minimal. In some cases, (like pigeon breeder's lung), wearing a mask can prevent exposure. If acute symptoms are severe, the patient may be treated with a steroid hormone for two to six weeks. This often suppresses the inflammatory response and allows the lungs a chance to recover. In the chronic stage, steroid treatment can delay further damage to the lungs and help preserve their function.

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Prognosis

In general, most of the symptoms of HP disappear when the patient is no longer exposed to the causative allergen. The actual chances of complete recovery depend in part on what form of HP is present. Older patients and those exposed repeatedly for long periods after initially developing symptoms tend to have a poorer long-term outlook. The worst outcome is that long repeated episodes of exposure will cause chronic lung inflammation, scar the lungs, and permanently make then unable to properly provide oxygen to the blood. Rarely, a patient will become permanently disabled.

Prevention

It is often not possible to prevent initial episodes of HP because there is no way of predicting which individuals (such as farmers) will have an allergic reaction to a particular allergen. Once the connection is made between a type of exposure and definite hypersensitivity symptoms, prevention of further episodes is simple as long as further exposure can be avoided.

Exactly how to avoid exposure depends on a person's work or activities and what is causing the reaction. People with farmer's lung can dry hay thoroughly before storing it. For pigeon breeder's lung (and many other types of HP), a mask can be worn. In many industrial settings, it is possible to take precautions that will limit the amount of allergen that workers will inhale. If it is not possible to avoid exposure altogether, exposure can be timed and strictly minimized.

ORGANIZATIONS

American Lung Association, 1301 Pennsylvania Ave. NW, Suite 800, Washington, DC, 20001, (202) 758-3355, (202) 452-1805, (800) 548-8252, info@lungusa.org, http://www.lungusa.org/.

Asthma and Allergy Foundation of America, 8201 Corporate Drive, Suite 1000, Landover, MD, 20785, (800) 727-8462, info@aafa.org, http://www.aafa.org/.

David A. Cramer, MD

Hypersomnia *see* **Sleep disorders**

Hypersplenism

Definition

Hypersplenism is a type of disorder that causes the spleen to rapidly and prematurely destroy blood cells.

Description

The spleen is located in the upper left area of the abdomen. One of this organ's major functions is to remove blood cells from the body's bloodstream. In hypersplenism, its normal function accelerates, and it begins to automatically remove cells that may still be normal in function. Sometimes the spleen will temporarily hold onto up to 90% of the body's platelets and 45% of the red blood cells. Hypersplenism may occur as a primary disease, leading to other complications, or as a secondary disease, resulting from an underlying disease or disorder. Hypersplenism is sometimes referred to as enlarged spleen (splenomegaly). An enlarged spleen is one of the symptoms of hypersplenism. What differentiates hypersplenism is its premature destruction of blood cells.

Causes and symptoms

Hypersplenism may be caused by a variety of disorders. Sometimes, it is brought on by a problem within the spleen itself and is referred to as primary hypersplenism. Secondary hypersplenism results from another disease such as chronic **malaria**, **rheumatoid arthritis**, **tuberculosis**, or **polycythemia vera**, a blood disorder. Spleen disorders in general are almost always secondary in nature. Hypersplenism may also be caused by tumors.

Symptoms of hypersplenism include easy bruising, easy contracting of bacterial diseases, **fever**, weakness, heart **palpitations**, and ulcerations of the mouth, legs, and feet. Individuals may also bleed unexpectedly and heavily from the nose or other mucous membranes and from the gastrointestinal or urinary tracts. Most patients will develop an enlarged spleen, anemia, leukopenia, or abnormally low white blood cell counts, or **thrombocytopenia**, a deficiency of circulating platelets in the blood. Other symptoms may be present that reflect the underlying disease that has caused hypersplenism.

An enlarged spleen can be caused by a variety of diseases, including **hemolytic anemia**, liver **cirrhosis**, leukemia, malignant lymphoma and other infections and inflammatory diseases. Splenomegaly occurs in about 10% of **systemic lupus erythematosus** patients. Sometimes it is caused by recent viral infection, such as mononucleosis. An enlarged spleen may cause **pain** in the upper left side of the abdomen and a premature feeling of fullness at meals.

Diagnosis

Diagnosis of hypersplenism begins with review of symptoms and patient history and careful feeling (palpation) of the spleen. Sometimes, a physician can feel an enlarged spleen. X ray studies, such as ultrasound and computed tomography scan (CT scan), may help

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diagnose an enlarged spleen and possible underlying causes, such as tumors. Blood tests indicate decreases in white blood cells, red blood cells, or platelets. Another test measures red blood cells in the liver and spleen after injection of a radioactive substance and indicates areas where the spleen is holding on to large numbers of red cells or is destroying them.

Enlarged spleens are diagnosed using a combination of patient history; **physical examination**, including palpation of the spleen, if possible; and diagnostic tests. A history of fever and systemic symptoms may be present because of infection, malaria, or an inflammatory disorder. A **complete blood count** is taken to check counts of young red blood cells. **Liver function tests**, CT scans, and ultrasound exams can also help to detect an enlarged spleen.

Treatment

In secondary hypersplenism, the underlying disease must be treated to prevent further sequestration or destruction of blood cells, and possible spleen enlargement. Those therapies will be tried prior to removal of the spleen (**splenectomy**), which is avoided if possible. In severe cases, the spleen must be removed. Splenectomy will correct the effects of low blood cell concentrations in the blood.

Prognosis

Prognosis depends on the underlying cause and progression of the disease. Left untreated, spleen enlargement can lead to serious complications. Hypersplenism can also lead to complications due to decreased blood cell counts.

Prevention

Some of the underlying causes of hypersplenism or enlarged spleen can be prevented, such as certain forms of anemia and cirrhosis of the liver due to alcohol use. In other cases, the hypersplenism may not be preventable, as it is a complication to an underlying disorder.

ORGANIZATIONS

American Liver Foundation, 75 Maiden Lane, Suite 603, New York, NY, 10038, (212) 668-1000, (212) 483-8179, http://www.liverfoundation.org/.

American Society of Hematology, 2021 L St. NW, Suite 900, Washington, DC, 20036, (202) 776-0544, (202) 776-0545, http://www.hematology.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

Teresa Norris, RN

Hypertension

Definition

Hypertension is high blood pressure. Blood pressure is the force of blood pushing against the walls of arteries as it flows through them. Arteries are the blood vessels that carry oxygenated blood from the heart to the body's tissues.

Demographics

Hypertension is a major health problem, especially because it has no symptoms. Many people have hypertension without knowing it. In the United States, about 50 million people age six and older have high blood pressure. Hypertension is more common in men than women and in people over the age of 65 than in younger persons. More than half of all Americans over the age of 65 have hypertension. It also is more common in African Americans than in white Americans.

Description

As blood flows through arteries it pushes against the inside of the artery walls. The more pressure the blood exerts on the artery walls, the higher the blood pressure will be. The size of small arteries also affects the blood pressure. When the muscular walls of arteries are relaxed, or dilated, the pressure of the blood flowing through them is lower than when the artery walls narrow, or constrict.

Blood pressure is highest when the heart beats to push blood out into the arteries. When the heart relaxes to fill with blood again, the pressure is at its

The effects of hypertension on the heart and kidney. Hypertension has caused renal atrophy and scarring, and left ventricular hypertrophy in the sectioned heart (at right). *(Dr. E. Walker/Photo Researchers, Inc.)*

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lowest point. Blood pressure when the heart beats is called systolic pressure. Blood pressure when the heart is at rest is called diastolic pressure. When blood pressure is measured, the systolic pressure is stated first and the diastolic pressure second. Blood pressure is measured in millimeters of mercury (mm Hg). For example, if a person's systolic pressure is 120 and diastolic pressure is 80, it is written as 120/80 mm Hg. The American Heart Association has long considered blood pressure less than 140 over 90 normal for adults. However, the National Heart, Lung, and Blood Institute in Bethesda, Maryland, released new clinical guidelines for blood pressure in 2003, lowering the standard normal readings. A normal reading was lowered to less than 120 over less than 80.

Hypertension is serious because people with the condition have a higher risk for heart disease and other medical problems than people with normal blood pressure. Serious complications can be avoided by getting regular blood pressure checks and treating hypertension as soon as it is diagnosed.

If left untreated, hypertension can lead to the following medical conditions:

- arteriosclerosis, also called atherosclerosis
- heart attack
- stroke
- enlarged heart
- kidney damage

Arteriosclerosis is hardening of the arteries. The walls of arteries have a layer of muscle and elastic tissue that makes them flexible and able to dilate and constrict as blood flows through them. High blood pressure can make the artery walls thicken and harden. When artery walls thicken, the inside of the blood vessel narrows. Cholesterol and fats are more likely to build up on the walls of damaged arteries, making them even narrower. **Blood clots** also can get trapped in narrowed arteries, blocking the flow of blood.

Arteries narrowed by arteriosclerosis may not deliver enough blood to organs and other tissues. Reduced or blocked blood flow to the heart can cause a **heart attack**. If an artery to the brain is blocked, a **stroke** can result.

Hypertension makes the heart work harder to pump blood through the body. The extra workload can make the heart muscle thicken and stretch. When the heart becomes too enlarged it cannot pump enough blood. If the hypertension is not treated, the heart may fail.

The kidneys remove the body's wastes from the blood. If hypertension thickens the arteries to the kidneys, less waste can be filtered from the blood. As the condition worsens, the kidneys fail and wastes build up in the blood. Dialysis or a kidney transplant are needed when the kidneys fail. About 25% of people who receive **kidney dialysis** have kidney failure caused by hypertension.

Risk factors

Even though the cause of most hypertension is not known, some people have risk factors that increase their chance of developing hypertension. Many of these risk factors can be avoided to lower the chance of developing hypertension or as part of a treatment program to lower blood pressure.

Risk factors for hypertension include:

- age over 60
- male sex
- race
- heredity
- salt sensitivity
- obesity
- inactive lifestyle
- heavy alcohol consumption
- use of oral contraceptives

Some people inherit a tendency for hypertension. People with family members who have hypertension are more likely to develop it than those whose relatives are not hypertensive. People with these risk factors can avoid or eliminate other risk factors to lower their chance of developing hypertension. A 2003 report found that the rise in incidence of high blood pressure among children is most likely due to an increase in the number of overweight and obese children and adolescents.

Causes and symptoms

Many different actions or situations can normally raise blood pressure. Physical activity can temporarily raise blood pressure. Stressful situations can make blood pressure go up; when the **stress** goes away, blood pressure usually returns to normal. These temporary increases in blood pressure are not considered hypertension. A diagnosis of hypertension is made only when a person has multiple high blood pressure readings over a period of time.

The cause of hypertension is not known in 90–95% of the people who have it. Hypertension without a known cause is called primary or essential hypertension.

When a person has hypertension caused by another medical condition, it is called secondary hypertension. Secondary hypertension can be caused by a number of

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different illnesses. Many people with kidney disorders have secondary hypertension. The kidneys regulate the balance of salt and water in the body. If the kidneys cannot rid the body of excess salt and water, blood pressure goes up. Kidney infections, a narrowing of the arteries that carry blood to the kidneys, called **renal artery stenosis**, and other kidney disorders can disturb the salt and water balance.

Cushing's syndrome and tumors of the pituitary and adrenal glands often increase levels of the adrenal gland hormones cortisol, adrenalin, and aldosterone, which can cause hypertension. Other conditions that can cause hypertension are blood vessel diseases, thyroid gland disorders, some prescribed drugs, **alcoholism**, and **pregnancy**.

One of the most dangerous features of hypertension is the fact that it does not usually cause any symptoms. Individuals may not be aware that they have the condition, or they may mistakenly downplay its importance, simply because it is not causing any discernible problems. Without treatment, the deleterious effects of hypertension progress unchecked.

When blood pressure becomes extremely high, for example over 180/110 mmHg (termed malignant hypertension), symptoms such as **headache**, visual disturbances, **anxiety**, and **shortness of breath** may occur. If left untreated, stroke may supervene, or a hypertensive crisis, in which organs cannot receive an adequate blood supply and begin to fail, may occur.

Diagnosis

Examination

Because hypertension does not cause symptoms, it is important to have blood pressure checked regularly. Blood pressure is measured with an instrument called a sphygmomanometer. A cloth-covered rubber cuff is wrapped around the upper arm and inflated. When the cuff is inflated, an artery in the arm is squeezed to momentarily stop the flow of blood. Then, the air is let out of the cuff while a stethoscope placed over the artery is used to detect the sound of the blood spurting back through the artery. This first sound is the systolic pressure, the pressure when the heart beats. The last sound heard as the rest of the air is released is the diastolic pressure, the pressure between heart beats. Both sounds are recorded on the mercury gauge on the sphygmomanometer.

Normal blood pressure is defined by a range of values. Blood pressure lower than 120/80 mm Hg is considered normal. A number of factors such as **pain**, stress, or anxiety can cause a temporary increase in blood pressure. For this reason, hypertension is not diagnosed on one high blood pressure reading. If a blood pressure reading is 120/80 or higher for the first time, the physician will have the person return for another blood pressure check. Diagnosis of hypertension usually is made based on two or more readings after the first visit.

Systolic hypertension of the elderly is common and is diagnosed when the diastolic pressure is normal or low, but the systolic is elevated, e.g., 170/70 mm Hg. This condition usually co-exists with hardening of the arteries (**atherosclerosis**).

Blood pressure measurements are classified in stages, according to severity:

- normal blood pressure: less than 120/80 mm Hg
- pre-hypertension: 120–129/80–89 mm Hg
- Stage 1 hypertension: 140–159/90–99 mm Hg
- Stage 2 hypertension: at or greater than 160–179/100–109 mm Hg

A typical **physical examination** to evaluate hypertension includes:

- medical and family history
- physical examination
- ophthalmoscopy: Examination of the blood vessels in the eye
- chest x ray
- electrocardiograph (ECG)
- blood and urine tests

The medical and family history help the physician determine if the patient has any conditions or disorders that might contribute to or cause the hypertension. A family history of hypertension might suggest a genetic predisposition for hypertension.

The physical exam may include several blood pressure readings at different times and in different positions. The physician uses a stethoscope to listen to sounds made by the heart and blood flowing through the arteries. The pulse, reflexes, and height and weight are checked and recorded. Internal organs are palpated, or felt, to determine if they are enlarged.

Because hypertension can cause damage to the blood vessels in the eyes, the eyes may be checked with a instrument called an ophthalmoscope. The physician will look for thickening, narrowing, or hemorrhages in the blood vessels.

Tests

A **chest x ray** can detect an enlarged heart, other vascular (heart) abnormalities, or lung disease.

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An electrocardiogram (ECG) measures the electrical activity of the heart. It can detect if the heart muscle is enlarged and if there is damage to the heart muscle from blocked arteries.

Urine and blood tests may be done to evaluate health and to detect the presence of disorders that might cause hypertension.

Treatment

Traditional

There is no cure for primary hypertension, but blood pressure can almost always be lowered with the correct treatment. The goal of treatment is to lower blood pressure to levels that will prevent heart disease and other complications of hypertension. In secondary hypertension, the disease that is responsible for the hypertension is treated in addition to the hypertension itself. Successful treatment of the underlying disorder may cure the secondary hypertension.

Guidelines advise that clinicians work with patients to agree on blood pressure goals and develop a treatment plan for the individual patient. Actual combinations of medications and lifestyle changes will vary from one person to the next. Treatment to lower blood pressure may include changes in diet, getting regular **exercise**, and taking antihypertensive medications. Patients falling into the pre-hypertension range who do not have damage to the heart or kidneys often are advised to make lifestyle changes only. A 2003 report of a clinical trial showed that adults with elevated blood pressures lowered them as much as 38% by making lifestyle changes and participating in the DASH diet, which encourages eating more fruit and vegetables.

Drugs

Patients with stage 1 hypertension may be advised to take antihypertensive medication. Numerous drugs have been developed to treat hypertension. The choice of medication depends on the stage of hypertension, side effects, other medical conditions the patient may have, and other medicines the patient is taking.

If treatment with a single medicine fails to lower blood pressure enough, a different medicine may be tried or another medicine may be added to the first. Patients with more severe hypertension may initially be given a combination of medicines to control their hypertension. Combining antihypertensive medicines with different types of action often controls blood pressure with smaller doses of each drug than would be needed for just one.

Antihypertensive medicines fall into several classes of drugs:

- diuretics
- beta-blockers
- calcium channel blockers
- angiotensin converting enzyme inhibitors (ACE inhibitors)
- alpha-blockers
- alpha-beta blockers
- vasodilators
- peripheral acting adrenergic antagonists
- centrally acting agonists

Diuretics help the kidneys eliminate excess salt and water from the body's tissues and the blood. This reduces the swelling caused by fluid buildup in the tissues. The reduction of fluid dilates the walls of arteries and lowers blood pressure. Diuretics are recommended as the first drug of choice for most patients with high blood pressure and as part of any multi-drug combination.

Beta-blockers lower blood pressure by acting on the nervous system to slow the heart rate and reduce the force of the heart's contraction. They are used with caution in patients with **heart failure**, **asthma**, diabetes, or circulation problems in the hands and feet.

Calcium channel blockers block the entry of **calcium** into muscle cells in artery walls. Muscle cells need calcium to constrict, so reducing their calcium keeps them more relaxed and lowers blood pressure.

ACE inhibitors block the production of substances that constrict blood vessels. They also help reduce the build-up of water and salt in the tissues. They often are given to patients with heart failure, **kidney disease**, or diabetes. ACE inhibitors may be used together with diuretics.

Alpha-blockers act on the nervous system to dilate arteries and reduce the force of the heart's contractions.

Alpha-beta blockers combine the actions of alpha and **beta blockers**.

Vasodilators act directly on arteries to relax their walls so blood can move more easily through them. They lower blood pressure rapidly and are injected in hypertensive emergencies when patients have dangerously high blood pressure.

Peripheral acting adrenergic antagonists act on the nervous system to relax arteries and reduce the force of the heart's contractions. They usually are prescribed together with a diuretic. Peripheral acting

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adrenergic antagonists can cause slowed mental function and lethargy.

Centrally acting agonists also act on the nervous system to relax arteries and slow the heart rate. They are usually used with other antihypertensive medicines.

Home remedies

Lifestyle changes that may reduce blood pressure by 5 to 10 mm Hg include:

- reducing salt intake
- reducing fat intake
- losing weight
- getting regular exercise
- quitting smoking
- reducing alcohol consumption
- managing stress

Prognosis

There is no cure for hypertension. However, it can be well controlled with proper treatment. Therapy with a combination of lifestyle changes and antihypertensive medicines can keep blood pressure at levels that will not cause damage to the heart or other organs. The key to avoiding serious complications of hypertension is to detect and treat it before damage occurs. Because antihypertensive medicines control blood pressure, but do not cure it, patients must continue taking the medications to maintain reduced blood pressure levels and avoid complications.

Prevention

Prevention of hypertension centers on avoiding or eliminating known risk factors. Even persons at risk because of age, race, or sex or those who have an inherited risk can lower their chance of developing hypertension.

The risk of developing hypertension can be reduced by:

- reducing salt intake
- reducing fat intake
- losing weight
- getting regular exercise
- quitting smoking
- reducing alcohol consumption
- managing stress

Resources

BOOKS

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Libby, P., et al. *Braunwald's Heart Disease*, 8th ed. Philadelphia: Saunders, 2007.

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McNamara, Damian. "Trial Shows Efficacy of Lifestyle Changes for BP: More Intensive Than Typical Office Visit." *Family Practice News*, July 1, 2003: 1-2.

"New BP Guidelines Establish Diagnosis of Pre-hypertension: Level Seeks to Identify At-risk Individuals Early." *Case Management Advisor*, July 2003: S1.

"New Hypertension Guidelines: JNC-7." *Clinical Cardiology Alert*, July 2003: 54-63.

ORGANIZATIONS

American Heart Association, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, http://www.americanheart.org.

National Heart, Lung and Blood Institute, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi.nih.gov.

Texas Heart Institute, P.O. Box 20345, Houston, TX, 77225-0345, (800) 292-2221, hic@heart.thi.tmc.edu, http://www.texasheart.org.

Toni Rizzo
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Hyperthermia *see* **Fever**

Hyperthyroidism

Definition

Hyperthyroidism is the overproduction of **thyroid hormones** by an overactive thyroid gland. More specifically, the thyroid gland produces too much of a hormone called thyroxine.

The term *hyperthyroidism* covers any disease which results in overabundance of thyroid hormone. Other names for hyperthyroidism, or specific diseases within the category, include Graves' disease, diffuse toxic **goiter**, Basedow's disease, Parry's disease, and thyrotoxicosis.

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A symptom of hyperthyroidism is the enlargement of the thyroid gland. *(© Lester V. Bergman/Corbis.)*

Demographics

Hyperthyroidism is a fairly common disorder; the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) estimates that about 1% of the population of the United States and Canada has some form of hyperthyroidism. It is primarily a disease of adults; most patients are 35 or older at the time of diagnosis. Only about 5% of patients are younger than 15 years of age. The peak age for hyperthyroidism caused by Graves' disease is 35 to 40 years; hyperthyroidism caused by multinodular goiter is more common in adults over 50 than in younger adults.

The disease is 10 times more common in women than in men, and the annual incidence of hyperthyroidism in the United States is about 1 per 1,000 women. About 7% of women of childbearing age develop postpartum **thyroiditis** in the year after they give birth. Between 3% and 7% of adults in the United States develop thyroid nodules. Occult hyperthyroidism may occur in patients over 65 and is characterized by a distinct lack of typical symptoms. Diffuse toxic goiter occurs in as many as 80% of patients with hyperthyroidism.

Among children, about five times as many girls as boys develop hyperthyroidism. Almost all cases of pediatric hyperthyroidism are the form called Graves' disease. There is a form of hyperthyroidism called neonatal Graves' disease, which occurs in infants born of mothers with Graves' disease. Children with such other conditions as trisomy 21 (**Down syndrome**), **Addison's disease**, diabetes, **systemic lupus erythematosus**, **rheumatoid arthritis**, **myasthenia gravis**, **vitiligo**, **pernicious anemia**, and immune thrombocytopenic purpura are more likely to develop Graves' disease.

Hyperthyroidism is equally common among Caucasians, Asians, and Hispanics in the United States but is less common among African Americans. The reason for this difference was not known as of 2009.

Description

Located in the front of the neck, the thyroid gland is a butterfly-shaped structure lying between the Adam's apple and the collarbone. It takes its name from a Greek word meaning "shield." It consists of two lobes about 2 inches in length (in adults) connected by a thin strip of tissue called the isthmus. The thyroid gland weighs about a tenth of an ounce in newborns and 0.6–1.5 ounces in adults. One of the largest endocrine glands in the body, the thyroid controls the rate at which the body burns energy, its sensitivity to other hormones, and its manufacture of proteins.

The thyroid gland produces two hormones: thyroxine (T_4) and triiodothyronine (T_3, which regulate the body's metabolic rate by helping to form protein ribonucleic acid (RNA) and increasing oxygen absorption in every cell. In turn, the production of these hormones is controlled by thyroid-stimulating hormone (TSH), which is produced by the pituitary gland. Hyperthyroidism occurs when production of the thyroid hormones increases despite the level of TSH being produced. The excessive amount of thyroid hormones in the blood increases the body's metabolism, producing both mental and physical symptoms.

Risk factors

Risk factors for hyperthyroidism include:

- Female sex
- Age over 60
- Family history of thyroid disorders. Some genes have been identified as of 2009 that increase a person's susceptibility to autoimmune thyroid disease.
- Personal history of thyroid surgery or goiter
- Having type 1 diabetes, pernicious anemia, or primary adrenal insufficiency
- Pregnancy
- Giving birth within the past 6 months

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- Eating large amounts of iodine-containing foods.
- Use of medications containing iodine, particularly amiodarone (Cordarone), a drug given to treat irregular heart rhythms.

Causes and symptoms

Causes

Hyperthyroidism is often associated with the body's production of autoantibodies in the blood that cause the thyroid to grow and secrete excess thyroid hormone. This condition, as well as other forms of hyperthyroidism, may be inherited. It accounts for 70–75% of cases of hyperthyroidism.

Other causes of hyperthyroidism include multinodular goiter or Plummer's disease (about 15–20% of cases of hyperthyroidism), a condition in which adenomas (nodules or lumps) form within the thyroid gland and cause it to secrete a larger than normal amount of thyroid hormone, and thyroiditis, a condition in which a malfunction of the immune system or a viral infection causes the thyroid gland to leak thyroid hormone. Last, hyperthyroidism can be caused by taking too much thyroid hormone in tablet form. In a few very rare cases, hyperthyroidism can be caused by a malignant (cancerous) tumor in the thyroid gland.

Symptoms

Regardless of the cause or age of the patient, hyperthyroidism produces the same symptoms, including sudden weight loss with increased appetite, **shortness of breath** and **fatigue**, intolerance of heat, heart **palpitations**, increased frequency of bowel movements, warm and smooth skin, weak muscles, **tremors**, **anxiety**, and difficulty sleeping. Women of childbearing age may also notice decreased menstrual flow and irregular menstrual cycles.

The symptoms of hyperthyroidism are often less noticeable in older adults, and may consist mainly of an increased heart rate, heat intolerance, and a tendency to become tired during ordinary activities. In addition, **beta blockers** (a type of heart medication) can mask the symptoms of hyperthyroidism in seniors.

Patients with Graves' disease often have a goiter (visible enlargement of the thyroid gland), although as many as 10 percent do not. These patients may also have bulging eyes. Thyroid storm, a serious form of hyperthyroidism, may show up as sudden and acute symptoms, some of which mimic typical hyperthyroidism, as well as the addition of **fever** (104°F or higher), substantial weakness, extreme restlessness, confusion, emotional swings or **psychosis**, or **coma**. Fortunately, such a fulminant course of Graves' disease is rare in children and adolescents.

Babies with neonatal Graves' disease may suffer from **prematurity**, airway obstruction, and **heart failure**. **Death** occurs in as many as 16 percent of these babies, and other complications from which survivors may suffer include craniosynostosis (early closure of the sutures of the skull, which can result in compression of the growing brain), and developmental delay.

Diagnosis

The diagnosis of hyperthyroidism is based on a combination of patient history, a **physical examination**, and the results of laboratory and imaging tests. In most cases, patients are evaluated and treated by an endocrinologist rather than a family doctor.

Examination

Patients concerned that they may have nodules in their thyroid or an enlarged thyroid can conduct a "neck check" at home by examining their neck below the Adam's apple and above the collarbone while swallowing water and looking in a handheld mirror. Detailed instructions for the neck check can be found at the AACE link under the "Other" Resources listed for this article.

An endocrinologist will look for physical signs and symptoms indicated by the patient's history during an office examination. The patient will typically be asked to lift the head and swallow several times while the doctor feels the part of the neck containing the thyroid gland. On inspection, the physician may note such symptoms as a goiter, warm, smooth, and moist skin, eye bulging or a staring gaze, high blood pressure, irregular heart rhythm, hyperactivity, overactive reflexes, tremor, and muscle weakness. **Pregnancy** or recent **childbirth** or a family history of thyroid disorders may also be clues to a diagnosis of hyperthyroidism.

Tests

A simple blood test can be performed to determine the amount of thyroid hormone in the patient's blood. The American Thyroid Association recommends that adults, particularly women, have this blood test to detect thyroid problems every five years starting at age 35. The diagnosis is usually straightforward with this combination of clinical history, physical examination, and routine blood hormone tests. Radioimmunoassay, a test to show concentrations of thyroid hormones with the use of a radioisotope mixed with fluid samples, helps confirm the diagnosis.

A thyroid scan is a nuclear medicine procedure involving injection of a radioisotope dye that will tag the thyroid and help produce a clear image of inflammation or involvement of the entire thyroid. Other

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KEY TERMS

Adenoma—The medical term for a benign (noncancerous) tumor that originates in a gland. Thyroid nodules are one type of adenoma.

Endocrine gland—Any gland that makes hormones and secretes them directly into the bloodstream.

Endocrinologist—A doctor who specializes in diagnosing and treating disorders of the endocrine glands and the hormones they secrete.

Fulminant—Referring to a disease process that is explosive in onset, severe, and potentially deadly.

Goiter—Chronic enlargement of the thyroid gland.

Gonads—Organs that produce gametes (eggs or sperm), such as the ovaries and testes.

Graves' disease—An autoimmune disorder of the thyroid gland, in which the gland swells to twice its normal size and secretes too much thyroid hormone. Graves' disease accounts for 70–75% of cases of hyperthyroidism. It is named for an Irish doctor named Robert James Graves, who described a case of the disorder in 1835.

Hormone—A chemical released by specialized cells that affects cells in other parts of the body. Hormones regulate such body processes as growth, metabolism, the immune system, reproduction, hunger, and mood.

Multinodular goiter—A condition in which benign lumps of tissue (nodules) form within the thyroid gland and cause it to secrete too much thyroid hormone. It is also called Plummer's disease.

Palpitations—Rapid and forceful heartbeat.

Postpartum—After childbirth.

Radioisotope—One of two or more atoms with the same number of protons but a different number of neutrons with a nuclear composition. In nuclear scanning, radioactive isotopes are used as a diagnostic agent.

Thyroid storm—A rare but potentially life-threatening complication of hyperthyroidism, characterized by fever over 104°F, irregular heart rhythm, vomiting, diarrhea, dehydration, coma, and death.

Thyroidectomy—Surgical removal of the thyroid gland.

Thyroiditis—Inflammation of the thyroid gland. It can be caused by a viral infection, a malfunction of the immune system, or certain medications.

Thyrotoxicosis—Another term for hyperthyroidism.

Vitiligo—A chronic skin disorder that causes loss of pigmentation (color) from patches of skin, most often on the face, hands, and wrists.

tests can determine thyroid function and thyroid-stimulating hormone levels. Ultrasonography, **computed tomography scans** (CT scan), and **magnetic resonance imaging** (MRI) may provide visual confirmation of a diagnosis or help to determine the extent of involvement.

Procedures

The doctor may also order a fine needle aspiration biopsy (FNAB), a procedure in which the doctor inserts a thin needle into a suspected thyroid nodule to extract a sample of cells for examination under a microscope. The doctor usually uses an ultrasound monitor to guide the needle. A FNAB can be performed in an outpatient clinic or a doctor's office; it is safer and less invasive than an open surgical biopsy.

Treatment

Traditional

Treatment of hyperthyroidism will depend on the specific disease and individual circumstances such as age, severity of disease, and other conditions affecting a patient's health. No single approach to treatment works for all patients.

Drugs

Hyperthyroidism is usually treated with medications whenever possible. The two types of drugs most often prescribed are antithyroid drugs and radioactive iodine.

ANTITHYROID DRUGS. Antithyroid drugs are often administered to help the patient's body cease overproduction of thyroid hormones. The antithyroid drugs most commonly prescribed are methimazole (Tapazole) and propylthiouracil (PTU). About 20% to 30% of patients with Graves' disease will have long-term remission of hyperthyroidism after treatment with antithyroid drugs for a period of 12–18 months. It takes several weeks or months for antithyroid drugs to bring the patient's level of thyroid hormone into the normal range. Patients may be given beta blockers for symptom relief during this period.

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Antithyroid drugs are also used in preparation for either radioiodine treatment or surgery in patients diagnosed with multinodular goiter. These medications may work for young adults, pregnant women, and others. Women who are pregnant should be treated with the lowest dose required to maintain thyroid function in order to minimize the risk of **hypothyroidism** in the infant.

Antithyroid drugs can have unpleasant side effects, such as **rashes**, **itching**, or increased susceptibility to infection due to a decreased level of white blood cells. In rare cases these medications can lead to liver failure.

RADIOACTIVE IODINE. Radioactive iodine (iodine-131) is often prescribed to damage cells that make thyroid hormone. The cells need iodine to make the hormone, so they will absorb any iodine found in the body. The patient may take an iodine capsule daily for several weeks, resulting in the eventual shrinkage of the thyroid in size, reduced hormone production and a return to normal blood levels. Some patients may receive a single larger oral dose of radioactive iodine to treat the disease more quickly. This should only be done for patients who are not of reproductive age or are not planning to have children, since a large amount can concentrate in the reproductive organs (gonads). The risk of long-term side effects is low, however, as radioactive iodine has been used for over 60 years to treat patients with hyperthyroidism and doctors have followed these patients carefully.

Most patients who are given iodone-131 eventually develop hypothyroidism, which is an abnormally low level of thyroid hormone. Most endocrinologists do not consider this side effect of iodine-131 to be a major problem, however, because hypothyroidism is easier to treat and has fewer long-term complications than hyperthyroidism.

BETA BLOCKERS. Beta blockers may be used in the treatment of patients with hyperthyroidism even though they do not suppress the activity of the thyroid gland. They are useful in regulating the patient's heart rhythm and reducing such symptoms as palpitations, tremor, and nervousness until antithyroid medications can begin to take effect. The beta blockers most often prescribed for hyperthyroidism are the longer-acting drugs like atenolol (Tenormin), metoprolol (Lopressor), and nadolol (Corgard).

Surgery

Some patients may undergo surgery to treat hyperthyroidism. Surgery is usually recommended when the results of a FNAB indicate that the patient has a malignancy in the thyroid, or when the thyroid gland is so enlarged that it is putting pressure on the patient's windpipe or esophagus.

Most commonly, patients treated with **thyroidectomy** in the form of partial or total removal of the thyroid suffer from large goiter and have suffered relapses, even after repeated attempts to address the disease through drug therapy. Some patients may be candidates for surgery because they were not good candidates for iodine therapy, or refused iodine administration. Patients receiving thyroidectomy or iodine therapy must be carefully monitored for years to watch for signs of hypothyroidism, or insufficient production of thyroid hormones, which can occur as a complication of thyroid production suppression.

Alternative

Consumption of such foods as broccoli, Brussels sprouts, cabbage, cauliflower, kale, rutabagas, spinach, turnips, peaches, and pears can help naturally suppress thyroid hormone production. Caffeinated drinks and dairy products should be avoided. Under the supervision of a trained physician, high dosages of certain vitamin/mineral combinations can help to alleviate hyperthyroidism.

Prognosis

Hyperthyroidism is generally treatable and carries a good prognosis. Most patients lead normal lives with proper treatment. Thyroid storm, however, can be life-threatening and can lead to heart, liver, or kidney failure. Luckily, this form of fulminant hyperthyroidism is rare in children and adolescents.

Hyperthyroidism is associated with an increased risk of **Alzheimer's disease** in later life even when the thyroid dysfunction has been successfully treated. The reason for this association was not fully understood as of 2009.

Prevention

Although a periodic neck check at home cannot prevent hyperthyroidism in the strict sense of prevention, it can help in detecting the condition earlier rather than later.

There are no known prevention methods for hyperthyroidism, since its causes were either inherited or not completely understood as of 2009. The best prevention tactic is knowledge of family history and close attention to symptoms and signs of the disease. Careful attention to prescribed therapy can prevent complications of the disease.

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American Academy of Otolaryngology—Head and Neck Surgery, 1650 Diagonal Road, Alexandria, VA, 22314, 703-836-4444, http://www.entnet.org/.

American Association of Clinical Endocrinologists (AACE), 245 Riverside Ave., Suite 200, Jacksonville, FL, 32202, 904-353-7878, http://www.aace.com/.

American Thyroid Association (ATA), 6066 Leesburg Pike, Suite 550, Falls Church, VA, 22041, 703-998-8890, 703-998-8893, thyroid@thyroid.org, http://www.thyroid.org/.

Hormone Foundation, 8401 Connecticut Avenue, Suite 900, Chevy Chase, MD, 20815, 800–HORMONE, 301-941-0259, hormone@endo-society.org, http://www.hormone.org/.

National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), Building 31. Rm 9A06, 31 Center Drive, MSC 2560, Bethesda, MD, 20892-2560, 301-496-3583, http://www2.niddk.nih.gov/Footer/ContactNIDDK.htm, http://www2.niddk.nih.gov/.

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Hypertrophic cardiomyopathy

Definition

Cardiomyopathy is an ongoing disease process that damages the muscle wall of the lower chambers of the heart. Hypertrophic cardiomyopathy is a form of cardiomyopathy in which the walls of the heart's chambers thicken abnormally. Other names for hypertrophic cardiomyopathy are idiopathic hypertrophic subaortic stenosis and asymmetrical septal hypertrophy.

Description

Hypertrophic cardiomyopathy usually appears in young people, often in athletes. For this reason it is sometimes called athletic heart muscle disease. However, people of any age can develop hypertrophic cardiomyopathy. Often there are no symptoms of hypertrophic cardiomyopathy. Sudden **death** can occur, caused by a heart arrhythmia. The American Heart Association

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This illustration shows hypertrophic muscle in the heart. The abnormally thick wall of muscle prevents the chambers from stretching to fill up with blood, making the heart less efficient. The extra tissue may also push on the heart valve (center), causing it to leak. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

reports that 36% of young athletes who die suddenly have probable or definite hypertrophic cardiomyopathy.

Hypertrophic cardiomyopathy is the result of abnormal growth of the heart muscle cells. The wall between the heart's chambers (the septum) may become so thickened that it blocks the flow of blood through the lower left chamber (left ventricle). The thickened wall may push on the heart valve between the two left heart chambers (mitral valve), making it leaky. The thickened muscle walls also prevent the heart from stretching as much as it should to fill with blood.

Causes and symptoms

The cause of hypertrophic cardiomyopathy is not known. In about one-half of cases, the disease is inherited. An abnormal gene has been identified in these patients. In cases that are not hereditary, a gene that was normal at birth may later become abnormal.

Often people with hypertrophic cardiomyopathy have no symptoms. Unfortunately, the first sign of the condition may be sudden death caused by an abnormal heart rhythm. When symptoms do appear, they include **shortness of breath** on exertion, **dizziness**, **fainting**, **fatigue**, and chest **pain**.

Diagnosis

The diagnosis is based on the patient's symptoms (if any), a complete **physical examination**, and tests that detect abnormalities of the heart chambers. Usually, there is an abnormal heart murmur that worsens with the **Valsalva maneuver**. The electrocardiogram (ECG), which provides a record of electrical changes in the heart muscle during the heartbeat, also is typically abnormal.

Sometimes, a routine **chest x ray** may show that the heart is enlarged. **Echocardiography**, a procedure that produces images of the heart's structure, is usually done. These images can show if the heart wall is thickened and if there are any abnormalities of the heart valves.

Treatment

Treatment of hypertrophic cardiomyopathy usually consists of taking medicines and restricting strenuous **exercise**. Drugs called **beta blockers** and **calcium channel blockers** are usually prescribed. Beta blockers reduce the force of the heart's contractions. **Calcium** channel blockers can help improve the flexibility of the heart muscle walls, allowing them to stretch more. **Antiarrhythmic drugs** may also be given to prevent abnormal heart rhythms.

Patients with hypertrophic cardiomyopathy are also told to avoid strenuous exercise to reduce the risk of passing out or sudden death.

In some cases, if the medications do not help relieve symptoms, surgery may help. In an operation called myotomy-myectomy a piece of the septum is removed to improve blood flow through the heart chamber.

Some patients have **pacemakers** and/or defibrillators implanted to help control the heart rate and rhythm. Pacemakers and defibrillators provide electrical impulses to the heart, which can return the heart beat to a normal rhythm.

If these treatment methods fail and a patient develops **heart failure**, a heart transplant may be necessary.

Prognosis

Some people with hypertrophic cardiomyopathy may not have obstructed blood flow and may never experience symptoms. Others may only experience mild symptoms. With treatment, symptoms may improve. In some patients, the disease may progress to heart failure.

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Prevention

While hypertrophic cardiomyopathy cannot be prevented, precautionary measures may prevent sudden deaths. Anyone planning to take part in a program of strenuous competitive exercise should have a checkup by a physician first. A physical examination before athletic participation can usually, but not always, detect conditions like hypertrophic cardiomyopathy. Anyone who experiences symptoms of shortness of breath, tiredness, or fainting with exercise should see a physician.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

Texas Heart Institute. Heart Information Service, MC 3-116, PO Box 20345, Houston, TX, 77225, (832) 355-4011, (800) 292-2221, http://www.texasheart.org.

Toni Rizzo

Hypervitaminosis *see* **Vitamin toxicity**

Hyphema

Definition

A hyphema is an accumulation of blood in the front (anterior) chamber of the eye. It is usually caused by blunt eye trauma.

Description

The anterior chamber (AC) is located behind the front of the eye. The AC is filled with a fluid called aqueous humor. This fluid helps form a cushion for the eye and provides an important route for nutrient and waste transport. Contusive forces from high velocity projectiles (approximately 34% of emergency room cases) such as a rock, crab apples, ice balls, badminton birds, and bungee cords can tear local blood vessels in the eye. Blunt impact from a basketball or racketball accounts for about 62% of cases. Tearing a small blood vessel can cause seepage of blood into a visible layer portion of the AC, causing the affected person to have a red eye.

Causes and symptoms

Hyphema is caused by blunt, projectile, or explosion (about 4% of cases) injuries. These injuries cause a local blood vessel in the eye to tear, filling the front portion of the AC with blood. The initial complaint is a dramatic decrease in vision that eventually gets better as blood seeps towards the back of the eye. Patients will have extreme **pain**, an increase in intraocular pressure (the pressure inside the eye), and **nausea**. Patients usually will show a red eye and a recent history of trauma. Patients are vulnerable to more bleeding three to five days post injury.

Diagnosis

All persons with hyphema must be examined by an ophthalmologist (a physician who specializes in the medical and surgical care of the eye). Usually the clinician will use an ophthalmoscope to visualize the internal structures and damage. In some cases there may be small microscopic bleeds that may form clots (microhyphema) and require specialized instrumentation (a slit lamp) for visualization.

Treatment

Bloodthinners, such as **aspirin** and **nonsteroidal anti-inflammatory drugs**, should be avoided. In most cases the affected person can be medically managed on an outpatient basis. The eye should be shielded, but not patched. The patient should be placed on bed rest with the head elevated 45°. This position allows blood to leave the AC allowing for better vision. Several studies suggest administering medications (aminocaproic acid) that stabilize clot formation, reducing the possibility of increased bleeding.

Prognosis

The outcome depends on the severity of the trauma. Most cases progress well with conservative treatment. Some cases may develop an increase in the pressure within the eye (glaucoma). If this develops the hyphema must be surgically removed by an ophthalmologist. In patients who have a preexisting blood disorder, surgical evacuation should be considered to prevent damage to the optic nerve (the nerve that transmits impulses for processing in the brain).

Prevention

The American Academy of Ophthalmology recommends special eyewear made of polycarbonate lenses when at risk of eye injury. This type of lens has sufficient impact resistance.

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Laith Farid Gulli, M.D.

Hypnosis *see* **Hypnotherapy**

Hypnotherapy

Definition

Hypnotherapy is the treatment of a variety of health conditions by hypnotism or by inducing prolonged sleep.

Pioneers in this field, such as James Braid and James Esdaile, discovered that hypnosis could be used to successfully anesthetize patients for surgeries. James Braid accidentally discovered that one of his patients began to enter a hypnotic state while staring at a fixed light as he waited for his **eye examination** to begin. Since mesmerism had fallen out of favor, Braid coined the term hypnotism, which is derived from the Greek word for sleep. Braid also used the techniques of monotony, rhythm, and imitation to assist in inducing a hypnotic state. These techniques are still in use.

Around 1900, there were very few preoperative anesthetic drugs available. Patients were naturally apprehensive when facing surgery. One out of four hundred patients would die, not from the surgical procedure, but from the anesthesia. Dr. Henry Munro was one of the first physicians to use hypnotherapy to alleviate patient fears about having surgery. He would get his patients into a hypnotic state and discuss their fears with them, telling them they would feel a lot better following surgery. Ether was the most common anesthetic at that time, and Dr. Munro found that he was able to perform surgery using only about 10% of the usual amount of ether.

Purpose

Hypnotherapy is used in a number of fields including **psychotherapy**, surgery, dentistry, research, and medicine. Hypnotherapy is commonly used as an alternative treatment for a wide range of health conditions, including weight control, **pain management**, and **smoking** cessation. It is also used to control **pain** in a variety of conditions such as **headache**, facial **neuralgia**, arthritis, **burns**, musculoskeletal disorders, **childbirth**, and many more. Hypnotherapy is being used in place of anesthesia, particularly in patients who prove to be allergic to anesthetic drugs, for surgeries such as hysterectomies, cesarean sections, certain cardiovascular procedures, **thyroidectomy**, and others. Dentistry is using hypnotherapy with success on patients who are allergic to all types of novocaine drugs. Hypnotherapy is also useful in helping patients overcome **phobias**.

Hypnotherapy is used for nonmedical patients as well as those who wish to overcome bad habits. Hypnotherapy has been shown to help those who suffer from performance **anxiety**, such as in sports, and speaking in public. In academic applications, it has also been shown to help with learning, participating in the classroom, concentrating, studying, focusing attention span, improving memory, and helping remove mental blocks about particular subjects.

In more general areas, hypnotherapy has been found to be beneficial for problems such as motivation, procrastination, decision making, personal achievement and development, job performance, buried or repressed memories, relaxation, and **stress** management.

Description

Origins

Hypnotherapy is thought to date back to the healing practices of ancient Greece and Egypt. Many religions such as Judaism, Christianity, Islam, and others have attributed trance-like behavior to spiritual or divine possession.

Austrian physician, Franz Mesmer (1734–1815), is credited with being the first person to scientifically investigate the idea of hypnotherapy, in 1779, to treat a variety of health conditions. Mesmer studied medicine at the University of Vienna and received his medical degree in 1766. Mesmer is believed to have been the first doctor to understand the relationship of psychological trauma to illness. He induced a trance-like state, which became known as mesmerism, in his patients to successfully treat nervous disorders. These techniques became the foundation for modern-day hypnotherapy.

Mesmer's original interest was in the effect of celestial bodies on human lives. He later became interested in the effects of magnetism, and found that magnets could have tremendous healing effects on the human body. Mesmer believed that the human body contained a magnetic fluid that promoted health and well being. It was thought that any blockage to the normal flow of this magnetic fluid would result in

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illness, and that the use of the mesmerism technique could restore the normal flow.

Mesmer performed his technique by passing his hands up and down the patient's body. The technique was supposed to transmit magnetic fluid from his hands to the bodies of his patients. During this time, there was no clear delineation between health conditions that were physical or psychological in nature. Although Mesmer did not realize it at that time, his treatments were most effective for those conditions that were primarily psychosomatic.

Mesmer's technique appeared to be quite successful in the treatment of his patients, but he was the subject of scorn and ridicule from the medical profession. Because of all the controversy surrounding mesmerism, and because Mesmer's personality was quite eccentric, a commission was convened to investigate his techniques and procedures. A very distinguished panel of investigators included Benjamin Franklin, the French chemist Antoine-Laurent Lavoisier, and physician Jacques Guillotin. The commission acknowledged that patients did seem to obtain noticeable relief from their conditions, but the whole idea was dismissed as being medical quackery.

It took more than 200 years for hypnotherapy to be incorporated into medical treatment. In 1955, the British Medical Association approved the use of hypnotherapy as a valid medical treatment, with the American Medical Association (AMA) giving its approval in 1958.

Hypnotherapy involves achieving a psychological state of awareness that is different from the ordinary state of consciousness. While in a hypnotic state, a variety of phenomena can occur. These phenomena include alterations in memory, heightened susceptibility to suggestion, **paralysis**, sweating, and blushing. All of these changes can be produced or removed in the hypnotic state. Many studies have shown that roughly 90% of the population is capable of being hypnotized.

This state of awareness can be achieved by relaxing the body, focusing on breathing, and shifting attention away from the external environment. In this state, the patient has a heightened receptivity to suggestion. The usual procedure for inducing a hypnotic trance in another person is by direct command repeated in a soothing, monotonous tone of voice.

Preparations

Ideally, the following conditions should be present to successfully achieve a state of hypnosis:

- willingness to be hypnotized
- rapport between the patient or client and the hypnotherapist
- a comfortable environment that is conducive to relaxation

Precautions

Hypnotherapy can have negative outcomes. When used as entertainment, people have been hypnotized to say or do things that would normally embarrass them. There have been instances where people already dangerously close to psychological breakdown have been pushed into an emotional crisis during what was supposed to be a harmless demonstration of hypnosis. A statement from the World Hypnosis Organization (WHO) warns against performing hypnosis on patients suffering from **psychosis**, organic psychiatric conditions, or antisocial **personality disorders**. Because there are no standard licensing requirements, in the wrong hands, there is a risk that the hypnotist will have difficulty in controlling or ending a hypnotic state that has been induced in the patient.

There is a commonly held belief that a person cannot be coerced into doing things that they would not normally do while under hypnosis. The hynotherapist should take care however, not to give suggestions during hypnosis that are contrary to the patient's moral code.

Many religions do not condone the practice of hypnotherapy. Leaders of the Jehovah's Witnesses and Christian Science religions oppose the use of hypnotherapy and advise their members to avoid it completely, whether for entertainment or therapy. The Church of Jesus Christ of Latter-Day Saints approves it for medical purposes, but cautions members against allowing themselves to be hypnotized for entertainment or demonstration purposes.

In 1985, The AMA convened a commission that warned against using hypnotherapy to aid in recollection of events. The commission cited studies that showed the possibility of hypnotic recall resulting on confabulation or an artificial sense of certainty about the course of events. As a result, many states limit or prohibit testimony of hypnotized witnesses or victims.

Side effects

Experiments have been conducted to determine any side effects of hypnotherapy. Some subjects have reported side effects such as headache, stiff neck, drowsiness, cognitive distortion or confusion, **dizziness**, and

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anxiety. However, most of these effects cleared up within several hours of the hypnotherapy session.

Research and general acceptance

Research on the effectiveness of hypnotherapy on a variety of medical conditions is extensive. In one study, the use of hypnotherapy did not seem to alter the core symptoms in the treatment of attention-deficit hyperactivity disorder (**ADHD**); however, it did seem to be useful in managing the associated symptoms including sleep disturbances and tics.

Hypnotherapy is being studied in children who have common, chronic problems and to aid in relieving pain. Children are particularly good candidates for hypnotherapy because their lack of worldly experience enables them to move easily between the rational world and their imagination. Studies with children have shown responses to hypnotherapy ranging from diminished pain and anxiety during a number of medical procedures, a 50% range in reduction of symptoms or a complete resolution of a medical condition, and a reduction in use of anti-nausea medication and **vomiting** during **chemotherapy** for childhood cancers.

The use of hypnotherapy with **cancer** patients is another area being investigated. A meta-analysis of 116 studies showed very positive results of using hypnotherapy with cancer patients. Ninety-two percent showed a positive effect on depression; 93% showed a positive effect on physical well-being; 81% showed a positive effect on **vomiting**; and 92% showed a positive effect on pain.

ORGANIZATIONS

American Board of Hypnotherapy, P.O. Box 531605, Henderson, NV, 89053, (702) 456-3267, (702) 436-3267, Candace@abh-abnlp.com, http://www.abh-abnlp.com/.

American Psychotherapy & Medical Hypnosis Association, 3430 Creekwood Drive, Brownsville, TX, 78526, (956) 465-1581, admin@apmha.com, http://apmha.com/.

American Society of Clinical Hypnosis, 140 N. Bloomingdale Rd, Bloomingdale, IL, 60108, (630) 980-4740, (630) 351-8490, info@asch.net, http://www.asch.net/.

Hypnotherapy Society, PO Box 131, Arundel, UK, BN18 8BR, secretary@hypnotherapysociety.com, http://www.hypnotherapysociety.com.

International Council for Medical and Clinical Therapists, 7361 McWhorter Place, Suite 300, Annandale, VA, 2203-5649, (703) 658-2014, http://www.seec-icmct.com/icmct.htm.

International Medical and Dental Hypnotherapy Association, 8852 SR 3001, Laceyville, PA, 18623, (570) 869-1021, (570) 869-1249, (800) 553-6886, info@imdha.com, http://www.imdha.com/.

Society for Clinical and Experimental Hypnosis, 728 Old McLean Village Drive, McLean, VA, 22101.

World Hypnosis Organization, Inc, 2521 W. Montrose Avenue, Chicago, IL, 60618, (773) 267-6677, copal@anet-chi.com, http://www.worldhypnosis.org.

Kim A. Sharp, M.Ln.

Hypoactive sexual desire disorder

Definition

Hypoactive sexual desire disorder (HSDD) is a persistent or recurrent extreme aversion to or avoidance of genital sexual contact with a partner. HSDD is also called sexual aversion, inhibited sexual desire, sexual apathy, or sexual anorexia.

Demographics

HSDD is one of the most common sexual disorders. However the incidence of HSDD is difficult to estimate since as many as 40% of adults report a loss of sexual desire at some point in their lives. HSDD has traditionally been associated with women; however 30% of women report that they have more interest in sex than their male partners. Estimates of the incidence of HSDD in both males and females range from 5 to more than 20 percent.

Description

People with HSDD have a low level of sexual interest and desire that is manifested by the failure to initiate sexual activity or to respond to a partner's sexual overtures. However sexual desire normally fluctuates over the course of person's life. Often sexual desire is high at the beginning of a relationship and low as a relationship wanes. Illness can affect sexual desire, as can life changes such as **pregnancy** and **menopause** in women. According to the American Psychiatric Association's *Diagnostic and Statistical Manual of Mental Disorders*, fourth edition, text revision (*DSM–IV–TR*), a diagnosis of HSDD requires a persistent or recurrent lack of sexual desire that causes marked distress or interpersonal instability. In the most extreme form of HSDD, the patient not only lacks sexual desire, but may find sex to be distasteful, repulsive, or revolting.

HSDD can take various forms:

- Primary HSDD is a condition in which the patient has never felt much sexual interest or desire.

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- Secondary or acquired HSDD occurs in patients who formerly had normal sexual desires but no longer have any interest in sex.
- Generalized HSDD is a lack of sexual desire in all situations and with any partner.
- Situational or selective HSDD is an aversion directed at a specific partner or only under certain circumstances.

Risk factors

Because HSDD is caused by so many different physiological, psychological, and emotional factors, it is difficult to delineate risk factors. However people who have experienced sexual trauma or were raised to have negative attitudes toward sex may be at greater risk for primary HSDD.

Causes and symptoms

The major symptom of HSDD is a lack of interest in sex, even under circumstances that are usually erotic, such as viewing pornography. Sexual activity is infrequent or nonexistent, causing distress or discord within relationships.

HSDD can result from physical, emotional, and/or psychological factors. Lifelong or primary HSDD can be a consequence of sexual trauma such as incest, **sexual abuse**, or **rape**. It can result from repressive family attitudes towards sex, which are sometimes reinforced by rigid religious training. HSDD occasionally occurs after initial attempts at sexual intercourse result in **pain** or sexual failure.

Acquired or situational HSDD in an adult is commonly associated with boredom in a sexual relationship. In such cases, as sexual frequency with the partner decreases, real or fantasized sexual desire for others remains normal or even increases. In addition to boredom, relationship issues that can cause situational HSDD include:

- lack of emotional connection with a sexual partner
- frequent quarrelling or unresolved conflicts with a partner
- poorly communicated sexual needs and preferences
- incompatible sexual interest, often because the unaffected partner is sexually demanding
- infidelity or other breach of trust

Psychological causes of HSDD include:

- a history of physical abuse
- depression
- anxiety
- stress
- poor body image
- low self–esteem

Physical causes of HSDD can include:

- hormonal changes due to pregnancy or breastfeeding
- estrogen deficiency due to female menopause
- low levels of the male sex hormone testosterone, which can also be deficient in postmenopausal women
- other hormonal abnormalities
- illnesses, such as cancer, arthritis, diabetes, high blood pressure, coronary artery disease, or neurological diseases
- surgery of the breasts or genital tract
- obesity
- drug or alcohol abuse
- impairment of sexual function, especially male erectile dysfunction or female vaginismus—an involuntary contraction or spasm of the lower vaginal muscles—which prevents vaginal penetration
- the inability to have an orgasm (aorgasmia)
- infertility
- fatigue

Various medications can cause HSDD including:

- selective serotonin reuptake inhibitors (SSRIs), including the antidepressants sertraline (Zoloft), paroxetine (Paxil), and fluoxetine (Prozac)
- blood pressure medications
- antihistamines
- birth control pills
- chemotherapy drugs
- HIV/AIDS drugs
- some hair–loss remedies

Painful intercourse (**dyspareunia**) is more common in women than in men, but can cause HSDD in either sex. Dyspareunia usually has a physical cause, such as an allergic reaction to a spermicidal preparation, lubricant, or condom. Female dyspareunia can be caused by **vaginismus**, urogenital trauma or infection, inflammatory conditions of the labia or vagina, or vaginal injuries. Male dyspareunia can result from infections of the prostate gland, urethra, or testes. Painful erections can be a consequence of **Peyronie's disease**, which is characterized by fibrotic changes in the shaft of the penis that prevent a normal erection.

Delayed sexual maturation is another potential cause of HSDD. In girls delayed sexual maturation is characterized by a lack of breast enlargement by age 13 or by more than a five–year lapse between the initiation of breast growth and the onset of menstruation. Boys

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KEY TERMS

Dyspareunia—Difficult or painful sexual intercourse.

Estrogen—Any of several naturally occurring or synthetic steroid hormones that promote the growth and maintenance of the female reproductive system.

Kegel exercises—Repetitive contractions to tone the pubococcygeal muscle of the pelvic floor for enhancing sexual response during intercourse or controlling incontinence.

Labia—The fatty folds of the vulva.

Priapism—A prolonged erection lasting more than four hours.

Prolactinoma—A benign (noncancerous) tumor of the pituitary gland that secretes the hormone prolactin.

Sexual anhedonia—The inability to experience sexual pleasure.

Testosterone—The primary male sex hormone, which is also produced at low levels in females.

Urethra—The tube that discharges urine from the bladder to the outside of the body.

Vaginismus—A painful spasmodic vaginal contraction.

who have no testicular enlargement by 13.5 years of age or who experience more than a five–year lapse between initial and completed growth of the genitalia are considered to have delayed maturation. Delayed **puberty** can result from:

- familial constitutional disorders
- genetic defects such as Turner's syndrome in females or Klinefelter's syndrome in males
- central nervous system disorders, such as pituitary conditions that interfere with the secretion of gonadotropic hormones
- chronic illnesses such as diabetes mellitus, chronic renal failure, or cystic fibrosis

A rare but important cause of HSDD is a functional prolactin–secreting tumor of the pituitary gland, called a prolactinoma. Although prolactinomas are benign tumors, they can cause visual disturbances by enlarging and exerting pressure on the optic nerves. In females prolactinomas are associated with **galactorrhea** (**lactation** in the absence of pregnancy), **amenorrhea** (lack of a menstrual period), symptoms of estrogen deficiency, and dyspareunia. Males with prolactinomas typically have no interest in sex, although they can achieve an erection.

The pain that accompanies **priapism** can cause HSDD in males. Priapism is an erection lasting more than four hours and occurring in the absence of sexual stimulation. It is not associated with sexual excitement, and the erection does not subside after ejaculation. Although priapism can occur at any age, it is common in boys between the ages of 5 and 10 and in men between the ages of 20 and 50. Priapism in children is commonly associated with leukemia and **sickle cell disease** or occurs secondary to trauma. The most common cause in adults is the intrapenile injection of agents to correct **erectile dysfunction**. Priapism can also be caused by the use of psychotropic drugs, such as chlorpromazine and prazosin.

Sexual anhedonia is a rare type of male HSDD, in which the man experiences erection and ejaculation but derives no pleasure from orgasm. This is attributed to penile anesthesia, caused by psychogenic factors in a hysterical or obsessive person. Loss of tactile sensation in the penis is rarely due to physical factors unless there are associated anesthetized areas around the anus or scrotum.

Diagnosis

Examination

Diagnosis of HSDD will include a complete physical exam, a gynecological exam for women, a psychological evaluation, and medical and sexual histories, as well as an evaluation of prescribed and over–the–counter medications. Any physical causes of HSDD—such as abnormalities of the genitalia, prolactinoma, chronic renal disease, **diabetes mellitus**, a genetic disorder, or a family history of the disorder—must be identified.

Tests

Screening tests or questionnaires may be used to evaluate a patient's degree of sexual desire. Other testing may include:

- blood pressure
- estrogen levels in females, particularly in pre– and post–menopausal women
- testosterone levels in both males and females
- blood prolactin levels
- glucose tolerance to test for diabetes

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- thyroid function
- iron deficiency

Procedures

Imaging techniques may be used in the diagnosis of physical causes of HSDD. Enlargement of the pituitary gland can be detected by **magnetic resonance imaging** (MRI) or computerized axial tomography (CAT or CT) scanning.

Treatment

Traditional

Any medical conditions underlying HSDD must be addressed; for example, genitourinary infections, poorly controlled diabetes, **substance abuse**, or suspect medications. Psychological causes of HSDD are addressed through behavioral or dynamic **psychotherapy**. HSDD often requires referral to a specialized counselor or sex therapist. Sexual anhedonia requires psychiatric referral unless there is evidence of **spinal cord injury** or **peripheral neuropathy**. Any other sexual disorders that can contribute to HSDD, such as erectile dysfunction, must be addressed. If the HSDD appears to be of a temporary or transient interpersonal nature, couples therapy may be beneficial. This requires the patience, support, and understanding of the sexual partner.

Drugs

In addition to any necessary adjustments in current medications, HSDD is sometimes treated with drugs:

- Systemic or local estrogen or estrogen/progesterone therapy can treat low hormone levels in menopausal women.
- A blood testosterone level of less than 300 nanograms (ng) per deciliter (dL) in males or 10 ng/dL in females may suggest testosterone replacement therapy. However this is controversial for women and may have adverse side effects.
- Prescription testosterone creams or gels for women may improve sexual desire.
- Tricyclic antidepressants (TCAs) or monoamine oxidase inhibitors (MAOIs) may be used to treat depression or panic symptoms accompanying HSDD.
- Some studies have reported that non–depressed younger women with HSDD may respond favorably to sustained–release tablets of the antidepressant bupropion hydrochloride (Wellbutrin). Women have reported significant increases in frequency of sexual arousal, sexual fantasies, and desire to engage in sexual activities. Bupropion enhances the activity of the neurotransmitters norepinephrine and dopamine, which affect sexual desire.
- Dopamine–stimulating drugs also have been found to increase sexual desire in some men.
- Flibanserin, an antidepressant–type drug, is being marketed as a treatment for female HSDD, but in June 2010, a U.S. Food and Drug Administration (FDA) advisory committee voted 10 to 1 against approving the drug for this purpose.

Alternative

Alternative remedies for HSDD include:

- vitamin E applied to the vagina
- Zestra genital massage oil, a proprietary blend of botanicals that includes borage seed and evening primrose oils, Angelica root, and vitamins C and E
- ArginMax, a nutritional supplement

Home remedies

Some sex therapists recommend a period of abstinence from genital sex and an increased emphasis on non–genital sex for the treatment of HSDD. Other methods for treating HSDD include:

- sexual lubricants
- experimenting with different sexual positions and settings, sex toys, and fantasies
- scheduling time for intimacy
- practicing open and honest communication with sexual partners
- regular aerobic exercise and strength–training to improve mood, body image, and libido
- stress management techniques
- for women, practicing Kegel (pelvic floor muscle) exercises for increasing pleasurable sexual sensations and libido

Prognosis

Prognosis depends primarily on the underlying causes of HSDD. For certain medical conditions the prognosis for the development or recovery of sexual interest is good. Examples include testosterone therapy for **hypogonadism** or appropriate treatment of a prolactin–secreting pituitary tumor. However with certain genetic defects, such as Turner's and Klinefelter's syndromes, attainment of sexual function is impossible.

In general, psychotherapy has proved to be only minimally effective in the treatment of HSDD. However

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the vast majority of HSDD cases are situational in nature, usually due to dissatisfaction or loss of interest in a sexual partner. In cases of marital discord, couples counseling by a healthcare professional trained in the field can be of significant assistance. However cases in which both partners are dissatisfied often do not respond to such therapy and these situations frequently culminate in separation, finding new sexual partners, or divorce.

Prevention

Since the majority of HSDD cases are situational, they are difficult to predict or prevent. However, open and honest communication between sexual partners is an important step.

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American Academy of Family Physicians (AAFP), 11400 Tomahawk Creek Pkwy., Leawood, KS, 66211–2680, (913) 906–6000, (800) 274–6000, (913) 906–6075, http://www.aafp.org/online/en/home.html.

American Association of Sex Educators, Counselors, and Therapists (AASECT), PO Box 1960, Ashland, VA, 23005–1960, (804) 752–0026, (804) 752–0056, aacect@aasect.org, http://www.aasect.org.

American College of Obstetricians and Gynecologists (ACOG), PO Box 96920, Washington, DC, 20090–6920, (202) 638–5577, (800) 673–8444, resources@acog.org, http://www.acog.org.

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Hypocalcemia

Definition

Hypocalcemia, a low blood **calcium** level, occurs when the level of total calcium in the blood falls below 8.5 mg/dL. The normal concentration of calcium in the blood serum is 8.7–10.4 mg/dL.

Description

Calcium is an important mineral for maintaining human health. It is not only a component of bones and teeth, but is also essential for normal blood clotting and necessary for normal muscle and nerve functions. The calcium ion (Ca^{2+}) has two positive charges. In bone, where 99% of calcium is found, calcium ions occur as a complex with phosphate to form crystals of calcium phosphate. In the bloodstream, calcium ions also occur in complexes, and here calcium is found combined with proteins and various nutrients. However, in the bloodstream, calcium also occurs in a free form. Normally, about 47% of the calcium in the blood plasma is free, 40% is bound to protein, and about 10% occurs in a complex form. Although all calcium in the bloodstream serves a useful purpose, only the concentration of free calcium ions has a direct influence on the functioning of nerves and muscles. For this reason, the

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KEY TERMS

Albumin—A type of protein made by the liver and found in the blood.

Cardiac dysrhythmias—Abnormal heart rate, rhythm, or sequence of rhythms.

Ion—A particle that has a positive or negative charge.

measurement of the concentration of free calcium is more important in the diagnosis of disease than measuring the level of total calcium or complexed calcium. The level of total calcium in the blood serum is normally 8.7–10.4 mg/dL, while the level of free calcium is normally 4–5 mg/dL.

Causes and symptoms

Hypocalcemia can be caused by **hypoparathyroidism**, failure to produce 1,25-dihydroxyvitamin D, low levels of plasma magnesium, or by failure to get adequate amounts of calcium or vitamin D in the diet. Hypoparathyroidism involves the failure of the parathyroid gland to make parathyroid hormone. Parathyroid hormone controls and maintains plasma calcium levels. The hormone exerts its effect on the kidneys, where it triggers the synthesis of 1,25-dihydroxyvitamin D. Thus, hypocalcemia can be independently caused by damage to the parathyroid gland or to the kidneys. 1,25-Dihydroxyvitamin D stimulates the uptake of calcium from the diet and the mobilization of calcium from the bone. Bone mobilization means the natural process by which the body dissolves part of the bone in the skeleton in order to maintain or raise the levels of plasma calcium ions.

Low plasma magnesium levels (hypomagnesia) can result in hypocalcemia. Hypomagnesia can occur with **alcoholism** or with diseases characterized by an inability to properly absorb fat. Magnesium is required for parathyroid hormone to play its part in maintaining plasma calcium levels. For this reason, any disease that results in lowered plasma magnesium levels may also cause hypocalcemia.

Hypocalcemia may also result from the consumption of toxic levels of phosphate. Phosphate is a constituent of certain enema formulas. An enema is a solution used to cleanse the intestines via a device inserted into the rectum. Cases of hypocalcemia have been documented where people swallowed enema formulas, or where an enema has been administered to an infant.

Symptoms of severe hypocalcemia include **numbness** or **tingling** around the mouth or in the feet and hands, as well as **muscle spasms** in the face, feet, and hands. Hypocalcemia can result in depression, **memory loss**, or **hallucinations**. Long-term hypocalcemia can also result in dry skin and outbreaks of **psoriasis**. Chronic (lasting more than one year) and moderate hypocalcemia can result in **cataracts** (damage to the eyes).

Diagnosis

Tests

Hypocalcemia is diagnosed by acquiring a sample of blood and then measuring the calcium level in the blood. Hypocalcemia has several causes, and a full diagnosis requires assessment of the parathyroid gland, kidneys, and the plasma magnesium concentration. Other tests that may be ordered include magnesium level, phosphate level, and tests to determine the blood levels of other electrolytes. The physician may also order tests to determine renal function such as the blood urea nitrogen (BUN) and creatinine level blood tests. Blood testing for PTH level, albumin level, liver function, and coagulation capability may be done as well.

The patient may be placed on cardiac monitoring to assess for cardiac dysrhythmias that can be triggered as a result of low calcium levels.

Treatment

The method chosen for treatment depends on the exact cause and on the severity of the hypocalcemia.

Drugs

Severe hypocalcemia requires intravenous replacement of calcium ions, usually in the form of calcium gluconate or calcium chloride. Oral calcium supplements are prescribed for long term treatment (non-emergency) of hypocalcemia. The oral supplements may take the form of calcium citrate, calcium carbonate, calcium chloride, or calcium gluconate. Hypocalcemia resulting from kidney failure is treated with injections of 1,25-dihydroxyvitamin D. Oral vitamin D supplements can increase gastrointestinal absorption of calcium. If hypocalcemia results from hypoparathyroidism, treatment may include oral calcium, 1,25-dihydroxyvitamin D, or other drugs. When low serum magnesium levels occur with hypocalcemia, the magnesium deficiency must be corrected to effectively treat the hypocalcemia.

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Prognosis

The prognosis for correcting hypocalcemia is excellent. Damage to the eye that may result from chronic hypocalcemia cannot be reversed.

Prevention

The first, and most obvious, way to help prevent hypocalcemia is to ensure that adequate amounts of calcium and vitamin D are consumed each day, either in the diet or as supplements. The hypocalcemia that may occur with damage to the parathyroid gland or to the kidneys cannot be prevented. Hypocalcemia resulting from overuse of **enemas** can be prevented by reducing enema usage. Hypocalcemia resulting from magnesium deficiency tends to occur in chronic alcoholics, and this type of hypocalcemia can be prevented by reducing alcohol consumption and increasing the intake of healthy foods.

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Hypochondriac *see* **Hypochondriasis**

Hypochondriasis

Definition

Hypochondriasis is a mental disorder characterized by excessive fear of or preoccupation with a serious illness, despite medical testing and reassurance to the contrary. It was formerly called hypochondriacal neurosis.

Description

Although hypochondriasis is often considered a disorder that primarily affects adults, it is now increasingly recognized in children and adolescents. In addition, hypochondriasis may develop in elderly people without previous histories of health-related fears. The disorder accounts for about 5% of psychiatric patients and is equally common in men and women.

Causes and symptoms

The causes of hypochondriasis are not precisely known. Children may have physical symptoms that resemble or mimic those of other family members. In adults, hypochondriasis may sometimes reflect a self-centered character structure or a wish to be taken care of by others; it may also have been copied from a parent's behavior. In elderly people, hypochondriasis may be associated with depression or grief. It may also involve biologically based hypersensitivity to internal stimuli.

Most hypochondriacs are worried about being physically sick, although some express fear of insanity. The symptoms reported can range from general descriptions of a specific illness to unusual complaints. In many instances the symptoms reflect intensified awareness of ordinary body functions, such as heartbeat, breathing, or stomach noises. It is important to understand that a hypochondriac's symptoms are not "in the head" in the sense of being delusional. The symptoms are real, but the patient misinterprets bodily functions and attributes them to a serious or even lethal cause.

Diagnosis

The diagnosis is often complicated by the patient's detailed understanding of symptoms and medical terminology from previous contacts with doctors. If a new doctor suspects hypochondriasis, he or she will usually order a complete medical workup in order to rule out physical disease.

Psychological evaluation is also necessary to rule out other disorders that involve feelings of **anxiety** or complaints of physical illness. These disorders include depression, **panic disorder**, and **schizophrenia** with somatic (physical) **delusions**. The following features are characteristic of hypochondriasis:

- The patient is not psychotic (out of touch with reality or hallucinating).
- The patient gets upset or blames the doctor when told there is "nothing wrong," or that there is a psychological basis for the problem.
- There is a correlation between episodes of hypochondriacal behavior and stressful periods in the patient's life.
- The behavior has lasted at least six months.

Evaluation of children and adolescents with hypochondriasis should include the possibility of **abuse** by family members.

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Treatment

The goal of therapy is to help the patient (and family) live with the symptoms and to modify thinking and behavior that reinforces hypochondriacal symptoms. This treatment orientation is called supportive, as distinct from insight-oriented, because hypochondriacs usually resist psychological interpretations of their symptoms. Supportive treatment may include medications to relieve anxiety. Some clinicians look carefully for "masked" depression and treat with antidepressants.

Follow-up care includes regular physical checkups because about 30% of patients with hypochondriasis will eventually develop a serious physical illness. The physician also tries to prevent unnecessary medical testing and "doctor shopping" on the patient's part.

Prognosis

Between 33% and 55% of patients with hypochondriasis can expect significant improvement from the current methods of treatment.

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Rebecca J. Frey, PhD

Hypoesthesias *see* **Numbness and tingling**

Hypoglycemia

Definition

The condition called hypoglycemia is literally translated as low blood sugar. Hypoglycemia occurs when blood sugar (or blood glucose) concentrations fall below a level necessary to properly support the body's need for energy and stability throughout its cells.

Demographics

Attempts at quantifying the incidence of hypoglycemia is challenging, as many individuals do not regularly record, nor report the occurrence of this condition to their healthcare provider. It is thought to affect as many as 1 out of 1,000 people and can occur for a variety of reasons. Episodes of hypoglycemia occurring at night (nocturnal hypoglycemia) are commonly undetected by patients, and it is believed that about 6% of all deaths in diabetes are due to unrecognized nocturnal hypoglycemia.

Description

Carbohydrates are the main dietary source of the glucose that is manufactured in the liver and absorbed into the bloodstream to fuel the body's cells and organs. Glucose concentration is controlled by hormones, primarily insulin and glucagon. Glucose concentration also is controlled by epinephrine (adrenalin) and norepinephrine, as well as growth hormone. If these regulators are not working properly, levels of blood sugar can become either excessive (as in hyperglycemia) or inadequate (as in hypoglycemia). If a person has a blood sugar level of 50 mg/dL or less, he or she is considered hypoglycemic, although glucose levels vary widely from one person to another.

Hypoglycemia can occur in several ways.

Drug-induced hypoglycemia

Drug-induced hypoglycemia, a complication of diabetes, is the most commonly seen and most dangerous form of hypoglycemia.

Hypoglycemia occurs most often in diabetics who must inject insulin periodically to lower their blood sugar. While other diabetics also are vulnerable to low blood sugar episodes, they have a lower risk of a serious outcome than insulin-dependent diabetics. Unless recognized and treated immediately, severe hypoglycemia in the insulin-dependent diabetic can lead to generalized convulsions followed by **amnesia** and unconsciousness. **Death**, though rare, is a possible outcome.

In insulin-dependent diabetics, hypoglycemia known as an insulin reaction or insulin **shock** can be caused by several factors. These include overmedicating with manufactured insulin, missing or delaying a meal, eating too little food for the amount of insulin taken, exercising too strenuously, drinking too much alcohol, or any combination of these factors.

Reactive hypoglycemia

Reactive hypoglycemia (also called postprandial hypoglycemia) occurs about 2–4 hours after eating a meal. A number of reasons for this reaction have been proposed, but no single cause has been identified.

In some cases, this form of hypoglycemia appears to be associated with malfunctions or diseases of the liver, pituitary, adrenals, liver, or pancreas. These conditions are unrelated to diabetes. Children intolerant of a natural sugar (fructose) or who have inherited defects that affect digestion also may experience

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hypoglycemic attacks. Some children with a negative reaction to **aspirin** also experience reactive hypoglycemia. It sometimes occurs among people with an intolerance to the sugar found in milk (galactose), and it also often begins before diabetes strikes later in life.

Fasting hypoglycemia

Fasting hypoglycemia sometimes occurs after long periods without food, but it also happens occasionally following strenuous **exercise**, such as running in a marathon.

Other factors sometimes associated with hypoglycemia include:

- pregnancy
- a weakened immune system
- a poor diet high in simple carbohydrates
- prolonged use of drugs, including antibiotics
- chronic physical or mental stress
- heartbeat irregularities (arrhythmias)
- allergies
- breast cancer
- high blood pressure treated with beta-blocker medications (after strenuous exercise)
- upper gastrointestinal tract surgery

Causes and symptoms

When carbohydrates are eaten, they are converted to glucose that goes into the bloodstream and is distributed throughout the body. Simultaneously, a combination of chemicals that regulate how our body's cells absorb that sugar is released from the liver, pancreas, and adrenal glands. These chemical regulators include insulin, glucagon, epinephrine (adrenalin), and norepinephrine. The mixture of these regulators released following digestion of carbohydrates is never the same, since the amount of carbohydrates that are eaten is never the same.

Interactions among the regulators are complicated. Any abnormalities in the effectiveness of any one of the regulators can reduce or increase the body's absorption of glucose. Gastrointestinal enzymes such as amylase and lactase that break down carbohydrates may not be functioning properly. These abnormalities may produce hyperglycemia or hypoglycemia and can be detected when the level of glucose in the blood is measured.

Cell sensitivity to these regulators can be changed in many ways. Over time, a person's **stress** level, exercise patterns, advancing age, and dietary habits influence cellular sensitivity. For example, a diet consistently overly rich in carbohydrates increases insulin requirements over time. Eventually, cells can become less receptive to the effects of the regulating chemicals, which can lead to glucose intolerance.

Diet is both a major factor in producing hypoglycemia as well as the primary method for controlling it. **Diets** typical of Western cultures contain excess carbohydrates, especially in the form of simple carbohydrates such as sweeteners, which are more easily converted to sugar. In developing parts of the world, the typical diet contains even higher levels of carbohydrates. Fewer dairy products and meats are eaten, and grains, vegetables, and fruits are consumed. This dietary trend is balanced, however, since people in these cultures eat small meals and usually use carbohydrates efficiently through physical labor.

Early symptoms of severe hypoglycemia, particularly in the drug-induced type of hypoglycemia, resemble an extreme shock reaction. Symptoms include:

- cold and pale skin
- numbness around the mouth
- apprehension
- heart palpitations
- emotional outbursts
- hand tremors
- mental cloudiness
- dilated pupils
- sweating
- fainting

Mild attacks, however, are more common in reactive hypoglycemia and are characterized by extreme tiredness. Patients first lose their alertness, then their muscle strength and coordination. Thinking grows fuzzy, and finally the patient becomes so tired that he or she becomes "zombie-like," awake but not functioning. Sometimes the patient will actually fall asleep. Unplanned naps are typical of the chronic hypoglycemic patient, particularly following meals.

Additional symptoms of reactive hypoglycemia include headaches, double vision, staggering or inability to walk, a craving for salt and/or sweets, abdominal distress, premenstrual tension, chronic **colitis**, **allergies**, ringing in the ears, unusual patterns in the frequency of urination, skin eruptions and inflammations, **pain** in the neck and shoulder muscles, memory problems, and sudden and excessive sweating.

Unfortunately, a number of these symptoms mimic those of other conditions. For example, the depression, **insomnia**, irritability, lack of concentration, crying spells, **phobias**, forgetfulness, confusion, unsocial behavior, and

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suicidal tendencies commonly seen in nervous system and psychiatric disorders also may be hypoglycemic symptoms. It is very important that anyone with symptoms that may suggest reactive hypoglycemia see a doctor.

Because all of its possible symptoms are not likely to be seen in any one person at a specific time, diagnosing hypoglycemia can be difficult. One or more of its many symptoms may be due to another illness. Symptoms may persist in a variety of forms for long periods of time. Symptoms also can change over time within the same person. Some of the factors that can influence symptoms include physical or mental activities, physical or mental state, the amount of time passed since the last meal, the amount and quality of sleep, and exercise patterns.

Diagnosis

Drug-induced hypoglycemia

Once diabetes is diagnosed, the patient monitors his or her blood sugar level with a portable machine called a glucometer. The diabetic places a small blood sample on a test strip that the machine can read. If the test reveals that the blood sugar level is too low, the diabetic can make a correction by eating or drinking an additional carbohydrate.

Reactive hypoglycemia

Reactive hypoglycemia only can be diagnosed by a doctor. Symptoms usually improve after the patient has gone on an appropriate diet. Reactive hypoglycemia was diagnosed more frequently in the late twentieth century than at the end of the first decade of the twenty-first century. Studies have shown that most people suffering from its symptoms test normal for blood sugar, leading many doctors to suggest that actual cases of reactive hypoglycemia are quite rare. Some doctors think that people with hypoglycemic symptoms may be particularly sensitive to the body's normal postmeal release of the hormone epinephrine, or are actually suffering from some other physical or mental problem. Other doctors believe reactive hypoglycemia actually is the early onset of diabetes that occurs after a number of years. There continues to be disagreement about the cause of reactive hypoglycemia.

A common test to diagnose hypoglycemia is the extended oral glucose tolerance test. Following an overnight fast, a concentrated solution of glucose is drunk and blood samples are taken hourly for five to six hours. Though this test remains helpful in early identification of diabetes, its use in diagnosing chronic reactive hypoglycemia has lost favor because it can trigger hypoglycemic symptoms in people with otherwise normal glucose readings. Some doctors now recommend that blood sugar be tested at the actual time a person experiences hypoglycemic symptoms.

Treatment

Treatment of the immediate symptoms of hypoglycemia can include eating sugar. For example, a patient can eat a piece of candy, drink milk, or drink fruit juice. Glucose tablets can be used by patients, especially those who are diabetic. Effective treatment of hypoglycemia over time requires the patient to follow a modified diet. Patients usually are encouraged to eat small, but frequent, meals throughout the day, avoiding excess simple sugars (including alcohol), fats, and fruit drinks. Those patients with severe hypoglycemia may require fast-acting glucagon injections that can stabilize their blood sugar within approximately 15 minutes.

Alternative treatment

A holistic approach to reactive hypoglycemia is based on the belief that a number of factors may create the condition. Among them are heredity, the effects of other illnesses, emotional stress, too much or too little exercise, bad lighting, poor diet, and environmental pollution. Therefore, a number of alternative methods have been proposed as useful in treating the condition. **Homeopathy**, **acupuncture**, and **applied kinesiology**, for example, have been used, as have herbal remedies. One of the herbal remedies commonly suggested for hypoglycemia is a decoction (an extract made by boiling) of gentian (*Gentiana lutea*). It should be drunk warm 15–30 minutes before a meal. Gentian is believed to help stimulate the endocrine (hormone-producing) glands.

In addition to dietary modifications, people with hypoglycemia may benefit from supplementing their diet with chromium, which is believed to help improve blood sugar levels. Chromium is found in whole grain breads and cereals, cheese, molasses, lean meats, and brewer's yeast. Hypoglycemics should avoid alcohol, **caffeine**, and cigarette smoke, since these substances can cause significant swings in blood sugar levels.

Prevention

Drug-induced hypoglycemia

Preventing hypoglycemic insulin reactions in diabetics requires taking glucose readings through frequent blood sampling. Insulin then can be regulated based on those readings. Continuous glucose monitoring sensors have been developed to help diabetics remain more aware of possible hypoglycemic episodes. These monitors even can check for episodes while the patient sleeps,

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when many will experience severe hypoglycemia but not know it. Those who don't pay attention to severe hypoglycemia events or who have had previous severe hypoglycemia are the most likely to have future severe hypoglycemia. An audible alert can let the patient know immediately that he or she needs to take care of his or her blood sugar level. Continuous monitoring has proved particularly helpful in pediatric patients with Type 1 diabetes.

Maintaining proper diet also is a factor. Programmable insulin pumps implanted under the skin have proven useful in reducing the incidence of hypoglycemic episodes for insulin-dependent diabetics. Clinical studies continue to seek additional ways to control diabetes and drug-induced hypoglycemia. Tests of a substance called pramlintide indicate that it may help improve glycemic control in diabetics.

Reactive hypoglycemia

The onset of reactive hypoglycemia can be avoided or at least delayed by following the same kind of diet used to control it. While not as restrictive as the diet diabetics must follow to keep tight control over their disease, it is quite similar.

There are a variety of diet recommendations for the reactive hypoglycemic. Patients should:

- avoid overeating
- never skip breakfast
- include protein in all meals and snacks, preferably from sources low in fat, such as the white meat of chicken or turkey, most fish, soy products, or skim milk
- restrict intake of fats (particularly saturated fats, such as animal fats), and avoiding refined sugars and processed foods
- be aware of the differences between some vegetables, such as potatoes and carrots. These vegetables have a higher sugar content than others (like squash and broccoli). Patients should be aware of these differences and note any reactions they have to them.
- be aware of differences found in grain products. White flour is a carbohydrate that is rapidly absorbed into the bloodstream, while oats take much longer to break down in the body.
- keep a "food diary." Until the diet is stabilized, a patient should note what and how much he/she eats and drinks at every meal. If symptoms appear following a meal or snack, patients should note them and look for patterns.
- eat fresh fruits, but restrict the amount they eat at one time. Patients should remember to eat a source of protein whenever they eat high sources of carbohydrate like fruit. Apples make particularly good snacks because, of all fruits, the carbohydrate in apples is digested most slowly.
- follow a diet that is high in fiber. Fruit is a good source of fiber, as are oatmeal and oat bran. Fiber slows the buildup of sugar in the blood during digestion.

A doctor can recommend a proper diet, and there are many cookbooks available for diabetics. Recipes found in such books are equally effective in helping to control hypoglycemia.

Prognosis

Like diabetes, there is no cure for reactive hypoglycemia, only ways to control it. While some chronic cases will continue through life (rarely is there complete remission of the condition), others will develop into type II (age onset) diabetes. Hypoglycemia appears to have a higher-than-average incidence in families where there has been a history of hypoglycemia or diabetes among their members, but whether hypoglycemia is a controllable warning of oncoming diabetes has not yet been determined by clinical research.

A condition known as hypoglycemia unawareness can develop in those who do not control their blood glucose, particularly in people with Type 1 diabetes. These people may lose notice of the automatic warning symptoms of hypoglycemia that normally occur as their bodies become so used to frequent periods of hypoglycemia. It is not a permanent event, but can be treated by careful avoidance of hypoglycemia for about two weeks.

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ORGANIZATIONS

American Diabetes Association, 1701 North Beauregard St., Alexandria, VA, 22311, (800) 342–2383, AskADA@diabetes.org, http://www.diabetes.org.
Hypoglycemia Association, Inc., 18008 New Hampshire Ave., PO Box 165, Ashton, MD, 20861-0165
National Hypoglycemia Association, Inc., PO Box 120, Ridgewood, NJ, 07451, (201) 670-1189
The Hypoglycemia Support Foundation, Inc., http://www.hypoglycemia.org/default.asp.

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Hypogonadism

Definition

Hypogonadism is the condition more prevalent in males in which the production of sex hormones and germ cells are inadequate.

Description

Gonads are the organs of sexual differentiation—in the female, they are ovaries; in the male, the testes. Along with producing eggs and sperm, they produce sex hormones that generate all the differences between men and women. If they produce too little sex hormone, then either the growth of the sexual organs or their function is impaired.

The gonads are not independent in their function, however. They are closely controlled by the pituitary gland. The pituitary hormones are the same for males and females, but the gonadal hormones are different. Men produce mostly androgens, and women produce mostly estrogens. These two hormones regulate the development of the embryo, determining whether it is a male or a female. They also direct the adolescent maturation of sex organs into their adult form. Further, they sustain those organs and their function throughout the reproductive years. The effects of estrogen reach beyond that to sustain bone strength and protect the cardiovascular system from degenerative disease.

Hormones can be inadequate during or after each stage of development—embryonic and adolescent. During each stage, inadequate hormone stimulation will prevent normal development. After each stage, a decrease in hormone stimulation will result in failed function and perhaps some shrinkage. The organs affected principally by sex hormones are the male and female genitals, both internal and external, and the female breasts. Body hair, fat deposition, bone and muscle growth, and some brain functions are also influenced.

Causes and symptoms

Sex is determined at the moment of conception by sex chromosomes. Females have two X chromosomes, while males have one X and one Y chromosome. If male sperm with a Y chromosome fertilizes an egg, the baby will be male. This is true throughout the animal kingdom. Genetic defects sometimes result in changes in the chromosomes. If sex chromosomes are involved, there is a change in the development of sexual characteristics.

Female is the default sex of the embryo, so most of the sex organ deficits at birth occur in boys. Some, but not all, are due to inadequate androgen stimulation. The penis may be small, the testicles undescended (cryptorchidism), or various degrees of "feminization" of the genitals may be present.

After birth, sexual development does not occur until **puberty**. Hypogonadism most often shows up as an abnormality in boys during puberty. Again, not every defect is due to inadequate hormones. Some are due to too much of the wrong ones. Kallmann's syndrome is a birth defect in the brain that prevents release of hormones and appears as failure of male puberty. Some boys have adequate amounts of androgen in their system but fail to respond to them, a condition known as androgen resistance.

Female problems in puberty are not caused by too little estrogen. Even female reproductive problems are rarely related to a simple lack of hormones, but rather to complex cycling rhythms gone wrong. All the problems with too little hormone happen during **menopause**, which is a normal hypogonadism.

A number of adverse events can damage the gonads and result in decreased hormone levels. The childhood disease **mumps**, if acquired after puberty, can infect and destroy the testicles—a disease called viral **orchitis**. Ionizing radiation and **chemotherapy**, trauma, several drugs (spironolactone, a diuretic and ketoconazole, an

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antifungal agent), alcohol, **marijuana**, heroin, **methadone**, and environmental toxins can all damage testicles and decrease their hormone production. Severe diseases in the liver or kidneys, certain infections, sickle cell anemia, and some cancers also affect gonads. To treat some male cancers, it is necessary to remove the testicles, thereby preventing the androgens from stimulating **cancer** growth. This procedure, called castration or *orchiectomy*, removes androgen stimulation from the whole body.

For several reasons the pituitary can fail. It happens rarely after **pregnancy**. It used to be removed to treat advanced breast or **prostate cancer**. Sometimes the pituitary develops a tumor that destroys it. Failure of the pituitary is called **hypopituitarism** leaves the gonads with no stimulation to produce hormones.

Besides the tissue changes generated by hormone stimulation, the only other symptoms relate to sexual desire and function. Libido is enhanced by testosterone, and male sexual performance requires androgens. The role of female hormones in female sexual activity is less clear, although hormones strengthen tissues and promote healthy secretions, facilitating sexual activity.

Diagnosis

There are accurate blood tests for most of the hormones in the body, including those from the pituitary and even some from the hypothalamus. Chromosomes can be analyzed, and gonads can be, but rarely are, biopsied.

Treatment

Replacement of missing body chemicals is much easier than suppressing excesses. Estrogen replacement is recommended for nearly all women after menopause for its many beneficial effects. Estrogen can be taken by mouth, injection, or skin patch. It is strongly recommended that the other female hormone, progesterone, be taken as well, because it prevents overgrowth of uterine lining and uterine cancer. Testosterone replacement is available for males who are deficient.

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Hypokalemia

Definition

Hypokalemia is a condition of below-normal levels of potassium in the blood serum. Potassium, a necessary electrolyte, facilitates nerve impulse conduction and the contraction of skeletal and smooth muscles, including the heart. It also facilitates cell membrane function and proper enzyme activity. Levels must be kept in a proper (homeostatic) balance for the maintenance of health. The normal concentration of potassium in the serum is in the range of 3.5–5.0 mEq/L. Hypokalemia means serum or plasma levels of potassium ions that fall below 3.5 mEq/L. Moderate hypokalemia may be defined as serum potassium between 2.5 and 3.0 mEq/L, while severe hypokalemia is defined as serum potassium under 2.5 mEq/L. (Potassium concentrations are often expressed in units of milliequivalents per liter [mEq/L], rather than in units of millimolarity [mM], however, both units are identical and mean the same thing when applied to concentrations of potassium ions.)

Hypokalemia can result from two general causes: either from an overall depletion in the body's potassium or from excessive uptake of potassium by muscle from surrounding fluids.

Description

A normal adult weighing about 154 lb (70 kg) has about 3.6 **moles** of potassium ions in his body. Most of this potassium (about 98%) occurs inside various cells and organs, where normal concentrations are about 150 mEq/L. Blood serum concentrations are much lower—only about 0.4% of the body's potassium is found in blood serum. Hypokalemia can be caused by the sudden uptake of potassium ions from the bloodstream by muscle or other organs or by an overall depletion of the body's potassium. Hypokalemia due to overall depletion tends to be a chronic phenomenon, while hypokalemia due to a shift in location tends to be a temporary disorder.

Causes and symptoms

Hypokalemia is most commonly caused by the use of **diuretics**. Diuretics are drugs that increase the excretion of water and salts in the urine. Diuretics are used to treat a number of medical conditions, including **hypertension** (high blood pressure), congestive **heart failure**, **liver disease**, and **kidney disease**. Diuretic treatment can have the side effect of producing hypokalemia. In fact, the most common cause of hypokalemia in the elderly is the use of diuretics. The use of

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furosemide and thiazide, two commonly used diuretic drugs, can lead to hypokalemia. In contrast, spironolactone and triamterene are diuretics that do not provoke hypokalemia.

Other common causes of hypokalemia are excessive **diarrhea** or **vomiting**. Diarrhea and **vomiting** can be produced by infections of the gastrointestinal tract. Caused by a variety of organisms, including bacteria, protozoa, and viruses, diarrhea is a major world health problem. It is responsible for about a quarter of the 10 million infant deaths that occur each year. Although nearly all of these deaths occur in the poorer parts of Asia and Africa, diarrheal diseases are a leading cause of infant **death** in the United States. Diarrhea results in various abnormalities, such as **dehydration** (loss in body water), **hyponatremia** (low **sodium** level in the blood), and hypokalemia.

Because of the need for potassium to control muscle action, hypokalemia can cause the heart to stop beating. Young infants are especially at risk for death from this cause, especially where severe diarrhea continues for two weeks or longer. Diarrhea due to laxative **abuse** is an occasional cause of hypokalemia in the adolescent or adult. Enema abuse is a related cause of hypokalemia. Laxative abuse is especially difficult to diagnose and treat, because patients usually deny the practice. Up to 20% of persons complaining of chronic diarrhea practice laxative abuse. Laxative abuse is often part of **eating disorders**, such as **anorexia nervosa** or **bulimia nervosa**. Hypokalemia that occurs with these eating disorders may be life-threatening.

The potassium loss that accompanies vomiting is only partly due to loss of potassium from the vomit. Vomiting also has the effect of provoking an increase in potassium loss in the urine. It expels acid from the mouth, and this loss of acid results in alkalization of the blood. (Alkalization of the blood means that the pH of the blood increases slightly.) An increased blood pH has a direct effect on the kidneys. Alkaline blood provokes the kidneys to release excessive amounts of potassium in the urine. Severe and continual vomiting can cause excessive losses of potassium from the body and hypokalemia.

A third general cause of hypokalemia is prolonged **fasting** and **starvation**. In most people, after three weeks of fasting, blood serum potassium levels decline to below 3.0 mEq/L and result in severe hypokalemia. In some persons, serum potassium may be naturally maintained at about 3.0 mEq/L, even after 100 days of fasting. During fasting, muscle is naturally broken down, and the muscle protein is converted to sugar (glucose) to supply to the brain the glucose that is essential for its functioning. Other organs are able to survive with a mixed supply of fat and glucose. The potassium within the muscle cell is released during the gradual process of muscle breakdown that occurs with starvation, and this can help counteract the trend to hypokalemia during starvation. Eating an unbalanced diet does not cause hypokalemia because most foods, such as fruits (especially bananas, oranges, and melons), vegetables, meat, milk, and cheese, are good sources of potassium. Only foods such as butter, margarine, vegetable oil, soda water, jelly beans, and hard candies are extremely poor in potassium.

Alcoholism occasionally results in hypokalemia. About one-half of alcoholics hospitalized for withdrawal symptoms experience hypokalemia. The hypokalemia of alcoholics occurs for a variety of reasons, usually poor **nutrition**, vomiting, and diarrhea. Hypokalemia can also be caused by **hyperaldosteronism**; **Cushing's syndrome**; hereditary kidney defects, such as Liddle's syndrome, Bartter's syndrome, and Franconi's syndrome; and eating too much licorice.

Symptoms

Mild hypokalemia usually results in no symptoms, while moderate hypokalemia results in confusion, disorientation, weakness, and discomfort of muscles. On occasion, moderate hypokalemia causes cramps during **exercise**. Another symptom of moderate hypokalemia is a discomfort in the legs that is experienced while sitting still. The patient may experience an annoying feeling that can be relieved by shifting the positions of the legs or by stomping the feet on the floor. Severe hypokalemia results in extreme weakness of the body and, on occasion, in **paralysis**. The paralysis that occurs is "flaccid paralysis," or limpness. Paralysis of the muscles of the lungs results in death. Other signs of severe hypokalemia include low blood pressure (hypokalemia), low heart rate, and signs of an **ileus**. Another dangerous result of severe hypokalemia is abnormal heart beat (arrhythmia) that can lead to death from cardiac arrest (cessation of heart beat).

Diagnosis

Hypokalemia can be measured by acquiring a sample of blood and by then measuring the concentration of potassium ions in the blood. Since hypokalemia results in abnormalities in heart rhythm, an electrocardiogram is usually used in the diagnosis of hypokalemia. The diagnosis of the cause of hypokalemia can be done by measuring the potassium content of the urine. Where urinary potassium is under 25 mEq/L per day, it means that the patient has experienced excessive losses

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KEY TERMS

Cardiac arrhythmia—An abnormality in the rate or rhythm of the heartbeat.

Ileus—A blockage of the intestine. Ileus caused by hypokalemia is often termed paralytic ileus because peristalsis, the rhythmic contractions within the bowel that propels digested food through the intestinal tract, ceases.

of potassium due to diarrhea. The urinary potassium test is useful in cases where the patient is denying the practice of laxative or enema abuse. In contrast, where hypokalemia is due to the use of diuretic drugs, the content of potassium in the urine will be high—over 40 mEq/L per day.

Treatment

In emergency situations, when severe hypokalemia is suspected, the patient should be placed on a cardiac monitor, and respiratory status should be assessed. If laboratory test results show potassium levels below 2.5 mEq/L, intravenous potassium should be given. Patients with severe hypokalemia may receive intravenous potassium in the emergency department or may need to be admitted to an inpatient facility to continue replacement therapy under close observation.

In less urgent cases, potassium can be given orally in pill form. Oral potassium chloride is the safest and most effective treatment for hypokalemia. Generally, the consumption of 40–80 mEq/L of KCl per day is sufficient to correct the hypokalemia that results from diuretic therapy. For many people taking diuretics, potassium supplements are not necessary as long as they eat a balanced diet containing foods rich in potassium.

Prognosis

The prognosis for correcting hypokalemia is excellent. In emergency situations where potassium is administered intravenously, the physician must be careful not to give too much potassium. The administration of potassium at high levels, or at a high rate, can lead to abnormally high levels of serum potassium, which can result in cardiac **arrhythmias**.

Prevention

Hypokalemia is not a concern for healthy persons, since potassium is present in a great variety of foods. For patients taking diuretics, the American Dietetic Association recommends use of a high potassium diet. The American Dietetic Association states that if hypokalemia has already occurred, use of the high potassium diet alone may not reverse hypokalemia. Useful components of a high potassium diet include bananas, tomatoes, cantaloupes, figs, raisins, kidney beans, potatoes, and milk.

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Hypolipoproteinemia

Definition

Hypolipoproteinemia (or hypolipidemia) is the lack of fat in the blood.

Description

Although quite rare, hypolipoproteinemia is a serious condition. Blood absorbs fat from food in the intestine and transports it as a combined package with proteins and other chemicals like cholesterol. Much of the fat goes straight into the liver for processing. The cholesterol, a waste product, ends up in the bile. The proteins act as vessels, carrying the other chemicals around. These packages of fat, cholesterol, and proteins are called lipoproteins.

Causes and symptoms

Low blood fats can be the result of several diseases, or they can be a primary genetic disease with other associated abnormalities.

- Malnutrition is a lack of food, including fats, in the diet.
- Malabsorption is the inability of the bowel to absorb food, causing malnutrition.

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- Anemia (too few red blood cells) and hyperthyroidism (too much thyroid hormone) also reduce blood fats.
- Rare genetic conditions called hypobetalipoproteinemia and abetalipoproteinemia cause malabsorption plus nerve, eye, and skin problems in early childhood.
- Tangier disease, causes only the cholesterol to be low. It also produces nerve and eye problems in children.

Symptoms are associated more closely with the cause rather than the actual low blood fats.

Diagnosis

Blood studies of the various fat particles help identify both the low and high fat diseases. These tests are often done after an overnight fast to prevent interference from fat just being absorbed from food. Fats and proteins are grouped together and described by density—high-density lipoproteins (HDL), low-density lipoproteins (LDL), and very low-density lipoproteins (VLDL). There are also much bigger particles called chylomicrons. Each contain different proportions of cholesterol, fats, and protein.

Treatment

Supplemental vitamin E helps children with betalipoprotein deficiencies. There is no known treatment for Tangier disease. Treatment of the causes of the other forms of low blood fats reverses the condition.

Resources

BOOKS

Fauci, Anthony S., et al., eds. *Harrison's Principles of Internal Medicine*. 17th ed. New York: McGraw–Hill Professional, 2008.

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Hypomagnesemia *see* **Magnesium imbalance**

Hyponatremia

Definition

The normal concentration of **sodium** in the blood plasma is 136–145 mEq/L. Hyponatremia, the most commonly observed electrolyte imbalance, occurs when sodium falls below 130 mEq/L. Plasma sodium levels of 125 mEq/L or less are dangerous and can result in seizures and **coma**.

Description

Sodium is an atom, or ion, that carries a single positive charge. The sodium ion may be abbreviated as Na^+ or as simply Na. Sodium can occur as a salt in a crystalline solid. Sodium chloride (NaCl), sodium phosphate (Na_2HPO_4), and sodium bicarbonate ($NaHCO_3$) are commonly occurring salts. These salts can be dissolved in water or in juices of various foods. Dissolving involves the complete separation of ions, such as sodium and chloride, in common table salt (NaCl).

About 40% of the body's sodium is contained in bone. Approximately 2–5% occurs within organs and cells and the remaining 55% is in blood plasma and other extracellular fluids. The amount of sodium in blood plasma is typically 140 mEq/L, a much higher amount than is found in intracellular sodium (about 5 mEq/L). This asymmetric distribution of sodium ions is essential for human life. It makes possible proper nerve conduction, the passage of various nutrients into cells, and the maintenance of blood pressure.

The body continually regulates its handling of sodium. When dietary sodium is too high or low, the intestines and kidneys respond to adjust concentrations to normal. During the course of a day, the intestines absorb dietary sodium while the kidneys excrete a nearly equal amount of sodium into the urine. If a low sodium diet is consumed, the intestines increase their efficiency of sodium absorption, and the kidneys reduce its release into urine.

The concentration of sodium in the blood plasma depends on two things: 1) the total amount of sodium and, 2) water in arteries, veins, and capillaries (the circulatory system). The body uses separate mechanisms to regulate sodium and water, but they work together to correct blood pressure when it is too high or too low. Too low a concentration of sodium, or hyponatremia, can be corrected either by increasing sodium or by decreasing body water. The existence of separate mechanisms that regulate sodium concentration account for the fact that there are numerous diseases that can cause hyponatremia, including diseases of the kidney, pituitary gland, and hypothalamus.

Causes and symptoms

Hyponatremia can be caused by abnormal consumption or excretion of dietary sodium or water and by diseases that impair the body's ability to regulate them. Maintenance of a low salt diet for many months or excessive sweat loss during a race on a hot day can present a challenge to the body to conserve adequate sodium levels. While these conditions alone are not likely to cause hyponatremia, it can occur under special circumstances. For example, hyponatremia often occurs in

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patients taking diuretic drugs who maintain a low sodium diet. This is especially of concern in elderly patients, who have a reduced ability to regulate the concentrations of various nutrients in the bloodstream. Diuretic drugs that frequently cause hyponatremia include furosemide (Lasix), bumetanide (Bumex), and most commonly, the thiazide **diuretics**. Diuretics enhance the excretion of sodium into the urine, with the goal of correcting high blood pressure; too much sodium excretion can result in hyponatremia. Usually only mild hyponatremia occurs in patients taking diuretics, but when combined with a low sodium diet or with the excessive drinking of water, severe hyponatremia can develop.

Severe and prolonged **diarrhea** can cause hyponatremia. Severe diarrhea, causing the daily output of 8–10 L of fluid from the large intestines, results in the loss of large amounts of water, sodium, and various nutrients. Some diarrheal diseases release particularly large quantities of sodium and are most likely to cause hyponatremia.

Drinking excess water sometimes causes hyponatremia because the absorption of water into the bloodstream can dilute the sodium in the blood. This cause of hyponatremia is rare, but has been found in psychotic patients who compulsively drink more than 5 gal (20 L) of water per day. Excessive drinking of beer, which is mainly water and low in sodium, can also produce hyponatremia when combined with a poor diet.

Marathon running, under certain conditions, leads to hyponatremia. Races of 25–50 miles can result in the loss of great quantities (2–2.6 gal; 8–10 L) of sweat, which contains both sodium and water. Studies show that about 30% of marathon runners experience mild hyponatremia during a race. Runners who consume only pure water during a race can develop severe hyponatremia because the drinking water dilutes the sodium in the bloodstream. Such runners may experience neurological disorders as a result of the severe hyponatremia and require emergency treatment.

Hyponatremia also develops from disorders in organs that control the body's regulation of sodium or water. The adrenal gland secretes a hormone called aldosterone that travels to the kidney, where it causes the kidney to retain sodium by not excreting it into the urine. **Addison's disease** causes hyponatremia as a result of low levels of aldosterone due to damage to the adrenal gland. The hypothalamus and pituitary gland are involved in sodium regulation by making and releasing vasopressin, known as anti-diuretic hormone, into the bloodstream. Like aldosterone, vasopressin acts in the kidney, but it causes it to reduce the amount of water released into urine. With more vasopressin production, the body conserves water, resulting in a lower concentration of plasma sodium. Certain types of **cancer** cells produce vasopressin, leading to hyponatremia.

KEY TERMS

Cerebral edema—Movement of water into brain cells causing the cells to swell, which disrupts normal functioning of the cells.

Diuretic—Medication that enhances the functioning of the kidney. Typically results in increased elimination of urine from the body.

Plasma—Clear, yellow- or straw-colored fluid that is the liquid component of blood and lymphatic fluid.

Hyponatremia can be acute, developing over 48 hours or less, or chronic, taking days or sometimes weeks to develop. Patient symptoms are often milder if the hyponatremia occurs over time because the body, particularly the brain, has time to compensate for the lower serum (blood) sodium concentration. When hyponatremia occurs rapidly, there is less time for the brain to adjust to the lowered sodium level and clinical manifestations related to cerebral **edema** are common. If the cerebral edema is severe enough, the result may be herniation of the brainstem and **death**. Rapid identification and treatment of the hyponatremic state is critical in averting these serious complications.

Symptoms of moderate hyponatremia include tiredness, disorientation, **headache**, **muscle cramps**, and **nausea**. Severe hyponatremia can lead to seizures and coma. These neurological symptoms are thought to result from the movement of water into brain cells, causing them to swell and disrupt their functioning (cerebral edema).

In most cases of hyponatremia, doctors are primarily concerned with discovering the underlying disease causing the decline in plasma sodium levels. Death that occurs during hyponatremia is usually due to other features of the disease rather than to hyponatremia itself.

Diagnosis

Tests

Hyponatremia is diagnosed by acquiring a blood sample and then measuring the concentration of sodium ions in the blood. Unless the cause is obvious, a variety of tests are subsequently run to determine if sodium was lost from the urine, diarrhea, or from **vomiting**. Tests are also used to determine abnormalities in aldosterone or vasopressin levels. The patient's diet and use of diuretics must be considered.

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Treatment

The goals of treatment of acute hyponatremia are to raise the sodium level above 120 mEq/L and to raise the sodium level rapidly by 4–6 mEq/L within the first 1–2 hours of initiation of treatment. Patients with severe hyponatremia should be treated with an infusion of hypertonic (3%) saline to raise the serum sodium level by 4–6 mEq/L. Further correction could be dangerous and is avoided in most patients unless serious neurological symptoms are present.

Patients exhibiting mild symptoms as a result of chronic hyponatremia should be treated cautiously to avoid serious and irreversible damage to the central nervous system that could be precipitated by rapid and overcorrection of hyponatremia. The goals of therapy in these patients is slow and cautious correction of serum sodium levels and identification of the cause of the hyponatremia.

Prognosis

Hyponatremia is just one manifestation of a variety of disorders. While hyponatremia can easily be corrected, the prognosis for the underlying condition that causes it varies.

Prevention

Patients who take diuretic medications must be checked regularly for the development of hyponatremia.

Hyponatremia is more likely to occur in infants and in the elderly. Individuals in these groups are less able to express thirst and are also less able to independently regulate their fluid intake. Caregivers of infants and the elderly should be educated regarding the importance of adequate and appropriate fluid intake.

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Hypoparathyroidism

Definition

Hypoparathyroidism is the result of a decrease in production of parathyroid hormones by the parathyroid glands located behind the thyroid glands in the neck. The result is a low level of **calcium** in the blood.

Description

Parathyroid glands consist of four pea-shaped glands located on the back and side of the thyroid gland. The gland produces parathyroid hormone which, along with vitamin D and calcitonin, are important for the regulation of the calcium level in the body. Hypoparathyroidism affects both males and females of all ages.

Causes and symptoms

The accidental removal of the parathyroid glands during neck surgery is the most frequent cause of hypoparathyroidism. Complications of surgery on the parathyroid glands is another common cause of this disorder. There is the possibility of autoimmune genetic disorders causing hypoparathyroidism such as Hashimoto's **thyroiditis**, **pernicious anemia**, and **Addison's disease**. The destruction of the gland by radiation is a rare cause of hypoparathyroidism. Occasionally, the parathyroids are absent at birth causing low calcium levels and possible convulsions in the newborn. Symptoms in the advanced and continuous stages of hypoparathyroidism include splitting of the nails, inadequate tooth development and **mental retardation** in children, and seizures.

Abnormal low levels of calcium result in irritability of nerves, causing **numbness and tingling** of the hands and feet, with painful-cramp like **muscle spasms** known as tetany. Laryngeal spasms may also occur causing respiratory obstruction.

Diagnosis

Diagnostic measures begin with the individual's own observation of symptoms. A thorough medical history and **physical examination** by a physician is always required for an accurate diagnosis. The general practitioner may refer the individual to an endocrinologist, a medical specialist who studies the function of the parathyroid glands as well as other hormone producing glands. Laboratory studies include blood and urine tests to help determine phosphate and calcium levels. X rays are useful to determine any abnormalities in bone density associated with abnormal calcium

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levels. These **autoimmune disorders** may accompany hypoparathyroidism, but are not an actual cause of it.

Treatment

In the event of severe muscle spasms, hospitalization may be warranted for calcium injections. Raising carbon-dioxide levels in the blood, which can decrease muscle spasms, may be achieved in immediate situations by placing a paper bag over the mouth and blowing into it to "reuse" each breath. It is critical to obtain timely periodic laboratory tests to check calcium levels. A high calcium, low-phosphorous diet may be of significance and is directed by the physician or dietitian.

Prognosis

Presently hypoparathyroidism is considered incurable. The disorder requires lifelong replacement therapy to control symptoms. Medical research however, continues to search for a cure.

Prevention

There are no specific preventive measures for hypoparathyroidism. However, careful surgical techniques are critical to reduce the risk of damage to the gland during surgery.

ORGANIZATIONS

American Medical Association, 515 N. State St., Chicago, IL, 60654, (800) 621-8335, http://www.ama-assn.org/.

Jeffrey P. Larson, RPT

Hypophysectomy

Definition

Hypophysectomy or hypophysis is the removal of the pituitary gland.

Purpose

The pituitary gland is in the middle of the head. Removing this master gland is a drastic step that was taken in the extreme circumstance of two cancers that had escaped all other forms of treatment. Cancers of the female breast and male prostate grow faster in the presence of sex hormones. It used to be that sex hormones could be suppressed only by removing their source, the glands that made them. After the gonads were removed, some cancers continued to grow, so other stimulants to their growth had to removed. At this point, some **cancer** specialists turned to the pituitary.

With the development of new therapeutic agents and methods, especially new ways to manipulate hormones without removing their source, this type of endocrine surgery has been largely relegated to history. However, tumors develop in the pituitary gland that require removal of the tumor but partially preserving the gland.

Description

There are several surgical approaches to the pituitary. The surgeon will choose the best one for the specific procedure. The pituitary lies directly behind the nose, and access through the nose or the sinuses is often the best approach. Opening the skull and lifting the frontal lobe of the brain will expose the delicate neck of the pituitary gland. This approach works best if tumors have extended above the pituitary fossa (the cavity in which the gland lies).

Newer surgical methods using technology have made other approaches possible. Stereotaxis is a three-dimensional aiming technique using x rays or scans for guidance. Instruments can be placed in the brain with pinpoint accuracy through tiny holes in the skull. These instruments can then manipulate brain tissue, either to destroy it or remove it. Stereotaxis is also used to direct radiation with similar precision using a gamma knife. Access to some brain lesions can be gained through the blood vessels using tiny tubes and wires guided by x rays.

Preparation

Pituitary surgery is performed by neurosurgeons deep inside the skull. All the patient can do to prepare is keep as healthy as possible and trust that the surgeon will do his usual excellent job. Informed surgical consent is important so that the patient is fully confident of the need for surgery and the expected outcome.

Aftercare

Routine post-operative care is required. In addition, pituitary function will be assessed.

Risks

The risks of surgery are multiple. Procedures are painstakingly selected to minimize risk and maximize benefit. Unique to surgery on the pituitary is the risk of destroying the entire gland and leaving the entire endocrine system without guidance. This used to be the whole purpose of hypophysectomy. After the procedure, the endocrinologist, a physician specializing in

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the study and care of the endocrine system, would provide the patient with all the hormones needed. Patients with no pituitary function did and still do quite well because of the available hormone replacements.

Normal results

Complete removal of the pituitary was the goal for cancer treatment. In the early twenty-first century, removal of tumors with preservation of the gland is the goal.

Abnormal results

Tumors may not be completely removed, due to their attachment to vital structures.

Resources

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J. Ricker Polsdorfer, MD

Hypopigmentation *see* **Albinism; Vitiligo**

Hypopituitarism

Definition

Hypopituitarism is loss of function in an endocrine gland due to failure of the pituitary gland to secrete hormones which stimulate that gland's function. The pituitary gland is located at the base of the brain. Patients diagnosed with hypopituitarism may be deficient in one single hormone, several hormones, or have complete pituitary failure.

Description

The pituitary is a pea-sized gland located at the base of the brain, and surrounded by bone. The hypothalamus, another endocrine organ in the brain, controls the function of the pituitary gland by providing "hormonal orders." In turn, the pituitary gland regulates the many hormones that control various functions and organs within the body. The posterior pituitary acts as a sort of storage area for the hypothalamus and passes on hormones that control function of the muscles and kidneys. The anterior pituitary produces its own hormones which help to regulate several endocrine functions.

In hypopituitarism, something interferes with the production and release of these hormones, thus affecting the function of the target gland. Commonly affected hormones may include:

Gonadotropin deficiency

Gonadotropin deficiency involves two distinct hormones affecting the reproductive system. Luteinizing hormone (LH) stimulates the testes in men and the ovaries in women. This deficiency can affect fertility in men and women and menstruation in women. Follicle-stimulating hormone (FSH) has similar effects to LH.

Thyroid stimulating hormone deficiency

Thyroid stimulating hormone (TSH) is involved in stimulation of the thyroid gland. A lack of stimulation in the gland leads to **hypothyroidism**.

Adrenocorticotopic hormone deficiency

Also known as corticotropin, adrenocorticotopic hormone (ACTH) stimulates the adrenal gland to produce a hormone similar to cortisone, called cortisol. The loss of this hormone can lead to serious problems.

Growth hormone deficiency

Growth hormone (GH) regulates the body's growth. Patients who lose supply of this hormone before physical maturity will suffer impaired growth. Loss of the hormone can also affect adults.

Other hormone deficiencies

Prolactin stimulates the female breast to produce milk. A hormone produced by the posterior pituitary, antidiuretic hormone (ADH), controls the function of the kidneys. When this hormone is deficient, **diabetes insipidus** can result. However, patients with hypopituitarism rarely suffer ADH deficiency, unless the hypopituitarism is the result of hypothalamus disease.

Multiple hormone deficiencies

Deficiency of a single pituitary hormone occurs less commonly than deficiency of more than one hormone. Sometimes referred to as progressive pituitary hormone deficiency or partial hypopituitarism, there is usually a predictable order of hormone loss. Generally, growth hormone is lost first, then luteinizing hormone deficiency follows. The loss of follicle-stimulating hormone, thyroid stimulating hormone and adrenocorticotopic hormones follow much later. The progressive loss of pituitary hormone secretion is usually a slow process, which can occur over a period of

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months or years. Hypopituitarism does occasionally start suddenly with rapid onset of symptoms.

Panhypopituitarism

This condition represents the loss of all hormones released by the anterior pituitary gland. Panhypopituitarism is also known as complete pituitary failure.

Causes and symptoms

There are three major mechanisms that lead to the development of hypopituitarism. The first involves decreased release of hypothalamic hormones that stimulate pituitary function. The cause of decreased hypothalamic function may be congenital or acquired through interference such as tumors, inflammation, infection, mass lesions or interruption of blood supply. A second category of causes is any event or mass which interrupts the delivery of hormones from the hypothalamus. These may include particular tumors and aneurysms. Damage to the pituitary stalk from injury or surgery can also lead to hypopituitarism.

The third cause of hypopituitarism is damage to the pituitary gland cells. Destroyed cells can not produce the pituitary hormones that would normally be secreted by the gland. Cells may be destroyed by a number of tumors and diseases. Hypopituitarism is often caused by tumors, the most common of which is pituitary adenoma.

Symptoms of hypopituitarism vary with the affected hormones and severity of deficiency. Frequently, patients have had years of symptoms that were nonspecific until a major illness or **stress** occurred. Overall symptoms may include **fatigue**, sensitivity to cold, weakness, decreased appetite, weight loss and abdominal **pain**. Low blood pressure, **headache** and visual disturbances are other associated symptoms.

Gonadotropin deficiency

Symptoms specific to this hormone deficiency include decreased interest in sex for women and **infertility** in women and men. Women may also have premature cessation of menstruation, hot flashes, vaginal dryness and pain during intercourse. Women who are postmenopausal will not have obvious symptoms such as these and may first present with headache or loss of vision. Men may also suffer **sexual dysfunction** as a result of gonadotropin deficiency. In acquired gonadotropin deficiency, both men and women may notice loss of body hair.

Thyroid stimulating hormone deficiency

Intolerance to cold; fatigue; weight gain; **constipation**; and pale, waxy. and dry skin indicate thyroid hormone deficiency.

Adrenocorticotopic hormone deficiency

Symptoms of ACTH deficiency include fatigue, weakness, weight loss, and low blood pressure. **Nausea**, pale skin, and loss of pubic and armpit hair in women may also indicate deficiency of ACTH.

Growth hormone deficiency

In children, growth hormone deficiency will result in short stature and growth retardation. Symptoms such as **obesity** and skin wrinkling may or may not show in adults and normal release of growth hormone normally declines with age.

Other hormone deficiencies

Prolactin deficiency is rare and is the result of partial or generalized anterior pituitary failure. When present, the symptom is absence of milk production in women. There are no known symptoms for men. ADH deficiency may produce symptoms of diabetes insipidus, such as excessive thirst and frequent urination.

Multiple hormone deficiencies

Patients with multiple hormone deficiencies will show symptoms of one or more specific hormone deficiencies or some of the generalized symptoms listed in this article.

Panhypopituitarism

The absence of any pituitary function should show symptoms of one or all of the specific hormone deficiencies. In addition to those symptoms, patients may have dry, pale skin that is finely textured. The face may appear finely wrinkled and contain a disinterested expression.

Diagnosis

Once the diagnosis of a single hormone deficiency is made, it is strongly recommended that tests for other hormone deficiencies be conducted.

Gonadotropin deficiency

The detection of low levels of gonadotropin can be accomplished through simple blood tests which measure luteinizing hormone and follicle-stimulating hormone, simultaneously with gonadal steroid levels. The combination of results can indicate to a physician if the cause of decreased hormone levels or function belongs to hypopituitarism or some sort of primary gonadal failure. Diagnosis will vary among men and women.

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Thyroid stimulating hormone deficiency

Laboratory tests measuring thyroid function can help determine a diagnosis of TSH deficiency. The commonly used tests are T4 and TSH measurement done simultaneously to determine the reserve, or pool, of thyroid-stimulating hormone.

Adrenocorticotopic hormone deficiency

An insulin tolerance test may be given to determine if cortisol levels rise when **hypoglycemia** is induced. If they do not rise, there is insufficient reserve of cortisol, indicating an ACTH deficiency. If the insulin tolerance test is not safe for a particular patient, a glucagon test offers similar results. A CRH (corticotropin-releasing hormone) test may also be given. It involves injection of CRH to measure, through regularly drawn blood samples, a resulting rise in ACTH and cortisol. Other tests which stimulate ACTH may be ordered.

Growth hormone deficiency

Growth hormone deficiency is measured through the use of insulin-like growth factor I tests, which measure growth factors that are dependent on growth hormones. Sleep and **exercise** studies may also be used to test for growth hormone deficiency, since these activities are known to stimulate growth hormone secretion. Several drugs also induce secretion of growth hormone and may be given to measure hormone response. The standard test for growth hormone deficiency is the insulin-induced hypoglycemia test. This test does carry some risk from the induced hypoglycemia. Other tests include an arginine infusion test, clonidine test and growth-hormone releasing hormone test.

Other hormone deficiencies

If a test calculates normal levels of prolactin, deficiency of the hormone is eliminated as a diagnosis. A TRH (thyrotropin-releasing hormone) simulation test can determine prolactin levels. A number of tests are available to detect ADH levels and to determine diagnosis of diabetes insipidus.

Multiple and general hypopituitarism tests

Physicians should be aware that nonspecific symptoms can indicate deficiency of one or more hormones and should conduct a thorough clinical history. In general, diagnosis of hypopituitarism can be accomplished with a combination of dynamic tests and simple blood tests, as well as imaging exams. Most of these tests can be conducted in an outpatient lab or radiology facility. **Magnetic resonance imaging** (MRI) exams with gadolinium contrast enhancement are preferred imaging exams to study the region of the hypothalamus and pituitary gland. When an MRI is not available, a properly conducted computed tomography scan (CT scan) exam can take its place. These exams can confirm a tumor or other mass, which may be interfering with pituitary function.

Panhypopituitarism

The insulin-induced hypoglycemia, or insulin tolerance test, which is used to determine specific hormone deficiencies, is an excellent test to diagnose panhypopituitarism. This test can reveal levels of growth hormone, ACTH (cortisol) and prolactin deficiency. The presence of insufficient levels of all of these hormones is a good indication of complete pituitary failure. Imaging studies and clinical history are also important.

Treatment

Treatment differs widely, depending on the age and sex of the patient, severity of the deficiency, the number of hormones involved, and even the underlying cause of the hypopituitarism. Immediate hormone replacement is generally administered to replace the specific deficient hormone. Patient education is encouraged to help patients manage the impact of their hormone deficiency on daily life. For instance, certain illnesses, accidents or surgical procedures may have adverse complications due to hypopituitarism.

Gonadotropin deficiency

Replacement of gonadal **steroids** is common treatment for LH and FSH deficiency. Estrogen for women and testosterone for men will be prescribed in the lowest effective dosage possible, since there can be complications to this therapy. To correct women's loss of libido, small doses of androgens may be prescribed. To restore fertility in men, regular hormone injections may be required. Male and female patients whose hypopituitarism results from hypothalamic disease may be successfully treated with a hypothalamic releasing hormone (GnRH), which can restore gonadal function and fertility.

Thyroid stimulating hormone deficiency

In patients who have hypothyroidism, the function of the adrenal glands will be tested and treated with steroids before administering thyroid hormone replacement.

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Adrenocorticotopic hormone deficiency

Hydrocortisone or cortisone in divided doses may be given to replace this hormone deficiency. Most patients require 20 mg or less of hydrocortisone per day.

Growth hormone deficiency

It is essential to treat children suffering from growth hormone deficiency. The effectiveness of growth hormone therapy in adults, particularly elderly adults, is not as well documented. It is thought to help restore normal muscle to fat ratios. Growth hormone is an expensive and cautiously prescribed treatment.

Treatment of multiple deficiencies and panhypopituitarism

The treatment of hypopituitarism is usually very straightforward, but must normally continue for the remainder of the patient's life. Some patients may receive treatment with GnRH, the hypothalamic hormone. In most cases, treatment will be based on the specific deficiency demonstrated. Patients with hypopituitarism should be followed regularly to measure treatment effectiveness and to avoid overtreatment with hormone therapy. If the cause of the disorder is a tumor or lesion, radiation or surgical removal are treatment options. Successful removal may reverse the hypopituitarism. However, even after removal of the mass, **hormone replacement therapy** may still be necessary.

Prognosis

The prognosis for most patients with hypopituitarism is excellent. As long as therapy is continued, many experience normal life spans. However, hypopituitarism is usually a permanent condition and the prognosis depends on the primary cause of the disorder. It can be potentially life threatening, particularly when acute hypopituitarism occurs as a result of a large pituitary tumor. Morbidity from the disease has increased, although the cause is not known. It is possible that increased morbidity and **death** are due to overtreatment with hormones. Any time that recovery of pituitary function can occur is preferred to lifelong hormone therapy.

Prevention

There is no known prevention of hypopituitarism, except for prevention of damage to the pituitary/hypothalamic area from injury.

ORGANIZATIONS

Genetic Alliance, Inc., 4301 Connecticut Ave., NW, Suite 404, Washington, DC, 20008-2369, (202) 966-5557, (202) 966-8553, info@geneticalliance.org, http://www.geneticalliance.org.

The Human Growth Foundation, 997 Glen Cove Ave., Suite 5, Glen Head, NY, 11545, (516) 671-4055, (800) 451-6434, http://www.hgfound.org/.

Teresa Norris, RN

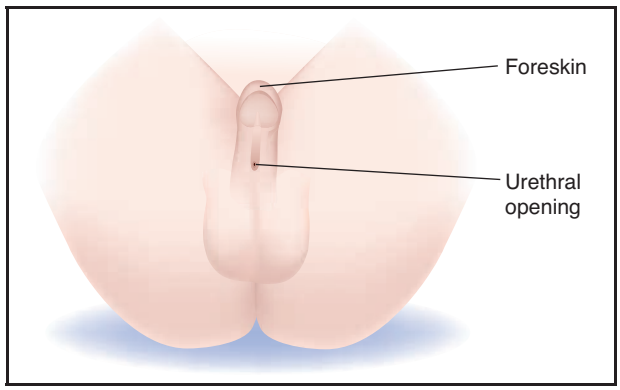
Hypoplastic anemia *see* **Aplastic anemia**

Hypospadias and epispadias

Definition

Hypospadias is a congenital defect, primarily of males, in which the urethra opens on the underside (ventrum) of the penis. It is one of the most common congenital abnormalities in the United States, occurring in about 1 of every 125 live male births. The corresponding defect in females is an opening of the urethra into the vagina and is rare.

Epispadias (also called bladder exstrophy) is a congenital defect of males in which the urethra opens on the upper surface (dorsum) of the penis. The corresponding defect in females is a fissure in the upper wall of the urethra and is quite rare.



In hypospadias, the urethra opens along the penile shaft rather than at the penile tip. *(Illustration by Argosy, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

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Description

In a male, the external opening of the urinary tract (external meatus) is normally located at the tip of the penis. In a female, it is normally located between the clitoris and the vagina.

In males with hypospadias, the urethra opens on the inferior surface or underside of the penis. In females with hypospadias, the urethra opens into the cavity of the vagina.

In males with epispadias, the urethra opens on the superior surface or upper side of the penis. In females with epispadias, there is a crack or fissure in the wall of the urethra and out of the body through an opening in the skin above the clitoris.

During the embryological development of males, a groove of tissue folds inward and then fuses to form a tube that becomes the urethra. Hypospadias occurs when the tube does not form or does not fuse completely. Epispadias is due to a defect in the tissue that folds inward to form the urethra.

During the development of a female, similar processes occur to form the urethra. The problem usually is insufficient length of the tube that becomes the urethra. As a result, the urethra opens in an abnormal location, resulting in a hypospadias. Occasionally, fissures form in the bladder. These may extend to the surface of the abdomen and fuse with the adjacent skin. This condition is most commonly identified as a defect in the bladder although it is technically an epispadias.

Hypospadias in males generally occur alone. Female hypospadias may be associated with abnormalities of the genital tract, since the urinary and genital tracts are formed in the same embryonic process.

Because it represents incomplete development of the penis, some experts think that insufficient male hormone may be responsible for hypospadias.

In males, the incidence of hypospadias is approximately one per 250 to 300 live births. Epispadias is much less common, having an incidence of about one per 100,000 live male births.

In females, hypospadias is much less common than in males. It appears about once in every 500,000 live female births. Epispadias is even more rare. Reliable estimates of the prevalence of epispadias in females are not available. Epispadias in females is often diagnosed and recorded as a bladder anomaly.

Causes and symptoms

Hypospadias and epispadias are congenital defects of the urinary tract. This means they occur during intrauterine development. There is no genetic basis for the defects. Specific causes for hypospadias are not known. This means that blood relatives do not have increased chances of developing them. Reports have shown some rise in prevalence of hypospadias among offspring of mothers who work in certain occupations where they may be exposed to chemicals that disrupt the endocrine system. However, a large trial ending in 2003 showed that aside from a slight increased risk among women who were hairdressers from 1992–1996, there is no evidence that maternal occupation or certain chemical exposure increases risk of hypospadias. The role of chemicals in the development of the defect remains uncertain.

Concern was once raised that use of the antihistamine loratadine (Claritin) early in **pregnancy** might cause hypospadias. However, a national clinical trial revealed in 2004 that there was no link between the drug and risk of second or third–degree hypospadias.

Hypospadias usually is not associated with other defects of the penis or urethra. In males, it can occur at any site along the underside of the penis. In females, the urethra exits the body in an abnormal location. This usually is due to inadequate length of the urethra.

Epispadias is associated with bladder abnormalities. In females, the front wall of the bladder does not fuse or close. The bladder fissure may extend to the external abdominal wall. In such a rare case, the front of the pelvis also is widely separated. In males, the bladder fissure extends into the urethra and simply becomes an opening somewhere along the upper surface of the penis.

Hypospadias is associated with difficulty in assigning gender to babies. This occurs when gender is not obvious at birth because of deformities in the sex organs.

Diagnosis

Male external urinary tract defects are discovered at birth during the first detailed examination of the newborn. Female urethral defects may not be discovered for some time due to the difficulty in viewing the infant vagina.

Treatment

Surgery is the treatment of choice for both hypospadias and epispadias. All surgical repairs should be undertaken early and completed without delay. This minimizes psychological trauma.

In males with hypospadias, one surgery usually is sufficient to repair the defect. With more complicated hypospadias (more than one abnormally situated

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KEY TERMS

Continence—Control of urination or bowel movement.

Urethra—The tube through which urine passes from the bladder to the outside of the body.

urethral opening), multiple surgeries may be required. In females with hypospadias, surgical repair technically is more complicated but can usually be completed in a brief interval of time.

Repairing an epispadias is more difficult. In males, this may involve other structures in the penis. Males should not be circumcised since the foreskin often is needed for the repair. Unfortunately, choices may be required that affect the ability to inseminate a female partner. Reproduction requires that the urethral meatus be close to the tip of the penis. Cosmetic appearance and ability to urinate (urinary continence) usually are the primary goals. Surgery for these defects is successful 70 to 80% of the time. Modern treatment of complete male epispadias allows for an excellent genital appearance and achievement of urinary continence.

In females, repair of epispadias may require multiple surgical procedures. Urinary continence and cosmetic appearance are the usual primary considerations. Urinary continence usually is achieved although cosmetic appearance may be somewhat compromised. Fertility is not usually affected. Repair rates that are similar or better than those for males usually can be achieved for females.

Hypospadias in both males and females is more of a nuisance and hindrance to reproduction than a threat to health. If surgery is not an option, the condition may be allowed to persist. This usually leads to an increased risk of infections in the lower urinary tract.

Prognosis

With adequate surgical repair, most males with simple hypospadias can lead normal lives with a penis that appears and functions in a normal manner. This includes fathering children. Females with simple hypospadias also have normal lives, including conceiving and bearing children.

The prognosis for epispadias depends on the extent of the defect. Most males with relatively minor epispadias lead normal lives, including fathering children. As the extent of the defect increases, surgical reconstruction generally is acceptable. However, many of these men are unable to conceive children. Most epispadias in females can be surgically repaired. The chances of residual disfigurement increase as the extent of the epispadias increases. Fertility in females is not generally affected by epispadias.

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ORGANIZATIONS

Association for the Bladder Exstrophy Community, 3075 First St., La Salle, MI, 48145, (866) 300–2222, http://www.bladderexstrophy.com.

Hypospadias and Epispadias Association, 240 W. 44th St., Suite 2, New York, NY, 10036, (212) 382–3471, http://heainfo.org.

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Hypotension

Definition

Hypotension is the medical term for low blood pressure.

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Description

The pressure of the blood in the arteries rises and falls as the heart and muscles handle demands of daily living, such as **exercise**, sleep, and **stress**. Some healthy people have blood pressure well below the average for their age, even though they have a completely normal heart and blood vessels. This is often true of athletes who are in superior shape. The term "hypotension" is usually used only when blood pressure has fallen so far that enough blood can no longer reach the brain, causing **dizziness** and **fainting**.

Causes and symptoms

Postural hypotension is the most common type of low blood pressure. In this condition, symptoms appear after a person sits up or stands quickly. In normal people, the cardiovascular system must make a quick adjustment to raise blood pressure slightly to account for the change in position. For those with postural hypotension, the blood pressure adjustment is not adequate or it doesn't happen. Postural hypotension may occur if someone is taking certain drugs or medicine for high blood pressure. It also happens to diabetics when nerve damage has disrupted the reflexes that control blood pressure.

Many people have a chronic problem with low blood pressure that is not particularly serious. This may include people who require certain medications, who are pregnant, have bad veins, or have arteriosclerosis (hardening of the arteries).

The most serious problem with low blood pressure occurs when there is a sudden drop, which can be life-threatening due to widespread **ischemia** (insufficient supply of blood to an organ due to blockage in an artery). This type of low blood pressure may be due to a wide variety of causes, including:

- trauma with extensive blood loss
- serious burns
- shock from various causes (e.g. anaphylaxis)
- heart attack
- adrenal failure (Addisonian crisis)
- cancer
- severe fever
- serious infection (septicemia)

Diagnosis

Blood pressure is a measure of the pressure in the arteries created by the heart contracting. During the day, a normal person's blood pressure changes constantly, depending on activity. Low blood pressure can be diagnosed by taking the blood pressure with a sphygmomanometer. This is a device with a soft rubber cuff that is inflated around the upper arm until it's tight enough to stop blood flow. The cuff is then slowly deflated until the health care worker, listening to the artery in the arm with a stethoscope, can hear the blood first as a beat forcing its way along the artery. This is the systolic pressure. The cuff is then deflated more until the beat disappears and the blood flows steadily through the open artery; this gives the diastolic pressure.

Blood pressure is recorded as systolic (higher) and diastolic (lower) pressures. A healthy young adult has a blood pressure of about 110/75, which typically rises with age to about 140/90 by age 60 (a reading now considered mildly elevated).

Treatment

Treatment of low blood pressure depends on the underlying cause, which can usually be resolved. For those people with postural hypotension, a medication adjustment may help prevent the problem. These individuals may find that rising more slowly, or getting out of bed in slow stages, helps the problem. Low blood pressure with no other symptoms does not need to be treated.

Prognosis

Low blood pressure as a result of injury or other underlying condition can usually be successfully treated if the trauma is not too extensive or is treated in time. Less serious forms of chronic low blood pressure have a good prognosis and do not require treatment.

Resources

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Carol A. Turkington

Hypothermia

Definition

Hypothermia, a potentially fatal condition, occurs when body temperature falls below 95°F (35°C).

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Description

Although hypothermia is an obvious danger for people living in cold climates, many cases have occurred when the air temperature is well above the freezing mark. Elderly people, for instance, have succumbed to hypothermia after prolonged exposure to indoor air temperatures of 50–65°F (10–18.3°C). In the United States, hypothermia is primarily an urban phenomenon associated with **alcoholism**, drug **addiction**, mental illness, and cold—water immersion accidents. The victims are often homeless male alcoholics. Officially, 11,817 deaths were attributed to hypothermia in the United States from 1979 to 1994, but experts suspect that many fatal cases go unrecognized. Nearly half the victims were 65 or older, with males dominating every age group. Nonwhites were also overrepresented in the statistics. Among males 65 and older, nonwhites outnumbered whites by more than four to one.

Causes and symptoms

Measured orally, a healthy person's body temperature can fluctuate between 97°F (36.1°C) and 100°F (37.8°C). Survival depends on maintaining temperature stability within this range by balancing the heat produced by metabolism with the heat lost to the environment through (for the most part) the skin and lungs. When environmental or other changes cause heat loss to outpace heat production, the brain triggers physiological and behavioral responses to restore the balance. The involuntary muscular activity of shivering, for example, aids heat production by accelerating metabolism. But if the cold stress is too great and the body's defenses are overwhelmed, body temperature begins to fall. Hypothermia is considered to begin once body temperature reaches 95°F (35°C), though even smaller drops in temperature can have an adverse effect.

Hypothermia is divided into two types: primary and secondary. Primary hypothermia occurs when the body's heat-balancing mechanisms are working properly but are subjected to extreme cold, whereas secondary hypothermia affects people whose heat-balancing mechanisms are impaired in some way and cannot respond adequately to moderate or perhaps even mild cold. Primary hypothermia typically involves exposure to cold air or immersion in cold water. The cold air variety usually takes at least several hours to develop, but immersion hypothermia will occur within about an hour of entering the water, since water draws heat away from the body much faster than air does. In secondary hypothermia, the body's heat-balancing mechanisms can fail for any number of reasons, including strokes, diabetes, **malnutrition**, bacterial infection, thyroid disease, spinal cord injuries (which prevent the brain from receiving crucial temperature-related information from other parts of the body), and the use of medications and other substances that affect the brain or spinal cord. Alcohol is one such substance. In smaller amounts it can put people at risk by interfering with their ability to recognize and avoid cold-weather dangers. In larger amounts it shuts down the body's heat-balancing mechanisms.

Secondary hypothermia is often a threat to the elderly, who may be on medications or suffering from illnesses that affect their ability to conserve heat. Malnutrition and immobility can also put the elderly at risk. Some medical research suggests as well that shivering and blood vessel narrowing—two of the body's defenses against cold—may not be triggered as quickly in older people. For these and other reasons, the elderly can, over a period of days or even weeks, fall victim to hypothermia in poorly insulated homes or other surroundings that family, friends, and caregivers may not recognize as life threatening. Another risk for the elderly is the fact that hypothermia can easily be misdiagnosed as a **stroke** or some other common illness of old age.

The signs and symptoms of hypothermia follow a typical course, though the body temperatures at which they occur vary from person to person depending on age, health, and other factors. The impact of hypothermia on the nervous system often becomes apparent quite early. Coordination, for instance, may begin to suffer as soon as body temperature reaches 95°F (35°C). The early signs of hypothermia also include cold and pale skin and intense shivering; the latter stops between 90°F (32.2°C) and 86°F (30°C). As body temperature continues to fall, speech becomes slurred, the muscles go rigid, and the victim becomes disoriented and experiences eyesight problems. Other harmful consequences include **dehydration** as well as liver and kidney failure. Heart rate, respiratory rate, and blood pressure rise during the first stages of hypothermia, but fall once the 90°F (32.2°C) mark is passed. Below 86°F (30°C) most victims are comatose, and below 82°F (27.8°C) the heart's rhythm becomes dangerously disordered. However, even at very low body temperatures, people can survive for several hours and be successfully revived, though they may appear to be dead.

Diagnosis

Information on the patient's prior health and activities often helps doctors establish a correct diagnosis and treatment plan. Pulse, blood pressure, temperature, and respiration require immediate monitoring. Because the temperature of the mouth is not an accurate guide to

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the body's core temperature, readings are taken at other sites, usually the ear, rectum, or esophagus. Other diagnostic tools include **electrocardiography**, which is used to evaluate heart rhythm, and blood and urine tests, which provide several kinds of key information; a **chest x ray** is also required. A computed tomography scan (CT scan) or **magnetic resonance imaging** (MRI) may be needed to check for head and other injuries.

Treatment

Emergency medical help should be summoned whenever a person appears hypothermic. The danger signs include intense shivering; stiffness and **numbness** in the arms and legs; stumbling and clumsiness; sleepiness, confusion, disorientation, **amnesia**, and irrational behavior; and difficulty speaking. Until emergency help arrives, a victim of outdoor hypothermia should be brought to shelter and warmed by removing wet clothing and footwear, drying the skin, and wrapping him or her in warm blankets or a sleeping bag. Gentle handling is necessary when moving the victim to avoid disturbing the heart. Rubbing the skin or giving the victim alcohol can be harmful, though warm drinks such as clear soup and tea are recommended for those who can swallow. Anyone who aids a victim of hypothermia should also look for signs of **frostbite** and be aware that attempting to rewarm a frostbitten area of the body before emergency help arrives can be extremely dangerous. For this reason, frostbitten areas must be kept away from heat sources such as campfires and car heaters.

Rewarming is the essence of hospital treatment for hypothermia. How rewarming proceeds depends on the body temperature. Different approaches are used for patients who are mildly hypothermic (the patient's body temperature is 90–95°F [32.2–35°C]), moderately hypothermic (86–90°F [30–32.2°C]), or severely hypothermic (less than 86°F [30°C]). Other considerations, such as the patient's age or the condition of the heart, can also influence treatment choices.

Mild hypothermia is reversed with passive rewarming. This technique relies on the patient's own metabolism to rewarm the body. Once wet clothing is removed and the skin is dried, the patient is covered with blankets and placed in a warm room. The goal is to raise the patient's temperature by 0.5–2°C an hour.

Moderate hypothermia is often treated first with active external rewarming and then with passive rewarming. Active external rewarming involves applying heat to the skin, for instance by placing the patient in a warm bath or wrapping the patient in electric heating blankets.

Severe hypothermia requires active internal rewarming, which is recommended for some cases of moderate hypothermia as well. There are several types of active internal rewarming. Cardiopulmonary bypass, in which the patient's blood is circulated through a rewarming device and then returned to the body, is considered the best, and can raise body temperature by 1–2°C every 3–5 minutes. However, many hospitals are not equipped to offer this treatment. The alternative is to introduce warm oxygen or fluids into the body.

Hypothermia treatment can also include, among other things, insulin, **antibiotics**, and fluid replacement therapy. When the heart has stopped, both **cardiopulmonary resuscitation** (CPR) and rewarming are necessary. Once a patient's condition has stabilized, he or she may need treatment for an underlying problem such as alcoholism or thyroid disease.

Prognosis

Victims of mild or moderate hypothermia usually enjoy a complete recovery. In regard to severely hypothermic patients, the prognosis for survival varies due to differences in people's physiological responses to cold.

Prevention

People who spend time outdoors in cold weather can reduce heat loss by wearing their clothing loosely and in layers and by keeping their hands, feet, and head well covered (30–50% of body heat is lost through the head). Because water draws heat away from the body so easily, staying dry is important, and wet clothing and footwear should be replaced as quickly as possible. Wind- and water-resistant outer garments are also crucial. Alcohol should be avoided because it promotes heat loss by expanding the blood vessels that carry body heat to the skin.

Preventing hypothermia among the elderly requires vigilance on the part of family, friends, and caregivers. An elderly person's home should be properly insulated and heated, with living areas kept at a temperature of 70°F (21.1°C). Warm clothing and bedding are essential, as are adequate food, rest, and **exercise**; warming the bed and bedroom before going to sleep is also recommended. Older people who live alone should be visited regularly—at least once a day during very cold weather—to ensure that their health remains sound and that they are taking good care of themselves. For help and advice, family members and others can turn to government and social service agencies. Meals on Wheels and visiting nurse programs, for instance, may be available, and it may be possible to obtain financial aid for winterizing and heating homes.

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Howard Baker

Hypothyroidism

Definition

Hypothyroidism is a condition in which a person's thyroid gland is not producing enough hormone. It may be caused by an autoimmune disorder, a genetic defect in a newborn, certain medications, surgical removal of the thyroid gland, **radiation therapy** for **cancer**, and other reasons.

There are three main types of hypothyroidism. The most common is primary hypothyroidism, in which the thyroid doesn't produce an adequate amount of T_4. Secondary hypothyroidism develops when the pituitary gland does not release enough of the thyroid-stimulating hormone (TSH) that prompts the thyroid to manufacture T_4. Tertiary hypothyroidism results from a malfunction of the hypothalamus, the part of the brain that controls the endocrine system. Drug-induced hypothyroidism, an adverse reaction to medication, occurs in 2 of every 10,000 people, but rarely causes severe hypothyroidism.

Demographics

According to the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), between 3 and 5% of the general population in the United States and Canada has some form of hypothyroidism. Apart from cretinism, which affects one child in every 3,000–4,000, hypothyroidism is largely a disease of adults. The most common form of primary hypothyroidism in North America is Hashimoto's disease, an autoimmune disorder that is diagnosed in about 14 women out of every 1000 and 1 man in every 2000.

Caucasians and Hispanics (particularly Mexican Americans) in North America have higher rates of hypothyroidism than African Americans. The reason for this difference was not known as of 2009.

Internationally, however, the most common cause of hypothyroidism is a lack of iodine in the diet. The prevalence of hypothyroidism caused by iodine deficiency in developing countries is 2–5%, increasing to 15% by age 75.

Description

Hypothyroidism is an endocrine disorder; that is, it is caused by underfunctioning of a gland that is part of the endocrine system—a group of small organs located throughout the body that regulate growth, metabolism, tissue function, and emotional mood. The thyroid gland itself is a butterfly-shaped organ weighing between half an ounce and 1.5 ounces in adults that lies at the base of the throat below the Adam's apple and above the collarbone. It takes its name from a Greek word meaning "shield." The thyroid consists of two lobes about 2 inches in length (in adults) connected by a thin strip of tissue called the isthmus.

Hypothyroidism develops when the thyroid gland fails to produce or secrete as much thyroxine (T_4) as the body needs. Because T_4 regulates such essential functions as heart rate, digestion, physical growth, and mental development, an insufficient supply of this hormone can slow life-sustaining processes, damage organs and tissues in every part of the body, and lead to life-threatening complications.

Hypothyroidism is not easy to diagnose because its symptoms are found in a number of other diseases; it often comes on slowly; and it may produce few or no symptoms in younger adults. In general, hypothyroidism is characterized by a slowing down of both physical and mental activities.

Risk factors

Risk factors for hypothyroidism include:

- Sex. Women are at greater risk of hypothyroidism than men. The female/male ratio among adults is between 2:1 and 8:1, depending on the age group being studied.
- Age over 50. In one Massachusetts study, 6 percent of women over 60 and 2.5 percent of men over 60 were found to be hypothyroid.
- Race. According to the National Institutes of Health (NIH), the rates of hypothyroidism in the United States are highest among Caucasians (5.1 percent) and Hispanics (4.1 percent) and lowest among African Americans (1.7 percent).
- Obesity.
- Having a small body size at birth and low body mass index during childhood.
- Family history of autoimmune disease.
- Having Turner syndrome, a genetic disorder in which a girl is born with only one X chromosome

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instead of the normal two. Turner syndrome affects 1 in every 2500 girls.

Causes and symptoms

Causes

The most common causes of hypothyroidism are:

- Hashimoto's disease. This is an autoimmune disorder in which the patient's immune system attacks the thyroid gland, leading to tissue destruction.
- Treatment for hyperthyroidism. People who have been treated for an oversupply of thyroid hormone (hyperthyroidism) with radioactive iodine (iodine-131) may lose their ability to produce enough thyroid hormone.
- Surgery on the thyroid gland.
- Radiation therapy for the treatment of head or neck cancer.
- Medications. Lithium, given to treat some psychiatric disorders, and certain heart medications may affect the functioning of the thyroid gland. Other drugs known to suppress thyroid function include amiodarone, a heart medication; interferon alpha, given to treat cancer; and stavudine, a drug used to treat HIV infection.
- Pregnancy. As many as 10% of women may become hypothyroid in the first year after childbirth, particularly if they have diabetes.
- Viral infections. These can cause a short-term inflammation of the thyroid gland known as thyroiditis in some people.
- A tumor in the pituitary gland. The pituitary gland produces a hormone called thyroid-stimulating hormone or TSH. Low levels of TSH can lead to secondary hypothyroidism.
- Congenital. About 1 baby in every 3,000–4,000 is born with a defective thyroid gland or no gland at all.
- Too little iodine in the diet. This cause of hypothyroidism is most common in developing countries; it is rare in North America and Europe.

Symptoms

Not every patient with an underactive thyroid has the same symptoms or has them with the same severity. Common symptoms of hypothyroidism, however, include the following:

- Increased sensitivity to cold weather.
- Dry, itchy skin and a pale or yellowish complexion.
- Dry brittle hair that falls out easily and nails that break or split.
- Constipation.
- Goiter (swelling in the front of the neck caused by thyroid enlargement).
- Hoarse voice and puffy facial skin.
- Unexplained weight gain of 10–20 pounds, most of which is fluid.
- Sore and aching muscles, most commonly in the shoulders and hips.
- In women, extra-long menstrual periods or unusually heavy bleeding.
- Weak leg muscles.
- Decreased sweating.
- Arthritis.
- Memory loss or difficulty concentrating.
- Slowed heart rate (less than 60 beats per minute) and lowered blood pressure.
- Depression.

Diagnosis

Adults

Hypothyroidism in adults can be difficult to diagnose because many of its early symptoms are not unique to it. In addition, the symptoms typically come on gradually; the person may simply feel tired or less energetic than usual, or develop dry, itchy skin and brittle hair that falls out easily. Hypothyroidism is sometimes referred to as a "silent" disease precisely because the early symptoms may be so mild that no one realizes anything is wrong. The classic symptoms of hypothyroidism—sensitivity to cold, puffy complexion, decreased sweating, and coarse skin—may occur in only 60 percent of patients. In addition, the patient's loss of energy and low mood may be misdiagnosed as a psychiatric disorder, most commonly major depression. It may take months to years before the person or their doctor begins to suspect a problem with the thyroid gland.

It's important to see a doctor if any of these symptoms appear unexpectedly. People whose hypothyroidism remains undiagnosed and untreated may eventually develop myxedema. Symptoms of this rare but potentially deadly complication include enlarged tongue, swollen facial features, hoarseness, and physical and mental sluggishness.

Myxedema **coma** can cause unresponsiveness; irregular, shallow breathing; and a drop in blood pressure and body temperature. The onset of this medical emergency can be sudden in people who are elderly or have been ill, injured, or exposed to very cold temperatures; have recently had surgery; or use

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KEY TERMS

Congenital—Present at birth.

Cretinism—A form of hypothyroidism found in some newborns.

Endocrine system—A system of small organs located throughout the body that regulate metabolism, growth and puberty, tissue function, and mood. The thyroid gland is part of the endocrine system.

Endocrinologist—A doctor who specializes in diagnosing and treating disorders of the endocrine glands and the hormones they secrete.

Goiter—A swelling in the neck caused by an enlarged thyroid gland.

Hashimoto's disease—An autoimmune disorder that is the most common cause of primary hypothyroidism. It was the first disease to be recognized as an autoimmune disorder. It is named for a Japanese doctor, Hakaru Hashimoto, who first described it in 1912.

Hormone—A chemical released by specialized cells that affects cells in other parts of the body. Hormones regulate such body processes as growth, metabolism, the immune system, reproduction, hunger, and mood.

Hyperthyroidism—A disease condition in which the thyroid gland produces too much thyroid hormone.

Hypothyroidism—A disease condition in which the thyroid gland does not produce enough thyroid hormone.

Metabolism—The chemical changes in living cells in which new materials are taken in and energy is provided for vital processes,

Myxedema—A synonym for hypothyroidism. Myxedema coma is a condition in which a person with untreated hypothyroidism loses consciousness. It is potentially fatal.

Thyroid-stimulating hormone (TSH)—A hormone produced by the pituitary gland that stimulates the thyroid gland to produce the hormones that regulate metabolism. Also called thyrotropin.

Thyroiditis—Inflammation of the thyroid gland. It can be caused by a viral infection, a malfunction of the immune system, or certain medications.

Thyroxine (T_4)—The thyroid hormone that regulates many essential body processes.

Triiodothyronine (T_3)—A thyroid hormone similar to thyroxine but more powerful. Preparations of triiodothyronine are used in treating hypothyroidism.

sedatives or antidepressants. Without immediate medical attention, myxedema coma can be fatal.

Children

In the United States, newborn infants between 24 and 72 hours old are tested for congenital thyroid deficiency (cretinism) using a test that measures the levels of thyroxine in the infant's blood. If the levels are low, the physician will likely repeat the blood test to confirm the diagnosis. The physician may take an x ray of the infant's legs. In an infant with hypothyroidism, the ends of the bones have an immature appearance. Treatment within the first few months of life can prevent **mental retardation** and physical abnormalities.

Older children who develop hypothyroidism may suddenly stop growing. If the child was above average height before the disease occurred, he or she may now be short compared to other children of the same age. Therefore, the most important feature of hypothyroidism in a child is a decrease in the rate of growth in height. If the disease is recognized early and adequately treated, the child will grow at an accelerated rate until reaching the same growth percentile where the child measured before the onset of hypothyroidism. Diagnosis of hypothyroidism in school-age children is based on the patient's observations, medical history, **physical examination**, and **thyroid function tests**.

Examination

The doctor may notice such signs of hypothyroidism during an office examination as dry skin, facial puffiness, a **goiter** in the neck, thin or brittle hair, poor muscle tone, pale complexion, and a slower than normal heart rate. As previously mentioned, however, it is possible for a person with hypothyroidism not to have these symptoms.

Tests

The diagnosis of hypothyroidism is usually made by tests of the patient's thyroid function following a careful history of the patient's symptoms. The first test is a blood test for thyroid-stimulating hormone, or TSH. TSH is a hormone produced by the pituitary gland in the brain that stimulates the thyroid gland to produce thyroid

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hormone. When the thyroid gland is not producing enough hormone, the pituitary gland secretes more TSH; thus a high level of TSH in the blood indicates that the thyroid gland is not as active as it should be.

The TSH test, however, does not always detect borderline cases of hypothyroidism. The doctor may order additional tests to measure the levels of thyroid hormone as well as TSH in the patient's blood. If the doctor thinks that the patient may have Hashimoto's disease, he or she may test for the presence of abnormal antibodies in the blood. Because Hashimoto's disease is an autoimmune disorder, there will be two or three types of anti-thyroid antibodies in the patient's blood in about 90 percent of cases

A woman being tested for hypothyroidism should let her doctor know if she is pregnant or **breastfeeding** and all patients should be sure their doctors are aware of any recent procedures involving radioactive materials or contrast media.

Procedures

In some cases, the doctor may also order an ultrasound study of the patient's neck in order to evaluate the size of the thyroid gland or take a small sample of thyroid tissue in order to make sure that the gland is not cancerous. The usual procedure for obtaining the tissue sample is a fine-needle aspiration biopsy or FNAB. To perform a FNAB, the doctor inserts a thin needle into the thyroid to extract a sample of cells for examination under a microscope. The doctor usually uses an ultrasound monitor to guide the needle. A FNAB can be performed in an outpatient clinic or a doctor's office; it is safer and less invasive than an open surgical biopsy.

Treatment

Traditional

Medications are the treatment of choice for hypothyroidism.

Drugs

Treatment for hypothyroidism consists of a daily dose of a synthetic form of thyroid hormone sold under the trade names of Synthroid, Levothroid, or Levoxyl. The patient is told that the drug must be taken as directed for the rest of his or her life.

In the early weeks of treatment, the patient will need to see the doctor every four to six weeks to have their TSH level checked and the dose of medication adjusted. After the doctor is satisfied with the dosage level and the patient's overall health, checkups are done every six to 12 months. The reason for this careful measurement of the medication is that too much of the synthetic hormone increases the risk of **osteoporosis** in later life or abnormal heart rhythms in the present. **Aging**, other medications, and changes in weight and general health can also affect how much replacement hormone a patient needs, and regular TSH tests are used to monitor hormone levels. Patients should not switch from one brand of thyroid hormone to another without a doctor's permission.

Medications and over-the-counter preparations that can affect the body's absorption of synthetic thyroid hormone include cholestyramine (Questran), **antacids** that contain aluminum hydroxide, **calcium** supplements, and iron supplements. A high intake of soy products or a diet high in fiber can also affect the body's absorption of the hormone, and the patient's doctor may need to adjust the dosage.

Congenital hypothyroidism or cretinism is also treated with synthetic thyroid hormone. It Most hospitals now screen newborns for thyroid problems, because untreated cretinism can lead to lifelong physical and mental developmental disorders.

Regular **exercise** and a high-fiber diet can help maintain thyroid function and prevent **constipation**.

Alternative

Alternative treatments are primarily aimed at strengthening the thyroid and will not eliminate the need for thyroid hormone medications. Herbal remedies to improve thyroid function and relieve symptoms of hypothyroidism include bladder wrack (*Fucus vesiculosus*), which can be taken in capsule form or as a tea. Some foods, including cabbage, peaches, radishes, soybeans, peanuts, and spinach, can interfere with the production of **thyroid hormones**. Anyone with hypothyroidism may want to avoid these foods.

The Shoulder Stand **yoga** position (at least once daily for 20 minutes) is believed to improve thyroid function.

One alternative treatment for hypothyroidism that should *not* be used is coconut oil. There is no evidence that coconut oil stimulates the thyroid gland, and a few studies suggest that it may actually lower thyroid function.

Prognosis

The prognosis for patients with hypothyroidism is very good, provided they take their medication as

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directed. They can usually live a normal life with a normal life expectancy. Children with cretinism have a good prognosis if the disorder is caught and treated early; some develop **learning disorders**, however, in spite of early treatment.

The chief risks to health are related to lack of treatment for hypothyroidism. If low levels of thyroid hormone are not diagnosed and treated, patients are at increased risk of goiter, an enlarged heart, and severe depression. In addition, women with untreated hypothyroidism have a higher risk of giving birth to babies with **cleft palate** and other **birth defects**.

One rare but potentially life-threatening complication of long-term untreated hypothyroidism is myxedema coma. In this condition, which is usually triggered by **stress** or illness, the person becomes extremely sensitive to cold, may be unusually drowsy, or lose consciousness. Heart rate, blood pressure, and breathing may all be abnormally low. Myxedema coma requires emergency treatment in a hospital with intravenous thyroid hormone and intensive care nursing.

Prevention

There were no proven ways to prevent hypothyroidism as of 2009 because the disorder has so many possible causes.

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American Association of Clinical Endocrinologists (AACE), 245 Riverside Ave., Suite 200, Jacksonville, FL, 32202, 904-353-7878, http://www.aace.com/.

American Thyroid Association (ATA), 6066 Leesburg Pike, Suite 550, Falls Church, VA, 22041, 703-998-8890, 703-998-8893, thyroid@thyroid.org, http://www.thyroid.org/.

Hormone Foundation, 8401 Connecticut Avenue, Suite 900, Chevy Chase, MD, 20815, 800–HORMONE, 301-941-0259, hormone@endo-society.org, http://www.hormone. org/.

National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), Building 31. Rm 9A06, 31 Center Drive, MSC 2560, Bethesda, MD, 20892-2560, 301-496-3583, http://www2.niddk.nih.gov/Footer/Contact NIDDK.htm, http://www2.niddk.nih.gov/.

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Hypotonic duodenography

Definition

Hypotonic duodenography is an x ray procedure that produces images of the duodenum. The duodenum is the first part of the small intestine.

Purpose

Hypotonic duodenography may be ordered to detect tumors of the head of the pancreas or the area where the pancreatic and bile ducts meet the small intestine. Lesions causing upper abdominal **pain** may be demonstrated by duodenography, and the procedure can aid in the diagnosis of chronic **pancreatitis**.

Precautions

Some patients with narrowing of the tubes in the upper gastrointestinal tract should not receive duodenography. Patients with certain heart disorders and glaucoma are cautioned against receiving an agent called anticholinergic, which is administered during the procedure to lessen intestinal **muscle spasms**. A hormone called glucagon may also be used to relax the intestines, but its use is not recommended in patients with most forms of diabetes.

Description

Hypotonic duodenography is also referred to as x ray of the duodenum or simply as duodenography. The patient is seated while the radiologist places a catheter in the nose and down into the stomach. Then the patient lies down and the tube is continued to the duodenum. The radiologist is guided in this placement by a fluoroscopic image. (Fluoroscopic equipment shows an immediate x ray. In this case, the x ray shows the location of the catheter as it is moved into the stomach and duodenum.) Next, either the glucagon is administered intravenously or anticholinergic is injected into the patient to relax the muscles of the intestine.

After several minutes, the physician will administer barium through the catheter. Barium is a contrast agent that will help highlight the area on the fluoroscopy screen and x rays. After a few films are taken, some of the barium is withdrawn and air is sent in through the catheter. Additional images are acquired and the catheter is then removed. The procedure takes from 30–60 minutes.

Preparation

Patients are required to fast from midnight before the test until after the test, or about 6–12 hours. Just prior to the exam, patients should remove dentures, glasses, and other objects that may interfere with the procedure. The patient may be instructed to empty his or her bladder just prior to duodenography.

Aftercare

The barium should be expelled within two to three days. Extra fluids and/or an agent given by the physician to help encourage bowel movement may aid in barium elimination. Physicians and patients should watch for possible reactions to the anticholinergic or glucagon. If an anticholinergic is used, patients are advised to empty their bladder within a few hours after the exam and to wait two hours for clearing of vision or have someone drive them home. Patients will notice that their stools are chalky white from the barium for one to three days following the procedure.

Risks

Abdominal cramping may occur when the physician instills air into the duodenum, but aside from the discomfort, there are few risks associated with this procedure. Side effects from the contrast, hormones or agents may occur. Those patients with diabetes, heart disease, or glaucoma run the highest risk of reaction and should not receive anticholinergic or glucagon, depending on their specific conditions. Elderly patients or those who are extremely ill, must be closely monitored during the procedure for possible return of fluid, or gastric reflux.

Normal results

The linings of the duodenum and surrounding tissues will look smooth and even. The shape of the head of the pancreas will appear normal and near the duodenal wall.

Abnormal results

Any masses or irregular nodules on the wall of the duodenum may indicate tumors or abnormality of tissue. Tumors of the head of the pancreas or of the opening into the intestine from the pancreatic and bile ducts may be seen. Chronic pancreatitis may be indicated on the x rays. In many instances, follow-up laboratory or imaging studies may be ordered to further study the abnormal findings and confirm a diagnosis.

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ORGANIZATIONS

American College of Radiology, 1891 Preston White Drive, Reston, VA, 20191, (703) 648-8900, (800) 227-5463, info@acr.org, www.acr.org.

National Cancer Institute (National Institutes of Health), NCI Office of Communications and Education, 6116 Executive Blvd. Suite 300, Bethesda, MD, 20892-8322, (800) 4-CANCER (422-6237), cancergovstaff@mail.nih.gov, http://www.cancer.gov/.

Teresa Odle

Hypovolemic shock *see* **Shock**

Hysterectomy

Definition

Hysterectomy is the surgical removal of all or part of the uterus. In a total hysterectomy, the uterus and cervix are removed. In some cases, the fallopian tubes and ovaries are removed along with the uterus, which is a hysterectomy with bilateral **salpingo-oophorectomy**. In a subtotal hysterectomy, only the uterus is removed. In a radical hysterectomy, the uterus, cervix, ovaries, oviducts, lymph nodes, and lymph channels are removed. The type of hysterectomy performed depends on the reason for the procedure. In all cases, menstruation permanently stops and a woman loses the ability to bear children.

Purpose

The most frequent reason for hysterectomy in American women is to remove fibroid tumors, accounting for 30% of these surgeries. Fibroid tumors are noncancerous (benign) growths in the uterus that can cause pelvic, **low back pain**, and heavy or lengthy menstrual periods. They occur in 30–40% of women over age 40 and are three times more likely to be present in African-American women than in Caucasian women. Fibroids do not need to be removed unless they are causing symptoms that interfere with a woman's normal activities.

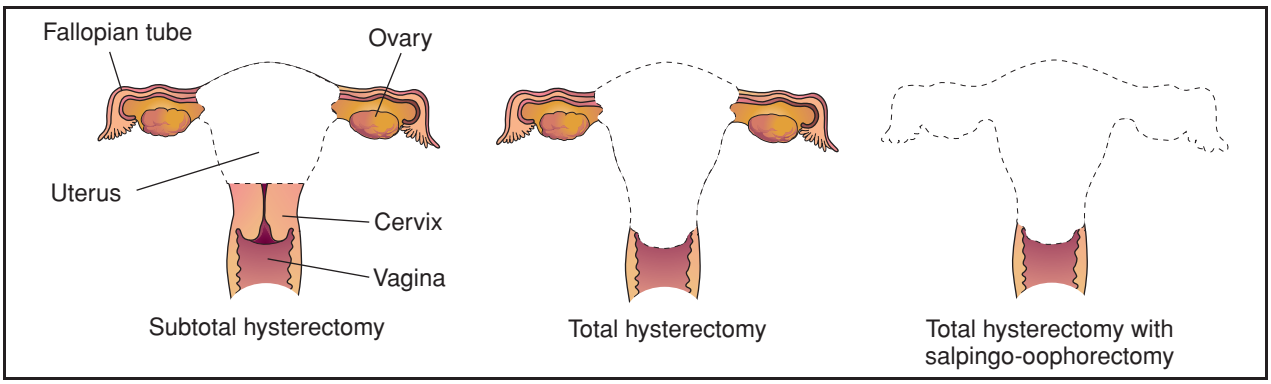
Treatment of **endometriosis** is the reason for 20% of hysterectomies. The endometrium is the lining of the uterus. Endometriosis occurs when the cells from the endometrium begin growing outside the uterus. The outlying endometrial cells respond to the hormones that control the menstrual cycle, bleeding each month the way the lining of the uterus does. This causes irritation of the surrounding tissue, leading to **pain** and scarring.

Twenty percent of hysterectomies are done because of heavy or abnormal vaginal bleeding that cannot be linked to any specific cause and cannot be controlled by other means. Another 20% are performed to treat prolapsed uterus, **pelvic inflammatory disease**, or endometrial hyperplasia, a potentially precancerous condition.

About 10% of hysterectomies are performed to treat **cancer** of the cervix, ovaries, or uterus. Women with cancer in one or more of these organs almost always have the organ(s) removed as part of their cancer treatment.

Demographics

Hysterectomy is the second most common operation performed on women in the United States. About 556,000 of these surgeries are done annually. By age 60, approximately one out of every three American women will have had a hysterectomy. It is estimated that 30% of hysterectomies are unnecessary.



Three types of hysterectomies: subtotal, total, and total with salpingo-oophorectomy. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

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KEY TERMS

Cervix—The lower part of the uterus extending into the vagina.

Fallopian tubes—Slender tubes that carry eggs (ova) from the ovaries to the uterus.

Lymph nodes—Small, compact structures lying along the channels that carry lymph, a yellowish fluid. Lymph nodes produce white blood cells (lymphocytes), which are important in forming antibodies that fight disease.

Pap smear—The common term for the Papanicolaou test, a simple smear method of examining stained cells to detect cancer of the cervix.

Prolapsed uterus—A uterus that has slipped out of place, sometimes protruding down through the vagina.

The frequency with which hysterectomies are performed in the United States has been questioned in recent years. It has been suggested that a large number of hysterectomies are performed unnecessarily. The United States has the highest rate of hysterectomies of any country in the world. Also, the frequency of this surgery varies across different regions of the United States. Rates are highest in the South and Midwest and are higher for African-American women. In the early twenty-first century, although the number of hysterectomies performed has declined, the number of hysterectomies performed on younger women in their 30s and 40s is increasing, and 55% of all hysterectomies are performed on women ages 35–49.

Description

A hysterectomy is classified according to what structures are removed during the procedure and what method is used to remove them.

Total hysterectomy

A total hysterectomy, sometimes called a simple hysterectomy, removes the entire uterus and the cervix. The ovaries are not removed and continue to secrete hormones. Total hysterectomies are usually performed in the case of uterine and **cervical cancer**. This is the most common kind of hysterectomy.

In addition to a total hysterectomy, a procedure called a bilateral salpingo-oophorectomy is sometimes performed. This surgery removes the ovaries and the fallopian tubes. Removal of the ovaries eliminates the main source of the hormone estrogen, so **menopause** occurs immediately. Removal of the ovaries and fallopian tubes is performed in about one-third of hysterectomy operations, often to reduce the risk of **ovarian cancer**.

Subtotal hysterectomy

If the reason for the hysterectomy is to remove **uterine fibroids**, treat abnormal bleeding, or relieve pelvic pain, it may be possible to remove only the uterus and leave the cervix. This procedure is called a subtotal hysterectomy (or partial hysterectomy), and removes the least amount of tissue. The opening to the cervix is left in place. Some women believe that leaving the cervix intact aids in their achieving sexual satisfaction. This procedure, which used to be rare, is now performed more frequently.

Subtotal hysterectomy is easier to perform than a total hysterectomy, but leaves a woman at risk for cervical cancer. She will still need to get yearly Pap smears.

Radical hysterectomy

Radical hysterectomies are performed on women with cervical cancer or **endometrial cancer** that has spread to the cervix. A radical hysterectomy removes the uterus, cervix, above part of the vagina, ovaries, fallopian tubes, lymph nodes, lymph channels, and tissue in the pelvic cavity that surrounds the cervix. This type of hysterectomy removes the most tissue and requires the longest hospital stay and a longer recovery period.

Methods of hysterectomy

There are two ways that hysterectomies can be performed. The choice of method depends on the type of hysterectomy, the doctor's experience, and the reason for the hysterectomy.

ABDOMINAL HYSTERECTOMY. About 75% of hysterectomies performed in the United States are abdominal hysterectomies. The surgeon makes a 4–6-in (10–15-cm) incision either horizontally across the pubic hair line from hip bone to hip bone or vertically from navel to pubic bone. Horizontal incisions leave a less noticeable scar, but vertical incisions give the surgeon a better view of the abdominal cavity. The blood vessels, fallopian tubes, and ligaments are cut away from the uterus, which is lifted out.

Abdominal hysterectomies take from one to three hours. The hospital stay is three to five days, and it takes four to eight weeks to return to normal activities.

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The advantages of an abdominal hysterectomy are that the uterus can be removed even if a woman has internal scarring (**adhesions**) from previous surgery or her fibroids are large. The surgeon has a good view of the abdominal cavity and more room to work. Also, surgeons tend to have the most experience with this type of hysterectomy. The abdominal incision is more painful than with vaginal hysterectomy, and the recovery period is longer.

VAGINAL HYSTERECTOMY. With a vaginal hysterectomy, the surgeon makes an incision near the top of the vagina. The surgeon then reaches through this incision to cut and tie off the ligaments, blood vessels, and fallopian tubes. Once the uterus is cut free, it is removed through the vagina. The operation takes one to two hours. The hospital stay is usually one to three days, and the return to normal activities takes about four weeks.

The advantages of this procedure are that it leaves no visible scar and is less painful. The disadvantage is that it is more difficult for the surgeon to see the uterus and surrounding tissue. This makes complications more common. Large fibroids cannot be removed using this technique. It is very difficult to remove the ovaries during a vaginal hysterectomy, so this approach may not be possible if the ovaries are involved.

Vaginal hysterectomy can also be performed using a laparoscopic technique. With this surgery, a tube containing a tiny camera is inserted through an incision in the navel. This allows the surgeon to see the uterus on a video monitor. The surgeon then inserts two slender instruments through small incisions in the abdomen and uses them to cut and tie off the blood vessels, fallopian tubes, and ligaments. When the uterus is detached, it is removed though a small incision at the top of the vagina.

This technique, called laparoscopic-assisted vaginal hysterectomy, allows surgeons to perform a vaginal hysterectomy that might otherwise be too difficult. The hospital stay is usually only one day. Recovery time is about two weeks. The disadvantage is that this operation is relatively new and requires great skill by the surgeon.

Any vaginal hysterectomy may have to be converted to an abdominal hysterectomy during surgery if complications develop.

Diagnosis/Preparation

Before surgery the doctor will order blood and urine tests. The woman may also meet with the anesthesiologist to evaluate any special conditions that might affect the administration of anesthesia. On the evening before the operation, the woman should eat a light dinner and then have nothing to eat or drink after midnight.

Aftercare

After surgery, a woman will feel some degree of discomfort; this is generally greatest in abdominal hysterectomies because of the incision. Hospital stays vary from about two days (laparoscopic-assisted vaginal hysterectomy) to five or six days (abdominal hysterectomy with bilateral salpingo-oophorectomy). During the hospital stay, the doctor will probably order more blood tests.

Return to normal activities such as driving and working takes anywhere from two to eight weeks, again depending on the type of surgery. Some women have emotional changes following a hysterectomy. Women who have had their ovaries removed will probably start **hormone replacement therapy**.

Risks

Hysterectomy is a relatively safe operation, although like all major surgery it carries risks. These include unanticipated reaction to anesthesia, internal bleeding, **blood clots**, damage to other organs such as the bladder, and post-surgery infection.

Other complications sometimes reported after a hysterectomy include changes in sex drive, weight gain, **constipation**, and pelvic pain. Hot flashes and other symptoms of menopause can occur if the ovaries are removed. Women who have both ovaries removed and who do not take estrogen replacement therapy run an increased risk for heart disease and **osteoporosis** (a condition that causes bones to be brittle). Women with a history of psychological and emotional problems before the hysterectomy are likely to experience psychological difficulties after the operation.

As in all major surgery, the health of the patient affects the risk of the operation. Women who have chronic heart or lung diseases, diabetes, or iron-deficiency anemia may not be good candidates for this operation. Heavy **smoking**, **obesity**, use of steroid drugs, and use of illicit drugs add to the surgical risk.

Normal results

Although there is some concern that hysterectomies may be performed unnecessarily, there are many conditions for which the operation improves a woman's quality of life. In the Maine Woman's Health Study, 71% of women who had hysterectomies to correct moderate or severe painful symptoms reported feeling better mentally, physically, and sexually after the operation.

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Morbidity and mortality rates

The rate of complications differs by the type of hysterectomy performed. Abdominal hysterectomy is associated with a higher rate of complications (9.3%), while the overall complication rate for vaginal hysterectomy is 5.3%, and 3.6% for laparoscopic vaginal hysterectomy. The risk of **death** from hysterectomy is about one in every 1,000 women. The rates of some of the more commonly reported complications are:

- excessive bleeding (hemorrhaging): 1.8–3.4%
- fever or infection: 0.8–4.0%
- accidental injury to another organ or structure: 1.5–1.8%

Alternatives

Women for whom a hysterectomy is recommended should discuss possible alternatives with their doctor and consider getting a second opinion, since this is major surgery with life-changing implications. Whether an alternative is appropriate for any individual woman is a decision she and her doctor should make together. Some alternative procedures to hysterectomy include:

- Embolization. During uterine artery embolization, interventional radiologists put a catheter into the artery that leads to the uterus and inject polyvinyl alcohol particles right where the artery leads to the blood vessels that nourish the fibroids. By killing off those blood vessels, the fibroids have no more blood supply, and they die off. Severe cramping and pain after the procedure is common, but serious complications are less than 5% and the procedure may protect fertility.
- Myomectomy. A myomectomy is a surgery used to remove fibroids, thus avoiding a hysterectomy. Hysteroscopic myomectomy, in which a surgical hysteroscope (telescope) is inserted into the uterus through the vagina, can be done on an outpatient basis. If there are large fibroids, however, an abdominal incision is required. Patients typically are hospitalized for two to three days after the procedure and require up to six weeks recovery. Laparoscopic myomectomies are also being done more often. They only require three small incisions in the abdomen and have much shorter hospitalization and recovery times. Once the fibroids have been removed, the surgeon must repair the wall of the uterus to eliminate future bleeding or infection.
- Endometrial ablation. In this surgical procedure, recommended for women with small fibroids, the entire lining of the uterus is removed. After undergoing endometrial ablation, patients are no longer fertile. The uterine cavity is filled with fluid and a hysteroscope is inserted to provide a clear view of the uterus. Then, the lining of the uterus is destroyed using a laser beam or electric voltage. The procedure is typically done under anesthesia, although women can go home the same day as the surgery. Another newer procedure involves using a balloon, which is filled with superheated liquid and inflated until it fills the uterus. The liquid kills the lining, and after eight minutes the balloon is removed.
- Endometrial resection. The uterine lining is destroyed during this procedure using an electrosurgical wire loop (similar to endometrial ablation).

Resources

BOOKS

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Townsend, Courtney M., et al. *Sabiston Textbook of Surgery*. 18th ed. Philadelphia: Saunders, 2007.

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"Hysterectomy." Medline Plus, February 19, 2009. http://www.nlm.nih.gov/medlineplus/ency/article/002915.htm

"Hysterectomy (abdominal): Discharge." Medline Plus, February 18, 2009. http://www.nlm.nih.gov/medlineplus/ency/patientinstructions/000275.htm

ORGANIZATIONS

American Cancer Society, 1599 Clifton Road NE, Atlanta, GA, 30329-4251, (800) 227-2345, http://www.cancer.org.

American College of Obstetricians and Gynecologists, 409 Twelfth Street SW, P.O. Box 96920, Washington, DC, 20090-6920, (202) 638-5577, http://www.acog.org.

National Cancer Institute, Building 31, Room 10A31, 31 Center Drive, MSC 2580, Bethesda, MD, 20892-2580, (800) 422-6237, http://www.nci.nih.gov.

Debra Gordon
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Hysteria

Definition

The term "hysteria" has been in use for more than 2,000 years, and its definition has become broader and more diffuse over time. In modern psychology and psychiatry, hysteria is a feature of hysterical disorders in which a patient experiences physical symptoms that have a psychological, rather than an organic, cause. It

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JEAN MARTIN CHARCOT (1825–1893)

(The Library of Congress.)

Jean Martin Charcot was born to a carriage maker on November 29, 1825, in Paris, France. Charcot attended the University of Paris, earning his medical degree in 1853. In 1860, he accepted a position at the university as a professor of pathological anatomy until 1862, when he was named senior physician at the Salpêtrière, a hospital for the treatment of mental illness.

Charcot's research and work on psychoneuroses and hysterical disorders untimately helped to dispell the belief that hysteria was a disorder found only in women. Charcot also explored the possibility that physiological abnormalities of the nervous system played a part when behavioral problems were exhibited. He became known for his ability to diagnose and locate these abnormalities of the central nervous system. Finally, Charcot's most notable contribution to the field of psychiatry was his successful use of hypnotism in the diagnosis and treatment of hysteria. He found that, while hypnotized, the patient recalled details, which were not readily available to the individual in a conscious state. In addition, Charcot found that the therapist could more easily influence the hypnotized patient during therapy. In 1882, Charcot presented his research findings to the French Academy of Sciences with favorable results.

Charcot was a prolific writer and a talented artist. Between 1888 and 1894, his complete works were compiled into nine volumes. His most noted work *Lectures on the Diseases of the Nervous System* was published in 1877. Charcot died on August 16, 1893.

is defined as an histrionic personality disorder characterized by excessive emotions, dramatics, and attention–seeking behavior.

Description

Hysterical disorders

Patients with hysterical disorders, such as conversion and somatization disorder experience physical symptoms that have no organic cause. Conversion disorder affects motor and sensory functions, while somatization affects the gastrointestinal, nervous, cardiopulmonary, or reproductive systems. These patients are not "faking" their ailments, as the symptoms are very real to them. Disorders with hysteric features typically begin in adolescence or early adulthood.

Histrionic personality disorder

Histrionic personality disorder has a prevalence of approximately 2-3 percent in the general population. It begins in early adulthood and has been diagnosed more frequently in women than in men. Histrionic personalities are typically self–centered and attention seeking. They operate on emotion, rather than fact or logic, and their conversation is full of generalizations and dramatic appeals. While the patient's enthusiasm, flirtatious behavior, and trusting nature may make them appear charming, their need for immediate gratification, mercurial displays of emotion, and constant demand for attention often alienates them from others.

Causes and symptoms

Hysterical disorders

Hysteria may be a defense mechanism to avoid painful emotions by unconsciously transferring this distress to the body. There may be a symbolic function for this behavior. For example a **rape** victim may develop paralyzed legs. Symptoms may mimic a number of physical and neurological disorders which must be ruled out before a diagnosis of hysteria is made.

Histrionic personality disorder

According to the *Diagnostic and Statistical Manual of Mental Disorders,* Fourth Edition (*DSM–IV*),

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KEY TERMS

Psychiatrist—A medical doctor who has completed specialized training in the diagnosis and treatment of mental illness. Psychiatrists can diagnose mental illnesses, provide mental health counseling, and prescribe medications.

Psychologist—A mental health professional who treats mental and behavioral disorders by support and insight to encourage healthy behavior patterns and personality growth. Psychologists also study the brain, behavior, emotions, and learning.

Psychotherapy—The treatment of mental and behavioral disorders by support and insight to encourage healthy behavior patterns and personality growth.

individuals with histrionic personality possess at least five of the following symptoms or personality features:

- a need to be the center of attention
- inappropriate, sexually seductive, or provocative behavior while interacting with others
- rapidly changing emotions and superficial expression of emotions
- vague and impressionistic speech (gives opinions without any supporting details)
- easily influenced by others
- believes relationships are more intimate than they are

Diagnosis

Hysterical disorders frequently prove to be actual medical or neurological disorders, which makes it important to rule these disorders out before diagnosing a patient with hysterical disorders. In addition to a patient interview, several clinical inventories may be used to assess the patient for hysterical tendencies, such as the Minnesota Multiphasic Personality Inventory–2 (MMPI–2) or the Millon Clinical Multiaxial Inventory–III (MCMI–III). These tests may be administered in an outpatient or hospital setting by a psychiatrist or psychologist.

Treatment

Hysterical disorders

For people with hysterical disorders, a supportive healthcare environment is critical. Regular appointments with a physician who acknowledges the patient's physical discomfort are important. **Psychotherapy** may be attempted to help the patient gain insight into the cause of their distress. Use of behavioral therapy can help to avoid reinforcing symptoms.

Histrionic personality disorder

Psychotherapy is generally the treatment of choice for histrionic personality disorder. It focuses on supporting the patient and on helping develop the skills needed to create meaningful relationships with others.

Prognosis

Hysterical disorders

The outcome for hysterical disorders varies by type. Somatization is typically a lifelong disorder, while conversion disorder may last for months or years. Symptoms of hysterical disorders may suddenly disappear, only to reappear in another form later.

Histrionic personality disorder

Individuals with histrionic personality disorder may be at a higher risk for suicidal gestures, attempts, or threats in an effort to gain attention. Providing a supportive environment for patients with both hysterical disorders and histrionic personality disorder is key to helping these patients.

Resources

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Shams, K. *Human Relation and Personified Relational Disorders*. Raleigh, NC: lulu.com, 2009.

ORGANIZATIONS

American Academy of Child and AdolescentPsychiatry, 3615 Wisconsin Ave., NW, Washington, DC, 20016–3007, (202) 966–7300, http://www.aacap.org .

American Psychiatric Association, 1000 Wilson Blvd., Suite 1825, Arlington, VA, 22209, (703) 907–7300, apa@psych.org, http://www.psych.org/.

National Alliance on Mental Illness (NAMI), 3803 N. Fairfax Dr., Suite 100, Arlington, VA, 22201, (703) 524–7600, (800) 950–NAMI (6264), (703) 524–9094, http://www.nami.org/Hometemplate.cfm.

National Institute of Mental Health (NIMH), 6001 Executive Blvd., Room 8184, MSC 9663, Bethesda, MD, 20892, (301) 443–4513, (866) 615–6464, (301) 443–4279, nimhinfo@nih.gov, http://www.nimh.nih.gov/index.shtml.

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National Mental Health Association (NMHA), 2000 N. Beauregard St., 6th floor, Alexandria, VA, 22311, (703) 684–7722, (800) 969–NMHA, (703) 684–5968, http://www1.nmha.org/.

Paula Anne Martin–Ford
Laura Jean Cataldo, RN, Ed.D.

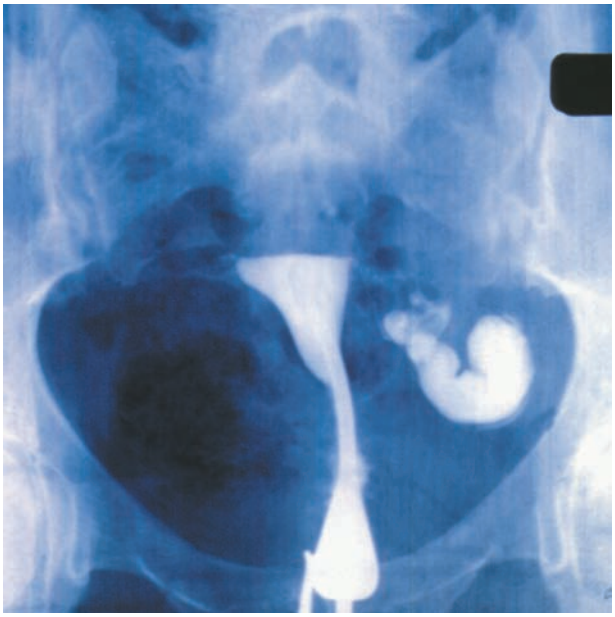
Hysterosalpingography

Definition

Hysterosalpingography is a procedure where x rays are taken of a woman's reproductive tract after a dye is injected. *Hystero* means uterus and *salpingo* means tubes, so hysterosalpingography literally means to take pictures of the uterus and fallopian tubes. This procedure may also be called hysterography (or HSG).

Purpose

Hysterosalpingography is used to determine if the fallopian tubes are open, or if there are any apparent abnormalities or defects in the uterus. It can be used to detect tumors, scar tissue, or tears in the lining of the uterus. This procedure is often used to help diagnose **infertility** in women. The fallopian tubes are the location where an egg from the ovary joins with sperm to produce a fertilized ovum. If the fallopian tubes are blocked or deformed, the egg may not be able to descend or the sperm may be blocked from moving up to meet the egg. Up to 30% of all cases of infertility are due to damaged or blocked fallopian tubes.



A hysterosalpingogram of the abdomen of a woman whose fallopian tubes are blocked. The fallopian tube (right on image) is blocked near the uterus, the triangular shape at center. The other fallopian tube is obstructed at a point further from the uterus where dilatation has occurred. *(Photo Researchers, Inc.)*

Precautions

This procedure should not be done on women who suspect they might be pregnant or who may have a pelvic infection. Women who have had an allergic reaction to dye used in previous x-ray procedures should inform their doctor.

Description

As with other types of pelvic examinations, the woman will lie on her back on an examination table with her legs sometimes raised in stirrups. The x ray equipment is placed above the abdomen.

A speculum is inserted into the vagina and a catheter (a thin tube) is inserted into the uterus through the cervix (the opening to the uterus). A small balloon in the catheter is inflated to hold it in place. A liquid water-based or oil-based dye is then injected through the catheter into the uterus. This process can cause cramping, **pain**, and uterine spasms.

As the dye spreads through the reproductive tract, the doctor may watch for blockages or abnormalities on an x ray monitor. Several x rays will also be taken. The procedure takes approximately 15–30 minutes. The x rays will be developed while the patient waits, but the final reading and interpretation of the x rays by a radiologist (a doctor who specializes in x rays) may not be available for a few days.

Interestingly, sometimes the hysterosalpingography procedure itself can be considered a treatment. The dye used can sometimes open up small blockages in the fallopian tubes. The need for additional test procedures or surgical treatments to deal with infertility should be discussed with the doctor.

Preparation

This procedure is generally done in the x-ray department of a hospital or large clinic. **General anesthesia** is not needed. A pain reliever may be taken prior to the procedure to lessen the severity of cramping.

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Aftercare

While no special aftercare is required after a hysterosalpingography, the woman may be observed for some period after the procedure to ensure that she does not have any allergic reactions to the dye. A sanitary napkin may be worn after the procedure to absorb dye that will flow out through the vaginal opening. If a blockage is seen in a tube, the patient may be given an antibiotic. A woman should notify her doctor if she experiences excessive bleeding, extensive pelvic pain, **fever**, or an unpleasant vaginal odor after the procedure. These symptoms may indicate a pelvic infection. Counseling may be necessary to interpret the results of the x rays, and to discuss any additional procedures to treat tubal blockages or uterine abnormalities found.

Risks

Cramps during the procedure are common. Complications associated with hysterosalpingography include abdominal pain, pelvic infection, and allergic reactions. It is also possible that abnormalities of the fallopian tubes and uterus will not be detected by this procedure.

Normal results

A normal hysterosalpingography will show a healthy, normally shaped uterus and unblocked fallopian tubes.

Abnormal results

Blockage of one or both of the fallopian tubes or abnormalities of the uterus may be detected.

ORGANIZATIONS

American Society for Reproductive Medicine, 1209 Montgomery Highway, Birmingham, AL, 35216-2809, (205) 978-5000, (205) 978-5005, asrm@asrm.org, http://www.asrm.org.

Altha Roberts Edgren

Hysteroscopy

Definition

Hysteroscopy is a procedure that allows a physician to look through the vagina and neck of the uterus (cervix) to inspect the cavity of the uterus. A telescope-like instrument called a hysteroscope is used. Hysteroscopy is used as both a diagnostic and a treatment tool.

Purpose

Diagnostic hysteroscopy may be used to evaluate the cause of **infertility**, to determine the cause of repeated miscarriages, or to help locate polyps and fibroids.

The procedure is also used to treat gynecological conditions, often instead of or in addition to **dilatation and curettage** (D&C). A D&C is a procedure for scraping the lining of the uterus. A D&C can be used to take a sample of the lining of the uterus for analysis. Hysteroscopy is an advance over D&C because the doctor can take tissue samples of specific areas or actually see fibroids, polyps, or structural abnormalities.

When used for treatment, the hysteroscope is used with other devices to remove polyps, fibroids, or IUDs that have become embedded in the wall of the uterus.

Precautions

The procedure is not performed on women with **cervical cancer**, **endometrial cancer**, or acute pelvic inflammation.

Description

Diagnostic hysteroscopy is performed in either a doctor's office or hospital. Before inserting the hysteroscope, the doctor injects a local anesthetic around the cervix. Once it has taken effect, the doctor dilates the cervix and then inserts a narrow lighted tube (the hysteroscope) through the cervix to reveal the inside of the uterus. Ordinarily, the walls of the uterus are touching each other. In order to get a better view, the uterus is inflated with carbon dioxide gas or fluid. Hysteroscopy takes about 30 minutes, and can cost anywhere from $750 to $4,000 depending on the extent of the procedure.

Treatment involving the use of hysteroscopy is usually performed as a day surgical procedure with regional or **general anesthesia**. Tiny surgical instruments are inserted through the hysteroscope, and are used to remove polyps or fibroids. A small sample of tissue lining the uterus is often removed for examination, especially if there is any abnormal bleeding.

Preparation

If the procedure is done in the doctor's office, the patient will be given a mild **pain** reliever before the procedure to ease cramping. The doctor will wash the vagina and cervix with an antiseptic solution.

If the procedure is done in the hospital under general anesthesia, the patient should not eat or drink

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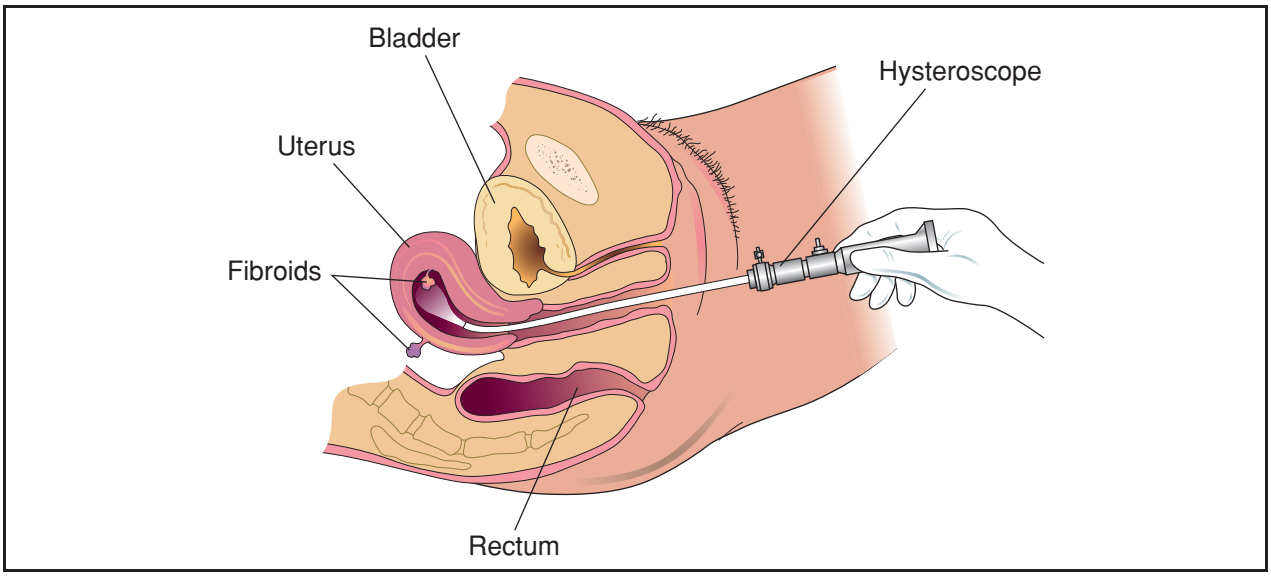

Hysteroscopy is a procedure that allows inspection of the uterus by using a telescope-like instrument called a hysteroscope.
(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)

anything (even water) after midnight the night before the procedure.

Aftercare

Many women experience light bleeding for several days after surgical hysteroscopy. Mild cramping or pain is common after operative hysteroscopy, but usually fades away within eight hours. If carbon dioxide gas was used, there may also be some shoulder pain. Nonprescription pain relievers may help ease discomfort. Women may want to take the day off and relax after having hysteroscopy.

Risks

Diagnostic hysteroscopy is a fairly safe procedure that only rarely causes complications. The primary risk is prolonged bleeding or infection, usually following surgical hysteroscopy to remove a growth.

Very rare complications include perforation of the uterus, bowel, or bladder. Surgery under general anesthesia causes the additional risks typically associated with anesthesia.

Patients should alert their health care provider if they develop any of these symptoms:

- abnormal discharge
- heavy bleeding
- fever over 101°F (38.3°C)
- severe lower abdominal pain

Normal results

A uterus with no fibroids or other growths would be considered normal and healthy.

Abnormal results

Using hysteroscopy, the doctor may find **uterine fibroids** or polyps (often the cause of abnormal bleeding) or a septum (extra fold of tissue down the center of the uterus) that can cause infertility. Sometimes, precancerous or malignant growths are discovered.

Resources

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Anon. "Looking Inside the Uterus." *Harvard Women's Health Watch* 4, no. 5 (January 1997): 4-5.

Carol A. Turkington

Hysterosonography

Definition

Hysterosonography, which is also called sonohysterography, is a new noninvasive technique that involves the slow infusion of sterile saline solution into a woman's uterus during ultrasound imaging. Hysterosonography allows the doctor to evaluate abnormal growths inside the uterus; abnormalities of the tissue lining the uterus

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(the endometrium); or disorders affecting deeper tissue layers. Hysterosonography does not require either radiation or contrast media, or invasive surgical procedures

Purpose

Hysterosonography is used to evaluate patients in the following groups:

- peri- or postmenopausal women with unexplained vaginal bleeding
- women whose endometrium appears abnormal during baseline ultrasound imaging
- women with fertility problems. Infertility is sometimes related to polyps, leiomyomas (fibroids), or adhesions inside the uterus. Adhesions are areas of tissue that have grown together to form bands or membranes across the inside of the uterus.
- women receiving tamoxifen therapy for breast cancer

Hysterosonography is useful as a screening test to minimize the use of more invasive diagnostic procedures, such as tissue biopsies and dilatation and curettage (D&C). Hysterosonography can also be used as a follow-up after uterine surgery to evaluate its success.

Precautions

Hysterosonography is difficult to perform in patients with certain abnormalities, including:

- Cervical stenosis. Cervical stenosis means that the lower end of the uterus is narrowed or tightened. It complicates the insertion of a tube (catheter).
- Adhesions or large fibroids. These growths sometimes block the flow of saline fluid into the uterus.

Patients with active **pelvic inflammatory disease** (PID) should not be tested with hysterosonography until the disease is brought under control. Women with chronic PID or heart problems are given **antibiotics** before the procedure.

Description

A hysterosonography is preceded by a baseline ultrasound examination performed through the vagina. This allows the doctor to detect an unsuspected **pregnancy** and to assess the thickness and possible abnormalities of the patient's endometrium. The doctor then inserts a catheter into the uterus and injects sterile saline fluid while ultrasound imaging is recorded on film or videotape. The procedure takes about 10 to 15 minutes.

Preparation

Patients do not require special preparation apart from the timing of the procedure. Patients with fertility problems are examined during the first 10 days of the menstrual cycle. Patients who may have polyps are usually examined at a later phase in the cycle. The best time for examining women with fibroids is still under discussion.

Aftercare

Aftercare consists of advising the patient to contact her doctor in case of abnormal bleeding, **fever**, or abdominal **pain**. Some spotting or cramping is common, however, and can usually be treated with **nonsteroidal anti-inflammatory drugs**, such as ibuprofen.

Risks

The chief risks are mild spotting and cramping after the procedure.

Normal results

Normal findings include a symmetrical uterus with a normal endometrium and no visible masses or tumors.

Abnormal results

Abnormal findings include **adhesions**; polyps; leiomyomas; abnormal thickening of the endometrium; or tissue changes related to tamoxifen (Nolvadex), which is a drug given for **breast cancer**.

Resources

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Rebecca J. Frey, PhD

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I

IBS *see* **Irritable bowel syndrome**

Ibuprophen *see* **Nonsteroidal anti-inflammatory drugs**

Ichthyosis

Definition

Derived from two Greek words meaning "fish" and "disease," ichthyosis is a congenital (meaning present at birth) dermatological (skin) disease that is represented by thick, scaly skin.

Description

The ichthyoses are a group of skin diseases caused by an abnormality in skin growth that results in drying and scaling. There are at least 20 types of ichthyosis. Ichthyosis can be more or less severe, sometimes accumulating thick scales and cracks that are painful and bloody. Ichthyosis is not contagious. Some forms of ichthyosis are inherited while others are acquired in later life as a symptom of systemic disorders.

The most common form of ichthyosis, accounting for 95% of all cases of ichthyosis, is called ichthyosis vulgaris (*vulgaris* is the Latin word for "common"), and occurs in approximately one person in every 250. It is inherited in an autosomal dominant manner. The most rare types of ichthyosis occur in fewer than one person in one million and are inherited in an autosomal recessive manner. Ichthyosis occurs regardless of the part of the world the child is from, or the ethnic background of the parents.

Acquired ichthyosis is extremely rare; neither its incidence in the United States nor its incidence in the rest of the world are known.

Both inherited and acquired ichthyoses affect males and females equally.

Causes and symptoms

Inherited ichthyoses

Depending on the specific type of ichthyosis, the inheritance can be autosomal recessive, autosomal dominant, X-linked recessive, X-linked dominant, or sporadic. Autosomal recessive means that the altered gene for the disease or trait is located on one of the first 22 pairs of chromosomes, which are also called "autosomes." Males and females are equally likely to have an autosomal recessive disease or trait. Recessive means that two copies of the altered gene are necessary to express the condition. Therefore, a child inherits one copy of the altered gene from each parent, who are called carriers (because they have only one copy of the altered gene). Since carriers do not express the altered gene, parents usually do not know they carry the altered gene that causes ichthyosis until they have an affected child. Carrier parents have a 1-in-4 chance (or 25%) with each **pregnancy**, to have a child with ichthyosis.

Autosomal dominant inheritance also means that both males and females are equally likely to have the disease but only one copy of the altered gene is necessary to have the condition. An individual with ichthyosis has a 50/50 chance to pass the condition to his or her child.

The skin is made up of several layers, supported underneath by a layer of fat that is thicker or thinner depending on location. The lower layers contain blood vessels, the middle layers contain actively growing cells, and the upper layer consists of dead cells that serve as a barrier to the outside world. This barrier is nearly waterproof and highly resistant to infection. Scattered throughout the middle layers are hair follicles, oil and sweat glands, and nerve endings. The upper layer is constantly flaking off and being

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replaced from beneath by new tissue. In ichthyosis, the skin's natural shedding process is slowed or inhibited; and in some types, skin cells are produced too rapidly.

The abnormality in skin growth and hydration called ichthyosis may present with symptoms at birth or in early childhood. Ichthyosis can itch relentlessly, leading to such complications of scratching as lichen simplex (**dermatitis** characterized by raw patches of skin). Either the cracking or the scratching can introduce infection, bringing with it discomfort and complications.

Acquired ichthyoses

The mildest form of acquired ichthyosis is called xeroderma, or dry flaky skin. It is not associated with any systemic diseases. Xeroderma occurs most often on the lower legs of middle-aged and elderly adults during cold weather, or on the lower legs of people who bathe too often. It is characterized chiefly by mild or moderate **itching**.

Ichthyosis may also be an early symptom of such disorders as **AIDS**, lymphoma, **hypothyroidism**, or **leprosy**. In these cases the ichthyosis is most noticeable on the patient's trunk and legs.

A few rare cases of acquired ichthyosis have been attributed to the use of certain drugs, specifically cimetidine (Tagamet), triparanol (Metasqualene), dixyrazine (a phenothiazine derivative used as an antipsychotic), nicotinic acid (vitamin B_3, butyrophenone antipsychotics (Haldol, Inapsine, Orap), and clofazimine (Lamprene).

Diagnosis

A dermatologist will often make the diagnosis of ichthyosis based on findings from a clinical examination. However, a **skin biopsy**, or DNA study (from a small blood sample) is necessary to confirm the diagnosis. Evaluation for associated problems is done by a complete physical medical examination.

For some types of ichythyosis, the abnormal gene has been identified and prenatal testing is available. At present this is true for the autosomal recessive congenital ichythoses, which include: lamellar ichthyosis (LI), autosomal recessive lamellar ichthyosis (ARLI), congenital ichthyosiform erythroderma (CIE), and nonbullous congenital ichthyosiform erythroderma (NBCIE).

There are four different genes that have been located for the autosomal recessive congenital ichthyoses. Testing, however, is available for only one gene, known as transglutaminase-1 (TGM1). This gene is located on chromosome 14. Once a couple has had a child with ichthyosis, and they have had the genetic cause identified by DNA studies (performed from a small blood sample), prenatal testing for future pregnancies may be considered. (Note that prenatal testing may not be possible if both mutations cannot be identified.) Prenatal diagnosis is available via either **chorionic villus sampling** (CVS) or **amniocentesis**. CVS is a biopsy of the placenta performed in the first trimester of pregnancy under ultrasound guidance. Ultrasound is the use of sound waves to visualize the developing fetus. The genetic makeup of the placenta is identical to the fetus and therefore the TGM1 gene can be studied from this tissue. There is approximately a one in 100 chance for **miscarriage** with CVS. Amniocentesis is a procedure done under ultrasound guidance in which a long thin needle is inserted through the mother's abdomen into the uterus, to withdraw a couple of tablespoons of amniotic fluid (fluid surrounding the developing baby) to study. The TGM1 gene can be studied using cells from the amniotic fluid. Other genetic tests, such as a chromosome analysis, may also be performed through either CVS or amniocentesis.

Acquired ichthyosis is usually diagnosed in the course of identifying the underlying disorder. With the exception of acquired ichthyosis related to lymphoma, a doctor cannot tell the difference between inherited and acquired ichthyosis by examining skin samples through a microscope.

Treatment

Most treatments for ichthyosis are topical, which means that they are applied directly to the skin, not taken internally. Xeroderma is eaily treated by minimizing bathing and applying an emollient cream or mineral oil after bathing while the skin is still moist. Some forms of ichthyosis require two forms of treatment—a reduction in the amount of scale buildup and moisturizing of the underlying skin. Several agents are available for each purpose. Reduction in the amount of scale is achieved by keratolytics. Among this class of drugs are urea, lactic acid, and salicylic acid. Petrolatum, 60% propylene glycol, and glycerin are successful moisturizing agents, as are many commercially available products. Increased humidity of the ambient air is also helpful in preventing skin dryness.

Because the skin acts as a barrier to the outside environment, medicines have a hard time penetrating, especially through the thick skin of the palms of the hands and the soles of the feet. This resistance is diminished greatly by maceration (softening the skin). Soaking hands in water macerates skin so that

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KEY TERMS

Amniocentesis—A procedure performed at 16–18 weeks of pregnancy in which a needle is inserted through a woman's abdomen into her uterus to draw out a small sample of the amniotic fluid from around the baby. Either the fluid itself or cells from the fluid can be used for a variety of tests to obtain information about genetic disorders and other medical conditions in the fetus.

Amniotic fluid—The fluid that surrounds a developing baby during pregnancy.

Autosomal dominant—A pattern of genetic inheritance where only one abnormal gene is needed to display the trait or disease.

Autosomal recessive inheritance—A pattern of genetic inheritance where two abnormal genes are needed to display the trait or disease.

Dermatologist—A physician who specializes in diagnosing and treating disorders of the skin.

Emollients—Petroleum or lanolin-based skin lubricants.

Keratin—A tough, nonwater-soluble protein found in the nails, hair, and the outermost layer of skin. Human hair is made up largely of keratin.

Keratinocytes—Skin cells.

Keratolytic—An agent that dissolves or breaks down the outer layer of skin (keratins).

Retinoids—A derivative of synthetic Vitamin A.

Sporadic—Isolated or appearing occasionally with no apparent pattern.

X-linked dominant inheritance—The inheritance of a trait by the presence of a single gene on the X chromosome in a male or female, passed from an affected female who has the gene on one of her X chromosomes.

X-linked recessive inheritance—The inheritance of a trait by the presence of a single gene on the X chromosome in a male, passed from a female who has the gene on one of her X chromosomes, and who is referred to as an unaffected carrier.

it looks like prune skin. Occlusion (covering) with rubber gloves or plastic wrap will also macerate skin. Applying medicines and then covering the skin with an occlusive dressing will facilitate entrance of the medicine and greatly magnify its effect.

Secondary treatments are necessary to control pruritus (itching) and infection. Commercial products containing camphor, menthol, eucalyptus oil, aloe, and similar substances are very effective as antipruritics. If the skin cracks deeply enough, a pathway for infection is created. **Topical antibiotics** like bacitracin are effective in prevention and in the early stages of these skin infections. Cleansing with hydrogen peroxide inhibits infection as well.

Finally, there are topical and internal derivatives of vitamin A called retinoids that improve skin growth and are used for severe cases of **acne**, ichthyosis, and other skin conditions. Tazarotene (Tazorac), a retinoid that was originally developed to treat **psoriasis** and acne, appears to give good results in treating ichthyosis with fewer side effects than other retinoids.

Prognosis

This condition requires continuous care throughout a lifetime. Properly treated, in most cases it is a cosmetic problem. There are a small number of lethal forms, such as harlequin fetus.

Resources

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OTHER

Immune Deficiency Foundation Website. www.primaryimmune.org.

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ORGANIZATIONS

Foundation for Ichthyosis and Related Skin Types (FIRST), 2616 North Broad Street, Colmar, PA, 18915, 215 997-9400, 215 997-9403, 800 545-3286, info@firstskinfoundation. org, http://www.firstskinfoundation.org/.

Genetic Alliance, Inc., 4301 Connecticut Ave., NW, Suite 404, Washington, DC, 20008-2369, 202 966-5557, 202 966-8553, info@geneticalliance.org, http://www.geneticalliance.org.

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923, (800) 999-6673, http://www.rarediseases.org.

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Icterus *see* **Jaundice**

Idiopathic hypertrophic subaortic stenosis *see* **Hypertrophic cardiomyopathy**

Idiopathic infiltrative lung diseases

Definition

The term *idiopathic* means "cause unknown." The idiopathic infiltrative lung diseases, also known as interstitial lung diseases, are a group of more than a hundred disorders seen in both adults and (less often) in children, whose cause is unknown but which tend to spread, or "infiltrate" through much or all of the lung tissue. They range from mild conditions that respond well to treatment, to progressive, nonresponsive disease states that severely limit lung function and may cause **death**.

Description

The body produces inflammatory cells in response to a variety of conditions, including a number of different diseases, pollutants, certain infections, exposure to organic dust or toxic fumes and vapors, and various drugs and poisons. When white blood cells and tissue fluid rich in protein collect in the small air sacs of the lungs, or alveoli, the sacs become inflamed (alveolitis). In time, the fluid may solidify and cause scar formation that replaces the normal lung tissue. This process is known as **pulmonary fibrosis**. In about half of all patients, no specific cause is ever found; they are said to have idiopathic pulmonary fibrosis.

Some patients have special types of interstitial lung disease that may occur in certain types of patients, or feature typical pathological changes when a sample of lung tissue is examined under a microscope. They include:

- Usual interstitial pneumonitis. Disease occurs in a patchy form throughout the lungs. Parts of the lungs can appear normal while others have dense scar tissue and lung cysts, often the end result of pulmonary fibrosis. This disease progresses quite slowly. Both children and adults may be affected.
- Desquamative interstitial pneumonitis. Similar-appearing lesions are present throughout the lungs. Both inflammatory cells and cells that have separated from the air sac linings ("desquamated") are present. Some researchers believe this is an early form of usual interstitial pneumonitis.
- Lymphocytic interstitial pneumonitis. Most of the cells infiltrating the lungs are the type of white blood cells called lymphocytes. Both the breathing tubes (bronchi) and blood vessels of the lungs become thickened. In children, this condition tends to occur when the immune system is not operating properly as occurs with Acquired Immune Deficiency Syndrome (AIDS).

Causes and symptoms

By definition, the causes of *idiopathic* infiltrative lung diseases are not known. Some forms of pulmonary fibrosis, however, do have specific causes and these may provide a clue as to what may cause idiopathic diseases. Known causes of pulmonary fibrosis include diseases that impair the body's immune function; infection by viruses and the bacterium causing **tuberculosis**; and exposure to such mineral dusts as silica or asbestos, or such organic materials as bird droppings. Other cases of pulmonary fibrosis result from exposure to fumes and vapors, radiation (in industry or medically), and certain drugs used to treat disease.

Patients with interstitial lung disease usually have labored breathing when exerting themselves. Often they **cough** and feel overly tired ("no stamina"). **Wheezing** is uncommon. When the physician listens to the patient's chest with a stethoscope, dry, crackling sounds may be heard. Some patients have vague chest **pain**. When disease progresses, the patient may breathe very rapidly, have mottled blue skin (because of getting too little oxygen), and lose weight. The fingertips may appear thick or club-shaped.

Diagnosis

Both **scars** in the lung and cysts (air-filled spaces) can be seen on a **chest x ray**. Up to 10% of patients, however, may have normal x rays even if their symptoms

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KEY TERMS

Bronchoalveolar lavage—A way of obtaining a sample of fluid from the airways by inserting a flexible tube through the windpipe. Used to diagnose the type of lung disease.

Desquamation—Shedding of the cells lining the insides of the air sacs. A feature of desquamative interstitial pneumonitis.

Idiopathic—A disease whose cause is unknown.

Immune system—A set of body chemicals and specialized cells that attack an invading agent (such as a virus) by forming antibodies that can engulf and destroy it.

Infiltrative—A process whereby inflammatory or other types of disease spread throughout an organ such as the lungs.

Interstitial—Refers to the connective tissue that supports the "working parts" of an organ, in the case of the lungs the air sacs.

Pulmonary fibrosis—A scarring process that is the end result of many forms of long-lasting lung disease.

are severe. A special type of x ray, high-resolution computed tomography scan (CT scan), often is helpful in adult patients. Tests of lung function will show that the lungs cannot hold enough air with each breath, and there is too little oxygen in the blood, especially after exercising. In a procedure called bronchoalveolar lavage, a tube is placed through the nose and windpipe into the bronchi and a small amount of saline is released and then withdrawn. This fluid can then be analyzed for cells. A tiny piece of lung tissue can be sampled using the same instrument. If necessary, a larger sample (a biopsy) is taken through an incision in the chest wall and examined under a microscope.

Treatment

The first medication given, providing scarring is not too extensive, is usually a steroid drug such as prednisone. An occasional patient will improve dramatically if steroid therapy stops the inflammation. Most patients, however, improve to a limited extent. It may take 6–12 weeks for a patient to begin to respond. Patients must be watched closely for a gain in body weight, high blood pressure, and depression. **Steroids** can also result in diabetes, ulcer disease, and cataract. Patients treated with steroids are at risk of contracting serious infection. If steroids have not proved effective or have caused serious side effects, other anti-inflammatory drugs, such as cyclophosphamide (Cytoxan) or azathioprine (Imuran), can be tried. Cytoxan sometimes is combined with a steroid, but it carries its own risks, which include bladder inflammation and suppression of the bone marrow. Some patients will benefit from a bronchodilator drug that relaxes the airway and makes breathing easier.

Some patients with interstitial lung disease, especially children, will need **oxygen therapy**. Usually oxygen is given during sleep or **exercise**, but if the blood oxygen level is very low it may be given constantly. A program of conditioning, training in how to breathe efficiently, energy-saving tips, and a proper diet will help patients achieve the highest possible level of function given the state of their illness. All patients should be vaccinated each year against **influenza**. A last resort for those with very advanced disease who do not respond to medication is **lung transplantation**. This operation is being done more widely, and it is even possible to replace both lungs.

Prognosis

A scoring system based on lung function and x ray appearances has been designed to help monitor a patient's course. In general, idiopathic forms of interstitial lung disease cause a good deal of illness, and a significant number of deaths. A majority of patients get worse over time, although survival for many years is certainly possible. An estimated one in five affected children fail to survive. In different series, survival times average between four and ten years. Early diagnosis gives the best chance of a patient recovering or at least stabilizing. Once the lungs are badly scarred, nothing short of lung transplantation offers hope of restoring lung function. Patients with desquamative interstitial pneumonitis tend to respond well to steroid treatment, and live longer than those with other types of infiltrative lung disease.

Prevention

Since we do not understand what causes idiopathic interstitial lung diseases, there is no way to prevent them. What can be done is to prevent extensive scarring of the lungs by making the diagnosis shortly after the first symptoms develop, and trying steroids or other drugs in hope of suppressing lung inflammation. Every effort should be made to avoid

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exposure to dusts, gases, chemicals, and even pets. Keeping fit and learning how to breathe efficiently will help maintain lung function as long as possible.

ORGANIZATIONS

American Lung Association, 1301 Pennsylvania Ave. NW, Suite 800, Washington, DC, 20001, 202 758-3355, 202 452-1805, 800 548-8252, info@lungusa.org, http://www.lungusa.org/.

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Idiopathic primary renal hematuric/proteinuric syndrome

Definition

This syndrome includes a group of disorders characterized by blood and protein in the urine and by damage to the kidney glomeruli (filtering structures) that may lead to kidney failure.

Description

This syndrome, also known as Berger's disease or IgA nephropathy, arises when internal kidney structures called glomeruli become inflamed and injured. It can occur at any age, but the great majority of patients are 16–35 when diagnosed. Males seem to be affected more often than females, and whites are more often affected than blacks. Blood in the urine (hematuria), either indicated by a visible change in the color of the urine or detected by laboratory testing, is a hallmark of this syndrome, and it may occur continuously or sporadically. The pattern of occurrence is not indicative of the severity of kidney damage.

Causes and symptoms

The glomeruli are the kidney structures that filter the blood and extract waste, which is then excreted as urine. The barrier between the blood and the urine side of the filter mechanism is a membrane only one cell layer thick. Anything that damages the membrane will result in hematuria. Symptoms of idiopathic primary renal hematruic/proteinuric syndrome are caused by inflammation of the glomeruli and deposit of IgA antibodies in kidney tissue. Although a genetic basis for this syndrome is suspected, this has not been proven. Symptoms often appear 24–48 hours after an upper respiratory or gastrointestinal infection. Symptoms of the syndrome include:

- blood in the urine (hematuria)
- protein in the urine (proteinuria)
- pain in the lower back or kidney area
- elevated blood pressure (20–30% of cases)
- nephrotic syndrome (less than 10% of cases)
- swelling (occasionally)

This condition usually does not get worse with time, although renal failure occasionally results. In patients with large amounts of IgA deposits in their glomeruli, the long-term prognosis may not be favorable. The syndrome can go into remission spontaneously, although this is more common in children than in adults.

Diagnosis

One of the objectives of diagnosis is to distinguish glomerular from non-glomerular kidney diseases. Idiopathic primary hematuric/proteinuric syndrome involves the glomeruli. The presence of fragmented or distorted red blood cells in the urine is evidence of glomerular disease. A high concentration of protein in the urine is also evidence for glomerular disease. The hematuria associated with this syndrome must be distinguished from that caused by urinary tract diseases, which can also cause a loss of blood into the urine. Biopsy of the patient's kidney shows deposits of IgA antibodies. Detecting IgA-antibody deposits rules out thin membrane disease as the cause of the hematuria and proteinuria. Test values are normal for ASO, complement, rheumatoid factor, antinuclear antibodies, anti-DNase, and cryoglobulins, all of which are associated with different types of **kidney disease**. A diagnosis of idiopathic primary renal hematuric/proteinuric syndrome is largely made by ruling out other diseases and their causes, leaving this syndrome as the remaining possible diagnosis.

Treatment

Many patients do not need specific treatment, except for those who have symptoms indicating a poor prognosis. Oral doses of **corticosteroids** are effective in patients with mild proteinuria and good kidney function. Other treatments, such as medications to lower blood pressure, are aimed at slowing or preventing kidney damage. If kidney failure develops, dialysis or **kidney transplantation** is necessary.

Prognosis

Idiopathic primary renal hematuric/proteinuric syndrome progresses slowly and in many cases does not progress at all. Risk for progression of the disorder is considered higher if there is:

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KEY TERMS

Glomeruli (singular, glomerulus)—Filtering structures in the kidneys.

Hematuria—The presence of hemoglobin or red blood cells in the urine.

Idiopathic—Refers to a disease that arises from an obscure or unknown cause.

Nephrotic syndrome—A kidney disorder characterized by fluid retention (edema) and proteinuria. It is caused by damage to the kidney glomeruli.

Proteinuria—The presence of protein in the urine exceeding normal levels.

- high blood pressure
- large amounts of protein in the urine
- increased levels of urea and creatinine in the blood (indications of kidney function)

About 25–35% of patients may develop kidney failure within about 25 years.

Prevention

Since the underlying causes of this syndrome are so poorly understood, there is no known prevention.

Resources

BOOKS

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ORGANIZATIONS

IgA Nephropathy Support Network, 89 Ashfield Road, Shelburne Falls, MA, 01370, 413 625-9339,.

National Kidney Foundation, Inc. , 30 East 33rd Street, New York, NY, 10016, 212 889-2210, 212 689-9261, 800 622-9010, http://www.kidney.org/.

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Idiopathic thrombocytopenic purpura

Definition

Idiopathic thrombocytopenic purpura, or ITP, is a bleeding disorder caused by an abnormally low level of platelets in the patient's blood. Platelets are small plate-shaped bodies in the blood that combine to form a plug when a blood vessel is injured. The platelet plug then binds certain proteins in the blood to form a clot that stops bleeding. ITP's name describes its cause and two symptoms. Idiopathic means that the disorder has no apparent cause. ITP is now often called immune thrombocytopenic purpura rather than idiopathic because of recent findings that ITP patients have autoimmune antibodies in their blood. **Thrombocytopenia** is another word for a decreased number of blood platelets. Purpura refers to a purplish or reddish-brown skin rash caused by the leakage of blood from broken capillaries into the skin. Other names for ITP include purpura hemorrhagica and essential thrombocytopenia.

Demographics

ITP may be either acute or chronic. The acute form is most common in children between the ages of one and six years; the chronic form is most common in adult females between 30 and 40. ITP is uncommon in adults older than age 60. Between 10% and 20% of children with ITP have the chronic form. ITP does not appear to be related to race, lifestyle, climate, or environmental factors.

In the United States, annual incidence of ITP is difficult to determine because it is thought that most cases of ITP are so mild that medical attention is not needed. Estimates are that ITP affects 5 in every 100,000 children and 2 in every 100,000 adults in the U.S. every year.

Description

ITP is a disorder that affects the overall *number* of blood platelets rather than their function. The normal platelet level in adults is between 150,000 and 450,000/mm^3. Platelet counts below 50,000 mm^3 increase the risk of dangerous bleeding from trauma; counts below 20,000/mm^3 increase the risk of spontaneous bleeding.

Causes and Symptoms

In adults, ITP is considered an autoimmune disorder, which means that the body produces antibodies that damage some of its own products–in this case, blood platelets. Some adults with chronic ITP also have other immune system disorders, such as **systemic lupus erythematosus** (SLE) or acute or chronic leukemia. ITP is usually triggered by a viral infection such as infection with **rubella**, **chickenpox**, **measles**, cytomegalovirus, **Epstein-Barr virus**, or hepatitis virus

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KEY TERMS

Autoimmune disorder—A disorder in which the patient's immune system produces antibodies that destroy some of the body's own products. ITP in adults is thought to be an autoimmune disorder.

Idiopathic—Of unknown cause. Idiopathic refers to a disease that is not preceded or caused by any known dysfunction or disorder in the body.

Petechiae—Small pinpoint hemorrhages in skin or mucous membranes caused by the rupture of capillaries.

Platelet—A blood component that helps to prevent blood from leaking from broken blood vessels. ITP is a bleeding disorder caused by an abnormally low level of platelets in the blood.

Prednisone—A corticosteroid medication that is used to treat ITP. Prednisone works by decreasing the effects of antibody on blood platelets. Long-term treatment with prednisone is thought to decrease antibody production.

Purpura—A skin discoloration of purplish or brownish red spots caused by bleeding from broken capillaries.

Splenectomy—Surgical removal of the spleen.

Thrombocytopenia—An abnormal decline in the number of platelets in the blood.

(A, B, C). It usually begins about two or three weeks after the infection. ITP may also occur as a result of infection with the human **immunodeficiency** virus (HIV). However, most commonly, ITP follows a viral upper respiratory infection or **gastroenteritis**.

Some medications are also linked to the development of ITP. These medications include:

- quinidine or quinine medications
- heparin
- antibiotics such as cephalosporin drugs and rifampicin
- analgesics
- diuretics
- antihypertensives

ITP is also associated with acute and chronic alcohol ingestion and is also seen in individuals with chronic **liver disease**.

In children, most cases of ITP are acute while in adults, most cases are chronic.

Acute ITP

Acute ITP is characterized by bleeding into the skin or from the nose, mouth, digestive tract, or urinary tract. The onset is usually sudden. Bleeding into the skin takes the form of purpura or petechiae. Purpura is a purplish or reddish-brown rash or discoloration of the skin; petechiae are small round pinpoint hemorrhages. Both are caused by the leakage of blood from tiny capillaries under the skin surface. In addition to purpura and petechiae, the patient may notice that he or she **bruises** more easily than usual. In extreme cases, patients with ITP may bleed into the lungs, brain, or other vital organs.

Chronic ITP

Chronic ITP has a gradual onset and may have minimal or no external symptoms. The low **platelet count** may be discovered in the course of a routine blood test. Most patients with chronic ITP, however, will consult their primary care doctor because of the purpuric skin rash, nosebleeds, or bleeding from the digestive or urinary tract. Women sometimes go to their gynecologist for unusually heavy or lengthy menstrual periods.

Diagnosis

ITP is usually considered a diagnosis of exclusion, which means that the doctor arrives at the diagnosis by a process of ruling out other possible causes. If the patient belongs to one or more of the risk groups for chronic ITP, the doctor may order a blood test for autoantibodies in the blood early in the diagnostic process.

Physical examination

If the doctor suspects ITP, he or she will examine the patient's skin for bruises, purpuric areas, or petechiae. If the patient has had nosebleeds or bleeding from the mouth or other parts of the body, the doctor will examine these areas for other possible causes of bleeding. Patients with ITP usually look and feel healthy except for the bleeding.

The most important features that the doctor will be looking for during the **physical examination** are the condition of the patient's spleen and the presence of **fever**. Patients with ITP do not have fever, whereas patients with lupus and some other types of thrombocytopenia are usually feverish. The doctor will have the patient lie flat on the examining table in order to feel the

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size of the spleen. If the spleen is noticeably enlarged, ITP is usually excluded as the diagnosis.

Laboratory testing

The doctor will order a **complete blood count** (CBC), a test of clotting time, a bone marrow test, and a test for antiplatelet antibodies if it is available in the hospital laboratory. Patients with ITP usually have platelet counts below 20,000/mm^3 and prolonged **bleeding time**. The size and appearance of the platelets may be abnormal. The red blood cell count (RBC) and **white blood cell count** (WBC) are usually normal, although about 10% of patients with ITP are also anemic. The blood marrow test yields normal results. Detection of antiplatelet antibodies in the blood is considered to confirm the diagnosis of ITP.

In most children, examination of the bone marrow is not required to diagnose acute ITP.

Treatment

General care and monitoring

There is no specific treatment for ITP. In most cases, the disorder will resolve without medications or surgery within two to six weeks. Nosebleeds can be treated with ice packs when necessary.

General care includes explaining ITP to the patient and advising him or her to watch for bruising, petechiae, or other signs of recurrence. Children should be discouraged from rough contact sports or other activities that increase the risk of trauma. Patients are also advised to avoid using **aspirin** or ibuprofen (Advil, Motrin) as **pain** relievers because these drugs lengthen the clotting time of blood.

Treatment with **corticosteroids** such as oral prednisone or IV methylprednisone are the initial drugs of choice for the treatment of ITP.

Emergency treatment

Patients with acute ITP who are losing large amounts of blood or bleeding into their central nervous system require emergency treatment. This includes transfusions of platelets, intravenous immunoglobulins, or treatment with corticosteroids such as methylprednisone. Prednisone is a steroid medication that decreases the effects of antibody on platelets and eventually lowers antibody production. If the patient has a history of ITP that has not responded to prednisone or immunoglobulins, the surgeon may remove the patient's spleen. This operation is called a **splenectomy**. The reason for removing the spleen when ITP does not respond to other forms of treatment is that the spleen sometimes keeps platelets out of the general blood circulation.

Medications and transfusions

Patients with chronic ITP can be treated with prednisone, immune globulin, or large doses of intravenous **gamma globulin**. Although 90% of patients respond to immunoglobulin treatment, it is very expensive. About 80% of patients respond to prednisone therapy. Platelet transfusions are not recommended for routine treatment of ITP. If the patient's platelet level does not improve within one to four months, or requires high doses of prednisone, the doctor may recommend splenectomy. All medications for ITP are given either orally or intravenously; intramuscular injection is avoided because of the possibility of causing bleeding into the skin.

Newer medications which may be used in the treatment of ITP include the monoclonal antibody rituximab (Rituxan) which can be combined with the corticosteroid dexamethasone to treat chronic ITP and thrombopoietin-receptor agonists romiplostim (Nplate) and eltrombopag (Promacta) which work by directly stimulating the bone marrow to increase platelet production.

Surgery

Between 80% and 85% of adults with ITP have a remission of the disorder after the spleen is removed. Splenectomy is usually avoided in children younger than five years because of the increased risk of a severe infection after the operation. In older children, however, splenectomy is recommended if the child has been treated for 12 months without improvement; if the ITP is very severe or the patient is getting worse; if the patient begins to bleed into the head or brain; and if the patient is an adolescent female with extremely heavy periods. Relapse of ITP is more common after splenectomy in patients with chronic ITP as compared to those with acute ITP.

Prognosis

The prognosis for recovery from acute ITP is good; 80% of patients recover without special treatment. The prognosis for chronic ITP is also good; most patients experience long-term remissions. In rare instances, however, ITP can cause life-threatening hemorrhage or bleeding into the central nervous system.

Prevention

In most individuals, ITP occurs as a manifestation of another disease or as a consequence of a viral infection. Therefore, at this time ITP cannot be entirely prevented.

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IHSS *see* **Hypertrophic cardiomyopathy**

Ileal conduit *see* **Urinary diversion surgery**

Ileocol *see* **Crohn's disease**

Ileostomy *see* **Enterostomy**

Ileus

Definition

Ileus is a partial or complete non–mechanical blockage of the small and/or large intestine. When this blockage occurs the bowel becomes full of gases and fluids. Consequently, patients often report mild abdominal **pain** and bloating. They may also experience poor appetite, **nausea**, and, sometimes, **vomiting**. The term "ileus" comes from the Latin word for **colic**. Ileus is sometimes also called bowel obstruction, intestinal volvulus, colonic ileus, and other such terms.

Demographics

The blockage of the intestines from the condition called ileus can occur at any age. In infants and children, it is the major cause of bowel obstruction. In adults, abdominal surgery can often bring about ileus. It occurs throughout the human population, regardless of one's ethnic background or other factors.

Description

There are two types of **intestinal obstructions** (when the bowel does not work correctly), mechanical and non–mechanical. Mechanical obstructions occur because the bowel is physically (structurally) blocked and its contents cannot pass the point of the obstruction. This happens when the bowel twists on itself (volvulus) or as the result of hernias, impacted feces, abnormal tissue growth, or the presence of foreign bodies in the intestines.

Unlike mechanical obstruction, non–mechanical obstruction, called ileus or paralytic ileus, occurs when there is not a structural problem within the bowel but, instead, because peristalsis stops. Peristalsis is the rhythmic contraction that moves material through the bowel. Thus, ileus occurs when the muscles of the bowel wall have failed, and they are unable to transport contents through the intestinal tract. Ileus is most often associated with an infection of the peritoneum (the membrane lining the abdomen). It is one of the major causes of bowel obstruction in infants and children.

Another common cause of ileus is a disruption or reduction of the blood supply to the abdomen. Handling the bowel during abdominal surgery can also cause peristalsis to stop, so people who have had abdominal surgery are more likely to experience ileus. When ileus results from abdominal surgery, the condition known as postoperative ileus, the condition is often temporary and usually lasts from 48 to 72 hours.

Ileus sometimes occurs as a complication of surgery on other parts of the body, including **joint replacement** or chest surgery.

Ileus can also be caused by kidney diseases, especially when potassium levels decrease. Ileus can also be caused by heart disease and certain **chemotherapy** drugs such as vinblastine (Velban, Velsar) and vincristine (Oncovin, Vincasar PES, Vincrex). Infants with **cystic fibrosis** are more likely to experience meconium ileus (a dark green material in the intestine). Over all, the total rate of bowel obstruction due both to mechanical and non–mechanical causes is one in one thousand people (1/1,000).

Causes and symptoms

The major cause of ileus is operations occurring within and about the intestines. However, normal activity of the intestines usually returns within hours to days after such operations. Other causes of ileus include:

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- drugs, such as antacids, chlorpromazine, opioids, warfarin, and amitriptline
- metabolic changes, such as those caused by low levels of iron, potassium magnesium, or sodium
- pneumonia
- heart attack (myocardial infarction)
- trauma, such as injuries to the head and spinal column
- pneumonia

When the bowel stops functioning, the following symptoms can occur:

- abdominal cramping
- abdominal distension, discomfort, and tenderness
- poor appetite
- nausea and vomiting, especially after eating
- excessive belching
- constipation
- failure to pass gas (flatulence) or to have a bowel movement (defecation)
- absence of abdominal cramping

Diagnosis

When a doctor listens with a stethoscope to the abdomen, there will be few or no bowel sounds, indicating that the intestine has stopped functioning. Ileus can be confirmed by x rays of the abdomen, **computed tomography scans** (CT scans), or ultrasound. It may be necessary to do more invasive tests, such as a **barium enema** or upper gastrointestinal (GI) series, if the obstruction is mechanical. Blood tests also are useful in diagnosing paralytic ileus.

Barium studies are used in cases of mechanical obstruction, but may cause problems by increasing pressure or intestinal contents if used in ileus. Also, in cases of suspected mechanical obstruction involving the gastrointestinal tract (from the small intestine downward) use of barium x rays are contraindicated, since they may contribute to the obstruction. In such cases a barium enema should always be performed first.

Treatment

Patients may be treated with supervised bed rest in a hospital and bowel rest. Bowel rest means that nothing is taken by mouth and patients are fed intravenously or through the use of a nasogastric tube. (A nasogastric tube provides relief for patients with **vomiting** and distension; however, it has not been found helpful with treating ileus itself.) A nasogastric tube is a tube inserted through the nose, down the throat, and into the stomach. A similar tube can be inserted in the intestine. The contents are then suctioned out. In some cases, especially where there is a mechanical obstruction, surgery may be necessary.

KEY TERMS

Bowel—The part of the intestines that is connected to the anus.

Computed tomography scan (or CT scan)—A computer enhanced x–ray study performed to detect abnormalities that do not show up on normal x rays.

Meconium—A greenish fecal material that forms the first bowel movement of an infant.

Peritoneum—The transparent membrane lining the abdominal cavity that holds internal organs in place.

Narcotics are often used after surgery for pain relief but can be replaced over time with nonsteroidal anti–inflammatory drugs (NSAIDs), which also help with reducing inflammation. Drug therapies that promote intestinal motility (ability of the intestine to move spontaneously), such as cisapride (Prepulsid, Propulsid) and vasopressin (Pitressin), are sometimes prescribed.

Alternative treatment

Alternative practitioners offer few treatment suggestions, but focus on prevention by keeping the bowels healthy through eating a good diet that is high in fiber and low in fat. If the case is not a medical emergency, homeopathic treatment and **traditional Chinese medicine** can recommend therapies that may help to reinstate peristalsis.

Prognosis

The outcome of ileus varies depending on its cause. Complications may occur, including infection, **jaundice** (yellow skin discoloration), perforation (hole) in the intestine, or electrolyte imbalances (any of a number of free–ion substances in the body that are not in normal concentrations).

Prevention

Most cases of ileus are not preventable. Surgery to remove a tumor or other mechanical obstruction will help prevent a recurrence.

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Some measures that have been recommended to minimize the severity of postoperative ileus or shorten its duration include making sure that any electrolyte imbalances are corrected, and using nonopioid medications to relieve pain, as opioid drugs (including morphine, oxycodone, and codeine) tend to cause **constipation**. One group of drugs that shows promise for treating abdominal pain is a class of medications known as kappa–opioid agonists. As of 2008, however, these drugs are still under investigation for controlling visceral pain in humans. Further clinical studies are needed to determine their ability to treat such pain.

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ORGANIZATIONS

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Immobilization

Definition

Immobilization refers to the process of holding a joint or bone in place with a splint, cast, or brace. This is done to prevent an injured area from moving while it heals.

Purpose

Splints, casts, and braces support and protect broken bones, dislocated joints, and such injured soft tissue as tendons and ligaments. Immobilization restricts motion to allow the injured area to heal. It can help reduce **pain**, swelling, and muscle spasm. In some cases, splints and casts are applied after surgical procedures that repair bones, tendons, or ligaments. This allows for protection and proper alignment early in the healing phase.

Precautions

There are no special precautions for immobilization.

Description

When an arm, hand, leg, or foot requires immobilization, the cast, splint, or brace will generally extend from the joint above the injury to the joint below the injury. For example, an injury to the mid-calf requires immobilization from the knee to the ankle and foot. Injuries of the hip and upper thigh or shoulder and upper arm require a cast that encircles the body and extends down the injured leg or arm.

Casts and splints

Casts are generally used for immobilization of a broken bone. Once the doctor makes sure the two broken ends of the bone are aligned, a cast is put on to keep them in place until they are rejoined through natural healing. Casts are applied by a physician, a nurse, or an assistant. They are custom-made to fit each person, and are usually made of plaster or fiberglass. Fiberglass weighs less than plaster, is more durable, and allows the skin more adequate airflow than plaster. A layer of cotton or synthetic padding is first wrapped around the skin to cover the injured area and protect the skin. The plaster or fiberglass is then applied over this.

Most casts should not be gotten wet. However, some types of fiberglass casts use Gore-tex padding that is waterproof and allows the person to completely immerse the cast in water when taking a shower or bath. There are some circumstances when this type of cast material can not be used.

A splint is often used to immobilize a dislocated joint while it heals. Splints are also often used for finger injuries, such as **fractures** or baseball finger. Baseball finger is an injury in which the tendon at the end of the finger is separated from the bone as a result of trauma. Splinting also is used to immobilize an

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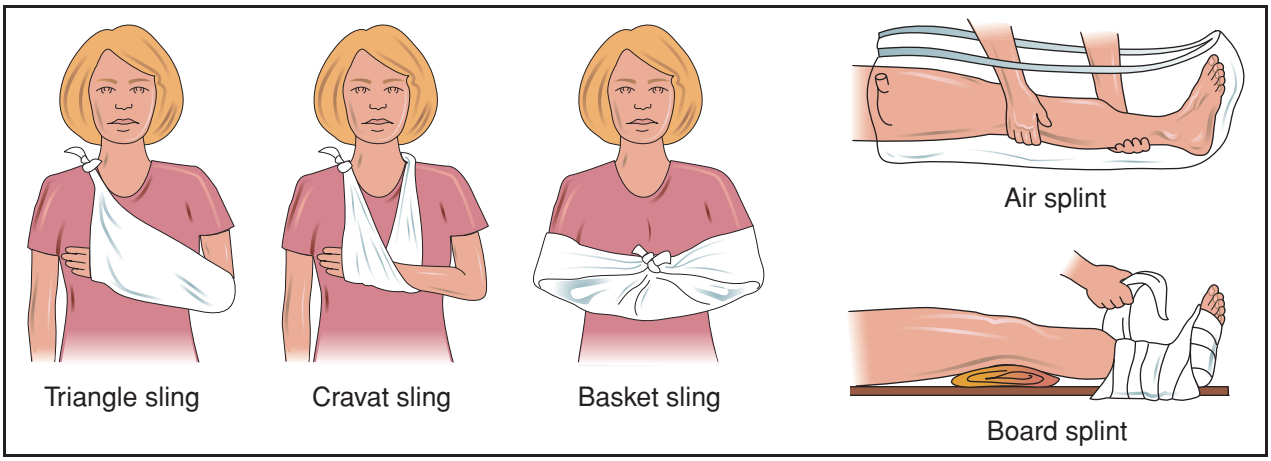

Immobilization refers to the process of immobilizing or fixating the position of a joint, bone, extremity, or torso with a splint, cast, or brace. Immobilization can help reduce pain, swelling, and muscle spasms. The illustrations above feature several types of immobilization techniques. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

injured arm or leg immediately after an injury. Before moving a person who has injured an arm or leg some type of temporary splint should be applied to prevent further injury to the area. Splints may be made of acrylic, polyethylene foam, plaster of paris, or aluminum. In an emergency, a splint can be made from a piece of wood or rolled magazine.

Slings

Slings are often used to support the arm after a fracture or other injury. They are generally used along with a cast or splint, but sometimes are used alone as a means of immobilization. They can be used in an emergency to immobilize the arm until the person can be seen by a doctor. A triangular bandage is placed under the injured arm and then tied around the neck.

Braces

Braces are used to support, align, or hold a body part in the correct position. Braces are sometimes used after a surgical procedure is performed on an arm or leg. They can also be used for an injury. Since some braces can be easily taken off and put back on, they are often used when the person must have **physical therapy** or **exercise** the limb during the healing process. Many braces can also be adjusted to allow for a certain amount of movement.

Braces can be custom-made, or a ready-made brace can be used. The off-the-shelf braces are made in a variety of shapes and sizes. They generally have Velcro straps that make the brace easy to adjust, and to put on and take off. Both braces and splints offer less support and protection than a cast and may not be a treatment option in all circumstances.

Collars

A collar is generally used for neck injuries. A soft collar can relieve pain by restricting movement of the head and neck. They also transfer some of the weight of the head from the neck to the chest. Stiff collars are generally used to support the neck when there has been a fracture in one of the bones of the neck. Cervical collars are widely used by emergency personnel at the scene of injuries when there is a potential neck or **head injury**.

Traction

Immobilization may also be secured by **traction**. Traction involves using a method for applying tension to correct the alignment of two structures (such as two bones) and hold them in the correct position. For example, if the bone in the thigh breaks, the broken ends may have a tendency to overlap. Use of traction will hold them in the correct position for healing to occur. The strongest form of traction involves inserting a stainless steel pin through a bony prominence attached by a horseshoe-shaped bow and rope to a pulley and weights suspended over the end of the patient's bed.

Traction must be balanced by countertraction. This is obtained by tilting the bed and allowing the patient's body to act as a counterweight. Another technique involves applying weights pulling in the opposite direction.

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Traction for neck injuries may be in the form of a leather or cotton cloth halter placed around the chin and lower back of the head. For very severe neck injuries that require maximum traction, tongs that resemble ice tongs are inserted into small holes drilled in the outer skull.

All traction requires careful observation and adjustment by doctors and nurses to maintain proper balance and alignment of the traction with free suspension of the weights.

Immobilization can also be secured by a form of traction called skin traction. This is a combination of a splint and traction that is applied to the arms or legs by strips of adhesive tape placed over the skin of the arm or leg. Adhesive strips, moleskin, or foam rubber traction strips are applied on the skin. This method is effective only if a moderate amount of traction is required.

Preparation

There are many reasons for immobilization using splints, casts, and braces. Each person should understand his or her diagnosis clearly.

Aftercare

After a cast or splint has been put on, the injured arm or leg should be elevated for 24 to 72 hours. It is recommended that the person lie or sit with the injured arm or leg raised above the level of the heart. Rest combined with elevation will reduce pain and speed the healing process by minimizing swelling.

Fingers or toes can be exercised as much as can be tolerated after casting. This has been found to decrease swelling and prevent stiffness. If excessive swelling is noted, the application of ice to the splint or cast may be helpful.

After the cast, splint, or brace is removed, gradual exercise is usually performed to regain muscle strength and motion. The doctor may also recommend **hydrotherapy**, **heat treatments**, and other forms of physical therapy.

Risks

For some people, such as those in traction, immobilization will require long periods of bedrest. Lying in one position in bed for an extended period of time can result in sores on the skin (decubitus ulcers) and skin infection. Long periods of bedrest can also cause a buildup of fluid in the lungs or an infection in the lungs (**pneumonia**). Urinary infection can also be a result of extended bedrest.

KEY TERMS

Decubitus ulcers— A pressure sore resulting from ulceration of the skin occurring in persons confined to bed for long periods of time

Ligament—Ligaments are structures that hold bones together and prevent excessive movement of the joint. They are tough, fibrous bands of tissue.

Pneumonia—An acute or chronic disease characterized by inflammation of the lungs and caused by viruses, bacteria, or other microorganisms.

Tendon—Tendons are structures that attach bones to muscles and muscles to other muscles.

People who have casts, splints, or braces on their arms or legs will generally spend several weeks not using the injured arm or leg. This lack of use can result in decreased muscle tone and shrinkage of the muscle (atrophy). Much of this loss can usually be regained, however, through **rehabilitation** after the injury has healed.

Immobility can also cause psychological **stress**. An individual restricted to a bed with a traction device may become frustrated and bored, and perhaps even depressed, irritable, and withdrawn.

There is the possibility of decreased circulation if the cast, splint, or brace fits too tightly. Excessive pressure over a nerve can cause irritation or possible damage if not corrected. If the cast, splint, or brace breaks or malfunctions, the healing process of the bone or soft tissue can be disrupted and lead to deformity.

Normal results

Normally, the surgical or injured area heals appropriately with the help of immobilization. The form of immobilization can be discontinued, which is followed by an appropriate rehabilitation program under the supervision of a physical therapist to regain range of motion and strength.

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Immune complex detection *see* **Immune complex test**

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Immune complex test

Definition

These tests evaluate the immune system, whose function is to defend the body against such invaders as bacteria and viruses. The immune system also plays a role in the control of **cancer**, and is responsible for the phenomena of allergy, hypersensitivity, and rejection problems when organs or tissue are transplanted.

One of the ways the immune system protects the body is by producing proteins called antibodies. Antibodies are formed in response to another type of protein called an antigen (anything foreign or different from a natural body protein). Immune complex reactions occur when large numbers of antigen-antibody complexes accumulate in the body.

Purpose

The purpose of the immune complex test is to demonstrate circulating immune complexes in the blood, to estimate the severity of immune complex disease, and to monitor response to therapy.

Precautions

Because this test is requested when the physician suspects that a patient's immune system is not functioning properly, special care should be taken during and after blood is drawn. For example, the venipuncture site should be kept clean and dry to avoid any chance of infection.

Description

Immune complexes are normally not detected in the blood. However, when immune complexes are produced faster than they can be cleared by the system, immune complex disease may occur. Examples of such disorders are drug sensitivity, **rheumatoid arthritis**, and a disease called **systemic lupus erythematosus**, or SLE.

The method generally used for detecting immune complexes is examination of a tissue obtained by biopsy (removal and examination of tissue sample) and the subsequent use of different staining techniques with specific antibodies. However, since tissue biopsies do not provide information about the level of complexes still in the circulatory system, serum assays obtained from blood samples which indirectly detect circulating immune complexes are useful. However, due to the variability of these complexes, several test methods may be used. Also, as most immune complex assays have not been standardized, more than one test may be required to achieve accurate results.

KEY TERMS

Antibody—A (immunoglobulin) molecule that interacts with a specific antigen. Antibodies provide protection from microscopic invaders like bacteria.

Antigen—Any substance that is capable under certain circumstances of producing an immune response either from antibodies or T-cells; bacteria are often antigens.

Autoimmune disorder—A disorder caused by a reaction of an individual's immune system against the organs or tissues of the body. Autoimmune processes can have different results: slow destruction of a particular type of cell or tissue, stimulation of an organ into excessive growth, or interference in function.

Biopsy—The removal and examination, usually under a microscope, of tissue from the living body. Used for diagnosis.

Systemic lupus erythematosus—A chronic disease of the connective tissues in the body; characterized by involvement of the skin, joints, kidneys, and serosal membranes (membranes that form the outer covering of organs in the abdomen or chest).

Preparation

This test requires a blood sample. It is not necessary for the patient to be in a **fasting** (nothing to eat or drink) state before the test.

Risks

Risks for this test are minimal, but may include slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after venipuncture, or hematoma (blood accumulating under the puncture site).

Normal results

Normally, immune complexes are not detected in the blood.

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Abnormal results

The presence of detectable immune complexes in the blood is important in the diagnosis of autoimmune diseases, such as SLE and rheumatoid arthritis. However, for definitive diagnosis, the results of other studies must be considered with the presence of any immune complex. For example, immune complexes are associated with high numbers of a component called antinuclear antibodies in the diagnosis of systemic lupus erythematosus. A different example is the kidneys. Because of their filtering functions, elements in the kidneys called renal glomeruli can be affected by immune complexes. In such cases, renal biopsy is used to provide conclusive evidence for immune complex.

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Immunodeficiency

Definition

Immunodeficiency disorders are a group of disorders in which part of the immune system is missing or defective. Therefore, the body's ability to fight infections is impaired. As a result, the person with an immunodeficiency disorder has frequent infections—thus, are at greater susceptibility to infection—that are generally more severe and last longer than usual. The infections involving immunodeficiency disorders commonly reside in the skin, throat, ears, sinuses, lungs, brain, spinal cord, urinary tract, and intestines.

Demographics

These disorders are caused by genetic or hereditary defects and, as such, can happen to anyone regardless of age or gender. While some immunodeficiency disorders are commonly scattered within the human population, other types are only infrequently found. Even though numerous types of such disorders exist they all have one feature in common: each involves a defect of a specific function of body's overall immune system.

Description

The immune system is the body's main method for fighting infections. Any defect in the immune system decreases a person's ability to fight infections. A person with an immunodeficiency disorder may get more frequent infections, heal more slowly, and have a higher incidence of some cancers.

The normal immune system involves a complex interaction of certain types of cells that can recognize and attack "foreign" invaders (called antigens), such as bacteria, viruses, toxins, fungi, and blood or tissues from other humans or species. It also plays a role in fighting **cancer**. The immune system has both innate and adaptive components. Innate immunity is made up of immune protections people are born with. Adaptive immunity develops throughout life. It adapts to fight off specific invading organisms. Adaptive immunity is divided into two components: humoral immunity and cellular immunity.

The innate immune system is made up of the skin (which acts as a barrier to prevent organisms from entering the body), white blood cells called phagocytes, a system of proteins called the complement system, and chemicals called interferons. When phagocytes encounter an invading organism, they surround and engulf it to destroy it. The complement system also attacks bacteria. The elements in the complement system create a hole in the outer layer of the target cell, which leads to the **death** of the cell.

The adaptive component of the immune system is extremely complex, and is still not entirely understood. Basically, it has the ability to recognize an organism or tumor cell as not being a normal part of the body, and to develop a response to attempt to eliminate it.

The humoral response of adaptive immunity involves a type of cell called B lymphocytes. B lymphocytes manufacture proteins called antibodies (which are also called immunoglobulins). Antibodies attach themselves to the invading foreign substance. This allows the phagocytes to begin engulfing and destroying the organism. The action of antibodies also activates the complement system. The humoral response is particularly useful for attacking bacteria.

The cellular response of adaptive immunity is useful for attacking viruses, some parasites, and possibly cancer cells. The main type of cell in the cellular response is T lymphocytes. There are helper T

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lymphocytes and killer T lymphocytes. The helper T lymphocytes play a role in recognizing invading organisms, and they also help killer T lymphocytes to multiply. As the name suggests, killer T lymphocytes act to destroy the target organism.

Defects can occur in any component of the immune system or in more than one component (combined immunodeficiency). Different immunodeficiency diseases involve different components of the immune system. The defects can be inherited and/or present at birth (congenital) or acquired.

Congenital immunodeficiency disorders

Congenital (primary) immunodeficiency is present at the time of birth, and is the result of genetic defects. These immunodeficiency disorders are also called primary immunodeficiencies. The disorders are generally classified according to the part of the immune system that is improperly functioning. The World Health Organization (WHO) estimates that over 70 primary immunodeficiency disorders are present around the world. In the United States, the National Institute of Child Health and Human Development estimates about 400 children are born annually with a primary immunodeficiency disorder. It also states that roughly 25,000 to 50,000 people are living in any given year with such a disorder. The number of new cases is rising in the United Sates as new laboratory tests become more commonly available. Congenital immunodeficiencies may occur because of defects in B lymphocytes, T lymphocytes, or both. They also can occur in the innate immune system.

HUMORAL IMMUNITY DISORDERS. Bruton's agammaglobulinemia, also known as **X–linked agammaglobulinemia**, is a congenital immunodeficiency disorder. The defect results in a decrease or absence of B lymphocytes, and therefore a decreased ability to make antibodies. People with this disorder are particularly susceptible to infections of the throat, skin, middle ear, and lungs. It is seen only in males because it is caused by a genetic defect on the X chromosome. Since males have only one X chromosome, they always have the defect if the gene is present. Females can have the defective gene, but since they have two X chromosomes, there will be a normal gene on the other X chromosome to counter it. Women may pass the defective gene on to their male children.

B LYMPHOCYTE DEFICIENCES. If there is an abnormality in either the development or function of B lymphocytes, the ability to make antibodies will be impaired. This allows the body to be susceptible to recurrent infections.

A type of B lymphocyte deficiency involves a group of disorders called selective immunoglobulin deficiency syndomes. Immunoglobulin is another name for antibody, and there are five different types of immunoglobulins (called IgA, IgG, IgM, IgD, and IgE). The most common type of immunoglobulin deficiency is selective IgA deficiency, occurring in about one in every 500 white (Caucasian) persons. The amounts of the other antibody types are normal. Some patients with selective IgA deficiency experience no symptoms, while others have occasional lung infections and **diarrhea**. In another immunoglobulin disorder, IgG and IgA antibodies are deficient and there is increased IgM. People with this disorder tend to get severe bacterial infections.

Common variable immunodeficiency is another type of B lymphocyte deficiency. In this disorder, the production of one or more of the immunoglobulin types is decreased and the antibody response to infections is impaired. It generally develops around the age of 10 to 20 years. The symptoms vary among affected people. Most people with this disorder have frequent infections, and some of them also experience anemia and **rheumatoid arthritis**. Many people with common variable immunodeficiency develop cancer.

T LYMPHOCYTE DEFICIENCIES. Severe defects in the ability of T lymphocytes to mature results in impaired immune responses to infections with antigens, such as viruses, fungi, and certain types of bacteria. These infections are usually severe and can be fatal.

DiGeorge syndrome is a T lymphocyte deficiency that starts during fetal development and is the result of a deletion in a particular chromosome. Children with DiGeorge syndrome either do not have a thymus or have an underdeveloped thymus. Since the thymus is a major organ that directs the production of T–lymphocytes, these patients have very low numbers of T–lymphocytes. They are susceptible to recurrent infections, and usually have physical abnormalities as well. For example, they may have low–set ears, a small receding jawbone, and wide–spaced eyes. People with DiGeorge syndrome are particularly susceptible to viral and fungal infections.

In some cases, no treatment is required for DiGeorge syndrome because T lymphocyte production improves. Either an underdeveloped thymus begins to produce more T lymphocytes or organ sites other than the thymus compensate by producing more T lymphocytes.

COMBINED IMMUNODEFICIENCIES. Some types of immunodeficiency disorders affect both B lymphocytes

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and T lymphocytes. For example, **severe combined immunodeficiency** disease (SCID), sometimes commonly called Bubble Boy Syndrome, is caused by the defective development or function of these two types of lymphocytes. It results in impaired humoral and cellular immune responses. SCID usually is recognized during the first year of life. It tends to cause a fungal infection of the mouth (thrush), diarrhea, **failure to thrive**, and serious infections. If not treated with a bone marrow transplant, a person with SCID will generally die from infections before age two. It is reported that the prevalence of SCID is one in 100,000 births, although that figure is regularly considered an underestimate. In some local populations, this figure is much greater. For instance, in the Navajo population within the United States, it is reported that one in 2,000 babies inherit SCID.

DISORDERS OF INNATE IMMUNITY. Disorders of innate immunity affect phagocytes or the complement system. These disorders also result in recurrent infections.

Acquired immunodeficiency disorders

Acquired (secondary) immunodeficiency is more common than congenital immunodeficiency. It is frequently the result of an infectious process or other disease, **malnutrition**, medications/drugs, or **aging**. For example, the human immunodeficiency virus (HIV) is the virus that causes acquired immunodeficiency syndrome (**AIDS**). However, this is not the most common cause of acquired immunodeficiency.

Acquired immunodeficiency often occurs as a complication of other conditions and diseases. For example, the most common causes of acquired immunodeficiency are malnutrition, some types of cancer, and infections. People who weigh less than 70% of the average weight of persons of the same age and gender are considered to be malnourished. Examples of types of infections that can lead to immunodeficiency are **chickenpox**, cytomegalovirus, German **measles**, measles, **tuberculosis**, **infectious mononucleosis** (Epstein–Barr virus), chronic hepatitis, lupus, and bacterial and fungal infections.

In 2003, a new infection emerged that produces immunodeficiency. **Severe acute respiratory syndrome (SARS)** mysteriously appeared in a hospital in China. It eventually affected 8,000 people in Asia and Canada, killing 800 altogether. **Fever**, lower respiratory tract symptoms, and abnormal chest x rays characterize the disease. However, it also produces immunodeficiency. No cases of the disease were reported from July 2003 through December 2003, but scientists feared it would reappear. Thus, the World Health Organization (WHO) set up a network of medical and research professionals to deal with SARS. As of May 2006, the SARS infection has been completely contained. However, it is not considered eradicated, so could possibility return to infect the human population.

Sometimes, acquired immunodeficiency is brought on by drugs used to treat another condition. For example, patients who have an organ transplant are given drugs to suppress the immune system so the body will not reject the organ. Also, some **chemotherapy** drugs, which are given to treat cancer, have the side effect of killing cells of the immune system. During the period of time that these drugs are being taken, the risk of infection increases. It usually returns to normal after the person stops taking the drugs.

Causes and symptoms

Congenital immunodeficiency is caused by genetic defects, which generally occur while the fetus is developing in the womb. These defects affect the development and/or function of one or more of the components of the immune system, such as lymphoid tissue within bone marrow, thymus, lymph nodes, tonsils, spleen, and gastrointestinal tract. Acquired immunodeficiency is the result of a disease process, and it occurs later in life. The causes, as described above, can be diseases, infections, or the side effects of drugs given to treat other conditions.

People with an immunodeficiency disorder tend to become infected by organisms that do not usually cause disease in healthy persons. The major symptoms of most immunodeficiency disorders are repeated infections that heal slowly. These chronic infections cause symptoms that persist for long periods of time. People with chronic infection tend to be pale and thin. They may have skin **rashes**. Their lymph nodes tend to be larger than normal and their liver and spleen may be enlarged, too. The lymph nodes are small organs that house antibodies and lymphocytes. Broken blood vessels, especially near the surface of the skin, may be seen. This can result in black–and–blue marks in the skin. The person may lose hair from their head. Sometimes, a red inflammation of the lining of the eye (**conjunctivitis**) is present. They may have a crusty appearance in and on the nose from chronic nasal dripping.

Diagnosis

Usually, the first sign that a person might have an immunodeficiency disorder is that they do not

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improve rapidly when given **antibiotics** to treat an infection. Strong indicators that an immunodeficiency disorder may be present are when rare diseases occur or the patient gets ill from organisms that do not normally cause diseases, especially if the patient repeatedly is infected. If this happens in very young children, it is an indication that a genetic defect may be causing an immunodeficiency disorder. When this situation occurs in older children or young adults, their medical history will be reviewed to determine if childhood diseases may have caused an immunodeficiency disorder. Other possibilities will then be considered, such as recently acquired infections—for example, HIV, hepatitis, tuberculosis, etc.

Laboratory tests are used to determine the exact nature of the immunodeficiency. Most tests are performed on blood samples. Blood contains antibodies, lymphocytes, phagocytes, and complement components—all of the major immune components that might cause immunodeficiency. A blood cell count will determine if the number of phagocytic cells or lymphocytes is below normal. Lower than normal counts of either of these two cell types correlates with immunodeficiencies. The blood cells also are checked for their appearance. Sometimes a person may have normal cell counts, but the cells are structurally defective. If the lymphocyte cell count is low, further testing is usually done to determine whether any particular type of lymphocyte is lower than normal. A lymphocyte proliferation test is done to determine if the lymphocytes can respond to stimuli. The failure to respond to stimulants correlates with immunodeficiency. A process called electrophoresis can measure antibody levels. Complement levels can be determined by immunodiagnostic tests.

Treatment

There is no cure for immunodeficiency disorders. Therapy is aimed at controlling infections and, for some disorders, replacing defective or absent components.

Patients with Bruton's agammaglobulinemia must be given periodic injections of a substance called **gamma globulin** throughout their lives to make up for their decreased ability to make antibodies. The gamma globulin preparation contains antibodies against common invading bacteria. If left untreated, the disease usually is fatal.

Common variable immunodeficiency also is treated with periodic injections of gamma globulin throughout life. Additionally, antibiotics are given when necessary to treat infections.

Patients with selective IgA deficiency usually do not require any treatment. Antibiotics can be given for frequent infections.

In some cases, treatment is not required for DiGeorge syndrome because T lymphocyte production improves on its own. Either an underdeveloped thymus begins to produce more T lymphocytes or organ sites other than the thymus compensate by producing more T lymphocytes. In some severe cases, a bone marrow transplant or thymus transplant can be done to correct the problem.

For patients with SCID, **bone marrow transplantation** is necessary. In this procedure, healthy bone marrow from a donor who has a similar type of tissue (usually a relative, such as a brother or sister) is removed. The bone marrow is a substance that resides in the cavity of bones. Such marrow produces blood including some of the white blood cells that make up the immune system. The bone marrow of the person receiving the transplant is destroyed, and is then replaced with marrow from the donor.

Treatment of the HIV infection that causes AIDS consists of drugs called antiretrovirals. These drugs attempt to inhibit the process that the virus goes through to kill T lymphocytes. Several of these drugs used in various combinations with one another can prolong the time period before the disease becomes apparent. However, this treatment is not a cure. Other treatments for people with AIDS are aimed at the particular infections and conditions that arise because of the impaired immune system. SARS is a relatively new acquired disease. Treatment to date involves combination therapy with **steroids** and interferon and supplemental oxygen for breathing difficulties. In 2004, the U.S. Food and Drug Administration approved the drug octagam 5% (Immune Globulin Intravenous (Human) 5%), an intravenous immunoglobulin product from the company Octapharma AG, to treat primary immunodeficiency diseases. At that time, the drug had been used in Europe for over ten years for the same purpose.

In most cases, immunodeficiency caused by malnutrition is reversible. The health of the immune system is directly linked to the nutritional status of the patient. Among the essential nutrients required by the immune system are proteins, **vitamins**, iron, and zinc.

For people being treated for cancer, periodic relief from chemotherapy drugs can restore the function of the immune system.

In general, people with immunodeficiency disorders should maintain a healthy diet because malnutrition can aggravate immunodeficiencies. They also should avoid being near people who have colds or

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KEY TERMS

Agammaglobulinemia—The lack of gamma globulins in the blood. Antibodies are the main gamma globulins of interest, so this term means a lack of antibodies.

are sick because they can easily acquire new infections. For the same reason, they should practice good personal hygiene, especially dental care. People with immunodeficiency disorders also should avoid eating undercooked food because it might contain bacteria that could cause infection. This food would not cause infection in persons with healthy immune systems, but in someone with an immunodeficiency, food is a potential source of infectious organisms. People with immunodeficiency should be given antibiotics at the first indication of an infection.

Prognosis

The prognosis depends on the type of immunodeficiency disorder. People with Bruton's agammaglobulinemia who are given injections of gamma globulin generally live into their 30s or 40s. They often die from chronic infections, usually of the lung. People with selective IgA deficiency generally live normal lives. They may experience problems if given a blood **transfusion**, and therefore they should wear a Medic Alert bracelet or have some other way of alerting any physician who treats them that they have this disorder.

SCID is the most serious of the immunodeficiency disorders. If a bone marrow transplant is not successfully performed, the child usually will not live beyond two years old.

People with HIV/AIDS are living longer than in the past because of **antiretroviral drugs** that became available in the mid-1990s. However, AIDS still is a fatal disease. People with AIDS usually die of opportunistic infections, which are infections that occur because the impaired immune system is unable to fight them.

Some complications that can occur include frequent or persistent illnesses and the increased risk from certain cancers. Infections are also much more likely with people having immunodeficiency disorders.

Prevention

There is no way to prevent a congenital immunodeficiency disorder. However, individuals with a congenital immunodeficiency disorder might want to consider getting **genetic counseling** before having children to find out if there is a chance they will pass the defect on to their children.

Some of the infections associated with acquired immunodeficiency can be prevented or treated before they cause problems. For example, there are effective treatments for tuberculosis and most bacterial and fungal infections. HIV infection can be prevented by practicing "safer sex" and not using illegal intravenous drugs. These are the primary routes of transmitting the virus. For people who do not know the HIV status of the person with whom they are having sex, safer sex involves using a condom.

Malnutrition can be prevented by getting adequate **nutrition**. Malnutrition tends to be more of a problem in developing countries.

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ORGANIZATIONS

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Immunoelectrophoresis

Definition

Immunoelectrophoresis, also called **gamma globulin** electrophoresis, or immunoglobulin electrophoresis, is a method of determining the blood levels of three major immunoglobulins: immunoglobulin M (IgM), immunoglobulin G (IgG), and immunoglobulin A (IgA).

Purpose

Immunoelectrophoresis is a powerful analytical technique with high resolving power as it combines separation of antigens by electrophoresis with immunodiffusion against an antiserum. The increased resolution is of benefit in the immunological examination of serum proteins. Immunoelectrophoresis aids in the diagnosis and evaluation of the therapeutic response in many disease states affecting the immune system. It is usually requested when a different type of electrophoresis, called a serum **protein electrophoresis**, has indicated a rise at the immunoglobulin level. Immunoelectrophoresis is also used frequently to diagnose **multiple myeloma**, a disease affecting the bone marrow.

Precautions

Drugs that may cause increased immunoglobulin levels include therapeutic gamma globulin, hydralazine, isoniazid, phenytoin (Dilantin), procainamide, **oral contraceptives**, **methadone**, **steroids**, and **tetanus** toxoid and antitoxin. The laboratory should be notified if the patient has received any vaccinations or immunizations in the six months before the test. This is mainly because prior immunizations lead to the increased immunoglobulin levels resulting in false positive results.

It should be noted that, because immunoelectrophoresis is not quantitative, it is being replaced by a procedure called immunofixation, which is more sensitive and easier to interpret.

Description

Serum proteins separate in agar gels under the influence of an electric field into albumin, alpha 1, alpha 2, and beta and gamma globulins. Immunoelectrophoresis is performed by placing serum on a slide containing a gel designed specifically for the test. An electric current is then passed through the gel, and immunoglobulins, which contain an electric charge, migrate through the gel according to the difference in their individual electric charges. Antiserum is placed alongside the slide to identify the specific type of immunoglobulin present. The results are used to identify different disease entities, and to aid in monitoring the course of the disease and the therapeutic response of the patient to such conditions as immune deficiencies, autoimmune disease, chronic infections, chronic viral infections, and intrauterine fetal infections.

There are five classes of antibodies: IgM, IgG, IgA, IgE, and IgD.

IgM is produced upon initial exposure to an antigen. For example, when a person receives the first tetanus **vaccination**, antitetanus antibodies of the IgM class are produced 10 to 14 days later. IgM is abundant in the blood but is not normally present in organs or tissues. IgM is primarily responsible for ABO blood grouping and rheumatoid factor, yet is involved in the immunologic reaction to other infections, such as hepatitis. Since IgM does not cross the placenta, an elevation of this immunoglobulin in the newborn indicates intrauterine infection such as **rubella**, cytomegalovirus (CMV) or a sexually transmitted disease (STD).

IgG is the most prevalent type of antibody, comprising approximately 75% of the serum immunoglobulins. IgG is produced upon subsequent exposure to an antigen. As an example, after receiving a second tetanus shot, or booster, a person produces IgG antibodies in five to seven days. IgG is present in both the blood and tissues, and is the only antibody to cross the placenta from the mother to the fetus. Maternal IgG protects the newborn for the first months of life, until the infant's immune system produces its own antibodies.

IgA constitutes approximately 15% of the immunoglobulins within the body. Although it is found to some degree in the blood, it is present primarily in the secretions of the respiratory and gastrointestinal tract, in saliva, colostrum (the yellowish fluid produced by the breasts during late **pregnancy** and the first few days after **childbirth**), and in tears. IgA plays an important role in defending the body against invasion of germs through the mucous membrane-lined organs.

IgE is the antibody that causes acute allergic reactions; it is measured to detect allergic conditions. IgD, which constitutes the smallest portion of the immunoglobulins, is rarely evaluated or detected, and its function is not well understood.

Preparation

This test requires a blood sample.

Aftercare

Because this test is ordered when either very low or very high levels of immunoglobulins are suspected,

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KEY TERMS

Antibody—A protein manufactured by the white blood cells to neutralize an antigen in the body. In some cases, excessive formation of antibodies leads to illness, allergy, or autoimmune disorders.

Antigen—A substance that can cause an immune response, resulting in production of an antibody, as part of the body's defense against infection and disease. Many antigens are foreign proteins not found naturally in the body, and include germs, toxins, and tissues from another person used in organ transplantation.

Autoimmune disorder—A condition in which antibodies are formed against the body's own tissues; for example, in some forms of arthritis.

the patient should be alert for any signs of infection after the test, including **fever**, chills, rash, or skin ulcers. Any bone **pain** or tenderness should also be immediately reported to the physician.

Risks

Risks for this test are minimal, but may include slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after venipuncture, or bruising.

Normal results

Reference ranges vary from laboratory to laboratory and depend upon the method used. For adults, normal values are usually found within the following ranges (1mg = approximately 0.000035 oz. and 1dL = approximately 0.33 oz.):

- IgM: 60–290 mg/dL
- IgG: 700–1,800 mg/dL
- IgA: 70–440 mg/dL

Abnormal results

Increased IgM levels can indicate **Waldenström's macroglobulinemia**, a malignancy caused by secretion of IgM at high levels by malignant lymphoplasma cells. Increased IgM levels can also indicate chronic infections, such as hepatitis or mononucleosis and autoimmune diseases, like **rheumatoid arthritis**.

Decreased IgM levels can be indicative of **AIDS**, immunosuppression caused by certain drugs like steroids or dextran, or leukemia.

Increased levels of IgG can indicate chronic **liver disease**, autoimmune diseases, hyperimmunization reactions, or certain chronic infections, such as **tuberculosis** or **sarcoidosis**.

Decreased levels of IgG can indicate **Wiskott-Aldrich syndrome**, a genetic deficiency caused by inadequate synthesis of IgG and other immunoglobulins. Decreased IgG can also be seen with AIDS and leukemia.

Increased levels of IgA can indicate chronic liver disease, chronic infections, or inflammatory bowel disease.

Decreased levels of IgA can be found in ataxia, a condition affecting balance and gait, limb or eye movements, speech, and telangiectasia, an increase in the size and number of the small blood vessels in an area of skin, causing redness. Decreased IgA levels are also seen in conditions of low blood protein (hypoproteinemia), and drug immuno-suppression.

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Immunoglobulin *see* **Gammaglobulin**

Immunoglobulin deficiency syndromes

Definition

Immunoglobulin deficiency syndromes are a group of **immunodeficiency** disorders in which the patient has a reduced number of or lack of antibodies.

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Demographics

The disorders can appear in anyone, from newborn babies to the elderly.

Description

Immunoglobulins (Ig), also commonly known as antibodies, are **gamma globulin** proteins. That is, they are a type of protein found in the blood and other fluids of humans and other vertebrates. Immunoglobulins are used to neutralize bacteria, viruses, and other invading foreign substances. There are five major classes of antibodies: IgG, IgM, IgA, IgD, and IgE. Each differs in its functional location, physical properties, and ability to counter foreign substances within the body.

- IgG is the most abundant of the classes of immunoglobulins. It is the antibody for viruses, bacteria, and antitoxins. In addition, it is found in most tissues and plasma. It is also the only Ig that is able to help provide immunity to a mother's fetus.
- IgM is the first antibody present in an immune response.
- IgA is an early antibody for bacteria and viruses. It is found in saliva, tears, and all other mucous secretions such as within respiratory and urogenital tracts.
- IgD activity is not well understood. However, research has shown that it functions primarily as a receptor on B–cells that have yet to be subjected to antigens.
- IgE is present in respiratory secretions. It is an antibody for parasitic diseases (such as those caused by parasitic worms), Hodgkin's disease, hay fever, atopic dermatitis, and allergic asthma.

All antibodies are made by B–lymphocytes (B–cells). Any disease that harms the development or function of B–cells causes a decrease in the amount of antibodies produced. Since antibodies are essential in fighting infectious diseases, people with immunoglobulin deficiency syndromes become ill more often than those without the disorder. However, the cellular immune system is still functional, so these patients are more prone to infection caused by organisms usually controlled by antibodies. Most of these invading germs (microbes) make capsules, a mechanism used to confuse the immune system. In a healthy body, antibodies can bind to the capsule and overcome the bacteria's defenses. The bacteria that make capsules include the streptococci, meningococci, and *Haemophilus influenzae*. These organisms cause such diseases as otitis, **sinusitis**, **pneumonia**, **meningitis**, **osteomyelitis**, septic arthritis, and **sepsis**. Patients with immunoglobulin deficiencies are also prone to some viral infections, including echovirus, enterovirus, and **hepatitis B**. They may also have a bad reaction to the attenuated version of the **polio** virus vaccine.

There are two types of immunodeficiency diseases: secondary and primary. Secondary disorders occur in normally healthy bodies that are suffering from an underlying disease. Once the disease is treated, the immunodeficiency is reversed.

Primary immunodeficiency diseases occur because of defective B–cells or antibodies. They account for approximately 50% of all immunodeficiencies, and they are, therefore, the most prevalent type of immunodeficiency disorders. These disorders include:

- X–linked agammaglobulinemia is an inherited disease. The defect is on the X chromosome and, consequently, this disease is seen more frequently in males than females. The defect results in a failure of B–cells to mature. Mature B–cells are capable of making antibodies and developing "memory," a feature in which the B–cell rapidly recognizes and responds to an infectious agent the next time it is encountered. Thus, patients with x–linked agammaglobulinemia do not generate mature B–cells. All classes of antibodies are decreased in agammaglobulinemia. It occurs in about one in 100,000 newborn males, without a predisposition to ethnic origin.
- Selective IgA deficiency, a mild but very common deficiency, is an inherited disease, resulting from a failure of B–cells to switch from making IgM, the early antibody, to IgA. Although the number of B–cells is normal, and the B–cells are otherwise normal (they can still make all other classes of antibodies), the amount of IgA produced is limited. This results in more infections of mucosal surfaces, such as the nose, mouth, throat, lungs, digestive tract, and intestines. Roughly no more than one in 333 people is inflicted by the deficiency; however its frequency is dependent on various populations.
- Transient hypogammaglobulinemia of infancy is a temporary disease of unknown cause. Normally, it appears after birth of a child with increased infections but, sometimes, without any symptoms. It is believed to be caused by a defect in the development of T–helper cells (cells that recognize foreign antigens and activate T– and B–cells in an immune response). As the child ages, the number and condition of T–helper cells normally improves and this situation usually corrects itself. Hypogammaglobulinemia is characterized by low levels of gammaglobulin (antibodies) in the blood. During the disease

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period, patients have decreased levels of IgG antibodies, and sometimes of IgA and IgM antibodies. In laboratory tests, the antibodies that are present do not react well with infectious bacteria. The incidence of the disease varies widely in infants.

- Common variable immunodeficiency, which includes a group of primary immunodeficiencies, is a defect in both B cells and T–lymphocytes. The differences of its members are the result of the underlying causes. Most causes are unknown. However, all result in a near complete lack of antibodies in the blood, and all occur very frequently with respect to other such related diseases.
- Ig heavy chain deletions is a genetic disease in which part of the antibody molecule is not produced. It results in the loss of several antibody classes and subclasses, including most IgG antibodies and all IgA and IgE antibodies. The disease occurs because part of the gene for the heavy chain has been lost.
- Selective IgG subclass deficiencies is a group of genetic diseases in which some of the subclasses of IgG are not made. There are four subclasses in the IgG class of antibodies. As the B–cell matures, it can switch from one subclass to another. In these diseases there is a defect in the maturation of the B–cells that results in a lack of switching.
- IgG deficiency with hyper–IgM is a disease that results when the B–cell fails to switch from making IgM to IgG. This produces an increase in the amount of IgM antibodies present and a decrease in the amount of IgG antibodies. This disease is the result of a genetic mutation.
- Severe combined immunodeficiency (SCID) is not strictly a deficiency of immunoglobulin, although it is often categorized within this group. It occurs due to the absence or dysfunction of important immune cells called T–cells, or of both T– and B–cells. The condition can be X–linked, in which case more males than females are affected, or it can be inherited in an autosomal fashion (in which case males and females can be equally affected). In SCID, the thymus gland (which produces T–cell) may be abnormal.

Causes and symptoms

Immunoglobulin deficiencies are the result of congenital defects affecting the development and function of B lymphocytes (B–cells). There are two main points in the development of B–cells when defects can occur. First, B–cells can fail to develop into antibody–producing cells. **X–linked agammaglobulinemia** is an example of this disease. Secondly, B–cells can fail to make a particular type of antibody or fail to switch classes during maturation. Initially, when B–cells start making antibodies for the first time, they make IgM. As they mature and develop memory, they switch to one of the other four classes of antibodies. Failures in switching or failure to make a subclass of antibody leads to immunoglobulin deficiency diseases. Another mechanism that results in decreased antibody production is a defect in T–helper cells. Generally, defects in T–helper cells are listed as severe combined immunodeficiencies.

KEY TERMS

Antibody—Another term for immunoglobulin. A protein molecule that specifically recognizes and attaches to infectious agents.

T–helper cell—A type of cell that recognizes foreign antigens and activates T– and B–cells in an immune response.

Symptoms are persistent and frequent infections, **diarrhea**, **failure to thrive**, and malabsorption (of nutrients).

Diagnosis

An immunodeficiency disease is suspected when children become ill frequently, especially from the same organisms, or from organisms that don't usually cause infection. Standard treatments may also fail. The profile of organisms that cause infection in patients with immunoglobulin deficiency syndrome is unique and is preliminary evidence for this disease. Laboratory tests are performed to verify the diagnosis. Antibodies can be found in the blood. Blood is collected and analyzed for the content and types of antibodies present. Depending on the type of immunoglobulin deficiency the laboratory tests will show a decrease or absence of antibodies or specific antibody subclasses.

Treatment

Immunodeficiency diseases cannot be cured. Intravenous administration of immunoglobulin may temporarily boost immunity, but these treatments may need to be repeated at regular intervals. Acute or chronic bacterial infections are treated with **antibiotics**; antifungal drugs are also available. Very few drugs are effective against viral diseases. In severe cases, **bone marrow transplantation** may be considered and can cure some cases of immunodeficiency

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Bone marrow transplantation can, in most cases, completely correct the immunodefiency.

Prognosis

Patients with immunoglobulin deficiency syndromes must practice impeccable health maintenance and care, paying particular attention to optimal dental care, in order to stay in good health.

Prevention

There is not a known way to prevent immunoglobulin deficiency syndromes.

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Immunoglobulin electrophoresis *see* **Immunoelectrophoresis**

Immunoglobulins G, A, and M test *see* **Immunoelectrophoresis**

Immunologic therapies

Definition

Immunologic therapy is the treatment of disease using medicines that boost the body's natural immune response.

Purpose

Immunologic therapy is used to improve the immune system's natural ability to fight diseases such as **cancer**, hepatitis and **AIDS**. These drugs may also be used to help the body recover from immunosuppression resulting from treatments such as **chemotherapy** or **radiation therapy**.

Description

Most drugs in this category are synthetic versions of substances produced naturally in the body. In their natural forms, these substances help defend the body against disease. For example, aldesleukin (Proleukin) is an artificially made form of interleukin-2, which helps white blood cells work. Aldesleukin is administered to patients with kidney cancers and skin cancers that have spread to other parts of the body. Filgrastim (Neupogen) and sargramostim (Leukine) are versions of natural substances called colony stimulating factors, which drive the bone marrow to make new white blood cells. Another type of drug, epoetin (Epogen, Procrit), is a synthetic version of human erythropoietin that stimulates the bone marrow to make new red blood cells. Thrombopoietin stimulates the production of platelets, disk-shaped bodies in the blood that are important in clotting. Interferons are substances the body produces naturally using immune cells to fight infections and tumors. The synthetic interferons carry brand names such as Alferon, Roferon or Intron A. Some of the interferons that are currently in use as drugs are Recombinant Interferon Alfa-2a,

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Recombinant Interferon Alfa-2b, interferon alfa-n1 and Interferon Alfa-n3. Alfa interferons are used to treat **hairy cell leukemia**, **malignant melanoma** and AIDs-related **Kaposi's sarcoma**. In addition interferons are also used for other conditions such as laryngeal papillomatosis, **genital warts** and certain types of hepatitis.

Recommended dosage

The recommended dosage depends on the type of immunologic therapy. For some medicines, the physician will decide the dosage for each patient, taking into account a patient's weight and whether he/she is taking other medicines. Some drugs used in immunologic therapy are given only in a hospital, under a physician's supervision. For those that patients may give themselves, check with the physician who prescribed the medicine or the pharmacist who filled the prescription for the correct dosage.

Most of these drugs come in injectable form. These drugs are generally administered by the cancer care provider.

Precautions

Aldesleukin

This medicine may temporarily increase the chance of getting infections. It may also lower the number of platelets in the blood, and thus possibly interfering with the blood's ability to clot. Taking these precautions may reduce the chance of such problems:

- Avoid people with infections, if possible.
- Be alert to signs of infection, such as fever, chills, sore throat, pain in the lower back or side, cough, hoarseness, or painful or difficulty with urination. If any of these symptoms occur, get in touch with a physician immediately.
- Be alert to signs of bleeding problems, such as black, tarry stools, tiny red spots on the skin, blood in the urine or stools, or any other unusual bleeding or bruising.
- Take care to avoid cuts or other injuries. Be especially careful when using knives, razors, nail clippers and other sharp objects. Check with a dentist for the best ways to clean the teeth and mouth without injuring the gums. Do not have dental work done without checking with a physician.
- Wash hands frequently, and avoid touching the eyes or inside of the nose unless the hands have just been washed.

Aldesleukin may make some medical conditions worse, such as **chickenpox**, **shingles** (herpes zoster), **liver disease**, lung disease, heart disease, underactive thyroid, **psoriasis**, immune system problems and mental problems. The medicine may increase the chance of seizures (convulsions) in people who are prone to having them. Also, the drug's effects may be greater in people with **kidney disease**, because their kidneys are slow to clear the medicine from their bodies.

Colony stimulating factors

Certain drugs used in treating cancer reduce the body's ability to fight infections. Although colony stimulating factors help restore the body's natural defenses, the process takes time. Getting prompt treatment for infections is important, even while taking this medicine. Call the physician at the first sign of illness or infection, such as a **sore throat**, **fever** or chills.

People with certain medical conditions could have problems if they take colony stimulating factors. People who have kidney disease, liver disease or conditions caused by inflammation or immune system problems can worsen these problems with colony stimulating factors. Those who have heart disease may be more likely to experience side effects such as water retention and heart rhythm problems while taking these drugs. Finally, patients who have lung disease might increase their chances of suffering from **shortness of breath**. Those who have any of these medical conditions should check with their personal physicians before using colony stimulating factors.

Epoetin

Epoetin is a medicine that may cause seizures (convulsions), especially in people who are prone to having them. No one who takes these drugs should drive, use machines or do anything considered dangerous in case of a seizure.

Epoetin helps the body make new red blood cells, but it is not effective unless there is adequate iron in the body. The physician may recommend taking iron supplements or certain **vitamins** that help supply the body with iron. It is necessary to follow the physician's advice in this instance—recommendations for iron in this case, as with any supplements should only come from a physician.

In studies of laboratory animals, epoetin taken during **pregnancy** caused **birth defects**, including damage to the bones and spine. However, the drug has not been reported to cause problems in human babies whose mothers take it. Women who are

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pregnant or who may become pregnant should check with their physicians for the most up-to-date information on the safety of taking this medicine during pregnancy.

People with certain medical conditions may have problems if they take this medicine. For example, the chance of side effects may be greater in people with high blood pressure, heart or blood vessel disease or a history of **blood clots**. Epoetin may not work properly in people who have bone problems or sickle cell anemia.

Interferons

Interferons can add to the effects of alcohol and other drugs that slow down the central nervous system, such as **antihistamines**, cold medicine, allergy medicine, sleep aids, medicine for seizures, tranquilizers, some **pain** relievers, and **muscle relaxants**. They may also add to the effects of anesthetics, including those used for dental procedures. Those taking interferons should check with their physicians before taking any of the above.

Some people experience **dizziness** or unusual **fatigue**, or become less alert than usual while being treated with these drugs. Because of these possible problems, anyone who takes these drugs should not drive, use machines or do anything else considered dangerous until they have determined how the drugs affect them.

Interferons often cause flu-like symptoms, including fever and chills. The physician who prescribes this medicine may recommend taking **acetaminophen** (Tylenol) before—and sometimes after—each dose to keep the fever from getting too high. If the physician recommends this, follow instructions carefully.

Like aldesleukin, interferons may temporarily increase the chance of getting infections and lower the number of platelets in the blood, leading to clotting problems. To help prevent these problems, follow the precautions for reducing the risk of infection and bleeding listed for aldesleukin.

People who have certain medical conditions may have problems if they take interferons. For example, the drugs may worsen some medical conditions, including heart disease, kidney disease, liver disease, lung disease, diabetes, bleeding problems and mental problems. In people who have overactive immune systems, these drugs can even increase the activity of the immune system. People who have shingles or chickenpox, or who have recently been exposed to chickenpox may increase their risk of developing severe problems in other parts of the body if they take interferons. People with a history of seizures or mental problems could at risk if taking interferon.

In teenage women, interferons may cause changes in the menstrual cycle. Young women should discuss this possibility with their physicians. Older people may be more sensitive to the effects of interferons. This may increase the chance of side effects.

These drugs are not known to cause fetal **death**, birth defects or other problems in humans when taken during pregnancy. Women who are pregnant or who may become pregnant should ask their physicians for the latest information on the safety of taking these drugs during pregnancy.

Women who are **breastfeeding** their babies may need to stop while taking this medicine. Whether interferons pass into breast milk is not known. Because of the chance of serious side effects to the baby, breastfeeding while taking interferon is discouraged. Check with a physician for advice.

General precautions for all types of immunologic therapy

Regular physician visits are necessary during immunologic therapy treatment. This gives the physician a chance to make sure the medicine is working and to check for unwanted side effects.

Anyone who has had unusual reactions to drugs used in immunologic therapy should let the physician know before resuming the drugs. Any **allergies** to foods, dyes, preservatives, or other substances should also be reported.

Side effects

Aldesleukin

In addition to its helpful effects, this medicine may cause serious side effects. Generally, it is given only in a hospital, where medical professionals can watch for early signs of problems. Medical tests might be performed to check for unwanted effects.

Anyone who has breathing problems, fever or chills while being given aldesleukin should check with a physician immediately.

Other side effects should be brought to a physician's attention as soon as possible:

- dizziness
- drowsiness
- confusion
- agitation
- depression

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- nausea and vomiting
- diarrhea
- sores in the mouth and on the lips
- tingling of hands or feet
- decrease in urination
- unexplained weight gain of five or more pounds

Some side effects are usually temporary and do not need medical attention unless they are bothersome. These include dry skin; itchy or burning skin; rash or redness followed by peeling; loss of appetite; and a general feeling of illness or discomfort.

Colony stimulating factors

As this medicine starts to work, the patient might experience mild pain in the lower back or hips. This is nothing to cause undue concern, and will usually go away within a few days. If the pain is intense or causes discomfort, the physician may prescribe a painkiller.

Other possible side effects include **headache**, joint or muscle pain and skin rash or **itching**. These side effects tend to disappear as the body adjusts to the medicine, and do not need medical treatment. If they continue, or they interfere with normal activities, check with a physician.

Epoetin

This medicine may cause flu-like symptoms, such as muscle aches, bone pain, fever, chills, shivering, and sweating, within a few hours after it is taken. These symptoms usually go away within 12 hours. If they do not, or if they are troubling, check with a physician. Other possible side effects that do not need medical attention are **diarrhea**, **nausea** or **vomiting** and fatigue or weakness.

Certain side effects should be brought to a physician's attention as soon as possible. These include headache, vision problems, increased blood pressure, fast heartbeat, weight gain and swelling of the face, fingers, lower legs, ankles or feet.

Anyone who has chest pain or seizures after taking epoetin should seek professional emergency medical attention immediately.

Interferons

This medicine may cause temporary hair loss (**alopecia**). While upsetting, it is not a sign that something is seriously wrong. The hair should grow back normally after treatment ends.

As the body adjusts to the medicine many other side effects usually go away during treatment. These include flu-like symptoms, taste alteration, loss of appetite (anorexia), **nausea and vomiting**, skin rash, and unusual fatigue. If these problems persist, or if they interfere with normal life, check with a physician.

A few more serious side effects should be brought to a physician's attention as soon as possible:

- confusion
- difficulty thinking or concentrating
- nervousness
- depression
- sleep problems
- numbness or tingling in the fingers, toes and face

General caution regarding side effects for all types of immunologic therapy

Other side effects are possible with any type of immunologic therapy. Anyone who has unusual symptoms during or after treatment with these drugs should should contact the physician immediately.

Interactions

Anyone who has immunologic therapy should let the physician know all other medicines being taken. Some combinations of drugs may interact, that can increase or decrease the effects of one or both drugs or can increase the likelihood of side effects. Consultation with a physician is highly recommended to get the insight on whether the possible interactions can interfere with drug therapy or cause harmful effects.

Immunoprevention

Considering that most of the biological modifiers such as cytokines elicit immune response that inhibit incipient tumors before they are clinically evident, immunoprevention has been proposed as a recent strategy for combating cancer. Treatment involving immune molecules (such as cytokines) prepared synthetically or that are not produced by the patients themselves is called as passive immunotherapy. Conversely, a vaccine is a form of active immune therapy because it elicits an immune response in patients. A cancer vaccine may be made of whole tumor cell or of substances or fragments contained in the tumor called antigens.

Newer types of immunologic therapy that are still considered investigational include cell-based therapies. Instead of using synthetic chemicals that resemble substances produced by the body, cell-based

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KEY TERMS

AIDS—Acquired immune deficiency syndrome. A disease caused by infection with the human immunodeficiency virus (HIV). In people with this disease, the immune system breaks down, increasing vulnerability to other infections and some types of cancer.

Bone marrow—Soft tissue that fills the hollow centers of bones. Blood cells and platelets (disk-shaped bodies in the blood that are important in clotting) are produced in the bone marrow.

Chemotherapy—Treatment of an illness with chemical agents. The term usually is used to describe the treatment of cancer with drugs.

Clot—A hard mass that forms when blood coagulates.

Fetus—A developing baby inside the womb.

Hepatitis—Inflammation of the liver caused by a virus, chemical, or drug.

Immune response—The body's natural protective reaction to disease and infection.

Immune system—The system that protects the body against disease and infection through immune responses.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Psoriasis—A skin disease that manifests itself with itchy, scaly, red patches on the skin.

Seizure—A sudden attack, spasm, or convulsion.

Shingles—A disease caused by an infection with the herpes zoster virus—the same virus that causes chickenpox. Symptoms of shingles include pain and blisters along one nerve, usually on the face, chest, stomach, or back.

Sickle cell anemia—An inherited disorder in which red blood cells contain an abnormal form of hemoglobin, a protein that carries oxygen. The abnormal form of hemoglobin causes the red cells to become sickle-shaped. The misshapen cells may clog blood vessels, preventing oxygen from reaching tissues and leading to pain, blood clots and other problems. Sickle cell anemia is most common in people of African descent and in people from Italy, Greece, India, and the Middle East.

therapies use modified stem cells or dendritic cells as vaccines against cancer. Stem cells are undifferentiated cells whose daughter cells can develop into various types of specialized cells, while dendritic cells are cells that are able to initiate and modify the immune system's responses to cancer by activating B cells and T cells. Dendritic cells appear to offer a promising new form of immunotherapy for cancer.

Another investigational form of treatment is the development of cell-free tumor-specific peptide vaccines. Peptides are subunits of protein molecules that contain two or more amino acids. Peptide vaccines are intended to induce responses in the patient's T cells that inhibit tumor growth. As of late 2003, however, peptide-based tumor vaccines have been shown to shrink cancerous tumors only in patients with limited disease.

Adoptive immunotherapy

Adoptive immunotherapy involves stimulating T lymphocytes by exposing them to tumor antigens. These modified cells are grown in the laboratory and then injected into patients. Since the cells taken from a different individual for this purpose often results in rejection, patients serve both as donor and recipient of their own T cells. Adoptive immunotherapy is particularly effective in patients who have received massive doses of radiation and chemotherapy. In such patients, therapy results in immunosuppression (weakened immune systems), making them vulnerable to viral infections. For example, CMV-specific T cells can reduce the risk of cytomegalovirus (CMV) infection in transplant patients.

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Immunosuppressant drugs

Definition

Immunosuppressant drugs, also called **anti-rejection drugs**, are used to prevent the body from rejecting a transplanted organ.

Purpose

When an organ, such as a liver, a heart or a kidney, is transplanted from one person (the donor) into another (the recipient), the immune system of the recipient triggers the same response against the new organ it would have to any foreign material, setting off a chain of events that can damage the transplanted organ. This process is called rejection and it can occur rapidly (acute rejection), or over a long period of time (chronic rejection). Rejection can occur despite close matching of the donated organ and the transplant patient. Immunosuppressant drugs greatly decrease the risks of rejection, protecting the new organ and preserving its function. These drugs act by blocking the immune system so that it is less likely to react against the transplanted organ. A wide variety of drugs are available to achieve this aim but work in different ways to reduce the risk of rejection.

In addition to being used to prevent organ rejection, immunosuppressant drugs are also used to treat such severe skin disorders as **psoriasis** and such other diseases as **rheumatoid arthritis**, **Crohn's disease** (chronic inflammation of the digestive tract) and patchy hair loss (**alopecia** areata). Some of these conditions are termed "autoimmune" diseases, indicating that the immune system is acting against the body itself.

Description

Immunosuppressant drugs can be classified according to their specific molecular mode of action. The three main immunosuppressant drugs currently used in organ transplantations are the following:

- Cyclosporins (Neoral, Sandimmune, SangCya). These drugs act by inhibiting T-cell activation, thus preventing T-cells from attacking the transplanted organ.
- Azathioprines (Imuran). These drugs disrupt the synthesis of DNA and RNA and cell division.
- Corticosteroids such as prednisolone (Deltasone, Orasone). These drugs suppress the inflammation associated with transplant rejection.

Most patients are prescribed a combination of drugs after their transplant, one from each of the above main groups; for example cyclosporin, azathioprine and prednisolone. Over a period of time, the doses of each drug and the number of drugs taken may be reduced as the risks of rejection decrease. However, most patients need to take at least one immunosuppressive for the rest of their lives.

Immunosuppressants can also be classified depending on the specific transplant:

- basiliximab (Simulect) is also used in combination with such other drugs as cyclosporin and corticosteroids, in kidney transplants
- daclizumab (Zenapax) is also used in combination with such other drugs as cyclosporin and corticosteroids, in kidney transplants
- muromonab CD3 (Orthoclone OKT3) is used, along with cyclosporin, in kidney, liver and heart transplants
- tacrolimus (Prograf) is used in liver transplants and is under study for kidney, bone marrow, heart, pancreas, pancreatic island cell, and small bowel transplantation

Some immunosuppressants are also used to treat a variety of autoimmune diseases:

- Azathioprine (Imuran) is used not only to prevent organ rejection in kidney transplants, but also in treatment of rheumatoid arthritis. It has been used to treat chronic ulcerative colitis, but it has been of limited value for this use.
- Cyclosporin (Sandimmune, Neoral) is used in heart, liver, kidney, pancreas, bone marrow and heart/lung transplantation. The Neoral form has been used to treat psoriasis and rheumatoid arthritis. The drug has also been used for many other conditions including multiple sclerosis, diabetes and myesthenia gravis.
- Glatiramer acetate (Copaxone) is used in treatment of relapsing-remitting multiple sclerosis. In one study, glatiramer reduced the frequency of multiple sclerosis attacks by 75% over a two-year period.

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- Mycopehnolate (CellCept) is used along with cyclosporin in kidney, liver and heart transplants. It has also been used to prevent the kidney problems associated with lupus erythematosus.
- Sirolimus (Rapamune) is used in combination with other drugs including cyclosporin and corticosteroids, in kidney transplants. The drug is also used for the treatment of psoriasis.

Recommended dosage

Immunosuppressant drugs are available only with a physician's prescription. They come in tablet, capsule, liquid and injectable forms.

The recommended dosage depends on the type and form of immunosuppressant drug and the purpose for which it is being used. Doses may be different for different patients. The prescribing physician or the pharmacist who filled the prescription will advise on correct dosage.

Taking immunosuppressant drugs exactly as directed is very important. Smaller, larger or more frequent doses should never be taken, and the drugs should never be taken for longer than directed. The physician will decide exactly how much of the medicine each patient needs. Blood tests often are necessary to monitor the action of the drug.

The prescribing physician should be consulted before stopping an immunosuppressant drug.

Precautions

Seeing a physician regularly while taking immunosuppressant drugs is important. These regular check-ups will allow the physician to make sure the drug is working as it should and to watch for unwanted side effects. These drugs are very powerful and can cause serious side effects, such as high blood pressure, kidney problems and liver problems. Some side effects may not show up until years after the medicine is used. Anyone who has been advised to take immunosuppressant drugs should thoroughly discuss the risks and benefits with the prescribing physician

Immunosuppressant drugs lower a person's resistance to infection and can make infections harder to treat. The drugs can also increase the chance of uncontrolled bleeding. Anyone who has a serious infection or injury while taking immunosuppressant drugs should get prompt medical attention and should make sure that the treating physician knows about the immunosuppressant prescription. The prescribing physician should be immediately informed if signs of infection, such as **fever** or chills, **cough** or hoarseness, **pain** in the lower back or side, or painful or difficult urination, bruising or bleeding, blood in the urine, bloody or black, tarry stools occur. Other ways of preventing infection and injury include washing the hands frequently, avoiding sports in which injuries may occur, and being careful when using knives, razors, fingernail clippers or other sharp objects. Avoiding contact with people who have infections is also important. In addition, people who are taking or have been taking immunosuppressant drugs should not have immunizations, such as **smallpox** vaccinations, without checking with their physicians. Because of their low resistance to infection, people taking these drugs might get the disease that the vaccine is designed to prevent. People taking immunosuppressant drugs also should avoid contact with anyone who has taken the oral **polio** vaccine, as there is a chance the virus could be passed on to them. Other people living in their home should not take the oral polio vaccine.

Immunosuppressant drugs may cause the gums to become tender and swollen or to bleed. If this happens, a physician or dentist should be notified. Regular brushing, flossing, cleaning and gum massage may help prevent this problem. A dentist can provide advice on how to clean the teeth and mouth without causing injury.

Special conditions

People who have certain medical conditions or who are taking certain other medicines may have problems if they take immunosuppressant drugs. Before taking these drugs, the prescribing physician should be informed about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to immunosuppressant drugs in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. Azathioprine may cause **birth defects** if used during **pregnancy**, or if either the male or female is using it at time of conception. Anyone taking this medicine should use a barrier method of birth control, such as a diaphragm or **condoms**. Birth control pills should not be used without a physician's approval. Women who become pregnant while taking this medicine should check with their physicians immediately.

The medicine's effects have not been studied in humans during pregnancy. Women who are pregnant or who may become pregnant and who need to take this medicine should check with their physicians.

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KEY TERMS

Antibody—Protein produced by the immune system in response to the presence in the body of an antigen.

Antigen—Any substance or organism that is foreign to the body. Examples of antigens are: bacteria, bacterial toxins, viruses, or other cells or proteins.

Autoimmune disease—A disease in which the immune system is overactive and has lost the ability to distinguish between self and non-self.

Chronic—A word used to describe a long-lasting condition. Chronic conditions often develop gradually and involve slow changes.

Corticosteroids—A class of drugs that are synthetic versions of the cortisone produced by the body. They rank among the most powerful anti-inflammatory agents.

Cortisone—Glucocorticoid produced by the adrenal cortex in response to stress. Cortisone is a steroid with anti-inflammatory and immunosuppressive properties.

Inflammation—A process occurring in body tissues, characterized by increased circulation and the accumulation of white blood cells. Inflammation also occurs in such disorders as arthritis and causes harmful effects.

Inflammatory—Pertaining to inflammation.

Immune response—Physiological response of the body controlled by the immune system that involves the production of antibodies to fight off specific foreign substances or agents (antigens).

Immune system—The network of organs, cells, and molecules that work together to defend the body from foreign substances and organisms causing infection and disease such as: bacteria, viruses, fungi and parasites.

Immunosuppressant—Any chemical substance that suppresses the immune response.

Immunosuppressive—Any agent that suppresses the immune response of an individual.

Immunosuppressive cytotoxic drugs—A class of drugs that function by destroying cells and suppressing the immune response.

Lymphocyte—Lymphocytes are white blood cells that participate in the immune response. The two main groups are the B cells that have antibody molecules on their surface and T cells that destroy antigens.

Psoriasis—A skin disease characterized by itchy, scaly, red patches on the skin.

Rejection—Rejection occurs when the body recognizes a new transplanted organ as "foreign" and turns on the immune system of the body.

T cells—Any of several lymphocytes that have specific antigen receptors, and that are involved in cell-mediated immunity and destruction of antigen-bearing cells.

Transplantation—The removal of tissue from one part of the body for implantation to another part of the body; or the removal of tissue or an organ from one individual and its implantation in another individual by surgery.

BREASTFEEDING. Immunosuppressant drugs pass into breast milk and may cause problems in nursing babies whose mothers take it. **Breastfeeding** is not recommended for women taking this medicine.

OTHER MEDICAL CONDITIONS. People who have certain medical conditions may have problems if they take immunosuppressant drugs. For example:

- People who have shingles (herpes zoster) or chickenpox, or who have recently been exposed to chickenpox, may develop severe disease in other parts of their bodies when they take these medicines.
- The medicine's effects may be greater in people with kidney disease or liver disease, because their bodies are slow to get rid of the medicine.
- The effects of oral forms of this medicine may be weakened in people with intestinal problems, because the medicine cannot be absorbed into the body.

Before using immunosuppressant drugs, people with these or other medical problems should make sure their physicians are aware of their conditions.

USE OF CERTAIN MEDICINES. Taking immunosuppressant drugs with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Side effects

Increased risk of infection is a common side effect of all the immunosuppressant drugs. The immune system protects the body from infections and when the immune system is suppressed, infections are more

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likely. Taking such **antibiotics** as co-trimoxazole prevents some of these infections. Immunosuppressant drugs are also associated with a slightly increased risk of **cancer** because the immune system also plays a role in protecting the body against some forms of cancer. For example, long-term use of immunosuppressant drugs carries an increased risk of developing skin cancer as a result of the combination of the drugs and exposure to sunlight.

Other side effects of immunosuppressant drugs are minor and usually go away as the body adjusts to the medicine. These include loss of appetite, **nausea** or **vomiting**, increased hair growth, and trembling or shaking of the hands. Medical attention is not necessary unless these side effects continue or cause problems.

The treating physician should be notified immediately if any of the following side effects occur:

- unusual tiredness or weakness
- fever or chills
- frequent need to urinate

Interactions

Immunosuppressant drugs may interact with other medicines. When this happens, the effects of one or both drugs may change or the risk of side effects may be greater. Other drugs may also have an adverse effect on immunosuppressant therapy. This is particularly important for patients taking cyclosporin or tacrolimus. For example, some drugs can cause the blood levels to rise, while others can cause the blood levels to fall and it is important to avoid such contraindicated combinations. Other examples are:

- The effects of azathioprine may be greater in people who take allopurinol, a medicine used to treat gout.
- A number of drugs, including female hormones (estrogens), male hormones (androgens), the antifungal drug ketoconazole (Nizoral), the ulcer drug cimetidine (Tagamet) and the erythromycins (used to treat infections), may increase the effects of cyclosporine.
- When sirolimus is taken at the same time as cyclosporin, the blood levels of sirolimus may be increased to a level where there are severe side effects. Although these two drugs are usually used together, the sirolimus should be taken four hours after the dose of cyclosporin.
- Tacrolimus is eliminated through the kidneys. When the drug is used with other drugs that may harm the kidneys, such as cyclosporin, the antibiotics gentamicin and amikacin, or the antifungal drug amphotericin B, blood levels of tacrolimus may be increased. Careful kidney monitoring is essential when tacrolimus is given with any drug that might cause kidney damage.
- The risk of cancer or infection may be greater when immunosuppressant drugs are combined with certain other drugs which also lower the body's ability to fight disease and infection. These drugs include corticosteroids such as prednisone; the anticancer drugs chlorambucil (Leukeran), cyclophosphamide (Cytoxan) and mercaptopurine (Purinethol); and the monoclonal antibody muromonab-CD3 (Orthoclone), which also is used to prevent transplanted organ rejection.

Not every drug that may interact with immunosuppressant drugs is listed here. Anyone who takes immunosuppressant drugs should let the physician know all other medicines he or she is taking and should ask whether the possible interactions can interfere with treatment.

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Immunotherapy *see* **Immunologic therapies**

Impacted tooth

Definition

An impacted tooth is any tooth that is prevented from reaching its normal position in the mouth by tissue, bone, or another tooth.

Description

The teeth that most commonly become impacted are the third molars, also called wisdom teeth. These large teeth are the last to develop, beginning to form when a person is about nine years old, but not breaking through the gum tissue until the late teens or early twenties. By this time, the jaws have stopped growing and may be too small to accommodate these four additional teeth. As the wisdom teeth continue to move, one or more may become impacted, either by running into the teeth next to them or becoming blocked within the jawbone or gum

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KEY TERMS

Dry socket—A painful condition following tooth extraction in which a blood clot does not properly fill the empty socket, leaving the bone underneath exposed to air and food.

Eruption—The process of a tooth breaking through the gum tissue to grow into place in the mouth.

Extraction—The removal of a tooth from its socket in the bone.

Pericoronitis—A gum condition in which irritation and inflammation are produced by the crown of an incompletely erupted tooth.

Wisdom tooth—One of the four last teeth on the top and bottom rows of teeth. Also called a third molar.

tissue. An impacted tooth can cause further dental problems, including infection of the gums, displacement of other teeth, or decay. At least one wisdom tooth becomes impacted in nine of every ten people.

Causes and Symptoms

The movement of an erupting wisdom tooth and any subsequent impaction may produce **pain** at the back of the jaw. Pain may also be the result of infection, either from decay in any exposed portion of the tooth or from trapped food and plaque in the surrounding gum tissue. Infection typically produces an unpleasant taste when biting down and **bad breath**. Another source of pain may be pericoronitis, a gum condition in which the crown of the incompletely erupted tooth produces inflammation, redness, and tenderness of the gums. Less common symptoms of an impacted tooth are swollen lymph nodes in the neck, difficulty opening the mouth, and prolonged **headache**.

Diagnosis

Upon visual examination, the dentist may find signs of infection or swelling in the area where the tooth is present or only partially erupted. **Dental x rays** are necessary to confirm tooth impaction.

Treatment

Because impacted teeth may cause dental problems with few if any symptoms to indicate damage, dentists commonly recommend the removal of all wisdom teeth, preferably while the patient is still a young adult. A dentist may perform an extraction with forceps and local anesthetic if the tooth is exposed and appears to be easily removable in one piece. However, he or she may refer a difficult extraction to an oral surgeon, a specialist who administers either nitrous oxide-oxygen (commonly called "laughing gas"), an intravenous sedative, or a general anesthetic to alleviate any pain or discomfort during the surgical procedure. Extracting an impacted tooth typically requires cutting through gum tissue to expose the tooth, and may require removing portions of bone to free the tooth. The tooth may have to be removed in pieces to minimize destruction to the surrounding structures. The extraction site may or may not require one or more stitches to help the incision heal.

Prognosis

The prognosis is very good when impacted teeth are removed from young healthy adults without complications. Potential complications include postoperative infection, temporary **numbness** from nerve irritation, jaw fracture, and jaw joint pain. An additional condition which may develop is called dry socket: when a blood clot does not properly form in the empty tooth socket, or is disturbed by an oral vacuum (such as from drinking through a straw or **smoking**), the bone beneath the socket is painfully exposed to air and food, and the extraction site heals more slowly.

ORGANIZATIONS

American Association of Oral & Maxillofacial Surgeons, 9700 West Bryn Mawr Avenue, Rosemont, IL, 60018-5701, 847 678-6200, 847 678-6286, 800 822-6637, http://www.aaoms.org.

Bethany Thivierge

Impedance phlebography

Definition

Impedance phlebography is a noninvasive test that uses electrical monitoring to measure blood flow in veins of the leg. Information from this test helps a doctor to detect **deep vein thrombosis** (**blood clots** or **thrombophlebitis**).

Purpose

Impedance phlebography may be done in order to:

- detect blood clots lodged in the deep veins of the leg

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- screen patients who are likely to have blood clots in the leg
- detect the source of blood clots in the lungs (pulmonary emboli)

Blood clots in the legs can lead to more serious problems. If a clot breaks loose from a leg vein, it may travel to the lungs and lodge in a blood vessel in the lungs. Blood clots are more likely to occur in people who have recently had leg injuries, surgery, **cancer**, or a long period of bed rest.

Precautions

Because this test is not invasive, it can be done on all patients. However, the accuracy of the results will be affected if the patient does not breathe normally or keep the leg muscles relaxed. Compression of the veins because of pelvic tumors or decreased blood flow, due to **shock** or any condition that reduces the amount of blood the heart pumps, may also change the test results.

Description

Impedance phlebography works by measuring the resistance to the transmission of electrical energy (impedance). This resistance changes depending on the volume of blood flowing through the veins. By graphing the impedance, a doctor or technician can tell whether a clot is obstructing blood flow.

Using conductive jelly, the examiner puts electrodes on the patient's calf. These electrodes are connected to an instrument called a plethysmograph, which records the changes in electrical resistance that occur during the test.

The patient lies down and raises one leg at a 30° angle, so that the calf is above the level of the heart. The examiner wraps a pressure cuff around the patient's thigh and inflates it to a pressure of 45–60 cm of water for 45 seconds. The plethysmograph records the electrical changes that correspond to changes in the volume of blood in the vein at the time the pressure is exerted and again three seconds after the cuff is deflated. This procedure is repeated several times in both legs.

This test takes 30 to 45 minutes. Impedance phlebography is also called an impedance test of blood flow or impedance plethysmography.

Preparation

Patients undergoing this test do not need to alter their diet, change their normal activities, or stop taking any medications. They will wear a surgical gown during the test, and be asked to urinate before the test starts. If keeping the legs elevated causes discomfort, mild **pain** medication will be given.

KEY TERMS

Thrombophlebitis—Inflammation of a vein, associated with the formation of a blood clot.

Aftercare

The patient may resume normal or postoperative activities after the test.

Risks

Impedance phlebography is painless and safe. It presents no risk to the patient.

Normal results

Normally, inflating the pressure cuff will cause a sharp rise in the pressure in the veins of the calf because blood flow is blocked. When the cuff is released, the pressure decreases rapidly as the blood flows away.

Abnormal results

If a clot is present, the pressure in the calf veins will already be high. It does not become sharply higher when the pressure cuff is tightened. When the pressure cuff is deflated, the clot blocks the flow of blood out of the calf vein. The decrease in pressure is not as rapid as when no clot is present, and the shape of the resulting graph is different.

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Tish Davidson, A.M.

Impedance plethysmography *see* **Impedance phlebography**

Impedance test of blood flow *see* **Impedance phlebography**

Impetigo

Definition

Impetigo refers to a very localized bacterial infection of the skin. There are two types, bullous and epidemic.

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Impetigo is a contagious bacterial skin infection that mostly affects the area around the nose and mouth. Usually caused by staphylococci, this person's impetigo was triggered by herpes simplex. *(Photo Researchers, Inc.)*

KEY TERMS

Systemic—Involving the whole body; the opposite of localized.

Ulcer—An irritated pit in the surface of a tissue.

Vesicle—A bump on the skin filled with fluid.

Description

Impetigo is a skin infection that tends primarily to afflict children. Impetigo caused by the bacterium *Staphylococcus aureus* (also known as staph) affects children of all ages. Impetigo caused by the bacteria called group A streptococci (also know as strep) are most common in children ages two to five.

The bacteria that cause impetigo are very contagious. They can be spread by a child from one part of his or her body to another by scratching, or contact with a towel, clothing, or stuffed animal. These same methods can pass the bacteria on from one person to another.

Impetigo tends to develop in areas of the skin that have already been damaged through some other mechanism (a cut or scrape, burn, insect bite, or vesicle from **chickenpox**).

Causes and symptoms

The first sign of bullous impetigo is a large bump on the skin with a clear, fluid-filled top (called a vesicle). The bump develops a scab-like, honey-colored crust. There is usually no redness or **pain**, although the area may be quite itchy. Ultimately, the skin in this area will become dry and flake away. Bullous impetigo is usually caused by staph bacteria.

Epidemic impetigo can be caused by staph or strep bacteria, and (as the name implies) is very easily passed among children. Certain factors, such as heat and humidity, crowded conditions, and poor hygiene increase the chance that this type of impetigo will spread rapidly among large groups of children. This type of impetigo involves the formation of a small vesicle surrounded by a circle of reddened skin. The vesicles appear first on the face and legs. When a child has several of these vesicles close together, they may spread to one another. The skin surface may become eaten away (ulcerated), leaving irritated pits. When there are many of these deep, pitting ulcers, with pus in the center and brownish-black scabs, the condition is called ecthyma. If left untreated, the type of bacteria causing this type of impetigo has the potential to cause a serious **kidney disease** called **glomerulonephritis**. Even when impetigo is initially caused by strep bacteria, the vesicles are frequently secondarily infected with staph bacteria.

Impetigo is usually an uncomplicated skin condition. Left untreated, however, it may develop into a serious disease, including **osteomyelitis** (bone infection), septic arthritis (joint infection), or **pneumonia**. If large quantities of bacteria are present and begin circulating in the bloodstream, the child is in danger of developing an overwhelming systemic infection known as **sepsis**.

Diagnosis

Characteristic appearance of the skin is the usual method of diagnosis, although fluid from the vesicles can be cultured and then examined in an attempt to identify the causative bacteria.

Treatment

Uncomplicated impetigo is usually treated with a topical antibiotic cream called mupirocin. In more serious, widespread cases of impetigo, or when the child has a **fever** or **swollen glands**, **antibiotics** may be given by mouth or even through a needle placed in a vein (intravenously).

Prognosis

Prognosis for a child with impetigo is excellent. The vast majority of children recover quickly, completely, and uneventfully.

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Prevention

Prevention involves good hygiene. Handwashing; never sharing towels, clothing, or stuffed animals; and keeping fingernails well-trimmed are easy precautions to take to avoid spreading the infection from one person to another.

Resources

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Rosalyn Carson-DeWitt, MD

Implant therapy *see* **Radioactive implants**

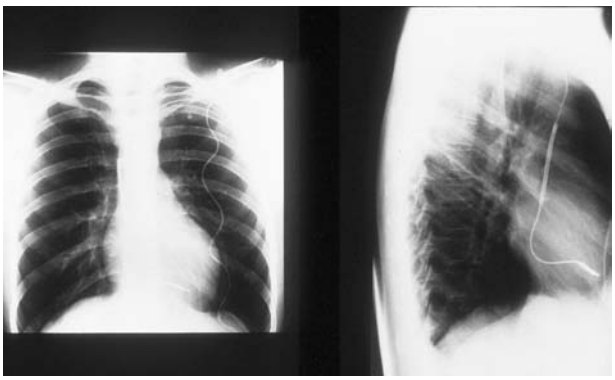
Implantable cardioverter-defibrillator

Definition

The implantable cardioverter-defibrillator is an electronic device to treat life-threatening heartbeat irregularities. It is surgically implanted.

Purpose

The implantable cardioverter-defibrillator is used to detect and stop serious ventricular **arrhythmias** and restore a normal heartbeat in people who are at high risk of sudden **death**. The American Heart Association recommends that implantable cardioverter-defibrillators only be considered for patients who have a life-threatening arrhythmia. A recent study by the National Heart, Lung, and Blood Institute demonstrated that implantable cardioverter-defibrillators are the treatment of choice instead of drug therapy for patients who have had a cardiac arrest or **heart attack** and are at risk for developing **ventricular tachycardia**, which is a very rapid heartbeat, or **ventricular fibrillation**, which is an ineffective, irregular heart activity. Other studies suggest that 20% of these high risk patients would die within two years without an implantable cardioverter-defibrillator. With the device, the five-year risk of sudden death drops to five percent.



X ray of implanted cardioverter-defibrillator. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Precautions

The implantable cardioverter-defibrillator should not be used on patients who faint from causes other than a known life-threatening ventricular arrhythmia, to treat slow heart rates, or during an emergency.

Description

According to the American College of Cardiology, more than 80,000 Americans currently have an implantable cardioverter-defibrillator; 17,000 of these were implanted in 1995 alone. The battery-powered device rescues the patient from a life-threatening arrhythmia by rapid pacing and/or delivering electrical shock(s) to suspend heart activity and then allow it to initiate a normal rhythm. Before the development of the implantable cardioverter-defibrillator, most people who experienced ventricular fibrillation and were not near a hospital with a well equipped emergency team died within minutes.

The implantable cardioverter-defibrillator is like a mini computer connected to the patient's heart. Newer models weigh less than 10 ounces and can be implanted beneath the skin of the chest in the pectoral region, without major surgery. A lead from the device is then inserted into the heart through a vein. The procedure is performed in an operating room under **general anesthesia**. Earlier versions of implantable cardioverter-defibrillators were implanted in the abdomen and required open-chest surgery to connect the electrodes to the left and right ventricles.

The implantable cardioverter-defibrillator is set above the patient's **exercise** heart rate. Once the device is in place, many tests will be conducted to ensure that the device is sensing and defibrillating properly. The newer implantable cardioverter-defibrillators last seven or eight years. Technology and procedures continue to evolve.

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KEY TERMS

Arrhythmia—A variation of the normal rhythm of the heartbeat.

Cardioverter—A device to apply electric shock to the chest to convert an abnormal heartbeat into a normal heartbeat.

Defibrillation—An electronic process which helps re-establish a normal heart rhythm.

Ventricles—The two large lower chambers of the heart which pump blood to the lungs and the rest of the human body.

Ventricular fibrillation—An arrhythmia in which the heart beats very fast but blood is not pumped out to the body. Ventricular fibrillation can quickly become fatal if not corrected.

Ventricular tachycardia—An arrhythmia in which the heart rate is more than 100 beats per minute.

Preparation

Before the procedure, a complete medical history and physical exam will be done. **Electrocardiography**, special electrophysiologic testing, **chest x ray**, **urinalysis**, and a blood test are usually also required.

Aftercare

The patient is monitored for arrhythmias and to ensure that the implantable cardioverter-defibrillator is working properly. The physician also watches for signs of infection. Before the patient leaves the hospital, the device is tested again. Anti-arrhythmia drug therapy is necessary in more than half of all patients with implantable cardioverter-defibrillators, but the number of drugs and the dosages are usually reduced. Any time a significant change in anti-arrhythmia medication is made, the device will be tested again.

The patient is taught how the device works, and that the shock it delivers will feel like a punch or kick in the chest. The patient is told to notify his/her physician when the implantable cardioverter-defibrillator delivers a shock, and to go to the emergency room if multiple shocks are sent within a short period of time.

Although most patients with implantable cardioverter-defibrillators are glad that they have the device and feel that it has extended their lives, they do experience fear and **anxiety**. This stems from the sensation of the shock(s), the unpredictable circumstances under which shock(s) occurs, and unknown outcomes.

Risks

There can be serious complications to the implantation of a cardioverter-defibrillator. These include inflammation of the pericardium, the sac that surrounds the heart; heart attack; congestive **heart failure**; and post-operative **stroke**. Serious infections can develop in the area around the device while the patient is initially hospitalized or up to several months later. Death due to the device's failure while being tested during surgery is an uncommon risk. The risk of death from the implantation procedure is about the same as that for a pacemaker, less than one percent. There are also potentially serious risks associated with the device's improper functioning once it is in place.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, 800 242-8721, Review.personal.info@heart.org.

Texas Heart Institute. Heart Information Service, MC 3-116, PO Box 20345, Houston, TX, 77225, 832 355-4011, 800 292-2221, http://www.texasheart.org.

Lori De Milto

Impotence

Definition

Impotence, often called **erectile dysfunction**, is the inability to achieve or maintain an erection long enough to engage in sexual intercourse.

Description

Under normal circumstances, when a man is sexually stimulated, his brain sends a message down the spinal cord and into the nerves of the penis. The nerve endings in the penis release chemical messengers, called neurotransmitters, that signal the corpora cavernosa (the two spongy rods of tissue that span the length of the penis) to relax and fill with blood. As they expand, the corpora cavernosa close off other veins that would normally drain blood from the penis. As the penis becomes engorged with blood, it enlarges and stiffens, causing an erection. Problems with blood vessels, nerves, or tissues of the penis can interfere with an erection.

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Causes and symptoms

It is estimated that up to 20 million American men frequently suffer from impotence and that it strikes up to half of all men between the ages of 40 and 70. Doctors used to think that most cases of impotence were psychological in origin, but they now recognize that, at least in older men, physical causes may play a primary role in 60% or more of all cases. In men over the age of 60, the leading cause is **atherosclerosis**, or narrowing of the arteries, which can restrict the flow of blood to the penis. Injury or disease of the connective tissue, such as **Peyronie's disease**, may prevent the corpora cavernosa from completely expanding. Damage to the nerves of the penis, from certain types of surgery or neurological conditions, such as Parkinson's disease or **multiple sclerosis**, may also cause impotence. Men with diabetes are especially at risk for impotence because of their high risk of both atherosclerosis and a nerve disease called **diabetic neuropathy**.

Certain types of blood pressure medications, antiulcer drugs, **antihistamines**, tranquilizers (especially before intercourse), antifungals (hetoconazole), antipsychotics, **antianxiety drugs**, and antidepressants, known as **selective serotonin reuptake inhibitors** (SSRIs, including Prozac and Paxil), can interfere with erectile function. **Smoking**, excessive alcohol consumption, and illicit drug use may also contribute. In rare cases, low levels of the male hormone testosterone may contribute to erectile failure. Finally, psychological factors, such as **stress**, guilt, or anxiety, may also play a role, even when the impotence is primarily due to organic causes.

Diagnosis

The doctor also obtains a thorough medical history to find out about past pelvic surgery, diabetes, cardiovascular disease, **kidney disease**, and any medications the man may be taking. The **physical examination** should include a genital examination, a measurement of blood flow through the penis, hormone tests, and a glucose test for diabetes.

In some cases, nocturnal penile tumescence testing is performed to find out whether the man has erections while asleep. Healthy men usually have about four or five erections throughout the night. The man applies a device to the penis called a Rigiscan before going to bed at night, and the device can determine whether he has had erections. (If a man is able to have normal erections at night, this suggests a psychological cause for his impotence.)

Treatment

Years ago, the standard treatment for impotence was an implantable penile prosthesis or long-term **psychotherapy**. Although physical causes are now more readily diagnosed and treated, individual or marital counseling is still an effective treatment for impotence when emotional factors play a role. Fortunately, other approaches are now available to treat the physical causes of impotence.

Medications

The first line and by far the most common treatment today is with the prescription drug **sildenafil citrate**, sold under the brand name Viagra. An estimated 20 million prescriptions for the pill have been filled since it was approved by the FDA in March 1998. It is also the most effective treatment with a success rate of more than 60%. The drug boosts levels of a substance called cyclic GMP, which is responsible for widening the blood vessels of the penis. In clinical studies, Viagra produced headaches in 16% of men who took it, and other side effects included flushing, **indigestion**, and stuffy nose.

The primary drawback to Viagra, which works about an hour after it is taken, it that the FDA cautions men with heart disease or low blood pressure to be thoroughly examined by a physician before obtaining a prescription.

In the summer of 2002, two investigational drugs were announced to become available in the near future to also treat erectile dysfunction. Vardenafil and tadalafil both helped men who also had such conditions as diabetes, high blood pressure and benign prostatic hypertrophy. The drugs are now available via prescription.

Vardenafil and tadalafil belong to the same group of chemical compounds as sildenafil, namely phosphodiesterase type 5 (PDE-5) inhibitors. Some men cannot benefit from sildenafil or the two newer PDE-5 inhibitors because they have low levels of nitric oxide. British investigators reported in late 2002 that three different types of compounds are being studied as possible medications for men with low levels of nitric oxide. They are Rho-kinase inhibitors, soluble guanylate cyclase activators, and nitric oxide-releasing PDE-5 inhibitors.

Other medications under investigation as treatments for impotence are topical agents. Topical means that they are applied externally to the skin rather than being injected or taken by mouth. If approved, these drugs would provide a noninvasive

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KEY TERMS

Alprostadil—A smooth muscle relaxant sometimes injected into the penis or applied to the urethral opening to treat impotence.

Atherosclerosis—A disorder in which plaques of cholesterol, lipids, and other debris build up on the inner walls of arteries, narrowing them.

Corpus cavernosum (plural, corpora cavernosa)—One of two rods of spongy tissue in the penis that become engorged with blood in order to produce an erection.

Gene therapy—A method of treating a disorder by replacing damaged or abnormal genes with normal ones. Some researchers think that gene therapy may offer a new way to treat impotence.

Neurotransmitters—Chemicals that modify or help transmit impulses between nerve synapses.

Papaverine—A smooth muscle relaxant sometimes injected into the penis as a treatment for impotence.

Peyronie's disease—A disease resulting from scarring of the corpus cavernosa, causing painful erections.

Topical—A type of medication that is applied to a specific and limited area of skin, and affects only the area to which it is applied.

Urethra—The small tube that drains urine from the bladder, as well as serving as a conduit for semen during ejaculation in men.

Viagra—Trade name of an orally administered drug for erectile failure first cleared for marketing in the United States in March 1998. Its generic name is sildenafil citrate.

alternative for men who cannot take sildenafil or other oral medications for impotence.

Injection therapy involves injecting a substance into the penis to enhance blood flow and cause an erection. The Food and Drug Administration (FDA) approved a drug called alprostadil (Caverject) for this purpose in July of 1995. Alprostadil relaxes smooth muscle tissue to enhance blood flow into the penis. It must be injected shortly before intercourse. Another, similar drug that is sometimes used is papaverine—not yet been approved by the FDA for this use. Either drug may sometimes cause painful erections or **priapism** (uncomfortable, prolonged erections) that must be treated with a shot of epinephrine.

Alprostadil may also be administered into the urethral opening of the penis. In MUSE (medical urethral system for erection), the man inserts a thin tube the width of a vermicelli noodle into his urethral opening and presses down on a plunger to deliver a tiny pellet containing alprostadil into his penis. The drug takes about 10 minutes to work and the erection lasts about an hour. The main side effect is a sensation of **pain** and burning in the urethra, which can last about five to 15 minutes.

Mechanical and surgical treatments

Another approach is vacuum therapy. The man inserts his penis into a clear plastic cylinder and uses a pump to force air out of the cylinder. This forms a partial vacuum around the penis, which helps to draw blood into the corpora cavernosa. The man then places a special ring over the base of the penis to trap the blood inside it. The only side effect with this type of treatment is occasional bruising if the vacuum is left on too long.

Implantable **penile prostheses** are usually considered a last resort for treating impotence. They are implanted in the corpora cavernosa to make the penis rigid without the need for blood flow. The semi-rigid type of prosthesis consists of a pair of flexible silicone rods that can be bent up or down. This type of device has a low failure rate but, unfortunately, it causes the penis to always be erect, which can be difficult to conceal under clothing.

The inflatable type of device consists of cylinders that are implanted in the corpora cavernosa, a fluid reservoir implanted in the abdomen, and a pump placed in the scrotum. The man squeezes the pump to move fluid into the cylinders and cause them to become rigid. (He reverses the process by squeezing the pump again.) While these devices allow for intermittent erections, they have a slightly higher malfunction rate than the silicon rods.

Men can return to sexual activity six to eight weeks after implantation surgery. Since implants affect the corpora cavernosa, they permanently take away a man's ability to have a natural erection.

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In rare cases, if narrowed or diseased veins are responsible for impotence, surgeons may reroute the blood flow into the corpus cavernosa or remove leaking vessels. However, the success rate with these procedures has been very low, and they are still considered experimental.

Gene therapy

A newer investigational approach to the treatment of erectile dysfunction is **gene therapy**. As of late 2002, several preclinical studies have shown promise, but none of the gene-based strategies so far have yet been tested for safety.

Alternative treatment

A number of herbs have been promoted for treating impotence. The most widely touted herbs for this purpose are *Coryanthe yohimbe* (available by prescription as yohimbine, with the trade name Yocon) and gingko (*Gingko biloba*), although neither has been conclusively shown to help the condition in controlled studies. In addition, gingko carries some risk of abnormal blood clotting and should be avoided by men taking blood thinners such as coumadin. Other herbs promoted for treating impotence include true unicorn root (*Aletrius farinosa*), **saw palmetto** (*Serenoa repens*), **ginseng** (*Panax ginseng*), and Siberian ginseng (*Eleuthrococcus senticosus*). *Strychnos Nux vomica* has been recommended, especially when impotence is caused by excessive alcohol, cigarettes, or dietary indiscretions, but it can be very toxic if taken improperly, so it should be used only under the strict supervision of a physician trained in its use.

Prognosis

With proper diagnosis, impotence can nearly always be treated or managed successfully. Unfortunately, fewer than 10% of impotent men seek treatment.

Prevention

There is no specific treatment to prevent impotence. Perhaps the most important measure is to maintain general good health and avoid atherosclerosis by exercising regularly, controlling weight, controlling **hypertension** and high cholesterol levels, and avoiding smoking. Avoiding excessive alcohol intake may also help.

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ORGANIZATIONS

American Urological Association (AUA), 1000 Corporate Boulevard, Linthicum, MD, 21090, 410 689-3700, 410 689-3800, 866 746-4282, aua@AUAnet.org, http://www.auanet.org.

American Urological Association Foundation, 1000 Corporate Blvd., Linthicum, MD, 21090, 410 689-3700, 410 689-3800, 866 746-4282, auafoundation@auafoundation.org, http://www.urologyhealth.org/.

Center for Biologics Evaluation and Research (CBER), U. S. Food and Drug Administration (FDA), 10903 New Hampshire Ave, Silver Spring, MD, 20993-0002, 888 463-6332, http://www.fda.gov/BiologicsBloodVaccines.

National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) NIH Bldg 31, Rm 9A06 31 Center Drive, MSC 2560, Bethesda, MD, 20892-2560, 301 496.3583, http://www2.niddk.nih.gov.

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Impulse control disorders

Definition

Impulse control disorders are characterized by an individual's inability to resist the impulse to perform an action that is harmful to one's self or others. This condition is a relatively new class of **personality disorders**. Medical researchers surmise that at the root of the problem, the afflicted person desires small, short–term pleasures or gains—often performed impulsively and without the ability to resist such behaviors—over the likelihood of much larger, long–term loses. Some of the most common types of these disorders are **intermittent explosive disorder**, kleptomania, pyromania, compulsive gambling disorder, and trichotillomania.

Demographics

Such disorders are found in both genders of the population. They usually begin to appear in children in and around the ages of seven to 15 years of age.

Description

All of these impulse control disorders involve the loss or lack of control in certain specific situations. The hallmark of these disorders is the individual's inability to stop impulses that may cause harm to themselves or others. Affected individuals often feel **anxiety** or tension in considering these behaviors. This anxiety or tension is relieved or diminished once the action is performed.

Intermittent explosive disorder (IED) is more common among males, and involves repeated and aggressive, violet outbursts that lead to assaults on others or destruction of property. These outbursts, often only ten to twenty minutes in duration, are unprovoked or seem to be out of proportion to the event that precedes them. Afterwards, such people often feel remorse and regret from such actions. The outbursts may happen in several separate incidents over a few hours or days or may occur as one or more every so many weeks or months. Examples of intermittent explosive disorder commonly found in daily life include road rage and domestic violence and **abuse**.

Kleptomania is more common among females, and involves the theft of objects that are seemingly worthless. The act of stealing relieves tension and anxiety, and increases personal gratification during the act. Once the act is accomplished, individuals feel relieved of their tensions. In addition, they do not steal for the sense of monetary gain. The actual stealing is not preplanned, and the concept of punishment for the crime does not occur to these individuals, although they are aware that what they are doing is wrong. The people afflicted with kleptomania are often very ashamed of their actions afterwards, but are unable to stop themselves and oftentimes unwilling to seek medical or psychological help.

Pyromania is more common among males, and involves setting fires in order to feel pleasure and relieve tension. It is classified by the deliberate setting of fires more than once. Pyromaniacs do not start fires for the same reasons as do arsonists. They are not looking for revenge, monetary gain, or political reasons, only feelings of relief or gratification. They do not start fires as direct part of criminal behavior or due to **hallucinations** (such as with drug use). The individual exhibits a fascination and attraction to fire and any objects associated with it. Pryomanics often direct their actions toward fire stations and other buildings associated with fire control and prevention.

Pathological gambling occurs in roughly one to three percent of the population, and involves excessive (compulsive) gambling despite heavy monetary losses. This disorder typically begins in youth, and affected individuals are often competitive, easily bored, restless, and generous. Their losses actually act as a motivating factor in continuing gambling in order to recoup some of what was lost. Pathological gamblers often use lies, theft, and fraud to continue their compulsive gambling habit. They often gamble more during periods of high **stress** or anxiety in order to counter their feelings. Often they gamble for the excitement and not for the money. However, many of them lose large amounts of money, which only makes them more anxious and, in turn, more likely to place larger and riskier bets.

Trichotillomania, also commonly called hair–pulling disorder, involves the uncontrollable, nearly continuous pulling of hair from one's own scalp, face, or other areas of the body, and is more common in females. It often begins in childhood, and is often associated with major depression or attention deficit/hyperactivity disorder. There is an increased sense of tension before pulling the hair, which is relieved once it is pulled out. Recurrent pulling out of one's hair may result in noticeable hair loss. It can be a mild problem for some people and in others, quite devastating. For all of them, the disorder is very emotional, especially when large amounts of hair are pulled from visible parts of the body, such as from the head. Affected individuals can undergo significant distress and impaired social, occupational, and functional behavior.

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Causes and symptoms

The exact causes of impulse control disorders are not fully understood as of 2010. Individuals who have had serious head injuries, however, can be at a higher risk for developing impulse control disorders, as are those with **epilepsy**.

Some cases of impulse control disorders appear to be side effects of general medical conditions. Several groups of researchers have noted that some older adults with Parkinson's disease become compulsive gamblers as the disease progresses. It is thought that this gambling behavior is a side effect of dopaminergic drugs, as it does not respond to standard treatments for compulsive gambling but only to changes in the patient's medication. A study performed in 2007, headed by a medical researcher from the U.S. National Institute of Neurological Disorders and Stroke, found that pathological gamblers who received dopamine agonists developed Parkinson's disease at a younger age than those without the disorder. Those with the disorder also scored lower on an impulsivity scale than did other people.

Another medical condition that is associated with impulse control disorders is carcinoid syndrome. In one group of 20 patients with the syndrome, 75% met DSM–IV diagnostic criteria for one or another impulse control disorder. The researchers attribute the connection to the high levels of serotonin (a neurotransmitter) produced by carcinoid tumors.

The cause of intermittent explosive disorder may be due to environmental, genetic, or biological factors, but the exact cause is still undetermined.

Numerous symptoms of intermittent explosive disorder are:

- irritability
- rage and anger
- tingling
- increased energy
- tremors and palpitations
- tightness of the chest
- headache or pressure in or about the head

The cause of kleptomania is not known for sure in the medical community. Some researchers have suggested that certain chemicals in the brain may be linked to the condition. However, additional research is needed before a determination of the cause of the disorder can be announced.

Some of the symptoms of kleptomania are:

- strong urges to steal even though the items are not needed
- tension and anxiety leading up to the act of stealing
- feelings of pleasure and satisfaction while in the act of the theft
- feelings of guilt, embarrassment, and shame afterwards

Although not known for sure, genetic and environmental factors are considered to be possible causes for pathological gambling. Certain natural occurring chemicals in the brain, such as dopamine, norepinephrine, and serotonin indicate possible associations with the disorder. Sometimes, medications taken (external to the disorder) may bring on the disorder. Serious injuries, such as brain trauma, can also contribute to pathological gambling.

Several symptoms of pathological gambling are:

- extreme excitement from taking large gambling bets
- being preoccupied with gambling
- increasing the number and/or amount of gambling bets
- showing more interest in gambling than other personal and professional interests
- lying about gambling
- feelings of remorse and guilt after gambling
- large debts and financial problems; also, some legal difficulties may develop
- problems holding onto job and career, and difficulties coping with family responsibilities

For trichotillomania, mutations in the gene SLITRK1 have been associated with the disorder. Tourette syndrome—in which people make unusual movements and sounds—is also linked to the disorder. Problems with natural chemicals in the brain, such as dopamine and serotonin, are suggested as a possible cause of trichotillomania.

Symptoms of trichotillomania include:

- bald or patchy spots on the scalp or other parts of the body
- excessive playing with hair or pulled–out hair, including chewing of hair
- thin or missing eyebrows and eyelashes
- pulling hair across the face, especially the lips

Diagnosis

A diagnosis of any of these impulse control disorders can be made only after other medical and psychiatric disorders that may cause the same symptoms have been ruled out. Once this is done a medical

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KEY TERMS

Carcinoid syndrome—The pattern of symptoms (often including asthma and diarrhea) associated with carcinoid tumors of the digestive tract or lungs.

Compulsive gambling disorder—An impulse control disorder in which an individual cannot resist gambling despite repeated losses.

Intermittent explosive disorder—A personality disorder in which an individual is prone to intermittent explosive episodes of aggression during which he or she causes bodily harm or destroys property.

Kleptomania—An impulse control disorder in which one steals objects that are of little or no value.

Pyromania—An impulse control disorder in which one sets fires.

Trichotillomania—An impulse or compulsion to pull out one's own hair.

professional analyzes the physical and mental problems apparent to the patient.

In addition, many doctors administer questionnaires or similar psychiatric screeners as part of the differential diagnosis. Two instruments that were devised in the early 2000s to specifically target impulsive behavior are the Gambling Urge Scale (GUS) and the Lifetime History of Impulsive Behaviors (LHIB) Interview.

For instance, in a medical diagnosis of pathological gambling, five or more of the following symptoms must be present:

- a preoccupation with gambling
- a need to gamble with more money to achieve the thrill of winning
- repeated attempts to control or stop gambling
- irritability or restlessness due to repeated attempts of control
- gambling as an escape from stress
- lying to cover up gambling
- conducting illegal activities, such as embezzling or fraud, to finance gambling
- losing a job or personal relationship due to gambling
- borrowing money to fund gambling

Treatment

A combination of psychological counseling and medication are the preferred treatments for impulse control disorders. For kleptomania, pyromania, and trichotillomania, behavior modification is usually the treatment of choice. Children with trichotillomania are often helped by antidepressant medication. For pathological gambling, treatment usually involves an adaptation of the model set forth by Alcoholics Anonymous. Individuals are counseled with the goal of eventual responding to appropriate social limits. In the case of intermittent explosive disorder, anger management and medication may be used in extreme cases of aggression.

Prognosis

These disorders can usually be controlled with medication, although the medication may need to be continued long–term to help prevent further aggressive outbursts. Long–term counseling is usually necessary as well. Support groups and meetings may also help these individuals.

The prognosis for intermittent explosive disorder, kleptomania, and pyromania is fair. Little is known about the prognosis for trichotillomania, and studies have shown that the condition can disappear for long periods (months to years) without any psychological counseling. For pathological gambling, the prognosis varies greatly from person to person. While total cure for this condition is unlikely, much like **alcoholism**, long periods of abstinence or continuous abstinence are possible.

Prevention

There are no known preventive treatments or measures for impulse control disorders.

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ORGANIZATIONS

American Psychiatric Association (APA), 1000 Wilson Blvd., Suite 1825, Arlington, VA, 22209, (888) 357–7924, http://www.psych.org.

Gamblers Anonymous International Service Office, PO Box 17173, Los Angeles, CA, 90017, (213) 386–8789, (213) 386–0030, isomain@gamblersanonymous.org, http://www.gamblersanonymous.org.

National Institute of Mental Health (NIMH), 6001 Executive Blvd., Room 8184, MSC 9663, Bethesda, MD, 20892–9663, (301) 443–4513, http://www.nimh.nih.gov.

Trichotillomania Learning Center, Inc., 207 McPherson St., Suite H, Santa Cruz, CA, 95060–5863, (831) 457–1004, (831) 426–4383, info@trich.org, http://www.trich.org.

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In vitro fertilization

Definition

In vitro fertilization (IVF) is a procedure in which eggs (ova) from a woman's ovary are removed. They are fertilized with sperm in a laboratory procedure, and then the fertilized egg (embryo) is returned to the woman's uterus.

Purpose

IVF is one of several assisted reproductive techniques (ART) used to help infertile couples to conceive a child. If after one year of having sexual intercourse without the use of birth control a woman is unable to get pregnant, **infertility** is suspected. Some of the reasons for infertility are damaged or blocked fallopian tubes, hormonal imbalance, or **endometriosis** in the woman. In the man, low sperm count or poor quality sperm can cause infertility.

IVF is one of several possible methods to increase the chance for an infertile couple to become pregnant. Its use depends on the reason for infertility. IVF may be an option if there is a blockage in the fallopian tube or endometriosis in the woman or low sperm count or poor quality sperm in the man. There are other possible treatments for these conditions, such as surgery for blocked tubes or endometriosis, which may be tried before IVF.

IVF will not work for a woman who is not capable of ovulating or a man who is not able to produce at least a few healthy sperm.

Precautions

The screening procedures and treatments for infertility can become a long, expensive, and sometimes, disappointing process. Each IVF attempt takes at least an entire menstrual cycle and can cost $5,000-$10,000, which may or may not be covered by health insurance. The **anxiety** of dealing with infertility can challenge both individuals and their relationship. The added **stress** and expense of multiple clinic visits, testing, treatments, and surgical procedures can become overwhelming. Couples may want to receive counseling and support throughout the process.

Description

In vitro fertilization is a procedure where the joining of egg and sperm takes place outside of the woman's body. A woman may be given fertility drugs before this procedure so that several eggs mature in the ovaries at the same time. Eggs (ova) are removed from a woman's ovaries using a long, thin needle. The physician gains access to the ovaries using one of two possible procedures. One procedure involves inserting the needle through the vagina (transvaginally). The physician guides the needle to the location of the ovaries with the help of an ultrasound machine. In the other procedure, called **laparoscopy**, a small thin tube with a viewing lens is inserted through an incision in the navel. This allows the physician to see inside the patient, and locate the ovaries, on a video monitor.

Once the eggs are removed, they are mixed with sperm in a laboratory dish or test tube. (This is where the term *test tube baby* comes from.) The eggs are monitored for several days. Once there is evidence that fertilization has occurred and the cells begin to divide, they are then returned to the woman's uterus.

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PATRICK CHRISTOPHER STEPTOE (1913–1988)

(AP Images.)

Patrick Christopher Steptoe was born in Oxfordshire, England, on June 9, 1913. His mother was a social worker and his father was a church organist. Steptoe entered the University of London's St. George Hospital Medical School, earning his physician's license in 1939 and becoming a member of the Royal College of Surgeons. When Steptoe volunteered as a naval surgeon during World War II, he was captured and held as a prisoner until his release in 1943. Following his release, Steptoe studied obstetrics and gynecology and moved to Manchester to start a private practice in 1948. In 1951, Steptoe accepted a position at Oldham General and District Hospital in England.

During his time at Oldham, Steptoe continued his study of fertility problems. Using a laparoscope, he developed a method to remove eggs from a woman's ovaries. In 1966, Steptoe teamed with physiologist Robert G. Edwards who had successfully fertilized eggs outside of the body. In 1968, the pair had a breakthrough when Edwards successfully fertilized an egg that Steptoe had removed, but their attempts to implant the embryo failed repeatedly. However, Steptoe and Edwards experienced success when a fertilized egg was implanted into the uterus of Leslie Brown. Brown gave birth to a healthy baby girl, Louise, on July 25, 1978.

Steptoe retired and built a clinic in Cambridge. He and Edwards were named Commanders of the British Empire, and Steptoe was honored with fellowship in the Royal Society. He and his wife had two children. Steptoe died on March 21, 1988.

In the procedure to remove eggs, enough may be gathered to be frozen and saved (either fertilized or unfertilized) for additional IVF attempts. A 2004 study from the Mayo Clinic found that frozen sperm was as effective as fresh sperm for IVF.

IVF has been used successfully since 1978, when the first child to be conceived by this method was born in England. Over the past 20 years, thousands of couples have used this method of ART or similar procedures to conceive.

Other types of assisted reproductive technologies might be used to achieve **pregnancy**. A procedure called intracytoplasmic sperm injection (ICSI) uses a manipulation technique that must be performed using a microscope to inject a single sperm into each egg. The fertilized eggs can then be returned to the uterus, as in IVF. In gamete intrafallopian tube transfer (GIFT) the eggs and sperm are mixed in a narrow tube and then deposited in the fallopian tube, where fertilization normally takes place. Another variation on IVF is zygote intrafallopian tube transfer (ZIFT). As in IVF, the fertilization of the eggs occurs in a laboratory dish. And, similar to GIFT, the embryos are placed in the fallopian tube (rather than the uterus as with IVF).

Preparation

Once a woman is determined to be a good candidate for in vitro fertilization, she will generally be given "fertility drugs" to stimulate ovulation and the development of multiple eggs. These drugs may include gonadotropin releasing hormone agonists (GnRHa), Pergonal, Clomid, or human chorionic gonadotropin (hcg). The maturation of the eggs is then monitored with ultrasound tests and frequent blood tests. If enough eggs mature, the physician will perform the procedure to remove them. The woman may be given a sedative prior to the procedure. A local anesthetic agent may also be used to reduce discomfort during the procedure.

Aftercare

After the IVF procedure is performed the woman can resume normal activities. A pregnancy test can be

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KEY TERMS

Fallopian tubes—In a woman's reproductive system, a pair of narrow tubes that carry the egg from the ovary to the uterus.

GIFT—Stands for gamete intrafallopian tube transfer. This is a process where eggs are taken from a woman's ovaries, mixed with sperm, and then deposited into the woman's fallopian tube.

ICSI—Stands for intracytoplasmic sperm injection. This process is used to inject a single sperm into each egg before the fertilized eggs are put back into the woman's body. The procedure may be used if the male has a low sperm count.

ZIFT—Stands for zygote intrafallopian tube transfer. In this process of in vitro fertilization, the eggs are fertilized in a laboratory dish and then placed in the woman's fallopian tube.

done approximately 12–14 days later to determine if the procedure was successful.

Risks

The risks associated with in vitro fertilization include the possibility of **multiple pregnancy** (since several embryos may be implanted) and **ectopic pregnancy** (an embryo that implants in the fallopian tube or in the abdominal cavity outside the uterus). There is a slight risk of ovarian rupture, bleeding, infections, and complications of anesthesia. If the procedure is successful and pregnancy is achieved, the pregnancy would carry the same risks as any pregnancy achieved without assisted technology.

Normal results

Success rates vary widely between clinics and between physicians performing the procedure and implantation does not guarantee pregnancy. Therefore, the procedure may have to be repeated more than once to achieve pregnancy. However, success rates have improved in recent years, up from 20% in 1995 to 27% in 2001.

Abnormal results

An ectopic or multiple pregnancy may abort spontaneously or may require termination if the health of the mother is at risk. The number of multiple pregnancies has decreased in recent years as technical advances and professional guidelines have led to implanting of fewer embryos per attempt.

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ORGANIZATIONS

American Society for Reproductive Medicine, 1209 Montgomery Highway, Birmingham, AL, 35216-2809, 205 978-5000, 205 978-5005, asrm@asrm.org, http://www.asrm.org.

Center for Fertility and In Vitro Fertilization Loma Linda University, 11370 Anderson St, Loma Linda, CA, 92354, 909 558-2851, 909 558-2450, amarta@llu. edu, http://lomalindahealth.org/health-care/our-services/fertility/index.page?.

Resolve, 1310 Broadway, Somerville, MA, 02144-1731, 617 623-0744, http://www.resolve.org.

Altha Roberts Edgren
Teresa G. Odle

Inclusion blennorrhea *see* **Inclusion conjunctivitis**

Inclusion conjunctivitis

Definition

Inclusion **conjunctivitis** is an inflammation of the conjunctiva (the membrane that lines the eyelids and covers the white part, or sclera, of the eyeball) by the bacterium *Chlamydia trachomatis*. Chlamydia is a sexually transmitted organism. Chlamydia was originally called "chlamydozoa" by Polish dermatologist Ludwig Halberstaedter and Czech zoologist Stanislaus von Prowazek in 1907 when they discovered *Chlamydia trachomatis*. Chlamydozoa is the Greek word for "mantle."

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Demographics

The disease usually affects teenagers and young adults who are sexually active. In fact, persons with the disease often times also have genital chlamydia (an infection of the genitals). The disease also occurs in newborn infants. Women are usually more susceptible to the disease than are men, and people in urban areas frequently acquire it more than do rural people.

Description

Inclusion conjunctivitis, known as neonatal inclusion conjunctivitis in the newborn and adult inclusion conjunctivitis in the adult, is also called inclusion blennorrhea, chlamydial conjunctivitis, or swimming pool conjunctivitis. It usually occurs from poor personal hygiene, specifically from the transmission of contaminated genital secretions to the eye. This disease affects four of 1,000 (0.4%) live births. Approximately half of the infants born to untreated infected mothers will develop the disease.

Causes and symptoms

Inclusion conjunctivitis in the newborn, called neonatal conjunctivitis, results from passage through an infected birth canal and develops from 5 to 12 days after birth. Both eyelids and conjunctivae are swollen and red in color. There may be a discharge of pus from the eyes, swelling of the eyelids, and redness around the eye. Irritation, infection, or blocked tear ducts are three primary causes of inclusion conjunctivitis. In infants, the disease can become very serious.

Most instances of adult inclusion conjunctivitis result from exposure to infected genital secretions. It is transmitted to the eye by fingers and occasionally by the water in swimming pools, poorly chlorinated hot tubs, or by sharing makeup. In adult inclusion conjunctivitis, one eye is usually involved, with a stringy discharge of mucus and pus. There may be little bumps called follicles inside the lower eyelid and the eye is red. Occasionally, the condition damages the cornea, causing cloudy areas and a growth of new blood vessels (neovascularization). Women sometimes report genito-urinary symptoms.

Diagnosis

Inclusion conjunctivitis is usually considered when the patient has a follicular conjunctivitis that will not go away, even after using **topical antibiotics**. Diagnosis depends upon tests performed on the discharge from the eye. Gram stains determine the type of microorganism, while culture and sensitivity tests determine which antibiotic will kill the harmful microorganism. Conjuntival scraping determines whether chlamydia is present in cells taken from the conjunctiva.

KEY TERMS

Cervicitis—Cervicitis is an inflammation of the cervix or neck of the uterus.

Conjunctiva—The conjunctiva is the membrane that lines the eyelids and covers the white part of the eyeball (sclera).

Cornea—The clear dome-shaped structure that covers the colored part of the eye (iris).

Neovascularization—Neovascularization is the growth of new blood vessels.

Urethritis—Urethritis is an inflammation of the urethra, the canal for the discharge of urine that extends from the bladder to the outside of the body.

Treatment

Treatment in the newborn consists of administration of tetracycline ointment to the conjunctiva and erythromycin orally or through intravenous therapy for fourteen days. Infants can also be given erythromycin ophthalmic ointment for one week, and erythromycin or azithromycin elixir for two to three weeks. The mother should be treated for **cervicitis** (inflammation of the uterine cervix) and the father for **urethritis** (inflammation of the urethra), even if they do not have symptoms of these diseases.

In adults, tetracycline ointment or drops should be applied to the conjunctiva and oral tetracycline, amoxacillin, or erythromycin should be taken for up to three weeks, or doxycycline for one week. A single oral dose of azithromycin helps to control redness in and around the eye, along with mucous discharge. In severe cases, intravenous **antibiotics** may also be used, together with topical antibiotics. If a blocked tear duct is to blame, warm and gently massages are given between the nasal area and the eye. They help to reduce swelling and irritation. If the blocked tear duct does not heal within one year, surgery may be necessary.

Patients should have weekly checkups so the doctor can monitor the healing.

Oral tetracycline should not be administered to children whose permanent teeth have not erupted. It should also not be given to nursing or pregnant women.

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Prognosis

Untreated inclusion conjunctivitis in the newborn persists for 3 to 12 months and usually heals; however, there may be scarring or neovascularization. The occurrence of it in infants has decreased over the past few decades as more women are screened and treated before they become pregnant. In the adult, if left untreated, the disease may continue for months and cause corneal neovascularization. Even if treated, antibiotics usually do not reverse damage that may have occurred, but they may help prevent it if given early enough. The infection can spread to the nasopharynx and the lower respiratory tract. **Pneumonia** can result if left untreated.

Prevention

The neonatal infection may be prevented by instilling erythromycin drops or ointment into the eye's conjunctival cul-de-sac at the baby's birth. Many state laws require medical professionals perform such preventative measures to babies born in hospitals. However, it is not prevented by silver nitrate, which was a treatment in the past. Instead, antibiotic eye drops are used.

Chlamydia is a contagious, sexually transmitted disease. Some systemic symptoms include a history of vaginitis, **pelvic inflammatory disease**, or urethritis. Patients with symptoms of these diseases should be treated by a physician.

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ORGANIZATIONS

American Academy of Ophthalmology, 655 Beach Street, San Francisco, CA, 94109, (415) 561-8500, eyenet@aao.org, http://www.eyenet.org.

American Optometric Association, 243 North Lindbergh Blvd., St. Louis, MO, 63141, (800) 365-2219, eyenet@aao.org, http://www.aoanet.org.

Lorraine Steefel, RN

Incompetent cervix

Definition

A cervix (the structure at the bottom of the uterus) that is incompetent is abnormally weak, and therefore it can gradually widen during **pregnancy**. Left untreated, this can result in repeated pregnancy losses or premature delivery.

Description

Incompetent cervix is the result of an anatomical abnormality. Normally, the cervix remains closed throughout pregnancy until labor begins. An incompetent cervix gradually opens due to the pressure from the developing fetus after about the 13th week of pregnancy. The cervix begins to thin out and widen without any contractions or labor. The membranes surrounding the fetus bulge down into the opening of the cervix until they break, resulting in the loss of the baby or a very premature delivery.

Causes and symptoms

Some factors that can contribute to the chance of a woman having an incompetent cervix include trauma to the cervix, physical abnormality of the cervix, or having been exposed to the drug diethylstilbestrol (DES) in the mother's womb. Some women have cervical incompetence for no obvious reason.

Diagnosis

Incompetent cervix is suspected when a woman has three consecutive spontaneous pregnancy losses during the second trimester (the fourth, fifth and sixth months of the pregnancy). The likelihood of this happening by random chance is less than 1%. Spontaneous losses due to incompetent cervix account for 20–25% of all second trimester losses. A spontaneous second trimester pregnancy loss is different from a **miscarriage**, which usually happens during the first three months of pregnancy.

The physician can check for abnormalities in the cervix by performing a manual examination or by an ultrasound test. The physician can also check to see if the cervix is prematurely widened (dilated). Because incompetent cervix is only one of several potential causes for this, the patient's past history of pregnancy losses must also be considered when making the diagnosis.

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KEY TERMS

Diethylstilbestrol (DES)—DES is a drug given to women a generation ago to prevent miscarriage. At that time it was not known that female children born of women who had been given DES would show a higher rate for cervical and other reproductive abnormalities, as well as a rare form of vaginal cancer, when they reached reproductive age.

Effacement—The thinning out of the cervix that normally occurs along with dilation shortly before delivery.

Preterm labor—Labor before the thirty-seventh week of pregnancy.

Treatment

Treatment for incompetent cervix is a surgical procedure called cervical cerclage. A stitch (suture) is used to tie the cervix shut to give it more support. It is most effective if it is performed somewhere between 14–16 weeks into the pregnancy. The stitch is removed near the end of pregnancy to allow for a normal birth.

Cervical cerclage can be performed under spinal, epidural, or **general anesthesia**. The patient will need to stay in the hospital for one or more days. The procedure to remove the suture is done without the need for anesthesia. The vagina is held open with an instrument called a speculum and the stitch is cut and removed. This may be slightly uncomfortable, but should not be painful.

Some possible risks of cerclage are premature rupture of the amniotic membranes, infection of the amniotic sac, and preterm labor. The risk of infection of the amniotic sac increases as the pregnancy progresses. For a cervix that is dilated 3 centimeters (cm), the risk is 30%.

After cerclage, a woman will be monitored for any preterm labor. The woman needs to consult her obstetrician immediately if there are any signs of contractions.

Cervical cerclage can not be performed if a woman is more than 4 cm dilated, if the fetus has already died in her uterus, or if her amniotic membranes are torn and her water has broken.

Prognosis

The success rate for cerclage correction of incompetent cervix is good. About 80-90% of the time women deliver healthy infants. The success rate is higher for cerclage done early in pregnancy.

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Tish Davidson, A.M.

Incontinence *see* **Urinary incontinence**

Indigestion

Definition

Indigestion, which is sometimes called **dyspepsia** or an upset stomach, is a general term covering a group of nonspecific symptoms in the digestive tract. It is not considered a disease but, rather, several symptoms that are experienced due to impaired digestion of consumed foods. Indigestion is often described as an uncomfortable feeling of fullness, bloating, **nausea**, **heartburn**, or gassy discomfort in the chest or upper abdomen. The symptoms develop during meals or shortly afterward. In most cases, indigestion is a minor problem that often clears up without professional treatment.

Demographics

Indigestion is a widespread condition that can occur at any age, for both men and women. It is estimated to occur at some time in 25% of the adult population of the United States.

Description

Most people with indigestion do not feel sick enough to see a doctor; nonetheless, it is a common reason for office visits. About 3% of visits to primary care doctors are for indigestion. Indigestion may only occur occasionally in some people, while others may have it daily.

Causes and symptoms

Physical causes

The symptoms associated with indigestion have a variety of possible physical and lifestyle causes, ranging from commonplace food items to serious systemic disorders:

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- Diet. Milk, milk products, alcoholic beverages, tea, and coffee cause indigestion in some people because they stimulate the stomach's production of acid. Chocolate, carbonated beverages, and spicy foods can also cause indigestion.
- Medications. Certain prescription drugs as well as over-the-counter medications can irritate the stomach lining. These medications include aspirin, nonsteroidal anti-inflammatory drugs (NSAIDs), some antibiotics, digoxin, theophylline, corticosteroids, iron (ferrous sulfate), oral contraceptives, and tricyclic antidepressants.
- Disorder of the stomach. Inflammation of the stomach (gastritis).
- Disorders of the pancreas and gallbladder. These include inflammation of the gallbladder or pancreas, cancer of the pancreas, and gallstones.
- Intestinal parasites. Parasitic infections that cause indigestion include amebiasis, fluke and tapeworm infections, giardiasis, and strongyloidiasis.
- Systemic disorders, including diabetes, thyroid disease, collagen vascular disease.
- Cancers of the digestive tract, such as stomach cancer.
- Conditions associated with women's reproductive organs. These conditions include menstrual cramps, pregnancy, and pelvic inflammatory disease.

Psychological and emotional causes

Indigestion often accompanies an emotional upset, because the part of the nervous system involved in the so-called "fight-or-flight" response also affects the digestive tract. People diagnosed with **anxiety**, nervousness, or **somatoform disorders** frequently have problems with indigestion. Many people in the general population, however, will also experience heartburn, "butterflies in the stomach," or stomach cramps when they are in upsetting situations—such as school examinations, arguments with family members, crises in their workplace, and other such emotional traumas. Some people's digestive systems appear to react more intensely to emotional **stress** due to hypersensitive nerve endings in their intestinal tract.

Symptoms

The most common symptoms include:

- Uncomfortable fullness in the stomach during and/or after meals, which lasts longer then normal, especially when not eating much food
- Awareness, mild discomfort, or even more severe pain, in the upper abdominal area, what is called the epigastric area
- Burning sensation in the upper abdomen (epigastric area)

Less common symptoms are:

- Bloating, with an uncomfortable feeling of tightness in the stomach
- Nausea, with a feeling that vomiting may occur
- Belching or burping

Specific gastrointestinal disorders

In some cases, the patient's description of the symptoms suggests a specific digestive disorder as the cause of the indigestion. Some doctors classify these cases into three groups.

ESOPHAGITIS TYPE. Esophagitis is an inflammation of the tube that carries food from the throat to the stomach (the esophagus). The tissues of the esophagus can become irritated by the flow (reflux) of stomach acid backward into the lower part of the esophagus. If the patient describes the indigestion in terms of frequent or intense heartburn, the doctor will consider **gastroesophageal reflux disease** (GERD) as a possible cause. GERD is a common disorder in the general population, affecting about 30% of adults.

PEPTIC ULCER TYPE. Patients who smoke and are over 45 years of age are more likely to have indigestion of the peptic ulcer type. This group also includes people who find that their indigestion is relieved by taking **antacids** or eating a small amount of food at each meal. Patients in this category are often found to have *Helicobacter pylori* infections. *H. pylori* is a rod-shaped bacterium that lives in the tissues of the stomach and causes irritation of the mucous lining of the stomach walls. Most people with *H. pylori* infections do not develop chronic indigestion, but the organism appears to cause peptic ulcer disease (PUD) in a vulnerable segment of the population.

NONULCER TYPE. Most cases of chronic indigestion—as many as 65%—fall into this third category. Nonulcer dyspepsia is sometimes called functional dyspepsia because it appears to be related to abnormalities in the way that the stomach empties its contents into the intestine. In some people, the stomach empties either too slowly or too rapidly. In others, the stomach's muscular contractions are irregular and uncoordinated as it receives, digests, and moves foods into the small intestine. These disorders of stomach movement (motility) may be caused by hypersensitive nerve endings in the stomach tissues. Patients in

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this group are likely to be younger than 45 years and have a history of taking medications for anxiety or depression.

Diagnosis

Patient history

Because indigestion is a nonspecific set of symptoms, patients who feel sick enough to seek medical attention are likely to go to their primary care doctor. The history does not always point to an obvious diagnosis. The doctor can, however, use the process of history-taking to evaluate the patient's mood or emotional state in order to assess the possibility of a psychiatric disturbance. In addition, asking about the location, intensity, timing, and recurrence of the indigestion can help the doctor weigh the different diagnostic possibilities.

An important part of the history-taking is asking about symptoms that may indicate a serious illness. These warning symptoms include:

- Weight loss
- Persistent vomiting
- Difficulty or pain in swallowing
- Vomiting blood or passing blood in the stools
- Anemia.

Imaging studies

If the doctor thinks that the indigestion should be investigated further, he or she will order an endoscopic examination of the stomach. An endoscope is a slender tube-shaped instrument that allows the doctor to look at the lining of the patient's stomach. If the patient has indigestion of the esophagitis type or nonulcer type, the stomach lining will appear normal. If the patient has PUD (peptic ulcer disease) the doctor will be able to see abnormal breaks or ulcerated areas in the tissue. He or she may also order ultrasound imaging of the abdomen, or a radionuclide scan to evaluate the motility of the stomach. Blood, breath, or stool tests may also be ordered to show if a bacterium is causing the problem. In addition, a biopsy may be required to analyze pieces of the affected tissue for damage.

Laboratory tests

BLOOD TESTS. If the patient is over 45 years of age, the doctor will have the patient's blood analyzed for a complete blood cell count, measurements of liver enzyme levels, electrolyte and serum **calcium** levels, and thyroid function.

TESTS FOR *HELICOBACTER PYLORI*. Doctors can now test patients for the presence of *H. pylori* without having to take a tissue sample from the stomach. One of these noninvasive tests is a blood test and the other is a breath test.

Treatment

Since most cases of indigestion are not caused by serious disorders, many doctors prefer to try medications and other treatment measures before ordering an **endoscopy**.

Diet and stress management

Many patients benefit from the doctor's reassurance that they do not have a serious or fatal disorder. Cutting out alcoholic beverages, drinks containing **caffeine**, and carbonated beverages often helps. Eliminating tobacco products is also helpful. The patient may also be asked to keep a record of food intake, daily schedule, and symptom severity. Food diaries sometimes reveal psychological or dietary factors that influence indigestion. Eating smaller but more frequent meals can also be beneficial, especially when eaten slowly.

Medications

Patients with the esophagitis type of indigestion are often treated with H_2 antagonists. H_2 antagonists are drugs that block the secretion of stomach acid. They include ranitidine (Zantac), cimetidine (Tagamet), nizatidine (Axid), and famotidine (Pepcid).

Antacid-type medicines, some found over-the-counter and others with a prescription, are commonly taken to reduce acid production in the stomach. Most of these include different combinations of magnesium, aluminum, and calcium. These medicines are usually found over-the-counter, and include Maalox, Rolaids, Tums, and Mylanta.

Some patients take **proton pump inhibitors** (PPIs). They are usually given to people who have both indigestion and GERD. PPIs, which also reduce stomach acid, include omeprazole (Prilosec), lansoprazole (Prevacid), and exomeprazole (Nexium).

Patients with motility disorders may be given prokinetic drugs. Prokinetic medications speed up the emptying of the stomach and increase intestinal motility. They include metoclopramide (Reglan) and cisapride (Propulsid). These drugs relieve symptoms in about 75% of patients.

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KEY TERMS

Dyspepsia—Another name for indigestion.

Endoscope—A slender tubular instrument used to examine the inside of the stomach.

Gastroesophageal reflux disease (GERD)—A disorder of the lower end of the esophagus, caused by stomach acid flowing backward into the esophagus and irritating the tissues.

H_2 antagonist—A type of drug that relieves indigestion by reducing the production of stomach acid.

Heartburn—A popular term for an uncomfortable burning sensation in the stomach and lower esophagus, sometimes caused by the reflux of small amounts of stomach acid.

Helicobacter pylori—A gram-negative rod-shaped bacterium that lives in the tissues of the stomach and causes inflammation of the stomach lining.

Motility—The movement or capacity for movement of an organism or body organ. Indigestion is sometimes caused by abnormal patterns in the motility of the stomach.

Peptic ulcer disease (PUD)—A stomach disorder marked by corrosion of the stomach lining due to the acid in the digestive juices.

Prokinetic—A drug that works to speed up the emptying of the stomach and the motility of the intestines.

Reflux—The backward flow of a body fluid or secretion. Indigestion is sometimes caused by the reflux of stomach acid into the esophagus.

Removal of H. pylori

It is not clear that patients with *H. pylori* infections who have *not* developed gastric ulcers need to have the bacterium removed. Some studies indicate, however, that these patients may benefit from antibiotic therapy.

Alternative treatment

HERBAL MEDICINES. Practitioners of Chinese traditional herbal medicine might recommend medicines derived from peony (*Paeonia lactiflora*), hibiscus (*Hibiscus sabdariffa*), or hare's ear (*Bupleurum chinense*) to treat indigestion. Western herbalists are likely to prescribe fennel (*Foeniculum vulgare*), lemon balm (*Melissa officinalis*), or peppermint (*Mentha piperita*) to relieve stomach cramps and heartburn.

HOMEOPATHY. Homeopaths tailor their remedies to the patient's overall personality profile as well as the specific symptoms. Depending on the patient's reaction to the indigestion and some of its likely causes, the homeopath might choose *Gelsemium* (*Gelsemium sempervirens*), *Carbo vegetalis*, *Nux vomica*, or *Pulsatilla* (*Pulsatilla nigricans*).

Other treatments

Some alternative treatments are aimed at lowering the patient's stress level or changing attitudes and beliefs that contribute to indigestion. These therapies and practices include **Reiki**, **reflexology**, **hydrotherapy**, therapeutic massage, **yoga**, and **meditation**.

Prognosis

Most cases of mild indigestion do not need medical treatment. For patients who consult a doctor and are given an endoscopic examination, 5 to 15% are diagnosed with GERD and 15 to 25% with PUD. About 1% of patients who are endoscoped have **stomach cancer**. Most patients with functional dyspepsia do well on either H_2 antagonists or prokinetic drugs, depending on the cause of their indigestion.

Prevention

Indigestion can often be prevented by attention to one's diet, general stress level, and ways of managing stress. Specific preventive measures include:

- Stop smoking.
- Cutting down on or eliminating alcohol, tea, or coffee.
- Avoiding foods that are highly spiced or loaded with fat.
- Eating slowly and keeping mealtimes relaxed.
- Practicing yoga or meditation.
- Not taking aspirin or other medications on an empty stomach.
- Keeping one's weight within normal limits.

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American Gastroenterological Association , 4930 Del Ray Avenue, Bethesda, MD, 20814, (301) 654-2055, (800) 296-4433, (301) 654-5920, member@gastro.org, http://www.gastro.org/.

Rebecca J. Frey, PhD

Indinavir *see* **Protease inhibitors**

Indirect Coombs' test *see* **Coombs' tests**

Indium scan of the body

Definition

A scanning procedure in which a patient's white blood cells are first labeled with the radioactive substance indium, and then the patient's body is scanned as a way of tracking the white blood cells at the site of possible infection.

Purpose

The procedure is used to detect inflammatory processes in the body such as infections. By labelling the leukocytes (white blood cells), radiologists or nuclear medicine specialists can then watch their migration toward an **abscess** or other infection.

Description

A nuclear medicine technologist withdraws about 50 mL of blood. White blood cells are collected, exposed to indium, and reinjected by IV back into the patient.

The scan is scheduled for between 18 and 24 hours after the white blood cells have been labelled with indium. (In some cases, more scanning may be scheduled 48 hours after labelling).

For the scan, the patient lies on a special scanning table, as either a single camera passing underneath the table or two cameras (one above the table and one underneath) are placed as close as possible to the body, slowly scanning the person's body.

The radiologist may need extra pictures, but these take only a few minutes each.

While the patient must remain perfectly still during the scan, there should be no discomfort.

KEY TERMS

Indium—A silvery metallic element with some nonmetallic chemical properties used to label white blood cells prior to scanning.

Leukocyte—A white blood cell protects the body against infection and fight infection when it occurs. They are bigger than red blood cells.

Aftercare

After the scan, the patient should be able to continue with normal daily activities with no problems.

Risks

The only risk during this scanning procedure could be to a patient who is pregnant, as with any type of injectable radioactive substance. If the woman is pregnant, the radiologist must be notified; if the scan is cleared, the radiologist may use a lower dosage of indium.

Normal results

The scan should reveal no infection or pathology.

Abnormal results

The scan will reveal details, such as location, about an infection in the patient's body.

Carol A. Turkington

Induction of labor

Definition

Induction of labor involves using artificial means to assist the mother in delivering her baby.

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KEY TERMS

Cesarean section—Delivery of a baby through an incision in the mother's abdomen instead of through the vagina; also called a C-section.

Preeclampsia—Hypertension (high blood pressure) experienced during pregnancy.

Rh blood incompatibility—A blood type problem between mother (who is Rh negative) and baby (who is Rh positive), making the immune system of the mother attack her unborn baby. During delivery of the first pregnancy, the mother's immune system becomes sensitive to the Rh positive blood of the baby. The mother's system may then attack later pregnancies and cause severe illness or death to those babies.

Vasoconstriction—Constriction of a blood vessel.

Purpose

Labor is brought on, or induced, when the **pregnancy** has extended significantly beyond the expected delivery date and the mother shows no signs of going into labor. Generally, if the unborn baby is more than two weeks past due, labor will be induced. In most cases, a mother delivers her baby between 38–42 weeks of pregnancy. This usually means that labor is induced if the pregnancy has lasted more than 42 weeks. Labor is also induced if the mother is suffering from diseases (**preeclampsia**, chronic **hypertension**), if there is an Rh blood incompatibility between the baby and the mother, or if the mother or baby has a medical problem that requires delivery of the baby (like a premature rupture of the membranes).

Description

The uterus is the hollow female organ that supports the development and nourishment of the unborn baby during pregnancy. Sometimes labor is induced by the rupturing the amniotic membrane to release amniotic fluid. This is an attempt to mimic the normal process of "breaking water" that occurs early in the normal birth process. This method is sometimes enough stimulation to induce contractions in the mother's uterus. If labor fails to start, drugs are used.

Most labor is induced by using the drug Pitocin, a synthetic form of oxytocin. Oxytocin is a natural hormone produced in the body by the pituitary gland. During normal labor, oxytocin causes contractions. When labor does not occur naturally, the doctor may give the mother Pitocin to start the contractions. Pitocin makes the uterus contract with strength and force almost immediately. This drug is given through a vein in a steady flow that allows the doctor to control the amount the mother is given.

Sometimes vaginal gels are used to induce labor. Normally, the baby will pass through the opening of the uterus (the cervix) into the birth canal during delivery. Because of this, the cervix softens and begins to enlarge (dilate) during the early part of labor to make room for the baby to pass through. The cervix will continue to dilate, and the contractions will eventually push the baby out of the mother's body. When labor needs to be induced, the cervix is often small, hard, and not ready for the process. The doctor may need to prepare or "ripen" the cervix to induce labor. The hormone prostaglandin in a gel form may be applied high in the vagina to soften and dilate the cervix, making the area ready for labor. This may be enough to stimulate contractions on its own. More often, prostaglandin gel is used in conjunction with Pitocin.

If all attempts to induce labor fail, a **cesarean section** is performed.

Risks

Once labor has been induced, the unborn baby is monitored to guard against a reduction in its oxygen supply, or hypoxia. The drugs used to induce labor cause vasoconstriction, which can decrease blood supply to the unborn baby. Throughout the process, the baby's heart rate is monitored by an electronic device placed on top of the mother's abdomen. The heart rate is one sign that the unborn baby is getting enough oxygen and remains healthy. Once the membranes are broken, prolonged labor may result in infection to either the newborn or the mother.

Normal results

Once labor is induced and the cervix has dilated, labor usually proceeds normally. When performed properly, induced labor is a safe procedure for both mother and baby.

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Infant massage

Definition

Infant massage refers to **massage therapy** as specifically applied to infants. In most cases, oil or lotion is used as it would be on an adult subject by a trained and licensed massage therapist. Medical professionals caring for infants might also use massage techniques on infants born prematurely, on those with motor or gastrointestinal problems, or on those who have been exposed to **cocaine** in utero.

Description

Various techniques are used in infant massage, with the different strokes specific to a particular therapy. Special handling is used for treating a baby with gas and **colic**. Some of the strokes are known as "Indian milking," which is a gentle stroking of the child's legs; and the "twist and squeeze" **stroke**, a gentle squeeze of the muscles in the thigh and calf. The light "feather" strokes often employed in regular Swedish massage are applied at the end of a massage. The procedure is not unlike certain forms of adult massage, but with extra care taken for the fragility of the infant.

There are also specific Chinese techniques of pediatric massage, including massage of children with special needs. In China, these forms of massage can be given by medical professionals, but parents are often taught how to do the simpler forms for home treatment of their children.

Infant receiving a massage. *(Photo Researchers, Inc.)*

Origins

The practice of massaging infants dates back to ancient times, particularly in Asian and Pacific Island cultures; that is, massage was a component of the baby's regular bath routine among the Maoris of New Zealand and the natives of the Hawaiian Islands. Touch in these cultures is considered healthful both physically and spiritually. Infant massage was also recommended by practitioners of Ayurveda in ancient India. It is likely that early humans practiced infant massage, as many other species of mammals, such as cats, dogs, horses, and monkeys lick or groom their young after birth to cleanse and stimulate them.

In the West, however, infant massage has received more attention in recent years in conjunction with the popularity of natural **childbirth** and midwife-assisted births. Dr. Frédéric Leboyer, a French physician who was one of the leaders of the natural childbirth movement, helped to popularize infant massage through his photojournalistic book on the Indian art of baby massage.

Infant massage was introduced formally into the United States in 1978 when Vimala Schneider McClure, a **yoga** practitioner who had served in an orphanage in Northern India, developed a training program for instructors at the request of childbirth educators. An early research study by R. Rice in 1976 had showed that premature babies who were massaged surged ahead in weight gain and neurological development over those who were not massaged. From McClure's training in India, her knowledge of Swedish massage and **reflexology**, along with her knowledge of yoga postures that she had already adapted for babies, she became the foremost authority on infant massage. In 1986 she founded the International Association of Infant Massage (IAIM), which has chapters in 26 countries around the world as of 2010. Another group, the International Institute of Infant Massage, has trained instructors in 40 countries.

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KEY TERMS

Ayurveda—The traditional medical system of India, considered a form of alternative medicine in Western countries.

Linoleic acid—An unsaturated omega-6 fatty acid found in many plant oils that humans need in their diet. Plant oils rich in linoleic acid are beneficial to the skin when used in massage.

Oxytocin—A hormone secreted in the brains of mammals that acts as a neurotransmitter in the brain and also functions in sexual arousal, maternal behavior, and emotional bonding in humans. Synthetic oxytocin is used to induce or support labor in difficult childbirths.

Benefits

According to the IAIM, the benefits of infant massage include:

- relaxation
- relief from stress
- interaction with adults, including fathers as well as mothers
- stimulation of the nervous system
- improved digestion and elimination
- improved blood circulation and skin condition
- relief of teething pains
- stimulation of oxytocin secretion in the person giving the massage. The IAIM states, "[Oxytocin] is useful as a pain reliever and has a calming effect on the person."

The results of several studies showed that infant massage alleviates the **stress** that newborns experience as a result of the enormous change that birth brings about in their lives after the 6–9 months they have spent in the womb. Both premature infants and full-term babies need the relaxation that comes from massaging and moving their limbs and muscles. In infants with colic, massage provides the relief necessary to disperse gas, ease **muscle spasms**, tone the digestive system and help it work efficiently. Some techniques even help bring relief from **teething** and emotional stress. The stimulation an infant receives from massage can aid circulation, strengthen muscles, help digestion, and relieve **constipation**. The bonding that occurs with massage between a parent and child enhances the entire process of bonding that comes with contact through all of the senses, including touch, voice, and sight. It affords a physical experience of quality time between the parents and the child as well as with any significant others in a baby's life.

Precautions

Extreme caution is necessary when performing infant massage. Strokes are made with the greatest delicacy in order not to harm the infant in any way. Proper techniques are taught by licensed massage therapists or IAIM instructors, ensuring that the infant is treated with appropriate physical touch. Anyone who is unfamiliar with handling a baby should receive appropriate instruction before beginning infant massage.

Practitioners of infant massage advise the use of sunflower seed oil or other oils rich in linoleic acid for infant massage, and avoid the use of mustard oil. Mustard oil is used in some traditional societies for infant massage but can harm the baby's skin.

Preparation

If lotions or oils are used, care is taken to ensure their safety on a baby's delicate skin. The most important consideration is to use vegetable oils rather than mineral oils, which can clog the pores in the skin. The oil that is used should be warmed in the caregiver's hands before applying it to the baby's skin. The environment in which the massage is given to an infant should be comfortably warm, and as calm and nonthreatening as possible.

Aftercare

No specific aftercare is required after infant massage.

Risks

No adverse side effects have been reported when infant massage is done properly after careful instruction, or by a licensed massage therapist who specializes in infant care.

Research and general acceptance

In addition to the study already noted regarding touch therapy, a website devoted to infant massage lists research published as early as 1969, and cites hundreds of

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individual projects that have been conducted throughout the world focusing on infant massage. Many of the studies are related to the benefits of massage and touch for premature infants and others born with such risk factors as drug dependence. Conclusions regarding the benefits are overwhelmingly positive. The proliferation of therapists licensed in infant massage across the United States and worldwide indicates that infant massage is increasingly recognized as a legitimate health care treatment. According to the International Institute of Infant Massage, as of 2010 instructors in the field "include OTs and PTs, child-life specialists, nurses, developmental specialists, childbirth educators, social workers, early interventionists, speech pathologists, case workers, doctors, massage therapists, midwives, **lactation** consultants, and of course parents."

As of 2010 there are 10 research studies of infant massage registered with the National Institutes of Health (NIH). The studies are investigating the benefits of massage for preterm infants, including weight gain, strengthening of the immune system, and development of the central nervous system; sensitivity training for parents; the use of **aromatherapy** together with massage in relieving distress in infants; and the role of infant massage in preventing mother/infant relational disturbances.

Training and certification

The IAIM offers four-day workshops in the countries where it has chapters for the training and certification of instructors in infant massage. Certified instructors (CIMIs) receive their certification after completing "practice teachings with families," passing an examination at the end of the workshop, and passing a clinical evaluation by a registered IAIM trainer. The International Institute of Infant Massage offers a similar four-day program "which includes participation in the four-day training and successful completion of a peer review take-home exam, which includes a practicum of teaching five families during the following four-month period." Tuition for the training as of 2010 is $595.

The licensing of massage therapists varies from state to state, as infant massage qualifies for consideration as medical treatment. Infant massage is becoming an increasingly popular discipline within the field. Numerous websites provide listings for infant massage specialists throughout the United States. The IAIM course is recognized as the official course for infant massage, while the National Certification Board for Therapeutic Massage and Bodywork (NTCTMB) has approved the International Institute of Infant Massage as an approved provider of continuing education. Completion of the institute's course in infant massage is credited as 30 hours of continuing education.

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The Pregnancy Show. This is a 3-1/2 minute video on the techniques of infant massage. http://www.youtube.com/watch?v=kZ4HPREfBgo

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ORGANIZATIONS

American Massage Therapy Association (AMTA), 500 Davis Street, Suite 900, Evanston, IL, 60201, 847-864-0123 , 877-905-2700, 847-864-5196, info@amtamassage.org, http://www.amtamassage.org/.

National Center for Complementary and Alternative Medicine (NCCAM), 9000 Rockville Pike, Bethesda, MD, 20892, info@nccam.nih.gov, http://nccam.nih.gov/.

Touch Research Institute, University of Miami, Miller School of Medicine, Miami, FL, 33136, tfield@med. miami.edu, http://www6.miami.edu/touch-research/.

International Association of Infant Massage (IAIM), Heidenstams Gata 9, Hisings Backa, Gothenburg, Sweden, S-422 47, +46 (0)31-528980, http://www.iaim.net/.

International Institute of Infant Massage, 605 Bledsoe Road, NW, AlbuquerqueNM, United States, 87107, 505-341-9381, 505-341-9386, info@infantmassage.com, http://infantmassageinstitute.com/.

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Infant respiratory distress syndrome *see* **Respiratory distress syndrome**

Infantile paralysis *see* **Polio**

Infarct avid imaging *see* **Technetium heart scan**

Infarction *see* **Stroke**

ELIZABETH LEE HAZEN (1885–1975)

Elizabeth Lee Hazen was born on August 24, 1885, in Rich, Mississippi. Hazen, born the middle of three children to Maggie (Harper) and William Edgar Hazen, was orphaned before she turned four. She and her sister went to live with their aunt and uncle shorly after her younger brother died. Hazen attended the Mississippi Industrial Institute and College at Columbus, receiving her B.S. degree in 1910. During college, Hazen became interested in science and she studied biology at Columbia University, earning her M.S. in 1917. After working in the U.S. Army laboratories during World War I, she returned to Columbia where she received her Ph.D. in microbiology in 1927. Following her work as an instructor at Columbia, Hazen accepted a position with the New York Department of Health where she researched bacterial diseases.

In 1948, Hazen and Rachel Brown began researching fungal infections found in humans due to antibiotic treatments and diseases. Some of the antibiotics they discovered did indeed kill the fungus; however, they also killed the test mice. Finally, Hazen located a microorganism on a farm in Virginia, and Brown's tests indicated that the microorganism produced two antibiotics, one of which proved effective for treating fungus and candidiasis in humans. Brown purified the antibiotic which was patented under the name *nystatin*. In 1954, the antibiotic became available in pill form. Hazen and Brown continued their research and discovered two other antibiotics. Hazen received numerous awards individually and with her research partner, Rachel Brown. Elizabeth Hazen died on June 24, 1975.

Infection control

Definition

Infection control refers to policies and procedures used to minimize the risk of spreading infections, especially in hospitals and human or animal health care facilities.

Purpose

The purpose of infection control is to reduce the occurrence of infectious diseases. These diseases are usually caused by bacteria or viruses and can be spread by human to human contact, animal to human contact, human contact with an infected surface, airborne transmission through tiny droplets of infectious agents suspended in the air, and, finally, by such common vehicles as food or water. Diseases that are spread from animals to humans are known as zoonoses; animals that carry disease agents from one host to another are known as vectors.

Infection control in hospitals and other health care settings

Infections contracted in hospitals are also called nosocomial infections. They occur in approximately 5% of all hospital patients. These infections result in increased time spent in the hospital and, in some cases, **death**. There are many reasons nosocomial infections are common, one of which is that many hospital patients have a weakened immune system which makes them more susceptible to infections. This weakened immune system can be caused either by the patient's diseases or by treatments given to the patient. Second, many medical procedures can increase the risk of infection by introducing infectious agents into the patient. Thirdly, many patients are admitted to

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Selected infectious diseases and corresponding treatment

Disease	Symptoms	Transmittal	Treatment
Chicken pox	Rash, low-grade fever	Person to person	None; acetaminophen may treat fever or discomfort
Common cold/influenza	Runny nose, sore throat, cough, fever, headache, muscle aches	Person to person	None, although various remedies may help relieve symptoms
Hepatitis A	Jaundice, flu-like symptoms	Sexual contact with an infected person or contact with contaminated blood, food, or water	None; acetaminophen may treat fever or pain
H1N1 influenza	Fever, cough, sore throat, body aches, loss of appetite, fatigue	Person to person	Antiviral drugs
Measles	Skin rash, runny nose and eyes, fever, cough	Person to person	None; acetaminophen may treat fever or discomfort
Meningitis	Neck pain, headache, pain caused by exposure to light, fever, nausea, drowsiness	Person to person	Antibiotics for bacterial meningitis, hospital care for viral meningitis
Methicillin-resistant Staphylococcus aureus (MRSA)	Rash, shortness of breath, fever, chest pain, headache	Person to person or contact with contaminated surfaces	Antibiotics
Mumps	Swelling of salivary glands	Person to person	Anti-inflammatory drugs
Ringworm	Skin rash	Contact with infected animal or person	Antifungal drugs applied topically or taken orally
Tetanus	Lockjaw, other spasms	Soil infection of wounds	Antibiotics, antitoxins, muscle relaxants

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hospitals because of **infectious disease**. These infectious agents can then be transferred from patient to patient by hospital workers or visitors.

Infection control has become a formal discipline in the United States since the 1950s, due to the spread of **staphylococcal infections** in hospitals. Because there is both the risk of health care providers acquiring infections themselves, and of their passing infections on to patients, the Centers for Disease Control and Prevention (CDC) established guidelines for infection control procedures. In addition to hospitals, infection control is important in nursing homes, clinics, child care centers, and restaurants, as well as in the home.

To lower the risk of nosocomial infections, the CDC began a national program of hospital inspection in 1970 known as the National Nosocomial Infections Surveillance system, or NNIS. The CDC reported that over 300 hospitals participate in the NNIS system as of the early 2000s. Data collected from the participating hospitals show that infection control programs can siginificantly improve patient safety, lower infection rates, and lower patient mortality.

Dental health care settings are similar to hospitals in that both personnel and equipment can transmit infection if proper safeguards are not observed. The CDC issued new guidelines in 2003 for the proper maintenance and sterilization of dental equipment, hand hygiene for dentists and dental hygienists, dental radiology, medications, and oral surgery, environmental infection control, and standards for dental laboratories.

The newest addition to the infection control specialist's resources is molecular typing, which speeds up the identification of a disease agent. Rapid identification in turn allows for timely containment of a disease outbreak.

Threat of emerging infectious diseases

Due to constant changes in our lifestyles and environments, new diseases are constantly appearing that people are susceptible to, making protection from the threat of infectious disease urgent. Many new contagious diseases have been identified in the past 30 years, such as **AIDS**, Ebola, and hantavirus. Increased travel between continents makes the worldwide spread of disease a bigger concern than it once was. Additionally, many common infectious diseases have become resistant to known treatments.

The emergence of the **severe acute respiratory syndrome (SARS)** epidemic in Asia in February

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KEY TERMS

Acquired immune deficiency syndrome (AIDS)—A disease that weakens the body's immune system. It is also known as HIV infection.

Antibiotic—A substance, such as a drug, that can stop a bacteria from growing or destroy the bacteria.

Antibiotic resistance—The ability of infectious agents to change their biochemistry in such a way as to make an antibiotic no longer effective.

Bioterrorism—The intentional use of disease-causing microbes or other biologic agents to intimidate or terrorize a civilian population for political or military reasons.

Ebola—The disease caused by the newly described and very deadly Ebola virus found in Africa.

Epidemiology—The branch of medicine that deals with the transmission of infectious diseases in large populations and with detection of the sources and causes of epidemics.

Hantavirus—A group of arboviruses that cause hemorrhagic fever (characterized by sudden onset, fever, aching and bleeding in the internal organs).

Immunization—Immunity refers to the body's ability to protect itself from a certain disease after it has been exposed to that disease. Through immunization, also known as vaccination, a small amount of an infectious agent is injected into the body to stimulate the body to develop immunity.

Immunocompromized—Refers to the condition of having a weakened immune system. This can happen due to genetic factors, drugs, or disease.

Nosocomial infection—An infection acquired in a hospital setting.

Staphylococcal infection—An infection caused by the organism *Staphlococcus*. Infection by this agent is common and is often resistant to antibiotics.

Vector—An animal carrier that transfers an infectious organism from one host to another.

Zoonosis (plural, zoonoses)—Any disease of animals that can be transmitted to humans under natural conditions. Lyme disease, rabies, psittacosis (parrot fever), cat-scratch fever, and monkeypox are examples of zoonoses.

2003 was a classic instance of an emerging disease that spread rapidly because of the increased frequency of international and intercontinental travel. In addition, the SARS outbreak demonstrated the vulnerability of hospitals and health care workers to emerging diseases. Clusters of cases within hospitals occurred in the early weeks of the epidemic when the disease had not yet been recognized and the first SARS patients were admitted without **isolation** precautions.

The SARS epidemic also raised a number of ethical and legal questions regarding current attitudes toward infection control.

Problems of antibiotic resistance

Because of the overuse of **antibiotics**, many bacteria have developed a resistance to common antibiotics. This means that newer antibiotics must continually be developed in order to treat an infection. However, further resistance seems to come about almost simultaneously. This indicates to many scientists that it might become more and more difficult to treat infectious diseases. The use of antibiotics outside of medicine also contributes to increased antibiotic resistance. One example of this is the use of antibiotics in animal husbandry. These negative trends can only be reversed by establishing a more rational use of antibiotics through treatment guidelines.

Bioterrorism

The events of September 11, 2001, and the **anthrax** scare that followed in October 2001 alerted public health officials as well as the general public to the possible use of infectious disease agents as weapons of terrorism. The Centers for Disease Control and Prevention (CDC) now has a list of topics and resources related to bioterrorism on its web site.

Description

The goals of infection control programs are: immunizing against preventable diseases, defining precautions that can prevent exposure to infectious agents, and restricting the exposure of health care workers to an infectious agent. An infection control practitioner is a specially trained professional, oftentimes a nurse, who oversees infection control programs.

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Commonly recommended precautions to avoid and control the spread of infections include:

- Vaccinate people and pets against diseases for which a vaccine is available. The vaccines used against infectious diseases are very safe compared to most drugs.
- Wash hands often.
- Cook food thoroughly.
- Use antibiotics only as directed.
- See a doctor for infections that do not heal.
- Avoid areas with a lot of insects.
- Be cautious around wild or unfamiliar animals, or any animals that are unusually aggressive. Do not purchase exotic animals as pets.
- Do not engage in unprotected sex or in intravenous drug use.
- Find out about infectious diseases when you make travel plans. Travelers' advisories and adult vaccination recommendations are available on the CDC web site or by calling the CDC's telephone service at 404-332-4559.

Because of the higher risk of spreading infectious disease in a hospital setting, higher levels of precautions are taken there. Typically, health care workers wear gloves with all patients, since it is difficult to know whether a transmittable disease is present or not. Patients who have a known infectious disease are isolated to decrease the risk of transmitting the infectious agent to another person. Hospital workers who come in contact with infected patients must wear gloves and gowns to decrease the risk of carrying the infectious agent to other patients. All articles of equipment that are used in an isolation room are decontaminated before reuse. Patients who are immunocompromised may be put in protective isolation to decrease the risk of infectious agents being brought into their room. Any hospital worker with infections, including colds, are restricted from that room.

Hospital infections can also be transmitted through the air. Thus care must be taken when handling infected materials so as to decrease the numbers of infectious agents that become airborne. Special care should also taken with hospital ventilation systems to prevent recirculation of contaminated air.

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ORGANIZATIONS

American College of Epidemiology, 1500 Sunday Drive, Suite 102, Raleigh, NC, 27607, 919 861-5573, 919 787-4916, info@acepidemiology.org, http://www.acepidemiology.org/.

American Public Health Association (APHA), 800 I Street NW, Washington, DC, 20001-3710, 202 777-APHA, 202 777-2534, http://www.apha.org.

American Veterinary Medical Association (AVMA), 1931 North Meacham Road, Suite 100, Schaumburg, IL,

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60173-4360, 847 925-1329, 800 248-2862, http://www.avma.org/.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, 800 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

National Institute of Allergies and Infectious Diseases, 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-6612, 301 496-5717, 301 402-3573, 866 284-4107, ocpostoffice@niaid.nih.gov, http://www.niaid.nih.gov.

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Infectious arthritis

Definition

Infectious arthritis, which is sometimes called septic arthritis or pyogenic arthritis, is a serious infection of the joints characterized by **pain**, **fever**, occasional chills, inflammation and swelling in one or more joints, and loss of function in the affected joints. It is considered a medical emergency.

Description

Infectious arthritis can occur in any age group, including newborns and children. In adults, it usually affects the wrists or one of the patient's weight-bearing joints–most often the knee–although about 20% of adult patients have symptoms in more than one joint. Multiple joint infection is common in children and typically involves the shoulders, knees, and hips.

Some groups of patients are at greater risk for developing infectious arthritis. These high-risk groups include:

- Patients with chronic rheumatoid arthritis.
- Patients with certain systemic infections, including gonorrhea and HIV infection. Women and male homosexuals are at greater risk for gonorrheal arthritis than are male heterosexuals.
- Patients with certain types of cancer.
- IV drug abusers and alcoholics.
- Patients with artificial (prosthetic) joints.
- Patients with diabetes, sickle cell anemia, or systemic lupus erythematosus (SLE).
- Patients with recent joint injuries or surgery, or patients receiving medications injected directly into a joint.

Causes and symptoms

In general, infectious arthritis is caused by the spread of a bacterial, viral, or fungal infection through the bloodstream to the joint. The disease agents may enter the joint directly from the outside as a result of an injury or a surgical procedure, or they may be carried to the joint by the blood from infections elsewhere in the body. The specific organisms vary somewhat according to age group. Newborns are most likely to acquire gonococcal infections of the joints from a mother with **gonorrhea**. Children may also acquire infectious arthritis from a hospital environment, often as a result of catheter placement. The organisms involved are usually either *Haemophilus influenzae* (in children under two years of age) or *Staphylococcus aureus*. In older children or adults, the infectious organisms include *Streptococcus pyogenes* and *Streptococcus viridans* as well as *Staphylococcus aureus*. *Staphylococcus epidermidis* is usually involved in joint infections related to surgery. Sexually active teenagers and adults frequently develop infectious arthritis from *Neisseria gonorrhoeae* infections. Older adults are often vulnerable to joint infections caused by gram-negative bacilli, including *Salmonella* and *Pseudomonas*.

Infectious arthritis often has a sudden onset, but symptoms sometimes develop over a period of three to 14 days. The symptoms include swelling in the infected joint and pain when the joint is moved. Infectious arthritis in the hip may be experienced as pain in the groin area that becomes much worse if the patient tries to walk. In 90% of cases, there is some leakage of tissue fluid into the affected joint. The joint is sore to the touch; it may or may not be warm to the touch, depending on how deep the infection lies within the joint. In most cases the patient will have fever and chills, although the fever may be only low-grade. Children sometimes develop **nausea and vomiting**.

Septic arthritis is considered a medical emergency because of the damage it causes to bone as well as cartilage, and its potential for creating **septic shock**, which is a potentially fatal condition. *Staphylococcus aureus* is capable of destroying cartilage in one or two days. Destruction of cartilage and bone in turn leads to **dislocations** of the joints and bones. If the infection is caused by bacteria, it can spread to the blood and surrounding tissues, causing abscesses or even blood poisoning. The most common complication of infectious arthritis is **osteoarthritis**.

Diagnosis

The diagnosis of infectious arthritis depends on a combination of laboratory testing with careful

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KEY TERMS

Arthrocentesis—A procedure in which the doctor inserts a needle into the patient's joint to withdraw fluid for diagnostic testing or to drain infected fluid from the joint.

Pyogenic arthritis—Another name for infectious arthritis. Pyogenic means that pus is formed during the disease process.

Sepsis—Invasion of the body by disease organisms or their toxins. Generalized sepsis can lead to shock and eventual death.

Septic arthritis—Another name for infectious arthritis.

Synovial fluid (SF)—A fluid secreted by tissues surrounding the joints that lubricates the joints.

history-taking and **physical examination** of the affected joint. It is important to keep in mind that infectious arthritis can coexist with other forms of arthritis, **gout**, **rheumatic fever**, **Lyme disease**, or other disorders that can cause a combination of joint pain and fever. In some cases, the doctor may consult a specialist in orthopedics or rheumatology to avoid misdiagnosis.

Patient history

The patient's history will tell the doctor whether he or she belongs to a high-risk group for infectious arthritis. Sudden onset of joint pain is also important information.

Physical examination

The doctor will examine the affected joint for swelling, soreness, warmth, and other signs of infection. Location is sometimes a clue to diagnosis; infection of an unusual joint, such as the joints between the breastbone and collarbone, or the pelvic joints, often occurs in drug abusers.

Laboratory tests

Laboratory testing is necessary to confirm the diagnosis of infectious arthritis. The doctor will perform an arthrocentesis, which is a procedure that involves withdrawing a sample of synovial fluid (SF) from the joint with a needle and syringe. SF is a lubricating fluid secreted by tissues surrounding the joints. Patients should be warned that arthrocentesis is a painful procedure. The fluid sample is sent for culture in the sealed syringe. SF from infected joints is usually streaked with pus or looks cloudy and watery. Cell counts usually indicate a high level of white cells; a level higher than 100,000 cells/mm^3 or a neutrophil proportion greater than 90% suggests septic arthritis. A Gram's stain of the culture obtained from the SF is usually positive for the specific disease organism.

Doctors sometimes order a biopsy of the synovial tissue near the joint if the fluid sample is negative. Cultures of other body fluids, such as urine, blood, or cervical mucus, may be taken in addition to the SF culture.

Diagnostic imaging

Diagnostic imaging is not helpful in the early stages of infectious arthritis. Destruction of bone or cartilage does not appear on x rays until 10–14 days after the onset of symptoms. Imaging studies are sometimes useful if the infection is in a deep-seated joint.

Treatment

Infectious arthritis requires usually requires several days of treatment in a hospital, with follow-up medication and **physical therapy** lasting several weeks or months.

Medications

Because of the possibility of serious damage to the joint or other complications if treatment is delayed, the patient will be started on intravenous **antibiotics** before the specific organism is identified. After the disease organism has been identified, the doctor may give the patient a drug that targets the specific bacterium or virus. **Nonsteroidal anti-inflammatory drugs** are usually given for viral infections.

Intravenous antibiotics are given for about two weeks, or until the inflammation has disappeared. The patient may then be given a two- to four-week course of oral antibiotics.

Surgery

In some cases, surgery is necessary to drain fluid from the infected joint. Patients who need surgical drainage include those who have not responded to antibiotic treatment, those with infections of the hip

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or other joints that are difficult to reach with arthrocentesis, and those with joint infections related to gunshot or other penetrating **wounds**.

Patients with severe damage to bone or cartilage may need **reconstructive surgery**, but it cannot be performed until the infection is completely gone.

Monitoring and supportive treatment

Infectious arthritis requires careful monitoring while the patient is in the hospital. The doctor will drain the joint on a daily basis and remove a small sample of fluid for culture to check the patient's response to the antibiotic.

Infectious arthritis often causes intense pain. Patients are given medications to relieve pain, together with hot compresses or ice packs on the affected joint. In some cases the patient's arm or leg is put in a splint to protect the sore joint from accidental movement. Recovery can be speeded up, however, if the patient practices range-of-motion exercises to the extent that the pain allows.

Prognosis

The prognosis depends on prompt treatment with antibiotics and drainage of the infected joint. About 70% of patients will recover without permanent joint damage. However, many patients will develop osteoarthritis or deformed joints. Children with infected hip joints sometimes suffer damage to the growth plate. If treatment is delayed, infectious arthritis has a mortality rate between 5% and 30% due to septic shock and **respiratory failure**.

Prevention

Some cases of infectious arthritis are preventable by lifestyle choices. These include avoidance of self-injected drugs; sexual abstinence or monogamous relationships; and prompt testing and treatment for suspected cases of gonorrhea. Patients receiving corticosteroid injections into the joints for osteoarthritis may want to weigh this treatment method against the increased risk of infectious arthritis.

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Rebecca J. Frey, PhD

Infectious disease

Definition

Infectious disease—also called communicable disease—is any illness caused by an infective agent—a germ, microbe, or parasite. Infective agents include bacteria, viruses, fungi, parasitic protozoa, and worms.

Demographics

Virtually all children contract infectious disease, especially during infancy and early childhood. Respiratory and gastrointestinal infections are the most common causes of illness in children. Respiratory infections affect as many as 32% of all infants. Up to 26% of infants contract gastrointestinal infections.

Worldwide, more children and adults die from infectious disease than any other single cause. The vast majority of these deaths occur in poorer counties with limited access to prevention, medical care, and drugs. In 2008, infectious disease killed 5,970,000 children under the age of five, accounting for 68% of all deaths in that age group: an estimated 18% died of **pneumonia**, 15% of **diarrhea**, and eight percent of **malaria**. According to the World Health Organization (WHO), more than 800,000 children under five die every year from **pneumococcal pneumonia** and **meningitis**. Children under age two are at particular risk for serious pneumococcal infections. Children with HIV/AIDS are 20–40 more likely than others to contract pneumococcal infections. Pneumococcal meningitis is disabling or fatal in 40–70% of affected children.

Among American children, the frequency and severity of infectious disease has declined dramatically in recent decades, primarily due to the development of vaccines for common childhood infections. The United States is one of the few places in the world where **polio** has been completely eradicated. Childhood pneumococcal infections caused by vaccine–targeted bacterial strains have been almost completely eliminated.

Description

When an infective agent enters the body and begins to multiply, the immune system responds with various defensive mechanisms that protect against most infectious disease. However when an infective agent temporarily evades or overwhelms the immune system and begins to damage tissues, signs and symptoms of disease develop.

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The most common infectious diseases are contagious—they spread via direct transfer of an infective agent from one person to another. Shaking hands, kissing, or coughing or sneezing on someone can directly transmit contagious diseases such as colds, flu, or **tuberculosis** (TB). Some infective agents, including cold viruses, can be contracted by indirect contact with a contaminated surface such as a faucet, doorknob, or computer keyboard. International airplane travel is responsible for the spread of contagious diseases around the world. Infant diarrhea caused by rotavirus or the protozoan *Giardia lamblia* often spreads among babies and young children through the accidental transferring of feces from hand to mouth after diaper changes. Some infectious diseases can be passed from a mother to her unborn child across the placenta or during birth.

Other infectious diseases can be transmitted from animals or animal waste to humans. Dog and cat saliva may contain more than 100 different types of infective agents. *Pasteurella* bacteria are the most common microbes transmitted via pet **bites**. These bacteria can cause serious—sometimes fatal—infectious diseases such as meningitis, an inflammation of the lining of the brain and spinal cord. **Toxoplasmosis** is a bacterial infection that is transmitted via cat feces. Pet reptiles, such as turtles, snakes, and iguanas, can transmit *Salmonella* bacteria. Wild animals can directly or indirectly transmit a wide variety of infectious disease.

Some infectious diseases are transferred between human hosts by insect vectors:

- Mosquitoes transfer the protozoan that causes malaria, as well as West Nile virus, dengue fever, and viral encephalitis.
- Body lice can transmit typhus.
- Fleas can transmit typhus and transfer plague bacteria from rodents to humans.
- Deer ticks—which are actually more closely related to crabs than to insects—can transfer the bacterium that causes Lyme disease from mice to humans.
- Ticks can also transmit the bacterium that cause Rocky Mountain spotted fever and tularemia and the protozoan that causes babesiosis.

Some infectious diseases are spread from a single source to many people through contaminated food or water. For example, the bacterium ***Escherichia coli*** (*E. coli*) can be transmitted via unwashed fruit or vegetables or undercooked meat.

Some infectious diseases have recently emerged, re–emerged, or become much more widespread and dangerous by acquiring drug resistance. Examples include:

- methicillin–resistant *Staphylococcus aureus* (MRSA) bacteria
- multi– and extensively drug–resistant TB bacteria
- 2009 H1N1 influenza virus
- H5N1 avian influenza virus
- West Nile virus
- Ebola virus
- Marburg virus
- Nipah virus
- SARS virus
- dengue virus
- polio virus
- malaria parasite

Risk factors

Risk factors for respiratory or gastrointestinal infectious diseases in babies include:

- premature birth
- low birth weight
- low socioeconomic status
- multiple siblings
- daycare
- parental smoking

Children with weakened immune systems are at increased risk for infectious disease. Infection can occur if a child:

- has HIV/AIDS
- has an autoimmune disease
- is taking steroids or anti–rejection drugs for a transplanted organ
- is being treated for cancer

In 2010, scientists reported the discovery of mutations that increase susceptibility to infectious disease. The mutations are in a gene called CISH that encodes a protein that regulates the immune system's response to infectious disease. A child who inherits one of these mutations from a parent has an 18% increased risk for infectious disease. Inheriting four or more of the mutations increases the risk to 81%.

Causes and symptoms

Although most bacteria are not harmful—and some types are essential for proper functioning of the human body—some bacteria produce toxins that cause infectious disease. *Streptococcus* can cause infections ranging from relatively mild ear infections to

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KEY TERMS

Bacteria—Single–celled microorganisms that live in soil, water, organic matter, plants, and animals, and are associated with a number of infectious diseases.

Fungi—A kingdom of saprophytic and parasitic spore–producing organisms that include mushrooms and yeast.

Helminths—Parasitic worms, such as tapeworms or liver flukes, that can live in the human body.

Immunization—Treatment, usually by vaccination, to produce immunity to a specific infective agent.

Meningitis—An infection or inflammation of membranes surrounding the brain and spinal cord.

Pneumococcal—Infection by the bacterium *Streptococcus pneumoniae* that causes acute pneumonia.

Pneumonia—Inflammation of the lungs, usually caused by infection with a bacterium, virus, or fungus.

Protozoa—Single–celled microorganisms of the Kingdom Protista, some of which can cause infectious disease in humans.

Vaccine—A preparation of live, weakened, or killed microorganisms that is administered to produce or increase immunity to specific diseases.

strep throat to potentially fatal pneumococcal pneumonia, meningitis, and **sepsis** or blood poisoning. Children can be especially vulnerable to bacteria that cause:

- diphtheria
- pertussis or whooping cough
- tetanus
- urinary tract infections

Viruses cause many childhood diseases including:

- common colds
- influenzas
- diarrhea from rotaviruses
- measles
- mumps
- rubella (German measles)
- chicken pox
- polio
- hepatitis
- human papillomavirus (HPV)
- herpes
- HIV/AIDS

Fungi cause various infectious diseases including:

- thrush, a mouth and throat infection in infants caused by *Candida albicans*
- skin conditions, such as ringworm and athlete's foot
- pneumonia caused by *Pneumocystis carinii*

Protozoan parasites cause infectious diseases such as malaria, **giardiasis**, and toxoplasmosis. Helminths are larger parasites—such as tapeworms and roundworms—that can infect the intestinal tract, lungs, liver, skin, or brain.

Symptoms of infectious disease vary with the type of infection. However many infectious diseases have symptoms that include:

- fever and chills
- loss of appetite
- muscle aches
- fatigue

Diagnosis

Examination

A medical history and physical exam—including the child's breathing pattern and respiratory rate, body temperature, and other symptoms—may be sufficient for diagnosing an infectious disease. Sometimes an infectious organism in a blood or urine sample can be seen under a microscope.

Tests

Blood, urine, throat swabs, or other bodily secretions may be cultured in a laboratory to identify the infective agent. Diagnosis of some infectious diseases requires a **lumbar puncture** or spinal tap to obtain a sample of cerebrospinal fluid.

Procedures

Diagnostic procedures may include:

- a chest x ray to diagnose pneumonia
- computerized tomography (CT) scans or magnetic resonance imaging (MRI)
- a biopsy—the removal of a tiny amount of tissue from an infected area, such as the lung for diagnosing fungal pneumonia

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Treatment

Traditional

Treatment depends on the type of infectious disease. Some diseases resolve on their own without any treatment other than possibly relieving symptoms.

Drugs

- Bacterial infections are treated with antibiotics.
- A very few antiviral drugs, such as acyclovir, are available for treating viral infections such as flu and herpes.
- Various drugs may be used to treat hepatitis B and C.
- HIV/AIDS is treated with a combination of drugs known as highly active antiretroviral therapy (HAART).
- Fungal infections of the skin and nails may be treated with over–the–counter or prescription medications applied directly to the affected area.
- Oral antifungal medications are used to treat systemic fungal infections, such as histoplasmosis, or severe infections of the mouth and throat in children with weakened immune systems.
- Only a very few anti–parasitic drugs are available and some of these are either very toxic or are becoming less effective with the spread of drug–resistant parasites.

Alternative

A wide variety of alternative therapies are used to treat infectious disease, although bacterial infections usually require **antibiotics**. Yogurt containing healthy gut bacteria can ease gastrointestinal symptoms and has been shown to reduce the incidence of some common infections in children.

Home remedies

Many mild infectious diseases respond well to home remedies. Bed rest and drinking plenty of fluids are the most common remedies.

Prognosis

Prognosis varies greatly depending on the type of infectious disease. Some, such as the **common cold**, usually resolve quickly without medical treatment, and most infectious diseases have only minor complications. However some—such as pneumonia or meningitis—can be life–threatening. Even some common and usually mild infectious diseases—such as **measles**, **mumps**, chicken pox, or seasonal flu—can be dangerous or life–threatening in very young children.

Prevention

Many common infectious diseases are preventable with good hygiene and vaccines. The best protection is frequent and thorough hand washing:

- before, during, and after handling food
- before eating
- after using the toilet
- after changing diapers
- after touching animals or their toys, leashes, or waste
- after touching trash, cleaning rags, drains, or soil
- after contact with body fluids, including blood, vomit, saliva, or nasal secretions
- before cleaning a wound, administering medicine, or inserting contact lenses
- more often, if someone in the home is ill

Hands should be washed by:

- wetting with water and applying soap
- rubbing them together vigorously to lather and scrub all surfaces for 20 seconds
- rinsing well under running water
- drying with a paper towel or air dryer
- turning off the faucet with a paper towel
- using alcohol–based disposable hand wipes or sanitizers if soap and water are not available

Other practices for preventing infectious disease include:

- breastfeeding, which helps protect infants from respiratory and gastrointestinal infections
- avoiding touching one's eyes, nose, and mouth
- covering one's mouth and nose when coughing or sneezing
- rinsing fresh fruit and vegetables under running water and scrubbing firm–skinned produce with a vegetable brush
- keeping meat, poultry, seafood, and eggs separated from other foods at all times
- refrigerating foods promptly at a constant temperature of 40°F (4°C) or below, with enough room for cold air to circulate freely
- freezing foods at 0°F (–18°C) or below
- using separate cutting boards for produce and meat, poultry, seafood, or eggs
- washing cutting boards, dishes, utensils, and counter tops with hot, soapy water between preparation of each food item
- never reusing marinades from raw foods without boiling first

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- thoroughly cooking all foods, especially meat, at the correct temperature
- cleaning with disposable paper towels or sanitizing wipes, cloth towels that are washed in hot water, or sponges that are washed in the dishwasher or microwaved daily for 30 seconds
- cleaning and disinfecting all bathroom surfaces, especially when someone in the home has an infectious disease
- avoiding sharing personal items, including toothbrushes, combs, drinking glasses, and eating utensils
- keeping children home when they are sick
- not flying when ill
- practicing safer sex or abstaining from sex entirely to avoid sexually transmitted infections that can be passed to unborn children

Precautions against contracting infectious disease from animals include:

- adopting pets from an animal shelter or purchasing from a reputable store or breeder
- obtaining routine care and immunizations for your pet from a veterinarian
- obeying leash laws
- cleaning litter boxes daily, except when a person is pregnant
- keeping children away from pet waste
- keeping sandboxes covered
- washing one's hands thoroughly after contact with animals
- keeping wild animals away from the house
- using insect repellent and routinely checking for ticks and removing them immediately by applying gentle, steady pressure with tweezers

Children should be immunized as follows:

- at birth or as soon as possible: hepatitis B (HBV)
- at one–four months: HBV
- at two months: diphtheria, tetanus, and acellular pertussis (DTaP); haemophilus influenza type b (Hib); inactivated poliovirus (IPV); pneumococcal conjugate (PCV); rotavirus (RV)
- four months: DTaP; Hib; IPV; PCV; RV
- six months: DTaP; Hib; PCV; RV
- six months and annually: seasonal flu
- six to 18 months: HBV; IPV
- 12–15 months: varicella (chicken pox, Var); Hib; PCV; measles, mumps, and rubella (MMR)
- 12–23 months: hepatitis A (HepA)
- 15–18 months: DTaP
- four–six years: IPV; Var; DTaP; MMR
- 11–12 years: DTaP booster; meningitis (MCV)
- girls at 11–12 years: human papillomavirus (HPV) to prevent genital warts and cervical cancer
- additional immunizations for foreign travel

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National Foundation for Infectious Diseases (NFID), 4733 Bethesda Ave., Suite 750, Bethesda, MD, 20814, (301) 656–0003, (301) 907–0878, info@nfid.org, http://www.nfid.org.

National Institute of Allergy and Infectious Diseases, Office of Communications and Public Liaison (NIAID), 6610 Rockledge Dr., Bethesda, MD, 20892–66123, (866) 284–4107, http://www3.niaid.nih.gov.

U.S. Centers for Disease Control and Prevention (CDC), 1600 Clifton Rd., Atlanta, GA, 30333, (800) CDC–INFO (232–4636), cdcinfo@cdc.gov, http://www.cdc.gov.

Margaret Alic, PhD

Infectious hepatitis *see* **Hepatitis A**

Infectious mononucleosis

Definition

Infectious mononucleosis is a contagious illness caused by the **Epstein-Barr virus** that can affect the liver, lymph nodes, and oral cavity. While mononucleosis is not usually a serious disease, its primary symptoms of **fatigue** and lack of energy can linger for several months.

Description

Infectious mononucleosis, frequently called "mono" or the "kissing disease," is caused by the Epstein-Barr virus (EBV) found in saliva and mucus.

Sore throat and swollen tonsils caused by infectious mononucleosis. *(Dr. P. Marazzi/Photo Researchers, Inc.)*

The virus affects a type of white blood cell called the B lymphocyte producing characteristic atypical lymphocytes that may be useful in the diagnosis of the disease.

While anyone, even young children, can develop mononucleosis, it occurs most often in young adults between the ages of 15 and 35 and is especially common in teenagers. The mononucleosis infection rate among college students who have not previously been exposed to EBV has been estimated to be about 15%. In younger children, the illness may not be recognized.

The disease typically runs its course in four to six weeks in people with normally functioning immune systems. People with weakened or suppressed immune systems, such as **AIDS** patients or those who have had organ transplants, are particularly vulnerable to the potentially serious complications of infectious mononucleosis.

Causes and symptoms

The EBV that causes mononucleosis is related to a group of herpes viruses, including those that cause **cold sores**, chicken pox, and **shingles**. Most people are exposed to EBV at some point during their lives. Mononucleosis is most commonly spread by contact with virus-infected saliva through coughing, sneezing, kissing, or sharing drinking glasses or eating utensils.

In addition to general weakness and fatigue, symptoms of mononucleosis may include any or all of the following:

- Sore throat and/or swollen tonsils
- Fever and chills
- Nausea and vomiting, or decreased appetite
- Swollen lymph nodes in the neck and armpits
- Headaches or joint pain
- Enlarged spleen
- Jaundice
- Skin rash.

Complications that can occur with mononucleosis include a temporarily enlarged spleen or inflamed liver. In rare instances, the spleen may rupture, producing sharp **pain** on the left side of the abdomen, a symptom that warrants immediate medical attention. Additional symptoms of a ruptured spleen include light headedness, rapidly beating heart, and difficulty breathing. Other rare, but potentially life-threatening, complications may involve the heart or brain. The infection may also cause significant destruction of the body's red blood cells or platelets.

Symptoms do not usually appear until four to seven weeks after exposure to EBV. An infected

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KEY TERMS

Antibody—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

Herpes viruses—A group of viruses that can cause cold sores, shingles, chicken pox, and congenital abnormalities. The Epstein-Barr virus which causes mononucleosis belongs to this group of viruses.

Reye's syndrome—A very serious, rare disease, most common in children, which involves an upper respiratory tract infection followed by brain and liver damage.

person can be contagious during this incubation time period and for as many as five months after the disappearance of symptoms. Also, the virus will be excreted in the saliva intermittently for the rest of their lives, although the individual will experience no symptoms. Contrary to popular belief, the EBV is not highly contagious. As a result, individuals living in a household or college dormitory with someone who has mononucleosis have a very small risk of being infected unless they have direct contact with the person's saliva.

Diagnosis

If symptoms associated with a cold persist longer than two weeks, mononucleosis is a possibility; however, a variety of other conditions can produce similar symptoms. If mononucleosis is suspected, a physician will typically conduct a **physical examination**, including a "Monospot" antibody blood test that can indicate the presence of proteins or antibodies produced in response to infection with the EBV. These antibodies may not be detectable, however, until the second or third weeks of the illness. Occasionally, when this test is inconclusive, other blood tests may be conducted.

Treatment

The most effective treatment for infectious mononucleosis is rest and a gradual return to regular activities. Individuals with mild cases may not require bed rest but should limit their activities. Any strenuous activity, athletic endeavors, or heavy lifting should be avoided until the symptoms completely subside, since excessive activity may cause the spleen to rupture.

The **sore throat** and **dehydration** that usually accompany mononucleosis may be relieved by drinking water and fruit juices. Gargling salt water or taking throat lozenges may also relieve discomfort. In addition, taking over-the-counter medications, such as **acetaminophen** or ibuprofen, may relieve symptoms, but **aspirin** should be avoided because mononucleosis has been associated with **Reye's syndrome**, a serious illness aggravated by aspirin.

While **antibiotics** do not affect EBV, the sore throat accompanying mononucleosis can be complicated by a streptococcal infection, which can be treated with antibiotics. Cortisone anti-inflammatory medications are also occasionally prescribed for the treatment of severely swollen tonsils or throat tissues.

Prognosis

While the severity and length of illness varies, most people diagnosed with mononucleosis will be able to return to their normal daily routines within two to three weeks, particularly if they rest during this time period. It may take two to three months before a person's usual energy levels return. One of the most common problems in treating mononucleosis, particularly in teenagers, is that people return to their usual activities too quickly and then experience a relapse of symptoms. Once the disease has completely run its course, the person cannot be re-infected.

Prevention

Although there is no way to avoid becoming infected with EBV, paying general attention to good hygiene and avoiding sharing beverage glasses or having close contact with people who have mononucleosis or cold symptoms can help prevent infection.

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National Institute of Allergies and Infectious Diseases, 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-6612, 301 496-5717, 301 402-3573, 866 284-4107, ocpostoffice@niaid.nih.gov, http://www.niaid.nih.gov.

Susan J. Montgomery

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Infertility

Definition

Infertility, is the biological failure of a couple to conceive a **pregnancy** after trying to do so frequently and without the use of contraceptives for at least one full year. In primary infertility, pregnancy has never occurred. In secondary infertility, one or both members of the couple has previously conceived, but is unable to conceive again after a full year of trying. The inability to conceive may be due to a single cause or multiple causes, in either the female or the male, or both. However, medical treatments are available that are safe and effective so that many couples can eventually become pregnant.

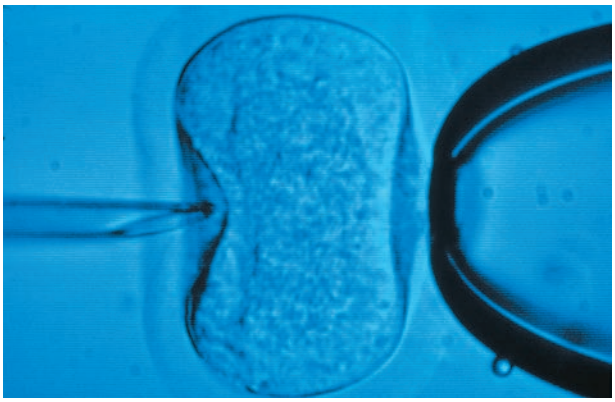
Demographics

Infertility can occur in both men and women.

Description

Most couples in the United States conceive within the first six months of trying when they do so without contraceptive devices and techniques. In fact, according to the Mayo Clinic, about 85% of couples become pregnant after 12 months of trying, while about half of the remaining 15% become pregnant over the next 36 months. However, according to 2008 statistics, infertility is a problem for about 10 to 15% of couples at any given time. Infertility has increased as a problem over the last 40 years. Some studies pin the blame for this increase on social phenomena, including the tendency for marriage to occur at a later age, which means that couples are trying to start families at a later age. It is well known that fertility in women decreases with increasing age, as illustrated by the following statistics:

- Infertility in married women ages 16–20 = 4.5%
- Infertility in married women ages 35–40 = 31.8%
- Infertility in married women over the age of 40 = 70%.



A microscopic image of a needle (left) injecting sperm cells directly into a human egg (center). The broad object at right is a pipette used to hold the ovum steady. *(Hank Morgan/Photo Researchers, Inc.)*

Today, individuals often have multiple sexual partners before they marry and try to have children. This increase in numbers of sexual partners has led to an increase in sexually transmitted infections. Scarring from these infections, especially from **pelvic inflammatory disease** (a serious infection of the female reproductive organs, most commonly caused by **gonorrhea**) seems to be in part responsible for the increase in infertility. Furthermore, use of some forms of a contraceptive called the intrauterine device (**IUD**) contributed to an increased rate of pelvic inflammatory disease, with subsequent scarring. However, newer IUDs do not lead to this increased rate of infection.

To understand issues of infertility, it is first necessary to understand the basics of human reproduction. Fertilization occurs when a sperm from the male merges with an egg (ovum) from the female, creating a zygote that contains genetic material from both the father and the mother. If pregnancy is then established, the zygote will develop into an embryo, then a fetus, and ultimately a baby will be born.

The male contribution to fertilization and the establishment of pregnancy is the sperm. Sperm are small cells that carry the father's genetic material. This genetic material is contained within the oval head of the sperm. The sperm are mixed into fluid called semen, which is discharged from the penis during sexual intercourse. The whip–like tail of the sperm allows the sperm to swim up the female reproductive tract, in search of the egg it will try to fertilize.

The female makes many contributions to fertilization and the establishment of pregnancy. The ovum (plural: ova) is the cell that carries the mother's genetic material. These ova develop within the ovaries. Once a month, a single mature ovum is produced, which leaves the ovary in a process called ovulation. This ovum enters a tube (the Fallopian tube) leading to the uterus. The ovum needs to meet up with the sperm in the Fallopian tube if fertilization is to occur.

When fertilization occurs, the resulting cell (which now contains genetic material from both the mother and the father) is called the zygote. This single cell divides into multiple cells within the Fallopian tube, and the resulting cluster of cells (called a blastocyst)

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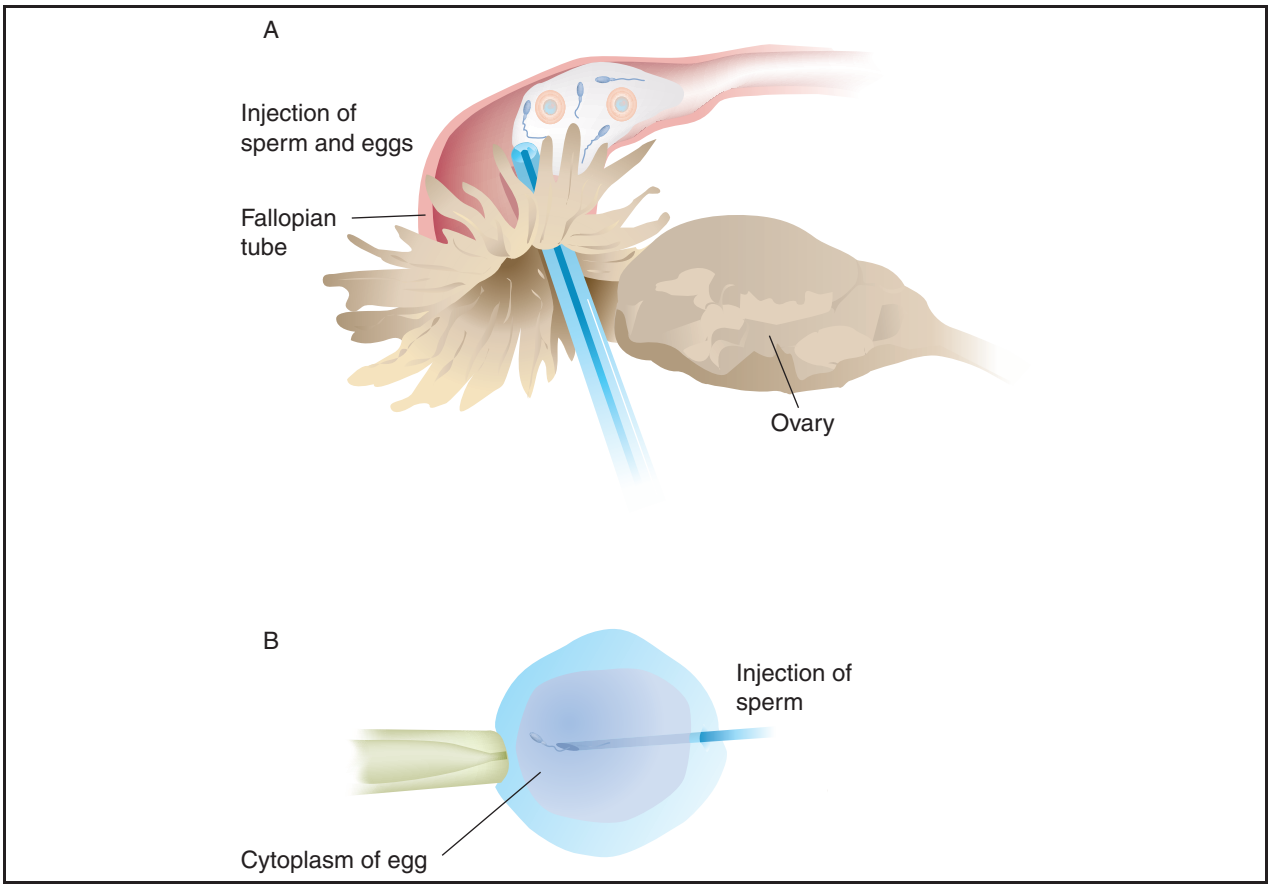

A. An egg and sperm are injected into the fallopian tube to encourage natural fertilization in a procedure called gamete intrafallopian transfer (GIFT). B. An alternative to GIFT is the injection of sperm directly into an egg using microscopic needles. *(Illustration by Argosy, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

then moves into the womb (uterus). The uterine lining (endometrium) has been preparing itself to receive a pregnancy by growing thicker. If the blastocyst successfully reaches the inside of the uterus and attaches itself to the wall of the uterus, implantation and pregnancy have been achieved.

Causes and symptoms

Unlike most medical problems, infertility is an issue requiring the careful evaluation of two separate individuals, as well as an evaluation of their interactions with each other. In about three to four percent of couples, no cause for infertility is discovered. Medical studies have shown that **smoking** adds to infertility problems for both men and women. In addition, men and women who smoke are less likely to respond to infertility treatment.

The main factors involved in causing infertility, listing from the most to the least common, include:

- Male problems: 20%
- Male and female problems: 30–40%
- Female problems: 40–50%. (In these cases the problem is likely to come from conditions such as ovulation problems, pelvic adhesions and endometriosis, or cervical factors.)

Male factors

Male infertility can be caused by a number of different characteristics of the sperm. To check for these characteristics, a sample of semen is obtained and examined under the microscope, a procedure known as **semen analysis**. Four basic characteristics are usually evaluated:

- Sperm count refers to the number of sperm present in a semen sample. The normal number of sperm present in one milliliter (mL) of semen is more than 20 million. An individual with only five to 20 million sperm per milliliter of semen is considered subfertile,

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an individual with fewer than five million sperm per milliliter of semen is considered infertile.

- Sperm are also examined to see how well they swim (sperm motility) and to be sure that most have normal structure.
- Not all sperm within a specimen of semen will be perfectly normal. Some may be immature, and some may have abnormalities of the head or tail. A normal semen sample will contain no more than 25% abnormal forms of sperm.
- Volume of the semen sample is important. An abnormal amount of semen could affect the ability of the sperm to successfully fertilize an ovum.

Another test can be performed to evaluate the ability of the sperm to penetrate the outer coat of the ovum. This test is conducted by observing whether sperm in a semen sample can penetrate the outer coat of a guinea pig ovum. Fertilization cannot occur, of course, but this test is useful in predicting the ability of the individual's sperm to penetrate a human ovum.

Any number of conditions result in abnormal findings in the semen analysis. Genetic problems at birth can lead to improper growth of the testicles and, thus, infertility. Men can be born with one or both testicles that have not descended properly from the abdominal cavity (where testicles develop originally) into the scrotal sac, or may be born with only one instead of the normal two testicles. When testicles have not descended from the abdominal cavity, they are exposed to a higher body temperature than when they are descended. The higher temperature reduces the production of sperm. Testicle size can be smaller than normal. Past infections (including **mumps**) can affect testicular function, as can a past injury. For instance, exposure to sexually transmitted infections (STIs), such as gonorrhea and chlamydia, can result in infertility. The presence of abnormally large veins (varicocele) in the testicles can increase testicular temperature, which decreases sperm count.

History of having been exposed to various toxins, drug use, excess alcohol use, use of anabolic **steroids**, certain medications, diabetes, thyroid problems or other endocrine disturbances, and prostate problems can have direct effects on the formation of sperm (spermatogenesis). Problems with the male anatomy can cause sperm to be ejaculated not out of the penis, but into the bladder (a process known as retrograde ejaculation). Diabetes is a medical disorder and prostate, urethral, and bladder surgeries are three procedures that can lead to retrograde ejaculation. In addition, scarring from past infections can interfere with ejaculation. A condition called **hypospadias** can also cause infertility. Hypospadias occurs when the urinary opening on a man' penis is incorrectly located on its underside so that sperm cannot reach the cervix of a woman.

Sexual issues, such as **erectile dysfunction**, **premature ejaculation**, and **dyspareunia** (painful intercourse), can contribute to a male's infertility. Various psychological problems can also lead to a diminished level of fertility. **Stress** and depression can interfere with hormones that help to produce sperm. Men with long–term depression may have reduced sperm count. Physically, a man who is underweight so that he has been denied certain nutrients, such as vitamin C, zinc, and folate, may lead to infertility. On the other hand, **obesity** (being extremely overweight) in males can also be a contributing factor in infertility.

Treatment of male infertility includes addressing known reversible factors first; for example, discontinuing any medication known to have an effect on spermatogenesis or ejaculation, as well as decreasing alcohol intake, and treating thyroid or other endocrine disease. Varicoceles can be treated surgically. Testosterone in low doses can improve sperm motility.

Other treatments of male infertility include collecting semen samples from multiple ejaculations, after which the semen is put through a process that allows the most motile sperm to be sorted out. These motile sperm are pooled together to create a concentrate that can be deposited into the female partner's uterus at a time that coincides with ovulation. In cases where the male partner's sperm is proven to be absolutely unable to cause pregnancy in the female partner, and with the consent of both partners, donor sperm may be used for this process. Depositing the male partner's sperm or donor sperm by mechanical means into the female partner are both forms of artificial insemination.

Ovulatory problems

The first step in diagnosing ovulatory problems in women is to make sure that an ovum is being produced each month. A woman's morning body temperature is slightly higher around the time of ovulation. A woman can measure and record her temperatures daily and a chart can be drawn to show whether or not ovulation has occurred. Luteinizing hormone (LH) is released just before ovulation. A simple urine test can be done to check if LH has been released around the time that ovulation is expected.

Treatment of ovulatory problems depends on the cause. If a thyroid or pituitary problem is responsible, simply treating that problem can restore fertility. (The

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thyroid and pituitary glands release hormones that also are involved in regulating a woman's menstrual cycle.) Medication can also be used to stimulate fertility. The most commonly used of these medications are clomiphene (Clomid) and menotropin (Pergonal). These drugs increase the risk of multiple births (twins, triplets, etc.). Other possible medications include gonadotropin medications, which are injected medications made up of hormones produced in the pituitary glands. They may directly stimulate the ovaries to produce eggs. Follicle stimulating hormone (FSH) has a 95% chance of simulating ovulation in women with an ovulatory problem. However, its use does not guarantee a successful pregnancy and may lead to multiple pregnancies.

Pelvic adhesions and endometriosis

Pelvic **adhesions** and **endometriosis** can cause infertility by preventing the sperm from reaching the egg or interfering with fertilization. Pelvic adhesions are fibrous **scars**. These scars can be the result of past infections, such as pelvic inflammatory disease, or infections following abortions or prior births. Previous surgeries can also leave behind scarring.

Endometriosis may lead to pelvic adhesions. Endometriosis is the abnormal location of uterine tissue outside of the uterus. When uterine tissue is planted elsewhere in the pelvis, it still bleeds on a monthly basis with the start of the normal menstrual period. This leads to irritation within the pelvis around the site of this abnormal tissue and bleeding, and may cause scarring, along with pelvic **pain**.

Pelvic adhesions cause infertility by blocking the Fallopian tubes. The ovum may be prevented from traveling down the Fallopian tube from the ovary or the sperm may be prevented from traveling up the Fallopian tube from the uterus.

A hysterosalpingogram (HSG) can show if the Fallopian tubes are blocked. This is an x–ray examination that tests whether dye material can travel through the patient's Fallopian tubes. A few women become pregnant following this x–ray exam. It is thought that the dye material in some way helps flush out the tubes, decreasing any existing obstruction. Scarring also can be diagnosed by examining the pelvic area with a scope that can be inserted into the abdomen through a tiny incision made near the naval. This scoping technique is called **laparoscopy**.

Pelvic adhesions can be treated during laparoscopy. The adhesions are cut using special instruments. Endometriosis can be treated with certain medications, but may also require surgery to repair any obstruction caused by adhesions.

Cervical factors

The cervix is the opening from the vagina into the uterus through which the sperm must pass. Mucus produced by the cervix helps to transport the sperm into the uterus. Injury to the cervix or scarring of the cervix after surgery or infection can result in a smaller than normal cervical opening, making it difficult for the sperm to enter. Injury or infection can also decrease the number of glands in the cervix, leading to a smaller amount of cervical mucus. In other situations, the mucus produced is the wrong consistency (perhaps too thick) to allow sperm to travel through the cervix. In addition, some women produce antibodies (immune cells) that are specifically directed to identify sperm as foreign invaders and to kill them.

Cervical mucus can be examined under a microscope to diagnose whether cervical factors are contributing to infertility. The interaction of a live sperm sample from the male partner and a sample of cervical mucus from the female partner can also be examined. This procedure is called a post–coital test.

Treatment of cervical factors includes **antibiotics** in the case of an infection, steroids to decrease production of anti–sperm antibodies, and artificial insemination techniques to completely bypass the cervical mucus.

Other causes of female infertility include: Fallopian tube damage or blockage (usually caused by inflammation), elevated prolactin (hyperprolactinemia), **polycystic ovary syndrome** (which results in the production of too much androgen hormone), early **menopause** (premature ovarian failure), **uterine fibroids** (benign tumors on the wall of the uterus), and various other medical problems (such as **sickle cell disease**, **kidney disease**, and diabetes).

Treatment

Couples can naturally increase the chances of becoming pregnant by having sexual intercourse as frequently as possible. However, it is especially important to have it between the tenth day and eighteen day after the beginning of a woman's menstrual period. Ovulation normally occurs, when menstruation periods are regularly spaced apart, about fourteen days before menstruation begins. Therefore, sexual activity should be especially frequent from three days before to three days after ovulation. For additional help, a physician may recommend using an ovulation prediction test kit to help determine the best times for intercourse.

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KEY TERMS

Blastocyst—A cluster of cells representing multiple cell divisions that have occurred in the Fallopian tube after successful fertilization of an ovum by a sperm. This is the developmental form which must leave the Fallopian tube, enter the uterus, and implant itself in the uterus to achieve actual pregnancy.

Cervix—The opening from the vagina, which leads into the uterus.

Embryo—The stage of development of a baby between the second and eighth weeks after conception.

Endometrium—The lining of the uterus.

Fallopian tube—The tube leading from the ovary into the uterus. Just as there are two ovaries, there are two Fallopian tubes.

Fetus—A baby developing in the uterus from the third month to birth.

Ovary—The female organ in which eggs (ova) are stored and mature.

Ovum (plural: ova)—The reproductive cell of the female, which contains genetic information and participates in the act of fertilization. Also popularly called the egg.

Semen—The fluid that contains sperm, which is ejaculated by the male.

Sperm—The reproductive cell of the male, which contains genetic information and participates in the act of fertilization of an ovum.

Spermatogenesis—The process by which sperm develop to become mature sperm, capable of fertilizing an ovum.

Zygote—The result of the sperm successfully fertilizing the ovum. The zygote is a single cell that contains the genetic material of both the mother and the father.

Assisted reproductive techniques include **in vitro fertilization** (IVF), gamete intrafallopian transfer (GIFT), and zygote intrafallopian tube transfer (ZIFT). These are usually used after other techniques to treat infertility have failed.

In vitro fertilization involves the use of a drug to induce the simultaneous release of many eggs from the female's ovaries, which are retrieved surgically. Meanwhile, several semen samples are obtained from the male partner, and a sperm concentrate is prepared. The ova and sperm are then combined in a laboratory, where several of the ova may be fertilized. Cell division is allowed to take place up to the embryo stage. While this takes place, the female may be given drugs to ensure that her uterus is ready to receive an embryo. Three or four of the embryos are transferred to the female's uterus, and the wait begins to see if any or all of them implant and result in an actual pregnancy.

Success rates of IVF are still rather low. Most centers report pregnancy rates between 10–20%. Since most IVF procedures put more than one embryo into the uterus, the chance for a multiple birth (twins or more) is greatly increased in couples undergoing IVF.

GIFT involves retrieval of both multiple ova and semen, and the mechanical placement of both within the female partner's Fallopian tubes, where one hopes that fertilization will occur. ZIFT involves the same retrieval of ova and semen, and fertilization and growth in the laboratory up to the zygote stage, at which point the zygotes are placed in the Fallopian tubes. Both GIFT and ZIFT seem to have higher success rates than traditional IVF.

Prognosis

It is very difficult to obtain statistics regarding the prognosis of infertility because many different problems may exist within an individual or couple trying to conceive. In general, it is believed that of all couples who undergo a complete evaluation of infertility followed by treatment and therapies, about half will ultimately have a successful pregnancy. Of those couples who do not choose to undergo evaluation or treatment, about five percent go on to conceive after a year or more of infertility.

Prevention

Having fewer sexual partners and using contraceptive devices (such as **condoms**) that reduce the chances of contracting sexually transmitted infections, such as chlamydia and gonorrhea, can reduce the chances of becoming infertile. Getting a mumps **vaccination** is also an effective way to prevent infertility. Maintaining a healthy lifestyle with respect to diet and **exercise** is also helpful. Advice from your family doctor or a medical professional is beneficial in learning more about how to prevent infertility.

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ORGANIZATIONS

American Society for Reproductive Medicine, 1209 Montgomery Hwy., Birmingham, AL, 35216–2809, (205) 978–5000, (205) 978–5005, asrm@asrm.org, http://www.asrm.com.
International Center for Infertility Information Dissemination, PO Box 6836, Arlington, VA, 22206, (703) 379–9178, (703) 379–1593, http://www.inciid.org.

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Infertility drugs

Definition

Infertility drugs are medicines that help bring about **pregnancy**.

Purpose

Infertility is the inability of a man and woman to achieve pregnancy after at least a year of having regular sexual intercourse without any type of birth control. There are many possible reasons for infertility, and finding the most effective treatment for a couple may involve many tests to find the problem. For pregnancy to occur, the woman's reproductive system must release eggs regularly—a process called ovulation. The man must produce healthy sperm that are able to reach and unite with an egg. And once an egg is fertilized, it must travel to the woman's uterus (womb), become implanted and remain there to be nourished.

If a couple is infertile because the woman is not ovulating, infertility drugs may be prescribed to stimulate ovulation. The first step usually is to try a drug such as clomiphene. If that does not work, human chorionic gonadotropin (hCG) may be tried, usually in combination with other infertility drugs.

Clomiphene and hCG may also be used to treat other conditions in both males and females.

Description

Clomiphene (Clomid, Milophene, and Serophene)) comes in tablet form and is available only with a physician's prescription. Human chorionic gonadotropin is given as an injection, only under a physician's supervision.

Clomiphene citrate is used to increase the natural production of the hormones that stimulate ovulation in otherwise healthy women. When clomiphene is administered, the body produces higher levels of luteinizing hormone (LH), follicle stimulating hormone (FSH), and gonadotropins. These hormones induce ovulation.

Human chorionic gonadotropin (hCG) is sold under many brand names including Gonic, Pregnyl, Ovidrel, Chorex, Chorigon, and Profasi. This hormone stimulates the gonads in both men and women. In men, hCG increases androgen production. In women, it increases the levels of progesterone. Human chorionic gonadotropin can help stimulate ovulation in women.

Although some people believe that hCG can help lose weight, there is no evidence that this hormone offers any benefit in weight loss programs. Many medical organizations, such as the American Medical Association (AMA), warn about using hCG for such a purpose. Consequently, it should not be used for this purpose.

A number of other natural and synthetic hormones are used to induce ovulation. Urofollitropin (Bravelle, Fertinex) is a concentrated preparation of human hormones, while follitropin alfa (Gonal–F) and follitropin beta (Follistim) are human FSH preparations of recombinant DNA (deoxyribonucleic acid) origin. Developments in this field are continuous. For example, in June 2004, the U.S. Food and Drug Administration (FDA) approved a follitropin beta injection, called Follistim AQ Cartridge, in individualized doses for women to self–inject. Then, in 2008, the FDA approved SpermCheck Fertility test kit, made by ContraVac, which tests for sperm count in men.

Menotropins (Pergonal, Humegon, Repronex) are often given with human chorionic gonadotropin to stimulate ovulation in women and sperm production in men.

Recommended dosage

Dosage may be different for different patients. The physician who prescribed the drug or the pharmacist who filled the prescription will recommend the correct dosage.

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Clomiphene must be taken at certain times during the menstrual cycle and patients should follow directions exactly. It is usually taken once a day for five days, beginning on or about day five of the menstrual cycle. However, this dosage and the times in which it is taken may be different for various individuals. Consequently, do not take it in dosages that are more or less than what is prescribed by the doctor. Go strictly by what the doctor says.

Precautions

Seeing a physician regularly while taking infertility drugs is important because side effects and complications can occur.

Treatment with infertility drugs increases the chance of multiple births. Although this eventuality may seem like a good thing to couples who want children very badly, multiple fetuses can cause problems during pregnancy and delivery and can even threaten the babies' survival.

Having intercourse at the proper time in the woman's menstrual cycle helps increase the chance of pregnancy. The physician may recommend using an ovulation prediction test kit to help determine the best times for intercourse.

Some people feel dizzy or lightheaded, or less alert when using clomiphene. The medicine may also cause blurred vision and other vision changes. Individuals who take clomiphene should not drive, use machines, or do anything else that might be dangerous until they have found out how the drugs affect them.

Questions remain about the safety of long–term treatment with clomiphene. Women should not have more than six courses of treatment with this drug and should ask their physicians for the most up–to–date information about its use.

Special conditions

People who have certain medical conditions or who are taking certain other medicines may have problems if they take infertility drugs. Before taking these drugs, patients should tell the physician about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to infertility drugs in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGMAMCY. Clomiphene may cause **birth defects** if taken during pregnancy. Women who think they have become pregnant while taking clomiphene should stop taking the medicine immediately and check with their physicians.

OTHER MEDICAL CONDITIONS. Infertility drugs may make some medical conditions worse. Before using infertility drugs, people with any of these medical problems should make sure their physicians are aware of their conditions:

- Endometriosis
- Fibroid tumors of the uterus
- Unusual vaginal bleeding
- Ovarian cyst
- Enlarged ovaries
- Inflamed veins caused by blood clots
- Liver disease, now or in the past
- Depression.

USE OF CERTAIN MEDICINES. Taking infertility drugs with certain other medicines may affect the way the drugs work or may increase the chance of side effects.

KEY TERMS

Endometriosis—A condition in which tissue like that normally found in the lining of the uterus is present outside the uterus. The condition often causes pain and bleeding.

Fetus—A developing baby inside the womb.

Fibroid tumor—A noncancerous tumor formed of fibrous tissue.

Ovary—A reproductive organ in females that produces eggs and hormones.

Side effects

When used in low doses for a short time, clomiphene and HCG rarely cause side effects. However, anyone who has stomach or pelvic **pain** or bloating while taking either medicine should check with a physician immediately. Infertility drugs may also cause less serious symptoms such as hot flashes, breast tenderness or swelling, heavy menstrual periods, bleeding between menstrual periods, **nausea** or **vomiting**, **dizziness**, lightheadedness, irritability, nervousness, restlessness, **headache**, tiredness, sleep problems, or depression. These problems usually go away as the body adjusts to the drug and do not require medical treatment unless they continue or they interfere with normal activities.

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Other side effects are possible. Anyone who has unusual symptoms after taking infertility drugs should contact a physician.

Interactions

Infertility drugs may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes infertility drugs should let the physician know all other medicines she is taking.

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American Society for Reproductive Medicine (ASRM), 1209 Montgomery Hwy., Birmingham, AL, 35216–2809, (205) 978–5000, (205) 978–5005, asrm@asrm.org, http://www.asrm.com.

International Center for Infertility Information Dissemination (INCIID), PO Box 6836, Arlington, VA, 22206, (703) 379–9178, (703) 379–1593, INCIIDinfo@inciid.org, http://www.inciid.org.

Nancy Ross–Flanigan
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Infertility therapies

Definition

Infertility is the inability of a man and a woman to conceive a child through sexual intercourse. There are many possible reasons for the problem, which can involve the man, the woman, or both partners. Various treatments, or infertility therapies, are available that enable a woman to become pregnant; the correct one will depend on the specific cause of the infertility.

Purpose

Infertility treatment is aimed at enabling a woman to have a baby by treating the man, the woman, or both partners. During normal conception of a child, the man's sperm travels to the woman's Fallopian tubes, where, if conditions are right, it will encounter an egg that has been released from the ovary. The sperm fertilizes the egg, which will enter the uterus where it implants and begins to divide, forming an embryo. The embryo develops during **pregnancy** into a baby.

Infertility treatment attempts to correct or compensate for any abnormalities in this process that prevent the fertilization of an egg or development of an embryo.

Precautions

It is important for a couple contemplating infertility treatment to examine their own ideas and feelings about the process and consider ethical objections before the woman becomes pregnant from such treatment. Some infertility clinics recommend that couples attend at least one session with a psychologist or psychiatrist before proceeding with infertility therapy. In this way couples can freely express their concerns and learn more about what they are about to experience. It also helps to identify couples that may be having difficulties coping with the situation. Infertility support groups are also available in most areas to help with questions that arise, along with helping to provide an experienced viewpoint about infertility therapy.

Description

About 85% of women who are trying to get pregnant and use no birth control will do so within one year, and half of the other 15% become pregnant within another three years. If after one year of having sexual intercourse with no **contraception** a couple has not conceived, they should seek the advice of a physician. Tests can be performed to look for possible infertility problems.

Treating an underlying infection or illness is the first step in infertility treatment. The physician may also suggest improving general health, changing diet, reducing **stress**, and counseling.

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Treatment

Low sperm count treatments

The most common cause of male infertility is failure to produce enough healthy sperm. For fertilization to occur, the number of sperm cells in the man's semen (the fluid ejected during sexual intercourse) must be sufficient, and the sperm cells must have the right shape, appearance, and activity (motility).

Defects in sperm can be caused by an infection resulting from a sexually transmitted infection (STI), a blockage caused by a varicose vein in the scrotum (varicocele), an endocrine imbalance, or problems with other male reproductive organs (such as the testicles, prostate gland, or seminal vesicles).

A **physical examination** of a man's genitals is usually the first step in identifying a low sperm count. The medical history of the man is also collected, especially noting incidences of illnesses, injuries, and recurring health problems. Semen is also examined with a **semen analysis** test. The number of sperm is counted under a microscope.

If low sperm count is the problem, it is possible to restore fertility by:

- treating any underlying infections.
- timing sex to coincide with the time the woman is ovulating, which means that the egg is released from the ovary and is beginning to travel down the Fallopian tube (the site of fertilization).
- having sex less often to build up the number of sperm in the semen.
- treating any endocrine imbalance with drugs.
- having a surgical procedure to remove a varicocele (varicocelectomy).

Fertility drugs

If infertility is due to a woman's failure to release eggs from the ovary (ovulate), fertility drugs can help bring hormone levels into balance, stimulating the ovaries and triggering egg production.

Surgical repair

In some women, infertility is due to blocked Fallopian tubes. The egg is released from the ovary, but sperm is prevented from reaching it because of a physical obstruction in the Fallopian tube. If this is the case, surgery may help repair the damage. Microsurgery can sometimes repair the damage to scarred Fallopian tubes if it is not too severe. Not all tube damage can be repaired, however, and most tubal problems are more successfully treated with **in vitro fertilization**.

Fibroid tumors in the uterus also may cause infertility, and they can be surgically treated. **Endometriosis**, a condition in which parts of the lining of the uterus become imbedded on other internal organs (such as the ovaries or Fallopian tubes) may contribute to infertility. It may be necessary to surgically remove the endometrial tissue to improve fertility.

Artificial insemination

Artificial insemination may be tried if sperm count is low, the man is impotent, or the woman's vagina creates a hostile environment for the sperm. The procedure is not always successful. In this procedure, semen is collected and placed into the woman's cervix with a small syringe at the time of ovulation. From the cervix, sperm can travel to the Fallopian tube where fertilization takes place. If the partner's sperm count is low, it can be mixed with donor sperm before being transferred into the uterus.

If sperm is not present in the male partner's semen, then artificial insemination can be performed using a donor's sperm obtained from a sperm bank.

Assisted reproductive technologies

Some fertility treatments require removal of eggs and/or sperm and manipulation of them in certain ways in a laboratory to assist fertilization. These techniques are called as a group: assisted reproductive technologies (ART). They have helped thousands of women each year in the United States to become pregnant so that couples can have their own biological children.

IN VITRO FERTILIZATION (IVF). When infertility cannot be treated by other means or when the cause is not known, it is still possible to become pregnant through in vitro fertilization (IVF), a costly, complex procedure that achieves pregnancy about 20% of the time. IVF is usually recommended when both Fallopian tubes are blocked, but it can be used for other problems (such as endometriosis, cervical factor infertility, and ovulation disorders).

In this procedure, a woman's eggs are removed by withdrawing them from the woman' ovaries with a special needle. Attempts are then made to fertilize the eggs with sperm from her partner or a donor. This fertilization takes place in a Petri dish in a laboratory. The fertilized egg (embryo) is then returned to the woman's uterus so that it can develop normally from that point.

Often, three to six fertilized eggs are returned at the same time into the uterus. Usually one or two of

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the embryos survive and grow into fetuses, but sometimes three or more fetuses result.

A child born in this method is popularly known as a "test tube baby," but in fact the child actually develops inside the mother. Only the fertilization of the egg takes place in the laboratory. The birth of the first test tube baby occurred in 1978 in the United Kingdom. As of 2008, around three million babies around the world had been born with the help of in vitro fertilization, with about half a million of them in the United States.

INTRACYTOPLASMIC SPERM INJECTION (ICSI). In a variation of IVF called intracytoplasmic sperm injection (ICSI), single sperm cells are injected directly into each egg with the use of a microscopic technique called micromanipulation. This process, developed in 1991 in Belgium, may be helpful for men with severe infertility (low sperm count) and also when eggs cannot be easily penetrated by sperm.

GAMETE INTERFALLOPIAN TRANSFER (GIFT). In this technique, eggs are removed from the ovaries of a woman and placed directly into one of her two Fallopian tubes to encourage fertilization to occur naturally. At least one normal Fallopian tube must be available for the procedure to work successfully. This procedure, developed by Argentine endocrinologist Ricardo Asch (1947–), is performed by means of **laparoscopy**. In laparoscopy, a small tube with a viewing lens at one end is inserted into the abdomen through a small incision. The lens allows the physician to see inside the patient on a video monitor.

ZYGOTE INTRAFALLOPIAN TRANSFER (ZIFT). If infertility is caused by a low sperm count, zygote intrafallopian transfer (ZIFT) can be tried. This technique combines GIFT and IVF. This procedure is also called a "tubal embryo transfer."

In this technique, in–vitro fertilization is first performed, so that the actual fertilization takes place and is confirmed in the laboratory. Two days later, instead of placing the embryo in the uterus, the physician performs laparoscopy to place the embryos in the Fallopian tube, much as with the GIFT procedure. The success of this technique is usually not known for about five weeks.

A woman must have at least one functioning Fallopian tube in order to participate in ZIFT.

Preparation

Couples who are having fertility problems may want to limit or avoid:

- tobacco
- alcohol
- caffeine
- stress
- tight–fitting undershorts (men)
- hot tubs, saunas and steam rooms (high temperatures can kill sperm).

KEY TERMS

Gamete—An egg (ovum) from the female or a mature sperm from the male.

Laparoscopy—A procedure in which a viewing tube is inserted through the abdominal wall to examine a woman's reproductive organs.

Ovulation—The release of an egg from the ovary. Fertilization can occur within a day or two of ovulation.

Zygote—A fertilized egg.

Risks

Women who take fertility drugs have a higher likelihood of getting pregnant with more than one child at a time, resulting in multiple pregnancies. Such pregnancies also carry the risk of low birth weight for the infants born as a result of this procedure. There are also rare but serious side effects to fertility drugs. **Birth defects** have been shown to be possible when assisted reproductive technologies are used. For instance, ovarian hyperstimulation syndrome (OHSS) may occur at a higher rate in women using infertility therapies than with other women. OHSS is a complication—directly caused by the use of fertility medications—in which the ovaries become enlarged, abdominal swelling occurs, blood pressure decreases, and other symptoms occur. Invasive procedures used with the various types of infertility therapies, as with any type of surgery, carry risk of infection, bleeding, and other complications.

Normal results

Typically, at least half of all couples who are infertile will respond to treatment with a successful pregnancy. For those who cannot become pregnant with treatment or insemination, surrogate parenting or adopting may be other options.

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RESOLVE: The National Infertility Association, 1760 Old Meadow Rd., Suite 500, McLean, VA, 22102, (703) 556–7172, (703) 506–3266, info@resolve.org, http://www.resolve.org.

Carol A. Turkington

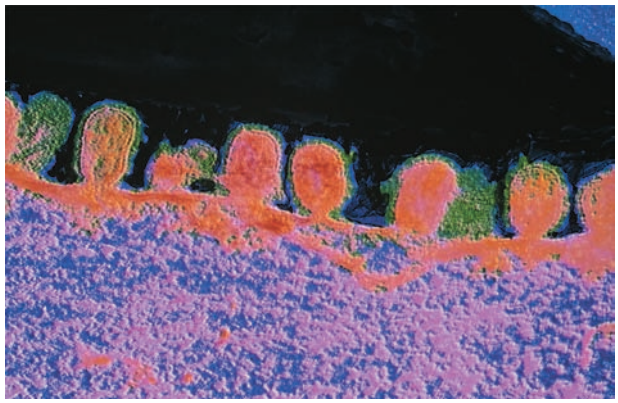
Influenza

Definition

Usually referred to as the flu or grippe, influenza is a highly infectious respiratory disease. The disease is caused by certain strains of the influenza virus. When the virus is inhaled, it attacks cells in the upper respiratory tract, causing typical flu symptoms such as **fatigue**, **fever** and chills, a hacking **cough**, and body aches. Influenza victims are also susceptible to potentially life-threatening secondary infections. Although the stomach or intestinal "flu" is commonly blamed for stomach upsets and **diarrhea**, the influenza virus rarely causes gastrointestinal symptoms. Such symptoms are most likely due to other organisms such as rotavirus, *Salmonella*, *Shigella*, or ***Escherichia coli***.

Description

The flu is considerably more debilitating than the **common cold**. Influenza outbreaks occur suddenly, and infection spreads rapidly. The annual **death** toll attributable to influenza and its complications averages 20,000 in the United States alone.



A transmission electron microscopy (TEM) image of influenza viruses budding from the surface of an infected cell. *(SPL/Photo Researchers, Inc.)*

In the 1918-1919 Spanish flu pandemic, the death toll reached a staggering 20–40 million worldwide. Approximately 500,000 of these fatalities occurred in the United States.

Influenza outbreaks occur on a regular basis. The most serious outbreaks are pandemics, which affect millions of people worldwide and last for several months. The 1918–1919 influenza outbreak serves as the primary example of an influenza pandemic. Pandemics also occurred in 1957 and 1968 with the Asian flu and Hong Kong flu, respectively. The Asian flu was responsible for 70,000 deaths in the United States, while the Hong Kong flu killed 34,000.

Epidemics are widespread regional outbreaks that occur every two to three years and affect 5–10% of the population. The Russian flu in the winter of 1977 is an example of an epidemic. A regional epidemic is shorter lived than a pandemic, lasting only several weeks. Finally, there are smaller outbreaks each winter that are confined to specific locales.

The earliest existing descriptions of influenza were written nearly 2500 years ago by the ancient Greek physician Hippocrates. Historically, influenza was ascribed to a number of different agents, including "bad air" and several different bacteria. In fact, its name comes from the Italian word for "influence," because people in eighteenth-century Europe thought that the disease was caused by the influence of bad weather. It was not until 1933 that the causative agent was identified as a virus.

There are three types of influenza viruses, identified as A, B, and C. Influenza A can infect a range of animal species, including humans, pigs, horses, and birds, but only humans are infected by types B and C. Influenza A is responsible for most flu cases, while

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infection with types B and C virus are less common and cause a milder illness.

In the United States, 90% of all deaths from influenza occur among persons older than 65. Flu-related deaths have increased substantially in the United States since the 1970s, largely because of the **aging** of the American population. In addition, elderly persons are vulnerable because they are often reluctant to be vaccinated against flu.

A new concern regarding influenza is the possibility that hostile groups or governments could use the virus as an agent of bioterrorism. A report published in early 2003 noted that Type A influenza virus has a high potential for use as such an agent because of the virulence of the Type A strain that broke out in Hong Kong in 1997 and the development of laboratory methods for generating large quantities of the virus. The report recommended the stockpiling of present **antiviral drugs** and speeding up the development of new ones.

Causes and symptoms

Approximately one to four days after infection with the influenza virus, the victim is hit with an array of symptoms. "Hit" is an appropriate term, because symptoms are sudden, harsh, and unmistakable. Typical influenza symptoms include the abrupt onset of a **headache**, dry cough, and chills, rapidly followed by overall achiness and a fever that may run as high as 104°F (40°C). As the fever subsides, nasal congestion and a **sore throat** become noticeable. Flu victims feel extremely tired and weak and may not return to their normal energy levels for several days or even a couple of weeks.

Influenza complications usually arise from bacterial infections of the lower respiratory tract. Signs of a secondary respiratory infection often appear just as the victim seems to be recovering. These signs include high fever, intense chills, chest pains associated with breathing, and a productive cough with thick yellowish green sputum. If these symptoms appear, medical treatment is necessary. Other secondary infections, such as sinus or ear infections, may also require medical intervention. Heart and lung problems, and other chronic diseases, can be aggravated by influenza, which is a particular concern with elderly patients.

With children and teenagers, it is advisable to be alert for symptoms of **Reye's syndrome**, a rare, but serious complication. Symptoms of Reye's syndrome are **nausea and vomiting**, and more seriously, neurological problems such as confusion or **delirium**. The syndrome has been associated with the use of **aspirin** to relieve flu symptoms.

Diagnosis

Although there are specific tests to identify the flu virus strain from respiratory samples, doctors typically rely on a set of symptoms and the presence of influenza in the community for diagnosis. Specific tests are useful to determine the type of flu in the community, but they do little for individual treatment. Doctors may administer tests, such as throat cultures, to identify secondary infections.

Since 1999, however, seven rapid diagnostic tests for flu have become commercially available. These tests appear to be especially useful in diagnosing flu in children, allowing doctors to make more accurate treatment decisions in less time.

Treatment

Essentially, a bout of influenza must be allowed to run its course. Symptoms can be relieved with bed rest and by keeping well hydrated. A steam vaporizer may make breathing easier, and **pain** relievers will take care of the aches and pain. Food may not seem very appetizing, but an effort should be made to consume nourishing food. Recovery should not be pushed too rapidly. Returning to normal activities too quickly invites a possible relapse or complications.

Drugs

Since influenza is a viral infection, **antibiotics** are useless in treating it. However, antibiotics are frequently used to treat secondary infections.

Over-the-counter medications are used to treat flu symptoms, but it is not necessary to purchase a medication marketed specifically for flu symptoms. Any medication that is designed to relieve symptoms, such as pain and coughing, will provide some relief. Medications containing alcohol, however, should be avoided because of the dehydrating effects of alcohol. The best medicine for symptoms is simply an analgesic, such as aspirin, **acetaminophen**, or naproxen. Without a doctor's approval, aspirin is generally not recommended for people under 18 owing to its association with Reye's syndrome, a rare aspirin-associated complication seen in children recovering from the flu. To be on the safe side, children should receive acetaminophen or ibuprofen to treat their symptoms.

There are four antiviral drugs marketed for treating influenza. To be effective, treatment should begin no later than two days after symptoms appear. Antivirals may be useful in treating patients who have weakened immune systems or who are at risk for developing serious complications. They include amantadine

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(Symmetrel, Symadine) and rimantadine (Flumandine), which work against Type A influenza, and zanamavir (Relenza) and oseltamavir phosphate (Tamiflu), which work against both Types A and B influenza. Amantadine and rimantadine can cause side effects such as nervousness, **anxiety**, lightheadedness, and **nausea**. Severe side effects include seizures, delirium, and hallucination, but are rare and are nearly always limited to people who have kidney problems, seizure disorders, or psychiatric disorders. The new drugs zanamavir and oseltamavir phosphate have few side effects but can cause **dizziness**, jitters, and **insomnia**.

Alternative treatments

There are several alternative treatments that may help in fighting off the virus and recovering from the flu, in addition to easing flu symptoms.

- Acupuncture and acupressure. Both are said to stimulate natural resistance, relieve nasal congestion and headaches, fight fever, and calm coughs, depending on the acupuncture and acupressure points used.
- Aromatherapy. Aromatherapists recommend gargling daily with one drop each of the essential oils of tea tree (*Melaleuca* spp.) and lemon mixed in a glass of warm water. If already suffering from the flu, two drops of tea tree oil in a hot bath may help ease the symptoms. Essential oils of eucalyptus (*Eucalyptus globulus*) or peppermint (*Mentha piperita*) added to a steam vaporizer may help clear chest and nasal congestion.
- Herbal remedies. Herbal remedies can be used to stimulate the immune system (echinacea), as antivirals (*Hydrastis canadensis*) goldenseal and garlic (*Allium sativum*), or directed at whatever symptoms arise as a result of the flu. For example, an infusion of boneset (*Eupatroium perfoliatum*) may counteract aches and fever, and yarrow (*Achillea millefolium*) or elderflower tinctures may combat chills.
- Homeopathy. To prevent flu, a homeopathic remedy called *Oscillococcinum* may be taken at the first sign of flu symptoms and repeated for a day or two. Although oscillococcinum is a popular flu remedy in Europe, a research study published in 2003 found it to be ineffective. Other homeopathic remedies recommended vary according to the specific flu symptoms present. *Gelsemium* (*Gelsemium sempervirens*) is recommended to combat weakness accompanied by chills, a headache, and nasal congestion. *Bryonia* (*Bryonia alba*) may be used to treat muscle aches, headaches, and a dry cough. For restlessness, chills, hoarseness, and achy joints, poison ivy (*Rhus toxicodendron*) is recommended. Finally, for achiness and a dry cough or chills, *Eupatorium perfoliatum* is suggested.
- Hydrotherapy. A bath to induce a fever will speed recovery from the flu by creating an environment in the body where the flu virus cannot survive. The patient should take a bath as hot as he/she can tolerate and remain in the bath for 20–30 minutes. While in the bath, the patient drinks a cup of yarrow or elderflower tea to induce sweating. During the bath, a cold cloth is held on the forehead or at the nape of the neck to keep the temperature down in the brain. The patient is assisted when getting out of the bath (he/she may feel weak or dizzy) and then gets into bed and covers up with layers of blankets to induce more sweating.
- Traditional Chinese medicine (TCM). Practitioners of TCM recommend mixtures of herbs to prevent flu as well as to relieve symptoms once a person has fallen ill. There are several different recipes for these remedies, but most contain ginger and Japanese honeysuckle in addition to other ingredients.
- Vitamins. For adults, 2–3 grams of vitamin C daily may help prevent the flu. Increasing the dose to 5–7 grams per day during the flu can felp fight the infection. (The dose should be reduced if diarrhea develops.)

Prognosis

Following proper treatment guidelines, healthy people under the age of 65 usually suffer no long-term consequences associated with flu infection. The elderly and the chronically ill are at greater risk for secondary infection and other complications, but they can also enjoy a complete recovery.

Most people recover fully from an influenza infection, but it should not be viewed complacently. Influenza is a serious disease, and approximately 1 in 1,000 cases proves fatal.

Prevention

The Centers for Disease Control and Prevention recommend that people get an influenza vaccine injection each year before flu season starts. In the United States, flu season typically runs from late December to early March. Vaccines should be received two to six weeks prior to the onset of flu season to allow the body enough time to establish immunity. Adults only need one dose of the yearly vaccine, but children under nine years of age who have not previously been immunized should receive two doses with a month between each dose.

Each season's flu vaccine contains three virus strains that are the most likely to be encountered in

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KEY TERMS

Bioterrorism—The intentional use of disease-causing microbes or other biologic agents to intimidate or terrorize a civilian population for political or military reasons. Type A influenza virus could be used as an agent of bioterrorism.

Common cold—A mild illness caused by a upper respiratory viruses. Usual symptoms include nasal congestion, coughing, sneezing, throat irritation, and a low-grade fever.

Epidemic—A widespread regional disease outbreak.

Guillain-Barré syndrome—Also called acute idiopathic polyneuritis, this condition is a neurologic syndrome that can cause numbness in the limbs and muscle weakness following certain viral infections.

Pandemic—Worldwide outbreak of an infection, afflicting millions of victims.

the coming flu season. When there is a good match between the anticipated flu strains and the strains used in the vaccine, the vaccine is 70–90% effective in people under 65. Because immune response diminishes somewhat with age, people over 65 may not receive the same level of protection from the vaccine, but even if they do contract the flu, the vaccine diminishes the severity and helps prevent complications.

The virus strains used to make the vaccine are inactivated and will not cause the flu. In the past, flu symptoms were associated with vaccine preparations that were not as highly purified as modern vaccines, not to the virus itself. In 1976, there was a slightly increased risk of developing **Guillain-Barré syndrome**, a very rare disorder, associated with the swine flu vaccine. This association occurred only with the 1976 swine flu vaccine preparation and has never recurred.

Serious side effects with modern vaccines are extremely unusual. Some people experience a slight soreness at the point of injection, which resolves within a day or two. People who have never been exposed to influenza, particularly children, may experience one to two days of a slight fever, tiredness, and muscle aches. These symptoms start within 6–12 hours after the **vaccination**.

It should be noted that certain people should not receive an influenza vaccine. Infants six months and younger have immature immune systems and will not benefit from the vaccine. Since the vaccines are prepared using hen eggs, people who have severe **allergies** to eggs or other vaccine components should not receive the influenza vaccine. As an alternative, they may receive a course of amantadine or rimantadine, which are also used as a protective measure against influenza. Other people who might receive these drugs are those who have been immunized after the flu season has started or who are immunocompromised, such as people with advanced HIV disease. Amantadine and rimantadine are 70–90% effective in preventing influenza.

There are two types of influenza vaccines: the flu shot and the flu mist. The flu shot consists of inactivated (killed) influenza viruses and is given by injection into the muscle. With the flu mist, the live, attenuated (weakened) influenza vaccine (LAIV) is sprayed into the nostrils, but this type of vaccination is not recommended for persons over the age of 49. Both injectable and mist vaccine typically contain three influenza viruses, two of type A virus and one of type B virus. The strains of viruses included in the vaccine change yearly based on international surveillance data of influenza cases and estimations by scientists on what types and strains of viruses will be prevalent in the coming influenza season. When the strains included in the vaccine are well matched to the strains present in the community, the vaccine usually can protect seven to nine out of ten vaccinated persons. However, in elderly people, the vaccine may not work as well in preventing influenza, but will result in decrease in severity of symptoms and in the risk of health complications.

In April 2009, the United States Department of Health and Human Services declared a public health emergency regarding human cases of H1N1 influenza A, more commonly called swine flu. Swine flu was of special concern because for several reasons. Experts believed that the virus was a new strain of influenza with a genetic composition different from the familiar viruses that cause seasonal influenza. Because it was radically different, individuals were especially susceptible to developing serious illness. In addition, the virus often caused more intense symptoms in young, healthy people than in the elderly or the very young who are the greatest target of seasonal flu. Because the decision had already been made about which strains of seasonal flu were to be included in the vaccine for the

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next flu season and manufacture had already begun, a special push was made to make a separate vaccine against the swine flu. Thus, in the winter of 2009 through the 2010 flu season, people were advised to get two separate flu shots, one against seasonal flu and one against the new H1N1 influenza A.

Certain groups are strongly advised to be vaccinated because they are at increased risk for influenza-related complications:

- All people 65 years and older
- Residents of nursing homes and chronic-care facilities, regardless of age
- Adults and children who have chronic heart or lung problems, such as asthma
- Adults and children who have chronic metabolic diseases, such as diabetes and renal dysfunction, as well as severe anemia or inherited hemoglobin disorders
- Children and teenagers who are on long-term aspirin therapy
- Women who will be in their second or third trimester during flu season or women who are nursing
- Anyone who is immunocompromised, including HIV-infected persons, cancer patients, organ transplant recipients, and patients receiving steroids, chemotherapy, or radiation therapy
- Anyone in contact with the above groups, such as teachers, care givers, health-care personnel, and family members
- Travelers to foreign countries.

A person need not be in one of the at-risk categories listed above, however, to receive a flu vaccination. Anyone who wants to forego the discomfort and inconvenience of an influenza attack may receive the vaccine.

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Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, 800 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

National Institute of Allergies and Infectious Diseases, 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-6612, 301 496-5717, 301 402-3573, 866 284-4107, ocpostoffice@niaid.nih.gov, http://www.niaid.nih.gov.

Julia Barrett
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Influenza vaccination

Definition

An **influenza vaccination** is a vaccination that is used to protect individuals against the viruses that cause influenza, which is also called the flu.

Purpose

Influenza vaccination helps to protect people against getting influenza. Protection is imperfect because the viruses that cause influenza are constantly changing (mutating). Influenza vaccines are updated every year to reflect the current stains of flu that are expected to be most prevalent, and re-vaccination is recommended every year.

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KEY TERMS

Guillain-Barre Syndrome—A disorder characterized by progressive symmetrical paralysis and loss of reflexes, usually beginning in the legs. The paralysis characteristically involves more than one limb (most commonly the legs), is progressive, and usually proceeds from the end of an extremity toward the torso. Guillain-Barre usually occurs after a respiratory infection, and it is apparently caused by a misdirected immune response that results in the direct destruction of the myelin sheath surrounding the peripheral nerves or of the axon of the nerve itself.

Influenza —Commonly known as flu; an infectious disease of birds and mammals caused by viruses of the family Orthomyxoviridae (the influenza viruses); common symptoms of the disease are the chills, then fever, sore throat, muscle pains, severe headache, coughing, weakness and general feelings of illness.

Vaccination—Injection of a killed or weakened microbe in order to stimulate the immune system against the microbe, thereby preventing disease. Vaccinations, or immunizations, work by stimulating the immune system, the natural disease-fighting system of the body. The healthy immune system is able to recognize invading bacteria and viruses and produce substances (antibodies) to destroy or disable them. Vaccinations prepare the immune system to ward off a disease. To immunize against viral diseases, the virus used in the vaccine has been weakened or killed.

Description

Every year in the United States about 226,000 people are hospitalized and 36,000 die of influenza-related complications, most often bacterial **pneumonia**, **dehydration**, or a worsening of chronic medical conditions, such as congestive **heart failure**, **asthma**, or diabetes. Ninety% of the deaths occur in individuals 65 years and older. During influenza epidemics, hospitalization rates for older people increase two to five times compared to other seasons of the year and, more than half of the hospitalizations are people 65 and older.

An influenza vaccination is the best way to be protected from contracting influenza. Older Hispanic and African-American adults are much less likely to be vaccinated against influenza than their white counterparts. The rate of vaccination of senior citizens is about 65% in the United States African-Americans 65 years and older lag behind whites by about 21% in getting annual vaccinations, while Hispanic Americans 65 years and older lag behind whites by 19%. In large urban areas with high levels of unvaccinated persons, there is a potential for outbreaks of influenza; thus improving overall immunization coverage rates is essential. Studies have also shown that elderly people who choose to be vaccinated are generally in better health than those who fail to get the vaccine, so influenza control strategies should be developed to target those who are not being vaccinated. The United States Centers for Disease Control and Prevention (CDC) has set a target date of 2010 to increase influenza vaccinations to 90% among all adults aged 65 years and older, with an emphasis on vaccinating minority groups. In the U.S. the influenza vaccination is provided at no cost to all senior citizens covered by Medicare.

There are two types of influenza vaccines: the flu shot and the flu mist. The flu shot consists of inactivated (killed) influenza viruses and is given by injection into the muscle. With the flu mist, the live, attenuated (weakened) influenza vaccine (LAIV) is sprayed into the nostrils, but this type of vaccination is not recommended for persons over the age of 49. Both injectable and mist vaccine typically contain three influenza viruses, two of type A virus and one of type B virus. The strain of viruses included in the vaccine change yearly based on international surveillance data of influenza cases and estimations by scientists on what types and strains of viruses will be prevalent in the coming influenza season. When the strains included in the vaccine are well matched to the strains present in the community, the vaccine usually can protect seven to nine out of ten vaccinated persons. However, in elderly people, the vaccine may not work as well in preventing influenza, but will result in decrease in severity of symptoms and in the risk of health complications.

In April 2009, the United States Department of Health and Human Services declared a public health emergency regarding human cases of H1N1 influenza A, more commonly called swine flu. Swine flu was of special concern because for several reasons. Experts believed that the virus was a new strain of influenza with a genetic composition different from the familiar viruses that cause seasonal influenza. Because it was

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radically different, individuals were especially susceptible to developing serious illness. In addition, the virus often caused more intense symptoms in young, healthy people than in the elderly or the very young who are the greatest target of seasonal flu. Because the decision had already been made about which strains of seasonal flu were to be included in the vaccine for the next flu season and manufacture had already begun, a special push was made to make a separate vaccine against the swine flu. Thus, in the winter of 2009 through the 2010 flu season, people were advised to get two separate flu shots, one against seasonal flu and one against the new H1N1 influenza A.

Vaccinations against influenza are especially important for those who are not in good health. The vaccination is recommended for persons who have trouble swallowing or breathing, are receiving long term steroid therapy, or who have had heart attacks, heart disease, lung diseases such as asthma, **emphysema**, or chronic **bronchitis**, diabetes, HIV, blood disorders such as sickle cell anemia or other **hemoglobinopathies**, kidney or **liver disease**, or weakened immune systems. Individuals with such conditions are at an increased risk of developing serious influenza-related complications. Those who are at a high risk of complications and who have not received their influenza vaccination the preceding fall or winter should be vaccinated before travel to the tropics, travel with tourist groups, or travel to the Southern Hemisphere during April through September.

Recommended dosage

As of 2010, the United States Centers for Disease Control and Prevention (CDC) recommended that the following groups be vaccinated against seasonal influenza.

- children between the ages of 6 months and 19 years
- pregnant women
- all individuals age 50 or older
- people with certain chronic medical problems
- health care workers
- people caring for or living with children under age 5
- people caring for or living with someone at high risk for complications from influenza
- healthy individuals of any age who wish to reduce their chances of getting the flu, especially those living in group situations such as dormitories or military barracks

All persons 50 years of age and older should receive one dose intramuscularly of the inactivated seasonal influenza vaccine every year. Individuals ages 2–49 may be given flu mist rather than an injection. Ideally vaccination should occur during the period from September to mid-November, but a vaccination received later may still be beneficial. Influenza can occur any time from November through May in the northern hemisphere, with cases usually peaking in January or February. The influenza vaccine can safely be given with other vaccines, including the pneumococcal vaccine.

As of the 2009–2010 influenza season, additional vaccination against H1N1 swine flu was recommended for everyone with first responders, health care workers, and other high-risk individuals given priority.

Precautions

People who should not be vaccinated against influenza without first contacting a physician for advice include:

- those who have a severe allergy to chicken eggs
- those who have had a severe reaction to an influenza vaccination previously
- those who previously developed Guillain-Barre Syndrome (a very rare condition that results in weakness and paralysis of muscles of the body) within six weeks of getting an influenza vaccination

In addition, a person who has a moderate or severe illness with a **fever** should wait to get vaccinated until their symptoms decrease.

It takes up to two weeks to develop protection after the shot, with the protection from the vaccination lasting up to one year.

Side effects

Although the risk of the influenza vaccine causing serious harm or **death** is small and is much less than the health risks from contracting influenza, the vaccine, as with any medicine, can cause problems such as severe allergic reactions. Because the viruses in the vaccine have been killed, no one can get influenza from the vaccine. Mild problems that can occur soon after the vaccination is given and lasting 1 to 2 days include:

- soreness, redness, or swelling where the shot was given
- low grade fever
- aches
- chills
- general feelings of ill health
- runny nose (flu mist only)
- wheezing (flu mist only)
- sore throat (flu mist only)

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More severe problems that can be associated with the influenza vaccine are life-threatening allergic reactions. These will occur within a few minutes to a few hours after the shot. A person should stay in the clinic where the shot was given for 15 minutes, in case an immediate reaction occurs. Such reactions could include **hives**, difficulty breathing, or swelling of the throat, tongue, or lips. If a severe reaction occurs after the person leaves the clinic, the affected person should immediately be taken to an emergency health care facility. The chance of such an adverse reaction occurring is estimated at less than one in a million people. Any adverse reaction should be reported to the U.S. Department of Heath and Human Services through the Vaccine Adverse Event Reporting Service. If a person has had a serious reaction to a vaccine, a federal program, the National Vaccine Injury Compensation Program, is available to help pay for the care of the person harmed or injured by the shot.

Interactions

Influenza vaccines are not known to interact with any drugs or foods.

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United States Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (404) 639-3534, 800-CDC-INFO (800-232-4636). TTY: (888) 232-6348, inquiry@cdc.gov, http://www.cdc.gov.

World Health Organization, Avenue Appia 20, 1211 Geneva 27, Switzerland, +22 41 791 21 11, +22 41 791 31 11, info@who.int, http://www.who.int.

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Infrequent menstruation *see* **Oligomenorrhea**

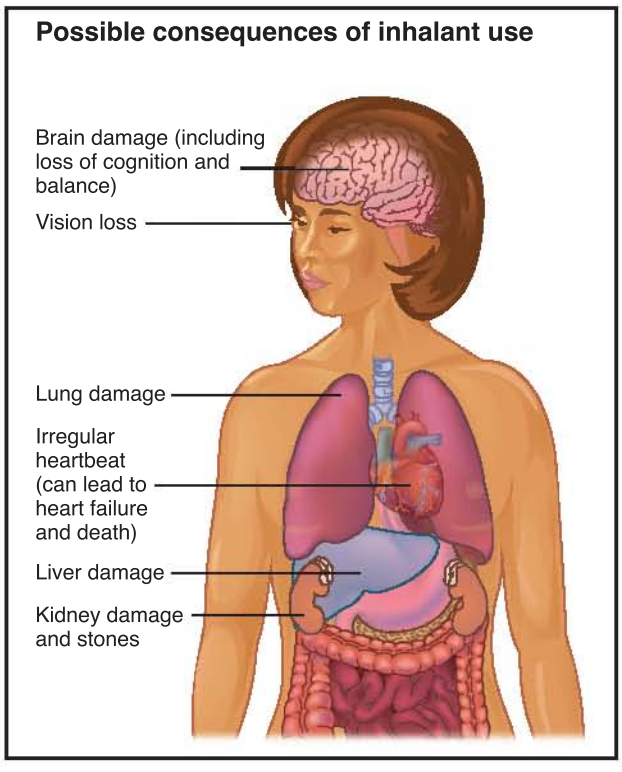
Inhalants and related disorders

Definition

Inhalants are chemicals that are inhaled through the nose or mouth for a quick "high." They include a broad range of chemicals found in hundreds of different readily available products. Inhalant intoxication, **abuse**, and dependence are classified as substance use disorders.

Demographics

Inhalants are one of the few substance use disorders that more often affect younger children. Because inhalants are inexpensive and readily available, they are often used by children aged 6–16, as well as by people with little money. In 2008, two million Americans aged 12 and over abused inhalants. It has been estimated that 10–20% of youths aged 12–17 have tried inhalants and about 6% of Americans tried inhalants prior to the fourth grade. The peak period for inhalant use appears to be the seventh through ninth grades. However inhalant use among American teens may be on the decline.



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Among adults and children younger than 12, inhalant use is more common among males than females. However there are no gender differences in inhalant use in teens between the ages of 12 and 17.

The use of inhalants and inhalant dependence are common among those who do not have access to other drugs or are otherwise isolated, such as prison inmates. As with other substance use disorders, people who have greater access to inhalants are more likely to develop dependence. This group includes workers in industrial settings.

Description

Inhalants include volatile solvents—liquids that vaporize at room temperature—and aerosols—sprays that contain both solvents and propellants. Examples of inhalants include:

- glue
- gasoline
- paint thinner
- hairspray
- lighter fluid
- spray paint
- nail polish remover
- correction fluid
- rubber cement
- felt-tip marker fluids
- vegetable sprays
- certain cleaners

Inhalants are generally used by breathing in the vapors directly from the container ("sniffing"), by inhaling fumes from substances placed in a bag ("bagging"), or by inhaling from a cloth soaked in the substance ("huffing"). Inhalants take effect very quickly because they enter the bloodstream directly from the lungs. The "high" from inhalants is usually brief, so they are often used repeatedly over several hours. This pattern of use can be particularly dangerous, leading to unconsciousness or even **death**.

The American Psychiatric Association's *Diagnostic and Statistical Manual of Mental Disorders*, fourth edition, text revision (*DSM-IV-TR*) does not include use of anesthetic gases (such as nitrous oxide, chloroform, and ether) or nitrites (such as amyl and butyl nitrites) as inhalant-related disorders because they have slightly different intoxication properties. Rather, use of these substances is classified with other substance-related disorders. However the symptoms are very similar to those of inhalants and related disorders.

Although only a small proportion of inhalant use meets the diagnostic criteria for abuse or dependence, all use of chemical inhalants constitutes abuse, since they are not being used for their intended purposes. Unlike all other substance dependencies, inhalants and related disorders may not result in clinically significant **withdrawal syndromes**. Instead inhalants are sometimes considered to be "gateway" drugs, because inhalant use often precedes the use of other substances such as alcohol, **marijuana**, or **cocaine**.

Risk factors

Factors associated with inhalant disorders include poverty, a history of childhood abuse, poor grades, and dropping out of school. However the latter two factors may be a result of inhalant use rather than a cause. Inhalants are often used in group settings and are highly subject to peer influence.

Causes and symptoms

The symptoms of inhalant intoxication differ slightly depending on the type of inhalant, the amount used, and other factors. However in general, intoxication from an inhalant usually occurs within five minutes and lasts for 5–30 minutes. Inhalants typically depress the central nervous system, with effects similar to those of alcohol, and produce euphoria, excitement, **dizziness**, and slurred speech. Inhalant intoxication can cause a feeling of floating or a sense of power.

An overdose of inhalant can result in **coma** or death. The most serious medical risk of inhalant use is "sudden sniffing death." Inhalants, especially repeated use in a single, prolonged session, can cause a rapid and irregular heartbeat or severe breathing difficulties, followed by **heart failure** and death. Sudden sniffing death can occur within minutes. Inhalant use also can cause permanent damage to the brain, lungs, kidneys, muscles, and heart. In addition to damage from the vapors themselves, many inhalants contain dangerously high levels of copper, zinc, and heavy metals.

The *DSM-IV-TR* requires the following criteria for a diagnosis of inhalant intoxication:

- Use: There was recent intentional inhalant use.
- Personality changes: There are significant behavioral or psychological changes during or shortly after inhaling. These might include provoking a fight, assault, using poor judgment, apathy, or impaired functioning at work or school or in a social situation.
- Inhalant-specific intoxication syndrome: Two or more of the following symptoms occur during or shortly after inhalant use or exposure: dizziness;

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KEY TERMS

Aerosols—Sprays that contain propellants and solvents, including many household products.

Delusion—A persistent false belief held in the face of strong contradictory evidence.

Euphoria—An exaggerated state of psychological and physical well-being.

Hallucinations—False sensory perceptions; hearing sounds or seeing people or objects that are not there. Hallucinations can also affect the senses of smell, touch, and taste.

Tolerance—The body's adjustment to a drug so that it takes more and more to produce the same physiological or psychological effects.

Volatile solvents—Liquids that vaporize at room temperature, including a variety of industrial and household products and art and office-supply solvents.

involuntary side-to-side eye movements (nystagmus); loss of coordination; slurred speech; unsteady gait (difficulty walking); lethargy (fatigue); slowed reflexes; psychomotor retardation (moving slowly); tremor (shaking); generalized muscle weakness; blurred or double vision; stupor or coma; euphoria.

Inhalant abuse is defined as significant negative consequences from the recurrent use of inhalants without physical dependence on the substance. Abusers typically use inhalants less frequently than those with inhalant dependence, but nevertheless suffer negative consequences. For example inhalant abuse may contribute to poor grades or school truancy. According to the *DSM-IV-TR*, to meet the diagnostic criteria for inhalant abuse, one or more of the following symptoms must occur and cause significant impairment or distress within a 12-month period:

- Interference with role fulfillment: Inhalant use frequently interferes with obligations at work, home, or school. Users may be unable to perform chores or pay attention at school.
- Danger to self: The user repeatedly uses inhalants in physically hazardous situations such as while driving a car.
- Legal problems: The user has recurrent legal problems related to inhalant use, such as assault arrests.
- Social problems: The user continues to use inhalants despite repeated interpersonal or relationship problems caused by or worsened by their use. For example the affected person may have arguments related to inhalant use.

Inhalant dependence or **addiction** is a syndrome in which inhalant use continues despite significant problems caused by or worsened by the use. The problems may involve employment, family relationships, and/or physical impairments such as kidney or liver damage. Users may find it difficult to stop using inhalants despite these problems. Heavy users of inhalants may develop a tolerance to the substance that suggests physical dependence. Dependent users may inhale daily or several times per week. The solitary use of inhalants is associated with heavy, prolonged use and may indicate dependency. To meet the diagnostic criteria for inhalant dependence the *DSM-IV-TR* requires that three or more of the following symptoms occur and cause significant impairment or distress within a 12-month period:

- Tolerance: The user has developed tolerance to the inhalant, as indicated by the same amount having less effect over time or by the need to use increasingly higher amounts to achieve the same effect. After a period of regular inhalant use, users often find that they require at least 50% more than the original amount to achieve the same effect.
- Loss of control: The user repeatedly uses a larger amount of inhalant than planned or uses over a longer period of time than planned; for example using inhalants on school days after initially limiting their use to weekends.
- Inability to stop using: The user has either unsuccessfully attempted to cut down or stop using inhalants or has a persistent desire to stop.
- Time: The user spends large amounts of time obtaining inhalants, using them, being under their influence, and recovering from their effects. Although inhalants may be readily available for very little money, they may be used repeatedly for hours every day.
- Interference with activities: The user either abandons or reduces the amount of time devoted to recreational and social activities and/or occupational activities because of inhalant use. Inhalant use may replace sports, time with friends, or work.
- Harm to self: Inhalant use continues despite physical problems, such as liver or heart damage, or psychological problems, such as depression or memory loss, that are caused by or worsened by the inhalant use.

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Diagnosis

Users rarely seek diagnosis and treatment for inhalant abuse or dependence on their own. A child or adolescent may be brought to a doctor by a parent or other relative who is concerned about personality changes, a chemical odor on the child's breath, or other signs of inhalant abuse. The parent may have discovered empty containers of the inhaled substance. Sometimes inhalant use by a child or adolescent is diagnosed in a hospital emergency room after an overdose or accidental injury.

Examination

Inhalant use is sometimes diagnosed by the existence of:

- auditory, visual, or tactile hallucinations
- other perceptual disturbances, such as illusions
- delusions, such as a belief that one can fly

Inhalant disorder may be difficult to diagnose, since intoxication from alcohol, sedatives, hypnotics (medications to induce sleep), or anxiolytics (tranquilizers) can resemble inhalant intoxication. The use of other substances is not uncommon among inhalant abusers and those with inhalant dependency often have other **substance abuse** disorders as well. In the latter case inhalant use is usually secondary to other substance use, since inhalants are only occasionally the primary drug of choice.

Tests

Although inhalants can be detected in blood or urine samples, laboratory tests may not always confirm a diagnosis of inhalant disorder since the substances do not remain in the body for very long.

Treatment

Traditional

Inhalant intoxication is often treated in a hospital emergency room because of serious psychological or medical consequences. The latter may include **headache**, **nausea**, **vomiting**, severe breathing difficulties, heart failure, or injuries sustained while under the influence of inhalants, such as falls or auto accidents. Life-threatening **burns** are common since many inhalants are highly flammable. Users may also require emergency treatment for suffocation from inhaling from a plastic bag placed over the head or from **choking** on inhaled vomit.

Treatment of inhalant and related disorders usually takes a long period and involves:

- family support
- different social networks if the individual uses inhalants with friends
- new coping skills
- increased self-esteem

Prognosis

The course of inhalant use, abuse, and dependence differs somewhat depending on the user's age. Younger children who regularly abuse inhalants, especially after school and on weekends—and even children who are dependent on inhalants—often stop on their own as they get older. They may avoid substance use altogether or move on to other substances. Adults suffering from inhalant abuse or dependence may continue to use regularly for years. Alternatively they may binge frequently—using inhalants much more often for shorter periods of time. This pattern of use can also continue for years. Chronic inhalant users are difficult to treat because they often have other serious personal and social problems, have difficulty avoiding inhalants, and frequently relapse.

Prevention

Comprehensive prevention programs that involve families, schools, communities, and media such as television can be effective in reducing substance abuse. The focus of such programs is the avoidance of any initial contact with abused substances. This is the most effective method for preventing inhalant and related disorders.

Parents and teachers can help prevent inhalant abuse by educating children about the negative effects of inhalants and by recognizing signs of inhalant use including:

1. chemical odors on a child's breath or clothes
2. slurred speech
3. drunken or disoriented behavior
4. nausea or lack of appetite
5. inattentiveness
6. poor coordination

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"NIDA InfoFacts: Inhalants." National Institute on Drug Abuse. http://www.drugabuse.gov/infofacts/inhalants.html

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American Psychological Association, 750 First Street, NE , Washington, DC, 20002-4242, (202) 336-5500, (800) 374-2721, http://www.apa.org.
National Clearinghouse for Alcohol and Drug Information, P.O. Box 2345, Rockville, MD, 20847-2345, (877) SAMHSA7, (240) 221-4292, http://ncadi.samhsa.gov/default.aspx.
National Institute on Drug Abuse, 6001 Executive Boulevard, Room 5213, Bethesda, MD, 20892-9561, (301) 443-1124, information@nida.nih.gov, http://www.drugabuse.gov/NIDAHome.html.
Substance Abuse & Mental Health Services Administration (SAMHSA) Health Information Network (SHIN), PO Box 2345, Rockville, MD, 20847-2345, (877) SAMHSA-7 (726-4727), (240) 221-4292, SHIN @samhsa.hhs.gov, http://www.samhsa.gov/shin.

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Inhalation therapies

Definition

Inhalation therapies are a group of respiratory, or breathing, treatments designed to help restore or improve breathing function in patients with a variety of diseases, conditions, or injuries. The treatments range from at-home **oxygen therapy** for patients with **chronic obstructive pulmonary disease** to mechanical ventilation for patients with acute **respiratory failure**. Inhalation therapies usually include the following categories:

- Oxygen therapy
- Incentive spirometry
- Continuous positive airway pressure (CPAP)
- Oxygen chamber therapy
- Mechanical ventilation
- Newborn life support.

Purpose

Inhalation therapies are ordered for various stages of diseases which are causing progressive or sudden respiratory failure. Although physicians generally follow guidelines to assign specific therapy according the type and stage of a disease, the ultimate decision is based on a number of tests indicating pulmonary function and the presence or absence of oxygen in body organs and tissues.

Oxygen therapy

Oxygen therapy is most commonly ordered to support patients with **emphysema** and other chronic obstructive pulmonary disease (COPD). The oxygen therapy is usually ordered once decreased oxygen saturation in the blood or tissues is demonstrated. Oxygen therapy may also be used in the hospital setting to help return a patient's breathing and oxygen levels to normal.

Incentive spirometry

Spirometry is a diagnostic method for measuring gases and respiratory function. Incentive spirometry may be ordered to help patients practice and improve controlled breathing. It may be ordered after surgery to the abdomen, lungs, neck, or head.

Continuous positive airway pressure (CPAP)

Common uses of continuous positive airway pressure include **sleep apnea**, **respiratory distress syndrome** in infants, and **adult respiratory distress syndrome**. Signs of **atelectasis** (absence of gas from the lungs) or abnormalities of the lower airways may also indicate CPAP.

Oxygen chamber therapy

Oxygen chamber therapy is ordered for various causes that indicate immediate need for oxygen

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saturation in the blood. Divers with decompression illness, climbers at high altitudes, patients suffering from severe carbon dioxide **poisoning**, and children or adults in acute respiratory distress may require oxygen chamber therapy. In recent years, physicians have also used the forced pressure of oxygen chambers to help heal **burns** and other **wounds**, since the pressure under which the oxygen is delivered can reach areas that are blocked off or suffering from poor circulation.

Mechanical ventilation

Mechanical ventilation is ordered for patients in acute respiratory distress, and is often used in an intensive care situation. In some cases, mechanical ventilation is a final attempt to continue the breathing function in a patient and may be considered "life-sustaining."

Newborn life support

Newborn babies, particularly those who were premature, may require inhalation therapies immediately upon birth, since the lungs are among the last organs to fully develop. Some newborns suffer from serious respiratory problems or birth complications, such as respiratory distress syndrome, neonatal wet lung syndrome, apnea of **prematurity** or persistent fetal circulation, which may require inhalation therapies.

Precautions

There are numerous indications for not prescribing various inhalation therapies.

Oxygen therapy

Patients and family members who smoke should not have oxygen prescribed or should avoid **smoking** in the area to prevent combustion. Sedatives should be avoided for patients on oxygen therapy.

Incentive spirometry

Patients who are unable or unwilling to properly and consistently practice incentive spirometry as prescribed should not receive this form of treatment.

Continuous positive airway pressure (CPAP)

Patients unable or unwilling to comply with the physician's instructions for use of CPAP are not likely to have it prescribed. Extremely obese patients may have less success with this form of therapy for the treatment of sleep apnea.

Oxygen chamber therapy

Complications may arise from this form of treatment and during transport to or from the oxygen chamber. Therefore, some patients may not receive enough benefit to outweigh possible complications. All patients, particularly children, must be carefully monitored.

Mechanical ventilation

Use of mechanical ventilation will be carefully weighed against benefit and possible risks. Some patients will require **sedation** to prevent fighting of the ventilator, which can increase the risk of complications.

Newborn life support

Not all infants with breathing problems will require measures as severe as mechanical ventilation. The physician will make the determination based on weight and condition of the infant. Newborns with patent ductus arteriosis, a handicap affecting the pulmonary artery, are more likely to suffer pulmonary hemorrhage from mechanical ventilation.

Description

Oxygen therapy

Once a patient shows hypoxemia, or decreased oxygen in arterial blood, supplemental oxygen may be ordered. The main purpose of the oxygen is to prevent damage to vital organs resulting from inadequate oxygen supply. The lowest possible saturation will be given to keep the patient's measurements at a minimum acceptable level. The oxygen is administered through a mask or nasal tube, or sometimes directly into the trachea. The amount of oxygen prescribed is measured in liters of flow per minute. Patients with chronic hypoxemia, most likely in late stages of COPD, will often receive long-term oxygen therapy.

Most patients will receive their long-term oxygen therapy through home oxygen use. A physician must prescribe home oxygen and levels will be monitored to ensure that the correct amount of oxygen is administered. Some patients will receive oxygen therapy only at night or when exercising.

The choice of type of home oxygen systems will vary depending on availability, cost considerations, and the mobility of the patient. Those patients who are ambulatory, especially those who work, will need a system with a small portable tank. Depending on the system chosen, frequent deliveries of oxygen and filling of portable tanks will be necessary.

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In the case of respiratory distress in newborns or adults, oxygen therapy may be attempted before mechanical ventilation since it is a noninvasive and less expensive choice. Oxygen has been found effective in treating patients with other diseases such as **cystic fibrosis**, chronic congestive **heart failure**, or other lung diseases.

Incentive spirometry

Incentive spirometry is also referred to as sustained maximal inspiration. It is designed to mimic natural sighs and yawns. A device provides positive feedback when a patient inhales at a predetermined rate and sustains the breath for a specific period of time. This helps teach the patient to take long, slow, and deep breaths. A spirometer, or equipment that measures pulmonary function, is provided to the patient and a respiratory therapist will work with the patient to demonstrate and explain the technique. Once patients show mastery of the technique, they are instructed to practice the exercises frequently on their own.

Continuous positive airway pressure (CPAP)

Patients with sleep apnea will receive continuous positive airway pressure to prevent upper airway collapse. It is usually administered through a tight-fitting mask as humidified oxygen. The pressure of flow is constant during both exhaling and inhaling and the level of pressure is determined based on each individual. Most patients undergoing CPAP in a hospital setting will receive continuous monitoring of some vital signs and periodic sampling of blood gas values.

Oxygen chamber therapy

Also known as hyperbaric oxygen chamber or hyperbaric oxygen therapy (HBO), this treatment delivers pure oxygen under pressure equal to that of 2–3 times normal atmospheric pressure. For years, this treatment has been especially effective on scuba divers who suffer from the "bends," or decompression illness. The patient enters the chamber, a plastic cylinder-shaped structure that is normally transparent. In most cases, just one patient will enter by being rolled into the chamber on a type of stretcher. Once inside, the oxygen will be delivered under forced pressure and the patient is free to read, nap, or listen to the radio. The therapy usually lasts one hour, although it can take up to five hours in serious decompression cases. Before exiting the chamber, the pressure will eventually be lowered to normal atmospheric level.

Mechanical ventilation

In general, mechanical ventilation replaces or supports the normal ventilatory lung function of a patient. Although normally delivered in a hospital, often to treat serious illness, mechanical ventilation may be performed at home under the order and supervision of a physician and home health agency. The patient will usually be intubated and the ventilator machine "takes over" the breathing function.

There are several modes and methods of mechanical ventilation, each offering different advantages and disadvantages. In assist/control ventilation, the oldest mode of ventilation, the physician predetermines settings and the ventilator delivers a breath each time the patient makes an effort to inhale. In synchronized intermittent mandatory ventilation, the machine senses a patient's effort to inhale and delivers the preset amount. The amount cannot be increased by the patient's effort. Pressure-control ventilation involves the physician's selection of a peak pressure and this method is most useful for patients suffering from obstructive airways disease. In cases of severe hypoventilation, an endotracheal tube must be inserted. If a patient will be on mechanical ventilation for more than two weeks, a tracheostomy, or surgical incision, will be performed for placement of the breathing tubes.

There are other modes of ventilation that may be used, including high-frequency ventilation, a newer technique that delivers 100 to 200 breaths per minute to the patient. The breaths are delivered through a humidified, high-pressure gas jet. High-frequency ventilation may be ordered when a patient does not respond to conventional mechanical ventilation or for certain conditions and circumstances.

Newborn life support

Premature infants, especially those born before the 28th week of gestation, have underdeveloped breathing muscles and immature structures within the lungs. These infants will require breathing support, often in the form of mechanical ventilation. The support delivers warm, humidified, oxygen-enriched gases either by oxygen hood or through mechanical ventilation. In serious cases, the infant may require mechanical ventilation with CPAP or positive-end expiratory pressure (PEEP) through a tightly fitting face mask or even by endotracheal intubation.

Need for continued resuscitation for newborns depends not only on gestational age, but on signs indicating ineffective breathing, including color, heart rate, and respiratory effort. CPAP will be delivered through

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nasal or endotracheal tubes with a continuous-flow ventilator specifically designed for infants. An alarm system alerts the neonatal staff to problems and monitoring of breathing and other vital functions will accompany the therapy. As respiratory distress syndrome begins to resolve, usually in four or five days, the type of support will be reduced accordingly and the infant may be weaned from the ventilator and moved to only CPAP or an oxygen hood.

Preparation

Preparation for any of these treatments is normally not necessary, and in fact, these therapies may be administered as a result of an emergency situation. Some of the methods, particularly incentive spirometry, or at-home oxygen or ventilation, will require education and cooperation with a home health agency or respiratory therapist. Pretreatment testing of various indicators of respiratory function and oxygen saturation will be performed to determine exact needs of individual patients.

Aftercare

Pulmonary function tests and other tests will be performed to verify that treatments have been successful or to monitor and adjust treatments. Mechanical ventilation will require weaning from the equipment and may also require care for the area surrounding the intubation.

Risks

Inhalation therapies may carry risks, complications or side effects including:

Oxygen therapy

At-home oxygen therapy carries risk if improper care is taken to follow instructions when handling the oxygen. Patients are cautioned not to smoke near the oxygen supply and to keep the supply away from other sources that may cause electrical spark, flames, or intense heat. Patients on home oxygen therapy should avoid use of sedatives.

Incentive spirometry

The major risk associated with incentive spirometry relates to improper use. Patients must be carefully instructed in the technique and monitored periodically for compliance and improvement. Barotrauma, injury to the middle ear or sinuses caused by imbalance between the affected cavity and the outside, or ambient pressure, can result form incentive spirometry. A patient may also suffer discomfort or **fatigue**.

Continuous positive airway pressure (CPAP)

The effectiveness of CPAP may be limited if patients do not cooperate. Possible side effects of CPAP include skin abrasions from the mask, leakage from the tube or mask, nasal congestion, nasal or oral dryness, or discomfort from the pressure of delivery.

Oxygen chamber therapy

Hyperbaric oxygen therapy is painless. The only risk would be associated with improper administration of the pressure levels, which should not occur, since respiratory staff and the supervising physician should be thoroughly trained in performance of this therapy. The drawback to hyperbaric oxygen treatment is the limited availability of chambers. Many cities do not have readily available chambers.

Mechanical ventilation

The biggest risk of mechanical ventilation is sometimes considered to be a patient's dependence on the machine and the difficulty of weaning the patient. The physician will carefully select and monitor the mode of ventilation, the machine's settings, and the patient's progress to prevent this complication. A patient may therefore be left on a ventilator after sufficient progress is made to gradually wean breathing dependence.

Intubation and mechanical ventilation are frightening and uncomfortable for many patients and they may fight the ventilator. If this occurs, the physician may order a sedative to ensure cooperation and effectiveness of the therapy. Intubation often results in irritation to the trachea and larynx. Tracheostomy is associated with risk of bleeding, **pneumothorax**, local infection, and increased incidence of aspiration.

Newborn life support

Infants are continuously monitored to determine even small changes in breathing function. Mechanical ventilation can result in increases in respiratory distress or other complications. It is possible for the ventilator to be accidentally disconnected and staff is trained to watch for signs or alarms indicating disconnection. Mechanical ventilation increases risk of infection in premature babies. Complications of PEEP or CPAP may include pneumothorax or decreased cardiac output.

Normal results

Oxygen therapy

In the case of COPD, oxygen therapy does not treat the disease but can prolong life, quality of life,

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KEY TERMS

Aspiration—Accidental suction of fluids or vomit into the respiratory system.

Cannula—A tube inserted into a cavity to serve as a channel for the transport of fluid.

Endotracheal—Placed within the trachea.

Hypoventilation—Reduced ventilation in the lungs' air sacs resulting in above normal carbon dioxide pressure.

Hypoxemia—A condition in which there is deficient oxygen supply in the blood.

Hypoxia—Low levels of oxygen in blood, tissue, or air.

Intubation—Placement of a tube into a hollow organ (such as the trachea).

Pneumothorax—Presence of gas or air in the hollow space around the lungs.

Trachea—The windpipe, or main channel by which air passes to and from the lungs.

and onset of more serious symptoms. Effective oxygen therapy for any patient should lead to improved or sustained levels of oxygen in arterial blood.

Incentive spirometry

With proper use of incentive spirometry, the physician should observe improved pulse rate, decreased respiratory rate, improved respiratory muscle performance, and other indicators of improved function. Lung function following lung resection should show marked improvement following incentive spirometry.

Continuous positive airway pressure

Successful CPAP will result in reduction in apnea for those suffering from sleep apnea. A study reported on in 1998 demonstrated that CPAP was effective in the majority of patients with sleep apnea, with the exception of significantly obese patients with blood gas values that were worse during waking hours at rest and at **exercise**. Hospitalized patients on CPAP therapy should show improvement in blood gas and other pulmonary measurements as expected by the treating physician.

Oxygen chamber therapy

Divers undergoing emergency treatment in a **hyperbaric chamber** should show immediate improvement in oxygen levels throughout the body, regardless of blood flow restrictions, after one or two treatments. Those patients receiving oxygen chamber therapy for difficult wounds may continue to receive treatments daily for several weeks before satisfactory results are reached. Patients with carbon dioxide poisoning should show improvement in or recovery of neurologic function. Results of hyperbaric chamber therapy depend largely on how quickly the patient was brought to the chamber, as well as the severity of the initial condition.

Mechanical ventilation

Successful mechanical ventilation will result in gradual decrease in dependence on the ventilator and weaning from the machine. Reduction of therapy to another form, such as CPAP or oxygen therapy, indicates that ventilation has worked as expected. In the case of COPD, exacerbation may be successfully treated with mechanical ventilation and the patient may return to home oxygen therapy. Pediatric patients will demonstrate normal growth and development as a normal result of long-term mechanical ventilation at home. Some patients, particularly those in a hospital intensive care unit, will not be able to breathe again without the ventilator and families and physicians will face tough choices about continued **life support**.

Newborn life support

Neonates will be constantly monitored to measure lung function. Those measurements will help caregivers determine if and when mechanical ventilation can be reduced and CPAP or oxygen mask begun. CPAP is considered successful when the infant's respiratory rate is reduced by 30–40%, a chest radiograph shows improved lung volume and appearance, stabilization of oxygen levels is documented and caregivers observe improvement in the infant's comfort. Evidence that there is no infection from ventilation is also considered normal. In some cases, inhalation therapy, including mechanical ventilation, will not work and the infant's parents and physicians will face tough decisions about invasive procedures with associated high risks or cessation of life support.

Resources

OTHER

Hyperbaric Research and Treatment Center Page. http://www.hyperbaricrx.com.

ORGANIZATIONS

American Association for Respiratory Care, 9425 N. MacArthur Blvd, Suite 100, Irving, TX, 75063-4706, 972 243-2272, 972 484-2720, info@aarc.org, http://ww.aarc.org.

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American Lung Association, 1301 Pennsylvania Ave. NW, Suite 800, Washington, DC, 20001, 202 758-3355, 202 452-1805, 800 548-8252, info@lungusa.org, http://www.lungusa.org/.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, 301 592-8573, 240 629-3246, http://www.nhlbi.nih.gov.

Teresa Odle

Inner ear infection *see* **Labyrinthitis**

Insecticide poisoning

Definition

Insecticide **poisoning** is exposure to a group of chemicals designed to eradicate insects that cause affected persons to develop clinical signs that can progress to **death**.

Description

Insecticides belong to a group of chemicals called organophosphates used to protect against insects. Their use is popular since they are effective and do not remain in the environment, disintegrating within a few days. Organophosphates act to inhibit an enzyme in humans called acetyl cholinesterase. This enzyme functions to degrade a chemical called acetylcholine, which excites nerve cells. The resultant effect of organophosphates would be an increase in acetylcholine, thus causing initial excitation of nerve cells.

Poisoning can occur with a broad range of symptoms affecting the functioning of nerves and initial symptoms similar to the flu such as **vomiting**, abdominal **pain**, **dizziness**, and **headache**. Common names for insecticides include dichlorvos, chlorpyrifos, diazinon, fenthion, malathion, parathion, and carbamate. A special type of insecticide called paraquat is very lethal and responsible for approximately 1,000 deaths per year just in Japan. Paraquat poisoning releases oxygen free radicals that destroy lung and kidney tissues. When poisoning is suspected, a comprehensive management and assessment plan should be performed. This initial assessment should include:

- Description of toxins: names of chemical(s).
- Magnitude of exposure: determination of amount of exposure.
- Progression of symptoms: determining the progression of symptoms can provide information concerning life support and overall outcome.
- Time of exposure: knowing the time of exposure is vital since symptoms may be delayed, and it may assist to develop a management plan.
- Medical history: underlying diseases and therapeutic mediations may worsen toxic manifestations.

General signs and symptoms of insecticide poisoning

Symptom/sign	Common causative agents	Possible causative agents
Rotten egg odor	Sulfur	
Hypothermia	Creosote Norbormide	
Hyperthermia (fever, pyrexia)	Nitrophenols Pentachlorophenol	Borate Thallium Metaldehyde Inorganic arsenicals Chlorophenoxy compounds Cadmium dusts Naphthalene
Chills	Phosphine Arsine	
Hot sensations	Nitrophenols Chlordimeform	Pentachlorophenol
Myalgia	Paraquat Chlorophenoxy compounds	
Thirst	Pentachlorophenol Nitrophenois Inorganic arsenicals Phosphorus Phosphides Sodium fluoride Cholecalciferol Aminopyridine	Borate Endothall
Anorexia	Organophosphates Carbamate insecticides Nicotine Pentachlorophenol Hexachlorobenzene Chlordimeform Cholecalciferol	Halocarbon fumigants Nitrophenols Inorganic arsenicals Aminopyridine
Alcohol intolerance	Thiram Calcium cyanamide	
Sweet taste in the mouth	Chlordimeform	
Metallic taste in the mouth	Inorganic arsenicals Organic mercury	
Salty, soapy taste in the mouth	Sodium fluoride	

SOURCE: U.S. Environmental Protection Agency, *Recognition and Management of Pesticide Poisoning*, "Index of Signs and Symptoms." Available online at: http://www.epa.gov/oppfead1/safety/healthcare/handbook/handbook.htm (accessed August 18, 2010).

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KEY TERMS

Acetylcholine—A chemical called a neurotransmitter that functions to excite nerve cells.

Acetylcholinesterase—An enzyme that breaks down acetylcholine.

Central nervous system—Consists of the brain and spinal cord and integrates and processes information.

Enzyme—A protein that speeds up a chemical reaction, but is not consumed during the process.

Oxygen free radicals—Reactive molecules containing oxygen and can cause cell damage.

Causes and symptoms

Exposure to insecticides can occur by ingestion, inhalation, or exposure to skin or eyes. The chemicals are absorbed through the skin, lungs, and gastrointestinal tract and then widely distributed in tissues. Symptoms cover a broad spectrum and affect several organ systems:

- Gastrointestinal: nausea, vomiting, cramps, excess salivation, and loss of bowel movement control
- Lungs: increases in bronchial mucous secretions, coughing, wheezing, difficulty breathing, and water collection in the lungs (this can progress to breathing cessation)
- Skin: sweating
- Eyes: blurred vision, smaller sized pupil, and increased tearing
- Heart: slowed heart rate, block of the electrical conduction responsible of heartbeat, and lowered blood pressure
- Urinary system: urinary frequency and lack of control
- Central nervous system: convulsions, confusion, paralysis, and coma

Diagnosis

The confirmatory diagnosis for insecticide poisoning is the measurement of blood acetyl cholinesterase less than 50% of normal. The chemicals can also be detected by specific urine testing. Signs and symptoms in addition to a comprehensive poisoning assessment are essential for diagnosis. Carbamate insecticide poisoning exhibits symptoms similar to organophosphate poisoning but without central nervous system signs.

Treatment

Decontaminate exposed clothing and wash with soap and water immediately. Emergency measures may focus on ventilator support and heart monitoring. If inhalation is suspected, the patient should be removed from the site of exposure. If the eyes were the entry site, they should be flushed with large amounts of water. If the chemicals were ingested, the stomach may be washed out and **activated charcoal** may be administered. Atropine or glycopyrrolate (Robinul) is the drug of choice for carbamate insecticide poisoning. It reverses many symptoms, but is only partially effective for central nervous symptom effects such as **coma** and convulsions. A medication called Pralidoxime is also commonly indicated to reactivate acetylcholinesterase and to reverse typical symptoms due to organophosphate poisoning. Additionally, the patient is monitored for heart, lung, liver functioning, specific blood tests, and oxygen levels in blood.

Prognosis

Prognosis depends on the specific chemical of exposure, magnitude and time of exposure, progression of symptoms (severity), and onset for medical attention.

Prevention

Adherence to accepted guidelines for handling and management is the key to preventing insecticide poisoning. These may include masks, gowns, gloves, goggles, respiratory breathing machines, or hazardous material suits.

Resources

BOOKS

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Rakel, Robert E., Edward T. Bope, and Howard F. Conn. *Conn's Current Therapy 2004: Latest Approved Methods of Treatment for the Practicing Physician*. Philadelphia: Saunders, 2004.

PERIODICALS

Blain, P. G. "Effects of Insecticides." *Lancet* 357 (5 May 2001): 1442.

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OTHER

Material Safety Data Sheets. http://www.oshweb.com/owd/owd01.nsf/rubriek?openform&rubriek=EHEN-4QHD69.

National Toxicology Program. http://ntp.niehs.nih.gov.

Laith Farid Gulli, M.D.

Insomnia

Definition

Insomnia is the inability to obtain an adequate amount or quality of sleep. The difficulty may be in falling asleep, remaining asleep, or waking up too early. A person may experience one or all of these symptoms. People with insomnia do not feel refreshed when they wake up. Insomnia affects more than 70 million people, according to the National Institutes of Health. The sleeplessness is a symptom that may be caused by physical or mental conditions or circumstances. Furthermore, research indicated that insomnia may also be a medical condition, according to the National Sleep Foundation (NSF).

Description

There are two main types of insomnia. One is acute insomnia (sometimes called transient insomnia). This type occurs when insomnia symptoms exist over a reasonably short period of time. The other type is chronic insomnia, which is diagnosed when the symptoms manifest themselves over a longer period (generally more than one month). Insomnia can also be classified as either primary or secondary. Primary insomnia is a disorder that cannot be attributed to another condition or disorder. Secondary insomnia can be traced back to a source, which may be a medical condition; the use of medications, alcohol, or other substances; or a mental disorder such as severe depression.

Adults need approximately seven to eight hours of sleep each night. Teenagers should get about nine hours of sleep, and infants need to sleep from 16 to 18 hours of sleep each day. Sleep is essential for mental and physical restoration. It is a cycle with two separate states: rapid eye movement (REM), the stage in which most dreaming occurs; and non-REM (NREM). Four stages of sleep take place during NREM: stage I, when the person passes from relaxed wakefulness; stage II, an early stage of light sleep; stages III and IV, which are increasing degrees of deep sleep. Most stage IV sleep (also called delta sleep) occurs in the first several hours of sleep. A period of REM sleep normally follows a period of NREM sleep.

Disrupted sleep

Sleeplessness or insomnia may be caused by a physical condition such as **obesity**, a mental condition such as depression, shift work with irregular hours, or a traumatic event. In the days immediately after the terrorist attacks on September 11, 2001, 47% of Americans rated their sleep as "poor," or "fair," according to NSF's "2002 Sleep in America" poll. In comparison, 27% of poll participants rated sleep as poor or fair for most nights of that year.

The foundation's 2005 poll indicated that women were more likely to experience insomnia than men. NSF explored that demographic in the "2007 Sleep in America" poll of women between the ages of 18 and 64. That study showed that sleep problems such as insomnia were experienced by 72% of working mothers and 68% of single working women. Furthermore, 74% of stay-at-home mothers displayed symptoms of insomnia during a couple nights each week.

That poll paralleled other research that showed that women are 1.3 more likely to report insomnia than men. They may experience sleeplessness before and at the onset of their menstrual cycle, during **pregnancy**, and **menopause**. In addition, the foundation reported that people over the age of 65 are more likely to be bothered by insomnia than younger individuals.

Furthermore, people who are divorced, widowed, or separated are more likely to have the problem than those who are married. In addition, insomnia is more frequently reported by those with lower socioeconomic status.

Insomnia is classified both by its nightly symptoms and its duration. Sleep-onset insomnia refers to difficulty falling asleep. Maintenance insomnia refers to waking frequently during the night or waking early. Insomnia is also classified in relation to the number of sleepless nights. Short-term, or transient, insomnia is a common occurrence and usually lasts only a few days. Long-term, or chronic, insomnia lasts more than three weeks. This condition increases the risk for injuries in the home, at the workplace, and while driving because of the person experiences daytime sleepiness and decreased concentration ability. Chronic insomnia could also lead to **mood disorders** such as depression.

Not all disruptions in the normal pattern of sleeping and waking are considered insomnia. Such factors as **jet lag**, unusually high levels of **stress**, changing work shifts, or other drastic changes in the person's

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routine can all lead to sleep problems. Unless the problems are ongoing and severe enough that they are causing distress for the person in important areas of life, he or she is not considered to have insomnia.

Causes and symptoms

The symptoms of insomnia can vary greatly from person to person. Some people find that they have trouble falling asleep at night and can lie in bed for hours without being able to drift off. Others find that they fall asleep easily, but wake many times during the night. Other people awaken too early in the morning and are then unable to get back to sleep. Some people even get enough hours of sleep but find that they do not feel rested, often because their sleep is too light.

Not all people experiencing insomnia have symptoms that occur during the daytime, but many do. Some people experience such symptoms as reduced ability to concentrate or pay attention, decreased alertness, and mental sluggishness. Some people have trouble staying awake. More people think that they have these symptoms than actually do. Upon clinical examination, many people who think that they are excessively sleepy during the day actually are not.

Transient insomnia is often caused by a temporary situation in a person's life such as an argument with a loved one, a brief medical illness, or jet lag. When the situation is resolved or the precipitating factor disappears, the condition goes away, usually without medical treatment.

Prescription drugs such as **asthma** medicine, **steroids**, and anti-depressants may cause insomnia. Sleeplessness may also be a side effect of over-the-counter products such as nasal **decongestants** and appetite suppressants.

Chronic insomnia usually has different causes, and there may be more than one factor contributing to sleeplessness. Causes of insomnia include:

- A medical condition or its treatment, including sleep apnea, diabetes, arthritis, a heart condition, and asthma
- Use of substances such as caffeine, alcohol, and nicotine
- Psychiatric conditions such as mood or anxiety disorders
- Stress or depression, such as sadness caused by the loss of a loved one or a job.
- A change in work shift
- A work schedule with nontraditional hours. Shift workers who may experience insomnia include medical professionals, truck drivers, the military, and people working at businesses open 24 hours a day.
- Sleep-disordered breathing, such as snoring
- Periodic jerky leg movements, *nocturnal myoclonus*, which occur just as the individual is falling asleep.
- Restless legs syndrome, which involves the urge to move the legs. The person may also experience feelings such as tingling or cramping.
- Repeated nightmares or panic attacks during sleep

Excessive worrying about whether the person will be able to fall asleep may also cause insomnia. The concern creates so much **anxiety** that the individual's bedtime rituals and behavior actually trigger insomnia, a condition called psychophysiological insomnia.

Symptoms of insomnia

People who have insomnia do not start the day refreshed from a good night's sleep. They are tired. They may have difficulty falling asleep and commonly lie in bed tossing and turning for hours. Or the individual may go to sleep without a problem but wakes in the early hours of the morning. The person is either unable to go back to sleep or drifts into a restless, unsatisfying sleep. This is a common symptom in the elderly and those suffering from depression. Sometimes sleep patterns are reversed and the individual has difficulty staying awake during the day and takes frequent naps. The sleep at night is fitful and frequently interrupted.

Demographics

There are many different opinions about how much of the general American population experiences insomnia. Estimates suggest that around 5–20% of the adult population suffers from some form of insomnia or long-term sleeping problem. Nearly half report at least occasional sleeping problems. Accurate data are difficult to gather, as many people misperceive how much sleep they actually get and how many times they normally wake up during the night. It is generally agreed, however, that women are more likely than men to suffer from insomnia. As people get older, they are also are more likely to experience insomnia. People who are nervous or tense are more likely to have insomnia than those who are not. Lastly, people who live near airports or other sources of nighttime as well as daytime noise have higher rates of insomnia than the general population.

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Diagnosis

Insomnia is a disorder that is usually self-reported; that is, patients usually bring up the subject of sleep problems with their doctors rather than the doctor suggesting the diagnosis. There are no laboratory tests for insomnia, but the doctor may suggest keeping a sleep diary, in which the patient notes the time they went to bed, the time(s) at which they got up during the night, their activities before bed, etc. Sleep diaries can be helpful in uncovering specific factors related to the insomnia.

Insomnia, unlike some medical conditions, is easily recognizable, as people know when they are not getting enough sleep. The key to treating insomnia is determining its causes. Some people can identify sleep-inhibiting factors such as a **death** in the family or a hectic work schedule with too much caffeine consumption and not enough **exercise**. A doctor will take factors such as these into account when making a diagnosis.

The physician's diagnosis is based on the patient's reported signs and symptoms. The doctor may review a patient's health history or order tests to determine if a medical condition is causing the insomnia. The physician may ask if the patient is depressed, in **pain**, under stress, or taking medications, according to the National Sleep Foundation. The doctor may ask about disruptions in a patient's life such as working nontraditional shifts or traveling across different time zones.

It may be useful for the patient to keep a daily record for two weeks of sleep patterns, food intake, use of alcohol, **caffeine**, nicotine, medications, exercise, and any other information recommended by the physician. If the patient has a bed partner, information can be obtained about whether the patient snores or is restless during sleep. This information, together with a medical history and **physical examination**, can help confirm the doctor's assessment.

A wide variety of healthcare professionals can recognize and treat insomnia. When a patient with chronic insomnia does not respond to treatment, or the condition is not adequately explained by the patient's physical, emotional, or mental circumstances, then more extensive testing by a specialist in **sleep disorders** may be warranted.

According to the *Diagnostic and Statistical Manual of Mental Disorders-IV-TR*(*DSM-IV-TR*), which presents the guidelines used by the American Psychiatric Association for diagnosis of disorders, in order to be diagnosed with primary insomnia, a person must experience the symptoms for at least a month, and the symptoms must cause them distress or reduce their ability to function successfully. The symptoms cannot be caused by a different sleep disorder, a medical condition, or be a side effect of medications or **substance abuse**.

Insomnia may also be comorbid with (occur together with) other psychiatric disorders, including **mania**, depression, and the **anxiety disorders**.

Treatment

In both alternative and conventional medicine, treatment of insomnia includes alleviating or coping with any physical and emotional problems that contribute to the condition. Also effective is exploring changes in lifestyle that will improve the situation.

Many treatments have been explored for treating insomnia in a number of different settings. The patient may wish to consider consulting a sleep clinic or a doctor who specializes in the treatment of sleep disorders as well as their family doctor.

Behavioral and educational therapies are usually tried first, because they do not have side effects and cannot create a chemical dependence the way some sleep medications can. Many different approaches have been designed to help patients whose insomnia is linked to particular factors.

Changes in behavior

Patients can make changes in their daily routine that are simple and effective in treating insomnia. Eating a healthy diet rich in **calcium**, magnesium, and the B **vitamins** is also beneficial.

Patients should go to bed only when sleepy and use the bedroom only for sleep or sex. Activities such as reading, watching television, or snacking should take place elsewhere. If people are unable to go to sleep, they should go into another room and do some quiet activity such as reading. People should return to bed only when sleepy. Patients should set the alarm and get up every morning at the same time, no matter how much they have slept, to establish a regular sleep-wake pattern. Naps during the day should be avoided, but if absolutely necessary, then a 30-minute nap early in the afternoon may not interfere with sleep at night.

Another successful technique is called sleep-restriction therapy, restricting the time in bed to the actual time spent sleeping. This approach allows a slight sleep debt to build up, which increases the individual's ability to fall asleep and stay asleep. If a patient sleeps five hours a night, the time in bed is

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limited to 5–5.5 hours. The time in bed is gradually increased in small segments, with the individual rising at the same time each morning; at least 85% of the time in bed must be spent sleeping.

Mind and body relaxation

Incorporating relaxation techniques into bedtime rituals helps a person go to sleep faster and improves the quality of sleep. These, alone or in combination with other relaxation techniques, can safely promote sleepiness. Also effective are massage techniques such as **shiatsu**, the traditional Japanese form of body work. Gentle pressure is applied to points of the body to bring on sleep.

Learning to substitute pleasant thoughts for unpleasant ones (imagery training) helps reduce worrying. Another technique is using recordings that combine the sounds of nature with soft relaxing music. **Meditation**, prayer, and breathing exercises could also be effective.

Insomnia may be treated professionally through techniques such as cognitive therapy. The therapist works with the patient to discover attitudes and feelings that disrupt sleep.

Herbal remedies

Many alternative treatments are effective in treating both the symptom of insomnia and its underlying causes. Much treatment is centered on herbal remedies, but the United States Food and Drug Administration does not regulate these treatments, which means that the remedies have not proven to be safe or effective. Furthermore, ingredients are not standardized to comply with regulations. People should consult with their healthcare provider or complementary medicine practitioner before taking herbal remedies. This is especially important because some remedies such as melatonin interact with herbals like valerian and prescription medicines.

Valerian

Research up to the spring of 2008 indicated that valerian may help with insomnia. People who took valerian fell asleep more quickly and experienced improved slumber. Because of the herb's sedative properties, valerian is used to treat insomnia and anxiety. It is an approved remedy in the German Commission E Monographs, a guide to herbal remedies. Approved uses include sleeping disorders caused by nervousness.

Valerian's sedative properties have been studied in animals and people. As of the spring of 2008, valerian was regarded as probably safe when taken at the recommended dosage. The remedy did not appear to disrupt sleep cycles or REM sleep.

Furthermore, a combination of valerian and hops could help with sleeplessness. Other herbs most recommended for treating insomnia include skullcap and **ginseng**. Herbal products are available in capsule, tincture, and powdered form. Some people treat insomnia by sipping a warm cup of tea made with an herb mixture such as valerian, chamomile, hops, lemon balm, passionflower, or **St. John′s wort**.

Aromatherapy and hydrotherapy

Aromatherapy involves healing through essential oils, the aromatic extracts of plants. Essential oils may be used for a soothing bath; applied to the face, neck, shoulders, and pillow; or diffused in air.

Hydrotherapy consists of a warm bath, scented with an essence such as rose, lavender, or marjoram. Valerian may also be added to bath water.

Dream pillows

Another form of aromatherapy involves sleeping on a dream pillow. Also known as a sleep pillow, it can be made by sewing together two 8-inch pieces of fabric. There should be an opening to insert a tablespoon. Herbs such as hops, chamomile, and lavender are spooned into the dream pillow, which is placed under the bed pillow.

Melatonin

Melatonin is a natural hormone that is secreted from the brain's pineal gland. The gland regulates a person's biological clock, particularly day and night cycles. Melatonin is generally used as a jet lag remedy. It may also help establish sleep patterns for shift workers. While melatonin may help people fall asleep more quickly, studies indicated limited success when it was used for treating insomnia. Melatonin is not regulated by the FDA, so the long-term effects of taking it are not known.

Traditional Chinese medicine

Traditional Chinese medicine (TCM) treatments for insomnia include **acupuncture** and herbal remedies. Acupuncture involves the insertion of needles to manipulate energy flows around the body. Acupuncture is also applied to the treatment of conditions, including anxiety.

In TCM, herbs are used as remedies in teas and other preparations. Treatments for insomnia include

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reishi, a medicinal mushroom available in extract form. However, the side effects of reishi could include **dizziness** and nose bleeds, so it is important to consult with a healthcare professional before taking this remedy.

Light therapy

In **light therapy**, natural or artificial light is used to boost serotonin, a neurotransmitter in the brain related to reducing anxiety. This therapy is used to treat **seasonal affective disorder**, a condition that some people experience when there is less sunlight or fewer daylight hours. Some people with this disorder feel depressed during the winter, and their spirits pick up during the summer. Light therapy is used to combat the depression experienced during the winter. There were no known risks as of the spring of 2008.

A study on the use of bright light therapy to treat insomnia was described in the July 2005 edition of the professional journal *Sleep*. The research involved 24 men diagnosed with early-morning waking insomnia. During the two nights of the study, the men were exposed to light while watching television. Some received bright light (2,500-lux white light) from 8 p.m. to midnight the first night and from 9 p.m. to 1 a.m. the following night. The other subjects were in the dim-light control group. The subjects in the bright light group said they tended to sleep longer than they did before the treatment. They woke up later. When they did waken, they went back to sleep more quickly.

Massage therapy

Massage therapy encourages relaxation by relaxing tense muscles throughout the body. It is especially helpful for restless leg syndrome, when this is a cause of insomnia. A massage once a week by a registered massage therapist may help the individual relieve stress that is causing sleeplessness.

Allopathic treatment

A physician may determine that drug therapy is necessary to treat insomnia. Drugs may be prescribed if the patient is undergoing a crisis or insomnia persists after a patient has made lifestyle changes. However, drug therapy is regarded as a short-term remedy, not a solution.

Conventional medications given for insomnia include sedatives, tranquilizers, and anti-anxiety drugs. All require a doctor's prescription and may be habit-forming. They could lose effectiveness over time and can reduce alertness during the day. The medications should be taken up to four times daily or as directed for approximately three to four weeks. The dose will vary with the physician, patient, and medication. If insomnia is related to depression, then an antidepressant medication may be helpful.

Drugs prescribed for improving sleep are called hypnotics. This category includes **benzodiazepines**, which are prescribed for anxiety and insomnia. Benzodiazepines commonly prescribed for insomnia include triazolam (Halcion), tempazepam (Restoril), lorazepam (Ativan), alprazolam (Xanax), fluazepam (Dalmane), and oxazepam (Serax).

Another medication prescribed for insomnia is zolpidem tartrate (Ambien). Recently, two drugs have been approved by the US Food and Drug Administration for long-term use. A drug called ramelteon (brand name Rozerem) has shown no evidence of potential for **abuse**, dependence or withdrawal in clinical studies. Eszopiclone (brand name Lunesta) is also approved for long-term use. Rozerem and Lunesta are currently available by prescription only.

Over-the-counter sleep products include Nytol, Sominex, Unisom Nightime Tablets, and Tylenol PM. While these products are usually not addictive, some experts believe they are not very effective in sustaining stage IV sleep and can affect the quality of sleep.

Nutrition/Dietetic concerns

Calcium and magnesium are recommended as **nutritional supplements** because of their calming effects. Because these essential nutrients must be in balance with each other, they should be taken together daily with a meal. Supplemental B vitamin complex is also recommended to help relieve stress and achieve a restful state. Caffeine and alcohol should be avoided. Relaxing teas containing chamomile and/or catnip (catmint) can be consumed before bed. Herbal tinctures such as skullcap, passionflower, hops, kava kava, or valerian root are considered nerviness and are known to calm the nervous system and promote restful sleep. A natural hormone produced by the body, dehydroepisterone (DHEA), is reduced in older individuals and has been shown to improve sleep when taken as a supplement. It is available in whole food stores and in some pharmacies.

Expected results

Insomnia has numerous causes and treatments, so the amount of time may vary before results are seen. A prescription drug may bring immediate results to someone coping with a spouse's death. An herbal remedy may not work immediately for a person who

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consumed excessive amounts of caffeine to stay awake at work after a sleepless night. A procedure such as cognitive therapy may take some time as therapist and patient work to resolve issues that hinder sleep.

Research has provided information about when some treatments take effect:

- Valerian is sold commercially in the form of capsules, extracts, and teas. The capsule or extract dosage ranges from 300 to 600 mg. As a sleep aid, it should be taken shortly before bedtime. People who have trouble falling asleep may see results quickly. It could take from two weeks to a month before a person with chronic insomnia experiences improved sleep.
- A combination of hops and valerian at bedtime could provide a good night's sleep.
- Melatonin is taken in a dose of from 0.3 to 3 mg an hour of retiring. When taken as a 3-mg dose one to two hours before bed for a maximum of four to five days per week, the dietary supplement melatonin was said to be effective in shortening the time before a person fell asleep. Side effects could include nightmares and sleepwalking.
- St. John's wort can take two weeks to take effect.
- A combination of alternative therapies should bring a difference in disturbed sleep within two to four days.
- Combinations of treatments could more quickly bring about an uninterrupted night of sleep. The person who reduces caffeine intake, walks for 15 minutes, and enjoys an herbal bath may discover that that combination brings restful sleep.
- Acupuncture is said to bring some people immediate relief. In small studies, people said that after treatment that it was easier to fall asleep and they remained asleep. This treatment is safe when it is done correctly.
- Light therapy proved to be effective in the treatment of men whose insomnia caused them to wake early. In that study, the men said they experienced an immediate benefit. However, no women were studied, and the research did not include people with other types of insomnia.

Prevention

Prevention of insomnia centers around the promotion of a healthy lifestyle. A balance of rest, recreation, and exercise in combination with stress management, regular physical examinations, and a healthy diet can do much to reduce the risk. Walking is also recommended. However, exercise should be done no more than three hours before bedtime.

KEY TERMS

Biofeedback—A training technique that enables an individual to gain some element of control over involuntary body functions.

Mood disorder—A group of mental disorders involving a disturbance of mood, along with either a full or partial excessively happy (manic) or extremely sad (depressive) syndrome not caused by any other physical or mental disorder. Mood refers to a prolonged emotion.

Sleep apnea—A condition in which a person stops breathing while asleep. These periods can last up to a minute or more and can occur many times each hour. In order to start breathing again, the person must become semi-awake. The episodes are not remembered, but the following day the person feels tired and sleepy. If severe, sleep apnea can cause other medical problems.

Sleep disorder—Any condition that interferes with sleep. As of 2008, at least 84 have been identified, according to the American Sleep Disorders Association.

Also to be avoided in the evening are drinks that contain caffeine such as coffee, tea, and colas. Chocolate contains a stimulant and may keep people awake. In addition, alcohol may initially make a person sleepy. However, it could have the opposite effect a few hours later.

Maintaining a comfortable bedroom temperature, reducing noise, and eliminating light are also helpful. The bedroom should be used only for sleeping, not watching television or reading.

Exercise, relaxation, and **nutrition** should be considered ongoing preventive measures. While life brings unexpected stresses and pressures, the person who is familiar with relaxation techniques is more prepared to cope with insomnia.

Prognosis

Insomnia can be prevented or corrected in most adults, although in some cases an underlying illness will require treatment in order to correct related insomnia. **Sleep apnea** is a potentially serious disorder related to breathing difficulties and chronic lung conditions; it can be fatal if not treated.

Untreated insomnia has potentially serious consequences, including an increased risk of motor vehicle

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accidents, impaired school or job performance, and a high rate of absenteeism from work. Fortunately, insomnia can be treated very effectively in most patients. Treatment using a combination of approaches is usually most effective. Patients who have had insomnia once are at an increased risk for recurrent insomnia.

Caregiver concerns

An individual who is not enjoying regular sleep may become anxious, depressed or irritable during the day, and may also fall asleep for long periods, preventing sleep at night. The caregiver can encourage movement and exercise during the day, which will help the individual gain a good night's sleep. The evening meal should be served early enough to allow two hours for digestion before trying to go to sleep. If the individual is taking sleeping medication, dosage should be checked by the caregiver to avoid overdosing. Activities during the day should be carefully supervised to prevent accidents caused by inattention or drowsiness.

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ORGANIZATIONS

American Academy of Sleep Medicine. 6301 Bandel Road NW, Suite 101, Rochester, MN, 55901. Telephone: (507) 287-6006. www.asda.org

American Medical Association., 515 N. State St., Chicago, IL, 60610, (800) 621-8335, http://www.ama-assn.org.

American Sleep Association, 614 South 8th Street, Suite 282, Philadelphia, PA, 19147, 443-593-2285, sleep@1sleep.com

National Sleep Foundation., 1522 K St. NW, Suite 500, Washington, DC, DC, 20005, (202) 347-3471, http://www.sleepfoundation.org/.

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Insulin *see* **Antidiabetic drugs**

Insulin resistance

Definition

Insulin resistance is not a disease as such but rather a state or condition in which a person's body tissues have a lowered level of response to insulin, a hormone secreted by the pancreas that helps to regulate the level of glucose (sugar) in the body. As a result, the person's body produces larger quantities of insulin to maintain normal levels of glucose in the blood. There is considerable individual variation in

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sensitivity to insulin within the general population, with the most insulin-sensitive persons being as much as six times as sensitive to the hormone as those identified as most resistant. Some doctors use an arbitrary number, defining insulin resistance as a need for 200 or more units of insulin per day to control blood sugar levels. Various researchers have estimated that 3–16 percent of the general population in the United States and Canada is insulin-resistant; another figure that is sometimes given is 70–80 million Americans.

Insulin resistance can be thought of as a set of metabolic dysfunctions associated with or contributing to a range of serious health problems. These disorders include type 2 diabetes (formerly called adult-onset or non-insulin-dependent diabetes), the metabolic syndrome (formerly known as syndrome X), **obesity**, and **polycystic ovary syndrome**. Some doctors prefer the term "insulin resistance syndrome" to "metabolic syndrome."

Description

To understand insulin resistance, it may be helpful for the reader to have a brief account of the way insulin works in the body. After a person eats a meal, digestive juices in the small intestine break down starch or complex sugars in the food into glucose, a simple sugar. The glucose then passes into the bloodstream. When the concentration of glucose in the blood reaches a certain point, the pancreas is stimulated to release insulin into the blood. As the insulin reaches cells in muscle and fatty (adipose) tissues, it attaches itself to molecules called insulin receptors on the surface of the cells. The activation of the insulin receptors sets in motion a series of complex biochemical signals within the cells that allow the cells to take in the glucose and convert it to energy. If the pancreas fails to produce enough insulin or the insulin receptors do not function properly, the cells cannot take in the glucose and the level of glucose in the blood remains high.

The insulin may fail to bind to the insulin receptors for any of several reasons. Some persons inherit a gene mutation that leads to the production of a defective form of insulin that cannot bind normally to the insulin receptor. Others may have one of two types of abnormalities in the insulin receptors themselves. In type A, the insulin receptor is missing from the cell surface or does not function properly. In type B, the person's immune system produces autoantibodies to the insulin receptor.

In the early stages of insulin resistance, the pancreas steps up its production of insulin in order to control the increased levels of glucose in the blood. As a result, it is not unusual for patients to have high blood sugar levels and high blood insulin levels (a condition known as hyperinsulinemia) at the same time. If insulin resistance is not detected and treated, however, the islets of Langerhans (the insulin-secreting groups of cells) in the pancreas may eventually shut down and decrease in number.

Causes and symptoms

Causes

The reasons for the development of insulin resistance are not completely understood as of the early 2000s, but several factors that contribute to it have been identified:

- Genetic factors. Insulin resistance is known to run in families. Genetic mutations may affect the insulin receptor, the signaling proteins within cells, or the mechanisms of glucose transport.
- Obesity. Being overweight keeps the muscles from using insulin properly, as it decreases the number of insulin receptors on cell surfaces.
- Low level of physical activity. Because muscle tissue takes up 95 percent of the glucose that insulin helps the body utilize (brain cells and blood cells do not depend on insulin to help them use glucose), inactivity further reduces the muscles ability to use insulin effectively.
- Aging. The aging process affects the efficiency of glucose transport.
- Other diseases and disorders. Some disorders—most notably Cushing syndrome and cirrhosis—and such stresses on the body as trauma, surgery, malnutrition, or severe infections speed up the breakdown of insulin or interfere with its effects.
- Certain medications. Some drugs, including cyclosporine, niacin, and the protease inhibitors used to treat HIV infection, may contribute to insulin resistance.

Symptoms

The symptoms of insulin resistance vary considerably from person to person. Some people may have no noticeable symptoms until they develop signs of heart disease or are diagnosed with high blood pressure during a routine checkup. Other patients may come to the doctor with extremely high levels of blood sugar (hyperglycemia) and such classical symptoms of diabetes as thirst, frequent urination, and weight loss. A small percentage of patients—most commonly women with polycystic ovary syndrome—

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develop a velvet-textured blackish or dark brown discoloration of the skin known as acanthosis nigricans. This symptom, which is most commonly found on the neck, groin, elbows, knees, knuckles, or armpits, is thought to appear when high levels of insulin in the blood spill over into the skin. This spillover activates insulin receptors in the skin and causes it to develop an abnormal texture and color. Acanthosis nigricans occurs more frequently in Hispanic and African American patients than in Caucasians.

Disorders associated with insulin resistance

Insulin resistance became an important field of research in the late 1980s, when doctors first began to understand it as a precondition of several common but serious threats to health. As of the early 2000s, insulin resistance is associated with the following disorders:

- Obesity. Obesity is not only the most common cause of insulin resistance but is a growing health concern in its own right. According to the National Institutes of Health (NIH), the percentage of American adults who meet the criteria for obesity rose from 25 percent to 33 percent between 1990 and 2000—an increase of a third within the space of a decade. Obesity is a risk factor for the development of type 2 diabetes, high blood pressure, and coronary artery disease.
- Pre-diabetes and type 2 diabetes. The NIH estimates that about 6.3 percent of the American population has diabetes. Of these 18.3 million people, 5.2 million are undiagnosed. Type 2 diabetes is much more common than type 1, accounting for 90–95 percent of patients with diabetes. Diabetes increases a person's risk of blindness, kidney disease, heart disease and stroke, disorders of the nervous system, complications during pregnancy, and dental problems; it also worsens the prognosis for such infectious diseases as influenza or pneumonia. About 41 million Americans are thought to have pre-diabetes, which is a condition marked by elevated levels of blood glucose after fasting or after a 2-hour test for glucose tolerance. According to the NIH, a majority of pre-diabetic people will develop type 2 diabetes within 10 years unless they lose between 5 and 7 percent of their body weight.
- Heart disease. Insulin resistance has been linked to a group of risk factors for heart disease and stroke known as the metabolic syndrome (formerly called syndrome X). The metabolic syndrome, like obesity, has become increasingly prevalent in the United States since the 1990s; as of the early 2000s, about a quarter of the general adult population is thought to have it, with the rate rising to 40 percent for adults over the age of 60. To be diagnosed with the metabolic syndrome, a person must have three or more of the following risk factors: a waist circumference greater than 40 in (102 cm) in men or 35 in (88 cm) in women; a level of blood triglycerides of 150 milligrams per deciliter (mg/dL) or higher; blood pressure of 130/85 Hg or higher; fasting blood sugar level of 110 mg/dL or higher; and a blood level of high-density lipoprotein (HDL) cholesterol (the so-called "good" cholesterol) lower than 50 mg/dL for men or 40 mg/dL for women.
- Polycystic ovary syndrome (PCOS). PCOS is an endocrine disorder that develops in 3–10 percent of premenopausal women as a result of the formation of cysts (small fluid-filled sacs) in the ovaries. Women with PCOS do not have normal menstrual periods; they are often infertile and may develop hirsutism (excess body hair) or other indications of high levels of androgens (male sex hormones) in the blood. This condition is called hyperandrogenism, and has been linked to insulin resistance in women with PCOS. Weight loss in these patients usually corrects hyperandrogenism and often restores normal ovulation patterns and fertility.

Diagnosis

Patient history and physical examination

Because insulin resistance is a silent condition in many people, the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) recommends that all adults over the age of 45 be tested for type 2 diabetes. People younger than 45 who are overweight and have one or more of the following risk factors should also visit their doctor to be tested:

- One or more family members with diabetes.
- High levels of triglycerides and low levels of HDL cholesterol as defined by the criteria for metabolic syndrome.
- Hypertension (high blood pressure).
- A history of smoking.
- A history of diabetes during pregnancy (gestational diabetes).
- Giving birth to a baby weighing more than 9 pounds. In addition to increasing the mother's risk of developing type 2 diabetes, children who are large for their gestational age (LGA) at birth have an increased risk of developing insulin resistance and metabolic syndrome in later life.
- Having African American, Hispanic, Native American, or Asian American/Pacific Islander heritage.

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Some signs and symptoms associated with insulin resistance can be detected by a primary care physician during a routine office visit. Blood pressure, weight, body shape, and the condition of the skin can be checked, as well as determining whether the patient meets the criteria for obesity or is less severely overweight. Obesity is determined by the patient's body mass index, or BMI. The BMI, which is an indirect measurement of the amount of body fat, is calculated in English units by multiplying a person's weight in pounds by 703.1, and dividing that number by the person's height in inches squared. A BMI between 19 and 24 is considered normal; 25–29 is overweight; 30–34 is moderately obese; 35–39 is severely obese; and 40 or higher is defined as morbidly obese. The doctor may also evaluate the patient for obesity in the office by measuring the thickness of the skinfold at the back of the upper arm.

The distribution of the patient's weight is also significant, as insulin resistance is associated with a so-called "apple-shaped" figure, in which much of the excess weight is carried around the abdomen. People whose excess weight is carried on the hips (the "pear-shaped" figure) or distributed more evenly on the body are less likely to develop insulin resistance. One way of measuring weight distribution is the patient's waist-to-hip ratio; a ratio greater than 1.0 in men or 0.8 in women is strongly correlated with insulin resistance.

Laboratory tests

There is no single laboratory test that can be used to diagnose insulin resistance by itself. Doctors usually evaluate individual patients on the basis of specific symptoms or risk factors. The tests most commonly used include the following:

- Blood glucose tests. A high level of blood glucose may indicate either that the body is not producing enough insulin or is not using it effectively. Two common tests used to screen for insulin resistance are the fasting glucose test and the glucose tolerance test. In the fasting glucose test, the person takes no food after midnight and has their blood glucose level measured early in the morning. Normal blood glucose levels after several hours without food should be below 100 milligrams per deciliter (mg/dL). If the level is between 100 and 125 mg/dL, the person has impaired fasting glucose (IFG) or pre-diabetes. If the level is over 126 and is confirmed by a second test, the person has diabetes. In the glucose tolerance test, the person is given a sugar solution to drink and their blood glucose level is measured 2 hours later. A normal level is 140 mg/dL; 140–199 mg/dL indicates impaired glucose tolerance (IGT) or pre-diabetes, while a level of 200 mg/dL or higher indicates diabetes.
- Tests of blood insulin levels. These help to determine whether high blood glucose levels are the result of insufficient production of insulin or inefficient use of insulin.
- Lipid profile test. This test measures the amount of total cholesterol, high-density lipoprotein (HDL) cholesterol, low-density lipoprotein (LDL) cholesterol, and triglycerides. Patients with insulin resistance will have high levels of LDL cholesterol and triglycerides with low levels of HDL cholesterol.
- Measurement of blood electrolytes and uric acid. Many patients with the metabolic syndrome have high blood levels of uric acid.

A highly accurate technique for measuring insulin resistance is called the euglycemic clamp technique. The patient's blood insulin level is kept ("clamped") at a high but steady level by continual insulin infusion while the blood glucose level is monitored at frequent intervals. Glucose concentrations in the blood are maintained at a normal level by an adjustable-rate glucose drip. The amount of glucose needed to maintain a normal blood glucose level over a given unit of time indicates the degree of insulin resistance. This test, however, requires complex equipment and careful monitoring; it is considered too cumbersome to use in routine screening and is used mostly by researchers.

Treatment

Lifestyle modifications

Lifestyle modifications are the first line of treatment in dealing with insulin resistance:

- Weight reduction. Losing weight increases the body's sensitivity to insulin. It is not necessary, however, for patients to reduce their weight to the ideal levels listed on life insurance charts. In recent years, researchers have found that even a modest weight loss—usually defined as 10 percent of the patient's pretreatment weight—is enough to control or at least improve insulin resistance and other health complications of obesity. Weight reduction is usually accomplished by a combination of reduced calorie intake and increased physical activity. Insulin sensitivity is reported to improve within a few days of lowered calorie intake, even before the patient loses a measurable amount of weight.
- Exercise. Regular exercise improves the body's sensitivity to insulin by increasing the muscles' uptake of glucose from the bloodstream, by increasing the efficiency of the circulatory system and glucose transport,

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and by reducing the amount of fat around the patient's abdomen. The American Academy of Family Practice (AAFP) recommends 30 minutes of moderately intense physical activity on most or all days of the week for people diagnosed with insulin resistance. Walking is a very good form of exercise because it does not require any special equipment other than comfortable walking shoes, can be combined with doing errands, and can be done either alone or with a group of friends. Riding a bicycle is another form of exercise recommended for weight control.

- Adding foods high in fiber to the diet. A diet high in natural fiber, found in whole grains and vegetables, lowers the levels of blood insulin as well as lowering the patient's risk of developing high blood pressure.
- Quitting smoking. Giving up smoking lowers the risk of heart disease, stroke, or lung cancer as well as increasing the body's sensitivity to insulin.
- Limiting alcohol consumption. Alcohol is a source of "empty" calories with little nutritional value of its own.

Medications

There are several different types of medications that can be used to treat patients with abnormal blood sugar or insulin levels:

- Biguanides. Biguanides are drugs that improve the body's sensitivity to insulin by lowering the absorption of glucose in the small intestine, decreasing the liver's production of glucose, and increasing the uptake of glucose in muscle and fatty tissues. Metformin (Glucophage), a drug used in the treatment of type 2 diabetes, is the most commonly used biguanide in treating insulin resistance. It has also been studied as a possible treatment in preventing or delaying the onset of type 2 diabetes.
- Thiazolidinediones. These drugs stimulate glucose uptake in the muscles and fatty tissues by activating specific receptors in the cell nucleus. They also lower blood insulin levels in patients with hyperinsulinemia. The thiazolidinediones include pioglitazone (Actos) and rosiglitazone (Avandia).
- Glucocorticoids. These drugs may be given to patients with insulin resistance caused by anti-insulin antibodies produced by their immune system. Prednisone (Deltasone) is the most commonly used glucocorticoid.
- Insulin itself. Some patients with insulin resistance benefit from injectable insulin to reduce their blood sugar levels.

As of early 2005, however, the Food and Drug Administration (FDA) has not approved any drugs for the treatment of insulin resistance by itself. For this reason, the American Diabetes Association does not recommend treating insulin resistance with medications unless the patient has already been diagnosed with diabetes.

The patient's doctor may also prescribe medications to treat specific health problems associated with insulin resistance. These drugs may include **diuretics** and other medications to lower blood pressure; **aspirin** to reduce the risk of **heart attack**; medications to lower the levels of **triglycerides** and LDL cholesterol in the blood; and weight-control drugs. The drugs most frequently prescribed in the early 2000s to help patients lose weight are orlistat (Xenical) and sibutramine (Meridia).

Acanthosis nigricans may be treated with topical preparations containing Retin-A, 20% urea, or salicylic acid; however, many patients find that the skin disorder improves by itself following weight loss.

Surgery

Insulin resistance by itself does not require surgical treatment; however, patients who have already developed heart disease may require coronary artery bypass surgery. In addition, very obese patients—those with a BMI of 40 or higher—may benefit from **bariatric surgery**. Bariatric surgery includes such procedures as vertical banded gastroplasty and **gastric bypass**, which limit the amount of food that the stomach can contain.

Alternative treatment

Some alternative treatments for insulin resistance and type 2 diabetes have been studied by the Agency for Healthcare Research and Quality (AHRQ). One study reported in 2004 that **omega-3 fatty acids**, a dietary supplement commonly derived from fish, canola, or soybean oil, did not appear to have any significant effect on blood sugar levels or blood insulin levels in patients diagnosed with type 2 diabetes or the metabolic syndrome. An earlier study of **Ayurvedic medicine**, the traditional medical system of India, reported in 2001 that certain herbs used to make Ayurvedic medicines, such as fenugreek, holy basil, *Coccinia indica*, and *Gymnema sylvestre* appear to be effective in lowering blood sugar levels and merit further study. The AHRQ report also noted that the Ayurvedic practice of combining herbal medicines with **yoga** and other forms of physical activity should be investigated further.

Other alternative treatments for insulin resistance and type 2 diabetes include chromium supplements, **ginseng**, **biofeedback**, and **acupuncture**. The connection between chromium supplementation and insulin resistance is that the body needs chromium to produce a substance called glucose tolerance factor, which increases the effectiveness of insulin. Further studies need to be done,

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KEY TERMS

Acanthosis nigricans—A dark brownish or blackish discoloration of the skin related to overweight and high levels of insulin in the blood. Acanthosis nigricans is most likely to develop in the groin or armpits, or around the back of the neck.

Bariatrics—The branch of medicine that deals with the prevention and treatment of obesity and related disorders.

Body mass index (BMI)—A measurement that has replaced weight as the preferred determinant of obesity. The BMI can be calculated (in English units) as 703.1 times a person's weight in pounds divided by the square of the person's height in inches.

Glucose—A simple sugar produced when carbohydrates are broken down in the small intestine. It is the primary source of energy for the body. Various tests that measure blood glucose levels are used in diagnosing insulin resistance.

Hyperandrogenism—Excessive secretion of androgens (male sex hormones).

Hyperinsulinemia—The medical term for high levels of insulin in the blood.

Insulin—A protein hormone secreted by the islets of Langerhans in the pancreas in response to eating. Insulin carries glucose and amino acids to muscle and adipose cells and promotes their efficient use and storage.

Islets of Langerhans—Special structures in the pancreas responsible for insulin secretion among other functions. They are named for Paul Langerhans, the German researcher who first identified them in 1869.

Lipids—A group of fats and fat-like substances that are not soluble in water, are stored in the body, and serve as a source of fuel for the body.

Metabolic syndrome—A group of risk factors for heart disease, diabetes, and stroke. It includes abdominal obesity, high blood pressure, high blood glucose levels, and low levels of high-density lipoprotein (HDL) cholesterol. The metabolic syndrome is sometimes called the insulin resistance syndrome.

Metabolism—The sum of an organism's physical and chemical processes that produce and maintain living tissue, and make energy available to the organism. Insulin resistance is a disorder of metabolism.

Obesity—Excessive weight gain due to accumulation of fat in the body, sometimes defined as a BMI of 30 or higher, or body weight greater than 30 percent above one's desirable weight on standard height-weight tables.

Pancreas—A large gland located behind the stomach near the spleen that secretes digestive enzymes into the small intestine and insulin into the bloodstream.

Syndrome—In general, a set of symptoms that occur together as signs of a disease or disorder.

Syndrome X—A term that was sometimes used for metabolic syndrome when the syndrome was first identified in the 1960s.

Triglycerides—Fatty compounds synthesized from carbohydrates during the process of digestion and stored in the body's adipose (fat) tissues. High levels of triglycerides in the blood are associated with insulin resistance.

Type 2 diabetes mellitus—One of the two major types of diabetes mellitus, characterized by late age of onset (30 years or older), insulin resistance, high levels of blood sugar, and little or no need for supplemental insulin. It was formerly known as adult-onset or non-insulin-dependent diabetes.

however, before recommendations about dietary chromium as a treatment for insulin resistance can be made.

Prognosis

Since insulin resistance is a condition that precedes the appearance of symptoms of a number of different disorders, its prognosis depends in part on the patient's age, ethnicity, family history, and severity of any current health problems. Some patients diagnosed with insulin resistance eventually develop type 2 diabetes, but it is not yet known why the others do not; for example, some patients do not develop diabetes in spite of a high degree of insulin resistance. What is known at present is that weight reduction and **exercise** can control or even reverse insulin resistance in many people.

Prevention

Genetic factors contributing to insulin resistance cannot be changed as of the early 2000s.

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With regard to lifestyle factors, the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) reported the findings of a study of the effects of lifestyle changes or metformin on the incidence of diabetes in a group of over 3200 overweight people with impaired glucose tolerance, which is a risk factor for developing type 2 diabetes. The researchers found that the subjects in the lifestyle modification group, who lowered their food intake and took 30-minute walks five days a week, had a 58-percent lower incidence of diabetes. The subjects who received metformin had a 31-percent lower incidence of diabetes. Lifestyle changes were most effective in volunteers over the age of 60, while metformin was most effective in younger subjects. In short, the 2002 study confirmed the beneficial effects of lowered food intake and increased activity as preventive measures against type 2 diabetes.

Another important part of preventing insulin resistance is patient education. A number of resources on weight control and exercise written for the general public are available from the Weight-Control Information Network (WIN) on the NIDDK website at http://win.niddk.nih.gov/publications/physical.htm. Some pamphlets are available in Spanish as well as English. Patient education materials on insulin resistance in relation to heart disease and diabetes can be downloaded free of charge from the American Heart Association and American Diabetes Association websites.

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ORGANIZATIONS

American Academy of Dermatology, PO Box 4014, Schaumburg, IL, 60168-4014, 847 240-1859, 866 503-SKIN (7546), http://www.aad.org.

American Diabetes Association, 1701 North Beauregard Street, Alexandria, VA, 22311, 800 342-2383, Ask ADA@diabetes.org, http://www.diabetes.org/.

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, 800 242-8721, Review.personal.info@heart.org.

National Diabetes Information Clearinghouse (NDIC), 1 Information Way, Bethesda, MD, 20892-3560, 703 738-4929, 800 860-8747, ndic@info.niddk.nih.gov, http://diabetes.niddk.nih.gov/.

The Obesity Society, 8630 Fenton St., Suite 814, Silver Spring, MD, 20910, 301 563-6526, 301 563-6595, http://www.obesity.org/.

Rebecca Frey, PhD

Intelligence tests *see* **Stanford-Binet intelligence scales; Wechsler intelligence test**

Intention tremor *see* **Tremors**

Interferon *see* **Antiviral drugs; Immunologic therapies**

Interleukin-2 *see* **Immunologic therapies**

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Intermittent claudication

Definition

Intermittent claudication is a **pain**, cramping, or weakness in the legs (usually the calf muscle of one or both lower limbs, although it can sometimes occur in the arms), especially when exercising such as walking or climbing stairs. The pain, which occurs because of reduced blood flow through the limbs, is intermittent and goes away when the person rests. It is a type of arterial occlusive disease. Intermittent claudication is also called **angina** cruris or sometimes simply as claudication and is a symptom of peripheral artery disease.

Demographics

People age 50 years or older are at risk of intermittent claudication. The risk increases with age. Statistically, 5% of men and 2.5% of women experience symptoms of this condition, according to the Vascular Disease Foundation (VDF). Many people with this condition have cholesterol plaque build-up in the leg's arteries. **Smoking** raises the risk, as do high blood pressure, **obesity**, lack of **exercise**, and diabetes.

Description

Claudication comes from the Latin word (*cludicare*) that means "to limp," and the condition is characterized by intermittent pain, usually of the leg muscles but not the joints. Poor circulation produces the pain. The legs do not receive the oxygen-rich (oxygenated) blood supply needed for activities like walking and exercising. The decreased blood flow is caused by the narrowing or damage of arteries that bring blood to the legs and feet. Most patients also have cholesterol plaque in the arteries of their legs.

The leg pain produced by claudication is usually experienced as cramping in the thighs, calves, hips, and feet. The pain stops several minutes after the person rests, but returns when the person performs activities that use the leg muscles. If untreated, claudication is no longer intermittent and occurs when a person is resting.

Intermittent claudication is the main symptom of peripheral arterial disease (PAD), which is also known as **peripheral vascular disease** or occlusive arterial disease. Intermittent claudication is an early symptom of the condition that affects peripheral arteries, those blood vessels located outside the heart. PAD is caused by arteriosclerosis, the narrowing and hardening of the arteries. According to the National Heart, Lung, and Blood Institute, about 10% of people with PAD also have intermittent claudication.

Women with diabetes are much more likely to experience PAD as those without diabetes, according to the American Diabetes Association (ADA). Furthermore, intermittent claudication is related to a two to three times increased risk of coronary heart disease, **stroke**, or cardiac failure in men with diabetes, according to the association.

Causes and symptoms

Intermittent claudication is caused by poor circulation and is experienced in a person's muscle groups. It affects the peripheral arteries that convey oxygen-rich blood from the heart to the legs. A person with this condition feels pain shortly after beginning to exercise. Walking may trigger the pain in an inactive person. Activities such as climbing stairs, walking rapidly or dancing can cause the pain to increase.

The person feels the pain as tightness in the calf, thigh, or buttocks. The pain stops after the person rests for several minutes. However, it returns when the person reaches the exertion level that previously produced the pain.

Intermittent claudication is the primary symptom of PAD, the condition causing reduced flow of blood and oxygen to tissues. If the intermittent condition is not treated, the person will find that resting does not relieve pain. As arteries become more clogged, the person could feel pain even when not exercising. Symptoms include cold or numb feet and toes, poor balance when standing, a drop in leg strength, sores that heal slowly, and **erectile dysfunction** (**impotence**).

The most common cause of intermittent claudication is **atherosclerosis**. It involves atherosclerotic lesions of the limbs. Such lesions reduce the amount of blood to the muscles of the lower legs. The symptoms of atherosclerosis, and of intermittent claudication, are:

- Cyanosis (blue discoloration of skin, especially toes or fingers).
- Pain, cramping, burning/aching feeling, tightness, or weakness, especially in the low extremities (legs, feet, calves, hips, or buttocks), while walking or exercising.
- Deteriorate changes such as shiny skin and hair loss.
- Decreased body temperature; including a feeling of cold and a look of pallor.
- Sores on lower legs, feet, toes, arms, or elsewhere.
- Impotence (men).

In the advanced stages of PAD, the person experiences pain when resting. This condition, ischemic

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rest pain, is characterized by symptoms visible on the feet and toes. These include ulcers, loss of hair, and the change to red color when feet are suspended. Other symptoms include blue or purple markings on the legs, feet, and toes. The coloring is a sign that less oxygen is reaching these areas. Furthermore, black skin on the legs and feet is a sign of **gangrene** infection.

Risks

The risk factors for intermittent claudication include:

- High blood pressure.
- Total blood cholesterol over 240 milligrams per deciliter.
- Obesity (being extremely overweight).
- Diabetes.
- Tobacco products, such as smoking.
- Over 70 years of age (over 50 years of age for tobacco users or those with diabetes).
- Family history of peripheral artery disease, atherosclerosis, or intermittent claudication.

Diagnosis

If a person experiences symptoms of intermittent claudication, their doctor will review the patient's medical history and examine the person for signs of the condition. This examination includes checking for a lower pulse or the absence of a pulse behind the knee, on the ankle, foot, and groin.

The doctor may order an ankle-brachial index (ABI) test to determine whether arteries are blocked. This procedure will verify if the person has PAD and provides information on the severity of the condition. The ABI measures blood pressure in the arms and ankle. Readings are taken when the person is at rest and after exercising lightly by walking on a treadmill. The ABI index is found by dividing the ankle blood pressure by the pressure for the arm. An ABI below 0.90 in a person at rest is a sign of PAD.

The physician may also order a Doppler ultrasound examination to measure the flow of blood through the arteries. Cuffs are placed on four places on each leg. The doctor then moves an ultrasound probe over arteries in the foot. The probe detects signals (sound waves) from the artery. Testing can last from 20 minutes to an hour. The results will show the degree of PAD for the patient. The procedures are usually covered by medical insurance.

Treatment

Lifestyle changes are the primary form of treating intermittent claudication. Physicians advise people to quit smoking, exercise, and to follow the American Heart Association's healthy diet guidelines. Other suggestions may be to lower blood pressure and cholesterol levels.

The goal of treatment is stop development of PAD. By exercising, eating a diet that includes fiber and low-fat foods, and not smoking, a person could also reverse the build-up that clogs arteries. After several months of this regimen, many people experience a lessening of leg pain. If pain continues, the doctor may prescribe medication. Furthermore, surgery may be needed in some cases. In most cases, when treated properly, intermittent claudication can be controlled without pain so patients can live an active lifestyle.

Walking

Walking is frequently an important treatment for intermittent claudication. A person experiencing the pain of intermittent claudication may not feel like walking. However, walking can increase the capacity to exercise. Before starting an exercise program, the person should consult with consult with a doctor.

The physician reviews the patient's medical history, does a physical and may order an exercise **stress test** on a treadmill. The test shows how long a person walks before claudication starts. Information such as blood pressure is used to evaluate the person's ability to walk. The findings are also used to develop a medically supervised exercise program.

At the beginning, the treadmill is set to cause claudication symptoms in three to five minutes, according to the Vascular Disease Foundation. The person walks until pain is moderately severe. A rest period is scheduled after the person walks eight to 10 minutes.

The person walks and rests, with the goal of walking for a total of 35 minutes. The person walks at least three times weekly. If a treadmill is not available, VDF recommends that people walk on a track. Generally, a person walking three times weekly will be able to walk longer after three to 12 months.

Medications

People diagnosed with PAD are at a high risk for a stroke and **heart attack**. Regularly taking **aspirin** may reduce this risk. Clopidogrel, a drug marketed as Plavix, has been shown to also reduce such risks. Other medications include angiotensin converting enzyme

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(ACE) inhibitors, beta-blockers, pentoxifylline, and cilostazol (selective PDE3 inhibitor).

A doctor may also prescribe cilostazol—sold under the name Pletal—which extends the distance people can walk without pain. One tablet is taken twice daily.

Surgical procedures

Surgical procedures may be necessary in cases where intermittent claudication is disabling. The person experiences pain when resting, has open sores that do not heal, or symptoms of gangrene like dying skin in the leg or foot.

Bypass surgery directs blood through a grafted blood vessel, bypassing the damaged artery. The grafted vessel is either a healthy artery or vein or an artificial vessel.

Angioplasty is a procedure to open blocked blood vessels. A catheter (tube) is inserted in the groin and moved to the artery. Then a tiny balloon is inflated to open the artery. Another angioplasty procedure involves the insertion of a stent, a metal device that keeps the vessel open.

Angioplasty is a minimally invasive procedure. **Local anesthesia** is used, and a person is able to resume normal activities within one to two days. The cost of angioplasty is less than one-half the cost of bypass surgery. A non-invasive procedure is not as risky as surgery. However, a bypass may be needed when multiple sections of blood vessels are blocked.

Once a person is diagnosed with intermittent claudication, health plans usually cover part of treatment costs.

Alternative treatment

Ginkgo biloba extract, an herbal remedy, has been used by people with intermittent claudication. The extract made from the dried leaves of the Gingko tree is thought to improve blood flow, allowing people to walk longer without pain.

However, herbal remedies are not regulated the U.S. Food and Drug Administration, and people should consult with their doctors before taking ginkgo. Furthermore, use of this remedy could interact adversely when taken with vitamin E and vitamin B_3, which are also used as alternative treatments, and some other medications.

Prognosis

If untreated, advanced intermittent claudication can eventually restrict a person's mobility. In later stages, people feel pain when resting. The leg or foot may feel cold. In the extreme stage, the person might need a cane, walker, or wheelchair. There is more risk of gangrene developing, and **amputation** might be necessary. Diabetics face an increased risk of amputation. PAD also increases the risk of heart attacks and strokes.

KEY TERMS

Arthrosclerosis—A condition where fatty deposits cause the arteries to narrow.

Gangrene—The decay of tissue in the body; it is caused by an obstruction to the blood supply.

Prevention

A healthy lifestyle is the best method for preventing intermittent claudication. Cigarette smokers should quit smoking. Regular exercise and a healthy diet may help reduce the risk of this condition. Maintaining healthy blood pressure and cholesterol levels may also help to prevent this condition.

The methods of preventing intermittent claudication are also the means for managing the risks associated with a diagnosis of PAD.

People can learn more about peripheral vascular disease through public education programs like the free Legs for Life screenings held at sites across the nation. The program, started by the Society of Interventional Radiology, features a free ABI testing.

Resources

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"Peripheral Artery Disease" National Heart, Lung, and Blood Institute. http://www.nhlbi.nih.gov/health/dci/Diseases/pad/pad_signs.html. (accessed July 7, 2010).

ORGANIZATIONS

American Diabetes Association, 1701 North Beauregard St., Alexandria, VA, 22311, (800) 342–2383, AskADA@diabetes.org, http://www.diabetes.org.
Society of Interventional Radiology, 3975 Fair Ridge Drive, Suite 400 North, Fairfax, VA, 22033, (800) 488-7284, http://www.sirweb.org.
Vascular Disease Foundation, 1075 S. Yukon Street, Suite 320, Lakewood, CO, 22033, (888) 833-4463, info@vdf.org, http://www.vdf.org.

Liz Swain

Intermittent explosive disorder

Definition

Intermittent explosive disorder (IED) is a mental disturbance that is characterized by specific and repeated episodes of violent and aggressive behavior that may involve harm to others or destruction of property. Throwing and breaking of objects are often part of the behavior. Often the anger and violence seen in such an individual reaches a point of uncontrollable rage. Such behavior seems out of context to the situation at hand during such outburst. Common signs of IED are temper tantrums, domestic **abuse**, and road rage. IED is sometimes grouped together as an impulse–control disorder with other such behavioral disorders such as kleptomania, pyromania, and pathological gambling.

A person must meet certain specific criteria to be diagnosed with IED:

- There must be several separate episodes of failure to restrain aggressive impulses that result in serious assaults against others or property destruction.
- The degree of aggression expressed must be out of proportion to any provocation or other stressor prior to the incidents.
- The behavior cannot be accounted for by another mental disorder, substance abuse, medication side effects, or such general medical conditions as epilepsy or head injuries.

Many psychiatrists do not place intermittent explosive disorder into a separate clinical category but consider it a symptom of other psychiatric and mental disorders. In many cases individuals diagnosed with IED do in fact have a dual psychiatric diagnosis. IED is frequently associated with mood and **anxiety disorders**, **substance abuse** and **eating disorders**, and narcissistic, paranoid, and antisocial **personality disorders**.

Demographics

With regard to sex and age group, the majority of individuals diagnosed with IED in the United States are adolescent and adult males. Women do experience IED, however, and have reported it as part of **premenstrual syndrome** (PMS). IED may appear in childhood but is usually misdiagnosed as temper tantrums. Later in life, it often goes undiagnosed for years because it is a relatively rare condition.

According to researchers at the National Institutes of Health, in 2006, approximately 2.2 million persons in the United States (about 7.3% of the total population) met the criteria for IED, with a total of 11.5 to 16 million meeting the lifetime criteria for the disorder.

Description

People diagnosed with IED sometimes describe strong impulses to act aggressively prior to the specific incidents reported to the doctor and/or the police. They may experience racing thoughts or a heightened energy level during the aggressive episode, with **fatigue** and depression developing shortly afterward. Some report various physical sensations, including tightness in the chest, **tingling** sensations, increased energy, tremor, hearing echoes, irritability, or a feeling of pressure inside the head.

Many people diagnosed with IED appear to have general problems with anger or other impulsive behaviors between explosive episodes. Some are able to control aggressive impulses without acting on them while others act out in less destructive ways, such as screaming at someone rather than attacking them physically.

Causes and symptoms

Causes

As with other impulse–control disorders, the cause of IED has not been determined. As of 2010, researchers disagree as to whether it is learned behavior

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(environmental in nature), the result of biochemical or neurological abnormalities (biological in nature), or a combination of factors. Some scientists have reported abnormally low levels of serotonin, a neurotransmitter that affects mood, in the cerebrospinal fluid of some anger–prone persons, but the relationship of this finding to IED is not clear. Generally, IED patients also have higher levels of the hormone testosterone in the systems. Similarly, some individuals diagnosed with IED have a medical history that includes migraine headaches, seizures, attention–deficit hyperactivity disorder, or developmental problems of various types, but it is not clear that these cause IED, as most persons with migraines, learning problems, or other neurological disorders do not develop IED.

Some psychiatrists who take a cognitive approach to mental disorders believe that IED results from rigid beliefs and a tendency to misinterpret other people's behavior in accordance with these beliefs. According to American psychologist Aaron Beck (1921–), a pioneer in the application of cognitive therapy to violence–prone individuals, most people diagnosed with IED believe that other people are basically hostile and untrustworthy, that physical force is the only way to obtain respect from others, and that life in general is a battlefield. Beck also identifies certain characteristic errors in thinking that go along with these beliefs:

- Personalizing. The person interprets others' behavior as directed specifically against him or her.
- Selective perception. The person notices only those features of situations or interactions that fit his or her negative view of the world rather than taking in all available information.
- Misinterpreting the motives of others. The person tends to see neutral or even friendly behavior as either malicious or manipulative.
- Denial. The person blames others for provoking his or her violence while denying or minimizing his or her own role in the fight or other outburst.

Symptoms

The symptoms that can precede episodes of IED, or can accompany the disorder, include:

- Rage.
- Increased energy.
- Tingling.
- Tremors.
- Palpitations.
- Irritability.
- Headache, or feeling of pressure in the head.
- Tightness in the chest.

Risks

People with increased risk of having intermittent explosive disorder may have these other characteristics:

- Substance abuse (more likely to have abused drugs or alcohol).
- Age (younger people are more prone to IED).
- Gender (men are more likely than women to have IED).
- Other mental health problems (people with other mental illnesses, such as anxiety attacks or depression, are more likely to also have IED).
- Previous physical abuse (people previously abused physically as children are at higher risk of IED).

Diagnosis

The diagnosis of IED is basically a diagnosis of exclusion, which means that the doctor will eliminate such other possibilities as neurological disorders, mood or substance abuse disorders, **anxiety** syndromes, and personality disorders before deciding that the patient meets the DSM–IV criteria for IED. In addition to taking a history and performing a **physical examination** to rule out general medical conditions, the doctor may administer one or more psychiatric inventories or screeners to determine whether the person meets the criteria for other mental disorders.

In some cases the doctor may order imaging studies or refer the person to a neurologist to rule out brain tumors, traumatic injuries of the nervous system, **epilepsy**, or similar physical conditions.

Patients diagnosed with IED are also usually diagnosed with at least one other disorder, such as personality disorders, substance abuse, or neurological disorders.

Along with these other evaluations, the doctor will also investigate the personal and professional history of the patient. People with IED often have problems in school, keeping a job, and interpersonal relationships (including divorce), along with numerous automobile accidents and law enforcement crimes.

Treatment

Emergency room treatment

A person brought to a hospital emergency room by family members, police, or other emergency personnel after an explosive episode will be evaluated by a psychiatrist to see whether he or she can safely be released after any necessary medical treatment. If the patient appears to be a danger to him/herself or others,

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KEY TERMS

Cognitive therapy—A form of short–term psychotherapy that focuses on changing people's patterns of emotional reaction by correcting distorted patterns of thinking and perception.

Delirium—An acute but temporary disturbance of consciousness marked by confusion, difficulty paying attention, delusions, hallucinations, or restlessness. Delirium may be caused by drug intoxication, high fever related to infection, head trauma, brain tumors, kidney or liver failure, or various metabolic disturbances.

Kleptomania—A mental disorder characterized by impulsive stealing.

Neurotransmitter—Any of a group of chemicals that transmit nerve impulses across the gap (synapse) between two nerve cells.

Pyromania—A mental disorder characterized by setting fires.

Serotonin—A neurotransmitter or brain chemical that is responsible for transporting nerve impulses.

the person may be involuntarily committed for further treatment. In terms of legal issues, a doctor is required by law to notify the specific individuals as well as the police if the patient threatens to harm particular persons. In most states, the doctor is also required by law to report suspected abuse of children, the elderly, or other vulnerable family members.

The doctor will perform a thorough medical examination to determine whether the explosive outburst was related to substance abuse, withdrawal from drugs, head trauma, **delirium**, or other physical conditions. If the patient becomes assaultive inside the hospital, he or she may be placed in restraints or given a tranquilizer (usually either lorazepam [Ativan] or diazepam [Valium]), usually by injection. In addition to the physical examination, the doctor will obtain as detailed a history as possible from the family members or others who accompanied the patient.

Medications

Medications that have been shown to be beneficial in treating IED in nonemergency situations include lithium, carbamazepine (Tegretol), propranolol (Inderal), and such **selective serotonin reuptake inhibitors** as fluoxetine (Prozac) and sertraline (Zoloft). Adolescents diagnosed with IED have been reported to respond well to clozapine (Clozaril), a drug normally used to treat **schizophrenia** and other psychotic disorders.

Psychotherapy

Some persons with IED benefit from cognitive therapy in addition to medications, particularly if they are concerned about the impact of their disorder on their education, employment, or interpersonal relationships. Psychoanalytic approaches are not useful in treating IED.

Prognosis

The prognosis of IED depends on several factors that include the individual's socioeconomic status, the stability of his or her family, the values of the surrounding neighborhood, and his or her motivation to change. As some patients age the disorder tends to decrease in its severity. However, in others the disorder becomes chronic.

Prevention

There is not a clear way to prevent this disorder. It is also difficult to diagnose until symptoms begin to appear. Since the causes of IED are not fully understood as of the early 2010s, preventive strategies should focus on treatment of young children (particularly boys) who may be at risk for IED before they enter adolescence. Teaching self–control skills at a young age is been shown helpful in controlling the disorder.

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ORGANIZATIONS

American Academy of Child and Adolescent Psychiatry, 3615 Wisconsin Ave., NW, Washington, DC, 20016–3007, (202) 966–7300, (202) 966–2891, http://www.aacap.org.

American Psychiatric Association, 1000 Wilson Blvd, Suite 1825, Arlington, VA, 22209, 888) 357–7924, http://www.psych.org.

National Institute of Mental Health, 6001 Executive Blvd., Room 8184, MSC 9663, Bethesda, MD, 20892–9663, (866) 615–6464, http://www.nimh.nih.gov.

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Internal fetal monitoring *see* **Electronic fetal monitoring**

Internuclear ophthalmoplegia *see* **Ophthalmoplegia**

Interpositional reconstruction *see* **Arthroplasty**

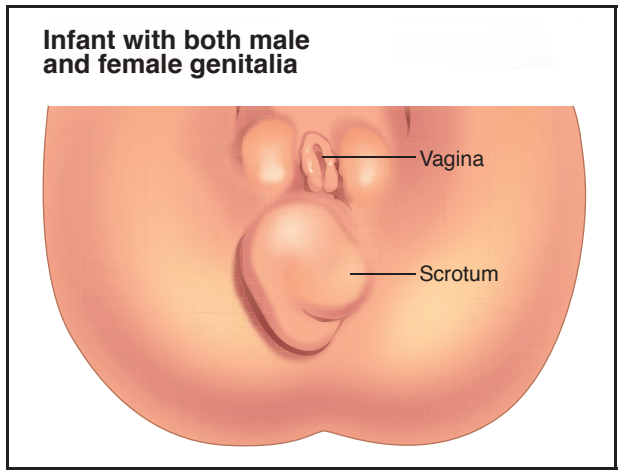
Intersex states

Definition

Intersex states are conditions where a newborn's sex organs (genitals) look unusual, making it impossible to identify the sex of the baby from its outward appearance.

Description

All developing babies start out with external sex organs that look female. If the baby is male, the internal sex organs mature and begin to produce the male hormone testosterone. If the hormones reach the tissues correctly, the external genitals that looked female change into the scrotum and penis. Sometimes, the genetic sex (as indicated by chromosomes) may not match the appearance of the external sex organs. About 1 in every 2,000 births results in a baby whose sex organs look unusual.



An illustration depicting an infant born with both male and female genitalia. Such a condition can make identification of gender impossible from outward appearance. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Patients with intersex states can be classified as a true hermaphrodite, a female pseudohermaphrodite, or a male pseudohermaphrodite. This is determined by examining the internal and external structures of the child.

A true hermaphrodite is born with both ovaries and testicles. They also have mixed male and female external genitals. This condition is extremely rare.

A female pseudohermaphrodite is a genetic female. However, the external sex organs have been masculinized and look like a penis. This may occur if the mother takes the hormone progesterone to prevent a **miscarriage**, but more often it is caused by an overproduction of certain hormones.

A male pseudohermaphrodite is a genetic male. However, the external sex organs fail to develop normally. Intersex males may have testes and a female-like vulva, or a very small penis.

Causes and symptoms

Any abnormality in chromosomes or sex hormones, or in the unborn baby's response to the hormones, can lead to an intersex state in a newborn.

Intersex states may also be caused by a condition called **congenital adrenal hyperplasia**, which occurs in about 1 out of every 5,000 newborns. This disease blocks the baby's metabolism and can cause a range of symptoms, including abnormal genitals.

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KEY TERMS

Chromosomes—Spaghetti-like structures located within the nucleus (or central portion) of each cell. Chromosomes contain the genetic information necessary to direct the development and functioning of all cells and systems in the body. They pass on hereditary traits from parents to child (like eye color) and determine whether the child will be male or female.

Diagnosis

When doctors are uncertain about a newborn's sex, a specialist in infant hormonal problems is consulted as soon as possible. Ultrasound can locate a uterus behind the bladder and can determine if there is a cervix or uterine canal. Blood tests can check the levels of sex hormones in the baby's blood, and chromosome analysis (called karyotyping) can determine sex. Explorative surgery or a biopsy of reproductive tissue may be necessary. Only after thorough testing can a correct diagnosis and determination of sex be made.

Treatment

Treatment of intersex states is controversial. Traditional treatment assigns sex according to test results, the potential for the child to identify with a sex, and the ease of genital surgery to make the organs look more normal. Treatment may then include **reconstructive surgery** followed by hormone therapy. Babies born with congenital adrenal hyperplasia can be treated with cortisone-type drugs and sometimes surgery.

Counseling should be given to the entire family of an intersex newborn. Families should explore all available medical and surgical options. Counseling should also be provided to the child when he or she is old enough.

Prognosis

Since the mid-1950s, doctors have typically assigned a sex to an intersex infant based on how easy reconstructive surgery would be. The American Academy of Pediatrics states that children with these types of genitals can be raised successfully as members of either sex, and recommends surgery within the first 15 months of life.

Some people are critical of this approach, including intersex adults who were operated on as children. The remolded genitals do not function sexually and can be the source of lifelong **pain**. They suggest that surgery be delayed until the patient can make informed choices about surgery and intervention.

ORGANIZATIONS

Ambiguous Genitalia Support Network, P.O. Box 313, Clements, CA, 95227, 209 727-0313.

Intersex Society of North America, 979 Golf Course Drive #282, Rohnert Park , CA, 94928, 801 348-5350, http://www.isna.org/.

Carol A. Turkington

Interstitial microwave thermal therapy

Definition

Interstitial microwave thermal therapy is a type of hyperthermia treatment for **cancer**, in which heat produced by microwaves (which are a non-ionizing form of radiation) is used in conjunction with other cancer treatments, such as radiation or **chemotherapy**, to kill cancer cells associated with tumors located deep with the body.

Purpose

The purpose of interstitial microwave thermal therapy is to damage and kill cancer cells associated with tumors that are deep within the body. Interstitial microwave therapy is a type of hyperthermia cancer treatment procedure (also called thermal therapy or thermotherapy) in which body tissue and the cancerous tumor are exposed to high temperatures (up to 113°F). Hyperthermia kills cancer cells with usually only minimal injury to normal tissues by damaging proteins and structures within the cells. Thermal therapy is usually used with other forms of cancer therapy, such as radiation and chemotherapy. The increased temperatures may make some cancer cells more sensitive to radiation or may harm some cancer cells that radiation cannot damage.

Precautions

If a patient has become insensitive to **pain** due to disease, radiation, surgery, anesthetics, or other conditions, hyperthermia treatment cannot be used to treat tumors. Also the excessive heating of normal surrounding tissue is prevented by normal blood perfusion, so hyperthermia should not be used in patients with known circulatory problems in the heated areas or in patients who are taking vasoconstrictive drugs.

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Description

Interstitial microwave thermal therapy is used to treat tumors that are deep within the body, such as brain, cervical, breast, prostate, and neck tumors. This technique allows the tumor to be heated to higher temperatures than external thermal therapy techniques allow. Probes or needles are inserted into the tumor, guided by the use of imaging techniques, such as ultrasound, to make sure that the probe is properly located within the tumor. A new type of microwave generator includes electronic phase control that allows the operator to electronically direct and shape the pattern of hyperthermia treatments based on the positioning the microwave antennae array that is used in treating the tumor. The treatment pattern can be electronically targeted on the tumor position, shape, and size.

Tissues are heated as the electromagnetic energy produced by the microwave treatment results in heating through molecular excitation. This energy is dissipated in normal living tissue by the blood that perfuses through the tissue. However, since large solid malignant tumors have less blood perfusion than the surrounding normal tissue, for a given absorbed thermal dose, the tumor reaches a higher temperature than the normal tissue. Tumors present within normal tissue will therefore be preferentially heated and will reach higher temperatures than the surrounding tissue.

As cancerous tumors grow rapidly, their need for blood quickly begins to exceed the available blood supply, and major portions of the tumors become blood-starved. These blood-starved tumors are resistant to both radiation and chemotherapy. Chemotherapy drugs carried through the blood cannot effectively penetrate tumors that have poor blood flow. Poor blood flow also means that the tumors are oxygen-starved (hypoxic), making it difficult for **radiation therapy** to make the oxygen radicals that are needed to destroy the DNA of cancer cells. Hypoxic cancer cells, which are an especially dangerous type of cancer, for they have a tendency to metastasize and spread the cancer to other parts of the body, are three times more resistant to ionizing radiation than are normal cells.

When the tumor is heated to **fever** levels through the use of microwave thermal therapy, its blood vessels expand so that more blood can flow into the tumor in order to carry away the excess heat. With the increased blood flow, more blood-borne chemotherapy drugs can be carried into the tumor. Blood is also the source of oxygen for tumors, so with increased blood flow due to the thermal therapy, radiation therapy can form the necessary oxygen radicals to kill the cancer cells. The increased temperature also acts as a drug activator, accelerating chemical reactions and pulling increased oxygen molecules into the tumor tissue for chemical reactions with the chemotherapy drug. **Hypothermia** also enhances the effectiveness of chemotherapy drugs encapsulated in liposomes, increasing the penetration of the drug into the tumor.

When tumors are heated to higher temperatures for at least an hour, the tumors in some cases have been shown to decrease in size and to exhibit necrosis (**death** of the tumor cells). Therefore, hyperthermia by itself also tends to shrink tumors, often dramatically, due to the collapse of dead cancer cells, making it easier to remove the tumor by surgical techniques. For tumors of the head and neck, a smaller tumor due to hyperthermia treatment may reduce the disfiguration associated with surgical removal of the tumor.

Hyperthermia is being studied as a means of enhancing **gene therapy** by acting as an activator to turn on new biological therapies, by speeding up gene production by thousands of times. In addition, hyperthermia is used as an essential tool to turn on antitumor vaccines that are based on heat shock proteins. Hyperthermia has been shown to prevent a cancererous tumor from growing new blood vessels to expand its blood supply. With regards to quality of life, hyperthermia lessens pain and stimulates the immune system, thus helping patients recover from toxic cancer therapies such as ionizing radiation and chemotherapy. Even in patients with terminal cancer, hyperthermia can provide benefits through the alleviation of bleeding, pain, and infection.

The use of hyperthermia alone and in conjunction with radiation therapy has been approved by the United States Food and Drug Administration for the treatment of advanced, recurrent, and persistent tumors, upon authorization of a licensed practitioner. When used with radiation, the treatment regimen usually consists of 10 hyperthermia treatments delivered twice a week, at 72 hour intervals. The prescribed radiation is administered within 30 minutes of the hyperthermia treatment. During each heat treatment, the temperature within the tumor is usually maintained at 42.5 °C for 60 minutes. The use of hyperthermia in conjunction with chemotherapy is presently investigational in the United States.

The effectiveness of treatment is related to the temperature achieved during the treatment process, the length of the treatment, and cell and tissue characteristics. The temperature within the tumor must be monitored to ensure that the appropriate temperature is achieved, but not exceeded, in the treatment area.

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KEY TERMS

Blood perfusion—A physiological term that refers to the process of nutritive delivery of arterial blood to a capillary bed in the biological tissue.

Hyperthermia therapy—A type of treatment in which body tissue is exposed to high temperatures to damage and kill cancer cells or to make cancer cells more sensitive to the effects of radiation and certain anticancer drugs.

Non-ionizing radiation—Rays of energy that move in long, slow wave patterns and do not penetrate cells.

Ionizing radiation—Any electromagnetic or particulate radiation capable of producing ions, directly or indirectly, in its passage through matter.

Monitoring is accomplished by inserting small needles or tubes with small thermometers into the treatment area. Imaging techniques such as computed tomography (CT) are used to make sure that the temperature probes are positioned appropriately.

Preparation

The safety and effectiveness of hyperthermia treatment is dependent on careful placement of the temperature probes and careful monitoring of tissue temperatures during treatment.

Aftercare

During the treatment period, which may last for weeks, the patient must be instructed in proper care of implanted catheters and temperature probe sites to avoid the risk of infection.

Risks

Excessive heating of normal tissues may result in areas of thermal aseptic necrosis that will require medical care. The electromagnetic radiation from the microwave equipment can interfere with electronic devices such as cardiac **pacemakers** or other implanted electronic devices. Thermal treatment of tumors in the neck or head may result in inadvertent heating of thermoregulatory centers in the brain stem, thus resulting in overheating of the body, beyond levels that the patient can tolerate. Metallic implants, such as joint protheses or dental braces may become excessively and preferentially overheated and adversely affect the patient.

Normal results

The effectiveness of interstitial microwave thermal therapy varies among cancer patients. For example, studies have shown in Phase III clinical trials, when hyperthermia was used with ionizing radiation treatment, that the following treatment improvements were seen, as compared to the use of ionizing radiation therapy alone:

- complete response for recurrent breast cancer increased from 38% to 60%
- 2-year survival for globlastoma (brain cancer) increased from 15% to 31%
- complete response for advanced cervical cancer increased from 57% to 83%

Known side effects of hypothermia are associated with direct effects of heat on tissues and indirect effects of tumor necrosis. These side effects, as determined in various medical studies, include:

- surface burns and blistering in the area of application of heat by the microwave applicators; experienced in about 10% of the tumor sites studied.
- localized and temporary pain in the area of and during the delivery of the heat by the microwave applicators; experienced in about 8% of the tumor sites studied.
- ulceration from rapid tumor necrosis following successful hyperthermia treatment, resulting in fever from toxemia and patient discomfort through drainage and bleeding; experienced in about 4% of the tumor sites studied.
- local and systematic (rarely) infections from placement of the temperature probes and from ulceration related to tumor necrosis; experienced in about 2% of the tumor sites studied.

Abnormal results

Hyperthermia has the potential for producing the following adverse reactions as a result of exposure to electromagnetic radiation:

- cataracts
- permanent or temporary male sterility
- exacerbation of existing diseases due to additional systemic stress
- enhanced drug activity
- thermal stress

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ORGANIZATIONS

Society for Thermal Medicine, PO Box 1897, Lawrence, KS, 66044-1897, 785 843-1274, 800 627-0326, stm@ allenpress.com, http://www.thermaltherapy.org.

Judith L. Sims

Intestinal culture *see* **Stool culture**

Intestinal lymphangiectasia *see* **Malabsorption syndrome**

Intestinal obstructions

Definition

Intestinal obstructions, sometimes also called bowel obstructions, refers to the partial or complete mechanical or non–mechanical blockages of fluids or foods of the small or large intestine (which includes the colon, cecum, and rectum). When such obstructions occur, they can lead to reduced or blocked passage of digested materials through the intestines. They are often caused by intestinal **adhesions**, hernias, or tumors.

Demographics

The disorder occurs in people of all ages, genders, and ethnic backgrounds.

Description

There are two types of intestinal obstructions, mechanical and non–mechanical. Mechanical obstructions occur because the bowel (intestines) is physically blocked and its contents cannot get past the obstruction. Mechanical obstructions can occur for several reasons. Sometimes the bowel twists on itself (volvulus) or telescopes into itself (**intussusception**). Mechanical obstruction can also result from hernias, impacted feces, abnormal tissue growth, the presence of foreign bodies in the intestines (including **gallstones**), or inflammatory bowel disease (**Crohn's disease**). Non–mechanical obstruction, called **ileus**, occurs because the wavelike muscular contractions of the intestine (peristalsis) that ordinarily move food through the digestive tract stop.

Mechanical obstruction in infants

Infants under one year of age are most likely to have intestinal obstruction caused by meconium ileus, volvulus, and intussusception. Meconium ileus, which is the inability to pass the first fecal excretion after birth (meconium), is a disorder of newborns. It is an early clue that the infant has **cystic fibrosis**, but may also occur in very low birth weight (VLBW) infants. In meconium ileus, the material that is blocking the intestine is thick and stringy, rather than the collection of mucus and bile that is passed by normal infants. The abnormal meconium must be removed with an enema or through surgery.

Volvulus is the medical term for twisting of either the small or large bowel. The twisting may cut off the blood supply to the bowel, leading to tissue **death** (**gangrene**). This development is called a strangulating obstruction.

In intussusception, the bowel telescopes into itself like a radio antenna folding up. Intussusception is most common in children between the ages of three and nine months, although it also occurs in older children. Almost twice as many boys suffer intussusception as girls. It is, however, difficult for doctors to predict which infants will suffer from intestinal obstruction.

Mechanical obstruction in adults

Obstructions in adults are usually caused by tumors, trauma, volvulus, the presence of foreign bodies such as gallstones, or hernias, although they have also been reported in adults with cystic fibrosis. Volvulus occurs most often in elderly adults and psychiatrically disturbed patients. Intussusception in adults is usually associated with tumors in the bowel, whether benign or malignant.

More recently, gastroenterologists have described a postsurgical complication known as early postoperative small bowel obstruction, or EPSBO. Although this condition was at one time confused with postoperative ileus, it is now known to be caused by mechanical obstructions resulting from **radiation therapy** for **cancer** or laparoscopic surgery. Most cases can be successfully treated within 10–14 days of surgery.

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Causes and symptoms

Causes

Causes of intestinal obstructions can be subdivided into two primary groups: small bowel obstruction and large bowel obstruction. Causes of small bowel obstruction include:

- adhesions (usually from abdominal surgery, but sometimes present at birth)
- hernias (protrusion of intestines through cavity that contains it)
- Crohn's disease (inflammatory disease of the intestines)
- neoplasm (abnormal growth of tissue mass)
- intussusception (layering [telescoping] of sections of intestines within other sections, children only)
- volvulus (abnormal twist in bowel)
- superior mesenteric artery syndrome (compression of part of duodenum by abdominal aorta and superior mesenteric artery)
- intestinal atresia (narrowing or absence of part of intestine)
- carcinoid (neuroendocrine tumor)
- foreign bodies (such as gall stones or swallowed objects)
- ischaemic stricture (abnormal narrowing of intestines usually at outlet from stomach)

Large bowel obstruction can be caused by the following:

- neoplasm
- hernias
- cancer
- inflammatory bowel disease (inflammation of the colon)
- diverticulitis (small pouches in digestive tract become inflamed or infected)
- colonic volvulus (twist in colon)
- fecal impaction (blocked, impacted feces in rectum)
- intestinal atresia
- endometriosis (uterine tissue found outside of uterus, in women only)

Almost all of the causes of intestinal obstructions occur in the small intestines rather than the large intestines.

Symptoms

One of the earliest signs of mechanical intestinal obstruction is abdominal **pain** or cramps that come and go in waves. Infants typically pull up their legs and cry in pain, then stop crying suddenly. They will then behave normally for as long as 15–30 minutes, only to start crying again when the next cramp begins. The cramping results from the inability of the muscular contractions of the bowel to push the digested food past the obstruction.

Vomiting is another symptom of intestinal obstruction. The speed of its onset is a clue to the location of the obstruction. **Vomiting** follows shortly after the pain if the obstruction is in the small intestine but it is delayed if found in the large intestine. The vomited material may be fecal in character. When the patient has a mechanical obstruction, the doctor will first hear active, high–pitched gurgling and splashing bowel sounds while listening with a stethoscope. Later these sounds decrease, and then stop. If the blockage is complete, the patient will not pass any gas or feces. If the blockage is only partial, however, the patient may have **diarrhea**. Initially there is little or no **fever**.

When the material in the bowel cannot move past the obstruction, the body reabsorbs large amounts of fluid and the abdomen becomes sore to the touch and swollen. The balance of certain important chemicals (electrolytes) in the blood is upset. Persistent vomiting can cause the patient to become dehydrated. Without treatment, the patient can suffer **shock** and kidney failure.

Strangulation occurs when a loop of the intestine is cut off from its blood supply. Strangulation occurs in about 25% of cases of small bowel obstruction. It is a serious condition that can progress to gangrene within six hours.

Risks

The following pre–existing conditions can add to the risk of contracting intestinal obstructions:

- Crohn's disease
- abdominal or pelvic surgeries
- long–lasting constipation
- malrotation (congenital condition in which intestines do not develop normally)

If someone has advanced intestinal obstruction of one type or the other, certain symptoms will be apparent due to infection within the lining of the abdominal cavity (a condition known as **peritonitis**). These symptoms include:

- tenderness, pain, and swelling in abdominal area
- thirst, but low urine output
- fluid in abdomen
- vomiting and nausea

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KEY TERMS

Electrolytes—Salts and minerals that ionize in body fluids. Electrolytes control the body's fluid balance as well as performing other important functions.

Gangrene—The death of soft tissue in any part of the body when the blood supply is obstructed.

Ileus—Obstruction of the intestines caused by the absence of peristalsis.

Intussusception—The slipping or telescoping of one part of the intestine into the section next to it.

Meconium—A greenish fecal material that constitutes the first bowel movement of an infant.

Peristalsis—The waves of muscular contraction in the intestines that push the food along during the process of digestion.

Strangulated obstruction—An obstruction in which a loop of the intestine has its blood supply cut off.

Volvulus—A twisting of the intestine that causes an obstruction.

- fever and chills
- inability to pass gas or have a bowel movement

When advanced peritonitis occurs, more severe symptoms occur. They include:

- weak, rapid pulse
- either abnormally slow, shallow breathing or rapid breathing
- pale, clammy skin
- inability to pass gas or have a bowel movement
- dilated pupils in the eyes
- eyes that stare off into the distance

If such symptoms occur, the patient has most likely gone into shock, and immediate emergency care should be sought.

Diagnosis

Imaging studies

If the doctor suspects intestinal obstruction based on the **physical examination** and patient history, he or she will order x rays, a computed tomography scan (CT scan), or an ultrasound evaluation of the abdomen. In many cases the patient is given a **barium enema**. A suspension of barium sulfate, which is a white powder, is inserted through the rectum, and the intestinal area is photographed. Barium acts as a contrast material and allows the location of the obstruction to be visualized on film.

Laboratory tests

The first blood test of a patient with an intestinal obstruction usually gives normal results, but later tests indicate electrolyte imbalances. There is no way to determine if an obstruction is simple or strangulated except by performing surgery.

Treatment

Initial assessment

All patients with suspected intestinal obstruction are hospitalized. Treatment must be rapid, because strangulating obstructions can be fatal. The first step in treatment is inserting a nasogastric tube to suction out the contents of the stomach and intestines. The patient is then given intravenous fluids to prevent **dehydration** and correct electrolyte imbalances.

Nonsurgical approaches

Surgery can be avoided for some patients. In some cases of volvulus, guiding a rectal tube into the intestines will straighten the twisted bowels. In infants, a barium enema may reverse intussusception in 50–90% of the cases. An air enema is sometimes used instead of a barium enema. This treatment successfully relieves the obstruction in many infants. The children are usually hospitalized for observation for two to three days after these procedures. In patients with only partial obstruction, a barium enema may dissolve the blockage.

Surgical treatment

If these efforts fail, surgery is necessary. Strangulated obstructions require emergency surgery. The obstructed area is removed and part of the bowel is cut away. If the obstruction is caused by tumors, polyps, or scar tissue, they are removed. Hernias, if present, are repaired. **Antibiotics** are given to reduce the possibility of infection.

Alternative treatment

Alternative practitioners offer few suggestions for treatment. They focus on preventive strategies,

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particularly the use of high–fiber **diets** to keep the bowels healthy through regular elimination.

Prognosis

The prognosis for intestinal obstructions depends on age, previous illnesses (especially lung, heart, or kidney problems), and the specific cause of the obstruction within the intestines. Generally, healthy people have good prospects. However, when intestinal obstructions are associated with cancer, the prognosis is not as favorable.

Mortality

Untreated intestinal obstructions can be fatal. Delayed diagnosis of volvulus in infants has a mortality rate of 23–33% with prompt diagnosis and treatment the mortality rate is three to nine percent. The bowel either strangulates or perforates, causing massive infection. Tissues within the intestines soon die, which leads to perforation of the intestines and infection. The patient eventually goes into shock. With prompt treatment, however, most patients recover successfully without complications.

Recurrence

As many as 80% of patients whose volvulus is treated without surgery have recurrences. Recurrences in infants with intussusception are most likely to happen during the first 36 hours after the blockage has been cleared. The mortality rate for unsuccessfully treated infants is one to two percent.

Prevention

Most cases of intestinal obstruction are not preventable. Surgery to remove tumors, polyps, or gallstones helps prevent recurrences. Other medical treatments and therapies may help to reduce the risk from many forms of intestinal obstructions.

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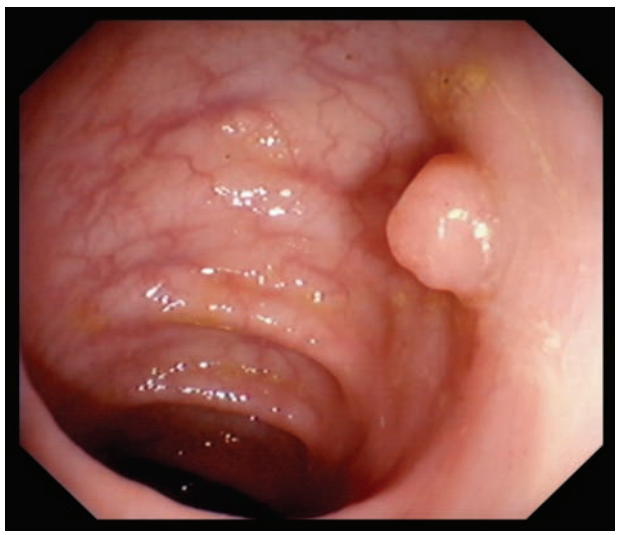
Intestinal polyps

Definition

The word polyp refers to any overgrowth of tissue from the surface of mucous membranes. Intestinal polyps, sometimes also called colorectal polyps (or sometimes just colon polyps), grow out of the lining of the small and large bowels (intestines). Polyps come in a variety of shapes—round, droplet, and irregular being the most common. They also come in many sizes, from those smaller than a pea to others as large as a golf ball. Most are harmless but in a small percentage of cases they can become cancerous (colorectal **cancer**, or



A benign polyp in a patients colon, viewed through an endoscope. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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cancers of the colon and rectum) and dangerous to one's health and well–being, especially as one grows older.

Demographics

Intestinal polyps can occur in anyone, regardless of age or other characteristics. However, as one ages the likelihood of developing them increases. In fact, 50 years of age and older is the time when polyps are more likely to develop in humans. The risks from intestinal polyps can be reduced by eating a high–fiber, low–fat diet. A family history of intestinal polyps also increases one's risk of getting them.

The National Cancer Institute (NCI) predicted that about 102,900 new cases of **colon cancer** and approximately 39,670 new cases of **rectal cancer** would occur in the United States in 2010. In addition, NCI predicted that, in the same year, about 51,370 deaths would occur because of colon and rectal cancers (or, colorectal cancer).

Description

Polyps are one of many forms of tissue overproduction that can occur in the body. Cells in many body tissues sometimes keep growing beyond their usual limits. Medical scientists call this process *neoplasia*, which means simply "new growth." An individual overgrowth is called a neoplasm. In most cases these growths are limited, and the result is a benign swelling or mass of cells called a tumor. If the new growth occurs on the surface of the tissue instead of inside an organ it is often called a polyp. Cancer is another type of neoplasm marked by unlimited tissue growth. The essential feature that distinguishes cancer from nonmalignant neoplasms is that it does not stop growing.

Intestinal polyps are a common form of neoplasm. All intestinal polyps arise from the inner lining of the intestinal wall. This layer of mucosal tissue does the work of digestion. About 30% of the general population will develop intestinal polyps at some point in life, with the likelihood increasing with age. Most of these polyps are never noticed during a person's lifetime because they do not cause problems. They are often discovered accidentally at **autopsy**. The primary importance of intestinal polyps is that one percent of them become cancerous. Because the polyps that eventually turn malignant cannot be identified in advance, they are all suspect.

Location of intestinal polyps

The chances of a polyp's becoming cancerous depend to some extent on its location within the digestive tract.

COLON. Ninety–five percent of all intestinal polyps develop inside the large bowel. Several hereditary diseases produce large numbers of intestinal polyps. These disorders include:

- Familial polyposis of the colon.
- Gardner's syndrome.
- Lynch's syndrome.
- Turcot's syndrome.
- Peutz–Jeghers syndrome.
- Juvenile polyposis.

All of these disorders are inherited in an autosomal dominant pattern. This pattern means that the disorders are not sex–linked and that a child can inherit the disorder from either parent. In all of these hereditary disorders, the intestinal polyps appear during or after **puberty**. The first four diseases on the list have such a high rate of cancer of the large bowel (colon)—virtually 100% by the age of 40 years of age—that persons diagnosed with any of them should have the colon removed surgically in early adulthood.

STOMACH. The stomach's lining is host to polyps of a similar appearance, but there is no agreement as to their potential for becoming **stomach cancer**.

SMALL INTESTINE. Polyps in the small bowel do not seem to have malignant potential. Instead, they can produce obstruction in either of two ways. A large polyp can obstruct the bowel by its sheer size. Smaller polyps can be picked up by the rhythmic contractions (peristalsis) of the intestines and pull the part of the bowel to which they are attached into the adjoining section. The result is a telescoping of one section of bowel into another, called **intussusception**.

Causes and symptoms

Population studies of colon cancer suggest that age and diet play an important role in the disease, and, by implication, in the formation of colon polyps. Increased risk of colon cancer begins at the age of 40 years. Most people who have colon cancer are in their 50s or older. The most consistent interpretation of colon cancer data is that animal fats—though not vegetable fats—are the single most important dietary factor the raises the risk of colon polyps. Lack of fiber in the diet may also contribute to polyp formation. Primarily, a person is at elevated risk for colon polyps if their diet consists of high fat, high percentage of red meat, and low fiber.

A family history of colon polyps or cancer also is a factor. The presence of inflammatory intestinal conditions, such as **Crohn's disease** and ulcerative **colitis**, also increases the risk of colon polyps. African Americans and Ashkenazi Jews of Eastern European descent are two groups of people with higher risk for colon cancer.

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KEY TERMS

Autosomal dominance—A pattern of heredity in which a trait is inherited without respect to sex and from either parent. The hereditary diseases associated with intestinal polyps are all autosomal dominant.

Colectomy—Surgical removal of the large bowel.

Intussusception—The slipping of one section of the intestine inside an adjoining section. Intussusception can be caused by small intestinal polyps.

Mucosal—Refers to tissues that produce mucus, such as the digestive, genital and urinary tracts.

Neoplasm—A new growth of abnormal tissue.

Peristalsis—The rhythmic contractions of muscular tubes like the intestines that carry the contents along the tube.

Sigmoid—The S–shaped curve of the large intestine where the colon joins the rectum.

Lifestyle and the environment are also factors. Increased risk occurs when a person smokes tobacco products, drinks alcoholic beverages, and is obese (excessively overweight). In fact, smokers are approximately 20% more likely to develop colon polyps than are non–smokers. The more inactive one's lifestyle is, the more likely one will develop colon cancer. Exposure to carcinogenic substances (those known to cause cancer), such as asbestos, increases risks for colon cancer.

Three primary types of colon polyps occur: adenomatous polyps (most polyps are of this kind, but only a few become cancerous); hyperplastic polyps (second most frequent polyps, and they often occur in left colon and rectum); and inflammatory polyps (usually occur after ulcerative colitis or Crohn's disease). Most smaller sized polyps do not cause symptoms. However, larger ones eventually cause intestinal obstruction, which produces cramping abdominal **pain** with **nausea and vomiting**. As colon polyps evolve into cancers, they begin to produce symptoms that include rectal bleeding, blood in the stool, and altered bowel habits (including **constipation**, **diarrhea**, or narrowing of the stool).

Rectal bleeding may occur after a bowel movement. Such bleeding may be due to colon polyps, but may also be the result of **hemorrhoids** or minor tears in the anus. Blood in the stool, which may show up as red streaks within the stool or turn the stool black, can be an indication of colon polyps, but they may also be the result of eating red–colored foods (red streaks in the stool) or iron supplements and various anti–diarrhea medications (black stool). A change in bowel conditions can indicate the presence of colon polyps but can also be the result of other unrelated medical conditions.

Diagnosis

Routine screening for bowel cancer is recommended for everyone over the age of 50 years, and for those with a history of colorectal cancer over the age of 40 years. Medical professionals can test for some diseases that increase the risk for colorectal cancer, such as familial adenomatous polyposis (FAP) which increases one's risk for developing multiple colon polyps. Screening may be as simple as testing the stool for blood (such as through a **fecal occult blood test** [FOBT]) or as elaborate as **colonoscopy**. The FOBT is a noninvasive test that is often performed at the doctor' office or at home. Although it tests only for blood in the stool, the FOBT is a good beginning point for diagnosis.

A stool DNA test detects cancer cells that are present in the stool. Such cancer cells will have altered DNA, which makes this test advantageous for detecting pre–cancerous polyps and colon cancer. As of July 2010, this test has not been approved by the U.S. Food and Drug Administration (FDA).

Most polyps are in the lower segment of the colon, called the sigmoid colon. These polyps can be seen with a shorter scope (tube) called a flexible sigmoidoscope. Flexible **sigmoidoscopy** is a procedure that uses a narrow, lighted tube to examine the rectum and sigmoid (the last third of the colon). A **barium enema** is a diagnostic tool that evaluates the entire large intestine with a barium dye placed inside the colon and an x–ray image. The colon is filled with barium sulfate (a white substance) that shows up as a shadow when imaged by an x–ray film. The colon can also be filled with barium sulfate and air, which is called a double contrast study.

Colonoscopy is a procedure in which the doctor threads an instrument called a colonoscope up through the entire large bowel. The colonoscope is a long, narrow tube attached to a video camera (for imaging inside the colon) and monitor (for viewing outside by the medical team). If one or more polyps are discovered during the examination, they can be removed. Computerized tomographic colonography (CTC) is a colonoscopy that is performed virtually (that is, without actually inserting an instrument inside the colon). It involves a

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computerized tomography scan of the colon. This three–dimensional look of the colon allows the medical professionals to make a detailed analysis of the colon. However, for this technique, any polyps discovered are not able to be removed.

Because polyps take about ten years to turn into cancers, routine examinations are recommended every three to five years.

Treatment

All polyps should be removed as preventive care. Most of them can be taken out through a colonoscope, in which the larger polyps are snared with a wire loop and the smaller ones are cauterized with an electrical current. Complications like obstruction and intussusception are surgical emergencies. The largest of the polyps can be removed with laparoscopic techniques, in which small incisions are cut into the abdominal wall so tiny instruments can be used to remove such polyps. Endoscopic mucosal resection (EMR) is a specialized procedure for removing large polyps with a colonoscope. The polyp is separated from other tissue with an injected liquid so the procedure can take place.

Chemotherapy, radiation, or a combination of the two is also used to treat colorectal cancer. In serious cases, parts of the colon may have to be removed. In more severe cases, a total proctocolectomy is performed, one in which all of the colon and rectum is removed.

Prognosis

Patients with intestinal polyps have an excellent outlook for the future once the polyps are removed. However, polyps left within the intestines can develop into cancer over time.

Prevention

Patients with hereditary disorders associated with polyps must undergo total colectomy early in adult life. All children of parents with these disorders should be screened early in adulthood, because half of them will have the same disease. For the bulk of the population, increased consumption of dietary fiber and decreased consumption of animal fat are the best preventives known at present. For the occasional intestinal polyp that arises in spite of good dietary habits, routine screening should prevent it from becoming cancerous.

Overall, the following are recommended to reduce the chances of developing colon polyps:

- Consume calcium and vitamin D, such as in no–fat or low–fat milk and other dairy products; some fish, and vitamin supplements.
- Consume fruits and vegetables, especially those high in antioxidants; those with deep green, dark yellow, dark orange colorings, such as squash, sweet potatoes, spinach, and broccoli; and those with lycopene such as tomatoes and red bell peppers and others with red colorings.
- Eat whole grains, such as those found in breads.
- Reduce unhealthy fats such as saturated fats and trans fats to less than 10% per day and total fats to less than 30% daily. When eating fats, select healthy ones such as unsaturated fats (monounsaturated and polyunsaturated fats).
- Limit alcohol consumption to one drink per day for women and two drinks per day for men.
- Stop using tobacco products such as cigarettes.
- Be as physically active as possible.
- Maintain a healthy mass to body index (BMI).

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Intestinal strangulation *see* **Intestinal obstructions**

Intoxication confusional state *see* **Delirium**

Intracavity therapy *see* **Radioactive implants**

Intracranial abscess *see* **Brain abscess**

Intrapartum monitoring *see* **Electronic fetal monitoring**

Intrauterine device *see* **IUD**

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Intrauterine growth retardation

Definition

Intrauterine growth retardation (IUGR) occurs when the unborn baby (fetus) is at or below the 10th weight percentile for his or her gestational age (in weeks). In other words, the unborn baby is developing poorly (more slowly then normal) within the womb. After being born, these babies usually have low weights and are likely to continue having health problems later in life.

Description

There are standards or averages in weight for unborn babies according to their age in weeks. When the baby's weight is at or below the 10th percentile for his or her age, it is called intrauterine growth retardation, or fetal growth restriction. These babies are smaller than they should be for their age. How much a baby weighs at birth depends not only on how many weeks old it is, but the rate at which it has grown. This growth process is complex and delicate. There are three phases associated with the development of the baby. During the first phase, cells multiply in the baby's organs. This occurs from the beginning of development through the early part of the fourth month. During the second phase, cells continue to multiply and the organs grow. In the third phase (after 32 weeks of development), growth occurs quickly and the baby may gain as much as seven ounces (200 grams) per week. If the delicate process of development and weight gain is disturbed or interrupted, the baby can suffer from restricted growth.

IUGR is usually classified as symmetrical or asymmetrical. In symmetrical IUGR, the baby's head and body are proportionately small. In asymmetrical IUGR, the baby's brain is abnormally large when compared to the liver. In a normal infant, the brain weighs about three times as much as the liver. In asymmetrical IUGR, the brain can weigh five or six times as much as the liver.

Causes and symptoms

Doctors think that the two types of IUGR may be linked to the time during development that the problem occurs. Symmetrical IUGR may occur when the unborn baby experiences a problem during early development. Asymmetrical IUGR may occur when the unborn baby experiences a problem during later development. While not true for all asymmetrical cases, doctors think that sometimes the placenta may allow the brain to get more oxygen and **nutrition** while the liver gets less.

There are many IUGR risk factors involving the mother and the unborn baby. A mother is at risk for having a growth restricted infant if she:

- Has had a previous baby who suffered from IUGR
- Has poor weight gain and lack of nutrition (malnutrition) during pregnancy
- Is socially deprived
- Uses substances (like tobacco, narcotics, alcohol, and some prescription drugs, such as anticonvulsants) that can cause abnormal development or birth defects
- Has a vascular disease (like chronic hypertension [high blood pressure], preeclampsia [hypertension during pregnancy], or heart disease)
- Has chronic kidney disease
- Has sickle cell anemia
- Has a coagulation/antibody disorder called antiphospholipid antibody syndrome that causes blood clots
- Has a serious lung disease
- Has a low total blood volume during early pregnancy
- Is pregnant with more than one baby (multiple pregnancies)

A mother that is very small in size (weight) is more likely to have a fetus that is underweight when compared to normally sized unborn babies. Such a situation is not always caused by IUGR. About one out of three babies born smaller than normal have IUGR, while the other two are born smaller usually because the mother is smaller herself.

Additionally, an unborn baby may suffer from IUGR if it has:

- Exposure to an infection, including German measles (rubella), cytomegalovirus, tuberculosis, syphilis, or toxoplasmosis
- A defect in the kidneys, abdominal wall, or in the cardiovascular system
- A chromosome defect, especially trisomy 18 (Edwards' syndrome), Down syndrome, or anencephaly (missing parts of the brain)
- A primary disorder of bone or cartilage
- A chronic lack of oxygen during development (hypoxia), such as from living at high altitudes
- Placenta or umbilical cord defects such as placenta previa (placenta too low in uterus) or placental abruption (placenta detaching from uterus)
- Developed outside of the uterus.

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KEY TERMS

Preeclampsia—Hypertension (high blood pressure) during pregnancy.

Diagnosis

IUGR can be difficult to diagnose and in many cases doctors are not able to make an exact diagnosis until the baby is born. A mother who has had a growth–restricted baby is at risk of having another during a later **pregnancy**. Such mothers are monitored closely during pregnancy. The length in weeks of the pregnancy must be carefully determined so that the doctor will know if development and weight gain are appropriate.

Checking the mother's weight and abdomen measurements can help diagnose cases when other risk factors are not present. Measuring the girth of the abdomen is often used as a tool for diagnosing IUGR. During pregnancy, the healthcare provider will use a tape measure to record the height from the pubic bone to the top of the uterus (the uterine fundal height, in centimeters).

As the pregnancy continues and the baby grows, the uterus stretches upward in the direction of the mother's head. Between 18 and 30 weeks of gestation, the uterine fundal height equals the weeks of gestation. For example, if the mother is 26 weeks pregnant, then the fundal height should be about 26 centimeters. If the uterine fundal height is more than two to three centimeters below normal, then IUGR is suspected. Ultrasound is used to evaluate the growth of the baby. Usually, IUGR is diagnosed after week 32 of pregnancy. This is during the phase of rapid growth when the baby should be gaining more weight. IUGR caused by genetic factors or infection may sometimes be detected earlier.

Treatment

Treatment is not available that improves fetal growth, but IUGR babies who are at or near term have the best outcome if delivered promptly. If IUGR is caused by a problem with the placenta and the baby is otherwise healthy, early diagnosis and treatment of the problem may reduce the chance of a serious outcome. Pregnant women suspected of carrying a fetus with IUGR will be monitored closely with several ultrasounds during the course of the pregnancy.

Measurements of movement, blood flow, growth, and fluid surrounding the fetus, will be carefully taken. Fetal monitoring is one test that indicates the health of a fetus. **Amniocentesis**, where a tiny amount of amniotic fluid is withdrawn from the uterus, is a way to test for chromosomal abnormalities.

A fetus that cannot tolerate the **stress** of natural labor may be delivered by **cesarean section** (c–section).

Prognosis

Babies who suffer from IUGR are at an increased risk for intrauterine (inside the womb) **death**, stress during vaginal delivery, abnormally high red blood cell count, low blood sugar (**hypoglycemia**), low body temperature (**hypothermia**), lower resistance to infection, difficulty maintaining body temperature, and abnormal development of the nervous system. These risks increase with the severity of the growth restriction. The growth that occurs after birth cannot be predicted with certainty based on the size of the baby when it is born. Infants with asymmetrical IUGR are more likely to catch up in growth after birth than are infants who suffer from prolonged symmetrical IUGR.

However, doctors cannot reliably predict an infant's future progress. Each case is unique. Some infants who have IUGR will develop normally, while others will have complications of the nervous system or intellectual problems like **learning disorders**. If IUGR is related to a disease or a genetic defect, the future of the infant is related to the severity and the nature of that disorder. Generally, most IUGR babies will attain a normal weight and height within two years of birth.

Prevention

The risk factors that can complicate pregnancies should be strictly controlled. Avoid alcohol, tobacco products, and drugs that are not part of the pregnancy. Make sure that regular prenatal care is obtained from medical professionals.

Movement of the unborn baby inside the mother is a reliable way to indicate its general health. A healthy baby moves and kicks often. Your caregiver may request a fetal kick count in between prenatal appointments to check on the number of kicks. A baby that has moved frequently in the past but has stopped kicking may be a sign of a problem. In such cases, call the pediatrician or other medical profession caring for the mother and baby.

The more nutrients that the mother takes in means the more nutrients for the unborn baby. Eat healthy

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foods and always go by the amount of calories recommended by the doctor. Plenty of rest is essential. At least eight hours of sleep each night should be taken by the mother, and naps during the day are also helpful.

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Linda Jones

Intravenous nutrition *see* **Nutrition through an intravenous line**

Intravenous pyelography *see* **Intravenous urography**

Intravenous rehydration

Definition

Rehydration is the process of replenishing the human body with water, or water and electrolytes, which have been previously lost through **dehydration**. This process can be performed orally or intravenously. With mild dehydration, oral rehydration is usually used. However, for more severe cases, which can cause serious and permanent injury or even **death**, intravenous rehydration is the method of choice within the medical community. For the method of intravenous (IV) rehydration, a sterile water solution containing small amounts of salt or sugar (and usually essential **minerals** and **vitamins**), are injected into the body through a tube attached to a needle, which is inserted into a vein.

Purpose

Fever, **vomiting**, and **diarrhea** can cause a person to become dehydrated fairly quickly. Infants and children are especially vulnerable to dehydration because of their smaller body weights and of a higher turnover of water and electrolytes, and due to their increased susceptibility to sicknesses such as those involving **vomiting** and diarrhea. Adult patients can become dehydrated due to an illness, surgery, or accident. Athletes, who have overexerted themselves and, thus, become dehydrated, may also require rehydration with IV fluids. An IV for rehydration can be used for several hours to several days, and is generally used if a patient cannot drink fluids.

Precautions

Patients receiving IV therapy need to be monitored to ensure that the IV solutions are providing the correct amounts of fluids and minerals needed. People with kidney and heart disease are at increased risk for **overhydration**, so they must be carefully monitored when receiving IV therapy.

Demographics

Because dehydration is common throughout the human population, intravenous rehydration may be used on any persons in need of such medical treatment. Infants and children, due to their young age, are at greater risk of becoming dehydrated. Adults recovering from surgeries and those that are sick are also vulnerable for dehydration. Athletes that overexert themselves may also become dehydrated. Hot weather, accidents, and medical problems can also cause a person to become dehydrated.

Description

Basic IV solutions are sterile water with small amounts of **sodium** chloride (salt) or dextrose (sugar) supplied in bottles or thick plastic bags that can hang on a stand mounted next to the patient's bed. Additional minerals like potassium, phosphate, magnesium, chloride, **calcium**, vitamins, or drugs can be added to the IV solution by injecting them into the bottle or bag with a needle.

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Risks

There is a small risk of infection at the injection site. It is possible that the IV solution will not provide all of the nutrients needed, leading to a deficiency or an imbalance. If the needle becomes dislodged, it is possible that the solution may flow into tissues around the injection site rather than into the vein.

Causes and symptoms

Initial symptoms of dehydration that indicate the possible need for intravenous rehydration include:

- Headache
- Flushing in the face
- Dry, warm skin
- Muscle cramps, especially in the legs and arms
- Lower than normal, and sudden decrease, in blood pressure
- Dizziness or fainting when standings
- Abnormal thirst or the inability to drink
- Decreased urine output and unusually dark yellow-colored urine
- Tiredness, weakness, sleepiness, lethargic
- Irritability, confusion
- Dry mouth, dry tongue with thick saliva

More serious symptoms of dehydration that indicate a more critical need for intravenous rehydration include:

- Low blood pressure
- Delirium
- Unconsciousness/comotose
- Swelling of the tongue
- No urine output
- Lethargy or extreme sleepiness
- Fainting
- Rapid, deep breathing
- Weak, fast pulse
- Severe muscle contractions, especially in the arms, legs, back, and stomach
- Bloated stomach
- Dry eyes, sunken look to eyes
- Wrinkly look to skin, a lost firmness (elasticity) to the skin

Diagnosis

Anyone who exhibits signs and symptoms of moderate to severe dehydration should be taken promptly to an emergency medical professional for appropriate care. At the medical facility, the team will observe for physical characteristics as to indicate low blood pressure, rapid heart rate, appearance of **shock**, poor skin features (lack of elasticity), delayed capillary refill (rate at which blood refills capillaries), and other such signs that indicate dehydration.

Tests that may be performed to indicate moderate to severe dehydration include: **complete blood count** (CBC), creatinine, blood urea nitrogen (BUN), urine specific gravity, and various blood chemistries (such as those indicating sodium, bicarbonate, and potassium).

KEY TERMS

Intravenous—Into a vein; a needle is inserted into a vein in the back of the hand, inside the elbow, or some other location on the body. Fluids, nutrients, and drugs can be injected.

Treatment

Moderate and (especially) severely dehydrated persons should be initially treated by emergency personnel. Take such people to an emergency room at the hospital or other such facility where immediate emergency care can be given. The person should receive intravenous rehydration with salts and fluids through the vein (intravenously) because such a method provides a fast way to introduce water and essential nutrients into the body. This is especially important in life-threatening situations.

Preparation

A doctor orders the IV solution and any additional nutrients or drugs to be added to it. The doctor also specifies the rate at which the IV will be infused. The IV solutions are prepared under the supervision of a doctor, pharmacist, or nurse, using sanitary techniques that prevent bacterial contamination. Just like a prescription, the IV is labeled clearly to show its contents and the amounts of any additives. The skin around the area where the needle is inserted is cleaned and disinfected. Once the needle is in place, it will be taped to the skin to prevent it from dislodging.

The vein usually used are those in the arm, however, those veins in the back of the hand or the median cubital vein on the inside of the elbow can also be used. Generally, any appropriate vein can be used.

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Aftercare

Patients need to take fluids by mouth before an IV solution is discontinued. After the IV needle is removed, the site should be inspected for any signs of bleeding or infection.

Prognosis

People with mild to serious dehydration will usually recover when they are given intravenous rehydration promptly and effectively at the first signs of being dehydrated. However, seizures, permanent brain damage and, even, death can result to people who are not given such treatment.

Prevention

To prevent the need for intravenous rehydration, make sure the body is properly hydrated. Consume plenty of fluids on a daily basis, along with foods that are high in water content such as fruits and vegetables. When exercising or performing other strenuous activities, make sure sufficient water is consumed before, during, and after such events. If a person is overly sweating and feels overheated during hot conditions, stop all activity and rest in a shady area to lower the body temperature. Drink fluids to replace any that have been lost. However, do not consume too much water because such a condition can also cause problems.

Fluids can be lost in the body in cold weather, not only in hot weather. **Exercise** or strenuous activity in cold weather, while wearing insulated clothing, can cause sweating and, thus, lost of hydration in the body. Even conditions inside involving very low humidity can contribute to a person's losing moisture within the body. In addition, locations of high altitudes, usually over 8,200 feet, or 2,500 meters, can cause a body to need more fluids.

During illnesses, such as those that include vomiting or diarrhea, make sure water or other fluids that can replenish lost electrolytes are taken promptly and regularly.

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Altha Roberts Edgren

Intravenous urography

Definition

Intravenous urography is a test which x rays the urinary system using intravenous dye for diagnostic purposes.

Of the many ways to obtain images of the urinary system, the intravenous injection of a contrast agent has been traditionally considered the best. The kidneys excrete the dye into the urine. X rays can then create pictures of every structure through which the urine passes.

The procedure has several variations and many names.

- Intravenous pyelography (IVP).
- Urography.
- Pyelography.
- Antegrade pyelography differentiates this procedure from "retrograde pyelography," which injects dye into the lower end of the system, therefore flowing backward or "retrograde." Retrograde pyelography is better able to define problems in the lower parts of the system and is the only way to get x rays if the kidneys are not working well.
- Nephrotomography is somewhat different in that the x rays are taken by a moving x ray source onto a film moving in the opposite direction. By accurately coordinating the movement, all but a single plane of tissue is blurred, and that plane is seen without overlying shadows.

Every method available gives good pictures of this system, and the question becomes one of choosing among many excellent alternatives. Each condition has special requirements, while each technique has distinctive benefits and drawbacks.

- Nuclear scans rely on the radiation given off by certain atoms. Chemicals containing such atoms are injected into the bloodstream. They reach the kidneys, where

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images are constructed by measuring the radiation emitted. The radiation is no more dangerous than standard x rays. The images require considerable training to interpret, but unique information is often available using this technology. Different chemicals can concentrate the radiation in different types of tissue. This technique may require several days for the chemical to concentrate at its destination. It also requires a special detector to create the image.

- Ultrasound is a quick, safe, simple, and inexpensive way to obtain views of internal organs. Although less detailed than other methods, it may be sufficient.
- Retrograde pyelography is better able to define problems in the lower parts of the system and is the only way to get x rays if the kidneys are not working well. Dye is usually injected through an instrument (cystoscope) passed into the bladder through the urethra.
- Computed tomography scans (CT or CAT scanning) uses the same kind of radiation used in x rays, but it collects information by computer in such a way that three dimensional images can be constructed, eliminating interference from nearby structures. CT scanning requires a special apparatus.
- Magnetic resonance imaging (MRI) uses magnetic fields and radio frequency signals, instead of ionizing radiation, to create computerized images. This form of energy is entirely safe as long as the patient has no metal in his or her body. The technique is far more versatile than CT scanning. MRI requires special apparatus and, because of the powerful magnets needed, even a special building all by itself. It is quite expensive.

Purpose

Most diseases of the kidneys, ureters, and bladder will yield information to this procedure, which actually has two phases. First, it requires a functioning kidney to filter the dye out of the blood into the urine. The time required for the dye to appear on x rays correlates accurately with kidney function. The second phase gives detailed anatomical images of the urinary tract. Within the first few minutes the dye "lights up" the kidneys, a phase called the nephrogram. Subsequent pictures follow the dye down the ureters and into the bladder. A final film taken after urinating reveals how well the bladder empties.

IVPs are most often done to assess structural abnormalities or obstruction to urine flow. If kidney function is at issue, more films are taken sooner to catch the earliest phase of the process.

- Stones, tumors and congenital malformations account for many of the findings.
- Kidney cysts and cancers can be seen.

KEY TERMS

Contrast agent—Any substance that causes shadows on x rays, also known as contrast dye or medium.

Intravenous—Into a vein.

- Displacement of a kidney or ureter suggests a space-occupying lesion like a cancer pushing it out of the way.
- Bad valves where the ureters enter the bladder will often show up.
- Bladder cancers and other abnormalities are often outlined by the dye in the bladder.
- An enlarged prostate gland will show up as incomplete bladder emptying and a bump at the bottom of the bladder.

Precautions

The only serious complication of an IVP is allergy to the iodine-containing dye that is used. Such an allergy is rare, but it can be dramatic and even lethal. Emergency measures taken immediately are usually effective.

Description

IVPs are usually done in the morning. In the x ray suite, the patient will undress and lie down. There are two methods of injecting the dye. An intravenous line can be established, through which the dye will be consistently fed through the body during the procedure. The other method is to give the dye all at once through a needle that is immediately withdrawn. X rays are taken until the dye has reached the bladder, an interval of half an hour or less. The patient will be asked to empty the bladder before one last x ray.

Preparation

Emptying the bowel with **laxatives** or **enemas** prevents bowel shadows from obscuring the details of the urinary system. An empty stomach prevents the complications of **vomiting**, a rare effect of the contrast agent. Therefore, the night before the IVP the patient will be asked to evacuate the bowels and to drink sparingly.

Risks

Allergy to the contrast agent is the only risk. Anyone with a possible iodine allergy or a previous

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reaction to x ray dye must be particularly careful to inform the x ray personnel.

Resources

BOOKS

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J. Ricker Polsdorfer, MD

Intussusception

Definition

Intussusception is the enfolding of one segment of the intestine within another. It is characterized and initially presents with recurring attacks of cramping abdominal **pain** that gradually become more painful.

Description

Intussusception occurs when part of the bowel or intestine is wrapped around itself producing a mass-like object on the right side of the abdomen during palpation (a procedure used during a **physical examination**, when the examiner touches the abdomen with his/her hand, usually feeling for mass, pain, or discomfort). The number of new cases of intussuscetion is approximately 1.5 to four cases per 1,000 live births. The onset of abdominal pain is usually abrupt and severe. Just as fast as the onset of pain appears, it disappears and the child resumes activity normally. This process of sudden severe abdominal pain appearing out of the blue then disappearing is repeated with duration of painful attacks. The pain usually increases after approximately five hours of recurrent cycles of severe abdominal pain followed by relaxation. **Vomiting** and **diarrhea** occur in about 90% of cases within six to 12 hours after initial onset of symptoms.

Physical examination and palpation usually reveal a sausage shaped mass of enfolded bowel in the right upper mid portion of the abdomen. Within a few hours approximately 50% of cases have bloody, mucus filled bowel movements. At about this time the child is visibly very ill with **fever**, tenderness, and distended abdomen. Intussusception is the most frequent cause of intestinal obstruction during the first two years of life and commonly affects children between three to 12 months of age. The disease is three times more common in males than in females. In about 85% of cases the cause is idiopathic (meaning unknown). The remaining 15% of cases can be caused by a variety of other diseases such as tumors of the lymph nodes (lymphoma), fat tumors (lipomas), foreign bodies/objects, or from infections that mobilize immune cells to the area causing an inflammatory reaction and intestinal blockage. Most cases of intussusception do not strangulate the affected bowel within the first 24 hours. If the disease is not treated after this time, the possibility of intestinal **gangrene**, **shock**, and **death** increases.

Causes and symptoms

The major symptom of intussusception is when a healthy child suddenly and without warning experiences severe abdominal pain that subsides and usually results in continuation of normal activities such as playing. The duration of the painful attacks increases as the hours go by. Usually, the child develops **nausea**, **vomiting**, and diarrhea soon afterwards in about 90% of all cases. The child becomes weak, exhausted, and develops a fever. The affected child may also expel bloody, mucus-like bowel movements. These blood filled bowel movements are usually due to impaired blood flow to the obstructed area. During palpation there may be a sausage-shaped mass located on the upper right mid portion of the abdomen. If the disease progresses and is undetected, the child may develop death of cells within the affected area. Additionally, there may be perforation or hole in the intussusception bowel that can cause a life threatening infection in the peritoneum (a layer of tissue that protects the organs and intestines within the abdominal cavity). This infection of the peritoneum is called **peritonitis**. Some patients may exhibit altered states of consciousness or seizures.

Diagnosis

A presumed diagnosis can be made by history alone. If the clinician suspect's intussusception x-ray films should be performed, which may reveal a mass in the right upper mid abdominal region. Two classical clinical signs are mucus-blood filled stools and a "coiled string" appearance in the affected bowel as visualized during an x ray with a **barium enema**. Blood chemistry analysis is not specific for intussusception. Depending on vomiting and blood loss through the stools, blood chemistry may reflect signs of **dehydration** and anemia.

Treatment

Treating intussusception by reduction (alleviating the source of blockage) is an emergency procedure. The barium examination is not only the diagnostic tool of choice, but also frequently curative. Infusion

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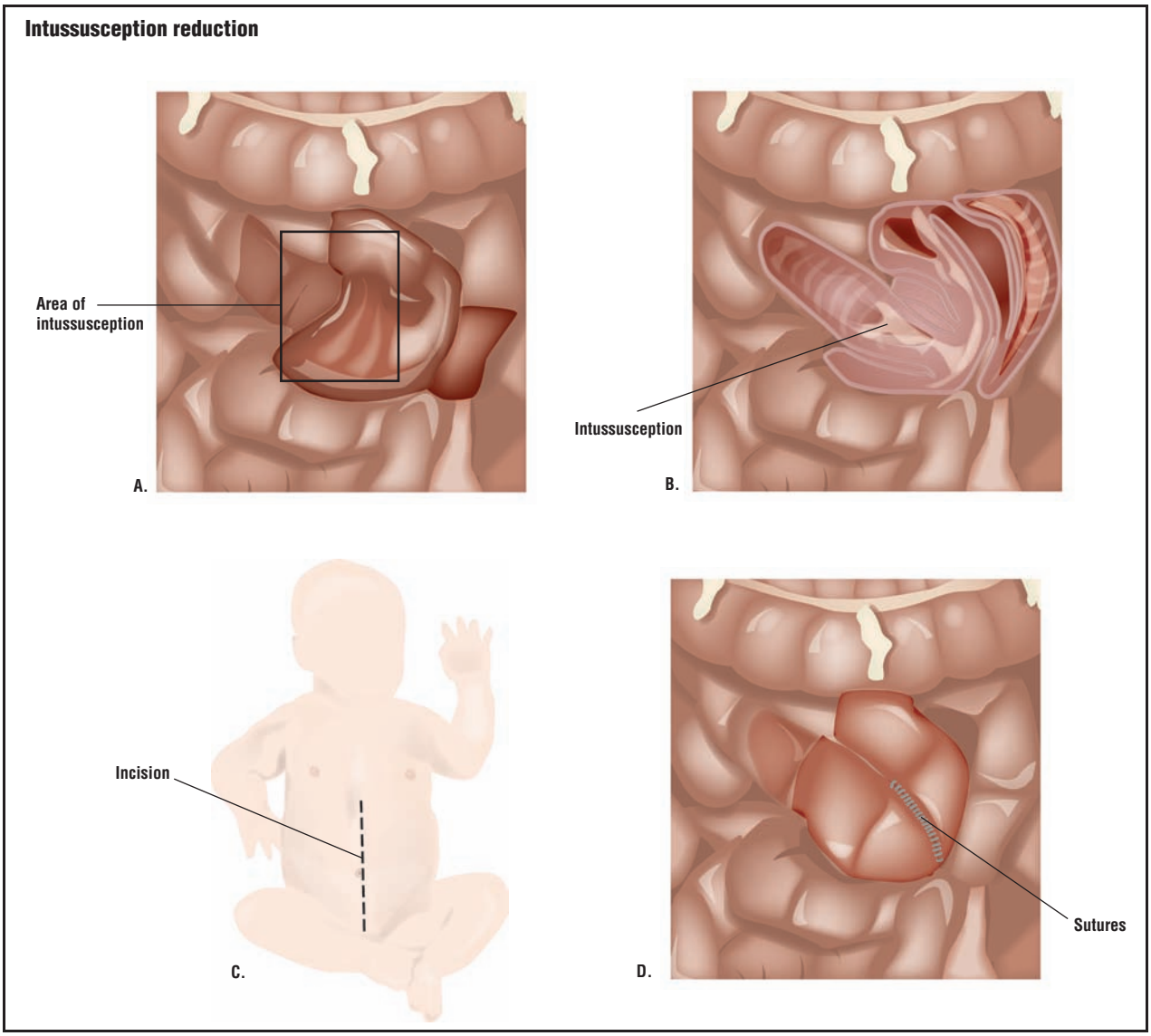

Intussusception of the bowel results in the bowel telescoping onto itself (A and B). To repair it, an incision is made in the baby's abdomen to expose the bowel (C). If the surgeon cannot manipulate the bowel into a normal shape manually, the area of intussusception will be removed and remaining bowel sutured together (D). *(Illustration by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)*

by gravity from a catheter placed in the rectum will tend to relieve pressure buildup. If this does not relieve the area, then air can be pumped into the colon to clear blockage. If these procedures are unsuccessful then surgery is required. Approximately 25% of affected children require surgical intervention. Surgery in the affected bowel is advantageous since the actual cause can be removed, and the procedure decreases the possibility of recurrences. In general without surgical correction of the affected bowel, there is a 5–10% chance of recurrence. Recurrence usually appears within the first 24 to 48 hours after barium procedure.

Prognosis

The outcome of intussusception depends on the duration of symptoms before treatment initiation. Most infants will recover if treatment is initiated within the first 24 hours. Untreated intussusception is almost always fatal. Overall even with treatment, approximately 1–2% of affected children will die.

Prevention

Prevention of death can be accomplished with immediate medical care, within the first 24 hours.

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KEY TERMS

Barium—A chemical used in certain radiological studies to enhance visualization of anatomical structures.

Obstruction—A blockage that prevents movement.

Once intussusception is suspected, emergency measures should be initiated. Untreated intussusception is almost always fatal. There is an increased chance for death if the disorder is not treated within 48 hours.

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Laith Farid Gulli, M.D.

Iodine *see* **Antiseptics**

Iodine uptake test *see* **Thyroid nuclear medicine scan**

Ipecac

Definition

Ipecac syrup is a bitter tasting medicine that was formerly given to induce **vomiting** in cases of accidental **poisoning**.

Purpose

Nowadays, **activated charcoal** and gastric lavage (pumping the stomach) are more rapid and effective means of preventing serious illness and **death** from accidental poisoning.

In cases of acute poisoning, contact either the local poison control center, local hospital emergency room, or family doctor for instructions.

Ipecac plant (*Cephaelis ipecacuanha*). *(© Plantaphile.)*

Ipecac syrup should *never* be used to induce **vomiting** if the poison is

- strong alkali (lye)
- strong acids (bleach)
- strychnine
- crude oil products like kerosene, fuel oil, gasoline, coal oil, paint thinner, or cleaning fluids

Ipecac should never be given to people who are drowsy, unconscious, or having difficulty swallowing.

Ipecac syrup is sometimes used to induce vomiting for weight control. This is dangerous and can cause heart problems and death. Additionally, violent retching and vomiting can cause tears in the esophagus resulting in vomiting blood, seizures, or even death.

Resources

OTHER

Mayo Clinic online. http://www.mayoclinic.com.

James Waun, MD, RPh

Ipratropium *see* **Bronchodilators**

I.Q. tests *see* **Stanford-Binet intelligence scales; Wechsler intelligence test**

Iridocyclitis *see* **Uveitis**

Iritis *see* **Uveitis**

Iron-binding capacity test *see* **Iron tests**

Iron-utilization anemias *see* **Sideroblastic anemia**

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Iron deficiency anemia

Definition

Anemia is a condition, which is the result of insufficient numbers of healthy red blood cells, that can be caused by iron deficiency, folate deficiency, vitamin B_{12} deficiency, and other causes. The term iron deficiency anemia means anemia that is due to iron deficiency—that is, the insufficient dietary intake or absorption of iron in the body. Iron deficiency anemia is characterized by the production of smaller than normal red blood cells and less than the normal number of red cells in the blood. When examined under a microscope, the red blood cells also appear pale or light colored due to too little iron in the blood. For this reason, the anemia that occurs with iron deficiency is also called hypochronic microcytic anemia. Because fewer healthy red blood cells are produced (which causes less hemoglobin to be produced and, thus, less oxygen to be carried throughout the body), people with iron deficiency anemia often experience a lack of energy throughout their daily lives.

Demographics

Anyone has the potential for acquiring iron deficiency anemia. In the United States, approximately 20% of all women of child-bearing years, about 50% of pregnant women, and between 2 and 3 % of all men of similar ages have iron deficiency anemia. Women are generally at higher risk for iron deficiency anemia because they lose iron during menstruation.

Description

Iron deficiency anemia is the most common type of anemia throughout the world. In the United States, iron deficiency anemia occurs to a lesser extent than in developing countries because of the higher consumption of red meat and the practice of food fortification (addition of iron to foods by manufacturers). Anemia in the United States is caused by a variety of sources, including excessive losses of iron in menstrual fluids and excessive bleeding in the gastrointestinal tract. The condition can also be produced by **lead poisoning**, often in children ingesting lead-based paints while playing. In developing countries located in tropical climates, the most common cause of iron deficiency anemia is infestation with hookworm.

Risks

The following groups have more chance of getting iron deficiency anemia than other groups: women, infants and children, and people with certain medical conditions. The following are factors that can contribute to increased risk of getting iron deficiency anemia: **pregnancy** (additional iron is needed for support of the fetus), heavy menstrual periods (which depletes iron in the body), low iron diet (such as vegetarian **diets** in which iron in allowed foods, such as vegetables, are not absorbed as well as iron in not-allowed foods, such as meat), and internal bleeding (such as from an ulcer or polyps). Donating blood and eating unhealthy foods on a regular basis are also other ways to increase one' risk of iron deficiency anemia.

Causes and symptoms

Infancy is a period of increased risk for iron deficiency. The human infant is born with a built-in supply of iron, which can be tapped during periods of drinking low-iron milk or formula. Both human milk and cow milk contain rather low levels of iron (0.5–1.0 milligrams of iron per liter [mg iron/L]). However, the iron in human milk is about 50% absorbed by the infant, while the iron of cow milk is only 10% absorbed. During the first six months of life, growth of the infant is made possible by the milk in the diet and by the infant's built-in supply. However, premature infants have a lower supply of iron and, for this reason, it is recommended that pre-term infants (beginning at 2 months of age) be given oral supplements of 7 mg iron/day, as ferrous sulfate. Iron deficiency can be provoked where infants are fed formulas that are based on unfortified cow milk. For example, unfortified cow milk is given free of charge to mothers in Chile. This practice has the fortunate result of preventing general **malnutrition**, but the unfortunate result of allowing the development of mild iron deficiency.

The normal rate of blood loss in the feces is 0.5–1.0 milliliter per day (mL/day). These losses can increase with colorectal **cancer**. About 60% of colorectal cancers result in further blood losses, where the extent of blood loss is 2–10 mL/day. Cancer of the colon and rectum can provoke losses of blood, resulting in iron deficiency anemia. The fecal blood test is widely used to screen for the presence of cancer of the colon or rectum. In the absence of testing, colorectal cancer may be first detected because of the resulting iron deficiency anemia.

Infection with hookworm can provoke iron deficiency and iron deficiency anemia. The hookworm is a parasitic worm. It thrives in warm climates, including in the southern United States. The hookworm enters the body through the skin, as through bare feet. The hookworm then migrates to the small intestines where

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it attaches itself to the villi (small sausage-shaped structures in the intestines that are used for the absorption of all nutrients). The hookworm provokes damage to the villi, which results in blood loss. They also produce anti-coagulants, which promote continued bleeding. Each worm can provoke the loss of up to 0.25 mL of blood per day.

Bleeding and blood losses through gastrointestinal tract can be provoked by colorectal cancer and hookworms, as mentioned above, but also by **hemorrhoids**, anal fissures, **irritable bowel syndrome**, aspirin-induced bleeding, blood clotting disorders, and **diverticulosis** (a condition caused by an abnormal opening from the intestine or bladder). Several genetic diseases exist which lead to bleeding disorders, and these include **hemophilia** A, hemophilia B, and von Willebrand's disease. Of these, only von Willebrand's disease leads to gastrointestinal bleeding.

The symptoms of iron deficiency anemia include weakness and **fatigue**. These symptoms result because of the lack of function of the red blood cells, and the reduced ability of the red blood cells to carry iron to exercising muscles. Iron deficiency can also affect other tissues, including the tongue and fingernails. Prolonged iron deficiency can result in changes of the tongue; such as, it may become smooth, shiny, and reddened. This condition is called glossitis. The tongue may also become sore and inflamed. The fingernails may grow abnormally, acquiring a spoon-shaped appearance. They may also grow out brittle in texture and appearance.

The whites of the eyes may appear bluish in color. Other symptoms can include irritability, **headache**, cravings of food and other unusual substances while generally having a overall poor appetite, pale skin color, **shortness of breath**, irregular heartbeat, dizziness/lightheadedness, cold feeling of the extremities (hands and feet), and irritability. If iron deficiency anemia is mild, however, symptoms may not appear. Symptoms begin to show up as the condition worsens.

Decreased iron intake is a contributing factor in iron deficiency and iron deficiency anemia. The iron content of cabbage, for example, is about 1.6 milligrams per kilogram (1.6 mg/kg) food, while that of spinach (33 mg/kg), lima beans (15 mg/kg), potatoes (14 mg/kg), tomatoes (3 mg/kg), apples (1.5 mg/kg), raisins (20 mg/kg), whole wheat bread (43 mg/kg), eggs (20 mg/kg), canned tuna (13 mg/kg), chicken (11 mg/kg), beef (28 mg/kg), corn oil (0.6 mg/kg), and peanut butter (6.0 mg/kg), are indicated. One can see that apples, tomatoes, and vegetable oil are relatively low in iron, while whole wheat bread, spinach, and beef are relatively high in iron. The assessment of whether a food is low or high in iron can also be made by comparing the amount of that food eaten per day with the recommended dietary allowance (RDA), which is part of the Dietary Reference Intakes (DRIs), for iron. The RDA for iron for the adult male (19 to 50 years of age) is 8 milligram per day (mg/day), while that for the adult woman (of the same age range) is 18 mg/day. For adult males and females (51 years and older) the RDA for iron is 8 mg/day. The RDA during pregnancy is 27 mg/day. The RDA for infants of 7 to 12 months of age is 11 mg/day, for children 1 to 3 years of age it is 7 mg/day, for children 4 to 8 years it is 10 mg/day, for children 9 to 13 years it is 8 mg/day, and for children 14 to 18 years it is 11 mg/day for males and 15 mg/day for females. The RDA values are based on the assumption that the consumer eats a mixture of plant and animal foods.

The above list of iron values alone may be deceptive, since the availability of iron in fruits, vegetables, and grains is very low, while that the availability from meat is much higher. The availability of iron in plants ranges from only 1–10%, while that in meat, fish, chicken, and liver is 20–30%. The term availability means the percent of dietary iron that is absorbed via the gastrointestinal tract to the bloodstream. Non-absorbed iron is lost in the feces.

Interactions between various foods can influence the absorption of dietary iron. Vitamin C can increase the absorption of dietary iron. Orange juice is a rich source of vitamin C. Thus, if a plant food, such as rice, is consumed with orange juice, then the orange juice can enhance the absorption of the iron of the rice. Vitamin C is also added to infant formulas, and the increased use of formulas fortified with both iron and vitamin C has led to a marked decline in anemia in infants and young children in the United States. In contrast, if rice is consumed with tea, certain chemicals in the tea (tannins) can reduce the absorption of the iron. Phytic acid is a chemical that naturally occurs in legumes, cereals, and nuts. Phytic acid, which can account for 1–5% of the weight of these foods, is a potent inhibitor of iron absorption. The increased availability of the iron in meat products is partly due to the fact that heme-iron is absorbed to a greater extent than free iron salts, and to a greater extent than iron in the phytic acid/iron complex. Nearly all of the iron in plants is nonheme-iron. Much of the iron in meat is nonheme-iron as well. The nonheme-iron in meat, fish, chicken and liver may be about 20% available. The heme-iron of meat may be close to 30% available. The most available source of iron is human milk (50% availability).

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KEY TERMS

Hematocrit—The proportion of whole blood in the body, by volume, that is composed of red blood cells.

Hemoglobin—An iron-containing protein that resides within red blood cells. Hemoglobin accounts for about 95% of the protein in the red blood cell.

Protoporphyrin IX—A protein. The measurement of this protein is useful for the assessment of iron status. Hemoglobin consists of a complex of a protein plus heme. Heme consists of iron plus protoporphyrin IX. Normally, during the course of red blood cell formation, protoporphyrin IX acquires iron, to generate heme, and the heme becomes incorporated into hemoglobin. However, in iron deficiency, protophoryrin IX builds up.

Recommended Dietary Allowance (RDA)—The quantities of nutrients of the diet that are required to maintain human health. RDAs are established by the Food and Nutrition Board of the National Academy of Sciences and may be revised every few years.

Diagnosis

Iron deficiency anemia in infants is defined as a hemoglobin level below 109 mg/mL of whole blood, and a **hematocrit** (percentage of blood volume with respect to red blood cells) of under 33%. Anemia in adult males is defined as a hemoglobin under 130 mg/mL and a hematocrit of under 39%. Anemia in adult females is defined as hemoglobin under 120 mg/mL and a hematocrit of under 35%. Anemia in pregnant women is defined as hemoglobin of under 110 mg/mL and hematocrit of under 31%.

When an abnormally high presence of blood is found in the feces during a **fecal occult blood test**, the physician needs to examine the gastrointestinal tract to determine the cause of bleeding. Here, the diagnosis for iron deficiency anemia includes the examination using a sigmoidoscope. The sigmoidoscope is an instrument that consists of a flexible tube that permits examination of the colon to a distance of 60 centimeters (cm). A **barium enema**, with an x ray, may also be used to detect abnormalities that can cause bleeding.

The diagnosis of iron deficiency anemia should include a test for oral iron absorption, where evidence suggests that oral iron supplements fail in treating anemia. The oral iron absorption test is conducted by eating 64 mg iron (325 mg ferrous sulfate) in a single dose. Blood samples are then taken after 2 hours and 4 hours. The iron content of the blood serum is then measured. The concentration of iron should rise by an increment of about 22 micromolar, where iron absorption is normal. Lesser increases in concentration mean that iron absorption is abnormal, and that therapy should involve injections or infusions of iron.

Treatment

Oral iron supplements (pills) may contain various iron salts. These iron salts include ferrous sulfate, ferrous gluconate, or ferrous fumarate. These pills are most effective if they are taken on an empty stomach. Milk and **antacids** should not be taken with such pills. However, vitamin C, such as in orange juice, increases the absorption of iron. Injections and infusions of iron can be carried out with a preparation called iron dextran. In patients with poor iron absorption (by the gut), therapy with injection or infusion is preferable over oral supplements. Intravenous injections are often made into a vein or muscle. Treatment of iron deficiency anemia sometimes requires more than therapy with iron. Where hemorrhoids provoke iron deficiency, surgery may prove essential to prevent recurrent iron deficiency anemia. Where iron deficiency is provoked by bleeding due to **aspirin** treatment, aspirin should be discontinued. Where iron deficiency is provoked by hookworm infections, therapy for this parasite should be used, along with protection of the feet by wearing shoes whenever walking in hookworm-infested soil.

Prognosis

The prognosis for treating and curing iron deficiency anemia is excellent. Perhaps the main problem is failure to take iron supplements. With adequate treatments most cases of iron deficiency anemia goes away in a few weeks. In cases of pregnant women, the health care worker may recommend taking 100–200 mg iron/day. This dose is rather high, and can lead to **nausea**, **diarrhea**, or abdominal **pain** in 10–20% of women taking this dose. The reason for using this high dose is to affect a rapid cure for anemia, where the anemia is detected at a mid-point during the pregnancy. The above problems of side effects and noncompliance can be avoided by taking iron doses (100–200 mg) only once a week, where supplements are initiated some time prior to conception, or continuously throughout the fertile period of life. The problem of compliance is not

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an issue where infusions are used, however a fraction of patients treated with iron infusions experience side effects, such as flushing, headache, nausea, **anaphylaxis**, or seizures. A number of studies have shown that iron deficiency anemia in infancy can result in reduced intelligence, where intelligence was measured in early childhood. It is not certain if iron supplementation of children with reduced intelligence, due to iron-deficiency anemia in infancy, has any influence in allowing a "catch-up" in intellectual development.

If left untreated, iron deficiency anemia can lead to heart problems such as irregular or rapid heartbeat (as the heart tries to pump more blood that contains less oxygen) or **angina** (chest pains that occur then the heart does not receive sufficient oxygenated blood). It can also cause complications during pregnancy in women and delayed mental and physical growth spurts in children.

Prevention

In the healthy population, all of the mineral deficiencies can be prevented by the consumption of inorganic nutrients at levels defined by the RDA. Iron deficiency anemia in infants and young children can be prevented by the use of fortified foods. Liquid cow milk-based infant formulas are generally supplemented with iron (12 mg/L). The iron in liquid formulas is added as ferrous sulfate or ferrous gluconate. Commercial infant cereals are also fortified with iron, and here small particles of elemental iron are added. The levels used are about 0.5 gram iron/kg dry cereal. This amount of iron is about 10-fold greater than that of the iron naturally present in the cereal. Foods that are rich in iron include, poultry, red meat (such as liver), pork, seafood, egg yolks, whole-grain breads, raisins, legumes (such as beans and peas), dark green leafy vegetables (such as spinach), nuts and seeds and dried fruits (such as apricots and raisins). Many other foods are fortified with iron (such as breakfast foods).

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Tom Brody, PhD

Iron overload *see* **Hemochromatosis**

Iron tests

Definition

Iron tests are a group of blood tests that are done to evaluate the iron level in blood serum, the body's capacity to absorb iron, and the amount of iron actually stored in the body. Iron is an essential trace element; it is necessary for the formation of red blood cells and certain enzymes. At the other extreme, high levels of iron can be poisonous.

Purpose

There are four different types of tests that measure the body's iron levels and storage. They are called iron level tests, total iron-binding capacity (TIBC) tests, ferritin tests, and transferrin tests. These tests are given for several reasons:

- To help in the differential diagnosis of different types of anemia.
- To assess the severity of anemia and monitor the treatment of patients with chronic anemia.
- To evaluate protein depletion and other forms of malnutrition.
- To check for certain liver disorders.
- To evaluate the possibility of chronic gastrointestinal bleeding. Blood loss from the digestive tract is a common cause of iron deficiency anemia.
- To help diagnose certain unusual disorders, including iron poisoning, thalassemia, hemosiderosis, and hemochromatosis.

A serum iron test can be used without the others to evaluate cases of iron **poisoning**.

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Precautions

Patients should not have their blood tested for iron within four days of a blood **transfusion** or tests and treatments that use radioactive materials. Recent high **stress** levels or **sleep deprivation** are additional reasons for postponing iron tests.

Blood samples for iron tests should be taken early in the morning because serum iron levels vary during the day. This precaution is especially important in evaluating the results of iron replacement therapy.

Description

Iron tests are performed on samples of the patient's blood, withdrawn from a vein into a vacuum tube. The amount of blood taken is between 6 mL and 10 mL (1/3 of a fluid ounce). The procedure, which is called a venipuncture, takes about five minutes.

Iron level test

The iron level test measures the amount of iron in the blood serum that is being carried by a protein (transferrin) in the blood plasma.

Medications and substances that can cause *increased* iron levels include chloramphenicol, estrogen preparations, dietary iron supplements, alcoholic beverages, methyldopa, and birth control pills.

Medications that can cause *decreased* iron levels include ACTH, colchicine, deferoxamine, methicillin, and testosterone.

Total iron-binding capacity (TIBC) test

The TIBC test measures the amount of iron that the blood would carry if the transferrin were fully saturated. Since transferrin is produced by the liver, the TIBC can be used to monitor liver function and **nutrition**.

Medications that can cause *increased* TIBC levels include fluorides and birth control pills.

Medications that can cause *decreased* TIBC levels include chloramphenicol and ACTH.

Transferrin test

The transferrin test is a direct measurement of transferrin–which is also called siderophilin–levels in the blood. Some laboratories prefer this measurement to the TIBC. The saturation level of the transferrin can be calculated by dividing the serum iron level by the TIBC.

Ferritin test

The ferritin test measures the level of a protein in the blood that stores iron for later use by the body.

Medications that can cause *increased* ferritin levels include dietary iron supplements. In addition, some diseases that do not directly affect the body's iron storage can cause artificially high ferritin levels. These disorders include infections, late-stage cancers, lymphomas, and severe inflammations. Alcoholics often have high ferritin levels.

Preparation

Patient history

Before patients are tested for iron, they should be checked for any of the following factors:

- Prescription medications that affect iron levels, absorption, or storage
- Blood transfusion or radioactive medications within the last four days
- Recent extreme stress or sleep deprivation
- Recent eating habits. Test results can be affected by eating large amounts of iron-rich foods shortly before the blood test.

Fasting

Patients scheduled for an iron level, TIBC, or transferrin test should fast for 12 hours before the blood is drawn. They are allowed to drink water. Patients scheduled for a ferritin test do not need to fast but they should not have any alcoholic beverages before the test.

Aftercare

Aftercare consists of routine care of the area around the venipuncture.

Risks

The primary risk is the possibility of a bruise or swelling in the area of the venipuncture. The patient can apply moist warm compresses if there is any discomfort.

Normal results

Iron level test

Normal serum iron values are as follows:

- Adult males: 75–175 micrograms/dL
- Adult females: 65–165 micrograms/dL
- Children: 50–120 micrograms/dL
- Newborns: 100–250 micrograms/dL.

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KEY TERMS

Anemia—A disorder marked by low hemoglobin levels in red blood cells, which leads to a deficiency of oxygen in the blood.

Ferritin—A protein found in the liver, spleen, and bone marrow that stores iron.

Hemochromatosis—A disorder of iron absorption characterized by bronze-colored skin. It can cause painful joints, diabetes, and liver damage if the iron concentration is not lowered.

Hemosiderosis—An overload of iron in the body resulting from repeated blood transfusions. Hemosiderosis occurs most often in patients with thalassemia.

Iron poisoning—A potentially fatal condition caused by swallowing large amounts of iron dietary supplements. Most cases occur in children who have taken adult- strength iron formulas. The symptoms of iron poisoning include vomiting, bloody diarrhea, convulsions, low blood pressure, and turning blue.

Plasma—The liquid part of blood.

Siderophilin—Another name for transferrin.

Thalassemia—A hereditary form of anemia that occurs most frequently in people of Mediterranean origin.

Transferrin—A protein in blood plasma that carries iron derived from food intake to the liver, spleen, and bone marrow.

TIBC test

Normal TIBC values are as follows:

- Adult males: 300–400 micrograms/dL
- Adult females: 300–450 micrograms/dL.

Transferrin test

Normal transferrin values are as follows:

- Adult males: 200–400 mg/dL
- Adult females: 200–400 mg/dL
- Children: 203–360 mg/dL
- Newborns: 130–275 mg/dL.

Normal transferrin saturation values are between 30–40%.

Ferritin test

Normal ferritin values are as follows:

- Adult males: 20–300 ng/mL
- Adult females: 20–120 ng/mL
- Children (one month): 200–600 ng/mL
- Children (two to five months): 50–200 ng/mL
- Children (six months to 15 years): 7–140 ng/mL
- Newborns: 25–200 ng/mL.

Abnormal results

Iron level test

Serum iron level is *increased* in **thalassemia**, **hemochromatosis**, severe hepatitis, **liver disease**, **lead poisoning**, acute leukemia, and **kidney disease**. It is also increased by multiple blood transfusions and intramuscular iron injections.

Iron levels above 350–500 micrograms/dL are considered toxic; levels over 1000 micrograms/dL indicate severe iron poisoning.

Serum iron level is *decreased* in **iron deficiency anemia**, chronic blood loss, chronic diseases (lupus, **rheumatoid arthritis**), late **pregnancy**, chronically heavy menstrual periods, and thyroid deficiency.

TIBC test

The TIBC is *increased* in iron deficiency anemia, **polycythemia vera**, pregnancy, blood loss, severe hepatitis, and the use of birth control pills.

The TIBC is *decreased* in **malnutrition**, severe **burns**, hemochromatosis, anemia caused by infections and chronic diseases, **cirrhosis** of the liver, and kidney disease.

Transferrin test

Transferrin is *increased* in iron deficiency anemia, pregnancy, **hormone replacement therapy** (HRT), and the use of birth control pills.

Transferrin is *decreased* in protein deficiency, liver damage, malnutrition, severe burns, kidney disease, chronic infections, and certain genetic disorders.

Ferritin test

Ferritin is *increased* in liver disease, iron overload from hemochromatosis, certain types of anemia, acute leukemia, Hodgkin's disease, **breast cancer**, thalassemia, infections, inflammatory diseases, and hemosiderosis.

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Ferritin levels may be normal or slightly above normal in patients with kidney disease.

Ferritin is *decreased* in chronic iron deficiency and severe protein depletion.

Resources

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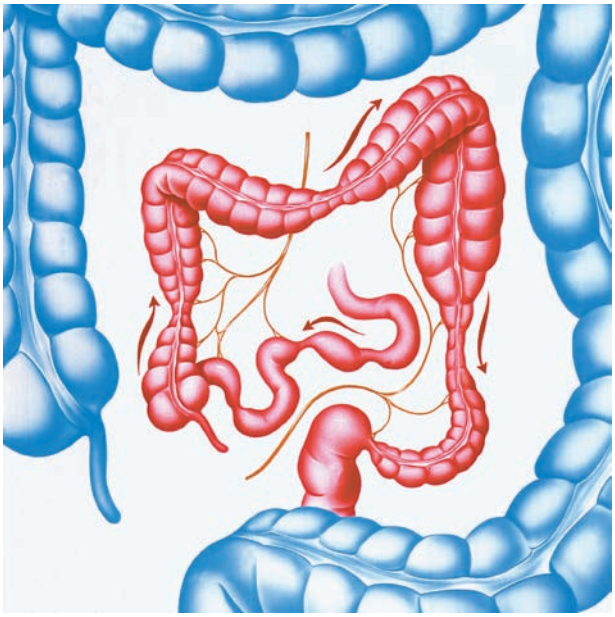
Rebecca J. Frey, PhD

Irregular bite *see* **Malocclusion**

Irritable bowel syndrome

Definition

Irritable bowel syndrome (IBS) is a common intestinal condition characterized by abdominal **pain** and cramps; changes in bowel movements (**diarrhea**, **constipation**, or both); gassiness; bloating; **nausea**; and other symptoms. There is no cure for IBS. Much about the condition remains unknown or poorly understood; however, dietary changes, drugs, and psychological treatment are often able to eliminate or substantially reduce its symptoms.



Normal and diseased (center) colons. Areas of constriction in the colon cause constipation, while areas of distention cause diarrhea. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Demographics

No one knows for sure how many Americans suffer from IBS. Surveys indicate a range of 10–20%, with perhaps as many as 30% of Americans experiencing IBS at some point in their lives. IBS normally makes its first appearance during young adulthood, and in half of all cases symptoms begin before age 35. Women with IBS outnumber men by two to one, for reasons that are not yet understood. IBS is responsible for more time lost from work and school than any medical problem other than the **common cold**. It accounts for more than half of all the patients seen by specialists in diseases of the digestive system (gastroenterologists). Yet only half–possibly as few as 15%–of IBS sufferers ever consult a doctor.

Description

IBS is the name people use today for a condition that was once called–among other things–colitis, mucous **colitis**, spastic colon, nervous colon, spastic bowel, and functional bowel disorder. Some of these names reflected the now outdated belief that IBS is a purely psychological disorder, a product of the patient's imagination. Although modern medicine recognizes that **stress** can trigger IBS attacks, medical specialists agree that IBS is a genuine physical disorder–or group of disorders–with specific identifiable characteristics.

Causes and symptoms

Symptoms

The symptoms of IBS tend to rise and fall in intensity rather than growing steadily worse over time. They always include abdominal pain, which may be relieved by defecation; diarrhea or constipation; or diarrhea alternating with constipation. Other symptoms–which vary from person to person–include cramps; gassiness; bloating; nausea; a powerful and uncontrollable urge to defecate (urgency); passage of a sticky fluid (mucus) during bowel movements; or the feeling after finishing a bowel movement that the bowels are still not completely empty. The accepted diagnostic criteria–known as the Rome criteria–require at least three months of continuous or recurrent symptoms before IBS can be confirmed. According to Christine B. Dalton and Douglas A. Drossman in the *American Family Physician,* an estimated 70% of IBS cases can be described as "mild;" 25% as "moderate;" and 5% as "severe." In mild cases the symptoms are slight. As a general rule,

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they are not present all the time and do not interfere with work and other normal activities. Moderate IBS occasionally disrupts normal activities and may cause some psychological problems. People with severe IBS often find living a normal life impossible and experience crippling psychological problems as a result. For some the physical pain is constant and intense.

Causes

Researchers remain unsure about the cause or causes of IBS. It is called a functional disorder because it is thought to result from changes in the activity of the major part of the large intestine (the colon). After food is digested by the stomach and small intestine, the undigested material passes in liquid form into the colon, which absorbs water and salts. This process may take several days. In a healthy person the colon is quiet during most of that period except after meals, when its muscles contract in a series of wavelike movements called peristalsis. Peristalsis helps absorption by bringing the undigested material into contact with the colon wall. It also pushes undigested material that has been converted into solid or semisolid feces toward the rectum, where it remains until defecation. In IBS, however, the normal rhythm and intensity of peristalsis is disrupted. Sometimes there is too little peristalsis, which can slow the passage of undigested material through the colon and cause constipation. Sometimes there is too much, which has the opposite effect and causes diarrhea. A Johns Hopkins University study found that healthy volunteers experienced 6–8 contractions of the colon each day, compared with up to 25 contractions a day for volunteers suffering from IBS with diarrhea, and an almost complete absence of contractions among constipated IBS volunteers. In addition to differences in the number of contractions, many of the IBS volunteers experienced powerful spasmodic contractions affecting a larger-than-normal area of the colon–"like having a Charlie horse in the gut," according to one of the investigators.

DIET. Some kinds of food and drink appear to play a key role in triggering IBS attacks. Food and drink that healthy people can ingest without any trouble may disrupt peristalsis in IBS patients, which probably explains why IBS attacks often occur shortly after meals. Chocolate, milk products, **caffeine** (in coffee, tea, colas, and other drinks), and large quantities of alcohol are some of the chief culprits. Other kinds of food have also been identified as problems, however, and the pattern of what can and cannot be tolerated is different for each person. Characteristically, IBS symptoms rarely occur at night and disrupt the patient's sleep.

STRESS. Stress is an important factor in IBS because of the close nervous system connections between the brain and the intestines. Although researchers do not yet understand all of the links between changes in the nervous system and IBS, they point out the similarities between mild digestive upsets and IBS. Just as healthy people can feel nauseated or have an upset stomach when under stress, people with IBS react the same way, but to a greater degree. Finally, IBS symptoms sometimes intensify during menstruation, which suggests that female reproductive hormones are another trigger.

Diagnosis

Diagnosing IBS is a fairly complex task because the disorder does not produce changes that can be identified during a **physical examination** or by laboratory tests. When IBS is suspected, the doctor (who can be either a family doctor or a specialist) needs to determine whether the patient's symptoms satisfy the Rome criteria. The doctor must rule out other conditions that resemble IBS, such as **Crohn's disease** and ulcerative colitis. These disorders are ruled out by questioning the patient about his or her physical and mental health (the medical history), performing a physical examination, and ordering laboratory tests. Normally the patient is asked to provide a stool sample that can be tested for blood and intestinal parasites. In some cases x rays or an internal examination of the colon using a flexible instrument inserted through the anus (a sigmoidoscope or colonoscope) is necessary. The doctor also may ask the patient to try a lactose-free diet for two or three weeks to see whether **lactose intolerance** is causing the symptoms.

Treatment

Dietary changes, sometimes supplemented by drugs or **psychotherapy**, are considered the key to successful treatment. The following approach, offered by Dalton and Drossman, is typical of the advice found in the medical literature on IBS. The authors tie their approach to the severity of the patient's symptoms:

Mild symptoms

Dalton and Drossman recommend a low-fat, high-fiber diet. Problem-causing substances such as lactose, caffeine, beans, cabbage, cucumbers, broccoli, fatty foods, alcohol, and medications should be identified and avoided. Bran or 15-25 grams a day of an over-the-counter psyllium laxative (Metamucil or Fiberall) may also help both constipation and

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KEY TERMS

Anus—The opening at the lower end of the rectum.

Crohn's disease—A disease characterized by inflammation of the intestines. Its early symptoms may resemble those of IBS.

Defecation—Passage of feces through the anus.

Feces—Undigested food and other waste that is eliminated through the anus. Feces are also called fecal matter or stools.

Lactose—A sugar found in milk and milk products. Some people are lactose intolerant, meaning they have trouble digesting lactose. Lactose intolerance can produce symptoms resembling those of IBS.

Peristalsis—The periodic waves of muscular contractions that move food through the intestines during the process of digestion.

Ulcerative colitis—A disease that inflames and causes breaks (ulcers) in the colon and rectum, which are parts of the large intestine.

diarrhea. The patient can still have milk or milk products if lactose intolerance is not a problem. People with irregular bowel habits–particularly constipated patients–may be helped by establishing set times for meals and bathroom visits.

Moderate symptoms

The advice given by Dalton and Drossman in mild cases applies here as well. They also suggest that patients keep a diary of symptoms for two or three weeks, covering daily activities including meals, and emotional responses to events. The doctor can then review the diary with the patient to identify possible problem areas.

Although a high-fiber diet remains the standard treatment for constipated patients, such **laxatives** as lactulose (Chronulac) or sorbitol may be prescribed. Loperamide (Imodium) and cholestyramine (Questran) are suggested for diarrhea. Abdominal pain after meals can be reduced by taking **antispasmodic drugs** such as hyoscyamine (Anaspaz, Cystospaz, or Levsin) or dicyclomine (Bemote, Bentyl, or Di-Spaz) before eating.

Dalton and Drossman also suggest psychological counseling or behavioral therapy for some patients to reduce **anxiety** and to learn to cope with the pain and other symptoms of IBS. Relaxation therapy, hypnosis, **biofeedback**, and **cognitive-behavioral therapy** are examples of behavioral therapy.

Severe symptoms

When IBS produces constant pain that interferes with everyday life, **antidepressant drugs** can help by blocking pain transmission from the nervous system. Dalton and Drossman also underscore the importance of an ongoing and supportive doctor-patient relationship.

Alternative treatment

Alternative and mainstream approaches to IBS treatment overlap to a certain extent. Like mainstream doctors, alternative practitioners advise a high-fiber diet to reduce digestive system irritation. They also suggest avoiding alcohol, caffeine, and fatty, gassy, or spicy foods. Recommended stress management techniques include **yoga**, **meditation**, hypnosis, biofeedback, and **reflexology**. Reflexology is a technique of foot massage that is thought to relieve diarrhea, constipation, and other IBS symptoms.

Alternative medicine also emphasizes such herbal remedies as ginger (*Zingiber officinale*), buckthorn (*Rhamnus purshiana*), and enteric-coated peppermint oil. Enteric coating prevents digestion until the peppermint oil reaches the small intestine, thus avoiding irritation of the upper part of the digestive tract. Chamomile (*Matricaria recutita*), valerian (*Valeriana officinalis*), rosemary (*Rosemarinus officinalis*), lemon balm (*Melissa officinalis*), and other herbs are recommended for their antispasmodic properties. The list of alternative treatments for IBS is in fact quite long. It includes **aromatherapy**, homeopathy, **hydrotherapy**, juice therapy, **acupuncture**, **chiropractic**, **osteopathy**, **naturopathic medicine**, and Chinese traditional herbal medicine.

Prognosis

IBS is not a life-threatening condition. It does not cause intestinal bleeding or inflammation, nor does it cause other bowel diseases or **cancer**. Although IBS can last a lifetime, in up to 30% of cases the symptoms eventually disappear, and

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symptoms decrease significantly with treatment in about 60%. Even if the symptoms cannot be eliminated, with appropriate treatment they can usually be brought under control to the point where IBS becomes merely an occasional inconvenience. Treatment requires a long-term commitment, however; six months or more may be needed before the patient notices substantial improvement.

Prevention

Because the cause of IBS is not understood, there are no definitive ways to prevent it. However, some of the following may generally improve digestion:

- Drink sufficient water, about 8 glasses per day
- Follow a high-fiber diet
- Avoid foods that make you feel uncomfortable. For some people, these include highly acidic or spicy foods, caffeinated beverages, and alcohol.
- Physical activity can help improve digestion
- Learn to avoid and cope with stress in your life
- Eating many small meals a day is preferable to eating fewer very larfge meals
- Be aware of medications that you may take that could cause constipation, or irritate your stomach

Resources

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ORGANIZATIONS

American College of Gastroenterology, P.O. Box 342260, Bethesda, MD, 20827-2260, (301) 263-9000, http://www.acg.gi.org.

American Gastroenterological Association, 4930 Del Ray Avenue, Bethesda, MD, 20814, (301) 654-2055, (301) 654-5920, http://www.gastro.org.

IBS Self Help and Support Group, 1440 Whalley Avenue, New Haven, CT, 06515, http://www.ibsgroup.org.

International Foundation for Functional Gastrointestinal Disorders, P. O. Box 170864, Milwaukee, WI, 53217, (888) 964-2001, (414) 964-7176, http://www.iffgd.org.

National Digestive Diseases Information Clearinghouse (NDDIC), 2 Information Way, Bethesda, MD, 20892-3570, (800) 891-5389, (703) 738-4929, http://digestive.niddk.nih.gov.

Howard Baker

Ischemia

Definition

Ischemia is an insufficient supply of blood to an organ, usually due to a blocked artery.

Description

Myocardial ischemia is an intermediate condition in **coronary artery disease** during which the heart tissue is slowly or suddenly starved of oxygen and other nutrients. Eventually, the affected heart tissue will die. When blood flow is completely blocked to the heart, ischemia can lead to a **heart attack**. Ischemia can be silent or symptomatic. According to the American Heart Association, up to four million Americans may have silent ischemia and be at high risk of having a heart attack with no warning.

Symptomatic ischemia is characterized by chest **pain** called **angina** pectoris. The American Heart

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This patient's foot is affected with ischemia. Ischemia occurs when there is an insufficient supply of blood to a specific organ or tissue. *(Dr. P. Marazzi/Photo Researchers, Inc.)*

Association estimates that nearly seven million Americans have angina pectoris, usually called angina. Angina occurs more frequently in women than in men, and in blacks and Hispanics more than in whites. It also occurs more frequently as people age–25% of women over the age of 85 and 27% of men who are 80–84 years old have angina.

People with angina are at risk of having a heart attack. Stable angina occurs during exertion, can be quickly relieved by resting or taking nitroglycerine, and lasts from three to twenty minutes. Unstable angina, which increases the risk of a heart attack, occurs more frequently, lasts longer, is more severe, and may cause discomfort during rest or light exertion.

Ischemia can also occur in the arteries of the brain, where blockages can lead to a **stroke**. About 80–85% of all strokes are ischemic. Most blockages in the cerebral arteries are due to a blood clot, often in an artery narrowed by plaque. Sometimes, a blood clot in the heart or aorta travels to a cerebral artery. A **transient ischemic attack** (TIA) is a "mini-stroke" caused by a temporary deficiency of blood supply to the brain. It occurs suddenly, lasts a few minutes to a few hours, and is a strong warning sign of an impending stroke. Ischemia can also effect intestines, legs, feet and kidneys. Pain, malfunctions, and damage in those areas may result.

Causes and symptoms

Ischemia is almost always caused by blockage of an artery, usually due to atherosclerotic plaque. Myocardial ischemia is also caused by **blood clots** (which tend to form on plaque), artery spasms or contractions, or any of these factors combined. Silent ischemia is usually caused by emotional or mental **stress** or by exertion, but there are no symptoms. Angina is usually caused by increased oxygen demand when the heart is working harder than usual, for example, during **exercise**, or during mental or physical stress. According to researchers at Harvard University, physical stress is harder on the heart than mental stress. A TIA is caused by a blood clot briefly blocking a cerebral artery.

Risk factors

The risk factors for myocardial ischemia are the same as those for coronary artery disease. For TIA, coronary artery disease is also a risk factor.

- Heredity. People whose parents have coronary artery disease are more likely to develop it. African Americans are also at higher risk.
- Sex. Men are more likely to have heart attacks than women, and to have them at a younger age.
- Age. Men who are 45 years of age and older and women who are 55 years of age and older are considered to be at risk.
- Smoking. Smoking increases both the chance of developing coronary artery disease and the chance of dying from it. Second hand smoke may also increase risk.
- High cholesterol. Risk of developing coronary artery disease increases as blood cholesterol levels increase. When combined with other factors, the risk is even greater.
- High blood pressure. High blood pressure makes the heart work harder, and with time, weakens it. When combined with obesity, smoking, high cholesterol, or diabetes, the risk of heart attack or stroke increases several times.
- Lack of physical activity. Lack of exercise increases the risk of coronary artery disease.
- Diabetes mellitus. The risk of developing coronary artery disease is seriously increased for diabetics.
- Obesity. Excess weight increases the strain on the heart and increases the risk of developing coronary artery disease, even if no other risk factors are present. Obesity increases blood pressure and blood cholesterol, and can lead to diabetes.
- Stress and anger. Some scientists believe that stress and anger can contribute to the development of coronary artery disease. Stress increases the heart rate and blood pressure and can injure the lining of the arteries. Angina attacks often occur after anger, as do many heart attacks and strokes.

Angina symptoms include:

- A tight, squeezing, heavy, burning, or choking pain that is usually beneath the breastbone—the pain may spread to the throat, jaw, or one arm

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- A feeling of heaviness or tightness that is not painful
- A feeling similar to gas or indigestion
- Attacks brought on by exertion and relieved by rest.

If the pain or discomfort continues or intensifies, immediate medical help should be sought, ideally within 30 minutes.

TIA symptoms include:

- Sudden weakness, tingling, or numbness, usually in one arm or leg or both the arm and leg on the same side of the body, as well as sometimes in the face
- Sudden loss of coordination
- Loss of vision or double vision
- Difficulty speaking
- Vertigo and loss of balance.

Diagnosis

Diagnostic tests for myocardial ischemia include: resting, exercise, or ambulatory electrocardiograms; scintigraphic studies (radioactive heart scans); **echocardiography**; coronary **angiography**; and, rarely, **positron emission tomography**. Diagnostic tests for TIA include physician review of symptoms, **computed tomography scans** (CT scans), carotid artery ultrasound (**Doppler ultrasonography**), and **magnetic resonance imaging**. Angiography is the best test for ischemia of any organ.

An electrocardiogram (ECG) shows the heart's activity and may reveal a lack of oxygen. Electrodes covered with conducting jelly are placed on the patient's chest, arms, and legs. Impulses of the heart's activity are recorded on paper. The test takes about 10 minutes and is performed in a physician's office. About 25% of patients with angina have normal electrocardiograms. Another type of electrocardiogram, the exercise **stress test**, measures response to exertion when the patient is exercising on a treadmill or a stationary bike. It is performed in a physician's office or an exercise laboratory and takes 15 to 30 minutes. This test is more accurate than a resting ECG in diagnosing ischemia. Sometimes an ambulatory ECG is ordered. For this test, the patient wears a portable ECG machine called a Holter monitor for 12, 24, or 48 hours.

Myocardial perfusion scintigraphy and radionuclide angiography are nuclear studies involving the injection of a radioactive material (e.g., thallium) which is absorbed by healthy tissue. A gamma scintillation camera displays and records a series of images of the radioactive material's movement through the heart. Both tests are usually performed in a hospital's nuclear medicine department and take about 30 minutes to an hour. A perfusion scan is sometimes performed at the end of a stress test.

An echocardiogram uses sound waves to create an image of the heart's chambers and valves. The technician applies gel to a handheld transducer then presses it against the patient's chest. The heart's sound waves are converted into an image on a monitor. Performed in a cardiology outpatient diagnostic laboratory, the test takes 30 minutes to an hour. It can reveal abnormalities in the heart wall that indicate ischemia, but it doesn't evaluate the coronary arteries directly.

Coronary angiography is the most accurate diagnostic technique, but it is also the most invasive. It shows the heart's chambers, great vessels, and coronary arteries by using a contrast solution and x-ray technology. A moving picture is recorded of the blood flow through the coronary arteries. The patient is awake, but sedated, and connected to ECG electrodes and an intravenous line. A local anesthetic is injected. The cardiologist then inserts a catheter into a blood vessel and guides it into the heart. Coronary angiography is performed in a **cardiac catheterization** laboratory and takes from half an hour to two hours.

Positron emission tomography (PET) is a noninvasive nuclear test used to evaluate the heart tissue. A **PET** scanner traces high-energy gamma rays released from radioactive particles to provide three-dimensional images of the heart tissue. Performed at a hospital, it usually takes from one hour to one hour and 45 minutes. PET is very expensive and not widely available.

Computed tomography scans (CT scans) and magnetic resonance imaging (MRI) are computerized scanning methods. CT scanning uses a thin x-ray beam to show three-dimensional views of soft tissues. It is performed at a hospital or clinic and takes less than a minute. MRI uses a magnetic field to produce clear, cross-sectional images of soft tissues. The patient lies on a table which slides into a tunnel-like scanner. It is usually performed at a hospital and takes about 30 minutes.

Treatment

Angina is treated with drug therapy and surgery. Drugs such as nitrates, beta-blockers, and **calcium channel blockers** relieve chest pain, but they cannot clear blocked arteries. **Aspirin** helps prevent blood clots. Surgical procedures include percutaneous transluminal coronary **angioplasty** and **coronary artery bypass graft surgery**.

Nitroglycerin is the classic treatment for angina. It quickly relieves pain and discomfort by opening the

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coronary arteries and allowing more blood to flow to the heart. **Beta blockers** reduce the amount of oxygen required by the heart during stress. **Calcium** channel blockers help keep the arteries open and reduce blood pressure. Aspirin helps prevent blood clots from forming on plaques.

Percutaneous transluminal coronary angioplasty and coronary artery bypass graft surgery are invasive procedures which improve blood flow in the coronary arteries. Percutaneous transluminal coronary angioplasty is a non-surgical procedure in which a catheter tipped with a balloon is threaded from a blood vessel in the thigh into the blocked artery. The balloon is inflated, compressing the plaque to enlarge the blood vessel and open the blocked artery. The balloon is deflated and the catheter is removed. The procedure is performed by a cardiologist in a hospital and generally requires a two-day stay. Sometimes a metal stent is placed in the artery to prevent closing of the artery.

In coronary artery bypass graft, called bypass surgery, a detour is built around the coronary artery blockage with a healthy leg vein or chest wall artery. The healthy vein or artery then supplies oxygen-rich blood to the heart. Bypass surgery is major surgery appropriate for patients with blockages in two or three major coronary arteries or severely narrowed left main coronary arteries, as well as those who have not responded to other treatments. It is performed in a hospital under **general anesthesia** using a heart-lung machine to support the patient while the healthy vein or artery is attached to the coronary artery.

There are several experimental surgical procedures: **atherectomy**, where the surgeon shaves off and removes strips of plaque from the blocked artery; laser angioplasty, where a catheter with a laser tip is inserted to burn or break down the plaque; and insertion of a metal coil, called a stent, that can be implanted permanently to keep a blocked artery open. This stenting procedure is becoming more common. Another experimental procedure uses a laser to drill channels in the heart muscle to increase blood supply.

TIAs are treated by drugs that control high blood pressure and reduce the likelihood of blood clots and surgery. Aspirin is commonly used and anticoagulants are sometimes used to prevent blood clots. In some cases, carotid **endarterectomy** surgery is performed to help prevent further TIAs. The procedure involves removing arterial plaque from inside blood vessels.

The use of **chelation therapy**, a long-term injection by a physician of a cocktail of synthetic amino acid, ethylenediaminetetracetric acid, and **anticoagulant drugs** and nutrients, is controversial.

Alternative treatment

Ischemia can be life-threatening. Although there are alternative treatments for angina, traditional medical care may be necessary. Prevention of the cause of ischemia, primarily **atherosclerosis**, is primary. This becomes even more important for people with a family history of heart disease. Dietary modifications, especially the reduction or elimination of saturated fats (primarily found in meat), are essential. Increased fiber (found in fresh fruits and vegetables, grains, and beans) can help the body eliminate excessive cholesterol through the stools. Exercise, particularly aerobic exercise, is essential for circulation health. Not **smoking** will prevent damage from smoke and the harmful substances it contains.

Abana, a mixture of herbs and **minerals** used in **Ayurvedic medicine**, can reduce the frequency and severity of angina attacks. Western herbal medicine recommends hawthorn (*Crataegus laevigata* or *C. oxyacantha*) to relieve long-term angina, since it strengthens the contractility of the heart muscles. **Nutritional supplements** and botanical medicines that act as **antioxidants**, for example, **vitamins** C and E, selenium, gingko (*Gingko biloba*), bilberry (*Vaccinium myrtillus*), and hawthorn, can help prevent initial arterial injury that can lead to the formation of plaque deposits. Cactus (*Cactus grandiflorus*) is a homeopathic remedy used for pain relief during an attack. Mind/body relaxation techniques such as **yoga** and **biofeedback** can help control strong emotions and stress.

Prognosis

In many cases, ischemia can be successfully treated, but the underlying disease process of atherosclerosis is usually not "cured." New diagnostic techniques enable doctors to identify ischemia earlier. New technologies and surgical procedures can prevent angina from leading to a heart attack or TIA from resulting in a stroke. The outcome for patients with silent ischemia has not been well established.

Prevention

A healthy lifestyle, including eating right, getting regular exercise, maintaining a healthy weight, not smoking, drinking in moderation, not using illegal drugs, controlling **hypertension**, and managing stress are practices that can reduce the risk of ischemia progressing to a heart attack or stroke.

A healthy diet includes a variety of foods that are low in fat, especially saturated fat; low in cholesterol;

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KEY TERMS

Atherosclerosis—A process in which the walls of the arteries thicken due to the accumulation of plaque in the blood vessels. Atherosclerosis is the cause of most coronary artery disease.

Coronary artery disease—A narrowing or blockage, due to atherosclerosis, of the arteries that provide oxygen and nutrients to the heart. When blood flow is cutoff, the result is a heart attack.

Plaque—A deposit of fatty and other substances that accumulate in the lining of the artery wall.

Stroke—A sudden decrease or loss of consciousness caused by rupture or blockage of a blood vessel by a blood clot or hemorrhage in the brain. Ischemic strokes are caused by blood clots in a cerebral artery.

and high in fiber. Plenty of fruits and vegetables should be eaten and **sodium** should be limited. Fat should comprise no more than 30% of total daily calories. Cholesterol should be limited to about 300 mg and sodium to about 2,400 mg per day.

Moderate aerobic exercise lasting about 30 minutes four or more times per week is recommended for maximum heart health, according to the Centers for Disease Control and Prevention and the American College of Sports Medicine. Three 10-minute exercise periods are also beneficial. If any risk factors are present, a physician's clearance should be obtained before starting exercise.

Maintaining a desirable body weight is also important. People who are 20% or more over their ideal body weight have an increased risk of developing coronary artery disease or stroke.

Smoking has many adverse effects on the heart and arteries, so should be avoided. Heart damage caused by smoking can be improved by quitting. Several studies have shown that ex-smokers face the same risk of heart disease as non-smokers within five to ten years of quitting.

Excessive drinking can increase risk factors for heart disease. Modest consumption of alcohol, however, can actually protect against coronary artery disease. The American Heart Association defines moderate consumption as one ounce of alcohol per day–roughly one cocktail, one 8-ounce glass of wine, or two 12-ounce glasses of beer.

Commonly used illegal drugs can seriously harm the heart and should never be used. Even stimulants like ephedra and **decongestants** like pseudoephedrine can be harmful to patients with hypertension or heart disease.

Treatment should be sought for hypertension. High blood pressure can be completely controlled through lifestyle changes and medication. Stress, which can increase the risk of a heart attack or stroke, should also be managed. While it cannot always be avoided, it can be controlled.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, 800 242-8721, Review.personal.info@heart.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, 301 592-8573, 240 629-3246, http://www.nhlbi.nih.gov.

Texas Heart Institute. Heart Information Service, MC 3-116, PO Box 20345, Houston, TX, 77225, 832 355-4011, 800 292-2221, http://www.texasheart.org.

Lori De Milto

Isocarboxazid *see* **Monoamine oxidase inhibitors**

Isolation

Definition

Isolation refers to the precautions that are taken in the hospital to prevent the spread of an infectious agent from an infected or colonized patient to susceptible persons.

Purpose

Isolation practices are designed to minimize the transmission of infection in the hospital, using current understanding of the way infections can transmit. Isolation should be done in a user friendly, well-accepted, inexpensive way that interferes as little as possible with patient care, minimizes patient discomfort, and avoids unnecessary use.

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Precautions

The type of precautions used should be viewed as a flexible scale that may range from the least to the most demanding methods of prevention. These methods should always take into account that differences exist in the way that diseases are spread. Recognition and understanding of these differences will avoid use of insufficient or unnecessary interventions.

Description

Isolation practices can include placement in a private room or with a select roommate, the use of protective barriers such as masks, gowns and gloves, a special emphasis on handwashing (which is always very important), and special handling of contaminated articles. Because of the differences among infectious diseases, more than one of these precautions may be necessary to prevent spread of some diseases but may not be necessary for others.

The Centers for Disease Control and Prevention (CDC) and the Hospital Infection Control Practice Advisory Committee (HICPAC) have led the way in defining the guidelines for hospital-based infection precautions. The most current system recommended for use in hospitals consists of two levels of precautions. The first level is Standard Precautions which apply to all patients at all times because signs and symptoms of infection are not always obvious and therefore may unknowingly pose a risk for a susceptible person. The second level is known as Transmission-Based Precautions which are intended for individuals who have a known or suspected infection with certain organisms.

Frequently, patients are admitted to the hospital without a definite diagnosis, but with clues to suggest an infection. These patients should be isolated with the appropriate precautions until a definite diagnosis is made.

Standard Precautions

Standard Precautions define all the steps that should be taken to prevent spread of infection from person to person when there is an anticipated contact with:

- Blood
- Body fluids
- Secretions, such as phlegm
- Excretions, such as urine and feces (not including sweat) whether or not they contain visible blood
- Nonintact skin, such as an open wound
- Mucous membranes, such as the mouth cavity.

Standard Precautions includes the use of one or combinations of the following practices. The level of use will always depend on the anticipated contact with the patient:

- Handwashing, the most important infection control method
- Use of latex or other protective gloves
- Masks, eye protection and/or face shield
- Gowns
- Proper handling of soiled patient care equipment
- Proper environmental cleaning
- Minimal handling of soiled linen
- Proper disposal of needles and other sharp equipment such as scalpels
- Placement in a private room for patients who cannot maintain appropriate cleanliness or contain body fluids.

Transmission Based Precautions

Transmission Based Precautions may be needed in addition to Standard Precautions for selected patients who are known or suspected to harbor certain infections. These precautions are divided into three categories that reflect the differences in the way infections are transmitted. Some diseases may require more than one isolation category.

AIRBORNE PRECAUTIONS. Airborne Precautions prevent diseases that are transmitted by minute particles called droplet nuclei or contaminated dust particles. These particles, because of their size, can remain suspended in the air for long periods of time; even after the infected person has left the room. Some examples of diseases requiring these precautions are **tuberculosis**, **measles**, and **chickenpox**.

A patient needing Airborne Precautions should be assigned to a private room with special ventilation requirements. The door to this room must be closed at all possible times. If a patient must move from the isolation room to another area of the hospital, the patient should be wearing a mask during the transport. Anyone entering the isolation room to provide care to the patient must wear a special mask called a respirator.

DROPLET PRECAUTIONS. Droplet Precautions prevent the spread of organisms that travel on particles much larger than the droplet nuclei. These particles do not spend much time suspended in the air, and usually do not travel beyond a several foot range from the patient. These particles are produced when

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KEY TERMS

Colonized—This occurs when a microorganism is found on or in a person without causing a disease.

Disinfected—Decreased the number of microorganisms on or in an object.

Latex—A rubber material which gloves and condoms are made from.

Phlegm—Another word for sputum; material coughed up from a person's airways.

Stethoscope—A medical instrument for listening to a patient's heart and lungs.

a patient coughs, talks, or sneezes. Examples of disease requiring droplet precautions are meningococcal **meningitis** (a serious bacterial infection of the lining of the brain), **influenza**, **mumps**, and German measles (**rubella**).

Patients who require Droplet Precautions should be placed in a private room or with a roommate who is infected with the same organism. The door to the room may remain open. Health care workers will need to wear masks within 3 ft of the patient. Patients moving about the hospital away from the isolation room should wear a mask.

CONTACT PRECAUTIONS. Contact Precautions prevent spread of organisms from an infected patient through direct (touching the patient) or indirect (touching surfaces or objects that have been in contact with the patient) contact. Examples of patients who might be placed in Contact Precautions are those infected with:

- Antibiotic-resistant bacteria
- Hepatitis A
- Scabies
- Impetigo
- Lice-

This type of precaution requires the patient to be placed in a private room or with a roommate who has the same infection. Health care workers should wear gloves when entering the room. They should change their gloves if they touch material that contains large volumes of organisms such as soiled **dressings**. Prior to leaving the room, health care workers should remove the gloves and wash their hands with medicated soap. In addition, they may need to wear protective gowns if there is a chance of contact with potentially infective materials such as **diarrhea** or wound drainage that cannot be contained or if there is likely to be extensive contact with the patient or environment.

Patient care items, such as a stethoscope, that are used for a patient in Contact Precautions should not be shared with other patients unless they are properly cleaned and disinfected before reuse. Patients should leave the isolation room infrequently.

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Suzanne M. Lutwick, MPH

Isoniazid *see* **Antituberculosis drugs**
Isosorbide dinitrate *see* **Antiangina drugs**
Isotretinoin *see* **Antiacne drugs**
Isradipine *see* **Calcium channel blockers**

Itching

Definition

Itching is an intense, distracting irritation or tickling sensation that may be felt all over the skin's surface, or confined to just one area. The medical term for itching is pruritus.

Description

Itching instinctively leads most people to scratch the affected area. Different people can tolerate different amounts of itching, and anyone's threshold of tolerance can be changed due to **stress**, emotions, and other factors. In general, itching is more severe if the skin is warm, and if there are few distractions. This is why people tend to notice itching more at night.

Causes and symptoms

The biology underlying itching is not fully understood. It is believed that itching results from the interactions of several different chemical messengers. Although itching and **pain** sensations were at one time thought to be sent along the same nerve pathways, researchers reported the discovery in 2003 of itch-specific nerve pathways. Nerve endings that are specifically sensitive to itching have been named pruriceptors.

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Research into itching has been helped by the recent invention of a mechanical device called the Matcher, which electrically stimulates the patient's left hand. When the intensity of the stimulation equals the intensity of itching that the patient is experiencing elsewhere in the body, the patient stops the stimulation and the device automatically records the measurement. The Matcher was found to be sensitive to immediate changes in the patient's perception of itching as well as reliable in its measurements.

Stress and emotional upset can make itching worse, no matter what the underlying cause. If emotional problems are the primary reason for the itch, the condition is known as psychogenic itching. Some people become convinced that their itch is caused by a parasite; this conviction is often linked to burning sensations in the tongue, and may be caused by a major psychiatric disorder.

Generalized itching

Itching that occurs all over the body may indicate a medical condition such as **diabetes mellitus**, **liver disease**, kidney failure, **jaundice**, thyroid disorders (and rarely, **cancer**). Blood disorders such as leukemia, and lymphatic conditions such as Hodgkin's disease may sometimes cause itching as well.

Some people may develop an itch without a rash when they take certain drugs (such as **aspirin**, codeine, **cocaine**); others may develop an itchy red "drug rash" or **hives** because of an allergy to a specific drug. Some medications given to cancer patients may also cause itching.

Itching also may be caused when any of the family of hookworm larvae penetrate the skin. This includes swimmer's itch and creeping eruption caused by cat or dog hookworm, and ground itch caused by the "true" hookworm.

Many skin conditions cause an itchy rash. These include:

- Atopic dermatitis
- Chickenpox
- Contact dermatitis
- Dermatitis herpetiformis (occasionally)
- Eczema
- Fungus infections (such as athlete's foot)
- Hives (urticaria)
- Insect bites
- Lice
- Lichen planus
- Neurodermatitis (lichen simplex chronicus)
- Psoriasis (occasionally)
- Scabies.

On the other hand, itching all over the body can be caused by something as simple as bathing too often, which removes the skin's natural oils and may make the skin too dry and scaly.

Localized itching

Specific itchy areas may occur if a person comes in contact with soap, detergents, and wool or other rough-textured, scratchy material. Adults who have **hemorrhoids**, anal fissure, or persistent **diarrhea** may notice itching around the anus (called "pruritus ani"). In children, itching in this area is most likely due to worms.

Intense itching in the external genitalia in women ("pruritus vulvae") may be due to **candidiasis**, hormonal changes, or the use of certain spermicides or vaginal suppositories, ointments, or deodorants.

It is also common for older people to suffer from dry, itchy skin (especially on the back) for no obvious reason. Younger people also may notice dry, itchy skin in cold weather. Itching is also a common complaint during **pregnancy**.

Diagnosis

Itching is a symptom that is quite obvious to its victim. Someone who itches all over should seek medical care. Because itching can be caused by such a wide variety of triggers, a complete physical exam and medical history will help diagnose the underlying problem. A variety of blood and stool tests may help determine the underlying cause.

Treatment

Antihistamines such as diphenhydramine (Benadryl) can help relieve itching caused by hives, but will not affect itching from other causes. Most antihistamines also make people sleepy, which can help patients sleep who would otherwise be awake from the itch.

Specific treatment of itching depends on the underlying condition that causes it. In general, itchy skin should be treated very gently. While scratching may temporarily ease the itch, in the long run scratching just makes it worse. In addition, scratching can lead to an endless cycle of itch–scratch–more itching.

To avoid the urge to scratch, a person can apply a cooling or soothing lotion or cold compress when the urge to scratch occurs. Soaps are often irritating to the skin, and can make an itch

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KEY TERMS

Atopic dermatitis—An intensely itchy inflammation often found on the face of people prone to allergies. In infants and early childhood, it is called infantile eczema.

Creeping eruption—Itchy irregular, wandering red lines on the foot made by burrowing larvae of the hookworm family and some roundworms.

Dermatitis herpetiformis—A chronic very itchy skin disease with groups of red lesions that leave spots behind when they heal. It is sometimes associated with cancer of an internal organ.

Eczema—A superficial type of inflammation of the skin that may be very itchy and weeping in the early stages; later, the affected skin becomes crusted, scaly, and thick. There is no known cause.

Hodgkin's disease—A type of cancer characterized by a slowly-enlarging lymph tissue; symptoms include generalized itching.

Lichen planus—A noncancerous, chronic itchy skin disease that causes small, flat purple plaques on wrists, forearm, ankles.

Neurodermatitis—An itchy skin disease (also called lichen simplex chronicus) found in nervous, anxious people.

Pruriceptors—Nerve endings specialized to perceive itching sensations.

Pruritus—The medical term for itching.

Psoriasis—A common, chronic skin disorder that causes red patches anywhere on the body. Occasionally, the lesions may itch.

Scabies—A contagious parasitic skin disease characterized by intense itching.

Swimmer's itch—An allergic skin inflammation caused by a sensitivity to flatworms that die under the skin, causing an itchy rash.

worse; they should be avoided, or used only when necessary.

Creams or ointments containing cortisone may help control the itch from insect **bites**, **contact dermatitis** or **eczema**. Cortisone cream should not be applied to the face unless a doctor prescribes it.

Probably the most common cause of itching is dry skin. There are a number of simple things a person can do to ease the annoying itch:

- Do not wear tight clothes
- Avoid synthetic fabrics
- Do not take long baths
- Wash the area in lukewarm water with a little baking soda
- For generalized itching, take a lukewarm shower
- Try a lukewarm oatmeal (or Aveeno) bath for generalized itching
- Apply bath oil or lotion (without added colors or scents) right after bathing.

Itching may also be treated with whole-body medications. In addition to antihistamines, some of these systemic treatments include:

- tricyclic antidepressants
- sedatives or tranquilizers
- such selective serotonin reputake inhibitors as paroxetine (Paxil) and sertraline (Zoloft)
- binding agents (such as cholestyramine which relieves itching associated with kidney or liver disease).
- aspirin
- cimetidine

People who itch as a result of mental problems or stress should seek help from a mental health expert.

Alternative and complementary therapies

A well-balanced diet that includes carbohydrates, fats, **minerals**, proteins, **vitamins**, and liquids will help to maintain skin health. Capsules that contain eicosapentaenoic acid, which is obtained from herring, mackerel, or salmon, may help to reduce itching. Vitamin A plays an important role in skin health. Vitamin E (capsules or ointment) may reduce itching. Patients should check with their treating physician before using supplements.

Homeopathy has been reported to be effective in treating systemic itching associated with hemodialysis.

Baths containing oil with milk or oatmeal are effective at relieving localized itching. Evening primrose oil may soothe itching and may be as effective as **corticosteroids**. Calendula cream may relieve short-term itching. Other herbal treatments that have been recently reported to relieve itching include sangre de

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drago, a preparation made with sap from a South American tree; and a mixture of honey, olive oil, and beeswax.

Distraction, **music therapy**, relaxation techniques, and visualization may be useful in relieving itching. Ultraviolet **light therapy** may relieve itching associated with conditions of the skin, kidneys, blood, and gallbladder. There are some reports of the use of **acupuncture** and transcutaneous electrical nerve stimulators (TENS) to relieve itching.

Prognosis

Most cases of itching go away when the underlying cause is treated successfully.

Prevention

There are certain things people can do to avoid itchy skin. Patients who tend toward itchy skin should:

- Avoid a daily bath
- Use only lukewarm water when bathing
- Use only gentle soap
- Pat dry, not rub dry, after bathing, leaving a bit of water on the skin
- Apply a moisture-holding ointment or cream after the bath
- Use a humidifier in the home.

Patients who are allergic to certain substances, medications, and so on can avoid the resulting itch if they avoid contact with the allergen. Avoiding insect bites, bee **stings**, **poison ivy** and so on can prevent the resulting itch. Treating sensitive skin carefully, avoiding overdrying of the skin, and protecting against diseases that cause itchy **rashes** are all good ways to avoid itching.

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Rebecca J. Frey, PhD

IUD

Definition

An IUD is an intrauterine device made of plastic and/or copper that is inserted into the womb (uterus) by way of the vaginal canal. One type releases a hormone (progesterone), and is replaced each year. The second type is made of copper and can be left in place for five years. The most common shape in current use is a plastic "T" which is wrapped with copper wire.

Purpose

IUDs are used to prevent **pregnancy** and are considered to be 95-98% effective. It should be noted that IUDs offer no protection against the acquired immune deficiency syndrome (**AIDS**) virus or other **sexually transmitted diseases** (STDs).

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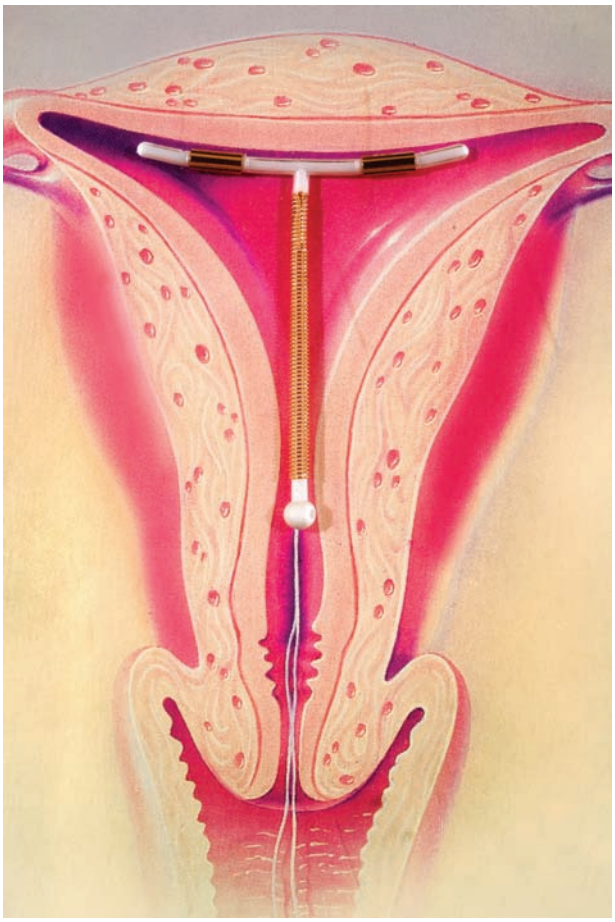

An intrauterine device, inserted and used as a form of birth control. *(© Spencer Grant/Alamy.)*

KEY TERMS

Antiseptic—A chemical that prevents the growth of germs.

Hormone—Chemicals that are produced in an organ or gland and then are carried by the blood to another part of the body where they produce a special effect for which they were designed.

Pap test—A procedure by which cells are collected from the cervix and vagina by inserting a swab into the vaginal canal. These cells are then examined under a microscope in order to detect signs of early cancer.

Precautions

IUDs are placed in the uterus by physicians. Prior to placement the doctor will take a medical history, do a **physical examination**, and take a **Pap test**. Women who have had tubal pregnancies, an abnormal Pap smear, or abnormal vaginal bleeding are generally disqualified from using this form of **contraception**. Also, women who have STDs, an allergy to copper, severe **pain** with periods (menstruation), sex with multiple partners, or who are currently pregnant are not eligible for an IUD. There are no age restrictions.

Description

There is continuing controversy over exactly how IUDs prevent pregnancy. Some researchers think pregnancy is controlled by preventing conception (fertilization), while others believe that the devices prevent embryo attachment to the uterine wall (implantation).

IUDs which release a hormone may prevent pregnancy in several ways. Since one hormonal response is a thickening of the mucous at the entrance to the uterus, it is more difficult for the sperm to gain entry. This prevents the sperm from reaching an ovum. At the same time, the lining of the uterus becomes thinner, making it more difficult for a fertilized egg to implant itself in the uterus. The copper device slowly releases copper which is believed to weaken and perhaps kill sperm. An alternate explanation is that these objects "sweep" the uterus, dislodging any fertilized egg that attempts to implant itself. In addition, both devices tend to cause a mild inflammatory reaction in the lining of the uterus which also has an adverse impact on implantation.

Preparation

After the physician approves the use of an IUD, the woman's genital area is washed thoroughly with soap and water in preparation of IUD insertion. The opening into the uterus (cervix) will also be cleaned with an antiseptic such as an iodine solution. Actual IUD insertion takes about five minutes, during which a **local anesthesia** is used to reduce any discomfort associated with the procedure. A plastic string connected to the IUD will hang out of the uterus into the vagina. The string is used to periodically check the position of the IUD.

Aftercare

The woman will be taught to watch for the signs and symptoms of potential complications and how to check the string, which should be done at least once a week. To check the string, the woman should first wash her hands with soap and water. From a squatting position, or with one foot elevated (such as on a chair), she should gently insert her finger into the vagina until she nears the cervix. If she cannot feel the string, if the string feels longer than

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it should, or if she can feel part of the IUD, she should notify her physician immediately. Additional information that needs to be reported includes painful intercourse and unusual discharge from the vagina.

Risks

Serious risks are rare, but include heavy bleeding, pain, infection, cramps, **pelvic inflammatory disease**, perforation of the uterus, and **ectopic pregnancy**.

ORGANIZATIONS

Planned Parenthood Federation of America, Inc., 434 West 33rd St., New York, NY, 10001, (212)541-7800, (212) 245-1845, (800) 230-7526, http://search.plannedparenthood.org.

Donald G. Barstow, RN

Ivory bones *see* **Osteopetroses**

Ivy method *see* **Bleeding time**

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J

Japanese encephalitis

Definition

Japanese **encephalitis** is an infection of the brain caused by a virus. The virus is transmitted to humans by mosquitoes.

Demographics

Many of these areas are in Asia, including Japan, Korea, China, India, Thailand, Indonesia, Malaysia, Vietnam, Taiwan, and the Philippines. Areas where the disease-causing arbovirus is always present are referred to as being endemic for the disease. In such areas, blood tests will reveal that more than 70% of all adults have been infected at some point with the arbovirus.

Because the virus that causes Japanese encephalitis is carried by mosquitoes, the number of people infected increases during those seasons when mosquitoes are abundant. This tends to be in the warmest, rainiest months. In addition to humans, wild birds and pigs are susceptible to infection with this arbovirus. Because the specific type of mosquito carrying the Japanese encephalitis arbovirus frequently breeds in rice paddies, the disease is considered to be primarily a rural problem.

About 45,000 cases of Japanese encephalitis are reported each year; however, the disease is thought to be seriously underreported. The disease is about 1.5 times more common in men than in women, possibly because men are likely to spend more time outdoors in areas where the disease is endemic. Cases in the United States are exceedingly rare (less than 1 case per year) and usually occur in military personnel or other Americans who have returned home after living in affected areas.

Description

The virus that causes Japanese encephalitis is called an arbovirus, which is an arthropod-borne virus. Mosquitoes are a type of arthropod. Mosquitoes in a number of regions carry this virus. The virus is passed to humans when the mosquitoes bite them. The disease cannot be passed directly from human to human, nor can it be passed directly from animals infected with the virus to human. Not all infections cause severe symptoms; in many cases the only symptoms are a **fever** and **headache**. In areas where the virus is common, most people become infected by the time they are young adults.

Causes and symptoms

The virus is transferred to a human when an infected mosquito sucks that person's blood. Once in the body, the virus travels to various glands where it multiplies. The virus can then enter the bloodstream. Ultimately, the virus settles in the brain, where it causes serious problems.

The time from becoming infected to starting to show symptoms (incubation period) usually is 5–15 days. Serious cases of Japanese encephalitis begin abruptly with fever, severe headache, **nausea**, and **vomiting**. As the tissue covering the brain and spinal cord (the meninges) becomes infected and swollen, the patient will develop a stiff and painful neck. By day two or three, the patient begins to suffer the effects of swelling in the brain. These effects include:

- problems with balance and coordination
- paralysis of some muscle groups
- tremors
- seizures
- lapses in consciousness
- a stiff, mask-like appearance of the face.

The patient becomes dehydrated and loses weight. If the patient survives the illness, the fever will decrease by about day seven and the symptoms will begin to improve by about day 14. Other patients will continue to have extremely high fevers and their symptoms will get worse. In these cases, **coma** and then **death** occur

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KEY TERMS

Encephalitis—A swelling of the brain, potentially causing serious brain damage.

Endemic—Naturally and consistently present in a certain geographical region.

in 7–14 days. Many patients who recover have permanent disabilities due to brain damage.

Diagnosis

Most diagnostic techniques for Japanese encephalitis do not yield results very quickly. The diagnosis is made primarily on the basis of the patient's symptoms and the knowledge of the kinds of illnesses endemic to a particular geographic region.

Tests

Immunofluorescence tests, where special viral markers react with human antibodies that have been tagged with a fluorescent chemical, are used to verify the disease. However, these results tend to be unavailable until week two of the infection. Other tests involve comparing the presence and quantity of particular antibodies in the blood or spinal fluid during week one with those present during week two of the illness.

Treatment

There are no treatments available to stop or slow the progression of Japanese encephalitis. Only the symptoms of each patient can be treated. Fluids are given to decrease **dehydration** and medications are given to decrease fever and **pain**. Medications are available to attempt to decrease brain swelling. Patients in a coma may require mechanical assistance with breathing.

Prognosis

While the majority of people infected with arbovirus never become seriously sick, those who develop Japanese encephalitis become very ill. Death ranges can range from 30–60%. A variety of long-term problems may haunt those who recover from the illness. These problems include:

- movement difficulties where the arms, legs, or body jerks or writhes involuntarily
- shaking
- paralysis
- inability to control emotions
- loss of mental abilities
- mental disturbances, including schizophrenia (which may affect as many as 75% of Japanese encephalitis survivors).

Young children are most likely to have serious, long-term problems after an infection.

Prevention

Two different vaccines are available for immunization against Japanese encephalitis. A three-dose vaccine is available for Japanese encephalitis and is commonly given to young children in areas where the disease is endemic. A two-dose vaccine can be give to people age 17 and older. Both vaccines are given over the period of a 28–30 days and should be completed at least 7–10 days before entering an area where the Japanese encephalitis virus is common.

The vaccine is not 100% effective, thus controlling the mosquito population with insecticides is an essential preventive measure. Visitors to regions with high rates of Japanese encephalitis should take precautions (like using mosquito repellents such as DEET and sleeping under a bed net) to avoid contact with mosquitoes.

Resources

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ORGANIZATIONS

United States Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (404) 639-3534, 800-CDC-INFO (800-232-4636). TTY: (888) 232-6348, inquiry@cdc.gov, http://www.cdc.gov.

World Health Organization, Avenue Appia 20, 1211 Geneva 27, Switzerland, +22 41 791 21 11, +22 41 791 31 11, info@who.int, http://www.who.int.

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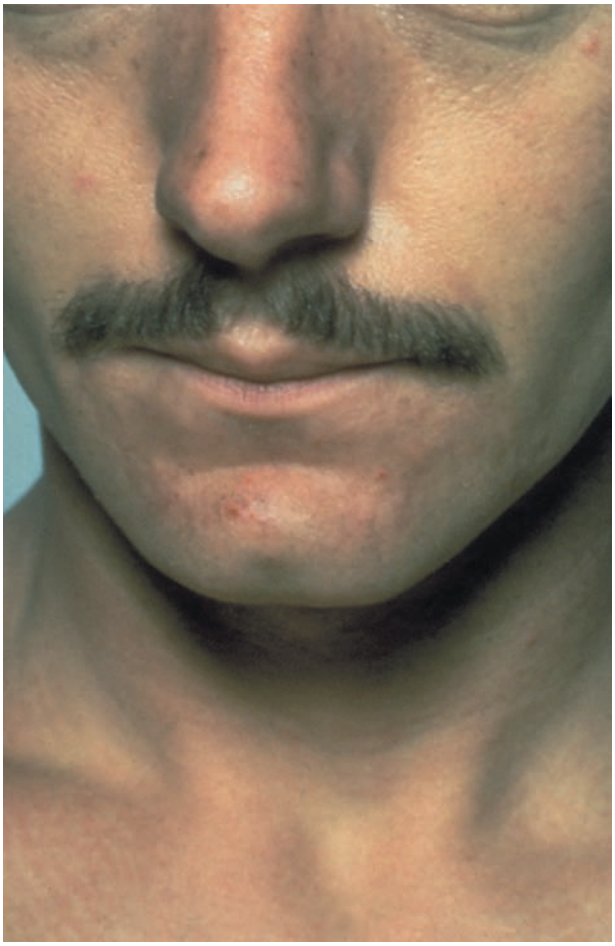
Jaundice

Definition

Jaundice is a condition in which the skin and whites of the eyes turn yellowish from increased levels of a waste product called bilirubin. Although jaundice is common in newborn infants, at any time after the first few weeks of life it can be a symptom of a serious underlying condition. Jaundice is sometimes called hyperbilirubinemia or icterus from the Greek word for the condition.

Demographics

Newborn jaundice affects more than half of all full-term newborns and 80% of premature newborns within the first few days of life, although only about 10% of newborns require treatment. Jaundice is often more severe in Asian and Native American infants. **Biliary atresia**, a congenital defect in the bile ducts that can cause severe hyperbilirubinemia in otherwise healthy infants, occurs in about one in every 15,000 live births and girls are slightly more at risk than boys.



This patient suffers from obstructive jaundice, which is often caused by gallstones. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Description

Bilirubin is a yellow pigment that is formed from the breakdown of hemoglobin—the oxygen-carrying protein in red blood cells (RBCs). RBCs normally are removed from the blood and broken down in the spleen and other parts of the body after about 120 days in circulation. About 1% of RBCs are normally broken down and replaced each day. Bilirubin is carried to the liver where it is attached or conjugated to another molecule and added to bile. Conjugated bilirubin is known as direct or soluble bilirubin and unconjugated bilirubin is known as indirect or insoluble bilirubin.

Bile that is formed in the liver passes into the network of hepatic bile ducts, which join to form a single tube. One branch of this tube carries bile to the gallbladder where it is stored and concentrated. When food enters the stomach, the gallbladder is stimulated to release bile to the intestines through the common bile duct. Before the common bile duct reaches the intestines, it is joined by a duct from the pancreas. Bile and pancreatic juice enter the intestine through a valve called the ampulla of Vater. After entering the intestine, bile and pancreatic secretions assist in digestion and bile is excreted in the stool. However if bilirubin accumulates in the blood rather than being excreted, it discolors tissues, turning the skin and whites of the eyes yellow.

Risk factors

Risk factors for newborn jaundice include:

- Asian or Native American parentage
- a parent or sibling who had high bilirubin levels at birth
- maternal diabetes
- premature birth
- induced labor
- birth at a high altitude
- bruising during birth
- excessive weight loss during the first few days after birth

Causes and symptoms

Although jaundice is always caused by a buildup of bilirubin in the blood and tissues, there are many different causes for this buildup. The causes can be divided into three categories based on where they

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A newborn baby undergoes phototherapy with visible blue light to treat his jaundice. *(Ron Sutherland/SPL/ Photo Researchers, Inc.)*

occur in the bilirubin cycle: before, in, or after the liver—pre-hepatic, hepatic, or post-hepatic.

The pre-hepatic cause of jaundice is hemolysis—the **death** of RBCs at a faster-than-normal rate, which releases hemoglobin and causes bilirubin to accumulate. The many causes of hemolysis include:

- Malaria. The malaria parasite develops inside RBCs and destroys them when it matures. Bilirubin can enter the urine in sufficient quantities to cause "blackwater fever," which is often lethal.
- Certain drugs. Hemolysis is a rare but sudden side effect of some antibiotics, anti-tuberculosis medications, drugs that regulate heartbeat, and levodopa for treating **Parkinson's disease**.
- Certain drugs in combination with an inherited deficiency in the enzyme glucose-6-phosphate dehydrogenase (G6PD). G6PD deficiency affects more than 200 million people worldwide. Some of the drugs listed above, as well as certain others, especially vitamins C and K and anti-malarial medications such as quinine, can cause hemolysis in people with G6PD deficiency.
- Poisons. Snake and spider venoms, certain bacterial toxins, copper, and some organic industrial chemicals cause hemolysis by directly attacking RBC membranes.
- Artificial heart valves. The inflexible moving parts of artificial heart valves damage RBCs.
- Hereditary RBC disorders. Sickle cell disease, which results in abnormal hemoglobin, spherocytosis, which weakens the outer membrane of RBCs, and various other inherited defects that affect the internal chemistry of RBCs can all cause hemolysis.
- Enlargement of the spleen. The spleen filters the blood and destroys old RBCs. If it becomes enlarged, healthy RBCs also are filtered out resulting in hemolysis. A wide variety of conditions can cause enlargement of the spleen.
- Diseases of the small blood vessels. As the RBCs move through diseased capillaries they can be damaged by rough surfaces on the inside of vessel walls.
- Immune reactions. The immune system can produce antibodies that destroy RBCs.
- Blood transfusions. Hemolysis can result from a transfusion with an incompatible blood type.
- Kidney failure and other serious diseases. Several diseases cause defective blood coagulation that destroys RBCs.
- Erythroblastosis fetalis. This results from too many immature RBCs (erythroblasts) in a newborn, usually because of a blood factor incompatibility between the mother and infant that causes maternal antibodies to destroy the newborn's RBCs.

Newborn jaundice results from both pre-hepatic and hepatic sources of excess bilirubin. At birth the newborn immediately begins converting from fetal to adult-type hemoglobin. The removal of the fetal hemoglobin can overload the immature liver for a week or two after birth, resulting in excess bilirubin and jaundice. Bilirubin gives a newborn's stools their yellow color. Jaundice usually appears first on the face, on the third or fourth day after birth, and progresses downward to the chest, abdomen, legs, and feet. If newborn feeding is delayed for any reason, such as illness, a digestive tract problem, or low fluid intake due to inefficient **breastfeeding**, the infant produces fewer stools, which can result in critically high blood levels of bilirubin and severe jaundice.

Jaundice at birth or within the first 24 hours can be a sign of abnormal jaundice, which can be very dangerous, particularly in preterm or unhealthy

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KEY TERMS

Ampulla of Vater—The widened portion of the duct through which bile and pancreatic juices enter the intestine. Ampulla is a Latin word for a bottle with a narrow neck that opens into a wide body.

Anemia—A deficiency in hemoglobin, red blood cells, or total blood volume.

Bile—A liquid secreted by the liver and passed through ducts to the small intestine where it aids in the digestion and absorption of fats.

Biliary atresia—The underdevelopment or absence of bile ducts.

Biliary system/bile ducts—The gall bladder and the system of tubes that carries bile from the liver into the intestine.

Bilirubin—A reddish-yellow pigment that is a breakdown product of hemoglobin and is excreted by the liver into the bile.

Cirrhosis—Disruption of liver function due to damage from chronic progressive disease.

Crigler-Najjar syndrome—A moderate to severe form of hereditary jaundice.

Erythroblastosis fetalis—A disorder of newborn infants marked by a high level of immature red blood cells (erythroblasts).

Gilbert's syndrome—A mild hereditary form of jaundice.

Glucose-6-phosphate dehydrogenase (G6PD) deficiency—A hereditary disorder that, in combination with certain medications, can lead to episodes of hemolytic anemia.

Hemoglobin—The red substance in blood cells that carries oxygen.

Hemolysis—The destruction or breakdown of red blood cells.

Hepatic—Referring to the liver.

Hepatitis—Inflammation of the liver or the disease or condition causing liver inflammation.

Hyperbilirubinemia —An excess of bilirubin in the blood.

Icterus—Jaundice.

Microangiopathic—Pertaining to disorders of the small blood vessels.

Pancreas—The organ beneath the stomach that produces digestive juices, insulin, and other hormones.

Sickle cell disease—A hereditary defect in hemoglobin that changes the shape of red blood cells.

Splenectomy—Surgical removal of the spleen.

newborns. **Erythroblastosis fetalis** is the most common cause of abnormal newborn jaundice.

Other causes of hepatic jaundice include a variety of liver diseases in which the damaged organ cannot to keep up with bilirubin processing. These hepatic causes of jaundice include:

- starvation
- circulating (systemic) infections
- certain medications
- hepatitis
- cirrhosis
- hereditary defects in liver chemistry, including Gilbert's syndrome and Crigler-Najjar syndrome

Obstructive jaundices are post-hepatic forms caused by failure of soluble bilirubin to reach the intestines after leaving the liver. The most common cause of obstructive jaundice is **gallstones** in the ducts of the biliary system. Other causes of obstructive jaundice include:

- birth defects such as biliary atresia or infections that damage the bile ducts
- drugs
- cancers
- physical injury
- certain drugs—and rarely, pregnancy—that simply cause the bile in the ducts to stop flowing

Jaundice has no symptoms other than discoloration of the skin and eyes and is usually harmless, although the underlying condition may cause other symptoms and complications. However if unconjugated bilirubin reaches the newborn brain, it can cause permanent damage. Prolonged jaundice can also upset the balance of chemicals in the bile and cause the formation of stones.

Diagnosis

Examination

Jaundice is usually evident from the yellowish tint of the eyes and complexion. All newborns are examined under good light for signs of jaundice. The physician will feel (palpate) the liver and spleen to check for

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enlargement and evaluate any abdominal **pain**. The location and severity of abdominal pain and the presence or absence of **fever** help distinguish between hepatic and obstructive jaundice.

Tests

Blood tests measure the levels of total and/or conjugated bilirubin in the blood. Total bilirubin in the blood serum is normally between 0.3 milligrams (mg) per deciliter (dL) and 1.9 mg/dL. Conjugated or direct bilirubin is normally 0–0.3 mg/dL. Jaundice occurs when the total bilirubin level rises to 3 mg/dL or higher. It may be necessary to repeatedly measure bilirubin levels in jaundiced newborns because of the danger of insoluble bilirubin reaching the brain. An instrument called a bilirubinometer can be held against the infant's skin to assess the level of jaundice, eliminating the need for blood tests.

Additional tests may include:

- blood cell counts to detect anemia
- tests for blood-clotting function
- tests for excess destruction of RBCs
- blood tests to assess liver function
- urine and stool samples to check for signs of bacterial or viral infection

Procedures

Various procedures may be used to diagnose a disorder underlying jaundice:

- Sometimes a bone marrow biopsy is necessary to diagnose blood-formation disorders.
- Ultrasound or a nuclear scan may be used to evaluate the spleen.
- A liver biopsy may be necessary to diagnose liver disease. A thin needle is used to remove a tiny core of liver tissue, which is sent to the laboratory for microscopic examination.
- Computed tomography (CT) or magnetic resonance imaging (MRI) scans are very useful for imaging certain conditions such as cancers in and around the liver or gallstones in the common bile duct.
- Various imaging techniques can be used to diagnose diseases of the biliary system. X rays for obtaining functional as well as anatomical information are taken one day after swallowing a contrast agent that is secreted into the bile. Alternatively contrast dye can be injected directly into the bile ducts, through a thin needle pushed into the liver or through a scope that is passed through the stomach to inject the dye into the ampulla of Vater.

Treatment

Traditional

Jaundice itself is treated only in newborns with dangerously high bilirubin levels. In the past it was necessary to exchange most of the infant's blood. Now the newborn can be fitted with eye protection and placed under a high-intensity, cool, blue-fluorescent light. The light is absorbed by the bilirubin and converts it into a harmless form than can be excreted in the bile and urine. Other **phototherapy** methods—such as a fiber optic bilirubin blanket—incorporate the light into a blanket so that the child can be breastfed during treatment or treated at home. Frequent feedings lead to more frequent stools, which reduces the reabsorption of bilirubin from the intestines into the blood. The infant also may be given additional fluids, possibly intravenously, to help remove bilirubin.

Obstructive jaundice frequently requires surgery. Surgery for biliary atresia must be performed within the first few weeks of life to prevent fatal liver damage. A common technique is to stitch an open piece of intestine over a bare patch of liver. Tiny bile ducts in that part of the liver will begin to discharge their bile into the intestine and pressure from the obstructed ducts elsewhere will release in that direction. As the bile flow increases, the ducts grow to accommodate it until all of the bile is redirected through the open pathways.

There are a variety of treatments for other conditions underlying jaundice:

- Any medications that are causing hemolysis or arresting the flow of bile are stopped immediately.
- Hemolytic diseases are treated, if at all, with medications and blood transfusions, except in the case of an enlarged spleen. Surgical removal of the spleen (splenectomy) can sometimes cure hemolytic anemia.
- Although there are no specific cures for most liver diseases, the liver can recover from even severe damage and regenerate from only a small remnant of original tissue.

Prognosis

Prognosis depends on the condition underlying the jaundice. Normal newborn jaundice is not harmful and disappears after one–two weeks. In cases of severe newborn jaundice, phototherapy usually returns bilirubin levels to normal within a few days. Infants with a duct obstruction within the liver itself usually require a liver transplant by the age of two.

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Prevention

Prevention of jaundice involves preventing the underlying condition:

- Malaria in tropical or subtropical countries can often be prevented by precautions such as bed nets treated with insecticides or mosquito repellants and prophylactic drugs such as mefloquine.
- Hemolytic side effects from medications can be minimized with early detection and immediate cessation of the drug.
- G6PD-deficiency hemolysis can be prevented by testing patients before administering the causative drugs.
- Erythroblastosis fetalis can be prevented by treating an Rh-negative mother with a gamma-globulin solution called RhoGAM if there is a possibility that she is developing antibodies against her baby's blood.

The American Academy of Pediatrics recommendations for identifying and managing **neonatal jaundice** include:

- assessing all newborns for risk of severe jaundice, including measuring bilirubin levels before hospital discharge
- a follow-up visit within three–five days after birth when bilirubin levels are likely to peak
- breastfeeding a newborn at least eight–12 times per day, since effective breastfeeding significantly reduces the risk of hyperbilirubinemia

Resources

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ORGANIZATIONS

American Academy of Pediatrics, 141 Northwest Point Blvd., Elk Grove Village, IL, 60007-1098, (874) 434-4000, (874) 434-8000, kidsdocs@aap.org, http://www.aap.org.

American Liver Foundation, 75 Maiden Lane, Suite 603, New York, NY, 10038, (212) 668-1000, (212) 483-8179, http://www.liverfoundation.org.

National Institute of Diabetes and Digestive and Kidney Diseases, Building 31, Room 9A06, 31 Center Drive, MSC 2560, Bethesda, MD, 20892-2560, (301) 496-3583, http://www2.niddk.nih.gov.

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Jaw wiring

Definition

Jaw wiring, also known as maxillomandibular fixation, is a surgical procedure where metal pins and wires are anchored into the jaw bones and surrounding tissues to keep the jaw from moving.

Purpose

Sports injuries, automobile accidents, falls, or fistfights are a few of the situations where the jaw might be fractured or broken. In these cases, jaw wiring may be necessary to keep the bones aligned and stable while the jaw heals. The presence of **cancer** or other diseased tissues may make removal and reconstruction of the jaw necessary. Wiring the jaws shut has been used in the past as a weight loss aid in cases of extreme **obesity** where other treatments had failed, although this procedure is rarely used for that purpose today.

Precautions

Traumatic injuries to the face can cause damage to facial nerves and salivary glands and ducts. These injuries can also leave **scars** that may require additional surgery to correct.

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KEY TERMS

Oral and maxillofacial surgeon—A dentist who is trained to perform surgery to correct injuries, defects, or conditions of the mouth, teeth, jaws, and face.

Otolaryngologist—A doctor who is trained to treat injuries, defects, or conditions of the head and neck.

Description

Jaw wiring surgery can be performed by an oral or maxillofacial surgeon (a specially trained dentist), or by an otolaryngologist (a doctor specializing in surgeries of the head and neck). The procedure may be done in a medical or dental office if the office is staffed and equipped to handle this type of surgery. More often, this surgery is performed in a hospital or medical center surgical area. If jaw wiring is required due to an injury, the surgeon may set the fracture immediately before swelling sets in. It is also possible to wait (up to several weeks) until the swelling goes down and some of the soft tissue injuries have healed, prior to wiring the jaw fracture.

The surgeon realigns the fractured bones. Every effort is made to restore the shape and appearance of the original jaw line. If any teeth were damaged, repair or replacement may be done at the same time. Small incisions may be made through the skin and surrounding tissue so the pins and wires can be set into the jawbone to hold the fracture together. To prevent the lower jaw from moving during healing, pins and wires may be inserted into the top jaw, as well. The upper and lower jaws are then wired together in order to stabilize the fracture.

As with other types of bone **fractures**, the jaw may take several weeks to heal. Another type of jaw immobilization that has been developed more recently, rigid fixation uses small metal plates and screws rather than pins and wires to secure the jaw bones. The main benefit of this technique is that the jaws do not have to be wired shut, allowing the patient to return to a more normal lifestyle sooner.

Preparation

X rays of the fractured area may be taken prior to surgery. Depending on the extent of the facial injury or condition to be corrected, the patient may receive a sedative for relaxation, a local anesthetic drug to numb the area, and/or an anesthetic agent to induce unconsciousness prior to the surgery.

Aftercare

A patient whose jaw has been wired will not be able to eat solid foods for several weeks. In order for the bone and surrounding tissues to heal, it is important to maintain adequate **nutrition**. A liquid diet that can be consumed through a straw, will be required. Soft, precooked foods can be liquefied in a blender, however, it may be difficult for the patient to consume adequate calories, protein, **vitamins**, and **minerals** with this type of diet. Liquid diet formulas may be a good alternative. The patient will also have to be taught how to care for the mouth, teeth, and injured area while the wires are in place.

Risks

It is possible that scarring may occur due to the need to make small incisions in the skin in order to insert the wires. With any surgical procedure, there are risks associated with the anesthetic drugs used and the possibility of infection. If there is a risk that the patient may vomit, the jaw wiring may pose a **choking** hazard. It may be recommended that wire cutters be kept available in case the wires need to be cut in an emergency situation.

Resources

OTHER

"Know the Score on Facial Sports Injuries." *The Virtual Hospital Page*. University of Iowa. http://www.entassociates.com/facial_injuries.htm.

"Topic: Maxillofacial Trauma." *Connecticut Maxillofacial Surgeons Page*. http://www.cmsllc.com/toptrm.html.

ORGANIZATIONS

American Association of Oral & Maxillofacial Surgeons, 9700 West Bryn Mawr Avenue, Rosemont, IL, 60018-5701, (847) 678-6200, (847) 678-6286, (800) 822-6637, http://www.aaoms.org.

American Dental Association, 211 E. Chicago Ave., Chicago, IL, 60611-2678, (312) 440-2500, http://www.ada.org.

Altha Roberts Edgren

JC virus infection *see* **Progressive multifocal leukoencephalopathy**

Jejunostomy *see* **Enterostomy**

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Jet lag

Definition

Jet lag, also sometimes called desynchronosis, is a physiological condition marked by **fatigue**, **insomnia**, and irritability that is caused by air travel—usually going from east to west or from west to east—through many changing time zones. It is classified as a circadian rhythm sleep disorder because it alters (disrupts) the natural circadian rhythm ("internal body clock") in humans. The temporary condition is primarily caused by air travel across several time zones, but can also be caused by shift work or other factors. Jet lag comes about from the inability of the internal body clock to adjust quickly enough to drastic changes in the normal sleep and wake cycle. Usually it lasts only for a few days but it can last longer depending on the length of travel and the steps taken to counter it.

Generally, jet lag lasts longer when traveling west to east, than it does when flying east to west. A general relationship is: jet lag lasts two-thirds of a day for each time zone crossed while flying eastward, and lasts one-half of a day for each time zone crossed while heading westward. Thus, flying westward across two time zones would cause jet lag for about one day for the average air traveler.

Demographics

The condition called jet lag can occur in air travelers of all ages and genders when they travel across several time zones. Prior research does not support the contention that it affects those of one age more than another. However, medical studies do show that women are at higher risk than men for getting jet lag, primarily due to the higher levels of estrogen in women's bodies. Exposure to natural light after completing a long trip usually helps to accelerate the adaption process, especially when travel is over three or more time zones.

Description

The natural circadian rhythm in humans is located in the suprachiasmatic nuclei at the base of the hypothalamus, all within the brain. The suprachiasmatic nuclei contain receptors that receive melatonin, which is manufactured in the pineal gland. Melatonin is released based on the amount of darkness or light in one's local environment. More of it is released during the night and less during the day. Consequently, a person's sleep and wake cycle (or "internal body clock") is established by this relationship with the manufacture and release of melatonin based on dark and light cycles.

Over millions of years living organisms have become accustomed to periods of night and day alternating at set intervals. Thus, they (both plants and animals) have a tendency to operate on an approximate 24-hour cycle based on the cycles of sunlight and darkness. Most of the human body's regulating hormones follow this cycle, known as circadian rhythm. The word circadian comes from the Latin, *circa*, meaning about, and *dies*, meaning day. These cycles are not exactly 24 hours long, hence the "circa." Each chemical has its own cycle of highs and lows, interacting with and influencing the other cycles. Characteristics such as body temperature, sleepiness, thyroid function, growth hormone, metabolic processes, adrenal hormones, and the sleep hormone melatonin cycle with daylight. A direct connection exists between the retina (where light hits the back of the eye) and the part of the brain that controls all these hormones. Artificial light has some effect, but sunlight has much more.

When people are without clocks in a compartment that is completely closed to sunlight, most of them fall into a circadian cycle of about 25 hours. Normally, all the regulating chemicals follow one another in order like threads in a weaving pattern. Every morning the sunlight resets the cycle, stimulating the leading chemicals and thus compensating for the difference between the 24-hour day and the 25-hour innate rhythm.

When traveling through a number of time zones, most people reset their rhythms within a few days, demonstrating the adaptability of the human species. Some people, however, have upset rhythms that last much longer. Whatever the period of adjustment, the experience can cause biological and brain wave activity that tries to cope with the new situation. During this coping period, the human undergoing jet lag may feel irritable, fatigue, and disorientiation.

Causes and symptoms

Jet lag is primarily caused by the direction of travel and the number of time zones crossed. However, it can also be affected by a person's ability (or inability) to sleep just before, during, and just after traveling; tolerance (or intolerance) to air travel, and the similarity (or difference) of the natural day-and-night cycle between the departing and arriving locations.

Flying north or south, such as from Chicago, Illinois, to Houston, Texas, does not generally cause jet lag because a time zone has not been changed and periods of night and day have not changed. However, flying east or west, such as from New York City to Los Angeles, does cause jet lag in people. Traveling west to east is generally considered to be more disruptive than

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travel from east to west. This difference occurs because the circadian cycle is pushed forward (earlier time zone) rather than back (later time zone) when traveling west to east as compared to traveling east to west. Thus, as people travel to places where daylight and darkness are different from what they are used to, then the body's clock becomes disrupted and jet lag occurs. However, flying north or south can cause jet jag when travel changes the normal period of darkness to daytime and the normal period of sunlight to night–time, such as when traveling from Denver, Colorado, in the Northern Hemisphere, to Lima, Peru, in the Southern Hemisphere.

When jet lag occurs, the body's natural pattern is upset. Such things as sleep, body temperature, and hormone regulation are no longer in synchronization to the new environment. Consequently, it takes the human body a period of adjustment to realign itself to its new locality. Traveling through a few time zones at a time is not as disruptive to circadian rhythms as traveling around the world can be. The foremost symptom of jet lag is altered sleep pattern—sleepiness during the day, and insomnia during the night. Jet lag may also include **indigestion** and trouble concentrating. Individuals afflicted by jet lag will alternate in and out of a normal day-night cycle.

It may take one person several days to adjust to a new time zone, while another person may not even experience any problems. Generally, one or two new time zones will not cause problems, but more than that number will usually cause some symptoms identified with jet lag.

Symptoms associated with jet lag include: fatigue, insomnia, irritability, **anxiety** or mild depression, **nausea**, **headache**, disorientation, loss of appetite, **diarrhea** or **constipation** (along with general gastrointestinal disturbances), reduced ability (or inability) to perform common physical and mental tasks, and decreased ability to concentrate. Disorientation and fatigue are the two most common symptoms of jet lag.

Shift work is another cause of what is called jet lag, although it has nothing to do with flying in an airplane. Many people work shifts that are not the customary time during the daylight hour, which is usually called first shift (or day work). They may work a second shift from late in the afternoon to the middle of the night, say, from 5 p.m. to 2 a.m. In another scenario, a person might work a third shift from the middle of the night to early in the morning, for example, from midnight to 8 a.m. In either case, such changes in the normal schedule of being awake during sunlight hours and sleeping during darkness can cause symptoms very similar to jet lag. These symptoms can be worsened when shift work is changed over a week, for instance, five days of working third shift but a two-day weekend where the worker tries to resume a normal life.

Treatment

Current treatments

In cases of short-term insomnia triggered by jet lag, a physician may recommend over-the-counter (OTC) sleeping pills or prescription medication. These medicines may help to counter the biological imbalance caused by jet lag. However, they can cause adverse side effects. Thus, such medication should only be taken under the guidance of a health care professional.

Investigational treatments

A medication that is considered investigational is a melatonin agonist known as LY 156735 (PD–6735). An agonist is a drug that stimulates activity at cell receptors that are normally stimulated by such naturally occurring substances as melatonin. LY 156735 was found to speed up the re–adaptation time of volunteer subjects following a simulated nine–hour time shift. As of 2010, it is still under development as a treatment for jet lag, insomnia, and other such **sleep disorders**. Melatonin is thought to increase the ability to drift off to sleep but it not believed to help in increasing the amount of sleep one gets. It is not regulated by the Food and Drug Administration (FDA) but may be bought at health food stores and other such retail stores. Consult a medical professional before trying such drugs.

Another area of research involves the genes that encode the proteins governing circadian rhythms. It is known that differences among individuals in adaptability to time zone changes are to some extent genetically determined. Targeting the genes that affect this adaptability may yield new treatments for jet lag and other disorders of circadian rhythm. As of 2010, these medical studies are still underway.

Alternative treatment

Exposure to bright morning sunlight cures jet lag after a few days in most people. A few will have prolonged sleep phase difficulties. For these, a curious treatment has achieved success. By forcing one's self into a 27-hour day, complete with the appropriate stimulation from bright light, all the errant chemical cycles will be able to catch up during one week.

When selecting an international flight, individuals should try to arrange an early evening arrival in their destination city. When an individual is traveling to a destination in the east, he or she can try going to bed and waking up a few hours earlier several days before

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KEY TERMS

Agonist—A medication that has an affinity for and stimulates the activity of cell receptors that are normally stimulated by naturally occurring substances, including melatonin.

Circadian—Pertaining to biological rhythms occurring at approximately 24-hour intervals. Jet lag is caused by a disruption of the human body's circadian clock.

Hormone—A chemical made in one part of the body that has an effect on another part.

Melatonin—A hormone that helps to regulate circadian rhythms.

their flight. If travel is to the west, going to bed and waking up later than usual can help the body start to adjust to the upcoming time change.

The following precautions taken during an international flight can help to limit or prevent jet lag:

- Stay hydrated. Drink plenty of water and juices to prevent dehydration. Beverages and foods with caffeine should be avoided because of their stimulant properties. Alcohol should also be avoided.
- Stretch and walk. As much movement as possible during a flight helps circulation, which moves nutrients and waste through the body and aids in elimination.
- Stay on time. Set watches and clocks ahead to the time in the destination city to start adjusting to the change.
- Eat a light snack upon arrival at the destination.
- Get as much natural sunlight as possible to help reset one's biological clock. Do not stay inside because avoidance of sunlight makes matters worse.
- Sleep smart. Draw the shade and sleep during the evening hours in the destination city, even if it is still daylight outside of the airplane. Earplugs and sleep masks may be helpful in blocking noise and light. Many airlines provide these items on international flights.
- Dress comfortably. Wear or bring comfortable clothes that will make sleeping during the flight easier.

Once arriving in their destination city, individuals should spend as much time outdoors in the sunlight as possible during the day to reset their internal clock and lessen the symptoms of jet lag. Bedtime should be postponed until at least 10 P.M., with no daytime naps. If a daytime nap is absolutely necessary, it should be limited to no more than two hours.

To promote a restful sleeping environment in a hotel setting, individuals should request that the hotel desk hold all phone calls. Because sleeping in too late can also prolong jet lag, an early wake-up call should be requested if an alarm clock is not available. If the hotel room is noisy, a portable white noise machine can help to block outside traffic and hallway noises. A room air conditioner or fan can serve the same purpose. The temperature in the room should also be adjusted for sleeping comfort.

All **antioxidants** help to decrease the effects of jet lag. Extra doses of **vitamins** A, C, and E, as well as zinc and selenium, two days before and two days after a flight help to alleviate jet lag. Melatonin, a hormone which helps to regulate circadian rhythms, can also help to combat jet lag. Melatonin is available as an over-the-counter supplement in most health food stores and pharmacies, but no more than 3 milligrams (mg) should be used in a 24-hour period.

If weather prevents an individual from spending time in the sunlight, **light therapy** may be beneficial in decreasing jet lag symptoms. Light therapy, or **phototherapy**, uses a device called a light box, which contains a set of fluorescent or incandescent lights in front of a reflector. Typically, the patient sits for 30 minutes next to a 10,000-lux box (which is about 50 times as bright as an ordinary indoor light; lux is a measurement for illuminance). Light therapy is safe for most people, but those with eye diseases should consult a healthcare professional before undergoing the treatment.

Prognosis

Jet lag usually lasts 24–48 hours after travel has taken place. In that short time period, the body adjusts to the time change, and with enough rest and daytime exposure to sunlight, it returns to normal circadian rhythm.

According to the American Sleep Association, almost 93% of travelers will experience jet lag at some point in their travels. Generally, the human body will take one–half to one day to completely adapt to its new surroundings for every one time zone crossed. However, this relationship can vary drastically depending on individuals. For instance, frequent air travelers may have not have any symptoms of jet lag after years of flying, while people on their first flight may be already very

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nervous and anxious about their trip and may experience debilitating jet lag.

Prevention

One cannot prevent jet lag, but it can be minimized with the following recommendations. Eat a nutritious diet (foods do not have an effect on jet lag but eating healthy can assist the body to counter changes that it experiences while flying), and get plenty of rest and **exercise** before the flight. Exercising and sleeping are also two excellent ways to minimize jet lag. For any medical conditions that may cause problems during and after the flight, visit the doctor beforehand to prepare for such problems. It is always advisable to start preparing for one's new time zone before actually going. Adapt to the new time gradually over the days, or weeks, before the flight.

During the flight, do not drink alcoholic beverages and drinks with **caffeine**. Both beverages can increase the symptoms of jet lag. On the other hand, drink plenty of water to avoid **dehydration** that is present in the cabin of airplanes. For long journeys, move around inside the airplane on a regular basis. While in the seat, exercise the legs. For travelers able to take extra time in their flight, stay overnight in an in-between city.

Melatonin is still under consideration by the U.S. Food and Drug Administration (FDA) as to being effective or not in minimizing or even preventing jet lag. The nutritional supplement has been shown in some medical studies to be effective when 0.5 to 5 milligrams (mg) of melatonin are taken during the first few days of air travel. However, as of July 2010, the FDA does not regulate it, and caution is advised for its use in countering jet lag. The FDA has also found that some melatonin products, especially those found on the Internet, have been found to contain contaminants that may cause unforeseen problems if taken by unsuspecting air travelers.

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ORGANIZATIONS

American Academy of Sleep Medicine, 2510 North Frontage Rd., Darien, IL, 60561, (630) 737–9700, (630) 737–9790, http://www.aasmnet.org.

National Sleep Foundation, 1522 K St., NW, Suite 500, Washington, DC, 20005, (202) 347–3471, (202) 347–3472, nsf@sleepfoundation.org, http://www.sleepfoundation.org.

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Jock itch

Definition

Also known as *Tinea cruris*, jock itch is a growth of fungus in the warm, moist area of the groin.

Description

Although there are many causes of jock itch, this term has become synonymous with *tinea cruris*, a common fungal infection that affects the groin and inner thighs of men and woman. *Tinea* is the name of the fungus; *cruris* comes from the Latin word for leg. Jock itch can develop when tight garments trap moisture and heat. This creates an environment in which fungi multiply and flourish. Athletes often get jock itch but non-athletic men who sweat a lot can also get it. Jock itch occurs more commonly in men, but can affect women as well. The jock itch fungus may cause a rash on the upper and inner thighs, the armpits, and the area just underneath the breasts. Many people with *tinea cruris* also have **athlete's foot**. Athlete's foot is called *tinea pedis*.

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KEY TERMS

Fungus—A single-celled or multi-celled organism without chlorophyll that reproduces by spores and lives by absorbing nutrients from organic matter.

Scrotum—The external pouch of skin and muscle containing the testes (testicles).

Vaginal yeast infection—An overgrowth of fungus in the vaginal area.

Causes and symptoms

The rash of jock itch starts in the groin fold usually on both sides. If the rash advances, it usually advances down the inner thigh. The advancing edge is redder and more raised than areas that have been infected longer. The advancing edge is usually scaly and very easily distinguished or well demarcated. The skin within the border turns a reddish-brown and loses much of its scale. Jock itch can spread to the pubic and genital regions and sometimes to the buttocks.

Jock itch caused by *T. rubrum* does not involve the scrotum or penis. If those areas are involved, the most likely agent is *Candida albicans*, the same type of yeast that causes vaginal yeast infections.

Diagnosis

Often a case of jock itch can be identified based on the characteristic description previously described. If assessed by a conventional doctor, the area of affected skin may be scraped onto a glass slide for definitive diagnosis under the microscope. In order to determine the exact type of fungus present, a small piece of affected skin maybe sent off to the lab for further study.

Treatment

Typical conventional treatment for jock itch involves the use of an anti-fungal cream, spray, or powder twice a day for about two weeks. Three commonly used, over-the-counter anti-fungals are *miconazole* (Micatin), *clotrimazole* (Lotrimin) and *tolnaftate* (Tinactin). While the tendency to discontinue treatment once **itching** disappears is common, it is important to use the anti-fungal for a full two-week course in order to prevent recurrence of the infection.

Alternative treatment

Topical treatments include poultices of peppermint, oregano, or lavender. Tea tree oil, diluted with a carrier oil of almond oil, can be applied to the rash several times per day. Cedarwood and jasmine oils can relieve itching when applied in the same manner. Grapefruit seed extract can be taken as a strong solution of 15 drops in 1 oz of water.

Another alternative remedy for jock itch is to wash the groin area with the diluted juice of a freshly squeezed lemon, which can help dry up the rash. A hair dryer on the cool setting can also be used on the area after showering to dry it thoroughly. A warm bath relieves itching in many patients. The affected area should kept clean and dry, and loose-fitting, cotton underwear is recommended.

Prognosis

Treatment for jock itch is quick and usually effective, but the condition often comes back. With treatment, jock itch improves in two or three days and is completely gone in three or four weeks. The following people should be especially vigilant to prevent the problem from returning:

- Athletes
- People with fungal infections that affect other parts of the body (such as athlete's foot)
- People who wear tight clothing
- People with damaged or altered immune systems, including people with HIV or AIDS

Prevention

The best prevention of jock itch is cleanliness and sanitation. This includes keeping the groin area dry, wearing loose-fitting rather than tight clothing, wear boxer shorts rather than briefs, change sweat-covered clothes as soon as possible, showering immediately after working out or playing a sport and then applying talc, and washing workout clothes or sports uniforms after each use.

Resources

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ORGANIZATIONS

American Academy of Dermatology, PO Box 4014, Schaumburg, IL, 60168-4014, (847) 240-1859, (866) 503-SKIN (7546), http://www.aad.org.

Ken R. Wells,

Joint aspiration *see* **Joint fluid analysis**

KEY TERMS

Joint—The point where two bones meet.

Pathology—The branch of medicine that looks at abnormal changes in cells and tissues which signal disease.

Synovial membrane—Membrane lining a joint.

Trocar—A sharp pointed tube through which a needle can be inserted.

Joint biopsy

Definition

A joint or synovial membrane biopsy refers to a procedure where a sample of the joint lining or synovial membrane is taken.

Purpose

A joint biopsy is performed to determine why a joint is painful or swollen. It is usually reserved for more difficult cases where the diagnosis is not clear. The test can be used to diagnose bacterial or fungal infections, an abnormal buildup of iron, **cancer**, or other diseases.

Precautions

The procedure must be done under very sterile conditions to reduce the risk of infection.

Description

The test is performed either in the doctor's office, clinic, or hospital by a surgeon. There are many different ways to perform this biopsy: through an incision in the joint; with a scope inserted in the joint; or, more typically, by the insertion of a sharp instrument through the skin. The procedure can be taken from any joint, but the most common joint requiring biopsy is the knee. A sharp instrument (trocar) is pushed into the joint space. A needle with an attached syringe is inserted into the joint to withdraw fluid for laboratory analysis. The surgeon may instill numbing medicine into the joint and along the needle track before the needle is withdrawn. The trocar and then the biopsy needle is inserted and specimens taken. After the specimen is taken, both the trocar and the biopsy needle are removed, a bandage is placed over the joint, and the samples are sent to pathology for analysis.

Preparation

Blood tests will be done to check that **blood clots** properly. A mild sedative may be given before the procedure. With the patient lying down, the skin over the joint is disinfected and a local anesthetic is injected into the skin and tissue just below the skin.

Aftercare

The joint will need rest for at least one day. Normal activity can resume if there is no increased **pain** or swelling.

Risks

There is a chance of joint swelling or tenderness. Rarely, bleeding and infection can occur in the joint, or the biopsy needle could break off or strike a nerve or blood vessel. The risk of infection is higher if the patient has an immune deficiency.

Resources

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Jeanine Barone

Joint endoscopy *see* **Arthroscopy**

Joint fluid analysis

Definition

Joint fluid analysis, also called synovial fluid analysis, or arthrocentesis, is a procedure used to assess joint-related abnormalities, such as in the knee or elbow.

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KEY TERMS

Aspirate—The removal by suction of a fluid from a body cavity using a needle.

Bursae—A closed sac lined with a synovial membrane and filled with fluid, usually found in areas subject to friction, such as where a tendon passes over a bone.

Hematoma—A localized mass of blood that is confined within an organ or tissue.

Synovial fluid—A transparent lubricating fluid secreted in a sac to protect an area where a tendon passes over a bone.

Purpose

The purpose of a joint fluid analysis is to identify the cause of swelling in the joints, to relieve **pain** and distention from fluid accumulation in the joint, and to diagnose certain types of arthritis and inflammatory joint diseases. The test is also a method to determine whether an infection, either bacterial or fungal, exists within the joint.

Precautions

Joint fluid analysis should not be performed on any patient who is uncooperative, especially if the patient cannot or will not keep the joint immobile throughout the procedure. Patients with certain infections should be excluded from the procedure, particularly those who have a local infection along the proposed needle track. The joint space should be accessible. Therefore, a poorly accessible joint space, such as in hip aspiration in an obese patient, should not be subject to this procedure.

Description

The test is also called arthrocentesis, joint tap, and closed joint aspiration. Normal synovial fluid is a clear or pale-yellow fluid found in small amounts in joints, bursae (fluid-filled sac found on points of friction, like joints), and tendon sheaths. The procedure is done by passing a needle into a joint space and sucking out (aspirating) synovial fluid for diagnostic analysis. When the sample is sent to the laboratory, the fluid is analyzed for color, clarity, quantity, and chemical composition. It is also examined microscopically to check for the presence of bacteria and other cells.

The procedure takes about 10 minutes. Prior to the procedure, any risks that are involved should be explained to the patient. No intravenous pain medications or sedatives are required, although the patient will be given a local anesthetic.

The patient is asked to lie on their back and remain relaxed. The local anesthetic, typically an injection of lidocaine, is then administered. The clinician is usually seated next to the patient. Then the clinician marks exactly where the needle is to enter. As the needle enters the joint, a "pop" may be felt or heard. This is normal. Correct placement of the needle in the joint space is normally painless. At this point, the clinician slowly drains some of the fluid into the syringe. The needle is then withdrawn and adhesive tape is placed over the needle site.

Preparation

Glucose, or sugar, in the joint can be a signal of arthritis. If the clinician will be doing a glucose test, the patient will be asked to fast for 6–12 hours preceding the procedure. If not, there is no special preparation required for a joint fluid analysis.

Aftercare

Some post-procedural pain may be experienced. For this reason, the patient should arrange to be driven home by someone else. Aftercare of the joints will depend on the results of the analysis.

Risks

While joint fluid analysis is generally a safe procedure, especially when performed on a large, easily accessible joint, such as the knee, some risks are possible. Some of the complications to the procedure, although rare, include infection at the site of the needle stick, an accumulation of blood (hematoma) formation, local pain, injury to cartilage, tendon rupture, and nerve damage.

Normal results

The results of a normal joint fluid analysis include fluid of a clear or pale-yellow color and the absence of bacteria, fungus, and other cells, such as white blood cells.

Abnormal results

The results of an abnormal joint fluid analysis include fluid that is turbid, or cloudy. Also, white

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blood cells and other blood cells may be found, from which the clinician can make a diagnosis and arrive at a treatment for the joint problem. An abnormal result can indicate an infection caused by a bacteria, or **tuberculosis**. Or, there might be inflammation that is caused by **gout**, **rheumatoid arthritis**, or **osteoarthritis**.

Resources

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Ron Gasbarro

Joint infection *see* **Infectious arthritis**
Joint radiography *see* **Arthrography**

Joint replacement

Definition

Joint replacement is the surgical replacement of a joint with an artificial prosthesis.

Great advances have been made in joint replacement since the first hip replacement was performed in the United States in 1969. Improvements have been made in the endurance and compatibility of materials used and the surgical techniques to install artificial joints. Custom joints can be made using a mold of the original joint that duplicate the original with a very high degree of accuracy.

The most common joints to be replaced are hips and knees. There is ongoing work on elbow and other joint replacement, but some joint problems are still treated with joint resection (the surgical removal of the joint in question) or interpositional reconstruction (the reassembly of the joint from constituent parts).

Purpose

Seventy percent of joint replacements are performed because arthritis has caused the joint to stiffen and become painful to the point where normal daily activities are no longer possible. If the joint does not respond to conservative treatment such medication, weight loss, activity restriction, and use of walking aids such as a cane, joint replacement is considered appropriate.

Patients with **rheumatoid arthritis** or other connective tissue diseases may also be candidates for joint replacement, but the results are usually less satisfactory in those patients. Elderly people who fall and break their hip often undergo hip replacement when the probability of successful bone healing is low.

The components of a prosthetic hip joint, removed due to loosening. On the right is the metal shaft encased in the cement which fixed it to the inside of the femur. On the left is the plastic socket. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

More than 773,000 hip and knee replacements are performed in the United States each year. Since the lifetime of the artificial joint is limited, the best candidates or joint replacement are over age 60.

Changing demographics will likely place new emphasis on joint replacement procedures in the healthcare system. For example, the demand for joint replacement surgery in younger people is rising dramatically as rising **obesity** rates stress younger joints. According to the American Academy of Orthopedic Surgeons, more than half of patients needing hip or knee replacements will be under 65 by 2016. Also, total joint replacement surgeries, now including shoulder and ankle replacements, are greatly rising at a time

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KEY TERMS

Catheterization—Inserting a tube into the bladder so that a patient can urinate without leaving the bed.

Prosthesis—A synthetic replacement for a missing part of the body, such as a knee or a hip.

Rheumatoid arthritis—A joint disease of unknown origins that may begin at an early age causing deformity and loss of function in the joints.

when fewer doctors are choosing **orthopedic surgery** as a career.

Description

Joint replacements are performed under general or regional anesthesia in a hospital by an orthopedic surgeon. Some medical centers specialize in joint replacement, and these centers generally have a higher success rate than less specialized facilities. The specific techniques of joint replacement vary depending on the joint involved.

Hip Replacement

During a hip replacement, the surgeon makes an incision along the top of the thigh bone (femur) and pulls the thigh bone away from the socket of the hip bone (the acetabulum). An artificial socket made of metal coated with polyethylene (plastic) to reduce friction is inserted in the hip. The top of the thigh bone is cut, and a piece of artificial thigh made of metal is fitted into the lower thigh bone on one end and the new socket on the other.

The artificial hip can either be held in place by synthetic cement or by natural bone in-growth. The cement is an acrylic polymer. It assures good locking of the prosthesis to the remaining bone. However, bubbles left in the cement after it cures may act as weak spots, causing the development of cracks. This promotes loosening of the prosthesis later in life. If additional surgery is needed, all the cement must be removed before additional surgery can be performed.

An artificial hip fixed by natural bone in-growth requires more precise surgical techniques to assure maximum contact between the remaining natural bone and the prosthesis. The prosthesis is made so that it contains small pores that encourage the natural bone to grow into it. Growth begins 6 to 12 weeks after surgery. The short-term outcome with non-cemented hips is less satisfactory, with patients reporting more thigh **pain**, but the long-term outlook is better, with fewer cases of hip loosening in non-cemented hips. The current trend is to use the non-cemented technique. Hospital stays last from four to eight days.

A false color x-ray image of the human pelvis showing a prosthetic hip joint. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Knee Replacement

The doctor puts a tourniquet above the knee, then makes a cut to expose the knee joint. The ligaments surrounding the knee are loosened, then the shin bone and thigh bone are cut and the knee removed. The artificial knee is then cemented into place on the remaining stubs of those bones. The excess cement is removed, and the knee is closed. Hospital stays range from three to six days.

In both types of surgery, preventing infection is very important. **Antibiotics** are given intravenously and continued in pill form after the surgery. Fluid and blood loss can be great, and sometimes blood transfusions are needed.

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Preparation

Many patients choose to donate their own blood for **transfusion** during the surgery. This prevents any blood incompatibility problems or the transmission of bloodborne diseases.

Prior to surgery, all the standard preoperative blood and urine tests are performed, and the patient meets with the anesthesiologist to discuss any special conditions that affect the administration of anesthesia. Patients receiving **general anesthesia** should not eat or drink for ten hours prior to the operation.

Aftercare

Immediately after the operation the patient will be catheterized so that he or she will not have to get out of bed to urinate. The patient will be monitored for infection. Antibiotics are continued and pain medication is prescribed. **Physical therapy** begins (first passive exercises, then active ones) as soon as possible using a walker, cane, or crutches for additional support. Long term care of the artificial joint involves refraining from heavy activity and heavy lifting, and learning how to sit, walk, how to get out of beds, chairs, and cars so as not to dislocate the joint.

Risks

The immediate risks during and after surgery include the development of **blood clots** that may come loose and block the arteries, excessive loss of blood, and infection. Blood-thinning medication is usually given to reduce the risk of clots forming. Some elderly people experience short term confusion and disorientation from the anesthesia.

Although joint replacement surgery is highly successful, there is an increased risk of nerve injury. Dislocation or fracture of the hip joint is also a possibility. Infection caused by the operation can occur as long as a year later and can be difficult to treat. Some doctors add antibiotics directly to the cement used to fix the replacement joint in place. Loosening of the joint is the most common cause of failure in hip joints that are not infected. This may require another joint replacement surgery in about 12% of patients within a 15-year period following the first procedure.

Joint replacements are performed successfully on an older-than-average group of patients. People with diseases that interfere with blood clotting are not good candidates for joint replacement. Joint replacement surgery should not be done on patients with infection, or any heart, kidney or lung problems that would make it risky to undergo general anesthesia.

Results

More than 90% of patients receiving hip replacements achieve complete relief from pain and significant improvement in joint function. The success rate is slightly lower in knee replacements, and drops still more for other joint replacement operations.

Resources

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ORGANIZATIONS

Arthritis Foundation, P.O. Box 7669, Atlanta, GA, 30357–0669, (404) 872–7100, (800) 283–7800, http://www.arthritis.org.

National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS), 1 AMS Circle, Bethesda, MD, 20892–3675, (877) 22–NIAMS (226–4267), (301) 718–6366, NIAMSinfo@mail.nih.gov, http://www.niams.nih.gov.

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Joint resection *see* **Arthroplasty**

Joint x rays *see* **Arthrography**

Juvenile arthritis

Definition

Juvenile arthritis (JA) is not a single disorder but a group of arthritides (plural of arthritis) that affect children and teenagers below the age of 16. JA has been known by various names since 1970, including juvenile **rheumatoid arthritis** (JRA), juvenile idiopathic arthritis (JIA), and juvenile chronic arthritis (JCA). All the conditions included under the general term of JA strike children under age 16, and all have immune-mediated joint inflammation as their major manifestation. The International League of Associations for Rheumatology

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(ILAR) has tried to bridge these differences with a unifying set of criteria to define juvenile arthritis.

Demographics

According to the American College of Rheumatology (ACR), as of 2010 about one child in every 1,000 in the United States develops some form of JA. Doctors estimate that around 300,000 children in the United States have been diagnosed with JIA. Native Americans in both Canada and the United States have somewhat higher rates of JA than members of other racial and ethnic groups. Internationally, Norway and Australia have the highest rates of JA, while Africa and individuals of African ancestry appear to have lower than average rates. The reason for these differences is not yet known.

Description

The skeletal system of the body is made up of different types of the strong, fibrous tissue known as connective tissue. Bone, cartilage, ligaments, and tendons are all forms of connective tissue that have different compositions, and thus different characteristics.

The joints are structures that hold two or more bones together. Some joints (synovial joints) allow for movement between the bones being joined (called articulating bones). The simplest model of a synovial joint involves two bones, separated by a slight gap called the joint cavity. The ends of each articular bone are covered by a layer of cartilage. A tough tissue called the articular capsule surrounds both articular bones and the joint cavity. The articular capsule has two components: the fibrous membrane on the outside, and the synovial membrane (or synovium) on the inside. The fibrous membrane may include tough bands of fibrous tissue called ligaments, which are responsible for providing support to the joints. The synovial membrane has special cells and many capillaries (tiny blood vessels). This membrane produces a supply of synovial fluid that fills the joint cavity, lubricates it, and helps the articular bones move smoothly about the joint.

In JA, the synovial membrane becomes intensely inflamed. Usually thin and delicate, the synovium becomes thick and stiff, with numerous infoldings on its surface. The membrane becomes invaded by white blood cells, which produce a variety of destructive chemicals. The cartilage along the articular surfaces of the bones may be attacked and destroyed, and the bone, articular capsule, and ligaments may begin to be worn away. These processes severely interfere with movement in the joint.

JA specifically refers to chronic arthritic conditions that affect a child under the age of 16 years and last for a minimum of three to six months. JA is often characterized by a waxing and waning course, with flares separated by periods during which no symptoms are noted (remission). Some of the medical literature refers to JA as juvenile rheumatoid arthritis, although most types of JA differ significantly from the adult disease called rheumatoid arthritis, in terms of symptoms, progression, and prognosis.

Risk factors

The two major risk factors for JA are sex and race. Most forms of JA are more common in girls than in boys (the major exception being eye disorders), and more common in Caucasian and Native American children than in children of other races.

Causes and symptoms

Causes

A number of different causes have been sought to explain the onset of JA. There seems to be some genetic link, because the tendency to develop JA sometimes runs in a particular family, and because certain genetic markers are more frequently found in patients with JA and other related diseases. Genes that have been linked to increased susceptibility to JA as of 2010 include the *IL2RA/CD25* gene and the *VTCN1* gene.

Many researchers have looked for some infectious cause for JA, but no clear connection to a particular organism has ever been made. JA is considered by some to be an autoimmune disorder. **Autoimmune disorders** occur when the body's immune system mistakenly identifies the body's own tissue as foreign and goes about attacking those tissues as if trying to rid the body of an invader (such as a bacteria, virus, or fungi). While an autoimmune mechanism is strongly suspected, certain markers of such a mechanism (such as rheumatoid factor, often present in adults with such disorders) are rarely present in children with JA.

Symptoms

Joint symptoms of arthritis may include stiffness, **pain**, redness and warmth of the joint, and swelling. Bone in the area of an affected joint may grow too quickly, or too slowly, resulting in limbs that are of different lengths. When the child tries to avoid moving a painful joint, the muscle may begin to shorten from disuse. This is called a contracture.

Symptoms of JA depend on the particular subtype. According to criteria published by the American College of Rheumatology (ACR) in 1973 and modified in 1977,

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KEY TERMS

Articular bones—Two or more bones connected with each other via a joint.

Biologics—A class of drugs produced by means of biological processes involving recombinant DNA technology.

Congenital—Present at birth.

Contracture—Shortening of a muscle or joint due to a disease condition or injury.

Flare—A recurrence or worsening of the symptoms of JA.

Idiopathic—Of unknown cause or spontaneous origin. JRA is sometimes called juvenile idiopathic arthritis or JIA because its causes are still not fully known.

Joint—A structure that holds two or more bones together.

Rheumatology—The branch of medicine that specializes in the diagnosis and treatment of disorders affecting the muscles and joints.

Synovial joint—A particular type of joint that allows for movement in the articular bones.

Synovial membrane—The membrane that lines the inside of the articular capsule of a joint and produces a lubricating fluid called synovial fluid.

Uveitis—Inflammation of the pigmented vascular covering of the eye, which includes the choroid, iris, and ciliary body. Uveitis is a common complication of JRA.

JRA is classified by the symptoms that appear within the first six months of the disorder:

- Pauciarticular JA: This is the most common and the least severe type of JA, affecting about 40–60% of all JA patients. This type affects fewer than four joints, usually the knee, ankle, wrist, and/or elbow. Other more general (systemic) symptoms are usually absent, and the child's growth usually remains normal. Very few children (less than 15%) with pauciarticular JA end up with deformed joints. Some children with this form of JA experience painless swelling of the joint. Some children with JA have a serious inflammation of structures within the eye, which if left undiagnosed and untreated could lead to blindness. This condition is known as uveitis, and affects about 20% of children diagnosed with JRA. While many children have cycles of flares and remissions, in some children the disease completely and permanently resolves within a few years of diagnosis.
- Polyarticular JA: About 40% of all cases of JA are of this type. More girls than boys are diagnosed with this form of JA. This type is most common in children up to age three or after the age of 10. Polyarticular JA affects five or more joints simultaneously. It usually affects the small joints of both hands and both feet, although other large joints may be affected as well. Some patients with arthritis in their knees experience a different rate of growth in each leg. Ultimately, one leg will grow longer than the other. About half of all patients with polyarticular JA have arthritis of the spine and/or hip. Some patients with polyarticular JA have other symptoms of a systemic illness, including anemia (low red blood cell count), decreased growth rate, low appetite, low-grade fever, and a slight rash. The disease is most severe in those children who are diagnosed in early adolescence. Some of these children test positive for a marker present in other autoimmune disorders, called rheumatoid factor (RF). RF is found in adults who have rheumatoid arthritis. Children who are positive for RF tend to have a more severe course, with a disabling form of arthritis that destroys and deforms the joints. This type of arthritis is thought to be the adult form of rheumatoid arthritis occurring at a very early age.
- Systemic-onset JA: Sometimes called Still disease (after a physician who originally described it), this is a type of JA that occurs in about 10–20% of all patients with JA. Boys and girls are equally affected, and diagnosis is usually made between the ages of 5–10 years. The initial symptoms are not usually related to the joints. Instead, these children have high fevers; a rash; decreased appetite and weight loss; severe joint and muscle pain; swollen lymph nodes, spleen, and liver; and serious anemia. Some children experience other complications, including inflammation of the sac containing the heart (pericarditis); inflammation of the tissue lining the chest cavity and lungs (pleuritis); and inflammation of the heart muscle (myocarditis). The eye inflammation often seen in pauciarticular JA is uncommon in systemic onset JA. Symptoms of actual arthritis begin later in the course of systemic onset JA, and they often involve the wrists and ankles. Many of these children continue to have periodic flares of fever and systemic symptoms throughout childhood. Some children will go on to develop a polyarticular type of JA.

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- Enthesis-related arthritis (sometimes called spondyloarthropathy): This type of JA most commonly affects boys older than eight years of age. The arthritis occurs in the knees and ankles, moving over time to include the hips and lower spine. Inflammation of the eye may occur occasionally, but usually resolves without permanent damage.
- Psoriatic JA: This type of arthritis usually shows up in fewer than four joints, but spreads to include multiple joints (appearing similar to polyarticular JA). Hips, back, fingers, and toes are frequently affected. A skin condition called psoriasis accompanies this type of arthritis. Children often have pits or ridges in their fingernails. The arthritis usually progresses to become a serious, disabling problem.

There is some disagreement among specialists about the classification of JRA. Some prefer the EULAR classification, introduced in 1977, to the ACR system. More recently the International League of Associations for Rheumatology (ILAR) has identified a unifying set of criteria to define juvenile arthritis. As of 2010, inconsistencies in naming the specific types of juvenile arthritis and their criteria for diagnosis continue to exist.

Diagnosis

The diagnosis of JA is not always obvious and may be delayed because some children do not complain of pain, and swelling of the joints may not be obvious.

Diagnosis of JA is usually made on the basis of the child's collection of symptoms together with elimination of other possible causes of the symptoms. Disorders to be ruled out include lupus, **Lyme disease**, certain bone disorders, infections, and childhood **cancer**. The diagnosis will usually involve a referral from the child's pediatrician to a rheumatologist, a physician specializing in disorders of the muscles and joints).

Examination

Symptoms of JA that the doctor can observe or measure during an office physical include:

- limping
- fever
- difficulty in moving or using an arm or leg
- swollen joint(s)
- skin rash on the chest, arms, or legs that comes and goes with fever
- swollen lymph nodes
- enlarged liver and spleen
- red eyes
- pain when a bright light is shone in the eye.

Tests

There is no blood test as of 2010 that can be used to diagnose JA, and other laboratory tests often show normal results. A blood test may be useful in ruling out certain infections as a cause of the child's symptoms. Some nonspecific indicators of inflammation may be elevated, including **white blood cell count**, **erythrocyte sedimentation rate**, and a marker called **C-reactive protein**. As with any chronic disease, anemia may be present. Children with an extraordinarily early onset of the adult type of rheumatoid arthritis will have a positive test for rheumatoid factor.

Imaging studies (most often x rays) may be taken to rule out broken or fractured bones, congenital defects in the joints, tumors, or some types of **infectious disease**. X-ray studies may also be done to monitor the development of the child's bones. **Magnetic resonance imaging** (MRI) and ultrasound are used increasingly as of 2010 to detect damage caused by JA in order to prevent further damage to the child's joints.

Procedures

In some cases the doctor may tap a swollen joint by inserting a small hollow needle into the joint to withdraw some of the fluid. This fluid can be analyzed to help determine the cause of the arthritis. In addition, withdrawing fluid may ease the discomfort in the joint.

Treatment

Traditional

Mainstream treatment of JA involves the use of appropriate medications together with physical and **occupational therapy** as needed. Some children with JA may eventually need surgery, including **joint replacement**, and others may require psychological counseling to cope with depression or anger related to their symptoms. The goal of therapy is to control symptoms, maintain functioning of the child's joints, and prevent damage to the joints.

Drugs

Treating JA involves efforts to decrease the amount of inflammation in order to preserve movement. Medications that can be used for this include such nonsteroidal anti-inflammatory agents (NSAIDs) as ibuprofen (Motrin, Ibuprin), naproxen (Aleve, Naprelan, Naprosyn), diclofenac (Voltaren, Cataflam), and Tolmetin (Tolectin). Oral steroid medications are effective but have many serious side effects with long-term use. Injections of **steroids** into an affected joint can be helpful. Steroid eye drops are used to treat eye inflammation.

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Occasionally, splints are used to rest painful joints and to try to prevent or improve deformities.

Children who do not respond to treatment with NSAIDs may be given disease-modifying **antirheumatic drugs** or DMARDs. DMARDs include such medications as hydroxychloroquine (Plaquenil), sulfasalazine (Azulfidine), and methotrexate (Rheumatrex). More recent agents used to treat JA include biologics, which are drugs produced using recombinant DNA technology. Biologics used to treat JA include etanercept (Embrel), infliximab (Remicade), adalimumab (Humira), and abatacept (Orencia). Biologics work by blocking high levels of proteins that cause inflammation in the body.

Alternative

Juice therapy has been suggested as an alternative treatment for arthritis. It works to detoxify the body, helping to reduce JA symptoms. Some recommended fruits and vegetables to include in the juice are carrots, celery, cabbage, potatoes, cherries, lemons, beets, cucumbers, radishes, and garlic. Tomatoes and other vegetables in the nightshade family (potatoes, eggplant, red and green peppers) are discouraged.

As an adjunct therapy, **aromatherapy** preparations use cypress, fennel, and lemon. Massage oils include rosemary, benzoin, chamomile, camphor, juniper, and lavender. Other types of therapy that have been used include **acupuncture**, **acupressure**, and bodywork.

Nutritional supplements that may be beneficial include large amounts of **antioxidants** (**vitamins** C, A, E, zinc, selenium, and flavenoids), as well as B vitamins and a full complement of **minerals** (including boron, copper, manganese). Other nutrients that assist in detoxifying the body, including methionine, cysteine, and other amino acids, may also be helpful. A number of autoimmune disorders, including JA, seem to have a relationship to **food allergies**. Identification and elimination of reactive foods may result in a decrease in JA symptoms. Constitutional homeopathy can work to quiet the symptoms of JA and bring about balance to the whole person. None of these alternative treatments, however, have been proven effective in clinical trials that meet the standards of conventional Western medicine.

Prognosis

The prognosis for pauciarticular JA is quite good, as is the prognosis for spondyloarthropathy. Polyarticular JA carries a somewhat worse prognosis; children who have many joints involved, or who have a positive rheumatoid factor are more likely to have chronic pain, disability, and problems with school attendance. Systemic onset JA has a variable prognosis, depending on the organ systems affected, and the progression to polyarticular JA. JRA is rarely life-threatening; however, about 1–5% of all JA patients die of such complications as infection, inflammation of the heart, or **kidney disease**. In addition, depression and other psychological problems are common in children with JA, particularly when they enter their teen years. Many children benefit from support groups and special summer camp programs for children with JA.

Prevention

Because so little is known about the causes of JA, there are no recommendations as of 2010 for preventing its development.

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ORGANIZATIONS

American College of Rheumatology (ACR), 2200 Lake Boulevard NE, Atlanta, GA, 30319, (404) 633-3777, (404) 633-1870, acr@rheumatology.org, http://www.rheumatology.org.
Arthritis Foundation, PO Box 7669, Atlanta, GA, 30357-0669, (800) 283-7800, http://www.arthritis.org.
European League against Rheumatism (EULAR), Seestrasse 240, Zürich, Switzerland, CH 8802 Kächberg, +41 44 716 30 30, +41 44 716 30 39, http://www.eular.org.
International League of Associations for Rheumatology (ILAR), ndavidai@rheumatology.org, http://www.ilar.org.
National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS), 1 AMS Circle, Bethesda, MD, 20892-3675, (301) 495-4484, (877) 22-NIAMS, (301) 718-6366, NIAMSinfo@mail.nih.gov, http://www.niams.nih.gov.

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K

Kala-azar *see* **Leishmaniasis**

Kaposi's sarcoma

Definition

Kaposi's sarcoma (KS) is a form of **cancer** that is manifested by lesions on the skin and can also progress to involve internal organs. It most often is found in patients with acquired **immunodeficiency** syndrome (**AIDS**) and can be fatal.

Demographics

The incidence of KS was very rare in the United States before the AIDS epidemic with only 19 cases reported in men between the ages of 20 and 54 years in the years 1975 to 1980. In 1981, an aggressive form of KS began to appear in homosexual men. At that time, almost half of homosexual men diagnosed with AIDS also developed KS. Incidence of KS peaked in 1989 and has decreased significantly since that time as a result of safer sexual practices and the introduction of highly active antiretroviral therapy (HAART). Among transplant patients, the incidence rate is about one in every 200 patients. At this time about 2500 new cases of KS are diagnosed each year in the United States, although there may be some underreporting of cases in the AIDS population.

Internationally, the incidence of KS remains very high in Africa. The highest rates of classic KS are found in Sicily and in Sardinia. These cases are, in general, unrelated to AIDS.

Description

Kaposi's sarcoma (KS) was once a very rare form of cancer, primarily affecting elderly men of Mediterranean and eastern European background, until the 1980s, when it began to appear among AIDS patients. It manifests in four distinct forms. The first form, called classic or sporadic KS, was described by the Austrian dermatologist Moritz Kaposi more than a century ago. Classic KS usually affects older men of Mediterranean or eastern European ancestry by producing tumors on the lower legs. Though at times painful and disfiguring, the tumors generally are not life–threatening. The second form of the disease, African endemic KS, affects boys and men primarily. It can appear as classic KS, or in a more deadly form that quickly spreads to tissues below the skin, the bones, and lymph system, leading to **death** within a few years of diagnosis. Another form of KS, immunocompromised KS, is observed in kidney and liver transplant patients who take immunosuppressive drugs to prevent rejection of their organ transplant.

This HIV-positive patient is afflicted with Kaposi's sarcoma inside the mouth. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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Kaposi's sarcoma usually appears on the lower extremities, as evidenced on this patient's hip. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

MORIZ KAPOSI (1837–1902)

Moriz Kohn Kaposi was born in 1837 to very poor Hungarian parents. He studied dermatology under Ferdinand von Hebra at the University of Vienna, earning his medical degree in 1861. Kaposi took a position in Hebra's clinic and ultimately became a lecturer where he was responsible for educating numerous dermatologists. Kaposi and Hebra coauthored *The Handbook of Diseases of the Skin* which had great success. Kaposi married Hebra's daughter and the couple had one son, Hermann (1872). When Hebra died, Kaposi filled the vacant spot as director of the skin clinic and as Vienna's most renowned dermatologist.

Between 1872 and 1887, Kaposi discovered nine skin diseases that had not been previously documented. His discovery of a malignant disease that strikes the lymph nodes and skin (Kaposi's sarcoma 1872) has been documented as the most noteworthy. This disease was seen relatively rarely in the United States until the 1980s when it was tied to AIDS. This sarcoma has been the most common tumor found in AIDS patients. In 1872, Kaposi also studied cases of lupus erythematosus, which had no previous documentation. Kaposi was a prolific writer who published *Pathology and Treatment of Diseases of the Skin* in addition to numerous other publications, which he completed individually and with other authors. Kaposi died in 1902.

Immunocompromised KS usually reverses after the immunosuppressive drug is stopped. The fourth form of KS, epidemic AIDS–related KS, emerged as one of the first illnesses observed among those with AIDS. Unlike classic KS, AIDS–related KS tumors occur in advanced HIV infection and generally appear on the upper body, including the head, neck, and back. Tumors also can appear on the soft palate and gum areas of the mouth. In more advanced cases, they can be found in the stomach and intestines, the lymph nodes, and the lungs.

Causes and symptoms

Classic KS, which typically results in a disease course which is long and generally indolent, is thought to be caused by immune system dysregulation (a combination of factors which lead to immune suppression and immune activation) although the exact cause has not yet been identified. Currently, it is thought that this type of KS may be caused by suppression of the immune system as the individual ages, as a result of the genetic makeup of the patient, as a result of diagnosis with another type of cancer in the same individual and possibly results from concurrent malarial infection in some people.

The cause of immunocompromised KS appears to be directly related to treatment with immunosuppressive drugs following organ transplant or in patients receiving immunosuppressive therapies. These patients' risk for developing KS is increased by 100 times. Most patients develop this type of KS within 15–30 months following transplant. As stated earlier, once the patient stops taking the immunosuppressive drugs, the KS may regress. A newer antirejection drug, sirolimus (Rapamune), has been shown to have a dual effect which is advantageous to transplant patients who have been diagnosed with KS. Sirolimus appears to have an immunosuppressive effect as well as an antitumor (anti–KS) effect. A small group of kidney transplant patients who were diagnosed with KS post–transplant were switched from the immunosuppressive drug cyclosporine to sirolimus. All of the patients in this study experienced regression of their KS; all cutaneous KS lesions in all of the patients

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KEY TERMS

African endemic Kaposi's sarcoma—A form of KS that affects men and boys and that can appear like classic KS or in a more lethal form.

AIDS–related Kaposi's sarcoma—A form of KS that emerged as one of the first illnesses associated with AIDS patients. Tumors usually appear on the upper body, the soft palate and gum areas, and, as the disease advances, in the lymph nodes, stomach, intestines, and lungs.

Apoptosis—Cell death.

Classic Kaposi's sarcoma—A form of KS that usually affects older men of Mediterranean or eastern European backgrounds and produces tumors on the lower legs.

Cytokines—Regulatory proteins that are produced by the immune system.

Human herpesvirus 8—Also called Kaposi's sarcoma–associated herpesvirus (KSHV), this virus is thought to be a cause for KS.

Iatrogenic Kaposi's sarcoma—A form of KS that develops in transplant patients who take immunosuppressive drugs to prevent rejection of their organ transplant.

MCH–1—Major histocompatibility complex proteins that protect cells from invasion.

disappeared. In addition, none of these patients experienced rejection.

The cause of African KS is also linked to immune dysregulation. This type of KS occurs primarily in men but also occurs in African women and children, often in individuals who are not HIV positive. The course of this type of KS can be aggressive or indolent. African KS involves the lymph nodes more often than the classic form of KS. In African children who are not HIV positive and who are diagnosed with African KS, lymph node involvement may also be accompanied by visceral KS. This KS disease pattern results in an extremely poor prognosis; virtually 100% of the children with this disease profile are dead within three years.

Epidemic AIDS–related KS is the most aggressive form of KS and is associated with patients with advanced HIV infection who are severely immunocompromised. It appears that infection with human herpes virus 8 (HHV–8) must be present for this type of KS to develop. HHV–8 is transmitted via saliva. It is not yet known whether the virus can be spread via blood–borne transmission. KS may be caused by HHV–8 and activation of other immune system factors including oncostatin M, IL–1, IL–6, fibroblast growth factor, tumor necrosis factor, and the HIV–tat protein, which act as co–stimulants, as well as other abnormal cytokines. A patient infected with HHV–8 who is co–infected with HIV, appears to be much more susceptible to an aggressive KS disease course. Patients who are co–infected with HHV–8 and HIV are 500 to 10,000 times more likely to develop KS.

Therefore, a very complex combination of factors appears to contribute to the development of all four variants of KS. This combination of factors is likely to include environmental factors, immune system factors, infection with human herpesvirus 8 (HHV–8) and in some individuals, co–infection with HIV.

Symptoms of Kaposi's sarcoma vary depending on the extent of the disease. KS produces pink, purple, or brown tumors on the skin, mucous membranes, or internal organs. Other symptoms which may be present, depending on the extent of the disease, include tumor–associated **lymphedema**, **pain** associated with walking if lesions are present on the feet, a variety of gastrointestinal symptoms if the lesions are present in the gastrointestinal tract, as well as **cough**, difficulty breathing, coughing up blood, and chest pain if pulmonary involvement is present.

Diagnosis

Many physicians diagnose KS based on the appearance of the skin tumors and the patient's medical history. Unexplained cough or chest pain, as well as unexplained stomach or intestinal pain or bleeding, can suggest that the disease has moved beyond the skin. The most certain diagnosis can be achieved by taking a biopsy sample of a suspected KS lesion and examining it under high–power magnification. For suspected involvement of internal organs, physicians use a bronchoscope to examine the lungs or an endoscope to view the stomach and intestinal tract. Tests such as the CD4 lymphocyte count and plasma HIV viral–load studies may be conducted on patients diagnosed with HIV.

Treatment

Treatment goals for KS are simple: to reduce the severity of symptoms, shrink tumors, and prevent disease progression. The advent of HAART has resulted

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in marked advancements in the treatment of KS and is generally the first therapy initiated. Most patients respond very well to HAART although response is dependent on stage of disease. Patients diagnosed with KS that has not affected the visceral organs may receive HAART as the sole treatment modality.

Patients whose disease has spread to the visceral organs and who are considered to be poor risk KS patients may be treated with a variety of modalities including **chemotherapy** which is used with palliative intent. Chemotherapy drugs approved by the FDA to treat AIDS–related KS include liposomal doxorubicin (Doxil), used in patients who have been previously treated; liposomal daunorubicin (DaunoXome), which is approved as a first–line treatment option; and paclitaxel (Taxol), also approved for patients who have been previously treated. These drugs have resulted in high response rates often with less toxicity as compared to other drugs.

In addition, **radiation therapy** may be used and is often very effective in treating lesions that are considered to be advanced and symptomatic. Surgery may be an option to remove small superficial KS lesions. Some KS lesions may be treated with chemotherapy such as vincristine or vinblastine injected directly into the lesion (intralesional therapy) although the lesions are likely to recur in other areas. Systemic infusion of chemotherapy drugs may be more effective. Other treatment options which may be employed include **cryotherapy** with liquid nitrogen applied topically to treat small facial lesions, laser photocoagulation to shrink small lesions, and application of topical retinoids such as alitretinoin (Panretin) gel to lesions.

Interferon–alfa, interferon combined with chemotherapy, interleukin–12, and chemotherapy using a variety of agents have been used as palliative agents to treat KS that is symptomatic or life–threatening. Treatment options being explored in clinical trials include therapy with thalidomide and other antiangiogenesis agents. Other trials are focused on investigating whether antiviral therapy utilizing drugs such as foscarnet and ganciclovir may be effective because of the link between human herpesvirus and KS.

Prognosis

The prognosis for patients with classic KS is good. Tumors can frequently be controlled and patients frequently die of other causes before any serious spread. African endemic KS can progress rapidly and lead to premature death, despite treatment. In AIDS–related KS, milder cases can frequently be controlled; the prognosis for more advanced and rapidly progressing cases is less certain and dependent on the patient's overall medical condition. There are indications that KS can be stabilized or reversed in patients whose level of HIV in the blood is reduced to undetectable levels via combined antiretroviral therapy.

Prevention

Safer sex practices may help to prevent AIDS–related KS by decreasing the risk of transmission of HHV–8 through sexual means. Treatment with antiretrovirals may help to preserve the function of the immune system in HIV patients and delay the appearance and progression of KS lesions. In fact, since the introduction of HAART in those infected with HIV, KS has decreased substantially. However, it still remains the most common cancer among those infected with HIV.

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Kawasaki syndrome

Definition

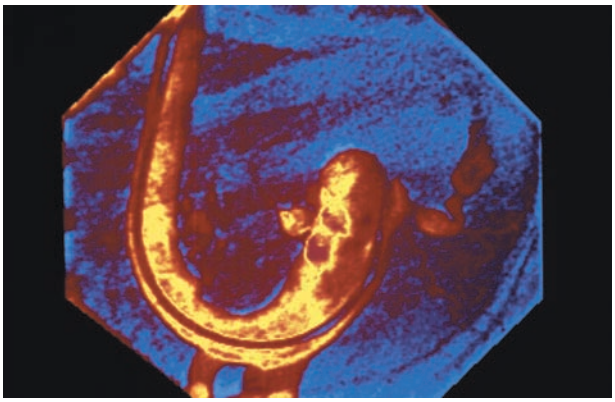
Kawasaki syndrome is a potentially fatal inflammatory disease that affects several organ systems in the body, including the heart, circulatory system, mucous membranes, skin, and immune system. It occurs primarily in infants and children but has also been identified in adults as old as 34 years. Its cause is unknown.

Description

Kawasaki syndrome, also called mucocutaneous lymph node syndrome (MLNS), is an inflammatory disorder with potentially fatal complications affecting the heart and its larger arteries. Nearly twice as many males are affected as females. Although persons of Asian descent are affected more frequently than either black or white individuals, there does not appear to be a distinctive geographic pattern of occurrence. Eighty percent of cases involve children under the age of four. Although the disease usually appears in individuals, it sometimes affects several members of the same family and occasionally occurs in small epidemics.

Causes and symptoms

The specific cause of Kawasaki syndrome is unknown, although the disease resembles infectious illnesses in many ways. It has been suggested that Kawasaki syndrome represents an allergic reaction or other unusual response to certain types of infections. Some researchers think that the syndrome may be caused by the interaction of an immune cell, called the T cell, with certain poisons (toxins) secreted by bacteria.



An angiogram showing abnormal coronary arteries in a child suffering from Kawasaki's disease. The coronary arteries are abnormal and weakened in that they bulge into balloon shapes, or aneurysms, along their lengths. This illness afflicts children between the ages of 1–2 years. *(Mehau Kulyk/SPL/Photo Researchers, Inc.)*

Kawasaki syndrome has an abrupt onset, with **fever** as high as 104°F (40°C) and a rash that spreads over the patient's chest and genital area. The fever is followed by a characteristic peeling of the skin beginning at the fingertips and toenails. In addition to the body rash, the patient's lips become very red, with the tongue developing a "strawberry" appearance. The palms, soles, and mucous membranes that line the eyelids and cover the exposed portion of the eyeball (conjuntivae) become purplish-red and swollen. The lymph nodes in the patient's neck may also become swollen. These symptoms may last from two weeks to three months, with relapses in some patients.

In addition to the major symptoms, about 30% of patients develop joint pains or arthritis, usually in the large joints of the body. Others develop **pneumonia**, **diarrhea**, dry or cracked lips, **jaundice**, or an inflammation of the membranes covering the brain and spinal cord (**meningitis**). A few patients develop symptoms of inflammation in the liver (hepatitis), gallbladder, lungs, or tonsils.

About 20% of patients with Kawasaki syndrome develop complications of the cardiovascular system. These complications include inflammation of the heart tissue (**myocarditis**), disturbances in heartbeat rhythm (**arrhythmias**), and areas of blood vessel dilation (aneurysms) in the coronary arteries. Other patients may develop inflammation of an artery (arteritis) in their arms or legs. Complications of the heart or arteries begin to develop around the tenth day after the illness begins, when the fever and rash begin to subside. A few patients may develop **gangrene**, or the **death** of soft tissue, in their hands and feet. The specific causes of these complications are not yet known.

Diagnosis

Because Kawasaki syndrome is primarily a disease of infants and young children, the disease is most likely to be diagnosed by a pediatrician. The physician will first consider the possible involvement of other diseases that cause fever and skin **rashes**, including **scarlet fever**, **measles**, **Rocky Mountain spotted fever**, **toxoplasmosis** (a disease carried by cats), juvenile **rheumatoid arthritis**, and a blistering and inflammation of the skin caused by reactions to certain medications (Stevens-Johnson syndrome).

Once other diseases have been ruled out, the patient's symptoms will be compared with a set of diagnostic criteria. The patient must have a fever lasting

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KEY TERMS

Aneurysm—Dilation of an artery caused by thinning and weakening of the vessel wall.

Arrythmia—Abnormal heart rhythm.

Arteritis—Inflammation of an artery.

Cardiomegaly—An enlarged heart.

Conjunctivae—The mucous membranes that cover the exposed area of the eyeball and line the inner surface of the eyelids.

Exanthem—A skin eruption associated with a disease, usually one accompanied by fever as in Kawasaki syndrome.

Gangrene—The death of soft tissue in a part of the body, usually caused by obstructed circulation.

Hepatitis—Inflammation of the liver.

Meningitis—Inflammation of the membranes, called the meninges, covering the brain and spinal cord.

Mucocutaneous lymph node syndrome (MLNS)—Mucocutaneous lymph node syndrome, another name for Kawasaki syndrome. The name comes from the key symptoms of the disease, which involve the mucous membranes of the mouth and throat, the skin, and the lymph nodes.

Myocarditis—Inflammation of the heart muscle.

Stevens-Johnson syndrome—A severe inflammatory skin eruption that occurs as a result of an allergic reaction or respiratory infection.

T cell—A type of white blood cell that develops in the thymus gland and helps to regulate the immune system's response to infections or malignancy.

five days or longer that does not respond to **antibiotics**, together with four of the following five symptoms:

- Inflammation of the conjunctivae of both eyes with no discharge
- At least one of the following changes in the mucous membranes of the mouth and throat: "strawberry" tongue; cracked lips; or swollen throat tissues
- At least one of the following changes in the hands or feet: swelling caused by excess fluid in the tissues; peeling of the skin; or abnormal redness of the skin
- A skin eruption or rash associated with fever (exanthem) on the patient's trunk
- Swelling of the lymph nodes in the neck to a size greater than 1.5 cm.

Since the cause of Kawasaki syndrome is unknown, there are no laboratory tests that can confirm the diagnosis. The following test results, however, are associated with the disease:

- Blood tests show a high white blood cell count, high platelet count, a high level of protein in the blood serum, and mild anemia
- Chest x ray may show enlargement of the heart (cardiomegaly)
- Urine may show the presence of pus or an abnormally high level of protein
- An electrocardiogram may show changes in the heartbeat rhythm

In addition to these tests, it is important to take a series of echocardiograms during the course of the illness because 20% of Kawasaki patients will develop coronary aneurysms or arteritis that will not appear during the first examination.

Treatment

Kawasaki syndrome is usually treated with a combination of **aspirin**, to control the patient's fever and skin inflammation, and high doses of intravenous immune globulin to reduce the possibility of coronary artery complications. Some patients with heart complications may be treated with drugs that reduce blood clotting or may receive corrective surgery.

Follow-up care includes two to three months of monitoring with chest x rays, **electrocardiography**, and **echocardiography**. Treatment with aspirin is often continued for several months.

Prognosis

Most patients with Kawasaki syndrome will recover completely, but about 1–2% will die as a result of **blood clots** forming in the coronary arteries or as a result of a **heart attack**. Deaths are sudden and unpredictable. Almost 95% of fatalities occur within six months of infection, but some have been reported as long as 10 years afterward. Long-term follow-up of patients with aneurysms indicates that about half show some healing of the aneurysm. The remaining half has a high risk of heart complications in later life.

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Rebecca J. Frey, PhD

Keloids

Definition

Keloids are excessive (overgrowths) of fibrous tissue or **scars** that can occur after an injury to the skin has healed (such as a burn), at the site of intentional alterations of the skin (such as an ear **piercing**), or as the result from medical procedures or illnesses (such as a **vaccination** or the **chickenpox**). Sometimes, they develop without any apparent cause. These heavy, sometimes irregular, and often very noticeable scars are also called cheloid, keloid, or hypertrophic scars. In individuals prone to keloids, even minor traumas to the skin, such as ear piercing, can cause keloids. The word "keloid" itself comes from the Greek word for a crab's claw; it was first used by a French physician to describe the way that keloids grow sideways into normal skin. The term keloidosis is intended to describe the situation when many keloids have occurred in one individual.

Demographics

Keloids are somewhat common in women and young people under the age of 30 years. They are also commonly found in families, with the malady inherited from one generation to the next. They occur most frequently in individuals of African–American descent and in those with darker skin. They are more common in Polynesians and Chinese than in people from India or Malaysia. Caucasians are the least frequently affected by keloids. Other risk factors include a family history of keloids, surgery, **acne**, **burns**, ear piercing, vaccinations, or insect bites. Spontaneous keloids have been reported occasionally in siblings. Keloids are infrequently found among the elderly.

Although the association of keloids with darker skin pigmentation suggests a genetic linkage of some sort, no specific genes have been identified in connection with keloids as of the early 2010s.

Description

Keloids usually start out as a small bump or raised spot on the skin. The size of the bump gradually becomes larger over time, and eventually becomes a mature keloid. Keloids can occur anywhere on the body, but they are most common on the earlobes, upper back, shoulders, and chest. The pattern of distribution of keloids differs according to race, with facial keloids more common in Caucasians and relatively uncommon in Asians. African Americans are more likely to develop keloids on the legs or feet than among either Asians or Caucasians. In general, keloids consist of hard, raised scars that may be slightly pink or whitish. They may itch and be painful, and some keloids can grow to be quite large.

Causes and symptoms

Although the cause of keloids is unknown, it is thought that they are due to the body's failure to turn off the healing process needed to repair skin. When this occurs, extra collagen forms at the site of the scar, and keeps forming because healing does not shut down, resulting in keloid formation. Scientists working on genomics, or the determination of the entire DNA (deoxyribonucleic acid) sequence of organisms, may one day learn the cause(s) of keloids.

Initially, keloids begin as a small lump where the skin has been injured. This lump grows and can eventually become very large and cosmetically unacceptable. Keloids often result from the following conditions:

- Chickenpox
- Acne
- Burns
- Piercings
- Scratches
- Cuts from surgeries
- Wounds
- Vaccinations

The symptoms associated with keloids include lesions that are:

- Flesh–colored, red, or pink
- Nodular or ridged
- At the site of an injury or wound
- Itchy while growing

Diagnosis

A dermatologist can usually make the diagnosis of a keloid based on looking at the scar or the appearance of the skin. In some cases, however, a biopsy may be necessary to rule out other types of **skin lesions**, such as tumors.

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Treatment

Most keloids do not need treatment. When they do, several options are available. The treatment of choice for keloids is usually an injection of corticosteroid drugs such as cortisone directly into the lesion. These injections cause the keloid to become atrophic, or thinner, and are repeated every three to four weeks until the keloid has been resolved to the individual's satisfaction. Other therapies include laser treatment or **radiation therapy**, and topical treatments are undergoing study.

Surgery is often used in combination with corticosteroid injections. The injections are given for several weeks, and then the keloid is surgically removed. The injections are then continued for several weeks. Surgical removal of the keloid may also be used in conjunction with radiation therapy, which delivers small amounts of radiation to the affected area.

Another surgical option is cryosurgery, in which liquid nitrogen is used to freeze the tissues in the keloid. The treatment may need to be repeated to remove as much of the keloid as possible; however, cryosurgery prevents keloids from recurring in about 70% of patients.

Newer approaches include silastic gel sheeting, which makes use of pressure to flatten the keloid. The patient is advised to apply a silastic gel each night for several months. The gel is then kept securely in place with tape, cloth, or a bandage. The dressing is changed daily for seven to 10 days for minor cases, and for as long as 12 months in very serious cases.

Finally, researchers are now studying a type of tape that has been soaked with **steroids**, which are released slowly into the keloid, causing it to thin over time.

Newer treatments include injections of interferon directly into the keloid, and local application of five percent imiquimod cream, which induces the skin where it is applied to produce interferon. The imiquimod cream is reported to lower the risk of keloid recurrence significantly.

Prognosis

Although keloids are unsightly, they are not life–threatening nor medically dangerous. Keloids do not have a tendency to develop into malignancies, but they can become cosmetically unacceptable. Keloids can gradually lessen after treatment, but many recur. And just as they can occur spontaneously, they can also resolve spontaneously. Over time, many keloids become smaller and less noticeable. When surgery is performed, a scar usually forms at the sight of the keloid. Sometimes the scar is larger in area than the original keloid.

KEY TERMS

Atrophy—A wasting away of, becoming thinner, less strong.

Corticosteroids—Any of several steroid medications used to suppress inflammation, allergic, or immune responses of the body.

Cryosurgery—The use of extreme cold to kill or remove tissue.

Imiquimod cream is now used to minimize the possibilities of keloids forming after surgery. Often, the area surrounding and at the keloid site can become tender and feel uncomfortable to the person. This sensation is often caused by irritation from the rubbing of clothing or other personal articles that the person is wearing.

People who have keloids can prevent them from discoloring by protecting them from sunlight, or using sunblock when exposing them to sunlight.

Prevention

Preventive measures include avoiding any trauma to the skin, and compression pressure dressing for high–risk patients who have suffered burns to their skin. Proper care of the skin on a daily basis is also important, including the prompt treatment of skin abrasions and cuts. Such treatment includes cleaning the site, applying antibiotic medicine on and around the affected skin, placing a protective dressing over the wound, and applying stitches to the cut if deemed medically necessary. Patients with a tendency to form keloids should avoid any sort of elective surgery. Individuals who are prone to develop keloids or who have a history of keloids should immediately care for any cuts or abrasions they may sustain.

To lower the risk of keloids, surgeons are advised to close incisions with as little tension on the sutures as possible, and to use buried sutures whenever possible.

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American Academy of Dermatology, 930 E. Woodfield Rd., PO Box 4014, Schaumburg, IL, 60168–4014, (847) 330–0230, (866) 503–7546, (847) 240–1859, http://www.aad.org.
U.S. Food and Drug Administration, 10903 New Hampshire Ave., Silver Spring, MD, 20993–0002, (888) INFO–FDA (463–6332), http://www.fda.gov.

Liz Meszaros
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Keratitis

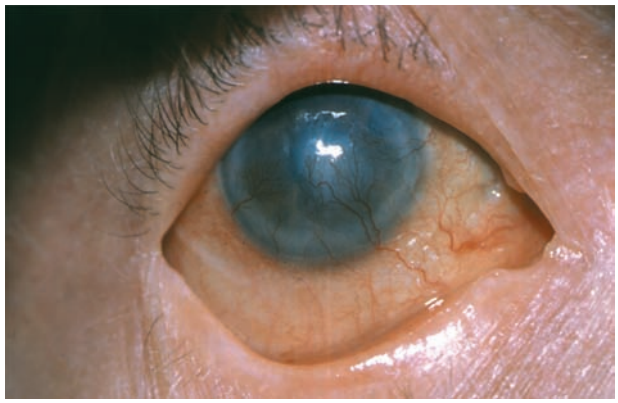
Definition

Keratitis is an inflammation of the cornea, the transparent dome–shaped membrane that covers the colored part of the eye (iris) and the pupil of the eye. Keratitis can be the result of an infection caused by bacteria, virus, fungi or parasites. Noninfectious Keratitis can be caused by a scratch or abrasion to the eye or by prolonged contact lens usage.

There are differing degrees of Keratitis. If only the upper layers of the cornea are involved, a condition known as superficial keratitis, there is usually no permanent damage. However, when keratitis affects the lower layers of the cornea, a condition called deep keratitis, the damage caused may leave a scar in the cornea permanently impair vision.

Description

There are many types and causes of keratitis. Organisms cannot generally invade an intact, healthy cornea. However, certain conditions can allow an infection to occur. For example, a scratch can leave the cornea open to infection. A very dry eye can also decrease the cornea's protective mechanisms.



Close-up of a damaged cornea due to complications following cataract surgery. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Risk factors that increase the likelihood of developing this condition include:

- poor contact lens care; overuse of contact lenses
- illnesses or other factors that reduce the body's ability to overcome infection (compromised immune system, such as from diabetes)
- previous injuries
- cold sores, genital herpes, and other viral infections
- crowded, dirty living conditions; poor hygiene
- warm climates, especially if it is humid
- corticosteroids that treat eye problems
- poor nutrition (especially a deficiency of Vitamin A, which is essential for normal vision)

Some common types of keratitis are listed below.

Herpes simplex keratitis

A major cause of adult eye disease, herpes simplex keratitis may lead to:

- chronic inflammation of the cornea
- development of tiny blood vessels in the eye
- scarring
- loss of vision
- glaucoma

This infection generally begins with inflammation of the membrane lining the eyelid (conjunctiva) and the portion of the eyeball that comes into contact with it. Subsequent infections are characterized by a pattern of lesions that resemble the veins of a leaf. These infections are called dendritic keratitis and aid in diagnosis of the condition.

Recurrences may be brought on by **stress**, **fatigue**, or ultraviolet (UV) light exposure. Repeated episodes of

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dendritic keratitis can cause sores, permanent scarring, and **numbness** of the cornea.

Recurrent dendritic keratitis is often followed by disciform keratitis. This condition is characterized by clouding and deep, disc–shaped swelling of the cornea and by inflammation of the iris.

It is very important not to use topical **corticosteroids** with herpes simplex keratitis as it can make the condition much worse, possibly leading to blindness.

Bacterial keratitis

People who have bacterial keratitis wake up with their eyelids stuck together. There can be pain, sensitivity to light, redness, tearing, and a decrease in vision. This condition, which is usually aggressive, can be caused by wearing soft contact lenses overnight. One study found that overnight wear can increase risk by 10 to 15 times more than daily wear. Improper lens care is also a factor. Contaminated makeup can also contain bacteria.

Bacterial keratitis usually is caused by the bacteria *Staphylococcus aureus* and *Pseudomonas aeruginosa* (especially for wearers of contact lenses). The infection makes the cornea cloudy, and may also cause abscesses to develop in the stroma, which is located beneath the outer layer of the cornea.

Fungal keratitis

Usually a consequence of injuring the cornea in a farm–like setting or in a place where plant material is present, fungal keratitis often develops slowly. This condition:

- usually affects people with weakened immune systems
- often results in infection within the eyeball
- may cause stromal abscesses

This type of keratitis is usually caused by the fungus *Aspergillus fumigatus* or by one of many fungus species within the genus *Fusarium*. It can also be caused by species within the yeast genus of *Candida*. The symptoms of fungal keratisis include red, painful eyed, blurred vision, increased sensitivity to light, and excessive discharge around the eye or increased production of tears. The condition usually does not improve when contact lenses are removed or when an antibiotic treatment is used. Fungal keratisis is a relatively rare disorder.

Peripheral ulcerative keratitis

Peripheral ulcerative keratitis is also called marginal keratolysis or peripheral rheumatoid ulceration. This condition is often associated with active or chronic disorders such as:

- rheumatoid arthritis
- relapsing polychondritis (connective–tissue inflammation)
- Wegener's granulomatosis, a rare condition characterized by kidney disease and development of nodules in the respiratory tract

Superficial punctate keratitis

Often associated with the type of viruses that cause upper respiratory infection (adenoviruses), superficial punctate keratitis is characterized by destruction of pinpoint areas in the outer layer of the cornea (epithelium). One or both eyes may be affected.

Acanthamoeba keratitis

This pus–producing condition, also called amoebic keratitis, is very painful. It is a common source of infection of the cornea. It is especially troublesome in people who wear soft or rigid contact lenses. This type of keratitis is caused by the bacterium *Acanthamoeba*. It can be found in tap water, soil, and swimming pools.

Photokeratitis

Photokeratitis, sometimes also called ultraviolet keratitis or snowblindness, is caused by excess exposure to natural or artificial UV light without proper eye protection. This condition can occur at high altitudes from sunlight reflecting off of snow fields or from, sun–tanning lamps, or welding arcs. It is very painful because it causes a type of "sunburn" to the cornea. The condition may occur several hours after exposure, and may last one to two days. In all cases, symptoms include pain in the eyes and increased production of tears.

Interstitial keratitis

Also called parenchymatous keratitis, interstitial keratitis is a chronic inflammation of tissue deep within the cornea. Interstitial keratitis is rare in the United States. Interstitial keratitis affects both eyes and usually occurs as a complication of congenital or acquired **syphilis**. In congenital syphilis, it can occur between the age of two years and **puberty**. It may also happen in people with **tuberculosis**, **leprosy**, or other diseases.

Causes and symptoms

In summary, keratitis can be caused by:

- contaminated contact lenses
- bacterial, fungal, or parasitic infections

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- viral infections, such as from the herpes virus and other viruses that cause chlamydia
- dry eyes resulting from disorders of the eyelid or diminished ability to form tears
- exposure to very bright light
- contaminated water
- foreign object injury
- upper respiratory infection
- sensitivity or allergic reactions
- vitamin A deficiency

Symptoms of keratitis include, but are not limited to:

- excessive tearing or discharge from eyes
- pain in and around eyes
- swelling of eyes
- itchy or burning feeling in eyes
- feeling of foriegn object in eye
- difficulty opening eyelids
- sensitivity to light
- inflammation of the eyelid
- decrease in vision
- redness of the eyes

Diagnosis

A case history will be taken and vision will be tested. Examination with a slit lamp, an instrument that is a microscope and focuses a beam of light on the eye, is important for diagnosis. The cornea can be examined with fluorescein, a yellow dye that highlights defects in the cornea. Deeper layers of the cornea can also be analyzed with the slit lamp. Infiltrates, hazy looking areas in the cornea, can be seen by the doctor and aid in the diagnosis. Samples of infectious matter removed from the eye will be sent for laboratory analysis.

Treatment

Antibiotic, antifungal, or antiviral oral medication are used to treat the appropriate organism. Broad–spectrum **antibiotics** are used immediately, but once the laboratory analysis determines the offending organism, the medication may be changed. Sometimes more than one medication is necessary.

A sterile, cotton–tipped applicator may be used to gently remove infected tissue and allow the eye to heal more rapidly. **Laser surgery** is sometimes performed to destroy unhealthy cells, and some severe infections require corneal transplants.

Antifungal, antibiotic, or antiviral eyedrops or ointments are usually prescribed for keratitis, but they should be used only by patients under a doctor's care. Inappropriate prescriptions or over–the–counter preparations can make symptoms more severe and cause tissue deterioration. Topical corticosteroids can cause great harm to the cornea in patient's with herpes simplex keratitis.

KEY TERMS

Abscess—A collection of pus.

Glaucoma—An eye disease characterized by an increase of pressure in the eye. Left untreated, blindness may result.

Infiltrate—A collection of cells not usually present in that area. In the cornea, infiltrates may be a collection of white blood cells.

Inflammation—A localized response to an injury. May include swelling, redness, and pain.

A patient with keratitis may wear a patch to protect the healing eye from bright light, **foreign objects**, the lid rubbing against the cornea, and other irritants. The patient will probably return every day to the eye doctor to check on the progress.

Although early detection and treatment can cure most forms of keratitis, the infection can cause:

- glaucoma
- permanent scarring
- ulceration of the cornea
- blindness

Prognosis

When treated promptly and effectively, keratitis can be treated without loss of vision. However, when minor cases of keratitis are left untreated they can lead to serious complications that may permanently damage or eliminate vision in the eyes. Such complications include chronic or recurrent viral infections of the cornea, corneal swelling or scarring, blindness, open corneal sores, and chronic corneal inflammation.

Prevention

Contact lenses should only be worn as recommended by an eye care professional and cleaned using sterile lens–cleaning and disinfecting solutions. Tap water is not sterile and should not be used to clean contact lenses. Always, wash, rinse, and dry one's hands before handling contact lenses. It is important to go for follow–up checkups because small defects in the

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cornea can occur without the patient' being aware of it. Remove lenses if eyes become red or irritated. Replace contact lenses as scheduled. Proteins and other materials can deposit on the contacts, leading to an increased risk of infection. Clean contact lens cases as directed and replace contact lens cases every three months. Do not wear contact lenses while swimming or in a hot tub.

Eating a well–balanced diet and wearing protective glasses when working or playing in potentially dangerous situations can reduce anyone's risk of developing keratitis. Protective goggles should be worn while mowing the lawn so that if twigs are tossed up they cannot hurt the eyes. Goggles or sunglasses with UV coatings can help protect against damage from UV light.

Avoid touching the eyes if one has an infection, such as a cold sore, to prevent infection within the eyes. Discontinue wearing contact lenses if keratitis occurs frequently. Minimize the use of corticosteroid eye drops, which increase the risks of viral infections.

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American Academy of Ophthalmology, PO Box 7424, San Francisco, CA, 94120–7424, (415) 561–8500, http://www.aao.org.

American Optometric Association, 243 North Lindbergh Blvd., St. Louis, MO, 63141, (314) 991–4100, (800) 365–2219, http://www.aoanet.org.

National Eye Institute, 2020 Vision Pl., Bethesda, MD, 20892–3655, (301) 496–5248, http://www.nei.nih.gov.

Prevent Blindness America, 211 West Wacker Dr., Suite 1700, Chicago, IL, 60606, (800) 331–2020, http://www.preventblindness.org.

Maureen Haggerty

Keratosis pilaris

Definition

Keratosis pilaris is a common skin condition that looks like small, rough goose bumps (patches), which are actually dead skin cells that build up around the hair follicle. Also called follicular keratosis, or simply KP, it is a commonly found follicular condition that most frequently appears on the back and outer sides of the upper arms, thighs, and buttocks. KP can also be located on the lower arms, hands, legs, and lower back. It never appears on the soles of the feet or the palms of the hands. It is rarely present on the face. When it does appear on the face (especially on the cheeks), KP is commonly mistaken for **acne**. It is also described as 'chicken bumps' and 'chicken skin'. Although the appearance of keratosis pilaris on the body is not desirable, it does not pose a medical risk. It is considered to be completely harmless to the human body.

Demographics

KP can be contracted by anyone all over the world but it is often considered a fairly common condition of children and adolescents. Consequently, more adolescents are at risk for it (about 50% to 80% worldwide) than are adults (about 40%). It is also more commonly found on women than it is on men. It appears equally in all races. Generally, KP improves with age. About 30% to 50% of people who have keratosis pilaris also have a family history for it. People who are obese or have troubling long–term health issues are at increased risk for contracting KP. However, people of normal weight and otherwise good health have also been found to have keratosis pilaris.

Description

Keratosis pilaris is called a hyperkeratinization of the skin because the buildup of keratin on the skin is thought by the medical community to cause the rough bumps and the overall poor skin appearance that characterize the condition. For people with KP, the process called keratinization is defective; that is, the formation of the epidermal skin is not normal, which causes bumps to form. Why this happens is not known to medical professionals, although various assumptions have been made as to why keratosis pilaris occurs on some people but not on others.

KP is a disorder that occurs around the hair follicles of the upper and lower arms, hands, lower back, thighs, legs, and sometimes the buttocks. It presents as small, benign bumps or papules that are actually waxy

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build–ups of keratin. Normally the skin sloughs (sheds) them off. However, around the hair follicle where the papules form, the keratinized skin cells slough off at a slower rate, clogging the follicles.

The disorder is generally thought to be genetic in nature, although the symptoms of keratosis pilaris are often seen with **ichthyosis** (a disease in which the skin becomes dry, scaly and thick) and allergic **dermatitis** (a form of dermatitis associated with an allergic reaction). It is also observed in people of all ages who have inherited the condition or who have a **vitamin A deficiency** or dry skin. Keratosis pilaris is a self–limiting disorder that usually disappears as the person ages. It can become more severe when conditions are dry such as during the winter months or in dry, arid climates.

A localized area on the skin may show an appearance of between 10 to 100 bumps that may give the area a sandpaper–looking appearance. Some of the bumps may appear slightly red in color, which indicates that they are inflamed. Most bumps are white in color, and are from one to two millimeters in diameter.

Causes and symptoms

The specific causes of this disorder are unknown. However, they are known to exist as keratin builds up. Keratin is a hard protein that helps to protect the skin from infections and harmful substances. When keratin builds up it forms a scaly plug that blocks the opening to the hair follicle. These blockages cause the small, rough bumps associated with keratosis pilaris. Since this disorder sometimes runs in families, it is thought to be a hereditary condition, one in which people have a genetic predisposition for it. If one child has KP then his or her siblings seem to be more likely to acquire it, too, especially among children of multiple births. Keratosis pilaris is not a serious disorder and is not contagious. Dry skin seems to make the condition worsen. Consequently, cold winter months are more troublesome for people with KP than are the warm summer months.

The symptoms of keratosis pilaris are based on the development of small white papules (or acne–like bumps) the size of a grain of sand on the upper arms, thighs, and occasionally the buttocks and face. The papules occur around a hair follicle and are firm and white. They feel a little like coarse sandpaper (that is, like dry, rough patches of skin), but they are not usually painful and **itching** is not usually associated with them. They are sometimes reddish in color, which indicates inflammation. They are easily removed and the material inside the papule usually contains a small, coiled hair.

Diagnosis

The diagnosis for keratosis pilaris is often made by a dermatologist or physician while making a **physical examination** of unrelated skin conditions. Laboratory tests or skin tests have yet to be developed to identify keratosis pilaris. A medical professional can easily diagnose this disorder by examining the skin and reviewing the patient's medical history and family background with respect to skin conditions. During the physical examination, the physician looks for the signs and symptoms associated with KP.

Treatment

There is no cure for keratosis pilaris. It is treatable but usually the treatment is difficult. To treat keratosis pilaris patients can try several strategies to lessen the bumps. First, the patient can supplement the natural removal of dry skin and papules by using a loofah or another type of scrub for showering or bathing. A mild cleanser is recommended. A long–term skin care program that is used regularly seems to produce the best results. Sometimes several skin care plans are used in combination to produce more desirable results.

Most of the treatment options center around (1) topical exfoliants, including medicated creams that include alpha–hydroxy, lactic or salicylic acids, or urea, which moisturize and soften dry skin and remove dead skin cells; (2) topical **corticosteroids**, such as hydrocortisone type substances, which suppress the immune system and decrease the production of skin cells; and (3) topical retinoids, such as tretinoin and tazarotene, which increase the production of skin cells and help to prevent the plugging up of hair follicles.

A variety of different over–the–counter (OTC) lotions, ointments, and creams can also be applied after showering while the skin is still moist and then used several times a day to keep the area moist. Medicated lotions with urea, 15% alpha hydroxy acids, or tretinoin (Retin A) can also be prescribed by the dermatologist and applied one to two times daily. Systemic (oral) medications are not prescribed for keratosis pilaris. However if papules are opened and become infected, **antibiotics** may be necessary to treat the infection.

Lactic acid lotions such as AmLactin and Lac–Hydrin may be prescribed. In addition, salicylic acid (Salex lotion or cream) and topical steroid creams (triamcinolone acetonide 0.1%, or hydrocortisone butyrate [Locoid Lipocream]) may also be prescribed as possible treatments for KP. Sometimes, these lotions are manufactured so they combine more than one of these ingredients in case the prescribing physician or

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KEY TERMS

Benign—Not cancerous.

Dermatologist—A physician who specializes in diseases and disorders of the skin.

Ichthyosis—A group of congenital disorders of keratinization characterized by dryness and scaling of the skin.

Keratin—The hard, waxy material that is made by the outer layer of skin cells.

dermatologist uses combination plans. Many other treatment options are also available. Each should be used only under the direction of a physician.

Sometimes minor surgical procedures are used for keratosis pilaris when KP persists even though multiple treatments have been attempted. Gentle acne extraction is one such procedure that can help to correct the problem. Microdermabrasion is another procedure that can be performed, usually in an in–office environment. The procedure exfoliates the skin with a gentle rubbing of abrasive particles (such as aluminum crystals) along with the lifting off the extracted skin with a vacuum. Chemical peels (a chemical solution to remove the top layer of dead skin), **photodynamic therapy** (PDT, consisting of a photosensitizer, light, and tissue oxygen), blue–light lasers (which emits electromagnetic radiation at a wavelength of between 360 and 480 nanometers), and intense pulsed light (IPL) instruments (which produce electromagnetic radiation at high intensities for very short periods) are also used as treatments. Other procedures are also available. It is always important that such procedures are used with the approval and under the direction of a physician.

Prognosis

Unfortunately, the treatment for keratosis pilaris is often disappointing. Although extreme cases of keratosis pilaris can occasionally be unsightly, the disorder is not life threatening and usually begins to disappear as the patient ages. Overall, however, many cases resolve themselves as the person gets older. KP usually disappears by the age of 30 years. In others, the problem persists with chronic reoccurrences and remissions of keratosis pilaris. Although treatment of keratosis pilaris is often frustrating to the patient, prescription medications and skin care measures can improve the appearance of the affected skin areas with consistency and persistence.

Prevention

Since keratosis pilaris is thought to be a genetic disorder and is observed in several members of the same family, there is nothing that can be done to prevent this disorder. Following the treatment advice above can alleviate the outward characteristics of keratosis pilaris. Mild soaps and cleansers help to minimize the problem. Do not aggressively rub the skin because such action will irritate the condition. When washing and bathing or showering, use warm water. Hot water dries the skin more. Keep a bath or shower to less than 15 minutes in duration. Gently dry off with a patting motion, and do not use harsh rubbing motions. The regular application of emollients is also helpful. Preventing dry skin is also recommended. Use a moisturizing lotion or lubricating cream on a regular basis, especially right after drying off from washing. The application of lactic acid, an over–the–counter product, has been shown to help remove excess keratin from the skin. Maintain humidified air within the home to avoid dry air, which will aggravate the problem.

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ORGANIZATIONS

American Academy of Dermatology, 930 East Woodfield R.d, PO Box 4014, Schaumburg, IL, 60168–4014, (847) 330–0230, (866) 503–7546, (847) 240–1859, http://www.aad.org.

Sally C. McFarlane–Parrott

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Kidney biopsy

Definition

Kidney biopsy is a medical procedure in which a small piece of tissue is removed from the kidney for microscopic examination.

Purpose

The test is usually done to diagnose **kidney disease** and to evaluate the extent of damage to the kidney. A biopsy is also frequently ordered to detect the reason for acute renal failure when normal office procedures and tests fail to establish the cause. In addition, information regarding the progression of the disease and how it is responding to medical treatment can be obtained from a biopsy. Occasionally a biopsy may be done to confirm a diagnosis of **kidney cancer**, to determine its aggressiveness, and decide on the mode of treatment.

Precautions

The biopsy is not recommended for patients who have any uncontrollable bleeding disorders. Platelets are blood cells that play an important role in the blood clotting process. If the bleeding disorder is caused by a low **platelet count** (less than 50,000 per cubic millimeter of blood), then a platelet **transfusion** can be done just before performing the biopsy.

Description

The kidneys, a pair of organsas shaped like kidney beans that are lie on either side of the backbone, just above the waist. The periphery (parenchyma) of the kidney is made up of tiny tubes. These tubes filter and clean the blood by taking out the waste products and making urine. The urine is collected in the central portion of the kidney. Tubes called ureters drain the urine from the kidney into the bladder, where it is held until it is voided from the body.

A kidney specialist (nephrologist) performs the biopsy. It can be done either in the doctor's office or in a local hospital. The patient may be given a calming drug before the procedure to help him relax. The skin and muscles on the back overlying the site that is to be biopsied may be numbed with **local anesthesia**.

The patient will be asked to lie face down and a pad or a rolled towel may be placed under the stomach. Either the left or the right kidney may be biopsied depending on the results of the imaging tests: x rays, **computed tomography scans** (CT scans), **magnetic resonance imaging** (MRI), and ultrasound. The area that will be biopsied is cleaned with an antiseptic solution and sterile drapes are placed on it. The skin is numbed with local anesthesia. A small incision is made on the skin with a scalpel blade. Using a long needle, the physician injects local anesthesia into the incision so that it infiltrates down to the kidney. The biopsy needle is then advanced slowly through the incision. The patient is asked to hold his or her breath each time the needle is pushed forward. Once the wall (capsule) of the kidney has been penetrated, the patient can breathe normally. The tissue is collected for examination and the needle is withdrawn. The needle may be re-inserted into another part of the kidney so that tissue is collected from at least three different areas. The tissue samples are sent to the laboratory for examination. The entire procedure may last about an hour.

Preparation

Before performing the biopsy, the doctor should be made aware of all the medications that the patient is taking. The doctor should also be told whether the patient is allergic to any medications. The procedure and the risks of the procedure are explained to the patient and the necessary consent forms are obtained. The patient should be told that a kidney biopsy requires a 24-hour stay in the hospital after the biopsy.

Some doctors order blood tests to check for clotting problems before performing the biopsy. The patient's blood type may also be determined in case a transfusion becomes necessary.

Aftercare

Immediately after the biopsy, pulse, respiration, and temperature (vital signs) are measured. If they are stable, the patient is instructed to lie flat in bed for at least 12 hours. The pulse and blood pressure are checked at regular intervals by the nursing staff. All urine voided by the patient in the first 12–24 hours is examined in the laboratory for blood cells.

If bleeding is severe, iron levels in the blood drop significantly, or the patient complains of severe **pain** at the biopsy site, the physician should be contacted immediately. After the patient goes home, he should avoid heavy lifting, vigorous **exercise**, and contact sports for at least one or two weeks.

Risks

The risks of a kidney biopsy are very small. Severe bleeding may occur after the procedure. There is also a slight chance that an infection or a lump of blood under the skin that looks black and blue (hematoma)

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KEY TERMS

Biopsy—The surgical removal and microscopic examination of living tissue for diagnostic purposes.

Computed tomography (CT) scan—A medical procedure in which a series of x rays are taken and put together by a computer in order to form detailed pictures of areas inside the body.

Magnetic resonance imaging (MRI)—A medical procedure used for diagnostic purposes in which pictures of areas inside the body can be created using a magnet linked to a computer.

Nephrologist—A doctor who specializes in the diseases and disorders of the kidneys.

Renal ultrasound—A painless and non-invasive procedure in which sound waves are bounced off the kidneys. These sound waves produce a pattern of echoes that are then used by the computer to create pictures of areas inside the kidney (sonograms).

may develop. In most cases, the hematoma disappears by itself and does not cause any pain. However, severe pain or a drop in blood pressure and iron levels in the blood indicates that the hematoma is expanding. This condition could lead to complications and should be reported immediately to the doctor.

Very rarely, the patient may develop high blood pressure (**hypertension**), and the bleeding may be severe enough to require a transfusion. In extremely rare circumstances, the kidney may rupture, or the surrounding organs (pancreas, bowel, spleen, and liver) may be punctured. **Death** occurs in about one in 3000 cases.

Normal results

The results are normal if no abnormalities can be seen in the tissue samples with the naked eye, with an electron microscope or through staining with a fluorescent dye (immunofluorescence).

Abnormal results

Any abnormalities in the size, color, and consistency of the sample will be reported as an abnormal result. In addition, any change in the structure of the renal tubules, the presence of red blood cells, or abnormalities in the cells are considered an abnormal result. If cancerous changes are detected in the kidney cells, they are further characterized in order to determine the stage of the tumor and decide on the appropriate mode of treatment.

ORGANIZATIONS

National Kidney Cancer Association, P.O. Box 96503, Washington, DC, 20090, (800) 850-9132, kidney.cancer@hotmail.com, http://www.kidneycancer.org.

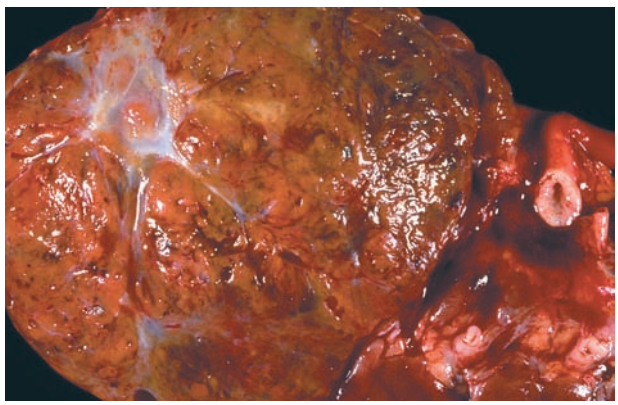
National Kidney Foundation, Inc. , 30 East 33rd Street, New York, NY, 10016, (212) 889-2210, (212) 689-9261, (800) 622-9010, http://www.kidney.org.

Lata Cherath, PhD

Kidney cancer

Definition

Kidney **cancer** is a disease in which the cells in certain tissues of the kidney start to grow uncontrollably and form tumors. Renal cell carcinoma, which occurs in the cells lining the kidneys (epithelial cells), is the most common type of kidney cancer. Eighty-five percent of all kidney tumors are renal cell carcinomas. **Wilms' tumor** is a rapidly developing cancer of the kidney most often found in children under four years of age.



An extracted cancerous kidney. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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Description

The kidneys are a pair of organs that lie on either side of the spine just above the waist. Inside each kidney are tiny tubes (tubules) that filter and clean the blood, taking out the waste products and making urine. The urine that is made by the kidney passes through a tube called the ureter into the bladder. Urine is held in the bladder until it is discharged from the body. Renal cell carcinoma generally develops in the lining of the tubules that filter and clean the blood. Cancer that develops in the central portion of the kidney (where the urine is collected and drained into the ureters) is known as transitional cell cancer of the renal pelvis. Transitional cell cancer is similar to **bladder cancer**.

Kidney cancer accounts for approximately 2–3% of all cancers. In the United States, kidney cancer is the tenth most common cancer and the incidence has increased by 43% since 1973; the **death** rate has increased by 16%. According to the American Cancer Society, 35,710 Americans were diagnosed with kidney cancer in 2004, and 12,480 died from the disease. RCC accounts for 90–95% of malignant neoplasms that originate from the kidney.

Causes and symptoms

The causes of kidney cancer are unknown, but men seem to have a greater risk than women of contracting the disease; the male:female ratio in the United States and Canada is 3:2 as of the early 2000s. There is a strong association between cigarette **smoking** and kidney cancer. Cigarette smokers are twice as likely as non-smokers are to develop kidney cancer. Working around coke ovens has been shown to increase people's risk of developing this cancer. Certain types of painkillers that contain the chemical phenacetin are associated with kidney cancer. The United States government discontinued use of **analgesics** containing phenacetin about 20 years ago. **Obesity** may be yet another risk factor for kidney cancer. Some studies show a loose association between kidney cancer and occupational exposure to cadmium, petroleum products, lead, dry-cleaning solvents, trichloroethylene (TCE), and asbestos. Other risk factors for the development of kidney cancer include Hispanic heritage and preexisting von Hippel-Lindau disease.

The most common symptom of kidney cancer is blood in the urine (hematuria). Other symptoms include painful urination, **pain** in the lower back or on the sides, abdominal pain, a lump or hard mass that can be felt in the kidney area, unexplained weight loss, **fever**, weakness, **fatigue**, and high blood pressure.

Other symptoms may occur if the cancer has spread beyond its original location. Spread of kidney cancer most commonly occurs to the lung (55%), liver (33%), bone (33%), adrenal (20%), and opposite kidney (10%). Lymph node spread is also common, occurring in about 25% of patients).

Diagnosis

A diagnostic examination for kidney cancer includes taking a thorough medical history and making a complete **physical examination** in which the doctor will probe (palpate) the abdomen for lumps. Blood tests will be ordered to check for changes in blood chemistry caused by substances released by the tumor. Laboratory tests may show abnormal levels of iron in the blood. Either a low red blood cell count (anemia) or a high red blood cell count (erythrocytosis) may accompany kidney cancer. Occasionally, patients will have high **calcium** levels.

If the doctor suspects kidney cancer, an intravenous pyelogram (IVP) may be ordered. An IVP is an x-ray test in which a dye in injected into a vein in the arm. The dye travels through the body, and when it is concentrated in the urine to be discharged, it outlines the kidneys, ureters, and the urinary bladder. On an x-ray image, the dye will reveal any abnormalities of the urinary tract. The IVP may miss small kidney cancers.

Renal ultrasound is a diagnostic test in which sound waves are used to form an image of the kidneys. Ultrasound is a painless and non-invasive procedure that can be used to detect even very small kidney tumors. Imaging tests such as **computed tomography scans** (CT scans) and **magnetic resonance imaging** (MRI) can be used to evaluate the kidneys and the surrounding organs. These tests are used to check whether the tumor has spread outside the kidney to other organs in the abdomen. If the patient complains of bone pain, a special x ray called a **bone scan** may be ordered to rule out spread to the bones. A **chest x ray** may be taken to rule out spread to the lungs.

A **kidney biopsy** is used to positively confirm the diagnosis of kidney cancer. During this procedure, a small piece of tissue is removed from the tumor and examined under a microscope. The biopsy will give information about the type of tumor, the cells that are involved, and the aggressiveness of the tumor (tumor stage).

Treatment

Each person's treatment is different and depends on several factors. The location, size, and extent of the tumor have to be considered in addition to the patient's

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KEY TERMS

Biopsy—The surgical removal and microscopic examination of living tissue for diagnostic purposes.

Bone scan—An x-ray study in which patients are given an intravenous injection of a small amount of a radioactive material that travels in the blood. When it reaches the bones, it can be detected by x ray to make a picture of their internal structure.

Chemotherapy—Treatment with anticancer drugs.

Computed tomography (CT) scan—A medical procedure in which a series of x-ray images are made and put together by a computer to form detailed pictures of areas inside the body.

Cryoablation—A technique for removing tissue by destroying it with extreme cold.

Hematuria—Blood in the urine.

Immunotherapy—Treatment of cancer by stimulating the body's immune defense system.

Intravenous pyelogram (IVP)—A procedure in which a dye is injected into a vein in the arm. The dye travels through the body and concentrates in the urine to be discharged. It outlines the kidneys, ureters, and the urinary bladder. An x-ray image is then made and any abnormalities of the urinary tract are revealed.

Magnetic resonance imaging (MRI)—A medical procedure used for diagnostic purposes in which pictures of areas inside the body can be created using a magnet linked to a computer.

Nephrectomy—A medical procedure in which the kidney is surgically removed.

Radiation therapy—Treatment with high-energy radiation from x-ray machines, cobalt, radium, or other sources.

Renal ultrasound—A painless and non-invasive procedure in which sound waves are bounced off the kidneys. These sound waves produce a pattern of echoes that are then used by the computer to create pictures of areas inside the kidney (sonograms).

age, general health, and medical history. In addition, much has changed in the treatment and management of kidney cancer since the 1980s, including new surgical techniques, new **anticancer drugs**, and the development of effective treatments for advanced disease.

The primary treatment for kidney cancer that has not spread to other parts of the body, which is a Stage I, II, or III tumor, is surgical removal of the diseased kidney (**nephrectomy**). Because most cancers affect only one kidney, the patient can function well with the remaining one. Two types of surgical procedure are used. Radical nephrectomy removes the entire kidney and the surrounding tissue. Sometimes, the lymph nodes surrounding the kidney are also removed. Partial nephrectomy removes only part of the kidney along with the tumor. This procedure is used either when the tumor is very small or when it is not practical to remove the entire kidney. It is not practical to remove a kidney when the patient has only one kidney or when both kidneys have tumors. There is a small (5%) chance of missing some of the cancer. Nephrectomy can also be useful for Stage IV cancers, but alternative surgical procedures such as transarterial angioinfarction may be used.

The rapid development and widespread use of laparoscopic techniques has made it possible for surgeons to remove small tumors while sparing the rest of the kidney. Most tumors removed by **laparoscopy** are 4 cm (1.6 in) in size or smaller. Laparoscopy also allows the surgeon to remove small tumors with cryoablation (destroying the tumor by freezing it) rather than cutting.

Radiation therapy, which consists of exposing the cancer cells to high-energy gamma rays from an external source, generally destroys cancer cells with minimal damage to the normal tissue. Side effects are **nausea**, fatigue, and stomach upsets. These symptoms disappear when the treatment is over. In kidney cancer, radiation therapy has been shown to alleviate pain and bleeding, especially when the cancer is inoperable. However, it has not proven to be of much use in destroying the kidney cancer cells. Therefore radiation therapy is not used very often as a treatment for cancer or as a routine adjuvant to nephrectomy. Radiotherapy, however, is used to manage metastatic kidney cancer.

Treatment of kidney cancer with anticancer drugs (**chemotherapy**) has not produced good results. However, new drugs and new combinations of drugs continue to be tested in clinical trials. One new drug, semaxanib (SU5416), is reported to have good results in treating patients with kidney cancer. However, semaxanib is still undergoing clinical trials in the United States.

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Immunologic therapy (or immunotherapy), a form of treatment in which the body's immune system is harnessed to help fight the cancer, is a new mode of therapy that is being tested for kidney cancer. Clinical trials with substances produced by the immune cells (aldesleukin and interferon) have shown some promise in destroying kidney cancer cells. These substances have been approved for use but they can be very toxic and produce severe side effects. The benefits derived from the treatment have to be weighed very carefully against the side effects in each case. Immunotherapy is the most promising systemic therapy for metastatic kidney cancer.

Prognosis

Because kidney cancer is often caught early and sometimes progresses slowly, the chances of a surgical cure are good. Length of survival depends on the size of the original tumor, the aggressiveness of the specific cells making up the tumor, and whether the cancer cells spread from the kidney to surrounding or distant tissues.

Kidney cancer is also one of the few cancers for which there are well-documented cases of spontaneous remission without therapy. Unfortunately, recurrences can occur even as long as ten years after the original diagnosis and treatment, and cancer can also crop up in the other, previously unaffected kidney.

Prevention

The exact cause of kidney cancer is not known, so it is not possible to prevent all cases. However, because a strong association between kidney cancer and tobacco has been shown, avoiding tobacco is the best way to lower one's risk of developing this cancer. Using care when working with cancer-causing agents such as asbestos and cadmium and eating a well-balanced diet may also help prevent kidney cancer.

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ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (800) 227-2345, http://www.cancer.org.

Cancer Research Institute (National Headquarters), One Exchange Plaza, 55 Broadway, Suite 1802, New York, NY, (212) 688-7515, (212) 832-9376, (800) 992-2623, http://www.cancerresearch.org.

National Cancer Institute (National Institutes of Health), NCI Office of Communications and Education, 6116 Executive Blvd. Suite 300, Bethesda, MD, 20892-8322, (800) 4-CANCER (422-6237), cancergovstaff@mail.nih.gov, http://www.cancer.gov.

National Kidney Cancer Association, P.O. Box 96503, Washington, DC, 20090, (800) 850-9132, kidney.cancer@hotmail.com, http://www.kidneycancer.org.

National Kidney Foundation, Inc. , 30 East 33rd Street, New York, NY, 10016, (212) 889-2210, (212) 689-9261, (800) 622-9010, http://www.kidney.org.

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Kidney dialysis *see* **Dialysis, kidney**

Kidney disease

Definition

Kidney disease is a general term for any damage that reduces the functioning of the kidney. Kidney disease is also called renal disease.

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Description

The kidneys are a pair bean-shaped, fist-sized organs that are located below the rib cage near the middle of the back. In adults they filter about 200 quarts (190 L) of blood every day to remove waste products that result from the normal activities of tissues in the body. These wastes circulate in the blood. and if not removed they would damage the body. The kidneys also play a crucial role in regulating the amount of water and chemicals (electrolytes) in the body such as **sodium**, potassium and phosphorous.

Inside the kidneys are about one million tiny units called nephrons. Inside each nephron is a very thin blood vessel called a capillary that twists around a very thin tube called a tubule. This combination of capillary and tubule inside the nephron is called a glomerulous and it is here that the blood is filtered. Water, electrolytes, and waste products (but not red blood cells) can pass across the capillary wall and into the tubule. The kidney then regulates how much water and which other substances can pass back into the blood in the capillary to keep the body in balance. Waste products, excess water, and excess electrolytes remain in the tubule and eventually leave the body as urine.

The kidneys also release three regulatory chemicals—erythropoietin, renin, and calcitriol—that affect other functions in the body. Erythropoietin stimulates the bone marrow to produce new red blood cells. Renin helps regulate blood pressure, and calcitriol is a form of vitamin D and is important in maintaining bones and the level of **calcium** in the body.

Because the kidney has many functions, there are many types of kidney disease. Congenital kidney diseases are disorders that are present at birth. **Polycystic kidney disease** (PKD) is a rare disorder in which children inherit defective genes from both parents that cause cysts full of fluid to develop in the kidneys and replace the blood filtering units. As a result, the kidneys cannot adequately remove wastes from the body. There are two other types of PDK. One is inherited, but does not appear until adulthood, and the other develops as a result of long-term kidney damage. In total, about half a million people in the United States have some form of PKD. Hereditary disease and **birth defects** are the most common causes of kidney disease in children up to age 14.

Acute kidney diseases are problems that develop suddenly. Many acute kidney diseases can be cured, but some may cause permanent damage. Common acute kidney diseases include kidney infection, hemolytic uremic syndrome, **nephrotic syndrome** in children, and damage caused by injury to the kidney or poisoning. Hemolytic uremic syndrome is a rare disease that usually affects children under age ten and is caused by eating food contaminated with bacteria. The bacteria release a poison that damages the kidney and causes **acute kidney failure**. Most children who develop this disease recover and their kidney function returns to normal.

Chronic kidney disease is disease that is slow to develop and usually does not show any symptoms until kidney damage is permanent. The National Kidney and Urologic Disease Information Clearinghouse, a federal agency, estimates that about 4.5% of people over age 20 have chronic kidney disease as indicated by tests that measure kidney function. The most common cause of chronic kidney disease in the United States is diabetes. It accounts for between 33% and 40% of all new cases of chronic kidney disease in the United States. In diabetes, the body cannot break down glucose (sugar). This extra glucose in the blood damages the nephrons so that they no longer filter blood effectively.

High or uncontrolled blood pressure (**hypertension**) is the second leading cause of chronic kidney disease. It accounts for between 27% and 30% of all new cases of chronic kidney disease. High blood pressure damages the capillaries in the nephron, so that they can no longer work with the tubules to filter the blood. Glomerulonephtitis is a term for several different chronic kidney diseases where damage to the nephrons causes protein or red blood cells pass into the urine. **Kidney cancer** is uncommon, accounting for only 2% of **cancer** cases.

Over-the-counter **analgesics** (pain medications) such as **aspirin**, **acetaminophen** (Tylenol), ibuprofen (Advil), naxopren sodium (Aleve), and similar medications that can be bought without a prescription may make kidney disease worse in individuals who already have kidney damage or cause kidney damage in healthy individuals who take these medications daily for several years. The chance of damage is increased when these pain medications are taken in combination with each other or with **caffeine** or codeine (Some painkilling tablets are a combination of pain medications and caffeine or codeine). Individuals who take these painkillers regularly or who have been told they have kidney damage should discuss the risk of these medications with their physician.

Chronic kidney disease can lead to end-stage renal disease (ESRD), in which there is almost total failure of the kidneys. If renal function is reduced to only 25% of normal, serious illness results. When this drops to 10–15% of normal, **death** occurs unless the individual receives dialysis or a kidney transplant. In 2002, there

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were over 100,300 new cases of ESRD, 44% of which were caused by diabetes. Treatment of ESRD in the United States cost about $25.2 billion in 2002.

Causes and symptoms

Causes of kidney disease are many and varied. Leading causes are diabetes, high blood pressure, inherited disease, and infection. Acute kidney disease is often marked by a lack of urination and increased fluid build up in the body. Chronic kidney disease is often called a "silent" killer, because no obvious symptoms develop until the kidneys are permanently damaged. The National Kidney Foundation estimated in 2005 that 20 million Americans had undetected moderate chronic kidney disease. Chronic kidney disease most often results from other diseases such as diabetes or hypertension.

Diagnosis

Simple blood and urine tests can indicated kidney disease, but more extensive testing may be needed to determine the exact nature of the disease. A blood test that measures serum creatinine, a waste product, can indicate how well the kidneys are working. Although normal levels of creatinine vary (an average range is 0.6–1.2 mg/dL), a higher than expected level in the blood may indicate kidney damage. A blood urea nitrogen (BUN) blood test measures waste products circulating in the blood. Normal levels range from 7%–20 mg/dL. The less well the kidney is working, the higher the BUN.

A 24-hour urine collection test will accurately measure how much urine the kidneys are producing in a day. A **urinalysis** can determine if protein or red blood cells are leaking into the urine indicating abnormal kidney function. A creatinine clearance test compares the amount of creatinine in a 24-hour urine sample with the amount of creatinine in the blood to determine how much blood the kidneys are filtering each minute.

Based on the results of blood and urine tests, other tests such as a CT scan, MRI, or **kidney biopsy** may be ordered.

Treatment

Most treatment for kidney disease involves treating the underlying cause of the disease, such as controlling high blood pressure or diabetes. Diuretic medication ("water pills") may be given to help relieve fluid accumulation. **Antibiotics** are used to treat kidney infections. Other drugs may be given to treat specific kidney diseases.

KEY TERMS

Congenital—Present at birth.

Diuretic—A substance that stimulates the kidney to excrete water.

Glomerulous—A twisted mass of blood capillaries and urine tubules in the kidney where filtering of waste products occurs.

Hormone—A chemical produced by living cells that travels through the circulatory system and affects tissue at some distance from where it was released.

Hypertension—High blood pressure.

Nephron—The smallest functional unit of the kidney involved in the removal of waste products and excess water from the blood.

Diet and lifestyle changes are an important part of controlling kidney disease. **Obesity** increases blood pressure, so losing weight can help limit kidney damage, as can stopping **smoking**. Reducing sodium (salt) in the diet also helps control blood pressure. In certain kinds of kidney disease, potassium is removed in abnormally large quantities by the kidneys and excreted in urine. Eating more foods such as bananas, dried beans and peas, nuts, and potatoes that are high in potassium or taking a potassium supplement pill help reverse this effect. When protein is found in the urine, some physicians recommend reducing the amount of protein (mainly found in meat) in the diet.

When kidneys fail completely in ESRD, there are only two alternatives: dialysis or kidney transplant. There are two types of dialysis. Peritoneal dialysis uses a membrane in the individual's abdomen to filter waste products. The most common kind of peritoneal dialysis is continuous ambulatory peritoneal dialysis (CAPD), in which the individual is hooked up to a bag of dialysis fluid that he carries with him, allowing continuous dialysis. The fluid is changed four times a day. In another form of peritoneal dialysis, the abdomen is filled with dialysis fluid. Wastes filter into the fluid for several hours often while the individual is asleep, the then the fluid is drained from the body. Peritoneal dialysis can be done at home without the need for a health care professional.

In hemodialysis, the individual must go to a dialysis center about three times a week. His blood is sent through a machine that filters out the waste and then returns the cleansed blood to his body. The process takes three to four hours and is done by a health care professional.

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Kidney transplants can come from either a living donor or a deceased donor. Donors are matched with recipients based on blood type and must take drugs to prevent their immune system from rejecting the kidney after transplantation. The United Network for Organ Sharing (UNOS) coordinates matching donor kidneys with appropriate recipients. More than 100 clinical trials are enrolling patients with various types of kidney disease.

Alternative treatment

Alternative treatments tend to focus on removing excess water from the body, but have limited effect on serious disease. Asparagus (*Asparagus officinalis*) birch tea (*Betula* species), goldenrod infusion (*Solidago* species), horsetail (*Equisetum arvense*), and stinging nettle (*Urtica dioica*) all are used to stimulate urine production.

Prognosis

Many individuals recover normal kidney function after developing acute kidney disease, although in some cases, such as poisoning and injury, kidney damage may be permanent. Chronic kidney disease tends to get progressively worse as the individual ages. More than 15,000 kidney transplants are done each year, and there is a often long waiting list for donated kidneys. 80.6% of individuals receiving a transplant from a deceased donor survive for at least 5 years, and 90.4% of individuals receiving a kidney donated from a living donor survive for at least 5 years.

Prevention

Maintaining a healthy body weight, getting regular **exercise**, and not smoking all promote kidney health. Controlling underlying diseases such as diabetes and high blood pressure are important in preventing chronic kidney diseases.

Resources

OTHER

"About Kidney Disease." National Kidney Disease Education Program. June 30, 2010 (accessed October 16, 2010). http://www.nkdep.nih.gov/patients/kidney_disease_information.htm.

ORGANIZATIONS

American Association of Kidney Patients, 3505 E. Frontage Road, Suite 315, Tampa, FL, 33607, (813) 636-8122, (800) 749-2257, info@aakp.org, http://www.aakp.org.

American Urological Association Foundation, 1000 Corporate Blvd., Linthicum, MD, 21090, (410) 689-3700, (410) 689-3800, (866) 746-4282, auafoundation@auafoundation.org, http://www.urologyhealth.org.

National Institute of Diabetes and Digestive and Kidney Diseases, NIDDK, NIH Bldg 31, Rm 9A06 31 Center Drive, MSC 2560, Bethesda, MD, 20892-2560, (301) 496.3583, http://www2.niddk.nih.gov.

National Kidney Foundation, Inc. , 30 East 33rd Street, New York, NY, 10016, (212) 889-2210, (212) 689-9261, (800) 622-9010, http://www.kidney.org.

United Network for Organ Sharing (UNOS), 700 N. 4th Street; PO Box 2484, Richmond, VA, 23218, (804) 782-4800, (804) 782-4817, (888) 894-6361, http://www.unos.org.

Tish Davidson, A.M.

Kidney failure *see* **Acute kidney failure; Chronic kidney failure**

Kidney function tests

Definition

Kidney function tests is a collective term for a variety of individual tests and procedures that can be done to evaluate how well the kidneys are functioning.

Purpose

The kidneys, the body's natural filtration system, perform many vital functions, including removing metabolic waste products from the bloodstream, regulating the body's water balance, and maintaining the pH (acidity/alkalinity) of the body's fluids. Approximately one and a half quarts of blood per minute are circulated through the kidneys, where waste chemicals are filtered out and eliminated from the body (along with excess water) in the form of urine. Kidney function tests help to determine if the kidneys are performing their tasks adequately.

Precautions

A complete history should be taken prior to kidney function tests to assess the patient's food and drug intake. A wide variety of prescription and over-the-counter medications can affect blood and urine kidney function test results, as can some food and beverages.

Description

Many conditions can affect the ability of the kidneys to carry-out their vital functions. Some lead to a rapid (acute) decline in kidney function; others lead to a gradual (chronic) decline in function. Both result in a build-up of

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toxic waste substances in the blood. A number of clinical laboratory tests that measure the levels of substances normally regulated by the kidneys can help determine the cause and extent of kidney dysfunction. These tests are done on urine samples, as well as on blood samples.

Urine tests

There are a variety of urine tests that assess kidney function. A simple, inexpensive screening test, called a routine **urinalysis**, is often the first test administered if kidney problems are suspected. A small, randomly collected urine sample is examined physically for things like color, odor, appearance, and concentration (specific gravity); chemically for substances such as protein, glucose, and pH (acidity/ alkalinity); and microscopically for the presence of cellular elements (red blood cells, white blood cells, and epithelial cells), bacteria, crystals, and casts (structures formed by the deposit of protein, cells, and other substances in the kidneys' tubules). If results indicate a possibility of disease or impaired kidney function, one or more of the following additional tests is usually performed to more specifically diagnose the cause and the level of decline in kidney function.

- Creatinine clearance test. This test evaluates how efficiently the kidneys clear a substance called creatinine from the blood. Creatinine, a waste product of muscle energy metabolism, is produced at a constant rate that is proportional to the muscle mass of the individual. Because the body does not recycle it, all of the creatinine filtered by the kidneys in a given amount of time is excreted in the urine, making creatinine clearance a very specific measurement of kidney function. The test is performed on a timed urine specimen—a cumulative sample collected over a two to twenty-four hour period. Determination of the blood creatinine level is also required to calculate the urine clearance.
- Urea clearance test. Urea is a waste product that is created by protein metabolism and excreted in the urine. The urea clearance test requires a blood sample to measure the amount of urea in the bloodstream and two urine specimens, collected one hour apart, to determine the amount of urea that is filtered, or cleared, by the kidneys into the urine.
- Urine osmolality test. Urine osmolality is a measurement of the number of dissolved particles in urine. It is a more precise measurement than specific gravity for evaluating the ability of the kidneys to concentrate or dilute the urine. Kidneys that are functioning normally will excrete more water into the urine as fluid intake is increased, diluting the urine. If fluid intake is decreased, the kidneys excrete less water and the urine becomes more concentrated. The test may be done on a urine sample collected first thing in the morning, on multiple timed samples, or on a cumulative sample collected over a twenty-four hour period. The patient will typically be prescribed a high-protein diet for several days before the test and asked to drink no fluids the night before the test.
- Urine protein test. Healthy kidneys filter all proteins from the bloodstream and then reabsorb them, allowing no protein, or only slight amounts of protein, into the urine. The persistent presence of significant amounts of protein in the urine, then, is an important indicator of kidney disease. A positive screening test for protein (included in a routine urinalysis) on a random urine sample is usually followed-up with a test on a 24-hour urine sample that more precisely measures the quantity of protein.

Blood tests

There are also several blood tests that can aid in evaluating kidney function. These include:

- Blood urea nitrogen test (BUN). Urea is a by-product of protein metabolism. This waste product is formed in the liver, then filtered from the blood and excreted in the urine by the kidneys. The BUN test measures the amount of nitrogen contained in the urea. High BUN levels can indicate kidney dysfunction, but because blood urea nitrogen is also affected by protein intake and liver function, the test is usually done in conjunction with a blood creatinine, a more specific indicator of kidney function.
- Creatinine test. This test measures blood levels of creatinine, a by-product of muscle energy metabolism that, like urea, is filtered from the blood by the kidneys and excreted into the urine. Production of creatinine depends on an individual's muscle mass, which usually fluctuates very little. With normal kidney function, then, the amount of creatinine in the blood remains relatively constant and normal. For this reason, and because creatinine is affected very little by liver function, an elevated blood creatinine is a more sensitive indication of impaired kidney function than the BUN.
- Other blood tests. Measurement of the blood levels of other elements regulated in part by the kidneys can also be useful in evaluating kidney function. These include sodium, potassium, chloride, bicarbonate, calcium, magnesium, phosphorus, protein, uric acid, and glucose.

Preparation

Patients will be given specific instructions for collection of urine samples, depending on the test to be performed. Some timed urine tests require an extended

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KEY TERMS

Blood urea nitrogen (BUN)—The nitrogen portion of urea in the bloodstream. Urea is a waste product of protein metabolism in the body.

Creatinine—The metabolized by-product of creatine, an organic acid that assists the body in producing muscle contractions. Creatinine is found in the bloodstream and in muscle tissue. It is removed from the blood by the kidneys and excreted in the urine.

Osmolality—A measurement of urine concentration that depends on the number of particles dissolved in it. Values are expressed as milliosmols per kilogram (mOsm/kg) of water.

Urea—A by-product of protein metabolism that is formed in the liver. Because urea contains ammonia, which is toxic to the body, it must be quickly filtered from the blood by the kidneys and excreted in the urine.

collection period of up to 24 hours, during which time the patient collects all urine voided and transfers it to a specimen container. Refrigeration and/or preservatives are typically required to maintain the integrity of such urine specimens. Certain dietary and/or medication restrictions may be imposed for some of the blood and urine tests. The patient may also be instructed to avoid **exercise** for a period of time before a test.

Aftercare

If medication was discontinued prior to a urine kidney function test, it may be resumed once the test is completed.

Risks

Risks for these tests are minimal, but may include slight bleeding from a blood-drawing site, hematoma (accumulation of blood under a puncture site), or **fainting** or feeling light-headed after venipuncture. In addition, suspension of medication or dietary changes imposed in preparation for some blood or urine tests may trigger side-effects in some individuals.

Normal results

Normal values for many tests are determined by the patient's age and sex. Reference values can also vary by laboratory, but are generally within the ranges that follow.

Urine tests

- Creatinine clearance. For a 24-hour urine collection, normal results are 90-139 mL/min for adult males less than 40 years old, and 80-125 mL/min for adult females less than 40 years old. For people over 40, values decrease by 6.5 mL/min for each decade of life.
- Urea clearance. With maximum clearance, normal is 64–99 mL/min.
- Urine osmolality. With restricted fluid intake (concentration testing), osmolality should be greater than 800 mOsm/kg of water. With increased fluid intake (dilution testing), osmolality should be less than 100 mOSm/kg in at least one of the specimens collected.
- Urine protein. A 24-hour urine collection should contain no more than 150 mg of protein.

Blood tests

- Blood urea nitrogen (BUN). 8–20 mg/dL.
- Creatinine. 0.8–1.2 mg/dL for males, and 0.6–0.9 mg/dL for females.

Abnormal results

Low clearance values for creatinine and urea indicate diminished ability of the kidneys to filter these waste products from the blood and excrete them in the urine. As clearance levels decrease, blood levels of creatinine and urea nitrogen increase. Since it can be affected by other factors, an elevated BUN, by itself, is suggestive, but not diagnostic, for kidney dysfunction. An abnormally elevated blood creatinine, a more specific and sensitive indicator of **kidney disease** than the BUN, is diagnostic of impaired kidney function.

Inability of the kidneys to concentrate the urine in response to restricted fluid intake, or to dilute the urine in response to increased fluid intake during osmolality testing may indicate decreased kidney function. Because the kidneys normally excrete almost no protein in the urine, its persistent presence, in amounts that exceed the normal 24-hour urine value, usually indicates some type of kidney disease as well.

ORGANIZATIONS

National Kidney Foundation, Inc., 30 East 33rd Street, New York, NY, 10016, (212) 889-2210, (212) 689-9261, (800) 622-9010, http://www.kidney.org.

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Kidney nuclear medicine scan

Definition

A kidney nuclear medicine scan, or study, is a simple outpatient test that involves administering small amounts of radioactive substances, called tracers, into the body and then imaging the kidneys and bladder with a special camera. The images obtained can help in the diagnosis and treatment of certain kidney diseases.

Purpose

While many tests, such as x rays, ultrasound exams, or **computed tomography scans** (CT scans), can reveal the structure of the kidneys (its anatomy), the kidney nuclear medicine scan is unique in that it reveals how the kidneys are functioning. This is valuable information in helping a doctor make a diagnosis. Therefore, the kidney nuclear medicine scan is performed primarily to see how well the kidneys are working and, at the same time, they can identify some of the various structures that make up the kidney.

Precautions

If a patient is pregnant, it is generally recommended that she not have a kidney nuclear medicine scan. The unborn baby is more sensitive to radiation than an adult. If a woman thinks she might be pregnant, she should inform her doctor of this too.

Women who are **breastfeeding** should also inform their doctor. The doctor may recommend the woman stop breastfeeding for a day or two after a kidney nuclear medicine scan, depending on the particular tracer that was used since the tracer can accumulate in breast milk.

Description

Nuclear medicine is a branch of radiology that uses radioactive materials to diagnose or treat various diseases. These radioactive materials (tracers) may also be called radiopharmaceuticals, and they accumulate (collect) in specific organs in the body. Radiopharmaceuticals are able to yield valuable information about the particular organ being studied.

Whether outside the body or inside the body, tracers emit radioactive signals, called gamma rays, which can be collected and counted by a special device, called a gamma camera. The images of the kidney that the camera produces are called renal scans.

The kidney nuclear medicine scan can be performed on an outpatient basis, usually by a nuclear medicine technologist. The technologist helps prepare the patient for the exam by positioning him or her on an exam table or cart in the imaging area. The patient's position is usually flat on the back. The patient must lie still during imaging to prevent blurring of the images that will be taken. The technologist positions the camera as close to the kidney (or kidneys) as possible to obtain the best images.

In the next step of the procedure, the technologist injects the radiopharmaceutical into the patient. This may be done with one single injection or through an intravenous (IV) line. Immediately after the tracer is injected, imaging begins. It is important to obtain images right away because the tracer's radioactivity begins to diminish (decay). The time required for one-half of the tracer's activity to decay is called the tracer's half-life (T 1/2). The half-life is unique to each radiopharmaceutical. Also, it is important to see the kidney in its immediate state.

Serial pictures are taken with the gamma camera and may be seen on a computer or TV-like screen. The camera doesn't emit radiation, it only records it. The images then are stored on film.

A kidney nuclear medicine scan ranges from 45 minutes to three hours in length, depending on the goals of the test. But the test typically takes about an hour to an hour-and-a-half.

Once the images and curves are obtained, the nuclear medicine physician or radiologist analyzes, or reads, them. Various information can be provided to the doctor through these, depending on the test that was performed. A variety of kidney nuclear medicine studies are available for a doctor to help in making diagnoses. It is important to understand that kidney nuclear medicine scans are good at identifying when there is an abnormality, but they do not always identify the specific problem. They are very useful in providing information about how the various parts of the kidneys function, which, in turn, can assist in making a diagnosis.

Studies may be performed to determine the rate at which the kidney's are filtering a patient's blood. These studies use a radiopharmaceutical, called Technetium DTPA (Tc 99m DTPA). This radiopharmaceutical also can identify obstruction (blockage) in the collecting system. To study how well the tubules and ducts of the kidney are functioning, the radiopharmaceutical Technetium MAG3 is used. Studying tubular function is a good indicator of overall renal function.

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KEY TERMS

Intravenous pyelogram (IVP)—X-ray technique using dye to image the kidneys, ureters, and bladder.

Renal—Having to do with the kidneys.

Renal artery stenosis—Narrowing or constriction of the artery that supplies the kidney with blood.

In many renal diseases, one of the first things that disappears or diminishes is the tubular function.

Candidates for a kidney nuclear medicine scan are patients who have:

- Renal failure or chronic renal failure
- Obstruction in their urine collection systems
- Renal artery stenosis
- A kidney transplant.

Preparation

No preparation is necessary for a kidney nuclear medicine scan. The doctor may ask the patient to refrain from certain medications, however, before the scan if the medications might interfere with the test. For example, if a scan is being performed to study **renal artery stenosis**, the patient may have to refrain from taking medications for **hypertension**.

Aftercare

Patients can resume their normal daily activities immediately after the test. Most tracers are passed naturally from the body, though drinking fluids after a kidney nuclear medicine scan can help flush the tracer into the urine and out of the body more quickly.

Risks

Nuclear medicine procedures are very safe. Unlike some of the dyes that may be used in x-ray studies, radioactive tracers rarely cause side effects. There are no long-lasting effects of the tracers themselves, because they have no functional effects on the body's tissues.

Normal results

The test reveals normal kidney function for age and medical situation.

Abnormal results

The test reveals a change in function that may be attributable to a disease process, such as obstruction or a malfunctioning kidney. If the test is abnormal, the patient may be recalled another day for a repeat study, performed differently, to narrow the list of causes.

ORGANIZATIONS

Society of Nuclear Medicine (SNM), 1850 Samuel Morse Dr., Reston, VA, 20190, (703) 708-9000, (703) 708-9015, http://www.snm.org.

Collette L. Placek

Kidney removal *see* **Nephrectomy**

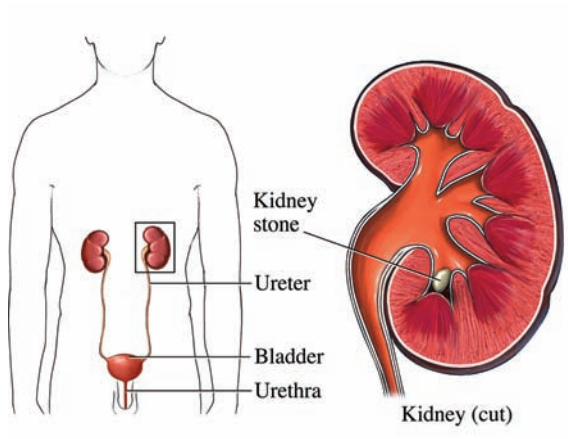
Kidney stones

Definition

Kidney stones are solid accumulations of material that form in the tubal system of the kidney. Kidney stones cause problems when they block the flow of urine within the kidney or urinary tract. When the stones move through the ureter, they can cause severe **pain**.

Description

Urine is formed by the kidneys. Blood flows into the kidneys, and nephrons (specialized tubes) within the kidneys allow a certain amount of fluid from the blood, along with certain substances dissolved in that fluid, to flow out of the body as urine. Sometimes, a problem causes the dissolved substances to become



Kidney stones can occur in the ureter near the bladder or kidney. *(© Nucleus Medical Art, Inc./Alamy.)*

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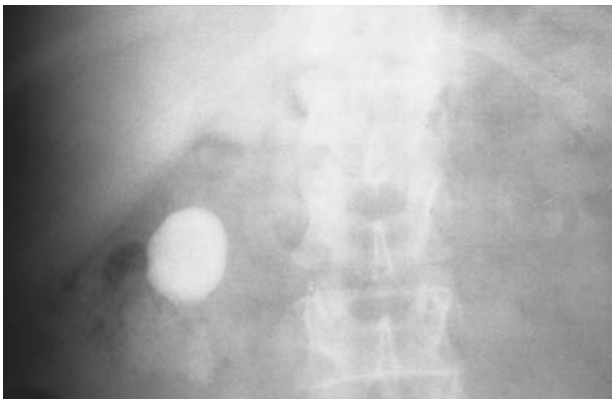

X ray of kidney stone. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

solid again. Tiny crystals then form in the urine, meet, and cling together to create a larger solid mass called a kidney stone.

Many kidney stones are small enough that the kidney continues to function normally, and the stones never cause any pain. These are called "silent stones." Kidney stones cause problems when they interfere with the normal flow of urine. They can obstruct (block) the flow through the ureter. The kidney is not accustomed to experiencing any pressure. When pressure builds from backed-up urine, the kidney may swell (**hydronephrosis**). If the kidney is subjected to this pressure for some time, there may be damage to delicate kidney structures. When the kidney stone is lodged further down the ureter, the backed-up urine may also cause the ureter to swell (hydroureter). Because the ureter is a muscular tube, the presence of a stone makes the tube spasm, causing severe pain.

About 10% of all people have a significant kidney stone during their lifetime. Kidney stones are most common among white men over age 30, people who have previously had kidney stones, and people whose family members are prone to developing kidney stones. Eating a lot of animal protein and drinking too few fluids are also thought to contribute to the development of kidney stones.

Causes and symptoms

Kidney stones can be composed of a variety of substances. The most common types of kidney stones are described here.

Calcium stones

About 80% of all kidney stones are **calcium** stones. These stones are composed of either calcium and phosphate, or calcium and oxalate. People with calcium stones may have other diseases that cause them to have increased blood levels of calcium. These diseases include primary parathyroidism, **sarcoidosis**, **hyperthyroidism**, **renal tubular acidosis**, **multiple myeloma**, hyperoxaluria, and some types of **cancer**.

Struvite stones

Struvite stones account for 10% of all kidney stones. Struvite stones are composed of magnesium ammonium phosphate. These stones occur most often in patients who have had repeated urinary tract infections caused by certain types of bacteria. These bacteria produce a substance called urease that increases the urine pH and makes the urine more alkaline. This chemical environment allows struvite to settle out of the urine, forming stones.

Uric acid stones

About 5% of all kidney stones are uric acid stones. These occur when increased amounts of uric acid circulate in the bloodstream. When the uric acid content becomes very high, it can no longer remain dissolved and solid particles of uric acid settle out of the urine. A kidney stone is formed when these particles cling to each other within the kidney, slowly forming a solid mass. About half of all patients with this type of stone also have deposits of uric acid elsewhere in their bodies, commonly in the joint of the big toe. This painful disorder is called **gout**. Other causes of uric acid stones include **chemotherapy** for cancer, bone marrow disorders in which certain types of blood cells are over-produced, and an inherited disorder called **Lesch-Nyhan syndrome**.

Cystine stones

Cystine stones account for 2% of all kidney stones. Cystine is a type of amino acid, and people with this type of kidney stone have an abnormality in the way their bodies process amino acids in the diet.

Patients who have kidney stones usually do not have symptoms until the stone passes into the ureter. Before this, some people may notice blood in their urine. Once the stone is in the ureter, however, most people experience bouts of very severe pain. The pain is crampy, spasmodic, and intense. It usually begins in the flank region, the area between the lower ribs and the hip bone. As the stone moves closer to the bladder, a patient will often feel the pain radiating along the inner thigh. Women may feel the pain in the vulva, while men often feel pain in the testicles. **Nausea**, **vomiting**, frequent and painful urination, and blood

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in the urine are common. **Fever** and chills usually mean that the ureter has become obstructed, allowing bacteria to become trapped in the kidney and cause a kidney infection (**pyelonephritis**).

Diagnosis

Most often in a healthy adult, diagnosis of kidney stones is based on the patient's pattern of severe, distinctive pain. Diagnosis may include laboratory examination of a urine sample and an x-ray examination. During the passage of a stone, examination of the urine usually reveals blood. A number of imaging tests can, if necessary, be used to diagnose kidney stones. A plain x ray of the kidneys, ureters, and bladder may or may not reveal the stone. An ultrasound can also be used to detect renal blockage. The use of computed tomography (CT) scans has been added to diagnose of some kidney stones.

When a patient is passing a kidney stone, the urine is strained through a special sieve to catch the stone. If the stone can be located (often it cannot), it can then be sent to a laboratory for analysis to determine the chemical composition of the stone. After the kidney stone has been passed, other tests may be done to understand the underlying condition that may have caused the stone to form. Collecting urine for 24 hours, followed by careful analysis of its chemical makeup, can often determine the reason for stone formation.

Treatment

It is believed that stones will pass more quickly if the patient is encouraged to drink large amounts of water (2–3 quarts per day). Cranberry (*Vaccinium macrocarpon*) juice has been a traditional remedy for the treatment and prevention of kidney stones. Although clinical trials have found that cranberry juice has some effect on urinary tract infections, its effectiveness in treating kidney stones is unproven.

Herbal remedies that have anti-lithic (stone-dissolving) action can assist in dissolving small kidney stones. These include gravel root (*Eupatorium purpureum*), hydrangea (*Hydrangea aborescens*), and wild carrot (*Daucus carota*). Starfruit (*Averrhoa carambola*) is recommended to increase the amount of urine a patient passes and to relieve pain.

A Chinese herbal practitioner may use herbs such as *Semen Abutili seu Malvae, Semen plantaginis,* and *Herba lygodii japonici* for urinary stones. Dietary changes can be made to reduce the risk of future stone formation and to facilitate the resorption of existing stones. Supplementation with magnesium, a smooth muscle relaxant, can help reduce pain and facilitate stone passing. **Guided imagery** may also be used to help relieve pain. Large stones may require conventional medical intervention.

Allopathic treatment

The pain associated with a kidney stone sends most patients to the emergency room, and a patient with a kidney stone will say that the most important aspect of treatment is adequate pain relief. Because the pain of passing a kidney stone is so severe, narcotic pain medications are usually required. If the patient is **vomiting** or unable to drink fluids because of the pain, it may be necessary to provide intravenous fluids and anti-emetics (drugs that stop vomiting). If symptoms and urine tests indicate the presence of infection, **antibiotics** are required.

Although most kidney stones pass on their own, some do not. The preferred method of treatment is extracorporeal shock wave **lithotripsy** (ESWL). Shock waves are aimed at the stone. The energy of the shock waves causes the stone to vibrate and fragment into small pieces that can be more easily passed. This procedure is generally done under light anesthesia because the shock waves cause pain. If the stone is lodged in the ureter, the urologist may insert a device into the ureter that can direct laser or ultrasound energy at the stone and pulverize it. If the stone is large and ESWL does not work, the stone may be removed by minimally invasive surgery.

Expected results

A patient's prognosis depends on the underlying disorder causing the development of kidney stones. In most cases, patients with uncomplicated calcium stones recover very well. About 60% of these patients, however, will have other kidney stones. Struvite stones are particularly dangerous because they may grow extremely large, filling the tubes within the kidney. These are called staghorn stones and will not pass out in the urine. They require surgical removal. Uric acid stones may also become staghorn stones.

Prevention

Prevention of kidney stones depends on the type of stone and the presence or absence of an underlying disease. In almost all cases, increasing fluid intake so that a person consistently drinks 2 to 3 quarts (liters) of water a day is an important preventative measure. Drinking a glass of lemonade made with real lemons or real lemon concentrate also helps increase the amount of citrate in the urine. Citrate makes it more difficult for kidney stones to form.

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KEY TERMS

Diuretic—A substance that removes water from the body by increasing urine production.

pH—A measure of the acidity of a fluid. On a scale of 1 to 14, a pH of 7 is neutral. Higher pH readings are alkaline and lower pH readings are acidic.

Ureter—A tube that carries urine from the kidney to the bladder.

People with calcium oxalate stones do not need to reduce the amount of calcium in their diet but may reduce the amount of foods containing oxalate. These foods include rhubarb, star fruit, beets, beet greens, collards, okra, refried beans, spinach, Swiss chard, sweet potatoes, sesame seeds, almonds, and soy products. A vegan diet or one very low in animal products also is effective in preventing kidney stones, especially when combined with a very low salt diet.

People prone to form kidney stones may also be given medication to help prevent their formation. A thiazide diuretic can help prevent the formation of calcium stones. Allopurinol (Zyloprim, Aloprim) reduces the amount of uric acid blood and urine and helps prevent the formation of uric acid stones. Sturvite stones often form when the kidney becomes infected, so preventing infection also helps to prevent stone formation. Cystine stones are difficult to prevent.

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ORGANIZATIONS

Alternative Medicine Foundation., PO Box 60016, Potomac, MD, 20859, (301) 340-1960, http://www.amfoundation.org.

American Association of Oriental Medicine., PO Box 162340, Sacramento, CA, 95816, (866) 455-7999, (914) 443-4770, http://www.aaaomonline.org.

American Holistic Medical Association., PO Box 2016, Edmonds, WA, 98020, (425) 967-0737, http://www.holisticmedicine.org.

National Kidney Foundation., 30 East Thirty-third Street, New York, NY, 10016, (800) 622-9010, http://www.kidney.org.

Paula Ford-Martin
Laura Jean Cataldo, RN, Ed.D.

Kidney transplantation

Definition

Kidney transplantation is a surgical procedure to remove a healthy, functioning kidney from a living or brain-dead donor and implant it into a patient with non-functioning kidneys.

Purpose

Kidney transplantation is performed on patients with **chronic kidney failure**, or end-stage renal disease (ESRD). ESRD occurs when a disease, disorder, or congenital condition damages the kidneys so that they are no longer capable of adequately removing fluids

National transplant waiting list by organ type (June 2010)

Organ needed	Persons waiting
Kidney	85,296
Liver	16,031
Heart	3,141
Kidney/Pancreas	2,199
Lung	1,802
Pancreas	1,450
Intestine	242
Heart/Lung	79

SOURCE: U.S. Department of Health and Human Services, Organ Procurement and Transplantation Network. Available online at: http://optn.transplant.hrsa.gov/data/default.asp (accessed June 8, 2010).

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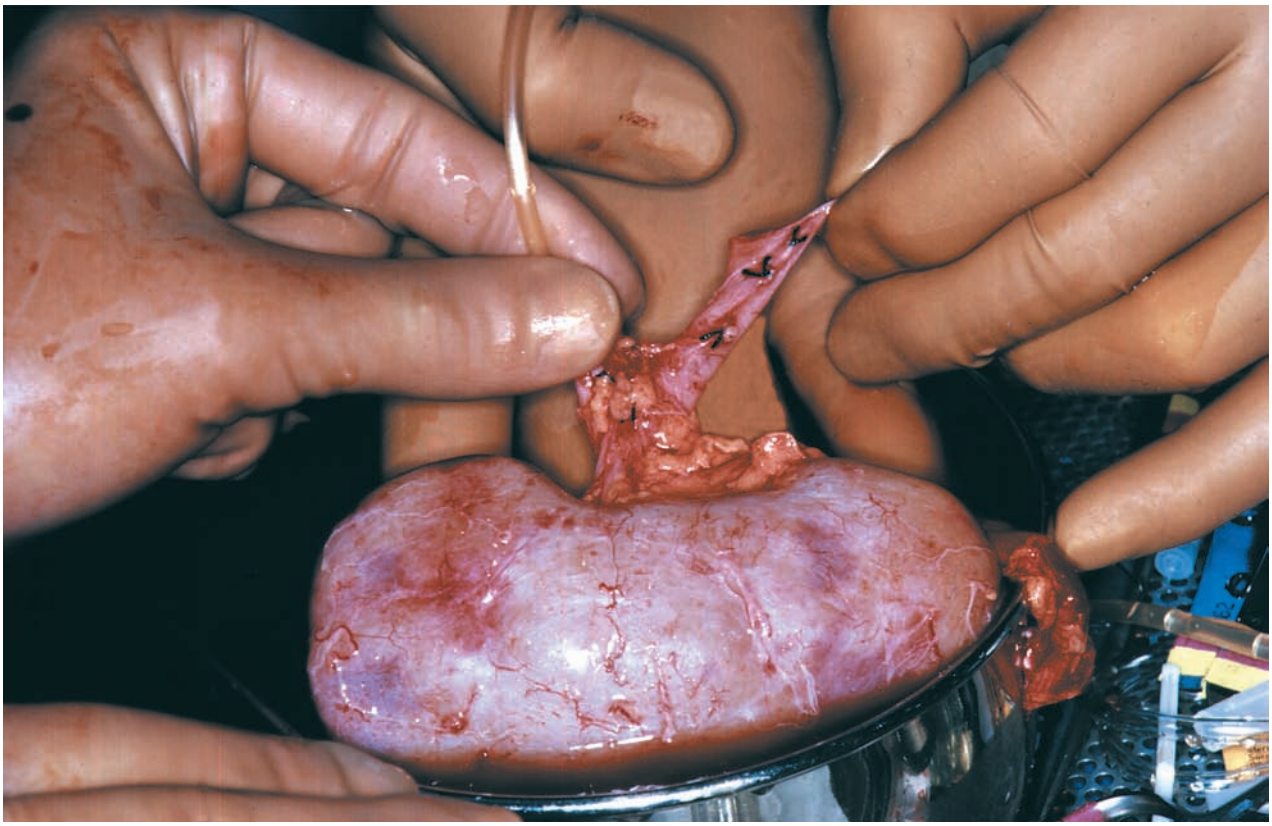

A human kidney is being prepped by medical personnel prior to transplantation. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

and wastes from the body or of maintaining the proper level of certain kidney-regulated chemicals in the bloodstream. Without long-term dialysis or a kidney transplant, ESRD is fatal.

Demographics

Diabetes mellitus is the leading single cause of ESRD. **Hypertension** (high blood pressure) is the second leading cause of ESRD in adults, followed by **glomerulonephritis**. African Americans are more likely to develop hypertension-related ESRD than Caucasians and Hispanics. People of Native American and Hispanic descent are at an elevated risk for both **kidney disease** and diabetes.

Among children and young adults under 20 on dialysis, glomerulonephritis is the leading cause of ESRD, followed by hereditary, cystic, and congenital diseases account. According to the United States Renal Data System (USRDS), the average waiting period for a kidney transplant for patients under age 20 is 10 months, compared to the adult wait of approximately two years.

Almost 80,000 people in the U.S. are waiting for a donor kidney on the official transplant list. Less than 25% of that number received a kidney transplant in 2008, while almost 5,000 people died waiting for a transplant. In order to increase the donor pool and reduce the shortage of organs, some scientists advocate an "opt-out" system, where consent for **organ donation** at the time of **death** is presumed unless the person specified otherwise. Currently in the U.S., an "opt in" system requires potential donors to register their consent, which is usually noted on the driver's license. Several countries already have an opt-out system in place, and in Israel, another system is expected to increase donor organs by giving persons who consent to become donors by signing a card priority for a transplant should they need one themselves.

Description

Kidney transplantation involves surgically attaching a functioning kidney, or graft, from a brain-dead organ donor (a cadaver transplant) or from a living donor to a patient with ESRD. Living donors may be

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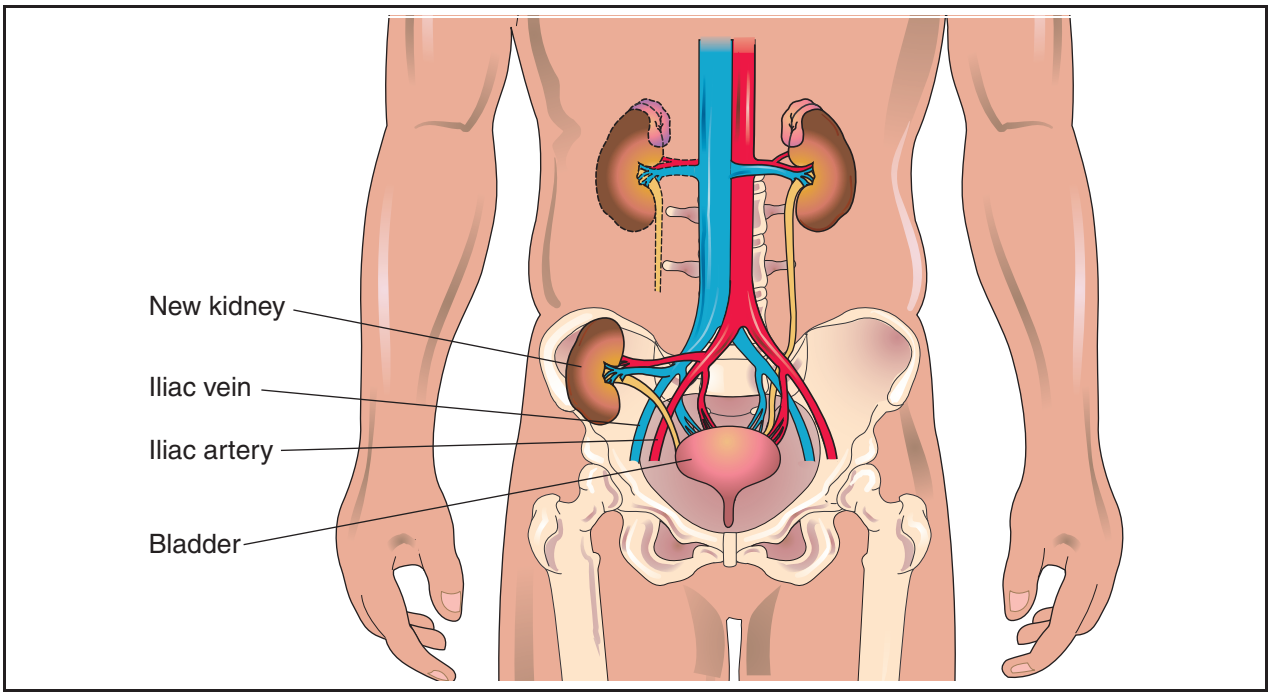

Kidney transplantation involves the surgical attachment of a functioning kidney, or graft, from a donor to a patient with end-stage renal disease (ESRD). During the procedure, the surgeon makes an incision in the patient's flank and implants the new kidney above the pelvic bone and below the non-functioning kidney by suturing the kidney artery and vein to the patient's iliac artery and vein. The ureter of the new kidney is then attached directly to the bladder of the patient.
(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)

related or unrelated to the patient, but a related donor has a better chance of having a kidney that is a stronger biological match for the patient.

Open nephrectomy

The surgical procedure to remove a kidney from a living donor is called a **nephrectomy**. In a traditional, open nephrectomy, the kidney donor is administered **general anesthesia** and a 6–10 in. (15.2–25.4 cm) incision through several layers of muscle is made on the side or front of the abdomen. The blood vessels connecting the kidney to the donor are cut and clamped, and the ureter is also cut and clamped between the bladder and kidney. The kidney and an attached section of ureter are removed from the donor. The vessels and ureter in the donor are then tied off and the incision is sutured together again. A similar procedure is used to harvest cadaver kidneys, although both kidneys are typically removed at once, and blood and cell samples for **tissue typing** are also taken.

Laparoscopic nephrectomy

Laparoscopic nephrectomy is a form of minimally invasive surgery using instruments on long, narrow rods to view, cut, and remove the donor kidney. The surgeon views the kidney and surrounding tissue with a flexible videoscope. The videoscope and surgical instruments are maneuvered through four small incisions in the abdomen, and carbon dioxide is pumped into the abdominal cavity to inflate it for an improved visualization of the kidney. Once the kidney is freed, it is secured in a bag and pulled through a fifth incision, approximately 3 in. (7.6 cm) wide, in the front of the abdominal wall below the navel. Although this surgical technique takes slightly longer than an open nephrectomy, studies have shown that it promotes a faster recovery time, shorter hospital stays, and less postoperative **pain** for kidney donors.

A modified laparoscopic technique called hand-assisted laparoscopic nephrectomy may also be used to remove the kidney. In the hand-assisted surgery, a small incision of 3–5 in. (7.6–12.7 cm) is made in the patient's abdomen. The incision allows the surgeon to place his hand in the abdominal cavity using a special surgical glove that also maintains a seal for the inflation of the abdominal cavity with carbon dioxide. The technique gives the surgeon the benefit of using his or her hands to feel the kidney and related structures. The kidney is then removed through the incision by hand instead of with a bag.

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KEY TERMS

Arteriogram—A diagnostic test that involves viewing the arteries and/or attached organs by injecting a contrast medium or dye, into the artery and taking an x ray.

Congenital—Present at birth.

Dialysis—A blood filtration therapy that replaces the function of the kidneys, filtering fluids, and waste products out of the bloodstream. There are two types of dialysis treatment: hemodialysis, which uses an artificial kidney, or dialyzer, as a blood filter; and peritoneal dialysis, which uses the patient's abdominal cavity (peritoneum) as a blood filter.

Glomerulonephritis—A disease of the kidney that causes inflammation and scarring and impairs the kidney's ability to filter waste products from the blood.

Iliac artery—Large blood vessel in the pelvis that leads into the leg.

Immunosuppressive medication—Drugs given to a transplant recipient to prevent his or her immune system from attacking the transplanted organ.

Rejection—The process in which the immune system attacks foreign tissue such as a transplanted organ.

Videoscope—A surgical camera.

Once removed, kidneys from live donors and cadavers are placed on ice and flushed with a cold preservative solution. The kidney can be preserved in this solution for 24–48 hours until the transplant takes place. The sooner the transplant takes place after harvesting the kidney, the better the chances are for proper functioning.

Kidney transplantation

During the transplant operation, the kidney recipient is typically under general anesthesia and administered **antibiotics** to prevent possible infection. A catheter is placed in the bladder before surgery begins. An incision is made in the flank of the patient, and the surgeon implants the kidney above the pelvic bone and below the existing, non-functioning kidney by suturing the kidney artery and vein to the patient's iliac artery and vein. The ureter of the new kidney is attached directly to the kidney recipient's bladder. Once the new kidney is attached, the patient's existing, diseased kidneys may or may not be removed, depending on the circumstances surrounding the kidney failure. Barring any complications, the transplant operation takes about three to four hours.

Since 1973, Medicare has picked up 80% of ESRD treatment costs, including the costs of transplantation for both the kidney donor and the recipient. Medicare also covers 80% of immunosuppressive medication costs for up to three years. To qualify for Medicare ESRD benefits, a patient must be insured or eligible for benefits under Social Security, or be a spouse or child of an eligible American. Private insurance and state Medicaid programs often cover the remaining 20% of treatment costs.

Patients with a history of heart disease, lung disease, **cancer**, or hepatitis may not be suitable candidates for receiving a kidney transplant.

Precautions

Because the patient's immune system is suppressed with a transplant, he or she is at an increased risk for infection. The incision area should be kept clean, and the transplant recipient should avoid contact with people who have colds, viruses, or similar illnesses. If the patient has pets, he or she should not handle animal waste. The transplant team will provide detailed instructions on what should be avoided post-transplant. After recovery, the patient will still have to be vigilant about exposure to viruses and other environmental dangers.

Transplant recipients may need to adjust their dietary habits. Certain immunosuppressive medications cause increased appetite or **sodium** and protein retention, and the patient may have to adjust his or her intake of calories, salt, and protein to compensate.

Preparation

Patients with chronic renal disease who need a transplant and do not have a living donor registered with United Network for Organ Sharing (UNOS) are placed on a waiting list for a cadaver kidney transplant. UNOS is a non-profit organization that is under contract with the federal government to administer the Organ Procurement and Transplant Network (OPTN) and the national Scientific Registry of Transplant Recipients (SRTR).

Kidney allocation is based on a mathematical formula that awards points for factors that can affect a successful transplant, such as time spent on the transplant list, the patient's health status, and age. The most important part of the equation is that the kidney be compatible with the patient's body. A human kidney

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has a set of six antigens, substances that stimulate the production of antibodies. (Antibodies then attach to cells they recognize as foreign and attack them.) Donors are tissue matched for 0–6 of the antigens, and compatibility is determined by the number and strength of those matched pairs. Blood type matching is also important. Patients with a living donor who is a close relative have the best chance of a close match.

Before being placed on the transplant list, potential kidney recipients must undergo a comprehensive physical evaluation. In addition to the compatibility testing, radiological tests, urine tests, and a psychological evaluation will be performed. A panel of reactive antibody (PRA) is performed by mixing the patient's serum (white blood cells) with serum from a panel of 60 randomly selected donors. The patient's PRA sensitivity is determined by how many of these random samples his or her serum reacts with; for example, a reaction to the antibodies of six of the samples would mean a PRA of 10%. High reactivity (also called sensitization) means that the recipient would likely reject a transplant from the donor. The more reactions, the higher the PRA and the lower the chances of an overall match from the general population. Patients with a high PRA face a much longer waiting period for a suitable kidney match.

Potential living kidney donors also undergo a complete medical history and **physical examination** to evaluate their suitability for donation. Extensive blood tests are performed on both donor and recipient. The blood samples are used to tissue type for antigen matches, and confirm that blood types are compatible. A PRA is performed to ensure that the recipient antibodies will not have a negative reaction to the donor antigens. If a reaction does occur, there are some treatment protocols that can be attempted to reduce reactivity, including immunosuppresant drugs and **plasmapheresis** (a blood filtration therapy).

The donor's kidney function will be evaluated with a urine test as well. In some cases, a special dye that shows up on x rays is injected into an artery, and x rays are taken to show the blood supply of the donor kidney (a procedure called an arteriogram).

Once compatibility is confirmed and the physical preparations for kidney transplantation are complete, both donor and recipient may undergo a psychological or psychiatric evaluation to ensure that they are emotionally prepared for the transplant procedure and aftercare regimen.

Aftercare

A typical hospital stay for a transplant recipient is about five days. Both kidney donors and recipients will experience some discomfort in the area of the incision after surgery. Pain relievers are administered following the transplant operation. Patients may also experience **numbness**, caused by severed nerves, near or on the incision.

A regimen of immunosuppressive, or anti-rejection, medication is prescribed to prevent the body's immune system from rejecting the new kidney. Common immunosuppressants include cyclosporine, prednisone, tacrolimus, mycophenolate mofetil, sirolimus, baxsiliximab, daclizumab, and azathioprine. The kidney recipient will be required to take a course of **immunosuppressant drugs** for the lifespan of the new kidney. Intravenous antibodies may also be administered after **transplant surgery** and during rejection episodes.

Risks

As with any surgical procedure, the kidney transplantation procedure carries some risk for both a living donor and a graft recipient. Possible complications include infection and bleeding (hemorrhage). A lymphocele, a pool of lymphatic fluid around the kidney that is generated by lymphatic vessels damaged in surgery, occurs in up to 20% of transplant patients and can obstruct urine flow and/or blood flow to the kidney if not diagnosed and drained promptly. Less common is a urine leak outside of the bladder, which occurs in approximately 3% of kidney transplants when the ureter suffers damage during the procedure. This problem is usually correctable with follow-up surgery.

A transplanted kidney may be rejected by the patient. Rejection occurs when the patient's immune system recognizes the new kidney as a foreign body and attacks the kidney. It may occur soon after transplantation, or several months or years after the procedure has taken place. Rejection episodes are not uncommon in the first weeks after transplantation surgery, and are treated with high-dose injections of immunosuppressant drugs. If a rejection episode cannot be reversed and kidney failure continues, the patient will typically go back on dialysis. Another transplant procedure can be attempted at a later date if another kidney becomes available.

The biggest risk to the recovering transplant recipient is not from the operation or the kidney itself, but from the immunosuppressive medication he or she must take. Because these drugs suppress the immune system, the patient is susceptible to infections such as cytomegalovirus (CMV) and varicella (**chickenpox**). Other medications that fight viral and bacterial infections can offset this risk to a degree. The immunosuppressants can also cause a host of possible side effects, from high blood pressure to **osteoporosis**. Prescription and dosage adjustments can lessen side effects for some patients.

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Results

Normal results

The new kidney may start functioning immediately, or may take several weeks to begin producing urine. Living donor kidneys are more likely to begin functioning earlier than cadaver kidneys, which frequently suffer some reversible damage during the kidney transplant and storage procedure. Patients may have to undergo dialysis for several weeks while their new kidney establishes an acceptable level of functioning.

Studies have shown that after they recover from surgery, kidney donors typically have no long-term complications from the loss of one kidney, and their remaining kidney will increase its functioning to compensate for the loss of the other.

Morbidity and mortality rates

Survival rates for patients undergoing kidney transplants are 89–98% one year post-transplant, and 67.4–91.4% five years after transplant. About 4,000 patients on the transplant waiting list die annually while awaiting a kidney. The success of a kidney transplant graft depends on the strength of the match between donor and recipient and the source of the kidney. Transplantations using living donor kidneys have a higher rate of success than do cadaver kidney transplantations.

Alternatives

Patients who develop chronic kidney failure must either go on dialysis treatment or receive a kidney transplant to survive.

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American Association of Kidney Patients, 3505 E. Frontage Rd., Suite 315, Tampa, FL, 33607, (800) 749–2257, info@aakp.org, http://www.aakp.org.

American Kidney Fund, 6110 Executive Boulevard, Suite 1010, Rockville, MD, 20852, (800) 638–8299, helpline@akfinc.org.

United Network for Organ Sharing, 700 North 4th St., Richmond, VA, 23219, (888) 894–6361, http://www.transplantliving.org.

Paula Anne Ford-Martin
Brenda W. Lerner

Kidney ultrasound *see* **Abdominal ultrasound**

Kidney, ureter, and bladder x-ray study

Definition

A kidney, ureter, and bladder (KUB) x-ray study is an abdominal x ray. Despite its name, KUB does not show the ureters and only sometimes shows the kidneys and bladder and, even then, with uncertainty.

Purpose

The KUB study is a diagnostic test used to detect **kidney stones** and to diagnose some gastrointestinal disorders. The KUB is also used as a follow-up procedure after the placement of devices such as ureteral stents and nasogastric or nasointestinal tubes (feeding tubes) to verify proper positioning.

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An x-ray image of a human torso and abdomen showing a blocked ureter. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

KEY TERMS

Ureteral stent—A surgical device implanted in patients with damaged ureters that holds the ureter open so that urine can flow freely from the kidneys to the bladder.

Precautions

Because of the risks of radiation exposure to the fetus, pregnant women are advised to avoid this x-ray procedure.

A KUB study is a preliminary screening test for kidney stones, and should be followed by a more sophisticated series of diagnostic tests [such as an **abdominal ultrasound**, **intravenous urography**, or computed tomography scan (CT scan)] if kidney stones are suspected.

Description

A KUB is typically a single x-ray procedure. The patient lies flat on his back on an x-ray table. An x-ray plate is placed underneath him near the small of the back, and the x-ray camera is aimed at his abdomen. The patient is asked to hold his breath and lie still while the x ray is taken. Sometimes a second KUB will be ordered, with the patient standing, or if unable to do so, lying on his side.

Preparation

A KUB study requires no special diet, fluid restrictions, medications, or other preparation. The patient is typically required to wear a hospital gown or similar attire and to remove all jewelry so the x-ray camera has an unobstructed view of the abdomen. A lead apron may be placed over the abdominal areas of the body not being x-rayed to shield the patient from unnecessary radiation.

Aftercare

No special aftercare treatment or regimen is required for a KUB study.

Risks

Because the KUB study is an x-ray procedure, it does involve minor exposure to radiation.

Normal results

Normal KUB x-ray films show two kidneys of a similar size and shape. A normal amount of intestinal gas is seen.

Abnormal results

Abnormal KUB films may show calculi (kidney stones). If both kidneys are visible, it may be possible to diagnose renal size discrepancies. The films may also show too much bowel gas indicating possible obstruction or soft tissue masses.

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Kinesiology, applied

Definition

Kinesiology is a series of tests that locate weaknesses in specific muscles reflecting imbalances throughout the body. Then specific massages or **acupressure** techniques are used in an attempt to rebalance what has been revealed by the kinesiology tests. Thus, kinesiology is used as both an assessment tool and as a limited therapeutic modality.

Purpose

Kinesiology claims to be a healing system that detects and corrects imbalances in the body before they develop into a disease, and which restores overall system balance and harmony. It is used to alleviate muscle, bone, and joint problems, treat all manner of aches and pains, and correct many areas of imbalance and discomfort.

Precautions

Since interpretation of the muscle tests is both complex and subjective, it should only be performed by a licensed health professional trained to look for "subclinical" symptoms (those which have not yet become a major problem). Kinesiology, itself, is more of a diagnostic technique and should not be thought of as a cure for any particular problem.

Description

Traditionally, the word "kinesiology" refers simply to the study of muscles and body movement. In 1964, however, American chiropractor George J. Goodheart founded what has become known as applied kinesiology when he linked oriental ideas about energy flow in the body with western techniques of muscle testing. First, Goodheart noted that all muscles are related to other muscles. He observed that for each movement a muscle makes, there is another muscle or group of muscles involved with that movement; one muscle contracts while another one relaxes. So when he was presented with a painful, overly-tight muscle, he would observe and treat the opposite, and necessarily weak, muscle to restore balance. This was then a very new technique.

Further, Goodheart argued that there is a definite and real connection between muscles, glands, and organs, and that by testing the strength of certain muscles he could learn about the health or condition of the gland or organ to which it was related.

KEY TERMS

Acupressure—A form of acupuncture in which certain points of the body are pressed with the fingers and hands to release energy blocks.

Alleviate—To make something easier to be endured.

Complementary—Something that serves to fill out or complete something else.

Deficiency—A shortage of something necessary for health.

Diagnostic—The art or act of identifying a disease from its signs and symptoms.

Flaccid—Flabby, limp, weak.

Meridian—In traditional Chinese medicine, the channels which run beneath the skin through which the body's energy flows.

Spasm—An involuntary, sudden, violent contraction of a muscle or a group of muscles.

Applied kinesiology is based on the idea that the body is an interacting unit made of different parts that interconnect and affect each other. Everything we do affects the body as a whole; therefore, a problem in one area can cause trouble in another area. According to kinesiology, the muscles eventually register and reflect anything that is wrong with any part of the body, whether physical or mental. Thus, a particular digestive problem might show up in the related and corresponding muscles of the legs. By testing the strength of certain muscles, the kinesiologist claims to be able to gain access to the body's communication system, and, thus, to read the health status of each of the body's major components.

The manual testing of muscles or muscle strength is not new, and was used in the late 1940s to evaluate muscle function and strength and to assess the extent of an injury. Applied kinesiology measures whether a muscle is stuck in the "on" position, acting like a tense muscle spasm, or is stuck "off," appearing weak or flaccid. It is called manual testing because it is done without instruments, using only the kinesiologist's fingertip pressure. During the first and longest appointment, which lasts about an hour, the kinesiologist conducts a complete consultation, asking about the patient's history and background. During the **physical examination**, patients sit or lie down, then the kinesiologist holds the patient's leg or arm to isolate a particular muscle. The practitioner then touches a point on the body which he believes is related to that muscle, and,

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with quick, gentle, and painless pressure, pushes down on the limb. Patients are asked to resist this pressure, and, if they cannot, an imbalance is suspected in the related organ, gland, or body part. This diagnostic technique uses muscles to find the cause of a problem, and is based on **traditional Chinese medicine** and its idea that the body has common energy meridians, or channels, for both organs and muscles. Kinesiologists also claim that they are able to locate muscle weaknesses that stem from a variety of causes such as **allergies**, mineral and vitamin deficiencies, as well as from problems with the lymph system. Once the exact cause is determined, the kinesiologist uses his fingertips to work the appropriate corresponding acupressure points in order to rebalance the flow of energy and restore health. Often he will recommend a complementary program of **nutrition** therapy.

Risks

There are no major risks associated with this gentle, noninvasive therapy. It is generally safe for people of all ages and has no side effects.

Normal results

If applied kinesiology does what it claims, patients should expect muscle testing to discover the cause of their physical complaint and to be told how to correct it.

ORGANIZATIONS

International College of Applied Kinesiology, 17A Lenox Pointe NE, Atlanta, GA, 30324, (404) 634-0201, http://www.icak.com.

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Kleine-Levin syndrome *see* **Sleep disorders**

Klinefelter syndrome

Definition

Klinefelter syndrome is a chromosomal disorder that affects only males. People with this condition are born with at least one extra X chromosome. The syndrome was first identified and described in 1942 by Harry Fitch Klinefelter, Jr., an American physician.

Description

Klinefelter syndrome is a condition in which one or more extra X chromosomes are present in a male. Boys with this condition appear normal at birth. They enter **puberty** normally, but by mid puberty have low levels of testosterone causing small testicles and the inability to make sperm. Affected males may also have learning disabilities and behavior problems such as **shyness** and immaturity, and an increased risk for certain other health problems.

Klinefelter syndrome is one of the most common chromosomal abnormalities. About 1 in every 500 to 800 males is born with this disorder; approximately 3000 affected boys are born each year in the United States. About 3% of the infertile male population have Klinefelter syndrome. The condition appears to affect all racial and ethnic groups equally.

Causes and symptoms

Chromosomes are found in the cells in the body. Chromosomes contain genes, structures that tell the body how to grow and develop. Chromosomes are responsible for passing on hereditary traits from parents to child. Chromosomes also determine whether the child will be male or female. Normally, a person has a total of 46 chromosomes in each cell, two of which are responsible for determining that individual's sex. These two sex chromosomes are called X and Y. The combination of these two types of chromosomes determines the sex of a child. Females have two X chromosomes (the XX combination); males have one X and one Y chromosome (the XY combination).

In Klinefelter syndrome, a problem very early in development results in an abnormal number of chromosomes. About 60% of embryos with Klinefelter syndrome do not survive the fetal period. Most commonly, a male with Klinefelter syndrome will be born with 47 chromosomes in each cell, rather than the normal number of 46. The extra chromosome is an X chromosome. This means that rather than having the normal XY combination, the male has an XXY combination. Because people with Klinefelter syndrome have a Y chromosome, they are all male.

Approximately 1/3 of all males with Klinefelter syndrome have other chromosomal abnormalities involving an extra X chromosome. Mosaic Klinefelter syndrome occurs when some of the cells in the body have an extra X chromosome and the others have normal male chromosomes. These males can have the same or milder symptoms than non-mosaic Klinefelter syndrome. Males with more than one additional extra X chromosome, such as 48,XXXY, are usually more severely affected than males with 47,XXY.

Klinefelter syndrome is not considered an inherited condition. The risk of Klinefelter syndrome reoccurring

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KEY TERMS

Chromosome—A microscopic thread-like structure found within each cell of the body and consists of a complex of proteins and DNA. Humans have 46 chromosomes arranged into 23 pairs. Changes in either the total number of chromosomes or their shape and size (structure) may lead to physical or mental abnormalities.

Gonadotrophin—Hormones that stimulate the ovary and testicles.

Gynecomastia—Excessive growth of breast tissue in males.

Leydig cells—Cells that make up the endocrine tissue of the testis and produce testosterone. They are named for Franz von Leydig (1821–1908), the German professor of anatomy who first identified them.

Testosterone—Hormone produced in the testicles that is involved in male secondary sex characteristics.

in another **pregnancy** is not increased above the general population risk.

The symptoms of Klinefelter syndrome are variable and not every affected person will have all of the features of the condition. Males with Klinefelter syndrome appear normal at birth and have normal male genitalia. From childhood, males with Klinefelter syndrome are taller than average with long limbs. Approximately 20–50% have a mild intention tremor, an uncontrolled shaking. Many males with Klinefelter syndrome have poor upper body strength and can be clumsy. Klinefelter syndrome does not cause homosexuality. Approximately 1/3 of males with Klinefelter syndrome have **gynecomastia** or breast growth, some requiring **breast reduction** surgery.

Most boys enter puberty normally, though some can be delayed. The Leydig cells in the testicles usually produce testosterone. With Klinefelter syndrome, the Leydig cells fail to work properly causing the testosterone production to slow. By mid-puberty, testosterone production is decreased to approximately half of normal. This can lead to decreased facial and pubic hair growth. The decreased testosterone also causes an increase in two other hormones, follicle stimulating hormone (FSH) and luteinizing hormone (LH). Normally, FSH and LH help the immature sperm cells grow and develop. In Klinefelter syndrome, there are few or no sperm cells. The increased amount of FSH and LH causes hyalinization and fibrosis, the growth of excess fibrous tissue, in the seminiferous tubules, where the sperm are normally located. As a result, the testicles appear smaller and firmer than normal. With rare exception, men with Klinefelter syndrome are infertile because they can not make sperm.

While it was once believed that all boys with Klinefelter syndrome are mentally retarded, doctors now know that the disorder can exist without retardation. However, children with Klinefelter syndrome frequently have difficulty with language, including learning to speak, read, and write. Approximately 50% of males with Klinefelter syndrome are dyslexic.

Some people with Klinefelter syndrome have difficulty with social skills and tend to be more shy, anxious, or immature than their peers. They can also have poor judgment and do not handle stressful situations well. As a result, they often do not feel comfortable in large social gatherings. Some people with Klinefelter syndrome can also have **anxiety**, nervousness and/or depression.

The greater the number of X chromosomes present, the greater the disability; each extra X chromosome lowers the child's IQ by about 15 points. Boys with several extra X-chromosomes have distinctive facial features, more severe retardation, deformities of bony structures, and even more disordered development of male features.

Diagnosis

Diagnosis of Klinefelter syndrome is made by examining chromosomes for evidence of more than one X chromosome present in a male. This can be done in pregnancy with prenatal testing such as a **chorionic villus sampling** or **amniocentesis**. Chorionic villus sampling is a procedure done early in pregnancy (approximately 10–12 weeks) to obtain a small sample of the placenta for testing. An amniocentesis is done further along in pregnancy (from approximately 16–18 weeks) to obtain a sample of fluid surrounding the baby for testing. Both procedures have a risk of **miscarriage**. Usually these procedures are done for a reason other than diagnosing Klinefelter syndrome. For example, a prenatal diagnostic procedure may be done on an older woman to determine if her baby has **Down syndrome**. If the diagnosis of Klinefelter syndrome is suspected in a

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young boy or adult male, chromosome testing can also be on a small blood or skin sample after birth.

Many men with Klinefelter syndrome go through life without being diagnosed. The two most common complaints leading to diagnosis of the condition are gynecomastia and **infertility**.

Treatment

There is no treatment available to change a person's chromosomal makeup. Children with Klinefelter syndrome may benefit from **speech therapy** for speech problems or other educational interventions for learning disabilities. Testosterone injections started around the time of puberty may help to produce more normal development including more muscle mass, hair growth and increased sex drive. Testosterone supplementation will not increase testicular size, decrease breast growth or correct infertility. Psychiatric consultation may be helpful when the boy reaches adolescence.

Some doctors recommend **mastectomy** as a surgical treatment for gynecomastia, on the grounds that the enlarged breasts are often socially stressful for affected males and significantly increase their risk of **breast cancer**.

Prognosis

While many men with Klinefelter syndrome go on to live normal lives, nearly 100% of these men will be sterile (unable to produce a child). However, a few men with Klinefelter syndrome have been reported who have fathered a child through the use of assisted fertility services.

Males with Klinefelter syndrome have an increased risk of several systemic conditions, including **epilepsy**, **osteoporosis**, such **autoimmune disorders** as lupus and arthritis, diabetes, and breast and **germ cell tumors**. One Danish study reported in 2004 that men with Klinefelter's syndrome have a slightly shortened life span, dying about 2.1 years earlier than men without the syndrome.

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Klinefelter Syndrome Support Group Home Page. http://klinefeltersyndrome.org.

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KS&A, Klinefelter Syndrome, P.O. Box 461047, Aurora, CO, 80046-1047, (303) 400-9040, (888)999-9428, info@genetic.org, http://www.genetic.org.

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923, (800) 999-6673, http://www.rarediseases.org.

The American Association for Klinefelter Syndrome Information and Support, 2945 W. Farwell Ave, Chicago, IL, 60645-2925, (888) 466-5747, http://www.aaksis.org.

Carin Lea Beltz, MS
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Knee injuries

Definition

The knee joint consists of bone, ligaments, cartilage, and fluid. It moves with the help of surrounding muscles and tendons. When any of these structures is degraded, the knee can become injured. According to the Mayo Clinic, nearly one out of three Americans older than 45 years of age have some type of knee **pain**. Whether it is a minor or major problem, it usually involves a certain amount of pain and a degree of difficulty in walking.

The five most common knee problems are arthritis, tendonitis, **bruises**, cartilage tears, and damaged ligaments, with arthritis being the most common problem of the bones of the knee. The ligaments and tendons of

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the knee can also become injured. Damage to the anterior cruciate ligament (ACL) is a common problem of knee ligaments and tendons. Knee injuries can be caused by accidents, impacts and other such traumas, sudden or awkward movements (misalignments), and gradual wear and tear of the knee joint (degeneration).

Most injuries of the knee are minor and are usually treated at home with rest and ice packs. Serious injuries necessitate treatments by physicians and **rehabilitation** experts. Often, various types of surgeries are needed to correct the worst knee injuries such as a ruptured ligament or tendon.

Demographics

Because the knee joint is both vulnerable and used extensively in many activities, it is prone to injuries in all peoples young and old. The American Academy of Orthopaedic Surgeons (AAOS) estimates that approximately nine million American adults are diagnosed with knee **osteoarthritis** each year. Osteoarthritis of the knee is deterioration (degradation) of the knee joint. Over half of all people with knee osteoarthritis were over the age of 65 years. The AAOS states that knee osteoarthritis is a leading cause of disability in the United States. In some sports including football, skiing, gymnastics, and racket sports, injury rates to avid practitioners can be nearly 50%, and knee injuries are the most common reason patients visit orthopedic doctors. An estimated one in five runners gets a knee injury at some point in their lives. The majority of knee injuries, however, are minor and do not require intensive treatment.

Description

The knee, the largest joint in the body, connects the thighbone (femur) to the lower leg (tibia). It is a complex and efficient joint consisting of ligaments, cartilage, and the bone of the kneecap (patella). All of these parts can be injured. Inside the knee joint is synovial fluid that protects and lubricates the parts, which may increase as the result of an injury, causing swelling. The bursa are sacs in the knee that contain synovial fluid and provide cushioning and lubrication.

Four ligaments comprise the knee joint. The medial collateral ligament (MCL) runs along the inside of the knee, while the lateral collateral ligament (LCL) is on the outside of the knee. The cruciate ligaments cross inside the knee. The anterior cruciate ligament (ACL) is deep inside the knee and limits rotation of the joint. The posterior cruciate ligament (PCL) is also inside the knee and limits the backward movement of the joint. Ligaments in the knee can be partially or completely torn, depending on the extent of the injury.

The minisci cartilage are two thin, oval–shaped tissues that act as cushions between the ends of the leg bones. The medial miniscus is the cartilage closest to the other leg while the lateral miniscus is nearer the outside of the knee. Injuries to the minisci include tears from injuries and impact and degenerative wearing away of the structure. The minisci can be partially or completely torn during injury.

The bones around the knee, including the kneecap, can be broken, fractured, or chipped. The patellar tendon connects the kneecap to the shinbone, while the quadriceps tendon connects the quadriceps muscle to the patella. The patellar tendon can be torn or can develop injury and pain from degeneration. It can also be fully dislocated or partially dislocated (called subluxation). The tendons in the knee may develop pain and inflammation known as tendonitis.

The bones of the knee joint are covered with tissue known as articular cartilage. This cartilage can be injured or fractured, and can also develop a degenerative condition called chondromalacia. Osteoarthritis is the condition associated with the wearing down of this cartilage.

There are many risks that increase one's chance of having a knee injury. These risks include:

- Excessive weight, being obese, because of the additional weight being carried in part by the knees.
- Sports and activities that are considered high risk for knee injuries, such as basketball, racquetball, downhill skiing, and tennis.
- Overuse, repeated activities can lead to fatigue in the muscles around the joints and contribute to tissue damage.
- Neuromuscular abnormalities, such as different lengths for legs and misaligned knees, can increase the likelihood of knee injuries.
- Muscle inflexibility and weakness provides less support for the knee and adds to more stress placed upon the knees.
- Previous injuries to the knee make is more likely that future knee injuries will occur.
- Gender increases the likelihood of certain types of knee problems; that is, males are more likely to have some knee problems (such as a dislocated kneecap), while females are more likely to have others (such as Osgood–Schlatter disease).
- Age increases the likelihood of more knee problems.

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Causes and symptoms

Knee injuries are commonly caused by the following: impact (such as from an accident, landing after a fall, and a blow from an object), repeated stress/overuse, sudden motion (excessive turning, pivoting, or stopping), rapidly growing bones, and age–related degeneration.

There are many specific causes of knee injuries. Arthritis may develop from an auto–immune disorder, known as **rheumatoid arthritis**, or may be caused by the gradual wear and tear of the joint, known as osteoarthritis. Symptoms of arthritis in the knee include pain ranging from dull aches to severe pain, and may be accompanied by swelling and range of movement loss. Arthritic symptoms may tend to be worst in the morning and decrease throughout the day as the knee is used. Arthritis can be caused by lupus, **Lyme disease**, and other infections.

Hyperextended knee can occur when the knee is extended beyond its normal range. When this happens the knee bends back on itself, which usually causes minor damage, along with pain and swelling. However, hyperextended knee can also cause a partial or complete tear in a ligament, which produces more problems. Then the patella, the bone that covers the front of the knee, is dislodged from its normal position, so a dislocated kneecap can occur. The kneecap will look obviously out of place, and it can even be moved from side to side with ease. Symptoms of a hyperextended knee include swelling, intense pain, problems straightening the knee, and difficulty walking.

Cartilage injuries may include chondromalacia, with symptoms including dull pain at any time and more intense pain while climbing stairs. Damage to the minisci cartilage often occurs from sudden twists, forceful plants, and awkward movements. (The meniscus is a C–shaped piece of cartilage that curves inside of the knee joint.) A torn cartilage may make a popping sound, and may be accompanied by mild to severe pain, particularly while straightening the leg. Swelling, stiffening, and loss of movement are also symptoms of cartilage tears, as are clicking sounds and friction in the knee during movement. A knee suffering from a cartilage injury may become completely immobile.

Ligament injuries, which produces immediate pain when it occurs, may cause dull or severe pain, swelling, loss of the range of movement of the joint, and loss of the stability and strength of the knee. Ligament injuries typically occur from strong blows and forces applied to the knee. Injuries to the MCL are the most common, often caused by impact to the side of the knee joint. Of the cruciate ligaments, the PCL is less commonly injured than the ACL. Typically, forceful blows to the knee, such as during car accidents, injure the PCL, while the ACL can be injured by impacts and by sudden twists. Torn ligaments may be accompanied by a popping sound indicating the rupture, and may not always cause pain, so that some of them go unnoticed. Torn ligaments may weaken the knee and cause buckling or folding under weight.

Tendon injuries range from tendonitis to torn tendons. Symptoms of tendonitis include pain (which worsens when movement occurs such as running or climbing), irritation, inflammation, inability to completely extend or straighten the knee, and swelling (especially in the front of the knee or just below the kneecap), while ruptured tendons can cause more intense pain, swelling, and loss of movement.

Osgood–Shlatter disease is a condition common in young boys and girls who play running and jumping sports. Symptoms include swelling, tenderness of the tibial tuberosity located below the kneecap, and inflammation of the patellar tendon and pain in the front of the knee during and after strenuous activity.

Iliotibial band syndrome is common in running and other repetitive sports, characterized by a sharp, burning pain at the outer side of the knee caused by **stress** on the band of tendons there. Sometimes this condition causes a snapping sensation when the knee is straightened. Long–distance runners are especially susceptible to illiotibial band syndrome. The pain usually goes away when at rest after running but returns when climbing occurs. Swelling usually does not occur with this problem and normal range of motion within the knee is usually present.

Bursitis is a problem caused by inflammation in the bursa, or the small fluid sacs that cushion the outside of the knee joint. Symptoms of bursitis include redness, swelling, constant pain, stiffness or aching while walking, and added pain when climbing. Infection may also occur within the bursae, which can cause **fever**, and additional pain and swelling.

Diagnosis

Depending on the severity of the condition, family physicians or orthopedic physicians who specialize in the knee joint may be consulted. A complete **physical examination** will be performed, along with a comprehensive review of past medical records. If arthritis is suspected, a rheumatologist may be consulted. The diagnostic process includes taking a complete patient history with details of the pain and the circumstances of the injury. During a physical exam, the doctor will specifically include several manual techniques of moving the knee joint and legs in various positions to help determine the type of injury. An experienced practitioner can often

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make an accurate diagnosis of injuries by performing a sequence of manual diagnostic tests.

Laboratory tests may be ordered to further or clarify the diagnosis. X rays can show damage to the bones as well as the narrowing of the knee space that may imply cartilage problems. For more in–depth diagnosis, a computerized axial tomographic (CAT) scan is an x–ray technique that can provide three–dimensional views of the bones in the knee. A **magnetic resonance imaging** (MRI) scan gives a computerized portrait of the interior of the knee, and may show damage to the ligaments and cartilage. **Arthroscopy** is a form of minor surgery in which a tiny camera is inserted into the knee, giving a very accurate view of the joint. Radionuclide scanning (bone scans) use radioactive material injected into the bloodstream to monitor the blood flow in particular areas. If infection or rheumatoid arthritis is suspected, a physician may order blood tests for diagnosis. Biopsies, in which pieces of tissue are laboratory tested, may also be used for diagnosis.

Treatment

When a person suspects a knee injury, the first treatment recommended by the Mayo Clinic is a process called P.R.I.C.E., which stands for protection, rest, ice, compression, and elevation. First, the person should "protect" the knee from further motion by using a wrap that immobilizes the knee and/or crutches or braces if necessary. Then, cease the activity that caused the injury and immediately "rest" and immobilize the joint. "Ice" may be applied to reduce pain and swelling, and "compression", such as wraps and braces, may be used to immobilize the knee. "Elevating" the leg is also helpful in reducing swelling and aiding circulation. Immediate care will prevent the worsening of the injury.

Generally, pain relievers such as nonsteroidal anti–inflammatory drugs (NSAIDs) can be used. They include **aspirin**, ibuprofen (such as Advil), and naproxen (such as Aleve). **Physical therapy** may also be necessary so that the knee regains is normal movement.

Treatment options for knee injuries can range from rest and light activity, to physical therapy, to surgery. Most knee injuries are treated with proper rest, **exercise**, and strengthening programs recommended by physicians. For injuries that require surgery or deeper diagnosis, arthroscopy is the least invasive technique and involves a short recovery time. Arthroscopy is commonly used to repair cartilage and partially torn ligaments. For severe knee injuries, **reconstructive surgery** or open knee surgery may be required. Full knee replacements may also be performed for severely damaged knees. After surgery, physical therapy programs for rehabilitation are recommended. Treatment for osteoarthritis includes over–the–counter painkillers, exercise, and weight reduction. For rheumatoid arthritis, more powerful prescription medications, such as **steroids** and stronger painkillers, and intensive physical therapy may be ordered. Knee injuries associated with infection may require **antibiotics**.

KEY TERMS

Lupus—Chronic inflammatory disease caused by immune system disorder.

Lyme disease—Bacterial infection spread by ticks.

Orthopedist—Physician specializing in the diagnosis and treatment of problems involving the skeletal system.

Rheumatologist—Physician specializing in the diagnosis and treatment of arthritis and related conditions.

Alternative treatment

Alternative therapies for knee injuries focus on supporting the body's ability to heal itself. Various therapies may include bodywork and postural adjustments such as **chiropractic** and **Rolfing** work, in addition to physical therapy and gentle exercise routines. Herbal remedies and **nutritional supplements** may be used to aid the healing process and reduce symptoms. **Acupuncture** may be used for pain relief, and **yoga** is a low–impact exercise routine that increases flexibility, good alignment, and strength.

Prevention

The best prevention for knee injuries is being aware of activities that carry high risks for knee injuries and acting carefully. The knees can be strengthened by evenly building the muscles in the quadriceps and hamstrings. Increasing flexibility in the body through stretching can also help reduce injuries. Properly fitting shoes and other sports equipment are essential for preventing injury as well. Finally, before engaging in activities that stress the knee, a thorough and gradual warm–up routine, including aerobic activity and stretching, will lessen the chances of knee injury.

General life–style habits are also recommended to reduce the risk for knee injuries. These include maintaining a health height–to–weight ratio (commonly called the body mass index); exercising on a regular basis (to keep the knees and the surrounding materials

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strong and flexible); warming up before exercising and cooling down after exercising; not over exercising the knees if they are hurting; and using protective devices when involved in high–risk sports (such as knee pads in basketball). It is also important to wear a seat belt and harness while driving because kneecap injuries are common when automobiles crash into other cars and objects along the road.

Resources

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ORGANIZATIONS

American Academy of Orthopaedic Surgeons, 6300 North River Rd., Rosemont, IL, 60018–4262, (847) 823–7186, (800) 824–BONE (–2663), (847) 823–8125, http://www.aaos.org.

National Athletic Trainers' Association, 2952 Stemmons Fwy., Suite 200, Dallas, TX, 75247, (214) 637–6282, (214) 637–2206, http://www.nata.org.

American Physical Therapy Association, 1111 North Fairfax St., Alexandria, VA, 22314–1488, (703) 684–APTA (–2782), (800) 999–2782, (703) 684–7343, http://www.apta.org.

Douglas Dupler

Knee replacement *see* **Joint replacement**

Kneecap removal

Definition

Kneecap removal, or patellectomy, is the surgical removal of the patella, commonly called the kneecap.

Purpose

Kneecap removal is done under three circumstances:

- When the kneecap is fractured or shattered
- When the kneecap dislocates easily and repeatedly
- When degenerative arthritis of the kneecap causes extreme pain

A person of any age can break a kneecap in an accident. When the bone is shattered beyond repair, the kneecap is removed. No prosthesis or artificial replacement part is put in its place.

Dislocation of the kneecap is most common in young girls between the ages of 10-14. Initially, the kneecap will pop back into place of its own accord, but **pain** may continue. If dislocation occurs too often, or the kneecap doesn't go back into place correctly, the patella may rub the other bones in the knee, causing an arthritis-like condition. Some people are born with **birth defects** that cause the kneecap to dislocate frequently.

Degenerative arthritis of the kneecap, also called patellar arthritis or *chondromalacia patellae*, can cause enough pain that it is necessary to remove the kneecap. As techniques of **joint replacement** have improved, arthritis in the knee is more frequently treated with total knee replacement.

Precautions

People who have had their kneecap removed for degenerative arthritis and then later have to have a total knee replacement are more likely to have problems with the stability of their artificial knee than those who only have total knee replacement. This is because the realigned muscles and tendons provide less support once the kneecap is removed.

Description

Kneecap removal is performed under either general or **local anesthesia** at a hospital or freestanding surgical center, by an orthopedic surgeon. The surgeon makes an incision around the kneecap. Then, the muscles and tendons attached to the kneecap are cut and the kneecap is removed. Next, the muscles are sewed back together, and the skin is closed with sutures or clips that stay in place about one week. Any hospital stay is generally brief.

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KEY TERMS

Degenerative arthritis, or osteoarthritis—A non-inflammatory type of arthritis, usually occurring in older people, characterized by degeneration of cartilage, enlargement of the margins of the bones, and changes in the membranes in the joints.

Preparation

Prior to surgery, x rays and other diagnostic tests are done on the knee to determine if removing the kneecap is the appropriate treatment. Pre-operative blood and urine tests are also done.

Aftercare

Pain relievers may be prescribed for a few days. The patient will initially need to use a cane, or crutches, to walk. **Physical therapy** exercises to strengthen the knee should be begun immediately. Driving should be avoided for several weeks. Full recovery can take months.

Risks

Risks involved with kneecap removal are similar to those that occur in any surgical procedure, mainly allergic reaction to anesthesia, excessive bleeding, and infection.

Normal results

People who have kneecap removal because of a broken bone or repeated **dislocations** have the best chance for complete recovery. Those who have this operation because of arthritis may have less successful results, and later need a total knee replacement.

Resources

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Griffith, H. Winter. *The Complete Guide to Symptoms, Illness and Surgery*. 5th ed. New York: Perigee, 2006.

Tish Davidson, A.M.

KOH test

Definition

The KOH test takes its name from the chemical formula for potassium hydroxide (KOH), which is the substance used in the test. The test, which is also called a potassium hydroxide preparation, is done to rapidly diagnose fungal infections of the hair, skin, or nails. A sample of the infected area is analyzed under a microscope following the addition of a few drops of potassium hydroxide.

Purpose

The primary purpose of the KOH test is the differential diagnosis of infections produced by dermatophytes and *Candida albicans* from other skin disorders. Dermatophytes are a type of fungus that invade the top layer of the skin, hair, or nails, and produce an infection commonly known as **ringworm**, technically known as tinea. It can appear as "jock itch" in the groin or inner thighs (tinea cruris); on the feet (tinea pedis); on the scalp and hair (tinea capitis); and on the nails (tinea unguium). Tinea versicolor appears anywhere on the skin and produces characteristic unpigmented patches. Tinea unguium affects the nails.

Similar symptoms of redness, scaling, and **itching** can be caused by other conditions, such as **eczema** and **psoriasis**. The KOH test is a quick, inexpensive test—often done in a physician's office—to see if these symptoms are caused by a dermatophyte. If a dermatophyte is found, treatment is started immediately; further tests are seldom necessary.

A yeast (candidal) infection of the skin or a mucous membrane, such as the mouth, often produces a white cheesy material at the infection site. This type of infection, known as thrush, is also identified with the KOH test.

Description

The KOH test involves the preparation of a slide for viewing under the laboratory microscope. KOH mixed with a blue-black dye is added to a sample from the infected tissues. This mixture makes it easier to see the dermatophytes or yeast under the microscope. The KOH dissolves skin cells, hair, and debris; the dye adds color. The slide is gently heated to speed up the action of the KOH. Finally the slide is examined under a microscope.

Dermatophytes are easily recognized under the microscope by their long branch-like structures. Yeast cells look round or oval. The dermatophyte that causes tinea versicolor has a characteristic spaghetti-and-meatballs appearance.

If the KOH test is done in the doctor's office, the results are usually available while the person waits. If the test is sent to a laboratory, the results will be ready the same or following day. The KOH test is covered by insurance when medically necessary.

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KEY TERMS

Dermatophyte—A type of fungus that causes diseases of the skin, including tinea or ringworm.

KOH—The chemical formula for potassium hydroxide, which is used to perform the KOH test. The test is also called a potassium hydroxide preparation.

Thrush—A disease of the mouth, caused by *Candida albicans* and characterized by a whitish growth and ulcers. It can be diagnosed with the KOH test.

Tinea—A superficial infection of the skin, hair, or nails, caused by a fungus and commonly known as ringworm.

Preparation

The physician selects an infected area from which to collect the sample. Scales and cells from the area are scraped using a scalpel. If the test is to be analyzed immediately, the scrapings are placed directly onto a microscope slide. If the test will be sent to a laboratory, the scrapings are placed in a sterile covered container.

Normal results

A normal, or negative, KOH test shows no fungi (no dermatophytes or yeast).

Abnormal results

Dermatophytes or yeast seen on a KOH test indicate the person has a fungal infection. Follow-up tests are usually unnecessary.

Resources

PERIODICALS

Crissey, John Thorne. "Common Dermatophyte Infections. A Simple Diagnostic Test and Current Management." *Postgraduate Medicine* February 1998: 191–192, 197–198, 200, 205.

Nancy J. Nordenson

Korsakoff's psychosis *see* **Korsakoff's syndrome**

Korsakoff's syndrome

Definition

Korsakoff's syndrome is a memory disorder which is caused by a deficiency of vitamin B_1, also called thiamine.

Description

In the United States, the most common cause of thiamine deficiency is **alcoholism**. Other conditions which cause thiamine deficiency occur quite rarely, but can be seen in patients undergoing dialysis (a procedure used primarily for patients suffering from kidney failure, during which the patient's blood circulates outside of the body, is mechanically cleansed, and then is circulated back into the body), pregnant women with a condition called **hyperemesis gravidarum** (a condition of extreme morning sickness, during which the woman vomits up nearly all fluid and food intake), and patients after surgery who are given vitamin-free fluids for a prolonged period of time. Thiamine deficiency is an important cause of disability in developing countries where the main source of food is polished rice (rice with the more nutritious outer husk removed).

An associated disorder, Wernicke's syndrome, often precedes Korsakoff's syndrome. In fact, they so often occur together that the spectrum of symptoms produced during the course of the two diseases is frequently referred to as Wernicke-Korsakoff syndrome. The main symptoms of Wernicke's syndrome include ataxia (difficulty in walking and maintaining balance), **paralysis** of some of the muscles responsible for movement of the eyes, and confusion. Untreated Wernicke's will lead to **coma** and then **death**.

Causes and symptoms

One of the main reasons that alcoholism leads to thiamine deficiency has to do with the high-calorie nature of alcohol. A person with a large alcohol intake often, in essence, substitutes alcohol for other, more nutritive calorie sources. Food intake drops off considerably, and multiple vitamin deficiencies develop. Furthermore, it is believed that alcohol increases the body's requirements for B vitamins, at the same time interfering with the absorption of thiamine from the intestine and impairing the body's ability to store and use thiamine. Direct neurotoxic (poisonous damage to the nerves) effects of alcohol may also play some role.

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Thiamine is involved in a variety of reactions which provide energy to the neurons (nerve cells) of the brain. When thiamine is unavailable, these reactions cannot be carried out, and the important end-products of the reactions are not produced. Furthermore, certain other substances begin to accumulate, and are thought to cause damage to the vulnerable neurons. The area of the brain believed to be responsible for the symptoms of Korsakoff's syndrome is called the diencephalon, specifically the structures called the mamillary bodies and the thalamus.

An individual with Korsakoff's syndrome displays much difficulty with memory. The main area of memory affected is the ability to learn new information. Usually, intelligence and memory for past events is relatively unaffected, so that an individual may remember what occurred 20 years previously, but is unable to remember what occurred 20 minutes ago. This memory defect is referred to as anterograde **amnesia**, and leads to a peculiar symptom called "confabulation," in which a person suffering from Korsakoff's fills in the gaps in his or her memory with fabricated or imagined information. For instance, a person may insist that a doctor to whom he or she has just been introduced is actually an old high school classmate, and may have a lengthy story to back this up. When asked, as part of a memory test, to remember the name of three objects which the examiner listed ten minutes earlier, a person with Korsakoff's may list three entirely different objects and be completely convincing in his or her certainty. In fact, one of the hallmarks of Korsakoff's is the person's complete unawareness of the memory defect, and complete lack of worry or concern when it is pointed out.

Diagnosis

Whenever someone has a possible diagnosis of alcoholism, and then has the sudden onset of memory difficulties, it is important to seriously consider the diagnosis of Korsakoff's syndrome. While there is no specific laboratory test to diagnose Korsakoff's syndrome in a patient, a careful exam of the individual's mental state should be rather revealing. Although the patient's ability to confabulate answers may be convincing, checking the patient's retention of factual information (asking, for example, for the name of the current president of the United States), along with the patient's ability to learn new information (repeating a series of numbers, or recalling the names of three objects ten minutes after having been asked to memorize them) should point to the diagnosis. Certainly a patient known to have just begun recovery from Wernicke's syndrome, who then begins displaying memory difficulties, would be very likely to have developed Korsakoff's syndrome. A **physical examination** may also show signs of Wernicke's syndrome, such as **peripheral neuropathy**.

KEY TERMS

Amnesia—Inability to remember events or experiences. Memory loss. Includes: 1) Anterograde amnesia: inability to retain the memory of events occurring after the time of the injury or disease which brought about the amnesic state. 2) Retrograde amnesia: inability to recall the memory of events which occurred prior to the time of the injury or disease which brought about the amnesic state.

Confabulation—An attempt to fill in memory gaps by fabricating information or details.

Diencephalon—A part of the brain that binds the mesencephalon to the cerebral hemispheres. Considered by some as part of the brain stem.

Treatment

Treatment of both Korsakoff's and Wernicke's syndromes involves the immediate administration of thiamine. In fact, any individual who is hospitalized for any reason and who is suspected of being an alcoholic, should receive thiamine. The combined Wernicke-Korsakoff syndrome has actually been precipitated in alcoholic patients hospitalized for other medical illnesses, due to the administration of thiamine-free intravenous fluids (intravenous fluids are those fluids containing vital sugars and salts which are given to the patient through a needle inserted in a vein). Also, the vitamin therapy may be impaired by the feeding of carbohydrates prior to the giving of thiamine; since carbohydrates cannot be metabolized with thiamine.

Prognosis

Fifteen to twenty percent of all patients hospitalized for Wernicke's syndrome will die of the disorder. Although the degree of ataxia nearly always improves with treatment, half of those who survive will continue to have some permanent difficulty walking. The paralysis of the eye muscles almost always resolves completely with thiamine treatment. Recovery from Wernicke's begins to occur rapidly after thiamine is given. Improvement in the symptoms of Korsakoff's syndrome, however, can take months and months of thiamine replacement. Furthermore, patients who develop Korsakoff's syndrome are almost universally

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memory-impaired for the rest of their lives. Even with thiamine treatment, the memory deficits tend to be irreversible, with less than 20% of patients even approaching recovery. The development of Korsakoff's syndrome often results in an individual requiring a supervised living situation.

Prevention

Prevention depends on either maintaining a diet with a sufficient intake of thiamine, or supplementing an inadequate diet with vitamin preparations. Certainly, one of the most important forms of prevention involves treating the underlying alcohol **addiction**.

ORGANIZATIONS

National Institute on Alcohol Abuse and Alcoholism (NIAAA), 5635 Fishers Lane, MSC 9304, Bethesda, MD, 20892-9304, (301) 443-3860, http://www.niaaa.nih.gov.

Rosalyn Carson-DeWitt, MD

KUB *see* **Kidney, ureter, and bladder x-ray study**

Kuru *see* **Creutzfeldt-Jakob disease**

Kwashiorkor *see* **Protein-energy malnutrition**

This patient's spine shows excessive backward curvature at the level of the upper chest. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Kyphosis

Definition

Kyphosis is the extreme curvature of the upper back also known as a hunchback.

Description

The upper back bone (thoracic region), is normally curved forward. If the curve exceeds 50° it is considered abnormal (kyphotic).

Causes and symptoms

Kyphosis can be divided into three ages of acquisition—birth, old age, and the time in between.

- Spinal birth defects can result in a fixed, exaggerated curve. Vertebrae can be fused together, shaped wrong, extraneous, or partially missing. Congenital and hereditary defects in bone growth weaken bone and result in exaggerated curves wherever gravity or muscles pull on them. Dwarfism is such a defect.
- During life, several events can distort the spine. Because the natural tendency of the thoracic spine is to curve forward, any weakness of the supporting structures will tend in that direction. A diseased thoracic vertebra (a spine bone) will ordinarily crumble its forward edge first, increasing the kyphotic curve. Conditions that can do this include cancer, tuberculosis, Scheuermann's disease, and certain kinds of arthritis. Healthy vertebra will fracture forward with rapid deceleration injuries, such as in car crashes when the victim is not wearing a seat belt.
- Later in life, kyphosis is caused from osteoporosis, bone weakness, and crumbling forward.

The **stress** caused by kyphosis produces such symptoms as an increase in musculoskeletal pains, tension headaches, back aches, and joint pains.

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KEY TERMS

Congenital—Present at birth.

Dwarfism—A congenital disease of bone growth that results in short stature and weak bones.

Orthopedic—Refers to surgery on the supporting structures of the body: bones, joints, ligaments, muscles.

Osteoporosis—A weakening of bones due to calcium loss that affects post-menopausal women.

Scheuermann's disease—Juvenile kyphosis due to damaged bone in the spinal vertebrae.

Diagnosis

A quick look at the back will usually identify kyphosis. X rays of the spine will confirm the diagnosis and identify its cause.

Treatment

Congenital defects have to be repaired surgically. The procedures are delicate, complicated, and lengthy. Often orthopedic hardware must be placed to stabilize the back bone. At other times, a device called a Milwaukee brace can hold the back in place from the outside. Fitting Milwaukee braces comfortably is difficult because they tend to rub and cause sores.

Kyphosis acquired during the younger years requires treatment directed at the cause, such as medications for **tuberculosis**. Surgical reconstruction or bracing may also be necessary.

Kyphosis induced by **osteoporosis** is generally not treated except to prevent further bone softening.

Prognosis

Congenital kyphosis may be alleviated to some extent by surgery and bracing. Kyphosis occurring later in life may worsen over time.

Prevention

Preventing osteoporosis is within the grasp of modern medicine. Menopausal women must start early with estrogen replacement, **calcium** supplementation, and appropriate **exercise**. The treatment must continue through the remainder of life. Evidence suggests that a high calcium intake even during younger years delays the onset of symptomatic osteoporosis. Dairy products are the major dietary sources of calcium.

ORGANIZATIONS

Arthritis Foundation, P.O. Box 7669, Atlanta, GA, 30357-0669, (404) 872-7100, http://www.arthritis.org.

National Osteoporosis Foundation (NOF), 1150 17th Street NW, Suite 850, Washington, DC, 20036-4603, (202) 223-2226, (202) 223-2237, (800) 231-4222, http://www.nof.org.

Osteoporosis and Related Bone Diseases—National Resource Center, 2 AMS Circle, Bethesda, MD, 20892-3676, (202) 223-0344, (202) 293-2356, NIAMSBoneInfo@mail.nih.gov, http://www.niams.nih.gov/Health_Info/bone/default.asp.

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L

Labor and delivery *see* **Childbirth**
Labor induction *see* **Induction of labor**

Labyrinthitis

Definition

Labyrinthitis is an inflammatory disorder of the inner ear, or the system of passages called the bony labyrinth that contains the vestibular system, which senses changes of position to the head. The disorder is often a complication of **otitis media**. Derived from the Latin word labyrinthus, the medical condition called labyrinthitis is produced by the spread of bacterial or viral infections from the head or respiratory tract into the inner ear. A person with labyrinthitis will have irritation and swelling of the inner ear, along with a reduced ability to maintain their balance and a diminished ability to hear in one or both ears.

Demographics

Anyone can contract the various forms of labyrinthitis. Viral labyrinthitis is the most common form of the disorder. It is usually reported in adults from 30 to 60 years of age. The viral condition is rarely seen in children.

Description

Labyrinthitis is characterized by **dizziness** or feelings of **motion sickness** caused by disturbance of the sense of balance. Along with a balance disorder, people with labyrinthitis may also experience **hearing loss** and **tinnitus**. People who are getting over an upper respiratory tract infection (URI) often get labyrinthitis.

People at increased risk from labyrinthitis include those with previous **ear surgery**, frequent infections, alcohol **abuse**, tobacco use, **fatigue**, **stress**, dizziness or hearing loss, diabetes, **stroke**, migraine headaches, use of certain drugs (especially **aspirin**), trauma of the head or spine, ear disease, or high blood pressure.

Causes and symptoms

Causes

The disease agents that cause labyrinthitis may reach the inner ear by one of three routes:

- Bacteria may be carried from the middle ear or the membranes that cover the brain.
- Viruses that cause mumps, measles, influenza, and colds may reach the inner ear following an upper respiratory infection.
- Rubella virus can cause labyrinthitis in infants prior to birth.

The major cause of labyrinthitis is viral. Some of the viruses that can cause labyrinthitis are the cytomegalovirus, **mumps** virus, **rubella** virus, **influenza** virus, herpes simplex virus 1, and adenovirus. Other causes of labyrinthitis include severe stress, head injuries, **allergies**, medicine reactions, or toxic drugs.

Symptoms

The primary symptoms of labyrinthitis are vertigo (dizziness, abnormal sense of movements), accompanied by hearing loss (in one ear) and a sensation of ringing in one or both ears (called tinnitus). Vertigo occurs because the inner ear, part of the vestibular system that coordinates sensory inputs, controls the sense of balance as well as hearing. Difficulty focusing of the eyes is another symptom. Oftentimes patients have trouble sensing both linear and rotational motion. Some patients also experience **nausea**, **fever**, **anxiety**, **vomiting**, general sickness, and spontaneous eye movements (**nystagmus**) in the direction of the unaffected ear. Other symptoms include earache, weakness in the face (possibly on one side more than the other side), decreases in eyesight, and stiffness or **pain** in the neck. Inflammation in the middle

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KEY TERMS

Labyrinth—The bony cavity of the inner ear.

Meniere's syndrome—A disease of the inner ear marked by recurrent episodes of vertigo and roaring in the ears lasting several hours. Its cause is unknown.

Otitis media—Inflammation of the middle ear. It can lead to labyrinthitis.

Vertigo—A sensation of dizziness marked by the feeling that one's self or surroundings are spinning or whirling.

ear (otitis media) can also occur. Bacterial labyrinthitis may produce a discharge from the infected ear.

A common side effect of labyrinthitis is anxiety. Such a problem can produce panic attacks, heart **palpitations**, and **tremors**. In serious cases, depression can happen.

Diagnosis

The diagnosis of labyrinthitis is based on a combination of the patient's symptoms and history—especially a history of a recent upper respiratory infection. The doctor will test the patient's hearing, and order a laboratory culture to identify the organism if the patient has a discharge. A complete physical and neurological examination will include the head and neck, especially in the areas of the otologic, ocular, and cranial nerves. The otologic examination will consist of looking for signs of **mastoiditis** (an infection of the temporal bone of the skull behind the ear), **cellulitis** (inflammation of connective tissue), or previous ear surgery, along with an inspection of the ear canal, the tympanic membrane, and the middle ear. The ocular exam should include an inspection of the eyes with respect to general motion and eyelid response, along with other abnormalities of vision. The neurologic exam will consist of an inspection in and about the cranial nerve.

If there is not a history of a recent infection, the doctor will order extra tests in order to exclude injuries to the brain or Meniere's disease. Possible tests include an electronystagmography (ENG), **electroencephalography** (EEG), head computed tomography (CT) scan, hearing test, and head **magnetic resonance imaging** (MRI) scan.

Treatment

Medication

Patients with minor labyrinthitis are initially given bed rest and plenty of fluids at home. They are asked to avoid sudden changes in position, not to read, avoid bright lights, and to gradually resume normal activities as symptoms decrease. They are prescribed **antibiotics**, either by mouth or intravenously to clear up the infection.

More pronounced symptoms of labyrinthitis may require care in a hospital or other health care facility. Intravenous fluids and medicines to control **vomiting**, dizziness, and nausea are also given. Patients may be given meclizine (Antivert, Bonine), scopolamine (Maldemar, Scopace, Transderm-Scop), or prochlorperazine (Compazine, Buccastem, Phenotil) for vertigo and nausea. For anxiety and depression, antidepressants or sedative-hypnotics (Valium) are given.

To treat labyrinthitis itself, selective serotonin-reuptake inhibitors have been found to be effective. They work by stimulating neural growth within the inner ear, along with relieving some of the symptoms like dizziness. **Corticosteroids**, such as prednisone, have also been shown to be an effective way to treat labyrinthitis during its early stages. When a virus causes labyrinthitis, antiviral medicines such as valacyclovir are used as early as possible so as not to permanently damage the inner ear. Vestibular **rehabilitation** therapy (VRT) is also provided to treat dizziness.

Surgery

Some patients require surgery to drain the inner and middle ear.

Supportive care

Patients with labyrinthitis should rest in bed for three to five days until the acute dizziness subsides. Patients who are dehydrated by repeated vomiting may need intravenous fluid replacement. In addition, patients are advised to avoid driving or similar activities for four to six weeks after the acute symptoms subside, because they may have occasional dizzy spells during that period.

Prognosis

Most patients with labyrinthitis recover completely within two to three weeks, although it often takes five to six weeks for the vertigo to disappear completely and the patient's hearing to return to normal. To return

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completely back to normal conditions (without dizziness and balance problems) a recovery time of months or even a year or so is sometimes the case. Hearing usually returns to normal. In a few cases, the hearing loss is permanent, and other symptoms may never return to normal. Dizziness may continue with older patients.

Prevention

The most effective preventive strategy includes prompt treatment of ear and respiratory infections by medical professionals, as well as the monitoring of patients with mumps, **measles**, influenza, or colds for signs of dizziness or hearing problems.

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Rebecca J. Frey, PhD

Laceration repair

Definition

A laceration is a wound caused by a sharp object producing edges that may be jagged, dirty, or bleeding. Lacerations most often affect the skin, but any tissue may be lacerated, including subcutaneous fat, tendon, muscle, or bone.

Purpose

A laceration should be repaired if it:

- continues to bleed after application of pressure for ten to fifteen minutes
- is more than one-eighth to one-fourth inch deep
- exposes fat, muscle, tendon, or bone
- causes a change in function surrounding the area of the laceration
- is dirty or has visible debris in it
- is located in an area where an unsightly scar is undesirable.

Eleven sutures are necessary to close up the laceration on this person's forehead. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Precautions

Lacerations are less likely to become infected if they are repaired soon after they occur. Many physicians will not repair a laceration that is more than eight hours old because the risk of infection is too great.

Description

Laceration repair mends a tear in the skin or other tissue. The procedure is similar to repairing a tear in clothing. Primary care physicians, emergency room

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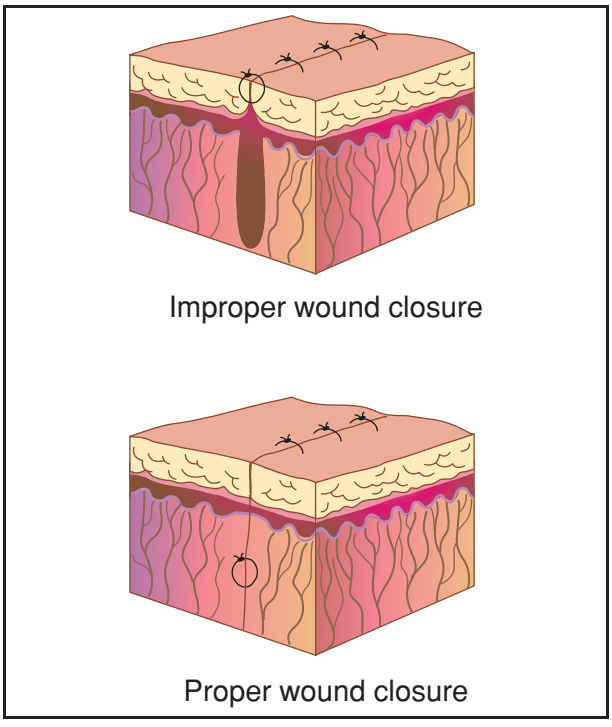

A laceration is a traumatic break in the skin caused by a sharp object producing edges that may be jagged, dirty, or bleeding. The underlying tissue may also be severed. In such instances, the physician may place absorbable sutures in the tissue to help bring the edges together before the skin is sutured close. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

physicians, and surgeons usually repair lacerations. The four goals of laceration repair are to stop bleeding, prevent infection, preserve function, and restore appearance. Insurance companies do pay for the procedure. Cost depends upon the severity and size of the laceration.

Before repairing the laceration, the physician thoroughly examines the wound and the underlying tendons or nerves. If nerves or tendons have been injured, a surgeon may be needed to complete the repair. The laceration is cleaned by removing any foreign material or debris. Removing **foreign objects** from penetrating **wounds** can sometimes cause bleeding, so this type of wound must be cleaned very carefully. The wound is then irrigated with saline solution and a disinfectant. The disinfecting agent may be mild soap or a commercial preparation. An antibacterial agent may be applied.

Once the wound has been cleansed, the physician anesthetizes the area of the repair by injecting a local anesthetic. The physician may trim edges that are jagged or extremely uneven. Tissue that is too damaged to heal must be removed (**debridement**) to prevent infection. If the laceration is deep, several absorbable stitches

KEY TERMS

Debridement—The act of removing any foreign material and damaged or contaminated tissue from a wound to expose surrounding healthy tissue.

(sutures) are placed in the tissue under the skin to help bring the tissue layers together. Suturing also helps eliminate any pockets where tissue fluid or blood can accumulate. The skin wound is closed with sutures. Suture material used on the surface of a wound is usually non-absorbable and will have to be removed later. A light dressing or an adhesive bandage is applied for 24–48 hours. In areas where a dressing is not feasible, an antibiotic ointment can be applied. If the laceration is the result of a human or animal bite, if it is very dirty, or if the patient has a medical condition that alters wound healing, oral **antibiotics** may be prescribed.

Aftercare

The laceration is kept clean and dry for at least 24 hours after the repair. Light bathing is generally permitted after 24 hours if the wound is not soaked. The physician will provide directions for any special wound care. Sutures are removed 3–14 days after the repair is completed. Timing of suture removal depends on the location of the laceration and physician preference.

The repair should be observed frequently for signs of infection, which include redness, swelling, tenderness, drainage from the wound, red streaks in the skin surrounding the repair, chills, or **fever**. If any of these occur, the physician should be contacted immediately.

Risks

The most common complication of any laceration repair is infection. Risk of infection can be minimized by cleansing the wound thoroughly. Wounds from **bites** or dirty objects or wounds that have a large amount of dirt in them are most likely to become infected.

All lacerations will heal with a scar. Wounds that are repaired with sutures are less likely to develop **scars** that are unsightly, but no one can predict how wounds will heal and who will develop unsightly scars. **Plastic surgery** can improve the appearance of many scars.

Resources

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Mary Jeanne Krob, MD, FACS

Lacerations *see* **Wounds**

Lacrimal duct obstruction

Definition

A lacrimal duct obstruction is a condition caused by a partial or complete blockage of the tear duct, the thin channel (small tube) that normally drains tears from the surface of the eye and into the nose. A blocked tear duct occurs usually when the drainage system between the inside corner of the eye and the inside of the nose is obstructed by something or does not properly open. When either case happens, tears on the surface of the eyes are not allowed to move into the nose so that they can be reabsorbed into the body or evaporated into the air. Consequently, the tear duct sac fills with tears. If not treated promptly, such a situation can lead to a watery, irritated eye that first becomes swollen and inflamed and, later, possibly infected.

Demographics

An obstruction of the tear duct is rarely found in healthy adults. When it does appear in an adult it usually results from an injury suffered in or around the eyes. However, tear duct blockage has been verified to be more prominent in older adults, being an age-related condition. The condition can also be present at birth, with about 6 to 20 out of 100 newborn babies having lacrimal duct obstruction. When this case arises, it is congenital and is called nasolacrimal duct obstruction.

Description

The lacrimal glands, located above each eyeball, produce tears. The tears flow over the eye, and then drain through the nasolacrimal ducts. A tiny hole at the inner edge of each eyelid marks the opening of the ducts, which lead to the lacrimal sacs located on the side of the nose. The tears pass from the sacs into the nasolacrimal ducts and then into the nose. Once in the nose, they are either reabsorbed by the body or evaporated into the air.

When a tear duct becomes obstructed, tears may spill over the eyelids and run down the face. Stagnant tears within the system can become infected, leading to recurrent red eyes and infections. Excessive tearing can also produce secondary skin changes on the lower eyelids.

Increased risks for acquiring lacrimal duct obstruction include:

- premature birth
- age and gender (females are more at risk than males; as are older people over younger ones)
- chronic eye infections (dacrosystitis)
- family history of blocked tear ducts
- previous cancer treatments (chemotherapy or radiation), especially of the face or head
- abnormal bone growth or tumors around the eyes
- chronic eye inflammation (conjunctivitis)
- previous surgeries of the eye or eyelid, along with nasal or sinus surgery
- use of glaucoma medications

Causes and symptoms

An obstructed lacrimal tear duct can result in inflammation and infection of the lacrimal sac. The area beneath the eyes next to the nose can become red, inflamed, and sensitive to the touch. The area usually is swollen, painful, and there may be a mucous discharge from the opening of the nasal corner of the eye. Blurred vision may also occur, along with bloody tears. Common complaints include **itching**, irritation, burning, redness, foreign body sensation, and tearing. Symptoms are worsened by cold weather, high winds, bright sunlight, and exposure to upper respiratory infections.

The first symptom to appear is usually excessive tearing. It may occur as the appearance of wet-looking eyes or grow as large as excessive amounts of tears running down the cheeks. Newborns have symptoms starting from a few days to a few weeks after being born. In all ages, symptoms include redness and inflammation around the eye or nose. Yellow mucus may appear from the corners of the eye. Eventually, eyelids may stick together. Infection is usually a latter-stage symptom, especially in the eyelids.

Children frequently have a congenital lacrimal duct obstruction. Six to ten percent of all children are born before their tear ducts are open. The unopened tear duct is caused by immature tissue at the end of the tear duct, which causes it not to open normally. Children may also acquire lacrimal duct obstruction due to infections, abnormal growth of the nasal bone, and undeveloped openings in the corners of the eyes.

In adults, a common cause of lacrimal duct obstruction is involution, which is progressive degeneration occurring naturally with advancing age,

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resulting in shriveling of organs or tissues. Other causes include:

- eyelid disorders
- infections by bacteria, viruses, fungi, and parasites
- inflammation
- regular use of eye drops or excessive use of nasal spray
- topical medications that treat eye problems
- systemic chemotherapy
- trauma from previous surgeries to the bone at the side of the nose
- injuries to the face
- abnormal development of the skull and face
- foreign bodies
- sinus disease
- nasal polyps
- cysts and stones
- malignant or benign tumors

Smoking tobacco products can also increase the likelihood of tear blockages.

Diagnosis

The medical professional will rely initially on the patient's medical history and a **physical examination**. If the primary symptom is excessive tearing, the first step is for the health care professional to determine if the overflow of tears is due to an increase in tear production or a decrease in tear drainage. Tests will establish the amount of tears being produced and whether the tears are draining normally. Such tests include the fluorescein dye disappearance (test for ability of tears to drain), irrigation and probing (test for ability to drain and presence of blockage), and dacryocystography or dacryoscintigraphy (test to indicate cause of blockage with use of medical scans).

Causes of increased tear production may include trichiasis, a disease in which the eyelashes produce constant irritation, and eyelid malpositions and diseases. If abnormal tear production is ruled out, then obstructions in tear drainage is the most likely cause of the excessive tearing. Additional observations of swollen lacrimal sac area and purulent eye discharge indicate that there may be a lacrimal duct infection present. To define the diagnosis, the lacrimal discharge may be cultured to determine possible infective agents, while various imaging techniques may be used to detect the type of obstruction. Dye tracer tests are also used to test for blockages.

Treatment

Lacrimal duct obstructions in children often resolve spontaneously, with 95% showing resolution before the child is one year old. Daily massaging (two to four times each day) of the lacrimal sac may help open the blockage. A topical antibiotic ointment may be applied if infection is present. If the blockage is not resolved after several weeks to months of this therapy, a physician may attempt forceful irrigation. Dilation, probing, and irrigation to open up the duct under **general anesthesia** or under a restraint is a last resort, after six months to one year or so of less invasive treatments. The dilation, probing, and irrigation technique is usually successful in the vast majority of the cases with children.

In adults, the condition is generally correctable, with conservative treatments usually recommended. The cause of the blockage and a person's age may make treatment more difficult. The infected or inflamed area may be massaged, with warm compresses applied to provide relief and speed the healing process. The health care provider may also irrigate the infected area. Topical antibiotic ointments and oral **antibiotics** are often applied to reduce infection. The use of **analgesics** such as **aspirin** may be recommended to control discomfort and reduce swelling.

The eyes can be kept clean by wiping drainage away from them. Moisten a cotton call or clean washcloth with warn water. Wipe carefully and gently once from the inner to the outer part of the eye. Repeat multiple times, if necessary; with a new cotton ball or washcloth. To clean eyelashes, use a gentle downward motion onto the eyelash with a moist cotton ball. If the eyelash contains dried substances, apply a warm, moistened cotton ball over the eye lash for a few minutes.

Minimally invasive treatments or surgeries may also be necessary if conservative measures fail to help. One such treatment is stenting or intubation. Tiny polyurethane- or silicone-based tubes are used to clear blockages or to widen narrowing of the tear ducts. The most frequent surgery is called an external dacryocystorhinostomy. An incision is made on the side of the nose so the surgeon can insert a stent.

In another treatment, balloon catheter dilation helps to resolve problems with passages narrowed by inflammation, scarring, or other related problems. In one such surgery, a complete reconstruction of the drainage system is performed. Called conjunctivodacryocystorhinostomy, it creates to new passageway (an artificial duct) for the tears to drain.

Procedures called endoscopic or endonasal are also sometimes used. Without making an incision, the

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KEY TERMS

Lacrimal duct—A short canal leading from a small orifice at the medial angle of each eyelid to the lacrimal sac.

Lacrimal gland—An almond-shaped gland that secretes tears.

Lacrimal sac—The dilated upper end of the nasolacrimal duct in which the lacrimal ducts empty.

Nasolacrimal duct—A channel that transmits tears from the lacrimal sac to the nose.

Purulent—Consisting of or containing pus.

Tear—A drop of the clear, salty fluid secreted by the lachrimal gland.

Trichiasis—A disease of the eye, in which the eyelashes, being turned in upon the eyeball, produce constant irritation by the motion of the lids.

surgeon inserts tiny instruments attached to cameras through the nasal opening to correct the problem.

As with children, the procedure called dilation, probing, and irrigation can also be effectively applied to adults.

Prognosis

Most adults respond positively to conservative treatments. If such approaches fail to clear the obstruction, surgical procedures are available, with success rates greater than 90%. The vast majority of children out grow the condition, and treatments are usually unnecessary. However, when treatments are necessary, they usually solve the problem.

Prevention

Lacrimal duct obstruction is not preventable. In many cases, the cause of a lacrimal duct obstruction is not known. Most of the cases are congenital (present at birth). However, there are several effective ways to minimize the chances of having a blockage of the tear ducts. For parents, if your child has blockage of the tear ducts, keep the baby away from winds, sunlight, and coldness.

For adults, always treat sinus or eye infections promptly. When engaging in strenuous **exercise** and activities (such as bicycling) or contact sports (such as hockey)—when injuries to the face are likely—always wear a helmet or protective eye gear. In addition, do not smoke tobacco products and do not abuse nasal sprays.

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ORGANIZATIONS

American Academy of Ophthalmology, P.O. Box 7424, San Francisco, CA, 94120-7424, (415) 561-8500, (415) 561-8533, http://www.aao.org/.

American Optometric Association, 243 North Lindbergh Boulevard, St. Louis, MO, 63141, (314) 991-4100, (800) 365-2219, http://www.aoanet.org.

National Eye Institute, 2020 Vision Place, Bethesda, MD, 20892-3655, (301) 496-5248, http://www.nei.nih.gov/.

Judith Sims

Lacrimal sac infection *see* **Dacryocystitis**

Lactate dehydrogenase isoenzymes test

Definition

The enzyme lactate dehydrogenase (also known as lactic dehydrogenase, or LDH) is found in the cells of almost all body tissues. The enzyme is especially concentrated in the heart, liver, red blood cells, kidneys, muscles, brain, and lungs. The total LDH can be further separated into five components or fractions labeled by number: LDH-1, LDH-2, LDH-3, LDH-4, and LDH-5. Each of these fractions, called isoenzymes, is used mainly by a different set of cells or tissues in the body. For this reason, the relative amounts of a particular isoenzyme of LDH in the blood can provide valuable diagnostic information.

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Purpose

The LDH isoenzymes test assists in differentiating **heart attack**, anemia, lung injury, or **liver disease** from other conditions that may cause the same symptoms (differential diagnosis).

Precautions

Strenuous **exercise** may raise levels of total LDH, specifically the isoenzymes LDH-1, LDH-2, and LDH-5. Alcohol, anesthetics, **aspirin**, **narcotics**, procainamide, fluorides, and mithramycin may also raise levels of LDH. Ascorbic acid (vitamin C) can lower levels of LDH.

KEY TERMS

Differential diagnosis—Comparing and contrasting the signs, symptoms, and laboratory findings of two or more diseases to determine which is causing the patient's condition.

Enzyme—A protein that regulates the rate of a chemical reaction in the body, increasing the speed at which the change occurs.

Isoenzyme—One of a group of enzymes that bring about the same reaction but are vary in their physical properties.

Description

LDH is found in the cells of almost all body tissues. When certain conditions injure cells in tissues containing LDH, it is released into the bloodstream. Because LDH is so widely distributed throughout the body, analysis of total LDH will not help make a diagnosis of a particular disease. Because this enzyme is actually composed of five different isoenzymes, however, analysis of the different LDH isoenzyme levels in the blood can help in the diagnosis of some diseases.

The five LDH isoenzymes are: LDH-1, LDH-2, LDH-3, LDH-4, and LDH-5. In general, each isoenzyme is used mostly by the cells in a specific tissue. LDH-1 is found mainly in the heart. LDH-2 is primarily associated with the system in the body that defends against infection (reticuloendothelial system). LDH-3 is found in the lungs and other tissues, LDH-4 in the kidney, placenta, and pancreas, and LDH-5 in liver and striated (skeletal) muscle. Normally, levels of LDH-2 are higher than those of the other isoenzymes.

Certain diseases have classic patterns of elevated LDH isoenzyme levels. For example, an LDH-1 level higher than that of LDH-2 is indicative of a heart attack or injury; elevations of LDH-2 and LDH-3 indicate lung injury or disease; elevations of LDH-4 and LDH-5 indicate liver or muscle disease or both. A rise of all LDH isoenzymes at the same time is diagnostic of injury to multiple organs. For example, a heart attack with congestive **heart failure** may cause symptoms of lung and liver congestion. Advanced **cancer** and autoimmune diseases such as lupus can also cause this pattern.

One of the most important diagnostic uses for the LDH isoenzymes test is in the differential diagnosis of myocardial infarction or heart attack. The total LDH level rises within 24–48 hours after a heart attack, peaks in two to three days, and returns to normal in approximately five to ten days. This pattern is a useful tool for a delayed diagnosis of heart attack. The LDH-1 isoenzyme level, however, is more sensitive and specific than the total LDH. Normally, the level of LDH-2 is higher than the level of LDH-1. An LDH-1 level higher than that of LDH-2, a phenomenon known as "flipped LDH," is strongly indicative of a heart attack. The flipped LDH usually appears within 12–24 hours after a heart attack. In about 80% of cases, flipped LDH is present within 48 hours of the incident. A normal LDH-1/LDH-2 ratio is considered reliable evidence that a heart attack has not occurred.

It should be noted that two conditions might cause elevated LDH isoenzymes at the same time and that one may confuse the other. For example, a patient with **pneumonia** may also be having an acute heart attack. In this instance, the LDH-1 level would rise with the LDH-2 and LDH-3. Because of this complication, some laboratories measure only the LDH-1 and consider an elevated LDH level with LDH-1 higher than 40% to be diagnostic of heart damage. LDH isoenzymes test is not used much anymore for diagnosis of heart attack. Tests for the protein troponin, which is found in myocardial cells, have been found to be more accurate.

Preparation

This test requires a blood sample. The patient need not fast (nothing to eat or drink) before the test unless requested to do so by the physician.

Risks

Risks for this test are minimal. The patient may experience slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after the vein is punctured (venipuncture), or an accumulation of blood under the puncture site (hematoma).

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Results

Reference values for normal levels of LDH isoenzymes vary from laboratory to laboratory but can generally be found within the following ranges:

- LDH-1: 17–27%
- LDH-2: 27–37%
- LDH-3: 18–25%
- LDH-4: 8–16%
- LDH-5: 6–16%

Increased levels of LDH-1 are seen in myocardial infarction, red blood cell diseases like **hemolytic anemia**, **kidney disease** including **kidney transplantation** rejection, and testicular tumors. Increased levels of LDH-2 are found in lung diseases such as pneumonia and congestive heart failure, as well as in lymphomas and other tumors. Elevations of LDH-3 are significant in lung disease and certain tumors. Elevations of LDH-4 are greatly increased in **pancreatitis**. High levels of LDH-5 are found in liver disease, intestinal problems, and skeletal muscle disease and injury, such as **muscular dystrophy** and recent muscular trauma.

Diffuse disease or injury (for example, collagen disease, **shock**, low blood pressure) and advanced solid-tumor cancers cause significant elevations of all LDH isoenzymes at the same time.

Resources

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Pagana, Kathleen Deska, and Timothy J. Pagana. *Mosby's Manual of Diagnostic and Laboratory Tests*. 4th ed. St. Louis: Mosby, 2009.

Janis O. Flores

Lactate dehydrogenase test

Definition

Lactate dehydrogenase, also called lactic dehydrogenase, or LDH, is an enzyme found in the cells of many body tissues, including the heart, liver, kidneys, skeletal muscle, brain, red blood cells, and lungs. It is responsible for converting muscle lactic acid into pyruvic acid, an essential step in producing cellular energy.

Purpose

Lactic dehydrogenase is present in almost all body tissues, so the LDH test is used to detect tissue alterations and as an aid in the diagnosis of **heart attack**, anemia, and **liver disease**. Newer injury markers are becoming more useful than LDH for heart attack diagnosis.

Precautions

Because the LDH enzyme is so widely distributed throughout the body, cellular damage causes an elevation of the total serum LDH. As a result, the diagnostic usefulness of this enzyme by itself is not as valuable as determination of the five fractions that comprise the LDH. These fractions are called isoenzymes and are better indicators of disease than is the total LDH. The fractions are LDH-1, LDH-2, LDH-3, LDH-4, and LDH-5. A normal total LDH level does not mean that individual isoenzyme levels should not be measured. Individual isoenzyme ranges can help differentiate a diagnosis.

Description

When disease or injury affects tissues containing LDH, the cells release LDH into the bloodstream, where it is identified in higher than normal levels. For example, when a person has a heart attack, the LDH level begins to rise about 12 hours after the attack and usually returns to normal within 5–10 days. The LDH is also elevated in diseases of the liver, in certain types of anemia, and in cases of excessive destruction of cells, as in **fractures**, trauma, muscle damage, and shock.

Cancers can also elevate LDH level. Additionally, some patients have chronically elevated LDH with no identifiable cause and no apparent consequence.

Preparation

This test requires a blood sample. It is not necessary for the patient to fast (nothing to eat or drink) before the test unless the physician requests it.

Risks

Risks for this test are minimal, but may include slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after venipuncture, or hematoma (blood accumulating under the puncture site).

Results

Reference ranges for total LDH vary from laboratory to laboratory. Normal values are also higher in childhood. For adults, in most laboratories, the range

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KEY TERMS

Enzyme—A protein that regulates the rate of a chemical reaction in the body, increasing the speed at which the change occurs.

Isoenzyme—One of a group of enzymes that catalyze the same reaction but are differentiated by variations in physical properties.

can be up to approximately 200 units/L, but is usually found within 45-90 U/L.

Abnormal results

Due to the fact that many common disease processes cause elevations in the total LDH level, a breakdown of the five different isoenzymes that make up the total LDH is often helpful for diagnosis. In certain disorders, the total LDH may be within normal limits, but individual isoenzyme elevations can indicate specific organ or tissue damage. For example, the LDH-2 fraction is normally greater than LDH-1 in the blood. After an acute heart attack, however, the LDH-1 rises over the LDH-2 in what is known as a "flipped LDH."

Certain diagnoses can be assisted by determination of the total LDH. One example is **infectious mononucleosis**, in which the LDH is usually more elevated than a liver enzyme called AST. Conversely, in cases of viral hepatitis, the liver enzymes AST and ALT are greatly increased over the LDH.

Resources

BOOKS

Pagana, Kathleen Deska, and Timothy J. Pagana. *Mosby's Manual of Diagnostic and Laboratory Tests*. 4th ed. St. Louis: Mosby, 2009.

Janis O. Flores

Lactation

Definition

Lactation is the medical term used for **breastfeeding**. It also specifically refers to the synthesis and secretion of milk.

Purpose

Breastfeeding provides a baby with **nutrition** in the form of breast milk. Not only does breast milk contain all the nutrients needed by a rapidly developing newborn, but it also contains antibodies that provide the baby with additional protection from common early childhood diseases.

Precautions

Most common illnesses cannot be transmitted via breast milk. However, some viruses, including HIV (the virus that causes **AIDS**) can be passed in breast milk; for this reason, women who are HIV-positive should not breastfeed. Vitamin D supplements are often recommended for babies who are breastfed because breast milk is low in vitamin D, a vitamin that promotes strong bones.

Many medications have not been tested in nursing women, so it is not known if these drugs can affect a breast-fed child. A nursing woman should always check with her doctor before taking any medications, including over-the-counter drugs.

In addition, these drugs are not safe to take while nursing:

- radioactive drugs for some diagnostic tests
- chemotherapy drugs for cancer
- bromocriptine
- ergotamine
- lithium
- methotrexate
- street drugs (including marijuana, heroin, amphetamines)
- tobacco

Breastfeeding women should not drink alcohol for at least two hours before breastfeeding, and should not smoke.

Description

Early in a woman's **pregnancy** her milk-producing glands, called mammary glands, begin to prepare for the baby's arrival and by the sixteenth week of pregnancy the breasts are ready to produce milk. Shortly after the baby is born, the expulsion of the placenta triggers hormone shifts in the woman's body to activate lactation. The levels of the hormones estrogen and progesterone fall abruptly while the level of the hormone prolactin—the main hormone involved in the biosynthesis of milk—increases. The anterior pituitary gland secretes prolactin during lactation in very large quantities so that by 36–96 hours after the baby's birth the woman's milk volume has dramatically increased. After this time, the volume of

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milk the mother produces levels off and the removal of milk becomes the predominant factor in regulating the volume of milk production.

Another hormone called oxytocin controls the release of milk from the breasts. The baby's sucking stimulates nerve endings in the nipple, which signal the mother's pituitary gland to release the oxytocin. This is called the "let–down reflex." While the baby's sucking is the primary stimulus for the reflex, a baby's cry, thoughts of the baby, or the sound of running water also may trigger the response.

Breast milk cannot be duplicated by artificial milk, although both contain protein, fat, and carbohydrates. Breast milk changes to meet the specific needs of a baby. In particular, the mother produces milk called colostrum at the end of pregnancy and in the initial postpartum period. Colostrum is called "first milk" and is thicker than mature milk. It is yellowish in color and is rich in proteins, many of which are immunoglobulins that can protect the child against illness and **allergies**. Immunoglobulins are part of the body's natural defense system against infections and other agents that can cause disease. Breast milk also helps a baby's own immune system mature faster. As a result, breast-fed babies have fewer ear infections, bouts of **diarrhea**, **rashes**, allergies, and other medical problems than bottle-fed babies do.

Benefits

In addition to providing some protection against infection, breast milk has other benefits. Because it is easily digested, babies are less likely to get constipated.

Breastfeeding is also good for the mother. It releases hormones that stimulate the uterus to contract, helping the uterus to return to normal size after delivery and reducing the risk of bleeding. The act of producing milk burns calories, which helps the mother to lose excess weight gained during pregnancy. Breastfeeding also may be related to a lower risk of **breast cancer**, **ovarian cancer**, and **cervical cancer**.

Breast milk is free, and saves money by eliminating the need to buy artificial milk (formula), bottles, and nipples. It also eliminates the need to sterilize feeding equipment and mix formula with clean, pathogen-free water, a critical consideration in many developing countries. Because breast-fed babies overall have fewer illnesses, their health care costs may be lower.

Breastfeeding should begin as soon as possible after birth and should continue every two to three hours. However, all babies are different; some need to nurse very frequently at first, while others can go much longer between feedings. A baby should be fed at least eight to 12 times in 24 hours. Because breast milk is easily digested, a baby may be hungry again as soon as one and one-half hours after the last meal. Frequent nursing will also help in increasing milk production.

Some babies have no trouble breastfeeding, while others may need some assistance. Once the baby begins to suck, the mother should make sure that most of the areola (the colored part of the nipple) is in the baby's mouth. Proper latching-on will help stimulate milk flow and will prevent nipple soreness.

Breastfeeding mothers should offer the baby both breasts at each feeding. Breastfeeding takes about 15–20 minutes on each side. After stopping the feeding on one side, the mother should burp the baby before offering the other breast. If the baby does not continue feeding, the next feeding should begin with the second breast.

Mothers can tell if the baby is getting enough milk by checking diapers; a baby who is wetting between four to six disposable diapers or six to eight cloth diapers and who has three or four bowel movements in 24 hours is probably getting enough milk.

Preparation

Loose, front-opening clothes and a good nursing bra are recommended. Mothers should find a comfortable chair with lots of pillows, supporting the arm and back, in which to nurse. Feet should rest on a low footstool with knees raised slightly. The baby should be level with the breast. The new mother may have to experiment with different ways of holding the baby before finding one that is comfortable for both the mother and baby.

Several members of the health care team, including obstetricians, nurses, midwives, and lactation consultants, are equipped to provide guidance and support to mothers who wish to breastfeed their babies. By meeting specific eligibility requirements and passing an independent examination, lactation consultants may be certified by the International Board of Lactation Consultants. Such certification demonstrates that these consultants possess the necessary skills, knowledge, and attitudes to provide quality breastfeeding assistance. It is important for new mothers to understand that breastfeeding is something that mothers and babies must learn to do together. The development of a satisfying breastfeeding relationship requires patience on the mother's part and the mother may benefit from the support and guidance of a lactation consultant or other qualified member of her health care team.

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KEY TERMS

Areola—The pigmented, circular area surrounding the nipple of each breast.

Bromocriptine—A drug used to treat Parkinson's disease that can decrease a woman's milk supply.

Ergotamine—A drug used to prevent or treat migraine headaches. This can cause vomiting, diarrhea, and convulsions in infants.

Immunoglobulin—A protein produced by plasma cells; a component of the immune system. Transferred in utero and through breast milk, immunoglobulins provide passive immunity to the baby.

Lactation—Secretion of milk from the breasts; the act of breastfeeding.

Latch-on—The process whereby the baby opens the mouth widely and first exerts negative pressure on the mother's nipple and then positive pressure. Good latch-on will result in adequate transfer of milk into the baby's mouth and prevent sore nipples from occurring.

Lithium—A drug used to treat manic depression (bipolar disorder) that can be transmitted in breast milk.

Methotrexate—An anticancer drug also used to treat arthritis that can suppress an infant's immune system when taken by a nursing mother.

Postpartum—Refers to the six-week period after childbirth.

Complications

New mothers may experience breastfeeding problems, including:

- Engorged breasts. Breasts that are too full can prevent the baby from sucking. Expressing milk manually or with a breast pump can help, as can warm showers and compresses.
- Sore nipples. In the early weeks nipples may become sore and even cracked. Treatments include changing the position that the baby nurses in, ensuring that the baby has latched on to most of the areola, and using lanolin-based lotion on the nipples. Nipple shields are sometimes effective as a short-term remedy, but their use may reduce milk supply, further irritate the breast, and change the baby's sucking pattern.
- Inverted nipples: A mother with inverted nipples may still breastfeed in most instances. The baby should be enticed to open the mouth widely before latching on. The mother can use various techniques to evert the nipple such as wearing a breast shell between feedings, rolling the nipple, pulling the nipple out, and applying a breast pump on the breast for a few seconds before starting the breastfeeding session.
- Infection. Soreness and inflammation on the breast surface or a fever in the mother, may be an indication of a breast infection called mastitis. Antibiotics and continued nursing on the affected side may solve the problem.

Results

There are no rules about when to stop breastfeeding. A baby needs breast milk or artificial milk for at least the first year of life. As long as a baby eats age-appropriate solid food, the mother may nurse for several years.

Health care team roles

Several members of the health care team, including obstetricians, nurses, midwives, and lactation consultants, are equipped to provide guidance and support to mothers who wish to breastfeed their babies. By meeting specific eligibility requirements and passing an independent examination, lactation consultants may be certified by the International Board of Lactation Consultants. Such certification demonstrates that these consultants possess the necessary skills, knowledge, and attitudes to provide quality breastfeeding assistance. It is important for new mothers to understand that breastfeeding is something that mothers and babies must learn to do together. The development of a satisfying breastfeeding relationship requires patience on the mother's part and the mother may benefit from the support and guidance of a lactation consultant or other qualified member of her health care team.

Resources

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Champ, Martine, and Christine Hoebler. "Functional Food for Pregnant, Lactating Women and in Perinatal Nutrition: a Role for Dietary Fibers?" *Current Opinion in Clinical Nutrition & Metabolic Care*. 12(6) (November 2009): 565–74.

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ORGANIZATIONS

International Board of Lactation Consultant Examiners (IBLCE), 6402 Arlington Blvd., Suite 350, Falls Church, VA, 22042, (703) 560-7330, (703) 560-7332, iblce@ibcle.org, www.iblce.org.

La Leche League International, PO Box 4079, Schaumburg, IL, 60168–4079, (800) 525-3243, (847) 519-9585, http://www.llli.org.

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Lactic acid test

Definition

Lactic acid is an acid produced by cells during chemical processes in the body that do not require oxygen (anaerobic metabolism). Anaerobic metabolism occurs only when too little oxygen is present for the more usual aerobic metabolism (oxygen requiring). Lactic acid is a contributing factor in **muscle cramps**. It is also produced in tissues when conditions such as **heart attack** or **shock** reduce the blood supply responsible for carrying oxygen. Normally, lactic acid is removed from the blood by the liver. When an excess of lactic acid accumulates for any reason, the result is a condition called lactic acidosis.

Purpose

The lactic acid test is used as an indirect assessment of the oxygen level in tissues and to determine the cause and course of lactic acidosis.

Precautions

During blood collection, the patient should be instructed to relax the hand. Clenching and unclenching the fist will cause a build-up of potassium and lactic acid from the hand muscles that will falsely elevate the levels.

Description

The degree of acidity is an important chemical property of blood and other body fluids. Acidity is expressed on a pH scale where 7.0 is neutral, above 7.0 is basic (alkaline), and below 7.0 is acidic. A strong acid has a very low pH (near 1.0). A strong base has a very high pH (near 14.0). Blood is normally slightly alkaline or basic. It has a pH range of 7.35–7.45. The balance of acid to base in blood is precisely controlled. Even a minor deviation from the normal range can severely affect many organs.

Lactic acid (present in the blood as lactate ion) is a product of the breakdown of glucose to generate energy. It is found primarily in muscle cells and red blood cells. The lactate ion concentration in the blood depends on the rates of energy production and metabolism. Levels may increase significantly during **exercise**.

Together, lactic acid and another chemical (pyruvate) form a reversible reaction regulated by the oxygen supply to the blood and tissues. When oxygen levels are low, pyruvate converts to lactic acid; when oxygen levels are adequate, lactic acid converts to pyruvate. When the liver fails to metabolize lactose sufficiently or when too much pyruvate converts to lactate, lactic acidosis occurs. Measurement of blood lactate levels is recommended for all patients with symptoms of lactic acidosis. Testing is generally indicated if the blood pH level falls below 7.25–7.35.

Because of the close relationship between pyruvate and lactic acid, comparison of blood levels of the two substances can provide reliable information about tissue oxidation. However, pyruvate measurement is technically difficult and seldom performed. Lactic acid is measured more often, in either venous or arterial blood samples.

Preparation

This test requires a blood sample. The patient should have nothing to eat or drink (**fasting**) from midnight the night before the test. Because lactic acid is produced by exertion, the patient should rest for at least one hour before the test.

Risks

Risks for this test are minimal. The patient may experience slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after puncture of the vein (venipuncture), or an accumulation of blood under the puncture site (hematoma).

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KEY TERMS

Acidosis—A disturbance of the balance of acid to base in the body causing an accumulation of acid or loss of alkali (base). There are two types of acidosis: metabolic and respiratory. One of the most common causes of metabolic acidosis is an overdose of aspirin. Respiratory acidosis is caused by impaired breathing caused by conditions such as severe chronic bronchitis, bronchial asthma, or airway obstruction.

Results

Reference values vary from laboratory to laboratory but can be found within the following ranges:

- Venous blood: 4.5–19.8 mg/dL
- Arterial blood: 4.5–14.4 mg/dL

High blood lactate levels, together with decreased oxygen in tissues, may be caused by strenuous muscle exercise, shock, hemorrhage, severe infection in the blood stream, heart attack, or cardiac arrest. When tissue oxygenation is low for no apparent reason, increased lactate levels may be caused by systemic disorders like diabetes, leukemia, **liver disease**, or kidney failure. Defects in enzymes may also be responsible, as in glycogen storage disease (von Gierke's disease). Lactate is also increased in certain instances of intestinal obstruction.

Lactic acidosis can be caused by taking large doses of **acetaminophen** and alcohol and by intravenous infusion of epinephrine, glucagon, fructose, or sorbitol. Antifreeze **poisoning** can also cause lactic acidosis. In rare instances, a diabetic medication, metformin (Glucophage), causes lactic acidosis. People with weak kidneys should not take metformin.

Resources

BOOKS

Pagana, Kathleen Deska, and Timothy J. Pagana. *Mosby's Manual of Diagnostic and Laboratory Tests*. 4th ed. St. Louis: Mosby, 2009.

Paul A. Johnson, Ed.M.

Lactic acidosis *see* **Metabolic acidosis**

Lactogen test *see* **Prolactin test**

Lactogenic hormone test *see* **Prolactin test**

Lactose intolerance

Definition

Lactose intolerance refers to the inability of the body to fully digest lactose, which is a type of sugar found in milk. It is also sometimes called lactose deficiency. Although the condition is neither serious nor fatal, it can cause much discomfort in the form of gastrointestinal distress. Many people have low levels of the enzyme lactase in their bodies (which break down lactose) but do not show any symptoms of lactose intolerance. Thus, people with lactose intolerance have both low lactase levels and the associated symptoms. The condition can be regulated by reducing or eliminating the consumption of products containing milk.

Demographics

The condition of being lactose intolerant is common in adults around the world. However, it is more common in such ethnic groups as Africans, African Americans, South Americans, Asians, Native Americans, and people from Mediterranean descent. It is less common in people descended from, or living in, northern and western parts of Europe and North America. The age at which lactose intolerance first begins can vary. In Caucasians, the first signs of lactose intolerance can begin as early as the age of five years. In African Americans, the age is even earlier, at two years. An estimated 30 million American adults (out of about 220 million adults, in 2010, about 14%) have some degree of lactose intolerance by the age of 20 years.

Description

Lactose is the form of sugar present in milk and other dairy products, and some non-dairy products, too. Human milk is considered the product with the highest concentration of lactose, with about 9%. Unprocessed cow milk has about 4.7% of lactose. The enzyme lactase, which is normally produced by cells lining the small intestine, breaks down lactose into substances that can be absorbed into the bloodstream. When dairy products are ingested, the lactose reaches the digestive system and is broken down by lactase into the simpler sugars of glucose and galactose. The liver changes the galactose into glucose, which then enters the bloodstream and raises the blood glucose level. Lactose intolerance occurs when, due to a deficiency of lactase, lactose is not completely broken down, unprocessed lactose proceeds into the colon (large intestine), and the glucose level does not rise. While not

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usually dangerous, lactose intolerance can cause severe discomfort in the form of bloating, **diarrhea**, and gas.

It is estimated that from 30 to 50 million Americans, young and old, suffer from the symptoms of lactose intolerance, but not everyone who is deficient in lactase experiences symptoms. Experts contend that approximately 75% of the adult population worldwide does not produce enough lactase and is at risk for some or all of the symptoms of lactose intolerance.

Risk factors

Many factors may cause increasing risk of contracting lactose intolerance. Some of these major factors include:

- Ethnicity (certain ethnic groups are more predisposed to it)
- Age (as one ages the condition becomes more common)
- Diseases (especially relating to the small intestines, such as Celiac disease and Crohn's disease)
- Premature babies (reduced levels of lactase are common in infants born prematurely)
- Radiation (directed toward the abdominal area).

Causes and symptoms

Lactose intolerance can be caused by some diseases of the digestive system and by injuries to the small intestine that result in a decreased production of lactase. This type of the condition is called secondary lactose intolerance. While rare, some children are also born unable to produce the enzyme. This type is called congenital lactose intolerance, being passed down from both parents to the child through autosomal recessive inheritance. For many, however, lactase deficiency develops naturally because, after about two years of age, the body produces less lactase. When age is a factor in acquiring the condition, it is called primary lactose intolerance.

Overall, symptoms include **nausea**, cramps, diarrhea, abdominal bloating, gas (flatulence), floating and foul-smelling stools, **malnutrition**, and weight loss. In children, an additional symptom is slow growth. The symptoms, which may be mild to severe, usually occur between 30 minutes to two hours after eating or drinking lactose-containing foods.

Diagnosis

Usually health care professionals measure the absorption of lactose in the digestive system by using the lactose tolerance test, lactose-hydrogen breath test, or stool acidity test. Each of these can be performed outpatient, through a hospital, clinic or doctor's office.

People taking the lactose tolerance test must fast before being tested. They then drink a lactose-containing liquid for the test and medical personnel take blood samples during the next two hours to measure the patient's blood glucose level. The blood glucose level, or blood sugar level, indicates how well the body is digesting the lactose. A diagnosis of lactose intolerance is confirmed when blood glucose level does not rise. This test is not administered to infants and very young children because they are more prone to **dehydration**, which can result from diarrhea from the liquid.

Health care professionals measure the amount of hydrogen in the breath using the lactose-hydrogen breath test. Hydrogen is usually detected only in small amounts in the breath. However, when bacteria ferment undigested lactose, which is found in the colon, hydrogen in the breath is produced in greater quantities. The hydrogen is exhaled after being absorbed from the intestines and carried through the bloodstream to the lungs. The hydrogen breath test involves having the patient drink a lactose-containing beverage. Health care professionals monitor the breath at regular intervals to see if the hydrogen levels rise, which indicates improper lactose digestion. People taking the test who have had certain foods, medications, or cigarettes before the test may get inaccurate results. While the test is available to children and adults, newborns and young children should not have it because of the risk of dehydration from drinking the beverage that can cause diarrhea in those who are lactose intolerant.

A stool acidity test measures the amount of acid in the stool. This is a safe test for newborns and young children. The test detects lactic acid and other short-chain fatty acids from undigested lactose fermented by bacteria in the colon. Glucose might also be in the stool sample, resulting form unabsorbed lactose in the colon.

Medical professionals may also examine the small intestines with a procedure called an enteroscopy. A thin, flexible tube, which is called an endoscope, is inserted through the mouth or nose and down into the upper gastrointestinal tract. Balloons, attached to the endoscope, allow the physician the ability to observe the small intestine. A procedure called a **colonoscopy** may also be used. A tube is inserted into the rectum and up into the small intestine. In both cases, tissue samples may be removed and examined by trained laboratory technicians.

Treatment

Pediatricians might recommend that parents of newborns and very young children who are suspected

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of having lactose intolerance simply change from cow's milk to a soy formula. Since treatments are not available that can improve the body's ability to produce lactase, lactose deficiency treatments instead, are focused on controlling the diet.

Most people affected by lactose intolerance do well if they limit their intake of lactose foods and drinks. People differ in the amounts they can handle before experiencing symptoms. Some have to stop lactose completely. People who are sensitive after ingesting small amounts of lactose can take lactase enzymes, which are available without a prescription. Using the liquid form, people can add a few drops in their milk, put the milk in the refrigerator and drink it after 24 hours, when the lactase enzymes have worked to reduce the lactose content by 70%. If the milk is heated first and double the amount of lactase liquid is added, the milk will be 90% lactose free. Recently, researchers have developed a chewable lactase enzyme tablet. By taking three to six tablets just before eating, the tablets help people digest lactose-containing solid foods. Supermarkets also carry lactose-reduced milk and other products, which contain the needed nutrients found in the regular products but without the lactose.

Foods that contain lactose are milk, low-fat milk, skim milk, chocolate milk, buttermilk, sweetened condensed milk, dried whole milk, instant nonfat dry milk, low-fat yogurts, frozen yogurts ice cream, ice milk, sherbet, cheese, cottage cheese, low-fat cottage cheese, cream and butter. Other foods that may contain hidden lactose are: nondairy creamers, powdered artificial sweeteners, foods containing milk power or nonfat milk solids, bread, cake, margarine, creamed soups, pancakes, waffles, processed breakfast cereals, salad **dressings**, luncheon meats, potato chips, puddings, custards, confections and some meat products. These forms of hidden lactose may appear on packaging labels as whey, curds, milk solids, lactoserum, dry milk solids, milk by-products, modified milk ingredients, non-fat dry milk powder, and other such terms.

Many cultured milk products, such as yogurt, contain probiotics, which are living organisms that help to maintain a well regulated digestive system. These products can be used to help with gastrointestinal problems. Probiotics also help to digest lactose, when the body cannot do so naturally.

Prognosis

Lactose intolerance is easy to manage. People of all ages however, especially children, have to replace the **calcium** lost during the reduction (or elimination) of milk products by taking supplements and eating calcium-rich foods, such as leafy vegetables (broccoli, spinach, and kale), certain seafood (canned salmon, oysters, sardines, and shrimp), calcium-fortified foods, almonds, oranges, pinto beans, rhubarb, and tofu. Many people who suffer with lactose intolerance will be able to continue eating some milk products. Some diary products may be tolerable to one's system depending on the amount of lactose contained within t hem. Many times milk can be consumed in smaller amounts to lessen the problem associated with the malady. In addition, milk consumed with meals is usually less problematic. Yogurt contains enzymes that break down lactose, so lactose-intolerant people may tolerate it. The condition is not considered dangerous. However, unless treated properly, people with lactose intolerance have to contend with weight loss and malnutrition, along with many symptoms that cause discomfort.

KEY TERMS

Galactose—Simple sugar derived from milk sugar.

Glucose—A simple sugar and the chief energy source in the body.

Lactase enzyme—The enzyme produced by cells that line the small intestine which allows the body to break down lactose.

Lactose—The primary sugar in milk.

Prevention

Often, lactose intolerance is a natural occurrence that cannot be avoided. However, people can prevent symptoms by managing the condition with diet and lactase supplements. Foods and beverages that state they are "lactose-free" can be substituted for diary products. Milk can be treated with commercially available lactase products (lactase drops) that remove almost all of the lactose contained within milk. Lactase capsules or tablets are also available, which can be taken orally before eating meals that include dairy products.

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American Dietetic Association, 120 South Riverside Plaza, Suite 2000, Chicago, IL, 60606-6995, (312) 899-0040, (800) 877-1600, http://www.eatright.org/.

American Gastroenterological Association, 4930 Del Ray Avenue, Bethesda, MD, 20814, (301) 654-2055, (301) 654-5920, http://www.gastro.org/.

Lisette Hilton

Lambliasis *see* **Giardiasis**

Laminectomy

Definition

A laminectomy is a surgical procedure in which the surgeon removes a portion of the bony arch, or lamina, on the dorsal surface of a vertebra, which is one of the bones that make up the human spinal column. It is done to relieve back **pain** that has not been helped by more conservative treatments. In most cases a laminectomy is an elective procedure rather than emergency surgery. A laminectomy for relief of pain in the lower back is called a lumbar laminectomy or an open decompression.

Purpose

Structure of the spine

In order to understand why removal of a piece of bone from the arch of a vertebra relieves pain, it is helpful to have a brief description of the structure of the spinal column and the vertebrae themselves. In humans, the spine comprises 33 vertebrae, some of which are fused together. There are seven vertebrae in the cervical (neck) part of the spine; 12 vertebrae in the thoracic (chest) region; five in the lumbar (lower back) region; five vertebrae that are fused to form the sacrum; and four vertebrae that are fused to form the coccyx, or tailbone. It is the vertebrae in the lumbar portion of the spine that are most likely to be affected by the disorders that cause back pain.

The 24 vertebrae that are not fused are stacked vertically in an S-shaped column that extends from the tailbone below the waist up to the back of the head. This column is held in alignment by ligaments, cartilage, and muscles. About half the weight of a person's body is carried by the spinal column itself and the other half by the muscles and ligaments that hold the spine in alignment. The bony arches of the laminae on each vertebra form a canal that contains and protects the spinal cord. The spinal cord extends from the base of the brain to the upper part of the lumbar spine, where it ends in a collection of nerve fibers known as the cauda equina, which is a Latin phrase meaning "horse's tail." Other nerves branching out from the spinal cord pass through openings formed by adjoining vertebrae. These openings are known as foramina (singular, foramen).

Between each vertebra is a disk that serves to cushion the vertebrae when a person bends, stretches, or twists the spinal column. The disks also keep the foramina between the vertebrae open so that the spinal nerves can pass through without being pinched or damaged. As people age, the intervertebral disks begin to lose moisture and break down, which reduces the size of the foramina between the vertebrae. In addition, bone spurs may form inside the vertebrae and cause the spinal canal itself to become narrower. Either of these processes can compress the spinal nerves, leading to pain, **tingling** sensations, or weakness in the lower back and legs. A lumbar laminectomy relieves pressure on the spinal nerves by removing the disk, piece of bone, tumor, or other structure that is causing the compression.

Causes of lower back pain

The disks and vertebrae in the lower back are particularly vulnerable to the effects of **aging** and daily wear and tear because they bear the full weight of the upper body, even when one is sitting quietly in a chair. When a person bends forward, 50% of the motion occurs at the hips, but the remaining 50% involves the lumbar spine. The force exerted in bending is not evenly divided among the five lumbar vertebrae; the segments between the third and fourth lumbar

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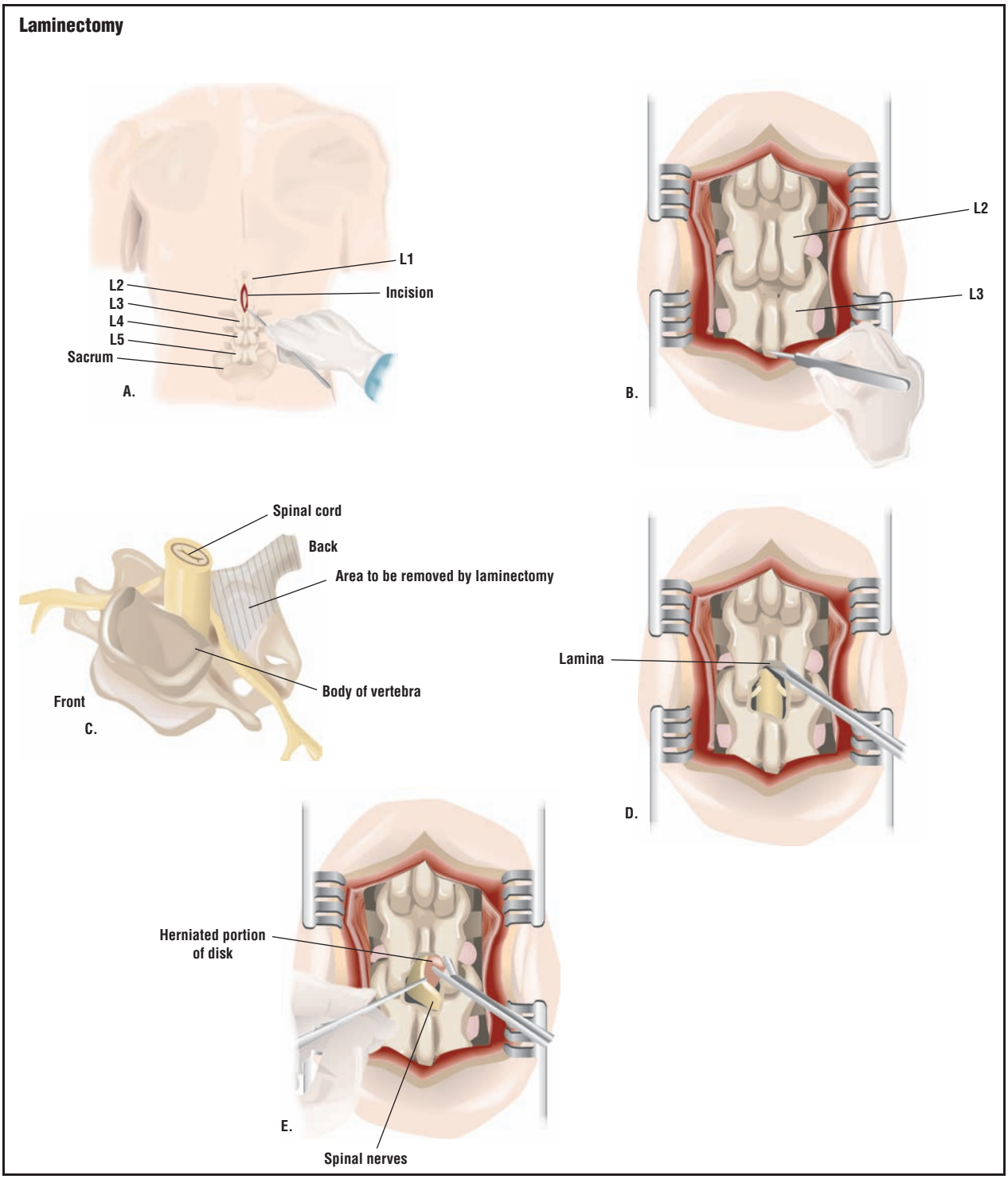

In this posterior (from the back) lumbar laminectomy, an incision is made in the patient's back over the lumbar vertebrae (A). The wound is opened with retractors to expose the L2 and L3 vertebrae (B). A piece of bone at the back of the vertebrae is removed (C and D), allowing a damaged disk to be repaired (E). *(Illustration by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)*

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KEY TERMS

Cauda equina—The collection of spinal nerve roots that lie inside the spinal column below the end of the spinal cord. The name comes from the Latin for "horse's tail."

Cauda equina syndrome (CES)—A group of symptoms characterized by numbness or pain in the legs and/or loss of bladder and bowel control, caused by compression and paralysis of the nerve roots in the cauda equina. CES is a medical emergency.

Chiropractic—A system of therapy based on the notion that health and disease are related to the interactions between the brain and the nervous system. Treatment involves manipulation and adjustment of the segments of the spinal column. Chiropractic is considered a form of alternative medicine.

Decompression—Any surgical procedure done to relieve pressure on a nerve or other part of the body. A laminectomy is sometimes called an open decompression.

Dorsal—Referring to a position closer to the back than to the stomach. The laminae in the spinal column are located on the dorsal side of each vertebra.

Dura—A tough fibrous membrane that covers and protects the spinal cord.

Foramen (plural, foramina)—The medical term for a natural opening or passage. The foramina of the spinal column are openings between the vertebrae for the spinal nerves to branch off from the spinal cord.

Laminae (singular, lamina)—The broad plates of bone on the upper surface of the vertebrae that fuse together at the midline to form a bony covering over the spinal canal.

Laminotomy—A less invasive alternative to a laminectomy in which a hole is drilled through the lamina.

Ligamenta flava (singular, ligamentum flavum)—A series of bands of tissue that are attached to the vertebrae in the spinal column. They help to hold the spine straight and to close the spaces between the laminar arches. The Latin name means "yellow band(s)."

Lumbar—Pertaining to the part of the back between the chest and the pelvis.

Myelogram—A special type of x-ray study of the spinal cord, made after a contrast medium has been injected into the space surrounding the cord.

Osteopathy—A system of therapy that uses standard medical and surgical methods of diagnosis and treatment while emphasizing the importance of proper body alignment and manipulative treatment of musculoskeletal disorders. Osteopathy is considered mainstream primary care medicine rather than an alternative system.

Pain disorder—A psychiatric disorder in which pain in one or more parts of the body is caused or made worse by psychological factors. The lower back is one of the most common sites for pain related to this disorder.

Retractor—An instrument used during surgery to hold an incision open and pull back underlying layers of tissue.

Sciatica—Pain in the lower back, buttock, or leg along the course of the sciatic nerve.

Somatization disorder—A chronic condition in which psychological stresses are converted into physical symptoms that interfere with work and relationships. Lower back pain is a frequent complaint of patients with somatization disorder.

Spinal stenosis—Narrowing of the canals in the vertebrae or around the nerve roots, causing pressure on the spinal cord and nerves.

Vertebra (plural, vertebrae)—One of the bones of the spinal column. There are 33 vertebrae in the human spine.

vertebrae (L3-L4) and the fourth and fifth (L4-L5) are most likely to break down over time. More than 95% of spinal disk operations are performed on the fourth and fifth lumbar vertebrae.

Specific symptoms and disorders that affect the lower back include:

- Sciatica. Sciatica refers to sudden pain felt as radiating from the lower back through the buttocks and down the back of one leg. The pain, which may be experienced as weakness in the leg, a tingling feeling, or a "pins and needles" sensation, runs along the course of the sciatic nerve. Sciatica is a common symptom of a herniated disk.
- Spinal stenosis. Spinal stenosis is a disorder that results from the narrowing of the spinal canal surrounding the spinal cord and eventually compressing the cord. It may result from hereditary factors, from the effects of aging, or from changes in the pattern of blood flow to

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the lower back. Spinal stenosis is sometimes difficult to diagnose because its early symptoms can be caused by a number of other conditions and because the patient usually has no history of back problems or recent injuries. Imaging studies may be necessary for accurate diagnosis.

- Cauda equina syndrome (CES). Cauda equina syndrome is a rare disorder caused when a ruptured disk, bone fracture, or spinal stenosis put intense pressure on the cauda equina, the collection of spinal nerve roots at the lower end of the spinal cord. CES may be triggered by a fall, automobile accident, or penetrating gunshot injury. It is characterized by loss of sensation or altered sensation in the legs, buttocks, or feet; pain, numbness, or weakness in one or both legs; difficulty walking; or loss of control over bladder and bowel functions. *Cauda equina syndrome is a medical emergency requiring immediate treatment*. If the pressure on the nerves in the cauda equina is not relieved quickly, permanent paralysis and loss of bladder or bowel control may result.
- Herniated disk. The disks between the vertebrae in the spine consist of a fibrous outer part called the annulus and a softer inner nucleus. A disk is said to herniate when the nucleus ruptures and is forced through the outer annulus into the spaces between the vertebrae. The material that is forced out may put pressure on the nerve roots or compress the spinal cord itself. In other cases, the chemicals leaking from the ruptured nucleus may irritate or inflame the spinal nerves. More than 80% of herniated disks affect the spinal nerves associated with the L5 vertebra or the first sacral vertebra.
- Osteoarthritis (OA). OA is a disorder in which the cartilage in the hips, knees, and other joints gradually breaks down, allowing the surfaces of the bones to rub directly against each other. In the spine, OA may result in thickening of the ligaments surrounding the spinal column. As the ligaments increase in size, they may begin to compress the spinal cord.

Factors that increase a person's risk of developing pain in the lower back include:

- Hereditary factors. Some people are born with relatively narrow spinal canals and may develop spinal stenosis fairly early in life.
- Sex. Men are at greater risk of lower back problems than women, in part because they carry a greater proportion of their total body weight in the upper body.
- Age. The intervertebral disks tend to lose their moisture content and become thinner as people get older.
- Occupation. Jobs that require long periods of driving (long-distance trucking; bus, taxi, or limousine operation) are hard on the lower back because of vibrations from the road surface transmitted upward to the spine. Occupations that require heavy lifting (nursing, child care, construction work, airplane maintenance) put extra stress on the lumbar vertebrae. Other high-risk occupations include professional sports, professional dance, assembly line work, foundry work, mining, and mail or package delivery.
- Lifestyle. Wearing high-heeled shoes, carrying heavy briefcases or shoulder bags on one side of the body, or sitting for long periods of time in one position can all throw the spine out of alignment.
- Obesity. Being overweight, particularly if the extra pounds are concentrated in the abdomen, adds to the strain on the muscles and ligaments that support the spinal column.
- Trauma. Injuries to the back from contact sports, falls, criminal assaults, or automobile accidents may lead to misalignment of the vertebrae or a ruptured disk. Traumatic injuries may also trigger the onset of cauda equina syndrome.

Demographics

Pain in the lower back is a chronic condition that has been treated in various ways from the beginnings of human medical practice. The earliest description of disorders affecting the lumbar vertebrae was written in 3000 B.C. by an ancient Egyptian surgeon. In the modern world, back pain is responsible for more time lost from work than any other cause except the **common cold**. Between 10% and 15% of workers' compensation claims are related to chronic pain in the lower back. It is estimated that the direct and indirect costs of back pain to the American economy range between $75 and $80 billion per year.

In the United States, about 13 million people seek medical help each year for the condition. According to the Centers for Disease Control, 14% of all new visits to primary care doctors are related to problems in the lower back. The CDC estimates that 2.4 million adults in the United States are chronically disabled by back pain, with another 2.4 million temporarily disabled. About 80% of people will experience pain in the lower back at some point in their lifetime; on a yearly basis, one person in every five will have some kind of back pain.

Back pain primarily affects the adult population, most commonly people between the ages of 45 and 64. It is more common among men than women, and more common among Caucasians and Hispanics than among African Americans or Asian Americans.

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Description

A laminectomy is performed with the patient under **general anesthesia**, usually positioned lying on the side or stomach. The surgeon begins by making a small straight incision over the damaged vertebra.

The surgeon next uses a retractor to spread apart the muscles and fatty tissue overlying the spine. When the laminae have been reached, the surgeon cuts away part of the bony arch in order to expose the ligamentum flavum, which is a band of yellow tissue attached to the vertebra that helps to support the spinal column and closes in the spaces between the vertebral arches. The surgeon then cuts an opening in the ligamentum flavum in order to reach the spinal canal and expose the compressed nerve. At this point the cause of the compression (**herniated disk**, tumor, bone spur, or a fragment of the disk that has separated from the remainder) will be visible.

Bone spurs, if any, are removed in order to enlarge the foramina and the spinal canal. If the disk is herniated, the surgeon uses the retractor to move the compressed nerve aside and removes as much of the disk as necessary to relieve pressure on the nerve. The space that was occupied by the disk will be filled eventually by new connective tissue.

If necessary, a spinal fusion is performed to stabilize the patient's lower back. A small piece of bone taken from the hip is grafted onto the spine and attached with metal screws or plates to support the lumbar vertebrae.

Following completion of the spinal fusion, the surgeon closes the incision in layers, using different types of sutures for the muscles, connective tissues, and skin. The entire procedure takes one to three hours.

Diagnosis/Preparation

Diagnosis

The differential diagnosis of lower back pain is complicated by the number of possible causes and the patient's reaction to the discomfort. In many cases the patient's perception of back pain is influenced by poor-quality sleep or emotional issues related to occupation or family matters. A primary care doctor will begin by taking a careful medical and occupational history, asking about the onset of the pain as well as its location and other characteristics. Back pain associated with the lumbar spine very often affects the patient's ability to move, and the muscles overlying the affected vertebrae may feel sore or tight. Pain resulting from heavy lifting usually begins within 24 hours of the overexertion. Most patients who do not have a history of chronic pain in the lower back feel better after 48 hours of bed rest with pain medication and either a heating pad or ice pack to relax **muscle spasms**.

If the patient's pain is not helped by rest and other conservative treatments, he or she will be referred to an orthopedic surgeon for a more detailed evaluation. An orthopedic evaluation includes a **physical examination**, neurological workup, and imaging studies. In the physical examination, the doctor will ask the patient to sit, stand, or walk in order to see how these functions are affected by the pain. The patient may be asked to **cough** or to lie on a table and lift each leg in turn without bending the knee, as these maneuvers can help to diagnose nerve root disorders. The doctor will also palpate (feel) the patient's spinal column and the overlying muscles and ligaments to determine the external location of any tender spots, **bruises**, thickening of the ligaments, or other structural abnormalities. The neurological workup will focus on the patient's reflexes and the spinal nerves that affect the functioning of the legs. Imaging studies for lower back pain typically include an x-ray study and CT scan of the lower spine, which will reveal bone deformities, narrowing of the intervertebral disks, and loss of cartilage. An MRI may be ordered if **spinal stenosis** is suspected. In some cases the doctor may order a myelogram, which is an x ray or CT scan of the lumbar spine performed after a special dye has been injected into the spinal fluid.

Lower back pain is one of several common general medical conditions that require the doctor to assess the possibility that the patient has a concurrent psychiatric disorder. Such diagnoses as somatization disorder or pain disorder do not mean that the patient's physical symptoms are imaginary or that they should not receive surgical or medical treatment. Rather, a psychiatric diagnosis indicates that the patient is allowing the back pain to become the central focus of life or responding to it in other problematic ways. Some researchers in Europe as well as North America think that the frequency of lower back problems in workers' disability claims reflect emotional dissatisfaction with work as well as physical stresses related to specific jobs.

Preparation

Most hospitals require patients to have the following tests before a laminectomy: a complete physical examination; **complete blood count** (CBC); an electrocardiogram (EKG); a urine test; and tests that measure the speed of blood clotting.

Aspirin and arthritis medications should be discontinued seven to 10 days before a laminectomy because they thin the blood and affect clotting time. Patients should provide the surgeon and anesthesiologist with a

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complete list of all medications, including over-the-counter and herbal preparations, that they take on a regular basis.

The patient is asked to stop **smoking** at least a week before surgery and to take nothing by mouth after midnight before the procedure.

Aftercare

Aftercare following a laminectomy begins in the hospital. Most patients will remain in the hospital for one to three days after the procedure. During this period the patient will be given fluids and antibiotic medications intravenously to prevent infection. Medications for pain will be given every three to four hours, or through a device known as a PCA (patient-controlled anesthesia). The PCA is a small pump that delivers a dose of medication into the IV when the patient pushes a button. To get the lungs back to normal functioning, a respiratory therapist will ask the patient to do some simple breathing exercises and begin walking within several hours of surgery.

Aftercare during the hospital stay is also intended to lower the risk of a venous thromboembolism (VTE), or blood clot in the deep veins of the leg. Prevention of VTE involves medications to thin the blood and wearing compression stockings or boots.

Most surgeons prefer to see patients one week after surgery to remove stitches and check for any postoperative complications. Patients should not drive or return to work before their checkup. A second follow-up examination is usually done four to eight weeks after the laminectomy.

Patients can help speed their recovery by taking short walks on a daily basis; avoiding sitting or standing in the same position for long periods of time; taking brief naps during the day; and sleeping on the stomach or the side. They may take a daily bath or shower without needing to cover the incision. The incision should be carefully patted dry, however, rather than rubbed.

Risks

Risks associated with a laminectomy include:

- bleeding
- infection
- damage to the spinal cord or other nerves
- weakening or loss of function in the legs
- blood clots
- leakage of spinal fluid resulting from tears in the dura, the protective membrane that covers the spinal cord
- worsening of back pain

Results

Normal results depend on the cause of the patient's lower back pain; most patients can expect considerable relief from pain and some improvement in functioning. There is some disagreement among surgeons about the success rate of laminectomies, however, which appears to be due to the fact that the operation is generally done to improve quality of life—cauda equina syndrome is the only indication for an emergency laminectomy. Different sources report success rates between 26% and 99%, with 64% as the average figure. According to one study, 31% of patients were dissatisfied with the results of the operation, possibly because they may have had unrealistic expectations of the results.

Morbidity and mortality rates

The mortality rate for a lumbar laminectomy is between 0.8% and 1%. Rates of complications depend partly on whether a spinal fusion is performed as part of the procedure; while the general rate of complications following a lumbar laminectomy is given as 6–7%, the rate rises to 12% of a spinal fusion has been done.

Alternatives

Conservative treatments

Surgery for lower back pain is considered a treatment of last resort, with the exception of cauda equina syndrome. Patients should always try one or more conservative approaches before consulting a surgeon about a laminectomy. In addition, most health insurers will require proof that the surgery is necessary, since the average total cost of a lumbar laminectomy is $85,000.

Some conservative approaches that have been found to relieve lower back pain include:

- Analgesic or muscle relaxant medications. Analgesics are drugs given to relieve pain. The most commonly prescribed pain medications are aspirin or NSAIDs. Muscle relaxants include methocarbamol, cyclobenzaprine, or diazepam.
- Epidural injections. Epidural injections are given directly into the space surrounding the spinal cord. Corticosteroids are the medications most commonly given by this route, but preliminary reports indicate that epidural injections of indomethacin are also effective in relieving recurrent pain in the lower back.
- Rest. Bed rest for 48 hours usually relieves acute lower back pain resulting from muscle strain.
- Appropriate exercise. Brief walks are recommended as a good form of exercise to improve blood circulation, particularly after surgery. In addition, there are several

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simple exercises that can be done at home to strengthen the muscles of the lower back. A short pamphlet entitled *Back Pain Exercises* may be downloaded free of charge from the American Academy of Orthopaedic Surgeons (AAOS) web site.

- Losing weight. People who are severely obese may wish to consider weight reduction surgery to reduce the stress on their spine as well as their heart and respiratory system.
- Occupational modifications or change. Lower back pain related to the patient's occupation can sometimes be eased by taking periodic breaks from sitting in one position; by using a desk and chair proportioned to one's height; by learning to use the muscles of the thighs when lifting heavy objects rather than the lower back muscles; and by maintaining proper posture when standing or sitting. In some cases the patient may be helped by changing occupations.
- Physical therapy. A licensed physical therapist can be helpful in identifying the patient's functional back problems and planning a course of treatment to improve flexibility, strength, and range of motion.
- Osteopathic manipulative treatment (OMT). Osteopathic physicians (DOs) receive the same training in medicine and surgery as MDs; however, they are also trained to evaluate postural and spinal abnormalities and to perform several different manual techniques for relief of back pain. An article published in the *New England Journal of Medicine* in 1999 reported that OMT was as effective as physical therapy and standard medication in relieving lower back pain, with fewer side effects and lower health care costs. OMT is recommended in the United Kingdom as a very low-risk treatment that is more effective than bed rest or mild analgesics.
- Transcutaneous electrical nerve stimulation (TENS). TENS is a treatment technique developed in the late 1960s that delivers a mild electrical current to stimulate nerves through electrodes attached to the skin overlying a painful part of the body. It is thought that TENS works by stimulating the production of endorphins, which are the body's natural painkilling compounds.

Surgical alternatives

The most common surgical alternative to laminectomy is a minimally invasive laminotomy and/or microdiscectomy. In this procedure, which takes about an hour, the surgeon makes a 0.5 in (1.3 cm) incision in the lower back and uses a series of small dilators to separate the layers of muscle and fatty tissue over the spine rather than cutting through them with a scalpel. A tube-shaped retractor is inserted to expose the part of the lamina over the nerve root. The surgeon then uses a power drill to make a small hole in the lamina to expose the nerve itself. After the nerve has been moved aside with the retractor, a small grasping device is used to remove the herniated portion or fragments of the damaged spinal disk.

The advantages of these minimally invasive procedures are fewer complications and a shortened recovery time for the patient. The average postoperative stay is three hours. In addition, 90% of patients are pleased with the results.

Complementary and alternative (CAM) approaches

Two alternative methods of treating back disorders that have been shown to help many patients are **acupuncture** and **chiropractic**. Chiropractic is based on the belief that the body has abilities to heal itself provided that nerve impulses can move freely between the brain and the rest of the body. Chiropractors manipulate the segments of the spine in order to bring them into proper alignment and restore the nervous system to proper functioning. Many are qualified to perform acupuncture as well as chiropractic adjustments of the vertebrae and other joints. Several British and Swedish studies have reported that acupuncture and chiropractic are at least as effective as other conservative measures in relieving pain in the lower back.

Movement therapies, including **yoga**, **tai chi**, and gentle stretching exercises, may be useful in maintaining or improving flexibility and range of motion in the spine. A qualified yoga instructor can work with the patient's doctor before or after surgery to put together an individualized set of beneficial stretching and breathing exercises. The **Alexander technique** is a type of **movement therapy** that is often helpful to patients who need to improve their posture.

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ORGANIZATIONS

American Academy of Orthopedic Surgeons, 6300 North River Road, Rosemont, IL, 60018-4262, (847) 823-7186, (800) 346-2267, (847) 823-8125, http://www.aaos.org.

American Academy of Neurological and Orthopaedic Surgeons (AANOS), 2300 South Rancho Drive, Suite 202, Las Vegas, NV, 89102, (702) 388-7390, http://www.aanos.org.

The American Board of Neurological Surgery, 6550 Fannin Street, Suite 2139, Houston, TX, 77030, (713) 441-6015, http://www.abns.org.

American Chiropractic Association, 1701 Clarendon Boulevard, Arlington, VA, 22209, (703) 276-8800, (703) 243-2593, memberinfo@acatoday.org, http://www.acatoday.org.

American Physical Therapy Association, 1111 North Fairfax Street, Fairfax, VA, 22314-1488, (703) 684-APTA (2782), (800) 999-APTA (2782), (703) 684-7343, http://www.apta.org.

National Rehabilitation Information Center, 8201 Corporate Drive, Suite 600, Landover, MD, 20785, (301) 459-5900, (800) 346-2742, (301) 459-4263, naricinfo@heitechservices.com, http://www.naric.com/.

Rebecca Frey, Ph.D.

Laminectomy *see* **Disk removal**
Language disturbance *see* **Aphasia**
Laparoscopic cholecystectomy *see* **Cholecystectomy**

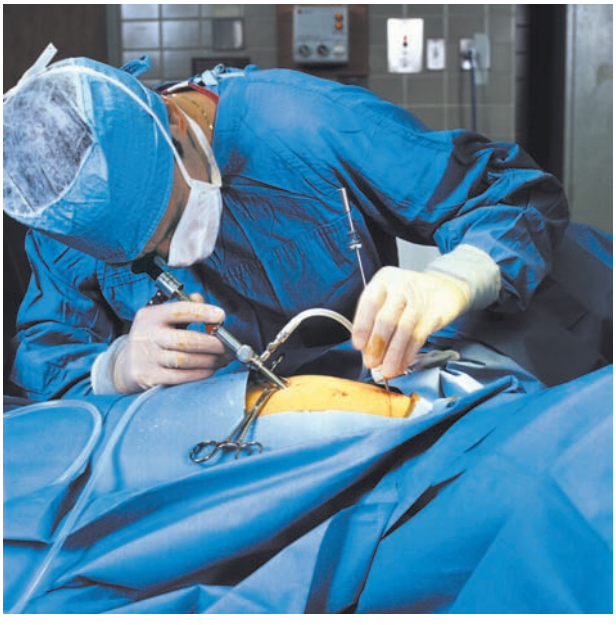
Laparoscopy

Definition

Laparoscopy is a minimally invasive procedure used as a diagnostic tool and surgical procedure that is performed to examine the abdominal and pelvic organs, or the thorax, head, or neck. Tissue samples can also be collected for biopsy using laparoscopy and malignancies treated when it is combined with other therapies. Laparoscopy can also be used for some cardiac and vascular procedures.

Purpose

Laparoscopy is performed to examine the abdominal and pelvic organs to diagnose certain conditions and—depending on the condition—can be used to perform surgery. Laparoscopy is commonly used in gynecology to examine the outside of the uterus, the fallopian tubes, and the ovaries—particularly in pelvic **pain** cases where the underlying cause cannot be determined using diagnostic imaging (ultrasound and



This surgeon is performing a laparoscopic procedure on a patient. *(Photo Researchers, Inc. Reproduced by permission.)*

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KEY TERMS

Ascites—Accumulation of fluid in the abdominal cavity; laparoscopy may be used to determine its cause.

Cholecystitis—Inflammation of the gallbladder, often diagnosed using laparoscopy.

Electrosurgical device—A medical device that uses electrical current to cauterize or coagulate tissue during surgical procedures; often used in conjunction with laparoscopy.

Embolism—Blockage of an artery by a clot, air or gas, or foreign material. Gas embolism may occur as a result of insufflation of the abdominal cavity during laparoscopy.

Endometriosis—A disease involving occurrence of endometrial tissue (lining of the uterus) outside the uterus in the abdominal cavity; often diagnosed and treated using laparoscopy.

Hysterectomy—Surgical removal of the uterus; often performed laparoscopically.

Insufflation—Inflation of the abdominal cavity using carbon dioxide; performed prior to laparoscopy to give the surgeon space to maneuver surgical equipment.

Oophorectomy—Surgical removal of the ovaries; often performed laparoscopically.

Pneumothorax—Air or gas in the pleural space (lung area) that may occur as a complication of laparoscopy and insufflation.

Subcutaneous emphysema—A pathologic accumulation of air underneath the skin resulting from improper insufflation technique.

Trocar—A small sharp instrument used to puncture the abdomen at the beginning of the laparoscopic procedure.

computed tomography). Examples of gynecologic conditions diagnosed using laparoscopy include **endometriosis**, **ectopic pregnancy**, **ovarian cysts**, **pelvic inflammatory disease** [PID], **infertility**, and **cancer**. Laparoscopy is used in **general surgery** to examine the abdominal organs, including the gallbladder, bile ducts, the liver, the appendix, and the intestines.

During the laparoscopic surgical procedure, certain conditions can be treated using instruments and devices specifically designed for laparoscopy. Medical devices that can be used in conjunction with laparoscopy include surgical lasers and electrosurgical units. Laparoscopic surgery is now preferred over open surgery for several types of procedures because of its minimally invasive nature and its association with fewer complications.

Microlaparoscopy can be performed in the physician's office using smaller laparoscopes. Common clinical applications in gynecology include pain mapping (for endometriosis), sterilization, and fertility procedures. Common applications in general surgery include evaluation of chronic and acute abdominal pain (as in **appendicitis**), basic trauma evaluation, biopsies, and evaluation of abdominal masses.

Laparoscopy is commonly used by gynecologists, urologists, and general surgeons for abdominal and pelvic applications. Laparoscopy is also being used by orthopedic surgeons for spinal applications and by cardiac surgeons for minimally invasive heart surgery. Newer video-assisted laparoscopic procedures include **thyroidectomy** and **parathyroidectomy**.

Demographics

At first, laparoscopy was only been performed on young, healthy adults, but the use of this technique has greatly expanded. Populations on whom laparoscopies are now performed include infants, children, the elderly, the obese, and those with chronic disease states, such as cancer. The applications of this type of surgery have grown considerably over the years to include a variety of patient populations, and will continue to do so with the refinement of laparascopic techniques.

Description

Laparoscopy is typically performed in the hospital under **general anesthesia**, although some laparoscopic procedures can be performed using local anesthetic agents. Once under anesthesia, a urinary catheter is inserted into the patient's bladder for urine collection. To begin the procedure, a small incision is made just below the navel and a cannula or trocar is inserted into the incision to accommodate the insertion of the laparoscope. Other incisions may be made in the abdomen to allow the insertion of additional laparoscopic instrumentation. A laparoscopic insufflation device is used to inflate the abdomen with carbon dioxide gas to create a space in which the laparoscopic surgeon can maneuver the instruments. After the laparoscopic diagnosis and treatment are completed, the laparoscope, cannula, and other instrumentation are removed, and the incision is sutured and bandaged.

Laparoscopes have integral cameras for transmitting images during the procedure, and are available in various sizes depending upon the type of procedure performed. The images from the laparoscope are transmitted to a

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viewing monitor that the surgeon uses to visualize the internal anatomy and guide any surgical procedure. Video and photographic equipment are also used to document the surgery, and may be used postoperatively to explain the results of the procedure to the patient.

Robotic systems are available to assist with laparoscopy. A robotic arm, attached to the operating table may be used to hold and position the laparoscope. This serves to reduce unintentional camera movement that is common when a surgical assistant holds the laparoscope. The surgeon controls the robotic arm movement by foot pedal with voice-activated command, or with a handheld control panel.

Microlaparoscopy has become more common over the past few years. The procedure involves the use of smaller laparoscopes (that is, 2 mm compared to 5–10 mm for hospital laparoscopy), with the patient undergoing **local anesthesia** with conscious **sedation** (during which the patient remains awake but very relaxed) in a physician's office. Video and photographic equipment, previously explained, may be used.

Laparoscopy has been explored in combination with other therapies for the treatment of certain types of malignancies, including pelvic and aortic lymph node dissection, **ovarian cancer**, and early **cervical cancer**. Laparoscopic radiofrequency ablation is a technique whereby laproscopy assists in the delivery of radiofrequency probes that distribute pulses to a tumor site. The pulses generate heat in malignant tumor cells and destroys them.

The introduction of items such as temperature-controlled instruments, surgical instruments with greater rotation and articulation, improved imaging systems, and multiple robotic devices will expand the utility of laparoscopic techniques in the future. The skills of surgeons will be enhanced as well, with further development of training simulators and computer technology.

Diagnosis/Preparation

Before undergoing laparoscopic surgery, the patient should be prepared by the doctor for the procedure both psychologically and physically. It is very important that the patient receive realistic counseling before surgery and prior to giving informed consent. This includes discussion about further open abdominal surgery (laparotomy) that may be required during laparoscopic surgery, information about potential complications during surgery, and the possible need for blood transfusions. In the case of diagnostic laparoscopy for chronic pelvic pain, the procedure may simply indicate that all organs are normal and the patient should be prepared for this possibility. The surgery may be explained using pictures, models, videotapes, and movies. It is especially important for the patient to be able to ask questions and express concerns. It may be helpful, for the patient to have a family member or friend present during discussions with the doctor. Such conversations could understandably cause **anxiety**, and information relayed may not be adequately recalled under such circumstances.

There is usually a presurgical exam two weeks before the surgery to gather a medical history and obtain blood and urine samples for laboratory testing. It is important that the patient inform the doctor completely about any prior surgeries, medical conditions, or medications taken on a regular basis, including **nonsteroidal anti-inflammatory drugs** (NSAIDs), such as **aspirin**. Patients taking blood thinners, like Coumadin or Heparin (generic name: warfarin) should not adjust their medication themselves, but should speak with their prescribing doctors regarding their upcoming surgery. (Patients should never adjust dosage without their doctors' approval. This is especially important for elderly patients, asthmatics, those with **hypertension**, or those who are on ACE inhibitors.) If a tubal dye study is planned during the procedure, the patient may also be required to provide information on menstrual history. For some procedures, an autologous (self) **blood donation** may be suggested prior to the surgery to replace blood that may be lost during the procedure. Chest x rays may also be required. For some obese patients, weight loss may be necessary prior to surgery.

Immediately before to surgery, there are several pre-operative steps that the patient may be advised to take. The patient should shower at least 24 hours prior to the surgery, and gently but thoroughly cleanse the umbilicus (belly button) with antibacterial soap and water using a cotton-tipped swab. Because laparoscopy requires general anesthesia in most cases, the patient may be asked to eat lightly 24 hours prior to surgery and fast at least 12 hours prior to surgery. Bowel cleansing with a laxative may also required, allowing the it to be more easily visualized and to prevent complications in the unlikely event of bowel injury. Those who are have diabetes or have **hypoglycemia** may wish to schedule their procedures early in the morning to avoid low blood sugar reactions. The patient should follow the directions of the hospital staff, arriving early on the day of surgery to sign paperwork and to be screened by the anesthesiology staff. Questions will be asked regarding current medications and dosages, **allergies** to medication, previous experiences with anesthesia (that is, allergic reactions, and previous experiences regarding time-to-consciousness),

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and a variety of other questions. It is often helpful for the patient to make a list of this information beforehand so that the information can be easily retrieved when requested by the hospital staff.

Aftercare

Following laparoscopy, patients are required to remain in a recovery area until the immediate effects of anesthesia subside and until normal voiding is accomplished (especially if a urinary catheter was used during the surgery). Vital signs are monitored to ensure that there are no reactions to anesthesia or internal injuries present. There may be some **nausea** and/or **vomiting**, which may be reduced by the use of the propofol anesthetic for healthy patients undergoing elective procedures such as **tubal ligation**, diagnostic laparoscopy, or **hernia repair**. Laparoscopy is usually an outpatient procedure and patients are discharged from the recovery area within a few hours after the procedure. For elderly patients and those with other medical conditions, recovery may be slower. Patients with more serious medical conditions, or patients undergoing emergency laparoscopy, an overnight hospital stay or a stay of several days may be required.

Discharged patients will receive instructions regarding activity level, medications, postoperative dietary modifications, and possible side effects of the procedure. It may be helpful to have a friend or family member present when these instructions are given, as the after-effects of anesthesia may cause some temporary confusion. Postoperative instructions may include information on when one might resume normal activities such as bathing, housework, and driving. Depending on the nature of the laparoscopic procedure and the patient's medical condition, daily activity may be restricted for a few days and strenuous during administration of anesthesia may cause some soreness. Additionally, shoulder pain may persist as long as 36 hours after surgery. Pain-relieving medications and **antibiotics** may be prescribed for several days postoperatively.

Patients will be instructed to watch for signs of a **urinary tract infection** (UTI) or unusual pain; either may indicate organ injury. It is important to understand the difference between normal discomfort and pain, because pain may indicate a problem. Patients may also experience an elevated temperature, and occasionally "postlaparoscopy syndrome"; this condition is similar in appearance to **peritonitis** (marked by abdominal pain, **constipation**, **vomiting**, and **fever**) that disappears shortly after surgery without antibiotics. However, any postoperative symptoms that cause concern for the patient should be discussed with the doctor, so that any fears can be alleviated and recovery can be accomplished. Due to the after-effects of anesthesia, patients should not drive themselves home.

It is advisable for someone to stay with the patient for a few hours following the procedure, in case complications arise. Injury to an organ might not be readily apparent for several days after the procedure. The physical signs that should be watched for and reported immediately include:

- fever and chills
- abdominal distension
- vomiting
- difficulty urinating
- sharp and unusual pain in the abdomen or bowel
- redness at the incision site, which indicates infection
- discharge from any places where tubes were inserted or incisions were made

Additional complications may include a urinary tract infection (resulting from catheterization) and minor infection of the incision site. An injury to the ureter may be indicated by abdominal distention or a pain in the flank. Additional testing may be required if a complication is suspected.

Risks

Complications may be associated with the laparoscopy procedure in general, or may be specific to the type of operation that is performed. Patients should consult with their doctors regarding the types of risks that are specific for their procedures. The most serious complication that can occur during laparoscopy is laceration of a major abdominal blood vessel resulting from improper positioning, inadequate insufflation (inflation) of the abdomen, abnormal pelvic anatomy, and too much force exerted during scope insertion. Thin patients with well-developed abdominal muscles are at higher risk, since the aorta may only be an inch or so below the skin. Obese patients are also at higher risk because more forceful and deeper needle and scope penetration is required. During laparoscopy, there is also a risk of bleeding from blood vessels, and **adhesions** may require repair by open surgery if bleeding cannot be stopped using laparoscopic instrumentation. In laparoscopic procedures that use electrosurgical devices, **burns** to the incision site are possible due to passage of electrical current through the laparoscope caused by a fault or malfunction in the equipment.

Complications related to insufflation of the abdominal cavity include gas inadvertently entering a blood vessel and causing an **embolism**, **pneumothorax**, or subcutaneous **emphysema**. One common but not serious side effect of insufflation is pain in the shoulder

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and upper chest area for a day or two following the procedure.

Any abdominal surgery, including laparoscopy, carries the risk of unintentional organ injury (punctures and perforations). For example, the bowel, bladder, ureters, or fallopian tubes may be injured during the laparoscopic procedure. Many times these injuries are unavoidable due to the patient's anatomy or medical condition. Patients at higher risk for bowel injury include those with chronic bowel disease, PID, a history of pervious abdominal surgery, or severe endometriosis. Some types of laparoscopic procedures have a higher risk of organ injury. For instance, during laparoscopic removal of endometriosis adhesions or ovaries, the ureters may be injured due to their proximity to each other.

Several clinical studies have shown that the complication rate during laparoscopy is associated with inadequate surgeon experience. Surgeons who are more experienced in laparoscopic procedures have fewer complications than those performing their first 100 cases.

Results

In diagnostic laparoscopy, the surgeon will be able to see signs of a disease or condition (for example, endometriosis adhesions; ovarian cysts; diseased gallbladder) immediately, and can either treat the condition surgically or proceed with appropriate medical management. In diagnostic laparoscopy, biopsies may be taken of tissue in questionable areas, and laboratory results will govern medical treatment. In therapeutic laparoscopy, the surgeon performs a procedure that rectifies a known medical problem, such as **hernia** repair or appendix removal. Because laparoscopy is minimally invasive compared to open surgery, patients may experience less trauma and postoperative discomfort, have fewer procedural complications, have a shorter hospital stay, and return more quickly to daily activities. The results will vary, however, depending on the patients's condition and type of treatment.

Morbidity and mortality rates

Laparoscopic surgery, like most surgeries, is not without risk. Risks should be thoroughly explained to the patient. Complications from laparoscopic surgeries arise in 1–5% of the cases, with a mortality of about 0.05%. Complications may arise from the laparoscopic entry during procedure, and the risks vary depending on the elements specific to a particular procedure. For example, the risk of injury to the common bile duct in laparoscopic biliary surgery is 0.3–0.6% of cases. The factors that contribute to morbidity are currently under study and debate. Injury may occur to blood vessels and internal organs. Some studies examining malpractice data indicate that trocar injury to the bowel or blood vessels may account up to one-fourth of laparoscopic medical claims. It has been suggested that these injuries can be reduced by alterations in the placement and use of the Verses needle, or by using an open technique of trocar insertion in which a blunt cannula (non-bladed) is inserted into the abdominal cavity through an incision. The insertion of secondary trocars may be of particular interest as a risk factor. There is still some debate, however, as to which method of trocar insertion is most appropriate in a particular situation, as no technique is without risk. The most commonly cited injury in laparoscopic malpractice claims has been injury to the bile duct (66%). Proper identification of this structure by an experienced surgeon, or by a cholangiogram, may reduce this type of injury. Other areas of the body may be injured during access including the stomach, bladder, and liver. Hemorrhages may also occur during the operation.

Laparoscopic entry injuries have been the subject of recent study. Data collected from insurance companies and medical device regulation indicate that bowel and vascular injuries may account for 76% of the injuries that occur when a primary port is created. Delayed recognition of bowel injuries was noted to be an important factor in mortality. The risk of possible injury or **death** in laparoscopy depends on such factors as the anatomy of the patient, the force of entry, and the type operative procedure being performed.

Alternatives

The alternatives to laparoscopy vary, depending on the medical condition being treated. Laparotomy (open abdominal surgery with larger incision) may be pursued when further visualization is needed to treat the condition, such as in the case of pain of severe endometriosis with deeper lesions. For those female patients with pelvic masses, transvaginal sonography may be a helpful technique in obtaining information about whether such masses are malignant, assisting in the choice between laparoscopy or laparotomy.

Resources

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OTHER

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ORGANIZATIONS

American College of Obstetricians and Gynecologists, P.O. Box 96920, Washington, DC, 20090-6920, (202) 638-5577, http://www.acog.org.

Society of American Gastrointestinal Endoscopic Surgeons (SAGES), 2716 Ocean Park Boulevard, Suite 3000, Santa Monica, CA, 90405, (310) 314-2404, http://www.endoscopy-sages.com.

Society of Laparoendoscopic Surgeons, 7330 SW Sixty-second Place, Suite 410, Miami, FL, 33143-4825, (305) 665-9959, http://www.sls.org.

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Laryngeal cancer

Definition

Laryngeal **cancer** is cancer of the larynx or voice box.

Description

The larynx is located where the throat divides into the esophagus and the trachea. The esophagus is the tube that takes food to the stomach. The trachea, or windpipe, takes air to the lungs. The area where the larynx is located is sometimes called the Adam's apple.

The larynx has two main functions. It contains the vocal cords, cartilage, and small muscles that make up the voice box. When a person speaks, small muscles tighten the vocal cords, narrowing the distance between them. As air is exhaled past the tightened vocal cords, it creates sounds that are formed into speech by the mouth, lips, and tongue.

The second function of the larynx is to allow air to enter the trachea and to keep food, saliva, and foreign material from entering the lungs. A flap of tissue called the epiglottis covers the trachea each time a person swallows. This blocks foreign material from entering the lungs. When not swallowing, the epiglottis retracts, and air flows into the trachea. During treatment for cancer of the larynx, both of these functions may be lost.

Cancers of the larynx develop slowly. About 95% of these cancers develop from thin, flat cells similar to skin cells called squamous epithelial cells. These cells line the larynx. Gradually, the squamous epithelial cells begin to change and are replaced with abnormal cells. These abnormal cells are not cancerous but are pre-malignant cells that have the potential to develop into cancer. This condition is called dysplasia. Most people with dysplasia never develop cancer. The condition simply goes away without any treatment, especially if the person with dysplasia stops **smoking** or drinking alcohol.

The larynx is made up of three parts, the glottis, the supraglottis, and the subglottis. Cancer can start in any of these regions. Treatment and survival rates depend on which parts of the larynx are affected and whether the cancer has spread to neighboring areas of the neck or distant parts of the body.

The glottis is the middle part of the larynx. It contains the vocal cords. Cancers that develop on the vocal cords are often diagnosed very early because even small vocal cord tumors cause hoarseness. In addition, the vocal cords have no connection to the lymphatic system. This means that cancers on the vocal cord do not spread easily. When confined to the vocal cords without any involvement of other parts of the larynx, the cure rate for this cancer is 75% to 95%.

The supraglottis is the area above the vocal cords. It contains the epiglottis, which protects the trachea from foreign materials. Cancers that develop in this region are usually not found as early as cancers of the glottis because the symptoms are less distinct. The supraglottis region has many connections to the lymphatic system, so cancers in this region tend to spread easily to the lymph nodes and may spread to other parts of the body (lymph nodes are small bean-shaped structures that are found throughout the body; they produce and store infection-fighting cells). In 25% to 50% of people with cancer in the supraglottal region, the cancer has already spread to the lymph nodes by the time they are diagnosed. Because of this, survival rates are lower than for cancers that involve only the glottis.

The subglottis is the region below the vocal cords. Cancer starting in the subglottis region is rare. When it does, it is usually detected only after it has spread to the vocal cords, where it causes obvious symptoms such as hoarseness. Because the cancer has already begun to spread by the time it is detected, survival rates are generally lower than for cancers in other parts of the larynx.

About 12,000 new cases of cancer of the larynx develop in the United States each year. Each year, about 3,900 die of the disease. Laryngeal cancer is between four and five times more common in men than in women. Almost all men who develop laryngeal cancer are over age 55. Laryngeal cancer is about 50%

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more common among African-American men than among other Americans.

It is thought that older men are more likely to develop laryngeal cancer than women because the two main risk factors for acquiring the disease are lifetime habits of smoking and alcohol **abuse**. More men are heavy smokers and drinkers than women, and more African-American men are heavy smokers than other men in the United States. However, as smoking becomes more prevalent among women, it seems likely that more cases of laryngeal cancer in females will be seen.

Causes and symptoms

Laryngeal cancer develops when the normal cells lining the larynx are replaced with abnormal cells (dysplasia) that become malignant and reproduce to form tumors. The development of dysplasia is strongly linked to life-long habits of smoking and heavy use of alcohol. The more a person smokes, the greater the risk of developing laryngeal cancer. It is unusual for someone who does not smoke or drink to develop cancer of the larynx. Occasionally, however, people who inhale asbestos particles, wood dust, paint or industrial chemical fumes over a long period of time develop the disease.

The symptoms of laryngeal cancer depend on the location of the tumor. Tumors on the vocal cords are rarely painful, but cause hoarseness. Anyone who is continually hoarse for more than two weeks or who has a **cough** that does not go away should be checked by a doctor.

Tumors in the supraglottal region above the vocal cords often cause more, but less distinct symptoms. These include:

- persistent sore throat
- pain when swallowing
- difficulty swallowing or frequent choking on food
- bad breath
- lumps in the neck
- persistent ear pain (called referred pain; the source of the pain is not the ear)
- change in voice quality

Tumors that begin below the vocal cords are rare, but may cause noisy or difficult breathing. All the symptoms above can also be caused other cancers as well as by less seriousness illnesses. However, if these symptoms persist, it is important to see a doctor and find their cause, because the earlier cancer treatment begins, the more successful it is.

Diagnosis

On the first visit to a doctor for symptoms that suggest laryngeal cancer, the doctor first takes a complete medical history, including family history of cancer and lifestyle information about smoking and alcohol use. The doctor also does a **physical examination**, paying special attention to the neck region for lumps, tenderness, or swelling.

The next step is examination by an otolaryngologist, or ear, nose, and throat (ENT) specialist. This doctor also performs a physical examination, but in addition will also want to look inside the throat at the larynx. Initially, the doctor may spray a local anesthetic on the back of the throat to prevent gagging, then use a long-handled mirror to look at the larynx and vocal cords. This examination is done in the doctor's office. It may cause gagging but is usually painless.

A more extensive examination involves a **laryngoscopy**. In a laryngoscopy, a lighted fiberoptic tube called a laryngoscope that contains a tiny camera is inserted through the patient's nose and mouth and snaked down the throat so that the doctor can see the larynx and surrounding area. This procedure can be done with a sedative and local anesthetic in a doctor's office. More often, the procedure is done in an outpatient surgery clinic or hospital under **general anesthesia**. This allows the doctor to use tiny clips on the end of the laryngoscope to take biopsies (tissue samples) of any abnormal-looking areas.

Laryngoscopies are normally painless and take about one hour. Some people find their throat feels scratchy after the procedure. Since laryngoscopies are done under **sedation**, patients should not drive immediately after the procedure, and should have someone available to take them home. Laryngoscopy is a standard procedure that is covered by insurance.

The locations of the samples taken during the laryngoscopy are recorded, and the samples are then sent to the laboratory where they are examined under the microscope by a pathologist who specializes in diagnosing diseases through cell samples and laboratory tests. It may take several days to get the results. Based on the findings of the pathologist, cancer can be diagnosed and staged.

Once cancer is diagnosed, other tests will probably be done to help determine the exact size and location of the tumors. This information is helpful in determining which treatments are most appropriate. These tests may include:

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- Endoscopy. Similar to a laryngoscopy, this test is done when it appears that cancer may have spread to other areas, such as the esophagus or trachea.
- Computed tomography (CT or CAT) scan. Using x-ray images taken from several angles and computer modeling, CT scans allow parts of the body to be seen as a cross section. This helps locate and size the tumors, and provides information on whether they can be surgically removed.
- Magnetic resonance imaging (MRI). MRI uses magnets and radio waves to create more detailed cross-sectional scans than computed tomography. This detailed information is needed if surgery on the larynx area is planned.
- Barium swallow. Barium is a substance that, unlike soft tissue, shows up on x rays. Swallowed barium coats the throat and allows x-ray pictures to be made of the tissues lining the throat.
- Chest x ray. Done to determine if cancer has spread to the lungs. Since most people with laryngeal cancer are smokers, the risk of also having lung cancer or emphysema is high.
- Fine needle aspiration (FNA) biopsy. If any lumps on the neck are found, a thin needle is inserted into the lump, and some cells are removed for analysis by the pathologist.
- Additional blood and urine tests. These tests do not diagnose cancer, but help to determine the patient's general health and provide information to determine which cancer treatments are most appropriate.

Treatment

Staging

Once cancer of the larynx is found, more tests will be done to find out if cancer cells have spread to other parts of the body. This is called staging. A doctor needs to know the stage of the disease to plan treatment. In cancer of the larynx, the definitions of the early stages depend on where the cancer started.

STAGE I. The cancer is only in the area where it started and has not spread to lymph nodes in the area or to other parts of the body. The exact definition of stage I depends on where the cancer started, as follows:

- Supraglottis: The cancer is only in one area of the supraglottis and the vocal cords can move normally.
- Glottis: The cancer is only in the vocal cords and the vocal cords can move normally.
- Subglottis: The cancer has not spread outside of the subglottis.

STAGE II. The cancer is only in the larynx and has not spread to lymph nodes in the area or to other parts of the body. The exact definition of stage II depends on where the cancer started, as follows:

- Supraglottis: The cancer is in more than one area of the supraglottis, but the vocal cords can move normally.
- Glottis: The cancer has spread to the supraglottis or the subglottis or both. The vocal cords may or may not be able to move normally.
- Subglottis: The cancer has spread to the vocal cords, which may or may not be able to move normally.

STAGE III. Either of the following may be true:

- The cancer has not spread outside of the larynx, but the vocal cords cannot move normally, or the cancer has spread to tissues next to the larynx.
- The cancer has spread to one lymph node on the same side of the neck as the cancer, and the lymph node measures no more than 3 centimeters (just over 1 inch).

STAGE IV. Any of the following may be true:

- The cancer has spread to tissues around the larynx, such as the pharynx or the tissues in the neck. The lymph nodes in the area may or may not contain cancer.
- The cancer has spread to more than one lymph node on the same side of the neck as the cancer, to lymph nodes on one or both sides of the neck, or to any lymph node that measures more than 6 centimeters (over 2 inches).
- The cancer has spread to other parts of the body.

RECURRENT. Recurrent disease means that the cancer has come back (recurred) after it has been treated. It may come back in the larynx or in another part of the body.

Treatment

Treatment is based on the stage of the cancer as well as its location and the health of the individual. Generally, there are three types of treatments for cancer of the larynx. These are surgery, radiation, and **chemotherapy**. They can be used alone or in combination based in the stage of the caner. Getting a second opinion after the cancer has been staged can be very helpful in sorting out treatment options and should always be considered.

SURGERY. The goal of surgery is to cut out the tissue that contains malignant cells. There are several common surgeries to treat laryngeal cancer.

Stage III and stage IV cancers are usually treated with total **laryngectomy**. This is an operation to remove

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the entire larynx. Sometimes other tissues around the larynx are also removed. Total laryngectomy removes the vocal cords. Alternate methods of voice communication must be learned with the help of a speech pathologist. Laryngectomy is treated in depth as a separate entry in this volume.

Smaller tumors are sometimes treated by partial laryngectomy. The goal is to remove the cancer but save as much of the larynx (and corresponding speech capability) as possible. Very small tumors or cancer in situ are sometimes successfully treated with laser excision surgery. In this type of surgery, a narrowly-targeted beam of light from a laser is used to remove the cancer.

Advanced cancer (Stages III and IV) that has spread to the lymph nodes often requires an operation called a neck dissection. The goal of a neck dissection is to remove the lymph nodes and prevent the cancer from spreading. There are several forms of neck dissection. A **radical neck dissection** is the operation that removes the most tissue.

Several other operations are sometimes performed because of laryngeal cancer. A **tracheotomy** is a surgical procedure in which an artificial opening is made in the trachea (windpipe) to allow air into the lungs. This operation is necessary if the larynx is totally removed. A **gastrectomy** tube is a feeding tube placed through skin and directly into the stomach. It is used to give **nutrition** to people who cannot swallow or whose esophagus is blocked by a tumor. People who have a total laryngectomy usually do not need a gastrectomy tube if their esophagus remains intact.

RADIATION. **Radiation therapy** uses high-energy rays, such as x rays or gamma rays, to kill cancer cells. The advantage of radiation therapy is that it preserves the larynx and the ability to speak. The disadvantage is that it may not kill all the cancer cells. Radiation therapy can be used alone in early stage cancers or in combination with surgery. Sometimes it is tried first with the plan that if it fails to cure the cancer, surgery still remains an option. Often, radiation therapy is used after surgery for advanced cancers to kill any cells the surgeon might not have removed.

There are two types of radiation therapy. External beam radiation therapy focuses rays from outside the body on the cancerous tissue. This is the most common type of radiation therapy used to treat laryngeal cancer. With internal radiation therapy, also called brachytherapy, radioactive materials are placed directly on the cancerous tissue. This type of radiation therapy is a much less common treatment for laryngeal cancer.

External radiation therapy is given in doses called fractions. A common treatment involves giving fractions five days a week for seven weeks. Clinical trials are underway to determine the benefits of accelerating the delivery of fractions (accelerated fractionation) or dividing fractions into smaller doses given more than once a day (hyperfractionation). Side effects of radiation therapy include **dry mouth**, **sore throat**, hoarseness, skin problems, trouble swallowing, and diminished ability to taste.

CHEMOTHERAPY. Chemotherapy is the use of drugs to kill cancer cells. Unlike radiation therapy, which is targeted to a specific tissue, chemotherapy drugs are either taken by mouth or intravenously (through a vein) and circulate throughout the whole body. They are used mainly to treat advanced laryngeal cancer that is inoperable or that has metastasized to a distant site. Chemotherapy is often used after surgery or in combination with radiation therapy. Clinical trials are underway to determine the best combination of treatments for advanced cancer.

The two most common chemotherapy drugs used to treat laryngeal cancer are cisplatin and 5-fluorouracil (5-FU). There are many side effects associated with chemotherapy drugs, including **nausea and vomiting**, loss of appetite, hair loss, **diarrhea**, and mouth sores. Chemotherapy can also damage the blood-producing cells of the bone marrow, which can result in low blood cell counts, increased chance of infection, and abnormal bleeding or bruising.

Alternative treatment

Alternative and complementary therapies range from herbal remedies, vitamin supplements, and special **diets** to spiritual practices, **acupuncture**, massage, and similar treatments. When these therapies are used in addition to conventional medicine, they are called complementary therapies. When they are used instead of conventional medicine, they are called alternative therapies.

Complementary or alternative therapies are widely used by people with cancer. One large study published in the *Journal of Clinical Oncology* in July, 2000 found that 83% of all cancer patients studied used some form of complementary or alternative medicine as part of their cancer treatment. No specific alternative therapies have been directed toward laryngeal cancer. However, good nutrition and activities that reduce **stress** and promote a positive view of life have no unwanted side-effects and appear to be beneficial in boosting the immune system in fighting cancer.

Unlike traditional pharmaceuticals, complementary and alternative therapies are not evaluated by the United

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KEY TERMS

Dysplasia—The abnormal change in size, shape or organization of adult cells.

Lymph—Clear, slightly yellow fluid carried by a network of thin tubes to every part of the body. Cells that fight infection are carried in the lymph.

Lymphatic system—Primary defense against infection in the body. The lymphatic system consists of tissues, organs, and channels (similar to veins) that produce, store, and transport lymph and white blood cells to fight infection.

Lymph nodes—Small, bean-shaped collections of tissue found in a lymph vessel. They produce cells and proteins that fight infection, and also filter lymph. Nodes are sometimes called lymph glands.

Metastasize—Spread of cells from the original site of the cancer to other parts of the body where secondary tumors are formed.

Malignant—Cancerous. Cells tend to reproduce without normal controls on growth and form tumors or invade other tissues.

States Food and Drug Administration (FDA) for either safety or effectiveness. These therapies may have interactions with traditional pharmaceuticals. Patients should be wary of "miracle cures" and notify their doctors if they are using herbal remedies, vitamin supplements or other unprescribed treatments. Alternative and experimental treatments normally are not covered by insurance.

Prognosis

Cure rates and survival rates can predict group outcomes, but can never precisely predict the outcome for a single individual. However, the earlier laryngeal cancer is discovered and treated, the more likely it will be cured.

Cancers found in stage 0 and stage 1 have a 75% to 95% cure rate depending on the site. Late stage cancers that have metastasized have a very poor survival rate, with intermediate stages falling somewhere in between. People who have had laryngeal cancer are at greatest risk for recurrence (having cancer come back), especially in the head and neck, during the first two to three years after treatment. Check-ups during the first year are needed every other month, and four times a year during the second year. It is rare for laryngeal cancer to recur after five years of being cancer-free.

Prevention

By far, the most effective way to prevent laryngeal cancer is not to smoke. Smokers who quit smoking also significantly decrease their risk of developing the disease. Other ways to prevent laryngeal cancer include limiting the use of alcohol, eating a well-balanced diet, seeking treatment for prolonged **heartburn**, and avoiding inhaling asbestos and chemical fumes.

Resources

OTHER

"Laryngeal and Hypopharyngeal Cancer." *CancerNet*. December 2009. http://www.cancer.net/patient/Cancer+Types/Laryngeal+and+Hypopharyngeal+Cancer.

"What you Need to Know About Cancer of the Larynx." *CancerNet* November 2000. [cited July 19, 2001]. http://www.cancernet.nci.nih.gov.

ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (800) 227-2345, http://www.cancer.org.

National Cancer Institute (National Institutes of Health), NCI Office of Communications and Education, 6116 Executive Blvd. Suite 300, Bethesda, MD, 20892-8322, (800) 4-CANCER (422-6237), cancergovstaff@mail.nih.gov, http://www.cancer.gov/.

National Cancer Institute Office of Cancer Complementary and Alternative Medicine, 6116 Executive Blvd., Suite 609, MSC 8339, Bethesda, MD, 20892, (301) 435-7980, (301) 480-0075, ncioccam1-r@mail.nih.gov, http://www.cancer.gov/cam/.

National Center for Complementary and Alternative Medicine (NCCAM), P.O. Box 7923, Gaitherburg, MD, 20898, (866) 464-3616, (888) 644-6226, info@nccam.nih.gov, http://nccam.nih.gov/.

Tish Davidson, A.M.

Laryngectomy

Definition

Laryngectomy is the partial or complete surgical removal of the larynx, usually as a treatment for **cancer** of the larynx.

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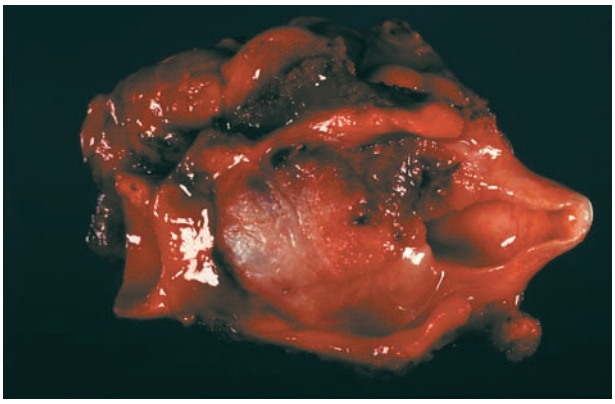

A pathology photograph of an extracted tumor found on the larynx. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Purpose

Normally a laryngectomy is performed to remove tumors or cancerous tissue. In rare cases, it may be done when the larynx is badly damaged by gunshot, automobile injuries, or similar violent accidents. Laryngectomies can be total or partial. Total laryngectomies are done when cancer is advanced. The entire larynx is removed. Often if the cancer has spread, other surrounding structures in the neck, such as lymph nodes, are removed at the same time. Partial laryngectomies are done when cancer is limited to one spot. Only the area with the tumor is removed. Laryngectomies may also be performed when other cancer treatment options, such as radiation or **chemotherapy**, fail.

Precautions

Laryngectomy is done only after cancer of the larynx has been diagnosed by a series of tests that allow the otolaryngologist (a specialist often called an ear, nose, and throat doctor) to look into the throat and take tissue samples (biopsies) to confirm and stage the cancer. People need to be in good general health to undergo a laryngectomy, and will have standard preoperative blood work and tests to make sure they are able to safely withstand the operation.

Description

The larynx is located slightly below the point where the throat divides into the esophagus, which takes food to the stomach, and the trachea (windpipe), which takes air to the lungs. Because of its location, the larynx plays a critical role in normal breathing, swallowing, and speaking. Within the larynx, vocal folds (often called vocal cords) vibrate as air is exhaled past, thus creating speech. The epiglottis protects the trachea, making sure that only air gets into the lungs. When the larynx is removed, these functions are lost.

Once the larynx is removed, air can no longer flow into the lungs. During this operation, the surgeon removes the larynx through an incision in the neck. The surgeon also performs a **tracheotomy**. He makes an artificial opening called a stoma in the front of the neck. The upper portion of the trachea is brought to the stoma and secured, making a permanent alternate way for air to get to the lungs. The connection between the throat and the esophagus is not normally affected, so after healing, the person whose larynx has been removed (called a laryngectomee) can eat normally. However, normal speech is no longer possible. Several alternate means of vocal communication can be learned with the help of a speech pathologist.

Preparation

As with any surgical procedure, the patient will be required to sign a consent form after the procedure is thoroughly explained. Many patients prefer a second opinion, and some insurers require it. Blood and urine studies, along with **chest x ray** and EKG may be ordered as the doctor deems necessary. The patient also has a preoperative meeting with an anesthesiologist. If a complete laryngectomy is planned, it may be helpful to meet with a speech pathologist and/or an established laryngectomee for discussion of post-operative expectations and support.

Aftercare

A person undergoing a laryngectomy spends several days in intensive care (ICU) and receives intravenous (IV) fluids and medication. As with any major surgery, the blood pressure, pulse, and respirations are monitored regularly. The patient is encouraged to turn, **cough**, and deep breathe to help mobilize secretions in the lungs. One or more drains are usually inserted in the neck to remove any fluids that collect. These drains are removed after several days.

It takes two to three weeks for the tissues of the throat to heal. During this time, the laryngectomee cannot swallow food and must receive **nutrition** through a tube inserted through the nose and down the throat into the stomach. During this time, even people with partial laryngectomies are unable to speak.

When air is drawn in normally through the nose, it is warmed and moistened before it reaches the lungs. When air is drawn in through the stoma, it does not

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have the opportunity to be warmed and humidified. In order to keep the stoma from drying out and becoming crusty, laryngectomees are encouraged to breathe artificially humidified air. The stoma is usually covered with a light cloth to keep it clean and to keep unwanted particles from accidentally entering the lungs. Care of the stoma is extremely important, since it is the person's only way to get air to the lungs. After a laryngectomy, a healthcare professional will teach the laryngectomee and his or her caregivers how to care for the stoma.

Immediately after a laryngectomy, an alternate method of communication such as writing notes, gesturing, or pointing must be used. A partial laryngectomy patient will gradually regain some speech several weeks after the operation, but the voice may be hoarse, weak, and strained. A speech pathologist will work with a complete laryngectomee to establish new ways of communicating.

There are three main methods of vocalizing after a total laryngectomy. In esophageal speech the laryngectomee learns how to "swallow" air down into the esophagus and creates sounds by releasing the air. This method requires quite a bit of coordination and learning, and produces short bursts (7 or 8 syllables) of low-volume sound.

Tracheoesophageal speech diverts air through a hole in the trachea made by the surgeon. The air then passes through an implanted artificial voice prosthesis (a small tube that makes a sound when air goes through it). Recent advances have been made in implanting voice prostheses that produce good voice quality.

The third method of artificial sound communication involves using a hand-held electronic device that translates vibrations into sounds. There are several different styles of these devices, but all require the use of at least one hand to hold the device to the throat. The choice of which method to use depends on many things including the age and health of the laryngectomee, and whether other parts of the mouth, such as the tongue, have also been removed.

Many patients resume daily activities after surgery. Special precautions must be taken during showering or shaving. Special instruction and equipment is also required for those who wish to swim or water ski, as it is dangerous for water to enter the windpipe and lungs through the stoma.

Regular follow-up visits are important following treatment for cancer of the larynx because there is a higher-than-average risk of developing a new cancer in the mouth, throat, or other regions of the head or neck.

KEY TERMS

Larynx—Also known as the voice box, the larynx is composed of cartilage that contains the apparatus for voice production. This includes the vocal cords and the muscles and ligaments that move the cords.

Lymph nodes—Accumulations of tissue along a lymph channel, which produce cells called lymphocytes that fight infection.

Tracheostomy—A surgical procedure in which an artificial opening is made in the trachea (windpipe) to allow air into the lungs.

Many self-help and support groups are available to help patients meet others who face similar problems.

Risks

Laryngectomy is often successful in curing early stage cancers. However it does cause lifestyle changes. Laryngectomees must learn new ways of speaking. They must be continually concerned about the care of their stoma. Serious infections can occur if water or other foreign material enters the lungs through an unprotected stoma. Also, women who undergo partial laryngectomy or who learn some types of artificial speech will have a deep voice similar to that of a man. For some women this presents psychological challenges.

Results

Ideally, removal of the larynx will remove all cancerous material. The person will recover from the operation, make lifestyle adjustments, and return to an active life.

Sometimes cancer has spread to surrounding tissues and it is necessary to remove lymph nodes, parts of the tongue, or other cancerous tissues. As with any major operation, post- surgical infection is possible. Infection is of particular concern to laryngectomees who have chosen to have a voice prosthesis implanted, and is one of the major reasons for having to remove the device.

ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (800) 227-2345, http://www.cancer.org.

The International Association of Laryngectomees (IAL), 925B Peachtree Street - NE Suite 316 , Atlanta, GA, 30309, (866) 425-3678, http://www.theial.com/ial/.

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National Institute on Deafness and Other Communication Disorders, National Institutes of Health, 31 Center Drive, MSC 2320, Bethesda, MD, 20892-2320, (301) 496-7243, (301) 402-0018, nidcdinfo@nidcd.nih.gov , http://www.nidcd.nih.gov/.

NCI Office of Communications and Education, 6116 Executive Blvd. Suite 300, Bethesda, MD, 20892-8322, (800) 4-CANCER (422-6237), cancergovstaff@mail. nih.gov, http://www.cancer.gov/aboutnci/cis.

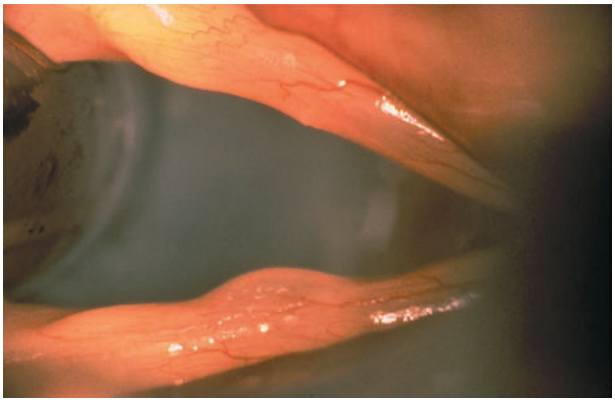
The Voice Center at Eastern Virginia Medical School, PO Box 1980, Norfolk, VA, 23501-1980, (757) 446-7360, http://www.evms.edu/evms.

Kathleen D. Wright, RN
Tish Davidson, AM

Laryngitis

Definition

Laryngitis, one type of dysphonia (disorders of the voice), is caused by inflammation of the larynx, resulting in distortion (hoarseness) of the voice. Sometimes irritation of the vocal cords, which are contained within the larynx, causes a complete, but temporary, loss of the voice. Acute laryngitis usually lasts for less than a few days and usually causes only strain on the vocal cords, while the chronic form of the inflammation can extend out to several weeks and may cause serious problems.



An endoscopic view of a patient's vocal cords with laryngitis. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Demographics

The disorder is found in both children and adults, and is equally common in all races of people all over the world. It is equally prevalent in men and women.

Description

When air is breathed in (inspired), it passes through the nose and the nasopharynx or through the mouth and the oropharynx. These are both connected to the larynx, a tube made of cartilage. The vocal cords, responsible for setting up the vibrations necessary for speech, are located within the larynx. They consist of two folds of mucous membrane, which surround muscle and cartilage. The air continues down the larynx to the trachea. The trachea then splits into two branches, the left and right bronchi (bronchial tubes). These bronchi branch into smaller air tubes which run within the lungs, leading to the small air sacs of the lungs (alveoli).

Either food, liquid, or air may be taken in through the mouth. While air goes into the larynx and the respiratory system, food and liquid are directed into the tube leading to the stomach, the esophagus. Because food or liquid in the bronchial tubes or lungs could cause a blockage or lead to an infection, the airway must be protected. The epiglottis is a leaf-like piece of cartilage extending upwards from the larynx. The epiglottis can close down over the larynx when someone is eating or drinking, preventing these substances from entering the airway.

In laryngitis, the tissues below the level of the epiglottis are swollen and inflamed. This causes swelling around the area of the vocal cords, so that they cannot vibrate normally. A hoarse sound to the voice is very characteristic of laryngitis. Laryngitis is a very common problem, and often occurs during the course of an upper respiratory tract infection (cold).

Causes and symptoms

Acute laryngitis is caused almost 100% of the time by a virus. The same viruses that cause the majority of simple upper respiratory infections (colds, **bronchitis**, etc.), along with the **mumps** and **measles**, are responsible for laryngitis. These include human parainfluenza viruses (HPIVs), influenzavirus A, human respiratory syncytial virus (RSV), human rhinovirus, coronaviruses, and enteric cytopathic human orphan virus (ECHO virus). Extremely rarely, bacteria such as Group A streptococcus bacterium (*Streptococcus pyogenes*), *Moraxella catarrhalis*, or those strains of mycobacteria (usually *Mycobacterium tuberculosis*) that cause **tuberculosis** may cause laryngitis. In people with faulty immune systems (particular due to acquired **immunodeficiency** syndrome, or **AIDS**),

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infections with fungi may be responsible for laryngitis. In addition, factors that can contribute to laryngitis include **allergies**, acid reflux disease or similar problems, alcohol consumption, **smoking** tobacco products, and excessive coughing.

Chronic laryngitis is usually caused by strain to the vocal cords from inhaled irritants (chemical fumes, smoke, etc.), excessive alcohol use, chronic **sinusitis**, smoking, acid reflux, and excessive use of the voice (singers, etc.). It can also be caused, although less frequently, by bacterial, fungal, or parasitic infections. Chronic laryngitis can also be caused by **cancer** or tumors, **vocal cord paralysis** (from injuries, strokes or other health problems, and age-related problems).

Symptoms usually begin along with, or following, symptoms of a cold. A sore, scratchy, dry throat; **fever**; runny nose; achiness; and **fatigue** may all occur. Difficulty swallowing sometimes occurs with **streptococcal infections**. The patient may **cough** and wheeze. Most characteristically, the patient's voice will sound weak, strained, hoarse, and raspy. Sometimes the voice is temporarily lost. Swollen lymph nodes in the throat, face, or chest may also be present.

In extremely rare cases, the swelling of the larynx may cause symptoms of airway obstruction. This is more common in infants, because the diameter of their airways is so small. In that case, the baby may have a greatly increased respiratory rate, and exhibit loud high-pitched sounds with breathing (called **stridor**). In other cases, blood may be coughed up, increased production of saliva in the mouth may be present, and difficulties in eating may also occur.

Diagnosis

A visit to the doctor is necessary if such symptoms last for over a few days. If hoarseness remains for more than two weeks, then a trip to a physician is wise. For children, always seek medical care if the child has trouble swallowing, difficulty breathing, a body temperature of over 103°F (39°C), excessive drooling, and noisy, high-pitched sounds while inhaling. When at the health-care professional, diagnosis is usually made by learning the history of a cold followed by hoarseness. The throat usually appears red and somewhat swollen. Listening to the chest and back with a stethoscope may reveal some harsh **wheezing** sounds with inspiration (breathing in).

In long-standing (chronic laryngitis), tuberculosis may be suspected. Using a scope called a laryngoscope, examination of the airway will show redness, swelling, small bumps of tissue called nodules, and irritated pits in the tissue called ulcerations. The medical professional will examine the back of the throat with a small, lighted mirror. In some cases, a fiber-optic **laryngoscopy** may be performed. In such procedures, an endoscope with a small camera and light is inserted into the nose or mouth so that the physician can examine the throat and, especially, watch the action of the vocal cords while the patient is speaking.

In other cases, the medical team may analyze a sample of tissue suspected as part of the laryngitis. The biopsy will be removed and taken to a medical laboratory where it will be examined under a microscope. In still other cases, special skin testing (TB testing) will reveal whether the individual has been exposed to the bacteria causing tuberculosis (TB).

Treatment

Treatment of a simple, viral laryngitis simply addresses the symptoms. Gargling with warm salt water, **pain** relievers such as **acetaminophen**, the use of vaporizers to create moist air, and rest will help the illness resolve within a week. **Corticosteroids** may sometimes be used to reduce inflammation. However, such medication is usually only used in certain cases, such as when the laryngitis is more severe or there is an urgent need to recover more quickly.

Antibiotic or anti-fungal medication may be prescribed or given if the laryngitis is due to a bacterial or fungal infection, respectively.

In an infant who is clearly struggling for air, it may be necessary to put in an artificial airway for a short period of time. This is very rarely needed.

An individual with tubercular laryngitis is treated with a combination of medications used to treat classic TB. In people with fungal laryngitis, a variety of anti-fungal medications are available.

If laryngitis is caused by gastroesophageal reflux, sometimes also called **gastroesophageal reflux disease** (GERD), the person may be given ranitidine hydrochloride (Zantac) or omeprazole (Prilosec) for one to two months.

For laryngitis patients with severe hoarseness a visit to the voice pathologist or laryngologist may be necessary. In some cases **speech therapy** or a various surgical procedures may be recommended. People who sing or others who use their voices frequently (such as teachers) may be asked to rest their voice until it returns to normal.

Alternative treatment

Alternative treatments include **aromatherapy** inhalations made with benzoin, lavender, frankincense,

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KEY TERMS

Epiglottis—A leaf-like piece of cartilage extending upwards from the larynx, which can close like a lid over the trachea to prevent the airway from receiving any food or liquid being swallowed.

Larynx—The part of the airway lying between the pharynx and the trachea.

Nasopharynx—The part of the airway into which the nose leads.

Oropharynx—The part of the airway into which the mouth leads.

Trachea—The part of the airway which leads into the bronchial tubes.

thyme, and sandalwood. Decoctions (extracts made by boiling an herb in water) or infusions (extracts made by steeping an herb in boiling water) can be made with red sage (*Salvia officinalis* var. *rubra*) and yarrow (*Achillea millefolium*) or with licorice (*Glycyrrhiza glabra*). These are used for gargling, and are said to reduce pain. **Echinacea** (*Echinacea* spp.) tincture taken in water every hour for 48 hours is recommended to boost the immune system. Antiviral herbs, including usnea (*Usnea* spp.), lomatium (*Lomatium dissectum*), and ligusticum (*Ligusticum porteri*), may help hasten recovery from laryngitis. Homeopathic remedies are recommended based on the patient's symptoms. Some people may get relief from placing cold compresses on the throat.

Prognosis

Prognosis for laryngitis is excellent. Recovery is complete, and usually occurs within a week's time.

Prevention

Prevention of laryngitis is the same as for any upper respiratory infections. The only way to even attempt to prevent such illnesses is by good hand washing, and by avoiding situations where one might come in contact with people who might be sick. However, even with relatively good hygiene practices, most people will get about five to six colds per year. It is unpredictable which of these may lead to laryngitis.

In addition, do not smoke and avoid situations where second-hand smoke may be present. Also, drink plenty of water daily to keep the throat moist.

Resources

BOOKS

Feigin, Ralph D. et al., editors. *Feigin ' Cherry' Textbook of Pediatric Infectious Diseases*. Philadelphia: Saunders/Elsevier, 2009.

Fried, Marvin P. et al., editors. *The Larynx*. San Diego: Plural, 2009.

OTHER

"Laryngitis." Mayo Clinic. (April 3, 2010), http://www.mayoclinic. com/health/laryngitis/DS00366. (accessed July 26, 2010).

"Laryngitis." Medline Plus, National Library of Medicine and National Institutes of Health. (October 10, 2008), http://www.nlm.nih.gov/medlineplus/ency/article/001385.htm. (accessed July 26, 2010).

ORGANIZATIONS

American Academy of Otolaryngology–Head and Neck Surgery, Inc., 1650 Diagonal Road, Alexandria, VA, 22314-2857, (703) 836-4444, http://www.entnet.org.

Rosalyn Carson-DeWitt, MD

Laryngoscopy

Definition

Laryngoscopy refers to a procedure used to view the inside of the larynx (the voice box).

Description

The purpose and advantage of seeing inside the larynx is to detect tumors, foreign bodies, nerve or structural injury, or other abnormalities. Two methods allow the larynx to be seen directly during the examination. In one, a flexible tube with a fiber-optic device is threaded through the nasal passage and down into the throat. The other method uses a rigid viewing tube passed directly from the mouth, through the throat, into the larynx. A light and lens affixed to the endoscope are used in both methods. The endoscopic tube may also be equipped to suction debris or remove material for biopsy. **Bronchoscopy** is a similar, but more extensive procedure in which the tube is continued through the larynx, down into the trachea and bronchi.

Preparation

Laryngoscopy is done in the hospital with a local anesthetic spray to minimize discomfort and suppress

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KEY TERMS

Endoscopic tube—A tube that is inserted into a hollow organ permitting a physician to see the inside it.

the gag reflex. Patients are requested not to eat for several hours before the examination.

Aftercare

If the throat is sore, soothing liquids or lozenges will probably relieve any temporary discomfort.

Risks

This procedure carries no serious risks, although the patient may experience soreness of the throat or **cough** up small amounts of blood until the irritation subsides.

Results

A normal result would be the absence of signs of disease or damage.

An abnormal finding, such as a tumor or an object lodged in the tissue, would either be removed or described for further medical attention.

Jill S. Lasker

Larynx removal *see* **Laryngectomy**

Laser-assisted in-situ keratomileusis *see* **Photorefractive keratectomy and laser-assisted in-situ keratomileusis**

Laser surgery

Definition

The term "laser" means light amplification by stimulated emission of radiation. Laser surgery uses a laser light source to remove tissues that are diseased or unwanted, to treat blood vessels that are bleeding, or to terminate tumors or lesions. Laser beams are strong beams of light produced by electrically stimulating a particular material, in the case of laser surgery, most often carbon dioxide, argon, or neodymium.

The special light beam is focused to treat tissues by heating the cells until they burst. There are a number of different laser types. Each has a different use and color. Three types of laser that are commonly used are: the carbon dioxide (CO_2) laser; the YAG laser (yttrium aluminum garnet); and the argon laser.

Purpose

Laser surgery is used to:

- cut or destroy tissue that is abnormal or diseased without harming healthy, normal tissue
- shrink or destroy tumors and lesions
- close off nerve endings to reduce postoperative pain
- cauterize (seal) blood vessels to reduce blood loss
- seal lymph vessels to minimize swelling and decrease spread of tumor cells
- remove moles, warts, and tattoos
- decrease the appearance of skin wrinkles

Precautions

Anyone who is thinking about having laser surgery should ask the surgeon to:

- explain why laser surgery is likely to be of greater benefit than traditional surgery
- describe the surgeon's experience in performing the laser procedure the patient is considering

Because some lasers can temporarily or permanently discolor the skin of blacks, Asians, and Hispanics, a dark-skinned patient should make sure that the surgeon has successfully performed laser procedures on people of color. Potential problems include infection, **pain**, scarring, and changes in skin color.

Some types of laser surgery should not be performed on pregnant women or on patients with severe cardiopulmonary disease or other serious health problems.

Additionally, because some laser surgical procedures are performed under **general anesthesia**, its risks should be fully discussed with the anesthesiologist. The patient should fully disclose all over-the-counter and prescription medications that are being taken, as well as the foods and beverages that are generally consumed; some can interact with agents used in anesthesia.

Description

Lasers are used to perform many surgical procedures. Lasers of various wavelengths are used remove tissue, cut, coagulate, and vaporize. Often times, lasers can take the place of conventional surgical tools—scalpels, cryosugery probes, electrosurgical units, or

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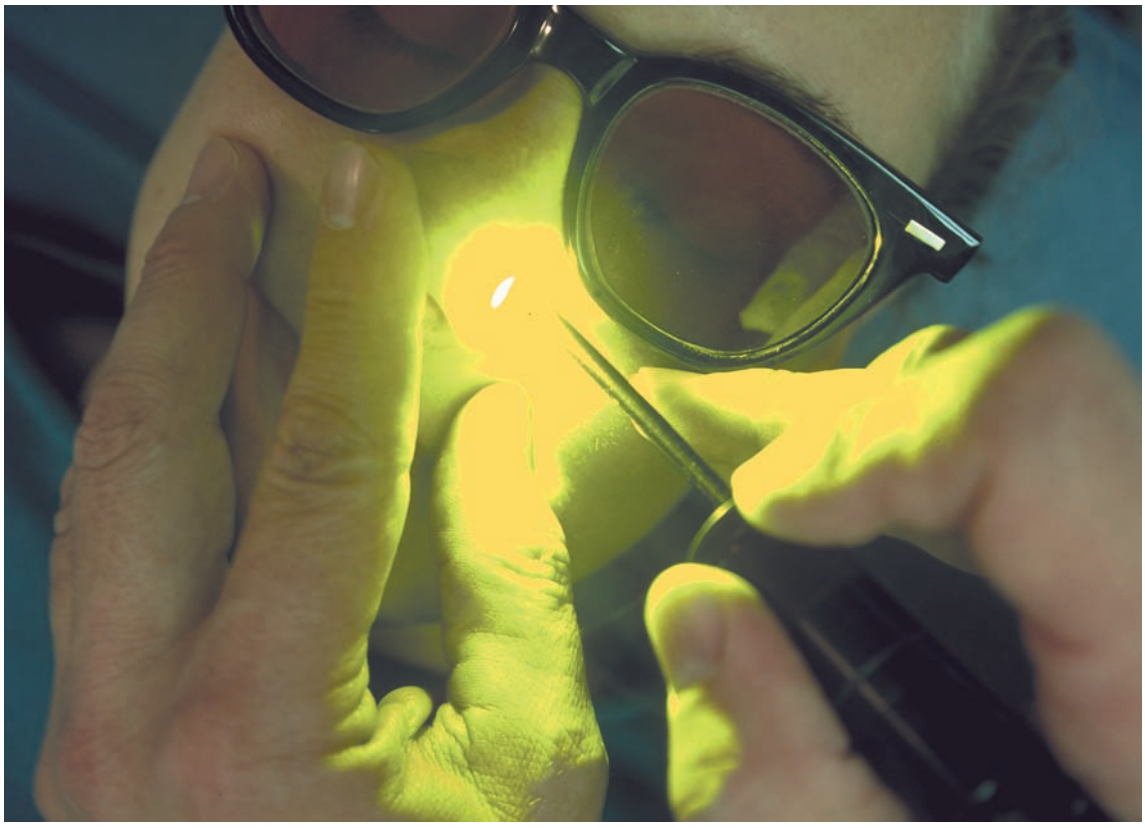

Cosmetic laser surgery in progress. The wavelengths of the laser's light can be matched to a specific target, enabling the physician to destroy the capillaries near the skin's surface without damaging the surrounding tissue. *(Will & Deni McIntyre/ Photo Researchers, Inc.)*

microwave devices—to carry out standard procedures such as **mastectomy** (breast surgery). By using lasers, surgeons can accomplish more complex tasks and reduce blood loss, decrease postoperative patient discomfort, decrease the chances of infection to the wound, reduce the spread of some cancers, minimize the extent of surgery (in some cases), and achieve better outcomes in wound healing. Also, because lasers are more precise, the laser can penetrate tissue by adjusting the intensity of the light.

Lasers are also extremely useful in both open and laparoscopic procedures. Breast surgery, **hernia repair**, **bowel resection**, hemorrhoidectomy, gallbladder removal, and solid organ surgery are among the common types of laser surgery.

The first working laser was introduced in 1960. Initially used to treat diseases and disorders of the eye, the device was first used to treat diseases and disorders of the eye, whose transparent tissues gave ophthalmic surgeons a clear view of how the narrow, concentrated beam was being directed. Dermatologic surgeons also helped to pioneer laser surgery, and developed and improved upon many early techniques and more refined surgical procedures.

Types of lasers

The three types of lasers most often used in medical treatment are the:

- Carbon dioxide (CO_2) laser. Primarily a surgical tool, this device converts light energy to heat strong enough to minimize bleeding, while cutting through or vaporizes tissue.
- Neodymium: yttrium-aluminum-garnet (Nd:YAG) laser. Capable of penetrating tissue more deeply than other lasers, the Nd:YAG laser enables blood to clot quickly, allowing surgeons to see and can enable surgeons to see and touch body parts that could otherwise be reached only through open (invasive) surgery.
- Argon laser. This laser provides the limited penetration needed for eye surgery and superficial skin disorders. In a special procedure known as photodynamic therapy (PDT), this laser uses light-sensitive dyes to shrink or dissolve tumors.

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KEY TERMS

Argon—A colorless, odorless gas.

Astigmatism—A condition in which one or both eyes cannot filter light properly and images appear blurred and indistinct.

Canker sore—A blister-like sore on the inside of the mouth that can be painful but is not serious.

Carbon dioxide—A heavy, colorless gas that dissolves in water.

Cardiopulmonary disease—Illness of the heart and lungs.

Cardiopulmonary resuscitation (CPR)—An emergency procedure used to restore circulation and prevent brain death to a person who has collapsed, is unconscious, is not breathing, and has no pulse.

Cauterize—To use heat or chemicals to stop bleeding, prevent the spread of infection, or destroy tissue.

Cornea—The outer, transparent lens that covers the pupil of the eye and admits light.

Endometriosis—An often painful gynecologic condition in which endometrial tissue migrates from the inside of the uterus to other organs inside and beyond the abdominal cavity.

Glaucoma—A disease of the eye in which increased pressure within the eyeball can cause gradual loss of vision.

Invasive surgery—A form of surgery that involves making an incision in the patient's body and inserting instruments or other medical devices into it.

Laparoscopic procedures—Surgical procedures during which surgeons rely on a laparoscope—a pencil-thin instrument that has its own lighting system and miniature video camera. To perform surgeries, only small incisions are needed to insert the instruments and the miniature camera.

Nearsightedness—A condition in which one or both eyes cannot focus normally, causing objects at a distance to appear blurred and indistinct. Also called myopia.

Ovarian cyst—A benign or malignant growth on an ovary. An ovarian cyst can disappear without treatment or become extremely painful and have to be surgically removed.

Pilonidal cyst—A special kind of abscess that occurs in the cleft between the buttocks. Forms frequently in adolescence after long trips that involve sitting.

Vaporize—To dissolve solid material or convert it into smoke or gas.

Varicose veins—Swollen, twisted veins, usually occurring in the legs, that occur more often in women than in men.

Laser applications

Sometimes described as "scalpels of light," lasers are used alone or with conventional surgical instruments in a array of procedures that:

- improve appearance
- relieve pain
- restore function
- save lives

Laser surgery is often standard operating procedure for specialists in:

- cardiology (branch of medicine which deals with the heart and its diseases)
- dentistry (branch of medicine which deals with the anatomy and development and diseases of the teeth)
- dermatology (science which treats the skin, its structure, functions, and its diseases)
- gastroenterology (science which treats disorders of the stomach and intestines)
- gynecology (science which treats of the structure and diseases of women)
- neurosurgery (surgery of the nervous system)
- oncology (cancer treatment)
- ophthalmology (treatment of disorders of the eye)
- orthopedics (treatment of disorders of bones, joints, muscles, ligaments, and tendons)
- otolaryngology (treatment of disorders of the ears, nose, and throat)
- pulmonology (treatment of disorders of the respiratory system)
- urology (treatment of disorders of the urinary tract and of the male reproductive system)

Routine uses of lasers, include eliminating **birthmarks**, skin discoloration, and skin changes due to **aging**, and removing benign, precancerous, or cancerous tissues or tumors. Lasers are used to stop a patient's **snoring**, remove tonsils, remove or transplant hair, and relieve pain and restore function in patients who are too

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weak to undergo major surgery. Lasers are also used to treat:

- angina (chest pain)
- cancerous or noncancerous tumors that cannot be removed or destroyed
- cold and canker sores, gum disease, and tooth sensitivity or decay
- ectopic pregnancy (development of a fertilized egg outside the uterus)
- endometriosis
- fibroid tumors
- gallstones
- glaucoma, mild-to-moderate nearsightedness and astigmatism, and other conditions that impair sight
- migraine headaches
- noncancerous enlargement of the prostate gland
- nosebleeds
- ovarian cysts
- ulcers
- varicose veins
- warts
- numerous other conditions, diseases, and disorders

Advantages of laser surgery

Often referred to as "bloodless surgery," laser procedures usually involve less bleeding than conventional surgery. The heat generated by the laser keeps the surgical site free of germs and reduces the risk of infection. Because a smaller incision is required, laser procedures often take less time (and cost less money) than traditional surgery. Sealing off blood vessels and nerves reduces bleeding, swelling, scarring, pain, and the length of the recovery period.

Disadvantages of laser surgery

Although many laser surgeries can be performed in a doctor's office, rather than in a hospital, the person guiding the laser must be at least as thoroughly trained and highly skilled as someone performing the same procedure in a hospital setting. The American Society for Laser Medicine and Surgery urges that:

- All operative areas be equipped with oxygen and other drugs and equipment required for cardiopulmonary resuscitation (CPR).
- Nonphysicians performing laser procedures be properly trained, licensed, and insured.
- A qualified and experienced supervising physician be able to respond to and manage unanticipated events or other emergencies within five minutes of the time they occur.
- Emergency transportation to a hospital or other acute care facility (ACF) be available whenever laser surgery is performed in a non-hospital setting.

Diagnosis/Preparation

Because laser surgery is used to treat so many diverse conditions, the patient should ask the physician for detailed instructions about how to prepare for a specific procedure. Diet, activities, and medications may not have to be limited prior to surgery, but some procedures require a **physical examination**, a medical history, and conversation with the patient that:

- enables the doctor to evaluate the patient's general health and current medical status
- provides the doctor with information about how the patient has responded to other illnesses, hospital stays, and diagnostic or therapeutic procedures
- clarifies what the patient expects the outcome of the procedure to be

Aftercare

Most laser surgeries can be performed on an outpatient basis, and patients are usually permitted to leave the hospital or medical office when their vital signs have stabilized. A patient who has been sedated should not be discharged until recovery from the anesthesia is complete, unless a responsible adult is available to accompany the patient home.

The doctor may prescribe analgesic (pain-relieving) medication, and should provide easy-to-understand, written instructions on how to take the medication. The doctor should also be able to give the patient a good estimate of how the patient's recovery should progress, the recovery time, and what to do in case complications or emergency arise. The amount of time it takes for the patient to recover from surgery depends on the surgery and on the individual. Recovery time for laser surgery is, for the most part, faster than for traditional surgery.

Risks

Like traditional surgery, laser surgery can be complicated by:

- hemorrhage
- infection
- perforation (piercing) of an organ or tissue

Laser surgery can also involve risks that are not associated with traditional surgical procedures. Being careless or not practicing safe surgical techniques can severely burn the patient's lungs. Patients must wear protective eye shields while undergoing laser surgery on

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any part of the face near the eyes or eyelids, and the United States Food and Drug Administration has said that both doctors and patients must use special wavelength-specific, protective eyewear whenever a CO_2 laser is used.

There are other kinds of dangers that laser surgery can impose of which the patient should be aware. Laser beams have the capacity to do a great deal of damage when coupled with high enough energy and absorption. They can ignite clothing, paper, and hair. Further, the risk of fire from lasers increases in the presence of oxygen. Hair should be protected and clothing should be tied back, or removed, within the treatment areas. It is important to guard against electric shock, as lasers require the use of high voltage. Critically, installation must ensure proper wiring.

Laser beams can burn or destroy healthy tissue, cause injuries that are painful and sometimes permanent, and actually compound problems they are supposed to solve. Errors or inaccuracies in laser surgery can worsen a patient's vision, for example, and lasers can scar and even change the skin color of some patients.

All of the above risks, precautions, and potential complications should be discussed by the doctor with the patient.

Results

The nature and severity of the problem, the skill of the surgeon performing the procedure, and the patient's general health and realistic expectations are among the factors that influence the outcome of laser surgery. Successful procedures can enable patients to feel better, look younger, and enjoy longer, fuller, more active lives.

A patient who is considering any kind of laser surgery should ask the doctor to provide detailed information about what the outcome of the surgery is expected to be, what the recovery process will involve, and how long it will probably be before a normal appearance is regained and the patient can resume normal activities.

A person who is considering any type of laser surgery should ask the doctor to provide specific and detailed information about what could go wrong during the procedure and what the negative impact on the patient's health or appearance might be.

Lighter or darker skin may appear, for example, when a laser is used to remove sun damage or age spots from an olive- or dark-skinned individual. This abnormal pigmentation may or may not disappear over time.

Scarring or rupturing of the cornea is uncommon, but laser surgery on one or both eyes can:

- increase sensitivity to light or glare
- reduce night vision
- permanently cloud vision, or cause sharpness of vision to decline throughout the day

Signs of infection following laser surgery include:

- burning
- crusting of the skin
- itching
- pain
- scarring
- severe redness
- swelling

Resources

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ORGANIZATIONS

American Society for Laser Medicine and Surgery, 2404 Stewart Avenue, Suite 240, Wausau, WI, 54401, (715) 845-9283, (715) 848-2493, information@aslms.org, http://www.aslms.org.

Cancer Information Service, 9000 Rockville Pike, Building 31, Suite 10A18, Bethesda, MD, 20892, http://wwwicic.nci.nih.gov.

Mayo Clinic, Division of Colon and Rectal Surgery , 200 First Street SW, Rochester, MN, 55905, (507) 284-2511, http://www.mayoclinic.org/colorectalsurgery-rst/laparoscopicsurgery.html.

Mayo Clinic, Mayo Foundation for Medical Education and Research, 200 First Street SW, Rochester, MN, 55905, (507) 284-2511, http://www.mayoclinic.com .

National Cancer Institute, NCI Public Inquiries Office, 6116 Executive Boulevard, Bethesda, MD, 20892-8322, (800) 422-6237, http://www.cancer.gov.

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LASIK *see* **Photorefractive keratectomy and laser-assisted in-situ keratomileusis**

Lassa fever *see* **Hemorrhagic fevers**

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Late effects of childhood cancer and its treatment

Definition

Late effects of childhood **cancer** treatment may be defined as any adverse effect of treatment that does not resolve after treatment is completed or which appears after the completion of the treatment for cancer. Late effects can include adverse effects on major organ systems, problems with cognitive and psychosocial functioning as well as the development of second malignancies.

Demographics

Due to the effectiveness of treatment modalities in treating childhood cancers, deaths from these cancers have decreased dramatically over the last 50 years. Before 1970, virtually all children diagnosed with cancer died from the disease. Today, with current therapy, 79% of children affected by cancer are able to be cured. The numbers of survivors of childhood cancers are increasing with an estimated 1 long-term childhood cancer survivor among every 450 adolescents and young adults in the United States. There are approximately 300,000 long-term childhood cancer survivors in the U.S. alone. Two-thirds of childhood cancer survivors will develop at least one late adverse effect as a result of their treatment for cancer.

Description

As ever-increasing numbers of children are surviving cancer, follow-up of these survivors has focused attention on adverse effects which may occur sometimes years after receiving treatment for childhood cancer. Many of these adverse effects become evident as the child matures into **puberty** and young adulthood. Many young cancer survivors have at least one organ system which has been impacted either by the cancer or by treatment for the cancer.

Late effects can be caused by **chemotherapy**, **radiation therapy**, hematopoietic stem cell transplant, and/or surgery. Virtually any organ of the body can be affected. According to the Children's Oncology Group of the American Academy of Pediatrics, the risk of late effects is directly related to the intensity of the cancer therapy received as treatment. Treatment methodologies which increase risk for late effects include longer treatment with higher doses of chemotherapy and radiation therapy, therapy which includes more than one treatment modality, e.g., a combination of chemotherapy and radiation as opposed to using only one of the modalities alone, and receiving therapy to treat relapse of disease. The patient's age at the time of the treatment also influences the potential for adverse late effects with younger children being at higher risk. Young children are particularly susceptible to the effects of cancer treatments which can result in impaired growth, cognitive function, sexual development, and organ function.

Most of the time, chemotherapy results in immediate and acute effects. However, some late effects of treatment with chemotherapy can develop. For example, treatment with chemotherapy drugs classified as alkylating agents can lead to problems such as delayed or arrested puberty and **infertility** and can result in the development of a different or second cancer. Treatment with radiation therapy can impede normal growth and development, can impair organ function and can lead to the development of cancer as well.

Late Effects by Organ System

Neurocognitive effects

Tests of cognitive function and academic achievement in childhood cancer survivors confirm the negative impact of radiation therapy targeted to the brain in infants and children. The negative effects are especially pronounced in survivors of the brain cancer, medulloblastoma, because of the higher doses of radiation therapy experienced by those survivors.

Neurocognitive effects such as seizures, **memory loss**, and decrease in cognitive function as evidenced by lower IQ and mathematics scores are associated with cranial radiation therapy and intrathecal administration of chemotherapy used in the treatment of children with acute lymphoblastic leukemia (ALL). Studies of children with brain tumors who were treated with surgery and radiation to the brain reveal similar neurocognitive deficits. Children who were younger than 3 years of age when treated experience more pronounced negative neurocognitive consequences.

Cardiac effects

Damage to the heart and cardiovascular system can occur as a result of treatment with radiation therapy that includes all or part of the heart in the treatment field. Childhood survivors of Hodgkin disease or those who received radiation to the spine as treatment for some brain tumors are at increased risk. Late effects of radiation therapy which included the heart in the treatment field includes pericardial effusions, constrictive **pericarditis** and premature **coronary artery disease**.

Childhood cancer survivors, especially infants and toddlers, who were treated with chemotherapy drugs classified as anthracyclines are at higher risk for the

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development of heart damage including anthracycline-induced **cardiomyopathy**. The use of anthracycline chemotherapy in children can also lead to the development of congestive **heart failure**, pericarditis, and ventricular **arrhythmias**. **Mitral valve insufficiency** can also occur as a late effect.

Pulmonary effects

Cancer treatments which can affect the lungs and result in late effects include radiation therapy and chemotherapy. Late effects of radiation therapy develop over a period of months and even years resulting in pneumonitis and **pulmonary fibrosis**.

Chemotherapy agents which can cause long-term adverse effects to the lungs include bleomycin, which is used in the treatment of children with **germ cell tumors** and lymphoma, and nitrosureas such as carmustine, which are used in the treatment of children with brain tumors. Pulmonary damage is increased when these agents are used in combination with radiation therapy. Adverse effects include pneumonitis and other pulmonary toxicities.

Endocrine and reproductive effects

Radiation therapy and treatment with chemotherapy agents classified as alkylating agents can lead to endocrine toxicity. Endocrine toxicity can negatively affect growth which can result in short stature.

Chemotherapy agents, particularly nitrogen mustard, procarbazine, and cyclophosphamide are the most damaging to the reproductive system. Young women treated with these drugs in combination with radiation may undergo **premature menopause** with the average age at **menopause** in one study at age 31 years. Young women who experience early menopause are then at increased risk of **osteoporosis** and heart disease at an earlier age than the general population.

Radiation to the reproductive organs in childhood can lead to fertility problems in men and in women in later years. Results of a study released in 2010 revealed that women who received radiation to the pelvic region prior to menarche were 12 times more likely to experience **stillbirth** and neonatal **death** of their offspring. In women treated with radiation therapy after menarche there was no significantly increased risk irregardless of the dose of radiation. In males, radiation to the testes did not affect risk for stillbirth or neonatal death rates of offspring nor was risk increased for the offspring of men and women who were treated in childhood with alkylating chemotherapy agents.

Children, particularly girls, diagnosed with acute lymphoblastic leukemia (ALL) and who were treated with higher doses of cranial irradiation, are more likely to develop **obesity** as a late effect.

Damage to the thyroid gland can also occur after radiation to the neck and/or chest.

Risk for second malignancies

Childhood cancer survivors who were treated with radiation therapy, chemotherapy or both modalities combined are at increased risk for the development of second malignant neoplasm (cancer). Risk for the development of a second cancer is related to the total dose received of chemotherapy and/or radiation therapy. Higher doses are correlated with increased risk of malignancy development.

Chemotherapy agents classified as alkylating agents especially nitrogen mustard, cyclophosphamide, ifosfamide, melphalan, and procarbazine damage DNA which can result in the development of a second malignancy such as acute myelogenous leukemia (AML). AML typically occurs 4–8 years after treatment for the first malignancy with alkylating agents.

Treatment with chemotherapy drugs classified as epipodophyllotoxins, such as etoposide and teniposide, can also result in the development of leukemia. In one study, about 12% of patients treated with acute lymphoblastic leukemia (ALL) developed secondary AML which is almost always fatal.

The risk of developing a second cancer after treatment with radiation therapy is related to the age of the patient at the time of the treatment and the total dose received. The risk of developing the second malignancy increases with time with as many as 20 years elapsing before the development of the secondary cancer. The most common second malignant neoplasms to develop include **breast cancer** after radiation to the chest as part of treatment for Hodgkin disease, brain tumors after radiation to the brain and central nervous system for the treatment of ALL, soft tissue **sarcomas**, and bone, thyroid and bladder cancers.

Prevention

Prevention of late effects of cancer therapies is receiving increased scrutiny and is generating substantial amounts of research as increased numbers of children survive cancer. Current treatment protocols attempt to treat childhood cancer while sparing normal tissues and organs as much as possible. Newer therapies and radiation techniques allow for more precise targeting of therapies. In addition, radiation therapy and some chemotherapy agents may be omitted or delayed in very young children. Other drugs, known

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KEY TERMS

Cardiomyopathy—A disease or disorder which affects the heart muscle.

Intrathecal—Administration of chemotherapy drugs injected into the cerebrospinal fluids which surround the brain and spinal cord.

Pericardial effusion—An accumulation of excess fluid in the pericardial sac which surrounds the heart.

Pneumonitis—Inflammation of the lungs.

Pulmonary fibrosis—Scarring of lung tissue.

as chemoprotectants, can be utilized to lessen the known toxicities of some chemotherapy drugs.

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ORGANIZATIONS

CureSearch for Children's Cancer, National Childhood Cancer Foundation, 4600 East West Highway, Suite 600, Bethesda, Maryland, 20814-3457, (800) 458-6223 (U.S. and Canada), info@curesearch.org, http://www.curesearch.org.

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Laxatives

Definition

Laxatives are products that promote bowel movements.

Purpose

Laxatives are used to treat constipation—the passage of small amounts of hard, dry stools, usually fewer than three times a week. Before recommending the use of laxatives, differential diagnosis is usually performed because prolonged **constipation** may be evidence of a significant problem, such as localized **peritonitis** (an infection of the abdominal wall) or **diverticulitis** (an infection of part of the intestine). Complaints of constipation also may be associated with **obsessive-compulsive disorder**. Use of laxatives should be avoided in these cases. Individuals should be aware that patterns of defecation are highly variable. Normal patterns may vary from two to three times daily to two to three times weekly.

Laxatives may also be used prophylactically for patients recovering from a myocardial infarction (**heart attack**) or those who have had recent surgery and should not strain during defecation. Laxatives are also used to cleanse the lower bowel before a **colonoscopy** or similar diagnostic imaging procedure.

Description

Laxatives may be grouped by mechanism of action. Saline cathartics include dibasic **sodium** phosphate (Phospo-Soda), magnesium citrate, magnesium hydroxide (milk of magnesia), magnesium sulfate (Epsom salts), and sodium biphosphate. These laxatives act by attracting and holding water in the intestine and may produce a watery stool. Magnesium sulfate is the most potent of the laxatives in this group.

Stimulant and irritant laxatives increase the contracting movements of the intestine, causing stool to move faster through the bowl and giving less time for water to be absorbed. Examples of these laxatives include cascara and bisadocyl (Dulcolax.) Castor oil works in a similar fashion.

Bulk-producing laxatives increase the volume of the stool, soften the stool, and stimulate intestinal motility. Psyllium (Metamucil, Konsil) and methylcellulose (Citrucel) are examples of this type of laxative. The overall effect is similar to that of eating high-fiber foods, and this class of laxative is most suitable for regular use. Many primary care physicians suggest

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KEY TERMS

Cathartic colon—A poorly functioning colon, resulting from the chronic abuse of stimulant cathartics.

Colon—The large intestine.

Diverticulitis—Inflammation of the part of the intestine known as the diverticulum.

Fiber—Carbohydrate material in food that cannot be digested.

Hyperosmotic—Hypertonic, containing a higher concentration of salts or other dissolved materials than normal tissues.

Osteomalacia—A disease of adults, characterized by softening of the bone. Similar to rickets which is seen in children.

Pregnancy category—A system of classifying drugs according to their established risks for use during pregnancy. Category A: Controlled human studies have demonstrated no fetal risk. Category B: Animal studies indicate no fetal risk, but no human studies, or adverse effects in animals, but not in well-controlled human studies. Category C: No adequate human or animal studies, or adverse fetal effects in animal studies, but no available human data. Category D: Evidence of fetal risk, but benefits outweigh risks. Category X: Evidence of fetal risk. Risks outweigh any benefits.

Steatorrhea—An excess of fat in the stool.

Stool—The solid waste that is left after food is digested. Stool forms in the intestines and passes out of the body through the anus.

that patients try laxatives in this category before using saline or stimulant laxatives.

Stool softener laxatives causes water to be retained within the fecal mass, providing a larger, softer stool. Docusate (Colace) is a representative example of the stool softener class of laxatives. It must be taken before the fecal mass forms to have any effect, so it has no effect on acute constipation. It may, however, be useful in preventing constipation in patients with recurrent problems or in those who are about to take a constipating drug, such as narcotic **analgesics**.

Mineral oil is an emollient laxative. Emollient laxatives act by retarding intestinal absorption of fecal water and moving the feces more easily through the intestine, thereby softening the stool.

The hyperosmotic laxatives are glycerin and lactulose (Chronulac, Duphalac), both of which act by holding water within the intestine. Lactulose may also increase contractions of the intestine.

Some newer options for the treatment of chronic constipation are being developed by researchers. These include alternative therapies such as **biofeedback**, newer drugs like tegaserod (Zelnorm) and prucalopride, which stimulate peristalsis (muscle contraction in the intestine), a nerve growth factor known as neurotrophin-3, and electrical stimulation of the colon.

Recommended dosage

Dosage varies widely depending on the product and whether constipation is acute or chronic. See specific products or consult a healthcare provider.

Precautions

Short-term use of laxatives is generally safe except in patients experiencing **appendicitis**, fecal impaction, or intestinal obstruction. Lactulose is composed of two sugar molecules, galactose and fructose and should not be administered to patients who require a low galactose diet.

Chronic use of laxatives may result in fluid and electrolyte imbalances, steatorrhea, osteomalacia, **diarrhea**, cathartic colon, and **liver disease**. Excessive intake of mineral oil may cause impaired absorption of the oil-soluble **vitamins** A, D, E, and K. Excessive use of magnesium salts may cause hypermagnesemia.

Lactulose and magnesium sulfate are **pregnancy** category B substances, which means that there is there is no evidence in animals of harm to a fetus from the drug, but no significant studies on humans have been performed. Casanthranol, cascara sagrada, danthron, docusate sodium, docusate **calcium**, docusate potassium, mineral oil and senna are pregnancy category C substances, meaning that either harm to the fetus has been shown in animals or there are no animal studies available, and there are no controlled human studies. Casanthranol, cascara sagrada and danthron are excreted in breast milk, resulting in the potential for increased incidence of diarrhea in a nursing infant.

The American College of Toxicology states that cathartics should *not* be used as a means of clearing poisons from the digestive tract of a **poisoning** victim. Although some physicians have administered these laxatives along with **activated charcoal** in order to

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reduce the body's absorption of the poison, this treatment is no longer recommended.

Interactions

Mineral oil and docusate should not be used in combination. Docusate is an emulsifying agent that will increase the absorption of mineral oil.

Bisacodyl tablets are enteric coated, and so they should not be used in combination with **antacids**. The antacids will cause premature rupture of the enteric coating. Many medications should not be taken within two hours of taking a laxative. The patient should ask his or her doctor or pharmacist about this and other possible considerations before beginning to take a laxative.

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ORGANIZATIONS

American Society of Health-System Pharmacists (ASHP), 7272 Wisconsin Avenue, Bethesda, MD, 20814, (301) 657-3000, (866) 279-0681, http://www.ashp.org.

National Digestive Diseases Information Clearinghouse (NDDIC), 2 Information Way, Bethesda, MD, 20892-3570, (703) 738-4929, (800) 891-5389, http://digestive.niddk.nih.gov.

United States Food and Drug Administration (FDA), 10903 New Hampshire Ave, Silver Spring, MD, 02993-0002, (888) 463-6332, http://www.fda.gov.

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Lazy eye *see* **Amblyopia**

LCM *see* **Lymphocytic choriomeningitis**

LDH isoenzymes test *see* **Lactate dehydrogenase isoenzymes test**

LDH test *see* **Lactate dehydrogenase test**

Lead poisoning

Definition

Lead poisoning occurs when a person swallows, absorbs, or inhales lead in any form. The result can be damaging to the brain, nerves, and many other parts of the body. Acute lead poisoning, which is somewhat rare, occurs when a relatively large amount of lead is taken into the body over a short period of time. Chronic lead poisoning—a common problem in children—occurs when small amounts of lead are taken in over a longer period. The Centers for Disease Control and Prevention (CDC) defines childhood lead poisoning as a whole-blood lead concentration equal to or greater than 10 micrograms/dL.

Description

Lead can damage almost every system in the human body, and it can also cause high blood pressure (**hypertension**). It is particularly harmful to the developing brain of fetuses and young children. The higher the level of lead in a child's blood, and the longer this elevated level lasts, the greater the chance of ill effects. Over the long term, lead poisoning in a child can lead to learning disabilities, behavioral problems, and even **mental retardation**. At very high levels, lead poisoning can cause seizures, **coma**, and even **death**. Most deaths are among males (74%), African Americans (67%), adults over the age of 45 (76%), and Southerners (70%).

About one out of every six children in the United States has a high level of lead in the blood, according to the Agency for Toxic Substances and Disease Registry. Many of these children are exposed to lead through peeling paint in older homes. Others are exposed through dust or soil that has been contaminated by old paint or past emissions of leaded gasoline. Since children between the ages of 12–36 months are apt to put things in their mouths, they are more likely than older children to take in lead. Pregnant women who come into contact with lead can pass it along to the fetus.

More than 80% of American homes built before 1978 have lead-based paint in them, according to the Centers for Disease Control and Prevention (CDC). The older the home, the more likely it is to contain lead paint, and the higher the concentration of lead in the paint is apt to be. Some homes also have lead in the water pipes or plumbing. People may have lead in the paint, dust, or soil around their homes or in their drinking water without knowing it, since lead can't be seen, smelled, or tasted. Because lead doesn't break down naturally, it can continue to cause problems until it is removed.

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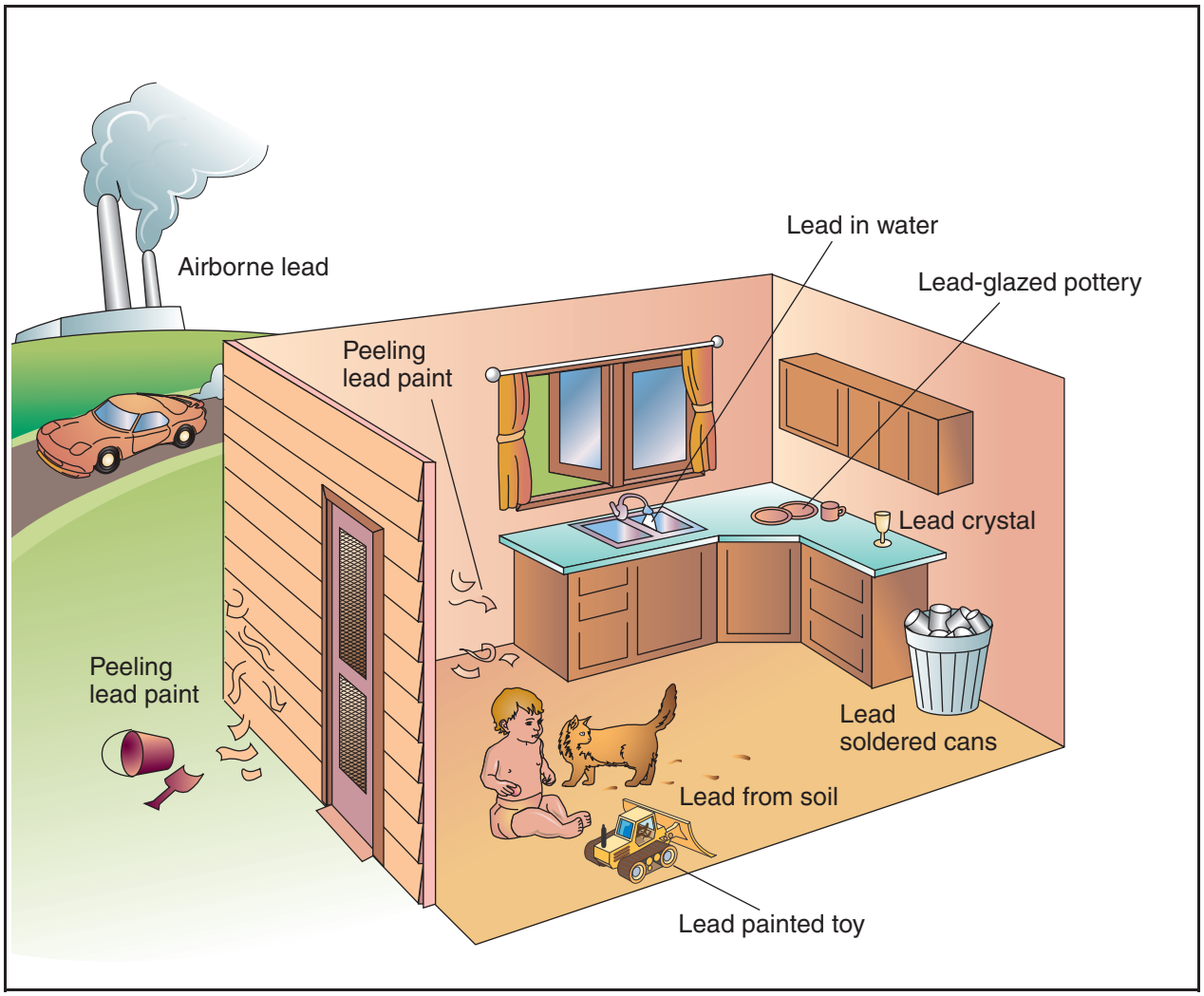

Continuous exposure to lead can damage nearly every system in the human body and is particularly harmful to the developing brain of fetuses and young children. Common sources of lead exposure include lead-based paint, dust and soil, drinking water, food from cans, and eating utensils, such as plates and drinking glasses, that are lead-based. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Lead poisoning and the broad issue of dangerously high levels of lead in common consumer product, especially those made in China, became a major issue in 2007.The summer of 2007 saw a record number of recalls of millions of toys made in China, primarily because of high levels of lead. Affected were several of the leading United States toy companies. In August 2007, Fisher-Price recalled one million toy products, including popular Sesame Street characters, Dora the Explorer, and Go, Diego, Go. That same month, Mattel recalled millions of toys involving such high-profile brands as Barbie, Sarge die cast cars, Doggie Day Care, and Polly Pocket Play Sets, according to the U.S. Consumer Product Safety Commission. Worldwide, Mattel recalled 18.2 million Chinese-made toys as of September 2007, including nearly 10 million in the United States. In November 2007, at the start of the holiday buying season, Kmart removed jewelry from its stores that had been advertised as lead-free after extremely high concentrations of lead were found in some pieces. In some cases, more than half of the jewelry's content was lead. Kmart refused to say how many pieces were involved or where they were made. In August 2007, two U.S. law firms filed class action lawsuits against Mattel Inc. asking for more than $5 million in damages.

Causes and symptoms

Before scientists knew how harmful it could be, lead was widely used in paint, gasoline, water pipes, and many

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other products. Today house paint is almost lead-free, gasoline is unleaded, and household plumbing is no longer made with lead materials. Still, remnants of the old hazards remain. Following are some sources of lead exposure:

- Lead-based paint. This is the most common source of exposure to large amounts of lead among preschoolers. Children may eat paint chips from older homes that have fallen into disrepair. They may also chew on painted surfaces such as windowsills. In addition, paint may be disturbed during remodeling.
- Dust and soil. These can be contaminated with lead from old paint or past emissions of leaded gasoline. In addition, pollution from operating or abandoned industrial sites and smelters can find its way into the soil, resulting in soil contamination.
- Drinking water. Exposure may come from lead water pipes, found in many homes built before 1930. Even newer copper pipes may have lead solder. Also, some new homes have brass faucets and fittings that can leach lead.
- Jobs and hobbies. A number of activities can expose participants to lead. These include making pottery or stained glass, refinishing furniture, doing home repairs, and using indoor firing ranges. When adults take part in such activities, they may inadvertently expose children to lead residue that is on their clothing or on scrap materials.
- Food. Imported food cans often have lead solder. Lead may also be found in leaded crystal glassware and some imported ceramic or old ceramic dishes (e.g., ceramic dishes from Mexico). A 2003 study of cases of lead poisoning in pregnant women found that 70% of the patients were Hispanics, most of whom had absorbed the lead from their pottery. In addition, food may be contaminated by lead in the water or soil.
- Folk medicines. Certain folk medicines (for example, alarcon, alkohl, azarcon, bali goli, coral, ghasard, greta, liga, pay-loo-ah, and rueda) and traditional cosmetics (kohl, for example) contain large amounts of lead.
- Moonshine whiskey. Lead poisoning from drinking illegally distilled liquor is still a cause of death among adults in the southern United States.
- Gunshot wounds. Toxic amounts of lead can be absorbed from bullets or bullet fragments that remain in the body after emergency surgery.

Chronic lead poisoning

New evidence suggests that lead may be harmful to children even at low levels that were once thought to be safe, and the risk of damage rises as blood levels of lead increase. The symptoms of chronic lead poisoning take time to develop, however. Children can appear healthy despite having high levels of lead in their blood. Over time, though, problems such as the following may arise:

- learning disabilities
- hyperactivity
- mental retardation
- slowed growth
- hearing loss
- headaches

It is also known that certain genetic factors increase the harmful effects of lead poisoning in susceptible children; however, these factors are not completely understood.

Lead poisoning is also harmful to adults, in whom it can cause high blood pressure, digestive problems, nerve disorders, **memory loss**, and muscle and joint **pain**. In addition, it can lead to difficulties during **pregnancy**, as well as cause reproductive problems in men and women.

More recently, chronic exposure to lead in the environment has been found to speed up the progression of kidney disorders in patients without diabetes.

Acute lead poisoning

Acute lead poisoning, while less common, shows up more quickly and can be fatal. Symptoms such as the following may occur:

- severe abdominal pain
- diarrhea
- nausea and vomiting
- weakness of the limbs
- seizures
- coma

Diagnosis

A high level of lead in the blood can be detected with a simple blood test. In fact, testing is the only way to know for sure if children without symptoms have been exposed to lead, since they can appear healthy even as long-term damage occurs. The CDC recommends testing all children at 12 months of age and, if possible, again at 24 months. Testing should start at six months for children at risk for lead poisoning. Based on these test results and a child's risk factors, the doctor will then decide whether further testing is needed and how often. In some states, more frequent testing is required by law.

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Children at risk

Children with an increased risk of lead poisoning include those who:

- Live in or regularly visit a house built before 1978 in which chipped or peeling paint is present.
- Live in or regularly visit a house that was built before 1978 where remodeling is planned or underway.
- Have a brother or sister, housemate, or playmate that has been diagnosed with lead poisoning.
- Have the habit of eating dirt, or have been diagnosed with pica.
- Live with an adult whose job or hobby involves exposure to lead.
- Live near an active lead smelter, battery-recycling plant, or other industry that can create lead pollution.

Adults at risk

Testing is also important for adults whose job or hobby puts them at risk for lead poisoning. This includes people who take part in the following activities:

- glazed pottery or stained glass making
- furniture refinishing
- home renovation
- target shooting at indoor firing ranges
- battery reclamation
- precious metal refining
- radiator repair
- art restoration

Treatment

The first step in treating lead poisoning is to avoid further contact with lead. For adults, this usually means making changes at work or in hobbies. For children, it means finding and removing sources of lead in the home. In most states, the public health department can help assess the home and identify lead sources.

If the problem is lead paint, a professional with special training should remove it. Removal of lead paint is not a do-it-yourself project. Scraping or sanding lead paint creates large amounts of dust that can poison people in the home. This dust can stay around long after the work is completed. In addition, heating lead paint can release lead into the air. For these reasons, lead paint should only be removed by someone who knows how to do the job safely and has the equipment to clean up thoroughly. Occupants, especially children and pregnant women, should leave the home until the cleanup is finished.

Medical professionals should take all necessary steps to remove bullets or bullet fragments from patients with gunshot injuries.

Chelation therapy

If blood levels of lead are high enough, the doctor may also prescribe **chelation therapy**. This refers to treatment with chemicals that bind to the lead and help the body pass it in urine at a faster rate. There are four chemical agents that may be used for this purpose, either alone or in combination. Edetate **calcium** disodium (EDTA calcium) and dimercaprol (BAL) are given through an intravenous line or in shots, while succimer (Chemet) and penicillamine (Cuprimine, Depen) are taken by mouth. (Although many doctors prescribe penicillamine for lead poisoning, this use of the drug has not been approved by the Food and Drug Administration.)

Alternative treatment

Changes in diet are no substitute for medical treatment. However, getting enough calcium, zinc, and protein may help reduce the amount of lead the body absorbs. Iron is also important, since people who are deficient in this nutrient absorb more lead. Garlic and thiamine, a B-complex vitamin, have been used to treat lead poisoning in animals. However, their usefulness in humans for this purpose has not been proved. Nutritional, botanical, and homeopathic medicines can be administered once the source is removed, to help correct any imbalances brought on by lead toxicity.

Prognosis

If acute lead poisoning reaches the stage of seizures and coma, there is a high risk of death. Even if the person survives, there is a good chance of permanent brain damage. The long-term effects of lower levels of lead can also be permanent and severe. However, if chronic lead poisoning is caught early, these negative effects can be limited by reducing future exposure to lead and getting proper medical treatment.

Prevention

Many cases of lead poisoning can be prevented. These steps can help:

- Keep the areas where children play as clean and dust-free as possible.
- Wash pacifiers and bottles when they fall to the floor, and wash stuffed animals and toys often.
- Make sure children wash their hands before meals and at bedtime.

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KEY TERMS

Chelation therapy—Treatment with chemicals that bind to a poisonous metal and help the body pass it in urine at a faster rate.

Dimercaprol (BAL)—A chemical agent used to remove excess lead from the body.

Edetate calcium disodium (EDTA calcium)—A chemical agent used to remove excess lead from the body.

Penicillamine (Cuprimine, Depen)—A drug used to treat medical problems (such as excess copper in the body and rheumatoid arthritis) and to prevent kidney stones. It is also sometimes prescribed to remove excess lead from the body.

Pica—An abnormal appetite or craving for non-food items, often such substances as chalk, clay, dirt, laundry starch, or charcoal.

Succimer (Chemet)—A drug used to remove excess lead from the body.

- Mop floors and wipe windowsills and other chewable surfaces, such as cribs, twice a week with a solution of powdered dishwasher detergent in warm water.
- Plant bushes next to an older home with painted exterior walls to keep children at a distance.
- Plant grass or another ground cover in soil that is likely to be contaminated, such as soil around a home built before 1960 or located near a major highway.
- Have household tap water tested to find out if it contains lead.
- Use only water from the cold-water tap for drinking, cooking, and making baby formula, since hot water is likely to contain higher levels of lead.
- If the cold water hasn't been used for six hours or more, run it for several seconds, until it becomes as cold as it will get, before using it for drinking or cooking. The more time water has been sitting in the pipes, the more lead it may contain.
- If you work with lead in your job or hobby, change your clothes before you go home.
- Do not store food in open cans, especially imported cans.
- Do not store or serve food in pottery meant for decorative use.

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Childhood Lead Poisoning Prevention Branch, Centers for Disease Control and Prevention, 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov/nceh/lead/.

Consumer Product Safety Commission, 4330 East West Highway, Bethesda, MD, 20814, (301) 504-7923, (301) 504-0124, (800) 638-2772, http://www.cpsc.gov/.

National Safety Council, 1121 Spring Lake Dr., Itasca, IL, 60143-3201, (630) 285-1121, (630) 285-1315, (800) 621-7615, customerservice@nsc.org, http://www.nsc.org.

The National Lead Information Center, 422 S. Clinton Ave., Rochester, NY, 14620, (585) 232-3111, (800) 424-5323, http://www.epa.gov/lead.

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Learning disorders

Definition

Learning disorders are academic difficulties experienced by children and adults of average to above-average intelligence. People with learning disorders have difficulty with reading, writing, mathematics, or a combination of the three. These difficulties significantly interfere with academic achievement or daily living.

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Description

Learning disorders, or disabilities, affect approximately 2 million children between the ages of six and 17 (5% of public school children), although some experts think the figure may be as high as 15%. These children have specific impairments in acquiring, retaining, and processing information. Standardized tests place them well below their IQ range in their area of difficulty. The three main types of learning disorders are reading disorders, mathematics disorders, and disorders of written expression. The male: female ratio for learning disorders is about 5:1.

Reading disorders

Reading disorders are the most common type of learning disorder. Children with reading disorders have difficulty recognizing and interpreting letters and words (**dyslexia**). They aren't able to recognize and decode the sounds and syllables (phonetic structure) behind written words and language in general. This condition lowers accuracy and comprehension in reading.

Mathematics disorders

Children with mathematics disorders (dyscalculia) have problems recognizing and counting numbers correctly. They have difficulty using numbers in everyday settings. Mathematics disorders are typically diagnosed in the first few years of elementary school when formal teaching of numbers and basic math concepts begins. Children with mathematics disorders usually have a coexisting reading disorder, a disorder of written expression, or both.

Disorders of written expression

Disorders of written expression typically occur in combination with reading disorders or mathematics disorders or both. The condition is characterized by difficulty with written compositions (dysgraphia). Children with this type of learning disorder have problems with spelling, punctuation, grammar, and organizing their thoughts in writing.

Causes and symptoms

Learning disorders are thought to be caused by neurological abnormalities that trigger impairments in the regions of the brain that control visual and language processing and attention and planning. These traits may be genetically linked. Children from families with a history of learning disorders are more likely to develop disorders themselves. In 2003 a team of Finnish researchers reported finding a candidate gene for developmental dyslexia on human chromosome 15q21.

Learning difficulties may also be caused by such medical conditions as a traumatic brain injury or brain infections such as **encephalitis** or **meningitis**.

The defining symptom of a learning disorder is academic performance that is markedly below a child's age and grade capabilities and measured IQ. Children with a reading disorder may confuse or transpose words or letters and omit or add syllables to words. The written homework of children with disorders of written expression is filled with grammatical, spelling, punctuation, and organizational errors. The child's handwriting is often extremely poor. Children with mathematical disorders are often unable to count in the correct sequence, to name numbers, and to understand numerical concepts.

Diagnosis

Problems with vision or hearing, mental disorders (depression, attention-deficit/hyperactivity disorder), **mental retardation**, cultural and language differences, and inadequate teaching may be mistaken for learning disorders or complicate a diagnosis. A comprehensive medical, psychological, and educational assessment is critical to making a clear and correct diagnosis.

A child thought to have a learning disorder should undergo a complete medical examination to rule out an organic cause. If none is found, a psychoeducational assessment should be performed by a psychologist, psychiatrist, neurologist, neuropsychologist, or learning specialist. A complete medical, family, social, and educational history is compiled from existing medical and school records and from interviews with the child and the child's parents and teachers. A series of written and verbal tests are then given to the child to evaluate his or her cognitive and intellectual functioning. Commonly used tests include the Wechsler Intelligence Scale for Children (WISC-III), the Woodcock-Johnson Psychoeducational Battery, the Peabody Individual Achievement Test-Revised (PIAT-R) and the California Verbal Learning Test (CVLT). Federal legislation mandates that this testing is free of charge within the public school system.

Treatment

Once a learning disorder has been diagnosed, an individual education plan (IEP) is developed for the child in question. IEPs are based on psychoeducational test findings. They provide for annual retesting to measure a child's progress. Learning-disordered students may receive special instruction within a regular general education class or they may be taught in a special education or learning center for a portion of the day.

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KEY TERMS

Dyslexia—An inability to read, write, or spell words in spite of the ability to see and recognize letters. Dyslexia is an autosomal dominant disorder thst occurs more frequently in males.

IQ—Intelligence quotient; a measure of intellectual functioning determined by performance on standardized intelligence tests.

Phonics—A system to teach reading by teaching the speech sounds associated with single letters, letter combinations, and syllables.

Common strategies for the treatment of reading disorders focus first on improving a child's recognition of the sounds of letters and language through phonics training. Later strategies focus on comprehension, retention, and study skills. Students with disorders of written expression are often encouraged to keep journals and to write with a computer keyboard instead of a pencil. Instruction for students with mathematical disorders emphasizes real-world uses of arithmetic, such as balancing a checkbook or comparing prices.

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ORGANIZATIONS

Learning Disabilities Association of America, 4156 Library Road, Pittsburg, PA, 15234-1349, (412) 341-1515, (412) 344-0224, http://www.ldanatl.org/.

National Center for Learning Disabilities, 381 Park Avenue South, Suite 1401, New York, NY, 10016, (212) 545-7510, (212) 545-9665, (888) 575-7373, ncld@ncld.org, http://www.ncld.org.

The Interactive Guide to Learning Disabilities for Parents, Teachers, and Children, 2775 S. Quincy St., Arlington, VA, 22206, (703) 998-2060, http://www.ldonline.org.

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Leeches

Definition

Leeches are bloodsucking worms with segmented bodies. They belong to the same large classification of worms as earthworms and certain oceanic worms.

Leeches can primarily be found in freshwater lakes, ponds, or rivers. They range in size from 0.2 in (5 mm) to nearly 18 in (45 cm) and have two characteristic suckers located at either end of their bodies. Leeches consume the blood of a wide variety of animal hosts, ranging from fish to humans. To feed, a leech first attaches itself to the host using the suckers. One of these suckers surrounds the leech's mouth, which contains three sets of jaws that bite into the host's flesh, making a Y-shaped incision. As the leech begins

These leeches are being used to reduce venous congestion, or excessive amounts of blood in the blood vessels. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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to feed, its saliva releases chemicals that dilate blood vessels, thin the blood, and deaden the **pain** of the bite. Because of the saliva's effects, a person bitten by a leech may not even be aware of it until afterwards, when he or she sees the incision and the trickle of blood that is difficult to stop.

For centuries, leeches were a common tool of doctors, who believed that many diseases were the result of "imbalances" in the body that could be stabilized by releasing blood. For example, leeches were sometimes attached to veins in the temples to treat headaches. Advances in medical knowledge led doctors to abandon bloodletting and the use of leeches in the mid-nineteenth century. In recent years, however, doctors have found a new purpose for leeches–helping to restore blood circulation to grafted or severely injured tissue.

Purpose

There are many occasions in medicine, mostly in surgery and trauma care, when blood accumulates and causes trouble. Leeches can be used to reduce the swelling of any tissue that is holding too much blood. This problem is most likely to occur in two situations:

- Trauma. Large blood clots resulting from trauma can threaten tissue survival by their size and pressure. Blood clots can also obstruct the patient's airway.
- Surgical procedures involving reattachment of severed body parts or tissue reconstruction following burns. In these situations it is difficult for the surgeon to make a route for blood to leave the affected part and return to the circulation. The hardest part of reattaching severed extremities like fingers, toes and ears is to reconnect the tiny veins. If the veins are not reconnected, blood will accumulate in the injured area. A similar situation occurs when plastic surgeons move large flaps of skin to replace skin lost to burns, trauma or radical surgery. The skin flaps often drain blood poorly, get congested, and begin to die. Leeches have come to the rescue in both situations.

Precautions

It is important to use only leeches that have been raised in the laboratory under sterile conditions in order to protect patients from infection. Therapeutic leeches belong to one of two species–*Hirudo michaelseni* or *Hirudo medicinalis*.

Description

One or more leeches are applied to the swollen area, depending on the size of the graft or injury, and left on for several hours. The benefits of the treatment lie not in the amount of blood that the leeches ingest, but in the anti-bloodclotting (anticoagulant) enzymes in the saliva that allow blood to flow from the bite for up to six hours after the animal is detached, effectively draining away blood that could otherwise accumulate and cause tissue **death**. Leech saliva has been described as a better anticoagulant than many currently available to treat strokes and heart attacks. Active investigation of the chemicals in leech saliva is currently under way, and one anticoagulant drug, hirudin, is derived from the tissues of *Hirudo medicinalis*.

KEY TERMS

Anemia—A blood disorder marked by low hemoglobin levels in red blood cells, which leads to a deficiency of oxygen in the blood.

Anticoagulant—A chemical or medication that prevents blood from clotting.

Aftercare

The leeches are removed by pulling them off or by loosening their grip with **cocaine**, heat, or acid. The used leeches are then killed by placing them in an alcohol solution and disposed of as a biohazard. Proper care of the patient's sore is important, as is monitoring the rate at which it bleeds after the leech is removed. Any clots that form at the wound site during treatment should be removed to ensure effective blood flow.

Risks

Infection is a constant possibility until the sore heals. It is also necessary to monitor the amount of blood that the leeches have removed from the patient, since a drop in red blood cell counts could occur in rare cases of prolonged bleeding.

Resources

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J. Ricker Polsdorfer, MD

Left ventricular failure *see* **Heart failure**

Leg veins x ray *see* **Venography**

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Legg-Calvé *see* **Osteochondroses**
Legionella pneumophila infection *see* **Legionnaires' disease**
Legionellosis *see* **Legionnaires' disease**

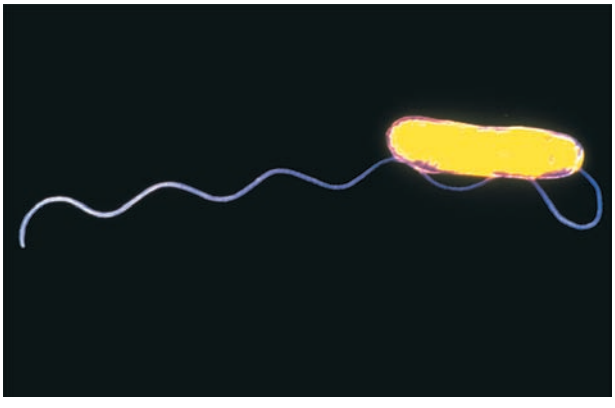
Legionnaires' disease

Definition

Legionnaires' disease is a type of **pneumonia** caused by *Legionella* bacteria. The bacterial species responsible for Legionnaires' disease is *L. pneumophila*. Major symptoms include **fever**, chills, muscle aches, and a **cough** that is initially nonproductive. Definitive diagnosis relies on specific laboratory tests for the bacteria, bacterial antigens, or antibodies produced by the body's immune system. As with other types of pneumonia, Legionnaires' disease poses the greatest threat to people who are elderly, ill, or immunocompromised.

Description

Legionella bacteria were first identified as a cause of pneumonia in 1976, following an outbreak of pneumonia among people who had attended an American Legion convention in Philadelphia, Pennsylvania. This eponymous outbreak prompted further investigation into *Legionella* and it was discovered that earlier unexplained pneumonia outbreaks were linked to the bacteria. The earliest cases of Legionnaires' disease were shown to have occurred in 1965, but samples of the bacteria exist from 1947.



A transmission electron microscopy (TEM) image of *Legionella pneumophila*, the bacteria that causes Legionnaires' disease. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Exposure to the *Legionella* bacteria doesn't necessarily lead to infection. According to some studies, an estimated 5–10% of the American population show serologic evidence of exposure, the majority of whom do not develop symptoms of an infection. *Legionella* bacteria account for 2–15% of the total number of pneumonia cases requiring hospitalization in the United States.

There are at least 40 types of *Legionella* bacteria, half of which are capable of producing disease in humans. A disease that arises from infection by *Legionella* bacteria is referred to as legionellosis. The *L. pneumophila bacterium*, the root cause of Legionnaires' disease, causes 90% of legionellosis cases. The second most common cause of legionellosis is the *L. micdadei* bacterium, which produces the Philadelphia pneumonia-causing agent.

Approximately 10,000–40,000 people in the United States develop Legionnaires' disease annually. The people who are the most likely to become ill are over age 50. The risk is greater for people who suffer from health conditions such as malignancy, diabetes, lung disease, or **kidney disease**. Other risk factors include immunosuppressive therapy and cigarette **smoking**. Legionnaires' disease has occurred in children, but typically it has been confined to newborns receiving respiratory therapy, children who have had recent operations, and children who are immunosuppressed. People with HIV infection and **AIDS** do not seem to contract Legionnaires' disease with any greater frequency than the rest of the population, however, if contracted, the disease is likely to be more severe compared to other cases.

Cases of Legionnaires' disease that occur in conjunction with an outbreak, or epidemic, are more likely to be diagnosed quickly. Early diagnosis aids effective and successful treatment. During epidemic outbreaks, fatalities have ranged from 5% for previously healthy individuals to 24% for individuals with underlying illnesses. Sporadic cases (that is, cases unrelated to a wider outbreak) are harder to detect and treatment may be delayed pending an accurate diagnosis. The overall fatality rate for sporadic cases ranges from 10–19%. The outlook is bleaker in severe cases that require respiratory support or dialysis. In such cases, fatality may reach 67%.

Causes and symptoms

Legionnaires' disease is caused by inhaling *Legionella* bacteria from the environment. Typically, the bacteria are dispersed in aerosols of contaminated water. These aerosols are produced by devices in which warm water can stagnate, such as air-conditioning cooling towers, humidifiers, shower heads, and faucets. There have also been cases linked to whirlpool spa baths and water misters in grocery store produce departments. Aspiration of contaminated water is also a potential

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source of infection, particularly in hospital-acquired cases of Legionnaires' disease. There is no evidence of person-to-person transmission of Legionnaires' disease.

Once the bacteria are in the lungs, cellular representatives of the body's immune system (alveolar macrophages) congregate to destroy the invaders. The typical macrophage defense is to phagocytose the invader and demolish it in a process analogous to swallowing and digesting it. However, the *Legionella* bacteria survive being phagocytosed. Instead of being destroyed within the macrophage, they grow and replicate, eventually killing the macrophage. When the macrophage dies, many new *Legionella* bacteria are released into the lungs and worsen the infection.

Legionnaires' disease develops 2–10 days after exposure to the bacteria. Early symptoms include lethargy, headaches, fever, chills, muscle aches, and a lack of appetite. Respiratory symptoms such as coughing or congestion are usually absent. As the disease progresses, a dry, hacking cough develops and may become productive after a few days. In about a third of Legionnaires' disease cases, blood is present in the sputum. Half of the people who develop Legionnaires' disease suffer **shortness of breath** and a third complain of breathing-related chest **pain**. The fever can become quite high, reaching 104°F (40°C) in many cases, and may be accompanied by a decreased heart rate.

Although the pneumonia affects the lungs, Legionnaires' disease is accompanied by symptoms that affect other areas of the body. About half the victims experience **diarrhea** and a quarter have **nausea and vomiting** and abdominal pain. In about 10% of cases, acute renal failure and scanty urine production accompany the disease. Changes in mental status, such as disorientation, confusion, and **hallucinations**, also occur in about a quarter of cases.

In addition to Legionnaires' disease, *L. pneumophila* legionellosis also includes a milder disease, Pontiac fever. Unlike Legionnaires' disease, Pontiac fever does not involve the lower respiratory tract. The symptoms usually appear within 36 hours of exposure and include fever, **headache**, muscle aches, and lethargy. Symptoms last only a few days and medical intervention is not necessary.

Diagnosis

The symptoms of Legionnaires' disease are common to many types of pneumonia and diagnosis of sporadic cases can be difficult. The symptoms and chest x rays that confirm a case of pneumonia are not useful in differentiating between Legionnaires' disease and other pneumonias. If a pneumonia case involves multisystem symptoms, such as diarrhea and **vomiting**, and an initially dry cough, laboratory tests are done to definitively identify *L. pneumophila* as the cause of the infection.

If Legionnaires' disease is suspected, several tests are available to reveal or indicate the presence of *L. pneumophila* bacteria in the body. Since the immune system creates antibodies against infectious agents, examining the blood for these indicators is a key test. The level of immunoglobulins, or antibody molecules, in the blood reveals the presence of infection. In microscopic examination of the patient's sputum, a fluorescent stain linked to antibodies against *L. pneumophila* can uncover the presence of the bacteria. Other means of revealing the bacteria's presence from patient sputum samples include **isolation** of the organism on culture media or detection of the bacteria by DNA probe. Another test detects *L. pneumophila* antigens in the urine.

Treatment

Most cases of *Legionella* pneumonia show improvement within 12–48 hours of starting antibiotic therapy. The antibiotic of choice has been erythromycin, sometimes paired with a second antibiotic, rifampin. Tetracycline, alone or with rifampin, is also used to treat Legionnaires' disease, but has had more mixed success in comparison to erythromycin. Other **antibiotics** that have been used successfully to combat *Legionella* include doxycycline, clarithromycin, fluorinated quinolones, and trimethoprim/sulfamethoxazole.

The type of antibiotic prescribed by the doctor depends on several factors including the severity of infection, potential **allergies**, and interaction with previously prescribed drugs. For example, erythromycin interacts with warfarin, a blood thinner. Several drugs, such as **penicillins** and **cephalosporins**, are ineffective against the infection. Although they may be deadly to the bacteria in laboratory tests, their chemical structure prevents them from being absorbed into the areas of the lung where the bacteria are present.

In severe cases with complications, antibiotic therapy may be joined by respiratory support. If renal failure occurs, dialysis is required until renal function is recovered.

Prognosis

Appropriate medical treatment has a major impact on recovery from Legionnaires' disease. Outcome is also linked to the victim's general health and absence of complications. If the patient survives the infection, recovery from Legionnaires' disease is

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KEY TERMS

Antibody—A molecule created by the immune system in response to the presence of an antigen. It serves to recognize the invader and help defend the body from infection.

Antigen—A molecule, such as a protein, which is associated with a particular infectious agent. The immune system uses this molecule as the identifying characteristic of the infectious invader.

Culture—A laboratory system for growing bacteria for further study.

DNA probe—An agent that binds directly to a predefined sequence of nucleic acids.

Immunocompromised—Refers to conditions in which the immune system is not functioning properly and cannot adequately protect the body from infection.

Immunoglobulin—The protein molecule that serves as the primary building block of antibodies.

Immunosuppressive therapy—Medical treatment in which the immune system is purposefully thwarted. Such treatment is necessary, for example, to prevent organ rejection in transplant cases.

Legionellosis—A disease caused by infection with a Legionella bacterium.

Media—Substance which contains all the nutrients necessary for bacteria to grow in a culture.

Phagocytosis—The "ingestion" of a piece of matter by a cell.

complete. Similar to other types of pneumonia, severe cases of Legionnaires' disease may cause scarring in the lung tissue as a result of the infection. Renal failure, if it occurs, is reversible and renal function returns as the patient's health improves. Occasionally, **fatigue** and weakness may linger for several months after the infection has been successfully treated.

Prevention

Since the bacteria thrive in warm stagnant water, regularly disinfecting ductwork, pipes, and other areas that may serve as breeding areas is the best method for preventing outbreaks of Legionnaires' disease. Most outbreaks of Legionnaires' disease can be traced to specific points of exposure, such as hospitals, hotels, and other places where people gather. Sporadic cases are harder to determine and there is insufficient evidence to point to exposure in individual homes.

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Julia Barrett

Leiomyomas *see* **Uterine fibroids**

Leishmaniasis

Definition

Leishmaniasis refers to several different illnesses caused by infection with a parasitic organism called a protozoan. Specifically, the organism belongs to the genus *Leishmania*. The disease is transmitted to humans from certain species of the infected female sand fly (order Dipteran) that are found in sandy areas. In the United States, the sand fly is often referred to by the terms of horse fly, greenhead, sand flea, sand gnats, and various others. In the Balkans the sand fly is called the

This condition, also called an oriental sore, is caused by the bacterium *L. tropica*. *(© Lester V. Bergman/Corbis.)*

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Balkan sore; in India, the Delhi boil; and in Iraq the Baghdad boil; while in Afghanistan it is called saldana.

Demographics

All ages of people are susceptible to the disease. However, children are at greater risk than are adults. In addition, it is more common in rural areas than in urban settings. The disease is also of greater risk to men than it is to women, probably because males tend to be outside more frequently than females and are more likely to be exposed to sand flies at a higher rate. The risk of getting the disease is higher during nighttime because sand flies are more active in darkness then in sunlight. People also at heightened risk for the disease are adventure travelers, ecotourists, and other tourists visiting areas where leishmaniasis is more common. Volunteers, missionaries, soldiers in such areas where the disease is common are also at higher risk, as are bird watchers, ornithologists (people who study birds), and people who frequently work and play outside.

Medical studies have shown that people with acquired immune deficiency syndrome (**AIDS**) have a 100 to 1,000 greater chance of developing visceral leishmaniasis, one of the four primary types of leishmaniasis.

The disease is found primarily in the tropics, subtropics, and southern Europe. In the Western Hemisphere, it is found in parts of Mexico, Central America, and South America (but not in Chile or Uruguay). In the Eastern Hemisphere, it is frequently located in parts of Asia, the Middle East, southern Europe, and Africa.

At any one time, about 12 to 20 million people throughout the world are infected with leishmaniasis. According to the U.S. Centers for Disease Control and Prevention (CDC), about 1.5 million new cases of cutaenous leishmaniasis, the most common type of the disease, are reported yearly worldwide, while about a half million new cases of visceral leishmaniasis, the second most common type, are estimated annually. It is estimated that over 80,000 deaths occur annually from the disease.

While leishmaniasis exists as a disease in about 88 countries on five continents, some countries are hit harder than others. The vast majority of cases of cutaneous leishmaniasis take place in Afghanistan, Algeria, Brazil, Iran, Iraq, Peru, Saudi Arabia, and Syria. Almost all of the cases of visceral leishmaniasis happen in Bangladesh, Brazil, India, Nepal, and Sudan. Other areas that harbor the causative protozoa include China, many countries throughout Africa, Mexico, Central and South America, Turkey, and Greece. Cases of leishmaniasis occur in the United States but only from people who have traveled outside of the country. In addition, cases of cutaneous leishmaniasis have taken place in Texas and Oklahoma. Past cases of visceral leishmaniasis have not been reported in the United States, according to the CDC.

Description

Protozoa are considered to be the most simple organisms in the animal kingdom. They are all single-celled. The blood-sucking sand fly carries the types of protozoa that cause leishmaniasis. The sand fly is referred to as the disease vector, simply meaning that the infectious agent (the protozoan) is transported by the sand fly and passed on to other animals or humans in whom the protozoan will set up residence and cause disease. The animal or human in which the protozoan then resides is referred to as the host.

Once the protozoan is within the human host, the human's immune system is activated to try to combat the invader. Specialized immune cells called macrophages work to swallow up the protozoa. Usually, this technique kills a foreign invader, but these protozoa can survive and flourish within macrophages. The protozoa multiply within the macrophages, ultimately causing the macrophage to burst open. The protozoa are released, and take up residence within other neighboring cells.

At this point, the course of the disease caused by the protozoa is dependent on the specific type of protozoa, and on the type of reaction the protozoa elicits from the immune system. There are several types of protozoa that cause leishmaniasis, and they produce different patterns of disease progression.

There are four primary types of leishmaniasis. They are:

- Localized (simple) cutaneous leishmaniasis, which is the most common type, causes a skin sore at the site of the bite. This type can then proceed to become any of the other three types.
- Diffuse cutaneous leishmaniasis, which is difficult to treat, can produce large areas of skin lesions that resemble leprosy.
- Mucocutaneous leishmaniasis, which starts with skin ulcers, is especially troublesome for the nose and mouth.
- Visceral leishmaniasis, which is the second most common type and the most serious one because it usually affects some of the internal organs (such as liver and spleen), can be fatal if not treated promptly.

Causes and symptoms

There are a number of types of protozoa that can cause leishmaniasis. Each type exists in specific

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locations, and there are different patterns to the kind of disease each causes. The overall species name is Leishmania (commonly abbreviated L.). The specific types include: *L. Donovani, L. Infantum, L. Chagasi, L. Mexicana, L. Amazonensis, L. Tropica, L. Major, L. Aethiopica, L. Brasiliensis, L. Guyaensis, L. Panamensis, L. Peruviana*. Some of the names are reflective of the locale in which the specific protozoa is most commonly found, or in which it was first discovered.

Localized cutaneous leishmaniasis

This type of disease, also called simple cutaneous leishmaniasis, occurs most commonly in China, India, Asia Minor, Africa, the Mediterranean Basin, and Central America. It has ranged in an area from northern Argentina all the way up to southern Texas. It is called different names in different locations, including chiclero ulcer, bush **yaws**, uta, oriental sore, Aleppo boil, and Baghdad sore.

This is perhaps the least drastic type of disease caused by any of the *Leishmania*. Several weeks or months after being bitten by an infected sand fly, the host may notice an itchy bump (lesion) on an arm, leg, or face. Lymph nodes in the area of this bump may be swollen. Within several months, the bump develops a crater (ulceration) in the center, with a raised, reddened ridge around it. There may be several of these lesions (sores) near each other, and they may spread into each other to form one large lesion. Often, individual lesions change in size and appearance as they develop. Eventually, they may have a raised edge and a central ulcerated area. People with sores also often have **swollen glands** near the infected areas. Although localized cutaneous leishmaniasis usually heals on its own, it may take as long as one year. A depressed, light-colored scar usually remains behind. Some lesions never heal, and may invade and destroy the tissue below. For example, lesions on the ears may slowly, but surely, invade and destroy the cartilage that supports the outer ear.

Diffuse cutaneous leishmaniasis

This type of disease occurs most often in Ethiopia, Brazil, Dominican Republic, and Venezuela.

The lesions of diffuse cutaneous leishmaniasis are very similar to those of localized cutaneous leishmaniasis, except they are spread all over the body. The body's immune system apparently fails to battle the protozoa, which are free to spread throughout. The characteristic lesions resemble those of the dread biblical disease, **leprosy**.

Mucocutaneous leishmaniasis

This type of leishmaniasis occurs primarily in the tropics of South America.

With an incubation period of from one to three months, the disease begins with the same sores noted in localized cutaneous leishmaniasis. Sometimes these primary lesions heal, other times they spread and become larger. Some years after the first lesion is noted (and sometimes several years after that lesion has totally healed), new lesions appear in the mouth and nose, and occasionally in the area between the genitalia and the anus (the perineum). These new lesions, called mucosal lesions, are particularly destructive and painful. Sometimes their appearance is delayed twenty years from the first presence of the primary lesions.

The mucosal lesions erode underlying tissue and cartilage, frequently eating through the septum (the cartilage that separates the two nostrils). If the lesions spread to the roof of the mouth and the larynx (the part of the wind pipe which contains the vocal cords), they may prevent speech. Other symptoms include **fever**, weight loss, and anemia (low red blood cell count). There is always a large danger of bacteria infecting the already open sores.

Visceral leishmaniasis

This type of leishmaniasis occurs in India, China, the southern region of Russia, and throughout Africa, the Mediterranean, and South and Central America. It is frequently called Kala-Azar or Dumdum fever.

In this disease, the protozoa use the bloodstream to travel to the liver, spleen, lymph nodes, and bone marrow. Fever may last for as long as eight weeks, disappear, and then reappear again. The lymph nodes, spleen, and liver are often quite enlarged. Weakness, **fatigue**, loss of appetite, **diarrhea**, and weight loss are common. Abnormal blood tests also result, including low red blood cell count, low **white blood cell count**, and low **platelet count**. Kala-azar translates (from the country of India) to mean "black fever." The name kala-azar comes from a characteristic of this type of leishmaniasis. Individuals with light-colored skin take on a darker, grayish skin tone, particularly of their face and hands. A variety of lesions appear on the skin.

Diagnosis

Diagnosis for each of these types of leishmaniasis involves taking a scraping from a lesion, preparing it in a laboratory, and examining it under a microscope to demonstrate the causative protozoan. Other methods that have been used include:

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KEY TERMS

Host—The organism (such as a monkey or human) in which another organism (such as a virus or bacteria) is living.

Larynx—The part of the airway lying between the pharynx and the trachea.

Leishman-Donovan body—A body of a (trypanosomatid) protozoa at a particular and characteristic stage in its life cycle; the infectious (trypanosomatid) protozoa can cause leishmaniasis, and is relatively easy to identify at that stage.

Lesion—A disruption of the normal structure and function of a tissue by some disease process.

Macrophage—A cell of the immune system that engulfs and digests foreign invaders such as bacteria and viruses in an attempt to stop them from causing disease within the body.

Protozoa—A group of organisms which are the smallest members of the animal kingdom, consisting of a single cell.

Ulceration—An area of pitting and irritation.

Vector—A carrier organism (such as a fly or mosquito) that to delivers a virus (or other agent of infection) to a host.

- Culturing a sample piece of tissue in a laboratory to allow the protozoa to multiply for easier microscopic identification.
- Injecting a mouse or hamster with a solution made of scrapings from a patient's lesion to see if the animal develops a leishmaniasis-like disease.
- Demonstrating the presence in macrophages of the characteristic-appearing protozoan, called Leishman-Donovan bodies.

In some types of leishmaniasis, a skin test (similar to that given for **tuberculosis**, or TB) may be used. In this test, a solution containing a small bit of the protozoan antigen (cell marker that causes the human immune system to react) is injected or scratched into a patient's skin. In a positive reaction, cells from the immune system will race to this spot, causing a characteristic skin lesion. Not all types of leishmaniasis cause a positive skin test, however. The CDC states that diagnosis of leishmaniasis can be difficult. Results from laboratory tests frequently come back as negative even when the person has the disease.

Treatment

The treatment of choice for all types of leishmaniasis is a type of drug containing the element antimony. These include **sodium** sitogluconate, and meglumin antimonate. When these types of drugs do not work, other medications with anti-protozoal activity are utilized, including amphotericin B, pentamidine, flagyl, and allopurinol. In 2004, it was reported that the world's first non-profit drug company was seeking approval in India for a drug to cure visceral leishmaniasis. Historically, an estimated 200,000 people die annually from the disease in that country. The company, called One World Health, hoped to offer the drug called paromomycin for a three-week treatment course. In 2006, paromomycin was approved by the Drug Controller General of India for treatment of visceral leishmaniasis.

Prognosis

The prognosis for leishmaniasis is quite variable, and depends on the specific strain of infecting protozoan, as well as the individual patient's immune system response to infection. Localized cutaneous leishmaniasis may not require any treatment. Although it may take many months, these lesions usually heal themselves completely. Only rarely do these lesions fail to heal and become more destructive.

Diffuse cutaneous leishmaniasis may smolder on for years without treatment, eventually progressing to mucocutaneous leishmaniasis, and ultimately causing **death** when the large, open lesions become infected with bacteria.

Mucocutaneous leishmaniasis is often relatively resistant to treatment. Untreated visceral leishmaniasis has a 90% death rate, but only a 10% death rate with proper treatment.

Visceral leishmaniasis has been increasingly associated with human **immunodeficiency** virus (HIV). For example, the two have appeared together in southern Europe, primarily among intravenous drug users. If treated properly, the risk from death is minimal. However, the rates of mortality in untreated cases has been shown to range from 75% to 95%. Even when death does not occur from the disease, it can leave the person disfigured and with serious deformities. Advanced cases of visceral leishmaniasis can eventually cause death if left untreated.

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Prevention

Prevention involves protecting against sand fly **bites**. Insect repellents used around homes, on clothing, on skin, and on bed nets (to protect people while sleeping) are effective measures.

Reducing the population of sand flies is also an important preventive measure. In areas where leishmaniasis is very common, recommendations include clearing the land of trees and brush for at least 984 feet (300 meters) around all villages, and regularly spraying the area with insecticides. Because rodents often carry the protozoan that causes leishmaniasis, careful rodent control should be practiced. Dogs, which also carry the protozoan, can be given a simple blood test.

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ORGANIZATIONS

Centers for Disease Control and Prevention, 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

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Leprosy

Definition

Leprosy is a slowly progressing chronic bacterial infection that affects the skin, peripheral nerves in the hands and feet, upper respiratory tract, and mucous membranes of the nose, throat, and eyes. Destruction of the nerve endings causes the affected areas to lose sensation. Leprosy is a progressive disease; that is, one that takes anywhere from six months to 40 years to develop. If left untreated, it can cause **skin lesions** and inflammatory nodules (granulomas) on the skin and nerves and, ultimately, permanent damage and disfigurement to the skin, nerves, limbs, eyes, and other body parts. It primarily affects the outer extremities such as the eyes, nose, earlobes, hands, testicles (in men), and feet.

Lesions such as these are characteristic of leprosy.
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Demographics

The World Health Organization (WHO) places the number of identified leprosy cases in the world at 212,802 as of the 2008. According to WHO, the number of new cases globally decreased by about 4% from 2007 to 2008. Seventy percent of all cases are located in just three countries: India, Indonesia, and Myanamar (Burma). The infection can be acquired, however, in the Western Hemisphere as well. According to the Department of Health and Human Services, there are about 6,500 reported cases in the United States (with approximately 3,300 of them requiring active medical intervention) as of last quarter of the 2000s. Almost all of the U.S. cases involve immigrants from developing countries. Cases also occur in some areas of the Caribbean. Although it was thought for many years that only humans are affected by the disease, 15% of wild

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armadillos in southern Texas and Louisiana have been found to be infected with *M. leprae*.

Description

Leprosy is also known as Hansen's disease after Norwegian physician Gerhard Armauer Hansen (1841–1912), who in 1878 identified the bacillus (rod-shaped bacterium) *Mycobacterium leprae* (*M leprae*) that causes the disease.

The infection is characterized by abnormal changes of the skin. These changes, called lesions, are at first flat and red. Upon enlarging, they have irregular shapes and a characteristic appearance. The lesions are typically darker in color around the edges with discolored pale centers. Because the organism grows best at lower body temperatures, the leprosy bacillus prefers the skin, the mucous membranes, and the nerves. Infection in the nerves and their eventual destruction leads to sensory loss. The loss of sensation in the fingers and toes increases the risk of injury. Inadequate care causes infection of open **wounds**. **Gangrene** may also follow, resulting in the deformation or **death** of body tissue.

Because of the disabling deformities associated with it, leprosy has been considered one of the most dreaded diseases since Biblical times (beginning at about 1500 B.C. and ending around A.D. 100), though much of what was called leprosy in the Old Testament most likely was not the same disease. Its victims were often shunned by the community, kept at arm's length, or sent to a leper colony. Many people still have misconceptions about the disease. Contrary to popular belief, it is not highly communicable and is extremely slow to develop. Household contacts of most cases and the medical personnel caring for Hansen's disease patients are not at particular risk. It is very curable, although the treatment is long-term, requiring multiple medications.

Causes and symptoms

The organism that causes leprosy is a rod-shaped bacterium called *Mycobacterium leprae*. This bacterium is related to *Mycobacterium tuberculosis*, the causative agent of **tuberculosis**. *M. leprae* is considered an obligate intracellular bacterium; that is, a bacterium that is able to grow only inside certain human and animal cells. Because special staining techniques involving acids are required to view these bacteria under the microscope, they are referred to as acid-fast bacilli (AFB).

When *Mycobacterium leprae* invades the body, one of two reactions can take place. In tuberculoid leprosy (TT), the milder form of the disease, the body's immune cells attempt to seal off the infection from the rest of the body by surrounding the offending pathogen. Because this response by the immune system occurs in the deeper layers of the skin, the hair follicles, sweat glands, and nerves can be destroyed. As a result, the skin becomes dry and discolored and loses its sensitivity. Involvement of nerves on the face, arms, or legs can cause them to enlarge and to become easily felt by the examining doctor. This finding is highly suggestive of TT. The scarcity of bacteria in this type of leprosy leads to it being referred to as paucibacillary (PB) leprosy. Seventy to eighty percent of all leprosy cases are of the tuberculoid type.

In lepromatous (LL) leprosy, which is the second and more contagious form of the disease, the body's immune system is unable to mount a strong response to the invading organism. Hence, the organism multiplies freely in the skin. This type of leprosy is also called the multibacillary (MB) leprosy, because of the presence of large numbers of bacteria. The characteristic feature of this disease is the appearance of large nodules or lesions all over the body and face. Occasionally, the mucous membranes of the eyes, nose, and throat may be involved. Facial involvement can produce a lion-like appearance (leonine facies). This type of leprosy can lead to blindness, drastic change in voice, or mutilation of the nose. Leprosy can strike anyone; however, children seem to be more susceptible than adults.

The early symptoms of leprosy are not apparent, and they may very slowly develop over many years without much notice. Well-defined skin lesions that are numb are the first symptoms of tuberculoid leprosy. **Numbness** and a decreasing ability to sense hot and cold temperatures are two other early symptoms of leprosy. Lepromatous leprosy is characterized by a chronic stuffy nose due to invasion of the mucous membranes, and the presence of nodules and lesions all over the body and face. As the disease advances, the sense of touch, **pain**, and pressure are decreased and, eventually lost. Skin lesions of hypopigmented macules (flat and pale areas of the skin) also appear, as do nearly painless ulcers and increased dryness of the eyes. Eventually, large ulcerated areas are produced. Eventually facial disfiguration develops, along with loss of fingers and toes.

Although patients with leprosy are commonly thought not to suffer pain, neuroapthic pain caused by inflammation of peripheral nerve endings is increasingly recognized as a major complication of the disease in many patients. **Corticosteroids** may be given to reduce the inflammation.

The incubation period of the leprosy bacillus varies anywhere from six months to ten years. On an average, it takes four years for the symptoms of tuberculoid

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leprosy to develop. Probably because of the slow growth of the bacillus, lepromatous leprosy develops even more slowly, taking an average of eight years for the initial lesions to appear.

It is still not very clear how the leprosy bacillus is transmitted from person to person; about 50% of patients diagnosed with the disease have a history of close contact with an infected family member. Since untreated patients have a large number of *M. leprae* bacilli in their nasal secretions, it is thought that transmission may take place via nasal droplets. The milder tubercular form of leprosy may be transmitted by insect carriers or by contact with infected soil.

Some medical researchers contend that *M. leprae* is transmitted from one human to another through nasal secretions or droplets. However, other scientists think that the bacterium enters the body through breaks in the skin. As of 2010, the specific ways that the bacterium enters the body is being investigated by scientists.

The disease appears primarily in the poorest of the world's countries. In addition, environmental factors such as overpopulated areas, unhygienic living conditions, contaminated water, risk of other immune-compromising diseases, and insufficient diet/extreme **malnutrition** may also be contributing factors adding to the risk of leprosy.

Diagnosis

Leprosy is usually diagnosed through clinical investigations. One of the hallmarks of leprosy is the presence of AFB in smears taken from the skin lesions, nasal scrapings, or tissue secretions. In patients with LL leprosy, the bacilli are easily detected; however, in TT leprosy the bacteria are very few and almost impossible to find. In such cases, a diagnosis is made based on the clinical signs and symptoms, the type and distribution of skin lesions, and history of having lived in an endemic area. Generally, laboratory analysis is not used because such labs are rarely found in these very poor countries where leprosy is mostly found.

The signs and symptoms characteristic of leprosy can be easily identified by a health worker after a short training period. There is no need for a laboratory investigation to confirm a leprosy diagnosis, except in very rare circumstances.

In an endemic area, if smears from an individual show the presence of AFB, or if he/she has typical skin lesions, then that person should definitely be regarded as having leprosy. Usually, there is slight discoloration of the skin (sometimes called hypopigmented patches of skin) and loss of skin sensitivity along with redness of the area. Thickened nerves accompanied by weakness of muscles supplied by the affected nerve are very typical of the disease. One characteristic occurrence is a foot drop where the foot cannot be flexed upwards, affecting the ability to walk.

When laboratory tests are used, such tests usually include a CBC (**complete blood count**) test, liver function test, creatinine (clearance) test, and a nerve biopsy.

Treatment

A vaccine for leprosy is still not available. The most widely used drug for leprosy is dapsone (DDS). However, the emergence of dapsone-resistant strains prompted the introduction of multidrug therapy, or MDT. MDT combines dapsone, rifampin (Rifadin; also known as rifampicin), and clofazimine (Lamprene), all of which are powerful antibacterial drugs. Patients with MB leprosy are usually treated with all three drugs, while patients with PB leprosy are only given rifampin and dapsone. Usually three months after starting treatment, a patient ceases being infectious, though not everyone with this disease is necessarily infectious before treatment. Depending on the type of leprosy, the time required for treatment may vary from six months to two years or more.

Each of the drugs has minor side effects. Dapsone can cause **nausea**, **dizziness**, **palpitations**, **jaundice**, and rash. A doctor should be contacted immediately if a rash develops. Dapsone also interacts with the second drug, rifampin. Rifampin increases the metabolizing of dapsone in the body, requiring an adjustment of the dapsone dosage. Rifampin may also cause **muscle cramps**, or nausea. If jaundice, flu-like symptoms or a rash appear, a doctor should be contacted immediately. The third drug, clofazimine may cause severe abdominal pain and **diarrhea**, as well as discoloration of the skin. Red to brownish black discoloration of the skin and bodily fluids, including sweat, may persist for months to years after use.

Thalidomide, the most famous agent of **birth defects** in the twentieth century, is now being used to treat complications of leprosy and similar diseases. Thalidomide regulates the immune response by suppressing a protein, tumor necrosis factor alpha.

Leprosy patients should be aware that treatment itself can cause a potentially serious immune system response called a lepra reaction. When **antibiotics** kill *M. leprae*, antigens (the proteins on the surface of the organism that initiate the body's immune system response) are released from the dying bacteria. In some people, when the antigens combine with the antibodies to *M. Leprae* in the bloodstream, a reaction called

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KEY TERMS

Endemic area—A geographical area where a particular disease is prevalent.

Gangrene—Death of tissue due to loss of blood supply followed by bacterial invasion and putrefaction.

Incubation period—The time it takes for symptoms to develop after initial exposure to a disease-causing organism.

Lesion—Any visible, local abnormality of the tissues of the skin, such as a wound, sore, rash, or boil.

Mucous membranes—The inner tissue that covers or lines body cavities or canals open to the outside, such as nose and mouth. These membranes secrete mucus and absorb water and salts.

Nasal scraping—Pathological material obtained for clinical study by scratching the inner surface of the nose with a clinical instrument.

Nodules—A small mass of tissue in the form of a protuberance or a knot that is solid and can be detected by touch.

Pathogen—Any disease-producing agent or microorganism.

Smear—A specimen prepared for microscopic study by spreading the material across a slide and treating it with a specific stain.

erythema nodosum leprosum may occur, resulting in new lesions and peripheral nerve damage. Cortisone-type medications and, increasingly, thalidomide are used to minimize the effects of lepra reactions.

Surgery may be performed in order to make cosmetic improvements to the patient. In some cases, severe ulcers caused by leprosy may be treated surgically with small skin grafts. In other cases, some movement of the limbs can be restored or, at least, some neural function improved.

Prognosis

Leprosy is curable; however, the deformities and nerve damage associated with leprosy are often irreversible. Prevention or **rehabilitation** of these defects is an integral part of management of the disease. **Reconstructive surgery**, aimed at preventing and correcting deformities, offers the greatest hope for disabled patients. Sometimes, the deformities are such that the patients will not benefit from this type of surgery.

Comprehensive care involves teaching patients to care for themselves. If the patients have significant nerve damage or are at high risk of developing deformities, they must be taught to take care of their insensitive limbs, similar to diabetics with lower leg nerve damage. Lacking the sensation of pain in many cases, the patients should constantly check themselves to identify cuts and **bruises**. If adequate care is not taken, these wounds become festering sores and a source of dangerous infection. Physiotherapy exercises are taught to the patients to maintain a range of movement in finger joints and prevent the deformities from worsening. Prefabricated standardized splints are available and are extremely effective in correcting and preventing certain common deformities in leprosy. Special kinds of footwear have been designed for patients with insensitive feet in order to prevent or minimize the progression of foot ulcers.

The genome of *M leprae* has been sequenced as of 2010. The completion of this project has allowed much more research to be performed in the search for better treatments and a cure for leprosy. Scientists are currently working on how the bacterium infects humans, how the infection is transmitted within the body, what the period of incubation is for the disease, and many more avenues toward solving the problem.

Prevention

By early diagnosis and appropriate treatment of infected individuals, even a disease as ancient as leprosy can be controlled. People who are in immediate contact with the leprosy patient should be tested for leprosy. Annual examinations should also be conducted on these people for a period of five years following their last contact with an infectious patient. Some physicians have advocated dapsone treatment for people in close household contact with leprosy patients.

The WHO Action Program for the Elimination of Leprosy adopted a resolution calling for the elimination of leprosy around the world by the year 2005. This goal was not reached, however; a computer simulation performed for WHO by a team of Dutch researchers in 2004 indicates that leprosy is likely to persist in some parts of the world until 2020, although its incidence will continue to decline.

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The WHO Action Program has now defined a strategy to eventually eliminate the disease as a public health problem. Members of the program hope to reach a rate of 1 or less leprosy case per 10,000 population. As of 2008, this "elimination" rate of 1 per 10,000 have been reached in most countries with the highest rates of leprosy. In 2007, the countries of Mozambique and the Democratic Republic of the Congo reached this elimination rate. Other nations of the world are nearing this elimination rate but still have areas of high concentration within their boundaries. Some of these countries include Angola, Brazil, Central African Republic, India, Madagascar, Nepal, and Tanzania.

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American Leprosy Missions, 1 ALM Way, Greenville, SC, 29601, (864) 271-7040, (800) 543-3135, (864) 271-7062, amlep@leprosy.org, http://www.leprosy.org/.

International Federation of Anti-Leprosy Associations (ILEP), 234 Blythe Road, London, United Kingdom, W14 0HJ, +44 (0) 20 7602 6925, +44 (0) 20 7371 1621, ilep@ilep.org.uk, http://www.ilep.org.uk/.

LEPRA Health in Action, 28 Middleborough, Colchester Essex, United Kingdom, CO1 1TG, +44 (0) 01206 216700, +44 (0) 01206 762151, http://www.leprahealthinaction.org/.

Leprosy Mission International, 80 Windmill Road, BrentfordMiddlesex, United Kingdom, TW8 0QH, +44 (0) 20 8326 6767, +44 (0) 20 8326 6777, friends@timint.org, http://www.leprosymission.org/.

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Leptospirosis

Definition

Leptospirosis is a febrile (**fever**) disease caused primarily by infection with the bacterium *Leptospira interrogans*, but also by other bacteria within the genus *Leptospira*. *L. interrogans* is sometimes classified as a spirochete because it has a spiral shape. It can be transmitted to humans by various wild animals such as rats, opossums, raccoons, foxes, and skunks. Domesticated animals such as dogs and livestock can also carry and transmit the disease. Humans may also acquire the disease through soil or water infected by such animals. This rare disease and contagious infection can range from very mild and symptomless to a more serious, even life-threatening form, that may be associated with kidney (renal) failure. German physician Adolf Weil (1848–1916) first described the disease in 1886. It was later observed in 1907 from a slice of renal tissue during a post mortem procedure.

Demographics

The disease is relatively rare in humans. Leptospirosis is usually found in tropical and subtropical areas, especially around stagnant or slow-moving waters, but can be present anywhere worldwide. It is also more likely to be a problem during the months of July through October and February through March. The infection is often transmitted to humans after they have drunk water contaminated with animal urine. It can also be contracted through such contamination of breaks in the skin and through mucous membranes such as the eyes.

Leptospirosis is rarely found in the continental part of the United States. However, when it is present in the United States, it is most often located in the state of Hawaii. According to the Centers for Disease Control and Prevention (CDC), between 100 and 200 cases of leptospirosis are reported in the United States each year. In addition, nearly 75% of cases of leptospirosis in North America occur in males. Further, about 50% of cases happen in Hawaii, followed by the southern Atlantic, Gulf, and Pacific coastal states. However, because of the nonspecific symptoms of leptospirosis, it is believed that the occurrence in the United States is

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actually much higher. Leptospirosis occurs year-round in North America, but about half of the cases take place between July and October.

Description

An infection by the bacterium *Leptospira interrogans* goes by different names in different regions. Alternate names for leptospirosis include mud fever, canefield fever, Rat Catcher's Yellows, seven–day fever, swamp fever, cane cutter's fever, rice field fever, Stuttgart disease, Swineherd's disease, and Fort Bragg fever. More severe cases of leptospirosis are called Weil's syndrome or icterohemorrhagic fever.

Leptospirosis is called a **zoonosis** because it is a disease of animals that can be transmitted to humans. It can be a very serious problem in the livestock industry. *Leptospira* bacteria have been found in dogs, rats, livestock, mice, voles, rabbits, hedgehogs, skunks, possums, frogs, fish, snakes, and certain birds and insects. Infected animals pass the bacteria in their urine for months, or even years. In the United States, rats and dogs are more commonly linked with human leptospirosis than other animals.

Humans are considered accidental hosts and become infected with *Leptospira interrogans* by coming into contact with urine from infected animals. Transmission of the organism occurs through direct contact with urine, or through contact with soil, water, or plants that have been contaminated by animal urine. *Leptospira interrogans* can survive for as long as six months outdoors under favorable conditions. Leptospira bacteria can enter the body through cuts or other skin damage or through mucous membranes (such as the inside of the mouth and nose). Researchers believe that the bacteria may be able to pass through intact skin, although evidence for this hypothesis has not been obtained.

Once past the skin barrier, bacteria enter the blood stream and rapidly spread throughout the body. The infection causes damage to the inner lining of blood vessels. The liver, kidneys, heart, lungs, central nervous system, and eyes may be affected.

There are two stages in the disease process. The first stage is during the active Leptospira infection and is called the bacteremic or septicemic phase. The bacteremic phase lasts from three to seven days and presents as typical flu-like symptoms. During this phase, bacteria can be found in the patient's blood and cerebrospinal fluid. The second stage, or immune phase, takes place either immediately after the bacteremic stage or after a one to three day symptom-free period. The immune phase can last up to one month. During the immune phase, symptoms are milder but **meningitis** (inflammation of spinal cord and brain tissues) is common. Bacteria can be isolated only from the urine during this second phase.

Causes and symptoms

Leptospirosis is caused primarily by an infection with the bacterium *Leptospira interrogans*. Bacteria are spread through contact with urine from infected animals. Persons at an increased risk for leptospirosis include farmers, ranchers, slaughterhouse workers, miners, animal health care workers and veterinarians, fish farmers and processors, sewage and canal workers, cane harvesters, and soldiers. High-risk activities include care of pets (especially dogs); the raising of livestock; hunting and trapping; trail biking; freshwater swimming, rafting, canoeing, and kayaking; and participating in sports within muddy fields.

Symptoms of *Leptospira* infection appear within two to 26 days following exposure to the bacteria, with 10 days being the average number of days. Because the symptoms can be nonspecific, most people who have antibodies to *Leptospira* do not remember having had an illness. Eighty five to 90% of the cases are not serious and clear up on their own. Symptoms of the first stage of leptospirosis last three to seven days and include:

- fever (with a temperature of 100–105°F [38–41°C])
- severe headache
- muscle pain
- stomach pain
- chills
- nausea
- vomiting
- diarrhea
- back pain
- joint pain
- neck stiffness
- extreme exhaustion

Dry **cough**, **sore throat**, and body rash sometimes also occur. Other symptoms, which are usually less frequently observed, are enlarged lymph glands, liver, and spleen, abnormal sounds from the lungs, skin rash, and muscle tenderness or rigidity.

Following the first stage of disease, a brief symptom-free period ensues for most patients. The symptoms of the second stage vary in each patient. Most patients have a low-grade fever, **headache**, **vomiting**, and rash. Aseptic meningitis is common in the second stage, symptoms of which include headache and **photosensitivity**

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(sensitivity of the eye to light). *Leptospira* can affect the eyes and make them cloudy and yellow to orange colored. Vision may be blurred.

Ten percent of the persons infected with *Leptospira* develop a serious disease called Weil's syndrome. The symptoms of Weil's syndrome are more severe than those described above and there is no distinction between the first and second stages of disease. The hallmark of Weil's syndrome is liver, kidney, and blood vessel disease. The signs of severe disease are apparent after 3–7 days of illness. In addition to those listed above, symptoms of Weil's syndrome include **jaundice** (yellow skin and eyes), decreased or no urine output, **hypotension** (low blood pressure), rash, anemia (decreased number of red blood cells), **shock**, and severe mental status changes. Red spots on the skin, "blood shot" eyes, and bloody sputum signal that blood vessel damage and hemorrhage have occurred.

Diagnosis

Leptospirosis can be diagnosed and treated by doctors who specialize in infectious diseases. During the bacteremic phase of the disease, the symptoms are relatively nonspecific. This often causes an initial misdiagnosis because many diseases have similar symptoms to leptospirosis. The later symptoms of jaundice and kidney failure together with the bacteremic phase symptoms suggest leptospirosis. Blood samples will be tested to look for antibodies to *Leptospira interrogans*. Blood samples taken over a period of a few days would show an increase in the number of antibodies. Isolating *Leptospira* bacteria from blood, cerebrospinal fluid (performed by spinal tap), and urine samples is diagnostic of leptospirosis. Tests for **white blood cell count** and creatine kinase may also be performed. It may take six weeks for *Leptospira* to grow in laboratory media. Most insurance companies cover the diagnosis and treatment of this infection.

Several diagnostic tests for leptospirosis have been devised that are more accurate as well as faster than standard cultures. One test uses flow cytometry light scatter analysis; this method can evaluate a sample of infected serum in as little as 90 minutes. A second technique is an IgM-enzyme-linked immunosorbent assay (ELISA), which detects the presence of IgM antibodies to *L. interrogans* in blood serum samples.

Treatment

Leptospirosis is treated with **antibiotics** (such as tetracycline or chloramphenicol), penicillin (Bicillin, Wycillin), doxycycline (Monodox, Vibramycin), or erythromycin (E-mycin, Ery-Tab). However, many doctors prefer to treat patients with ceftriaxone, which is easier to use than intravenous penicillin. Ciprofloxacin may be combined with other drugs in caring for patients who develop **uveitis**. It is generally agreed that antibiotic treatment during the first few days of illness is helpful. However, leptospirosis is often not diagnosed until the later stages of illness. The benefit of antibiotic treatment in the later stages of disease, however, is controversial. A rare complication of antibiotic therapy for leptospirosis is the occurrence of the Jarisch–Herxheimer reaction, which is characterized by fever, chills, headache, and muscle **pain**.

Patients with severe illness require hospitalization for treatment and monitoring. Medication or other treatment for pain, fever, **vomiting**, fluid loss, bleeding, mental changes, and low blood pressure may be provided. Patients with kidney failure require hemodialysis to remove waste products from the blood.

KEY TERMS

Hemodialysis—The removal of waste products from the blood stream in patients with kidney failure. Blood is removed from a vein, passed through a dialysis machine, and then put back into a vein.

Jarisch–Herxheimer reaction—A rare reaction to the dead bacteria in the blood stream following antibiotic treatment.

Meningitis—Inflammation of tissues in the brain and spinal cord. Aseptic meningitis refers to meningitis with no bacteria present in the cerebral spinal fluid.

Spirochete—Any of a family of spiral- or coil-shaped bacteria known as Spirochetae. *L. interrogans* is a spirochete, as well as are the organisms that cause syphilis and relapsing fever.

Zoonosis (plural, zoonoses)—Any disease of animals that can be transmitted to humans. Leptospirosis is an example of a zoonosis.

Prognosis

The majority of patients infected with *Leptospira interrogans* experience a complete recovery when treated promptly. Ten percent of patients develop eye inflammation (uveitis) up to one year after the illness. Other complications include excessive bleeding, meningitis, and Jarisch-Herxheimer reaction. In the United States, about one out of every 100 patients die from leptospirosis. **Death** is usually caused by kidney failure, but has

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also been caused by **myocarditis** (inflammation of heart tissue), **septic shock** (reduced blood flow to the organs because of the bacterial infection), organ failure, and/or poorly functioning lungs. Mortality is highest in patients over 60 years of age.

Prevention

Persons who are at an extremely high risk (such as soldiers training in wetlands) can be pretreated with 200 milligrams (mg) of doxycycline once a week. As of the early 2010s, no vaccine is available to prevent leptospirosis in humans, although similar vaccines have been formulated by veterinarians for dogs, swine, cattle, and other animals.

There are many ways to decrease the chances of being infected by *Leptospira*. These include:

- Avoid swimming or wading in freshwater ponds and slowly moving streams, especially those located near farms.
- Do not conduct canoe or kayak capsizing drills in freshwater ponds. Use a swimming pool instead.
- Boil or chemically treat pond or stream water before drinking it or cooking with it.
- Control rats and mice around the home.
- Have pets and farm animals vaccinated against *Leptospira*.
- Wear protective clothing (gloves, boots, long pants, and long-sleeved shirts) when working with wet soil or plants.

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American Veterinary Medical Association (AVMA), 1931 North Meacham Rd., Suite 100, Schaumburg, IL, 60173–4360, (800) 248-2862, (847) 925-1329, http://www.avma.org.

Centers for Disease Control and Prevention, 1600 Clifton Rd., Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

International Leptospirosis Society, Faculty of Medicine, Nursing and Health Sciences, Monash UniversityVictoria, Australia, 3800, +61 3 9905 4301, +61 3 9905 4302, enquiries@med.monash.edu.au, http://www.med.monash.edu.au/microbiology/staff/adler/ils.html.

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Lesch-Nyhan syndrome

Definition

Lesch-Nyhan syndrome, which is also known as HPRT deficiency or Kelley-Seegmiller syndrome, is a rare genetic disorder that affects males. Males with this syndrome develop physical handicaps, **mental retardation**, and kidney problems. It is caused by a total absence of a key enzyme that affects the level of uric acid in the body. Self-injury or **self-mutilation** is a distinctive feature of this genetic disease.

Description

Lesch-Nyhan syndrome was first described in 1964 by Drs. Michael Lesch and William Nyhan. The enzyme deficiency that causes the disorder was discovered in 1967 by a researcher named Seegmiller. The syndrome is caused by a severe change (mutation) in a gene that encodes an enzyme known as hypoxanthine-guanine phosphoribosyl transferase, or HPRT. This gene was identified and sequenced by Friedmann and colleagues in 1985. HPRT catalyzes a reaction that is necessary to prevent the buildup of uric acid, a nitrogenous waste product that is ordinarily excreted from the body through the kidneys. A severe mutation in the HPRT gene leads to an absence of HPRT enzyme activity which, in turn, leads to markedly elevated uric acid levels in the blood (hyperuricemia). This buildup of uric acid is toxic to the body and is related to the symptoms associated with the disease. Absence of the HPRT enzyme activity is also thought to alter the chemistry of certain parts of the brain, such as the basal ganglia, affecting neurotransmitters (chemicals used for communication between nerve cells), acids, and other chemicals. This change in the nervous system is also related to the symptoms associated with Lesch-Nyhan syndrome.

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Males with Lesch-Nyhan syndrome develop neurologic problems during infancy. Infants with Lesch-Nyhan syndrome have weak muscle tone (hypotonia) and are unable to develop normally. Affected males develop uncontrollable writhing movements (athetosis) and muscle stiffness (spasticity) over time. Lack of speech is also a common feature of Lesch-Nyhan syndrome. The most dramatic symptom of Lesch-Nyhan syndrome, however, is the compulsive self-injury seen in 85% of affected males. This self-injury involves the biting of their own lips, tongue, and finger tips, as well as head banging. This behavior leads to serious injury and scarring.

Lesch-Nyhan syndrome affects approximately one in 380,000 live births. It occurs evenly among races. Almost always, only male children are affected, although a few cases of the disorder in girls have been reported. Women carriers usually do not have any symptoms. Women carriers can occasionally develop inflammation of the joints (**gout**) as they get older.

Causes and symptoms

Severe changes (mutations) in the HPRT gene completely halt the activity of the enzyme HPRT. There have been many different severe mutations identified in the HPRT gene. These mutations may be different between families. The HPRT gene is located on the X chromosome. Since the HPRT gene is located on the X chromosome, Lesch-Nyhan syndrome is considered X-linked. This means that it only affects males.

A person's sex is determined by their chromosomes. Males have one X chromosome and one Y chromosome. Females, on the other hand, have two X chromosomes. Males who possess a severe mutation in their HPRT gene will develop Lesch-Nyhan syndrome. Females who possess a severe mutation in their HPRT gene will not. They are considered to be carriers. This is because females have another X chromosome without the mutation that prevents them from getting this disease. If a woman is a carrier, she has a 50% risk with any **pregnancy** to pass on her X chromosome with the mutation. Therefore, with every male pregnancy she has a 50% risk to have an affected son, and with every female pregnancy she has a 50% risk to have a daughter who is a carrier.

At birth, males with Lesch-Nyhan syndrome appear completely normal. Development is usually normal for the first few months. Symptoms develop between three to six months of age. Sand-like crystals of uric acid in the diapers may be one of the first symptoms of the disease. The baby may be unusually irritable. Typically, the first sign of nervous system impairment is the inability to lift their head or sit up at an appropriate age. Many patients with Lesch-Nyhan will never learn to walk. By the end of the first year, writhing motions (athetosis), and spasmodic movements of the limbs and facial muscles (chorea) are clear evidence of defective motor development.

The compulsive self-injury associated with Lesch-Nyhan syndrome begins, on average, at three years. The self-injury begins with biting of the lips and tongue. As the disease progresses, affected individuals frequently develop finger biting and head banging. The self-injury can increase during times of **stress**.

Males with Lesch-Nyhan disease may also develop kidney damage due to **kidney stones**. Swollen and tender joints (gout) is another common problem.

Diagnosis

The diagnosis of Lesch-Nyhan syndrome is based initially on the distinctive pattern of the child's symptoms, most commonly involuntary muscle movements or failure to crawl and walk at the usual ages. In some cases the first symptom is related to overproduction of uric acid; the parents notice "orange sand" in the child's diapers. The "sand" is actually crystals of uric acid tinged with blood.

Measuring the amount of uric acid in a person's blood or urine can not definitively diagnose Lesch-Nyhan syndrome. It is diagnosed by measuring the activity of the HPRT enzyme through a blood test. When the activity of the enzyme is very low it is diagnostic of Lesch-Nyhan syndrome. It can also be diagnosed by DNA testing. This is also a blood test. DNA testing checks for changes (mutations) in the HPRT gene. Results from DNA testing are helpful in confirming the diagnosis and also when the child's family is interested in prenatal testing for future pregnancies.

Prenatal diagnosis is possible by DNA testing of fetal tissue drawn by **amniocentesis** or **chorionic villus sampling** (CVS). Fetuses should be tested if the mother is a carrier of a change (mutation) in her HPRT gene. A woman is at risk of being a carrier if she has a son with Lesch-Nyhan syndrome or someone in her family has Lesch-Nyhan syndrome. Any woman at risk of being a carrier should have DNA testing through a blood test.

Treatment

There are no known treatments for the neurological defects of Lesch-Nyhan. Allopurinol (Aloprim,

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KEY TERMS

Amniocentesis—A procedure performed at 16–18 weeks of pregnancy in which a needle is inserted through a woman's abdomen into her uterus to draw out a small sample of the amniotic fluid from around the baby. Either the fluid itself or cells from the fluid can be used for a variety of tests to obtain information about genetic disorders and other medical conditions in the fetus.

Athetosis—A condition marked by slow, writhing, involuntary muscle movements.

Basal ganglia—A section of the brain responsible for smooth muscular movement.

Chorea—Involuntary, rapid, jerky movements.

Chorionic villus sampling (CVS)—A procedure used for prenatal diagnosis at 10–12 weeks gestation. Under ultrasound guidance a needle is inserted either through the mother's vagina or abdominal wall and a sample of cells is collected from around the early embryo. These cells are then tested for chromosome abnormalities or other genetic diseases.

Enzyme—A protein that catalyzes a biochemical reaction or change without changing its own structure or function.

Mutation—A permanent change in the genetic material that may alter a trait or characteristic of an individual, or manifest as disease, and can be transmitted to offspring.

Neurotransmitter—Chemical in the brain that transmits information from one nerve cell to another.

Palsy—Uncontrolable tremors.

Spasticity—Increased mucle tone, or stiffness, which leads to uncontrolled, awkward movements.

Zyloprim), a drug usually prescribed to lower the risk of gout attacks, can lower blood uric acid levels. This medication is a preventive; it does not correct many of the symptoms of Lesch-Nyhan. Other drugs that are given to manage spasticity include baclofen (Lioresal), which is a muscle relaxant, and benzodiazepine tranquilizers.

Some patients with Lesch-Nyhan syndrome have their teeth removed to prevent self-injury. Restraints may be recommended to reduce self-destructive behaviors, although some patients can be managed with a combination of behavioral modification therapy and medications.

Prognosis

With strong supportive care, infants born with Lesch-Nyhan can live into adulthood with symptoms continuing throughout life. Few live beyond 40, however, with **death** usually resulting either from kidney failure or from aspiration **pneumonia**. Sudden unexpected death from **respiratory failure** is common in these patients.

At present, there are no preventive measures for Lesch-Nyhan syndrome. However, recent studies have indicated that this genetic disorder may be a good candidate for treatment with gene replacement therapy. Unfortunately, the technology necessary to implement this therapy has not yet been perfected.

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ORGANIZATIONS

Genetic Alliance, Inc., 4301 Connecticut Ave., NW, Suite 404, Washington, DC, 20008-2369, (202) 966-5557, (202) 966-8553, info@geneticalliance.org, http://www.geneticalliance.org.

Lesch-Nyhan Disease International Study Group, http://www.lesch-nyhan.org/.

LND Net, http://lndnet.ning.com/.An online Lesch-Nyhan Disease support group.

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National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923, (800) 999-6673, http://www.rarediseases.org.

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Leukemia stains

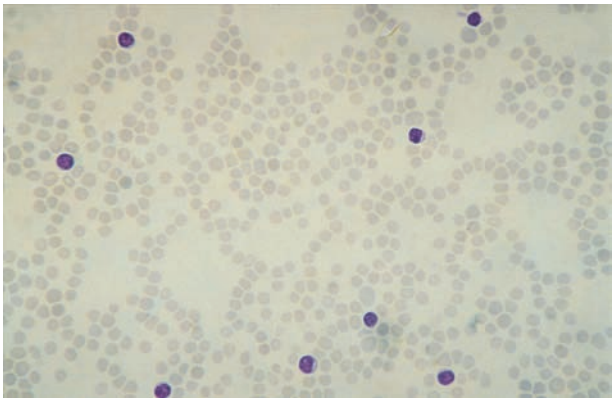
Definition

Leukemia stains are laboratory tests done on bone marrow or blood samples to help diagnose specific types of leukemia.

Purpose

Leukemia stains are done to diagnose and classify leukemia. Blood contains red cells, several varieties of white cells, and platelets. Cancerous overproduction of any one type of cell produces one of many types of leukemia. A patient's specific type of leukemia must be classified in order to provide the best treatment and most accurate prognosis.

The type and maturity of the cells involved are identified by analyzing blood and bone marrow under a microscope. Often, however, the abnormality or immaturity of the cells make it difficult to identify the cell types with certainty. Special leukemia stains help to distinguish one cell type from another.



A magnified stain of chronic lymphocytic leukemia cells. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Description

Special stains are added to bone marrow or blood that has been smeared on a microscope slide. Cell types react differently to the chemicals in the stains.

If the patient has few white cells, a buffy coat smear is made. A tube of blood is spun in a centrifuge. Red cells fall, plasma rises, and white cells settle in a thin middle layer called the buffy coat. The smear is made from this layer.

Sudan black B stain

This stain distinguishes between acute lymphoblastic leukemia (cells stain positive) and acute myeloblastic leukemia (cells stain negative).

Periodic acid-Schiff stain (PAS)

The PAS stain is primarily used to identify erythroleukemia, a leukemia of immature red blood cells. These cells stain a bright fuchsia.

Terminal deoxynucleotidyl transferase stain (TdT)

The TdT stain differentiates between acute lymphoblastic leukemia (cells stain positive) and acute myelogenous leukemia (cells stain negative).

Leukocyte alkaline phosphatase (LAP)

The LAP stain is used to determine if an increase of cells is due to chronic myelogenous leukemia or a noncancerous reaction to an infection or similar conditions. Cells from a noncancerous reaction stain positive with many intense blue granules; cells from chronic myelogenous leukemia have few blue granules.

Tartrate-resistant acid phosphatase stain (TRAP)

The TRAP stain is primarily used to identify **hairy cell leukemia** cells. These cells stain with purple to dark red granules.

Myeloperoxidase stain

The myeloperoxidase stain distinguishes between the immature cells in acute myeloblastic leukemia (cells stain positive) and those in acute lymphoblastic leukemia (cells stain negative).

Leukocyte specific esterase

This stain identifies granulocytes, which show red granules.

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KEY TERMS

Bone marrow—The spongy tissue inside large bones where blood cells are formed.

Buffy coat—The thin layer of concentrated white blood cells that forms when a tube of blood is spun in a centrifuge.

Leukemia—Any of several cancers of the bone marrow characterized by the abnormal increase of a type of blood cell.

Leukemia stains—Special stains added to smears of blood or bone marrow, performed to diagnose and classify leukemia.

Leukocyte nonspecific esterase

Nonspecific esterase stain identifies monocytes and immature platelets (megakaryocytes), which show positive black granules.

Preparation

Leukemia stains are done on smears of blood or bone marrow. To collect blood, a healthcare worker draws blood from a vein in the inner elbow region. Collection of the sample takes only a few minutes.

When bone marrow is needed, the person is given **local anesthesia**. Then the physician inserts a needle through the skin and into the bone—usually the breast bone or hip bone—and 0.5–2 mL of bone marrow is withdrawn. This procedure takes approximately 30 minutes.

Aftercare

Patients sometimes feel discomfort or bruising at the puncture site after blood collection. They may also become dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Warm packs to the puncture site relieve discomfort.

Collection of bone marrow is done under a physician's supervision. The patient is asked to rest after the procedure and is watched for weakness and signs of bleeding.

Results

A normal blood or bone marrow smear shows no evidence of leukemic cells. The expected reaction of cells varies with the type of stain.

Leukemia stain results that help diagnosis and classify leukemia are supported by the results of other laboratory tests and the person's clinical condition.

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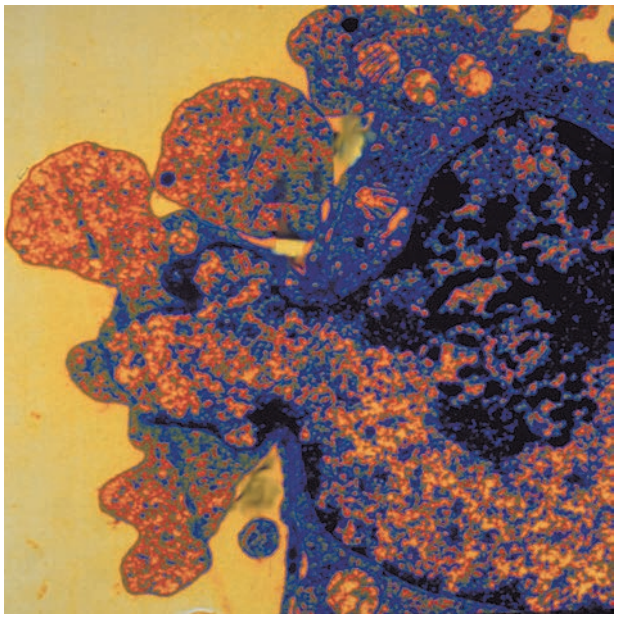
Nancy J. Nordenson

Leukemias, acute

Definition

Leukemia is a **cancer** that starts in the organs that make blood, namely the bone marrow and the lymph system. Depending on their characteristics, leukemias can be divided into two broad types. Acute leukemias are the rapidly progressing leukemias, while the **chronic leukemias** progress more slowly. The vast majority of the childhood leukemias are of the acute form.



An enhanced transmission electron microscopy (TEM) image of acute myelogenous leukemia cells. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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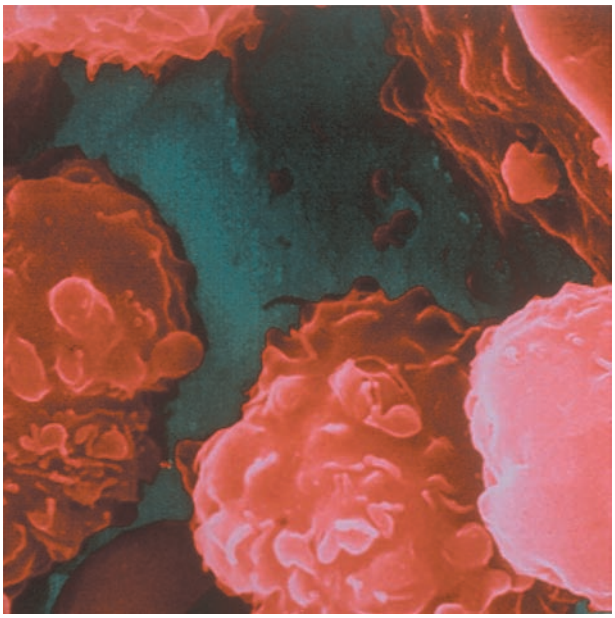

An enhanced scanning electron microscopy (SEM) image of acute myelogenous leukemia cells. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Description

The cells that make up blood are produced in the bone marrow and the lymph system. The bone marrow is the spongy tissue found in the large bones of the body. The lymph system includes the spleen (an organ in the upper abdomen), the thymus (a small organ beneath the breastbone), and the tonsils (an organ in the throat). In addition, the lymph vessels (tiny tubes that branch like blood vessels into all parts of the body) and lymph nodes (pea-shaped organs that are found along the network of lymph vessels) are also part of the lymph system. The lymph is a milky fluid that contains cells. Clusters of lymph nodes are found in the neck, underarm, pelvis, abdomen, and chest.

The cells found in the blood are the red blood cells (RBCs), which carry oxygen and other materials to all tissues of the body; white blood cells (WBCs) that fight infection; and the platelets, which play a part in the clotting of the blood. The white blood cells can be further subdivided into three main types: granulocytes, monocytes, and lymphocytes.

The granulocytes, as their name suggests, have particles (granules) inside them. These granules contain special proteins (enzymes) and several other substances that can break down chemicals and destroy microorganisms, such as bacteria. Monocytes are the second type of white blood cell. They are also important in defending the body against pathogens.

The lymphocytes form the third type of white blood cell. There are two main types of lymphocytes: T lymphocytes and B lymphocytes. They have different functions within the immune system. The B cells protect the body by making "antibodies." Antibodies are proteins that can attach to the surfaces of bacteria and viruses. This "attachment" sends signals to many other cell types to come and destroy the antibody-coated organism. The T cells protect the body against viruses. When a virus enters a cell, it produces certain proteins that are projected onto the surface of the infected cell. The T cells recognize these proteins and make certain chemicals that are capable of destroying the virus-infected cells. In addition, the T cells can destroy some types of cancer cells.

The bone marrow makes stem cells, which are the precursors of the different blood cells. These stem cells mature through stages into either RBCs, WBCs, or platelets. In acute leukemias, the maturation process of the white blood cells is interrupted. The immature cells (or "blasts") proliferate rapidly and begin to accumulate in various organs and tissues, thereby affecting their normal function. This uncontrolled proliferation of the immature cells in the bone marrow affects the production of the normal red blood cells and platelets as well.

Acute leukemias are of two types: acute lymphocytic leukemia and acute myelogenous leukemia. Different types of white blood cells are involved in the two leukemias. In acute lymphocytic leukemia (ALL), it is the T or the B lymphocytes that become cancerous. The B cell leukemias are more common than T cell leukemias. Acute myelogenous leukemia, also known as acute nonlymphocytic leukemia (ANLL), is a cancer of the monocytes and/or granulocytes.

Leukemias account for 2% of all cancers. Because leukemia is the most common form of childhood cancer, it is often regarded as a disease of childhood. However, leukemias affect nine times as many adults as children. Half of the cases occur in people who are 60 years of age or older. The incidence of acute and chronic leukemias is about the same. According to the estimates of the American Cancer Society (ACS), approximately 29,000 new cases of leukemia were diagnosed in 1998.

Causes and symptoms

Leukemia strikes both sexes and all ages. The human T-cell leukemia virus (HTLV-I) is believed to be the causative agent for some kinds of leukemias. However, the cause of most leukemias is not known. Acute lymphoid leukemia (ALL) is more common

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CHARLOTTE FRIEND (1921–1987)

(The Library of Congress.)

Charlotte Friend was born to Russian immigrants, Morris Friend and Cecilia (Wolpin), on March 11, 1921, in New York City. At three years of age, her father died of a heart condition. Friend's decision to pursue a career in medicine may well have been influenced by her father's death and by her mother's occupation as a pharmacist. As a child, Friend read books about bacteriologists and, by age ten, she knew that she wanted to study bacteriology. She attended Hunter College, enlisting in the U.S. Navy after her graduation in 1944.

Friend attended Yale University, earning her Ph.D. in bacteriology in 1950. After working for the Memorial Sloan-Kettering Institute for Cancer Research, she became an associate professor at Cornell University in 1952. Friend began researching cancer and became particularly interested in leukemia and its cause. She believed that a virus caused the disease and confirmed this theory by using an electron microscope to photograph the virus in mice. Her findings were initially met with much skepticism but she was able to develop a vaccine that was used successfully with mice, which added credibility to her theory. Her breakthroughs have led medical researchers to new methods of treating cancer and to a greater understanding of the disease.

Friend was a prolific writer who published 113 original papers, 49 abstracts, book chapters, and reviews, many of which she completed individually. She was diagnosed with lymphoma and died on January 13, 1987.

among Caucasians than among African-Americans, while acute myeloid leukemia (AML) affects both races equally. The incidence of acute leukemia is slightly higher among men than women. People with Jewish ancestry have a higher likelihood of getting leukemia. A higher incidence of leukemia has also been observed among persons with **Down syndrome** and some other genetic abnormalities.

Exposure to ionizing radiation and to certain organic chemicals, such as benzene, is believed to increase the risk of getting leukemia. Having a history of diseases that damage the bone marrow, such as **aplastic anemia**, or a history of cancers of the lymphatic system puts people at a high risk for developing acute leukemias. Similarly, the use of anticancer medications, immunosuppressants, and the antibiotic chloramphenicol are also considered risk factors for developing acute leukemias.

The symptoms of leukemia are generally vague and non-specific. A patient may experience all or some of the following symptoms:

- weakness or chronic fatigue
- fever of unknown origin
- weight loss that is not due to dieting or exercise
- frequent bacterial or viral infections
- headaches
- skin rash
- non-specific bone pain
- easy bruising
- bleeding from gums or nose
- blood in urine or stools
- enlarged lymph nodes and/or spleen
- abdominal fullness

Diagnosis

Like all cancers, acute leukemias are best treated when found early. There are no screening tests available.

If the doctor has reason to suspect leukemia, he or she will conduct a very thorough **physical**

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examination to look for enlarged lymph nodes in the neck, underarm, and pelvic region. Swollen gums, enlarged liver or spleen, **bruises**, or pinpoint red **rashes** all over the body are some of the signs of leukemia. Urine and blood tests may be ordered to check for microscopic amounts of blood in the urine and to obtain a complete differential blood count. This count will give the numbers and percentages of the different cells found in the blood. An abnormal blood test might suggest leukemia; however, the diagnosis has to be confirmed by more specific tests.

The doctor may perform a **bone marrow biopsy** to confirm the diagnosis of leukemia. During the biopsy, a cylindrical piece of bone and marrow is removed. The tissue is generally taken out of the hipbone. These samples are sent to the laboratory for examination. In addition to diagnosis, the biopsy is also repeated during the treatment phase of the disease to see if the leukemia is responding to therapy.

A spinal tap (**lumbar puncture**) is another procedure that the doctor may order to diagnose leukemia. In this procedure, a small needle is inserted into the spinal cavity in the lower back to withdraw some cerebrospinal fluid and to look for leukemic cells.

Standard imaging tests, such as x rays, **computed tomography scans** (CT scans), and **magnetic resonance imaging** (MRI) may be used to check whether the leukemic cells have invaded other areas of the body, such as the bones, chest, kidneys, abdomen, or brain. A gallium scan or **bone scan** is a test in which a radioactive chemical is injected into the body. This chemical accumulates in the areas of cancer or infection, allowing them to be viewed with a special camera.

Treatment

There are two phases of treatment for leukemia. The first phase is called "induction therapy." As the name suggests, during this phase, the main aim of the treatment is to reduce the number of leukemic cells as far as possible and induce a remission in the patient. Once the patient shows no obvious signs of leukemia (no leukemic cells are detected in blood tests and bone marrow biopsies), the patient is said to be in remission. The second phase of treatment is then initiated. This is called continuation or maintenance therapy, and the aim in this case is to kill any remaining cells and to maintain the remission for as long as possible.

Chemotherapy is the use of drugs to kill cancer cells. It is usually the treatment of choice and is used to relieve symptoms and achieve long-term remission of the disease. Generally, combination chemotherapy, in which multiple drugs are used, is more efficient than using a single drug for the treatment. Some drugs may be administered intravenously through a vein in the arm; others may be given by mouth in the form of pills. If the cancer cells have invaded the brain, then chemotherapeutic drugs may be put into the fluid that surrounds the brain through a needle in the brain or back. This is known as intrathecal chemotherapy.

Because leukemia cells can spread to all the organs via the blood stream and the lymph vessels, surgery is not considered an option for treating leukemias.

Radiation therapy, which involves the use of x rays or other high-energy rays to kill cancer cells and shrink tumors, may be used in some cases. For acute leukemias, the source of radiation is usually outside the body (external radiation therapy). If the leukemic cells have spread to the brain, radiation therapy can be given to the brain.

Bone marrow transplantation is a process in which the patient's diseased bone marrow is replaced with healthy marrow. There are two ways of doing a bone marrow transplant. In an allogeneic bone marrow transplant, healthy marrow is taken from a donor whose tissue is either the same as or very closely resembles the patient's tissues. The donor may be a twin, a brother or sister (sibling), or a person who is not related at all. First, the patient's bone marrow is destroyed with very high doses of chemotherapy and radiation therapy. Healthy marrow from the donor is then given to the patient through a needle in a vein to replace the destroyed marrow.

In the second type of bone marrow transplant, called an autologous bone marrow transplant, some of the patient's own marrow is taken out and treated with a combination of **anticancer drugs** to kill all the abnormal cells. This marrow is then frozen to save it. The marrow remaining in the patient's body is destroyed with high-dose chemotherapy and radiation therapy. The marrow that was frozen is then thawed and given back to the patient through a needle in a vein. This mode of bone marrow transplant is currently being investigated in clinical trials.

Biological therapy or immunotherapy is a mode of treatment in which the body's own immune system is harnessed to fight the cancer. Substances that are routinely made by the immune system (such as growth factors, hormones, and disease-fighting proteins) are either synthetically made in a laboratory or their effectiveness is boosted and they are then put back into the patient's body. This treatment mode is also being investigated in clinical trials all over the country at major cancer centers.

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KEY TERMS

Antibodies—Proteins made by the B lymphocytes in response to the presence of infectious agents, such as bacteria or viruses, in the body.

Biopsy—The surgical removal and microscopic examination of living tissue for diagnostic purposes.

Chemotherapy—Treatment with drugs that act against cancer.

Computerized tomography (CT) scan—A series of x rays put together by a computer in order to form detailed pictures of areas inside the body.

Cytokines—Chemicals made by the cells that act on other cells to stimulate or inhibit their function. Cytokines that stimulate growth are called "growth factors."

Immunotherapy—Treatment of cancer by stimulating the body's immune defense system.

Lumbar puncture—A procedure in which the doctor inserts a small needle into the spinal cavity in the lower back to withdraw some spinal fluid for testing. Also known as a "spinal tap."

Magnetic resonance imaging (MRI)—A medical procedure using a magnet linked to a computer to picture areas inside the body.

Maturation—The process by which stem cells transform from immature cells without a specific function into a particular type of blood cell with defined functions.

Radiation therapy—Treatment using high-energy radiation from x-ray machines, cobalt, radium, or other sources.

Remission—A disappearance of a disease as a result of treatment. Complete remission means that all disease is gone. Partial remission means that the disease is significantly improved by treatment, but residual traces of the disease are still present.

Prognosis

Like all cancers, the prognosis for leukemia depends on the patient's age and general health. According to statistics, more than 60% of the patients with leukemia survive for at least a year after diagnosis. Acute myelocytic leukemia (AML) has a poorer prognosis rate than acute lymphocytic leukemias (ALL) and the chronic leukemias. In the last 15 to 20 years, the five-year survival rate for patients with ALL has increased from 38% to 57%.

Interestingly enough, since most childhood leukemias are of the ALL type, chemotherapy has been highly successful in their treatment. This is because chemotherapeutic drugs are most effective against actively growing cells. Due to the new combinations of anticancer drugs being used, the survival rates among children with ALL have improved dramatically. Eighty percent of the children diagnosed with ALL now survive for five years or more, as compared to 50% in the late 1970s.

Prevention

Most cancers can be prevented by changes in lifestyle or diet, which will reduce the risk factors. However, in leukemias, there are no such known risk factors. Therefore, at the present time, no way is known to prevent leukemias from developing. People who are at an increased risk for developing leukemia because of proven exposure to ionizing radiation or exposure to the toxic liquid benzene, and people with Down syndrome, should undergo periodic medical checkups.

ORGANIZATIONS

American Cancer Society, 250 Williams Street, Atlanta, GA, 30303-1002, (800) ACS-2345, https://www.cancer.org/.

National Cancer Institute, 6116 Executive Blvd., Room 3036A, Bethesda, MD, 20892-8322, (800) 422-6237, http://www.cancer.gov.

Leukemia Society of America, Inc., 600 Third Ave, New York, NY, 20892-8322, (800) 955-4572, http://www.leukemia.org.

Lata Cherath, PhD

Leukemias, chronic

Definition

Chronic leukemia is a disease in which too many white blood cells are made in the bone marrow. Depending on the type of white blood cell that is

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involved, chronic leukemia can be classified as chronic lymphocytic leukemia or chronic myeloid leukemia.

Description

Chronic leukemia is a **cancer** that starts in the blood cells made in the bone marrow. The bone marrow is the spongy tissue found in the large bones of the body. The bone marrow makes precursor cells called "blasts" or "stem cells" that mature into different types of blood cells. Unlike **acute leukemias**, in which the process of maturation of the blast cells is interrupted, in chronic leukemias, the cells do mature and only a few remain as immature cells. However, even though the cells appear normal, they do not function as normal cells.

The different types of cells that are produced in the bone marrow are red blood cells (RBCs), which carry oxygen and other materials to all tissues of the body; white blood cells (WBCs), which fight infection; and platelets, which play a part in the clotting of the blood. The white blood cells can be further subdivided into three main types: the granulocytes, monocytes, and the lymphocytes.

The granulocytes, as their name suggests, have granules (particles) inside them. These granules contain special proteins (enzymes) and several other substances that can break down chemicals and destroy microorganisms such as bacteria.

Monocytes are the second type of white blood cell. They are also important in defending the body against pathogens.

The lymphocytes form the third type of white blood cell. There are two main types of lymphocytes: T lymphocytes and B lymphocytes. They have different functions within the immune system. The B cells protect the body by making "antibodies." Antibodies are proteins that can attach to the surfaces of bacteria and viruses. This attachment sends signals to many other cell types to come and destroy the antibody-coated organism. The T cell protects the body against viruses. When a virus enters a cell, it produces certain proteins that are projected onto the surface of the infected cell. The T cells can recognize these proteins and produce certain chemicals (cytokines) that are capable of destroying the virus-infected cells. In addition, the T cells can destroy some types of cancer cells.

Chronic leukemias develop very gradually. The abnormal lymphocytes multiply slowly, but in a poorly regulated manner. They live much longer and thus their numbers build up in the body. The two types of chronic leukemias can be easily distinguished under the microscope. Chronic lymphocytic leukemia (CLL) involves the T or B lymphocytes. B cell abnormalities are more common than T cell abnormalities. T cells are affected in only 5% of the patients. The T and B lymphocytes can be differentiated from the other types of white blood cells based on their size and by the absence of granules inside them. In chronic myelogenous leukemia (CML), the cells that are affected are the granulocytes.

Chronic lymphocytic leukemia (CLL) often has no symptoms at first and may remain undetected for a long time. Chronic myelogenous leukemia (CML), on the other hand, may progress to a more acute form.

Chronic leukemias account for 1.2% of all cancers. Because leukemia is the most common form of childhood cancer, it is often regarded as a disease of childhood. However, leukemias affect nine times as many adults as children. In chronic lymphoid leukemia, 90% of the cases are seen in people who are 50 years or older, with the average age at diagnosis being 65. The incidence of the disease increases with age. It is almost never seen in children. Chronic myeloid leukemias are generally seen in people in their mid-40s. It accounts for about 4% of childhood leukemia cases. According to the estimates of the American Cancer Society (ACS), approximately 29,000 new cases of leukemia will be diagnosed in 1998.

Causes and symptoms

Leukemia strikes both sexes and all ages. Although the cause is unknown, chronic leukemia is linked to genetic abnormalities and environmental factors. For example, exposure to ionizing radiation and to certain organic chemicals, such as benzene, is believed to increase the risks for getting leukemia. Chronic leukemia occurs in some people who are infected with two human retroviruses (HTLV-I and HTLV-II). An abnormal chromosome known as the Philadelphia chromosome is seen in 90% of those with CML. The incidence of chronic leukemia is slightly higher among men than women.

The symptoms of chronic leukemia are generally vague and non-specific. In chronic lymphoid leukemia (CLL), a patient may experience all or some of the following symptoms:

- swollen lymph nodes
- an enlarged spleen, which could make the patient complain of abdominal fullness
- chronic fatigue
- a general feeling of ill-health
- fever of unknown origin
- night sweats
- weight loss that is not due to dieting or exercise
- frequent bacterial or viral infections

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In the early stages of chronic myeloid leukemia (CML), the symptoms are more or less similar to CLL. In the later stages of the disease, the patient may experience these symptoms:

- non-specific bone pain
- bleeding problems
- mucus membrane irritation
- frequent infections
- a pale color due to a low red blood cell count (anemia)
- swollen lymph glands
- fever
- night sweats

Diagnosis

There are no screening tests available for chronic leukemias. The detection of these diseases may occur by chance during a routine **physical examination**.

If the doctor has reason to suspect leukemia, he or she will conduct a very thorough physical examination to look for enlarged lymph nodes in the neck, underarm, and pelvic region. Swollen gums, an enlarged liver or spleen, **bruises**, or pinpoint red **rashes** all over the body are some of the signs of leukemia. Urine and blood tests may be ordered to check for microscopic amounts of blood in the urine and to obtain a complete differential blood count. This count will give the numbers and percentages of the different cells found in the blood. An abnormal blood test might suggest leukemia; however, the diagnosis has to be confirmed by more specific tests.

The doctor may perform a **bone marrow biopsy** to confirm the diagnosis of leukemia. During the bone marrow biopsy, a cylindrical piece of bone and marrow is removed. The tissue is generally taken out of the hipbone. These samples are sent to the laboratory for examination. In addition to diagnosis, bone marrow biopsy is also done during the treatment phase of the disease to see if the leukemia is responding to therapy.

Standard imaging tests such as x rays, **computed tomography scans** (CT scans), and **magnetic resonance imaging** (MRI) may be used to check whether the leukemic cells have invaded other organs of the body, such as the bones, chest, kidneys, abdomen, or brain.

Treatment

The treatment depends on the specific type of chronic leukemia and its stage. In general, **chemotherapy** is the standard approach to both CLL and CML. **Radiation therapy** is occasionally used. Because leukemia cells can spread to all the organs via the blood stream and the lymph vessels, surgery is not considered an option for treating leukemias.

Bone marrow transplantation (BMT) is becoming the treatment of choice for CML because it has the possibility of curing the illness. BMT is generally not considered an option in treating CLL because CLL primarily affects older people, who are not considered to be good candidates for the procedure.

In BMT, the patient's diseased bone marrow is replaced with healthy marrow. There are two ways of doing a bone marrow transplant. In an allogeneic bone marrow transplant, healthy marrow is taken from another person (donor) whose tissue is either the same or very closely resembles the patient's tissues. The donor may be a twin, a sibling, or a person who is not related at all. First, the patient's bone marrow is destroyed with very high doses of chemotherapy and radiation therapy. To replace the destroyed marrow, healthy marrow from the donor is given to the patient through a needle in the vein.

In the second type of bone marrow transplant, called an autologous bone marrow transplant, some of the patient's own marrow is taken out and treated with a combination of **anticancer drugs** to kill all the abnormal cells. This marrow is then frozen to save it. The marrow remaining in the patient's body is then destroyed with high dose chemotherapy and radiation therapy. Following that, the patient's own marrow that was frozen is thawed and given back to the patient through a needle in the vein. This mode of bone marrow transplant is currently being investigated in clinical trials.

In chronic lymphoid leukemia (CLL), chemotherapy is generally the treatment of choice. Depending on the stage of the disease, single or multiple drugs may be given. Drugs commonly prescribed include **steroids**, chlorambucil, fludarabine, and cladribine. Low dose radiation therapy may be given to the whole body, or it may be used to alleviate the symptoms and discomfort due to an enlarged spleen and lymph nodes. The spleen may be removed in a procedure called a **splenectomy**.

In chronic myeloid leukemia (CML), the treatment of choice is bone marrow transplantation. During the slow progress (chronic phase) of the disease, chemotherapy may be given to try to improve the cell counts. Radiation therapy, which involves the use of x rays or other high-energy rays to kill cancer cells and shrink tumors, may be used in some cases to reduce the discomfort and **pain** due to an enlarged spleen. For chronic leukemias, the source of radiation is usually outside the body (external radiation therapy). If the

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KEY TERMS

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Remission—A disappearance of a disease as a result of treatment. Complete remission means that all disease is gone. Partial remission means that the disease is significantly improved by treatment, but residual traces of the disease are still present.

leukemic cells have spread to the brain, radiation therapy can be directed at the brain. As the disease progresses, the spleen may be removed in an attempt to try to control the pain and to improve the blood counts.

In the acute phase of CML, aggressive chemotherapy is given. Combination chemotherapy, in which multiple drugs are used, is more efficient than using a single drug for the treatment. The drugs may either be administered intravenously through a vein in the arm or by mouth in the form of pills. If the cancer cells have invaded the central nervous system (CNS), chemotherapeutic drugs may be put into the fluid that surrounds the brain through a needle in the brain or back. This is known as intrathecal chemotherapy.

Biological therapy or immunotherapy is a mode of treatment in which the body's own immune system is harnessed to fight the cancer. Substances that are routinely made by the immune system (such as growth factors, hormones, and disease-fighting proteins) are either synthetically made in a laboratory, or their effectiveness is boosted and they are then put back into the patient's body. This treatment mode is also being investigated in clinical trials all over the country at major cancer centers.

Prognosis

The prognosis for leukemia depends on the patient's age and general health. According to statistics, in chronic lymphoid leukemia, the overall survival for all stages of the disease is nine years. Most of the deaths in people with CLL are due to infections or other illnesses that occur as a result of the leukemia.

In CML, if bone marrow transplantation is performed within one to three years of diagnosis, 50–60% of the patients survive three years or more. If the disease progresses to the acute phase, the prognosis is poor. Less than 20% of these patients go into remission.

Prevention

Most cancers can be prevented by changes in lifestyle or diet, which will reduce the risk factors. However, in leukemias, there are no known risk factors. Therefore, at the present time, there is no way known to prevent the leukemias from developing. People who are at an increased risk for developing leukemia because of proven exposure to ionizing radiation, the organic liquid benzene, or people who have a history of other cancers of the lymphoid system (Hodgkin's lymphoma) should undergo periodic medical checkups.

ORGANIZATIONS

American Cancer Society, 250 Williams Street, Atlanta, GA, 30303-1002, (800) ACS-2345, https://www.cancer.org/.

National Cancer Institute, 6116 Executive Blvd., Room 3036A, Bethesda, MD, 20892-8322, (800) 422-6237, http://www.cancer.gov.

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Leukemia Society of America, Inc., 600 Third Ave, New York, NY, 20892-8322, (800) 955 4572, http://www.leukemia.org.

Lata Cherath, PhD

Leukocytosis

Definition

Leukocytosis is a condition characterized by an elevated number of white cells in the blood.

Description

Leukocytosis is a condition that affects all types of white blood cells. Other illnesses, such as neutrophilia, lymphocytosis, and granulocytosis, target specific types of white blood cells. Normal white blood cell counts are 4,300–10,800 white blood cells per microliter. Leukocyte or white blood cell levels are considered elevated when they are between 15,000–20,000 per microliter. The increased number of leukocytes can occur abnormally as a result of an infection, **cancer**, or drug intake; however, leukocytosis can occur normally after eating a large meal or experiencing **stress**.

Causes and symptoms

Leukemias can cause white blood cell counts to increase to as much as 100,000. Each kind of white cell can produce a leukemia. Apart from leukemias, nearly all leukocytosis is due to one type of white blood cell, the polymorphonuclear leukocyte (PMN). These conditions are more accurately referred to as neutrophilia.

The most common and important cause of neutrophilia is infection, and most infections cause neutrophilia. The degree of elevation often indicates the severity of the infection. Tissue damage from other causes raises the white count for similar reasons. **Burns**, infarction (cutting off the blood supply to a region of the body so that it dies), crush injuries, inflammatory diseases, poisonings, and severe diseases, like kidney failure and **diabetic ketoacidosis**, all cause neutrophilia.

Counts almost as high occur in leukemoid (leukemia-like) reactions caused by infection and non-infectious inflammation.

Drugs can also cause leukocytosis. Cortisone-like drugs (prednisone), lithium, and NSAIDs are the most common offenders.

KEY TERMS

Biopsy—Surgical removal of tissue for examination.

Inflammation—Heat, swelling, redness, and pain caused by tissue injury.

Ketoacidosis—A severe stage of diabetes where acids and ketones accumulate in the body.

NSAID—Non-steroidal anti-inflammatory drug such as ibuprofen.

Non-specific stresses also cause white blood cells to increase in the blood. Extensive testing of medical students reveals that neutrophilia accompanies every examination. Vigorous **exercise** and intense excitement also cause elevated white blood cell counts.

Diagnosis

A **complete blood count** (CBC) is one of the first tests obtained in any medical setting. More than 11,000 white cells in a cubic millimeter of blood is considered high. **Bone marrow biopsy** may help clarify the cause.

Treatment

Relieving the underlying cause returns the count to normal.

Prognosis

By treating the underlying condition, white blood cell counts usually return to normal

Resources

BOOKS

Fauci, Anthony S., et al., eds. *Harrison's Principles of Internal Medicine*. 17th ed. New York: McGraw–Hill Professional, 2008.

J. Ricker Polsdorfer, MD

Leukotriene inhibitors

Definition

Leukotriene inhibitors are prescription medications that treat **asthma** and some **allergies** by blocking

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the formation or activity of leukotrienes—small mediator chemicals produced by cells in the body.

Purpose

More than 50 million Americans suffer from asthma and allergies. Asthma is one of the most prevalent chronic diseases in the United States, affecting 9 million (12.7%) of children. Seasonal allergies affect 20–40 million (20%) of Americans, about 40% of them children. It is estimated that 60–70% of those with asthma also suffer from **allergic rhinitis**, allergies affecting the mucous membranes of the nose.

Asthma, an inflammation of the bronchial airways, and seasonal allergies and allergic **rhinitis** involve several chemical mediators including histamine and leukotrienes. Leukotrienes are a class of unsaturated fatty-acid chains containing 20 carbon atoms.

During an asthma attack or within minutes of exposure to an allergen such as dust or pollen, leukotrienes are released by a type of blood cell in the lungs, causing the following responses:

- contraction of the bronchial airway muscles
- inflammation of the airway linings
- swelling and narrowing of the airways
- production of mucus and fluid
- wheezing and shortness of breath
- nasal congestion

Leukotriene inhibitors may decrease the symptoms of mild to moderate allergen-induced asthma, improve nighttime symptoms, and reduce the number of acute asthma attacks. Taken daily on a long-term basis they may help to prevent or control the symptoms of persistent asthma—asthma with symptoms that last at least two days per week or two nights per month. They also are prescribed for children with frequent or more severe asthma attacks and for those who dislike or have difficulty using asthma inhalers. Although leukotriene inhibitors may decrease the need for inhaled beta-agonists or **corticosteroids**, they are not used to treat asthma attacks. Leukotriene inhibitors also may be used to treat symptoms of allergic rhinitis or short-term seasonal allergies, including sneezing, runny nose, **itching**, and **wheezing**.

Description

Leukotriene inhibitors are often called leukotriene:

- blockers
- modifiers
- antagonists
- pathway modifiers

When they were first introduced in 1996, leukotriene inhibitors represented the first new class of asthma medication in two decades. Classified as anti-inflammatories, they were originally developed to improve lung function in asthmatics by relaxing the smooth muscles around the bronchial airways and by reducing lung inflammation.

Types of leukotriene inhibitors

The available leukotriene inhibitors are: montelukast (Singulair), zafirlukast (Accolate), and zileuton (Zyflo).

Montelukast and zafirlukast are leukotriene-receptor antagonists that prevent leukotriene from binding to cell receptors and initiating the chain of events leading to symptoms of allergy and asthma. Montelukast works rapidly. It is the only leukotriene inhibitor that has been approved by the U.S. Food and Drug Administration (FDA) for use in children as young as two, as well as for the treatment of seasonal allergies.

Zafirlukast is a synthetic peptide that inhibits the receptor binding of three leukotreines (LTC4, LTD4, and LTE4) that cause smooth muscle constriction. It is used for mild to moderate persistent asthma, exercise-induced asthma, and the management of allergic rhinitis in those aged seven and older.

Zileuton is a 5-lipooxygenase pathway inhibitor that interferes with the synthesis of LTA4, LTC4, LTD4, and LTE4. It is used to treat chronic asthma in adolescents and adults.

Effectiveness

Leukotriene inhibitors may be prescribed along with **inhaled corticosteroids** for control of mild to moderate, persistent asthma. Used alone they are less effective than low-dose inhaled corticosteroids. However, they enable some people to reduce their doses of inhaled corticosteroids. Leukotriene inhibitors may be an option for people with mild asthma who want to avoid corticosteroids, which can cause serious side effects with long-term use. When used in conjunction with beta-agonists, leukotriene inhibitors reduce symptoms and may lower the beta-agonist usage.

Leukotriene inhibitors appear to decrease the symptoms of seasonal allergic rhinitis. Although they may relieve nasal congestion better than **antihistamines**, they are less effective than corticosteroid nasal sprays. A leukotriene inhibitor combined with

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an antihistamine may be more effective than either drug alone.

Leukotriene inhibitors have helped some children who suffer from nocturnal asthma, exercise- and aspirin-induced asthma, allergic rhinitis, and seasonal allergies.

Clinical studies

Montelukast appears to be an effective asthma controller in about one-third of patients. Another one-third receives no benefit. However, most long-term studies have found that standard inhaled corticosteroids are more effective for controlling asthma than either beta-agonists or leukotriene inhibitors.

A 2003 analysis of 13 clinical studies found that Singulair and Accolate resulted in 60% more asthma flare-ups and other symptoms as compared with traditional asthma treatments. Patients using inhaled corticosteroids had fewer daytime symptoms and night awakenings than those taking Singulair or Accolate. The researchers advised against switching to a leukotriene inhibiter unless the dosage of inhaled medication is less than 400 micrograms per day.

A 2005 study sponsored by Merck, the maker of Singulair, found that a one-year course of Singulair was useful for treating two- to five-year-olds with occasional asthma attacks that were triggered by respiratory infections. Singulair reduced this type of asthma flare-up by 32% as compared with a control group receiving a placebo. Singulair also delayed the onset of the first asthma flare-up and reduced the need for inhaled medication. However, it did not reduce the length or severity of the flare-up once it had begun. The researchers suggested that children with infection-triggered asthma should begin taking a leukotriene inhibitor before the start of the flu season or at the onset of an upper-respiratory-tract infection.

Another 2005 study found that children whose asthma improved with montelukast alone were younger and had had asthma for a shorter period of time as compared with children whose asthma improved only with inhaled corticosteroids. Among the children whose lung function improved by at least 7.5%, 5% took montelukast alone, 23% were on inhaled corticosteroids only, and 17% were on both medications.

Other uses

Leukotriene inhibitors have been used successfully to treat inflammations of the esophagus (esophagitis) or stomach and intestines (**gastroenteritis**) that are caused by white blood cells called eosinophils that are involved in allergic reactions. Montelukast has been used to successfully treat symptoms of interstitial **cystitis**, a chronic inflammation of the bladder.

Recommended dosage

Montelukast is taken once per day in the evening so as to relieve morning allergy symptoms. Although dosing may vary, average daily doses of montelukast for asthma and seasonal allergies are: children aged 1–5: one 4-mg chewable tablet or 4-mg oral granules (one packet), swallowed whole or mixed in a spoonful of soft food; children aged 6–14: one 5-mg chewable tablet; children over 14 and adults: one 10-mg tablet.

The average doses of zafirlukast for children aged 7–11 are 10-mg tablets twice a day. Children aged 12 and older and adults usually take 20-mg tablets twice a day. Zafirlukast is taken one hour before or two hours after a meal, since food reduces its bioavailability by about 49%.

The average dose of zileuton is a 600-mg tablet four times per day for children aged 12 and older and adults.

Leukotriene inhibitors are expensive. Missed doses should be taken as soon as possible unless it is almost time for the next dose, in which case the dose should be skipped.

Precautions

Although leukotriene inhibitors are considered safe, they can raise the levels of liver enzymes. The FDA recommends **liver function tests** monthly for the first three months on medication, followed by quarterly monitoring for the next year, and continued interim testing. Zileuton is contraindicated for those with elevated liver enzymes, active **alcoholism**, or **liver disease**. Increased levels of liver enzymes may be detectable in the blood within two months of starting zileuton. Zileuton can affect liver function and, one rare occasions, can damage the liver.

It is unclear whether leukotriene inhibitors should be taken during **pregnancy**. Zafirlukast and zileuton should not be used by a woman who is **breastfeeding**. Both medications have been found to increase the risk of mild to moderate respiratory tract infections in patients aged 55 and older.

Medical conditions that may interfere with the use of montelukast include: allergies to **aspirin** or non-steroidal anti-inflammatories (NSAIDs); liver disease, which can increase the blood levels of the drug; and **phenylketonuria** because chewable tablets may contain aspartame.

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KEY TERMS

Allergic rhinitis—Nasal symptoms caused by an allergic reaction.

Asthma—A disease that causes the bronchial airways to narrow, swell, and produce mucus, making breathing difficult.

Beta-agonist—Beta2-agonist; beta-adrenergic agonist; a bronchodilator medication—inhaled or oral—that relaxes the muscles surrounding the airways to relieve asthma symptoms.

Corticosteroids—Inhaled medications for long-term control of asthma.

Leukotrienes—A class of small molecules produced by cells in response to allergen exposure; they contribute to allergy and asthma symptoms.

Montelukast (Singulair)—An inhibitor that prevents leukotrienes from binding to cell receptors; taken over time, montelukast can reduce or prevent symptoms of asthma and allergies.

Zafirlukast (Accolate)—An inhibitor that prevents leukotrienes from binding to cell receptors; taken over time, zafirlukast can help reduce or prevent asthma symptoms.

Zileuton (Zyflo)—A medication that interferes with the biosynthetic pathway that produces leukotrienes; used to help prevent asthma attacks.

A healthcare provider should be contacted if an increased number of short-acting bronchodilator inhalations are needed to relieve an acute asthma attack or if more than the maximum number of daily inhalations are required while using zileuton.

To be effective montelukast and zafirlukast must be taken at the same time every day. Zileuton must be taken at regularly spaced intervals every day, even if asthma symptoms appear to improve. Montelukast should be continued through an acute asthma attack in addition to rescue medication.

Side effects

Although leukotriene inhibitors generally have few side effects and those may subside as the body adjusts to the drug, headaches are common with these medications. Headaches occur in 18–19% of those taking montelukast and in 25% of those taking zileutin. Among 7 to 11 year olds on zanfirlukast, 4.5% suffer from headaches, as do 12.9% of those aged 12 and over.

Other less common side effects of leukotriene inhibitors include:

- rash
- fatigue
- dizziness
- abdominal pain
- nausea and vomiting
- diarrhea

Montelukast appears to cause fewer side effects than other leukotriene inhibitors and is less likely to affect the liver. Side effects occurring in less than 4.2% of patients include:

- heartburn
- weakness
- fever
- nasal congestion
- cough
- dental pain
- rarely, pus in the urine

Rare side effects of zileuton include:

- itching
- flu-like symptoms
- upper right abdominal pain
- yellow eyes or skin (jaundice)

Interactions

Drugs that may interact with montelukast include:

- aspirin
- NSAIDs
- phenobarbital
- rifampin

Zafirlukast and zileuton can raise the blood levels of the asthma medication theophylline (Theo Dur and others) and the blood thinner warfarin (Coumarin). Theophylline levels and blood-clotting times should be monitored frequently.

Medications that may interact with zafirlukast include:

- aspirin
- blood pressure medications
- some seizure medications

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Medications that may interact with zileuton include:

- the beta-blocker propanolol
- beta-agonists
- terfenadine (Seldane and others)

Resources

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Mayo Clinic Staff. "Medications and Immunotherapy for Asthma." *Asthma Center*. MayoClinic.com. August 13, 2004 [cited March 14, 2005]. http://www.mayoclinic.com/invoke.cfm?objectid = 58BCFCCC-BB00-4E67-A29876A9D30B65ED.

ORGANIZATIONS

American Academy of Allergy, Asthma & Immunology, 555 East Wells Street, Suite 1100, Milwaukee, WI, 53202-3823, (414) 272-6071, http://www.aaaai.org.

Childhood Asthma Research and Education (CARE) Network. National Heart, Lung, and Blood Institute, 6701 Rockledge Drive, MSC 7952, Bethesda, MD, 20892-7952, (301) 435-0202, (301) 480-3557, taggartv@nhlbi.nih.gov, http://www.asthma-carenet.org.

Margaret Alic, Ph.D.

Levodopa *see* **Antiparkinson drugs**

Levothyroxine *see* **Thyroid hormones**

LGV *see* **Lymphogranuloma venereum**

Lice infestation

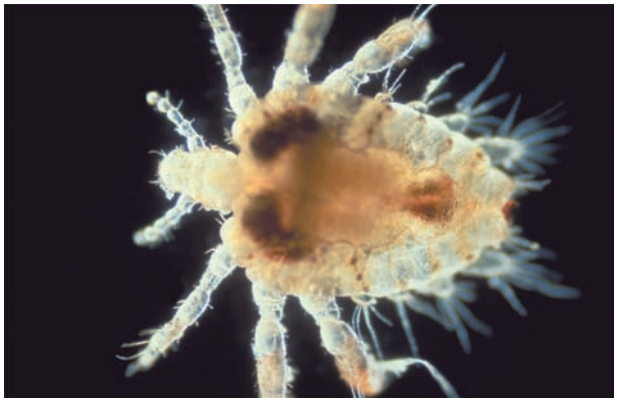
Definition

Lice infestation is a condition in which large numbers of lice are present on a person's scalp, body, or pubic area. It is called an infestation rather than an infection because the parasites live on the skin and outside of the body rather than in the internal organs. Lice are tiny insects that can spread from one person to another through close contact; through sharing such personal items as clothing, hats, combs, or hairbrushes; or through lying on a bed, pillow, or carpet that has been in contact with someone with lice.

Demographics

The demographics of lice infestation vary depending on the type of lice involved. On the whole, lice infestations are common in the general population; there are at least 12 million cases in the United States each year, although this figure is only an estimate. Head lice infestations are often not reported because people find them socially embarrassing—even though the Centers for Disease Control and Prevention (CDC) states that "Personal hygiene or cleanliness in the home or school has nothing to do with getting head lice." The number of all three types of lice infestations in Europe as well as North America has increased in recent years; a recent study of schoolchildren in Belgium, Turkey, and the Czech Republic found that rates of head lice infestations ranged from 9–16%.

Head lice are most common in schoolchildren between the ages of 3 and 11, and their families. Girls are more likely to be infested than boys because



A close-up view of a body louse. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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they are more likely to share clothing and other personal items with friends. It can be difficult to prevent a child from picking up head lice at school because of the amount of close contact among children and their belongings.

Body lice infest both children and adults; there is no difference in frequency between men and women. Homeless people and others who live in crowded conditions without opportunities to bathe or shower regularly are at greatest risk of getting body lice. Pubic lice are most common in people between the ages of 14 and 40 who are sexually active.

There is some seasonal difference in lice infestations in temperate climates; head lice infestations are more common during the warmer months while body and pubic lice infestations are more common in the fall and winter.

Description

Lice are a long-standing pest, having infested prehistoric humans as well as ancient humans after the invention of writing; the oldest known fossils of lice eggs are at least 10,000 years old. In modern societies, there are three related species of human lice that live on different parts of the body:

- head lice, *Pediculus humanus capitis*
- body lice, *Pediculosis humanus corporis*
- pubic lice, *Phthirus pubis,* commonly called "crab" lice

The three types of lice that infest humans are somewhat different in size and outward appearance. Head lice are 1–2 mm long, white or gray in color, and have flattened abdomens. The female louse lays her nits (eggs) close to the base of a hair shaft and attaches them to it with a sticky glue-like substance. The glue is what makes it so difficult to remove the nits from the hair shaft.

Body lice are about twice the size of head lice, between 2 and 4 mm long. The body louse lives in the seams of clothing, emerging at night to feed on the person's body. Pubic lice are smaller and broader, about 1.2 mm long. They have larger front claws, which is why pubic lice are sometimes called "crabs." The claws enable pubic lice to cling to the coarse hairs in the human groin and armpit areas.

Pediculosis capitis is an infestation of head lice. A body lice infestation is called pediculosis corporis. Pediculosis palpebrarum or Phthiriasis palpebrarum, caused by crab lice, is an infestation of the eyebrows and eyelashes.

Lice infestations are not usually dangerous. However, head lice infestations present a serious public health problem because they spread easily among schoolchildren. In general, lice infestations occur in crowded, unsanitary facilities including prison, military, and refugee camps. Lice infestations also occur frequently among the homeless.

Lice are transmitted through personal contact or infected clothing, bedding, or towels. Pubic lice are sexually transmitted. Lice do not jump, hop, or fly and they do not live on pets.

Risk factors

Risk factors for lice infestation include:

- Close body-to-body contact between family members or playmates.
- Sharing personal belongings, including headphones, combs, brushes, hats, scarves, and other personal items.
- Contact with contaminated furniture or bedding. Couch cushions and upholstery can harbor lice as well as pillows and sheets or blankets.
- Homelessness or imprisonment.
- Sexual contact with a large number of partners.

Causes and symptoms

Causes

The cause of lice infestations is the presence of head, body, or pubic lice on a person's body or in their clothing. The life cycle of lice helps to explain some of the symptoms of an infestation. When the nit or egg hatches, about 8–10 days after being laid, it produces an immature louse called a nymph. The nymph needs blood to survive. It has sucking mouth parts on its head that can pierce the skin and draw blood to feed on. Human lice feed about five times a day for 35 to 45 minutes at a time. The nymph becomes a mature adult about ten days after hatching. Its complete life cycle is between 30 and 35 days in length.

Symptoms

Lice infestations are characterized by intense **itching** caused by an allergic reaction to a toxin in the lice saliva. The itching can interfere with sleep and concentration. Repeated **bites** can lead to generalized skin eruptions or inflammation. Scratching or scraping at the bites can cause **hives** or abrasions that may lead to bacterial skin infections. Swelling or inflammation of the neck glands are common complications of head lice.

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KEY TERMS

Crabs—An informal term for pubic lice.

Endemic—A condition that is always present in a given population, such as human lice infestation.

Host—An organism that is infected by a virus, bacterium, or parasite.

Infestation—A condition in which a parasite develops and multiplies on the body of its host rather than inside the body.

Insecticide—A pesticide that kills insects.

Lindane—An organic chloride, neurotoxic insecticide that kills lice.

Malathion—An organic phosphate, neurotoxic insecticide that kills lice.

Neurotoxin—A chemical compound that is toxic to the central nervous system.

Nit—The egg sac laid by adult female lice.

Nymph—The immature louse that hatches from the nit.

Pediculicide—Any substance that kills lice.

Pediculosis (plural, pediculoses)—A lice infestation.

Permethrin—A synthetic pyrethroid for killing lice.

Petroleum jelly or ointment—Petrolatum, a gelatinous substance obtained from oil that is used as a protective dressing.

Piperonyl butoxide—A liquid organic compound that enhances the activity of insecticides.

Pyrethrin, pyrethroid—Naturally-occurring insecticide extracted from chrysanthemum flowers. It paralyzes lice so that they cannot feed.

Wood's lamp—A special lamp that uses ultraviolet light to detect certain types of skin infections and infestations. It was invented in 1903 by a physicist named Robert Wood.

Some symptoms of a lice infestation depend on the area of the body that is affected:

- Head lice: Itchy scalp due to an allergic reaction to the bites of the lice; small red bumps on the head or neck; sensation of something moving over the scalp; an irritated rash caused by scratching the itchy parts of the scalp.
- Body lice: Itching and a rash caused by an allergic reaction to the bites of the lice. A long-term infestation may cause discoloration of the skin of the waist area and upper thighs. There may also be open sores caused by scratching the itching areas; these raw areas can become infected by other disease organisms.
- Pubic lice: Itching in the genital area or other body areas with coarse hair (armpits, mustache area, eyebrows, eyelashes), and visible nits or lice crawling in the affected area. Crab lice in children may be an indication of sexual activity or abuse.

Diagnosis

Examination

The steady increase in all three types of lice infestations since 1980 means that the diagnosis and treatment of such infestations is one of the most common tasks in a general medical practice. A diagnosis of lice infestation can be made in the doctor's office by examining the skin, hair, pubic area, or clothing of the affected person. The doctor can collect nits from the hair by using a fine-toothed comb or remove lice from the body with a piece of cellulose tape. The organisms can then be studied under the microscope to determine the type of lice involved. Lice usually are diagnosed by the itching. However, itching may not occur until several weeks after infestation, if at all. The tickling caused by moving lice may be noticeable. Definite diagnosis requires identification of lice or their nits.

Head lice may cause irritability in children. Scalp irritations or sores may be present. Although head lice in children are usually limited to the scalp, in adults, head lice can spread to eyebrows, eyelashes, mustaches, and beards. An adult louse may be visible as movement on the scalp, especially around the ears, nape of the neck, and center line of the crown—the warmest parts of the head. Since less than 20 mature lice may be present at a given time during infestation, the nits often are easier to spot. Nits vary in color from grayish-white to yellow, brown, or black. They are visible at the base or on the shaft of individual hairs. Applying about 10 oz (280 g) of isopropyl (rubbing) alcohol to the hair and rubbing with a white towel for about 30 seconds releases lice onto the towel for identification.

Body lice appear similar to head lice; however, they burrow into the skin and are rarely seen except

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on clothing, where they lay their nits in seams. Over time, body lice infestations can lead to a thickening and discoloring of the skin around the waist, groin, and upper thighs. Scratching may cause sores that become infected with bacteria or fungi.

Pubic lice usually appear first on genital hair, although they may spread to other body hair. In young children, pubic lice are usually seen on the eyebrows or eyelashes. Pubic lice appear as brown or gray moving dots on the skin. There are usually only a few live lice present and they move very quickly away from light. Their white nits can be seen on hair shafts close to the skin. Although pubic lice sometimes produce small, bluish spots called maculae ceruleae on the trunk or thighs, usually it is easier to spot scratching marks. Small dark-brown specks of lice excretion may be visible on underwear.

Since pediculicides (medications for treating lice) are usually strong insecticides with potential side effects, it is important to rule out other causes of scratching and skin inflammation. The oval-shaped head lice nits can be distinguished from dandruff because they are glued at an angle to the hair shaft. In contrast, flat, irregularly shaped flakes of dandruff shake off easily. A healthcare professional needs to distinguish between body lice and scabies—a disease caused by skin mites—and between pubic lice and **eczema**, a skin condition.

Tests

Another test that can be performed to diagnose lice infestations involves the use of a Wood's lamp, which is a device that uses ultraviolet light to detect lice, fungal infections, and a few other types of skin infections. The patient is taken into a dark room while the doctor shines the lamp on the area that may be infested. If lice or nits are present, they will glow greenish-yellow.

Patients diagnosed with an infestation of pubic lice may be given a blood test to check for HIV and other **sexually transmitted diseases**.

Treatment

Traditional

Most treatments apply to all types of lice infestation and, particularly with head lice, treatments are an area of great controversy. The questionable safety and effectiveness of allopathic (fighting disease with remedies that produce effects different from those produced by the disease) treatments has spurred the search for alternative therapies. As of 2010, there is no single product or method that assures 100% destruction of the eggs and hatched lice after just one treatment. With any type of treatment, itching may not subside for several days.

Head lice

Most authorities believe that head lice should be treated immediately upon discovery. Before beginning any treatment:

- test a small scalp section for allergic reactions to the medication
- a vinegar rinse may help to loosen nits
- wash hair with regular shampoo

Treatments that are applied to the scalp and hair include:

- olive oil or petroleum ointment to smother the lice; cover the head with a shower cap, four to six hours per day for three to four days
- olive oil (three parts) and essential oil of lavender (one part)
- herbal shampoos or pomades
- a mixture of paw paw, thymol, and tea tree oil
- a combination of coconut oil, anise, and ylang ylang
- other mixtures of essential oils
- RID Pure Alternative, a nontoxic, hypoallergenic, dye and fragrance-free product
- a spray containing phenethyl propionate, cedar oil, peppermint oil, and sodium lauryl sulfate (LiceFreee)
- cocamide DEA (a lathering agent), triethanolamine (a local irritant), and disodium EDTA (a chelator), (SafeTek) is both a nontoxic pediculicide and a conditioner for combing out lice and nits

Cutting the hair or shaving the head may be effective. Aromatherapies also are available. Infested eyelashes and eyebrows should be treated with petroleum jelly for several days and the nits should be plucked off with tweezers or fingernails.

Body lice

Treatment for body lice is a thorough washing of the entire body and replacing infected clothing. Clothing and bedding should be washed at 140°F (60°C) and dried at high temperature, or dry-cleaned.

Pubic lice

A common herbal treatment for pubic lice consists of:

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- oil of pennyroyal, *Mentha pulegium*, 25%
- oil of garlic, *Allium sativum*, 25%
- distilled water, 50%

The mixture is applied to the pubic hair once a day for three days. Anyone with pubic lice should be tested for other sexually transmitted diseases.

Nit removal

Neither alternative nor allopathic treatments will kill all lice nits. Hair and pubic lice nits must be removed manually to prevent re-infestation as the eggs hatch. Manual removal alone may effectively treat a lice infestation.

Before removing nits, one of the following procedures may be used:

- 50% vinegar rinse to loosen the nits
- wiping individual locks of hair from base to tip with a cloth soaked in vinegar
- 8% formic acid solution applied to the hair for 10 minutes, rinsed out, and towel-dried
- catching live lice with a comb, tweezers, fingernails, or by sticking them with double-sided tape
- enzymatic lice-egg remover

Furthermore, hair should be clean, damp, and untangled and hair conditioner should not be used on hair treated allopathically. Clothing should be removed and a towel placed between the hair and shoulders. Divide hair into 6 square-inch (6 sq.-cm.) sections. Clips or elastics can be used to divide long hair. This will help ensure that the entire scalp is inspected.

Nits are manually removed with:

- any fine-toothed comb, including pet flea combs
- a specialized nit comb (LiceMeister, LiceOut)
- a battery-powered vibrating or anti-static comb
- tweezers
- baby safety scissors
- fingernails

To comb out nits, comb along each hair section from scalp to tip. Between each passing, dip the comb in water and wipe with a paper towel to remove lice and nits. Hold the comb to the light to be sure it is clean. If necessary, clean comb with a tooth or fingernail brush or dental floss. Work under a good light using a magnifying glass if necessary. Do not rush—long, thick hair may take an hour to comb out thoroughly. Wash towels and clothing after combing. This treatment should be repeated at least twice a week for at least two weeks.

Reinfestation

Reinfestation occurs often with all types of lice due to:

- ineffective or incomplete treatment
- chemical-resistant lice
- failure to remove live nits
- failure to treat all infected household members, playmates, or sexual partners
- failure to remove nits from clothing, bedding, towels, or other items
- reinfestation from another source

Reinfestation with body or pubic lice can be prevented by washing underclothes, sleepwear, bedding, and towels in hot, soapy water and drying with high heat for at least 20 minutes. Clothing infected with body lice should be ironed under high heat. Sexual partners should be treated for public lice simultaneously and should re-examine themselves for several days.

To prevent head lice reinfestation:

- Repeat lice checks and nit removal daily until none are found.
- Notify school, camp, or day care center, and parents of playmates.
- Check and if necessary treat household members, playmates, schoolmates, school or daycare staff, and others in close contact with an infestation.
- Treat combs and brushes with rubbing alcohol, Lysol, or soapy water above 130°F (54°C).
- Wash all bedding, clothing, headgear, scarves, and coats with soapy water at 130°F (54°C) and dry with high heat for at least 20 minutes.
- Wash or vacuum stuffed animals and other toys.
- Vacuum all helmets, carpets, rugs, mattresses, pillows, upholstery, and car seats.
- Remove the vacuum cleaner bag after use, seal in a plastic bag, and place in the outside garbage.
- Non-washable items should be dry cleaned or sealed in a plastic bag for up to four weeks.
- Lice pesticide sprays for inanimate objects are toxic and are not recommended.
- Repeat treatment if necessary.

Infested eyelashes are treated with a thick coating of prescription petroleum ointment, applied twice daily for ten days.

Drugs

All types of lice are treated allopathically with insecticidal lotions, shampoos, or cream rinses.

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This woman's eyelashes are infested with nits, or eggs, of a body louse. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Experts disagree about the effectiveness and/or safety of pediculicides. Pediculicides do not kill nits, so nit removal and a second application in seven to 10 days may be necessary. Pediculicides can be poisonous if used improperly or too frequently and overuse can lead to the proliferation of chemically resistant lice. The residue may remain on the hair for several weeks and can cause skin or eye irritations.

Pediculicides should *not* be used:

- near broken skin, eyes, or mucous membranes
- in the bathtub or shower
- by pregnant or nursing women or children under two
- by those with allergies, asthma, epilepsy, or some other medical conditions

PYRETHROIDS. All U.S. Food and Drug Administration (FDA)-approved nonprescription pediculicides contain relatively safe and effective pyrethroids. Insecticidal pyrethrins (0.33%) (RID, A-200) are extracts from chrysanthemum flowers. Permethrin (1%) (Nix) is a more stable synthetic pyrethrin. Pyrethroid pediculicides usually contain 4% piperonyl butoxide.

To treat with pyrethroids:

- Apply for specified time, usually ten minutes.
- Thoroughly rinse out.
- Do not wash hair for one or two days after treatment.
- Do not use cream rinse, hair spray, mousse, gels, mayonnaise, or vinegar before or within one week after treatment. These products may reduce pediculicide effectiveness.

During the 1990s, as schools began requiring children to be lice and nit-free, the use of pyrethroids rose significantly and the FDA began receiving reports of ineffectiveness. The FDA ordered new labeling of pyrethroid pediculicides on the outside of the carton, in simpler language, and with more information in 2006. Permethrin sprays for treating mattresses, furniture, and other items are not recommended.

OTHER INSECTICIDES. Prescription insecticides are used when other lice treatments fail or cannot be used. These pesticides include:

- Malathion (0.5% in Ovide), a neurotoxic organophosphate, was withdrawn from the U.S. market due to an increase in malathion-resistant lice and re-introduced in 1999. It is foul-smelling and flammable. Sometimes infested clothing is treated with a 1% malathion powder. The chief advantage of malthion is that it is effective against lice that have developed resistance to lindane and permethrin.
- Lindane (1% or higher; Kwell), an organochloride neurotoxin, can induce seizures and death in susceptible people, even when used according to the directions. In 2003 the FDA required new labeling and a reduction in bottle size.
- Ivermectin (Stromectol), an oral treatment for intestinal parasites, is effective against head lice but has not been approved for that use by the FDA as of 2010. It is approved in Europe for the treatment of head lice, and a recent clinical trial reported in the *New England Journal of Medicine* in March 2010 that oral ivermectin is superior to malathion for difficult-to-treat head lice.

Prognosis

Despite the presence of chemically resistant lice and the thoroughness required to prevent reinfestation, essentially all lice infestations can be eradicated eventually. Lice infestations by themselves are not fatal; however, body lice are dangerous because they can transmit three potentially fatal illnesses: **typhus**, **relapsing fever**, and **trench fever**. Pubic lice are not known to spread other diseases as of 2010. In 2009, 25% of head lice from homeless persons in San Francisco were found to be carrying *Bartonella quintana*, the bacterium that causes trench **fever**. This finding suggests that head lice as well as body lice are potential carriers of emerging diseases.

Prevention

Prevention of lice infestation depends on adequate personal hygiene and the following public health measures:

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- avoid sharing combs, brushes, hair accessories, hats, towels, or bedding
- check hair and scalp weekly for lice and nits
- limit the number of sexual partners

Regular lice checks in schools and "no nit" reentry policies have not been shown to be effective. The American Academy of Pediatrics, the Harvard School of Public Health, and the National Association of School Nurses recommend their elimination, although many healthcare professionals disagree.

Scientists have identified both the gene that enables head and body lice to digest blood and the gene that helps lice combat deadly infections, with the potential for new treatments and preventatives for lice infestation.

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ORGANIZATIONS

American Academy of Dermatology, PO Box 4014, Schaumburg, IL, 60168-4014, (847) 330-0230, (866) 503-SKIN (503-7546), (847) 240-1859, http://www.aad.org.

American Academy of Family Physicians (AAFP), PO Box 11210, Shawnee Mission, KS, 66207, (913) 906-6000, (800) 274-2237, (913) 906-6075, contactcenter@aafp.org, http://www.aafp.org.

American Academy of Pediatrics (AAP), 141 Northwest Point Boulevard, Elk Grove Village, IL, 60007, (847) 434-4000, (847) 434-8000, http://www.aap.org.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

National Pediculosis Association (NPA), 1005 Boylston Street, Suite 343, Newton, MA, 02461, (800) 323-1305 ext 7971, (800) 235-1305, npa@headlice.org, http://www.headlice.org.

U.S. Food and Drug Administration (FDA), 10903 New Hampshire Ave., Silver Spring, MD, 20993, (888) 463-6332, http://www.fda.gov.

World Health Organization (WHO), Avenue Appia 20, 1211 Geneva 27, Switzerland, + 41 22 791 21 11, + 41 22 791 31 11, info@who.int, http://www.who.int/en/.

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Lichen planus

Definition

Lichen planus is a chronic mucocutaneous (relating to the skin and mucous membrane) condition of unknown origin that produces rows of small, shiny,

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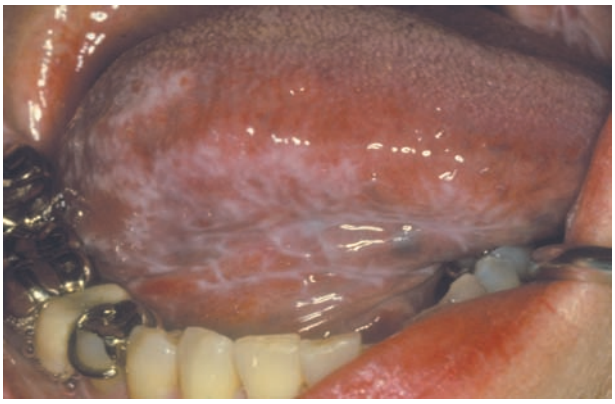
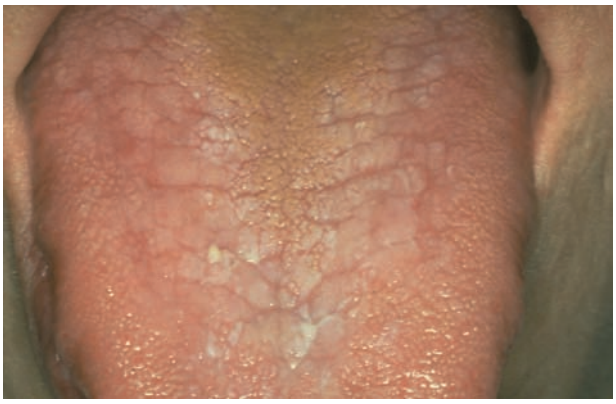


Lichen planus appearing under the tongue. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*



One example of lichen planus on the tongue. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

flat–topped, itchy pink or purple raised papules or lesions (bumps) or **rashes** (spots) on the wrists, forearms or lower legs, especially in middle-aged patients. It sometimes also affects the mucous membranes, such as those within the mouth and genitals. The name refers to the inflammatory appearance of the skin.

Demographics

The condition affects females more than males, in an approximate ratio of three to two. It also affects middle-aged people more often than younger or older people. Infants and children rarely get the condition. Lichen planus is found throughout the world and is equally distributed among races. It affects between one and two percent of the world' population. The majority of the people affected by licken planus consist of middle-aged women. People with **hepatitis C** or **cirrhosis** (liver scarring) are also more likely to get lichen planus.

Description

The condition is not contagious nor infectious. However, it is difficult to treat, with reoccurrences coming back for years even with proper treatment. Lesions are found on the skin, genitals, and in the mouth. Most cases resolve spontaneously within two years. These features usually characterize the affected skin: purple in color, shape of polygonal papules, without depth (flat to the skin's surface), and itchy but without any apparent reason (pruritic). They are most often located on the wrists and ankles. When the condition begins to heal, the skin turns a brownish or blue–black color, which may remain for a long time.

Causes and symptoms

No one knows what causes lichen planus, although some experts suspect that it is an abnormal immune reaction following a viral infection, probably aggravated by **stress**. The condition does not involve any known pathogens and it cannot be passed from one person to another (not contagious). The condition is similar to symptoms caused by exposure to arsenic, bismuth, gold, iodides, quinide, **diuretics**, or developers used in color photography. The rashes that it produces are called lichenoid reactions. These reactions are further classified as lichenoid mucositis (of the mucosa) or lichenoid **dermatitis** (of the skin). Either one can be caused by heart disease, arthritis, medications used to control high blood pressure, and reactions to **allergies**. Occasionally, lichen planus in the mouth appears to be an allergic reaction to medications, filling material, dental hygiene products, chewing gum, or candy.

Symptoms can appear suddenly, or they may gradually develop, usually as a rash on the insides of the wrists, forearms, ankles, or legs. The rash may also be present on the scalp, neck, lower back, nails of the fingers and toes, or on the mucous membranes of the nose, mouth, vagina, penis, and anus. Lesions on the skin may be preceded by a dryness and metallic taste or burning in the mouth.

Once lesions appear, usually in rows, they change over time into flat, glistening, purple lesions marked with white lines or spots. Color may change from purple to pink, and then to red. Mild to severe **itching** is common. White, lacy lesions are usually painless, but eroded lesions often burn and can be painful. A soreness or burning sensation can emerge when symptoms involve the mucous membranes. When the nails are affected, their appearance often becomes split, thin, and grooved. The nails may eventually be lost. Hair on the scalp, when lichen planus is apparent,

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KEY TERMS

PUVA—A type of phototherapy that combines the oral or topical photosensitizing chemical psoralen, plus long–wave ultraviolet light-A (UVA).

becomes thin, with the scalp itself appearing red and irritated. All of the hair on the scalp may be lost. As the lesions clear up, they usually leave a brown or gray discoloration behind, especially in dark skinned people. Rashes on the nails or scalp may leave permanent scarring.

Lichen planus in the mouth, sometimes called oral lichen planus, occurs in six different forms with a variety of symptoms. They may appear as lacy-white streaks, white plaques, or eroded ulcers. The streaks consist of small, pale reddish, slightly raised bumps, often on the tongue or inside the cheeks. Often the gums are affected, so that the surface of the gum peels off, leaving the gums red and raw. The area around the mouth may be painful and tender, with a burning or itching sensation. It may also feel dry and have a metallic taste to it. Food and beverages may have a diminished taste to them.

Diagnosis

A medical history of the patient is gathered, along with the performance of a **physical examination**. A doctor can probably diagnose the condition simply from looking at the characteristic lesions, but a **skin biopsy**, usually from a punch biopsy test, may be needed to confirm the diagnosis. A punch biopsy test removes a tiny section of the deeper layers of the skin. The biopsy, which is of an average depth of 0.25 inch (6 millimeters), is examined under a microscope to detect whether lichen planus is present.

Treatment

There is no cure for lichen planus. Treatment, which is usually difficult and long-term, is aimed at easing symptoms. Itching can be treated with steroid creams and oral **antihistamines**. Cool compresses and baths containing colloidal oatmeal can also help. Cortisosteroid ointment may be applied to the skin for minor irritations. Severe lesions can be treated with **corticosteroids** by mouth, or combinations of photochemotherapy (such as PUVA) and griseofulvin. PUVA, which stands for psoralen (also called psoralene) plus UVA treatment, is used when the patient takes an oral dose of psoralen to sensitize the skin and then the skin is exposed to ultraviolet-A (UVA) light. Griseofulvin (also called grisovin) is an antifungal drug.

Immunosuppressant medications may also be used. Hydroxychloroquine (Plaquenil), an antimalaria drug, is sometimes provided to reduce inflammation. Tacrolimus (FK-506 or Fujimycin), an immunosuppressive drug, is often taken to reduce allergic symptoms. Immune-modulating medication, such as imiquimod (Aldara) or tacrolimus (Protoic) may also be used. Dapsone, which is often given to treat **acne**, is sometimes used too. Aloe vera is applied to help return the damaged skin to its normal state.

Patients with lesions in the mouth may find that regular professional cleaning of the teeth and conscientious dental care improve the condition. Using milder toothpastes instead of tartar control products also seems to lessen the number of ulcers and makes them less sensitive. A combination of oral corticosteroids and extra-strength corticosteroid ointments applied to the affected areas are often used for mucous membranes.

Even though lichen planus may go away with treatment, it can come back, sometimes years later.

Prognosis

While lichen planus can be annoying, it is usually fairly benign and clears up on its own. It may take months to reach its peak, but it usually clears up within 18 months. Normally, lichen planus is non–cancerous. However, long-term lesions associated with lichen planus can result in increased risk from squamous cell carcinoma, which is a type of skin **cancer**.

Prevention

It is recommended that people with at increased risk from lichen planus do not use tobacco products, such as cigarettes, because tobacco adds to the risk of squamous cell carcinoma. Regular examinations are advised for people more likely to contract lichen planus so that any changes to mucous membranes or the skin can be regularly monitored by medical professionals.

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Carol A. Turkington

Lichen simplex chronicus

Definition

Lichen simplex chronicus (LSC) is a chronic inflammation of the skin (**dermatitis**) characterized by small, round itchy spots that thicken and become leathery as a result of scratching. Various degrees of scaling also occur from repeated scratching or rubbing. The inflammation occurs most frequently in the following areas: scalp, outer lower part of lower leg, knee, wrist, ankle, side and back of neck, forearm, elbow, scrotum, vulva, anal area, upper eyelid, ear opening, and fold behind ear. The itchiness felt by the person may be so intense that he or she is unable to stop. Soon, the patient continues to scratch out of habit, when begins the progression of the brown, thick, leathery skin.

Demographics

The chronic inflammation can occur in any human. It is not known to occur more or less frequently with respect to race. Its exact frequency has not been identified by the medical community. However, it is more common in women than in men. It is also more prevalent in adults age 30 to 50 years. People with previous skin conditions or with a family history of skin disorders, such as **psoriasis** and **eczema**, are more likely to develop lichen simplex chronicus. People are not at risk from dying of lichen simplex chronicus.

Description

Also termed neurodermatis and scratch dermatitis, lichen simplex chronicus is the result of chronic skin irritation. Initial irritation causes **itching**, and in turn, itching causes scratching. Scratching usually leads to further irritation, which damages the skin. The possibility of infection is greatly increased when the outer layer of protective skin is broken. Skin usually repairs itself quickly. However, in the case of lichen simplex chronicus, healing skin causes more itching and more scratching causes a thickening of the skin (lichen). The small skin patches are usually one to 10 inches (3–25 centimeters) in diameter.

Some complications from the condition if present for long periods include bacterial skin infection, permanent scarring, and permanent changes in the color of the skin.

Causes and symptoms

The cause of lichen simplex chronicus is not known. It is seen as often being caused by constant rubbing of the skin, such as in disorders like psoriasis and eczema. It may also occur when something continually irritates the skin, such as clothing. It may also result when such conditions as **anxiety**, depression, or nervousness occurs. The rubbing begins the chain of events that leads from itching to scratching and then to the presence of leather-like skin patches. Children are susceptible to the disorder because they often rub and scratch their skin, such as when insect **bites** occur. Mentally disabled children that have repetitive motions as part of their disability are also at higher risk for contracting lichen simplex chronicus.

Symptoms include chronic itching, which is often accompanied by nervous tension. The appearance of scratch marks and leathery skin patches can be found anywhere on the body. A prolonged lichen simplex chronicus can result in brown-colored pigmentation at the site of irritation. Signs of infection include a yellowish, thick fluid coming from the excessively scratched areas. **Pain** may also be another sign of infection. Other symptoms include **skin lesions** that are often located on the wrist, neck, wrist, forearms, inner elbow, thighs, lower leg, back of knee, and rectum/anus area. The lesions are usually raw looking and darkened or reddened, and include scratch marks, defined borders, and extended skin lines.

Diagnosis

A dermatologist, a physician specializing in the study and treatment of skin disorders, can make a diagnosis after a visual examination. Specifically, the medical professional looks at the appearance of the skin, and determines the period that itching and scratching have occurred. A patch test, sometimes also called a contact delayed hypersensitivity allergy

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test, is used to eliminate other disorders that may be the cause. Small drops of various diluted chemicals are placed onto the skin to see if an allergic reaction occurs.

A skin lesion biopsy, also called a punch biopsy, may be needed to confirm a diagnosis of lichen simplex chronicus. The biopsy (a tiny piece of removed skin) is sent to a laboratory so it can be analyzed under a microscope. The result will confirm whether or not the condition is due to lichen simplex chronicus or another disorder such as **lichen planus**.

Treatment

Treatment of the itching is necessary to stop the scratching and resulting skin damage. There are a number of ways to stop itching. Perhaps the most important is to cut fingernails very short. Ice can substitute for the relief of scratching. Heat and fuzzy clothing worsen itching; cold and smooth clothing pacify it. If the itching is persistent, **dressings** may be applied to the affected areas.

Among the topical medications that relieve itching are a number of commercial preparations containing menthol, camphor, eucalyptus oil, and aloe. Topical cortisone is also available without a prescription. Some preparations also contain **antihistamines**, which penetrate intact skin poorly. All these medicines work better under occlusion, which means putting a waterproof barrier like a rubber glove, plastic wrap, or cloth dressing over them. For broken skin, **topical antibiotics** like bacitracin help prevent infection. These preparations should be used early to forestall further damage to the skin.

Reducing the buildup of thick skin or thickened lesions may require medicines that dissolve or melt keratin, the major chemical in skin's outer layer. These keratolytics include urea, lactic acid, and salicylic acid. Lotions or soaps containing coal tar may also be recommended.

Resistant cases of lichen simplex chronicus will often respond to cortisone-like drugs injected directly into the lesions.

Sedatives or tranquilizers may be prescribed to combat the nervous tension and anxiety that often accompanies the condition.

In addition, counseling with a dermatologist may be necessary to minimize or eliminate the need to scratch and itch. Consultation with an allergist may also be needed. Specific psychological counseling in **stress** management or behavior modification should be sought for people with anxiety and stress.

KEY TERMS

Antihistamine—A chemical that interferes with the action of histamine. Histamine is part of an inflammatory response and helps to cause itching.

Callus—Thickened skin due to chronic rubbing or irritation.

Lesion—Abnormal change in tissue caused by localized disease.

Prognosis

Diligent adherence to treatment is usually rewarded with a resolution of the condition. The original cause of itching may be gone, or it may reappear. Preventive treatment in its early stages will arrest the process. Reducing stress and anxiety in one' life will help to minimize or eliminate the problem.

Prevention

Ways to prevent lichen simplex chronicus include keeping nails cut close so less damage is done to the skin when scratching occurs. Also, cover areas prone to scratching, especially if they are unconsciously scratched while sleep. Use over-the-counter creams or medications to eliminate the itchiness. Prevent dry skin by using moisturizing creams and ointments. Also, take cool baths filled with baking soda, colloidal oatmeal, or other similar ingredients that help to relieve skin irritants. When using cleansing products, such as clothing detergents, choose ones that do not contain perfumes and dyes. Maintain a healthy lifestyle that includes reducing stress and anxiety.

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J. Ricker Polsdorfer, MD

Life support

Definition

Life support refers to a spectrum of techniques and therapies used to maintain life after the failure of one or more vital organs. When someone is critically injured or seriously ill, life-saving techniques and therapies (such as a feeding tube, organ transplantation, heart and lung bypass machine, **cardiopulmonary resuscitation** [CPR], dialysis, defibrillator, and artificial pacemaker) are used in the attempt to sustain and save the patient' life. Such measures are often performed in such places as an operating room, emergency room (ER), intensive care unit (ICU), and ambulance. However, as such measures become more technically advanced, some become available in every day places. One such device is called the portable defibrillator, or automated external defibrillator. Bought by companies and governments, they are often ready to be used at a moment's notice in business settings and public areas.

Purpose

A patient requires life support when one or more vital organs fail, due to causes such as trauma, infection, **cancer**, **heart attack**, or chronic disease. Among the purposes of life support are to:

- Establish and maintain the ABCs of resuscitation—airway, breathing, and circulation.
- Restore the patient's homeostasis—the internal chemical and physical balance of the body.
- Protect the patient from complications of the underlying disease and its treatment.

The ABCs of life support is supported by a part of medical care that is commonly called basic life support (BLS). Within BLS, the medical professionals are called upon to care for patients with life-threatening illnesses and injuries until the patients can be provided with more comprehensive medical care. For instance, medical personnel inside an ambulance at the scene of a traffic accident are one type of person involved in BLS. These people receive BLS training in order to be certified at their position. Other people trained in BLS include firefighters, police officers, teachers, and security guards. Specific portions of the training involve guidelines of action that are to be used when coming across specific emergencies such as drowning, massive bleeding, or cardiac arrest. Once the BLS personnel transport the patient to the hospital or other medical facility, the next phase of medical care is begun—that of the advanced life support (ALS).

Precautions

Patients and families need to recognize that life support is an extremely painful, expensive, and emotionally wrenching experience. Life support exposes a patient to vast risks of further medical complications, and offers no guarantee of a positive outcome. Even in successful cases, recovery may be slow and frustrating.

Description

Successful life support begins with establishing the ABC's of resuscitation—airway, breathing, and circulation.

The airway refers to a clear and unobstructed passageway for air (primarily oxygen) to enter the lungs from outside the body and for primarily carbon dioxide to exit the lungs through the mouth and nose. The patient's airway may become blocked by:

- Foreign body obstruction, as by food or dentures
- Injury-related damage and swelling, as from a wound or surgery
- Loss of protective reflexes due to coma of any origin

Life support may begin with basic cardiopulmonary resuscitation (CPR), as in cases of cardiac arrest. Thereafter, the most common technique used to create a secure airway is insertion of an endotracheal (ET) tube through the mouth or nose into the windpipe (trachea). An alternative method of securing an airway is by **tracheotomy**, a surgical procedure in which a tube is inserted into the trachea through an incision made in the base of the throat. Of the two options, placement of an ET tube is usually quicker and more convenient, and thus occurs much more commonly. Doctors perform a tracheotomy when they cannot establish an ET

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airway, or when the patient will require an artificial airway for more than a week or two.

Breathing refers to the movement of air in and out of the lungs (respiration). Inadequate breathing may result from:

- Heart disease, as in congestive heart failure
- Primary diseases of the lungs, such as pneumonia, asthma, or emphysema
- Coma of any cause, such as narcotic overdose or stroke
- Muscle fatigue or neuromuscular disease (spinal cord injury or polio)
- Pain, from rib fractures or surgery on the chest

When the patient cannot breathe sufficiently, the physician will use a ventilator, a machine that pumps air in and out of the patient's lungs. For many doctors and members of the public, the term "life support" calls up the image of an ET tube and ventilator.

Circulation refers to the adequate flow of blood around the body from the heart to vital organs. The blood delivers oxygen to all cells of the body and removes carbon dioxide from all cells. Circulation can fail due to:

- Primary disease of the heart (heart attack)
- Blood loss (trauma or internal bleeding of any cause)
- Severe infection (sepsis)
- Drug reactions or overdoses
- Extreme allergic reaction
- Severe dehydration (gastroenteritis or heat-related illness)

In order to ensure adequate circulation, the patient will require one or more intravenous (IV) tubes (catheters). The IVs may include both the short needle and tube commonly used in the hand or forearm, and longer catheters inserted into the larger and more central veins of the body. Catheters inserted into these larger veins are known as central lines. Through the IVs the patient receives fluids, drugs, and blood transfusions as needed to support the circulation.

Once the ABC's are secure, life support is directed at maintaining homeostasis, the body's delicate chemical and physical balance. In a healthy person, the body keeps precise control over many components of its makeup, such as its fluids, nutrients, and pressures. When vital organs fail, the body can no longer regulate these components, and the doctor must take steps to restore the normal state.

Preserving the body's internal equilibrium requires careful monitoring of innumerable indicators of the patient's well-being. These indicators include:

- Vital signs (heartbeats per minute, breaths per minute, blood pressure, body temperature, and weight)
- Fluids (input and output of the body)
- Blood cell counts
- Chemical substances of the body (sodium, potassium, sugar, and many others)
- Pressures in the circulation, lungs, and perhaps even the brain
- Presence of germs (bacteria, fungi) causing infection in body systems (lungs, blood, urine)

This intensive monitoring usually takes place in an intensive care unit (ICU) or critical care unit (CCU) and requires:

- Specialized physicians, such as cardiologists, intensivists, and surgeons
- Highly-skilled nursing care, often one nurse per patient around-the-clock
- Extensive support staff, such as respiratory therapists, laboratory technicians, radiology technicians, dieticians, and pharmacists
- Constant measurement of basics such as pulse, heart rhythm, and oxygen level in the blood
- Frequent inspection of the patient's alertness, color, and level of pain
- Use of catheters in the veins and arteries to withdraw blood samples and measure pressures in the circulation
- Use of tubes in the bladder (Foley catheter), stomach (nasogastric tube), and other body cavities
- Frequent laboratory tests on blood, urine, drainage from wounds, and other body specimens
- X-ray, ultrasound, computerized tomography (CT), and other imaging procedures
- Electrocardiograms

The treatments of life support include:

- Oxygen
- Intravenous fluids with sugar and basic salts
- Drugs to improve circulation and other body functions
- Antibiotics
- Transfusions
- Surgery
- Nutritional supplements by vein or stomach tube
- Tubes in body cavities (chest or abdomen) to relieve fluid buildup
- Dialysis
- Pacemaker

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KEY TERMS

Cardiopulmonary—Relating to the heart and lungs.

Central line—A tube placed by needle into a large, central vein of the body.

Coma—Unconsciousness.

Defibrillation—Use of an electric shock to restore a normal heartbeat.

Endotracheal tube—A tube placed into the windpipe through the nose or mouth.

Foley catheter—A tube that drains urine from the bladder.

Homeostasis—The internal chemical and physical balance of the body.

Nasogastric tube—A tube placed through the nose into the stomach.

Neuromuscular—Relating to nerves and muscles.

Resuscitation—Treatments to restore an adequate airway, breathing, and circulation.

Sepsis—An overwhelming infection with effects throughout the body.

Tracheotomy—A surgical procedure in which a tube is inserted into the trachea through an incision made in the base of the throat.

Trauma—Serious physical injury.

Ventilator—A machine that pumps air in and out of the lungs.

Vital signs—Basic indicators of body function, usually meaning heartbeats per minute, breaths per minute, blood pressure, body temperature, and weight.

- Electrical defibrillation
- Various machines to assist heart or lung function
- Transplantation of organs or mechanical substitutes (artificial heart)
- Sedation or even temporary paralysis to enable the patient to tolerate these procedures

Preparation

The need for life support may arise suddenly and with little warning. All people should discuss in advance with family and doctor their wishes for the use of life support should a medical crisis develop. The doctor will note the preferences in the patient's record. Patients should sign documents such as an Advance Directive and Durable Power of Attorney for Health Care to express their wishes and designate a surrogate decision-maker in case of incapacitation.

Physicians and medical care providers must anticipate the possibility that a patient will require life support, perhaps suddenly. In preparation, doctors and medical staff must:

- Receive training in resuscitation skills
- Monitor patients carefully
- Maintain proper supplies and equipment
- Discuss in advance with patients and patients' families whether or not to begin life support

Aftercare

If a patient survives life support treatments, doctors will cautiously try to wean the patient from the support systems. Being able to breathe adequately without the ventilator is one major hurdle. Patients commonly fail in their first attempts to breathe on their own, often tiring out after a few hours. Thus, the doctor will reconnect the ventilator, give the patient a rest, and try again in a day or two.

As the patient regains organ function, there is less need for monitors, tests, and treatments that require an intensive care setting. The doctor may transfer the patient to a lower level of hospital care, a skilled nursing facility (SNF), or perhaps directly to home. Physical and occupational therapists may help the patient improve strength and endurance. The patient will receive continuing care from the primary doctor and specialists as needed. The patient may require prescription drugs, assist devices, and psychological therapists.

Risks

The risks and consequences of life support are enormous. These risks include:

- Physical dangers
- Emotional suffering
- Financial costs
- Societal discord

The physical dangers of life support encompass all the hazards of the patient's underlying disease and treatments. Among these risks are:

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- Permanent damage to the brain, kidneys, and other vital organs caused by poor circulation or low oxygen content of the blood
- Direct damage to organs from use of medical instruments and procedures
- Infections, often with organisms that are highly resistant to antibiotics
- Abnormal blood clots
- Skin ulcers from lying immobilized for long periods
- Extreme pain
- Exposure of medical personnel to communicable diseases

The emotional consequences of life support touch patients, families, and medical caregivers. These repercussions arise from:

- The frightening environment of an ICU
- The need to make life-and-death decisions
- The anger, guilt, and grief that relate to life-threatening illness
- The fact that many lengthy and difficult treatments will end in failure

The financial costs of life support are huge. A single day of life support costs many thousands of dollars. These expenses fall on individual payers, insurance companies, health plans, and governments. All such payers face difficult decisions regarding the allotment of money for such treatment, especially in cases that are likely to be futile.

Although the removal of life support from a seriously ill or injured person may be seen as a rare occurrence in society, it has been found to be relatively common. In fact, in a 2008 study funded by the National Institute of Nursing Research, and appearing in the *American Journal of Respiratory and Critical Care Medicine*, a gradual removal of life support, called sequential withdrawal, was found to be quite common. In fact, Dr. J. Randall Curtis, the principal investigator of the study, states that the sequential withdrawal of life support: "...occurred in nearly half of the patients we studied." The study also found that, when necessary, sequential withdrawal was less traumatic to the patient's family than was the immediate removal of all life-support measures.

Society as a whole faces difficult decisions surrounding life support. Some governments have enacted regulations that establish priorities for the spending of health care resources. Patients who do not receive treatment under such rules may feel victimized by society's choices.

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Isaac R. Berniker

Light sensitivity *see* **Photosensitivity**

Light therapy

Definition

Light therapy, or **phototherapy**, is the administration of doses of bright light in order to treat a variety of sleep and **mood disorders**. It is most commonly used to re-regulate the body's internal clock and/or relieve depression.

Purpose

Light therapy is most often prescribed to treat **seasonal affective disorder**, a form of depression most often associated with shortened daylight hours in northern latitudes from the late fall to the early spring. It is also occasionally employed to treat such sleep-related disorders as **insomnia** and **jet lag**. Recently, light therapy has also been found effective in the treatment of such nonseasonal forms of depression as **bipolar disorder**. One 2001 study found that bright light reduced depressive symptoms 12–35% more than a placebo treatment in nine out of 10 randomized controlled trials.

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When used to treat SAD or other forms of depression, light therapy has several advantages over prescription antidepressants. Light therapy tends to work faster than medications, alleviating depressive symptoms within two to 14 days after beginning light therapy as opposed to an average of four to six weeks with medication. And unlike antidepressants, which can cause a variety of side effects from **nausea** to concentration problems, light therapy is extremely well tolerated. Some side effects are possible with light but are generally not serious enough to cause discontinuation of the therapy.

There are several other different applications for light therapy, including:

- Full-spectrum/UV light therapy for disorders of the skin. A subtype of light therapy that is often prescribed to treat skin diseases, rashes, and jaundice.
- Cold laser therapy. The treatment involves focusing very low-intensity beams of laser light on the skin, and is used in laser acupuncture to treat a myriad of symptoms and illnesses, including pain, stress, and tendinitis.
- Colored light therapy. In colored light therapy, different colored filters are applied over a light source to achieve specific therapeutic effects. The colored light is then focused on the patient, either with a floodlight which covers the patient with the colored light, or with a beam of light that is focused on the area of the illness.
- Back of knee light therapy. According to a 1998 study published in the journal *Science*, the area behind the human knee known as the popliteal region contains photoreceptors that can help to adjust the body's circadian rhythms. The authors of the study found that they could manipulate circadian rhythms by focusing a bright light on the popliteal region. Further studies are underway to determine the efficacy of this treatment on disorders such as SAD and diabetic nerve pain.

Description

Light therapy is generally administered at home. The most commonly used light therapy equipment is a portable lighting device known as a light box. The light box may be a full-spectrum box, in which the lighting element contains all wavelengths of light found in natural light (including UV rays), or it may be a bright light box, in which the lighting element emits non-UV white light. The box may be mounted upright to a wall, or slanted downwards towards a table.

The patient sits in front of the box for a prescribed period of time (anywhere from 15 minutes to several hours). For patients just starting on the therapy, initial sessions are usually only 10–15 minutes in length. Some patients with SAD undergo light therapy session two or three times a day, others only once. The time of day and number of times treatment is administered depends on the physical needs and lifestyle of the individual patient. If light therapy has been prescribed for the treatment of SAD, it typically begins in the fall months as the days begin to shorten, and continues throughout the winter and possibly the early spring. Patients with a long-standing history of SAD are usually able to establish a time-table or pattern to their depressive symptoms, and can initiate treatment accordingly before symptoms begin.

The light from a slanted light box is designed to focus on the table it sits upon, so patients may look down to read or do other sedentary activities during therapy. Patients using an upright light box must face the light source, and should glance toward the light source occasionally without staring directly into the light. The light sources in these light boxes typically range from 2,500–10,000 lux (in contrast, average indoor lighting is 300–500 lux; a sunny summer day is about 100,000 lux).

Light boxes can be purchased for between $200 and $500. Some healthcare providers and healthcare supply companies also rent the fixtures. This gives a patient the opportunity to have a trial run of the therapy before making the investment in a light box. Recently, several new light box products have become available. Dawn simulators are lighting devices or fixtures that are programmed to turn on gradually, from dim to bright light, to simulate the sunrise. They are sometimes prescribed for individuals who have difficulty getting up in the morning due to SAD symptoms. Another device known as a light visor is designed to give an individual more mobility during treatment. The visor is a lighting apparatus that is worn like a sun visor around the crown of the head. Patients with any history of eye problems should consult their healthcare professional before attempting to use a light visor.

Origins

Light, both natural and artificial, has been prescribed throughout the ages for healing purposes. Sunlight has been used medicinally since the time of the ancient Greeks; Hippocrates, the father of modern medicine, prescribed exposure to sunlight for a number of illnesses. In the late nineteenth and early twentieth centuries, bright light and fresh air were

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KEY TERMS

Dawn simulation—A form of light therapy in which the patient is exposed while asleep to gradually brightening white light over a period of an hour and a half.

Lux—The International System unit for measuring illumination, equal to one lumen per square meter.

Neurotransmitter—A chemical in the brain that transmits messages between neurons, or nerve cells.

Seasonal affective disorder (SAD)—A mood disorder characterized by depression, weight gain, and sleepiness during the winter months. An estimated 4–6% of the population of Canada and the northern United States suffers from SAD.

Serotonin—A neurotransmitter that is involved in mood disorders as well as transmitting nerve impulses.

frequently prescribed for a number of mood and **stress** related disorders. In fact, prior to World War II (1939–1945), hospitals were regularly built with solariums, or sun rooms, in which patients could spend time recuperating in the sunlight.

Precautions

Patients with eye problems should see an ophthalmologist regularly both before and during light therapy. Because UV rays are emitted by the light box, patients taking photosensitizing medications should consult with their healthcare provider before beginning treatment. In addition, patients with medical conditions that make them sensitive to UV rays should also be seen by a healthcare professional before starting phototherapy.

Patients beginning light therapy for SAD may need to adjust the length, frequency, and timing of their phototherapy sessions in order to achieve the maximum benefits. Patients should keep their healthcare provider informed of their progress and the status of their depressive symptoms. Occasionally, additional treatment measures for depression (e.g, antidepressants, herbal remedies, **psychotherapy**) may be recommended as an adjunct, or companion treatment, to light therapy.

Preparation

Full-spectrum light boxes do emit UV rays, so patients with sun-sensitive skin should apply a sun screen before sitting in front of the box for an extended period of time.

Risks

Some patients undergoing light therapy treatments report side effects of eyestrain, headaches, insomnia, **fatigue**, **sunburn**, and dry eyes and nose. Most of these effects can be managed by adjusting the timing and duration of the light therapy sessions. A strong sun block and eye and nose drops can alleviate the others. Long-term studies have shown no negative effects to eye function of individuals undergoing light therapy treatment.

A small percentage of light therapy patients may experience hypomania, a feeling of exaggerated, hyperelevated mood. Again, adjusting the length and frequency of treatment sessions can usually manage this side effect.

Research and general acceptance

Light therapy is widely accepted by both traditional and complementary medicine as an effective treatment for SAD. The exact mechanisms by which the treatment works are not known, but the bright light employed in light therapy may act to readjust the body's circadian rhythms, or internal clock. Other popular theories are that light triggers the production of serotonin, a neurotransmitter believed to be related to **depressive disorders**, or that it influences the body's production of melatonin, a hormone that may be related to circadian rhythms. A recent British study suggests that dawn simulation, a form of light therapy in which the patient is exposed to white light of gradually increasing brightness (peaking at 250 lux after 90 minutes) may be even more effective in treating depression than exposure to bright light. Dawn simulation is started around 4:30 or 5 a.m., while the patient is still asleep.

Wide-spectrum UV light treatment for skin disorders such as **psoriasis** is also considered a standard treatment option in clinical practice. However, such other light-related treatments as cold laser therapy and colored light therapy are not generally accepted, since few or no scientific studies exist on the techniques.

Training and certification

Psychiatrists, psychologists, and other mental healthcare professional prescribe light therapy treatment for SAD. Holistic healthcare professionals and light therapists who specialize in this treatment are also available; in some states, these professionals

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require a license, so individuals should check with their state board of health to ensure their practitioner has the proper credentials. Light therapy for skin disorders should be prescribed by a dermatologist or other healthcare professional with expertise in skin diseases and light therapy treatment.

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ORGANIZATIONS

National Depressive and Manic Depressive Association, 730 Franklin Street, Suite 501, Chicago, IL, 60610, (800) 826–3632, http://www.ndmda.org.

Society for Light Treatment and Biological Rhythms, 824 Howard Ave., New Haven, CT, 60610, (203) 764–4324, http://www.sltbr.org.

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Light treatment *see* **Ultraviolet light treatment**

Lipase test

Definition

The lipase test is a blood test performed to determine the serum level of a specific protein (enzyme) involved in digestion. Lipase is an enzyme produced by the pancreas, which is a large gland situated near the stomach. Lipase works to break down a certain type of blood lipid (**triglycerides**) into fatty acids.

Lipase appears in the blood together with another enzyme called amylase following damage to or diseases affecting the pancreas. It was once thought that abnormally high lipase levels were associated only with diseases of the pancreas. Other conditions are now known to be associated with high lipase levels, especially kidney failure and intestinal obstruction. Diseases involving the pancreas, however, produce much higher lipase levels than diseases of other organs. Lipase levels in pancreatic disorders are often 5–10 times higher than normal.

Purpose

The lipase test is most often used in evaluating inflammation of the pancreas (**pancreatitis**), but it is also useful in diagnosing kidney failure, intestinal obstruction, **mumps**, and peptic ulcers. Doctors often order amylase and lipase tests at the same time to help distinguish pancreatitis from ulcers and other disorders in the abdomen. If the patient has acute (sudden onset) pancreatitis, the lipase level usually rises somewhat later than the amylase level—about 24–48 hours after onset of symptoms—and remains abnormally high for 5–7 days. Because the lipase level peaks later and remains elevated longer, its determination is more useful in late diagnosis of acute pancreatitis. Conversely, however, lipase levels are not as useful in diagnosing chronic pancreatic disease.

Precautions

Patients should be asked whether they are taking certain prescription drugs that can affect the accuracy of the lipase test. Drugs that can cause elevated lipase levels include bethanechol, cholinergics, codeine, indomethacin, meperidine, methacholine, and morphine. Drugs that may decrease levels include **calcium** ions.

Description

A lipase test is performed on a sample of the patient's blood, withdrawn from a vein into a vacuum tube. The procedure, which is called a venipuncture, takes about five minutes.

Preparation

The patient should have nothing to eat or drink for 12 hours before the lipase test.

Risks

Risks for this test are minimal, but may include slight bleeding from the puncture site, a small bruise or swelling in the area, **fainting**, or feeling lightheaded.

Results

Reference values for lipase determination are laboratory- and method-specific. In general, normal results are usually less than 200 units/L (triolein methods by titration or turbidimetry).

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KEY TERMS

Amylase—A digestive enzyme that breaks down starch.

Lipid—A greasy organic compound that cannot be dissolved in water. Triglycerides, which are broken down by lipase, are one type of blood lipid.

Pancreas—An elongated gland situated across the back of the abdomen behind the stomach. It secretes both digestive enzymes and hormones. Pancreatic hormones regulate the level of sugar in the blood.

Pancreatitis—Inflammation of the pancreas, frequently caused by gallstones, alcohol abuse, viral infection, or injury.

Turbidimetry—A technique of measurement that analyzes the amount of sediment in a liquid.

Increased lipase levels are found in acute pancreatitis, chronic relapsing pancreatitis, and pancreatic **cancer**. High lipase levels also occur in certain liver diseases, kidney failure, bowel obstruction, peptic ulcer disease, and tumors or inflammation of the salivary glands.

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Lipidoses

Definition

Lipidoses are heredity metabolic disorders, passed from parents to their children, characterized by defects of the digestive system that impair the way the body uses fats (a type of lipid) from the diet. When the body is unable to properly digest fats, one or more enzymes used to metabolize lipids are not produced in sufficient amounts or are improperly produced. Consequently, lipids accumulate in body tissues in abnormal amounts. Lipids are molecules that include fats, waxes, oils, fat-soluble **vitamins**, sterols (such as estrogen and cholesterol), and other related compounds whose primary task is to store energy. Consequently, lipidoses are also called by the name of lipid storage disorders or diseases. When lipids excessively accumulate over time they can eventually lead to cell and tissue damage, especially affecting the brain, peripheral nervous system, spleen, liver, and bone marrow.

Demographics

This group of diseases is inherited from one or both parents. In each case of lipidoses, the parent carries a gene that is unable to regulate a particular protein. In some cases, neither parent has the disorder but passes it on to their offspring, equally affecting both males and females. In other instances, the mother carries the damaged gene and passes it on to her offspring, with the males more severely affected by the disorder than the females.

Description

The digestion, storage, and use of fats from foods is a complex process that involves hundreds of chemical reactions in the body. In most people, the body is already programmed by its genetic code to produce all of the enzymes and chemicals necessary to carry out these functions. These genetic instructions are passed from parents to their offspring during reproduction.

People with lipidoses are born without the genetic codes needed to tell their bodies how to complete a particular part of the fat digestion process. In most of these disorders, the body does not produce a certain enzyme or chemical. Over 30 different disorders of fat metabolism are related to genetic defects. Although the defects are passed from parents to children, the parents often do not have the disorders themselves.

The symptoms, available treatments, and long-term consequences of these conditions vary greatly. Some of the conditions become apparent shortly after the infant is born; in others, symptoms may not develop until adulthood. For most of the lipidoses, diagnosis is suspected based on the symptoms and family history. Blood tests, urine tests, and tissue tests can be used to confirm the diagnosis. **Genetic testing** can be used, in some cases, to identify the defective gene. Some of these disorders can be controlled with changes in the diet, medications, or

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enzyme supplements. For many, treatment is not available. Some may cause **death** in childhood or contribute to a shortened life expectancy. Some of the most common or most serious lipidoses are discussed below.

Fabry's disease

Causes and symptoms

Approximately one in every 40,000 males is born with Fabry's disease, which is also called Fabry disease and alpha-galactosidase-A deficiency. This condition has an X-linked, recessive pattern of inheritance, meaning that the defective gene is carried on the X chromosome. A female who carries a defective recessive gene on one of her two X chromosomes has a 50% chance of passing the defective gene to her sons who will develop the disorder associated with the defective gene (a male receives one X chromosome from his mother and one Y chromosome from his father). She also has a 50% chance of passing the defective recessive gene to her daughters who will be carriers of the disorder (like their mother). Some female carriers of Fabry's disease show mild signs of the disorder, especially cloudiness of the cornea.

The gene that is defective in Fabry's disease causes a deficiency of the enzyme alpha-galactosidase A. Without this enzyme, fatty compounds start to line the blood vessels. The collection of fatty deposits eventually affects blood vessels in the skin, heart, kidneys, and nervous system. The first symptoms in childhood are **pain** and discomfort in the hands and feet brought on by **exercise**, **fever**, **stress**, or changes in the weather. A raised rash of dark red-purple non-cancerous, spots (called angiokeratomas) is common, especially on skin between the waistline and the knees. Other symptoms include a decreased ability to sweat and changes in the cornea or outer layer of the eye. Other symptoms include gastrointestinal problems, heart enlargement, and progressive kidney damage. Although the disease begins in childhood, it progresses very slowly. Kidney and heart problems develop in adulthood.

Diagnosis

The diagnosis can be confirmed by a blood test to measure for alpha-galactosidase A. Women who are carries of the defective gene can also be identified by a blood test.

Treatment

Treatment focuses on prevention of symptoms and long-term complications and slowing down the progression of the disease. Daily doses of phenytoin **sodium** (Phenytek, Dilantin, Infatabs), diphenylhydantoin (Dilantin), or carbamazapine (Tegretol) can prevent or reduce the severity of pain in the hands and feet associated with the condition. To help with gastrointestinal problems, metoclopramide (Maxolon, Primperan, Pramin) may be given and, to help digest fats, the nutritional supplement called Lipisorb may be provided. A low-sodium, low-protein diet may be beneficial to those patients who have some kidney complications. If kidney problems progress, **kidney dialysis** or **kidney transplantation** may be required. Enzyme replacement therapy is currently being explored at helping to ease pain, reduce storage problems, and to improve organ capabilities.

Prognosis

Although patients with Fabry's disease usually survive to adulthood, they are at increased risk for **stroke**, heart attacks, and kidney damage. They usually die prematurely from complications of these high-risk conditions.

Drugs such as phenytoin and carbamazepine are often prescribed to treat pain that accompanies Fabry's disease. Metoclopramaide or Lipisorb (a nutritional supplement) can ease gastrointestinal distress that often occurs in Fabry's patients, and some individuals may require kidney transplant or dialysis. Recent experiments indicate that enzyme replacement can reduce storage, ease pain, and improve organ function in patients with Fabry's disease.

Gaucher disease

Causes and symptoms

Gaucher (pronounced go-shay) disease, also called Gaucher's disease, is the most common of the lipid storage disorders. It is found in populations all over the world (20,000 to 40,000 people have a type of the disease), and it occurs with equal frequency in males and females. **Gaucher disease** has a recessive pattern of inheritance, meaning that a person must inherit a copy of the defective gene from both parents in order to have the disease. The genetic defect causes a deficiency of the enzyme glucocerebrosidase that is responsible for breaking down a certain type of fat and releasing it from fat cells. These fat cells begin to crowd out healthy cells in the liver, spleen, bones, and nervous system. Symptoms of Gaucher disease can start in infancy, childhood, or adulthood.

Three types of Gaucher disease have been identified, but there are many variations in how

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symptoms develop. Type 1 (non-neuropathic type) is the most common and affects both children and adults. It occurs much more often in people of Eastern European and Russian Jewish (Ashkenazi) ancestry, affecting 1 out of every 450 live births. The first signs of the disease include an enlarged liver and spleen, causing the abdomen to swell. Children with this condition may be shorter than the normal height. Other symptoms include tiredness, pain, bone deterioration, bone lesions, broken bones, lymph node swelling, anemia, low blood **platelet count**, and bruising. It also may include yellow spots on the eyes and a brownish color to the skin. People with Gaucher disease are more prone to infections than are other people. Type 2 Gaucher disease (acute infantile neuropathic type) is more serious. It normally begins within the first few months after birth. Symptoms, which are similar to those in Type 1, progress rapidly, but also include nervous system damage, limb rigidity, and decreased ability to swallow or suck. Symptoms of Type 3 Gaucher disease (chronic neuronopathic type) begin during early childhood with symptoms like Type 1. Unlike Type 2, the progress of the disease is slower, although it also includes nervous system damage. Anemia, respiratory problems, and poor coordination are some of its specific symptoms.

Diagnosis

Gaucher disease may be suspected based on symptoms and is confirmed with a blood test for levels of the enzyme. Samples of tissue from an affected area may also be used to confirm a diagnosis of the disease.

Treatment

The symptoms of Gaucher disease in Type 1 and Type 3 Gaucher disease can be stopped and even reversed by treatment with injections of enzyme replacements. Such treatment has been found to counter many of the symptoms such as abnormal blood count, and liver and spleen size. Two enzyme drugs currently available are alglucerase (Ceredase) and imiglucerase (Cerezyme). Other treatments address specific symptoms such as anemia, broken bones, or pain. Type 1 and Type 3 Gaucher disease often results in brain and nervous system damage. There is not a way to reverse such damage.

Prognosis

The pain and deformities associated with symptoms can make coping with this illness very challenging for individuals and families. With treatment and control of symptoms, people with Type 1 Gaucher disease may lead fairly long and normal lives. Most infants with Type 2 die before the age of 2 years. Children with Type 3 Gaucher disease may survive to adolescence and early adulthood.

Krabbe's disease

Causes and symptoms

Krabbe's disease, also called Krabbe disease, is caused by a deficiency of the enzyme galactoside beta-galactosidase. It has a recessive pattern of inheritance and is believed to occur in 1 of 40,000 births in the United States. This condition, which is also called globoid cell leukodystrophy or Krabbe leukodystrophy, is characterized by acute central and peripheral nervous system degeneration. It develops in early infancy with initial symptoms of irritability, **vomiting**, and episodes of partial unconsciousness. Symptoms progress rapidly to seizures, muscle weakness, difficulty swallowing, blindness, deafness, **mental retardation**, and **paralysis**. Other symptoms include muscle weakness,

Treatment

A cure for Krabbe's disease is not available. Treatment is supportive at best, with actions that help to relieve symptoms. Some clinical trials have shown that children who receive umbilical cord blood stem cells from non-family members before any symptoms are present develop lessened neurological impairment than other children with the disease. Bone marrow transplants have also been tried in the more modest cases of Krabbe's disease.

Prognosis

Children born with Krabbe's disease die in infancy, usually before the age of 2 years. As shown by recent trials, children who have received umbilical cord blood stem cells or bone marrow transplants before symptoms are present show better prognosis than other children with the disease. People who get the disease later in later usually have a less severe form of it and live longer, too.

Niemann-Pick disease

Causes and symptoms

At least five different forms of Niemann-Pick disease (NPD) have been identified. The different types seem to be related to the activity level of the enzyme sphingomyelinase. In patients with Types A and B NPD, there is a build up of sphingomyelin in cells of

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the brain, liver, spleen, kidney, and lung. Type A is the most common form of NPD and the most serious, with death usually occurring by the age of 18 months. Symptoms develop within the first few months of life and include poor appetite, failure to grow, enlarged liver and spleen, and the appearance of cherry red spots in the retina of the eye. Type B (also labeled juvenile onset) develops in infancy or childhood with symptoms of mild liver or spleen enlargement and lung problems. Some adults with this form (Type E) may also show a loss of muscle coordination. Types C or D NPD are related to cholesterol transfer out of cells. Children with Types C or D grow normally in early childhood, but eventually develop difficulty in walking and loss of muscle coordination. Ultimately, the nervous system becomes severely damaged and these patients die. Type C occurs in any population, while Type D has been identified only in patients from Nova Scotia, Canada.

Diagnosis

Diagnosis is confirmed by analyzing a sample of tissue. Prenatal diagnosis of Types A and B of NPD can be done with **amniocentesis** or **chorionic villus sampling**.

Treatment

There is not a cure for Niemann-Pick disease. Treatment consists of supportive care to deal with symptoms and the development of complications. **Bone marrow transplantation** is being investigated as a possible treatment for Type B. So far, the results have shown promise, but additional trials are necessary. Low-cholesterol **diets** may be helpful for patients with Types C and D, but clinical trials have not been promising.

Prognosis

Patients with Type A NPD usually die within the first year and a half of life, usually from infection or neurological problems. Type B patients generally live to adulthood but suffer from significant liver and lung problems. They usually require supplemental oxygen due to decreased function in their lungs. Bone marrow transplants have been attempted with such Type B patients. With Types C and D NPD, there is significant nervous system damage leading to severe **muscle spasms**, seizures, and eventually, to **coma** and death. Some patients with Types C and D die in childhood, while less severely affected patients may survive to adulthood.

Refsum's disease

Causes and symptoms

Refsum's disease, also called Refsum disease and Adult Refsum disease (ARD), has a recessive pattern of inheritance and affects populations from Northern Europe, particularly Scandinavians most frequently. It is due to a deficiency of phytanic acid hydroxylase, an enzyme that breaks down a fatty acid called phytanic acid. This condition affects the nervous system, eyes, bones, and skin. Symptoms, which usually appear by age 20 years, include vision problems (retinitis pigmentosa and rhythmic eye movements [nystagmus]), loss of muscle coordination, loss of sense of smell (**anosmia**), pain, **numbness**, and elevated protein in the cerebrospinal fluid. Later symptoms include deafness, abnormalities with the heartbeat (cardiac arrnythmias), lack of coordination (ataxis), weakness and numbness (peripheral neuropath), and scaly, dry skin (**ichthyosis**). Still other people may have shortened toes or fingers. If symptoms do not appear in the 20s, they may begin appearing in the 40s or 50s.

Treatment

A diet free of phytanic acid (found in dairy products, fatty fish [such as tuna, cod, and haddock], lamb, stewed beef and lamb, white bread, white rice, boiled potatoes, and egg yolk) can reduce some of the symptoms. **Plasmapheresis**, a process where whole blood is removed from the body, processed through a filtering system, and then return to the body, may be used to filter phytanic acid from the blood.

Prognosis

Refsum's disease is the lipidoses that is most treatable because a change in diet can control the disease. By removing phytanic acid from the diet, the symptoms associated with it usually disappear. Problems with hearing, vision, and smell may continue even with treatment. If left untreated, the disease may eventually lead to death from irregularities of the heart.

Tay-Sachs disease

Causes and symptoms

Tay-Sachs disease (TSD) is a fatal condition caused by a deficiency of the enzyme beta-hexosaminidase A, which allows excessive amounts of the fatty material called ganglioside G_{M2} to build up in tissues and nerve cells within the brain. The defective gene that causes this disorder is found in roughly 1 in 250 people in the general population. However, certain populations

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KEY TERMS

Amniocentesis—A procedure where a needle is inserted through the abdomen into the uterus of a pregnant woman to remove a small amount of the fluid that surrounds the developing fetus. This test can be performed at about week 16 of the pregnancy. Cells from the fetus can be tested for genetic defects.

Chorionic villi sampling—A procedure to remove a small tissue sample of the placenta, the sac that surrounds the developing fetus. This test can be performed as early as week 10 of the pregnancy. The tissue can be tested for genetic defects.

Lipids—Organic compounds not soluble in water, but soluble in fat solvents such as alcohol. Lipids are stored in the body as energy reserves and are also important components of cell membranes.

Recessive—Refers to an inherited characteristic or trait that is expressed only when two copies of the gene responsible for it are present.

X-linked—Refers to a gene carried on the X chromosome, one of the two sex chromosomes.

have significantly higher rates of TSD. French-Canadians living near the St. Lawrence River and in the Cajun regions of Louisiana are at higher risk of having a child with TSD. The highest risk seems to be in people of Eastern European and Russian Jewish (Ashkenazi) descent. Tay-Sachs disease has a recessive pattern of inheritance, and approximately 1 in every 27 people of Jewish ancestry in the United States carries the TSD gene. Symptoms develop in infancy and are due to the accumulation of a fatty acid compound in the nervous system. Early symptoms include reduced vision and physical coordination, deafness, seizures, red spots on retina of eyes, and mental retardation. Eventually, the child develops problems with breathing and swallowing. Blindness, paralysis, and death follow. In another type of the disease, it occurs in people in their 20s or early 30s. They begin to have problems walking. Eventually, their nervous system progressively deteriorates.

Diagnosis

Carriers of the Tay-Sachs related gene can be identified with a blood test. Amniocentesis or chorionic villi sampling can be used to determine if the fetus has Tay-Sachs disease.

Treatment

Treatment options are not available for Tay-Sachs disease. Parents who are identified as carriers may want to seek **genetic counseling**. If a fetus is identified as having TSD, parents may consider termination of the **pregnancy**. If a person contracts the disease, anticonvulsant medication can be prescribed to control seizures. As neurological problems continue, swallowing may be difficult, and a feeding tube may be inserted to help in providing nutrient.

Prognosis

Children born with Tay-Sachs disease become increasingly debilitated; most die by about age four years, usually from infections.

Wolman's disease

Causes and symptoms

Wolman's disease, a type of acid lipase deficiency and acid lipase disease, is caused by a genetic defect (with a recessive pattern of inheritance) that results in deficiency of an enzyme that breaks down cholesterol. It occurs in both males and females. This causes large amounts of fat to accumulate in body tissues. Infants are born without symptoms and they appear to be normal. However, symptoms begin in the first few weeks of life and include an enlarged liver and spleen, adrenal calcification (hardening of adrenal tissue due to deposits of **calcium** salts), **vomiting**, anemia, **jaundice**, and fatty stools.

Treatment

Treatment is not currently available.

Prognosis

Infants usually die by the age of one year. They usually die from **malnutrition**. However, if they survive as children, they may live into adulthood

Prevention

Couples who have family histories of genetic defects can undergo genetic testing and counseling to see if they are at risk for having a child with one of the lipidoses disorders. During pregnancy, cell samples can be collected from the fetus using amniocentesis or chorionic villi sampling. The results of these tests

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can indicate if the developing fetus has a lipidosis disorder. Termination of the pregnancy may be considered in some cases.

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ORGANIZATIONS

Fabry Support and Information Group, 108 N.E. Second Street, Suite C; P. O. Box 510, Concordia, MO, 64020-0510, (660) 463-1355, (660) 463-1356, http://www.fabry.org/.

National Institute of Neurological Disorders and Stroke, Post Office Box 20824, Bethesda, MD, 20824, (301) 496-5751, (800) 352-9424, http://www.ninds.nih.gov/.

National Niemann-Pick Foundation, 401 Madison Avenue, Suite B; P.O. Box 49, Fort Atkinson, WI, 53538, (920) 563-0930, (877) 287-3672, (920) 563-0931, nnpdf@nnpdf.org, http://www.nnpdf.org/.

National Organization for Rare Disorders, 55 Kanosia Avenue; P. O. Box 1968, Danbury, CT, 06813-1968, (203) 744-0100, (203) 798-2291, http://www.rarediseases.org/.

National Tay-Sachs and Allied Diseases Association, 2001 Beacon Street, Suite 204, Boston, MA, 02135, (800) 906-8723, (617) 277-0134, http://www.ntsad.org/.

Altha Roberts Edgren

Lipoproteins test

Definition

Lipoproteins are the "packages" in which cholesterol and **triglycerides** travel throughout the body. Measuring the amount of cholesterol carried by each type of lipoprotein helps determine a person's risk for cardiovascular disease (disease that affects the heart and blood vessels, also called CVD).

Purpose

Cholesterol and triglycerides are fat-like substances called lipids. Cholesterol is used to build cell membranes and hormones. The body makes cholesterol and gets it from food. Triglycerides provide a major source of energy to the body tissues. Both cholesterol and triglycerides are vital to body function, but an excess of either one, especially cholesterol, puts a person at risk of cardiovascular disease.

Because cholesterol and triglycerides can't dissolve in watery liquid, they must be transported by something that can dissolve in blood serum. Lipoproteins contain cholesterol and triglycerides at the core and an outer layer of protein, called apolipoprotein.

There are four major classes of lipoproteins: chylomicrons, very low-density lipoproteins (VLDL), low-density lipoproteins (LDL), and high-density lipoproteins (HDL). There also are less commonly measured classes such as lipoprotein(a) and subtypes of the main classes. Each lipoprotein has characteristics that make the cholesterol it carries a greater or lesser risk. Measuring each type of lipoprotein helps determine a person's risk for cardiovascular disease more

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accurately than cholesterol measurement alone. When a person is discovered to be at risk, treatment by diet or medication can be started and his or her response to treatment monitored by repeated testing.

Description

Chylomicrons

Chylomicrons are made in the intestines from the triglycerides in food. They contain very little cholesterol. Chylomicrons circulate in the blood, getting smaller as they deposit the triglycerides in fatty tissue. Twelve hours after a meal, they are gone from circulation. Serum collected from a person directly after eating will form a creamy layer on the top if left undisturbed and refrigerated overnight. This creamy layer is the chylomicrons.

Very low-density lipoproteins (VLDL)

VLDL are formed in the liver by the combination of cholesterol, triglycerides formed from circulating fatty acids, and apolipoprotein. This lipoprotein particle is smaller than a chylomicron, and contains less triglyceride but more cholesterol (10–15% of a person's total cholesterol). As the VLDL circulates in the blood, triglycerides are deposited and the particle gets smaller, eventually becoming a low-density lipoprotein (LDL). Serum from a person with a large amount of VLDL will be cloudy.

Low-density lipoproteins (LDL)

LDL, often called "bad" cholesterol, is formed primarily by the breakdown of VLDL. LDL contains little triglycerides and a large amount of cholesterol (60–70% of a person's total cholesterol). Although the particles are much smaller than chylomicrons and VLDL, LDL particles can vary in size and chemical structure. These variations represent subclasses within the LDL class. Serum from a person with a large amount of LDL will be clear.

LDL carries cholesterol in the blood and deposits it in body tissues and in the walls of blood vessels, a condition known as **atherosclerosis**. The amount of LDL in a person's blood is directly related to his or her risk of cardiovascular disease. The higher the LDL level, the greater the risk. LDL is the lipoprotein class most used to trigger and monitor cholesterol lowering therapy.

High-density lipoproteins (HDL)

HDL is often called "good" cholesterol. HDL removes excess cholesterol from tissues and vessel walls and carries it to the liver, where it is removed from the blood and discarded. The amount of HDL in a person's blood is inversely related to his or her risk of cardiovascular disease. The lower the HDL level, the greater the risk; the higher the level, the lower the risk. The smallest lipoprotein, it contains 20–30% of a person's total cholesterol and can be separated into two major subclasses.

Lipoprotein(a)

Lipoprotein(a) is found in lower concentrations than other lipoproteins, yet it carries a unique and significant risk for cardiovascular disease. Because of its similarity to LDL, test methods often don't measure it separately, but include it within the LDL class. Testing specifically for this class may uncover why a person is not responding to standard cholesterol-lowering treatment. High lipoprotein(a) levels may not respond to treatment aimed at high LDL.

Measurement guidelines

The Expert Panel of the National Cholesterol Education Program (NCEP) sponsored by the National Institutes of Health has published guidelines for the detection of high cholesterol in adults. The NCEP panel recommends that adults over the age of 20 be tested for cholesterol and HDL every five years. If the cholesterol is high, the HDL is low (below 35 mg/dL), or other risk factors are present, a complete lipoprotein profile that includes total cholesterol, triglycerides, HDL, and calculated LDL should be done.

Measurement methods

There are a variety of methods to measure the lipoprotein classes. All require separation of the classes before they can be measured. One way to separate them is by spinning serum (the yellow, watery liquid that separates from the cells when **blood clots**) for a long time in a high-speed centrifuge (called ultracentrifugation). The most dense classes will settle toward the bottom, the least dense toward the top. Following centrifugation, the most complete measurement of all the lipoprotein classes is done using electrophoresis. This procedure measures the quantity of each lipoprotein class based on its movement in an electrical field.

In 2003, a new test called the vertical auto profile or VAP, was developed that provides detailed measurements of cholesterol subclasses. These subclasses play important roles in patients later developing heart disease. The new tests were predicted to help identify important, emerging risk factors for heart disease.

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KEY TERMS

Atherosclerosis—Disease of blood vessels caused by deposits of cholesterol on the inside walls of the vessels.

Cardiovascular disease—Disease that affects the heart and blood vessels.

Cholesterol—A fat-like substance called a lipid. It is used to build cell membranes and hormones. The body makes cholesterol and gets it from food.

Lipoproteins—The packages in which cholesterol and triglycerides travel throughout the body.

Other, less extensive procedures also are used. For example, if only HDL is to be measured, a chemical is added to the serum that will clump the other classes, leaving HDL free in the serum to be measured by a chemical method. LDL often is not measured directly but its level is calculated based on the measurements of total cholesterol, HDL, and triglycerides. The formula is called the Friedewald formula: LDL = total cholesterol - HDL - (triglycerides/5). The calculated result will be inaccurate in a person with high triglycerides. Results usually are available the same or following day.

Preparation

The patient must fast for 12 hours before the test, eating nothing and drinking only water. The person should not have alcohol for 24 hours before the test. There should be a stable diet and no illnesses occurring in the preceding two weeks.

A lipoproteins test requires 5 mL (milliliters) of blood. A person's physical position while having blood collected affects the results. Values from blood drawn while a person is sitting may be different from those while the person is standing. If repeated testing is done, the person should be in the same position each time.

Aftercare

Discomfort or bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Warm packs to the puncture site relieve discomfort.

Results

People with HDL levels between 45 mg/dL and 59 mg/dL carry an average risk for cardiovascular disease. People with HDL levels above 60 mg/dL have a negative risk factor and appear to be protected from cardiovascular disease.

LDL levels below 130 mg/dL are desirable.

Some people have normal variations in their lipoprotein and total cholesterol levels. Repeat testing may be necessary, especially if a value is at a borderline risk category point.

Abnormal results

People with HDL levels of 36–44 mg/dL have a moderate risk of cardiovascular disease. HDL levels below 35 mg/dL are a major risk.

LDL levels of 130–159 mg/dL place a person at a borderline high risk of cardiovascular disease; levels above 160 mg/dL place a person at high risk. Relative proportions between HDL and LDL are important also. Results of a large clinical trial in 2003 showed that the new VAP cholesterol tests increased lipid-lowering therapy by 59% in high-risk patients with diabetes.

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American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi. nih.gov.

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Liposuction

Definition

Liposuction, also known as lipoplasty or suction-assisted lipectomy, is **cosmetic surgery** performed to remove unwanted deposits of fat from under the skin. The surgeon sculpts and re-contours a person's body by removing excess fat deposits that have been

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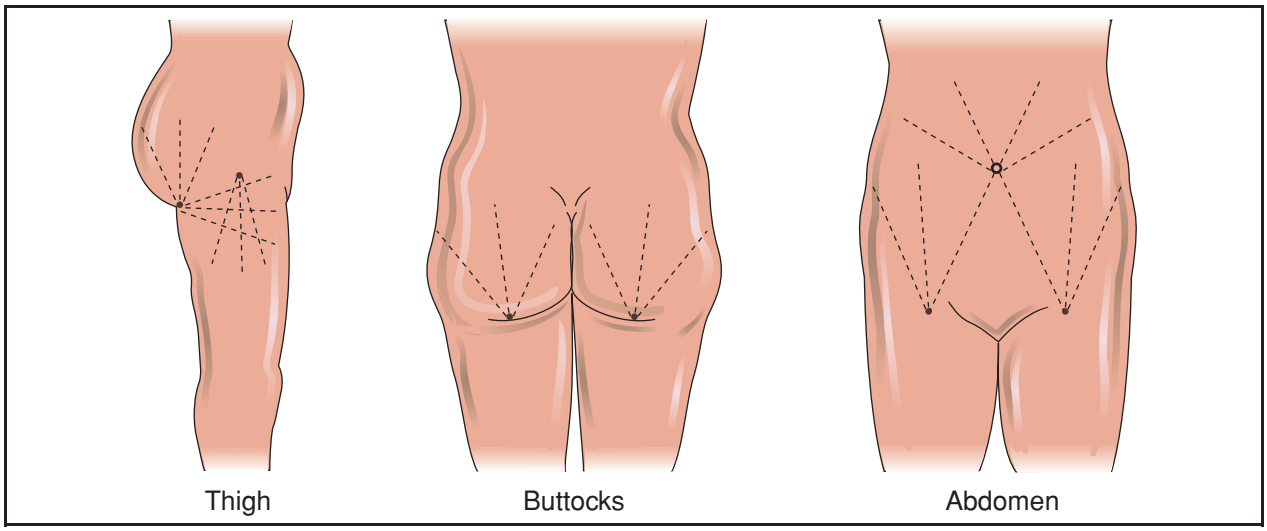

Common entry sites for liposuction procedures. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

"Before" photo of patient undergoing liposuction. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

"After" photo of same patient following liposuction. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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resistant to reduction by diet or **exercise**. Removal of fat cells is permanent.

Purpose

Liposuction is intended to reduce and smooth the contours of the body and improve a person's appearance. Its goal is cosmetic improvement. Liposuction does not remove large quantities of fat and is not intended as a weight-reduction technique. The average amount of fat removed is about 1 quart (1 liter). Although liposuction is not intended to remove cellulite (lumpy fat), some doctors believe that it improves the appearance of areas that contain cellulite, including thighs, hips, buttocks, abdomen, and chin. A technique called liposhaving shows more promise at reducing cellulite. Liposhaving can be done under **local anesthesia** and is reported to be less traumatic to the skin than liposuction. Liposuction is most often performed by board-certified plastic surgeons.

Demographics

Liposuction is the most commonly performed cosmetic procedure for men in the United States and the second most common cosmetic procedure (after breast augmentation) for women. In 2006, about 403,680 liposuction procedures were performed in the United States. This is more than double the amount performed ten years earlier.

Description

Most liposuction procedures are performed under local anesthesia. Local anesthesia produces loss of sensation without loss of consciousness. The tumescent, or wet, technique is used most often. In this technique, a large volume of very dilute anesthetic is injected under the person's skin, making the tissue swollen (tumescent) and firm. Epinephrine is added to the solution to reduce bleeding, which allows the removal of larger amounts of fat.

The physician first numbs the skin with an injection of local anesthetic. After the skin is desensitized, the doctor makes a series of tiny incisions no larger than 0.12–0.25 in (3–6 mm) in length. Flooding the area with more dilute anesthetic, fat is then extracted with suction through a long, blunt hollow tube called a cannula. The doctor repeatedly pushes the cannula through the fat layers in a radiating pattern creating tunnels, thus removing fat and re-contouring the area.

Some newer modifications to the procedure include the use of a cutting cannula called a liposhaver. Formerly some surgeons used ultrasound to help break up the fat deposits, but this technique has largely been abandoned because it created greater safety risks than the tumescent technique. Larger incisions may be closed with a suture or staple, while micro incisions are covered with **bandages** but do not need sutures. Incisions usually heal completely within two weeks and should leave few or no **scars**

KEY TERMS

Cellulite—Dimpled skin that is caused by uneven fat deposits beneath the surface.

Epinephrine—Epinephrine, also called adrenalin, occurs naturally in the body and causes blood vessels to constrict or narrow. As a drug, it is used to reduce bleeding.

Hemoglobin—The component of blood that carries oxygen to the tissues.

Liposhaving—Involves removing fat that lies closer to the surface of the skin by using a needle-like instrument that contains a sharp-edged shaving device.

The length of time required to perform the procedure varies with the amount of fat that is to be removed and the number of areas to be treated. Most operations take from 30 minutes up to two hours, but extensive procedures can take longer. Risk of complications increases the more extensive the procedure. The length of time required also varies with the manner in which the anesthetic is injected.

The cost of liposuction varies depending upon the fees commonly charged in the region of the country where it is performed, the extent of the area being treated, and the person performing the procedure. In the mid-2000s, an increasing trend was for Americans to go overseas to have cosmetic procedures performed in countries where they cost substantially less than in the United States. These procedures are cosmetic and are not covered by most insurance policies.

Diagnosis/Preparation

Liposuction is most successful when performed on persons who have firm, elastic skin and concentrated pockets of fat in areas that are characterized by cellulite. To get good results after fat removal, the skin must contract to conform to the new contours without sagging. Older persons have less elastic skin and, consequently, may not be good candidates for this procedure. People with generalized fat distribution, rather

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than localized pockets, are not good candidates. Candidates should be in good general health and free of heart or lung disease. People who have poor circulation or who have had recent surgery at the intended site of fat reduction are not good candidates.

The doctor will conduct a **physical examination** and may order blood work to determine clotting time and hemoglobin level for transfusions, in case the need should arise. The person may be placed on **antibiotics** before surgery to ward off potential infection.

Aftercare

Liposuction is normally an outpatient procedure. Patients should plan to have someone available to drive them home and stay with them for the next 12–24 hours. If the tumescent technique is used, the patient will feel little or no **pain** for 24 hours following the procedure but after that may have soreness and swelling for several weeks. After some liposuction surgery, the patient may need to wear a support garment continuously for 2–3 weeks. If ankles or calves were treated, support hose should be worn for up to 6 weeks. The support garments can be removed during bathing. A drainage tube placed under the skin in the area of the procedure may be needed to prevent fluid build-up.

The incisions involved in this procedure are tiny, but the surgeon may close them with metal sutures or staples. These will be removed a few days surgery. Some micro-incisions are small enough that the doctor may not need to close them with sutures. Minor bleeding or seepage through the incision site(s) is common after this procedure. Wearing the elastic bandage or support garment helps reduce fluid loss.

The patient usually can return to normal activity within a week. Any postoperative bruising is expected to go away within 10–14 days. Postoperative swelling begins to go down after a week. It may take 3–6 months for the final contour to be reached depending on the extent of the surgery.

Risks

Liposuction under local anesthesia using the tumescent technique is exceptionally safe so long as the patient is in good health. The main hazards associated with this surgery involve migration of a blood clot or fat globule to the heart, brain, or lungs. Such an event can cause a **heart attack** or **stroke**. Ultrasound assisted liposuction has largely been abandoned because of safety concerns such as **burns** and complications such as scarring.

Staying in bed increases the risk of clot formation, but too much activity can result in increased swelling of the surgical area. Such swelling is a result of excess fluid and blood accumulation, and generally comes from not wearing the compression garments. If necessary, this excess fluid can be drained with a needle in the doctor's office.

Infection is another complication, but this rarely occurs. If the physician is skilled and works in a sterile environment, infection should not be much of a concern.

The greatest risk of complications arises when too much fat is removed or too many parts of the body are worked on at one time. If too much fat is removed, the skin may peel in that area. Smokers are at increased risk for shedding skin because their circulation is impaired. Removing too much fat may also cause the patient to go into **shock**.

Results

The loss of fat cells is permanent, and the patient should have smoother, more pleasing body contours without excessive bulges. Nevertheless, if the patient overeats, the remaining fat cells will grow in size. Although the patient may gain weight, the body should retain the new proportions and the suctioned area should remain proportionally smaller.

Tiny scars at the site of incision are normal. The doctor usually makes the incisions in places where the scars are not likely to show.

In some instances, the skin may appear rippled, wavy, or baggy after surgery. Pigmentation spots may develop. The re-contoured area may be uneven. This unevenness can be corrected with a second procedure that is less extensive than the first.

Morbidity and mortality rates

The morbidity rate from liposuction is less than 1%. Mortality is exceedingly rare.

Alternatives

Some of the alternatives to liposuction include modifying diet to lose excess body fat, exercise, accepting one's body and appearance as it is, or using clothing or makeup to downplay or emphasize body or facial features.

Resources

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ORGANIZATIONS

American Board of Plastic Surgery, Seven Penn Center, Suite 400, 1635 Market Street, Philadelphia, PA, 19103-2204, (215) 587-9322, http://www.abplsurg.org.
American College of Surgeons, 633 North Saint Claire Street, Chicago, IL, 60611, (312) 202-5000, http://www.facs.org.
American Society for Aesthetic Plastic Surgery, 11081 Winners Circle, Los Alamitos, CA, 90720, (888) 272-7711, http://www.surgery.org.
American Society for Dermatologic Surgery, 5550 Meadowbrook Drive, Suite 120, Rolling Meadows, IL, 60006, (847) 956-0900, http://www.asds-net.org.
American Society of Plastic and Reconstructive Surgeons, 444 E. Algonquin Road, Arlington Heights, IL, 60005, (847) 228-9900, http://www.plasticsurgery.org.

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Listeria monocytogenes infection *see* **Listeriosis**

Listeriosis

Definition

Listeriosis is an **infectious disease** caused by a bacterium, *Listeria monocytogenes*, which is most commonly acquired by eating contaminated food. The organism can spread to the blood stream and central nervous system. During **pregnancy**, listeriosis often causes **miscarriage** or **stillbirth**. It is also more likely to cause serious illness in the elderly, in newborns, or in people with weakened immune systems. Although listeriosis is infectious (caused by a disease organism), it is not contagious; that is, it is not spread by direct contact with other infected persons, with the exception of vaginal transmission during **childbirth**.

Demographics

Listeriosis, also called listeria infection, is usually an uncommon disease in the general human population in North America and Western Europe. There are on average 9.7 cases per million persons per year in Canada and the United States, and five cases per million per year in Europe; however, European doctors have reported as of early 2010 that the rate of listeriosis in Europe has been rising since 2005. Listeriosis is far more common among domestic animals, farm animals (particularly cattle and sheep), game animals, poultry, and wild birds than among humans. Listeriosis outbreaks are sporadic (rare and scattered in occurrence) rather than epidemic; they are, however, more common in cold or temperate climates than in the tropics, and more likely to occur in the summer in North America. The most recent foodborne outbreak in the United States occurred in Massachusetts in 2007 and involved contaminated milk.

Description

Listeriosis is caused by an infection with the gram-positive bacterium *Listeria monocytogenes*. The bacterium was named for Joseph Lister (1827–1912), a British surgeon honored as the pioneer of antiseptic surgery. The bacterium is rod-shaped and moves about with the help of a small flagellum. It secretes a chemical that causes the destruction of red blood cells.

This bacterium is carried by at least 64 different species of animals, and it has also been found in soil, water, sewage, and animal feed. Five out of every 100 people carry *L. monocytogenes* in their intestines. The bacterium is hardy and can survive in a wide temperature range, from 39°F (3.9°C) to 111°F (43.9°C). It is found almost everywhere in the world in plants and soils.

Listeriosis is considered a foodborne disease because most people become infected after eating food contaminated with *L. monocytogenes*. However, a woman can pass the bacteria to her baby during pregnancy. In addition, there have been a few cases in which veterinarians or farm workers have developed *Listeria* skin infections by touching infected calves or poultry.

There are five distinct clinical forms of listeriosis:

- Infection during pregnancy, most commonly in the third trimester.
- Neonatal (newborn) infection, which can take two forms: an early-onset inflammation of the entire body (sepsis), which usually results in premature

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birth; and a late-onset infection of the central nervous system, which the baby acquires during vaginal delivery.

- Central nervous system (CNS) infection. *L. monocytogenes* has a special predilection for the central nervous system of humans. The infection may take the form of inflammation of the membranes covering the brain (meningitis), paralysis of the cranial nerves, inflammation of the brain tissue itself (encephalitis), or abscesses. Patients may suffer from seizures and changes in mental status.
- Gastroenteritis (inflammation of the digestive tract). *L. monocytogenes* can cause diarrhea lasting one to three days.
- Cutaneous listeriosis. This is an infection of the skin most likely to affect veterinarians and others who handle infected farm or wild animals.

Risk factors

Persons at particular risk for listeriosis include the elderly, pregnant women, newborns, those who take glucocorticosteroid medications (which suppress immune responses to infection), and those with a weakened immune system (immunocompromised). Risk is increased when a person suffers from diseases such as **AIDS**, **cancer**, **kidney disease**, **diabetes mellitus**, or by the use of certain medications. Infection is most common in babies younger than one month old and adults over 60 years of age. Pregnant women account for 27% of the cases and immunocompromised persons account for almost 70%. Persons with AIDS are 280 times more likely to get listeriosis than others.

With the exception of pregnant women, sex is not a risk factor for listeriosis; neither is race nor ethnicity.

Causes and symptoms

As noted, persons become infected with *L. monocytogenes* by eating contaminated food. *Listeria* has been found on raw vegetables, fish, poultry, raw (unpasteurized) milk, fresh meat, processed meat (such as deli meat, hot dogs, and canned meat), and certain soft cheeses—particularly Brie, Camembert, feta cheese, and bleu cheese. Listeriosis outbreaks in the United States since the 1980s have been linked to cole slaw, milk, Mexican–style cheese, undercooked hot dogs, undercooked chicken, and delicatessen or salad bar–type foods.

Unlike most other bacteria, *L. monocytogenes* does not stop growing when food is in the refrigerator—its growth is merely slowed. Although initial levels of the bacterium in contaminated foods are usually low, its ability to survive and multiply at low temperatures allows it to reach levels high enough to cause human disease, particularly if contaminated foods that allow for the growth of the organism are stored for prolonged times under refrigeration. Fortunately, typical cooking temperatures and the pasteurization process in milk do kill this bacterium.

Listeria bacteria can pass through the wall of the intestines, and from there they can get into the blood stream. Once in the blood stream, they can be transported anywhere in the body, but are commonly found the central nervous system (brain and spinal cord). In pregnant women they are often found in the placenta (the organ which connects the baby's umbilical cord to the uterus). *Listeria monocytogenes* live inside specific white blood cells called macrophages. Inside macrophages, the bacteria can hide from immune responses and become inaccessible to certain **antibiotics**. *Listeria* bacteria are capable of multiplying within macrophages, and then may spread to other macrophages.

Gastrointestinal listeriosis

After consuming food contaminated with this bacteria, symptoms of infection may appear anywhere from 11–70 days later. Most people do not get any noticeable symptoms. Scientists are unsure, but they believe that *L. monocytogenes* can cause upset stomach and intestinal problems just like other food-borne illnesses. Persons with listeriosis may develop such flu-like symptoms as **fever**, **headache**, **nausea and vomiting**, tiredness, and **diarrhea**.

Listeriosis in pregnancy

Pregnant women experience a mild, flu–like illness with fever, muscle aches, upset stomach, and intestinal problems. They recover, but the infection can cause miscarriage, **premature labor**, early rupture of the birth sac, and stillbirth. Unfortunately, half of the newborns infected with *Listeria* will die from the illness.

Neonatal listeriosis

There are two types of listeriosis in the newborn baby: early-onset disease and late-onset disease. Early-onset disease refers to a serious illness that is present at birth and usually causes the baby to be born prematurely. Babies infected during pregnancy usually have a blood infection (**sepsis**) and may have a serious, whole body infection called granulomatosis infantisepticum. When a full-term baby becomes infected with *Listeria* during childbirth, that situation is called late-onset disease. Commonly, symptoms of late–onset listeriosis

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KEY TERMS

Abscess—An accumulation of pus caused by localized infection in tissues or organs. *L. monocytogenes* can cause abscesses in many organs, including the brain, spleen, and liver.

Brain stem—The posterior portion of the brain that connects directly to the spinal cord. It regulates breathing, heart function, and the sleep-wake cycle as well as maintaining consciousness.

Cutaneous—Pertaining to the skin.

Encephalitis—Acute inflammation of brain tissue.

Endocarditis—Inflammation of the endocardium, the inner layer of heart tissue.

Flagellum—A tail-like projection extending from the cell walls of certain bacteria. Its name is the Latin word for "whip."

Glucocorticosteroids—Also called glucocorticoids, a class of steroid hormones that play important roles in metabolism and the immune system. Synthetic glucocorticosteroids are drugs given to control certain allergic and immune system disorders; they include cortisone, prednisone, aldosterone, and dexamethasone. These drugs suppress the immune response to infection; thus they can increase a person's risk of listeriosis.

Immunocompromised—To have a poor immune system due to disease or medication. Immunocompromised persons are at risk for developing infections because they can not fight off microorganisms as can healthy persons.

Macrophages—White blood cells whose job is to destroy invading microorganisms. *Listeria monocytogenes* avoids being killed and can multiply within the macrophage.

Meningitis—Inflammation of the meninges, the layers of membranes that cover and protect the brain and spinal cord.

Sepsis—An inflammatory response of the whole body to an infection. Listeriosis in newborns may take the form of sepsis.

Sporadic—Rare and occasional in occurrence. Listeriosis in humans is a sporadic disease.

appear about two weeks after birth. Babies with late-term disease typically have **meningitis** (inflammation of the brain and spinal tissues); yet they have a better chance of surviving than those with early-onset disease.

Central nervous system involvement

Immunocompromised adults are at risk for a serious infection of the blood stream and central nervous system (brain and spinal cord). Meningitis occurs in about half of the cases of adult listeriosis. Symptoms of listerial meningitis occur about four days after the flu-like symptoms and include fever, personality change, uncoordinated muscle movement, **tremors**, muscle contractions, seizures, and slipping in and out of consciousness.

L. monocytogenes causes **endocarditis** in about 7.5% of cases of listeriosis. Endocarditis is an inflammation of heart tissue due to bacterial infection. Listerial endocarditis causes **death** in about half of patients. Other diseases which have been caused by *Listeria monocytogenes* include **brain abscess**, eye infection, hepatitis (**liver disease**), **peritonitis** (abdominal infection), lung infection, joint infection, arthritis, heart disease, bone infection, and gallbladder infection.

Diagnosis

Listeriosis may be diagnosed and treated by infectious disease specialists and internal medicine specialists. The diagnosis and treatment of this infection should be covered by most insurance providers.

Examination

The doctor may or may not suspect listeriosis on the basis of an office examination, as the symptoms of a gastrointestinal listeria infection are not unique to *L. monocytogenes*. A patient with listerial meningitis or **encephalitis** may have seizures, problems with movement, or mental status changes. But again, these can be caused by other disease organisms affecting the CNS. Laboratory tests are required to rule out other causes of the patient's symptoms.

Tests

The only way to confirm a diagnosis of listeriosis as of 2010 is to isolate *L. monocytogenes* from blood, cerebrospinal fluid (CSF), urine, or stool. A sample of cerebrospinal fluid is removed from the spinal cord using a needle and syringe. This procedure is commonly called a spinal tap. The amniotic fluid (the fluid that surrounds the unborn baby inside the uterus) may be tested in pregnant women with listeriosis.

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This sample is obtained by inserting a needle through the abdomen into the uterus and withdrawing fluid. *L. monocytogenes* grows well in laboratory media, and test results can be available within a few days. Blood cultures and CSF tests are more reliable for identifying *L. monocytogenes* than stool tests.

Imaging tests may be performed if endocarditis or involvement of the brain stem are suspect. **Transesophageal echocardiography** is used to diagnose endocarditis. MRI is the most accurate form of imaging for identifying listeria infections in the brain stem.

Treatment

Traditional

Medications are the treatment of choice for listeriosis. Intravenous antibiotics must be started immediately as soon as the diagnosis is suspected or confirmed.

Drugs

Listeriosis is treated with antibiotics, most often ampicillin (Omnipen), chloramphenicol (Chloromycetin), or sulfamethoxazole-trimethoprim (Bactrim, Septra). Because the bacteria live within macrophage cells, treatment may be difficult and the treatment periods may vary. Usually, pregnant women are treated for two weeks; newborns, two to three weeks; adults with mild disease, two to four weeks; persons with meningitis, three weeks; persons with brain abscesses, six weeks; and persons with endocarditis, four to six weeks.

Patients are often hospitalized for treatment and monitoring. However, it is not necessary to isolate them because listeriosis is not spread by human contact. Other drugs may be provided to relieve **pain** and fever and to treat other reactions to the infection.

Prognosis

Although listeriosis is a relatively uncommon infectious disease, it does cause significant mortality; the overall mortality rate for listeria infections in humans in 20–30%. Listeriosis is the most virulent form of foodborne disease in North America, with fatality rates higher than those of **botulism** or *Salmonella***food poisoning**. According to the Centers for Disease Control and Prevention (CDC), there are on average 500 deaths from listeriosis each year in the United States.

Prevention

The CDC recommends the following precautions to prevent getting listeriosis:

- Cook all raw food thoroughly, and wash all raw vegetables carefully.
- Wash hands, knives, and cutting boards in hot soapy water after handling uncooked foods.
- Avoid drinking raw (unpasteurized) milk or consuming dairy products made from raw milk.
- Pregnant women or immunocompromised people should avoid Brie, Camembert, feta, Mexican queso blanco or queso fresco, and bleu cheese. Cream cheese, yogurt, and cottage cheese are safe to eat.
- Reheat leftovers or ready-to-eat foods like hot dogs until they are steaming hot.
- Avoid delicatessen foods unless they can be thoroughly reheated.
- Cook all fish and meat to safe internal temperatures.

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ORGANIZATIONS

American College of Emergency Physicians (ACEP), 1125 Executive Circle, Irving, TX, 75038-2522, (972) 550-0911, (800) 798-1822, (972) 580-2816, http://www.acep.org/.
American Veterinary Medical Association (AVMA), 1931 North Meacham Rd., Suite 100, Schaumburg, IL, 60173-4360, (847) 925-8070, (847) 925-1329, avmainfo@avma.org, http://www.avma.org/.
Centers for Disease Control and Prevention (CDC), 1600 Clifton Rd., Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.
National Institute of Allergy and Infectious Diseases (NIAID), 6610 Rockledge Dr., MSC 6612, Bethesda, MD, 20892-6612, (301) 496-5717, (866) 284-4107, (301) 402-3573, http://www3.niaid.nih.gov.
U.S. Food and Drug Administration (FDA), 10903 New Hampshire Ave., Silver Spring, MD, 20993, (888) 463-6332, http://www.fda.gov/.
World Health Organization (WHO), Avenue Appia 20, 1211 Geneva 27, Switzerland, + 41 22 791 21 11, + 41 22 791 31 11, info@who.int, http://www.who.int/en/.

Belinda Rowland, PhD
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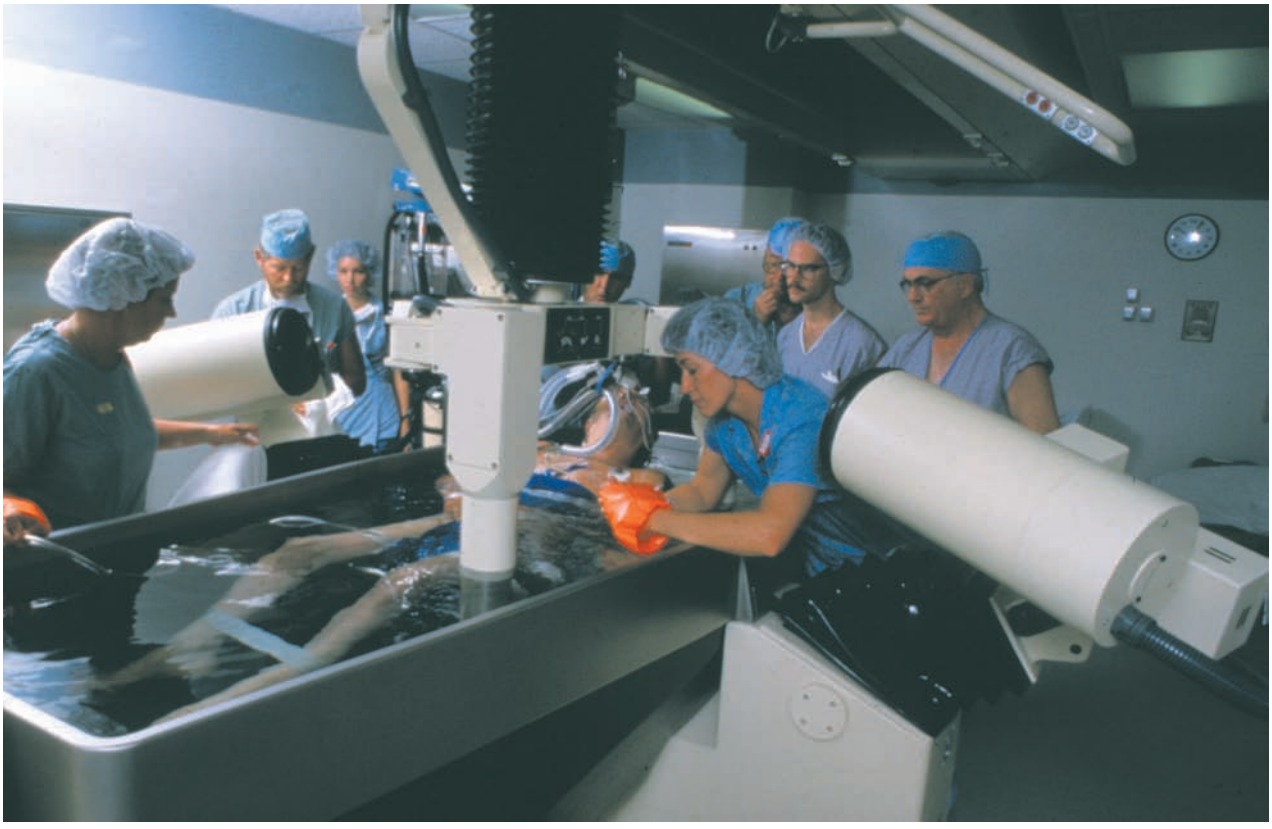
Lithotripsy

Definition

Lithotripsy is the use of high-energy shock waves to fragment and disintegrate **kidney stones**. The shock wave, created by using a high-voltage spark or an electromagnetic impulse, is focused on the stone. This shock wave shatters the stone and this allows the fragments to pass through the urinary system. Since the shock wave is generated outside the body, the procedure is termed extracorporeal shock wave lithotripsy, or ESWL.



A lithotripter in use by patient in tub. This noninvasive method crushes kidney stones through shock waves. *(Photo Researchers, Inc.)*

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KEY TERMS

Aneurysm—A dilation of the wall of an artery which causes a weak area prone to rupturing.

Bladder—Organ in which urine is stored prior to urination.

Bleeding disorder—Problems in the clotting mechanism of the blood.

Cardiologist—A physician who specializes in problems of the heart.

EKG—A tracing of the electrical activity of the heart.

ESWL (Extracorporeal shock wave lithotripsy)—The use of focused shock waves, generated outside the body, to fragment kidney stones.

Gravel—The debris which is formed from a fragmented kidney stone.

IVP (Intravenous pyelogram)—The use of a dye, injected into the veins, used to locate kidney stones. Also used to determine the anatomy of the urinary system.

Kidney stone—A hard mass that forms in the urinary tract and which can cause pain, bleeding, obstruction, or infection. Stones are primarily made up of calcium.

Stent—A plastic tube placed in the ureter prior to the ESWL procedure which facilitates the passage of gravel and urine.

Ultrasound—Sound waves used to determine the internal structures of the body.

Ureter—A tube which carries urine from the kidney to the bladder.

Urethra—A tube through which urine passes during urination.

Urologist—A physician who specializes in problems of the urinary system.

Purpose

ESWL is used when a kidney stone is too large to pass on its own, or when a stone becomes stuck in a ureter (a tube which carries urine from the kidney to the bladder) and will not pass. Kidney stones are extremely painful and can cause serious medical complications if not removed.

Precautions

ESWL should not be considered for patients with severe skeletal deformities, patients weighing over 300 lbs (136 kg), patients with abdominal aortic aneurysms, or patients with uncontrollable bleeding disorders. Patients who are pregnant should not be treated with ESWL. Patients with cardiac **pacemakers** should be evaluated by a cardiologist familiar with ESWL. The cardiologist should be present during the ESWL procedure in the event the pacemaker needs to be overridden.

Description

Lithotripsy uses the technique of focused shock waves to fragment a stone in the kidney or the ureter. The patient is placed in a tub of water or in contact with a water-filled cushion, and a shock wave is created which is focused on the stone. The wave shatters and fragments the stone. The resulting debris, called gravel, then passes through the remainder of the ureter, through the bladder, and through the urethra during urination. There is minimal chance of damage to skin or internal organs because biologic tissues are resilient, not brittle, and because the the shock waves are not focused on them.

Preparation

Prior to the lithotripsy procedure, a complete **physical examination** is done, followed by tests to determine the number, location, and size of the stone or stones. A test called an intravenous pyelogram, or IVP, is used to locate the stones. An IVP involves injecting a dye into a vein in the arm. This dye, which shows up on x ray, travels through the bloodstream and is excreted by the kidneys. The dye then flows down the ureters and into the bladder. The dye surrounds the stones, and x rays are then used to evaluate the stones and the anatomy of the urinary system. (Some people are allergic to the dye material, so it cannot be used. For these people, focused sound waves, called ultrasound, can be used to see where the stones are located.) Blood tests are done to determine if any potential bleeding problems exist. For women of childbearing age, a **pregnancy** test is done to make sure the patient isn't pregnant; and elderly patients have an EKG done to make sure no potential heart problems exist. Some patients may have a stent placed prior to the lithotripsy procedure. A stent is a plastic tube placed in the ureter which allows the passage of gravel and urine after the ESWL procedure is completed.

Aftercare

Most patients have a lot of blood in their urine after the ESWL procedure. This is normal and should clear

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after several days to a week or so. Lots of fluids should be taken to encourage the flushing of any gravel remaining in the urinary system. The patient should follow up with the urologist in about two weeks to make sure that everything is going as planned. If a stent has been inserted, it is normally removed at this time. Patients may return to work whenever they feel able.

Risks

Abdominal **pain** is not uncommon after ESWL, but it is usually not cause to worry. However, persistent or severe abdominal pain may imply unexpected internal injury. Colicky renal pain is very common as gravel is still passing. Other problems may include perirenal hematomas (**blood clots** near the kidneys) in 66% of the cases; nerve palsies; **pancreatitis** (inflammation of the pancreas); and obstruction by stone fragments. Occasionally, stones may not be completely fragmented during the first ESWL treatment and further ESWL procedures may be required.

ORGANIZATIONS

American Urological Association (AUA), 1000 Corporate Boulevard, Linthicum, MD, 21090, (410) 689-3700, (410) 689-3800, (866) 746-4282, aua@AUAnet.org, http://www.auanet.org.

Joseph Knight, PA

Live cell therapy *see* **Cell therapy**

Liver-spleen scan *see* **Liver nuclear medicine scan**

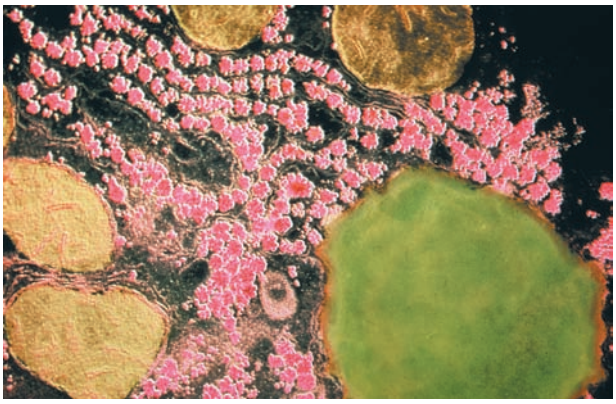
Liver biopsy

Definition

A liver biopsy is a medical procedure performed to obtain a small piece of liver tissue for diagnostic testing. Liver biopsies are sometimes called percutaneous liver biopsies, because the tissue sample is obtained by going through the patient's skin.

Purpose

A liver biopsy is usually done to diagnose a tumor, or to evaluate the extent of damage that has occurred to the liver because of chronic disease. Biopsies are often performed to identify abnormalities in liver tissues after imaging studies have failed to yield clear results.



A false color image of hepatocyte cells of the liver that secrete bile. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

A liver biopsy may be ordered to evaluate any of the following conditions or disorders:

- jaundice
- cirrhosis
- hemochromatosis—a condition of excess iron in the liver.
- repeated abnormal results from liver function tests
- unexplained swelling or enlargement of the liver
- primary cancers of the liver, such as hepatomas, cholangiocarcinomas, and angiosarcomas
- metastatic cancers of the liver

Precautions

Some patients should not have percutaneous liver biopsies. They include patients with any of the following conditions:

- platelet count below 60,000
- longer-than-normal prothrombin time
- liver tumor that contains a large number of blood vessels
- history of unexplained bleeding
- watery (hydatid) cyst
- infection in either the cavity around the lungs, or the diaphragm

Description

Percutaneous liver biopsy is done with a special hollow needle, called a Menghini needle, attached to a suction syringe. Doctors who specialize in the digestive system or liver will sometimes perform liver biopsies. But in most cases, a radiologist (a doctor who specializes in x rays and imaging studies) performs the

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biopsy. The radiologist will use computed tomography scan (CT scan) or ultrasound to guide the choice of the site for the biopsy.

An hour or so before the biopsy, the patient may be given a sedative to help relaxation. He or she is then asked to lie on the back with the right elbow to the side and the right hand under the head. The patient is instructed to lie as still as possible during the procedure. He or she is warned to expect a sensation resembling a punch in the right shoulder, but to hold still in spite of the momentary feeling.

The doctor marks a spot on the skin where the needle will be inserted and thoroughly cleanses the right side of the upper abdomen with an antiseptic solution. The patient is then given an anesthetic at the biopsy site.

The needle with attached syringe is inserted into the patient's chest wall. The doctor then draws the plunger of the syringe back to create a vacuum. At this point the patient is asked to take a deep breath, exhale the air and hold their breath at the point of complete exhalation. The needle is inserted into the liver and withdrawn quickly, usually within two seconds or less. The negative pressure in the syringe draws or pulls a sample of liver tissue into the biopsy needle. As soon as the needle is withdrawn, the patient can breathe normally. Pressure is applied at the biopsy site to stop any bleeding, and a bandage will be placed over it. The entire procedure takes 10 to 15 minutes. Test results are usually available within a day.

KEY TERMS

Biopsy—A procedure where a piece of tissue is removed from a patient for diagnostic testing.

Menghini needle—A special needle used to obtain a sample of liver tissue.

Percutaneous biopsy—A biopsy in which a needle is inserted and a tissue sample removed through the skin.

Prothrombin time—A blood test that determines how quickly a person's blood will clot.

Vital signs—A person's essential body functions, usually defined as the pulse, body temperature, and breathing rate.

Preparation

Aspirin and non-steroidal anti-inflammatory drugs (NSAIDs) such as ibuprofen are known to thin the blood and interfere with clotting. These medications should be avoided for at least a week before the biopsy. Four to eight hours before the biopsy, patients should stop eating and drinking.

The patient's blood will be tested prior to the biopsy to make sure that it is clotting normally. Tests will include a **platelet count** and a **prothrombin time**. Doctors will also ensure that the patient is not taking any other medications, such as blood thinners like Coumadin, that might affect blood clotting.

Aftercare

Liver biopsies are outpatient procedures in most hospitals. After the biopsy, patients are usually instructed to lie on their right side for about two hours. This provides pressure to the biopsy site and helps prevent bleeding. A nurse will check the patient's vital signs at regular intervals. If there are no complications, the patient is sent home within about four to eight hours.

Patients should arrange to have a friend or relative take them home after discharge. Bed rest for a day is recommended, followed by a week of avoiding heavy work or strenuous **exercise**. The patient can resume eating a normal diet.

Some mild soreness in the area of the biopsy is normal after the anesthetic wears off. Irritation of the muscle that lies over the liver can also cause mild discomfort in the shoulder for some patients. Tylenol can be taken for minor soreness, but aspirin and NSAIDs are best avoided. Patients should call their doctor if they have severe **pain** in the abdomen, chest or shoulder, difficulty breathing, or persistent bleeding. These signs may indicate that there has been leakage of bile into the abdominal cavity, or that air has been introduced into the cavity around the lungs.

Risks

The risks of a liver biopsy are usually very small. When complications do occur, over 90% are apparent within 24 hours after the biopsy. The most significant risk is internal bleeding. Bleeding is most likely to occur in elderly patients, in patients with **cirrhosis**, or in patients with a tumor that has many blood vessels. Other complications from percutaneous liver biopsies include the leakage of bile or the introduction of air into the chest cavity (**pneumothorax**). There is also a small chance that an infection may occur, or an internal organ such as the lung, gall bladder, or kidney could be punctured.

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Results

After the biopsy, the liver sample is sent to the pathology laboratory for study under a microscope. A normal (negative) result would find no evidence of **cancer** or other disease in the tissue sample.

Changes in liver tissue that are visible under the microscope indicate abnormal results. Possible causes for the abnormality include the presence of a tumor, or a disease such as hepatitis.

Resources

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Lata Cherath, PhD

Liver cancer

Definition

Liver **cancer** is a relatively rare form of cancer but has a high mortality rate. Liver cancers can be classified into two types. They are either primary, when the cancer starts in the liver itself, or metastatic, when the cancer has spread to the liver from some other part of the body.

Description

Primary liver cancer

Primary liver cancer is a relatively rare disease in the United States, representing about 2% of all malignancies and 4% of newly diagnosed cancers. Hepatocellular carcinoma (HCC) is the fifth most common cancer in the world. It is much more common outside the United States, representing 10% to 50% of malignancies in Africa and parts of Asia. Rates of HCC in men are at least two to three times higher than for women. In high–risk areas (East and Southeast Asia, sub-Saharan Africa), men are even more likely to have HCC than women.

According to the American Cancer Society, 18,920 people in the United States will be diagnosed with primary liver cancer in 2004, and 14,270 persons will die from the disease. The incidence of primary liver cancer has been rising in the United States and Canada since the mid-1990s, most likely as a result of the rising rate of **hepatitis C** infections.

TYPES OF PRIMARY LIVER CANCER. In adults, most primary liver cancers belong to one of two types: hepatomas, or hepatocellular carcinomas (HCC), which start in the liver tissue itself; and cholangiomas, or cholangiocarcinomas, which are cancers that develop in the bile ducts inside the liver. About 80% to 90% of primary liver cancers are hepatomas. In the United States, about five persons in every 200,000 will develop a hepatoma (70% to 75% of cases of primary liver cancers are HCC). In Africa and Asia, over 40 persons in 200,000 will develop this form of cancer (more than 90% of cases of primary liver are HCC). Two rare types of primary liver cancer are mixed-cell tumors and Kupffer cell **sarcomas**.

One type of primary liver cancer, called a hepatoblastoma, usually occurs in children younger than four years of age and between the ages of 12 and 15. Unlike liver cancers in adults, hepatoblastomas have a good chance of being treated successfully. Approximately 70% of children with hepatoblastomas experience complete cures. If the tumor is detected early, the survival rate is over 90%.

Metastatic liver cancer

The second major category of liver cancer, metastatic liver cancer, is about 20 times as common in the United States as primary liver cancer. Because blood from all parts of the body must pass through the liver for filtration, cancer cells from other organs and tissues easily reach the liver, where they can lodge and grow into secondary tumors. Primary cancers in the colon, stomach, pancreas, rectum, esophagus, breast, lung, or skin are the most likely to metastasize (spread) to the liver. It is not unusual for the metastatic cancer in the liver to be the first noticeable sign of a cancer that started in another organ. After **cirrhosis**, metastatic liver cancer is the most common cause of fatal **liver disease**.

Causes and symptoms

Risk factors

The exact cause of primary liver cancer is still unknown. In adults, however, certain factors are known to place some individuals at higher risk of developing liver cancer. These factors include:

- Male sex.
- Age over 60 years.

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- Ethnicity. Asian Americans with cirrhosis have four times as great a chance of developing liver cancer as Caucasians with cirrhosis, and African Americans have twice the risk of Caucasians. In addition, Asians often develop liver cancer at much younger ages than either African Americans or Caucasians.
- Exposure to substances in the environment that tend to cause cancer (carcinogens). These include: a substance produced by a mold that grows on rice and peanuts (aflatoxin); thorium dioxide, which was once used as a contrast dye for x rays of the liver; vinyl chloride, used in manufacturing plastics; and cigarette smoking.
- Use of oral estrogens for birth control.
- Hereditary hemochromatosis. This is a disorder characterized by abnormally high levels of iron storage in the body. It often develops into cirrhosis.
- Cirrhosis. Hepatomas appear to be a frequent complication of cirrhosis of the liver. Between 30% and 70% of hepatoma patients also have cirrhosis. It is estimated that a patient with cirrhosis has 40 times the chance of developing a hepatoma than a person with a healthy liver.
- Exposure to hepatitis viruses: Hepatitis B (HBV), Hepatitis C (HCV), Hepatitis D (HDV), or Hepatitis G (HGV). It is estimated that 80% of worldwide HCC is associated with chronic HBV infection. In Africa and most of Asia, exposure to hepatitis B is an important factor; in Japan and some Western countries, exposure to hepatitis C is connected with a higher risk of developing liver cancer. In the United States, nearly 25% of patients with liver cancer show evidence of HBV infection. Hepatitis is commonly found among intravenous drug abusers. The 70% increase in HCC incidence in the United States is thought to be due to increasing rates of HBV and HCV infections due to increased sexual promiscuity and illicit drug needle sharing. The association between HDV and HGV and HCC is unclear at this time.

Symptoms of liver cancer

The early symptoms of primary, as well as metastatic, liver cancer are often vague and not unique to liver disorders. The long period between the beginning of the tumor's growth and the first signs of illness is the major reason why the disease has such a high mortality rate. At the time of diagnosis, patients are often fatigued, with **fever**, abdominal **pain**, and loss of appetite. They may look emaciated and generally ill. As the tumor enlarges, it stretches the membrane surrounding the liver (the capsule), causing pain in the upper abdomen on the right side. The pain may extend into the back and shoulder. Some patients develop a collection of fluid, known as **ascites**, in the abdominal cavity. Others may show signs of bleeding into the digestive tract. In addition, the tumor may block the ducts of the liver or the gall bladder, leading to **jaundice**. In patients with jaundice, the whites of the eyes and the skin may turn yellow, and the urine becomes dark-colored.

Diagnosis

Physical examination

If the doctor suspects a diagnosis of liver cancer, he or she will check the patient's history for risk factors and pay close attention to the condition of the patient's abdomen during the **physical examination**. Masses or lumps in the liver and ascites can often be felt while the patient is lying flat on the examination table. The liver is usually swollen and hard in patients with liver cancer; it may be sore when the doctor presses on it. In some cases, the patient's spleen is also enlarged. The doctor may be able to hear an abnormal sound (bruit) or rubbing noise (friction rub) if he or she uses a stethoscope to listen to the blood vessels that lie near the liver. The noises are caused by the pressure of the tumor on the blood vessels.

Laboratory tests

Blood tests may be used to test liver function or to evaluate risk factors in the patient's history. Between 50% and 75% of primary liver cancer patients have abnormally high blood serum levels of a particular protein (alpha-fetoprotein or AFP). The AFP test, however, cannot be used by itself to confirm a diagnosis of liver cancer, because cirrhosis or chronic hepatitis can also produce high alpha–fetoprotein levels. Tests for alkaline phosphatase, bilirubin, lactic dehydrogenase, and other chemicals indicate that the liver is not functioning normally. About 75% of patients with liver cancer show evidence of hepatitis infection. Again, however, abnormal liver function test results are not specific for liver cancer.

Imaging studies

Imaging studies are useful in locating specific areas of abnormal tissue in the liver. Liver tumors as small as an inch across can now be detected by ultrasound or computed tomography scan (CT scan). Imaging studies, however, cannot tell the difference between a hepatoma and other abnormal masses or lumps of tissue (nodules) in the liver. A sample of liver tissue for biopsy is needed to make the definitive

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diagnosis of a primary liver cancer. CT or ultrasound can be used to guide the doctor in selecting the best location for obtaining the biopsy sample.

Chest x rays may be used to see whether the liver tumor is primary or has metastasized from a primary tumor in the lungs.

Liver biopsy

Liver biopsy is considered to provide the definite diagnosis of liver cancer. A sample of the liver or tissue fluid is removed with a fine needle and is checked under a microscope for the presence of cancer cells. In about 70% of cases, the biopsy is positive for cancer. In most cases, there is little risk to the patient from the biopsy procedure. In about 0.4% of cases, however, the patient develops a fatal hemorrhage from the biopsy because some tumors are supplied with a large number of blood vessels and bleed very easily.

Laparoscopy

The doctor may also perform a **laparoscopy** to help in the diagnosis of liver cancer. First, the doctor makes a small cut in the patient's abdomen and inserts a small, lighted tube called a laparoscope to view the area. A small piece of liver tissue is removed and examined under a microscope for the presence of cancer cells.

Treatment

Treatment of liver cancer is based on several factors, including the type of cancer (primary or metastatic); stage (early or advanced); the location of other primary cancers or metastases in the patient's body; the patient's age; and other coexisting diseases, including cirrhosis. For many patients, treatment of liver cancer is primarily intended to relieve the pain caused by the cancer but cannot cure it.

Surgery

Few liver cancers in adults can be cured by surgery because they are usually too advanced by the time they are discovered. If the cancer is contained within one lobe of the liver, and if the patient does not have either cirrhosis, jaundice, or ascites, surgery is the best treatment option. Patients who can have their entire tumor removed have the best chance for survival. Unfortunately, only about 5% of patients with metastatic cancer (from primary tumors in the colon or rectum) fall into this group. If the entire visible tumor can be removed, about 25% of patients will be cured. The operation that is performed is called a partial hepatectomy, or partial removal of the liver. The surgeon will remove either an entire lobe of the liver (a **lobectomy**) or cut out the area around the tumor (a wedge resection).

A newer technique that is reported to be safe and effective is laparoscopic radiofrequency ablation (RFA). RFA is a technique in which the surgeon places a special needle electrode in the tumor under guidance from MRI or CT scanning. When the electrode has been properly placed, a radiofrequency current is passed through it, heating the tumor and killing the cancer cells. RFA can be used to treat tumors that are too small or too inaccessible for removal by conventional open surgery.

Chemotherapy

Some patients with metastatic cancer of the liver can have their lives prolonged for a few months by **chemotherapy**, although cure is not possible. If the tumor cannot be removed by surgery, a tube (catheter) can be placed in the main artery of the liver and an implantable infusion pump can be installed. The pump allows much higher concentrations of the cancer drug to be carried to the tumor than is possible with chemotherapy carried through the bloodstream. The drug that is used for infusion pump therapy is usually floxuridine (FUDR), given for 14-day periods alternating with 14-day rests. Systemic chemotherapy can also be used to treat liver cancer. The medications usually used are 5-fluorouracil (Adrucil, Efudex) or methotrexate (MTX, Mexate). Systemic chemotherapy does not, however, significantly lengthen the patient's survival time.

Radiation therapy

Radiation therapy is the use of high-energy rays or x rays to kill cancer cells or to shrink tumors. Its use in liver cancer, however, is only to give short–term relief from some of the symptoms. Liver cancers are not sensitive to radiation, and radiation therapy will not prolong the patient's life.

Liver transplantation

Removal of the entire liver (total hepatectomy) and **liver transplantation** can be used to treat liver cancer. However, there is a high risk of tumor recurrence and metastases after transplantation. In addition, most patients have cancer that is too far advanced at the time of diagnosis to benefit from liver transplantation.

Other therapies

Other therapeutic approaches include:

- Hepatic artery embolization with chemotherapy (chemoembolization).

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KEY TERMS

Aflatoxin—A substance produced by molds that grow on rice and peanuts. Exposure to aflatoxin is thought to explain the high rates of primary liver cancer in Africa and parts of Asia.

Alpha-fetoprotein—A protein in blood serum that is found in abnormally high concentrations in most patients with primary liver cancer.

Cirrhosis—A chronic degenerative disease of the liver, in which normal cells are replaced by fibrous tissue. Cirrhosis is a major risk factor for the later development of liver cancer.

Cryoablation—A technique for removing cancerous tissue by killing it with extreme cold.

Hepatitis—A viral disease characterized by inflammation of the liver cells (hepatocytes). People infected with hepatitis B or hepatitis C virus are at an increased risk for developing liver cancer.

Metastatic cancer—A cancer that has spread to an organ or tissue from a primary cancer located elsewhere in the body.

Radiofrequency ablation—A technique for removing a tumor by heating it with a radiofrequency current passed through a needle electrode.

- Alcohol ablation via ultrasound-guided percutaneous injection.
- Ultrasound-guided cryoablation.
- Immunotherapy with monoclonal antibodies tagged with cytotoxic agents.
- Gene therapy with retroviral vectors containing genes expressing cytotoxic agents.

Alternative treatment

Many patients find that alternative and complementary therapies help to reduce the **stress** associated with illness, improve immune function, and boost spirits. While there is no clinical evidence that these therapies specifically combat disease, activities such as **biofeedback**, relaxation, **therapeutic touch**, **massage therapy** and **guided imagery** have no side effects and have been reported to enhance well–being.

Several other healing therapies are sometimes used as supplemental or replacement cancer treatments, such as antineoplastons, cancell, cartilage (bovine and shark), laetrile, and mistletoe. Many of these therapies have not been the subject of safety and efficacy trials by the National Cancer Institute (NCI). The NCI has conducted trials on cancell, laetrile, and other alternative therapies and found no anticancer activity. These treatments have varying effectiveness and safety considerations. Patients using any alternative remedy should first consult their doctor in order to prevent harmful side effects or interactions with traditional cancer treatment.

Prognosis

Liver cancer has a very poor prognosis because it is often not diagnosed until it has metastasized. Fewer than 10% of patients survive three years after the initial diagnosis; the overall five-year survival rate for patients with hepatomas is around 4%. Most patients with primary liver cancer die within six months of diagnosis, usually from liver failure; fewer than 5% are cured of the disease. Patients with liver cancers that metastasized from cancers in the colon live slightly longer than those whose cancers spread from cancers in the stomach or pancreas.

African American and Hispanic patients have much lower 5-year survival rates than Caucasian patients. It is not yet known, however, whether cultural differences as well as biological factors may be partly responsible for the variation in survival rates.

Prevention

There are no useful strategies at present for preventing metastatic cancers of the liver. Primary liver cancers, however, are 75% to 80% preventable. Current strategies focus on widespread **vaccination** for **hepatitis B**, early treatment of hereditary **hemochromatosis**, and screening of high-risk patients with alpha–fetoprotein testing and ultrasound examinations.

Lifestyle factors that can be modified in order to prevent liver cancer include avoidance of exposure to toxic chemicals and foods harboring molds that produce aflatoxin. Most important, however, is avoidance of alcohol and drug **abuse**. Alcohol abuse is responsible for 60% to 75% of cases of cirrhosis, which is a major risk factor for eventual development of primary liver cancer. Hepatitis is a widespread disease among persons who abuse intravenous drugs.

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American College of Gastroenterology, PO Box 342260, Bethesda, MD, 20827-2260, (30·) 263-9000, http://www.acg.gi.org.

American Institute for Cancer Research (AICR), 1759 R St. NW, Washington, DC, 20009, (202) 328-7744, (202) 328-7226, (800) 843-8114, aicrweb@aicr.org, http://aicr.org.

American Liver Foundation, 75 Maiden Lane, Suite 603, New York, NY, 10038, (212) 668-1000, (212) 483-8179, http://www.liverfoundation.org/.

CancerCare, National Office, 275 Seventh Ave., Floor 22, New York, NY, 10001, (212) 712-8400, (212) 712-8495, (800) 813-HOPE, info@cancercare.org, http://www.cancercare.org/.

Cancer Hope Network, 2 North Road - Suite A, Chester, NJ, 07930, (908) 879-4039, (908) 879-6518, (800) 552-4366, http://www.cancerhopenetwork.org/.

Hospice Education Institute, 3 Unity Square; P.O. Box 98, Machiasport, ME, 04655-0098, (207) 255-8800, (207) 255-8008, (800) 331-1620, info@hospiceworld.org, http://www.hospiceworld.org/.

National Cancer Institute (National Institutes of Health), NCI Office of Communications and Education, 6116 Executive Blvd. Suite 300, Bethesda, MD, 20892-8322, (800) 4-CANCER (422-6237), cancergovstaff@mail.nih.gov, http://www.cancer.gov/.

Rebecca J. Frey, PhD
Laura Ruth, PhD

Liver cirrhosis *see* **Cirrhosis**

Liver disease

Definition

Liver disease is a general term for any damage that reduces the functioning of the liver.

Description

The liver is a large, solid organ located in the upper right-hand side of the abdomen. Most of the liver lies under the rib cage, which helps protect it from physical injury. The liver is made up of two main lobes and two minor lobes and has a total weight in adults of about 3.5 lb (1.6 kg).

Within the liver are tiny ducts (tubes) that collect bile, a product secreted by the liver. Bile is stored in to the gall bladder and then released into the intestines after meals to help in the digestion of fats and the absorption of certain **vitamins**. This system of bile production by the liver, transport through the bile ducts, and storage in the gall bladder is called the biliary system. Damage to this system is called biliary disease.

The liver receives blood that comes directly from the intestines. At any given time the liver contains about 13% of the blood circulating in the body. This blood is rich in nutruents (food, vitamins, and **minerals**) that the body needs to function. Some of the most important functions of the liver are to process these nutrients.

Important functions of the liver include:

- manufacturing and regulating the production of proteins. The most important proteins made in the liver are albumin, which helps maintain blood volume, and clotting factors to help regulate blood clotting.
- making and storing fatty acids and cholesterol.
- forming and releasing bile
- processing and storing sugars in the form of glycogen, which can then be re-converted into energy
- Storing iron, an important element in blood formation

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- Breaking down (detoxifying) alcohol, drugs, and environmental poisons so that they can be removed from the body.
- Processing and removing bilirubin, a product released when red blood cells break down, and ammonia, a toxic waste product of protein breakdown.
- Defending against infection by removing bacteria from the blood and making chemicals necessary to the functioning of the immune system.

Although the liver is the only organ that has the capacity to grow back, or regenerate, after injury or damage, sometimes the damage is too great for it to heal. The American Association for the Study of Liver Disease estimates that about 25 million Americans experience a liver-related disease each year. Individuals cannot live without a functioning liver. The ability to transplant livers is improving, **liver transplantation** is not nearly as common or successful as **kidney transplantation**.

Because the liver has many vital functions, there are many types of liver disease. The American Liver Foundation estimates that over 20,000 Americans die of chronic liver disease each year and another 360,000 are hospitalized. Individuals cannot live without a functioning liver.

Congenital Liver Diseases

Congenital liver diseases are disorders that are present at birth. Inherited liver diseases and disorders include:

- Alagile syndrome, a disorder that causes withering of the bile ducts. This disease occurs in less than 1 in 100,000 individuals.
- Alpha 1-antitrypsin deficiency, an inborn error in metabolism and the most common type of genetic liver disease.
- Galactosemia, a hereditary metabolic disease in which the liver is unable to break down the sugar galactose found in milk. It occurs in about one in every 20,000 births.
- Hematochromatosis, a hereditary metabolic disorder in which too much iron is absorbed from the diet and stored in the liver. This disease affects over one million Americans.
- Porphyria, a disorder in which the component of blood that contains iron is not correctly formed.
- Tyrosinemia, a rare inherited error in metabolism that causes severe liver disease in infants and children. It affects fewer than 200,000 individuals in the United States.
- Type I glycogen storage disease, a lack of the enzyme that helps regulate blood glucose (sugar) levels.
- Wilson's disease, an inherited disorder in which copper is accumulated in the liver and nervous system.

Acquired Liver Diseases

Many liver diseases are acquired from infection and exposure of the liver to toxic substances such as alcohol or drugs. In some areas of the world (although not the United States) liver parasites are a common cause of liver disease. In the United States, the most common acquired liver diseases are **hepatitis A**, B, and C and **cirrhosis**. Hepatitis A causes an acute (short-term) illness and is caused by a virus found in food or drinking water contaminated with feces. Hepatitis A infects between 125,000 and 250,000 people in the United States each year and causes about 100 deaths annually.

Hepatitis B is a viral infection spread by blood exchange and sexual contact with an infected person. It can be passed from an infected mother to her fetus. In most people hepatitis B is a short-term illness that causes mild symptoms such as **fatigue**, but in 2–6% of people, the disease lasts a long time and causes permanent liver damage. More than 75,000 people in the United States become infected with hepatitis B each year. Chinese Americans have a hepatitis B infection rate five times that of Caucasian Americans.

Hepatitis C is caused by a virus spread mainly through contact with the blood of an infected person, such as through sharing needles to inject drugs or from a mother to a fetus. Individuals infected with hepatitis C virus may not feel sick or know that they are infected for many years, but the disease can increase the likelihood of developing **liver cancer** of cirrhosis. The American Liver Foundation estimates that 4 million Americans are infected with hepatitis C, resulting in 10,000–12,000 deaths each year. About 70% of individuals who are infected do not know that they have the virus. African Americans have the highest rate of hepatitis C infections and are twice as likely to be infected with hepatitis C as Caucasian Americans.

Cirrhosis of the liver involves the formation of permanent scar tissue in the liver and loss of liver function. It is often caused by chronic alcohol **abuse** (alcoholic liver disease), but it can also be caused by diseases such as hepatitis. Cirrhosis interferes with blood flow through the liver and can raise pressure in blood vessels supplying the liver and decrease the absorption of nutrients from the blood, leading to **malnutrition**. The liver of individuals with cirrhosis

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KEY TERMS

Biliary—Relating to the system that produces and transports bile.

Bile—A yellowish-green material secreted by the liver, stored by the gall bladder, and emptied into the small intestine to aid in the digestion and absorption of fats.

Bilirubin—A reddish-yellow substance that results from the breakdown of aging red blood cells. It is found in blood and bile, and if it accumulates in large quantities can cause jaundice.

Biopsy—A diagnostic procedure in which a small sample of tissue is obtained and examined under the microscope to determine they type and stage of a disease.

Congenital—Present at birth.

Feces—Waste products eliminated from the large intestine; excrement.

Jaundice—A yellowish tinge to the skin and whites of the eyes that indicates malfunction of the biliary system and/or liver and build up of bile components in the blood.

is also less effective in removing toxic wastes from the blood. Cirrhosis can be fatal.

Over 800 over-the-counter and prescription drugs, as well as illicit street drugs, can cause liver damage. One of the most common drugs to cause liver damage is **acetaminophen** (Tylenol) when taken at high doses or by individuals who already have some liver damage. Exposure to toxic chemicals, physical injury, and blockage of the bile ducts call also cause liver damage.

Liver **cancer** can either develop first in the liver (primary liver cancer) or spread there from another site (metastasized cancer). About 16,000 new cases of primary liver cancer are diagnosed each year, most commonly in middle age and older men. Although the cause of liver cancer is unclear, it appears to be associated with chronic infections of hepatitis B and C.

Causes and symptoms

The causes of liver disease are many and varied. Leading causes are viral infection, alcohol abuse, and inherited disease. A common symptoms of liver disease are **jaundice**. With jaundice, the skin and the whites of the eyes take on a yellowish color as a result of the accumulation of bilirubin and bile pigments in the blood. This is a sign that the liver or the biliary system is not functioning properly. Other symptoms of liver disease include an enlarged liver and swollen abdomen, **nausea**, **vomiting**, weight loss, and fatigue. Some infections cause flu-like symptoms of **fever**, **headache**, and weakness.

Diagnosis

Liver function tests, sometimes called a liver panel, measure various enzymes, proteins, and waste products in the blood. These readings can tell a physician whether the liver is damaged and give an idea of how well it is functioning. Liver function tests are the most common way to diagnose liver damage. Based on the results of a liver panel, additional blood tests for infection, a **liver biopsy**, or liver scan may be done to pinpoint the reason for loss of function.

Treatment

Treatments depend on the type of liver disease an individual has. Many liver diseases are treated with altered **diets**, abstinence from alcohol, and medication. Hepatitis can be treated with antiviral medications such as interferon or ribavirin. Liver cancer is treated with **chemotherapy**, radiation, and surgery. More than 300 clinical trials are enrolling patients with various types of liver disease in experimental treatment programs. Information on current clinical trials can be found at www.clinicaltrials.gov.

If the liver fails completely, a liver transplant is possible. About 5,600 liver transplants were performed in the United States in 2003. Donors and recipients are matched on the basis of blood type and must also be about the same weight. There is no machine like a **kidney dialysis** machine to perform the functions of the liver while individuals are awaiting a transplant. In 2003, 1,800 people died awaiting a liver donor, and about 18,000 more are on the waiting list awaiting a donated liver. Livers to be transplanted can come from either a living donor or a deceased donor.

Alternative treatment

A great deal of interest in alternative treatments for hepatitis C has resulted in a review of alternative and complementary treatments by the National Center for Complementary and Alternative Medicine (NCCAM), a division of the United States National Institutes of Health. Although there was in 2003 not

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enough solid experimental evidence to show that any herbal treatments cured hepatitis C, the most promising herbal treatment was an extract of milk thistle (*Silybum marianum*), a plant in the aster family that has been used for centuries in Europe to treat liver disease and jaundice. Some studies suggested that extracts of milk thistle promoted the growth of certain types of liver cells and acted as an anti-oxidant to protect the liver while producing few unwanted side effects. Other studies showed no protective effects.

Licorice root (*Glycyrrhiza glabra*) was also reviewed by NCCAM. Some studies suggested that licorice root had antiviral properties, however this herb did not reduce the amount of hepatitis C virus circulating in the blood. Long term use of licorice root can have serious, health-threatening side effects.

Other alternative treatments studied by NCCAM include **ginseng** (*Panax quinquefolius* and *Panax ginseng*), which they concluded might possibly have a positive effect on the liver, especially in the elderly, and schisandra (*Schisandra chinensis* and *Schisandra sphenanthera*) used in Chinese medicine, which seemed to have a liver-protective effect in laboratory animals. Thymus extract and colloidal silver were found to be ineffective in treating liver disease.

Prognosis

The course of liver disease depends on the type of disease. Many individuals recover completely from infections of hepatitis A and B. However, if liver scarring occurs, the effects are irreversible. The initial success rate for liver transplants is good, with about 90% of individuals receiving a liver transplant are alive one year after the transplant operation. However, no alternative treatments produced a better outcome than traditional treatments of hepatitis C.

Prevention

Prevention is an effective way to avoid liver disease. Vaccines exist for hepatitis A and B (but not hepatitis C), although many individuals remain unvaccinated. In addition to **vaccination**, individuals can decrease the likelihood of developing liver disease by

- practicing safe sex
- avoiding sharing needles
- eating a healthy, balanced diet
- taking medications as prescribed
- avoiding drinking alcohol.

Resources

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ORGANIZATIONS

American Association for the Study of Liver Diseases, 1001 North Fairfax Street, Suite 400, Alexandria, VA, 22314, (703) 299-9766, (703) 299-9622, aasld@aasld.org, http://www.aasld.org.

American Liver Foundation, 75 Maiden Lane, Suite 603, New York, NY, 10038, (212) 668-1000, (212) 483-8179, http://www.liverfoundation.org/.

Tish Davidson, A.M.

Liver encephalopathy

Definition

Liver encephalopathy is a potentially life-threatening disease in which toxic substances accumulate in the blood. Also known as hepatic encephalopathy or hepatic **coma**, this condition can cause confusion, disorientation, abnormal neurological signs, loss of consciousness, and **death**.

Description

A normally functioning liver metabolizes and detoxifies substances formed in the body during the digestive process. Impaired liver function allows substances like ammonia (formed when the body digests protein), some fatty acids, phenol, and mercaptans to escape into the bloodstream. From there, they may penetrate the blood-brain barrier, affect the central nervous system (CNS), and lead to hepatic coma.

Hepatic coma is most common in patients with chronic **liver disease**. It occurs in 50–70% of all those with **cirrhosis**.

Causes and symptoms

The cause of hepatic coma is unknown, but the condition is frequently associated with the following conditions:

- Acute or chronic liver disease
- Gastrointestinal bleeding

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- Azotemia, the accumulation of nitrogen-containing compounds (such as urea) in the blood
- Inherited disorders that disrupt the process by which nitrogen is decomposed and excreted
- The use of shunts (devices implanted in the body to redirect the flow of fluid from one vessel to another)
- Electrolyte imbalances, including low levels of potassium (hypokalemia) and abnormally alkaline blood pH (alkalosis). These imbalances may result from the overuse of sedatives, analgesics, or diuretics; reduced levels of oxygen (hypoxia), or withdrawal of excessive amounts of body fluid (hypovolemia)
- Constipation, which may increase the body's nitrogen load
- Surgery
- Infection
- Acute liver disease.

Binge drinking and acute infection are common causes of hepatic coma in patients with long-standing liver disease.

Symptoms of hepatic encephalopathy range from almost unnoticeable changes in personality, energy levels, and thinking patterns to deep coma.

Inability to reproduce a star or other simple design (**apraxia**) and deterioration of handwriting are common symptoms of early encephalopathy. Decreased brain function can also cause inappropriate behavior, lack of interest in personal grooming, mood swings, and uncharacteristically poor judgment.

The patient may be less alert than usual and develop new sleep patterns. Movement and speech may be slow and labored.

As the disease progresses, patients become confused, drowsy, and disoriented. The breath and urine acquires a sweet, musky odor. The hands shake, the outstretched arms flap (asterixis or "liver flap"), and the patient may lapse into unconsciousness. As coma deepens, reflexes may be heightened (hyperreflexia). The toes sometimes splay when the sole of the foot is stroked (Babinski reflex).

Agitation occasionally occurs in children and in adults who suddenly develop severe symptoms. Seizures are uncommon.

Diagnosis

The absence of sensitive, reliable tests for encephalopathy make the physician's personal observations and professional judgment the most valuable diagnostic tools.

KEY TERMS

Cirrhosis—A serious disease of the liver caused by chronic damage to its cells and the eventual formation of scar tissue (fibrosis).

Coma—A condition of deep unconsciousness from which the person cannot be aroused.

Electrolytes—Substances that conduct electricity when they are in solution. In the body, electrolytes in the blood and tissues enable nerve impulses to flow normally.

Encephalopathy—A dysfunction of the brain. Hepatic encephalopathy is brain dysfunction that occurs because the liver isn't removing harmful substances from the blood.

Confusion, disorientation, and other indications of impaired brain function strongly suggest encephalopathy in patients known to have liver disease. CAT scans and examination of spinal fluid don't provide diagnostic clues. Elevated arterial ammonia levels are almost always present in hepatic coma, but levels are not necessarily correlated with the severity or extent of the disease.

Magnetic resonance imaging (MRI) can show severe brain swelling that often occurs prior to coma, and **electroencephalography** (EEG) detects abnormal brain waves even in patients with early, mild symptoms. Blood and urine analyses can provide important information about the cause of encephalopathy in patients suspected of taking large quantities of sedatives or other drugs.

Treatment

This condition may disappear if the cause of symptoms is eliminated. In other cases, treatment is designed to improve liver function as much as possible; remove or relieve factors that worsen symptoms; and decrease the body's production of poisonous substances.

All non-essential medications are discontinued. Soft restraints are recommended in place of sedatives for patients who become agitated.

Enemas or **laxatives** are used to stimulate expulsion of toxic intestinal products. All or most protein is eliminated from the diet, and supplemental feeding may be necessary to replenish lost calories. Regular doses of neomycin (Neobiotic), taken orally or administered to comatose patients in liquid form through a tube, may be used to decrease production of protein-digesting bacteria in the bowel.

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Lactulose, a synthetic sugar, changes the characteristics of intestinal bacteria, decreases the amount of ammonia accumulated in the body, and has laxative properties. The patient is given hourly doses of lactulose syrup until **diarrhea** occurs, then dosage is adjusted to maintain regular bowel function. Lactulose and dietary-protein restrictions may be used to control chronic encephalopathy.

Prognosis

Encephalopathy may be reversible if the responsible factor is identified and removed or treated. Patients whose condition is the result of chronic liver disease may recover completely after the underlying cause is corrected.

Despite intensive treatment, encephalopathy caused by acute liver inflammation (fulminant hepatitis) is fatal for as many as 80% of patients. Those with chronic liver failure often die in hepatic coma.

ORGANIZATIONS

American Liver Foundation, 75 Maiden Lane, Suite 603, New York, NY, 10038, (212) 668-1000, (212) 483-8179, http://www.liverfoundation.org/.

Maureen Haggerty

Liver fluke infections *see* **Fluke infections**

Liver function tests

Definition

Liver function tests, or LFTs, include tests that are routinely measured in all clinical laboratories. LFTs include bilirubin, a compound formed by the breakdown of hemoglobin; ammonia, a breakdown product of protein that is normally converted into urea by the liver before being excreted by the kidneys; proteins that are made by the liver, including total protein, albumin, prothrombin, and fibrinogen; cholesterol and **triglycerides**, which are made and excreted via the liver; and the enzymes alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), gamma-glutamyl transferase (GGT), and lactate dehydrogenase (LDH). Other liver function tests include serological tests (to demonstrate antibodies); DNA tests for hepatitis and other viruses; and tests for antimitochondrial and smooth muscle antibodies, transthyretin (prealbumin), **protein electrophoresis**, bile acids, alpha-fetoprotein, and a constellation of other enzymes that help differentiate necrotic (characterized by the **death** of tissue) versus obstructive **liver disease**.

Purpose

Liver function tests done individually do not give the physician much information, but used in combination with a careful history, **physical examination**, and imaging studies, they contribute to making an accurate diagnosis of the specific liver disorder. Different tests will show abnormalities in response to liver inflammation; liver injury due to drugs, alcohol, toxins, or viruses; liver malfunction due to blockage of the flow of bile; and liver cancers.

Precautions

Blood for LFTs is collected by sticking a needle into a vein. The nurse or phlebotomist (person trained to draw blood) performing the procedure must be careful to clean the skin before sticking in the needle.

Bilirubin: Drugs that may cause increased blood levels of total bilirubin include anabolic **steroids**, **antibiotics**, antimalarials, ascorbic acid, Diabinese, codeine, **diuretics**, epinephrine, **oral contraceptives**, and vitamin A.

Ammonia: Muscular exertion can increase ammonia levels, while cigarette **smoking** produces significant increases within one hour of inhalation. Drugs that may cause increased levels include alcohol, **barbiturates**, **narcotics**, and diuretics. Drugs that may decrease levels include antibiotics, levodopa, lactobacillus, and potassium salts.

ALT: Drugs that may increase ALT levels include **acetaminophen**, ampicillin, codeine, dicumarol, indomethacin, methotrexate, oral contraceptives, **tetracyclines**, and verapamil. Previous intramuscular injections may cause elevated levels.

GGT: Drugs that may cause increased GGT levels include alcohol, phenytoin, and phenobarbital. Drugs that may cause decreased levels include oral contraceptives.

LDH: Strenuous activity may raise levels of LDH. Alcohol, anesthetics, **aspirin**, narcotics, procainamide, and fluoride may also raise levels. Ascorbic acid (vitamin C) can lower levels of LDH.

Description

The liver is the largest and one of the most important organs in the body. As the body's "chemical factory," it regulates the levels of most of the biomolecules found in the blood, and acts with the kidneys to clear the blood of drugs and toxic substances. The liver metabolizes these products, alters their chemical structure, makes them water soluble, and excretes them in

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KEY TERMS

Bile acid—A detergent that is made in the liver and excreted into the intestine to aid in the absorption of fats.

Biliary—Relating to bile.

Cirrhosis—A liver disease where there is a loss of normal liver tissues, replaced by scar tissue. This is usually caused by chronic alcohol abuse, but also can be caused by blockage of the bile ducts.

Detoxification—A process of altering the chemical structure of a compound to make it less toxic.

Hepatitis—Inflammation of the liver.

Hepatocyte—Liver cell.

Isoenzyme—One of a group of enzymes that brings about the same reactions on the same chemicals, but are different in their physical properties.

Jaundice—Hyperbilirubinemia, or too much bilirubin in the blood. Bilirubin will be deposited in the skin and the mucosal membranes. The whites of the eyes and the skin appear yellow.

Lipoprotein—A chemical combination of a protein and a lipid (fats).

Neonatal jaundice—A disorder in newborns where the liver is too premature to conjugate bilirubin, which builds up in the blood.

bile. Laboratory tests for total protein, albumin, ammonia, transthyretin, and cholesterol are markers for the synthetic (chemical-producing) function of the liver. Tests for cholesterol, bilirubin, ALP, and bile salts are measures of the secretory (excretory) function of the liver. The enzymes ALT, AST, GGT, LDH, and tests for viruses are markers for liver injury.

Some liver function tests are used to determine if the liver has been damaged or its function impaired. Elevations of these markers for liver injury or disease tell the physician that something is wrong with the liver. ALT and bilirubin are the two primary tests used largely for this purpose. Bilirubin is measured by two tests, called total and direct bilirubin. While total bilirubin is elevated in various liver diseases, it is also increased in certain (hemolytic) **anemias** caused by increased red blood cell turnover. Neonatal hyperbilirubinemia (**jaundice**) is a condition caused by an immature liver than cannot conjugate (process) the bilirubin. The level of total bilirubin in the blood becomes elevated and must be monitored closely in order to prevent damage to the brain caused by unconjugated bilirubin, which has a high affinity for brain tissue. Bilirubin levels can be decreased by exposing the baby to UV light. Direct bilirubin is formed only by the liver, and therefore, it is specific for hepatic or biliary disease. Its concentration in the blood is very low (0–0.2 mg/dL) and therefore, even slight increases are significant. Highest levels of direct bilirubin are seen in obstructive liver diseases. However, direct bilirubin is not sensitive to all forms of liver disease and is not always elevated in the earliest stages of disease. Therefore, ALT is needed to exclude a diagnosis.

Although ALT is present in other tissues, its concentration in the liver is far greater than any other tissue. The enzyme is very sensitive to liver injury. Consequently, if ALT or direct bilirubin is increased, then some form of liver disease is likely. If both are normal, then liver disease is unlikely.

These two tests, along with others, are used to help make a diagnosis. The most useful tests for this purpose are the liver function enzymes and the ratio of direct to total bilirubin. These tests are used to differentiate diseases characterized primarily by hepatocellular damage (necrosis, or cell death) from those characterized by obstructive damage (**cholestasis** or blockage of bile flow). Liver cell damage may be caused by viral hepatitis, hepatitis induced by drugs or poisons (toxic hepatitis), **alcoholic hepatitis**, hypoxic necrosis (a consequence of congestive **heart failure**), chronic hepatitis, and **cirrhosis** of the liver. Obstructive liver diseases include intrahepatic (within the liver) obstructive disease or extrahepatic (outside the liver) obstruction. In both cases, the direct bilirubin is often greatly elevated because the liver can conjugate the bilirubin, but this direct bilirubin cannot be excreted via the bile. In such cases the ratio of direct to total bilirubin is greater than 0.4.

Aspartate aminotransferase (AST) is not as specific for liver disease as ALT is. However, differentiation of acute and chronic forms of liver disease is aided by examining the ratio of ALT to AST, called the DeRitis ratio. In acute hepatitis, **Reye's syndrome**, and **infectious mononucleosis**, the ALT predominates. However, in alcoholic liver disease, chronic hepatitis, and cirrhosis, the AST predominates.

Alkaline phosphatase (ALP) is increased in obstructive liver diseases, but it is not specific for the liver. Increases are commonly seen in bone diseases,

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late **pregnancy**, leukemia, and some other malignancies. The enzyme gamma-glutamyl transferase (GGT) is used to help differentiate the source of an elevated ALP. GGT is greatly increased in obstructive jaundice, alcoholic liver disease, and hepatic **cancer**. When the increase in GGT is two or more times greater than the increase in ALP, the source of the ALP is considered to be from the liver. When the increase in GGT is five or more times the increase in ALP, this points to a diagnosis of alcoholic hepatitis. GGT, but not AST and ALT, is elevated in the first stages of liver inflammation due to alcohol consumption, and GGT is useful as a marker for excessive drinking. GGT has been shown to rise after acute persistent alcohol ingestion and then fall when alcohol is avoided.

Lactate dehydrogenase (LDH) is found in almost all cells in the body. LDH is increased in megaloblastic and hemolytic anemias, leukemias and lymphomas, myocardial infarction, infectious mononucleosis, muscle wasting diseases, and both necrotic and obstructive jaundice. LDH is markedly increased in most cases of **liver cancer**. An enzyme pattern showing a marked increase in LDH and to a lesser degree ALP with only slightly increased transaminases (AST and ALT) is seen in cancer of the liver.

Some liver function tests are not sensitive enough to be used for diagnostic purposes, but are elevated in severe or chronic liver diseases. These tests are used primarily to indicate the extent of damage to the liver. Tests falling into this category are ammonia, total protein, albumin, cholesterol, transthyretin, fibrinogen, and the **prothrombin time**.

Analysis of blood ammonia aids in the diagnosis of severe liver diseases and helps to monitor the course of these diseases. Together with the AST and the ALT, ammonia levels are used to confirm a diagnosis of Reye's syndrome, a rare disorder usually seen in children and associated with infection and aspirin intake. Reye's syndrome is characterized by brain and liver damage following an upper respiratory tract infection, **chickenpox**, or **influenza**. Ammonia levels are also helpful in the diagnosis and treatment of hepatic encephalopathy, a serious brain condition caused by the accumulated toxins that result from liver disease and liver failure. Ammonia levels in the blood are normally very low. Increasing ammonia signals end-stage liver disease and a high risk of hepatic **coma**.

Albumin is the protein found in the highest concentration in blood, making up over half of the protein mass. A persistently low albumin in liver disease is a sign of progressive liver failure. In the acute stages of liver disease, proteins such as transthyretin (prealbumin) may be measured to give an indication of the severity of the disease.

Cholesterol is synthesized by the liver. Its balance is maintained by the liver's ability to remove cholesterol from lipoproteins, and use it to produce bile acids and salts that it excretes into the bile ducts. In obstructive jaundice caused by stones, biliary tract scarring, or cancer, the bile cannot be eliminated. Cholesterol and triglycerides may accumulate in the blood as low-density lipoprotein (LDL) cholesterol. In acute necrotic liver diseases, triglycerides may be elevated. In liver failure caused by necrosis, the liver's ability to synthesize cholesterol is reduced, and blood levels may be low.

The liver is responsible for production of the vitamin K clotting factors. In obstructive liver diseases a deficiency of vitamin K-derived clotting factors results from failure to absorb vitamin K. In obstructive jaundice, an intramuscular injection of vitamin K will be given. In severe necrotic disease, the liver cannot synthesize clotting factors from vitamin K.

The most prevalent liver disease is viral hepatitis. Tests for this condition include a variety of antigen and antibody markers and nucleic acid tests. In addition to hepatitis A-E, viral hepatitis may be caused by **Epstein-Barr virus** (EBV) and cytomegalovirus (CMV) infections of the liver. Tests for these viruses such as the infectious mononucleosis antibody test, anti-viral capsid antigen test (anti-VCA), and anti-CMV test are useful in diagnosing these infections.

Liver disease may be caused by autoimmune mechanisms in which autoantibodies destroy liver cells. Autoimmune necrosis is associated with **systemic lupus erythematosus** and chronic viral hepatitis, usually caused by **hepatitis B** and **hepatitis C** virus infections. These conditions give rise to anti-smooth muscle antibodies and anti-nuclear antibodies, and tests for these are useful markers for chronic hepatitis. Antibodies to mitochondrial antigens (antimitochondrial antibodies) are found in the blood of more than 90% of persons with **primary biliary cirrhosis**.

Preparation

Patients are asked to fast and to inform clinicians of all drugs, even over-the-counter drugs, that they are taking. Many times liver function tests are done on an emergency basis. Thus **fasting** and obtaining a medical history may not be possible.

Aftercare

Patients will have blood drawn into a vacuum tube and may experience some **pain** and burning at

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the site of injection. A gauze bandage may be placed over the site to prevent further bleeding. If the patient is suffering from severe liver disease, he or she may lack clotting factors. The nurse or caregiver should be careful to monitor bleeding in these patients after obtaining blood.

Results

Reference ranges vary from laboratory to laboratory and also depend upon the method used. However, normal values are generally framed by the ranges shown below.

- ALT: 5–35 IU/L. (Values for the elderly may be slightly higher, and values also may be higher in men and in African-Americans.)
- AST: 0–35 IU/L.
- ALP: 30–120 IU/LALP is higher in children, older adults and pregnant females.
- GGT: males 2–30 U/L; females 1–24 U/L.
- LDH: 0–4 days old: 290–775 U/L; 4–10 days: 545–2000 U/L; 10 days–24 months: 180–430 U/L; 24 months–12 years: 110–295 U/L; 12–60 years: 100–190 U/L; 60 years: 110–210 U/L.
- Bilirubin: (Adult, elderly, and child) Total bilirubin: 0.1–1.0 mg/dL; indirect bilirubin: 0.2–0.8 mg/dL; direct bilirubin: 0.0–0.3 mg/dL. (Newborn) Total bilirubin: 1–12 mg/dL. Note: critical values for adult: greater than 1.2 mg/dL. Critical values for newborn (requiring immediate treatment): greater than 15 mg/dL.
- Ammonia: 10–70 micrograms per dL (heparinized plasma). Normal values for this test vary widely, depending upon the age of the patient and the type of specimen.
- Albumin: 3.2–5.4 g/L.

Abnormal results

ALT: Values are significantly increased in cases of hepatitis, and moderately increased in cirrhosis, liver tumor, obstructive jaundice, and severe **burns**. Values are mildly increased in **pancreatitis**, **heart attack**, infectious mononucleosis, and **shock**. Most useful when compared with ALP levels.

AST: High levels may indicate liver cell damage, hepatitis, heart attack, heart failure, or gall stones.

ALP: Elevated levels occur in diseases that impair bile formation (cholestasis). ALP may also be elevated in many other liver disorders, as well as some lung cancers (bronchogenic carcinoma) and Hodgkin's lymphoma. However, elevated ALP levels may also occur in otherwise healthy people, especially among older people.

GGT: Increased levels are diagnostic of hepatitis, cirrhosis, liver tumor or metastasis, as well as injury from drugs toxic to the liver. GGT levels may increase with alcohol ingestion, heart attack, pancreatitis, infectious mononucleosis, and Reye's syndrome.

LDH: Elevated LDH is seen with heart attack, **kidney disease**, hemolysis, viral hepatitis, infectious mononucleosis, Hodgkin's disease, abdominal and lung cancers, **germ cell tumors**, progressive **muscular dystrophy**, and **pulmonary embolism**. LD is not normally elevated in cirrhosis.

Bilirubin: Increased indirect or total bilirubin levels can indicate various serious anemias, including hemolytic disease of the newborn and **transfusion** reaction. Increased direct bilirubin levels can be diagnostic of bile duct obstruction, **gallstones**, cirrhosis, or hepatitis. It is important to note that if total bilirubin levels in the newborn reach or exceed critical levels, exchange transfusion is necessary to avoid kernicterus, a condition that causes brain damage from bilirubin in the brain.

Ammonia: Increased levels are seen in primary liver cell disease, Reye's syndrome, severe heart failure, hemolytic disease of the newborn, and hepatic encephalopathy.

Albumin: Albumin levels are increased due to **dehydration**. They are decreased due to a decrease in synthesis of the protein which is seen in severe liver failure and in conditions such as burns or renal disease that cause loss of albumin from the blood.

Patient education

Healthcare providers should inform the patient of any abnormal results and explain how these values reflect the status of their liver disease. It is important to guide the patient in ways to stop behaviors such as taking drugs or drinking alcohol, if these are the causes of the illness.

Resources

BOOKS

Feldman, M, et al. *Sleisenger & Fordtran's Gastrointestinal and Liver Disease*, 8th ed. St. Louis: Mosby, 2005.

McPherson RA et al. *Henry's Clinical Diagnosis and Management By Laboratory Methods*, 21st ed. Philadelphia: Saunders, 2007.

ORGANIZATIONS

American Association for the Study of Liver Disease, 1001 North Fairfax, Suite 400, Alexandria, VA, 22314, (703)

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299-9766, (703) 299-9622, aasld@aasld.org, http://www.aasld.org.

American Liver Foundation, 75 Maiden Lane, Suite 603, New York, NY, 10038, (212) 668-1000, (212) 483-8179, http://www.liverfoundation.org.

National Cancer Institute, NCI Public Inquiries Office, 6116 Executive Boulevard, Bethesda, MD, 20892-8322, (800) 422-6237, http://www.cancer.gov.

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Brenda W. Lerner

Liver nuclear medicine scan

Definition

A liver scan is a diagnostic procedure to evaluate the liver for suspected disease. A radioactive substance which concentrates in the liver is injected intravenously and the image of its distribution in the body is analyzed to diagnose certain abnormalities.

Purpose

In the past, liver scans were used to evaluate the liver in a wide variety of situations. It was considered a useful study to detect abnormalities, but was often not able to establish a specific diagnosis. In the 1990s, radionuclide imaging of the liver (use of a radioactive form of cobalt or iodine) evolved into a more specialized study, used to identify individual diseases or conditions. This is accomplished by using different radioisotopes precisely designed to further evaluate a particular case. Isotopes are different forms of the same substance, such as radioactive iodine, that are injected into the body. This allows the physician to trace the process of the substance throughout the part of the body that is being tested for disease.

A liver scan is usually ordered after blood studies and other imaging procedures have shown a liver abnormality. It is most often used to further evaluate masses or tumors. These may be benign growths in the liver, or **cancer** which has developed in the liver or has spread (or metastasized) from another organ.

A liver scan may also be helpful in diagnosing specific disorders, by detecting features which are characteristic of a disorder, such as **cirrhosis** of the liver. This study may also be part of the battery of tests used to evaluate potential candidates for liver transplant.

KEY TERMS

Radioisotope—A radioactive, or radiation-emitting form of an element.

Radionuclide—A substance which emits radiation that can be detected by a scanner as the substance disintegrates.

Precautions

Women who are pregnant or breast feeding should not have this test.

Description

This test can be performed in an outpatient setting or a hospital x-ray department. The patient usually lies down while a radioactive substance (radioactive isotope) which accumulates in the liver is injected through a vein in the arm. Scanning times may vary, depending on the specific radioisotope used. It most often begins within minutes after injection. The radionuclide scanner, sometimes called a gamma camera or scintillation camera, is positioned above the upper abdomen and may lightly touch the patient. It is important for the patient to lie quietly. Position changes and brief periods of breath holding may be required. The test usually takes approximately one hour.

A specialized liver scan used to assess blood flow is frequently used. It may be referred to as a radionuclide blood pool or volume study, a labeled red cell scintigram, or some combination of these terms. Other studies may be named for the radioisotope used. This test may also be called a liver-spleen scan.

Preparation

No physical preparation is required. A liver scan should be performed before doing any study that uses iodinated or barium-containing contrast agents, to prevent inaccurate results.

The patients should understand that there is no danger of radioactive exposure to themselves or others. Only small amounts of radionuclide are used. The total amount of radiation absorbed is often less than the dose received from ordinary x rays. The scanner does not emit any radiation, but detects and records it from the patient.

Aftercare

No special precautions are needed.

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Results

A normal scan will show a liver of normal size, shape, and position.

An abnormal liver scan may result from a mass. Depending on the radioisotope and technique used, the scan may identify particular types of tumors or certain cancers. Too much radioisotope in the spleen and bones, compared to the liver, can indicate potential **hypertension** or cirrhosis. Liver diseases such as cirrhosis or hepatitis may also cause an abnormal scan, but are rarely diagnosed from the information revealed by this study alone.

Resources

PERIODICALS

Drane, Walter E. "Scintigraphic Techniques for Hepatic Imaging." *Radiologic Clinics of North America* 36 (March 1998): 309-318.

Ellen S. Weber, MSN

National transplant waiting list by organ type (June 2010)

Organ needed	Persons waiting
Kidney	85,296
Liver	16,031
Heart	3,141
Kidney/Pancreas	2,199
Lung	1,802
Pancreas	1,450
Intestine	242
Heart/Lung	79

SOURCE: U.S. Department of Health and Human Services, Organ Procurement and Transplantation Network. Available online at: http://optn.transplant.hrsa.gov/data/default.asp (accessed June 8, 2010).

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Liver transplantation

Definition

Liver transplantation is a surgery that removes a diseased liver and replace it with a healthy donor liver.

Purpose

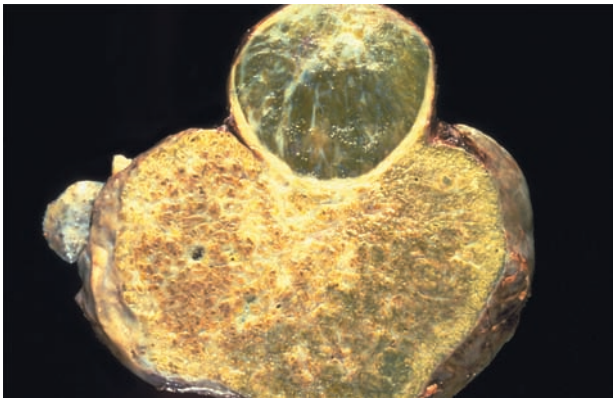
The liver is the body's principle chemical factory. It receives all nutrients, drugs, and toxins absorbed from the intestines and performs the final stages of digestion, converting food into energy and replacement parts for the body. The liver also filters the blood of all waste products, removes and detoxifies poisons and excretes many of these into the bile. It processes other chemicals for excretion by the kidneys. The liver is also an energy storage organ, changing food energy to a chemical called glycogen that can be rapidly converted to fuel.

As the liver fails, all of its functions diminish. **Nutrition** suffers, toxins build up, and waste products accumulate. Scar tissue builds up on the liver if disease is of long duration. As the liver **scars**, blood flow is progressively restricted in the portal vein, which carries blood from the stomach and abdominal organs to the liver. The resulting high blood pressure (**hypertension**) causes swelling of and bleeding from the blood vessels of the esophagus. Severe **jaundice**, fluid accumulation in the abdomen (**ascites**), and deterioration of mental function, due to the build-up of toxins in the blood (**liver encephalopathy**), eventually occur, leading to **death**.

Among the many causes of liver failure that bring patients to **transplant surgery** are:

- Progressive hepatitis (mostly due to virus infection) accounts for more than a third.
- Alcohol damage brings in about 20%.
- Scarring or abnormality of the biliary system accounts for roughly another 20%.
- The remainder comes from selected cancers, other uncommon diseases, and a situation called fulminant liver failure.

Fulminant liver failure most commonly happens during acute viral hepatitis, but it is also the result of **mushroom poisoning** by *Amanita phalloides* and toxic reactions to some medicines, like an overdose of



The diseased liver of a patient ready for transplantation. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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KEY TERMS

Acetaminophen—A common pain reliever (Tylenol).

Antigen—Any chemical that provokes an immune response.

Bile ducts—Tubes carrying bile from the liver to the intestines.

Biliary system—The tree of tubes that carries bile.

Hepatic artery—The blood vessel supplying arterial blood to the liver.

Inferior vena cava—The biggest vein in the body, returning blood to the heart from the lower half of the body.

Leukemia—A cancer of the white blood cells.

Lymphoma—A cancer of lymphatic tissue.

Portal vein—The blood vessel carrying venous blood from the abdominal organs to the liver.

acetaminophen. This is a special category of candidates for liver transplant because of the speed of their disease and the immediate need of treatment.

The first human liver transplant was performed in 1963, and since then, thousands of liver transplants are done every year. Since the introduction of of cyclosporine (a drug that suppresses the immune response that rejects the donor organ), success rates for liver transplantation have reached 85%.

Precautions

Patients with advanced heart and lung disease, who are HIV positive, and who abuse drugs and alcohol are poor candidates for liver tranplantation. Their ability to survive the surgery and the difficult recovery period, as well as their longterm prognosis, is hindered by their conditions.

Description

There are three types of liver transplantation methods. They include:

- Orthotopic transplantation is the replacement of a whole diseased liver with a healthy donor liver.
- Heterotopic transplantation is the addition of a donor liver at another site, while the diseased liver is left intact.
- Reduced-size liver transplantation is the replacement of a whole diseased liver with a portion of a healthy donor liver. Reduced-size liver transplants are most often performed on children.

When an orthotopic transplantation is performed, a segment of the inferior vena cava attached to the liver is taken from the donor as well. The same parts are removed from the recipient and replaced by connecting the inferior vena cava, the hepatic artery, the portal vein and the bile ducts.

When there is a possibility that the afflicted liver may recover, a heterotopic tranplantation is performed. The donor liver is placed in a different site, but it still has to have the same connections. It is usually attached very near the original liver, and if the original liver recovers, the donor shrivels away. If the original liver does not recover, it will shrivel, leaving the donor in place.

Reduced-size liver transplantation tranplants part of a donor liver into a patient. It is possible to divide the liver into eight pieces, each supplied by a different set of blood vessels. Two of these pieces have been enough to save a patient in liver failure, especially if the patient is a child. It is therefore possible to transplant one liver into at least two patients and to transplant part of a liver from a living donor and have both donor and recipient survive. Liver tissue grows to accommodate its job so long as there is initially enough of the organ to use. Patients have survived with only 15–20% of their original liver, provided that 15–20% was healthy.

Availability of organs for transplant is a current crisis in the transplantation business. In October 1997, a national distribution system was established that gives priority to the sickest patients closest in location to the donor liver, but makes livers available nationally. It is now possible to preserve a liver out of the body for 10–20 hours by flushing it with cooled solutions of special chemicals and nutrients, so it can be transported across the country.

Preparation

Before transplantation takes place, the patient is first determined to be a good candidate for transplantation by going through rigorous medical examination. A suitable candidate boosts their nutritional intake in order to ensure that they are as healthy as possible before surgery. Drugs are administered that will decrease rejection after surgery. Consultation with the patient, as well as any

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family, is conducted to explain the surgery and its complications. Psychological counciling is recommended.

Aftercare

In order to prevent organ rejection, immunosuppressive drugs will be taken. Hospitalization ranges from four weeks to five months, depending on the rate of recovery.

Successfully receiving a transplanted liver is only the beginning of a life-long process. Patients with transplanted livers have to stay on **immunosuppressant drugs** for the rest of their lives to prevent organ rejection. Although many can reduce the dosage after the initial few months, virtually none can discontinue drugs altogether. Prednisone, azathioprine, and tacrolimus are often combined with cyclosporine for better results. Newer immunosuppressive agents are coming that promise even better results. In spite of immunosuppressants, rejection occurs most of the time and requires additional medication. In some cases it cannot be reversed, and retransplantation becomes necessary.

Risks

Early failure of the transplant occurs once in four surgeries and has to be repeated. Some transplants never work, some succumb to infection, and some suffer immune rejection. Primary failure is apparent within one or two days. Infections happen in half the patients and often appear during the first week. Rejection usually starts at the end of the first week. The surgery itself may need revision because of narrowing, leaking, or **blood clots** at the connections.

There are potential social and economic problems, psychological problems, and a vast array of possible medical and surgical complications. Close medical surveillance must continue for the rest of the patient's life. Infections are a constant risk while on immunosuppressive agents, because the immune system is supposed to prevent them. A way has not yet been devised to control rejection without hampering immune defenses against infections. Not only do ordinary infections pose a threat, but because of the impaired immunity, transplant patients are susceptible to the same "opportunistic" infections that threaten **AIDS** patients–pneumocystis **pneumonia**, herpes and cytomegalovirus infections, fungi, and a host of bacteria.

Immunosuppression also hinders the body's ability to resist **cancer**. All the drugs used to prevent rejection increase the risk of leukemias and lymphomas.

There is also a risk of the original disease returning. Hepatitis virus still inhabits the patient, as does the urge to drink alcohol. Newer **antiviral drugs** hold out promise for dealing with hepatitis, and Alcoholics Anonymous (AA) is the most effective treatment known for **alcoholism**.

Drug reactions are also a continuing threat. Every drug used to suppress the immune system has potential problems.

ORGANIZATIONS

American Liver Foundation, 75 Maiden Lane, Suite 603, New York, NY, 10038, (212) 668-1000, (212) 483-8179, http://www.liverfoundation.org/.

J. Ricker Polsdorfer, MD

Ller-Christi *see* **Histiocytosis X**

Loaiasis *see* **Filariasis**

Lobectomy

Definition

A lobectomy is the removal of a lobe of one of the organs, usually referring to the brain, the lung, or the liver.

Purpose

Lobectomies are usually performed to prevent the spread of **cancer** from one part of an organ to other parts or to other parts of the body. Lobectomies also are performed on patients with severe seizure disorders (such as some forms of **epilepsy**) to prevent further seizures. However, there are differences in each of the three organs on which lobectomies may be performed.

Description

The brain

Each lobe of the brain performs a different function, and when part of the brain is removed, it does not grow back. However, other parts of the brain can take over some, or all, of the function of the missing part of the brain. Depending on the part of the brain removed, the effects may be quite severe, or nearly nonexistent.

The most commonly referenced brain lobectomy in the medical literature is the removal of the temporal lobe. Temporal lobectomy usually is performed to prevent debilitating seizures. Seizures are commonly caused by temporal lobe epilepsy, but can also be caused by brain tumors in the temporal lobe. Thus,

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lobectomy of the temporal lobe in patients with a temporal lobe tumor reduces or eliminates seizures, and has the beneficial side effect of removing the tumor mass.

The lung

Lobectomies of the lung also are called pulmonary lobectomies. Each part of the lung performs the same function: it exchanges oxygen for carbon dioxide in the blood. There are many different lobes of the lung, however, and some lobes exchange more oxygen than others. Lobes of the lung do not regenerate after they are removed. Therefore, removal of a large portion of the lung may cause a person to need oxygen or ventilator support for the rest of his or her life. However, removal of a small portion of the lung may result in very little change to the patient's quality of life. A test (a quantitative ventilation/perfusion scan, or quantitative V/Q scan) may be used before surgery to help determine how much of the lung can safely be removed.

The outcome of lung lobectomies also depends on the general health of the entire lung; **emphysema** and **smoking** would have a negative impact on the health of a patient's lung. The surgeon may perform the surgery with video assistance and special tools to decrease **pain** and speed patient recovery following surgery.

The liver

A lobectomy of the liver is also called a hepatic lobectomy. The liver plays a major role in digestion, in the transformation of food into energy, and in filtering and storing blood. It processes nutrients and drugs, produces bile, controls the level of glucose (sugar) in the blood, detoxifies blood, and regulates blood clotting. Unlike the brain and the lung, the liver may regrow, or regenerate, after part of the liver has been removed. In addition, since every part of the liver performs the same functions, the liver is the organ whose function is least likely to be severely affected by lobectomy, in the long term, because it regenerates. However, as the liver is central to the body's functions, removal of too much of the liver at once may result in **coma** or **death**.

Precautions

Brain lobectomies should not be performed unless the patient has been unable to control seizures through medication. Additionally, the seizures must be caused by a single, relatively small, localized part of the brain that can be resected without severe damage. Lung lobectomies should only be performed on patients with early stage non-small cell carcinoma of the lung, or as part of a combination of therapies at later stages. Since even a "complete removal" of the tumor does not result in an overwhelming survival rate after five years, other therapies also may be considered. Small cell cancer of the lung does not respond to surgical intervention. Patients with **liver disease** that is too extensive may need a liver transplant rather than a liver lobectomy. Patients with blood clotting problems, either due to chemotherapeutic agents or for other reasons, should have these problems addressed before surgery.

Preparation

Before surgery, patients should not take **aspirin** or ibuprofen for one week. Patients also should consult their physician about any blood-thinning medications such as coumadin or warfarin. The night before surgery, patients will usually be asked not to eat or drink after a certain time.

Aftercare

Each surgery offers different aftercare challenges. Patients may need to be hospitalized for some time after the operation. Patients with portions of their brain removed may require **rehabilitation** of a physical, mental, or emotional nature depending on the portion of the brain that has been removed. Patients who have had portions of their lungs removed probably will require a tube in their chest to drain fluid, and may require a machine to help them breathe. They also may require oxygen, either on a temporary or permanent basis. Patients who have had hepatic lobectomies also may have drainage tubes, and may also have initial dietary restrictions. Physicians should be consulted for the specifics of aftercare in each individual situation.

Risks

Specific risks vary from surgery to surgery and should be discussed with a physician. In general, any surgery requiring a general anesthetic may, uncommonly, result in death. Improperly performed brain surgery may result in permanent brain damage. Depending on the surgeon and the size of the tissue removed, patients may be at risk for some types of brain damage. As previously mentioned, patients having part of a lung removed may have difficulty breathing and may require the use of oxygen. Patients also may experience infection (**pneumonia**), or **blood clots**. Liver resection (surgery) may result in the following

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complications: coma, slow return of normal bowel function, and biliary leakage.

Results

Most patients who undergo temporal lobectomy experience few or no seizures after surgery (some estimates range from about 70% to about 90% success rate). Unfortunately, lung lobectomy is not as successful. 50% of cancer patients with completely removable stage I non-small cell cancer of the lung survive five years after the procedure. If the cancer has progressed beyond this stage, or if the cancer is not completely removable, the chances for survival drop significantly. The results of liver resection vary. The possible outcomes of each surgical type should be discussed with the patient's physician. Generally, the less severe the cancer, and the less tissue that needs to be removed, the better the outcome.

Abnormal results vary from operation to operation and should be discussed thoroughly with the patient's physician before surgery. Patients who undergo temporal lobectomy may, rarely, die as a result of the operation (a complication in less than 1% of patients). Patients also may have problems with their vision, or problems with speech. Abnormal results from the removal of part of the lung could include pneumonia or blood clots (which may result in **stroke**, **heart attack**, or other problems) after the surgery. Also, a small percentage of patients undergoing lung lobectomy die during or soon after the surgery. The percentage of patients who suffer death varies from about 3–6% depending on the amount of lung tissue removed. Finally, abnormal outcomes from liver resection can include coma, death, and problems with liver function.

Resources

PERIODICALS

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Tatum, W. O., and S. R. Benbadis. "The Neurosurgical Treatment of Epilepsy." *Archives of Family Medicine* 9, no. 10 (November–December 2000): 1142–1147.

OTHER

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Lobectomy *see* **Lung surgery**

Lobotomy *see* **Psychosurgery**

Local anesthetic *see* **Anesthesia, local**

Localized scratch dermatitis *see* **Lichen simplex chronicus**

Lockjaw *see* **Tetanus**

Loperamide *see* **Antidiarrheal drugs**

Loratadine *see* **Antihistamines**

Lou Gehrig's disease *see* **Amyotrophic lateral sclerosis**

Louis-Bar syndrome *see* **Ataxia-telangiectasia**

Low back pain

Definition

Low back **pain** is a common musculoskeletal symptom that may be either acute or chronic. It may be caused by a variety of diseases and disorders that affect the lumbar spine. Low back pain is often accompanied by **sciatica**, which is pain that involves the sciatic nerve and is felt in the lower back, the buttocks, and the backs of the thighs.

Description

Low back pain is a symptom that affects 80% of the general United States population at some point in life with sufficient severity to cause absence from work. It is the second most common reason for visits to primary care doctors, and is estimated to cost the American economy $75 billion every year.

Low back pain may be experienced in several different ways:

- Localized. In localized pain the patient will feel soreness or discomfort when the doctor palpates, or presses on, a specific surface area of the lower back.
- Diffuse. Diffuse pain is spread over a larger area and comes from deep tissue layers.

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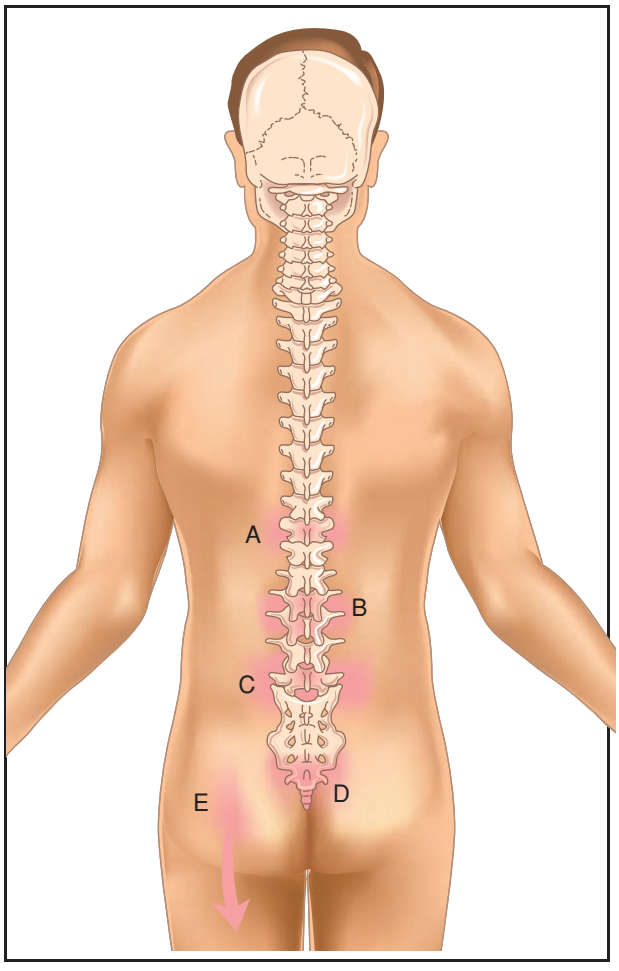

Sites of low back pain. Pain anywhere along the spine (A) can be caused by osteoarthritis. Pain along one or the other side of the spine may be (B) a kidney infection. Trauma to back muscles, joints, or disks (C) causes low back pain. Damage to the coccyx (D) can occur during a fall. Sciatica (E) can cause pain to run down from the back and buttocks area down a leg. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

- Radicular. The pain is caused by irritation of a nerve root. Sciatica is an example of radicular pain.
- Referred. The pain is perceived in the lower back but is caused by inflammation elsewhere—often in the kidneys or lower abdomen.

Causes and Symptoms

Acute pain

Acute pain in the lower back that does not extend to the leg is most commonly caused by a sprain or muscle tear, usually occurring within 24 hours of heavy lifting or overuse of the back muscles. The pain is usually localized, and there may be **muscle spasms** or soreness when the doctor touches the area. The patient usually feels better when resting.

Chronic pain

Chronic low back pain has several different possible causes:

MECHANICAL. Chronic strain on the muscles of the lower back may be caused by **obesity**; **pregnancy**; or job-related stooping, bending, or other stressful postures.

MALIGNANCY. Low back pain at night that is not relieved by lying down may be caused by a tumor in the cauda equina (the roots of the spinal nerves controlling sensation in and movement of the legs), or a **cancer** that has spread to the spine from the prostate, breasts, or lungs. The risk factors for the spread of cancer to the lower back include a history of **smoking**, sudden weight loss, and age over 50.

ANKYLOSING SPONDYLITIS. Ankylosing spondylitis is a form of arthritis that causes chronic pain in the lower back. The pain is made worse by sitting or lying down and improves when the patient gets up. It is most commonly seen in males between 16 and 35. Ankylosing spondylitis is often confused with mechanical back pain in its early stages.

HERNIATED SPINAL DISK. Disk herniation is a disorder in which a spinal disk begins to bulge outward between the vertebrae. Herniated or ruptured disks are a common cause of chronic low back pain in adults.

PSYCHOGENIC. Back pain that is out of proportion to a minor injury, or that is unusually prolonged, may be associated with a somatoform disorder or other psychiatric disturbance.

Low back pain with leg involvement

Low back pain that radiates down the leg usually indicates involvement of the sciatic nerve. The nerve can be pinched or irritated by herniated disks, tumors of the cauda equina, abscesses in the space between the spinal cord and its covering, **spinal stenosis**, and compression **fractures**. Some patients experience **numbness** or weakness of the legs as well as pain.

Diagnosis

The diagnosis of low back pain can be complicated. Most cases are initially evaluated by primary care physicians rather than by specialists.

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Initial workup

PATIENT HISTORY. The doctor will ask the patient specific questions about the location of the pain, its characteristics, its onset, and the body positions or activities that make it better or worse. If the doctor suspects that the pain is referred from other organs, he or she will ask about a history of diabetes, peptic ulcers, **kidney stones**, urinary tract infections, or **heart murmurs**.

PHYSICAL EXAMINATION. The doctor will examine the patient's back and hips to check for conditions that require surgery or emergency treatment. The examination includes several tests that involve moving the patient's legs in specific positions to test for nerve root irritation or disk herniation. The flexibility of the lumbar vertebrae may be measured to rule out ankylosing spondylitis.

Imaging studies

Imaging studies are not usually performed on patients whose history and **physical examination** suggest routine muscle strain or overuse. X rays are ordered for patients whose symptoms suggest cancer, infection, inflammation, pelvic or abdominal disease, or bone fractures. MRIs are usually ordered only for patients with certain types of masses or tumors.

It is important to know that the appearance of some abnormalities on imaging studies of the lower back does not necessarily indicate that they cause the pain. Many patients have minor deformities that do not create symptoms. The doctor must compare the results of imaging studies very carefully with information from the patient's history and physical examination.

Treatment

All forms of treatment of low back pain are aimed either at symptom relief or to prevent interference with the processes of healing. None of these methods appear to speed up healing.

Acute pain

Acute back pain is treated with **nonsteroidal anti-inflammatory drugs** (NSAIDs), such as ibuprofen, **muscle relaxants**, or **aspirin**. Applications of heat or cold compresses are also helpful to most patients. If the patient has not experienced some improvement after several weeks of treatment, the doctor will reinvestigate the cause of the pain.

Chronic pain

Patients with chronic back pain are treated with a combination of medications, **physical therapy**, andoccupational or lifestyle modification. The medicationsgiven are usually NSAIDs, although patients withhypertension, kidney problems, or stomach ulcers should not take these drugs. Patients who take NSAIDs for longer than six weeks should be monitored periodically for complications.

Physical therapy for chronic low back pain usually includes regular **exercise** for fitness and flexibility, and massage or application of heat if necessary.

Lifestyle modifications include giving up smoking, weight reduction (if necessary), and evaluation of the patient's occupation or other customary activities.

Patients with herniated disks are treated surgically if the pain does not respond to medication.

Patients with chronic low back pain sometimesbenefit from **pain management** techniques, including **biofeedback**, **acupuncture**, and **chiropractic** manipulation of the spine.

Psychotherapy is recommended for patients whose back pain is associated with a somatoform, **anxiety**, or depressive disorder.

Low back pain with leg involvement

Treatment of sciatica and other disorders that involve the legs may include NSAIDs. Patients with long-standing sciatica or spinal stenosis that do not respond to NSAIDs are treated surgically. Although some doctors use cortisone injections to relieve the pain, this form of treatment is still debated.

Alternative treatment

A thorough differential diagnosis is important before any treatment is considered. There are times when alternative therapies are the most beneficial, and other times when more invasive treatments are needed.

Chiropractic

Chiropractic treats patients by manipulating or adjusting sections of the spine. It is one of the most popular forms of alternative treatment in the United States for relief of back pain caused by straining or lifting injuries. Some osteopathic physicians, physical therapists, and naturopathic physicians also use spinal manipulation to treat patients with low back pain.

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KEY TERMS

Ankylosing spondylitis—A type of arthritis that causes gradual loss of flexibility in the spinal column. It occurs most commonly in males between 16 and 35.

Cauda equina—The roots of the spinal nerves controlling movement and sensation in the legs. These nerve roots are located in the lower spine and resemble a horse's tail (*cauda equina* in Latin).

Chiropractic—A method of treatment based on the interactions of the spine and the nervous system. Chiropractors adjust or manipulate segments of the patient's spinal column in order to relieve pain.

Lumbar spine—The segment of the human spine above the pelvis that is involved in low back pain. There are five vertebrae, or bones, in the lumbar spine.

Radicular—Pain that is caused by the root of a nerve.

Referred pain—Pain that is experienced in one part of the body but originates in another organ or area. The pain is referred because the nerves that supply the damaged organ enter the spine in the same segment as the nerves that supply the area where the pain is felt.

Sciatica—Pain caused by irritation of the sciatic nerve. Sciatica is felt in the lower back, the buttocks, and the backs of the upper legs.

Spinal stenosis—A form of sciatica that is caused by a narrowing of the spinal canal in the lumbar vertebrae. The narrowing puts pressure on the roots of the sciatic nerve.

Traditional Chinese medicine

Practitioners of **traditional Chinese medicine** treat low back pain with acupuncture, *tui na* (push-and-rub) massage, and the application of herbal poultices.

Herbal medicine

Herbal medicine can utilize a variety of antispasmodic herbs in combination to help relieve low back pain due to spasm. Lobelia (*Lobelia inflata*) and myrrh (*Commiphora molmol*) are two examples of antispasmodic herbs.

Homeopathy

Homeopathic treatment for acute back pain consists of applications of *Arnica* oil to the sore area or oral doses of *Arnica* or *Rhus toxicodendron*. *Bellis perennis* is recommended for deep muscle injuries. Other remedies may be recommended based on the symptoms presented by the patient.

Body work and yoga

Massage and the numerous other body work techniques can be very effective in treating low back pain. **Yoga**, practiced regularly and done properly, can be most useful in preventing future episodes of low back pain.

Prognosis

The prognosis for most patients with acute low back pain is excellent. About 80% of patients recover completely in 4–6 weeks. The prognosis for recovery from chronic pain depends on the underlying cause.

Prevention

Low back pain due to muscle strain can be prevented by lifestyle choices, including regular physical exercise and weight control, avoiding smoking, and learning the proper techniques for lifting and moving heavy objects. Exercises designed to strengthen the muscles of the lower back, and chairs or car seats with lumbar supports are also recommended.

Resources

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Low blood magnesium *see* **Magnesium imbalance**

Low blood phosphate level *see* **Phosphorus imbalance**

Low blood pressure *see* **Orthostatic hypotension; Hypotension**

Low blood sugar *see* **Hypoglycemia**

Low calcium blood level *see* **Hypocalcemia**

Low potassium blood level *see* **Hypokalemia**

Low sodium blood level *see* **Hyponatremia**

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Low sugar diet

Definition

Low-sugar **diets** are a specialized form of low-carbohydrate diets for diabetes management or weight loss. Some are derived from general guidelines drawn up by such organizations as the American Diabetes Association (ADA) or the American Heart Association (AHA); others, like the Sugar Busters diet, are diet plans published by individuals or groups for the general public. Low-sugar diets are based on reducing the total amount of sugar obtained in the diet from fruits, starches, and other foods, not just from table sugar and such other sweeteners as honey, molasses, or corn syrup.

Standard classifications and definitions of dietary sugars are as follows:

- Simple sugars. These include monosaccharides (glucose, galactose, and fructose) and disaccharides (sucrose [glucose plus fructose], found in sugar cane, sugar beets, honey, and corn syrup; lactose [glucose plus galactose], found in milk products; and maltose [glucose plus glucose], found in malt.
- Complex carbohydrates (starches). These foods contain glucose.
- Naturally occurring or intrinsic sugars. These sugars occur naturally in whole fruit, vegetable, and milk products.
- Added or extrinsic sugars. These are sugars or syrups added during food processing or at the table.
- Total sugars. This term refers to the sum total of naturally occurring and added sugars in a specific food.
- High-fructose corn syrup. This is a sweetener that is produced from corn syrup that undergoes enzymatic processing to increase its fructose content and is then mixed with glucose.

Purpose

The purpose of low-sugar diets is to assist in the long-term management of **diabetes mellitus**, to enable weight loss or weight management, or both.

Demographics

It is difficult to estimate how many diabetics or dieters in North America are trying to manage their respective conditions on low-sugar diets. At one point in the early 2000s, some writers thought that as many as 18% of American adults were using low-carbohydrate diets of one type or another; another estimate published in 2006 is that 3.4% of American adults are following one of these diets at any given time. What is known, however, is that the average American diet as of 2009 is much higher in sugar than is permitted by low-carbohydrate or low-sugar diets.

According to the American Heart Association (AHA), the average American consumes 355 calories per day (22.5 teaspoons) in the form of sugars added to foods, mostly soft drinks and other sweetened beverages. The demographic with the highest daily sugar intake is males between the ages of 14 and 19, who consume an average of 34 teaspoons of sugar per day. The AHA stated in August 2009 that a prudent sugar intake for the average American woman is less than a third of this amount (100 calories or 6 teaspoons) and less than half of it for the average man (150 calories or 9 teaspoons).

Precautions

The most important precautions for low-sugar diets, as for any other diet intended for weight control or diabetes management, are making sure that the diet is based on accurate medical information and sound nutritional advice, and that it includes foods and recipes that the individual patient enjoys, for the sake of long-term compliance.

Several specific precautions recommended for low-sugar diets include the following:

- Read food labels carefully. Required nutritional labeling lists the ingredients in a food product in the order of their amount within the product. The higher an ingredient's position in the list, the larger the amount of it in the food. People on a low-sugar diet should not consume any product in which sugar is listed as one of the top 3 ingredients.
- Remember that there are many different forms of sugar in food products: high-fructose corn syrup, brown sugar, beet sugar, cane sugar, sorbitol, mannitol, raw sugar, agave nectar, cane sugar juice, turbinado sugar, honey, maltodextrin, molasses, dextrose, and sucrose.
- Drink water instead of soda pop or sugary fruit juice. These products can contain as much as 4 tablespoons of sugar per can.
- Avoid adding table sugar to cereals, tea, coffee, grapefruit, and other foods that many people habitually sweeten. One suggestion often made is to cut the usual amount of sugar added at the table in half, then in half again the following week until the craving for it disappears.
- Be aware that sugar is often added to such products as bread, catsup, canned soup, tomato sauce, and

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other canned foods even though it is not needed. Look for brands of these items that do not contain added sugar.

- Try cutting the amount of sugar called for in some cookie or pie recipes. In many cases the recipe will work just as well with half the amount of sugar.

Description

General low-sugar diets

Most diabetic diet plans are based on some form of carbohydrate counting or carbohydrate measurement because carbohydrates are the nutrients with the greatest impact on blood glucose levels. A low-sugar diet is based on the assumption that sugars are to be avoided as much as possible in favor of starchy carbohydrates.

Some low-sugar diets are based on the glycemic index (GI), an approach to carbohydrate counting based on the knowledge that the body does not convert all carbohydrates in food to glucose with the same speed or efficiency. The glycemic index (GI) is a classification of foods according to the speed at which the body converts their carbohydrate to glucose. Glucose itself is assigned a value of 100 on the glycemic index and other foods are measured against it. Any food below 55 is considered to have a low GI. Examples include grapefruit juice (48), oatmeal (42), and spaghetti (41).

Sugar Busters diet

The Sugar Busters diet is a popularized version of a low-GI diet available in an inexpensive paperback edition and supported by a website with a chat forum. There is a child's version of the diet available as well as a book for adults, written by a team of three doctors and the CEO of a Fortune 500 energy company (who is listed as the first author).

The Sugar Busters diet is essentially a diet that eliminates sources of sugar and other high-GI carbohydrates in order to lower blood insulin levels. It requires the dieter to eliminate all refined sugar, honey, and molasses; white flour and products made with it (white bread, cake, bagels, crackers, and tortillas); potatoes; most forms of white rice; corn flour; sugared soft drinks; beer; and other foods that are high on the GI index. The general rule is that any permissible food must contain 3 grams of sugar or less per serving. A more detailed list of acceptable and unacceptable foods can be found at the "Newbie Tips" link listed below. The published book contains little information on tailoring the diet to individual needs; a common criticism of it is that it is a one-size-fits-all approach to carbohydrate counting.

Origins

Low-carbohydrate diets for both diabetes management and weight loss have been produced by various organizations and individual authors in North America since the 1960s. Low-sugar diets, however, did not gain much attention from the general public until the 1990s. The concept of the glycemic index was introduced by David Jenkins, a Canadian physician, in 1981. The first version of the Sugar Busters diet, based on the glycemic index, was published in New Orleans in 1998, with a revised version following in 2003.

Preparation

Preparation for using a low-sugar or any other diet plan for weight loss includes consulting a primary care physician. Persons wishing to try the Sugar Busters diet should read the introduction to the book first and understand the theory underlying this diet before making food purchases and meal plans based on the diet.

Preparation for following a low-sugar or any other diabetic diet usually involves meeting with a dietitian or diabetes counselor as well as the doctor in order to plan a diet that will work well with the patient's food preferences and lifestyle. Children and adolescents, athletes, and all type 1 diabetics need to take particular care regarding the timing of their meals as well as the total calories and specific foods included in the diet.

Aftercare

A low-sugar, low-carbohydrate, or any other diabetes diet is a lifelong part of diabetes management. Follow-up includes regular medical checkups, home monitoring of blood glucose levels, and consultations with a dietitian if adjustments are needed.

A low-sugar or any other specific diet for weight management is also a lifelong undertaking and should be followed under a doctor's and/or a dietitian's supervision.

Risks

As of 2009, there are no known risks to health in following a low-sugar diet under a doctor's supervision provided the diet is nutritionally sound. Some researchers note, however, that the long-term effects of low-sugar or low-carbohydrate diets are still

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KEY TERMS

Agave nectar—A sweetener produced commercially in Mexico from the leaves of the agave, a succulent plant with thick fleshy leaves.

Bariatric—Related to or specializing in the treatment of obesity.

Blood glucose—The main sugar that the body makes from the food in the diet.

Disaccharide—Any sugar formed when two monosaccharides are joined together and a molecule of water is removed.

Fructose—A monosaccharide sugar found in many fruits.

Glycemic index (GI)—A measurement of the speed at which the body converts carbohydrates in foods to blood glucose. The more rapidly a food's carbohydrates are converted to glucose, the higher its GI.

Insulin—A hormone secreted by the pancreas that causes the cells in the liver, muscle and fatty tissues of the body to use the glucose carried in the bloodstream after a meal.

Monosaccharide—The simplest form of sugar. Monosaccharides combine to form disaccharides and such complex carbohydrates as starch and cellulose.

Pancreas—A small organ that lies between the stomach and the liver and secretes insulin.

Sucrose—The scientific name for table sugar. Sucrose is a disaccharide derived from glucose and fructose.

Turbinado sugar—A type of sugar made from sugar cane extract. It resembles light brown sugar in color but is paler and has larger crystals. It is called demerara sugar in the United Kingdom.

unknown, as no studies of the benefits of these diets have been conducted over long enough periods of time to determine whether they may increase the risk of such conditions as heart disease, **cancer**, and kidney or bone problems—which take years to develop. Over the short term, diabetics are at risk of complications from their disease if they try extreme fad diets for rapid weight loss or if they fail to stay within their individual dietary guidelines.

One group of people who should be particularly careful in trying a low-sugar diet is athletes, particularly long-distance or marathon runners. Athletes (or people who **exercise** vigorously for long periods of time) require more high-glycemic index foods in the diet that supply large quantities of glucose quickly to meet the body's needs for energy. Even the authors of the Sugar Busters diet recognize that "this diet may not be exactly right for [athletes and fitness buffs]."

Results

The results of a properly designed low-sugar diabetic diet include improved stability in blood glucose levels; weight loss when needed; lowered risk of the complications of diabetes; and patient satisfaction with the food choices and dishes allowed on the diet. The major problem with low-sugar diets as well as low-carbohydrate diets in general is the difficulty most patients have in sticking with them over the long term because of their restrictiveness. Researchers at the Mayo Clinic have noted that the dropout rate for these diets is the same as that for low-fat diets and other restrictive diet plans.

Another problem associated with the Sugar Busters diet and other diet plans based on the glycemic index is their complexity. Doctors at the Joslin Diabetes Center comment, "The more complex a meal plan is, the less likely people are to follow it. The glycemic index is a fairly complex meal planning tool." In addition, different people's bodies respond differently to so-called "high" and "low" GI foods. A registered dietitian may be able to help patients determine their own individual glycemic index of foods based on how their blood glucose level responds to the various meals and snacks they usually eat.

Health care team roles

All members of the health care team may come into contact with diabetic patients. The nurse plays a particularly important role in teaching patients the skills necessary to manage this complex disease, and educating them about the effects of their medications. Registered dietitians and diabetes counselors are also important participants in nutritional planning and patient education. Diabetes education is an ongoing process that may require periodic consultation with a specialized diabetes counselor as well as participation in a diabetes support group.

Persons following a low-sugar diet for weight loss or weight management rather than diabetes management should consult their primary care physician to

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make sure that such a diet is appropriate for them, particularly if they participate in sports or other forms of vigorous exercise. They may also wish to consult a registered dietitian to help them plan an individualized low-sugar diet based on the glycemic index.

Alternatives

Bariatric (weight-loss) surgery is sometimes recommended for severely obese patients with type 2 diabetes and a body mass index (BMI) over 35. Blood sugar levels return to normal in 55 to 95% of people with diabetes depending on the procedure performed. The most effective type of weight-loss surgery for type 2 diabetics appears to be a procedure in which part of the small intestine is bypassed. This procedure is expensive, however, and involves the possibility of such long-term complications as **osteoporosis** and nutritional deficiencies. It also requires major adjustments in the patient's lifestyle.

Research and general acceptance

There is little consensus on the merits of low-sugar diets as of 2009. Studies of low-GI diets have yielded conflicting results regarding their effectiveness; and as previously noted, many of these diets are sufficiently complex as to discourage many people from using them. Although the Sugar Busters diet is reported to help people lose weight, at least in the short term, the Clinical Trials website notes that this diet has not been evaluated for either long-term safety or efficacy as of late 2009. There is one clinical trial under way as of 2009 of a general low-sugar diet in obese adolescents.

Caregiver concerns

Caregivers need to make sure that a diabetic or obese person in their care adheres to the food choices, meal plans, calorie allotment, and timing of meals in their diet. "Cheating" on one's diet can have severe short-term as well as long-term consequences for a poorly controlled diabetic.

Caregivers caring for a person trying to manage diabetes or lose weight on a low-sugar diet should also make sure that they understand the theories underlying these diets and encourage the dieter to stick with the plan.

Resources

BOOKS

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Joslin Diabetes Center. *The Glycemic Index and Diabetes*. http://www.joslin.org/info/the_glycemic_index_and_diabetes.html

Sugar Busters! *Newbie Tips*. This is a summary of the food restrictions and other recommendations of the Sugar Busters diet. http://www.sugarbusters.com/filessb/newbietips.htm

ORGANIZATIONS

American Diabetes Association, 1701 North Beauregard Street, Alexandria, VA, 22311, 800-DIABETES (800-342-2383), AskADA@diabetes.org, http://www.diabetes.org/.

American Dietetic Association, 120 South Riverside Plaza, Suite 2000, Chicago, IL, 60606-6995, (800) 877-1600, http://www.eatright.org/cps/rde/xchg/ada/hs.xsl/index.html.

American Society for Metabolic and Bariatric Surgery (ASMBS), 100 SW 75th Street, Suite 201, Gainesville, FL, 32607, (352) 331-4900, (352) 331-4975, info@asmbs.org, http://www.asbs.org/.

Joslin Diabetes Center, One Joslin Place, Boston, MA, 02215, (617) 732-2400, (800) JOSLIN-1, diabetes@joslin.harvard.edu, http://www.joslin.org/index.html.

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National Diabetes Education Program (NDEP), One Diabetes Way, Bethesda, MD, 20814-9692, (301) 496-3583, http://ndep.nih.gov/.
National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), Building 31. Rm 9A06, 31 Center Drive, MSC 2560, Bethesda, MD, 20892-2560, (301) 496-3583, http://www2.niddk.nih.gov/Footer/ContactNIDDK.htm, http://www2.niddk.nih.gov/.
Sugar Busters!, http://www.sugarbusters.com/index.html.

Rebecca J. Frey, PhD

Lower esophageal ring

Definition

Lower esophageal ring is a condition in which there is a ring of tissue inside the lower part of the esophagus (the tube connecting the throat with the stomach). This tissue causes narrowing and partial blockage of the esophagus. Lower esophageal ring can also refer to the ring itself.

Description

Lower esophageal ring (also called Schatzki's ring and B-ring) affects about 10–14% of the population. Normally, the lower part of the esophagus, near where the esophagus meets the stomach, has an inside diameter of 1.5–2 inches. The diameter of this part of the esophagus is less when lower esophageal ring is present, and diameters as small as one-eighth inch have been seen. When the inside diameter is less than about three-fourths of an inch, intermittent difficulty with swallowing can result. About 96% of people with lower esophageal ring have no symptoms.

Causes and symptoms

Causes

Lower esophageal ring seems to result from infoldings of tissue near the bottom of the esophagus, but the underlying cause is unknown. Although some specialists speculate they are due to a congenital defect, most people do not develop symptoms until they reach their forties or later. Although lower esophageal ring is generally associated with **hiatal hernia**, and sometimes with **heartburn**, the cause/effect relationship is unclear.

Symptoms

Intermittent difficulty swallowing solid food is the primary symptom of this condition. The degree of difficulty in swallowing is directly related to the degree the esophagus is narrowed. Certain foods, especially tough or fibrous foods like meat, are more likely to cause swallowing difficulties.

Diagnosis

Gastroenterologists and internists are best equipped to diagnose and treat lower esophageal ring. The diagnosis is based on the patient's history of swallowing difficulties and a barium x ray of the upper gastrointestinal tract. For a barium x ray, the patient swallows a liquid containing barium, a substance that is opaque to x rays. Subsequent x-ray photography reveals the shape of the esophagus and any narrow regions present.

The presence of a lower esophageal ring can also be shown with a test called an esophagoscopy. This procedure visualizes the inside of the esophagus with an inserted, thin, flexible tube. However, this test is less sensitive for lower esophageal ring and costs about five times as much as barium x ray. However, if the findings of a barium x ray are not definitive, esophagoscopy should be done. Biopsies can then be done on questionable areas.

Treatment

Dietary change

Swallowing difficulties due to lower esophageal ring can often be relieved by chewing food more thoroughly. Soft foods and liquids may also be recommended.

Dilation

Lower esophageal rings can be corrected by passing a bougie (a cylindrical, mercury-filled dilator) through the esophagus. This procedure, called bougienage, is effective most of the time, but may need to be repeated every few years. Complications and adverse reactions are extremely rare.

Surgery

If bougienage is unsuccessful, lower esophageal ring tissue can be surgically removed.

Prognosis

The probability of a favorable outcome is high. Swallowing difficulties can be alleviated in almost every case, and the rate of complications from bougienage or surgery is less than 1%.

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KEY TERMS

Bougie—A mercury-filled dilator in the shape of a cylinder or tapered cylinder. Bougies come in a range of different sizes.

Bougienage—The procedure of dilating tubal organs, like the esophagus, with a bougie or bougies.

Congenital—Existing at birth.

Dysphagia—Difficulty swallowing.

Esophagoscopy (also esophagoendoscopy)—Examination of the inside of the esophagus using a flexible tube that transmits video images.

Esophagus—The tube connecting the throat to the stomach, which is about ten inches long in adults. It is coated with mucus and surrounded by muscles, and pushes food to the stomach by sequential waves of contraction. It functions to transport food from the throat to the stomach and to keep the contents of the stomach in the stomach.

Heartburn—A burning sensation in the chest that can extend to the neck, throat, and face, caused by the movement of stomach acid into the esophagus.

Hiatal hernia—A condition where part of the stomach extends through the diaphragm into the chest cavity.

Prevention

Since the cause of lower esophageal ring is not known, there are no definitive preventive measures. Nevertheless, anyone with lower esophageal ring who also suffers from heartburn would be wise to prevent or treat the heartburn. It is possible that the stomach acid in the esophagus associated with heartburn contributes to esophageal ring.

ORGANIZATIONS

American College of Gastroenterology, P. O. Box 342260, Bethesda, MD, 20827-2260, (301) 263-9000, http://www.acg.gi.org.

American Gastroenterological Association (AGA), 4930 Del Ray Avenue, Bethesda, MD, 20814, (301) 654-2055, (301) 654-5920, member@gastro.org, http://www.gastro.org.

American Society for Gastrointestinal Endoscopy, 1520 Kensington Road, Suite 202, Oak Brook, IL, 60523, (630) 573-0600, (630) 573-0691, (866) 353-2743, info!asge.org, http://www.asge.org/.

National Digestive Diseases Information Clearinghouse (NDDIC), 2 Information Way, Bethesda, MD, 20892-3570, (703) 738-4929, (800) 891-5389, http://digestive.niddk.nih.gov.

Lorraine Lica, PhD

Lower GI exam *see* **Barium enema**

LSD *see* **Lysergic acid diethylamide**

Lues *see* **Syphilis**

Lumbar puncture

Definition

Lumbar puncture (LP) is the technique of using a needle to withdraw cerebrospinal fluid (CSF) from the spinal canal. CSF is the clear, watery liquid that protects the central nervous system from injury and cushions it from the surrounding bone structure. It contains a variety of substances, particularly glucose (sugar), protein, and white blood cells from the immune system.

Purpose

Lumbar puncture, or spinal tap, is used to diagnose some malignancies, such as certain types of brain **cancer** and leukemia, as well as other medical conditions that affect the central nervous system. It is sometimes used to assess patients with certain psychiatric symptoms and conditions.

It is also used for injecting **chemotherapy** directly into the CSF. This type of treatment is called intrathecal therapy. Other medical conditions diagnosed with lumbar puncture include:

- viral and bacterial meningitis
- syphilis, a sexually transmitted disease
- bleeding (hemorrhaging) around the brain and spinal cord
- multiple sclerosis, a disease that affects the myelin coating of the nerve fibers of the brain and spinal cord
- Guillain-Barré syndrome, an inflammation of the nerves

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KEY TERMS

Acute lymphoblastic leukemia (ALL)—A type of leukemia, also called acute lymphocytic leukemia, primarily in children, affecting lymphocytes.

Encephalitis—An inflammation or infection of the brain and spinal cord caused by a virus or as a complication of another infection.

Guillain-Barré syndrome—An inflammation involving nerves that affects the extremities. The inflammation may spread to the face, arms, and chest.

Immune system—Protects the body against infection.

Intrathecal therapy—Injecting chemotherapy directly into the CSF using lumbar puncture.

Manometer—A device used to measure fluid pressure.

Meningitis—An infection or inflammation of the membranes or tissues that cover the brain and spinal cord, and caused by bacteria or a virus.

Multiple sclerosis—A disease that destroys the covering (myelin sheath) of nerve fibers of the brain and spinal cord.

Spinal canal—The cavity or hollow space within the spine that contains cerebrospinal fluid.

Thrombocytopenia—Reduced platelet levels.

Vertebrae—The bones of the spinal column. There are 33 along the spine, with five (called L1–L5) making up the lower lumbar region.

Precautions

In some circumstances, a lumbar puncture to withdraw a small amount of CSF for analysis may lead to serious complications. Lumbar puncture should be performed only with extreme caution, and only if the benefits are thought to outweigh the risks, in certain conditions. For example, in people who have blood clotting (coagulation) or bleeding disorders or who are on anticoagulant treatment, lumbar puncture can cause bleeding that can compress the spinal cord. The term for this condition is spinal **subdural hematoma**, and it is a rare complication. However, it is of concern to some cancer patients whose low platelet counts (**thrombocytopenia**) make them more susceptible to bleeding. In some cases, these patients are given a platelet **transfusion** prior to lumbar puncture, but this procedure is still under investigation. A four-year study, supported in part by the National Cancer Institute, researched the risk of lumbar puncture on children with acute lymphoblastic leukemia (ALL). No serious lumbar puncture complications were observed in this study of over 5,000 children.

Lumbar puncture has been shown to be less precise than some other methods in monitoring intracranial fluid pressure. A transducer provides more accurate information about changes in the flow of blood and cerebrospinal fluid within the brain.

A traumatic lumbar puncture (TLP) occurs when a blood vessel is inadvertently ruptured during the procedure. If this happens as part of a diagnostic leukemia workup, there is the potential of contaminating the CSF specimen that has been removed with leukemia cells, causing a false positive test result.

If there is a large **brain tumor** or other mass, removal of CSF can cause pressure shifts within the brain (herniation), causing compression of the brain stem and other vital structures, and leading to irreversible brain damage or **death**. These problems are easily avoided by checking blood coagulation through a blood test and by doing a computed tomography scan (CT) or **magnetic resonance imaging** (MRI) scan before attempting the lumbar puncture. In addition, a lumbar puncture procedure should never be performed at the site of a localized skin infection on the lower back because the infection may be introduced into the CSF and may spread to the brain or spinal cord.

Description

In a lumbar puncture, the area of the spinal column used to obtain the CSF sample is in the lumbar spine, or lower section of the back. In rare instances, such as a spinal fluid blockage in the middle of the back, a doctor may perform a spinal tap in the neck. The lower lumbar spine (usually between the vertebrae known as L4–5) is preferable because the spinal cord stops near L2, and a needle introduced below this level will miss the spinal cord and encounter only nerve roots, which are easily pushed aside.

A lumbar puncture takes about 15–30 minutes. Patients can undergo the test in a doctor's office, laboratory, or outpatient hospital setting. Sometimes it requires an inpatient hospital stay. If the patient has severe **osteoarthritis** of the spine, is extremely

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uncooperative, or obese, it may be necessary to introduce the spinal needle using x-ray guidance.

In order to get an accurate sample of cerebrospinal fluid, it is critical that a patient is in the proper position. The spine must be curved to allow as much space as possible between the lower vertebrae, or bones of the back, for the doctor to insert a lumbar puncture needle between the vertebrae and withdraw a small amount of fluid. The most common position is for the patient to lie on his or her side with the back at the edge of the exam table, head and chin bent down, knees drawn up to the chest, and arms clasped around the knees. (Small infants and people who are obese may need to curve their spines in a sitting position.) People should talk to their doctors if they have any questions about their position because it is important to be comfortable and to remain still during the entire procedure. In fact, the doctor will explain the procedure to the patient (or guardian) so that the patient can agree in writing to have it done (informed consent). If the patient is anxious or uncooperative, a short-acting sedative may be given.

During a lumbar puncture, the doctor drapes the back with a sterile covering that has an opening over the puncture site and cleans the skin surface with an antiseptic solution. Patients receive a local anesthetic to minimize any **pain** in the lower back.

The doctor inserts a thin hollow needle in the space between two vertebrae of the lower back and slowly advances it through ligamentous tissues toward the spine. A steady flow of clear cerebrospinal fluid, normally the color of water, will begin to fill the needle as soon as it enters the spinal canal. The doctor measures the cerebrospinal fluid pressure with a special instrument called a manometer and withdraws several vials of fluid for laboratory analysis. The amount of fluid collected depends on the type and number of tests needed to diagnose a particular medical disorder.

In some cases, the doctor must remove and reposition the needle. This occurs when there is not an even flow of fluid, the needle hits bone or a blood vessel, or the patient reports sharp, unusual pain.

Preparation

Patients can go about their normal activities before a lumbar puncture. Experts recommend that patients relax before the procedure to release any muscle tension, since the lumbar puncture needle must pass through muscle tissue before it reaches the spinal canal. A patient's level of relaxation before and during the procedure plays a critical role in the test's success. Relaxation may be difficult for those patients who face frequent lumbar punctures, such as children with leukemia. In these cases, it is especially important for the child to receive psychological support before and after each procedure. It may be helpful to praise a child who remained still and quiet during the procedure, and to remind the child of his or her good behavior before the next lumbar puncture.

Aftercare

After the procedure, the doctor covers the site of the puncture with a sterile bandage. Patients must avoid sitting or standing and remain lying down for as long as six hours after the lumbar puncture. They should also drink plenty of fluids to help prevent lumbar puncture **headache**, which is discussed in the next section.

Risks

The most common side effect of lumbar puncture is a headache. This problem occurs in 10–20% of adult patients and in up to 40% of children. It is caused by decreased CSF pressure related to a small leak of CSF through the puncture site. These headaches usually are a dull pain, although some people report a throbbing sensation. A stiff neck and **nausea** may accompany the headache. A lumbar puncture headache typically begins within a few hours to two days after the procedure and usually persists a few days, although it can last several weeks or months.

In some cases, the headache can be prevented by lying flat for an hour after the lumbar puncture, and taking in more fluids for 24 hours after the procedure. Since an upright position worsens the pain, lying flat also helps control the pain, along with prescription or non–prescription pain relief medication, preferably one containing **caffeine**. In rare cases, the puncture site leak is "patched" using the patient's own blood. People may also experience back pain. Headaches and backaches appear to be more common in adolescents than in younger children, and more common in girls than in boys.

Patients who receive **anticancer drugs** through lumbar puncture sometimes have **nausea and vomiting**. Intrathecal methotrexate can cause mouth sores. Some of these symptoms may be relieved by antinausea drugs prescribed by the physician.

In a very few cases, lumbar puncture in infants can lead to such complications as paraplegia. These complications are associated with the smaller size of the

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infant's central nervous system and increased difficulty in avoiding certain parts of the spinal cord when performing an LP.

People should talk to their doctors about complications from a lumbar puncture. In most cases, this procedure is safe and effective. Some patients experience pain, difficulty urinating, infection, or leakage of cerebrospinal fluid from the puncture site after the procedure.

Results

Normal CSF is clear and colorless. It may be straw or yellow–colored if there is excess protein, which may occur with cancer or inflammation. It may be cloudy in infections; blood–tinged if there was recent bleeding; or yellow to brown (xanthochromic) if caused by an older instance of bleeding.

A series of laboratory tests analyze the CSF for a variety of substances to rule out cancer or other medical disorders of the central nervous system. The following are normal values for commonly tested substances:

- CSF pressure: 50–180 mmH_2O
- Glucose: 40–85 mg/dL
- Protein: 15–50 mg/dL
- Leukocytes (white blood cells): total less than 5 per mL
- Lymphocytes (specific type of white blood cell): 60–70%
- Monocytes (a kind of white blood cell): 30–50%
- Neutrophils (another kind of white blood cell): none

Normally, there are no red blood cells in the CSF unless the needle passes though a blood vessel on route to the CSF. If this is the case, there should be more red blood cells in the first tube collected than in the last.

Abnormal results

A lumbar puncture is sometimes used as part of a diagnostic cancer workup. Abnormal test result values in the pressure or any of the substances found in the cerebrospinal fluid may suggest a number of medical problems including a tumor or spinal cord obstruction; hemorrhaging or bleeding in the central nervous system; infection from bacterial, viral, or fungal microorganisms; or an inflammation of the nerves. If there is a tumor in the meninges (membranes around the brain and spinal cord), the CSF may have higher protein levels, lower glucose levels, and a mild increase in lymphocytes (pleocytosis). It is important for patients to review the results of a **cerebrospinal fluid analysis** with their doctor and to discuss any treatment plans.

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ORGANIZATIONS

American Academy of Neurology, 1080 Montreal Avenue, St. Paul, MN, 55116-2325, (800) 879-1960, (651) 695-2791, membersservices@aan.com, http://www. aan.com.

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Lumbar stenosis *see* **Spinal stenosis**
Lumbosacral radiculopathy *see* **Sciatica**

Lumpectomy

Definition

Lumpectomy is a type of surgery for **breast cancer**. It is considered "breast-conserving" surgery because only the malignant tumor and a surrounding margin of normal breast tissue are removed. Lymph nodes in the armpit (axilla) may also be removed. This procedure is also called lymph node dissection.

Purpose

Lumpectomy is a surgical treatment for newly diagnosed breast **cancer**. It is estimated that at least 50% of women with breast cancer are good candidates for this procedure. The location, size, and type of tumor are of primary importance when considering breast cancer surgery options. The size of the breast is another factor the surgeon considers when recommending surgery. The patient's psychological outlook, as well as her lifestyle and preferences, should also be taken into account when treatment decisions are being made.

The extent and severity of a cancer is evaluated, or "staged," according to a fairly complex system. Staging considers the size of the tumor and whether the cancer has spread (metastasized) to adjacent tissues, such as the chest wall, the lymph nodes, and/or to distant parts of the body. Women with early stage

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breast cancers are usually better candidates for lumpectomy. In most cases, a course of **radiation therapy** after surgery is part of the treatment. **Chemotherapy** or hormone treatment may also be prescribed.

In some instances, women with later stage breast cancer may be able to have lumpectomies. Chemotherapy may be administered before surgery to decrease tumor size and the chance of metastasis in selected cases.

Contraindications to lumpectomy

There are a number of factors that may prevent or prohibit a breast cancer patient from having a lumpectomy. The tumor itself may be too large or located in an area where it would be difficult to remove with good cosmetic results. Sometimes several areas of cancer are found in one breast, so the tumor cannot be removed as a single lump. A cancer that has already attached itself to nearby structures, such as the skin or the chest wall, needs more extensive surgery.

Demographics

The American Cancer Society estimated that in 2010, 250,500 new cases of breast cancer will be diagnosed in the United States and 40,200 women will die as a result of the disease. Approximately one in eight women will develop breast cancer at some point in her life. The risk of developing breast cancer increases with age: women aged 30 to 40 have a one in 252 chance of developing breast cancer; women aged 40 to 50 have a one in 68 chance; women aged 50 to 60 have a one in 35 chance; and women aged 60 to 70 have a one in 27 chance—and these statistics do not even account for genetic and environmental factors. Also, about one percent of all breast cancers are diagnosed in men.

Description

Any amount of tissue, from 1–50% of the breast, may be removed and called a lumpectomy. Breast conservation surgery is a frequently used synonym for lumpectomy. Partial **mastectomy**, quadrantectomy, segmental excision, wide excision, and tylectomy are other, less commonly used names for this procedure.

The surgery is usually done while the patient is general anesthetic. Local anesthetic with additional **sedation** may be used for some patients. The tumor and surrounding margin of tissue is removed and sent to a pathologist for examination. The surgical site is then closed. Newer techniques may use **magnetic resonance imaging** guidance to more accurately identify the breast tissue to be removed. Additionally, laser instruments may be used to perform the actual lumpectomy.

If axillary lymph nodes were not removed before, a second incision may be made in the armpit. The fat pad that contains lymph nodes is removed from this area and is also sent to the pathologist for analysis. This portion of the procedure is called an axillary lymph node dissection; it is critical for determining the stage of the cancer. Typically, 10 to 15 nodes are removed, but the number may vary. A newer alternative to axillary lymph node dissection involves removal of only one lymph node. This technique, called sentinel node biopsy, samples just the first lymph node to which the breast tissue drains. If the sentinel node is negative, it is likely that no cancer has spread to more distant lymph nodes. If the sentinel node is positive, then the surgeon may have to proceed with an axillary lymph node dissection. Surgical drains may be left in place in either location to prevent fluid accumulation. The surgery may last from one to three hours.

Alternatives to lumpectomy

Certain medical or physical circumstances may also eliminate lumpectomy as a treatment option. Sometimes lumpectomy may be attempted, but the surgeon is unable to remove the tumor with a sufficient amount of surrounding normal tissue. This may be termed "persistently positive margins," or "lack of clear margins." Lumpectomy is suitable for women who have had previous lumpectomies and have a recurrence of breast cancer.

Because of the need for radiation therapy after lumpectomy, this surgery may be medically unacceptable. A breast cancer discovered during **pregnancy** is not amenable to lumpectomy because radiation therapy is part of the treatment. Radiation therapy cannot be administered to pregnant women because it may injure the fetus. If, however, delivery would be completed prior to the need for radiation, pregnant women may undergo lumpectomy. A woman who has already had therapeutic radiation to the chest area for other reasons cannot undergo additional exposure for breast cancer therapy.

The need for radiation therapy may also be a barrier due to nonmedical concerns. Some women simply fear this type of treatment and choose more extensive surgery so that radiation will not be required. The commitment of time, usually five days a week for six weeks, may not be acceptable for others. This may be due to financial, personal, or job-related constraints. Finally, in geographically isolated areas, a course of radiation therapy may require lengthy travel and perhaps unacceptable amounts of time away from family and other responsibilities.

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A procedure in which the entire affected breast is removed, called a mastectomy, has been shown to be equally effective in treating breast cancer as lumpectomy, in terms of rates of recurrence and survival. Some women may choose to have a mastectomy because they strongly fear a recurrence of breast cancer, and may consider a lumpectomy too risky. Others may feel uncomfortable with a breast that has had a cancer, and would experience more peace of mind with the entire breast removed.

Preparation

Routine preoperative preparations, such as having nothing to eat or drink the night before surgery, are typically ordered for a lumpectomy. Information about expected outcomes and potential complications is also part of preparation for lumpectomy, as it is for any surgical procedure. It is especially important that women know about sensations they might experience after the operation, so the they are not misinterpreted as signs of further cancer or poor healing.

If the tumor is not able to be felt (not palpable), a pre-operative localization procedure is needed. A fine wire, or other device, is placed at the tumor site, using x ray or ultrasound for guidance. This is usually done in the radiology department of a hospital. The woman is most often sitting up and awake, although some sedation may be administered.

Aftercare

The patient may stay in the hospital one or two days, or return home the same day. This generally depends on the extent of the surgery, the medical condition of the patient, and physician and patient preferences. A woman usually goes home with a small bandage. The inner part of the surgical site usually has dissolvable stitches. The skin may be sutured or stitched; or the skin edges may be held together with steristrips, which are special thin, clear pieces of tape.

After a lumpectomy, patients are usually cautioned against lifting anything that weighs over five pounds for several days. Other activities may be restricted (especially if the axillary lymph nodes were removed) according to individual needs. **Pain** is often enough to limit inappropriate motion. Women are often instructed to wear a well-fitting support bra both day and night for approximately one week after surgery.

Pain is usually well controlled with prescribed medication. If it is not, the patient should contact the surgeon, as severe pain may be a sign of a complication, which needs medical attention. A return visit to the surgeon is normally scheduled approximately ten days to two weeks after the operation.

KEY TERMS

Axillary lymph node—Lymph nodes under the arm.

Lymph node—A small mass of tissue in the form of a knot or protuberance. They are the primary source of lymph fluid, which serves in the body's defense by removing toxic fluids and bacteria.

Quadrantectomy—Removal of a quadrant, or about a quarter of the breast.

Radiation therapy is usually started as soon as possible after lumpectomy. Other additional treatments, such as chemotherapy or hormone therapy, may also be prescribed. The timing of these is specific to each individual patient.

Risks

The risks are similar to those associated with any surgical procedure. Risks include bleeding, infection, breast asymmetry, anesthesia reaction, or unexpected scarring. A lumpectomy may also cause loss of sensation in the breast. The size and shape of the breast will be affected by the operation. Fluid can accumulate in the area where tissue was removed, requiring drainage.

If lymph node dissection is performed, there are several potential complications. A woman may experience decreased feeling in the back of her armpit. She may also experience other sensations, including **numbness**, **tingling**, or increased skin sensitivity. An inflammation of the arm vein, called phlebitis, can occur. There may be injury to the nerves controlling arm motion.

There is a risk of developing **lymphedema** (swelling of the arm) after axillary lymph node dissection. This swelling can range from mild to very severe. It can be treated with elastic **bandages** and specialized **physical therapy**, but it is a chronic condition, requiring continuing care. Lymphedema can arise at any time, even years after surgery.

Approximately 17% of patients develop lymphedema after axillary lymph node dissection, while only 3% of patients develop lymphedema after sentinel node biopsy. Five percent of women are unhappy with the cosmetic effects of the surgery.

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Results

When lumpectomy is performed, it is anticipated that it will be the definitive surgical treatment for breast cancer. Other forms of therapy, especially radiation, are often prescribed as part of the total treatment plan. The expected outcome is no recurrence of the breast cancer.

The outcome of breast cancer is very dependent of the stage at the time of diagnosis. For stage 0 disease, the five-year survival is almost 100%. For stage I (early/lymph node negative), the five-year survival is alsom almost 100%. For stage II (early/lymph node positive), the five-year survival decreases to 81–92%. For stage III disease (locally advanced), the five-year survival is 54-67%. For women with stage IV (metastatic) breast cancer, the five-year survival is about 20%.

Resources

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ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329-4251, (800) 227–2345, http://www.cancer.org.

National Lymphedema Network, 2211 Post St., Suite 404, San Francisco, CA, 94115–3427, (415) 921–1306, (800) 541–3259, http://www.wenet.net/~lymphnet.

Susan G. Komen for the Cure, 5005 LBJ Freeway, Suite 250, Dallas, TX, 75244, (877) GO–KOMEN, (877) 465–6636, http://ww5.komen.org.

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Lumpy breasts *see* **Fibrocystic condition of the breast**

Lumpy jaw *see* **Actinomycosis**

Lung abscess

Definition

Lung **abscess** is an acute or chronic infection of the lung, marked by a localized collection of pus within cavities, inflammation, and destruction of the pulmonary tissue (necrosis of the lung). Sometimes small abscesses form, which are called lung **gangrene** or necrotizing **pneumonia**. Acute abscesses last for only four to six weeks, while chronic abscesses last much longer.

Demographics

The infection of the lung called lung abscess can affect anyone in the world at any age. Males are more prone to it than females. The frequency of its occurrence in the United States is unknown.

Description

Lung abscess is the end result of a number of different disease processes ranging from fungal and bacterial infections to **cancer**. The following aerobic bacterial species can lead to lung abscess:

- *Pseudomonas aeruginosa*
- *Klebsiella pneumoniae*
- *Haemophilus influenzae*
- *Staphylococcus aureus*
- *Streptococcus pneumoniae*
- *Streptococcus pyogenes*
- Species within the genus *Nocardia*
- Species within the genus *Actinomyces*
- Fungal species.

The following non-bacterial and atypical bacterial pathogen species can also lead to lung abscess:

- Parasitic species within the genera *Paragonimus* (flatworms) and *Entamoeba* (amoeba).
- Species within the genus *Mycobacterium*.
- Fungi species within the genera *Aspergillus, Histoplasma, Blastomyces,* and *Coccidioides*.

Patients who are most vulnerable include those weakened by cancer and other chronic diseases; patients with a history of **substance abuse** including alcohol,

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diabetes, **epilepsy** and seizures, and poor dental hygiene; patients who have recently had operations under anesthesia; and **stroke** patients. The elderly are more likely to have lung abscess than any other age group because of increased risk from **periodontal disease** (disorders in and around the teeth), dysphagia (difficulties with swallowing), and aspiration (entry of foreign material into trachea and lungs). In children, the most vulnerable patients are those with weakened immune systems, **malnutrition**, or blunt injuries to the chest.

Causes and symptoms

The immediate cause of most lung abscesses is infection caused by bacteria. About 65% of these infections are produced by anaerobes, which are bacteria that do not need air or oxygen to live. The remaining cases are caused by a mixture of anaerobic and aerobic (air breathing) bacteria and other pathogens. When the bacteria arrive in the lung, special cells called phagocytes engulf or eat them. The phagocytes release chemicals that contribute to inflammation and eventual necrosis, or **death**, of a part of the lung tissue. Several different ways are available for bacteria to get into the lungs. Some of them are: aspiration, bronchial obstruction, and spread of infection.

Aspiration

Aspiration refers to the accidental inhalation of material from the mouth or throat into the airway and lungs. It is responsible for about 50% of cases of lung abscess. The human mouth and gums contain large numbers of anaerobic bacteria; patients with periodontal disease or poor **oral hygiene** have higher concentrations of these organisms. Aspiration is most likely to occur in patients who are unconscious or semi-conscious due to anesthesia, seizures, alcohol and drug **abuse**, or stroke. Patients who have problems swallowing or coughing, or who have nasogastric tubes in place are also at risk of aspiration.

Bronchial obstruction

The bronchi are the two branches of the windpipe that lead into the lungs. If they are blocked by tissue swelling, cancerous tumors, or **foreign objects**, a lung abscess may form from infection trapped behind the blockage.

Spread of infection

About 20% of cases of pneumonia that cause the death of lung tissue (necrotizing pneumonia) will develop into lung abscess. Lung abscess can also be caused by the spread of other infections from the liver, abdominal cavity, or open chest **wounds**. Rarely, acquired immune deficiency syndrome (**AIDS**) patients can develop lung abscess from *Pneumocystis carinii* and other organisms that take advantage of a weakened immune system.

Lung abscess is usually slow to develop. It may take about two weeks after aspiration or bronchial obstruction for an abscess to produce noticeable symptoms. The patient may be acutely ill for two weeks to three months. In the beginning, the symptoms of lung abscess are difficult to distinguish from those of severe pneumonia. Adults will usually have moderate **fever** (101 to 102°F/38 to 39°C), chills, chest **pain**, and general weakness. Children may or may not have chest pain, but usually suffer weight loss and high fevers. As the illness progresses, about 75% of patients will **cough** up foul or musty-smelling sputum; some also cough up blood.

Lung abscess can lead to serious complications, including **emphysema**, spread of the abscess to other parts of the lung, hemorrhage, **adult respiratory distress syndrome**, rupture of the abscess, inflammation of the membrane surrounding the heart, or chronic inflammation of the lung.

Symptoms of lung abscess is dependent on whether the abscess is caused by anaerobic bacterial infection or other pathogens. If it is caused by anaerobic bacterial infection, patients often have symptoms that slowly appear over a matter of weeks to months. Common symptoms are cough with mucus, fever, night sweats, weight loss, and anorexia. If lung abscess is caused by other pathogens, the symptoms come on more quickly. However, abscesses from fungi and species within the bacterial genera *Nocardia* and *Mycobacteria* often produce more gradual symptoms that progressively worsen.

Diagnosis

The diagnosis is made on the basis of the patient's medical history (especially recent operations under **general anesthesia**) and general health as well as imaging studies. Smears and cultures taken from the patient's sputum for microbiologic diagnosis are not usually very helpful because they will be contaminated with bacteria from the mouth. The doctor will first use a bronchoscope (lighted tube inserted into the windpipe) to rule out the possibility of lung cancer. In some cases of serious infection, the doctor can use a fiberoptic bronchoscope with a protected specimen brush to take material directly from the patient's lungs, for identification of the organism. This technique is time- consuming and expensive, and requires the patient to be taken off **antibiotics** for 48 hours. It is usually used only to evaluate severely ill patients with weakened immune systems.

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KEY TERMS

Abscess—An area of injured body tissue that fills with pus, as in lung abscess.

Anaerobe—A type of bacterium that does not require air or oxygen to live. Anaerobic bacteria are frequent causes of lung abscess.

Aspiration—Inhalation of fluid or foreign bodies into the airway or lungs. Aspiration often happens after vomiting.

Bronchoscope—A lighted, flexible tube inserted into the windpipe to view the bronchi or withdraw fluid samples for testing. Bronchoscopy with a protected brush can be used in the diagnosis of lung abscess in severely ill patients.

Bronchus—One of the two large tubes connecting the windpipe and the lungs.

Leukocytosis—An increased level of white cells in the blood. Leukocytosis is a common reaction to infections, including lung abscess.

Necrotizing pneumonia—Pneumonia that causes the death of lung tissue. It often precedes the development of lung abscess.

Sputum—The substance that is brought up from the lungs and airway when a person coughs or spits. It is usually a mixture of saliva and mucus, but may contain blood or pus in patients with lung abscess or other diseases of the lungs.

In most cases, the doctor will use the results of a **chest x ray** to help distinguish lung abscess from **empyema**, cancer, **tuberculosis**, or cysts. In patients with lung abscess, the x ray scan will show a thick-walled unified clear space or cavity surrounded by solid tissue. There is often a visible air-fluid level. The doctor may also order a computed tomography (CT) scan of the chest, in order to have a clearer picture of the exact location of the abscess.

Blood tests cannot be used to make a diagnosis of lung abscess, but they can be useful in ruling out other conditions. Patients with lung abscess usually have abnormally high white blood cell counts (**leukocytosis**) when their blood is tested, but this condition is not unique to lung abscess.

Treatment

Lung abscess is treated with a combination of antibiotic drugs, **oxygen therapy**, and surgery. The antibiotics that are usually given for lung abscess are penicillin G, penicillin V, and clindamycin. They are given intravenously until the patient shows signs of improvement, and then they are continued in oral form. The patient may need to take antibiotics for a month or longer, until the chest x ray indicates that the abscess is healing. Oxygen may be given to patients who are having trouble breathing.

Surgical treatment

Most patients with lung abscess will not need surgery. About 5% of patients—usually those who do not respond to antibiotics or are coughing up large amounts of blood (500 milliliters or more)—may have emergency surgery for removal of the diseased part of the lung or for insertion of a tube to drain the abscess. Antibiotic treatment is considered to have failed if fever and other symptoms continue after ten to 14 days of treatment; if chest x rays indicate that the abscess is not shrinking; or if the patient has pneumonia that is spreading to other parts of the lung.

Supportive care

Because lung abscess is a serious condition, patients need quiet and bed rest. Hospital care usually includes increasing the patient's fluid intake to loosen up the secretions in the lungs, and **physical therapy** to strengthen the patient's breathing muscles.

Follow-up

Patients with lung abscess need careful follow-up care after the acute infection subsides. Follow-up usually includes a series of chest x rays to make sure that the infection has cleared up. Treatment with antibiotics may continue for as long as four months, to prevent recurrence.

Prognosis

About 90 to 95% of lung abscess patients can be treated successfully with antibiotics alone. Patients who need surgical treatment have a mortality rate of 10 to 15%. Those that have higher risks of death from lung abscess are anyone with malnutrition, human **immunodeficiency** virus (HIV), or mental debilitation, and the elderly. Those with HIV and other immunocompromised conditions also have a high mortality rate.

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Prevention

Some of the conditions that make people more vulnerable to lung abscess concern long-term lifestyle behaviors, such as substance abuse and lack of dental care. Others, however, are connected with chronic illness and hospitalization. Aspiration can be prevented with proper care of unconscious patients, which includes suctioning of throat secretions and positioning patients to promote drainage. Conscious patients can be given physical therapy to help them cough up material in their lungs and airways. Patients with weakened immune systems can be isolated from patients with pneumonia or fungal infections.

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Lung biopsy

Definition

Lung biopsy is a procedure for obtaining a small sample of lung tissue for examination. The tissue is usually examined under a microscope, and may be sent to a microbiological laboratory for culture. Microscopic examination is performed by a pathologist.

Purpose

A lung biopsy is usually performed to determine the cause of abnormalities, such as nodules that appear on chest x rays. It can confirm a diagnosis of **cancer**, especially if malignant cells are detected in the patient's sputum or bronchial washing. In addition to evaluating lung tumors and their associated symptoms, lung biopsies may be used to diagnose lung infections, especially **tuberculosis** and **Pneumocystis pneumonia**, drug reactions, and chronic diseases of the lungs such as **sarcoidosis** and **pulmonary fibrosis**.

A lung biopsy can be used for treatment as well as diagnosis. **Bronchoscopy**, a type of lung biopsy performed with a long, flexible slender instrument called a bronchoscope, can be used to clear a patient's air passages of secretions and to remove airway blockages.

Demographics

Lung cancer is the leading cause of cancer-related deaths in the United States. About 219,440 patients were newly diagnosed with lung cancer in 2009 (about 116,090 in men and 103,350 in women). It claimed nearly 159,390 lives in 2009 (86,990 in men and 70,490 in women). Worldwide, lung cancer kills more people than cancers of the breast, prostate, colon, and pancreas combined. Cigarette **smoking** accounts for nearly 90% of cases of lung cancer in the United States.

Description

Overview

The right and left lungs are separated by the mediastinum, which contains the heart, trachea, lymph nodes, and esophagus. Lung biopsies sometimes involve **mediastinoscopy**.

Types of lung biopsies

Lung biopsies are performed using a variety of techniques, depending on where the abnormal tissue is located in the lung, the health and age of the patient, and the presence of lung disease. A bronchoscopy is ordered if a lesion identified on the x ray seems to be located on the wall (periphery) of the chest. If the suspicious area lies close to the chest wall, a needle biopsy can be done. If both methods fail to diagnose the problem, an open lung biopsy may be performed. When there is a question about whether the lung cancer or suspicious mass has spread to the lymph nodes in the mediastinum, a mediastinoscopy is performed.

BRONCHOSCOPIC BIOPSY. During the bronchoscopy, a thin, lighted tube (bronchoscope) is passed from the nose or mouth, down the windpipe (trachea) to the air passages (bronchi) leading to the lungs. Through the bronchoscope, the physician views the airways, and is able to clear mucus from blocked

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airways, and collect cells or tissue samples for laboratory analysis.

NEEDLE BIOPSY. The patient is mildly sedated, but awake during the needle biopsy procedure. He or she sits in a chair with arms folded in front on a table. An x-ray technician uses a computerized axial tomography (CAT) scanner or a fluoroscope to identify the precise location of the suspicious areas. Markers are placed on the overlying skin to identify the biopsy site. The skin is thoroughly cleansed with an antiseptic solution, and a local anesthetic is injected to numb the area. The patient will feel a brief stinging sensation when the anesthetic is injected.

The physician makes a small incision, about half an inch (1.25 cm) in length. The patient is asked to take a deep breath and hold it while the physician inserts the biopsy needle through the incision into the lung tissue to be biopsied. The patient may feel pressure, and a brief sharp **pain** when the needle touches the lung tissue. Most patients do not experience severe pain. The patient should refrain from coughing during the procedure. The needle is withdrawn when enough tissue has been obtained. Pressure is applied at the biopsy site and a sterile bandage is placed over the incision. A **chest x ray** is performed immediately after the procedure to check for potential complications. The entire procedure takes 30–60 minutes.

OPEN BIOPSY. Open biopsies are performed in a hospital operating room under **general anesthesia**. Once the anesthesia has taken effect, the surgeon makes an incision over the lung area, a procedure called a thoracotomy. Some lung tissue is removed and the incision is closed with sutures. Chest tubes are placed with one end inside the lung and the other end protruding through the closed incision. Chest tubes are used to drain fluid and blood, and re-expand the lungs. They are usually removed the day after the procedure. The entire procedure normally takes about an hour. A chest x ray is performed immediately after the procedure to check for potential complications.

VIDEO-ASSISTED THORACOSCOPIC SURGERY. A minimally invasive technique, video-assisted thoracoscopic surgery (VATS) can be used to biopsy lung and mediastinal lesions. VATS may be performed on selected patients in place of open lung biopsy. While the patient is under general anesthesia, the surgeon makes several small incisions in the chest wall. A thorascope, a thin, hollow, lighted tube with a tiny video camera mounted on it, is inserted through one of the small incisions. The other incisions allow the surgeon to insert special instruments to retrieve tissue for biopsy.

MEDIASTINOSCOPY. This procedure is performed under general anesthesia. A 2–3 inch (5–8 cm) incision is made at the base of the neck. A thin, hollow, lighted tube, called a mediastinoscope, is inserted through the incision into the space between the right and the left lungs. The surgeon removes any lymph nodes or tissues that look abnormal. The mediastinoscope is then removed, and the incision is sutured and bandaged. A mediastinoscopy takes about an hour.

Preparation

Before scheduling a lung biopsy, the physician performs a careful evaluation of the patient's medical history and symptoms, and performs a **physical examination**. Chest x rays and sputum cytology (examination of cells obtained from a deep-cough mucus sample) are other diagnostic tests that may be performed. An electrocardiogram (EKG) and laboratory tests may be performed before the procedure to check for blood clotting problems, anemia, and blood type, should a **transfusion** become necessary.

During a preoperative appointment, usually scheduled within one to two weeks before the procedure, the patient receives information about what to expect during the procedure and the recovery period. During this appointment or just before the procedure, the patient usually meets with the physician (or physicians) performing the procedure (the pulmonologist, interventional radiologist, or thoracic surgeon).

A chest x ray or CAT scan of the chest is used to identify the area to be biopsied.

About an hour before the biopsy procedure, the patient receives a sedative. Medication may also be given to dry up airway secretions. General anesthesia is not used for this procedure.

For at least 12 hours before the open biopsy, VATS, or mediastinoscopy procedures, the patient should not eat or drink anything. Prior to these procedures, an intravenous line is placed in a vein in the patient's arm to deliver medications or fluids as necessary. A hollow tube, called an endotracheal tube, is passed through the patient's mouth into the airway leading to the lungs. Its purpose is to deliver the general anesthetic. The chest area is cleansed with an antiseptic solution. In the mediastinoscopy procedure, the neck is also cleansed to prepare for the incision.

Smoking cessation

Patients who will undergo surgical diagnostic and treatment procedures should be encouraged to stop

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KEY TERMS

Bronchoscopy—A medical test that enables the physician to see the breathing passages and the lungs through a hollow, lighted tube.

Chest x ray—Brief exposure of the chest to radiation to produce an image of the chest and its internal structures.

Endotracheal tube—A hollow tube that is inserted into the windpipe to administer anesthesia.

Lung nodule—See pulmonary nodule.

Lymph nodes—Small, bean-shaped structures that serve as filters, scattered along the lymphatic vessels. Lymph nodes trap bacteria or cancer cells that are traveling through the lymphatic system.

Malignant—Cancerous.

Mediastinoscopy—A procedure that allows the physician to see the organs in the mediastinal space using a thin, lighted, hollow tube (a mediastinoscope).

Mediastinum—The area between the lungs, bounded by the spine, breastbone, and diaphragm.

Pleural cavity—The space between the lungs and the chest wall.

Pneumothorax—A condition in which air or gas enters the pleura (area around the lungs) and causes a collapse of the lung.

Pulmonary nodule—A lesion surrounded by normal lung tissue. Nodules may be caused by bacteria, fungi, or a tumor (benign or cancerous).

Sputum—A mucus-rich secretion that is coughed up from the passageways (bronchial tubes) and the lungs.

Sputum cytology—A lab test in which a microscope is used to check for cancer cells in the sputum.

Thoracentesis—Removal of fluid from the pleural cavity.

smoking and stop using tobacco products. The patient needs to make the commitment to be a nonsmoker after the procedure. Patients able to stop smoking several weeks before surgical procedures have fewer postoperative complications. Smoking cessation programs are available in many communities. The patient should ask a health care provider for more information if he or she needs help with smoking cessation.

Informed consent

Informed consent is an educational process between health care providers and patients. Before any procedure is performed, the patient is asked to sign a consent form. Prior to signing the form, the patient should understand the nature and purpose of the diagnostic procedure or treatment, its risks and benefits, and alternatives, including the option of not proceeding with the test or treatment. During the discussions, the health care providers are available to answer the patient's questions about the consent form or procedure.

Aftercare

Needle biopsy

Following a needle biopsy, the patient is allowed to rest comfortably. He or she may be required to lie flat for two hours following the procedure to prevent the risk of bleeding. The nurse checks the patient's status at two-hour intervals. If there are no complications after four hours, the patient can go home once he or she has received instructions about resuming normal activities. The patient should rest at home for a day or two before returning to regular activities, and should avoid strenuous activities for one week after the biopsy.

Open biopsy, VATS, or mediastinoscopy

After an open biopsy, VATS, or mediastinoscopy, the patient is taken to the recovery room for observation. The patient receives oxygen via a face mask or nasal cannula. If no complications develop, the patient is taken to a hospital room. Temperature, blood oxygen level, pulse, blood pressure, and respiration are monitored. Chest tubes remain in place after surgery to prevent the lungs from collapsing, and to remove blood and fluids. The tubes are usually removed the day after the procedure.

The patient may experience some grogginess for a few hours after the procedure. He or she may have a **sore throat** from the endotracheal tube. The patient may also have some pain or discomfort at the incision site, which can be relieved by pain medication. It is common for patients to require some pain medication for up to two weeks following the procedure.

After receiving instructions about resuming normal activities and caring for the incision, the patient usually goes home the day after surgery. The

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patient should not drive while taking narcotic pain medication.

Patients may experience **fatigue** and muscle aches for a day or two because of the general anesthesia. The patient can gradually increase activities, as tolerated. Walking is recommended. Sutures are usually removed after one to two weeks.

The physician should be notified immediately if the patient experiences extreme pain, light-headedness, or difficulty breathing after the procedure. Sputum may be slightly bloody for a day or two after the procedure. Heavy or persistent bleeding requires evaluation by the physician.

Risks

Lung biopsies should not be performed on patients who have a bleeding disorder or abnormal blood clotting because of low platelet counts, or prolonged **prothrombin time** (PT) or **partial thromboplastin time** (PTT). Platelets are small blood cells that play a role in the blood clotting process. PT and PTT measure how well blood is clotting. If clotting times are prolonged, it may be unsafe to perform a biopsy because of the risk of bleeding. If the **platelet count** is lower than 50,000/cubic mm, the patient may be given a platelet transfusion as a temporary relief measure, and a biopsy can then be performed.

In addition, lung biopsies should not be performed if other tests indicate the patient has enlarged alveoli associated with **emphysema**, **pulmonary hypertension**, or enlargement of the right ventricle of the heart (**cor pulmonale**).

The normal risks of any surgical procedure include bleeding, infection, or **pneumonia**. The risk of these complications is higher in patients undergoing open biopsy procedures, as is the risk of **pneumothorax** (lung collapse). In rare cases, the lung collapses because of air that leaks in through the hole made by the biopsy needle. A chest x ray is done immediately after the biopsy to detect the development of this potential complication. If a pneumothorax occurs, a chest tube is inserted into the pleural cavity to re-expand the lung. Signs of pneumothorax include **shortness of breath**, rapid heart rate, or blueness of the skin (a late sign). If the patient has any of these symptoms after being discharged from the hospital, it is important to call the health care provider or emergency services immediately.

Bronchoscopic biopsy

Bronchoscopy is generally safe, and complications are rare. If they do occur, complications may include spasms of the bronchial tubes that can impair breathing, irregular heart rhythms, or infections such as pneumonia.

Needle biopsy

Needle biopsy is associated with fewer risks than open biopsy because it does not involve general anesthesia. Some **hemoptysis** (coughing up blood) occurs in 5% of needle biopsies. Prolonged bleeding or infection may also occur, although these are very rare complications.

Open biopsy

Possible complications of an open biopsy include infection or pneumothorax. If the patient has very severe breathing problems before the biopsy, breathing may be further impaired following the operation. Patients with normal lung function prior to the biopsy have a very small risk of respiratory problems resulting from or following the procedure.

Mediastinoscopy

Complications due to mediastinoscopy are rare. Possible complications include pneumothorax or bleeding caused by damage to the blood vessels near the heart. Mediastinitis, infection of the mediastinum, may develop. Injury to the esophagus or larynx may occur. If the nerves leading to the larynx are injured, the patient may be left with a permanently hoarse voice. All of these complications are rare.

Results

Normal results indicate no evidence of infection in the lungs, no detection of lumps or nodules, and cells that are free from cancerous abnormalities.

Abnormal results of needle biopsy, VATS, and open biopsy may be associated with diseases other than cancer. Nodules in the lungs may be due to active infections such as tuberculosis, or may be **scars** from a previous infection. In 33% of biopsies using a mediastinoscope, the biopsied lymph nodes prove to be cancerous. Abnormal results should always be considered in the context of the patient's medical history, physical examination, and other tests such as sputum examination, and chest x rays before a final diagnosis is made.

The risk of **death** from needle biopsy is rare. The risk of death from open biopsy is one in 3,000 cases. In mediastinoscopy, death occurs in fewer than one in 3,000 cases.

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Alternatives

The type of alternative diagnostic procedures available depend upon each patient's diagnosis.

Some people may be eligible to participate in clinical trials, research programs conducted with patients to evaluate a new medical treatment, drug, or device. The purpose of clinical trials is to find new and improved methods of treating different diseases and special conditions. For more information on current clinical trials, visit the National Institutes of Health's ClinicalTrials.gov at http://www.clinicaltrials.gov or call (888) FIND-NLM [(888) 346-3656] or (301) 594-5983.

The National Cancer Institute (NCI) has conducted a clinical trial to evaluate a technology—low-dose helical computed tomography—for its effectiveness in screening for lung cancer. One study concluded that this test is more sensitive in detecting specific conditions related to lung cancer than other screening tests.

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ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329–4251, (800) 227–2345, info@cancer.org, http://www.cancer.org.

American Lung Association, 1301 Pennsylvania Ave., NW, Suite 800, Washington, DC, 20004, (800) 548–8252, webmaster@lungusa.org, http://www.lungusa.org.

National Heart, Lung and Blood Institute, P.O. Box 30105, Bethesda, MD, 20824–0105, (301) 251–2222, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi.nih.gov.

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Lung cancer, non-small cell

Definition

Non-small cell lung **cancer** (NSCLC) is a disease in which the cells of the lung tissues grow uncontrollably and form tumors.

Demographics

Worldwide, lung cancer is the most common cancer in males, and the fifth most common cancer in women. The worldwide mortality rate for patients with lung cancer is 86%. In the United States, lung cancer is the leading cause of **death** from cancer among both men and women. The World Health Organization estimates that the worldwide mortality from lung cancer will increase to three million by the year 2025. Of those three million deaths, almost two and a half million will result from non-small cell lung cancer.

The American Cancer Society (ACS) estimates that 219,440 Americans will develop lung cancer in 2009, 116,090 men and 103,350 women. Of these patients, 159,000 will die of the disease.

The incidence of lung cancer is beginning to fall in developed countries. This may be a result of antismoking campaigns. In developing countries, however, rates continue to rise, which may be a consequence of both industrialization and the increasing use of tobacco products.

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Description

There are two kinds of lung cancers, primary and secondary. Primary lung cancer starts in the lung itself, and is divided into **small cell lung cancer** and non-small cell lung cancer. Small cell lung cancers are shaped like an oat and called oat-cell cancers; they are aggressive, spread rapidly, and represent 20% of lung cancers. Non-small cell lung cancer represents almost 80% of all primary lung cancers. Secondary lung cancer is cancer that starts somewhere else in the body (for example, the breast or colon) and spreads to the lungs.

The lungs

The lungs are located along with the heart in the chest cavity. The lungs are not simply hollow balloons but have a very organized structure consisting of hollow tubes, blood vessels and elastic tissue. The hollow tubes, called bronchi, are highly branched, becoming smaller and more numerous at each branching. They end in tiny, blind sacs made of elastic tissue called alveoli. These sacs are where the oxygen a person breathes in is taken up into the blood, and where carbon dioxide moves out of the blood to be breathed out.

Normal healthy lungs are continually secreting mucus that not only keeps the lungs moist, but also protects the lungs by trapping foreign particles like dust and dirt in breathed air. The inside of the lungs is covered with small hairlike structures called cilia. The cilia move in such a way that mucus is swept up out of the lungs and into the throat.

Lung cancer

Most lung cancers start in the cells that line the bronchi, and can take years to develop. As they grow larger they prevent the lungs from functioning normally. The tumor can reduce the capacity of the lungs, or block the movement of air through the bronchi in the lungs. As a result, less oxygen gets into the blood and patients feel short of breath. Tumors may also block the normal movement of mucus up into the throat. As a result, mucus builds up in the lungs and infection may develop behind the tumor. Once lung cancer has developed it frequently spreads to other parts of the body.

The speed at which non-small cell tumors grow depends on the type of cells that make up the tumor. The following three types account for the vast majority of non-small cell tumors:

- Adenocarcinomas are the most common and often cause no symptoms. Frequently they are not found until they are advanced.
- Squamous cell carcinomas usually produce symptoms because they are centrally located and block the lungs.
- Undifferentiated large cell and giant cell carcinomas tend to grow rapidly, and spread quickly to other parts of the body.

Causes and symptoms

Causes

Tobacco **smoking** accounts for 87% of all lung cancers. Giving up tobacco can prevent most lung cancers. Smoking **marijuana** cigarettes is considered another risk factor for cancer of the lung. Second hand smoke also contributes to the development of lung cancer among nonsmokers.

Certain hazardous materials that people may be exposed to in their jobs have been shown to cause lung cancer. These include asbestos, coal products, and radioactive substances. Air pollution may also be a contributing factor. Exposure to radon, a colorless, odorless gas that sometimes accumulates in the basement of homes, may cause lung cancer in a tiny minority of patients. In addition, patients whose lungs are scarred from other lung conditions may have an increased risk of developing lung cancer.

Symptoms

Lung cancers tend to spread very early, and only 15% are detected in their early stages. The chances of early detection, however, can be improved by seeking medical care at once if any of the following symptoms appear:

- a cough that does not go away
- chest pain
- shortness of breath
- recurrent lung infections, such as bronchitis or pneumonia
- bloody or brown-colored spit or phlegm (sputum)
- persistent hoarseness
- significant weight loss that is not due to dieting or vigorous exercise; fatigue and loss of appetite
- unexplained fever

Although these symptoms may be caused by diseases other than lung cancer, it is important to consult a doctor to rule out the possibility of lung cancer.

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If lung cancer has spread to other organs, the patient may have other symptoms such as headaches, bone **fractures**, **pain**, bleeding, or **blood clots**.

Diagnosis

Physical examination and diagnostic tests

The doctor will first take a detailed medical history and assess risk factors. During a complete **physical examination** the doctor will examine the patient's throat to rule out other possible causes of hoarseness or coughing, and will listen to the patient's breathing and chest sounds.

If the doctor has reason to suspect lung cancer, particularly if the patient has a history of heavy smoking or occupational exposure to irritating substances, a **chest x ray** may be ordered to see if there are any masses in the lungs. Special imaging techniques, such as computed tomography (CT) scans or **magnetic resonance imaging** (MRI), may provide more precise information about the size, shape, and location of any tumors.

Sputum analysis

Sputum analysis is a noninvasive test that involves microscopic examination of cells that are coughed up from the lungs. This test can diagnose at least 30% of lung cancers, even if tumors are not visible on chest x rays. In addition, the test can detect cancer in its very early stages, before it spreads to other regions. The sputum test does not provide any information about the location of the tumor.

Lung biopsy

Lung biopsy is the most definitive diagnostic tool for cancer. It can be performed in three different ways. **Bronchoscopy** involves the insertion of a slender, lighted tube, called a bronchoscope, down the patient's throat and into the lungs. This test allows the doctor to see the tubes inside the lungs, and to obtain samples of lung tissue. If a needle biopsy is to be performed, the location of the tumor is first identified using a computerized tomography (CT) scan or magnetic resonance imaging (MRI). The doctor then inserts a needle through the chest wall and collects a sample of tissue from the tumor. In the third procedure, known as surgical biopsy, the chest wall is opened up and a part of the tumor, or all of it, is removed. A doctor who specializes in the study of diseased tissue (a pathologist) examines the tumor to identify the cancer's type and stage.

Treatment

Staging

Treatment for non-small cell lung cancer depends primarily on the stage of the cancer. Staging is a process that tells the doctor if the cancer has spread and the extent of its spread. The most commonly used treatments are surgery, **radiation therapy**, and **chemotherapy**.

Non-small cell lung cancer has six stages:

- Occult carcinoma. Cancer cells have been found in the sputum, but no tumor has yet been found.
- Stage 0. A small group of cancerous cells have been found in one location.
- Stage I. The cancer is only in the lung and has not spread anywhere else.
- Stage II. The cancer has spread to nearby lymph nodes.
- Stage III. The cancer has spread to more distant lymph nodes, and/or other parts of the chest like the diaphragm.
- Stage IV. The cancer has spread to other parts of the body.

Surgery

Surgery is the standard treatment for the earlier stages of non-small cell lung cancer. The surgeon will decide on the type of surgery, depending on how much of the lung is affected. There are three different types of surgical procedures:

- Wedge resection is the removal of a small part of the lung.
- Lobectomy is the removal of one lobe of the lung. (The right lung has three lobes and the left lung has two lobes.)
- Pneumonectomy is the removal of an entire lung.

Lung surgery is a major procedure and patients can expect to experience pain, weakness in the chest, and **shortness of breath**. Air and fluid collect in the chest after surgery. As a result, patients will need help to turn over, **cough**, and breath deeply. Patients should be encouraged to perform these activities because they help get rid of the air and fluid and speed up recovery. It can take patients several months before they regain their energy and strength.

Radiotherapy

Patients whose cancer has progressed too far for surgery (Stages III and IV) may receive radiotherapy. Radiotherapy involves the use of high-energy rays to

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KEY TERMS

Bronchi—The tubes that carry air into the lungs.

Lymph—Clear fluid containing white blood cells that is collected from the tissues of the body and flows in vessels called the lymphatic system.

Lymph node—Small oval-shaped filters in the lymphatic system that trap bacteria and other unwanted particles to ensure their removal from the body.

Palliative—Referring to any type of treatment that is given to relieve the symptoms of a disease rather than to cure it.

Respiratory distress—A condition in which patients with lung disease are not able to get enough oxygen.

kill cancer cells. It is used either by itself or in combination with surgery or chemotherapy. The amount of radiation used depends on the size and the location of the tumor.

Radiation therapy may produce such side effects as tiredness, skin **rashes**, upset stomach, and **diarrhea**. Dry or sore throats, difficulty in swallowing, and loss of hair in the treated area are all minor side effects of radiation. These may disappear either during the course of the treatment or after the treatment is over.

Chemotherapy

Chemotherapy is also given to patients whose cancer has progressed too far for surgery. Chemotherapy is medication that is usually given intravenously to kill cancer cells. These drugs enter the bloodstream and travel to all parts of the body, killing cancer cells that have spread to different organs. Chemotherapy is used as the primary treatment for cancers that have spread beyond the lung and cannot be removed by surgery. It can also be used in addition to surgery or radiation therapy.

Chemotherapy for NSCLC has made significant advances since the early 1980s in improving the patient's quality of life as well as length of survival. Newer cytotoxic (cell-killing) agents developed in the 1990s, such as the taxanes, are typically combined with either cisplatin or carboplatin as first-line therapy for non-small cell lung cancer.

Newer drugs for lung cancer developed since 2000 include gefinitib (Iressa) and pemetrexed (Alimta). The FDA approved gefinitib in May 2003 as a treatment for patients with NSCLC who have not responded to platinum-based or taxane chemotherapy. It is taken by mouth and works by inhibiting an enzyme involved in the growth of tumor cells. Pemetrexed, which is given by injection, was approved by the FDA in February 2004 for the treatment of **mesothelioma**, a type of lung cancer caused by exposure to asbestos fibers. However, the drug appears to be effective in treating other types of lung cancer as well.

Chemotherapy is also used as palliative treatment for non-small cell lung cancer. Palliative refers to any type of therapy that is given to relieve the symptoms of a disease but not to cure it.

Clinical trials

Patients diagnosed with non-small cell lung cancer should discuss participating in clinical trials with their doctor. There are many clinical trials currently underway that are investigating all different stages of the disease. These trials are studying various new treatment options including:

- Chemotherapy with new drugs, and combinations of drugs
- Courses of chemotherapy prior to surgery
- Radiotherapy after surgery
- Chemotherapy and radiotherapy in combination

Information on open clinical trials is available on the Internet from the National Cancer Institute at http://cancertrials.nci.nih.gov.

Alternative and complementary therapies

Because non-small cell lung cancer has a poor prognosis with conventional medical treatment, many patients are willing to try complementary and alternative therapies. These therapies are used to try to reduce **stress**, ease side effects and symptoms, or control disease. Two treatments sometimes used are shark cartilage and mistletoe. Although shark cartilage is thought to interfere with the tumor's blood supply, clinical trials have so far been inconclusive. Mistletoe is a poisonous plant that has been shown to kill cancer cells in the laboratory. Again, however, clinical trials with cancer patients have been inconclusive.

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Patients who decide to try complementary and alternative therapies should tell their doctors. Some of these therapies may interfere with conventional treatment.

Coping with cancer treatment

The side effects associated with treatment of non-small cell lung cancer can be severe. Patients should ask their doctors about medications to treat **nausea and vomiting**, and other side effects. It is particularly important to eat a nutritious diet and to drink plenty of fluids. In addition, most patients report feeling very tired and should get plenty of rest.

Patients should consider joining local support groups with people who are coping with the same experiences. Many people with cancer find they can share thoughts and feelings with group members that they do not feel comfortable sharing with friends or family. Support groups are also a good source of information about coping with cancer.

Prognosis

The prognosis for non-small cell lung cancer is better if the disease is found early, and removed surgically. For patients whose disease is caught in Stage I, the survival rate five years after surgery ranges from 60% to 80%. Up to 55% of Stage II patients are alive after five years, but only about 30% of Stage III patients make it to five years. Unfortunately, 85% of patients already have at least Stage III cancer by the time they are diagnosed. Many of these patients have disease that is too advanced for surgery. Despite treatment with radiotherapy and chemotherapy, the five-year survival for patients with inoperable disease is extremely low.

Prevention

The best way to prevent lung cancer is not to start smoking or to quit smoking. Secondhand smoke from other people's tobacco should also be avoided. Appropriate precautions should be taken when working with cancer-causing substances (**carcinogens**). Testing houses for the presence of radon gas, and removing asbestos from buildings have also been suggested as preventive strategies.

Resources

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American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329–4251, (800) 227-2345, info@cancer.org, http://www.cancer.org.

American Lung Association, 1301 Pennsylvania Ave., NW, Suite 800, Washington, DC, 20004, (800) 548-8252, webmaster@lungusa.org, http://www.lungusa.org.

National Heart, Lung and Blood Institute, P.O. Box 30105, Bethesda, MD, 20824–0105, (301) 251-2222, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi.nih.gov.

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Lung cancer, small cell

Definition

Small cell lung **cancer** is a disease in which the cells of the lung tissues grow uncontrollably and form tumors.

Demographics

Lung cancer is a growing global epidemic. Worldwide, lung cancer is the second most common cancer among both men and women and is the leading cause of cancer **death** in both sexes. The worldwide mortality rate for patients with lung cancer is 86%. Of the 160,000 deaths from lung cancer that occur annually

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A normal lung (left) and the lung of a cigarette smoker (right). *(A. Glauberman/Photo Researchers, Inc.)*

in the United States, about 40,000 are caused by small cell lung cancer. Although there are differences in mortality rates between ethnic groups, this is mainly due to differences in **smoking** habits.

Description

Lung cancer is divided into two main types: small cell and non-small cell. Small cell lung cancer is the least common of the two, accounting for only about 10% to 15% of all lung cancers. In the past, the disease was called oat cell cancer because, when viewed under a microscope, the cancer cells resemble oats. This type of lung cancer grows quickly and is more likely to spread to other organs in the body.

The lungs are located along with the heart in the chest cavity. The lungs are not simply hollow balloons, but have a very organized structure consisting of hollow tubes, blood vessels, and elastic tissue. The hollow tubes, called bronchi, are multi-branched, becoming smaller and more numerous at each branching. They end in tiny, blind sacs made of elastic tissue called alveoli. These sacs are where the oxygen a person breathes in is taken up into the blood, and where carbon dioxide moves out of the blood to be breathed out.

Normal, healthy lungs are continually secreting mucus that not only keeps the lungs moist, but also protects the lungs by trapping foreign particles like dust and dirt in breathed air. The inside of the lungs is covered with small, hair-like structures called cilia. The cilia move in such a way that mucus is swept up out of the lungs and into the throat.

Small cell lung tumors usually start to develop in the central bronchi. They grow quickly and prevent the lungs from functioning at their full capacity. Tumors may block the movement of air through the bronchi in the lungs. As a result, less oxygen gets into the blood and patients feel short of breath. Tumors may also block the normal movement of mucus into the throat. As a result, mucus builds up in the lungs and infection may develop behind the tumor.

Causes and symptoms

Causes

Tobacco smoking accounts for nearly 90% of all lung cancers. The risk of developing lung cancer is increased for smokers who start at a young age, and for those who have smoked for a long time. The risk

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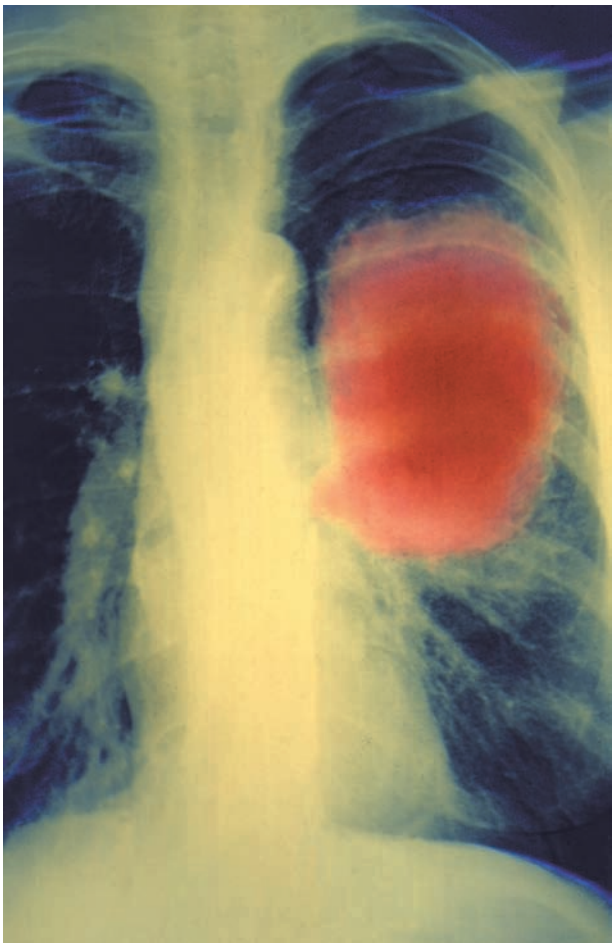

An x-ray image showing an oval-shaped carcinoma in the left lung (right of image). *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

also increases as more cigarettes are smoked, and when cigarettes with higher tar content are smoked. Smoking **marijuana** cigarettes is also a risk factor for lung cancer. These cigarettes have a higher tar content than tobacco cigarettes.

Certain hazardous materials that people may be exposed to in their jobs have been shown to cause lung cancer. These include asbestos, coal products, and radioactive substances. Air pollution may also be a contributing factor. Exposure to radon, a colorless, odorless gas that sometimes accumulates in the basement of homes, may cause lung cancer in some patients. In addition, patients whose lungs are scarred from other lung conditions may have an increased risk of developing lung cancer.

Although the exact cause of lung cancer is not known, people with a family history of lung cancer appear to have a slightly higher risk of contracting the disease.

Symptoms

Small cell lung cancer is an aggressive disease that spreads quickly. Symptoms depend on the tumor's location within the lung, and on whether the cancer has spread to other parts of the body. More than 80% of small cell lung cancer patients have symptoms for only three months or less, and few cases are detected early. The following symptoms are the most commonly reported by small cell lung cancer patients at the time of their diagnosis:

- a persistent cough
- chest pain
- shortness of breath and wheezing
- persistent hoarseness
- fatigue and loss of appetite

Although some patients may experience bloody spit or phlegm, this symptom is more commonly seen in patients with other types of lung cancer.

Small cell tumors often press against a large blood vessel near the lungs called the superior vena cava (SVC), causing a condition known as SCV syndrome. This condition may cause patients to retain water, **cough**, and have **shortness of breath**. Because small cell lung cancer often spreads quickly to the bones and central nervous system, patients may also have bone **pain**, headaches, and seizures.

Small cell lung cancer can cause several hormonal disorders. About 40% of patients begin to secrete an anti-diuretic hormone at the wrong time. This hormone causes the body to retain water, which may result in the patient experiencing confusion, seizures, or **coma**. Less common are the development of **Cushing's syndrome** and the Eaton-Lambert syndrome. Symptoms of Cushing's syndrome include **obesity**, severe **fatigue**, high blood pressure, backache, high blood sugar, easy bruising, and bluish-red stretch marks on the skin. Eaton-Lambert syndrome is a neuromuscular disorder that causes muscle weakness, fatigue, and a **tingling** sensation on the skin. All of these hormonal disorders usually diminish after the lung tumor is successfully treated.

Diagnosis

If lung cancer is suspected, the doctor will take a detailed medical history that checks both symptoms and risk factors. During a complete **physical examination**, the doctor will examine the patient's throat to rule out other possible causes of hoarseness or coughing, and listen to the patient's breathing and the sounds made when the patient's chest and upper back are tapped. A **chest x ray** may be ordered to

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check for masses in the lungs. Special imaging techniques, such as computed tomography (CT) scans or **magnetic resonance imaging** (MRI), may provide more precise information about the size, shape, and location of any tumors.

Sputum analysis involves microscopic examination of the cells that are either coughed up from the lungs, or are collected through a special instrument called a bronchoscope. The sputum test does not, however, provide any information about the location of the tumor and must be followed by other tests.

Lung biopsy is the most definitive diagnostic tool for cancer. It can be performed in several different ways. The doctor can perform a **bronchoscopy**, which involves the insertion of a slender, lighted tube, called a bronchoscope, down the patient's throat and into the lungs. In addition to viewing the passageways of the lungs, the doctor can use the bronchoscope to obtain samples of the lung tissue. In another procedure known as a needle biopsy, the location of the tumor is first identified using a CT scan or MRI. The doctor then inserts a needle through the chest wall and collects a sample of tissue from the tumor. In the third procedure, known as surgical biopsy, the chest wall is opened up and a part of the tumor, or all of it, is removed for examination.

Treatment

Staging

Staging procedures are important in lung cancer because they tell doctors whether patients have disease only in their lungs, or whether the cancer has spread to other parts of the body. To establish the cancer stage, doctors have to perform various tests. These may include **bone marrow aspiration and biopsy**, CT scans of the chest and abdomen, MRI scans of the brain, and radionuclide bone scans. All of these tests determine the extent to which the cancer has spread. Once the stage is determined, doctors can decide on a course of treatment, and can have a better idea of the patient's prognosis.

Unlike other types of lung cancer, the staging of small cell lung cancer is relatively simple. This is because approximately 70% of patients already have metastatic disease when they are diagnosed, and small differences in the amount of tumor found in the lungs do not change the prognosis. Small cell lung cancer is usually divided into three stages:

- Limited stage: The cancer is found only in one lung and in lymph nodes close to the lung.
- Extensive stage: The cancer has spread beyond the lungs to other parts of the body.
- Recurrent stage: The cancer has returned following treatment.

Without treatment, small cell lung cancer has the most aggressive clinical course of any type of pulmonary tumor, with median survival from diagnosis of only 2–4 months. Compared with other cell types of lung cancer, small cell lung cancer has a greater tendency to be widely disseminated by the time of diagnosis, but is much more responsive to **chemotherapy** and irradiation.

Treatment of small cell lung cancer depends on whether the patient has limited, extensive, or recurrent disease. Treatment usually involves radiotherapy and chemotherapy. Surgery is rarely used for this type of lung cancer because the tumor is usually too advanced.

Patients with limited-stage disease are usually treated with chemotherapy. Combinations of two or more drugs have a better effect than treatment with a single drug. Up to 90% of patients with this stage of disease will respond to chemotherapy. The chemotherapy most commonly prescribed is a combination of the drugs etoposide (Vepesid) and cisplatin (Platinol). Combining chemotherapy with chest radiotherapy and/or occasionally surgery has also prolonged survival for limited-stage patients.

In addition to chest radiotherapy, some patients are also treated with **radiation therapy** to the brain, even if no cancer is found there. This treatment, called prophylactic cranial irradiation (PCI), is given to prevent tumors from forming in the brain. The combination of etoposide and cisplatin chemotherapy with chest radiation therapy and PCI has increased the two-year survival of limited-stage small cell lung cancer patients to almost 50%.

Combinations of different chemotherapy agents are also used for treating extensive-stage small cell lung cancer. However, compared with limited-stage patients, the percentage of extensive-stage patients who respond to therapy is lower. Commonly used drug combinations include cyclophosphamide (Cytoxan), doxorubicin (Adriamycin), and vincristine (Oncovin), or etoposide and cisplatin. The addition of radiation therapy to chemotherapy does not improve survival in these patients. However, radiation therapy is used for the palliative (pain relief) treatment of symptoms of metastatic lung cancer, particularly brain and bone tumors.

Patients who have recurrent small cell lung cancer often become resistant to chemotherapy. These patients

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are treated with palliative radiotherapy. Their doctor may also recommend that they take part in a clinical trial of a new therapy. Patients whose relapse occurs more than six months after their initial treatment, however, may still respond to traditional chemotherapy.

Coping with cancer treatment

The side effects associated with treatment of small cell lung cancer can be severe. Patients should ask their doctor about medications to treat **nausea and vomiting** and other side effects. It is particularly important to eat a nutritious diet and to drink plenty of fluids. In addition, most patients report feeling very tired and should get plenty of rest.

Clinical trials

Most of the improvements in the survival of patients with small cell lung cancer are the result of clinical trials. Ongoing trials are investigating new chemotherapy and radiotherapy regimens. In addition, entirely new types of therapy, such as **gene therapy** and biological therapy, are now being tested. Patients with a lung cancer diagnosis should ask their doctor about participating in a clinical trial.

Information on open clinical trials is available on the Internet from the National Cancer Institute at http://cancertrials.nci.nih.gov.

Alternative treatment

Many cancer patients have tried using shark cartilage to treat their disease. Shark cartilage is thought to interfere with the tumor's blood supply. A clinical trial using this treatment in lung cancer patients is ongoing. Information on this and other alternative treatments is available on the Internet from the National Center for Complementary and Alternative Medicine.

Patients who decide to try complementary and alternative therapies should tell their doctor. Some of these therapies may interfere with conventional treatment.

Prognosis

Small cell lung cancer is a very aggressive disease. Without treatment, limited-stage patients will survive for three to six months, while extensive-stage patients will survive six to 12 weeks. However, small cell lung cancer is much more responsive to chemotherapy and radiation therapy than other types of lung cancer. Among patients treated with chemotherapy, 70–90% have a major response to treatment.

KEY TERMS

Bronchi—Hollow tubes that carry air into the lungs.

PCI—A type of radiotherapy that is used to prevent tumors from growing in the brain.

Radionuclide bone scan—A test that tells if cancer has spread to the bones.

Superior vena cava (SVC) syndrome—A condition seen in lung cancer patients where the tumor presses against a large blood vessel and causes various symptoms.

Survival in patients responding to therapy is four to five times longer than in patients without treatment. In addition, two years after the start of therapy, about 10% of patients remain free of disease. In general, women tend to have a better prognosis than men. Patients whose disease has spread to the central nervous system or liver have a much worse prognosis. Although the overall survival at five years is 5% to 10%, survival is higher in patients with limited stage disease. About 70% of patients who are disease free after two years do not relapse. After five to 10 disease-free years, relapses are rare.

Prevention

The best way to prevent lung cancer is either not start smoking, or quit smoking. Secondhand smoke from other people's tobacco should also be avoided. Appropriate precautions should be taken when working with substances that can cause cancer (**carcinogens**). Testing houses for the presence of radon gas, and removing asbestos from buildings have also been suggested as preventive strategies.

Resources

BOOKS

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ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329-4251, (800) 227-2345, info@cancer.org, http://www.cancer.org.

American Lung Association, 1301 Pennsylvania Ave., NW, Suite 800, Washington, DC, 20004, (800) 548-8252, webmaster@lungusa.org, http://www.lungusa.org.

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National Heart, Lung and Blood Institute, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 251-2222, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi.nih.gov.

Alliance for Lung Cancer Advocacy, Support, and Education, P.O. Box 849, Vancouver, WA, 98666, (800) 298-2436., nhlbiinfo@nhlbi.nih.gov, http://www.alcase.org.

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Lung diseases due to gas or chemical exposure

Definition

Lung diseases due to gas or chemical exposure are conditions that can be acquired from indoor and outdoor air pollution and from ingesting tobacco smoke.

Description

The lungs are susceptible to many airborne poisons and irritants. Mucus present in the airways blocks foreign particles of a certain size; however it is unable to filter all airborne particulates. There are hundreds of substances that can pollute air and harm lungs. Harmful gases and chemicals are just one type of airborne pollutant that can adversely affect the lungs. They include:

- Vehicle exhaust
- Localized pollutants such as arsenic, asbestos, lead, and mercury
- Outdoor pollutants caused by industry and intensified by weather conditions
- Household heating devices, such as wood–burning stoves
- Household chemical products
- Tobacco smoke.

Lungs respond to irritants in four ways, each of which can occur separately or, more often, trigger other responses.

- Asthma occurs when irritation causes the smooth muscles surrounding the airways to constrict.
- Increased mucus comes from irritated mucus glands lining the airway. Excess mucus clogs the airway and prevents air from circulating.
- Constriction of the lungs results from scarring when supporting tissues are damaged.
- Cancer is caused by certain irritants, such as asbestos and tobacco smoke.

The major categories into which airborne irritants fall are allergic, organic, inorganic, and poisonous, with many agents occupying more than one category.

- Allergic irritants bother only people who are sensitive to them. Cat hair, insect parts, and pollen are common allergens. Chemicals called sulfites, which are widely used as food preservatives, also cause asthma.
- There are many organic dusts that irritate the lungs. Most of them occur on the job and cause occupational lung disease. Grain dust causes silo filler's disease. Cotton and other textile dusts cause byssinosis. Mold spores in hay cause farmer's lung.
- Inorganic dusts and aerosolized chemicals also are found mostly on the job. Classic among them are asbestos and coal dust. Many metals (cadmium, arsenic, chromium, and phosphorus), various other fine particles (cement, mica, rock), acid fumes, ammonia, ozone, and automobile and industrial emissions are part of a very long list.
- While tobacco smoke is a culprit in many smokers, a 2003 report found that those who work in the tobacco industry experience higher incidence of lung disease from tobacco dust in their work environment.
- Most intentional poisons (cyanide, nerve gas) that enter through the lungs pass through and damage other parts of the body. Mustard gas, used during World War I and banned since that time, directly and immediately destroys lungs.
- Tobacco use scars the lungs and causes emphysema and lung cancer.

Causes and symptoms

Lung disease generates three major symptoms: coughing, **wheezing**, and **shortness of breath**. It also predisposes the lungs to infections such as **bronchitis** and **pneumonia**. **Cancer** is a late effect, requiring prolonged exposure to an irritant. In the case of tobacco, an average of a pack of cigarettes a day for forty years, or two packs a day for twenty years, greatly increases the risk of lung cancer.

Diagnosis

A history of exposure combined with a **chest x ray** and lung function studies completes the diagnostic evaluation in most cases. Lung function measures the amount of air breathed in and out, the speed it moves, and the effectiveness of oxygen exchange within the

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KEY TERMS

Allergen—A substance that causes an allergic reaction in those who are sensitive to it.

Asthma—Temporary airway narrowing that causes wheezing and shortness of breath due to allergies.

Bronchitis—Infection in the bronchi (breathing tubes).

Pneumonia—Infection or inflammation in the lung itself.

blood. If the cause still is unclear, a **lung biopsy** aids diagnosis.

Treatment

Eliminating the offending irritant and early **antibiotics** for infection are primary. There are many techniques available to remove excess mucus from the lungs. Respiratory therapists are trained in these methods. Finally, there are several machines available to enrich the oxygen content of breathed air.

A surgical treatment called lung reduction volume surgery is emerging as a treatment for certain people over age 65 with severe **emphysema**. It promises substantial return of lung function for selected patients by cutting away diseased parts of the lungs so that healthy tissue functions better. In the fall of 2003, Medicare announced that it would begin paying for the surgery.

Prognosis

Many of these diseases are progressive, because the irritants stay in the lungs forever. Others remain stable after the offensive agents are removed from the environment. Lungs do not heal from destructive damage, but they can clean out infection and excess mucus, and function better.

Prevention

Industrial air filters, adequate ventilation, and respirators in polluted work sites now are mandatory. Tobacco smoke is the world's leading cause of lung disease and many other afflictions. **Smoking** cessation programs are widely available.

Resources

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ORGANIZATIONS

American Lung Association, 1301 Pennsylvania Ave. NW , Washington, DC, 20004, (202) 785-3355 , (202) 452-1805, http://www.lungusa.org.

American Thoracic Society, 61 Broadway, 6th floor, New York, NY, 10000, (212) 315-8600, http://www.thoracic.org.

Centers for Disease Control and Prevention, 1600 Clifton Rd., NE, Atlanta, GA, 30333, (404) 639-3311, (800) 311-3435, http://www.cdc.gov.org.

National Heart, Lung, and Blood Institute, PO Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573. TTY: (240) 629-3255, http://www.nhlbi.nih.gov.

Smoking Cessation, 466 14th St., Suite 10, San Francisco, CA, 94103, http://www.smoking–cessation.org.

World Health Organization, 20 Avenue Appia, 1211 Geneva 27, Switzerland, +41 (22) 791 4140, http://www.who.int/gtb.

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Lung fluke infections *see* **Fluke infections**

Lung function tests *see* **Pulmonary function test**

Lung perfusion and ventilation scan

Definition

A lung perfusion scan is a nuclear medicine test that produces a picture of blood flow to the lungs. A lung ventilation scan measures the ability of the lungs to take in air and uses radiopharmaceuticals to produce a picture of how air is distributed in the lungs.

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Purpose

Lung perfusion scans and lung ventilation scans are usually performed in the same session. They are done to detect pulmonary embolisms, determine how much blood is flowing to lungs, determine which areas of the lungs are capable of ventilation, and assess how well the lungs are functioning after surgery. These tests are called by different names, including perfusion lung scan, aerosol lung scan, radionucleotide ventilation lung scan, ventilation lung scan, xenon lung scan, ventilation/perfusion scanning (VPS), pulmonary scintiphotography, or, most commonly, V/Q scan.

Description

In a lung perfusion scan, a small amount of a protein labeled with a radioisotope is injected into the patient's hand or arm vein. The patient is positioned under a special camera that can detect radioactive material, and a series of photographs are made of the chest. When these images are projected onto a screen (oscilloscope), they show how the radioactive protein has been distributed by the blood in the blood vessels running through the lungs.

In a lung ventilation scan, a mask is placed over the nose and mouth, and the patient is asked to inhale and exhale a combination of air and radioactive gas. Pictures are then taken that show the distribution of the gas in the lungs. Each test takes 15–30 minutes.

Preparation

There is little preparation needed for these tests. The patient may eat and drink normally before the procedure. Tests to check for **pulmonary embolism** are often performed on an emergency basis.

The amount of radioactivity to which a person is exposed during these tests is very low and is not harmful. However, if the patient has had other recent radionuclear tests, it may be necessary to wait until other radiopharmaceuticals have been cleared from the body so that they do not interfere with these tests.

Aftercare

No special aftercare is needed. The patient may resume normal activities immediately. The patient may be asked to consume increased amounts of fluids (unless contraindicated because of a medical condition) for one to two days after the procedures to help speed up the elimination of the radioactive material from the body.

KEY TERMS

Pulmonary embolism—A blood clot in the arteries that is traveling to the lungs.

Radiopharmaceutical—A radioactive isotope that can be injected or inhaled into the body and then traced for radiologic purposes. For example, the radioactive isotope technetium-99m (Tc-99m) is injected into the body as part of the lung perfusion scan procedure.

Risks

There are practically no risks associated with these tests.

Results

Normal results

Normal results in both tests show an even distribution of radioactive material in all parts of the lungs.

Abnormal results

In the lung perfusion scan, an absence of radioactive marker material suggests decreased blood flow to that part of the lung, which could indicate a pulmonary **embolism**. However, **pneumonia**, **emphysema**, or lung tumors can create readings on the lung perfusion scan that falsely suggest a pulmonary embolism is present.

In the lung ventilation scan, absence of marker material when the lung perfusion scan for the area is normal suggests lung disease.

Certain combinations of abnormalities in lung perfusion and ventilation scans suggest pulmonary embolism.

Resources

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Lung surgery

Definition

Lung surgery includes a variety of procedures used to diagnose or treat diseases of the lungs. Biopsies are performed to extract a small amount of tissue for diagnosis, resections remove a portion of lung tissue, and other surgeries are aimed at reducing the volume of the lungs, removing cancerous tumors, or improving lung function.

Purpose

The type of lung surgery performed will depend upon the underlying disease or condition, as well as other factors.

- Pneumonectomy usually refers to the removal of a lung, or sometimes one or more lobes (sections containing lung tissue, air sacs, ducts, and respiratory bronchiole). It is most commonly indicated in certain forms and stages of lung cancer.
- Thoracotomy, or surgical incision of the chest wall, is used primarily as a diagnostic tool when other procedures have failed to provide adequate diagnostic information.
- Lobectomy is the term used to describe removal of one lobe of a lung. It is most commonly indicated for lung cancer, but may also be used for cystic fibrosis patients if other treatments have failed.
- Other surgical procedures include segmental resection or wedge resection. A resection is the removal of a part of the lung, often in order to remove a tumor. Wedge resection is removal of a wedge-shaped portion of lung tissue.
- Volume reduction surgery is a newer surgery used to help relieve shortness of breath and increase tolerance for exercise in patients with chronic obstructive pulmonary disease, such as emphysema.
- Other surgeries are continuously improved upon to make biopsy less invasive and surgery more effective, such as video-assisted lobectomy. Other purposes for lung surgery may include severe abscess, areas of long-term infection, or permanently enlarged or collapsed lung tissue.

Precautions

Thoracotomy should not be performed on patients whose general health status will not tolerate major surgery. Any surgery carries with it risks associated with **general anesthesia** and possibility of infection. Patients whose risk for these complications outweighs benefit may not be considered candidates for lung surgery. Each individual patient's condition will be reviewed prior to the treatment decision.

Description

Lung surgery procedures will vary depending on the underlying cause of the surgical test or intervention. A patient will be placed under general anesthesia during the surgery. An incision is made to examine the lungs. Diseased tissue is removed and may be sent for biopsy. Following the surgery, drainage tubes may be placed in the chest to drain fluids, blood, and air from the chest cavity. Tubes will most likely remain in place for one to two days, depending on the surgery and the patient's condition. The chest cavity, ribs, and skin are closed and the incision will be sutured. Hospital stay averages from three to 10 days.

Pneumonectomy consists of removal of all of one lung. It may often be indicated only when a **lobectomy** does not successfully remove the cancerous or damaged tissue. Thoracotomy consists of reaching the lung tissue through incision and obtaining tissue for a biopsy. The biopsy is used to diagnose or stage **cancer**, and thoracotomy may be avoided until other less invasive methods have failed. Volume reduction surgery involves incision and removal of those parts of the lung or lungs which are the most destroyed, in order to allow for full function of the remaining lung structure. This procedure is still being studied.

Lobectomy is performed in the same general manner as other lung surgeries, but will involve removal of an entire lobe of the lung. Most patients with Stage I or II **non-small cell lung cancer** will receive this treatment for their disease, or a less extensive resection. Lobectomy may only be performed if a wedge or segmental resection is ineffective, but is generally preferred as treatment for primary lung cancer in any patient who can tolerate the procedure. Wedge and segmental resections are still major surgery, but remove less tissue and may be the first choice for some patients, such as those with Stage I and Stage II non-small cell lung cancer. Patients who do not have enough pulmonary function to undergo a lobectomy will receive a wedge or segmental resection instead. This may lead to a higher recurrence rate of cancer. In general, the surgery method chosen will depend on specific circumstances and consideration of benefit versus risk.

Preparation

Preparation for lung surgery is much like that for any major surgery. Patients will receive instructions

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from a physician concerning limit of food or water intake prior to the surgery, as well as risks and expected recovery. Patients should continue to follow treatment for the underlying condition, unless instructed otherwise by the physician, and should discuss medications and changes in condition with their physician prior to the surgery.

Aftercare

The chest tube inserted at the end of surgery will remain in place until the lung has fully expanded. Patients will be carefully monitored in the hospital for complications and infection. Deep breathing is recommended to help lessen the risk of **pneumonia** and infection. Breathing exercises will also help expand the lung. After discharge from the hospital, the patient may still receive some **pain** or infection-fighting medications and should recover within one to three months of the operation.

Risks

Risks of lung surgery follows those of any major surgery involving general anesthesia. These risks include reactions to anesthetics or medications, bleeding, infection, and problems restoring breathing. Lung surgery, in particular, offers the risk of pneumonia and **blood clots**. Thoracotomy, as a biopsy procedure, offers greater risk than most biopsy procedures.

Results

Outcome for any lung surgery depends on many factors and the severity of disease. In general, the predicted benefits, which justified the surgery, are normal expected results. Thoracotomy results in a definitive diagnosis in more than 90% of patients. Volume reduction surgery has been shown to result in relief of some symptoms and improvement in quality of life for selected patients with severe **emphysema** and have shown short-term promise.

Mortality from lung surgery improves as procedures move from the more complete pneumonectomy to lobectomy, and the lowest rate for segmental resection.

ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (800) 227-2345, http://www.cancer.org.

American Lung Association, 1301 Pennsylvania Ave. NW, Suite 800, Washington, DC, 20001, (202) 758-3355, (202) 452-1805, (800) 548-8252, info@lungusa.org, http://www.lungusa.org/.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

Teresa Odle

Lung transplantation

Definition

Lung transplantation involves removal of one or both diseased lungs from a patient and the replacement of the lungs with healthy organs from a donor. Lung transplantation may refer to single, double, or even heart-lung transplantation.

Purpose

The purpose of lung transplantation is to replace a lung that no longer functions, or is cancerous, with a healthy lung. In order to qualify for lung transplantation, a patient must suffer from severe lung disease which limits activities of daily living. There should be potential for rehabilitated breathing function. Attempts at other medical treatments should be exhausted before transplantion is considered. Many candidates for this procedure have end-stage fibrotic

National transplant waiting list by organ type (June 2010)

Organ needed	Persons waiting
Kidney	85,296
Liver	16,031
Heart	3,141
Kidney/Pancreas	2,199
Lung	1,802
Pancreas	1,450
Intestine	242
Heart/Lung	79

SOURCE: U.S. Department of Health and Human Services, Organ Procurement and Transplantation Network. Available online at: http://optn.transplant.hrsa.gov/data/default.asp (accessed June 8, 2010).

(Table by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)

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lung disease, are dependent on **oxygen therapy**, and are likely to die of their disease in 12–18 months.

Patients with **emphysema** or **chronic obstructive pulmonary disease** (COPD) should be under 60 years of age, have a life expectancy without transplantation of two years or less, progressive deterioration, and emotional stability in order to be considered for lung transplantation. Young patients with end-stage **silicosis** (a progressive lung disease) may be candidates for lung or heart-lung transplantation. Patients with Stage III or Stage IV **sarcoidosis** (a chronic lung disease) with **cor pulmonale** should be considered as early as possible for lung transplantation. Other indicators of lung transplantation include pulmonary **vascular disease** and chronic pulmonary infection.

Precautions

Patients who have diseases or conditions which may make them more susceptible to organ rejection should not receive a lung transplant. This includes patients who are acutely ill and unstable; who have uncontrolled or untreatable pulmonary infection; significant dysfunction of other organs, particularly the liver, kidney, or central nervous system; and those with significant coronary disease or left ventricular dysfunction. Patients who actively smoke cigarettes or are dependent on drugs or alcohol may not be selected. There are a variety of protocols that are used to determine if a patient will be placed on a transplant recipient list, and criteria may vary depending on location.

Description

Once a patient has been selected as a possible organ recipient, the process of waiting for a donor organ match begins. The donor organ must meet clear requirements for tissue match in order to reduce the chance of organ rejection. It is estimated that it takes an average of one to two years to receive a suitable donor lung, and the wait is made less predictable by the necessity for tissue match. Patients on a recipient list must be available and ready to come to the hospital immediately when a donor match is found, since the life of the lungs outside the body is brief.

Single lung transplantation is performed via a standard thoracotomy (incision in the chest wall) with the patient under **general anesthesia**. Cardiopulmonary bypass (diversion of blood flow from the heart) is not always necessary for a single lung transplant. If bypass is necessary, it involves re-routing of the blood through tubes to a heart-lung bypass machine. Double lung transplantation involves implanting the lungs as two separate lungs, and cardiopulmonary bypass is usually required. The patient's lung or lungs are removed and the donor lungs are stitched into place. Drainage tubes are inserted into the chest area to help drain fluid, blood, and air out of the chest. They may remain in place for several days. Transplantation requires a long hospital stay and recovery can last up to six months.

Heart-lung transplants always require the use of cardiopulmonary bypass. An incision is made through the middle of the sternum. The heart, lung, and supporting structures are transplanted into the recipient at the same time.

Preparation

In addition to tests and criteria for selection as a candidate for transplantation, patients will be prepared by discussing the procedure, risks, and expected prognosis at length with their doctor. Patients should continue to follow all therapies and medications for treatment of the underlying disease unless otherwise instructed by their physician. Since lung transplantation takes place under general anesthesia, normal surgical and anesthesia preparation should be taken when possible. These include no food or drink from midnight before the surgery, discussion of current medications with the physician, and informing the physician of any changes in condition while on the recipient waiting list.

Aftercare

Careful monitoring will take place in a recovery room immediately following the surgery and in the patient's hospital room. Patients must take immunosuppression, or anti-rejection, drugs to reduce the risk of rejection of the transplanted organ. The body considers the new organ an invader and will fight its presence. The **anti-rejection drugs** lower the body's immune function in order to improve acceptance of the new organs. This also makes the patient more susceptible to infection.

Frequent check-ups with a physician, including x ray and blood tests, will be necessary following surgery, probably for a period of several years.

Risks

Lung transplantation is a complicated and risky procedure, partly because of the organs and systems involved, and also because of the risk of rejection by the recipient's body. Acute rejection most often occurs within the first four months following surgery, but may occur years later. Infection is a substantial risk

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KEY TERMS

Pulmonary—Refers to the respiratory system, or breathing function and system.

Sarcoidosis—A chronic disease with unknown cause that involves formation of nodules in bones, skin, lymph nodes, and lungs.

Silicosis—A progressive disease that results in impairment of lung function and is caused by inhalation of dust containing silica.

for organ recipients. An early complication of the surgery can be poor healing of the bronchial and tracheal openings created during the surgery. A late complication and risk is chronic rejection. This can result in inflammation of the bronchial tubes or in late infection from the prolonged use of **immunosuppressant drugs** to fight rejection. Overall, lung transplant recipients have demonstrated average one and two-year survival rates of more than 70%.

Results

The outcome of lung transplantation can be measured in survival rates, and also in improved quality of life for recipients. Studies have reported improved quality of life after lung and heart-lung transplants. One study showed that at the two-year follow-up period, 86% of studied recipients reported no limitation to their activity. Demonstration of normal results for patients may include quality of life measurements, as well as testing to ensure lack of infection and rejection.

ORGANIZATIONS

Children's Organ Transplant Association, Inc. , 2501 COTA Drive, Bloomington, IN, 47403, (812) 336-8885, (800) 366-2682, cota@cota.org, http://www.cota.org.

Second Wind Lung Transplant Association, 3440 Halliday Ave., St. Louis, MO, 63118-1102, (888) 855-9463, http://www.2ndwind.org.

Teresa Odle

Lupus erythematosus *see* **Systemic lupus erythematosus**

Luque rod *see* **Spinal instrumentation**

Luteinizing hormone test

Definition

The luteinizing hormone (LH) test is a test of the blood or urine to measure the level of luteinizing hormone (lutropin). This hormone level is highest immediately before a woman ovulates during her menstrual cycle.

Purpose

The LH test is frequently used to determine the timing of ovulation. Couples who are trying to become pregnant may use information about the timing of ovulation to improve their chance of conception. The LH test and other hormone tests may be used during **infertility** screening to chart a woman's menstrual cycle. It may also be used during preparation for **in vitro fertilization**, to determine when eggs are mature and ready to be removed from the ovary.

Description

Lutenizing hormone is a hormone released by the pituitary gland, a small gland at the base of the brain. The hormone stimulates the ovaries to produce and release eggs each month during the menstrual cycle. The level of LH in the blood is highest before ovulation. This increase in hormone level is sometimes called a "surge." A urine or blood sample can be analyzed by a laboratory for the level of LH present. An LH test may be used as part of an infertility screening to determine if there is a hormonal imbalance that might make it difficult to become pregnant. If fertility drugs are given to stimulate ovulation, an LH test can help determine the best time for sexual intercourse. The LH test may also be used to determine when eggs are mature enough to be surgically removed from the ovary as part of the in vitro fertilization process. LH tests may also aid in the diagnoses of polycystic ovary disease, premature ovarian failure, and **menopause**.

A urine LH detection kit is also available for use at home. These are sometimes called "ovulation tests" and are similar to home **pregnancy** test kits. A sample of the woman's first morning urine is tested with the materials provided in the kit. These home tests are often used by women who want to become pregnant. By monitoring levels of LH and watching for the "surge," they can time sexual intercourse to coincide with ovulation, increasing the chance that the egg will be fertilized.

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KEY TERMS

Lutropin—Another term for luteinizing hormone, this hormone stimulates the development and release of the egg from the ovary.

Preparation

If a blood sample is taken, the skin around the vein where the needle will be inserted is swabbed with an antiseptic. No special preparation is necessary for collection of a urine sample.

Aftercare

No special aftercare is required. If the blood is tested, as with any blood sampling, the area where the needle was inserted should be kept clean.

Risks

There are no significant risks associated with either the blood or urine test for LH.

Results

The level of LH in the blood or urine will vary depending on when the sample was taken during the menstrual cycle. LH levels will be highest around the time of ovulation, about halfway between a woman's menstrual periods. Levels will be lower during the rest of the month. Women who have already experienced menopause will normally have lower LH levels.

LH levels that remain low throughout the menstrual cycle may indicate a hormonal imbalance that could prevent ovulation. Additional testing may be required if this test is done as part of an infertility screening.

Resources

BOOKS

Lowrance, James M. *Thyroid Hormones and the Tests that Monitor Them: Hormonal Functions, Imbalances and Treatments*. Seattle: CreateSpace, 2010.

Altha Roberts Edgren

Lyme borreliosis *see* **Lyme disease**

Lyme disease

Definition

Lyme disease is an infection transmitted by the bite of ticks carrying the spiral-shaped bacterium *Borrelia burgdorferi*. The effects of this infection can be long-term and disabling unless it is recognized and treated properly with **antibiotics**.

Demographics

Controversy clouds the true incidence of Lyme disease because no test is 100% diagnostic for the disease, and many of its symptoms mimic those of so many other diseases. Cases of Lyme disease have been reported in 49 of the 50 states; however, distribution is not uniform. The United States Centers for Disease Control and Prevention (CDC) report that 93% of cases come from 10 states: Connecticut, Delaware, Maryland, Massachusetts, Minnesota, New Jersey, New York, Pennsylvania, Rhode Island, and Wisconsin. Oregon and northern California also report a significant number of cases.

Prevalence estimates range for 4 in 100,000 population to 9.1 per 100,000 population. In states where Lyme disease is more common, the rate can be as high as 37.4 per 100,000 population. In 2007, 27,000 new cases were reported in the United States. Some epidemiologists believe that the actual incidence of Lyme disease in the United States may be 5–10 times greater than that reported by the CDC. The reasons for this difference include the narrowness of the CDC's case definition as well as frequent misdiagnoses of the disease.

Lyme disease has also been found in Canada, most countries in continental Europe, some countries of the former Soviet Union, Japan, China, and Australia. In Europe the disease has been found in Austria,

Adult male deer tick. *(Kent Wood/Photo Researchers, Inc.)*

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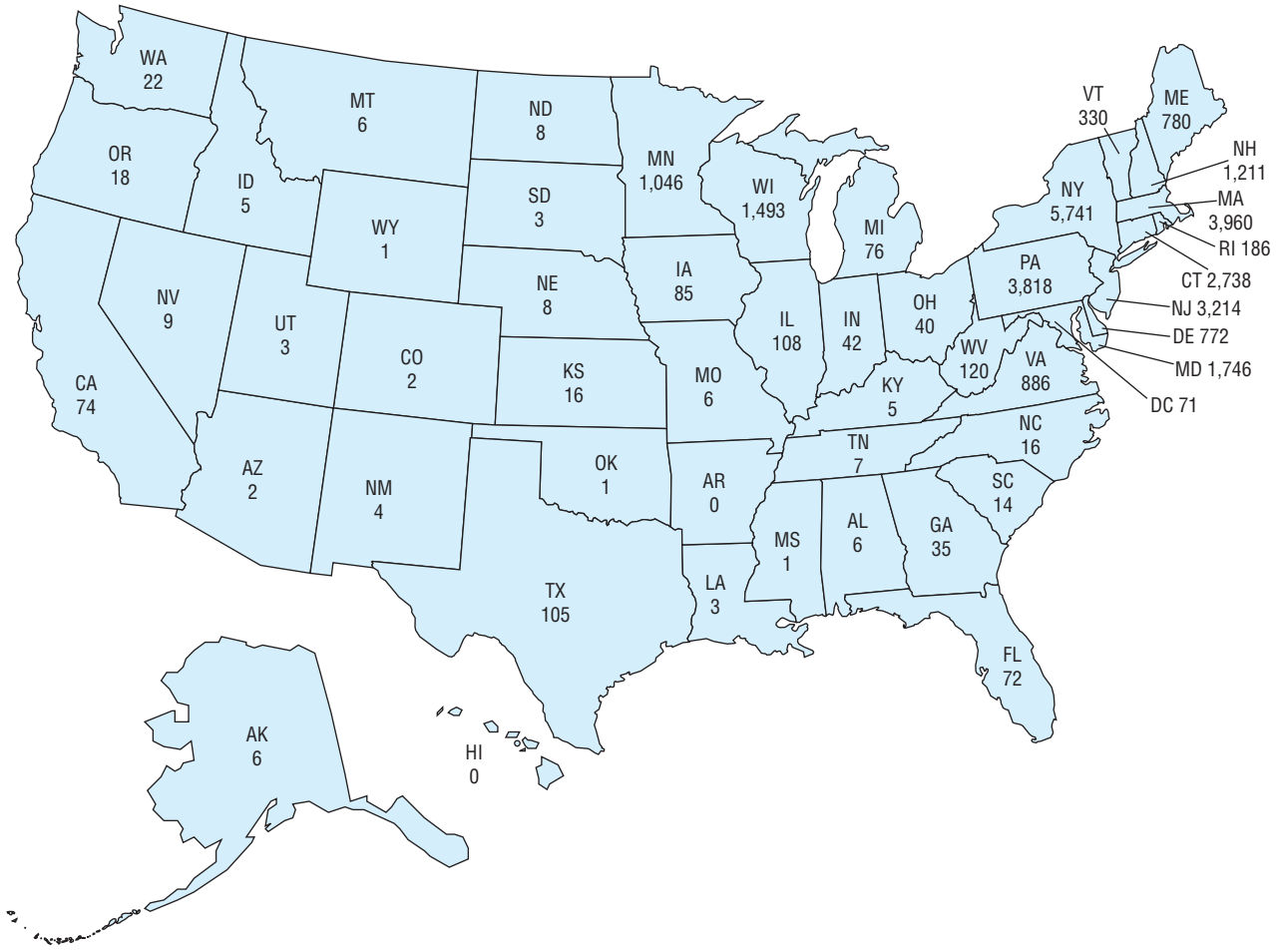
Confirmed Lyme disease cases by state, 2008



Total confirmed cases: 28,921

SOURCE: Centers for Disease Control and Prevention, Division of Vector-Borne Infectious Diseases, "Reported Lyme disease cases by state, 1999-2008." Available online at: http://www.cdc.gov/ncidod/dvbid/lyme/ld_rptdLymeCasesbyState.htm (accessed June 9, 2010).

Lyme disease is caused by an infection transmitted by the bite of ticks carrying the *Borrelia burgdorferi* bacterium. *(Map by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)*

Germany, Poland, Finland, and Norway, The highest rate reported as of mid-2010 was in Slovenia, where there were an estimated 206 cases per 100,000 population and in Austria where there were 135 cases per 100,000 population.

Lyme disease affects men and women equally. People ages 5–14 and 50–59 are most likely to contract Lyme disease because these groups are more likely to participate in outdoor activities where they are exposed to ticks. About one-quarter of cases occur in children under age 5, while the fewest cases are reported in the 20–24 year old age group.

Description

Lyme is named for Lyme, Connecticut, the town where it was first diagnosed in 1975 after a puzzling outbreak of arthritis. The organism causing the disease is named for its discoverer, Willy Burgdorfer. Lyme disease, which is also called Lyme borreliosis, is a vector-borne disease. This term means that it is delivered from one host to another. It is also classified as a **zoonosis**, which means that it is a disease of animals that can be transmitted to humans under natural conditions. In this case, a tick bearing the *B. burgdorferi* organism inserts it into a host's bloodstream when it

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The first sign of Lyme disease is usually an itchy, bull's-eye rash around the site of the tick bite. *(© Scott Camazine/Alamy.)*

bites the host to feed on its blood. It is important to note that neither *B. burgdorferi* nor Lyme disease can be transmitted directly from one person to another or from pets to humans.

In the United States, Lyme disease accounts for more than 90% of all reported vector-borne illnesses. It is a significant public health problem and continues to be diagnosed in increasing numbers. The CDC attributes this increase to the growing size of the deer herd and the geographical spread of infected ticks rather than to improved diagnosis.

Risk factors

People who spend a lot of time outdoors in wooded areas are at greatest risk of encountering ticks and developing Lyme disease. The risk for acquiring Lyme disease also depends on what stage in its life cycle a tick has reached. A tick passes through three stages of development—larva, nymph, and adult—each of which is dependent on a live host for food. In the United States, *B. burgdorferi* is borne by ticks of several species in the genus *Ixodes*, which usually feed on the white-footed mouse and deer (and are often called deer ticks). In the summer, the larval ticks hatch from eggs laid in the ground and feed by attaching themselves to small animals and birds. At this stage they are not a problem for humans. It is the next stage—the nymph—that causes most cases of Lyme disease. Nymphs are very active from spring through early summer, at the height of outdoor activity for most people. Because they are still quite small (less than 2 mm), they are difficult to spot, giving them ample opportunity to transmit *B. burgdorferi* while feeding. Although far more adult ticks than nymphs carry *B. burgdorferi*, the adult ticks are much larger, more easily noticed, and more likely to be removed before the 24 hours or more of continuous feeding needed to transmit *B. burgdorferi*.

Causes and symptoms

Lyme disease is caused by *B. burgdorferi*. Once *B. burgdorferi* gains entry to the body through a tick bite, it can move through the bloodstream quickly. Only 12 hours after entering the bloodstream, *B. burgdorferi* can be found in cerebrospinal fluid (which means it can affect the nervous system). Treating Lyme disease early and thoroughly is important because Lyme disease can hide for long periods within the body in a clinically latent state. That ability explains why symptoms can recur in cycles and can flare up after months or years, even over decades. It is important to note, however, that many people who are exposed to *B. burgdorferi* do not develop the disease.

Lyme disease usually is described in terms of length of infection (time since the person was bitten by a tick infected with Lyme disease) and whether *B. burgdorferi* is localized or disseminated (spread through the body by fluids and cells carrying *B. burgdorferi*). When and how symptoms of Lyme disease appear can vary widely from patient to patient. People who experience recurrent bouts of symptoms over time are said to have chronic Lyme disease.

Early localized Lyme disease

The most recognizable indicator of Lyme disease is a rash around the site of the tick bite. Often, the tick exposure has not been recognized. The eruption might be warm or itch. The rash—erythema migrans (EM)—generally develops within 3–30 days and usually begins as a round, red patch that expands outward. About 75% of patients with Lyme disease develop EM. Clearing may take place from the center out,

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KEY TERMS

Antibody—A protein normally produced by the immune system to fight infection or rid the body of foreign material. The material that stimulates the production of antibodies is called an antigen. Specific antibodies are produced in response to each different antigen and can only inactivate that particular antigen.

Antigen—Any foreign substance, usually a protein, that stimulates the body's immune system to produce antibodies.

Babesiosis—A disease caused by protozoa of the genus *Babesia* characterized by a malaria-like fever, anemia, vomiting, muscle pain, and enlargement of the spleen. Babesiosis, like Lyme disease, is carried by a tick.

Bell's palsy—Facial paralysis or weakness with a sudden onset, caused by swelling or inflammation of the seventh cranial nerve, which controls the facial muscles. Disseminated Lyme disease sometimes causes Bell's palsy.

Blood-brain barrier—A specialized, semi-permeable layer of cells around the blood vessels in the brain that controls which substances can leave the circulatory system and enter the brain.

Cerebrospinal fluid—A clear fluid that fills the hollow cavity inside the brain and spinal cord. The cerebrospinal fluid has several functions, including providing a cushion for the brain against shock or impact, and removing waste products from the brain.

Disseminated—Scattered or distributed throughout the body. Lyme disease that has progressed beyond the stage of localized EM is said to be disseminated.

ELISA protocols—ELISA is an acronym for "enzyme-linked immunosorbent assay"; it is a highly sensitive technique for detecting and measuring antigens or antibodies in a solution.

Erythema migrans (EM)—A red skin rash that is one of the first signs of Lyme disease in about 75% of patients.

Lymph nodes—Small, bean-shaped masses of tissue scattered along the lymphatic system that act as filters and immune monitors, removing fluids, bacteria, or cancer cells that travel through the lymph system.

Opportunistic infection—An infection by organisms that usually do not cause infection in people whose immune systems are working normally.

Vector—An animal carrier that transfers an infectious organism from one host to another. The vector that transmits Lyme disease from wildlife to humans is the deer tick or black-legged tick.

Zoonosis (plural, zoonoses)—Any disease of animals that can be transmitted to humans under natural conditions. Lyme disease and babesiosis are examples of zoonoses.

leaving a bull's-eye effect; in some cases, the center gets redder instead of clearing. The rash may look like a bruise on people with dark skin. Of those who develop Lyme disease, about 50% notice flu-like symptoms, including **fatigue**, **headache**, chills and **fever**, muscle and joint **pain**, and lymph node swelling. However, a rash at the site can also be an allergic reaction to the tick saliva rather than an indicator of Lyme disease, particularly if the rash appears in *less* than three days and disappears only days later.

Late disseminated disease and chronic Lyme disease

Weeks, months, or even years after an untreated tick bite, symptoms can appear in several forms, including:

- fatigue, forgetfulness, confusion, mood swings, irritability, numbness.
- neurologic problems, such as pain (unexplained and not triggered by an injury), Bell's palsy (facial paralysis, usually one-sided but may be on both sides), and a mimicking of the inflammation of brain membranes known as meningitis; (fever, severe headache).
- arthritis (short episodes of pain and swelling in joints) and other musculoskeletal complaints. Arthritis eventually develops in about 60% of patients with untreated Lyme disease.

Less common effects of Lyme disease are heart abnormalities such as irregular rhythm (**arrhythmias**) or cardiac block and eye abnormalities such as swelling of the cornea, tissue, or eye muscles and nerves.

A late-stage complication of Lyme disease that affects the skin is acrodermatitis chronica atrophicans, a disorder in which the skin on the person's lower legs or hands becomes inflamed and paper-thin. This disorder is seen more frequently in Europe than in the United States.

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Diagnosis

Examination

A clear diagnosis of Lyme disease can be difficult and relies on information the patient provides and the doctor's clinical judgment, particularly through elimination of other possible causes of the symptoms. Lyme disease may mimic other conditions, including **chronic fatigue syndrome** (CFS), **multiple sclerosis** (MS), and other diseases with many symptoms involving multiple body systems. Differential diagnosis (distinguishing Lyme disease from other diseases) is based on clinical evaluation with laboratory tests used for clarification, when necessary.

Doctors generally know which disease-causing organisms are common in their geographic area. The most helpful piece of information is whether a tick bite or rash was noticed and whether it happened locally or while traveling. Doctors may not consider Lyme disease if it is rare locally, but will take it into account if a patient mentions vacationing in an area where the disease is commonly found.

Children may have difficulty effectively verbalizing their symptoms and as such, their symptoms may be misdiagnosed. Parents who suspect Lyme disease in their children should inform their doctor about the possibility of the disease and be proactive in requesting further medical evaluation and treatment.

Tests

As of 2010, the United States Food and Drug Administration (FDA) had approved two blood tests for Lyme disease. This these looks for antigens (substances that stimulate the production of antibodies) produced by *B. burgdorferi* rather than for the bacterium itself. Prevue B is a rapid test that can give results within one hour. The C6 Lyme Peptide ELISA (enzyme-linked immunosorbent assay) test takes longer to give results, but is more sensitive. A positive result from either test can be confirmed by a second blood test known as the Western blot test, which must be done in a laboratory.

Early diagnosis and prompt treatment are critical to preventing the neurologic complications of Lyme disease. Fewer than 50% of children realize that they have been bitten by a tick. Any child that develops a round, bull's-eye skin rash, joint pain, flu-like symptoms, and/or neurologic symptoms should see a doctor. Because the rash may not be readily visible (e.g., on the scalp under hair), children living in or visiting areas with a high incidence of Lyme disease and those participating in frequent outdoor activities during active tick months who develop joint pain and neurologic symptoms should see a doctor.

Treatment

Traditional

Immediate removal of an attached tick is the first step in treatment for people who know they have been bitten. Because black-legged ticks are slow feeders, it takes about 36 hours for *B. burgdorferi* to make its way into the body; infection is unlikely if the tick is removed within 24 hours of attachment. People who find ticks on themselves should *not* use a hot match, petroleum jelly, nail polish, or similar items to remove the tick. They should use fine-tipped tweezers, grasp the tick as close to the skin as possible, and pull the tick away from the skin with a steady motion. The area should then be cleansed with an antiseptic.

Because most children do not realize they have been in tick-infested areas or been bitten by a tick and because deer ticks can be the size of a poppy seed or smaller, parents should be diligent about checking children for ticks, especially if the family lives in or visits an area with a high incidence of Lyme disease or an area near tick habitats.

Drugs

For most patients, initial therapy consists of oral antibiotics such as doxycycline (Doryx, Vibramycin) or amoxicillin (Amoxil, Trimox) for 14–21 days. If there poor response, alternative antibiotics such as Cefuroxime axetil (Ceftin), Clarithromycin (Biaxin), or azithromycin (Zithromax) are tried. When symptoms indicate nervous system involvement or a severe episode of Lyme disease, intravenous antibiotics such as ceftriaxone (Rocephin), cefotaxime (Claforan), or intravenous penicillin may be given for 14–30 days.

The physician may have to adjust the treatment regimen or change medications based on the patient's response. Treatment can be difficult because *B. burgdorferi* comes in several strains, some may react to different antibiotics than others. Also, *B. burgdorferi* can shut itself up in cell niches, allowing it to hide from antibiotics. Finally, antibiotics can kill *B. burgdorferi* only while it is active rather than dormant.

Complementary and Alternative

Antibiotic therapy is essential in treating Lyme disease, however, complementary therapies may minimize symptoms of Lyme disease or improve the immune response. These include vitamin and **nutritional supplements**, mostly for chronic fatigue and increased

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susceptibility to infection. For example, yogurt and *Lactobacillus acidophilus* preparations help fight yeast infections, which are common in people on long-term antibiotic therapy. In addition, botanical medicine and homeopathy can be considered to help bring the body's systems back to a state of health and well being. A Western herb, spilanthes (*Spilanthes* spp.), may have an effect on diseases like Lyme disease that are caused by spirochetes (spiral-shaped bacteria), although this effect has not been proven to the satisfaction of practitioners of conventional medicine.

Other complementary and alternative therapies used in treating Lyme disease include:

- Chinese medicine. Formulae used to treat systemic bacterial infections include Wu Wei Xiao Du Yin (Five-Ingredient Decoction to Eliminate Toxin), Yin Hua Jie Du Tang (Honeysuckle Decoction to Relieve Toxicity), and Huang Lian Jie Du Tang (Coptis Decoction to Relieve Toxicity). Inflammation at the site of infection may be treated externally with Yu Lu San (Jade Dew Extract) or Jin Huang San (Golden Yellow Powder). Specific Chinese herbs and treatments can be used for specific symptoms. For examples, for systemic bacterial infection, one may use honeysuckle flower, forsythia, isatidis, scutellaria, and phellodendron. Acupuncture and ear acupuncture treatments are also used.
- Herbals. Botanical remedies include Echinacea (*Echinacea* species) to clear infection and boost the immune system, goldenseal (*Hydrastis canadensis*) to clear infection and boost the immune system, garlic to clear bacterial infection, and spilanthes (*Spilanthes* species) for spirochete infections.
- Hydrotherapy. The joint pain associated with Lyme disease can be treated with hydrotherapy. Dull, penetrating pain may be relieved by applying a warm compress to the affected area. Sharp, intense pain may be relieved by applying an ice pack to the affected area.
- Guided imagery. The patient may treat Lyme disease by visualizing Bb as looking like ticks swimming in the bloodstream being killed by the flame of a candle.
- Probiotics. Probiotics is treatment with beneficial microbes either by ingestion or through a suppository. Probiotics can restore a healthy balance of bacteria to the body in cases in which long-term antibiotic use has caused diarrhea or yeast infection. Yogurt or *Lactobacillus acidophilus* preparations may be ingested.

Prognosis

If aggressive antibiotic therapy is given early, and the patient cooperates fully and sticks to the medication regimen, recovery should be complete. Only a small percentage of Lyme disease patients fail to respond or relapse (have recurring episodes). Most long-term effects of the disease result when diagnosis and treatment is delayed or missed. Co-infection with other infectious organisms spread by ticks in the same areas as *B. burgdorferi* (**babesiosis** and **ehrlichiosis**, for instance) may be responsible for treatment failures or more severe symptoms. Most fatalities reported with Lyme disease involved patients co-infected with babesiosis.

Prevention

Minimizing risk of exposure

Precautions to avoid contact with ticks include moving leaves and brush away from living quarters. Most important are personal protection techniques when outdoors, such as:

- spraying tick repellent on clothing and exposed skin.
- wearing light-colored clothing to maximize ability to see ticks.
- tucking pant legs into socks or boot top.
- checking children and pets frequently for ticks.
- inspecting each individual living in high-risk areas daily for ticks in the spring and summer.

Minimizing risk of disease

The two most important factors are removing the tick quickly and carefully, and seeking a doctor's evaluation at the first sign of symptoms of Lyme disease. When in an area that may be tick-populated:

- Check for ticks, particularly in the area of the groin, underarm, behind ears, and on the scalp.
- Stay calm and grasp the tick as near to the skin as possible, using tweezers.
- To minimize the risk of squeezing more bacteria into the bite, pull straight back steadily and slowly to remove the tick.
- Do not try to remove the tick by using petroleum jelly, alcohol, or a lit match.
- Place the tick in a closed container (for species identification later, should symptoms develop) or dispose of it by flushing.
- See a physician immediately for any sort of rash or patchy discoloration that appears three to 30 days after a tick bite.

A vaccine for Lyme disease was available from 1998 to 2002, when it was removed from the United States market. Protection provided by the vaccine fades over time. Anyone who was vaccinated at the time the vaccine was available likely no longer has

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any protection against the disease. A vaccine still exists for dogs, although veterinarians have mixed ideas about its use.

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ORGANIZATIONS

American Lyme Disease Foundation, P. O. Box 466, Lyme, CT, 06371, inquire@adlf.com, http://www.aldf.com.

Lyme Disease Network of NJ. , 43 Winton Road, East Brunswick, NJ, 08816, http://www.lymenet.org.

National Institute of Allergy and Infectious Diseases Office of Communications and Government Relations, 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-6612, (301) 496-5717, (866) 284-4107 or TDD: (800)877-8339 (for hearing impaired), (301) 402-3573, http://www3.niaid.nih.gov.

United States Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (404) 639-3534, 800-CDC-INFO (800-232-4636). TTY: (888) 232-6348, inquiry@cdc.gov, http://www.cdc.gov.

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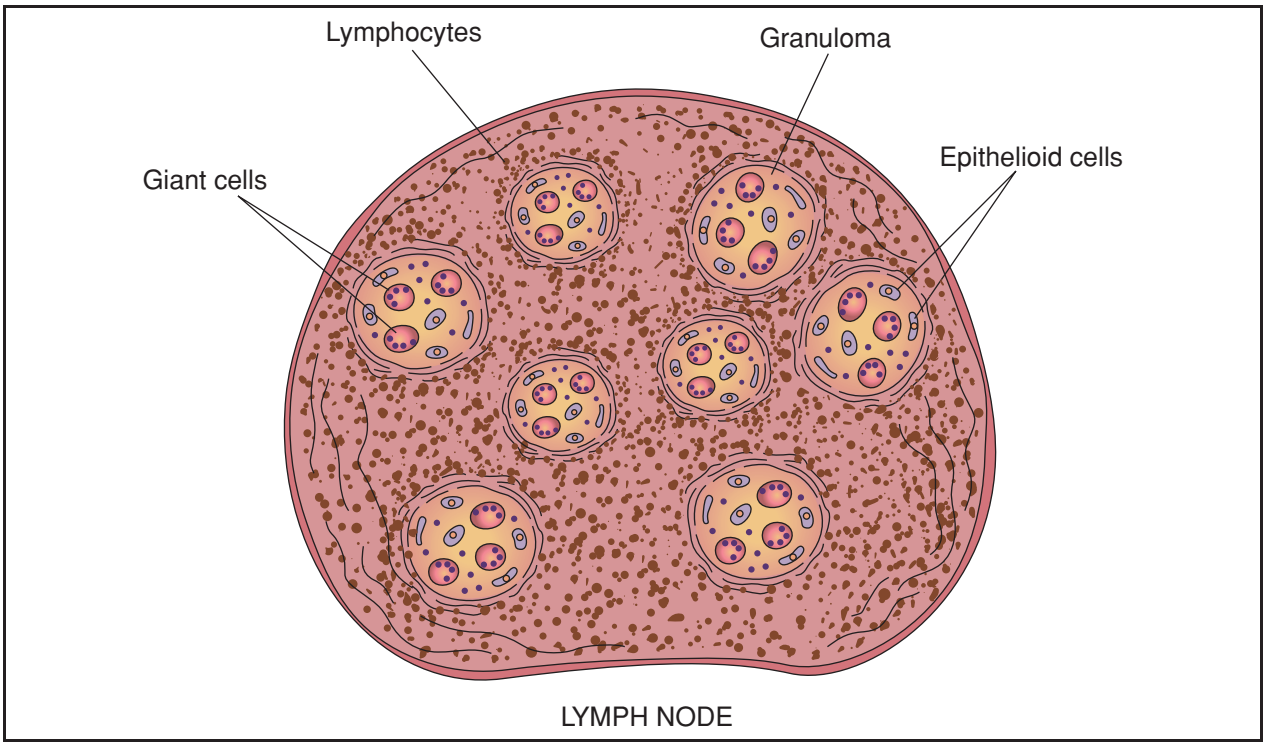
Lymph node angiogram *see* **Lymphangiography**

Lymph node biopsy

Definition

A lymph node biopsy is a procedure in which all or part of a lymph node is removed and examined to determine whether there is **cancer** within the node, or to determine the cause of **swollen glands** in the head and neck region.



Lymph node biopsy is a procedure in which a sample of lymph node tissue is removed for laboratory analysis. It is generally performed on an outpatient basis. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

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KEY TERMS

Lymph nodes—Small bean-shaped organs located throughout the lymphatic system. The lymph nodes store special cells that can trap cancer cells or bacteria that are traveling through the body in lymph. Also called lymph glands.

Lymphocytes—Small white blood cells that bear the major responsibility for carrying out the activities of the immune system; they number about 1 trillion.

Malignant—Cancerous. Cells tend to reproduce without normal controls on growth and form tumors or invade other tissues.

Sentinel node—The first lymph node or group of nodes to which cancer cells are likely to spread from a primary tumor.

Spleen—An organ located at the left side of the stomach that acts as a reservoir for blood cells and produces lymphocytes and other products involved in fighting infection.

Thymus—An organ near the base of the neck that produces cells that fight infection. It is at its largest at puberty, then declines in size and function during adult life.

Tonsils—Small masses of tissue at the back of the throat.

Purpose

The lymph system is the body's primary defense against infection. It consists of the spleen, tonsils, thymus, lymph nodes, lymph vessels, and the clear, slightly yellow fluid called lymph. These components produce and transport white blood cells called lymphocytes and macrophages that rid the body of infection. The lymph system is also involved in the production of antibodies. Antibodies are proteins that fight bacteria, viruses, and other foreign materials that enter the body.

The lymph vessels are similar to veins, only instead of carrying blood as veins do, they circulate lymph to most tissues in the body. Lymph nodes are about 600 small, bean-shaped collections of tissue found along the lymph vessel. They produce cells and proteins that fight infection, and clean and filter lymph. Lymph nodes are sometimes called lymph glands, although they are not true glands. When someone talks about having swollen glands, they are actually referring to lymph nodes.

Normal lymph glands are no larger than 0.5 in (1.3 cm) in diameter and are difficult to feel. However, lymph nodes can enlarge to greater than 2.5 in (6 cm) and can become sore. Most often the swelling is caused by an infection, but it can also be caused by cancer.

Cancers can metastasize (spread) through the lymph system from the site of the original tumor to distant parts of the body where secondary tumors are formed. The purpose of a lymph node biopsy is to determine the cause of the swelling and/or to see whether cancer has begun to spread through the lymph system. This information is important in staging the cancer and devising a treatment plan.

Precautions

Women who are pregnant should inform their doctor before a lymph node biopsy, although **pregnancy** will not affect the results.

Description

There are three kinds of lymph node biopsy. Fine-needle aspiration (FNA) biopsy, often just called needle biopsy, is done when the lymph node of interest is near the surface of the body. A hematologist (a doctor who specializes in blood diseases) usually performs the test. In FNA biopsy, a needle is inserted through the skin and into the lymph node, and a sample of tissue is drawn from the node. This material is preserved and sent to the laboratory for examination.

Advantages of a needle biopsy are that the test is minimally invasive. Only a local anesthetic is used, the procedure generally takes less than half an hour, and there is little **pain** afterwards. The disadvantage is that cancer may not be detected in the small sample of cells removed by the needle.

Open lymph node biopsy is a surgical procedure. It is done by a surgeon under **general anesthesia** on lymph nodes in the interior of the body and under **local anesthesia** on surface lymph nodes where FNA biopsy is considered inadequate. Once there is adequate anesthesia, the surgeon makes a small cut and removes either the entire lymph node or a slice of tissue that is then sent to the laboratory for examination. Results in both kinds of biopsies take one to three days.

Open biopsy can be advantageous in that it is easier to detect and identify the type of cancer in a large piece of tissue. Also, lymph nodes deep in the body can be

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sampled. Disadvantages include a longer recovery time, soreness at the biopsy site for several days, and the use of deeper anesthesia, increasing the risks to the patient. The procedure is done in a hospital or outpatient surgery center and takes about an hour, with additional time to recover from general anesthesia.

The third type of lymph node biopsy is known as sentinel node biopsy or sentinel node procedure. A sentinel node is the first lymph node or group of nodes reached by a cancer metastasizing from a primary tumor. This type of biopsy was pioneered at the John Wayne Cancer Institute in the 1990s. It is done as part of cancer staging, to determine whether a cancer has spread to a nearby lymph node. Sentinel node biopsy is most commonly done in patients with **breast cancer** or **malignant melanoma**, although it has also been used in patients with **colon cancer**, cancer of the cervix, or **vulvar cancer**.

To perform a sentinel node biopsy, the surgeon injects a radioactive form of technetium near the tumor several hours before the biopsy. About 15 minutes before the biopsy, a blue dye is injected in the same manner. The nodes that take up the dye and radioactive tracer are the sentinel lymph nodes. The surgeon then removes the sentinel nodes and sends them to a pathologist for examination, which takes less than 30 minutes. If cancer is detected in the sentinel node, the surgeon can remove additional lymph nodes. The advantage of the sentinel node procedure is to avoid the unnecessary removal of lymph tissue. This type of biopsy can be done as an outpatient procedure or require a short hospital stay.

Preparation

No particular preparation is necessary for a needle biopsy. For an open biopsy, patients need standard preoperative blood tests and other tests to evaluate general health. The doctor should be informed about any medications (prescription, non-prescription, or herbal) the patient is taking, as well as past bleeding problems or **allergies** to medication or anesthesia.

Aftercare

Little aftercare is needed in a needle biopsy other than a bandage to keep the biopsy site clean. Patients who have general anesthesia for an open biopsy often feel drowsy and tired for several days following the procedure, and should not plan to drive home after biopsy. The incision site must be kept clean and dry, and a follow-up visit to check on healing is usually necessary.

Risks

There are few risks associated with lymph node biopsy. The main risks are excessive bleeding (usually only in people with blood disorders) and allergic reaction to general anesthesia (rare). Occasionally the biopsy site becomes infected. In a few cases there may be **numbness** or nerve damage when the lymph node being tested lies close to a nerve. Some patients who have sentinel node biopsies develop an allergic reaction to the blue dye or find their urine or skin temporarily discolored by the dye.

Results

Normal lymph nodes are small and flat. When examined under the microscope, they show no signs of cancer or infection.

Abnormal lymph nodes are usually enlarged and contain cancerous (malignant) cells and/or show signs of infection.

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ORGANIZATIONS

Alliance for Lung Cancer Advocacy, Support, and Education, P.O. Box 849, Vancouver, WA, 98666, (800) 298-2436., nhlbiinfo@nhlbi.nih.gov, http://www.alcase.org.

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329–4251, (800) 227–2345, info@cancer.org, http://www.cancer.org.

American Lung Association, 1301 Pennsylvania Ave., NW, Suite 800, Washington, DC, 20004, (800) 548–8252, webmaster@lungusa.org, http://www.lungusa.org.

National Heart, Lung and Blood Institute, P.O. Box 30105, Bethesda, MD, 20824–0105, (301) 251–2222, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi.nih.gov.

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Lymphadenitis

Definition

Lymphadenitis is the inflammation of a lymph node, also sometimes called a lymph gland. The inflammation happens usually in the presence of swollen or enlarged lymph node(s). Because of this symptom, lymphadenitis is commonly called swollen lymph nodes. It is often a complication of a bacterial infection of a wound, although viruses or other disease agents can also cause it. Lymphadenitis may be either one that involving a number of lymph nodes all over the body (what is called generalized lymphadenitis) or limited to a few nodes in the area of a localized infection (what is termed localized lymphadenitis). Most of the time, the infection of lymph nodes occur in the head and neck, or in the areas of the armpits and groin.

The condition is sometimes accompanied by lymphangitis, which is the inflammation of the lymphatic vessels that connect the lymph nodes. When the disease of a lymph node is caused by an autoimmune disease or a malignancy, in addition to infection, the disease is called lymphadenopathy.

Swollen lymph node glands in a young girl's neck. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Demographics

Anyone from anywhere in the world can contract lymphadenitis.

Description

Lymphadenitis is marked by swollen lymph nodes that are painful, in most cases, when the doctor touches them. If the lymphadenitis is related to an infected wound, the skin over the nodes may be red and warm to the touch. If the lymphatic vessels are also infected, there will be red streaks extending from the wound in the direction of the lymph nodes. In most cases, the infectious organisms are hemolytic *Streptococci* or *Staphylococci*.

The lymphatic system consists of a vast network or organs, lymph vessels (channels), lymph ducts, and lymph nodes that stretch throughout the human body. The system moves fluid, called lymph, from the tissues to the bloodstream. About 600 lymph nodes exist in the body, with most of them located in the head and neck. They are used to filter the lymph fluid, and to help counter infection, with the use of white blood cells. This extensive network of lymphatic vessels throughout the body and their relation to the lymph nodes helps to explain why bacterial infection of the nodes can spread rapidly to or from other parts of the body. Lymphadenitis in children often occurs in the neck area because these lymph nodes are close to

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the ears and throat, which are frequent locations of bacterial infections in children.

Causes and symptoms

Streptococcal and staphylococcal bacteria are the most common causes of lymphadenitis, although viruses, protozoa, rickettsiae, fungi, and the **tuberculosis** bacillus can also infect the lymph nodes. Diseases or disorders that involve lymph nodes in specific areas of the body include rabbit **fever** (**tularemia**), **cat-scratch disease**, **lymphogranuloma venereum**, **toxoplasmosis**, **chancroid**, **sexually transmitted diseases** such as **genital herpes** and **syphilis**, **strep throat**, ear infections, mononucleosis, infected **acne**, infections from **wounds**, dental abscesses, and bubonic **plague**.

In children, **tonsillitis** or bacterial sore throats are the most common causes of lymphadenitis in the neck area. Diseases that involve lymph nodes throughout the body include mononucleosis, **cytomegalovirus infection**, toxoplasmosis, and **brucellosis**. Because lymph nodes play a critical role in fighting off bacteria, viruses, and other foreign invaders within the human body, it is especially important to see a medical professional when these glands become swollen and enlarged.

The early symptoms of lymphadenitis are swelling of the nodes caused by a buildup of tissue fluid and an increased number of white blood cells resulting from the body's response to the infection. The enlargement of the nodes may reach upwards of 0.4 inch (about 1 centimeter). These nodes are also usually tender to the touch. Further developments include fever, often as high as 101 to 102°F (38 to 39°C) together with chills, runny nose, **sore throat**, loss of appetite and weight loss, heavy perspiration or night sweats, difficult in swallowing and breathing, a rapid pulse, red and inflamed skin over the swollen gland, and general weakness.

If lymph nodes become swollen throughout the body, then such a situation may indicate the infection is one involving mononucleosis, **measles**, or **mumps**; or an immune disorder such as **rheumatoid arthritis**, human **immunodeficiency** virus (HIV), or lupus. In rare cases, the lymph node may grow larger and become hard to the touch—a condition that is rare but may indicate a tumor.

Diagnosis

Physical examination

The diagnosis of lymphadenitis is usually based on a combination of the patient's history, the external symptoms, and laboratory cultures. The doctor will press (palpate) the affected lymph nodes to see if they are sore or tender. Swollen nodes without soreness are often caused by cat-scratch disease. In children, the doctor will need to rule out mumps, tumors in the neck region, and congenital cysts that resemble swollen lymph nodes.

Although lymphadenitis is usually diagnosed in lymph nodes in the neck, arms, or legs, it can also occur in lymph nodes in the chest or abdomen. If the patient has acutely swollen lymph nodes in the groin, the doctor will need to rule out a **hernia** in the groin that has failed to reduce (incarcerated inguinal hernia). Hernias occur in 1% of the general population; 85% of patients with hernias are male.

Laboratory tests

The most significant tests are a **white blood cell count** (WBC) and a **blood culture** to identify the organism. A high proportion of immature white blood cells indicates a bacterial infection. Blood cultures may be positive, most often for a species of staphylococcus or streptococcus. In some cases, the doctor may order a biopsy of the lymph node.

Other tests the doctor may order include an x ray or computerized tomography (CT) scan of the effected area. A **lymph node biopsy** may also be performed so that a small sample of the lymph node can be examined within a laboratory setting.

Treatment

Medications

The medications given for lymphadenitis vary according to the bacterium or virus that is causing it. If the patient also has lymphangitis, he or she will be treated with **antibiotics**, usually penicillin G (Pfizerpen, Pentids), nafcillin (Nafcil, Unipen), or **cephalosporins**. Erythromycin (Eryc, E-Mycin, Erythrocin) is given to patients who are allergic to penicillin.

Over-the-counter **pain** relievers (analgesics/analgesics) may also be used to reduce pain and relieve some of the symptoms. Anti-inflammatory drugs help to reduce inflammation and swelling.

Treatment of swollen lymph nodes where the underlying cause is an immune disorder revolves around treating the underlying condition itself.

If the swollen lymph nodes are caused by different types of **cancer** (such as lymphoma, leukemia, or other cancers that spread to the lymph nodes), then treatment depends on the recommended treatment for

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KEY TERMS

Hemolytic—Able to break down or dissolve red blood cells. The bacteria that cause lymphadenitis are hemolytic.

Hernia—The bulging of a part of the intestine or other organ through its surrounding wall of tissue. Most hernias are in the abdominal cavity. An inguinal hernia is located in the groin area.

Lymph nodes—The gland-like masses of tissue in the lymphatic system that contain lymphocytes. The lymph nodes also filter lymph, which is a clear yellowish tissue fluid that carries lymphocytes and fats throughout the body.

Lymphangitis—Inflammation of the lymphatic vessels. It often occurs together with lymphadenitis.

Septicemia—The presence of bacteria and their toxins in the bloodstream. Septicemia is sometimes called blood poisoning.

Staphylococcus—Any of several species of spherical bacteria that occur in groups of four or irregular clusters. *Staphylococci* frequently cause skin infections.

Streptococcus—Any of several species of bacteria that are spherical in shape and form pairs or chains. *Streptococci* cause scarlet fever, tonsillitis, and pneumonia, and are often involved in lymphadenitis.

the cancer, such as **chemotherapy**, radiation, or surgery.

If lymphadenitis is not treated properly the formation of abscesses may occur. These abscesses contain fluid, white blood cells, bacteria, dead tissue, and other materials. When such abscesses occur, a doctor usually drains them, along with prescribing antibiotics. In addition, when a bacterial infection occurs within the lymphatic system, such a condition can lead to **sepsis**, which is a serious infection found within the bloodstream. Hospitalization is usually required because intravenous antibiotics are needed to combat the widespread infection.

Supportive care

Supportive care of lymphadenitis includes resting the affected limb and treating the area with hot, moist compresses.

Surgery

Cellulitis associated with lymphadenitis should *not* be treated surgically because of the risk of spreading the infection. Pus is drained only if there is an **abscess** and usually after the patient has been started on antibiotic treatment. In some cases, a biopsy of an inflamed lymph node is necessary if a diagnosis has not been made and response to treatment has not occurred.

Prognosis

The prognosis for a full recovery is good if the patient is treated promptly with antibiotics. In most cases, the infection can be brought under control in three or four days. However, it may take several weeks, or even months, for the swelling to subside and the area to return to normal. Patients with untreated lymphadenitis may develop blood poisoning (septicemia), which is sometimes fatal.

Prevention

Prevention of lymphadenitis depends on prompt treatment of bacterial and viral infections. The practice of living healthy, with special concern on good hygiene, is especially helpful in preventing lymphadenitis, as it is in any infection.

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Lymphangiography

Definition

Lymphangiography, or lymph node angiogram, is a test which utilizes x-ray technology, along with the injection of a contrast agent, to view lymphatic circulation and lymph nodes for diagnostic purposes.

Purpose

The lymphatic system is a one way circulation that channels tissue fluid back into the heart. The watery fluid called lymph seeps out of the blood into tissues, and while journeying back to the heart, it picks up germs, **cancer** cells, and some waste products. Lymph passes through the lymph nodes, which are major arsenals of immune defense that attack germs carried in the lymph. Cancer cells are also subject to attack in lymph nodes.

Cancers of the lymph system, such as Hodgkin's disease and non-Hodgkin's lymphomas, spread throughout the body. Treatment often depends upon finding all the disease and directing radiation to each location. Planning other kinds of treatment, such as surgery or **chemotherapy**, may also require that the full extent of the disease be known.

The lymphatic circulation may become clogged by infection, injury, or several other types of cancer that have spread through lymphatic channels. Swelling, sometimes massive, can result from blocked lymphatics. The most outstanding example of this is the tropical disease **filariasis**, which results in the swelling of the legs termed elephangiasis.

Lymphangiography gives precise information on the extent and location of lymph vessels and lymph nodes. Oftentimes, it is performed to evaluate the extent of a lymphatic cancer. Rarely, it is a tool, which aids surgeons attempting to reconstruct the lymphatics.

Precautions

Lymphangiography should not be performed on patients with dye or shellfish **allergies** or on patients with chronic lung disease, **kidney disease**, heart disease, or **liver disease**.

Description

A lymphangiogram begins by injecting a blue dye into a hand or foot. The lymph system picks up dye, which in turn will highlight the lymph vessels. This process may take a full day. When the lymphatic channel is clearly visible, the radiologist will insert an even tinier needle into that vessel and inject a contrast agent. X rays outline the journey of the contrast agent as it travels to the heart through lymph vessels and nodes.

KEY TERMS

Contrast agent—A substance that makes shadows on x rays.

Filariasis—A tropical disease caused by worms that live in lymph channels.

Hodgkin's disease—A cancer of the lymphatic system.

Lymphoma—A type of lyphatic cancer.

Preparation

Unless a dye allergy is suspected, no special preparation is need. If an allergy is suspected, a non-ionic contrast agent can be administered instead.

Aftercare

Prior to suture removal seven to 10 days after the procedure, the patient should watch for any sign of infection around the site.

Risks

Lipid **pneumonia** can occur if the contrast agent penetrates the thoracic duct. An allergic reaction to the contrast agent is possible, causing a range of symptoms that can range from innocuous to life threatening.

Resources

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Tretbar, Lawrence, L., et al., eds. *Lymphedema: Diagnosis and Treatment*. Berlin: Springer, 2007.

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Lymphedema

Definition

Lymphedema involves blockage of the lymph vessels, with a resulting accumulation of lymphatic fluid in the interstitial tissues of the body.

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Demographics

Lymphedema affects approximately 100 million people worldwide, including at least 3 million people in the United States. It is estimated to affect approximately 10–40% of women affected by **breast cancer**. Women who undergo surgery to remove lymph nodes under the arm (axillary area) are at risk for lymphedema, as are those who have radiation in the underarm area.

Description

The lymphatic system consists of lymph vessels and lymph nodes throughout the body. The lymph vessels collect lymphatic fluid, which consists of protein, water, fats, and wastes from cells. The lymph vessels transport the fluid to the lymph nodes, where waste materials and foreign materials are filtered out from the fluid. The fluid is then returned to the blood. When the vessels are damaged or missing, the lymph fluid cannot move freely throughout the system but accumulates. This accumulation of fluid results in abnormal swelling of the arm(s) or leg(s), and occasionally swelling in other parts of the body.

Causes

Primary lymphedema is an inherited condition, where the patient is born without lymph vessels and nodes. The swelling associated with primary lymphedema usually occurs during adolescence and affects the foot or calf. A rare form of primary lymphedema, called Milroy's Disease, occurs in **pregnancy**. However, secondary lymphedema, or acquired lymphedema, develops as a result of an injury to the lymph system. Specific causes include surgical treatments for certain types of cancers, especially those cancers that currently require the removal of lymph nodes. Radiation treatment for **cancer** or for some AIDs-related diseases such as Kaposi-Sarcoma may also result in lymphedema, as radiation may damage or destroy lymph nodes or cause the formation of scar tissue that can interrupt the normal flow of the lymphatic fluid. Specific cancers and their treatment that may result in lymphedema include **malignant melanoma**, breast (in both women and men), gynecological, head and neck, prostate, testicular, bladder, and **colon cancer**. Other causes of lymphedema include trauma to the lymphatic system from **burns**, **liposuction**, tattooing, injuries, surgery, radiation, **obesity**, heart or circulatory disease, and **multiple sclerosis**. Lymphedema in people at risk may not develop the condition immediately, but develop the condition weeks, months, or even years later. Aircraft travel has been linked to the development of lymphedema in patients after cancer surgery, possible due to the decreased cabin pressure.

In Western countries, one of the most common causes of lymphedema is **mastectomy** with axillary dissection (removal of the breast and underarm lymph tissue for treatment of breast cancer), which may result in lymphedema of the breast, underarm, or arm on the side of the surgery in 10–20% of patients. This occurs because the lymphatic drainage of the arm passes through the axilla (armpit), and tissue in the axilla is removed during the mastectomy. To reduce the risk of developing lymphedema after breast cancer treatment, there is an alternative treatment that avoids axillary lymph node dissection. Sentinel **lymph node biopsy** is a new diagnostic procedure used to determine whether the breast cancer has spread (metastasized) to axillary lymph nodes. A sentinel lymph node biopsy requires the removal of only one to three lymph nodes for close review by a pathologist. If the sentinel nodes do not contain tumor (cancer) cells, this may eliminate the need to remove additional lymph nodes in the axillary area. Early research on this technique indicates that sentinel lymph node biopsy may be associated with less **pain** and fewer complications than standard axillary dissection. Because the procedure is so new, long term data are not yet available. However, there is still a risk for developing lymphedema because of follow-up radiation treatments or **chemotherapy**, which may also damage the lymph nodes.

Symptoms of lymphedema include:

- swelling of an affected limb, which may develop gradually or suddenly
- tightness of the skin and a feeling of heaviness in the affected area
- discomfort or a feeling of "pins and needles" in the affected area
- pitting edema, which can be identified by observing a temporary indentation in the swollen area when pressure is placed on the affected area
- aching in the adjacent shoulder or hip due to the increasing weight of the swelling limb
- tight fitting of a ring, wristwatch, or bracelet, without a gain in weight.

Diagnosis

In 90% of the cases, lymphedema is diagnosed through observations, measurements, and symptoms. The remaining 10% require the use of more complex diagnostic tests such as lymphoscintigraphy. Lymphoscintigraphy is a technique in which a radioactive

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KEY TERMS

Axillary nodes—Lymph nodes found in the armpit that drain the lymph channels from the breast.

Clinical aromatherapy—Aromatherapy is the therapeutic use of plant-derived, aromatic essential oils to promote physical and psychological well-being. It is sometimes used in combination with massage and other therapeutic techniques as part of a holistic treatment approach.

Debulking—General term used for surgeries in which subcutaneous tissue is removed from a lymphodemous limb.

Fibrosis—Formation of fibrous tissue as a reaction or as a repair process; may occur due to treatment and/or disease. in lymphedema condition known as hardening of the limb with resulting restriction of circulatory flow, increased infection, and weeping sores.

Fibrotic—Pertaining to or characterized by fibrosis. In dermatological description, "fibrotic" would be used to describe leathery, bound-down, or thickened, scarred skin.

Interstitial fluid—The fluid between cells in tissues. Referred to as the liquid substance of the body.

Interstitial space—The fluid filled areas that surround the cells of a given tissue; also known as tissue space.

Long-stretch bandages—Specialized bandages, similar to an Ace bandage, that have 100 to 200% stretch.

Low-stretch bandage—Specialized bandages, with 30 to 90% stretch, that are used to obtain the correct compression during the treatment of lymphedema; also known as short-stretch bandages.

Lymph—The almost colorless fluid that bathes body tissues and is found in the lymphatic vessels that drain the tissues of the fluid that filters across the blood vessel walls from blood. Lymph carries antibodies and lymphocytes (white blood cells that help fight infection) that have entered the lymph nodes from the blood.

Lymph nodes—Small bean-shaped organs of the immune system, distributed widely throughout the body and linked by lymphatic vessels. Lymph nodes are garrisons of B, T, and other immune cells.

Lymph System—When sickness or infection invades the body, the immune system is the first line of defense. A big part of that defense is the lymph system. Lymph is carried through the body by lymph vessels that have valves and muscles to help move the fluid. Along the route are lymph nodes that serve as filters for harmful substances. This network of vessels and nodes together is called the lymph system.

Lymphatic fluid—The clear fluid found outside the cells which bathes the tissues. It is collected, filtered, and transported by the lymphatic system from around the tissues to the blood circulatory system. Fluid that collects as a result of lymphedema.

Nail beds—The underlying connective tissue that nourishes the finger and toenails.

Pitting edema—When a swollen area is pressed, the pressure leaves an indentation (pit) that takes time to fill back in.

Sentinel node biopsy—A newer procedure performed in order to determine whether breast cancer has spread to auxiliary (underarm) lymph nodes. A blue radioactive tracer and/or blue dye is injected into the area of the breast tumor. The lymphatic vessels carry the dye or radioactive material, to a "sentinel node". This sentinel node is thought to be the first lymph node receiving fluid from the tumor and the one most likely to contain cancer cells if the cancer has spread. Only if the sentinel node contains cancer cells are more lymph nodes removed.

Skin contracture—A permanent tightening of the skin that prevents normal movement of the associated body part and that can cause permanent deformity. A contracture develops when the normally elastic connective tissues are replaced by inelastic fibrous tissue. This makes the affected area resistant to stretching and prevents normal movement.

substance that concentrates in the lymphatic vessels is injected into the affected tissue and is mapped using a gamma camera, which images the location of the radioactive tracer. **Magnetic resonance imaging** (MRI), computed tomography (CT) scanning, and duplex ultrasound are imaging techniques that are also sometimes used as diagnostic tools for lymphedema.

Persons who have developed lymphedema after cancer treatment should be checked for a diagnosis of possible reoccurrence of cancer, if they experience a sudden increase of swelling, since the tumor growth may be responsible for blocking lymphatic flow.

There are three stages associated with the diagnosis of lymphedema:

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- Stage 1 (spontaneously reversible) - tissue is still at the pitting stage and soft to the touch. Upon waking in the morning, the limbs or affected areas are of normal or almost normal size.
- Stage 2 (spontaneously irreversible) - tissue is non-pitting and no longer soft to the touch, fibrosis begins to form, and the limbs increase in size.
- Stage 3 (lymphostatic elephantiasis) - swelling is irreversible and the affected areas are very swollen. The skin hardens and begins to break down, fibrosis is more extensive, and patients may need surgery to remove some of the swollen tissues.

Treatments

Lymphedema is a chronic condition that cannot be cured but can be improved with treatment. There are several major components of a lymphedema treatment program, which should be administered by the health care provider in cooperation with a physical therapist trained in lymphedema treatment. Complete Decongestive Therapy (CDT; also referred to as Complex Decongestive Therapy (CDT) or as Complete Decongestive Physiotherapy (CDP)) combines manual lymph drainage (MLD) with compression techniques and with patient education on self-care needs. The goals of the treatment program are to:

- remove the stagnant lymph fluids out of the tissues
- reduce and help control swelling
- soften fibrotic tissue
- improve the overall health of the patient

However, some lymphedema specialists feel that lymphedema patients with metastatic cancer should not be treated with CDT, to prevent the spreading of the cancer.

MLD was developed in 1932 in Denmark by a doctor and his wife. It was widely used in Europe and now is accepted as a therapy for lymphedema patients in the United States. In MLD a series of rhythmic, light strokes are made in a specific sequence along the lymphatic vessels and the adjoining tissues. These movements remove the lymph fluids from the tissues and return them to the circulatory system, thus reducing swelling in the affected area.

Compression techniques include the use of compression garments, compression aids, and compression **bandages**. These techniques encourage natural drainage and prevent swelling by supporting tissues in a way that aids in drainage. Compression garments are knit, stretch sleeves or stockings. Compression aids are custom-fitted sleeves, stockings, or pads made of fabric-covered foam. Bandages are an effective and flexible means of compression. They work when the patient is active or is resting and can easily be adjusted to fit changing limb sizes. However, the bandage should be a special type of short-stretch bandage and not the long-stretch bandage that is commonly known as Ace bandages. Only persons who are trained in lymphedema therapy should tape or wrap swollen areas.

Self-care techniques are practiced by the patient or his or her caregiver at home, between visits to the therapist. Self-care techniques include self-massage, skin care to maintain healthy tissue, nutritious diet, and **exercise** to increase lymph flow, increase mobility, and to improve the patient's general health.

Exposure to extreme heat has the potential to increase lymphedema swelling, so an affected person or a person at risk of developing lymphedema should avoid hot tubs, saunas, and steam rooms.

To keep the affected extremities as healthy as possible, a person with lymphedema should keep the swollen areas clean and avoid heavy lifting and pulling as well as avoid any type of trauma, such as cuts, **bruises**, **sunburn** or other burns, injections, **sports injuries**, insect **bites**, or cat scratches. Some doctors and lymphedema therapists recommend that a person with lymphedema use a preventative course of **antibiotics** when having dental treatment, that is, starting antibiotics several days before the appointment and continuing several days afterwards. A person at risk of developing lymphedema (for example, a woman who has been treated for breast cancer) should also observe the same type of precautions to prevent the development of the condition.

If infections occur, then all treatments for lymphedema should be discontinued while the infection is present, and the infection treated with antibiotics.

Surgery is sometimes used to remove excess tissue ("debulking") if the swollen limb becomes so large and heavy as to interfere with movement.

Exercise is important for a person with lymphedema, but only in moderation. If the extremity starts to ache, the person should lie down and elevate the swollen limb. Recommended exercises include walking, swimming, light aerobics, bike riding, and **yoga**.

Persons with lymphedema should wear a lymphedema alert bracelet or necklace for safety during a medical emergency, explaining the risk of infections. They may also benefit from counseling and membership in support groups to deal with the psychological impact of the disease. Sometimes patients with lymphedema will be denied insurance coverage for treatment; as a result patient advocacy groups in 2005

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are attempting to get a law passed through the U.S. Congress guaranteeing insurance coverage for lymphedema.

Alternative and complementary therapies

The use of clinical **aromatherapy** in conjunction with CDT may improve the quality of life for persons with lymphedema. Clinical aromatherapy involves the use of essential oils to improve the functioning of the immune system, for the immune system is closely associated with the lymphatic system. Also a massage oil comprised of a blend of frankincense, grapefruit, hyssop, and lavender, may be used to soften scarred and fibrotic tissues. Radiation treatments can cause skin **contractures**, which can be helped by massage with a blend of cajeput, frankincense, hyssop, lavender, sage, and tea tree. Radiation can also have adverse effects on the bowel, resulting in poor bowel functioning, scarring, and activity restrictions. Massaging the abdomen with a blend of grapefruit, fennel, helichrysum, lavender, myrrh, and sage may improve intestinal functions. When compression techniques are used, the underlying skin can be treated with a blend of bay laurel, chamomile, geranium, helchrysum, lavender, patchouli, and vetiver in a combination of castor oil, safflower oil, and grapeseed oil as carrier oils. Good skin care is important in preventing infections. Body oils that contain cajeput, cypress, lavender, marjoram, and rosewood can be applied after bathing to keep the skin moist and healthy. Finger nail beds can be a portal of entry for infections, so can be kept moist with an essential oil blend of chamomile, geranium, lavender, lemon, sage, tea tree, and ylang ylang.

Prognosis

Lymphedema is a very serious condition. There is no cure for lymphedema and once it develops, it can be a long-term, uncomfortable, and sometimes painful condition requiring daily treatment. When lymphedema is not treated, the protein-rich fluid continues to accumulate, leading to even more swelling and hardening (referred to as fibrosis) of the tissues. This fluid is a good culture medium for bacteria, thus resulting in reoccurring infections when there are injuries to the skin, decrease or loss of functioning of the affected limbs, and skin breakdown. Infections, referred to lymphangitis, can affect the connective tissue under the skin. Repeated infections may result in scarring, which in turn makes the tissue susceptible to more swelling and infection. Over time, these infections result in tissue hardening (i.e., fibrosis), which is a characteristic of advanced chronic lymphedema. In very severe cases, untreated lymphedema may even result in a rare form of lymphatic cancer called lymphangiosarcoma.

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Lymphedema Awareness Foundation. http://www.elymphnotes. org/

Lymphedema People. Web site: www.lymphedemapeople.com/

National Lymphedema Network, Latham Square Building, Suite 1111, 1611 Telegraph Avenue, Oakland, CA 94612-2138. Telephone: (800) 541-3259. Fax: (510) 208-3110. Web site: www.lymphnet.org

Judith Sims, Ed.D.
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Lymphocyte typing

Definition

Lymphocyte typing focuses on identifying the numbers and relative percentages of lymphocytes in an individual's bloodstream. Lymphocytes, primarily T cells and B cells, are types of white blood cells, the underlying supports of the immune system in the bloodstream.

Purpose

Determining the numbers and relative percentages of T cells and B cells provides information on

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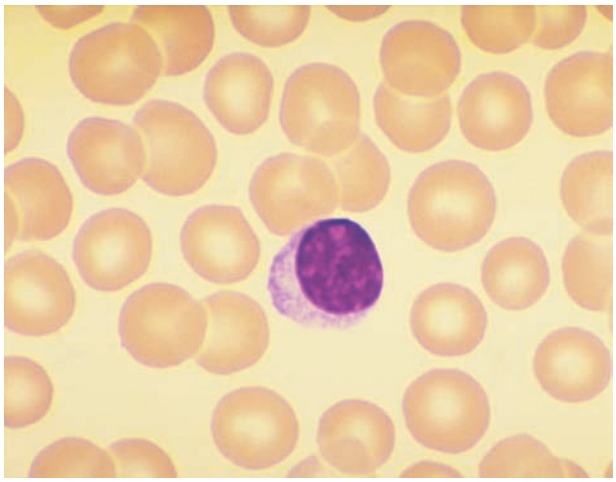

A lymphocyte cell. *(© Lester V. Bergman/Corbis.)*

KEY TERMS

Immune system—The body's system of defenses against infectious diseases.

Lymphocytosis—A condition in which the number of lymphocytes increases above normal levels.

Lymphopenia—A condition in which the number of lymphocytes falls below normal levels.

White blood cell—A class of cells in the blood that form the foundation of the body's immune system.

the state of a person's immune system. By comparing these values to normal numbers and percentages, the presence of disease and the side effects of certain drugs can be revealed. Lymphocyte typing can also show whether a person has been exposed to certain poisonous substances.

Description

To do a **white blood cell count**, a small amount of blood is drawn from a vein. The total number of white blood cells is calculated, either through microscopic examination of a blood smear or by using automated counting equipment. For a white blood cell count with differential, 100 white blood cells are counted and the proportion of each type is calculated. Since T cells and B cells have similar appearances, a differential can only give the proportion of lymphocytes in the blood, not the proportion of specific lymphocyte types.

For more specific information on B cells and T cells, it is necessary to divide the blood into its separate components. In this procedure, a tube of blood is placed in a centrifuge, a piece of equipment that spins the tube in circles at high speed. The force generated by the spinning causes the various elements in the bloodstream to settle at different levels of the tube.

The lymphocytes are extracted from the tube and treated with special dyes, or stains. Each stain is equipped with an antibody portion that adheres to a specific type of lymphocyte, such as a B cell or a T cell. The stains make the cells visible to an automated counting machine, called a flow cytometer. Based on the number of times the machine detects a particular stain, it can calculate the number of the associated cell type. This procedure can also be used to classify T cells and B cells into their subtypes.

Preparation

If possible, a person should avoid eating a heavy meal within hours of the test or engaging in strenuous **exercise** for the 24 hours preceding the blood test.

Results

In general, normal levels of white blood cells vary slightly by age and gender. Normal values are lower in children under the age of 15 and in young adults between the ages of 20 and 30. After age 30, men have slightly higher levels of white blood cells than women.

Normal adult levels of white blood cells are 4,500–11,000 cells per microliter of blood. Lymphocytes account for approximately 25–45% of the total white blood cell count; the normal range is 1,000–4,800 lymphocytes per microliter of blood. Of the total lymphocytes, 60–80% are T cells and approximately 15% are B cells. (There are two other types of lymphocytes; natural killer and K-type; that constitute a minor proportion of the total lymphocyte numbers.)

Abnormal results

A higher-than-normal level of lymphocytes is called lymphocytosis. Lymphocytosis occurs if a person has a viral, bacterial, or other type of infection. It can also occur with certain blood disorders, such as leukemia.

Lower-than-normal levels of lymphocytes is called lymphopenia. Lymphopenia can be an indicator of certain cancers, bone marrow failure, or immune system deficiency. Medical treatments, such as **chemotherapy** and **radiation therapy**, can also deplete the body's supply of lymphocytes, as can exposure to poisonous substances.

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Julia Barrett

Lymphocytic choriomeningitis

Definition

Lymphocytic choriomeningitis (LCM) is a viral infection of the membranes surrounding the brain and spinal cord and of the cerebrospinal fluid.

Description

Lymphocytic choriomeningitis virus infection is relatively rare and recovery usually occurs spontaneously within a couple of weeks. Many cases are probably not even identified because the symptoms range from extremely mild to those resembling severe flu. A few patients develop symptoms of **meningitis**. In some rare cases, the LCM viral infection can spread throughout the central nervous system, and may even be fatal.

Causes and symptoms

LCM is caused by an arenavirus, which is an RNA virus and is a mild cousin in the family containing the much more threatening arenaviruses that cause hemmorrhagic **fever**. Humans acquire LCM virus from infected rodents by coming in contact with the animals or their excretions. Exposure to the virus is not as unlikely to occur as it seems, because the viral hosts can be common house mice and even pets, such as hamsters and chinchillas. Most cases of LCM occur in fall and winter, when mice seek warmth inside dwellings. Food and dust can become contaminated by the excretions of rodents infected with LCM virus. In 1997, French scientists alerted physicians to suspect LCM viral infection in people who had contact with Syrian hamsters.

The symptoms of LCM occur in two phases. The first (prodrome) stage can produce fever, chills, muscle aches, **cough**, and **vomiting**. In the second phase, characteristic meningitis symptoms of **headache**, stiff neck, listlessness, and **nausea and vomiting** may occur. In adults, complications are rare and recovery may even occur before the second phase.

KEY TERMS

Prodrome—Symptom(s) experienced prior to the onset of a disease. For example, visual disturbances may precede and signal the onset of a migraine headache.

The virus is not spread from person to person, except through **pregnancy**. LCM virus is one of the few viruses that can cross the placenta from mother to child during pregnancy and may be an underrecognized cause of congenital infection in newborns. Infection with cytomegalovirus, *Toxoplasma gondii*,or LCM virus can appear similar enough in infants to be confused when diagnosed. In cases that have been recognized among infants, LCM viral infection has a high mortality rate (about one-third of the babies studied died).

Diagnosis

LCM can be distinguished from bacterial meningitis by the history of prodrome symptoms and the period of time before meningitis symptoms begin, which is about 15–21 days for LCM.

Treatment

No antiviral agents exist for LCM virus. Treatment consists of supporting the patient and treating the symptoms until the infection subsides, generally within a few weeks.

Jill S. Lasker

Lymphocytic leukemia, acute *see* **Leukemias, acute**

Lymphocytic leukemia, chronic *see* **Leukemias, chronic**

Lymphocytopenia

Definition

Lymphocytopenia is a condition marked by an abnormally low level of lymphocytes in the blood.

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Lymphocytes are a specific type of white blood cell with important functions in the immune system.

Description

Lymphocytes normally account for 15–40% of all white cells in the bloodstream. They help to protect the body from infections caused by viruses or fungi. They also coordinate the activities of other cells in the immune system. In addition, lymphocytes fight **cancer** and develop into antibody-producing cells that neutralize the effect of foreign substances in the blood.

Lymphocytopenia is the result of abnormalities in the way lymphocytes are produced, make their way through the bloodstream, or are lost or destroyed. These conditions can result from congenital or drug-induced decreases in the body's ability to recognize and attack invaders.

Causes and symptoms

Lymphocytopenia has a wide range of possible causes:

- AIDS and other viral, bacterial, and fungal infections
- Chronic failure of the right ventricle of the heart (this chamber of the heart pumps blood to the lungs)
- Hodgkin's disease and cancers of the lymphatic system
- A leak or rupture in the thoracic duct. The thoracic duct removes lymphatic fluid from the legs and abdomen.
- Leukemia
- Side effects of prescription medications
- Malnutrition. Diets that are low in protein and overall calorie intake may cause lymphocytopenia.
- Radiation therapy
- High stress levels
- Trauma.

The symptoms of lymphocytopenia vary. Lymphocytes constitute only a fraction of the body's white blood cells, and a decline in their number may not produce any symptoms. A patient who has lymphocytopenia may have symptoms of the condition responsible for the depressed level of lymphocytes.

Diagnosis

Lymphocytopenia is most often detected when blood tests are performed to diagnose other diseases.

KEY TERMS

B lymphocyte—A type of lymphocyte that circulates in the blood and lymph and produces antibodies when it encounters specific antigens. B lymphocytes are also called B cells.

Lymph—A clear yellowish fluid circulated by the lymphatic system. The lymph carries mostly lymphocytes and fats.

Lymphocyte—A specific type of white blood cell that is important in the production of antibodies.

Treatment

Treatment for lymphocytopenia is designed to identify and correct the underlying cause of the condition.

Drug-depressed lymphocyte levels usually return to normal a few days after the patient stops taking the medication.

A deficiency of B lymphocytes, which mature into antibody-producing plasma cells, can result in abnormally low lymphocyte levels. When the number of B lymphocytes is low, the patient may be treated with **antibiotics**, antifungal medications, antiviral agents, or a substance containing a high concentration of antibodies (**gamma globulin**) to prevent infection.

It is not usually possible to restore normal lymphocyte levels in **AIDS** patients. Drugs like AZT (azidothymidine, sold under the trade name Retrovir) can increase the number of helper T cells, which help other cells wipe out disease organisms.

Prognosis

Very low levels of lymphocytes make patients vulnerable to life-threatening infection. Researchers are studying the effectiveness of transplanting bone marrow and other cells to restore normal lymphocyte levels. **Gene therapy**, which uses the body's own resources or artificial substances to counter diseases or disorders, is also being evaluated as a treatment for lymphocytopenia.

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Maureen Haggerty

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Lymphogranuloma venereum

Definition

Lymphogranuloma venereum (LGV) is a sexually transmitted systemic disease (STD) caused by a parasitic organism closely related to certain types of bacteria. It affects the lymph nodes and rectal area, as well as the genitals, in humans. The name comes from two Latin words that mean a swelling of granulation tissue in the lymph nodes resulting from sexual intercourse. Granulation tissue is tissue that forms during wound or ulcer healing that has a rough or lumpy surface.

Description

Although LGV is easily treated in its early stages, it can produce serious complications in its later stages. LGV is most likely to occur among people living in tropical or subtropical countries and among military personnel or tourists in countries or large cities with high rates of the disease. Prostitutes play a major role in carrying and transmitting LGV, as was documented during an outbreak in Florida in the late 1980s. There are about 1000 documented cases of LGV in the United States in an average year.

This man suffers from lymphogranuloma venereum, a venereal disease that is caused by the bacterium *Chlamydia trachomatis.* *(© Dr. Milton Reisch/Corbis.)*

Causes and symptoms

LGV is caused by *Chlamydia trachomatis*, a globe-shaped parasitic organism that reproduces only inside of living cells. *C. trachomatis* has 17 subtypes and is responsible for a wide range of infections in both men and women; however, only subtypes L1, L2, and L3 cause lymphogranuloma venereum. The parasite has a two-part lifecycle. In the first stage, it is inert and can survive outside of cells. In its second stage, it lacks a cell wall and actively reproduces after gaining entry to a cell. As the chlamydia organism reproduces inside the cell, it pushes the nucleus aside and forms an inclusion that can be identified with tissue staining. LGV differs from other diseases caused by *C. trachomatis* in that it affects the body's lymphatic system and not just the moist tissues of the genital region. In humans, the chlamydia organism is transmitted through vaginal or anal intercourse, oral sex, or contact with fluid from open ulcers or infected tissues.

Lymphogranuloma venereum has three stages. In its primary stage, the disease is more likely to be detected in men; it may go unnoticed in women. After an incubation period of four to 30 days, a small painless ulcer or blister develops in the genital area. Second-stage LGV develops between one and six weeks later. In this stage, the infection spreads to the lymphatic system, forming buboes (swellings) in the lymph nodes of the groin area. The buboes often merge, soften, and rupture, forming sinuses and fistulas (hollow passages and ducts) that carry an infectious bloody discharge to the outside of the body. Patients with second-stage LGV may also have **fever**, **nausea**, headaches, pains in their joints, skin **rashes**, and enlargement of the spleen or liver. Third-stage LGV, which is sometimes called anogenitorectal syndrome, develops in about 25% of patients. In men, this stage is usually seen in homosexuals. Third-stage LGV is marked by rectal **pain**, **constipation**, a discharge containing pus or bloody mucus, and the development of strictures (narrowing or tightening of a body passage) in the rectum or vagina.

LGV can have a number of serious complications. *C. trachomatis* infections of any subtype are associated with long-term fertility problems in women. Strictures in the rectum can completely close off the lower bowel, producing eventual rupture of the bowel and inflammation of the abdominal cavity. The patient can develop chronic abscesses or fistulae in the anal area or in the vagina in women. Long-term blockages in the lymph nodes can produce **elephantiasis**, a condition in which the patient's upper legs and groin area become greatly enlarged. Patients with chronic LGV infection

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KEY TERMS

Anogenitorectal syndrome—Another name for third-stage LGV.

Aspiration—A procedure in which pus or other fluid is removed from a body cavity through a hollow needle connected to a syringe.

Bubo—An inflamed swelling inside a lymph node, characteristic of second-stage LGV.

Elephantiasis—Abnormal enlargement of the legs and groin area caused by blockage of the lymphatic system, as a complication of LGV.

Fistula—A passageway formed by a disease or injury that drains fluid from an infected area to the outside or to other parts of the body.

Lymph—A clear yellowish fluid that circulates throughout the body, carrying white blood cells and fats. The system that produces and circulates lymph is called the lymphatic system; it includes lymph vessels, lymph nodes, the thymus gland, and the spleen.

Proctitis—Inflammation of the anus and rectum.

Stricture—An abnormal narrowing or tightening of a body passage. LGV can cause strictures to form in the patient's rectum, or in the vagina of female patients.

have a higher risk of developing **cancer** in the inflamed areas.

Chronic LGV can be reactivated in patients who become infected with the **AIDS** virus. These patients develop open ulcers in the groin that are difficult to treat.

Diagnosis

The diagnosis of LGV is usually made on the basis of the patient's history, careful examination of the genital area and lymph nodes, and blood tests or cultures to confirm the diagnosis. In the early stages of the disease, the doctor will need to distinguish between LGV and such other STDs as **syphilis** and herpes. If the patient has developed buboes, the doctor will need to rule out **tuberculosis**, **cat-scratch disease**, bubonic **plague**, or **tularemia** (a disease similar to plague that is carried by rabbits and squirrels). If the patient has developed rectal strictures, the doctor will need to rule out tumors or **colitis**.

There are several blood tests that can be used to confirm the diagnosis of LGV. The most commonly used are the complement fixation (CF) test and the microimmunofluorescence (micro-IF) tests. Although the micro-IF test is considered more sensitive than the CF test, it is less widely available. An antibody titer (concentration) of 1:64 or greater on the CF test or 1:512 or greater on the micro-IF test is needed to make the diagnosis of LGV. In some cases, the diagnosis can be made from culturing *C. trachomatis* taken from samples of tissue fluid from ulcers or buboes, or from a tissue sample from the patient's rectum.

Treatment

LGV is treated with oral **antibiotics**, usually tetracycline or doxycycline for 10–20 days, or erythromycin or trimethoprim sulfamethoxazole for 14 days. Pregnant women are usually treated with erythromycin rather than the **tetracyclines**, because this class of medications can harm the fetus.

Patients who have developed second- and third-stage complications may need surgical treatment. The doctor can treat buboes by withdrawing fluid from them through a hollow needle into a suction syringe. This procedure is called aspiration. Fistulas and abscesses also can be treated surgically. Patients who develop elephantiasis are usually treated by plastic surgeons. Patients with rectal strictures may need surgery to prevent bowel obstruction and rupture into the abdomen.

Prognosis

The prognosis for recovery for most patients is good, with the exception of AIDS patients. Prompt treatment of the early stages of LGV is essential to prevent transmission of the disease as well as fertility problems and other serious complications of the later stages.

Prevention

Prevention of lymphogranuloma venereum has four important aspects:

- Avoidance of casual sexual contacts, particularly with prostitutes, in countries with high rates of the disease.

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- Observance of proper safeguards by health professionals. Doctors and other healthcare workers should wear gloves when touching infected areas of the patient's body or handling soiled dressings and other contaminated items. All contaminated materials and instruments should be double-bagged before disposing.
- Tracing and examination of an infected person's recent sexual contacts.
- Monitoring the patient for recurring symptoms for a period of six months after antibiotic treatment.

Resources

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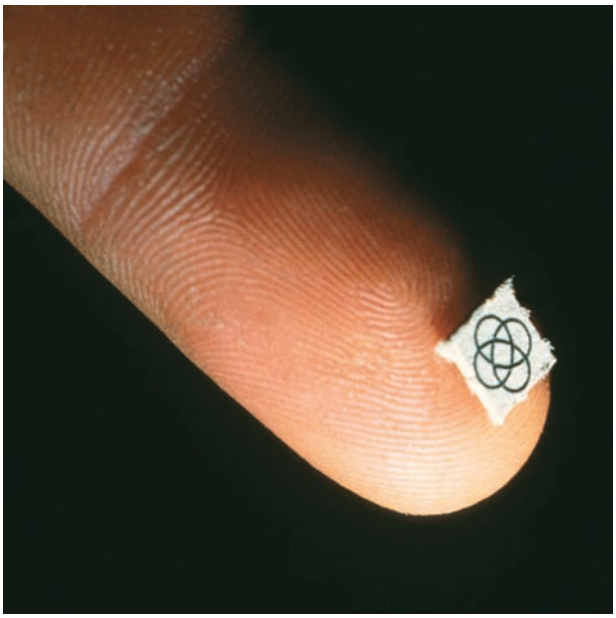
Rebecca J. Frey, PhD

Lymphomas *see* **Hodgkin's disease**

Lymphopenia *see* **Lymphocytopenia**

Lymphosarcomas *see* **Malignant lymphomas**



LSD on blotter paper. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Lysergic acid diethylamide (LSD)

Definition

Lysergic acid diethylamide (LSD), also known as "acid," belongs to a class of drugs known as hallucinogens, which distort perceptions of reality. LSD is the most potent mood and perception-altering drug known: doses as small as 30 micrograms can produce effects lasting six to 12 hours.

Purpose

In the United States, LSD has no accepted medical use and its manufacture and possession are illegal.

Description

LSD is produced synthetically from ergot, a fungus that grows on rye grass and some grains. This odorless, colorless, and slightly bitter-tasting chemical can be absorbed through the skin, but is usually taken orally. It is commonly distributed in small squares of drug-soaked absorbent paper which are chewed and swallowed. LSD and other hallucinogen use by secondary school students has decreased since 1998, but has increased among older teens and young adults attending dance clubs, raves, and concerts, according to the National Institute on Drug **Abuse**.

LSD alters perceptions by disrupting the action of serotonin, a neurotransmitter. How this happens is unknown. Its effects are most prominent in the cerebral cortex, the brain area involved in mood and perception, and the locus ceruleus, an area in the brain stem where sensory signals converge from all parts of the body. Mescaline and psilocybin, natural hallucinogens resembling LSD, have been used in social and religious rituals for thousands of years.

After its discovery in 1938, LSD was used experimentally to treat neuroses, narcotic **addiction**, **autism**, **alcoholism**, terminal **cancer**, and to study psychoses and **schizophrenia**. Nearly 30 years after its discovery, manufacture, possession, sale and use of LSD was restricted in the United States under the Drug Abuse Control Amendment of 1965.

Effects from LSD begin within an hour and last up to 12 hours. It is absorbed from the intestinal tract, circulates throughout the body and brain, is metabolized in the liver, and excreted in the urine within 24 hours. Physical effects of LSD may include loss of appetite, sleeplessness, pupil dilation, **dry mouth**, salivation, **palpitations**, perspiration, **nausea**, **dizziness**,

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KEY TERMS

Acid—Common street name for LSD.

Cerebral cortex—Brain region responsible for reasoning, mood, and perception.

Hallucinogen—A drug that distorts sensory perceptions and disturbs emotion, judgment, and memory.

Hallucinogen persisting perception disorder (HPPD)—The recurrence of LSD effects after the drug experience has ended.

Locus ceruleus—Area in the brain stem that processes sensory signals from all areas of the body.

Neurotransmitter—Chemical compound in the brain that transmits signals from one nerve cell to another.

Serotonin—A neurotransmitter that modulates the actions of other neurotransmitters in the brain.

blurred vision, **anxiety**, and increases in body temperature, heartbeat, blood pressure and blood sugar.

The major mental effects of LSD are emotional and sensory. Emotions may quickly shift from euphoria to confusion and despair. Users may simultaneously experience several emotions. Colors, smells, and sounds may be intense. Users may see sounds or smell colors. Time may seem to stand still. Users may have out-of-body sensations or feel as though their bodies have changed shape or merged with another person or object.

Precautions

Though it is a dangerous drug, LSD is not addictive like **cocaine**, amphetamines, heroin, alcohol, and nicotine. Its effects are unpredictable and vary with the amount taken and other underlying factors like personality, mood, expectations and environment. Users may have enjoyable experiences with some LSD trips and terrifying anxiety and despair with others. Most LSD-related deaths stem from panic reactions during intense LSD-triggered illusions.

Side Effects

There are two long-term effects associated with LSD use. One is **psychosis**; the other is "flashbacks.", hallucinogen persisting perception disorder (HPPD). The causes and how LSD produces these effects is unknown. They have been seen in chronic hallucinogen users with underlying personality problems and in individuals with no history of psychological disorders. Flashbacks can last from a few seconds to several hours. They generally involve seeing bright flashes, halos or trails attached to moving objects. LSD-induced psychosis may include dramatic mood swings, loss of cognitive and communication skills, and **hallucinations**.

According to the Drug Abuse Warning Network (DAWN), the number of LSD-related hospital emergencies is low compared to those related to cocaine, heroin, **marijuana**, **methamphetamine**, and other illicit drugs. One reason for this trend may be that LSD currently sold on the black market is less potent than in the past. LSD dose strengths tend to range from 20 to 80 micrograms today, compared to 100 to 200 micrograms reported during the 1960s and early 1970s.

Interactions

LSD flashbacks can be spurred by use of drugs such as marijuana. Preliminary evidence suggests serotonin reuptake inhibitors like Prozac and Zoloft may also exacerbate the LSD flashback syndrome.

ORGANIZATIONS

National Clearinghouse for Alcohol and Drug Information, P.O. Box 2345, Rockville, MD, 20847-2345, (877) 726-4727, http://store.samhsa.gov/.

National Institute on Drug Abuse, 6001 Executive Blvd., Room 5213, Bethesda, MD, (301) 443-1124, information@nida.nih.gov, http://drugabuse.gov.

United States Drug Enforcement Administration, Dr Mailstop: AXS, 2401 Jefferson Davis Highway, Alexandria, VA, 22301, (202) 307-1000, http://www.dea.gov.

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James E. Waun, MD, RPh

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M

Macular degeneration

Definition

Macular degeneration is the progressive deterioration of a critical region of the retina called the macula. Age-related macular degeneration (ARMD) is the most common form of macular degeneration. It is also known as age-related maculopathy (ARM), aged macular degeneration, and senile macular degeneration.

Demographics

Macular degeneration is the most common cause of legal blindness in people over 60, and accounts for approximately 11.7% of blindness in the United States or about 10 million Americans. Estimates of the frequency of macular degeneration vary widely by how the disorder is defined by researchers. Some studies estimate that more than 20% of Americans over the age of 60 are affected by the disorder. Other studies, with more rigorous criteria, have found that about 2% of Americans over age 70 and 6% over age 80 have significant macular degeneration.

Caucasians are most likely to be affected by macular degeneration. Individuals of Asian or African descent are less frequently affected, although the incidence has begun to rise in some Asian countries. Individuals of Inuit descent are at a higher risk. Females are slightly more likely to develop macular degeneration than males. People who have light colored eyes tend to have more severe degeneration than those with dark colored eyes. The reason for this is not known. Individuals who smoke, are obese, or have cardiovascular problems are also at increased risk for macular degeneration.

Description

The macula is a 3–5 mm area in the central part of the retina. It is very sensitive to light and is the part of the eye that allows people to see sharp, crisp details. In ARMD, central vision becomes blurry and may be completely lost. Peripheral vision (seeing "out of the corner of your eye") is not affected, so although people with ARMD may become legally blind (visual acuity of 20/200 or worse), ARMD does not lead to a complete absence of sight. Damage done to the retina by ARMD cannot be repaired. Vision cannot be restored to normal levels, but vision loss can often be slowed, especially if the disease is diagnosed early.

ARMD is subdivided into a dry (atrophic) and a wet (exudative) form. The dry form is more common and accounts for 70–90% of cases of ARMD. It progresses more slowly than the wet form and vision loss is less severe. In the dry form, the macula thins over time as part of the **aging** process and the pigmented retinal epithelium (a dark-colored cell layer at the back of the eye) is gradually lost. Words may appear blurred or hazy and colors may appear dim or gray.

In the wet form of ARMD, new blood vessels grow underneath the retina and distort the retina. These blood vessels can leak, causing scar tissue to form on the retina. The wet form may cause visual distortion and make straight lines appear wavy. A central blind spot develops. The wet type progresses more rapidly and vision loss is more pronounced. Treatments are available for some, but not most, cases of the wet form.

Other less common forms of macular degeneration include:

- Cystoid macular degeneration. Loss of vision in the macula due to fluid-filled areas (cysts) in the macular region. This may be a result of other disorders, such as aging, inflammation, or high myopia.
- Diabetic macular degeneration. Deterioration of the macula due to diabetes.
- Senile disciform degeneration (also known as Kuhnt-Junius macular degeneration). A specific and severe type of the wet form of ARMD that involves leaking blood vessels (hemorrhaging) in the macular region. It usually occurs in people over 40 years old.

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A slit-lamp view showing macular degeneration of the eye. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Causes and symptoms

Causes

The root cause of ARMD is not known, but scientists have found multiple genes that appear to be associated with the disease and there appears to be an inherited tendency toward developing the disorder. Dry ARMD develops because waste products build up in the retina. The outermost layer of the retina is called the retinal pigment epithelium (RPE). Under this is a layer of blood vessels called the choroid. Nutrients for the retina pass from the choroid blood vessels into the RPE. Waste products from the retina pass in the opposite direction, enter the bloodstream, and are removed. As individuals age, the RPE begins break down and thin out (atrophy). The waste-disposal system slows down, and waste begins to accumulate faster than it can be removed. Waste buildup causes clumps of yellow pigment, called drusen, to develop under the retina. Drusen are common in people over age 60. Ultimately this failure to dispose of retinal waste causes cells in the macula to become damaged, leading to a loss of central vision.

Some of the same things that are bad for the heart are thought to contribute to the development of macular degeneration. These risk factors include **smoking** and a diet that is rich in saturated fat. Smokers have a risk of developing ARMD that is approximately 2.4–3 times that of non-smokers. Smoking increases the risk of developing wet-type ARMD, and may increase the risk of developing dry-type as well. Dietary fat also increase the risk. In one study of older (aged 45–84) Americans, signs of early ARMD were 80% more common in the group who ate the most saturated fat compared to those who ate the least. Low consumption of **antioxidants**, such as foods rich in vitamin A, is associated with a higher risk for developing ARMD. Consumption of moderate amounts of red wine and foods rich in vitamin A is associated with a lower risk. It is generally believed that exposure to ultraviolet (UV) light may contribute to disease development, but this has not been proven.

Wet ARMD develops because the new blood vessels suddenly grow in the choroid layer. These are called choroidal neovascularizations (CNVs). They appear to grow in response to an accumulation of waste or lack of **nutrition** in the retina when the RPE begins to break down. The CNVs leak blood and fluid into the retina (thus the name "wet") causing disruption of the nutrition system and damaging the cells of the macula.

Another less common form of wet ARMD called retinal pigment epithelial detachment occurs when the choroid layer does not grown any CNVs, but fluid from the blood vessels already present leaks and collects under the RPE. Symptoms are the same as for other wet ARMD, but vision deteriorates much more slowly (months or years instead of days or weeks). Eventually new CNVs develop and this form of wet ARMD progresses to the more common form of wet ARMD.

Symptoms

Symptoms of dry and wet ARMD differ. Often dry ARMD shows no symptoms, and neither wet nor dry ARMD cause **pain**. In other cases, individuals with dry ARMD may:

- need more light for reading.
- find the colors look paler or washed out.
- have difficulty doing detailed work, such as needlepoint or model-making.
- have slightly hazy vision.
- take longer for their vision to adapt to low lighting.
- develop a blurry or blind spot in the center of their field of vision.

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KEY TERMS

Antioxidant—A molecule that prevents oxidation. In the body antioxidants attach to other molecules called free radicals and prevent the free radicals from causing damage to cell walls, DNA, and other parts of the cell.

Drusen—Clumps of pigment that accumulate under the retina when wastes build up faster than they can be removed. Drusen are a sign of dry age-related macular degeneration.

Fovea—A tiny pit in the macula that is responsible for sharp vision.

Macula—The sensitive center of the retina that is responsible for detailed central vision.

Neovascularization—Growth of new capillaries.

Off-label use—Drugs in the United States are approved by the Food and Drug Administration (FDA) for specific uses based on the results of clinical trials. However, it is legal for physicians to administer these drugs for other "off-label" uses. It is not legal for pharmaceutical companies to advertise drugs for off-label uses.

Photoreceptors—Specialized nerve cells (rods and cones) in the retina that are responsible for vision.

Retina—The light-sensitive membrane at the back of the eye that images are focused on. The retina sends the images to the brain via the optic nerve.

The main symptoms of wet ARMD are that straight lines appear distorted and central vision deteriorates rapidly. Sudden onset of symptoms, particularly vision distortion, requires immediate evaluation by an ophthalmologist.

A few people with ARMD develop visual **hallucinations**. They may see patterns, animals, faces, or other objects. This is called Charles Bonnet syndrome, and it is a neurological side effect of ARMD. Although these hallucinations can be upsetting they are not a sign of mental illness.

Diagnosis

To make the diagnosis of macular degeneration, the doctor (an ophthalmologist or a retinal specialist) dilates the pupil with eye drops and examines the interior of the eye, looking at the retina for the presence of yellow bumps called drusen and for gross changes in the macula such as thinning. The doctor also administers a visual field test, looking for blank spots in the central vision. The doctor may call for fluorescein **angiography** (intravenous injection of fluorescent dye followed by visual examination and photography of the back of the eye) to determine if blood vessels in the retina are leaking.

A central visual field test called an Amsler grid is usually given to patients who are suspected of having ARMD. It is a grid printed on a sheet of paper (so it is easy to take home). When looking at a central dot on the page, the patient should call the doctor right away if any of the lines appear to be wavy or missing. This may be an indication of fluid and the onset of wet ARMD. Patients may also be asked to come in for more frequent checkups.

Treatment

ARMD cannot be reversed or cured. The goal of treatment is to slow vision loss. Treatment depends on the type, location, and stage of ARMD. For mild (early-stage) dry ARMD, often the process only involves watchful waiting. Individuals should have regular eye examinations and see their eye care professional immediately if they note any vision changes. They can monitor their vision at home for signs that dry ARMD is converting to wet ARMD by using an Amsler grid obtainable from their physician. This is a simple checkerboard line grid with a dot in the middle. While staring at the dot, individuals with ARMD may notice that some of the lines appear to be missing. If the lines appear wavy, this is a sign that wet ARMD may be developing.

In wet-type ARMD and in senile disciform macular degeneration, new capillaries grow in the macular region and leak. Treatment for wet ARMD, involves procedures and drug therapy. Not every procedure is appropriate for every patient. Many clinical trials are currently underway to test new drugs and treatments for ARMD. Individuals interested in participating in a clinical trial at no cost can find a list of trials currently enrolling new patients at http://www.clinicaltrials.gov.

Photocoagulation is an outpatient procedure in which the doctor uses a laser to burn the CNVs and seal or destroy them so that they will not leak fluid. This is an outpatient procedure. This procedure is often unsuccessful or produces less than the desired results.

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Photodynamic therapy (PDT) involves the injection of the drug verteporfin (Visudyne) followed by laser treatment. The drug accumulates in the CNVs and is activated by laser light. Once activated, it destroys the CNVs. The procedure is not particularly painful. It takes about half an hour and can be done a in the doctor's office.

Drug injections can be given to stop the growth of CNVs and to reduce fluid leakage. These drugs are called anti-vascular endothelial growth factor (anti-VEGF) medications or anti-angiogenesis drugs. These include:

- pegaptanib (Macugen). This drug is approved for use in wet ARMD. It requires a series of injections.
- ranibizumab (Lucentis). This drug is approved for use in ARMD. It destroys new blood vessels and decreases leakage. It has shown some signs of improving vision. In 2008, Lucentis was very expensive (about $2,000 per treatment) and was not covered by all insurance carriers.
- bevacizumab (Avastin). This drug is approved for treatment of colorectal cancer. Its use in treating ARMD is an off-label use. However, it appears to have some of the benefits of Lucentis at a much lower price.

kenalog is a steroid drug that is used to treat inflammation. Using it to treat ARMD is an off-label use, however, it appears to be somewhat effective in reducing fluid, especially if used in combination with photodynamic therapy.

Alternative and Complementary treatment

A large research study called the Age-Related Eye Disease Study (ARED) found that certain dietary supplements slowed the progression of vision loss by up to 25% in cases of moderate to advanced ARMD. The question of preventing ARMD was not addressed. The ARED supplements included the antioxidants vitamin C, vitamin E, beta-carotene (which is converted in the body to vitamin A), and the **minerals** zinc, and copper. More recent studies have suggested lutein and zeaxanthin may also be beneficial.

The ARED supplements are to be taken in specific amounts that are often at higher levels than can be acquired through diet alone or than are found in standard multivitamin tablets. Individuals should not begin taking these dietary supplements on their own. They should consult their physician about whether they would benefit from ARED supplementation and review with their physician all medications they are taking in order to prevent harmful interactions.

Home Remedies

Consumption of a diet rich in antioxidants (beta carotene and the mixed carotenoids that are precursors of vitamin A, **vitamins** C and E, selenium, and zinc), or taking antioxidant **nutritional supplements**, may help prevent macular degeneration, particularly if started early in life. Good dietary sources of antioxidants include citrus fruits, cauliflower, broccoli, nuts, seeds, orange and yellow vegetables, cherries, blackberries, and blueberries.

Prognosis

The dry form of ARMD is self-limiting and eventually stabilizes. The loss of vision is permanent. About 15% of people with dry ARMD develop wet ARMD. Wet ARMD can progress rapidly and result in legal blindness with only coarse peripheral vision remaining, thus limiting daily activities.

Many patients with macular degeneration lose their central vision permanently and may become legally blind. However, macular degeneration rarely causes total loss of vision. Peripheral vision is usually retained. The patient can compensate, to some extent, for the loss of central vision, even though macular degeneration may render them legally blind. Improved lighting and special low-vision aids may help even if sharpness of vision (visual acuity) is poor. Vision aids include special magnifiers that allow the patient to read and telescopic aids for long-distance vision. The use of these visual aids plus the retained peripheral vision usually allow the patient to remain independent. Registration as a legally blind person will enable a patient to obtain special services and considerations.

Prevention

Avoiding the risk factors for macular degeneration may help prevent it. This includes avoiding tobacco smoke and eating a diet low in saturated fat. Some other behaviors that may help reduce the risk of wet-type ARMD are eating a diet rich in green, leafy vegetables and yellow vegetables such as carrots, sweet potatoes, and winter squash; drinking moderate amounts of alcohol, such as one or two glasses of red wine a day; and taking an antioxidant vitamin supplement, especially vitamin A. Some vitamins may be toxic in large doses, so patients should speak with their doctors. Vitamins C and E have not been shown to reduce risk, nor did selenium in one large study. The use of zinc is controversial: some studies showed a benefit, others showed no benefit, and one actually showed an increased risk of ARMD with increased levels of zinc in the blood. Some doctors suggest that wearing UV-blocking sunglasses reduces risk.

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American Macular Degeneration Foundation, P.O. Box 515, Northampton, MA, 01061-0515, (413) 268-7660, amdf@macular.org, http://www.macular.org/.

American Optometric Association, 243 N. Lindbergh Blvd., St. Louis, MO, 63141, (800) 365-2219, http://www.aao.org.

EyeCare America Foundation of the American Academy of Ophthalmology, P. O. Box 429098, San Francisco, CA, 94142-9098, (877) 887-6327, (800) 324-EYES (3937), (415) 561-8567, pubserv@aao.org, http://www.eyecare america.org.

The Macular Degeneration Partnership, 8733 Beverly Blvd. #201, Los Angeles, CA, 90048, (888) 430-9898, (301) 623-1837, http://www.amd.org.

National Eye Institute, 31 Center Drive MSC 2510, Bethesda, MD, 20992-3655, (301) 496-5248, 2020@nei.nih.gov, http://www.nei.nih.gov.

Prevent Blindness America, 211 West Wacker Drive Suite 1700, Chicago, IL, 60606, (800) 331-2020, http://www.preventblindness.org.

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Macule *see* **Skin lesions**

Mad cow disease *see* **Creutzfeldt-Jakob disease**

Madura foot *see* **Mycetoma**

Maduromycosis *see* **Mycetoma**

Magnesium hydroxide *see* **Antacids**

Magnesium imbalance

Definition

As a mineral found in the fluid that surrounds cells, magnesium (Mg) is an essential component of more than 300 enzymes that regulate many body functions. Imbalances occur when the blood contains more or less magnesium than it should. When in balance, adults ingest approximately 310 to 420 milligrams of magnesium each day, with differences in daily nutritional requirements based primarily on gender and weight.

Specifically, the recommended dietary allowance (RDA), from the Institute of Medicine (which is part of the U.S. National Academies), for males and females one to three years of age is 80 milligrams; four to eight years, 130 milligrams; and nine to 13 years, 240 milligrams. For 14 to 18 years of age, the daily RDA is 410 milligrams for males and 360 milligrams for females; 19 to 30 years, 400 milligrams for males and 310 milligrams for females; and 31 years or older, 420 milligrams for males and 320 milligrams for females.

Demographics

An imbalance of magnesium in the human body can occur to anyone regardless of gender, race, or nationality.

Description

Magnesium is essential for good health. Being the fourth most abundant mineral in the human body, it is necessary for the formation and functioning of healthy bones, teeth, muscles, and nerves. The average adult contains about 25 grams of magnesium. About half of all magnesium in the body is located in the bones. However, it is also found in cells within tissues, organs, and blood. It converts food into energy, builds proteins, and is instrumental in maintaining adequate levels of **calcium** in the blood. Magnesium helps prevent cardiovascular disease and irregular heartbeat, reduces the risk of bone loss (**osteoporosis**), and increases an individual's chance of surviving a **heart attack**. It may also help prevent **stroke** and lessen the effects of existing osteoporosis.

Fish, dairy products, leafy green vegetables such as spinach, broccoli, and peas, legumes, nuts (especially almonds and cashews), seeds (especially sesame seeds), blackstrap molasses, and whole grain cereals (especially buckwheat) are especially good sources of magnesium, but varying amounts of this mineral are found in almost all foods. A wide variety of healthy foods helps to assure adequate amounts of magnesium in the body. For instance, about 80 milligrams of magnesium is contained in one-half cup of spinach, while 25 milligrams is found in one slice of whole wheat bread, and about 50 milligrams in two tablespoons of peanut butter.

Unhealthy foods, such as highly processed foods (such as what is often found in fast food restaurants),

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contain very low amounts of magnesium because it is usually eliminated from such foods during processing. Most foods contain only low concentrations of magnesium. In the human body, some is stored in the kidneys, and excess amounts of magnesium are excreted in the urine or stools.

Magnesium deficiency (hypomagnesemia) or excess (hypermagnesemia) is rare, but either condition can be serious.

Causes and symptoms

Hypomagnesemia

Magnesium deficiency most often occurs in people who have been fed intravenously for a long time, whose diet does not contain enough magnesium, or who are unable to absorb and excrete the mineral properly.

Secreting too much aldosterone (the hormone that regulates the body's salt-fluid balance), ADH (a hormone that inhibits urine production), or thyroid hormone can cause hypomagnesemia.

Other factors associated with hypomagnesemia include:

- Loss of body fluids as a result of stomach suctioning or chronic diarrhea
- Cisplatin (a chemotherapy drug)
- Long-term diuretic therapy
- Hypercalcemia (abnormally high levels of calcium in the blood)
- Diabetic acidosis (a condition in which the body's tissues have a higher-than-normal acid content)
- Complications of bowel surgery
- Chronic alcoholism
- Malnutrition
- Starvation
- Severe dehydration.

People who have hypomagnesemia usually experience loss of weight and appetite, bloating, and muscle **pain**, and they pass stools that have a high fat content. In addition, they may be listless, disoriented, confused, and very irritable. Other symptoms of hypomagnesemia are:

- Nausea
- Vomiting
- Muscle weakness, along with stiffness, aches, cramps, and spasms
- Tremor
- Irregular heart beat, angina
- Back pain
- Headaches
- Joint and bone pain
- Constipation
- Nervousness
- Delusions and hallucinations
- Leg and foot cramps
- Muscle twitches (spasms)
- Changes in blood pressure.

Severe magnesium deficiency can cause seizures, especially in children. It can also contribute to cardiovascular disease, osteoporosis, high blood pressure, migraine headaches, diabetes, **anxiety disorders**, and other such diseases.

Neonatal hypomagnesemia can occur in premature babies and in infants who have genetic parathyroid disorders or who have had blood transfusions. This condition also occurs in babies born to magnesium-deficient mothers or to women who have:

- Diabetes mellitus
- Hyperparathyroidism (overactive parathyroid glands)
- Toxemia (a pregnancy-related condition characterized by high blood pressure and fluid retention).

Hypermagnesemia

Hypermagnesemia is most common in patients whose kidneys cannot excrete the magnesium they derive from food or take as medication. This condition can also develop in patients who take magnesium salts, or in healthy people who use large quantities of magnesium-containing **antacids**, **laxatives**, or **analgesics** (pain relievers).

Magnesium **poisoning** can cause severe **diarrhea** in young people, and mask the symptoms of other illnesses. Very high overdoses can lead to **coma**. The risk of complications of magnesium poisoning is greatest for:

- Elderly people with inefficient kidney function
- Patients with kidney problems or intestinal disorders
- People who use antihistamines, muscle relaxants, or narcotics.

Severe **dehydration** or an overdose of supplements taken to counteract hypomagnesemia can also cause this condition.

People who have hypermagnesemia may feel flushed and drowsy, perspire heavily, and have diarrhea. Breathing becomes shallow, reflexes diminish, and the patient becomes unresponsive. Muscle weakness and **hallucinations** are common. The patient's heart beat slows dramatically and blood pressure

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KEY TERMS

Hypermagnesemia—An abnormally high concentration of magnesium in the blood.

Hypomagnesemia—An abnormally low concentration of magnesium in the blood.

plummets. Extreme toxicity, which can lead to coma and cardiac arrest, can be fatal.

Diagnosis

Blood tests are used by physicians and other medical professionals to measure magnesium levels.

Treatment

The goal of treatment is to identify and correct the cause of the imbalance. Oral magnesium supplements or injections are usually prescribed to correct mild magnesium deficiency. If the deficiency is more severe or does not respond to treatment, magnesium sulfate or magnesium chloride may be administered intravenously.

Doctors usually prescribe **diuretics** (urine-producing drugs) for patients with hypermagnesemia and advise them to drink more fluids to flush the excess mineral from the body. Patients whose magnesium levels are extremely high may need mechanical support to breathe and to circulate blood throughout their bodies.

Intravenously administered calcium gluconate may reverse damage caused by excess magnesium. Intravenous furosemide (Lasix) or ethacrynic acid (Edecrin) can increase magnesium excretion in patients who get enough fluids and whose kidneys are functioning properly.

In an emergency, dialysis can provide temporary relief for patients whose kidney function is poor or who are unable to excrete excess **minerals**.

Prognosis

Because imbalances may recur if the underlying condition is not eliminated, monitoring of magnesium levels should continue after treatment has been completed.

Prevention

Most people consume adequate amounts of magnesium in the food they eat. The eating of fruits, vegetables, and whole grains is important to maintain healthy levels of magnesium in the body. Dietary supplements can be used safely, but should only be used under a doctor's care and supervision.

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Maureen Haggerty

Magnetic field therapy

Definition

Magnetic therapy is the use of magnets to relieve **pain** in various areas of the body.

Purpose

Some of the benefits that magnetic therapy claims to provide include:

- pain relief
- reduction of swelling
- improved tissue alkalinization
- more restful sleep
- increased tissue oxygenation
- relief of stress
- increased levels of cellular oxygen
- improved blood circulation
- anti-infective activity

Description

Origins

Magnetic therapy dates as far back as the ancient Egyptians. Magnets have long been believed to have healing powers associated with muscle pain and stiffness. Chinese healers as early as 200 B.C. were said to use magnetic lodestones on the body to correct unhealthy

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imbalances in the flow of *qi,* or energy. The ancient Chinese medical text known as *The Yellow Emperor's Canon of Internal Medicine* describes this procedure. The *Vedas*, or ancient Hindu scriptures, also mention the treatment of diseases with lodestones. The word "lodestone" or leading stone, came from the use of these stones as compasses. The word "magnet" probably stems from the Greek *Magnes lithos*, or "stone from Magnesia," a region of Greece rich in magnetic stones. The Greek phrase later became *magneta* in Latin.

Sir William Gilbert's 1600 treatise, *De Magnete*, was the first scholarly attempt to explain the nature of magnetism and how it differed from the attractive force of static electricity. Gilbert allegedly used magnets to relieve the arthritic pains of Queen Elizabeth I. Contemporary American interest in magnetic therapy began in the 1990s, as several professional golfers and football players offered testimony that the devices seemed to cure their nagging aches and injuries.

Many centuries ago, the earth was surrounded by a much stronger magnetic field than it is today. Over the past century and a half, scientists have been studying the decline of this magnetic field and the effects it has had on human health. When the first cosmonauts and astronauts went into space, physicians noted that they experienced bone **calcium** loss and **muscle cramps** when they were out of the Earth's magnetic field for any extended period of time. After this discovery was made, artificial magnetic fields were placed in the space capsules.

There are two theories that are used to explain magnetic therapy. One theory maintains that magnets produce a slight electrical current. When magnets are applied to a painful area of the body, the nerves in that area are stimulated, thus releasing the body's natural painkillers. The other theory maintains that when magnets are applied to a painful area of the body, all cells in that area react in such a way as to increase blood circulation, ion exchange, and oxygen flow to the area. Magnetic fields attract and repel charged particles in the bloodstream, increasing blood flow and producing heat. Increased oxygen in the tissues and blood stream is thought to make a considerable difference in the speed of healing.

Preparations

There are no special preparations for using magnetic therapy other than purchasing a product that is specific for the painful area being treated. Products available in a range of prices include necklaces and bracelets; knee, back, shoulder and wrist braces; mattress pads; gloves; shoe inserts; and more.

Precautions

The primary precaution involved with magnetic therapy is to recognize the expense of this therapy. The use of magnets for therapy has become big business. They can be found in mail–order catalogs and stores ranging from upscale department stores to specialty stores. As is the case with many popular self–administered therapies, many far–fetched claims are being made about the effectiveness of magnetic therapy. Consumers should adopt a "let the buyer beware" approach to magnetic therapy. Persons who are interested in this form of treatment should try out a small, inexpensive item to see if it works for them before investing in the more expensive products.

Side effects

There are very few side effects from using magnetic therapy. Generally, patients using this therapy find that it either works for them or it does not. Patients using transcranial magnetic stimulation for the treatment of depression reported mild **headache** as their only side effect.

Research and general acceptance

Magnetic therapy is becoming more and more widely accepted as an alternative method of pain relief. Since the late 1950s, hundreds of studies have demonstrated the effectiveness of magnetic therapy. In 1997, a group of physicians at Baylor College of Medicine in Houston, Texas studied the use of magnetic therapy in 50 patients who had developed **polio** earlier in life. These patients had muscle and joint pain that standard treatments failed to manage. In this study, 29 of the patients wore a magnet taped over a trouble spot, and 21 others wore a nonmagnetic device. Neither the researchers nor the patients were told which treatment they were receiving (magnetic or nonmagnetic). As is the case with most studies involving a placebo, some of the patients responded to the nonmagnetic therapy, but 75% of those using the magnetic therapy reported feeling much better.

In another study at New York Medical College in Valhalla, New York, a neurologist tested magnetic therapy on a group of 19 men and women complaining of moderate to severe burning, **tingling**, or **numbness** in their feet. Their problems were caused by diabetes or other conditions present such as **alcoholism**. This group of patients wore a magnetic insole inside one of their socks or shoes for 24 hours a day over a two–month period, except while bathing. They wore a nonmagnetic insert in their other sock or shoe. Then for two months they wore magnetic inserts on both feet. By the end of the

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KEY TERMS

Fibromyalgia—A chronic syndrome characterized by fatigue, widespread muscular pain, and pain at specific points on the body.

Lodestone—A variety of magnetite that possesses magnetic polarity.

Transcranial magnetic stimulation—A procedure used to treat patients with depression.

study, nine out of ten of the diabetic patients reported relief, while only three of nine non–diabetic patients reported relief. The neurologist in charge of the study believes that this study opens the door to additional research into magnetic therapy for diabetic patients.

A federally funded study is underway at the University of Virginia. This study is evaluating the effectiveness of magnetic mattress pads in easing the muscle pain, stiffness and **fatigue** associated with fibromyalgia.

Magnetic therapy is now being offered for the treatment of patients suffering from depression. A procedure called transcranial magnetic stimulation (TMS) has been beneficial for patients with depression when standard depression treatments, such as anti–depression medication and therapy, have not worked. Patients undergoing TMS have experienced a lower relapse rate than those using **electroconvulsive therapy**. Unlike electroconvulsive therapy, patients using magnetic therapy have not suffered from seizures, memory lapses, or impaired thinking. Mayo Clinic, a large teaching hospital in Rochester, Minnesota has offered TMS as a treatment option for depression since 2002.

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American Holistic Medical Association (AHMA), 23366 Commerce Park, Suite 101B, Beachwood, OH, 44122, (216) 292–6644, http://www.holisticmedicine.org.

American Pain Society, 700 W. Lake Ave., Glenview, IL, 60025, (847) 375–4715. , http://www.ampainsoc.org.

Benson–Henry Institute for Mind Body Medicine at Massachusetts General Hospital, 151 Merrimac St., 4th Floor, Boston, MA, 02114, (617) 643–6090, http://www.massgeneral.org/bhi.

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Magnetic resonance imaging

Definition

Magnetic resonance imaging (MRI) is the newest, and perhaps most versatile, medical imaging technology available. Doctors can get highly refined images of the body's interior without surgery, using MRI. By using strong magnets and pulses of radio waves to manipulate the natural magnetic properties in the body, this technique makes better images of organs and soft tissues than those of other scanning technologies. MRI is particularly useful for imaging the brain and spine, as well as the soft tissues of joints and the interior structure of bones. The entire body is visible to the technique, which poses few known health risks.

Purpose

MRI was developed in the 1980s. The latest additions to MRI technology are **angiography** (MRA) and spectroscopy (MRS). MRA was developed to study blood flow, while MRS can identify the chemical composition of diseased tissue and produce color images of brain function. The many advantages of MRI include:

- Detail. MRI creates precise images of the body based on the varying proportions of magnetic elements in different tissues. Very minor fluctuations in chemical composition can be determined. MRI images have greater natural contrast than standard x rays, computed tomography scan (CT scan), or ultrasound, all of which depend on the differing physical properties

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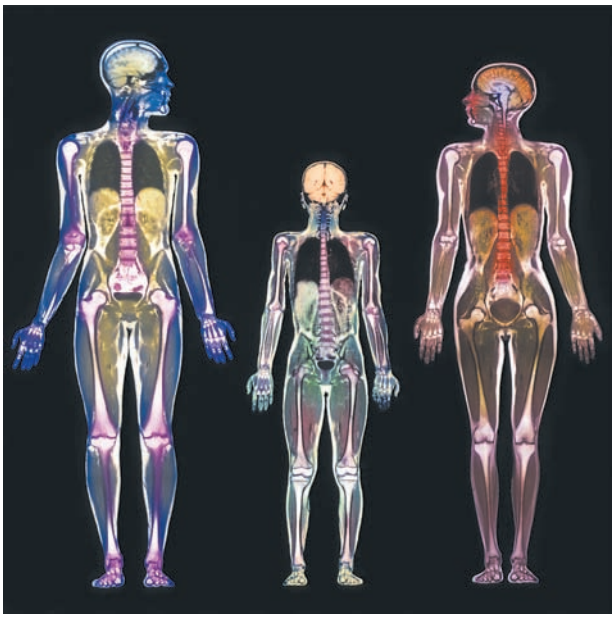

MRI body scans of a man, woman, and child. *(Simon Fraser/ Photo Researchers, Inc.)*

of tissues. This sensitivity lets MRI distinguish fine variations in tissues deep within the body. It also is particularly useful for spotting and distinguishing diseased tissues (tumors and other lesions) early in their development. Often, doctors prescribe an MRI scan to more fully investigate earlier findings of the other imaging techniques.

- Scope. The entire body can be scanned, from head to toe and from the skin to the deepest recesses of the brain. Moreover, MRI scans are not obstructed by bone, gas, or body waste, which can hinder other imaging techniques. (Although the scans can be degraded by motion such as breathing, heartbeat, and normal bowel activity.) The MRI process produces cross-sectional images of the body that are as sharp in the middle as on the edges, even of the brain through the skull. A close series of these two-dimensional images can provide a three-dimensional view of a targeted area.
- Safety. MRI does not depend on potentially harmful ionizing radiation, as do standard x-ray and CT scans. There are no known risks specific to the procedure, other than for people who might have metal objects in their bodies.

MRI is being used increasingly during surgical operations, particularly those involving very small structures in the head and neck, as well as for preoperative assessment and planning. Intraoperative MRIs have shown themselves to be safe as well as feasible, and to improve the surgeon's ability to remove the entire tumor or other abnormality.

Given all the advantages, doctors would undoubtedly prescribe MRI as frequently as ultrasound scanning, but the MRI process is complex and costly. The process requires large, expensive, and complicated equipment; a highly trained operator; and a doctor specializing in radiology. Generally, MRI is prescribed only when serious symptoms and/or negative results from other tests indicate a need. Many times another test is appropriate for the type of diagnosis needed.

Doctors may prescribe an MRI scan of different areas of the body.

- Brain and head. MRI technology was developed because of the need for brain imaging. It is one of the few imaging tools that can see through bone (the skull) and deliver high quality pictures of the brain's delicate soft tissue structures. MRI may be needed for patients with symptoms of a brain tumor, stroke, or infection (like meningitis). MRI also may be needed when cognitive and/or psychological symptoms suggest brain disease (like Alzheimer's or Huntington's diseases, or multiple sclerosis), or when developmental retardation suggests a birth defect. MRI can also provide pictures of the sinuses and other areas of the head beneath the face. Recent refinements in MRI technology may make this form of diagnostic imaging even more useful in evaluating patients with brain cancer, stroke, schizophrenia, or epilepsy. In particular, a new 3-D approach to MRI imaging known as diffusion tensor imaging, or DTI, measures the flow of water within brain tissue, allowing the radiologist to tell where the normal flow of fluid is disrupted, and to distinguish more clearly between cancerous and normal brain tissue. The introduction of DTI has led to a technique known as fiber tracking, which allows the neurosurgeon to tell whether a space-occupying brain tumor has damaged or displaced the nerve pathways in the white matter of the brain. This information in turn improves the surgeon's accuracy during the actual operation.
- Spine. Spinal problems can create a host of seemingly unrelated symptoms. MRI is particularly useful for identifying and evaluating degenerated or herniated spinal discs. It can also be used to determine the condition of nerve tissue within the spinal cord.
- Joint. MRI scanning is most commonly used to diagnose and assess joint problems. MRI can provide clear images of the bone, cartilage, ligament, and tendon that comprise a joint. MRI can be used to diagnose joint injuries due to sports, advancing age,

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or arthritis. MRI can also be used to diagnose shoulder problems, like a torn rotator cuff. MRI can also detect the presence of an otherwise hidden tumor or infection in a joint, and can be used to diagnose the nature of developmental joint abnormalities in children.

- Skeleton. The properties of MRI that allow it to see through the skull also allow it to view the inside of bones. It can be used to detect bone cancer, inspect the marrow for leukemia and other diseases, assess bone loss (osteoporosis), and examine complex fractures.
- The rest of the body. While CT and ultrasound satisfy most chest, abdominal, and general body imaging needs, MRI may be needed in certain circumstances to provide better pictures or when repeated scanning is required. The progress of some therapies, like liver cancer therapy, needs to be monitored, and the effect of repeated x-ray exposure is a concern.

Description

In essence, MRI produces a map of hydrogen distribution in the body. Hydrogen is the simplest element known, the most abundant in biological tissue, and one that can be magnetized. It will align itself within a strong magnetic field, like the needle of a compass. The earth's magnetic field is not strong enough to keep a person's hydrogen atoms pointing in the same direction, but the superconducting magnet of an MRI machine can. This comprises the "magnetic" part of MRI.

Once a patient's hydrogen atoms have been aligned in the magnet, pulses of very specific radio wave frequencies are used to knock them back out of alignment. The hydrogen atoms alternately absorb and emit radio wave energy, vibrating back and forth between their resting (magnetized) state and their agitated (radio pulse) state. This comprises the "resonance" part of MRI.

The MRI equipment records the duration, strength, and source location of the signals emitted by the atoms as they relax and translates the data into an image on a television monitor. The state of hydrogen in diseased tissue differs from healthy tissue of the same type, making MRI particularly good at identifying tumors and other lesions. In some cases, chemical agents such as gadolinium can be injected to improve the contrast between healthy and diseased tissue.

A single MRI exposure produces a two-dimensional image of a slice through the entire target area. A series of these image slices closely spaced (usually less than half an inch) makes a virtual three-dimensional view of the area.

Magnetic resonance spectroscopy (MRS) is different from MRI because MRS uses a continuous band of radio wave frequencies to excite hydrogen atoms in a variety of chemical compounds other than water. These compounds absorb and emit radio energy at characteristic frequencies, or spectra, which can be used to identify them. Generally, a color image is created by assigning a color to each distinctive spectral emission. This comprises the "spectroscopy" part of MRS. MRS is still experimental and is available in only a few research centers.

Doctors primarily use MRS to study the brain and disorders, like **epilepsy**, **Alzheimer's disease**, brain tumors, and the effects of drugs on brain growth and metabolism. The technique is also useful in evaluating metabolic disorders of the muscles and nervous system.

Magnetic resonance angiography (MRA) is another variation on standard MRI. MRA, like other types of angiography, looks specifically at fluid flow within the blood (vascular) system, but does so without the injection of dyes or radioactive tracers. Standard MRI cannot make a good picture of flowing blood, but MRA uses specific radio pulse sequences to capture usable signals. The technique is generally used in combination with MRI to obtain images that show both vascular structure and flow within the brain and head in cases of **stroke**, or when a blood clot or aneurysm is suspected.

Regardless of the exact type of MRI planned, or area of the body targeted, the procedure involved is basically the same and occurs in a special MRI suite. The patient usually lies on a narrow table and is made as comfortable as possible. Transmitters are positioned on the body and the cushioned table that the patient is laying on moves into a long tube that houses the magnet. The tube is as long as an average adult lying down, and the tube is narrow and open at both ends. Once the area to be examined has been properly positioned, a radio pulse is applied. Then a two-dimensional image corresponding to one slice through the area is made. The table then moves a fraction of an inch and the next image is made. Each image exposure takes several seconds and the entire exam will last anywhere from 30–90 minutes. During this time, the patient is not allowed to move. If the patient moves during the scan, the picture will not be clear.

An open MRI scanner is less restrictive, and is usually open on two or three sides. Although this type of machine accommodates larger or claustrophobic persons with greater ease, high-field or "closed"

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KEY TERMS

Angiography—Any of the different methods for investigating the condition of blood vessels, usually via a combination of radiological imaging and injections of chemical tracing and contrasting agents.

Diffusion tensor imaging (DTI)—A refinement of magnetic resonance imaging that allows the doctor to measure the flow of water and track the pathways of white matter in the brain. DTI is able to detect abnormalities in the brain that do not show up on standard MRI scans.

Gadolinium—A very rare metallic element useful for its sensitivity to electromagnetic resonance, among other things. Traces of it can be injected into the body to enhance the MRI pictures.

Hydrogen—The simplest, most common element known in the universe. It is composed of a single electron (negatively charged particle) circling a nucleus consisting of a single proton (positively charged particle). It is the nuclear proton of hydrogen that makes MRI possible by reacting resonantly to radio waves while aligned in a magnetic field.

Ionizing radiation—Electromagnetic radiation that can damage living tissue by disrupting and destroying individual cells. All types of nuclear decay radiation (including x rays) are potentially ionizing. Radio waves do not damage organic tissues they pass through.

Magnetic field—The three-dimensional area surrounding a magnet, in which its force is active. During MRI, the patient's body is permeated by the force field of a superconducting magnet.

Radio waves— Electromagnetic energy of the frequency range corresponding to that used in radio communications, usually 10,000 cycles per second to 300 billion cycles per second. Radio waves are the same as visible light, x rays, and all other types of electromagnetic radiation, but are of a higher frequency.

MRI machines usually generate more accurate and detailed images. The stand-up type of open MRI generates images of the spine, allowing the physician to evaluate images made in the weight-bearing state.

Depending on the area to be imaged, the radiowave transmitters will be positioned in different locations.

- For the head and neck, a helmet-like hat is worn.
- For the spine, chest, and abdomen, the patient will be lying on the transmitters.
- For the knee, shoulder, or other joint, the transmitters will be applied directly to the joint.

Additional probes will monitor vital signs (like pulse, respiration, etc.).

The process is very noisy and confining. The patient hears a thumping sound for the duration of the procedure. Since the procedure is noisy, music supplied via earphones is often provided. Some patients become anxious or panic because they are in the small, enclosed tube. This is why vital signs are monitored and the patient and medical team can communicate between each other. If the chest or abdomen are to be imaged, the patient will be asked to hold his/her breath as each exposure is made. Other instructions may be given to the patient, as needed. In many cases, the entire examination will be performed by an MRI operator who is not a doctor. However, the supervising radiologist should be available to consult as necessary during the exam, and will view and interpret the results sometime later.

Preparation

In some cases (such as for MRI brain scanning or an MRA), a chemical designed to increase image contrast may be given by the radiologist immediately before the exam. If a patient suffers from **anxiety** or claustrophobia, drugs may be given to help the patient relax.

The patient must remove all metal objects (watches, jewelry, **eye glasses**, hair clips, etc). Any magnetized objects (like credit and bank machine cards, audio tapes, etc.) should be kept far away from the MRI equipment because they can be erased. Patients cannot bring their wallet or keys into the MRI machine. The patient may be asked to wear clothing without metal snaps, buckles, or zippers, unless a medical gown is worn during the procedure. The patient may be asked to remove any hair spray, hair gel, or cosmetics that may interfere with the scan.

Aftercare

No aftercare is necessary, unless the patient received medication or had a reaction to a contrast agent. Normally, patients can immediately return to

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their daily activities. If the exam reveals a serious condition that requires more testing and/or treatment, appropriate information and counseling will be needed.

Risks

MRI poses no known health risks to the patient and produces no physical side effects. Again, the potential effects of MRI on an unborn baby are not well known. Any woman who is, or may be, pregnant, should carefully discuss this issue with her doctor and radiologist before undergoing a scan. The most common problems are minor bleeding and bruising at the site of contrast injection. Since neither are reportable events, morbidity can only be estimated. Occasionally, an unknown allergy to seafood is discovered after injecting contrast. No deaths have been reported from MRI tests.

MRI scanning should not be used when there is the potential for an interaction between the strong MRI magnet and metal objects that might be imbedded in a patient's body. The force of magnetic attraction on certain types of metal objects (including surgical steel) could move them within the body and cause serious injury. Metal may be imbedded in a person's body for several reasons.

- Medical. People with implanted cardiac pacemakers, metal aneurysm clips, or who have had broken bones repaired with metal pins, screws, rods, or plates must tell their radiologist prior to having an MRI scan. In some cases (like a metal rod in a reconstructed leg) the difficulty may be overcome.
- Injury. Patients must tell their doctors if they have bullet fragments or other metal pieces in their body from old wounds. The suspected presence of metal, whether from an old or recent wound, should be confirmed before scanning.
- Occupational. People with significant work exposure to metal particles (working with a metal grinder, for example) should discuss this with their doctor and radiologist. The patient may need pre-scan testing—usually a single, regular x ray of the eyes to see if any metal is present.

Chemical agents designed to improve the picture and/or allow for the imaging of blood or other fluid flow during MRA may be injected. In rare cases, patients may be allergic to or intolerant of these agents, and these patients should not receive them. If these chemical agents are to be used, patients should discuss any concerns they have with their doctor and radiologist.

The potential side effects of magnetic and electric fields on human health remain a source of debate. In particular, the possible effects on an unborn baby are not well known. Any woman who is, or may be, pregnant should carefully discuss this issue with her doctor and radiologist before undergoing a scan.

As with all medical imaging techniques, **obesity** greatly interferes with the quality of MRI.

Results

Normal results

A normal MRI, MRA, or MRS result is one that shows the patient's physical condition to fall within normal ranges for the target area scanned.

Abnormal results

Generally, MRI is prescribed only when serious symptoms and/or negative results from other tests indicate a need. There often exists strong evidence of a condition that the scan is designed to detect and assess. Thus, the results will often be abnormal, confirming the earlier diagnosis. At that point, further testing and appropriate medical treatment is needed. For example, if the MRI indicates the presence of a **brain tumor**, an MRS may be prescribed to determine the type of tumor so that aggressive treatment can begin immediately without the need for a surgical biopsy.

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ORGANIZATIONS

American College of Radiology, 1891 Preston White Drive, Reston, VA, 22091, (800) 227–5463, info@acr.org, http://www.acr.org.

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Magnetic resonance spectroscopy *see* **Magnetic resonance imaging**
Major depression *see* **Depressive disorders**
Major tranquilizers *see* **Antipsychotic drugs**

Malabsorption syndrome

Definition

Malabsorption syndrome is a broad term for numerous conditions that alter the ability of the intestines, primarily the small intestines, to absorb nutrients, such as fats, proteins, and carbohydrates, adequately into the bloodstream. It may refer to malabsorption of one specific nutrient or for specific fats, proteins, carbohydrates, or trace elements (micronutrients). Malabsorpotion syndrome is not a disease but a set of symptoms that is the result of the presence of some type of disorder.

Demographics

Anyone of any age, gender, or nationality can be subjected to malabsorption syndrome.

Description

The purpose of the gastrointestinal (GI) tract, which includes the stomach and the intestines, is to digest and absorb nutrients, such as fats, proteins, and carbohydrates, water, **vitamins**, and trace **minerals**. Secretions within the GI tract break down foods ingested by humans so that eventually the final digestible products are absorbed through the intestinal cells. However, in a state involving malabsorpition syndrome, the food nutrients are abnormally absorbed across the GI tract, primarily the small intestine (or, small bowel), which can lead to **malnutrition** and many of the various forms of anemia.

Causes and symptoms

Protein, fats, and carbohydrates (macronutrients) normally are absorbed in the small intestine; the small bowel also absorbs about 80% of the eight to ten liters of fluid ingested daily. Many different conditions affect fluid and nutrient absorption by the intestine. A fault in the digestive process may result from failure of the body to produce the enzymes needed to digest certain foods. Congenital structural defects or diseases of the pancreas, gall bladder, or liver may alter the digestive process. Inflammation, infection, injury, or surgical removal of portions of the intestine may also result in absorption problems; reduced length or surface area of intestine available for fluid and nutrient absorption can result in malabsorption. **Radiation therapy** may injure the mucosal lining of the intestine, resulting in **diarrhea** that may not become evident until several years later. The use of some **antibiotics** can also affect the bacteria that normally live in the intestine and affect intestinal function.

Risk factors for malabsorption syndrome include:

- premature birth
- family history of malabsorption or cystic fibrosis
- use of certain drugs, such as mineral oil or other laxatives
- travel to foreign countries
- intestinal surgery, including bowel transplantation
- excess alcohol consumption.

The most common symptoms of malabsorption include:

- Anemia, with weakness and fatigue due to inadequate absorption of vitamin B_{12}, iron, and folic acid
- Diarrhea, steatorrhea (excessive amount of fat in the stool), and abdominal distention with cramps, bloating, and gas (flatulence) due to impaired water and carbohydrate absorption, and irritation from unabsorbed fatty acids. The individual may also report explosive diarrhea with greasy, foul-smelling stools.
- Edema (fluid retention in the body's tissues) due to decreased protein absorption

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- Malnutrition and weight loss due to decreased fat, carbohydrate, and protein absorption. Weight may be 80% to 90% of usual weight despite increased oral intake of nutrients.
- Muscle cramping due to decreased vitamin D, calcium, and potassium levels
- Muscle wasting and atrophy due to decreased protein absorption and metabolism
- Perianal skin burning, itching, or soreness due to frequent loose stools.

Irregular heart rhythms may also result from inadequate levels of potassium and other electrolytes. Blood clotting disorders may occur due to a **vitamin K deficiency**. A person with malabsorption syndrome may over time lack sufficient amounts of iron, proteins, and various vitamins and minerals in the body. Consequently, malnutrition may result, along with such **anemias** involving deficiencies with vitamin K (which can cause excess bleeding), vitamin A (weakening of the eyes), vitamin D (muscle cramping), **calcium** (weakening of the bones), vitamin B_{12}, iron, and folate (**fatigue** and general weakness). Children with malabsorption syndrome often exhibit a failure to grow and thrive.

Malabsorption syndrome can be caused by poor production of enzymes used in the digestive process by the pancreas. Such problems can cause pancreatic diseases. Too much acid in the stomach or not enough bile in the liver can contribute to digestive disorders.

Several disorders can lead to malabsorption syndrome including **cystic fibrosis**, chronic **liver disease**, chronic **pancreatitis**, **Crohn's disease**, **lactose intolerance**, **cholestasis**, abetalipoproteinemia, and **biliary atresia**. Other disorders can include the following.

Tropical sprue is a malabsorptive disorder that is uncommon in the United States, but seen more often in people from the Caribbean, India, or southeast Asia. Although its cause is unknown, it is thought to be related to environmental factors, including infection, intestinal parasites, or possibly the consumption of certain food toxins. Symptoms often include a sore tongue, anemia, weight loss, along with diarrhea and passage of fatty stools.

Celiac disease (also called gluten enteropathy and non-tropical sprue) is another disorder within the classification of malabsorption syndrome. In this disorder people are intolerant to food that contain gluten, or a protein contained in grains such as barley, rye, and wheat. When such foods are eaten, the body's immune system begins to fight off what it thinks are foreign materials. Consequently, the small intestines are damaged Symptoms include diarrhea, abdominal **pain**, and irritability. However, some people with Celiac disease have few symptoms, and sometimes symptoms are nonexistent.

Whipple's disease is a relatively rare malabsorptive disorder, affecting mostly middle-aged men. The cause is thought to be related to bacterial infection, resulting in nutritional deficiencies, chronic low-grade **fever**, diarrhea, joint pain, weight loss, and darkening of the skin's pigmentation. Other organs of the body may be affected, including the brain, heart, lungs, and eyes.

Short bowel syndromes—which may be present at birth (congenital) or the result of surgery—reduce the surface area of the bowel available to absorb nutrients and can also result in malabsorption syndrome. Congenital short bowel syndrome occurs in about 24 out of 100,000 live births and has a high mortality rate (about 38%).

Other conditions that can bring on malabsorption syndrome include: acquired immune deficiency syndrome (**AIDS**), some medications (such as tetracycline, **antacids**, and some that treat **obesity**), radiation treatments, and parasites.

Diagnosis

The diagnosis of malabsorption syndrome and identification of the underlying cause can require extensive diagnostic testing. The first phase involves a thorough medical history and **physical examination** by a physician, who will then determine the appropriate laboratory studies and x rays to assist in diagnosis. A 72-hour stool collection may be ordered for fecal fat measurement; increased fecal fat in the stool collected indicates malabsorption. A biopsy of the small intestine may be done to assist in differentiating between malabsorption syndrome and small bowel disease. Diagnostic sonographic (what is commonly called ultrasound) scans, computed tomography (CT) scans, **magnetic resonance imaging** (MRI) scans, and x ray scans, along with barium **enemas**, may also be ordered to identify abnormalities of the gastrointestinal tract and pancreas.

A newer method of obtaining diagnostic information about the small intestine was approved by the Food and Drug Administration (FDA) in 2001 and is known as capsule **endoscopy**. It includes the use of an imaging capsule, a portable belt-pack image receiver and recorder, and a specially modified computer. The patient swallows the capsule, which is the size of a large pill. A miniature lens in the capsule transmits images through an antenna/transmitter to the belt-pack receiver, which the patient wears under ordinary clothing as he or she goes about daily activities. The belt-pack recording device is returned after seven or eight

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KEY TERMS

Anemia—A decrease in the number of red blood cells in the bloodstream, characterized by pallor, loss of energy, and generalized weakness.

Atrophy—A wasting away of a tissue or organ, often because of insufficient nutrition.

Biopsy—A tissue sample removed from the body for examination under the microscope.

Cystic fibrosis—A hereditary genetic disorder that occurs most often in Caucasians. Thick, sticky secretions from mucus-producing glands cause blockages in the pancreatic ducts and the airways.

Edema—From the Greek word meaning swelling, an excessive accumulation of fluid in the tissue spaces. Excessive generalized edema may also be referred to as ascites.

Gluten enteropathy—A hereditary malabsorption disorder caused by sensitivity to gluten, a protein found in wheat, rye, barley, and oats. Also called non-tropical sprue or Celiac disease.

Intestines—The intestines, also known as the bowels, are divided into the large and small intestines. They extend from the stomach to the anus.

Short bowel syndrome—A condition in which the bowel is not as long as normal, either because of surgery or because of a congenital defect. Because the bowel has less surface area to absorb nutrients, it can result in malabsorption syndrome.

Steatorrhea—An excessive amount of fat in the stool.

Trace elements—A group of elements that are present in the human body in very small amounts but are nonetheless important to good health. They include chromium, copper, cobalt, iodine, iron, selenium, and zinc. Trace elements are also called micronutrients.

hours to the doctor, who then examines the images recorded as a digital video. The capsule itself is simply allowed to pass through the digestive tract.

Preparation requires only **fasting** the night before capsule endoscopy and taking nothing but clear liquids for two hours after swallowing the capsule. After four hours the patient can eat food without interfering with the test. As of the early 2010s, capsule endoscopy is used to evaluate gastrointestinal bleeding from unknown causes, inflammatory bowel disease, some malabsorption syndromes, and to monitor surgical patients following small-bowel transplantation.

Laboratory studies of the blood may include:

- Serum cholesterol. May be low due to decreased fat absorption and digestion.
- Serum sodium, potassium, and chloride. May be low due to electrolyte losses with diarrhea.
- Serum calcium. May be low due to vitamin D and amino acid malabsorption.
- Serum protein and albumin. May be low due to protein losses.
- Serum vitamin A and carotene. May be low due to bile salt deficiency and impaired fat absorption.
- D-xylose test. Decreased excretion may indicate malabsorption.
- Schilling test. May indicate malabsorption of vitamin B_{12}.

Treatment

Fluid and nutrient monitoring and replacement is essential for any individual with malabsorption syndrome. Hospitalization may be required when severe fluid and electrolyte imbalances occur. Consultation with a dietitian to assist with nutritional support and meal planning is helpful. If the patient is able to eat, the diet and supplements should provide bulk and be rich in carbohydrates, proteins, fats, minerals, and vitamins. The patient should be encouraged to eat several small, frequent meals throughout the day, avoiding fluids and foods that promote diarrhea. Intake and output should be monitored, along with the number, color, and consistency of stools.

The individual with malabsorption syndrome must be monitored for **dehydration**, including dry tongue, mouth and skin; increased thirst; low, concentrated urine output; or feeling weak or dizzy when standing. Pulse and blood pressure should be monitored, observing for increased or irregular pulse rate, or **hypotension** (low blood pressure). The individual should also be alert for signs of nutrient, vitamin, and mineral depletion, including **nausea** or **vomiting**; fissures at corner of mouth; fatigue or weakness; dry, pluckable hair; easy bruising; **tingling** in fingers or toes; and **numbness** or burning sensation in legs or feet. Fluid volume excess, as a result of diminished protein stores, may require fluid intake restrictions. The physician should also be notified of any **shortness of breath**.

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Other specific medical management for malabsorption syndrome is dependent upon the cause. Treatment for tropical sprue consists of **folic acid** supplements and long-term antibiotics. Depending on the severity of the disorder, this treatment may be continued for six months or longer. Whipple's disease also may require long-term use of antibiotics, such as tetracycline. Management of some individuals with malabsorption syndrome may require injections of vitamin B_{12} and oral iron supplements. The doctor may also prescribe enzymes to replace missing intestinal enzymes, or antispasmodics to reduce abdominal cramping and associated diarrhea. People with cystic fibrosis and chronic pancreatitis require pancreatic supplements. Those with lactose intolerance or gluten enteropathy (non-tropical sprue, or Celiac disease) will have to modify their **diets** to avoid foods that they cannot properly digest.

Prognosis

The expected course for the individual with malabsorption syndrome varies depending on the cause. The onset of symptoms may be slow and difficult to diagnose. Treatment may be long, complicated, and changed often for optimal effectiveness. Patience and a positive attitude are important in controlling or curing the disorder. Careful monitoring is necessary to prevent additional illnesses caused by nutritional deficiencies. Without proper treatment for malabsorption syndrome the following conditions can result: **heart failure**, **gallstones**, **kidney stones**, anemia, **osteoporosis**, and malnutrition.

Prevention

The type of preventive measures used for malabsorption syndrome depends on the specific condition that causes it.

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Malaria

Definition

Malaria is a serious **infectious disease** spread by certain mosquitoes. It is most common in tropical climates. It is characterized by recurrent symptoms of chills, **fever**, and an enlarged spleen. The disease can be treated with medication, but it often recurs. Malaria is endemic (occurs frequently in a particular locality) in many third world countries. Isolated, small outbreaks sometimes occur within the boundaries of the United States.

Description

Malaria is a growing problem in the United States. Although only about 1400 new cases were reported in the United States and its territories in 2000, many involved returning travelers. In addition, locally transmitted malaria has occurred in California, Florida, Texas, Michigan, New Jersey, and New York City. While malaria can be transmitted in blood, the American blood supply is not screened for malaria. Widespread malarial epidemics are far less likely to occur in the United States, but small localized epidemics could return to the Western world. As of late 2002, primary care physicians are being advised to screen returning travelers with fever for malaria, and a team of public health doctors in Minnesota is recommending screening immigrants, refugees, and international adoptees for the disease—particularly those from high-risk areas.

The picture is far more bleak, however, outside the territorial boundaries of the United States. A

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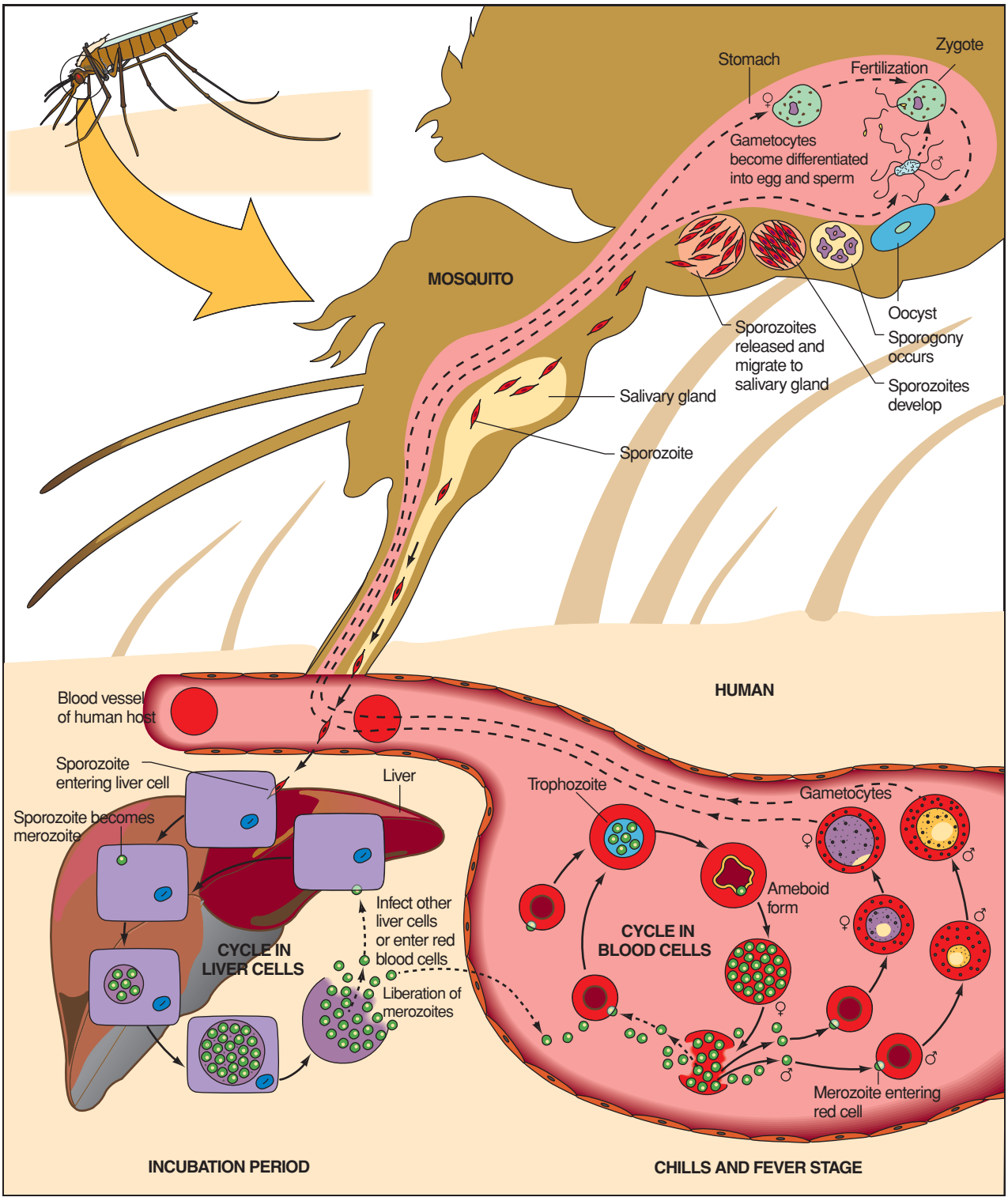

The life cycle of *Plasmodium vivax*, the parasite that causes malaria. *(Illustration by Hans & Cassady, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

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Malaria

Malaria caused an estimated 863,000 deaths in the world in 2008 (most recent year for which the World Health Organization [WHO] had statistics).

The majority of deaths occurred in the following regions:

- 89% in the African region
- 6% in the Eastern Mediterranean region
- 5% in the South-East Asia region

- The estimated death toll in Africa declined by 34,000 compared to 2006, mainly due to a decrease in the total number of deaths from all causes in children younger than 5.
- Thirty-one percent of African households were estimated to own at least one insecticide-treated net (ITN) in 2008, compared to 17% in 2006. More children under 5 years of age used an ITN in 2008 (24%) than in previous years, but the World Health Assembly target for usage in children is 80%.

SOURCE: World Health Organization, *World Malaria Report 2009*. Available online at: http://whqlibdoc.who.int/publications/2009/9789241563901_eng.pdf (accessed August 13, 2010).

(Table by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)

recent government panel warned that disaster looms over Africa from the disease. Malaria infects between 300 and 500 million people every year in Africa, India, southeast Asia, the Middle East, Oceania, and Central and South America. A 2002 report stated that malaria kills 2.7 million people each year, more than 75 percent of them African children under the age of five. It is predicted that within five years, malaria will kill about as many people as does **AIDS**. As many as half a billion people worldwide are left with chronic anemia due to malaria infection. In some parts of Africa, people battle up to 40 or more separate episodes of malaria in their lifetimes. The spread of malaria is becoming even more serious as the parasites that cause malaria develop resistance to the drugs used to treat the condition. In late 2002, a group of public health researchers in Thailand reported that a combination treatment regimen involving two drugs known as dihydroartemisinin and azithromycin shows promise in treating multidrug-resistant malaria in southeast Asia.

Causes and symptoms

Human malaria is caused by four different species of a parasite belonging to genus *Plasmodium*: *Plasmodium falciparum* (the most deadly), *Plasmodium vivax*, *Plasmodium malariae*, and *Plasmodium ovale*. The last two are fairly uncommon. Many animals can get malaria, but human malaria does not spread to animals. In turn, animal malaria does not spread to humans.

A person gets malaria when bitten by a female mosquito that is looking for a blood meal and is infected with the malaria parasite. The parasites enter the blood stream and travel to the liver, where they multiply. When they re-emerge into the blood, symptoms appear. By the time a patient shows symptoms, the parasites have reproduced very rapidly, clogging blood vessels and rupturing blood cells.

Malaria cannot be casually transmitted directly from one person to another. Instead, a mosquito **bites** an infected person and then passes the infection on to the next human it bites. It is also possible to spread malaria via contaminated needles or in blood transfusions. This is why all blood donors are carefully screened with questionnaires for possible exposure to malaria.

It is possible to contract malaria in non-endemic areas, although such cases are rare. Nevertheless, at least 89 cases of so-called airport malaria, in which travelers contract malaria while passing through crowded airport terminals, have been identified since 1969.

The amount of time between the mosquito bite and the appearance of symptoms varies, depending on the strain of parasite involved. The incubation period is usually between 8 and 12 days for falciparum malaria, but it can be as long as a month for the other types. Symptoms from some strains of *P.vivax* may not appear until 8–10 months after the mosquito bite occurred.

The primary symptom of all types of malaria is the "malaria ague" (chills and fever). In most cases, the fever has three stages, beginning with uncontrollable shivering for an hour or two, followed by a rapid spike in temperature (as high as 106°F), which lasts three to six hours. Then, just as suddenly, the patient begins to sweat profusely, which will quickly bring down the fever. Other symptoms may include **fatigue**, severe **headache**, or **nausea and vomiting**. As the sweating subsides, the patient typically feels exhausted and falls asleep. In many cases, this cycle of chills, fever, and sweating occurs every other day, or every third day, and may last for between a week and a month. Those with the chronic form of malaria may have a relapse as long as 50 years after the initial infection.

Falciparum malaria is far more severe than other types of malaria because the parasite attacks all red blood cells, not just the young or old cells, as do other types. It causes the red blood cells to become very "sticky." A patient with this type of malaria can die within hours of the first symptoms. The fever is prolonged. So many red blood cells are destroyed that they block the blood vessels in vital organs (especially

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the kidneys), and the spleen becomes enlarged. There may be brain damage, leading to **coma** and convulsions. The kidneys and liver may fail.

Malaria in **pregnancy** can lead to premature delivery, **miscarriage**, or **stillbirth**.

Certain kinds of mosquitoes (called anopheles) can pick up the parasite by biting an infected human. (The more common kinds of mosquitoes in the United States do not transmit the infection.) This is true for as long as that human has parasites in his/her blood. Since strains of malaria do not protect against each other, it is possible to be reinfected with the parasites again and again. It is also possible to develop a chronic infection without developing an effective immune response.

Diagnosis

Malaria is diagnosed by examining blood under a microscope. The parasite can be seen in the blood smears on a slide. These blood smears may need to be repeated over a 72-hour period in order to make a diagnosis. Antibody tests are not usually helpful because many people developed antibodies from past infections, and the tests may not be readily available. A new laser test to detect the presence of malaria parasites in the blood was developed in 2002, but is still under clinical study.

Two new techniques to speed the laboratory diagnosis of malaria show promise as of late 2002. The first is acridine orange (AO), a staining agent that works much faster (3–10 min) than the traditional Giemsa stain (45–60 min) in making the malaria parasites visible under a microscope. The second is a bioassay technique that measures the amount of a substance called histadine-rich protein II (HRP2) in the patient's blood. It allows for a very accurate estimation of parasite development. A dip strip that tests for the presence of HRP2 in blood samples appears to be more accurate in diagnosing malaria than standard microscopic analysis.

Anyone who becomes ill with chills and fever after being in an area where malaria exists must see a doctor and mention their recent travel to endemic areas. A person with the above symptoms who has been in a high-risk area should insist on a blood test for malaria. The doctor may believe the symptoms are just the common flu virus. Malaria is often misdiagnosed by North American doctors who are not used to seeing the disease. Delaying treatment of falciparum malaria can be fatal.

Treatment

Falciparum malaria is a medical emergency that must be treated in the hospital. The type of drugs, the method of giving them, and the length of the treatment depend on where the malaria was contracted and how sick the patient is.

For all strains except falciparum, the treatment for malaria is usually chloroquine (Aralen) by mouth for three days. Those falciparum strains suspected to be resistant to chloroquine are usually treated with a combination of quinine and tetracycline. In countries where quinine resistance is developing, other treatments may include clindamycin (Cleocin), mefloquin (Lariam), or sulfadoxone/pyrimethamine (Fansidar). Most patients receive an antibiotic for seven days. Those who are very ill may need intensive care and intravenous (IV) malaria treatment for the first three days.

Anyone who acquired falciparum malaria in the Dominican Republic, Haiti, Central America west of the Panama Canal, the Middle East, or Egypt can still be cured with chloroquine. Almost all strains of falciparum malaria in Africa, South Africa, India, and southeast Asia are now resistant to chloroquine. In Thailand and Cambodia, there are strains of falciparum malaria that have some resistance to almost all known drugs.

A patient with falciparum malaria needs to be hospitalized and given **antimalarial drugs** in different combinations and doses depending on the resistance of the strain. The patient may need IV fluids, red blood cell transfusions, **kidney dialysis**, and assistance breathing.

A drug called primaquine may prevent relapses after recovery from *P. vivax* or *P. ovale*. These relapses are caused by a form of the parasite that remains in the liver and can reactivate months or years later.

Another new drug, halofantrine, is available abroad. While it is licensed in the United States, it is not marketed in this country and it is not recommended by the Centers for Disease Control and Prevention in Atlanta.

Alternative treatments

The Chinese herb qiinghaosu (the Western name is artemisinin) has been used in China and southeast Asia to fight severe malaria, and became available in Europe in 1994. Because this treatment often fails, it is usually combined with another antimalarial drug (mefloquine) to boost its effectiveness. It is not available in the United States and other parts of the

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KEY TERMS

Arteminisinins—A family of antimalarial products derived from an ancient Chinese herbal remedy. Two of the most popular varieties are artemether and artesunate, used mainly in southeast Asia in combination with mefloquine.

Chloroquine—An antimalarial drug that was first used in the 1940s, until the first evidence of quinine resistance appeared in the 1960s. It is now ineffective against falciparum malaria almost everywhere. However, because it is inexpensive, it is still the antimalarial drug most widely used in Africa. Native individuals with partial immunity may have better results with chloroquine than a traveler with no previous exposure.

Mefloquine—An antimalarial drug that was developed by the United States Army in the early 1980s. Today, malaria resistance to this drug has become a problem in some parts of Asia (especially Thailand and Cambodia).

Mefloquine—An antimalarial drug that was developed by the United States Army in the early 1980s. Today, malaria resistance to this drug has become a problem in some parts of Asia (especially Thailand and Cambodia).

Quinine—One of the first treatments for malaria, quinine is a natural product made from the bark of the Cinchona tree. It was popular until being superseded by the development of chloroquine in the 1940s. In the wake of widespread chloroquine resistance, however, it has become popular again. Quinine, or its close relative quinidine, can be given intravenously to treat severe *Falciparum* malaria.

Sulfadoxone/pyrimethamine (Fansidar)—An antimalarial drug developed in the 1960s. It is the first drug tried in some parts of the world where chloroquine resistance is widespread. It has been associated with severe allergic reactions due to its sulfa component.

developed world due to fears of its toxicity, in addition to licensing and other issues.

A Western herb called wormwood (*Artemesia annua*) that is taken as a daily dose can be effective against malaria. Protecting the liver with herbs like goldenseal (*Hydrastis canadensis*), Chinese goldenthread (*Coptis chinensis*), and milk thistle (*Silybum marianum*) can be used as preventive treatment. Preventing mosquitoes from biting you while in the tropics is another possible way to avoid malaria.

As of late 2002, researchers are studying a traditional African herbal remedy against malaria. Extracts from *Microglossa pyrifolia*, a trailing shrub belonging to the daisy family (Asteraceae), show promise in treating drug-resistent strains of *P. falciparum*.

Prognosis

If treated in the early stages, malaria can be cured. Those who live in areas where malaria is epidemic, however, can contract the disease repeatedly, never fully recovering between bouts of acute infection.

Prevention

Several researchers are currently working on a malarial vaccine, but the complex life cycle of the malaria parasite makes it difficult. A parasite has much more genetic material than a virus or bacterium. For this reason, a successful vaccine has not yet been developed.

Malaria is an especially difficult disease to prevent by **vaccination** because the parasite goes through several separate stages. One recent promising vaccine appears to have protected up to 60% of people exposed to malaria. This was evident during field trials for the drug that were conducted in South America and Africa. It is not yet commercially available.

The World Health Association (WHO) has been trying to eliminate malaria for the past 30 years by controlling mosquitoes. Their efforts were successful as long as the pesticide DDT killed mosquitoes and antimalarial drugs cured those who were infected. Today, however, the problem has returned a hundredfold, especially in Africa. Because both the mosquito and parasite are now extremely resistant to the insecticides designed to kill them, governments are now trying to teach people to take antimalarial drugs as a preventive medicine and avoid getting bitten by mosquitoes.

A newer strategy as of late 2002 involves the development of genetically modified non-biting mosquitoes. A research team in Italy is studying the feasibility of this means of controlling malaria.

Travelers to high-risk areas should use insect repellant containing DEET for exposed skin. Because DEET is toxic in large amounts, children should not

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use a concentration higher than 35%. DEET should not be inhaled. It should not be rubbed onto the eye area, on any broken or irritated skin, or on children's hands. It should be thoroughly washed off after coming indoors.

Those who use the following preventive measures get fewer infections than those who do not:

- Between dusk and dawn, remain indoors in well-screened areas.
- Sleep inside pyrethrin or permethrin repellent-soaked mosquito nets.
- Wear clothes over the entire body.

Anyone visiting endemic areas should take antimalarial drugs starting a day or two before they leave the United States. The drugs used are usually chloroquine or mefloquine. This treatment is continued through at least four weeks after leaving the endemic area. However, even those who take antimalarial drugs and are careful to avoid mosquito bites can still contract malaria.

International travelers are at risk for becoming infected. Most Americans who have acquired falciparum malaria were visiting sub-Saharan Africa; travelers in Asia and South America are less at risk. Travelers who stay in air conditioned hotels on tourist itineraries in urban or resort areas are at lower risk than backpackers, missionaries, and Peace Corps volunteers. Some people in western cities where malaria does not usually exist may acquire the infection from a mosquito carried onto a jet. This is called airport or runway malaria.

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Malaya *see* **Elephantiasis**
Male breast enlargement *see* **Gynecomastia**
Male condom *see* **Condom**
Male infertility *see* **Infertility**
Male pattern baldness *see* **Alopecia**

Malignant lymphomas

Definition

Lymphomas are a group of cancers in which cells of the lymphatic system become abnormal and start to grow uncontrollably. Because there is lymph tissue in many parts of the body, lymphomas can start in almost any organ of the body.

Description

The lymph system is made up of ducts or tubules that carry lymph to all parts of the body. Lymph is a milky fluid that contains the lymphocytes or white blood cells. These are the infection-fighting cells of the blood. Small pea-shaped organs are found along the network of lymph vessels. These are called the lymph nodes, and their main function is to make and store the lymphocytes. Clusters of lymph nodes are found in the pelvis region, underarm, neck, chest, and abdomen.

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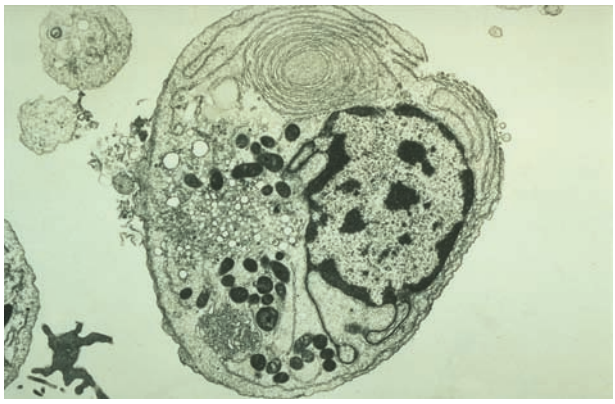

A malignant lymph cell. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

The spleen (an organ in the upper abdomen), the tonsils, and the thymus (a small organ found beneath the breastbone) are part of the lymphatic system.

The lymphocyte is the main cell of the lymphoid tissue. There are two main types of lymphocytes: the T lymphocyte and the B lymphocyte. Lymphomas develop from these two cell types. B cell lymphomas are more common among adults, while among children, the incidence of T and B cell lymphomas are almost equal.

The T and the B cell perform different jobs within the immune system. When an infectious bacterium enters the body, the B cell makes proteins called "antibodies." These antibodies attach themselves to the bacteria, and flag them for destruction by other immune cells. The T cells help protect the body against viruses. When a virus enters the cell, it generally produces certain proteins that are projected on the surface of the infected cell. T cells recognize these proteins and produce certain substances (cytokines) that destroy the infected cells. Some of the cytokines made by the T cells attract other cell types, which are capable of digesting the virus-infected cell. The T cells can also destroy some types of cancerous cells.

Lymphomas can be divided into two main types: Hodgkin's lymphoma or Hodgkin's disease, and non-Hodgkin's lymphomas. There are at least 10 types of non-Hodgkin's lymphomas. They are grouped (staged) by how aggressively they grow; slow growing (low grade), intermediate growing, and rapidly growing (high grade); and how far they spread.

A majority of non-Hodgkin's lymphomas begin in the lymph nodes. About 20% start in other organs, such as the lungs, liver or the gastrointestinal tract. Malignant lymphocytes multiply uncontrollably and do not perform their normal functions. Hence, the body's ability to fight infections is affected. In addition, these malignant cells may crowd the bone marrow, and, depending on the stage, prevent the production of normal red blood cells, white blood cells, and platelets. A low red blood cell count causes anemia, while a reduction in the number of platelets makes the person susceptible to excessive bleeding. Cancerous cells can also invade other organs through the circulatory system of the lymph, causing those organs to malfunction.

Causes and symptoms

The exact cause of non-Hodgkin's lymphomas is not known. However, the incidence has increased significantly in the recent years. Part of the increase is due to the **AIDS** epidemic. Individuals infected with the AIDS virus have a higher likelihood of developing non-Hodgkin's lymphomas. In general, males are at a higher risk for having non-Hodgkin's lymphomas than are females. The risk increases with age. Though it can strike people as young as 40, people between the ages of 60 and 69 are at the highest risk.

People exposed to certain pesticides and ionizing radiation have a higher than average chance of developing this disease. For example, an increased incidence of lymphomas has been seen in survivors of the atomic bomb explosion in Hiroshima, and in people who have undergone aggressive **radiation therapy**. People who suffer from immune-deficient disorders, as well as those who have been treated with immune suppressive drugs for heart or kidney transplants, and for conditions such as **rheumatoid arthritis** and autoimmune diseases, are at an increased risk for this disease.

There have been some studies that have shown a loose association between retroviruses, such as HTLV-I, and some rare forms of lymphoma. The **Epstein-Barr virus** has been linked to Burkitt's lymphoma in African countries. However, a direct cause-and-effect relationship has not been established.

The symptoms of lymphomas are often vague and non-specific. Patients may experience loss of appetite, weight loss, **nausea**, **vomiting**, abdominal discomfort, and **indigestion**. The patient may complain of a feeling of fullness, which is a result of enlarged lymph nodes in the abdomen. Pressure or **pain** in the lower back is another symptom. In the advanced stages, the patient may have bone pain, headaches, constant coughing, and abnormal pressure and congestion in the face, neck, and upper chest. Some may have fevers and night sweats. In most cases, patients go to the doctor

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because of the presence of **swollen glands** in the neck, armpits, or groin area. Since all the symptoms are common to many other illnesses, it is essential to seek medical attention if any of the conditions persist for two weeks or more. Only a qualified physician can correctly diagnose if the symptoms are due to lymphoma or some other ailment.

Diagnosis

Like all cancers, lymphomas are best treated when found early. However, it is often difficult to diagnose lymphomas. There are no screening tests available, and, since the symptoms are non-specific, lymphomas are rarely recognized in their early stages. Detection often occurs by chance during a routine **physical examination**.

When the doctor suspects lymphoma, a complete medical history is taken, and a thorough physical examination is performed. Enlargement of the lymph nodes, liver, or spleen may suggest lymphomas. Blood tests will determine the cell counts and obtain information on how well the organs, such as the kidney and liver, are functioning.

A biopsy of the enlarged lymph node is the most definitive diagnostic tool for staging purposes. The doctor may perform a **bone marrow biopsy**. During the biopsy, a cylindrical piece of bone and marrow fluid is removed. They are generally taken out of the hipbone. These samples are sent to the laboratory for examination. In addition to diagnosis, the biopsy may also be repeated during the treatment phase of the disease to see if the lymphoma is responding to therapy.

Once the exact form of lymphoma is known, it is then staged to determine how aggressive it is, and how far it has spread. Staging is necessary to plan appropriate treatment.

Conventional imaging tests, such as x rays, **computed tomography scans** (CT scans), **magnetic resonance imaging**, and abdominal sonograms, are used to determine the extent of spread of the disease.

Lymphangiograms are x rays of the lymphatic system. In this procedure, a special dye is injected into the lymphatic channels through a small cut (incision) made in each foot. The dye is injected slowly over a period of three to four hours. This dye clearly outlines the lymphatic system and allows it to stand out. Multiple x rays are then taken and any abnormality, if present, is revealed.

Rarely, a **lumbar puncture** or a spinal tap is performed to check if malignant cells are present in the fluid surrounding the brain. In this test, the physician inserts a needle into the epidural space at the base of the spine and collects a small amount of spinal fluid for microscopic examination.

Treatment

Treatment options for lymphomas depend on the type of lymphoma and its present stage. In most cases, treatment consists of **chemotherapy**, radiotherapy, or a combination of the two methods.

Chemotherapy is the use of anti-cancer drugs to kill **cancer** cells. In non-Hodgkin's lymphomas, combination therapy, which involves the use of multiple drugs, has been found more effective than single drug use. The treatment may last about six months, but in some cases may last as long as a year. The drugs may either be administered intravenously (through a vein) in the arm or given orally in the form of pills. If cancer cells have invaded the central nervous system, then chemotherapeutic drugs may be instilled, through a needle in the brain or back, into the fluid that surrounds the brain. This procedure is known as intrathecal chemotherapy.

Radiation therapy, where high-energy ionizing rays are directed at specific portions of the body, such as the upper chest, abdomen, pelvis, or neck, is often used for treatment of lymphomas. External radiation therapy, where the rays are directed from a source outside the body, is the most common mode of radiation treatment.

Bone marrow transplantation is used in cases where the lymphomas do not respond to conventional therapy, or in cases where the patient has had a relapse or suffers from recurrent lymphomas.

There are two ways of doing bone marrow transplantation. In a procedure called "allogeneic bone marrow transplant," a donor is found whose marrow matches that of the patient. The donor can be a twin (best match), a sibling, or a person who is not related at all. High-dose chemotherapy or radiation therapy is given to eradicate the lymphoma. The donor marrow is then given to replace the marrow destroyed by the therapy.

In "autologous bone marrow transplantation," some of the patient's own bone marrow is harvested, chemically purged, and frozen. High-dose chemotherapy and radiation therapy are given. The marrow that was harvested, purged, and frozen is then thawed and put back into the patient's body to replace the destroyed marrow.

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KEY TERMS

Antibodies—Proteins made by the B lymphocytes in response to the presence of infectious agents such as bacteria or viruses in the body.

Biopsy—The surgical removal and microscopic examination of living tissue for diagnostic purposes.

Growth factors (cytokines)—Chemicals made by the cells that act on other cells to stimulate or inhibit their function. Cytokines that stimulate growth are called "growth factors."

A new treatment option for patients with lymphoma is known as "peripheral stem cell transplantation." In this treatment approach, cells that normally circulate in the blood are collected when the patient has normal blood counts taken, and these cells are saved via a process called "pheresis." Researchers are exploring whether these cells can be used to restore the normal function and development of blood cells, rather than using a bone marrow transplant.

Prognosis

Like all cancers, the prognosis for lymphoma depends on the stage of the cancer, and the patient's age and general health. When all the different types and stages of lymphoma are considered together, only 50% of patients survive 5 years or more after initial diagnosis. This is because some types of lymphoma are more aggressive than others.

The survival rate among children is definitely better than among older people. About 90% of the children diagnosed with early stage disease survive 5 years or more, while only 60-70% of adults diagnosed with low grade lymphomas survive for 5 years or more. The survival rate for children with the more advanced stages is about 75-85%, while among adults it is 40-60%.

Prevention

Although many cancers may be prevented by making diet and life style changes which reduce risk factors, there is currently no known way to prevent lymphomas. Protecting oneself from developing AIDS, which may be a risk factor for lymphomas, is the only preventive measure that can be practiced.

At present, there are no special tests that are available for early detection of non-Hodgkin's lymphomas. Paying prompt attention to the signs and symptoms of this disease, and seeing a doctor if the symptoms persist, are the best strategies for an early diagnosis of lymphoma. Early detection affords the best chance for a cure.

Resources

OTHER

"Adults Non-Hodgkin's Lymphoma." *National Cancer Institute Page*. http://www.nci.nih.gov.

"Childhood Non-Hodgkin's Lymphoma." *National Cancer Institute Page*. http://www.nci.nih.gov.

"Hodgkin's Disease" and Non-Hodgkin's Lymphoma." *The Leukemia Society*. http://www.leukemia-lymphoma.org/hm_lls.

ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (800) 227-2345, http://www.cancer.org.

Cancer Research Institute (National Headquarters), One Exchange Plaza, 55 Broadway, Suite 1802, New York, NY, (212) 688-7515, (212) 832-9376, (800) 992-2623, http://www.cancerresearch.org/.

Leukemia and Lymphoma Society, 1311 Mamaroneck Avenue, Suite 310, White Plains, NY, 10605, (800) 955-4572, http://www.leukemia-lymphoma.org.

Lymphoma Research Foundation, 8800 Venice Boulevard, Suite 207, Los Angeles, CA, 90034, (212) 349-2910, (212) 349-2886, (800) 235-6848, Helpline@lymphoma.org, http://www.lymphoma.org.

National Cancer Institute (National Institutes of Health), NCI Office of Communications and Education, 6116 Executive Blvd. Suite 300, Bethesda, MD, 20892-8322, (800) 4-CANCER (422-6237), cancergovstaff@mail.nih.gov, http://www.cancer.gov/.

Oncolink. University of Pennsylvania Cancer Center, 3400 Spruce Street, 2 Donner, Philadelphia, PA, 19104, (215) 349-8895, (215) 349-5445, hampshire@uphs.upenn.edu, http://oncolink.org.

Lata Cherath, PhD

Malignant melanoma

Definition

Malignant melanoma is a type of **cancer** arising from the melanocyte cells of the skin. Melanocytes are cells in the skin that produce a pigment called melanin. Malignant melanoma develops when the melanocytes no longer respond to normal control mechanisms of cellular growth. They may then invade nearby structures or spread to other organs in the body

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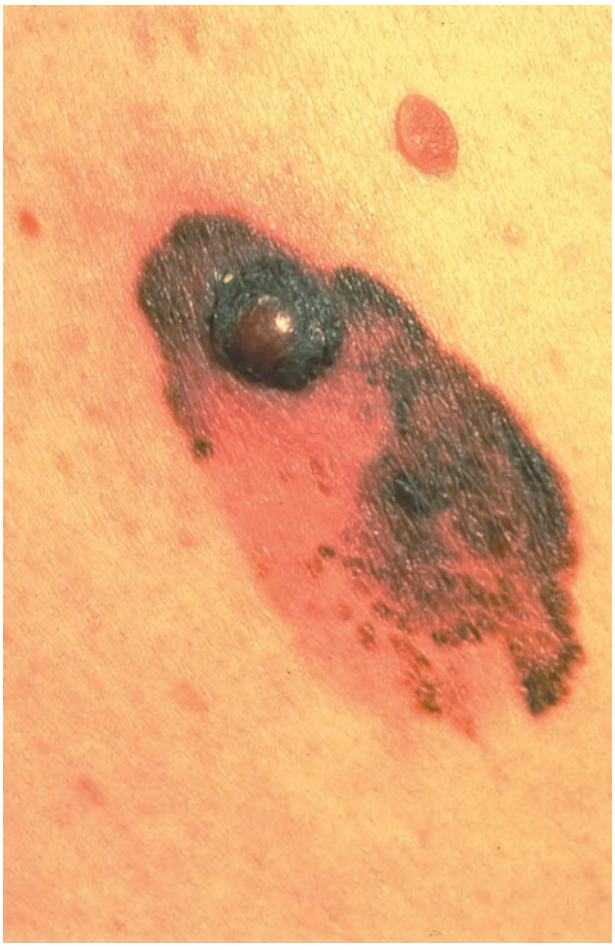

A close-up image of a malignant melanoma on a patient's back. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

(metastasis), where again they invade and compromise the function of that organ.

Description

Melanocytes are derived from a structure in the human embryo called the neural crest. They are distributed in the epidermis and thus are found throughout the skin. They produce a brown pigment known as melanin and are responsible for racial variation in skin color as well as the color of **moles**. Malignant degeneration of the melanocyte gives rise to the tumor known as melanoma, which has four subtypes. These are: superficial spreading, nodular, lentigo maligna, and acral lentiginous melanomas, accounting for 70%, 15% to 30%, 4% to 10%, and 2% to 8% of cases, respectively. Malignant melanoma may develop anywhere on the body. In men, it is most common on the trunk. In women, it is most common on the back or legs. The subtype also may influence where the tumor develops; lentigo melanoma is more common on the face while acral lentiginous melanoma is more common on the palms of the hand, soles of the feet, or in the nail beds.

The locally invasive characteristic of this tumor involves vertical penetration through the skin and into the dermis and subcutaneous (under-the-skin) tissues of the malignant melanocytes. With the exception of the nodular variety of melanoma, there is often a phase of radial or lateral growth associated with these tumors. Since it is the vertical growth that characterizes the malignancy, the nodular variant of melanoma carries the worst prognosis. Fortunately, the superficial spreading type is most common.

The primary tumor begins in the skin, often from the melanocytes of a pre-existing mole. Once it becomes invasive, it may progress beyond the site of origin to the regional lymph nodes or travel to other organ systems in the body and become systemic in nature.

Lymph is the clear, protein-rich fluid that bathes the cells throughout our body. Lymph will work its way back to the bloodstream via small channels known as lymphatics. Along the way, the lymph is filtered through cellular stations known as nodes, thus they are called lymph nodes. Nearly all organs in the body have a primary lymph node group filtering the tissue fluid, or lymph, that comes from that organ. Different areas of the skin have different primary nodal stations. For the leg, they are in the groin. For the arm, the armpit or axilla. For the face, it is the neck. Depending where on the torso the tumor develops, it may drain into one groin or armpit, or both.

Cancer, as it invades in its place of origin, may also work its way into blood vessels. If this occurs, it provides yet another route for the cancer to spread to other organs of the body. When the cancer spreads elsewhere in the body, it has become systemic in extent and the tumor growing elsewhere is known as a metastasis.

Untreated malignant melanoma follows a classic progression. It begins and grows locally, penetrating vertically. It may be carried via the lymph to the regional nodes, known as regional metastasis. It may go from the lymph to the bloodstream or penetrate blood vessels, directly allowing it a route to go elsewhere in the body. When systemic disease or distant metastasis occur, melanoma commonly involves the lung, brain, liver, or occasionally bone. The malignancy causes **death** when its uncontrolled growth compromises vital organ function.

Of the anticipated new cases of cancer for the year 2003 in the United States, malignant melanoma will account for 5% of malignancies in men and 4% in

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women, being the sixth most common cancer in men and the seventh in women. It is estimated there will be 560,000 total cancer deaths in the United States in 2007. Malignant melanoma will account for 8.110 of these deaths.

The incidence of primary cutaneous malignant melanoma has been steadily increasing, possibly related to increase of sun exposure. Currently, the risk is about 13 per 100,000 of the population. It affects all age groups but is most commonly seen in patients between 30 and 60 years of age.

Sun exposure definitely increases the risk of developing melanoma, particularly in older males. The melanocytes are part of the integument's photoprotective mechanism; in response to sunlight, they produce melanin that has a protective role from the sun's ultraviolet rays. For Caucasians, the amount of melanin present in the skin is directly related to sun exposure. However, it is not so much the total sun exposure that seems important, rather it is the history of **sunburn**, (especially if severe or at an early age), that correlates with the increased risk. On this basis populations of fair-skinned people living in areas of high sun exposure such as the southwest United States or Australia are subject to increased risk. Malignant melanoma also affects non-Caucasians—though sun exposure probably does not play a role—at a rate of 10% that of Caucasians. The most common form of melanoma in African Americans is acral lentiginous melanoma.

Malignant melanoma may arise in the skin anywhere on the body. It is estimated that 50%–70% develop spontaneously while the remainder start in a pre-existing mole.

Causes and symptoms

The predisposing causes to the development of malignant melanoma are environmental and genetic. The environmental factor is excessive sun exposure. There are also genetically transmitted familial syndromes with alterations in the CDKN2A gene, which encodes for the tumor-suppressing proteins p16 and p19. In 2003 a group of Swedish researchers reported that 63 out of a group of 71 melanoma patients, or 89% of the group, had mutations in either the NRAS or the BRAF gene. The researchers found that these mutations occur at an early point in the development of melanoma and remain as the tumor progresses.

As of early 2003, some researchers think there may be two pathways to malignant melanoma, one involving exposure to sunlight and the other with melanocyte proliferation triggered by other factors. This hypothesis is based on the difference in distribution of moles on the body between patients who develop melanomas on the face and neck, and those who develop melanomas on the trunk.

A small percentage of melanomas arise within burn scar tissue. Researchers do not fully understand the relationship between deep **burns** and an increased risk of skin cancer.

As mentioned previously, melanin production in fair-skinned people is induced by sun exposure. An exposure substantial enough to result in mild sunburn will be followed by melanin producing a tan that may last a few weeks. Both ultraviolet radiation and damaging oxygen radicals caused by sun exposure may damage cells, particularly their DNA. It is suspected that this damage induces mutations that result in the development of malignant melanoma. Though these mutations are alterations of the genome causing the melanoma, they are environmentally induced and account for sporadic or spontaneous cases of this disease.

A positive family history of one or two first-degree relatives having had melanoma substantially increases the risk on a genetic basis. A family tendency is observed in 8% to 12% of patients. There is a syndrome known as the dysplastic (atypical) nevus syndrome that is characterized by atypical moles with bothersome clinical features in children under age 10. Such individuals have to be observed closely for the development of malignant melanoma. Chromosome 9p has been identified as being involved in familial predisposition. There are mutations in up to 50% of familial melanoma patients of the tumor-suppressing gene CDKN2A. The actual number of moles increases risk, but the size of the moles needs be considered. Those with 10 larger moles of over 1 cm (0.4 in.) are at more risk than those with a higher number (50-99) of smaller moles. Finally, when a child is born with a large congenital mole, careful observation for change is appropriate because of increased risk.

An excellent way of identifying changes of significance in a mole is the ABCDE rule:

- Asymmetry
- Border irregularity
- Color variegation
- Diameter greater than 6 mm (0.24 in)
- Elevation above surrounding tissue.

Notice that three of the criteria refer to variability of the lesion (color variegation refers to areas of light color and black scattered within the mole). Thus small, uniform regular lesions have less cause for concern. It is important to realize that change in a mole or the

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rapid development of a new one are very important symptoms.

Another summary of important changes in a mole is the Glasgow 7-point scale. The symptoms and signs below can occur anywhere on the skin, including the palms of the hands, soles of the feet, and also the nail beds:

- Change in size
- Change in shape
- Change in color
- Inflammation
- Crusting and bleeding
- Sensory change
- Diameter greater than 7 mm (0.28 in.

In this scheme, change is emphasized along with size. Bleeding and sensory changes are relatively late symptoms.

Symptoms related to the presence of regional disease are mostly those of nodules or lumps in the areas containing the lymph nodes draining the area. Thus nodularity can be found in the armpit, the groin, or the neck if regional nodes are involved. There is also a special type of metastasis that can occur regionally with malignant melanoma; it is known as an in-transit metastasis. If the melanoma is spreading through the lymph system, some of the tumor may grow there, resulting in a nodule part way between the primary site and the original lymph node. These in-transit metastasis are seen both at the time of original presentation or later after primary treatment has been rendered, the latter being a type of recurrence.

Finally, in those who either present with or progress to widespread or systemic disease, symptoms and signs are related to the affected organ. Thus neurological problems, lung problems, or liver problems develop depending on the organ involved.

Diagnosis

None of the clinical signs or symptoms discussed above are absolute indications that a patient has malignant melanoma. The actual diagnosis is accomplished by biopsy, a procedure that removes tissue to examine under a microscope. It is important that the signs and symptoms are used to develop a suspicion of the diagnosis because the way the biopsy is performed for melanoma may be different than for other lesions of the skin.

The doctor may also use a dermatoscope to examine the mole prior to removal. The dermatoscope, which can be used to distinguish between benign moles and melanomas, is an instrument that resembles an ophthalmoscope. An immersion oil is first applied to the mole to make the outer layers of skin transparent.

When dealing with an early malignant melanoma, it is very important to establish the exact thickness of penetration of the primary tumor. Any biopsy that does not remove the full vertical extent of the primary is inadequate. Therefore, if a skin lesion is suspicious, full thickness excisional biopsy is the approach recommended. Shave biopsies and biopsies that remove only a portion of the suspect area are inappropriate. Often, in an early case, the excision involves just the suspicious lesion with minimal normal skin, but it should be a full vertical excision of the skin. If a melanoma is diagnosed, further treatment of this area will often be necessary but does not compromise outcome (prognosis). In some special areas of the body, minor modifications may be necessary about initial total excision, but full thickness excision should always be the goal. (See staging, below.)

Once the diagnosis is obtained, careful examination of the patient for regional lymph node involvement should be done. A careful review to uncover any symptoms of widespread disease is also appropriate.

The more common patient has an early melanoma, and extensive testing is not usually warranted. Routine testing in this situation involves a **complete blood count**, a **chest x ray**, and determinations of blood enzymes including lactic dehydrogenase and alkaline phosphatase.

If the patient has signs or symptoms of more advanced disease, or if the lesion's depth of penetration is sizeable, further imaging studies may be appropriate. These would involve CAT scans of the abdomen, the chest, or regional nodal areas, or a CT or MRI of the brain.

Treatment

The key to successful treatment is early diagnosis. Patients identified with localized, thin, small lesions (typified by superficial spreading subtype) nearly always survive. For those with advanced lesions, the outcome is poor in spite of progress in systemic therapy.

Clinical staging

Malignant melanoma is locally staged based on the depth of penetration through the skin and its appendages. There are two ways of looking at the depth of penetration. The Clarke system utilizes the layers of the dermis and the skin appendages present at that layer to identify the depth of penetration. The

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Breslow system uses the absolute measurement of depth. Though useful conceptually, the Clarke system is used less frequently because of the fact that skin is of different thickness in different regions of the body. The depth of penetration is much greater when the tumor reaches the subcutaneous fat when the skin involved is the back as opposed to the face. It turns out that the Breslow measurement is more reproducible and thus more useful; therefore, for purposes here, depth of penetration by absolute measurement (Breslow) is used in local staging.

These stages are subdivided on the basis of penetration. Stage Ia is 0.75 mm or less (1 mm = 0.04 in), and Stage Ib is 0.75–1.5 mm penetration. Stage IIa is 1.5–4.0 mm and Stage IIb is over 4.0 mm or into the subcutaneous fat. In stage III and IV, there is disease beyond the primary site. Stage III is defined by the presence of in-transit or regional nodal metastasis or both. Stage IV is defined by the presence of distant metastasis.

Once the diagnosis of malignant melanoma has been established by biopsy and the stage has been identified using the results of the examination and studies, a treatment plan is developed. Melanoma is not cured unless it is diagnosed at a stage when it can be isolated and removed surgically. Considerations revolve around the extent of the local and regional nodal surgery for stages I through III. For stage IV patients, or those that are treated and then develop recurrence at distant sites, **chemotherapy** or immunotherapy is planned. Studies are in progress to improve the results from traditional chemotherapeutic regimens. Adjuvant therapy (auxiliary drug treatment used to make possibility of relapse less for those at high risk) is also considered.

Surgical therapy for the primary site is that of wide local removal of the skin including subcutaneous tissue surrounding the lesion. In the past, wide excisions were large and encompassed 2 in. of tissue in all directions wherever feasible. It has been shown that such wide local excisions are not necessary and the issue has become: how wide is enough? Studies from the World Health Organization Melanoma Group and by the Melanoma Intergroup Committee in the United States have provided general guidelines based on the depth of penetration of the melanoma. These guidelines and anatomic considerations need to be kept in mind by the surgeon.

The next issue in primary management is whether the patient should have the regional lymph nodes removed in addition to treatment of the primary tumor. The problems associated with the resection of regional lymph nodes are those of lifelong **edema** or swelling in the extremity. Though it does not occur in all patients (5% to 20%, depending on the extremity and extent of the dissection), it can be a disabling symptom. Certainly, if it could be ascertained that there was disease in the nodes, resection (removal) would be appropriate. However, if there was no disease, the risk of edema should be avoided. In patients with no signs of regional disease, depth of penetration of the primary tumor helps guide the decision. If the tumor penetrates less than 1mm, dissection is not usually done. If it is 1-2 mm, node dissection may be done at the time of primary treatment or the patient may be observed and only undergo lymph node dissection if the area later shows signs of disease. If the patient has enlarged lymph nodes or the depth of the tumor has led to the evaluation by CAT scan showing enlarged nodes, resection of the nodes will be considered. In the latter case, more extensive imaging of the lung, liver, or brain may be appropriate to be sure the patient does not already have stage IV disease.

Questions related to which patients should have resection of regional lymph nodes have led to an intermediary procedure known as sentinel node mapping and biopsy. Intermediate thickness melanomas between 1 and 4 mm deep (0.04 and 0.16 in.) may have nodal involvement even if the examination and any other studies done are normal. If a radioisotope tracer or blue dye is injected into the area of the primary tumor, very shortly it will travel to the lymph nodes draining that area. These sentinel nodes are thus identifiable and are the most likely to harbor any regional metastatic disease. If these nodes alone are biopsied and are normal, the rest of the lymph node group can be spared. If they show microscopic deposits of tumor, then the full resection of the lymph node group may be completed. This procedure allows selection of those patients with intermediate thickness melanoma who will benefit from the regional lymph node dissection.

Patients with metastatic melanoma who do not respond well to other therapies may be candidates for treatment with aldesleukin. Aldesleukin is a form of interleukin, a specific kind of biological response modifier that promotes the development of T-cells. These cells are part of the lymphatic system and can directly interact with and fight cancer cells. Although aldesleukin is produced naturally in the body, its therapeutic form is developed via biotechnology in a laboratory setting. Treatment is considered palliative, which means that it provides comfort but does not produce a cure. Side effects, however, can be severe, and range from flu-like symptoms to whole-body infection (**sepsis**) and **coma**.

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KEY TERMS

Adjuvant therapy—Treatment given to patients who are at risk of having microscopic untreated disease present but have no obvious symptoms.

Dermis—The deeper portion or layer of the skin beneath the epidermis.

Dysplastic nevus syndrome—A familial syndrome characterized by the presence of multiple atypical appearing moles, often at a young age.

Epidermis—The uppermost layer of skin cells.

Genome—The genetic makeup of a cell, composed of DNA.

Immunotherapy—A form of treatment that uses biologic agents to enhance or stimulate normal immune function.

Integument—The medical name for the skin.

Lymph node dissection—Surgical removal of a group of lymph nodes.

Lymphedema—Swelling of an arm or leg following surgical removal of the lymph nodes that drain the limb.

Melanocytes—Skin cells derived from the neural crest that produce the protein pigment melanin.

Metastasis (plural, metastases)—A tumor growth or deposit that has spread via lymph or blood to an area of the body remote from the primary tumor.

Nevus (plural, nevi)—A medical term for mole.

Resection—The act of removing something surgically.

Skin appendages—Structures related to the integument such as hair follicles and sweat glands.

Variegation—Patchy variation in color.

Some patients, such as those with IIb or stage III melanoma, are at high risk for the development of recurrence after treatment. Although these patients are clinically free of disease after undergoing primary treatment, they are more likely to have some microscopic disease in the body that studies have not yet been able to identify. In an effort to decrease the rate of relapse, adjuvant therapy may be considered. Interferon alpha 2a is an agent that stimulates the immune system. This adjuvant therapy may slightly increase the duration of a patient's disease-free state and lengthen overall survival. However, interferon alpha 2a has high toxicity and patients may not tolerate the side effects.

Unfortunately, treatment for those patients who present with or go on to develop systemic disease usually fails; melanoma that has metastasized to the brain is particularly difficult to treat. The chemotherapeutic agent dacarbazine, or DTIC, seems to be the most active agent. Overall responses are noted in about 20% of patients, and they last only two to six months. Combination therapy may be an option. The regimen of DTIC + BCNU (carmustine) + cisplatin + tamoxifen delivers a response rate of 40%. Combining biologic or immunologic agents such as interferon with standard chemotherapeutic agents is under study and showing improved response rates, though toxicity is substantial and only the healthier, younger patients tolerate the treatment.

Some researchers are investigating the reasons why melanomas are so resistant to chemotherapy. One suggestion is that the genes ordinarily responsible for apoptosis (cell self-destruction) do not function normally in melanomas. The development of new drugs to treat melanoma depends on a better understanding of the complex processes involved in apoptosis. As of 2007, several new drugs were in development. The most promising seemed to be Zadazin (thymalfasin) when used in combination with standard dacarbazine (DTIC) chemotherapy.

Alternative treatment

Though **radiation therapy** has a minimal role in the primary treatment of malignant melanoma, for patients who have metastatic disease, radiation may be helpful. This is true in patients who have developed tumor deposits in such areas as the brain or bone.

Prognosis

Almost all patients survive stage Ia malignant melanoma, and the survivorship for stage I overall is more than 90%. Survival drops in stage IIa to about 65% at five years and is worse yet for stage IIb at slightly over 50%. Stage III has a survival rate at 5 years of 10%–47%, depending on the size and number of regional nodes involved. Stage IV malignant melanoma is almost always a fatal disease.

Coping with cancer treatment

For those with familial tendencies for malignant melanoma, **genetic counseling** may be appropriate. Psychological counseling may be appropriate for

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anyone having trouble coping with a potentially fatal disease. Local cancer support groups may be helpful and are often identified by contacting local hospitals or the American Cancer Society.

Prevention

Though it is difficult to prove that **sunscreens** statistically reduce the frequency of malignant melanoma at this time, most authorities recommend their use as protection from ultraviolet light (considered a major factor in the development of melanoma.) Avoidance of severe sunburns is recommended.

Resources

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ORGANIZATIONS

American Academy of Dermatology, PO Box 4014, Schaumburg, IL, 60168-4014, (847) 240-1859, (866) 503-SKIN (7546), http://www.aad.org.

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (800) 227-2345, http://www.cancer.org.

British Association for Cancer Research. Institute of Cancer Research, McElwain Laboratories, St. James's University Hospital, Beckett Street, Leeds, Great Britain, LS9 7TF, 440 113 206-5611, 440 113 242-9886, bacr@leeds.ac.uk, http://www.bacr.org.uk.

Canadian Cancer Society, 10 Alcorn Ave., Suite 200, Toronto, CanadaOntario, M4V 3B1, (426) 961-7223, (416) 961-4189, http://www.cancer.ca.

National Cancer Institute (National Institutes of Health), NCI Office of Communications and Education, 6116 Executive Blvd. Suite 300, Bethesda, MD, 20892-8322, (800) 4-CANCER (422-6237), cancergovstaff@mail.nih.gov, http://www.cancer.gov/.

Skin Cancer Foundation, 149 Madison Avenue Suite 901, New York, NY, 10016, (212) 725-5176, http://www.skincancer.org.

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Malignant plasmacytoma *see* **Multiple myeloma**

Malingering

Definition

In the context of medicine, malingering is the act of intentionally feigning or exaggerating physical or psychological symptoms for motives involving personal or financial gain. Various examples of malingering include fabricating mental or physical disorders in order to avoid school, work, or military service; or to obtain financial compensation, avoid criminal prosecution, or obtain **narcotics** and other drugs.

Demographics

Malingering can occur within any individual all over the world. Because it is often impossible to determine who is malingering and who is not, it is very difficult to statistically measure how frequently malingering occurs.

Description

People may feign physical or psychological illness for any number of reasons. Faked illness can get them out of work, military duty, or criminal prosecution. It can also help them obtain financial compensation through insurance claims, lawsuits, or workers' compensation. Feigned symptoms may also be a way of getting the doctor to prescribe certain drugs.

According to the American Psychiatric Association, patients who malinger are different from people who invent symptoms for sympathy (factitious diseases). Patients who malinger clearly have something tangible to gain. People with factitious diseases appear to have a need to play the "sick" role. They may feign illness for attention or sympathy.

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KEY TERMS

Antisocial personality—A personality characterized by attitudes and behaviors at odds with society's customs and moral standards, including illegal acts.

Factitious diseases—Conditions in which symptoms are deliberately manufactured by patients in order to gain attention and sympathy. Patients with factitious diseases do not fake symptoms for obvious financial gain or to evade the legal system.

Post-traumatic stress disorder (PTSD)—A disorder that occurs among survivors of severe environmental stress such as a tornado, an airplane crash, or military combat. Symptoms include anxiety, insomnia, flashbacks, and nightmares. Patients with PTSD are unnecessarily vigilant; they may experience survivor guilt, and they sometimes cannot concentrate or experience joy.

Malingering may take the form of complaints of chronic **whiplash pain** from automobile accidents. Whiplash claims are controversial. Although some people clearly do suffer from whiplash injury, others may be exaggerating the pain for insurance claims or lawsuits. Some intriguing scientific studies have shown that chronic whiplash pain after automobile accidents is almost nonexistent in countries where the legal systems do not encourage personal injury lawsuits or financial settlements. The psychological symptoms experienced by survivors of disaster (**post-traumatic stress disorder**) are also faked by malingerers.

Causes and symptoms

People malinger for personal gain. The symptoms may vary, but generally are similar to symptoms involving **chronic fatigue syndrome** or chronic pain. Generally, malingerers complain of psychological disorders such as **anxiety**. They may also complain of chronic pain for which objective tests such as x rays cannot find any physical cause.

Many dishonest methods are used by individuals feigning symptoms of malingering. Some of these include harming oneself, trying to convince medical professionals one has a disease after learning about its details (such as symptoms) in medical textbooks, taking drugs that provoke certain symptoms common in some diseases, performing excess **exercise** to induce muscle strain or other physical types of ailments, and overdosing on drugs.

Diagnosis

Malingering may be suspected:

- When a patient is referred for examination by an attorney
- When the onset of illness coincides with a large financial incentive, such as a new disability policy
- When objective medical tests do not confirm the patient's complaints
- When the patient does not cooperate with the diagnostic work-up or prescribed treatment
- When the patient has antisocial attitudes and behaviors (antisocial personality).

The diagnosis of malingering is a challenge for doctors. On the one hand, the doctor does not want to overlook a treatable disease. On the other hand, he or she does not want to continue ordering tests and treatments if the symptoms are faked. Malingering is difficult to distinguish from certain legitimate **personality disorders**, such as factitious diseases or post-traumatic distress syndrome. In legal cases, malingering patients may be referred to a psychiatrist. Psychiatrists use certain written tests to try to determine whether the patient is faking the symptoms.

Treatment

In a sense, malingering cannot be treated because the American Psychiatric Association does not recognize it as a personality disorder. Patients who are purposefully faking symptoms for gain do not want to be cured. Often, the malingering patient fails to report any improvement with treatment, and the doctor may try many treatments without success. Treatment may include cognitive behavioral therapy, **psychotherapy**, **family therapy**, or other such types of psychological treatments. However, treatment sessions may be difficult because the malingerer may not accept such treatment when confronted with it. The malingerer may then go to another medical facility where their symptoms and medical history are not known, and they are free to once again pursue their acts of malingering.

Prognosis

If the malingerer accepts his/her malady, then treatment can be positively received, and malingering

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minimized or even eliminated. However, if the malingerer does not accept his/her own predicament, then treatment is often difficult and lengthy, with the outcome often times coming out without a resolution. Treatment of malingers by the medical profession has found that most patients do not accept psychiatric help. In addition, the recovery of malingers, who do not accept and acknowledge their problem, is rarely accomplished.

Prevention

The ability to accurately prevent people from malingering is difficult at best. When not detected and allowed to persist in society, the act of malingerers placed enormous financial burdens on any country's health care system. According to the Texas Department of Insurance, fraud that includes malingering costs the U.S. insurance industry approximately $150 billion each year.

Resources

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ORGANIZATIONS

American Psychiatric Association, 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209, (703) 907-7300, (880) 357-7924, apa@psych.org, http://www.psych.org/.

Robert Scott Dinsmoor

Mallet finger

Definition

Mallet finger refers to the involuntary flexion (bending) of the distal phalanx of a finger caused by the disruption or tearing of its extensor digitorum tendon at the distal interphalangeal joint (DIPJ). That is, a deformity has occurred in the finger when a tendon within that finger is damaged (lacerated) by a blunt impact. The result is that instead of being in a resting position, the outermost joint on the back of the finger remains abnormally flexed. Because of this description, it is also called extensor tendon injury. Mallet finger is also called dropped finger.

Demographics

Anyone who attempts to catch a ball (such as a football) or contacts an object (such as hitting the finger against a hard, stationary table or cabinet) has the potential of getting mallet finger. A sprain of the interphalangeal joint is common in sports. The most common injury of the interphalangeal joints is a sprain of the proximal interphalangeal joint (PIPJ). This injury is often called a jammed finger. Mallet finger occurs less frequently than a jammed finger.

Description

Tendons are the strong "cables" between muscles and bones that help control movements of the body. They consist of white, glistening, fibrous cords of various length and thickness, either round or flattened, and lacking in elasticity. In mallet finger, which often occurs as a sports–related injury, the tendon on the back of the finger becomes damaged or torn near the outermost joint. Without the support provided by the tendon, the short bone at the tip of the finger drops downward at an awkward angle. This bone, referred to as the "distal phalanx" of a finger, is the one furthest from the palm. In addition to tendon damage, mallet finger may involve a fracture of the distal phalanx.

Because the injury often occurs in such sports as baseball and softball (along with basketball and volleyball), it is commonly called baseball finger. The injury occurs when a ball (or some other object such as a knife) strikes the tip of the finger on the outstretched hand, jams the finger, and damages the tendon within the finger so it can no longer straighten the finger. This contact causes rupturing (hyperflexion) of the extensor digitorum tendon. In some incidences, the force of the ball or object causes a part of the bone along the tendon to pull away.

Causes and symptoms

Mallet finger usually occurs while playing a sport that involves a ball—for example, reaching out to catch a hard pass in basketball or bare–handing a baseball. Instead of landing on the palm of the hand, the ball accidentally hits the tip of an extended (or partially extended) finger. This straight–on impact causes instantaneous stretch of the tendon, which

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may overextend or tear away. Mallet finger can also result from hitting the hand against a hard object or receiving a cut from a sharp edge such as a knife.

Symptoms of mallet finger include **pain** and swelling around the top part of the finger, near the outermost joint. These symptoms occur immediately after the injury. Redness, bruising, and further swelling develop soon afterward. The finger may be unable to be extended; however, it still may be moved with help. Sometimes blood collects beneath the nail of the affected finger. If the object also strikes the nail, it may become detached. The tip of the finger has an abnormal–looking downward droop.

Diagnosis

Mallet finger is usually diagnosed after a relatively brief **physical examination** conducted by an emergency care physician or by an orthopedist, the type of doctor who specializes in such injuries. The downward droop of the fingertip is the major indication of mallet finger, along with the tenderness and pain that occurs in the affected area. X rays will be taken to determine if the bone at the top of the finger has been fractured. Mallet finger is typically covered by medical insurance.

Treatment

If symptoms of mallet finger appear, the affected individual should consult a physician or seek emergency care. In the meantime, ice (wrapped in a towel or cloth) can be applied to the affected area to help reduce swelling and tenderness, and to alleviate pain.

Treatment usually involves first applying ice to the finger, with the affected hand elevated above the heart. The medical professional will in almost all cases attach a splint, sometimes called a Mallet splint, around the top of the affected finger in order to keep it extended and allow the injury to heal. The splint must be worn at all times for six to eight weeks, though it may be briefly removed to wash the finger, but with extreme care so as not to allow the fingertip to bend. For the next six to eight weeks after that, the splint need only be worn during sleep or athletic activities.

Two other treatment option include the wearing of a small plaster cast or the wearing of an extension block k–wire for approximately four weeks. In all cases, the device helps to immobilize the finger so that the tendon can reattach itself.

After the full amount of time has expired for wearing the device, it is then usually worn less often, but for another three to four weeks.

KEY TERMS

Distal phalanx—The outermost bone of any finger or toe.

Fracture—A break in bone.

Orthopedist—A doctor who specializes in disorders of the musculoskeletal system.

Phalanx—Any of the digital bones of the hand or foot. Humans have three phalanges to each finger and toe with the exception of the thumb and big toe which have only two each.

Tendon—A tough cord of dense white fibrous connective tissue that connects a muscle with some other part, especially a bone, and transmits the force which the muscle exerts.

If the bone at the top of the finger has sustained a large fracture, surgery may be necessary. An orthopedic surgeon or a hand specialist will usually perform the surgery. If the tendon was damaged due to a cut, stitches may be required both to repair the tendon and to adequately close the wound. In addition, if blood is present underneath the nail, or if the nail is detached, the possibility of a nail laceration or a compound fracture is present, and medical help should be sought immediately.

Over-the-counter (OTC) or prescription pain medication can be used to alleviate pain.

Alternative treatment

Acupuncture, therapeutic massage, and **yoga** are believed by some practitioners of alternative medicine to have generalized pain–relieving effects. Any of these therapies may provide additional comfort while the finger heals.

Prognosis

With proper treatment, most people regain full use of the affected finger. However, in some cases, although the finger regains its normal position, the person never regains full extension of the fingertip. In such cases, a deformity called “swan neck” results. While treatment is in progress, the device to hold the finger stationary sometimes causes a pressure sore over the distal interphalengeal joint. When damage to the bone or nail occurs, complications can result, such as stiffness, infection, and tenderness.

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Prevention

There is not a specific way to prevent mallet finger, other than using extreme care and caution when performing routine activities and catching objects during sporting events and activities.

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ORGANIZATIONS

American Academy of Orthopaedic Surgeons (AAOS), 6300 North River Rd., Rosemont, IL, 60018–4262, (847) 823–7186, (847) 823–8125, http://www.aaos.org/.

American Society for Surgery of the Hand (ASSH), 6300 North River Rd., Suite 600, Rosemont, IL, 60018, (847) 384–8300, (847) 384–1435, info@assh.org, http://www.assh.org/.

Greg Annussek

Mallory-Weiss syndrome

Definition

Mallory-Weiss syndrome is bleeding from an arterial blood vessel in the upper gastrointestinal tract, caused by a mucosal gastric tear at or near the point where the esophagus and stomach join.

Description

Mallory-Weiss syndrome causes about 5% of all upper gastrointestinal bleeding. The condition was originally diagnosed in alcoholics and is associated with heavy alcohol use, although it can also be found in patients who are not alcoholics. Earlier episodes of heavy hiccupping, **vomiting**, and retching are reported by about half the patients who are diagnosed with Mallory-Weiss syndrome. It is thought that the tear or laceration occurs when there is a sudden increase in intra-abdominal pressure. Patients with increased pressure in the vein leading into the liver (portal **hypertension**) are more likely to bleed heavily from an esophageal laceration than those whose blood pressure is normal.

KEY TERMS

Electrolytes—Salts and minerals that can conduct electrical impulses in the body. Common human electrolytes are sodium chloride, potassium, calcium, and sodium bicarbonate. Electrolytes control the fluid balance of the body and are important in muscle contraction, energy generation, and almost every major biochemical reaction in the body.

Endoscopy—A procedure in which an instrument containing a camera and a light source is inserted into the gastrointestinal tract so that the doctor can visually inspect the gastrointestinal system.

Esophageal varix—An enlarged vein of the esophagus. (Plural: esophageal varices.)

Portal hypertension—High blood pressure in the portal vein, which carries blood from the abdominal organs to the liver.

Causes and symptoms

In Mallory-Weiss syndrome, a tear occurs in the gastric mucosa, near where the esophagus and stomach join. About 10% of the tears are in the esophagus. Most are either right at the junction of the esophagus and stomach or in the stomach just slightly below the junction.

Bleeding from the tear causes a disruption in fluid and electrolyte balance of the body. The patient often produces vomit tinged with either fresh blood or older, blackish blood. Blood loss can be considerable.

Diagnosis

A Mallory-Weiss syndrome tear is not visible on standard upper gastrointestinal x rays. A tear about one-eighth to one and one-half inches long (0.5–4 cm) is revealed by **endoscopy**. Endoscopy also shows that in 35% of patients there is another potential cause for gastrointestinal bleeding, such as peptic ulcer, erosive **gastritis**, or esophageal varices.

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Treatment

The patient is resuscitated and stabilized with blood transfusions and intravenous fluids to restore the fluid and electrolyte balance. Most of the time, esophageal bleeding stops spontaneously. When bleeding does not stop, patients are treated with an injection of epinephrine (adrenaline) and/or the bleeding artery is cauterized with heat. If these treatments fail, surgery is performed to stop the bleeding.

Prognosis

In 90-95% of patients whose bleeding does not stop spontaneously, cauterization without surgery will stop the bleeding. Patients at highest risk for a recurrence of bleeding are those with portal hypertension.

Prevention

Mallory-Weiss syndrome is associated with **alcoholism**. Limiting alcohol intake may help prevent the disorder.

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Tish Davidson, A.M.

Malnutrition

Definition

Malnutrition is the condition that develops when the body acquires a disproportionate, inadequate, or unbalanced amount of the **vitamins**, **minerals**, and other nutrients it needs to maintain healthy tissues and organ function. It may also develop when the body has problems digesting or absorbing nutrients, or has certain medical conditions. When malnutrition occurs, many different disorders may arise depending on the specific nutrient(s) involved in the malnutrition. One form of malnutrition is called **starvation**.

Demographics

Malnutrition is a major problem all over the world, but it is more likely to occur in the poorest countries of the world where natural disasters, political instabilities and wars, and poverty are more likely to be present. It is an exceptionally serious problem with infants, children, and adolescents because such nutrients are exceptionally important during this period of extreme physical and mental growth. Malnutrition is estimated is occur in over 70% of children living in Asia, about 26% in Africa, and around four percent in Latin America and the Caribbean. In the United States, about one percent of children suffer from chronic malnutrition. According to the United Nations' Food Programme (UNFP), a child dies every six seconds somewhere in the world from malnutrition and related causes.

According to the United Nations Food and Agriculture Organization (FAO), approximately 1.02 billion people in the world are considered to be below standards provided by international nutritional guidelines, from data presented on October 14, 2009. This 2009 figure is greater than in 2006, when the number stood at 854 million. In this same period of time, it is estimated that poor **nutrition** is a contributing factor in approximately five million of the 10.9 million deaths each year of children.

Description

Undernutrition

Infants, young children, and teenagers need additional nutrients. So do women who are pregnant or **breastfeeding**. Nutrient loss can be accelerated by **diarrhea**, excessive sweating, heavy bleeding (hemorrhage), or kidney failure. Nutrient intake can be restricted by age–related illnesses and conditions, excessive dieting, **food allergies**, severe injury, serious illness, a lengthy hospitalization, or **substance abuse**.

For instance, someone who has a untreated medical disorder—such as **celiac disease** in which gluten (a protein found in barley, rye, and wheat) is not digestible; or **lactose intolerance**, in which milk and other dairy products are difficult to digest—is at a higher risk for malnutrition than someone without such disorders.

The leading cause of **death** in children in developing countries is **protein–energy malnutrition**. This type of malnutrition is the result of inadequate intake of calories from proteins, vitamins, and minerals. Children who are already undernourished can suffer from protein–energy malnutrition (PEM) when rapid growth, infection, or disease increases the need for protein and essential minerals. These essential minerals are known as micronutrients or trace elements. The World Health Organization (WHO) estimates that two billion people around the world do not consume sufficient amounts of iron in their daily diet. Iron is an

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important nutrient that is found in red meat, eggs, and foods fortified with iron.

Two types of protein–energy malnutrition have been described—kwashiorkor and marasmus. Kwashiorkor occurs with fair or adequate calorie intake but inadequate protein intake, while marasmus occurs when the diet is inadequate in both calories and protein. A kwashiorkor diet may consist of only vegetables. In such cases, a wide variety of vegetables is needed to obtain all the necessary nutrients in one's diet. With a marasmus diet the body may receive so little protein that it eventually cannot digest any protein, with irreversible and fatal results.

Overnutrition

In the United States, nutritional deficiencies have generally been replaced by dietary imbalances or excesses associated with many of the leading causes of death and disability. Overnutrition results from eating too much, eating too many of the wrong things, not exercising enough, or taking too many vitamins or other dietary replacements.

Risk of overnutrition is also increased by being more than 20% overweight, consuming a diet high in fat and salt, and taking high doses of:

- Nicotinic acid (niacin) to lower elevated cholesterol levels
- Vitamin B_6 to relieve premenstrual syndrome
- Vitamin A to clear up skin problems
- Iron or other trace minerals not prescribed by a doctor.

Nutritional disorders can affect any system in the body and the senses of sight, taste, and smell. They may also produce **anxiety**, changes in mood, and other psychiatric symptoms. Malnutrition begins with changes in nutrient levels in blood and tissues. Alterations in enzyme levels, tissue abnormalities, and organ malfunction may be followed by illness and death.

Causes and symptoms

Causes

Poverty and lack of food are the primary reasons why malnutrition occurs in the United States. Ten percent of all members of low–income households do not always have enough healthful foods to eat. Protein–energy malnutrition occurs in 50% of surgical patients and in 48% of all other hospital patients.

Another cause of malnutrition is loss of appetite associated with the **aging** process. Malnutrition affects one in four elderly Americans, in part because they may lose interest in eating. In addition, such dementia–type illnesses as **Alzheimer's disease** may cause elderly persons to forget to eat.

There is an increased risk of malnutrition associated with chronic diseases, especially disease of the intestinal tract, kidneys, and liver. Patients with chronic diseases like **cancer**, acquired immune deficiency syndrome (**AIDS**), intestinal parasites, and other gastric disorders may lose weight rapidly and become susceptible to undernourishment because they cannot absorb valuable vitamins, calories, and iron.

People with drug or alcohol dependencies are also at increased risk of malnutrition. These people tend to maintain inadequate **diets** for long periods of time, and their ability to absorb nutrients is impaired by the alcohol or drug's affect on body tissues, particularly the liver, pancreas, and brain.

Eating disorders are another cause of malnutrition. People with anorexia or bulimia may restrict their food intake to such extremes that they become malnourished.

Food **allergies** may also lead to malnutrition. Some people with food allergies may find it difficult to obtain food that they can digest. In addition, people with food allergies often need additional calorie intake to maintain their weight.

Failure to absorb nutrients in food following bariatric (weight loss) surgery are yet another cause of malnutrition. **Bariatric surgery** includes such techniques as stomach stapling (gastroplasty) and various intestinal bypass procedures to help people eat less and lose weight. Malnutrition is, however, a possible side effect of bariatric surgery.

Symptoms

Unintentionally losing 10 pounds (4.5 kilograms of mass) or more in weight may be a sign of malnutrition. Malnourished people may appear to be skinny or bloated. Their skin is pale, thick, dry, and **bruises** easily. **Rashes** and changes in pigmentation are common.

Hair is thin, tightly curled, and pulls out easily. Joints ache and bones are soft and tender. The gums bleed easily, and they are swollen. The tongue may be swollen or shriveled and cracked. Visual disturbances include night blindness and increased sensitivity to light and glare.

Symptoms may vary depending on the specific cause of the malnutrition. However, some other general symptoms of malnutrition include:

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KEY TERMS

Anemia—Not enough red blood cells in the blood.

Anorexia nervosa—Eating disorder marked by malnutrition and weight loss, commonly occurring in young women.

Bariatric—Pertaining to the study, prevention, or treatment of overweight.

Calorie—A unit of heat measurement used in nutrition to measure the energy value of foods. A Calorie is the amount of heat energy needed to raise the temperature of 1 kilogram of water 1°C.

Kwashiorkor—Severe malnutrition in children primarily caused by a protein–poor diet, characterized by growth retardation.

Marasmus—Severe malnutrition in children caused by a diet lacking in calories as well as protein. Marasmus may also be caused by disease and parasitic infection.

Micronutrients—Essential dietary elements that are needed only in very small quantities. Micronutrients are also known as trace elements. They include copper, zinc, selenium, iodine, magnesium, iron, cobalt, and chromium.

- anemia
- fatigue
- diarrhea
- disorientation and dizziness
- fragile bones, osteoporosis
- irritability, anxiety, and attention deficits
- goiter (enlarged thyroid gland)
- loss of reflexes and lack of muscular coordination
- muscle twitches
- poor immune function (which hinders the body' ability to fight infections)
- difficulty learning
- slow growth, both physically and mentally, in children
- amenorrhea (cessation of menstrual periods)
- scaling and cracking of the lips and mouth
- dry, scaly skin
- bloated stomach.

Malnourished children may be short for their age, thin, listless, and have weakened immune systems.

Diagnosis

Overall appearance, behavior, body–fat distribution, and organ function can alert a family physician, internist, or nutrition specialist to the presence of malnutrition. Patients may be asked to record what they eat during a specific period. X rays can determine bone density and reveal gastrointestinal disturbances, and heart and lung damage.

Blood and urine tests are used to measure the patient's levels of vitamins, minerals, and waste products. Nutritional status can also be determined by:

- Comparing a patient's weight to standardized charts
- Calculating body mass index (BMI) according to a formula that divides height into weight
- Measuring skin–fold thickness or the circumference of the upper arm.

Treatment

Normalizing nutritional status starts with a nutritional assessment. This process enables a clinical nutritionist or registered dietician to confirm the presence of malnutrition, assess the effects of the disorder, and formulate diets that will restore adequate nutrition.

Patients who cannot or will not eat, or who are unable to absorb nutrients taken by mouth, may be fed intravenously (parenteral nutrition) or through a tube inserted into the gastrointestinal (GI) tract (enteral nutrition).

Tube feeding is often used to provide nutrients to patients who have suffered **burns** or who have inflammatory bowel disease. This procedure involves inserting a thin tube through the nose and carefully guiding it along the throat until it reaches the stomach or small intestine. If long–term tube feeding is necessary, the tube may be placed directly into the stomach or small intestine through an incision in the abdomen.

Tube feeding cannot always deliver adequate nutrients to patients who:

- Are severely malnourished
- Require surgery
- Are undergoing chemotherapy or radiation treatments
- Have been seriously burned
- Have persistent diarrhea or vomiting
- Whose gastrointestinal tract is paralyzed.

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Intravenous feeding can supply some or all of the nutrients these patients need.

Prognosis

The prognosis for malnutrition depends directly on its cause. Most cases of malnutrition can be corrected. However, if the cause is an illness, then the condition must be first eliminated so that the patient can completely recover from malnutrition. In some cases, the damage done by malnutrition may be irreversible even though it is not severe enough to cause death. Up to 10% of a person's body weight can be lost without side effects, but if more than 40% is lost, the situation is almost always fatal. Death usually results from **heart failure**, electrolyte imbalance, or low body temperature. Patients with semi–consciousness, persistent diarrhea, **jaundice**, or low blood **sodium** levels have a poorer prognosis.

Some children with protein–energy malnutrition recover completely. Others have many health problems throughout life, including **mental retardation** and the inability to absorb nutrients through the intestinal tract. Prognosis for all patients with malnutrition seems to be dependent on the age of the patient, and the length and severity of the malnutrition, with young children and the elderly having the highest rate of long–term complications, including both physical and mental disabilities and illnesses, and death.

Prevention

Breastfeeding a baby for at least six months is considered the best way to prevent early-childhood malnutrition. The U.S. Department of Agriculture and the Department of Health and Human Services recommend that all Americans over the age of two years:

- Consume plenty of fruits, grains, and vegetables
- Eat a well–balanced variety of foods that are low in fats and cholesterols and contain only moderate amounts of salt, sugars, and sodium
- Engage in moderate physical activity for at least 30 minutes, at least several times a week
- Achieve or maintain their ideal weight
- Use alcohol sparingly or avoid it altogether.

Every patient admitted to a hospital should be screened for the presence of illnesses and conditions that could lead to protein–energy malnutrition. Patients with higher–than–average risk for malnutrition should be more closely assessed and reevaluated often during long–term hospitalization or nursing–home care.

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American Institute of Nutrition (AIN), 9650 Rockville Pike, Bethesda, MD, 20814, (301) 634–7050, (301) 634–7892, http://www.nutrition.org/.

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Malocclusion

Definition

Malocclusion is a misalignment in the way the upper and lower sets of teeth fit together in biting or chewing. The word malocclusion literally means "bad bite." The condition may also be referred to with such terms as irregular bite, misaligned teeth, crossbite, underbite, or overbite. American dentist and orthodontist Edward Angle (1855–1930) was the first scientist to classify malocclusion.

Demographics

Most humans have various tiny degrees of malocclusion, with most problems being handed down from generation to generation (hereditary). Their problem is not very noticeable and does not usually need to be treated. However, others have more serious forms of malocclusion; often times require orthodontic or surgical treatment.

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This patient's teeth are misarranged because of excessive thumb sucking. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Orthodontia treatments usually include the use of braces and retainers. *(© Lester V. Bergman/Corbis.)*

Description

Occlusion refers to the alignment of teeth, specifically the way that the upper set of teeth fit slightly over the lower set of teeth. Malocclusion occurs when there is a misalignment of these two sets of teeth. The cause may be due to the differing sizes of the upper and lower jaws, or possibly due to the jaw in relationship to the size of the teeth. Within the problem, the teeth may appear crooked, crowded, or protruding. It may affect a person's appearance, speech, and/or ability to eat.

Three different classes of malocclusion generally occurs. They are:

- Neutrocclusion: The bite of the two sets of teeth is normal but the upper set overlap the lower teeth more than usual, which causes problems such as overcrowding of the teeth or incorrect spacing of the teeth.
- Distocclusion (retrognathism or "overbite"): The upper jaw and its teeth overlap the bottom jaw and its teeth.
- Mesiocclusio (prognathism or "underbite"): The lower jaw protrudes forward, which causes the lower jaw and its teeth to overlap the upper jaw and its teeth.

Causes and symptoms

Malocclusions are most often inherited, but may be acquired. Inherited conditions include too many or too few teeth, too much or too little space between teeth, irregular mouth and jaw size and shape, and atypical formations of the jaws and face, such as a **cleft palate**. Malocclusions may be acquired from habits like finger or thumb sucking (or pacifier use), tongue thrusting, premature loss of teeth from an accident or dental disease, and medical conditions such as enlarged tonsils and adenoids that lead to mouth breathing.

They may also occur due to incorrectly fitting **dental fillings**, appliances, retainers, and other devices worn on the teeth. Other causes include an abnormal structure to the face, **pain** or other discomfort while biting and chewing, and difficulties with speaking or breathing.

Malocclusions may be symptomless or they may produce pain from increased **stress** on the oral structures. Teeth may show abnormal signs of wear on the chewing surfaces or decay in areas of tight overlap. Chewing may be difficult.

Diagnosis

Malocclusion is most often found during a routine dental examination. A dentist will check a patient's occlusion by watching how the teeth make contact when the patient bites down normally. The dentist may ask the patient to bite down with a piece of coated paper between the upper and lower teeth; this paper

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will leave colored marks at the points of contact. When malocclusion is suspected, the dentist will commonly refer the patient to an orthodontist for further diagnosis and treatment. The orthodontist will take photographs and x rays of the face and mouth for further study. To confirm the presence and extent of malocclusion, the orthodontist makes plaster, plastic, or artificial stone models of the patient's teeth from impressions. These models duplicate the fit of the teeth and are very useful in treatment planning.

Treatment

Even though most people have minor forms of malocclusion, such cases are rarely treated by a medical professional. However, when it is more serious malocclusion may be remedied by orthodontic treatment; **orthodontics** is a specialty of dentistry that manages the growth and correction of dental and facial structures. Braces are the most commonly used orthodontic appliances in the treatment of malocclusion. Such measures are used to position teeth into a more normal alignment. According to the U.S. Bureau of Labor Statistics, about 5,000 orthodontists are practicing in the United States in 2008. At any given time, approximately 4 million people in the United States are wearing braces, including about 800,000 adults.

Braces apply constant gentle force to slowly change the position of the teeth, straightening them and properly aligning them with the opposing teeth. Braces consist of brackets cemented to the surface of each tooth and wires of stainless steel or nickel titanium alloy. When the wires are threaded through the brackets, they exert pressure against the teeth, causing them to move gradually.

Invisalign® is an alternative to traditional braces and can also be used to correct malocclusion. Invisalign is a series of clear aligners that are worn to shift and straighten teeth gradually. Each aligner is custom made for the wearer and changed every two weeks to slowly shift teeth into correct alignment.

Braces are not removable for daily tooth brushing, so the patient must be especially diligent about keeping the mouth clean and removing food particles which become easily trapped, to prevent **tooth decay**. Crunchy foods should be avoided to minimize the risk of breaking the appliance. Hard fruits, vegetables, and breads must be cut into bite-sized pieces before eating. Foods that are sticky, including chewing gum, should be avoided because they may pull off the brackets or weaken the cement. Carbonated beverages may also weaken the cement, as well as contribute to tooth decay. Teeth should be brushed immediately after eating sweet foods. Special floss threaders are available to make flossing easier.

If overcrowding is creating malocclusion, one or more teeth may be extracted (surgically removed), giving the others room to move. If a tooth has not yet erupted or is prematurely lost, then the orthodontist may insert an appliance called a space maintainer to keep the other teeth from moving out of their natural position. In severe cases of malocclusion, surgery may be necessary and the patient would be referred to yet another specialist, an oral or maxillofacial surgeon.

Once the teeth have been moved into their new position, the braces are removed and a retainer is worn until the teeth stabilize in that position. Retainers do not move teeth, they only hold them in place.

Orthodontic treatment is the only effective treatment for malocclusion not requiring surgery. However, depending on the cause and severity of the condition, an orthodontist may be able to suggest other appliances as alternatives to braces.

Alternative treatment

There are some techniques of **craniosacral therapy** that can alter structure. This therapy may allow correction of some cases of malocclusion. If surgery is required, pre- and post-surgical care with homeopathic remedies, as well as vitamin and mineral supplements, can enhance recovery. Night guards are sometimes recommended to ease the strain on the jaw and to limit teeth grinding.

Prognosis

Depending on the cause and severity of the malocclusion and the appliance used in treatment, a patient may expect correction of the condition to take two or more years. Patients typically wear braces 18 to 24 months and a retainer for another year. Treatment is faster and more successful in children and teens whose teeth and bones are still developing. The length of treatment time is also affected by how well the patient follows orthodontic instructions. When malocclusion is corrected, it usually reduces the risk from tooth decay, along with helping to relieve undue pressure on the temporomandibular joint (TMJ), which can cause TMJ disorder (TMD). However, then treatment is applied to someone with malocclusion, specifically with braces, there may be some discomfort during the treatment. Irritation of the gums and mouth may result from the appliances on the teeth. Sometimes chewing or speaking may be adversely affected.

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KEY TERMS

Braces—An orthodontic appliance consisting or brackets cemented to the surface of each tooth and wires of stainless steel or nickel titanium alloy. Braces are used to treat malocclusion by changing the position of the teeth.

Impression—An imprint of the upper or lower teeth made in a pliable material that sets. When this material has hardened, it may be filled with plaster, plastic, or artificial stone to make an exact model of the teeth.

Occlusion—The way the upper and lower teeth fit together in biting or chewing.

Retainer—An orthodontic appliance that is worn to stabilize teeth in a new position.

Space maintainer—An orthodontic appliance that is worn to prevent adjacent teeth from moving into the space left by an unerupted or prematurely lost tooth.

Prevention

In general, malocclusion is not preventable. It may be minimized by controlling habits such as finger or thumb sucking. An initial consultation with an orthodontist before a child is seven years old may lead to appropriate management of the growth and development of the child's dental and facial structures, circumventing many of the factors contributing to malocclusion.

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American Association of Oral and Maxillofacial Surgeons, 9700 West Bryn Mawr Avenue, Rosemont, IL, 60018-5701, (847) 678-6200, (800) 822-6637, (847) 678-6286, http://www.aaoms.org/.

American Association of Orthodontists, 401 North Lindbergh Boulevard, St. Louis, MO, 63141-7816, (800) 787-2444, http://www.braces.org/.

Bethany Thivierge

MALT lymphoma

Definition

MALT lymphomas are solid tumors that originate from cancerous growth of immune cells that are recruited to secretory tissue such as the gastrointestinal tract, salivary glands, lungs, and the thyroid gland.

Description

The digestive tract is generally not associated with lymphoid tissue, with the exception of small collections of lymphocytes such as Peyer's patches. A specific kind of white blood cell, B-lymphocytes, can accumulate in response to infections of the digestive tract and other secretory tissues, or as a result of autoimmune conditions such as Sjgren's syndrome. When the growth of these lymphocytes is maintained through continued infection or autoimmune disease, a malignant cell can arise and replace the normal lymphocytes. These lymphomas, derived from mucosa-associated lymphoid tissue (MALT), most commonly arise in the stomach. Their growth seems to be dependent upon continuous stimulation of the immune system by an infectious agent, such as H. pylori, or some other entity, termed an antigen, that the body recognizes as foreign. This antigen-driven growth permits these tumors to be treated by eliminating the stimulus that generated the original, normal immune response. In the stomach they are associated, in greater than 90% of all cases, with the bacteria called Helicobacter pylori (H. pylori). This bacteria is also associated with peptic stomach irritation, ulcers, and gastric **cancer**. MALT lymphomas are generally indolent, that is, they grow slowly and cause little in the way of symptoms. Those MALT lymphomas that arise in the stomach in response to H. pylori infections are generally successfully treated with **antibiotics**, which eliminate the bacteria.

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Demographics

MALT lymphomas occur at a frequency of about 1.5 per 100,000 people per year in the United States and account for about 10% of all non-Hodgkin's lymphomas. The frequency varies among different populations. For example, in parts of Italy the frequency of MALT lymphomas is as high as 13 per 100,000 people per year. This can in part be attributed to different rates of infection with H. pylori. However, other hereditary, dietary, or environmental factors are almost certainly involved.

Causes and symptoms

The majority of MALT lymphomas appear to be the result of infectious agents, most commonly H. pylori in the stomach. It is not known if infectious agents also cause MALT lymphomas outside of the stomach. In some cases, such as in the thyroid, MALT lymphomas seem to arise in patients who have autoimmune diseases, which make their immune systems treat their own tissue as foreign or antigenic. It is believed that there must be additional factors, in addition to infection or autoimmunity, that influence the development of MALT lymphomas. For example, in the United States, where infections with H. pylori are quite common, less than 1 in 30,000 people who have H. pylori in their stomachs develop MALT lymphomas. In addition, individuals who develop MALT lymphomas are more likely to develop other forms of cancer. This would suggest that there might be genetic factors predisposing individuals to develop MALT lymphomas or other tumors in response to environmental or infectious agents.

In general, patients have stomach **pain**, ulcers, or other localized symptoms, but rarely do they suffer from systemic complaints such as **fatigue** or **fever**.

Diagnosis

The indolent nature of most MALT lymphomas means that the majority of patients are diagnosed at early stages with relatively nonspecific symptoms. In the case of gastric MALT lymphomas, the physician will then have a gastroenterologist perform an **endoscopy** to examine the interior of the stomach. MALT lymphomas are then recognized as areas of inflammation or ulceration within the stomach. It is unusual for masses recognizable as tumors to be seen upon examination. Definitive diagnosis of MALT lymphoma requires a biopsy, in which a bit of tissue is removed from the stomach or other involved site. Examination of this tissue by a pathologist is the first step in distinguishing among the possible diagnoses of inflammation, indolent lymphoma, or a more aggressive form of cancer, such as gastric cancer or a rapidly growing non-Hodgkin's lymphoma. The pathologist evaluates the type of lymphoid cells that are present in the biopsy to establish the nature of the lesion. In addition, it is essential that the pathologist determine whether or not the lymphoma has grown beyond the borders of the mucosa, which lines the stomach or other gland.

Treatment

The best staging system to employ for MALT lymphomas is still the subject of discussion. However, it is standard practice that patients presenting with MALT lymphomas should be evaluated in a similar manner to individuals with nodal lymphomas, the more common type of lymphoma that originates at sites within the lymphoid system. These procedures include a complete history and physical, blood tests, chest x rays, and **bone marrow biopsy**. This evaluation will permit the oncologist to determine if the disease is localized or if it has spread to other sites within the body.

In general, the prognosis for patients with MALT lymphomas is good, with overall five-year survival rates that are greater than 80%. The features that are most closely related to the outlook for newly diagnosed individual patients are: whether the primary site is in the stomach or is extra-gastric; if the disease has spread beyond the initial location; and whether the histologic evaluation of the initial tumor biopsies is consistent with a low-grade, slowly growing lesion, as compared to a high-grade lesion that is more rapidly growing. In general, the histologic grade is the most important feature, with high-grade lesions requiring the most aggressive treatment.

Treatment of MALT lymphomas differs from that of most lymphomas. In the most common type of MALT lymphomas—low-grade lesions originating in the stomach—treatment with antibiotics to eliminate H. pylori leads to complete remissions in the majority of patients. The effectiveness of this treatment is indistinguishable from surgery, **chemotherapy**, **radiation therapy**, or a combination of surgery with drugs or irradiation. Approximately one-third of patients in this group have evidence of disseminated disease, where lymphoma cells are detected at sites in addition to the gastric mucosa. The response of these patients to antibiotic treatment is not significantly different from that for individuals with localized disease. For both groups a complete remission is achieved in about 75% of patients, who remain, on average, free of disease for about 5 years.

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KEY TERMS

Antigen—A foreign substance that leads to an immune response, including the production of antibodies by B cells.

Autoimmune disease—A condition in which an individual's immune system reacts to their own tissues, viewing self components as if they were foreign antigens.

Bone marrow biopsy—A procedure in which cellular material is removed from the pelvis or breastbone and examined under a microscope to look for the presence of abnormal blood cells characteristic of specific forms of leukemia and lymphoma.

Indolent lymphoma (also called low-grade)—Cancerous growths of lymphoid tissue that progress slowly to more aggressive forms of cancer.

Lymphoid tissue—Sites within the body that produce cells of the immune system, including lymph nodes, bone marrow, and the thymus.

Prognosis

Patients with MALT lymphomas arising outside of the digestive tract also have good prognoses. Effective treatment for these lymphomas has been achieved with local radiation, chemotherapy, and/or interferon. Surgery followed by chemotherapy or radiation is also effective with nongastrointestinal MALT lymphomas. Overall these patients have five-year survival rates greater than 90%.

While the outlook for patients with MALT lymphomas is good, difficulties in diagnosis and staging have left the optimal treatment a matter of continued study. This is an especially open question for those patients who fail to respond to antibiotic therapy, or whose disease recurs. It may be the case that in these patients, the MALT lymphoma may have already progressed to a point where high-grade lesions, not observed in the original biopsies, were resistant to the initial treatment. The best treatment for these patients remains to be established. In general, these patients are treated with chemotherapy in a similar manner to patients with other types of lymphoma. Given the success of antibiotics, and the good prognosis for gastric MALT lymphomas in general, no sufficient body of evidence exists to determine the best chemotherapy for patients who fail to achieve a complete and lasting remission upon initial treatment. At present, a chemotherapeutic regime designated CHOP includes the anti-cancer drugs cyclophosphamide, doxorubicin, vincristine, and prednisone. Similar drug combinations are being used for patients whose MALT lymphomas do not respond to antibiotic treatment.

Clinical trials are underway and mostly concentrate upon optimizing treatment of gastric MALT lymphomas that involve H. pylori. The aspects of treatment being addressed are the most effective antibiotics and the use of **antacids** to modulate irritation in the stomach. These protocols have been designed to follow the natural history of gastric lymphomas and to establish the biological features that predict treatment response to antibiotics and duration of remission.

Prevention

There are currently no commonly accepted means to prevent MALT lymphomas. While the H. pylori infections are associated with this and other gastric disease, the eradication of H pylori in asymptomatic individuals is not currently recommended for prevention of MALT lymphomas or gastric cancer.

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Warren Maltzman, Ph.D.

Malta fever *see* **Brucellosis**

Mammogram screening *see* **Mammography**

Mammography

Definition

Mammography is the study of the breast using x rays. The actual test is called a mammogram. It is an x ray of the breast that shows the fatty, fibrous, and glandular tissues. There are two types of mammograms. A screening mammogram is ordered for women who have no problems with their breasts. It consists of two x-ray views of each breast: a craniocaudal (from above) and a mediolateral oblique (from the sides). A diagnostic

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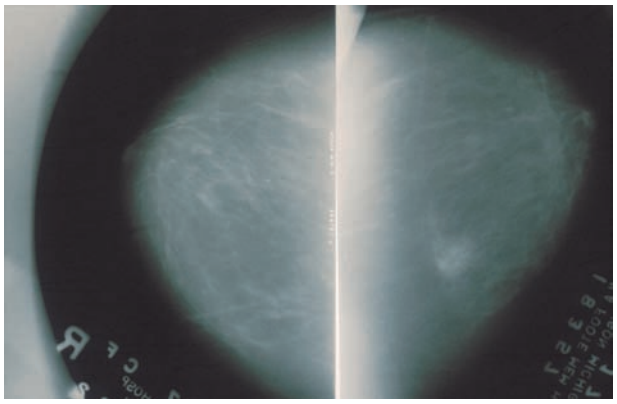

Comparison of two mammograms—cancerous tissue is shown on left and normal tissue on right. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

A person undergoing a mammography. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

mammogram is for evaluation of abnormalities in either men or women. Additional x rays from other angles, or special coned views of certain areas, are taken.

Purpose

The purpose of screening mammography is **breast cancer** detection. A screening test, by definition, is used for patients without any signs or symptoms, in order to detect disease as early as possible. Many studies have shown that having regular mammograms increases a woman's chances of finding breast **cancer** in an early stage, when it is more likely to be curable. It has been estimated that a mammogram may find a cancer as much as two or three years before it can be felt. Radiologists look specifically for the presence of microcalcifications and other abnormalities that can be associated with malignancy. New digital mammography and computer-aided reporting can automatically enhance and magnify the mammograms for easier identification of these tiny calcifications.

The American Cancer Society (ACS) guidelines recommend an annual screening mammogram for every woman of average risk beginning at age 40. In late 2009, the United States Preventive Services Task Force (USPSTF) announced a change in its guidelines for screening mammography. Although USPSTF no longer recommends routine mammograms for screening for women between the ages of 40 and 49, the American Cancer Society, after a review of both the USPSTF data and additional current research, stands by its current recommendations. According to the USPSTF, women in their forties experience false negative screening results and therefore undergo unnecessary treatment at rates high enough to make overall screening unnecessary. The American Cancer Society responded in a November 16, 2009 press release stating that the benefits of screening mammograms in women age 40 to 49 outweigh the limitations and that ultimately, mammograms save lives.

The highest risk factor for developing cancer is advancing age. Some women are at an increased risk for developing breast cancer, such as those with a positive family history of the disease. Beginning screening mammography at a younger age may be recommended for these women.

Diagnostic mammography is used to evaluate an existing problem, such as a lump, discharge from the nipple, or unusual tenderness in one area. It is also done to evaluate further abnormalities that have been seen on screening mammograms. The radiologist normally views the films immediately and may ask for additional views such as a magnification view of one specific area. Additional studies such as an ultrasound of the breast may be performed as well to determine if the lesion is cystic or solid. Breast-specific **positron emission tomography (PET)** scans as well as an MRI (**magnetic resonance imaging**) may be ordered to further evaluate a tumor, but mammography is still the first choice in detecting small tumors on a screening basis.

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Description

A mammogram may be offered in a variety of settings. Hospitals, outpatient clinics, physician's offices, or other facilities may have mammography equipment. In the United States only places certified by the Food and Drug Administration (FDA) are legally permitted to perform, interpret, or develop mammograms. Mammograms are taken with dedicated machines using high frequency generators, low kvp, molybdenum targets and specialized x-ray beam filtration. Sensitive high contrast film and screen combinations along with prolonged developing enable the visualization of minute breast detail.

In addition to the usual paperwork, a woman will be asked to fill out a questionnaire asking for information on her current medical history. Beyond her personal and family history of cancer, details about menstruation, previous breast surgeries, child bearing, birth control, and **hormone replacement therapy** are recorded. Information about **breast self-examination** (BSE) and other breast health issues are usually available at no charge.

At some centers, a technologist may perform a **physical examination** of the breasts before the mammogram. Whether or not this is done, it is essential for the technologist to record any lumps, nipple discharge, breast **pain** or other concerns of the patient. All visible **scars**, **tattoos** and nipple alterations must be carefully noted as well.

Clothing from the waist up is removed, along with necklaces and dangling earrings. A hospital gown or similar covering is put on. A small self-adhesive metal marker may be placed on each nipple by the x-ray technologist. This allows the nipple to be viewed as a reference point on the film for concise tumor location and easier centering for additional views.

Patients are positioned for mammograms differently, depending on the type of mammogram being performed:

- Craniocaudal position (CC): The woman stands or sits facing the mammogram machine. One breast is exposed and raised to a level position while the height of the cassette holder is adjusted to the same level. The breast is placed mid-film with the nipple in profile and the head turned away from the side being x rayed. The shoulder is relaxed and pulled slightly backward while the breast is pulled as far forward as possible. The technologist holds the breast in place and slowly lowers the compression with a foot pedal. The breast is compressed between the film holder and a rectangle of plastic (called a paddle). The breast is compressed until the skin is taut and the breast tissue firm when touched on the lateral side. The exposure is taken immediately and the compression released. Good compression can be uncomfortable, but it is very necessary. Compression reduces the thickness of the breast, creates a uniform density and separates overlying tissues. This allows for a detailed image with a lower exposure time and decreased radiation dose to the patient. The same view is repeated on the opposite breast.
- Mediolateral oblique position (MLO): The woman is positioned with her side toward the mammography unit. The film holder is angled parallel to the pectoral muscle, anywhere from 30 to 60 degrees depending on the size and height of the patient. The taller and thinner the patient the higher the angle. The height of the machine is level with the axilla (armpit). The arm is placed at the top of the cassette holder with a corner touching the armpit. The breast is lifted forward and upward and compression is applied until the breast is held firmly in place by the paddle. The nipple should be in profile and the opposite breast held away if necessary by the patient. This procedure is repeated for the other breast. A total of four x rays, two of each breast, are taken for a screening mammogram. Additional x rays, using special paddles, different breast positions, or other techniques may be taken for a diagnostic mammogram.

The mammogram may be seen and interpreted by a radiologist right away, or it may not be reviewed until later. If there is any questionable area or abnormality, extra x rays may be recommended. These may be taken during the same appointment. More commonly, especially for screening mammograms, the woman is called back on another day for these additional films.

A screening mammogram usually takes approximately 15 to 30 minutes. A woman having a diagnostic mammogram can expect to spend up to an hour for the procedure.

The cost of mammography varies widely. Many mammography facilities accept "self referral." This means women can schedule themselves without a physician's referral. However, some insurance policies do require a doctor's prescription to ensure payment. Medicare will pay for annual screening mammograms for all women over age 39.

Preparation

The compression or squeezing of the breast necessary for a mammogram is a concern of many women. Mammograms should be scheduled when a woman's breasts are least likely to be tender. One to two weeks after the first day of the menstrual period is usually best, as the breasts may be tender during a menstrual period. Some women with sensitive breasts also find that stopping or decreasing **caffeine** intake from coffee, tea, colas, and

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KEY TERMS

Breast biopsy—A procedure where suspicious tissue is removed and examined by a pathologist for cancer or other disease. The breast tissue may be obtained by open surgery, or through a needle.

Craniocaudal—Head to tail, x-ray beam directly overhead the part being examined.

Radiographically dense—An abundance of glandular tissue that results in diminished anatomic detail on the mammogram.

chocolate for a week or two before the examination decreases any discomfort. Women receiving hormone therapy may also have sensitive breasts. Over-the-counter pain relievers are recommended an hour before the mammogram appointment when pain is a significant problem.

Women should not put deodorant, powder, or lotion on their upper body on the day the mammogram is performed. Particles from these products can get on the breast or film holder and may show up as abnormalities on the mammogram. Most facilities will have special wipes available for those patients who need to wash before the mammogram.

Aftercare

No special aftercare is required.

Risks

The risk of radiation exposure from a mammogram is considered minimal and not significant. Experts are unanimous that any negligible risk is by far outweighed by the potential benefits of mammography. Patients who have **breast implants** must be x rayed with caution and compression is minimally applied so that the sac is not ruptured. Special techniques and positioning skills must be learned before a technologist can x ray a patient with breast implants.

Some breast cancers do not show up on mammograms, or "hide" in dense breast tissue. A normal (or negative) study is not a guarantee that a woman is cancer-free. The false-negative rate is estimated to be 15–20%, higher in younger women and women with dense breasts.

False positive readings are also possible. Breast biopsies may be recommended on the basis of a mammogram, and find no cancer. It is estimated that 75–80% of all breast biopsies resulted in benign (no cancer present) findings. This is considered an acceptable rate, because recommending fewer biopsies would result in too many missed cancers.

Results

A mammography report describes details about the x-ray appearance of the breasts. It also rates the mammogram according to standardized categories, as part of the Breast Imaging Reporting and Data System (BIRADS) created by the American College of Radiology (ACR). A normal mammogram may be rated as BIRADS 1 or negative, which means no abnormalities were seen. A normal mammogram may also be rated as BIRADS 2 or benign findings. This means there are one or more abnormalities but they are clearly benign (not cancerous), or variations of normal. Some kinds of calcifications, enlarged lymph nodes or obvious cysts might generate a BIRADS 2 rating.

Many mammograms are considered borderline or indeterminate in their findings. BIRADS 3 means either additional images are needed, or an abnormality is seen and is probably (but not definitely) benign. A follow-up mammogram within a short interval of six to 12 months is suggested. This helps to ensure that the abnormality is not changing, or is "stable." Only the affected side will be x rayed at this time. Some women are uncomfortable or anxious about waiting, and may want to consult with their doctor about having a biopsy. BIRADS 4 means suspicious for cancer. A biopsy is usually recommended in this case. BIRADS 5 means an abnormality is highly suggestive of cancer. A biopsy or other appropriate action should be taken.

Screening mammograms are not usually recommended for women under age 40 who have no special risk factors and a normal physical breast examination. A mammogram may be useful if a lump or other problem is discovered in a woman aged 30–40. Below age 30, breasts tend to be radiographically dense, which means the breasts contain a large amount of glandular tissue that is difficult to image in fine detail. Mammograms for this age group are controversial. An ultrasound of the breasts is usually done instead.

Patient education

The mammography technologist must be empathetic to the patient's modesty and **anxiety**. He or she must explain that compression is necessary to improve the quality of the image but does not harm the breasts. Patients may be very anxious when additional films are requested. Explaining that an extra view gives the radiologist more information will help to ease the patient's tension.

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American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329-4251, (800) 227–2345, http://www.cancer.org.

Susan G. Komen for the Cure, 5005 LBJ Freeway, Suite 250, Dallas, TX, 75244, (877) GO–KOMEN, (877) 465–6636, http://ww5.komen.org.

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Manganese excess *see* **Mineral toxicity**

Mania

Definition

Mania is an abnormally elated mental state, typically characterized by feelings of euphoria, lack of inhibitions, racing thoughts, diminished need for sleep, talkativeness, risk taking, and irritability. In extreme cases, mania can induce **hallucinations** and other psychotic symptoms.

Description

Mania typically occurs as a symptom of **bipolar disorder** (a mood disorder characterized by both manic and depressive episodes). Individuals experiencing a manic episode often have feelings of self–importance, elation, talkativeness, sociability, and a desire to embark on goal–oriented activities, coupled with the less desirable characteristics of irritability, impatience, impulsiveness, hyperactivity, and a decreased need for sleep. (Hypomania is a term applied to a condition resembling mania. It is characterized by persistent or elevated expansive mood, hyperactivity, inflated self esteem, etc., but of less intensity than mania.) Severe mania may have psychotic features.

Causes and symptoms

Mania can be induced by the use or **abuse** of stimulant drugs such as **cocaine** and amphetamines. It is also the predominant feature of bipolar disorder, or manic depression, an affective mental illness that causes radical emotional changes and mood swings.

The Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (*DSM–IV*), the diagnostic standard for mental health professionals in the United States, describes a manic episode as an abnormally elevated mood lasting at least one week that is distinguished by at least three of the following symptoms: inflated self–esteem, decreased need for sleep, talkativeness, racing thoughts, distractibility, increase in goal–directed activity, or excessive involvement in pleasurable activities that have a high potential for painful consequences. If the mood of the patient is irritable and not elevated, four of these symptoms are required.

Diagnosis

Mania is usually diagnosed and treated by a psychiatrist and/or a psychologist in an outpatient setting. However, most severely manic patients require hospitalization. In addition to an interview, several

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KEY TERMS

Bipolar disorder—Formerly called manic–depressive disorder. A mood disorder characterized alternating periods of overconfidence and activity (manic highs) and depressive lows.

Hypomania—A less severe form of elevated mood state that is a characteristic of bipolar type II disorder.

Mixed mania—A mental state in which symptoms of both depression and mania occur simultaneously.

Psychiatrist—A medical doctor who has completed specialized training in the diagnosis and treatment of mental illness. Psychiatrists can diagnose mental illnesses, provide mental health counseling, and prescribe medications.

Psychologist—A mental health professional who treats mental and behavioral disorders by support and insight to encourage healthy behavior patterns and personality growth. Psychologists also study the brain, behavior, emotions, and learning.

Psychotherapy—The treatment of mental and behavioral disorders by support and insight to encourage healthy behavior patterns and personality growth.

clinical inventories or scales may be used to assess the patient's mental status and determine the presence and severity of mania. An assessment commonly includes the Young Mania Rating Scale (YMRS). The Mini–Mental State Examination (MMSE) may also be given to screen out other illnesses such as **dementia**.

Treatment

Mania is treated primarily with drugs. The following mood–stabilizing agents are commonly prescribed to regulate manic episodes:

- Lithium (Cibalith–S, Eskalith, Lithane) is one of the oldest and most frequently prescribed drugs available for the treatment of mania. Because the drug takes four to seven days to reach a therapeutic level in the bloodstream, it is sometimes prescribed in conjunction with neuroleptics (antipsychotic drugs) and/or benzodiazepines (tranquilizers) to provide more immediate relief of mania.
- Carbamazepine (Tegretol, Atretol) is an anticonvulsant drug usually prescribed in conjunction with other mood–stabilizing agents. The drug is often used to treat bipolar patients who have not responded well to lithium therapy. As of early 1998, carbamazepine was not approved for the treatment of mania by the FDA.
- Valproate (divalproex sodium, or Depakote; valproic acid, or Depakene) is an anticonvulsant drug prescribed alone or in combination with carbamazepine and/or lithium. For patients experiencing "mixed mania," or mania with features of depression, valproate is preferred over lithium.

Clozapine (Clozaril) is an atypical antipsychotic medication used to control manic episodes in patients who have not responded to typical mood–stabilizing agents. The drug has also been a useful preventative treatment in some bipolar patients. Other new anticonvulsants (lamotrigine, gubapentin) are being investigated for treatment of mania and bipolar disorder.

Prognosis

Patients experiencing mania as a result of bipolar disorder require long–term care to prevent recurrence; bipolar disorder is a chronic condition that requires lifelong observation and treatment after diagnosis. Data show that almost 90% of patients who experience one manic episode will go on to have another.

Prevention

Mania as a result of bipolar disorder can only be prevented through ongoing pharmacologic treatment. Patient education in the form of therapy or self–help groups is crucial for training patients to recognize signs of mania and to take an active part in their treatment program. **Psychotherapy** is an important adjunctive treatment for patients with bipolar disorder.

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American Academy of Child and Adolescent Psychiatry, 3615 Wisconsin Ave., NW , Washington, DC, 20016–3007, (202) 966–7300, http://www.aacap.org .

American Psychiatric Association, 1000 Wilson Blvd., Suite 1825, Arlington, VA, 22209, (703) 907–7300, apa@psych.org, http://www.psych.org/.

American Psychological Association (APA), 750 First St. NE, Washington, DC, 20002–4242, (202) 336–5500, http://www.apa.org.

National Alliance on Mental Illness (NAMI), 3803 N. Fairfax Dr., Suite 100, Arlington, VA, 22201, (703) 524–7600, (800) 950–NAMI (6264), (703) 524–9094, http://www.nami.org/Hometemplate.cfm.

National Institute of Mental Health (NIMH), 6001 Executive Blvd, Room 8184, MSC 9663, Bethesda, MD, 20892, (301) 443–4513, (866) 615–6464, (301) 443–4279, nimhinfo@nih.gov, http://www.nimh.nih.gov/index.shtml.

National Mental Health Association (NMHA), 2000 N. Beauregard St., 6th Floor, Alexandria, VA, 22311, (703) 684–7722, (800) 969–NMHA, (703) 684–5968, http://www1.nmha.org/.

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Manic depression *see* **Bipolar disorder**

Manic episode *see* **Mania**

MAO inhibitors *see* **Monoamine oxidase inhibitors**

Marasmus *see* **Protein-energy malnutrition**

Marble bones *see* **Osteopetroses**

Marburg virus infection *see* **Hemorrhagic fevers**

Marfan syndrome

Definition

Marfan syndrome is an inherited disorder of the connective tissue that causes abnormalities of the patient's eyes, cardiovascular system, and musculoskeletal system. It is named for the French pediatrician, Antoine Marfan (1858-1942), who first described it in 1896. Marfan syndrome is sometimes called arachnodactyly, which means "spider-like fingers" in Greek, since one of the characteristic signs of the disease is disproportionately long fingers and toes. It is estimated that one person in every 3000-5000 has Marfan syndrome, or about 50,000 people in the United States. Marfan syndrome is one of the more common inheritable disorders.

Description

Marfan syndrome affects three major organ systems of the body: the heart and circulatory system, the bones and muscles, and the eyes. The genetic mutation responsible for Marfan was discovered in 1991. It affects the body's production of fibrillin, which is a protein that is an important part of connective tissue. Fibrillin is the primary component of the microfibrils that allow tissues to stretch repeatedly without weakening. Because the patient's fibrillin is abnormal, his or her connective tissues are looser than usual, which weakens or damages the support structures of the entire body.

The most common external signs associated with Marfan syndrome include excessively long arms and legs, with the patient's arm span being greater than his or her height. The fingers and toes may be long and slender, with loose joints that can be bent beyond their normal limits. This unusual flexibility is called hypermobility. The patient's face may also be long and narrow, and he or she may have a noticeable curvature of the spine. It is important to note, however, that Marfan patients vary widely in the external signs of their disorder and in their severity; even two patients from the same family may look quite different. Most of the external features of Marfan syndrome become more pronounced as the patient gets older, so that diagnosis of the disorder is often easier in adults than in children. In many cases, the patient may have few or very minor outward signs of the disorder, and the diagnosis may be missed until the patient develops vision problems or cardiac symptoms.

Marfan syndrome by itself does not affect a person's intelligence or ability to learn. There is, however, some clinical evidence that children with Marfan have a slightly higher rate of hyperactivity and attention-deficit disorder (ADD) than the general population. In addition, a child with undiagnosed nearsightedness related to Marfan may have difficulty seeing the blackboard or reading printed materials, and thus do poorly in school.

Marfan syndrome affects males and females equally, and appears to be distributed equally among all races and ethnic groups. The rate of mutation of the fibrillin gene, however, appears to be related to the age

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of the patient's father; older fathers are more likely to have new mutations appear in chromosome 15.

Causes and symptoms

Marfan syndrome is caused by a single gene for fibrillin on chromosome 15, which is inherited in most cases from an affected parent. Between 15 and 25% of cases result from spontaneous mutations. Mutations of the fibrillin gene (FBNI) are unique to each family affected by Marfan, which makes rapid genetic diagnosis impossible, given present technology. The syndrome is an autosomal dominant disorder, which means that someone who has it has a 50% chance of passing it on to any offspring.

Another important genetic characteristic of Marfan syndrome is variable expression. This term means that the mutated fibrillin gene can produce a variety of symptoms of very different degrees of severity, even in members of the same family.

Cardiac and circulatory abnormalities

The most important complications of Marfan are those affecting the heart and major blood vessels; some are potentially life-threatening. About 90% of Marfan patients will develop cardiac complications.

- Aortic enlargement. This is the most serious potential complication of Marfan syndrome. Because of the abnormalities of the patient's fibrillin, the walls of the aorta (the large blood vessel that carries blood away from the heart) are weaker than normal and tend to stretch and bulge out of shape. This stretching increases the likelihood of an aortic dissection, which is a tear or separation between the layers of tissue that make up the aorta. An aortic dissection usually causes severe pain in the abdomen, back, or chest, depending on the section of the aorta that is affected. Rupture of the aorta is a medical emergency requiring immediate surgery and medication.
- Aortic regurgitation. A weakened and enlarged aorta may allow some blood to leak back into the heart during each heartbeat; this condition is called aortic regurgitation. Aortic regurgitation occasionally causes shortness of breath during normal activity. In serious cases, it causes the left ventricle of the heart to enlarge and may eventually lead to heart failure.
- Mitral valve prolapse. Between 75 and 85% of Marfan patients have loose or "floppy" mitral valves, which are the valves that separate the chambers of the heart. When these valves do not cover the opening between the chambers completely, the condition is called mitral valve prolapse. Complications of mitral valve prolapse include heart murmurs and arrhythmias. In rare cases, mitral valve prolapse can cause sudden death.
- Infective endocarditis. Infective endocarditis is an infection of the endothelium, the tissue that lines the heart. In patients with Marfan, it is the abnormal mitral valve that is most likely to become infected.
- Other complications. Some patients with Marfan develop cystic disease of the lungs or recurrent spontaneous pneumothorax, which is a condition in which air accumulates in the space around the lungs. Many will also eventually develop emphysema.

Musculoskeletal abnormalities

Marfan syndrome causes an increase in the length of the patient's bones, with decreased support from the ligaments that hold the bones together. As a result, the patient may develop various deformities of the skeleton or disorders related to the relative looseness of the ligaments.

Disorders of the spine

- Scoliosis. Scoliosis, or curvature of the spine, is a disorder in which the vertebrae that make up the spine twist out of line from side to side into an S-shape or a spiral. It is caused by a combination of the rapid growth of children with Marfan, and the looseness of the ligaments that help the spine to keep its shape.
- Kyphosis is an abnormal outward curvature of the spine at the back, sometimes called hunch back when it occurs in the upper back. Marfan patients may develop kyphosis either in the upper (thoracic) spine or the lower (lumbar) spine.
- Spondylolisthesis. Spondylolisthesis is the medical term for a forward slippage of one vertebra on the one below it. It produces an ache or stiffness in the lower back.
- Dural ectasia. The dura is the tough, fibrous outermost membrane covering the brain and the spinal cord. The weak dura in Marfan patients swells or bulges under the pressure of the spinal fluid. This swelling is called ectasia. In most cases, dural ectasia occurs in the lower spine, producing low back ache, a burning feeling, or numbness or weakness in the legs.

Disorders of the chest and lower body

- Pectus excavatum. Pectus excavatum is a malformation of the chest in which the patient's breastbone, or sternum, is sunken inward. It can cause difficulties in breathing, especially if the heart, spine, and lung have been affected by Marfan. It also usually causes concerns about appearance.

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- Pectus carinatum. In other patients with Marfan the sternum is pushed outward and narrowed. Although pectus carinatum does not cause breathing difficulties, it can cause embarassment about appearance. A few patients with Marfan may have a pectus excavatum on one side of their chest and a pectus carinatum on the other.
- Foot disorders. Patients with Marfan are more likely to develop pes planus (flat feet) or so-called "claw" or "hammer" toes than people in the general population. They are also more likely to suffer from chronic pain in their feet.
- Protrusio acetabulae. The acetabulum is the socket of the hip joint. In patient's with Marfan, the acetabulum becomes deeper than normal during growth, for reasons that are not yet understood. Although protrusio acetabulae does not cause problems during childhood and adolescence, it can lead to a painful form of arthritis in adult life.

Disorders of the eyes and face

Although the visual problems that are related to Marfan syndrome are rarely life-threatening, they are important in that they may be the patient's first indication of the disorder. Eye disorders related to the syndrome include the following:

- Myopia (nearsightedness). Most patients with Marfan develop nearsightedness, usually in childhood.
- Ectopia lentis. Ectopia lentis is the medical term for dislocation of the lens of the eye. Between 65 and 75% of Marfan patients have dislocated lenses. This condition is an important indication for diagnosis of the syndrome because there are relatively few other disorders that produce it.
- Glaucoma. This condition is much more prevalent in patients with Marfan syndrome than in the general population.
- Cataracts. Patients with Marfan are more likely to develop cataracts, and to develop them much earlier in life, sometimes as early as 40 years of age.
- Retinal detachment. Patients with Marfan are more vulnerable to this disorder because of the weakness of their connective tissues. Untreated retinal detachment can cause blindness. The danger of retinal detachment is an important reason for patients to avoid contact sports or other activities that could cause a blow on the head or being knocked to the ground.
- Other facial problems. Patients with Marfan sometimes develop dental problems related to crowding of the teeth caused by a high-arched palate and a narrow jaw.

Other disorders

- Striae. Striae are stretch marks in the skin caused by rapid weight gain or growth; they frequently occur in pregnant women, for example. Marfan patients often develop striae over the shoulders, hips, and lower back at an early age because of rapid bone growth. Although the patient may be self-conscious about the striae, they are not a danger to health.
- Obstructive sleep apnea. Obstructive sleep apnea refers to partial obstruction of the airway during sleep, causing irregular breathing and sometimes snoring. In patients with Marfan, obstructive sleep apnea is caused by the unusual flexibility of the tissues lining the patient's airway. This disturbed breathing pattern increases the risk of aortic dissection.

Diagnosis

Presently, there is no objective diagnostic test for Marfan syndrome, in part because the disorder does not produce any measurable biochemical changes in the patient's blood or body fluids, or cellular changes that could be detected from a tissue sample. Although researchers in molecular biology are currently investigating the FBNI gene through a process called mutational analysis, it is presently not useful as a diagnostic test because there is evidence that there can be mutations in the fibrillin gene that do not produce Marfan. Similarly, there is no reliable prenatal test, although some physicians have used ultrasound to try to determine the length of fetal limbs in at-risk pregnancies.

The diagnosis is made by taking a family history and a thorough examination of the patient's eyes, heart, and bone structure. The examination should include an echocardiogram taken by a cardiologist, a slit-lamp **eye examination** by an ophthalmologist, and a work-up of the patient's spinal column by an orthopedic specialist. In terms of the cardiac examination, a standard electrocardiogram (EKG) is not sufficient for diagnosis; only the echocardiogram can detect possible enlargement of the aorta. The importance of the slit-lamp examination is that it allows the doctor to detect a dislocated lens, which is a significant indication of the syndrome.

The symptoms of Marfan syndrome in some patients resemble the symptoms of homocystinuria, which is an inherited disorder marked by extremely high levels of homocystine in the patient's blood and urine. This possibility can be excluded by a urine test.

In other cases, the diagnosis remains uncertain because of the mildness of the patient's symptoms, the absence of a family history of the syndrome, and

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other variables. These borderline conditions are sometimes referred to as marfanoid syndromes.

Treatment

The treatment and management of Marfan is tailored to the specific symptoms of each patient. Some patients find that the syndrome has little impact on their overall lifestyle; others have found their lives centered on the disorder.

Cardiovascular system

After a person has been diagnosed with Marfan, he or she should be monitored with an echocardiogram every six months until it is clear that the aorta is not growing larger. After that, the patient should have an echocardiogram once a year. If the echocardiogram does not allow the physician to visualize all portions of the aorta, CT (computed tomography) or MRI (**magnetic resonance imaging**) may be used. In cases involving a possible **aortic dissection**, the patient may be given a TEE (transesophageal echocardiogram).

Medications. A Marfan patient may be given drugs called beta-blockers to slow down the rate of aortic enlargement and decrease the risk of dissection by lowering the blood pressure and decreasing the forcefulness of the heartbeat. The most commonly used beta-blockers in Marfan patients are propranolol (Inderal) and atenolol (Tenormin). Patients who are allergic to beta-blockers may be given a **calcium** blocker such as verapamil.

Because Marfan patients are at increased risk for infective **endocarditis**, they must take a prophylactic dose of an antibiotic before having dental work or minor surgery, as these procedures may allow bacteria to enter the bloodstream. Penicillin and amoxicillin are the **antibiotics** most often used.

Surgical treatment. Surgery may be necessary if the width of the patient's aorta increases rapidly or reaches a critical size (about 2 inches). The most common surgical treatment involves replacing the patient's aortic valve and several inches of the aorta itself with a composite graft, which is a prosthetic heart valve sewn into one end of a Dacron tube. This surgery has been performed widely since about 1985; most patients who have had a composite graft have not needed additional surgery.

Patients who have had a valve replaced must take an anticoagulant medication, usually warfarin (Coumadin), in order to minimize the possibility of a clot forming on the prosthetic valve.

Musculoskeletal system

Children diagnosed with Marfan should be checked for **scoliosis** by their pediatricians at each annual **physical examination**. The doctor simply asks the child to bend forward while the back is examined for changes in the curvature. In addition, the child's spine should be x rayed in order to measure the extent of scoliosis or **kyphosis**. The curve is measured in degrees by the angle between the vertebrae as seen on the x ray. Curves of 20° or less are not likely to become worse. Curves between 20 and 40 degrees are likely to increase in children or adolescents. Curves of 40 degrees or more are highly likely to worsen, even in an adult, because the spine is so badly imbalanced that the force of gravity will increase the curvature.

Scoliosis between 20 and 40 degrees in children is usually treated with a back brace. The child must wear this appliance about 23 hours a day until growth is complete. If the spinal curvature increases to 40 or 50 degrees, the patient may require surgery in order to prevent lung problems, back **pain**, and further deformity. Surgical treatment of scoliosis involves straightening the spine with metal rods and fusing the vertebrae in the straightened position.

Spondylolisthesis is treated with a brace in mild cases. If the slippage is more than 30 degree, the slipped vertebra may require surgical realignment.

Dural ectasia can be distinguished from other causes of back pain on an MRI. Mild cases are usually not treated. Medication or spinal shunting to remove some of the spinal fluid are used to treat severe cases.

Pectus excavatum and pectus carinatum can be treated by surgery. In pectus excavatum, the deformed breastbone and ribs are raised and straightened by a metal bar. After four to six months, the bar is removed in an outpatient procedure.

Protrusio acetabulae may require surgery in adult life to provide the patient with an artificial hip joint, if the arthritic pains are severe.

Pain in the feet or limbs is usually treated with a mild analgesic such as **acetaminophen**. Patients with Marfan should consider wearing shoes with low heels, special cushions, or orthotic inserts. Foot surgery is rarely necessary.

Visual and dental concerns

Patients with Marfan should have a thorough eye examination, including a slit-lamp examination, to test for dislocation of the lens as well as nearsightedness. Dislocation can be treated by a combination of

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special glasses and daily use of one percent atropine sulfate ophthalmic drops, or by surgery.

Because patients with Marfan are at increased risk of glaucoma, they should have the fluid pressure inside the eye measured every year as part of an eye examination. Glaucoma can be treated with medications or with surgery.

Cataracts are treated with increasing success by implant surgery. It is important, however, to seek treatment at medical centers with eye surgeons familiar with the possible complications of **cataract surgery** in patients with Marfan syndrome.

All persons with Marfan should be taught to recognize the signs of **retinal detachment** (sudden blurring of vision in one eye becoming progressively worse without pain or redness) and to seek professional help immediately.

Children with Marfan should be evaluated by their dentist at each checkup for crowding of the teeth and possible misalignment, and referred to an orthodontist if necessary.

Athletic activities and occupational choice. People with Marfan should avoid sports or occupations that require heavy weight lifting, rough physical contact, or rapid changes in atmospheric pressure (e.g., scuba diving). Weight lifting increases blood pressure, which in turn may enlarge the aorta. Rough physical contact may cause retinal detachment. Sudden changes in air pressure may produce **pneumothorax**. Regular noncompetitive physical **exercise**, however, is beneficial for Marfan patients. Good choices include brisk walking, shooting baskets, and slow-paced tennis.

Social and lifestyle issues

SMOKING. Smoking is particularly harmful for Marfan patients because it increases their risk of **emphysema**.

PREGNANCY. Until very recently, women with Marfan were advised not to become pregnant because of the risk of aortic enlargement or dissection. The development of beta-blockers and echocardiograms, however, allows doctors now to monitor patients throughout pregnancy. It is recommended that patients have an echocardiogram during each of the three trimesters of pregnancy. Normal, vaginal delivery is not necessarily more stressful than a Caesarian section, but patients in prolonged labor may be given a Caesarian to reduce strain on the heart. A pregnant woman with Marfan should also receive **genetic counseling** regarding the 50% risk of having a child with the syndrome.

APPEARANCE AND SOCIAL CONCERNS. Children and adolescents with Marfan may benefit from supportive counseling regarding appearance, particularly if their symptoms are severe and causing them to withdraw from social activities. In addition, families may wish to seek counseling regarding the effects of the syndrome on relationships within the family. Many people respond with guilt, fear, or blame when a genetic disorder is diagnosed in the family, or they may overprotect the affected member. Support groups are often good sources of information about Marfan; they can offer helpful suggestions about living with it as well as emotional support.

KEY TERMS

Arachnodactyly—A condition characterized by abnormally long and slender fingers and toes.

Ectopia lentis—Dislocation of the lens of the eye. It is one of the most important single indicators in diagnosing Marfan syndrome.

Fibrillin—A protein that is an important part of the structure of the body's connective tissue. In Marfan's syndrome, the gene responsible for fibrillin has mutated, causing the body to produce a defective protein.

Hypermobility—Unusual flexibility of the joints, allowing them to be bent or moved beyond their normal range of motion.

Kyphosis—An abnormal outward curvature of the spine, with a hump at the upper back.

Pectus carinatum—An abnormality of the chest in which the sternum (breastbone) is pushed outward. It is sometimes called "pigeon breast."

Pectus excavatum—An abnormality of the chest in which the sternum (breastbone) sinks inward; sometimes called "funnel chest."

Scoliosis—An abnormal, side-to-side curvature of the spine.

Prognosis

The prognosis for patient's with Marfan has improved markedly in recent years. The life expectancy of people with the syndrome has increased to 72 years, up from 48 years in 1972. This dramatic improvement is attributed to new surgical techniques, improved diagnosis, and new techniques of medical treatment.

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The most important single factor in improving the patient's prognosis is early diagnosis. The earlier that a patient can benefit from the new techniques and lifestyle modifications, the more likely he or she is to have a longer life expectancy.

Resources

BOOKS

Ammash, Naser, M., Thoralf M Sundt, and Heidi M Connolly. *Marfan Syndrome: Diagnosis and Management*. New York: Elsevier, 2008.

Beers, Mark H., Robert S. Porter, and Thomas V. Jones, eds. *The Merck Manual of Diagnosis and Therapy*. 18th ed. Whitehouse Station, NJ: Merck Research Laboratories, 2006.

Rebecca J. Frey, PhD

Marie-Strümpell disease *see* **Ankylosing spondylitis**

Marijuana

Definition

Marijuana *Cannabis sativa L.*, also known as hemp, is a member of the Cannabaceae family. It contains the psychoactive drug delta-9-tetrahydrocannabinol (THC).

Demographics

The whole cannabis plant, including buds, leaves, seeds, and root, have all been used throughout the long history of this controversial herb. Despite persistent legal restrictions and criminal penalties for illicit use, marijuana continues to be widely used in the United States and throughout the world, both for its mood-altering properties and its medicinal applications. According to the National Survey on drug Use and Health, in 2008, 25.8 million Americans over age 12 had used marijuana within the past year. In 2009, the World Health Organization (WHO) estimated that 147 million people or 2.5% of the world's population used marijuana.

Description

Marijuana is a somewhat weedy plant that can grow as high as 18 ft (5.4 m). The hairy leaves are arranged opposite one another on the erect and branching stem. Leaves are palmate and compound, deeply divided into five to seven narrow, toothed and pointed leaflets. Male and female flowers are small and greenish in color and grow on separate plants. Male flowers grow in the leaf axils in elongated clusters. The female flowers grow in spike-like clusters. The resinous blossoms have five sepals and five petals. The male and female blossoms can be distinguished at maturity. The male plant matures first, shedding its pollen and dying after flowering. Female plants die after dropping mature seeds.

Marijuana produces an abundance of quickly germinating seeds. This hardy annual is wind pollinated and has escaped from cultivation to grow wild along roadsides, trails, stream banks, and in wayside places throughout the world. The plant matures within three to five months after the seed has been sown.

The species *C. sativa L.* has many variations, depending on the soil, temperature, and light conditions, and the origin of the parent seed. These factors also affect the relative amounts of THC and cannabidiol, the active chemicals present in varying amounts in cannabis, and determine if the plant is primarily a fiber type or an intoxicant. Generally the species grown at higher elevations and in hotter climates exude more of resin and are more potent intoxicants.

History

Marijuana has been cultivated for thousands of years. Cannabis was first described for its therapeutic use in the first known Chinese pharmacopoeia, the *Pen Ts'ao*. (A pharmacopoeia is a book containing a list of medicinal drugs, and their descriptions of preparation and use.) Cannabis was called a "superior" herb by the Emperor Shen-Nung (2737-2697 B.C.), who is believed to have authored the work. Cannabis was recommended as a treatment for numerous common ailments.

Around that same period in Egypt, cannabis was used as a treatment for sore eyes. The herb was used in India in cultural and religious ceremonies, and recorded in Sanskrit scriptural texts around 1,400 B.C. Cannabis was considered a holy herb and was characterized as the "soother of grief," "the sky flyer," and "the poor man's heaven."

Centuries later, around 700 B.C., the Assyrian people used the herb they called *Qunnabu,* for incense. The ancient Greeks used cannabis as a remedy to treat inflammation, earache, and **edema**. Shortly after 500 B.C. the historian and geographer Herodotus recorded that the peoples known as Scythians used cannabis to produce fine linens. They called the herb *kannabis* and inhaled the "intoxicating vapor" that resulted when it

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was burned. By the year 100 B.C. the Chinese were using cannabis to make paper.

Cannabis use and cultivation migrated with the movement of various traders and travelers, and knowledge of the herb's value spread throughout the Middle East, Eastern Europe, and Africa. Around 100, Dioscorides, a surgeon in the Roman Legions under the Emperor Nero, named the herb *Cannabis sativa* and recorded numerous medicinal uses. In the second century, the Chinese physician Hoa-Tho, used cannabis in surgical procedures, relying on its analgesic properties. In ancient India, around 600, Sanskrit writers recorded a recipe for "pills of gaiety," a combination of hemp and sugar. By 1150, Muslims were using cannabis fiber in Europe's first paper production. This use of cannabis as a durable and renewable source of paper fiber continued for the next 750 years.

By the 1300s, government and religious authorities, concerned about the psychoactive effects on citizens consuming the herb, began placing harsh restrictions on its use. The Emir Soudon Sheikhouni of Joneima outlawed cannabis use among the poor. He destroyed the crops and ordered that offenders' teeth be pulled out. In 1484, Pope Innocent VIII outlawed the use of hashish, a concentrated form of cannabis. Cannabis cultivation continued, however, because of its economic value as a fiber-producing plant. A little more than a century later, the English queen, Elizabeth I, issued a decree commanding that landowners holding sixty acres or more must grow hemp or pay a fine. Commerce in hemp, which was primarily valued for the strength and versatility of its fibers, was profitable and thriving. Hemp ropes and sails were crossing the sea to North America with the explorers.

By 1621, the British were growing cannabis in Virginia where cultivation of hemp was mandatory. In 1776, the Declaration of Independence was drafted on hemp paper. Both President George Washington and President Thomas Jefferson were advocates of hemp as a valuable cash crop. Jefferson urged farmers to grow the crop in lieu of tobacco. By the 1850s, hemp had become the third largest agricultural crop grown in North America. That year the United States Census recorded 8,327 hemp plantations, each with 2,000 or more acres in cultivation. However, the invention of the cotton gin was already bringing many changes, and cotton was becoming a prime and profitable textile fiber. More change came with the introduction of the sulfite and chlorine processes used to turn trees into paper. Restrictions on the personal use of cannabis as a mood-altering, psychoactive herb, were soon to follow.

Controversy

The 1856 edition of the *Encyclopedia Britannica*, in its lengthy entry on hemp, noted that the herb "produces inebriation and **delirium** of decidedly hilarious character, inducing violent laughter, jumping and dancing." This inebriating effect of marijuana use has fueled the controversy and led to restrictions that have surrounded marijuana use throughout history in many cultures and regions of the world. Cannabis use has been criminalized in some parts of the United States since 1915. Utah was the first state to criminalize it, then California and Texas. By 1923, Louisiana, Nevada, Oregon, and Washington had legal restrictions on the herb. New York prohibited cannabis use in 1927. Despite the restrictions, cannabis use was woven into the cultural and social fabric in some communities, and widespread use persisted, particularly among the Mexican, Asian, and African American populations.

In the United States in 1937, the federal government passed the Marijuana Tax Act, prohibiting the cultivation and farming of marijuana. The act prohibited industrial and medical use of marijuana and classified the flowering tops as a narcotic. Since then, restrictions on the cultivation and use of cannabis have continued. Marijuana was categorized as an illegal narcotic, in the company of **LSD**, heroin, **cocaine**, and morphine. Despite that, illegal use continued.

In a reversal of the state-by-state progression of criminalizing marijuana that led to the 1937 Marijuana Tax Act, there is a movement underway, state by state, to endorse the legalized use of medical marijuana. By 2010, 14 states in the United States had legalized medical marijuana and two other states had passed laws favorable to its medical use without actually legalizing the drug. A growing body of scientific research and many thousands of years of folk use support the importance of medical marijuana in treatment of a variety of illnesses. The economic value of hemp in the textile, paper, and cordage industries has a long history.

Controversy persists around this herb. The World Health Organization, in a 1998 study, stated that the risks from cannabis use were unlikely to seriously compare to the public health risks of the legal drugs, alcohol, and tobacco. Controversy continues on how addictive marijuana is, given the **addiction** potential of many prescription drugs used as **muscle relaxants**, hypnotics, and **analgesics**. One legitimate concern is the effect of **smoking** on the lungs. Cannabis smoke carries even more tars and other particulate matter than tobacco smoke.

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KEY TERMS

Antiemetic—A drug or herbal preparation given to relieve nausea and vomiting. Marijuana has antiemetic properties.

Cannabinoids—The chemical compounds that are the active principles in marijuana.

Edema—Swelling of a body tissue due to collection of fluids.

Euphoria—An intense feeling of elation or well being. Many marijuana users experience temporary euphoria.

Glaucoma—An eye disorder caused by damage to the optic nerve resulting in vision loss. Glaucoma is usually accompanied by inflammation and increased pressure in the eye (intraocular pressure). There are several types that may develop suddenly or gradually.

Causes and Symptoms

Marijuana is ingested by smoking the dried herb, which quickly delivers the active ingredients to the blood system. It can also be added to food (often brownies) and eaten. Cannabis contains chemical compounds known as cannabinoids. Different cannabinoids seem to exert different effects on the body after ingestion. Scientific research indicates that these substances have potential therapeutic value for **pain** relief, control of **nausea and vomiting**, and appetite stimulation. The primary active agent is THC. This chemical may constitute as much as 12% of the active chemicals in the herb, and is said to be responsible for as much as 70–100% of the euphoric response, or "high," experienced when ingesting the herb. The predominance of this mental lightness or euphoria depends on the balance of other active ingredients and the freshness of the herb. THC degrades into a component known as cannabinol, or CBN. This relatively inactive chemical predominates in marijuana that has been stored too long before use. Another chemical component, cannabidiol, known as CBD, has a sedative and mildly analgesic (pain relieving) effect, and contributes to lethargy sometimes experienced by marijuana users.

Despite the fact that on the federal level marijuana use remains illegal, in the United States in the twenty-first century there is strong interest in medicinal uses of marijuana. The herb appears to have analgesic, antiemetic, anti-inflammatory, sedative, anticonvulsive, and laxative actions. Clinical studies have demonstrated its effectiveness in relieving **nausea** and **vomiting** following **chemotherapy** treatments for **cancer**. The herb has also been shown to reduce intra-ocular pressure in the eye a beneficial action in the treatment for glaucoma. However, marijuana is not more effective in lowering pressure in the eye than legal prescription drugs.

Cannabis has proven anticonvulsive action, and may be helpful in treating **epilepsy**. Marijuana also increases appetite and reduces nausea and has been used with **AIDS** patients to counter weight loss and wasting that may result from the disease. Several chemical constituents of cannabis displayed antimicrobial action and antibacterial effects in research studies. The components CBC and THC have been shown to destroy and inhibit the growth of streptococci and staphylococci bacteria. In 2007, a Harvard University study found that the active ingredient of marijuana cut lung tumor growth in mice in half.

Because marijuana use is illegal in many places and because of the conditions under which the plants are raised causes variation in the amounts of active ingredients, there is no standard dosage for medical use. In states that have legalized the use of medical marijuana, the legally permissible amounts for an individual to possess range from 1 ounce (28 g) to 24 ounces (680 g). THC extract is available legally in some countries in capsule form. In the United States this form of THC is available only for clinical experimental purposes.

The *PDR for Herbal Medicine* reports that the most common effect of marijuana use is psychotropic, as a euphoric state (pronounced gaiety, laughing fits) occurs almost immediately after smoking the herb. Long-term usage leads to a clear increase in tolerance for most of the pharmacological effects. Chronic use results in increased risk of **laryngitis**, **bronchitis**, apathy, psychic decline, and disturbances of sexual functions. In addition chronic sinus and fungal infections have been linked to chronic marijuana smoking.

Research has shown that cannabis acts to increase heartbeat by as much as 40 beats per minute. A study reported by the American Heart Association concluded that smoking marijuana can precipitate a **heart attack** in persons with pre-existing heart conditions. One hour after smoking marijuana, the likelihood of having a heart attack is 4.5 times greater than if the person had not smoked, according to the research. Marijuana also can cause a drop in blood pressure resulting in **dizziness**.

Marijuana use during **pregnancy** has been found to reduce the newborn's birth weight, a possible indication of problems. Pregnant and **breastfeeding** women should

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avoid using marijuana. Other research has shown that marijuana decreases male fertility and increases the number of abnormal sperm found in semen.

An additional health concern is the effect that marijuana smoking has on the lungs. Cannabis smoke carries more tars and other particulate matter than tobacco smoke. Long-term use is also associated with an increase in respiratory diseases such as bronchitis.

Studies have shown that motor coordination and driving ability can be impaired for up to eight hours after smoking marijuana. Individuals should avoid driving and using heavy machinery for several hours after using the herb.

More seriously, marijuana has been linked to the onset or worsening of certain psychiatric conditions, including **panic disorder**, **schizophrenia**, and depersonalization disorder. Persons diagnosed with or at risk for these conditions should not use marijuana. Chronic marijuana use also interferes with the ability to organize and recall complex information.

Marijuana use may mask the perceived effects of alcohol and cocaine when the drugs are consumed together. Marijuana is said to exert a synergistic effect with other medicinal agents. When used with nitrous oxide it may enhance the nitrous oxide effect.

Marijuana use by individuals taking selective serotonin re-uptake inhibitors (SSRIs, used to treat depression) may develop manic symptoms. Use in individuals taking **tricyclic antidepressants** can produce delirium and racing heart (tachycardia).

In the United States, marijuana is considered a Class I narcotic, and federal law has restricted its use since 1937. Penalties include fines and imprisonment in some states, but the herb has been decriminalized in others. California, for example, issues cards identifying medical marijuana users and allows them to purchase the drug openly at certain clinics. As of late 2010, 14 states (Alaska, California, Colorado, Hawaii, Maine, Michigan, Montana, Nevada, New Jersey, New Mexico, Oregon, Rhode Island, Vermont, Washington) along with the District of Columbia, had enacted laws that legalized medical marijuana. Eight states had pending legislation or ballot measures to legalize medical marijuana (Arizona, Illinois, Massachusetts, New York, North Carolina, Ohio, Pennsylvania, and South Dakota). In other countries, the legal status of and penalty for using marijuana vary widely.

Illegally purchased marijuana carries the potential to be laced with other toxins and mind-altering drugs. Since marijuana is illegal under federal law, there are no regulations or quality control to establish standardized purity of the herb.

Diagnosis

Marijuana use can be diagnosed through a urine drug-screening test. The drug is definitely detectable in urine for 1–5 days after use; however, it may be detected in the urine for as long as 21 days after use. Marijuana use is commonly looked for in pre-employment drug screening.

Treatment

Many people do not consider recreational marijuana use harmful, especially as the medical community is increasingly recognizing that the drug has medically beneficial qualities. Marijuana use often occurs in conjunction with **abuse** of alcohol and other drugs. In this situation, treatment of the other drug often takes precedence over treatment for marijuana use. **Cognitive-behavioral therapy**, in which users learn to recognize, manage and avoid situations most likely to lead to marijuana use and develop healthy ways to cope with stressful situations can be successful in stopping marijuana use in motivated individuals.

Prognosis

Marijuana use peaks during adolescence and then gradually declines, although there are still many older adults who use marijuana recreationally Although marijuana is less likely than some other drugs to lead to dependence, heavy users may experience a withdrawal syndrome characterized by **anxiety**, irritability, chills, and **muscle cramps** if they stop usage abruptly.

Prevention

Recreational marijuana use is difficult to prevent, and drug education programs have not been successful in reducing the number of people who experiment with marijuana. As medical use of marijuana becomes more common, attitudes in the United States have shifted away from punishing individuals who possess small amounts of marijuana for personal use, making prevention increasingly difficult.

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ORGANIZATIONS

American Medical Marijuana Association, 17415 Ocean Drive, Fort Bragg, CA, 95437, amma@drugsense.org, http://americanmarijuana.org.

National Center for Complementary and Alternative Medicine Clearinghouse, PO Box 7923, Gaithersburg, MD, 20898, (301) 519-3153. TTY: (866) 464-3615, (888) 644-6226, (866) 464-3616, http://nccam.nih.gov.

National Clearinghouse on Alcohol and Drug Information., P. O. Box 2345, Rockville, MD, 20847, (877) SAMHSA-7; Hablamos español: (877) 767-8432; TDD: (800) 487-4889, (240) 221-4292, http://ncadi.samhsa.gov.

National Council on Alcohol and Drug Dependence, 244 East 58th Street 4th Floor, New York, NY, 10022, (212) 269-7797, 24-hour help line: (800) NCA-CALL, (212) 269-7510, national@mcadd.org, http://www.ncadd.org.

Partnership for a Drug-free America, 405 Lexington Avenue, Ste 1601, New York, NY, 10174, (212) 922-1560, (212) 922-1570, http://www.drugfree.org.

Clare Hanrahan
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Marriage counseling

Definition

Marriage counseling is a type of **psychotherapy** for a married couple or established partners that tries to resolve problems in the relationship. Typically, two people attend counseling sessions together to discuss specific issues; however, in some cases only one partner works within the sessions. It may also be called marital therapy, couple therapy, or relationship counseling.

Before the late twentieth century, close friends, family members, or religious leaders primarily performed marriage counseling. Since then, the guidance most often comes from psychiatrists, psychologists, social workers, and marriage/family counselors. With the use of such professionals, certifications and regulations have been established to guide and control these activities. One of the most commonly accepted credentials comes from the American Association for Marriage and Family Therapy.

Purpose

Marriage counseling provides help to couples, whether they are married or not, and whether the pair are heterosexual or homosexual. It is based on research showing that individuals and their problems are best handled within the context of their relationships. Marriage counselors are trained in psychotherapy and family systems, and focus on understanding their clients' symptoms and the way their interactions contribute to problems in the relationship.

Various issues are discussed in marriage counseling. Some of the more critical issues addressed include:

- Infidelity issues
- Sexual problems
- Financial difficulties
- Physical disabilities
- Mental illnesses
- Anger management problems
- Domestic abuse
- Alcohol/substance abuse

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- Communications difficulties
- Children and other family members interactions.

Description

Marriage counseling is usually a short-term therapy that may take only a few sessions to work out problems in the relationship. Longer-term counseling may also occur, with a range of sessions usually from 12 to 24 in number. Typically, marriage counselors ask questions about the couple's roles, patterns, rules, goals, and beliefs. Therapy often begins as the couple analyzes the good and bad aspects of the relationship. The marriage counselor then works with the couple to help them understand that, in most cases, both partners are contributing to problems in the relationship. When this is understood, the two can then learn to change how they interact with each other to solve problems. The partners may be encouraged to draw up a contract in which each partner describes the behavior he or she will be trying to maintain. Sometimes counseling is also provided for the entire family, not just for a couple.

Marriage is not a requirement for two people to get help from a marriage counselor. Any one person wishing to improve his or her relationships can acquire help with behavioral problems, relationship issues, or with mental or emotional disorders. Marriage counselors also offer treatment (pre-marital therapy) for couples before they get married to help them understand potential problem areas. A third type of marriage counseling involves post-marital therapy, in which divorcing couples who share children seek help in working out their differences. Couples in the midst of a divorce find that marriage therapy during separation can help them find a common ground as they negotiate interpersonal issues and child custody.

Choosing a therapist

A marriage counselor is trained to use different types of therapy in work with individuals, couples, and groups. American Association of Marriage and Family Therapy (AAMFT) training includes supervision by experienced therapists, who hold a minimum of a master's degree (including specific training in marriage and family therapy), and specific graduate training in marriage and family therapy.

When looking for a marriage counselor, a couple should find out the counselor's training and educational background, professional associations, such as the AAMFT, and state licensure, and whether the person has experience in treating particular kinds of problem. Also, questions should be asked concerning fees, insurance coverage, the average length of therapy, and so on.

Normal results

Marriage counseling helps couples learn to deal more effectively with problems, and can help prevent small problems from becoming serious. Research shows that marriage counseling, when effective, tends to improve a person's physical as well as mental health, in addition to improving the relationship.

Resources

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ORGANIZATIONS

American Association for Marriage and Family Therapy, 112 South Alfred Street, Alexandria, VA, 22314-3061, (703) 838-9808, (703) 838-9805, http://www.aamft.org/.

American Psychological Association, 750 First Street N.E., Washington, DC, 20002-4242, (202) 336-5500, (800) 374-2721, http://www.apa.org/.

Carol A. Turkington

Marshall-Marchetti-Krantz procedure

Definition

The Marshall-Marchetti-Krantz procedure surgically reinforces the bladder neck in order to prevent unintentional urine loss.

Purpose

The Marshall-Marchetti-Krantz procedure is performed to correct stress incontinence in women, a common result of **childbirth** and/or **menopause**. Incontinence also occurs when an individual involuntarily loses urine after pressure is placed on the abdomen (like during **exercise**, sexual activity, sneezing, coughing, laughing, or hugging).

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KEY TERMS

Biofeedback—Biofeedback training monitors temperature and muscle contractions in the vagina to help incontinent patients control their pelvic muscles.

Bladder training—A behavioral modification program used to treat stress incontinence. Bladder training involves putting the patient on a toilet schedule, and gradually increasing the time interval between urination.

Catheter—A long, thin, flexible tube. A catheter is used to drain the bladder of urine during a Marshall-Marchetti-Krantz procedure.

Kegel exercises—Exercises that tighten the pelvic floor muscles. Kegel exercises can assist some women in controlling their stress incontinence.

Urethra—The narrow tube, leading from the bladder that drains the body's urine.

Precautions

In some women, stress incontinence may be controlled through nonsurgical means, such as:

- Kegel exercises (exercises that tighten pelvic muscles)
- Biofeedback (monitors temperature and muscle contractions in the vagina to help incontinent patients control their pelvic muscles)
- Bladder training (behavioral modification program used to treat stress incontinence)
- Medication
- Inserted incontinence devices.

Each patient should undergo a full diagnostic workup to determine the best course of treatment.

Description

The Marshall-Marchetti-Krantz procedure, also known as **retropubic suspension** or bladder neck suspension surgery, is performed by a surgeon in a hospital setting. The patient is placed under **general anesthesia**, and a long, thin, flexible tube (catheter) is inserted into the bladder through the narrow tube (urethra) that drains the body's urine. An incision is made across the abdomen, and the bladder is exposed. The bladder is separated from surrounding tissues. Stitches (sutures) are placed in these tissues near the bladder neck and urethra. The urethra is then lifted, and the sutures are attached to the pubic bone itself, or to tissue (fascia) behind the pubic bone. The sutures support the bladder neck, helping the patient gain control over urine flow.

Preparation

A complete evaluation to determine the cause of incontinence is critical to proper treatment. A thorough medical history and general **physical examination** should be performed on candidates for the Marshall-Marchetti-Krantz procedure. Diagnostic testing may include x rays, ultrasound, urine tests, and examination of the pelvis. It may also include a series of urodynamic testing exams that measure bladder pressure and capacity, and urinary flow.

Patients undergoing a Marshall-Marchetti-Krantz procedure must not eat or drink for eight hours prior to the surgery.

Aftercare

Recovery from a Marshall-Marchetti-Krantz procedure requires two to six days of hospitalization. The catheter will be removed from the patient's bladder once normal bladder function resumes. Patients are advised to refrain from heavy lifting for four to six weeks after the procedure.

Patients should contact their physician immediately if they experience **fever**, **dizziness**, or extreme **nausea**, or if their incision site becomes swollen, red, or hard.

Risks

The Marshall-Marchetti-Krantz procedure is an invasive surgical procedure and, as such, it carries risks of infection, internal bleeding, and hemorrhage. There is also a possibility of permanent damage to the bladder or urethra. The urethra may become scarred, causing a permanent narrowing, or stricture.

Normal results

Approximately 85% of women who undergo the Marshall-Marchetti-Krantz procedure are cured of their stress incontinence.

ORGANIZATIONS

American Urological Association Foundation, 1000 Corporate Blvd., Linthicum, MD, 21090, (410) 689-3700, (410) 689-3800, (866) 746-4282, auafoundation@auafoundation.org, http://www.urologyhealth.org/.

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National Association for Continence, P.O. Box 1019, Charleston, SC, 29402-1019, (843) 377-0900, (843) 377-0905, (800) 252-3337, memberservices@nafc.org, http://www.nafc.org.

Paula Anne Ford-Martin

Massage therapy

Definition

Massage therapy is the scientific manipulation of the soft tissues of the body for the purpose of normalizing those tissues and consists of manual techniques that include applying fixed or movable pressure, holding, and/or causing movement of or to the body.

Purpose

Generally, massage is known to affect the circulation of blood and the flow of blood and lymph, reduce muscular tension or flaccidity, affect the nervous system through stimulation or **sedation**, and enhance tissue healing. These effects provide a number of benefits:

- reduction of muscle tension and stiffness
- relief of muscle spasms
- greater flexibility and range of motion
- increase of the ease and efficiency of movement
- relief of stress and aide of relaxation
- promotion of deeper and easier breathing
- improvement of the circulation of blood and movement of lymph
- relief of tension-related conditions, such as headaches and eyestrain
- promotion of faster healing of soft tissue injuries, such as pulled muscles and sprained ligaments, and reduction in pain and swelling related to such injuries
- reduction in the formation of excessive scar tissue following soft tissue injuries
- enhancement in the health and nourishment of skin
- improvement in posture through changing tension patterns that affect posture
- reduction in stress and an excellent stress management tool
- creation of a feeling of well-being
- reduction in levels of anxiety
- increase in awareness of the mind-body connection
- promotion of a relaxed state of mental awareness

Massage therapy also has a number of documented clinical benefits. For example, massage can reduce **anxiety**, improve pulmonary function in young **asthma** patients, reduce psycho-emotional distress in persons suffering from chronic inflammatory bowel disease, increase weight and improve motor development in premature infants, and may enhance immune system functioning. Some medical conditions that massage therapy can help are: **allergies**, anxiety and **stress**, arthritis, asthma and **bronchitis**, **carpal tunnel syndrome** and other repetitive motion injuries, chronic and temporary **pain**, circulatory problems, depression, digestive disorders, **tension headache**, **insomnia**, myofascial pain, **sports injuries**, and temporomandibular joint dysfunction.

Description

Origins

Massage therapy is one of the oldest health care practices known to history. References to massage are found in Chinese medical texts more than 4,000 years old. Massage has been advocated in Western health care practices at least since the time of Hippocrates, the "Father of Medicine." In the fourth century B.C. Hippocrates wrote, "The physician must be acquainted with many things and assuredly with rubbing" (the ancient Greek term for massage was rubbing).

The roots of modern, scientific massage therapy go back to Per Henrik Ling (1776–1839), a Swede, who developed an integrated system consisting of massage and active and passive exercises. Ling established the Royal Central Gymnastic Institute in Sweden in 1813 to teach his methods.

Modern, scientific massage therapy was introduced in the United States in the 1850s by two New York physicians, brothers George and Charles Taylor, who had studied in Sweden. The first clinics for massage therapy in the United States were opened by two Swedish physicians after the Civil War period. Doctor Baron Nils Posse operated the Posse Institute in Boston and Doctor Hartwig Nissen opened the Swedish Health Institute near the Capitol in Washington, D.C.

Although there were periods when massage fell out of favor, in the 1960s it made a comeback in a different way as a tool for relaxation, communication, and alternative healing. Today, massage is one of the most popular healing modalities. It is used by conventional, as well as alternative, medical communities and is now covered by some health insurance plans.

Massage therapy is the scientific manipulation of the soft tissues of the body for the purpose of

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normalizing those tissues and consists of a group of manual techniques that include applying fixed or movable pressure, holding, and/or causing movement of or to the body. While massage therapy is applied primarily with the hands, sometimes the forearms or elbows are used. These techniques affect the muscular, skeletal, circulatory, lymphatic, nervous, and other systems of the body. The basic philosophy of massage therapy embraces the concept of *vis Medicatrix naturae*, which is aiding the ability of the body to heal itself, and is aimed at achieving or increasing health and well-being.

Touch is the fundamental medium of massage therapy. While massage can be described in terms of the type of techniques performed, touch is not used solely in a mechanistic way in massage therapy. One could look at a diagram or photo of a massage technique that depicts where to place one's hands and what direction the **stroke** should go, but this would not convey everything that is important for giving a good massage. Massage also has an artistic component.

Because massage usually involves applying touch with some degree of pressure and movement, the massage therapist must use touch with sensitivity in order to determine the optimal amount of pressure to use for each person. For example, using too much pressure may cause the body to tense up, while using too little may not have enough effect. Touch used with sensitivity also allows the massage therapist to receive useful information via his or her hands about the client's body, such as locating areas of muscle tension and other soft tissue problems. Because touch is also a form of communication, sensitive touch can convey a sense of caring—an essential element in the therapeutic relationship—to the person receiving massage.

In practice, many massage therapists use more than one technique or method in their work and sometimes combine several. Effective massage therapists ascertain each person's needs and then use the techniques that will meet those needs best.

Swedish massage uses a system of long gliding strokes, kneading, and friction techniques on the more superficial layers of muscles, generally in the direction of blood flow toward the heart, and sometimes combined with active and passive movements of the joints. It is used to promote general relaxation, improve circulation and range of motion, and relieve muscle tension. Swedish massage is the most commonly used form of massage.

Deep tissue massage is used to release chronic patterns of muscular tension using slow strokes, direct pressure, or friction directed across the grain of the muscles. It is applied with greater pressure and to deeper layers of muscle than Swedish, which is why it is called deep tissue and is effective for chronic muscular tension.

Sports massage uses techniques that are similar to Swedish and deep tissue, but are specially adapted to deal with the effects of athletic performance on the body and the needs of athletes regarding training, performing, and recovery from injury.

Neuromuscular massage is a form of deep massage that is applied to individual muscles. It is used primarily to release trigger points (intense knots of muscle tension that refer pain to other parts of the body), and also to increase blood flow. It is often used to reduce pain. Trigger point massage and myotherapy are similar forms.

Acupressure applies finger or thumb pressure to specific points located on the **acupuncture** meridians (channels of energy flow identified in Asian concepts of anatomy) in order to release blocked energy along these meridians that causes physical discomforts, and rebalance the energy flow. **Shiatsu** is a Japanese form of acupressure.

The cost of massage therapy varies according to geographic location, experience of the massage therapist, and length of the massage. In the United States, the average range is from $35-60 for a one hour session. Massage therapy sessions at a client's home or office may cost more due to travel time for the massage therapist. Most sessions are one hour. Frequency of massage sessions can vary widely. If a person is receiving massage for a specific problem, frequency can vary widely based on the condition, though it usually will be once a week. Some people incorporate massage into their regular personal health and fitness program. They will go for massage on a regular basis, varying from once a week to once a month.

The first appointment generally begins with information gathering, such as the reason for getting massage therapy, physical condition and medical history, and other areas. The client is asked to remove clothing to one's level of comfort. Undressing takes place in private, and a sheet or towel is provided for draping. The massage therapist will undrape only the part of the body being massaged. The client's modesty is respected at all times. The massage therapist may use an oil or cream, which will be absorbed into the skin in a short time.

To receive the most benefit from a massage, generally the person being massaged should give the therapist accurate health information, report discomfort of any kind (whether it is from the massage itself or due to the room temperature or any other distractions), and be as receptive and open to the process as possible.

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Insurance coverage for massage therapy varies widely. There tends to be greater coverage in states that license massage therapy. In most cases, a physician's prescription for massage therapy is needed. Once massage therapy is prescribed, authorization from the insurer may be needed if coverage is not clearly spelled out in one's policy or plan.

Preparations

Going for a massage requires little in the way of preparation. Generally, one should be clean and should not eat just before a massage. One should not be under the influence of alcohol or non-medicinal drugs. Massage therapists generally work by appointment and usually will provide information about how to prepare for an appointment at the time of making the appointment.

Precautions

Massage is comparatively safe; however it is generally contraindicated, i.e., it should not be used, if a person has one of the following conditions: advanced heart diseases, **hypertension** (high blood pressure), phlebitis, thrombosis, **embolism**, kidney failure, **cancer** if massage would accelerate metastasis (i.e., spread a tumor) or damage tissue that is fragile due to **chemotherapy** or other treatment, infectious diseases, contagious skin conditions, acute inflammation, infected injuries, unhealed **fractures**, **dislocations**, **frostbite**, large hernias, torn ligaments, conditions prone to hemorrhage, and **psychosis**.

Massage should not be used locally on affected areas (i.e., avoid using massage on the specific areas of the body that are affected by the condition) for the following conditions: **rheumatoid arthritis** flare up, **eczema**, **goiter**, and open **skin lesions**. Massage may be used on the areas of the body that are not affected by these conditions.

In some cases, precautions should be taken before using massage for the following conditions: **pregnancy**, high fevers, **osteoporosis**, diabetes, recent post-operative cases in which pain and muscular splinting (i.e., tightening as a protective reaction) would be increased, apprehension, and mental conditions that may impair communication or perception. In such cases, massage may or may not be appropriate. The decision on whether to use massage must be based on whether it may cause harm. For example, if someone has osteoporosis, the concern is whether bones are strong enough to withstand the pressure applied. If one has a health condition and has any hesitation about whether massage therapy would be appropriate, a physician should be consulted.

Side effects

Massage therapy does not have side effects. Sometimes people are concerned that massage may leave them too relaxed or too mentally unfocused. To the contrary, massage tends to leave people feeling more relaxed and alert.

Research and general acceptance

Before 1939, more than 600 research studies on massage appeared in the main journals of medicine in English. However, the pace of research was slowed by medicine's disinterest in massage therapy.

Massage therapy research picked up again in the 1980s, as the growing popularity of massage paralleled the growing interest in complementary and alternative medicine. Well designed studies have documented the benefits of massage therapy for the treatment of acute and chronic pain, acute and chronic inflammation, chronic **lymphedema**, **nausea**, muscle spasm, various soft tissue dysfunctions, anxiety, depression, insomnia, and psycho-emotional stress, which may aggravate mental illness.

Premature infants treated with daily massage therapy gain more weight and have shorter hospital stays than infants who are not massaged. A study of 40 low-birth-weight babies found that the 20 massaged babies had a 47% greater weight gain per day and stayed in the hospital an average of six days less than 20 infants who did not receive massage, resulting a cost savings of approximately $3,000 per infant. Cocaine-exposed, preterm infants given massage three times daily for a 10 day period showed significant improvement. Results indicated that massaged infants had fewer postnatal complications and exhibited fewer stress behaviors during the 10 day period, had a 28% greater daily weight gain, and demonstrated more mature motor behaviors.

A study comparing 52 hospitalized depressed and adjustment disorder children and adolescents with a control group that viewed relaxation videotapes, found massage therapy subjects were less depressed and anxious, and had lower saliva cortisol levels (an indicator of less depression).

Another study showed massage therapy produced relaxation in 18 elderly subjects, demonstrated in measures such as decreased blood pressure and heart rate and increased skin temperature.

A combination of massage techniques for 52 subjects with traumatically induced spinal pain led to significant improvements in acute and chronic pain and increased muscle flexibility and tone. This study also found massage therapy to be extremely cost effective,

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with cost savings ranging from 15-50%. Massage has also been shown to stimulate the body's ability to naturally control pain by stimulating the brain to produce endorphins. Fibromyalgia is an example of a condition that may be favorably affected by this effect.

A pilot study of five subjects with symptoms of tension and anxiety found a significant response to massage therapy in one or more psycho-physiological parameters of heart rate, frontalis and forearm extensor electromyograms (EMGs) and skin resistance, which demonstrate relaxation of muscle tension and reduced anxiety.

Lymph drainage massage has been shown to be more effective than mechanized methods or diuretic drugs to control lymphedema secondary to radical **mastectomy**, consequently using massage to control lymphedema would significantly lower treatment costs. A study found that massage therapy can have a powerful effect upon psycho-emotional distress in persons suffering from chronic inflammatory bowel disease. Massage therapy was effective in reducing the frequency of episodes of pain and disability in these patients.

Massage may enhance the immune system. A study suggests an increase in cytotoxic capacity associated with massage. A study of **chronic fatigue syndrome** subjects found that a group receiving massage therapy had lower depression, emotional distress, and somatic symptom scores, more hours of sleep, and lower epinephrine and cortisol levels than a control group.

ORGANIZATIONS

American Massage Therapy Association, 500 Davis Street, Suite 900, Evanston, IL, 60201-4695, (847) 864-0123, (847) 864-5196, (877) 905-2700, info@amtamassage.org, http://www.amtamassage.org/.

Elliot Greene

Mastectomy

Definition

Mastectomy is the surgical removal of the breast for the treatment or prevention of **breast cancer**.

Purpose

Mastectomy is performed as a surgical treatment for breast **cancer**. The severity of a breast cancer is evaluated according to a complex system called staging. This takes into account the size of the tumor and whether it has spread to the lymph nodes, adjacent tissues, and/or distant parts of the body. A mastectomy usually is the recommended surgery for more advanced breast cancers. Women with earlier stage breast cancers, who might also have breast-conserving surgery (**lumpectomy**), may choose to have a mastectomy. In the United States, approximately 50,000 women a year undergo mastectomy.

The size, location, and type of tumor are important considerations when choosing the best surgery to treat breast cancer. The size of the breast also is an important factor. A woman's psychological concerns and lifestyle choices also should be considered when making a decision.

There are many factors that may make a mastectomy the treatment of choice for a patient. Large tumors are difficult to remove with good cosmetic results. This is especially true if the woman has small breasts. Sometimes multiple areas of cancer are found in one breast, making removal of the whole breast necessary. The surgeon sometimes is unable to remove the tumor with a sufficient amount, or margin, of normal tissue surrounding it. In this situation, the entire breast needs to be removed. Recurrence of breast cancer after a lumpectomy is another indication for mastectomy.

Radiation therapy is almost always recommended following a lumpectomy. If a woman is unable to have radiation, a mastectomy is the treatment of choice. Pregnant women cannot have radiation therapy for fear of harming the fetus. A woman with certain collagen vascular diseases, such as **systemic lupus erythematosus** or **scleroderma**, would experience unacceptable scarring and damage to her connective tissue from radiation exposure. Any woman who has had therapeutic radiation to the chest area for other reasons cannot tolerate additional exposure for breast cancer therapy.

The need for radiation therapy after breast conserving surgery may make mastectomy more appealing for nonmedical reasons. Some women fear radiation and choose the more extensive surgery so radiation treatment will not be required. The commitment of time, usually five days a week for six weeks, may not be acceptable for other women. This may be due to financial, personal, or job-related factors. In geographically isolated areas, a course of radiation therapy may require lengthy travel and perhaps unacceptable amounts of time away from family or other responsibilities.

Some women choose mastectomy because they strongly fear recurrence of the breast cancer, and

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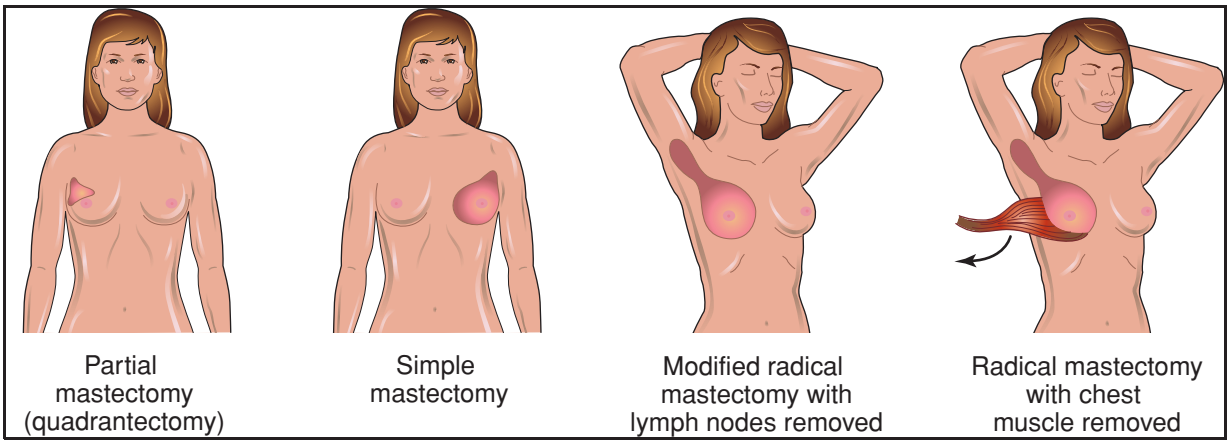

There are four types of mastectomies: partial mastectomy, or lumpectomy, in which the tumor and surrounding tissue is removed; simple mastectomy, where the entire breast and some axillary lymph nodes are removed; modified radical mastectomy, in which the entire breast and all axillary lymph nodes are removed; and the radical mastectomy, where the entire breast, axillary lymph nodes, and chest muscles are removed. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

lumpectomy seems too risky. Keeping a breast that has contained cancer may feel uncomfortable for some patients. They prefer mastectomy, so the entire breast will be removed. However, studies have shown that survival rates for women choosing mastectomy and those undergoing breast-conserving surgery have been the same.

The issue of prophylactic or preventive mastectomy, or removal of the breast to prevent future breast cancer, is controversial. Women with a strong family history of breast cancer and/or who test positive for a known cancer-causing gene may choose to have both breasts removed. Patients who have had certain types of breast cancers that are more likely to recur may elect to have the unaffected breast removed. Although there is some evidence that this procedure can decrease the chances of developing breast cancer, it is not a guarantee. It is not possible to guarantee that all breast tissue has been removed. There have been cases of breast cancers occurring after both breasts have been removed.

Studies have shown that women who choose preventive mastectomy generally are satisfied with their choice, but also believe they lacked enough information before deciding, particularly about the surgery, **genetic testing**, and **breast reconstruction**. A study released in 2003 concerning women who underwent radical mastectomy of one breast and chose surgical removal of the other breast as a preventive measure found that 83% were highly satisfied with their decision.

Precautions

The decision to have mastectomy or lumpectomy should be carefully considered. It is important that the woman be fully informed of all the potential risks and benefits of each surgical treatment before making a choice.

Description

There are several types of mastectomies. The radical mastectomy, also called the Halsted mastectomy, is rarely performed today. It was developed in the late 1800s, when it was thought that more extensive surgery was most likely to cure cancer. A radical mastectomy involves removal of the breast, all surrounding lymph nodes up to the collarbone, and the underlying chest muscle. Women often were left disfigured and disabled, with a large defect in the chest wall requiring **skin grafting**, and significantly decreased arm sensation and motion. Unfortunately, and inaccurately, it still is the operation many women picture when the word mastectomy is mentioned.

Surgery that removes breast tissue, nipple, an ellipse of skin, and some axillary or underarm lymph nodes, but leaves the chest muscle intact, usually is called a modified radical mastectomy. This is the most common type of mastectomy performed today. The surgery leaves a woman with a more normal chest shape than the older radical mastectomy procedure, and a scar that is not visible in most clothing. It also allows for immediate or delayed breast reconstruction.

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In a simple mastectomy, only the breast tissue, nipple, and a small piece of overlying skin are removed. If a few of the axillary lymph nodes closest to the breast also are taken out, the surgery may be called an extended simple mastectomy.

There are other variations on the term mastectomy. A skin-sparing mastectomy uses special techniques that preserve the patient's breast skin for use in reconstruction, although the nipple still is removed. Total mastectomy is a confusing expression, as it may be used to refer to a modified radical mastectomy or a simple mastectomy. In 2003, surgeons reported on a new technique that spared the nipple in many women with early stage breast cancer.

Many women choose to have breast reconstruction performed in conjunction with the mastectomy. The reconstruction can be done using a woman's own abdominal tissue, or using saline-filled artificial expanders, which leave the breast relatively flat but partially reconstructed. Additionally, there are psychological benefits to coming out of the surgery with the first step to a reconstructed breast. Immediate reconstruction will add time and cost to the mastectomy procedure, but the patient can avoid the physical impact of a later surgery.

A mastectomy typically is performed in a hospital setting, but specialized outpatient facilities sometimes are used. The surgery is done under **general anesthesia**. The type and location of the incision may vary according to plans for reconstruction or other factors, such as old **scars**. As much breast tissue as possible is removed. Approximately 10 to 20 axillary lymph nodes usually are removed. All tissue is sent to the pathology laboratory for analysis. If no immediate reconstruction is planned, surgical drains are left in place to prevent fluid accumulation. The skin is sutured and **bandages** are applied.

The surgery may take from two to five hours. Patients usually stay at least one night in the hospital, although outpatient mastectomy is increasingly performed for about 10% of all patients. Insurance usually covers the cost of mastectomy. If immediate reconstruction is performed, the length of stay, recovery period, insurance reimbursement, and fees will vary. In 1998, the Women's Health and Cancer Rights Act required insurance plans to cover the cost of breast reconstruction in conjunction with a mastectomy procedure.

Preparation

Routine preoperative preparations, such as not eating or drinking the night before surgery, typically are ordered for a mastectomy. On rare occasions, the patient also may be asked to donate blood in case a blood **transfusion** is required during surgery. The patient should advise the surgeon of any medications she is taking. Information regarding expected outcomes and potential complications also should be part of preparation for a mastectomy, as for any surgical procedure. It is especially important that women know about sensations they might experience after surgery, so they are not misinterpreted as a sign of poor wound healing or recurrent cancer.

Aftercare

In the past, women often stayed in the hospital at least several days. Now many patients go home the same day or within a day or two after their mastectomies. Visits from home care nurses can sometimes be arranged, but patients need to learn how to care for themselves before discharge from the hospital. Patients may need to learn to change bandages and/or care for the incision. The surgical drains must be attended to properly; this includes emptying the drain, measuring fluid output, moving clots through the drain, and identifying problems that need attention from the doctor or nurse. If the drain becomes blocked, fluid or blood may collect at the surgical site. Left untreated, this accumulation may cause infection and/or delayed wound healing.

After a mastectomy, activities such as driving may be restricted according to individual needs. **Pain** is usually well controlled with prescribed medication. Severe pain may be a sign of complications, and should be reported to the physician. A return visit to the surgeon is usually scheduled 7 to 10 days after the procedure.

Exercises to maintain shoulder and arm mobility may be prescribed as early as 24 hours after surgery. These are very important in restoring strength and promoting good circulation. However, intense **exercise** should be avoided for a time after surgery in order to prevent injury. The specific exercises suggested by the physician will change as healing progresses. **Physical therapy** is an integral part of care after a mastectomy, aiding in the overall recovery process.

Emotional care is another important aspect of recovery from a mastectomy. A mastectomy patient may feel a range of emotions including depression, negative self-image, grief, fear and **anxiety** about possible recurrence of the cancer, anger, or guilt. Patients are advised to seek counseling and/or support groups and to express their emotions to others, whether family, friends, or therapists. Assistance in dealing with the

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KEY TERMS

Axillary—Located in or near the armpit.

Lymphedema—Swelling caused by an accumulation of fluid from faulty lymph drainage.

Mastectomy, modified radical—Total mastectomy with axillary lymph node dissection, but with preservation of the pectoral muscles.

Mastectomy, radical—Removal of the breast, pectoral muscles, axillary lymph nodes, and associated skin and subcutaneous tissue.

Mastectomy, simple—Removal of only the breast tissue, nipple and a small portion of the overlying skin

psychological effects of the breast cancer diagnosis, as well as the surgery, can be invaluable for women.

Measures to prevent injury or infection to the affected arm should be taken, especially if axillary lymph nodes were removed. There are a number of specific instructions directed toward avoiding pressure or constriction of the arm. Extra care must be exercised to avoid injury, to treat it properly if it occurs, and to seek medical attention promptly when appropriate.

Additional treatment for breast cancer may be necessary after a mastectomy. Depending on the type of tumor, lymph node status, and other factors, **chemotherapy**, radiation therapy, and/or hormone therapy may be prescribed.

Risks

Risks that are common to any surgical procedure include bleeding, infection, anesthesia reaction, or unexpected scarring. After mastectomy and axillary lymph node dissection, a number of complications are possible. A woman may experience decreased feeling in the back of her armpit or other sensations including **numbness**, **tingling**, or increased skin sensitivity. Some women report phantom breast symptoms, experiencing **itching**, aching, or other sensations in the breast that has been removed. There may be scarring around where the lymph nodes were removed, resulting in decreased arm mobility and requiring more intense physical therapy.

Approximately 10% to 20% of patients develop **lymphedema** after axillary lymph node removal. This swelling of the arm, caused by faulty lymph drainage, can range from mild to severe. It can be treated with elevation, elastic bandages, and specialized physical therapy. Lymphedema is a chronic condition that requires continuing treatment. This complication can arise at any time, even years after surgery. A new technique called sentinel lymph node mapping and biopsy often eliminates the need for removing some or all lymph nodes by testing the first lymph node for cancer.

Normal results

A mastectomy is performed as the definitive surgical treatment for breast cancer. The goal of the procedure is that the breast cancer is completely removed and does not recur.

Abnormal results

An abnormal result of a mastectomy is the incomplete removal of the breast cancer or a recurrence of the cancer. Other abnormal results include long-lasting (chronic) pain or impairment that does not improve after several months of physical therapy.

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American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (800) 227-2345, http://www.cancer.org.

Breast Cancer Network of Strength, 135 S. LaSalle St., Suite 2000, Chicago, IL, 60603, (312) 986-8338, (312) 294-8597, (800) 221-2141, http://www.networkofstrength.org.

National Lymphedema Network, 116 New Montgomery Street, Suite 235, San Francisco, CA, 94105, (415) 908-3681, (415) 908-3813, (800) 541-3259, nln@lymphnet.org, http://www.lymphnet.org.

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Mastitis

Definition

Mastitis is an inflammation within the breast tissue that is usually caused by an infection. It usually only occurs in women who are **breastfeeding** their babies; generally, during the first two months of breast-feeding an infant.

Demographics

Mastitis usually occurs in lactating mothers. In some cases, it occurs as the result of inflammatory lesions on the breast of females neither pregnant nor breastfeeding. In rare cases it can occur in men.

Description

Breastfeeding is the act of allowing a baby to suckle at the breast to drink the mother's milk. In the process, unaccustomed to the vigorous pull and tug of the infant's suck, the nipples may become sore, cracked, or irritated. This creates a tiny opening in the breast, through which bacteria can enter. The presence of milk, with high sugar content, gives the bacteria an excellent source of **nutrition**. Under these conditions, the bacteria are able to multiply, until they are plentiful enough to cause an infection within the breast.

Mastitis usually begins more than two to four weeks after delivery of the baby. It is a relatively uncommon complication of breastfeeding mothers, occurring in only approximately 3% to 5% of nursing women.

Women are at increased risk from getting mastitis if one or more of the following have occurred:

Mastitis is usually caused by a bacterial infection through a nipple damaged during breastfeeding. *(Dr. P. Marazzi/SPL/Photo Researchers, Inc.)*

- Mastitis has occurred previously
- Anemia is present
- Nipples become irritated or cracked. Irritation can be caused by a nursing brassiere (bra) that is too tight
- Breast-feeding is not performed on a regular basis, or if the breasts are not completely emptied of milk during breast-feeding.

Causes and symptoms

Mastitis frequently occurs when bacteria contact a nipple on a female breast, although it can enter the breast from elsewhere. It can also occur due to improper breast-feeding techniques. The most common species of bacteria causing mastitis is called *Staphylococcus aureus*; however, it can also be caused by the species *Staphylococcus epidermidis* and certain species within the genus *Streptococci*. In 25% to 30% of people, this bacterium is present on the skin lining of normal, uninfected nostrils. It is probably this bacterium, clinging to the baby's nostrils, that is available to create infection when an opportunity (such as a crack in the nipple or a sore nipple of a nursing mother) presents itself.

Usually, only one breast is involved. An area of the affected breast becomes swollen, tender, red, hard (sometimes lumpy), itchy, and painful (often with a burning sensation). Other symptoms of mastitis include a general feeling of illness, including **fever** (with a temperature equal to or greater than 101°F [38.3°C]), **nausea**, **vomiting**, aches, shivering and chills, **fatigue**, and increased heart rate. Breast engorgement (enlarged veins and increased pressure due to excess milk production) may also occur. Advanced signs of mastitis includes swollen and tender (or painful) lymph nodes in the armpit adjacent to the infected breast and flu-like symptoms that worsen over time.

Diagnosis

Women should visit their doctor or other health care provider as soon as symptoms of mastitis appear, especially if flu-like symptoms appear, along with the presence of a reddish color on one or more of the breasts, breast **pain**, or abnormal leakage of milk from the nipples. Diagnosis by the doctor involves obtaining a sample of breast milk from the infected breast. The milk is cultured, allowing colonies of bacteria to grow. The causative bacteria then can be specially prepared for identification under a microscope. At the same time, tests can be performed to determine what type of antibiotic would be most effective against that particular bacterium. Sometimes, women and

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their physicians confuse mastitis with breast engorgement, or the tenderness and redness that appear when milk builds up in the breasts. Mastitis often can be distinguished if symptoms are accompanied by fever.

Treatment

A number of **antibiotics** are used to treat mastitis, including cephalexin, amoxicillin, azithromycin, dicloxacillin, and clindamycin. Breastfeeding usually should be continued, because the rate of **abscess** formation (an abscess is a persistent pocket of pus) in the infected breast goes up steeply among women who stop breastfeeding during a bout with mastitis. Most practitioners allow women to take **acetaminophen** (such as Tylenol) or ibuprofen (such as Advil) while nursing, to relieve both fever and pain. As always, breastfeeding women need to make sure that any medication they take is also safe for the baby, since almost all drugs they take appear in the breast milk. Warm compresses applied to the affected breast can be soothing.

Prognosis

Prognosis for uncomplicated mastitis is excellent when it is treated properly with medicine. About 10% of women with mastitis will end up with an abscess within the affected breast. An abscess is a collection of pus within the breast. This complication will require a surgical procedure to drain the pus.

Prevention

The most important aspect of prevention involves good hand-washing to try to prevent the infant from acquiring the *Staphylococcus aureus* bacterium, or another species of bacteria, in the first place. Keeping the breasts, and especially the nipples, clean before breastfeeding also helps prevent infection. Preventing the breasts from becoming engorged may help prevent mastitis by preventing plugging of milk ducts. Breastfeeding often throughout the day is advised. When unable to breast-feed use a breast-pump to remove the milk. Placing warm or cold packs on the breasts can also help to relieve the pain.

To make sure all of the milk is extracted from the breast, place a warm, wet washcloth over the affected breast for about 15 to 20 minutes before breast-feeding. Such an action helps to increase the flow of milk out of the nipple during breast-feeding. Other health care practices such as getting plenty of rest, drinking sufficient fluids daily, and eating healthy, nutritious meals can also help to avoid fatigue and anemia, which also helps to prevent mastitis. Rather than stopping the act of breastfeeding suddenly it is wise to slowly reduce the amount of times breast-feeding occurs in a day over a several week period.

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ORGANIZATIONS

La Leche League International, 957 North Plum Grove Road, Schaumburg, IL, 60173, (847) 519-7730, (800) 525-3243, (847) 969-0460, http://www.llli.org/.

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Mastocytosis

Definition

Mastocytosis is a disease characterized by the presence of too many mast cells in various organs and tissues.

Description

The body has a variety of free-roaming cell populations that function as immunogenic agents. Most immunogenic cells fall into the category of white blood cells, but some remain in tissues and are not found in the blood. Mast cells are such a group.

Mast cells are found primarily in the skin and digestive system, including the liver and spleen, and produce histamine, a chemical most famous for its ability to cause **itching**. Histamine also causes acid **indigestion**, **diarrhea**, flushing, heart pounding, headaches, and can even cause the blood pressure to drop suddenly.

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KEY TERMS

Nonsteroidal anti-inflammatory drugs (NSAIDs)—Aspirin, ibuprofen, naproxen, and many others.

Peptic ulcer—Ulcers in the stomach and upper duodenum (first portion of the small intestine) caused by stomach acid and a bacterium called *Helicobacter pylori*.

Mastocytosis comes in three forms. Most cases produce symptoms but do not shorten life expectancy. The three forms are:

- Mastocytoma, a benign skin tumor.
- Urticaria pigmentosa, small collections of mast cells in the skin that manifest as salmon or brown-colored patches.
- Systemic mastocytosis, the collection of mast cells in the skin, lymph nodes, liver, spleen, gastrointestinal tract, and bones.

Causes and symptoms

The cause of mastocytosis is unknown. People with systemic mastocytosis have bone and joint **pain**. Peptic ulcers are frequent because of the increased stomach acid stimulated by histamine. Many patients with systemic mastocytosis also develop urticaria pigmentosa. These **skin lesions** itch when stroked and may become fluid-filled.

Diagnosis

A biopsy of the skin patches aids diagnosis. An elevated level of histamine in the urine or blood is also indicative of mastocytosis.

Treatment

Mastocytoma usually occurs in childhood and clears-up on its own. Urticaria pigmentosa (present alone without systemic disease) also dramatically clears or improves as adolescence approaches.

Several medications are helpful in relieving symptoms of systemic mastocytosis. **Antihistamines** and drugs that reduce stomach acid are frequently needed. Headaches respond to migraine treatment. A medicine called cromolyn helps with the bowel symptoms. Several other standard and experimental medications have been used.

Prognosis

Mastocytoma and urticaria pigmentosa rarely if ever, develop into systemic mastocytosis, and both spontaneously improve over time. Systemic mastocytosis is only symptomatically treated. There is no known treatment that decreases the number of mast cells within tissue.

Resources

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J. Ricker Polsdorfer, MD

Mastoid tympanoplasty *see* **Mastoidectomy**

Mastoidectomy

Definition

Mastoidectomy is a surgical procedure to remove an infected portion of the bone behind the ear when medical treatment is not effective. This surgery is rarely needed today because of the widespread use of **antibiotics**.

Purpose

Mastoidectomy is performed to remove infected air cells within the mastoid bone caused by **mastoiditis**, ear infection, or an inflammatory disease of the middle ear (cholesteatoma). The cells are open spaces containing air that are located throughout the mastoid bone. They are connected to a cavity in the upper part of the bone, which is in turn connected to the middle ear. As a result, infections in the middle ear can sometimes spread through the mastoid bone. When antibiotics cannot clear this infection, it may be necessary to remove the infected air cells by surgery. Mastoidectomies are also performed sometimes to repair paralyzed facial nerves.

Description

Mastoidectomy is performed less often today because of the widespread use of antibiotics to treat ear infections.

There are several different types of mastoidectomy:

- Simple (or closed). The operation is performed through the ear or through a cut (incision) behind

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KEY TERMS

Cholesteatoma—A rare but chronic inflammatory disease in which skin cells and debris collect in the middle ear, usually as a result of an ear infection.

Mastoid bone—The prominent bone behind the ear that projects from the temporal bone of the skull.

Mastoiditis—An inflammation of the bone behind the ear (the mastoid bone) caused by an infection spreading from the middle ear to the cavity in the mastoid bone.

the ear. The surgeon opens the mastoid bone and removes the infected air cells. The eardrum is cut (incised) to drain the middle ear. Topical antibiotics are then placed in the ear.

- Radical mastoidectomy. The eardrum and most middle ear structures are removed, but the innermost small bone (the stapes) is left behind so that a hearing aid can be used later to offset the hearing loss.
- Modified radical mastoidectomy. The eardrum and the middle ear structures are saved, which allows for better hearing than is possible after a radical operation.

The wound is then stitched up around a drainage tube, which is removed a day or two later. The procedure usually takes between two and three hours.

Preparation

The doctor will give the patient a thorough ear, nose, and throat examination as well as a detailed hearing test before surgery. Patients are given an injection before surgery to make them drowsy.

Aftercare

Painkillers are usually needed for the first day or two after the operation. The patient should drink fluids freely. After the stitches are removed, the bulky mastoid dressing can be replaced with a smaller dressing if the ear is still draining. The patient is given antibiotics for several days.

The patient should tell the doctor if any of the following symptoms occur:

- Bright red blood on the dressing.
- Stiff neck or disorientation. These may be signs of meningitis.
- Facial paralysis, drooping mouth, or problems swallowing.

Risks

Complications do not often occur, but they may include:

- Persistent ear drainage.
- Infections, including meningitis or brain abscesses.
- Hearing loss.
- Facial nerve injury. This is a rare complication.
- Temporary dizziness.
- Temporary loss of taste on the side of the tongue.

ORGANIZATIONS

American Academy of Otolaryngology—Head and Neck Surgery, 1650 Diagonal Road, Alexandria, VA, 22314-2857, (703) 836-4444, http://www.entnet.org.

American Hearing Research Organization, 8 South Michigan Avenue, Suite #1205, Chicago, IL, 60603-4539, (312) 726-9670, (312) 726-9695, http://www.american-hearing.org.

Better Hearing Institute, 1444 I Street, NW, Suite 700, Washington, DC, 20005, (202) 449-1100, (800) 327-9355, mail@betterhearing.org, http://www.better hearing.org/

Carol A. Turkington

Mastoiditis

Definition

Mastoiditis is an infection of the spaces within the mastoid bone (located immediately behind the outside ear) within the skull. It is usually associated with **otitis media**, an infection of the middle ear. In the most serious cases, the bone itself becomes infected.

Demographics

Mastoiditis can occur in humans at any age, and equally of males and females. However, it is more likely to occur in children, primarily in younger children from six months to about one year of age. It rarely occurs in developed countries, such as the United States. Its incidence in the United States is usually less than four out of 100,000 people (0.004%) annually.

Description

The mastoid is a part of the side (temporal bone) of the skull. It can be felt as a bony bump just behind and slightly above the level of the earlobe. The mastoid has been described as resembling a "honeycomb"

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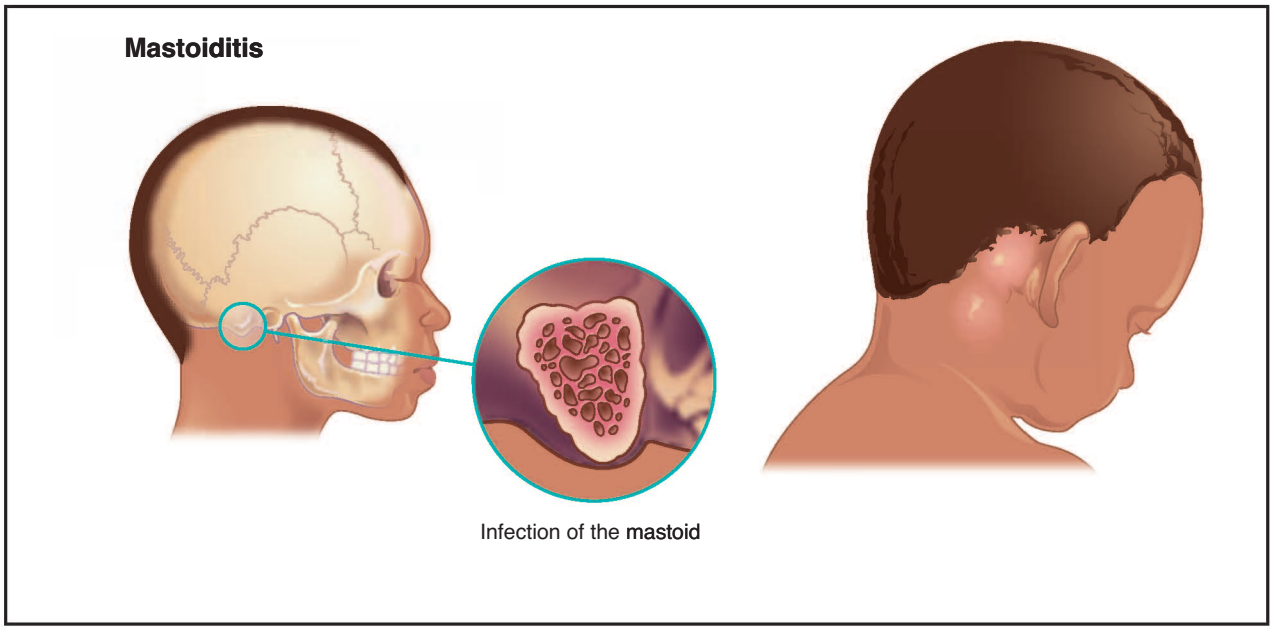

Illustration depicting infection of the mastoid (part of the temporal bone in the skull), and the appearance of the infection on the surface of the skin. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

of tiny partitioned-off airspaces. The mastoid is connected with the middle ear, so that when there is a collection of fluid in the middle ear, there is usually also a slight collection of fluid within the airspaces of the mastoid.

Mastoiditis can range from a simple case of some fluid escaping into the mastoid air cells during a middle ear infection, to a more complex infection which penetrates through to the lining of the mastoid bone, to a very severe and destructive infection of the mastoid bone itself.

Increased complications after getting mastoiditis may include:

- Paralysis of the face
- Meningitis (inflammation of the meninges)
- Hearing loss
- Infection extending throughout the body
- Vertigo (dizziness when stationary)
- Damaged or destroyed mastoid bone
- Epidural abscess

Causes and symptoms

Mastoiditis is caused by the same types of bacteria that cause middle ear infections (*Streptococcus pneumoniae* and *Haemophilus influenzae*), as well as by a variety of other bacteria (*Staphylococcus aureus*, *Pseuodomonas aeruginosa*, *Klebsiella*, ***Escherichia coli***, *Proteus*, *Prevotella*, *Fusobacterium*, *Porphyromonas*, and *Bacteroides*). Mastoiditis may occur due to the progression of an untreated, or undertreated, middle ear infection (what is called acute otitis media). The infection most often occurs in children.

Symptoms of mastoiditis may at first be the same as symptoms of an early middle ear infection. With progression, however, the swollen mastoid may push the outer ear slightly forward and away from the head. The area behind the ear will appear red and swollen, and will be very sore. **Fever** is usually present, and appears suddenly in most cases. A **headache** frequently is a symptom. There may be drainage of pus from the infected ear. In some cases, the skin over the mastoid may develop an opening through which pus drains. The reduced ability to hear may also occur. In infants, the symptoms can include irritability, **diarrhea**, fever, and poor feeding.

Diagnosis

Mastoiditis is usually suspected by a family physician or an ear, nose, and throat (ENT) specialist when a severe middle ear infection is accompanied by redness, swelling, and **pain** in the mastoid area. A **magnetic resonance imaging** (MRI) scan may be used, or a computed tomography (CT) scan may also be used; both show inflammation and fluid within the airspaces of the mastoid, as well as the erosion of the little walls of bone that should separate the air spaces. Several

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KEY TERMS

Abscess—A pocket of infection, usually including a collection of pus.

Meningitis—Inflammation and infection of the tissues covering the brain and spinal cord (the meninges).

Otitis or oteitis—An infection of the middle ear; marked by an enlargement of bone, tenderness and dull aching pain.

head and skull CT scans may be requested. If fluid drains from the ear or mastoid, a culture of the drainage will allow a laboratory to indentify the causative organism. If there is no fluid available, a tiny needle can be used to obtain a sample of the fluid which has accumulated behind the eardrum.

Treatment

Identification of the causative organism guides the practitioner's choice of antibiotic. Depending on the severity of the infection, the antibiotic can be given initially through a needle in the vein (intravenously, or IV), and then (as the patient improves) by mouth. Oftentimes, long-term treatment, or repeat treatment, of **antibiotics** is necessary. The group of antibiotics called penicillin may be used unless the patient is allergic to it. In such cases, clindamycin may be used.

In the case of a very severe infection of the mastoid bone itself, with a collection of pus (**abscess**), an operation to remove the mastoid part of the temporal bone is often necessary (**mastoidectomy**). Surgery to drain the middle ear is often performed to solve the problem with the middle ear infection.

Prognosis

With early identification of mastoiditis, the prognosis is very good. Sometimes it is difficult to make sure the antibiotics reach the interior of the mastoid area. In this case, the prognosis is less positive. When symptoms are not caught early enough, however, a number of complications can occur. These include an infection of the tissues covering the brain and spinal cord (**meningitis**), a pocket of infection within the brain (abscess), or an abscess within the muscles of the neck. All of these complications have potentially more serious prognoses. With the use of antibiotics, mastoiditis has become a minor ailment, only infrequently occurring in the United States. However, before antibiotics were discovered, it could easily cause **death**. In fact, at one time mastoiditis was one of the primary causes of death among children.

Prevention

Prevention of mastoiditis involves careful and complete treatment of any middle ear infections.

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ORGANIZATIONS

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Maternal serum alpha-fetoprotein test *see* **Alpha-fetoprotein test**

Maternal to fetal infections

Definition

Maternal to fetal infections are transmitted from the mother to her fetus, either across the placenta during fetal development (prenatal) or during labor and passage through the birth canal (perinatal).

Description

Antibodies in the maternal blood prevent most infections from being transmitted to the fetus. However, some maternal to fetal infections, particularly in

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the first trimester of **pregnancy**, can cause **miscarriage** or severe **birth defects**. Other infections can cause preterm labor, fetal or neonatal **death**, or serious illness in newborns. Perinatal transmissions infect the fetus after its protective membranes rupture—the water breaks—and during labor and delivery when the fetus is exposed to maternal blood. Perinatal transmission is more likely if the waters break prematurely.

Toxoplasmosis

Up to one-third of all people are infected with **toxoplasmosis**. The U.S. Centers for Disease Control and Prevention (CDC) estimate that 25-45% of women of childbearing age carry the parasite *Toxoplasma gondii* that causes toxoplasmosis. Very few infected people have symptoms and most pregnant women have antibodies that protect the fetus from infection. However, in one-third of women who are infected for the first time during pregnancy, the parasite infects the placenta and enters the fetal circulation. Congenital (present at birth) infection occurs in one out of every 800-1,400 infants born to infected mothers. The fetal infection rate is above 60% if maternal infection occurs during the third trimester, but the most severe fetal complications occur with first-trimester infection.

Viral respiratory infections

Cytomegalovirus (CMV) is the most common infection that can be transmitted to a fetus. Fifty to eighty percent of childbearing-age women have been infected by CMV prior to pregnancy. About 1-3% of women have their first or primary CMV infection during pregnancy and about one-third of these infections are transmitted to fetuses. Although most infants with congenital CMV have no problems, infection in early pregnancy can cause miscarriage or birth defects and CMV is a leading cause of congenital deafness. In later pregnancy CMV infection may cause preterm labor, **stillbirth**, or serious newborn illness. In the United States about 8,000 infants annually are born with potentially fatal CMV-related birth defects.

Fifth disease, caused by the parvovirus B19, is very common among children. About one-half of all adults are susceptible. About one-third of infants whose mothers contract fifth disease during pregnancy show signs of infection at birth. Although not usually dangerous, fifth disease contracted early in pregnancy can cause miscarriage or severe fetal anemia (low blood count) that can lead to congestive **heart failure**.

A fetus infected from its mother by *Varicella zoster* virus may develop pocks that can cause limb deformities early in development. If a woman contracts varicella (**chickenpox**) during the first 20 weeks of pregnancy, there is a 2% chance that her newborn will have varicella syndrome. The greatest risk from varicella is if the mother contracts the virus just before delivery when she has not yet produced antibodies to protect the newborn.

In the past, **rubella** was a common cause of birth defects. Routine vaccinations have made prenatal infection rare in the developed world. Rubella infection during the first 10 weeks of pregnancy may cause fetal death and more than 50% of newborns have severe birth defects. Infections contracted later in pregnancy do not cause congenital defects, although the newborn may become seriously ill and eventually develop **diabetes mellitus**.

Bacterial infections

Invasive group B streptococcal (GBS) disease is the most common cause of life-threatening infection in newborns. Up to 20% of pregnant women carry GBS in their vaginas during the last trimester, with the potential of infecting the fetus during birth. Although premature infants are more susceptible to GBS, 75% of infected infants are full-term. During the 1970s GBS emerged as the most common cause of newborn **sepsis**, or blood infection, and meningitis—infection of the fluid and lining surrounding the brain. GBS also is a frequent cause of newborn **pneumonia**. Maternal infection at conception or within the first two weeks of pregnancy may lead to hearing and vision loss and **mental retardation**. Between 1993 and 2002 congenital GBS infection in the United States decreased from 1.7 per 1,000 live births to 0.4 per 1,000 due to the use of **antibiotics** during delivery.

The food-borne bacterial infections listeriosis—caused by *Listeria monocytogenes*—and salmonellosis or food poisoning—caused by *Salmonella* bacteria—can be transmitted to a fetus. *L. monocytogenes* is ubiquitous in soil and groundwater, on plants, and in animals. Most human infections result from ingesting contaminated foods. Hormonal changes make pregnant women about 20 times more likely than other healthy adults to contract **listeriosis** and about one-third of all cases occur in pregnant women. Listeriosis can cause miscarriage, fetal or newborn death, premature delivery, or severe illness in the mother and infant.

Each year an estimated 8,000 pregnant women in the United States are infected with **syphilis** caused by

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the spirochete *Treponema pallidum*. Rising rates of syphilis among pregnant women are increasing the number of infants born with congenital syphilis. Congenital syphilis is a severe, disabling, and often life-threatening disease that can cause facial deformity, blindness, and deafness.

Every year in the United States an estimated 40,000 pregnant women are infected with gonorrhea—caused by *Neisseria gonorrhoeae*—and an estimated 200,000 are infected with chlamydia—caused by *Chlamydia trachomatis*. Chlamydia can cause premature membrane rupture and labor. Both infections can cause newborn conjunctivitis—a discharge of pus from the eyes.

Sexually transmitted viral infections

Each year an estimated 8,000 pregnant American women are infected with HIV, the human **immunodeficiency** virus that causes acquired immune deficiency syndrome (**AIDS**). About 20-25% of pregnant women with untreated HIV transmit it to their fetuses. In developed countries widespread HIV testing and antiretroviral therapy have reduced maternal-fetal transmission dramatically.

Genital herpes are caused by herpes simplex virus (HSV) type-2 and, less frequently, by HSV type-1 that usually causes **cold sores**. About 25% of American adults are infected with HSV-2, affecting one in 1,800-5,000 live births. There is little risk of fetal transmission if the mother is infected before the third trimester and has no genital sores at the time of delivery. Infection during the third trimester—when the virus is likely to be active and the mother has not yet made sufficient antibodies to protect her fetus—may lead to congenital HSV infection. This can seriously damage the newborn's eyes, central nervous system, and internal organs, lead to mental retardation and, rarely, death.

Genital or venereal **warts** are caused by some types of human papillomavirus (HPV). At least 20 million Americans are infected and about 5.5 million new cases are reported annually. **Genital warts** are highly infectious and tend to grow faster during pregnancy. If vaginal warts are very large they may interfere with the infant's passage through the birth canal, necessitating a **cesarean section** (C-section).

An estimated 8,000 pregnant women are infected with **hepatitis B** in the United States every year. They are at risk for premature delivery and, if untreated, newborns may develop chronic **liver disease**.

Causes and symptoms

Toxoplasmosis

The single-celled protozoan *Toxoplasma gondii* produces eggs in cat intestines. The eggs shed in cat feces and can survive for up to 18 months in the soil. Human infection occurs from handling contaminated soil or feces or by ingesting raw or undercooked meat from infected animals.

Although the symptoms of toxoplasmosis usually are very mild or absent, infection occurring early in fetal development can cause:

- premature birth and low birth weight—under 5 lb (2.3 kg)
- slow growth
- fever
- skin rashes
- easy bruising
- anemia
- a small or large head (microcephaly or macrocephaly)
- fluid in the cavities of the brain (hydrocephaly)
- inflammation of the brain, heart, or lungs
- severe or prolonged jaundice
- an enlarged liver and spleen
- an eye inflammation called choriorectinitis, which can lead to blindness
- severe illness or death shortly after birth

Symptoms of congenital toxoplasmosis may appear months or years after birth and may include seizures or other neurological problems, **visual impairment**, **hearing loss**, or mental retardation.

Viral respiratory infections

Although most CMV-infected newborns have no symptoms, 10-15% may exhibit:

- low birth weight
- rashes
- small bruises
- jaundice
- enlarged liver and spleen
- hernias in the groin
- microcephaly or hydrocephaly
- respiratory problems
- brain damage

From 0.5-15% of CMV-infected infants develop hearing, vision, or neurological problems over several years. In addition to crossing the placenta, there is a 1% risk of perinatal CMV transmission.

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Symptoms of congenital fifth disease include:

- bright red rash on the cheeks
- lacy, red rash on the neck, trunk, and legs
- joint pain
- fatigue
- malaise

Varicella syndrome in a newborn is characterized by abnormally small limbs and head, scarring of the skin, eye defects, and mental retardation.

In addition to various birth defects, newborns infected with rubella early in the pregnancy may have:

- low birth weight
- bruising
- bluish-red skin lesions
- enlarged lymph nodes
- enlarged liver and spleen
- brain inflammation
- pneumonia

Bacterial infections

Although most GBS carriers have no symptoms, GBS in pregnant women may cause bladder or urinary tract infections, infection of the womb, or stillbirth.

Pregnant women are more likely to transmit GBS to their fetuses if they:

- previously delivered a GBS-infected baby
- have a urinary tract infection caused by GBS
- carry GBS late in pregnancy
- begin labor or membrane rupture before 37 weeks of gestation
- have membrane rupture 18 hours or more before delivery
- experience fever during labor

Symptoms of congenital GBS infection include breathing difficulties, **shock**, sepsis, pneumonia, and **meningitis**.

Listeriosis may cause flu-like symptoms and the infection can be transmitted prenatally even if the mother has no symptoms.

Symptoms of salmonellosis can be severe in pregnant women and newborns and may include **diarrhea**, **fever**, abdominal cramps, and rarely, meningitis.

Syphilis can be transmitted to a fetus either prenatally or perinatally if the mother is infected during pregnancy or was inadequately treated for a past infection. In adults, syphilis usually causes genital lesions 10-90 days after exposure, with a rash developing six weeks later. Symptoms may go unnoticed. Congenital syphilis can cause premature birth or stillbirth.

A surviving newborn with untreated congenital syphilis may have no initial symptoms but may gain little weight and, during the first month of life, develop:

- rash or small fluid-filled blisters on the palms and soles of the feet
- raised bumps around the nose, mouth, and diaper region
- cracks around the mouth
- nasal discharge of mucus, pus, or blood
- enlarged lymph nodes, liver, and spleen
- bone inflammation
- rarely, meningitis

Early-stage symptoms of congenital syphilis include:

- failure to thrive
- fever
- severe congenital pneumonia
- rash and lesions around the mouth, genitalia, and anus
- bone lesions
- nose cartilage infection or saddle nose (lacking a bridge)

Symptoms of late-stage congenital syphilis include:

- copper-colored rashes on the face, palms, and soles
- scarring around earlier lesions
- gray patches on the anus or outer vagina
- notched or peg-shaped teeth
- joint swelling
- bone pain
- abnormalities in the lower leg bones
- neurological conditions
- visual loss or blindness
- hearing loss or deafness

Both **gonorrhea** and chlamydia can be transmitted perinatally. **Conjunctivitis** caused by gonorrhea usually appears two to seven days after birth. Conjunctivitis caused by chlamydia usually appears 5–12 days after birth, although sometimes it takes six weeks to develop.

Symptoms of gonorrhea in women, if present, may include:

- bleeding during vaginal intercourse
- pain or burning with urination

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- yellow or bloody vaginal discharge
- pelvic inflammatory disease

Sexually transmitted viral infections

HIV can be transmitted through the placenta, during labor and delivery, and through breast milk. HIV-infected infants do not have symptoms at birth; although about 15% develop serious symptoms or die within the first year. Almost one-half die by the age of 10.

The risk of maternal HIV transmission is increased by the mother's use of illicit drugs, the amount of HIV in the mother (viral load), severe inflammation of the fetal membranes, and a prolonged period between membrane rupture and delivery.

Most women carrying HSV never have recognizable symptoms; however a first episode of genital herpes during pregnancy can be passed to the fetus and may cause premature birth. Both HSV-1 and HSV-2 can be transmitted during birth if the mother has active genital sores, causing facial or genital herpes in the newborn.

Initial symptoms of congenital herpes usually appear within four weeks of birth and may be quite mild:

- blisters on the skin
- fever
- tiredness
- loss of appetite

More serious symptoms of congenital HSV infection include:

- a skin rash with small fluid-filled blisters
- chronic or recurring eye and skin infections
- cataracts
- widespread infection affecting many organs including the lungs and liver
- a life-threatening brain infection called herpes encephalitis

Nearly 50% of women infected with HPV have no symptoms, but genital warts may appear weeks or months after infection. They can become larger during pregnancy causing difficulty with urination. Vaginal warts can reduce the elasticity of the vagina and cause obstruction during delivery. Symptoms of congenital HPV infection may include lung infection and obstructed air passages from warts inside the windpipe.

Hepatitis B can be transmitted to the fetus through the placenta, but most often it is transmitted perinatally. Since the virus is thought to pass through the umbilical cord, C-sections do not prevent transmission. Congenital hepatitis B can cause chronic liver infection, but symptoms are typically not apparent until young adulthood.

Diagnosis

Diagnosis of maternal, fetal, or congenital infection can be difficult. An obstetrician may diagnose a maternal infection based on the woman's symptoms and blood tests. Sometimes a fetal infection can be diagnosed using ultrasound. Diagnosis of congenital infections in newborns may be based on a **physical examination**, symptoms, and blood or urine tests. Ultrasound scanning may be used to image the newborn's brain and **echocardiography** may be used to diagnose heart problems.

Toxoplasmosis

Prenatal toxoplasmosis can be determined by a blood test for maternal antibodies, testing of the amniotic fluid and fetal blood, or during fetal ultrasound.

Postnatal diagnosis for congenital toxoplasmosis involves antibody tests of the cord blood and cerebrospinal fluid, an ophthalmologic and neurological examination, and a computed axial tomography (CT or CAT) scan.

A 2005 study advised that all pregnant women and newborns have blood screenings for toxoplasmosis.

Viral and bacterial infections

Blood tests can be used to diagnose listeriosis and to check for maternal antibodies against CMV or fifth disease. Ultrasound may be used for fetal fifth disease. GBS is diagnosed using bacterial cultures from blood, spinal fluid, skin, the vagina, or rectum.

Sexually transmitted infections (STIs)

The CDC recommends that all pregnant women be screened on their first prenatal visit for syphilis, gonorrhea, chlamydia, HIV, hepatitis B, and **hepatitis C**.

Infants are tested for syphilis at birth. Syphilis in an older infant may be diagnosed by a blood test, a **lumbar puncture** to look for signs of syphilis in the brain and central nervous system, an ophthalmologic examination, dark-field microscopy to visualize the spirochete, or **bone x rays**.

Maternal gonorrhea can be diagnosed by staining or culturing a cervical smear or testing for the bacterial DNA in a urine or cervical sample.

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KEY TERMS

Antibody—A blood protein produced in response to a specific foreign substance including bacteria, viruses, and parasites; the antibody destroys the organism, providing protection against disease.

Cesarean section; C-section—Incision through the abdominal and uterine walls to deliver the fetus.

Conjunctivitis—An inflammation of the eye that can be caused by gonorrhea or chlamydia.

Cytomegalovirus (CMV)—A common human herpes virus that is normally not harmful but may cause severe complications if transmitted to a fetus.

Fifth disease—Erythema infectiosum; a common respiratory infection among children caused by parvovirus B19 that usually is not serious but can cause fetal complications.

Group B streptococcal (GBS) disease—A common bacterial infection that is potentially life-threatening if transmitted to a fetus during early pregnancy or birth.

Herpes simplex virus (HSV)—A very common sexually transmitted infection; type-2 HSV causes genital herpes and type-1 HSV usually causes cold sores but can cause genital herpes; congenital HSV can be transmitted to the fetus during birth if the mother has an active infection.

Human papillomavirus (HPV)—A large family of viruses, some of which cause genital warts; HPV can be transmitted to a fetus during birth.

Immune globulin—Serum containing antibodies against a specific infection.

Listeriosis—A food-borne bacterial infection caused by *Listeria monocytogenes* to which pregnant women are particularly susceptible.

Meningitis—An inflammation of the membranes covering the brain and spinal cord that can be caused by various congenital infections.

Perinatal infection—A maternal infection that is transmitted to the fetus after membrane rupture or during labor or delivery.

Placenta—The uterine organ that provides nourishment to the fetus.

Prenatal infection—A maternal infection that is transmitted to the fetus through the placenta.

Rubella—Also called German measles or three-day measles; a viral infection that causes death or severe birth defects if transmitted to the fetus during the first 10 weeks of gestation.

Salmonellosis—Food poisoning; an infection by bacteria of the genus *Salmonella* that usually causes severe diarrhea and may be transmitted to the fetus.

Sepsis—A systemic or body-wide response to infection.

Sexually transmitted infection (STI)—An infectious disease that is transmitted through sexual activity.

Ultrasound—High-frequency sound waves that are used to visualize parts of the body or a fetus in the womb.

Varicella—Chickenpox; a disease caused by the *Varicella zoster* virus—human herpes virus 3—that can cause severe birth defects if transmitted to the fetus during the first 20 weeks of pregnancy and newborn complications if it is transmitted perinatally.

Women who were not screened for HIV during pregnancy may be screened during labor or delivery with a rapid test. The most common screening for HIV tests for antibodies in the blood; however, most infants born to infected mothers test positive for 6-18 months because of the presence of maternal antibodies. An HIV blood test performed within 48 hours of birth detects only about 40% of infections, so testing is repeated at one and six months.

An HSV culture from an affected genital site—preferably on the first day of the outbreak—can test for herpes simplex. A blood test can show if a person has ever been infected with HSV and may distinguish between HSV-1 and HSV-2 and old or recently acquired infections. An examination or test can indicate whether a pregnant woman has active genital herpes near the time of delivery.

Genital warts are diagnosed visually. Vinegar may whiten infected areas to make them more visible. Cervical warts can be diagnosed by removing a piece of tissue for microscopic examination.

Treatment

Infants born with serious infections are treated in the neonatal care unit with intravenous drugs. Infants born to infected mothers may be treated with medications even if they show few or no signs of infection.

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Toxoplasmosis

Maternal toxoplasmosis is treated with spiramycin during the first and early second trimesters of pregnancy. Fetal toxoplasmosis may be treated by giving the mother pyrimethamine and **sulfonamides** such as sulfadiazine during the later second and third trimesters.

Newborns with symptoms of toxoplasmosis are treated with pyrimethamine and sulfadiazine for one year; leucovorin for one year to protect the bone marrow from pyrimethamine toxicity; **corticosteroids** for heart, lung, or eye inflammations; clindamycin; and a corticosteroid to reduce the inflammation of chorioretinitis.

Viral respiratory infections

There is no effective treatment for CMV, although ganciclovir may be used to treat some symptoms.

Fetal anemia caused by fifth disease may resolve on its own. If the fetus is at risk for heart failure, a fetal blood **transfusion** may be performed. The mother also may receive medication that passes through the placenta to the fetus.

Exposure to chickenpox or rubella by a nonimmune pregnant woman may be treated with an injection of immune globulin to help prevent fetal transmission. Congenital chickenpox is treated immediately to prevent serious complications or death. There is no specific treatment for rubella infection.

Bacterial infections

Pregnant women with GBS in their urine are treated with penicillin. Most GBS-carriers are treated with intravenous antibiotics from membrane rupture through labor to prevent fetal transmission. Infants born with congenital GBS infections are treated immediately with intravenous antibiotics.

Maternal and congenital listeriosis and syphilis are treated with antibiotics.

Maternal gonorrhea may be treated with cefixime, ceftriaxone, or levofloxacin. Since women often are infected with both gonorrhea and chlamydia, a combination of antibiotics such as ceftriaxone and doxycycline or azithromycin are used to treat both infections.

An antibiotic ointment such as silver nitrate is placed under the eyelids of all newborns as preventative treatment for gonorrhea. An infant born to a gonorrhea-infected mother is treated with penicillin. Conjunctivitis caused by gonorrhea is treated with an eye ointment containing polymyxin and bacitracin, erythromycin, or tetracycline. An antibiotic such as ceftriaxone is given intravenously. Congenital chlamydia is treated with erythromycin eye ointment and oral tablets.

Viral STIs

Women who are being treated for HIV with combination drugs may stop treatment for the first trimester of pregnancy to avoid the risk of birth defects and to avoid missing doses due to **vomiting**, which can cause the growth of drug-resistant HIV strains. The side effects of the anti-retroviral drugs may worsen during pregnancy, but stopping treatment can worsen a woman's condition.

Zidovudine (ZDV, AZT, Retrovir) is the only drug that has been proven to help prevent fetal HIV infection. HIV-positive pregnant women usually take ZDV from 14-34 weeks of gestation. During delivery the mother receives ZDV intravenously. The newborn is given liquid ZDV every six hours for six weeks. A 2004 study of HIV-positive Thai women found that oral ZDV beginning at 28 weeks of gestation, with a single dose of nevirapine during labor, greatly reduces HIV transmission.

Pneumonia caused by *Pneumocystis carinii* often is the first AIDS-related illness to appear in HIV-infected infants and is a major cause of death during the first year. The CDC recommends that all babies born to HIV-infected mothers be treated with anti-pneumonia drugs beginning at 4–6 weeks and continuing until the infant is found to be HIV-negative.

Outbreaks of genital herpes just prior to delivery may be prevented by acyclovir (Zovirax), famciclovir (Famvir), or valacyclover (Valtrex). An HSV-infected newborn is treated immediately with intravenous **antiviral drugs** such as acyclovir. Eye infections are treated with trifluridine drops.

There is no cure for HPV and treatment during pregnancy often is ineffective, although it may include:

- Imiquimod cream
- 5% 5-fluorouracil cream
- trichloroacetic acid
- freezing or burning the warts with a laser
- surgical removal
- alpha interferon injected into the wart

HPV infection in newborns is treated by surgically removing the warts. If the warts obstruct breathing passages, frequent **laser surgery** is required. Interferon may be used to reduce the likelihood of recurrence.

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Non-infected pregnant women may begin the hepatitis B vaccine series if they are at high-risk for infection. Infants born to mothers infected with hepatitis B are given both the first dose of hepatitis B vaccine and hepatitis B immune globulin within 12 hours of birth. The second and third doses of vaccine are given at one month and six months of age.

Prognosis

Maternal treatment with spiramycin for toxoplasmosis infection occurring within the first two weeks of pregnancy prevents transmission to the fetus. The prognosis for congenital toxoplasmosis depends on its severity.

Most infants with congenital CMV survive with treatment, but almost all are affected by its effects.

A GBS-carrier's risk of delivering an infected child decreases from one in 200 to one in 4,000 if she is treated with antibiotics. GBS-infected mothers are less likely to infect their newborns if treated with antibiotics during labor. Immediate penicillin treatment for GBS-infected newborns is very effective, but about 5% of GBS-infected newborns die.

Many fetuses infected with syphilis early in gestation are stillborn. Nearly 50% of untreated fetuses die shortly before or after birth. The fetus is at minimal risk if the mother receives adequate treatment with penicillin during pregnancy.

Pregnant women on combined antiretroviral therapy are at a 1–2% risk of transmitting HIV to the fetus. If the mother's viral load is under 1,000 and she is treated with ZDV, the risk of transmission is almost zero. Mothers with a high viral load may reduce the risk of transmission by having a C-section before labor begins and the membranes rupture. Congenital HIV infection that is treated with combination drugs, including **protease inhibitors**, may reduce the risk of death by 67%.

Women with an active HSV infection can reduce the risk of fetal transmission with a C-section. Although immediate medication for the newborn may prevent or reduce the damage from HSV, half of infants born with widespread HSV infections die and the other half may have brain damage.

Infants born to hepatitis B-infected mothers have a greater-than-95% chance of being protected against the virus if they receive the first dose of vaccine and immune globulin within 12 hours of birth.

Prevention

General advice for preventing infection during pregnancy includes:

- good hygiene—including frequent thorough hand washing and not sharing food or drinks—particularly for mothers who have or work with young children and may be at risk for CMV
- vaccinations several months before a planned pregnancy
- appropriate vaccinations after the first trimester of pregnancy
- contacting a healthcare provider immediately upon being exposed to a transmittable infection

To avoid *Taxoplasma* during pregnancy women should:

- keep cats indoors
- avoid handling cat litter without rubber gloves and wash thoroughly
- disinfect the cat box with boiling water for five minutes
- cover sandboxes
- wear gloves for gardening and wash afterward
- avoid insects that may have been exposed to cat feces
- wash after handling cats, raw meat or poultry, soil, or sand
- avoid raw or undercooked meat and poultry, unwashed fruits and vegetables, raw eggs, and unpasteurized milk
- kill *Taxoplasma* by freezing food or cooking it thoroughly

All non-immune women of childbearing age should be vaccinated against rubella and chickenpox before pregnancy. Pregnant women should be tested for immunity to rubella at their first prenatal visit.

Women should be tested for GBS between 35 and 37 weeks of pregnancy to determine whether the bacteria are likely to be present at delivery.

Since *Listeria* can grow at temperatures below 40°F (4°C), pregnant women should handle food cautiously and avoid:

- hot dogs, luncheon, and deli meats unless they are reheated to steaming
- soft cheeses
- refrigerated meat spreads
- refrigerated smoked seafood unless it is in a cooked dish
- raw unpasteurized milk

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Pregnant women should use precooked or ready-to-eat perishables immediately, clean the refrigerator regularly, and keep the refrigerator at or below 40°F (4°C).

Salmonellosis may be prevented by:

- cooking all meat, poultry, seafood, and eggs thoroughly
- avoiding sushi containing raw fish
- washing raw vegetables thoroughly
- avoiding unpasteurized milk, soft cheeses, and alfalfa sprouts

STIs can be prevented by abstaining from sexual contact outside of a mutually monogamous relationship using latex **condoms** correctly and consistently, and avoiding blood-contaminated needles, razors, or other items.

Precautions for preventing fetal exposure to HIV-infected maternal blood include avoiding **amniocentesis**, fetal scalp blood sampling, and premature rupturing of the fetal membranes.

Prevention of maternal to fetal HSV transmission includes:

- abstaining from sexual activity during the last trimester of pregnancy or if there are signs of an outbreak or visible sores
- using a condom even if no symptoms are present
- postponing membrane rupture
- avoiding a fetal monitor that makes tiny punctures in the scalp
- avoiding vacuum or forceps deliveries that cause breaks in the infant's scalp

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ORGANIZATIONS

American College of Obstetricians and Gynecologists, 409 12th St. SW, PO Box 96920, Washington, DC, 20080-6920, (202) 863-2518, http://www.acog.org.

American Social Health Association, PO Box 13827, Research Triangle Park, NC, 27709-3827, (919) 361-8400, http://www.ashastd.org.

Association of Women's Health, Obstetric and Neonatal Nurses, 2000 L Street NW, Suite 740, Washington, DC, 20036, (202) 261-2400, (800) 673-8499, http://www.awhonn.org.

Centers for Disease Control and Prevention, 1600 Clifton Road, Atlanta, GA, 30333, (888) 232-3228, http://www.cdc.gov.

Hepatitis B Foundation, 700 East Butler Avenue, Doylestown, PA, 18901-3697, (215) 489-4900, http://www.hepb.org.

March of Dimes Birth Defects Foundation, 1275 Mamaroneck Avenue, White Plains, NY, 10605, (914) 997-4488, http://www.marchofdimes.com.

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Mathematics disorder *see* **Learning disorders**

Maxillofacial trauma

Definition

Maxillofacial trauma refers to any injury to the face or jaw caused by physical force, **foreign objects**, or **burns**.

Face of an elderly woman suffering from maxillofacial trauma. *(Dr. P. Marazzi/Photo Researchers, Inc.)*

Description

Maxillofacial trauma includes injuries to any of the bony or fleshy structures of the face.

Any part of the face may be affected. Teeth may be knocked out or loosened. The eyes and their muscles, nerves, and blood vessels may be injured as well as the eye socket (orbit), which can be fractured by a forceful blow. The lower jaw (mandible) may be dislocated by force. Although anchored by strong muscles for chewing, the jaw is unstable in comparison with other bones and is easily dislocated from the temporomandibular joints that attach it to the skull. A fractured nose or jaw may affect the ability to breathe or eat. Any maxillofacial trauma may also prevent the passage of air or be severe enough to cause a **concussion** or more serious brain injury.

Athletes are particularly at risk of maxillofacial injuries. Boxers suffer repeated blows to the face and occasional knockouts (traumatic brain injury). Football, basketball, hockey, and soccer players, and many other athletes are at risk for milder forms of brain injury called concussions. There are an estimated 300,000 cases every year. Overall, there are one million new traumatic brain injuries every year, causing 50,000 deaths. Of the rest, seven to nine percent are left with long–term disability.

Burns to the face are also categorized as maxillofacial trauma.

Causes and symptoms

There are no reliable statistics on the incidence of maxillofacial trauma because there are so many types, and many are not reported. Automobile accidents are a major cause of maxillofacial trauma, as is participation in sports, fights, and other violent acts. Another cause of such injuries is being hit by an object accidentally, for instance being hit by a baseball while watching a game. People most at risk are athletes, anyone who drives a vehicle or rides in one, and those who do dangerous work or engage in aggressive types of behavior.

One study reported in August 2000 that 42% of all facial **fractures** resulted from sports activity.

The major symptoms of most facial injuries are **pain**, swelling, bleeding, and bruising, although a fractured jaw also prevents the person from working his or her jaw properly, and symptoms of a fractured nose also include black eyes and possible blockage of the airway due to swelling and bleeding.

Symptoms of eye injury or orbital fracture can include blurred or double vision, decreased mobility

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of the eye, and **numbness** in the area of the eye. In severe injuries there can be temporary or permanent loss of vision.

Burn symptoms are pain, redness, and possibly blisters, **fever**, and **headache**. Extensive burns can cause the victim to go into **shock**. In that situation, he or she has low blood pressure and a rapid pulse.

Symptoms of traumatic brain injury include problems with thinking, memory, and judgment as well as mood swings, and difficulty with coordination and balance. These symptoms linger for weeks or months, and in severe cases can be permanent. Double vision for months after an injury is not uncommon.

Diagnosis

Trauma is usually diagnosed in an emergency room or physician's office by **physical examination** and/or x ray. Some injuries require diagnosis by a specialist. A detailed report of how the injury occurred is also taken. In some cases, diagnosis cannot be made until swelling subsides.

Treatment

Treatment varies, depending on the type and extent of the injury.

Dislocation of the jaw can be treated by a primary care physician by exerting pressure in the proper manner. If muscle spasm prevents the jaw from moving back into alignment, a sedative is administered intravenously (IV) to relax the muscles. Afterward, the patient must avoid opening the jaw wide as he or she will be prone to repeat **dislocations**.

A jaw fracture may be minor enough to heal with simple limitation of movement and time. More serious fractures require complicated, multi–step treatment. The jaw must be surgically immobilized by a qualified oral or maxillofacial surgeon or an otolaryngologist. The jaw is properly aligned and secured with metal pins and wires. Proper alignment is necessary to ensure that the bite is correct. If the bite is off, the patient may develop a painful disorder called temporomandibular joint syndrome.

During the weeks of healing the patient is limited to a liquid diet sipped through a straw and must be careful not to choke or vomit since he or she cannot open the mouth to expel the vomitus. The surgeon will prescribe pain relievers and perhaps **muscle relaxants**. Healing time varies according to the patient's overall health, but will take at least several weeks.

Another common maxillofacial fracture is a broken nose. The bones that form the bridge of the nose may be fractured, but cartilage may also be damaged, particularly the nasal septum which divides the nose. If hit from the side, the bones and cartilage are displaced to the side, but if hit from the front, they are splayed out. Severe swelling can inhibit diagnosis and treatment. Mild trauma to the nose can sometimes heal without the person' being aware of the fracture unless there is obvious deformity. The nose will be tender for at least three weeks.

Either before the swelling begins or after it subsides, some 10 days after the injury, the doctor can assess the extent of the damage. Physical examination of the inside using a speculum and the outside, in addition to a detailed history of how the injury occurred will determine appropriate treatment. The doctor should be informed of any previous nasal fractures, nasal surgery, or chronic disease such as **osteoporosis**. Sometimes an x ray is useful, but it is not always required.

A primary care physician may treat a nasal fracture, but if there is extensive damage or the air passage is blocked, the physician will refer the patient to an otolaryngologist or a plastic surgeon for treatment. Initially the nose may be packed to control bleeding and hold the shape. It is reset under anesthesia. A protective shield or bandage may be placed over it while the fracture heals.

In the case of orbital fractures, there is great danger of permanent damage to vision. Double vision and decreased mobility of the eye are common complications. Surgical reconstruction may be required if the fracture changes the position of the eye or there is other facial deformity. Treatment requires a maxillofacial surgeon.

When the eyes have been exposed to chemicals, they must be washed out for 15 minutes with clear water. **Contact lenses** may be removed only after rinsing the eyes. The eyes should then be kept covered until the person can be evaluated by a primary care physician or ophthalmologist.

When a foreign object is lodged in the eye, the person should not rub the eye or put pressure on it, which would further injure the eyeball. The eye should be covered to protect it until medical attention can be obtained.

Several kinds of traumatic injuries can occur to the mouth. A person can suffer a laceration (cut) to the lips or tongue, or loosening of teeth, or have teeth knocked out. Such injuries often accompany a jaw fracture or other facial injury. **Wounds** to the soft

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KEY TERMS

Corneal abrasion—A scratch on the surface of the eyeball.

Mandible—The lower jaw, a U–shaped bone attached to the skull at the temporomandibular joints.

Maxilla—The bone of the upper jaw, which serves as a foundation of the face and supports the orbits.

Nasal septum—The cartilage that divides the nose in half.

Orbit—The eye socket, which contains the eyeball, muscles, nerves, and blood vessels that serve the eye.

Otolaryngologist—Ear, nose, and throat specialist.

Shock—A reduction of blood flow in the body caused by loss of blood and/or fluids. Can be fatal if not treated quickly.

Temporomandibular joint (TMJ)—The mandible attaches to the temporal bone of the skull and works like a hinge.

Temporomandibular joint syndrome (TMJ syndrome)—An incorrect alignment of the lower jaw to the skull that causes the bite to be off line. It causes chronic headaches, nausea, and other symptoms.

Vermilion border—The line between the lip and the skin.

tissues of the mouth bleed freely, but the plentiful blood supply that leads to this heavy bleeding also helps healing. It is important to clean the wound thoroughly with salt water or hydrogen peroxide rinse to prevent infection. Large cuts may require sutures, and should be done by a maxillofacial surgeon for a good cosmetic result, particularly when the laceration is on the edge of the lip line (vermilion). The doctor will prescribe an antibiotic because there is normally a large amount of bacteria present in the mouth.

Any injury to the teeth should be evaluated by a dentist for treatment and prevention of infection. Implantation of a tooth is sometimes possible if it has been handled carefully and protected. The tooth should be held by the crown, not the root, and kept in milk, saline, or contact lens fluid. The patient's dentist can refer him or her to a specialist in this field.

For first degree burns, put a cold–water compress on the area or run cold water on it. Put a clean bandage on it for protection. Second and third degree burn victims must be taken to the hospital for treatment.

Fluids are replaced there through an IV. This is vital since a patient in shock will die unless lost fluids are replaced quickly. **Antibiotics** are given to combat infection since burns make the body vulnerable to infection.

Treatment for a **head injury** requires examination by a primary care physician unless symptoms point to a more serious injury. In that case, the victim must seek emergency care. A concussion is treated with rest and avoidance of contact sports. Very often athletes who have suffered a concussion are allowed to play again too soon, perhaps in the mistaken impression that the injury is not so bad if the player did not lose consciousness. Anyone who has had one concussion is at increased risk of another one.

Danger signs that the injury is more serious include worsening headaches, **vomiting**, weakness, numbness, unsteadiness, change in the appearance of the eyes, seizures, slurred speech, confusion, agitation, or the victim will not wake up. These signs require immediate transport to the hospital. A neurologist will evaluate the situation, usually with a CT scan. A stay in a **rehabilitation** facility may become necessary.

Alternative treatments

Fractures, burns, and deep lacerations require treatment by a doctor but alternative treatments can help the body withstand injury and assist the healing process. **Calcium**, **minerals**, **vitamins**, all part of a balanced and nutrient–rich diet, as well as regular **exercise**, build strong bones that can withstand force well. After an injury, **craniosacral therapy** may help healing and ease the headaches that follow a concussion or other head trauma. A physical therapist can offer ultrasound that raises temperature to ease pain, or **biofeedback** in which the patient learns how to tense and relax muscles to relieve pain. **Hydrotherapy** may ease the **stress** of recovering from trauma. Chinese medicine seeks to reconnect the chi along the body's meridians and thus aid healing. Homeopathic physicians may prescribe natural medicines such as Arnica or Symphytum to enhance healing.

Prognosis

When appropriate treatment is obtained quickly after an injury, the prognosis can be excellent. However, if the victim of trauma has osteoporosis or a

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debilitating chronic disease, healing is more problematic. Healing also depends upon the extent of the injury. An automobile accident or a gunshot wound, for example, can cause severe facial trauma that may require multiple surgical procedures and a considerable amount of time to heal. Burns and lacerations cause scarring that might be improved by **plastic surgery**.

Prevention

Safety equipment is vital to preventing maxillofacial trauma from automobile accidents and sports. Here is a partial list of equipment people should always use:

- seat belts
- automobile air bags
- approved child safety seats
- helmets for riding motorcycles or bicycles, skateboarding, snowboarding, and other sports
- safety glasses for the job, yard work, sports
- other approved safety equipment for sports, such as mouthguards, masks, and goggles

Resources

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ORGANIZATIONS

American Association of Oral and Maxillofacial Surgeons (AAOMS), 9700 W. Bryn Mawr Ave., Rosemont, IL, 60018, (847) 678–6200, http://www.aaoms.org.

Brain Injury Association, Inc., 105 N. Alfred St., Alexandria, VA, 22314, (703) 236–6000, http://www.biausa.org.

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MCS syndrome *see* **Multiple chemical sensitivity**

MD *see* **Muscular dystrophy**

Measles

Definition

Measles is an infection caused by a virus, which causes an illness displaying a characteristic skin rash known as an exanthem. Measles is also sometimes called rubeola, 5-day measles, or hard measles.

Description

Measles infections appear all over the world. Prior to the current effective immunization program, large-scale measles outbreaks occurred on a two to three-year cycle, usually in the winter and spring. Smaller outbreaks occurred during the off-years. Babies up to about eight months of age are usually protected from contracting measles, due to immune cells they receive from their mothers in the uterus. Once someone has had measles infection, he or she can never get it again.

Causes and symptoms

Measles is caused by a type of virus called a paramyxovirus. It is an extremely contagious infection, spread through the tiny droplets that may spray into the air when an individual carrying the virus sneezes or coughs. About 85% of those people exposed to the virus will become infected with it. About 95% of those people infected with the virus will develop the illness called measles. Once someone is infected with the virus, it takes about 7–18 days before he or she actually becomes ill. The most contagious time period is the three to five days before symptoms begin through about four days after the characteristic measles rash has begun to appear.

Measles on child's face. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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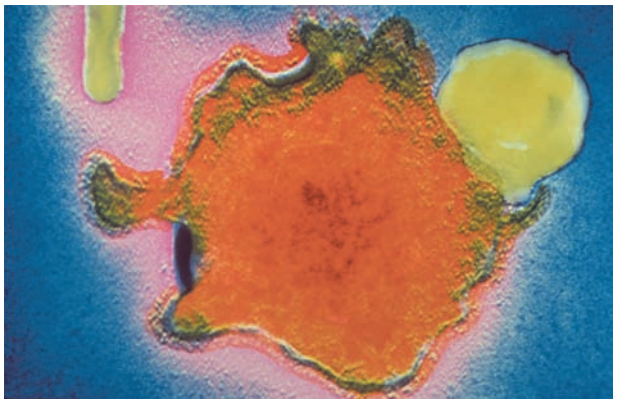

A transmission electron microscopy (TEM) image of a single measles virion. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

The first signs of measles infection are **fever**, extremely runny nose, red, runny eyes, and a **cough**. A few days later, a rash appears in the mouth, particularly on the mucous membrane which lines the cheeks. This rash consists of tiny white dots (like grains of salt or sand) on a reddish bump. These are called Koplik's spots, and are unique to measles infection. The throat becomes red, swollen, and sore.

A couple of days after the appearance of the Koplik's spots, the measles rash begins. It appears in a characteristic progression, from the head, face, and neck, to the trunk, then abdomen, and next out along the arms and legs. The rash starts out as flat, red patches, but eventually develops some bumps. The rash may be somewhat itchy. When the rash begins to appear, the fever usually climbs higher, sometimes reaching as high as 105°F (40.5°C). There may be **nausea**, **vomiting**, **diarrhea**, and multiple swollen lymph nodes. The cough is usually more problematic at this point, and the patient feels awful. The rash usually lasts about five days. As it fades, it turns a brownish color, and eventually the affected skin becomes dry and flaky.

Many patients (about 5–15%) develop other complications. Bacterial infections, such as ear infections, sinus infections, and **pneumonia** are common, especially in children. Other viral infections may also strike the patient, including **croup**, **bronchitis**, **laryngitis**, or viral pneumonia. Inflammation of the liver, appendix, intestine, or lymph nodes within the abdomen may cause other complications. Rarely, inflammations of the heart or kidneys, a drop in **platelet count** (causing episodes of difficult-to-control bleeding), or reactivation of an old **tuberculosis** infection can occur.

An extremely serious complication of measles infection is swelling of the brain. Called **encephalitis**, this can occur up to several weeks after the basic measles symptoms have resolved. About one out of every thousand patients develops this complication, and about 10-15% of these patients die. Symptoms include fever, **headache**, sleepiness, seizures, and **coma**. Long-term problems following recovery from measles encephalitis may include seizures and **mental retardation**.

A very rare complication of measles can occur up to 10 years following the initial infection. Called **subacute sclerosing panencephalitis**, this is a slowly progressing, smoldering swelling and destruction of the entire brain. It is most common among people who had measles infection prior to the age of two years. Symptoms include changes in personality, decreased intelligence with accompanying school problems, decreased coordination, involuntary jerks and movements of the body. The disease progresses so that the individual becomes increasingly dependent, ultimately becoming bedridden and unaware of his or her surroundings. Blindness may develop, and the temperature may spike (rise rapidly) and fall unpredictably as the brain structures responsible for temperature regulation are affected. **Death** is inevitable.

Measles during **pregnancy** is a serious disease, leading to increased risk of a **miscarriage** or **stillbirth**. In addition, the mother's illness may progress to pneumonia.

Diagnosis

Measles infection is almost always diagnosed based on its characteristic symptoms, including Koplik's spots, and a rash which spreads from central body structures out toward the arms and legs. If there is any doubt as to the diagnosis, then a specimen of body fluids (mucus, urine) can be collected and combined with fluorescent-tagged measles virus antibodies. Antibodies are produced by the body's immune cells that can recognize and bind to markers (antigens) on the outside of specific organisms, in this case the measles virus. Once the fluorescent antibodies have attached themselves to the measles antigens in the specimen, the specimen can be viewed under a special microscope to verify the presence of measles virus.

Treatment

There are no treatments available to stop measles infection. Treatment is primarily aimed at helping the patient to be as comfortable as possible, and watching

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KEY TERMS

Antibodies—Cells made by the immune system which have the ability to recognize foreign invaders (bacteria, viruses), and thus stimulate the immune system to kill them.

Antigens—Markers on the outside of such organisms as bacteria and viruses, which allow antibodies to recognize foreign invaders.

Encephalitis—Swelling, inflammation of the brain.

Exanthem (plural, exanthems or exanthemata)—A skin eruption regarded as a characteristic sign of such diseases as measles, German measles, and scarlet fever.

Koplik's spots—Tiny spots occurring inside the mouth, especially on the inside of the cheek. These spots consist of minuscule white dots (like grains of salt or sand) set onto a reddened bump. Unique to measles.

carefully so that **antibiotics** can be started promptly if a bacterial infection develops. Fever and discomfort can be treated with **acetaminophen**. Children with measles should never be given **aspirin**, as this has caused the fatal disease **Reye's syndrome** in the past. A cool-mist vaporizer may help decrease the cough. Patients should be given a lot of liquids to drink, in order to avoid **dehydration** from the fever.

Some studies have shown that children with measles encephalitis benefit from relatively large doses of vitamin A.

Alternative treatment

Botanical immune enhancement (with **echinacea**, for example) can assist the body in working through this viral infection. Homeopathic support also can be effective throughout the course of the illness. Some specific alternative treatments to soothe patients with measles include the Chinese herbs bupleurum (*Bupleurum chinense*) and peppermint (*Mentha piperita*), as well as a preparation made from empty cicada (*Cryptotympana atrata*) shells. The itchiness of the rash can be relieved with witch hazel (*Hamamelis virginiana*), chickweed (*Stellaria media*), or oatmeal baths. The eyes can be soothed with an eyewash made from the herb eyebright (*Euphrasia officinalis*). Practitioners of **ayurvedic medicine** recommend ginger or clove tea.

Prognosis

The prognosis for an otherwise healthy, well-nourished child who contracts measles is usually quite good. In developing countries, however, death rates may reach 15–25%. Adolescents and adults usually have a more difficult course. Women who contract the disease while pregnant may give birth to a baby with hearing impairment. Although only 1 in 1,000 patients with measles will develop encephalitis, 10–15% of those who do will die, and about another 25% will be left with permanent brain damage.

Prevention

Measles is a highly preventable infection. A very effective vaccine exists, made of live measles viruses which have been treated so that they cannot cause actual infection. The important markers on the viruses are intact, however, which causes an individual's immune system to react. Immune cells called antibodies are produced, which in the event of a future infection with measles virus will quickly recognize the organism, and kill it off. Measles vaccines are usually given at about 15 months of age; because prior to that age, the baby's immune system is not mature enough to initiate a reaction strong enough to insure long-term protection from the virus. A repeat injection should be given at about 10 or 11 years of age. Outbreaks on college campuses have occurred among unimmunized or incorrectly immunized students.

Measles vaccine should not be given to a pregnant woman, however, in spite of the seriousness of gestational measles. The reason for not giving this particular vaccine during pregnancy is the risk of transmitting measles to the unborn child.

Surprisingly, new cases of measles began being reported in some countries—including Great Britain—in 2001 because of parents' fears about vaccine safety. The combined vaccine for measles, **mumps**, and **rubella** (MMR) was claimed to cause **autism** or bowel disorders in some children. However, the World Health Organization (WHO) says there is no scientific merit to these claims. The United Nations expressed concern that unwarranted fear of the vaccine would begin spreading the disease in developing countries, and ultimately in developed countries as well. Parents in Britain began demanding the measles vaccine as a separate dose and scientists were exploring that option as an alternative to the combined MMR vaccine. Unfortunately, several children died during an outbreak of measles in Dublin because they had not received the vaccine. Child mortality due to measles is considered

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largely preventable, and making the MMR vaccine widely available in developing countries is part of WHO's strategy to reduce child mortality by two-thirds by the year 2015.

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ORGANIZATIONS

American Academy of Pediatrics (AAP), 141 Northwest Point Boulevard, Elk Grove Village, IL, 60007-1098, (847) 434-4000, (847) 424-8000, kidsdocs@aap.org, http://www.aap.org.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

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Mebendazole *see* **Antihelminthic drugs**

Mechanical debridement *see* **Debridement**

Mechanical ventilation *see* **Inhalation therapies**

Meckel's diverticulum

Definition

Meckel's diverticulum is a congenital pouch (diverticulum) approximately two inches in length and located at the lower (distal) end of the small intestine. It was named for Johann F. Meckel, a German anatomist who first described the structure.

Description

The diverticulum is most easily described as a blind pouch that is a remnant of the omphalomesenteric duct or yolk sac that nourished the early embryo. It contains all layers of the intestine and may have ectopic tissue present from either the pancreas or stomach.

The rule of 2s is the classical description. It is located about 2 ft from the end of the small intestine, is often about 2 in in length, occurs in about 2% of the population, is twice as common in males as females, and can contain two types of ectopic tissue—stomach or pancreas. Many who have a Meckel's diverticulum never have trouble but those that do present in the first two decades of life and often in the first two years.

A close-up image of a patient's small intestine with a protruding sac. This condition, called Meckel's diverticulum, is a congenital abnormality occurring in 2% of the population, usually males. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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KEY TERMS

Appendectomy—The procedure to surgically remove an appendix.

Appendicitis—Inflammation of the appendix.

Appendix—A portion of intestine attached to the cecum.

Cecum—The first part of the large bowel.

Congenital—Refers to a disorder which is present at birth.

Distal—Away from the point of origin.

Ectopic—Tissue found in an abnormal location.

Intussusception—One piece of bowel inside another, causing obstruction.

Isotope—Any of two or more species of atoms of a chemical element with the same atomic number and nearly identical chemical behavior but with differing atomic mass and physical properties.

Peptic ulcer—A wound in the bowel that can be caused by stomach acid or a bacterium called *Helicobacter pylori*.

Volvulus—A twisted loop of bowel, causing obstruction.

There are three major complications that may result from the development of Meckel's diverticulum. The most common problem is inflammation or infection that mimics **appendicitis**. This diagnosis is defined at the time of surgery for suspected appendicitis. Bleeding caused by ectopic stomach tissue that results in a bleeding ulcer is the second most frequent problem. Bleeding may be brisk or massive. The third potential complication is obstruction due to **intussusception**, or a twist around a persistent connection to the abdominal wall. This problem presents as a small bowel obstruction, however, the true cause is identified at the time of surgical exploration.

Meckel's diverticulum is a developmental defect that is present in about 2% of people, but does not always cause symptoms. Meckel's diverticula (plural of diverticulum) are found twice as frequently in men as in women. Complications occur three to five times more frequently in males.

Causes and symptoms

Meckel's diverticulum is not hereditary. It is a vestigial remnant of the omphalomesenteric duct, an embryonic structure that becomes the intestine. As such, there is no genetic defect or abnormality.

Symptoms usually occur in children under 10 years of age. There may be bleeding from the rectum, **pain** and **vomiting**, or simply tiredness and weakness from unnoticed blood loss. It is common for a Meckel's diverticulum to be mistaken for the much more common disease appendicitis. If there is obstruction, the abdomen will distend and there will be cramping pain and **vomiting**.

Diagnosis

The situation may be so acute that surgery is needed on an emergency basis. This is often the case with bowel obstruction. With heavy bleeding or severe pain, whatever the cause, surgery is required. The finer points of diagnosis can be accomplished when the abdomen is open for inspection during a surgical procedure. This situation is called an acute abdomen.

If there is more time (not an emergency situation), the best way to diagnose Meckel's diverticulum is with a nuclear scan. A radioactive isotope injected into the bloodstream will accumulate at sites of bleeding or in stomach tissue. If a piece of stomach tissue or a pool of blood shows up in the lower intestine, Meckel's diverticulum is indicated.

Treatment

A Meckel's diverticulum that is causing discomfort, bleeding, or obstruction must be surgically removed. This procedure is very similar to an **appendectomy**.

Prognosis

The outcome after surgery is usually excellent. The source of bleeding, pain, or obstruction is removed so the symptoms also disappear. A Meckel's diverticulum will not return.

Resources

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"Meckel's Diverticulum." *Merck Manual*. http://www.merck.com/pubs/mmanual/section19/chapter268/268d.htm.

ORGANIZATIONS

American Academy of Family Physicians (AAFP), 11400 Tomahawk Creek Parkway, Leawood, KS, 66211-2680, (913) 906-6000, (913) 906-6075, (800) 271-2237, http://www.aafp.org/.
American Academy of Pediatrics (AAP), 141 Northwest Point Boulevard, Elk Grove Village, IL, 60007-1098, (847) 434-4000, (847) 424-8000, kidsdocs@aap.org, http://www.aap.org.
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American College of Surgeons, 633 North St. Clair St., Chicago, IL, 60611-3211, (212) 202-5000, (312) 202-5001, (800) 621-4111, postmaster@facs.org, http://www.facs.org.
American Medical Association, 515 N. State St., Chicago, IL, 60654, (800) 621-8335, http://www.ama-assn.org/.

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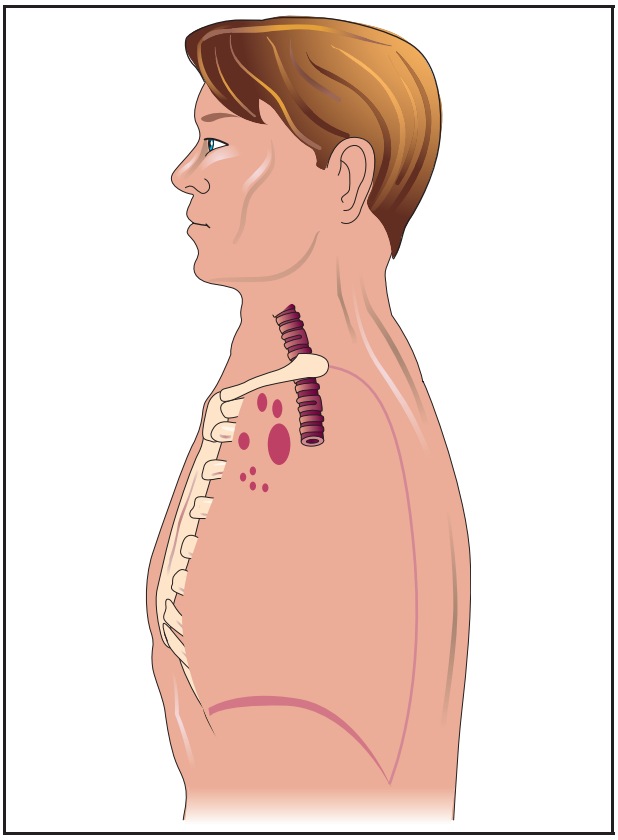
Median nerve entrapment *see* **Carpal tunnel syndrome**



Mediastinoscopy is a surgical procedure used to detect or stage lymphoma or lung cancer. In this procedure, the surgeon makes an incision below the neck and inserts a mediastinoscope (a narrow, hollow tube with an attached light) through it to reach the area behind the breastbone. The surgeon can then insert tools through the scope to collect tissue for laboratory analysis. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Mediastinoscopy

Definition

Mediastinoscopy is a surgical procedure that allows physicians to view areas of the mediastinum, the cavity behind the breastbone that lies between the lungs. The organs in the mediastinum include the heart and its vessels, the lymph nodes, trachea, esophagus, and thymus.

Mediastinoscopy is most commonly used to detect or stage **cancer**. It is also ordered to detect infection, and to confirm diagnosis of certain conditions and diseases of the respiratory organs. The procedure involves insertion of an endotracheal (within the trachea) tube, followed by a small incision in the chest. A mediastinoscope is inserted through the incision. The purpose of this equipment is to allow the physician to directly see the organs inside the mediastinum, and to collect tissue samples for laboratory study.

Purpose

Mediastinoscopy is often the diagnostic method of choice for detecting lymphoma, including Hodgkin's disease. The diagnosis of **sarcoidosis** (a chronic lung disease) and the staging of lung cancer can also be accomplished through mediastinoscopy. Lung cancer staging involves the placement of the cancer's progression into stages, or levels. These stages help a physician study cancer and provide consistent definition levels of cancer and corresponding treatments. The lymph nodes in the mediastinum are likely to show if lung cancer has spread beyond the lungs. Mediastinoscopy allows a physician to observe and extract a sample from the nodes for further study. Involvement

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of these lymph nodes indicates diagnosis and stages of lung cancer.

Mediastinoscopy may also be ordered to verify a diagnosis that was not clearly confirmed by other methods, such as certain radiographic and laboratory studies. Mediastinoscopy may also aid in certain surgical biopsies of nodes or cancerous tissue in the mediastinum. In fact, the surgeon may immediately perform a surgical procedure if a malignant tumor is confirmed while the patient is undergoing mediastinoscopy, thus combining the diagnostic exam and surgical procedure into one operation when possible.

Although still performed in 2001, advancements in computed tomography (CT) and **magnetic resonance imaging** (MRI) techniques, as well as the new developments in ultrasonography, have led to a decline in the use of mediastinoscopy. In addition, better results of fine-needle aspiration (drawing out fluid by suction) and core-needle biopsy (using a needle to obtain a small tissue sample) investigations, along with new techniques in **thoracoscopy** (examination of the thoracic cavity with a lighted instrument called a thoracoscope) offer additional options in examining mediastinal masses. Mediastinoscopy may be required, however, when these other methods cannot be used or when the results they provide are inconclusive.

Precautions

Because mediastinoscopy is a surgical procedure, it should only be performed when the benefits of the exam's findings outweigh the risks of surgery and anesthesia. Patients who previously had mediastinoscopy should not receive it again if there is scarring present from the first exam.

Several other medical conditions, such as impaired cerebral circulation, obstruction or distortion of the upper airway, or thoracic **aortic aneurysm** (abnormal dilation of the thoracic aorta) may also preclude mediastinoscopy. Anatomic structures that can be compressed by the mediastinoscope may complicate these pre-existing medical conditions.

Description

Mediastinoscopy is usually performed in a hospital under **general anesthesia**. An endotracheal tube is inserted first, after **local anesthesia** is applied to the throat. Once the patient is under general anesthesia, a small incision is made usually just below the neck or at the notch at the top of the breastbone. The surgeon may clear a path and feel the patient's lymph nodes first to evaluate any abnormalities within the nodes. Next, the physician will insert the mediastinoscope through the incision. The scope is a narrow, hollow tube with an attached light that allows the surgeon to see inside the area. The surgeon can insert tools through the hollow tube to help perform biopsies. A sample of tissue from the lymph nodes or a mass can be extracted and sent for study under a microscope or on to a laboratory for further testing.

In some cases, analysis of the tissue sample which shows malignancy will suggest the need for immediate surgery while the patient is already prepared and under anesthesia. In other cases, the surgeon will complete the visual study and tissue extraction and stitch the small incision closed. The patient will remain in the surgery recovery area until it is determined that the effects of anesthesia have lessened and it is safe for the patient to leave the area. The entire procedure should take about an hour, not counting preparation and recovery time. Studies have shown that mediastinoscopy is a safe, thorough, and cost-effective diagnostic tool with less risk than some other procedures.

Preparation

Patients are asked to sign a consent form after having reviewed the risks of mediastinoscopy and known risks or reactions to anesthesia. The physician will normally instruct the patient to fast from midnight before the test until after the procedure is completed. A physician may also prescribe a sedative the night before the exam and before the procedure. Often a local anesthetic will be applied to the throat to prevent discomfort during placement of the endotracheal tube.

Aftercare

Following mediastinoscopy, patients will be carefully monitored to watch for changes in vital signs or indications of complications of the procedure or the anesthesia. A patient may have a **sore throat** from the endotracheal tube, temporary chest **pain**, and soreness or tenderness at the site of incision.

Risks

Complications from the actual mediastinoscopy procedure are relatively rare—the overall complication rate in various studies has been 1.3–3.0%. However, the following complications, in decreasing order of frequency, have been reported:

- hemorrhage
- pneumothorax (air in the pleural space)
- recurrent laryngeal nerve injury, causing hoarseness
- infection

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KEY TERMS

Endotracheal—Placed within the trachea, also known as the windpipe.

Hodgkin's disease—A malignancy of lymphoid tissue found in the lymph nodes, spleen, liver, and bone marrow.

Lymph nodes—Small round structures located throughout the body; contain cells that fight infections.

Pleural space—Space between the layers of the pleura (membrane lining the lungs and thorax).

Sarcoidosis—A chronic disease characterized by nodules in the lungs, skin, lymph nodes, and bones; however, any tissue or organ in the body may be affected.

Thymus—An unpaired organ in the mediastinal cavity that is important in the body's immune response.

- tumor implantation in the wound
- phrenic nerve injury (injury to a thoracic nerve)
- esophageal injury
- chylothorax (chyle—a milky lymphatic fluid—in the pleural space)
- air embolism (air bubble)
- transient hemiparesis (paralysis on one side of the body)

The usual risks associated with general anesthesia also apply to this procedure.

Normal results

In the majority of procedures performed to diagnose cancer, a normal result involves evidence of small, smooth, normal-appearing lymph nodes and no abnormal tissue, growths, or signs of infection. In the case of lung cancer staging, results are related to the severity and progression of the cancer.

Abnormal results

Abnormal findings may indicate lung cancer, **tuberculosis**, the spread of disease from one body part to another, sarcoidosis (a disease that causes nodules, usually affecting the lungs), lymphoma (abnormalities in the lymph tissues), and Hodgkin's disease.

Resources

BOOKS

Fischbach, Frances Talaska, and Marshall Barnett Dunning. *A Manual of Laboratory and Diagnostic Tests*. 8th ed. Philadelphia: Wolters Kluwer Heath/Lippincott Williams & Wilkins, 2009.

Pagana, Kathleen Deska, and Timothy J. Pagana. *Mosby's Manual of Diagnostic and Laboratory Tests*. 4th ed. St. Louis: Mosby, 2009.

ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (800) 227-2345, http://www.cancer.org.

American Lung Association, 1301 Pennsylvania Ave. NW, Suite 800, Washington, DC, 20001, (202) 758-3355, (202) 452-1805, (800) 548-8252, info@lungusa.org, http://www.lungusa.org/.

Lung Cancer Alliance, 888 16th St, NW, Suite 140, Washington, DC, 20006, (202) 463-2080, (800) 298-2436, info@ lunjgcanceralliance.org, http://www.lungcanceralliance.org.

Teresa Odle

Medical marijuana *see* **Marijuana**

Meditation

Definition

Meditation is a practice of concentrated focus upon a sound, object, visualization, the breath, movement, or attention itself in order to increase awareness of the present moment, reduce **stress**, promote relaxation, and enhance personal and spiritual growth.

Purpose

Meditation benefits people with or without acute medical illness or stress. People who meditate regularly have been shown to feel less **anxiety** and depression. They also report that they experience more enjoyment and appreciation of life and that their relationships with others are improved. Meditation produces a state of deep relaxation and a sense of balance or equanimity. According to Michael J. Baime, "Meditation cultivates an emotional stability that allows the meditator to experience intense emotions fully while simultaneously maintaining perspective on them." Out of this experience of emotional stability, one may gain greater insight and understanding about one's thoughts, feelings, and actions. This insight in turn offers the possibility to feel more confident and in control of life. Meditation facilitates a greater sense of calmness, empathy, and acceptance of self and others.

Meditation can be used with other forms of medical treatment and is an important complementary

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Two people engaged in meditation. *(iofoto/Shutterstock.com.)*

therapy for both the treatment and prevention of many stress-related conditions. Regular meditation can reduce the number of symptoms experienced by patients with a wide range of illnesses and disorders. Based upon clinical evidence as well as theoretical understanding, meditation is considered to be one of the better therapies for **panic disorder**, **generalized anxiety disorder**, substance dependence and **abuse**, ulcers, **colitis**, chronic **pain**, **psoriasis**, and dysthymic disorder. It is considered to be a valuable adjunctive therapy for moderate **hypertension** (high blood pressure), prevention of cardiac arrest (**heart attack**), prevention of **atherosclerosis** (hardening of arteries), arthritis (including fibromyalgia), **cancer**, **insomnia**, migraine, and prevention of **stroke**. Meditation may also be a valuable complementary therapy for **allergies** and **asthma** because of the role stress plays in these conditions. Meditative practices have been reported to improve function or reduce symptoms in patients with some neurological disorders as well. These include people with Parkinson's disease, people who experience **fatigue** with **multiple sclerosis**, and people with **epilepsy** who are resistant to standard treatment.

Overall, a 1995 report to the National Institutes of Health on alternative medicine concluded that, "More than 30 years of research, as well as the experience of a large and growing number of individuals and health care providers, suggests that meditation and similar forms of relaxation can lead to better health, higher quality of life, and lowered health care costs. . ."

Description

Origins

Meditation techniques have been practiced for millennia. Originally, they were intended to develop spiritual understanding, awareness, and direct experience of ultimate reality. The many different religious traditions in the world have given rise to a rich variety of meditative practices. These include the contemplative practices of Christian religious orders, the Buddhist practice of sitting meditation, and the whirling movements of the Sufi dervishes. Although meditation is an important spiritual practice in many religious and spiritual traditions, it can be practiced by anyone regardless of their religious or cultural background to relieve stress and pain.

As Western medical practitioners begin to understand the mind's role in health and disease, there has been more interest in the use of meditation in medicine. Meditative practices are increasingly offered in medical clinics and hospitals as a tool for improving health and quality of life. Meditation has been used as the primary therapy for treating certain diseases; as an additional therapy in a comprehensive treatment plan; and as a means of improving the quality of life of people with debilitating, chronic, or terminal illnesses.

Sitting meditation is generally done in an upright seated position, either in a chair or cross-legged on a cushion on the floor. The spine is straight yet relaxed. Sometimes the eyes are closed. Other times the eyes are open and gazing softly into the distance or at an object. Depending on the type of meditation, the meditator may be concentrating on the sensation of the movement of the breath, counting the breath, silently repeating a sound, chanting, visualizing an image, focusing awareness on the center of the body, opening to all sensory experiences including thoughts, or performing stylized ritual movements with the hands.

Movement meditation can be spontaneous and free-form or involve highly structured, choreographed, repetitive patterns. Movement meditation is particularly helpful for those people who find it difficult to remain still.

Generally speaking, there are two main types of meditation. These types are concentration meditation and mindfulness meditation. Concentration meditation practices involve focusing attention on a single object. Objects of meditation can include the breath, an inner or external image, a movement pattern (as in **tai chi** or **yoga**), or a sound, word, or phrase that is repeated silently (mantra). The purpose of concentrative practices is to learn to focus one's attention or develop concentration. When thoughts or emotions

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MAHARISHI MAHESH YOGI (1911–2008)

(Bernard Gotfryd/Premium Archive/Getty Images.)

Maharishi Mahesh Yogi was one of the most recognized spiritual leaders of the world. Almost single-handedly, the Maharishi (meaning great sage) brought Eastern culture into Western consciousness. He emerged in the late 1950s in London and the United States as a missionary in the cause of Hinduism, the philosophy of which is called Vedanta—a belief that "holds that God is to be found in every creature and object, that the purpose of human life is to realize the godliness in oneself and that religious truths are universal."

By 1967, the Maharishi became a leader among flower-children and an anti-drug advocate. The Maharishi's sudden popularity was helped along by such early fans as the Beatles, Mia Farrow, and Shirley MacLaine. These people, and many others, practiced Transcendental Meditation (TM), a Hindu-influenced procedure that endures in the United States to this day.

When the 1960s drew to a close, the Maharishi began to fade from public view. The guru still had enough followers, though, to people the Maharishi International University, founded in 1971. One of the main draws of Maharishi International University was the study of TM-Sidha, an exotic form of Transcendental Meditation. Sidhas believe that group meditation can elicit the maharishi effect—a force strong enough to conjure world peace.

In 1990, the Maharishi relocated his headquarters from Seelisberg, Switzerland to a former Franciscan monastery in Vlodrop, Netherlands, where he continued his work in TM and tried to affect change in the world with peace. He died in 2008. More information about TM and the history of it's credited founder can be found on http://www.tm.org/

arise, the meditator gently directs the mind back to the original object of concentration.

Mindfulness meditation practices involve becoming aware of the entire field of attention. The meditator is instructed to be aware of all thoughts, feelings, perceptions or sensations as they arise in each moment. Mindfulness meditation practices are enhanced by the meditator's ability to focus and quiet the mind. Many meditation practices are a blend of these two forms.

The study and application of meditation to health care has focused on three specific approaches: 1. transcendental meditation (TM); 2. The "relaxation response," a general approach to meditation developed by Dr. Herbert Benson; and 3. mindfulness meditation, specifically the program of mindfulness-based **stress reduction** (MBSR) developed by Jon Kabat-Zinn.

Transcendental meditation

TM has its origins in the Vedic tradition of India and was introduced to the West by Maharishi Mahesh Yogi. TM has been taught to somewhere between two and four million people. It is one of the most widely practiced forms of meditation in the West. TM has been studied many times; these studies have produced much of the information about the physiology of meditation. In TM, the meditator sits with closed eyes and concentrates on a single syllable or word (mantra) for 20 minutes at a time, twice a day. When thoughts or feelings arise, the attention is brought back to the mantra. According to Charles Alexander, an important TM researcher, "During TM, ordinary waking mental activity is said to settle down, until even the subtlest thought is transcended and a completely unified wholeness of awareness...is experienced. In this silent, self-referential state of pure wakefulness, consciousness is fully awake to itself alone. . . ." TM supporters believe that TM practices are more beneficial than other meditation practices.

The relaxation response

The relaxation response involves a similar form of mental focusing. Dr. Herbert Benson, one of the first Western doctors to conduct research on the effects of

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meditation, developed this approach after observing the profound health benefits of a state of bodily calm he calls "the relaxation response." In order to elicit this response in the body, he teaches patients to focus upon the repetition of a word, sound, prayer, phrase, or movement activity (including swimming, jogging, yoga, and even knitting) for 10–20 minutes at a time, twice a day. Patients are also taught not to pay attention to distracting thoughts and to return their focus to the original repetition. The choice of the focused repetition is up to the individual. Instead of Sanskrit terms, the meditator can choose what is personally meaningful, such as a phrase from a Christian or Jewish prayer.

Mindfulness meditation

Mindfulness meditation comes out of traditional Buddhist meditation practices. Psychologist Jon Kabat-Zinn has been instrumental in bringing this form of meditation into medical settings. In formal mindfulness practice, the meditator sits with eyes closed, focusing the attention on the sensations and movement of the breath for approximately 45–60 minutes at a time, at least once a day. Informal mindfulness practice involves bringing awareness to every activity in daily life. Wandering thoughts or distracting feelings are simply noticed without resisting or reacting to them. The essence of mindfulness meditation is not what one focuses on but rather the quality of awareness the meditator brings to each moment. According to Kabat-Zinn, "It is this investigative, discerning observation of whatever comes up in the present moment that is the hallmark of mindfulness and differentiates it most from other forms of meditation. The goal of mindfulness is for you to be more aware, more in touch with life and whatever is happening in your own body and mind at the time it is happening—that is, the present moment." The MBSR program consists of a series of classes involving meditation, movement, and group process. There are over 240 MBSR programs offered in health care settings around the world.

Meditation is not considered a medical procedure or intervention by most insurers. Many patients pay for meditation training themselves. Frequently, religious groups or meditation centers offer meditation instruction free of charge or for a nominal donation. Hospitals may offer MBSR classes at a reduced rate for their patients and a slightly higher rate for the general public.

Precautions

Meditation appears to be safe for most people. There are, however, case reports and studies noting some adverse effects. Thirty-three to 50% of the people participating in long silent meditation retreats (two weeks to three months) reported increased tension, anxiety, confusion, and depression. On the other hand, most of these same people also reported very positive effects from their meditation practice. Kabat-Zinn notes that these studies fail to differentiate between serious psychiatric disturbances and normal emotional mood swings. These studies do suggest, however, that meditation may not be recommended for people with psychotic disorders, severe depression, and other severe **personality disorders** unless they are also receiving psychological or medical treatment.

KEY TERMS

Dervish—A member of the Sufi order. Their practice of meditation involves whirling ecstatic dance.

Mantra—A sacred word or formula repeated over and over to concentrate the mind.

Transcendental meditation (TM)—A meditation technique based on Hindu practices that involves the repetition of a mantra.

Side effects

There are no reported side effects from meditation except for positive benefits.

Research and general acceptance

The scientific study of the physiological effects of meditation began in the early 1960s. These studies prove that meditation affects metabolism, the endocrine system, the central nervous system, and the autonomic nervous system. In one study, three advanced practitioners of Tibetan Buddhist meditation practices demonstrated the ability to increase "inner heat" as much as 61%. During a different meditative practice they were able to dramatically slow down the rate at which their bodies consumed oxygen. Preliminary research shows that mindfulness meditation is associated with increased levels of melatonin. These findings suggest a potential role for meditation in the treatment and prevention of breast and prostrate cancer.

Despite the inherent difficulties in designing research studies, there is a large amount of evidence of the medical benefits of meditation. Meditation is particularly effective as a treatment for chronic pain. Studies have shown meditation reduces symptoms of pain and pain-related drug use. In a four-year follow-up study, the majority of patients in a MBSR program

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reported "moderate to great improvement" in pain as a result of participation in the program.

Meditation has long been recommended as a treatment for high blood pressure; however, there is a debate over the amount of benefit that meditation offers. Although most studies show a reduction in blood pressure with meditation, medication is still more effective at lowering high blood pressure.

Meditation may also be an effective treatment for **coronary artery disease**. A study of 21 patients practicing TM for eight months showed increases in their amount of **exercise** tolerance, amount of workload, and a delay in the onset of ST-segment depression. Meditation is also an important part of Dean Ornish's program, which has been proven to reverse coronary artery disease.

Research also suggests that meditation is effective in the treatment of chemical dependency. Gelderloos and others reviewed 24 studies and reported that all of them showed that TM is helpful in programs to stop **smoking** and also in programs for drug and alcohol abuse.

Studies also imply that meditation is helpful in reducing symptoms of anxiety and in treating anxiety-related disorders. Furthermore, a study in 1998 of 37 psoriasis patients showed that those practicing mindfulness meditation had more rapid clearing of their skin condition, with standard UV light treatment, than the control subjects. Another study found that meditation decreased the symptoms of fibromyalgia; over half of the patients reported significant improvement. Meditation was one of several stress management techniques used in a small study of HIV-positive men. The study showed improvements in the T-cell counts of the men, as well as in several psychological measures of well-being.

Resources

BOOKS

Ernst, Edzard, Max H. Pittler, and Barbara Wider, eds. *The Desktop Guide to Complementary and Alternative Medicine: An Evidence–Based Approach*. 2nd ed. St. Louis: Mosby, 2006.

Freeman, Lyn W. *Mosby's Complementary & Alternative Medicine: A Research–Based Approach*. 3rd ed. St. Louis: Mosby, 2008.

ORGANIZATIONS

Benson-Henry Institute for Mind-Body Medicine, 151 Merrimac Street, 4th Floor, Boston, MA, 02114, (617) 643-6090, (617) 643-6077, mindbody@partners.org, http://www.massgeneral.org.

Insight Meditation Society, 1230 Pleasant St., Barre, MA, 01005, (973) 355-4378, rc@dharma.org, http://www.dharma.org/.

Linda Chrisman

Mediterranean diet

Definition

The Mediterranean diet is better described as a nutritional model or pattern of food consumption rather than a diet in the usual sense of the word. To begin with, there is more than one Mediterranean diet, if the phrase is understood to refer to the traditional foods and eating patterns found in the countries bordering the Mediterranean Sea. Francesco Visioli, a researcher who has edited two books on the subject, prefers the term "Mediterranean diets" in the plural to reflect the fact that "the populations in the Mediterranean area have different cultures, religions, economic prosperity, and [levels of] education, and all these factors have some influence on dietary habits and health." For example, Visioli notes that alcohol intake is very low in the Maghreb (coastal northwestern Africa) because most inhabitants of the region are Muslim, and consequently cereal grains figure more prominently in their diet than in most other Mediterranean countries. In addition, the differences among the various forms of the Mediterranean diet are important in understanding some of the research studies that have been done on it, as will be described more fully below.

Origins

The origins of the pattern of food consumption found in Mediterranean countries go back several millennia into history; descriptions of meals in ancient Greek and Roman literature would not be out of place in contemporary Mediterranean diet cookbooks. The first description of the traditional Mediterranean diet as it was followed in the mid-twentieth century, however, was not in a cookbook; it was in a research study funded by the Rockefeller Foundation and published in 1953. The author was Leland Allbaugh, who carried out a study of the island of Crete as an underdeveloped area. Allbaugh noted the heavy use of olive oil, whole-grain foods, fruits, fish, and vegetables in cooking as well as the geography and other features of the island.

The Cretan version of the Mediterranean diet became the focus of medical research on the Mediterranean diet following the publication of Ancel Keys's Seven Country Study in 1980. Keys (1904–2004) was a professor of physiology at the University of Minnesota who had a varied background in biology and biochemistry before turning to **nutrition** almost by accident. Hired by the Army in 1941 to develop portable rations for troops in combat, Keys was responsible for creating what the Army then called K rations.

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Mediterranean diet

Frequency	Food	Tips
Monthly	Red meats	No more than a few times month
Weekly	Sweets	Opt instead for naturally sweet fresh fruit
	Eggs	Less than 4 per week, including those in processed foods
	Poultry	A few times a week. Take the skin off and choose white meat to lower fat intake
	Fish	A few times a week
Daily	Cheese and yogurt	Cheese and yogurt are good sources of calcium. Choose low-fat varieties
	Olive oil	The beneficial health effects of olive oil are due to its high content of monounsaturated fats and antioxidants. Olive oil is high in calories, consume in moderation to reduce calorie intake
	Fruits	At least a serving at every meal. A serving of fruit is a healthy option for snacks
	Vegetables	At least a serving at every meal. Choose a variety of colors
	Beans, legumes, nuts	Beans are a healthy source of protein, and are loaded with soluble fiber, which has been shown to lower blood cholesterol levels by five percent or more. Most nuts contain monounsaturated (heart-healthy) fat. A handful of nuts is a healthy option for snacks
	Whole grains, including breads, pasta, rice, couscous, and polenta	A grain is considered whole when all three parts—bran, germ and endosperm—are present. Substitute whole wheat for white bread, brown rice for white rice and whole-wheat flour when baking. Mix pasta, rice, couscous, polenta and potatoes with vegetables and legumes
	Water	At least 6 glasses daily
	Wine (in moderation)	The U.S. Department of Agriculture defines moderation as no more than a five-ounce glass of wine daily for women and up to 2 glasses (10 ounces) daily for men
	Physical activity	Thirty minutes of cardiovascular activity a day is recommended to get in shape, burn calories and boost the metabolism

Mediterranean diet tips, based on the Mediterranean diet pyramid. *(Table by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)*

His next wartime project was a **starvation** experiment, which he conducted in order to determine the food needs of starving civilians in war-torn Europe. American soldiers who were trying to feed refugees in the newly liberated countries found that there was no reliable medical information about treating starvation victims. Keys recruited 36 healthy male volunteers in 1944 who were conscientious objectors, most of them from the historic peace churches. For five months the subjects were given half the normal calorie requirement of an adult male and asked to **exercise** regularly on a treadmill. The average weight loss was 25% of body weight. Three months after the experiment ended, Keys found that none of the subjects had regained their weight or physical capacity. He learned that renutrition following starvation requires several months of above-average calorie intake, that vitamin supplements are needed, and that the proportion of protein in the diet must be increased. He wrote a booklet with this information for use by relief agencies after the war ended.

In the process of studying the effects of starvation in European men who survived the war, however, Keys noticed that the rate of heart attacks among them dropped markedly as food supplies decreased. He wondered whether dietary factors might be involved in heart disease. A study of Minnesota businessmen and professors in the mid-1950s showed him that the fat content of food—particularly the saturated fats found in the meat and dairy products consumed in large amounts by Midwesterners—was indeed a factor. After that experiment, Keys began to think in terms of diet as preventive medicine. He first encountered Mediterranean **diets** during visits to Italy and Spain to conduct research for the World Health Organization. His studies of food consumption patterns in those countries eventually led to the Seven Countries Study, which was a systematic comparison of diet, risk factors for heart disease, and disease experience in men between the ages of 40 and 59 in eighteen rural areas of Japan, Finland, Greece, Italy, the former Yugoslavia, the Netherlands, and the United States from 1958 to 1970. (Women were not included as subjects because of the rarity of heart attacks among them at that time and because the physical examinations were fairly invasive). In addition to asking the subjects to keep records of their food intake, the researchers performed chemical analyses of the foods the subjects ate. It was found that the men living on the island of Crete—the location of Leland Allbaugh's 1953 study—had the lowest rate of heart attacks of any group of subjects in the study.

Subsequent studies of Mediterranean diets have been conducted in subjects who have already suffered heart attacks and in women subjects. One consistent

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finding of recent research, however, is that subjects are less healthy in the early twenty-first century than the participants of the late 1950s because the traditional diets of the Mediterranean region have been increasingly abandoned in favor of fast foods and higher consumption of fatty meat products and sweets, as well as other staples of American and Northern European diets that are high in trans-fatty acids. In addition, changing agricultural practices around the Mediterranean have resulted in poultry and meat with higher fat content than was the case in the 1960s. As a result of concern about these trends, an association for the advancement of the Mediterranean diet was formed in Spain in 1995 and later funded the Foundation for the Advancement of the Mediterranean Diet, which is presently headquartered in Barcelona. The Foundation's objectives include publication and dissemination of scientific findings about the diet and the promotion of its healthful use among different population groups.

Description

Typical Mediterranean diet

In general, Mediterranean diets have five major characteristics:

- High levels of fruits and vegetables, breads and other cereals, potatoes, beans, nuts, and seeds.
- Olive oil as the principal or only source of fat in the diet.
- Moderate amounts of dairy products, fish, and poultry; little use of red meat.
- Eggs used no more than 4 times weekly.
- Wine consumed in moderate amounts—two glasses per day for men, one glass for women.

Since wine and olive oil are obtained from their respective plant sources by physical (crushing or pressing) rather than chemical processes, their nutrients retain all the properties of their sources. Wine contains polyphenols, which are powerful **antioxidants** and also have a relaxing effect on blood vessels, thus lowering blood pressure.

The Mediterranean Diet Pyramid is an illustrated version of this typical dietary pattern. The base of the pyramid is labeled "Daily Physical Activity," with four layers of foods consumed on a daily basis above it. Fish, poultry, eggs, and sweets are in the next section of the pyramid—foods that may be eaten weekly. At the very top of the pyramid is red meat, to be eaten no more than once a month. The pyramid may be found online at http://www.mediterraneandietinfo.com/Mediterranean-Food-Pyramid.htm and several other nutrition websites.

The Cretan diet

The Cretan version of the Mediterranean diet as it was used on the island in the 1960s was distinctive in several respects because it contained:

- A higher proportion of total calories from fat (40%), almost all of it from olive oil. It was low in animal fats (butter was rarely eaten) and saturated fats.
- A relatively low level of carbohydrate intake (45% of daily calories), with most of the carbohydrates coming from fruits (2 to 3 per day) and vegetables (2 to 3 cups per day)—many of them foods with a low glycemic index. Vegetables are an integral part of meals in the Cretan diet—they are not considered side dishes.
- Generous portions of whole-grain bread (8 slices per day). The bread was made from slowly fermented dough, however, and had a lower glycemic index than most contemporary breads.
- Moderate intake of fish (about 40 grams per day), which, however, is rich in omega-3 fatty acids.
- A higher intake of meat than in most versions of the Mediterranean diet, mostly as lamb, chicken, or pork.
- High intake of alpha-linolenic acid (ALA; an omega-3 fatty acid thought to lower the risk of heart disease) from nuts (particularly walnuts), seeds, wild greens (particularly purslane [*Portulaca oleracea*]), and legumes. Lamb is also a good source of ALA.

Online versions of the Mediterranean diet

Two of the diets available through eDiets.com as of early 2007 are Mediterranean-type diets, the New Mediterranean Diet and the Sonoma Diet. Both plans are recipe-based, are customized to incorporate foods that the dieter enjoys, and provide personalized weekly meal plans. The New Mediterranean Diet costs $4.49 per week, with a minimum enrollment of 12 weeks, or $53.88 for the three-month trial period. The Sonoma Diet, which is an adaptation of the traditional Mediterranean diet to foods more commonly available in the United States, costs $5 per week for a minimum enrollment period of five weeks. The Sonoma Diet comes with a portion guide and wine guide as well as a customized weekly meal plan.

Function

The function of Mediterranean diets as used in the United States and Western Europe is primarily preventive health care and only secondarily as a means to weight loss. There are several books available with weight-loss regimens based on Mediterranean diets, as well as cookbooks with recipes from a variety of Mediterranean countries.

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Benefits

Preventive health care

Most of the scientific research that has been done on Mediterranean diets concerns their role in preventing or lowering the risk of various diseases.

HEART DISEASE. Mediterranean diets became popular in the 1980s largely because of their association with lowered risk of heart attacks and **stroke**, particularly in men, following the publication of the Seven Countries study. Mediterranean diets are thought to protect against heart disease because of their high levels of **omega-3 fatty acids** even though blood cholesterol levels are not lowered.

ALZHEIMER'S DISEASE. A study published in *Annals of Neurology* in 2006 reported that subjects in a group of 2000 participants averaging 76 years of age who followed a Mediterranean-type diet closely were less likely to develop Alzheimer's than those who did not. Further study is needed, however, to discover whether factors other than diet may have affected the outcome.

ASTHMA AND ALLERGIES. A group of researchers in Crete reported in 2007 that the low rate of **wheezing** and **allergic rhinitis** (runny nose) on the island may be related to the traditional Cretan diet. Children who had a high consumption of nuts, grapes, oranges, apples, and tomatoes (the main local products) were less likely to suffer from **asthma** or nasal **allergies**. Children who ate large amounts of margarine, however, were more likely to develop these conditions.

METABOLIC SYNDROME. Research conducted at a clinic in Naples, Italy, suggests that Mediterranean diets lower the risk of developing or reversing the effects of metabolic syndrome, a condition associated with **insulin resistance** and an increased risk of heart disease and type 2 diabetes. The results from this clinic were corroborated by a study done at Tufts University in Massachusetts, which found that the symptoms of metabolic syndrome were reduced even in patients who did not lose weight on the diet.

Weight loss

Some population studies carried out in Mediterranean countries (particularly Italy and Spain) have found that close adherence to a traditional Mediterranean diet is associated with lower weight and a lower body mass index. Although there are relatively few studies of Mediterranean diets as weight-reduction regimens, a research team at the Harvard School of Public Health reported in 2007 that a Mediterranean-style diet is an effective approach to weight loss for many people. A major reason for its effectiveness is the wide variety of enjoyable foods permitted on the diet combined with a rich tradition of ethnic recipes making use of these foods—which makes it easier and more pleasant for people to stay on the diet for long periods of time.

Precautions

People who are making any major change in their dietary pattern in general should always consult their physician first. In addition, people who are taking **monoamine oxidase inhibitors** (MAOIs) for the treatment of depression should check with their doctor, as these drugs interact with a chemical called tyramine to cause sudden increases in blood pressure. Tyramine is found in red wines, particularly aged wines like Chianti, and in aged cheeses.

People using a Mediterranean diet for weight reduction should watch portion size and monitor their consumption of olive oil, cheese, and yogurt, which are high in calories. Dieters may wish to consider switching to low-fat cheeses and yogurts.

Because olive oil is a staple of Mediterranean diets, consumers should purchase it from reliable sources. The safety of olive oil is not ordinarily a concern in North America; however, samples of olive oils sold in Europe and North Africa are sometimes found to be contaminated by mycotoxins (toxins produced by molds and fungi that grow on olives and other fruits). Some mycotoxins do not have any known effects on humans, but aflatoxin, which has been found in olive oil, is a powerful carcinogen and has been implicated in **liver cancer**.

Risks

There are no major risks associated with following a traditional Mediterranean diet for people who have consulted a physician beforehand if they intend to use the diet as a weight-loss regimen. Health crises caused by food interactions with MAOIs are uncommon but can be fatal (about 90 deaths over a 40-year period).

The risk of **cancer** or any other disease from aflatoxin-contaminated olive oil is minimal in the United States and Canada.

Research and general acceptance

Mediterranean diets have been the subject of more medical research since the 1960s than any other regional or ethnic diet. Interest in Mediterranean diets has been high because nutritional research in general has moved away from curing deficiency diseases in the direction of preventive health care.

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The Seven Countries Study

The results from the Seven Countries study were published in book form in 1980. The research teams found that Japanese and Greek men had far lower rates of cardiovascular disease than men from the other five other countries, with the Greek subjects from the island of Crete having the lowest rate of all. Although the study and thirty years of follow-up reports showed that the relationship among heart disease, body mass, weight, and **obesity** is complex, the Seven Countries research also showed that the type of fat in the diet is more important than the amount, and that the use of monounsaturated fats—particularly olive oil—is correlated with a lower risk of **heart attack** and stroke. The twenty-year follow-up report indicated that 81% of the difference in coronary deaths among the seven countries could be explained by differences in the average intake of saturated fatty acids.

A detailed description of the Seven Countries study, the research that preceded it, and an overview of its findings can be found online on the website of the University of Minnesota School of Public Health, Division of Epidemiology and Community Health, at http://www.epi.umn.edu/about/7countries/index.shtm.

The Lyon Diet Heart Study

The Lyon Diet Heart Study was the first clinical trial to demonstrate the beneficial effects of a Mediterranean-type diet. Begun in 1995, it was a major investigation of the effectiveness of a modified Cretan diet in preventing recurrent heart attacks. The subjects were a group of 605 Frenchmen under 70 years of age who had been treated in the previous 6 months for a heart attack. They were recruited from several hospitals in the area of Lyon, a city in east-central France. Half the subjects were given an hour-long educational introduction to a modified version of the Cretan diet (canola oil was substituted for olive oil) and advised to follow this Mediterranean-style diet. The other half (the control group) were given a prudent diet recommended by the American Heart Association (AHA). At the end of 4 years, overall **death** rates were 56% lower in the group that followed the modified Cretan diet.

Ongoing research

Mediterranean diets continue to be fruitful subjects for medical investigators, partly because the countries where they originated are changing so rapidly, and partly because discussion continues as to which of the components of these diets is the most important in disease prevention. Although olive oil has been the focus of many studies, recent research done in Greece seems to indicate that the combination of the various foods and food groups in Mediterranean diets is what makes them so healthful, rather than any one specific component. This position is sometimes called the whole-diet approach.

In addition, other researchers are studying lifestyle factors other than food that may well contribute to the beneficial effects of Mediterranean cooking. These include a generally more relaxed attitude toward life; higher levels of physical activity (made possible in part by the warm sunny climate of the region); and the **fasting** practices of Greek Orthodox Christians, which lower fat intake and restrict the believer to a vegetarian diet for about 110 days out of every year.

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University of Minnesota School of Public Health, Division of Epidemiology and Community Health (EpiCH), West Bank Office Building,1300 South Second Street, Suite 300, Minneapolis, MN, 55454-1015, (612) 624-1818, http://www.epi.umn.edu/about/7countries/index.shtm.

Rebecca J. Frey, Ph.D.

Medullary sponge kidney

Definition

Medullary sponge kidney is a congenital defect of the kidneys where the kidneys fill with pools of urine.

Demographics

One in every 100 to 200 people have some form of this disease.

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KEY TERMS

Congenital—Present at birth.

Intravenous pyelogram—X rays of the upper urinary system using a contrast agent that is excreted by the kidneys into the urine.

Thiazide diuretic—A particular class of medication that encourages urine production.

Ureter—A tube that carries urine from the kidney to the bladder.

Description

The kidneys filter urine from the blood and direct it down tiny collecting tubes toward the ureters (ducts that carry urine from the kidney to the bladder). These tiny tubes gradually join together until they reach the renal pelvis, where the ureters begin. As the tubes join, they are supposed to get progressively bigger as they get fewer in number. In medullary sponge kidney, the tubes are irregular in diameter, forming pools of urine along the way. These pools encourage stone formation and infection.

Causes and symptoms

Although some cases of this disorder seem to be inherited, usually the cause is not known.

The symptoms associated with medullary sponge kidney are those related to infection and stone passage. Infection causes **fever**; back and flank **pain**; cloudy, frequent, and burning urine; and general discomfort. Stones cause pain in the flank or groin as they pass. They usually cause some bleeding. The bleeding may not be visible in the urine, but it is apparent under a microscope.

Diagnosis

Recurring kidney infections, bleeding, or stones will prompt x rays of the kidneys. The appearance of medullary sponge kidney on an intravenous pyelogram (x rays of the upper urinary system) is characteristic.

Treatment

Many people never have trouble with this disorder. For those that do, infections and stones require periodic treatment. Infections should be treated with **antibiotics** early in order to prevent kidney damage. Stones may need to be surgically removed. Often, removal can be accomplished without an incision but rather by reaching up with instruments through the lower urinary tract to grab the stones. This procedure is called a ureteroscopy. There is also a method of stone treatment called extracorporeal shock wave **lithotripsy** (ESWL). A special machine delivers a focused blast of shock waves that breaks stones into sand so that they will pass out naturally. It is considered reasonably safe and usually effective.

Prognosis

Ignoring symptoms can result in progressive damage to the kidneys and ultimate kidney failure, but attentive early treatment will preserve kidney function.

Prevention

Diligent monitoring for infection at regular intervals and at the first symptom will give the best long-term results. By drinking extra liquids, most stones can be prevented. The most common kind of stones, **calcium** stones, can be deterred by regularly taking a medication (thiazide diuretic) that encourages urine production.

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American Association of Kidney Patients, 3505 E. Frontage Rd., Suite 315, Tampa, FL, 33607, (800) 749-2257, info@aakp.org, http://www.aakp.org.

American Kidney Fund (AKF), 6110 Executive Boulevard, Suite 1010, Rockville, MD, 20852, (800) 638-8299, http://www.kidneyfund.org.

National Kidney Foundation, 30 East 33rd St., New York, NY, 10016, (800) 622-9010, http://www.kidney.org.

National Kidney and Urologic Disease Information Clearinghouse, 3 Information Way, Bethesda, MD, 20892, (800) 891-5390, nkudic@info.niddk.nih.gov, http://kidney.niddk.nih.gov.

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Medulloblastoma *see* **Brain tumor**
Mefloquine *see* **Antimalarial drugs**
Megalencephaly *see* **Congenital brain defects**
Melanoma *see* **Malignant melanoma**

KEY TERMS

Osteomyelitis—An inflammation of bone or bone marrow, often caused by bacterial infections. Chronic melioidosis may cause osteomyelitis.

Septicemia—Bacterial infection of the bloodstream. One form of melioidosis is an acute septicemic infection.

Melioidosis

Definition

Melioidosis is an **infectious disease** of humans and animals caused by a gram-negative bacillus found in soil and water. It has both acute and chronic forms.

Description

Melioidosis, which is sometimes called *Pseudomonas pseudomallei* infection, is endemic (occurring naturally and consistently) in Southeast Asia, Australia, and parts of Africa. It was rare in the United States prior to recent immigration from Southeast Asia. Melioidosis is presently a public health concern because it is most common in **AIDS** patients and intravenous drug users.

Causes and symptoms

Melioidosis is caused by *Pseudomonas pseudomallei,* a bacillus that can cause disease in sheep, goats, pigs, horses, and other animals, as well as in humans. The organism enters the body through skin abrasions, **burns**, or **wounds** infected by contaminated soil; inhalation of dust; or by eating food contaminated with *P. pseudomallei*. Person-to-person transmission is unusual. Drug addicts acquire the disease from shared needles. The incubation period is two to three days.

Chronic melioidosis is characterized by **osteomyelitis** (inflammation of the bone) and pus-filled abscesses in the skin, lungs, or other organs. Acute melioidosis takes one of three forms: a localized skin infection that may spread to nearby lymph nodes; an infection of the lungs associated with high **fever** (102°F/38.9°C), **headache**, chest **pain**, and coughing; and septicemia (blood poisoning) characterized by disorientation, difficulty breathing, severe headache, and an eruption of pimples on the head or trunk. The third form is most common among drug addicts and may be rapidly fatal.

Diagnosis

Melioidosis is usually suspected based on the patient's history, especially travel, occupational exposure to infected animals, or a history of intravenous drug. Diagnosis must then be confirmed through laboratory tests. *P. pseudomallei* can be cultured from samples of the patient's sputum, blood, or tissue fluid from abscesses. Blood tests, including complement fixation (CF) tests and hemagglutination tests, also help to confirm the diagnosis. In acute infections, chest x rays and **liver function tests** are usually abnormal.

Treatment

Patients with mild or moderate infections are given a course of trimethoprim-sulfamethoxazole (TMP/SMX) and ceftazidime by mouth. Patients with acute melioidosis are given a lengthy course of ceftazidime followed by TMP/SMX. In patients with acute septicemia, a combination of **antibiotics** is administered intravenously, usually tetracycline, chloramphenicol, and TMP/SMX.

Prognosis

The mortality rate in acute cases of pulmonary melioidosis is about 10%; the mortality rate for the septicemic form is significantly higher (slightly above 50%). The prognosis for recovery from mild infections is excellent.

Prevention

There is no form of immunization for melioidosis. Prevention requires prompt cleansing of scrapes, burns, or other open wounds in areas where the disease is common and avoidance of needle sharing among drug addicts.

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Rebecca J. Frey, PhD

Membranous glomerulopathy *see* **Nephrotic syndrome**

Memory loss

Definition

Memory loss is the inability to recall past events or knowledge. It is also called forgetfulness, **amnesia**, impaired memory, and loss of memory. Forgetfulness is generally mild and is experienced by almost everyone during life. Amnesia is total loss of memories, such as name and personal history.

General description

Mild memory loss, such as the inability to recall someone's name or where an item was last placed (such as keys or eyeglasses), occurs in adults of all ages. It usually becomes more frequent as a person ages. Mild memory loss is referred to as forgetfulness. Mild cognitive impairment (MCI) or impaired memory is considered a transitional state between normal forgetfulness and severe memory loss. At least one cognitive (thinking) function, usually memory, is below normal or declining. When memory is affected, the condition is called amnesic MCI. Although some people with MCI remain stable or even improve, studies show that the majority, especially those with amnesic MCI, eventually develop **dementia**.

Severe memory loss is memory impairment to such a degree that it affects a person's ability to do everyday activities, such as driving, handling finances, or shopping. Severe memory loss includes dementia and Alzheimer's disease.

There is a big difference between mild and severe forgetfulness. Mild forgetfulness is more common as people age. It may take longer for older people to learn new things, remember familiar names or words, or where they last placed commonly used objects. These are usually signs of mild forgetfulness and not serious memory loss problems. The most common types of severe memory loss are dementia and Alzheimer's disease.

Dementia

Dementia is a descriptive term for a collection of symptoms caused by a number of disorders affecting the brain. People with dementia have significantly impaired intellectual functioning that interferes with normal activities and relationships. They lose their ability to solve problems and maintain emotional control, and they may experience personality changes and behavioral problems, such as agitation, **delusions**, and **hallucinations**. While memory loss is a common symptom of dementia, memory loss by itself does not mean that a person has dementia.

Dementia is a condition almost always associated with the elderly. Doctors diagnose dementia only if two or more brain functions—such as memory and language skills—are significantly impaired without loss of consciousness. There are different types of dementia, including Alzheimer's disease (AD), Pick disease, frontal lobe dementia, multi-infarct dementia, and dementia caused by an **infectious disease**, usually human **immunodeficiency** virus (HIV). AD is the most common type of dementia.

Alzheimer's disease

Alzheimer's disease (AD) is an illness of the brain and is a type of dementia. AD causes changes in the

Possible causes of reversible memory loss

- **Alcoholism:** Abuse of alcohol can severely impair a person's mental abilities and may cause memory loss by interacting with medications.
- **Depression or other mental health disorder:** Stress, anxiety, or depression can trigger temporary memory loss, especially in older people. When the stress is diminished, the symptoms disappear.
- **Medications:** Single medications or certain drug interactions may produce side effects or symptoms that mimic Alzheimer's disease. Specific medications include pain relievers, blood pressure medications, and sedatives.
- **Minor head trauma or injuries:** Falls or other head injuries may cause a loss of consciousness, with the victim having no recollection of the incident. Patients should see a doctor if they find an unexplained lump on the head or feel mentally fuzzy after even a minor fall.
- **Vitamin B-12 deficiency:** Vitamin B-12 helps to maintain healthy nerve and red blood cells. A deficiency, particularly common in older adults, may result in memory loss.

SOURCE: Mayo Clinic, "Memory loss: When to seek help." Available online at: http://www.mayoclinic.com/health/memory-loss/HQ00094 (accessed August 16, 2010).

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brain tissue, including abnormal clumps (amyloid plaques) and tangled bundles of fibers (neurofibrillary tangles). Excessive amounts of these plaques and tangles in the brain are considered signs of AD. Onset of AD usually begins after age 60 and nearly half of people age 85 and older may be affected. Although it is not a normal part of **aging**, AD is a disorder that, with almost no exceptions, affects older people and progresses as the person ages. There is no cure and only limited treatments are available.

The cause of AD is unknown but it is suspected to be caused by multiple factors. In addition to formation of amyloid plaques and neurofibrillary tangles, researchers have found other brain changes in people with AD. Nerve cells die in areas of the brain that are vital to memory and other mental abilities, and connections between nerve cells are disrupted. There are lower levels of some of the chemicals in the brain that carry messages back and forth between nerve cells. AD may impair thinking and memory by disrupting these messages.

Genetics also plays a role in disease development. AD is a genetic disease, meaning it is inherited and may affect several members in a family. The extent genetic factors play in developing AD remains unclear. Some studies indicate more than half of people with AD inherited it in their genetic profile. Other studies indicate only 25% of AD cases are inherited. Non-inherited AD is referred to as sporadic Alzheimer's disease. As of 2007, researchers had discovered three genes that can cause early-onset AD when mutated, and two genes that increase the risk for late-onset AD (one of which is the SORL 1 gene).

AD often starts slowly. People with AD often blame their forgetfulness on old age. Over time, their memory problems worsen and they lose the ability to drive a car, cook a meal, or even read a newspaper. They may get lost easily and find even simple things confusing. Some people become worried, angry, or violent. At some point, people with advanced AD may need someone to take care of all their needs, including feeding, bathing, and grooming, either at home or in a nursing home.

Demographics

No statistics are kept on mild memory loss since it is considered a minor inconvenience that nearly everyone experiences, especially as they grow older. The same is true for MCI, since there is no medical consensus on its definition. Accurate figures are also difficult to obtain because not everyone with a decline of memory shows symptoms.

As of 2007, the U. S. Congress' Office of Technology Assessment estimated that up to 6.8 million people in the United States had dementia, and at least 1.8 million of those were severely affected. Studies have found that almost half of all people age 85 and older have some form of dementia. Dementia usually begins after age 60, and the risk increases with age. At least 5% of men and women ages 65–74 have dementia.

The Alzheimer's Association estimates 5.1 million Americans have AD. By 2050 the number could rise to 13.2 million, according to the American Health Assistance Foundation (AHAF). The exact number is difficult to determine since AD is often misdiagnosed as another condition or is not diagnosed until the disease is in its later stages. The AHAF reports that approximately 65,800 people die from complication related to AD, and 350,000 new cases of AD are diagnosed each year in the United States. Worldwide, AHAF estimates 26 million people have AD as of 2007 and projects that number will increase to 106 million by 2050.

Causes and symptoms

Causes of memory loss besides the normal forgetfulness associated with aging include:

- side effects of medication
- dementia, Alzheimer's disease, and other degenerative nerve disorders of the brain
- trauma or injury to the head
- seizures
- alcoholism and drug abuse
- stroke
- brain tumors or infection
- herpes encephalitis
- depression

All forms of dementia result from the **death** of nerve cells and/or the loss of communication among these cells.

Diagnosis

Mild memory loss

Without using formal tests it may be possible to get an idea of cognitive function by discussing current events with the patient. A physician may ask the person if they read the newspapers or watch the news on television. If so, the physician questions the patient about a recent news event. If the person is interested in sports or a particular sports team, questions related to the sport or team should be asked that any fan would know, such as the name of the team's manager or head coach, or the names and positions of top players.

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Dementia and AD

Doctors use a number of methods to diagnose dementia and AD. Unfortunately, a definitive diagnosis of AD cannot be confirmed unless an **autopsy** is performed after death. Diagnosis before death is based upon observational findings of unexplained, slowly progressive dementia and brain-imaging studies that show a reduction in the size of the brain. Brain-imaging (neuroimaging) refers to the use of **positron emission tomography (PET)**, **magnetic resonance imaging** (MRI), or computed topography (CT) scans. These are special types of pictures that allow the brain or other internal body structures to be visualized.

Tests that measure memory, language skills, math skills, and other abilities related to mental functioning are also used to help the physician accurately diagnose a patient's condition. For example, people with dementia or AD often show changes in executive functions (such as problem-solving), memory, and the ability to perform once-automatic tasks. Diagnosis is established after first excluding other possible causes for dementia or AD. It is important that any treatable conditions, such as depression, normal pressure **hydrocephalus**, or vitamin B_{12} deficiency, which cause similar symptoms are ruled out. Early, accurate diagnosis of dementia and AD is important for patients and their families because it allows early treatment of symptoms. For people with AD or other progressive dementias, early diagnosis may allow them to plan for the future while they can still help to make decisions. These patients also may benefit from drug treatment.

Treatment

The clinical effectiveness of treating mild memory impairment where no specific medical cause has been identified, has yet to be fully tested. It is believed that these individuals might represent patients who are just beginning to develop AD and might benefit more from available treatments for AD than those patients with dementia. Besides drugs, other ways to improve memory in older adults is to learn a new skill, such as using the internet; use memory tools such as appointment calendars, to-do lists, and reminder notes; getting adequate sleep; exercising regularly; eating a healthy diet; and restricting alcohol consumption.

There is no cure for dementia and there are no treatments that reverse or halt disease progression for most of the dementias. Patients can benefit to some extent from treatment with available medications and other measures, such as cognitive training. Many people with dementia, particularly those in the early stages, may benefit from practicing tasks designed to improve performance in specific aspects of cognitive functioning. For example, people can sometimes be taught to use memory aids, such as mnemonics, computerized recall devices, or note taking. Behavior modification—rewarding appropriate or positive behavior and ignoring inappropriate behavior—also may help control unacceptable or dangerous behaviors associated with dementia.

There is no cure for AD. However, medicines that treat the symptoms of AD are available and work best for patients in the early stage of the disease. Some medicines keep memory loss and other symptoms from getting worse for a time. Other medicines work to help people with AD sleep better or feel less worried and depressed. These medicines do not directly treat the disease, but they do help patients feel more comfortable in their surroundings.

As of 2008, there were five oral drugs approved by the U.S. Food and Drug Administration (FDA) to control the symptoms of AD and slow its progression. Four of these drugs, called cholinesterase inhibitors, slow the metabolic breakdown of acetylcholine, an important brain chemical involved in nerve cell communication. These drugs make more of this chemical available for communication between cells, which in turn slows the progression of cognitive impairment. Cholinesterase inhibitors can be effective for patients with mild to moderate symptoms of AD. These four drugs are tacrine (Cognex), donepezil (Aricept), rivastigmine (Exelon), and galantamine (Razadyne). In 2006, the FDA approved the use of donepezil to treat severe symptoms of AD and in 2007, approved rivastigmine in a patch form that delivers the drug through the skin. The fifth drug, memantine (Namenda), is approved to treat moderate to severe AD. Adverse side effects of all five drugs include **nausea**, **dizziness**, **headache**, and **fatigue**. Some of these drugs also are used to treat non-AD types of dementia.

Nutrition/Dietetic concerns

Several studies have found that high fat and high calorie **diets** may increase the risk of developing AD and other types of progressive dementia. Other risk factors for dementia and AD include alcohol, salt, and refined carbohydrates. It is recommended that patients with dementia avoid environmental toxins, such as tobacco smoke.

The incidence of AD in European and North American countries has been shown to be reduced with fish consumption. Researchers speculate that **Omega-3 fatty acids** in fish may delay the onset of

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KEY TERMS

Amnesic—Relating to amnesia, the loss of memory.

Amyloid plaque—A waxy, translucent substance composed of complex protein fibers and polysaccharides that forms in body tissues in some degenerative diseases, such as Alzheimer's disease.

Antioxidant—A substance that inhibits the destructive effects of oxidation in the body.

Computed tomography (CT) scan—A diagnostic radiological scan in which cross-sectional images of the body are formed and shown on a computer screen.

Delusion—A persistent false belief held in the face of strong contradictory evidence.

Dementia—A usually progressive deterioration of intellectual functions, such as memory, that can occur while other brain functions such as those controlling movement and the senses are retained.

Genetic disease—A disease that is inherited from one or both parents.

Hydrocephalus—An increase of cerebrospinal fluid around the brain, resulting in an enlarged head.

Magnetic resonance imaging (MRI)—An imaging technique that uses electromagnetic radiation to obtain images of the body's soft tissues.

Parkinson's disease—A progressive nervous disorder marked by symptoms of trembling hands, lifeless face, monotone voice, and a slow shuffling walk.

Positron emission tomography (PET)—A method of medical imaging capable of displaying the metabolic activity of organs in the body that is useful in investigating brain disorders.

Tomography—A technique of using ultrasound, gamma rays, or x rays to produce a focused image of the structures across a specific depth within the body, while blurring details at other depths.

AD. Anti-inflammatory agents, such as **antioxidants**, have shown some effectiveness in treating dementia. A diet that includes antioxidants such as vitamin C, vitamin E, selenium, green tea, and **ginkgo biloba** extract, may be beneficial. Ginkgo biloba, in addition to its antioxidant properties, increases blood and oxygen flow to the brain, thereby boosting brain function.

Therapy

For mild memory loss, therapy may include activities such as playing cards, board games, and word games like crossword puzzles and anagrams. Reading books, magazines, or newspapers regularly, and then discussing them with friends, relatives, or caregivers also aids memory retention.

There are no specific therapies associated with dementia or AD. A patient with these disorders is encouraged to **exercise** as much as their symptoms or physical limitations allow. Daily supervised walks are a good general exercise for people with severe memory impairment. Physicians recommend that people with dementia or AD try to live as normal a life as possible. This includes maintaining contact with and visiting friends and relatives, and maintaining their usual daily routines. Caregivers can assist with these recommendations.

Prognosis

Only about 15% of people with mild memory loss progress to dementia or AD. The other 85% continues to live a relatively normal life with memory loss causing only minimal interference in their daily lives. Patients with dementia or AD typically survive 8–10 years after diagnosis. Death is most frequently related to **malnutrition**, secondary infection (infection that is not the initial medical problem, such as **pneumonia**) or heart disease. Malnutrition is a state in which not enough calories are taken in to support the normal functions of the human body. Malnourished people are also more prone to infections. There is no evidence that links AD to heart disease, but the rate for both increases as people age.

Prevention

Restricting alcohol intake to one or two drinks a day or less, not **smoking**, eating a healthy diet, and exercising both mentally and physically on a regular basis can prevent or delay the onset of mild memory loss. Higher education achievement seems to reduce risk, but this may be related to people of higher education remaining more mentally active in retirement.

As of early 2008, there was no known way to prevent dementia or AD. A number of studies in laboratory mice indicate that a Mediterranean-style diet low in sugar and saturated animal fat, and high in

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fruits, vegetables, and whole-grains may reduce the risk of developing abnormal memory loss, including dementia. Several studies also suggest that a glass of red wine once a day may provide protection against memory loss.

Research has revealed a number of other factors that may prevent or delay the onset of memory loss some people. For example, studies have shown that people with diabetes who maintain tight control over glucose (sugar) levels in their blood tend to score better on tests of cognitive function than those with poorly controlled diabetes. Several studies also suggest that people who engage in intellectually stimulating activities, such as social interactions, chess, crossword puzzles, and playing a musical instrument significantly lower their risk of developing forms of dementia. Mental activities may stimulate the brain in a way that increases a person's cognitive reserve—the ability to cope with or compensate for the pathologic changes associated with dementia.

Care giver concerns

Caring for a person with severe memory loss at home is a difficult task and can become overwhelming. Each day brings new challenges as the caregiver copes with changing levels of ability and new patterns of behavior. Caregivers themselves often are at increased risk for depression and illness, especially if they do not receive adequate support from family, friends, and the community. A major struggle caregivers face is dealing with the difficult behaviors of the person they are caring for. Basic activities of daily living such as dressing, bathing, and eating often become difficult to manage for both the person with severe memory loss and the caregiver. Having a plan for getting through the day can help caregivers cope.

Each person with severe memory loss is unique and responds differently. Caregivers should remain calm and offer reassurance to the person in their care. Community organizations are often available to provide assistance and support groups for caregivers can provide a place to express their feelings and help anticipate future challenges. The person with severe memory loss must be monitored closely when they are unable to determine their own care. Caregivers should learn to recognize signs that the memory loss is getting progressively worse.

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Alzheimer's Association, 225 N. Michigan Ave., 17th Floor, Chicago, IL, 60601-7633, (312) 335-8700, (800) 272-3900, (866) 699-1246, info@alz.org, http://www.alz.org.

Alzheimer's Australia, P.O. Box 4019, HawkerACT, Australia, 2614, 612 6254 4233, (800) 100-500 (Australia only), http://www.alzheimers.org.au.

Alzheimer's Disease Education and Referral Center, P.O. Box 8250, Silver Spring, MD, 20907-8250, (800) 438-4380, (301) 495-3334, adear@nia.nih.gov, http://www.nia.nih.gov/alzheimers.

Alzheimer's Foundation of America, 322 8th Ave., 6th Floor, New York, NY, 10001, (866) 232-8484, (646) 638-1546, info@alzfdn.org, http://www.alzfdn.org.

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American Geriatrics Society, Empire State Building, 350 Fifth Ave., Suite 801, New York, NY, 10118, (212) 308-1414, (212) 832-8646, info@americangeriatrics.org, http://www.americangeriatrics.org.

American Health Assistance Foundation, 22512 Gateway Center Dr., Clarkburg, MD, 20871, (301) 948-3244, (800) 437-2423, (301) 258-9454, iquiroz@ahaf.org, http://www.ahaf.org.

Association for Frontotemporal Dementias, 1616 Walnut St., Suite 1100, Philadelphia, PA, 19103, (267) 514-7221, (866) 507-7222, info@ftd-picks.org, http://www.ftd-picks.org.

European Alzheimer's Disease Consortium, Dept. of Internal Medicine and Clinical Gerontology, Toulouse University Hospital, 170 Avenue de Casselardit, Toulouse, France, 31300, 33-5-6177-7649, 33-5-6149-7109, reynish.e@chu-toulouse.fr, http://www.eadc.alz.heimer-europe.org.

Ken R. Wells

Memory loss *see* **Amnesia**

Ménière's disease

Definition

Ménière's disease is a condition characterized by recurrent vertigo (**dizziness**), **hearing loss**, and **tinnitus** (a roaring, buzzing or ringing sound in the ears).

Description

Ménière's disease was named for the French physician Prosper Ménière, who first described the illness in 1861. It is an abnormality within the inner ear. A fluid called endolymph moves in the membranous labyrinth or semicircular canals within the bony labyrinth inside the inner ear. When the head or body moves, the endolymph moves, causing nerve receptors in the membranous labyrinth to send signals to the brain about the body's motion. A change in the volume of the endolymph fluid, or swelling or rupture of the membranous labyrinth, is thought to result in Ménière's disease symptoms.

Causes and symptoms

Causes

The cause of Ménière's disease is unknown; however, scientists are studying several possible causes, including noise pollution, viral infections, or alterations in the patterns of blood flow in the structures of the inner ear. Since Ménière's disease sometimes runs in families, researchers are also looking into genetic factors as possible causes of the disorder.

One area of research that shows promise is the possible relationship between Ménière's disease and **migraine headache**. Dr. Ménière himself suggested the possibility of a link, but early studies yielded conflicting results. A rigorous German study published in late 2002 reported that the lifetime prevalence of migraine was 56% in patients diagnosed with Ménière's disease as compared to 25% for controls. The researchers noted that further work is necessary to determine the exact nature of the relationship between the two disorders.

A study published in late 2002 reported that there is a significant increase in the number of CD4 cells in the blood of patients having an acute attack of Ménière's disease. CD4 cells are a subtype of T cells, which are produced in the thymus gland and regulate the immune system's response to infected or malignant cells. Further research is needed to clarify the role of these cells in Ménière's disease.

Another possible factor in the development of Ménière's disease is the loss of myelin from the cells surrounding the vestibular nerve fibers. Myelin is a whitish fatty material in the cell membrane of the Schwann cells that form a sheath around certain nerve cells. It acts like an electrical insulator. A team of researchers at the University of Virginia reported in 2002 that the vestibular nerve cells in patients with unilateral Ménière's disease are demyelinated; that is, they have lost their protective "insulation." The researchers are investigating the possibility that a viral disease or disorder of the immune system is responsible for the demyelination of the vestibular nerve cells.

Symptoms

The symptoms of Ménière's disease are associated with a change in fluid volume within the labyrinth of the inner ear. Symptoms include severe dizziness or vertigo, tinnitus, hearing loss, and the sensation of **pain** or pressure in the affected ear. Symptoms appear suddenly, last up to several hours, and can occur as often as daily to as infrequently as once a year. A typical attack includes vertigo, tinnitus, and hearing loss; however, some individuals with Ménière's disease may experience a single symptom, like an occasional bout of slight dizziness or periodic, intense ringing in the ear. Attacks of severe vertigo can force the sufferer to have to sit or lie down, and may be accompanied by **headache**, **nausea**, **vomiting**, or **diarrhea**. Hearing

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tends to recover between attacks, but becomes progressively worse over time.

Ménière's disease usually starts between the ages of 20 and 50 years; however, it is not uncommon for elderly people to develop the disease without a previous history of symptoms. Ménière's disease affects men and women in equal numbers. In most patients only one ear is affected but in about 15% both ears are involved.

Diagnosis

An estimated 3–5 million people in the United States have Ménière's disease, and almost 100,000 new cases are diagnosed each year. Diagnosis is based on medical history, **physical examination**, hearing and **balance tests**, and medical imaging with **magnetic resonance imaging** (MRI).

Several types of tests may be used to diagnose the disease and to evaluation the extent of hearing loss. In patients with Ménière's disease, audiometric tests (hearing tests) usually indicate a sensory type of hearing loss in the affected ear. Speech discrimination or the ability to distinguish between words that sound alike is often diminished. In about 50% of patients, the balance function is reduced in the affected ear. An electronystagnograph (ENG) may be used to evaluate balance. Since the eyes and ears work together through the nervous system to coordinate balance, measurement of eye movements can be used to test the balance system. For this test, the patient is seated in a darkened room and recording electrodes, similar to those used with a heart monitor, are placed near the eyes. Warm and cool water or air are gently introduced into the each ear canal and eye movements are recorded.

Another test that may be used is an electrocochleograph (EcoG), which can measure increased inner ear fluid pressure.

Treatment

There is no cure for Ménière's disease, but medication, surgery, and dietary and behavioral changes, can help control or improve the symptoms.

Medications

Symptoms of Ménière's disease may be treated with a variety of oral medicine or through injections. **Antihistamines**, like diphenhydramine, meclizine, and cyclizine can be prescribed to sedate the vestibular system. A barbiturate medication like pentobarbital may be used to completely sedate the patient and relieve the vertigo. Anticholinergic drugs, like atropine or scopolamine, can help minimize **nausea and vomiting**. Diazepam has been found to be particularly effective for relief of vertigo and nausea in Ménière's disease. There have been some reports of successful control of vertigo after **antibiotics** (gentamicin or streptomycin) or a steroid medication (dexamethasone) are injected directly into the inner ear. Some researchers have found that gentamicin is effective in relieving tinnitus as well as vertigo.

A newer medication that appears to be effective in treating the vertigo associated with Ménière's disease is flunarizine, which is sold under the trade name Sibelium. Flunarizine is a **calcium** channel blocker and anticonvulsant that is presently used to treat Parkinson's disease, migraine headache, and other circulatory disorders that affect the brain.

Surgical procedures

Surgical procedures may be recommended if the vertigo attacks are frequent, severe, or disabling and cannot be controlled by other treatments. The most common surgical treatment is insertion of a small tube or shunt to drain some of the fluid from the canal. This treatment usually preserves hearing and controls vertigo in about one-half to two-thirds of cases, but it is not a permanent cure in all patients.

The vestibular nerve leads from the inner ear to the brain and is responsible for conducting nerve impulses related to balance. A vestibular neurectomy is a procedure where this nerve is cut so the distorted impulses causing dizziness no longer reach the brain. This procedure permanently cures the majority of patients and hearing is preserved in most cases. There is a slight risk that hearing or facial muscle control will be affected.

A labyrinthectomy is a surgical procedure in which the balance and hearing mechanism in the inner ear are destroyed on one side. This procedure is considered when the patient has poor hearing in the affected ear. Labyrinthectomy results in the highest rates of control of vertigo attacks, however, it also causes complete deafness in the affected ear.

Alternative treatment

Changes in diet and behavior are sometimes recommended. Eliminating **caffeine**, alcohol, and salt may relieve the frequency and intensity of attacks in some people with Ménière's disease. Reducing **stress** levels and eliminating tobacco use may also help.

Acupuncture is an alternative treatment that has been shown to help patients with Ménière's disease. The World Health Organization (WHO) lists Ménière's disease as one of 104 conditions that can be treated effectively with acupuncture.

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KEY TERMS

Myelin—A whitish fatty substance that acts like an electrical insulator around certain nerves in the peripheral nervous system. It is thought that the loss of the myelin surrounding the vestibular nerves may influence the development of Ménière's disease.

T cell—A type of white blood cell produced in the thymus gland that regulates the immune system's response to diseased or malignant cells. It is possible that a subcategory of T cells known as CD4 cells plays a role in Ménière's disease.

Tinnitus—A roaring, buzzing or ringing sound in the ears.

Transcutaneous electrical nerve stimulation (TENS)—A treatment in which a mild electrical current is passed through electrodes on the skin to stimulate nerves and block pain signals.

Vertigo—The medical term for dizziness or a spinning sensation.

Prognosis

Ménière's disease is a complex and unpredictable condition for which there is no cure. The vertigo associated with the disease can generally be managed or eliminated with medications and surgery. Hearing tends to become worse over time, and some of the surgical procedures recommended, in fact, cause deafness.

Prevention

Since the cause of Ménière's disease is unknown, there are no current strategies for its prevention. Research continues on the environmental and biological factors that may cause Ménière's disease or induce an attack, as well as on the physiological components of the fluid and labyrinth system involved in hearing and balance. Preventive strategies and more effective treatment should become evident once these mechanisms are better understood.

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ORGANIZATIONS

American Academy of Otolaryngology—Head and Neck Surgery, 1650 Diagonal Road, Alexandria, VA, 22314-2857, (703) 836-4444, http://www.entnet.org.

EAR Foundation of Arizona, 668 North 44th Street, Suite 300, Phoenix, AZ, 85008, (602) 685-1050, (602) 239-5117, melissa@earfoundationaz.com, http://www.earfoundationaz.com.

Vestibular Disorders Association (VEDA), P.O. Box 4467, Portland, OR, 97208-4467, (503) 229-8064, (800) 837-8428, http://www.vestibular.org.

Altha Roberts Edgren
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Meningioma *see* **Brain tumor**

Meningitis

Definition

Meningitis is a potentially fatal inflammation of the meninges, the membranes that encase the brain and spinal cord. Meningitis is most commonly caused

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HATTIE ALEXANDER (1901–1968)

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Hattie Alexander, a dedicated pediatrician, medical educator, and researcher in microbiology, won international recognition for deriving a serum to combat influenzal meningitis, a common disease that previously had been nearly always fatal to infants and young children. Alexander subsequently investigated microbiological genetics and the processes whereby bacteria, through genetic mutation, acquire resistance to antibiotics. In 1964, as president of the American Pediatric Society, she became one of the first women to head a national medical association.

As an intern at the Harriet Lane Home of Johns Hopkins Hospital from 1930 to 1931, Alexander became interested in influenzal meningitis. The source of the disease was *Hemophilus influenzae*, a bacteria that causes inflammation of the meninges, the membranes surrounding the brain and spinal cord. In 1931, Alexander began a second internship at the Babies Hospital of the Columbia-Presbyterian Medical Center in New York City. There, she witnessed first-hand the futility of medical efforts to save babies who had contracted influenzal meningitis.

Alexander's early research focused on deriving a serum (the liquid component of blood, in which antibodies are contained) that would be effective against influenzal meningitis. Serums derived from animals that have been exposed to a specific disease-producing bacterium often contain antibodies against the disease and can be developed for use in immunizing humans against it. Alexander knew that the Rockefeller Institute in New York City, however, had been able to prepare a rabbit serum for the treatment of pneumonia, another bacterial disease. Alexander therefore experimented with rabbit serums, and by 1939 was able to announce the development of a rabbit serum effective in curing infants of influenzal meningitis.

In the early 1940s, Alexander experimented with the use of drugs in combination with rabbit serum in the treatment of influenzal meningitis. Within the next two years, she saw infant deaths due to the disease drop by eighty percent.

by viruses, but also may be caused by a bacterial, or less commonly, a fungal infection. Non-infective causes of meningitis include certain drug **allergies**, some cancers, and **systemic lupus erythematosus** (SLE). Inflammation causes swelling of the brain. As the brain swells, fragile brain tissues are pressed against the skull. Brain cells in these areas can become damaged and eventually die.

Demographics

According to the Centers for Disease Control and Prevention (CDC), there are about 1.5 cases of bacterial meningitis for every 100,000 persons in the United States each year. The introduction of Hib vaccine against *Haemophilus influenzae* in 1990 has changed the demographics of bacterial meningitis in North America, shifting the median age of this type of meningitis from less than 2 years of age to 39 years. In addition, in the 2000s, there was an increase in cases among adults over age 60.

People of any race can get meningitis; however, African Americans are more likely to get meningitis than either Caucasian or Hispanic Americans. Infant males in the United States are three times more likely to develop meningitis than infant females; the rates are similar for both genders in adults.

The rates of meningitis in developing countries are thought to be at least 10 times as high as those in the United States and Canada. The lack of vaccines in these countries is the major factor in the difference. Periodic epidemics occur in sub-Saharan Africa and parts of India.

Description

Doctors sometimes divide cases of meningitis into three categories according to the speed of symptom

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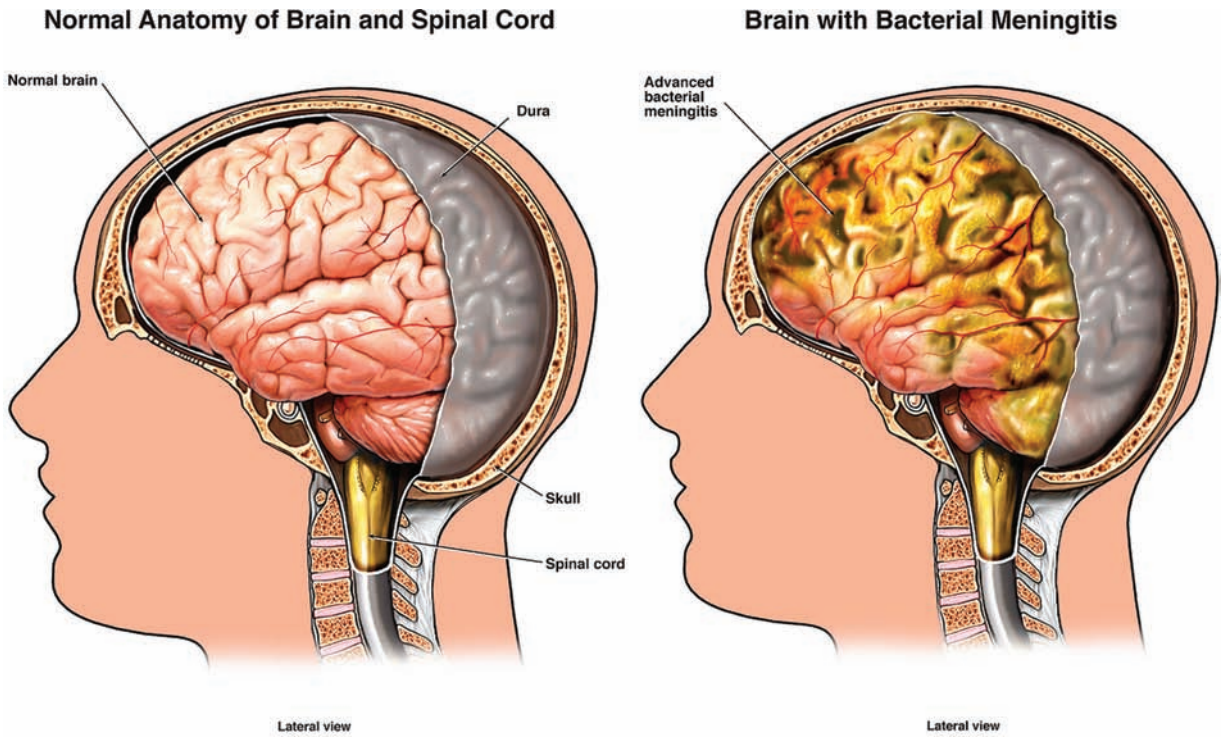

Illustration of bacterial meningitis in an adult. *(© PHOTOTAKE Inc./Alamy.)*

development. Acute meningitis develops in less than 24 hours and is caused by one of several species of bacteria; it is considered a medical emergency. Subacute meningitis takes between 1 and 7 days for symptoms to appear; it may be caused by bacteria or viruses. Chronic meningitis develops over a period of more than a week and may result from an infection or a noninfectious cause.

Structure of the brain

In order to understand why meningitis can be so dangerous, it is important to have a basic understanding of the anatomy of the brain. The meninges are three separate membranes, layered together, which encase the brain and spinal cord:

- The dura mater is the toughest, outermost layer, and is closely attached to the inside of the skull.
- The middle layer, the arachnoid mater, is important because of its involvement in the normal flow of the cerebrospinal fluid (CSF), a lubricating and nutritive fluid that bathes both the brain and the spinal cord.
- The innermost layer, the pia mater, helps direct blood vessels into the brain.
- The space between the arachnoid mater and the pia mater contains CSF, which helps insulate the brain from trauma. Many blood vessels, as well as peripheral and cranial nerves, pass through this space.

CSF, produced in specialized chambers deep inside the brain, flows over the surface of the brain and spinal cord. This fluid serves to cushion these relatively delicate structures, as well as supplying important nutrients for brain cells. CSF is reabsorbed by blood vessels located within the meninges. A careful balance between CSF production and reabsorption is important to avoid the accumulation of too much CSF.

Because the brain is enclosed in the hard, bony case of the skull, any disease that produces swelling will be damaging to the brain. The skull cannot expand at all, so when the swollen brain tissue pushes up against the skull's hard bone, the brain tissue becomes damaged and the blood supply is compromised, and this tissue may ultimately die. Furthermore, swelling on the right side of the brain will not only cause pressure and damage to that side of the brain, but by taking up precious space within the tight confines of the skull, the left side of the brain will also be pushed up against the hard surface of the skull, causing damage to the left side of the brain, as well.

Types of meningitis

Viral meningitis, which is also called aseptic meningitis, is the most common type of meningitis. It is a

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less severe infection than bacterial meningitis, is rarely fatal, and may not require any specific treatment. Viral meningitis is caused by one or more enteroviruses, which are viruses that normally live in the digestive tract. Viral meningitis usually develops in the late summer and early fall, and is most likely to affect children and adults under age 30. Most viral infections occur in children under the age of 5. Enteroviruses are present in saliva, throat mucus, and feces; they can be transmitted through direct contact with an infected person or an infected object or surface. Viral meningitis can also be caused by the viruses that cause **chickenpox**, **mumps**, HIV infection, **West Nile virus** infection, and **genital herpes**.

Bacterial meningitis is a medical emergency and has a high mortality rate if untreated. The origin of a bacterial infection leading to meningitis varies according to an individual's age, habits, geographical location, and health status. In newborns, the most common agents of meningitis are those contracted from the mother during labor and delivery, including the bacteria Group B streptococci, ***Escherichia coli***, and *Listeria monocytogenes*. Older children are more frequently infected by *Haemophilus influenzae*, *Neisseria meningitidis*, and *Streptococcus pneumoniae* bacteria, while adults are infected by *S. pneumoniae* and *N. meningitidis*. Persons who have had pneumococcal meningitis may be left with lifelong damage to their nervous system that includes deafness and brain damage. *N. meningitidis* is highly contagious and can cause epidemics. Epidemics of meningitis most often occur under crowded conditions, such as day care centers, college residence halls, or military barracks. Meningococcal meningitis has a mortality rate of 10–15 %.

Meningitis caused by fungi is rare in the general population but is a fairly common opportunistic infection in patients with HIV infection.

Risk factors

Risk factors for meningitis include:

- age. Since the introduction of childhood vaccines, bacterial meningitis is now more common in young adults.
- group living situations. These may include military bases, college dormitories, and child care centers.
- having a weakened immune system. People with AIDS or diabetes are at increased risk of meningitis.
- working with animals. Farmers and others who work with animals have an increased risk of *Listeria* infections.
- pregnancy.
- spleen removal. People who have had their spleen (a part of the immune system) removed have weaker immune systems.
- gender. Among newborns, boys are 3 times more likely than girls to get meningitis.
- lifestyle. Unsafe sexual practices and having a large number of sexual partners increases the risk of viral meningitis.

Causes and symptoms

Meningitis occurs when disease organisms that have entered the body and multiplied in the nose, mouth, and throat get into the bloodstream and are carried to the brain and the meninges. In a few cases meningitis can develop when the bacteria gain entrance to the body through a surgical incision or an injury to the head or neck. A few cases of meningitis result from inflammatory diseases like lupus or certain cancers.

Organisms causing meningitis

About 90% of cases of viral meningitis is caused by viruses from the enterovirus family. Viruses from this family also cause viral **gastritis** (stomach flu). However, viruses that cause mumps, **measles**, and **polio** can also cause viral meningitis. Although these diseases are uncommon in developed countries, they are still prevalent in the developing world and may be of concern to travelers.

Bacterial meningitis is caused primarily by four types of bacteria.

- *Streptococcus pneumoniae*. This is also called pneumococcal meningitis. This bacterium also causes pneumonia, ear, and sinus infections. It is a leading cause of bacterial meningitis in young children.
- *Neisseria meningitidis*. Also called meningococcal meningitis, this bacterium is highly contagious and is often responsible for outbreaks of meningitis among young adults.
- *Haemophilus influenzae*. Routine childhood vaccinations against Haemophilus bacteria have been available since the 1990s and in the developed world have substantially reduced this cause of meningitis.
- *Listeria monocytogenes*. Pregnant women and older adults are at higher risk than other groups for contracting listeria meningitis. Listeria can cross the placenta and kill a developing fetus.

Methods of disease transmission

Bacterial meningitis can be passed from person to person through coughing, sneezing, or kissing, but the

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disease does not spread as easily as the **common cold**. Once in the body, the bacteria are carried to the brain through the blood. However, in some cases, a person may have another type of infection (for instance, infection of the lungs, throat, or tissues of the heart) caused by an organism that can also cause meningitis. If this initial infection is not properly treated, the organism will continue to multiply, find its way into the blood stream, and be delivered in sufficient quantities to invade past the blood-brain barrier. Direct spread occurs when an organism spreads to the meninges from infected tissue next to or very near the meninges. This can occur, for example, with a severe and poorly treated ear or sinus infection. Insect and pet **bites** can also deliver disease organisms directly into the bloodstream.

Patients who experience skull **fractures** have abnormal openings to the sinuses, nasal passages, and middle ears. Organisms that usually live in the human respiratory system without causing disease can pass through openings caused by such fractures, reach the meninges, and cause infection. Similarly, patients who undergo surgical procedures or who have had foreign bodies surgically placed within their skulls (such as tubes to drain abnormal amounts of accumulated CSF) have an increased risk of meningitis.

Disease organisms can also reach the meninges via an uncommon method called intraneural spread. Intraneural spread involves an organism invading the body at a considerable distance away from the head, spreading along a nerve, and using that nerve as a pathway into the skull, where the organism can multiply and cause meningitis. Herpes simplex virus is known to use this type of spread, as is the **rabies** virus.

Symptoms

The most important symptoms used to diagnose meningitis are a high **fever**, stiff neck, and severe **headache**, which may come on in less than a day after infection. Other symptoms in adults may include:

- nausea and vomiting.
- extreme sensitivity to light (photophobia).
- confusion and difficulty concentrating.
- seizures.
- loss of appetite.
- drowsiness or difficulty waking up.
- skin rash (more common with meningococcal meningitis).

Infants and small children may have somewhat different symptoms:

- bulging of the soft spot (fontanelle) at the top of an infant's skull.
- constant crying.
- poor feeding.
- unusual sleepiness.
- stiffness in the baby's body as well as neck.

It is important to note that very young infants may not show the classic signs of meningitis. Early in infancy, a baby's immune system is not yet developed enough to mount a fever in response to infection, so fever may be absent. In some infants with meningitis, seizures are the only identifiable symptom. Similarly, debilitated elderly people may not have fever or other clearly identifiable symptoms of meningitis.

Diagnosis

Diagnosis of the cause of meningitis is essential to proper treatment, as the **antibiotics** used to treat bacterial meningitis are not useful in treating viral meningitis. A patient who has acute bacterial meningitis will usually have treatment started as soon as the doctor obtains a sample of cerebrospinal fluid for testing. The CSF is obtained by performing a **lumbar puncture**, also known as a spinal tap. This is a procedure in which a needle is inserted into an area in the lower back where the doctor can easily obtain a sample of cerebrospinal fluid.

Examination

An examination of a patient with suspected meningitis will include a recent history of the patient's activities to indicate possible exposure to disease agents, such as recent travel, contact with infected persons, or contact with animals or insects. The season of the year may be an important diagnostic clue; **enterovirus infections** are more common in North America in late summer and early fall, while insect-borne infections are more common in late spring and summer. The doctor will also perform a neurological examination, which includes testing of the patient's hearing and speech, vision, coordination and balance, reflexes, mental status, and recent changes in mood or behavior. In addition, certain manipulations of the patient's head (lowering the head, chin toward chest, for example) are difficult to perform and painful for a person with meningitis.

A patient with subacute meningitis may be given an examination to check for an ear, throat, or sinus infection. In addition to moving the patient's head, the doctor may also perform two other maneuvers to see whether the patient's meninges are inflamed. In one test, the doctor raises the patient's leg at the hip to a

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KEY TERMS

Arachnoid mater—The middle layer of the meninges.

Aseptic meningitis—A term that is sometimes used for meningitis that is not caused by bacteria.

Blood-brain barrier—An arrangement of cells within the blood vessels of the brain that prevents the passage of toxic substances, including infectious agents, from the blood and into the brain. It also makes it difficult for certain medications to pass into brain tissue.

Cerebrospinal fluid (CSF)—Fluid made in chambers within the brain which then flows over the surface of the brain and spinal cord. CSF provides nutrition to cells of the nervous system, as well as providing a cushion for the structures of the central nervous system.

Dura mater—The outermost layer of the meninges.

Enteroviruses—A family of viruses that normally live in the digestive tract.

Hydrocephalus—Abnormal accumulation of cerebrospinal fluid within the cavities inside the brain.

Lumbar puncture (LP)—A medical test in which a very narrow needle is inserted into a specific space between the vertebrae of the lower back in order to obtain a sample of CSF for examination. It is also known as a spinal tap.

Meninges (singular, meninx)—The membranes that cover the brain and spinal cord.

Opportunistic infection—An infection caused by an organism that does not cause disease in a person with a healthy immune system.

Photophobia—Abnormal sensitivity to light.

Pia mater—The innermost layer of the meninges.

Systemic lupus erythematosus (SLE)—A chronic, inflammatory, autoimmune disorder in which the individual's immune system attacks, injures, and destroys the body's own organs and tissues. It may affect many organ systems including the skin, joints, lungs, heart, and kidneys.

right angle from the examining table and tries to straighten the lower leg. If the leg cannot be straightened or if the patient experiences neck **pain**, he or she most likely has meningitis. The other maneuver involves bending the patient's neck forward as they lie on the table. If the knees and hips flex upward, the patient probably has meningitis.

Tests

If a sample of CSF is taken, it is sent to a laboratory for analysis. The CSF is then examined under a microscope to look for bacteria or fungi. Normal CSF contains set percentages of glucose and protein. These percentages will vary with bacterial, viral, or other causes of meningitis. For example, bacterial meningitis causes a smaller than normal percentage of glucose to be present in CSF, as the bacteria are essentially "eating" the host's glucose, and using it for their own **nutrition** and energy production. Normal CSF should contain no infection-fighting cells (white blood cells), so the presence of white blood cells in CSF is another indication of meningitis. Some of the withdrawn CSF is also put into special lab dishes to allow growth of the suspected infecting organism, which can then be identified more easily.

Identification of the specific bacterium can take as long as a week; meanwhile, the doctor can begin to treat the patient with a broad-spectrum antibiotic until the test results come back. In some cases the doctor will swab the patient's throat to obtain a sample of mucus and saliva for culture. The sample can be sent to a local or state laboratory or to the CDC for analysis. Throat cultures usually take between 2 and 3 days to yield results.

In March 2007 the Food and Drug Administration (FDA) approved a rapid CSF test that identifies virus particles in CSF called the Xpert EV test. Using a sample of CSF, this test can accurately identify about 90% of viral meningitis cases in less than three hours. Since bacterial meningitis is often fatal, if no virus is found in the CSF, the disease is treated as if it is caused by bacteria until proven otherwise. This test allows doctors to distinguish fairly quickly between viral and bacterial meningitis and avoid giving unnecessary antibiotics to patients with viral meningitis.

The doctor may also order such imaging tests as a computed tomography (CT) scan or **magnetic resonance imaging** (MRI). A CT scan may detect signs of inflammation of the meninges. Imaging tests can also be used to rule out head trauma, **stroke**, tumors, and **blood clots** in the brain.

Treatment

Traditional

Meningitis is a medical emergency. Individuals with the symptoms of meningitis must get to a hospital

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as quickly as possible, particularly if the symptoms have developed in less than one day. People who are acutely ill and are taken to a hospital are usually treated within 30 minutes of their arrival, as emergency room doctors assume that the patient has bacterial meningitis and do not want to delay treatment until the specific organism is identified. A sample of cerebrospinal fluid is taken by a spinal tap for analysis; then the patient is given intravenous penicillin or another broad-spectrum antibiotic, intravenous fluids, and pure oxygen to assist breathing. The patient may also need to be treated for seizures, or to have fluid drained from the sinuses or from the space between the meninges and the brain. After the specific bacterium has been identified, the doctor can adjust the type and dosage of the antibiotics given to the patient. People with bacterial meningitis may need additional treatment for **shock**, seizures, **dehydration**, and brain swelling. Serious cases of bacterial meningitis may require treatment in an intensive care unit (ICU) and **life support**.

Viral meningitis cannot be treated with antibiotics. Patients are usually advised to stay home and rest in bed for a few weeks. They can take over-the-counter pain relievers for muscle aches and pains and to bring down fever. If the viral meningitis is caused by the herpes virus, the doctor may also prescribe acyclovir or gancyclovir, **antiviral drugs** used to treat herpes.

Drugs

Bacterial meningitis is usually treated with a combination of intravenous antibiotics. The specific combination depends on the patient's age and immune status; however, most antibiotic combinations consist of ampicillin (Marcillin, Omnipen) plus cefotaxime (Claforan) or ceftriaxone (Rocephin) plus vancomycin (Vancocin). Treatment is given for 7–10 days for less severe infections to 14–21 days for severe infections. In some cases the patient may also be given **steroids**, most commonly dexamethasone, to reduce inflammation caused by the bacteria.

Alternative

Because meningitis is a potentially deadly condition, traditional medical doctors should be contacted immediately for diagnosis and treatment. Alternative treatments should be used only to support the recovery process following appropriate antibiotic treatments, or used concurrently with antibiotic treatments.

Alternative therapies, such as homeopathy, **traditional Chinese medicine**, and Western herbal medicine may help patients regain their health and build up their immune systems. The recovering individual, under the direction of a professional alternative therapist, may opt to include mushrooms into his or her diet to stimulate immune function. The patient should contact an experienced herbalist or homeopathic practitioner for specific remedies.

Prognosis

The patient's prognosis depends on the type of meningitis that they have as well as their overall health. Patients who experience only headache, fever, and stiff neck may recover in 2–4 weeks. Patients with bacterial meningitis typically show some relief within 48 to 72 hours following initial treatment; however, they are more likely to experience complications caused by the disease. Acute bacterial meningitis has a mortality rate of 10–15 percent even with treatment. The reported mortality rates for each specific organism are 19–26% for *S. pneumoniae* meningitis, 3–6% for *H. influenzae* meningitis, 3–13% for *N. meningitidis* meningitis, and 15–29% for *L. monocytogenes* meningitis. Pneumococcal meningitis may have a mortality rate as high as 21 percent. Of the patients who survive bacterial meningitis, between 10 and 20 percent will suffer such complications as blindness, **hydrocephalus**, **hearing loss**, **learning disorders**, or even **paralysis**. Scarring of the meninges may result in obstruction of the normal flow of CSF, causing abnormal accumulation of CSF. This may be a chronic problem for some people, requiring the installation of shunt tubes to drain the accumulation on a regular basis.

Viral meningitis is usually a much milder disease than bacterial meningitis. Patients receiving treatment for viral meningitis and **encephalitis** usually see some relief in 24–48 hours. Some patients may need to be hospitalized for supportive care for a week or so, but most can recover at home within two to four weeks. Complications are rare with viral meningitis; the mortality rate is less than 1%.

Prevention

As of 2010, several vaccines can be used to prevent meningitis. As has already been mentioned, the rates of *Haemophilus influenzae* meningitis among young children dropped dramatically after the Hib vaccine was added to childhood immunization schedules in the 1990s. Other vaccines have been developed to protect adults as well as children from pneumococcal and meningococcal meningitis. There is one type of pneumococcal vaccine known as PCV7, recommended for children between 2 and 5 years of age who are at high risk of infection.

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A different vaccine known as PPV is recommended for adults at risk of pneumococcal meningitis: those over 65, those with weakened immune systems, those with diabetes or heart disease, and those whose spleen was removed. The vaccine that protects against the meningococcus is known as Menactra or MCV4. It is recommended for all children at 11–12 and for college students who were not vaccinated at that age. MCV4 can also be used to protect people exposed to meningitis during an outbreak or who must travel to countries with high rates of meningococcal meningitis. Adults over 55 should be immunized with a similar vaccine called MPSV4, a meningococcal polysaccharide vaccine known as Menomune.

Other preventive measures that people can take include:

- Keeping the immune system strong by getting enough sleep, exercising regularly, and eating a healthy diet.
- Washing the hands regularly, particularly when living in a dormitory or similar shared housing situation.
- Avoiding sharing glasses, drinking cups, food utensils, and similar items with others who may be infected or exposed to infection.
- Covering the mouth or nose before sneezing or coughing.
- Taking any antibiotics that may be prescribed during a meningitis outbreak in one's school or workplace.
- Asking the doctor about vaccination against meningitis before traveling abroad.

Resources

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Meningitis: Questions and Answers. United States Centers for Disease Control and Prevention. February 23, 2010. http://www.cdc.gov/meningitis/about/faq.html

ORGANIZATIONS

Immunization Action Coalition (IAC), 1573 Selby Avenue, Suite 234, Saint Paul, MN, 55104, (651)647-9009, (651)647-9131, admin@immunize.org, http://www.immunize.org.

Infectious Diseases Society of America (IDSA), 1300 Wilson Boulevard, Suite 300, Arlington, VA, 22209, (703) 299-0200, (703) 299-0204, info@idsociety.org, http://www.idsociety.org.

Meningitis Research Foundation, Midland Way, ThornburyBristol, United Kingdom, BS25 2BS, 01454 281811, 01454 281094, info@meningitis.org, http://www.meningitis.org.

National Institute of Allergy and Infectious Diseases Office of Communications and Government Relations, 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-6612, (301) 496-5717, (866) 284-4107 or TDD: (800)877-8339 (for hearing impaired), (301) 402-3573, http://www3.niaid.nih.gov.

National Institute of Neurological Disorders and Stroke (NINDS), P.O. Box 5801, Bethesda, MD, 20828, (301) 496-5751. TTY: (301) 468-5981, (800) 352-9424, http://www.ninds.nih.gov.

United States Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (404) 639-3534, 800-CDC-INFO (800-232-4636). TTY: (888) 232-6348, inquiry@cdc.gov, http://www.cdc.gov.

World Health Organization (WHO), Avenue Appia 20, 1211 Geneva 27, Switzerland, + 41 22 791 21 11, + 41 22 791 31 11, info@who.int, http://www.who.int/en.

Helen Colby, MS
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Meningocele *see* **Spina bifida**

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Meningococcemia

Definition

Meningococcemia is the presence of meningococcus in the bloodstream. Meningococcus, a bacteria formally called *Neisseria meningitidis*, can be one of the most dramatic and rapidly fatal of all infectious diseases.

Causes and symptoms

Meningococcemia, a relatively uncommon infection, occurs most commonly in children and young adults. In susceptible people, it may cause a very severe illness that can produce **death** within hours. The bacteria, which can spread from person to person, usually first causes a colonization in the upper airway, but without symptoms. From there, it can penetrate into the bloodstream to the central nervous system and cause **meningitis** or develop into a full-blown bloodstream infection (meningococcemia). Fortunately in most colonized people, this does not happen and the result of this colonization is long-lasting immunity against the particular strain.

After colonization is established, symptoms can develop within one day to one to two weeks. After a short period of time (one hour up to one to two days) when the patient complains of **fever** and muscle aches, more severe symptoms can develop. Unfortunately during this early stage, a doctor cannot tell this illness from any other illness, such as a viral infection like **influenza**. Unless the case is occurring in a person known to have been exposed to or in the midst of an epidemic of meningococcal disease, there may be no specific symptoms or signs found that help the doctor diagnose the problem. Rarely, a low-grade bloodstream infection called chronic meningococcemia can occur.

A close-up image of a person's hand with meningococcemia. This disease is caused by the presence of meningococcus (*Neisseria meningitidis*) in the bloodstream. The organism can cause multiple illnesses and can damage small blood vessels. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

After this initial period, the patient will often complain of continued fever, shaking chills, overwhelming weakness, and even a feeling of impending doom. The organism is multiplying in the bloodstream, unchecked by the immune system. The severity of the illness and its dire complications are caused by the damage the organism does to the small blood vessel walls. This damage is called a **vasculitis**, an inflammation of a blood vessel. Damage to the small vessels causes them to become leaky. The first signs of the infection's severity are small bleeding spots seen on the skin (petechiae). A doctor should always suspect meningococcemia when he/she finds an acutely ill patient with fever, chills, and petechiae.

Quickly (within hours), the blood vessel damage increases and large bleeding areas on the skin (purpura) are seen. The same changes are taking place in the affected person's internal organs. The blood pressure is often low and there may be signs of bleeding from other organs (like coughing up blood, nose bleeds, blood in the urine). The organism not only damages the blood vessels by causing them to leak, but also causes clotting inside the vessels. If this clotting occurs in the larger arteries, it results in major tissue damage. Essentially, large areas of skin, muscle, and internal organs die from lack of blood and oxygen. Even if the disease is quickly diagnosed and treated, the patient has a high risk of dying.

Diagnosis

The diagnosis of meningococcemia can be made by the growth of the organism from blood cultures. Treatment should begin when the diagnosis is suspected and should not be delayed waiting for positive cultures. Obtaining fluid from a petechial spot and staining it in the laboratory can assist in quickly seeing the organism.

Treatment

Immediate treatment of a suspected case of meningococcemia begins with **antibiotics** that work against the organism. Possible choices include penicillin G, ceftriaxone (Rocephin), cefotaxime (Claforan), or trimethoprim/sulfamethoxazole (Bactrim, Septra). If the patient is diagnosed in a doctor's office, antibiotics should be given immediately if possible, even before transfer to the hospital and even if cultures cannot be obtained before treatment. It is most likely

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KEY TERMS

Blood culture—A procedure where blood is collected from a vein and is placed in a small bottle that contains a special liquid; the liquid will make any organisms that are present in the blood sample grow. These organisms can then be grown and identified in the laboratory so that the proper antibiotic can be given to the patient.

Colonization—The presence of bacteria on a body surface (like on the skin, mouth, intestines or airway) without causing disease in the person.

Complement—One of several proteins in the blood that acts with other proteins to assist in killing bacteria.

Meningitis—Inflammation of the membranes of the brain or spinal cord.

that the speed of initial treatment will affect the ultimate outcome.

Prognosis

As many as 15-20% of patients with meningococcemia will die as a result of the acute infection. A significant percentage of the survivors will have tissue damage that requires surgical treatment. This treatment may consist of skin grafts, or even partial or full amputations of an arm or leg. Certain people with immune system defects (particularly those with defects in the complement system) may have recurrent episodes of meningococcemia. These patients, however, seem to have a less serious outcome.

Prevention

Although a vaccine is available for meningococcus, it is still difficult at this time to produce a vaccine for the type B organism, the most common one in the United States. Because of this and the short time that the vaccine seems to offer protection, the product has not been routinely used in the United States. It can be used for travelers going to areas where meningococcal disease is more common or is epidemic. Recently, the vaccine has been suggested for use in incoming college freshman, particularly those living in dormitories. These students appear to have a somewhat higher risk of meningococcal infections.

It is, however, recommended that all people take certain antibiotics if they have had contact (like at home or in a daycare) with a person who has meningococcal infection. The most common antibiotics given are rifampin (Rifadin) or ciprofloxacin (Cipro). These medicines are usually taken by mouth twice a day for two days. This treatment will decrease the risk of infection in these people who have been exposed. However, the overall risk to people who have been exposed, even without antibiotic use, is probably no more than 1-2%.

ORGANIZATIONS

University of Maryland Medical System, 22 S. Greene Street, Baltimore, MD 21201. TDD: (401) 328-9600 or (800) 492-5538, http://www.umm.edu/ency/article/001349.htm.

Larry I. Lutwick, MD

Meningomyelocele *see* **Spina bifida**
Menkes' syndrome *see* **Mineral deficiency**

Menopause

Definition

Menopause represents the irreversible end of ovulation and menstruation. Technically menopause refers to the final menstrual period after which a woman can no longer conceive children. Nevertheless, menopause is not an abrupt event, but a gradual process that involves many physical and hormonal changes before fertility ceases. Menopause is not a disease that needs to be treated, but a natural result of **aging**. However, the changes that occur during the time surrounding menopause can cause symptoms of widely varying severity that a women may wish to treat. Women have many options for managing these symptoms.

Description

Perimenopause is the time surrounding menopause. It can last for several years, and many women have irregular periods and other changes during this time. Although it is not easy to pinpoint when menopause begins, doctors agree that it is complete when a woman has not had a menstrual period for a full year.

There is no method to determine when the ovaries will begin to scale back, but a woman can get a general idea of when she will experience menopause based on her family history, body type, and lifestyle. A woman is likely to enter menopause at about the same age as her mother and sisters. Women who are smokers are more likely to begin menopause earlier than

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nonsmokers. Women who began menstruating early will not necessarily stop having periods early. Eight out of every 100 women stop menstruating before age 40. At the other end of the spectrum, five out of every 100 continue to have periods until they are almost 60. The average age of menopause is 51.

Causes & symptoms

Once a woman enters **puberty**, her body releases one of the more than 400,000 eggs (ova) that are stored in her ovaries, about every 28 days in response to the interaction of several hormones. Blood supply to the womb (uterus) increases, and the lining of the uterus thickens in anticipation of receiving a fertilized egg. If the egg is not fertilized, the level of progesterone, the hormone mainly responsible for this uterine thickening, drops, and the uterine lining is sloughed off along with some blood. This menstrual flow is visible evidence ovulation has occurred.

By the time a woman reaches her late 30s or 40s, her ovaries begin to produce less of the female hormones estrogen and progesterone and to release eggs less regularly. As the levels of hormones fluctuate, the menstrual cycle begins to change. Some women may have longer periods with heavy flow followed by shorter cycles and very little bleeding. Others will begin to miss periods entirely. These irregular menstrual cycles make it more difficult for a woman to become pregnant. The gradual decline of estrogen also causes a wide variety of changes in tissues that respond to estrogen including the vagina, vulva, uterus, bladder, urethra, breasts, bones, heart, blood vessels, brain, skin, hair, and mucous membranes. Less immediately, the long-term lack of estrogen can make a woman more vulnerable to **osteoporosis**.

The most common symptom of perimenopause include:

- changes in the menstrual cycle
- hot flashes
- night sweats
- insomnia
- mood swings and increased irritability
- memory or concentration problems
- vaginal dryness
- heavy bleeding
- fatigue
- depression
- changes in the thickness and texture of hair
- headaches
- heart palpitations
- sexual disinterest
- urinary changes
- weight gain

Diagnosis

The clearest indication of menopause is the absence of a period for one full year. If it has been at least three months since a woman's last period, a follicle-stimulating hormone (FSH) test might be helpful in determining whether menopause has occurred. FSH levels rise steadily as a woman ages. The FSH test alone cannot be used as proof that a woman has entered early menopause. A better measure of menopause is to determine the levels of FSH, estrogen, progesterone, testosterone, and related hormones at mid-cycle. These tests are not routinely performed as most women can recognize the symptoms of perimenopause and menopause. They can, however, be helpful diagnostic tests in younger women who are showing symptoms of perimenopause.

Treatment

Decisions about if and how to treat symptoms associated with perimenopause should be made by a woman and her health care provider after taking into consideration her medical history and current research findings. Some women report success in using natural remedies to treat the unpleasant symptoms of menopause, although alternative therapies have only received significant attention in the United States in the last decade or so. Debate continues until scientific studies can prove these treatments' effectiveness on menopausal symptoms.

For women nearing menopause, alternative medical practitioners and traditional healthcare professionals generally recommend a diet high in fresh fruits, fresh vegetables, whole grains, nuts, seeds, and fresh vegetable juices and low in sugary treats and fats, especially animal fats. Calorie and portion control becomes more important as metabolism slows. Because a decrease in estrogen accelerates bone loss, women should make sure they get enough **calcium**. Most often a calcium supplement is recommended in addition to dairy products that provide calcium. Women generally need less iron after menopause because they no longer bleed monthly.

Herbs

Herbs have been used to relieve menopausal symptoms for centuries. In reasonable quantities, many herbs are relatively safe. Often adverse reactions to herbs come not from the herbs themselves, but from contaminants. Because the United States Food and

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Drug Administration (FDA) does not regulate herbal products as strictly as pharmaceutical medicines, contamination, mislabeling, or accidental overdose is possible. Herbs should be purchased from a recognized company or through a qualified herbal practitioner. Herbal practitioners recommend a dose based on a woman's history, body size, lifestyle, diet, and reported symptoms. Women who choose to take herbs for menopausal symptoms should learn as much as possible about herbs and work with a qualified practitioner such as an herbalist, a traditional Chinese doctor, or a naturopathic physician.

The following list of herbs include those that herbalists recommend to treat menopausal symptoms:

- black cohosh (*Cimicifuga racemosa*): hot flashes and other menstrual complaints
- black currant (*Ribes migrum*): breast tenderness
- chaste tree/chasteberry (*Vitex agnus-castus*): hot flashes, excessive menstrual bleeding, moodiness
- chickweed (*Stellaria media*): hot flashes
- evening primrose oil (*Oenothera biennis*): mood swings, irritability, breast tenderness
- fennel (*Foeniculum vulgare*): hot flashes, digestive gas, bloating
- flaxseed (*Linum usitatissimum*): excessive menstrual bleeding, breast tenderness, and other symptoms, including dry skin and vaginal dryness
- ginkgo (*Ginkgo biloba*): memory problems
- ginseng (*Panax ginseng*): hot flashes, fatigue, vaginal thinning
- hawthorn (*Crataegus laevigata*): memory problems, fuzzy thinking
- horsetail (*Equisetum arvense*): osteoporosis
- lady's mantle (*Alchemilla vulgaris*): excessive menstrual bleeding
- Licorice (*Glycyrrhiza glabra*) root: general menopausal symptoms
- Mexican wild yam (*Dioscorea villosa*) root: vaginal dryness, hot flashes, general menopause symptoms
- motherwort (*Leonurus cardiaca*): night sweats, hot flashes
- oat straw (*Avena sativa*): mood swings, anxiety
- passionflower (*Passiflora incarnata*): insomnia, pain
- raspberry leaf (*Rubus idaeus*): normalizes hormonal system
- sage (*Salvia officinalis*): mood swings, headaches, night sweats
- skullcap (*Scutellaria lateriflora*): insomnia
- sesame oil (*Sesamum orientale*): vaginal dryness (applied topically)
- valerian (*Valeriana officinalis*): insomnia
- violet (*Viola odorata*): hot flashes.

Natural estrogens (phytoestrogens)

Phytoestrogens are estrogen compounds found in plants. Proponents of plant estrogens (including soy products) believe that plant estrogens are better than synthetic estrogens, but science has not yet proved this. The results of small preliminary trials suggest that the estrogen compounds in soy products (soy is very high in plant estrogens) can relieve the severity of hot flashes and lower cholesterol. In one study at Bowman-Gray Medical School in North Carolina, women were able to ease their menopausal symptoms such as hot flashes by eating a large amount of fruits, vegetables, and whole grains, together with 4 oz of tofu four times a week. However, no one has shown that plant estrogens can provide these benefits without causing the same negative side effects as estrogen replacement therapy. In addition, it is difficult to judge how much estrogen is in various plant products as there is no requirement for standardization. Many women believe that natural or plant-based means harmless. In large doses, phytoestrogens can promote the abnormal growth of cells in the uterine lining. Unopposed estrogen of any type can lead to an increased risk of **cancer**.

Several studies have shown that a black cohosh extract (Remifemin) relieved menopausal symptoms as well as or better than estrogen and that it showed the greatest promise among alternative treatments. In a 2007 study conducted at the University of Pennsylvania and published in *International Journal of Cancer*, Remifemin was also shown to reduce the risk of **breast cancer**. The United States Office of Dietary Supplements considers the evidence from studies of black cohosh promising but cautions that the long-term safety of this herb has not been established and recommends that if women choose to use black cohosh extract, they do so for no more than six months.

Flaxseeds also are a good source of phytoestrogens. Other sources include red clover leaf, licorice, wild yam, chickpeas, pinto beans, lima beans, and pomegranates. In 2003, red clover leaf was thought to offer relief for hot flashes, but in two short clinical trials, it failed to demonstrate hot flash relief.

Homeopathy

Women interested in homeopathic remedies for menopausal symptoms should consult a homeopathic physician. The following homeopathic remedies are

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often recommended to alleviate specific groups of symptoms:

- lachesis: hot flashes, irritability, talkativeness, tightness around abdomen, dizziness, fainting
- sepia: bleeding between periods, chilliness, tearfulness, withdrawal from loved ones, sinking feeling in stomach
- pulsatilla: tearfulness, thirstless, feels better with others, avoids heat, hot flashes, varicose veins, hemorrhoids
- sulfur: philosophical personality, feeling hot, itching and burning of vagina and rectum
- lycopodium: low self esteem, bloated after eating, infrequent menstruation, low blood sugar, weak digestion, belching
- *Argentum nitricum:* gas, indigestion, craving for sweets and chocolate, panic attacks, fear of crossing bridges
- Magnesium phosphoricum: severe cramping
- transitional formula: hot flashes, night sweats, insomnia, skin-crawling sensation
- women's formula: perimenopause, PMS, irregular cycles, infertility, absent or excessive bleeding, menopausal discomfort
- vital formula: anxiety, headaches, palpitations, PMS, mood swings

Yoga

Many women find that **yoga** can ease menopausal symptoms. Yoga focuses on helping women unite the mind, body, and spirit to create balance. Because yoga has been shown to balance the endocrine system, some experts believe it may affect hormone-related problems. Studies have found that yoga can reduce **stress**, improve mood, boost a sluggish metabolism, and slow the heart rate. Specific yoga positions deal with particular problems, such as hot flashes, mood swings, vaginal and urinary problems, and other pains.

Exercise

Exercise helps ease hot flashes by lowering the amount of circulating FSH and by raising endorphin levels (which drop during a hot flash). Even exercising 20 minutes three times a week can significantly reduce hot flashes. Weight bearing exercises help to prevent osteoporosis. Regular exercise also provides many health benefits unrelated to menopause.

Acupuncture

This ancient Asian art involves placing very thin needles into different parts of the body to stimulate the system and unblock energy. It is usually painless and has been used for many menopausal symptoms including **insomnia**, hot flashes, and irregular periods. Practitioners believe that **acupuncture** can facilitate the opening of blocked energy channels, allowing the life force energy (chi) to flow freely. This allows the menopausal woman to keep her energy moving. Blocked energy usually increases the symptoms of menopause.

Acupressure and massage

Therapeutic massage involving **acupressure** can bring relief from a wide range of menopause symptoms by placing finger pressure at the same meridian points on the body that are used in acupuncture. There are more than 80 different types of massage, including foot **reflexology**, **Shiatsu** massage, and Swedish massage, but they all are based on the idea that boosting the circulation of blood and lymph benefits health. Breast massage (rubbing castor oil or olive oil on the breasts for five minutes three times a week) is claimed to help balance hormone levels, help the uterus contract during menstruation, and prevents cramping pains.

Biofeedback

Some women have been able to control hot flashes through **biofeedback**, a painless technique that helps a person train her mind to control her body. A biofeedback machine provides information about body processes (such as heart rate) as the woman relaxes her body. Using this technique, it is possible to control the body's temperature, heart rate, and breathing.

Other treatments

Therapeutic touch, an energy-based practice, may relieve menopausal symptoms. Cold compresses on the face and neck can ease hot flashes. Sound or **music therapy** may relieve stress and other menopausal symptoms. Prayer or **meditation** can help improve coping ability.

Dietary supplements

Women should discuss the use of dietary supplements with their health care provider. Some supplements interfere with the action of traditional pharmaceuticals and herbal remedies. Other supplements are harmful in large quantities. Supplementation with calcium, vitamin D, vitamin K, boron, manganese, magnesium, and phosphorous may aid in preventing osteoporosis. Vitamin E supplementation may reduce hot flashes and risk of heart disease.

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KEY TERMS

Endometrium—The lining of the uterus that is shed with each menstrual period.

Estrogen—Female hormone produced by the ovaries and released by the follicles as they mature. Responsible for female sexual characteristics, estrogen stimulates and triggers a response from at least 300 tissues, and may help some types of breast cancer to grow. After menopause, the production of the hormone gradually stops.

Follicle-stimulating hormone (FSH)—The pituitary hormone that stimulates the ovary to mature egg capsules (follicles). It is linked with rising estrogen production throughout the cycle. An elevated FSH (above 40) indicates menopause.

Hormone—A chemical messenger secreted by a gland that is released into the blood, and that travels to distant cells where it exerts an effect.

Hormone replacement therapy (HRT)—The use of estrogen and progesterone to replace hormones that the ovary no longer supplies. HRT is no longer used as long-term therapy for postmenopausal women.

Hot flash—A wave of heat that is one of the most common perimenopausal symptoms, triggered by the hypothalamus' response to estrogen withdrawal.

Hysterectomy—Surgical removal of the uterus.

Ovary—One of the two almond-shaped glands in the female reproductive system responsible for producing eggs and the hormones estrogen and progesterone.

Phytoestrogen—An estrogen-like substance produced by plants.

Placebo—A pill or liquid given during the study of a drug or dietary supplement that contains no medication or active ingredient. Usually study participants do not know if they are receiving a pill containing the drug or an identical-appearing placebo.

Progesterone—The hormone that is produced by the ovary after ovulation to prepare the uterine lining for a fertilized egg.

Testosterone—Male hormone produced by the testes and (in small amounts) in the ovaries. Testosterone is responsible for some masculine secondary sex characteristics such as growth of body hair and deepening voice.

Uterus—The female reproductive organ that contains and nourishes a fetus from implantation until birth. Also known as the womb.

Allopathic treatment

When a woman enters menopause, her levels of estrogen drop and symptoms, such as hot flashes and vaginal dryness, begin. Before 2002, many physicians treated these symptoms with **hormone replacement therapy** (HRT). HRT treats these symptoms by increasing estrogen and progesterone levels enough to suppress symptoms. However, in the summer of 2002, preliminary results from a large Women's Health Initiative study were released that showed HRT could have significantly harmful effects (harmful enough that the study was stopped early). The study found that a combination of estrogen and progestin (a form of progesterone) HRT caused the following when compared to a placebo (no hormones):

- increased risk of heart attack, stroke, and blood clots
- increased risk of invasive breast cancer
- increased risk of dementia
- decreased risk of colorectal cancer
- decreased risk of bone fractures

Treatment with estrogen alone produced the following results:

- no change in the risk of heart attacks
- increased risk of stroke and blood clots
- unclear changes in the risk of breast cancer
- no change in the risk of colorectal cancer
- decreased risk of bone fractures
- no data available on changes in risk of dementia

At the time the results of the Women's Health Initiative became available, about 9 million American women were using HRT. Most physicians now no longer routinely recommend HRT to treat menopausal symptoms. Nevertheless, under certain circumstances when symptoms associated with menopause are so severe as to interfere with activities of daily life, a short course of HRT may be prescribed. Some doctors believe that short-term use of estrogen for those women with severe symptoms of hot flashes or night sweats is a sensible choice as long as they do not have a history of breast cancer. However, other doctors believe that in almost all cases the risks of HRT

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outweigh the benefits. The decision should be made by a woman and her doctor after taking into consideration her medical history and situation. Women who choose to take hormones should have an annual mammogram, breast exam, and **pelvic exam** and should report any unusual vaginal bleeding or spotting (a sign of possible uterine cancer).

Postmenopausal treatment for osteoporosis

Raloxifene (Evista, Keoxifene) is a drug that is used to treat osteoporosis (bone loss) in postmenopausal women. It does not increase the risk breast cancer, although it may increase breast tenderness. It may also worsen hot flashes and cause uterine bleeding. It is not a treatment for symptoms associated with menopause. Several other drugs are also available to help reduce the risk of **fractures** in postmenopausal women with osteoporosis. In 2002, the FDA approved teriparatide (Forteo) for the treatment of osteoporosis. Ibandronate (Boniva) and alendronate (Fosamax) are also used to treat osteoporosis in postmenopausal women.

Testosterone replacement

The ovaries also produce a small amount of male hormones (about 300 micrograms), which decrease slightly as a woman enters menopause. Most women never need testosterone replacement. Testosterone can improve the libido, and decrease **anxiety** and depression. Adding testosterone is especially beneficial to women who have had hysterectomies. Testosterone also eases breast tenderness and helps prevent bone loss. Side effects include mild **acne** and some facial hair growth.

Expected results

Menopause is a natural condition of aging. Some women experience no problems associated with menopause, while others notice significant unpleasant symptoms. Results of allopathic and alternative treatments vary from one woman to another.

Prevention

Because menopause is a natural part of the aging process it cannot be prevented, however, some of the symptoms can be relieved by the treatments listed above.

Resources

BOOKS

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"Menopause Infocenter" *Holistic Online*. [cited October 30, 2009]. http://www.holisticonline.com/remedies/hrt/hrt_home.htm

"Menopause Online" *Menopause Online*. [cited October 30, 2009]. http://www.menopause-online.com

ORGANIZATIONS

American Holistic Medical Association., PO Box 2016, Edmonds, WA, 98020, (425) 967-0737., http://www.holisticmedicine.org.

American Menopause Foundation, Inc., Empire State Bldg., 350 Fifth Ave., Ste. 2822, New York, NY, 10118, (212) 714- 2398., http://www.americanmenopause.org.

Federation of Feminist Women's Health Centers., 14220 Interurban Ave South #140, Seattle, WA, 98168, http://www.fwhc.org/menopause.

National Women's Health Network., 514 10th Street NW, Suite 400, Washington, DC, 20004, (202) 628-7814, http://www.nwhn.org.

North American Menopause Society., PO Box 94527, Cleveland, OH, 44101, (216) 844-8748., http://www.menopause.org.

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Menorrhagia *see* **Dysfunctional uterine bleeding**

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Men's health

Definition

Men's health is concerned with identifying, preventing, and treating conditions that are most common or specific to men.

Purpose

Men live on average seven years less than women; life expectancy in the United States is 72 years for men and 79 years for women. The reasons for this discrepancy are not completely understood. Men may have some genetic predisposition for lower life expectancy, as women tend to outlive men in most areas throughout the world. But men also have different lifestyle patterns that increase the wear and tear on their bodies. Studies have shown that men tend to drink and smoke more than women, men obtain medical care less frequently than women, and men generally have more stressful habits. It is clear to health professionals that men can benefit from increased knowledge of male medical issues and by understanding how lifestyle choices impact health.

According to the Centers for Disease Control (CDC), the ten leading causes of **death** for men in the United States are:

1. heart disease
2. cancer
3. stroke
4. accidents
5. lung disease (including emphysema and chronic bronchitis)
6. pneumonia
7. diabetes
8. suicide
9. liver disease
10. homicides

Men can experience conditions as diverse as **sexually transmitted diseases** (STDs), mental illness, arthritis, urinary tract infections, athletic injuries, hair and skin problems, and digestive disorders. The field of men's health strives to reduce the risks and incidence of men's conditions by researching preventive practices, designing testing procedures for early detection, and recommending specialized courses of treatment.

Description

Prevention

Preventive practices for men's health emphasize diet, **exercise** and **stress** management, as well as elimination of risky behaviors such as **smoking** and excessive drinking. Four of the leading causes of death for American men are related to diet—heart disease, **cancer**, **stroke**, and diabetes. In addition, men are more likely than women to have diet-related conditions including high cholesterol, high blood pressure, and **obesity**, all of which increase the risk of certain diseases and premature death.

For American men, dietary problems are usually not the result of getting too little nourishment but of eating too much fat, sugar, and overall calories. The dietary change most likely to improve the health of males is reduced intake of fats, particularly cholesterol and saturated fats. Cholesterol and saturated fats are found mainly in meat and dairy products. Calories from fat should amount to no more than 30% of total daily calories. Eating adequate protein is generally not a problem for American men, so replacing some dairy and meat consumption with high fiber vegetable proteins such as beans and soy would be beneficial. Complex carbohydrates should provide the bulk of daily calories, such as those from whole grains and legumes, while sugar intake such as in soft drinks, desserts, and processed foods should be significantly reduced. Increasing dietary fiber is recommended by eating plenty of fresh fruits, vegetables, whole grains, and legumes. Other principles of a healthy diet are avoiding artificial and processed foods, eating food that is as fresh and natural as possible, drinking plenty of water, and avoiding hydrogenated or partially hydrogenated oils, which contain unhealthy substances called trans-fatty acids. Overeating should be avoided as should snacking between meals. Alcohol intake should be limited to one or two glasses per day.

Exercise

The health of men has been affected as work patterns have shifted. Physical labor has been replaced by machines and office work. Studies have estimated that more than 30% of Americans are now obese, which means that nearly one out of three people is significantly overweight. Obesity poses many risks including increased chance of heart disease, diabetes, and some cancers. Effective exercise programs help men control weight, reduce stress, increase energy levels, improve self-esteem, reduce **pain** and injuries, and improve sleep. Exercise programs should emphasize flexibility and stretching as well as plenty of aerobic

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activities, such as running and swimming. These activities exercise the heart and lungs and burn excess calories. Men may also choose anaerobic activities such as weight training to add muscles and increase strength. Routines should begin with warm-ups to reduce the chances of injuries and end with cool-down exercises to speed recovery.

Stress reduction

Stress is a silent killer; chronic (long-term) stress is a risk factor in many of the major diseases affecting men's mortality rates. Prolonged stress may cause ulcers, **sleep disorders**, addictions, depression, **anxiety**, and other conditions. Reduction of stress may require changes in both activities and attitudes. Exercise is recommended, as is reducing dependence on alcohol and nicotine. Men with extreme job-related stress may choose to spend more time with their families or in enjoyable activities. Men with stress levels that lead to destructive behaviors may need to pursue **psychotherapy** or significant lifestyle changes. **Nutrition**, social support, and healthy sleep patterns also reduce stress.

Alternative therapies may help with **stress reduction**. Their use has been adopted by many leading health centers. **Biofeedback** utilizes machines that monitor users' stress levels, helping people learn to control them. **Meditation** and other mind/body techniques are taught to enable the relaxation response, which has the opposite effects of stress in the body.

Testing

Routine physical examinations performed by physicians are recommended every three years for men in their twenties and thirties, every two years for men in their forties, and every year for men over 50. Physicians may order several screening tests depending on the age and condition of the patient. Blood tests screen for diabetes, high cholesterol, cancer, infections, and HIV. The prostate-specific antigen (PSA) test is a blood screen for **prostate cancer**. The digital rectal exam is used to manually check the prostate gland for enlargement or irregularities. Urine tests check for infections, kidney problems, and diabetes. The **fecal occult blood test** examines the stool for indications of ulcers or cancer. A **sigmoidoscopy** checks the health of the rectum and lower colon. Electrocardiograms (ECGs) check the status of the heart. Older men should consult an ophthalmologist (eye specialist) every two years for vision and glaucoma testing.

Men may perform self-tests as preventative measures. During a skin cancer self-exam, the entire skin is checked closely for irregular or changing **moles**, lesions, or blemishes, usually red, white or blue in color. Abnormal findings should be reported to a physician. Like some forms of skin cancer, **testicular cancer** tends to spread rapidly and early detection is crucial. The testicular self-exam is best performed in the shower or bath, because warm water relaxes the scrotum. The testicles are gently rolled and massaged between the fingers and thumb to feel for bumps, swelling, tenderness, or irregularities. Some self-test kits are available in pharmacies, including kits for blood pressure, high cholesterol, colorectal cancer, and blood glucose (diabetes). These do not take the place of proper medical care, and physicians should be consulted before their use.

Heart disease

Heart disease is the major cause of death among men. It claims nearly 500,000 lives each year in the United States and is more likely in men than women. Heart disease can take several forms but the most prevalent is coronary heart disease, in which the blood vessels that supply the heart with oxygen become blocked and the heart muscle becomes increasingly stressed. Arteriosclerosis, a major factor, is the hardening of arteries due to the accumulation of fatty materials. **Hypertension**, or high blood pressure, also poses major risks for both heart disease and stroke. **Angina** pectoris is the chest pain associated with the early stages of heart disease; it affects more than three million American men. When the blockage of blood supply to the heart becomes severe, a myocardial infarction (**heart attack**) may occur, which can be fatal.

The main symptom of angina pectoris is sharp pain on the left side of the chest that may radiate throughout the upper body. Other symptoms include **shortness of breath**, **dizziness**, **fatigue**, and swelling in the legs and ankles. Angina may be triggered by physical or emotional stress and lasts up to 30 minutes. Heart attacks have similar symptoms but with longer and more intense pain in the chest and upper body and may be accompanied by cold sweats and **vomiting**.

The American Heart Association lists the main risk factors for heart disease as being male, old age, having family history of the disease, smoking, high **cholesterol, high** blood pressure, diabetes, **alcoholism**, obesity, physical inactivity, and stress. Lifestyle habits such as diet, exercise and stress control play major roles in the development and prevention of heart disease in men.

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Osteoporosis

Osteoporosis is a disease characterized by a decrease in bone mass and density. Often thought of as disease more prevalent in women, more than two million men have the disease. It develops about 10 to 15 years later in life in men than in women and risk of **fractures** from the disease can be greater in men. Men can decrease their risk by increasing **calcium** and vitamin D.

Cancer

The American Cancer Society (ACS) estimates that more than 1.5 million cases of cancer were reported in 2010, not including the nearly 2 million cases of skin cancers. Men have a slightly higher risk for cancer than women. The World Health Organization (WHO) estimates that the number of cancer cases in most countries will double in the next 25 years, while men's prostate cancer is expected to go up 40% worldwide. The most common cancers in men are skin, prostate, lung, colorectal (colon and rectum), lymphoma (lymph glands), oral (mouth and throat), and testicular cancer. The ACS lists seven warning signs of cancer:

- unusual bleeding or discharge
- changes in bowel or bladder patterns
- persistent sores
- lumps or irregularities on the body
- difficulty swallowing or indigestion
- changes in warts or moles
- persistent cough or hoarseness in the throat

Although the causes of cancer are incompletely understood, there are several risk factors that increase its chances: family history of cancer, smoking, poor diet (high in fat, low in fiber), excessive alcohol consumption, skin damage from sunlight, and exposure to radiation, chemicals, and environmental pollutants.

The prostate gland is a walnut-sized organ in the male reproductive system, located near the rectum below the bladder. The ACS reported that nearly 217,000 new cases of prostate cancer would be diagnosed in 2010, causing more than 32,000 deaths, making prostate cancer the second most fatal cancer for men behind lung cancer. Worldwide studies have shown that about 12% of men in Western countries get prostate cancer, while 50% have enlarged prostates. Benign prostatic hyperplasia (BPH) is the enlargement of the prostate gland, called benign when it is non-cancerous although growth can be rapid.

With early detection, 98% of men with prostate cancer survive for five years. Symptoms of prostate cancer include difficulty in stopping or starting urination, frequent nighttime urination (nocturia), weak urine flow, and blood in the urine or semen.

Testicular cancer is most common in men between the ages of 15 and 34. The ACS estimated that there would be about 8,100 new cases of testicular cancer in 2005 in the United States. Cigarette smoking increases the risk of testicular cancer but quitting smoking does not reduce the risk.

Stroke

Strokes occur when the blood supply to the brain is interrupted and brain function becomes impaired due to lack of oxygen. Ischemic strokes occur due to blood vessels becoming blocked while hemorrhagic strokes are the result of broken blood vessels in or near the brain. Ischemic strokes account for about 80% of all strokes. The American Heart Association estimates that more than 600,000 Americans have strokes each year, with men having a 20% higher risk of stroke than women, although more women die from strokes. Other risk factors are hypertension (high blood pressure), previous heart attacks, age, family history, high cholesterol, smoking, obesity, alcoholism, and physical inactivity. African Americans have 60% greater chances for strokes than whites.

Symptoms of strokes include sudden weakness or **numbness**, blurring or loss of vision, difficulty speaking or understanding, sudden severe **headache**, and dizziness or falling. Stroke victims should receive immediate emergency care.

Diabetes mellitus

Carbohydrate intolerance—the inability to properly metabolize sugars—is known as **diabetes mellitus**, often just shortened to diabetes. The pancreas makes insulin, a hormone responsible for a cell's uptake of glucose (sugar) from blood for energy. People who have diabetes do not make enough insulin, or else the body cannot use what is made. Treatment includes achieving a healthy weight, engaging in exercise, and prescription medication. Sometimes people are able to cure their diabetes with diet and weight loss.

A proper diet for people with diabetes is comparable to what the average healthy person should already be eating. Basic tenets include: eat three meals daily, incorporate healthful snacks, focus on foods high in fiber, combine protein and carbohydrates with moderate amounts of unsaturated fat, and avoid sugar-sweetened beverages to reduce overall caloric intake.

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Male urinary tract problems

The urinary system includes the kidneys and bladder, the ureters between the kidneys and bladder, and the urethra, the tube through which urine flows from the bladder. Symptoms of urinary tract problems include frequent urination, excessive urination at night, painful or burning urination, weak urination, blood in the urine, or incontinence (involuntary loss of urine). **Urethritis** is infection of the urethra, which is a major symptom of sexually transmitted diseases (STDs). **Kidney stones** (nephrolithiasis) are the most common urinary tract problems, accounting for nearly one out of every 100 hospital admissions in the United States. Eighty percent of kidney stone patients are men. About 12% of American men develop kidney stones during their lifetimes. Kidney stones cause extreme pain when they move from the kidneys into the ureters. Ten percent of kidney stone cases require surgery. The best prevention for kidney stones is drinking plenty of fluids daily.

The male reproductive system

The male reproductive system includes the penis, testicles, scrotum, prostate, and other organs. Problems include **orchitis**, or infection of the testicles, and hydrocele, the buildup of fluid on the testicles. **Epididymitis** is inflammation of the tube that transports sperm from the testicles, and can cause severe pain, swelling, and **fever**. A varicocele is a group of **varicose veins** in the scrotum that can cause swelling and damage sperm. **Peyronie's disease** is the abnormal curvature of the penis caused by accumulated scar tissue. **Testicular torsion** is considered a medical emergency, when a testicle becomes twisted and blood supply is cut off. This condition can lead to permanent damage if not treated quickly. It is most common in males between the ages of 12 and 18. **Prostatitis** is infection or inflammation of the prostate gland.

Sexually transmitted diseases include **genital warts**, chlamydia, **gonorrhea**, **syphilis**, **genital herpes**, hepatitis, and HIV (human **immunodeficiency** virus). HIV is the leading cause of death for American men between the ages of 25 and 45. Symptoms of STDs include discharge of fluid from the penis; painful urination; sores, lesions, **itching**, or **rashes** in the genital area; and swelling of the lymph nodes in the groin.

Prevention of STDs begins with safe sexual behavior: wearing **condoms**, limiting the number of sexual partners, not mixing sexual encounters with alcohol, and avoiding sexual contact with infected people, prostitutes, and intravenous drug users. Men who engage in risky behaviors should have frequent HIV tests and medical examinations.

Male sexual health

Erectile dysfunction (ED), also called **impotence**, is a man's inability to maintain an erection for sexual intercourse. It affects nearly one in every 10 American men. Incidence of ED increases with age, but the problem can occur at any age. Up to 80% of ED is caused by physical problems, while 20% of cases are psychogenic, or psychological in origin. Causes of ED include hormonal problems, injuries, nerve damage, diseases, infections, diabetes, stress, depression, anxiety, drug **abuse**, and interactions with prescription drugs. ED may be the first indication of circulation problems due to diabetes, high blood pressure, or **coronary artery disease**.

A self-test men can perform to determine whether ED is physical or psychological is the stamp test, or nocturnal penile tumescence test. Physically healthy men experience several prolonged erections during sleep. The stamp test is done by attaching a strip of stamps around the penis before bedtime; if the stamps are torn in the morning, it generally indicates that nocturnal (nightly) erections have occurred and thus ED is not physiological. Men with ED should see a urologist for further diagnosis and discussion of the several treatment options available including drugs, hormone injections, and surgical repair or implants. Several new prescription drugs have become available in recent years.

Infertility occurs when men lack an adequate supply of sperm to cause **pregnancy**. As many as 15% of American couples, or more than five million Americans, are affected by infertility in one or both partners. A WHO project found that in about 20% of infertile couples, the problem was due to the man, while in another 27% of couples both partners had infertility problems. Injuries, **birth defects**, infections, environmental pollutants, chronic stress, drug abuse, and hormonal problems may account for male infertility, while one in four cases has no apparent cause and is termed idiopathic infertility. Declining sperm counts have been observed in industrialized countries, and possible explanations for this decrease are as diverse as increased environmental pollutants to the use of plastic diapers, which a German study claims damages infant testicles by keeping in excess heat. Male infertility can be diagnosed by sperm analysis, blood tests, radiographic scans of the testicles, and other tests.

Other types of **sexual dysfunction** include **premature ejaculation**, in which men cannot sustain

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intercourse long enough to bring their partners to climax, and retarded ejaculation (also called male orgasmic disorder) when male orgasm becomes difficult. Some men have periods of inadequate sexual desire (**hypoactive sexual desire disorder**), while sexual aversion disorder (SAD) is fear and repulsion of sexual activity. **Dyspareunia** is painful intercourse, and should be reported to physicians as it may indicate STDs or infections. In addition to medical care, sexual dysfunction may be treated by **sex therapy** or psychotherapy depending on its causes.

Vasectomies, a form of male birth control, are surgical operations that sever the tubes that transport sperm from the testicles. Vasectomies can be reversed but 10% of men become infertile due to the surgery. **Circumcision** is the surgical removal of the foreskin of the penis, for religious and medical reasons, performed on 60% of newborn males in the United States. Increasing controversy surrounds this procedure. Advocates of circumcision claim it prevents infections (called **balanitis**) on the head of the penis and reduces chances of **penile cancer**. Opponents of circumcision claim that the outdated procedure affords no medical benefits, causes unnecessary pain for infants, and that the lack of a foreskin may reduce sexual pleasure and performance.

Men's emotional health

Depression is a mood disorder marked by sadness, emotional pain, and the inability to feel pleasure. At least 10% of men will experience an episode of major depression at least once in their lives. Men with depression are five times more likely to commit **suicide**, a major cause of mortality in men. Men are half as likely as women to seek psychological help. Men may experience depression and emotional problems between the ages of 50 and 65, called the midlife crisis, as men face the major transition into retirement and older age.

Panic attacks have symptoms of overwhelming fear, chest pain, shortness of breath, numbness, and increased heart rate. Men may mistake them as heart attacks. Men also are plagued by addictions to nicotine, alcohol, and other drugs, which are often the unhealthy escape routes from deeper emotional issues. Studies have estimated that as many as one-third of Americans have sleep disorders, which may be psychological in origin and related to anxiety, stress, and lifestyle.

Mental illness can be particularly difficult for men because in our society men are taught to withhold rather than express emotions and feelings. Emotional problems can be strong signals for men to communicate and confront deeper issues. Help can be found from physicians, psychotherapists, and spiritual or religious counselors.

KEY TERMS

Emphysema—Disease of severe lung deterioration and impairment.

Obesity—Condition defined as being overweight by 30% of normal limits.

Sigmoidoscopy—Test procedure using an optical instrument to view the internal rectum and colon.

Urologist—Physician specializing in male reproductive and urinary systems.

Resources

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"Men's Health: Erectile Dysfunction." *Medical Update* January 2004: 2.

"Osteoporosis Develops Later in Men, Hits Harder." *Internal Medicine News* March 15, 2004: 30.

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A Man's Life Online Magazine. http://www.manslife.com.

The Prostate Cancer Infolink. http://www.comed.com/prostate.

ORGANIZATIONS

American Foundation for Urologic Disease, 1128 N. Charles St., Baltimore, MD, 21201, (401) 468-1800, http://www.afud.org.

American Urological Association Foundation, 1000 Corporate Blvd., Linthicum, MD, 21090, (410) 689-3700, (410) 689-3800, (866) 746-4282, auafoundation@auafoundation.org, http://www.urologyhealth.org/.

The Center for Holistic Urology, Columbia University Medical Center. Atchley Pavilion 11th Floor, 161 Ft. Washington Ave., New York, NY, 10032, (212) 305-0114, http://www.holisticurology.columbia.edu.

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Menstrual disorders

Definition

A menstrual disorder is a physical or emotional problem that interferes with the normal menstrual cycle, causing **pain**, unusually heavy or light bleeding, delayed menarche, or missed periods.

Description

A woman of childbearing age should menstruate every 28 days or so unless she is pregnant or moving into **menopause**. Numerous things can go wrong with the normal menstrual cycle, some the result of physical causes, others emotional. These include **amenorrhea**, or the cessation of menstruation, menorrhagia, or heavy bleeding, and **dysmenorrhea**, or severe menstrual cramps. Nearly every woman will experience one or more of these menstrual irregularities at some time in her life.

Amenorrhea

There are two types of amenorrhea: primary and secondary. Overall, they affect 2–5% of childbearing women, a number that is considerably higher among female athletes (possibly as high as 66%).

Primary amenorrhea occurs when a girl at least 16 years old is not menstruating. Young girls may not have regular periods for their first year or two, or their periods may be very light, a condition known as **oligomenorrhea**. A light flow is nothing to worry about. But if the period has not begun at all by age 16, there may be something wrong. Amenorrhea is most common in girls who are severely underweight and/or **exercise** intensely, both of which affect the amount of body fat necessary to trigger the release of hormones that, in turn, begin **puberty**.

Secondary amenorrhea occurs in women of childbearing age after a period of normal menstruation and is diagnosed when menstruation has stopped for three months. It can occur in women of any age.

Dysmenorrhea

Characterized by menstrual cramps or painful periods, dysmenorrhea, which comes from the Greek words for "painful flow," affects nearly every woman at some point in her life. It is the most common reproductive problem in women, resulting in numerous days absent from school, work, and other activities. There are two types: primary and secondary.

Primary, or normal cramps, affects up to 90% of all women, usually occurring in women about three years after they start menstruating and continuing through their mid-twenties or until they have a child. About 10% of women who have this type of dysmenorrhea cannot work, attend school, or participate in their normal activities. It may be accompanied by backache, **dizziness**, **headache**, **nausea**, **vomiting**, **diarrhea**, and tenseness. The symptoms typically start a day or two before menstruation, usually ending when menstruation actually begins.

Secondary dysmenorrhea has an underlying physical cause and primarily affects older women, although it may also occur immediately after a woman begins menstruation.

Menorrhagia

Menorrhagia, or heavy bleeding, most commonly occurs in the years just before menopause or just after women start menstruating. It occurs in 15–20% of American women.

Premenstrual dysphoric disorder (PMDD)

The fourth edition of the *Diagnostic and Statistical Manual of Mental Disorders*, or DSM-IV, lists **premenstrual dysphoric disorder** (PMDD) in an appendix of criteria sets for further study. To meet full criteria for PMDD, a patient must have at least five out of 11 emotional or physical symptoms during the week preceding the menses for most menstrual cycles over the previous 12 months. Although the DSM-IV definition of PMDD as a mental disorder is controversial because of fear that it could be used to justify prejudice or job discrimination against women, there is evidence that a significant proportion of premenopausal women experience emotional distress or impairment in job functioning in the week before their menstrual period. One group of researchers estimates that 3–8% of women of childbearing age meet the strict DSM-IV criteria for PMDD, with another 13–18% having symptoms severe enough to interfere with their normal activities.

Causes and symptoms

Amenorrhea

The only symptom of primary amenorrhea is delayed menstruation. In addition to low body weight or excessive exercise, other causes of primary amenorrhea include Turner's syndrome, a birth defect related to the reproductive system, or ovarian problems. In 2003, a group of researchers reported on a new genetic mutation associated with primary amenorrhea. In

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KEY TERMS

Adenomyosis—Uterine thickening caused when endometrial tissue, which normally lines the uterus, extends outward into the fibrous and muscular tissue of the uterus.

Cervical polyps—Growths originating from the surface of the cervix or endocervical canal. These small, fragile growths hang from a stalk and protrude through the cervical opening (the os).

Cushing's syndrome—A group of conditions caused by increased production of cortisol hormones or by the administration of glucocorticoid hormones (cortisone-like hormones).

Endometriosis—A condition in which the tissue that normally lines the uterus (endometrium) grows in other areas of the body, causing pain, irregular bleeding, and frequently, infertility.

Fibroids—Benign tumors of muscle and connective tissue that develop within or are attached to the uterine wall.

Hyperthyroidism—An imbalance in metabolism that occurs from overproduction of thyroid hormone.

Inflammatory bowel disease—A chronic inflammatory disease that can affect any part of the gastrointestinal tract but most commonly affects the ileum.

Lupus (systemic lupus erythematosus or SLE)—A chronic inflammatory autoimmune disorder that may affect many organ systems including the skin, joints, and internal organs.

Menarche—The first menstrual period or the establishment of the menstrual function.

Osteopenia—Reduction in bone mass, usually caused by a lowered rate of formation of new bone that is insufficient to keep up with the rate of bone destruction. Osteopenia often occurs together with amenorrhea and eating disorders in female athletes. It can lead to premature osteoporosis if left untreated.

Pelvic inflammatory disease (PID)—A general term referring to infection involving the lining of the uterus, the Fallopian tubes, or the ovaries.

Turner's syndrome—A disorder in women caused by an inherited chromosomal defect. This disorder inhibits sexual development and causes infertility. A symptom is absence of menstruation.

secondary amenorrhea, the primary symptom is the ceasing of menstruation for at least three months. Causes include **pregnancy** or **breastfeeding**, sudden weight loss or gain, intense exercise, **stress**, endocrine disorders affecting the thyroid, pituitary, or adrenal glands, including **Cushing's syndrome** and **hyperthyroidism**, and problems with or surgery on the ovaries, including removal of the ovaries, cysts or ovarian tumors.

Amenorrhea in athletes or dancers is frequently associated with two other disorders—osteopenia, or reduced bone mass, and **eating disorders**. This combination is sometimes called the female athlete triad. Osteopenia is of concern because it can lead to premature **osteoporosis**.

Dysmenorrhea

Primary dysmenorrhea is related to the production of prostaglandins, natural chemicals the body makes that cause an inflammatory reaction. They also cause the muscles of the uterus to contract, thus helping the uterus shed the lining built up during the first part of a woman's cycle. Women with severe menstrual pain have higher levels of prostaglandin in their menstrual blood than women who do not have such pain. In some women, prostaglandins can cause some of the smooth muscles in the gastrointestinal tract to contract, resulting in the nausea, **vomiting**, and diarrhea some women experience. Prostaglandins also cause the arteries and veins to expand, so that blood collects in them rather than flowing freely through them, causing pain and heaviness. Yet another reason for severe cramps, particularly in women who have not yet had a baby, is that the flow of the blood and clots through the tiny cervical opening is painful. After a woman has a baby, however, the cervix opening is larger.

Secondary dysmenorrhea is more serious and is related to some underlying cause. The pain may feel like regular menstrual cramps, but may last longer than normal and occur throughout the month. It may be stronger on one side of the body than the other. Possible causes include:

- a tipped uterus
- endometriosis, a condition in which the same type of tissue found in the lining of the uterus occurs outside the uterus, usually elsewhere in the pelvic cavity

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- adenomyosis, a condition in which the endometrial lining grows into the muscle of the uterus
- fibroids
- pelvic inflammatory disease (PID)
- an IUD
- a uterine, ovarian, bowel, or bladder tumor
- uterine polyps
- inflammatory bowel disease
- scarring or adhesions from earlier surgery

Menorrhagia

Heavy bleeding during menstruation is usually related to a hormonal imbalance, although other causes include fibroids, cervical or endometrial polyps, the autoimmune disease lupus, **pelvic inflammatory disease** (PID), blood platelet disorder, a hereditary blood factor deficiency, or, possibly, some reproductive cancers. Thus, menorrhagia is actually a symptom of an underlying condition rather than a disease itself. It may also be related to the use of an **IUD**.

Women with menorrhagia experience not only significant inconvenience, but may feel very tired due to the loss of iron-rich blood. It is usually diagnosed when a woman soaks through a tampon or pad every hour for several hours or has a period lasting more than seven days. Clots are not related to menorrhagia, although women with heavy cycles may pass clots. They are typically a normal part of menstruation, more common when a woman has been sitting or in a stationary position for a while.

Diagnosis

Women should seek care from a gynecologist, family practitioner, or internist for menstrual irregularities. Depending on the problem, various tests and procedures will be performed, but the one common to any menstrual problem is a **pelvic exam**. This should be scheduled when women are not menstruating, simply for convenience.

Examination

Male doctors typically have a female nurse or assistant in the room. The examination begins by checking the external genitalia for any sores or irregularities. Then the doctor inserts a speculum (a metal duckbill-shaped device that holds open the vagina) into the vagina and peers throughout the opening to evaluate the health of the cervix (opening of the uterus), and inside the vagina, looking for growths or any other abnormalities.

The doctor also manually examines the woman, inserting two fingers into the vagina while pressing on the abdomen, again feeling for any lumps or other abnormalities, checking the size and shape of the reproductive organs, and watching for any signs of infection, such as tenderness or pain. The exam is typically covered by insurance and takes about ten minutes.

Tests

Several different tests may be done for menstrual irregularities. Blood, stool, and urine tests may be conducted to check for levels of various hormones, blood cells, and other chemicals. In the absence of menses, a pregnancy test can be done to test for the presence of certain hormones that indicate a pregnancy has occurred.

An ultrasound, typically performed by a trained ultrasound technologist, involves using sound waves to get an image of the reproductive system. It is used to look for fibroids and other ovarian abnormalities that may cause heavy bleeding or cramps. Typically, the technologist smears a jelly over the woman's stomach, then places a probe on her stomach and watches the images appear on a computer screen. It is painless. Women may be asked not to urinate for several hours prior to the test, as a full bladder makes it easier to see the other internal organs. The test takes about 20 minutes.

An **endometrial biopsy** is used to check the health of uterine tissue in women who have unusually heavy bleeding. This test should be performed by the physician. Women should take a pain reliever such as ibuprofen or naproxen prior to the procedure, as there may be some cramping. The woman lies back on the table with her feet in stirrups and the doctor inserts a speculum, then opens the cervix slightly with an instrument called a tenaculum. Then the doctor slides a small, hollow catheter into the uterus and sucks out a small piece of tissue from the uterine lining. The tissue is examined for any abnormalities in a laboratory. The test takes about 30 minutes and is typically covered by insurance. Some bleeding may result afterward.

Procedures

Dilatation and curettage (D&C) is a very common minor surgical procedure in which the cervix is opened and the lining of the uterus is scraped for a tissue sample. This procedure is performed for the purpose of diagnosis as well as treatment for problems such as cervical polyps or **endometriosis**. It is also performed after a **miscarriage** or abortion.

Laparascopy and **hysteroscopy** are surgical procedures in which a small camera is inserted into the woman to view the inside of the pelvis, abdomen, or uterus.

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Treatment

Amenorrhea

For primary amenorrhea with no underlying problem, no treatment is necessary, and a wait-and-see approach is often adopted. If women have genetic or hormonal abnormalities, amenorrhea is often treated with **oral contraceptives** that contain combinations of estrogen and progestin. Side effects include bloating, weight gain, and **acne**, although some birth control pills actually improve acne. Progestins, or synthetic progesterone, are also used alone to "jump start" a woman's period. They include medroxyprogesterone (Provera, Amen, **Depo-Provera**), norethindrone acetate (Aygestin, Norlutate), and norgestrel (Ovrel). If the amenorrhea is due to a physical problem, such as a closed vagina, surgery may be required.

With secondary amenorrhea, treatment depends on the cause. Hormonal imbalances are treated with supplemental hormones. Tumors or cysts may require surgery. **Obesity** may require a diet and exercise regimen, while amenorrhea resulting from too much dieting or exercise necessitates lifestyle changes.

Dysmenorrhea

Primary dysmenorrhea is typically treated with nonsteroidal anti-inflammatory medications like ibuprofen and naproxen, which studies show help 64–100% of women. Birth control pills relieve pain and symptoms in about 90% of women by suppressing ovulation and reducing the amount of menstrual blood. It may take up to three cycles before a woman feels relief. Heat from a heating pad or hot bath, can also help relieve pain.

Treatment for secondary dysmenorrhea depends on the underlying cause of the condition.

Menorrhagia

If there are no other problems, and the bleeding is due to hormonal imbalances, birth control pills are often prescribed to bring the bleeding under control and regulate menstruation. Such medications as ibuprofen and naproxen can also help reduce the bleeding and any cramping associated with it. In severe cases, doctors may recommend removing the uterus during a **hysterectomy**, or performing some form of endometrial ablation, which removes the lining of the uterus. These procedures are typically only offered to women who have completed their families. A recent British study reported that many women prefer endometrial ablation to hysterectomy because it is less invasive and safer. In 2009, the FDA approved the intrauterine hormonal device, Mirena, for use in women experiencing heavy bleeding.

Premenstrual dysphoric disorder (PMDD)

Medications that have been reported to be effective in treating PMDD include the **tricyclic antidepressants** and the **selective serotonin reuptake inhibitors** (SSRIs). Effective treatments other than medications include cognitive behavioral therapy (CBT), aerobic exercise, and dietary supplements containing **calcium**, magnesium, and vitamin B_6.

Alternative treatment

Amenorrhea

There are several herbal remedies that can bring on menstruation, including: black cohosh, cramp bark, chasteberry, celery, turmeric, and marsh mallow. Numerous relaxation techniques, such as **meditation**, deep breathing, and **yoga** can help reduce stress and its effects on menstruation.

Dysmenorrhea

Alternative treatments used to help relieve menstrual pain include:

- Transcutaneous electrical nerve stimulation (TENS). Several studies found relieved pain in 42–60% of participants, working faster than naproxen in one study.
- Acupuncture: One study of 43 patients followed for a year found that 90% of those who had acupuncture once a week for three menstrual cycles had less pain, and 43% used less pain medication.
- Omega-3 fatty acids: Often sold as fish oil supplements, they are a known anti-inflammatory, working against the effects of prostaglandins. Studies found that women with low amounts of omega-3 fatty acids in their diets were more likely to have menstrual cramps; those who took supplements had less pain.
- Vitamin B_1: One large study found that symptoms disappeared in 87% of women who took 100 mg a day for 90 days.
- Magnesium supplements: One study of 30 women who took 4.5 mg of oral magnesium three times daily for part of the month decreased their symptoms up to 84%.

Menorrhagia

Herbs used to treat menorrhagia include yarrow, nettles, and shepherd's purse, as well as agrimony (particularly used in Chinese medicine), ladies mantle,

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vervain, and red raspberry, which are thought to strengthen the uterus. Vitex is another herb recommended for a variety of menstrual disorders ranging from menorrhagia to **premenstrual syndrome** (PMS). Women may want to discuss with their doctor about taking an iron supplement to replace the iron lost during the heavy bleeding. Helpful **vitamins** include vitamin A, because women with heavy bleeding typically have lower levels of vitamins A, K (aids in clotting), and C and bioflavinoids, which help strengthen veins and capillaries. Zinc may also help.

Prognosis

The prognosis for all menstrual irregularities is good once treatment is initiated.

Prevention

Amenorrhea

Simply following a healthy exercise and nutritional program can help prevent amenorrhea, as can reducing stress and learning relaxation techniques. Avoiding excessive alcohol intake and quitting **smoking** may prevent missed periods.

Dysmenorrhea

Prevention includes taking certain dietary supplements and vitamins. Exercise may also help.

Menorrhagia

There is little women can do to prevent this menstrual irregularity other than discovering the root cause.

Resources

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ORGANIZATIONS

American Congress of Obstetricians and Gynecologists (ACOG), PO Box 96920, Washington, DC, 20090-6920, (202) 638-5577, http://www.acog.org.

American Psychiatric Association (APA), 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209, (888) 357-7924, http://www.psych.org.

Healthy Women, 157 Broad Street, Suite 106, Red Bank, NJ, 07701, (877) 986-9472, http://www.healthywomen.org.

Society for Women's Health Research, 1025 Conneticut Ave. NW, Suite 701, Washington, DC, 20036, (202) 223-8224, info@swhr.org, http://www.womenshealthresearch.org.

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Menstrual pain *see* **Dysmenorrhea**

Mental retardation

Definition

Mental retardation is a developmental disability that first appears in children under the age of 18. It is defined as an intellectual functioning level (as measured by standard tests for intelligence quotient) that is

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well below average and significant limitations in daily living skills (adaptive functioning).

Description

Mental retardation occurs in 2.5–3% of the general population. About 6–7.5 million mentally retarded individuals live in the United States alone. Mental retardation begins in childhood or adolescence before the age of 18. In most cases, it persists throughout adulthood. A diagnosis of mental retardation is made if an individual has an intellectual functioning level well below average and significant limitations in two or more adaptive skill areas. Intellectual functioning level is defined by standardized tests that measure the ability to reason in terms of mental age (intelligence quotient or IQ). Mental retardation is defined as IQ score below 70–75. Adaptive skills are the skills needed for daily life. Such skills include the ability to produce and understand language (communication); home-living skills; use of community resources; health, safety, leisure, self-care, and social skills; self-direction; functional academic skills (reading, writing, and arithmetic); and work skills.

In general, mentally retarded children reach developmental milestones such as walking and talking much later than the general population. Symptoms of mental retardation may appear at birth or later in childhood. Time of onset depends on the suspected cause of the disability. Some cases of mild mental retardation are not diagnosed before the child enters preschool. These children typically have difficulties with social, communication, and functional academic skills. Children who have a neurological disorder or illness such as **encephalitis** or **meningitis** may suddenly show signs of cognitive impairment and adaptive difficulties.

Mental retardation varies in severity. *The Diagnostic and Statistical Manual of Mental Disorders,* Fourth Edition (*DSM-IV*) is the diagnostic standard for mental healthcare professionals in the United States. The *DSM-IV* classifies four different degrees of mental retardation: *mild, moderate, severe*, and *profound.* These categories are based on the functioning level of the individual.

Mild mental retardation

Approximately 85% of the mentally retarded population is in the mildly retarded category. Their IQ score ranges from 50–75, and they can often acquire academic skills up to the 6th grade level. They can become fairly self-sufficient and in some cases live independently, with community and social support.

Moderate mental retardation

About 10% of the mentally retarded population is considered moderately retarded. Moderately retarded individuals have IQ scores ranging from 35–55. They can carry out work and self-care tasks with moderate supervision. They typically acquire communication skills in childhood and are able to live and function successfully within the community in a supervised environment such as a group home.

Severe mental retardation

About 3–4% of the mentally retarded population is severely retarded. Severely retarded individuals have IQ scores of 20–40. They may master very basic self-care skills and some communication skills. Many severely retarded individuals are able to live in a group home.

Profound mental retardation

Only 1–2% of the mentally retarded population is classified as profoundly retarded. Profoundly retarded individuals have IQ scores under 20–25. They may be able to develop basic self-care and communication skills with appropriate support and training. Their retardation is often caused by an accompanying neurological disorder. The profoundly retarded need a high level of structure and supervision.

The American Association on Mental Retardation (AAMR) has developed another widely accepted diagnostic classification system for mental retardation. The AAMR classification system focuses on the capabilities of the retarded individual rather than on the limitations. The categories describe the level of support required. They are: *intermittent support, limited support, extensive support*, and *pervasive support*. To some extent, the AAMR classification mirrors the *DSM-IV* classification. Intermittent support, for example, is support needed only occasionally, perhaps during times of **stress** or crisis. It is the type of support typically required for most mildly retarded individuals. At the other end of the spectrum, pervasive support, or life-long, daily support for most adaptive areas, would be required for profoundly retarded individuals.

Causes and symptoms

Low IQ scores and limitations in adaptive skills are the hallmarks of mental retardation. Aggression, self-injury, and **mood disorders** are sometimes associated with the disability. The severity of the symptoms and the age at which they first appear depend on the cause. Children who are mentally retarded reach developmental milestones significantly later than expected, if at all. If retardation is caused by chromosomal or other

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genetic disorders, it is often apparent from infancy. If retardation is caused by childhood illnesses or injuries, learning and adaptive skills that were once easy may suddenly become difficult or impossible to master.

In about 35% of cases, the cause of mental retardation cannot be found. Biological and environmental factors that can cause mental retardation include:

Genetics

About 5% of mental retardation is caused by hereditary factors. Mental retardation may be caused by an inherited abnormality of the genes, such as **fragile X syndrome**. Fragile X, a defect in the chromosome that determines sex, is the most common inherited cause of mental retardation. Single gene defects such as **phenylketonuria** (PKU) and other inborn errors of metabolism may also cause mental retardation if they are not found and treated early. An accident or mutation in genetic development may also cause retardation. Examples of such accidents are development of an extra chromosome 18 (trisomy 18) and **Down syndrome**. Down syndrome, also called mongolism or trisomy 21, is caused by an abnormality in the development of chromosome 21. It is the most common genetic cause of mental retardation.

Prenatal illnesses and issues

Fetal alcohol syndrome affects one in 600 children in the United States. It is caused by excessive alcohol intake in the first twelve weeks (trimester) of **pregnancy**. Some studies have shown that even moderate alcohol use during pregnancy may cause learning disabilities in children. Drug **abuse** and cigarette **smoking** during pregnancy have also been linked to mental retardation.

Maternal infections and illnesses such as glandular disorders, **rubella**, **toxoplasmosis**, and **cytomegalovirus infection** may cause mental retardation. When the mother has high blood pressure (**hypertension**) or blood poisoning (toxemia), the flow of oxygen to the fetus may be reduced, causing brain damage and mental retardation.

Birth defects that cause physical deformities of the head, brain, and central nervous system frequently cause mental retardation. Neural tube defect, for example, is a birth defect in which the neural tube that forms the spinal cord does not close completely. This defect may cause children to develop an accumulation of cerebrospinal fluid on the brain (**hydrocephalus**). Hydrocephalus can cause learning impairment by putting pressure on the brain.

Childhood illnesses and injuries

Hyperthyroidism, **whooping cough**, **chickenpox**, **measles**, and Hib disease (a bacterial infection) may cause mental retardation if they are not treated adequately. An infection of the membrane covering the brain (meningitis) or an inflammation of the brain itself (encephalitis) cause swelling that in turn may cause brain damage and mental retardation. Traumatic brain injury caused by a blow or a violent shake to the head may also cause brain damage and mental retardation in children.

Environmental factors

Ignored or neglected infants who are not provided the mental and physical stimulation required for normal development may suffer irreversible learning impairments. Children who live in poverty and suffer from **malnutrition**, unhealthy living conditions, and improper or inadequate medical care are at a higher risk. Exposure to lead can also cause mental retardation. Many children have developed **lead poisoning** by eating the flaking lead-based paint often found in older buildings.

Diagnosis

If mental retardation is suspected, a comprehensive **physical examination** and medical history should be done immediately to discover any organic cause of symptoms. Conditions such as hyperthyroidism and PKU are treatable. If these conditions are discovered early, the progression of retardation can be stopped and, in some cases, partially reversed. If a neurological cause such as brain injury is suspected, the child may be referred to a neurologist or neuropsychologist for testing.

A complete medical, family, social, and educational history is compiled from existing medical and school records (if applicable) and from interviews with parents. Children are given intelligence tests to measure their learning abilities and intellectual functioning. Such tests include the Stanford-Binet Intelligence Scale, the Wechsler Intelligence Scales, the Wechsler Preschool and Primary Scale of Intelligence, and the Kaufmann Assessment Battery for Children. For infants, the Bayley Scales of Infant Development may be used to assess motor, language, and problem-solving skills. Interviews with parents or other caregivers are used to assess the child's daily living, muscle control, communication, and social skills. The Woodcock-Johnson Scales of Independent Behavior and the Vineland Adaptive Behavior Scale (VABS) are frequently used to test these skills.

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KEY TERMS

Amniocentesis—A test usually done between 16 and 20 weeks of pregnancy to detect any abnormalities in the development of the fetus. A small amount of the fluid surrounding the fetus (amniotic fluid) is drawn out through a needle inserted into the mother's womb. Laboratory analysis of this fluid can detect various genetic defects, such as Down syndrome, or neural tube defects.

Developmental delay—The failure to meet certain developmental milestones, such as sitting, walking, and talking, at the average age. Developmental delay may indicate a problem in development of the central nervous system.

Down syndrome—A disorder caused by an abnormality at the 21st chromosome. One symptom of Down syndrome is mental retardation.

Extensive support—Ongoing daily support required to assist an individual in a specific adaptive area, such as daily help with preparing meals.

Hib disease—An infection caused by *Haemophilus influenza* type b (Hib). This disease mainly affects children under the age of five. In that age group, it is the leading cause of bacterial meningitis, pneumonia, joint and bone infections, and throat inflammations.

Inborn error of metabolism—A rare enzyme deficiency; children with inborn errors of metabolism do not have certain enzymes that the body requires to maintain organ functions. Inborn errors of metabolism can cause brain damage and mental retardation if left untreated. Phenylketonuria is an inborn error of metabolism.

Limited support—A predetermined period of assistance required to deal with a specific event, such as training for a new job.

Phenylketonuria (PKU)—An inborn error in metabolism that prevents the body from using phenylalanine, an amino acid necessary for normal growth and development.

Trisomy—An abnormality in chromosomal development. Chromosomes are the structures within a cell that carry its genetic information. They are organized in pairs. Humans have 23 pairs of chromosomes. In a trisomy syndrome, an extra chromosome is present so that the individual has three of a particular chromosome instead of the normal pair. An extra chromosome 18 (trisomy 18) causes mental retardation.

Ultrasonography—A process that uses the reflection of high-frequency sound waves to make an image of structures deep within the body. Ultrasonography is routinely used to detect fetal abnormalities.

Treatment

Federal legislation entitles mentally retarded children to free testing and appropriate, individualized education and skills training within the school system from ages 3–21. For children under the age of three, many states have established early intervention programs that assess, recommend, and begin treatment programs. Many day schools are available to help train retarded children in basic skills such as bathing and feeding themselves. Extracurricular activities and social programs are also important in helping retarded children and adolescents gain self-esteem.

Training in independent living and job skills is often begun in early adulthood. The level of training depends on the degree of retardation. Mildly retarded individuals can often acquire the skills needed to live independently and hold an outside job. Moderate to profoundly retarded individuals usually require supervised community living.

Family therapy can help relatives of the mentally retarded develop coping skills. It can also help parents deal with feelings of guilt or anger. A supportive, warm home environment is essential to help the mentally retarded reach their full potential.

Prognosis

Individuals with mild to moderate mental retardation are frequently able to achieve some self-sufficiency and to lead happy and fulfilling lives. To reach these goals, they need appropriate and consistent educational, community, social, family, and vocational supports. The outlook is less promising for those with severe to profound retardation. Studies have shown that these individuals have a shortened life expectancy. The diseases that are usually associated with severe retardation may cause the shorter life span. People with Down syndrome will develop the brain changes that characterize **Alzheimer's disease** in later life and may develop the clinical symptoms of this disease as well.

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Prevention

Immunization against diseases such as measles and Hib prevents many of the illnesses that can cause mental retardation. In addition, all children should undergo routine developmental screening as part of their pediatric care. Screening is particularly critical for those children who may be neglected or undernourished or may live in disease-producing conditions. Newborn screening and immediate treatment for PKU and hyperthyroidism can usually catch these disorders early enough to prevent retardation.

Good prenatal care can also help prevent retardation. Pregnant women should be educated about the risks of drinking and the need to maintain good **nutrition** during pregnancy. Tests such as **amniocentesis** and ultrasonography can determine whether a fetus is developing normally in the womb.

Resources

OTHER

Americans with Disabilities Act (ADA) Page. http://www.usdoj.gov/crt/ada/adahom1.htm.

ORGANIZATIONS

American Association on Intellectual and Developmental Disabilities, 501 3rd Street, NW Suite 200, Washington, DC, 20001, (202) 387-1968, (202) 387-2193, (800) 424-3688, http://www.aamr.org.

The Arc, 1660 L Street, NW, Suite 301, Washington, DC, 20036, (202) 534-3700, (202) 534-3731, (800) 433-5255, info@thearc.org, http://www.thearc.org.

Paula Anne Ford-Martin

Mental status examination

Definition

A mental status examination (MSE) is an assessment of a patient's level of cognitive (knowledge-related) ability, appearance, emotional mood, and speech and thought patterns at the time of evaluation. It is one part of a full neurologic (nervous system) examination and includes the examiner's observations about the patient's attitude and cooperativeness as well as the patient's answers to specific questions. The most commonly used test of cognitive functioning per se is the so-called Folstein Mini-Mental Status Examination (MMSE), developed in 1975.

Purpose

The purpose of a mental status examination is to assess the presence and extent of a person's mental impairment. The cognitive functions that are measured during the MSE include the person's sense of time, place, and personal identity; memory; speech; general intellectual level; mathematical ability; insight or judgment; and reasoning or problem-solving ability. Complete MSEs are most commonly given to elderly people and to other patients being evaluated for **dementia** (including AIDS-related dementia). Dementia is an overall decline in a person's intellectual function—including difficulties with language, simple calculations, planning or decision-making, and motor (muscular movement) skills as well as loss of memory. The MSE is an important part of the differential diagnosis of dementia and other psychiatric symptoms or disorders. The MSE results may suggest specific areas for further testing or specific types of required tests. A mental status examination can also be given repeatedly to monitor or document changes in a patient's condition.

Precautions

The MSE cannot be given to a patient who cannot pay attention to the examiner, for example as a result of being in a **coma** or unconscious; or is completely unable to speak (aphasic); or is not fluent in the language of the examiner.

Description

The MMSE of Folstein evaluates five areas of mental status, namely, orientation, registration, attention and calculation, recall, and language. A complete MSE is more comprehensive and evaluates the following ten areas of functioning:

- Appearance. The examiner notes the person's age, race, sex, civil status, and overall appearance. These features are significant because poor personal hygiene or grooming may reflect a loss of interest in self-care or physical inability to bathe or dress oneself.
- Movement and behavior. The examiner observes the person's gait (manner of walking), posture, coordination, eye contact, facial expressions, and similar behaviors. Problems with walking or coordination may reflect a disorder of the central nervous system.
- Affect. Affect refers to a person's outwardly observable emotional reactions. It may include either a lack of emotional response to an event or an overreaction.
- Mood. Mood refers to the underlying emotional "atmosphere" or tone of the person's answers.

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- Speech. The examiner evaluates the volume of the person's voice, the rate or speed of speech, the length of answers to questions, the appropriateness and clarity of the answers, and similar characteristics.
- Thought content. The examiner assesses what the patient is saying for indications of hallucinations, delusions, obsessions, symptoms of dissociation, or thoughts of suicide. Dissociation refers to the splitting-off of certain memories or mental processes from conscious awareness. Dissociative symptoms include feelings of unreality, depersonalization, and confusion about one's identity.
- Thought process. Thought process refers to the logical connections between thoughts and their relevance to the main thread of conversation. Irrelevant detail, repeated words and phrases, interrupted thinking (thought blocking), and loose, illogical connections between thoughts, may be signs of a thought disorder.
- Cognition. Cognition refers to the act or condition of knowing. The evaluation assesses the person's orientation (ability to locate himself or herself) with regard to time, place, and personal identity; long- and short-term memory; ability to perform simple arithmetic (counting backward by threes or sevens); general intellectual level or fund of knowledge (identifying the last five presidents, or similar questions); ability to think abstractly (explaining a proverb); ability to name specified objects and read or write complete sentences; ability to understand and perform a task (showing the examiner how to comb one's hair or throw a ball); ability to draw a simple map or copy a design or geometrical figure; ability to distinguish between right and left.
- Judgment. The examiner asks the person what he or she would do about a commonsense problem, such as running out of a prescription medication.
- Insight. Insight refers to a person's ability to recognize a problem and understand its nature and severity.

The length of time required for a mental status examination depends on the patient's condition. It may take as little as five minutes to examine a healthy person. Patients with speech problems or intellectual impairments, dementia, or other organic brain disorders may require fifteen or twenty minutes. The examiner may choose to spend more time on certain portions of the MSE and less time on others, depending on the patient's condition and answers.

Preparation

Preparation for a mental status examination includes a careful medical and psychiatric history of the patient. The history helps the examiner to interpret the patient's appearance and answers with greater accuracy, because some physical illnesses may produce psychiatric symptoms or require medications that influence the patient's mood or attentiveness. The psychiatric history should include a family history as well as the patient's personal history of development, behavior patterns, and previous treatment for mental disorders (if any). Symptoms of dissociation, for example, often point to a history of childhood **abuse**, **rape**, or other severe emotional traumas in adult life. The examiner should also include information about the patient's occupation, level of education, marital status, and right- or left-handedness. Information about occupation and education helps in evaluating the patient's use of language, extent of **memory loss**, reasoning ability, and similar functions. Handedness is important in determining which half of the patient's brain is involved in writing, picking up a pencil, or other similar tasks that he or she may be asked to perform during the examination.

Aftercare

Depending on the examiner's specific observations, the patient may be given additional tests for follow-up. These tests might include blood or urine samples to test for drug or alcohol abuse, anemia, diabetes, disorders of the liver or kidneys, vitamin or thyroid deficiencies, medication side effects, or **syphilis** and **AIDS**. Brain imaging (CT, MRI, or **PET** scans) may be used to look for signs of seizures, strokes, head trauma, brain tumors, or other evidence of damage to specific parts of the brain. A spinal tap may be performed if the doctor thinks the patient may have an infection of the central nervous system.

Normal results

Normal results for a mental status examination depend to some extent on the patient's history, level of education, and recent life events. For example, a depressed mood is appropriate in the context of a recent **death** or other sad event in the patient's family but inappropriate in the context of a recent pay raise. Speech patterns are often influenced by racial or ethnic background as well as by occupation or schooling. In general, however, the absence of obvious **delusions**, **hallucinations**, or thought disorders together with the presence of insight, good judgment, and socially appropriate appearance and behavior are considered normal results. A normal numerical score for the MMSE is between 28 and 30.

Abnormal results

Abnormal results for a mental status examination include:

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KEY TERMS

Aphasia—The loss of the ability to speak, or to understand written or spoken language. A person who cannot speak or understand language is said to be aphasic.

Cognition—The act or process of knowing or perceiving.

Coma—A state of prolonged unconsciousness in which a person cannot respond to spoken commands or mildly painful physical stimuli.

Delusion—A belief that is resistant to reason or contrary to actual fact. Common delusions include delusions of persecution, delusions about one's importance (sometimes called delusions of grandeur), or delusions of being controlled by others.

Dementia—A decline in a person's level of intellectual functioning. Dementia includes memory loss as well as difficulties with language, simple calculations, planning or decision-making, and motor (muscular movement) skills.

Dissociation—The splitting off of certain mental processes from conscious awareness. Specific symptoms of dissociation include feelings of unreality, depersonalization, and confusion about one's identity.

Hallucination—A sensory experience, usually involving either sight or hearing, of something that does not exist outside the mind.

Illusion—A false visual perception of an object that others perceive correctly. A common example is the number of sightings of "UFOs" that turn out to be airplanes or weather balloons.

Obsession—Domination of thoughts or feelings by a persistent idea, desire, or image.

Organic brain disorder—An organic brain disorder refers to impaired brain function due to damage or deterioration of brain tissue.

- Any evidence of organic brain damage.
- Evidence of thought disorders.
- A mood or affect that is clearly inappropriate to its context.
- Thoughts of suicide.
- Disturbed speech patterns.
- Dissociative symptoms.
- Delusions or hallucinations.

A score below 27 on the MMSE usually indicates an organic brain disorder.

Resources

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Rebecca J. Frey, PhD

Mercury poisoning

Definition

Mercury **poisoning** is exposure to harmful amounts of the toxic element, usually by breathing mercury vapors or ingesting compounds containing mercury. Mercury poisoning can permanently damage the nervous system and immune system, as well as the brain, lungs, kidneys, heart, and liver. High–level exposure can be fatal. Developing fetuses are particularly sensitive to mercury poisoning.

Demographics

The prevalence of mercury poisoning in American children is hotly debated, but is generally considered to be rare. Fish and shellfish contaminated with methylmercury are the major sources of mercury poisoning in the United States and around the world. A 2009 study by the U.S. Centers for Disease Control and Prevention (CDC) on the exposure of children to elemental mercury found that the largest releases exposing the most children were caused by children stealing mercury from a school or industrial site. The vast majority of elemental exposures:

- were minimal or nontoxic
- occurred in homes or schools
- involved broken thermometers

Description

Mercury (Hg) is a naturally occurring element in air, water, and soil. There are three forms of mercury that pose different potential health hazards:

- Elemental or metallic mercury, also called quicksilver, is a shiny, silvery metal that is a liquid at room

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Safe tuna consumption

If you weigh:	Don't eat more than one can of tuna every: White Albacore	Chunk light
20 lbs	10 weeks	3 weeks
30 lbs	6 weeks	2 weeks
40 lbs	5 weeks	11 days
50 lbs	4 weeks	9 days
60 lbs	3 weeks	7 days
70 lbs	3 weeks	6 days
80 lbs	2 weeks	6 days
90 lbs	2 weeks	5 days
100 lbs	2 weeks	5 days
110 lbs	12 days	4 days
120 lbs	11 days	4 days
130 lbs	10 days	4 days
140 lbs	10 days	3 days
150+ lbs	9 days	3 days

SOURCE: Food and Drug Administration test results for mercury and fish, and the Environmental Protection Agency's determination of safe levels of mercury. Accessed from the Natural Resources Defense Council's "Eating Tuna Safely," available online at: http://www.nrdc.org/health/effects/mercury/tuna.asp (September 20, 2010).

Safe tuna consumption by weight, based on mercury levels. *(Table by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)*

temperature, but is easily vaporized to a colorless, odorless gas that can be inhaled. Elemental mercury is released into the air by natural processes such as volcanic activity and by various industrial processes, especially coal–burning power plants. It is extremely poisonous and 79–80% of inhaled mercury vapor is absorbed by the lungs. In the past, mercury vapors poisoned hat makers—hence the Mad Hatter of *Alice in Wonderland*. Elemental mercury is used in thermometers, compact fluorescent light bulbs (CFLs), electrical switches, and older–type dental fillings.

- Inorganic mercury compounds include mercuric oxide (HgO) and mercuric salts, such as mercuric chloride ($HgCl_2$). These compounds are usually white powders or crystals. Inorganic mercury is used in many industries and can be found in some skin ointments and creams, disinfectants, fungicides, folk medicines, red cinnabar pigment, and button batteries that power small electronics.
- Organic mercury compounds are carbon–containing substances, such as methylmercury, ethylmercury, and phenylmercury. Bacteria in soil and water convert inorganic mercury in the environment into methylmercury, which accumulates in fish. Larger and older fish generally have the highest levels of methylmercury. In some parts of the world, organic mercury is used as an antifungal agent in seed grain fed to animals. It is also found in older antiseptics and in some medical preservatives, including trace amounts of thimerosal in some childhood vaccines.

Because the body cannot easily rid itself of mercury, repeated exposure result in its build up in tissues. Elemental mercury vapor and methylmercury are the most dangerous forms because they readily reach the brain. Most humans have trace amounts of methylmercury in their bodies. Methylmercury crosses the placenta to the developing fetus, whose red blood cells can have mercury concentrations that are 30% higher than those of the mother. It also passes to the newborn child through breast milk. Fetuses, infants, and young children are significantly more sensitive to the effects of mercury than adults. During the 1950s, large amounts of organic mercury were dumped in Japan's Minamata Bay, killing some 1,000 people and causing severe nervous system damage in unborn children. Thus mercury poisoning is sometimes called fetal Minamata Bay disease. Mercury poisonings have also occurred from eating meat from animals fed contaminated grain.

Risk factors

The major risk factor for mercury poisoning in children is the consumption of large amounts of contaminated fish and shellfish. Children who play with found or spilled mercury are also at risk.

Causes and symptoms

The most common cause of mercury poisoning is eating fish and shellfish contaminated with high levels of methylmercury. Less common causes of mercury poisoning include:

- inhalation of vapors from spills, breakage of mercury–containing devices, off–gassing from polyurethane flooring containing a mercury catalyst, or mercury accumulation in poorly ventilated buildings
- breathing contaminated air from incinerators or industry
- inadequate remediation of toxic sites
- mercury used in cultural rituals or ceremonies
- mercury tracked home from workplaces
- mercury–based amalgams in dental fillings
- swallowing or inhaling mercury–containing batteries or their components
- direct skin contact with the element or its compounds

The same level of mercury vapor can result in higher mercury concentrations in children than in adults, because children have larger lung surface

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Mercury levels in fish

Least mercury

Anchovies
Butterfish
Catfish
Clam
Crab (Domestic)
Crawfish/Crayfish
Croaker (Atlantic)
Flounder
Haddock (Atlantic)
Hake
Herring
Mackerel (N. Atlantic, Chub)
Mullet
Oyster
Perch (Ocean)
Plaice
Pollock
Salmon (Canned)
Salmon (Fresh)
Sardine
Scallop
Shad (American)
Shrimp
Sole (Pacific)
Squid (Calamari)
Tilapia
Trout (Freshwater)
Whitefish
Whiting

Moderate mercury

Bass (Striped, Black)
Carp
Cod (Alaskan)
Croaker (White Pacific)
Halibut (Atlantic)
Halibut (Pacific)
Jacksmelt (Silverside)
Lobster
Mahi Mahi
Monkfish
Perch (Freshwater)
Sablefish
Skate
Snapper
Tuna (Canned chunk light)
Tuna (Skipjack)
Weakfish (Sea Trout)

High mercury

Bluefish
Grouper
Mackerel (Spanish, Gulf)
Sea bass (Chilean)
Tuna (Canned Albacore)
Tuna (Yellowfin)

Highest mercury

Mackerel (King)
Marlin
Orange roughy
Shark
Swordfish
Tilefish
Tuna (Bigeye, Ahi)

Least mercury: Less than 0.09 parts per million (ppm)
Moderate mercury: 0.09–0.29 ppm; safe to eat six or less servings each month
High mercury: 0.3–0.49 ppm, safe to eat three or less servings each month
Highest mercury: More than 0.5 ppm; avoid eating

SOURCE: Food and Drug Administration test results for mercury and fish, and the Environmental Protection Agency's determination of safe levels of mercury. Accessed from the Natural Resources Defense Council's "Consumer Guide to Mercury in Fish," available online at: http://www.nrdc.org/health/effects/mercury/guide.asp (September 20, 2010).

(Table by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)

areas for their body weight. Furthermore, since mercury vapors are more dense than air, there are higher levels closer to the ground where children breathe in the vapors. Although elemental mercury vapor is only slowly absorbed through the skin, it can irritate the skin and eyes and cause **contact dermatitis**. Touching or swallowing elemental liquid mercury is usually not harmful because it rolls off the skin and very little is absorbed by the gastrointestinal tract.

The effects of mercury exposure depend on a variety of factors including the:

- form of mercury
- dose
- route of exposure—inhaled, ingested, or skin contact
- child's age, with fetuses and very young children being most susceptible
- child's health

Symptoms of elemental mercury poisoning appear within a few hours of exposure to high levels of vapor. Smaller amounts inhaled daily cause symptoms that develop over time. Symptoms can include:

- a metallic taste
- swollen, bleeding gums
- skin rashes
- eye irritation
- respiratory symptoms, especially in children, including severe coughing, shortness of breath, or difficulty breathing
- gastrointestinal symptoms, including nausea, vomiting, and diarrhea
- fever and chills
- high blood pressure or heart rate
- headaches
- neuromuscular symptoms, such as weakness, twitching, tremors, muscle atrophy, and impaired nerve responses
- emotional effects, such as mood swings, irritability, nervousness, or excessive shyness
- insomnia
- disturbed sensations
- cognitive impairment
- with high exposure, kidney impairment, respiratory failure, and death

Unlike elemental mercury, inorganic and organic mercury are absorbed through the intestinal tract, although a swallowed battery may pass harmlessly through a child. Symptoms of inorganic mercury poisoning include:

- skin rashes and dermatitis
- metallic taste
- drooling
- mouth lesions, severe mouth pain, and throat swelling
- severe abdominal pain
- vomiting
- bloody diarrhea
- decreased or absent urination
- severe breathing difficulty
- muscle weakness

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- mood swings
- memory loss
- mental disturbances
- shock
- kidney failure
- death

Methylmercury can interfere with the neurological development of fetuses, infants, and children, causing:

- cerebral palsy
- brain damage and mental retardation
- language deficits
- attention deficits
- poor coordination
- growth retardation
- blindness
- seizures
- microcephaly (small head)

Symptoms of organic mercury poisoning most often develop over years or decades and include:

- "pins and needles" in the hands and feet and around the mouth
- numbness or pain on the skin
- poor coordination
- tremors
- muscle weakness
- impaired vision or blindness
- impaired speech and hearing
- impaired memory
- seizures and death with high–level exposure

KEY TERMS

Button batteries—Tiny, round batteries containing mercuric chloride that power items such as watches, hearing aids, calculators, cameras, and penlights.

Cerebral palsy—Brain damage before, during, or just after birth that results in lack of muscle coordination and problems with speech.

Chelators—Various compounds that bind to metals such as mercury.

Contact dermatitis—Skin inflammation from contact with an allergen or other irritating substance.

Elemental mercury; Hg—Metallic mercury; quicksilver; a heavy, silvery, poisonous metallic element that is a liquid at room temperature but vaporizes readily.

Inorganic mercury—Inorganic compounds such as mercuric oxide (HgO) and mercuric chloride ($HgCl_2$).

Mercuric chloride; mercury(II) chloride; $HgCl_2$—A poisonous crystalline form of inorganic mercury that is used as a disinfectant and fungicide.

Methylmercury—Any of various toxic compounds containing the organic grouping CH_3Hg. These compounds occur as industrial byproducts and pesticide residues, accumulate in fish and other organisms, especially those high on the food chain, and are rapidly absorbed through the human intestine to cause neurological disorders such as Minamata disease.

Organic mercury—Poisonous compounds containing mercury and carbon, such as methylmercury, ethylmercury, and phenylmercury.

Thimerosal—A crystalline organic mercury compound used as an antifungal and antibacterial agent and present in very small amounts in some vaccines.

Diagnosis

Examination

The child's vital signs—including temperature, pulse, breathing rate, and blood pressure—will be monitored. Important diagnostic information includes:

- the type and amount of exposure
- the time and duration of exposure
- the name of the product and its ingredients and strength

Tests

Blood or urine samples can be tested for exposure to elemental and inorganic mercury. Exposure to methylmercury is measured in whole blood or scalp hair. Mercury levels are often expressed as parts per million (ppm). For example, 1 ppm mercury in hair is equal to 1 milligram (mg) per kilogram (kg) of hair. The average mercury level in the hair of unaffected people is 2 ppm. Blood and urine tests may also be used to detect kidney damage from mercury poisoning.

Procedures

- For swallowed inorganic mercury, an endoscope—a flexible instrument with a camera—may be inserted through the throat to look for burns in the esophagus or stomach.

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- X rays are taken immediately to locate swallowed batteries and monitor their passing through the gastrointestinal tract.
- X rays may be taken to diagnose lung or kidney damage.

Treatment

Traditional

Although inhaled elemental mercury poisoning can be difficult to treat, possibilities include:

- humidified oxygen or air
- a breathing tube inserted in the lungs
- suctioning mercury out of the lungs

Inorganic mercury poisoning is treated with supportive measures, including possibly intravenous fluids and electrolytes.

- Swallowed mercuric oxide may be treated by gastric lavage, in which a tube is inserted through the mouth to wash out the stomach.
- Swallowed mercuric chloride may be treated by making the child vomit.
- Endoscopy may be used to remove a swallowed battery from the esophagus or stomach.
- An inhaled battery is removed immediately from the larynx with a laryngoscope or from the lungs with a bronchoscope or by surgery.

Treatment for methylmercury poisoning depends on the severity and is similar to treatments for **cerebral palsy**. It may include fluids and electrolytes and **kidney dialysis**.

Drugs

Chelators—drugs that bind mercury and other heavy metals—may be required for weeks or months to remove mercury from the blood and protect the kidneys and brain. Other medications to treat mercury poisoning include:

- activated charcoal to absorb swallowed mercury in the stomach
- drugs to induce vomiting for mercuric chloride poisoning
- laxatives for mercuric oxide or mercuric chloride poisoning
- medications to treat symptoms

Alternative

There are various alternative types of **chelation therapy**. These include bentonite clay baths and combinations of herbs, amino acids, and other **nutritional supplements**.

Home remedies

Mercury poisoning should be treated by immediately removing the child from the source of exposure, if possible. The U.S. National Poison Control Center should be called for instructions: (800) 222–1222.

Prognosis

- A single low–level exposure to elemental mercury does not usually require treatment and is unlikely to have long–term effects.
- Untreated mercury poisoning can eventually cause pain, muscle weakness, vision loss, paralysis, or death.
- Severe elemental mercury poisoning can cause long–term damage to the lungs, kidneys, and central nervous system, including brain damage. Very large exposures are usually fatal.
- Swallowed batteries usually pass through the gastrointestinal tract without causing serious damage; however the prognosis depends on the type of battery and how quickly the condition is treated.
- Severe inorganic mercury poisoning can cause massive blood and fluid loss, kidney failure, and probable death.
- Mercuric chloride is very toxic and even small swallowed doses can cause kidney failure and death. The prognosis depends on the amount of mercury, the symptoms within the first 10–15 minutes, and how quickly the poisoning is treated. Poisoning that occurs slowly over time may result in permanent brain damage.
- Mercuric oxide poisoning also can lead to organ failure and death.
- Damage from methylmercury is irreversible, although the symptoms do not usually worsen without additional exposure. Chronic brain damage from organic mercury poisoning is hard to treat and some children never recover. Methylmercury poisoning may also increase the risk for heart attacks.
- Both mercuric chloride and methylmercury are considered possible carcinogens.

Prevention

The U.S. Food and Drug Administration (FDA) and the Environmental Protection Agency (EPA) recommend that young children and women who are pregnant, may become pregnant, or are nursing:

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- not eat swordfish, shark, king mackerel, or tilefish, all of which have high mercury levels
- eat up to 12 ounces (340 grams or two average portions) per week of a variety of low–mercury fish and shellfish, such as shrimp, canned light tuna, salmon, pollock, catfish, fish sticks, or fast–food fish
- eat no more than six ounces (170 grams) per week of albacore ("white") tuna steak, which has higher levels of mercury
- check local advisories for fish caught by family and friends in local waters
- eat no more than six ounces (170 grams) per week of noncommercially caught fish from local waters if no advisories are available, and eat no other fish during the week
- feed young children smaller portions of fish

Other preventions for mercury poisoning include:

- teaching children never to touch mercury or any shiny, silver liquid
- carefully handling and properly disposing of mercury–containing products such as thermometers and fluorescent light bulbs
- following established procedures for mercury spills
- never vacuuming up spilled mercury, since this causes vaporization
- keeping children and pregnant women away from areas where liquid mercury is used
- contacting local health departments for large mercury spills

Resources

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ORGANIZATIONS

Agency for Toxic Substances and Disease Registry (ATSDR), 4770 Buford Hwy. NE, Atlanta, GA, 30341, (888) 422–8737; (800) 232–4636, (770) 488–4178, cdcinfo@cdc.gov, http://www.atsdr.cdc.gov.

National Institute of Neurological Disorders and Stroke (NINDS), NIH Neurological Institute, PO Box 5801, Bethesda, MD, 20824, (301) 496–5751, (800) 352–9424, http://www.ninds.nih.gov/index.htm.

U.S. Environmental Protection Agency (EPA), Ariel Rios Building, 1200 Pennsylvania Ave. NW, Washington, DC, 20460, http://www.epa.gov.

U.S. Food and Drug Administration (FDA), 10903 New Hampshire Ave., Silver Spring, MD, 20993–0002, (888) INFO–FDA, http://www.fda.gov.

Margaret Alic, PhD

Mesothelioma

Definition

Mesothelioma, also called malignant mesothelioma, is an uncommon disease that causes **cancer** cells to form within the lining of the chest, abdomen, or around the heart. Its primary cause is believed to be

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exposure to asbestos. Malignant mesothelioma is also known as asbestos cancer or simply "meso."

Demographics

Mesothelioma remains relatively uncommon in the United States, with approximately 2,500–3,000 new cases reported annually. The incidence rates are much higher in Western Europe (over 5,000 cases reported annually). These numbers are expected to climb over the next 20 years because symptoms do not appear until 30–50 years after asbestos exposure. Older males (median age 60 at diagnosis) are three to five times more likely to develop mesothelioma than females. This is most like because males predominance in those professions with an increased risk of asbestos exposure.

Description

Mesothelioma causes cancerous cells to develop in the body's mesothelium, where they can spread to and damage vital organs and tissue. These malignant cells can also metastasize (spread) to other sites in the body. Mesothelioma is very difficult to diagnose and responds poorly to most treatment modalities, resulting in a poor prognosis.

The disease derives its name from the mesothelium, a sac-like membrane that protects most of the body's internal organs. The mesothelium is divided into two distinct protective layers of cells: the visceral layer directly surrounding the organ and the parietal layer, a sac around the body cavity. By releasing a lubricating fluid, the mesothelium allows the organs to move more freely within the body cavity. (e.g., in the contraction and expansion of the lungs). The mesothelium also is referred to according to where it is located in the body: pleura (chest), peritoneum (abdomen), and pericardium (heart).

Over two-thirds of all mesothelioma cases begin in the pleura region. Pleural mesothelioma spreads through the chest cavity, occasionally developing in the lungs as well. The disease most commonly causes an excess build-up of fluid inside the chest cavity (**pleural effusion**). This excess fluid increases pressure on the lungs and restricts breathing. In addition, malignant cells can cause the pleural lining to thicken and restrict the breathing space even further.

Peritoneal mesothelioma is the second most common form of the disease, accounting for less than 30% of all cases. Malignant cells form in the peritoneum, affecting the abdomen, bowel, liver, and spleen. Similar to pleural mesothelioma, the peritoneal mesothelioma causes a build up of excess fluid in the abdominal cavity. Normal functions such as digestion can be hindered by the obstruction of organ movement.

Very rare forms of mesothelioma occur in the pericardium, as well as the mesothelium of the male and female reproductive organs. Cystic mesothelioma of the peritoneum, another rare form of the disease, occurs predominantly in women and is more benign in nature.

Malignant mesothelioma takes the form of one of three cell-types: epithelioid (50% to 70% of cases), sarcomatous (7% to 20% of cases), and biphasic/mixed (20% to 35% of cases). Of these cell-types, epithelioid mesothelioma carries the most favorable prognosis, followed by biphasic, and finally sarcomatous (very aggressive).

Causes and symptoms

Causes

Approximately 80% of all mesothelioma patients have a history of asbestos exposure. The majority of these patients were employed in an industry that involved the use of asbestos in some fashion. In addition to occupational exposure, household exposure of family members is not uncommon. An exposed individual can carry the asbestos particles on their clothing, skin, and in their hair when they return home, resulting in paraoccupational exposure. Even brief exposure to asbestos, as little as one to two months, can result in long-term consequences. Although the dangers of asbestos have been known for decades, the long latency period of mesothelioma (30–40 years) means that majority of patients were exposed as far back as the 1950s. Estimates suggest that up to eight million Americans have already been exposed. Workers who, in particular, show a higher incidence of asbestos exposure include:

- insulators (asbestos workers)
- boilermakers
- shipfitters
- steel workers
- maintenance workers
- plumbers
- brake mechanics

Exposure to asbestos most often causes the lose of one copy of chromosome 22. Other changes also appear in tumor suppressor genes. These genes regulate the growth and division of cells. In cancer, the regulatory mechanism malfunctions and cells grow wildly and form tumors.

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Symptoms

Mesothelioma is very aggressive once it takes hold. However, its initial symptoms are generally non-specific in nature and/or mimic other conditions, such as persistent **pneumonia** or gastronomical disorders. Some patients will exhibit no symptoms at all. As such, proper evaluation and diagnosis are commonly delayed.

Patients with pleural mesothelioma most commonly exhibit signs of dyspnea, pleural effusions, and/or chest **pain**. The majority of pleural effusion symptoms will appear in the right lung (60% of the time). Patients also may have persistent **cough**, weight loss, weakness, **fever**, and difficulty swallowing (dysphagia).

Patients with peritoneal mesothelioma most commonly show signs of pain and/or swelling in the abdomen from fluid retention or tumor growth. Weight loss, **nausea**, bowel obstruction, anemia, fever, and swelling in the legs and/or feet are also known symptoms.

Diagnosis

Examination

Only a physician can properly diagnose mesothelioma. A review of the patient's medical history, including any past exposure to asbestos, should be conducted for any patient displaying dyspnea, chest pain, fluid build-up, or pain and/or swelling in the abdomen. This review may be followed with a complete **physical examination** that should involve the use of imaging techniques. X rays, computed tomography (CT) scans, and magnetic resonance (MRI) scans of the chest and/or abdomen, as well as lung function tests, provide the doctor with critical diagnostic information. Although **positron emission tomography** scans are expensive and may not be covered under most insurance, this diagnostic tool has proven very useful in determining tumor sites and staging of the disease.

Procedures

If indicated, the doctor may wish to internally examine the patient's chest and/or abdominal cavity. These diagnostic procedures, known as **thoracoscopy** (chest) and peritoneoscopy (abdomen), usually are conducted in a hospital setting. Both procedures involve a fiber-optic imaging tool being inserted into the patient through an incision. These endoscopic tools provide the doctor with a closer look at the body cavity and any abnormal tissue or fluid build-up found therein. Excess fluid can be suctioned out through a needle or tube in a process known as **thoracentesis** (for the chest) or **paracentesis** (for the abdomen). Additionally, the doctor may perform a biopsy of any abnormal tissue they discover during this time. Pathological examination of abnormal tissue, as well as fluid, remains the only effective method of confirming the diagnosis of mesothelioma. Biopsy will also assist the doctor in properly staging the disease's progression.

Cancer staging

Once a confirmation of malignant mesothelioma has been established, the doctor will conduct further tests to determine the extent to which the primary disease has spread. This diagnostic process is known as staging. Malignant pleural mesothelioma of can be broken into four stages:

- Localized Malignant Mesothelioma (Stage 1)—Cancer is present in the right or left pleura. May involve the lung, the pericardium, or diaphragm on that side.
- Advanced Malignant Mesothelioma (Stage 2)—Cancer has spread beyond the right or left pleura to lymph nodes on that side. May involve the lung, the pericardium, or diaphragm on that side.
- Advanced Malignant Mesothelioma (Stage 3)—Cancer has spread into the chest wall, diaphragm, ribs, heart, esophagus, or through the abdominal lining. Nearby lymph nodes may or may not be involved.
- Advanced Malignant Mesothelioma (Stage 4)—Cancer shows evidence of metastasis or spread through the bloodstream to distant organs and/or tissues.

Recurrent malignant mesothelioma may also develop, where the cancer returns in its original location or elsewhere in the body even after treatment.

Treatment

There are three traditional treatment modalities for mesothelioma: surgery, **radiation therapy**, and **chemotherapy**. The location and the stage of the disease, as well as the patient's age and health status, will determine which treatment is most appropriate. Modalities can be combined if indicated. Indeed, the multimodality approach appears to provide the most positive results for treating mesothelioma.

Surgery, the most common treatment, involves the removal of the tumor. In the early stages of mesothelioma, this usually involves removal of a section of the mesothelium and surrounding tissue, but may require removing part of the diaphragm as well. For more advanced stages of the disease, removing the entire lung (a procedure known as **pneumonectomy**) may be the only option.

Radiation therapy, also known as radiotherapy, destroys and shrinks the cancer cells through various

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types of radiation. Both external (from a machine) and internal (such direct application of as radioisotopes) radiation therapies can be used to treat malignant mesothelioma.

Finally, chemotherapy, a systemic treatment modality, uses **anticancer drugs** to destroy the cancerous cells throughout the body. The majority of drugs used to treat mesothelioma are delivered intravenously. The effectiveness of intracavitary chemotherapy, the process of directly injecting the drugs into the chest or abdominal cavity, is being studied.

Pain and other symptoms caused by fluid build-up around the chest and/or abdomen can be treated by draining excess fluid through a needle or tube. These procedures are known as thoracentesis (chest) and paracentesis (abdomen). Drugs, radiotherapy, and surgery can also relieve or prevent further fluid accumulation.

Physicians are currently studying other treatment modalities, such as immunotherapy, **gene therapy**, and intraoperative **photodynamic therapy**. Individuals with mesothelioma who wish to participate in a clinical trial of an experimental therapy can find a list of clinical trials at http://clinicaltrials.gov. There is no cost to the patient to participate in a clinical trial.

Alternative and Complementary treatment

Nutritional issues are common in patients with cancer. The cancer causes some problems with diet and **nutrition**, while others are related to treatment or medication side effects. Maintaining adequate food intake and balanced nutrition in patients with lung cancer is important. A dietitian who specializes in cancer patients can suggest ways to maintain nutrition during treatment.

Although alternative practitioners may offer remedies for "curing" cancer, there is no known way to rid the body of cancer cells. Turning to unproven alternative remedies may be tempting as health declines, but this is unlikely to be helpful and may interfere with beneficial traditional therapy. Responsible alternative medicine practitioners view cancer as a holistic problem and strive to strengthen and support the physical, mental, and spiritual aspects of patients. Alternative practices that support psychological and spiritual health often prove beneficial to improving the quality of life of the individual with cancer. Techniques to reduce **stress**, such as **acupuncture**, **aromatherapy**, massage, and **reflexology**, can provide addition benefit to the patient's sense of well-being.

Palliative care

Because mesothelioma is an aggressive cancer with a poor prognosis, **palliative care** may be the preferred or only option available to patients. This is particularly true for the advanced stages of the disease. By treating the symptoms rather than the disease itself, the goal of this approach is to improve quality of life rather than to extend life. Palliative care aims to relieve the patient's discomfort caused by dyspnea and pain. Chemotherapy, radiation, and/or surgical treatment as needed to control symptoms, in combination with effective management of pain and respiratory function, should form the basis of proper palliative care of patients with mesothelioma.

KEY TERMS

Asbestos—A naturally occurring mineral, utilized worldwide for its durability and heat resistant qualities. Extremely fibrous in nature, asbestos particles can easily enter the respiratory system and damage sensitive tissue. This damage can result in asbestosis, mesothelioma, and lung cancer.

Dyspnea—A difficulty in breathing or shortness of breath, typically associated with some form of heart or lung disease. Also known as air hunger.

Mesothelium—A membrane/sac that protects the body's major internal organs and allows them freedom of movement (for example, lung contractions). The mesothelium is comprised of several regions, including the abdominal cavity (peritoneum), the chest cavity (pleura), and pericardium (heart).

Palliative—Treatment and care whose goal is to relieve pain and improve quality of life when a cure is not possible.

Pleural effusion—An abnormal accumulation of fluid in the pleura, a fibrous membrane that lines the inside of the chest cavity and protects the lungs. This accumulation can cause shortness of breath, cough, and chest pain.

Prognosis

The stage, location, and cell-type is involved, as well as the patient's age and health status affect life expectancy. Even with aggressive treatment, the prognosis for mesothelioma patients is poor. Overall survival rate from time of diagnosis is about one year. Pleural mesothelioma offers a median survival time of approximately 16–17 months after initial symptoms. Prognosis for peritoneal mesothelioma is poorer and has a median survival time of only ten months after initial symptoms. The more advanced stages of

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mesothelioma may offer as little as four or five months of survival time.

The survival time for patients with localized mesothelioma can be extended several months with aggressive therapy, with roughly 20% of patients surviving past the five-year mark. Therapy programs recently developed at leading cancer centers have extended this survival time even further. In 2010, the five-year survival rate for patients with mesothelioma was 10%. Low as this number is, it represents an improvement over earlier survival times.

Prevention

Avoiding asbestos exposure or taking protective measures if exposure is unavoidable is the best way to prevent mesothelioma. Unfortunately, because of the significant delay between exposure and onset (30–50 years), it is probably too late to prevent the development of mesothelioma for most patients. Not **smoking** may slow the disease's progression and/or prevent other further complications associated with asbestos exposure.

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Mesothelioma. MedlinePlus. January 11, 2010. http://www.nlm.nih.gov/medlineplus/mesothelioma.html.

ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd., NE, Atlanta, GA, 30329, (404) 320-3333, (800) ACS-2345, http://www.cancer.org.

Mesothelioma Applied Research Foundation, PO Box 91840, Santa Barbara, CA, 93190-1840, (805) 563-8400, (805) 563-8411, http://www.curemeso.org/site/c.kkLUJ7MPKtH/b.3076109/k.FF9C/Mesothelioma_Applied_Research_Foundation.htm.

National Cancer Institute Public Inquires Office., 6116 Executive Boulevard, Room 3036A, Bethesda, MD, 20892-8322, (800) 4-CANCER. TTY (800) 332-8615, http://www.cancer.gov.

Jason Fryer
Tish Davidson, AM

Metabolic acidosis

Definition

Metabolic acidosis is a pH imbalance in which the body has accumulated too much acid and does not have enough bicarbonate to effectively neutralize the effects of the acid.

Description

Metabolic acidosis, as a disruption of the body's acid/base balance, can be a mild symptom brought on by a lack of insulin, a **starvation** diet, or a gastrointestinal disorder like **vomiting** and **diarrhea**. Metabolic acidosis can indicate a more serious problem with a major organ like the liver, heart, or kidneys. It can also be one of the first signs of **drug overdose** or **poisoning**.

Causes and symptoms

Metabolic acidosis occurs when the body has more acid than base in it. Chemists use the term "pH" to describe how acidic or basic a substance is. Based on a scale of 14, a pH of 7.0 is neutral. A pH below 7.0 is an acid; the lower the number, the stronger the acid. A pH above 7.0 is a base; the higher the number, the stronger the base. Blood pH is slightly basic (alkaline), with a normal range of 7.36-7.44.

Acid is a natural by-product of the breakdown of fats and other processes in the body; however, in some conditions, the body does not have enough bicarbonate, an acid neutralizer, to balance the acids produced. This can occur when the body uses fats for energy instead of carbohydrates. Conditions where metabolic acidosis can occur include chronic **alcoholism**, **malnutrition**, and **diabetic ketoacidosis**. Consuming a diet low in carbohydrates and high in fats can also produce metabolic acidosis. The disorder may also be a symptom of another condition like kidney failure, liver failure, or severe diarrhea. The build up of lactic acid in the blood due to such conditions as **heart failure**, **shock**, or **cancer**, induces metabolic acidosis. Some poisonings and overdoses (**aspirin**, methanol, or ethylene glycol) also produce symptoms of metabolic acidosis.

In mild cases of metabolic acidosis, symptoms include **headache**, lack of energy, and sleepiness. Breathing may become fast and shallow. **Nausea**, **vomiting**, diarrhea, **dehydration**, and loss of appetite are also associated with metabolic acidosis. Diabetic patients with symptoms of metabolic acidosis may also have breath that smells fruity. The patient may lose consciousness or become disoriented. Severe cases can produce **coma** and **death**.

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KEY TERMS

Diabetic ketoacidosis—A condition caused by low insulin levels where the amount of sugar and ketones in the blood is high.

pH—A measurement of the acidity or alkalinity of a solution based on the amount of hydrogen ions available. Based on a scale of 14, a pH of 7.0 is neutral. A pH below 7.0 is an acid; the lower the number, the stronger the acid. A pH above 7.0 is a base; the higher the number, the stronger the base. Blood pH is slightly alkaline (basic) with a normal range of 7.36-7.44.

Diagnosis

Metabolic acidosis is suspected based on symptoms, but is usually confirmed by laboratory tests on blood and urine samples. Blood pH below 7.35 confirms the condition. Levels of other blood components, including potassium, glucose, ketones, or lactic acid, may also be above normal ranges. The level of bicarbonate in the blood will be low, usually less than 22 mEq/L. Urine pH may fall below 4.5 in metabolic acidosis.

Treatment

Treatment focuses first on correcting the acid imbalance. Usually, **sodium** bicarbonate and fluids will be injected into the blood through a vein. An intravenous line may be started to administer fluids and allow for the quick injection of other drugs that may be needed. If the patient is diabetic, insulin may be administered. Drugs to regulate blood pressure or heart rate, to prevent seizures, or to control **nausea and vomiting** might be given. Vital signs like pulse, respiration, blood pressure, and body temperature will be monitored. The underlying cause of the metabolic acidosis must also be diagnosed and corrected.

Prognosis

If the metabolic acidosis is recognized and treated promptly, the patient may have no long-term complications, however, the underlying condition that caused the acidosis needs to be corrected or managed. Severe metabolic acidosis that is left untreated will lead to coma and death.

Prevention

Diabetic patients need to routinely test their urine for sugar and acetone, strictly follow their appropriate diet, and take any medications or insulin to prevent metabolic acidosis. Patients receiving **tube feedings** or intravenous feedings must be monitored to prevent dehydration or the accumulation of ketones or lactic acid.

Resources

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Altha Roberts Edgren

Metabolic alkalosis

Definition

Metabolic alkalosis is a pH imbalance in which the body has accumulated too much of an alkaline substance, such as bicarbonate, and does not have enough acid to effectively neutralize the effects of the alkali.

Description

Metabolic alkalosis, as a disturbance of the body's acid/base balance, can be a mild condition, brought on by **vomiting**, the use of **steroids** or diuretic drugs, or the overuse of **antacids** or **laxatives**. Metabolic alkalosis can also indicate a more serious problem with a major organ such as the kidneys.

Causes and symptoms

Metabolic alkalosis occurs when the body has more base than acid in the system. Chemists use the term "pH" to decribe how acidic or alkaline (also called basic) a substance is. Based on a scale of 14, a pH of 7.0 is neutral. A pH below 7.0 is an acid; the lower the number, the stronger the acid. A pH above 7.0 is alkaline; the higher the number, the stronger the alkali. Blood pH is slightly alkaline, with a normal range of 7.36-7.44. Conditions that lead to a reduced amount of fluid in the body, like **vomiting** or excessive urination due to use of diuretic drugs, change the balance of fluids and salts. The blood levels of potassium and **sodium** can decrease dramatically, causing symptoms of metabolic alkalosis.

In cases of metabolic alkalosis, slowed breathing may be an initial symptom. The patient may have episodes of apnea (not breathing) that may go on 15 seconds or longer. **Cyanosis**, a bluish or purplish discoloration of the skin, may also develop as a sign of

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KEY TERMS

pH—A measurement of the acidity or alkalinity of a solution based on the amount of hydrogen ions available. Based on a scale of 14, a pH of 7.0 is neutral. A pH below 7.0 is an acid; the lower the number, the stronger the acid. A pH above 7.0 is a base; the higher the number, the stronger the base. Blood pH is slightly alkaline (basic) with a normal range of 7.36-7.44.

inadequate oxygen intake. **Nausea**, vomiting, and **diarrhea** may also occur. Other symptoms can include irritability, twitching, confusion, and picking at bedclothes. Rapid heart rate, irregular heart beats, and a drop in blood pressure are also symptoms. Severe cases can lead to convulsions and **coma**.

Diagnosis

Metabolic alkalosis may be suspected based on symptoms, but often may not be noticeable. The condition is usually confirmed by laboratory tests on blood and urine samples. Blood pH above 7.45 confirms the condition. Levels of other blood components, including salts like potassium, sodium, and chloride, fall below normal ranges. The level of bicarbonate in the blood will be high, usually greater than 29 mEq/L. Urine pH may rise to about 7.0 in metabolic alkalosis.

Treatment

Treatment focuses first on correcting the imbalance. An intravenous line may be started to administer fluids (generally normal saline, a salt water solution) and allow for the quick injection of other drugs that may be needed. Potassium chloride will be administered. Drugs to regulate blood pressure or heart rate, or to control **nausea and vomiting** might be given. Vital signs like pulse, respiration, blood pressure, and body temperature will be monitored. The underlying cause of the metabolic alkalosis must also be diagnosed and corrected.

Prognosis

If metabolic alkalosis is recognized and treated promptly, the patient may have no long-term complications; however, the underlying condition that caused the alkalosis needs to be corrected or managed. Severe metabolic alkalosis that is left untreated will lead to convulsions, **heart failure**, and coma.

Prevention

Patients receiving **tube feedings** or intravenous feedings must be monitored to prevent an imbalance of fluids and salts, particularly potassium, sodium, and chloride. Overuse of some drugs, including **diuretics**, laxatives, and antacids, should be avoided.

Resources

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Cecil, Russell L., Lee Goldman, and D. A. Audiello. *Cecil Medicine*. 23rd ed, Philadelphia: Saunders Elsevier, 2008.

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Altha Roberts Edgren

Metabolic encephalopahty *see* **Delirium**

Methadone

Definition

Methadone is a powerful narcotic drug in the same class as heroin. This class is known as the opioids.

Purpose

Methadone, formerly known as dolophine, is a psycho-active drug, meaning that it affects the mind or behavior. It belongs to the class of opioids, drugs that share some of the analgesic properties, and mimic the action of some of the body's naturally occurring chemicals called peptides, such as endorphins and enkephalines.

Methadone is used to relieve chronic **pain** in **cancer** patients and as a maintenance drug to control withdrawal symptoms in people undergoing treatment for opiate **addiction**.

In opiate addiction treatment, methadone blocks the opioid receptors of the brain that bind opiates such as heroin. The blocking of these receptors leads to two major effects:

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- because these chemical receptors remain blocked by methadone for up to 24 hours, even if a person addicted to heroin takes heroin after the administration of methadone, this person is not likely to feel the same effects of the heroin as he or she previously felt;
- because the action of methadone is associated with slower and less intense withdrawal symptoms than those of heroin, the patient can experience milder opiate effects while the addiction is being treated and avoid the unpleasant withdrawal symptoms associated with heroin.

Methadone has also been shown to reduce cravings for heroin while not altering a person's mood.

Precautions

Methadone magnifies the effects of alcohol and other **central nervous system depressants**, such as **antihistamines**, cold medicines, sedatives, tranquilizers, other prescription and over-the-counter (OTC) pain medications, **barbiturates**, seizure medications, **muscle relaxants**, and certain anesthetics including some dental anesthetics. Alcohol and other central nervous system depressants should not be taken or consumed while methadone is being taken.

Methadone is a powerful narcotic. It can cause some people to feel drowsy, dizzy, or light-headed. People taking methadone should not drive a car or operate machinery.

Intentional or accidental overdose of methadone can lead to unconsciousness, **coma**, or **death**. The signs of methadone overdose include confusion, difficulty speaking, seizures, severe nervousness or restlessness, severe **dizziness**, severe drowsiness, and/or slow or troubled breathing. These symptoms are increased by alcohol or other central nervous system (CNS) depressants. Anyone who feels that he or she, or someone else, may have overdosed on methadone, or a combination of methadone and other central nervous system depressants, should seek emergency medical attention for that person at once.

Description

A typical adult dosage for methadone is 5–20 mg as an oral solution, 2.5–10 mg as an oral tablet or injection, every four to eight hours as necessary for pain. When used for **detoxification**, methadone is initially given in a dose of 15–100 mg per day as an oral solution. This dose is then decreased until the patient no longer requires the medication. The injection form of methadone is only used for detoxification in patients who are unable to take the medication by mouth.

Preparation

No preparation is generally necessary prior to the intake of methadone as a pain reliever. In cases of maintenance treatments, it is important to be sure that the patient is not currently intoxicated by alcohol, heroin, other opioids, or taking other central nervous system depressants.

Aftercare

Patients receiving methadone should be monitored for adverse reactions to this drug, and/or possible accidental overdose.

Risks

Methadone can interfere with or exacerbate certain medical conditions. For these reasons, it is important that the prescribing physician be informed of any current case, or history of:

- alcohol abuse
- brain disease or head injury
- colitis
- drug dependency, particularly of narcotics
- emotional problems
- emphysema, asthma, or other chronic lung disease
- enlarged prostate
- gallstones or gallbladder disease
- heart disease
- kidney disease
- liver disease
- problems with urination
- seizures
- underactive thyroid

Side effects

The most common side effects of methadone include:

- constipation
- dizziness
- drowsiness
- itching
- nausea
- urine retention
- vomiting

Less common side effects of methadone include:

- abnormally fast or slow heartbeat
- blurred or double vision
- cold, clammy skin

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KEY TERMS

Analgesic—Any agent that relieves pain.

Central nervous system (CNS) depressant—Any drug that tends to reduce the activity of the central nervous system. The major drug categories included in this classification are: alcohol, anesthetics, anti-anxiety medications, antihistamines, antipsychotics, hypnotics, narcotics, sedatives, and tranquilizers.

Endorphins—Any of several opiate peptides naturally produced in the brain that bind to certain neuron receptors and have the effect of relieving pain.

Enkephalines—Peptide produced by the body that have analgesic properties.

Morphine—Morphine is the naturally occurring opioid in the opium poppy, *Papaver somniferum*. It is a powerful narcotic analgesic, and its primary clinical use is in the management of moderately severe to severe pain. After heroin, morphine has the greatest potential for addiction of all narcotic analgesics.

Narcotic—Any drug that produces insensibility or stupor and/or generally causes effects similar to those caused by morphine.

Opiate—Any narcotic analgesic derived from a natural source, such as morphine from the opium poppy.

Opioid receptors—Receptors located in the brain and various organs that bind opiates or opioid substances.

Opioids—One of the major classes of semi or fully synthetic psycho-active drugs that includes methadone.

Psychoactive drugs—Any drug that affects the mind or behavior. There are five main classes of psychoactive drugs: opiates and opioids (e.g. heroin and methadone); stimulants (e.g. cocaine, nicotine), depressants (e.g. tranquilizers, antipsychotics, alcohol), hallucinogens (e.g. LSD), and marijuana and hashish.

Receptor—A molecular structure on the surface that selectively binds a specific substance resulting in a specific physiological effect.

- depression or other mood changes
- dry mouth
- fainting
- hallucinations
- hives
- loss of appetite
- nightmares or unusual dreams
- pinpoint pupils of the eyes
- redness or flushing of the face
- restlessness
- rigid muscles
- ringing or buzzing in the ears
- seizure
- severe drowsiness
- skin reaction at the site of injection
- stomach cramps or pain
- sweating
- trouble sleeping (insomnia)
- yellowing of the skin or whites of the eyes

Normal results

Normal results after the administration of methadone to treat chronic pain is the alleviation of that patient's pain, at least to the point where the pain is bearable.

Normal results of methadone treatment to control heroin addiction, is that the patient reduces heroin intake almost immediately upon starting methadone treatments, followed by complete abstinence, usually within two weeks after starting treatment.

ORGANIZATIONS

National Alliance for Medication Assisted Recovery, 435 Second Avenue, New York, NY, 10010, nama.info@methadone.org, http://www.methadone.org.

National Clearinghouse for Alcohol and Drug Information, P.O. Box 2345, Rockville, MD, 20847-2345, (877) 726-4727, http://store.samhsa.gov/.

Paul A. Johnson, Ed.M.

Methamphetamine

Definition

Methamphetamine, or meth, is an addictive central nervous system (CNS) stimulant with limited medical value. The United States Drug Enforcement Administration (DEA) lists methamphetamine as a Schedule II drug, which means it has high **abuse**

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Methamphetamine

Short-term effects:

- Increased alertness
- Rapid and irregular heartbeat
- Rise in blood pressure and body temperature

Long-term effects:

- Anxiety and feelings of confusion
- Dental problems
- Increased risk of contracting diseases such as HIV/AIDS and hepatitis
- Insomnia
- Mood disturbances
- Violent behavior

In 2008, 850,000 Americans aged 12 and older had abused methamphetamine at least once in the past year, 11% of whom were younger than 18.

SOURCE: National Institutes of Health, National Institute on Drug Abuse, "Methamphetamine." Available online at: http://www.drugabuse.gov/drugpages/methamphetamine.html; also Substance Abuse and Mental Health Services Administration, *Results from the 2008 National Survey on Drug Use and Health: National Findings*. Available online at: http://www.oas.samhsa.gov/nsduh/2k8nsduh/2k8Results.cfm (accessed August 19, 2010).

Consequences of methamphetamine abuse. *(Table by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)*

potential and must be prescribed by a prescription that cannot be refilled.

Demographics

The national Monitoring the Future survey of 2008 found that in 2007 about 1.3 million Americans had used methamphetamine, a decrease from 1.9 million in 2006. This survey found that 2.3% of eighth graders, 2.4% of 10th graders, and 2.8% of twelfth graders had tried methamphetamine at some time in their lives.

In the United States, methamphetamine use peaks in white men 30–40 years old; however, according the Monitoring the Future survey, the average age of first use in 2007 was 19.1 years. In the United States, Methamphetamine use is highest in western states. Internationally, methamphetamine use is highest in Eastern Europe and Southeast Asia.

Description

Methamphetamine was first synthesized in Japan in 1919 and was used as a drug therapy in **asthma** inhalers in the 1930s. Amphetamines of all kinds were used during World War II by both sides to increase the alertness and prolong wakefulness of soldiers. After the war, the government developed stricter regulations for the manufacture and use of amphetamines, but they remained popular among people who wanted to stay awake for long periods (e.g., students, long-haul truckers) and were commonly used by people who wanted to lose weight. In 1970, more restrictions were put on methamphetamine, so that today it is a Schedule II drug. Despite this, methamphetamine remains a popular drug of abuse.

Methamphetamine is produced illegally in many countries, including the United States, and can be synthesized with readily available materials. The drug's misuse is deemed to be a major societal problem. Methamphetamine is addictive. It goes by the street names of ice, crystal, crystal meth, speed, crank, and glass.

Methamphetamine is similar to other CNS stimulants, such as amphetamine (its parent drug), methylphenidate, and **cocaine**, in that it stimulates dopamine reward pathways in the brain. Consistent with its stimulant profile, methamphetamine causes increased activity and talkativeness, decreased appetite and **fatigue**, and a general sense of well being. Compared to amphetamine, methamphetamine is more potent and longer lasting, and it has more harmful effects on the brain. In animals, a single high dose of methamphetamine has been shown to damage nerve terminals in the dopamine-containing regions of the brain.

Methamphetamine is a white, odorless, bitter-tasting crystalline powder that easily dissolves in water or alcohol. Misuse occurs in many forms, as methamphetamine can be smoked, snorted, injected, or taken orally. When smoked or injected, methamphetamine enters the brain very rapidly and immediately produces an intense but short-lived rush that many abusers find extremely pleasurable. Snorting or oral ingestion produces euphoria—a feeling of being high—within minutes. As with other abused stimulants, methamphetamine is most often used in a binge-and-crash pattern. A "run" of repeated doses may be continued over the course of days (binge) before stopping (crash). Exhaustion occurs with repeated use of methamphetamine, involving intense fatigue and need for sleep after the stimulation phase.

Approved medical indications for the drug are the sleep disorder **narcolepsy**, **attention deficit hyperactivity disorder (ADHD)**, and extreme **obesity**, but in each case methamphetamine is a second-line drug at best and is used only after other, less harmful drugs have failed.

The prescription drug (brand name Desoxyn) comes in the form of a small white tablet, which is orally ingested. Dosing begins at 5 mg once or twice a day and is increased weekly until the lowest effective dose is attained. Desoxyn should not be taken with

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KEY TERMS

Central nervous system (CNS)—Part of the nervous system consisting of the brain, cranial nerves and spinal cord. The brain is the center of higher processes, such as thought and emotion and is responsible for the coordination and control of bodily activities and the interpretation of information from the senses. The cranial nerves and spinal cord link the brain to the peripheral nervous system, that is the nerves present in the rest of body.

Dopamine—A neurochemical made in the brain that is involved in many brain activities, including movement and emotion.

Hallucination—A false or distorted perception of objects, sounds, or events that seems real. Hallucinations usually result from drugs or mental disorders.

Psychosis—A serious mental disorder characterized by defective or lost contact with reality often with hallucinations or delusions.

other stimulants (including **caffeine** and **decongestants**) or **antidepressant drugs** (especially **monoamine oxidase inhibitors** [MAOs], but also **tricyclic antidepressants**). Desoxyn should not be taken by patients with glaucoma, cardiovascular disease (including **hypertension** and arteriosclerosis), or **hyperthyroidism**.

Causes and Symptoms

Short-term effects of methamphetamine relate to its stimulation of the brain and the cardiovascular system. Euphoria and rush, alertness, increased physical activity, and decreased sleep and appetite occur from an increase in available dopamine in the brain. Any or all of these effects can lead to compulsive use of the drug that characterizes **addiction**. In addition, methamphetamine causes rapid heart beat (tachycardia), increased respiration, and increased blood pressure (hypertension), and with very high doses, increased body temperature (hyperthermia) and convulsions can occur.

Chronic use of methamphetamine can result in two hallmark features of addiction: tolerance and dependence. Tolerance to the euphoric effects in particular can prompt abusers to take higher or more frequent doses of the drug. Withdrawal symptoms in chronic users include depression, **anxiety**, fatigue, and an intense craving for the drug. Users who inject methamphetamine risk contracting life-threatening viruses such as HIV and hepatitis through the use of dirty needles.

With repeated use, methamphetamine can cause anxiety, **insomnia**, mood disturbances, confusion, **hallucinations**, **psychosis**, and violent behavior. Psychotic features sometimes emerge, such as **paranoia**, hallucinations, and **delusions**, and can last well after methamphetamine use has stopped. **Stroke** and weight loss are other long-term effects.

Diagnosis

Methamphetamine use may be suspected by the symptoms described above and confirmed with a urine drug screening test

Treatment

For acute intoxication accompanied by psychosis, patients may be calmed by reassurance and a quiet setting, but sometimes **antipsychotic drugs** or sedatives are administered. Substances that prevent absorption from the gastrointestinal tract (e.g., **activated charcoal**) may be used if the drug was taken orally. Additional care is given as needed (e.g., keeping the airways open, treatment of seizures.) Individual with methamphetamine intoxication may be violent, agitated, and a danger to themselves and others.

The most effective treatment for methamphetamine addiction is cognitive-behavioral intervention such as counseling but may also include family education, drug testing, and group support in a twelve-step program. The goal of these modalities is to modify the patient's thinking, expectancies, and behaviors to increase coping skills in the face of life's stressors. Contingent management is a promising behavioral intervention, where incentives are provided in exchange for staying clean and for participating in treatment. Residential programs/therapeutic communities may be helpful, particularly in more severe cases.

Antidepressant drugs such as bupropion (Wellbutrin) can be a useful treatment aid, but as of 2010, there are no FDA-approved medications specifically for the treat stimulant addiction.

Prognosis

Addiction is a complex disorder, and prospects for individual addicts vary widely. Chronic methamphetamine use causes changes in brain and mental function While some effects are reversible, others are very long lasting and perhaps permanent. Methamphetamine is addictive. Relapses are common, and cravings may continue for a long time after drug use has stopped.

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Prevention

Teenagers are a target group for prevention strategies as adolescence and young adulthood are associated with exposure to and an inclination to experiment with drugs. Drug education and prevention programs should begin a early, and parents and teachers should be alert to the possibility of methamphetamine abuse.

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National Clearinghouse on Alcohol and Drug Information, P. O. Box 2345, Rockville, MD, 20847, (877) SAMHSA-7; Hablamos español: (877) 767-8432; TDD: (800) 487-4889, (240) 221-4292, http://ncadi.samhsa.gov.

National Council on Alcohol and Drug Dependence, 244 East 58th Street 4th Floor, New York, NY, 10022, (212) 269-7797, 24-hour help line: (800) NCA-CALL, (212) 269-7510, national@mcadd.org, http://www.ncadd.org.

Partnership for a Drug-free America, 405 Lexington Avenue, Ste 1601, New York, NY, 10174, (212) 922-1560, (212) 922-1570, http://www.drugfree.org.

Jill U. Adams
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Methemoglobinemia

Definition

When excessive hemoglobin in the blood is converted to another chemical that cannot deliver oxygen to tissues, called methemoglobin.

Description

The molecule hemoglobin in the blood is responsible for binding oxygen to give to the body. When hemoglobin is oxidized to methemoglobin its structure changes and it is no longer able to bind oxygen. Hemoglobin is constantly under oxidizing stresses: however, normally less than 1% of a person's hemoglobin is in the methemoglobin state. This is due to the body's systems that reduce methemoglobin back to hemoglobin. Infants have a higher risk of acquiring methemoglobinemia because infant hemoglobin is more prone to be oxidized to methemoglobin.

Causes and symptoms

Methemoglobinemia can either be congenital or acquired.

There are two causes of the congenital form. One cause is a defect in the body's systems to reduce methemoglobin to hemoglobin. The other cause is a mutant form of hemoglobin called hemoglobin M that cannot bind to oxygen. Both of these forms are typically benign.

Acquired methemoglobinemia is caused by an external source, usually a drug or medication. Some of these medications include benzocaine, lidocaine and prilocaine. These medications can inhibit the body's systems of reducing methemoglobin to hemoglobin resulting in methemoglobinemia.

With a methemoglobin level of 3-15% skin can turn to a pale gray or blue (**cyanosis**). With levels above 25% the following symptoms may be present:

- Cyanosis unaffected by oxygen administration
- Blood that is dark or chocolate in color that will not change to red in the presence of oxygen
- Headache
- Weakness
- Confusion
- Chest pain

When methemoglobin levels are above 70% **death** may result if not treated immediately.

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KEY TERMS

Cyanosis—When the body does not receive enough oxygen.

Oxidation—When a chemical element or compound loses an electron.

Reduction—When a chemical element or compound gains an electron.

Diagnosis

Diagnosis is based on the symptoms and history. If these are indicative of methemoglobinemia blood tests are performed to confirm the presence and level of methemoglobin.

Treatment

For acquired methemoglobinemia the typical treatment is with methylene blue. This is administered with an IV over a five-minute period and results are typically seen within 20 minutes. Methylene blue reduces methemoglobin back to hemoglobin.

Though congenital methemoglobinemia is usually benign, the form due to a defective reducing system can be treated with ascorbic acid (vitamin C) taken daily. The other congenital form due to hemoglobin M has no treatment as of late.

Alternative treatment

There are not any known alternative treatments for methemoglobinemia. Methylene blue, or a similar treatment, is needed to reduce methemoglobin to hemoglobin.

Prognosis

If found early, acquired methemoglobinemia can be easily treated with no side effects. After treatment with methylene blue the patient can expect a full recovery.

Congenital methemoglobinemia is typically benign and should be observed. If methemoglobinemia symptoms occur the person should be taken to the hospital for treatment.

Prevention

If a person gets methemoglobinemia from a certain medication that medication should be avoided at all costs in the future. For people with congenital methemoglobinemia medications or other things that are known to oxidize hemoglobin should be avoided.

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Thomas Scott Eagan
Ronald Watson, PhD

Methylphenidate *see* **Central nervous system stimulants**

Metoprolol *see* **Beta blockers**

Metronidazole *see* **Antiprotozoal drugs**

Micronaz *see* **Antifungal drugs, topical**

Microphthalmia and anophthalmia

Definition

Anophthalmia is the complete absence of an eye. Microphthalmia is an eye that is abnormally small.

Description

Anophthalmia is caused by a defect in embryonic development. The total absence of an eye is extremely rare and often a clinical sign associated with a broad range of genetic disorders or, more commonly, a sporadic mutation. Sporadic transmission occurs in the affected individual due to a genetic abnormality. It is not passed on from the parents, but usually due to a combination of environmental and genetic influences. More commonly anophthalmia clinically presents as a small cyst. The defect, which causes anophthalmia, is an absence of the optic vesicle, a structure important for eye development. The genetic abnormality usually occurs during weeks one to three after conception. It is estimated that the incidence of microphthalmia occurs 0.22 times per 1,000 live births. Anophthalmia can occur during adult life but not associated with a genetic cause.

Microphthalmia refers to an abnormally small eye. This clinical sign is often associated with autosomal dominant or recessively transmitted genetic disorders. Most disorders dominantly inherited with microphthalmia are associated with some visual capabilities

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in infancy and early childhood. Microphthalmia may be isolated (the only presenting sign) or associated with a range of ocular or systemic abnormalities. Isolated cases of microphthalmia may be sporadic or inherited. There is a variable degree of **visual impairment**. Microphthalmia occurs due to autosomal recessive transmission and is part of a syndrome associated with abnormalities in the retina or systemic lesions. Microphthalmia results from a developmental defect after formation of the optic vesicle. The developmental abnormality causes the optic vesicle to fold inwards, resulting in the formation of a cyst. The cyst will progressively swell from birth, and it may be situated along the optic nerve. The cyst may also be situated along other important eye structures.

Causes and symptoms

Microphthalmia and anophthalmia can be caused by sporadic or genetic mutations. Anophthalmia is characterized by a total absence of an eye. Anophthalmia in an adult is usually caused by trauma, infection, tumor, or advanced eye disease.

Diagnosis

Microscope examination confirms the diagnosis of true anophthalmia. The clinician examines a piece of tissue taken from the eye and notes eviscerated tissue. For microphthalmia the confirmation can be established by eye measurements. Eyes that have an axial length of <21 mm in an adult or <19 mm in a one-year-old child are described as having microphthalmia.

Treatment

Large cysts causing microphthalmia should be aspirated or removed surgically. There is no known cure for anophthalmia or microphthalmia. For anophthalmia a prosthetic eye can be fitted which may involve surgery. Treatment for microphthalmia depends on the complexity of eye involvement.

Prognosis

For anophthalmia, prosthetic eyes should be seen by a specialist two to three times per year to assess fit, mobility, and smoothness. They are usually well tolerated and have good appearance and mobility. The clinical course for microphthalmia depends on the extent of smallness, but usually patients progress favorably without major treatment. Since the smallness is distinctly noticeable, there may be individual cosmetic considerations.

KEY TERMS

Axial—A straight line passing through a spherical body between its two poles and about which the body may revolve.

Eviserated—Removal of eye contents.

Prostheses—A synthetic object that resembles a missing anatomical part.

Retina—A major portion of the eye responsible for reception of visual light rays.

Prevention

There is no known prevention for either, since these clinical signs are commonly associated with genetic inheritance.

Resources

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ORGANIZATIONS

American Society of Human Genetics, 9650 Rockville Pike, Bethesda, MD, 20814-3998, (301) 634-7300, (301) 634-7079, http://www.ashg.org/.

Laith Farid Gulli, M.D.

Middle ear infection *see* **Otitis media**

Mifeprex *see* **Mifepristone**

Mifepristone

Definition

Mifepristone, mifeprex, RU 486, is a drug used to produce medical abortion within 49 days of the last menstrual period.

Purpose

This medication is primarily used for ending pregnancies within 19 days after the last menstrual period.

Description

Mifepristone blocks progesterone, the hormone necessary for maintaining **pregnancy**, causing the uterus to shed its lining and producing menstrual-like bleeding.

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Three doctor or clinic visits are required for medical termination of pregnancy. Following a medical history, **physical examination**, and confirmation of pregnancy, 600mg of mifepristone, three 200mg tablets, are given as a single dose. Two days later, on day three, if termination of pregnancy cannot be confirmed, 400mcg of misoprostol, two 200mcg tablets, are given at one time. Additional medication, like ibuprofen, may be needed to relieve abdominal **pain** and cramping. On day 14, if termination cannot be confirmed, **dilatation and curettage** or suction evacuation of the uterine cavity is done, usually under **local anesthesia**. Depending on the amount of vaginal bleeding, a **hemoglobin test** may be needed.

Contraindications to medical termination of pregnancy

- Women who are more than seven weeks pregnant, 49 days since their last menstrual period, should not take mifepristone.
- Women who have an IUD, intrauterine device, for contraception.
- Women who take long-term corticosteroids or have chronic adrenal failure.
- Women with bleeding disorders or who take blood thinning medications like warfarin or aspirin.
- Women with suspected ectopic pregnancy
- Women who do not have adequate access to emergency medical services
- Women who cannot or will not adhere to the three visit protocol for medical termination of pregnancy.

Aftercare

There may be heavy bleeding and abdominal cramping when early pregnancies are interrupted with mifepristone and misoprostol.

Until vaginal bleeding has essentially stopped, sexual intercourse increases the risk of infection.

It may take days or weeks for women to stabilize their hormonal balances after medical abortion. Some women experience mood swings, **anxiety**, the blues or even depression. Though these symptoms subside over time, counseling or support groups may be helpful.

Complications of medical abortion

Uterine infection, with **fever** and abdominal pain and tenderness, is the most serious complication of medical abortion.

Anemia from heavy or prolonged vaginal bleeding can be a serious complication.

KEY TERMS

Dilatation and curettage (D and C)—A surgical procedure where the cervix is dilated and an instrument is introduced to scrape tissue from the walls of the uterus to complete termination of pregnancy.

Misprostol—A drug used in combination with mifepristone to cause uterine contractions that expel the contents of the uterus.

Other common side effects include: **fatigue**, headaches, **dizziness**, anxiety, **nausea**, **vomiting**, **diarrhea**, and low-back pain.

Normal results

Most women feel better within two weeks. Bleeding and spotting usually stop within 16 days, but may last up to a month.

Abnormal results

In some cases, mifepristone does not completely terminate pregnancy. When that happens, surgical termination like **dilatation and curettage** (D and C) or suction of the uterine cavity is required. Five to eight percent of women taking mifepristone require a surgical termination of pregnancy, according to the FDA. During a D and C, usually done under local anesthesia at a hospital or clinic, the cervix is dilated and an instrument is used to scrape residual tissue away from the walls of the uterus. This generally stops heavy bleeding.

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James Waun, MD, RPh

Migraine headache

Definition

Migraine is a type of **headache** marked by severe head **pain** lasting several hours or more.

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Description

Migraine is an intense and often debilitating type of headache. The term *migraine* is derived from the Greek word *hemikrania*, meaning "half the head," because the classic migraine headache affects only one side of the person's head. Migraines affect as many as 24 million people in the United States, and are responsible for billions of dollars in lost work, poor job performance, and direct medical costs. Approximately 18% of women and 6% of men experience at least one migraine attack per year. Currently, one American in 11 now suffers from migraines, more than three times as many are women, with most of them being between the ages of 30 and 49. Migraines often begin in adolescence, and are rare after age 60.

Two types of migraine are recognized. Eighty percent of migraine sufferers experience "migraine without aura" (common migraine). In "migraine with aura," or classic migraine, the pain is preceded or accompanied by visual or other sensory disturbances, including **hallucinations**, partial obstruction of the visual field, **numbness** or **tingling**, or a feeling of heaviness. Symptoms are often most prominent on one side of the head or body, and may begin as early as 72 hours before the onset of pain.

People who experience migraines overwhelmingly describe them as intensely painful with an onset often characterized by an "aura," which is a sensory warning described as seeing flashes of light, or spots, or feeling a tingling in limbs. Migraines can be extremely incapacitating and can last for hours or even days. For instance, "status migrainosus" is a severe migraine that can last 72 hours or longer and often results in hospitalization. For many sufferers, migraine is associated with other illnesses such as depression, **anxiety**, **stroke**, **irritable bowel syndrome**, **epilepsy**, and **hypertension**.

Demographics

The World Health Organization (WHO) considers migraines to be one of the most debilitating diseases in the world. In the United States, some 17% of women and 6% of men have experienced a migraine. According to the National Headache Foundation, an estimated 28 million Americans have migraine headaches. A 2005 survey, sponsored by the National Headache Foundation, reported that 90% of people with migraines could not function normally on the day of a migraine attack, 80% experienced abnormal sensitivity to light and noise, 75% experienced **nausea and vomiting**, 30% required bed rest, and 25% missed at least 1 day of work due to migraine in past 3 months. In Canada, more than 3 million people suffer from migraine headaches. Women tend to develop migraines three times more often than men. Migraine headaches start in childhood or adolescence and continue throughout adult life.

Causes

The cause of migraines is presently unknown. They are believed to be sparked by spasms in the cerebral arteries which constrict or widen abnormally as a result of serotonin imbalance. Although the precise cause is still being researched, migraine-triggering factors have been documented. For example, women often report that their migraine occurs during or right before the onset of their menstrual cycle. Other triggers include:

- stress
- lack of sleep
- changes in weather
- use of contraceptives
- use of hormone replacement therapies
- environmental chemicals
- liver problems
- dental infections
- some foods including cured meats, red wine, onion, freshly baked yeast products, eggs, alcohol, nuts, and aged cheese
- medical conditions
- medications

The most widely accepted hypothesis of migraine suggests that a migraine attack is precipitated when pain-sensing nerve cells in the brain (called nociceptors) release chemicals called neuropeptides. At least one of the neurotransmitters, substance P, increases the pain sensitivity of nearby nociceptors. This process is called sensitization.

Other neuropeptides act on the smooth muscle surrounding cranial blood vessels. This smooth muscle regulates blood flow in the brain by relaxing or contracting, thus dilating (enlarging) or constricting the enclosed blood vessels. At the onset of a migraine headache, neuropeptides are thought to cause muscle relaxation, allowing vessel dilation and increased blood flow. Other neuropeptides increase the leakiness of cranial vessels, allowing fluid leak, and promote inflammation and tissue swelling. The pain of migraine is thought to result from this combination of increased pain sensitivity, tissue and vessel swelling, and inflammation. The aura seen during a migraine may be related to constriction in the blood vessels that dilate in the headache phase.

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Migraines commonly develop in three distinct stages:

- The aura phase: This stage marks the onset of migraine and commonly lasts from 15 to 30 minutes with symptoms that may involve visual disturbances, numbness, dizziness, ringing in the ear, weakness on one side of the body, and sensitivity to light, smells, and noises.
- The headache phase: This phase is characterized by an excruciating headache that may last from hours to days with symptoms such as nausea, sensitivity to light, diarrhea, vomiting, excessive perspiration and chills. It often occurs only on one side of the head.
- The post–headache phase: After the headache has subsided, the skull often remains very tender and the person feels totally exhausted.

Genetics

Susceptibility to some types of migraine is inherited. A child of a migraine sufferer has as much as a 50% chance of developing migraines. If both parents are affected, the chance rises to 70%. In 2002, a team of Australian researchers identified a region on human chromosome 1 that influences susceptibility to migraine. It is likely that more than one gene is involved in the inherited forms of the disorder. Many cases of migraine, however, have no obvious familial basis. It is likely that the genes that are involved set the stage for migraine, and that full development requires environmental influences, as well.

Two groups of Italian researchers have recently identified two loci on human chromosomes 1 and 14 respectively that are linked to migraine headaches. The locus on chromosome 1q23 has been linked to familial hemiplegic migraine type 2, while the locus on chromosome 14q21 is associated with migraine without aura.

Triggers

A wide variety of foods, drugs, environmental cues, and personal events are known to trigger migraines. It is not known how most triggers set off the events of migraine, nor why individual migraine sufferers are affected by particular triggers but not others.

Common food triggers include:

- alcohol
- caffeine products, as well as caffeine withdrawal
- chocolate
- foods with an extremely high sugar content
- dairy products
- fermented or pickled foods
- citrus fruits
- nuts
- processed foods, especially those containing nitrites, sulfites, or monosodium glutamate (MSG)

Environmental and event-related triggers include:

- stress or time pressure
- menstrual periods, menopause
- sleep changes or disturbances, including oversleeping
- prolonged overexertion or uncomfortable posture
- hunger or fasting
- odors, smoke, or perfume
- strong glare or flashing lights

Drugs that may trigger migraine include:

- oral contraceptives
- estrogen replacement therapy
- Theophylline
- Reserpine
- Nifedipine
- Indomethicin
- Cimetidine
- overuse of decongestants
- analgesic overuse
- benzodiazepine withdrawal

Symptoms

Migraine without aura may be preceded by elevations in mood or energy level for up to 24 hours before the attack. Other pre-migraine symptoms may include **fatigue**, depression, and excessive yawning.

Aura most often begins with shimmering, jagged arcs of white or colored light progressing over the visual field in the course of 10–20 minutes. This may be preceded or replaced by dark areas or other visual disturbances. **Numbness and tingling** are common, especially of the face and hands. These sensations may spread, and may be accompanied by a sensation of weakness or heaviness in the affected limb.

Migraine pain is often present only on one side of the head, although it may involve both, or switch sides during attacks. The pain is usually throbbing, and may range from mild to incapacitating. It is often accompanied by **nausea** or **vomiting**, painful sensitivity to light and sound, and intolerance of food or odors. Blurred vision is also common.

The pain tends to intensify over the first 30 minutes to several hours, and may last from several hours to a day, or longer. Afterward, the affected person is usually weary, and sensitive to sudden head movements.

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Diagnosis

Diagnosis is commonly established on the basis of the patient's medical history and a physical exam. The following tests may also be prescribed to rule out other possible causes of headache:

- Computerized tomography (CT) scan: A CT scan uses computer-directed x rays that provide a view of the brain to identify possible conditions that may also cause headache, such as tumors, infections, and other medical problems.
- Magnetic resonance imaging (MRI): This imaging technique uses radio waves and a powerful magnet to produce very detailed views of the brain and its blood vessels. It may also help diagnose tumors, strokes, aneurysms, and other brain abnormalities.
- Spinal tap: In this procedure, a thin needle is inserted between two vertebrae in the lower back to extract a sample of cerebrospinal fluid for laboratory analysis. It may eliminate other diseases such as meningitis that also cause intense headaches.

Treatment

At the onset of symptoms, the migraine sufferer should seek out a quiet, dark room and attempt to sleep. Placing a cold, damp cloth or a cold pack on the forehead may help. Additionally, tying a headband tightly around the head can relieve migraines.

Migraine headaches are often linked with **food allergies** or intolerances. Identification and elimination of the offending food or foods can decrease the frequency of migraines and/or alleviate these headaches altogether.

Magnesium and **calcium** have been shown to be of benefit to migraine sufferers, as these **minerals** maintain healthy blood vessels. Pantothenic acid is also considered helpful, as it helps the body produce serotonin.

Allopathic treatments

Nonsteroidal anti-inflammatory drugs (NSAIDs) **acetaminophen** (Tylenol), ibuprofen (Motrin), and naproxen (Aleve) are helpful for early and mild headache. Excedrin Migraine is a combination product that is indicated for migraine headache.

More severe or unresponsive attacks may be treated with ergotamine (botulinum toxin), dihydroergotamine, sumatriptan (Imitrex), beta-blockers and calcium channel-blockers, antiseizure drugs, antidepressants (SSRIs), meperidine, or metoclopramide. Some of these drugs are also available as nasal sprays, intramuscular injections, or rectal suppositories when **vomiting** prevents taking the drug by mouth.

Sumatriptan and other triptan drugs (zolmitriptan, rizatriptan, naratriptan, almotriptan, and frovatriptan) should not be taken by people with any kind of **vascular disease** because they cause coronary artery narrowing. Otherwise these drugs have been shown to be very safe.

Continued use of some **antimigraine drugs** can lead to "rebound headache," marked by frequent or chronic headaches, especially in the early morning hours. Rebound headache can be avoided by using antimigraine drugs under a doctor's supervision, with the minimum dose necessary to treat symptoms. Tizanidine (Zanaflex) has been reported to be effective in treating rebound headaches when taken together with an NSAID.

Treatment of migraine presents special problems in the elderly. The presence of other diseases may prevent the use of some medications. Another concern is that older patients are more likely than younger ones to experience adverse side effects. Older migraine patients accordingly require cautious treatment that takes into account possible pharmacological interactions associated with their greater use of drugs for other medical conditions. Paracetamol (acetaminophen) is considered the safest medication for symptomatic treatment of migraine in the elderly.

Alternative treatment

Alternative treatments for migraine include:

- Acupressure. Pressing on the Gates of Consciousness (GB 20) points can relieve migraine.
- Acupuncture. A National Institutes of Health (NIH) panel concluded that acupuncture may be a useful treatment for headache.
- Aromatherapy. The essential oil rosemary eases migraine pain.
- Autogenic training. Autogenic training is a form of self-hypnosis developed in Germany in the 1930s that has been shown in several studies to relieve the pain of migraine.
- Cognitive behavior therapy.
- Herbals. Valerian (*Valeriana officinalis*), passionflower (*Passiflora incarnata*), feverfew (*Chrysanthemum parthenium*), ginger, ginkgo (*Ginkgo biloba*), goldenseal (*Hydrastis canadensis*), hawthorn (*Crataegus oxyacantha*), linden, wood betony (*Stachys officinalis*), skullcap (*Scutellaria lateriflora*), or cramp bark (*Viburnum opulus*) may relieve migraines.
- Hydrotherapy. Contrast showers, in which a short hot shower is followed by a longer cold shower, may

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KEY TERMS

Aura—A group of visual or other sensations that precedes the onset of a migraine attack.

Autogenic training—A form of self-hypnosis developed in Germany that appears to be beneficial to migraine sufferers.

Coenzyme Q_{10}—A substance used by cells in the human body to produce energy for cell maintenance and growth. It is being studied as a possible preventive for migraine headaches.

Nociceptor—A specialized type of nerve cell that senses pain.

Transcutaneous electrical nerve stimulation (TENS)—A treatment in which a mild electrical current is passed through electrodes on the skin to stimulate nerves and block pain signals.

halt an oncoming migraine. A hot enema can temporarily relieve migraine pain.

- Naturopathy. Migraine headaches are one of the most common reasons for consulting naturopathic practitioners. Naturopaths typically treat migraine with a combination of nutritional therapy and mind/body techniques.
- Relaxation techniques. Meditation, yoga, hypnosis, visualization, breathing exercises, or progressive muscular relaxation may halt the progression of a migraine.
- Supplements. Clinical studies have shown that vitamin B_2 (riboflavin), magnesium, 5-HTP, or melatonin can reduce the severity of migraines.
- Transcutaneous electrical nerve stimulation (TENS).

Prognosis

Most people can control migraines through recognizing and avoiding triggers, and by using effective treatments. Some people with severe migraines do not respond to preventive or drug therapy. Migraines usually wane in intensity by age 60 and beyond.

Taking a combination of medications when migraine attacks occur brings some amount of relief to most people and allows them to limit the disabling effects of these headaches. Some researchers believe that women after **menopause** may experience fewer migraines due to the decline in estrogen levels.

Prevention

Migraine sufferers are encouraged to keep track of their personal triggering factors since avoiding them can decrease the occurrence of migraine attacks. For some people, it may mean avoiding certain foods associated with previous migraine headaches, for others it may mean the avoidance of stressful situations. **Stress** management therapies, such as relaxation and **biofeedback**, may also reduce the occurrence and intensity of migraine headaches.

One substance that is being studied as a possible migraine preventive is coenzyme Q_{10}, a compound used by cells to produce energy needed for cell growth and maintenance. Coenzyme Q_{10} has been studied as a possible complementary treatment for **cancer**. Its use in preventing migraines is encouraging and merits further study.

Lifestyle changes can help prevent migraine. Besides avoiding triggers, regular aerobic **exercise** has been shown to help reduce stress. Women who have identified estrogen as a trigger may select to avoid this type of medication or consult with their physician to modify dosage.

A study published in early 2003 reported that three drugs currently used to treat disorders of muscle tone are being explored as possible preventive treatments for migraine. They are botulinum toxin type A (Botox), baclofen (Lioresal), and tizanidine (Zanaflex). Early results of open trials of these medications are positive.

Anti-epileptic drugs, which are also known as anticonvulsants, are also being studied as possible migraine preventives. Sodium valproate (Epilim) is the only drug approved by the Food and Drug Administration (FDA) for prevention of migraine. Such newer anticonvulsants as gabapentin (Neurontin) and topiramate (Topamax) are presently being evaluated as migraine preventives.

A natural preparation made from butterbur root (*Petasites hybridus*) has been sold in Germany since the 1970s as a migraine preventive under the trade name Petadolex. Petadolex has been available in the United States since December 1998 and has passed several clinical safety and postmarketing surveillance trials.

Other possible preventive measures include: eating at regular times, not skipping meals, reducing the use of **caffeine** and pain-relievers, restricting physical exertion (especially on hot days), and keeping regular sleep hours, but not oversleeping.

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ORGANIZATIONS

American Headache Society (AHS), 19 Mantua Road, Mount Royal, NJ, 08061, (856)423 0258, (856)423-0082, http://www.achenet.org.

American Pain Foundation, 201 North Charles St., Suite 710, Baltimore, MD, 21201-4111, (888)615-PAIN, info@ painfoundation.org, http://www.painfoundation.org.

National Institute of Neurological Disorders and Stroke (NINDS), P.O. Box 5801, Bethesda, MD, 20824, (301) 496-5751, (800) 352-9424, http://www.ninds.nih.gov.

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Miliaria *see* **Prickly heat**

Mineral deficiency

Definition

The term mineral deficiency means a condition in which the concentration of any one of the **minerals** essential to human health is abnormally low in the body. In some cases, an abnormally low mineral concentration is defined as that which leads to an impairment in a function dependent on the mineral. In other cases, the convention may be to define an abnormally low mineral concentration as a level lower than that found in a specific healthy population.

The mineral nutrients are defined as all inorganic substances that are required for life. As far as human **nutrition** is concerned, the inorganic nutrients include

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water, **sodium**, potassium, chloride, **calcium**, phosphate, sulfate, magnesium, iron, copper, zinc, manganese, iodine, selenium, and molybdenum. Although these substances are all elements, they are never consumed in that form in the diet. Instead, they are consumed in the form of compounds, such as sulfates and iodides.

There is some evidence that other inorganic nutrients, such as chromium and boron, play a part in human health, but their role is not well established. Fluoride has been proven to increase the strength of bones and teeth, but there is little or no reason to believe that it is needed for human life.

The mineral content of the body may be measured by testing samples of blood plasma, red blood cells, or urine. In the case of calcium and phosphate deficiency, the diagnosis may also involve taking x rays of the skeleton. In the case of iodine deficiency, the diagnosis may include examining the patient's neck with the eyes and hands. In the case of iron deficiency, the diagnosis may include the performance of a stair–stepping test by the patient. Since all minerals serve strikingly different functions in the body, tests for the corresponding deficiency are markedly different from each other.

Description

Laboratory studies with animals have revealed that severe deficiencies in any one of the inorganic nutrients can result in very specific symptoms, and finally in **death**, due to the failure of functions associated with that nutrient. In humans, deficiency in one nutrient may occur less often than deficiency in several nutrients. A patient suffering from **malnutrition** tends to be deficient in a variety of nutrients. In the United States, malnutrition is most often found among severe alcoholics. In part, this is because alcohol consumption may supply half of the energy requirement, resulting in a mineral and vitamin intake of half the expected level. Deficiencies in one nutrient do occur, for example, in human populations living in iodine–poor regions of the world, and in iron deficient persons who lose excess iron by abnormal bleeding.

Inorganic nutrients have a great variety of functions in the body. Water, sodium, and potassium deficiencies are most closely associated with abnormal nerve action and cardiac **arrhythmias**. Deficiencies in these nutrients tend to result not from a lack of content in the diet, but from excessive losses due to severe **diarrhea** and other causes. Iodine deficiency is a global public health problem. It occurs in parts of the world with iodine–deficient soils, and results in **goiter**, which involves a relatively harmless swelling of the neck, and cretinism, a severe birth defect. The only use of iodine in the body is for making thyroid hormone. However, since thyroid hormone has a variety of roles in development of the embryo, iodine deficiency during **pregnancy** results in a number of **birth defects**.

Calcium deficiency due to lack of dietary calcium occurs only rarely. However, calcium deficiency due to **vitamin D deficiency** can be found among certain populations. Vitamin D is required for the efficient absorption of calcium from the diet, and hence vitamin D deficiency in growing infants and children can result in calcium deficiency.

Dietary phosphate deficiency is rare because phosphate is plentiful in plant and animal foods, but also because phosphate is efficiently absorbed from the diet into the body. Iron deficiency causes anemia (lack of red blood cells), which results in tiredness and **shortness of breath**.

Dietary deficiencies in the remaining inorganic nutrients tend to be rare. Magnesium deficiency is uncommon, but when it occurs it tends to occur in chronic alcoholics, in persons taking diuretic drugs, and in those suffering from severe and prolonged diarrhea. Magnesium deficiency tends to occur with the same conditions that provoke deficiencies in sodium and potassium. Zinc deficiency is rare, but it has been found in impoverished populations in the Middle East, who rely on unleavened whole wheat bread as a major food source. Copper deficiency is also rare, but dramatic and health–threatening changes in copper metabolism occur in two genetic diseases, Wilson's disease and Menkes' disease.

Selenium deficiency may occur in regions of the world where soils are poor in selenium. Low–selenium soils can produce foods that are also low in selenium. Premature infants may also be at risk for selenium deficiency. Manganese deficiency is very rare. Experimental studies with humans fed a manganese deficient diet have revealed that the deficiency produces a scaly, red rash on the skin of the upper torso. Molybdenum deficiency has probably never occurred, but indirect evidence suggests that if molybdenum deficiency could occur, it would result in **mental retardation** and death.

Causes and symptoms

Sodium deficiency (**hyponatremia**) and water deficiency are the most serious and widespread deficiencies in the world. These deficiencies tend to arise from excessive losses from the body, as during prolonged and severe diarrhea or **vomiting**. Diarrheal diseases are a major world health problem, and are responsible for about a quarter of the 10 million infant

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deaths that occur each year. Nearly all of these deaths occur in impoverished parts of Africa and Asia, where they result from contamination of the water supply by animal and human feces.

The main concern in treating diarrheal diseases is **dehydration**, that is, the losses of sodium and water which deplete the fluids of the circulatory system (the heart, veins, arteries, and capillaries). Severe losses of the fluids of the circulatory system result in **shock**. Shock nearly always occurs when dehydration is severe enough to produce a 10% reduction in body weight. Shock, which is defined as inadequate supply of blood to the various tissues of the body, results in a lack of oxygen to all cells of the body. Although diarrheal fluids contain a number of electrolytes, the main concern in avoiding shock is the replacement of sodium and water.

Sodium deficiency and potassium deficiency also frequently result during treatment with drugs called **diuretics**. Diuretics cause loss of sodium from the body. These drugs are used to treat high blood pressure (**hypertension**), where the resulting decline in blood pressure reduces the risk for cardiovascular disease. However, diuretics can lead to sodium deficiency, resulting in low plasma sodium levels. A side effect of some diuretics is excessive loss of potassium, and low plasma potassium (**hypokalemia**) may result.

Iodine deficiency tends to occur in regions of the world where the soil is poor in iodine. Where soil used in agriculture is poor in iodine, foods grown in the soil will also be low in iodine. An iodine intake of 0.10–0.15 mg/day is considered to be nutritionally adequate, while iodine deficiency occurs at levels of less than 0.05 mg/day. Goiter, an enlargement of the thyroid gland (located in the neck), results from iodine deficiency. Goiter continues to be a problem in eastern Europe, parts of India and South America, and in Southeast Asia. Goiter has been eradicated in the United States because of the fortification of foods with iodine. Iodine deficiency during pregnancy results in cretinism in the newborn. Cretinism involves mental retardation, a large tongue, and sometimes deafness, muteness, and lameness.

Iron deficiency occurs due to periods of dietary deficiency, rapid growth, and excessive loss of the body's iron. Human milk and cow milk both contains low levels of iron. Infants are at risk for acquiring iron deficiency because their rapid rate of growth depends on a corresponding increased supply of dietary iron, for use in making blood and muscles. Human milk is a better source of iron than cow milk, since about half of the iron in human breast milk is absorbed by the infant's digestive tract. In contrast, only 10% of the iron in cow milk is absorbed by the infant. Surveys of lower–income families in the United States have revealed that about six percent of infants are anemic indicating a deficiency of iron in their **diets**. Blood loss that occurs with menstruation in women, as well as with a variety of causes of intestinal bleeding is a major cause of iron deficiency. The symptoms of iron deficiency are generally limited to anemia, and the resulting tiredness, weakness, and a reduced ability to perform physical work.

Calcium and phosphate are closely related nutrients. About 99% of the calcium and 85% of the phosphate in the body occur in the skeleton, where they exist as crystals of solid calcium phosphate. Both of these nutrients occur in a great variety of foods. Milk, eggs, and green, leafy vegetables are rich in calcium and phosphate. Whole cow milk, for example, contains about 1.2 g calcium and 0.95 g phosphorus per kg of food. Broccoli contains 1.0 g calcium and 0.67 g phosphorus per kg food. Eggs supply about one third of the calcium and phosphate of the overall population of the United States. Dietary deficiencies in calcium (**hypocalcemia**) or phosphate are extremely rare throughout the world. Vitamin D deficiency can be found among young infants, the elderly, and others who may be shielded from sunshine for prolonged periods of time. Vitamin D deficiency impairs the absorption of calcium from the diet, and in this way can provoke calcium deficiency even when the diet contains adequate calcium.

Zinc deficiency has been found among peasant populations in rural areas of the Middle East. Unleavened whole wheat bread can account for 75% of the energy intake in these areas. This diet, which does not contain meat, does contain zinc, but it also contains phytic acid at a level of about three grams per day. Phytic acid, which occurs naturally in wheat, inhibits zinc absorption. The yeast used to leaven bread produces enzymes that inactivate the phytic acid. Unleavened bread does not contain yeast, and therefore, contains intact phytic acid. The symptoms of zinc deficiency include lack of sexual maturation, lack of pubic hair, and small stature. The amount of phytic acid in a typical American diet cannot provoke zinc deficiency.

Zinc deficiency is relatively uncommon in the United States, but it may occur in adults with **alcoholism** or intestinal malabsorption problems. Low plasma zinc has been found in patients with alcoholic **cirrhosis**, **Crohn's disease**, and **celiac disease**. Experimental studies with humans have shown that the signs of zinc deficiency are detectable after two to five weeks of consumption of the zinc–free diet. The signs include a

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rash and diarrhea. The rash occurs on the face, groin, hands, and feet. These symptoms can easily be reversed by administering zinc. An emerging concern is that increased calcium intake can interfere with zinc absorption or retention. Hence, there is some interest in the question as to whether persons taking calcium to prevent **osteoporosis** should also take zinc supplements.

Severe alterations in copper metabolism occur in two genetic diseases, Wilson's disease and Menkes' disease. Both of these diseases are rare and occur in about one in 100,000 births. Both diseases involve mutations in copper transport proteins, that is, in special channels that allow the passage of copper ions through cell membranes. Menkes' disease is a genetic disease involving mental retardation and death before the age of three years. The disease also results in steely or kinky hair. The hair is tangled, grayish, and easily broken. Menkes' disease involves a decrease in copper levels in serum, the liver, and brain, and increases in copper in cells of the intestines and kidney.

Selenium deficiency may occur in premature infants, since this population naturally tends to have low levels of plasma selenium. Full term infants have plasma selenium levels of about 0.001–0.002 mM, while premature infants may have levels about one third this amount. Whether these lower levels result in adverse consequences is not clear. Selenium deficiency occurs in regions of the world containing low–selenium soils. These regions include Keshan Province in China, New Zealand, and Finland. In Keshan Province, a disease (Keshan disease) occurs which results in deterioration of regions of the heart and the development of fibers in these regions. Keshan disease, which may be fatal, is thought to result from a combination of selenium deficiency and a virus.

Diagnosis

The diagnosis of deficiencies in water, sodium, potassium, iron, calcium, and phosphate involves chemical testing of the blood plasma, urine, and red blood cells.

Iodine deficiency can be diagnosed by measuring the concentration of iodine in the urine. A urinary level greater than 0.05 mg iodine per gram creatinine means adequate iodine status. Levels under 0.025 mg iodine/g creatinine indicate a serious risk.

Normal blood serum magnesium levels are 1.2–2.0 mM. Magnesium deficiency results in hypomagnesemia, which is defined as serum magnesium levels below 0.8 mM. Magnesium levels below 0.5 mM provoke a decline in serum calcium levels. Hypomagnesemia can also result in low serum potassium. Some of the symptoms of hypomagnesemia, which include twitching and convulsions, actually result from the hypocalcemia. Other symptoms of hypomagnesemia, such as cardiac arrhythmias, result from low potassium levels.

There is no reliable test for zinc deficiency. When humans eat diets containing normal levels of zinc (16 mg/day), the level of urinary zinc is about 0.45 mg/day, while humans consuming low–zinc diets (0.3 mg/day) may have urinary levels of about 0.150 mg/day. Plasma zinc levels tend to be maintained during a dietary deficiency in zinc. Plasma and urinary zinc levels can be influenced by a variety of factors, and for this reason cannot provide a clear picture of zinc status.

Selenium deficiency may be diagnosed by measuring the selenium in plasma or red blood cells, where the normal values are 70 ng/mL and 90 ng/mL, respectively. There is also some interest in measuring the activity of an enzyme in blood platelets, in order to assess selenium status. This enzyme is glutathione peroxidase. Platelets are small cells of the bloodstream which are used mainly to allow the clotting of blood after an injury.

Treatment

The treatment of deficiencies in sodium, potassium, calcium, phosphate, and iron usually involves intravenous injections of the deficient mineral.

Iodine deficiency can be easily prevented and treated by fortifying foods with iodine. Table salt is fortified with 100 mg potassium iodide per kg sodium chloride. Goiter was once common in the United States in areas from Washington State to the Great Lakes region, but this problem has been eliminated by the use of iodized salt. Public health programs in impoverished countries have involved injections of synthetic oils containing iodine. Goiter is reversible but, cretinism is not.

Magnesium deficiency can be treated with a magnesium–rich diet. If magnesium deficiency is due to a prolonged period of depletion, treatment may include injections of magnesium sulfate (2.0 mL of 50% $MgSO_4$). Where magnesium deficiency is severe enough to provoke convulsions, magnesium needs to be administered by injections or infusions. For infusion, 500 mL of a 1% solution (1 gram/100 mL) of magnesium sulfate is gradually introduced into a vein over the course of about five hours.

Zinc deficiency and copper deficiency are quite rare, but when they are detected or suspected, they can be treated by consuming zinc or copper, on a daily basis, at levels defined by the RDA.

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KEY TERMS

Recommended Dietary Allowance—The Recommended Dietary Allowances (RDAs) are quantities of nutrients that are required each day to maintain human health. RDAs are established by the Food and Nutrition Board of the National Academy of Sciences and may be revised every few years. A separate RDA value exists for each nutrient.

Selenium deficiency in adults can be treated by eating 100 mg selenium per day for a week, where the selenium is supplied as selenomethionine. The incidence of Keshan disease in China has been reduced by supplementing children's diets with 1.0 mg sodium selenite per week.

Prognosis

In iodine deficiency, the prognosis for treating goiter is excellent; however cretinism cannot be reversed. The effects of iron deficiency are not life–threatening and can be easily treated. The prognosis for treating magnesium deficiency is excellent. The symptoms may be relieved promptly or, at most, within two days of starting treatment. In cases of zinc deficiency in Iran and other parts of the Middle East, supplementation of the diets of affected young adults with zinc has been found to provoke the growth of pubic hair and enlargement of genitalia to a normal size within a few months.

Prevention

In a healthy population, all mineral deficiencies can be prevented by the consumption of inorganic nutrients at levels defined by the Recommended Dietary Allowances (RDA). Where a balanced diet is not available, government programs for treating individuals, or for fortifying the food supply, may be used. Government sponsored programs for the prevention of iron deficiency and iodine deficiency are widespread throughout the world. Selenium treatment programs have been used in parts of the world where selenium deficiency exists. Attention to potassium status, and to the prevention of potassium deficiency, is an issue mainly in patients taking diuretic drugs. In many cases of mineral deficiency, the deficiency occurs because of disease, and individual medical attention, rather than preventative measures, is used. The prevention of calcium deficiency is generally not an issue or concern, however calcium supplements are widely used with the hope of preventing osteoporosis. The prevention of deficiencies in magnesium, zinc, copper, manganese, or molybdenum are not major health issues in the United States. Ensuring an adequate intake of these minerals, by eating a balanced diet or by taking mineral supplements, is the best way to prevent deficiencies.

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Sharon, Michael. *Nutrient A–Z: A User's Guide to Foods, Herbs, Vitamins, Minerals & Supplements,* 4th ed. New York, NY: Carlton Publishing Group, 2009.

ORGANIZATIONS

American Dietetic Association, 120 South Riverside Plaza, Suite 2000, Chicago, IL, 60606–6995, (800) 877–1600, http://www.eatright.org.

Food and Nutrition Information Center, National Agricultural Library, United States Department of Agriculture, 10301 Baltimore Ave., Room 105, Beltsville, MD, 20705, (301) 504–5414, http://fnic.nal.usda.gov.

Linus Pauling Institute. Oregon State University, 571 Weniger Hall, Corvallis, OR, 97331–6512, (541) 717–5075, (541) 737–5077, http://lpi.oregonstate.edu.

Office of Dietary Supplements, National Institutes of Health., 6100 Executive Blvd., Room 3B01, MSC 7517, Bethesda, MD, 20892–7517, (301) 435–2920, http://ods.od.nih.gov.

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Mineral excess *see* **Mineral toxicity**

Mineral toxicity

Definition

The term mineral toxicity means a condition in which the concentration in the body of any one of a variety of **minerals** is abnormally high, and in which there is an adverse effect on health.

Description

In general, mineral toxicity results when there is an accidental consumption of too much of any mineral, as with drinking ocean water (**sodium** toxicity) or with overexposure to industrial pollutants, household

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chemicals, or certain drugs. Mineral toxicity may also apply to toxicity that can be the result of certain diseases or injuries. For example, **hemochromatosis** leads to iron toxicity; Wilson's disease results in copper toxicity; severe trauma can lead to **hyperkalemia** (potassium toxicity).

The mineral nutrients are defined as all the inorganic substances that are required for life. As far as human **nutrition** is concerned, the inorganic nutrients include water, sodium, potassium, chloride, **calcium**, phosphate, sulfate, magnesium, iron, copper, zinc, manganese, iodine, selenium, and molybdenum.

The mineral content of the body may be measured by testing samples of blood plasma, red blood cells, and urine.

Causes and symptoms

An increase in the concentrations of sodium in the bloodstream can be toxic. The normal concentration of sodium in blood plasma is 136–145 mM, while levels over 152 mM can result in seizures and **death**. Increased plasma sodium, which is called **hypernatremia**, causes various cells of the body, including those of the brain, to shrink. Shrinkage of brain cells results in confusion, **coma**, **paralysis** of the lung muscles, and death. Death has occurred in situations in which table salt (sodium chloride) was accidently used, instead of sugar, for feeding infants. Death due to sodium toxicity has also resulted when baking soda (sodium bicarbonate) was used during attempted therapy of excessive **diarrhea** or **vomiting**. Although a variety of processed foods contain high levels of sodium chloride, the levels used are not enough to result in sodium toxicity.

The normal level of potassium in the bloodstream is in the range of 3.5–5.0 mM, while levels of 6.3–8.0 mM (severe hyperkalemia) result in cardiac **arrhythmias** or even death due to cardiac arrest. Potassium is potentially quite toxic; however toxicity or death due to potassium **poisoning** is usually prevented because of the **vomiting** reflex. Consumption of food results in mild increases in the concentration of potassium in the bloodstream, but levels of potassium do not become toxic because of the uptake of potassium by various cells of the body, as well as by the action of the kidneys transferring the potassium ions from the blood to the urine. The body's regulatory mechanisms can easily be overwhelmed, however, when potassium chloride is injected intravenously, as high doses of injected potassium can easily result in death.

Iodine toxicity can result from an intake of 2.0 mg of iodide per day. Ttoxicity results in impairment of the creation of thyroid hormone, resulting in lower levels of thyroid hormone in the bloodstream. The thyroid gland enlarges, as a consequence, and a **goiter** develops. This enlargement is also called **hyperthyroidism**. Goiter is usually caused by iodine deficiency. In addition to goiter, iodine toxicity produces ulcers on the skin. This condition has been called "kelp acne," because of its association with eating kelp, an ocean plant, which contains high levels of iodine. Iodine toxicity occurs in Japan, where large amounts of seaweed are consumed.

Iron toxicity is not uncommon, due to the wide availability of iron pills. A lethal dose of iron is in the range of 200–250 mg iron/kg body weight. Hence, a child who accidently eats 20 or more iron tablets may die as a result of iron toxicity. Within six hours of ingestion, iron toxicity can result in vomiting, diarrhea, abdominal **pain**, seizures, and possibly coma. A latent period, during which symptoms appear to improve, may occur, but that period is followed by **shock**, low blood glucose, liver damage, convulsions, and death, occurring 12–48 hours after toxic levels of iron are ingested.

Nitrite poisoning should be considered along with iron toxicity, since nitrite produces its toxic effect by reacting with the iron component of hemoglobin. Hemoglobin is an iron–containing protein found in red blood cells. This protein is responsible for the transport of nearly all of the oxygen, acquired from the lungs, to various tissues and organs of the body. Hemoglobin accounts for the red color of red blood cells. A very small fraction of hemoglobin spontaneously oxidizes per day, producing a protein of a slightly different structure, called methemoglobin. Normally, the amount of methemoglobin constitutes less than one percent of total hemoglobin. Methemoglobin can accumulate in the blood as a result of nitrite poisoning. Infants are especially susceptible to poisoning by nitrite.

Nitrate, which is naturally present in green leafy vegetables and in the water supply is rapidly converted to nitrite by naturally occurring bacteria residing on our tongue, as well as in the intestines, and then absorbed into the bloodstream. The amount of nitrate that is supplied by leafy vegetables and in drinking water is generally about 100–170 mg/day. The amount of nitrite supplied by a typical diet is much less, that is, than 0.1 mg nitrite/day. Poisoning by nitrite, or nitrate after its conversion to nitrite, results in the inability of hemoglobin to carry oxygen throughout the body. This condition is manifested by the blue color of skin. Adverse symptoms occur when over 30% of hemoglobin has been converted to methemoglobin, and these symptoms include cardiac arrhythmias, **headache**, **nausea and vomiting**, and in severe cases, seizures.

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Calcium and phosphate are closely related nutrients. Calcium toxicity is rare, but overconsumption of calcium supplements may lead to deposits of calcium phosphate in the soft tissues of the body. Phosphate toxicity can occur with overuse of **laxatives** or **enemas** that contain phosphate. Severe phosphate toxicity can result in **hypocalcemia**, and in various symptoms resulting from low plasma calcium levels. Moderate phosphate toxicity, occurring over a period of months, can result in the deposit of calcium phosphate crystals in various tissues of the body.

Zinc toxicity is rare, but it can occur in metal workers who are exposed to fumes containing zinc. Excessive dietary supplements of zinc can result in **nausea**, vomiting, and diarrhea. Chronic intake of excessive zinc supplements can result in copper deficiency, as zinc inhibits the absorption of copper.

Severe alterations in copper metabolism occur in two genetic diseases, Wilson's disease and Menkes' disease. Both of these diseases are rare and occur in about one in 100,000 births. Both diseases involve mutations in the proteins that transport copper, that is, in special channels that allow the passage of copper ions through cell membranes. Wilson's disease tends to occur in teenagers and in young adults, and then remain for the lifetime. Copper accumulates in the liver, kidney, and brain, resulting in damage to the liver and nervous system. Wilson's disease can be successfully controlled by lifelong treatment with d–penicillamine. Treatment also involves avoiding foods that are high in copper, such as liver, nuts, chocolate, and mollusks. After an initial period of treatment with penicillamine, Wilson's disease may be treated with zinc (150 mg oral Zn/day). The zinc inhibits the absorption of dietary copper.

Selenium toxicity occurs in regions of the world, including some parts of China, where soils contain high levels of selenium. A daily intake of 0.75–5.0 mg selenium may occur in these regions, due to the presence of selenium in foods and water. Early signs of selenium toxicity include nausea, weakness, and diarrhea. With continued intake of selenium, changes in fingernails and hair loss results, and damage to the nervous system occurs. The breath may acquire a garlic odor, as a result of the increased production of dimethylselenide in the body, and its release via the lungs.

Manganese toxicity occurs in miners in manganese mines, where men breath air containing dust bearing manganese at a concentration of 5–250 mg/cubic meter. Manganese toxicity in miners has been documented in Chile, India, Japan, Mexico, and elsewhere. Symptoms of manganese poisoning typically occur within several months or years of exposure. These symptoms include a mental disorder resembling **schizophrenia**, as well as hyperirritability, violent acts, **hallucinations**, and difficulty in walking.

KEY TERMS

Recommended Dietary Allowance—The Recommended Dietary Allowances (RDAs) are quantities of nutrients that are required each day to maintain human health. RDAs are established by the Food and Nutrition Board of the National Academy of Sciences and may be revised every few years. A separate RDA value exists for each nutrient.

Diagnosis

The initial diagnosis of mineral toxicity involves questioning the patient in order to determine any unusual aspects of the diet, unusual intake of drugs and chemicals, and possible occupational exposure. Diagnosis of mineral toxicities also involves measuring the metal concentration in the plasma or urine. Concentrations that are above the normal range can confirm the initial, suspected diagnosis.

Treatment

Iron toxicity is treated by efforts to remove remaining iron from the stomach, by use of a solution of five percent sodium bicarbonate. Where plasma iron levels are above 0.35 mg/dL, the patient is treated with deferoxamine. Treatment of manganese toxicity involves removal of the patient from the high manganese environment, as well as lifelong doses of the drug L–dopa. The treatment is only partially successful. Treatment of nitrite or nitrate toxicity involves inhalation of 100% oxygen for several hours. If oxygen treatment is not effective, then methylene blue may be injected, as a 1.0% solution, in a dose of 1.0 mg methylene blue/kg body weight.

Prognosis

The prognosis for treating toxicity due to sodium, potassium, calcium, and phosphate is usually excellent. Toxicity due to the deposit of calcium phosphate crystals is not usually reversible. The prognosis for treating iodine toxicity is excellent. For any mineral overdose that causes coma or seizures, the prognosis for recovery is often poor, and death results in a small fraction of patients. For any mineral toxicity that causes nerve damage, the prognosis is often fair to poor.

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Prevention

When mineral toxicity results from the excessive consumption of mineral supplements, toxicity can be prevented by not using supplements. In the case of manganese, toxicity can be prevented by avoiding work in manganese mines. In the case of iodine, toxicity can be prevented by avoiding overconsumption of seaweed or kelp. In the case of selenium toxicity that arises due to high–selenium soils, toxicity can be prevented by relying on food and water acquired from a low–selenium region.

Resources

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Sharon, Michael. *Nutrient A–Z: A User's Guide to Foods, Herbs, Vitamins, Minerals & Supplements,* 4th ed. New York, NY: Carlton Publishing Group, 2009.

ORGANIZATIONS

American Dietetic Association, 120 South Riverside Plaza, Suite 2000, Chicago, IL, 60606–6995, (800) 877–1600, http://www.eatright.org.

Food and Nutrition Information Center, National Agricultural Library, United States Department of Agriculture, 10301 Baltimore Ave., Room 105, Beltsville, MD, 20705, (301) 504–5414, http:fnic.nal.usda.gov.

Linus Pauling Institute. Oregon State University, 571 Weniger Hall, Corvallis, OR, 97331–6512, (541) 717–5075, (541) 737–5077, http://lpi.oregonstate.edu.

Office of Dietary Supplements, National Institutes of Health, 6100 Executive Blvd., Room 3B01, MSC 7517, Bethesda, MD, 20892–7517, (301) 435–2920, http://ods.od.nih.gov.

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Minerals

Definition

The minerals (inorganic nutrients) that are relevant to human **nutrition** include water, **sodium**, potassium, chloride, **calcium**, phosphate, sulfate, magnesium, iron, copper, zinc, manganese, iodine, selenium, and molybdenum. Cobalt is a required mineral for human health, but it is supplied by vitamin B_{12}. Cobalt appears to have no other function, aside from being part of this vitamin. There is some evidence that chromium, boron, and other inorganic elements play some part in human nutrition, but the evidence is indirect and not yet convincing. Fluoride seems not to be required for human life, but its presence in the diet contributes to long term dental health. Some of the minerals do not occur as single atoms, but occur as molecules. These include water, phosphate, sulfate, and selenite (a form of selenium). Sulfate contains an atom of sulfur. We do not need to eat sulfate, since the body can acquire all the sulfate it needs from protein.

The statement that various minerals, or inorganic nutrients, are required for life means that their continued supply in the diet is needed for growth, maintenance of body weight in adulthood, and for reproduction. The amount of each mineral that is needed to support growth during infancy and childhood, to maintain body weight and health, and to facilitate **pregnancy** and **lactation**, are listed in a table called the Recommended Dietary Allowances (RDA). This table was compiled by the Food and Nutrition Board, a committee that serves the United States government. All of the values listed in the RDA indicate the daily amounts that are expected to maintain health throughout most of the general population. The actual levels of each inorganic nutrient required by any given individual is likely to be less than that stated by the RDA. The RDAs are all based on studies that provided the exact, minimal requirement of each mineral needed to maintain health. However, the RDA values are actually greater than the minimal requirement, as determined by studies on small groups of healthy human subjects, in order to accomodate the variability expected among the general population.

The RDAs for adult males are 800 mg of calcium, 800 mg of phosphorus, 350 mg of magnesium, 10 mg of iron, 15 mg of zinc, 0.15 mg of iodine, and 0.07 mg of selenium. The RDA for sodium is expressed as a range (0.5-2.4 g/day). The minimal requirement for chloride is about 0.75 g/day, and the minimal requirement for potassium is 1.6-2.0 g/day, though RDA values have not been set for these nutrients. The RDAs for several other minerals has not been determined, and here the estimated safe and adequate daily dietary intake has been listed by the Food and Nutrition Board. These values are listed for copper (1.5-3.0 mg), manganese (2-5 mg), fluoride (1.5-4.0 mg), molybdenum (0.075-0.25 mg), and chromium (0.05-0.2 mg). In noting the appearance of chromium in this list, one should note that the function of chromium is essentially unknown, and evidence for its necessity exists only for animals, and not for human beings. In considering the amount of any mineral used for treating **mineral deficiency**, one should compare the recommended level with the RDA

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for that mineral. Treatment at a level that is one tenth of the RDA might not be expected to be adequate, while treatment at levels ranging from 10-1,000 times the RDA might be expected to exert a toxic effect, depending on the mineral. In this way, one can judge whether any claim of action, for a specific mineral treatment, is likely to be adequate or appropriate.

Purpose

People are treated with minerals for several reasons. The primary reason is to relieve a mineral deficiency, when a deficiency has been detected. Chemical tests suitable for the detection of all mineral deficiencies are available. The diagnosis of the deficiency is often aided by tests that do not involve chemical reactions, such as the **hematocrit** test for the red blood cell content in blood for iron deficiency, the visual examination of the neck for iodine deficiency, or the examination of bones by densitometry for calcium deficiency. Mineral treatment is conducted after a test and diagnosis for iron-deficiency anemia, in the case of iron, and after a test and diagnosis for hypomagnesemia, in the case of magnesium, to give two examples.

A second general reason for mineral treatment is to prevent the development of a possible or expected deficiency. Here, minerals are administered when tests for possible mineral deficiency are not given. Examples include the practice of giving young infants iron supplements, and of the food industry's practice of supplementing infant formulas with iron. The purpose here is to reduce the risk for **iron deficiency anemia**. Another example is the practice of many women of taking calcium supplements, with the hope of reducing the risk of **osteoporosis**.

Most minerals are commercially available at supermarkets, drug stores, and specialty stores. There is reason to believe that the purchase and consumption of most of these minerals is beneficial to health for some, but not all, of the minerals. Potassium supplements are useful for reducing blood pressure, in cases of persons with high blood pressure. The effect of potassium varies from person to person. The consumption of calcium supplements is likely to have some effect on reducing the risk for osteoporosis. The consumption of selenium supplements is expected to be of value only for residents of Keshan Province, China, because of the established association of selenium deficiency in this region with "Keshan disease."

Precautions

During emergency treatment of sodium deficiency (**hyponatremia**), potassium deficiency (**hypokalemia**), and calcium deficiency (**hypocalcemia**) with intravenous injections, extreme caution must be taken to avoid producing toxic levels of each of these minerals (**hypernatremia**, **hyperkalemia**, and **hypercalcemia**), as **mineral toxicity** can be life-threatening in some instances. The latter three conditions can be life threatening. Selenium is distinguished among most of the nutrients in that dietary intakes at levels only ten times that of the RDA can be toxic. Hence, one must guard against any overdose of selenium. Calcium and zinc supplements, when taken orally, are distinguished among most of the other minerals in that their toxicity is relatively uncommon.

Description

Minerals are used in treatments by three methods, namely, by replacing a poor diet with a diet that supplies the RDA, by consuming oral supplements, or by injections or infusions. Injections are especially useful for infants, for mentally disabled persons, or where the physician wants to be totally sure of compliance. Infusions, as well as injections, are essential for medical emergencies, as during mineral deficiency situations like hyponatremia, hypokalemia, hypocalcemia, and hypomagnesemia. Oral mineral supplements are especially useful for mentally alert persons who otherwise cannot or will not consume food that is a good mineral source, such as meat. For example, a vegetarian who will not consume meat may be encouraged to consume oral supplements of iron, as well as supplements of vitamin B_{12}.

Iron treatment is used for young infants, given as supplements of 7 mg of iron per day to prevent anemia. Iron is also supplied to infants via the food industry's practice of including iron at 12 mg/L in cow milk-based infant formulas, as well as adding powdered iron at levels of 50 mg iron per 100 g dry infant cereal.

Calcium supplements, along with estrogen and calcitonin therapy, are commonly used in the prevention and treatment of osteoporosis. Estrogen and calcitonin are naturally occurring hormones. Bone loss occurs with **diets** supplying under 400 mg Ca/day. Bone loss can be minimized with the consumption of the RDA for calcium. There is some thought that all postmenopausal women should consume 1,000–1,500 mg of calcium per day. These levels are higher than the RDA. There is some evidence that such supplementation can reduce bone losses in some bones, such as the elbow (ulna), but not in other bones. Calcium absorption by the intestines decreases with **aging**, especially after the age of 70. The regulatory mechanisms of the intestines that allow absorption of adequate calcium

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(500 mg Ca/day or less) may be impaired in the elderly. Because of these changes, there is much interest in increasing the RDA for calcium for older women.

Fluoride has been proven to reduce the rate of **tooth decay**. When fluoride occurs in the diet, it is incorporated into the structure of the teeth, and other bones. The optimal range of fluoride in drinking water is 0.7-1.2 mg/L. This level results in a reduction in the rate of tooth decay by about 50%. The American Dental Association recommends that persons living in areas lacking fluoridated water take fluoride supplements. The recommendation is 0.25 mg F/day from the ages of 0-2 years, 0.5 mg F/day for 2-3 years, and 1.0 mg F/day for ages 3-13 years.

Magnesium is often used to treat a dangerous condition, called **eclampsia**, that occasionally occurs during pregnancy. In this case, magnesium is used as a drug, and not to relieve a deficiency. High blood pressure is a fairly common disorder during pregnancy, affecting 1-5% of pregnant mothers. **Hypertension** during pregnancy can result in increased release of protein in the urine. In pregnancy, the combination of hypertension with increased urinary protein is called **preeclampsia**. Preeclampsia is a concern during pregnancies as it may lead to eclampsia. Eclampsia involves convulsions and possibly **death** to the mother. Magnesium sulfate is the drug of choice for preventing the convulsions of eclampsia.

Treatment with cobalt, in the form of vitamin B_{12}, is used for relieving the symptoms of **pernicious anemia**. Pernicious anemia is a relatively common disease which tends to occur in persons older than 40 years. Free cobalt is never used for the treatment of any disease.

Preparation

Evaluation of a patient's mineral levels requires a blood sample, and the preparation of plasma or serum from the blood sample. An overnight fast is usually recommended as preparation prior to drawing the blood and chemical analysis. The reason for this is that any mineral present in the food consumed at breakfast may artificially boost the plasma mineral content beyond the normal **fasting** level, and thereby mask a mineral deficiency. In some cases, red blood cells are used for the mineral status assay.

Aftercare

The healthcare provider assesses the patient's response to mineral treatment. A positive response confirms that the diagnosis was correct. Lack of response indicates that the diagnosis was incorrect, that the patient had failed to take the mineral supplement, or that a higher dose of mineral was needed. The response to mineral treatment can be monitored by chemical tests, by an examination of red blood cells or white blood cells, or by physiological tests, depending on the exact mineral deficiency.

Risks

There are few risks associated with mineral treatment. In treating emergency cases of hyponatremia, hypokalemia, or hypocalcemia by intravenous injections, there exists a very real risk that giving too much sodium, potassium, or calcium, can result in hypernatremia, hyperkalemia, or hypercalcemia, respectively. Risk for toxicity is rare where treatment is by dietary means. This is because the intestines act as a barrier, and absorption of any mineral supplement is gradual. The gradual passage of any mineral through the intestines, especially when the mineral supplement is taken with food, allows the various organs of the body to acquire the mineral. Gradual passage of the mineral into the bloodstream also allows the kidneys to excrete the mineral in the urine, should levels of the mineral rise to toxic levels in the blood.

Resources

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Tom Brody, PhD
Karl Finley

Minnesota multiphasic personality inventory (MMPI-2)

Definition

The Minnesota Multiphasic Personality Inventory (MMPI-2; MMPI-A) is a written psychological assessment, or test, used to diagnose mental disorders.

Purpose

The MMPI is used to screen for personality and **psychosocial disorders** in adults and adolescents. It is also frequently administered as part of a neuropsychological test battery to evaluate cognitive functioning.

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KEY TERMS

Neuropsychological testing—Tests used to evaluate patients who have experienced a traumatic brain injury, brain damage, or organic neurological problems (e.g., dementia). It may also be used to evaluate the progress of a patient who has undergone treatment or rehabilitation for a neurological injury or illness.

Norms—Normative or mean score for a particular age group.

Psychopathology—A mental disorder or illness, such as schizophrenia, personality disorder, or major depressive disorder.

Standardization—The process of determining established norms and procedures for a test to act as a standard reference point for future test results.

Precautions

The MMPI should be administered, scored, and interpreted by a clinical professional trained in its use, preferably a psychologist or psychiatrist. The MMPI is only one element of psychological assessment, and should never be used alone as the sole basis for a diagnosis. A detailed history of the test subject and a review of psychological, medical, educational, or other relevant records are required to lay the groundwork for interpreting the results of any psychological measurement.

Cultural and language differences in the test subject may affect test performance and may result in inaccurate MMPI results. The test administrator should be informed before psychological testing begins if the test taker is not fluent in English and/or has a unique cultural background.

Description

The original MMPI was developed at the University of Minnesota and introduced in 1942. The current standardized version for adults 18 and over, the MMPI-2, was released in 1989, with a subsequent revision of certain test elements in early 2001. The MMPI-2 has 567 items, or questions, and takes approximately 60 to 90 minutes to complete. There is a short form of the test that is comprised of the first 370 items on the long-form MMPI-2. There is also a version of the inventory for adolescents age 14 to 18, the MMPI-A.

The questions asked on the MMPI are designed to evaluate the thoughts, emotions, attitudes, and behavioral traits that comprise personality. The results of the test reflect an individual's personality strengths and weaknesses, and may identify certain disturbances of personality (psychopathologies) or mental deficits caused by neurological problems.

There are six validity scales and ten basic clinical or personality scales scored in the MMPI-2, and a number of supplementary scales and subscales that may be used with the test. The validity scales are used to determine whether the test results are actually valid (i.e., if the test-taker was truthful, answered cooperatively and not randomly) and to assess the test-taker's response style (i.e., cooperative, defensive). Each clinical scale uses a set or subset of MMPI-2 questions to evaluate a specific personality trait. The MMPI should always be administered in a controlled environment by a psychologist or other qualified mental health professional trained in its use.

Preparation

The administrator should provide the test subject with information on the nature of the test and its intended use, complete standardized instructions to taking the MMPI (including any time limits, and information on the confidentiality of the results).

Normal results

The MMPI should be scored and interpreted by a trained professional. When interpreting test results for test subjects, the test administrator will review what the test evaluates, its precision in evaluation and any margins of error involved in scoring, and what the individual scores mean in the context of overall norms for the test and the background of the test subject.

Resources

BOOKS

Graham, John R. *MMPI–2: Assessing Personality and Psychopathology*. 4th ed. New York: Oxford University Press, 2006.

ORGANIZATIONS

ERIC Clearinghouse on Assessment and Evaluation, 1131 Shriver Laboratory (Bldg 075), University of Maryland, College Park, MD, 20742, (800) 464-3742, feedback3@ericae.net, http://www.ericae.net.

Paula Anne Ford-Martin

Minor tranquilizers *see* **Antianxiety drugs**

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Minority health

Definition

Minority health addresses the special medical and/or health needs associated with specific ethnic and racial groups—those that are included in the minority populations within the United States.

Demographics

Some of the specific ethnic and racial groups in the United States that are included within minority populations, as stated by the Office of Minority Health (part of the U.S. Department of Health and Human Services), include Native Americans and Alaska Natives, Asian Americans, Blacks/African Americans, Hispanics/Latinos, Native Hawaiians, and other Pacific Islanders.

Description

The United States, as well as many other countries, experiences cultural diversity. This poses specific health issues that are specific to ethnic groups. Additionally, the propensity for certain diseases or illnesses is of concern in certain minority groups. These specific health issues include infant mortality rates, **cancer**, cardiovascular disease, diabetes, HIV (human **immunodeficiency** virus) infection, and immunizations.

Infant mortality rates

Infant mortality rates (IMRs) in the United States and in all countries worldwide are an accurate indicator of health status. They provide information concerning programs about **pregnancy** education and counseling, technological advances, and procedures and aftercare. IMRs vary among racial groups. The IMR in the United States, in 2010, is estimated to be 6.22 per 1,000 live births, according to the Central Intelligence Agency. Males have an IMR of 6.9, while females have 5.51.

African Americans had an IMR of 13.6 per 1,000 live births, approximately 2.5 times higher than Caucasians. The IMRs among American Native Indian groups varies greatly, with some communities possessing IMRs about two times more than national rates. Overall Native Americans had an IMR of 8.1. Additionally Hispanic Americans IMRs (7.6 per 1,000 live births, overall) are also diverse for separate groups, since the IMRs for example among Puerto Rican Americans is higher (8.3 per 1,000 live births) while with Mexican Americans it is lower (5.5 per 1,000 live births). Asian- and Pacific Islander Americans came in at 4.9, Central Americans and South-Americans at 4.7, and Cuban Americans at 4.4 per 1,000 live births. (Statistics for the various minority groups were provided by the U.S. Centers for Disease Control and Prevention.)

Cancer

Cancer is a serious national, worldwide, and minority health concern. In 2008, the number of non-institutionalized adults who had ever been diagnosed with cancer in the United States stood at 17.9 million, or about 7.9% of the adult population. It is the second cause of **death** in the United States, claiming over half a million lives each year (approximately 565,000 in 2008, according to the American Cancer Society). Approximately 50% of persons who develop cancer will die from it.

There is great disparity among the cancer rates in minority groups. Across genders, cancer death rates for African Americans are 35% higher when compared to statistics for Caucasian Americans. The death rates for **prostate cancer** (two times more) and lung cancer (27 times more) are disproportionately higher when compared to Caucasians. In addition, Hispanic men and women have higher incidence and mortality rates for stomach and **liver cancer** than non-Hispanics.

Additionally, Alaskan native men and women have a greater propensity for cancers in the rectum and colon than do Caucasians. Native American/Alaska Native men are more at risk for liver and **stomach cancer**, when compared to non-Hispanic white men. Asian American men are more prone to stomach cancer than are non-Hispanic white men. At the same time, Asian and Pacific Islander American women will develop stomach cancer more often than non-Hispanic American white women.

There are also gender differences among ethnic groups and specific cancers. Lung cancers in African American and Hawaiian men are higher when compared with Caucasian males. Vietnamese females who live in the United States have five times more new cases of **cervical cancer** when compared to Caucasian women. Hispanic females also have a greater incidence of cervical cancer than Caucasian females, and they are more likely to have **kidney cancer** when compared to non-Hispanic white women.

Cardiovascular disease

Cardiovascular disease is responsible for the leading cause of disability and death rates about equal to death from all other diseases combined. Cardiovascular disease can affect the patient's lifestyle and function in

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addition to having an impact on family members. The financial costs are very high. Among ethnic and racial groups, cardiovascular disease is the leading cause of death. African Americans are more likely to have high blood pressure than other ethnic groups in the United States. However, African Americans and non-Hispanic white Americans have similar rates of heart disease. Unfortunately, African American males are three times more likely to die from heart disease than are white males.

Stroke is the leading cause of cardiovascular related death, which occurs in higher numbers for Asian American males when compared to Caucasian men. Mexican American men and women and African-American males have a higher incidence of **hypertension**. African American women have higher rates of being overweight, which is a major risk factor of cardiovascular disease. Mexican Americans, African Americans, Native Hawaiian/Pacific Islanders, and Native Americans/Alaskan Natives also have higher rates of **obesity** than do other groups.

Diabetes

Diabetes—a serious health problem in Americans and ethnic groups—is the seventh leading cause of death in the United States. About 40% of all American adults have pre-diabetes. Racial and ethnic minorities are especially at risk for diabetes. The prevalence of diabetes in African Americans is about twice than for Caucasians, according to the Office of Mental Health. The elderly within the African American population is especially at risk for diabetes, even more so for women over the age of 65 years. Diabetes is also common in older Hispanics. Native Americans and Alaska Natives have approximately double the risk for diabetes than do non-Hispanic whites.

HIV

HIV infection/AIDS (acquired immune deficiency syndrome) is the most common cause of death for all persons age 25 to 44 years old. Ethnic groups account for about 25% of the United States population and nearly two-thirds of all recently diagnosed **AIDS** cases, according to the Office of Minority Health. In addition, about 75% of all babies born with HIV/AIDS is a member of one of the minority groups in the United States. Besides an increase of sexual transmission of HIV/AIDS within the minority communities, there is also an increase in HIV among ethnic groups related to intravenous drug usage. Specifically, African Americans, both men and women, are more likely to die from AIDS than are non-Hispanic white men.

Immunizations

The gap among immunization, the reduction of preventable disease by **vaccination**, between minority groups and whites has narrowed over the past years. However, there are still smaller percentages of minority adults being immunized when compared to white adults. Overall, immunization rates among all groups are much higher than compared to adults. In 2008, the Office of Minority Health reported that 70% of older non-Hispanic whites received the **influenza** (flu) vaccination, while only 51% of older African Americans and 56% of Hispanics received the vaccine.

Tuberculosis is a disease that is controlled by immunizations. However, Asian and Pacific Islander Americans were 23 times more at risk for contracting tuberculosis (TB) than were non-Hispanic whites. **Hepatitis B** is another disease controlled with vaccines. Even though rates of hepatitis B continue to decline in the United States in the twenty-first century, its rate is twice as high for non-Hispanic blacks when compared to non-Hispanic whites. The Office of Minority Health also reports that, in 2008, older Asian Americans and Hispanic Americans (those over 65 years of age) were less likely to have received a **pneumonia** vaccine as compared to older non-Hispanic whites.

The Office of Minority Health and Health Disparities (OMHHD) stated that, in 2000, children living below the poverty level in the United States had lower immunization levels overall than did those above the poverty level. Disparities still exist, in 2010, concerning immunization rates among racial and ethnic groups in the United States. During the 2010s, the OMHHD hopes to be able to achieve and maintain a 90% rate of childhood immunization and to achieve a 60% rate in flu and pneumonia vaccinations in the United States. Such rates would help to eliminate disparities among minority groups within regards to immunizations.

Causes and symptoms

IMRs are correlated with prenatal care. Women who receive adequate prenatal care tend to have better pregnancy outcomes when compared to little or no care. Women who receive inadequate prenatal care also have increased chances of delivering a very low birth weight (VLBW) infant, which is linked to risk of early death.

Cancer is related to several preventable lifestyle choices. Tobacco use, diet, and exposure to the Sun (skin cancer) can be prevented by lifestyle modifications. Additionally many cancers can occur due to lack of interest and/or lack of availability for screening and educational programs.

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DR. ANTONIA NOVELLO (1944–)

(Terry Ashe/Getty Images.)

Born Antonia Coello was born in Fajardo, Puerto Rico, on August 23, 1944, the oldest of three children. At eight years old, she suffered two blows that she would carry all of her life. Her father, Antonio Coello, died, leaving her mother, Ana Delia Flores Coello, to raise her children alone until she later remarried Ramon Flores, an electrician. Novello was also diagnosed with a chronic condition called congenital megacolon, an illness in which her colon was overly large and not functioning properly, which required regular hospitalization. Although an operation would have helped Novello, it was not performed until she was 18 years old, and even after the surgery, complications followed her for years. Because of her childhood illness, Novello grew up wanting to be a doctor.

On October 17, 1989, President George Bush officially nominated Novello for Surgeon General. The fourteenth United States Surgeon General, Novello, sworn in on March 9, 1990, remarked that "the American dream is well and alive. . .today the West Side Story comes to the West Wing." Novello was the first woman and the first Hispanic to be appointed Surgeon General of the United States. Noted for her philosophy of "good science, good sense" and for her approachability, Novello was dedicated to the prevention of AIDS, substance abuse, and smoking, as well as to the education of the American public. Her special concerns were for women, children, and hispanics—populations often overlooked by public health services.

After serving as Surgeon General, Dr. Novello was a special representative to United Nations Children's Fund from 1993 to 1996, where she expanded her efforts to address the health and nutritional needs of women, children, and adolescents, to a global scale. From 1996 to 1999 she was visiting professor of health policy and management at Johns Hopkins School of Health and Hygiene, where she advised on health services for poor communities. To mark the fiftieth anniversary of the Universal Declaration of Human Rights in 1998, Novello organized an unprecedented meeting between Surgeon General David Satcher and seven others who had held the office. In 1999, Governor George Pataki nominated her to be commissioner of health for the state of New York, a move that drew cries of betrayal from the abortion rights movement over her opposition to abortion. At the time, Mr. Pataki called her a trailblazer in addressing children's health issues who could help lead the state's effort to save money by moving recipients of Medicaid, the health care program for the poor, into managed care.

Novello served as commissioner until 2006. On May 12, 2009 in New York, she was charged in a 20 count indictment with theft of government services, defrauding the government and filing a false instrument. On June 26, 2009, in a plea deal with prosecutors, she pleaded guilty to one charge of filing a false document involving a worker's duties.

Cardiovascular diseases are higher among persons with high blood cholesterol and high blood pressure. Certain lifestyle choices may increase the chance for heart disease includes lack of **exercise**, overweight, and cigarette **smoking**. Cardiovascular disease is responsible for over 50% of the deaths in persons with diabetes.

HIV occurs at a higher frequency among homosexuals (the number of African American males who have AIDS through sex with men has increased). Additionally unprotected sexual intercourse and sharing used needles for IV drug injection are strongly correlated with infection.

Vaccinations are an effective method of preventing certain disease such as **polio**, **tetanus**, pertussis, **diphtheria**, influenza, hepatitis b, and pneumococcal infections. Approximately 90% of influenza related mortality is associated with persons aged 65 and older. This is mostly due to neglect of vaccinations. About 45,000 adults each year die of diseases related to hepatitis B, pneumococcal, and influenza infections.

Diagnosis

The diagnosis of VLBW is by weight. Infants who weigh 1,500 grams (1.5 kilograms, or 3.3 pounds) at

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KEY TERMS

Prevalence—Number of existing cases relative to time.

Propensity—A greater risk for developing a disease.

birth are at high risk for death. For cancer, the diagnosis can be made through screening procedures such as **mammography** (for **breast cancer**), PAP smear (PAP is short for papanicolau, which is used to identify cervical cancer), and lifestyle modifications such as avoidance of ultraviolet rays from the Sun (and artificially produced radiation, such as from **tanning** beds), cigarette smoking, balanced **diets**, and adequate **nutrition**. Other specific screening tests (PSA, prostate surface antigen) are helpful for diagnosing prostate cancer.

Cardiovascular diseases can be detected by medical check-ups. Blood pressure and cholesterol levels can be measured. Obesity can be diagnosed by assessing a person's weight relative to their height (what is called BMI, or body mass index). Diabetes and its complications can be detected by blood tests, in-depth eye examinations, and studies that assess the flow of blood through blood vessels in legs. HIV can be detected through a careful history/physical examination and analysis of blood using a special test called a western blot. Infections caused by lack of immunizations can either be detected by careful **physical examination** and culturing the specific microorganism in the laboratory.

Treatment

Treatment is directed at the primary causes(s) that minorities have increased chances of developing disease(s). Cancer may require treatment utilizing surgery, radiotherapy, or **chemotherapy**. Cardiovascular diseases may require surgical procedures for establishing a diagnosis and initiating treatment. Depending on the extent of disease, cardiovascular management can become complicated requiring medications and daily lifestyle modifications. Treatment usually includes medications, dietary modifications, and—if complications arise—specific interventions tailored to alleviating the problem. HIV can be treated with specific medications and more often than not with symptomatic treatment as reported complications arise. Diseases caused by lack of immunizations are treated based on the primary disease. The best method of treatment is through prevention and generating public awareness through educational awareness.

Alternative treatment

Alternative therapies do exist, but more research is needed to substantiate present data. The diseases that relate to minority health are best treated with nationally accepted standards of care.

Prognosis

Generally the prognosis is related to the diagnosis, patients state of health, age, and if there is another disease or complication in addition to the presenting problem. The course for IMRs is related to educational programs and prenatal care, which includes medical and psychological treatments. The prognosis for chronic diseases such as cardiovascular problems, high blood pressure, cancer, and diabetes is variable. These diseases are not cured and control is achieved by standardized treatment options. Eventually complications, even with treatment can potentially occur. For HIV the clinical course at present is death even though this process may take years. Educational programs with an emphasis on disease prevention can potentially improve outcomes concerning pediatric and geriatric diseases.

Prevention

Prevention is accomplished best through educational programs specific to target populations. IMRs can be prevented by increasing awareness, interest, and accessibility for prenatal care that address a comprehensive approach for the needs of each patient. Regular physicals and special screening tests ca potentially prevent certain cancers in high-risk groups. Educational programs concerning lifestyle modifications, diet, exercise, and testing may prevent the development of cardiovascular disease and diabetes. Educational programs assemble to illicit IV drug abusers and persons who engage in unprotected sexual intercourse may decrease the incidence of HIV infection.

All adults in the United States should be proactive, making sure to get information on those preventable diseases they are at most risk for acquiring and for which vaccines are available. Parents and other caregivers should make sure that their children have been fully vaccinated by the age of two years. Sons and daughters of **aging** parents should assure that their parents are receiving the necessary vaccines, such as pneumococcal vaccines (for pneumonia), which will help them stay healthy and minimize their risks of premature death.

The importance of diagnosing, treating, and preventing minority health programs over the next decade will become increasingly important. The U.S.

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Census Bureau estimates that by 2100, only about 40% of the U.S. population will consist of non-Hispanic whites. As minority groups grow faster in the future, their health will become a larger factor in the overall health of all Americans. Hopefully, the disparities in health issue with minorities, when compared to whites, will dissipate, especially with regards to preventable diseases, disabilities, and mortality.

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ORGANIZATIONS

Office of Minority Health, Post Office Box 37337, Washington, DC, 20013-7337, (800) 444-6472, http://minorityhealth.hhs.gov/.

Office of Minority Health and Health Disparities, 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, http://www.cdc.gov/omhd/.

Minoxidil

Definition

Minoxidil is a drug that is available in two forms: as a solution or foam, Rogaine, applied topically to the scalp to promote hair growth, and as tablets, Loniten, to treat high blood pressure.

Purpose

Hair growth and the reversal of male pattern baldness was a side effect noted when Loniten was used to treat high blood pressure. How it stimulates hair growth is not known.

Rogaine solution and foam, in 2% and 5% concentrations, are available in the U.S. without a prescription.

Rogaine is more likely to be effective in men and women under age 40. It must be used daily for up to three months before hair growth become noticeable. Once daily use is stopped, hair loss begins again. Rogaine is more likely to be effective in men and women under age 40.

Minoxidil does not work for everyone. Forty-eight percent of men who use it for one year can expect to see moderate to dense regrowth of hair; thirty-six percent minimal regrowth, and sixteen percent no regrowth.

Women and men respond similarly to topical minoxidil.

Minoxidil tablets, orally, is only used for treating severe high blood pressure and has serious has side effects that generally require using additional medications.

Precautions

It is important to carefully follow the package directions for the amount to use (dose) and proper application and handling of minoxidil solution or foam.

Minoxidil should not be used 24 hours before or after applying hair treatments such as coloring, permanent or relaxer. Before applying these treatments, the hair should be thoroughly washed and dried.

After applying minoxidil, hands should be thoroughly washed.

To reduce the risk of absorption through the skin, Minoxidil should be used only on small areas of the scalp.

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People with sunburns and/or chronic skin or scalp **rashes** or conditions may absorb minoxidil into their bodies and run a greater risk of side effects.

People who have had unusual or allergic skin reactions to dyes and preservatives may be at greater risk for allergic reactions to minoxidil foam or solution.

People who use cortisone creams or ointments, petroleum jelly (Vaseline), or tretinoin (Retin-A) on their scalps risk absorbing more minoxidil into their bodies and experiencing side effects.

Minoxidil enters breast milk and is not recommended for use in nursing mothers.

Preparation

Before applying topical minoxidil, the hair and scalp should be clean and dry.

Aftercare

Immediately after applying minoxidil, hands and other areas of the body that may have come into contact with the drug, where hair growth is not desired, should be washed.

Do not wash hair for four hours after applying minoxidil.

Topical minoxidil should be allowed to air-dry for two to four hours before clothing is pulled on or off over the head, a hat is worn, or the person using it goes to bed. Minoxidil may stain clothing, hats, or bed linens.

Do not use a blow dryer or other hair-drying method. People using minoxidil should not shampoo, wash, or rinse their hair for at least 4 hours after minoxidil is applied.

Risks

More common side effects from using topical minoxidil include **itching**, burning, redness, and tenderness over hair roots in treated areas. These usually go away within a couple of weeks.

Unwanted hair growth may occur adjacent to treated areas or in areas where the medicine has been inadvertently transferred.

Side effects that may occur if topically minoxidil is absorbed into the body include:

- changes in vision, most commonly blurred vision
- chest pain
- dizziness
- rapid or irregular pulse
- very low blood pressure
- fast or irregular heartbeat
- flushing of the skin
- headache
- lightheadedness
- numbness or tingling in the hands, feet, or face
- rapid weight gain
- swelling of the hands, feet, lower legs, or face

Normal results

When new growth begins, the first hairs may be soft and barely visible. For some, this is the extent of the effectiveness of this medication. For others, the down-like hair develops into hair of the same color and thickness as the other hairs on their heads.

Minoxidil is a treatment, not a cure, for hair loss. Once a person stops using it, the re-grown hair will be lost within 90 days.

Resources

OTHER

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James Waun, MD, RPh

Miscarriage

Definition

Miscarriage means loss of an embryo or fetus before the 20th week of **pregnancy**. Most miscarriages occur during the first 14 weeks of pregnancy. The medical term for miscarriage is spontaneous abortion.

Description

Miscarriages are very common. Approximately 20% of pregnancies (one in five) end in miscarriage. The most common cause is a genetic abnormality of the fetus. Not all women realize that they are miscarrying and others may not seek medical care when it occurs.

A miscarriage is often a traumatic event for both partners, and can cause feelings similar to the loss of a child or other member of the family. Fortunately, 90% of women who have had one miscarriage subsequently have a normal pregnancy and healthy baby; 60% are able to have a healthy baby after two miscarriages. Even a woman who has had three miscarriages in a

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row still has more than a 50% chance of having a successful pregnancy the fourth time.

Causes and symptoms

There are many reasons why a woman's pregnancy ends in miscarriage. Often the cause is not clear. However, more than half the miscarriages that occur in the first eight weeks of pregnancy involve serious chromosomal abnormalities or **birth defects** that would make it impossible for the baby to survive. These are different from inherited genetic diseases. They probably occur during development of the specific egg or sperm, and therefore are not likely to occur again.

In about 17% of cases, miscarriage is caused by an abnormal hormonal imbalance that interferes with the ability of the uterus to support the growing embryo. This is known as luteal phase defect. In another 10% of cases, there is a problem with the structure of the uterus or cervix. This can especially occur in women whose mothers used diethylstilbestrol (DES) when pregnant with them.

The risk of miscarriage is increased by:

- Smoking (up to a 50% increased risk)
- Infection
- Exposure to toxins (such as arsenic, lead, formaldehyde, benzene, and ethylene oxide)
- Multiple pregnancy
- Poorly controlled diabetes.

The most common symptom of miscarriage is bleeding from the vagina, which may be light or heavy. However, bleeding during early pregnancy is common and is not always serious. Many women have slight vaginal bleeding after the egg implants in the uterus (about 7-10 days after conception), which can be mistaken for a threatened miscarriage. A few women bleed at the time of their monthly periods through the pregnancy. However, any bleeding in the first three months of pregnancy (first trimester) is considered a threat of miscarriage.

Women should not ignore vaginal bleeding during early pregnancy. In addition to signaling a threatened miscarriage, it could also indicate a potentially life-threatening condition known as **ectopic pregnancy**. In an ectopic pregnancy, the fetus implants at a site other than the inside of the uterus. Most often this occurs in the fallopian tube.

Cramping is another common sign of a possible miscarriage. The cramping occurs because the uterus attempts to push out the pregnancy tissue. If a pregnant woman experiences both bleeding and cramping the possibility of miscarriage is more likely than if only one of these symptoms is present.

If a woman experiences any sign of impending miscarriage, she should be examined by a practitioner. The doctor or nurse will perform a **pelvic exam** to check if the cervix is closed as it should be. If the cervix is open, miscarriage is inevitable and nothing can preserve the pregnancy. Symptoms of an inevitable miscarriage may include dull relentless or sharp intermittent **pain** in the lower abdomen or back. Bleeding may be heavy. Clotted material and tissue (the placenta and embryo) may pass from the vagina.

A situation in which only some of the products in the uterus have been expelled is called an incomplete miscarriage. Pain and bleeding may continue and become severe. An incomplete miscarriage requires medical attention.

A "missed abortion" occurs when the fetus has died but neither the fetus nor placenta is expelled. There may not be any bleeding or pain, but the symptoms of pregnancy will disappear. The physician may suspect a missed abortion if the uterus does not continue to grow. The physician will diagnose a missed abortion with an ultrasound examination.

A woman should contact her doctor if she experiences any of the following:

- Any bleeding during pregnancy.
- Pain or cramps during pregnancy.
- Passing of tissue.
- Fever and chills during or after miscarriage.

Diagnosis

If a woman experiences any sign of impending miscarriage she should see a doctor or nurse for a pelvic examination to check if the cervix is closed, as it should be. If the cervix is open, miscarriage is inevitable.

An ultrasound examination can confirm a missed abortion if the uterus has shrunk and the patient has had continual spotting with no other symptoms.

Treatment

Threatened miscarriage

For women who experience bleeding and cramping, bed rest is often ordered until symptoms disappear. Women should not have sex until the outcome of the threatened miscarriage is determined. If bleeding and cramping are severe, women should drink fluids only.

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KEY TERMS

Diethylstilbestrol (DES)—This is a synthetic estrogen drug that is used to treat a number of hormonal conditions. However, it causes problems in developing fetuses and should not be taken during pregnancy. From about 1938 to 1971, DES was given to pregnant women because it was thought to prevent miscarriage. Children of women who took the drug during pregnancy are at risk for certain health problems.

Dilatation and curettage (D&C)—A procedure in which the neck of the womb (cervix) is expanded and the lining of the uterus is scraped to remove pregnancy tissue or abnormal tissue.

Embryo—An unborn child in the first eight weeks after conception. After the eighth week until birth, the baby is called a fetus.

Miscarriage

Although it may be psychologically difficult, if a woman has a miscarriage at home she should try to collect any material she passes in a clean container for analysis in a laboratory. This may help determine why the miscarriage occurred.

An incomplete miscarriage or missed abortion may require the removal of the fetus and placenta by a D&C (**dilatation and curettage**). In this procedure the contents of the uterus are scraped out. It is performed in the doctor's office or hospital.

After miscarriage, a doctor may prescribe rest or **antibiotics** for infection. There will be some bleeding from the vagina for several days to two weeks after miscarriage. To give the cervix time to close and avoid possible infection, women should not use tampons or have sex for at least two weeks. Couples should wait for one to three normal menstrual cycles before trying to get pregnant again.

Prognosis

A miscarriage that is properly treated is not life-threatening, and usually does not affect a woman's ability to deliver a healthy baby in the future.

Feelings of grief and loss after a miscarriage are common. In fact, some women who experience a miscarriage suffer from major depression during the six months after the loss. This is especially true for women who don't have any children or who have had depression in the past. The emotional crisis can be similar to that of a woman whose baby has died after birth.

Prevention

The majority of miscarriages cannot be prevented because they are caused by severe genetic problems determined at conception. Some doctors advise women who have a threatened miscarriage to rest in bed for a day and avoid sex for a few weeks after the bleeding stops. Other experts believe that a healthy woman (especially early in the pregnancy) should continue normal activities instead of protecting a pregnancy that may end in miscarriage later on, causing even more profound distress.

If miscarriage was caused by a hormonal imbalance (luteal phase defect), this can be treated with a hormone called progesterone to help prevent subsequent miscarriages. If structural problems have led to repeated miscarriage, there are some possible procedures to treat these problems. Other possible ways to prevent miscarriage are to treat genital infections, eat a well-balanced diet, and refrain from **smoking** and using recreational drugs.

ORGANIZATIONS

American College of Obstetricians and Gynecologists (ACOG), PO Box 96920, Washington, DC, 20090-6920, (202) 638-5577, http://www.acog.org.

Hygeia Foundation, 264 Amity Road Suite 211, Woodbridge, CT, 06525, (800) 893-9198, info@hygeiafoundation.org, http://www.hygeiafoundation.org.

Carol A. Turkington

Mitral incompetence *see* **Mitral valve insufficiency**

Mitral regurgitation *see* **Mitral valve insufficiency**

Mitral stenosis *see* **Mitral valve stenosis**

Mitral valve insufficiency

Definition

Mitral valve insufficiency is a term used when the valve between the upper left chamber of the heart (atrium) and the lower left chamber (ventricle) does not close well enough to prevent back flow of blood when the ventricle contracts. Mitral valve insufficiency

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is also known as mitral valve regurgitation or mitral valve incompetence.

Description

Normally, blood enters the left atrium of the heart from the lungs and is pumped through the mitral valve into the left ventricle. The left ventricle contracts to pump the blood forward into the aorta. The aorta is a large artery that sends oxygenated blood through the circulatory system to all of the tissues in the body. If the mitral valve is leaky due to mitral valve insufficiency, it allows some blood to get pushed back into the atrium. This extra blood creates an increase in pressure in the atrium, which then increases blood pressure in the vessels that bring the blood from the lungs to the heart. Increased pressure in these vessels can result in increased fluid buildup in the lungs.

Causes and symptoms

In the past, **rheumatic fever** was the most common cause of mitral valve insufficiency. However, the increased use of **antibiotics** for **strep throat** has made rheumatic **fever** rare in developed countries. In these countries, mitral valve insufficiency caused by rheumatic fever is seen mostly in the elderly. In countries with less developed health care, rheumatic fever is still common and is often a cause of mitral valve insufficiency.

Heart attacks that damage the structures that support the mitral valve are a common cause of mitral valve insufficiency. Myxomatous degeneration can cause a "floppy" mitral valve that leaks. In other cases, the valve simply deteriorates with age and becomes less efficient.

People with mitral valve insufficiency may not have any symptoms at all. It is often discovered during a doctor's visit when the doctor listens to the heart sounds.

Both the left atrium and left ventricle tend to get a little bigger when the mitral valve does not work properly. The ventricle has to pump more blood so it gets bigger to increase the force of each beat. The atrium gets bigger to hold the extra blood. An enlarged ventricle can cause **palpitations**. An enlarged atrium can develop an erratic rhythm (**atrial fibrillation**), which reduces its efficiency and can lead to **blood clots** forming in the atrium.

Diagnosis

When the doctor listens to the heart sounds, mitral valve insufficiency is generally recognized by the sound the blood makes as it leaks backward. It sounds like a regurgitant murmur. The next step is generally a **chest x ray** and an electrocardiogram (ECG) to see if the heart is enlarged. The most definitive noninvasive test is **echocardiography**, a test that uses sound waves to make an image of the heart. This test gives a picture of the valve in action and shows the severity of the problem.

KEY TERMS

Aorta—A large artery beginning at the base of the left ventricle.

Atrium—One of the two upper chambers of the heart.

Rheumatic fever—An illness that sometimes follows a streptococcal infection of the throat.

Ventricle—One of the two lower chambers of the heart.

Treatment

A severely impaired valve needs to be repaired or replaced. Either option will require surgery. Repairing the valve can fix the problem completely or reduce it enough to make it bearable and prevent damage to the heart. Valves can be replaced with either a mechanical valve or one that is partly mechanical and partly from a pig's heart.

Mechanical valves are effective but can increase the incidence of blood clots. To prevent blood clots from forming, the patient will need to take drugs that prevent abnormal blood clotting (anticoagulants). The valves made partly from a pigs heart do not have as great a risk of blood clots but don't last as long as fully mechanical valves. If a valve wears out, it must be replaced again.

Damaged heart valves are easily infected. Anytime a procedure is contemplated that might allow infectious organisms to enter the blood, the person with mitral valve insufficiency should take antibiotics to prevent possible infection.

Prognosis

The diagnostic, medical and surgical procedures available to the person with mitral valve insufficiency are all likely to produce good results.

Prevention

The only possible way to prevent mitral valve insufficiency is to prevent rheumatic fever. This can be done by evaluating sore throats for the presence of

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the bacteria that causes strep throat. Strep throat is easily treated with antibiotics.

Resources

OTHER

The Merck Page. http://www.merck.com.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review. personal.info@heart.org.

Dorothy Elinor Stonely

Mitral valve prolapse

Definition

Mitral valve prolapse (MVP) is a ballooning of the support structures of the mitral heart valve into the left upper collection chamber of the heart.

Description

Other names for MVP include floppy valve and Barlow's syndrome. The mitral valve is located on the left side of the heart between the top chamber (left atrium) and the bottom chamber (left ventricle). The valve opens and closes according to the heartbeat and the pressure that is exerted upon it from the blood in both chambers.

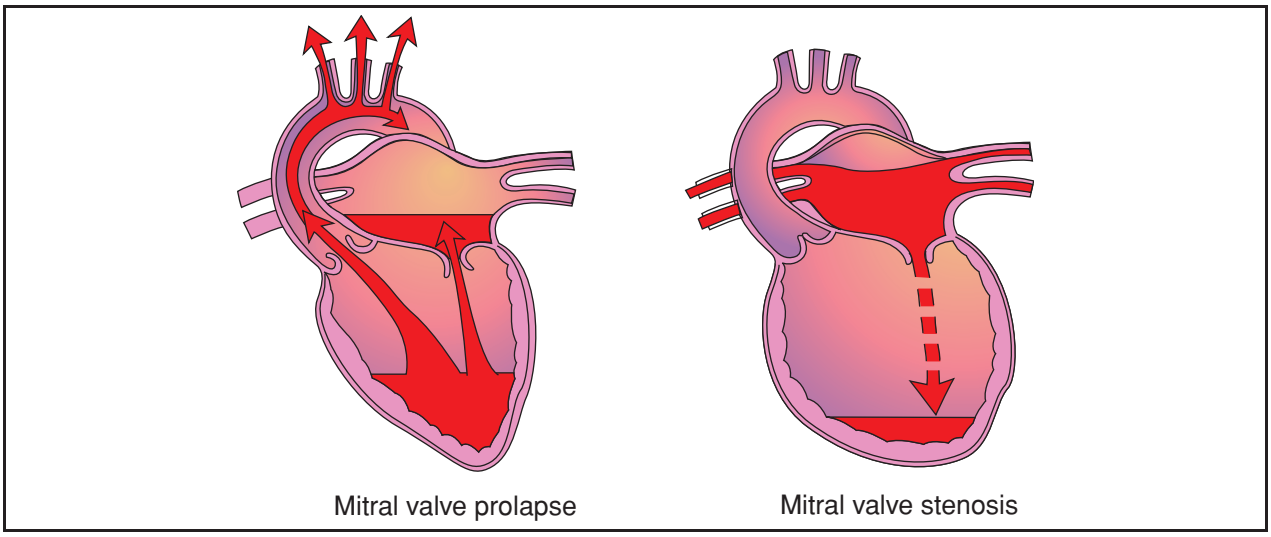
The valve has supporting structures that attach to the heart muscle to help it open and close properly. When these structures weaken or lengthen abnormally, the valve may balloon into the left atrium. Sometimes this can cause the mitral valve to leak blood backward.

This condition may be inherited and occurs in approximately 10% of the population. It affects more women than men and often peaks after the age of 40.

Causes and symptoms

MVP may occur due to rheumatic heart disease but is usually found in healthy people. Changes that occur in the valve are caused by rapid multiplication of cells in the middle layer that presses on the outer layer. The outer layer weakens, causing a prolapse of the valve toward the left atrium.

Most persons do not have symptoms. Those that do may experience sharp, left-sided chest **pain**. Some complain of **fatigue**, or a pounding feeling in the chest. Others can have an irregular heart beat and even pass out. Some persons may experience difficulty breathing, ankle swelling and fluid in the lungs. Other symptoms may include **anxiety**, headaches, morning tiredness and constantly cold hands and feet. **Death** from this condition is rare.



Mitral valve prolapse occurs when the mitral valve does not open and close properly. When this happens, the valve may balloon into the left atrium of the heart, causing the mitral valve to leak blood backward. Mitral valve stenosis refers to the narrowing of the mitral valve, in which the flow of blood from the atrium to the ventricle becomes restricted. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

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KEY TERMS

Heart murmur—Sound during the heartbeat caused by a heart valve that does not close properly.

Rheumatic heart disease—A condition caused by a streptococcus infection which can result in permanent heart damage.

Diagnosis

The diagnosis of MVP is based on symptoms and physical exam. During the exam, the physician may hear a click and/or heart murmur with a stethoscope.

The best diagnostic test for MVP is the echocardiogram. The test reflects sound waves through the chest wall to give two-dimensional color flow pictures of the heart, its size, position, motion, chambers, and valves. Unfortunately, during the early 1980s, this diagnosis was often made excessively from faulty echocardiographic criteria prevalent at that time.

Any person with symptoms or family history of MVP should consider having an echocardiogram. The test takes 15-20 minutes and is done in doctor's offices and hospitals. It is performed by trained technicians and is read by cardiologists. Family physicians, internists, cardiologists, and nurse practitioners can treat MVP. Echocardiograms are recommended periodically depending on the extent of valve leakage.

Treatment

Persons who experience certain types of an irregular heartbeat with MVP should be treated. Propranolol (Inderal) or other **beta blockers** or **digoxin** (Lanoxin) are often helpful. Persons who develop moderate to severe symptoms with a leaky mitral valve may require repair or replacement of the mitral valve with an artificial heart valve. Persons with MVP and a leaky valve need to protect themselves from heart or heart valve infections. **Antibiotics** should be taken before any surgical, dental or oral procedures according to the American Heart Association recommendations.

Other treatments include drinking lots of fluids during strenuous activity and hot weather. Water pills, **caffeine** and donating blood may aggravate the symptoms of MVP.

Prognosis

MVP is usually not a serious condition. However, dangerous, untreated irregular heartbeats may rarely cause sudden death. These persons should be carefully monitored.

Resources

PERIODICALS

McGrath, Dicey. "Mitral Valve Prolapse." *American Journal of Nursing* May 1997: 40-41.

Lisa Papp, RN

Mitral valve stenosis

Definition

The term stenosis means an abnormal narrowing of an opening. Mitral valve stenosis refers to a condition in the heart in which one of the valve openings has become narrow and restricts the flow of blood from the upper left chamber (left atrium) to the lower left chamber (left ventricle).

Description

In the heart, the valve that regulates the flow of blood between the left atrium and the left ventricle is called the mitral valve. If the mitral valve is abnormally narrow, due to disease or birth defect, blood flow from the atrium to the ventricle is restricted. This restricted flow leads to an increase in the pressure of blood in the left atrium. Over a period of time, this back pressure causes fluid to leak into the lungs. It can also lead to an abnormal heart rhythm (**atrial fibrillation**), which further decreases the efficiency of the pumping action of the heart.

Causes and symptoms

Mitral valve stenosis is almost always caused by **rheumatic fever**. As a result of rheumatic **fever**, the leaflets that form the opening of the valve are partially fused together. Mitral valve stenosis can also be present at birth. Babies born with this problem usually require surgery if they are to survive. Sometimes, growths or tumors can block the mitral valve, mimicking mitral valve stenosis.

If the restriction is severe, the increased blood pressure can lead to **heart failure**. The first symptoms of heart failure, which are **fatigue** and **shortness of breath**, usually appear only during physical activity. As the condition gets worse, symptoms may also be felt even during rest. A person may also develop a deep red coloring in the cheeks.

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KEY TERMS

Atrium—One of the two upper chambers of the heart.

Beta blocker—A drug that can be used to reduce blood pressure.

Rheumatic fever—An illness which sometimes follows a streptococcal infection of the throat.

Ventricle—One of the two lower chambers of the heart.

Diagnosis

Mitral valve stenosis is usually detected by a physician listening to heart sounds. Normal heart valves open silently to permit the flow of blood. A stenotic valve makes a snapping sound followed by a "rumbling" murmur. The condition can be confirmed with a **chest x ray** and an electrocardiogram, both of which will show an enlarged atrium. **Echocardiography**, which produces images of the heart's structure, is also helpful in making the diagnosis. If surgery is necessary, **cardiac catheterization** may be done to fully evaluate the heart before the operation.

Treatment

Drug therapy may help to slow the heart rate, strengthen the heart beat, and control abnormal heart rhythm. Drugs such as **beta blockers**, **calcium channel blockers**, and **digoxin** may be prescribed. A drug that prevents abnormal blood clotting (anticoagulant) called warfarin (Coumadin) may be recommended. If drug therapy does not produce satisfactory results, valve repair or replacement may be necessary.

Repair can be accomplished in two ways. In the first method, **balloon valvuloplasty**, the doctor will try to stretch the valve opening by threading a thin tube (catheter) with a balloon tip through a vein and into the heart. Once the catheter is positioned in the valve, the balloon is inflated, separating the fused areas. The second method involves opening the heart and surgically separating the fused areas.

If the valve is damaged beyond repair, it can be replaced with a mechanical valve or one that is partly mechanical and partly made from a pig's heart.

Prognosis

Procedures available to treat mitral valve stenosis, whether medical or surgical, all produce effective results.

Prevention

The only possible way to prevent mitral valve stenosis is to prevent rheumatic fever. This can be done by evaluating sore throats for the presence of the bacteria that causes **strep throat**. Strep throat is easily treated with **antibiotics**.

Resources

OTHER

The Merck Page. http://www.merck.com.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review. personal.info@heart.org.

Dorothy Elinor Stonely

Molar pregnancy *see* **Hydatidiform mole**

Moles

Definition

A mole (nevus) is a pigmented (colored) spot on the outer layer of the skin (epidermis).

Description

Moles can be round, oval, flat, or raised. They can occur singly or in clusters on any part of the body. Most moles are brown, but colors can range from pinkish flesh tones to yellow, dark blue, or black.

Demographics

Everyone has at least a few moles. They generally appear by the time a person is 20 and resemble freckles at first. A mole's color and shape don't usually change. Changes in hormone levels that occur during **puberty** and **pregnancy** can make moles larger and darker. New moles may also appear during this period.

A mole usually lasts about 50 years before beginning to fade. Some moles disappear completely, and some never lighten at all. Some moles develop stalks that raise them above the skin's surface; these moles eventually drop off.

Types of moles

About 1–3% of all babies have one or more moles when they are born. Moles that are present at birth are called congenital nevi.

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Woman's birthmark being removed by laser. *(Alexander Tsiaras/Photo Researchers, Inc.)*

Other types of moles include:

- Junctional moles, which are usually brown and may be flat or slightly raised.
- Compound moles, which are slightly raised, range in color from tan to dark brown, and involve pigment-producing cells (melanocytes) in both the upper and lower layers of the skin (epidermis and dermis).
- Dermal moles, which range from flesh-color to brown, are elevated, most common on the upper body, and may contain hairs.
- Sebaceous moles, which are produced by overactive oil glands and are yellow and rough-textured.
- Blue moles, which are slightly raised, colored by pigment deep within the skin, and most common on the head, neck, and arms of women.

Most moles are benign, but atypical moles (dysplastic nevi) may develop into **malignant melanoma**, a potentially fatal form of skin **cancer**. Atypical moles are usually hereditary. Most are bigger than a pencil eraser, and the shape and pigmentation are irregular.

Congenital nevi are more apt to become cancerous than moles that develop after birth, especially if they are more than eight inches in diameter. Lentigo maligna (melanotic freckle of Hutchinson), most common on the face and after the age of 50, first appears as a flat spot containing two or more shades of tan. It gradually becomes larger and darker. One in three of these moles develop into a form of skin cancer known as lentigo maligna melanoma.

Causes and symptoms

The cause of moles is unknown, although atypical moles seem to run in families and result from exposure to sunlight.

In the past several years, researchers have identified two genes known as CDKN2A and CDK4 that govern susceptibility to melanoma in humans. Most experts, however, think that these susceptibility genes are not sufficient by themselves to account for moles becoming cancerous but are influenced by a combination of other inherited traits and environmental factors.

Diagnosis

Only a small percentage of moles require medical attention. A mole that has the following symptoms

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should be evaluated by a dermatologist (a physician spealizing in skin diseases).

- Appears after the age of 20
- Bleeds
- Itches
- Looks unusual or changes in any way.

A doctor who suspects skin cancer will remove all or part of the mole for microscopic examination. This procedure, which is usually performed in a doctor's office, is simple, relatively painless, and does not take more than a few minutes. It does leave a scar.

The doctor may also use a dermatoscope to examine the mole prior to removal. The dermatoscope, which can be used to distinguish between benign moles and melanomas, is an instrument that resembles an ophthalmoscope. An immersion oil is first applied to the mole to make the outer layers of skin transparent.

A combination of high-frequency ultrasound and color Doppler studies has also been shown to have a high degree of accuracy in distinguishing between melanomas and benign moles.

Treatment

If laboratory analysis confirms that a mole is cancerous, the dermatologist will remove the rest of the mole. Patients should realize that slicing off a section of a malignant mole will not cause the cancer to spread.

Removing a mole for cosmetic reasons involves numbing the area and using scissors or a scalpel to remove the elevated portion. The patient is left with a flat mole the same color as the original growth. Cutting out parts of the mole above and beneath the surface of the skin can leave a scar more noticeable than the mole.

Cryotherapy may also be used to remove moles. In cryotherapy, the physician uses an extremely cold liquid to freeze and destroy the skin growth.

Scissors or a razor can be used to temporarily remove hair from a mole. Permanent hair removal, however, requires electrolysis or surgical removal of the mole.

Prognosis

Moles are rarely cancerous and, once removed, unlikely to recur. A dermatologist should be consulted if a mole reappears after being removed.

Prevention

Wearing a sunscreen and limiting sun exposure may prevent some moles. Anyone who has moles should examine them every month and see a dermatologist if changes in size, shape, color, or texture occur or if new moles appear.

KEY TERMS

Dermatology—The branch of medicine that studies and treats disorders of the skin.

Malignant melanoma—A potentially fatal form of skin cancer that develops from melanocytes, which are skin cells containing melanin.

Melanin—A dark insoluble pigment found in humans in the skin, hair, choroid layer of the eye, and a part of the brain called the substantia nigra.

Nevus (plural, nevi)—The medical term for any anomaly of the skin that is present at birth, including moles and birthmarks.

A team of researchers at Duke University reported in 2003 that topical application of a combination of 15% vitamin C and 1% vitamin E over a four-day period offered significant protection against **sunburn**. The researchers suggest that this combination may protect skin against **aging** caused by sunlight as well.

Anyone with a family history of melanoma should see a dermatologist for an annual skin examination. Everyone should know the ABCDEs of melanoma:

- A: Asymmetry, which occurs when the two halves of the mole are not identical
- B: Borders that are irregular or indistinct
- C: Color that varies in a single mole
- D: Diameter, which should be no larger than a pencil eraser (about 6 mm)
- E: Elevated above the surrounding tissue.

A mole with any of these characteristics should be evaluated by a dermatologist.

Advances in photographic technique have now made it easier to track the development of moles with the help of whole-body photographs. A growing number of hospitals are offering these photographs as part of outpatient mole-monitoring services.

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American Academy of Dermatology, 930 N. Meacham Road, P.O. Box 4014, Schaumburg, IL, 60168-4014, (847) 330-0230, (847) 330-0050, www.aad.org.

American Cancer Society, 250 Williams Street, Atlanta, GA, 30303, (404) 320-3333.

National Cancer Institute (NCI), 6116 Executive Boulevard, MSC8332, Suite 3036A, Bethesda, MD, 20892-8322, (800) 821-CANCER, www.nci.nih.gov.

Nevus Outreach, Inc., 1601 Madison Blvd., Bartesville, OK, 74006, (877) 426-3887, www.nevus.org.

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Karl Finley

Molybdenum excess *see* **Mineral toxicity**
Mometasone *see* **Corticosteroids**
Moncytic ehrlichiosis *see* **Ehrlichiosis**
Mongolism *see* **Down syndrome**
Moniliasis *see* **Candidiasis**

Monkeypox

Definition

Monkeypox is an **infectious disease** caused by an orthopoxvirus. Orthopoxviruses are a genus of viruses that include the disease agents that cause human **smallpox**, cowpox, and camelpox as well as monkeypox. Monkeypox, which was first identified in humans in an outbreak in Africa in 1970, usually produces a less severe illness with fewer fatalities than smallpox. However, its symptoms are similar: **fever**, pus-filled blisters all over the body, and respiratory problems.

Monkeypox is classified as a **zoonosis**, which means that it is a disease of animals that can be transmitted to humans under natural conditions. The first cases of monkeypox reported in humans involved contact between humans and animals in the African rain forest. The outbreak that made headlines in the United States in June 2003, however, involved animals purchased as pets from pet stores. In nature, monkeypox has been found in monkeys, chimpanzees, rabbits, prairie dogs, Gambian rats, ground squirrels, and mice. It is not known as of late 2003 whether other wild or domestic animals can contract monkeypox.

Description

Prior to 2003, most monkeypox cases were diagnosed in remote areas of central and west Africa. Between February 1996 and October 1997, however, there were 511 suspected cases of monkeypox in the Democratic Republic of the Congo (DRC, formerly Zaire). This outbreak, the largest ever, raised fears that the virus had mutated and become more infectious.

In late 1997, the U.S. Centers for Disease Control and Prevention (CDC) and the World Health Organization (WHO) announced that this relatively large outbreak was likely due to human behavior, rather than virus mutation. During the outbreak, the DRC was embroiled in civil war. Food shortages increased reliance on hunting and raised chances that people would come into contact with infected animals.

The 2003 outbreak in the United States, which was the first confirmed instance of community-acquired monkeypox in North America, came to the attention of the CDC in early June, when a laboratory in Wisconsin identified the monkeypox virus in samples taken from the skin of an infected patient and lymph node tissue from the patient's pet prairie dog. By the end of June, cases of monkeypox in humans had been identified in six Midwestern states (Illinois, Indiana, Kansas, Missouri, Ohio, and Wisconsin). The patients acquired the virus from infected prairie dogs purchased as pets, which in turn were infected through contact with animals imported from Africa that were sold in the same pet stores.

Monkeypox is less severe than smallpox and can sometimes be confused with **chickenpox**. It seems partly preventable with smallpox **vaccination**, but vaccination programs were discontinued in the late 1970s. (Barring samples stored in laboratories, smallpox has been eradicated.) People under the age of 16—those born after smallpox vaccination ended—seem the most susceptible to monkeypox. During the 1996-97 outbreak, approximately 85% of the cases were in this age group.

Although the monkeypox virus is related to the smallpox virus, experts do not think (as of late 2003) that it is likely to be cultivated as an agent of bioterrorism. Monkeypox is much less easily transmitted person-to-person than smallpox and has a much lower fatality rate.

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Causes and symptoms

The monkeypox virus is transmitted to humans through an infected animal's blood, body sores, or bite; or through handling an infected animal's bedding or cage. Initial symptoms of monkeypox in humans include fever, a bodywide rash (exanthem) of pus-filled blisters, and flu-like muscle aches and **fatigue**. These symptoms can be accompanied by **diarrhea**, swollen lymph nodes, a **sore throat**, and mouth sores. In some cases, a victim may experience trouble breathing. Symptoms are at their worst for 3–7 days, after which the fever lessens and blisters begin to form crusts.

The symptoms of monkeypox in pet rabbits, rats, or mice include inflammation of the eyes, a nasal discharge, fever, loss of appetite, a skin rash, and tiredness. Pet monkeys typically develop a rash with pus-filled lesions on the palms of the hands, trunk, and tail. They may also have mouth ulcers.

Diagnosis

Since the symptoms of monkeypox resemble other diseases caused by orthopox viruses, definitive diagnosis may require laboratory testing to uncover the virus or evidence (from antibodies in the blood) that it is present. Laboratory techniques that can be used to identify the monkeypox virus include electron microscopy, polymerase chain reaction (PCR), immunohistochemistry, and ELISA testing.

Treatment

Like most viruses, monkeypox cannot be resolved with medication. The only treatment option is symptomatic—that is, patients are made as comfortable as possible. In March 1998, the U.S. Army Medical Research Institute for Infectious Diseases reported that an antiviral drug called cidofovir may combat monkeypox infection. Additional studies report that cidofovir appears to be safe and effective as a treatment for monkeypox in humans.The drug has worked successfully in primates, but further research is needed to determine its effectiveness in humans.

Prognosis

Children are more likely to contract the disease and have the highest **death** rate. Monkeypox is not as lethal as smallpox, but the death rate among young children may reach 2–10%. In some cases, hospitalization is required. Recovery is good among survivors, although some scarring may result from the blisters.

KEY TERMS

Antiviral—Refers to a drug that can destroy viruses and help treat illnesses caused by them.

Bioterrorism—The intentional use of disease-causing microbes or other biologic agents to intimidate or terrorize a civilian population for political or military reasons.

Mutation—A change in an organism's genetic code that causes it to develop new characteristics.

Orthopoxvirus—The genus of viruses that includes monkeypox, smallpox, cowpox, and camelpox.

Symptomatic—Refers to treatment that addresses the symptoms of an illness, but not its underlying cause.

Zoonosis (plural, zoonoses)—Any disease of animals that can be transmitted to humans under natural conditions. Monkeypox is a zoonosis.

Prevention

Monkeypox is one of the diseases that physicians, veterinarians, and public health officials are required by law to report to the CDC.

Although smallpox vaccination offers some protection against monkeypox, experts do not generally recommend getting a smallpox vaccination simply to guard against monkeypox if one has not been exposed to it. However, the CDC recommends as of June 2003 that anyone who has had close contact with humans or animals infected with monkeypox, or has helped to care for them, should be vaccinated against smallpox. The vaccination can be administered as late as 14 days after exposure to the virus. In addition, veterinarians or public health personnel conducting field investigations should be vaccinated before any exposure to monkeypox.

As of late 2003, no cases of monkeypox were identified in cats or dogs belonging to people infected by the June outbreak. The American Veterinary Medicine Association (AVMA) recommends, however, that cats, dogs, or other mammals that have been in contact with an animal known to have monkeypox should be kept in quarantine for 30 days from the date of exposure.

People who have a pet with symptoms of monkeypox should *not* take it to an animal shelter or release it into the wild. They should isolate it from humans and other animals, and take it to a veterinarian in a closed, chew-proof container with air holes.

On June 11, 2003, the CDC and the Food and Drug Administration (FDA) issued a joint order prohibiting

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the importation of rats and other rodents from Africa. In addition, the agencies banned the sale and distribution of prairie dogs and six species of African rodents in the United States.

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ORGANIZATIONS

American Veterinary Medical Association (AVMA), 1931 North Meacham Road, Suite 100, Schaumburg, IL, 60173-4360, (847) 925-1329, (800) 248-2862, http://www.avma.org/.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

Julia Barrett
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Monoamine oxidase inhibitors

Definition

Monoamine oxidase inhibitors (MAOI) are medicines used to treat severe mental depression.

Purpose

Like other **antidepressant drugs**, MAOI help reduce the sadness, hopelessness, apathy and lack of interest in life that are typical of depression. In use since the 1950s, these drugs are associated with greater risks of interactions with foods and other drugs than other types of antidepressants, and are generally reserved for cases where other drugs are not effective.

Description

MAOI work by correcting chemical imbalances in the brain. Normally, chemicals, called neurotransmitters, carry signals between brain cells. Some neurotransmitters, such as serotonin and norepinephrine, play important roles in controlling mood. MAOI are believed to block or reduce the breakdown of serotonin and norepinephrine, prolonging and increasing their effects.

MAOI are available only with a physician's prescription. Examples include isocarboxazid (Marplan), phenelzine (Nardil), tranylcypromine (Parnate), available as tablets; and selegiline (Emsam), available as a skin patch.

Recommended dosage

Dosage depends on the type of MAOI prescribed, the type of depression treated, and characteristics of individual patients. Prescribers or pharmacists can advise on correct dosage and use.

Always take MAOI exactly as directed. These drugs may take up to several weeks to be effective. Do not stop taking them suddenly, as withdrawal symptoms may occur. Prescribers should advise and monitor reducing or discontinuing these drugs.

MAOI may be taken with or without food, or on an empty stomach. Some foods and beverages must be avoided while taking these drugs.

Precautions

All types of antidepressant medications increase the risk of **suicide** in children, adolescents, and young adults.

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These drugs may worsen **psychosis**, and should not be used alone to treat **bipolar disorder**.

Diabetics using insulin may experience more low blood sugars when they take MAOI

MAOI may cause serious and possibly life-threatening high blood pressure within several hours after eating certain foods like aged cheeses, smoked or pickled meats, chocolate, foods containing monosodium glutamate (MSG), or drinking red wine or caffeinated beverages. Before started on these drugs, a full list of foods and beverages to be avoided should be obtained from a physician or pharmacist.

The effects and interactions of these drugs with food, beverages and other drugs may continue for up to two weeks after they are discontinued.

MAOI should be discontinued at least two weeks before anesthesia or elective surgery, or dental procedures where local anesthetics containing epinephrine might be used.

These drugs may produce dangerously high blood pressure in people who take **central nervous system stimulants** to treat **attention deficit hyperactivity disorder (ADHD)**.

When taken with **central nervous system depressants**, like cyclobenzaprine (Flexeril), meperidine (Demerol), bupropion (Wellbutrin), and buspirone (Buspar), **delirium**, excitement, **coma**, seizures, or high **fever** may occur.

At least five weeks should elapse after discontinuing **selective serotonin reuptake inhibitors** (SSRIs), like Prozac, before beginning treatment with MAOI.

Anyone who is taking MAOIs should not use medicines that have not been approved or prescribed by physicians familiar with these drugs. This includes over-the-counter medicines like sleep aids; colds, coughs, hay fever, or **asthma** medications, including nose drops or sprays containing neosynephrine or pseudoephedrine; medicines to increase alertness or keep from falling asleep, like NoDoz; and appetite control products.

MAOI may cause blurred vision or make people feel drowsy, dizzy or lightheaded. Anyone taking these drugs should not drive, use machines or do other potentially dangerous activities until they are familiar with the drugs's effects.

The elderly may be more sensitive to the effects of MAOI.

Special conditions

People with certain medical conditions or who are taking certain other medicines can have problems if they take MAOI. Before taking these drugs, be sure to let your physician know about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to MAOI in the past should let his or her physician know before taking them again. Physicians should be told about **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. MAOI may increase the risks of **birth defects** or problems in newborns. Women who are, or may become, pregnant should discuss these issues with their physicians before taking a MAOI.

BREASTFEEDING. MAOI pass into breast milk and are not recommended for nursing mothers unless the expected benefits outweigh the risks.

DIABETES. Diabetics using insulin and/or oral drugs to control blood sugar should be aware that MAOI increase sensitivity to these drugs.

ANGINA. People with **angina** (chest **pain**) may feel more energetic while taking MAOI and should be careful not to overexert themselves.

OTHER MEDICAL CONDITIONS. Before using MAOI, people with any of these medical problems should make sure their physicians are aware of their conditions:

- Alcohol abuse
- High blood pressure
- Recent heart attack or stroke
- Heart or blood vessel disease
- Liver disease
- Kidney disease
- Frequent or severe headaches
- Epilepsy
- Parkinson's disease
- Current or past mental illness
- Asthma or bronchitis
- Overactive thyroid
- Pheochromocytoma (a tumor of the adrenal gland).

USE OF CERTAIN MEDICINES. Taking MAOI with certain other drugs may affect the way the drugs work and increase the risk of side/adverse effects.

Side effects

The most common side effects include **dizziness**, lightheadedness, drowsiness, weakness, blurred vision, shakiness or trembling, restlessness, sleep problems or twitching during sleep, weight gain, decreased sexual ability, difficulty with urination, and **headache**. These problems usually go away as the body adjusts to the drug and do not require medical treatment unless they interfere with normal activities.

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KEY TERMS

Anxiety—Apprehension in response to real or imagined stress, danger, or dreaded situations. Physical symptoms like rapid pulse, sweating, trembling, fatigue, and weakness may accompany anxiety.

Central nervous system—The brain and spinal cord.

Depression—A mental condition where people feel extremely sad and lose interest in life. People with depression may also have sleep problems and loss of appetite and may have trouble concentrating and carrying out everyday activities.

Neurotransmitters—Chemicals that carry impulses, messages, between nerve cells.

Phobia—Intense, illogical fear of specific things like heights, crowds or open spaces.

Withdrawal symptoms—Physical and/or mental symptoms that occur when people stop using drugs to which they have become physically or psychologically dependent.

Serious side/averse effects may occur. If any of the following occur seek emergency medical attention:

- Severe chest pain
- Severe headache
- Stiff, sore neck
- Enlarged pupils
- Hypersensitivity to light
- Rapid or slow heartbeat
- Sweating, with or without fever or cold, clammy skin
- Nausea and vomiting.

Other side effects may occur. Anyone who has unusual or troublesome symptoms while taking MAOI should contact their physician.

Interactions

MAOI interact with many other medicines, changing the effects of one or both drugs and changing the risks of side/adverse effects. *People taking MAOI must check with their physicians before taking other prescription or nonprescription (over-the-counter) medicines.*

Drugs that interact with MAO inhibitors include:

- Central nervous system (CNS) depressants, stimulants, over the counter medicines for allergies, colds, hay fever, sleep and asthma; sedatives; tranquilizers; prescription pain medicines; muscle relaxants; antiseizure medicines; barbiturates; and anesthetics
- Medicine for high blood pressure
- Other antidepressants, including tricyclic antidepressants (such as Tofranil and Norpramin), antidepressants that raise serotonin levels (such as Prozac and Zoloft), and bupropion (Wellbutrin)
- Insulin and diabetes medicines taken by mouth
- Water pills (diuretics)

The list above does not include every drug that may interact with MAOI. Check with a physician or pharmacist before combining MAOI with any other prescription or nonprescription (over-the-counter) medicine.

Nancy Ross-Flanigan

Mononucleosis *see* **Infectious mononucleosis**

Montezuma's revenge *see* **Traveler's diarrhea**

Mood disorders

Definition

Mood disorders are mental disorders characterized by periods of depression, sometimes alternating with periods of elevated mood.

Description

While many people go through sad or elated moods from time to time, people with mood disorders suffer from severe or prolonged mood states that disrupt their daily functioning. Among the general mood disorders classified in the fourth edition (1994) of the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM–IV*) are major depressive disorder, **bipolar disorder**, and dysthymia.

In classifying and diagnosing mood disorders, doctors determine if the mood disorder is unipolar or bipolar. When only one extreme in mood (the depressed state) is experienced, this type of depression is called unipolar. Major depression refers to a single severe period of depression, marked by negative or hopeless thoughts and physical symptoms like **fatigue**. In major depressive disorder, some patients have isolated episodes of depression. Between these episodes, the patient does not feel depressed or have other symptoms

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associated with depression. Other patients have more frequent episodes.

Bipolar depression or bipolar disorder (sometimes called manic depression) refers to a condition in which people experience two extremes in mood. They alternate between depression (the "low" mood) and **mania** or hypomania (the "high" mood). These patients go from depression to a frenzied, abnormal elevation in mood. Mania and hypomania are similar, but mania is usually more severe and debilitating to the patient.

Dysthymia is a recurrent or lengthy depression that may last a lifetime. It is similar to major depressive disorder, but dysthymia is chronic, long–lasting, persistent, and mild. Patients may have symptoms that are not as severe as major depression, but the symptoms last for many years. It seems that a mild form of the depression is always present. In some cases, people also may experience a major depressive episode in addition to their dysthymia, a condition sometimes referred to as a "double depression."

Causes and symptoms

Mood disorders tend to run in families. These disorders are associated with imbalances in certain chemicals that carry signals between brain cells (neurotransmitters). These chemicals include serotonin, norepinephrine, and dopamine. Women are more vulnerable to unipolar depression than are men. Major life stressors (such as divorce, serious financial problems, and **death** of a family member) often provoke the symptoms of depression in susceptible people.

Major depression is more serious than just feeling "sad" or "blue." The symptoms of major depression may include:

- Loss of appetite
- A change in sleep patterns, such as not sleeping (insomnia) or sleeping too much
- Feelings of worthlessness, hopelessness, or inappropriate guilt
- Fatigue
- Difficulty in concentrating or making decisions
- Overwhelming and intense feelings of sadness or grief
- Disturbed thinking.
- The person may also have physical symptoms such as stomachaches or headaches

Bipolar disorder includes mania or hypomania. Mania is an abnormal elevation in mood. The person may be excessively cheerful, have grandiose ideas, and may sleep less. He or she may talk nonstop for hours, have unending enthusiasm, and demonstrate poor judgement. Sometimes the elevation in mood is marked by irritability and hostility rather than cheerfulness. While the person may at first seem normal with an increase in energy, others who know the person well see a marked difference in behavior. The patient may seem to be in a frenzy and often will make poor, bizarre, or dangerous choices in his/her personal and professional lives. Hypomania is not as severe as mania and does not cause the level of impairment in work and social activities that mania can.

Diagnosis

Doctors diagnose mood disorders based on the patient's description of the symptoms as well as the patient's family history. The length of time the patient has had symptoms also is important. Generally patients are diagnosed with dysthymia if they feel depressed more days than not for at least two years. The depression is mild but long lasting. In major depressive disorder, the patient is depressed almost all day nearly every day of the week for at least two weeks. The depression is severe. Sometimes laboratory tests are performed to rule out other causes for the symptoms (such as thyroid disease). The diagnosis may be confirmed when a patient responds well to medication.

Treatment

The most effective treatment for mood disorders is a combination of medication and **psychotherapy**. Individuals may have better results if they also participate in family-focused therapy. The four different classes of drugs used in mood disorders are:

- Heterocyclic antidepressants (HCAs), such as amitriptyline (Elavil)
- Selective serotonin reuptake inhibitors (SSRI inhibitors), such as fluoxetine (Prozac), paroxetine (Paxil), and sertraline (Zoloft)
- Monoamine oxidase inhibitors (MAOI inhibitors), such as phenelzine sulfate (Nardil) and tranylcypromine sulfate (Parnate)
- Mood stabilizers, such as lithium carbonate (Eskalith) and valproate, often used in people with bipolar mood disorders.

A number of psychotherapy approaches are useful as well. Interpersonal psychotherapy helps the patient recognize the interaction between the mood disorder and interpersonal relationships. Cognitive–behavioral therapy explores how the patient's view of the world may be affecting his or her mood and outlook.

When depression fails to respond to treatment or when there is a high risk of **suicide**, **electroconvulsive**

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KEY TERMS

Cognitive therapy—Psychotherapy technique designed to help people change their attitudes, perceptions, and patterns of thinking.

Electroconvulsive therapy (ECT)—Therapy for mood disorders that involves passing electrical current through the brain in order to create a brief convulsion.

Neurotransmitter—A chemical that aids or alters the transmission of impulses between the points that connect nerves.

Serotonin—A chemical messenger in the brain thought to play a role in mood regulation.

therapy (ECT) sometimes is used. ECT is believed to affect neurotransmitters as medications do. Patients are anesthetized and given **muscle relaxants** to minimize discomfort. Then low–level electric current is passed through the brain to cause a brief convulsion. The most common side effect of ECT is mild, short–term **memory loss**.

Alternative treatment

There are many alternative therapies that may help in the treatment of mood disorders, including **acupuncture**, botanical medicine, homeopathy, **aromatherapy**, constitutional **hydrotherapy**, and **light therapy**. The therapy used is an individual choice. Short–term clinical studies have shown that the herb **St. John's wort** (*Hypericum perforatum*) can effectively treat some types of depression. Though it appears very safe, the herb may have some side effects and its long–term effectiveness has not been proven. It has not been tested in patients with bipolar disorder. Despite uncertainty concerning its effectiveness, a 2003 report said acceptance of the treatment continues to increase. A poll showed that about 41% of 15,000 science professionals in 62 countries said they would use St. John's wort for mild to moderate depression. Although St. John's wort appears to be a safe alternative to conventional antidepressants, care should be taken, as the herb can interfere with the actions of some pharmaceuticals. The usual dose is 300 mg three times daily. St. John's wort and **antidepressant drugs** should not be taken simultaneously, so patients should tell their doctor if they are taking St. John's wort.

Prognosis

Most cases of mood disorders can be successfully managed if properly diagnosed and treated.

Prevention

People can take steps to improve mild depression and keep it from becoming worse. They can learn **stress** management (such as relaxation training or breathing exercises), **exercise** regularly, and avoid drugs or alcohol.

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ORGANIZATIONS

American Psychiatric Association, 1000 Wilson Blvd., Suite 1825, Arlington, VA, 22209, (703) 907–7300, apa@psych.org, http://www.psych.org/.

American Psychological Association (APA), 750 First St. NE, Washington, DC, 20002–4242, (202) 336–5700, http://www.apa.org.

Anxiety Disorders Association of America., 8730 Georgia Ave., Suite 600, Silver Spring, MD, 20910, (240) 485–1001, http://www.adaa.org.

Depression and Bipolar Support Alliance (DBSA), 730 N. Franklin St., Suite 501, Chicago, IL, 60610, (800) 826–3632, http://www.dbsalliance.org.

National Alliance on Mental Illness (NAMI), Colonial Place Three, 2107 Wilson Blvd., Suite 300, Arlington, VA, 22201, (703) 524–7600, (800) 950–NAMI (6264), (703) 524–9094, http://www.nami.org/Hometemplate.cfm.

National Institute of Mental Health (NIMH), 6001 Executive Blvd, Room 8184, MSC 9663, Bethesda, MD,

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20892, (301) 443–4513, (866) 615–6464, (301) 443–4279, nimhinfo@nih.gov, http://www.nimh.nih.gov/index.shtml.

National Mental Health Association (NMHA), 2000 N. Beauregard St., 6th Floor, Alexandria, VA, 22311, (703) 684–7722, (800) 969–NMHA, (703) 684–5968, http://www1.nmha.org/.

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Morning after pill *see* **Mifepristone**

Motion sickness

Definition

Motion sickness is the uncomfortable **dizziness**, **nausea**, and **vomiting** that people experience when their sense of balance and equilibrium is disturbed by constant motion. Riding in a car, aboard a ship or boat, or riding on a swing all cause stimulation of the vestibular system and visual stimulation that often leads to discomfort. While motion sickness can be bothersome, it is not a serious illness, and can be prevented.

Demographics

Motion sickness is a common problem, with nearly 80% of the general population suffering from it at one time or another in their lives. People with migraine headaches or Ménière's syndrome, however, are more likely than others to have recurrent episodes of motion sickness. Researchers at the Naval Medical Center in San Diego, California, reported in 2003 that 70% of research subjects with severe motion sickness had abnormalities of the vestibular system; these abnormalities are often found in patients diagnosed with migraines or **Ménière's disease**.

While motion sickness may occur at any age, it is more common in children over the age of two, with the majority outgrowing this susceptibility.

Description

When looking at the causes of motion sickness, it is helpful to understand the role of the sensory organs. The sensory organs control a body's sense of balance by telling the brain what direction the body is pointing, the direction it is moving, and if it is standing still or turning. These messages are relayed by the inner ears (or labyrinth); the eyes; skin pressure receptors, such as in those in the feet; muscle and joint sensory receptors, which track what body parts are moving; and the central nervous system (the brain and spinal cord), which is responsible for processing all incoming sensory information.

Motion sickness and its symptoms arise when conflicting messages are sent to the central nervous system. An example of this phenomenon occurs while reading a book in the back seat of a moving car. The inner ears and skin receptors sense the motion, but the eyes register only the stationary pages of the book. This conflicting information may cause the usual motion sickness symptoms of dizziness, **nausea and vomiting**.

Causes and symptoms

While all five of the body's sensory organs contribute to motion sickness, excess stimulation to the vestibular system within the inner ear (the body's "balance center") has been shown to be one of the primary reasons for this condition. Balance problems, or vertigo, are caused by a conflict between what is seen and how the inner ear perceives it, leading to confusion in the brain. This confusion may result in higher heart rates, rapid breathing, nausea and sweating, along with dizziness and **vomiting**.

Pure optokinetic motion sickness is caused solely by visual stimuli, or what is seen. The optokinetic system is the reflex that allows the eyes to move when an object moves. Many people suffer when the object they view is rotating or swaying, even if they are standing still.

Additional factors that may contribute to the occurrence of motion sickness include:

- Poor ventilation.
- Anxiety or fear. Both have been found to lower a person's threshold for experiencing motion sickness symptoms.
- Food. It is recommended that a heavy meal of spicy and greasy foods be avoided before and during a trip.
- Alcohol. A drink is often thought to help calm the nerves, but in this case it could upset the stomach further. A hangover prior to the next morning's trip may also lead to motion sickness.
- Genetic factors. Research suggests that some people inherit a predisposition to motion sickness. This predisposition is more marked in some ethnic groups than in others. One study published in 2002 found that persons of Chinese or Japanese ancestry are significantly more vulnerable to motion sickness than persons of British ancestry.

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KEY TERMS

Acupressure—Often described as acupuncture without needles, acupressure is a traditional Chinese medical technique based on the theory of *qi* (life energy) flowing in energy meridians or channels in the body. Applying pressure with the thumb and fingers to acupressure points is thought to relieve specific conditions and promote overall balance and health.

Acupuncture—Based on the same traditional Chinese medical foundation as acupressure, acupuncture uses sterile needles inserted at specific points to treat certain conditions or relieve pain.

Neurological system—The tissue that initiates and transmits nerve impulses, including the brain, spinal cord, and nerves.

Optokinetic—A reflex that causes a person's eyes to move when his or her field of vision moves.

Vertigo—The sensation of moving around in space, or objects moving around a person. It is a disturbance of equilibrium.

Vestibular system—The brain and parts of the inner ear that work together to detect movement and position.

- Pregnancy. Susceptibility in women to vomiting during pregnancy appears to be related to motion sickness, although the precise connections are not yet well understood.

Often viewed as a minor annoyance, some travelers are temporarily immobilized by motion sickness, and a few continue to feel its effects for hours and even days after a trip (the "mal d'embarquement" syndrome).

Diagnosis

Most cases of motion sickness are mild and self–treatable disorders. If symptoms such as dizziness become chronic, a doctor may be able to help alleviate the discomfort by looking further into a patient's general health. Questions regarding medications, head injuries, recent infections, and other questions about the ear and neurological system will be asked. An examination of the ears, nose, and throat, as well as tests of nerve and balance function, may also be completed.

Severe cases of motion sickness symptoms, and those that become progressively worse, may require additional, specific tests. Diagnosis in these situations deserves the attention and care of a doctor with specialized skills in diseases of the ear, nose, throat, equilibrium, and neurological system.

Treatment

There are a variety of medications to help ease the symptoms of motion sickness, and most of these are available without a prescription. Known as over-the-counter (OTC) medications, these products should be taken 30–60 minutes before traveling in order to prevent motion sickness symptoms, as well as during an extended trip.

Drugs

The following OTC drugs consist of ingredients that have been considered safe and effective for the treatment of motion sickness by the Food and Drug Administration (FDA):

- Marezine (and others). Includes the active ingredient cyclizine and is not for use in children under age six.
- Benadryl (and others). Includes the active ingredient diphenhydramine and is not for use in children under age six.
- Dramamine (and others). Includes the active ingredient dimenhydrinate and is not for use in children under age two.
- Bonine (and others). Includes the active ingredient meclizine and is not for use in children under age 12.

Each of the active ingredients listed above are **antihistamines** whose main side effect is drowsiness. Caution should be used when driving a vehicle or operating machinery, and alcohol should be avoided when taking any drug for motion sickness. Large doses of OTC drugs for motion sickness may also cause **dry mouth** and occasional blurred vision.

The side effects of antihistamine antiemetics indicate that they should not be used by members of flight crews responsible for the control of aircraft or for other tasks that require sustained attention and alertness.

The FDA recommends that people with **emphysema**, chronic **bronchitis**, glaucoma, or difficulty urinating due to an **enlarged prostate** not use OTC drugs for motion sickness unless directed by their doctor.

Longer trips may require a prescription medication called scopolamine (Transderm Scop). Formerly used in the transdermal skin patch (now discontinued), travelers must now ask their doctor to prescribe it in the form of a gel. In gel form, scopolamine is most effective when smeared on the arm or neck and covered with a bandage.

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PATRICIA SUZANNE COWINGS (1948–)

Patricia Suzanne Cowings was born on December 15, 1948, in New York City. She was one of four children born to Sadie and Albert Cowings, a grocery store owner. Cowings showed interest in science by the time she was eleven years old. She enrolled in the State University of New York at Stony Brook, earning her bachelor's degree with honors in 1970. She began her graduate work at the University of California at Davis where she was awarded both her master's and her doctoral degrees in 1973. Cowings also received an associateship from the National Research Council that same year, which allowed her to complete two years of research at NASA's Ames Research Center. She has held a position as a researcher with Ames since 1977, and is currently the principal investigator of Psychophysiological Research Laboratories at NASA Ames Research Center (ARC), as well as a professor of psychiatry at the University of California, Los Angeles.

Cowings's work at Ames' Psychophysiological Research Laboratory led to major breakthroughs for astronauts. Her pioneering experiments with biofeedback as a method to control bodily functions has proven very effective for astronaut crews who experience "zero-gravity sickness syndrome." Her program was finally used during the 1992 *Endeavour* space flight. Presently, Cowings is researching exercises that will allow astronauts to maintain muscle strength while in zero gravity. She has published numerous papers with her colleague and husband, William B. Toscano. In addition, she has written articles including *The Relationship of Motion Sickness Susceptibility to Learned Autonomic Control for Symptom Suppression* (1982), *Autogenic-Feedback Training as a Preventive Method for Space Adaptation Syndrome* (1985), and *Autogenic-Feedback Training: A Preventive Method for Motion and Space Sickness* (1990).

Another prescription drug that is sometimes given for motion sickness is ondansetron (Zofran), which was originally developed to treat nausea associated with **cancer chemotherapy**. Unlike cyclizine, ondansetron appears to be safe for use in children under the age of six.

One newer class of anti–emetic drugs include compounds known as neurokinin–1 (substance P) antagonists. The neurokinins are usually prescribed for the control of nausea before surgery and following cancer chemotherapy, as well as preventing nausea in persons who have previously experienced severe motion sickness. The first of these new antiemetic drugs was known as aprepitant, and is sold under the trade name Emend.

Alternative treatment

Alternative treatments for motion sickness have become widely accepted as a standard means of care. Ginger (*Zingiber officinale*) in its various forms is often used to calm the stomach, and it is now known that the oils it contains (gingerols and shogaols) appear to relax the intestinal tract in addition to mildly depressing the central nervous system. Some of the most effective forms of ginger include the powdered, encapsulated form; ginger tea prepared from sliced ginger root; or candied pieces. All forms of ginger should be taken on an empty stomach.

Placing manual pressure on the Neiguan or Pericardium–6 **acupuncture** point (located about three finger–widths above the wrist on the inner arm), either by acupuncture, **acupressure**, or a mild, electrical pulse, has shown to be effective against the symptoms of motion sickness. Elastic wristbands sold at most drugstores are also used as a source of relief due to the pressure it places in this area. Pressing the small indentation (just below the earlobes in the indentations behind the jawbone) may also help in the functioning of the ear's balancing mechanism.

There are several homeopathic remedies that work specifically for motion sickness. They include *Cocculus*, *Petroleum*, and *Tabacum*. Alternative treatments should be used with care, as the benefits of many such treatments have not been confirmed by scientific research.

The National Aeronautics and Space Administration (NASA) has developed an additional treatment for motion sickness that has shown benefit for both military pilots and astronauts. NASA's autogenic feedback training exercises encourage pilots to reduce motion sickness symptoms by controlling their own responses to the sensations of flight using **biofeedback** and self–suggestion exercises. After one six–hour training session, eighty percent of pilot volunteers who had previously experienced symptoms of motion sickness reported increased motion sickness tolerance. With more study, NASA anticipates that the program could provide similar benefit to persons experiencing motion sickness, extreme **fatigue**, jet–lag, **insomnia**, and high **stress** work environments.

Prognosis

While there is no cure for motion sickness, its symptoms can be controlled or even prevented. Most people respond successfully to the variety of treatments available, or avoid the unpleasant symptoms through prevention methods.

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Prevention

Because motion sickness is easier to prevent than treat once it has begun, the best treatment is prevention. The following steps may help deter the unpleasant symptoms of motion sickness before they occur:

- Avoid reading while traveling, and do not sit in a backward facing seat.
- Always ride where the eyes may see the same motion that the body and inner ears feel. Safe positions include the front seat of the car while looking at distant scenery; the deck of a ship where the horizon can be seen; and sitting by the window of an airplane. The least motion on an airplane is in a seat over the wings.
- Maintain a fairly straight–ahead view.
- Eat a light meal before traveling, or if already nauseated, avoid food altogether.
- Avoid watching or talking to another traveler who is having motion sickness.
- Take motion sickness medicine at least 30–60 minutes before travel begins, or as recommended by a physician.
- Learn to live with the condition. Even those who frequently endure motion sickness can learn to travel by anticipating the conditions of their next trip. Research also suggests that increased exposure to the stimulation that causes motion sickness may help decrease its symptoms on future trips.

Resources

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ORGANIZATIONS

Vestibular Disorders Association, PO Box 13305, Portland, Oregon, 97213, (800) 837–8428, (503) 229–8064, copyeditor@vestibular.org, http://www.vestibular.org/index.php.

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Mountain sickness *see* **Altitude sickness**
Mouth cancer *see* **Head and neck cancer**

Movement disorders

Definition

Movement disorders are a group of diseases and syndromes affecting the ability to produce and control movement.

Description

Although it seems simple and effortless, normal movement in fact requires an astonishingly complex system of control. Disruption of any portion of this system can cause a person to produce movements that are too weak, too forceful, too uncoordinated, or too poorly controlled for the task at hand. Unwanted movements may occur at rest. Intentional movement may become impossible. Such conditions are called movement disorders.

Abnormal movements themselves are symptoms of underlying disorders. In some cases, the abnormal movements are the only symptoms. Disorders causing abnormal movements include:

- Parkinson's disease
- Parkinsonism caused by drugs or poisons
- Parkinson–plus syndromes (progressive supranuclear palsy, multiple system atrophy, and cortical–basal ganglionic degeneration)
- Huntington's disease
- Wilson's disease
- Inherited ataxias (Friedreich's ataxia, Machado–Joseph disease, and spinocerebellar ataxias)
- Tourette syndrome and other tic disorders
- Essential tremor
- Restless leg syndrome

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- Dystonia
- Stroke
- Cerebral palsy
- Encephalopathies
- Intoxication
- Poisoning by carbon monoxide, cyanide, methanol, or manganese.

Causes and symptoms

Causes

Movement is produced and coordinated by several interacting brain centers, including the motor cortex, the cerebellum, and a group of structures in the inner portions of the brain called the basal ganglia. Sensory information provides critical input on the current position and velocity of body parts, and spinal nerve cells (neurons) help prevent opposing muscle groups from contracting at the same time.

To understand how movement disorders occur, it is helpful to consider a normal voluntary movement, such as reaching to touch a nearby object with the right index finger. To accomplish the desired movement, the arm must be lifted and extended. The hand must be held out to align with the forearm, and the forefinger must be extended while the other fingers remain flexed.

THE MOTOR CORTEX. Voluntary motor commands begin in the motor cortex located on the outer, wrinkled surface of the brain. Movement of the right arm is begun by the left motor cortex, which generates a large volley of signals to the involved muscles. These electrical signals pass along upper motor neurons through the midbrain to the spinal cord. Within the spinal cord, they connect to lower motor neurons, which convey the signals out of the spinal cord to the surface of the muscles involved. Electrical stimulation of the muscles causes contraction, and the force of contraction pulling on the skeleton causes movement of the arm, hand, and fingers.

Damage to or **death** of any of the neurons along this path causes weakness or **paralysis** of the affected muscles.

ANTAGONISTIC MUSCLE PAIRS. This picture of movement is too simple, however. One important refinement to it comes from considering the role of opposing, or antagonistic, muscle pairs. Contraction of the biceps muscle, located on the top of the upper arm, pulls on the forearm to flex the elbow and bend the arm. Contraction of the triceps, located on the opposite side, extends the elbow and straightens the arm. Within the spine, these muscles are normally wired so that willed (voluntary) contraction of one is automatically accompanied by blocking of the other. In other words, the command to contract the biceps provokes another command within the spine to prevent contraction of the triceps. In this way, these antagonist muscles are kept from resisting one another. Spinal cord or brain injury can damage this control system and cause involuntary simultaneous contraction and spasticity, an increase in resistance to movement during motion.

THE CEREBELLUM. Once the movement of the arm is initiated, sensory information is needed to guide the finger to its precise destination. In addition to sight, the most important source of information comes from the "position sense" provided by the many sensory neurons located within the limbs (proprioception). Proprioception is the response allows a person to touch the nose with the finger even with the eyes closed. The balance organs in the ears provide important information about posture. Both postural and proprioceptive information are processed by a structure at the rear of the brain called the cerebellum. The cerebellum sends out electrical signals to modify movements as they progress, "sculpting" the barrage of voluntary commands into a tightly controlled, constantly evolving pattern. Cerebellar disorders cause inability to control the force, fine positioning, and speed of movements (ataxia). Disorders of the cerebellum may also impair the ability to judge distance so that a person under- or overreaches the target (dysmetria). Tremor during voluntary movements can also result from cerebellar damage.

THE BASAL GANGLIA. Both the cerebellum and the motor cortex send information to a set of structures deep within the brain that help control involuntary components of movement (basal ganglia). The basal ganglia send output messages to the motor cortex, helping to initiate movements, regulate repetitive or patterned movements, and control muscle tone.

Circuits within the basal ganglia are complex. Within this structure, some groups of cells begin the action of other basal ganglia components and some groups of cells block the action. These complicated feedback circuits are not entirely understood. Disruptions of these circuits are known to cause several distinct movement disorders. A portion of the basal ganglia called the substantia nigra sends electrical signals that block output from another structure called the subthalamic nucleus. The subthalamic nucleus sends signals to the globus pallidus, which in turn blocks the thalamic nuclei. Finally, the thalamic nuclei send signals to the motor cortex. The substantia nigra, then, begins movement and the globus pallidus blocks it.

This complicated circuit can be disrupted at several points. For instance, loss of substantia nigra cells,

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as in Parkinson's disease, increases blocking of the thalamic nuclei, preventing them from sending signals to the motor cortex. The result is a loss of movement (motor activity), a characteristic of Parkinson's.

In contrast, cell loss in early Huntington's disease decreases blocking of signals from the thalamic nuclei, causing more cortex stimulation and stronger but uncontrolled movements.

Disruptions in other portions of the basal ganglia are thought to cause tics, **tremors**, dystonia, and a variety of other movement disorders, although the exact mechanisms are not well understood.

Some movement disorders, including Huntington's disease and inherited ataxias, are caused by inherited genetic defects. Some disease that cause sustained muscle contraction limited to a particular muscle group (focal dystonia) are inherited, but others are caused by trauma. The cause of most cases of Parkinson's disease is unknown, although genes have been found for some familial forms.

Symptoms

Abnormal movements are broadly classified as either hyperkinetic—too much movement—and hypokinetic—too little movement. Hyperkinetic movements include:

- Dystonia. Sustained muscle contractions, often causing twisting or repetitive movements and abnormal postures. Dystonia may be limited to one area (focal) or may affect the whole body (general). Focal dystonias may affect the neck (cervical dystonia or torticollis), the face (one–sided or hemifacial spasm, contraction of the eyelid or blepharospasm, contraction of the mouth and jaw or oromandibular dystonia, simultaneous spasm of the chin and eyelid or Meige syndrome), the vocal cords (laryngeal dystonia), or the arms and legs (writer's cramp, occupational cramps). Dystonia may be painful as well as incapacitating.
- Tremor. Uncontrollable (involuntary) shaking of a body part. Tremor may occur only when muscles are relaxed or it may occur only during an action or holding an active posture.
- Tics. Involuntary, rapid, nonrhythmic movement or sound. Tics can be controlled briefly.
- Myoclonus. A sudden, shock–like muscle contraction. Myoclonic jerks may occur singly or repetitively. Unlike tics, myoclonus cannot be controlled even briefly.
- Chorea. Rapid, nonrhythmic, usually jerky movements, most often in the arms and legs.
- Ballism. Like chorea, but the movements are much larger, more explosive and involve more of the arm or leg. This condition, also called ballismus, can occur on both sides of the body or on one side only (hemiballismus).
- Akathisia. Restlessness and a desire to move to relieve uncomfortable sensations. Sensations may include a feeling of crawling, itching, stretching, or creeping, usually in the legs.
- Athetosis. Slow, writhing, continuous, uncontrollable movement of the arms and legs.

Hypokinetic movements include:

- Bradykinesia. Slowness of movement.
- Freezing. Inability to begin a movement or involuntary stopping of a movement before it is completed.
- Rigidity. An increase in muscle tension when an arm or leg is moved by an outside force.
- Postural instability. Loss of ability to maintain upright posture caused by slow or absent righting reflexes.

Diagnosis

Diagnosis of movement disorders requires a careful medical history and a thorough physical and neurological examination. Brain imaging studies are usually performed. Imaging techniques include computed tomography scan (CT scan), **positron emission tomography (PET)**, or **magnetic resonance imaging** (MRI) scans. Routine blood and urine analyses are performed. A **lumbar puncture** (spinal tap) may be necessary. Video recording of the abnormal movement is often used to analyze movement patterns and to track progress of the disorder and its treatment. **Genetic testing** is available for some forms of movement disorders.

Treatment

Treatment of a movement disorder begins with determining its cause. Physical and **occupational therapy** may help make up for lost control and strength. Drug therapy can help compensate for some imbalances of the basal ganglionic circuit. For instance, levodopa (L–dopa) or related compounds can substitute for lost dopamine–producing cells in Parkinson's disease. Conversely, blocking normal dopamine action is a possible treatment in some hyperkinetic disorders, including tics. Oral medications can also help reduce overall muscle tone. Local injections of botulinum toxin can selectively weaken overactive muscles in dystonia and spasticity. Destruction of peripheral nerves through injection of phenol can reduce spasticity. All of these treatments may have some side effects.

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KEY TERMS

Botulinum toxin—Any of a group of potent bacterial toxins or poisons produced by different strains of the bacterium *Clostridium botulinum*. The toxins cause muscle paralysis, and thus force the relaxation of a muscle in spasm.

Cerebral palsy—A movement disorder caused by a permanent brain defect or injury present at birth or shortly after. It is frequently associated with premature birth. Cerebral palsy is not progressive.

Computed tomography (CT)—An imaging technique in which cross–sectional x rays of the body are compiled to create a three–dimensional image of the body's internal structures.

Encephalopathy—An abnormality in the structure or function of tissues of the brain.

Essential tremor—An uncontrollable (involuntary) shaking of the hands, head, and face. Also called familial tremor because it is sometimes inherited, it can begin in the teens or in middle age. The exact cause is not known.

Fetal tissue transplantation—A method of treating Parkinson's and other neurological diseases by grafting brain cells from human fetuses onto the basal ganglia. Human adults cannot grow new brain cells but developing fetuses can. Grafting fetal tissue stimulates the growth of new brain cells in affected adult brains.

Hereditary ataxia—One of a group of hereditary degenerative diseases of the spinal cord or cerebellum. These diseases cause tremor, spasm, and wasting of muscle.

Huntington's disease—A rare hereditary condition that causes progressive chorea (jerky muscle movements) and mental deterioration that ends in dementia. Huntington's symptoms usually appear in patients in their 40s. There is no effective treatment.

Levodopa (L–dopa)—A substance used in the treatment of Parkinson's disease. Levodopa can cross the blood–brain barrier that protects the brain. Once in the brain, it is converted to dopamine and thus can replace the dopamine lost in Parkinson's disease.

Magnetic resonance imaging (MRI)—An imaging technique that uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

Parkinson's disease—A slowly progressive disease that destroys nerve cells in the basal ganglia and thus causes loss of dopamine, a chemical that aids in transmission of nerve signals (neurotransmitter). Parkinson's is characterized by shaking in resting muscles, a stooping posture, slurred speech, muscular stiffness, and weakness.

Positron emission tomography (PET)—A diagnostic technique in which computer–assisted x rays are used to track a radioactive substance inside a patient's body. PET can be used to study the biochemical activity of the brain.

Progressive supranuclear palsy—A rare disease that gradually destroys nerve cells in the parts of the brain that control eye movements, breathing, and muscle coordination. The loss of nerve cells causes palsy, or paralysis, that slowly gets worse as the disease progresses. The palsy affects ability to move the eyes, relax the muscles, and control balance.

Restless legs syndrome—A condition that causes an annoying feeling of tiredness, uneasiness, and itching deep within the muscle of the leg. It is accompanied by twitching and sometimes pain. The only relief is in walking or moving the legs.

Tourette syndrome—An abnormal condition that causes uncontrollable facial grimaces and tics and arm and shoulder movements. Tourette syndrome is perhaps best known for uncontrollable vocal tics that include grunts, shouts, and use of obscene language (coprolalia).

Wilson's disease—An inborn defect of copper metabolism in which free copper may be deposited in a variety of areas of the body. Deposits in the brain can cause tremor and other symptoms of Parkinson's disease.

Surgical destruction or inactivation of basal ganglionic circuits has proven effective for Parkinson's disease and is being tested for other movement disorders. Transplantation of fetal cells into the basal ganglia has produced mixed results in Parkinson's disease.

Alternative treatment

There are several alternative therapies that can be useful when treating movement disorders. The progress made will depend on the individual and his/her

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condition. Among the therapies that may be helpful are **acupuncture**, homeopathy, touch therapies, postural alignment therapies, and **biofeedback**.

Prognosis

The prognosis for a patient with a movement disorder depends on the specific disorder.

Prevention

Prevention depends on the specific disorder.

Resources

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Wyborny, Sheila. *Tourette Syndrome*. San Diego, CA, 2010.

ORGANIZATIONS

American Academy of Neurology , 1080 Montreal Ave., Saint Paul, MN, 55116, (800) 879–1960, http://www.aan.com.

American Academy of Physical Medicine and Rehabilitation , 9700 West Bryn Mawr Ave., Suite 200, Rosemont, IL, 60018–5701, 847–737–6000, http://www.aapmr.org.

American Physical Therapy Association, 1111 North Fairfax St., Alexandria, VA, 22314–1488, (703) 684–APTA (2782). TDD: (703) 683–6748, (800) 999–APTA (2782), http://www.apta.org.

The Movement Disorder Society , 555 East Wells St., Suite 1100 , Milwaukee, WI, 53202–3823 , (414) 276–2145, http://www.movementdisorders.org/.

Worldwide Education and Awareness for Movement Disorders, One Gustave L. Levy Pl., PO Box 1052, New York, NY, 10029, (800) 437–6683, http://www.wemove.org.

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Movement therapy

Definition

Movement therapy refers to a broad range of Eastern and Western movement approaches used to promote physical, mental, emotional, and spiritual well-being.

Purpose

The physical benefits of movement therapy include greater ease and range of movement, increased balance, strength and flexibility, improved muscle tone and coordination, joint resiliency, cardiovascular conditioning, enhanced athletic performance, stimulation of circulation, prevention of injuries, greater longevity, **pain** relief, and relief of rheumatic, neurological, spinal, **stress**, and respiratory disorders. Movement therapy can also be used as a **meditation** practice to quiet the mind, foster self-knowledge, and increase awareness. In addition, movement therapy is beneficial in alleviating emotional distress that is expressed through the body. These conditions include **eating disorders**, excessive clinging, and **anxiety** attacks. Since movements are related to thoughts and feelings, movement therapy can also bring about changes in attitude and emotions. People report an increase in self-esteem and self-image. Communication skills can be enhanced and tolerance of others increased. The physical openness facilitated by movement therapy leads to greater emotional openness and creativity.

Description

Origins

Movement is fundamental to human life. In fact movement is life. Contemporary physics tells us that the universe and everything in it is in constant motion. We can move our body and at the most basic level our body is movement. According to the somatic educator Thomas Hanna, "The living body is a moving body—indeed, it is a constantly moving body." The poet and philosopher Alan Watts eloquently states a similar view, "A living body is not a fixed thing but a flowing event, like a flame or a whirlpool." Centuries earlier, the great Western philosopher Socrates understood what modern physics has proven, "The universe is motion and nothing else."

Since the beginning of time, indigenous societies around the world have used movement and dance for individual and community healing. Movement and song were used for personal healing, to create community, to ensure successful crops, and to promote fertility. Movement is still an essential part of many healing traditions and practices throughout the world.

Western movement therapies generally developed out of the realm of dance. Many of these movement approaches were created by former dancers or choreographers who were searching for a way to prevent injury, attempting to recover from an injury, or who were curious about the effects of new ways of moving.

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Some movement therapies arose out of the fields of **physical therapy**, psychology, and bodywork. Other movement therapies were developed as way to treat an incurable disease or condition.

Eastern movement therapies, such as **yoga**, **qigong**, and t'ai chi began as a spiritual or self-defense practices and evolved into healing therapies. In China, for example, Taoist monks learned to use specific breathing and movement patterns in order to promote mental clarity, physical strength, and support their practice of meditation. These practices, later known as qigong and t'ai chi eventually became recognized as ways to increase health and prolong life.

There are countless approaches to movement therapy. Some approaches emphasize awareness and attention to inner sensations. Other approaches use movement as a form of **psychotherapy**, expressing and working through deep emotional issues. Some approaches emphasize alignment with gravity and specific movement sequences, while other approaches encourage spontaneous movement. Some approaches are primarily concerned with increasing the ease and efficiency of bodily movement. Other approaches address the reality of the body "as movement" instead of the body as only something that runs or walks through space.

The term movement therapy is often associated with dance therapy. Some dance therapists work privately with people who are interested in personal growth. Others work in mental health settings with autistic, brain injured and learning disabled children, the elderly, and disabled adults.

Laban movement analysis (LMA), formerly known as Effort-Shape is a comprehensive system for discriminating, describing, analyzing, and categorizing movements. LMA can be applied to dance, athletic coaching, fitness, acting, psychotherapy, and a variety of other professions. Certified movement analysts can "observe recurring patterns, note movement preferences, asses physical blocks and dysfunctional movement patterns, and the suggest new movement patterns." As a student of Rudolf Laban, Irmgard Bartenieff developed his form of movement analysis into a system of body training or reeducation called Bartenieff fundamentals (BF). The basic premise of this work is that once the student experiences a physical foundation, emotional, and intellectual expression become richer. BF uses specific exercises that are practiced on the floor, sitting, or standing to engage the deeper muscles of the body and enable a greater range of movement.

Authentic movement (AM) is based upon Mary Starks Whitehouse's understanding of dance, movement, and depth psychology. There is no movement instruction in AM, simply a mover and a witness. The mover waits and listens for an impulse to move and then follows or "moves with" the spontaneous movements that arise. These movements may or may not be visible to the witness. The movements may be in response to an emotion, a dream, a thought, pain, joy, or whatever is being experienced in the moment. The witness serves as a compassionate, non judgmental mirror and brings a "special quality of attention or presence." At the end of the session the mover and witness speak about their experiences together. AM is a powerful approach for self development and awareness and provides access to preverbal memories, creative ideas, and unconscious movement patterns that limit growth.

Gabrielle Roth (5 Rhythms movement) and Anna Halprin have both developed dynamic movement practices that emphasize personal growth, awareness, expression, and community. Although fundamentally different forms, each of these movement/dance approaches recognize and encourage our inherent desire for movement.

Several forms of movement therapy grew out of specific bodywork modalities. **Rolfing** movement integration (RMI) and Rolfing rhythms are movement forms which reinforce and help to integrate the structural body changes brought about by the hands-on work of Rolfing (structural integration). RMI uses a combination of touch and verbal directions to help develop greater awareness of one's vertical alignment and habitual movement patterns. RMI teacher Mary Bond says, "The premise of Rolfing Movement Integration... is that you can restore your structure to balance by changing the movement habits that perpetuate imbalance." Rolfing rhythms is a series of lively exercises designed to encourage awareness of the Rolfing principles of ease, length, balance, and harmony with gravity.

The movement education component of **Aston-Patterning** bodywork is called neurokinetics. This movement therapy teaches ways of moving with greater ease throughout every day activities. These movement patterns can also be used to release tension in the body. Aston fitness is an **exercise** program which includes warm-up techniques, exercises to increase muscle tone and stability, stretching, and cardiovascular fitness.

Rosen method movement (an adjunct to Rosen method bodywork) consists of simple fun movement exercises done to music in a group setting. Through gentle swinging, bouncing, and stretching every joint in the body experiences a full range of movement. The movements help to increase balance and rhythm and create more space for effortless breathing.

The movement form of **Trager psychophysical integration** bodywork, Mentastics, consists of fun, easy swinging, shaking, and stretching movements.

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These movements, developed by Dr. Milton Trager, create an experience of lightness and freedom in the body, allowing for greater ease in movement. Trager also worked successfully with **polio** patients.

Awareness through movement, the movement therapy form of the **Feldenkrais method**, consists of specific structured movement experiences taught as a group lesson. These lessons reeducate the brain without tiring the muscles. Most lessons are done lying down on the floor or sitting. Moshe Feldenkrais designed the lessons to "improve ability ... turn the impossible into the possible, the difficult into the easy, and the easy into the pleasant."

Ideokinesis is another movement approach emphasizing neuromuscular reeducation. Lulu Sweigart based her work on the pioneering approach of her teacher Mabel Elsworth Todd. Ideokinesis uses imagery to train the nervous system to stimulate the right muscles for the intended movement. If one continues to give the nervous system a clear mental picture of the movement intended, it will automatically select the best way to perform the movement. For example, to enhance balance in standing, Sweigart taught people to visualize "lines of movement" traveling through their bodies. Sweigart did not train teachers in ideokinesis but some individuals use ideokinetic imagery in the process of teaching movement.

The Mensendieck system of functional movement techniques is both corrective and preventative. Bess Mensendieck, a medical doctor, developed a series of exercises to reshape, rebuild, and revitalize the body. A student of this approach learns to use the conscious will to relax muscles and releases tension. There are more than 200 exercises that emphasize correct and graceful body movement through everyday activities. Unlike other movement therapy approaches this work is done undressed or in a bikini bottom, in front of mirrors. This allows the student to observe and feel where a movement originates. Success has been reported with many conditions including Parkinson's disease, muscle and joint injuries, and repetitive strain injuries.

The **Alexander technique** is another functional approach to movement therapy. In this approach a teacher gently uses hands and verbal directions to subtly guide the student through movements such as sitting, standing up, bending and walking. The Alexander technique emphasizes balance in the neck-head relationship. A teacher lightly steers the students head into the proper balance on the tip of the spine while the student is moving in ordinary ways. The student learns to respond to movement demands with the whole body, in a light integrated way. This approach to movement is particularly popular with actors and other performers.

Pilates or physical mind method is also popular with actors, dancers, athletes, and a broad range of other people. Pilates consists of over 500 exercises done on the floor or primarily with customized exercise equipment. The exercises combine sensory awareness and physical training. Students learn to move from a stable, central core. The exercises promote strength, flexibility, and balance. Pilates training is increasingly available in sports medicine clinics, fitness centers, dance schools, spas, and physical therapy offices.

Many approaches to movement therapy emphasize awareness of internal sensations. Charlotte Selver, a student of somatic pioneer Elsa Gindler, calls her style of teaching sensory awareness (SA). This approach has influenced the thinking of many innovators, including Fritz Perls, who developed **gestalt therapy**. Rather than suggesting a series of structured movements, visualizations, or body positions, in SA the teacher outlines experiments in which one can become aware of the sensations involved in any movement. A teacher might ask the student to feel the movement of her breathing while running, sitting, picking up a book, etc. This close attunement to inner sensory experience encourages an experience of body-mind unity in which breathing becomes less restricted and posture, coordination, flexibility, and balance are improved. There may also be the experience of increased energy and aliveness.

Gerda Alexander Eutony (GAE) is another movement therapy approach that is based upon internal awareness. Through GAE one becomes a master of self-sensing and knowing which includes becoming sensitive to the external environment, as well. For example, while lying on the floor sensing the breath, skin or form of the body, one also senses the connection with the ground. GAE is taught in group classes or private lessons which also include hands-on therapy. In 1987, after two years of observation in clinics throughout the world, GAE became the first mind-body discipline accepted by the World Health Organization (WHO) as an alternative health-care technique.

Kinetic awareness developed by dancer-choreographer Elaine Summers, emphasizes emotional and physical inquiry. Privately or in a group, a teacher sets up situations for the student to explore the possible causes of pain and movement restrictions within the body. Rubber balls of various sizes are used as props to focus attention inward, support the body in a stretched position and massage a specific area of the body. The work helps one to deal with chronic pain, move easily again after injuries and increase energy, flexibility, coordination, and comfort.

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Body-mind centering (BMC) was developed by Bonnie Bainbridge Cohen and is a comprehensive educational and therapeutic approach to movement. BMC practitioners use movement, touch, **guided imagery**, developmental repatterning, dialogue, music, large balls, and other props in an individual session to meet the needs of each person. BMC encourages people to develop a sensate awareness and experience of the ligaments, nerves, muscles, skin, fluids, organs, glands, fat, and fascia that make up one's body. It has been effective in preventing and rehabilitating from chronic injuries and in improving neuromuscular response in children with **cerebral palsy** and other neurological disorders.

Continuum movement has also been shown to be effective in treating neurological disorders including spinal chord injury. Developed by Emilie Conrad and Susan Harper, continuum movement is an inquiry into the creative flux of our body and all of life. Sound, breath, subtle and dynamic movements are explored that stimulate the brain and increase resonance with the fluid world of movement. The emphasis is upon unpredictable, spontaneous or spiral movements rather than a linear movement pattern. According to Conrad, "Awareness changes how we physically move. As we become more fluid and resilient so do the mental, emotional, and spiritual movements of our lives."

Eastern movement therapies such as yoga, t'ai chi, and qigong are also effective in healing and preventing a wide range of physical disorders, encouraging emotional stability, and enhancing spiritual awareness. There are a number of different approaches to yoga. Some emphasize the development of physical strength, flexibility, and alignment. Other forms of yoga emphasize inner awareness, opening, and meditation.

Precautions

People with acute injuries and chronic physical and mental conditions need to be careful when choosing a form of movement therapy. It is best to consult with a knowledgeable physician, physical therapist, or mental health therapist.

A special form of movement therapy known as constraint-induced movement therapy, or CIMT, is being used as of the early 2000s to rehabilitate the upper limbs of patients who have suffered a **stroke**, traumatic brain injury, or damage to the spinal cord. In CIMT, the arm that has been less affected by the injury is constrained by a sling for 90% of the patient's waking hours for a period of two weeks. The sling forces the patient to use the weaker arm more often; in addition, a physical therapist works with the patient to practice repetitive motions with the weaker arm. CIMT also appears to be useful in treating children with muscular weakness on one side of the body caused by cerebral palsy.

Research and general acceptance

Although research has documented the beneficial effects of dance therapy, qigong, t'ai chi, yoga, Alexander technique, awareness through movement (Feldenkrais), and Rolfing, other forms of movement therapy have not been as thoroughly researched.

CIMT has become widely accepted in **rehabilitation** medicine since its introduction in the mid-1990s, although some doctors still consider it experimental. Further research in CIMT is being carried out by the National Institute of Neurological Disorders and Stroke (NINDS), one of the National Institutes of Health.

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Linda Chrisman
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Mpell disease *see* **Ankylosing spondylitis**
MR *see* **Magnetic resonance imaging**
MRI *see* **Magnetic resonance imaging**

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MRSA infections

Definition

Methicillin–resistant *Staphylococcus aureus* (MRSA) infections are caused by a strain of staphylococcus bacterium that often does not respond to most classes of **antibiotics**.

Description

MRSA belongs to the emerging category of multidrug–resistant organisms (MDROs). These organisms are mostly disease–causing (pathogenic) bacteria that are resistant to one or more classes of antimicrobial agents. Methicillin is an antibiotic that has been used successfully to treat infections caused by *Staphylococcus aureus*, commonly known as "staph" infections. Staph bacteria are found on the skin and in the nose of approximately 33% of the general population. These staph bacteria are generally harmless unless they enter the body through a cut or other wound. If this happens, they often only cause minor skin infections in healthy people, or infections easily treated with antibiotics. Over the years however, the staph bacterium has mutated into MRSA, a strain that is resistant to methicillin and other antibiotics such as oxacillin, penicillin, and amoxicillin, meaning that these antibiotics are unable to clear the infections. MRSA infections have become a serious health issue, because they have a higher rate of fatalities.

There are two types of MRSA infections. The first is called "Healthcare–associated MRSA" (HA–MRSA) and it affects persons and patients admitted to hospitals and healthcare facilities such as nursing homes and dialysis centers. The second type is called "Community–associated MRSA" (CA–MRSA) and affects people who have not been hospitalized or had a medical procedure during the year before onset of infection. Individuals commonly affected by CA–MRSA include people involved in close–contact sports and activities, such as football players and wrestlers.

Demographics

MRSA was first isolated in the United States in 1968. By the early 1990s, MRSA accounted for 20%–25% of staph infections in hospitalized patients. In 2005, MRSA caused more than 94,000 life–threatening infections and approximately 18,650 deaths in the United States, most of them associated with hospitals, according to a Centers for Disease Control (CDC) report. The study found that about 85% of all invasive MRSA infections were associated with health care settings, of which two–thirds occurred in people who were hospitalized, underwent a medical procedure, or resided in a long–term care facility within the previous year. In contrast, about 15% of reported cases were considered to be CA–MRSA infections, meaning that MRSA infection occurred in people without documented exposures to healthcare. The infection rates were highest among people 65 years of age or older. African Americans were affected at twice the rate of whites, which could be due their higher rates of chronic illness.

Causes and symptoms

MRSA infections are caused by methicillin–resistant *Staphylococcus aureus*. The spread of MRSA infections however, is a consequence of:

- Unnecessary antibiotic use. MRSA infections are linked to years of unnecessary antibiotic use. Antibiotics are commonly prescribed for colds, flu, and other viral infections that do not respond to these drugs, as well as for simple bacterial infections that should normally clear on their own. Unfortunately, antibiotics promote the emergence of drug–resistant bacteria because they can't destroy all bacteria. Some bacteria survive treatment with one antibiotic and learn to resist by mutating. Often, a mutation against one antibiotic is often successful against other antibiotics.
- Presence of antibiotics in the food chain. In the Unites States, antibiotics are routinely given to cows, beef cattle, pigs, and chickens with the consequence that people often take them unknowingly in their food, as in milk or meats. Antibiotics can also find their way into drinking water systems when the runoff from animal feedlots contaminates streams and groundwater.
- Poor hygiene. The main mode of HA–MRSA transmission to other patients is through human hands, especially those of healthcare workers and patients sharing facilities. Hands may become contaminated with MRSA bacteria by contact with infected patients or with environmental surfaces in close proximity to the patient. The bacteria can then spread when a healthcare worker or patient touches other patients.

Symptoms of MRSA infections are variable. Skin infections usually cause pimples or **boils** that can be swollen, painful, and drain pus. They can quickly turn into deep, painful abscesses and can cause potentially life–threatening infections in bones, joints, surgical **wounds**, the bloodstream, heart valves, and lungs. Symptoms of serious MRSA infection may include:

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- Rash
- Shortness of breath
- Fever, chills
- Chest pain
- Muscle aches
- Headache

Diagnosis

MRSA is diagnosed by testing a tissue sample or nasal secretions for signs of staph bacteria. The sample is sent to a lab where it is incubated in a dish of nutrients that promote the growth of staph colonies which can then be identified.

In January 2008, the U.S. Food and Drug Administration (FDA) cleared for marketing the first rapid blood test for MRSA. It is called the "BD GeneOhm StaphSR Assay" and it uses molecular methods to identify whether a blood sample contains genetic material from the MRSA bacterium or the more common, less dangerous staph bacterium that can still be treated with methicillin. Rather than waiting more than two days for test results, health care personnel are now able to identify the source of a staph infection in only two hours, allowing for more effective treatment.

Treatment

Options for treating patients with MRSA infections are often extremely limited. Both HA and CA–MRSA still respond to certain antibiotics. In hospitals and care facilities, treatment generally relies on the antibiotic vancomycin. For serious infections, this antibiotic is administered intravenously, often for several weeks. CA–MRSA may be treated with vancomycin or other antibiotics that have proved effective against particular strains. However, vancomycin is also growing resistant with some hospitals reporting vancomycin–resistant *Staphylococcus aureus* (VRSA) infections. There are a limited number of antibiotics available to treat infections caused by VRSA and there is growing concern in the medical community that we will eventually run out of antibiotic–based treatment options, because *Staphylococcus aureus* seems to be mutating as fast as antibiotics are being developed. Increasingly, physicians are selecting to surgically drain abscesses caused by MRSA rather than prescribe antibiotics. For mild to moderate MRSA skin infections, incision and drainage by a healthcare provider has become the first–line treatment.

Alternative treatment

There are no alternatives to using antibiotics that are efficient or treatments that avoid them, such as **abscess** drainage.

Prognosis

The prognosis for MRSA infections varies with the type and severity of the infection, and the general health condition of the person who has the infection. MRSA **pneumonia** and blood poisoning have high documented **death** rates. Mild CA–MRSA infections that are appropriately treated result in recovery in almost all cases.

Prevention

In the United States, national efforts are underway to raise public awareness about MRSA and to encourage preventive measures such as washing hands and general clean hygiene. As a general rule, people should:

- Wash hands frequently with soap and water. Hands should be scrubbed briskly for 15 seconds, then dried with a disposable towel, also used to turn off the faucet in a public setting.
- Carry small bottles of alcohol–based hand sanitizer for use when there is no access to soap and water.
- Avoid sharing personal items such as towels, sheets, razors, clothing, and athletic equipment.
- Keep cuts and wounds clean and covered with sterile, dry bandages until they are closed and healed.
- Avoid contact with other people's wounds.
- Wash towels and bed linens in a washing machine using the hot water setting preferably with bleach and dry in a hot dryer.
- In case of skin infection, ask the care provider for a MRSA test, so as to avoid being prescribed drugs that are not effective.
- If prescribed an antibiotic course, it should be completed, even if the infection seems to be clearing.

In a health care clinic or hospital setting, people and patients can ask caregivers to:

- Wash their hands or use an alcohol–based hand sanitizer before being touched or examined.
- Wash their own hands frequently with soap and water.
- Ensure that intravenous tubes and catheters are inserted under sterile conditions.

However, it is now recognized that measures limited to hand washing will not prevent the spread of

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KEY TERMS

Abscess—Localized collection of pus in any part of the body that is surrounded by swelling.

Antibiotic—A drug used to treat infections caused by bacteria and other microorganisms.

Antibiotic–resistant—Microorganisms that continue to multiply although exposed to antibiotics.

Antimicrobial agent—A substance that kills microorganisms such as bacteria or mold, or stops them from growing and causing disease.

Bacterium—A single–celled microorganism that can be seen only through a microscope. Many bacteria cause disease.

Boil—A collection of pus localized deep in the skin.

Immune system—The integrated body system of organs, tissues, cells, and cell products such as antibodies that protects the body from foreign organisms or substances.

Multidrug–resistant organisms (MDROs)—Bacteria that are resistant to one or more classes of antimicrobial agents and usually are resistant to all but one or two commercially available antimicrobial agents.

Mutation—A change in hereditary material of an organism that can improve its chance of surviving and passing the beneficial change on to its offspring.

Pathogen—A disease–causing microorganism.

Pus—A generally viscous, yellowish–white fluid formed in infected tissue, consisting of white blood cells, cellular debris, and dead tissue.

MRSA and other MDROs. Health care facilities are now developing strategies to counter the spread of HA–MRSA. One proposed strategy that may control the spread of infection includes active surveillance for the detection of MRSA in patients admitted to intensive care units and other high–risk care areas. Another approach would be to screen all patients admitted to a health care facility.

Other strategies involve the reengineering of health care settings. For example, a recent clinical trial sponsored by the Canadian Institutes of Health Research (CIHR) is studying how engineering controls affect the acquisition and transmission of pathogenic organisms in a hospital environment. The trial involves a group of patients admitted to a hospital ward with novel **infection control** design features such as abundance of sinks, predominance of private rooms, absence of shared bathrooms/curtains, etc. compared to a group of patients admitted to a conventional ward. The study, started in 2008, aims to compare MRSA (and other MDRO) infection rates in both groups to identify which design factors are most important in pathogen transmission. In the United States, the Healthcare Infection Control Practices Advisory Committee reports that successful control of MDROs has been documented in the United States and abroad using a variety of combined interventions such as:

- Maintaining staffing levels appropriate in health care facilities for the required level of care.
- Providing the necessary number and appropriate placement of hand–washing sinks and alcohol–containing hand rub dispensers in the facility.
- Health care provider education to improve understanding of the MDRO problem.
- Surveillance control programs to detect newly emerging pathogens.
- Increased cleaning and disinfection of frequently touched surfaces (e.g., bedrails, charts, bedside commodes, doorknobs) in hospital settings.

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ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

National Institute of Allergies and Infectious Diseases, 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-6612, (301) 496-5717, (301) 402-3573, (866) 284-4107, ocpostoffice@niaid.nih.gov, http://www.niaid.nih.gov.

Monique Laberge, PhD

MS *see* **Multiple sclerosis**

M's disease *see* **Waldenström's macroglobulinemia**

Mucopolysaccharidoses

Definition

Mucopolysaccharidosis (MPS) is a general term for a number of inherited diseases that are caused by the accumulation of mucopolysaccharides, resulting in problems with an individual's development. With each condition, mucopolysaccharides accumulate in the cells and tissues of the body because of a deficiency of a specific enzyme. The specific enzyme that is deficient or absent is what distinguishes one type of MPS from another. However, before these enzymes were identified, the MPS disorders were diagnosed by the signs and symptoms that an individual expressed. The discovery of these enzymes resulted in a reclassification of some of the MPS disorders. These conditions are often referred to as MPS I, MPS II, MPS III, MPS IV, MPS VI, MPS VII, and MPS IX. However, these conditions are also referred to by their original names, which are Hurler, Hurler-Scheie, Scheie (all MPS I), Hunter (MPS II), Sanfilippo (MPS III), Morquio (MPS IV), Maroteaux-Lamy (MPS VI), Sly (MPS VII), and Hyaluronidase deficiency (MPS IX).

Description

Mucopolysaccharides are long chains of sugar molecules that are essential for building the bones, cartilage, skin, tendons, and other tissues in the body. Normally, the human body continuously breaks down and builds mucopolysaccharides. Another name for mucopolysaccharides is glycosaminoglycans (GAGs). There are many different types of GAGs and specific GAGs are unable to be broken down in each of the MPS conditions. There are several enzymes involved in breaking down each GAG and a deficiency or absence of any of the essential enzymes can cause the GAG to not be broken down completely and result in its accumulation in the tissues and organs in the body. In some MPS conditions, in addition to the GAG being stored in the body, some of the incompletely broken down GAGs can leave the body via the urine. When too much GAG is stored, organs and tissues can be damaged or not function properly.

Genetic profile

Except for MPS II, the MPS conditions are inherited in an autosomal recessive manner. MPS conditions occur when both of an individual's genes that produce the specific enzyme contain a mutation, causing them to not work properly. When both genes do not work properly, either none or a reduced amount of the enzyme is produced. An individual with an autosomal

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recessive condition inherits one of those non-working genes from each parent. These parents are called "carriers" of the condition. When two people are known carriers for an autosomal recessive condition, they have a 25% chance with each **pregnancy** to have a child affected with the disease. Some individuals with MPS do have children of their own. Children of parents who have an autosomal recessive condition are all carriers of that condition. These children are not at risk to develop the condition unless the other parent is a carrier or affected with the same autosomal recessive condition.

Unlike the other MPS conditions, MPS II is inherited in an X-linked recessive manner. This means that the gene causing the condition is located on the X chromosome, one of the two sex chromosomes. Since a male has only one X chromosome, he will have the disease if the X chromosome inherited from his mother carries the defective gene. Females, because they have two X chromosomes, are called "carriers" of the condition if only one of their X chromosomes has the gene that causes the condition, while the other X chromosome does not.

Causes and symptoms

Each type of MPS is caused by a deficiency of one of the enzymes involved in breaking down GAGs. It is the accumulation of the GAGs in the tissues and organs in the body that cause the wide array of symptoms characteristic of the MPS conditions. The accumulating material is stored in cellular structures called lysosomes, and these disorders are also known as lysosomal storage diseases.

MPS I

MPS I is caused by a deficiency of the enzyme alpha-L-iduronidase. Three conditions, Hurler, Hurler-Scheie, and Scheie syndromes, all are caused by a deficiency of this enzyme. Initially, these three conditions were felt to be separate because each were associated with different physical symptoms and prognoses. However, once the underlying cause of these conditions was identified, it was realized that these three conditions were all variants of the same disorder. The gene involved with MPS I is located on chromosome 4p16.3.

MPS I H (HURLER SYNDROME). It has been estimated that approximately one baby in 100,000 will be born with Hurler syndrome. Individuals with Hurler syndrome tend to have the most severe form of MPS I. Symptoms of Hurler syndrome are often evident within the first year or two after birth. Often these infants begin to develop as expected, but then reach a point where they begin to lose the skills that they have learned. Many of these infants may initially grow faster than expected, but their growth slows and typically stops by age three. Facial features also begin to appear "coarse." They develop a short nose, flatter face, thicker skin, and a protruding tongue. Additionally, their heads become larger and they develop more hair on their bodies with the hair becoming coarser. Their bones are also affected, with these children usually developing joint **contractures** (stiff joints), **kyphosis** (a specific type of curve to the spine), and broad hands with short fingers. Many of these children experience breathing difficulties, and respiratory infections are common. Other common problems include heart valve dysfunction, thickening of the heart muscle (**cardiomyopathy**), enlarged spleen and liver, clouding of the cornea, **hearing loss**, and **carpal tunnel syndrome**. These children typically do not live past age 12.

MPS I H/S (HURLER-SCHEIE SYNDROME). Hurler-Scheie syndrome is felt to be the intermediate form of MPS I, meaning that the symptoms are not as severe as those in individuals who have MPS I H but not as mild as those in MPS I S. Approximately one baby in 115,000 will be born with Hurler-Scheie syndrome. These individuals tend to be shorter than expected, and they can have normal intelligence, however, some individuals with MPS I H/S will experience learning difficulties. These individuals may develop some of the same physical features as those with Hurler syndrome, but usually they are not as severe. The prognosis for children with MPS I H/S is variable with some individuals dying during childhood, while others living to adulthood.

MPS I S (SCHEIE SYNDROME). Scheie syndrome is considered the mild form of MPS I. It is estimated that approximately one baby in 500,000 will be born with Scheie syndrome. Individuals with MPS I S usually have normal intelligence, but there have been some reports of individuals with MPS I S developing psychiatric problems. Common physical problems include corneal clouding, heart abnormalities, and orthopedic difficulties involving their hands and back. Individuals with MPS I S do not develop the facial features seen with MPS I H and usually these individuals have a normal life span.

MPS II (Hunter syndrome)

Hunter syndrome is caused by a deficiency of the enzyme iduronate-2-sulphatase. All individuals with Hunter syndrome are male, because the gene that causes the condition is located on the X chromosome, specifically Xq28. Like many MPS conditions, Hunter syndrome is divided into two groups, mild and severe. It has been estimated that approximately 1 in 110,000 males are born with Hunter syndrome, with the severe

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form being three times more common than the mild form. The severe form is felt to be associated with progressive **mental retardation** and physical disability, with most individuals dying before age 15. In the milder form, most of these individuals live to adulthood and have normal intelligence or only mild mental impairments. Males with the mild form of Hunter syndrome develop physical differences similar to the males with the severe form, but not as quickly. Men with mild Hunter syndrome can have a normal life span and some have had children. Most males with Hunter syndrome develop joint stiffness, chronic **diarrhea**, enlarged liver and spleen, heart valve problems, hearing loss, kyphosis, and tend to be shorter than expected. These symptoms tend to progress at a different rate depending on if an individual has the mild or severe form of MPS II.

MPS III (Sanfilippo syndrome)

MPS III, like the other MPS conditions, was initially diagnosed by the individual having certain physical characteristics. It was later discovered that the physical symptoms associated with Sanfilippo syndrome could be caused by a deficiency in one of four enzymes. Each type of MPS III is now subdivided into four groups, labeled A-D, based on the specific enzyme that is deficient. All four of these enzymes are involved in breaking down the same GAG, heparan sulfate. Heparan sulfate is mainly found in the central nervous system and accumulates in the brain when it cannot be broken down because one of those four enzymes are deficient or missing.

MPS III is a variable condition with symptoms beginning to appear between ages two and six years of age. Because of the accumulation of heparan sulfate in the central nervous system, the central nervous system is severely affected. In MPS III, signs that the central nervous system is degenerating usually are evident in most individuals between ages six and 10. Many children with MPS III will develop seizures, sleeplessness, thicker skin, joint contractures, enlarged tongues, cardiomyopathy, behavior problems, and mental retardation. The life expectancy in MPS III is also variable. On average, individuals with MPS III live until they are teenagers, with some living longer and others not that long.

MPS IIIA (SANFILIPPO SYNDROME TYPE A). MPS IIIA is caused by a deficiency of the enzyme heparan N-sulfatase. Type IIIA is felt to be the most severe of the four types, in which symptoms appear and **death** occurs at an earlier age. A study in British Columbia estimated that one in 324,617 live births are born with MPS IIIA. MPS IIIA is the most common of the four types in Northwestern Europe. The gene that causes MPS IIIA is located on the long arm of chromosome 17 (location 17q25).

MPS IIIB (SANFILIPPO SYNDROME TYPE B). MPS IIIB is due to a deficiency in N-acetyl-alpha-D-glucosaminidase (NAG). This type of MPS III is not felt to be as severe as Type IIIA and the characteristics vary. Type IIIB is the most common of the four in southeastern Europe. The gene associated with MPS IIIB is also located on the long arm of chromosome 17 (location 17q21).

MPS IIIC (SANFILIPPO SYNDROME TYPE C). A deficiency in the enzyme acetyl-CoA-alpha-glucosaminide acetyltransferase causes MPS IIIC. This is considered a rare form of MPS III. The gene involved in MPS IIIC is believed to be located on chromosome 14.

MPS IIID (SANFILIPPO SYNDROME TYPE D). MPS IIID is caused by a deficiency in the enzyme N-acetylglucosamine-6-sulfatase. This form of MPS III is also rare. The gene involved in MPS IIID is located on the long arm of chromosome 12 (location 12q14).

MPS IV (Morquio syndrome)

As with several of the MPS disorders, Morquio syndrome was diagnosed by the presence of particular signs and symptoms. However, it is now known that the deficiency of two different enzymes can cause the characteristics of MPS IV. These two types of MPS IV are called MPS IV A and MPS IV B. MPS IV is also variable in its severity. The intelligence of individuals with MPS IV is often completely normal. In individuals with a severe form, skeletal abnormalities can be extreme and include dwarfism, kyphosis (backward-curved spine), prominent breastbone, flat feet, and knock-knees. One of the earliest symptoms seen in this condition usually is a difference in the way the child walks. In individuals with a mild form of MPS IV, limb stiffness, and joint **pain** are the primary symptoms. MPS IV is one of the rarest MPS disorders, with approximately one baby in 300,000 born with this condition.

MPS IV A (MORQUIO SYNDROME TYPE A). MPS IV A is the "classic" or the severe form of the condition and is caused by a deficiency in the enzyme galactosamine-6-sulphatase. The gene involved with MPS IV A is located on the long arm of chromosome 16 (location 16q24.3).

MPS IV B (MORQUIO SYNDROME TYPE B). MPS IV B is considered the milder form of the condition. The enzyme, beta-galactosidase, is deficient in MPS IV B. The location of the gene that produces beta-galactosidase is located on the short arm of chromosome 3 (location 3p21).

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KEY TERMS

Cardiomyopathy—A thickening of the heart muscle.

Enzyme—A protein that catalyzes a biochemical reaction or change without changing its own structure or function.

Joint contractures—Stiffness of the joints that prevents full extension.

Kyphosis—An abnormal outward curvature of the spine, with a hump at the upper back.

Lysosome—Membrane-enclosed compartment in cells, containing many hydrolytic enzymes; where large molecules and cellular components are broken down.

Mucopolysaccharide—A complex molecule made of smaller sugar molecules strung together to form a chain. Found in mucous secretions and intercellular spaces.

Recessive gene—A type of gene that is not expressed as a trait unless inherited by both parents.

X-linked gene—A gene carried on the X chromosome, one of the two sex chromosomes.

MPS VI (Maroteaux-Lamy syndrome)

MPS VI, which is another rare form of MPS, is caused by a deficiency of the enzyme N-acetylglucosamine-4-sulphatase. This condition is also variable; individuals may have a mild or severe form of the condition. Typically, the nervous system or intelligence of an individual with MPS VI is not affected. Individuals with a more severe form of MPS VI can have airway obstruction, develop **hydrocephalus** (extra fluid accumulating in the brain) and have bone changes. Additionally, individuals with a severe form of MPS VI are more likely to die while in their teens. With a milder form of the condition, individuals tend to be shorter than expected for their age, develop corneal clouding, and live longer. The gene involved in MPS VI is believed to be located on the long arm of chromosome 5 (approximate location 5q11-13).

MPS VII (Sly syndrome)

MPS VII is an extremely rare form of MPS and is caused by a deficiency of the enzyme beta-glucuronidase. It is also highly variable, but symptoms are generally similar to those seen in individuals with Hurler syndrome. The gene that causes MPS VII is located on the long arm of chromosome 7 (location 7q21).

MPS IX (Hyaluronidase deficiency)

MPS IX is a condition that was first described in 1996 and has been grouped with the other MPS conditions by some researchers. MPS IX is caused by the deficiency of the enzyme hyaluronidase. In the few individuals described with this condition, the symptoms are variable, but some develop soft-tissue masses (growths under the skin). Also, these individuals are shorter than expected for their age. The gene involved in MPS IX is believed to be located on the short arm of chromosome 3 (possibly 3p21.3-21.2)

Many individuals with an MPS condition have problems with airway constriction. This constriction may be so serious as to create significant difficulties in administering **general anesthesia**. Therefore, it is recommended that surgical procedures be performed under **local anesthesia** whenever possible.

Diagnosis

While a diagnosis for each type of MPS can be made on the basis of the physical signs described above, several of the conditions have similar features. Therefore, enzyme analysis is used to determine the specific MPS disorder. Enzyme analysis usually cannot accurately determine if an individual is a carrier for a MPS condition. This is because the enzyme levels in individuals who are not carriers overlaps the enzyme levels seen in those individuals who are carrier for a MPS. With many of the MPS conditions, several mutations have been found in each gene involved that can cause symptoms of each condition. If the specific mutation is known in a family, DNA analysis may be possible.

Once a couple has had a child with an MPS condition, prenatal diagnosis is available to them to help determine if a fetus is affected with the same MPS as their other child. This can be accomplished through testing samples using procedures such as an **amniocentesis** or **chorionic villus sampling** (CVS). Each of these procedures has its own risks, benefits, and limitations.

Treatment

There is no cure for mucopolysaccharidosis. There are several types of experimental therapies that are being investigated. Typically, treatment

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involves trying to relieve some of the symptoms. For MPS I and VI, **bone marrow transplantation** has been attempted as a treatment option. In those conditions, bone marrow transplantation has sometimes been found to help slow down the progression or reverse some of symptoms of the disorder in some children. The benefits of a bone marrow transplantation are more likely to be noticed when performed on children under two years of age. However it is not certain that a bone marrow transplant can prevent further damage to certain organs and tissues, including the brain. Furthermore, bone marrow transplantation is not felt to be helpful in some MPS disorders and there are risks, benefits, and limitations with this procedure. In 2000, ten individuals with MPS I received recombinant human alpha-L-iduronidase every week for one year. Those individuals showed an improvement with some of their symptoms. Additionally, there is ongoing research involving gene replacement therapy (the insertion of normal copies of a gene into the cells of patients whose gene copies are defective).

Prevention

No specific preventive measures are available for genetic diseases of this type. For some of the MPS diseases, biochemical tests are available that will identify healthy individuals who are carriers of the defective gene, allowing them to make informed reproductive decisions. There is also the availability of prenatal diagnosis for all MPS disease to detect affected fetuses.

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ORGANIZATIONS

Canadian Society for Mucopolysaccharide and Related Diseases, PO Box 30034, North Vancouver, Canada British Columbia, V7H 2Y8, (604) 924-5130, (604) 924-5131, (800) 667-1846, info@mpssociety.ca, http://www.mpssociety.ca.

National Endocrine and Metabolic Diseases Information Service, 6 Information Way, Bethesda, MD, 20892-3569, (703) 738-4829, (888) 828-0904, endoandmeta@info.niddk.nih.gov, http://endocrine.niddk.nih.gov.

The National Information Centre for Inherited Metabolic Diseases, The Quadrangle, Crewe Hall, Weston Rd., Cheshire, England, CW1-6UR, 440 (845) 241-2172, (800) 652-3181, fam.svcs@climb.org.uk, http://www.climb.org.uk.

National MPS Society, PO Box 14686 , Durham, NC, 27709-4686, (877) 677-1001, (919) 806-2055, info@mps society.org, http://www.mpssociety.org.

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923, (800) 999-6673, http://www.rarediseases.org.

Society for Mucopolysaccharide Diseases, MPS House, Repton Place, White Lion Road, Amersham, Buckinghamshire, UK, HP7 9LP, 440 (845) 389-9901, mps@mpssociety.co.uk, http://www.mpssociety.co.uk.

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Mucormycosis

Definition

Mucormycosis is a rare but often fatal disease caused by certain fungi. It is sometimes called zygomycosis or phycomycosis. Mucormycosis is an opportunistic infection that typically develops in patients with weakened immune systems, diabetes, kidney failure, organ transplants, or **chemotherapy** for **cancer**. It may also develop in patients receiving an iron chelating drug called desferrioxamine (Desferal) as treatment for acute iron **poisoning**.

Description

In the United States, mucormycosis is most likely to develop in the patient's nasal area or in the lungs; however, it may also develop on the skin or in the digestive tract. Gastrointestinal disease usually develops only in severely malnourished patients. Cutaneous mucormycosis is most likely to develop under occlusive surgical **dressings**. Occlusive dressings are intended to keep air out of incisions or other **wounds**, but they also trap body heat and moisture.

The incidence of the disease is difficult to evaluate because it is very rare; however, the rate seems to be increasing. One American cancer center reported in

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2000 that mucormycosis was found in 0.7% of patients at **autopsy** and in 20 patients per 100,000 admissions to the center. The most recent mortality statistics from the Centers for Disease Control and Prevention (CDC) indicate that a total of 22 Americans died from mucormycosis in 2001—1 from pulmonary mucormycosis, 5 from rhinocerebral mucormycosis, 2 from disseminated mucormycosis, and 14 from unspecified forms of the disease.

As far as is known, mucormycosis affects members of either sex and all races equally, although the pulmonary form of the disease is somewhat more common in men than in women. Mucormycosis may develop in patients in any age group, including newborns.

Rhinocerebral mucormycosis

Rhinocerebral mucormycosis is an infection of the nose, eyes, and brain. The fungus destroys the tissue of the nasal passages, sinuses, or hard palate, producing a black or pus-filled discharge and visible patches of dying tissue. The patient will typically have **fever**, **pain**, and forward bulging of the eyes (proptosis). The fungus then invades the tissues around the eye socket and eventually the brain. At that point the patient may have convulsions or **paralysis** on one side of the body.

Pulmonary mucormycosis

Most patients with the pulmonary form of the disease are being treated for leukemia. The fungus enters the patient's lungs, where it eventually invades a major blood vessel, causing the patient to **cough** up blood or hemorrhage into the lungs.

Gastrointestinal mucormycosis

Gastrointestinal mucormycosis has been reported in premature or low-birth-weight infants as well as malnourished adults. It may lead to intestinal perforation and other complications requiring immediate surgery. A Spanish hospital reported in 2004 on an outbreak of gastrointestinal mucormycosis that affected five patients in an ICU over a 14-week period. Two of the patients died. The outbreak was eventually traced to a supply of wooden tongue depressors that had been contaminated by two species of *Rhizopus* fungi.

Causes and symptoms

Mucormycosis is caused by fungi of several different species, including *Mucor*, *Rhizopus*, *Absidia*, and *Rhizomucor*. When these organisms gain access to the mucous membranes of the patient's nose or lungs, they multiply rapidly and invade the nearby blood vessels. The fungi destroy soft tissue and bone, as well as the walls of blood vessels.

The early symptoms of rhinocerebral mucormycosis include fever, sinus pain, **headache**, and **cellulitis**. As the fungus reaches the eye tissues, the patient develops dilated pupils, drooping eyelids, a bulging eye, and eventually hemorrhage of the blood vessels in the brain, causing convulsions, partial paralysis, and **death**.

The symptoms of pulmonary mucormycosis include fever and difficulty breathing, with eventual bleeding from the lungs.

The symptoms of gastrointestinal mucormycosis are not unique to the disease, which may complicate diagnosis. Patients typically complain of pressure or pain in the abdomen, **nausea**, and **vomiting**.

Diagnosis

Diagnosis is usually based on a combination of the patient's medical history and a visual examination of the nose, throat, and eyes. The doctor will take a tissue sample for biopsy, or a PAS, potassium hydroxide (KOH), or Calcofluor stain in order to make a tentative diagnosis. Confirmation requires a laboratory culture.

Imaging studies are not needed to make the diagnosis. If the patient has mucormycosis, however, **magnetic resonance imaging** (MRI) and **computed tomography scans** (CT scans) will usually show the destruction of soft tissue or bone in patients with advanced disease. Chest x rays will sometimes show a cavity in the lung or an area filled with tissue fluid if the patient has pulmonary mucormycosis.

Treatment

Treatment is usually begun without waiting for laboratory reports because of the rapid spread and high mortality rate of the disease. Therapy includes intravenous amphotericin B (Fungizone); surgical removal of infected tissue; and careful monitoring of the disorder or condition that is responsible for the patient's vulnerability. Most patients who survive require a 4–6-week course of treatment.

Follow-up care includes educating patients about the signs of recurrent mucormycosis—particularly facial swelling and a black discharge from the nose—and telling them to see a doctor at once if they notice these symptoms.

Patients who survive rhinocerebral mucormycosis are often left with severe facial disfigurement and usually require **plastic surgery** to restore their appearance.

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KEY TERMS

Amphotericin B—An antibiotic used to treat mucormycosis and other severe fungal infections.

Opportunistic infection—An infection that develops only when a person's immune system is weakened.

Orbit—The bony cavity or socket surrounding the eye.

Zygomycosis—Another term for mucormycosis. The fungi that cause mucormycosis belong to a group called Zygomycetes.

Prognosis

The prognosis for recovery from mucormycosis is poor. The mortality rate is 30%–50% of patients with the rhinocerebral form, and even higher for patients with pulmonary mucormycosis. The disease is almost 100% fatal for patients with **AIDS**.

Prevention

Prevention depends on protecting high-risk patients from contact with sugary foods, decaying plants, moldy bread, manure, and other breeding grounds for fungi. In addition, health care professionals treating hospital inpatients should be careful to change occlusive dressings frequently and check the underlying skin for any signs of possible fungal infection.

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ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

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Mucoviscidosis *see* **Cystic fibrosis**

MUGA scan *see* **Multiple-gated acquisition (MUGA) scan**

Multiple chemical sensitivity

Definition

Multiple chemical sensitivity—also known as MCS syndrome, environmental illness, idiopathic environmental intolerance, chemical **AIDS**, total allergy syndrome, or simply MCS—is a disorder in which a person develops symptoms from exposure to chemicals in the environment. With each incidence of exposure, lower levels of the chemical will trigger a reaction and the person becomes increasingly vulnerable to reactions triggered by other chemicals.

Medical experts disagree on the cause of the syndrome, and as to whether MCS is a clinically recognized illness. In a 1992 position statement that remains unchanged today, the American Medical Association's Council on Scientific Affairs does not recognize MCS as a clinical condition due to a lack of accepted diagnostic criteria and controlled studies on the disorder. Many researchers in Europe as well as the United States regard MCS as a contemporary version of neurasthenia, a concept first introduced by a physician named George Miller Beard in 1869.

Demographics

Because MCS is difficult to diagnose, estimates vary as to what percentage of the population develops MCS. However, most MCS patients are female. The median age of MCS patients is 40 years old, and most experienced symptoms before they were 30 years old. There is also a large percentage of Persian Gulf War veterans who have reported symptoms of chemical sensitivity since their return from the Gulf in the early 1990s.

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KEY TERMS

Capsaicin—An alkaloid found in hot peppers that is used in an inhalation test to identify patients with MCS.

Degas—To release and vent gases. New building materials often give off gases and odors and the air should be well circulated to remove them.

Neurasthenia—A term coined in the late nineteenth century to refer to a condition of chronic mental and physical weakness and fatigue. Some researchers regard MCS as a twentieth-century version of neurasthenia.

Sick building syndrome—An illness related to MCS in which a person develops symptoms in response to chronic exposure to airborne environmental chemicals found in a tightly sealed building.

Description

Multiple chemical sensitivity typically begins with one high-dose exposure to a chemical, but it may also develop with long-term exposure to a low level of a chemical. Chemicals most often connected with MCS include: formaldehyde; pesticides; solvents; petrochemical fuels such as diesel, gasoline, and kerosene; waxes, detergents, and cleaning products; latex; tobacco smoke; perfumes and fragrances; and artificial colors, flavors, and preservatives. People who develop MCS are commonly exposed in one of the following situations: on the job as an industrial worker; residing or working in a poorly ventilated building; or living in conditions of high air or water pollution. Others may be exposed in unique incidents.

Causes and symptoms

Chemical exposure is often a result of indoor air pollution. Buildings that are tightly sealed for energy conservation may cause a related illness called sick building syndrome, in which people develop symptoms from chronic exposure to airborne environmental chemicals such as formaldehyde from the furniture, carpet glues, and latex caulking. A person moving into a newly constructed building, which has not had time to degas, may experience the initial high-dose exposure that leads to MCS.

As of 2010, the specific biochemical and physiological mechanisms in humans that lead to MCS are not well understood, however, studies suggest that MCS is the end result of four different mechanisms of sensitization acting to reinforce one another. Further research is required to test this hypothesis.

The symptoms of MCS vary from person to person and are not chemical-specific. Symptoms are not limited to one physiological system, but primarily affect the respiratory and nervous systems. Symptoms commonly reported are **headache**, **fatigue**, weakness, difficulty concentrating, short-term **memory loss**, **dizziness**, irritability and depression, **itching**, **numbness**, burning sensation, congestion, **sore throat**, hoarseness, **shortness of breath**, **cough**, and stomach pains.

One commonly reported symptom of MCS is a heightened sensitivity to odors, including a stronger emotional reaction to them. A Japanese study published in late 2002 reported that patients diagnosed with MCS can identify common odors as accurately as most people, but regard a greater number of them as unpleasant.

One test that has been devised to evaluate patients with MCS is the capsaicin inhalation test. Capsaicin is an alkaloid found in hot peppers that is sometimes used in topical creams and rubs for the treatment of arthritis. When inhaled, capsaicin causes coughing in healthy persons as well as those with **allergies** that affect the airway; however, persons with MCS cough more deeply and frequently than control subjects when given a dose of capsaicin. Although the test is not diagnostic in the strict sense, it has been shown to be an effective way of identifying patients with MCS.

Diagnosis

Multiple chemical sensitivity is a twentieth-century disorder, becoming more prevalent as more human-made chemicals are introduced into the environment in greater quantities. It is especially difficult to diagnose because it presents no consistent or measurable set of symptoms and has no single diagnostic test or marker. For example, a 2002 study of **PET** scans of MCS patients found no significant functional changes in the patients' brain tissues. Physicians are often either unaware of MCS as a condition, or refuse to accept that MCS exists. They may be unable to diagnose it, or may misdiagnose it as another degenerative disease, or may label it as a psychosomatic illness (a physical illness that is caused by emotional problems). Their lack of understanding generates frustration, **anxiety**, and distrust in patients already struggling with MCS. However, a new specialty of medicine is evolving to address MCS and related illnesses: occupational and environmental medicine. A physician looking for MCS will take a complete patient history and try to identify chemical exposures.

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Some MCS patients may be helped by a psychologic evaluation, particularly if they show signs of panic attacks or other **anxiety disorders**. It is known that many patients with MCS suffer from comorbid depression and anxiety. In addition, MCS patients appear to have high rates of **mood disorders** compared to **asthma** patients as well as normal test subjects.

Treatment

While doctors may recommend **antihistamines**, **analgesics**, and other medications to combat the symptoms, the most effective treatment is to avoid those chemicals which trigger the symptoms. This becomes increasingly difficult as the number of offending chemicals increases, and people with MCS often remain at home where they are able to control the chemicals in their environment. This isolation often limits their abilities to work and socialize, so supportive counseling may also be appropriate.

Alternative treatment

Some MCS patients find relief with **detoxification** programs of **exercise** and sweating, and chelation of heavy metals. Others support their health with nutritional regimens and immunotherapy vaccines. Some undergo food-allergy testing and testing for accumulated pesticides in the body to learn more about their condition and what chemicals to avoid. Homeopathy and **acupuncture** can give added support to any treatment program for MCS patients. Botanical medicine can help to support the liver and other involved organs.

Prognosis

Once MCS sets in, sensitivity continues to increase and a person's health continues to deteriorate. Strictly avoiding exposure to triggering chemicals for a year or more may improve health.

Prevention

Multiple chemical sensitivity is difficult to prevent because even at high-dose exposures, different people react differently. Ensuring adequate ventilation in situations with potential for acute high-dose or chronic low-dose chemical exposure, as well as wearing the proper protective equipment in industrial situations, will minimize the risk.

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ORGANIZATIONS

American Academy of Environmental Medicine, P.O. Box CN 1001-8001, New Hope, PA, 18938, (215) 862-4544

American College of Occupational and Environmental Medicine (ACOEM), 1114 North Arlington Heights Road, Arlington Heights, IL, 60004, (847) 818-1800, www.acoem.org.

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Multiple-gated acquisition (MUGA) scan

Definition

The multiple-gated acquisition (MUGA) scan is a non-invasive nuclear test that uses a radioactive isotope called technetium to evaluate the functioning of the heart's ventricles.

Purpose

The MUGA scan is performed to determine if the heart's left and right ventricles are functioning properly and to diagnose abnormalities in the heart wall. It can be ordered in the following patients:

- With known or suspected coronary artery disease, to diagnose the disease and predict outcomes
- With lesions in their heart valves
- Who have recently had a heart attack, to assess damage to heart tissue and predict the likelihood of future cardiac events

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KEY TERMS

Ejection fraction—The fraction of all blood in the ventricle that is ejected at each heartbeat. One of the main advantages of the MUGA scan is its ability to measure ejection fraction, one of the most important measures of the heart's performance.

Electrocardiogram—A test in which electronic sensors called electrodes are placed on the body to record the heart's electrical activities.

Heart attack—A cardiac emergency that occurs when a clot blocks blood flow in one or more of the heart's arteries. Oxygen supply to the heart muscle is cut off, resulting in the death of heart tissue in the affected area.

Ischemia—A decreased supply of oxygenated blood to a body part or organ, often marked by pain and organ dysfunction, as in ischemic heart disease.

Non-invasive—A procedure that does not penetrate the body.

Radioactive isotope—One of two or more atoms with the same number of protons but a different number of neutrons with a nuclear composition. In nuclear scanning, radioactive isotopes are used as a diagnostic agent.

Technetium—A radioactive isotope frequently used in radionuclide scanning of the heart and other organs. It is produced during nuclear fission reactions.

Ventricles—The heart's lower chambers are called the left and right ventricles. They send blood to the lungs and throughout the body. The MUGA scan is performed to evaluate the ventricles.

- With congestive heart failure
- Who have undergone percutaneous transluminal coronary angioplasty, coronary artery bypass graft surgery, or medical therapy, to assess the efficacy of the treatment
- With low cardiac output after open-heart surgery
- Who are undergoing chemotherapy

Precautions

Pregnant women and those who are **breastfeeding** should not be exposed to technetium.

Description

The MUGA scan measures the heart's function and the flow of blood through it. The strongest chamber in the heart is the left ventricle, which serves as the main pump of blood through the body. The left ventricular is assessed by measuring the amount of blood pumped with each heartbeat (the ejection fraction), ventricle filling, and the blood flow into the pumping chamber. A normal ejection fraction is 50% or more. The heart's ejection fraction is one of the most important measures of its performance. The right ventricle's ability to pump blood to the lungs is also assessed, and any abnormalities in the heart wall are identified. The MUGA scan is the most accurate, non-invasive test available to assess the heart's ventricles.

MUGA is a nuclear heart scan, which means that it involves the use of a radioactive isotope that targets the heart and a radionuclide detector that traces the absorption of the radioactive isotope. The isotope is injected into a vein and absorbed by healthy tissue at a known rate during a certain time period. The radionuclide detector, in this case a gamma scintillation camera, picks up the gamma rays emitted by the isotope.

During the MUGA scan, electrodes are placed on the patient's body so that an electrocardiogram (ECG) can be conducted. The imaging equipment and computer are synchronized with the ECG so that images of the heart can be recorded without motion or blur. Then a small amount of a mildly radioactive isotope called technetium Tc99m stannous pyrophosphate, usually called technetium, is injected, usually into an arm vein. While the patient lies motionless on the test table, a gamma scintillation camera follows the movement of the technetium through the blood circulating in the heart. The camera, which looks like an x-ray machine and is suspended above the table, moves back and forth over the patient. It displays multiple images of the heart in motion and records them on a computer for later analysis.

The MUGA scan is usually performed in a hospital's nuclear medicine department, but it can also be performed in an outpatient facility or at the patient's bedside if equipment is available. The scan is done immediately after injection of the technetium and usually takes about 30 minutes to one hour. It is also called multigated graft acquisition, multigated acquisition scan, cardiac blood-pool imaging, and equilibrium radionuclide **angiography**. Test results can be

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affected by patient movement during the test, electrocardiogram abnormalities, an irregular heartbeat, or long-acting nitrates.

The MUGA scan can be done with the patient at rest or exercising (called a **stress** MUGA). The stress MUGA is often performed in patients who have or are suspected of having **coronary artery disease**. The resting MUGA is compared to the stress MUGA and changes in the heart's pumping performance are analyzed. In some cases, the rest MUGA is compared to a nitroglycerin MUGA, in which a strong heart drug called nitroglycerin is administered to the patient before the scan. For the nitroglycerin MUGA, a cardiologist should be present.

The MUGA scan is not dangerous. The technetium is completely gone from the body within a few days of the test. The scan itself exposes the patient to about the same amount of radiation as a **chest x ray**. The patient can resume normal activities immediately after the test.

Normal results

If the patient's heart is normal, the technetium will appear to be evenly distributed in the scans. In a stress MUGA, patients with normal hearts will exhibit an increase in ejection fraction or no change.

Abnormal results

An uneven distribution of technetium in the heart indicates that the patient has coronary artery disease, a **cardiomyopathy**, or blood shunting within the heart. Abnormalities in a resting MUGA usually indicate a **heart attack**, while those that occur during **exercise** usually indicate **ischemia**. In a stress MUGA, patients with coronary artery disease may exhibit a decrease in ejection fraction.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

Texas Heart Institute. Heart Information Service, MC 3-116, PO Box 20345, Houston, TX, 77225, (832) 355-4011, (800) 292-2221, http://www.texasheart.org.

Lori De Milto

Multiple endocrine adenomatosis *see* **Multiple endocrine neoplasia syndromes**

Multiple endocrine neoplasia syndromes

Definition

The multiple endocrine neoplasia (MEN) syndromes are three related disorders affecting the thyroid and other hormonal (endocrine) glands of the body. MEN has previously been known as familial endocrine adenomatosis.

Description

The three forms of MEN are MEN1 (Wermer's syndrome), MEN2A (Sipple syndrome), and MEN2B (previously known as MEN3). Each is an autosomal dominant genetic condition which predisposes to hyperplasia (excessive growth of cells) and tumor formation in a number of endocrine glands.

Causes and symptoms

MEN1 patients experience hyperplasia or tumors of several endocrine glands, including the parathyroids, the pancreas, and the pituitary. The most frequent symptom of MEN1 is **hyperparathyroidism**. Overgrowth of the parathyroid glands leads to over secretion of parathyroid hormone, which leads to elevated blood **calcium** levels, **kidney stones**, weakened bones, and nervous system depression. Almost all MEN1 patients show parathyroid symptoms by age 40.

Tumors of the pancreas known as gastrinomas are also common in MEN1. Excessive secretion of gastrin (a hormone secreted into the stomach to aid in digestion) by these tumors can cause upper gastrointestinal ulcers. The anterior pituitary and the adrenal glands can also be affected. Unlike MEN2, the thyroid gland is rarely involved in MEN1 symptoms.

Patients with MEN2A and MEN2B experience two main symptoms, medullary **thyroid cancer** (MTC) and a tumor of the adrenal gland medulla known as **pheochromocytoma**. MTC is a slow—growing **cancer**, but one that can be cured in less than 50% of cases. Pheochromocytoma is usually a benign tumor that causes excessive secretion of adrenal hormones, which, in turn, can cause life—threatening **hypertension** and cardiac arrhythmia.

The two forms of MEN2 are distinguished by additional symptoms. MEN2A patients have a predisposition to increase in size (hypertrophy) and to develop tumors of the parathyroid gland. Although similar to MEN1, less than 20% of MEN2A patients show parathyroid involvement.

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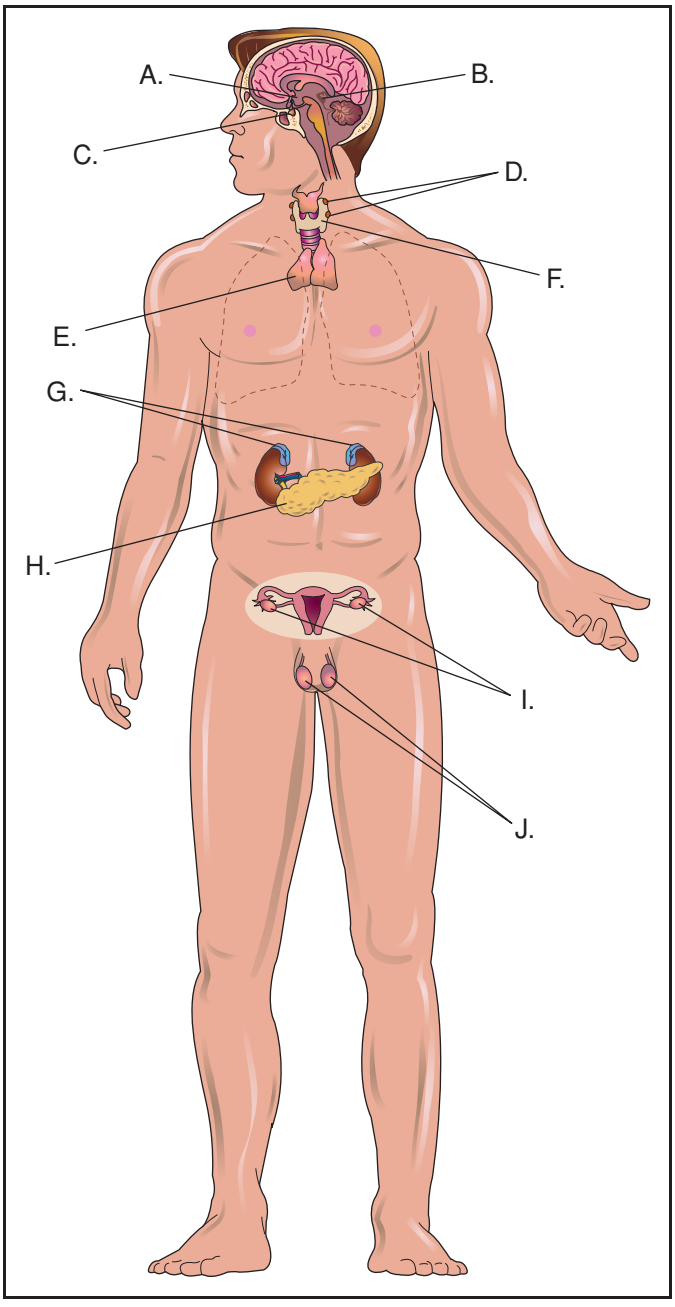

The human endocrine system: A. Hypothalamus. B. Pineal. C. Pituitary. D. Parathyroid. E. Thymus. F. Thyroid. G. Adrenals. H. Pancreas. I. Ovaries (female). J. Testes (male). *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

MEN2B patients show a variety of additional conditions: a characteristic facial appearance with swollen lips; tumors of the mucous membranes of the eye, mouth, tongue, and nasal cavity; enlarged colon; and skeletal abnormalities. Symptoms develop early in life (often under five years of age) in cases of MEN2B and the tumors are more aggressive. MEN2B is about ten—fold less common than MEN2A.

MEN1 is caused by mutation at the PYGM gene. PYGM is one of a group of genes known as tumor suppressor genes. A patient who inherits one defective copy of a tumor suppressor gene from either parent has a strong predisposition to the disease because of the high probability of incurring a second mutation in at least one dividing cell. That cell no longer possesses even one normal copy of the gene. When both copies are defective, tumor suppression fails and tumors develop.

Both types of MEN2 are caused by mutations in another gene, known as RET. A mutation in only one copy of the RET gene is sufficient to cause disease. A number of different mutations can lead to MEN2A, but only one specific genetic alteration leads to MEN2B.

For all types of MEN, the children of an affected individual have a 50% chance of inheriting the defective gene.

Diagnosis

Classical diagnosis of MEN is based on clinical features and on testing for elevated hormone levels. For MEN1, the relevant hormone is parathyroid hormone. For both types of MEN2, the greatest concern is development of medullary thyroid cancer. MTC can be detected by measuring levels of the thyroid hormone, calcitonin. Numerous other hormone levels can be measured to assess the involvement of the various other endocrine glands.

Diagnosis of MEN2B can be made by **physical examination** alone. However, MEN2A shows no distinct physical features and must be identified by measuring hormone levels or by finding endocrine tumors.

Since 1994, genetic screening using DNA technology has been available for both MEN1 and MEN2. This new methodology allows diagnosis prior to the onset of symptoms.

In the past, there was no way of definitively identifying which children had inherited the defective gene. As a result, all children had to be considered at risk. In the case of MEN2A and MEN2B, children would undergo frequent calcitonin testing. Molecular techniques now allow a positive distinction to be made between children who are and are not actually at risk.

Children who are identified as carriers of the RET gene can be offered total **thyroidectomy** on a preventative (prophylactic) basis to prevent the development of MTC.

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KEY TERMS

Endocrine—A term used to describe the glands that produce hormones in the body.

Hyperplasia—An overgrowth of normal cells within an organ or tissue.

Medullary thyroid cancer (MTC)—A slow-growing tumor associated with MEN.

Neoplasm—An abnormal formation of tissue; for example, a tumor.

Pheochromocytoma—A tumor of the medullary of the adrenal gland.

Treatment

No comprehensive treatment is available for genetic conditions such as MEN. However, some of the consequences of MEN can be symptomatically treated.

Pheochromocytoma in both types of MEN 2 can be cured by surgical removal of this slow growing tumor.

Treatment of MTC is by surgical removal of the thyroid, although doctors may disagree at what stage to remove the thyroid. After thyroidectomy, the patient will receive normal levels of thyroid hormone orally or by injection.

Even when surgery is performed early, metastatic spread of the cancer may have already occurred. Since this cancer is slow growing, metastasis may not be obvious. Metastasis is very serious in MTC because **chemotherapy** and **radiation therapy** are not effective in controlling its spread.

Prognosis

Diagnosed early, the prognosis for the MEN diseases is reasonably good, even for MEN2B, the most dangerous of the three forms. Even in the absence of treatment, a few individuals with MEN2A mutations will never show any symptoms at all. Analysis of at—risk family members using molecular genetic techniques will lead to earlier treatment and improved outcomes.

Prevention

One of the most serious consequences of MEN is MTC, which can be prevented by thyroidectomy. There is no preventive measure to block the occurrence of genetic mutations such as those that cause MEN.

Resources

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Harrow, Benjamin. *Glands in Health and Disease (1922)*. Charleston, SC: CreateSpace, 2010.

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Van Nostrand, Douglas, et al. *Thyroid Cancer: A Guide for Patients,* 2nd ed. Pasadena, MD: Keystone Press, 2010.

ORGANIZATIONS

Canadian MEN Society, PO Box 100, Meola, Saskatchewan, S0M 1XO, (306) 892–2080

National Institutes of Health (NIH), 9000 Rockville Pike, Bethesda, MD, 20892, (301) 496-4000, http://www.nih.gov/index.html.

National Library of Medicine, 8600 Rockville Pike, Bethesda, MD, 20894, http://www.nlm.nih.gov/medlineplus/medlineplus.html.

National Organization for Rare Diseases, PO Box 8923, Fairfield, CT, 06812, (213) 745–6518, http://www.rarediseases.org.

Victor Leipzig, Ph.D.
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Multiple myeloma

Definition

Multiple myeloma is a **cancer** in which antibody-producing plasma cells grow in an uncontrolled and invasive (malignant) manner.

Description

Multiple myeloma, also known as plasma cell myeloma, is the second-most common cancer of the blood. It is the most common type of plasma cell neoplasm. Multiple myeloma accounts for approximately 1% of all cancers and 2% of all deaths from cancer. Multiple myeloma is a disease in which malignant plasma cells spread through the bone marrow and hard outer portions of the large bones of the body. These myeloma cells may form tumors called plasmacytomas. Eventually, multiple soft spots or holes, called osteolytic lesions, form in the bones.

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This x ray of the patient's left clavicle indicates an occurrence of myelomas in the bone. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Bone marrow is the spongy tissue within the bones. The breastbone, spine, ribs, skull, pelvic bones, and the long bone of the thigh all are particularly rich in marrow. Bone marrow is a very active tissue that is responsible for producing the cells that circulate in the blood. These include the red blood cells that carry oxygen, the white blood cells that develop into immune system cells, and platelets, which cause blood to clot.

Plasma cells and immunoglobulins

Plasma cells develop from B-lymphocytes or B-cells, a type of white blood cell. B-cells, like all blood cells, develop from unspecialized stem cells in the bone marrow. Each B-cell carries a specific antibody that recognizes a specific foreign substance called an antigen. Antibodies are large proteins called immunoglobulins (Igs), which recognize and destroy foreign substances and organisms such as bacteria. When a B-cell encounters its antigen, it begins to divide rapidly to form mature plasma cells. These plasma cells are all identical (monoclonal). They produce large amounts of identical antibody that are specific for the antigen.

Malignant plasma cells

Multiple myeloma begins when the genetic material (DNA) is damaged during the development of a stem cell into a B-cell in the bone marrow. This causes the cell to develop into an abnormal or malignant plasmablast, a developmentally early form of plasma cell. Plasmablasts produce adhesive molecules that allow them to bond to the inside of the bone marrow. A growth factor, called interleukin-6, promotes uncontrolled growth of these myeloma cells in the bone marrow and prevents their natural **death**. Whereas normal bone marrow contains less than 5% plasma cells, bone marrow of an individual with multiple myeloma contains over 10% plasma cells.

In most cases of multiple myeloma, the malignant plasma cells all make an identical Ig. Igs are made up of four protein chains that are bonded together. Two of the chains are light and two are heavy. There are five classes of heavy chains, corresponding to five types of Igs with different immune system functions. The Igs from myeloma cells are nonfunctional and are called paraproteins. All of the paraproteins from any one individual are monoclonal (identical) because the myeloma cells are identical clones of a single plasma cell. Thus, the paraprotein is a monoclonal protein or M-protein. The M-proteins crowd out the functional Igs and other components of the immune system. They also cause functional antibodies, which are produced by normal plasma cells, to rapidly break down. Thus, multiple myeloma depresses the immune system.

In about 75% of multiple myeloma cases, the malignant plasma cells also produce monoclonal light chains, or incomplete Igs. These are called Bence-Jones proteins and are secreted in the urine. Approximately 1% of multiple myelomas are called nonsecretors because they do not produce any abnormal Ig.

Osteolytic lesions

About 70% of individuals with multiple myeloma have soft spots or lesions in their bones. These lesions can vary from quite small to grapefruit-size. In part, these lesions occur because the malignant plasma cells rapidly outgrow the normal bone-forming cells. In addition, malignant myeloma cells produce factors that affect cells called osteoclasts. These are the cells that normally destroy old bone, so that new bone can be produced by cells called osteoblasts. The myeloma cell factors increase both the activation and the growth of osteoclasts. As the osteoclasts multiply and migrate, they destroy healthy bone and create lesions. **Osteoporosis**, or widespread bone weakness, may develop.

There are more than 40,000 multiple myeloma patients in the United States. The American Cancer Society predicts an additional 14,400 new cases in 2001. About 11,200 Americans will die of the disease

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in 2001. Multiple myeloma is one of the leading causes of cancer deaths among African Americans.

In Western industrialized countries, approximately four people in 100,000 develop multiple myeloma. The incidence of multiple myeloma among African Americans is 9.5 per 100,000, about twice that of Caucasians. Asians have a much lower incidence of the disease. In China, for example, the incidence of multiple myeloma is only one in 100,000. The offspring and siblings of individuals with multiple myeloma are at a slightly increased risk for the disease.

At diagnosis, the average age of a multiple myeloma patient is 68 to 70. Although the average age at onset is decreasing, most multiple myelomas still occur in people over 40. This cancer is somewhat more prevalent in men than in women.

Causes and symptoms

Associations

The cause of multiple myeloma has not been determined. However, a number of possible associations have been identified:

- decreased immune system function; the immune systems of older individuals may be less efficient at detecting and destroying cancer cells
- genetic (hereditary) factors, suggested by the increased incidence in some ethnic groups and among family members
- occupational factors, suggested by the increased incidence among agricultural, petroleum, wood, and leather workers, and cosmetologists
- long-term exposure to herbicides, pesticides, petroleum products, heavy metals, plastics, and dusts such as asbestos
- radiation exposure, as among Japanese atomic bomb survivors, nuclear weapons workers, and medical personnel such as radiologists
- Kaposi's sarcoma-associated herpes virus (also called human herpes virus-8 or HHV-8), found in the blood and bone marrow cells of many multiple myeloma patients

Early symptoms

The accumulation of malignant plasma cells can result in tiny cracks or **fractures** in bones. Malignant plasma cells in the bone marrow can suppress the formation of red and white blood cells and platelets. About 80% of individuals with multiple myeloma are anemic due to low red blood cell formation. Low white blood cell formation results in increased susceptibility to infection, since new, functional antibodies are not produced. In addition, normal circulating antibodies are rapidly destroyed. Low platelet formation can result in poor blood clotting. It is rare, however, that insufficient white blood cell and platelet formations are presenting signs of multiple myeloma.

These factors cause the early symptoms of multiple myeloma:

- pain in the lower back or ribs
- fatigue and paleness due to anemia (low red blood cell count)
- frequent and recurring infections, including bacterial pneumonia, urinary-tract and kidney infections, and shingles
- bleeding

Bone destruction

Bone **pain**, particularly in the backbone, hips, and skull, is often the first symptom of multiple myeloma. As malignant plasma cells increase in the bone marrow, replacing normal marrow, they exert pressure on the bone. As overly active osteoclasts (large cells responsible for the breakdown of bone) remove bone tissue, the bone becomes soft. Fracture and spinal cord compression may occur.

Plasmacytomas (malignant tumors of plasma cells) may weaken bones, causing fractures. Fractured bones or weak or collapsed spinal bones, in turn, may place unusual pressure on nearby nerves, resulting in nerve pain, burning, or **numbness** and muscle weakness. Proteins produced by myeloma cells also may damage nerves.

Calcium from the destroyed bone enters the blood and urine, causing **hypercalcemia**, a medical condition in which abnormally high concentrations of calcium compounds exist in the bloodstream. High calcium affects nerve cell and kidney function. The symptoms of hypercalcemia include:

- weakness and fatigue
- depression
- mental confusion
- constipation
- increased thirst
- icreased urination
- nausea and vomiting
- kidney pain
- kidney failure

Hypercalcemia affects about one-third of multiple myeloma patients.

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Serum proteins

The accumulation of M-proteins in the serum (the liquid portion of the blood) may cause additional complications, such as hyperviscosity syndrome, or thickening of the blood (though rare in multiple myeloma patients). Symptoms of hyperviscosity include:

- fatigue
- headaches
- shortness of breath
- mental confusion
- chest pain
- kidney damage and failure
- vision problems
- Raynaud's phenomenon

Poor blood circulation, or Raynaud's phenomenon, can affect any part of the body, but particularly the fingers, toes, nose, and ears.

Cryoglobulinemia occurs when the protein in the blood forms particles under cold conditions. These particles can block small blood vessels and cause pain and numbness in the toes, fingers, and other extremities during cold weather.

Amyloidosis is a rare complication of multiple myeloma. It usually occurs in individuals whose plasma cells produce only Ig light chains. These Bence-Jones proteins combine with other serum proteins to form amyloid protein. This starchy substance can invade tissues, organs, and blood vessels. In particular, amyloid proteins can accumulate in the kidneys, where they block the tiny tubules that are the kidney's filtering system. Indicators of amyloidosis include:

- carpal tunnel syndrome
- kidney failure
- liver failure
- heart failure

Diagnosis

Blood and urine tests

Often, the original diagnosis of multiple myeloma is made from routine blood tests that are performed for other reasons. Blood tests may indicate:

- anemia
- abnormal red blood cells
- high serum protein levels
- how levels of normal antibody
- high calcium levels
- high blood urea nitrogen (BUN) levels
- high creatinine levels

Urea and creatinine normally are excreted in the urine. High levels of urea and creatinine in the blood indicate that the kidneys are not functioning properly to eliminate these substances.

Protein electrophoresis is a laboratory technique that uses an electrical current to separate the different proteins in the blood and urine on the basis of size and charge. Since all of the multiple myeloma M-proteins in the blood and urine are identical, electrophoresis of blood and urine from a patient with multiple myeloma shows a large M-protein spike, corresponding to the high concentration of monoclonal Ig. Electrophoresis of the urine also can detect Bence-Jones proteins.

Bones

A **bone marrow aspiration** utilizes a very thin, long needle to remove a sample of marrow from the hip bone. Alternatively, a **bone marrow biopsy** with a larger needle removes solid marrow tissue. The marrow is examined under the microscope for plasma cells and tumors. If 10% to 30% of the cells are plasma cells, multiple myeloma is the usual diagnosis.

X rays are used to detect osteoporosis, osteolytic lesions, and fractures. Computer-assisted tomography (CAT or CT) scans can detect lesions in both bone and soft tissue. **Magnetic resonance imaging** (MRI) may give a more detailed image of a certain bone or a region of the body.

Treatment

Related disorders

Monoclonal gammopathy of undetermined significance (MGUS) is a common condition in which a monoclonal Ig is detectable. However, there are no tumors or other symptoms of multiple myeloma. MGUS occurs in about 1% of the general population and in about 3% of those over age 70. Over a period of years, about 16% to 20% of those with MGUS will develop multiple myeloma or a related cancer called malignant lymphoma.

Occasionally, only a single plasmacytoma develops, either in the bone marrow (isolated plasmacytoma of the bone) or other tissues or organs (extramedullary plasmacytoma). Some individuals with solitary plasmacytoma may develop multiple myeloma.

Clinical stages

The Durie-Salmon system is used to stage multiple myeloma. Stage I multiple myeloma requires all of the following (1 gram = approx. 0.02 pints, 1 deciliter = approx. 0.33 ounces):

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- hemoglobin (the oxygen-transporting molecule of red blood cells) above 10 grams/deciliter (g/dl)
- serum calcium below 12 mg/dl
- normal bone structure or only isolated plasmacytoma
- low M-protein, based on established guideline levels of Ig protein chains

Approximately 5% of multiple myeloma cases are not progressing at diagnosis, and may not progress for months or years. This is called smoldering myeloma. These patients have stage I blood chemistry but no symptoms.

Stage II multiple myeloma fits neither stage I nor stage III. Stage III multiple myeloma meets one or more the following criteria:

- hemoglobin below 8.5 g/dl
- serum calcium above 12 mg/dl
- advanced bone lesions
- high M-protein

Each stage is subclassified as A or B, based on serum creatinine indicators of normal or abnormal kidney function. Most patients have stage III multiple myeloma at diagnosis.

Prognostic indicators

Prognostic indicators for multiple myeloma may be used instead of, or in addition to, the staging system described above. Prognostic indicators are laboratory tests that help to define the stage of the disease at diagnosis, and its progression during treatment. These indicators are:

- plasmablastic multiple myeloma (presence of plasmablasts, the precursor malignant plasma cells)
- plasma cell labeling index (the percentage of plasma cells that are actively dividing)
- beta 2-microglobulin, a protein secreted by B-cells that correlates with the myeloma cell mass (also indicates kidney damage)

Since multiple myeloma often progresses slowly, and since the treatments can be toxic, the disease may not be treated until M-protein levels in the blood are quite high. In particular, MGUS and smoldering myeloma may be followed closely but not treated. Solitary plasmacytomas are treated with radiation and/or surgery and followed closely with examinations and laboratory tests.

Chemotherapy

Chemotherapy, or treatment with anti-cancer drugs, is used for multiple myeloma. MP, a combination of the drugs melphalan and prednisone, is the standard treatment. Usually, the drugs are taken by mouth every 3 to 4 weeks for 6 to 9 months or longer, until the M-protein levels in the blood stop decreasing. MP usually results in a 50% reduction in M-protein.

Dexamethasone, a corticosteroid, sometimes is used to treat the elderly or those in poor health. It can drop the M-protein levels by 40% in untreated individuals and by 20% to 40% in patients who have not responded to previous treatment. Other chemotherapy drugs, including cyclophosphamide, carmustine, doxorubicin, vincristine, and chlorambucil, may be used as well.

Multiple myeloma usually recurs within a year after the end of chemotherapy. Although the chemotherapy can be repeated after each recurrence, it is progressively less responsive to treatment.

Side effects of chemotherapy may include:

- anemia
- hair loss
- nausea
- vomiting
- diarrhea
- mood swings
- swelling
- acne

These side effects disappear after treatment is discontinued.

Other drug treatments

Bisphosphonates are drugs that inhibit the activity of osteoclasts. These drugs can slow the progression of bone disease, reduce pain, and help prevent bone fractures. Different types of bisphosphonates inhibit osteoclasts in different ways. They also reduce the production of interleukin-6 by bone marrow cells. Laboratory studies suggest that bisphosphonates may kill or inhibit the growth of multiple myeloma cells. Pamidronate is the most common bisphosphonate for treating multiple myeloma.

The drug thalidomide appears to have several anti-myeloma activities. Thalidomide affects the immune system in various ways and it appears to inhibit myeloma cells, both directly and indirectly. It also inhibits the growth of new blood vessels that are needed by tumors. However, if thalidomide is taken during **pregnancy**, it an cause severe **birth defects** or death of the fetus.

The drug allopurinol may be used to reduce high blood levels of uric acid that result from kidney

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KEY TERMS

Amyloidosis—A complication of multiple myeloma in which amyloid protein accumulates in the kidneys and other organs, tissues, and blood vessels.

Anemia—Any condition in which the red blood cell count is below normal.

Antibody—Immunoglobulin produced by immune system cells that recognizes and binds to a specific foreign substance (antigen).

Antigen—Foreign substance that is recognized by a specific antibody.

B-cell (B-lymphocyte)—Type of white blood cell that produces antibodies.

Bence-Jones protein—Light chain of an immunoglobulin that is overproduced in multiple myeloma and is excreted in the urine.

Beta 2-microglobulin—Protein produced by B-cells; high concentrations in the blood are indicative of multiple myeloma.

Cryoglobulinemia—Condition in which protein in the blood forms particles in the cold, blocking blood vessels, leading to pain and numbness of the extremities.

Electrophoresis—Use of an electrical field to separate proteins in a mixture (such as blood or urine), on the basis of the size and electrical charge of the proteins.

Hemoglobin—Protein in red blood cells that carries oxygen.

Hypercalcemia—Abnormally high levels of calcium in the blood.

Hyperviscosity—Thick, viscous blood, caused by the accumulation of large proteins, such as immunoglobulins, in the serum.

Immunoglobulin (Ig)—Antibody; large protein produced by B-cells that recognizes and binds to a specific antigen.

M-protein—Monoclonal or myeloma protein; paraprotein; abnormal antibody found in large amounts in the blood and urine of individuals with multiple myeloma.

Malignant—A characteristic of cancer cells that grow uncontrollably and invade other tissues.

Monoclonal—Identical cells or proteins; cells (clones) derived from a single, genetically distinct cell, or proteins produced by these cells.

Monoclonal gammopathy of undetermined significance (MGUS)—Common condition in which M-protein is present, but there are no tumors or other symptoms of disease.

Neoplasm—Tumor made up of cancer cells.

Osteoblast—Bone-forming cell.

Osteoclast—Cell that absorbs bone.

Osteolytic lesion—Soft spot or hole in bone caused by cancer cells.

Osteoporosis—Condition in which the bones become weak and porous, due to loss of calcium and destruction of cells.

Paraprotein—M-protein; abnormal immunoglobulin produced in multiple myeloma.

Plasma cell—Type of white blood cell that produces antibodies; derived from an antigen-specific B-cell.

Platelet—Cell that is involved in blood clotting.

Stem cell—Undifferentiated cell that retains the ability to develop into any one of numerous cell types.

dysfunction. **Diuretics** can improve kidney function. Infections require prompt treatment with **antibiotics**.

BONE AND PERIPHERAL BLOOD STEM CELL TRANSPLANTATION. Bone marrow or peripheral blood stem cell transplantations (PBSCT) are used to replace the stem cells of the bone marrow following high-dosage chemotherapy. Chemotherapy destroys the bone marrow stem cells that are necessary to produce new blood cells. In an autologous transplant, the patient's bone marrow stem cells or peripheral blood stem cells (immature bone marrow cells found in the blood) are collected, treated with drugs to kill any myeloma cells, and frozen prior to chemotherapy. Growth factors are used to increase the number of peripheral stem cells prior to collection. A procedure called apheresis is used to collect the peripheral stem cells. Following high-dosage chemotherapy, the stem cells are reinjected into the individual. In an allogeneic transplant, the donor stem cells come from a genetically related individual such as a sibling.

Other treatments

Blood transfusions may be required to treat severe anemia.

Plasmapheresis, or plasma exchange **transfusion**, may be used to thin the blood to treat hyperviscosity syndrome. In this treatment, blood is removed and passed through a machine that separates the plasma,

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containing the M-protein, from the red and white blood cells and platelets. The blood cells are transfused back into the patient, along with a plasma substitute or donated plasma.

Multiple myeloma may be treated with high-energy x rays directed at a specific region of the body. **Radiation therapy** is used for treating bone pain.

Alternative treatment

Interferon alpha, an immune-defense protein that is produced by some white blood cells and bone marrow cells, can slow the growth of myeloma cells. It usually is given to patients following chemotherapy, to prolong their remission. However, interferon may have toxic effects in older individuals with multiple myeloma.

Once multiple myeloma is in remission, calcium and vitamin D supplements can improve bone density. It is important not to take these supplements when the myeloma is active. Individuals with multiple myeloma must drink large amounts of fluid to counter the effects of hyperviscous blood.

Prognosis

The prognosis for individuals with MGUS or solitary plasmacytoma is very good. Most do not develop multiple myeloma. However, approximately 15% of all patients with multiple myeloma die within three months of diagnosis. About 60% respond to treatment and live for an average of two and a half to three years following diagnosis. Approximately 23% of patients die of other illnesses associated with advanced age.

The prognosis for a given individual may be based on the prognostic indicators described above. The median survival for those without plasmablasts, and with a low plasma cell labeling index (PCLI) and low beta 2-microglobulin, is 5.5 years. The median survival for patients with plasmablastic multiple myeloma, or with a high PCLI (1% or greater) and high beta 2-microglobulin (4 or higher), is 1.9 and 2.4 years, respectively. Many multiple myeloma patients are missing part or all of chromosome 13. The deletion of this chromosome, along with high beta 2-microglobulin, leads to a poor prognosis.

With treatment, multiple myeloma may go into complete remission. This is defined as:

- M-protein absent from the blood and urine
- myeloma cells not detectable in the bone marrow
- no clinical symptoms
- negative laboratory tests

However, with very sensitive testing, a few myeloma cells are usually detectable and eventually lead to a recurrence of the disease, in the bone or elsewhere in the body.

Prevention

There are no clearly established risk factors for multiple myeloma and it is possible that a combination of factors interact to cause the disease. Thus, there is no method for preventing multiple myeloma.

Resources

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ORGANIZATIONS

Multiple Myeloma Research Foundation, 383 Main Avenue 5th Floor, Norwalk, CT, 06851, (203) 229-0464, (203) 229-0572, info@themmrf.org, http://www.themmrf.org.

Margaret Alic, Ph.D.

Multiple personality disorder

Definition

Multiple personality disorder, or MPD, is a mental disturbance classified as one of the **dissociative disorders** in the fourth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM–IV*). It

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has been renamed dissociative identity disorder (DID). MPD or DID is defined as a condition in which "two or more distinct identities or personality states" alternate in controlling the patient's consciousness and behavior. Note: "Split personality" is not an accurate term for DID and should not be used as a synonym for **schizophrenia**.

Description

The precise nature of DID (MPD) as well as its relationship to other mental disorders is still a subject of debate. Some researchers think that DID may be a relatively recent development in western society. It may be a culture–specific syndrome found in western society, caused primarily by both childhood **abuse** and unspecified long–term societal changes. Unlike depression or **anxiety disorders**, which have been recognized, in some form, for centuries, the earliest cases of persons reporting DID symptoms were not recorded until the 1790s. Most were considered medical oddities or curiosities until the late 1970s, when increasing numbers of cases were reported in the United States. Psychiatrists are still debating whether DID was previously misdiagnosed and underreported, or whether it is currently overdiagnosed. Because childhood trauma is a factor in the development of DID, some doctors think it may be a variation of **post–traumatic stress disorder** (PTSD). DID and PTSD are conditions in which dissociation is a prominent mechanism. The female to male ratio for DID is about 9:1, but the reasons for the gender imbalance are unclear. Some experts have attributed the imbalance in reported cases to higher rates of abuse of female children, and some to the possibility that males with DID are underreported because they might be in prison for violent crimes.

The most distinctive feature of DID is the formation and emergence of alternate personality states, or "alters." Patients with DID experience their alters as distinctive individuals possessing different names, histories, and personality traits. It is not unusual for DID patients to have alters of different genders, sexual orientations, ages, or nationalities. Some patients have been reported with alters that are not even human; alters have been animals, or even aliens from outer space. The average DID patient has between two and 10 alters, but some have been reported with over one hundred.

Causes and symptoms

The severe dissociation that characterizes patients with DID is currently understood to result from a set of causes:

- An innate ability to dissociate easily
- Repeated episodes of severe physical or sexual abuse in childhood
- The lack of a supportive or comforting person to counteract abusive relative(s)
- The influence of other relatives with dissociative symptoms or disorders

The relationship of dissociative disorders to childhood abuse has led to intense controversy and lawsuits concerning the accuracy of childhood memories. The brain's storage, retrieval, and interpretation of childhood memories are still not fully understood.

The major dissociative symptoms experienced by DID patients are **amnesia**, depersonalization, derealization, and identity disturbances.

Amnesia

Amnesia in DID is marked by gaps in patients' memory for long periods of their past, in some cases, their entire childhood. Most DID patients have amnesia, or "lost time," for periods when another personality is "out." They may report finding items in their house that they can not remember having purchased, finding notes written in different handwriting, or other evidence of unexplained activity.

Depersonalization

Depersonalization is a dissociative symptom in which the patient feels that his or her body is unreal, is changing, or is dissolving. Some DID patients experience depersonalization as feeling to be outside of their body, or as watching a movie of themselves.

Derealization

Derealization is a dissociative symptom in which the patient perceives the external environment as unreal. Patients may see walls, buildings, or other objects as changing in shape, size, or color. DID patients may fail to recognize relatives or close friends.

Identity disturbances

Identity disturbances in DID result from the patient's having split off entire personality traits or characteristics as well as memories. When a stressful or traumatic experience triggers the reemergence of these dissociated parts, the patient switches—usually within seconds—into an alternate personality. Some patients have histories of erratic performance in school or in their jobs caused by the emergence of alternate personalities during examinations or other

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stressful situations. Patients vary with regard to their alters' awareness of one another.

Diagnosis

The diagnosis of DID is complex and some physicians believe it is often missed, while others feel it is overdiagnosed. Patients have been known to have been treated under a variety of other psychiatric diagnoses for a long time before being re–diagnosed with DID. The average DID patient is in the mental health care system for six to seven years before being diagnosed as a person with DID. Many DID patients are misdiagnosed as depressed because the primary or "core" personality is subdued and withdrawn, particularly in female patients. However, some core personalities, or alters, may genuinely be depressed, and may benefit from antidepressant medications. One reason misdiagnoses are common is that DID patients may truly meet the criteria for **panic disorder** or somatization disorder.

Misdiagnoses include schizophrenia, **borderline personality disorder**, and, as noted, somatization disorder and panic disorder. DID patients are often frightened by their dissociative experiences, which can include losing awareness of hours or even days of time, meeting people who claim to know them by another name, or feeling "out of body." Persons with the disorder may go to emergency rooms or clinics because they fear they are going insane.

When a doctor is evaluating a patient for DID, he or she will first rule out physical conditions that sometimes produce amnesia, depersonalization, or derealization. These conditions include head injuries; brain disease, especially seizure disorders; side effects from medications; **substance abuse** or intoxication; AIDS–dementia complex; or recent periods of extreme physical **stress** and sleeplessness. In some cases, the doctor may give the patient an electroencephalograph (EEG) to exclude **epilepsy** or other seizure disorders. The physician also must consider whether the patient is **malingering** and/or offering fictitious complaints.

If the patient appears to be physically normal, the doctor will next rule out psychotic disturbances, including schizophrenia. Many patients with DID are misdiagnosed as schizophrenic because they may "hear" their alters "talking" inside their heads. If the doctor suspects DID, he or she can use a screening test called the Dissociative Experiences Scale (DES). If the patient has a high score on this test, he or she can be evaluated further with the Dissociative Disorders Interview Schedule (DDIS) or the Structured Clinical Interview for *DSM–IV* Dissociative Disorders (SCID–D). The doctor may also use the Hypnotic Induction Profile (HIP) or a similar test of the patient's hypnotizability.

Treatment

Treatment of DID may last for five to seven years in adults and usually requires several different treatment methods.

Psychotherapy

Ideally, patients with DID should be treated by a therapist with specialized training in dissociation. This specialized training is important because the patient's personality switches can be confusing or startling. In addition, many patients with DID have hostile or suicidal alter personalities. Most therapists who treat DID patients have rules or contracts for treatment that include such issues as the patient's responsibility for his or her safety. **Psychotherapy** for DID patients typically has several stages: an initial phase for uncovering and "mapping" the patient's alters; a phase of treating the traumatic memories and "fusing" the alters; and a phase of consolidating the patient's newly integrated personality.

Most therapists who treat multiples, or DID patients, recommend further treatment after personality integration, on the grounds that the patient has not learned the social skills that most people acquire in adolescence and early adult life. In addition, **family therapy** is often recommended to help the patient's family understand DID and the changes that occur during personality reintegration.

Many DID patients are helped by group as well as individual treatment, provided that the group is limited to people with dissociative disorders. DID patients sometimes have setbacks in mixed therapy groups because other patients are bothered or frightened by their personality switches.

Medications

Some doctors will prescribe tranquilizers or antidepressants for DID patients because their alter personalities may have **anxiety** or **mood disorders**. However, other therapists who treat DID patients prefer to keep medications to a minimum because these patients can easily become psychologically dependent on drugs. In addition, many DID patients have at least one alter who abuses drugs or alcohol, substances which are dangerous in combination with most tranquilizers.

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KEY TERMS

Alter—An alternate or secondary personality in a patient with DID.

Amnesia—A general medical term for loss of memory that is not due to ordinary forgetfulness. Amnesia can be caused by head injuries, brain disease, or epilepsy as well as by dissociation.

Depersonalization—A dissociative symptom in which the patient feels that his or her body is unreal, is changing, or is dissolving.

Derealization—A dissociative symptom in which the external environment is perceived as unreal.

Dissociation—A psychological mechanism that allows the mind to split off traumatic memories or disturbing ideas from conscious awareness.

Dissociative identity disorder (DID)—Term that replaced Multiple Personality Disorder (MPD). A condition in which two or more distinctive identities or personality states alternate in controlling a person's consciousness and behavior.

Hypnosis—An induced trance state used to treat the amnesia and identity disturbances that occur in dissociative identity disorder (DID).

Multiple personality disorder (MPD)—The former, though often still used, term for dissociative identity disorder (DID).

Primary personality—The core personality of an DID patient. In women, the primary personality is often timid and passive, and may be diagnosed as depressed.

Psychotherapy—The treatment of mental and behavioral disorders by support and insight to encourage healthy behavior patterns and personality growth.

Trauma—A disastrous or life–threatening event that can cause severe emotional distress. DID is associated with trauma in a person's early life or adult experience.

Hypnosis

While not always necessary, hypnosis is a standard method of treatment for DID patients. Hypnosis may help patients recover repressed ideas and memories. Further, hypnosis can also be used to control problematic behaviors that many DID patients exhibit, such as **self–mutilation**, or **eating disorders** like **bulimia nervosa**. In the later stages of treatment, the therapist may use hypnosis to "fuse" the alters as part of the patient's personality integration process.

Alternative treatment

Alternative treatments that help to relax the body are often recommended for DID patients as an adjunct to psychotherapy and/or medication. These treatments include **hydrotherapy**, botanical medicine (primarily herbs that help the nervous system), therapeutic massage, and **yoga**. Homeopathic treatment can also be effective for some people. **Art therapy** and the keeping of journals are often recommended as ways that patients can integrate their past into their present life. **Meditation** is usually discouraged until the patient's personality has been reintegrated.

Prognosis

Some therapists believe that the prognosis for recovery is excellent for children and good for most adults. Although treatment takes several years, it is often ultimately effective. As a general rule, the earlier the patient is diagnosed and properly treated, the better the prognosis.

Prevention

Prevention of DID requires intervention in abusive families and treating children with dissociative symptoms as early as possible.

Resources

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Shams, K. *Human Relation and Personified Relational Disorders*. Raleigh, NC: lulu.com, 2009.

ORGANIZATIONS

American Academy of Child and Adolescent Psychiatry, 3615 Wisconsin Ave., NW , Washington, DC, 20016–3007, (202) 966–7300, http://www.aacap.org.

American Psychiatric Association, 1000 Wilson Blvd., Suite 1825, Arlington, VA, 22209, (703) 907–7300, apa@psych.org, http://www.psych.org/.

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American Psychological Association (APA), 750 First St. NE, Washington, DC, 20002–4242, (202) 336–5700, http://www.apa.org.

National Alliance on Mental Illness (NAMI), 3803 N. Fairfax Dr., Suite 100, Arlington, VA, 22201, (703) 524–7600, (800) 950–NAMI (6264), (703) 524–9094, http://www.nami.org/Hometemplate.cfm.

National Institute of Mental Health (NIMH), 6001 Executive Blvd., Room 8184, MSC 9663, Bethesda, MD, 20892, (301) 443–4513, (866) 615–6464, (301) 443–4279, nimhinfo@nih.gov, http://www.nimh.nih.gov/index.shtml.

National Mental Health Association (NMHA), 2000 N. Beauregard St., 6th Floor, Alexandria, VA, 22311, (703) 684–7722, (800) 969–NMHA, (703) 684–5968, http://www1.nmha.org/.

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Multiple pregnancy

Definition

A multiple **pregnancy** is a pregnancy in which more than one fetus develops in the uterus at the same time.

Demographics

Multiple pregnancies occur in 1–2% of all pregnancies. The rate of twinning (the bearing of twins) is believed to be underestimated, as twin pregnancies with a singleton birth (an offspring born singly) are usually not recorded as twins.

Multiple births are more likely to occur in women who become pregnant after the age of 35. This is because hormonal changes in the body that occur as the woman ages increase the chance of more than one egg to being released at a time. Treatment for **infertility** also increases the chance of having a multiple pregnancy.

According to the United States Centers for Disease Control and Prevention (CDC) in 2006 there were 137,085 sets of twins born in the United States, 6,118 sets of triplets, 355 sets of quadruplets, and 67 instances of quintuplets or higher order births. That is a rate of twins of 32.1 per 1,000 live births and a rate of triplets or higher order births of 153.3 per 100,000 live births.

Description

A multiple pregnancy may be the result of the natural process of twinning, or it may be the result of the woman having taken fertility drugs. Because of the increase in artificial reproductive technology (ART), the incidence of multiple pregnancies has increased. The CDC reports that since 1980 the number of twins has risen by 52% and the number of triplets and high order multiples (more than three) has increased by 404%. An older maternal age and the use of fertility techniques are seen as the two major factors in these increases. While singletons have a 10% risk of being born preterm, multiple births have a 57% chance of being born prematurely. Premature birth places a newborn at higher risk for morbidity and mortality.

There are two categories of twins: monozygotic (identical twins) and dizygotic (fraternal twins). Monozygotic twins are twins that have developed from a single fertilized ovum (egg) that splits during embryonic development. These twins have the same genetic makeup and are always the same sex. They may be surrounded by one chorion (the outer embryonic membrane of the developing fetus), or may each have their own chorion. They may be surrounded by one amniotic sac (innermost of the membranes surrounding the embryo) or may each have their own amniotic sac. They may share a placenta or may each have their own placenta. These different possibilities depend on the time of the embryonic development at which the division took place. About 2–5% of monozygotic twins will share one amniotic sac. This rare occurrence puts the twins at risk for umbilical cord entanglement, cessation of blood flow, and **death**. Double survival of monoamniotic twins is rare.

Dizygotic twins develop from two fertilized ova. Their genetic makeup is different, and they are no more similar as any two siblings in a family. They may be the same or different sex. Each has its own chorion, amniotic sac, and placenta. While each twin has its own placenta, the placental implantations may be close enough that they fuse into one.

Multiple pregnancies of three or more fetuses may be the result of a single fertilized egg that splits, of multiple egg fertilizations, or a combination of the two processes.

Twins may not grow at the same rate. A 25% or more disparity in their growth is referred to as discordance, which occurs in about 10% of twin pregnancies. An extreme case of discordance occurs in the condition called twin-to-twin **transfusion**, also known as twin **oligohydramniospolyhydramnios** sequence. In

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A 3D ultrasound image of twin fetuses. *(© Medical-on-Line/Alamy.)*

this situation, one twin becomes the donor twin (receives too little blood from vessels in the fetuses' shared placenta that connect their blood circulations) and the other twin is the recipient (receives too much blood). The donor twin becomes small, pale, hypotensive, and anemic, with very little amniotic fluid. The recipient twin is large, polycythemic, hypertensive, with an excess of amniotic fluid. Both are at risk for **heart failure** and death.

Causes and symptoms

In a woman's menstrual cycle, one egg, or ovum, is normally released every month. If more than one egg is released, it is possible for each egg to be fertilized separately by different sperm cells. Fertility drugs encourage the release of more than one egg during the monthly menstrual cycle. In the case of monozygotic twins, only one egg was released and fertilized; but after fertilization it split, and separate fetuses developed. If the split is not complete, conjoined twins develop. Conjoined twins share certain body parts and organs. They may be referred to as Siamese twins. The chance of multiple pregnancy increases with an increase in maternal age. Genetics and racial background also play a role.

Diagnosis

A multiple pregnancy is suspected if the woman's uterus is growing too quickly for the gestational age, with excessive maternal weight gain, elevated levels of alpha-fetoprotein (a fetal protein that increases in the mother's blood during pregnancy) levels, unexplained severe maternal anemia, or with the auscultation (listening to sound to aid in diagnosis and treatment) of more than one fetal heartbeat. If undiagnosed at the time of quickening, the mother may feel movement in different parts of the uterus at the same time. Ultrasound can confirm the presence of a multiple pregnancy. Once the multiple pregnancy is confirmed,

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ultrasonography may be used to check fetal growth over time, and the presence of any anomalies.

While a mother carrying a singleton may have one ultrasound done during the pregnancy, the mother of a multiple pregnancy is much more likely to have several ultrasounds done. The experience, skill, and ability of the ultrasound technician to provide a calm environment can be a great help to the mother and her partner. The nurse working in a high-risk obstetric practice can provide a great deal of teaching both to inform the mother about what to expect and to decrease **anxiety** through knowledge.

A condition referred to as vanishing twin syndrome occurs in up to 50% of twin pregnancies diagnosed very early by ultrasound. This syndrome occurs when a twin pregnancy was diagnosed, but later one twin is found to have disappeared. It is not clear what causes this syndrome. In these cases, there may have been early pregnancy vaginal bleeding and a lower human chorionic gonadotropin (hCG; a type of hormone) level than would be expected. The placenta often shows a whitish area and the remnant of a gestational sac. The mother and surviving twin (born singly) are generally both healthy.

Treatment

The diagnosis of a multiple pregnancy will result in it being treated as a **high-risk pregnancy** because of associated maternal and fetal risks. In a triplet pregnancy the mother may be offered the choice of selective reduction to twins. However, the literature is unclear as to the overall value of reduction from three to two fetuses. In high order multiples, to decrease the risk of very early preterm birth and potential loss of fetal viability, selective reduction may take place. In selective reduction, high order multiples are reduced to triplets or twins. The procedure is usually completed before the end of the third month of gestation and involves a chemical injection into one or more developing embryos. A fetus that shows chromosomal damage is usually targeted first. While this process increases the chances of the viability of the remaining fetuses, it carries a significant emotional burden for the parents. It also raises ethical issues concerning the "right-to-life" of a fetus. Efforts are being made in the field of ART to prevent the development of high order multiples in order to avoid this situation as much as possible.

Prognosis

Prognosis for a multiple pregnancy depends on many factors. The higher the number of fetuses, the greater the risks. A twin pregnancy carries significantly more risks than a singleton pregnancy. The risks for triplets are similar to that of twins. The risks increase significantly with multiples of four or higher. Twins have a ten-fold risk of perinatal mortality over singletons.

While many multiple pregnancies have an excellent outcome, multiple pregnancy is still considered a high-risk pregnancy. The average gestation for a singleton is 38 to 42 weeks. For twins gestation averages 37 weeks; for triplets, 33 weeks; and for quadruplets, 31 weeks. The mother carrying a multiple pregnancy has an increased risk of:

- premature birth
- pregnancy-related hypertension and preeclampsia
- hydramnios (excess amniotic fluid)

LOUIS GERALD KEITH (1935–)

Louis Gerald Keith and his twin brother, Donald, were born on April 24, 1935, to Russian immigrants. Although the boys received much attention due to their status as twins, their parents encouraged them to pursue their own goals, and at age twelve, Louis decided he wanted to become a doctor. After completing his bachelor of science degree at the University of Illinois, Keith entered the Chicago Medical school, graduating with his degree in 1960. He joined the U.S. Public Health Service and was stationed in Puerto Rico after completing his residency and internship at Cook County Hospital. Keith returned to Chicago after receiving his certification in obstetrics and gynecology in 1967 and worked as a professor and a physician.

Keith began his research on twins when a friend's twin brother died of lymphoma. The fact that Keith was a twin made his research more personally fulfilling and worthwhile to him. Keith and Donald founded the Center for the Study of Multiple Birth in 1977 located in Chicago. The center, a non-profit facility, was the first multiple birth research organization in the United States. Keith has delivered many speeches and has published various study results. In addition to books and scientific articles written individually and cooperatively, he was co-author of *Multiple Pregnancy: Epidemiology, Gestation and Prenatal Outcome* (1996) with his brother Donald, and others. He was previously the chief obstetrician at the Prentice Women's Hospital and Maternity Center in Chicago, and is currently Professor of Obstetrics and Gynecology and Director of the Section of Undergraduate Education and Medical Student Affairs at Northwestern University Medical School in Chicago.

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- placenta previa (placenta covering the mouth of the womb-cervix)
- folic acid and iron deficiency
- gestational diabetes
- urinary tract infection
- placental abruption after the vaginal delivery of the first twin (separation of the placenta from the uterus before the baby is born)
- uterine atony (failure of the uterus to contract after birth) and postpartal hemorrhage due to exaggerated stretching of the uterus
- fatigue and backache
- cesarean delivery

The risks to fetuses in a multiple pregnancy are greater than that for a singleton and include:

- premature birth (Preterm labor for twins is seven to ten times more likely than for singletons and is a significant factor in perinatal morbidity and mortality.)
- intrauterine growth restriction
- congenital anomalies
- cerebral palsy with increased risk often due to preterm delivery
- discordance; more common with triplets than with twins
- dead fetus syndrome
- combined pregnancy, in which one twin develops in the uterus while the other is ectopic (other than in the uterus, such as the fallopian tube or peritoneal cavity)
- delayed delivery of second twin
- placental abruption

Prevention

Twinning is a naturally occurring phenomenon and cannot be completely prevented. It occurs more often in older mothers. Multiple births due to ART are a concern because a multiple pregnancy represents a complication of pregnancy. Efforts within the ART community are being made to minimize the incidence of high order multiples. Efforts to prevent or minimize maternal and fetal complications will result in closer monitoring. More frequent ultrasounds, biophysical profile, and/or nonstress tests may be ordered. Cervical length and change may be monitored as an indicator of preterm delivery. If both twins are vertex and vaginal delivery is attempted, both fetal heart rates will be monitored. Cesarean deliveries of twins are more common than for singletons. This is especially true in high order multiples. The overall cesarean delivery rate tends to be about 75%.

KEY TERMS

Chorion—The outer embryonic membrane of the developing fetus that gives rise to the placenta. Inside the chorion is the amniotic sac or sacs, inside of which are the fetuses.

Morbidity—Morbidity refers to an illness or disease condition. In statistics it refers to the rate at which a disease occurs.

Mortality—Mortality means death. In statistics it refers to the rate at which death occurs in a population for a particular disease condition.

Singleton—A singleton is a fetus that develops alone in the uterus.

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Melamid, Nir, Yariv Yogev, and Marek Glezerman. "Effect of Fetal Sex on Pregnancy Outcome in Twin Pregnancies." *Obstetrics & Gynecology,* (November 2009), 114(5), 1085-92.

ORGANIZATIONS

American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, IL, 60007-1098, (847)434-4000, (847)434-8000, http://www.aap.org.

Center for the Study of Multiple Birth, 33 East Superior Street, Suite 464, Chicago, IL, 60611, (312)695-1677, (312)908-8777, www.multiplebirth.com.

National Organization of Mothers of Twins Clubs, 2000 Mallory Lane, Suite 130-600, Franklin, TN, 37067, (248) 231-4480, info@nomotc.org, www.nomotc.org.

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Multiple sclerosis

Definition

Multiple sclerosis (MS) is a chronic autoimmune disorder affecting movement, sensation, and bodily functions. It is caused by destruction of the myelin insulation covering nerve fibers (neurons) in the central nervous system (brain and spinal cord).

Demographics

In 2008, multiple sclerosis affected about 400,000 people in the United States, with 10,000 new cases being diagnosed each year. Worldwide, MS affects between 1.5 and 2.5 million people. Most people have their first symptoms between the ages of 20 and 40; symptoms rarely begin before age 15 or after age 60. Women are almost twice as likely to get MS as men, especially in their early years. People of northern European ancestry are more likely to be affected than people of other racial backgrounds, and MS rates are higher in the United States, Canada, and Northern Europe than other parts of the world. The disorder is unknown among certain native peoples such as the Inuit (native people of the Arctic) and Maori (Native people of New Zealand).

Description

Multiple sclerosis is a slowly progressive disease of the central nervous system (CNS), which is comprised of the brain and spinal cord. In 1868, French physician Jean-Martin Charcot (1825-1893) provided the first detailed clinical description of the disease. Today researchers know that MS is an autoimmune disorder that causes the destruction of myelin, the insulating material that surrounds nerve fibers (neurons). Myelin helps electrical signals pass quickly and smoothly between the brain and the rest of the body. When the myelin layer is destroyed, nerve messages are sent more slowly and less efficiently. Patches of scar tissue, called plaques, form over the affected areas, further disrupting nerve communication. The symptoms of MS occur when the brain and spinal cord nerves no longer communicate properly with other parts of the body. MS causes a wide variety of symptoms and can affect vision, balance, strength, sensation, coordination, and bodily functions.

Risk factors

The risk of developing MS is slightly higher if another family member is affected, suggesting the influence of genetic factors. If one person in a family has MS, then that person's close family relatives (parents, children, siblings) have about a 5% greater chance of developing MS than people who do not have family members with the disorder. In addition, the higher prevalence of MS among people of northern European background suggests some genetic susceptibility.

Causes and symptoms

Causes

Multiple sclerosis is an autoimmune disorder, meaning it is caused by the body's own immune system. For unknown reasons, immune cells attack and destroy the myelin sheath that insulates neurons in the brain and spinal cord. This myelin sheath speeds transmission of nerve impulses and prevents electrical activity in one cell from short-circuiting to another cell. Disruption of communication between the brain and other parts of the body prevents normal passage of sensations and control messages, leading to the symptoms of MS. The demyelinated areas appear as plaques, small round areas of gray neuron without the white myelin covering. The progression of symptoms in MS is correlated with development of new plaques in the portion of the brain or spinal cord controlling the affected areas. Because there appears to be no pattern in the appearance of new plaques, the progression of MS can be unpredictable.

Despite considerable research, the trigger for this autoimmune destruction is still unknown. At various times, evidence has pointed to genes, environmental factors, viruses, or a combination of these.

The fact that the risk of developing MS is slightly higher if another family member is affected, suggests that there is a genetic susceptibility to the disease.

The role of an environmental factor is suggested by studies of the effect of migration on the risk of developing MS. Age plays an important role in determining this change in risk—young people in low-risk groups who move into countries with higher MS rates display the risk rates of their new surroundings, while older migrants retain the risk rate of their original home country. One interpretation of these studies is that an environmental factor, either protective or harmful, is acquired in early life; the risk of disorder later in life reflects the effects of the early environment.

These same data can be used to support the involvement of a slow-acting virus, one that is acquired early in live but begins its destructive effects much later.

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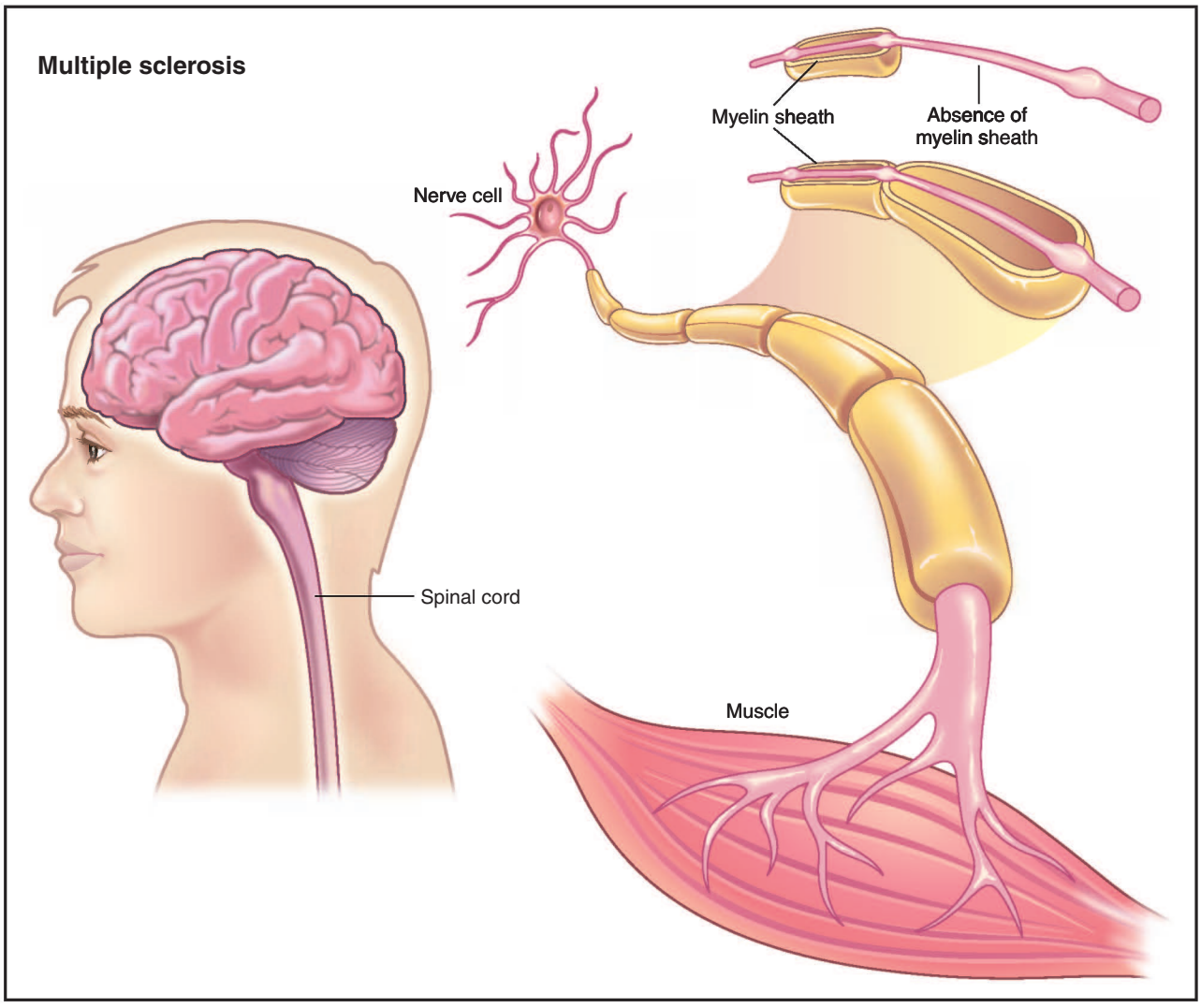

Multiple sclerosis (MS) is an autoimmune disease in which immune cells attack and destroy the myelin sheath, which stimulates neurons in the brain and spinal cord. When the myelin is destroyed, nerve messages are sent more slowly and less efficiently. Scar tissue then forms over the affected areas, disrupting nerve communication. MS symptoms occur when the brain and spinal cord nerves cease to communicate properly with other parts of the body. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Slow viruses are known to cause other disorders, including **AIDS**. In addition, viruses have been implicated in other **autoimmune disorders**. Many claims have been made for the role of viruses, slow or otherwise, as the trigger for MS, but as of 2009 no strong candidate has emerged.

How a virus could trigger the autoimmune reaction is also unclear. There are two main models of virally induced autoimmunity. The first suggests the immune system is actually attacking a virus (one too well-hidden for detection in the laboratory), and the myelin damage is an unintentional consequence of fighting the infection. The second model suggests the immune system mistakes myelin for a viral protein, one it encountered during a prior infection. Primed for the attack, it destroys myelin because it resembles the previously recognized viral invader.

Either of these models allows a role for genetic factors, since certain genes can increase the likelihood of autoimmunity, and it seems likely that more than one gene is involved in a person's susceptibility to MS. Environmental factors as well might change the sensitivity of the immune system or interact with myelin to provide the trigger for the secondary immune

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response. Possible environmental triggers that have been invoked in MS include viral infection, trauma, electrical injury, and chemical exposure, although controlled studies do not support a causative role.

Symptoms

MS is a diverse disease. No two affected persons are the same and each will experience different combinations of symptoms with differing severity. The symptoms of multiple sclerosis may occur in one of three patterns:

- The most common pattern is the relapsing-remitting pattern, in which there are clearly defined symptomatic attacks lasting 24 hours or more, followed by complete or almost complete improvement. The period between attacks may be a year or more at the beginning of the disorder, but may shrink to several months later on. About three-quarters of all people diagnosed with MS have this version of the disorder. This pattern is especially common in younger people who develop MS.
- In the primary progressive pattern, the disorder progresses without remission or with only occasional plateaus or slight improvements. This pattern is more common in older people. About 10% of people with the disorder have this pattern.
- In the secondary progressive pattern, the person with MS begins with relapses and remissions, followed by more steady progression of symptoms. In some people, what begins as a relapsing-remitting pattern develops into a secondary progressive pattern.

Between 10–20% of people have a benign type of MS, meaning their symptoms progress very little over the course of their lives.

Because plaques may form in any part of the central nervous system, the symptoms of MS vary widely from person-to-person and from stage-to-stage of the disorder. Initial symptoms often include:

- muscle weakness, causing difficulty walking
- loss of coordination or balance
- numbness, "pins and needles," (paresthesias) or other abnormal sensations
- visual disturbances, including blurred or double vision.

later symptoms may include:

- Fatigue
- muscle spasticity and stiffness
- tremors
- paralysis
- pain
- vertigo
- speech or swallowing difficulty
- loss of bowel and bladder control
- incontinence, constipation
- sexual dysfunction
- cognitive changes.

Weakness in one or both legs is common, and may be the first symptom noticed by a person with MS. Muscle spasticity, where muscles are excessive and continuously contracted, is also common and may be more disabling than weakness.

Double vision or eye tremor (**nystagmus**) may result from involvement of the nerve pathways controlling movement of the eye muscles. Visual disturbances result from involvement of the optic nerves (**optic neuritis**) and may include development of blind spots in one or both eyes, changes in color vision, or blindness. Optic neuritis usually involves only one eye at a time and is often associated with movement of the effected eye.

More than half of all people affected by MS have **pain** during the course of their disorder, and many experience chronic pain, including pain from spasticity. Acute pain occurs in about 10% of cases. This pain may be a sharp, stabbing pain especially in the face, neck, or down the back. Facial **numbness** and weakness are also common.

Cognitive changes, including memory disturbances, depression, and personality changes, are found in people affected by MS, although it is not entirely clear whether these changes are due primarily to the disorder or to the psychological reaction to it. Depression may be severe enough to require treatment in up to 25% of those with MS. A smaller number of people experience disorder-related euphoria, or abnormally elevated mood, usually after a long disorder duration and in combination with other psychological changes.

Symptoms of MS may be worsened by heat or increased body temperature, including **fever**, intense physical activity, or exposure to sun, hot baths, or showers.

Diagnosis

There is no single test that confirms the diagnosis of multiple sclerosis, and there are a number of other disorders with similar symptoms. While one person's diagnosis may be immediately suggested by symptoms and history, another's may not be confirmed without multiple tests and prolonged observation. The distribution of symptoms is important: MS affects multiple areas of the body over time. The pattern of symptoms is also critical, especially as evidence of the relapsing-

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KEY TERMS

Clinical trial—All new drugs undergo clinical trials before approval. Clinical trials are carefully conducted tests in which effectiveness and side effects are studied, with the placebo effect eliminated.

Evoked potentials—Tests that measure the brain's electrical response to stimulation of sensory organs (eyes or ears) or peripheral nerves (skin). These tests may help confirm the diagnosis of multiple sclerosis.

Myelin—A layer of insulation that surrounds the nerve fibers in the brain and spinal cord.

Plaque—Patches of scar tissue that form where the layer of myelin covering the nerve fibers is destroyed by the multiple sclerosis disorder process.

Primary progressive—A pattern of symptoms of multiple sclerosis in which the disorder progresses without remission, or with occasional plateaus or slight improvements.

Relapsing-remitting—A pattern of symptoms of multiple sclerosis in which symptomatic attacks occur that last 24 hours or more, followed by complete or almost complete improvement.

Secondary progressive—A pattern of symptoms of multiple sclerosis in which there are relapses and remissions, followed by more steady progression of symptoms.

remitting pattern, so a detailed medical history is one of the most important parts of the diagnostic process. A thorough search to exclude other causes of a patient's symptoms is especially important if the following features are present: 1) family history of neurologic disorder, 2) symptoms and findings attributable to a single anatomic location, 3) persistent back pain, 4) age of onset over 60 or under 15 years of age, or 5) progressively worsening disorder.

Tests

In addition to the medical history and a standard **neurological exam**, several lab tests are used to help confirm or rule out a diagnosis of MS:

- Magnetic resonance imaging (MRI) can reveal plaques on the brain and spinal cord. Gadolinium enhancement can distinguish between old and new plaques, allowing a correlation of new plaques with new symptoms. Plaques may be seen in several other disorders as well, including encephalomyelitis, neurosarcoidosis, and cerebral lupus. Plaques on MRI may be difficult to distinguish from small strokes, areas of decreased blood flow, or changes seen with trauma or normal aging.
- A lumbar puncture, or spinal tap, is done to measure levels of immune system proteins, which are usually elevated in the cerebrospinal fluid of a person with MS. This test may not be necessary if other tests are diagnostic.
- Evoked potential tests are electrical tests of conduction speed in the nerves that can reveal reduced speeds consistent with the damage caused by plaques. These tests may be done with small electrical charges applied to the skin (somatosensory evoked potential), with light patterns flashed on the eyes (visual evoked potential), or with sounds presented to the ears (auditory evoked potential).

The clinician making the diagnosis, usually a neurologist, may classify the disorder as "definite MS," meaning the symptoms and test results all point toward MS as the cause. "Probable MS" and "possible MS" reflect less certainty and may require more time to pass to observe the progression of the disorder and the distribution of symptoms.

Treatment

As of 2009, there was no cure for MS. Nevertheless, several drugs may slow progression of the disorder and moderate some symptoms in many patients, especially if started early.

MS causes a wide variety of symptoms, and the treatments for these are equally diverse. Most symptoms can be treated and complications avoided with good care and attention from medical professionals. Good health and **nutrition** remain important preventive measures. **Vaccination** against **influenza** can prevent respiratory complications. Preventing complications such as **pneumonia**, **bedsores**, injuries from falls, or urinary infection requires attention to the primary problems that may cause them. Shortened life spans with MS are almost always due to complications rather than primary symptoms themselves.

Drugs

Drug treatment of MS must be individualized. Not all drugs are appropriate for all patients. In the United States as of 2009, MS was most often treated with four drugs known as the ABCR drugs. These drugs are

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interferon beta-1a (Avonex), interferon beta-1b (Betaseron and Rebif) and glatiramer acetate (Copaxone). These drugs, on average, reduce relapses in the relapsing-remitting form of MS by about one-third. Different measurements from tests of each have demonstrated other benefits as well: Avonex may slow the progress of physical impairment, Betaseron and Rebif may reduce the severity of symptoms, and Copaxone may decrease disability. All four drugs are administered by injection, some into muscle (IM), and some under the skin (SC). Some controversy exists on the most effective dose and the frequency with which these drugs should be administered.

Although the ABCR drugs reduce relapses and may keep patients in relatively good health for the short-term, their long-term success has not been proven and they do not work well for patients who have reached a steadily progressive stage of MS. Individuals with progressive forms of MS may be treated with mitoxantrone (Novantrone), cyclophosphamide (Cytoxan, Neosar), azathioprine (Imuran), or methotrexate (Rheumatrex). All these drugs suppress the immune system. None is ideal, and all have potentially serious side effects. Corticosteroid drugs such as methylprednisolone (Medrol) also may be used to reduce inflammation. Long-term use of **corticosteroids** also causes serious side effects.

Training in bowel and bladder care may be needed to prevent or compensate for incontinence. If the urge to urinate becomes great before the bladder is full, some drugs may be helpful, including propantheline bromide (Probanthine), oxybutynin chloride (Ditropan), or imipramine (Tofranil). Baclofen (Lioresal) may relax the sphincter muscle, allowing full emptying. Intermittent catheterization is effective in controlling bladder dysfunction. In this technique, a catheter is used to periodically empty the bladder.

Spasticity can be treated with oral medications, including baclofen and diazepam (Valium), or by injection with botulinum toxin (Botox). Spasticity relief may also bring relief from chronic pain. More acute types of pain may respond to carbamazepine (Tegretol) or diphenylhydantoin (Dilantin). **Low back pain** is common from increased use of the back muscles to compensate for weakened legs. **Physical therapy** and over-the-counter pain relievers may help.

Fatigue may be partially avoidable with changes in the daily routine to allow more frequent rests. Amantadine (Symmetrel) and Modafinil (Provigil), although not specifically approved for use with MS, are often used to treat fatigue and improve alertness. Pemoline (Cylert), a drug formerly used to treat fatigue in MS patients, was withdrawn from sale in the United States in October 2005 because of potentially fatal liver complications. Visual disturbances often respond to corticosteroids. Other symptoms that may be treated with drugs include seizures, vertigo, and tremor.

Clinical trials of new drugs and drug combinations to treat MS are ongoing. Individuals with MS who wish to participate in the trial of an experimental therapy can find a list of clinical trials currently enrolling volunteers at http://clinicaltrials.gov. There is no cost to the patient to participate in a clinical trial.

Rehabilitative therapy

Physical therapy helps the person with MS to strengthen and retrain affected muscles, maintain range of motion, prevent muscle stiffening, learn to use assistive devices such as canes and walkers, and to learn safer and more energy-efficient ways of moving, sitting, and transferring. **Exercise** and stretching programs are usually designed by the physical therapist and taught to the patient and caregivers for use at home. Exercise is an important part of maintaining function for the person with MS. Swimming is often recommended, not only for its low-impact workout, but also because it allows strenuous activity without overheating.

Occupational therapy helps the person with MS adapt to her environment and adapt the environment to her. The occupational therapist suggests alternate strategies and assistive devices for activities of daily living, such as dressing, feeding, and washing, and evaluates the home and work environment for safety and efficiency improvements that may be made.

Alternative

Bee venom has been suggested as a treatment for MS, but no studies or objective reports support this claim.

In several studies, **marijuana** has been shown to have variable effects on the symptoms of MS. Improvements have been documented for tremor, pain, and spasticity, and worsening for posture and balance. Side effects have included weakness, **dizziness**, relaxation, and incoordination, as well as euphoria.

Some studies support the value of high doses of **vitamins**, **minerals**, and other dietary supplements for controlling disorder progression or improving symptoms. Alpha-linoleic and linoleic acids, as well as selenium and vitamin E, have shown effectiveness in the treatment of MS. Selenium and vitamin E act as **antioxidants**. In addition, a diet low in saturated fats, maintained over a long period, may retard the disorder process.

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Studies have also shown that t'ai chi can be an effective therapy for MS because it works to improve balance and increase strength.

There are conflicting views about the herb **Echinacea** and its benefit to MS. Some alternative practitioners recommend Echinacea for people with MS. However, Echinacea appears to stimulate different parts of the immune system, particularly immune cells known as macrophages. In MS these cells are very active already and further stimulation could worsen the disorder.

Prognosis

It is difficult to predict how multiple sclerosis will progress in any one person. Most people with MS will be able to continue to walk and function at their work for many years after their diagnosis. The factors associated with the mildest course of MS are being female, having the relapsing-remitting form, having the first symptoms at a younger age, having longer periods of remission between relapses, and initial symptoms of decreased sensation or vision rather than of weakness or incoordination.

Fewer than 5% of people with MS have a severe progressive form, leading to **death** from complications within five years. At the other extreme, 10–20% have a benign form, with a very slow or no progression of their symptoms. Studies have shown that about seven out of 10 people with MS are still alive 25 years after their diagnosis, compared to about nine out of 10 people of similar age without disorder. On average, MS shortens the lives of affected women by about six years, and men by 11 years. **Suicide** is a significant cause of death in MS, especially in younger patients. Suicide is completed 7.5 times more often in patients with MS than in those without the disorder.

The degree of disability a person experiences five years after onset is, on average, about three-quarters of the expected disability at 10–15 years. A benign course for the first five years usually indicates the disorder will not cause marked disability.

Prevention

There is no known way to prevent multiple sclerosis. Until the cause of the disorder is discovered, this is unlikely to change. Good nutrition, adequate rest, avoidance of **stress**, heat, and extreme physical exertion, and good bladder hygiene may improve quality of life and reduce symptoms.

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ORGANIZATIONS

Multiple Sclerosis Foundation (MSF), 6350 North Andrews Avenue, Fort Lauderdale, FL, 33309-2130, (954) 776-6805, (888) MS-FOCUS, (954) 351-0630, support@msfocus.org, http://www.msfacts.org.

National Institute of Neurological Disorders and Stroke (NINDS), P.O. Box 5801, Bethesda, MD, 20828, (301) 496-5751. TTY: (301) 468-5981, (800) 352-9424, http://www.ninds.nih.gov.

National Multiple Sclerosis Society, 733 Third Avenue, New York, NY, 10017, (800) 344-4867, http://www.nmss.org.

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Mumps

Definition

Mumps is a relatively mild short-term viral infection of the salivary glands that usually occurs during childhood. Typically, mumps is characterized by a painful swelling of both cheek areas, although the person could have swelling on one side or no perceivable swelling at all. The salivary glands are also called the parotid glands, therefore, mumps is sometimes referred to as an inflammation of the parotid glands (epidemic parotitis). The word mumps comes from an old English dialect, meaning lumps or bumps within the cheeks.

Description

Mumps is a very contagious infection that spreads easily in such highly populated areas as day care centers and schools. Although not as contagious as **measles** or **chickenpox**, mumps was once quite common. Prior to the release of a mumps vaccine in the United States in 1967, approximately 92% of all children had

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A young child with mumps. *(SPL/Photo Researchers, Inc.)*

been exposed to mumps by the age of 15. In these pre-vaccine years, most children contracted mumps between the ages of four and seven. Mumps epidemics came in two to five year cycles. The greatest mumps epidemic was in 1941 when approximately 250 cases were reported for every 100,000 people. In 1968, the year after the live mumps vaccine was released, only 76 cases were reported for every 100,000 people. By 1985, less than 3,000 cases of mumps were reported throughout the entire United States, which works out to about 1 case per 100,000 people. The reason for the decline in mumps was the increased usage of the mumps vaccine. However, 1987 noted a five-fold increase in the incidence of the disease because of the reluctance of some states to adopt comprehensive school immunization laws. Since then, state-enforced school entry requirements have achieved student immunization rates of nearly 100% in kindergarten and first grade. In 1996, the Centers for Disease Control and Prevention (CDC) reported only 751 cases of mumps nationwide, or, in other words, about one case for every five million people.

Causes and symptoms

The paramyxovirus that causes mumps is harbored in the saliva and is spread by sneezing, coughing, and other direct contact with another person's infected saliva. Once the person is exposed to the virus, symptoms generally occur in 14-24 days. Initial symptoms include chills, **headache**, loss of appetite, and a lack of energy. However, an infected person may not experience these initial symptoms. Swelling of the salivary glands in the face (parotitis) generally occurs within 12-24 hours of the above symptoms. Accompanying the **swollen glands** is **pain** on chewing or swallowing, especially with acidic beverages, such as lemonade. A **fever** as high as 104°F (40°C) is also common. Swelling of the glands reaches a maximum on about the second day and usually disappears by the seventh day. Once a person has contracted mumps, they become immune to the disease, despite how mild or severe their symptoms may have been.

While the majority of cases of mumps are uncomplicated and pass without incident, some complications can occur. Complications are, however, more noticeable in adults who get the infection. In 15% of cases, the covering of the brain and spinal cord becomes inflamed (**meningitis**). Symptoms of meningitis usually develop within four or five days after the first signs of mumps. These symptoms include a stiff neck, headache, **vomiting**, and a lack of energy. Mumps meningitis is usually resolved within seven days, and damage to the brain is exceedingly rare.

The mumps infection can spread into the brain causing inflammation of the brain (**encephalitis**). Symptoms of mumps encephalitis include the inability to feel pain, seizures, and high fever. Encephalitis can occur during the parotitis stage or one to two weeks later. Recovery from mumps encephalitis is usually complete, although complications, such as seizure disorders, have been noted. Only about 1 in 100 with mumps encephalitis dies from the complication.

About one-quarter of all post-pubertal males who contract mumps can develop a swelling of the scrotum (**orchitis**) about seven days after the parotitis stage. Symptoms include marked swelling of one or both testicles, severe pain, fever, **nausea**, and headache. Pain and swelling usually subside after five to seven days, although the testicles can remain tender for weeks.

Girls occasionally suffer an inflammation of the ovaries, or oophoritis, as a complication of mumps, but this condition is far less painful than orchitis in boys.

As of late 2002, some researchers in Europe are studying the possibility that mumps increases a person's risk of developing inflammatory bowel disease (IBD) in later life. This hypothesis will require further research, as present findings are inconclusive.

Diagnosis

When mumps reaches epidemic proportions, diagnosis is relatively easy on the basis of the physical symptoms. The doctor will take the child's temperature, gently palpate (touch) the skin over the parotid glands, and look inside the child's mouth. If the child has mumps, the openings to the ducts inside the mouth will be slightly inflamed and have a "pouty" appearance. With so many people vaccinated today, a case of

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KEY TERMS

Asymptomatic—Persons who carry a disease and may be capable of transmitting the disease but who do not exhibit symptoms of the disease are said to be asymptomatic.

Autism—A severe developmental disorder that usually begins before three years of age and affects a child's social as well as intellectual development. Some researchers theorized that immunization with the MMR vaccine was a risk factor for autism.

Encephalitis—Inflammation of the brain.

Epidemic parotitis—The medical name for mumps.

Immunoglobulin G (IgG)—A group of antibodies against certain viral infections that circulate in the bloodstream. One type of IgG is specific against the mumps paramyxovirus.

Meningitis—Inflammation of the membranes covering the brain and spinal cord.

Orchitis—Inflammation or swelling of the scrotal sac containing the testicles.

Paramyxovirus—A genus of viruses that includes the causative agent of mumps.

Parotitis—Inflammation and swelling of the salivary glands.

mumps must be properly diagnosed in the event the salivary glands are swollen for reasons other than viral infection. For example, in persons with poor **oral hygiene**, the salivary glands can be infected with bacteria. In these cases, **antibiotics** are necessary. Also in rare cases, the salivary glands can become blocked, develop tumors, or swell due to the use of certain drugs, such as iodine. A test can be performed to determine whether the person with swelling of the salivary glands actually has the mumps virus.

As of late 2002, researchers in London have reported the development of a bioassay for measuring mumps-specific IgG. This test would allow a doctor to check whether an individual patient is immune to mumps, and allow researchers to measure the susceptibility of a local population to mumps in areas with low rates of **vaccination**.

Treatment

When mumps does occurs, the illness is usually allowed to run its course. The symptoms, however, are treatable. Because of difficulty swallowing, the most important challenge is to keep the patient fed and hydrated. The individual should be provided a soft diet, consisting of cooked cereals, mashed potatoes, broth-based soups, prepared baby foods, or foods put through a home food processor. **Aspirin**, **acetaminophen**, or ibuprofen can relieve some of the pain due to swelling, headache, and fever. Avoid fruit juices and other acidic foods or beverages that can irritate the salivary glands. Avoid dairy products that can be hard to digest. In the event of complications, a physician should be contacted at once. For example, if orchitis occurs, a physician should be called. Also, supporting the scrotum in a cotton bed on an adhesive-tape bridge between the thighs can minimize tension. Ice packs are also helpful.

Alternative treatment

Acupressure can be used effectively to relieve pain caused by swollen glands. The patient can, by using the middle fingers, gently press the area between the jawbone and the ear for two minutes while breathing deeply.

A number of homeopathic remedies can be used for the treatment of mumps. For example, belladonna may be useful for flushing, redness, and swelling. Bryonia (wild hops) may be useful for irritability, lack of energy, or thirst. Phytolacca (poke root) may be prescribed for extremely swollen glands. A homeopathic physician should always be consulted for appropriate doses for children, and remedies that do not work within one day should be stopped. A homeopathic preparation of the mumps virus can also be used prophylactically or as a treatment for the disease.

Several herbal remedies may be useful in helping the body recover from the infection or may help alleviate the discomfort associated with the disease. **Echinacea** (*Echinacea* spp.) can be used to boost the immune system and help the body fight the infection. Other herbs taken internally, such as cleavers (*Galium aparine*), calendula (*Calendula officinalis*), and phytolacca (poke root), target the lymphatic system and may help to enhance the activity of the body's internal filtration system. Since phytolacca can be toxic, it should only be used by patients under the care of a skilled practitioner. Topical applications are also useful in relieving the discomfort of mumps. A cloth dipped in a heated mixture of vinegar and cayenne

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(*Capsicum frutescens*) can be wrapped around the neck several times a day. Cleavers or calendula can also be combined with vinegar, heated, and applied in a similar manner.

Prognosis

When mumps is uncomplicated, prognosis is excellent. However, in rare cases, a relapse occurs after about two weeks. Complications can also delay complete recovery.

Prevention

A vaccine exists to protect against mumps. The vaccine preparation (MMR) is usually given as part of a combination injection that helps protect against measles, mumps, and **rubella**. MMR is a live vaccine administered in one dose between the ages of 12-15 months, 4-6 years, or 11-12 years. Persons who are unsure of their mumps history and/or mumps vaccination history should be vaccinated. Susceptible health care workers, especially those who work in hospitals, should be vaccinated. Because mumps is still prevalent throughout the world, susceptible persons over age one who are traveling abroad would benefit from receiving the mumps vaccine.

The mumps vaccine is extremely effective, and virtually everyone should be vaccinated against this disease. There are, however, a few reasons why people should *not* be vaccinated against mumps:

- Pregnant women who contract mumps during pregnancy have an increased rate of miscarriage, but not birth defects. As a result, pregnant women should not receive the mumps vaccine because of the possibility of damage to the fetus. Women who have had the vaccine should postpone pregnancy for three months after vaccination.
- Unvaccinated persons who have been exposed to mumps should not get the vaccine, as it may not provide protection. The person should, however, be vaccinated if no symptoms result from the exposure to mumps.
- Persons with minor fever-producing illnesses, such as an upper respiratory infection, should not get the vaccine until the illness has subsided.
- Because mumps vaccine is produced using eggs, individuals who develop hives, swelling of the mouth or throat, dizziness, or breathing difficulties after eating eggs should not receive the mumps vaccine.
- Persons with immune deficiency diseases and/or those whose immunity has been suppressed with anticancer drugs, corticosteroids, or radiation should not receive the vaccine. Family members of immunocompromised people, however, should get vaccinated to reduce the risk of mumps.
- The CDC recommends that all children infected with human immunodeficiency disease (HIV) who are asymptomatic should receive an the MMR vaccine at 15 months of age.

The mumps vaccine has been controversial in recent years because of concern that its use was linked to a rise in the rate of childhood **autism**. The negative publicity given to the vaccine in the mass media led some parents to refuse to immunize their children with the MMR vaccine. One result has been an increase in the number of mumps outbreaks in several European countries, including Italy and the United Kingdom.

In the fall of 2002, the *New England Journal of Medicine* published a major Danish study disproving the hypothesis of a connection between the MMR vaccine and autism. A second study in Finland showed that the vaccine is not associated with aseptic meningitis or encephalitis as well as autism. Since these studies were published, American primary care physicians have once again reminded parents of the importance of immunizing their children against mumps and other childhood diseases.

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ORGANIZATIONS

American Academy of Pediatrics (AAP), 141 Northwest Point Boulevard, Elk Grove Village, IL, 60007-1098, (847) 434-4000, (847) 424-8000, kidsdocs@aap.org, http://www.aap.org.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

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Munchausen syndrome

Definition

Munchausen syndrome is a psychiatric disorder that causes an individual to self-inflict injury or illness or to fabricate symptoms of physical or mental illness, in order to receive medical care or hospitalization. In a variation of the disorder, Munchausen by proxy (MSBP), an individual, typically a mother, intentionally causes or fabricates illness in a child or other person under her care.

Description

Munchausen syndrome takes its name from Baron Karl Friederich von Munchausen, an 18th century German military man known for his tall tales. The disorder first appeared in psychiatric literature in the early 1950s when it was used to describe patients who sought hospitalization by inventing symptoms and complicated medical histories, and/or inducing illness and injury in themselves. Categorized as a factitious disorder (a disorder in which the physical or psychological symptoms are under voluntary control), Munchausen's syndrome seems to be motivated by a need to assume the role of a patient. Unlike **malingering**, there does not seem to be any clear secondary gain (e.g., money) in Munchausen syndrome.

Individuals with Munchausen by proxy syndrome use their child (or another dependent person) to fulfill their need to step into the patient role. The disorder most commonly victimizes children from birth to 8 years old. Parents with MSBP may only exaggerate or fabricate their child's symptoms, or they may deliberately induce symptoms through various methods, including **poisoning**, suffocation, **starvation**, or infecting the child's bloodstream.

Causes and symptoms

The exact cause of Munchausen syndrome is unknown. It has been theorized that Munchausen patients are motivated by a desire to be cared for, a need for attention, dependency, an ambivalence toward doctors, or a need to suffer. Factors that may predispose an individual to Munchausen's include a serious illness in childhood or an existing personality disorder.

The Munchausen patient presents a wide array of physical or psychiatric symptoms, usually limited only by their medical knowledge. Many Munchausen patients are very familiar with medical terminology and symptoms. Some common complaints include fevers, **rashes**, abscesses, bleeding, and **vomiting**. Common Munchausen by proxy symptoms include apnea (cessation of breathing), **fever**, **vomiting**, and **diarrhea**. In both Munchausen and MSBP syndromes, the suspected illness does not respond to a normal course of treatment. Patients or parents may push for invasive diagnostic procedures and display an extraordinary depth of knowledge of medical procedures.

Diagnosis

Because Munchausen sufferers often go from doctor to doctor, gaining admission into many hospitals along the way, diagnosis can be difficult. They are typically detected rather than diagnosed. During a course of treatment, they may be discovered by a hospital employee who encountered them during a previous hospitalization. Their caregivers may also notice that symptoms such as high fever occur only when the patient is left unattended. Occasionally, unprescribed medication used to induce symptoms is found with the patient's belongings. When the patient is confronted, they often react with outrage and check out of the hospital to seek treatment at another facility with a new caregiver.

Treatment

There is no clearly effective treatment for Munchausen syndrome. Extensive **psychotherapy** may be helpful with some Munchausen patients. If Munchausen syndrome co-exists with other mental disorders, such as a personality disorder, the underlying disorder is typically treated first.

Prognosis

The infections and injuries Munchausen patients self-inflict can cause serious illness. Patients often undergo countless unnecessary surgeries throughout their lifetimes. In addition, because of their frequent

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KEY TERMS

Apnea—A cessation of breathing.

Factitious disorder—A disorder in which the physical or psychological symptoms are under voluntary control.

hospitalizations, they have difficulty holding down a job. Further, their chronic health complaints may damage interpersonal relationships with family and friends. Children victimized by sufferers of MSBP are at a real risk for serious injury and possible **death**. Those who survive physically unscathed may suffer developmental problems later in life.

Prevention

Because the cause of Munchausen syndrome is unknown, formulating a prevention strategy is difficult. Some medical facilities and healthcare practitioners have attempted to limit hospital admissions for Munchausen patients by sharing medical records. While these attempts may curb the number of hospital admissions, they do not treat the underlying disorder and may endanger Munchausen sufferers that have made themselves critically ill and require treatment. Children who are found to be victims of persons with Munchausen by proxy syndrome should be immediately removed from the care of the abusing parent or guardian.

ORGANIZATIONS

American Psychiatric Association (APA), 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209, (888) 357-7924, apa@psych.org, http://www.psych.org.

American Psychological Association (APA), 750 First St. NE, Washington, DC, 20002-4242, (202) 336-5500, (800) 374-2721, http://www.apa.org/.

National Alliance for the Mentally Ill (NAMI), 3803 N. Fairfax Dr., Suite 100, Arlington, VA, 22203, (703) 524-7600, (703) 524-9094, (800) 950-6264, http://www.nami.org.

National Institute of Mental Health (NIMH). http://www.nimh.nih.gov

Paula Anne Ford-Martin

Mupirocin *see* **Antibiotics, topical**

Murine (endemic) typhus *see* **Typhus**

Muscle cramps *see* **Muscle spasms and cramps**

Muscle relaxants

Definition

Skeletal muscle relaxants are drugs that help loosen up or relax the muscles that control skeletal (body) movements. They are a separate class of drugs from the muscle relaxant drugs, given intravenously, to relax the same muscles for surgery or intubation.

Purpose

Skeletal muscle relaxants may be used to relieve spastic or tight muscles in diseases like **tetanus**, **multiple sclerosis**, **spinal cord injury**, or **stroke**. They are also used to relieve **muscle spasms** following injuries or minor muscle strains. Dantrolene (Dantrium) has been used to prevent or treat malignant hyperthermia in anesthesia or surgery.

Description

Skeletal muscle relaxants are divided into two groups: one, containing most of the drugs in this class, acts via the central nervous system to relax muscles; Dantrium is the only drug that acts directly on muscles.

Baclofen (Lioresal) may be administered orally or injected directly into the spinal-fluid sac to control muscle spasms.

Carisoprodol (Soma), chlorphenesin (Maolate), chlorzoxazone (Paraflex), cyclobenzaprine (Flexeril), diazepam (Valium), metaxalone (Skelaxin), methocarbamol (Robaxin), and orphenadrine (Norflex) are used, along with rest and perhaps **physical therapy**, to treat muscle spasms from sprains and minor injuries and to assist in **rehabilitation** following serious illness, major surgery, or stroke.

Diazepam (Valium) and methocarbamol (Robaxin) can be given by injection to relieve muscle spasms associated with tetanus.

Recommended dosage

Dose varies with the drug, route of administration, and purpose. There may be individual variations in absorption that require doses higher than those usually recommended. Consult specific references for further information.

Precautions

All drugs in this class may cause **sedation**. Baclofen, when injected into the spinal fluid sac, may produce unconsciousness, **shock**, and **respiratory failure**.

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KEY TERMS

Central nervous system—The brain and spinal cord.

Sedative—Medicine used to treat nervousness or restlessness.

Spasm—Sudden, involuntary tightening or tensing of a muscle or a group of muscles.

Tranquilizer (minor)—A drug that has a calming effect and is used to treat anxiety and emotional tension.

Diazepam may be addictive.

Dantrolene may damage the liver.

Tizanidine may cause low blood pressure; this may be controlled by starting with a low dose and increasing the dose gradually. Rarely, it can cause liver damage.

Methocarbamol and chlorzoxazone may cause harmless color changes in urine—orange or reddish-purple with chlorzoxazone and purple, brown, or green with methocarbamol. The urine will return to its normal color when the patient stops taking the medicine.

Not all drugs in this group have been evaluated for safety in **pregnancy** and breast feeding.

Baclofen passes into breast milk; breast feeding while taking it is not recommended.

Diazepam crosses the placenta and into breast milk; breast fed babies may become drowsy and lethargic.

Side effects

Drugs in this class may produce **dizziness**, drowsiness, or headaches. Alcohol may increase these effects.

Paradoxically, these drugs may cause stimulation and irritability.

Skeletal muscle relaxant drugs may cause **rashes**, with or without **itching**.

These drugs may produce upset stomach and **nausea**.

Interactions

Skeletal muscle relaxants have many potential **drug interactions**. Individual references should be consulted.

Because these drugs cause sedation, they should be used with caution with other drugs that may also cause drowsiness.

The activity of diazepam may be increased by drugs that inhibit its metabolism in the liver. These include: Cimetidine, **oral contraceptives**, Disulfiram, Fluoxetine, Isoniazid, Ketoconazole, Metoprolol, Propoxyphene, Propranolol, and Valproic acid.

Dantrolene may have an interaction with estrogens. Although no interaction has been demonstrated, the rate of liver damage in women over the age of 35 who were taking estrogens is higher than in other groups.

Samuel D. Uretsky, PharmD

Muscle spasms and cramps

Definition

Muscle spasms and cramps are spontaneous, often painful muscle contractions.

Description

Most people are familiar with the sudden **pain** of a muscle cramp. The rapid, uncontrolled contraction, or spasm, happens unexpectedly, with either no stimulation or some trivially small one. The muscle contraction and pain last for several minutes, and then slowly ease. Cramps may affect any muscle, but are most common in the calves, feet, and hands. While painful, they are harmless, and in most cases, not related to any underlying disorder. Nonetheless, cramps and spasms can be manifestations of many neurological or muscular diseases.

The terms cramp and spasm can be somewhat vague, and they are sometimes used to include types of abnormal muscle activity other than sudden painful contraction. These include stiffness at rest, slow muscle relaxation, and spontaneous contractions of a muscle at rest (fasciculation). Fasciculation is a type of painless muscle spasm, marked by rapid, uncoordinated contraction of many small muscle fibers. A critical part of diagnosis is to distinguish these different meanings and to allow the patient to describe the problem as precisely as possible.

Causes and symptoms

Causes

Normal voluntary muscle contraction begins when electrical signals are sent from the brain through the spinal cord along nerve cells called motor neurons.

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These include both the upper motor neurons within the brain and the lower motor neurons within the spinal cord and leading out to the muscle. At the muscle, chemicals released by the motor neuron stimulate the internal release of **calcium** ions from stores within the muscle cell. These calcium ions then interact with muscle proteins within the cell, causing the proteins (actin and myosin) to slide past one another. This motion pulls their fixed ends closer, thereby shortening the cell and, ultimately, the muscle itself. Recapture of calcium and unlinking of actin and myosin allows the muscle fiber to relax.

Abnormal contraction may be caused by abnormal activity at any stage in this process. Certain mechanisms within the brain and the rest of the central nervous system help regulate contraction. Interruption of these mechanisms can cause spasm. Motor neurons that are overly sensitive may fire below their normal thresholds. The muscle membrane itself may be overly sensitive, causing contraction without stimulation. Calcium ions may not be recaptured quickly enough, causing prolonged contraction.

Interruption of brain mechanisms and overly sensitive motor neurons may result from damage to the nerve pathways. Possible causes include **stroke**, **multiple sclerosis**, **cerebral palsy**, neurodegenerative diseases, trauma, **spinal cord injury**, and nervous system poisons such as strychnine, **tetanus**, and certain insecticides. Nerve damage may lead to a prolonged or permanent muscle shortening called contracture.

Changes in muscle responsiveness may be due to or associated with:

- Prolonged exercise. Curiously, relaxation of a muscle actually requires energy to be expended. The energy is used to recapture calcium and to unlink actin and myosin. Normally, sensations of pain and fatigue signal that it is time to rest. Ignoring or overriding those warning signals can lead to such severe energy depletion that the muscle cannot be relaxed, causing a cramp. The familiar advice about not swimming after a heavy meal, when blood flow is directed away from the muscles, is intended to avoid this type of cramp. Rigor mortis, the stiffness of a corpse within the first 24 hours after death, is also due to this phenomenon.
- Dehydration and salt depletion. This may be brought on by protracted vomiting or diarrhea, or by copious sweating during prolonged exercise, especially in high temperatures. Loss of fluids and salts—especially sodium, potassium, magnesium, and calcium—can disrupt ion balances in both muscle and nerves. This can prevent them from responding and recovering normally, and can lead to cramp.
- Metabolic disorders that affect the energy supply in muscle. These are inherited diseases in which particular muscle enzymes are deficient. They include deficiencies of myophosphorylase (McArdle's disease), phosphorylase b kinase, phosphofructokinase, phosphoglycerate kinase, and lactate dehydrogenase.
- Myotonia. This causes stiffness due to delayed relaxation of the muscle, but does not cause the spontaneous contraction usually associated with cramps. However, many patients with myotonia do experience cramping from exercise. Symptoms of myotonia are often worse in the cold. Myotonias include myotonic dystrophy, myotonia congenita, paramyotonia congenita, and neuromyotonia.

Fasciculations may be due to **fatigue**, cold, medications, metabolic disorders, nerve damage, or neurodegenerative disease, including **amyotrophic lateral sclerosis**. Most people experience brief, mild fasciculations from time to time, usually in the calves.

Symptoms

The pain of a muscle cramp is intense, localized, and often debilitating Coming on quickly, it may last for minutes and fade gradually. **Contractures** develop more slowly, over days or weeks, and may be permanent if untreated. Fasciculations may occur at rest or after muscle contraction, and may last several minutes.

Diagnosis

Abnormal contractions are diagnosed through a careful medical history, physical and neurological examination, and **electromyography** of the affected muscles. Electromyography records electrical activity in the muscle during rest and movement.

Treatment

Most cases of simple cramps require no treatment other than patience and stretching. Gently and gradually stretching and massaging the affected muscle may ease the pain and hasten recovery. In some cases **hydrotherapy**, **yoga**, or **massage therapy** may prove beneficial.

More prolonged or regular cramps may be treated with drugs such as carbamazepine, phenytoin, or quinine. Fluid and salt replacement, either orally or intravenously, is used to treat **dehydration**. Treatment of underlying metabolic or neurologic disease, where possible, may help relieve symptoms.

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KEY TERMS

Motor neuron—Nerve cells within the central nervous system that carry nerve impulses controlling muscle movement.

Alternative treatment

Cramps may be treated or prevented with Gingko (*Ginkgo biloba*) or Japanese quince (*Chaenomeles speciosa*). Supplements of vitamin E, niacin, calcium, and magnesium may also help. Taken at bedtime, they may help to reduce the likelihood of night cramps.

Prognosis

Occasional cramps are common, and have no special medical significance.

Prevention

The likelihood of developing cramps may be reduced by eating a healthy diet with appropriate levels of **minerals**, and getting regular **exercise** to build up energy reserves in muscle. Avoiding exercising in extreme heat helps prevent heat cramps. Heat cramps can also be avoided by taking salt tablets and water before prolonged exercise in extreme heat. Taking a warm bath before bedtime may increase circulation to the legs and reduce the incidence of nighttime leg cramps.

Resources

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ORGANIZATIONS

American Academy of Neurology , 1080 Montreal Ave., Saint Paul, MN, 55116, (800) 879–1960, http://www.aan.com.

American Association of Naturopathic Physicians, 8201 Greensboro Dr., Suite 300, McLean, VA, 22102, (206) 298–0126, http://naturopathic.org.

American Holistic Medical Association., PO Box 2016, Edmonds, WA, 98020, (425) 967–0737, http://www.holisticmedicine.org.

American Massage Therapy Association., 500 Davis St., Evanston, IL, 60201, (877) 905–2700, www.amtamassage.org.

National Institute of Neurological Disorders and Stroke (NINDS), P.O. Box 5801, Bethesda, MD, 20824, (301) 496–5751, (800) 352–9424, http://www.ninds.nih.gov.

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Muscular dystrophy

Definition

Muscular dystrophy (MD) is the name for a group of inherited disorders in which strength and muscle bulk gradually decline. Nine types of muscular dystrophies are generally recognized.

Demographics

According to National Institute for Neurological Disorders and **Stroke** (NINDS), MD occurs worldwide, and affects all races. Its incidence varies, as some types are more common than others. The most common forms in children are Duchenne and Becker MD and affect approximately 1 in every 3,500 to 5,000 boys, or between 400 and 600 live male births each year in the United States. Between 400 and 600 boys in the United States are born with these conditions each year. Females are rarely affected by these forms of muscular dystrophy. In Europe, the prevalence of Duchenne and Becker MD is 5 per 100,000 individuals.

Description

The muscular dystrophies include:

- ***Duchenne muscular dystrophy (DMD)***: DMD affects young boys, causing progressive muscle weakness, usually beginning in the legs. It is a severe form of muscular dystrophy. DMD occurs in about one in 3,500 male births, and affects approximately 8,000 boys and young men in the United States. A milder form occurs in a very small number of female carriers.

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- *Becker muscular dystrophy (BMD)*: BMD affects older boys and young men, following a milder course than DMD. It occurs in about one in 30,000 male births.
- *Emery–Dreifuss muscular dystrophy (EDMD)*: EDMD affects both males and females because it can be inherited as an autosomal dominant or recessive disorder. Symptoms include contractures and weakness in the calves, weakness in the shoulders and upper arms, and problems in the way electrical impulses travel through the heart to make it beat (heart conduction defects). Fewer than 300 cases of EDMD have been reported in the medical literature.
- *Limb–girdle muscular dystrophy (LGMD)*: LGMD begins in late childhood to early adulthood and affects both men and women, causing weakness in the muscles around the hips and shoulders, and weakness in the limbs. It is the most variable of the muscular dystrophies, and there are several different forms of the condition now recognized. Many people with suspected LGMD have probably been misdiagnosed in the past, and therefore, the prevalence of the condition is difficult to estimate. The highest prevalence of LGMD is in a small mountainous Basque province in northern Spain, where the condition affects 69 persons per million.
- *Facioscapulohumeral muscular dystrophy (FSH)*: FSH, also known as Landouzy–Dejerine condition, begins in late childhood to early adulthood and affects both men and women, causing weakness in the muscles of the face, shoulders, and upper arms. The hips and legs may also be affected. FSH occurs in about one out of every 20,000 people, and affects approximately 13,000 people in the United States.
- ***Myotonic dystrophy***: Also known as Steinert's disease, it affects both men and women, causing generalized weakness first seen in the face, feet, and hands. It is accompanied by the inability to relax the affected muscles (myotonia). Symptoms may begin from birth through adulthood. It is the most common form of muscular dystrophy, affecting more than 30,000 people in the United States.
- *Oculopharyngeal muscular dystrophy (OPMD)*: OPMD affects adults of both sexes, causing weakness in the eye muscles and throat. It is most common among French Canadian families in Quebec, and in Spanish American families in the southwestern United States.
- *Distal muscular dystrophy (DD)*: DD is a group of rare muscle diseases that have weakness and wasting of the distal (farthest from the center) muscles of the forearms, hands, lower legs, and feet in common. In general, the DDs are less severe, progress more slowly, and involve fewer muscles than the other dystrophies. DD usually begins in middle age or later, causing weakness in the muscles of the feet and hands. It is most common in Sweden, and rare in other parts of the world.
- *Congenital muscular dystrophy (CMD)*: CMD is a rare group of muscular dystrophies that have in common the presence of muscle weakness at birth (congenital), and abnormal muscle biopsies. CMD results in generalized weakness, and usually progresses slowly. A subtype, called Fukuyama CMD, also involves mental retardation and is more common in Japan.

Risk factors

Since the muscular dystrophies are inherited, people with a family history of MD are at increased risk.

Causes and symptoms

The muscular dystrophies are genetic conditions, meaning they are caused by alterations in genes. Genes, which are linked together on chromosomes, have two functions; they code for the production of proteins, and they are the material of inheritance. Parents pass along genes to their children, providing them with a complete set of instructions for making their own proteins.

Because both parents contribute genetic material to their offspring, each child carries two copies of almost every gene, one from each parent. For some conditions to occur, both copies must be altered. Such conditions are called autosomal recessive conditions. Some forms of LGMD and DD exhibit this pattern of inheritance, as does CMD. A person with only one altered copy, called a carrier, will not have the condition, but may pass the altered gene on to his children. When two carriers have children, the chances of having a child with the condition is one in four for each **pregnancy**.

Other conditions occur when only one altered gene copy is present. Such conditions are called autosomal dominant conditions. DM, FSH, and OPMD exhibit this pattern of inheritance, as do some forms of DD and LGMD. When a person affected by the condition has a child with someone not affected, the chances of having an affected child is one in two.

Because of chromosomal differences between the sexes, some genes are not present in two copies. The chromosomes that determine whether a person is male or female are called the X and Y chromosomes. A person with two X chromosomes is female, while a person with one X and one Y is male. While the X chromosome carries many genes, the Y chromosome carries almost none. Therefore, a male has only one copy of each gene

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on the X chromosome, and if it is altered, he will have the condition that alteration causes. Such conditions are said to be X–linked. X–linked conditions include DMD, BMD, and EDMD. Women are not usually affected by X–linked conditions, since they will likely have one unaltered copy between the two chromosomes. Some female carriers of DMD have a mild form of the condition, probably because their one unaltered gene copy is shut down in some of their cells.

Women carriers of X–linked conditions have a one in two chance of passing the altered gene on to each child born. Daughters who inherit the altered gene will be carriers. A son born without the altered gene will be free of the condition and cannot pass it on to his children. A son born with the altered gene will have the condition. He will pass the altered gene on to each of his daughters, who will then be carriers, but to none of his sons (because they inherit his Y chromosome).

Not all genetic alterations are inherited. As many as one third of the cases of DMD are due to new mutations that arise during egg formation in the mother. New mutations are less common in other forms of muscular dystrophy.

Several of the muscular dystrophies, including DMD, BMD, CMD, and most forms of LGMD, are due to alterations in the genes for a complex of muscle proteins. This complex spans the muscle cell membrane (a thin sheath that surrounds each muscle cell) to unite a fibrous network on the interior of the cell with a fibrous network on the outside. Theory holds that by linking these two networks, the complex acts as a "shock absorber," redistributing and evening out the forces generated by contraction of the muscle, thereby preventing rupture of the muscle membrane. Alterations in the proteins of the complex lead to deterioration of the muscle during normal contraction and relaxation cycles. Symptoms of these conditions set in as the muscle gradually exhausts its ability to repair itself.

Both DMD and BMD are caused by alterations in the gene for the protein called dystrophin. The alteration leading to DMD prevents the formation of any dystrophin, while that of BMD allows some protein to be made, accounting for the differences in severity and age of onset between the two conditions. Differences among the other muscular dystrophies in terms of the muscles involved and the ages of onset are less easily explained.

A number of genes have been found to cause LGMD. A majority of the more severe autosomal recessive types of LGMD with childhood–onset are caused by alterations in the genes responsible for making proteins called sarcoglycans. The sarcoglycans are a complex of proteins that are normally located in the muscle cell membrane along with dystrophin. Loss of these proteins causes the muscle cell membrane to lose some of its shock absorber qualities. The genes responsible include LGMD2D on chromosome 17, which codes for the alpha–sarcoglycan protein; LGMD2E on chromosome 4, which codes for the beta–sarcoglycan protein; LGMD2C on chromosome 13, which codes for the gamma–sarcoglycan protein; and LGMD2F on chromosome 5, which codes for the delta–sarcoglycan protein. Some cases of autosomal recessive LGMD are caused by an alteration in a gene, LGMD2A, on chromosome 15, which codes for a muscle enzyme, calpain 3. The relationship between this alteration and the symptoms of the condition is unclear. Alterations in a gene called LGMD2B on chromosome 2 that codes for the dysferlin protein, is also responsible for a minority of autosomal recessive LGMD cases. The exact role of dysferlin is not known. Finally, alterations in the LGMD2G gene on chromosome 17 which codes for a protein, telethonin, is responsible for autosomal recessive LGMD in two reported families. The exact role of telethonin is not known. Some families with autosomal recessive LGMD are not accounted for by alterations in any of the above mentioned genes, indicating that there are as yet undiscovered genes which can cause LGMD. The autosomal dominant LGMD genes have mostly been described in single families. These types of LGMD are considered quite rare.

The genes causing these types of LGMD, their chromosomal location, and the proteins they code for (when known) are listed below:

- LGMD1A (chromosome 5): myotilin
- LGMD1B (chromosome 1): laminin
- LGMD1C (chromosome 3): caveolin
- LGMD1D (chromosome 6)
- LGMD1E (chromosome 7)
- COL6A1 (chromosome 21): collagen VI alpha 1
- COL6A2 (chromosome 21): collagen VI alpha 2
- COL6A3 (chromosome 2): collagen VI alpha 3

The causes of the other muscular dystrophies are not as well understood:

- EDMD is due to a alteration in the gene for a protein called emerin, which is found in the membrane of a cell's nucleus, but whose exact function is unknown.
- Myotonic dystrophy is caused by alterations in a gene on chromosome 19 for an enzyme called myotonin protein kinase that may control the flow of charged particles within muscle cells. This gene alteration is called a triple repeat, meaning it contains extra triplets of DNA code. It is possible that this

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alteration affects nearby genes as well, and that the widespread symptoms of myotonic dystrophy are due to a range of genetic disruptions.

- The gene for OPMD appears to also be altered with a triple repeat. The function of the affected protein may involve translation of genetic messages in a cell's nucleus.
- The gene(s) for FSH is located on the long arm of chromosome 4 at gene location 4q35. Nearly all cases of FSH are associated with a deletion (missing piece) of genetic material in this region. Researchers are investigating the molecular connection of this deletion and FSH. It is not yet certain whether the deleted material contains an active gene or changes the regulation or activity of a nearby FSH gene. A small number of FSH cases are not linked to chromosome 4. Their linkage to any other chromosome or genetic feature is under investigation.
- The gene(s) responsible for DD have not yet been found.
- About 50% of individuals with CMD have their condition as a result of deficiency in a protein called merosin, which is made by a gene called laminin. The merosin protein usually lies outside muscle cells and links them to the surrounding tissue. When merosin is not produced, the muscle fibers degenerate soon after birth. A second gene called integrin is responsible for CMD in a few individuals but alterations in this gene are a rare cause of CMD. The gene responsible for Fukuyama CMD is FCMD and it is responsible for making a protein called fukutin whose function is not clear.

All of the muscular dystrophies are marked by muscle weakness as the major symptom. The distribution of symptoms, age of onset, and progression differ significantly. **Pain** is sometimes a symptom of each, usually due to the effects of weakness on joint position.

DUCHENNE MUSCULAR DYSTROPHY (DMD). A boy with Duchenne muscular dystrophy usually begins to show symptoms as a pre–schooler. The legs are affected first, making walking difficult and causing balance problems. Most patients walk three to six months later than expected and have difficulty running. Later on, a boy with DMD will push his hands against his knees to rise to a standing position, to compensate for leg weakness. About the same time, his calves will begin to enlarge, though with fibrous tissue rather than with muscle, and feel firm and rubbery; this condition gives DMD one of its alternate names, pseudohypertrophic muscular dystrophy. He will widen his stance to maintain balance, and walk with a waddling gait to advance his weakened legs. **Contractures** (permanent muscle tightening) usually begin by age five or six, most severely in the calf muscles. This pulls the foot down and back, forcing the boy to walk on tip–toes, and further decreases balance. Climbing stairs and rising unaided may become impossible by age nine or ten, and most boys use a wheelchair for mobility by the age of 12. Weakening of the trunk muscles around this age often leads to **scoliosis** (a side–to–side spine curvature) and **kyphosis** (a front–to–back curvature).

The most serious weakness of DMD is weakness of the diaphragm, the sheet of muscles at the top of the abdomen that perform the main work of breathing and coughing. Diaphragm weakness leads to reduced energy and stamina, and increased lung infection because of the inability to **cough** effectively. Young men with DMD often live into their twenties and beyond, provided they have mechanical ventilation assistance and good respiratory hygiene.

Among males with DMD, the incidence of **cardiomyopathy** (weakness of the heart muscle), increases steadily in teenage years. Almost all patients have cardiomyopathy after 18 years of age. It has also been shown that carrier females are at increased risk for cardiomyopathy and should also be screened.

About one third of males with DMD experience specific learning disabilities, including difficulty learning by ear rather than by sight and difficulty paying attention to long lists of instructions. Individualized educational programs usually compensate well for these disabilities.

BECKER MUSCULAR DYSTROPHY (BMD). The symptoms of BMD usually appear in late childhood to early adulthood. Though the progression of symptoms may parallel that of DMD, the symptoms are usually milder and the course more variable. The same pattern of leg weakness, unsteadiness, and contractures occur later for the young man with BMD, often allowing independent walking into the twenties or early thirties. Scoliosis may occur, but is usually milder and progresses more slowly. Cardiomyopathy occurs more commonly in BMD. Problems may include irregular heartbeats (**arrhythmias**) and congestive **heart failure**. Symptoms may include **fatigue**, **shortness of breath**, chest pain, and **dizziness**. Respiratory weakness also occurs, and may lead to the need for mechanical ventilation.

EMERY–DREIFUSS MUSCULAR DYSTROPHY (EDMD). This type of muscular dystrophy usually begins in early childhood, often with contractures preceding muscle weakness. Weakness affects the shoulder and upper arm initially, along with the calf muscles, leading to foot–drop. Most men with EDMD survive into middle age, although an abnormality in the heart's

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rhythm (**heart block**) may be fatal if not treated with a pacemaker.

LIMB–GIRDLE MUSCULAR DYSTROPHY (LGMD). While there are several genes that cause the various types of LGMD, two major clinical forms of LGMD are usually recognized. A severe childhood form is similar in appearance to DMD, but is inherited as an autosomal recessive trait. Symptoms of adult–onset LGMD usually appear in a person's teens or twenties, and are marked by progressive weakness and wasting of the muscles closest to the trunk. Contractures may occur, and the ability to walk is usually lost about 20 years after onset. Some people with LGMD develop respiratory weakness that requires use of a ventilator. Life–span may be somewhat shortened. Autosomal dominant forms usually occur later in life and progress relatively slowly.

FACIOSCAPULOHUMERAL MUSCULAR DYSTROPHY (FSH). FSH varies in its severity and age of onset, even among members of the same family. Symptoms most commonly begin in the teens or early twenties, though infant or childhood onset is possible. Symptoms tend to be more severe in those with earlier onset. The condition is named for the regions of the body most severely affected by the condition: muscles of the face (facio–), shoulders (scapulo–), and upper arms (humeral). Hips and legs may be affected as well. Children with FSH may develop partial or complete deafness.

The first symptom noticed is often difficulty lifting objects above the shoulders. The weakness may be greater on one side than the other. Shoulder weakness also causes the shoulder blades to jut backward, called scapular winging. Muscles in the upper arm often lose bulk sooner than those of the forearm, giving a "Popeye" appearance to the arms. Facial weakness may lead to loss of facial expression, difficulty closing the eyes completely, and inability to drink through a straw, blow up a balloon, or whistle. A person with FSH may not be able to wrinkle thier forehead. Contracture of the calf muscles may cause foot–drop, leading to frequent tripping over curbs or rough spots. People with earlier onset often require a wheelchair for mobility, while those with later onset rarely do.

MYOTONIC DYSTROPHY. Symptoms of **myotonic dystrophy** include facial weakness and a slack jaw, drooping eyelids (**ptosis**), and muscle wasting in the forearms and calves. A person with myotonic dystrophy has difficulty relaxing his grasp, especially if the object is cold. Myotonic dystrophy affects heart muscle, causing arrhythmias and heart block, and the muscles of the digestive system, leading to motility disorders and **constipation**. Other body systems are affected as well; myotonic dystrophy may cause **cataracts**, retinal degeneration, mental deficiency, frontal balding, skin disorders, testicular atrophy, **sleep apnea**, and **insulin resistance**. An increased need or desire for sleep is common, as is diminished motivation. The condition is extremely variable; some individuals show profound weakness as a newborn (congenital myotonic dystrophy), others show **mental retardation** in childhood, many show characteristic facial features and muscle wasting in adulthood, while the most mildly affected individuals show only cataracts in middle age with no other symptoms. Individuals with a severe form of mytonic dystropy typically have severe disabilities within 20 years of onset, although most do not require a wheelchair even late in life.

OCULOPHARYNGEAL MUSCULAR DYSTROPHY (OPMD). OPMD usually begins in a person's thirties or forties, with weakness in the muscles controlling the eyes and throat. Symptoms include drooping eyelids and difficulty swallowing (dysphagia). Weakness progresses to other muscles of the face, neck, and occasionally the upper limbs. Swallowing difficulty may cause aspiration, or the introduction of food or saliva into the airways. **Pneumonia** may follow.

DISTAL MUSCULAR DYSTROPHY (DD). DD usually begins in the twenties or thirties, with weakness in the hands, forearms, and lower legs. Difficulty with fine movements such as typing or fastening buttons may be the first symptoms. Symptoms progress slowly, and the condition usually does not affect life span.

CONGENITAL MUSCULAR DYSTROPHY (CMD). CMD is marked by severe muscle weakness from birth, with infants displaying "floppiness," very poor muscle tone, and they often have trouble moving their limbs or head against gravity. Mental function is normal but some are never able to walk. They may live into young adulthood or beyond. In contrast, children with Fukuyama CMD are rarely able to walk, and have severe mental retardation. Most children with this type of CMD die in childhood.

Diagnosis

For most forms of muscular dystrophy, accurate diagnosis is not difficult when done by someone familiar with the range of conditions. There are exceptions, however. Even with a muscle biopsy, it may be difficult to distinguish between FSH and another muscle condition, **polymyositis**. Childhood–onset LGMD is often mistaken for the much more common DMD, especially when it occurs in boys. BMD with an early onset appears very similar to DMD, and a genetic test may be needed to accurately distinguish them. The

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KEY TERMS

Amniocentesis—A procedure performed at 16–18 weeks of pregnancy in which a needle is inserted through a woman's abdomen into her uterus to draw out a small sample of the amniotic fluid from around the baby. Either the fluid itself or cells from the fluid can be used for a variety of tests to obtain information about genetic disorders and other medical conditions in the fetus.

Autosomal dominant—A pattern of genetic inheritance where only one abnormal gene is needed to display the trait or disease.

Autosomal recessive—A pattern of genetic inheritance where two abnormal genes are needed to display the trait or disease.

Becker muscular dystrophy (BMD)—A type of muscular dystrophy that affects older boys and men, and usually follows a milder course than Duchenne muscular dystrophy.

Chorionic villus sampling (CVS)—A procedure used for prenatal diagnosis at 10–12 weeks gestation. Under ultrasound guidance a needle is inserted either through the mother's vagina or abdominal wall and a sample of cells is collected from around the fetus. These cells are then tested for chromosome abnormalities or other genetic diseases.

Contracture—A tightening of muscles that prevents normal movement of the associated limb or other body part.

Distal muscular dystrophy (DD)—A form of muscular dystrophy that usually begins in middle age or later, causing weakness in the muscles of the feet and hands.

Duchenne muscular dystrophy (DMD)—The most severe form of muscular dystrophy, DMD usually affects young boys and causes progressive muscle weakness, usually beginning in the legs.

Dystrophin—A protein that helps muscle tissue repair itself. Both Duchenne muscular dystrophy and Becker muscular dystrophy are caused by flaws in the gene that instructs the body how to make this protein.

Facioscapulohumeral muscular dystrophy (FSH)—This form of muscular dystrophy, also known as Landouzy–Dejerine condition, begins in late childhood to early adulthood and affects both men and women, causing weakness in the muscles of the face, shoulders, and upper arms.

Limb–girdle muscular dystrophy (LGMD)—Form of muscular dystrophy that begins in late childhood to early adulthood and affects both men and women, causing weakness in the muscles around the hips and shoulders.

Myotonic dystrophy—A form of muscular dystrophy, also known as Steinert's condition, characterized by delay in the ability to relax muscles after forceful contraction, wasting of muscles, as well as other abnormalities.

Oculopharyngeal muscular dystrophy (OPMD)—Form of muscular dystrophy affecting adults of both sexes, and causing weakness in the eye muscles and throat.

muscular dystrophies may be confused with conditions involving the motor neurons, such as spinal muscular atrophy; conditions of the neuromuscular junction, such as **myasthenia gravis**; and other muscle conditions, as all involve generalized weakness of varying distribution.

Examination

The diagnosis of muscular dystrophy involves a careful medical history and a thorough physical exam to determine the distribution of symptoms and to rule out other causes. Family history may give important clues, since all the muscular dystrophies are genetic conditions (though no family history will be evident in the event of new mutations; in autosomal recessive inheritance, the family history may also be negative).

Tests

Lab tests may include:

- Blood level of the muscle enzyme creatine kinase (CK). CK levels rise in the blood due to muscle damage, and may be seen in some conditions even before symptoms appear.
- Muscle biopsy, in which a small piece of muscle tissue is removed for microscopic examination. Changes in the structure of muscle cells and presence of fibrous tissue or other aberrant structures are characteristic of different forms of muscular dystrophy. The muscle tissue can also be stained to detect the presence or absence of particular proteins, including dystrophin.
- Electromyogram (EMG). This electrical test is used to examine the response of the muscles to stimulation.

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Decreased response is seen in muscular dystrophy. Other characteristic changes are seen in DM.

- Genetic tests. Several of the muscular dystrophies can be positively identified by testing for the presence of the altered gene involved. Accurate genetic tests are available for DMD, BMD, DM, several forms of LGMD, and EDMD. Genetic testing for some of these conditions in future pregnancies of an affected individual or parents of an affected individual can be done before birth through amniocentesis or chorionic villus sampling. Prenatal testing can only be undertaken after the diagnosis in the affected individual has been genetically confirmed and the couple has been counseled regarding the risks of recurrence.
- Other specific tests as necessary. For EDMD, DMD and BMD, for example, an electrocardiogram may be needed to test heart function, and hearing tests are performed for children with FSH.

Prenatal diagnosis (testing of the baby while in the womb) can be done for those types of muscular dystrophy where the specific disease–causing gene alteration has been identified in a previously affected family member. Prenatal diagnosis can be done utilizing DNA extracted from tissue obtained by **chorionic villus sampling** or **amniocentesis**.

Treatment

There is no specific treatment that can stop or reverse any form of muscular dytrophy. MD management is focused on improving muscle and joint function, and slowing muscle deterioration. Treatment also seeks to prevent the complications of weakness, including decreased mobility and dexterity, contractures, scoliosis, heart alterations, and respiratory insufficiency.

Traditional

Physical therapy, regular stretching in particular, is used to maintain the range of motion of affected muscles and to prevent or delay contractures. Braces are used as well, especially on the ankles and feet to prevent tip–toeing. Full–leg braces may be used in children with DMD to prolong the period of independent walking. Strengthening other muscle groups to compensate for weakness may be possible if the affected muscles are few and isolated, as in the earlier stages of the milder muscular dystrophies. Regular, nonstrenuous **exercise** helps maintain general good health. Strenuous exercise is usually not recommended, since it may damage muscles further.

Occupational therapy also provides techniques and tools to compensate for the loss of strength and dexterity. Strategies may include modifications in the home, adaptive utensils and dressing aids, compensatory movements and positioning, wheelchair accessories, or communication aids.

Good **nutrition** helps to promote general health in all the muscular dystrophies. No special diet or supplement has been shown to be of use in any of the conditions. The weakness in the throat muscles seen especially in OPMD and later DMD may necessitate the use of a **gastrostomy** tube, inserted in the stomach to provide nutrition directly.

Drugs

For DMD, prednisone, a corticosteroid, has been shown to delay the progression of disease somewhat, for reasons that are still unclear. Some have reported improvement in strength and function in patients treated with a single dose. Improvement begins within ten days and plateaus after three months. Long–term benefit has not been demonstrated. Prednisone is also prescribed for BMD, though no controlled studies have tested its benefit.

Anticonvulsants, also known as antiepileptics, are also prescribed to control seizures and some muscle activity. Commonly used oral anticonvulsants include carbamazepine, phenytoin, clonazepam, gabapentin, topiramate, and felbamate. Respiratory infections are usually treated with **antibiotics**.

Alternative

When contractures become more pronounced, tenotomy surgery may be performed. In this operation, the tendon of the contractured muscle is cut, and the limb is braced in its normal resting position while the tendon regrows. In FSH, surgical fixation of the scapula can help compensate for shoulder weakness. For a person with OPMD, surgical lifting of the eyelids may help compensate for weakened muscular control. For a person with DM, sleep apnea may be treated surgically to maintain an open airway. Scoliosis surgery is often needed in boys with DMD, but much less often in other muscular dystrophies. Surgery is recommended at a much lower degree of curvature for DMD than for scoliosis due to other conditions, since the decline in respiratory function in DMD makes surgery at a later time dangerous. In this surgery, the vertebrae are fused together to maintain the spine in the upright position. Steel rods are inserted at the time of operation to keep the spine rigid while the bones grow together.

When any type of surgery is performed in patients with muscular dystrophy, anesthesia must be carefully selected. People with MD are susceptible to a severe

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reaction, known as malignant hyperthermia, when given halothane anesthetic.

The arrhythmias of EDMD and BMD may be treatable with antiarrhythmia drugs. A pacemaker may be implanted if these do not provide adequate control. Heart transplants are increasingly common for men with BMD. A complete cardiac evaluation is recommended at least once in all carrier females of DMD and EDMD.

People who develop weakness of the diaphragm or other ventilatory muscles may require a mechanical ventilator to continue breathing deeply enough. Air may be administered through a nasal mask or mouthpiece, or through a tracheostomy tube, which is inserted through a surgical incision through the neck and into the windpipe. Most people with muscular dystrophy do not need a tracheostomy, although some may prefer it to continual use of a mask or mouthpiece. Supplemental oxygen is not needed. Good hygiene of the lungs is critical for health and long–term survival of a person with weakened ventilatory muscles. Assisted cough techniques provide the strength needed to clear the airways of secretions; an assisted cough machine is also available and provides excellent results.

Clinical trials for the treatment of muscular dystrophies are currently sponsored by the National Institutes of Health (NIH) and other agencies. In 2009, NIH reported 23 on–going or recently completed studies. Some examples include the following:

- The evaluation of the efficacy of using far infrared radiation to manage muscular dystrophies. (NCT00674843)
- The evaluation of whether a high–dose weekly course of prednisone therapy is safer than and at least as effective as daily dose therapy for people with Duchenne muscular dystrophy. (NCT00110669)
- The study of the early signs and symptoms of fukutin–related protein (FKRP) muscular dystrophy to determine the reasons for differences in disease severity. (NCT00313677)
- The evaluation of the safety and efficacy of antisense oligonucleotides in Duchenne muscular dystrophy. (NCT00159250)

Clinical trial information is constantly updated by NIH and the most recent information on muscular dystrophy trials can be found at: http://clinicaltrials.gov/search/open/condition=%22Muscular+Dystrophies%22

Prognosis

The expected life span for a male with DMD has increased significantly in the past two decades. Most young men will live into their early or mid–twenties. Respiratory infections become an increasing problem as their breathing becomes weaker, and these infections are usually the cause of **death**.

The course of the other muscular dystrophies is more variable; expected life spans and degrees of disability are hard to predict, but may be related to age of onset and initial symptoms. Prediction is made more difficult because, as new genes are discovered, it is becoming clear that several of the dystrophies are not uniform disorders, but rather symptom groups caused by different genes.

People with dystrophies with significant heart involvement (BMD, EDMD, myotonic dystrophy) may nonetheless have almost normal life spans, provided that cardiac complications are monitored and treated aggressively. The respiratory involvement of BMD and LGMD similarly require careful and prompt treatment.

Prevention

There is no way to prevent any of the muscular dystrophies in a person who has the genes responsible for these disorders. Individuals with muscular dystrophy and their families may benefit from genetic counselling for information on the condition and recurrence risks for future pregnancies.

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"Muscular Dystrophy." *NINDS*. Information Page. http://www.ninds.nih.gov/disorders/md/md.htm (accessed December 12, 2009)

"Myotonic Muscular Dystrophy (MMD)." *MDA*. Information Page. http://www.mda.org/disease/dm.html (accessed December 12, 2009)

ORGANIZATIONS

Centers for Disease Control and Prevention (CDCP), 1600 Clifton Road, N.E., Atlanta, GA, 30333, (404) 639-3311, (800) 311-3435, inquiry@cdc.gov, http://www.cdc.gov.

Facioscapulohumeral Muscular Dystrophy (FSH) Society, 64 Grove Street, Watertown, MA, 02472, (781) 275-7781, (781) 860-0599, info@fshsociety.org, http://www.fshsociety.org.

Muscular Dystrophy Association (MDA), 3300 East Sunrise Drive, Tucson, AZ, 85718-3208, (520) 529-2000, (800) 572-1717, (520) 529-5300, mda@mdausa.org, http://www.mda.org.

Muscular Dystrophy Canada, 2345 Yonge St., Suite 900, TorontoON, Canada, M4P 2E5, (866) MUSCLE-8, (416) 488-7523, http://www.muscle.ca.

Muscular Dystrophy Family Foundation, 7220 U.S. 31 South, Indianapolis, IN, 46227, (317) 923-6333, (800) 544-1213, (317) 923-6334, mdff@mdff.org, http://www.mdff.org.

National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS), 31 Center Dr., Rm. 4C02, MSC 2350, Bethesda, MD, 20892-2350, (301) 496-8190, (877) 22-NIAMS, NIAMSinfo@mail.nih.gov, http://www.niams.nih.gov.

National Institute of Child Health and Human Development (NICHD), 31 Center Drive, Rm. 2A32, MSC 2425, Bethesda, MD, 20892-2425, (301) 496-5133, (301) 496-7101, http://www.nichd.nih.gov.

National Institute of Neurological Disorders and Stroke (NINDS), PO Box 5801, Bethesda, MD, 20824, (301) 496-5751, (800) 352-9424, http://www.ninds.nih.gov.

Parent Project Muscular Dystrophy (PPMD), 158 Linwood Plaza, Suite 220, Fort Lee, NJ, 07024, (201) 944-9985, (800) 714-5437, (201) 944-9987, info@parentprojectmd.org, http://www.parentprojectmd.org.

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Mushroom poisoning

Definition

Mushroom **poisoning** refers to the severe and often deadly effects of various toxins that are found in certain types of mushrooms. One type known as *Amanita phalloides*, appropriately called "death cap," accounts for the majority of cases. The toxins initially cause severe abdominal cramping, **vomiting**, and watery **diarrhea**, and then lead to liver and kidney failure.

Description

The highest reported incidences of mushroom poisoning occur in western Europe, where a popular pastime is amateur mushroom hunting. Since the 1970s, the United States has seen a marked increase in mushroom poisoning due to an increase in the popularity of "natural" foods, the use of mushrooms as recreational hallucinogens, and the gourmet qualities of wild mushrooms. About 90% of the deaths due to mushroom poisoning in the United States and western Europe result from eating *Amanita phalloides*. This mushroom is recognized by its metallic green cap (the color may vary from light yellow to greenish brown), white gills (located under the cap), white stem, and bulb-shaped structure at the base of the stem. A pure white variety of this species also occurs. Poisoning results from ingestion of as few as one to three mushrooms. Higher **death** (mortality) rates of more than 50% occur in children less than 10 years of age.

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A poisonous mushroom, Amanita muscaria. *(Photo Researchers, Inc.)*

Causes and symptoms

Poisonous mushrooms contain at least two different types of toxins, each of which can cause death if taken in large enough quantities. Some of the toxins found in poisonous mushrooms are among the most potent ever discovered. One group of poisons, known as amatoxins, blocks the production of DNA, the basis of cell reproduction. This leads to the death of many cells, especially those that reproduce frequently such as in the liver, intestines, and kidney. Other mushroom poisons affect the proteins needed for muscle contraction, and therefore reduce the ability of certain muscle groups to perform.

Symptoms of *Amanita* poisoning occur in different stages or phases. These include:

- First phase. Abdominal cramping, nausea, vomiting, and severe watery diarrhea occur anywhere from 6-24 hours after eating the mushroom and last for about 24 hours. These intestinal symptoms can lead to dehydration and low blood pressure (hypotension).
- Second phase. A period of remission of symptoms that lasts 1-2 days. During this time, the patient feels better, but blood tests begin to show evidence of liver and kidney damage.
- Third phase. Liver and kidney failure develop at this point and either lead to death within about a week or recovery within 2-3 weeks.

Other symptoms are due to either a decrease in blood clotting factors that leads to internal bleeding or reduced muscle function, with the development of weakness and **paralysis**.

Diagnosis

In most cases, the fact that the patient has recently eaten wild mushrooms is the clue to the cause of symptoms. Moreover, the identification of any remaining mushrooms by a qualified mushroom specialist (mycologist) can be a key to diagnosis. When in doubt, the toxin known as alpha-amantin can be found in the blood, urine, or stomach contents of an individual who has ingested poisonous *Amanita* mushrooms.

Treatment

It is important to remember that there is no specific antidote for mushroom poisoning. However, several advances in therapy have decreased the death rate over the last several years. Early replacement of lost body fluids has been a major factor in improving survival rates.

Therapy is aimed at decreasing the amount of toxin in the body. Initially, attempts are made to remove toxins from the upper gastrointestinal tract by inducing **vomiting** or by gastric lavage (stomach pumping). After that continuous aspiration of the upper portion of the small intestine through a nasogastric tube is done and oral charcoal (every four hours for 48 hours) is given to prevent absorption of toxin. These measures work best if started within six hours of ingestion.

In the United States, early removal of mushroom poison by way of an artificial kidney machine (dialysis) has become part of the treatment program. This is combined with the correction of any imbalances of salts (electrolytes) dissolved in the blood, such as **sodium** or potassium. An enzyme called thioctic acid and **corticosteroids** also appear to be beneficial, as well as high doses of penicillin. In Europe, a chemical taken from the milk thistle plant, *Silybum marianum*, is also part of treatment. When liver failure develops, **liver transplantation** may be the only treatment option.

Prognosis

The mortality rate has decreased with improved and rapid treatment. However, according to some medical reports death still occurs in 20-30% of cases,

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with a higher mortality rate of 50% in children less than 10 years old.

Prevention

The most important factor in preventing mushroom poisoning is to avoid eating wild or noncultivated mushrooms. For anyone not expert in mushroom identification, there are generally no easily recognizable differences between nonpoisonous and poisonous mushrooms. It is also important to remember that most mushroom poisons are not destroyed or deactivated by cooking, canning, freezing, drying, or other means of food preparation.

Resources

OTHER

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"Cyclopeptide-Containing Mushroom Toxicity." *The Toxikon Multimedia Project Page*. http://www.uic.edu/com/er/toxikon/mushroo.htm.

"Mushroom Poisoning in Children." *American Association of Family Physicians*. http://www.aafp.org/patientinfo/mushroom.html.

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Music therapy

Definition

Music therapy is a technique of complementary medicine that uses music prescribed in a skilled manner by trained therapists. Programs are designed to help patients overcome physical, emotional, intellectual, and social challenges. Applications range from improving the well being of geriatric patients in nursing homes to lowering the **stress** level and **pain** of women in labor. Music therapy is used in many settings, including schools, **rehabilitation** centers, hospitals, hospices, nursing homes, community centers, and sometimes even in the home.

Purpose

Music can be beneficial for anyone. Although it can be used therapeutically for people who have physical, emotional, social, or cognitive deficits, even those who are healthy can use music to relax, reduce stress, improve mood, or to accompany **exercise**. There are no potentially harmful or toxic effects. Music therapists help their patients achieve a number of goals through music, including improvement of communication, academic strengths, attention span, and motor skills. They may also assist with behavioral therapy and **pain management**.

Demographics

There are about 5000 board certified music therapists in the United States. The field is growing rapidly as an increasing number of both inpatient and outpatient healthcare settings incorporate music therapy into their treatment modalities.

Description

Origins

Music has been used throughout human history to express and affect human emotion. In biblical accounts, King Saul was reportedly soothed by David's harp music, and the ancient Greeks expressed thoughts about music having healing effects as well. Many cultures are steeped in musical traditions. It can change mood, have stimulant or sedative effects, and alter physiologic processes such as heart rate and breathing. The apparent health benefits of music to patients in Veterans Administration hospitals following World War II lead to it being studied and formalized as a complementary healing practice. Musicians were hired to continue working in the hospitals. Degrees in music therapy became available in the late 1940s, and in 1950, the first professional association of music therapists was formed in the United States. The National Association of Music Therapy merged with the American Association of Music Therapy in 1998 to become the American Music Therapy Association.

Physical effects

Brain function physically changes in response to music. The rhythm can guide the body into breathing in slower, deeper patterns that have a calming effect. Heart rate and blood pressure are also responsive to the types of music that are listened to. The speed of the heartbeat tends to speed or slow depending on the volume and speed of the auditory stimulus. Louder and faster noises tend to raise both heart rate and blood pressure; slower, softer, and more regular tones produce the opposite result. Music can also relieve muscle tension and improve motor skills. It is often used to help rebuild physical patterning skills in rehabilitation clinics. Levels of endorphins, natural pain relievers, are increased while listening to music, and levels of stress hormones are decreased. This latter

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KEY TERMS

Adjunctive—Refers to a form of treatment that is not strictly necessary to a therapy regimen but is helpful. Music therapy is an example of an adjunctive form of treatment.

Entrainment—The patterning of body processes and movements to the rhythm of music.

Physiologic—Refers to physiology, particularly normal, healthy, physical functioning.

effect may partially explain the ability of music to improve immune function. A study at Michigan State University showed that even 15 minutes of exposure to music could increase interleukin-1 levels, a consequence which also heightens immunity.

Mental effects

Depending on the type and style of sound, music can either sharpen mental acuity or assist in relaxation. Memory and learning can be enhanced, and this used with good results in children with learning disabilities. This effect may also be partially due to increased concentration that many people have while listening to music. Better productivity is another outcome of an improved ability to concentrate. The term "Mozart effect" was coined after a study showed that college students performed better on math problems when listening to classical music.

Emotional effects

The ability of music to influence human emotion is well known, and is used extensively by moviemakers. A variety of musical moods may be used to create feelings of calmness, tension, excitement, or romance. Lullabies have long been popular for soothing babies to sleep. Music can also be used to express emotion nonverbally, which can be a very valuable therapeutic tool in some settings.

Goals

Music is used to form a relationship between the therapist and the patient. The music therapist sets goals on an individual basis, depending on the reasons for treatment, and selects specific activities and exercises to help the patient progress. Objectives may include development of communication, cognitive, motor, emotional, and social skills. Some of the techniques used to achieve this are singing, listening, instrumental music, composition, creative movement, **guided imagery**, and other methods as appropriate. Other disciplines may be integrated as well, such as dance, art, and psychology. Patients may develop musical abilities as a result of therapy, but this is not a major concern. The primary aim is to improve the patient's ability to function.

Techniques

Learning to play an instrument is an excellent musical activity to develop motor skills in individuals with developmental delays, brain injuries, or other motor impairment. It is also an exercise in impulse control and group cooperation. Creative movement is another activity that can help to improve coordination, as well as strength, balance, and gait. Improvisation facilitates the nonverbal expression of emotion. It encourages socialization and communication about feelings as well. Singing develops articulation, rhythm, and breath control. Remembering lyrics and melody is an exercise in sequencing for **stroke** victims and others who may be intellectually impaired. Composition of words and music is one avenue available to assist the patient in working through fears and negative feelings. Listening is an excellent way to practice attending and remembering. It may also make the patient aware of memories and emotions that need to be acknowledged and perhaps talked about. Singing and discussion is a similar method, which is used with some patient populations to encourage dialogue. Guided Imagery and Music (GIM) is a very popular technique developed by music therapist Helen Bonny. Listening to music is used as a path to invoke emotions, picture, and symbols from the patient. This is a bridge to the exploration and expression of feelings.

Music and children

The sensory stimulation and playful nature of music can help to develop a child's ability to express emotion, communicate, and develop rhythmic movement. There is also some evidence to show that speech and language skills can be improved through the stimulation of both hemispheres of the brain. Just as with adults, appropriately selected music can decrease stress, **anxiety**, and pain. Music therapy in a hospital environment with those who are sick, **preparing for surgery**, or recovering postoperatively is appropriate and beneficial. Children can also experience improved self-esteem through musical activities that allow them to succeed.

Newborns may enjoy even greater benefits from music. Premature infants experience more rapid weight gain and an earlier discharge from the hospital than their peers who are not exposed to music. There is

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also anecdotal evidence of improved cognitive function in premature infants from listening to music.

Music and rehabilitation

Patients with brain damage from stroke, traumatic brain injury, or other neurologic conditions have been shown to exhibit significant improvement as a result of music therapy. This is theorized to be partially the result of entrainment, which is the synchronization of movement with the rhythm of the music. Consistent practice leads to gains in motor skill ability and efficiency. Cognitive processes and language skills often benefit from appropriate musical intervention.

Music therapy has also shown effectiveness in rehabilitating the hearing of children and adults who have had cochlear implant surgery to treat impaired hearing. Young children who have never heard sounds face a lengthy rehabilitation in order to learn how to interpret sound and form speech. Music therapy can serve as a bridge between non-verbal communication and the new sounds that toddlers are hearing and processing into language. In older adults with **cochlear implants**, music therapy can offer relaxation to minimize distortion among new sounds, and cues to remembering old sounds. Individualized music therapy is also used to reduce noise levels in people with **tinnitus**, or ringing in the ears.

Music and the elderly

The geriatric population can be particularly prone to anxiety and depression, particularly in nursing home residents. Chronic diseases causing pain are also not uncommon in this setting. Music is an excellent outlet to provide enjoyment, relaxation, relief from pain, and an opportunity to socialize and reminisce about music that has had special importance to the individual. It can have a striking effect on patients with **Alzheimer's disease**, even sometimes allowing them to focus and become more responsive for a time. Music has also been observed to decrease the agitation that is so common with this disease. One study shows that elderly people who play a musical instrument are more physically and emotionally fit as they age than their nonmusical peers are.

Music and psychiatric disorders

Music can be an effective tool for treating the mentally or emotionally ill. **Autism** is one disorder that has been particularly researched. Music therapy has enabled some autistic children to relate to others and have improved learning skills. **Substance abuse**, **schizophrenia**, **paranoia**, and disorders of personality, anxiety, and affect are all conditions that may be benefited by music therapy. In these groups, participation and social interaction are promoted through music. Reality orientation is improved. Patients are helped to develop coping skills, reduce stress, and express their feelings.

In the treatment of psychotic disorders, however, the benefits of music therapy appear to be limited. One study of patients diagnosed with schizophrenia or schizoaffective **psychosis** found that while music therapy improved the patients' social relationships, these benefits were relatively short-lived.

Music and hospice care

Pain, anxiety, and depression are major concerns with patients who are terminally ill, whether they are in hospice or not. Music can provide some relief from pain, through release of endorphins and promotion of relaxation. It can also provide an opportunity for the patient to reminisce and talk about the fears that are associated with **death** and dying. Music may help regulate the rapid breathing of a patient who is anxious, and soothe the mind. The Chalice of Repose project, headquartered at St. Patrick Hospital in Missoula, Montana, is one organization that attends and nurtures dying patients through the use of music, in a practice they called music-thanatology by developer Therese Schroeder-Sheker. Practitioners in this program work to relieve suffering through music prescribed for the individual patient.

Music and gynecologic procedures

Research has proven that women require less pharmaceutical pain relief during labor if they make use of music. Listening to music that is familiar and associated with positive imagery is the most helpful. During early labor, music will promote relaxation. Maternal movement is helpful to get the baby into a proper birthing position and dilate the cervix. Enjoying some "music to move by" can encourage the mother to stay active for as long as possible during labor. The rhythmic auditory stimulation may also prompt the body to release endorphins, which are a natural form of pain relief. Many women select different styles of music for each stage of labor, with a more intense, or faster-moving piece feeling like a natural accompaniment to the more difficult parts of labor. Instrumental music is often preferred.

The benefits of music therapy during **childbirth** have also been shown to apply to other surgical procedures. Women who have listened to music tapes

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during gynecologic surgery have more restful sleep following the procedure and less postoperative soreness.

Precautions

Patients making use of music therapy should not discontinue medications or therapies prescribed by other health providers without prior consultation.

Research and general acceptance

There is little disagreement among physicians that music can be of some benefit for patients, although the extent of its effects on physical well-being is not as well acknowledged in the medical community. Acceptance of music therapy as an adjunctive treatment modality is increasing, however, due to the growing diversity of patient populations receiving music therapy. Research has shown that listening to music can decrease anxiety, pain, and recovery time. There are also good data for the specific subpopulations discussed. A therapist referral can be made through the AMTA.

Training and certification

Music therapists are themselves often talented musicians; they also study the ways in which music can be applied to specific groups and circumstances. Coursework includes classes regarding music history and performance, behavioral science, and education. The American Music Therapy Association dictates what classes must be included in order for a music therapy program to be certified. There are approximately 70 colleges with approved curricula. A six-month internship follows the completion of the formal music therapy program, and the graduate is then able to take a national board exam to gain certification.

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ORGANIZATIONS

American Music Therapy Association, 8455 Colesville Road, Suite 1000, Silver Spring, MD, 20910, (301) 589–3300, (301) 589–5175 , info@musictherapy.org, http://www.musictherapy.org/.

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Mutism

Definition

Mutism is a rare childhood condition characterized by a consistent failure to speak in situations where talking is expected. As of 2010, the childhood disorder is more often called selective mutism or SM to distinguish it from akinetic mutism, a brain disorder in which the patient does not move about as well, as not being able to speak. Akinetic mutism is caused by severe damage to the frontal lobe of the brain. SM, in contrast, is an **anxiety** disorder that affects behavior rather than the structure and functioning of the brain itself. A child with selective mutism has the ability to converse normally, and does so, for example, in the home, but consistently fails to speak in such situations as at school or with strangers. The *Diagnostic and Statistical Manual of Mental Disorders*, fourth edition (DSM–IV), classifies selective mutism under the general category of "disorders usually first diagnosed in infancy, childhood, or adolescence."

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Demographics

It was estimated in the past that one in every 1,000 school–age children in North America is affected by selective mutism. However, a study carried out by the American Academy of Child and Adolescent Psychiatry (AACAP) reported in 2002 that a more accurate figure is seven children in every 1,000. DSM–IV states that the disorder "is apparently rare and is found in fewer than one percent of individuals seen in mental health settings." The condition is more common in girls, with a sex ratio of 2–2.5 females to one male. So far as is known, the condition is equally common in all racial and ethnic groups.

Description

Experts believe that selective mutism is associated with anxiety and fear in social situations such as in school or in the company of adults. It is, therefore, often considered a type of social phobia. Selective mutism is not a communication disorder because affected children can converse normally in some situations. It is not a developmental disorder because their ability to talk when they choose to do so is appropriate for their age level. This problem has been linked to anxiety, and one of the major ways in which both children and adults attempt to cope with anxiety is by avoiding whatever provokes the anxiety. The onset of selective mutism is often abrupt, occurring after the child has first entered school or suffered some other public humiliation.

Affected children are typically shy, and are especially so in the presence of strangers and unfamiliar surroundings or situations. However, the behaviors of children with this condition go beyond **shyness**. The condition becomes progressive in some cases, meaning that the child gradually stops talking to everyone, including his or her own parents.

Selective mutism was originally termed "elective mutism" when it was first listed in the third (1980) edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM–III). Doctors at the time thought that children with the disorder chose to remain silent when they could speak. It is now recognized that the inability to speak is involuntary and does not reflect stubbornness or opposition. The change from "elective" to "selective" mutism was made in the fourth edition (1994) of DSM (DSM–IV) to correct the misconception that children with SM are simply defiant and willful. They actually have a lower rate of oppositional disorder than their school–age peers.

Risk factors

Known risk factors for SM include a family history of **anxiety disorders**, particularly social phobia or **generalized anxiety disorder** (GAD). Some researchers report that rejection by peers or separation from caregivers due to severe illness or hospitalization in early childhood is also risk factors. According to the Selective Mutism Foundation (SMF), however, physical or emotional **abuse** within the family or family dysfunction is *not* usually causes of selective mutism.

Causes and symptoms

Mutism is believed to arise from anxiety experienced in social situations in which a child may be called upon to speak. Refusing to speak, or speaking in a whisper, spares the child from the possible humiliation or embarrassment of "saying the wrong thing." When asked a direct question by teachers, for example, the affected child may act as if he or she is unable to answer. Some children may communicate via gestures, nodding, or very brief utterances. Additional features may include excessive shyness, oppositional behavior, and impaired learning at school.

Some possible genetic or inborn causes of SM are currently under investigation. Some children appear to have an inborn susceptibility to high anxiety levels. Another theory maintains that children with SM have an overly excitable amygdala, an almond–shaped structure in the brain that governs the so–called fight–or–flight response. Still another theory holds that children with selective mutism suffer from sensory integration dysfunction, a neurological disorder that affects one' ability to process certain information coming from the senses. The resulting difficulties lead to anxiety, which in turn causes the child to "shut down" and stop talking to others.

Diagnosis

Selective mutism is usually diagnosed before a child is five years old, most often about the time the child starts school. The diagnosis is not always easy to make because the signs and symptoms can be confused with those of autism—particularly when the child is shy around the diagnostician. It is also important for the examiner to rule out cultural factors, such as recent immigration and little exposure to spoken English; or recent exposure to a traumatic event of some kind. It is not unusual for children to stop speaking temporarily after witnessing a murder, serious accident, or other frightening event. This type of mutism is transient, however, and usually clears up after a few weeks. For this reason DSM–IV specifies that the child's mutism

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KEY TERMS

Amygdala—An almond–shaped structure found deep within each medial temporal lobe of the brain that plays a primary role in the processing and memory of emotional experiences.

Behavior modification—A form of therapy that uses rewards to reinforce desired behavior. An example would be to give a child a piece of chocolate for grooming himself or herself appropriately.

Oppositional defiant disorder—A childhood behavioral disorder characterized by an ongoing pattern of disobedient, hostile, and defiant behavior toward authority figures that goes beyond the bounds of normal childhood conduct.

Sensory integration dysfunction—A neurological disorder in which a person has trouble processing and integrating all the information relayed to the brain by the various senses. Some researchers think that it is a possible cause of selective mutism.

must have lasted for a month or longer to meet the diagnostic criteria for SM. Other disorders that must be ruled out include **schizophrenia**, a pervasive developmental disorder (PDD), or **stuttering** or another communication disorder. Older children or teenagers may be asked about their **caffeine** intake, as heavy consumption of energy drinks can lead to jitteriness and other symptoms that resemble those of anxiety disorders.

Examination

The American Speech–Language–Hearing Association (ASHA) recomments that children who may suffer from SM should be evaluated by a speech–language pathologist in addition to a pediatrician and a child psychiatrist or psychologist. A complete diagnostic workup will include a number of different reviews, interviews, and tests:

- Educational review. The child's school reports, standardized test results, and teacher comments will be reviewed.
- Child Autism Rating Scale (CARS). This is a test administered by a licensed clinical psychologist to rule out autism or PDD.
- Parent/family interview. This interview is intended to gather information on such factors as language problems, family history of anxiety disorders (if any), general level of family functioning, and information from the parents about the history of the child's symptoms at home.
- Hearing test. This test is done to rule out hearing disorders or chronic middle ear infections as factors.
- Oral–motor examination. This is an examination of the strength and coordination of the muscles in the child's lips, jaws, and tongue.
- Speech and language evaluation. This part of the diagnostic workup looks at the child's ability to understand language, his or her patterns of verbal and nonverbal communication, and his or her ability to tell a simple story. If the child has difficulty communicating with the speech–language pathologist, the parents may be asked to make a videotape of the child talking at home.

Treatment

There is no single pattern of treatment for SM. Therapy is highly individualized, with the child's age, family situation, and overall health being taken into account. It is, however, important to start treatment as soon as possible after diagnosis, because children do not grow out of SM. In fact, their anxiety levels typically increase the longer the disorder goes untreated.

Most therapists will use a combination of behavioral strategies in treating a child with selective mutism. The most commonly employed behavioral techniques include:

- Stimulus fading. Stimulus fading refers to a technique in which the patient is brought into a controlled environment with someone with whom they are at ease and can communicate. Stimulus fading is usually used only with younger children, because older children and adolescents can quickly recognize it as a technique to get them to speak.
- Shaping. In shaping, the therapist gives the child positive reinforcement, first for interacting without speech, then for making sounds, then for making fully formed words.
- Self–modeling. In self–modeling, the therapist, parents, or teachers make videotapes of the child successfully communicating at home (or communicating successfully elsewhere, as with playmates). The child is then encouraged to watch him– or herself succeeding in speaking normally, as a way of boosting self–confidence and carrying over speaking normally into the classroom or other setting in which mutism occurs.
- Role–playing. This technique can be helpful in encouraging the child to feel comfortable in a variety of different settings with different participants.

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Drugs

The use of drugs in treating SM is controversial. Some doctors recommend low doses of antidepressants like fluoxetine (Prozac) or sertraline (Zoloft) to lower the child's anxiety level and speed up the process of **speech therapy**. If an antidepressant is used, it is not given for longer than nine to 12 months, and it is more likely to be given to older children or teenagers than to younger children. Other doctors, however, refuse to give medications to children with SM because of the risk of possible side effects. In any case, drugs should never be used as the sole treatment of selective mutism.

Prognosis

The prognosis for selective mutism varies considerably, although the overall prognosis is fair–to–good as of 2010. In general, children diagnosed before age 10 do better than those diagnosed and treated after age 12. Children with concurrent social phobia do not do as well as those with selective mutism alone. Individuals with SM who are not diagnosed or treated until they are adolescents have the poorest prognosis, most likely because they have fewer overall communication skills in social settings than children who were treated at younger ages. Although selective mutism was not the only disorder that was diagnosed in Seung–hui Cho, the student responsible for the Virginia Tech massacre of 2007, Cho was not diagnosed with SM or treated for it until he was in eighth grade. He was treated for three years for the disorder but refused further therapy during his junior year of high school.

Prevention

Selective mutism is difficult to prevent because relatively little is known about its causes or risk factors as of 2010. The best preventive approach is regular checkups for possible hearing problems in young children and more extensive evaluation as soon as a speech problem is present.

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American Academy of Child and Adolescent Psychiatry (AACAP), 3615 Wisconsin Ave., NW, Washington, DC, 20016-3007, (202) 966-7300, (202) 966-2891, http://www.aacap.org/.

American Psychiatric Association (APA), 1000 Wilson Blvd., Suite 1825, Arlington, VA, 22209-3901, (703) 907-7300, apa@psych.org, http://www.psych.org/.

American Speech–Language–Hearing Association (ASHA), 2200 Research Blvd., Rockville, MD, 20850-3289, (301) 296-5700, http://www.asha.org/default.htm.

Anxiety Disorders Association of America (ADAA), 8730 Georgia Ave., Suite 600, Silver Spring, MD, 20910, (240) 485-1001, (240) 485-1035, information@adaa.org, http://www.adaa.org/.

Selective Mutism Foundation (SMF), P.O. Box 13133, Sissonville, WV, 25360, http://www.selectivemutismfoundation.org/.

Selective Mutism Group/Childhood Anxiety Network, http://www.selectivemutism.org/contactus, http://www.selectivemutism.org/.

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MVP *see* **Mitral valve prolapse**

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Myasthenia gravis

Definition

Myasthenia gravis is an autoimmune disease that causes muscle weakness.

Description

Myasthenia gravis (MG) affects the neuromuscular junction, interrupting the communication between nerve and muscle, and thereby causing weakness. A person with MG may have difficulty moving their eyes, walking, speaking clearly, swallowing, and even breathing, depending on the severity and distribution of weakness. Increased weakness with exertion, and improvement with rest, is a characteristic feature of MG.

About 30,000 people in the United States are affected by MG. It can occur at any age, but is most common in women who are in their late teens and early twenties, and in men in their sixties and seventies.

Causes and symptoms

Myasthenia gravis is an autoimmune disease, meaning it is caused by the body's own immune system. In MG, the immune system attacks a receptor on the surface of muscle cells. This prevents the muscle from receiving the nerve impulses that normally make it respond. MG affects "voluntary" muscles, which are those muscles under conscious control responsible for movement. It does not affect heart muscle or the "smooth" muscle found in the digestive system and other internal organs.

A muscle is stimulated to contract when the nerve cell controlling it releases acetylcholine molecules onto its surface. The acetylcholine lands on a muscle protein called the acetylcholine receptor. This leads to rapid chemical changes in the muscle which cause it to contract. Acetylcholine is then broken down by acetylcholinesterase enzyme, to prevent further stimulation.

In MG, immune cells create antibodies against the acetylcholine receptor. Antibodies are proteins normally involved in fighting infection. When these antibodies attach to the receptor, they prevent it from receiving acetylcholine, decreasing the ability of the muscle to respond to stimulation.

Why the immune system creates these self-reactive "autoantibodies" is unknown, although there are several hypotheses:

- During fetal development, the immune system generates many B cells that can make autoantibodies, but B cells that could harm the body's own tissues are screened out and destroyed before birth. It is possible that the stage is set for MG when some of these cells escape detection.
- Genes controlling other parts of the immune system, called MHC genes, appear to influence how susceptible a person is to developing autoimmune disease.
- Infection may trigger some cases of MG. When activated, the immune system may mistake portions of the acetylcholine receptor for portions of an invading virus, though no candidate virus has yet been identified conclusively.
- About 10% of those with MG also have thymomas, or benign tumors of the thymus gland. The thymus is a principal organ of the immune system, and researchers speculate that thymic irregularities are involved in the progression of MG.

Some or all of these factors (developmental, genetic, infectious, and thymic) may interact to create the autoimmune reaction.

The earliest symptoms of MG often result from weakness of the extraocular muscles, which control eye movements. Symptoms involving the eye (ocular symptoms) include double vision (diplopia), especially when not gazing straight ahead, and difficulty raising the eyelids (**ptosis**). A person with ptosis may need to tilt their head back to see. Eye-related symptoms remain the only symptoms for about 15% of MG patients. Another common early symptom is difficulty chewing and swallowing, due to weakness in the bulbar muscles, which are in the mouth and throat. **Choking** becomes more likely, especially with food that requires extensive chewing.

Weakness usually becomes more widespread within several months of the first symptoms, reaching their maximum within a year in two-thirds of patients. Weakness may involve muscles of the arms, legs, neck, trunk, and face, and affect the ability to lift objects, walk, hold the head up, and speak.

Symptoms of MG become worse upon exertion, and better with rest. Heat, including heat from the sun, hot showers, and hot drinks, may increase weakness. Infection and **stress** may worsen symptoms. Symptoms may vary from day to day and month to month, with intervals of no weakness interspersed with a progressive decline in strength.

"Myasthenic crisis" may occur, in which the breathing muscles become too weak to provide adequate respiration. Symptoms include weak and shallow breathing, **shortness of breath**, pale or bluish

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skin color, and a racing heart. Myasthenic crisis is an emergency condition requiring immediate treatment. In patients treated with anticholinesterase agents, myasthenic crisis must be differentiated from cholinergic crisis related to overmedication.

Pregnancy worsens MG in about one third of women, has no effect in one third, and improves symptoms in another third. About 12% of infants born to women with MG have "neonatal myasthenia," a temporary but potentially life-threatening condition. It is caused by the transfer of maternal antibodies into the fetal circulation just before birth. Symptoms include weakness, floppiness, feeble cry, and difficulty feeding. The infant may have difficulty breathing, requiring the use of a ventilator. Neonatal myasthenia usually clears up within a month.

Diagnosis

Myasthenia gravis is often diagnosed accurately by a careful medical history and a neuromuscular exam, but several tests are used to confirm the diagnosis. Other conditions causing worsening of bulbar and skeletal muscles must be considered, including drug-induced myasthenia, thyroid disease, Lambert-Eaton myasthenic syndrome, **botulism**, and inherited muscular dystrophies.

MG causes characteristic changes in the electrical responses of muscles that may be observed with an electromyogram, which measures muscular response to electrical stimulation. Repetitive nerve stimulation leads to reduction in the height of the measured muscle response, reflecting the muscle's tendency to become fatigued.

Blood tests may confirm the presence of the antibody to the acetylcholine receptor, though up to a quarter of MG patients will not have detectable levels. A **chest x ray** or chest computed tomography scan (CT scan) may be performed to look for **thymoma**.

Treatment

While there is no cure for myasthenia gravis, there are a number of treatments that effectively control symptoms in most people.

Edrophonium (Tensilon) blocks the action of acetylcholinesterase, prolonging the effect of acetylcholine and increasing strength. An injection of edrophonium rapidly leads to a marked improvement in most people with MG. An alternate drug, neostigmine, may also be used.

Pyridostigmine (Mestinon) is usually the first drug tried. Like edrophonium, pyridostigmine blocks acetylcholinesterase. It is longer-acting, taken by mouth, and well-tolerated. Loss of responsiveness and disease progression combine to eventually make pyridostigmine ineffective in tolerable doses in many patients.

Thymectomy, or removal of the thymus gland, has increasingly become standard treatment for MG. Up to 85% of people with MG improve after thymectomy, with complete remission eventually seen in about 30%. The improvement may take months or even several years to fully develop. Thymectomy is not usually recommended for children with MG, since the thymus continues to play an important immune role throughout childhood.

Immune-suppressing drugs are used to treat MG if response to pyridostigmine and thymectomy are not adequate. Drugs include **corticosteroids** such as prednisone, and the non-steroids azathioprine (Imuran) and cyclosporine (Sandimmune).

Plasma exchange may be performed to treat myasthenic crisis or to improve very weak patients before thymectomy. In this procedure, blood plasma is removed and replaced with purified plasma free of autoantibodies. It can produce a temporary improvement in symptoms, but is too expensive for long-term treatment. Another blood treatment, intravenous immunoglobulin therapy, is also used for myasthenic crisis. In this procedure, large quantities of purified immune proteins (immunoglobulins) are injected. For unknown reasons, this leads to symptomatic improvement in up to 85% of patients. It is also too expensive for long-term treatment.

People with weakness of the bulbar muscles may need to eat softer foods that are easier to chew and swallow. In more severe cases, it may be necessary to obtain **nutrition** through a feeding tube placed into the stomach (**gastrostomy** tube).

Prognosis

Most people with MG can be treated successfully enough to prevent their condition from becoming debilitating. In some cases, however, symptoms may worsen even with vigorous treatment, leading to generalized weakness and disability. MG rarely causes early **death** except from myasthenic crisis.

Prevention

There is no known way to prevent myasthenia gravis. Thymectomy improves symptoms significantly in many patients, and relieves them entirely in some. Avoiding heat can help minimize symptoms.

Some drugs should be avoided by people with MG because they interfere with normal neuromuscular function.

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KEY TERMS

Antibody—An immune protein normally used by the body for combating infection and which is made by B cells.

Autoantibody—An antibody that reacts against part of the self.

Autoimmune disease—A disease caused by a reaction of the body's immune system.

Bulbar muscles—Muscles that control chewing, swallowing, and speaking.

Neuromuscular junction—The site at which nerve impulses are transmitted to muscles.

Pyridostigmine bromide (Mestinon)—An anticholinesterase drug used in treating myasthenia gravis.

Tensilon test—A test for diagnosing myasthenia gravis. Tensilon is injected into a vein and, if the person has MG, their muscle strength will improve for about five minutes.

Thymus gland—A small gland located just above the heart, involved in immune system development.

Drugs to be avoided or used with caution include:

- Many types of antibiotics, including erythromycin, streptomycin, and ampicillin
- Some cardiovascular drugs, including Verapamil, betaxolol, and propranolol
- Some drugs used in psychiatric conditions, including chlorpromazine, clozapine, and lithium.

Many other drugs may worsen symptoms as well, so patients should check with the doctor who treats their MG before taking any new drugs.

A Medic-Alert card or bracelet provides an important source of information to emergency providers about the special situation of a person with MG. They are available from health care providers.

ORGANIZATIONS

Muscular Dystrophy Association, 3300 East Sunrise Drive, Tucson, AZ, 85718, (800) 572-1717, http://www.mdausa.org.

Myasthenia Gravis Foundation of America, 355 Lexington Avenue, 15th Floor, New York, NY, 10017, (212) 297-2156, (212) 370-9047, (800) 541-5454, http://www.myasthenia.org/.

Richard Robinson

Mycetoma

Definition

Mycetoma, or maduromycosis, is a slow-growing bacterial or fungal infection focused in one area of the body, usually the foot. For this reason—and because the first medical reports were from doctors in Madura, India—an alternate name for the disease is Madura foot. The infection is characterized by an abnormal tissue mass beneath the skin, formation of cavities within the mass, and a fluid discharge. As the infection progresses, it affects the muscles and bones; at this advanced stage, disability may result.

Description

Although the bacteria and fungi that cause mycetoma are found in soil worldwide, the disease occurs mainly in tropical areas in India, Africa, South America, Central America, and southeast Asia. Mycetoma is an uncommon disease, affecting an unknown number of people annually.

There are more than 30 species of bacteria and fungi that can cause mycetoma. Bacteria or fungi can be introduced into the body through a relatively minor skin wound. The disease advances slowly over months or years, typically with minimal **pain**. When pain is experienced, it is usually due to secondary infections or bone involvement. Although it is rarely fatal, mycetoma causes deformities and potential disability at its advanced stage.

Causes and symptoms

Owing to a wound, bacteria or fungi gain entry into the skin. Approximately one month or more after the injury, a nodule forms under the skin surface. The nodule is painless, even as it increases in size over the following months. Eventually, the nodule forms a tumor, or mass of abnormal tissue. The tumor contains cavities—called sinuses—that discharge blood- or pus-tainted fluid. The fluid also contains tiny grains, less than two thousandths of an inch in size. The color of these grains depends on the type of bacteria or fungi causing the infection.

As the infection continues, surrounding tissue becomes involved, with an accumulation of scarring and loss of function. The infection can extend to the bone, causing inflammation, pain, and severe damage. Mycetoma may be complicated by secondary infections, in which new bacteria become established in the area and cause an additional set of problems.

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KEY TERMS

Biopsy—A medical procedure in which a small piece of tissue is surgically removed for microscopic examination.

Grains—Flecks of hardened material such as bacteria or fungi spores.

Nodule—A hardened area or knot sometimes associated with infection.

Secondary infection—Illness caused by new bacteria, viruses, or fungi becoming established in the wake of an initial infection.

Sinuses—Cavities or hollow areas.

Tumor—A mass or clump of abnormal tissue, not necessarily caused by a cancer.

Diagnosis

The primary symptoms of a tumor, sinuses, and grain-flecked discharge often provide enough information to diagnose mycetoma. In the early stages, prior to sinus formation, diagnosis may be more difficult and a biopsy, or microscopic examination of the tissue, may be necessary. If bone involvement is suspected, the area is x rayed to determine the extent of the damage. The species of bacteria or fungi at the root of the infection is identified by staining the discharge grains and inspecting them with a microscope.

Treatment

Combating mycetoma requires both surgery and drug therapy. Surgery usually consists of removing the tumor and a portion of the surrounding tissue. If the infection is extensive, **amputation** is sometimes necessary. Drug therapy is recommended in conjunction with surgery. The specific prescription depends on the type of bacteria or fungi causing the disease. Common medicines include antifungal drugs, such as ketoconazole and **antibiotics** (streptomycin sulfate, amikacin, sulfamethoxazole, penicillin, and rifampin).

Prognosis

Recovery from mycetoma may take months or years, and the infection recurs after surgery in at least 20% of cases. Drug therapy can reduce the chances of a re-established infection. The extent of deformity or disability depends on the severity of infection; the more deeply entrenched the infection, the greater the damage. By itself, mycetoma is rarely fatal, but secondary infections can be fatal.

Prevention

Mycetoma is a rare condition that is not contagious.

Resources

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The Merck Manuals Online Medical Library, http://www.merckmanuals.com/professional/sec14/ch180/ch180j.html (accessed December 6, 2010).

Julia Barrett

Mycobacterial infections, atypical

Definition

Atypical mycobacterial infections are infections caused by several types of mycobacteria similar to the germ that causes **tuberculosis**. These atypical mycobacterial infections are a frequent complication in patients with human **immunodeficiency** virus (HIV) infection or **AIDS**.

Description

Mycobacteria are a group of rod-shaped bacteria that cause several diseases, among them **leprosy** and tuberculosis. For some time, scientists have known of bacteria that are similar to *Mycobacterium tuberculosis,* the cause of tuberculosis, but that grow and act differently. When tuberculosis was a much more widespread problem and microbiology was much less able to tell the difference between similar microbes, these atypical mycobacteria were ignored. Today, they have been classified more precisely as members of the same species and called atypical (or nontuberculosis) mycobacteria.

Although the medical profession has known about these atypical infections for a long time, they were not considered a serious problem until the early 1980s. It was then that many of these atypical infections were noticed among homosexuals and intravenous drug users in New York City. These bacteria rarely cause infection in humans other than those with HIV or AIDS.

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Causes and symptoms

Although there are more than a dozen species of atypical mycobacteria, the two most common are *Mycobacterium kansasii* and *M. avium-intracellulare*. These microbes are found in many places in the environment: tap water, fresh and ocean water, milk, bird droppings, soil, and house dust. The manner in which these bacteria are transmitted is not completely understood. There is no evidence that they are transmitted from person to person.

M. avium-intracellulare (MAC or MAI) is a rare cause of lung disease in otherwise healthy humans but a frequent cause of infection among those whose resistance has been lowered by another disorder (opportunistic infection). According to some experts, MAC infection is an almost inevitable complication of HIV. The infection is caused by one of two similar organisms, *M. avium* and *M. intracellulare*.

AIDS patients are almost always attacked by these mycobacteria. Once inside the body, the atypical mycobacterial organisms colonize and grow in the lungs like tuberculosis. Because AIDS patients have a poorly functioning immune system, the microbes multiply because they aren't stopped by the body's normal response to infection. Once they have colonized the lungs, the organisms enter the bloodstream and spread throughout the body, affecting almost every organ. These devastating infections can invade the lymph nodes, liver, spleen, bone marrow, gastrointestinal tract, skin, and brain.

Symptoms include **shortness of breath**, **fever**, night sweats, weight loss, appetite loss, **fatigue**, and progressively severe **diarrhea**, stomach **pain**, **nausea and vomiting**. If the infection spreads to the brain, the patient may experience weakness, headaches, vision problems, and loss of balance.

MAC and *M. kansasii* sometimes cause lung infections in middle-aged and elderly people with chronic lung conditions. MAC, *M. kansasii*, and *M. scrofulaceum* may cause inflammation of the lymph nodes in otherwise healthy young children. *M. fortuitum* and *M. chelonae* cause skin and wound infections and abscesses after trauma or surgical procedures. *M. marinum* causes a nodular inflammation, usually on the arms and legs. This infection is called "swimming pool granuloma" because it is associated with swimming pools, fish tanks, and other bodies of water. *M. ulcerans* infection causes chronic skin ulcerations, usually on an arm or leg. Atypical mycobacteria infections can also occur without causing any symptoms. In such cases, a **tuberculin skin test** may be positive.

KEY TERMS

Culture—A test in which a sample of body fluid, such as prostatic fluid, is placed on materials specially formulated to grow microorganisms. A culture is used to learn what type of bacterium is causing infection.

Human immunodeficiency virus (HIV)—The virus that causes AIDS.

Diagnosis

The diagnosis is made from the patient's symptoms and organisms grown in culture from the site of infection. In cases of lung infection, a diagnostic workup will include a **chest x ray** and tests on discharges from the respiratory passages (sputum).

Treatment

These nontypical mycobacteria are not easy to treat in any patient and the problem is complicated when the person has AIDS. **Antibiotics** are not particularly effective, although rifabutin (a cousin of the anti-tuberculosis drug rifampin) and clofazimine (an anti-leprosy drug) have helped some patients. It is also possible to contain the infection to some degree by combining different drugs, including ethionamide, cycloserine, ethambutol, and streptomycin.

Prognosis

Because drug therapy is not easily effective, the overwhelming infections caused by these mycobacteria in AIDS patients can be fatal.

Prevention

People with HIV infection can prevent or delay the onset of MAC by taking disease-preventing drugs such as rifabutin.

AIDS patients and persons with tissue damage, such as skin **wounds** or pulmonary disease, can make a number of lifestyle changes to help prevent MAC infection. Since these mycobacteria are found in most city water systems, in hospital water supplies, and in bottled water, at-risk persons should boil drinking water. Persons at risk should also avoid raw foods, especially salads, root vegetables, and unpasteurized milk or cheese. Fruits and vegetables should be peeled and rinsed thoroughly. Conventional cooking (baking, boiling or steaming) destroys mycobacteria, which are killed at 176°F (80°C).

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Finally, at-risk patients should avoid contact with animals, especially birds and bird droppings. Pigeons in particular can transmit MAC.

ORGANIZATIONS

National AIDS Treatment Advocacy Project, 580 Broadway, Ste. 1010, New York, NY, 10012, (212) 219-0106, (212) 219-8473, (866) 26-NATAP, info@natap.org, http://www.natap.org.

Carol A. Turkington

Mycobacterium leprae infection *see* **Leprosy**

Mycobacterium tuberculosis see **Tuberculosis**

Mycoplasma infections

Definition

Mycoplasma are the smallest of the free-living organisms. (Unlike viruses, mycoplasma can reproduce outside of living cells.) Many species within the genus *Mycoplasma* thrive as parasites in human, bird, and animal hosts. Some species can cause disease in humans.

Description

Mycoplasma are found most often on the surfaces of mucous membranes. They can cause chronic inflammatory diseases of the respiratory system, urogenital tract, and joints. The most common human illnesses caused by mycoplasma are due to infection with *M. pneumoniae,* which is responsible for 10-20% of all pneumonias. This type of **pneumonia** is also called atypical pneumonia, walking pneumonia, or community-acquired pneumonia. Infection moves easily among people in close contact because it is spread primarily when infected droplets circulate in the air (that is, become aerosolized), usually due to coughing, spitting, or sneezing.

Causes and symptoms

Atypical pneumonias can affect otherwise healthy people who have close contact with one another. Pneumonia caused by *M. pneumoniae* may start out with symptoms of an upper respiratory infection, probably a **sore throat** progressing to a dry **cough** within a few days. Gradually, **fever**, **fatigue**, muscle aches, and a cough that produces thin sputum (spit or phlegm) will emerge. Nonrespiratory symptoms may occur too: abdominal **pain**, **headache**, and **diarrhea**; about 20% of patients may have ear pain.

KEY TERMS

Community-acquired—Refers to an infectious disease that is passed among individuals who have close contact with one another.

Another mycoplasma species, *M. hominis*, is common in the mucous membranes of the genital area (including the cervix), and can cause infection in both males and females. Its presence does not always result in symptoms.

Diagnosis

Usually, mycoplasma pneumonia will be identified after other common diagnoses are set aside. For example, a type of antibiotic known as a beta-lactam might be prescribed for a respiratory infection producing fever and cough. If symptoms do not improve in 3-5 days, the organism causing the disease is not a typical one and not susceptible to these **antibiotics**. If a Gram's stain (a common test done on sputum) does not indicate a gram-positive pathogen, the doctor will suspect a gram-negative organism, such as mycoplasma. The actual underlying organism may not be identified (it is not in almost 50% of cases of atypical pneumonia). Although it is rare, a rash may appear along with pneumonia symptoms.This should trigger suspicion of mycoplasma pneumonia, even if laboratory tests are inconclusive.

Standard x rays may reveal a patchy material that has entered the tissue; this can be evident for months. Laboratory tests include cold agglutinins, complement fixation, culture, and enzyme immunoassay. The presence of infection with *M. pneumoniae* would be indicated by a fourfold rise in *M. pneumoniae*-specific antibody in serum, during the illness or convalescence. Highly sophisticated and specific polymerase chain reaction methods (PCR) have been developed for many respiratory pathogens, including *M. pneumoniae*. They are not readily available and are very expensive.

Treatment

A 2-3 week course of certain antibiotics (erythromycin, azithromycin, clarithromycin, dirithromycin, or doxycycline) is generally prescribed for atypical pneumonia. This disease is infectious for weeks, even after the patient starts antibiotics. A persistent cough may linger for 6 weeks.

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Prognosis

Mycoplasma pneumonia may be involved in the onset of **asthma** in adults; other rare complications include meningoencephalitis, **Guillain-Barré syndrome**, mononeuritis multiplex, **myocarditis**, or **pericarditis**. This may increase the risk of acute **arrhythmias** leading to **sudden cardiac death**. However, with proper treatment and rest, recovery should be complete.

Prevention

At this time, there are no vaccines for mycoplasma infection. It is difficult to control its spread, especially in a group setting. The best measures are still the simplest ones. Avoid exposure to people with respiratory infections whenever possible. A person who has a respiratory infection should cover the face while coughing or sneezing.

Resources

BOOKS

Fauci, Anthony S., et al., eds. *Harrison's Principles of Internal Medicine*. 17th ed. New York: McGraw-Hill Professional, 2008.

Jill S. Lasker

Mycoplasmal pneumonia *see* **Mycoplasma infections**

Myelocytic leukemia, acute *see* **Leukemias, acute**

Myelodysplastic syndrome

Definition

Myelodysplastic syndrome (MDS) is a disease that is associated with decreased production of blood cells. Blood cells are produced in the bone marrow, and the blood cells of people with MDS do not mature normally. There are three major types of blood cells — red blood cells, white blood cells and platelets. Patients with MDS can have decreased production of one, two, or all three types of blood cells.

Description

Blood cells are used in the body for many different and important functions, such as carrying oxygen (red blood cells), fighting infection (white blood cells), and controlling bleeding (platelets). Blood cells are formed and stored in the bone marrow, which is the spongy tissue inside large bones. Stem cells, or immature blood cells, are stored in the bone marrow and have the ability to develop into all three types of mature blood cells. When the body needs a specific type of blood cell, the bone marrow uses its stockpile of stem cells to produce the kind of mature cells needed for that particular situation.

In patients who have MDS, blood cells fail to mature normally. In other words, the bone marrow is unable to develop a normal amount of mature blood cells, and is also not able to increase blood cell production when mature cells are needed. Sometimes, even the cells that are produced do not function normally. The marrow eventually becomes filled with the immature cells and there is not room for the normal cells to grow and develop. MDS therefore causes a shortage of functional blood cells.

Subtypes of MDS

MDS is divided into five different subtypes that are classified according to the number and appearance of blast cells in the bone marrow. It is important for doctors to know the type of MDS a patient has, because each subtype affects patients differently and requires specific treatment. The International Prognostic Scoring System (IPSS) can help the doctor to determine the best treatment for an individual patient. The subtypes are as follows:

- Refractory anemia (RA). Bone marrow with less than 5% blast cells and abnormal red blood cell blasts
- Refractory anemia with ring sideroblasts (RARS). Bone marrow with less than 5% blasts and characteristic abnormalities in red blood cells
- Refractory anemia with excess blasts (RAEB). Bone marrow with 5-20% blast cells, and higher risk of changing into acute leukemia over time
- Refractory anemia with excess blasts in transformation (RAEBT). Bone marrow with 21-30% blast cells. This form is most likely to change into acute leukemia.
- Chronic myelomonocytic leukemia (CMMoL). Marrow with 5-20% blasts and excess monocytes (a specific type of white blood cell).

Approximately 15,000 new cases are diagnosed annually in the United States. The average age at diagnosis is 70. The most common types are RA and RARS. It is rare to have MDS before age 50. MDS is slightly more common in males than in females.

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Causes and symptoms

Causes

There is no clear cause for the majority of MDS cases, which is referred to as primary or *de novo* myelodysplastic syndrome. In some cases, however, MDS results from earlier **cancer** treatments such as radiation and/or **chemotherapy**. This type of MDS is called secondary or treatment related MDS, is often seen 3 to 7 years after the exposure, and usually occurs in younger people.

Other possible causative agents for MDS include exposure to radiation, cigarette smoke, or toxic chemicals such as benzene. Children with pre-existing chromosomal abnormalities such as **Down syndrome** have a higher risk of developing MDS. MDS does not appear to run in families, nor can it be spread to other individuals.

Symptoms

MDS symptoms are related to the type of blood cells that the body is lacking. The earliest symptoms are usually due to anemia, which results from a shortage of mature red blood cells. Anemia causes patients to feel tired and out of breath because there is a lack of cells transporting oxygen throughout the body. MDS may also lead to a shortage of white blood cells resulting in an increased likelihood of infections. Another symptom of MDS is increased bleeding (e.g., blood in stool, nose bleeds, increased **bruises** or bleeding gums) which is due to low level of platelets. These symptoms can occur in any combination, depending on a given patient's specific subtype of MDS.

Diagnosis

Blood tests

People who have MDS usually visit their primary care doctor first, with symptoms of **fatigue**, and are then referred to a hematologist (a physician who specializes in diseases of the blood). The diagnosis of MDS requires a complete analysis of the patient's blood and bone marrow, which is done by the hematologist. A **complete blood count** (CBC) is done to determine the number of each blood cell type within the sample. Low numbers of red blood cells, white blood cells, and or platelets are signs that a patient has MDS. Numerous other medical problems such as bleeding, nutritional deficiencies, or adverse reaction to a medication can also cause low blood counts. The hematologist will investigate other causes for low blood counts before assigning a diagnosis of MDS. Blood cells in patients with MDS can also be abnormal when viewed under the microscope.

Bone marrow aspiration and biopsy

A **bone marrow biopsy** is required to confirm the diagnosis of MDS and determine the correct MDS subtype. This procedure involves a needle used to take a sample of marrow from inside the bone. The area of the skin where the needle is inserted is numbed and sometimes the patient is also sedated. Patients may experience some discomfort but the procedure is safe and is over fairly quickly. Marrow samples are usually taken from the back of the hip bone (iliac crest). A sample of the marrow, known as an aspirate, and a small piece of bone are both removed with the needle.

A hematologist or a pathologist (a specialist in diagnosing diseases through cell examination) will carefully examine the bone marrow sample through a microscope. Microscopic examination allows the doctor to determine the number and type of blast cells (immature cells) within the marrow in order to identify the MDS subtype. Cells from the bone marrow are also sent for cytogenetic testing, which analyzes the cells' chromosomes. Forty to seventy percent of MDS patients have abnormal bone marrow chromosomes as a result of the disease. The pattern of these abnormalities can be used to predict how a patient will respond to a particular treatment. Thus, the full set of information provided by a bone marrow biopsy and CBC will ultimately allow the doctor to recommend the most effective treatment plan.

International Prognostic Scoring System (IPSS) for MDS

Once a diagnosis of MDS is established, the doctor will calculate the IPSS score for each individual patient. The bone marrow blast percentage, chromosomal abnormalities and number of different blood types that are reduced determine the score. A score of 0 to 3.5 is assigned to each patient. Patients with lower score have a better prognosis and usually should not undertake treatment upon initial diagnosis. Patients with a higher score have more aggressive disease and should consider more aggressive treatment.

Treatments

Supportive care

Treatment for MDS is tailored to the patient's age, general health, specific MDS subtype, and IPSS score. Treatment varies for each patient, but most treatment strategies are designed to control the

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symptoms of MDS. This approach is called supportive care and aims to improve the patient's quality of life.

Supportive care for the MDS patients commonly includes red blood cell transfusions to relieve symptoms related to anemia. Red cell transfusions are relatively safe and the physician will review risks and benefits with this approach. Transfusions of any type only last a certain amount of time and therefore need to be repeated at certain intervals. Platelet transfusions can also be a way to control excessive bleeding. The doctor will decide with each individual patient when it is appropriate to give a **transfusion**. **Antibiotics** are used when needed to combat infections that can occur more frequently in patients with low white blood cell counts.

Bone marrow transplantation

Bone marrow transplantation (BMT) is a type of treatment that attempts to provide MDS patients with a cure. This strategy requires the patients to be in fairly good health and are therefore more likely to be used in younger patients. Bone marrow transplantation (BMT) has been found to be a successful treatment for MDS patients under the age of 50 (and some over 50 in good health). Following BMT, many patients are able to achieve long-term, disease-free survival. Unfortunately, most MDS patients cannot receive a traditional bone marrow transplant because of older age or because they do not have a suitable donor. Bone marrow donors are usually siblings or are obtained from the national bone marrow registry. "Mini"-bone marrow transplants use less intense chemotherapy, and are currently being tested in older patients who would otherwise not be candidates for traditional bone marrow transplants.

Chemotherapy

Chemotherapy has been used to treat some MDS patients; however, the disease often recurs after a period of time. This type of therapy uses cell-killing drugs that may also damage healthy cells in the body. Most chemotherapy drugs are associated with some side effects. For these reasons, chemotherapy is generally not used until the MDS becomes more aggressive or the patient has a high IPSS score.

Growth factors

Growth factors are natural proteins that the body normally uses to control blood production. These substances stimulate the patient's bone marrow to produce healthy blood cells. Growth factors that stimulate white cell production are G-CSF (also called neupogen or filgrastim) and GMCSF (Leukine, sargramostim). In order to increase red cell production another growth factor, erythropoietin (Procrit) is used. These growth factors are safe with few side effects and are available only in the injectable form. The physician will decide if this treatment is appropriate for an individual patient.

Alternative treatment

There are no alternative therapies that have been proven to successfully treat MDS. Some of the available alternative drugs can have adverse side effects and therefore a physician should be informed if they are being used.

Prognosis

The prognosis for MDS patients depends on the subtype of their disease and the IPSS score. Patients with RA, RARS or low IPSS score rarely develop leukemia and may live with disease for some years. The higher-risk patients including those with RAEB, RAEBt, CMMoL or high IPSS scores progress more rapidly, and require intensive therapy to control the disease.

Managing MDS requires frequent doctor appointments to monitor disease progression and to evaluate the response to treatment. Fortunately for many patients, recent advances in therapy have significantly enhanced their ability to cope with MDS. Experimental drugs and a better understanding of the disease are likely to improve the overall prognosis in the future.

Prevention

MDS is usually impossible to prevent. Being careful about daily activities and avoiding the use of aspirin-like products that thin the blood may prevent secondary complications of MDS such as bruising and bleeding. Practicing good hygiene and avoiding crowds or people with infections can sometimes prevent infections. A well balanced diet is recommended to increase overall energy.

Resources

BOOKS

Aguayo, Alvaro, Jorge Cortes, and Hagop Kantarjian. "Myelodysplastic Syndromes." In *Cancer Management: A Multidisciplinary Approach*, edited by Richard Pazdur, et al., 4th ed. PRR, Inc, 2000.

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ORGANIZATIONS

Aplastic Anemia Foundation of America, P.O. Box 613, Annapolis, MD, 21404, (800) 747-2820, www.aplastic.org.

Leukemia Society of America, 600 Third Avenue, New York, NY, 10016, (800) 955-4572, www.leukemia.org.

Myelodysplastic Syndromes Foundation, 464 Main Street, P.O. Box 477, Crosswicks, NJ, 08515, (800) MDS-0839, www.mds-foundation.org.

Andrea Ruskin, M.D.

Myelofibrosis

Definition

Myelofibrosis is a rare disease of the bone marrow in which collagen builds up fibrous scar tissue inside the marrow cavity. This is caused by the uncontrolled growth of a blood cell precursor, which results in the accumulation of scar tissue in bone marrow. Myelofibrosis goes by many names including idiopathic myelofibrosis, agnogenic myeloid metaplasia, chronic myelosclerosis, aleukemic megakaryocytic myelosis, and leukoerythroblastosis.

Description

Myelofibrosis can be associated with many other conditions including **breast cancer**, **prostate cancer**, Hodgkin's disease, non-Hodgkin's lymphoma, acute myeloid leukemia, acute lymphocytic leukemia, **hairy cell leukemia**, **multiple myeloma**, myeloproliferative diseases, **tuberculosis**, Gaucher's disease, and **Paget's disease of bone**. Myelofibrosis typically becomes progressively worse and can cause **death**.

In myelofibrosis, abnormal cells (hematopoietic stem cells) grow out of control and begin to produce both immature blood cells and excess scar (fibrous) tissue. The fibrous tissue builds up (fibrosis) primarily in the bone marrow, the place where blood cells are produced. The fibrous tissue interferes with the production of normal blood cells. The outcome of this is that the blood made by the bone marrow is of poor quality. To compensate for this, blood cell production occurs in other parts of the body (extramedullary hematopoiesis), but most notably in the spleen and liver. This causes enlargement of the spleen (splenomegaly) and the liver (hepatomegaly). Extramedullary hematopoiesis is not effective and, combined with the reduced production of blood cells by the bone marrow, a condition called anemia results.

The abnormal stem cells can spread throughout the body, settle in other organs, and form tumors that produce more abnormal blood cells and fibrous tissue. These tumors are most commonly found in the adrenals, kidneys, lymph nodes, breast, lungs, skin, bowel, thymus, thyroid, prostate, and urinary tract.

Most patients with myelofibrosis are over 50 years old; the average age at diagnosis is 65 years. However, myelofibrosis can occur at any age. Myelofibrosis occurs with equal frequency in women and men, but in children it affects girls twice as often as it does boys.

Causes and symptoms

Myelofibrosis is caused by an abnormality in a single stem cell, which causes it to grow out of control. Myelofibrosis tumors that have originated from a single cell are called monoclonal. The cause of the stem cell abnormality is unknown. Persons who were exposed to benzene or high doses of radiation have developed myelofibrosis. There may be an association between myelofibrosis and autoimmune diseases, such as **systemic lupus erythematosus** and **scleroderma**, in which the immune system treats certain molecules of the body as foreign invaders.

Symptoms usually appear slowly over a long period of time. About one quarter of all patients with myelofibrosis have no symptoms (asymptomatic). An enlarged spleen discovered at an annual medical examination may be the first clue. Symptoms of myelofibrosis include:

- fatigue
- weight loss
- paleness
- fever
- sweating
- weakness
- heart palpitations
- shortness of breath
- itchiness
- feeling full after eating a small amount of food
- stomach pain or discomfort
- pain in the left shoulder or upper left portion of the body
- unexpected bleeding
- bone pain, especially in the legs

Diagnosis

Because symptoms are similar to other diseases (mostly leukemias), myelofibrosis is not easy to

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diagnose. The doctor would use his or her hands to feel (palpate) for enlargement of the spleen and liver. Blood tests and urine tests would be performed. **Bone marrow aspiration and biopsy** can help make a diagnosis, but they often fail because of the fibrosis. X-ray imaging and **magnetic resonance imaging** (MRI) may be performed.

Treatment

Many asymptomatic patients, if stable, do not require treatment. There is no cure for myelofibrosis, although **bone marrow transplantation** is curative in some cases. Treatment is aimed at reducing symptoms and improving quality of life.

Medications

Male hormones (androgens) can be used to treat anemia but, in women, these drugs can cause the development of male characteristics (e.g., hair growth on the face and body). Glucocorticoid therapy is also an effective treatment of anemia and can improve myelofibrosis in children. Nutrients that stimulate blood formation (hematinics), such as iron, **folic acid**, and vitamin B_{12}, may reduce anemia. Cancer-chemotherapy (usually hydroxyurea) can decrease splenomegaly and hepatomegaly, reduce symptoms of myelofibrosis, lessen anemia, and sometimes reduce bone marrow fibrosis. The bone marrow of myelofibrosis patients is often not strong enough to withstand the harsh **chemotherapy** drugs, so this treatment is not always an option. Interferon-alpha has been shown to reduce spleen size, reduce bone **pain**, and, in some cases, increase the number of blood platelets (structures involved in blood clotting).

Other treatments

In certain cases, the enlarged spleen may be removed (**splenectomy**). Conditions that warrant splenectomy include spleen pain, the need for frequent blood **transfusion**, very low levels of platelets (**thrombocytopenia**), and extreme pressure in the blood vessels of the liver (portal **hypertension**).

Radiation therapy is used to treat splenomegaly, spleen pain, bone pain, tumors in certain places such as next to the spinal cord, and fluid accumulation inside the abdomen (**ascites**). Patients who are not strong enough to undergo splenectomy are often treated with radiation therapy.

Bone marrow transplantation may be used to treat some patients with myelofibrosis. This procedure may be performed on patients who are less than 50 years old, have a poor life expectancy, and have a brother or sister with blood-type similarities.

Patients with severe anemia may require blood transfusions.

KEY TERMS

Anemia—Low numbers of red blood cells in the blood.

Benzene—A colorless volatile flammable toxic liquid hydrocarbon used as a solvent and as a motor fuel.

Biopsy—Surgical removal of tissue for microscopic examination.

Fibrosis—Buildup of scar tissue.

Glucocorticoid therapy—Treatment using corticoids that are anti-inflammatory and immunosuppressive.

Leukemia—Cancer of white blood cells.

Portal hypertension—Extreme pressure on the blood vessels of the liver.

Stem cell—A cell that has the ability to become many different specialized cells.

Prognosis

Similar to leukemias, myelofibrosis is progressive and often requires therapy to control the disease. Myelofibrosis can progress to acute lymphocytic leukemia or lymphoma. Although a number of factors to predict the survival time have been proposed, advanced age or severe anemia are consistently associated with a poor prognosis. The average survival rate of patients diagnosed with myelofibrosis is five years. Death is usually caused by infection, bleeding, complications of splenectomy, **heart failure**, or progression to leukemia. Spontaneous remission is rare.

Prevention

Persons who have been exposed to radiation, benzene, or radioactive thorium dioxide (a chemical used during certain diagnostic radiological procedures) are at risk for myelofibrosis.

Resources

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Rodak, Bernadette F., George A. Fritsma, and Elaine Keohane. *Hematology Clinical Principles and Applications*. Philadelphia: Saunders, 2011.

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Myelogram *see* **Myelography**

Myelography

Definition

Myelography is an x-ray examination of the spinal canal. A contrast agent is injected through a needle into the space around the spinal cord to display the spinal cord, spinal canal, and nerve roots on an x ray.

Purpose

The purpose of a myelogram is to evaluate the spinal cord and/or nerve roots for suspected compression. Pressure on these delicate structures causes **pain** or other symptoms. A myelogram is performed when precise detail about the spinal cord is needed to make a definitive diagnosis. In most cases, myelography is used after other studies, such as **magnetic resonance imaging** (MRI) or a computed tomography scan (CT scan), have not yielded enough information to be sure of the disease process. Sometimes myelography followed by CT scan is an alternative for patients who cannot have an MRI scan, because they have a pacemaker or other implanted metallic device.

A herniated or ruptured intervertebral disc, popularly known as a slipped disc, is one of the most common causes for pressure on the spinal cord or nerve roots. Discs are pads of fiber and cartilage that contain rubbery tissue. They lie between the vertebrae, or individual bones, which make up the spine. Discs act as cushions, accommodating strains, shocks, and position changes. A disc may rupture suddenly, due to injury, or a sudden straining with the spine in an unnatural position. In other cases, the problem may come on gradually as a result of progressive deterioration of the discs with **aging**. The lower back is the most common area for this problem, but it sometimes occurs in the neck, and rarely in the upper back. A myelogram can help accurately locate the disc or discs involved.

Myelography may be used when a tumor is suspected. Tumors can originate in the spinal cord, or in tissues surrounding the cord. Cancers that have started in other parts of the body may spread or metastasize in the spine. It is important to precisely locate the mass causing pressure, so effective treatment can be undertaken. Patients with known **cancer** who develop back pain may require a myelogram for evaluation.

Other conditions that may be diagnosed using myelography include arthritic bony growths, known as spurs, narrowing of the spinal canal, called **spinal stenosis**, or malformations of the spine.

Precautions

Patients who are unable to lie still or cooperate with positioning should not have this examination. Severe congenital spinal abnormalities may make the examination technically difficult to carry out. Patients with a history of severe allergic reaction to contrast material (x-ray dye) should report this to their physician. Pretreatment with medications to minimize the risk of severe reaction may be recommended.

Description

Myelograms can be performed in a hospital x-ray department or in an outpatient radiology facility. The patient lies on the x-ray table on his or her stomach. The radiologist first looks at the spine under fluoroscopy, where the images appear on a monitor screen. This is done to find the best location to position the needle. The skin is cleaned, then numbed with local anesthetic. The needle is inserted. Occasionally, a small amount of cerebrospinal fluid, the clear fluid which surrounds the spinal cord and brain, may be withdrawn through the needle and sent for laboratory studies. Then contrast material is injected. The contrast material (dye) is a liquid that shows up on x rays.

The x-ray table is tilted slowly. This allows the contrast material to reach different levels in the spinal canal. The flow is observed under fluoroscopy, then x rays are taken with the table tilted at various angles. A footrest and shoulder straps or supports will keep the patient from sliding.

In many instances, a CT scan of the spine will be performed immediately after a myelogram, while the contrast material is still in the spinal canal. This helps outline internal structures most clearly.

A myelogram takes approximately 30-60 minutes. A CT scan adds about another hour to the examination. If the procedure is done as an outpatient exam, some facilities prefer the patient to stay in a recovery area for up to four hours.

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Preparation

Patients should be well hydrated at the time of a myelogram. Increasing fluids the day before the study is usually recommended. All food and fluid intake should be stopped approximately four hours before the myelogram.

Certain medications may need to be stopped for one to two days before myelography is performed. These include some antipsychotics, antidepressants, blood thinners, and diabetic medications. Patients should consult with their physician and/or the facility where the study is to be done.

Patients who smoke may be asked to stop the day before the test. This helps decrease the chance of **nausea** or headaches after the myelogram. Immediately before the examination, patients should empty their bowels and bladder.

Aftercare

After the examination is completed, the patient usually rests for several hours, with the head elevated. Extra fluids are encouraged, to help eliminate the contrast material and prevent headaches. A regular diet and routine medications may be resumed. Strenuous physical activity, especially any which involve bending over, may be discouraged for one or two days. The doctor should be notified if a **fever**, excessive **nausea and vomiting**, severe **headache**, or stiff neck develops.

Risks

Headache is a common complication of myelography. It may begin several hours to several days after the examination. The cause is thought to be changes in cerebrospinal fluid pressure, not a reaction to the dye. The headache may be mild and easily alleviated with rest and increased fluids. Sometimes, nonprescription medicine are recommended. In some instances, the headache may be more severe and require stronger medication or other measures for relief. Many factors influence whether the patient develops this problem. These include the type of needle used and the age and sex of the patient. Patients with a history of chronic or recurrent headache are more likely to develop a headache after a myelogram.

The chance of reaction to the contrast material is a very small, but potentially significant risk with myelography. It is estimated that only 5-10% of patients experience any effect from contrast exposure. The vast majority of reactions are mild, such as sneezing, nausea, or **anxiety**. These usually resolve by themselves.

KEY TERMS

Contrast agent—Also called a contrast medium, this is usually a barium or iodine dye that is injected into the area under investigation. The dye makes the interior body parts more visible on an x-ray film.

A moderate reaction, like **wheezing** or **hives**, may be treated with medication, but is not considered life threatening. Severe reactions, such as heart or **respiratory failure**, happen very infrequently. These require emergency medical treatment.

Rare complications of myelography include injury to the nerve roots from the needle, or from bleeding into the spaces around the roots. Inflammation of the delicate covering of the spinal cord, called arachnoiditis, or infections, can also occur. Seizures are another very uncommon complication reported after myelography.

Normal results

A normal myelogram would show a spinal canal of normal width, with no areas of constriction or obstruction.

Abnormal results

A myelogram may reveal a **herniated disk**, tumor, bone spurs, or narrowing of the spinal canal (spinal stenosis).

ORGANIZATIONS

Radiological Society of North America, 820 Jorie Boulevard, Oak Brook, IL, 60523-2251, (630) 571-2670, (630) 571-7837, (800) 381-6660, radiologyinfo.org.

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Myeloma *see* **Multiple myeloma**

Myers-Briggs type indicator

Definition

The Myers-Briggs Type Indicator (MBTI) is a widely used personality inventory, or test, employed in vocational, educational, and **psychotherapy** settings to evaluate personality type in adolescents and adults age 14 and older.

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Purpose

In an educational setting, the MBTI may be performed to assess student learning style. Career counselors use the test to help others determine what occupational field they might be best suited for, and it is also used in organizational settings to assess management skills and facilitate teamwork and problem-solving, including communication difficulties. Because the MBTI is also a tool for self-discovery, mental health professionals may administer the test in counseling sessions to provide their patients with insight into their behavior.

As of the early 2000s, the MBTI is also being used in the mental health field to assess vulnerability to **anxiety disorders** and depression. Preliminary results indicate that some of the 16 types are more susceptible to **mood disorders** than others. ISFPs, for example, are overrepresented among patients in treatment for unipolar depression, while the four ST types appear to be more vulnerable to **anxiety** states.

Precautions

The MBTI should be administered, scored, and interpreted only by a professional trained in its use. Cultural and language differences in the test subject may affect performance and may result in inaccurate test results. The test administrator should be informed before testing begins if the test taker is not fluent in English and/or he has a unique cultural background.

Description

In 2000, an estimated two million people took the MBTI, making it the most frequently used personality inventory available. The test was first introduced in 1942, the work of a mother and daughter, Katharine Cook Briggs and Isabel Briggs Myers. There are now several different versions of the test available. Form M, which contains 93 items, is the most commonly used.

The Myers-Briggs inventory is based on Carl Jung's theory of types, outlined in his 1921 work *Psychological Types*. Jung's theory holds that human beings are either *introverts* or *extraverts*, and their behavior follows from these inborn psychological types. He also believed that people take in and process information different ways, based on their personality traits.

The Myers-Briggs evaluates personality type and preference based on the four Jungian psychological types:

- extraversion (E) or introversion (I)
- sensing (S) or intuition (N)
- thinking (T) or feeling (F)
- judging (J) or perceiving (P)

KEY TERMS

Multitasking—Performing multiple duties or taking on multiple responsibilities and roles simultaneously.

Vocational—Relating to an occupation, career, or job.

Preparation

Prior to the administration of the MBTI, the test subject should be fully informed about the nature of the test and its intended use. He or she should also receive standardized instructions for taking the test and any information on the confidentiality of the results.

Normal results

Myers-Briggs results are reported as a four-letter personality type (e.g., ESTP, ISFJ). Each letter corresponds to an individual's preference in each of the four pairs of personality indicators (i.e., E or I, S or N, T or F, and J or P). There are a total of sixteen possible combinations of personality types on the MBTI.

Letter One: E or I

Extraverts focus more on people and things in the outside world, introverts on internal thoughts and ideas.

Letter Two: S or N

Sensing dominant personalities prefer to perceive things through sight, sound, taste, touch, and smell, while intuition dominant types look to past experience and are more abstract in their thinking.

Letter Three: T or F

The third subtype is a measure of how people use judgment. Thinking types use logic to judge the world, while feeling types tend to view things on the basis of what emotions they elicit.

Letter Four: J or P

Everyone judges and perceives, but those who are judging dominant are said to be more methodical and results-oriented, while perceiving dominant personalities are good at multitasking and are flexible.

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Resources

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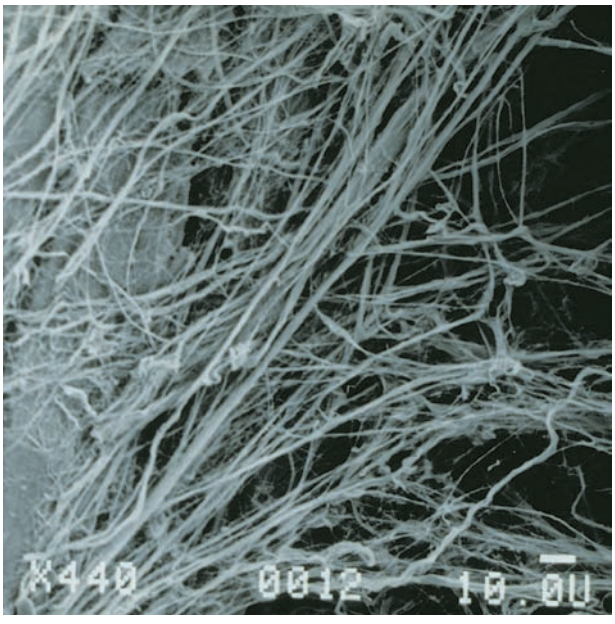
Paula Anne Ford-Martin
Rebecca J. Frey, PhD

Myocardial biopsy

Definition

Myocardial biopsy is a procedure wherein a small portion of tissue is removed from the heart muscle for testing. This test is also known as endomyocardial biopsy.



Once the catheter is threaded up into the heart, the surgeon will take several small samples of muscle for laboratory analysis. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

KEY TERMS

Anticoagulant—Medication that thins the blood and slows clot formation.

Aplastic anemia—A greatly decreased production of all of the formed elements of the blood caused by a failure of the cell-generating capacity of the bone marrow.

Electrocardiography—A test that uses electrodes attached to the chest with an adhesive gel to transmit the electrical impulses of the heart muscle to a recording device.

Leukemia—A disease characterized by an increasing number of abnormal cells in the blood.

Purpose

The main reason for a biopsy is to secure tissue samples that will be useful in the diagnosis, treatment, and care of heart muscle disorders. The test is also used to detect rejection after a **heart transplantation** procedure.

Precautions

This procedure is not used when the patient is taking blood-thinning medication (anticoagulant therapy). It should not be done when the patient has leukemia and **aplastic anemia** or if there is a blood clot on the interior wall of the heart.

Description

A long, flexible tube, called a catheter, is inserted into a vein and threaded up into the heart. The doctor can guide the catheter by watching its movement on a TV monitor showing an x-ray image of the area. The tip of the catheter is fitted with tiny jaws that the doctor can open and close. Once the catheter is in place, the doctor will take several small snips of muscle for microscopic examination.

Preparation

Preparation for myocardial biopsy is quite extensive. The patient will be asked not to eat for several hours before the procedure. A technician will shave the hair from the area of the incision and will also insert an intravenous line in the arm. The patient will be given a sedative to relax but will not be fully anesthetized. The patient will be connected to an

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electrocardiograph (ECG) to monitor the heart, and a blood-pressure cuff will be placed. Finally, the patient will be covered with sterile drapes, so that the area of the biopsy is kept free of germs. The cardiologist will numb the area where the catheter will be inserted.

Aftercare

At the end of the biopsy, the catheter will be removed and pressure will be applied at the site where it entered the blood vessel in order to encourage healing. The patient will then be taken to the recovery room. It is advisable to remain flat and not to move about for 6-8 hours. After that time, most people begin walking around. Swelling and bruising at the puncture site are common and usually go away without need for further attention.

Risks

The risks involved with myocardial biopsy are small because the patient is monitored closely and attended by well-trained staff. Racing of the heart (**palpitations**) and quivering of the heart muscles (**atrial fibrillation**) are both possible during the procedure.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

Dorothy Elinor Stonely

Myocardial infarction *see* **Heart attack**

Myocardial resection

Definition

Myocardial resection is a surgical procedure in which a portion of the heart muscle is removed.

Purpose

Myocardial resection is done to improve the stability of the heart function or rhythm. Also known as endocardial resection, this open-heart surgery is done to destroy or remove damaged areas of the heart that cause life-threatening heart rhythms. This procedure is often performed in people who have had a **heart attack**, in order to prevent future rapid heart rates. It is also used in people who have **Wolff-Parkinson-White syndrome** (a condition resulting in abnormal heart rhythm).

KEY TERMS

Implantable cardioverter-defibrillator—A device placed in the body to deliver an electrical shock to the heart in response to a serious abnormal rhythm.

Wolff-Parkinson-White syndrome—An abnormal, rapid heart rhythm, due to an extra pathway for the electrical impulses to travel from the atria to the ventricles.

Precautions

This is major surgery and should be the treatment of choice only after medications have failed and the use of an **implantable cardioverter-defibrillator** (a device that delivers electrical shock to control heart rhythm) has been ruled out.

Description

After receiving a general anesthetic, an incision will be made in the chest to expose the heart. When the exact source of the abnormal rhythm is identified, it is removed. If there are areas around the source that may contribute to the problem, they can be frozen with a special probe to further insure against dangerous heart rates. The amount of tissue removed is so small, usually only 2 or 3 millimeters, that there is no damage to the structure of the heart. On some occasions, aneurysms of the heart wall are removed as well.

Preparation

Prior to surgery, the physician will explain the procedure, routine blood tests will be completed, and consent forms will be signed.

Aftercare

Immediately after surgery, the patient will be moved to a recovery room until the affects of anesthesia have worn off. The patient will then be transferred to the intensive care unit for further recovery. In the intensive care unit, the heart will be monitored for any disturbances in rhythm and the patient will be watched for any signs of post-operative problems.

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Risks

The risks of myocardial resection are based in large part on the person's underlying heart condition and, therefore, vary greatly. The procedure involves opening the heart, so the person is at risk for the complications associated with major heart surgery such as **stroke**, shock, infection, and hemorrhage.

Normal results

Anywhere from 5-25% of post-heart attack patients do not survive open-heart surgery. The survivors have a 90% arrhythmia-free one-year survival rate, (arrthymia is an irregular heart beat).

ORGANIZATIONS

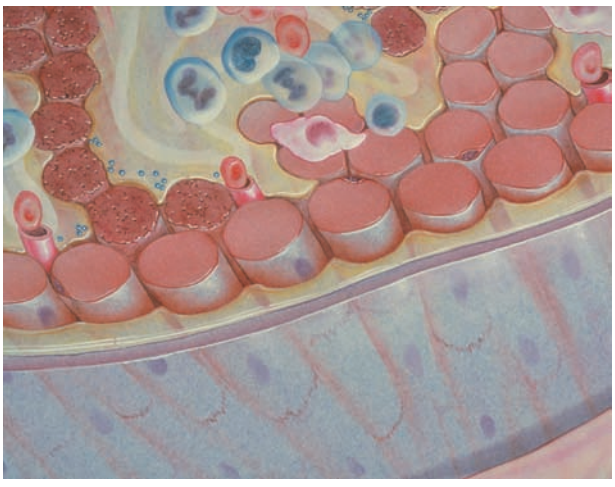
American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

Dorothy Elinor Stonely

Myocarditis

Definition

Myocarditis is an inflammatory disease of the heart muscle (myocardium) that can result from a variety of causes. While most cases are produced by a viral infection, an inflammation of the heart muscle may also be instigated by toxins, drugs, and hypersensitive immune reactions. Myocarditis is a rare but serious condition that affects both males and females of any age.



This illustration depicts the inflammation of the myocarditis, the middle muscular layer of the heart wall. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Description

Most cases of myocarditis in the United States originate from a virus, and the disease may remain undiagnosed by doctors due to its general lack of initial symptoms. The disease may also present itself as an acute, catastrophic illness that requires immediate treatment. Although the inflammation or degeneration of the heart muscle that myocarditis causes may be fatal, this disease often goes undetected. It may also disguise itself as ischemic, valvular, or hypertensive heart disease.

An inflammation of the heart muscle may occur as an isolated disorder or be the dominating feature of a systemic disease (one that affects the whole body, like **systemic lupus erythematosus**).

Causes and symptoms

While there are several contributing factors that may lead to myocarditis, the primary cause is viral. Myocarditis usually results from the Coxsackie B virus, and may also result from **measles**, **influenza**, chicken pox, hepatitis virus, or the adenovirus in children. If an acute onset of severe myocarditis occurs, a patient may display the following symptoms:

- Rhythm disturbances of the heart
- Rapid heartbeat (Ventricular tachycardia)
- Left or right ventricular enlargement
- Shortness of breath (Dyspnea)
- Pulmonary edema (the accumulation of fluid in the lungs due to left-sided heart failure)
- Swollen legs.

Additional causes of myocarditis include:

- Bacterial infections, such as tetanus, gonorrhea, or tuberculosis
- Parasite infections, such as Chagas' disease (which is caused by an insect-borne protozoan most commonly seen in Central and South America)
- Rheumatic fever
- Surgery on the heart
- Radiation therapy for cancer that is localized in the chest, such as breast or lung cancer
- Certain medications.

Research has shown that illegal drugs and toxic substances may also produce acute or chronic injury to the myocardium. These studies also indicate an increase in the incidence of toxic results from the use of **cocaine**. This illegal drug causes coronary artery

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KEY TERMS

Adenovirus—One type of virus that can cause upper respiratory tract infections.

Angiography—A procedure that uses x ray after injecting a radiopaque substance to examine the blood vessels and lymphatics.

Arrhythmia—An irregular heartbeat or action.

Cardiac catheterization—A diagnostic procedure that gives a comprehensive examination of how the heart and its blood vessels function; performed by inserting one or more catheters through a peripheral blood vessel in the arm or leg.

Coxsackie B virus—A mild virus belonging to a group of viruses (coxsackievirus) that may produce a variety of illnesses, including myocarditis.

Echocardiography—A noninvasive diagnostic procedure that uses ultrasound to examine internal cardiac structures.

Electrocardiogram—A record of the electrical activity of the heart, with each wave being labeled as P, Q, R, S, and T waves. Often used in the diagnosis of cases of abnormal cardiac rhythm and myocardial damage.

Hypertensive heart disease—High blood pressure resulting in a disease of the heart.

Ischemic heart disease—Insufficient blood supply to the heart muscle (myocardium).

Valvular heart disease—A disease of any one of the four valves that controls blood flow into, through, and out of the heart.

Ventricular tachycardia—An abnormally rapid heartbeat. It includes a series of at least three beats arising from a ventricular area at a rate of more than 100 beats per minute, usually ranging from 150-200 beats per minute.

spasm, myocardial infarction (**heart attack**), and **arrhythmias**, as well as myocarditis.

Further studies conducted in 1996 indicate that **malnutrition** encourages the Coxsackie B virus to flourish, leading to the potential development of myocarditis. Human **immunodeficiency** virus (HIV) is also now recognized as a cause of myocarditis, though its prevalence is not known.

Symptoms of myocarditis may start as **fatigue**, **shortness of breath**, **fever**, and aching of the joints, all characteristic of a flu-like illness. In contrast to this type of mild appearance, myocarditis may also appear suddenly in the form of **heart failure**, or **sudden cardiac death** without any prior symptoms. If an inflammation of the heart muscle leads to congestive heart failure, symptoms such as swollen feet and ankles, distended neck veins, a rapid heartbeat, and difficulty breathing while reclining may all appear.

Diagnosis

The best way to diagnose myocarditis may be through a person's observation of his or her own symptoms, followed by a thorough medical history and physical exam conducted by a doctor. Further tests usually include laboratory blood studies and **echocardiography**. An electrocardiogram (ECG) is also routinely used due to its ability to detect a mild case of the disease. **Cardiac catheterization** and **angiography** are additional diagnostic tests used to determine the presence of myocarditis, or to rule out other possible heart diseases that may lead to heart failure.

Another measure used to diagnosis myocarditis is the endomyocardial biopsy procedure. This invasive catheterization procedure examines a biopsied, or "snipped," piece of the endocardium (the lining membrane of the inner surface of the heart). The tissue sample is examined to verify the presence of the disease, as well as to try to determine the infective cause. An approach used only with a patient's consent, this procedure may also confirm acute myocarditis, allowing close monitoring of potential congestive heart failure.

Treatment

While myocarditis is a serious condition, there is no medical treatment necessary if it results from a general viral infection. The only steps to recovery include rest and avoidance of physical exertion. Adequate rest becomes more important to recovery if the case is severe myocarditis with signs of dilated **cardiomyopathy** (disease of the heart muscles). In this case, medical treatment for congestive heart failure may include the following medications: angiotensin converting enzyme (ACE) inhibitors, **diuretics** to reduce fluid retention, digitalis to stimulate a stronger heartbeat, and low-dose beta-blockers.

If myocarditis is caused by a bacterial infection, the disease is treated with **antibiotics** to fight the infection. If severe rhythm disturbances are involved, cardiac

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assist devices, an "artificial heart," or **heart transplantation** may be the only option for complete recovery.

Prognosis

The outlook for a diagnosed case of myocarditis caused by a viral infection is excellent, with many cases healing themselves spontaneously. Severe or acute myocarditis may be controlled with medication to prevent heart failure. Because this disease may be mild or may be extreme and cause serious arrhythmias, the prognosis varies. Cases of myocarditis may vary from complete healing (with or without significant scarring), to severe congestive heart failure leading to **death** or requiring a heart transplant.

Inflammation of the myocardium may also cause acute **pericarditis** (inflammation of the outer lining of the heart). Due to the potential effects of the disease, including sudden death, it is imperative that proper medical attention is obtained.

Prevention

Although myocarditis is an unpredictable disease, the following measures may help prevent its onset. Individuals should:

- Take extra measures to avoid infections, and obtain appropriate treatment for infections.
- Limit alcohol consumption to no more than one or two drinks a day, if any.
- Maintain current immunizations against diphtheria, tetanus, measles, rubella, and polio.
- Avoid anything that may cause the abnormal heart to work too hard, including salt and vigorous exercise.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

Beth A. Kapes

Myoglobin test

Definition

Myoglobin is a protein found in muscle. Myoglobin tests are done to evaluate a person who has symptoms of a **heart attack** (myocardial infarction) or other muscle damage.

Purpose

Myoglobin holds oxygen inside heart and skeletal muscle (muscles that attach to and move bones). It is continually released into the blood in small amounts due to normal turnover of muscle cells. Kidneys discard the myoglobin into urine.

When muscle is damaged, as in a heart attack, larger amounts of myoglobin are released and blood levels rise rapidly. Myoglobin is one of the first tests done to determine if a person with chest **pain** is having a heart attack, as it may be one of the first blood tests to become abnormal.

Damage or injury to skeletal muscle also causes myoglobin to be released into the blood.

Description

Heart attack must be diagnosed quickly. Medications to prevent heart damage are effective only within a limited number of hours. Yet, because of their risk for excessive bleeding, these medications are given only after a diagnosis of heart attack is made.

Myoglobin is one of several cardiac markers used to make the diagnosis. Cardiac markers are substances in blood whose levels rise in the hours following a heart attack. Increased levels help diagnose a heart attack; persistent normal levels rule it out.

Each cardiac marker rises, peaks, and returns to a normal level according to its own timeline, or diagnostic window. Myoglobin is useful because it has the earliest diagnostic window. It is the first marker to rise after chest pain begins. Myoglobin levels rise within two to three hours, and sometimes as early as 30 minutes. They peak after six to nine hours. The levels return to normal within 24-36 hours.

Although a rise in myoglobin supports a diagnosis of heart attack, it is not conclusive. Simultaneous skeletal muscle damage could also cause the increase. Myoglobin rules out, rather than proves, a diagnosis in the following way. If myoglobin levels have not risen after more than five hours, a heart attack in unlikely. Normal levels in the first two to three hours do not rule out an infarction.

The myoglobin test is sometimes repeated every one to two hours to watch for the rise and peak. Results are available within 30 minutes.

Myoglobin in large amounts is toxic to the kidney. When a person has high amounts of myoglobin in the blood, kidney function must be monitored.

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KEY TERMS

Cardiac marker—A substance in the blood that rises following a heart attack.

Diagnostic window—A cardiac marker's timeline for rising, peaking, and returning to normal after a heart attack.

Myoglobin—A protein that holds oxygen in heart and skeletal muscle. It rises after damage to either of these muscle types.

Preparation

This test requires 5 mL of blood. Collection of the sample takes only a few minutes. A urine myoglobin test requires 1 mL of urine collected into a urine collection cup.

Aftercare

Discomfort or bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Warm packs to the puncture site relieve discomfort.

Normal results

Normal results vary based on the laboratory and method used.

Abnormal results

Myoglobin levels and levels of other cardiac markers are usually considered before finally confirming a diagnosis of heart attack. A level that has doubled after one to two hours, even if the level is still in the normal range, indicates a significant rise that may be due to heart attack.

Increased levels are also found with skeletal muscle damage or disease, such as an injury, **muscular dystrophy**, or **polymyositis**. Myoglobin levels also rise during renal failure because kidneys lose their ability to clear myoglobin from blood.

Resources

BOOKS

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Nancy J. Nordenson

Myomas *see* **Uterine fibroids**

Myomectomy

Definition

Myomectomy is the removal of fibroids (noncancerous tumors) from the wall of the uterus. Myomectomy is the preferred treatment for symptomatic fibroids in women who want to keep their uterus. Larger fibroids must be removed with an abdominal incision, but small fibroids can be taken out using **laparoscopy** or **hysteroscopy**.

Purpose

A myomectomy can remove **uterine fibroids** that are causing symptoms. It is an alternative to surgical removal of the whole uterus (**hysterectomy**). The procedure can relieve fibroid-induced menstrual symptoms that have not responded to medication. Myomectomy also may be an effective treatment for **infertility** caused by the presence of fibroids.

Precautions

There is a risk that removal of the fibroids may lead to such severe bleeding that the uterus itself will have to be removed. Because of the risk of blood loss during a myomectomy, patients may want to consider banking their own blood before surgery.

Description

Usually, fibroids are buried in the outer wall of the uterus and abdominal surgery is required. If they are on the inner wall of the uterus, uterine fibroids can be removed using hysteroscopy. If they are on a stalk (pedunculated) on the outer surface of the uterus, laparoscopy can be performed.

Removing fibroids through abdominal surgery is a more difficult and slightly more risky operation than a hysterectomy. This is because the uterus bleeds from the sites where the fibroids were, and it may be difficult or impossible to stop the bleeding. This surgery is usually performed under **general anesthesia**, although some patients may be given a spinal or epidural anesthesia.

The incision may be horizontal (the "bikini" incision) or a vertical incision from the navel downward. After separating the muscle layers underneath the skin, the surgeon makes an opening in the abdominal wall. Next, the surgeon makes an incision over each fibroid, grasping and pulling out each growth.

Every opening in the uterine wall is then stitched with sutures. The uterus must be meticulously repaired

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in order to eliminate potential sites of bleeding or infection. Then, the surgeon sutures the abdominal wall and muscle layers above it with absorbable stitches, and closes the skin with clips or nonabsorbable stitches.

When appropriate, a laparoscopic myomectomy may be performed. In this procedure, the surgeon removes fibroids with the help of a viewing tube (laparoscope) inserted into the pelvic cavity through an incision in the navel. The fibroids are removed through a tiny incision under the navel that is much smaller than the 4 or 5 inch opening required for a standard myomectomy.

If the fibroids are small and located on the inner surface of the uterus, they can be removed with a thin telescope-like device called a hysteroscope. The hysteroscope is inserted into the vagina through the cervix and into the uterus. This procedure does not require any abdominal incision, so hospitalization is shorter.

Preparation

Surgeons often recommend hormone treatment with a drug called leuprolide (Lupron) two to six months before surgery in order to shrink the fibroids. This makes the fibroids easier to remove. In addition, Lupron stops menstruation, so women who are anemic have an opportunity to build up their blood count. While the drug treatment may reduce the risk of excess blood loss during surgery, there is a small risk that temporarily smaller fibroids might be missed during myomectomy, only to enlarge later after the surgery is completed.

Aftercare

Patients may need four to six weeks of recovery following a standard myomectomy before they can return to normal activities. Women who have had laparoscopic or hysteroscopic myomectomies, however, can leave the hospital the day after surgery and usually recovery completely within two to three days to one to three weeks.

Risks

The risks of a myomectomy performed by a skilled surgeon are about the same as hysterectomy (one of the most common and safest surgeries). Removing multiple fibroids is more difficult and slightly more risky.

Possible complications include:

- Infection.
- Blood loss.

KEY TERMS

Epidural anesthesia—A method of pain relief for surgery in which local anesthetic is injected into the epidural space in the middle and lower back.

- The wall of the uterus may be weakened if the removal of a large fibroid leaves a wound that extends the complete thickness of the wall. Special precautions may be needed in future pregnancies. For example, the delivery may need to be performed surgically (Caesarean section).
- Adverse reactions to anesthesia.
- Internal scarring (and possible infertility).

Since fibroids tend to appear and grow as a woman ages (until **menopause**), it is possible that new fibroids will appear after myomectomy.

Resources

OTHER

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Carol A. Turkington

Myopathies

Definition

Myopathies are diseases of skeletal muscle which are not caused by nerve disorders. These diseases cause the skeletal or voluntary muscles to become weak or wasted.

Description

There are many different types of myopathies, some of which are inherited, some inflammatory, and some caused by endocrine problems. Myopathies are rare and not usually fatal. Typically, effects are mild, largely causing muscle weakness and movement problems, and many are transitory. Only rarely will patients become dependent on a wheelchair. However, **muscular dystrophy** (which is technically a form of myopathy) is far more severe. Some types of this disease are fatal in early adulthood.

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Causes and symptoms

Myopathies are usually degenerative, but they are sometimes caused by drug side effects, chemical **poisoning**, or a chronic disorder of the immune system.

Genetic myopathies

Among their many functions, genes are responsible for overseeing the production of proteins important in maintaining healthy cells. Muscle cells produce thousands of proteins. With each of the inherited myopathies, a genetic defect is linked to a lack of, or problem with, one of the proteins needed for normal muscle cell function.

There are several different kinds of myopathy caused by defective genes:

- Central core disease
- Centronuclear (myotubular) myopathy
- Myotonia congenita
- Nemaline myopathy
- Paramyotonia congenita
- Periodic paralysis (hypokalemic and hyperkalemic forms)
- Mitochondrial myopathies.

Most of these genetic myopathies are dominant, which means that a child needs to inherit only one copy of the defective gene from one parent in order to have the disease. The parent with the defective gene also has the disorder, and each of this parent's children has a 50% chance of also inheriting the disease. Male and female children are equally at risk.

However, one form of myotonia congenita and some forms of nemaline myopathy must be inherited from both parents, each of whom carry a recessive defective gene but who do not have symptoms of the disease. Each child of such parents has a 25% chance of inheriting both genes and showing signs of the disease, and a 50% chance of inheriting one defective gene from only one parent. If the child inherited just one defective gene, he or she would be a carrier but would not show signs of the disease.

A few forms of centronuclear myopathy develop primarily in males. Females who inherit the defective gene are usually carriers without symptoms, like their mothers, but they can pass on the disease to their sons. Mitochondrial myopathies are inherited through the mother, since sperm do not contain mitochondria. (Mitochondria play a key role in energy production in the body's cells.)

The major symptoms associated with the genetic myopathies include:

- Central core disease: mild weakness of voluntary muscles, especially in the hips and legs; hip displacement; delays in reaching developmental motor milestones; problems with running, jumping, and climbing stairs develop in childhood
- Centronuclear myopathy: weakness of voluntary muscles including those on the face, arms, legs, and trunk; drooping upper eyelids; facial weakness; foot drop; affected muscles almost always lack reflexes
- Myotonia congenita: voluntary muscles of the arms, legs, and face are stiff or slow to relax after contracting (myotonia); stiffness triggered by fatigue, stress, cold, or long rest periods, such as a night's sleep; stiffness can be relieved by repeated movement of the affected muscles
- Nemaline myopathy: moderate weakness of voluntary muscles in the arms, legs, and trunk; mild weakness of facial muscles; delays in reaching developmental motor milestones; decreased or absent reflexes in affected muscles; long, narrow face; high-arched palate; jaw projects beyond upper part of the face
- Paramyotonia congenita: stiffness (myotonia) of voluntary muscles in the face, hands, and forearms; attacks spontaneous or triggered by cold temperatures; stiffness made worse by repeated movement; episodes of stiffness last longer than those seen in myotonia congenita
- Periodic paralysis: attacks of temporary muscle weakness (muscles work normally between attacks); in the hypokalemic (low calcium) form, attacks triggered by vigorous exercise, heavy meals (high in carbohydrates), insulin, stress, alcohol, infection, pregnancy; in the hyperkalemic (normal/high calcium) form, attacks triggered by vigorous exercise, stress, pregnancy, missing a meal, steroid drugs, high potassium intake
- Mitochondrial myopathies: symptoms vary quite widely with the form of the disease and may include progressive weakness of the eye muscles (ocular myopathy), weakness of the arms and legs, or multisystem problems primarily involving the brain and muscles.

Endocrine-related myopathies

In some cases, myopathies can be caused by a malfunctioning gland (or glands), which produces either too much or too little of the chemical messengers called hormones. Hormones are carried by the blood and one of their many functions is to regulate muscle activity. Problems in producing hormones can lead to muscle weakness.

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Hyperthyroid myopathy and hypothyroid myopathy affect different muscles in different ways. Hyperthyroid myopathy occurs when the thyroid gland produces too much thyroxine, leading to muscle weakness, some muscle wasting in hips and shoulders, and, sometimes, problems with eye muscles. The hypothyroid type occurs when too little hormone is produced, leading to stiffness, cramps, and weakness of arm and leg muscles.

Inflammatory myopathies

Some myopathies are inflammatory, leading to inflamed, weakened muscles. Inflammation is a protective response of injured tissues characterized by redness, increased heat, swelling, and/or **pain** in the affected area. Examples of this type include **polymyositis**, **dermatomyositis**, and **myositis** ossificans.

Dermatomyositis is a disease of the connective tissue that also involves weak, tender, inflamed muscles. In fact, muscle tissue loss may be so severe that the person may be unable to walk. Skin inflammation is also present. The cause is unknown, but viral infection and **antibiotics** are associated with the condition. In some cases, dermatomyositis is associated with rheumatologic disease or **cancer**. Polymyositis involves inflammation of many muscles usually accompanied by deformity, swelling, sleeplessness, pain, sweating, and tension. It, too, may be associated with cancer. Myositis ossificans is a rare inherited disease in which muscle tissue is replaced by bone, beginning in childhood.

Muscular dystrophy

While considered to be a separate group of diseases, the muscular dystrophies also technically involve muscle wasting and can be described as myopathies. These relatively rare diseases appear during childhood and adolescence, and are caused by muscle destruction or degeneration. They are a group of genetic disorders caused by problems in the production of key proteins.

The forms of muscular dystrophy (MD) differ according to the way they are inherited, the age of onset, the muscles they affect, and how fast they progress. The most common type is Duchenne MD, affecting one or two in every 10,000 boys. Other types of MD include Becker's, **myotonic dystrophy**, limb-girdle MD, and facioscapulohumeral MD.

Diagnosis

Early diagnosis of myopathy is important so that the best possible care can be provided as soon as possible. An experienced physician can diagnose a myopathy by evaluating a person's medical history and by performing a thorough physical exam. Diagnostic tests can help differentiate between the different types of myopathy, as well as between myopathy and other neuromuscular disorders. If the doctor suspects a genetic myopathy, a thorough family history will also be taken.

Diagnostic tests the doctor may order include:

- Measurements of potassium in the blood
- Muscle biopsy
- Electromyogram (EMG).

KEY TERMS

Electromyogram (EMG)—A diagnostic test that records the electrical activity of muscles. In the test, small electrodes are placed on or in the skin; the patterns of electrical activity are projected on a screen or over a loudspeaker. This procedure is used to test for muscle disorders, including muscular dystrophy.

Inflammation—A protective response of injured tissues characterized by redness, increased heat, swelling, and/or pain in the affected area.

Voluntary muscles—Muscles producing voluntary movement.

Treatment

Treatment depends on the specific type of myopathy the person has:

- Periodic paralysis: medication and dietary changes
- Hyperthyroid or hypothyroid myopathy: treatment of the underlying thyroid abnormality
- Myositis ossificans: medication may prevent abnormal bone formation, but there is no cure following onset
- Central core disease: no treatment
- Nemaline myopathy: no treatment
- Centronuclear (myotubular) myopathy: no treatment
- Paramyotonia congenita: treatment often unnecessary
- Myotonia congenita: drug treatment (if necessary), but drugs do not affect the underlying disease, and attacks may still occur.

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Prognosis

The prognosis for patients with myopathy depends on the type and severity of the individual disease. In most cases, the myopathy can be successfully treated and the patient returned to normal life.

Muscular dystrophy, however, is generally a much more serious condition. Duchenne's MD is usually fatal by the late teens; Becker's MD is less serious and may not be fatal until the 50s.

ORGANIZATIONS

Muscular Dystrophy Association, 3300 East Sunrise Drive, Tucson, AZ, 85718, (800) 572-1717, http://www.mdausa.org.

Carol A. Turkington

Myopia

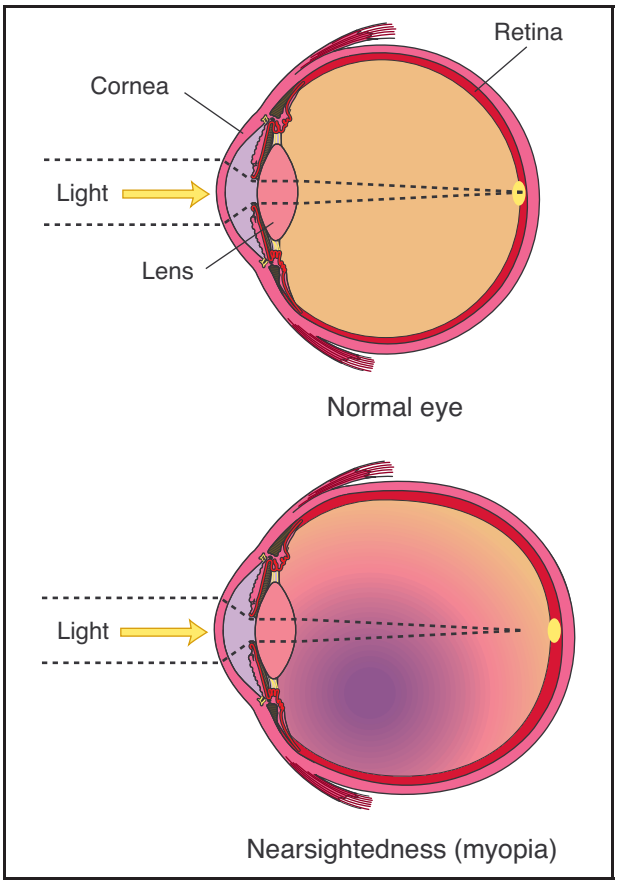
Definition

Myopia is the medical term for nearsightedness. People with myopia see objects more clearly when they are close to the eye, while distant objects appear blurred or fuzzy. Reading and close–up work may be clear, but distance vision is blurry.

Description

To understand myopia it is necessary to have a basic knowledge of the main parts of the eye's focusing system: the cornea, the lens, and the retina. The cornea is a tough, transparent, dome–shaped tissue that covers the front of the eye (not to be confused with the white, opaque sclera). The cornea lies in front of the iris (the colored part of the eye). The lens is a transparent, double–convex structure located behind the iris. The retina is a thin membrane that lines the rear of the eyeball. Light–sensitive retinal cells convert incoming light rays into electrical signals that are sent along the optic nerve to the brain, which then interprets the images.

In people with normal vision, parallel light rays enter the eye and are bent by the cornea and lens (a process called refraction) to focus precisely on the retina, providing a crisp, clear image. In the myopic eye, the focusing power of the cornea (the major refracting structure of the eye) and the lens is too great with respect to the length of the eyeball. Light rays are bent too much, and they converge in front of the retina. This inaccuracy is called a refractive error. In other words, an overfocused fuzzy image is sent to the brain.



Myopia, or nearsightedness, is a condition of the eye in which objects are seen more clearly when close to the eye while distant objects appear blurred or fuzzy. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

There are many types of myopia. Some common types include:

- Physiologic
- Pathologic
- Acquired.

By far the most common form, physiologic myopia develops in children sometime between the ages of five and 10 years and gradually progresses until the eye is fully grown. Physiologic myopia may include refractive myopia (the cornea and lens–bending properties are too strong) and axial myopia (the eyeball is too long). Pathologic myopia is a far less common abnormality. This condition begins as physiologic myopia, but rather than stabilizing, the eye continues to enlarge at an abnormal rate (progressive myopia). This more advanced type of myopia may lead to degenerative changes in the eye (degenerative myopia). Acquired myopia occurs after

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infancy. This condition may be seen in association with uncontrolled diabetes and certain types of **cataracts**. **Antihypertensive drugs** and other medications can also affect the refractive power of the lens.

Genetic profile

Eye care professionals have debated the role of genetics in the development of myopia for many years. Some believe that a tendency toward myopia may be inherited, but that the actual disorder results from a combination of environmental and genetic factors. Environmental factors include close work; work with computer monitors or other instruments that emit some light (electron microscopes, photographic equipment, lasers, etc.); emotional **stress**; and eye strain.

A variety of genetic patterns for inheriting myopia have been suggested, ranging from a recessive pattern with complete penetrance in people who are homozygotic for myopia to an autosomal dominant pattern; an autosomal recessive pattern; and various mixtures of these patterns. One explanation for this lack of agreement is that the genetic profile of high myopia (defined as a refractive error greater than –6 diopters) may differ from that of low myopia. Some researchers believe that high myopia is determined by genetic factors to a greater extent than low myopia.

The lack of clear consensus concerning the role of heredity in myopia may be due to the sensitivity of the human eye to very small changes in its anatomical structure. Since even small deviations from normal structure cause significant refractive errors, it may be difficult to single out any specific genetic or environmental factor as their cause.

Genetic markers and gene mapping

Since 1992, genetic markers that may be associated with genes for myopia have been located on human chromosomes 1, 2, 12, and 18. There is some genetic information on the short arm of chromosome 2 in highly myopic people. Genetic information for low myopia appears to be located on the short arm of chromosome 1, but it is not known whether this information governs the structure of the eye itself or vulnerability to environmental factors.

In 1998, a team of American researchers presented evidence that a gene for familial high myopia with an autosomal dominant transmission pattern could be mapped to human chromosome 18 in eight North American families. The same group also found a second locus for this form of myopia on human chromosome 12 in a large German/Italian family. In 1999, a group of French researchers found no linkage between chromosome 18 and 32 French families with familial high myopia. These findings have been taken to indicate that more than one gene is involved in the transmission of the disorder.

As of 2009, the heritability of high–grade myopia has been confirmed. Multiple high–grade myopia genetic loci have been identified, and confirmatory studies identifying high–grade and moderate myopia loci have also occurred. However, myopia susceptibility genes still remain unknown.

Family studies

It has been known for some years that a family history of myopia is one of the most important risk factors for developing the condition. Only 6–15% of children with myopia come from families in which neither parent is myopic. In families with one myopic parent, 23–40% of the children develop myopia. If both parents are myopic, the rate rises to 33–60% for their children. One American study found that children with two myopic parents are six times as likely to develop myopia themselves as children with only one or no myopic parents. The precise interplay of genetic and environmental factors in these family patterns, however, is not yet known.

One multigenerational study of Chinese patients indicated that third generation family members had a higher risk of developing myopia even if their parents were not myopic. The researchers concluded that, at least in China, the genetic factors in myopia have remained constant over the past three generations while the environmental factors have intensified. The increase in the percentage of people with myopia over the last 50 years in the United States has led American researchers to the same conclusion.

Demographics

The prevalence of refractive error in the United States has not been evaluated since the early 1970s. According to a 2006 study sponsored by the National Eye Institute (NEI), refractive errors are estimated to affect 42.2 million (35%) of Americans 40 years or older.

Myopia is the most common eye disorder in humans around the world. It affects some 20% of the adult population in the United States. In various reports, incidence frequently varies with age, sex, race, ethnicity, occupation, environment, and other factors. Myopia is more common in central and eastern Europe than in northern Europe, Britain, and the United States. It is also very common in certain populations, such as Chinese, Japanese, Arab, and Jewish

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KEY TERMS

Accommodation—The ability of the lens to change its focus from distant to near objects. It is achieved through the action of the ciliary muscles that change the shape of the lens.

Cornea—The transparent structure of the eye over the lens that is continous with the sclera in forming the outermost, protective, layer of the eye.

Diopter (D)—A unit of measure for describing refractive power.

Epi-LASIK—A surgical procedure that uses a blunt, plastic oscillating blade called an epithelial separator to cut a flap in the cornea.

Laser–assisted sub–epithelial keratomileusis (LASEK)—A surgical procedure in which the epithelium is loosened on the corneal surface. The loosened epithelium is then reflected away from the cornea, and laser ablation performed.

Laser–assisted in–situ keratomileusis (LASIK)—A surgical procedure that uses a cutting tool and a laser to modify the cornea and correct moderate to high levels of myopia.

Lens—The transparent, elastic, curved structure behind the iris (colored part of the eye) that helps focus light on the retina.

Ophthalmologist—A physician specializing in the medical and surgical treatment of eye disorders.

Optic nerve—A bundle of nerve fibers that carries visual messages from the retina in the form of electrical signals to the brain.

Optometrist—A medical professional who examines and tests the eyes for disease and treats visual disorders by prescribing corrective lenses and/or vision therapy. In many states, optometrists are licensed to use diagnostic and therapeutic drugs to treat certain ocular diseases.

Orthokeratology—A method of reshaping the cornea using a contact lens. It is not considered a permanent method to reduce myopia.

Peripheral vision—The ability to see objects that are not located directly in front of the eye. Peripheral vision allows people to see objects located on the side or edge of their field of vision.

Photorefractive keratectomy (PRK)—A procedure that uses an excimer laser to make modifications to the cornea and permanently correct myopia. As of early 1998, only two lasers have been approved by the FDA for this purpose.

Radial keratotomy (RK)—A surgical procedure involving the use of a diamond–tipped blade to make several spoke–like slits in the peripheral (non–viewing) portion of the cornea to improve the focus of the eye and correct myopia by flattening the cornea.

Refraction—The bending of light rays as they pass from one medium through another. Used to describe the action of the cornea and lens on light rays as they enter they eye. Also used to describe the determination and measurement of the eye's focusing system by an optometrist or ophthalmologist.

Refractive eye surgery—A general term for surgical procedures that can improve or correct refractive errors by permanently changing the shape of the cornea.

Retina—The light–sensitive layer of tissue in the back of the eye that receives and transmits visual signals to the brain through the optic nerve.

Visual acuity—The ability to distinguish details and shapes of objects.

persons. Myopia is uncommon in black, Nubian, and Sudanese persons.

Other factors that affect the demographic distribution of myopia are income level and education. The prevalence of myopia is higher among people with above–average incomes and educational attainments. Myopia is also more prevalent among people whose work requires a great deal of close focusing, including work with computers.

Signs and symptoms

Myopia is said to be caused by an elongation of the eyeball. This means that the oblong (as opposed to normal spherical) shape of the myopic eye causes the cornea and lens to focus at a point in front of the retina. A more precise explanation is that there is an inadequate correlation between the focusing power of the cornea and lens and the length of the eye.

People are generally born with a small amount of **hyperopia** (farsightedness), but as the eye grows this decreases and myopia does not become evident until later. This change is one reason why some researchers think that myopia is an acquired rather than an inherited trait.

The symptoms of myopia are blurred distance vision, eye discomfort, squinting, and eye strain.

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Diagnosis

The diagnosis of myopia is typically made during the first several years of elementary school when a teacher notices a child having difficulty seeing the chalkboard, reading, or concentrating. The teacher or school nurse often recommends an **eye examination** by an ophthalmologist or optometrist. An ophthalmologist—M.D. or D.O. (Doctor of Osteopathy)—is a medical doctor trained in the diagnosis and treatment of eye problems. Ophthalmologists also perform eye surgery. An optometrist (O.D.) diagnoses, manages and/or treats eye and visual disorders. In many states, optometrists are licensed to use diagnostic and therapeutic drugs.

A patient's distance vision is tested by reading letters or numbers on a chart posted a set distance away (usually 20 ft). The doctor asks the patient to view images through a variety of lenses to obtain the best correction. The doctor also examines the inside of the eye and the retina. An instrument called a slit lamp is used to examine the cornea and lens. The eyeglass prescription is written in terms of diopters (D), which measure the degree of refractive error. Mild to moderate myopia usually falls between -1.00D and -6.00D. Normal vision is commonly referred to as 20/20 to describe the eye's focusing ability at a distance of 20 ft from an object. For example, 20/50 means that a myopic person must stand 20 ft away from an eye chart to see what a normal person can see at 50 ft. The larger the bottom number, the greater the myopia.

Treatment and management

People with myopia have three main options for treatment: optical devices, such as eyeglasses and **contact lenses**, refractive eye surgery, and intraocular surgical procedures.

Optical devices

EYEGLASSES. Eyeglasses are the most common method used to correct myopia. Concave glass or plastic lenses are placed in frames in front of the eyes. The lenses are ground to the thickness and curvature specified in the eyeglass prescription. The lenses cause the light rays to diverge so that they focus further back, directly on the retina, producing clear distance vision.

CONTACT LENSES. Contact lenses are a second option for treatment. Contact lenses are extremely thin round discs of plastic that are worn on the eye in front of the cornea. Although there may be some initial discomfort, most people quickly grow accustomed to contact lenses. Hard contact lenses, made from a material called PMMA, are virtually obsolete. Rigid gas permeable lenses (RGP) are made of plastic that holds its shape but allows the passage of some oxygen into the eye. Some believe that RGP lenses may halt or slow the progression of myopia because they maintain a constant, gentle pressure that flattens the cornea. In 2004, results of a NEI–sponsored study called the Contact Lens and Myopia Progression (CLAMP) Study, were published. Researchers found that RGP contact lenses slowed the progression of myopia in young children. Researchers also found that RGP contact lenses did not slow the growth of the eye, responsible for the majority of myopia in children. Instead of slowing the growth of the eye, RGP lenses kept the cornea from changing shape more than soft contact lenses.

Soft contact lenses are made of flexible plastic and can be up to 80% water. Soft lenses offer increased comfort and the advantage of extended wear; some can be worn continuously for up to one week. While oxygen passes freely through soft lenses, bacterial contamination and other problems can occur, requiring replacement of lenses on a regular basis. It is very important to follow the cleaning and disinfecting regimens prescribed because protein and lipid buildup can occur on the lenses, causing discomfort or increasing the risk of infection. Contact lenses offer several benefits over glasses, including: better vision, less distortion, clear peripheral vision, and cosmetic appeal. In addition, contacts will not fog up from perspiration or changes in temperature.

Refractive eye surgery

For people who find glasses and contact lenses inconvenient or uncomfortable, and who meet selection criteria regarding age, degree of myopia, general health, etc., refractive eye surgery is a third treatment alternative. **Radial keratotomy** was the first such procedure developed, but has been replaced since the mid–1990s by photorefractive keratectomy (PRK), laser–assisted in–situ keratomileusis (LASIK), Epi-LASIK, and laser–assisted sub–epithelial keratomileusis (LASEK). Refractive eye surgery improves myopic vision by permanently changing the shape of the cornea so that light rays focus properly on the retina. These procedures are performed on an outpatient basis and generally take 10–30 minutes.

PHOTOREFRACTIVE KERATECTOMY (PRK). PRK involves the use of a computer to measure the shape of the cornea. Using these measurements, the surgeon uses a computer–controlled excimer laser to make modifications to the cornea. The PRK procedure flattens the cornea by vaporizing small amounts of tissue

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from the cornea's surface, thereby improving the cornea's refractive properties in focusing light on the retina. The ultra thin, outer layer of the eye (epithelium) is removed completely by laser energy during the PRK procedure, and eventually grows back. PRK has been approved by the Food and Drug Administration (FDA) for myopia since 1995 and the first excimer lasers used to perform PRK have been improved significantly in terms of size, efficiency, and accuracy. PRK can treat mild to moderate forms of myopia.

LASER–ASSISTED IN–SITU KERATOMILEUSIS (LASIK). As of December 2005, LASIK has been approved by the FDA for several different laser platforms. About 5 million procedures have been performed in the United States since the approval of the excimer laser for refractive surgery in late 1995. It is recommended for moderate to severe cases of myopia. As currently practiced, LASIK is perhaps best thought of as PRK performed under a flap instead of on the corneal surface. The flap is flipped back to expose the inner layers of the cornea. The cornea is treated with a laser to change the shape and focusing properties,then the flap is replaced. For myopic LASIK ablations, most of the laser energy is directed at the center of the treatment zone with the result that the central cornea is thus flattened.

LASER–ASSISTED SUB–EPITHELIAL KERATOMILEUSIS (LASEK). In a LASEK procedure, the epithelium is chemically loosened using dilute alcohol on the corneal surface. The loosened epithelium is then reflected away from the cornea, and laser ablation performed. The procedure preserves the extremely thin epithelial layer by lifting it from the eye's surface before using a laser for reshaping. After the LASEK procedure, the epithelium is replaced on the eye's surface.

EPI–LASIK. In Epi–LASIK, the surgeon uses a blunt, plastic oscillating blade called an epithelial separator to cut a flap in the cornea. Instead of the alcohol used in LASEK to loosen the epithelial sheet, the epithelial separator is used to separate the sheet from the eye. This avoids the possibility of an adverse reaction from the alcohol. Because it is more difficult to create the epithelial flap in people with steeper corneas (who have higher amounts of myopia), the procedure is considered more appropriate for people with less steep corneas (who have low myopia).

Intraocular surgical procedures

These procedures involve extraction of the clear lens with or without lens implantation and the use of intraocular lens (IOL) implants. IOLs have been used since 1999 for correcting large refractive errors in myopia. An IOL is a microscopic lens that can be placed inside the eye to correct certain vision problems. For patients who are extremely nearsighted and may have contraindications to LASIK, an IOL may be implanted in front of the iris to correct their distance vision and provide normal focusing ability and near vision. Although IOLs are intended to be permanent, the procedure is reversible.

Risks

All of these surgical procedures carry risks, the most serious being corneal scarring, corneal rupture, infection, flap problems, dry eye, cataracts, and loss of vision. The National Eye Institute (NEI) warns that before agreeing to refractive surgery, patients should get a clear picture of what they can expect. Surgeons should explain the risks and possible complications, as well as potential side effects.

Since refractive eye surgery does not guarantee 20/20 vision, it is important to have realistic expectations before choosing this treatment. For example, the American Academy of Ophthalmology (AAO) reports that nine out of 10 patients achieve 20/20 vision, but 20/20 does not always mean perfect vision. Detailed, precise vision may be slightly diminished. Even if the patient gains near-perfect vision, irritating side effects are also possible, such as postoperative **pain**, poor night vision, variation in visual acuity, light sensitivity and glare, and optical distortion. Finally, refractive eye surgeries are considered elective procedures and are rarely covered by insurance plans.

Alternative treatments

Some eye care professionals recommend treatments to help improve circulation, reduce eye strain, and relax the eye muscles. It is possible that by combining exercises with changes in behavior, the progression of myopia may be slowed or prevented. Alternative treatments include: visual therapy (also referred to as **vision training** or eye exercises); discontinuing close work; reducing eye strain (taking a rest break during periods of prolonged near vision tasks); and wearing bifocals to decrease the need to accommodate when doing close–up work.

Clinical trials

Clinical trials on myopia are currently sponsored by the National Institutes of Health (NIH) and other agencies. As of 2009, NIH was reporting 121 on–going and completed studies.

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Examples include:

- The evaluation of neurovision correction (NVC) technology for the treatment of low myopia. (NCT00469612)
- A study of the inheritance of myopia in families of various nationalities and ethnic backgrounds to identify gene changes that cause myopia or similar diseases. (NCT00272376)
- A study to determine whether the MEL 80 Excimer Laser is effective in the treatment of moderate to high myopia, when used as part of the LASIK procedure. (NCT00762541)

Clinical trial information is constantly updated by NIH and the most recent information on myopia trials can be found at: http://clinicaltrials.gov/ct2/results?term=myopia

Prognosis

Glasses and contact lenses can (but not always) correct the patient's vision to 20/20. Refractive surgery can make permanent improvements for the right candidates.

While the genetic factors that influence the transmission and severity of myopia cannot be changed, some environmental factors can be modified. They include reducing close work; reading and working in good light; taking frequent breaks when working at a computer or microscope for long periods of time; maintaining good **nutrition**; and practicing visual therapy (when recommended).

Eye strain can be prevented by using sufficient light for reading and close work, and by wearing corrective lenses as prescribed. Everyone should have regular eye examinations to see if their prescription has changed or if any other problems have developed. This is particularly important for people with high (degenerative) myopia who are at a greater risk of developing **retinal detachment**, retinal degeneration, glaucoma, or other problems.

Resources

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ORGANIZATIONS

American Academy of Ophthalmology (AAO), P.O. Box 7424, San Francisco, CA, 94120-7424, (415)561-8500, (415)561-8533, patientinfo@aao.org, http://www.aao.org.

American Optometric Association, 243 N. Lindbergh Blvd., St. Louis, MO, 63141, (800)365-2219, http://www.aoa.org.

EyeCare America, P.O. Box 429098, San Francisco, CA, 94142-9098, (877)887-6327, (415)561-8567, http://www.eyecareamerica.org/eyecare/.

National Eye Institute (NEI), 31 Center Drive MSC 2510, Bethesda, MD, 20892-3655, (301)496-5248, http://www.nei. nih.gov.

Rebecca J. Frey, PhD

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Myositis

Definition

Myositis is a rare disease in which the muscle fibers and skin are inflamed and damaged, resulting in muscle weakness. There are several types of myositis that affect different parts of the body.

Description

The persistent inflammation that is associated with myositis develops slowly over weeks to months and often years, with progressive weakening of the muscles. Later in the course of the disease development muscle wasting or shortening (contracture) may develop. Myositis can range in severity from mild to debilitating.

The forms of myositis include:

- Polymyositis (PM) inflames and weakens muscles in many parts of the body, and especially those parts closest to the trunk. With polymyositis, dysphagia (difficulty, discomfort, or pain in speaking or swallowing), fatigue, and pain in the muscles are common. PM rarely affects people under the age of 20, with the peak onset between the ages of 30 and 60.
- Dermatomyositis (DM) affects both the muscle fibers and skin by damaging the tiny blood vessels (capillaries) that supply blood to the muscle and skin, resulting in muscle weakness, pain, and fatigue. In addition the affected person develops a distinctive patchy, reddish rash on the eyelids, cheeks, bridge of the nose, back or upper chest, elbows, knees, and knuckles. There may also be hardened, tender bumps (possibly caused by inflammation of fat) under the skin. DM can occur at any age and is more common in females than males.
- Inclusion Body Myositis (IBM) typically begins after age 50, and is characterized by gradual weakening of muscles throughout the body, including the wrists or fingers, development of dysphagia, and atrophy of forearms and/or thigh muscles. Unlike the other types of myositis, IBM occurs more often in men than women, and also does not respond very well to drug therapy.
- Juvenile myositis (JM) involves muscle weakness, skin rash, and dysphagia in children. A common characteristic of JM is the formation of calcium deposits in the muscle (calcinosis). These deposits are hard and sometimes painful lumps of calcium under the skin that appear on the child's fingers, hands, elbows, and knees. Painful sores may appear if the lumps break through the skin. The child may also suffer from contractures, which is muscle shortening that results in joints staying bent. About half of the children with JM will have pain in their muscles.

Myositis is rare, affecting about 10 in one million people each year. DM and PM affect mostly women in the forties and fifties but men and children can also affect be affected, some at a young age (between the ages of 5 and 15). About 40,000 people in the United States may have this disease, with about 3,000 to 5,000 children affected.

Causes and symptoms

Myositis is thought to be an autoimmune disease. The body normally fights infections and disease by producing antibodies and white blood cells called lymphocytes in a process called the immune response. In an autoimmune disease, the immune response is overactive, and the immune system attacks and destroys the body's own normal healthy tissues. There is no known cause to the autoimmune response that results in myositis. However, investigators are studying whether the disease is triggered by such environmental agents as the organism that causes **toxoplasmosis**, *Toxoplasma gondii*, the **Lyme disease** organism, *Borrelia burgdorferi*, the coxsackievirus, or by **food allergies**. Some cases of IBM are thought to be inherited.

The first symptoms of most types of myositis are weakness and **pain** in the muscles of the hips and shoulders. The affected person may have trouble getting up from a chair, lifting the arms above the head, or climbing stairs, and may be too tired to walk or stand. DM and PM mostly affects muscles that are close to and within the trunk of the body, while IBM involves a wider range of muscles. Myositis may make it difficult for the person to speak or swallow. When the disease affects the lungs or chest muscles, the person may have difficulty breathing. If the person has DM, they may develop characteristic **rashes**. Other symptoms may include **fever** and joint pain and swelling.

The first signs of JM is usually a red and patchy skin rash and/or a red or purplish rash on the eyelids or cheeks that look like **allergies**. Weak muscles may develop at the same time as the rash, or may develop days, weeks, or months after the appearance of the rash. Other symptoms of JM include falling, a weaker voice (dysophonia), or dysphagia. Calcinosis usually develops later during the course of the disease.

Diagnosis

Myositis can a difficult disease to diagnose, because it is rare, because the symptoms develop

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slowly, and because it can be mistaken for other diseases causing muscle weakness such as limb-girdle **muscular dystrophy**. Many cases of myositis go undiagnosed for years. The health care provider must rule out other conditions such as **hypothyroidism**, toxin exposure, drug reactions, and genetic disorders that can also affect muscles. The **physical examination** will include a complete medical history focusing on symptoms and when they occurred, and blood tests for autoantibodies and muscle enzymes (for example, creatine kinase (CK), which when present in the blood indicates muscle damage). Specialized tests may also be performed, including:

- an electromyogram, which measures the electrical pattern of the muscles
- a muscle biopsy, in which a small piece of muscle is removed, stained, and examined by microscopic techniques to determine if muscle fibers are damaged and whether the muscle fibers are being infiltrated by cells of the immune system
- magnetic resonance imaging (MRI) to identify areas of muscle inflammation.

Treatment

There is no cure for myositis. However, prompt and aggressive treatment may reduce muscle inflammation and prevent muscle weakness from progressing. Because of the many different kinds of symptoms and a wide range of reactions to different drugs, each person's treatment for myositis should be individualized.

Drugs that are used for treatment include **corticosteroids**, such as prednisone, to reduce inflammation and improve the body's reaction to infections. Corticosteroids are usually taken in the form of pills, but may also be injected. The amount of creatine kinase (CK) levels in the blood are monitored to determine how well the medicine is working. Corticosteroids may produce a number of side effects, such as weight gain, difficulties in fighting infections, psychiatric changes, sleeping troubles, water retention, bone thinning, facial swelling, diabetes, and **cataracts**. Corticosteroid therapy usually leads to improvement in myositis symptoms within two to three months, after which the dose can be lowered to avoid the side effects. If the dose of corticosteriods is going to be reduced, it is essential to lower the dose over a period of time.

Immunosuppressant drugs are used to slow down the immune system's attack on healthy tissue and improve skin rashes. Persons may be prescribed these drugs to control myositis if they are unable to tolerate corticosteroids or if the corticosteroids are not accomplishing the desired degree of treatment. Immunosuppressant drugs may also be used in conjunction with corticosteroids so that lower doses of corticosteroids can be used. Immunosuppressant drugs include azathioprine, methotrexate, cyclosporine, tacrolimus, etanercept, and mycophenolate mofetil.

Intravenous immunoglobulin (IVIg) appears to aid in improving muscle strength in many persons with myositis, particularly those with DM. It may be less effective in PM, and its role in treating IBM requires more study, although it has been shown to help some patients with IBM if they are diagnosed early. Immunoglobulins are normal proteins in the blood that attack anything foreign in the body, such as viruses and bacteria. IVIg is made from donated blood plasma from people with normal immune systems. Side effects from the the use of IVIg include **headache** and flu-like symptoms.

Topical cream or ointment forms of some of the medicines, such as prednisone and tacrolimus, can be used to heal and soothe the rash associated with DM. Non-steriodal anti-inflammatory drugs (NSAIDS) such as **aspirin** or ibuprofen can be used for pain relief. Calcinosis can be treated with prednisone, plaquenil (also called hydroxychloroquine), intravenous immunoglobin (IVIG), cyclosporine, and methotrexate.

After drug treatment results in improvement, the affected person begins a program of regular stretching exercises to maintain range of motion in the weakened arms and legs. **Physical therapy** may be used to prevent permanent muscle shortening. Whirlpool baths, heat, and gentle massages may also provide relief. Adequate rest is necessary, and affected persons should take frequent breaks throughout the day and limit their activity.

Patients with throat problems should be evaluated by a speech therapist who can evaluate the swallowing-related problems and make recommendations regarding diet changes and safe swallowing techniques.

Before a woman with myositis becomes pregnant, she should discuss the medicines that she is taking with her health care provider and evaluate the possible risks that she and the baby face if she does become pregnant. Many of the drugs used in the treatment of myositis may be harmful to the fetus or to a breast-fed baby.

It is recommended that a doctor experienced in the treatment of myositis, assisted by a rheumatologist, dermatologist, or neurologist, be consulted. Oftentimes a patient may have to be treated at a

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major medical center, where the disease has been seen and treated before.

Alternative treatment

Various supplements may be used in conjunction with traditional treatment to offset side effects of conventional drug treatment. The use of these suppplements should be approved by the primary health care provider.

Immunosuppressant drugs such as methotroxate and cyclophosphamide increase the risk of infection, so a healthy well-balanced diet is required. Methotroxate impairs the body's ability to absorb **folic acid**, so foods high in folic acid, such as leafy green vegetables, fruits, and folate-fortified breads and cereals are recommended. The use of folate supplements may also be recommended by the health care provider. **Vitamins** C and E can be used to help with the pain and infections associated with calcinosis.

Corticosteroids may have multiple side effects when taken for long periods of time at high doses. **Calcium** and Vitamin D are recommended to lower the risk of **osteoporosis**, a common side effect of prednisone use. **Hypertension** and fluid retention may be controlled by a diet low in salt. Steroid-induced diabetes (hyperglycemia) can be aided by a diet low in sugar and other simple carbohydrates. Proteinuria, in which the body breaks down protein faster than normal, may mean that more protein should be included in the diet.

Weight gain associated with the use of corticosteroids can be managed by the use of the DASH (Dietary Approach to Stop Hypertension) diet, which is high in fruits, vegetables, dietary fiber, and low-fat dairy products. Information concerning this diet, developed by the National Institutes of Health, can be found at [htpp://www.nhlbi.nih.gov/health/public/heart/hbp/dash/]. Weight gain can overtax weakened muscles and should be avoided if possible.

Prognosis

The progression of PM and DM varies from person to person, but the lifespan of an affected person is not usually significantly affected. DM responds more favorably to therapy than PM. Overall, many patients do improve and have a functional recovery. About half of the patients recover and can discontinue treatment within 5 years of beginning treatment. In children the chances of a cure are better than in adults, although some children do suffer a relapse. Of the remaining 50%, about 20% will still have the active disease and will require ongoing treatment, while up to 30% may have some remaining muscle weakness. However, IBM is disabling, and most patients will require the use of an assistive device such as a cane, walker, or wheel chair. The older the patient is when contracting IBM, the more rapidly the disease progresses.

KEY TERMS

Coxsackievirus—Enterovirus causing a disease resembling poliomyelitis but without paralysis.

Dysphagia—Medical term for any difficulty, discomfort or pain when swallowing.

Limb-girdle muscular dystrophy—An autosomal recessive form of muscular dystrophy that appears anywhere from late childhood to middle age and is characterized by progressive muscular weakness beginning either in the shoulder or pelvic girdle; the disease usually progresses slowly with cardiopulmonary complications in the later stages.

Prevention

There is no known way to prevent myositis.

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ORGANIZATIONS

Muscular Dystrophy Association, 3300 East Sunrise Drive, Tucson, AZ, 85718, (800) 572-1717, http://www. mdausa.org.

The Myositis Association, 1737 King Street, Suite 600, Alexandria, VA, 22314, (800) 821-7356, TMA@myositis. org, http://www.myositis.org.

Myositis Support Group, PO Box 1793, Athens, TX, 75751, http://www.myositissupportgroup.org.

Judith Sims

Myositis *see* **Myopathies**

Myotonia atrophica *see* **Myotonic dystrophy**

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Myotonic dystrophy

Definition

Myotonic dystrophy is a progressive disease in which the muscles are weak and are slow to relax after contraction.

Demographics

DM occurs in about 1 per 7,000–8,000 people and has been described in people from all over the world. DM is an inherited disease, affecting males and females approximately equally. About 30,000 people in the United States are affected.

Description

Myotonic dystrophy (DM), also called dystrophia myotonica, myotonia atrophica, or Steinert's disease, is a common form of **muscular dystrophy**. Symptoms may appear at any time from infancy to adulthood. DM causes general weakness, usually beginning in the muscles of the hands, feet, neck, or face. It slowly progresses to involve other muscle groups, including the heart. DM affects a wide variety of other organ systems as well.

A severe form of DM, congenital myotonic dystrophy or Thomsen's disease, may appear in newborns of mothers who have DM. Congenital means that the condition is present from birth. The incidence of congenital myotonic dystrophy is thought to be about 1:20,000.

Risk factors

The most common type of DM is called DM1 and is caused by a mutation in a gene called myotonic dystrophy protein kinase (DMPK). The DMPK gene is located on chromosome 19q. When there is a mutation in this gene, a person develops DM1. The specific mutation that causes DM1 is called a trinucleotide repeat expansion. Risk for DM increases when a parent has a mutation in this gene.

Causes and symptoms

Some families with symptoms of DM do not have a mutation in the DMPK gene. Scientists have found that the DM in many of these families is caused by a mutation in a gene on chromosome 3. These families are said to have DM2.

Congenital myotonic dystrophy has been linked to a region on chromosome 7 that contains a muscle chloride channel gene.

Trinucleotide repeats

In the DMPK gene, there is a section of the genetic code called a CTG repeat. The letters stand for three nucleotides (complex organic molecules) known as cytosine, thymine, and guanine, and are repeated a certain number of times. In people who have DM1, this sequence of nucleotides is repeated too many times—more than the normal number of 37 times—making this section of the gene too big. This enlarged section of the gene is called a trinucleotide repeat expansion.

People who have repeat numbers in the normal range will not develop DM1 and cannot pass it to their children. Having more than 50 repeats causes DM1. People who have 38–49 repeats have a premutation and will not develop DM1, but can pass DM1 onto their children. Having repeats numbers greater than 1,000 causes congenital myotonic dystrophy.

In general, the more repeats in the affected range that someone has, the earlier the age of onset of symptoms and the more severe the symptoms. However, this is a general rule. It is not possible to look at a person's repeat number and predict at what age they will begin to have symptoms or how their condition will progress.

Exactly how the trinucleotide repeat expansion causes myotonia, the inability to relax muscles, is not yet understood. The disease somehow blocks the flow of electrical impulses across the muscle cell membrane. Without proper flow of charged particles, the muscle cannot return to its relaxed state after it has contracted.

Since 2001 it has been discovered that DM2 is caused by a CCTG (cytosine-cytosine-thymine-guanine) expansion on chromosome 3 at locus 3q21, but it is not known how this repeat affects muscle cell function.

Anticipation

Sometimes when a person who has repeat numbers in the affected or premutation range has children, the expansion grows larger. This is called anticipation. A larger expansion can result in an earlier age of onset in children than in their affected parent. Anticipation happens more often when a mother passes DM1 onto her children then when it is passed from the father. Occasionally, repeat sizes stay the same or even get smaller when they are passed to a person's children.

Inheritance

DM is inherited through autosomal dominant inheritance. This means that equal numbers of males and females are affected. It also means that only one

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gene in the pair needs to have the mutation in order for a person to be affected. Since a person only passes one copy of each gene onto their children, there is a 50% or one in two chance that a person who has DM will pass it onto each of their children. This percentage is not changed by results of other pregnancies. A person with a premutation also has a 50%, or one in two, chance of passing the altered gene on to each of their children. Whether or not their children will develop DM1 depends on whether the trinucleotide repeat becomes further expanded. A person who has repeat numbers in the normal range cannot pass DM1 onto their children.

There is a range in the severity of symptoms in DM and not everyone will have all of the symptoms.

Myotonic dystrophy causes weakness and delayed muscle relaxation called myotonia. Symptoms of DM include facial weakness and a slack jaw, drooping eyelids called **ptosis**, and muscle wasting in the forearms and calves. A person with DM has difficulty relaxing his or her grasp, especially in the cold. DM affects the heart muscle, causing irregularities in the heartbeat. It also affects the muscles of the digestive system, causing **constipation** and other digestive problems. DM may cause **cataracts**, retinal degeneration, low IQ, frontal balding, skin disorders, atrophy of the testicles, and diabetes. It can also cause sleep apnea—a condition in which normal breathing is interrupted during sleep. DM increases the need for sleep and decreases motivation. Severe disabilities do not set in until about 20 years after symptoms begin. Most people with myotonic dystrophy maintain the ability to walk, even late in life.

A severe form of DM, congenital myotonic dystrophy, may appear in newborns of mothers who have DM1. Congenital myotonic dystrophy is marked by severe weakness, poor sucking and swallowing responses, respiratory difficulty, delayed motor development, and **mental retardation**. **Death** in infancy is common in this type.

Some people who have a trinucleotide repeat expansion in their DMPK gene do not have symptoms or have very mild symptoms that go unnoticed. It is not unusual for a woman to be diagnosed with DM after she has an infant with congenital myotonic dystrophy.

Predictive testing

It is possible to test someone who is at risk for developing DM1 before they are showing symptoms to see whether they inherited an expanded trinucleotide repeat. This is called predictive testing. Predictive testing cannot determine the age of onset that someone will begin to have symptoms, or the course of the disease.

KEY TERMS

Electrocardiogram (ECG, EKG)—A test that uses electrodes attached to the chest with an adhesive gel to transmit the electrical impulses of the heart muscle to a recording device.

Electromyography (EMG)—A test that uses electrodes to record the electrical activity of muscle. The information gathered is used to diagnose neuromuscular disorders.

Muscular dystrophy—A group of inherited diseases characterized by progressive wasting of the muscles.

Nucleotide—Any of a group of organic molecules that link together to form the building blocks of DNA or RNA.

Sleep apnea—Temporary cessation of breathing while sleeping.

Trinucleotide repeat expansion—A sequence of three nucleotides that is repeated too many times in a section of a gene.

Diagnosis

Diagnosis of DM is not difficult once the disease is considered. However, the true problem may be masked because symptoms can begin at any age, can be mild or severe, and can occur with a wide variety of associated complaints.

Examination

Diagnosis of DM begins with a careful medical history and a thorough physical exam to determine the distribution of symptoms and to rule out other causes. A family history of DM or unexplained weakness helps to establish the diagnosis.

Tests

A definitive diagnosis of DM1 is done by **genetic testing**, usually by taking a small amount of blood. The DNA in the blood cells is examined and the number of repeats in the DMPK gene is determined. Various other tests may be done to help establish the diagnosis, but only rarely would other testing be needed. An electromyogram (EMG) is a test is used to examine the response of the muscles to stimulation. Characteristic changes are seen in DM that helps distinguish it from other muscle diseases.

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PRENATAL TESTING. Testing a **pregnancy** to determine whether an unborn child is affected is possible if genetic testing in a family has identified a DMPK mutation. This can be done at 10–12 weeks gestation by a procedure called **chorionic villus sampling** (CVS), which involves removing a tiny piece of the placenta and analyzing DNA from its cells. It can also be done by **amniocentesis** after 14 weeks gestation by removing a small amount of the amniotic fluid surrounding the baby and analyzing the cells in the fluid. Each of these procedures has a small risk of **miscarriage** associated with it and those who are interested in learning more should check with their doctor or genetic counselor.

Procedures

Removing a small piece of muscle tissue for microscopic examination is called a muscle biopsy. DM is marked by characteristic changes in the structure of muscle cells that can be seen on a muscle biopsy. An electrocardiogram could be performed to detect characteristic abnormalities in heart rhythm associated with DM. These symptoms often appear later in the course of the disease.

A procedure called preimplantation diagnosis allows a couple to have a child that is unaffected with the genetic condition in their family. This procedure is experimental and not widely available. Those interested in learning more about this procedure should check with their doctor or genetic counselor.

A group of researchers in Houston, Texas, reported in 2004 that they have successfully developed a technique for detecting the CCTG expansion that causes DM2 and estimating the size of the repeat expansion.

Treatment

Myotonic dystrophy cannot be cured, and no treatment can delay its progression. There is no standardized treatment for these disorders because the precise reasons for muscle weakness are not yet fully understood. However, many of the symptoms can be treated. **Physical therapy** can help preserve or increase strength and flexibility in muscles. Ankle and wrist braces can be used to support weakened limbs. **Occupational therapy** is used to develop tools and techniques to compensate for loss of strength and dexterity. A speech-language pathologist can provide retraining for weakness in the muscles controlling speech and swallowing.

Irregularities in the heartbeat may be treated with medication or a pacemaker. A yearly electrocardiogram is usually recommended to monitor the heartbeat. **Diabetes mellitus** in DM is treated in the same way that it is in the general population. A high-fiber diet can help prevent constipation. **Sleep apnea** may be treated with surgical procedures to open the airways or with nighttime ventilation. Treatment of sleep apnea may reduce drowsiness. Lens replacement surgery is available when cataracts develop. Pregnant woman should be followed by an obstetrician familiar with the particular problems of DM because complications can occur during pregnancy, labor and delivery.

Wearing a medical bracelet is advisable. Some emergency medications may have dangerous effects on the heart rhythm in a person with DM. Adverse reactions to **general anesthesia** may also occur.

Prognosis

The course of myotonic dystrophy varies. When symptoms appear earlier in life, disability tends to become more severe. Occasionally, people with DM require a wheelchair later in life. Children with congenital DM usually require special educational programs and physical and occupational therapy. For both types of DM, respiratory infections pose a danger when weakness becomes severe.

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ORGANIZATIONS

Muscular Dystrophy Association, 3300 East Sunrise Dr., Tucson, AZ, 85718, (520) 529-2000, (800) 572-1717, http://www.mdausa.org.

National Institutes of Health (NIH), 9000 Rockville Pike, Bethesda, MD, 20892, (301) 496-4000, http://www.nih.gov.

National Organization for Rare Diseases, 55 Kenosia Ave., PO Box 1968, Danbury, CT, 06813, (213) 744-0100, (800) 999-6673, http://www.rarediseases.org.

U.S. National Library of Medicine, 8600 Rockville Pike, Bethesda, MD, 20894, http://www.nlm.nih.gov/medlineplus/medlineplus.html.

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Myringotomy and ear tubes

Definition

Myringotomy is a surgical procedure in which a small incision is made in the eardrum (the tympanic membrane), usually in both ears. The English word is derived from *myringa,* modern Latin for drum membrane, and *tomē,* Greek for cutting. It is also called myringocentesis, tympanotomy, tympanostomy, or **paracentesis** of the tympanic membrane. Fluid in the middle ear can be drawn out through the incision.

Ear tubes, or tympanostomy tubes, are small tubes open at both ends that are inserted into the incisions in the eardrums during myringotomy. They come in various shapes and sizes and are made of plastic, metal, or both. They are left in place until they fall out by themselves or until they are removed by a doctor.

Demographics

In the United States, myringotomy and tube placement have become a mainstay of treatment for recurrent **otitis media** in children. More than 500,000 procedures are performed annually, making myringotomy the most common pediatric, ambulatory operation performed in the United States. Myringotomy in adults is a less common procedure than in children, primarily because adults benefit from certain changes in the anatomy of the middle ear that occur after childhood. In particular, the adult ear is less likely to accumulate fluid because the Eustachian tube, which connects the middle ear to the throat area, lies at about a 45–degree angle from the horizontal. This relatively steep angle means that the force of gravity helps to keep fluids from the throat containing disease organisms out of the middle ear. In children, however, the Eustachian tube is only about 10 degrees above the horizontal, which makes it relatively easy for disease organisms to migrate from the nose and throat into the inner ear. Myringotomies in adults are usually performed as a result of barotrauma, which is also known as pressure–related ear **pain** or barotitis media. Barotrauma refers to earache caused by unequal air pressure on the inside and outside of the eardrum. Adults with very narrow Eustachian tubes may experience barotrauma in relation to scuba diving, using elevators, or frequent flying. A myringotomy with tube insertion may be performed if the condition is not helped by **decongestants** or **antibiotics**.

Purpose

Myringotomy with the insertion of ear tubes is an optional treatment for inflammation of the middle ear with fluid collection (effusion) that lasts longer than three months (chronic otitis media with effusion) and does not respond to drug treatment. This condition is also called glue ear. Myringotomy is the recommended treatment if the condition lasts four to six months. Effusion refers to the collection of fluid that escapes from blood vessels or the lymphatic system. In this case, the effusion collects in the middle ear.

Initially, acute inflammation of the middle ear with effusion is treated with one or two courses of antibiotics. **Antihistamines** and decongestants have been used, but they have not been proven effective unless there is also hay **fever** or some other allergic inflammation that contributes to the problem. Myringotomy with or without the insertion of ear tubes is *not* recommended for initial treatment of otherwise healthy children with middle ear inflammation with effusion.

In about 10% of children, the effusion lasts for three months or longer, when the disease is considered chronic. In children with chronic disease, systemic **steroids** may help, but the evidence is not clear, and there are risks.

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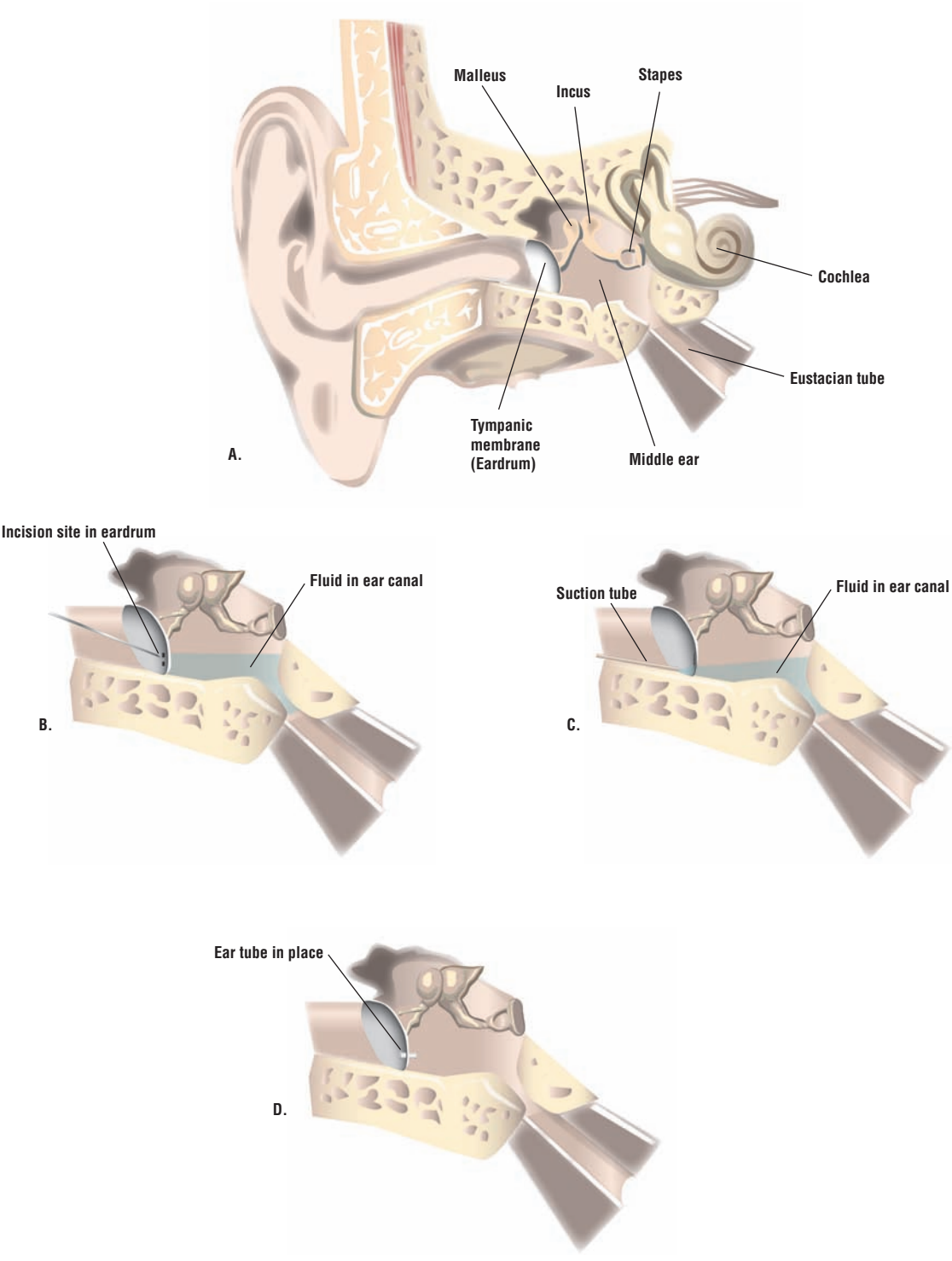
Myringotomy and ear tubes



During a myringotomy, an incision is made into the ear drum, or tympanic membrane (B). The fluid in the ear canal is suctioned out (C), and a small tube is put in place to allow future drainage in the event of an ear infection (D). *(Illustration by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)*

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KEY TERMS

Acute otitis media—Inflammation of the middle ear with signs of infection lasting less than three months.

Adenoids—Clusters of lymphoid tissue located in the upper throat above the roof of the mouth. Some doctors think that removal of the adenoids may lower the rate of recurrent otitis media in high–risk children.

Barotrauma—Ear pain caused by unequal air pressure on the inside and outside of the ear drum. Barotrauma, which is also called pressure–related ear pain or barotitis media, is the most common reason for myringotomies in adults.

Chronic otitis media—Inflammation of the middle ear with signs of infection lasting three months or longer.

Effusion—The escape of fluid from blood vessels or the lymphatic system and its collection in a cavity, in this case, the middle ear.

Eustachian tube—A canal that extends from the middle ear to the pharynx.

Insufflation—Blowing air into the ear as a test for the presence of fluid in the middle ear.

Middle ear—The cavity or space between the eardrum and the inner ear. It includes the eardrum, the three little bones (hammer, anvil, and stirrup) that transmit sound to the inner ear, and the Eustachian tube, which connects the inner ear to the nasopharynx (the back of the nose).

Otolaryngologist—A surgeon who specializes in treating disorders of the ears, nose, and throat.

Tympanic membrane—The eardrum. A thin disc of tissue that separates the outer ear from the middle ear.

Tympanostomy tube—Ear tube. A small tube made of metal or plastic that is inserted during myringotomy to ventilate the middle ear.

When medical treatment does not stop the effusion after three months in a child who is one to three years old, is otherwise healthy, and has **hearing loss** in both ears, myringotomy with insertion of ear tubes becomes an option. If the effusion lasts for four to six months, myringotomy with insertion of ear tubes is recommended.The purpose of myringotomy is to relieve symptoms, to restore hearing, to take a sample of the fluid to examine in the laboratory in order to identify any microorganisms present, or to insert ear tubes.

Ear tubes can be inserted into the incision during myringotomy and left there. The eardrum heals around them, securing them in place. They usually fall out on their own in six to 12 months or are removed by a doctor.While the tubes are in place, they keep the incision from closing, keeping a channel open between the middle ear and the outer ear. This allows fresh air to reach the middle ear, allowing fluid to drain out, and preventing pressure from building up in the middle ear. The patient's hearing returns to normal immediately and the risk of recurrence diminishes.

Most myringotomies in children are performed in children between one to two years of age. One Canadian study found that the number of myringotomies performed was 12.8 per thousand for children 11 months old or younger; 54.2 per thousand for children between 12 and 23 months old; and 11.1 per thousand for children between three and 15 years old. Sex and race do not appear to affect the number of myringotomies in any age group, although boys are reported to have a slightly higher rate of ear infections than girls.

Description

When a conventional myringotomy is performed, the ear is washed, a small incision made in the eardrum, the fluid sucked out, a tube inserted, and the ear packed with cotton to control bleeding.

Recent developments include the use of medical **acupuncture** to control pain during the procedure, and the use of carbon dioxide lasers to perform the myringotomy itself. Laser–assisted myringotomy can be performed in a doctor's office with only a local anesthetic. It has several advantages over the older technique: it is less painful; less frightening to children; and minimizes the need for tube insertion because the hole in the eardrum produced by the laser remains open longer than an incision done with a scalpel.

Another technique to keep the incision in the eardrum open without the need for tube insertion is application of a medication called mitomycin C, which was originally developed to treat **bladder cancer**. The mitomycin prevents the incision from sealing over. As of 2010, however, this approach is still being studied.

There has also been an effort to design ear tubes that are easier to insert or to remove, and to design tubes that stay in place longer. Ear tubes come in various shapes and sizes designed to meet the needs of each specific patient.

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Diagnosis/Preparation

The diagnosis of otitis media is based on the doctor's visual examination of the patient's ear and the patient's symptoms. Patients with otitis media complain of earache and usually have a fever, sometimes as high as 105°F (40.5°C). There may or may not be loss of hearing. Small children may have **nausea and vomiting**. When the doctor looks in the ear with an otoscope, the patient's eardrum will look swollen and may bulge outward. The doctor can evaluate the presence of fluid in the middle ear either by blowing air into the ear, known as insufflation, or by tympanometry, which is an indirect measurement of the mobility of the eardrum. If the eardrum has already ruptured, there may be a watery, bloody, or pus–streaked discharge.

Fluid removed from the ear can be taken to a laboratory for culture. The most common bacteria that cause otitis media are *Pneumococcus*, *Haemophilus influenzae*, and *Moraxella catarrhalis*. Some cases are caused by viruses, particularly respiratory syncytial virus (RSV).

A child scheduled for a myringotomy should not have food or water for four to six hours before anesthesia. Antibiotics are usually not needed.

If **local anesthesia** is used, a cream containing lidocaine and prilocaine is applied to the ear canal about 30 minutes before the myringotomy. If medical acupuncture is used for pain control, the acupuncture begins about 40 minutes before surgery and is continued during the procedure.

Aftercare

The use of antimicrobial drops is controversial. Water should be kept out of the ear canal until the eardrum is intact. A doctor should be notified if the tubes fall out.

Risks

The risks include:

- cutting the outer ear
- formation at the myringotomy site of granular nodes due to inflammation
- formation of a mass of skin cells and cholesterol in the middle ear that can grow and damage surrounding bone (cholesteatoma)
- permanent perforation of the eardrum

It is also possible that the incision will not heal properly, leaving a permanent hole in the eardrum. This result can cause some hearing loss and increases the risk of infection.

The ear tube may move inward and get trapped in the middle ear, rather than move out into the external ear, where it either falls out on its own or can be retrieved by a doctor. The exact incidence of tubes moving inward is not known, but it could increase the risk of further episodes of middle–ear inflammation, inflammation of the eardrum or the part of the skull directly behind the ear, formation of a mass in the middle ear, or infection due to the presence of a foreign body.

The surgery may not be a permanent cure. As many as 30% of children undergoing myringotomy with insertion of ear tubes need to undergo another procedure within five years.

Other risks include those associated with sedatives or **general anesthesia**. Some patients may prefer acupuncture for pain control in order to minimize these risks.

An additional element of postoperative care is the recommendation of many doctors that the child use ear plugs to keep water out of the ear during bathing or swimming to reduce the risk of infection and discharge.

Normal results

Parents often report that children talk better, hear better, are less irritable, sleep better, and behave better after myringotomy with the insertion of ear tubes. Normal results in adults include relief of ear pain and ability to resume flying or deep–sea diving without barotrauma.

Morbidity and mortality rates

Morbidity following myringotomy usually takes the form of either otorrhea, which is a persistent discharge from the ear, or changes in the size or texture of the eardrum. The risk of otorrhea is about 13%. If the procedure is repeated, the eardrum may shrink, retract, or become flaccid. The eardrum may also develop an area of hardened tissue. This condition is known as tympanosclerosis. The risk of hardening is 51% its effects on hearing are not known, but they appear to be insignificant.

In 2008, it was reported that morbidity following myringotomy in the United States is highest among children from families of low socioeconomic status. The study found that children from poor urban families had more episodes of otorrhea following tube insertion then children from suburban families. In addition, the episodes of otorrhea in the urban children lasted longer.

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Mortality rates are extremely low; case studies of fatalities following myringotomy are rare in the medical literature, and most involve adults.

Alternatives

Preventive measures

There are several lifestyle issues related to high rates of middle ear infection. One of the most serious is parental **smoking**. One study of the effects of passive smoking on **children's health** estimated that as many as 165,000 of the myringotomies performed each year on American children are related to the use of tobacco in the household.

Studies have shown that children in daycare have a higher risk of chronic ear infection, and therefore a higher risk of needing myringotomy.

A third factor that affects a child's risk of recurrent middle ear infection is **breastfeeding**. Toddlers who were breastfed as infants for at least four months have a lower risk of ear infection than those who were bottlefed.

Other surgical approaches

Because the adenoids may harbor infection, when myringotomy and tube placement fails, **adenoidectomy** may be performed in order to resolve chronic otitis media.

Alternative medicine

According to Dr. Kenneth Pelletier, former director of the program in complementary and alternative medicine at Stanford University, there is some evidence that homeopathic treatment is effective in reducing the pain of otitis media in children and lowering the risk of recurrence.

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ORGANIZATIONS

American Academy of Medical Acupuncture (AAMA), 4929 Wilshire Blvd., Suite 428, Los Angeles, CA, 90010, (323) 937–5514, http://www.medicalacupuncture.org.

American Academy of Otolaryngology, Head and Neck Surgery, Inc. (AAOHNSI), One Prince St., Alexandria, VA, 22314–3357, (703) 836–4444, http://www.entnet.org.

American Academy of Pediatrics (AAP), 141 Northwest Point Blvd., Elk Grove Village, IL, 60007, (847) 434–4000, http://www.aap.org.

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Myxedema *see* **Hypothyroidism**

Myxoma

Definition

A myxoma is a rare, usually noncancerous, primary tumor (a new growth of tissue) of the heart. It is the most common of all benign heart tumors.

Description

Myxoma is an intracardiac tumor; it is found inside the heart. Seventy five percent of all myxomas are found in the left atrium, and almost all other myxomas are found in the right atrium. It is very rare for a myxoma to be found in either of the ventricles. The tumor takes one of two general shapes: a round, firm mass, or an irregular shaped, soft, gelatinous mass. They are attached to the endocardium, the

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KEY TERMS

Embolus—A piece of tissue, blood clot, etc., that travels through the blood system and can lodge in smaller blood vessels anywhere in the body.

Metastasis—The spread of a cancer or infectious agent from the site of origin to other areas of the body.

Raynaud's phenomenon—Intermittant ischemia (deficient blood flow) of the fingers or toes, sometimes also affecting the ears and nose.

inside lining of the heart. The cells that make up the tumor are spindle-shaped cells and are embedded in a matrix rich in mucopolysaccharides (a group of carbohydrates). Myxomas may contain **calcium**, which shows up on x rays. The tumor gets its blood supply from capillaries that bring blood from the heart to the tumor. Thrombi (**blood clots**) may be attached to the outside of the myxoma.

There are three major syndromes linked to myxomas: embolic events, obstruction of blood flow, and constitutional syndromes. Embolic events happen when fragments of the tumor, or the thrombi attached to the outside of the tumor, are released and enter the blood stream. Gelatinous myxomas are more likely to embolize than the more firm form of this tumor.

Myxomas may also obstruct blood flow in the heart, usually at a heart valve. The mitral valve is the heart valve most commonly affected. Blood flow restrictions can lead to pulmonary congestion and heart valve disease. Embolization can lead to severe consequences. In cases of left atrial myxoma, 40-50% of patients experience embolization. Emboli usually end up in the brain, kidneys, and extremities.

The third syndrome linked to myxomas are called constitutional syndromes, nonspecific symptoms caused by the myxoma.

Causes and symptoms

There is no known causative agent for myxoma. The main symptoms, if any, produced by myxoma are generic and not specific. These include **fever**, weight loss, anemia, elevated white blood cell (WBC) count, decreased **platelet count**, and Raynaud's phenomenon. Most patients with myxoma are between 30-60 years of age.

Diagnosis

Diagnosis is made following a suspicion that a myxoma might be present, and can usually be confirmed by echocardiogram

Treatment

Surgery is used to remove the tumor. Myxomas can regrow if they are not completely removed. The survival rate for this operation is excellent.

Prognosis

Successful removal of the tumor rids the patient of this disease. Emboli from a myxoma may survive in other areas of the body. However, there is no evidence that myxoma is truly metastatic (able to transfer disease from one area to another), causing tumors in other areas of the body.

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John T. Lohr, PhD

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N

Nail-patella syndrome

Definition

Nail-patella syndrome, is a genetic disease of the connective tissue that produces defects in the fingernails, knee caps, and kidneys.

Description

Nail-patella syndrome is also known as Fong disease, hereditary onycho osteodysplasia (HOOD), iliac horn disease, and Turner-Kieser syndrome. Patients who have nail-patella syndrome may show a variety of physical defects. The hallmark features of this syndrome are poorly developed fingernails, toenails, and patellae (kneecaps). Other common abnormalities include elbow deformities, abnormally shaped pelvis bone (hip bone), and kidney (renal) disease.

Less common medical findings include defects of the upper lip, the roof of the mouth, and unusual skeletal abnormalities. Skeletal abnormalities may include poorly developed scapulae (shoulder blades), sideways-bent fingers (clinodactyly), **clubfoot**, **scoliosis**, and unusual neck bones. There are also other effects, such as thickening of the basement membrane in the skin and of the tiny clusters of capillaries (glomeruli) in the kidney. Scientists have recognized an association between nail-patella syndrome and **colon cancer**. Nail-patella syndrome is associated with open-angle glaucoma, which, if untreated, may lead to blindness. Patients may also have **cataracts**, drooping eyelids (**ptosis**), or corneal problems such as glaucoma.

People with nail-patella syndrome may display only a few or many of the recognized signs of this disease. Symptoms vary widely from person to person. Signs even vary within a single family with multiple affected members.

The incidence of nail-patella syndrome is approximately one in 50,000 births. This disorder affects males and females equally. It is found throughout the world and occurs in all ethnic groups. The strongest risk factor for nail-patella syndrome is a family history of the disease.

Causes and symptoms

Nail-patella syndrome has been recognized as an inherited disorder for more than 100 years. It is caused by mutations in a gene known as LIM homeobox transcription factor 1-beta (LMX1B), located on the long arm of chromosome 9.

The LMX1B gene codes for a protein that is important in organizing embryonic limb development. Mutations in this gene have been detected in many unrelated people with nail-patella syndrome. Scientists have also been able to interrupt this gene in mice to produce defects similar to those seen in human nail-patella syndrome.

Nail-patella syndrome is inherited in an autosomal dominant manner. This means that possession of only one copy of the defective gene is enough to cause disease. When a parent has nail-patella syndrome each of their children has a 50% chance of inheriting the disease-causing mutation.

A new mutation causing nail-patella syndrome can also occur, resulting in disease in a person with no family history. This is called a sporadic occurrence and accounts for approximately 20% of cases of nail-patella syndrome. The children of a person with sporadic nail-patella syndrome are also at a 50% risk of developing signs of the disorder.

Medical signs of nail-patella syndrome vary widely between patients. Some patients with this disorder do not display symptoms. These patients are discovered to have the nail-patella syndrome only when genetic studies trace their family history. Scientists are now working to learn what causes different people to display such different symptoms of nail-patella syndrome.

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The most obvious sign associated with nail-patella syndrome is absent, poorly developed, or unusual fingernails. Fingernail abnormalities are found in more than 80% of patients with this disorder. Abnormalities may be found in one or more fingernails. Only rarely are all fingernails affected. This disease most commonly affects the fingernails of the thumbs and index fingers. The pinky fingernail is least likely to be affected. Fingernails may be small and concave with pitting, ridges, splits, and/or discoloration. Toenails are less often affected. The lunulae, or light-colored crescent moons, at the base of the fingernail bed next to the cuticle are sometimes triangularly-shaped in people with nail-patella syndrome.

Kneecap abnormalities are the second most common sign associated with this disorder. Either or both kneecaps may be missing or poorly formed. If present, kneecaps are likely to be dislocated. The knees of people with nail-patella syndrome may have a square appearance. Besides the kneecap, other support structures including bones, ligaments, and tendons may also be malformed. These support structures stabilize the knee, therefore patients with some leg malformations may have difficulty in walking.

The hip bones of approximately 80% of patients with nail-patella syndrome have unusual bony projections called posterior iliac horns. These bony projections, or spurs, are internal and not obvious unless they are detected on X-ray. This unusual pelvic anatomy is not associated with any other disease.

Kidney disease is present in at least 30% of people with nail-patella syndrome. Biopsy shows lesions that resemble those of inflammation of the clusters of capillaries in the kidneys (**glomerulonephritis**), but without any infection present. Kidney failure is the most dangerous consequence of nail-patella syndrome. It occurs in about 30% of patients who have kidney involvement. An early sign of kidney involvement is the presence of protein or blood in the urine (chronic, benign proteinuria and hematuria.) Kidney involvement is progressive, so early diagnosis and treatment of renal disease is important. Kidney disease has been reported in children with nail-patella syndrome, but renal involvement more commonly develops during adulthood.

Various skeletal symptoms may occur. Patients with nail-patella syndrome may not be able to fully straighten their arms at the elbow. This may create a webbed appearance at the elbow joint. Patients may have sideways-bent fingers, poorly developed shoulder blades, clubfoot, hip dislocation, unusual neck bones, or scoliosis.

Eye problems may be present and vary from person to person. Nail-patella syndrome is associated with open angle glaucoma. Open angle glaucoma is caused by fluid blocked into the front chamber of the eye. This blocked fluid builds increasing pressure into the eye. If untreated, this increased pressure may lead to permanent damage of the optic nerve and irreversible blindness. Some patients with nail-patella syndrome have ptosis, or drooping eyelids. Nail-patella syndrome has also been associated with abnormalities of the cornea, cataracts, and **astigmatism**. Additionally, the irises of the eye may be multicolored, possibly displaying a clover-shaped pattern of color.

Diagnosis

Genetic testing for nail-patella syndrome is available only through research institutions that are working to further characterize this disorder. Genetic testing cannot predict which signs of the disease will develop, nor can genetic testing predict the severity of disease symptoms. Improved genetic testing for nail-patella syndrome is anticipated in the future.

Diagnosis of this disease is most often made on visual medical clues such as the characteristic abnormalities of the fingernails and kneecaps. Diagnosis is confirmed by X-ray images of the affected bones and, when indicated, **kidney biopsy**. The bony pelvic spurs found in 80% of patients with nail-patella syndrome are not associated with any other disease.

Prenatal diagnosis for nail-patella syndrome by third-trimester ultrasound was documented in 1998. Prenatal diagnosis via genetic testing of cells obtained by **chorionic villus sampling** was reported the same year. Prenatal genetic testing for nail-patella syndrome is not yet widely available. Controversy surrounds the use of prenatal testing for such a variable disorder. Prenatal testing cannot predict the extent of an individual's disease.

Treatment

Treatment is usually not necessary. Treatment, when required, depends on each patient's specific symptoms. Severe kidney disease is treated with dialysis or a kidney transplant. Patients receiving kidney transplants do not develop nail-patella type renal complications in their new kidney.

A wheelchair may be required if walking becomes painful due to bone, tendon, ligament, or muscle defects. **Orthopedic surgery** may be necessary for congenital clubfoot deformity. Manipulation or surgery may be required to correct hip dislocation. Cataracts are also surgically treated. Medical treatment at early

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KEY TERMS

Chorionic villus sampling (CVS)—A procedure used for prenatal diagnosis at 10–12 weeks gestation. Under ultrasound guidance a needle is inserted either through the mother's vagina or abdominal wall and a sample of cells is collected from around the early embryo. These cells are then tested for chromosome abnormalities or other genetic diseases.

Glomeruli—Tiny clusters of capillaries in the kidney.

Hematuria—The presence of blood in the urine.

Patella—The kneecap.

Proteinuria—Excess protein in the urine.

signs of glaucoma prevents progression of the disease to blindness.

Genetic counseling is offered to persons who have the disease. Parents with this disease have a 50% chance of passing it to each of their children. Current genetic testing technology cannot predict the severity or scope of an individual's symptoms.

Because many possible manifestations of nail-patella syndrome exist, patients are advised to pursue extra medical care including regular **urinalysis** and special eye exams. Children with nail-patella syndrome should be screened for scoliosis.

Prognosis

Survival among patients with nail-patella syndrome is not decreased unless a they exhibit renal complications. It is estimated that 8% of individuals with nail-patella syndrome who come to medical attention eventually die of kidney disease.

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Judy C. Hawkins, MS

Nail infections *see* **Onychomycosis**

Nail removal

Definition

Nail removal is a form of treatment that is sometimes necessary following traumatic injuries or recurrent infections in the area of the nail. There are nonsurgical as well as surgical methods of nail removal.

Purpose

Nails are removed only when necessary to allow the skin beneath the nail (the nail bed) to heal or in some cases, to remove a nail that has been partially pulled out in an accident. In the case of toenails, it is occasionally necessary to remove the nail of the large toe due to a chronic condition caused by badly fitted shoes. In general, however, doctors prefer to try other forms of treatment before removing the nail. Depending on the cause, nail disorders are usually treated through: the use of oral medications; medicated gels or creams applied directly to the skin around the nail; the avoidance of substances that irritate the nail folds; surgical lancing of abscesses around the nail; or the injection of **corticosteroids** under the nail fold.

The most common causes of nail disorders include:

- Trauma. The nails can be damaged by nail biting, using the fingernails as tools, and incorrect use of nail files and manicure scissors as well as by accidents and sports injuries.
- Infections. These include fungal infections under the nails, bacterial infections of cuts or breaks in the nail folds, or infections of the nails themselves caused by the fungus *Candida albicans*. Inflammation of the nail folds is called paronychia.
- Exposure to harsh detergents, industrial chemicals, hot water, and other irritants. People who work as dishwashers are especially vulnerable to separation of the nail itself from the nail bed (onycholysis).
- Systemic diseases and disorders. These include psoriasis, anemia, and certain congenital disorders.
- Allergic reactions to nail polish, polish remover, or the glue used to attach false nails.

Precautions

In the case of infections, it is necessary to distinguish between fungal, bacterial, and candidal infections before removing the nail. Cultures can usually be obtained from pus or tissue fluid from the affected nail.

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KEY TERMS

Avulse—To pull or tear away forcibly. In some cases, a surgeon must remove a nail by avulsing it from its matrix.

Matrix—The tissue at the base of the nail, from which the nail grows.

Nail bed—The layer of tissue underneath the nail.

Onycholysis—The separation of a nail from its underlying bed. Onycholysis is a common symptom of candidal infections of the nail or of exposure to harsh chemicals and detergents.

Paronychia—Inflammation of the folds of skin that surround a nail.

Description

Surgical nail removal

If necessary, the surgeon can remove the nail at its base with an instrument called a needlepoint scalpel. In a few cases, the nail may need to be pulled out (avulsed) from its matrix.

Nonsurgical nail removal

Nails can be removed by applying a mixture of 40% urea, 20% anhydrous lanolin, 5% white wax, 25% white petroleum jelly, and silica gel type H.

Preparation

For nonsurgical nail removal, the nail fold is treated with tincture of benzoin and covered with adhesive tape. The nail itself is thickly coated with the urea mixture, followed by a layer of plastic film and adhesive tape. The mixture is left on the nail for five to 10 days, after which the nail itself can be removed.

Aftercare

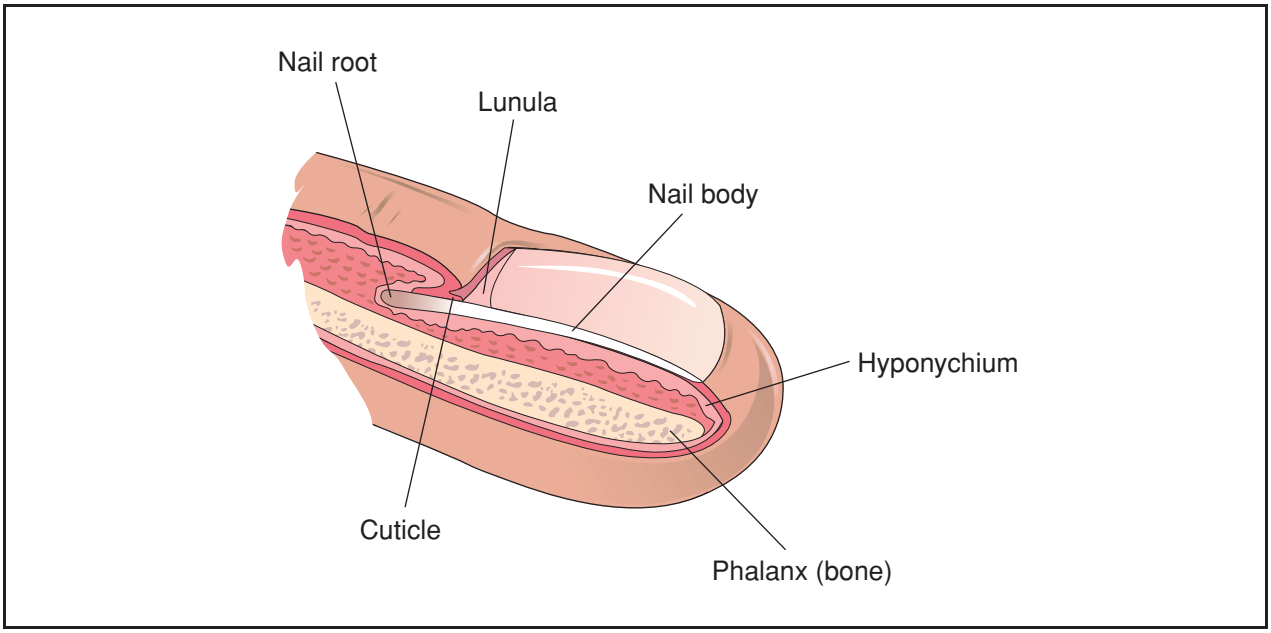
Aftercare of surgical removal is similar to the care of any minor surgical procedure. Aftercare of the urea paste method includes applying medication for the specific infection that is being treated.

Risks

Risks from either procedure are minimal.

Normal results

Normal results include the successful removal of the infected or damaged nail.



The physiology of the human fingernail. The most common causes of nail disorders include trauma, infections, exposure to harsh detergents, hot water and other irritants, systemic diseases and disorders, and allergic reactions to nail polish, nail polish remover, and nail glue.
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Rebecca J. Frey, PhD

Nalidixic acid *see* **Urinary anti-infectives**

Narcissistic personality disorder *see* **Personality disorders**

Narcolepsy

Definition

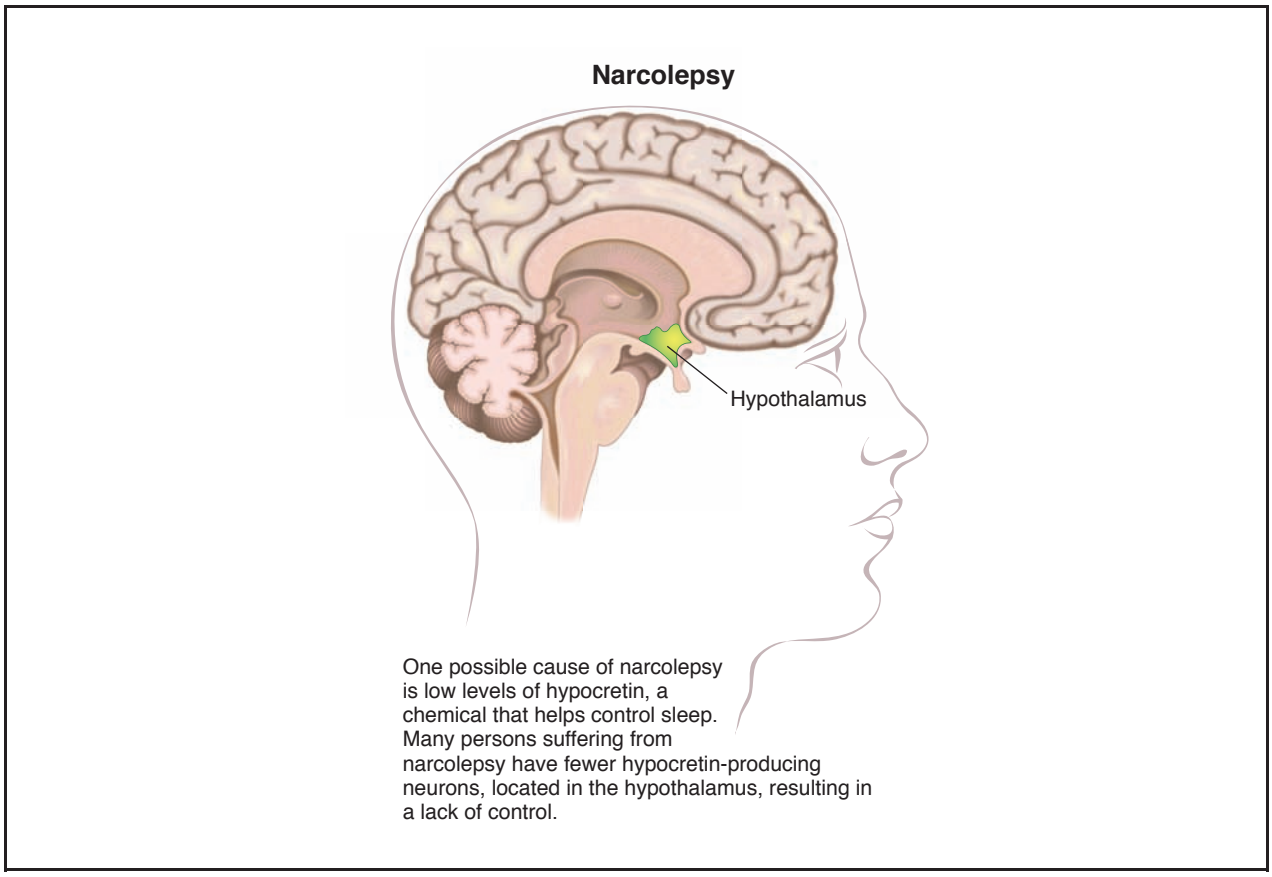
Narcolepsy is a neurological disorder marked by excessive daytime sleepiness, uncontrollable sleep attacks, and cataplexy (a sudden loss of muscle tone, usually lasting up to half an hour).

Demographics

According to the National Institute for Neurological Disorders and Stroke (NINDS), narcolepsy is an underrecognized and underdiagnosed condition in the United States. The exact prevalence is not known, but it is estimated to affect about one in every 2,000 Americans. The disorder occurs worldwide in every racial and ethnic group, affecting males and females equally. However, prevalence varies among populations. For example, narcolepsy is less prevalent in Israel (about one per 500,000) but considerably more prevalent in Japan (about one per 600).

Description

Narcolepsy is the second–leading cause of excessive daytime sleepiness (after obstructive **sleep apnea**). Persistent sleepiness and sleep attacks are the hallmarks of this condition. The sleepiness has been compared to the feeling of trying to stay awake after not sleeping for two or three days.



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KEY TERMS

Cataplexy—A symptom of narcolepsy in which there is a sudden episode of muscle weakness triggered by emotions. The muscle weakness may cause the person's knees to buckle, or the head to drop. In severe cases, the patient may become paralyzed for a few seconds to minutes.

Excessive daytime sleepiness (EDS)—A persistent sense of mental cloudiness, a lack of energy, a depressed mood, or extreme state of exhaustion.

Hypnagogic hallucinations—Dream–like auditory or visual hallucinations that occur while falling asleep.

Hypothalamus—A part of the forebrain that controls heartbeat, body temperature, thirst, hunger, body temperature and pressure, blood sugar levels, and other functions.

Sleep paralysis—An abnormal episode of sleep in which the patient cannot move for a few minutes, usually occurring on falling asleep or waking up. Often found in patients with narcolepsy.

People with narcolepsy fall asleep suddenly—anywhere, at any time, maybe even in the middle of a conversation. These sleep attacks can last from a few seconds to more than an hour. Depending on where they occur, they may be mildly inconvenient or even dangerous to the individual. Some people continue to function outwardly during the sleep episodes, such as talking or putting things away. But when they wake up, they have no memory of the event.

Narcolepsy is related to the deep, dreaming part of sleep known as rapid eye movement (REM) sleep. Normally when people fall asleep, they experience 90 minutes of non–REM sleep, which is then followed by REM sleep. People with narcolepsy, however, enter REM sleep immediately. In addition, REM sleep occurs inappropriately throughout the day.

Risk factors

According to the NINDS, close relatives of people with narcolepsy have a statistically higher risk of developing the condition than do members of the general population.

Causes and symptoms

Narcolepsy sometimes runs in families, but most cases are sporadic, meaning that the disorder occurs independently in individuals without strong evidence of being inherited. Some researchers therefore believe that the inheritance of narcolepsy is similar to that of heart disease. In heart disease, several genes play a role in being susceptible to the disorder, but it usually does not develop without an environmental trigger of some sort. Other factors, such as infection, immune system deficiencies, trauma, hormonal changes, and **stress** may also play a role in the development of the disease.

The immediate cause of narcolepsy remains unknown but as of 2009, medical researchers have made considerable progress in understanding the disorder and in identifying genes strongly associated with it. Abnormalities in various parts of the brain involved in regulating REM sleep were also discovered. Narcolepsy is now known to have one of the tightest associations with a specific form, or allele, of the HLA gene family. The HLA gene family provides instructions for making a group of related proteins known as the human leukocyte antigen (HLA) complex. The HLA complex helps the immune system distinguish the body's own proteins from proteins made by foreign invaders such as viruses and bacteria. From 88% to 98% of patients affected by narcolepsy have been shown to be positive for the allele known as HLA DQB1*0602. This allele strongly increases the susceptibility for cataplexy, although 41% of patients without cataplexy are carriers. DRB1 and DQB1 genes have been sequenced in narcolepsy patients but no mutation has been identified. This suggests that these genes strongly confer susceptibility to narcolepsy without their function being defective. It is accordingly believed that non–HLA genes may also be involved in susceptibility to narcolepsy.

While the symptoms of narcolepsy usually appear during the teens or 20s, the disease may not be diagnosed for many years. The most common major symptom is excessive daytime sleepiness (EDS), an overwhelming feeling of **fatigue**. After several months or years, cataplexy and other symptoms appear.

Cataplexy is the most dramatic symptom of narcolepsy. It affects 75% of people with the disorder. During attacks, the knees buckle and the neck muscles go slack. In extreme cases, the person may become paralyzed and fall to the floor. This loss of muscle tone is temporary, lasting from a few seconds to half an hour, but frightening. The attacks can occur at any time but are often triggered by strong emotions, such as anger, joy, or surprise.

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Other symptoms of narcolepsy include:

- sleep attacks: short, uncontrollable sleep episodes throughout the day
- sleep paralysis: a frightening inability to move shortly after awakening or dozing off
- auditory or visual hallucinations: intense, sometimes terrifying experiences at the beginning or end of a sleep period
- disturbed nighttime sleep: tossing and turning, nightmares, and frequent awakenings during the night

Diagnosis

Examination

In most patients, narcolepsy is not diagnosed until 10 to 15 years after the first symptoms appear. This is because the disorder is not familiar to most of the general public. The disorder is suspected when a person reports both excessive daytime sleepiness and cataplexy. Diagnosis is established on the basis of a clinical examination and comprehensive medical history.

Tests

Laboratory tests are required to confirm a diagnosis. These may include an overnight polysomnogram—a test in which sleep is monitored with **electrocardiography**, video, and respiratory parameters. A multiple sleep latency test, which measures sleep latency (onset) and how quickly REM sleep occurs, may be used. People who have narcolepsy usually fall asleep in less than five minutes.

If a diagnosis is in question, a genetic blood test can reveal the existence of certain substances in people who have a tendency to develop narcolepsy. Positive test results suggest, but do not prove, the existence of narcolepsy.

Treatment

Traditional

There is no cure for narcolepsy. It is not progressive, and it is not fatal, but it is chronic. The symptoms can be managed with medication or lifestyle adjustment.

Drugs

Amphetamine–like stimulant drugs are often prescribed to control drowsiness and EDS attacks. Patients who do not like taking high doses of stimulants may choose to take smaller doses and "manage" their lifestyles, such as by napping every couple of hours, to relieve daytime sleepiness. Antidepressants are often effective in treating symptoms of abnormal REM sleep. In 2002, the FDA approved Xyrem® (**sodium** oxybate or gamma hydroxybutyrate, also known as GHB) for treating people with narcolepsy who experience episodes of cataplexy.

Prognosis

Narcolepsy is not a degenerative disease, and patients do not develop other neurologic symptoms. However, narcolepsy can interfere with a person's ability to work, play, drive, and perform other daily activities. In severe cases, the disorder prevents people from living a normal life, leading to depression and a loss of independence.

Prevention

Narcolepsy cannot be prevented.

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National Institute of Neurological Disorders and Stroke (NINDS), P.O. Box 5801, Bethesda, MD, 20824, (301) 496-5751, (800) 352-9424, http://www.ninds.nih.gov.
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Narcotics

Definition

Narcotics are natural opioid drugs derived from the Asian poppy *Palaver somniferous*, or semi-synthetic or synthetic substitutes for these drugs.

Purpose

Narcotics are drugs that dull the sense of **pain**, and cause drowsiness or sleep. They are the most effective tool a physician has to relieve severe pain. Narcotics are also given pre-operatively to relieve **anxiety** and induce anesthesia. Other common uses are to suppress **cough** and to control very severe **diarrhea**. In large doses, they can suppress the ability to breathe and cause **coma** and **death**. Narcotics are also taken illegally for recreational use.

Classes of narcotics

Narcotics of natural origin

Codeine
Morphine
Opium
Thebaine

Semi-synthetic narcotics

Heroin
Hydrocodone
Hydromorphone
Oxycodone

Synthetic narcotics

Butorphanol
Dextropropoxyphene
Fentanyl
Meperidine
Pentazocine

Narcotics treatment drugs

Buprenorphine
LAAM
Methadone

SOURCE: U.S. Department of Justice, Drug Enforcement Administration, *Drugs of Abuse*, "Chapter 4: Narcotics." Available online at: http://www.justice.gov/dea/pubs/abuse/4-narc.htm (accessed August 19, 2010).

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Precautions

Narcotics should only be taken under the direction of a physician. These drugs depress the central nervous system and should not be taken with other drugs, such as alcohol, **barbiturates**, **antihistamines**, and **benzodiazepines** that also depress the central nervous system.

Opioids are broken down by the liver. Individuals with liver damage may not detoxify these substances as rapidly as healthy individuals, leading to potential accidental overdose. Street narcotics are of uncertain strength and may be contaminated with toxic chemicals or contain a mixture of drugs that can cause life-threatening reactions.

Description

Natural narcotics are derived directly from the sap of the unripe seed pods of the opium poppy. Morphine and codeine are the most familiar natural narcotics and are the narcotics most frequently used in medical settings. Often they are prescribed in combination with other non-narcotic drugs. Heroin is a

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semi-synthetic narcotic. It has no medical or legal uses. Other completely synthetic narcotics are made in the laboratory. These include drugs with medical uses such as fentanyl and oxycodone, and illegal "designer drugs" synthesized for recreational use. Some man-made narcotics are hundreds of times more potent than natural narcotics.

Narcotics depress the central nervous system. They work by binding chemically with receptors in a way that blocks the transmission of nerve impulses. These drugs do not cure the source of the pain; they simply block the individual's perception of pain. When used to treat cough or diarrhea, they slow or block muscle contractions.

Morphine (Roxanol, morphine sulfate, morphine hydrochloride) is the most commonly used medical narcotic for managing moderate to severe pain. It can be also be used to control extreme diarrhea caused by **cholera** or similar diseases. Morphine sulfate is a white powder that dissolves in water. It is usually given by injection into a muscle or intravenously by injection into a vein. When given intravenously, its effect occurs almost immediately. Individuals given morphine regularly have a high potential for developing dependence on the drug. Morphine can cause withdrawal symptoms if stopped abruptly. It is not a common street drug.

More codeine is prescribed medically than any other narcotic. Concentrations of codeine in the sap of the opium poppy are low, so most codeine is manufactured by chemical alteration of morphine. For pain control, codeine is combined with other non-narcotic painkillers such as **aspirin** (Empirin with Codeine,) **acetaminophen** (Tylenol with Codeine) or non-steroidal anti-inflammatory drugs. These combination painkillers are manufactured as tablets (most common) or liquids, and come in a variety of strengths based on the amount of codeine they contain. Codeine is also found in some cough syrups (Robitussin A-C, for example) and is used to control dry cough. Occasionally codeine is used to control severe diarrhea, although diphenoxylate (Lomotil) is used more often.

In Canada, certain low-dose codeine pain relievers are sold without prescription. In the United States pain medication with codeine requires a prescription. The likelihood of physical or psychological dependence on codeine is much lower than with morphine.

Hydromorphone (Dilaudid) is a narcotic synthetically produced from morphine. It is available in tablets or as an injectable solution and used for pain relief. It is one of the most common pain relievers prescribed for patients who are terminally ill, because it combines high effectiveness with low side effects.

Mederidine (Demerol) was originally developed to treat **muscle spasms** but is used mainly for pain relief. It is manufactured as tablets of varying strengths. Another synthetic pain relief narcotic whose use parallels mederidine is propoxyphene. When combined with aspirin this narcotic is known under the brand name Darvon. In November 2010, the U.S. Food and Drug Administration banned Darvon, Darvocet, and other pills containing propoxyphene.

Oxycodone (Oxycontin), a synthetic narcotic used for pain relief, is manufactured both alone and with aspirin (Percodan) or acetaminophen (Percoset) in tablets of various strengths. Oxycontin is a controlled release formula of oxycodone that controls pain continuously for 12 hours at a time. Oxycodone has a high potential for prescription-drug and street **abuse**. Hydrocodone with acetaminophen (Vicodin) is another synthetic narcotic whose use and potential abuse parallels oxycodone.

Fentanyl (Sublimaze, Actiq, Duragesic) is used as a surgical anesthetic. It is available as an injectable solution and as a skin patch.

Methadone is a synthetic narcotic used mainly as a substitute for heroin in heroin-withdrawal treatment, although it does have pain-killing properties. Methadone, when taken by mouth (liquid, wafers, tablets) provides little of the euphoria of heroin, but it blocks heroin cravings and withdrawal symptoms.

The first international attempts to control narcotic drugs were made in 1909 with the formation of the Opium Commission Forum, which developed the first international drug control treaty in 1912. Established in 1961, the International Narcotics Control Board (INCB), today regulates narcotics internationally. The INCB regulates the cultivation of raw materials to make narcotics and natural and man-made drugs. **Cocaine** and **marijuana** also fall under the board's control, although they are not technically narcotics. Narcotic drugs are also regulated by federal and state governments. In law enforcement, the term narcotics is extended to include other, mainly illicit drugs such as cocaine that have little medical use.

Preparation

No special preparation is required before being treated with narcotics, although, as with all medications, individuals should tell their physicians about all prescription and non-prescription drugs, supplements,

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KEY TERMS

Tapering—Gradually reducing the amount of a drug when stopping it abruptly would cause unpleasant withdrawal symptoms.

and herbal remedies that they are taking, as certain medications may enhance the effects of narcotics.

Aftercare

When an individual is prescribed narcotics regularly for an extended period, tolerance may develop. With tolerance, the individual must take higher and higher doses to achieve the same level of pain control. In some cases, when narcotics are stopped abruptly, withdrawal symptoms may develop. These include:

- anxiety
- irritability
- rapid breathing
- runny nose
- sweating
- vomiting and diarrhea
- confusion
- shaking
- lack of appetite

In order to prevent withdrawal symptoms, the dose of narcotics can be gradually diminished, a process known as tapering, until they can be discontinued completely without unpleasant effects. Individuals may also be treated with the drug cloindine (Catapres) to relieve some withdrawal symptoms.

Risks

All narcotics have the potential to become physically and psychologically addictive. When used regularly, tolerance can develop. Abuse and dependence on narcotic prescription drugs in an increasing problem among the elderly particularly and among members of the middle class generally.

Overdose and withdrawal symptoms and reactions caused by contamination with other drugs or toxic chemicals are common reasons for drug-related visits to the emergency room by individuals using street narcotics recreationally. Overdose is treated with the drug naloxone (ReVia). Naloxone blocks and reverses the effects of narcotics. When given intravenously it is effective within one to two minutes.

Normal results

When used as prescribed, narcotics are a generally safe and effective way to relieve pain and control cough and severe diarrhea. Individuals should not be afraid they will develop an **addiction** after a short-term course of narcotics following a dental or medical procedure, provided that they follow the physician's instructions for taking the drugs.

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National Institute on Drug Abuse, 6001 Executive Blvd., Room 5213, Bethesda, MD, (301) 443-1124, information@nida.nih.gov, http://drugabuse.gov.

United States Drug Enforcement Administration, Dr Mailstop: AXS, 2401 Jefferson Davis Highway, Alexandria, VA, 22301, (202) 307-1000, http://www.dea.gov.

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Nasal culture *see* **Nasopharyngeal culture**

Nasal irrigation

Definition

Nasal irrigation is the practice of flushing the nasal cavity with a sterile solution. The solution may contain **antibiotics** or steroid medications.

Purpose

Nasal irrigation is used to clear infected sinuses or may be performed after surgery to the nose region. It may be performed by adding antibiotics to the solution to treat **nasal polyps**, nasal septal deviation, allergic nasal inflammation, chronic sinus infection, and swollen mucous membranes. One benefit of nasal irrigation in treating these conditions is that it usually lowers the amount of medication that the patient must take by mouth.

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Irrigation is also used to treat long-term users of inhalants, such as illicit drugs (**cocaine**), or such occupational toxins as paint fumes, sawdust, pesticides, and coal dust.

Nasal irrigation may also be used in occupational medicine to monitor workers for exposure to airborne glass fibers, asbestos, and similar materials.

KEY TERMS

Irrigation—In medicine, the practice of washing out or flushing a wound or body opening with a stream of water or another liquid.

Saline—A solution made from salt and water.

Precautions

Nasal irrigation should not be performed on people who have frequent nosebleeds; have recently had nasal surgery; or whose gag reflex is impaired, as fluid may enter the windpipe.

Description

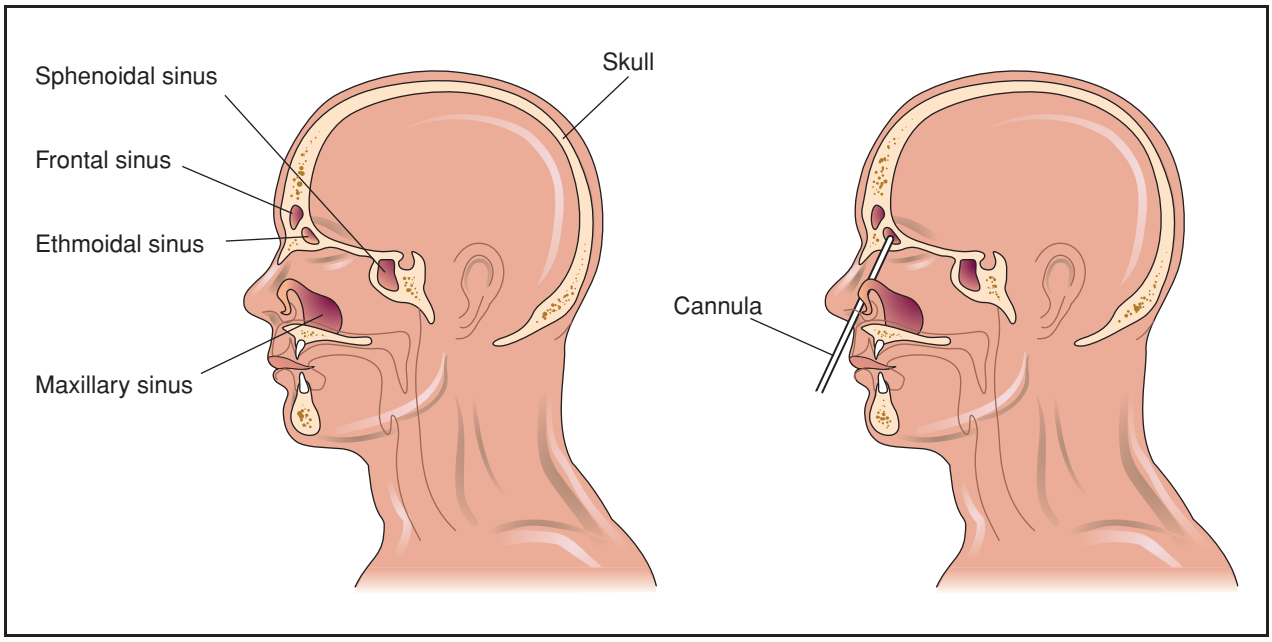
Nasal irrigation can be performed by the patient at home or by a medical professional. A forced-flow instrument, such as a syringe, is filled with a warm saline solution. The solution can be commercially prepared (Ayr, NaSal) or can be prepared by the patient, using one-half teaspoon salt with each eight ounces of warm water. Occasionally, antibiotics or **steroids** are added to the solution to kill bacteria and aid healing of irritated membrane. The syringe is then directed into the nostril. The irrigation solution loosens encrusted material in the nasal passage, and drainage takes place through the nose. The patient leans over a catch basin during irrigation, into which the debris flows. Irrigation continues until all debris is cleared from the passage. Nasal irrigation can be performed up to twice daily, unless the irrigation irritates the mucous membrane.

Preparation

Before nasal irrigation, the patient is instructed not to open his or her mouth or swallow during the procedure. Opening the mouth or swallowing may cause infectious material to move from the nasal passage into the sinuses or the ear.

Risks

Complications of nasal irrigation include irritation of the nasal passages due to extreme temperature of the irrigation solution. Rarely, irrigation



Because surgery in the nasal area has a high incidence rate for contamination with pathogenic bacteria, nasal irrigation is performed to remove loose tissue and prevent infection. The illustration (right) shows a cannula in place while the sinus passages are being flushed. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

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fluid may enter the windpipe in people with a poor gag reflex.

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Nasal packing

Definition

Nasal packing is the application of gauze or cotton packs to the nasal chambers.

Purpose

The most common purpose of nasal packing is to control bleeding following surgery to the septum or nasal reconstruction and to treat chronic nosebleeds. Packing is also used to provide support to the septum after surgery.

Description

Packing is the placement of gauze or cotton into the nasal area. Packing comes in three forms: gauze, cotton balls, and preformed cotton wedges. Packing is usually coated with **antibiotics** and, sometimes, petrolatum. The end of the nose may be taped to keep the packings in place or to prevent the patient from pulling them out. In cases of surgery, packings are frequently removed within 24–48 hours following surgery. In the case of nosebleeds, packing is left in for extended periods of time to promote healing and to prevent the patient from removing scar tissue which might reopen the wound. If both sides of the nose are packed, the patient must breathe through his or her mouth while the packs are in place.

In patients who are chronic nose pickers, frequent bleeding is common and ulceration of nasal tissue is possible. To promote healing and to prevent nose picking, both sides of the nose are packed with cotton that contains antibiotics. The nose is taped shut with surgical tape to prevent the packing from being removed. The packing is left in the nose for seven to 10 days. If the wound is high up in the nasal cavity, gauze strips treated with petrolatum and antibiotics are used. The strips are placed into the nose one layer at a time, folding one layer on top of the other until the area is completely packed.

Local packing is a procedure used when only a small part of the nose must be packed. Typically, this occurs when one blood vessel is prone to bleeding, and there is no need to block breathing through the nose. Local packing is used when the pack can remain in place by itself. This situation can be found at the turbinates. Turbinates are folds of tissue on the insides of the nose. The folds are sufficiently firm to support packing. A small piece of gauze or cotton is wedged in between the turbinates where the blood vessel being treated is located. Local packing is left in place for up to 48 hours and then removed. The main advantage to this type of packing is that it enables the patient to breathe through his or her nose. Local packing is also more comfortable than complete packing, although the patient will still experience a sensation that something is in the nasal cavity. The patient must be instructed not to interfere with or probe the packing while it is in place.

A postnasal pack is used to treat bleeding in the postnasal area. This is a difficult area to pack. Packs used in this area are made from cotton balls or gauze that have been tied into a tubular shape with heavy gauge suture or umbilical tape. Long lengths of suture or tape are left free. The lengths of suture or tape are used to help position the pack during installation and to remove it. An alternative is to cut a vaginal tampon

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KEY TERMS

Turbinate—Ridge-shaped cartilage or soft bony tissue inside the nose.

Ulcer—A sore on the skin or mucous tissue that produces pus and in which tissue is destroyed.

and reposition the strings. Balloons have been tried as a method to replace postnasal packing, but have not proved effective. After being tied, the pack is soaked with an antibiotic ointment. Generally, packs are formed larger than needed, so that they completely block the nasal passage. A catheter is passed through the nose and pulled out through the mouth. Strings from one end of the pack are tied to the catheter and the pack pulled into place by passing through the mouth and up the back of the nasal cavity. The pack is removed in a similar manner. Complications may occur if a pack compresses the eustachian tube, causing ear problems. The ear should be examined to ensure that infection is not developing.

Packing of the anterior (front) part of the nose is also performed following surgery such as **septoplasty** and **rhinoplasty**. In these operations, the surgeon cuts through the skin flap covering cartilage and bone in the center, top, and bottom of the nose to correct the shape of the nose. At the conclusion of the surgery, the skin flap is sutured back into place. The purposes of packing are to absorb any drainage from the incision and mucus produced by nasal tissue, and to support the skin flap and cartilage. The packing used is either gauze or preformed adsorbent wedges of cotton. Both are usually treated with antibiotic to reduce the chance of infections at the incision site. Generally, there is little bleeding following septoplasty and rhinoplasty, and the incisions heal normally. These packs are left in place for 24 to 48 hours and then removed.

Aftercare

Ice chips or mouthwash can be used to moisten the mouth while packing is in place, as the mouth may be dry from breathing through it. Humidifiers may also help with breathing. After nasal packing, the nose should not be blown for two to three days.

Since one of the major reasons that packing is performed is to heal damage to nasal blood vessels from nose-picking, follow-up examination should be done to ensure that the patient is no longer practicing this habit. If the patient has restarted nose-picking, therapy to alter this behavior should be pursued. When the packing completely blocks the nasal cavity and prevents breathing through the nose, the patient should adjust to breathing through the mouth. In elderly patients, adjustment may be more difficult. This leads to a drop in the blood oxygen content and an increase in blood carbon dioxide levels (CO_2). This, in turn, can cause respiratory and cardiac complications, including a racing pulse.

Risks

Nasal packing could cause a lack of oxygen in those who have difficulty breathing through their mouths. Rarely, sinus infection or middle-ear infection may occur.

Resources

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Nasal papillomas

Definition

Nasal papillomas are **warts** located inside the nose.

Description

Two types of tumors can grow inside the nose: polyps and papillomas. By far the most common are polyps, which have smooth surfaces. On the contrary, papillomas have irregular surfaces and are, in fact, warts. Papillomas may be caused by the same viruses that cause warts elsewhere on the body. They are inside the nose, more often on the side near the cheek, and, because of their internal structure, they are much more likely to bleed than polyps.

There is a special type of nasal papilloma called an inverting papilloma because of its unique appearance. About 10 or 15% of these are or can become cancers.

Causes and symptoms

Like polyps, papillomas can plug up the nose and disable the sense of smell. Unlike polyps, papillomas often bleed.

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KEY TERMS

Polyp—A tumor commonly found in the nasal cavity or intestine.

Diagnosis

A **physical examination** with special instruments will detect these tumors.

Treatment

Because of the possibility of **cancer**, all nasal papillomas must be removed surgically and sent to the laboratory for analysis. If a cancer is present, further surgery may be necessary to guarantee that all of the cancer has been removed. The initial surgery can be done in an office setting by a specialist in head and neck surgery, also known as otorhinolaryngology and popularly abbreviated ENT (ear, nose, and throat). Cancer surgery is more extensive and often requires hospitalization.

Prognosis

For benign (non-cancerous) lesions, removal is curative, although they tend to recur, just like warts elsewhere. The cancerous papillomas may occasionally escape complete surgical removal and spread to adjacent or distant sites. The prognosis is then much more complex.

Resources

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J. Ricker Polsdorfer, MD

Nasal polyps

Definition

A polyp is the medical term for any overgrowth of tissue from the surface of a body organ. Polyps come in all shapes—round, droplet, and irregular being the most common. Nasal polyps are teardrop-shaped while growing and resemble peeled grapes when they have reached their full size. The condition of nasal polyps is sometimes called nasal polyposis.

A nasal polyp inside patient's right nostril. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Description

Nasal polyps tend to occur in people with respiratory **allergies**. Hay fever (**allergic rhinitis**) is an irritation of the membranes of the nose by airborne particles or chemicals. These membranes secrete mucus. When irritated, they can also grow polyps. The nose is not only a passageway for air to reach the lungs; it also provides the connection between the sinuses and the outside world. Sinuses are lined with mucous membranes, just like the nose. Polyps can easily obstruct the drainage of mucus from the sinuses. When any fluid in the body is trapped so it cannot flow freely, it becomes infected. The result, **sinusitis**, is a common complication of allergic **rhinitis**.

Nasal polyps may also develop in children with **cystic fibrosis**.

Causes and symptoms

Some people who are allergic to **aspirin** develop both **asthma** and nasal polyps.

Nasal polyps often plug the nose, usually one side at a time. People with allergic rhinitis are so used to having a stopped-up nose they may not notice the difference when a polyp develops. Other polyps may be closer to a sinus opening, so airflow is not obstructed, but mucus becomes trapped in the sinus. In this case, there is a feeling of fullness in the head, no sense of smell, and perhaps a **headache**. The trapped mucus will eventually get infected, adding **pain**, fever, and perhaps bloody discharge from the nose.

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KEY TERMS

Allergen—Any substance that irritates only those who are sensitive (allergic) to it.

Asthma—Wheezing (labored breathing) due to allergies or irritation of the lungs.

Decongestant—Medicines that shrink blood vessels and consequently mucus membranes. Pseudoephedrine, phenylephrine, and phenylpropanolamine are the most common.

Polyposis—The medical term for the development of multiple polyps on a body part.

Sinus—Air-filled cavities surrounding the eyes and nose are lined with mucus-producing membranes. They cleanse the nose, add resonance to the voice, and partially determine the structure of the face.

Diagnosis

A **physical examination** will identify most polyps. Small polyps located higher up or further back may be hidden from view, but they will be detected with more sophisticated medical instruments. The otorhinolaryngologist is equipped to diagnose nasal polyps. In order to perform the examination, the doctor must apply medicine to reduce congestion in the swollen membranes. Cotton balls soaked with one of these agents and left in the nostrils for a few minutes provide adequate shrinkage.

Treatment

Most polyps can be removed by the head and neck surgeon as an office procedure called a nasal polypectomy. Bleeding, the only complication, is usually easy to control. Nose and sinus infections can be treated with **antibiotics** and **decongestants**, but if airflow is restricted, the infection will recur.

Prognosis

Polyps may reappear as long as the allergic irritation continues. In addition, one study of patients who had undergone nasal polypectomy reported that 60% had a recurrence of nasal polyposis, and 47% were advised to have revision surgery. The risk of recurrence is higher among patients with asthma.

Prevention

If aspirin is the cause of the polyps, all aspirin containing medications must be avoided.

Since most nasal polyps are the result of allergic rhinitis, they can be prevented by treating this condition. New treatments have greatly improved control of hay fever. There are now several spray medicines that are quite effective. Spray cortisone-like drugs, usually beclomethasone (Beconase, Vancenase) or flunisolide (Nasalide), are the most popular. Over-the-counter nasal decongestants have an irritating effect similar to the allergy they are supposed to be treating. Continued use can bring more trouble than relief and result in an **addiction** to nose sprays. The resulting disease, rhinitis medicamentosa, is more difficult to treat than allergic rhinitis.

Allergists and ENT surgeons both treat allergic rhinitis with a procedure called desensitization. After identifying suspect allergens using one of several methods, they will give the patient increasing doses of those allergens in order to produce blocking antibodies that will impede the allergic reaction. This approach is effective in a number of patients, but the treatment may take a period of months to years.

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Nasal trauma

Definition

Nasal trauma is defined as any injury to the nose or related structure that may result in bleeding, a physical deformity, a decreased ability to breathe normally because of obstruction, or an impaired sense of smell. The injury may be either internal or external.

Description

The human nose is composed of bone, soft tissue, and cartilage. It serves as a passageway for air to flow from the outside environment into the lower respiratory tract and lungs. At the same time, the nasal passages warm and humidify the air that enters the body.

Internal injuries to the nose typically occur when a foreign object (including the fingers) is placed in the nose or when a person takes in drugs of **abuse** (inhalants or **cocaine**) through the nose. External injuries to the nose are usually blunt force injuries related to sports participation, criminal violence, parental abuse, or automobile or bicycle accidents. This type of injury may result in a nasal fracture. The nasal bones are the most frequently fractured facial bones due to their position on the face, and are the third most common type of bone fracture in general after **fractures** of the wrist and collarbone. A force of only 30g is required to break the nasal bones, compared to 70g for the bones in the jaw and 200g for the bony ridge above the eyes. The pattern of the fracture depends on the direction of the blow to the nose, whether coming from the front, the side, or above the nose. Although not life-threatening by itself, a fractured nose may lead to difficulties in breathing as well as facial disfigurement.

Fractured nose of an elderly patient. *(Dr. P. Marazzi/Photo Researchers, Inc.)*

Fractures resulting from trauma to the nose may involve the bones of the septum (the partition of bone and cartilage dividing the two nostrils) as well as the bones surrounding the eyes. These bones include the nasal, maxilla, lacrimal, and frontal bones. Direct trauma to the bridge of the nose may also result in damage to a part of the base of the skull known as the cribriform plate. This injury in turn may allow cerebrospinal fluid to leak out of the skull and leave the body through the nose. Fractures may also damage the membranes that line the nasal passages, leading to possible formation of scar tissue, obstruction of the airway, and damage to the child's sense of smell.

In addition to fractures, external injuries of the nose include soft-tissue injuries resulting from **bites** (human and animal), insect **stings**, cuts, or scrapes. Penetrating injuries to the nasal area caused by air gun or BB pellets are also reported with increasing frequency in older children and adolescents. When fired at close range, these pellets can penetrate the skin and cheekbone and lodge in the nasal septum or the sinuses near the nose.

Lastly, nose **piercing** as a fashion trend is a type of intentional injury to the nose that has several possible complications, including infections of the cartilage and soft tissues in the nose; blockage of the airway due to a loosened stud or other nose ornament; and gastrointestinal emergencies caused by accidental swallowing of nose jewelry.

Causes and symptoms

Causes

External trauma to the nose may be accidental (transportation accidents, animal bites, air gun injuries, and **sports injuries**) or intentional (fights, criminal assault, domestic violence, nose piercing). Nasal injuries from athletic activities may result from contact with equipment (being hit in the face by a baseball, or other small ball hit at high speed, or by the bat or stick itself) or the bodies of other players (in sports such as football, boxing, martial arts, rugby). Nasal injuries from piercing include bacterial infections of

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the skin and nasal cartilage, allergic reactions to the jewelry, tissue damage, and periodic bleeding.

In a few cases, external trauma to the nose may also be iatrogenic, or caused by medical care. Most of these injuries result from medical examination of the nose—particularly in emergency circumstances—or as complications of **plastic surgery**. In a few cases damage to the nose is caused by **radiation therapy** for **cancer**.

Internal injuries to the nose may be either mechanical (caused by **foreign objects** in the nose or by picking or scratching the tissues lining the nose) or chemical (caused by environmental irritants or **substance abuse**).

Chemical injuries to the nose are caused by accidental or purposeful breathing or sniffing of irritating substances. These may include tobacco smoke; household cleaners (ammonia and chlorine bleach) and furniture polish; ozone and other air pollutants; cocaine; and glue, paint thinners, solvents, and similar household products that produce toxic vapors. An increasingly common form of chemical injury to the nasal membranes in toddlers is alkali **burns** caused by leakage from small batteries placed in the nose. While chemical damage to the nose is usually accidental in younger children, it is more often the result of substance abuse in adolescents. Taking cocaine through the nose ("snorting") or inhalant abuse ("sniffing" or "huffing") are the most common causes of chemical damage to the nose in older children or teenagers.

Symptoms

The symptoms of physical trauma to the nose may include:

- Flattening or other deformation of the shape of the nose
- Infections of the cartilage or soft tissue
- Epistaxis or bleeding from the nose
- Crepitus. Crepitus is the crackling or crunching sound heard when the ends of a fractured bone are rubbed together
- Pain and tissue swelling
- Airway blockage from bleeding, fluid discharge, or tissue swelling
- Rhinitis. Rhinitis is an inflammation of the mucous membranes lining the nose. In the case of a fracture, rhinitis may lead to increased tear production in the eyes and a runny nose
- Septal hematoma. A septal hematoma is a mass of blood from torn tissue that may collect within the cartilage that divides the two nostrils. It may become infected and form an abscess that eventually destroys the cartilage
- Bruising or discoloration (ecchymosis) of the tissues around the eye
- Leakage of cerebrospinal fluid through the nostrils

Chemical trauma to the nose may result in:

- Runny nose and watering of the eyes
- Pain
- Loss of the sense of smell
- Nasal congestion and sneezing
- Reddening and swelling of the mucous membranes lining the nose
- Eventual destruction of the cartilage in the nasal septum and the tissues lining the nose

Some common irritants that may be encountered in the home and workplace include:

- cleaning solutions and powders
- ammonia
- environmental tobacco smoke
- bleach
- metalworking fluids
- ozone
- sulfur dioxide
- paint thinners
- arsenic
- chromic acid
- copper dust and mists

Aftereffects following exposure to these chemicals are based not only on the concentration of the irritant but also on factors specific to the individual. Reactions vary among persons, even with similar exposures.

Diagnosis

Diagnosis of a fracture is normally based on a history of nasal trauma and clinical presentation. Epistaxis may or may not be present. An intranasal examination is performed in order to look for a septal hematoma that may result in serious consequences such as **death** of the septal cartilaginous tissue. The nose is also checked for tenderness, mobility, stability, and crepitance.

X-rays are normally not indicated, however, in more severe fractures involving multiple bones, a computed tomography (CT) scan may be required. The physician should look for associated injuries such as periorbital (surrounding the eye) ecchymosis, watery eyes, or diplopia (double vision) that may indicate orbital injuries. In addition, dental fractures and a cerebrospinal fluid (CSF) leak should be looked for.

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CSF leaks indicate a more severe injury possibly involving an ethmoid bone fracture.

The physician may also ask for photographs taken prior to the injury in order to determine the extent of deformity. Photographs may also be taken to document the injury in regards to possible legal actions.

In order to diagnose trauma sustained by a chemical injury, a history of exposure to potentially toxic chemicals should be ascertained. In addition, the patient should also bring information related to the types of chemicals that he or she has been exposed to. If injury occurs in the workplace, Material Safety Data Sheets should be available in the employer's poison control center that list the chemical components of commercial materials. Measurements of air from the patient's work area may also be obtained. Symptomatic improvement on off-days followed by a subsequent return of symptoms when returning to work confirms that the illness is work related. The physician should perform an intranasal examination to determine the extent of the chemical injury. A **chest x-ray** as well as a pulmonary function test may be ordered to determine if there is any subsequent lower respiratory tract involvement.

Treatment

Timing

Nasal injuries should be treated as promptly as possible to prevent complications. Batteries placed in the nose should be removed within four hours to prevent burns and other damage to the tissues from leaking chemicals. If a septal hematoma has developed, the doctor must remove it as quickly as possible to prevent infection or eventual death of the tissues in the nasal septum. Lastly, if the child has been bitten by an animal, the injury must be cleansed as soon as possible to lower the risk of **rabies**.

Treatment of nasal fractures is best performed during the first three hours after the injury. If this is impossible, management of a nasal fracture should be done within three to seven days. Timing is of utmost importance when treating nasal fractures because delays longer than seven to 10 days may allow the broken bones to set without proper alignment, or lead to such complications as scar tissue formation and airway obstruction. Poorly set nasal fractures usually require surgical correction.

Specific procedures

Foreign objects in the nose can be removed by nasal suction in most cases. Most nosebleeds are treated by 5–30 minutes of direct pressure on the nostrils, with the patient's head placed in an upright position. The doctor may also pack the nose with gauze coated with petroleum jelly. If the bleeding does not stop, or if it appears to originate in the upper nose, the doctor will consult a head and neck surgeon or an otolaryngologist for specialized evaluation of the bleeding.

Air gun or BB pellets that have penetrated the nose or nearby sinuses are generally removed with the help of an endoscope, which is a slender tubular instrument that allows the doctor to examine the inside of a body cavity.

Treatment of nasal fractures depends on the extent of the injury; the most difficult fractures to treat are those that involve the nasal septum. The doctor will usually reduce the fracture, which means that he or she will restore the damaged bones to their proper position and alignment. Although **local anesthesia** is usually sufficient for treating nasal fractures in adults and older teenagers, **general anesthesia** is usually given when treating these injuries in younger children.

Reductions of nasal fractures may be either open or closed. A closed reduction involves manipulation of the bones without cutting into the overlying skin. This type of reduction will be performed for fractures of the nasal bones that are limited in size and complexity. Open reductions are performed for more complex nasal fractures. In an open reduction, the nasal bones are moved back to their original location after the surgeon has made an incision in the overlying skin. This procedure is done for fractures involving dislocation of the septum as well as the nasal bones. In addition, an open reduction is necessary if the child has a septal hematoma or an open fracture in which the skin has been perforated. If a septal hematoma is present, the doctor will drain it and pack the nose to prevent subsequent accumulation of blood. The nasal bones are held in the proper position with external splints as well as the internal packing, and the splints are kept in place for seven to 10 days. The patient will be given **antibiotics** to lower the risk of infection and may be referred to an otolaryngologist or plastic surgeon for further evaluation. Ice packs or cold compresses can be applied at home to lower swelling and ease discomfort.

In the case of animal bites, the patient may be given passive or active immunization against rabies if there is a chance that the dog or other animal is rabid. This precaution is particularly important for animal bites on the nose or other parts of the face, as the

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KEY TERMS

Crepitus—A crackling or crunching sound heard when the ends of a fractured piece of bone rub against each other.

Diplopia—The medical term for seeing double.

Ecchymosis (plural, ecchymoses)—The medical term for a bruise. Ecchymoses may develop around the eyes following a nasal fracture.

Epistaxis—The medical term for a nosebleed.

Hematoma—A localized collection of blood that accumulates in an organ, tissue, or body space as the result of leakage from a broken blood vessel. Hematomas sometimes develop within the nasal cartilage when the nose is fractured.

Iatrogenic—Referring to injuries caused by a doctor. Nasal trauma may occasionally result from a doctor's examination of the nose or complications from plastic surgery.

Otolaryngologist—A doctor who specializes in diagnosing and treating disorders of the ears, nose, and throat.

Reduce—To restore a part of the body to its normal position or place, as in treating a fracture or dislocation. The repositioning of the bone or body part is called a reduction.

Rhinitis—An inflammation of the mucous membranes that line the nasal passages.

Rhinoplasty—Plastic surgery of the nose to repair or change the shape of the nose.

Septal hematoma—A mass of extravasated blood that is confined within the nasal septum.

Septum—The partition of bone and cartilage in the nose that separates the two nostrils.

incubation period of the rabies virus is much shorter for bites on the head and neck than for bites elsewhere on the body.

Complications can arise following treatment and therefore follow-up is necessary. Problems that may occur resemble symptoms of nasal fractures. Others include infection, CSF leakage, scar tissue build-up, and a saddle nose deformity where the bridge of the nose is markedly depressed.

Treatment for trauma caused by irritant inhalation involves removing the patient from the contaminated area or decreasing exposure time. Other measures include using a saline nasal spray or topical **steroids**. For acute injuries oxygen or supportive treatment for any subsequent lower respiratory tract involvement may be administered.

If the injury is occupation-related, changes should be made in order to eliminate future incidents. These changes may include having the patient wear a respiratory protection device while working. In addition, the employer should be made aware of the situation and employ measures to prevent future incidents.

Prognosis

Most types of nasal trauma have a good prognosis. Nosebleeds or tissue damage caused by scratching or picking at the nose usually clear completely once these habits are stopped. Infections or allergic reactions caused by foreign objects in the nose or piercing usually clear up promptly after the object or piece of jewelry is removed. Nasal fractures that do not involve the nasal septum or other facial bones and receive prompt treatment generally heal without deformities of the nose, cartilage destruction, or other complications. More extensive facial fractures, however, may require a second operation to correct the positioning of the bones and restore the appearance of the nose.

The prognosis for soft-tissue injuries to the nose depends on the cause and extent of the injuries. Such tearing or crushing injuries as those caused by bites take longer to heal than simple cuts, and may require plastic surgery at a later date to restore the appearance of the nose.

Damage to the tissues lining the nose caused by exposure to tobacco smoke or other irritants in the environment is usually reversible once the patient is removed from contact with the irritating substance. Erosion or destruction of the nasal cartilage as a result of inhalant or cocaine abuse, however, usually requires surgical treatment.

Prevention

Although most cases of nasal trauma happen inadvertently, some measures can be employed in order to prevent injury. Patients should be aware of the symptoms of nasal fracture and should seek medical attention as

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soon as possible to prevent more invasive reductions. Protective equipment should also be worn when playing sports. Employees should also be aware of irritating chemicals in their workplace and appropriate measures should be taken to avoid exposure.

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American Academy of Family Physicians (AAFP), 11400 Tomahawk Creek Parkway, Leawood, KS, 66211-2680, (913) 906-6000, (913) 906-6075, (800) 271-2237, http://www.aafp.org/.

American Academy of Otolaryngology—Head and Neck Surgery, 1650 Diagonal Road, Alexandria, VA, 22314-2857, (703) 836-4444, http://www.entnet.org.

American College of Sports Medicine (ACSM), 401 West Michigan Street, P.O. Box 1440, Indianapolis, IN, 46202-3233, (317) 637-9200, (317) 634-7817, http://www.acsm.org.

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Nasogastric suction

Definition

Nasogastric suction involves removing solids, liquids, or gasses from the stomach or small intestine by inserting a tube through the nose and suctioning the gastrointestinal material through the tube.

Purpose

Nasogastric suction may be done in the following situations:

- to decompress the stomach or small intestine when intestinal obstruction (ileus) is suspected
- prior to gastrointestinal operations
- to obtain a sample of the gastric contents for analysis
- to remove toxic substances
- to flush the stomach during gastrointestinal bleeding or poisonings

Nasogastric intubation, the insertion of a tube through the nose into the stomach or small intestine, is also done to temporarily feed certain patients. In this case, material is not suctioned out.

Precautions

Nasogastric tubes cannot be placed in patients who have blockages in their esophagus, enlarged esophageal veins or arteries that might bleed, or severe damage to the jaws and face. The tube cannot be inserted in a patient who is having convulsions, or who is losing or has lost consciousness unless a tube has been inserted into his or her airway (intubation).

Description

The patient sits upright while a lubricated tube is slipped through the nose and down the throat. The patient may be asked to sip water at a certain point in the procedure to facilitate the passage of the tube. If the tube is to be placed into the small intestine, the doctor may use an endoscope to help see where the tube is going. Once the tube is in place, material can be removed from the stomach or intestines with gentle suction.

There are several different types of nasogastric tubes, each with a different purpose. Tubes used for **stomach flushing** are called orogastric tubes and are the largest in diameter. Tubes that are threaded through the lower opening of the stomach (pylorus) and into the small intestine are stiffer and have a

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KEY TERMS

Endoscope—A piece of equipment with a camera and a light source in a thin tube that can be threaded through the nose into the gastrointestinal system so that the doctor can make a real-time visual examination.

Pylorus—The ring of muscle that controls the passage of material from the stomach into the small intestine.

balloon tip. Other specialized tubes are used for long-term and short-term feeding.

Preparation

Little preparation is necessary for this procedure other than educating the patient as to what will happen. The patient should remove dental appliances before the nasogastric tube is inserted.

Aftercare

After the tube is removed, no special care is needed. The patient's throat may feel irritated from the presence of the tube.

Risks

The most serious risk is that the patient will inhale some of the stomach contents into the lungs (aspiration). This may lead to bronchial infections and aspiration **pneumonia**. There is also the chance that the tube will be misplaced in the windpipe (trachea), causing violent coughing. Irritation to the throat and esophagus can cause bleeding.

Normal results

Nasogastric suctioning is normally well tolerated by patients and is a temporary treatment, performed in conjunction with other therapies.

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Tish Davidson, A.M.

Nasopharyngeal culture

Definition

A nasopharyngeal culture is used to identify pathogenic (disease-causing) organisms present in the nasal cavity that may cause upper respiratory tract symptoms.

Purpose

Some organisms that cause upper respiratory infections are carried primarily in the nasopharynx, or back of the nose. The person carrying these pathogenic bacteria may have no symptoms, but can still infect others with the pathogen and resulting illness. The most serious of these organisms is *Neisseriea meningitidis*, which causes **meningitis** or blood stream infection in infants. By culturing a sample from the nasopharynx, the physician can identify this organism, and others, in the asymptomatic carrier. The procedure can also be used as a substitute for a **throat culture** in infants, the elderly patient, the debilitated patient, or in cases where a throat culture is difficult to obtain.

Precautions

The technician taking the specimen should wear gloves to prevent spreading infectious organisms. The patient should not be taking **antibiotics**, as these drugs may influence the test results.

Description

The patient should **cough** before collection of the specimen. Then, as the patient tilts his or her head backwards, the caregiver will inspect the back of the throat using a penlight and tongue depressor. A swab on a flexible wire is inserted into the nostril, back to the nasal cavity and upper part of the throat. The swab is rotated quickly and then removed. Next, the swab is placed into a sterile tube with culture fluid in it for transport to the microbiology laboratory. To prevent contamination, the swab should not touch the patient's tongue or side of the nostrils.

When the sample reaches the laboratory, the swab will be spread onto an agar plate and the agar plate incubated for 24–48 hours, to allow organisms present to grow. These organisms will be identified and any pathogenic organisms may also be tested for susceptibility to specific antibiotics. This allows the treating physician to determine which antibiotics will be effective.

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Alternative procedures

In most cases of upper respiratory tract infections, a throat culture is more appropriate than a nasopharyngeal culture. However, the nasopharyngeal culture should be used in cases where throat cultures are difficult to obtain or to detect the carrier states of *Harmophilus influenzae* and meningococcal disease.

Some researchers regard the immunoblot method as preferable to a standard culture to detect certain species of pneumococci and other organisms that cause **pneumonia**. The immunoblot method uses a membrane that changes color in response to a specific antigen-antibody reaction.

As of the early 2000s, polymerase chain reaction (PCR) analysis is considered more sensitive than standard culture in detecting *Bordetella pertussis*, the bacterium that causes **whooping cough**. PCR has the additional advantage of providing test results more rapidly than culture.

Preparation

The procedure of inserting the swab should be described to the patient, as there is a slight discomfort associated with taking the sample. Other than that, no special preparation is necessary.

Aftercare

None

Risks

There is little to no risk involved in a nasopharyngeal culture.

Normal results

Bacteria that normally grow in the nose cavity will be identified by a nasopharyngeal culture. These include nonhemolytic streptococci, alpha-hemolytic streptococci, some *Neisseria* species, and some types of staphylococci.

Abnormal results

Pathogenic organisms that might be identified by this culture include

- Group A beta-hemolytic streptococci
- *Bordetella pertussis*, the causative agent of whooping cough

KEY TERMS

Antibiotic—A drug given to stop the growth of bacteria. Antibiotics are ineffective against viruses.

Nasopharynx—The back wall of the nasal cavity where it meets the throat.

- *Corynebacterium diptheriae*, the causative agent of diptheria
- *Staphylococcus aureus*, the causative agent of many staphylococcal infections

Additional bacteria are abnormal if they are found in large amounts. These include

- *Haemophilus influenzae*, a causative agent for certain types of meningitis and chronic pulmonary disease
- *Streptococcus pneumoniae*, a causative agent of pneumonia
- *Candida albicans*, the causative agent of thrush

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American Medical Association, 515 N. State St., Chicago, IL, 60654, (800) 621-8335, http://www.ama-assn.org/.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

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Native American health *see* **Minority health**

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Naturopathic medicine

Definition

Naturopathic medicine is a branch of medicine in which a variety of natural medicines and treatments are used to heal illness. It uses a system of medical diagnosis and therapeutics based on the patterns of chaos and organization in nature. It is founded on the premise that people are naturally healthy, and that healing can occur through removing obstacles to a cure and by stimulating the body's natural healing abilities. The foundations of health in natural medicine are diet, **nutrition**, homeopathy, physical manipulation, **stress** management, and **exercise**.

Naturopaths are general practitioners who treat a wide variety of illnesses. They believe in treating the "whole person"—the spirit as well as the physical body—and emphasize preventive care. They often recommend changes in diet and lifestyle to enhance the health of their patients.

Purpose

Naturopathic medicine is useful for treating chronic as well as acute diseases. It is sometimes used in conjunction with allopathic care to enhance wellness and relieve chronic symptoms, such as **fatigue** and **pain**. A naturopath treats a wide range of health problems, ranging from back pain to depression.

A naturopathic physician will spend extra time interviewing and examining the patient to find the underlying cause for a medical problem. Emotional and spiritual symptoms and patterns are included in the assessment. The naturopath often spends more time educating patients in preventive health, lifestyle, and nutrition than most MDs.

Description

Origins

People have always seen a connection to diet and disease, and many therapies are built around special **diets**. Naturopathy began in the 18th and 19th centuries, as the industrial revolution brought about unhealthy lifestyles, and the European custom of "taking the cure" at natural spas became popular. Benedict Lust, who believed deeply in natural medicine, organized naturopathy as a formal system of healthcare in the 1890s. By the early 1900s, it was flourishing.

The first naturopaths in the United States emphasized the healing properties of a nutritious diet, as did a number of their contemporaries. In the early 20th century, for instance, John Kellogg, a physician and vegetarian, opened a sanitarium that used healing methods such as **hydrotherapy**, often prescribed by today's naturopaths. His brother Will produced health foods, such as corn flakes and shredded wheat. The Kellogg brothers helped make naturopathic ideas popular and emphasized the value of whole grains over highly refined ones. They and one of their employees, C.W. Post, eventually went on to start the cereal companies that bear their names.

In the early 1900s, most states licensed naturopaths as physicians. There were 20 medical schools of naturopathic medicine. From early on, naturopathic physicians were considered "eclectic," since they drew on a variety of natural therapies and traditions for treating their patients.

In the 1930s, naturopathy dramatically declined for several reasons. Allopathic medicine finally stopped using therapies such as bloodletting and **heavy metal poisoning** as curatives. New therapies were more effective and less toxic. Allopathic medical schools became increasingly well-funded by foundations with links to the emerging drug industry. Also, allopathic physicians became much more organized and wielded political clout. Naturopathy has experienced a resurgence over the last 20 years, however. The lay public is aware of the connection between a healthy diet and lifestyle and avoiding chronic disease. In addition, conventional medicine is often unable to treat these chronic diseases. Patients are now health care consumers, and will seek their own resolution to health problems that cannot be resolved by conventional physicians. As a result, even medical groups which once considered naturopathy ineffective are now beginning to accept it.

Naturopathic medicine modalities include a variety of healing treatments, such as diet and clinical nutrition, homeopathy, botanical medicine, soft tissue and spinal manipulation, ultrasound, and therapeutic exercise. A naturopath provides complete diagnostic and treatment services in sciences such as obstetrics, pediatrics and obstetrics. Some are also licensed midwives.

Naturopaths consider health to be not just the absence of disease, but complete physical, mental and social well being. Naturopathic physicians often say that diseases must be healed not just by suppressing symptoms, but by rooting out the true cause. Symptoms are actually viewed as the body's natural efforts to heal itself and restore balance.

A typical office visit to a naturopath takes an hour. During the first visit, the doctor will ask detailed questions about the patient's symptoms, lifestyle, history of illness, and state of his or her emotions. The

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naturopath will take a complete medical history, and may order lab tests such as urine and blood tests. A naturopath may talk with the patient about the possible causes for an illness: poor diet, life stresses, occupational dangers, and mental, emotional, and spiritual problems. Naturopaths believe that even widely varying symptoms can sometimes be traced to one underlying cause. Often environmental or metabolic toxins or serious stress bring on an illness.

In some states, naturopaths prescribe pharmaceuticals. In these cases, naturopaths might prescribe natural medicines, such as natural hormones, glandular **thyroid hormones**, herbal extracts, **vitamins**, etc.

As with most doctors, treatment by a naturopath can range from one office visit to many. Some acute illnesses can be alleviated with one or two visits. Other chronic diseases need regular weekly or monthly attention. Clinical care provided by naturopathic physicians are covered by insurance in a number of states in the United States.

Preparations

There are about 1,500 naturopathic physicians in the United States practicing; nearly 80% of these practitioners entered the profession following the revival of interest in naturopathy in the late 1970s. Consumers can find naturopaths by contacting the American Association of Naturopathic Physicians (AANP) or logging on to their web site. Naturopaths recommended by the AANP have met requirements for state licensure and have taken a national exam that qualifies them to practice. Qualified naturopaths can also be found through the local branch of the national or state association of naturopathic physicians. It is sometimes useful to request names from another health care provider who knows naturopathic practitioners in the community.

Some states license naturopathic physicians. As of late 2010, those states included Hawaii, Alaska, Washington, Oregon, Utah, Montana, Arizona, Connecticut, New Hampshire, Vermont, Maine, California, Idaho, Minnesota, and Kansas, in addition to the territories of Puerto Rico and the Virgin Islands. Training via a correspondence school does not qualify a naturopath for licensure or to take the national qualifying examination.

Precautions

A good naturopath is always willing to work with the patient's other physicians or health care providers. To avoid **drug interactions** and to coordinate care, it is important for a patient to inform his or her allopathic doctor about supplements prescribed by a naturopath.

Many naturopaths give childhood vaccinations, but some do not. If a parent is concerned about this, it is best to go to an allopathic doctor for vaccinations.

Naturopaths are not licensed to perform major surgery, or prescribe **narcotics** and **antidepressant drugs**. They must involve an oncologist when treating a **cancer** patient.

Side effects

Although naturopathic remedies are from natural sources and typically pose much less risk than traditional drugs do, some do have side effects. One problem they can pose is the interaction with prescription medicines. It is important for a patient to inform his or her allopathic physician about any natural remedies or herbs prescribed by a naturopath.

It is also important to note that the U.S. Food and Drug Administration considers medicinal herbs as dietary supplements, not drugs, and so are not subject to the same regulations as drugs are. Because they come from natural sources, the active ingredients may not always be in the same concentration from bottle to bottle, since plants naturally vary. To guard against using too little or too much of a natural remedy, use herbs and supplements recommended by a naturopath or those produced by well-respected companies.

Research and general acceptance

Medical research in naturopathy has increased dramatically in the United States within the last 10 years. Naturopathic research often employs case histories, summaries of practitioners' clinical observations, and medical records. Some U.S. studies have also met today's scientific gold standard; they were double-blind and placebo-controlled. Much naturopathic research has also been done in Germany, France, England, India, and China.

Some mainstream medical practitioners remain distrustful of naturopathy, however. Such problems as health-food store employees without naturopathic credentials giving health-related advice to customers, or occasional rare cases of infections caused by naturopathic injections, continue to damage the reputation of this form of alternative medicine.

Research in naturopathy tends to focus on single treatments used by naturopaths, rather than naturopathy as a whole. In 1998, an extensive review of such single treatment studies found that naturopathic healing methods were effective for 15 different medical conditions, including **osteoarthritis**, **asthma**, and

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KEY TERMS

Clinical nutrition—The use of diet and nutritional supplements as a way to enhance health prevent disease.

Cryotherapy—The exposure of body tissue to extremely cold temperatures, often by applying a probe containing liquid nitrogen.

Herb—In naturopathy, a plant or plant derivative or extract prescribed for health or healing.

Homeopathy—The use of diluted remedies that have energetic rather than chemical properties. They are prescribed according to the axiom that "like cures like."

Hydrotherapy—The use of water as baths, poultices, and steams to heal.

Physical manipulation—The use of deep massage, spinal alignment, and joint manipulation to stimulate tissues.

Ultrasound—A therapy employing high frequency sound waves.

middle ear infections. A study of 8,341 men with damaged heart muscles in 1996 revealed that supplementation with niacin, a B vitamin, was associated with an 11% reduced risk of mortality over 15 years. In 1996, a study showed **St. John's wort** was as effective as prescription antidepressants in relieving depression, and had fewer side effects.

Studies have also demonstrated benefits in the arena of **women's health** issues. In one classic 1993 study, women with cervical dysplasia or abnormal Pap smears were treated by naturopaths with topical applications of herbs and dietary supplements. These medications included Bromelian, an enzyme from the pineapple; bloodroot; marigold; and zinc chloride; and suppositories made from herbal and nutritional ingredients, such as **echinacea**, vitamin A, and vitamin E. Thirty eight of the 43 women in the study had normal Pap smears and normal tissue biopsies after treatment. The study concluded that these protocols might benefit the health of patients undergoing more traditional treatments for cervical dysplasia, such as **cryotherapy**.

Other more recent research has documented the benefits of such nutritional foods as soy in relieving hot flashes and vaginal dryness. **Nutritional supplements** prescribed by naturopaths to enhance women's health during **menopause** have also proven effective; in general, naturopathy appears to be as useful as conventional medicine for treating menopausal symptoms. Research shows vitamin E supplements are helpful for 50% of postmenopausal women with thinning vaginal tissue. Studies also reveal that bioflavonoids with vitamin C and gamma-oryzanol, a substance taken from rice bran oil, can relieve hot flashes.

Another area of women's health concerns that naturopathy has taken seriously is a growing preference for skin care and beauty products derived from natural sources rather than from chemical laboratories. Such products are often more beneficial to the skin and less likely to cause **rashes** or other allergic reactions.

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American Association of Naturopathic Physicians, 4435 Wisconsin Ave., NW, Suite 403, Washington, DC, 20016, (202) 237-8150, (202) 237-8152, (866) 538-2267, member.services@naturopathic.org, http://naturopathic.org/.

Canadian Association of Naturopathic Doctors, 20 Holly St., Ste. 200, Toronto, Ontario, Canada M4S 3B1, (416) 496-8633, (416) 496-8634, (800) 551-4381, http://www.cand.ca.

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Naturopathy *see* **Naturopathic medicine**

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Nausea and vomiting

Definition

Nausea is the sensation of being about to vomit. **Vomiting**, or emesis, is the expelling of undigested food through the mouth.

Description

Nausea is a reaction to a number of causes that include overeating, infection, or irritation of the throat or stomach lining. Persistent or recurrent nausea and vomiting should be checked by a doctor.

A doctor should be called if nausea and vomiting occur:

- after eating rich or spoiled food or taking a new medication
- repeatedly or for 48 hours or longer
- following intense dizziness

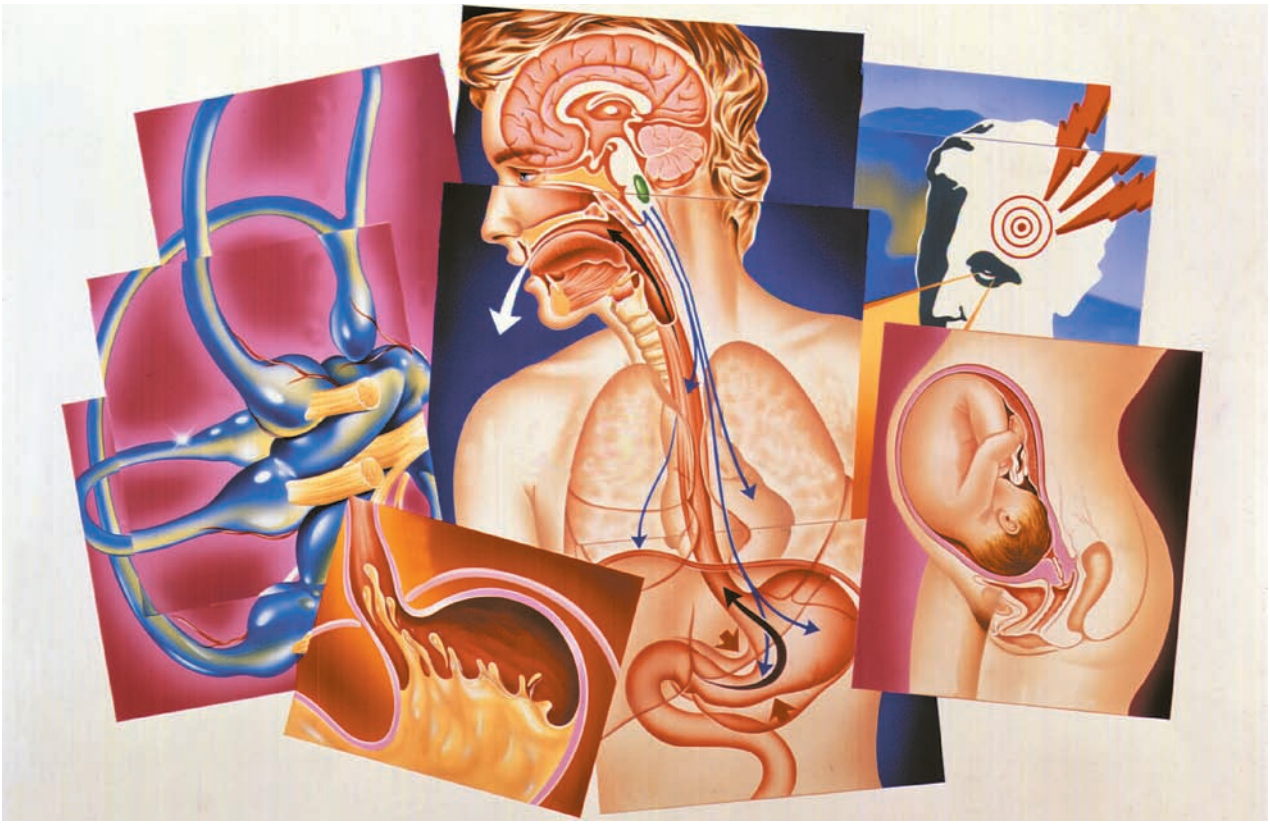
It is important to see a doctor if nausea and vomiting are accompanied by:

- yellowing of the skin and whites of the eyes
- pain in the chest or lower abdomen
- trouble with swallowing or urination
- dehydration or extreme thirst
- drowsiness or confusion
- constant, severe abdominal pain
- a fruity breath odor

A doctor should be notified if vomiting is heavy and/or bloody, if the vomitus looks like feces, or if the patient has been unable to keep food down for 24 hours.

An ambulance or emergency response number should be called immediately if:

- Diabetic shock is suspected.
- Nausea and vomiting continue after other symptoms of viral infection have subsided.



These illustrations depict the mechanism and causes of vomiting in the human body. An impulse from the brain stimulates the vomiting center (top center) in the brain stem. Nerve impulses sent to the stomach, diaphragm, and abdominal wall (bottom center) result in stomach's contents being expelled. Other causes of vomiting include raised pressure in the skull due to injury or tumor (upper right), and hormonal changes during pregnancy. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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- The patient has a severe headache.
- The patient is sweating and having chest pain and trouble breathing.
- The patient is known or suspected to have swallowed a drug overdose or poisonous substance.
- The patient has a high body temperature, muscle cramps, and other signs of heat exhaustion or heat stroke.
- Nausea, vomiting, and breathing problems occur after exposure to a known allergen.

Causes and symptoms

Persistent, unexplained, or recurring nausea and vomiting can be symptoms of a variety of serious illnesses. It can be caused by simply overeating or drinking too much alcohol. It can be due to **stress**, certain medications, or illness. For example, people who are given morphine or other opioid medications for **pain** relief after surgery sometimes feel nauseated by the drug. Such poisonous substances as arsenic and other heavy metals cause nausea and vomiting. Morning sickness is a consequence of pregnancy-related hormone changes. **Motion sickness** can be induced by traveling in a vehicle, plane, or on a boat. Many patients experience nausea after eating spoiled food or foods to which they are allergic. Patients who suffer **migraine headache** often experience nausea. **Cancer** patients on **chemotherapy** are nauseated. **Gallstones**, **gastroenteritis** and stomach ulcer may cause nausea and vomiting. These symptoms should be evaluated by a physician.

Nausea and vomiting may also be psychological in origin. Some people vomit under such conditions of emotional stress as family arguments, academic tests, airplane travel, losing a job, and similar high-stress situations. In addition, some **eating disorders** are characterized by self-induced vomiting.

Diagnosis

Diagnosis is based on the severity, frequency, and duration of symptoms, and other factors that could indicate the presence of a serious illness.

Diagnosis is based on the taking of a careful patient history. In some cases, the doctor may order laboratory tests or imaging studies to determine the presence of drugs or poisonous substances in the patient's blood or urine, or evidence of head injuries or abnormalities in the digestive tract. If the nausea and vomiting appear to be related to **anxiety**, stress, or an eating disorder, the doctor may refer the patient to a psychiatrist for further evaluation.

Treatment

Getting a breath of fresh air or getting away from whatever is causing the nausea can solve the problem. Eating olives or crackers or sucking on a lemon can calm the stomach by absorbing acid and excess fluid. Coke syrup is another proven remedy.

Vomiting relieves nausea right away but can cause **dehydration**. Sipping clear juices, weak tea, and some sports drinks help replace lost fluid and **minerals** without irritating the stomach. Food should be reintroduced gradually, beginning with small amounts of dry, bland food like crackers and toast.

Medications that are given to relieve nausea and vomiting are called antiemetics. Meclizine (Bonine), a medication for motion sickness, also diminishes the feeling of queasiness in the stomach. Dimenhydrinate (Dramamine), another motion-sickness drug, is not effective on other types of nausea and may cause drowsiness.

Newer drugs that have been developed to treat postoperative or postchemotherapy nausea and vomiting include ondansetron (Zofran) and granisetron (Kytril). Another treatment that has been found to lower the risk of nausea after surgery is intravenous administration of supplemental fluid before the operation.

Alternative treatment

Advocates of alternative treatments suggest **biofeedback**, **acupressure** and the use of herbs to calm the stomach. Biofeedback uses **exercise** and deep relaxation to control nausea. Acupressure (applying pressure to specific areas of the body) can be applied by wearing a special wristband or by applying firm pressure to:

- the back of the jawbone
- the webbing between the thumb and index finger
- the top of the foot
- the inside of the wrist
- the base of the rib cage

Acupuncture is another alternative treatment found to be effective in relieving nausea. A few people, however, experience nausea as a side effect of acupuncture.

Chamomile (*Matricaria recutita*) or lemon balm (*Melissa officinalis*) tea may relieve symptoms. Ginger (*Zingiber officinale*), another natural remedy, can be drunk as tea or taken as candy or powered capsules.

Prevention

Massage, **meditation**, **yoga**, and other relaxation techniques can help prevent stress-induced nausea.

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KEY TERMS

Acupuncture—A treatment technique associated with traditional Chinese medicine, in which thin needles are inserted into specific points located along energy channels in the human body known as meridians.

Antiemetic—A preparation or medication that relieves nausea and vomiting. Coke syrup, ginger, and motion sickness medications are examples of antiemetics.

Dehydration—Loss of fluid and minerals following vomiting, prolonged diarrhea, or excessive sweating.

Diabetic coma—Reduced level of consciousness that requires immediate medical attention.

Emesis—The medical term for vomiting.

Anti-nausea medication taken before traveling can prevent motion sickness. Sitting in the front seat, focusing on the horizon, and traveling after dark can also minimize symptoms.

Food should be fresh, properly prepared, and eaten slowly. Overeating, tight-fitting clothes, and strenuous activity immediately after a meal should be avoided.

Vomiting related to emotional upsets may be avoided by forms of **psychotherapy** that teach patients to manage stress in healthier ways.

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Nberg disease *see* **Osteopetroses**

NCV *see* **Electromyography**

Near-drowning

Definition

Near-drowning is the term for survival after suffocation caused by submersion in water or another fluid. Some experts exclude from this definition cases of temporary survival that end in **death** within 24 hours, which they prefer to classify as drownings.

Demographics

An estimated 15,000–70,000 near-drownings occur in the United States each year (insufficient reporting prevents a better estimate). The typical victim is young and male. Nearly half of all

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drownings and near-drownings involve children less than four years old. Home swimming pools pose the greatest risk for children, being the site of 60–90% of drownings in the 0–4 age group. Teenage boys also face a heightened risk of drowning and near-drowning, largely because of their tendency to behave recklessly, and to use drugs and alcohol (drugs and alcohol are implicated in 40–50% of teenage drownings). Males, however, predominate even in the earliest age-groups, possibly because young boys are often granted more freedom from supervision than young girls enjoy, making it more likely that they will stumble into danger and less likely that they will attract an adult's attention in time for a quick rescue. Roughly four out of five drowning victims are males.

Description

Drowning remains a significant public health concern, as it is a major cause of disability and death. Drowning has been previously defined as death secondary to asphyxia while immersed in a liquid, usually water, or within 24 hours of submersion. Near-drowning occurs when the victim survives.

Causes and symptoms

The circumstances leading to near-drownings (and drownings also) cannot be reduced to a single scenario involving nonswimmers accidentally entering deep water. On many occasions, near-drownings are secondary to an event such as a **heart attack** that causes unconsciousness or a head or spinal injury that prevents a diver from resurfacing. Near-drownings, moreover, can occur in shallow as well as deep water. Small children have drowned or almost drowned in bathtubs, toilets, industrial-size cleaning buckets, and washing machines. Bathtubs are especially dangerous for infants six months to one year old, who can sit up straight in a bathtub but may lack the ability to pull themselves out of the water if they slip under the surface.

A reduced concentration of oxygen in the blood (hypoxemia) is common to all near-drownings. Human life, of course, depends on a constant supply of oxygen-laden air reaching the blood by way of the lungs. When drowning begins, the larynx (an air passage) closes involuntarily, preventing both air and water from entering the lungs. In 10–15% of cases, hypoxemia results because the larynx stays closed. This is called "dry drowning." Hypoxemia also occurs in "wet drowning," the 85–90% of cases where the larynx relaxes and water enters the lungs. The physiological mechanisms that produce hypoxemia in wet drowning are different for freshwater and saltwater, but only a small amount of either kind of water is needed to damage the lungs and interfere with the body's oxygen intake. All of this happens very quickly: within three minutes of submersion most people are unconscious, and within five minutes the brain begins to suffer from lack of oxygen. Abnormal heart rhythms (cardiac dysrhythmias) often occur in near-drowning cases, and the heart may stop pumping (cardiac arrest). An increase in blood acidity (acidosis) is another consequence of near-drowning, and under some circumstances near-drowning can cause a substantial increase or decrease in the volume of circulating blood. Many victims experience a severe drop in body temperature (**hypothermia**).

The signs and symptoms of near-drowning can differ widely from person to person. Some victims are alert but agitated, while others are comatose. Breathing may have stopped, or the victim may be gasping for breath. Bluish skin (**cyanosis**), coughing, and frothy pink sputum (material expelled from the respiratory tract by coughing) are often observed. Rapid breathing (tachypnea), a rapid heart rate (tachycardia), and a low-grade **fever** are common during the first few hours after rescue. Conscious victims may appear confused, lethargic, or irritable.

Diagnosis

Diagnosis relies on a **physical examination** of the victim and on a wide range of tests and other procedures. Blood is taken to measure oxygen levels and for many other purposes. Pulse oximetry, another way of assessing oxygen levels, involves attaching a device called a pulse oximeter to the patient's finger. An electrocardiograph is used to monitor heart activity. X-rays can detect head and neck injuries and excess tissue fluid (**edema**) in the lungs.

Treatment

Treatment begins with removing the victim from the water and performing **cardiopulmonary resuscitation** (CPR). One purpose of CPR—which, of course, should be attempted only by people trained in its use—is to bring oxygen to the lungs, heart, brain, and other organs by breathing into the victim's mouth. When the victim's heart has stopped, CPR also attempts to get the heart pumping again by pressing down on the victim's chest. After CPR has been performed and emergency medical help has arrived on the scene, oxygen is administered to the victim. If the victim's breathing has stopped or is otherwise impaired, a tube is inserted into the windpipe (trachea) to maintain the

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airway (this is called endotracheal intubation). The victim is also checked for head, neck, and other injuries, and fluids are given intravenously. Hypothermia cases require careful handling to protect the heart.

In the emergency department, victims continue receiving oxygen until blood tests show a return to normal. About one-third are intubated and initially need mechanical support to breathe. Rewarming is undertaken when hypothermia is present. Victims may arrive needing treatment for cardiac arrest or cardiac dysrhythmias. Comatose patients present a special problem: although various treatment approaches have been tried, none have proved beneficial. Patients can be discharged from the emergency department after four to six hours if their blood oxygen level is normal and no signs or symptoms of near-drowning are present. But because lung problems can arise 12 or more hours after submersion, the medical staff must first be satisfied that the patients are willing and able to seek further medical help if necessary. Admission to a hospital for at least 24 hours for further observation and treatment is a must for patients who do not appear to recover fully in the emergency department.

Prognosis

Neurological damage is the major long-term concern in the treatment of near-drowning victims. Patients who arrive at an emergency department awake and alert usually survive with brain function intact, as do about 90% of those who arrive mentally impaired (lethargic, confused, and so forth) but not comatose. Death or permanent neurological damage is very likely when patients arrive comatose. Early rescue of near-drowning victims (within five minutes of submersion) and prompt CPR (within less than 10 minutes of submersion) seem to be the best guarantees of a complete recovery. An analysis of 715 patients admitted to emergency departments in 1971–81 revealed that 69% recovered completely, 25% died, and 6% survived but suffered permanent neurological damage.

Prevention

Prevention depends on educating parents, other adults, and teenagers about water safety. Parents must realize that young children who are left in or near water without adult supervision even for a short time can easily get into trouble, not just at the beach or next to a swimming pool, but in bathtubs and around toilets, buckets, washing machines, and other household articles where water can collect. Research on swimming pool drownings involving young children shows that the victims have usually been left unattended less than five minutes before the accident. Experts consider putting up a fence around a home swimming pool an essential precaution, and estimate that 50–90% of child drownings and near-drownings could be prevented if fences were widely adopted. The fence should be at least five feet high and unclimbable, have a self-closing and self-locking gate, and completely surround the pool.

Pool owners—and, indeed, all other adults—should consider learning CPR. Everyone, of course, should follow the rules for safe swimming and boating. Those who have a medical condition that can cause a seizure or otherwise threaten safety in the water are advised always to swim with a partner. And of course, people need to be aware that alcohol and drug use substantially increase the chances of an accident.

The danger of alcohol and drug use around water is a point that requires special emphasis where teenagers are concerned. Teenagers can also benefit from CPR training and safe swimming and boating classes.

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Nearsightedness *see* **Myopia**

Necrotizing enterocolitis

Definition

Necrotizing enterocolitis is a serious bacterial infection in the intestine, primarily of sick or premature newborn infants. It can cause the **death** (necrosis) of intestinal tissue and progress to blood poisoning (septicemia).

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KEY TERMS

Enteral nutrition—Liquid nutrition provided through tubes that enter the gastrointestinal tract, usually through the mouth or nose.

Necrosis—The death of cells, a portion of tissue, or a portion of an organ due to permanent damage of some sort, such as a lack of oxygen supply to the tissues.

Parenteral nutrition—Liquid nutrition provided through tubes that are placed in the veins.

Sepsis—The presence of pus–forming or other disease–causing organisms in the blood or tissues. Septicemia, commonly known as blood poisoning, is a common type of sepsis.

Description

Necrotizing enterocolitis develops in approximately 10% of newborns weighing less than two pounds (800 grams). It is a serious infection that can produce complications in the intestine itself—such as ulcers, perforations (holes) in the intestinal wall, and tissue necrosis—as well as progress to life–threatening septicemia. Necrotizing enterocolitis most commonly affects the lower portion of the small intestine (ileum). It is less common in the colon and upper small bowel.

Causes and symptoms

The cause of necrotizing enterocolitis is not clear. It is believed that the infection usually develops after the bowel wall has already been weakened or damaged by a lack of oxygen, predisposing it to bacterial invasion. Bacteria proliferate in the bowel and cause a deep infection that can kill bowel tissue and spread to the bloodstream.

Necrotizing enterocolitis almost always occurs in the first month of life. Infants who require **tube feedings** may have an increased risk for the disorder. A number of other conditions also make newborns susceptible, including **respiratory distress syndrome**, congenital heart problems, and episodes of apnea (cessation of breathing). The primary risk factor, however, is **prematurity**. Not only is the immature digestive tract less able to protect itself, but premature infants are subjected to many stresses on the body in their attempt to survive.

Early symptoms of necrotizing enterocolitis include an intolerance to formula, distended and tender abdomen, **vomiting**, and blood (visible or not) in the stool. One of the earliest signs may also be the need for mechanical support of the infant's breathing. If the infection spreads to the bloodstream, infants may develop lethargy and fluctuations in body temperature, and may periodically stop breathing.

Diagnosis

The key to reducing the complications of this disease is early suspicion by the physician. A series of x-rays of the bowel often reveals the progressive condition, and blood tests confirm infection.

Treatment

Over two–thirds of infants can be treated without surgery. Aggressive medical therapy is begun as soon as the condition is diagnosed or even suspected. Tube feedings into the gastrointestinal tract (enteral **nutrition**) are discontinued, and tube feedings into the veins (parenteral nutrition) are used instead until the condition has resolved. Intravenous fluids are given for several weeks while the bowel heals.

Some infants are placed on a ventilator to help them breathe, and some receive transfusions of platelets, which help the blood clot when there is internal bleeding. **Antibiotics** are usually given intravenously for at least 10 days. These infants require frequent evaluations by the physician, who may order multiple abdominal x-rays and blood tests to monitor their condition during the illness.

Sometimes, necrotizing enterocolitis must be treated with surgery. This is often the case when an infant's condition does not improve with medical therapy or there are signs of worsening infection.

Surgical treatment depends on the individual patient's condition. Patients with infection that has caused serious damage to the bowel may have portions of the bowel removed. It is sometimes necessary to create a substitute bowel by making an opening (**ostomy**) into the abdomen through the skin, from which waste products are discharged temporarily. But many physicians avoiding this procedure and operate to remove diseased bowel and repair the defect at the same time.

Postoperative complications are common, including wound infections and lack of healing, persistent **sepsis** and bowel necrosis, and a serious internal

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bleeding disorder known as disseminated intravascular coagulation.

Prognosis

Necrotizing enterocolitis is the most common cause of death in newborns undergoing surgery. The average mortality is 30–40%, even higher in severe cases.

Early identification and treatment are critical to improving the outcome for these infants. Aggressive nonsurgical support and careful timing of surgical intervention have improved overall survival; however, this condition can be fatal in about one–third of cases. With the resolution of the infection, the bowel may begin functioning within weeks or months. But infants need to be carefully monitored by a physician for years because of possible future complications.

About 10–35% of all survivors eventually develop a stricture, or narrowing, of the intestine that occurs with healing. This stricture can create an intestinal obstruction that will require surgery. Infants may also be more susceptible to future bacterial infections in the gastrointestinal tract and to a delay in growth. Infants with severe cases may also suffer neurological impairment.

The most serious long-term gastrointestinal complication associated with necrotizing enterocolitis is short-bowel, or short-gut, syndrome. This term refers to a condition that can develop when a large amount of bowel must be removed, making the intestines less able to absorb certain nutrients and enzymes. These infants gradually evolve from tube feedings to oral feedings, and medications are used to control the malabsorption, **diarrhea**, and other consequences of this condition.

Prevention

In very small or sick premature infants, the risk for necrotizing enterocolitis may be diminished by beginning parenteral nutrition and delaying enteral feedings for several days to weeks.

Some authorities have suggested that breast milk provides substances that may be protective, but there is no evidence that this practice reduces the risk of infection. A large multicenter trial showed that steroid drugs given to women in preterm labor may protect their offspring from necrotizing enterocolitis.

Sometimes necrotizing enterocolitis occurs in clusters, or outbreaks, in hospital newborn (neonatal) units. Because there is an infectious element to the disorder, infants with necrotizing enterocolitis may be isolated to avoid infecting other infants. Persons caring for these infants must also employ strict measures to prevent spreading the infection.

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Necrotizing fasciitis *see* **Flesh-eating disease**

Neisseria gonorrheae infection *see* **Gonorrhea**

Neisseria meningitidis bacteremia *see* **Meningococcemia**

Nelfinavir *see* **Protease inhibitors**

Neonatal jaundice

Definition

Neonatal **jaundice** refers to the yellow discoloration of the skin and sclera (whites) of the eyes in newborns, which results as the breakdown of bilirubin goes faster than the rate at which it can leave the body, causing its level to rise in the blood.

Demographics

Neonatal jaundice is extremely common. In the United States, it is the most common condition needing medical care in newborns. The incidence of neonatal jaundice varies with location and ethnicity. It is highest in those of East Asian, American Indian, and Greek descent. The condition is more common in white than in black babies, and the rate is increased in infants of mothers at high altitudes. Preterm babies have a higher rate of neonatal jaundice than full-term babies.

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A newborn baby undergoes phototherapy with visible blue light to treat his jaundice. *(Ron Sutherland/SPL/ Photo Researchers, Inc.)*

Description

Neonatal jaundice and hyperbilirubinemia are terms used when a newborn has a higher-than-normal level of bilirubin in the blood. Bilirubin is an end product of the breakdown of the hemoglobin present in the red blood cells at the end of their life cycle. Hemoglobin carries oxygen to tissues and cells. Before birth the placenta is not as efficient in providing oxygen as the baby's lungs will be after birth. Because of this, infants *in utero* have more red blood cells than they will need after birth to provide enough oxygen. Therefore, newborns have an excess of red blood cells that they need to process and an immature liver with which to complete the job.

When the fetus is *in utero*, bilirubin is processed through the placenta and the maternal-fetal circulation. After birth, the infant's often-immature liver must take over this task. Clinical jaundice (serum bilirubin levels of 5–7 mg/dL and above) occurs in about 60-70% of term newborns and about 80% of premature infants. Ever since hospital stays after delivery decreased to 24–48 hours postpartum, hyperbilirubinemia has become the leading cause of hospital re-admissions in the first two weeks of life. The greatest concern with hyperbilirubinemia is that the unexcreted bilirubin will begin to deposit in the brain of the newborn, resulting in a serious, potentially life-threatening condition called kernicterus. Kernicterus occurs in about 1.5 of every 100,000 live births in the United States. Another term used for kernicterus is brain encephalopathy.

Causes and symptoms

An elevated bilirubin level may be due to its increased production, a decreased rate of conjugation, or abnormalities of the liver. In order for the bilirubin to be excreted in the urine and stool, it must be converted, or conjugated, from a fat- or lipid-soluble form to a water-soluble form. Bilirubin that has not been excreted can be reabsorbed and contributes to increased blood levels.

Initial symptoms of a rising bilirubin level can be subtle, and usually include increased drowsiness, which leads to poor feeding, and the subsequent decreased urine and stool output. The diaper may contain orange spots, an indication of the presence of uric acid crystals, a sign of **dehydration**. A change in the infant's cry to a high-pitched tone may indicate early neurological damage.

There are several types of jaundice. Jaundice that sets in within the first 24 hours after birth is usually due to an Rh factor or ABO blood incompatibility between the mother and infant.

The most common form of neonatal jaundice appears between the first 24 and 72 hours after birth and is usually considered a benign form. It is often referred to as early-onset breast milk jaundice, and is related to insufficient **breastfeeding**, which results in decreased nutritional intake and decreased stool production. With decreased stool volume, the bilirubin in the stool is not adequately excreted, and remains available for reabsorption. Increasing feedings from six to 12 times a day, and checking for latching-on and a good sucking and swallowing patterns, can lead to a decreasing bilirubin level to within normal limits. To encourage adequate maternal milk production, infant supplementation with water or glucose is discouraged.

Late-onset breast milk jaundice may occur in 10–30% of breast-fed infants and appears in the second to sixth weeks of life. This form of jaundice is believed to

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KEY TERMS

Bilirubin—A yellowish-brown substance in the blood that forms as old red blood cells are broken down.

Jaundice—a condition in which bilirubin, a waste product caused by the normal breakdown or red blood cells, builds up in the body faster than the liver can break it down. People with jaundice develop yellowish skin and the whites of their eyes become yellow. The condition can occur in newborns and people with liver damage.

Kernicterus—A serious condition in which bilirubin deposits in the brain leading to permanent neurological damage and potentially death.

be related to a substance present in the mother's milk that affects the infant's absorption of bilirubin.

Risk factors

Risk factors for the development of hyperbilirubinemia include:

- premature birth
- East Asian and Native American descent
- maternal diabetes
- hemolytic disease in the neonate
- sepsis
- family history of jaundice
- presence of excessive bruising due to traumatic birth, and cephalhematoma
- oxytocin-induced delivery
- mother's use of sulfa medications during pregnancy
- history of familial liver disease
- delayed cord clamping
- thyroid gland abnormalities
- G6PD (glucose-6-phosphate dehydrogenase) deficiency

Diagnosis

Examination

Diagnosis of hyperbilirubinemia usually begins with the observation of jaundice at the time of **physical examination**. However, a delay in recognition of jaundice may occur since many infants have already gone home before its onset. Pediatric practices vary as to times of follow-up after hospital discharge. Parents may call their pediatric care provider's office because of jaundice, or because of a decreased ability of the infant to feed. Examination of the infant is best done next to a window so that the jaundice can be assessed in natural light.

Tests

Blood tests to check the bilirubin level, blood type, and for signs of dehydration will usually be ordered. Blood is drawn by a heel stick. Heel sticks on an infant can be difficult when the infant is dehydrated. Ways to facilitate a more successful blood draw include:

- Use of a heel warmer to increase circulation to the foot.
- Having a parent hold the infant in a seated position so that the foot is below the level of the heart.
- Having the parent feed the infant prior to the lab visit.

Treatment

Treatment is primarily focused on decreasing the bilirubin level to prevent the progression of the condition to kernicterus. In kernicterus, the bilirubin deposits in the brain. This extreme condition leads to central nervous system damage and can progress to **hearing loss**, seizures, and **death**.

Phototherapy

For many infants, increasing breastfeeding will be sufficient to bring about adequate hydration and an increase in gastric motility and the amount of stool, so that the bilirubin is effectively excreted from the body. Some infants may need the additional assistance of **phototherapy**. The light source most effective in treating hyperbilirubinemia occurs in the blue-green spectrum. Phototherapy may be provided in the hospital. In the hospital the infant is usually placed in a special bassinet, with an overhead light source. The skin is uncovered, exposing as much surface area to the light. The infant's eyes and genitals are usually shielded from direct light and heat, depending on the intensity of the light.

If the bilirubin level is under about 15–20 mg/dL, phototherapy may be administered via a fiberoptic source referred to as a blanket or belt in the home. The home unit is designed to encourage parent-infant bonding. The blanket/belt wraps around the infant's bare middle so that the cool light source is next to the

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skin. There is no need to shield the eyes from the light, and parents can hold, feed, and interact with the infant as usual. Most insurance companies cover the cost of the home rental for the phototherapy equipment and the accompanying daily home nursing visits.

In 1994 the American Academy of Pediatrics (AAP) developed guidelines for care and management of neonatal jaundice. These guidelines were reviewed and updated in 2004. In studies where experienced pediatric practitioners evaluated the same infants for jaundice, considerable discrepancies existed. Despite all the research done in this area, there are no consistent predictors of which infants will continue from benign jaundice to kernicterus. Research studies express concern over finding a balance between treating those that need treatment without treating well infants unnecessarily.

Prognosis

Jaundice addressed in its early stages rarely progresses to kernicterus, and therefore the prognosis for complete resolution of the problem is excellent. Phototherapy is extremely effective in bringing down the bilirubin levels. Some extreme cases may require a blood **transfusion**, but those situations are relatively rare. Infants who do develop kernicterus may continue to have long-term neurological effects present if the kernicterus was well established at the time of initiation of treatment.

Prevention

Primary prevention begins with addressing the risk factors mentioned previously. Prevention of kernicterus requires early detection, monitoring and potential treatment of jaundice with rising bilirubin levels. Frequent feedings of ten or more per day help to ensure adequate hydration, **nutrition**, gastric motility, and stool and urine output.

Resources

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ORGANIZATIONS

American Academy of Pediatrics, 141 Northwest Point Blvd., Elk Grove Village, IL, 60007-1098, (847) 434-4000, (847) 434-8000, http://www.aap.org.

Association of Women's Health, Obstetric, and Neonatal Nurses, 2000 L St., NW, Suite. 740, Washington, DC, 20036, (202) 261-2400, (800) 673-8499. Toll-free in Canada (800) 245-0231, (202) 728-0575, customerservice@awhonn.org, http://www.awhonn.org.

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Nephrectomy

Definition

Nephrectomy is the surgical procedure of removing a kidney or section of a kidney.

Purpose

Nephrectomy, or kidney removal, is performed on patients with **cancer** of the kidney (renal cell carcinoma); a disease in which cysts (sac-like structures) displace healthy kidney tissue (**polycystic kidney disease**); and serious kidney infections. It is also used to remove a healthy kidney from a donor for the purposes of **kidney transplantation**.

Precautions

Because the kidney is responsible for filtering wastes and fluid from the bloodstream, kidney function is critical to life. Nephrectomy candidates suffering from serious **kidney disease**, cancer, or infection usually have few treatment choices but to undergo the procedure. However, if kidney function is lost in the remaining kidney, the patient will require chronic dialysis treatments or transplantation of a healthy kidney to sustain life.

Description

Nephrectomy may involve removing a small portion of the kidney or the entire organ and surrounding tissues. In partial nephrectomy, only the diseased or infected portion of the kidney is removed. Radical nephrectomy involves removing the entire kidney, a section of the tube leading to the bladder (ureter), the gland that sits atop the kidney (adrenal gland), and the fatty tissue surrounding the kidney. A simple nephrectomy performed for transplant purposes requires removal of the kidney and a section of the attached

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ureter. A similar procedure is used to harvest cadaver kidneys, although both kidneys are typically removed at once (bilateral nephrectomy) and blood and cell samples for **tissue typing** are also taken.

The nephrectomy patient is administered **general anesthesia** and the surgeon makes an incision on the side or front of the abdomen. Muscle, fat, and tissue are cut away to reveal the kidney. The blood vessels connecting the kidney to the circulation are cut and clamped. Depending on the type of nephrectomy procedure being performed, the ureter, adrenal gland, and/or surrounding tissue may also be cut. The vessels and the ureter in the patient are then tied off and the incision is sewn up (sutured). The surgical procedure can take up to three hours, depending on the type of nephrectomy being performed.

Laparoscopic nephrectomy is a form of minimally invasive surgery that utilizes instruments on long, narrow rods to view, cut, and remove the kidney. The surgeon views the kidney and surrounding tissue with a flexible videoscope. The videoscope and surgical instruments are maneuvered through four small incisions in the abdomen. Once the kidney is freed, it is secured in a bag and pulled through a fifth incision, approximately 3 in (7.6 cm) wide, in the front of the abdominal wall below the navel. Although this surgical technique takes slightly longer than a traditional nephrectomy, preliminary studies have shown that it promotes a faster recovery time, shorter hospital stays, and less post-operative **pain** for kidney donors.

Preparation

Prior to surgery, blood samples will be taken from the patient to type and crossmatch in case **transfusion** is required during surgery. A catheter will also be inserted into the patient's bladder. The surgical procedure will be described to the patient, along with the possible risks.

Aftercare

Nephrectomy patients may experience considerable discomfort in the area of the incision. Patients may also experience **numbness**, caused by severed nerves, near or on the incision. Pain relievers are administered following the surgical procedure and during the recovery period on an as-needed basis. Although deep breathing and coughing may be painful due to the proximity of the incision to the diaphragm, breathing exercises are encouraged to prevent **pneumonia**. Patients should not drive an automobile for a minimum of two weeks.

KEY TERMS

Cadaver kidney—A kidney from a brain-dead organ donor used for purposes of kidney transplantation.

Polycystic kidney disease—A hereditary kidney disease that causes fluid- or blood-filled pouches of tissue called cysts to form on the tubules of the kidneys. These cysts impair normal kidney function.

Renal cell carcinoma—Cancer of the kidney.

Risks

Possible complications of a nephrectomy procedure include infection, bleeding (hemorrhage), and post-operative pneumonia. There is also the risk of kidney failure in a patient with impaired function or disease in the remaining kidney.

Normal results

Normal results of a nephrectomy are dependent on the purpose of the procedure and the type of nephrectomy performed. Immediately following the procedure, it is normal for patients to experience pain near the incision site, particularly when coughing or breathing deeply. Renal function of the patient is monitored carefully after nephrectomy surgery. If the remaining kidney is healthy, it will increase its functioning over time to compensate for the loss of the removed kidney.

Length of hospitalization depends on the type of nephrectomy procedure. Patients undergoing a laparoscopic radical nephrectomy may be released within two to four days after surgery. Traditional open nephrectomy patients are typically hospitalized for about a week. Recovery time will also vary, on average from three to six weeks.

ORGANIZATIONS

National Kidney Foundation, Inc., 30 East 33rd Street, New York, NY, 10016, (212) 889-2210, (212) 689-9261, (800) 622-9010, http://www.kidney.org/.

Paula Anne Ford-Martin

Nephritic syndrome *see* **Glomerulonephritis**

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Nephritis

Definition

Nephritis is inflammation of the kidney.

Description

The most prevalent form of acute nephritis is **glomerulonephritis**. This condition affects children and teenagers far more often than it affects adults. It is inflammation of the glomeruli, or small round filters located in the kidney. **Pyelonephritis** is recognized as inflammation of the kidney and upper urinary tract. It affects adults more than children. A third type of nephritis is hereditary nephritis, a rare inherited condition.

Causes and symptoms

Acute glomerulonephritis usually develops a few weeks after a strep infection of the throat or skin. Symptoms of glomerulonephritis include **fatigue**, high blood pressure, and swelling. Swelling is most notable in the hands, feet, ankles and face.

Pyelonephritis usually occurs suddenly, and the acute form of this disease is more common in adult women. The most common cause of this form of bacterial nephritis is the backward flow of infected urine from the bladder into the upper urinary tract. Its symptoms include **fever** and chills, fatigue, burning or frequent urination, cloudy or bloody urine, and aching **pain** on one or both sides of the lower back or abdomen.

Hereditary nephritis can be present at birth. The rare disease presents in many different forms and can be responsible for up to 5% of end-stage renal disease in men.

Diagnosis

Diagnosis of nephritis is based on:

- the patient's symptoms and medical history
- physical examination
- laboratory tests
- kidney function tests
- imaging studies such as ultrasound or x-rays to determine blockage and inflammation

Urinalysis can reveal the presence of:

- albumin and other proteins
- red and white blood cells
- pus, blood, or bacteria in the urine

Treatment

Treatment of glomerulonephritis normally includes drugs such as cortisone or cytotoxic drugs (those that are destructive to certain cells or antigens). **Diuretics** may be prescribed to increase urination. If high blood pressure is present, drugs may be prescribed to decrease the **hypertension**. Iron and vitamin supplements may be recommended if the patient becomes anemic.

Acute pyelonephritis may require hospitalization for severe illness. **Antibiotics** will be prescribed, with the length of treatment based on the severity of the infection. In the case of chronic pyelonephritis, a six-month course of antibiotics may be necessary to rid the infection. Surgery is sometimes necessary.

Treatment of hereditary nephritis depends of the variety of the disease and severity at the time of treatment.

Alternative treatment

Alternative treatment of nephritis should be used as a complement to medical care and under the supervision of a licensed practitioner. Some herbs thought to relieve symptoms of nephritis include cleavers (*Galium* spp.) and wild hydrangea.

Prognosis

Prognosis for most cases of glomerulonephritis is generally good. Ninety percent of children recover without complications. With proper medical treatment, symptoms usually subside within a few weeks, or at the most, a few months.

Pyelonephritis in the acute form offers a good prognosis if diagnosed and treated early. Follow-up urinalysis studies will determine if the patient remains bacteria-free. If the infection is not cured or continues to recur, it can lead to serious complications such as **bacteremia** (bacterial invasion of the bloodstream), hypertension, chronic pyelonephritis, and even permanent kidney damage.

If hereditary nephritis is not detected or treated, it can lead to complications such as eye problems, deafness or kidney failure.

Prevention

Streptococcal infections that may lead to glomerulonephritis can be prevented by avoiding exposure to strep infection and obtaining prompt medical treatment for **scarlet fever** or other infection.

Pyelonephritis can best be avoided if those with a history of urinary tract infections take care to drink

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plenty of fluids, urinate frequently, and practice good hygiene following urination.

Hereditary nephritis can not be prevented, but research to combat the disease continues.

Resources

OTHER

"Glomerulonephritis." *National Institute of Diabetes and Digestive and Kidney Disease*. http://www.niddk.nih.gov.

ORGANIZATIONS

American Kidney Fund (AKF), 6110 Executive Boulevard, Suite 1010, Rockville, MD, 20852, (800) 638-8299, http://www.kidneyfund.org.

National Kidney Foundation, Inc., 30 East 33rd Street, New York, NY, 10016, (212) 889-2210, (212) 689-9261, (800) 622-9010, http://www.kidney.org/.

Maureen Haggerty

Nephroblastoma *see* **Wilms' tumor**

Nephrocarcinoma *see* **Kidney cancer**

Nephrotic syndrome

Definition

Nephrotic syndrome is a collection of symptoms that occur because the tiny blood vessels (the glomeruli) in the kidney become leaky. This allows protein (normally never passed out in the urine) to leave the body in large amounts.

Demographics

Patients with nephrotic syndrome are from all age groups, although in children children between the ages of 18 months and four years have an increased risk of the disorder. In children, boys are more frequently affected; in adults, the ratio of men to women is closer to equal.

Description

The glomeruli (a single one is called a glomerulus) are tiny tufts of capillaries (the smallest type of blood vessels). Glomeruli are located in the kidneys, where they allow a certain amount of water and waste products to leave the blood, ultimately to be passed out of the body in the form of urine. Normally, proteins are unable to pass through the glomerular filter. Nephrotic syndrome, however, occurs when this filter becomes defective, allowing large quantities of protein to leave the blood circulation and pass out of the body in the urine.

A specimen of a nephrotic human kidney. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Causes and symptoms

Nephrotic syndrome can be caused by a number of different diseases. The common mechanism that seems to cause damage involves the immune system. For some reason, the immune system becomes directed against the person's own kidney. The glomeruli become increasingly leaky as various substances from the immune system are deposited within the kidney.

A number of different kidney disorders are associated with nephrotic syndrome, including:

- minimal change disease or MCD (responsible for about 80% of nephrotic syndrome in children, and about 20% in adults), which is a disorder of the glomeruli
- focal segmental glomerulosclerosis (FSGS)

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- membranous glomerulonephritis (MGN)
- membranoproliferative glomerulonephritis (MPGN)

Other types of diseases can also result in nephrotic syndrome. These include diabetes, sickle-cell anemia, **amyloidosis**, **systemic lupus erythematosus**, **sarcoidosis**, leukemia, lymphoma, **cancer** of the breast, colon, and stomach, reactions to drugs (including **nonsteroidal anti-inflammatory drugs**, lithium, and street heroine), allergic reactions (to insect **stings**, snake venom, and **poison ivy**), infections (**malaria**, various bacteria, **hepatitis B**, herpes zoster, and the virus which causes **AIDS**), and severe high blood pressure.

The first symptom of nephrotic syndrome is often foamy urine. As the syndrome progresses, swelling (**edema**) is noticed in the eyelids, hands, feet, knees, scrotum, and abdomen. The patient feels increasingly weak and fatigued. Appetite is greatly decreased. Over time, the loss of protein causes the muscles to become weak and small (called muscle wasting). The patient may note abdominal **pain** and difficulty breathing. Because the kidneys are involved in blood pressure regulation, abnormally low or abnormally high blood pressure may develop.

As the syndrome progresses the protein loss occurring in nephrotic syndrome will result in a generally malnourished state. Hair and nails become brittle, and growth is stunted. Bone becomes weak, and the body begins to lose other important nutrients (sugar, potassium, **calcium**). Infection is a serious and frequent complication, as are disorders of blood clotting. **Acute kidney failure** may develop.

Diagnosis

Tests

Diagnosis is based first on the laboratory examination of the urine and the blood. While the urine will reveal significant quantities of protein, the blood will reveal abnormally low amounts of circulating proteins. Blood tests also reveal a high level of cholesterol.

Procedures

In order to diagnose one of the kidney disorders that cause nephrotic syndrome, a small sample of the kidney will be removed for examination. This biopsy can be done with a long, very thin needle that is inserted through the skin under the ribs.

Treatment

Treatment depends on the underlying disorder that caused nephrotic syndrome.

KEY TERMS

Glomeruli—Tiny tufts of capillaries that carry blood within the kidneys. The blood is filtered by the glomeruli. The blood then continues through the circulatory system, but a certain amount of fluid and specific waste products are filtered out of the blood, to be removed from the body in the form of urine.

Immune system—The complex system within the body that serves to fight off harmful invaders, such as bacteria, viruses, fungi.

Kidney failure—The inability of the kidney to excrete toxic substances from the body.

Drugs

Medications that dampen the immune system are a mainstay of treatment. The first choice is usually a steroid drug (such as prednisone). Some conditions may require more potent medications, such as cyclophosphamide or cyclosporine. Treating the underlying conditions (lymphoma, cancers, heroine use, infections) that have led to nephrotic syndrome often improve the symptoms of nephrotic syndrome as well. Some patients require the use of specific medications to control high blood pressure. Occasionally, the quantity of fluid a patient is allowed to drink is restricted. Some patients benefit from the use of **diuretics** (which allow the kidney to produce more urine) to decrease swelling.

Prognosis

Prognosis depends on the underlying disorder. Minimal change disease has the best prognosis of all the kidney disorders, with 90% of all patients responding to treatment. Other types of kidney diseases have less favorable outcomes, with high rates of progression to kidney failure. When nephrotic syndrome is caused by another, treatable disorder (infection, allergic or drug reaction), the prognosis is very good.

Resources

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ORGANIZATIONS

American Association of Kidney Patients, 3505 E. Frontage Rd., Suite 315, Tampa, FL, 33607, (800) 749-2257, info@aakp.org, http://www.aakp.org.
American Kidney Fund (AKF), 6110 Executive Blvd., Suite 1010, Rockville, MD, 20852, (800) 638-8299, http://www.kidneyfund.org.
American Society of Pediatric Nephrology, 3400 Research Forest Dr., Suite B-7, The Woodlands, TX, 77381, (281) 419-0052, http://www.aspneph.com.
National Kidney Foundation, 30 East 33rd St., New York, NY, 10016, (800) 622-9010, http://www.kidney.org.
National Kidney and Urologic Disease Information Clearinghouse, 3 Information Way, Bethesda, MD, 20892, (800) 891-5390, nkudic@info.niddk.nih.gov, http://kidney.niddk.nih.gov.

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Nephrotoxic injury

Definition

Nephrotoxic injury is damage to one or both of the kidneys that results from exposure to a toxic material, usually through ingestion.

Description

The kidneys are the primary organs of the urinary system, which purifies the blood by removing wastes from it and excreting them from the body in urine. Every day, the kidneys filter about 45 gal (180 l) of blood, about four times as much as the amount that passes through any other organ. Because of this high volume, the kidneys are more often exposed to toxic substances in the blood and are very vulnerable to injury from those sources.

Each kidney contains more than one million structures called nephrons. Each nephron consists of two parts: the renal corpuscle and the renal tubule. The renal corpuscle is where the blood is filtered. It is made up of a network of capillaries (the glomerulus) and the structure that surrounds these capillaries (Bowman's capsule). Blood flows into the glomerulus, where the liquid part of the blood (plasma) passes through the walls of the capillaries and into Bowman's capsule (blood cells and some proteins are too big to pass through and therefore remain in the blood vessels). The plasma, now called filtrate, contains substances that the body needs, such as water, glucose, and other nutrients, as well as wastes, excess salts, and excess water. When the filtrate moves from Bowman's capsule into the renal tubules, about 99% of it is taken back up as the action of the tubules allows beneficial substances to be reabsorbed into the blood stream. The remaining filtrate is then passed to the bladder as urine.

When the kidneys are exposed to a toxic agent, either accidentally or intentionally (as in a **suicide** attempt), damage can occur in a number of different ways, depending upon the agent. One toxin may directly affect the glomerulus or the renal tubules, causing the cells of these structures to die. Another toxin may create other substances or conditions that result in the same cell death. Nephrotoxic injury can lead to acute renal failure, in which the kidneys suddenly lose their ability to function, or chronic renal failure, in which kidney function slowly deteriorates. If unchecked, renal failure can result in death.

Causes and symptoms

Several different substances can be toxic to the kidneys. These include:

- antibiotics, primarily aminoglycosides, sulphonamides, amphotericin B, polymyxin, neomycin, bacitracin, rifampin, trimethoprim, cephaloridine, methicillin, aminosalicylic acid, and oxy- and chlorotetracyclines
- analgesics, including acetaminophen (Tylenol), all nonsteroidal anti-inflammatory drugs, or NSAIDs (e.g. aspirin, ibuprofen), and all prostaglandin synthetase inhibitors
- contrast agents used in some diagnostic tests, such as sodium iodide
- heavy metals, such as lead, mercury, arsenic, and uranium
- anti-cancer drugs, such as cyclosporin, cisplatin, and cyclophosphamide
- methemoglobin-producing agents
- solvents and fuels, such as carbon tetrachloride, methanol, amyl alcohol, and ethylene glycol
- herbicides and pesticides
- overproduction of uric acid

Nephrotoxic injury is most commonly caused by drugs, primarily **antibiotics**, **analgesics**, and contrast agents. In some cases, such as with **aminoglycosides** and amphotericin B, the drug itself will damage the kidneys. In others, such as with methicillin,

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KEY TERMS

Bowman's capsule—The structure surrounding the glomerulus.

Chelate—A chemical that binds to heavy metals in the blood, thereby helping the body to excrete them in urine.

Contrast agent—Substance ingested so as to highlight anatomical structures in x-ray imaging tests.

Diuretic—A drug that promotes the excretion of urine.

Glomerulus—A network of capillaries located in the nephron where wastes are filtered from the blood.

Methemoglobin—A compound formed from hemoglobin by oxidation.

Nephron—Basic functional unit of the kidney.

Nephrotoxin—Substance that is poisonous to the kidneys.

Renal failure—Disorder characterized by the kidney's inability to filter wastes from the blood. It may be acute (occuring suddenly and usually reversable) or chronic (developing slowly over time as a result of permanent damage).

sulphonamides, and some contrast agents, the drug provokes an allergic reaction that destroys the kidneys. Some chemicals found in certain drugs and industrial agents damage the kidneys by converting the hemoglobin of red blood cells into methemoglobin, thereby interfering with the blood's transport of oxygen. In hospitals, the most common form of nephrotoxic injury is antibiotic nephropathy, which usually occurs when antibiotics are given to patients with already weakened kidneys. Analgesic nephropathy is another common form of nephrotoxic injury and occurs as a result of long-term **abuse** of analgesics, usually NSAIDs (e.g., ibuprofen). Analgesic nephropathy is most prevalent in women over 30. Lead nephropathy, arising from **lead poisoning**, and nephropathy, from ingestion of the solvent carbon tetrachloride, are also more common forms of nephrotoxic injury. Uric acid nephropathy is one form of nephropathy that is not caused by exposure to an external toxin; instead, it arises from the body's overproduction of uric acid, usually in persons with diseases of the lymph nodes or bone marrow.

Risk factors for nephrotoxic injury include:

- Age. The elderly are more likely to overdose on antibiotics or analgesics.
- Underlying kidney disease. Kidneys already weakened by conditions such as diabetes can be particularly susceptible to nephrotoxic injury.
- Severe dehydration.
- Prolonged exposure to heavy metals or solvents on the job or in the home.
- Presence of diseases that cause the overproduction of uric acid.

Symptoms of nephrotoxic injury are wide ranging and, in some cases, depend upon the type of toxin involved. In general, symptoms are similar to those of renal failure and include excess urea in the blood (azotemia), anemia, increased hydrogen ion concentration in the blood (acidosis), excess fluids in the body (**overhydration**), and high blood pressure (**hypertension**). Blood or pus may be present in the urine, as may uric acid crystals. A decrease in urinary output may also occur. If the toxin's effect on the kidneys remains unchecked, more serious symptoms of kidney failure may occur, including seizures and **coma**.

Diagnosis

Damage to the kidneys is assessed through a combination of **physical examination**, blood tests, urine tests, and imaging procedures. Diagnosis of nephrotoxic injury as the underlying cause results from a thorough investigation of the patient's history. Information regarding preexisting conditions, current prescriptions, and environmental exposures to toxins aid the physician in determining what toxin, if any, has caused the kidneys to malfunction.

Treatment

Treatment of nephrotoxic injury takes place in the hospital and focuses on removing the toxin from the patient's system, while maintaining kidney function. Removal methods are targeted to specific toxins and may include the use of **diuretics** or chelates to enhance excretion of the toxin in urine, or, in extreme cases, the direct removal of toxins from the blood via hemodialysis or passing the blood over an absorbent substance such as charcoal. Support of kidney function depends on the extent of damage to the organs and ranges from monitoring fluid levels to dialysis.

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Prognosis

The outcome of nephrotoxic injury is determined by the cause and severity of the damage. In cases where damage has not progressed beyond acute renal failure, kidney function can be fully restored once the toxin is removed from the system and equilibrium restored. However, if permanent damage has resulted in chronic renal failure, lifelong dialysis or a kidney transplant may be required.

Prevention

Exposure to nephrotoxins can be minimized several different ways. When taking antibiotics or analgesics, recommended dosages should be strictly followed. Also, elderly patients on these medications (for example, those taking **aspirin** for heart problems or NSAIDs for arthritis) should be closely monitored to prevent accidental overdose. Health care workers should be aware of any underlying conditions, such as diabetes or **allergies** to antibiotics, that may heighten the effect of a potential nephrotoxin. When using solvents or handling heavy metals, procedures regarding their safe use should be employed.

ORGANIZATIONS

American Kidney Fund (AKF), 6110 Executive Boulevard, Suite 1010, Rockville, MD, 20852, (800) 638-8299, http://www.kidneyfund.org.

National Kidney Foundation, Inc. , 30 East 33rd Street, New York, NY, 10016, (212) 889-2210, (212) 689-9261, (800) 622-9010, http://www.kidney.org/.

Bridget Travers

Nerve conduction velocity testing *see* **Electromyography**

Neural hearing loss *see* **Hearing loss**

Neuralgia

Definition

Neuralgia is defined as an intense burning or stabbing **pain** caused by irritation of or damage to a nerve. The pain is usually brief but may be severe. It often feels as if it is shooting along the course of the affected nerve.

Description

Different types of neuralgia occur depending on the reason the nerve has been irritated. Neuralgia can be triggered by a variety of causes, including **tooth decay**, eye strain, or **shingles** (an infection caused by the herpes zoster virus). Pain is usually felt in the part of the body that is supplied by the irritated nerve.

Causes and symptoms

Neuralgia is caused by irritation or nerve damage from systemic disease, inflammation, infection, and compression or physical irritation of a nerve. The location of the pain depends on the underlying condition that is irritating the nerve or the location of the particular nerve that is being irritated.

Neuralgia can result from tooth decay, poor diet, eye strain, nose infections, or exposure to damp and cold. Postherpetic neuralgia is an intense debilitating pain felt at the site of a previous attack of shingles. **Trigeminal neuralgia** (also called tic douloureux, the most common type of neuralgia), causes a brief, searing pain along the trigeminal nerve, which supplies sensation to the face. The facial pain of migraine neuralgia lasts between 30 minutes and an hour and occurs at the same time on successive days. The cause is not known.

Glossopharyngeal neuralgia is an intense pain felt at the back of the tongue, in the throat, and in the ear—all areas served by the glossopharyngeal nerve. The pain may occur spontaneously, or it can be triggered by talking, eating, or swallowing (especially cold foods such as ice cream). Its cause is not known.

Occipital neuralgia is caused by a pinched occipital nerve. There are two occipital nerves, each located at the back of the neck, each supplying feeling to the skin over half of the back of the head. These nerves can be pinched due to factors ranging from arthritis to injury, but the result is the same: **numbness**, pain, or **tingling** over half the base of the skull.

Diagnosis

Neuralgia is a symptom of an underlying disorder; its diagnosis depends on finding the cause of the condition creating the pain.

To diagnose occipital neuralgia, a doctor can inject a small amount of anesthetic into the region of the occipital nerve. If the pain temporarily disappears, and there are no other physical reasons for the pain, the doctor may recommend surgery to deal with the pinched nerve.

Treatment

Glossopharyngeal, trigeminal, and postherpetic neuralgias sometimes respond to **anticonvulsant**

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KEY TERMS

Desensitization—A technique of pain reduction in which the painful area is stimulated with whatever is causing the pain.

Dorsal root entry zone (DREZ)—A type of nerve surgery for postherpetic neuralgia that is occasionally used when the patient can get no other pain relief. The surgery destroys the area where damaged nerves join the central nervous system, thereby interfering with inappropriate pain messages from nerves to the brain.

Glossopharyngeal neuralgia—Sharp recurrent pain deep in the throat that extends to the area around the tonsils and possibly the ear. It is triggered by swallowing or chewing.

Migraine neuralgia—A variant of migraine pain, also called cluster headache, in which severe attacks of pain affect the eye and forehead on one side of the face.

Occipital neuralgia—Pain on one side of the back of the head caused by entrapment or pinching of an occipital nerve.

Postherpetic neuralgia—Persistent pain that occurs as a complication of a herpes zoster infection. Although the pain can be treated, the response is variable.

Shingles—A painful rash with blisters that appears along the course of a nerve. It is caused by infection with herpes zoster virus.

TENS—The abbreviation for transcutaneous electrical nerve stimulation, a technique used to control chronic pain. Electrodes placed over the painful area deliver a mild electrical impulse to nearby nerve pathways, thereby easing pain.

Trigeminal neuralgia—Brief episodes of severe shooting pain on one side of the face caused by inflammation of the root of the trigeminal nerve. Also referred to as tic douloureux.

drugs, such as carbamazepine or phenytoin, or to painkillers, such as **acetaminophen**. Trigeminal neuralgia may also be relieved by surgery in which the nerve is cut or decompressed. In some cases, compression neuralgia (including occipital neuralgia) can be relieved by surgery.

People with shingles should see a doctor within three days of developing the rash, since aggressive treatment of the blisters that appear with the rash can ease the severity of the infection and minimize the risk of developing postherpetic neuralgia. However, it is not clear whether the treatment can prevent postherpetic neuralgia.

If postherpetic neuralgia develops, a variety of treatments can be tried, since their effectiveness varies from person-to-person.

- antidepressants such as amitriptyline (Elavil)
- anticonvulsants (phenytoin, valproate, or carbamazepine)
- capsaicin (Xostrix), the only medication approved by the FDA for treatment of postherpetic neuralgia
- topical painkillers
- desensitization
- TENS (transcutaneous electrical nerve stimulation)
- dorsal root zone (DREZ) surgery (a treatment of last resort)

Alternative treatment

B-complex **vitamins**, primarily given by intramuscular injection, can be an effective treatment. A whole-foods diet with adequate protein, carbohydrates, and fats that also includes yeast, liver, wheat germ, and foods that are high in B vitamins may be helpful. **Acupuncture** is a very effective treatment, especially for postherpetic neuralgia. Homeopathic treatment can also be very effective when the correct remedy is used. Some botanical medicines may also be useful. For example, black cohosh (*Cimicifuga racemosa*) appears to have anti-inflammatory properties based on recent research.

Prognosis

The effectiveness of the treatment depends on the cause of the neuralgia, but many cases respond to pain relief.

Trigeminal neuralgia tends to come and go, but successive attacks may be disabling. Although neuralgia is not fatal, the patient's fear of being in pain can seriously interfere with daily life.

Some people with postherpetic neuralgia respond completely to treatment. Most people, however, experience some pain after treatment, and a few receive no relief at all. Some people live with this type of neuralgia for the rest of their lives, but for most, the condition gradually fades away within five years.

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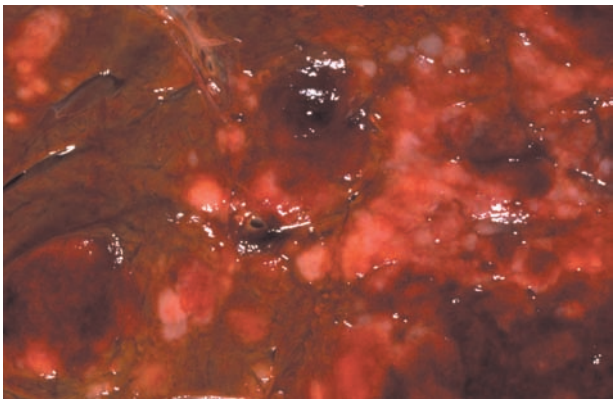
ORGANIZATIONS

American Chronic Pain Association, P.O. Box 850, Rocklin, CA, 95677, (916) 632-3208, (800) 533-3231, APA@pacbell.net, http://www.theacpa.org.

Americna Pain Society, 4700 W. Lake Ave., Glenview, IL, 60025, (847) 375-4715, (866) 574-2654, info@ampainsoc.org, http://www.ampainsoc.org.

National Institute of Neurological Disorders and Stroke (NINDS), NIH Neurological Institute, P. O. Box 5801, Bethesda, MD, 20824, (301) 496-5751, (800) 352-9424, http://www.ninds.nih.gov/.

Carol A. Turkington



A neuroblastoma appearing at the surface of the liver. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Neuroblastoma

Definition

Neuroblastoma is a type of **cancer** that usually originates either in the tissues of the adrenal gland or in the ganglia of the abdomen or in the ganglia of the nervous system. (Ganglia are masses of nerve tissue or groups of nerve cells.) Tumors develop in the nerve tissue in the neck, chest, abdomen, or pelvis.

Description

Neuroblastoma is one of the few cancer types known to secrete hormones. It occurs most often in children, and it is the third most common cancer that occurs in children. Approximately 7.5% of the childhood cancers diagnosed in 2001 were neuroblastomas, affecting one in 80,000 to 100,000 children in the United States. Close to 50% of cases of neuroblastoma occur in children younger than two years old. The disease is sometimes present at birth, but is usually not noticed until later. By the time the disease is diagnosed, it has often spread to the lymph nodes, liver, lungs, bones, or bone marrow. Approximately one-third of neuroblastomas start in the adrenal glands.

Demographics

According to some reports, African-American children develop the disease at a slightly higher rate than Caucasian children (8.7 per million compared to 8.0 per million cases diagnosed).

Causes and symptoms

The causes of neuroblastoma are not precisely known. Current research holds that neuroblastomas develop when cells produced by the fetus (neuroblast cells) fail to mature into normal nerve or adrenal cells and keep growing and proliferating. The first symptom of a neuroblastoma is usually an unusual growth or lump, found in most cases in the abdomen of the child, causing discomfort or a sensation of fullness and **pain**. Other symptoms such as **numbness** and **fatigue**, arise because of pressure caused by the tumor. Bone pain also occurs if the cancer has spread to the bone. If it has spread to the area behind the eye, the cancer may cause protruding eyes and dark circles around the eyes; in a few cases, blindness may be the presenting symptom. **Paralysis** may result from compression of the spinal cord. **Fever** is also reported in one case out of four. High blood pressure, persistent **diarrhea**, rapid heartbeat, reddening of the skin, and sweating occur occasionally. Some children may also have uncoordinated or jerky muscle movements, or uncontrollable eye movements, but these symptoms are rare. If the disease spreads to the skin, blue or purple patches may appear.

Diagnosis

A diagnosis of neuroblastoma usually requires blood and urine tests to investigate the nature and quantity of chemicals (neurotransmitters) released by the nerve cells. These are broken down by the body and released in urine. Additionally, scanning techniques are used to confirm the diagnosis of neuroblastoma. These techniques produce images or pictures of the inside of the body and they include computed tomography scan (CT scan) and **magnetic resonance imaging** (MRI). To confirm the diagnosis, the physician will surgically remove some of the tissue from the tumor or bone marrow, and examine the cells under the microscope (biopsy).

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Treatment

The treatment team usually consists of an oncologist specialized in the treatment of neuroblastoma, a surgeon to perform biopsies and possibly attempt surgical removal of the tumor, a **radiation therapy** team and, if indicated, a **bone marrow transplantation** team.

Staging

Once neuroblastoma has been diagnosed, the physician will perform more tests to determine if the cancer has spread to other tissues in the body. This process, called staging, is important for the physician to determine how to treat the cancer and check liver and kidney function. The staging system for neuroblastoma is based on how far the disease has spread from its original site to other tissues in the body.

Localized resectable (able to be cut out) neuroblastoma is confined to the site of origin, with no evidence that it has spread to other tissues, and the cancer can be surgically removed. Localized unresectable neuroblastoma is confined to the site of origin, but the cancer cannot be completely removed surgically. Regional neuroblastoma has extended beyond its original site to regional lymph nodes, and/or surrounding organs or tissues, but has not spread to distant sites in the body. Disseminated neuroblastoma has spread to distant lymph nodes, bone, liver, skin, bone marrow, and/or other organs. Stage 4S (or IVS, or "special") neuroblastoma has spread only to liver, skin, and/or, to a very limited extent, bone marrow. Recurrent neuroblastoma means that the cancer has come back, or continued to spread after it has been treated. It may come back in the original site or in another part of the body.

Treatments are available for children with all stages of neuroblastoma. More than one of these treatments may be used, depending on the stage of the disease. The four types of treatment used are:

- surgery (removing the tumor in an operation)
- radiation therapy (using high-energy x-rays to kill cancer cells)
- chemotherapy (using drugs to kill cancer cells)
- bone marrow transplantation (replacing the patient's bone marrow cells with those from a healthy person)

Surgery is used whenever possible, to remove as much of the cancer as possible, and can generally cure the disease if the cancer has not spread to other areas of the body. Before surgery, **chemotherapy** may be used to shrink the tumor so that it can be more easily removed during surgery; this is called neoadjuvant chemotherapy. Radiation therapy is often used after surgery; high-energy rays (radiation) are used to kill as many of the remaining cancer cells as possible. Chemotherapy (called adjuvant chemotherapy) may also be used after surgery to kill remaining cells. Bone marrow transplantation is used to replace bone marrow cells killed by radiation or chemotherapy. In some cases the patient's own bone marrow is removed prior to treatment and saved for transplantation later. Other times the bone marrow comes from a "matched" donor, such as a sibling.

One novel approach to treatment of neuroblastomas is therapy with desferoxamine (DFO), which is ordinarily used to treat iron **poisoning**. DFO has been shown to have antitumor activity in neuroblastomas and other cancers of the central nervous system. It is thought that the drug works by lowering the increased iron levels in the body associated with cancer.

There are significant differences in treatment protocols for neuroblastoma between the major North American study group (Children's Oncology Group) and its European counterpart, the Société Internationale d'Oncologie Pédiatrique (SIOP). These differences include biopsy techniques, the timing and extent of surgery, chemotherapy dosages, and the types of salvage therapy employed.

Alternative treatment

No alternative therapy has yet been reported as a substitute for conventional neuroblastoma treatment. Complementary therapies—such as retinoic acid therapy—have been shown to be beneficial to patients when administered after a conventional course of chemotherapy or transplantation.

Prognosis

The chances of recovery from neuroblastoma depend on the stage of the cancer, the age of the child at diagnosis, the location of the tumor, and the state and nature of the tumor cells evaluated under the microscope. Infants have a higher rate of cure than do children over one year of age, even when the disease has spread. In general, the prognosis for a young child with neuroblastoma is good: the predicted five-year survival rate is approximately 85% for children who had the onset of the disease in infancy, and 35% for those whose disease developed later.

Prevention

Neuroblastoma may be a genetic disease passed down from the parents. In 2004, a group of German researchers reported that a series of neuroblastomas demonstrated a consistent pattern of deletions and

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KEY TERMS

Adjuvant chemotherapy—Treatment of the tumor with drugs after surgery to kill as many of the remaining cancer cells as possible.

Adrenal gland—Gland located above each kidney consisting of an outer wall (cortex) that produces steroid hormones and an inner section (medulla) that produces other important hormones, such as adrenaline and noradrenaline.

Alternative therapy—A therapy is generally called alternative when it is used instead of conventional cancer treatments.

Biopsy—A small sample of tissue removed from the site of the tumor to be examined under a microscope.

Conventional therapy—Treatments that are widely accepted and practiced by the mainstream medical community.

Complementary therapy—A therapy is called complementary when it is used in addition to conventional cancer treatments.

Disseminated—Spread to other tissues.

Hormone—A substance produced by specialized cells that affects the way the body carries out the biochemical and energy-producing processes required to maintain health (metabolism.

Localized—Confined to a small area.

Neoadjuvant chemotherapy—Treatment of the tumor with drugs before surgery to reduce the size of the tumor.

Neuroblast cells—Cells produced by the fetus which mature into nerve cells and adrenal medulla cells.

Monoclonal antibody—A protein substance which is produced in the laboratory by a single population of cells. They are being tested as a possible form of cancer treatment.

Resectable cancer—A tumor that can be surgically removed.

Salvage therapy—Treatment measures taken late in the course of a disease after other therapies have failed. It is also known as rescue therapy.

Staging system—A system based on how far the cancer has spread from its original site, developed to help the physician determine how best to treat the disease.

Unresectable cancer—A tumor that cannot be completely removed by surgery.

overrepresentations on chromosomes 3, 10, 17q, and 20. There is currently no known method for its prevention.

Special concerns

After completion of a course of treatment for neuroblastoma, physicians sometimes recommend that the child undergo an investigative operation. This procedure allows the treatment team to evaluate how effective treatment has been, and may offer an opportunity to remove more of the tumor if it is still present.

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National Cancer Institute (National Institutes of Health), NCI Office of Communications and Education, 6116 Executive Blvd. Suite 300, Bethesda, MD, 20892-8322, (800) 4-CANCER (422-6237), cancergovstaff@mail.nih.gov, http://www.cancer.gov/.

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Neuroendocrine tumors

Definition

Neuroendocrine tumor refers to the type of cell that a tumor grows from rather than where that tumor is located. Neuroendocrine cells produce hormones or regulatory proteins, and so tumors of these cells usually have symptoms that are related to the specific hormones that they produce.

Description

Neuroendocrine cells have roles both in the endocrine system and the nervous system. They produce and secrete a variety of regulatory hormones, or neuropeptides, which include neurotransmitters and growth factors. When these cells become cancerous, they grow and overproduce their specific neuropeptide. Neuroendocrine tumors are generally rare. One type of neuroendocrine tumor is a carcinoid tumor. This type of tumor can occur in the intestinal tract, appendix, rectum, bronchial tubes, or ovary. Most carcinoid tumors secrete serotonin. When the blood concentration of this hormone is high enough, it causes carcinoid syndrome. This syndrome refers to a variety of symptoms that are caused by the excessive amount of hormone secreted rather than the tumor itself.

The total incidence of neuroendocrine tumors is thought to be between five and nine million people in the United States. It is possible that these tumors are underreported because they grow slowly and do not always produce dramatic symptoms.

Causes and symptoms

Many of the symptoms of carcinoid tumor are due to the hormones that the tumor secretes. These hormones can affect the whole body and cause what is referred to as carcinoid syndrome. The most common symptom of carcinoid syndrome is flushing, a sudden appearance of redness and warmth in the face and neck that can last from minutes to hours. Other symptoms of carcinoid syndrome are **diarrhea**, asthma-like symptoms and heart problems. Since most carcinoid tumors are found in the appendix, the symptoms are often similar to **appendicitis**, primarily **pain** in the abdomen. When these tumors are found in the small intestine, they can cause abdominal pain that is often initially diagnosed as bowel obstruction. Many patients have no symptoms and the carcinoids are found during routine **endoscopy** of the intestines.

Diagnosis

The diagnosis of carcinoid syndrome is made by the measurement of 5–hydroxy indole acetic acid (5–HIAA) in the urine. 5–HIAA is a breakdown (waste) product of serotonin. If the syndrome is diagnosed, the presence of carcinoid tumor is a given. When the syndrome is not present, diagnosis may be delayed, due to the vague symptoms present. Diagnosis can sometimes take up to two years. It is made by performing a number of tests, and the specific test used depends on the tumor's suspected location. The tests that may be performed include gastrointestinal endoscopy, **chest x-ray**, computed tomography scan (CT scan), **magnetic resonance imaging**, or ultrasound. A biopsy of the tumor is performed for diagnosis. A variety of hormones can be measured in the blood as well to indicate the presence of a carcinoid.

Treatment

The only effective treatment for carcinoid tumor is surgical removal of the tumor. Although **chemotherapy** is sometimes used when metastasis has occurred, it is rarely effective. The treatment for carcinoid syndrome is typically meant to decrease the severity of symptoms. Patients should avoid **stress** as well as foods that bring on the syndrome. Some medications can be given for symptomatic relief; for example, tumors of the gastrointestinal tract may be treated with octreotide (Sandostatin) or lanreotide (Somatuline) to relieve such symptoms as diarrhea and flushing. These drugs are known as somatostatin analogs.

Liver transplantation is a treatment option for patients with neuroendocrine tumors that have metastasized only to the liver. This approach is reported to offer patients long, disease-free periods and relief of symptoms.

Prognosis

The prognosis of carcinoid tumors is related to the specific growth patterns of that tumor, as well as its location. For example, a group of researchers at the University of Wisconsin reported in 2004 that patients with gastrointestinal tumors in the hindgut had longer

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KEY TERMS

Appendicitis—Inflammation of the appendix.

Growth factor—A local hormone produced by some cells that initiates growth.

Metastasis—The spread of disease from one part of the body to another, as when cancer cells appear in parts of the body remote from the site of the primary tumor.

Neurotransmitter—A chemical messenger used to transmit information in the nervous system.

periods of disease-free survival than those with foregut or midgut cancers. For localized disease the five-year survival rate can be 94%, whereas for patients where metastasis has occurred, the average five-year survival rate is 18%. It is not unusual for patients with carcinoid tumors to live 10–15 years after the initial diagnosis.

Prevention

Neuroendocrine tumors such as carcinoid tumors are rare, and no information consequently is yet available on cause or prevention.

Resources

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ORGANIZATIONS

Carcinoid Cancer Foundation, 333 Mamaroneck Ave. #492, New York, NY, 10605, (888) 722-3132, http://www.carcinoid.org/.

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Neurofibromatosis

Definition

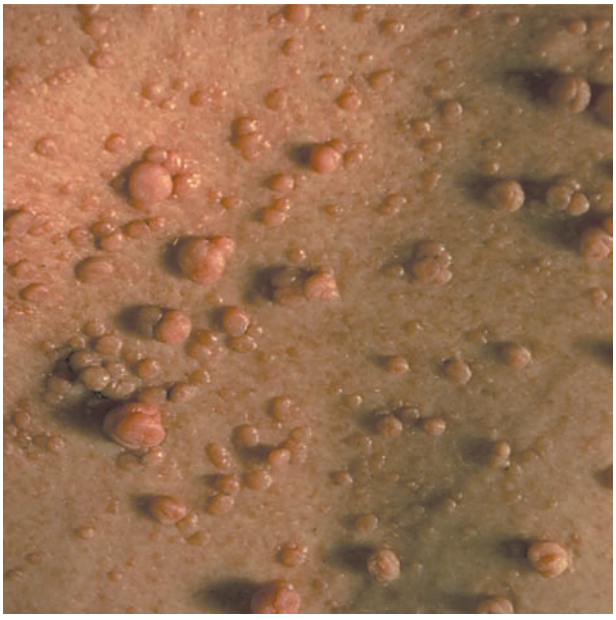
Neurofibromatosis (NF), or von Recklinghausen disease, is a genetic disease in which patients develop multiple soft tumors (neurofibromas). These tumors occur under the skin and throughout the nervous system.

Description

Neural crest cells are primitive cells which exist during fetal development. These cells eventually turn into:

- cells which form nerves throughout the brain, spinal cord, and body
- cells which serve as coverings around the nerves that course through the body
- pigment cells, which provide color to structures
- the meninges, the thin, membranous coverings of the brain and spinal cord
- cells which ultimately develop into the bony structures of the head and neck

In neurofibromatosis, a genetic defect causes these neural crest cells to develop abnormally. This results in numerous tumors and malformations of the nerves, bones, and skin.



This person's skin has multiple soft tumors, or neurofibromas. Such tumors develop underneath the skin. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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Neurofibromatosis occurs in about one of every 4,000 births. Two types of NF exist: NF-1 (90% of all cases), and NF-2 (10% of all cases).

Causes and symptoms

Both forms of neurofibromatosis are caused by a defective gene. NF-1 is due to a defect on chromosome 17; NF-2 results from a defect on chromosome 22. Both of these disorders are inherited in a dominant fashion. This means that anybody who receives just one defective gene will have the disease. However, a family pattern of NF is only evident in about half of all cases of NF. The other cases of NF occur due to a spontaneous mutation (a permanent change in the structure of a specific gene). Once such a spontaneous mutation has been established in an individual, however, it is then possible to be passed on to any offspring. The chance of a person with NF passing on the NF gene to a child is 50%.

NF-1 has a number of possible signs and can be diagnosed if any two of the following are present:

- The presence of café-au-lait (French for coffee-with-milk) spots. These are patches of tan or light brown skin, usually about 5-15 mm in diameter. Nearly all patients with NF-1 will display these spots.
- Multiple freckles in the armpit or groin area.
- Ninty percent of patients with NF-1 have tiny tumors called Lisch nodules in the iris (colored area) of the eye.
- Neurofibromas. These soft tumors are the hallmark of NF-1. They occur under the skin, often located along nerves or within the gastrointestinal tract. Neurofibromas are small and rubbery, and the skin overlying them may be somewhat purple in color.
- Skeletal deformities, such as a twisted spine (scoliosis), curved spine (humpback), or bowed legs.
- Tumors along the optic nerve, which cause vision disturbance in about 20% of patients.
- The presence of NF-1 in a patient's parent, child, or sibling.

There are very high rates of speech impairment, learning disabilities, and attention deficit disorder in children with NF-1. Other complications include the development of a **seizure disorder**, or the abnormal accumulation of fluid within the brain (**hydrocephalus**). A number of cancers are more common in patients with NF-1. These include a variety of types of malignant brain tumors, as well as leukemia, and cancerous tumors of certain muscles (rhabdomyosarcoma), the adrenal glands (**pheochromocytoma**), or the kidneys (**Wilms' tumor**).

Patients with NF-2 do not necessarily have the same characteristic skin symptoms (café-au-lait spots, freckling, and neurofibromas of the skin) that appear in NF-1. The characteristic symptoms of NF-2 are due to tumors along the acoustic nerve. Interfering with the function of this nerve results in the loss of hearing; and the tumor may spread to neighboring nervous system structures, causing weakness of the muscles of the face, **headache**, **dizziness**, poor balance, and uncoordinated walking. Cloudy areas on the lens of the eye (called **cataracts**) frequently develop at an unusually early age. As in NF-1, the chance of brain tumors developing is unusually high.

Diagnosis

Diagnosis is based on the symptoms outlined above. Diagnosis of NF-1 requires that at least two of the listed signs are present. Diagnosis of NF-2 requires the presence of either a mass on the acoustic nerve or another distinctive nervous system tumor. An important diagnostic clue for either NF-1 or NF-2 is the presence of the disorder in a patient's parent, child, or sibling.

Monitoring the progression of neurofibromatosis involves careful testing of vision and hearing. X-ray studies of the bones are frequently done to watch for the development of deformities. CT scans and MRI scans are performed to track the development/progression of tumors in the brain and along the nerves. Auditory evoked potentials (the electric response evoked in the cerebral cortex by stimulation of the acoustic nerve) may be helpful to determine involvement of the acoustic nerve, and EEG (electroencephalogram, a record of electrical currents in the brain) may be needed for patients with suspected seizures.

Treatment

There are no available treatments for the disorders that underlie either type of neurofibromatosis. To some extent, the symptoms of NF-1 and NF-2 can be treated individually. Skin tumors can be surgically removed. Some brain tumors, and tumors along the nerves, can be surgically removed, or treated with drugs (**chemotherapy**) or x-ray treatments (**radiation therapy**). Twisting or curving of the spine and bowed legs may require surgical treatment, or the wearing of a special brace.

Prognosis

Prognosis varies depending on the types of tumors which an individual develops. As tumors grow, they begin to destroy surrounding nerves and structures. Ultimately, this destruction can result in blindness, deafness, increasingly poor balance, and increasing difficulty with

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KEY TERMS

Chromosome—A structure within the nucleus of every cell, which contains genetic information governing the organism's development.

Mutation—A permanent change to the genetic code of an organism. Once established, a mutation can be passed on to offspring.

Neurofibroma—A soft tumor usually located on a nerve.

Tumor—An abnormal multiplying mass of cells.

the coordination necessary for walking. Deformities of the bones and spine can also interfere with walking and movement. When cancers develop, prognosis worsens according to the specific type of **cancer**.

Prevention

There is no known way to prevent the approximately 50% of all NF cases that occur due to a spontaneous change in the genes (mutation). New cases of inherited NF can be prevented with careful **genetic counseling** so that a person with NF understands that each of his or her offspring has a 50% chance of also having NF. When a parent has NF, and the specific genetic defect causing the parent's disease has been identified, tests can be performed on the fetus so that a during **pregnancy**. **Amniocentesis** or **chorionic villus sampling** are two techniques which allow small amounts of the developing baby's cells to be removed for examination. The tissue can then be examined for the presence of the parent's genetic defect. Some families choose to use this information in order to prepare for the arrival of a child with a serious medical problem. Other families may choose not to continue the pregnancy.

ORGANIZATIONS

Children's Foundation, 95 Pine St., 16th Floor, New York, NY, 10005-4002, (212) 344-6633, (800) 323-7938, info@ctf.org, http://www.ctf.org.

March of Dimes Birth Defects Foundation, 1275 Mamaroneck Ave., White Plains, NY, 10605, (914) 997-4488, http://www.modimes.org.

Neurofibromatosis, Inc. 8855 Annapolis Rd., #110, Lanham, P.O. Box 66884, Chicago, IL, 60666, (800) 942-6825, http://www.nfinc.org.

Rosalyn Carson-DeWitt, MD

Neurogenic arthropathy *see* **Charcot's joints**

Neurogenic bladder

Definition

Neurogenic bladder is a dysfunction that results from interference with the normal nerve pathways associated with urination.

Description

Normal bladder function is dependent on the nerves that sense the fullness of the bladder (sensory nerves) and on those that trigger the muscle movements that either empty it or retain urine (motor nerves). The reflex to urinate is triggered when the bladder fills to 300-500 mL. The bladder is then emptied when the contraction of the bladder wall muscles forces urine out through the urethra. The bladder, internal sphincters, and external sphincters may all be affected by nerve disorders that create abnormalities in bladder function.

There are two categories of neurogenic bladder dysfunction: overactive (spastic or hyper-reflexive) and underactive (flaccid or hypotonic). An overactive neurogenic bladder is characterized by uncontrolled, frequent expulsion of urine from the bladder. There is reduced bladder capacity and incomplete emptying of urine. An underactive neurogenic bladder has a capacity that is extremely large (up to 2000 mL). Due to a loss of the sensation of bladder filling, the bladder does not contract forcefully, and small amounts of urine dribble from the urethra as the bladder pressure reaches a breakthrough point.

Causes and symptoms

There are numerous causes for neurogenic bladder dysfunction and symptoms vary depending on the cause. An **overactive bladder** is caused by interruptions in the nerve pathways to the bladder occurring above the sacrum (five fused spinal vertebrae located just above the tailbone, or coccyx). This nerve damage results in a loss of sensation and motor control and is often seen in **stroke**, Parkinson's disease, and most forms of spinal-cord injuries. An underactive bladder is the result of interrupted bladder stimulation at the level of the sacral nerves. This may result from certain types of surgery on the spinal cord, sacral spinal tumors, or congenital defects. It also may be a complication of various diseases, such as **syphilis**, **diabetes mellitus**, or **polio**.

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Diagnosis

Neurogenic bladder is diagnosed by carefully recording fluid intake and urinary output and by measuring the quantity of urine remaining in the bladder after voiding (residual urine volume). This measurement is done by draining the bladder with a small rubber tube (catheter) after the person has urinated. Kidney function also is evaluated by regular laboratory testing of the blood and urine. **Cystometry** may be used to estimate the capacity of the bladder and the pressure changes within it. These measurements can help determine changes in bladder compliance in order to assess the effectiveness of treatment. Doctors may use a cystoscope to look inside the bladder and tubes that lead to it from the kidneys (ureters). **Cystoscopy** may be used to assess the loss of muscle fibers and elastic tissues and, in some cases, for removing small pieces of tissue for examination (biopsy).

Treatment

Doctors begin treating neurogenic bladder by attempting to reduce bladder stretching (distension) through intermittent or continuous catheterization. In intermittent catheterization, a small rubber catheter is inserted at regular intervals (four to six times per day) to approximate normal bladder function. This avoids the complications that may occur when a catheter remains in the bladder's outside opening (urethra) continuously (an indwelling catheter). Intermittent catheterization should be performed using strict sterile technique (asepsis) by skilled personnel, and hourly fluid intake and output must be recorded. Patients who can use their arms may be taught to catheterize themselves.

Indwelling catheters avoid distension by emptying the bladder continuously into a bedside drainage collector. Individuals with indwelling catheters are encouraged to maintain a high fluid intake in order to prevent bacteria from accumulating and growing in the urine. Increased fluid intake also decreases the concentration of **calcium** in the urine, minimizing urine crystallization and the subsequent formation of stones. Moving around as much as possible and a low calcium diet also help to reduce stone formation.

Drugs may be used to control the symptoms produced by a neurogenic bladder. The unwanted contractions of an overactive bladder with only small volumes of urine may be suppressed by drugs that relax the bladder (anticholinergics) such as propantheline (ProBanthine) and oxybutynin (Ditropan). Contraction of an underactive bladder with normal bladder volumes may be stimulated with parasympathomimetics (drugs that mimic the action resulting from stimulation of the parasympathetic nerves) such as bethanechol (Urecholine).

Long-term management for the individual with an overactive bladder is aimed at establishing an effective spontaneous reflex voiding. The amount of fluid taken in is controlled in measured amounts during the waking hours, with sips only toward bedtime to avoid bladder distension. At regular intervals during the day (every four to six hours when fluid intake is two to three liters per 24 hours), the patient attempts to void using pressure over the bladder (Crede maneuver). The patient may also stimulate reflex voiding by abdominal tapping or stretching of the anal sphincter. The **Valsalva maneuver**, involving efforts similar to those used when straining to pass stool, produces an increase in intra-abdominal pressure that is sometimes adequate to completely empty the bladder. The amount of urine remaining in the bladder (residual volume) is estimated by a comparison of fluid intake and output. The patient also may be catheterized immediately following the voiding attempt to determine residual urine. Catheterization intervals are lengthened as the residual urine volume decreases and catheterization may be discontinued when urine residuals are at an acceptable level to prevent **urinary tract infection**.

For an underactive bladder, the patient may be placed on a similar bladder routine with fluid intake and output adjusted to prevent bladder distension. If an adequate voiding reflex cannot be induced, the patient may be maintained on clean intermittent catheterization.

Some individuals who are unable to control urine output (**urinary incontinence**) due to deficient sphincter tone may benefit from perineal exercises. Although this is a somewhat dated technique, male patients with extensive sphincter damage may be helped by the use of a Cunningham clamp. The clamp is applied in a horizontal fashion behind the glans of the penis and must be removed approximately every four hours for bladder emptying to prevent bacteria from growing in the urine and causing an infection. Alternation of the Cunningham clamp with use of a condom collection device will reduce the skin irritation sometimes caused by the clamp.

Surgery is another treatment option for incontinence. Urinary diversion away from the bladder may involve creation of a urostomy or a continent diversion. The surgical implantation of an inflatable sphincter is another option for certain patients. An indwelling urinary catheter is sometimes used when all other methods of incontinence management have failed. The long-term use of an indwelling catheter almost inevitably leads to some urinary tract infections, and contributes to the formation of urinary stones (calculi). Doctors may prescribe **antibiotics** preventively to reduce recurrent urinary tract infection.

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KEY TERMS

Anticholinergic—An agent that blocks certain nerve impulses.

Catheterization—Insertion of a slender, flexible tube into the bladder to drain urine.

Compliance—A term used to describe how well a patient's behavior follows medical advice.

Cystometry—A test of bladder function in which pressure and volume of fluid in the bladder are measured during filling, storage, and voiding.

Cystoscopy—A direct method of bladder study and visualization using a cystoscope (self-contained optical lens system). The cystoscope can be manipulated to view the entire bladder, with a guide system to pass it up into the ureters (tubes leading from the kidneys to the bladder).

Glans penis—The bulbous tip of the penis.

Motor nerves—Nerves that cause movement when stimulated.

Parasympathomimetic—An agent whose effects mimic those resulting from stimulation of the parasympathetic nerves.

Perineal—The diamond-shaped region of the body between the pubic arch and the anus.

Reflex—An involuntary response to a particular stimulus.

Sensory nerves—Nerves that convey impulses from sense organs to the higher parts of the nervous system, including the brain.

Sphincter—A band of muscles that surrounds a natural opening in the body; these muscles can open or close the opening by relaxing or contracting.

Ureter—A tube leading from one of the kidneys to the bladder.

Urethra—The tube that leads from the bladder to the outside of the body.

Urostomy—A diversion of the urinary flow away from the bladder, resulting in output through the abdominal wall. The most common method involves use of a portion of intestine to conduct the urine out through the abdomen and into an external pouch worn for urine collection.

Alternative treatment

The cause of the bladder problem must be determined and treated appropriately. If nerve damage is not permanent, homeopathy and **acupuncture** may help restore function.

Prognosis

Individuals with an overactive bladder caused by spinal cord lesions at or above the seventh thoracic vertebra, are at risk for sympathetic dysreflexia, a life-threatening condition which can occur when the bladder (and/or rectum) becomes overly full. Initial symptoms include sweating (particularly on the forehead) and **headache**, with progression to slow heart rate (bradycardia) and high blood pressure (**hypertension**). Patients should notify their physician promptly if symptoms do not subside after the bladder (or rectum) is emptied, or if the bladder (or rectum) is full and cannot be emptied.

ORGANIZATIONS

American Urological Association (AUA), 1000 Corporate Boulevard, Linthicum, MD, 21090, (410) 689-3700, (410) 689-3800, (866) 746-4282, aua@AUAnet.org, http://www.auanet.org.

National Association for Continence, P.O. Box 1019, Charleston, SC, 29402-1019, (843) 377-0900, (843) 377-0905, (800) 252-3337, memberservices@nafc.org, http://www.nafc.org.

Simon Foundation for Continence, P.O. Box 815, Wilmette, IL, 60091, (800) 2237-4666, http://www.simonfoundation.org.

Kathleen D. Wright, RN

Neuroleptics *see* **Antipsychotic drugs**

Neurolinguistic programming

Definition

Neurolinguistic programming (NLP) is aimed at enhancing the healing process by changing the conscious and subconscious beliefs of patients about themselves, their illnesses, and the world. These limiting beliefs are "reprogrammed" using a variety of techniques drawn from other disciplines including **hypnotherapy** and **psychotherapy**.

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Purpose

Neurolinguistic programming has been used to change the limiting beliefs of patients about their prospects of recovery from a wide variety of medical conditions including Parkinson's disease, **AIDS**, migraines, arthritis, and **cancer**. Practitioners claim to be able to cure most **phobias** in less than one hour, and to help in making lifestyle changes regarding **exercise**, diet, **smoking**, etc. NLP has also been used to treat **allergies**. In other fields, claimed benefits include improved relationships, communication, motivation, and business performance.

Description

Origins

NLP was originally developed during the early 1970s by linguistics professor John Grinder, and psychology and mathematics student Richard Bandler, both of the University of California at Santa Cruz.

Studying the well-known psychotherapist Virginia Satir, the hypnotherapist Milton Erickson, the anthropologist Gregory Bateson, and others whom they considered "charismatic superstars" in their fields, Grinder and Bandler identified psychological, linguistic, and behavioral characteristics that they said contributed to the greatness of these individuals. On the other hand, they found that persons experiencing emotional difficulties could be similarly identified by posture, breathing pattern, choice of words, voice tone, eye movements, body language, and other characteristics.

Grinder and Bandler then focused on using these indicators to analyze and alter patterns of thought and behavior. After publishing their findings in two books in 1975, Grinder and Bandler parted company with one another, with a number of other collaborators, and with the University of California, continuing their work on NLP outside the formal world of academia. As a result, NLP split into a number of competing schools.

Popularized by television "infomercial" personality Anthony Robbins and others, NLP was quickly adopted in management and self-improvement circles. During the 1990s, there was growing interest in NLP's healing potential.

In a health-care context, practitioners of neurolinguistic programming first seek to identify the negative attitudes and beliefs with which a client has been "programmed" since birth. This is accomplished by asking questions and observing physical responses such as changes in skin color, muscle tension, etc. Then, a wide variety of techniques is employed to "reprogram" limiting beliefs. For example, clients with chronic illness such as AIDS or cancer might be asked to displace the despair and loss of identity caused by the disease by visualizing themselves in vigorous health. Treatment by NLP practitioners is often of shorter duration than that of other alternative practitioners, but NLP self-help seminars and courses can be quite expensive.

For those who wish to try self-treatment with NLP, a wide variety of books, audio tapes, and videos are available.

Precautions

NLP is particularly popular in the self-improvement and career-development fields, and some trainers and practitioners have little experience in its use for healing. Practitioners should be specifically asked about this.

Because NLP is intended to enhance the healing process, it should not be used independently of other healing methods. In all cases of serious illness, a physician should be consulted.

Side effects

NLP is believed to be generally free of harmful side effects.

Research and general acceptance

Although some physicians and mental health practitioners employ principles of neurolinguistic programming, the field is generally considered outside of mainstream medical practice and academic thinking.

ORGANIZATIONS

Association for NLP, Room, 11, Apsley Mills Cottage, London Road, Hemel Hempstead, Herts, HP3 9RL, (020) 3384 3217, (0845) 053 1176, http://www.anlp.org/.

International NLP Trainers Association, 1201 Delta Glen Court, Vienna, VA, 22182, wyatt.woodsmall@inlpta.org, http://www.inlpta.org.

Society of Neuro-Lingustic Programming, 7065 Bella Vista Road, Vernon, Canada, BC, V1H 1X3, (250) 545-6448, access@nlpmind.com, http://www.nlpmind.com/contact.

David Helwig

Neurologic bladder dysfunction *see* **Neurogenic bladder**

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Neurological exam

Definition

A neurological exam—also called a neurologic or neuro exam—is an evaluation of the nervous system, including the brain, spinal cord, the 12 cranial nerves that come from the brain, and the nerves that come from the spinal cord. A neurological exam uses observation and simple tests to assess motor and sensory skills and mental status. Motor skills include reflexes, muscle strength, eye and mouth movement, and coordination, balance, and gait. Sensory skills include hearing and speech, vision, taste, and smell. Mental status includes alertness, awareness of and interaction with one's environment, and mood and behavioral changes.

Purpose

Neurological exams are performed for a variety of purposes:

- as part of a complete physical exam
- as part of a newborn physical exam
- to assess or follow the effects of a head or spine birth defect
- for the diagnosis of a wide variety of diseases and conditions
- to follow the progression or management of a disease or condition
- to monitor an injury to the head, neck, or back
- to monitor recovery following brain surgery

Neurological exams are becoming routine in some sports, most notably preseason exams for all National Football League players to provide a baseline in case of **concussion**. A neurological exam can reveal signs of increased intracranial pressure or decreased brain function. In addition to concussions, neurological exams are performed on patients with any of the following symptoms:

- fatigue
- headaches
- blurred vision
- fever of unknown origin
- numbness or tingling in the arms or legs
- decreased arm or leg movement
- tremor
- uncontrollable jerky body movements
- problems with balance or coordination
- behavioral changes

A neurological exam is often one of the first procedures in the diagnosis of many diseases and conditions including:

- central nervous system (CNS) infections, such as encephalitis and meningitis
- stroke
- transient ischemic attacks—in which the exam results may be abnormal during the episode but normal immediately afterwards
- bleeding in the brain
- spinal cord injuries
- carotid artery disease
- peripheral neuropathy
- alcoholic neuropathy
- erectile dysfunction
- brain and spinal cord tumors, including pituitary tumors and primary CNS lymphomas
- nasopharyngeal cancer
- brain abscesses
- brain herniation
- epilepsy
- cerebral palsy
- dementia
- Alzheimer's disease
- Parkinson's disease
- Huntington's disease
- multiple sclerosis
- myasthenia gravis—a muscle weakness disorder
- neurological complications of HIV/AIDS
- systemic lupus erythematosus, a chronic inflammatory autoimmune disease
- amyotrophic lateral sclerosis (ALS)
- congenital toxoplasmosis
- craniosynostosis, a congenital defect in which one or more sutures on a infant's head close too early
- mitochondrial diseases
- motor neuron diseases
- metabolic diseases of muscle

Description

A neurological exam is neither invasive nor painful. It can be performed in a physician's office and involves only simple instruments such as a reflex hammer, tuning fork, needles, a light, and an ophthalmoscope. The simplest aspects of a neurological exam involve observing a patient's gait and coordination and whether the eyelids are drooping. However some specialized exams may require a neurologist to

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perform the tests and analyze the results. The extent of a neurological exam depends on the symptoms being evaluating and the patient's age and medical condition. For some injuries it may be necessary to repeat portions of the exam after swelling from the injury has decreased. In some cases, such as after a **stroke**, neurological exams may be repeated at regular intervals to monitor the condition.

A neurological exam focuses on:

- motor skills, including reflexes, muscle strength, head and facial movements, coordination, balance, and gait
- sensory skills
- mental status and basic cognitive skills
- cranial nerves

Motor nerve function—especially deep tendon reflexes—are central to a neurological exam. Deep tendon reflexes, also known as muscle stretch reflexes, are tendon responses to stimuli. Normally, tapping specific areas of tendons with a soft rubber hammer causes the muscle fibers to contract. The physician taps various points with a reflex hammer and observes any decrease in responsiveness.

The Babinski reflex is an important component of motor system evaluation. In patients over the age of two, stroking or scratching the outer side of the sole of the foot in a heel-to-toe direction normally causes the toes to curl downward. A brain or **spinal cord injury** is indicated by the toes fanning upward.

The physician will examine the patient's muscles for atrophy (shrinkage), twitching, or abnormal movements. Tests may be performed to evaluate the strength of all major muscle groups. Specific tests may include:

- squeezing fingers
- using the arms and legs to push and pull against the physician's hands
- passive movement of the joints by the physician and active movement by the patient

Head and facial movement tests may include:

- touching various areas of the face
- biting down
- swallowing
- smiling, grimacing, moving the cheeks, and baring the teeth
- tongue movement
- testing the gag reflex using a tongue blade
- head movements such as turning side to side against mild resistance
- shrugging the shoulders

Tests of coordination, balance, and gait may include:

- observation of a patient's walk and general coordination
- moving one's finger back and forth between one's nose and the examiner's finger, touching the tip of each
- tapping one's fingers together rapidly in a coordinated manner
- moving one's hands back and forth on top of one another as smoothly as possible
- rubbing one heel smoothly over the other shin
- drawing a spiral
- touching a finger to one's nose with the eyes closed
- balancing with the feet together and eyes closed
- standing with the eyes closed while being gently pushed to one side
- heel-to-toe walking in a straight line
- walking on one's toes
- turning abruptly
- running, hopping, skipping, or jumping
- evaluation of any functional limitations, such as difficulty writing or holding a cup or utensil

Sensory tests may include:

- hearing tests using a ticking watch or a tuning fork
- clarity, fluency, and coherence of speech
- vision tests
- examining the eye with a special light to evaluate the optic nerve
- using a light to evaluate pupil size reflex
- evaluating eye movement by having the patient follow a light or the examiner's finger in various directions with the eyes
- identifying various tastes—such as sweet, sour, and bitter—on the back of the tongue
- identifying different smells with the eyes closed
- identifying objects and sensations—such as sharp or dull—as the physician touches parts of the patient's body with a finger, sharp object, cotton ball, paint brush, dull needle, tuning fork, or alcohol swab
- identifying numbers or letters traced on the body
- using pinpricks to test a patient's pain response on different parts or opposite sides of the body
- using cold or warm objects to test temperature sensations
- sense of position by identifying the direction in which the examiner is moving a part of the patient's body, such as a big toe

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KEY TERMS

Automatism—An automatic action or reflex.

Babinski reflex—A reflex movement by the big toe when the sole is tickled: an upward response is normal in infancy, but indicates central nervous system damage in older children and adults.

Moro reflex—A reflex startle reaction in infants: the arms and legs move away from the body and to the side and are then drawn together.

Ophthalmoscope—An instrument for viewing the interior of the eye.

Stroke—A sudden diminishment of consciousness, sensation, or voluntary movement caused by a rupture or clot in a blood vessel in the brain.

Tendon reflex—A reflex action, such as a knee jerk, in which a light blow to the tendon causes the muscle to contract.

Evaluating mental status is particularly important when other parts of a neurological exam yield normal results. Sometimes small changes in memory or other intellectual abilities are the only indication of a problem. Evaluating mental skills can also be useful for determining a course of treatment and making a prognosis. Mental status tests may involve:

- observing a patient's state of consciousness or awareness of and responsiveness to the environment and the senses
- ability to follow simple and complex directions
- orientation with reference to time, place, and person, such as knowing the current time and date and the current president
- attentiveness
- ability to appropriately answer simple but detailed questions
- ability to read and write
- intellectual capacity including comprehension, insight, and judgment
- solving simple mathematical problems
- copying a three-dimensional drawing
- drawing a clock with the numbers and hands placed appropriately
- abstract reasoning tests such as explaining the meaning of common sayings
- memory tests, such as repeating sentences or a list of objects used early in the exam or describing yesterday's breakfast or what happened on the last holiday
- the patient's appearance, mood, and general behavior
- with an infant, observing the child's interaction with parents

Specific components of a neurological exam evaluate the function of each of the 12 cranial nerves:

- cranial nerve I—the olfactory nerve
- cranial nerve II—the optic nerve
- cranial nerve III—the oculomotor nerve responsible for pupil size and eye movement
- cranial nerve IV—the trochlear nerve involved in eye movement
- cranial nerve V—the trigeminal nerve—which has various functions including the ability to feel the face and inside the mouth, and moving muscles involved in chewing
- cranial nerve VI—the abducens nerve involved in eye movement
- cranial nerve VII—the facial nerve—which has various functions including taste and movement
- cranial nerve VIII—the acoustic nerve
- cranial nerve IX—the glossopharyngeal nerve involved in taste
- cranial nerve X—the vagus nerve involved in swallowing, gag reflex, and aspects of taste and speech
- cranial nerve XI—the accessory nerve involved in moving the head and shoulders
- cranial nerve XII—the hypoglossal nerve responsible for tongue movement

A newborn or infant neurological exam evaluates reflexes or automatisms, each of which disappears at a certain stage of normal development. These reflexes include, but are not limited to, the following:

- blinking—closing the eyes in response to a bright light
- Babinski reflex—the toes extending upward as an infant's foot is stroked
- crawling—infants making crawling motions when placed on their stomach
- Moro reflex—infants throw out their arms, open their hands, and throw back their heads when startled or moved rapidly
- palmar and plantar grasps—infants fingers and toes curl around a nearby finger

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- startle reflex—infants extend and flex the arms with the hands fisted in response to loud noise A measurement of head circumference is also part of a neurological exam in infants and younger children.

Benefits

A neurological exam is a relatively simple, quick, and inexpensive means of identifying a wide range of neurological abnormalities. In many cases a simple neurological exam has been found to be superior to expensive computed tomography (CT) scans for diagnoses. Neurological problems and nervous system damage can cause delays in infant and child development and functioning: early diagnosis of problems using a neurological exam can help identify the cause and decrease the likelihood of long-term complications.

Precautions

Precautions concerning a neurological exam include:

- The exam requires skill and patience on the part of the physician.
- Importantly, the exam requires the patient's cooperation.
- Responses can be affected by the wakefulness, awareness, and alertness of the patient, so the mental status portion of a neurological exam is usually performed early on.
- The sensory exam should be repeated for accuracy.

Aftercare

There are no special preparations or risks involved in a neurological exam. However abnormal results may require further procedures such as a CT scan, **magnetic resonance imaging** (MRI), x-rays, or laboratory tests. The patient may be referred to a neurologist or other specialist.

Resources

BOOKS

Levy, Michael. *Patient Encounters: The Neurology and Psychiatric Work-Up*. Philadelphia: Wolters Kluwer/ Lippincott Williams & Wilkins, 2010.

PERIODICALS

Gruber, Nancy. "Beyond Discharge: Impairment After Critical Illness." *RN* 71, no. 5 (May 2008): 29.

OTHER

"Chapter 5: Diagnosis & Follow-Up Testing." *A Primer of Brain Tumors*. http://www.abta.org/siteFiles/SitePages/CB001386B9BE886833764351A83EFA8B.pdf

"Neurological Diagnostic Tests and Procedures." *National Institute of Neurological Disorders and Stroke*. http://www.ninds.nih.gov/disorders/misc/diagnostic_tests.htm#examination

"Neurological Exam." *Children's Hospital Boston*. http://www.childrenshospital.org/az/Site1350/mainpageS1350P0.html

"What Is a Neurological Exam?" *Diagnostic Tests*. http://www.neurologychannel.com/neuroexam.shtml

ORGANIZATIONS

American Brain Tumor Association, 2720 River Road, Des Plaines, IL, 60018, (847) 827-9910, (800) 886-2282 , (847) 827-9918, infor@abta.org, http://www.abta.org.

National Institute of Neurological Disorders and Stroke (NINDS), NIH Neurological Institute, P.O. Box 5801, Bethesda, MD, 20824, (301) 496-5751, (800) 352-9424, http://www.ninds.nih.gov/index.htm.

Margaret Alic, PhD
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Neurosurgery

Definition

Neurosurgery is a specialized field of surgery for the treatment of diseases or conditions of the central nervous system (CNS) and spine.

Description

Neurosurgery is the specialized field of surgery that treats diseases that affect the CNS—the brain and the spine. A neurosurgeon is a medical doctor who has received extensive training in the surgical and medical management of neurological diseases. The field of neurosurgery is one of the most sophisticated surgical specialties and encompasses advanced surgical and imaging technology and new research in molecular neurosurgery and **gene therapy**. There are five general categories of neurosurgical diseases that are commonly managed by neurosurgeons: cerebrovascular (hemorrhage [bleeding] and aneurysms); traumatic **head injury**, or THI traumatic injury caused by accident); degenerative diseases of the spine; tumors in the CNS; functional neurosurgery; surgery for congenital abnormalities; and neurosurgical management of the CNS.

Cerebrovascular diseases that usually require surgery include spontaneous intracranial hemorrhage (bleeding within the skull), spontaneous **subarachnoid hemorrhage** (bleeding beneath the outer membranous covering of the brain), spontaneous intracerebral

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hemorrhage (bleeding within the brain), cerebral aneurysms (outpouchings of the blood vessel), hypertensive intracerebral hemorrhage (due to high blood pressure), and angiomatous malformations.

Brain hemorrhage

Spontaneous intracranial hemorrhage is a condition characterized by hemorrhage in the brain (hemorrhagic **stroke**) that results in a sudden onset of neurologically worsening symptoms (that include focal neurologic deficits and loss of consciousness). CT scans are helpful in identifying the intracranial hemorrhage, of which there are two types—subarachnoid hemorrhage and intracerebral hematoma.

The subarachnoid space is an area that exists between two layers of coverings (membranes) that wrap around the brain. A spontaneous subarachnoid hemorrhage is defined as blood (not caused by trauma), in the subarachnoid space. The amount of blood in the subarachnoid space can be a focal (small area) amount or a larger, more diffuse hemorrhage, which can be further complicated by having an intraventricular hemorrhage or intracerebral hematoma at the same time.

The incidence of subarachnoid hemorrhage is 10 per 100,000 persons per year; approximately 30% of Americans will sustain a subarachnoid hemorrhage annually. **Smoking** is a major factor in increasing the odds of sustaining a subarachnoid hemorrhage. Subarachnoid hemorrhage can affect adults of all ages, but usually peaks in the fourth and fifth decades of life. Approximately 60% of patients are female. Approximately 30% of subarachnoid hemorrhages occur during sleep.

The most frequent cause of spontaneous subarachnoid hemorrhage is rupture of an intracranial aneurysm. The symptoms of subarachnoid hemorrhage are a sudden onset of severe **headache** that worsens over time, **nausea**, loss of consciousness (with or without seizure), and **vomiting**. Depending on the severity of bleeding, additional symptoms can also include visual sensitivity to light (photophobia), a stiff neck, and minor (low-grade) **fever**. Symptoms occur before rupture of the aneurysm in 40% of patients, usually in those with a minor hemorrhage. These symptoms can also include headache or **dizziness**, and tend to go unnoticed.

After a subarachnoid hemorrhage, most patients are hypertensive (have high blood pressure) and experience changes in heart rate and rhythm. CT scans are the best diagnostic tool for subarachnoid hemorrhage. The hemorrhage can be visualized in the first 24 hours after onset in 90% of patients and in more than 50% in the first week. Spinal taps to sample the cerebrospinal fluid (CSF) may be required to evaluate some patients who have the potential to suffer a subarachnoid hemorrhage. This procedure involves the insertion of a thin needle between the lumbar vertebral bodies (L–4 and L–5) to allow the removal of a small amount of fluid to look for either red (RBCs) or white blood cells (WBCs). Once the aneurysm has been identified, the patient is taken for surgery. A **craniotomy** is performed using microsurgical techniques. The operative microscope helps to identify the aneurysm, which is then clipped. A berry aneurysm, or congenital aneurysm, is the reason for more than half of all cases of spontaneous subarachnoid hemorrhage.

A spontaneous intracerebral hemorrhage (or hematoma) (SICH) is a blood clot in brain tissue that can arise abruptly and is strongly correlated with **hypertension**. There are approximately 40,000 new

KEY TERMS

Angiomatous malformations—Tumors in blood vessels.

Cerebral aneurysms—A sac in a blood vessel in the brain that can rupture and cause bleeding in the brain.

Craniosynostosis—Premature closure of the skull, which results in skull deformities.

Craniotomy—Procedure to remove a lesion in the brain through an opening in the skull.

Desiccation—Extreme drying.

Encephaloceles—Protrusion of the brain through a defect in the skull.

Germinoma—A tumor of germ cells (ovum and sperm cells that participate in production of the developing embryo).

Hydrocephalus—A defect characterized by an increase in cerebrospinal fluid (CSF), which bathes and nourishes the brain and spinal cord.

Intraventricular hemorrhage—Hemorrhage in the ventricles of the brain.

Lymphoma—A tumor of lymph glands or lymph tissues.

Meninges—Membranes that cover the brain.

Myelomeningoceles (MMC)—A protrusion in the vertebral column containing spinal cord and meninges.

Subarachnoid space—A space between membranes that covers and protects the brain.

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cases of SICH in the United States annually. Stroke is the third leading cause of **death** in the United States, and SICH accounts for 10% of all stroke cases. Advancing age is a major predisposing factor for SICH: The incidence of SICH is two per 1,000 persons per year by age 45, and rises to 350 per 100,000 persons per year in those aged 80 years or more. Hypertensive intracerebral hemorrhage can occur in different areas within the brain. Damage to some areas may be associated with a very high death rate. Treatment includes comprehensive ICU (intensive care unit) management of hypertension and maintenance of adequate cerebral perfusion (oxygenated blood going to the brain).

Accidental head injury is a major public health problem. Trauma causes approximately 150,000 deaths annually in the United States; approximately half of these deaths were caused by fatal head trauma. Additionally, there are 10,000 new spinal cord injuries annually. The cost of disability (e.g., chronic long-term care, lost wages, and work) is very high. Approximately 200,000 persons in the United States are living with disabilities associated with head and spinal cord trauma.

Severe head injury is defined as an injury that produces **coma** (patient will not open eyes even to painful stimulus; is incapable of following simple commands; and cannot utter words). These clinical criteria are defined on the well-established Glasgow Coma Scale (GCS). A **physical examination** and neurologic assessment by a neurosurgeon and brain scan imaging (CT scan) are necessary for the initial evaluation. Additionally, a special catheter to monitor intracranial pressure (due to brain swelling) is necessary. A blood clot larger than 25 to 30 cubic centimeters is considered clinically large enough to cause progressive brain injury.

Tumors inside the brain (intracranial tumors) are typically of two types: primary and secondary intracranial tumors. Primary intracranial tumors (PICT) rarely metastasize and usually originate in the brain, coverings (membranes) of the brain, or the pituitary gland. The incidence of primary intracranial tumors is 11.5 per 100,000, or approximately 35,000 persons per year.

Secondary intracranial tumors arise from outside the brain coverings (meninges). Quite commonly, secondary intracranial tumors are bloodborne metastatic disease from primary malignant **cancer** outside the brain (i.e., cancer from some other location that has spread to the brain). Approximately 250,000 persons per year are affected by secondary intracranial tumors. A tumor in the brain can cause increased intracranial pressure, or cause symptoms associated with localized compression of the brain (i.e., a tumor grows and compresses part of the brain against the skull). One common cause of increased intracranial pressure is growth of a tumor that obstructs the duct system of cerebrospinal fluid (CSF), which bathes and nourishes the brain and spinal cord. Common symptoms can include nausea, **vomiting**, headache that is worse in the morning, and a reduced level of consciousness that causes drowsiness. Tumors causing focal compression on or irritation of the brain usually result in loss of neurologic function. This progressive loss of neurologic function can manifest as **tinnitus** (ringing in the ears) or **aphasia** (language problems).

Technical advancement has made surgical removal of brain tumors more effective and safer. Surgical management of intracranial tumors focuses on diagnosis and reduction of tumor mass. Depending on tumor location and patient health status, the neurosurgeon may perform a needle biopsy (called image-directed stereotactic needle biopsy) or a craniotomy to extract a piece of tumor for pathologic analysis. If the tumor is located in an area where surgery can be performed, the neurosurgeon generally will remove the mass if the patient can tolerate **general anesthesia**. Exceptions to a surgical option may be exercised to treat malignant tumors that are very sensitive to **chemotherapy** or **radiation therapy** (i.e., to manage lymphoma or germinoma). One of the most common types of tumors is the glioma, which accounts for 50% of all primary brain tumors.

Degenerative disorders of the spine

Degenerative disorders of the spine are a common problem. Between 50% and 90% of the population will experience back **pain** at some point in their lifetime. Most of these symptoms subside on their own within a few weeks; the cost, however, is realized in decreased productivity and lost wages—a public health problem. Pain in the lumbar spine is the most common reason adults seek medical attention. The lumbar spine comprises five lumbar vertebra and supports the weight of the entire vertebral column and head. Lower back disorders are among the most frequent reasons for referral to a neurosurgeon. Lumbar discs are prone to herniation and desiccation (drying out) as a result of the heavy load they bear and the motion to which they are subject. Nerves that run from the vertebrae extend out to distant body parts, and degeneration of the discs may change bony structures in such a manner that can cause nerve compression. Typically, patients with degenerative disorders of the spine may experience pain, **numbness**, paresthesia (**tingling**), and restriction of

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neck movement (if the affected vertebra is in the cervical spine, which is located in the back of the neck).

Surgery for congenital abnormalities

Congenital abnormalities arise during embryonic development. Important changes in growth and chemistry occur during the second week of human gestation; these changes contribute to the development of the nervous system. Several different types of cells proliferate as they move together or separate into other structures according to an orchestrated, natural timeline. Defects can occur at different stages of development. Among the defects with which infants can be born include myelomeningoceles, encephaloceles, **hydrocephalus**, and craniosynostosis.

Central nervous system infections

Solitary or multiple brain abscesses can occur as a result of infection in the brain. Patients present with clinical symptoms such as focal (a specific area is affected) neurologic signs, seizures, altered mental status, and increased intracranial pressure. CT scans and **magnetic resonance imaging** (MRI) are helpful for identification of brain abscesses. Surgery is usually indicated if the **abscess** fails to resolve or worsens following antibiotic treatment, or if there are signs of mass effect and brain herniation. Although rare, a spinal epidural abscess can occur. Typically, bacteria can spread in patients who have acute bacterial **meningitis** (infection of the subarachnoid spaces and meninges). The specific type of problem bacteria varies according to the patient's age.

Functional neurosurgery

Functional neurosurgery is a special type of surgical procedure used to manage movement disorder, **epilepsy**, and pain. Stereotactic neurosurgery makes use of a coordinate system that provides accurate navigation to a specific point or region in the brain. This is usually done by placing and fixing into position a frame on the scalp (using four threaded pins that penetrate the outer skull to stabilize the frame in position) under **local anesthesia**. A special box and sterotactic arc are placed to precisely determine X, Y, and Z coordinates of any point within the frame.

Epilepsy surgery

Approximately 70 people per 100,000 in the United States takes antiepileptic medications for seizure disorders. The risk of developing epilepsy over a lifetime is 3%, and there are 100,000 new cases per year. The majority of cases (approximately 60,000) are epilepsy of the temporal lobe (the brain lobes located on the sides of the head). Approximately 25% of temporal lobe seizure patients who are prescribed antiepileptic drugs continue to have seizures that are not controlled or that can be controlled, but the side effects of the medication outweigh the therapeutic benefits. Approximately 5,000 new cases per year require epilepsy surgery (partial anterior temporal **lobectomy**). The patient and neurosurgeon should consider surgery if continued seizures cause injuries due to repeated falls; driving restrictions; limitation of social interactions; problems related to education and learning; and employment limitations.

The future of neurosurgery

Neurosurgery as a field is faced with many new opportunities and challenges, based on advanced technological approaches and molecular approaches to neurosurgical problems. Advances in technology have allowed the neurosurgeon to precisely locate abnormal tissue in the brain and spinal cord, thereby preserving normal tissues from surgical trauma. In addition to cardiovascular neurosurgery, functional neurosurgery, neuro-oncologic neurosurgery (surgical removal of brain tumors), and spinal surgery, the future holds many new research innovations. In the new millennium, the field of molecular neurosurgery can make it possible to introduce genetic material into nerve cells and to redirect protein synthesis—to work toward reversing the disease process, in general.

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ORGANIZATIONS

The American Board of Neurological Surgery, 6550 Fannin Street, Suite 2139, Houston, TX, 77030, (713) 441-6015, http://www.abns.org.

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Neuromuscular junction disease *see* **Myasthenia gravis**

Neuropathic bladder *see* **Neurogenic bladder**

Neutropenia

Definition

Neutropenia is an abnormally low level of neutrophils in the blood. Neutrophils are white blood cells (WBCs) produced in the bone marrow that ingest bacteria. Neutropenia is sometimes called agranulocytosis or granulocytopenia because neutrophils make up about 60% of WBCs and have granules inside their cell walls. Neutropenia is a serious disorder because it makes the body vulnerable to bacterial and fungal infections.

Description

The normal level of neutrophils in human blood varies slightly by age and race. Infants have lower counts than older children and adults, and African Americans have lower counts than Caucasians or Asians. The average adult level is 1,500 cells/mm^3 of blood. Neutrophil counts (in cells/mm^3) are interpreted as follows:

- greater than 1,000–normal protection against infection
- 500–1,000–some increased risk of infection
- 200–500–great risk of severe infection
- lower than 200–risk of overwhelming infection; requires hospital treatment with antibiotics

Causes and symptoms

Causes

Neutropenia may result from three processes:

DECREASED WBC PRODUCTION. Lowered production of white blood cells is the most common cause of neutropenia. It can result from:

- medications that affect the bone marrow, including cancer drugs, chloramphenicol (Chloromycetin), anticonvulsant medications, and antipsychotic drugs (Thorazine, Prolixin, and other phenothiazines)
- hereditary and congenital disorders that affect the bone marrow, including familial neutropenia, cyclic neutropenia, and infantile agranulocytosis
- cancer, including certain types of leukemia
- radiation therapy
- exposure to pesticides
- vitamin B_{12} and folate (folic acid) deficiency

DESTRUCTION OF WBCS. WBCs are used up at a faster rate by:

- acute bacterial infections in adults
- infections in newborns
- certain autoimmune disorders, including systemic lupus erythematosus (SLE)
- penicillin, phenytoin (Dilantin), and sulfonamide medications (Benemid, Bactrim, Gantanol)

SEQUESTRATION AND MARGINATION OF WBCS. Sequestration and margination are processes in which neutrophils are removed from the general blood circulation and redistributed within the body. These processes can occur because of:

- hemodialysis
- Felty's syndrome or malaria, in which the neutrophils accumulate in the spleen
- bacterial infections, in which the neutrophils remain in the infected tissues without returning to the bloodstream

Symptoms

Neutropenia has no specific symptoms except the severity of the patient's current infection. In severe neutropenia, the patient is likely to develop **periodontal disease**, oral and rectal ulcers, **fever**, and bacterial **pneumonia**. Fever recurring every 19–30 days suggests cyclical neutropenia.

Diagnosis

Diagnosis is made on the basis of a **white blood cell count** and **differential** (determines the percentage of different types of WBCs). The cause of neutropenia is often difficult to establish and depends on a combination of the patient's history, genetic evaluation, **bone marrow biopsy**, and repeated measurements of the WBCs.

Treatment

Treatment of neutropenia depends on the underlying cause.

Medications

Patients with fever and other signs of infection are treated for seven to 10 days with **antibiotics**. Nutritional deficiencies are corrected by green vegetables to supply **folic acid**, and by vitamin B supplements.

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KEY TERMS

Cyclical neutropenia—A rare genetic blood disorder in which the patient's neutrophil level drops below 500/mm^3 for six to eight days every three weeks.

Differential—A blood cell count in which the percentages of cell types are calculated as well as the total number of cells.

Felty's syndrome—An autoimmune disorder in which neutropenia is associated with rheumatoid arthritis and an enlarged spleen.

Granulocyte—Any of several types of white blood cells that have granules in their cell substance. Neutrophils are the most common type of granulocyte.

Neutrophil—A granular white blood cell that ingests bacteria, dead tissue cells, and foreign matter.

Sargramostim—A medication made from yeast that stimulates WBC production. It is sold under the trade names Leukine and Prokine.

Sequestration and margination—The removal of neutrophils from circulating blood by cell changes that trap them in the lungs and spleen.

Medications known to cause neutropenia are stopped. Neutropenia related to pesticide exposure is treated by removing the patient from the contaminated environment.

Patients receiving **chemotherapy** for **cancer** may be given a blood growth factor called sargramostim (Leukine, Prokine) to stimulate WBC production.

Surgery

Patients with Felty's syndrome who have repeated infections may have their spleens removed.

Prognosis

The prognosis for mild or chronic neutropenia is excellent. Recovery from acute neutropenia depends on the severity of the patient's infection and the promptness of treatment.

Resources

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Rebecca J. Frey, PhD

Nevirapine *see* **Non-nucleoside reverse transcriptase inhibitors**

Nevus *see* **Moles**

Newborn life support *see* **Extracorporeal membrane oxygenation**

Niacin deficiency *see* **Pellagra**

Nicotine *see* **Smoking; Smoking-cessation drugs**

Nicotine and related disorders

Definition

Nicotine disorders are caused by the main psychoactive ingredient in tobacco. Nicotine is a physically and psychologically addictive drug. It is the most influential dependence-producing drug in the United States and worldwide, and its use is associated with many serious health risks.

Demographics

Although the prevalence of **smoking** has gradually decreased in the United States and many other industrialized countries since the 1970s, the use of tobacco products is rapidly increasing in developing nations, where approximately 80% of current smokers live. Younger populations may be particularly vulnerable. For example, a CDC survey from 2003 found that almost 42% of teenaged boys in one city in Mali were cigarette smokers. The World Health Organization currently attributes 4.9 million deaths per year globally to tobacco use among the estimated 1.2 billion smokers worldwide, a **death** total expected to double in two to three decades. Use of tobacco products in developing countries is of particular concern because these countries often lack adequate health care resources to treat smoking-related diseases, let alone support smoking cessation programs.

In the United States, the percentage of men who smoke outnumbers that of women 23% to 18.7%. In developing countries, male smokers outnumber women smokers, but among adolescent populations, girls and boys are becoming more equal in their rates of smoking. In the United States, people who smoke tend to have lower levels of formal education than those who do not. About half of patients diagnosed with psychiatric problems are smokers, while more

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Nicotine effects and trends

Effects:

- Nicotine is highly addictive.
- The tar in cigarettes increases a person's chance of developing lung cancer, emphysema, or chronic bronchitis.
- The carbon monoxide in smoke increases the risk of developing a cardiovascular disease.
- Pregnant smokers are more likely to have miscarriages or babies born with low birth weights.
- Secondhand smoke can cause lung cancer in adults and greatly increases the risk of respiratory illnesses in children.

Statistics and trends:

In 2008, nearly 71 million Americans aged 12 and older used a tobacco product at least once in the past month.

- Almost 60 million smoked cigarettes
- 8.7 million used smokeless tobacco
- More than 13 million smoked cigars
- Just under 2 million smoked pipe tobacco

SOURCE: National Institutes of Health, National Institute on Drug Abuse, "Tobacco/Nicotine." Available online at: http://www.drugabuse.gov/drugpages/nicotine.html (accessed August 16, 2010).

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than three-quarters of those who abuse other substances also smoke.

From 1997 to 2005, smoking among high-school students had declined after increasing dramatically in the 1990s; however, in 2005, there appears to have been a slight uptick in percentage of smokers in this group. Smoking among women with less than a high school education has shown a steady decline since a bump upward in 1995, but there was a slight increase from 2002 to 2004 among women with a high-school education. Smoking rates among white and African American males overall were almost identical in 2004, but African American males between the ages of 45 and 65 had the highest rates of any group, at 29% in 2004. Among pregnant women, the highest rates of smoking in 2003 occurred among American Indian or Alaska Native women, at 18%. In an age breakdown, women in the 18- to 19-year age group had the highest rates of smoking during **pregnancy**, at 17%, while education plays a strong role in whether a pregnant woman smokes: rates among women without a high-school diploma were 25.5%, while rates among women with at least a four-year degree were 1.6%.

Recent research suggests that there may be a genetic component to nicotine dependence, just as there is for alcohol dependence. Studies show that girls (but not boys) whose mothers smoked during pregnancy are four times more likely to smoke than those whose mothers were tobacco-free during pregnancy. Other research suggests that the absence of a certain enzyme in the body protects the body against nicotine dependence. In addition, there appears to be a sex-based difference among smokers: women may have a harder time quitting smoking.

Description

Nicotine is the most addictive and psychoactive chemical in tobacco, a plant native to the North America. Early European explorers learned to smoke its leaves from indigenous peoples who had been using tobacco for hundreds of years. They took tobacco back to Europe, where it became immensely popular. Tobacco became a major source of income for the American colonies and later for the United States. Advances in cigarette-making technology caused a boom in cigarette smoking in the early 1900s. Before the early twentieth century, most people who used tobacco used pipes, cigars, or chewing tobacco.

In the 1950s, researchers began to link cigarette smoking to certain respiratory diseases and cancers. In 1964 the Surgeon General of the United States issued the first health report on smoking. Cigarette smoking peaked in the United States in the 1960s, then began to decline as health concerns about tobacco increased. In 1971 cigarette advertising was banned from television, although tobacco products are still advertised in other media today. There are about 91.5 million current and former smokers in the United States, and in a 2004 survey, almost 4 million adolescents had tried smoking in the previous month. Most active smokers are addicted to nicotine.

Pure nicotine is a colorless liquid that turns brown and smells like tobacco when exposed to air. Nicotine can be absorbed through the skin, the lining of the mouth and nose, and the moist tissues lining the lungs. Cigarettes are the most efficient nicotine delivery system. Once tobacco smoke is inhaled, nicotine reaches the brain in less than 15 seconds. Because people who smoke pipes and cigars do not inhale, they absorb nicotine more slowly. Nicotine in chewing tobacco and snuff is absorbed through the mucous membranes lining the mouth and nasal passages. There are also several "hard snuff" and other new tobacco products being produced and marketed as alternative to traditional tobacco products. At least one study of the nicotine content of these products has found that some have lower levels of nicotine than regular tobacco products, but others contain comparable levels.

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KEY TERMS

Tapering—Gradually reducing the intake of an addictive substance (such as nicotine) as part of a cessation effort.

Withdrawal—Physical symptoms and psychological discomforts experienced after eliminating the intake of an addictive substance (such as nicotine) from the body.

Causes and symptoms

How nicotine works

Nicotine is the main addictive drug among the 4,000 compounds found in tobacco smoke. Such other substances in smoke as tar and carbon monoxide present documented health hazards, but they are not addictive and do not cause cravings or withdrawal symptoms to the extent that nicotine does. Neuroimaging technology has shown that levels of monoamine oxidase, the enzyme responsible for boosting mood-enhancing molecule levels in the brain, increase in response to smoking, even though nicotine does not affect levels of this enzyme. Thus, some other compound in cigarette smoke must be acting to exert this effect. In addition, a compound in cigarette smoke called acetylaldehyde may contribute to tobacco addiction and may have a stronger effect in adolescents.

Nicotine is both a stimulant and a sedative. It is a psychoactive drug, meaning that it works in the brain, alters brain chemistry, and changes mood. Once tobacco smoke is inhaled, nicotine passes rapidly through the linings of the lungs and into the blood. It quickly circulates to the brain where it stimulates release of dopamine, a neurotransmitter (nerve signaling molecule) in the brain that affects mood. Drugs that elicit an increase in dopamine influence the brain's "reward" pathway, causing the user to turn again to the drug for another pleasurable, rewarding dopamine response. This release accounts for the pleasurable sensation that most smokers feel almost as soon as they light a cigarette. Nicotine also decreases anger and increases the efficiency of a person's performance on long, dull tasks.

At the same time nicotine affects the brain, it also stimulates the adrenal glands. The adrenal glands are small, pea-sized organs located above each kidney that really act as two different endocrine organs. The adrenal gland produces several hormones in the medulla, or inner layer, including epinephrine, also called adrenaline. Under normal circumstances, adrenaline is released in response to stress or a perceived threat. It is sometimes called the "fight or flight" hormone, because it prepares the body for action. When adrenaline is released, blood pressure, heart rate, blood flow, and oxygen use increase. Glucose, a simple form of sugar used by the body, floods the body to provide extra energy to muscles. The overall effect of the release of the stress hormones is strain on the cardiovascular (heart and blood vessels) system. This response to stress produces inflammation in the blood vessels that ultimately results in buildup of plaque, which can block the vessels and cause stroke or heart attack.

Most people begin smoking between the ages of 12 and 20. Few people start smoking as adults over 21. Adolescents who smoke tend to begin as casual smokers, out of rebelliousness or a perceived need for social acceptance. Dependence on nicotine develops rapidly, however; one study suggests that 85–90% of adolescents who smoke four or more cigarettes become regular smokers. Nicotine is addictive, so being tobacco-free soon feels uncomfortable for users. In addition, smokers quickly develop tolerance to nicotine. Tolerance is a condition that occurs when the body needs a larger and larger dose of a substance to produce the same effect. For smokers, tolerance to nicotine means more frequent and more rapid smoking. Soon most smokers develop physical withdrawal symptoms when they try to stop smoking. Users of other forms of tobacco experience the same effects; however, the delivery of nicotine is slower and the effects may not be as pronounced.

Nicotine dependence

In addition to the physical dependence caused by the actions of nicotine on the brain, there is a strong psychological component to the dependency of most users of tobacco products, especially cigarette smokers. Most people who start smoking or using smokeless tobacco products do so because of social factors. These include:

- the desire to fit in with peers
- acceptance by family members who use tobacco
- rebelliousness
- the association of tobacco products with maturity and sophistication
- positive response to tobacco advertising

Such personal factors as mental illness (depression, anxiety, schizophrenia, or alcoholism); the need to reduce stress and anxiety; or a desire to avoid weight gain also influence people to start smoking. Once

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smoking has become a habit, whether physical addiction occurs or not, psychological factors play a significant role in continuing to smoke. People who want to stop smoking may be discouraged from doing so because:

- they live or work with people who smoke and who are not supportive of their quitting
- they believe they are incapable of quitting
- they perceive no health benefits to quitting
- they have tried to quit before and failed
- they associate cigarettes with specific pleasurable activities or social situations that they are not willing to give up
- they fear gaining weight

Successful smoking cessation programs must treat both the physical and psychological aspects of nicotine addiction.

Nicotine withdrawal

The American Psychiatric Association first recognized nicotine dependence and nicotine withdrawal as serious psychological problems in 1980. Today nicotine is considered an addictive drug, although a common and legalized one.

As is widely recognized, quitting can be difficult. Among people who try, between 75% and 80% will relapse within six months. Because of this rate, research has found that smoking cessation programs that last longer than six months can greatly enhance quit rates, achieving rates as high as 50% at one year. Combining a nicotine-withdrawal product (described in this article) with a behavioral-modification or support program has produced the greatest success rates.

The combination of physiological and psychological factors make withdrawal from nicotine very difficult. Symptoms of nicotine withdrawal include:

- irritability
- restlessness
- increased anger or frustration
- sleep disturbances
- inability to concentrate
- increased appetite or desire for sweets
- depression
- anxiety
- constant thoughts about smoking
- cravings for cigarettes
- decreased heart rate
- coughing

Withdrawal symptoms are usually more pronounced in smokers than in those who use smokeless tobacco products, and heavy smokers tend to have more symptoms than light smokers when they try to stop smoking. People with depression, schizophrenia, alcoholism, or mood disorders find it especially difficult to quit, as nicotine offers temporary relief for some of the symptoms of these disorders.

Symptoms of nicotine withdrawal begin rapidly and peak within one to three days. Withdrawal symptoms generally last three to four weeks, but a significant number of smokers have withdrawal symptoms lasting longer than one month. Some people have strong cravings for tobacco that last for months, even though the physical addiction to nicotine is gone. These cravings often occur in settings in which the person formerly smoked, such as at a party or while driving, or after a meal. Researchers believe that much of this extended craving is psychological.

Diagnosis

Smokers usually self-diagnose their nicotine dependence and nicotine withdrawal. Such questionnaires as the Fagerstrom Test for Nicotine Dependence (FTND), a short six-item assessment of cigarette use, help to determine the level of tobacco dependence. Physicians and mental health professionals are less concerned with diagnosis, which is usually straightforward, than with determining the physical and psychological factors in each patient that must be addressed for successful smoking cessation.

Treatments

Most people do not decide to stop smoking all of the sudden. Instead, they go through several preparatory stages before taking action. First is the precontemplation stage, in which the smoker does not even consider quitting. Precontemplation is followed by the contemplation stage, in which the smoker thinks about quitting, but takes no action. Contemplation eventually turns to preparation, often when counselors or family members encourage or urge the smoker to quit. Now the smoker starts making plans to quit soon. Finally the smoker arrives at the point of taking action.

Having decided to stop smoking, a person has many choices of programs and approaches. When mental health professionals are involved in smoking cessation efforts, one of their first jobs is to identify the physical and psychological factors that keep the person smoking. This identification helps to direct the smoker to the most appropriate type of program. Assessment examines the frequency of the person's

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smoking, his or her social and emotional attachment to cigarettes, commitment to change, available support system, and barriers to change. These conditions vary from person to person, which is why some smoking cessation programs work for one person and not another.

Medications

Before 1984, there were no medications to help smokers quit. In that year, a nicotine chewing gum (Nicorette) was approved by the United States Food and Drug Administration (FDA) as a prescription drug for smoking cessation. In 1996 it became available without prescription. Nicorette was the first of several medications used for nicotine replacement therapy, intended to gradually reduce nicotine dependence to prevent or reduce withdrawal symptoms. This approach, called tapering, is used in withdrawal of other addictive drugs. Studies indicate that people using these replacement therapies do not become addicted to them.

Nicotine gum comes in two strengths, 2 mg and 4 mg. As the gum is chewed, nicotine is released and absorbed through the lining of the mouth. Over a six- to 12-week period, the amount and strength of gum chewed can be decreased, until the smoker is weaned from his or her dependence on nicotine. People trying to quit smoking are instructed to use the gum when they feel a craving. Products with caffeine may limit nicotine absorption and should be avoided in a window of time around the gum "dose." Some people may not like the taste of the gum, and other common side effects include burning mouth and sore jaw. Anyone with heart problems, diabetes, ulcers, or who is pregnant or breastfeeding should consult with a doctor before beginning any nicotine-replacement product.

The nicotine transdermal patches have been available without prescription since 1996. They are marketed under several brand names, including Habitrol, Nicoderm, NicoDerm CQ, Prostep and Nicotrol. All but Nicotrol are 24-hour patches. Nicotrol is a 16-hour patch designed to be removed at night. The patches are worn on the skin between the neck and the waist, and provide a steady delivery of nicotine through the skin. Patches like Nicoderm come in varying strengths, and after several weeks, users can move down to a patch that delivers a lower dose. With the Nicotrol patch, a user simply ceases use after six weeks. Some people using the 24-hour patches experience sleep disturbances, and a few develop mild skin irritations, but generally side effects are few. Although fears that using a patch and smoking simultaneously have not been borne out, doctors still recommend not using the patch while smoking.

Two other nicotine delivery devices are available by prescription only. One is a nicotine nasal spray. It has the advantage of delivering nicotine rapidly, just as a cigarette does, although it delivers a much lower dose than a cigarette. Treatment with nasal spray usually lasts four to six weeks. Side effects include cold-like symptoms (runny nose, sneezing, etc.). A nicotine inhaler is also available that delivers nicotine through the tissues of the mouth. A major advantage of the inhaler is that it provides an alternative to having a cigarette in one's hands while still delivering nicotine. It delivers less nicotine in cold weather (under 50°F). Recommendations for both the spray and the inhaler are that they be used at least hourly at first.

There are two prescription drugs that are not nicotine replacement therapy that have been approved for treatment of nicotine dependence. The first-approved drug was buproprion (Zyban), an antidepressant that acts to cut down withdrawal symptoms. This drug may be used in combination with a nicotine-replacement therapy and behavioral therapy.

The newer drug is varenicline (Chantix), which was developed to help people stop smoking. This drug acts directly on the proteins in the brain that recognize and bind nicotine. Interfering with their action not only stops the brain from sending the pleasurable message of nicotine but also reduces the feelings of nicotine withdrawal. Some studies indicate that this drug can double a person's chances of quitting smoking. Side effects of this drug can include headache, nausea, vomiting, sleep problems, gas, and changes in taste sensation.

There is also a combination therapy of atropine and scopolamine that some nicotine cessation programs use. These are two anticholinergic (they block the effects of a class of protein receptors, the acetocholine receptors) drugs that affect dopamine levels in the brain and are administered in the form of shots, followed by self-administration with pills or patches. Side effects of these drugs include dry mouth, constipation, dizziness, or blurry vision, and people with conditions such as heart problems, high blood pressure, or glaucoma, cannot use these programs. In addition, use of this combination for smoking cessation is "off-label" (not approved by the FDA for this purpose), and there are no published studies on success rates with this approach.

Behavioral treatments

Behavioral treatments are used to help smokers learn to recognize and avoid specific situations that

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trigger desire for a cigarette. They also help the smoker learn to substitute other activities for smoking. Behavioral treatments are almost always combined with smoker education, and usually involve forming a support network of other smokers who are trying to quit.

Behavioral treatments often take place in support groups either in person or online. They are most effective when combined with nicotine reduction therapy. Other supportive techniques include the use of rewards for achieving certain goals and contracts to clarify and reinforce the goals. Aversive techniques include asking the smoker to inhale the tobacco smoke deeply and repeatedly to the point of nausea, so that smoking is no longer associated with pleasurable sensations. Overall, quit rates are highest when behavior modification is combined with nicotine replacement therapy and tapering. Behavior modification once was conducted in person, but with the advent of a telephonic and virtual world on the Internet, behavioral approaches have been adapted to mail, telephone, and the Web for greater access and flexibility. In 2004, the U.S. Department of Health and Human Services created a toll-free number for people who want to quit: 800-QUIT-NOW (800-784-8669). This number serves as the point of contact for smokers who want information and help.

Alternative treatments

Many alternative therapies have been tried to help smokers withdraw from nicotine. Hypnosis has proved helpful in some cases, but has not been tested in controlled clinical trials. **Acupuncture**, relaxation techniques, restricted environmental stimulation therapy (REST, a combination of relaxation and hypnosis techniques), special **diets**, and herbal supplements have all been used to help people stop smoking. Of these alternative techniques, clinical studies of REST showed substantial promise in helping people stop smoking permanently.

Prognosis

Smoking is a major health risk associated with nicotine dependence. About half of all smokers die of a smoking-related illness, often **cancer**. Most lung cancers are linked to smoking, and smoking is linked to about one-third of all cancer deaths. It kills an estimated 440,000 U.S. citizens each year—more than alcohol, **cocaine**, heroin, homicide, **suicide**, car accidents, fire, and **AIDS** combined. Smoking also causes such other lung problems as chronic **bronchitis** and **emphysema**, as well as worsening the symptoms of **asthma**. Other cancers associated with smoking include cancers of the mouth, esophagus, stomach, kidney, colon, and bladder. Smoking accounts for 20% of cardiovascular deaths. It significantly increases the risk of heart disease, **heart attack**, **stroke**, and aneurysm. Women who smoke during pregnancy have more miscarriages, premature babies, and low-birth-weight babies than nonsmokers. In addition, there is a two-fold increased risk that a child born to a mother who smokes will die of **Sudden Infant Death Syndrome**, thus making smoking an avoidable factor in this tragic occurrence. Secondhand smoke also endangers the health of nonsmokers in the smoker's family or workplace. Although most of these effects are not caused directly by nicotine, it is dependence on nicotine that keeps people smoking.

Even though it is difficult for smokers to break their chemical and psychological dependence on nicotine, they should remember that most of the negative health effects of smoking are reduced or reversed after quitting. Therefore, it is worth trying to quit smoking at any age, regardless of the length of time a person has had the habit.

Prevention

The best way to avoid nicotine dependence and withdrawal is to avoid the use of tobacco products.

Resources

BOOKS

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Nicotine Anonymous. http://www.nicotine-anonymous.org (accessed February 4, 2010).
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ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329-4251, (800) 227–2345, http://www.cancer.org.
American Lung Association, 1740 Broadway, New York, NY, 10019, (212) 315–8700, http://www.lungusa.org.

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Nicotinic acid deficiency *see* **Pellagra**
Niemann-Pick disease *see* **Lipidoses**
Nifedipine *see* **Calcium channel blockers**
Night blindness *see* **Vitamin A deficiency**

Night terrors

Definition

Night terrors are a sleep disorder characterized by **anxiety** episodes with extreme panic, often accompanied by screaming, flailing, fast breathing, and sweating that usually occur within a few hours after going to sleep.

Demographics

Night terrors occur most commonly in children between the ages of three and seven, especially boys ages five to seven; however, they can also occur in girls. After the age of seven they are not common at all. Night terrors may run in families. They can also occur in adults, especially with adults who use alcohol or have emotional problems. Affected individuals usually suffer these episodes within a few hours after going to sleep. They appear to bolt up suddenly, and wake up screaming, sweating and panicked. The episode may last anywhere from five to 20 minutes. During this time, the individual is actually asleep, although the eyes may open. Quite often, nothing can be done to comfort the affected person. Very often, the person has no memory of the episode upon waking the next day.

Description

Night terrors are differentiated from nightmares in that they have been shown to occur during Stage 4 of sleep, or in REM sleep, while nightmares can occur anytime throughout the sleep cycle.

Causes and symptoms

Suffering from night terrors seems to run in families. Extreme tension or **stress** can increase the incidence of the episodes. In adults, the use of alcohol also contributes to an increased incidence of night terrors. Episodes sometimes occur after an accident involving **head injury**. Other factors thought to contribute to episodic night terrors, but not actually cause them, include:

- medications
- excessive tiredness at bedtime
- eating a heavy meal prior to bedtime drug **abuse**

Diagnosis

Night terrors are primarily diagnosed by observing the person suffering from an episode. The following symptoms are characteristic of a person suffering from a night terror:

- panic
- sweating
- gasping, moaning, crying, or screaming during sleep
- little or no recollection of the episode upon awakening

Treatment

In most cases, the individual will still be asleep as the night terror episode happens and will prove difficult to awaken. The goal should be to help the affected person go back into a calm state of sleep. The lights should be turned on, and soothing comments should be directed at the person, avoiding brusque gestures such as shaking the person or shouting to startle them out of the episode. Any form of stress should be avoided.

Individuals affected by night terrors should be evaluated by a physician if they are really severe and occur frequently. A physician can recommend the best treatment for the particular circumstances of

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KEY TERMS

Benzodiazepines—A class of drugs that suppresses Stage 4 of sleep.

REM sleep—Rapid Eye Movement phase of sleep, a mentally active period during which dreaming occurs.

Sleep disorder—Any disorder that keep a person from falling asleep or staying asleep.

the night terrors. In some severe cases, the physician may prescribe a benzodiazepine tranquilizer, such as Diazepam, known to suppress Stage 4 of sleep. The physician may also refer the affected person for further evaluation by a sleep disorder specialist. It should be noted that episodic night terrors in children are normal and do not suggest the presence of psychological problems. In adults, night terrors are more likely to be related to a significant stress–related or emotional problem.

Prognosis

In children, night terror episodes in children usually end by the age of 12.

Prevention

If a child seems to have a regular pattern of night terror episodes, he should be gently awakened about 15 minutes before the episode usually happens. The child should be kept awake and out of the bed for a short period of time and then allowed to return to bed.

Since **sleep deprivation** is a strong trigger for night terror episodes, children should not be allowed to become overtired. Having children take a nap during the day may be useful.

Adults affected by night terror episodes should avoid stress, the consumption of alcohol and stimulants before going to sleep.

Resources

PERIODICALS

Stores, G. "Aspects of Parasomnias in Childhood and Adolescence." *Archives of Disease in Childhood.* 94(1) (January 2009): 63–9.

ORGANIZATIONS

American Sleep Disorders Association (ASDA), 6301 Bandel Rd., Suite 101, Rochester, MN, 55901, (507) 287–6008, http://www.asda.org.

National Foundation for Sleep and Related Disorders in Children (NFSRDC), 4200 W. Peterson, Suite 109, Chicago, IL, 60646, (708) 971–1086

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Nitrates *see* **Antiangina drugs**

Nitrofurantoin *see* **Urinary anti-infectives**

Nitrogen narcosis

Definition

Nitrogen narcosis is a condition that occurs in divers breathing compressed air. When divers go below depths of approximately 100 ft, increase in the partial pressure of nitrogen produces an altered mental state similar to alcohol intoxication.

Description

Nitrogen narcosis, commonly referred to as "rapture of the deep," typically becomes noticeable at 100 ft underwater and is incapacitating at 300 ft, causing stupor, blindness, unconsciousness, and even **death**. Nitrogen narcosis is also called "the martini effect" because divers experience an effect comparable to that from one martini on an empty stomach for every 50 ft of depth beyond the initial 100 ft.

Causes and symptoms

Nitrogen narcosis is caused by gases in the body acting in a manner described by Dalton's law of partial pressures: The total pressure of a gas mixture is equal to the sum of the partial pressures of gases in the mixture. As the total gas pressure increases with increasing dive depth, the partial pressure of nitrogen increases and more nitrogen becomes dissolved in the blood. This high nitrogen concentration impairs the conduction of nerve impulses and mimics the effects of alcohol or **narcotics**.

Symptoms of nitrogen narcosis include: wooziness; giddiness; euphoria; disorientation; loss of balance; loss of manual dexterity; slowing of reaction time; fixation of ideas; and impairment of complex reasoning. These effects are exacerbated by cold, **stress**, and a rapid rate of compression.

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KEY TERMS

Compressed air—Air that is held under pressure in a tank to be breathed by underwater divers. A tank of compressed air is part of a diver's scuba (self-contained underwater breathing apparatus) gear.

Compression—An increase in pressure from the surrounding water that occurs with increasing diving depth.

Partial pressure—The pressure exerted by one of the gases in a mixture of gases. The partial pressure of the gas is proportional to its concentration in the mixture. The total pressure of the gas mixture is the sum of the partial pressures of the gases in it (Dalton's law of partial pressure) and as the total pressure increases, each partial pressure increases proportionally.

Diagnosis

A diagnosis must be made on circumstantial evidence of atypical behavior, taking into consideration the depth of the dive and the rate of compression. Nitrogen narcosis may be differentiated from toxicity of oxygen, carbon monoxide, or carbon dioxide by the absence of such symptoms as **headache**, seizure, and bluish color of the lips and nail beds.

Treatment

The effects of nitrogen narcosis are totally reversed as the gas pressure decreases. They are typically gone by the time the diver returns to a water depth of 60 ft. Nitrogen narcosis has no hangover or lasting effects requiring further treatment. However, a doctor should be consulted whenever a diver has lost consciousness.

Prognosis

When a diver returns to a safe depth, the effects of nitrogen narcosis disappear completely. Some evidence exists that certain divers may become partially acclimated to the effects of nitrogen narcosis with frequency—the more often they dive, the less the increased nitrogen seems to affect them.

Prevention

Helium may be used as a substitute for nitrogen to dilute oxygen for deep water diving. It is colorless, odorless, tasteless, and chemically inert. However, it is more expensive than nitrogen and drains body heat from a diver. In diving with rapid compression, the helium-oxygen mixture may produce **nausea**, **dizziness**, and trembling, but these adverse reactions are less severe than nitrogen narcosis.

Nitrogen narcosis can be avoided by limiting the depth of dives. The risk of nitrogen narcosis may also be minimized by following safe diving practices, including proper equipment maintenance, low work effort, proper buoyancy, maintenance of visual cues, and focused thinking. In addition, no alcohol should be consumed within 24 hours of diving.

ORGANIZATIONS

Divers Alert Network, 6 West Colony Place, Durham, NC, 27705, (919) 684-2948, (919) 490-6630, (800) 446-2671, http://www.diversalertnetwork.org.

Undersea and Hyperbaric Medical Society, 21 West Colony Place, Suite 280, Durham, NC, 27705, (919) 490-5140, (919) 490-5149, (877) 533-UHMS (8467), uhms@ uhms@ org, http://www.uhms.org.

Bethany Thivierge

Nitroglycerin *see* **Antiangina drugs**

Nlein purpura *see* **Allergic purpura**

NMR *see* **Magnetic resonance imaging**

Nocardia asteroides infection *see* **Nocardiosis**

Nocardiosis

Definition

Nocardiosis is a serious infection caused by a fungus-like bacterium. The infection begins in the lungs and can spread to the brain.

Description

Nocardiosis is found throughout the world among people of all ages, although it is most common in older people and males. While people with poor immunity are vulnerable to this infection, it sometimes strikes individuals who have no history of other diseases. Nocardiosis is rare in **AIDS** patients. It is not transmitted by person-to-person contact.

Causes and symptoms

Nocardiosis is caused by a bacterium of the *Nocardia* species—usually *N. asteroides*, an organism

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KEY TERMS

Abscess—A localized area of infection in a body tissue. Abscesses in the brain or skin are possible complications of nocardiosis.

Meningitis—An infection of the outer covering of the brain (meninges) that can be caused by either bacteria or a virus.

that is normally found in the soil. The incubation period is not known, but is probably several weeks.

The bacteria can enter the human body when a person inhales contaminated dust. Less often, people can pick up the bacteria in contaminated puncture **wounds** or cuts.

Symptoms

The infection causes a **cough** similar to **pneumonia** or **tuberculosis**, producing thick, sometimes bloody, sputum. Other symptoms include chills, night sweats, chest **pain**, weakness, loss of appetite and weight loss. Nocardiosis does not, however, respond to short-term **antibiotics**.

Complications

In about one-third of patients, the infection spreads from the blood into the brain, causing brain abscesses. This complication can trigger a range of symptoms including severe **headache**, confusion, disorientation, **dizziness**, **nausea** and seizures, and problems in walking. If a **brain abscess** ruptures, it can lead to **meningitis**.

About a third of patients with nocardiosis also have abscesses in the skin or directly underneath the skin. They may also have lesions in other organs, such as the kidneys, liver, or bones.

Diagnosis

Nocardia is not easily identified from cultures of sputum or discharge. A doctor can diagnose the condition using special staining techniques and taking a thorough medical history. Lung biopsies or x-rays also may be required. Up to 40% of the time, however, a diagnosis can't be made until an **autopsy** is done.

Treatment

Treatment of nocardiosis includes bed rest and high doses of medication for a period of 12 to 18 months, including sulfonamide drugs or a combination of trimethoprim-sulfamethoxazole (Bactrim, Septra). If the patient doesn't respond to these drugs, antibiotics such as ampicillin (Amcill, Principen) or erythromycin (E-Mycin, Eryc) may be tried.

The abscesses may need to be drained and dead tissue cut away. Other symptoms are treated as necessary.

Prognosis

Nocardiosis is a serious disease with a high mortality rate. If it has been diagnosed early and caught before spreading to the brain, the prognosis is better. Even with appropriate treatment, however, the **death** rate is still 50%. Once the infection reaches the brain, the death rate is above 80%. This outcome is most commonly seen in patients with a weakened immune system.

Resources

BOOKS

Bordow, Richard A., Andrew L. Ries, and Timothy A. Morris. *Manual of Clinical Problems in Pulmonary Medicine*. Philadelphia: Lippincott Williams & Williams, 2005.

Carol A. Turkington

Nodule *see* **Skin lesions**

Non-A, non-B hepatitis *see* **Hepatitis C**

Non-Hodgkin's lymphomas *see* **Malignant lymphomas**

Non-melanoma skin cancer *see* **Skin cancer, non-melanoma**

Nongonococcal urethritis

Definition

Nongonococcal urethritis (NGU) is any inflammation of the urethra not due to **gonorrhea**. NGU is almost always contracted through sexual intercourse and is found far more often in men.

Description

Men between the ages of 15 and 30 who have multiple sex partners are most at risk for nongonococcal **urethritis** (NGU), which is believed to be the most common sexually transmitted disease in the United States.

Causes and symptoms

NGU is spread almost exclusively via sexual contact, and appears most often in men because a woman's urethra is less easily infected during sex. The

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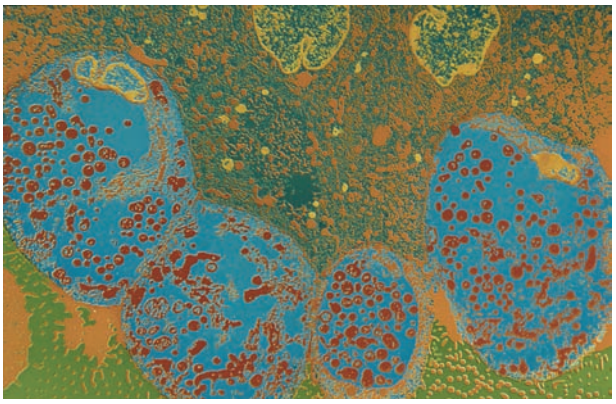

A microscopic image of non-specific urethritis. This sexually transmitted disease is usually caused by a bacterium of the genus *Chlamydia*. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

infection is most often due to *Chlamydia trachomatis*, the organism that causes chlamydia. Those that aren't caused by *Chlamydia trachomatis* are usually due to another bacterium, *Ureaplasma urealyticum*. In 10% to 20% of NGU cases, the cause is unknown.

Symptoms appear within one to five weeks after infection, and include a slight clear discharge (the color of the discharge can vary from one patient to the next), and **itching** or burning during or after urination.

However, some men never develop symptoms, and women almost never show signs of infection. However, it's possible that symptoms of burning or itching in or around the vagina may be due to NGU.

The disease is communicable from the time of first infection until the patient is cured. Past infection doesn't make a person immune.

Diagnosis

Nongonococcal urethritis is diagnosed by excluding other causes, since inflammation that is not caused by gonorrhea is classified as NGU. A microscopic and/or culture test of the discharge or urine can reveal the infection.

Since many people are infected with both NGU and **syphilis** at the same time, infected patients also should have a test for syphilis before treatment for NGU begins, and three months after treatment ends.

Treatment

Antibiotics such as tetracycline or azithromycin will cure NGU; both sexual partners should be treated at the same time.

KEY TERMS

Chlamydia—One of the most common sexually transmitted diseases in the United States. It causes discharge, inflammation and burning during urination. About half of the cases of nongonococcal urethritis are due to chlamydia.

Gonorrhea—A sexually transmitted disease that affects the genital mucous membranes of men and women.

Urethra—The tube that carries urine from the bladder through the outside of the body.

Patients taking tetracycline should avoid milk or milk products and take the medication at least one hour before or two hours after meals. On the last day of treatment, a male should have a urine test to make sure the infection has cleared. If it hasn't, he should take a second course of therapy. Men should use a condom during treatment and for several months after treatment is completed.

If urine tests indicate the infection is gone but symptoms persist, the doctor will check for signs of prostate inflammation.

Prognosis

NGU is completely curable with proper antibiotic treatment. Untreated, NGU can lead to sterility in both men and women, inflammation of the mouth of the uterus, and infections of the woman's internal sexual organs. An infection during **pregnancy** may lead to **pneumonia** or eye infections in the newborn child. Untreated men may develop swelling of the testicles and an infected prostate gland.

Prevention

People can prevent the spread of NGU by:

- using a condom
- limiting the number of sex partners
- washing the genital area after sex
- if infected, avoid sexual contact; take antibiotics, notify all partners

Resources

OTHER

Sexually Transmitted Diseases Hotline. (800) 227-8922.

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ORGANIZATIONS

American Social Health Association, P.O. Box 13827, Research Triangle Park, NC, 27709, (919) 361-8400, (919) 361-8425, http://www.ashastd.org/.

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Non-nucleoside reverse transcriptase inhibitors

Definition

Non-nucleoside reverse transcriptase inhibitors (NRTI) are a type of drug that interferes with an enzyme that is key to the replication (reproduction) of the human **immunodeficiency** virus (HIV). The drug is designed to help suppress the growth of HIV, but does not eliminate it.

Purpose

This medication is used to treat patients with the HIV virus and **AIDS** in combination with one or more other AIDS drugs. Combining NRTIs with older drugs improves their ability to lower the levels of HIV in the bloodstream, and strengthens the immune system.

HIV becomes rapidly resistant to this class of drugs when they are used alone. However, in combination with older drugs, they can interfere with the virus's ability to become resistant because they attack the virus on several fronts. As the virus tries to evade one drug, another attacks. This combination can lower the level of HIV in the blood to undetectable levels.

Precautions

Patients should not discontinue this drug without first consulting a physician–even if symptoms improve.

Description

Nucleoside analogues, the first class of HIV drugs to be developed, worked by incorporating themselves into the virus's DNA, making the DNA incomplete and therefore unable to create a new virus. Non-nucleoside inhibitors work at the same stage as nucleoside analogues, but act in a completely different way, preventing the conversion of RNA to DNA.

This class of drugs includes nevirapine (Viramune) and delavirdine (Rescriptor). It may take several weeks or months before the full benefits are apparent.

KEY TERMS

Human immunodeficiency virus (HIV)—The virus that causes AIDS.

Depending on the drug prescribed, doses may start with a lower amount and be increased after a short period of time.

Risks

A mild skin rash is common; a severe skin rash can be a life-threatening reaction. Other possible side effects include **fever**, blistering skin, mouth sores, aching joints, eye inflammation, **headache**, **nausea**, and tiredness.

Because the drug passes into breast milk, **breast-feeding** mothers should avoid the drug, or not nurse until the treatment is completed.

ORGANIZATIONS

National AIDS Treatment Advocacy Project, 580 Broadway, Ste. 1010, New York, NY, 10012, (212) 219-0106, (212) 219-8473, (866) 26-NATAP, info@natap.org, http://www.natap.org.

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Non-small cell lung cancer *see* **Lung cancer, non-small cell**

Non-tuberculous mycobacteria *see* **Mycobacterial infections, atypical**

Nonbacterial regional lymphadenitis *see* **Cat-scratch disease**

Noncholera vibrio infections *see* **Vibriosis**

Nonerosive gastritis *see* **Gastritis**

Nonsteroidal anti-inflammatory drugs

Definition

Nonsteroidal anti-inflammatory drugs are medicines that relieve **pain**, swelling, stiffness, and inflammation.

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Types of nonsteroidal anti-inflammatory drugs (NSAIDS)

Over-the-counter (OTC)

Aspirin (Bayer, Bufferin)

Ibuprofen (Advil, Motrin)

Naproxen sodium (Aleve)

Prescription

Celecoxib (Celebrex®)

Diclofenac (Cataflam®, Voltaren®, Arthrotec™ [combined with misoprostol])

Diflunisal (Dolobid®)

Etodolac (Lodine®, Lodine® XL)

Fenoprofen (Nalfon®, Nalfon® 200)

Flurbiprofen (Ansaid®)

Ibuprofen (Motrin®, Tab-Profen®, Vicoprofen® [combined with hydrocodone], Combunox™ [combined with oxycodone])

Indomethacin (Indocin®, Indocin® SR, Indo-Lemmon™, Indomethagan™)

Ketoprofen (Oruvail®)

Ketorolac (Toradol®)

Mefenamic Acid (Ponstel®)

Meloxicam (Mobic®)

Nabumetone (Relafen®)

Naproxen (Naprosyn®, Anaprox®, Anaprox® DS, EC-Naprosyn®, Naprelan®, Naprapac® [copackaged with lansoprazole])

Oxaprozin (Daypro®)

Piroxicam (Feldene®)

Sulindac (Clinoril®)

Tolmetin (Tolectin®, Tolectin DS®, Tolectin® 600)

SOURCE: U.S. Food and Drug Administration, "Medication Guide for Non-steroidal Anti-Inflammatory Drugs (NSAIDS)." Available online at: http://www.fda.gov/downloads/Drugs/DrugSafety/ucm089822.pdf (accessed August 17, 2010).

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Purpose

Nonsteroidal anti-inflammatory drugs (NSAIDs) are prescribed for a variety of painful conditions, including arthritis, **bursitis**, **tendinitis**, **gout**, menstrual cramps, sprains, strains, and other injuries. They are also given to control the pain of **cancer** and the side effects of **radiation therapy**.

A group of researchers associated with the Women's Health Initiative reported in 2003 that regular use of **aspirin**, ibuprofen, and other NSAIDs may help to lower a woman's risk of developing **breast cancer**. Further clinical trials are needed, however, to confirm the group's findings.

Description

Nonsteroidal anti-inflammatory drugs relieve pain, stiffness, swelling, and inflammation, but they do not cure the diseases or injuries responsible for these problems. Two drugs in this category, ibuprofen and naproxen, also reduce **fever**. Some nonsteroidal anti-inflammatory drugs can be bought over the counter; others are available only with a prescription from a physician or dentist.

Among the drugs in this group are diclofenac (Voltaren), etodolac (Lodine), flurbiprofen (Ansaid), ibuprofen (Motrin, Advil, Rufen), ketorolac (Toradol), nabumetone (Relafen), naproxen (Naprosyn); naproxen **sodium** (Aleve, Anaprox, Naprelan); and oxaprozin (Daypro). They are sold as tablets, capsules, caplets, liquids, and rectal suppositories, and some are available in chewable, extended-release, or delayed-release forms.

A newer group of NSAIDs known as **COX-2 inhibitors** are being used successfully to treat patients with allergic reactions to the older NSAIDs. Their name comes from the fact that they block an enzyme known as cyclooxygenase-2, or COX-2, which is involved in the inflammation pathway. The COX-2 inhibitors are also less likely to affect the patient's digestive tract. They include such drugs as celecoxib (Celebrex), rofecoxib (Vioxx), etoricoxib (Arcoxia), and valdecoxib (Bextra). With regard to cancer treatment, some studies indicate that the use of COX-2 inhibitors may postpone the need to prescribe narcotic medications for severe pain.

Recommended dosage

Recommended doses vary, depending on the patient, the type of nonsteroidal anti-inflammatory drug prescribed, the condition for which the drug is prescribed, and the form in which it is used. Always take nonsteroidal anti-inflammatory drugs exactly as directed. If using non-prescription (over-the-counter) types, follow the directions on the package label. For prescription types, check with the physician who prescribed the medicine or the pharmacist who filled the prescription. Never take larger or more frequent doses, and do not take the drug for longer than directed. Patients who take nonsteroidal anti-inflammatory drugs for severe arthritis must take them regularly over a long time. Several weeks may be needed to feel the results, so it is important to keep taking the medicine, even if it does not seem to be working at first.

When taking nonsteroidal anti-inflammatory drugs in tablet, capsule, or caplet form, always take them with a full, 8-ounce glass of water or milk. Taking these drugs with food or an antacid will help prevent stomach irritation.

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Precautions

Nonsteroidal anti-inflammatory drugs can cause a number of side effects, some of which may be very serious. These side effects are more likely when the drugs are taken in large doses or for a long time, or when two or more nonsteroidal anti-inflammatory drugs are taken together. Health care professionals can help patients weigh the risks or benefits of taking these medicines for long periods.

Do not take **acetaminophen**, aspirin, or other salicylates along with other nonsteroidal anti-inflammatory drugs for more than a few days unless directed to do so by a physician. Do not take ketorolac (Toradol) while taking other nonsteroidal anti-inflammatory drugs unless directed to do so by a physician.

Because older people are more sensitive than younger adults to nonsteroidal anti-inflammatory drugs, they may be more likely to have side effects. Some side effects, such as stomach problems, may also be more serious in older people.

Serious side effects are especially likely with one nonsteroidal anti-inflammatory drug, phenylbutazone. Patients age 40 and over are especially at risk of side effects from this drug, and the likelihood of serious side effects increases with age. Because of these potential problems, it is especially important to check with a physician before taking this medicine. Never take it for anything other than the condition for which it was prescribed, and never share it—or any other prescription drug—with another person.

Some nonsteroidal anti-inflammatory drugs can increase the chance of bleeding after surgery (including dental surgery), so anyone who is taking the drugs should alert the physician or dentist before surgery. Avoiding the medicine or switching to another type in the days prior to surgery may be necessary.

Some people feel drowsy, dizzy, confused, lightheaded, or less alert when using these drugs. Blurred vision or other vision problems also are possible side effects. For these reasons, anyone who takes these drugs should not drive, use machines or do anything else that might be dangerous until they have found out how the drugs affect them.

Nonsteroidal anti-inflammatory drugs make some people more sensitive to sunlight. Even brief exposure to sunlight can cause severe **sunburn**, **rashes**, redness, **itching**, blisters, or discoloration. Vision changes also may occur. To reduce the chance of these problems, avoid direct sunlight, especially from mid-morning to mid-afternoon; wear protective clothing, a hat, and sunglasses; and use a sunscreen with a skin protection factor (SPF) rating of at least 15. Do not use sunlamps, **tanning** booths or tanning beds while taking these drugs.

Special conditions

People with certain medical conditions and people who are taking some other medicines can have problems if they take nonsteroidal anti-inflammatory drugs. Before taking these drugs, be sure to let the physician know about any of these conditions:

ALLERGIES. Let the physician know about any **allergies** to foods, dyes, preservatives, or other substances. Anyone who has had reactions to nonsteroidal anti-inflammatory drugs in the past should also check with a physician before taking them again.

PREGNANCY. Women who are pregnant or who plan to become pregnant should check with their physicians before taking these medicines. Whether nonsteroidal anti-inflammatory drugs cause **birth defects** in people is unknown, but some do cause birth defects in laboratory animals. If taken late in **pregnancy**, these drugs may prolong pregnancy, lengthen labor time, cause problems during delivery, or affect the heart or blood flow of the fetus.

BREASTFEEDING. Some nonsteroidal anti-inflammatory drugs pass into breast milk. Women who are **breastfeeding** should check with their physicians before taking these drugs.

OTHER MEDICAL CONDITIONS. A number of medical conditions may influence the effects of nonsteroidal anti-inflammatory drugs. Anyone who has any of the conditions listed here should tell his or her physician about the condition before taking nonsteroidal anti-inflammatory drugs.

- stomach or intestinal problems, such as colitis or Crohn's disease
- liver disease
- current or past kidney disease; current or past kidney stones
- heart disease
- high blood pressure
- blood disorders, such as anemia, low platelet count, low white blood cell count
- bleeding problems
- diabetes mellitus
- hemorrhoids, rectal bleeding, or rectal irritation
- asthma
- Parkinson's disease
- epilepsy
- systemic lupus erythematosus

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KEY TERMS

Anemia—A lack of hemoglobin—the compound in blood that carries oxygen from the lungs throughout the body and brings waste carbon dioxide from the cells to the lungs, where it is released.

Bursitis—Inflammation of the tissue around a joint.

Colitis—Inflammation of the colon (large bowel)

COX-2 inhibitors—A class of newer nonsteroidal anti-inflammatory drugs (NSAIDs) that are less likely to cause side effects in the digestive tract. COX-2 inhibitors work by inhibiting the production of cyclo-oxygenase-2, an enzyme involved in inflammation.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Salicylates—A group of drugs that includes aspirin and related compounds. Salicylates are used to relieve pain, reduce inflammation, and lower fever.

Tendinitis—Inflammation of a tendon, which is a tough band of tissue that connects muscle to bone.

- diseases of the blood vessels, such as polymyalgia rheumatica and temporal arteritis
- fluid retention
- alcohol abuse
- mental illness

People who have sores or white spots in the mouth should tell the physician about them before starting to take nonsteroidal anti-inflammatory drugs. Sores or white spots that appear while taking the drug can be a sign of serious side effects.

SPECIAL DIETS. Some nonsteroidal anti-inflammatory drugs contain sugar or sodium, so anyone on a low-sugar or low-sodium diet should be sure to tell his or her physician.

SMOKING. People who smoke cigarettes may be more likely to have unwanted side effects from this medicine.

USE OF CERTAIN MEDICINES. Taking nonsteroidal anti-inflammatory drugs with certain other drugs may affect the way the drugs work or increase the risk of unwanted side effects.

Side effects

The most common side effects are stomach pain or cramps, **nausea**, **vomiting**, **indigestion**, **diarrhea**, **heartburn**, **headache**, **dizziness** or lightheadedness, and drowsiness. As the patient's body adjusts to the medicine, these symptoms usually disappear. If they do not, check with the physician who prescribed the medicine.

Serious side effects are rare, but do sometimes occur. If any of the following side effects occur, stop taking the medicine and get emergency medical care immediately:

- swelling or puffiness of the face
- swelling of the hands, feet, or lower legs
- rapid weight gain
- fainting
- breathing problems
- fast or irregular heartbeat
- tightness in the chest

Other side effects do not require emergency medical care, but should receive medical attention. If any of the following side effects occur, stop taking the medicine and call the physician who prescribed the medicine as soon as possible:

- severe pain, cramps, or burning in the stomach or abdomen
- convulsions
- fever
- severe nausea, heartburn, or indigestion
- white spots or sores in the mouth or on the lips
- rashes or red spots on the skin
- any unusual bleeding, including nosebleeds, spitting up or vomiting blood or dark material
- black, tarry stool
- chest pain
- unusual bruising
- severe headaches

A number of less common, temporary side effects are also possible. They usually do not need medical attention and will disappear once the body adjusts to the medicine. If they continue or interfere with normal activity, check with the physician. Among these side effects are:

- gas, bloating, or constipation
- bitter taste or other taste changes
- sweating
- restlessness, irritability, anxiety
- trembling or twitching

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Some patients who have had problems with side effects from NSAIDs may benefit from **acupuncture** as an adjunctive treatment in **pain management**. A recent study done in New York found that older patients with lower back pain related to cancer reported that their pain was relieved by acupuncture with fewer side effects than those caused by NSAIDs.

Interactions

Nonsteroidal anti-inflammatory drugs may interact with a variety of other medicines. When this happens, the effects of the drugs may change, and the risk of side effects may be greater. Anyone who takes these drugs should let the physician know all other medicines he or she is taking. Among the drugs that may interact with nonsteroidal anti-inflammatory drugs are:

- blood thinning drugs, such as warfarin (Coumadin)
- other nonsteroidal anti-inflammatory drugs
- heparin
- tetracyclines
- cyclosprorine
- digitalis drugs
- lithium
- phenytoin (Dilantin)
- zidovudine (AZT, Retrovir).

NSAIDs may also interact with certain herbal preparations sold as dietary supplements. Among the herbs known to interact with NSAIDs are bearberry (*Arctostaphylos uva-ursi*), feverfew (*Tanacetum parthenium*), evening primrose (*Oenothera biennis*), and gossypol, a pigment obtained from cottonseed oil and used as a male contraceptive. In most cases, the herb increases the tendency of NSAIDs to irritate the digestive tract. It is just as important for patients to inform their doctor of herbal remedies that they take on a regular basis as it is to give the doctor a list of their other prescription medications.

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United States Food and Drug Administration (FDA), 10903 New Hampshire Ave, Silver Spring, MD, 02993-0002, (888) 463-6332, http://www.fda.gov.

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Nontropical sprue *see* **Celiac disease**

Nonvenereal syphilis *see* **Bejel**

Norfloxacin *see* **Fluoroquinolones**

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Noroviruses

Definition

Noroviruses are a group of related, single-stranded RNA (ribonucleic acid) viruses that cause infection resulting in acute **gastroenteritis** in humans. Gastroenteritis, also commonly called stomach flu, involves an inflammation of the gastrointestinal tract, which results in **diarrhea**, abdominal **pain**, and **vomiting**. The infection caused by noroviruses is very highly contagious, being commonly spread through water or food that has been contaminated with fecal matter; or through contact with an infected person. Norovirus infections occur frequently in closed, and often-times crowded, environments where the viruses can quickly spread. Such places include as hospitals and medical facilities, schools, nursing/retirement homes and day-care facilities, and cruise ships.

Demographics

Anyone can become infected with a norovirus. During norovirus outbreaks there are high rates of infection among people of all ages. There are a large number of genetically distinct strains of noroviruses. Immunity appears to be specific for the norovirus strain and lasts for only a few months. Therefore, norovirus infection can recur throughout a person's lifetime. Because of genetic (inherited) differences among humans, some people appear to be more susceptible to norovirus infection and may suffer more severe illness. People with type O blood are at the highest risk for severe infection.

Description

Norovirus infection is caused by a variety of viruses. All such viruses cause acute gastroenteritis, an inflammation of the stomach and intestines. The illness is highly contagious, and usually requires professional medical care to treat the most serious of the symptoms, which often times included **dehydration**, bloody stool, abdominal pain, and **vomiting**. Noroviruses are difficult to eliminate in the environment because they can withstand very high and low temperatures, along with being able to resist most disinfectants.

Noroviral infection

Noroviruses are a major cause of viral gastroenteritis—an inflammation of the linings of the stomach and small and large intestines that causes vomiting and diarrhea. Viruses are responsible for 30 to 40% of all cases of infectious diarrhea, and viral gastroenteritis is the second most common illness in the United States, exceeded only by the **common cold**.

Infected individuals are contagious from the first onset of symptoms until at least three days after full recovery. Some people may remain contagious for as long as two weeks after recovery.

Gastroenteritis

Gastroenteritis often is referred to as the stomach flu even though the flu is a respiratory illness caused by an **influenza** virus. Other common names for viral gastroenteritis include:

- food poisoning
- winter-vomiting disease
- non-bacterial gastroenteritis
- calicivirus infection.

The U.S. Centers for Disease Control and Prevention (CDC) estimate, in 2010, that noroviruses are responsible for some 21 million cases of acute gastroenteritis in the United States every year. Epidemiologists estimate that about 50,000 Americans are hospitalized annually and about 400 people die each year because of norovirus infection. However, the CDC reported in 2006 that many reports of acute gastroenteritis go unreported. Consequently, the U.S. health organization suggests that up to 300,000 hospitalizations occur annually and about 5,000 deaths occur each year, all due to noroviruses. In developing countries, noroviruses are a major cause of human illness. The CDC estimate that about 900,000 visits to clinics and other medical facilities by children in developed countries of the world result in about 64,000 hospitalizations. Even worse, about 200,000 children under the age of five years die from noroviruses each year in developing countries of the world.

Gastroenteritis caused by infection with a norovirus is rarely a serious illness. Typically an infected person suddenly feels very ill and may vomit many times in a single day. The symptoms, although quite unpleasant, usually last only 24 to 60 hours.

Transmission

Noroviruses are ubiquitous in the environment. They are highly contagious and are considered to be among the most infectious of viruses. The reasons for this include:

- Only a small number of viral particles—as few as 10—are required for infection.
- Although noroviruses cannot reproduce outside of their human hosts, they can remain viable for weeks or even months on objects and surfaces.

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- Human immunity to norovirus is short-lived and strain-specific.

Noroviruses are transmitted among people by a fecal-oral route, either by ingestion of food or water contaminated with feces or by contact with the vomit or feces of an infected person. Norovirus infection can occur by:

- consuming contaminated food or liquids
- hand contact with contaminated objects or surfaces, followed by hand contact with the mouth
- contact with an infected person, including caring for the sick person or sharing food or utensils
- aerosolized vomit that is swallowed or that contaminates surfaces.

Environmental contamination or contact with infected clothing or linen also may be a source of transmission. Although evidence is not available that norovirus infection can occur via the respiratory system, the sudden and violent vomiting of noroviral gastroenteritis can lead to contamination of the surroundings and of public areas. Particles laden with virus can be suspended in the air and swallowed.

FOODBORNE TRANSMISSION. Noroviruses account for at least 50% of food-related outbreaks of gastroenteritis. A European study, published in 2010, showed that 21% of all norovirus outbreaks are caused by foodborne transmission. In addition, 25% of the outbreaks were initially reported to be "food handler-associated." This was later found to be caused from contamination of the food source. In addition, restaurant or catered foods are common sources of norovirus transmission, with subsequent infection of household members. The majority of norovirus outbreaks occur via contamination by a food handler immediately before the food is consumed.

Foods that frequently are associated with norovirus outbreaks include:

- foods that are eaten without further cooking, including sandwiches, salads, and bakery products
- liquids such as salad dressing or cake icing in which the virus becomes evenly distributed
- food that is contaminated at its source, including oysters and clams from contaminated waters and raspberries irrigated with sewage-contaminated water
- food that becomes contaminated before distribution, including salads and frozen fruit.
- Shellfish, including oysters and clams, concentrate norovirus from contaminated water in their tissues. Steaming shellfish may not completely inactivate the virus.

WATERBORNE TRANSMISSION. There is widespread norovirus contamination of rivers and seas, often with more than one strain of the virus. Waterborne outbreaks of norovirus have been associated with:

- sewage-contaminated wells
- contaminated municipal water systems
- stream and lake water
- swimming pools and spas
- commercial ice.

Outbreaks

Norovirus infection can spread rapidly through daycare centers, schools, prisons, hospitals, nursing homes, camps, and other confined spaces. Norovirus is responsible for about 40% of group- or institution-related outbreaks of diarrhea. Outbreaks usually peak during the winter months.

In 2008, it was reported that outbreaks of the norovirus occurred on several university campuses in California, Michigan, and Wisconsin. The CDC, along with state and local health departments, found that approximately 1,000 cases of illness resulted from these outbreaks, including 10 hospitalizations. In addition, one college campus was closed temporarily due to an outbreak.

Cruise ships have become notorious for norovirus outbreaks among passengers and staff. Cruise ships and naval vessels are at increased risk for contamination when docking in regions that lack adequate sanitation and where contaminated food or water may be brought onboard. Close living quarters and the arrival of new, susceptible passengers every one to two weeks exacerbate outbreaks on cruise ships. Norovirus outbreaks have been reported to continue through more than 12 successive cruises on a single ship.

Noroviruses are relatively rare on cruise ships but they do happen. In 2006, the CDC reported that 34 cases of norovirus were reported, while 27 were reported in 2007, 15 in 2008, and 13 in 2009—all from cruises originating from U.S. ports. In 2010, for instance, the Celebrity Cruises company had about 15% of its passengers come down with norovirus-like symptoms on its cruise ship that departed from Charleston, South Carolina, on February 15, 2010. A year before the incident, a paper published in the medical journal *Clinical Infectious Diseases* found that a large number of norovirus outbreaks on cruise ships were the result of dirty public restroom facilities. However, in 2010, the CDC reported that the trend was down for contracting a norovirus on a cruise ship sailing from a

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U.S. port. In fact, the incidence of noroviruses on a cruise ship was at a decade-long low as of January 2010. The International Council of Cruise Lines reported that less than 1% of passengers become infected with norovirus each year. As reported by the CDC the outbreaks on cruise ships during the 2000s were on the decline. However, it is too early in the 2010s to tell if the trend will continue.

Generally, outbreaks of norovirus appear on the increase. Near the end of the 2000s, the CDC reported that norovirus outbreaks were increasing in many closed, crowded facilities across the country.

Risk factors

Humans are at increased risk from contracting noroviruses if they:

- travel frequently on cruise ships or stay at lodging establishments where many people are living in close surroundings
- live with children that attend school or day care
- have a weakened immune system
- live in nursing homes, retirement centers, or other such facilities.

Causes and symptoms

Norovirus strains

Noroviruses lack outer envelopes and their genetic material is carried as single-stranded RNA rather than DNA (deoxyribonucleic acid). Although noroviruses are not new, the extent of norovirus infection was not recognized until the 1990s. This has led to increased research on noroviruses and more monitoring of outbreaks.

Until 2004 noroviruses were commonly referred to as:

- Norwalk virus
- Norwalk-like viruses (NLVs)
- caliciviruses
- small, round-structured viruses (SRSVs).

Noroviruses are named after the original strain—the Norwalk virus—that caused an outbreak of gastroenteritis in a Norwalk, Ohio, school in 1968. The virus was identified in 1972. Since then many related viruses have been identified. In 2004, these viruses were grouped together in the genus *Norovirus* within the Caliciviridae family of viruses. Eight to 10 distinct genogroups of norovirus have been found in various parts of the world. There are five common genogroups and, of those, three (GI, GII, and GIV) affect humans. Each of these groups can be further differentiated into at least 20 genetic clusters. Evidence suggests that noroviruses in different genetic clusters can recombine to form new, genetically distinct noroviruses. As of 2010, GII strains, especially GII4, are the most prevalent, and have caused the most norovirus outbreaks since 2002. However the most common method of identifying noroviruses—the reverse transcription-polymerase chain reaction (RT-PCR)—may not always identify GII genetic clusters correctly.

The increased number of norovirus outbreaks in European countries in the early 2000s—occurring in the spring and summer rather than in winter—were found to be associated with the emergence of a new variant of the GII4 strain. Increased international outbreaks in 2003 and 2004 also were caused by a GII4-related norovirus that was found to mutate rapidly. Mutations in the viral capsid—the virus' outer protective layer—were used to determine the predominant routes of norovirus transmission.

Then, in the first quarter of 2010, 334 cases of norovirus were reported at 65 different locations within the United Kingdom, Norway, France, Sweden, and Denmark. All of the cases were associated with the eating of raw oysters. The International Society of Infectious Diseases reports that the Rapid Alert System for Food and Feed database contained 19 reports of norovirus in oysters between March 2006 and March 2010—all within the European Union.

Symptoms

Symptoms of norovirus infection usually appear within 24–48 hours after exposure, with a median incubation period during outbreaks of 33–36 hours. However symptoms can occur as early as 12 hours or less after exposure.

Typical symptoms of norovirus infection are:

- nausea
- vomiting
- fever
- malaise (general feeling of sickness)
- watery or loose diarrhea without blood
- abdominal cramping and pain
- bloody stool
- dehydration
- weight loss.

Among children, vomiting is the predominant symptom, whereas diarrhea is more common in adults. Vomiting can be frequent and violent and may occur without warning.

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Additional symptoms of norovirus infection may include:

- low-grade fever
- chills
- headache
- muscle aches
- fatigue.

Dehydration is the major risk from gastroenteritis caused by norovirus, particularly among infants, young children, the elderly, and those with underlying health conditions. Symptoms of dehydration include:

- dry mouth
- increased or excessive thirst
- low urine output
- nausea
- dizziness or faintness
- sunken eyes
- sunken fontanelle—the soft spot on an infant's head
- confusion.

As many as 30–50% of norovirus infections do not produce symptoms. It is not known whether individuals with asymptomatic infections can transmit the virus.

Diagnosis

Identifying noroviruses

Viral gastroenteritis usually is diagnosed on the basis of the symptoms. Many types of viruses cause gastroenteritis. Rotoviruses are a leading cause of gastroenteritis in children who then transmit the virus to adults. In addition to noroviruses, viral gastroenteritis in humans can be caused by another genus of viruses within the Caliciviridae family. Formerly known as the Sapporo-like virus, or classic or typical calicivirus, these now are grouped in the genus *Sapovirus*. Other genera in the Caliciviridae family are not pathogenic in humans. Some bacteria and parasites also cause illnesses that are similar to norovirus infection.

The cloning and sequencing of noroviruses in the early 1990s made it easier to identify norovirus outbreaks. RT-PCR is the most commonly used method for identifying norovirus. With this technique the virus' RNA is used as the template for transcribing the corresponding DNA using the enzyme reverse transcriptase. The DNA is amplified into many copies using the polymerase chain reaction. Many state public health laboratories use this method to detect norovirus in vomit and stools. The best identification usually comes from stool samples taken within 48–72 hours after the onset of symptoms; however norovirus can be detected in stool samples taken five days after the onset of symptoms and sometimes even in samples taken up to two weeks after recovery.

Norovirus from fecal samples can be visualized using electron microscopy. With immune electron microscopy (IEM), antibodies against norovirus are collected from blood serum and used to trap and visualize the virus from fecal samples. However these methods require high concentrations of norovirus in the stool, as well as a fourfold increase in norovirus-specific antibodies in blood samples taken during the acute or recovery phases of gastroenteritis.

Enzyme-linked immunosorbent assays may be used to detect noroviruses in fecal samples. In these assays noroviral-specific antibodies bound to the virus are detected by the reaction of an enzyme that is attached to the antibody. Nucleic acid probes that hybridize with noroviral RNA also can be used for virus detection in feces.

A Japanese chemical company was producing a reagent kit that can be used to detect norovirus in two hours rather than the 12–24 hours needed for conventional detection. Other simpler methods for rapidly identifying norovirus are under development. As of 2010, further research is continuing on commercial devices for detecting norovirsuses. For example, scientists at the Department of Infectious Diseases, Osaka Prefectural Institute of Public Health (Osaka, Japan) are developing modified reagent kits for norovirus genogroups I and II. They reported their advancement in the *Journal of Medical Virology* (December 2009).

Investigating outbreaks

Epidemiological studies often involve sequencing the norovirus RNA. This can help to determine whether outbreaks in different geographical locations are connected to each other and can help trace the source of the norovirus to contaminated food or water. CaliciNet is a database that stores the RNA sequences of all norovirus strains that cause gastroenteritis in the United States.

Criteria that are sometimes used to determine whether an outbreak of gastroenteritis is caused by a norovirus include:

- a mean incubation period of 24–48 hours
- a mean duration time for illness of 12–60 hours
- vomiting in more than 50% of patients
- failure to find a bacterial cause for the illness.

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During investigations of norovirus outbreaks, food handlers may be asked to provide a stool sample and possibly a blood sample. Food rarely is tested for norovirus since each type of food requires a specific assay. However, tests are used to detect the virus in shellfish. When large amounts—1–26 gallons (5–100 liters)—of water are processed through specially designed filters, the norovirus can be concentrated and assayed by RT-PCR.

Treatment

Gastroenteritis caused by noroviruses usually resolves itself without treatment within a very few days. As of 2010, medications or vaccines are not available that are effective against the norovirus. Viruses are not affected by **antibiotics** and antidiarrheal medications may prolong the infection.

Norovirus infections should be treated by:

- drinking plenty of fluids, such as water and juice, to prevent dehydration caused by vomiting and diarrhea
- intravenous fluids if severe nausea prevents drinking, particularly in small children
- drinking oral rehydration fluids (ORFs) to prevent dehydration and to replace electrolytes (salt and minerals) and glucose
- avoiding alcohol and caffeine which can increase urination.

Commercially available ORFs include Naturalyte, Pedialyte, Infalyte, and Rehydralyte.

Juice, soda, and water do not replace lost electrolytes; nor do sports drinks replace nutrients and **minerals** lost through vomiting and diarrhea. In fact, drinks containing sugar may make diarrhea worse. Those taking **diuretics** should ask their healthcare provider whether to stop taking the medication during acute diarrhea.

Since the risk of dehydration is higher for infants and young children, the number of wet diapers per day should be closely monitored. Severely dehydrated children may receive rapid **intravenous rehydration** in a hospital or emergency-room setting.

A health care provider should be consulted if:

- symptoms of dehydration appear
- diarrhea persists for longer than a few days
- there is blood in the stool.

Alternative treatment

An infusion of meadowsweet (*Filipendula ulmaria*) may reduce **nausea**. Once the symptoms are reduced, slippery elm (*Ulmus fulva*) may calm the digestive system. Castor oil packs placed on the abdomen can reduce inflammation and discomfort.

Homeopathic remedies for gastroenteritis include *Arsenicum album*, **ipecac**, and *Nux vomica*. Chinese patent herbal remedies include Po Chai and Pill Curing.

During recovery from viral gastroenteritis, live cultures of *Lactobacillus acidophilus*, found in live-culture yogurt or as powder or capsules, may be useful for restoring the native flora of the digestive tract.

Prognosis

Norovirus infection is usually followed by complete recovery. Any long-term health effects are not known. Infected persons do not become long-term carriers of the virus. However, in some cases dehydration can become a very serious possible consequence of noroviral infection and can be fatal, particularly among young children, older people, and anyone with debilitating medical conditions or impaired immune systems.

Prevention

Noroviruses are difficult to destroy. They can survive freezing as well as temperatures as high as 140°F (60°C). Noroviruses can survive chlorine levels as high as 10 parts per million (ppm), far higher than the levels present in most public water systems. A 2004 study from the Netherlands found that inactivation of norovirus with 70% ethanol was inefficient and that **sodium** hypochlorite solutions were effective only at concentrations above 300 ppm.

The best prevention against noroviral infection is frequent, thorough hand washing with soap and water. All soaped hand surfaces should be rubbed vigorously for at least 10 seconds. The hands should be thoroughly rinsed under a stream of water. In particular hands always should be washed before handling food and after using the toilet or changing diapers.

Other important measures for preventing norovirus infection include:

- proper handling of cold foods
- careful washing of fruits and vegetables
- steaming oysters before eating, although even this may be insufficient for destroying norovirus
- taking particular care when handing the diapers of children with diarrhea
- properly disposing of sewage and diapers
- excluding sick infants and children from food preparation areas.

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KEY TERMS

Antibody—A blood protein produced in response to foreign material such as a virus; the antibody attaches to the virus and destroys it.

Calicivirus—A member of the Caliciviridae family of viruses that includes noroviruses.

Capsid—The outer protein coat of a virus.

Gastroenteritis—An inflammation of the lining of the stomach and intestines, usually caused by a viral or bacterial infection.

Genetic cluster—A group of viral strains with very similar, yet distinct, nucleic acid sequences.

Genogroup—Related viruses within a genus; may be further subdivided into genetic clusters.

Reverse transcription-polymerase chain reaction (RT-PCR)—A method of polymerase-chain-reaction amplification of nucleic acid sequences that uses RNA as the template for transcribing the corresponding DNA using reverse transcriptase.

To prevent further transmission of norovirus:

- All surfaces exposed to vomit or otherwise contaminated should be immediately cleaned and disinfected with a solution of between 5 to 10% bleach, followed by rinsing.
- Contaminated clothing and linens should be removed immediately and washed with hot water and detergent on the maximum machine cycle and with a minimum of handling, followed by machine drying.
- Vomit and feces should be discarded or flushed immediately and the toilet area should be kept clean.
- Exposed or contaminated food should be discarded.
- Masks may be worn while cleaning areas that have been badly contaminated with vomit or feces, such as in hospitals or nursing homes.
- Stay home and do not go to work or school in order to prevent further passing on of the virus.

Scientific studies have found that detergent-based cleaning with a cloth consistently fails to eliminate norovirus contamination. With fecal contamination, detergent-based cleaning, followed by cleaning with a combination hypochlorite/detergent formula containing 5,000 ppm of available chlorine significantly reduced contamination. However, norovirus still could be detected on as much as 28% of the surfaces. When this procedure failed to eliminate contamination, the virus was transmitted to the cleaner's hands. Contaminated fingers consistently transferred norovirus to up to seven different surfaces including doorknobs and telephones. However the contamination was diluted during secondary transmission and treatment with the combined bleach/detergent eliminated the virus without prior cleaning.

In situations where there is a periodic renewal of susceptible people, such as on cruise ships and at camps, the facility may have to be closed until cleaning is complete. Although many state and local health departments require that food handlers with gastroenteritis not return to work until two to three days following recovery, this may not be an adequate length of time to prevent noroviral transmission.

The prevention of norovirus outbreaks include reducing contamination of water supplies with human waste and using high-level chlorination—at least 10 ppm for more than 30 minutes. Surveillance of shorelines for potential sources of fecal contamination and for boats that are dumping human waste may help prevent shellfish-associated norovirus outbreaks.

In 2004, researchers at Washington University (St. Louis, Missouri) became the first to grow a norovirus in a laboratory setting. They grew a mouse norovirus, with the goal of studying the virus and developing a vaccine against it. Research is ongoing in the early 2010s. New surveillance systems also are being developed to detect norovirus outbreaks at an early stage.

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Norplant *see* **Depo-Provera/Norplant**

Norwalk virus infection *see* **Gastroenteritis**

Nose injuries *see* **Nasal trauma**

Nose irrigation *see* **Nasal irrigation**

Nose job *see* **Rhinoplasty**

Nose packing *see* **Nasal packing**

Nose papillomas *see* **Nasal papillomas**

Nose polyps *see* **Nasal polyps**

Nosebleed

Definition

A nosebleed is bleeding from the nose; the medical term for it is epistaxis.

Description

Unexpected bleeding from anywhere is cause for alarm. Persistent bleeding should always be investigated because it may be the earliest sign of **cancer**. Fortunately, nosebleeds are rarely a sign of cancer. A much more common cause of nosebleeds is injury from picking, blowing, or fisticuffs. People with hay fever have swollen membranes that are fragile and more likely to bleed.

Most nosebleeds (about 90%) come from the front of the septum, that plane of cartilage that separates the nostrils. These are called anterior nosebleeds. The lower front part of the septum has a mass of blood vessels on either side called Kiesselbach's plexus that is easy to injure. Nosebleeds from the more remote reaches of the nose are called posterior nosebleeds. They are less common, are less likely to have a benign cause, and are much harder to manage.

Nosebleeds are most likely to occur in children between the ages of two and 10 years, in part because younger children frequently insert small objects in the nose or pick at the tissues lining the nose. Nosebleeds in adolescents may indicate cocaine abuse. Nosebleeds in older adults may result from arteriosclerosis or high blood pressure.

Causes and symptoms

Nosebleeds may result from a number of different causes:

- local infections (colds, sinus infections)
- systemic infections (scarlet fever, typhoid fever, malaria)
- drying of the membranes lining the nose, often during heating season in colder climates

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KEY TERMS

Cautery—The use of heat, electricity, or chemicals to destroy tissue.

Embolization—A technique for stopping bleeding by introducing a substance into larger blood vessels that blocks or closes them.

Epistaxis—The medical term for nosebleed.

Kiesselbach's plexus—An area on the anterior part of the nasal septum that has a rich supply of blood vessels and is a common site of nosebleeds. It is named for Wilhelm Kiesselbach, a 19th-century German otolaryngologist.

Septum—The partition that separates the two nostrils. It consists of membranes, cartilage, and bone.

Styptic—Any remedy with an astringent and hemostatic (stopping bleeding) quality.

- medications, most commonly, overuse of nasal decongestant sprays
- trauma (from foreign objects in the nose; scratching or picking with the fingers; or blunt trauma to the face)
- tumors in the nasopharynx or paranasal sinuses
- cocaine abuse
- bleeding disorders (leukemia, liver disease, hemophilia and other hereditary clotting disorders)

Treatment

The first treatment is to pinch the patient's nostrils together, have them sit forward, and ask them to stay that way for 5–10 minutes. This method usually stops nosebleeds originating in Kiesselbach's plexus. The patient should not tilt his or her head backward, as this position may cause blood to drip backward into the throat or windpipe. It is best to hold the head upright.

In the case of small children, the doctor may examine the inside of the nose to check for foreign bodies, evidence of scratching or picking, etc. Small foreign bodies (watch batteries, dried peas or beans, buttons, etc.) can be removed by suction if necessary. The doctor may also have to remove clotted blood by suction.

Bleeding that continues originates from the back of the nose in most cases and will flow down the throat. If that happens, emergency intervention is needed.

As an emergency procedure, the nose will be packed front and/or back with cotton gauze and a rubber balloon from a Foley catheter. This treatment is not comfortable. Having no place to flow, the blood should clot, giving the ear, nose and throat specialists (otorhinolaryngologists) a chance to find the source and permanently repair it. If the packing has to remain for any length of time, **antibiotics** and **pain** medication will be necessary—antibiotics because the sinuses will be plugged up and prone to infection. Nose packing may so interfere with breathing that the patient will need supplemental oxygen.

Newer options for controlling posterior nosebleeds include the use of Surgicel, Merocel, or other oxidized cellulose products that expand with moisture. These may control the bleeding without the need for bulky **nasal packing**.

Many bleeds are from small exposed blood vessels with no other disease. They can be destroyed by cautery, usually done by applying silver nitrate to the affected area. Larger vessels may not respond to cautery. The surgeon may have to tie them off, which is known as ligation. Another technique that is sometimes used with larger vessels is embolization, in which the doctor injects a chemical to block or close the blood vessel.

Alternative treatment

Estrogen cream, the same preparation used to revitalize vaginal tissue, can toughen fragile blood vessels in the anterior septum and forestall the need for cauterization. Botanical medicines known as styptics, which slow down and can stop bleeding, may be taken internally or applied topically. Some of the plants used are *Achillea* (yarrow), trillium, geranium, and shepherd's purse (*Capsella bursa-pastoris*). Homeopathic remedies can be one of the quickest and most effective treatments for epistaxis.

Prevention

Both before and after a nosebleed, the patient should blow the nose gently and avoid picking or scratching the tissues that line it. Children with recurrent nosebleeds during heating season may benefit from the use of a cool-mist vaporizer to humidify the bedroom at night, or from the application of a small quantity of petroleum jelly to the inside of each nostril.

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Treatment of hay fever helps reduce the fragility of the tissues.

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American Academy of Family Physicians (AAFP), 11400 Tomahawk Creek Parkway, Leawood, KS, 66211-2680, (913) 906-6000, (913) 906-6075, (800) 271-2237, http://www.aafp.org/.

American Academy of Otolaryngology—Head and Neck Surgery, 1650 Diagonal Road, Alexandria, VA, 22314-2857, (703) 836-4444, http://www.entnet.org.

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Nosocomial infections *see* **Hospital-acquired infections**

NS *see* **Nephrotic syndrome**

NSAIDs *see* **Nonsteroidal anti-inflammatory drugs**

Nther's disease *see* **Porphyrias**

Nuclear magnetic resonance *see* **Magnetic resonance imaging**

Nucleoside analogs *see* **Antiretroviral drugs**

Numbness and tingling

Definition

Numbness and tingling are decreased or abnormal sensations caused by altered sensory nerve function.

Demographics

People of all ages experience episodes of numbness and tingling; however, these generally become more common as people age. Episodes of numbness and tingling are more common among people with diabetes, **hypothyroidism**, **alcoholism**, **malnutrition**, or who experience mechanical trauma, especially to their limbs, neck, or spine.

Description

The feeling of having a foot "fall asleep" is a familiar one. This same combination of numbness and tingling can occur in any region of the body and may be caused by a wide variety of disorders. Sensations such as these, which occur without any associated stimulus, are called paresthesias. Other types of paresthesias include feelings of cold, warmth, burning, **itching**, and skin crawling.

Causes and symptoms

Causes

Sensation is carried to the brain by neurons (nerve cells) running from the outer parts of the body to the spinal cord in bundles called nerves. In the spinal cord, these neurons make connections with other neurons that run up to the brain. Paresthesias are caused by disturbances in the function of neurons in the sensory pathway. This disturbance can occur in the central nervous system (the brain and spinal cord), the nerve roots that are attached to the spinal cord, or the peripheral nervous system (nerves outside the brain and spinal cord).

Peripheral disturbances are the most common cause of paresthesias. "Falling asleep" occurs when the blood supply to a nerve is cut off—a condition called **ischemia**. Ischemia usually occurs when an artery is compressed as it passes through a tightly flexed joint. Sleeping with the arms above the head or sitting with the legs tightly crossed frequently cause numbness and tingling.

Direct compression of the nerve also causes paresthesias. Compression can be short-lived, as when a heavy backpack compresses the nerves passing across the shoulders. Compression may also be chronic. Chronic nerve compression occurs in entrapment syndromes. The most common example is **carpal tunnel syndrome**. Carpal tunnel syndrome occurs when the median nerve is compressed as it passes through a narrow channel in the wrist. Repetitive motion or prolonged vibration can cause the lining of the channel to swell and press on the nerve. Chronic nerve root

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compression, or radiculopathy, can occur in disk disease or spinal arthritis.

Other causes of paresthesias related to disorders of the peripheral nerves include:

- Metabolic or nutritional disturbances. These disturbances include diabetes, hypothyroidism (a condition caused by too little activity of the thyroid gland), alcoholism, malnutrition, and vitamin B_{12} deficiency.
- Trauma. Trauma includes injuries that crush, sever, or pull on nerves.
- Inflammation.
- Connective tissue disease. These diseases include arthritis, systemic lupus erythematosus (a chronic inflammatory disease that affects many systems of the body, including the nervous system), polyarteritis nodosa (a vascular disease that causes widespread inflammation and ischemia of small and medium-size arteries), and Sjögren's syndrome (a disorder marked by insufficient moisture in the tear ducts, salivary glands, and other glands).
- Toxins. Toxins include heavy metals (metallic elements such as arsenic, lead, and mercury which can, in large amounts, cause poisoning), certain antibiotics and chemotherapy agents, solvents, and overdose of pyridoxine (vitamin B_6).
- Malignancy.
- Infections. Infections include Lyme disease, human immunodeficiency virus (HIV), and leprosy.
- Hereditary disease. These diseases include Charcot-Marie-Tooth disease (a hereditary disorder that causes wasting of the leg muscles, resulting in malformation of the foot), porphyria (a group of inherited disorders in which there is abnormally increased production of substances called porphyrins), and Denny-Brown's syndrome (a hereditary disorder of the nerve root).

Paresthesias can also be caused by central nervous system disturbances, including **stroke**, TIA (**transient ischemic attack**), tumor, trauma, **multiple sclerosis**, or infection.

Symptoms

Sensory nerves supply or innervate particular regions of the body. Determining the distribution of symptoms is an important way to identify the nerves involved. For instance, the median nerve innervates the thumb, the first two fingers, half of the ring finger, and the part of the hand to which they connect. The ulnar nerve innervates the other half of the ring finger, the little finger, and the remainder of the hand. Distribution of symptoms may also aid diagnosis of the underlying disease. Diabetes usually causes a symmetrical "glove and stocking" distribution in the hands and feet. Multiple sclerosis may cause symptoms in several, widely separated areas.

Other symptoms may accompany paresthesias, depending on the type and severity of the nerve disturbance. For instance, weakness may accompany damage to nerves that carry both sensory and motor neurons. (Motor neurons are those that carry messages outward from the brain.)

Diagnosis

A careful history of the patient is needed for a diagnosis of paresthesias. The medical history should focus on the onset, duration, and location of symptoms. The history may also reveal current related medical problems and recent or past exposure to drugs, toxins, infection, or trauma. The family medical history may suggest a familial disorder. A work history may reveal repetitive motion, chronic vibration, or industrial chemical exposure.

The physical and neurological examination tests for distribution of symptoms and alterations in reflexes, sensation, or strength. The distribution of symptoms may be mapped by successive stimulation over the affected area of the body.

Lab tests for paresthesia may include blood tests and **urinalysis** to detect metabolic or nutritional abnormalities. Other tests are used to look for specific suspected causes. Nerve conduction velocity tests, **electromyography**, and imaging studies of the affected area may be employed. Nerve biopsy may be indicated in selected cases.

Treatment

Treatment of paresthesias depends on the underlying cause. For limbs that have "fallen asleep," restoring circulation by stretching, exercising, or massaging the affected limb can quickly dissipate the numbness and tingling. If the paresthesia is caused by a chronic disease such as diabetes or occurs as a complication of treatments such as **chemotherapy**, most treatments are aimed at relieving symptoms. Anti-inflammatory drugs such as **aspirin** or ibuprofen are recommended if symptoms are mild. In more difficult cases, **antidepressant drugs** such as amitriptyline (Elavil) are sometimes prescribed. These drugs are given at a much lower dosage for this purpose than for relief of depression. They are thought to help because they alter the body's perception of **pain**. In

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KEY TERMS

Electromyography—A test that uses electrodes to record the electrical activity of muscle. The information gathered is used to diagnose neuromuscular disorders.

Motor nerve—Motor or efferent nerve cells carry impulses from the brain to muscle or organ tissue.

Nerve conduction velocity test—A test that measures the time it takes a nerve impulse to travel a specific distance over the nerve after electronic stimulation.

Nerve growth factor—A protein resembling insulin that affects growth and maintenance of nerve cells

Peripheral nervous system—The part of the nervous system that is outside the brain and spinal cord. Sensory, motor, and autonomic nerves are included.

Sensory nerves—Sensory or afferent nerves carry impulses of sensation from the periphery or outward parts of the body to the brain. Sensations include feelings, impressions, and awareness of the state of the body.

severe cases, opium derivatives such as codeine can be prescribed. Currently trials are being done to determine whether treatment with human nerve growth factor will be effective in regenerating the damaged nerves.

Alternative treatment

Several alternative treatments are available to help relieve symptoms of paresthesia. Nutritional therapy includes supplementation with B complex **vitamins**, especially vitamin B_{12} (intramuscular injection of vitamin B_{12} is most effective). Vitamin supplements should be used cautiously however. Overdose of vitamin B_6 is one of the causes of paresthesias. People experiencing paresthesia should also avoid alcohol. **Acupuncture** and massage are said to relieve symptoms. Self-massage with aromatic oils is sometimes helpful. The application of topical ointments containing capsaicin, the substance that makes hot peppers hot, provides relief for some. It may also be helpful to wear loosely fitting shoes and clothing. None of these alternatives should be used in place of traditional therapy for the underlying condition.

Prognosis

Treating the underlying disorder may reduce the occurrence of paresthesias. Paresthesias resulting from damaged nerves may persist throughout or even beyond the recovery period. The overall prognosis depends on the cause.

Prevention

Preventing the underlying disorder may reduce the incidence of paresthesias. For those with frequent paresthesias caused by ischemia, changes in posture may help.

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Richard Robinson
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Nummular dermatitis *see* **Dermatitis**

Nutrition

Definition

Nutrition is the sum of all the processes by which food enters and is utilized by the body. Nutrients include protein, carbohydrates, fats, **vitamins**, **minerals**, and water. Fiber in foods helps prevent disease and control weight.

Purpose

Nutrition is essential to life. It is required for growth and development from infancy through young adulthood and throughout life to provide energy and maintain bodily tissues and functions. Good nutrition

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promotes health and helps prevent **obesity** and disease. Nutrition is especially important during **pregnancy** and childhood to prevent growth retardation. Childhood and adolescent nutrition can have major ramifications on health in later life.

Demographics

Throughout much of the world families struggle to obtain adequate nutrition. In the United States and other developed countries nutrition is more often a matter of choice. According to the Centers for Disease Control (CDC), American society has become "obesogenic," with increased consumption of non-nutritional foods. Only 25% of Americans consume at least five daily servings of fruits and vegetables—the cornerstones of good nutrition. Americans are also eating more restaurant and fast food than in the past, along with larger portions and other changes in meal patterns and frequency.

Pediatric

The nutritional status and health of American children and adolescents has declined in recent years:

- The Healthy Eating Index from the U.S. Department of Agriculture (USDA) has found that among children aged two through nine, 60–80% have diets in need of improvement and 4–8% have poor diets, with 63% eating too little fruit and 78% eating too few vegetables.
- Only 21% of high school students report eating five or more daily servings of fruits and vegetables (other than fried potatoes and chips).
- Whole grains account for only 14% of the total daily grain consumption of children and adolescents.
- Only 39% of children aged two through 17 meet dietary recommendations for fiber (fruits, vegetables, dried beans and peas, and whole grains).
- More than 60% of children and teens eat too much saturated fat.
- Almost two-thirds of teens eat more than the recommended amount of total fat.
- Most teens eat too much processed, prepared, and junk foods.
- Among adolescent girls, 85% do not consume adequate calcium. Milk consumption by teenage girls has decreased 36% in recent decades, while soft-drink consumption has almost doubled among girls and almost tripled among adolescent boys.
- Eating disorders are the third most common chronic illness in adolescent girls, affecting as many as 5%.

Geriatric

According to a report by the Merck Institute of Aging and Health and the CDC, two-thirds of older Americans fail to practice good nutrition. Almost 90% of Americans over the age of 65 have one or more degenerative disorders that may have been prevented by better nutrition.

Pregnant or breastfeeding

Breast milk is ideal nutrition for most infants. **Breastfeeding** has increased significantly in the United States in recent decades, from 60% in 1993–1994 to 77% in 2005–2006. Breastfeeding rates by black Americans increased from 36% in 1993–1994 to 65% in 2005–2006. Breastfeeding rates are significantly higher among mothers with higher incomes and those aged 30 and over.

Description

The human body absorbs many different nutrients from food. A good nutrition plan includes a variety of foods from the different food groups, with adequate amounts of the nutrients in each group. Keys to good nutrition include:

- fruits, vegetables, and whole grains
- protein, fiber, calcium, iron, magnesium, potassium, and vitamins A, C, and E
- low-fat dairy products, lean meats, poultry, fish, and beans
- no more than 20–35% of total calories from fat, mostly from polyunsaturated and monounsaturated fats
- plenty of water
- more fluids and carbohydrates from fruits and whole grains for athletes and other physically active individuals
- additional vitamin D from fortified foods and/or supplements for older adults, those with darker skin, and people with insufficient exposure to sunlight
- limited salt (less than about one teaspoon daily for most people), added sugar, saturated fat, trans fat, cholesterol, and alcohol (no more than one drink per day for women and two for men)

Vitamins are required for regulating metabolism and maintaining normal growth and functioning. Minerals are vital for building tissue, muscles, and bones, and for many life-supporting systems, including hormones, oxygen transport, and enzyme function. Although foods are the preferred source of these nutrients, they can also be obtained from **nutritional supplements**.

In 2005 the USDA and the U.S. Department of Health and Human Services revised their *Dietary*

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Guidelines for Americans, with caloric requirements and servings adjusted for gender, age, and physical activity. The guidelines also make recommendations for special populations and incorporate the 2006 DASH (Dietary Approaches to Stop **Hypertension**) Eating Plan developed by the U.S. National Heart, Lung and Blood Institute. The USDA revised the traditional food pyramid to be customizable for individuals. The new guidelines and pyramid focus on balancing calories consumed and utilized by the body, with managed portions from the different food groups and the avoidance of high-sugar and high-fat foods.

USDA/DASH recommendations for a 2,000-calorie daily diet include:

- fruit group: 2–2.5 cups (4–5 servings) of fresh, frozen, canned, or dried fruit, with only limited juice
- vegetable group: 2–2.5 cups (4–5 servings)
- grain group: 6–8 ounce-equivalents of cereal, bread, crackers, rice, or pasta; with at least 50% whole grain
- meat and beans group: 5.5–6 ounce-equivalents of baked, broiled, or grilled lean meat, poultry, or fish, eggs, nuts, seeds, beans, peas, or tofu
- milk group: 2–3 cups low-fat/fat-free milk, yogurt, or cheese, or lactose-free, calcium-fortified products
- oils: 2–6 teaspoons
- discretionary: 267 calories; for example, solid fats (saturated fat such as butter, margarine, shortening, or lard) or added sugar

The vegetable group includes:

- dark greens, such as broccoli and leafy greens: three cups per week
- orange vegetables, such as carrots and sweet potatoes: two cups per week
- legumes, such as pinto or kidney beans, split peas, or lentils: three cups per week
- starchy vegetables: three cups per week
- other vegetables: 6.5 cups per week

Benefits

In addition to its essential role in growth and development, maintenance of bodily functions, and energy supply, good nutrition helps prevent weight gain with calories that are high in nutrients other than sugars and fats. Good nutrition also helps prevent various disorders including:

- dental caries
- iron-deficiency anemia
- osteoporosis
- hypertension
- heart disease
- type 2 diabetes
- some types of cancer

Precautions

In general:

- Fresh foods are usually more nutritious than packaged and processed foods.
- Fast and processed foods contain excess fat and sodium and high amounts of sugar, as well as artificial preservatives, and other additives.
- Fast and processed foods are deficient in fiber and essential vitamins and minerals, such as vitamin A, riboflavin, folic acid, vitamin E, calcium, magnesium, and potassium.
- It is difficult to gauge nutrition and calories when eating out and buying packaged foods.
- Vegetarians need to choose carefully from the basic foods groups to achieve recommended nutrient intakes, especially of protein, vitamins, and iron.
- Iron-deficiency anemia is very common in women. The recommended iron intake is 15–18 mg daily for females. Good sources of iron include dark-green leafy vegetables, legumes, iron-fortified breads and cereals, and red meat.
- Many adults do not obtain enough calcium from their diets, which can lead to osteoporosis in later life. Women aged 19–50 should consume 1,000 mg of calcium daily. Women over 50 require 1,200 mg. Good sources of calcium include dark-green leafy vegetables, calcium-fortified orange juice, bread, cereal, fish, and low-fat dairy products.
- Although nutritional supplementation is sometimes necessary, if possible, nutrients should come from food. Excessive use of vitamin and mineral supplements can lead to serious health problems.
- Diets should not be radically altered except under medical supervision.

Pediatric

Childhood nutrition requires adequate essential nutrients, fiber, and calories to maintain proper growth, maximize cognitive development, and promote health, while preventing excess weight gain. Poor nutrition in adolescence can cause growth and developmental problems and long-term complications including obesity, heart disease, and **osteoporosis**. Children's **diets** should include a variety of foods with high nutrient-to-calorie ratios. In addition:

- At age two, 25–33% of grains should be whole-grain, gradually increasing to 50% by age five.

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KEY TERMS

Calorie—A unit of food energy.

Carbohydrate—Sugars, starches, celluloses, and gums that are a major source of calories from foods.

Cholesterol—A fat-soluble steroid alcohol (sterol) found in animal fats and oils, and produced in the body from saturated fats. Cholesterol is required to produce vitamin D and various hormones and for the formation of cell membranes. High cholesterol levels contribute to the development of atherosclerosis.

Fat—Molecules composed of fatty acids and glycerol; the slowest utilized source of energy, but the most energy-efficient form of food. Each gram of fat supplies about nine calories, more than twice that supplied by the same amount of protein or carbohydrate.

Monounsaturated fat—Fats that contain one double or triple bond per molecule; examples include canola oil and olive oil.

Polyunsaturated fat—Fats that contain two or more double or triple bonds per molecule; examples include fish, safflower, sunflower, corn, and soybean oils.

Protein—Chains of amino acids that are essential constituents of all living cells and include structural components, enzymes, hormones, and antibodies.

Saturated fat—Fat molecules that contain only single bonds; examples include whole milk, cream, palm and coconut oils, and solid fats such as cheese, butter, and meat.

Trans fat—Fat that is produced by hydrogenation during food processing; trans fats increase bad cholesterol and decrease good cholesterol.

- The average adolescent protein requirement is about 300 mg per 0.4 in (1 cm) of height.
- Physically active adolescents require more fluids and more carbohydrates from fruit and whole grains.
- Requirements for vitamins and minerals increase during adolescence. Teenagers require 1,300 mg of calcium daily. Boys require 10-12 mg of iron and 15 mg of zinc daily. Girls require 15 mg of iron and 12 mg of zinc.
- Vegan and macrobiotic diets for adolescents may require nutritional supplements.

Geriatric

Various factors can interfere with nutrition in the elderly:

- medical conditions and/or medications
- reduced capacity to absorb and utilize nutrients
- oral/dental problems or difficulty chewing or swallowing
- gastrointestinal disturbances
- loss of appetite
- diminishing taste and smell
- changes in taste preferences
- loss of dexterity
- social isolation, loneliness, or depression
- economic limitations
- lack of cooking skills or desire to cook
- inadequate knowledge of nutrition
- dementia

The rate of metabolism can decline by as much as 30% over a lifetime and lean muscle mass can decrease by as much as 25% in the elderly, accompanied by an increase in body fat. Therefore, seniors need foods with high nutrient-to-calorie ratios. Although caloric requirements vary greatly, it has been recommended that, after age 50, men reduce their daily intake by 600 calories and women by 300 calories. Because seniors eat less and take in fewer calories, they also consume fewer vitamins and minerals, even though the body's need for some micronutrients may actually increase with age. This is especially true for vitamin D and **calcium**. A single daily multivitamin/mineral supplement can address nutritional gaps.

Other nutritional recommendations for seniors include:

- adequate protein for immune system health and maintenance and repair of body tissues
- dietary fiber from fruits, vegetables, beans, nuts, seeds, brown rice, and whole grains
- only small amounts of fats, oils, and sweets
- no more than 1,500 mg of sodium daily from all food sources (two-thirds of a teaspoon of table salt)
- adequate fluids—the elderly can easily become dehydrated
- vitamin B_{12} from fortified foods or supplements
- potassium from leafy green vegetables, tomatoes, bananas, and root vegetables such as potatoes to counter the effects of salt on blood pressure

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Pregnant or breastfeeding

Women have special nutritional needs during menstruation, pregnancy, **lactation**, and **menopause**. Pregnant and breastfeeding women have increased requirements for calories and for most nutrients. Pregnant and breastfeeding teenagers have even higher nutritional requirements than other pregnant women. Pregnant women should consume iron-rich plant foods and vitamin-C-rich foods that aid in the absorption of iron. **Folic acid**, a B vitamin, is particularly important during pregnancy, since it helps protect against brain and spinal cord **birth defects**. All women of childbearing age should consume 400 micrograms (μg) of folic acid daily and 600 μg during pregnancy. Pregnancy and breastfeeding deplete maternal calcium. Pregnant and lactating adult women should consume 1,000 mg of calcium daily. Pregnant and lactating teenagers require 1,300 mg.

Hormonal changes during pregnancy can trigger **gestational diabetes**, characterized by high levels of sugar in the blood. Changes in diet and **exercise** are often sufficient to keep blood sugar levels within the normal range. Women who experience gestational diabetes are more likely to develop type 2 diabetes later in life.

Other conditions and allergies

Many people with **allergies** or medical conditions require special diets, such as a low-fat, low-cholesterol diet for heart disease, a low-sodium diet for high blood pressure, or a low-calorie diet for weight reduction. Chronic illnesses, such as diabetes, as well as **substance abuse**, also create special nutritional requirements.

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ORGANIZATIONS

American Dietetic Association, 120 South Riverside Plaza, Suite 2000, Chicago, IL, 60606-6995, (800) 877-1600, http://www.eatright.org.

American Heart Association, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, http://www.americanheart.org.

Center for Nutrition Policy and Promotion, 3101 Park Center Drive, 10th Floor, Alexandria, VA, 22302-1594, (703) 305-7600, (888) 7-PYRAMID (779-7264), (703) 305-3300, Support@cnpp.usda.gov, http://www.cnpp.usda.gov.

Food and Nutrition Information Center, National Agricultural Library, 10301 Baltimore Avenue, Room 105, Beltsville, MD, 20705, (301) 504-5414, (301) 504-6409, http://fnic.nal.usda.gov.

National Heart, Lung and Blood Institute, NHLBI Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi.nih.gov.

U.S. Centers for Disease Control and Prevention, 1600 Clifton Rd., Atlanta, GA, 30333, (800) CDC-INFO (232-4636), cdcinfo@cdc.gov, http://www.cdc.gov.

Margaret Alic, PhD

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Nutrition through an intravenous line

Definition

Sterile solutions containing some or all of the nutrients necessary to support life, are injected into the body through a tube attached to a needle, which is inserted into a vein, either temporarily or for long-term treatment.

Purpose

Patients who cannot consume enough nutrients or who cannot eat at all due to an illness, surgery, or accident, can be fed through an intravenous (IV) line or tube. An IV can be used for as little as a few hours, to provide fluids to a patient during a short surgical procedure, or to rehydrate a patient after a viral illness.

Patients with more serious and long-term illnesses and conditions may require months or even years of intravenous therapy to meet their nutritional needs. These patients may require a central **venous access** port. A specialized catheter (silastic Broviac or Hickman) is inserted beneath the skin and positioned below the collarbone. Fluids can then be injected directly into the bloodstream for long periods of time. X-rays are taken to ensure that the permanent catheter is properly positioned.

Precautions

Patients receiving IV therapy need to be monitored to ensure that the IV solutions are providing the correct amounts of fluids, **minerals**, and other nutrients needed.

Description

There are two types of IV, or parenteral, **nutrition**. Parenteral nutrition is that which is delivered through a system other than the digestive system. In this case, the nutrition is delivered through a vein. Partial parenteral nutrition (PPN) is given for short periods of time, to replace some of the nutrients required daily and only supplements a normal diet. **Total parenteral nutrition** (TPN) is given to someone who cannot eat anything and must receive all nutrients required daily through an intravenous line. Both of these types of nutrition can be performed in a medical facility or at the patient's home. Home parenteral nutrition (HPN) usually requires a central venous catheter, which must first be inserted in a fully equipped medical facility. After it is inserted, therapy can continue at home.

Basic IV solutions are sterile water with small amounts of **sodium** (salt) or dextrose (sugar) supplied in bottles or thick plastic bags that can hang on a stand mounted next to the patient's bed. Additional minerals, like potassium and **calcium**, **vitamins**, or drugs can be added to the IV solution by injecting them into the bottle or bag with a needle. These simple sugar and salt solutions can provide fluids, calories, and electrolytes necessary for short periods of time. If a patient requires intravenous feeding for more than a few days, additional nutrients like proteins and fats will be included. The amounts of each of the nutrients to be added will depend on the patient's age, medical condition, and particular nutritional requirements.

Preparation

A doctor orders the IV solution and any additional nutrients or drugs to be added to it. The doctor also specifies the rate at which the IV will be infused. The IV solutions are prepared under the supervision of a doctor, pharmacist, or nurse, using sanitary techniques that prevent bacterial contamination. Just like a prescription, the IV is clearly labeled to show its contents and the amounts of any additives. The skin around the area where the needle is inserted is cleaned and sanitized. Once the needle is in place, it will be taped to the skin to prevent it from dislodging.

In the case of HPN, the IV solution is delivered to the patient's home on a regular basis and should be kept refrigerated. Each bag will have an expiration date, by which time the bag should be used. The solution should be allowed to be warmed to room temperature before intravenous nutrition begins.

Aftercare

Patients who have been on IV therapy for more than a few days may need to have foods reintroduced gradually to give the digestive tract time to start working again. After the IV needle is removed, the site should be inspected for any signs of bleeding or infection.

When using HPN, the catheter should be kept clean at all times. The **dressings** around the site should be changed at least once a week and the catheter site should be monitored closely for signs of redness, swelling, and drainage. The patient's extremities

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KEY TERMS

Home parenteral nutrition (HPN)—Long-term parenteral nutrition, given through a central venous catheter and administered in the patient's home.

Intravenous—Into a vein; a needle is inserted into a vein in the back of the hand, inside the elbow, or some other location on the body. Fluids, nutrients, and drugs can be injected.

Parenteral—Not in or through the digestive system. Parenteral nutrition is given through the veins of the circulatory system, rather than through the digestive system.

Partial parenteral nutrition (PPN)—A solution, containing some essential nutrients, is injected into a vein to supplement other means of nutrition, usually a partially normal diet of food.

Total parenteral nutrition (TPN)—A solution containing all the required nutrients including protein, fat, calories, vitamins, and minerals, is injected over the course of several hours, into a vein. TPN provides a complete and balanced source of nutrients for patients who cannot consume a normal diet.

should be watched for swelling, which is a sign of nutritional imbalance.

Risks

There is a risk of infection at the injection site, and for patients on long term IV therapy, the risk of an infection spreading to the entire body is fairly high. It is possible that the IV solution may not provide all of the nutrients needed, leading to a deficiency or an imbalance. If the needle becomes dislodged, it is possible that the solution may flow into tissues around the injection site rather than into the vein. The patient should be monitored regularly, particulary if receiving HPN, as intravenous nutrition can potentially cause infection at the site of the catheter, high blood sugar, and low blood potassium, which can all be life-threatening.

Resources

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Altha Roberts Edgren

Nutritional supplements

Definition

Nutritional supplements include **vitamins**, **minerals**, herbs, meal supplements, sports **nutrition** products, natural food supplements, and other related products used to boost the nutritional content of the diet.

Purpose

Nutritional supplements are used for many purposes. They can be added to the diet to boost overall health and energy, to provide immune system support and reduce the risks of illness and age-related conditions, to improve performance in athletic and mental activities, and to support the healing process during illness and disease. Although some supplements may be prescribed by a doctor or used for medical purposes, most of these products are regulated by the U.S. Food and Drug Administration (FDA) as food products, not as drugs. This means that they do not have to meet the strict standards that drugs do.

Description

According to the U.S. National Institute of Health's Office of Dietary Supplements, sales of dietary supplements in the United States reached $21.3 billion in 2005. By category, vitamins provided $3.0 billion in sales, herbs $4.4 billion, minerals $1.8 billion, sports nutrition products $2.2 billion, multivitamins/minerals $4.2 billion, and other supplements totaling $5.7 billion.

Vitamins

Vitamins are micronutrients, or substances that the body uses in small amounts, as compared to macronutrients, which are the proteins, fats, and carbohydrates that make up most of food. Vitamins are present in food, but adequate quantities of vitamins may be reduced when food is overcooked, processed, or improperly stored. For instance, processing whole wheat grain into white flour reduces the contents of vitamins B and E, fiber, and minerals, including zinc and iron. The body requires vitamins to support its basic biochemical functions, and deficiencies over time can lead to serious disorders and have other negative health consequences.

Vitamins are either water-soluble or fat-soluble. Water-soluble vitamins dissolve in water and are not stored in the body, meaning that the body needs them on a regular basis. Water-soluble vitamins include the B-complex vitamins and vitamin C. Fat-soluble vitamins are stored in the body's fatty tissue, meaning that

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extra quantities can be stored for use by the body later. Fat-soluble vitamins include vitamins A, D, E, and K.

The amount of vitamins needed by the body has been the subject of much research. The U.S. government has published recommended dietary allowances (RDAs) for each vitamin for the general population. These figures can be used as guidelines, but individuals may have different needs depending on gender, age, activity level, and health conditions.

Vitamins can be natural or synthetic. Natural vitamins are extracted from food sources, while synthetic vitamins are formulated in laboratory processes. The only vitamin for which there is a noted difference between the natural and synthetic forms is vitamin E. The natural form is labeled d-alpha-tocopherol while the synthetic form is named dl-alpha-tocopherol, with the extra "l" signifying laboratory production. Natural vitamin E has been shown to be absorbed slightly more efficiently by the body than the synthetic version. For other vitamins no significant differences in absorption have been noted.

Minerals

Minerals are micronutrients and are essential for the proper functioning of the body. Cells in the body require minerals as part of their basic make-up and chemical balance, and minerals are present in all foods. Minerals can either be bulk minerals, used by the body in larger quantities, or trace minerals, used by the body in minute or trace amounts. Bulk minerals include **sodium**, potassium, **calcium**, magnesium, and phosphorus. Trace minerals include iron, zinc, selenium, iodine, chromium, copper, manganese, and others. Some studies have shown that the amount of minerals, particularly trace minerals, may be decreasing in foods due to mineral depletion of the soil caused by unsustainable farming practices and soil erosion. Supplemental minerals are available in chelated form, in which they are bonded to proteins in order to improve their absorption by the body.

Herbs

Herbal supplements may be added to the diet for both nutritional and medicinal purposes. Herbs have been used for centuries in many traditional medicine systems, and as sources of phytochemicals, or substances found in plants that have notable effects on the body. Chinese medicine and **Ayurvedic medicine** from India, two of the world's oldest healing systems, use hundreds of herbal medications. Naturopathy and homeopathy, two other systems of natural healing, also rely on herbal preparations as their main sources of medication. Some of the medicinal effects of herbs are getting scientific validation; about one-fourth of all pharmaceuticals have been derived directly from plant sources, including **aspirin** (found in willow bark); codeine (from poppy seeds); paclitaxel (Taxol), a patented drug for ovarian and **breast cancer** (from the Pacific yew tree); and many others.

Herbs can supplement the diet to aid in overall health or may be intended to stimulate healing for specific conditions. For instance, **ginseng** is often used to increase overall health and vitality, while **echinacea** is popularly believed to stimulate the body's resistance to colds and infections. Herbs come in many forms. They can be purchased as capsules and tablets, as well as in tinctures, teas, syrups, and ointments.

Meal supplements

Meal supplements are used to replace or fortify meals. They may be designed for people with special needs, or for people with illnesses that may affect digestion capabilities and nutritional requirements. Meal supplements may contain specific blends of macronutrients, or proteins, carbohydrates, fats, and fiber. Some meal supplements consist of raw, unprocessed foods, or may be vegetarian or vegan, or have high protein and low fat composition. Meal supplements are available to support some popular diet programs. They are often fortified with vitamins, minerals, herbs, and nutrient-dense foods.

Sports nutrition

Nutritional supplements may be designed to provide specialized support for athletes. Some of these consist of high-protein products, such as amino acid supplements, while other products contain nutrients that support metabolism, energy, and athletic performance and recovery. People engaging in intense athletic activity may have increased needs for water-soluble vitamins, **antioxidants**, and certain minerals, including chromium. Sports drinks may contain blends of electrolytes (salts) that the body loses during exertion and sweating, as well as vitamins, minerals, and performance-supporting herbs.

Other nutritional supplements

Other nutritional supplements include nutrient-dense food products. Examples of these are brewer's yeast, spirulina (sea algea), bee pollen and royal jelly, fish oil and essential fatty acid supplements, colostrum (a specialty dairy product), psyllium seed husks (a source of fiber), wheat germ, wheatgrass, and medicinal mushrooms such as the shiitake and reishi varieties.

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Specialty products may offer particular health benefits or are targeted for specific conditions. These products may consist of whole foods or may be isolated compounds from natural or synthetic sources. Examples include antioxidants, probiotics (supplements containing bacteria helpful to the digestion process), digestive enzymes, shark cartilage, other animal products, and chemical extracts such as the hormone DHEA (dehydroepiandrosterone) and coenzyme Q10, an antioxidant.

General guidelines

Considering average dietary needs and the prevalence of certain health conditions, some basic guidelines may provide the foundation for the effective use of nutritional supplements. First, a high quality, broad-spectrum multivitamin and mineral supplement, taken once per day, may be recommended for some people. This should contain the B-complex vitamins B_6, B_{12}, and **folic acid**, which may help prevent heart disease, and the minerals zinc and copper, which aid immunity. In addition to a multivitamin, antioxidants can be added to a supplementation routine. These include vitamin A (or beta-carotene), vitamin C, and vitamin E, and the mineral selenium. Antioxidants are popularly believed have several positive effects on the body, such as slowing the **aging** process, reducing the risks of **cancer** and heart disease, and reducing the risks of illness and infection by supporting the immune system. Coenzyme Q10 is another antioxidant in wide usage, as studies have shown it may improve the health of the heart and reduce the effects of heart disease. Essential fatty acids, particularly omega-3, are also recommended as they are involved in many important processes in the body, including brain function. Calcium supplementation is recommended for the elderly and for women, to support bone strength. Calcium supplements that are balanced with magnesium have a less constipating effect and are better absorbed.

After basic nutritional requirements are supported, supplements may be used to target specific needs and health conditions. For instance, athletes, men, women, children, the elderly, and vegetarians have differing needs for nutrients, and an informed use of supplements would take these differences into account. People suffering from health conditions and diseases may use specific supplements to target their condition and to support the body's healing capacity by providing optimal amounts of nutrients.

Recommended dosage

Dosages of nutritional supplements vary widely, depending on the product and individual needs. For vitamins and minerals, U.S. RDA's are general guidelines. For other products, manufacturers' guidelines, consumer information sources such as nutritional books and magazines, and practitioners including nutritionists and naturopathic physicians may be consulted.

Precautions

Nutritional supplements are not regulated by the FDA in the same way that prescription and over-the-counter drugs are. Instead, nutritional supplements are regulated in the same way as food. This means that makers of nutritional supplements do not have to prove the effectiveness of their products before putting them on the market. Nutritional supplements that make claims about the benefits of their product are required to carry a label stating that "This statement has not been evaluated by the Food and Drug Administration. This product is not intended to diagnose, treat, cure, or prevent any disease."

Because nutritional supplements are regulated in the same way as food products, the FDA may only take action against a product once it is already on the market. This means that sometimes products that are harmful, contaminated, or that make misleading claims can make onto retail shelves. In the past products have been identified by the FDA as containing more, or less, of the vitamin, mineral, or herb, than stated on the package, as contaminated with pesticides, heavy metals, or prescription drugs, as containing herbs not identified on the label, and as possibly causing dangerous interactions with prescription drugs. Because of these concerns it is extremely important that individuals exercise caution when making decisions about taking nutritional supplements.

Overall diet is an important first consideration for those considering nutritional supplementation. Healthy dietary habits can help optimize nutrition and the absorption of supplements, and nutritional supplements cannot substitute for a diet that is not nutritionally balanced. A good diet contain a variety of wholesome foods. The U.S. Department of Agriculture's MyPyramid food guide provides guidelines for a healthy diet, and can be found at www.MyPyramid.gov. Variety in the diet is important to provide a full range of vitamins and minerals. Overeating inhibits digestion and absorption of nutrients, while regular exercise contributes to sound nutrition, by improving metabolism and digestion. Drinking plenty of water prevents **dehydration**, improves digestion, and helps the body flush out impurities.

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Generally, nutrients from food sources are more efficiently utilized by the body than isolated substances. For instance, fresh fruit and vegetable juice could be used to provide concentrated amounts of particular nutrients, such as vitamins A and C, to the diet. Eating plenty of leafy green vegetables is a healthy option for those wishing to add calcium to the diet.

Vitamins and minerals are most easily digested with food. Fat-soluble vitamins should be taken with food that contains fat. Vitamins tend to work synergistically, meaning that they work together in order to be effective. For instance, vitamin E requires some of the B-complex vitamins and the minerals selenium and zinc for most effective absorption. Some minerals may not be absorbed or may inhibit each other when taken in improper ratios. Generally, a high quality, broad-spectrum vitamin and mineral supplement is formulated to prevent unfavorable interactions.

Many vitamins, minerals, and herbs are toxic when taken in large quantities. Vitamin A can become toxic when taken in large amounts (more than 100,000 International Units), as can vitamin D. Substituting beta-carotene for vitamin A can alleviate this risk. Large doses of fat-soluble vitamins, because extra amounts of the vitamin are stored in the body, can have serious negative health consequences. Water-soluble vitamins are not stored in the body, and therefore extra quantities are excreted in the urine. Large doses of minerals, especially taken over time, may also have toxic effects in the body. Dosages far exceeding RDA's of vitamins are not recommended, nor are large doses of other supplements.

Vitamins, minerals, and herbs may interact dangerously with prescription or over-the-counter medications, may make some medications less effective, or may cause some medical conditions to become worse. For example, **St. John's wort** can interfere with birth control medications, with medications used to treat cancer and HIV infection, and medications taken by organ transplant patients. Ginseng can cause lowered blood sugar levels, which can be dangerous when used in combination with some medications used to treat diabetes. It is extremely important that individuals talk with their doctor or pharmacist about how a nutritional supplement may interact with their medications and affect their health conditions before beginning to take it.

Consumers can make wise choices for nutritional supplementation by consulting a physician, pharmacist, nutritionist, or other health professionals. Nutritional supplements are best added into the diet slowly, starting with small dosages and working up to the manufacturers' recommended amounts over time.

KEY TERMS

Antioxidants—A class of biochemicals that have been found to protect cells from free-radical damage.

Enzymes—Chemical catalysts that help initiate biochemical processes.

Essential fatty acids—Sources of fat in the diet, including omega-3 and omega-6 fatty acids.

Naturopathic physicians—Physicians specializing in the treatment of disease using a variety of natural methods and plant-based medicines.

Also, some supplements, such as herbal medications that may stimulate processes in the body, are best taken intermittently, allowing the body occasional rest periods without the supplement. To avoid unfavorable interactions, nutritional supplements are best used moderately and individually, rather than taking handfuls of capsules and tablets for various needs and conditions at the same time. Finally, consumers should be wary of excessive or grandiose health claims made by manufacturers of nutritional supplements and rely on scientific information to validate these claims.

Side effects

Some nutritional supplements can cause upset stomach and allergic reactions, including **rashes**, flushing, **nausea**, sweating, and headaches.

Interactions

Herbal preparations and nutritional supplements may interact unfavorably with pharmaceutical drugs. For instance, some nutritional supplements such as taking 5-HTP, a nutritional supplement for the brain, or the herb St. John's Wort, may not be recommended for those taking pharmaceutical antidepressants. Vitamin C should not be taken with aspirin, as it can irritate the stomach and limit absorption. Minerals should be taken in proper proportions to prevent unfavorable interactions; large amounts of zinc may deplete the body of the mineral copper, while too much calcium adversely affects the magnesium levels in the body. Balanced mineral supplements are recommended to alleviate these interactions.

Resources

BOOKS

Adele, Stephen, and Rehan Jalali. *Sports Supplement Buyer's Guide: Complete Nutrition for Your Active Lifestyle*. Laguna Beach, CA: Basic Health Publications, 2007.

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Balch, Phyllis A. *Prescription for Nutritional Healing*. East Rutherford, NJ: Penguin Group, 2005.
Shannon, Joyce Brennfleck. *Diet and Nutrition Sourcebook*. Detroit: Omnigraphics, 2006.

ORGANIZATIONS

Center for Science in the Public Interest, 1875 Connecticut Avenue NW, Suite 300, Washington, DC, 20009, (202) 332-9110, (202) 265-4954, cspinews@cspinet.org, http://www.cspinet.org.
USDA Food and Nutrition Information Center, http://www.nal.usda.gov/fnic.

Douglas Dupler

Nystagmus

Definition

Rhythmic, oscillating motions of the eyes are called nystagmus. The to-and-fro motion is generally involuntary. Vertical nystagmus occurs much less frequently than horizontal nystagmus and is often, but not necessarily, a sign of serious brain damage. Nystagmus can be a normal physiological response or a result of a pathologic problem.

Description

The eyes play a critical role in maintaining balance. They are directly connected to other organs of equilibrium, most important of which is the inner ear. Paired structures called the semicircular canals deep in the skull behind the ears sense motion and relay that information to balance control centers in the brain. The eyes send visual information to the same centers. A third set of sensors consists of nerve endings all over the body, particularly in joints, that detect position. All this information is integrated to allow the body to navigate in space and gravity.

It is possible to fool this system or to overload it with information so that it malfunctions. A spinning ride at the amusement park is a good way to overload it with information. The system has adapted to the spinning, expects it to go on forever, and carries that momentum for some time after it is over. Nystagmus is the lingering adjustment of the eyes to tracking the world as it revolves around them.

Nystagmus can be classified depending upon the type of motion of the eyes. In pendular nystagmus the speed of motion of the eyes is the same in both directions. In jerk nystagmus there is a slow and fast phase. The eyes move slowly in one direction and then seem to jerk back in the other direction.

Nystagmus can be present at birth (congenital) or acquired later on in life. A certain type of acquired nystagmus, called spasmus nutans, includes a head tilt and head bobbing and generally occurs between four to 12 months of age. It may last a few months to a few years, but generally goes away by itself.

Railway nystagmus is a physiological type of nystagmus. It happens when someone is on a moving train (thus the term railway) and is watching a stationary object which appears to be going by. The eyes slowly follow the object and then quickly jerk back to start over. Railway nystagmus (also called optokinetic nystagmus) is a type of jerk nystagmus. This phenomenon can be used to check vision in infants. Nystagmus can also be induced by fooling the semicircular canals. Caloric stimulation refers to a medical method of testing their connections to the brain, and therefore to the eyes. Cold or warm water flushed into the ear canal will generate motion signals from the inner ear. The eyes will respond to this signal with nystagmus if the pathways are intact.

Causes and symptoms

There are many causes of nystagmus. Nystagmus may be present at birth. It may be a result of the lack of development of normal binocular fixation early on in life. This can occur if there is a cataract at birth or a problem is some other part of the visual system. Some other conditions that nystagmus may be associated with include:

- Albinism. This condition is caused by a decrease in pigmentation and may affect the eyes.
- Disorders of the eyes. This may include optic atrophy, color blindness, very high nearsightedness (myopia) or severe astigmatism, or opacities in the structures of the eyes.
- Acute labyrinthitis. This is an inflammation in the inner ear. The patient may have dizziness (vertigo), nausea and vomiting, and nystagmus.
- Brain lesions. Disease in many parts of the brain can result in nystagmus.
- Alcohol and drugs. Alcohol and some medications (e.g., anti-epilepsy medications) can induce or exaggerate nystagmus.
- Multiple sclerosis. A disease of the central nervous system.

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KEY TERMS

Binocular fixation—Both eyes pointed to and looking at the same object.

Cataract—A clouding of the lens of the eye.

Optic atrophy—Degeneration of the optic nerve.

Semicircular canals—Structures of the inner ear that help in maintaining balance.

Vertigo—A sense of spinning usually accompanied by unsteadiness and nausea.

Diagnosis

Nystagmus is a sign, not a disease. If abnormal, it indicates a problem in one of the systems controlling it. An ophthalmologist and/or neuro-ophthalmologist should be consulted.

Treatment

There is one kind of nystagmus that seems to occur harmlessly by itself. The condition, benign positional vertigo, produces vertigo and nystagmus when the head is moved in certain directions. It can arise spontaneously or after a **concussion**. **Motion sickness** medicines sometimes help. But the reaction will dissipate if continuously evoked. Each morning a patient is asked to produce the symptom by moving his or her head around until it no longer happens. This prevents it from returning for several hours or the entire day.

Prisms, **contact lenses**, eyeglasses, or **eye muscle surgery** are some possible treatments. These therapies may reduce the nystagmus but may not alleviate it. Again, because nystagmus may be a symptom, it is important to determine the cause.

ORGANIZATIONS

American Academy of Ophthalmology (AAO), P.O. Box 7424, San Francisco, CA, 94120-7424, (415) 561-8500, (415) 561-8500, http://www.aao.org.

American Optometric Association, 243 North Lindbergh Blvd., St. Louis, MO, 63141, (314) 991-4100, (314) 991-4101, (800) 365-2219, http://www.aoa.org/.

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O

Obesity

Definition

Obesity is the excessive accumulation of body fat resulting in a body mass index (BMI) that is significantly above the norm and is associated with increased risk of illness, disability, and **death**. Medical professionals generally consider obesity to be a chronic illness requiring lifelong treatment and management. It is often grouped with other chronic conditions—such as high blood pressure and diabetes—that can be controlled but not cured.

Demographics

Obesity is a serious public-health problem that affects both sexes and all ethnic, racial, age, and socioeconomic groups in the United States and around the world. According to the U.S. Centers for Disease Control (CDC), more than one-third of adults in the United States are obese—more than 71 million people. Approximately 300,000 deaths a year are attributed to obesity, prompting public-health officials such as former Surgeon General C. Everett Koop to label obesity "the second leading cause of preventable deaths in the United States."

Slightly more women than men are obese in all adult age groups—35.3% of women and 33.3% of men. The highest percentage of obesity is in the 40–50-year age group. Approximately 53% of non-Hispanic black U.S. women and 51% of Mexican-American women aged 40-59 years are obese, compared with about 39% of non-Hispanic white women of the same age. Among women 60 years and older, 61% of non-Hispanic blacks are obese compared with 32% of non-Hispanic white women and 37% of Mexican-American women. These racial/ethnic differences in obesity rates are not seen among men.

Obesity is the most common nutritional disorder among U.S. children and teens. African-American and Hispanic children are considerably more likely to be overweight than Caucasian-American children.

According to the CDC, between the mid-1970s and the mid-2000s:

- The percentage of overweight and obese Americans aged 20–74 increased from 15.0% to 32.9%.
- The percentage of overweight children aged 2–5 increased from 5.0% to 13.9%.
- The percentage of overweight children aged 6–11 increased from 6.5% to 18.8%.
- The percentage of overweight and obese teenagers increased from 5.0% to 17.4%.

Similar trends are reported by the World Health Organization (WHO), which refers to the escalating global epidemic of obesity as "globesity." WHO estimated that in 2007, 1.6 billion people over age 15 were overweight and at least 400 million were obese.

Description

Obesity is excessive body weight that develops over time as people consume more calories than they expend in energy. As excess calories accumulate in the body, people first become overweight, then obese. The ability of the human body to store energy can mean the difference between life and death in times of famine. However this protective mechanism becomes a potential problem when food is readily available in unlimited quantities. This is evident in the increasing prevalence of obesity in modern society, particularly in the developed world. As obesity rates have increased, bariatrics—the branch of medicine that studies and treats obesity—has become a separate medical and surgical specialty.

The human body is composed of bone, muscle, specialized organ tissues, and fat. Together these comprise the total body mass, measured in pounds (lb) or kilograms (kg). Fat, or adipose tissue, is a combination of essential and storage fats. Essential fat is an energy source for the normal physiologic function of cells and

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organs, is tucked in and around internal organs, and is an important building block for all cells of the body. Storage fat is a reserve supply of energy. It accumulates in the chest and abdomen and, in much greater volume, under the skin. When the amount of energy consumed as food exceeds the amount of energy expended in the maintenance of life processes and physical activity, storage fat accumulates in excessive amounts.

In the past obesity was defined as body weight that was at least 20% above one's ideal weight, defined as the weight at which individuals of the same height, gender, and age had the lowest rate of death. Mild obesity was defined as 20–40% over ideal weight, moderate obesity as 40–100% over ideal, and gross or morbid obesity 100% over ideal weight.

Current guidelines use the body mass index (BMI) to define obesity. The BMI utilizes height and weight to compare the ratio of body fat to total body mass. To calculate BMI using metric units, weight in kilograms is divided by height in meters squared. To calculate BMI in English units, weight in pounds is divided by height in inches squared and then multiplied by 703. This calculated BMI is compared to the statistical distribution of BMIs for adults aged 20–29 to determine whether an individual is underweight, average, overweight, or obese. The 20- to 29-year age group was chosen as the standard because it represents fully developed adults at the point in their lives when they have the least amount of body fat. Ideally body fat is about 15% of total body mass for adult males and about 20–25% for adult females. A simple BMI calculator is available at http://www.nhlbisupport.com/bmi. However BMI does not distinguish between fat and muscle.

Adult BMIs are age- and gender-independent. All adults aged 20 and older are evaluated on the same BMI scale as follows:

- underweight: BMI below 18.5
- normal weight: BMI 18.5–24.9
- overweight: BMI 25.0–29.9
- obese: BMI 30 and above Research has shown that adults with BMIs within the normal weight range live longest and enjoy the best health.

The BMI for children and teens is calculated in the same way as for adults, but the results are interpreted differently. A child's BMI is compared to those of other children of the same age and gender and assigned to a percentile. For example, a girl in the 75th percentile for her age group weighs more than 74 of every 100 girls her age and less than 25 of every 100 girls her age:

- underweight: below the 5th percentile
- healthy weight: 5th percentile to below the 85th percentile
- at risk of overweight: 85th percentile to below the 95th percentile
- overweight: 95th percentile and above. The CDC does not use the term "obese" for children and teens because the proportion of body fat fluctuates during growth and development and is slightly higher than in mature adults.

Obesity places **stress** on the body's organs and puts people at higher risk for many serious and potentially life-threatening health problems:

- fatigue
- joint problems
- poor physical fitness
- digestive disorders
- dizzy spells
- rashes
- hypertension (high blood pressure)
- menstrual disorders
- complications during childbirth and surgery
- type 2 diabetes mellitus (non-insulin dependent)
- heart disease
- unexplained heart attack
- gallstones
- breathing problems
- hyperlipidemia
- infertility
- colon, prostate, endometrial, and breast cancers
- premature aging
- Alzheimer's disease

Obese individuals have a shorter life expectancy than people of normal weight. Many diseases, especially degenerative diseases of the joints, heart, and blood vessels, tend to be more severe in obese individuals, increasing the need for some surgical procedures. Obesity is directly related to the increasing prevalence of type 2 diabetes in the United States and for the appearance of type 2 diabetes in children, previously a rarity.

Although acute complications of obesity are rare in children, **childhood obesity** is a risk factor for **insulin resistance** and type 2 diabetes, **hypertension**, hyperlipidemia, liver and renal disease, and reproductive dysfunction. Childhood obesity increases the risk of deformed bones in the legs and feet. It can also result in emotional disorders such as depression caused by social isolation and negative comments by peers. Moreover childhood obesity increases the risks of adult obesity and cardiovascular disease.

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The cost of obesity to the U.S. economy in 2006 was estimated at about $100 billion, of which $52 billion were for direct healthcare costs and $33 billion were for weight-loss products and services. The increasing prevalence of obesity and diabetes in children and young adults heralds spiraling healthcare costs in the future. The social costs of obesity, including decreased productivity, discrimination, depression, and low self-esteem, are less easily measured.

In 1995 the Institute of Medicine of the U.S. National Academies published a report describing obesity as a "complex, multifactorial disease of appetite regulation and energy metabolism." The report cited the following outcomes from even relatively modest weight loss:

- lower blood pressure (and lower risk of heart attack and stroke)
- reduction of abnormally high levels of blood glucose
- lower blood levels of cholesterol and triglycerides (and lower risk of cardiovascular disease)
- lower incidence of sleep apnea
- lower risk for osteoarthritis in weight-bearing joints
- lower incidence of depression
- improved self-esteem

Risk factors

Obesity tends to run in families. Children of obese parents are about 13 times more likely than other children to be obese. Additional obese family members, including siblings and grandparents, greatly increases the likelihood of childhood obesity. The tendency toward a body type with an unusually high number of fat cells—termed *endomorphic*—appears to be inherited. Other genetic factors influence appetite and the metabolic rate at which food is transformed into energy. However family eating habits are major contributors to the development of obesity. Although the majority of adopted children have patterns of weight gain that more closely resemble those of their birth parents than those of their adoptive parents, normal-weight children adopted into obese families are more likely than other children to become obese. Longitudinal studies of juvenile-onset obesity have demonstrated parental and peer encouragement of overeating and even deliberate overfeeding of obese children.

Low socioeconomic status is a risk factor for adult-onset obesity.

Causes and symptoms

Obesity is caused by the consumption of more calories than the body uses for energy. The excess calories are stored as adipose tissue. Although inheritance may play a role, a genetic predisposition toward weight gain does not in itself cause obesity. Hormonal and genetic disorders account for less than 10% of obesity in children. Eating habits, physical activity, and environmental, behavioral, social, and cultural factors all contribute to the development of obesity.

Sometimes obesity does have a purely physiological cause:

- Cushing's syndrome, a disorder involving the excessive release of the hormone cortisol
- hypothyroidism caused by an under-active thyroid gland, resulting in low levels of the hormone thyroxin and the slow metabolism of food, causing excess unburned calories to be stored as fat
- some cases of hypoglycemia, or low blood sugar, due to a metabolic disorder that results in carbohydrates being stored as fat
- neurological disturbances, such as damage to the hypothalamus, a structure located deep within the brain that helps regulate appetite
- certain drugs such as steroids, antipsychotic medications, and antidepressants

Some researchers have suggested that low levels of the neurotransmitter serotonin increase cravings for carbohydrates. In addition, a combination of genetics and early nutritional habits may result in a higher "set point" for body weight that causes obese individuals to feel hunger more often than others. Recent obesity research has focused on two peptide hormones, leptin and ghrelin. Leptin produced by fat cells affects hunger and eating behavior and an insensitivity to leptin may contribute to obesity. Ghrelin is secreted by cells in the lining of the stomach and is important in appetite regulation and maintaining the body's energy balance.

However most obesity is caused by overeating. During the past decades American eating habits have changed significantly, with many people consuming larger meals and more high-calorie processed foods. School and workplace cafeterias often have a poor selection of nutritional food offerings. Furthermore it is estimated that in a given six-month period, 2–5% of Americans binge eat. It has been estimated that approximately 15% of the mildly obese participating in weight-loss programs have binge-eating disorder and that the percentage is much higher among the morbidly obese.

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Some recent studies have suggested that the amount of fat in a person's diet may have a greater impact on weight than the total number of calories. Carbohydrates from cereals, breads, fruits, and vegetables, and protein from fish, lean meat, turkey breasts, and skim milk are converted into fuel almost as soon as they are consumed. In contrast most fats are immediately stored in fat cells, which multiply and expand, adding to the body's weight and girth. However current evidence indicates that weight gain depends primarily on total calories consumed, rather than the amount from carbohydrates versus fats, and that low-fat **diets** are no more effective for weight reduction than low-calorie diets.

Sedentary lifestyles, which are particularly prevalent in affluent societies such as the United States, also contribute to obesity. Rather than physical labor on farms and in factories, people are now employed at sedentary jobs in post-industrial service industries. Calorie-saving; machines and devices—cars, computers, remote control devices, household electric appliances, and power tools—have become standard equipment. One study found that the average Western European adult walks about 8,000–9,000 steps daily. In contrast, among the Amish of Pennsylvania who do not use cars or electricity, men accumulate 18,425 steps daily and have no obesity. Amish women walk 14,196 steps daily and have an obesity rate of only 9%.

Psychological factors, such as depression and low self-esteem, can contribute to overeating and obesity. People may eat compulsively to overcome fear or social maladjustment, express defiance, or avoid intimate relationships.

Some babies are born obese. This can be caused by excessive insulin production in the fetuses of diabetic mothers or excess trans-placental nutrients in the case of obese mothers or those who gain excessive weight during **pregnancy**.

Some babies become obese because they are overfed. Grandmothers may value a "nice plump baby" or caregivers may use a bottle to quiet an infant or to demonstrate their own competence as child-rearers. Because obese one-year-olds may be physically delayed in crawling and walking, they become less active toddlers, burning fewer calories. By the age of 10, obese boys and girls are taller than their peers by as much as 10 centimeters. Their skeletal maturation, called "bone-age," is also accelerated, so they stop growing earlier. Sexual maturation is advanced. It is not uncommon for obese girls to experience precocious menarche (early onset of menstruation), sometimes even before age 10. Parental separation and divorce or other psychological stresses may stimulate compensatory overeating in children. Obese teenagers and, increasingly, obese preteens may combine periods of **binge eating** and caloric deprivation, leading to bulimia or **anorexia nervosa**.

In developed countries people generally experience increased BMI with age. The proportion of intra-abdominal fat, which correlates with disease and death, increases progressively with age. There is also a progressive decline in daily total energy expenditure, associated with decreased physical activity and lower metabolic activity, especially in those with chronic disabilities and diseases.

The major symptoms of obesity are excessive weight and large amounts of fatty tissue. Common secondary symptoms include **shortness of breath** and lower back pain from carrying excessive body weight. Obesity can also give rise to secondary conditions including:

- arthritis and other orthopedic problems
- hernias
- heartburn
- adult-onset asthma
- gum disease
- high cholesterol levels
- gallstones
- high blood pressure
- menstrual irregularities or cessation of menstruation (amenorhhea)
- decreased fertility and pregnancy complications
- incapacitating shortness of breath
- sleep apnea and sleeping disorders
- skin disorders from the bacterial breakdown of sweat and cellular material in thick folds of skin or from increased friction between folds
- emotional and social difficulties

Diagnosis

Examination

Obesity is usually diagnosed by observation of excessive storage fat and by calculating BMI from weight and height. Physicians also observe how the excess weight is carried by comparing waist and hip measurements: "apple-shaped" patients—who store most of their weight around the waist and abdomen—are at greater risk for **cancer**, heart disease, **stroke**, and diabetes than "pear-shaped" patients whose extra pounds settle primarily in their hips and thighs.

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KEY TERMS

Adipose tissue—Fat tissue.

Anemia—Red blood cell deficiency.

Appetite suppressant—A drug that reduces appetite.

Bariatrics—The branch of medicine that deals with the prevention and treatment of obesity and related disorders.

Binge-eating disorder—A condition characterized by uncontrolled eating.

Body Mass Index (BMI)—A measure of body fat: the ratio of weight in kilograms to the square of height in meters.

Calorie—A unit of food energy.

Carbohydrate—Sugars, starches, celluloses, and gums that are a major source of calories from foods.

Catecholamines—Hormones and neurotransmitters including dopamine, epinephrine, and norepinephrine.

Eating disorder—A condition characterized by an abnormal attitude towards food, altered appetite control, and unhealthy eating habits that affect health and the ability to function normally.

Epidemic—Affecting many individuals in a community or population and spreading rapidly.

Fat—Molecules composed of fatty acids and glycerol; the slowest utilized source of energy, but the most energy-efficient form of food. Each gram of fat supplies about nine calories, more than twice that supplied by the same amount of protein or carbohydrate.

Gastroplasty—A surgical procedure used to reduce digestive capacity by shortening the small intestine or shrinking the side of the stomach.

Ghrelin—A peptide hormone secreted primarily by the stomach that has been implicated in the control of food intake and fat storage.

Hyperlipidemia—Abnormally high levels of lipids in the blood.

Hyperplastic obesity—Excessive weight gain in childhood, characterized by an increase in the number of fat cells.

Hypertension—Abnormally high arterial blood pressure, which if left untreated can lead to heart disease and stroke.

Hypertrophic obesity—Excessive weight gain in adulthood, characterized by expansion of pre-existing fat cells.

Ideal weight—Weight corresponding to the lowest death rate for individuals of a specific height, gender, and age.

Leptin—A peptide hormone produced by fat cells that acts on the hypothalamus to suppress appetite and burn stored fat.

Metabolic activity—The sum of the chemical processes in the body that are necessary to maintain life.

Metabolic bone disease—Weakening of bones due to a deficiency of certain minerals, especially calcium.

Normal weight—A BMI of less than 25.0.

Obesity—An abnormal accumulation of body fat, usually 20% or more above ideal body weight or a BMI of 30.0 or above.

Osteoporosis—A disease characterized by low bone mass and structural deterioration of bone tissue, leading to bone fragility.

Overweight—A BMI between 25.0 and 30.0.

Serotonin—A neurotransmitter located primarily in the brain, blood serum, and stomach membrane.

Procedures

BMIs and other measurements do not necessarily accurately reflect body composition and muscle mass. A heavily muscled football player may weigh far more than a sedentary man of similar height, but have significantly less body fat. Chronic dieters, who have lost significant muscle mass during periods of caloric deprivation, may look slim and weigh little but have elevated body fat. Therefore direct measurements of body fat are obtained using calipers to measure skin-fold thickness at the back of the upper arm and other sites, which distinguishes between muscle and adipose tissue.

The most accurate means of estimating body fat is hydrostatic weighing—calculating the volume of water displaced by the body. The patient exhales as completely as possible and is immersed in water and the relative displacement is measured. Women whose body fat exceeds 30–32% of total body mass by this method and men whose body fat exceeds 25–27% are generally considered obese. Since this method is unpleasant and impractical, it is usually used only in scientific studies.

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Treatment

Traditional

Treatment of obesity aims at reducing weight to a BMI within the normal range (below 25.0). The best way to achieve weight loss is to reduce dietary caloric intake and increase physical activity. However obesity will return unless the weight loss includes lifes long behavioral changes. "Yo-yo" dieting, in which weight is repeatedly lost and regained, has been shown to increase the likelihood of fatal health problems even more than no weight loss at all.

Behavioral treatment for obesity is goal-directed and process-oriented and relies heavily on self-monitoring, with emphasis on:

- Food intake: This may involve keeping a food diary and learning the nutritional value, caloric content, and fat content of foods. It may involve changing shopping habits, such as only shopping on a certain day and buying only what is on the grocery list, timing meals and planning frequent small meals to prevent hunger pangs, and eating slowly to allow for satiation.
- Response to food: This may involve understanding psychological issues underlying eating habits. For example, some people binge eat when under stress, whereas others use food as a reward. By recognizing psychological triggers, alternate coping mechanisms, which do not focus on food, can be developed.
- Time usage: Integrating exercise into everyday life is a key to achieving and maintaining weight loss. Starting slowly and building endurance keeps patients from becoming discouraged. Varying routines and trying new activities keeps interest high.
- Stimulus control: This may involve removing environmental cues for inappropriate eating.
- Contingency management: A system of positive and negative reinforcements may help with behavioral modification.

Most mildly obese patients can make these lifestyle changes independently with medical supervision. Others may utilize a commercial weight-loss program such as Weight Watchers. The effectiveness of these programs is difficult to assess, since they vary widely, dropout rates are high, and few employ medical professionals. However programs that emphasize realistic goals, gradual progress, sensible eating, and **exercise** can be very helpful and are recommended by many physicians. Programs that promise instant weight loss or utilize severely restricted diets are not effective and, in some cases, can be dangerous.

Moderately obese patients require medically supervised behavior modification and weight loss. A realistic goal is a 10% weight loss over a six-month period. Most doctors use a balanced, low-calorie diet of 1200–1500 calories a day. However sometimes certain patients may be put on a medically supervised very-low 400–700 calorie liquid protein diet, with supplementation of **vitamins** and **minerals**, for as long as three months. This therapy should not be confused with commercial liquid-protein diets or weight-loss shakes and drinks. Very-low-calorie diets must be designed for specific patients who are monitored carefully and are used for only short periods. Physicians will also refer patients to professional therapists or psychiatrists for help in changing eating behaviors. Without changing eating habits and exercise patterns, the lost weight will be regained quickly.

For morbidly obese patients, dietary changes and behavior modification may be accompanied by **bariatric surgery**. Gastroplasty involves inserting staples to decrease the size of the stomach. Gastric banding is an inflatable band inserted around the upper stomach to create a small pouch and narrow passage into the remainder of the stomach. Although bariatric surgery has become less risky in recent years with innovations in equipment and surgical techniques, it is still performed only on patients for whom supervised diet and exercise strategies have failed, who are at least 100 lb (45 kg) overweight or twice their ideal body weight, and whose obesity seriously threatens their health. Risks and possible complications include infections, hernias, and **blood clots**. Overall, 10–20% of patients who undergo weight-loss surgery require additional operations to correct complications, more than 33% develop **gallstones**, and 30% develop nutritional deficiencies such as anemia, **osteoporosis**, or metabolic bone disease.

Other bariatric surgical procedures—including **liposuction**, a purely cosmetic procedure in which a suction device removes fat from beneath the skin, and **jaw wiring**, which can damage gums and teeth and cause painful muscle spasms—have no place in obesity treatment.

Weight loss is recommended for obese children over age seven and for obese children over age two who have medical complications. Weight maintenance is an appropriate goal for children over the age of two who have no medical complications. Most treatment approaches to childhood obesity involve a combination of caloric restriction, physical exercise, and behavioral therapy. Bariatric surgery is considered as a last resort only for adolescents who are fully grown.

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Drugs

The short-term use of prescription medications may assist some individuals in managing their condition, but it is never the sole treatment for obesity, nor are drugs ever considered as a cure for obesity. Diet drugs are designed to help medically at-risk obese patients "jump-start" their weight-loss effort and lose 10% or more of their starting body weight, in combination with a diet and exercise regimen. Prescription weight-loss drugs are approved by the U.S. Food and Drug Administration (FDA) only for patients with a BMI of 30 or above or a BMI of 27 or above and an obesity-related condition such as high blood pressure, type 2 diabetes, or dyslipidemia (abnormal amounts of fats in the blood). The weight is usually regained as soon as the drugs are discontinued, unless eating and exercise habits have changed.

Most appetite-suppressants are based on amphetamine. They increase levels of serotonin or catecholamine, brain chemicals that control feelings of fullness. Serotonin also regulates mood and may be linked to mood-related eating behaviors. Prescription weight-loss medications include:

- diethylpropion (Tenuate, Tenuate Dospan)
- mazindol (Mazanor, Sanorex)
- phendimetrazine (Bontril, Melfiat)
- phentermine (Adipex-P, Ionamin)
- sibutramine (Meridia)

Sibutramine should be taken only under close medical supervision. It can significantly elevate blood pressure and should not be used by patients with a history of congestive **heart failure**, heart disease, stroke, or uncontrolled high blood pressure.

While most of the immediate side effects of appetite suppressants are harmless, their long-term effects may be unknown. Dexfenfluramine hydrochloride (Redux), fenfluramine (Pondimin), and the fenfluramine-phentermine combination (Fen/Phen) were taken off the market after they were shown to cause potentially fatal cardiac effects. Phenylpropanolamine, a component of many nonprescription weight-loss and cold and **cough** medications (Acutrim, Dex-A-Diet, Dexatrim, Phenldrine, Phenoxine, PPA, Propagest, Rhindecon, Unitrol) was removed from shelves because of an increased risk of stroke. Appetite-suppressants can be habit-forming and have the potential for **abuse**. Appetite suppressants should not be used by patients taking **monoamine oxidase inhibitors** (MAOIs) and are not recommended for children.

Side effects of prescription and over-the-counter weight-loss products may include:

- constipation
- dry mouth
- headache
- irritability
- nausea
- nervousness
- sweating

Unlike appetite suppressants, orlistat is a lipase inhibitor that reduces the breakdown and absorption of dietary fat in the intestines. It is available in both prescription (Xenical) and non-prescription (alli) forms. Side effects of orlistat may include abdominal cramping, gas, fecal urgency, oily stools, frequent bowel movements, and **diarrhea**.

Other drugs are sometimes prescribed off-label for treating obesity. For example, fluoxetine (Prozac) is an antidepressant that sometimes aids in temporary weight loss. Side effects of this medication include diarrhea, **fatigue**, **insomnia**, **nausea**, and thirst.

Alternative

Functional food diets are newer, as yet unproven, approaches to weight loss:

- carbohydrates with a low glycemic index, which may help suppress appetite
- green tea extract, which may increase the body's energy expenditure
- chromium, which may encourage the burning of stored fat rather than lean muscle tissue

Various herbs and supplements are promoted for weight loss:

- Diuretic herbs, which increase urine production, can result in short-term weight loss, but do not help with lasting weight control. Increased urine output increases thirst to replace lost fluids and patients who use diuretics for an extended period of time eventually start retaining water anyway.
- In moderate doses, psyllium, a mucilaginous herb available in bulk-forming laxatives like Metamucil, absorbs fluid and provides a feeling of fullness.
- Red peppers and mustard may help encourage weight loss by accelerating the body's metabolic rate. They also cause thirst, so patients crave water instead of food.
- Walnuts can be a natural source of serotonin for providing a feeling of satiation.
- Dandelion (*Taraxacum officinale*) can increase metabolism and counter a desire for sugary foods.
- The amino acid 5-hydroxytryptophan (5-HTP), which is extracted from the seeds of *Griffonia simplicifolia*, is thought to increase serotonin levels in the brain. Patients should consult with their healthcare

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provider before taking 5-HTP, as it may interact with other medications and can have potentially serious side effects.

Acupressure and **acupuncture** can suppress food cravings. Visualization and **meditation** can create and reinforce a positive self-image that can enhance a patient's determination to lose weight. By improving physical strength, mental concentration, and emotional serenity, **yoga** can provide the same benefits. Patients who play soft slow music during meals often find that they eat less food but enjoy it more.

Home remedies

Eating the correct ratios of protein, carbohydrates, and high-quality fats are important for weight loss. Support and self-help groups—such as Overeaters Anonymous and TOPS (Taking Off Pounds Sensibly)—that promote nutritious, balanced diets can help patients maintain proper eating regimens.

Fad dieting can have harmful health effects. Weight should be lost gradually and steadily by decreasing calories while maintaining an adequate nutrient intake and level of physical activity. A daily caloric intake of 1,000–1,200 calories for women and 1,200–1,600 for men enables most people to lose weight safely. A loss of about 2 lb (1 kg) per week is recommended. Diets of less than 800 calories a day should never be attempted unless prescribed and monitored by a physician.

At least 60–90 minutes of daily moderate-intensity physical activity is usually recommended to maintain weight loss. Obese people who have led sedentary lives may need monitoring to avoid injury as they begin to increase their physical activity. Exercise should be increased gradually, perhaps starting by climbing stairs instead of taking elevators, followed by walking, biking, or swimming at a slow pace. Eventually 15-minute walks can be built up to brisk, 45–60-minute walks.

The American Academy of Family Physicians offers advice for families with children who need to maintain or lose weight:

- Weight-loss interventions should begin as soon as possible in children over 2 years of age.
- The family must be ready for change; if not, the program is likely to fail.
- The physician should educate the family as to the medical complications of obesity.
- All family members and caregivers should be involved in the treatment program.
- The physician should encourage the child and family, not criticize them.
- The treatment program should institute permanent changes in eating habits and other behaviors.
- The program should help the family to make small gradual changes.
- The program should include learning ways to monitor eating and exercise.
- Goals should be realistic; even a 5% weight loss, if maintained, can reduce risks to health.

Prognosis

The primary factor in achieving and maintaining weight loss is a lifelong commitment to sensible eating habits and regular exercise. As many as 85% of dieters who do not exercise on a regular basis regain their lost weight within two years and 90% regain it within five years. Short-term diet programs and repeatedly losing and regaining weight encourage the storage of fat and may increase the risk of heart disease.

However prudent dieting and exercise are not quick cures for obesity. With decreased caloric intake, the body breaks down muscle for carbohydrates. Much of the early weight loss on a very low-calorie diet represents loss of muscle tissue rather than fat. Similarly, fat is not easily accessed as fuel for exercise.

The chronically or habitually obese tend to come from families with a larger number of risk factors for obesity and have a much more difficult time losing weight than the newly obese. Likewise, previously obese people have a high probability of reverting to obesity.

When obesity develops in childhood, the total number of fat cells increases (hyperplastic obesity), whereas in adulthood the total amount of fat in each cell increases (hypertrophic obesity). Patients who were obese as children may have up to five times as many fat cells as a patient who became obese as an adult. Decreasing the amount of energy (food) consumed or increasing the amount of energy expended reduces the amount of fat in the cells—but does not reduce the number of fat cells already present—and this process is slow, just like the accumulation of excess fat.

Neonatal obesity does not necessarily translate into childhood or adult obesity, but there is an increased probability if the child is born or adopted into a family with multiple obese members. Likewise excess weight in a child under age three does not necessarily predict adult obesity unless one of the parents is obese.

Summer camps specializing in habitually obese children, especially girls, have little long-term success in reducing obesity and a high degree of recidivism for

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habitual overeating and under-exercising. About 30% of overweight girls eventually develop **eating disorders**.

According to the Obesity Prevention Center at the University of Minnesota, obesity-control programs that rely on educational messages encouraging greater physical activity and a healthier diet have been only modestly successful. The best outcomes have been with children's programs that have high levels of physical activity.

Prevention

Prevention is far superior to any available treatment for obesity. Obesity can be prevented by eating a healthy diet, being physically active, and making lifestyle changes that help maintain a normal weight. Examples include

- eating smaller portions of food
- taking the time to prepare healthy meals
- avoiding processed foods
- parking farther away from a store
- walking or bicycling instead of driving
- walking the dog instead of just letting it out

Obesity experts suggest that monitoring fat consumption, as well as counting calories, is a key to preventing excess weight gain. The National Cholesterol Education Program of the National Heart, Lung, and Blood Institute maintains that only 30% of calories should be derived from fat and only one-third of those should be saturated fats. High concentrations of saturated fats are found in meat, poultry, and dairy products. Fat replacers or substitutes are now added to many foods. They reduce the amount of fat and usually also reduce the number of calories. It is not clear what effect these will have on the long-term battle against obesity.

However total caloric intake cannot be ignored, since it is usually the slow accumulation of excess calories, regardless of the source, that results in obesity. A single daily cookie providing 25 excess calories will result in a 5-lb weight gain by the end of one year. Because most people eat more than they think they do, keeping a detailed and honest food diary is a useful way to assess eating habits. Eating three balanced, moderate-portion meals a day—with the main meal at mid-day—is a more effective way to prevent obesity than **fasting** or crash diets that trick the body into believing it is starving. After 12 hours without food, the body has depleted its stores of readily available energy and begins to protect itself for the long term. Metabolic rate starts to slow and muscle tissue is broken down for the raw materials needed for energy maintenance.

The U.S. Department of Agriculture (USDA) food pyramid, called *MyPyramid* to distinguish it from earlier versions, contains recommendations on diet and exercise based on the *Dietary Guidelines for Americans 2005*, tailored for an individual's BMI. It includes recommendations on physical activity and in seven food categories: grains, vegetables, fruits, milk, meat and beans, oils, and discretionary calories.

It has been suggested that there may be little benefit in encouraging weight loss in older people, especially when there are no obesity-related complications or when promoting changes in lifelong eating habits creates stress. However studies have shown that weight loss in seniors can lower the incidence of arthritis, diabetes, and other conditions, reduce cardiovascular risk factors, and improve well-being. Increased physical activity in the elderly also improves muscle strength and endurance.

The poor prognosis for reversing adult obesity makes childhood prevention imperative. Unhealthy eating patterns and behaviors associated with obesity can be addressed by programs in **nutrition**, exercise, and stress management involving the entire family.

Health care team roles

- Physicians diagnose obesity and prescribe drugs.
- Nutritionists and dietitians can design safe and effective meal plans based on individual requirements.
- Nurses also make nutritional recommendations and monitor daily dietary intake.
- Personal trainers and fitness instructors teach weight training and cardiovascular exercise to increase the amount of lean muscle mass and decrease body fat.
- Physical therapists design exercise programs for obese people with back or knee problems that prevent conventional exercising.
- Psychologists use therapies including hypnotism and imagery to help improve emotional well-being, self-esteem, and body image.
- Psychiatrists prescribe drugs to treat depression and anxiety disorders that result from and contribute to obesity.
- Holistic health professionals may use sound therapy, relaxation, and yoga to treat obesity.

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ORGANIZATIONS

American Academy of Family Physicians, 11400 Tomahawk Creek Parkway, Leawood, KS, 66211-2680, (913) 906-6000, (800) 274-6000, (913) 906-6075, http://www.aafp. org/online/en/home.html.

American Council for Fitness and Nutrition, 1350 I Street, Suite 300, Washington, DC, 20005, (614) 442-8793, input@acfn.org, http://www.acfn.org.

American Dietetic Association, 120 South Riverside Plaza, Suite 2000, Chicago, IL, 60606-6995, (800) 877-1600, http://www.eatright.org.

American Society for Metabolic and Bariatric Surgery, 100 SW 75th Street, Suite 201, Gainesville, FL, 32607, (352) 331-4900, (352) 331-4975, info@asmbs.org, http://www.asbs.org.

Centers for Disease Control and Prevention, 1600 Clifton Road, Atlanta, GA, 30333, (888) 232-6348, (301) 563-6595, cdcinfor@cdc.gov, http://www.cdc.gov.

National Heart, Lung, and Blood Institute, NHLBI Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi.nih.gov.

Obesity Prevention Center, University of Minnesota, 1300 South Second Street, Suite 300, Minneapolis, MN, 55454, (612) 625-6200, umopc@epi.umn.edu, http://www.ahc.umn.edu/opc/home.html.

The Obesity Society, 8630 Fenton Street, Suite 814, Silver Spring, MD, 20910, (301) 563-6526, (301) 563-6595, http://www.obesity.org.

Overeaters Anonymous, P.O. Box 44020, Rio Rancho, NM, 87174-4020, (505) 891-2664, (505) 891-4320, http://www.oa.org.

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Weight-Control Information Network (WIN), 1 WIN Way, Bethesda, MD, 20892-3665, (888) 232-6348, (202) 828-1028, win@info.niddk.nih.gov, http://win.niddk.nih.gov.

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Obesity surgery

Definition

Obesity surgery is an operation that either reduces the size of the stomach or bypasses a part of the digestive system so that severely overweight people obtain fewer calories and can achieve significant and permanent weight loss. Obesity surgery is also called **bariatric surgery**.

Purpose

Obesity is the second leading cause of preventable **death** in the United States after tobacco use. It is linked to the increased likelihood of developing more than 20 different diseases and disorders including high blood pressure (**hypertension**), type 2 diabetes, heart disease, **stroke**, deep vein **blood clots**, fatty **liver disease**, **sleep apnea**, **heartburn**, **gastroesophageal reflux disease** (GERD), gallstone disease, arthritis, **colon cancer**, breathing problems, and depression.

Obesity surgery is most often performed on severely overweight people who are more than twice their ideal weight or who has a body mass index (BMI) of 40 or above. BMI is a measure of body fatness that compares height to weight. This level of obesity often is referred to as morbid obesity since it substantially increases the risk of developing any of the health problems listed above. According to the National Institutes of Health, in 2006, 34% of Americans were overweight and 27% were obese. The average patient having obesity surgery is a woman in her late 30s who weighs about 300 pounds (135 kg).

Beginning in the early 2000s, some researchers concluded that obesity surgery could cure type 2 diabetes in many people who were not yet morbidly obese. Therefore, this surgery is now performed more often on less obese people whose risk of complications of surgery is outweighed by the need to lose weight to prevent health complications and for whom supervised weight loss and **exercise** programs have repeatedly failed. Obesity surgery, however, does not make people thin. Most people lose about 60% of their excess weight through this treatment. Changes in diet and exercise are required to maintain a normal weight. This surgery also has a high risk of complications, and therefore, is not undertaken for primarily cosmetic reasons.

The theory behind obesity surgery is that if the volume the stomach holds is reduced and the entrance into the intestine is made smaller to slow stomach emptying and/or if part of the small intestine is bypassed or shortened, people will not be able to consume and/or absorb as many calories. With obesity surgery, the volume of food the stomach can hold is reduced from about 4 cups to about 1/2 cup.

Insurers vary in whether they cover the costs of this surgery. Some insurers consider obesity surgery elective surgery and do not cover it. Others will cover these procedures when serious health risks can be documented. Documentation of the necessity for surgery and approval from the insurer should be sought before this operation is performed.

Precautions

Obesity surgery should not be performed on people who have substance addictions or who have psychological disorders. Other considerations in choosing candidates for obesity surgery include the general health of the person, the health risks posed by continued obesity, and the individual's willingness to comply with follow-up treatment.

Description

Obesity surgery is usually performed in a hospital by a surgeon who has experience with obesity surgery (a bariatric surgeon) or at a center that specializes in the procedure. **General anesthesia** is used, and the operation takes two-three hours. The hospital stay lasts about a week.

Restrictive surgeries

Adjustable gastric band, or Lap-Band surgery restricts the size of the stomach by placing a saline (salt water) filled bag around the stomach, pinching off a portion of it and leaving only a small pouch at the top. The exit to the pouch is narrowed so that the rate at which the pouch empties is slowed. Because the pouch is so small, the individual can only eat about half a cup of food at a time without feeling nauseated.

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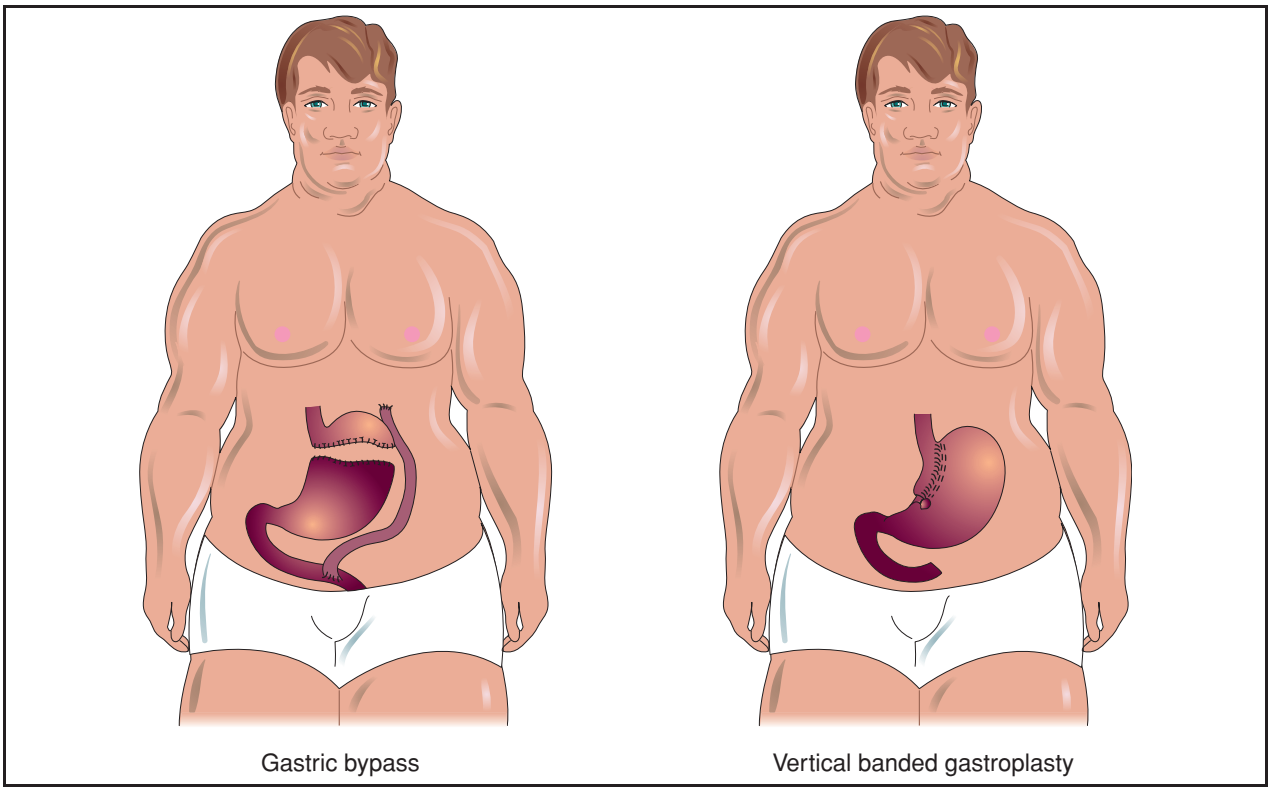

The purpose of obesity surgery is to reduce the size of the stomach and slow the stomach emptying process by narrowing the entrance into the intestine. With this surgery, the volume of food the stomach can hold is reduced from approximately 4 cups to approximately one-half cup. There are two types of procedures used for obesity surgery: gastric bypass surgery and vertical banded gastroplasty, as shown in the illustration above. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Adjustable gastric band surgery is the safest surgical weight-loss procedure. Recovery time is rapid compared to other weight-loss surgeries because no part of the digestive system is removed; digestion continues normally just with much smaller amounts of food. A port in the skin allows access to the saline bag so that the size of the stomach pouch opening can be adjusted without additional surgery. The surgery is reversible. The band can be removed because no part of the digestive system was surgically altered.

People who have adjustable band surgery do not feel hungry because stretch sensors in the wall of the stomach tell the brain that the stomach is full. Weight loss averages 50–65% of the excess body weight during the first two years.

Adjustable gastric band surgery also has disadvantages. Individuals must eat five or six very small meals a day. They will vomit if too much food is consumed at once or if it is not chewed well. They also must learn not to fill their stomachs with liquids during their meals. People who have had this surgery must still eat a healthy diet. A steady diet of high-calorie foods such as ice cream will cause weight gain.

Another type of restrictive surgery is vertical banded gastroplasty (VBG), also known as stomach stapling. This surgery is performed less often than Lap-Band surgery. With VBG, part of the stomach is stapled and banded shut making it smaller, so that individuals feel full sooner. The advantage of VBG is that the procedure is quick and has few complications. Disadvantages are that average weight loss is less than with other weight-loss surgeries, and staples can pull out allowing small leaks between the stomach and the abdomen to develop.

Surgery reducing absorption of nutrients

Gastric bypass surgery, also called malabsorptive surgery, has been performed in the United States for about 30 years. This surgery shortens the route that food takes through the digestive system, so that fewer nutrients are absorbed. Gastric bypass surgery is almost always combined with some type of stomach-

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restricting surgery so that less food is also moving through the digestive tract.

The most common type of gastric bypass surgery is Roux-en Y gastric bypass. Stapling and banding the stomach creates a small stomach pouch, then a Y-shaped piece of intestine is attached to the pouch on one end, and to the jejunum, or second part of the small intestine, on the other. This allows food to bypass the duodenum (the first part of the intestine) where many calories and nutrients are absorbed. The food then continues normally through the rest of the small intestine and the large intestine.

Roux-en Y gastric bypass allows individuals lose on average 60–70% of their excess weight. Many people are able to maintain the weight loss for 10 years or more and many of their obesity-related health problems are reduced or cured. Nevertheless, Roux-en Y surgery has serious disadvantages. This surgery permanently alters the digestive system. By bypassing the first part of the small intestine, many **vitamins** and **minerals** are no longer adequately absorbed. People who have Roux-en Y surgery must take **nutritional supplements** for the remainder of their lives to prevent vitamin and mineral deficiencies. In addition, dumping syndrome may develop. Dumping occurs when food moves too fast through the intestine and causes symptoms of **nausea**, bloating, weakness, sweating, **fainting** and **diarrhea**.

Billopancreatic diversion (BPD) is a more extreme surgery that bypasses about 9 ft (3 m) of the small intestine. In BPD, about two-thirds of the stomach is surgically removed, and a bypass is created to the ileum, or final portion of the small intestine. This severely restricts the amount of calories and nutrients that are absorbed into the bloodstream. Although large amounts of excess weight—between 75% and 80%—can be lost with BPD, nutrient deficiencies are greater and fat is poorly digested, so that bowel movements are frequent and stools are especially foul smelling.

KEY TERMS

Body Mass Index (BMI)—A measurement of fatness that compares height to weight.

Gastroesophageal reflux disease (GERD)—A condition where gastric juice from the stomach backs up into the bottom of the esophagus and causes irritation, inflammation or erosion of the cells lining the esophagus.

Heartburn—A pain in the center of the chest behind the breastbone caused by the contents of the stomach backflowing (refluxing) into the lower end of the esophagus and causing irritation.

Mineral—An inorganic substance found in the earth that is necessary in small quantities for the body to maintain health. Examples: zinc, copper, iron.

Morbidly obese—Defines a person who is 100 lb (45 kg) or more than 50% overweight and has a body mass index above 40.

Sleep apnea—A temporary interruption in breathing during sleep.

Type 2 diabetes—Sometimes called adult-onset diabetes, this disease prevents the body from properly using glucose (sugar), but can often be controlled with diet and exercise.

Vitamin—A nutrient that the body needs in small amounts to remain healthy but that the body cannot manufacture for itself and must acquire through diet.

Preparation

Many weight loss surgery centers require that patients receive pre-surgery nutritional and psychological counseling. After patients are carefully selected as appropriate for obesity surgery, they receive standard preoperative blood and urine tests and meet with an anesthesiologist to discuss how their health may affect the administration of anesthesia.

Aftercare

Immediately after the operation, most patients are restricted to a liquid diet for two-three weeks; however, some may remain on it for up to 12 weeks depending on the type of surgery they have and how fast they heal. Patients then move on to a diet of pureed food for about a month, and, after about two months, most can tolerate solid food. High-fat food is restricted because it is hard to digest and causes diarrhea. Patients are expected to work on changing their eating and exercise habits to assist in weight loss. Most people eat three-five small meals a day once they return to solid food. Eating too quickly or too much after obesity surgery can cause **nausea and vomiting** as well as intestinal "dumping," a condition in which undigested food is shunted too quickly into the small intestine, causing **pain**, diarrhea, weakness, and **dizziness**.

Risks

As in any abdominal surgery, there is always a risk of excessive bleeding, infection, and allergic reaction to anesthesia. Specific risks associated with obesity

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surgery include leaking or stretching of the pouch and loosening of the gastric staples. Although the average death rate associated with this procedure is less than 1%, the rate varies from center to center, ranging from 0–4%. Long-term failure rates can reach 50%. Additional surgery is sometimes required. Other complications of obesity surgery include an intolerance to foods high in fats, **lactose intolerance**, bouts of **vomiting**, diarrhea, and intestinal discomfort

Studies on the risks of these surgeries continue. A 2003 report showed that gastric bypass surgery risks increase with age, weight, and male gender. Patients age 55 and older experienced more complications than did younger patients and male patients had more life-threatening complications than female patients, particularly those who were more severely obese.

Normal results

Many people lose about 60% of the weight they need to reach their ideal weight through obesity surgery. However, surgery is not a magic weight-loss operation, and success depends on the patient's willingness to exercise and eat low-calorie foods. A 2003 report showed that extremely morbidly obese patients had a lower success rate with laparoscopic vertical banding gastroplasty than those considered simply morbidly obese. However, overall about 77% of patients reduce their excess weight by about 50% four years after the procedure.

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ORGANIZATIONS

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Weight-control Information Network, 1 WIN Way, Bethesda, MD, 20892-3665, (202)828-1028, (877)946-4627, win@info.niddk.nih.gov, http://win.-niddk. nih.gov.

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Obsessive-compulsive disorder

Definition

Obsessive-compulsive disorder (OCD) is a type of **anxiety** disorder. Anxiety disorder is the experience of prolonged, excessive worry about circumstances in one's life. OCD is characterized by distressing repetitive thoughts, impulses or images that are intense, or frightening, and that are unusual or not reasonable. These thoughts are usually followed by ritualized actions that can be either bizarre and irrational themselves, or can be perfectly reasonable actions, such as cleaning or hand washing, that are taken to extremes. These ritual actions, known as compulsions, help reduce anxiety caused by the individual's obsessive thoughts. Often described as the "disease of doubt," the sufferer usually knows the obsessive thoughts and compulsions are irrational but, on another level, fears they may be true.

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Description

According to the National Institutes of Health, approximately 2.2 million Americans adults have obsessive-compulsive disorder. The number of children affected with the disorder is not clear, however the Obsessive Compulsive Foundation reports that one in 25 Americans will experience OCD at some point during their lives. It can occur in children and adults. In children, symptoms often begin to appear around age 10 and in adults symptoms most commonly appear around age 21. According to the Obsessive Compulsive Foundation, up to one half of adults with OCD say that it began in childhood. Men and women are believed to be effected by OCD in approximately equal numbers. OCD affects people of all ethnicities.

It can be many years before an individual with obsessive-compulsive disorder is diagnosed. This is because individuals often try to hide their problems for fear of being labeled. Individuals with OCD are not in any way "crazy," but have repeating thoughts and fears that are so distressing, the individual cannot avoid acting on them. Individuals with OCD may recognize on some level that their fears are not rational, but find them so overwhelming that they are unable not to act upon them.

Most people with obsessive-compulsive disorder have both obsessions and compulsions, but some people have just one or the other. The degree to which this condition can interfere with daily living also varies. Some people are barely bothered, while others find the obsessions and compulsions to be profoundly traumatic and spend much time each day in compulsive actions.

Obsessions are intrusive, irrational thoughts that keep popping up in a person's mind, such as "my hands are dirty, I must wash them again." Typical obsessions include fears of dirt, germs, contamination, and violent or aggressive impulses. Other obsessions include feeling responsible for others' safety, or even the repeated thoughts that the person injured someone in a traffic accident when that is not the case. Additional obsessions can involve excessive religious feelings or intrusive sexual thoughts. The individual may need to confess frequently to a religious counselor or may fear acting out the strong sexual thoughts. People with obsessive-compulsive disorder may have an intense preoccupation with order and symmetry, or be unable to throw anything out.

Compulsions usually involve repetitive rituals such as excessive washing (especially hand washing or bathing), cleaning, checking and touching, counting, arranging or hoarding. Often, a person with obsessive-compulsive disorder is driven to perform the rituals because of a fear that if he or she does not something dreadful will happen. As the person performs these acts, he or she may feel better temporarily, but there is no lasting sense of satisfaction, completion, or safety after the act is performed. Although performing the compulsions may temporarily ease **stress**, this short-term comfort has a very high cost. A large quantity of time spent repeating compulsive actions can significantly interfere with activities like school and work, can put a significant strain on relationships, and not leave time for the individual to pursue other activities.

The difference between OCD and other compulsive behavior is that while people who have problems with gambling, overeating or with **substance abuse** may appear to be compulsive, these activities also provide pleasure to some degree. The compulsions of OCD, on the other hand, are never pleasurable.

OCD may be related to some other conditions, such as the continual urge to pull out body hair (trichotillomania), fear of having a serious disease (**hypochondriasis**), or preoccupation with imagined defects in personal appearance (body dysmorphia). Some people with OCD also have **Tourette syndrome**, a condition featuring tics and unwanted vocalizations (such as swearing). OCD can occur alongside depression and with other **anxiety disorders**.

Causes and symptoms

Research suggests that people who have a family member with OCD are more likely to develop obsessive-compulsive disorder themselves. Although no gene for OCD has been identified, it is believed that there may be a genetic predisposition that can be inherited. No one is certain what causes OCD, however there are several theories that have been suggested. Some experts believe that OCD is related to a chemical imbalance within the brain that causes a communication problem between the front part of the brain (frontal lobe) and deeper parts of the brain responsible for the repetitive behavior. Research has shown that the orbital cortex located on the underside of the brain's frontal lobe is overactive in OCD patients. This may be one reason for the feeling of alarm that pushes the patient to perform compulsive, repetitive actions. It is possible that people with OCD experience overactivity deep within the brain that causes the cells to get "stuck," much like a jammed transmission in a car damages the gears. This could lead to the development of rigid thinking and repetitive movements common to the disorder. The fact that drugs which boost the levels of serotonin, a brain

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messenger substance linked to emotion and many different anxiety disorders, in the brain can reduce OCD symptoms in many patients may indicate that OCD is related to decreased levels of serotonin in the brain.

Scientists believe there may be a link between childhood episodes of **strep throat** and the development of OCD. It appears that in some vulnerable children, strep throat (infection with group A beta-hemolytic streptococcal pharyngitis) may precede the onset of OCD symptoms. Some scientists hypothesize that this occurs because the antibodies (cells that the body produces to fight specific diseases) that fight strep throat may act on the brain in ways that cause problems with the way neurons communicate. When this happens OCD may result.

Diagnosis

People with obsessive-compulsive disorder may feel ashamed of their problem, may try to hide their symptoms, and may avoid seeking treatment for many reasons. OCD may become more severe as time goes on and it goes untreated, and more severe OCD may be more difficult to treat successfully. OCD may be frequently misdiagnosed or not diagnosed at all. According to the Obsessive Compulsive Foundation, an average of 17 years elapse between the time the OCD symptoms begin and the time appropriate treatment begins. The foundation also reports that individuals with OCD usually see three or four different doctors while seeking treatment.

There is no blood or other test that can determine whether or not an individual has obsessive-compulsive disorder. Instead, doctors must obtain and assess detailed information about an individual's symptoms and history, and may even talk to friends or relatives of the individual to try to obtain as much information as possible. Only after the doctor assesses all the information gathered can a diagnosis be made.

Treatment

Obsessive-compulsive disorder can be treated by **cognitive-behavioral therapy**, medication that regulates the brain's serotonin levels, or a combination of both. Drugs that are approved to treat obsessive-compulsive disorder include fluoxetine (Prozac), fluvoxamine (Luvox), paroxetine (Paxil), and sertraline (Zoloft), all **selective serotonin reuptake inhibitors** (SSRIs) that affect the level of serotonin in the brain. Older drugs include the antidepressant clomipramine (Anafranil), a widely-studied drug in the treatment of OCD, but one that carries a greater risk of side effects than some other available drugs. Drugs may need to be taken for 12 or more weeks before it is possible to determine if they are effective for the particular individual.

KEY TERMS

Anxiety disorder—The experience of prolonged, excessive worry about circumstances in one's life that is severe enough to disrupt daily life.

Cognitive-behavior therapy—A form of psychotherapy that seeks to modify behavior and change the patient's response to stimuli.

Compulsion—A rigid behavior that is repeated over and over unnecessarily.

Obsession—A recurring, distressing idea, thought or impulse that feels "foreign" or alien to the individual.

Selective serotonin reuptake inhibitors (SSRIs)—A class of antidepressants that work by blocking the reabsorption of serotonin in brain cells, raising the level of the chemical in the brain. SSRIs include Prozac, Zoloft, Luvex, and Paxil.

Serotonin—One of three major neurotransmitters found in the brain that is related to emotion, and is linked to the development of depression and obsessive-compulsive disorder.

Cognitive-behavioral therapy (CBT) helps individuals learn new ways of thinking, helping them end the obsessive thought patterns and learn new ways to cope with their fears that do not involve performing the compulsive rituals. Over time, the obsessive thoughts can be reduced, compulsive activities can be stopped, and the individual can spend more time doing enjoyable activities. Times of stress may increase an individual's worry or need to perform rituals, but cognitive-behavioral therapy also provides individuals with techniques to help them make it through such times.

In a few severe cases where patients have not responded to medication or behavioral therapy, brain surgery may be tried as a way of relieving the unwanted symptoms. Surgery can help up to a third of patients with the most severe form of OCD. The most common operation involves removing a section of the brain called the cingulate cortex. The serious side effects of this surgery for some patients include seizures, personality changes and decreased ability to plan.

Alternative treatment

Because OCD sometimes responds to SSRI antidepressants, a botanical medicine called **St. John's**

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wort (*Hypericum perforatum*) might have some beneficial effect as well, according to herbalists. St. John's wort is prescribed by herbalists for the treatment of anxiety and depression. They believe that this herb affects brain levels of serotonin in the same way that SSRI antidepressants do. In about one out of 400 people, St. John's wort may initially increase the level of anxiety. Homeopathic constitutional therapy can help rebalance the patient's mental, emotional, and physical well-being, allowing the behaviors of OCD to abate over time.

Prognosis

Obsessive-compulsive disorder is a chronic disease that, if untreated, can last for decades, fluctuating from mild to severe and often worsening with age. When treated by a combination of drugs and behavioral therapy, most patients experience a significant reduction of symptoms, and some patients go into complete remission. Unfortunately, not all patients have such a good response. Some people cannot find relief with either drugs or behavioral therapy. Hospitalization may be required in some extreme cases.

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ORGANIZATIONS

Anxiety Disorders Association of America, 8730 Georgia Ave., Suite 600, Silver Spring, MD, 20910, (240)485-1001 http://www.adaa.org.

International OCD Foundation, P.O. Box 961029, Boston, MA, 02196, (617)973-5801, (617)973-5803, info@ocfoundation.org, http://www.ocfoundation.org.

National Alliance for the Mentally Ill (NAMI), 3803 N. Fairfax Dr., Suite 100, Arlington, VA, 22203, (703)524-7600, (703)524-9094, (800)950-6264, http://www. nami.org.

Obsessive-Compulsive Anonymous, P.O. Box 215, New Hyde Park, NY, 11040, (516)739-0662, http://obsessivecompulsiveanonymous.org.

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Obsessive compulsive personality disorder *see* **Personality disorders**

Obstetric sonogram *see* **Pelvic ultrasound**

Obstetrical emergencies

Definition

Obstetrical emergencies are life-threatening medical conditions that occur in **pregnancy** or during or after labor and delivery.

Description

There are a number of illnesses and disorders of pregnancy that can threaten the well-being of both mother and child. Obstetrical emergencies may also occur during active labor, and after delivery (postpartum).

Obstetrical emergencies of pregnancy

ECTOPIC PREGNANCY. An ectopic, or tubal, pregnancy occurs when the fertilized egg implants itself in the fallopian tube rather than the uterine wall. If the pregnancy is not terminated at an early stage, the fallopian tube will rupture, causing internal hemorrhaging and potentially resulting in permanent **infertility**.

PLACENTAL ABRUPTION. Also called *abruptio placenta*, **placental abruption** occurs when the placenta separates from the uterus prematurely, causing bleeding and contractions. If more than 50% of the placenta separates, both the fetus and mother are at risk.

PLACENTA PREVIA. When the placenta attaches to the mouth of the uterus and partially or completely blocks the cervix, the position is termed *placenta previa* (or low-lying placenta). **Placenta previa** can result in premature bleeding and possible postpartum hemorrhage.

PREECLAMPSIA/ECLAMPSIA. Preeclampsia (toxemia), or pregnancy-induced high blood pressure, causes severe **edema** (swelling due to water retention) and can impair kidney and liver function. The condition occurs in approximately 5% of all United States pregnancies. If it progresses to **eclampsia**, toxemia is potentially fatal for mother and child.

PREMATURE RUPTURE OF MEMBRANES (PROM). Premature rupture of membranes is the breaking of the bag of waters (amniotic fluid) before contractions or labor begins. The situation is only considered an emergency if the break occurs before 37 weeks and results in significant leakage of amniotic fluid and/or infection of the amniotic sac.

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Obstetrical emergencies during labor and delivery

AMNIOTIC FLUID EMBOLISM. A rare but frequently fatal complication of labor, this condition occurs when amniotic fluid embolizes from the amniotic sac and through the veins of the uterus and into the circulatory system of the mother. The fetal cells present in the fluid then block or clog the pulmonary artery, resulting in **heart attack**. This complication can also happen during pregnancy, but usually occurs in the presence of strong contractions.

INVERSION OR RUPTURE OF UTERUS. During labor, a weak spot in the uterus (such as a scar or a uterine wall that is thinned by a **multiple pregnancy**) may tear, resulting in a uterine rupture. In certain circumstances, a portion of the placenta may stay attached to the wall and will pull the uterus out with it during delivery. This is called uterine inversion.

PLACENTA ACCRETA. *Placenta accreta* occurs when the placenta is implanted too deeply into the uterine wall, and will not detach during the late stages of **childbirth**, resulting in uncontrolled bleeding.

PROLAPSED UMBILICAL CORD. A prolapse of the umbilical cord occurs when the cord is pushed down into the cervix or vagina. If the cord becomes compressed, the oxygen supply to the fetus could be diminished, resulting in brain damage or possible **death**.

SHOULDER DYSTOCIA. Shoulder dystocia occurs when the baby's shoulder(s) becomes wedged in the birth canal after the head has been delivered.

Obstetrical emergencies postpartum

POSTPARTUM HEMORRHAGE OR INFECTION. Severe bleeding or uterine infection occurring after delivery is a serious, potentially fatal situation.

Causes and symptoms

Obstetrical emergencies can be caused by a number of factors, including **stress**, trauma, genetics, and other variables. In some cases, past medical history, including previous pregnancies and deliveries, may help an obstetrician anticipate the possibility of complications.

Signs and symptoms of an obstetrical emergency include, but are not limited to:

- Diminished fetal activity. In the late third trimester, fewer than 10 movements in a two-hour period may indicate that the fetus is in distress.
- Abnormal bleeding. During pregnancy, brown or white to pink vaginal discharge is normal, bright red blood or blood containing large clots is not. After delivery, continual blood loss of more than 500 mL indicates hemorrhage.
- Leaking amniotic fluid. Amniotic fluid is straw-colored and may easily be confused with urine leakage, but can be differentiated by its slightly sweet odor.
- Severe abdominal pain. Stomach or lower back pain can indicate preeclampsia or an undiagnosed ectopic pregnancy. Postpartum stomach pain can be a sign of infection or hemorrhage.
- Contractions. Regular contractions before 37 weeks of gestation can signal the onset of preterm labor due to obstetrical complications.
- Abrupt and rapid increase in blood pressure. Hypertension is one of the first signs of toxemia.
- Edema. Sudden and significant swelling of hands and feet caused by fluid retention from toxemia.
- Unpleasant smelling vaginal discharge. A thick, malodorous discharge from the vagina can indicate a postpartum infection.
- Fever. Fever may indicate an active infection.
- Loss of consciousness. Shock due to blood loss (hemorrhage) or amniotic embolism can precipitate a loss of consciousness in the mother.
- Blurred vision and headaches. Vision problems and headache are possible symptoms of preeclampsia.

Diagnosis

Diagnosis of an obstetrical emergency typically takes place in a hospital or other urgent care facility. A specialist will take the patient's medical history and perform a pelvic and general **physical examination**. The mother's vital signs are taken, and if preeclampsia is suspected, blood pressure may be monitored over a period of time. The fetal heartbeat is assessed with a doppler stethoscope, and diagnostic blood and urine tests of the mother may also be performed, including laboratory analysis for protein and/or bacterial infection. An **abdominal ultrasound** may aid in the diagnosis of any condition that involves a malpositioned placenta, such as placenta previa or placenta abruption.

In cases where an obstetrical complication is suspected, a fetal heart monitor is positioned externally on the mother's abdomen. If the fetal heart rate is erratic or weak, or if it does not respond to movement, the fetus may be in distress. A biophysical profile (BPP) may also be performed to evaluate the health of the fetus. The BPP uses data from an ultrasound examination to analyze the fetus size, movement, heart rate, and surrounding amniotic fluid.

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If the mother's membranes have ruptured and her cervix is partially dilated, an internal fetal scalp electrode can be inserted through the vagina to assess heart rate. A fetal oximetry monitor that measures the oxygen saturation levels of the fetus may also be attached to the scalp.

Treatment

Obstetrical emergencies of pregnancy

ECTOPIC PREGNANCY. Treatment of an **ectopic pregnancy** is laparoscopic surgical removal of the fertilized ovum. If the fallopian tube has burst or been damaged, further surgery will be necessary.

PLACENTAL ABRUPTION. In mild cases of placental abruption, bed rest may prevent further separation of the placenta and stem bleeding. If a significant abruption (more than 50%) occurs, the fetus may have to be delivered immediately and a blood **transfusion** may be required.

PLACENTA PREVIA. Hospitalization or highly restricted at-home bed rest is usually recommended if placenta previa is diagnosed after the twentieth week of pregnancy. If the fetus is at least 36 weeks old and the lungs are mature, a **cesarean section** is performed to deliver the baby.

PREECLAMPSIA/ECLAMPSIA. Treatment of preeclampsia depends upon the age of the fetus and the acuteness of the condition. A woman near full term who has only mild toxemia may have labor induced to deliver the child as soon as possible. Severe preeclampsia in a woman near term also calls for immediate delivery of the child, as this is the only known cure for the condition. However, if the fetus is under 28 weeks, the mother may be hospitalized and **steroids** may be administered to try to hasten lung development in the fetus. If the life of the mother or fetus appears to be in danger, the baby is delivered immediately, usually by cesarean section.

PREMATURE RUPTURE OF MEMBRANES (PROM). If PROM occurs before 37 weeks and/or results in significant leakage of amniotic fluid, a course of intravenous **antibiotics** is started. A culture of the cervix may be taken to analyze for the presence of bacterial infection. If the fetus is close to term, labor is typically induced if contractions do not start within 24 hours of rupture.

Obstetrical emergencies during labor and delivery

AMNIOTIC FLUID EMBOLISM. The stress of contractions can cause this complication, which has a high mortality rate. Administering steroids to the mother and delivering the fetus as soon as possible is the standard treatment.

INVERSION OR RUPTURE OF UTERUS. An inverted uterus is either manually or surgical replaced to the proper position. A ruptured uterus is repaired if possible, although if the damage is extreme, a **hysterectomy** (removal of the uterus) may be performed. A blood transfusion may be required in either case if hemorrhaging occurs.

PLACENTA ACCRETA. Women who experience placenta accreta will typically need to have their placenta surgically removed after delivery. Hysterectomy is necessary in some cases.

PROLAPSED UMBILICAL CORD. Saline may be infused into the vagina to relieve the compression. If the cord has prolapsed out the vaginal opening, it may be replaced, but immediate delivery by cesarean section is usually indicated.

Obstetrical emergencies postpartum

POSTPARTUM HEMORRHAGE OR INFECTION. The source of the hemorrhage is determined, and blood transfusion and IV fluids are given as necessary. Oxytocic drugs may be administered to encourage contraction of the uterus. Retained placenta is a frequent cause of persistent bleeding, and surgical removal of the remaining fragments (curettage) may be required. Surgical repair of lacerations to the birth canal or uterus may be required. Drugs that encourage coagulation (clotting) of the blood may be administered to stem the bleeding. Infrequently, hysterectomy is required.

In cases of infection, a course of intravenous antibiotics is prescribed. Most postpartum infections occur in the endometrium, or lining of the uterus, and may be also caused by a piece of retained placenta. If this is the case, it will also require surgical removal.

SHOULDER DYSTOCIA. The mother is usually positioned with her knees to her chest, known as the McRoberts maneuver, in an effort to free the child's shoulder. An **episiotomy** is also performed to widen the vaginal opening. If the shoulder cannot be dislodged from the pelvis, the baby's clavicle (collarbone) may have to be broken to complete the delivery before a lack of oxygen causes brain damage to the infant.

Prognosis

If a fetus is close to full-term (37 weeks) and the complication is detected early enough, the prognosis is usually good for mother and child. With advances in neonatal care, approximately 85% of infants weighing less than 3 lbs 5 oz survive, and these infants are being delivered at 28 weeks and younger. However, preterm infants have a greater chance of serious medical problems, and developmental disabilities occur in 25–50%. They also have a higher incidence of **learning disorders**,

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KEY TERMS

Amniotic fluid—The liquid in the placental sac that cushions the fetus and regulates temperature in the placental environment. Amniotic fluid also contains fetal cells.

Cesarean section—The surgical delivery of a fetus through an incision in the uterus.

Embolism—Blood vessel obstruction by a blood clot or other substance (e.g., air, cell matter).

Episiotomy—Incision of the perineum, the area between the vulva and the anus, to assist delivery and avoid severe tearing of the perineum.

Laparoscopic—A minimally-invasive surgical or diagnostic procedure that uses a flexible endoscope (laparoscope) to view and operate on structures in the abdomen.

Postpartum—After childbirth.

and are four to six times more likely to be diagnosed with attention-deficit hyperactivity disorder (**ADHD**).

Prevention

Proper prenatal care is the best prevention for obstetrical emergencies. When complications of pregnancy do arise, pregnant women who see their OB/GYN on a regular basis are more likely to get an early diagnosis, and with it, the best chance for fast and effective treatment. In addition, eating right and taking prenatal **vitamins** and supplements as recommended by a physician will also contribute to the health of both mother and child.

ORGANIZATIONS

National Institute of Child Health and Human Development, Bldg. 31, Room 2A32, MSC 2425, 31 Center Drive, Bethesda, MD, 20892-2425, (866)760-5947, (800)370-2943, http://www.nichd.nih.gov/.

Paula Anne Ford-Martin

Occupational asthma

Definition

Occupational **asthma** is a form of lung disease in which the breathing passages shrink, swell, or become inflamed or congested as a result of exposure to irritants in the workplace.

Description

As many as 15% of all cases of asthma may be related to on-the-job exposure to:

- animal hair
- dander
- dust composed of bacteria, protein, or organic matter like cereal, grains, cotton, and flax
- fumes created by metal soldering
- insulation and packaging materials
- mites and other insects
- paints

Hundreds of different types of jobs involve exposure to substances that could trigger occupational asthma, but only a small fraction of people who do such work develop this disorder. Occupational asthma is most apt to affect workers who have personal or family histories of **allergies** or asthma, or who are often required to handle or breathe dust or fumes created by especially irritating material.

Causes and symptoms

Although occupational asthma is not new, today, more than 240 causes of occupational asthma have been identified. It was probably first recorded in 1713 when one of the fathers of occupational health, Bernadina Ramazzini said bakers and textile workers had problems with coughing, **shortness of breath**, hoarseness and asthma. Even short-term exposure to low levels of one or more irritating substances can cause a very sensitive person to develop symptoms of occupational asthma. A person who has occupational asthma has one or more symptoms, including coughing, shortness of breath, tightness in the chest, and **wheezing**. Symptoms may appear less than 24 hours after the person is first exposed to the irritant or may develop two or three years later.

At first, symptoms appear while the person is at work or several hours after the end of the workday. Symptoms disappear or diminish when the person spends time away from the workplace and return or intensify when exposure is renewed.

As the condition becomes more advanced, symptoms sometimes occur even when the person is not in the workplace. Symptoms may also develop in response to minor sources of lung irritation.

Diagnosis

An allergist, occupational medicine specialist, or a doctor who treats lung disease performs a thorough

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ALICE HAMILTON (1869–1970)

(The Library of Congress.)

Alice Hamilton was born on February 27, 1869, in New York City, the second of five children born to Montgomery Hamilton, a wholesale grocer, and Gertrude (Pond) Hamilton. She earned a medical degree from the University of Michigan in 1893, without having completed an undergraduate degree and taking surprisingly few science courses. Realizing that she wanted to pursue research rather than medical practice, Hamilton went on to do further studies both in the United States and abroad: from 1895–1896 at Leipzig and Munich; 1896–1897 at Johns Hopkins; and 1902 in Paris at the Pasteur Institute. In 1897 she accepted a post as professor of pathology at the Women's Medical College at Northwestern University in Chicago.

In Chicago Hamilton became a resident of Hull House, the pioneering settlement designed to give care and advice to the poor of Chicago. Here, under the influence of Jane Addams, the founder of Hull House, Hamilton saw the effects of poverty up close, leading her to a lifelong career focused on industrial medicine.

Alice Hamilton was a pioneer in correcting the medical problems caused by industrialization, awakening the country in the early 20th century to the dangers of industrial poisons and hazardous working conditions. Through her untiring efforts, toxic substances in the lead, mining, painting, pottery, and rayon industries were exposed and legislation passed to protect workers. She was also a champion of worker's compensation laws, and was instrumental in bringing about this type of legislation in the state of Illinois. A medical doctor and researcher, she was the first woman of faculty status at Harvard University, and was a consultant on governmental commissions, both domestic and foreign.

physical examination and takes a medical history that explores:

- the kind of work the patient has done
- the types of exposures the patient may have experienced
- what symptoms the patient has had
- when, how often, and how severely symptoms have occurred

Performed before and after work, **pulmonary function tests** can show how job-related exposures affect the airway. Laboratory analysis of blood and sputum may confirm a diagnosis of workplace asthma. To pinpoint the cause more precisely, the doctor may ask the patient to inhale specific substances and monitor the body's response to them. This is called a challenge test.

Treatment

The most effective treatment for occupational asthma is to reduce or eliminate exposure to symptom-producing substances.

Medication may be prescribed for workers who can not prevent occasional exposure. Leukotriene modifiers (montelukast and zafirlukast) are new drugs that help manage asthma. They work by counteracting leukotrienes, which are substances released by white blood cells in the lung that cause the air passages to constrict and promote mucus secretion. Leukotriene modifiers also fight off some forms of **rhinitis**, an added bonus for people with asthma. Medication, **physical therapy**, and breathing aids may be needed to relieve symptoms of advanced occupational asthma involving airway damage.

A patient who has occupational asthma should learn what causes symptoms and how to control them, and what to do when an asthma attack occurs.

Because asthma symptoms and the substances that provoke them can change, a patient who has occupational asthma should be closely monitored by a family physician, allergist, or doctor who specializes in occupational medicine or lung disease.

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Prognosis

Occupational asthma can be reversible. However, continued exposure to the symptom-producing substance can cause permanent lung damage. Follow-up studies of people with occupational asthma show that some cannot be protected from the exposure or are forced to change jobs, lose their jobs, or have worse prospects for future jobs based on their allergies and asthma.

In time, occupational asthma can cause asthma-like symptoms to occur when the patient is exposed to tobacco smoke, household dust, and other ordinary irritants.

Smoking aggravates symptoms of occupational asthma. Patients who eliminate workplace exposure and stop smoking are more apt to recover fully than those who change jobs but continue to smoke.

Prevention

Industries and environments where employees have a heightened exposure to substances known to cause occupational asthma can take measures to diminish or eliminate the amount of pollution in the atmosphere or decrease the number of exposed workers.

Regular medical screening of workers in these environments may enable doctors to diagnose occupational asthma before permanent lung damage takes place.

Resources

PERIODICALS

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ORGANIZATIONS

American College of Allergy, Asthma & Immunology, 85 West Algonquin Road, Suite 550, Arlington Heights, IL, 60005, (847)427-1200, (847)427-1294, mail @acaai.org, http://acaai.org.

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Occupational therapy

Definition

Occupational therapy (OT) is a holistic, patient-centered, occupation-based approach to life-skills development for people with developmental disabilities, physical or mental diseases, injuries, or other health problems. Occupational therapy addresses physical, psychological, social, and environmental factors that interfere with functioning in various ways.

Purpose

The goal of occupational therapy is to help patients develop the skills and obtain the support necessary to live productive lives as independently as possible, to improve quality of life, and to decrease hospitalization and institutionalization.

Occupational therapy is used to treat a variety of physical and developmental disabilities, including:

- cerebral palsy, spina bifida, and other birth injuries and defects
- Down syndrome
- muscular dystrophy, arthritis, multiple sclerosis, or other serious chronic conditions
- developmental delays
- mental retardation
- autism
- learning disabilities
- attention deficit disorder (ADD)
- sensory processing/integrative disorders
- broken bones and other injuries from falls, sports injuries, or accidents
- brain and spinal cord injuries
- hand injuries
- amputations
- post-surgical conditions
- burns
- work-related injuries including lower-back problems and repetitive stress injury (RSI)
- limitations following a heart attack or stroke
- diabetes
- cancer
- Parkinson's disease

In recent years occupational therapy has expanded its scope into new areas, including:

- mental health and behavioral problems such as depression, dementia, Alzheimer's disease, schizophrenia,

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posttraumatic stress, substance abuse, and eating disorders
- visual impairment
- home modification
- ergonomics consulting

Demographics

The demand for occupational therapy is expected to continue grow, as the baby-boomer generation (those born between 1945 and 1965) ages and requires various services, such as modifications in order to stay in their homes. As people live longer despite serious illness and disability, occupational therapy will facilitate independence in daily living and working. For example, **stroke** is the major cause of disability in adults and it is estimated that 5.4 million Americans are living with the effects of stroke.

Description

Occupational therapy provides direct care to patients with physical, developmental, and mental disabilities, in settings that include:

- long-term-care (LTC) facilities
- skilled-nursing facilities (SNFs) and nursing homes
- assisted-living facilities
- mental-health facilities
- hospitals
- rehabilitation centers
- outpatient and children's clinics
- adult daycare centers
- home healthcare agencies
- schools
- foster-care residences
- group and private homes
- sheltered workplaces
- senior centers
- wellness education programs
- business-to-business consulting firms that specialize in ergonomics
- private practices

Occupational therapists may work with and receive referrals from:

- physicians and nurses
- psychologists and psychiatrists
- other health professionals
- social workers
- case managers
- courts
- teachers, and vocational and guidance counselors
- foster-care providers
- families
- clients themselves

Regardless of the setting, occupational therapy is centered on the needs of patients and the environments in which they live. The therapist may perform activities-of-daily-living (ADL) evaluations to determine patients' competence and independence in performing daily tasks at home, work or school, and within their social environments. Examples of activities of daily living might include dialing a phone, paying bills, using a computer, or driving a car. Children are evaluated by their abilities to perform activities such as writing the alphabet, drawing shapes, playing games, tying shoes, brushing teeth, combing hair, or squeezing a special grip meter. Following the evaluation the occupational therapist may implement a treatment plan or interventions to facilitate a more independent lifestyle. The OT may evaluate the need for special equipment such as splints, wheelchairs, bathing equipment, dressing devices, or communication aids.

Occupational therapists work within six broad fields:

- rehabilitation, disability, and participation
- productive aging
- children and youth
- mental health
- health and wellness
- work and industry

Within these broad categories occupational therapy can involve a wide range of interventions, including:

- exercises for improving mobility
- prevention of falls
- sensory integration
- home modifications for independent living
- analysis of home lighting and contrast for the visually impaired
- slings or splints to provide support to body parts
- assistive devices for activities such as opening a jar, putting on shoes, or taking a bath or shower
- chronic disease management
- home healthcare
- driving and alternative transportation
- stress management
- communication skills
- assertiveness skills
- problem solving

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KEY TERMS

Activities of daily living (ADL)—The skills and practices that determine how well individuals function in their daily lives and relate to and participate in their environment.

Alzheimer's disease—A progressive, neurodegenerative disease characterized by loss of function and death of nerve cells in several areas of the brain, leading to loss of mental functions, such as memory and learning. Alzheimer's disease is the most common cause of dementia.

Arthritis—Inflammation of one or more joints.

Attention deficit disorder (ADD)—A condition characterized by age-inappropriate attention span; often accompanied by age-inappropriate hyperactivity and impulsive behavior.

Autism—A variable developmental disorder that includes an impaired ability to communicate and form normal social relationships.

Ergonomics—The study of the relationship between people and their working environment.

Home modification—The altering of the physical environment of the home to remove hazards and provide a more functional environment; examples include the installation of grab bars and no-slip foot mats in the bathroom to prevent falls.

Parkinson's disease—A disorder of the brain characterized by shaking and difficulty with walking, movement, and coordination. The disease is associated with damage to a part of the brain that controls muscle movement.

Repetitive stress injury; repetitive strain injury (RSI)—Any of various musculoskeletal disorders—such as tendonitis or carpal tunnel syndrome—that are caused by cumulative damage to muscles, tendons, ligaments, nerves, or joints from highly repetitive movements, such as of the hand, wrist, arm, or shoulder.

Stroke—A sudden diminishing or loss of consciousness, sensation, or voluntary movement from a rupture or obstruction of a blood vessel in the brain.

- time management
- management of medications
- safety in the home and community
- pursuing vocational interests
- developing self-awareness
- interpersonal and social skills
- hygiene
- parenting skills

Occupational therapy provides early intervention for children with physical, sensory, or cognitive disabilities in daycare centers, preschools, and elementary and high schools. Occupational therapists also have an important role in disaster relief. OT can help children with disabilities become as independent as possible or successfully return to school after a long illness or serious injury. Childhood interventions may involve:

- working with children to brush their teeth, dress, tie their shoes, and feed themselves
- handwriting and drawing to improve finger dexterity
- coloring within the lines
- working on hand-eye coordination by hitting a target, batting a ball, or copying from the blackboard
- using a computer
- alternative ways for playing popular games
- teaching strategies for improving focus and attentiveness
- homework help
- managing a wheelchair in school
- interacting with others and improving social skills
- learning anger-management skills, such as writing about feelings or pursuing a physical activity

Occupational therapy often breaks tasks down into smaller steps, such as learning a song note by note. To learn to bathe, the client may first learn to turn on the water, then adjust the temperature, find soap and a towel, and then climb in the tub.

Occupational therapy also includes:

- adapting the home, school, or work environment to a client's needs
- developing educational programs, experiential learning, and treatment groups or classes
- housing and job placement, and ongoing monitoring
- assisting with client-run support groups
- consulting with employers about the requirements of the Americans with Disabilities Act
- developing transitional work programs

Occupational therapy in the workplace may involve:

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- evaluating a worker on the job
- recommending job modifications
- implementing and supervising a return-to-work program
- monitoring progress
- improving productivity
- ergonomics to maximize function and comfort and minimize repetitive stress injuries from jobs such as typing or assembly-line work

Origins

Occupational therapy developed as a healthcare specialty during World War I, to work with soldiers suffering from shell shock, amputations, and other injuries. In the early 20th century, occupational therapists also treated **tuberculosis** and **polio** patients. The advent of managed healthcare in the United States dramatically expanded the role of occupational therapy.

Benefits

In addition to helping the injured and disabled to perform everyday tasks, live independently, and work or attend school, occupational therapy can improve skills and help prevent injuries in people of any age and ability. Benefits of occupational therapy include:

- assessments of performance and skills
- customized treatment programs for improving clients' abilities to perform daily activities
- home and workplace evaluations and recommendations for adaptations
- guidance for family members and caregivers
- providing fun, positive activities for improving children's cognitive, physical, and motor skills and enhancing self-esteem and sense of accomplishment

Preparation

Client attitude and cooperation are key to successful occupational therapy. Clients should be active participants, aware of the short-term and long-term goals of their therapy and able to communicate with their therapists.

Aftercare

Clients must continue to practice what they have learned in their occupational therapy and make appropriate adjustments in their lives. Many clients have long-term monitoring and assessments.

Training and certification

Occupational therapists have master's or doctoral degrees in OT. Practitioners must complete supervised clinical internships in a variety of healthcare settings and pass a national examination. Occupational therapy assistants (OTAs) usually have associate degrees. OTAs are able to carry out treatment plans developed by occupational therapists, but do not perform evaluations and assessments. The National Board for Certification in Occupational Therapy provides certification for the profession.

Regular continuing education courses and additional training are necessary for occupational therapists to maintain competency. Practitioners can take advantage of continuing education courses offered by the American Occupational Therapy Association, as well as online courses, annual conference and exposition workshops, and educational sessions offered by leaders in occupational therapy.

The practice of occupational therapy is regulated in every state and licensing of occupational therapists is required in most states. Licensure defines the scope of OT practice and provides guidance to facilities and healthcare providers on the appropriate applications of occupational therapy.

Resources

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ORGANIZATIONS

American Occupational Therapy Association, Inc., 4720 Montgomery Lane, P.O. Box 31220, Bethesda, MD, 20824-1220, (301) 652-2682, (301) 652-7711, http://www.aota.org.

National Board for Certification in Occupational Therapy, Inc., 12 South Summit Avenue, Suite 100, Gaithersburg, MD, 20877-4150, (301) 990-7979, (301) 869-8492, info@nbcot.org, http://www.nbcot.org.

World Federation of Occupational Therapists, P.O. Box 30, Forrestfield, Western Australia, Australia, 6058, 61-8-9453-9746, admin@wfot.org.au, http://www.wfot.org.

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Ocular myopathy *see* **Ophthalmoplegia**

Ocular rosacea *see* **Rosacea**

Ofloxacin *see* **Fluoroquinolones**

Ohio Valley disease *see* **Histoplasmosis**

Oil spills: health effects

Definition

Along with fouling marine and coastal ecosystems, offshore oil spills also pose potential health hazards for humans, both as workers respond to the spill and as oil impacts the environment where people live. After the 1989 *Exxon Valdez* oil spill that occurred in Prince William Sound off the coast of Alaska, one study published in the *American Journal of Psychiatry* showed that residents living in areas impacted by the spill were more likely to suffer mental health problems than the general population, even years after the spill. Few studies were conducted, however, on the health impacts of workers who were exposed to the oil during clean-up efforts. In the wake of the 2010 BP *Deepwater Horizon* oil spill in the Gulf of Mexico, the information remains inconclusive on the actual health hazards that could result from the spill. At a gathering of public health experts in late June 2010, U.S. Surgeon General Regina Benjamin described some scientists as predicting little or no toxic effect from short-term exposure to the oil, while indicating that "other scientists express serious concerns about the potential short-term and long-term impacts the exposure to oil and dispersants could have on the health of responders and our communities."

Demographics

Virtually everyone who lives near a coastline could be affected by an oil spill, as more than 38,000 oil tankers traverse the world's oceans and seas, delivering oil in its various stages from ports near the extraction site to ports where it is refined and later consumed. Offshore drilling fields are located primarily in the North Sea, the Gulf of Mexico, the South China Sea, and off the coasts of Nigeria, Angola, Brazil, the Canadian Provinces of Nova Scotia and Newfoundland, and eastern Russia. Large land-based oil fields are located in the Middle East, the United States, Russia, Mexico, and Venezuela. Persons especially at risk to the potentially harmful effects of oil exposure include those with existing respiratory problems, pregnant women, and children.

Description

Although the composition of crude oil varies somewhat according to its source, crude oil is a naturally occurring brown or black liquid that is composed of a mixture of hydrocarbons and other organic compounds. Crude oil is toxic, flammable, and contains volatile organic compounds (VOCs) that have known adverse effects on human health. OVCs include benzene, a carcinogen, and polycyclic aromatic hydrocarbons (PACs), which are toxic to the central nervous system. The VOCs evaporate easily, moving from the oil into the air, and can be carried by prevailing winds miles from the source of the spill and into coastal communities. There is evidence that some dispersants, solvents, and collecting agents used to manage the spill, when combined with the oil, can potentiate some of the toxic effects of crude oil alone. Harmful airborne pollution released by burning the oil on the surface of a spill is also a health concern for both responders and local populations on nearby shores.

Causes and symptoms

People are exposed to oil-spill toxins through direct contact with oil on the skin, by breathing VOCs and other chemicals released into the air, or through oil-contaminated sand, soil, water, or food. Multiple exposure paths can occur simultaneously. All adverse reactions to oil are dependent upon both the duration of the exposure and a person's particular susceptibility to the particular toxins in the oil.

Hundreds of workers cleaning Alaskan shores, marshes, and oiled waterways during the *Exxon Valdez* spill complained of skin **rashes**, **dizziness**, headaches, and **nausea** during their work and for a short time afterwards. Some experienced longer-lasting

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KEY TERMS

Carcinogen—An agent that is known to cause cancer.

Dispersant—Chemicals that break up spilled oil into small particles that can be further scattered and broken down by water and wind, thus sparing oil damage to marine and coastal environments.

Mousse oil—Crude oil that has emulsified or weathered, mixed with dispersants, water, and marine material to form a spongy, light brown, mousse-like material.

Post-traumatic stress syndrome—A type of severe anxiety disorder that can develop after experiencing traumatic events or situations.

Teratogen—An agent that is known to disturb the development of an embryo or fetus.

Volatile organic compounds—VOCs, a large class of carbon-based chemicals that release gases into the air as they evaporate at room temperature. Found both in natural sources such as living trees, decomposing vegetation, and crude oil, and in manmade sources such as solvents, adhesives, and gasoline, VOCs help form ozone at ground levels and are major air contaminants.

symptoms including **shortness of breath**, muscle aches, and neurological problems including **numbness and tingling** of the extremities.

Public health officials along the Gulf coast are monitoring for these symptoms in communities affected by the *Deepwater Horizon* spill, as well as establishing data-collection methods to document possible longer-term consequences of oil exposure, such as kidney damage, **birth defects**, and **cancer**. As of late 2010, complaints among coastal residents, along with workers cleaning the oil both on land and at sea, have included skin rashes, headaches, nausea, and irritation in the throat and eyes. Several workers have also experienced heat **stress** due to working outside in hot and humid conditions.

Although high levels of mental and emotional stress are expected during a natural or technological disaster, the *Deepwater Horizon* oil spill impacted an area whose vulnerable population was still recovering from hurricanes Ivan, Katrina, and Rita. Benjamin Springgate, a physician and public health researcher at Tulane University in New Orleans, estimated that more than 30 % of people in the impact zone of Hurricane Katrina experienced symptoms of **anxiety**, depression, or other mental illness after the storm, and also predicted that the impacts of the *Deepwater Horizon* oil spill on the mental health of coastal residents will be a long-term situation. The most frequent symptoms of stress-related mental disorders include feelings of hopelessness, disturbances in sleep patterns, lack of concentration, mood swings, irritability, inability to make productive decisions, nightmares or persistent memories of disturbing or frightening events, and general anxiety.

Diagnosis

The most frequent mental disorders diagnosed among people affected by an oil spill include post-traumatic syndrome, **anxiety disorders**, and depression. These are diagnosed by a psychiatrist or other mental health professional, mostly after a careful discussion of the symptoms. Other oil-spill-related illnesses are diagnosed according to the nature of symptoms, **physical examination**, and additional diagnostic or laboratory tests. Chemical **pneumonia**, for example, is caused by respiratory irritation from exposure to VOCs or other chemicals, followed by inflammation and decreased lung function. It is most often diagnosed by history and physical examination, especially auscultation of (listening to) the lungs, examination of the sputum, and x-ray, as are other types of pneumonia.

Treatment

Mousse oil on the skin or tar balls can be cleaned with soap and water or mineral oil. Treatment of more serious illnesses of various body systems and organs exposed to oil depends on the system affected, the nature and length of the exposure, and the symptoms present. The U.S. Department of Health and Human Services has created a $10 million fund to track *Deepwater Horizon*-related illnesses in order to get a clear picture of their nature and to devise the most effective treatments. Also, more than 14,000 oil spill workers have volunteered to participate in a similar study for the Centers for Disease Control and Prevention (CDC).

Prognosis

The full effects of the *Deepwater Horizon* oil spill on the health and well-being of people living in communities along the northern Gulf of Mexico will not be fully known until the oil is cleaned and the physical, ecological, and economic environments are restored, a process that will take years. Scientists anticipate that the information gained from careful study of the

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detrimental effects of the oil spill on the physical and mental health of spill responders and Gulf coast residents will help identify both short-term and long-term health issues related to the spill, and allow for an effective response now and during future technological disasters.

Prevention

Avoiding contact with the oil is the most effective way to prevent negative health effects from an oil spill. Beaches along the northern Gulf Coast have "no swimming" signs and flags posted in locations where oil from the *Deepwater Horizon* spill has impacted the shore. Workers both offshore and at the spill site utilize a variety of personal protective equipment including gloves, white plastic protective (hazmat) suits, respirators, and other barrier methods designed to prevent exposure to oil.

Authorities have closed more than 30% of Gulf Coast federal fishing waters to both commercial and personal fishing in order to prevent oil-contaminated fish and shellfish from entering the food supply. Increased inspection of allowable catches helps ensure that Gulf fish making its way to the market are uncontaminated and of the usual high quality.

When winds bring fumes from the spill onshore, residents with existing respiratory problems are advised to remain indoors with re-circulating air. Pregnant women should avoid oil-contaminated beaches or air, as components of crude oil are known teratogens and exposure to crude oil can result in decreased fetal survival. Children are also particularly vulnerable to DNA damage from long-term exposure to airborne toxins emanating from oil spills. The U.S. Environmental Protection Agency has set up more than 100 monitoring stations along affected areas of the Gulf Coast to detect unhealthy levels of VOCs, overall ozone, and particulate matter in the air, and to issue regular air quality reports.

Innovative approaches are being taken along the Gulf Coast to reach people who may be experiencing symptoms of stress, but are unlikely to seek help for them. Peer listeners have been trained to identify signs of distress during conversation, to offer encouragement that help is available, and to provide referrals to nearby mental health services. Personnel with knowledge of and sensitivities to local cultures, including those who speak Vietnamese and Spanish, are also available to hear the needs and concerns of fishermen and other close-knit communities.

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Brenda Wilmoth Lerner, RN

Oligomenorrhea

Definition

Medical dictionaries define oligomenorrhea as infrequent or very light menstruation. But physicians typically apply a narrower definition, restricting the diagnosis of oligomenorrhea to women whose periods were regularly established before they developed problems with infrequent flow. With oligomenorrhea, menstrual periods occur at intervals of greater than 35 days, with only four to nine periods in a year.

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Description

True oligomenorrhea cannot occur until menstrual periods have been established. In the United States, 97.5% of women have begun normal menstrual cycles by age 16. The complete absence of menstruation, whether menstrual periods never start or whether they stop after having been established, is called **amenorrhea**. Oligomenorrhea can become amenorrhea if menstruation stops for six months or more.

It is quite common for women at the beginning and end of their reproductive lives to miss or have irregular periods. This is normal and is usually the result of imperfect coordination between the hypothalamus, the pituitary gland, and the ovaries. For no apparent reason, a few women menstruate (with ovulation occurring) on a regular schedule as infrequently as once every two months. For them that schedule is normal and not a cause for concern.

Women with **polycystic ovary syndrome** (PCOS) are also likely to suffer from oligomenorrhea. PCOS is a condition in which the ovaries become filled with small cysts. Women with PCOS show menstrual irregularities that range from oligomenorrhea and amenorrhea on the one hand to very heavy, irregular periods on the other. The condition affects about 6% of premenopausal women and is related to excess androgen production.

Other physical and emotional factors also cause a woman to miss periods. These include:

- emotional stress
- chronic illness
- poor nutrition
- eating disorders such as anorexia nervosa
- excessive exercise
- estrogen-secreting tumors
- illicit use of anabolic steriod drugs to enhance athletic performance

Professional ballet dancers, gymnasts, and ice skaters are especially at risk for oligomenorrhea because they combine strenuous physical activity with a diet intended to keep their weight down. Menstrual irregularities are now known to be one of the three disorders comprising the so-called "female athlete triad," the other disorders being disordered eating and **osteoporosis**. The triad was first formally named at the annual meeting of the American College of Sports Medicine in 1993, but doctors were aware of the combination of bone mineral loss, **stress**, **fractures**, **eating disorders**, and participation in women's sports for several decades before the triad was named. Women's coaches have become increasingly aware of the problem since the early 1990s, and are encouraging female athletes to seek medical advice.

Causes and symptoms

Symptoms of oligomenorrhea include:

- menstrual periods at intervals of more than 35 days
- irregular menstrual periods with unpredictable flow
- some women with oligomenorrhea may have difficulty conceiving

Oligomenorrhea that occurs in adolescents is often caused by immaturity or lack of synchronization between the hypothalamus, pituitary gland, and ovaries. The hypothalamus is part of the brain that controls body temperature, cellular metabolism, and basic functions such as eating, sleeping, and reproduction. It secretes hormones that regulate the pituitary gland.

The pituitary gland is then stimulated to produce hormones that affect growth and reproduction. At the beginning and end of a woman's reproductive life, some of these hormone messages may not be synchronized, causing menstrual irregularities.

In PCOS, oligomenorrhea is probably caused by inappropriate levels of both female and male hormones. Male hormones are produced in small quantities by all women, but in women with PCOS, levels of male hormone (androgens) are slightly higher than in other women. More recently, however, some researchers are hypothesizing that the ovaries of women with PCOS are abnormal in other respects. In 2003, a group of researchers in London reported that there are fundamental differences between the development of egg follicles in normal ovaries and follicle development in the ovaries of women with PCOS.

In athletes, models, actresses, dancers, and women with **anorexia nervosa**, oligomenorrhea occurs because the ratio of body fat to weight drops too low.

Diagnosis

History and physical examination

Diagnosis of oligomenorrhea begins with the patient informing the doctor about infrequent periods. The doctor will ask for a detailed description of the problem and take a history of how long it has existed and any patterns the patient has observed. A woman can assist the doctor in diagnosing the cause of oligomenorrhea by keeping a record of the time, frequency, length, and quantity of bleeding. She should also tell the doctor about any recent illnesses, including long-standing conditions like **diabetes mellitus**. The doctor

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may also inquire about the patient's diet, **exercise** patterns, sexual activity, contraceptive use, current medications, or past surgical procedures.

The doctor will then perform a **physical examination** to evaluate the patient's weight in proportion to her height, to check for signs of normal sexual development, to make sure the heart rhythm and other vital signs are normal, and to palpate (feel) the thyroid gland for evidence of swelling.

In the case of female athletes, the doctor may need to establish a relationship of trust with the patient before asking about such matters as diet, practice and workout schedules, and the use of such drugs as **steroids** or ephedrine. The presence of stress fractures in young women should be investigated. In some cases, the doctor may give the patients the Eating Disorder Inventory (EDI) or a similar screening questionnaire to help determine whether the patient is at risk for developing anorexia or bulimia.

Laboratory tests

After taking the woman's history, the gynecologist or family practitioner does a pelvic examination and **Pap test**. To rule out specific causes of oligomenorrhea, the doctor may also do a **pregnancy** test and blood tests to check the level of thyroid hormone. Based on the initial test results, the doctor may want to do tests to determine the level of other hormones that play a role in reproduction.

More sensitive monoclonal assays have been developed for measuring hormone levels in the blood serum of women with PCOS, thus allowing earlier and more accurate diagnosis.

Imaging studies

In some cases the doctor may order an ultrasound study of the pelvic region to check for anatomical abnormalities, or x-rays or a **bone scan** to check for bone fractures. In a few cases the doctor may order an MRI to rule out tumors affecting the hypothalamus or pituitary gland.

Treatment

Treatment of oligomenorrhea depends on the cause. In adolescents and women near **menopause**, oligomenorrhea usually needs no treatment. For some athletes, changes in training routines and eating habits may be enough to return the woman to a regular menstrual cycle.

Most patients suffering from oligomenorrhea are treated with birth-control pills. Other women, including those with PCOS, are treated with hormones. Prescribed hormones depend on which particular hormones are deficient or out of balance. When oligomenorrhea is associated with an eating disorder or the female athlete triad, the underlying condition must be treated. Consultation with a psychiatrist and nutritionist is usually necessary to manage an eating disorder. Female athletes may require **physical therapy** or **rehabilitation** as well.

Alternative treatment

As with conventional medicial treatments, alternative treatments are based on the cause of the condition. If a hormonal imbalance is revealed by laboratory testing, hormone replacements that are more "natural" for the body (including tri-estrogen and natural progesterone) are recommended. Glandular therapy can assist in bringing about a balance in the glands involved in the reproductive cycle, including the hypothalmus, pituitary, thyroid, ovarian, and adrenal glands. Since homeopathy and **acupuncture** work on deep, energetic levels to rebalance the body, these two modalities may be helpful in treating oligomenorrhea. Western and Chinese herbal medicines also can be very effective. Herbs used to treat oligomenorrhea include dong quai (*Angelica sinensis*), black cohosh (*Cimicifuga racemosa*), and chaste tree (*Vitex agnus-castus*). Herbal preparations used to bring on the menstrual period are known as emmenagogues. For some women, **meditation**, **guided imagery**, and visualization can play a key role in the treatment of oligomenorrhea by relieving emotional stress.

Diet and adequate **nutrition**, including adequate protein, essential fatty acids, whole grains, and fresh fruits and vegetables, are important for every woman, especially if deficiencies are present or if she regularly exercises very strenuously. Female athletes at the high school or college level should consult a nutritionist to make sure that they are eating a well-balanced diet that is adequate to maintain a healthy weight for their height. Girls participating in dance or in sports that emphasize weight control or a slender body type (gymnastics, track and field, swimming, and cheerleading) are at higher risk of developing eating disorders than those that are involved in such sports as softball, weight lifting, or basketball. In some cases the athlete may be given **calcium** or vitamin D supplements to lower the risk of osteoporosis.

Many women, including those with PCOS, are successfully treated with hormones for oligomenorrhea. They have more frequent periods and begin ovulating during their menstrual cycle, restoring their fertility.

For women who do not respond to hormones or who continue to have an underlying condition that

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KEY TERMS

Anorexia nervosa—A disorder of the mind and body in which people starve themselves in a desire to be thin, despite being of normal or below normal body weight for their size and age.

Cyst—An abnormal sac containing fluid or semi-solid material.

Emmenagogue—A medication or herbal preparation given to bring on a woman's menstrual period.

Female athlete triad—A combination of disorders frequently found in female athletes that includes disordered eating, osteoporosis, and oligo- or amenorrhea. The triad was first officially named in 1993.

Osteoporosis—The excessive loss of calcium from the bones, causing the bones to become fragile and break easily. Women who are not menstruating are especially vulnerable to this condition because estrogen, a hormone that protects bones against calcium loss, decreases drastically after menopause.

causes oligomenorrhea, the outlook is less positive. Women who have oligomenorrhea may have difficulty conceiving children and may receive fertility drugs. The absence of adequate estrogen increases risk for bone loss (osteoporosis) and cardiovascular disease. Women who do not have regular periods also are more likely to develop uterine **cancer**. Oligomenorrhea can become amenorrhea at any time, increasing the chance of having these complications.

Prevention

Oligomenorrhea is preventable only in women whose low body fat to weight ratio is keeping them from maintaining a regular menstrual cycle. Adequate nutrition and a less vigorous training schedules will normally prevent oligomenorrhea. When oligomenorrhea is caused by hormonal factors, it is not preventable, but it is often treatable.

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American Academy of Child and Adolescent Psychiatry (AACAP), 3615 Wisconsin Ave. NW, Washington, DC, 20013-3007, (202)966-7300, (202)966-2891, communications@aacap.org, http://www.aacap.org/.

American College of Sports Medicine (ACSM), 401 West Michigan Street, P.O. Box 1440, Indianapolis, IN, 46202-3233, (317)637-9200, (317)634-7817, http://www.acsm.org.

Polycystic Ovarian Syndrome Association, P.O. Box 3403, Englewood, CO, 80155-3403, info@pcosupport.org, http://www.pcosupport.org.

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Omega-3 fatty acids

Definition

Essential to human health, omega-3 fatty acids are a form of polyunsaturated fats that are not made by the body and must be obtained from a person's food.

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Purpose

Eating foods rich in omega-3 fatty acids is part of a healthy diet and helps people maintain their health.

Description

In recent years, a great deal of attention has been placed on the value of eating a low-fat diet. In some cases, people have taken this advice to the extreme by adopting a diet that is far too low in fat or, worse yet, a diet that has no fat at all. But the truth is that not all fat is bad. Although it is true that trans and saturated fats, which are found in high amounts in red meat, butter, whole milk, and some prepackaged foods, have been shown to raise a person's total cholesterol, polyunsaturated fats can actually play a part in keeping cholesterol low. Two especially good fats are the omega-3 fatty acids and the omega-6 fatty acids, which are polyunsaturated.

Two types of omega-3 fatty acids are eicosapentaenoic acid (EPA) and docosahexanoic acid (DHA), which are found mainly in oily cold-water fish, such as tuna, salmon, trout, herring, sardines, bass, swordfish, and mackerel. With the exception of seaweed, most plants do not contain EPA or DHA. However, alpha-linolenic acid (ALA), which is another kind of omega-3 fatty acid, is found in dark green leafy vegetables, flaxseed oil, fish oil, and canola oil, as well as nuts and beans, such as walnuts and soybeans. Enzymes in a person's body can convert ALA to EPA and DHA, which are the two kinds of omega-3 fatty acids easily utilized by the body.

Many experts agree that it is important to maintain a healthy balance between omega-3 fatty acids and omega-6 fatty acids. As Dr. Penny Kris-Etherton and her colleagues reported in their article published in the *American Journal of Nutrition* an overconsumption of omega-6 fatty acids has resulted in an unhealthy dietary shift in the American diet. The authors point out that what used to be a 1:1 ratio between omega-3 and omega-6 fatty acids is now estimated to be a 10:1 ratio. This poses a problem, researchers say, because consuming some of the beneficial effects gained from omega-3 fatty acids are negated by an overconsumption of omega-6 fatty acids. For example, omega-3 fatty acids have anti-inflammatory properties, whereas omega-6 fatty acids tend to promote inflammation. Cereals, whole grain bread, margarine, and vegetable oils, such as corn, peanut, and sunflower oil, are examples of omega-6 fatty acids. In addition, people consume a lot of omega-6 fatty acid simply by eating the meat of animals that were fed grain rich in omega-6. Some experts suggest that eating one to four times more omega-6 fatty acids than omega-3 fatty acids is a reasonable ratio. In other words, as dietitians often say, the key to a healthy diet is moderation and balance.

The health benefits of omega-3 fatty acids

There is strong evidence that omega-3 fatty acids protect a person against **atherosclerosis** and therefore against heart disease and **stroke**, as well as abnormal heart rhythms that cause **sudden cardiac death**, and possibly **autoimmune disorders**, such as lupus and **rheumatoid arthritis**. In fact, Drs. Dean Ornish and Mehmet Oz, renowned heart physicians, said in a 2002 article published in *O Magazine* that the benefits derived from consuming the proper daily dose of omega-3 fatty acids may help to reduce sudden cardiac **death** by as much as 50%. In fact, in an article published by *American Family Physician*, Dr. Maggie Covington, a clinical assistant professor at the University of Maryland, also emphasized the value of omega-3 fatty acids with regard to cardiovascular health and referred to one of the largest clinical trials to date, the GISSI-Prevenzione Trial, to illustrate her point. In the study, 11,324 patients with coronary heart disease were divided into four groups: one group received 300 mg of vitamin E, one group received 850 mg of omega-3 fatty acids, one group received the vitamin E and fatty acids, and one group served as the control group. After a little more than three years, "the group given omega-3 fatty acids only had a 45% reduction in sudden death and a 20% reduction in all-cause mortality," as stated by Dr. Covington.

According to the American Heart Association (AHA), the ways in which omega-3 fatty acids may reduce cardiovascular disease are still being studied. However, the AHA indicates that research as shown that omega-3 fatty acids:

- decrease the risk of arrthythmias, which can lead to sudden cardiac death
- decrease triglyceride levels
- decrease the growth rate of atherosclerotic plaque
- lower blood pressure slightly

In fact, numerous studies show that a diet rich in omega-3 fatty acids not only lowers bad cholesterol, known as LDL, but also lowers **triglycerides**, the fatty material that circulates in the blood. Interestingly, researchers have found that the cholesterol levels of Inuit Eskimos tend to be quite good, despite the fact that they have a high fat diet. The reason for

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this, research has found, is that their diet is high in fatty fish, which is loaded with omega-3 fatty acids. The same has often been said about the typical Mediterranean-style diet.

Said to reduce joint inflammation, omega-3 fatty acid supplements have been the focus of many studies attempting to validate its effectiveness in treating rheumatoid arthritis. According to a large body of research in the area, omega-3 fatty acid supplements are clearly effective in reducing the symptoms associated with rheumatoid arthritis, such as joint tenderness and stiffness. In some cases, a reduction in the amount of medication needed by rheumatoid arthritis patients has been noted.

More research needs to be done to substantiate the effectiveness of omega-3 fatty acids in treating **eating disorders**, attention deficit disorder, and depression. Some studies have indicated, for example, that children with behavioral problems and attention deficit disorder have lower than normal amounts of omega-3 fatty acids in their bodies. However, until there is more data in these very important areas of research, a conservative approach should be taken, especially when making changes to a child's diet. Parents should to talk to their child's pediatrician to ascertain if adding more omega-3 fatty acids to their child's diet is appropriate. In addition, parents should take special care to avoid feeding their children fish high in mercury. A food list containing items rich in omega-3 fatty acids can be obtained from a licensed dietitian.

Mercury levels and concerns about safety

A great deal of media attention has been focused on the high mercury levels found in some types of fish. People concerned about fish consumption and mercury levels can review public releases on the subject issued by the U. S. Food and Drug Administration and the Environmental Protection Agency. Special precautions exist for children and pregnant or **breastfeeding** women. They are advised to avoid shark, mackerel, swordfish, and tilefish. However, both the U.S. Food and Drug Administration and the Environmental Protection Agency emphasize the importance of dietary fish. Fish, they caution, should not be eliminated from the diet. In fact, Robert Oh, MD, stated in his 2005 article, which was published in *The Journal of the American Board of Family Practice,* "with the potential health benefits of fish, women of childbearing age should be encouraged to eat one to two low-mercury fish meals per week."

Contaminants and concerns about safety

Other concerns regarding fish safety have also been reported. In 2004, Hites and colleagues assessed organic contaminants in salmon in an article published in *Science*. Their conclusion that farmed salmon had higher concentrations of polychlorinated biphenyls than wild salmon prompted public concerns and a response from the American Cancer Society. Farmed fish in Europe was found to have higher levels of mercury than farmed salmon in North and South America; however, the American Cancer Society reminded the public that the "levels of toxins Hites and his colleagues found in the farmed salmon were still below what the U.S. Food and Drug Administration, which regulates food, considers hazardous." The American Cancer Society still continues to promote a healthy, varied diet, which includes fish as a food source.

Recommended dosage

The AHA recommends that people eat two servings of fish, such as tuna or salmon, at least twice a week. A person with coronary heart disease, according to the AHA, should consume 1 gram of omega-3 fatty acids daily through food intake, most preferably through the consumption of fatty fish. The AHA also states that "people with elevated triglycerides may need 2 to 4 grams of EPA and DHA per day provided as a supplement," which is available in liquid or capsule form. Ground or cracked flaxseed can easily be incorporated into a person's diet by sprinkling it over salads, soup, and cereal.

Sources differ, but here are some general examples:

- 3 ounces of pickled herring = 1.2 grams of omega-3 fatty acids
- 3 ounces of salmon = 1.3 grams of omega-3 fatty acids
- 3 ounces of halibut = 1.0 grams of omega-3 fatty acids
- 3 ounces of mackerel = 1.6 grams of omega-3 fatty acids
- 1 1/2 teaspoons of flaxseeds = 3 grams of omega-3 fatty acids

Precautions

In early 2004, the U.S. Food and Drug Administration along with the the Environmental Protection Agency issued a statement that women who are or may be pregnant, as well as breastfeeding mothers and children, should avoid eating some types of fish thought to contain high levels of mercury. Fish that

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typically contain high levels of mercury are shark, swordfish, and mackerel, whereas shrimp, canned light tuna, salmon, and catfish are generally thought to have low levels of mercury. Because many people engage in fishing as a hobby, women should be sure before they eat any fish caught by friends and family that the local stream or lake is considered low in mercury.

Conflicting information exists whether it is safe for patients with **macular degeneration** to take omega-3 fatty acids in supplement form. Until more data becomes available, it is better for people with macular degeneration to receive their omega-3 fatty acids from the food they eat.

Side effects

Fish oil supplements can cause **diarrhea** and gas. Also, some fish oil capsules may have a fishy aftertaste.

Interactions

Although there are no significant **drug interactions** associated with eating foods containing omega-3 fatty acids, patients who are being treated with blood-thinning medications should not take omega-3 fatty acid supplements without seeking the advice of their physicians. Excessive bleeding could result. For the same reason, some patients who plan to take more than 3 grams of omega-3 fatty acids in supplement form should first seek the approval of their physicians.

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American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (800)227-2345, http://www.cancer.org.

Lee Ann Paradise

Omeprazole *see* **Antiulcer drugs**

Omphalocele *see* **Abdominal wall defects**

Onchocerciasis *see* **Filariasis**

Onychomycosis

Definition

Onychomycosis is a fungal infection of the fingernails or toenails. The actual infection is of the bed of the nail and of the plate under the surface of the nail.

Description

Onychomycosis is the most common of all diseases of the nails in adults. In North America, the incidence falls roughly between 2–13%. The incidence of onychomycosis is also greater in older adults, and up to 90% of the elderly may be affected. Men are more commonly infected than women.

Individuals who are especially susceptible include those with chronic diseases such as diabetes and circulatory problems and those with diseases that suppress the immune system. Other risk factors include a family history, previous trauma to the nails, warm climate, and occlusive or tight footwear.

Causes and symptoms

Onychomycosis is caused by three types of fung: dermatophytes, yeasts, and nondermatophyte molds. Fungi are simple parasitic plant organisms that do not need sunlight to grow. Toenails are especially susceptible because fungi prefer dark damp places. Swimming pools, locker rooms, and showers typically harbor fungi. Chronic diseases such as diabetes, problems with the circulatory system, or immune deficiency disease are risk factors. A history of **athlete's foot** and excess perspiration are also risk factors.

Onychomycosis can be present for years without causing **pain** or disturbing symptoms. Typically, the nail becomes thicker and changes to a yellowish-brown. Foul-smelling debris may collect under the nail. The infection can spread to the surrounding nails and even the skin.

Diagnosis

To make a diagnosis of onychomycosis, the clinician must collect a specimen of the nail in which infection is suspected. A clipping is taken from the nail plate, and a sample of the debris from underneath the nail bed is also taken, usually with a sharp curette.

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Debris from the nail surface may also be taken. These will be sent for microscopic analysis to a laboratory, as well as cultured to determine what types of fungus are growing there.

Treatment

Onychomycosis is very difficult and sometimes impossible to treat, and therapy is often long-term. Therapy consists of topical treatments that are applied directly to the nails, as well as two systemic drugs, griseofulvin and ketoconazole. Topical therapy is reserved for only the mildest cases. The use of griseofulvin and ketoconazole is problematic, and there are typically high relapse rates of 50–85%. In addition, treatment must be continued for a long duration (10–18 months for toenails), with monthly laboratory monitoring for several side effects, including liver toxicity. Individuals taking these medications must also abstain from alcohol consumption.

In the past few years, newer oral antifungal agents have been developed, and include itraconazole (Sporanox), terbinafine (Lamisil), and fluconazole (Diflucan). These agents, when taken orally for as little as 12 weeks, bring about better cure rates and fewer side effects than either griseofulvin or ketoconazole. The most common side effect is stomach upset. Patients taking oral antifungal therapy must have a **complete blood count** and liver enzyme workup every four to six weeks. Terbinafine in particular has markedly less toxicity to the liver, one of the more severe side effects of the older agents, griseofulvin and ketoconazole.

Treatment should be continued until microscopic exam or culture shows no more fungal infection. Nails may, however, continue to look damaged even after a clinical cure is achieved. Nails may take up to a full year to return to normal. If the nail growth slows or stops, additional doses of antifungal therapy should be taken.

Nail **debridement** is another treatment option, but it is considered by many to be primitive compared with topical or systemic treatment. Clinicians perform nail debridement in their offices. The nail is cut and then thinned using surgical tools or chemicals, and then the loose debris under the nail is removed. The procedure is painless, and often improves the appearance of the nails immediately. In addition, it helps whatever medication being used to penetrate the newly thinned nail. Patients with very thickened nails will sometimes undergo chemical removal of a nail. A combination of oral, topical, and surgical removal can increase the chances of curing the infection.

KEY TERMS

Curette—Spoon-shaped instrument for removing debris, growths, or infected nail matter.

Dermatophytes, yeasts, and nondermatophyte molds—Three types of fungi responsible for fungal infections of the nails.

Alternative treatment

For controlling onychomycosis, as opposed to curing it, some experts advocate using Lotrimin cream, available over the counter. The cream should be thoroughly rubbed into the nail daily in order to control the infection.

In general, **nutrition** may also play a role in promoting good nail health and thus preventing nail disease. Adequate protein and **minerals**, in the form of nuts, seeds, whole grains, legumes, fresh vegetables, and fish, should be consumed. Sugars, alcohol, and **caffeine** should be avoided. Certain supplements may also be beneficial, including vitamin A (10,000 IU per day), zinc (15–30 mg per day), iron (ferrous glycinate 100 mg per day, vitamin B_{12} (1,000 mcg per day), and essential fatty acids in the form of flax, borage, or evening primrose oil (1,000–1,5000 mg twice daily).

Herbal remedies may also relieve some of the symptoms of onychomycosis. A combination of coneflower, oregano, spilanthes, usnea, Oregon grape root, and myrrh can be used as a tincture (20 drops four times daily).

Undiluted grapefruit seed extract and tea tree oil are also said to be beneficial when applied topically to the infected nails.

Prognosis

Onychomycosis is typically quite difficult to cure completely. Even if a clinical cure is achieved after long therapy with either topical or oral drugs, normal regrowth takes four to six months in the fingernails, and eight to 12 months in the toenails, which grow more slowly. Relapse is common, and often, the nail or nail bed is permanently damaged. For toenails infected with onychomycosis, terbinafine seems to offer the highest cure rate (35–50%). Itraconazole cure rates typically range from 25–40%, and those with fluconazole, which was recently approved in the United States, have not been documented by long-term trials

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Prevention

Keeping the feet clean and dry, and washing with soap and water and drying thoroughly are important preventive steps to take to prevent onychomycosis. Other preventive measures include keeping the nails cut short and wearing shower shoes whenever walking or showering in public places. Daily changes of shoes, socks, or hosiery are also helpful. Excessively tight hose or shoes promote moisture, which in turn, provides a wonderful environment for onychomycotic infections. To prevent this, individuals should wear only socks made of synthetic fibers, which can absorb moisture more quickly than those made of cotton or wools. Manicure and pedicure tools should be disinfected after each use. Finally, nail polish should not be applied to nails that are infected, as this causes the water or moisture that collects under the surface of the nail to not evaporate and be trapped.

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ORGANIZATIONS

American Academy of Dermatology, P.O. Box 4014, Schaumburg, IL, 60168-4014, (847)240-1859, (866)503-SKIN (7546), http://www.aad.org.

Liz Meszaros

Oophorectomy

Definition

Unilateral oophorectomy (also called an ovariectomy) is the surgical removal of an ovary. If one ovary is removed, a woman may continue to menstruate and have children. If both ovaries are removed, a procedure called a bilateral oophorectomy, menstruation stops and a woman loses the ability to have children.

Purpose

Oophorectomy is performed to:

- remove cancerous ovaries
- remove the source of estrogen that stimulates some cancers
- remove a large ovarian cyst
- excise an abscess
- treat endometriosis

In an oophorectomy, one or a portion of one ovary may be removed or both ovaries may be removed. When an oophorectomy is done to treat **ovarian cancer** or other spreading cancers, both ovaries are removed (called a bilateral oophorectomy). Removal of the ovaries and fallopian tubes is performed in about one-third of hysterectomies (surgical removal of the uterus), often to reduce the risk of ovarian **cancer**.

Oophorectomies are sometimes performed on premenopausal women who have estrogen-sensitive **breast cancer** in an effort to remove the main source of estrogen from their bodies. This procedure has become less common than it was in the 1990s. In the early 2000s, **chemotherapy** drugs are available that alter the production of estrogen, and tamoxifen blocks any of the effects any remaining estrogen may have on cancer cells.

Until the 1980s, women over age 40 had hysterectomies routinely, removing healthy ovaries and fallopian tubes at the same time. This operation is called a bilateral **salpingo-oophorectomy**. Many physicians reasoned that a woman over 40 was approaching **menopause** and soon her ovaries would stop secreting estrogen and releasing eggs. Removing the ovaries would eliminate her risk of ovarian cancer and only accelerate menopause by a few years.

In the 1990s, the thinking about routine oophorectomy began to change. The risk of ovarian cancer in women who have no family history of the disease is less than 1%. Furthermore, removing the ovaries increases the risk of cardiovascular disease and accelerates **osteoporosis** unless a woman takes prescribed hormone replacements.

Under certain circumstances, oophorectomy may still be the treatment of choice to prevent breast and ovarian cancer in certain high-risk women. A study done at the University of Pennsylvania and released in 2000 showed that healthy women who carried the BRCA1 or BRCA2 genetic mutations that predisposed them to breast cancer had their risk of breast cancer drop from 80% to 19% when their ovaries were removed before age 40. Women between the ages of 40 and 50 showed less risk reduction, and there

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KEY TERMS

Cyst—An abnormal sac containing fluid or semi-solid material.

Endometriosis—A benign condition that occurs when cells from the lining of the uterus begin growing outside the uterus.

Fallopian tubes—Slender tubes that carry ova from the ovaries to the uterus.

Hysterectomy—Surgical removal of the uterus.

Osteoporosis—The excessive loss of calcium from the bones, causing the bones to become fragile and break easily.

was no significant reduction of breast cancer risk in women over age 50. A 2002 study showed that five years after being identified as carrying BRCA1 or BRCA2 genetic mutations, 94% of women who had received a bilateral salpingo-oophorectomy were cancer-free, compared to 79% of women who had not received surgery.

The value of ovary removal in preventing both breast and ovarian cancer has been documented. However, there are disagreements within the medical community about when and at what age this treatment should be offered. Preventative oophorectomy, also called prophylactic oophorectomy, is not always covered by insurance. One study conducted in 2000 at the University of California at San Francisco found that only 20% of insurers paid for preventive bilateral oophorectomy (PBO). Another 25% had a policy against paying for the operation, and the remaining 55% said that they would decide about payment on an individual basis.

Demographics

Overall, ovarian cancer accounts for only 4% of all cancers in women. But the lifetime risk for developing ovarian cancer in women who have mutations in BRCA1 is significantly increased over the general population and may cause an ovarian cancer risk of 30% by age 60. For women at increased risk, oophorectomy may be considered after the age of 35 if childbearing is complete.

Other factors that increase a woman's risk of developing ovarian cancer include age (most ovarian cancers occur after menopause), the number of menstrual periods a woman has had (affected by age of onset, **pregnancy**, **breastfeeding**, and oral contraceptive use), history of breast cancer, diet, and family history. The incidence of ovarian cancer is highest among Native Americans (17.5 cases per 100,000 population), white (15.8 per 100,000), Vietnamese (13.8 per 100,000), white Hispanic (12.1 per 100,000), and Hawaiian (11.8 per 100,000) women; it is lowest among Korean (7.0 per 100,000) and Chinese (9.3 per 100,000) women. African American women have an ovarian cancer incidence of 10.2 per 100,000 population.

Description

Oophorectomy is done under general or regional anesthesia. It is often performed through the same type of incision, either vertical or horizontal, as an abdominal **hysterectomy**. Horizontal incisions leave a less noticeable scar, but vertical incisions give the surgeon a better view of the abdominal cavity. After the incision is made, the abdominal muscles are stretched apart, not cut, so that the surgeon can see the ovaries. Then the ovaries, and often the fallopian tubes, are removed.

Oophorectomy can sometimes be done with a laparoscopic procedure. With this surgery, a tube containing a tiny lens and light source is inserted through a small incision in the navel. A camera can be attached that allows the surgeon to see the abdominal cavity on a video monitor. When the ovaries are detached, they are removed though a small incision at the top of the vagina. The ovaries can also be cut into smaller sections and removed.

The advantages of abdominal incision are that the ovaries can be removed even if a woman has many **adhesions** from previous surgery. The surgeon gets a good view of the abdominal cavity and can check the surrounding tissue for disease. A vertical abdominal incision is mandatory if cancer is suspected. The disadvantages are that bleeding is more likely to be a complication of this type of operation. The operation is more painful than a laparoscopic operation and the recovery period is longer. A woman can expect to be in the hospital two to five days and will need three to six weeks to return to normal activities.

Diagnosis/Preparation

Before surgery, the doctor will order blood and urine tests, and any additional tests such as ultrasound or x-rays to help the surgeon visualize the woman's condition. The woman may also meet with the anesthesiologist to evaluate any special conditions that might affect the administration of anesthesia. A colon preparation may be done, if extensive surgery is anticipated.

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On the evening before the operation, the woman should eat a light dinner, then take nothing by mouth, including water or other liquids, after midnight.

Aftercare

After surgery a woman will feel discomfort. The degree of discomfort varies and is generally greatest with abdominal incisions, because the abdominal muscles must be stretched out of the way so that the surgeon can reach the ovaries. In order to minimize the risk of postoperative infection, **antibiotics** will be given.

When both ovaries are removed, women who do not have cancer are started on **hormone replacement therapy** to ease the symptoms of menopause that occur because estrogen produced by the ovaries is no longer present. If even part of one ovary remains, it will produce enough estrogen that a woman will continue to menstruate, unless her uterus was removed in a hysterectomy. To help offset the higher risks of heart and bone disease after loss of the ovaries, women should get plenty of **exercise**, maintain a low-fat diet, and ensure intake of **calcium** is adequate.

Return to normal activities takes anywhere from two to six weeks, depending on the type of surgery. When women have cancer, chemotherapy or radiation are often given in addition to surgery. Some women have emotional trauma following an oophorectomy, and can benefit from counseling and support groups.

Risks

Oophorectomy is a relatively safe operation, although, like all major surgery, it does carry some risks. These include unanticipated reaction to anesthesia, internal bleeding, **blood clots**, accidental damage to other organs, and post-surgery infection.

Complications after an oophorectomy include changes in sex drive, hot flashes, and other symptoms of menopause if both ovaries are removed. Women who have both ovaries removed and who do not take estrogen replacement therapy run an increased risk for cardiovascular disease and osteoporosis. Women with a history of psychological and emotional problems before an oophorectomy are more likely to experience psychological difficulties after the operation.

Complications may arise if the surgeon finds that cancer has spread to other places in the abdomen. If the cancer cannot be removed by surgery, it must be treated with chemotherapy and radiation.

Normal results

If the surgery is successful, the ovaries will be removed without complication, and the underlying problem resolved. In the case of cancer, all the cancer will be removed. A woman will become infertile following a bilateral oophorectomy.

Morbidity and mortality rates

Studies have shown that the complication rate following oophorectomy is essentially the same as that following hysterectomy. The rate of complications associated with hysterectomy differs by the procedure performed. Abdominal hysterectomy is associated with a higher rate of complications (9.3%), while the overall complication rate for vaginal hysterectomy is 5.3%, and 3.6% for laparoscopic vaginal hysterectomy. The risk of **death** is about one in every 1,000 women having a hysterectomy. The rates of some of the more commonly reported complications are:

- excessive bleeding (hemorrhaging): 1.8–3.4%
- fever or infection: 0.8–4.0%
- accidental injury to another organ or structure: 1.5–1.8%

Because of the cessation of hormone production that occurs with a bilateral oophorectomy, women who lose both ovaries also prematurely lose the protection these hormones provide against heart disease and osteoporosis. Women who have undergone bilateral oophorectomy are seven times more likely to develop coronary heart disease and much more likely to develop bone problems at an early age than are premenopausal women whose ovaries are intact.

Alternatives

Depending on the specific condition that warrants an oophorectomy, it may be possible to modify the surgery so at least a portion of one ovary remains, allowing the woman to avoid early menopause. In the case of prophylactic oophorectomy, drugs such as tamoxifen may be administered to block the effects that estrogen may have on cancer cells.

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ORGANIZATIONS

American Cancer Society, 1599 Clifton Road NE, Atlanta, GA, 30329-4251, (800) 227-2345, http://www.cancer.org.

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American College of Obstetricians and Gynecologists, 409 23th Street SW, P.O. Box 96920, Washington, DC, 20090-6920, (202)638-5577, http://www.acog.org.
National Cancer Institute, Building 31, Room 10A31, 31 Center Drive, MSC 2580, Bethesda, MD, 20892-2580, (800) 422-6237, http://www.nci.nih.gov.

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Open fracture reduction *see* **Fracture repair**
Ophthalmic antibiotics *see* **Antibiotics, ophthalmic**

Ophthalmoplegia

Definition

Ophthalmoplegia is a **paralysis** or weakness of one or more of the muscles that control eye movement. The condition can be caused by any of several neurologic disorders. It may be myopathic, meaning that the muscles controlling eye movement are directly involved, or neurogenic, meaning that the nerve pathways controlling eye muscles are affected. Diseases associated with ophthalmoplegia are ocular myopathy, which affects muscles, and internuclear ophthalmoplegia, a disorder caused by **multiple sclerosis**, a disease which affects nerves.

Description

Because the eyes do not move together in ophthalmoplegia, patients may complain of double vision. Double vision is especially troublesome if the ophthalmoplegia comes on suddenly or affects each eye differently. Because ophthalmoplegia is caused by another, underlying disease, it is often associated with other neurologic symptoms, including limb weakness, lack of coordination, and **numbness**.

Causes and symptoms

Ocular myopathy is also known as mitochondrial encephalomyelopathy with ophthalmoplegia or progressive external ophthalmoplegia. Because it is so often associated with diseases affecting many levels of the neurologic system, it is often referred to as "ophthalmoplegia plus." The main feature is progressive limitation of eye movements, usually with drooping of the eyelids (**ptosis**). Ptosis may occur years before other symptoms of ophthalmoplegia. Because both eyes are equally involved and because ability to move the eyes lessens gradually over the course of years, double vision is rare. On examination, the eyelids may appear thin. This disease usually begins in childhood or adolescence but may start later.

When ophthalmoplegia is caused by muscle degeneration (myopathic), muscle biopsy, in which a small piece of muscle is surgically removed and examined microscopically, will find characteristic abnormal muscle fibers called ragged red fibers. In this form of ophthalmoplegia, the patient may experience weakness of the face, the muscles involved in swallowing, the neck, or the limbs.

Progressive external ophthalmoplegia is sometimes associated with specific neurologic syndromes. These syndromes include familial forms of spastic paraplegia, spinocerebellar disorders, or sensorimotor **peripheral neuropathy**. Kearns-Sayre syndrome causes ophthalmoplegia along with loss of pigment in the retina, the light-sensitive membrane lining the eye. In addition, the disease may cause **heart block** that must be corrected with a pacemaker, increased protein in the cerebrospinal fluid, and a progressively disabling lack of muscular coordination (cerebellar syndrome). Symptoms of the disease appear before age 15.

Some of the progressive external ophthalmoplegia syndromes are unusual in that inheritance is controlled by DNA in the mitochondria. The mitochondria are rod-shaped structures within a cell that convert food to usable energy. Most inherited diseases are passed on by DNA in the cell nucleus, the core that contains the hereditary material. Mitochondrial inheritance tends to be passed on by the mother. Other forms of progressive external ophthalmoplegia are not inherited but occur sporadically with no clear family history. It is not known why some forms are neurogenic and others are myopathic. In the forms inherited through mitochondrial DNA, it is not known which gene product is affected.

Internuclear ophthalmoplegia in multiple sclerosis is caused by damage to a bundle of fibers in the brainstem called the medial longitudinal fasciculus. In this syndrome, the eye on the same side as the damaged medial longitudinal fasciculus is unable to look outward (that is, the left eye cannot look left). The other eye exhibits jerking movements (**nystagmus**) when the patient tries to look left. Internuclear ophthalmoplegia may be seen rarely without multiple sclerosis in patients with certain types of **cancer** or with Chiari type II malformation.

Eye **movement disorders** and ophthalmoplegia can also be seen with **progressive supranuclear palsy**, thyroid disease, **diabetes mellitus**, brainstem tumors,

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migraine, basilar artery **stroke**, pituitary stroke, **myasthenia gravis**, **muscular dystrophy**, and the Fisher variant of **Guillain-Barré syndrome**. A tumor or aneurysm in the cavernous sinus, located behind the eyes, can cause painful ophthalmoplegia. Painful ophthalmoplegia can also be caused by an inflammatory process, called Tolosa-Hunt syndrome,in the same area.

Diagnosis

The patient's medical and family history and the examination findings will usually help differentiate the various syndromes associated with ophthalmoplegia. In addition, each syndrome is associated with characteristic features, such as nystagmus or ptosis. All patients with progressive external ophthalmoplegia should have a muscle biopsy to look for ragged red fibers or changes suggesting muscular dystrophy. A sample should be sent for analysis of mitochondrial DNA. Electromyogram (EMG), measurement of electrical activity in the muscle, helps diagnose myopathy.

Computed tomography scan (CT scan) or **magnetic resonance imaging** (MRI) scans of the brain may be needed to rule out **brain tumor**, stroke, aneurysm, or multiple sclerosis. When multiple sclerosis is suspected, evoked potential testing of nerve response may also be helpful. Analysis of cerebrospinal fluid may show changes characteristic of multiple sclerosis or Kearns-Sayre syndrome. Other tests that may be helpful in Kearns-Sayre include electrocardiogram (measuring electrical activity of the heart muscles), retinal examination, and a hearing test (audiogram). For possible myasthenia gravis, the Tensilon (edrophonium) test should be done. Tests should also be done to measure activity of the cell-surface receptors for acetylcholine, a chemical that helps pass electrical impulses along nerve cells in the muscles. Thyroid disease and diabetes mellitus should be excluded by appropriate blood work.

Treatment

There are no specific cures for ocular myopathy or progressive external ophthalmoplegia. Vitamin E therapy has been used to treat Kearns-Sayre syndrome. Coenzyme Q (ubiquinone), a naturally occurring substance similar to vitamin K, is widely used to treat other forms of progressive external ophthalmoplegia, but the degree of success varies. Specific treatments are available for multiple sclerosis, myasthenia gravis, diabetes mellitus, and thyroid disease. Symptoms of ophthalmoplegia can be relieved by mechanical treatment. Surgical procedures can lift drooping eyelids or a patch over one eye can be used to relieve double vision. Because there is no blink response, a surgically lifted eyelid exposes the cornea of the eye so that it may become dry or be scratched. These complications must be avoided by using artificial tears and wearing eyepatches at night. In Kearns-Sayre syndrome, a pacemaker may be needed.

KEY TERMS

Cerebellar—Involving the cerebellum, which controls walking, balance, and coordination.

Cerebrospinal fluid—Fluid bathing the brain and spinal cord.

Heart block—A problem with electrical conduction in the heart muscle that may lead to irregular heart beat and require a pacemaker for treatment.

Mitochondria—Spherical or rod shaped parts of the cell. Mitochondria contain genetic material (DNA and RNA) and are responsible for converting food to energy.

Prognosis

The prognosis of progressive external ophthalmoplegia depends on the associated neurological problems; in particular, whether there is severe limb weakness or cerebellar symptoms that may be mild or disabling. As with most chronic neurologic diseases, mortality increases with disability. Progressive external ophthalmoplegia itself is not a life-threatening condition. Kearns-Sayre syndrome is disabling, probably shortens the life span, and few if any patients have children. Overall life expectancy for multiple sclerosis patients is seven years less than normal; **death** rates are higher for women than for men.

Prevention

There is no way to prevent ophthalmoplegia.

ORGANIZATIONS

American Academy of Neurology, 1080 Montreal Ave., St. Paul, MN, 55116, (651)695-2717, (651)695-2791, (800)879-1960, memberservices@aan.com, http://www.aan.com/.

Laurie Barclay, MD

Ophthalmoscopic examination *see* **Eye examination**

Opiate withdrawal *see* **Withdrawal syndromes**

Opioid analgesics *see* **Analgesics, opioid**

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Oppositional defiant disorder

Definition

Oppositional defiant disorder (ODD) is defined by the *Diagnostic and Statistical Manual of Mental Disorders*, fourth edition (DSM-IV), as a recurring pattern of negative, hostile, disobedient, and defiant behavior in a child or adolescent, lasting for at least six months without serious violation of the basic rights of others. The incidence of ODD in the U.S. population varies somewhat according to the sample studied; DSM-IV gives the rate as between 2–16% while the American Academy of Child and Adolescent Psychiatry (AACAP) gives a figure of 5%–15%, and a researcher at a children's hospital gives a rate of 6–10%.

Description

In order to meet DSM-IV criteria for ODD, the behavior disturbances must cause clinically significant problems in social, school, or work functioning. The course of oppositional defiant disorder varies among patients. In males, the disorder is more common among those who had problem temperaments or high motor activity in the preschool years. During the school years, patients may have low self-esteem, changing moods, and a low frustration tolerance. Patients may swear and use alcohol, tobacco, or illicit drugs at an early age. There are frequent conflicts with parents, teachers, and peers.

Children with this disorder show their negative and defiant behaviors by being persistently stubborn and resisting directions. They may be unwilling to compromise, give in, or negotiate with adults. Patients may deliberately or persistently test limits, ignore orders, argue, and fail to accept blame for misdeeds. Hostility is directed at adults or peers and is shown by verbal aggression or deliberately annoying others.

Causes and symptoms

Oppositional defiant disorder is more common in boys than girls before **puberty**; the disorder typically begins by age eight. After puberty the male:female ratio is about 1:1. Although the specific causes of the disorder are unknown, parents who are overly concerned with power and control may cause an eruption to occur. Symptoms often appear at home, but over time may appear in other settings as well. Usually the disorder occurs gradually over months or years. Several theories about the causes of oppositional defiant disorder are being investigated. Oppositional defiant disorder may be related to:

- the child's temperament and the family's response to that temperament
- an inherited predisposition to the disorder in some families
- marital discord or violence between husband and wife
- frequent or multiple geographical moves
- a neurological cause, like a head injury
- a chemical imbalance in the brain (especially with the brain chemical serotonin)

Oppositional defiant disorder appears to be more common in families where at least one parent has a history of a mood disorder, **conduct disorder**, **attention deficit hyperactivity disorder**, antisocial personality disorder, or a substance-related disorder. Additionally, some studies suggest that mothers with a depressive disorder are more likely to have children with oppositional behavior. However, it is unclear to what extent the mother's depression results from or causes oppositional behavior in children.

Symptoms include a pattern of negative, hostile, and defiant behavior lasting at least six months. During this time four or more specific behaviors must be present. These behaviors include the child who:

- often loses his/her temper
- often argues with adults
- often actively defies or refuses to comply with adults' requests or rules
- often deliberately annoys people
- often blames others for his/her mistakes or misbehavior
- is often touchy or easily annoyed by others
- is often angry and resentful
- is often spiteful or vindictive
- misbehaves
- swears or uses obscene language
- has a low opinion of him/herself

The diagnosis of oppositional defiant disorder is not made if the symptoms occur exclusively in psychotic or **mood disorders**. Criteria are not met for conduct disorder, and, if the child is 18 years old or older, criteria are not met for antisocial personality disorder. In other words, a child with oppositional defiant disorder does not show serious aggressive behaviors or exhibit the physical cruelty that is common in other disorders.

Additional problems may be present, including:

- learning problems
- a depressed mood
- hyperactivity (although attention deficit hyperactivity disorder must be ruled out)

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- substance abuse or dependence
- dramatic and erratic behavior

The patient with oppositional defiant disorder is moody, easily frustrated, and may abuse drugs.

Diagnosis

While psychological testing may be needed, the doctor must examine and talk with the child, talk with the parents, and review the medical history. Diagnosis is complicated because oppositional defiant disorder rarely travels alone. Children with attention deficit hyperactivity disorder will also have oppositional defiant disorder 50% of the time. Children with depression/anxiety will have oppositional defiant disorder 10–29% of the time. Because all of the features of this disorder are usually present in conduct disorder, oppositional defiant disorder is not diagnosed if the criteria are met for conduct disorder.

A diagnosis of oppositional defiant disorder should be considered only if the behaviors occur more frequently and have more serious consequences than is typically observed in other children of a similar developmental stage. Further, the behavior must lead to significant impairment in social, school, or work functioning.

A new evaluation scale known as the Oppositional Defiant Behavior Inventory (ODBI) has been developed as an aid to diagnosis. The ODBI appears to meet accepted standards of reliability and validity.

Treatment

Treatment of oppositional defiant disorder usually consists of group, individual and/or **family therapy**, and education. Of these, individual therapy is the most common. Therapy can provide a consistent daily schedule, support, consistent rules, discipline, and limits. It can also help train patients to get along with others and modify behaviors. Therapy can occur in residential, day treatment, or medical settings. Additionally, having a healthy role model as an example is important for the patient.

Parent management training focuses on teaching the parents specific and more effective techniques for handling the child's opposition and defiance. Research has shown that parent management training is more effective than family therapy. One variation of parent management training known as parent-child interaction therapy (PCIT) appears to be helpful over the long term; a group of Australian researchers reported in 2004 that families who were given a course of PCIT maintained their gains two years after the program ended.

As of the early 2000s, elementary school teachers are being trained to deal more effectively with classroom disruptions caused by children with ODD. The long-term effectiveness of these interventions, however, will require further study.

KEY TERMS

Attention deficit hyperactivity disorder—A persistent pattern of inattention, hyperactivity and/or impulsiveness; the pattern is more frequent and severe than is typically observed in people at a similar level of development.

Conduct disorder—A repetitive and persistent pattern of behavior in which the basic rights of others are violated or major age-appropriate rules of society are broken.

Whether involved in therapy or working on this disorder at home, the patient must work with his or her parents' guidance to make the fullest possible recovery. According to the New York Hospital/Cornell Medical Center, the patients must:

- use self timeouts
- identify what increases anxiety
- talk about feelings instead of acting on them
- find and use ways to calm themselves
- frequently remind themselves of their goals
- get involved in tasks and physical activities that provide a healthy outlet for energy
- learn how to talk with others
- develop a predictable, consistent, daily schedule of activity
- develop ways to obtain pleasure and feel good
- learn how to get along with other people
- find ways to limit stimulation
- learn to admit mistakes in a matter-of-fact way

Stimulant medication is used only when oppositional defiant disorder coexists with attention deficit hyperactivity disorder. Currently, no research is currently available on the use of other psychiatric medications in the treatment of oppositional defiant disorder.

Prognosis

The outcome varies. In some children the disorder evolves into a conduct disorder or a mood disorder. Later in life, oppositional defiant disorder can develop into passive aggressive personality disorder or antisocial personality disorder. Some children respond well to treatment and some do not. Generally, with

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treatment, reasonable adjustment in social settings and in the workplace can be made in adulthood.

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American Academy of Child and Adolescent Psychiatry (AACAP), 3615 Wisconsin Ave. NW, Washington, DC, 20013-3007, (202)966-7300, (202)966-2891, communications@aacap.org, http://www.aacap.org/.

American Psychiatric Association (APA), 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209, (888)357-7924, apa@psych.org, http://www.psych.org.

Families Anonymous, Inc., P.O. Box 3475, Culver City, CA, 90231-3475, (310)815-9682, (800)736-9805, famanon@FamiliesAnonymous.org, http://www.familiesanonymous.org/.

David James Doermann
Rebecca Frey, PhD

Optic atrophy

Definition

Optic atrophy can be defined as damage to the optic nerve resulting in a degeneration or destruction of the optic nerve. Optic atrophy may also be referred to as optic nerve head pallor because of the pale appearance of the optic nerve head as seen at the back of the eye. Possible causes of optic atrophy include: **optic neuritis**, Leber's hereditary optic atrophy, toxic or nutritional optic neuropathy, glaucoma, vascular disorders, trauma, and other systemic disorders.

Description

The process of vision involves light entering the eye and triggering chemical changes in the retina, a pigmented layer lining the back of the eye. Nerve impulses created by this process travel to the brain via the optic nerve. Using a hand-held instrument called an ophthalmoscope, the doctor can see the optic nerve head (optic disc) which is the part of the optic nerve that enters at the back of the eyeball. In optic atrophy, the disc is pale and has fewer blood vessels than normal.

Causes and symptoms

Symptoms of optic atrophy are a change in the optic disc and a decrease in visual function. This change in visual function can be a decrease in sharpness and clarity of vision (visual acuity) or decreases in side (peripheral) vision. Color vision and contrast sensitivity can also be affected.

There are many possible causes of optic atrophy. The causes can range from trauma to systemic disorders. Some possible causes of optic atrophy include:

- Optic neuritis. Optic neuritis is an inflammation of the optic nerve. It may be associated with eye pain worsened by eye movement. It is more common in young to middle-aged women. Some patients with optic neuritis may develop multiple sclerosis later on in life.
- Leber's hereditary optic neuropathy. This is a disease of young men (late teens, early 20s), characterized by an onset over a few weeks of painless, severe, central visual loss in one eye, followed weeks or months later by the same process in the other eye. At first the optic disc may be slightly swollen, but eventually there is optic atrophy. The visual loss is generally permanent. This condition is hereditary. If a patient knows that Leber's runs in the family, genetic counseling should be considered.
- Toxic optic neuropathy. Nutritional deficiencies and poisons can be associated with gradual vision loss and optic atrophy, or with sudden vision loss and optic disc swelling. Toxic and nutritional optic neuropathies are uncommon in the United States, but took on epidemic proportions in Cuba in 1992–1993. The most common toxic optic neuropathy is known as tobacco-alcohol amblyopia, thought to be caused by exposure to cyanide from tobacco smoking, and by low levels of vitamin B_{12} because of poor nutrition

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and poor absorption associated with drinking alcohol. Other possible toxins included ethambutol, methyl alcohol (moonshine), ethylene glycol (antifreeze), cyanide, lead, and carbon monoxide. Certain medications have also been implicated. Nutritional optic neuropathy may be caused by deficiencies of protein, or of the B vitamins and folate, associated with starvation, malabsorption, or alcoholism.

- Glaucoma. Glaucoma may be caused by an increase of pressure inside the eye. This increased pressure may eventually affect the optic nerve if left untreated.
- Compressive optic neuropathy. This is the result of a tumor or other lesion putting pressure on the optic nerve. Another possible cause is enlargement of muscles involved in eye movement seen in hyperthyroidism (Graves' disease).
- Retinitis pigmentosa. This is a hereditary ocular disorder.
- Syphilis. Left untreated, this disease may result in optic atrophy.

Diagnosis

Diagnosis involves recognizing the characteristic changes in the optic disc with an ophthalmoscope, and measuring visual acuity, usually with an eye chart. Visual field testing can test peripheral vision. Color vision and contrast sensitivity can also be tested. Family history is important in the diagnosis of inherited conditions. Exposure to poisons, drugs, and even medications should be determined. Suspected **poisoning** can be confirmed through blood and urine analysis, as can vitamin deficiency.

Brain **magnetic resonance imaging** (MRI) may show a tumor or other structure putting pressure on the optic nerve, or may show plaques characteristic of **multiple sclerosis**, which is frequently associated with optic neuritis. However, similar MRI lesions may appear in Leber's hereditary optic neuropathy. Mitochondrial DNA testing can be done on a blood sample, and can identify the mutation responsible for Leber's.

Visual evoked potentials (VEP), which measure speed of conduction over the nerve pathways involved in sight, may detect abnormalities in the clinically unaffected eye in early cases of Leber's. Fluorescein **angiography** gives more detail about blood vessels in the retina.

Treatment

Treatment of optic neuritis with **steroids** is controversial. There is no known treatment for Leber's hereditary optic neuropathy. Treatment of other causes of optic atrophy varies depending upon the underlying disease.

KEY TERMS

Atrophy—A destruction or dying of cells, tissues, or organs.

Cerebellar—Involving the part of the brain (cerebellum), which controls walking, balance, and coordination.

Mitochondia—A structure in the cell responsible for producing energy. A defect in the DNA in the mitochondria is involved in Leber's optic neuropathy.

Neuritis—An inflammation of the nerves.

Neuropathy—A disturbance of the nerves, not caused by an inflammation. For example, the cause may be toxins, or unknown.

Prognosis

Many patients with optic neuritis eventually develop multiple sclerosis. Most patients have a gradual recovery of vision after a single episode of optic neuritis, even without treatment. Prognosis for visual improvement in Leber's hereditary optic neuropathy is poor, with the specific rate highly dependent on which mitochondrial DNA mutation is present. If the cause of toxic or nutritional deficiency optic neuropathy can be found and treated early, such as stopping **smoking** and taking **vitamins** in tobacco-alcohol **amblyopia**, vision generally returns to near normal over several months' time. However, visual loss is often permanent in cases of long-standing toxic or nutritional deficiency optic neuropathy.

Prevention

People noticing a decrease in vision (central and/or side vision) should ask their eye care practitioner for a check up. Patients should also go for regular vision exams. Patients should ask their doctor how often that should be, as certain conditons may warrant more frequent exams. Early detection of inflammations or other problems lessens the chance of developing optic atrophy.

There are no preventive measures that can definitely abort Leber's hereditary optic neuropathy in those genetically at risk, or in those at risk based on earlier involvement of one eye. However, some

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doctors recommend that their patients take vitamin C, vitamin E, coenzyme Q_{10}, or other **antioxidants**, and that they avoid the use of tobacco or alcohol. Patients should ask their doctors about the use of vitamins. Avoiding toxin exposure and nutritional deficiency should prevent toxic or nutritional deficiency optic neuropathy.

ORGANIZATIONS

American Academy of Neurology, 1080 Montreal Ave., St. Paul, MN, 55116, (651)695-2717, (651) 695-2791, (800) 879-1960, memberservices@aan.com, http://www.aan.com/.

Prevent Blindness America, 211 West Wacker Drive, Suite 1700, Chicago, IL, 60606, (800)331-2020, http://www. preventblindness.org.

Laurie Barclay, MD

Optic neuritis

Definition

Optic neuritis is a vision disorder characterized by inflammation of the optic nerve.

Description

Optic neuritis occurs when the optic nerve, the pathway that transmits visual information to the brain, becomes inflamed and the myelin sheath that surrounds the nerve is destroyed (a process known as demyelination). It typically occurs in one eye at a time (70%), and the resulting vision loss is rapid and progressive, but only temporary. Thirty percent of patients experience occurrence in both eyes. Optic neuritis tends to afflict young adults with an average age in their 30s. Seventy-five percent of patients with optic neuritis are women.

Nerve damage that occurs in the section of the optic nerve located behind the eyeball, is called *retrobulbar neuritis*, and is most often associated with **multiple sclerosis**. Optic nerve inflammation and **edema** (swelling) caused by intracranial pressure at the place where the nerve enters the eyeball is termed *papillitis*.

Causes and symptoms

Symptoms of optic neuritis include one or more of the following:

- blurred or dimmed vision
- blind spots, particularly with central vision
- pain with eye movement
- headache
- sudden color blindness
- impaired night vision
- impaired contrast sensitivity

Optic neuritis is most commonly associated with multiple sclerosis (MS). Other causes include viral or fungal infections, encephalomyelitis, autoimmune diseases, or pressure on the nerve from tumors or vascular diseases (i.e., **temporal arteritis**). Some toxins, such as methanol and lead, can also damage the optic nerve, as can long-term **abuse** of alcohol and tobacco. Patients with non-MS related optic neuritis are usually immunocompromised in some way.

Diagnosis

An ophthalmologist, a physician trained in diseases of the eye, will typically make a diagnosis of optic neuritis. A complete visual exam, including a visual acuity test, color vision test, and examination of the retina and optic disc with an ophthalmoscope, will be performed. Clinical signs such as impaired pupil response may be apparent during an eye exam, but in some cases the eye may appear normal. A medical history will also be performed to determine if exposure to toxins such as lead may have caused the optic neuritis.

Further diagnostic testing such as **magnetic resonance imaging** (MRI) may be necessary to confirm a diagnosis of optic neuritis. An MRI can also reveal signs of multiple sclerosis.

Treatment

Treatment of optic neuritis depends on the underlying cause of the condition. Vision loss resulting from a viral condition usually resolves itself once the virus is treated, and optic neuritis resulting from toxin damage may improve once the source of the toxin is removed.

A course of intravenous **corticosteroids** (**steroids**) followed by oral steroids has been found to be helpful in restoring vision quickly to patients with MS-related episodes of optic neuritis, but its efficacy in preventing relapse is debatable. The Optic Neuritis Treatment Trial (ONTT) has shown that IV steroids may be effective in reducing the onset of MS for up to two years, but further studies are necessary. Oral prednisone has been found to increase the likelihood of recurrent episodes of optic neuritis, and is not recommended for treating the disorder.

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KEY TERMS

Atrophy—Cell wasting or death.

Multiple sclerosis—An autoimmune disease of the central nervous system characterized by damage to the myelin sheath that covers nerves.

Temporal arteritis—Also known as giant cell arteritis. Inflammation of the large arteries located in the temples which is marked by the presence of giant cells and symptoms of headache and facial pain.

Visual acuity test—An eye examination that determines sharpness of vision, typically performed by identifying objects and/or letters on an eye chart.

Prognosis

The vision loss associated with optic neuritis is usually temporary. Spontaneous remission occurs in two to eight weeks. Sixty-five to eighty percent of patients can expect 20/30 or better vision after recovery. Long-term prognosis depends on the underlying cause of the condition. If a viral infection has triggered the episode, it frequently resolves itself with no after effects. If optic neuritis is associated with multiple sclerosis, future episodes are not uncommon. Thirty-three percent of optic neuritis cases recur within five years. Each recurrence results in less recovery and worsening vision. There is a strong association between optic neuritis and MS. In those without multiple sclerosis, half who experience an episode of vision loss related to optic neuritis will develop the disease within 15 years.

Prevention

Regular annual eye exams are critical to maintaining healthy vision. Early treatment of vision problems can prevent permanent optic nerve damage (atrophy).

Resources

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ORGANIZATIONS

Prevent Blindness America, 211 West Wacker Drive, Suite 1700, Chicago, IL, 60606, (800)331-2020, http://www.preventblindness.org.

Paula Anne Ford-Martin

Oral cancer *see* **Head and neck cancer**
Oral cholecystography *see* **Gallbladder x rays**

Oral contraceptives

Definition

Oral contraceptives are medicines taken by mouth to help prevent **pregnancy**. They are also known as "the Pill," OCs, or birth-control pills.

Purpose

Oral contraceptives, birth-control pills, contain artificially made forms of two hormones produced naturally in the body. These hormones, estrogen and progestin, regulate a woman's menstrual cycle. When taken in the proper amounts, following a specific schedule, oral contraceptives are very effective in preventing pregnancy. Studies show that fewer than one of every 100 women who use oral contraceptives correctly becomes pregnant during the first year of use.

These pills have several effects that help prevent pregnancy. For pregnancy to occur, an egg must become mature inside a woman's ovary, be released, and travel to the fallopian tube. A male sperm must also reach the fallopian tube, where it fertilizes the egg. Then the fertilized egg must travel to the woman's uterus (womb), where it lodges in the uterus' lining and develops into a fetus. The main way that oral contraceptives prevent pregnancy is by keeping an egg from ripening fully. Eggs that do not ripen fully cannot be fertilized. In addition, birth-control pills thicken mucus in the woman's cervix, through which the sperm has to swim. This makes it more difficult for the sperm to reach the egg. Oral contraceptives also thin the uterine lining so that a fertilized egg cannot lodge there and develop.

Birth-control pills may cause good or bad side effects. For example, a woman's menstrual periods are regular and usually lighter when she is taking oral contraceptives, and the pills may reduce the risk of **ovarian cysts**, breast lumps, **pelvic inflammatory disease**, and other medical problems. However, taking birth-control pills increases the risk of **heart attack**, **stroke**, and **blood clots** in women with a family history of heart disease. Serious side effects such as these are more likely in women over 35 years of age who smoke cigarettes and in those with specific health problems such as high blood pressure, diabetes, or a history of breast or uterine **cancer**. A woman who wants to use

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A package of birth-control pills, an oral contraceptive. *(Lew Robertson/Brand X Pictures/Getty Images.)*

oral contraceptives should ask her physician for the latest information on the risks and benefits of all types of birth control and should consider her age, health, and medical history when deciding what to use.

Precautions

No form of birth control (except not having sex) is 100% effective. However, oral contraceptives can be highly effective when used properly. Discuss the options with a healthcare professional.

Oral contraceptives do not protect against **AIDS** or other **sexually transmitted diseases**. For protection against such diseases, use a latex condom.

Oral contraceptives are not effective immediately after a woman begins taking them. Physicians recommend using other forms of birth control for the first 1–3 weeks. Follow the instructions of the physician who prescribed the medicine.

Smoking cigarettes while taking oral contraceptives greatly increases the risk of serious side effects. *Women who take oral contraceptives should not smoke cigarettes.*

Seeing a physician regularly while taking this medicine is very important. The physician will note unwanted side effects. Follow his or her advice on how often you should be seen.

Anyone taking oral contraceptives should be sure to tell the healthcare professional in charge before having any surgical or dental procedures, laboratory tests, or emergency treatment.

This medicine may increase sensitivity to sunlight. Women using oral contraceptives should avoid too much sun exposure and should not use **tanning** beds, tanning booths, or sunlamps until they know how the medicine affects them. Some women taking oral contraceptives may get brown splotches on exposed areas of their skin. These usually go away over time after the women stop taking birth-control pills.

When possible, birth-control pills ought to be stopped for one month prior to, and not started again until two weeks after, major surgery involving prolonged immobility and/or an increased risk of blood clots.

Oral contraceptives may cause the gums to become tender and swollen, or to bleed. Careful brushing and flossing, gum massage, and regular cleaning may help prevent this problem. Check with a physician or dentist if gum problems develop.

Women who have certain medical conditions or who are taking certain other medicines may have problems if they take oral contraceptives. Before taking these drugs, be sure to let the physician know about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to estrogens or progestins in the past should let her physician know before taking oral contraceptives. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. Women who become pregnant or think they may have become pregnant while taking birth-control pills should stop taking them immediately and check with their physicians. Women who want to start taking oral contraceptives again after pregnancy should not refill their old prescriptions without checking with their physicians. The physician may need to change the prescription.

BREASTFEEDING. Women who are **breastfeeding** should check with their physicians before using oral contraceptives. The hormones in the pills may reduce

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the amount of breast milk and may pass to babies via milk. They may also cause **jaundice** and enlarged breasts in nursing babies whose mothers take the medicine.

OTHER MEDICAL CONDITIONS. Oral contraceptives may improve or worsen some medical conditions. The possibility that they may make a condition worse does not necessarily mean they cannot be used. In some cases, women may need only to be tested or followed more closely for medical problems while using oral contraceptives. Before using oral contraceptives, women with any of these medical problems should make sure their physicians are aware of their conditions:

- Female conditions such as menstrual problems, endometriosis, or fibroid tumors of the uterus. Birth-control pills usually make these problems better, but may sometimes make them worse or more difficult to diagnose.
- Heart or circulation problems; recent or past blood clots or stroke. Women who already have these problems may be at greater risk of developing blood clots or circulation problems if they use oral contraceptives. However, healthy women who do not smoke may lower their risk of circulation problems and heart disease by taking the pills.
- Breast cysts, lumps, or other non-cancerous breast problems. Oral contraceptives generally protect against these conditions, but physicians may recommend more frequent breast exams for women taking the pills.
- Breast cancer or other cancer (now or in the past, or family history). Oral contraceptives may make some existing cancers worse. Women with a family history of breast cancer may need more frequent screening for the disease if they decide to take birth-control pills.
- Migraine headaches. This condition may improve, but sometimes worsens with the use of birth-control pills.
- Diabetes. Blood sugar levels may increase slightly when oral contraceptives are used. Usually this increase is not enough to affect the amount of diabetes medicine needed. However, blood sugar will need to be monitored closely while taking oral contraceptives.
- Depression. This condition may worsen in women who already have it or may (rarely) occur again in women who were depressed in the past.
- Gallbladder disease, gallstones, high blood cholesterol, or chorea gravidarum (a nervous disorder). Oral contraceptives may make these conditions worse.
- Epilepsy, high blood pressure, heart or circulation problems. By increasing fluid build-up, oral contraceptives may make these conditions worse.

Description

Oral contraceptives (birth-control pills) come in a wide range of estrogen-progestin combinations. The pills in use today contain much lower doses of estrogen than those available in the past; these changes have reduced the likelihood of serious side effects. Some pills contain only progestin. These are prescribed mainly for women who need to avoid estrogens and may not be as effective in preventing pregnancy as the estrogen-progestin combinations.

These medicines come in tablet form, in containers designed to help women keep track of which tablet to take each day. The tablets are different colors, indicating amounts of hormones they contain. Some may contain no hormones at all. These are included simply to help women stay in the habit of taking a pill every day, as the hormone combination needs to be taken only on certain days of the menstrual cycle. Keeping the tablets in their original container and taking them exactly on schedule is very important. They will not be as effective if taken in the wrong order or if doses are missed.

Oral contraceptives are available only with a physician's prescription. Some commonly used brands are Demulen, Desogen, Loestrin, Lo/Ovral, Nordette, Ortho-Novum, Ortho-Tri-Cyclen, Estrostep, Ortho-cept, Alesse, Levlite and Ovcon.

The dose schedule depends on the type of oral contraceptive. The two basic schedules are a 21-day schedule and a 28-day schedule. On the 21-day schedule, take one tablet a day for 21 days, then skip 7 days and repeat the cycle. On the 28-day schedule, take one tablet a day for 28 days; then repeat the cycle. Be sure to carefully follow the instructions provided with the medicine. For additional information or explanations, check with the physician who prescribed the medicine or the pharmacist who filled the prescription.

Taking doses more than 24 hours apart may increase the chance of side effects or pregnancy. Try to take the medicine at the same time every day. Take care not to run out of pills. If possible, keep an extra month's supply on hand and replace it every month with the most recently filled prescription.

Try not to miss a dose, as this increases the risk of pregnancy. If a dose is missed, follow the package directions or check with the physician who prescribed the medicine for instructions. It may be necessary to use another form of birth control for some time after missing a dose.

Taking this medicine with food or at bedtime will help prevent **nausea**, a side effect that sometimes occurs during the first few weeks. Nausea usually goes away as the body adjusts to the medicine.

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Taking oral contraceptives may have several benefits outside of their ability to prevent pregnancy. Research indicates that with 10 to 12 years of oral contraceptive use, a woman's risk of **ovarian cancer** is reduced by up to 80%. There may also be an approximate 50% decrease in the rate of endometrial cancers in women. Another well-known, non-contraceptive benefit of taking oral contraceptives is improvement in **acne**. The combination oral contraceptive ethinyl estradiol/norgestimate has been approved by the U.S. Food and Drug Administration for the treatment of acne. Another positive effect of oral contraceptive use is improvement in abnormal uterine bleeding. Older women may also benefit from using oral contraceptives, because the pills can increase bone mass as women enter their menopausal years, when **osteoporosis** is a growing concern.

Oral contraceptives may be used on an emergency basis as a means of preventing pregnancy in women who have had unprotected intercourse. Plan B is available for this use, over the counter, in most drug stores.

Risks

Taking oral contraceptives with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Side effects

Serious side effects are rare in healthy women who do not smoke cigarettes. In women with certain health problems, however, oral contraceptives may cause problems such as **liver cancer**, non-cancerous liver tumors, blood clots, or stroke. Health-care professionals can help women weigh the benefits of being protected against unwanted pregnancy against the risks of possible health problems.

The most common minor side effects include emotional lability (swings), nausea; **vomiting**; abdominal cramping or bloating; breast **pain**, tenderness or swelling; swollen ankles or feet; tiredness; and acne. These usually go away as the body adjusts to the drug, and do not need medical attention unless they persist or interfere with normal activities.

Other side effects should be brought to the attention of the physician who prescribed the medicine. Check with the physician as soon as possible if any of the following side effects occur:

- missed periods, longer periods, or bleeding or spotting between periods
- headaches
- vaginal infection, itching, or irritation
- increased blood pressure

Women who have any of the following symptoms should get emergency help right away. These symptoms may be signs of blood clots:

- sudden changes in vision, speech, breathing, or coordination
- severe or sudden headache
- coughing up blood
- sudden, severe, or continuing pain in the abdomen or stomach
- pain in the chest, groin, or leg (especially in the calf)
- weakness, numbness, or pain in an arm or leg

Oral contraceptives may continue to affect the menstrual cycle for some time after a woman stops taking them. Women who miss periods for several months after stopping this medicine should check with their physicians.

Other rare side effects may occur. Anyone who has unusual symptoms while taking oral contraceptives should get in touch with her physician.

Interactions

Oral contraceptives interact with a number of other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes oral contraceptives should let the physician know all other medicines she is taking and should ask whether the possible interactions can interfere with drug therapy.

These drugs may make oral contraceptives less effective in preventing pregnancy. Anyone who takes these drugs should use an additional birth control method for the entire cycle in which the medicine is used:

- ampicillin
- penicillin V
- rifampin (Rifadin)
- tetracyclines
- griseofulvin (Gris-PEG, Fulvicin)
- corticosteroids
- barbiturates
- carbamazepine (Tegretol)
- phenytoin (Dilantin)
- primidone (Mysoline)
- ritonavir (Norvir)
- modafinil (Provigil)
- oxcarbazepine (Trileptal)
- St John's wort

In addition, taking these medicines with oral contraceptives may increase the risk of side effects or interfere with the medicine's effects:

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KEY TERMS

Cyst—An abnormal sac or enclosed cavity in the body, filled with liquid or partially solid material.

Endometriosis—A condition in which tissue, like that normally found in the lining of the uterus, is present outside the uterus. The condition often causes pain and bleeding.

Fallopian tube—One of a pair of slender tubes that extend from each ovary to the uterus. Eggs pass through the fallopian tubes to reach the uterus.

Fetus—A developing baby inside the womb.

Fibroid tumor—A noncancerous tumor formed of fibrous tissue.

Hormone—A substance that is produced in one part of the body, then travels through the bloodstream to another part of the body where it has its effect.

Jaundice—Yellowing of the eyes and skin due to the build up of a bile pigment (bilirubin) in the blood.

Migraine—A throbbing headache that usually affects only one side of the head. Nausea, vomiting, increased sensitivity to light, and other symptoms often accompany migraine.

Mucus—Thick fluid produced by the moist membranes that line many body cavities and structures.

Ovary—A reproductive organ in females that produces eggs and hormones.

Pelvic inflammatory disease—Inflammation of the female reproductive tract, caused by any of several microorganisms. Symptoms include severe abdominal pain, high fever, and vaginal discharge. Severe cases can result in sterility. Also called PID.

Uterus—A hollow organ in a female in which a fetus develops until birth.

- theophylline–effects of this medicine may increase, along with the chance of unwanted side effects and possible toxicity
- cyclosporine–effects of this medicine may increase, along with the chance of unwanted side effects

The list above does not include every drug that may interact with oral contraceptives. Be sure to check with a physician or pharmacist before combining oral contraceptives with any other prescription or nonprescription (over-the-counter) medicine.

As with any medication, the benefits and risks should be discussed with a physician.

Resources

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Oral herpes *see* **Cold sore**

Oral hygiene

Definition

Oral hygiene is the practice of keeping the mouth clean and healthy by brushing and flossing to prevent **tooth decay** and gum disease.

Purpose

The purpose of oral hygiene is to prevent the build-up of plaque, the sticky film of bacteria and food that forms on the teeth. Plaque adheres to the crevices and fissures of the teeth and generates acids that, when not removed on a regular basis, slowly eat away, or decay, the protective enamel surface of the teeth, causing holes (cavities) to form. Plaque also irritates gums and can lead to gum disease (**periodontal disease**) and tooth loss. Toothbrushing and flossing remove plaque from teeth, and antiseptic mouthwashes kill some of the bacteria that help form plaque. Fluoride—in toothpaste, drinking water, or dental treatments—also helps to protect teeth by binding with enamel to make it stronger. In addition to such daily oral care, regular visits to the dentist promote oral health. Preventative services that he or she can perform include fluoride treatments, sealant application, and scaling (scraping off the hardened plaque, called tartar). The dentist can also perform such diagnostic services as x-ray imaging and oral **cancer** screening as well as such treatment services as fillings, crowns, and bridges.

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Precautions

Maintaining oral hygiene should be a lifelong habit. An infant's gums and, later, teeth should be kept clean by wiping them with a moist cloth or a soft toothbrush. However, only a very small amount (the size of a pea) of toothpaste containing fluoride should be used since too much fluoride may be toxic to infants.

An adult who has partial or full dentures should also maintain good oral hygiene. Bridges and dentures must be kept clean to prevent gum disease. Dentures should be relined and adjusted by a dentist as necessary to maintain proper fit so the gums do not become red, swollen, and tender.

Brushing and flossing should be performed thoroughly but not too vigorously. Rough mechanical action may irritate or damage sensitive oral tissues. Sore or bleeding gums may be experienced for the first few days after flossing is begun. However, bleeding continuing beyond one week should be brought to the attention of a dentist. As a general rule, any sore or abnormal condition that does not disappear after 10 days should be examined by a dentist.

Description

Brushing

Brushing should be performed with a toothbrush and a fluoride toothpaste at least twice a day and preferably after every meal and snack. Effective brushing must clean each outer tooth surface, inner tooth surface, and the flat chewing surfaces of the back teeth. To clean the outer and inner surfaces, the toothbrush should be held at a 45-degree angle against the gums and moved back and forth in short strokes (no more than one toothwidth distance). To clean the inside surfaces of the front teeth, the toothbrush should be held vertically and the bristles at the tip (called the toe of the brush) moved gently up and down against each tooth. To clean the chewing surfaces of the large back teeth, the brush should be held flat and moved back and forth. Finally, the tongue should also be brushed using a back-to-front sweeping motion to remove food particles and bacteria that may sour the breath.

Toothbrushes wear out and should be replaced every three months. Consumers should look for toothbrushes with soft, nylon, rounded bristles in a size and shape that allows them to reach all tooth surfaces easily.

Holding a toothbrush may be difficult for people with limited use of their hands. The toothbrush handle may be modified by inserting it into a rubber ball for easier gripping.

Flossing

Flossing once a day helps prevent gum disease by removing food particles and plaque at and below the gumline as well as between teeth. To begin, most of an 18-in (45-cm) strand of floss is wrapped around the third finger of one hand. A 1-in (2.5-cm) section is then grasped firmly between the thumb and forefinger of each hand. The floss is eased between two teeth and worked gently up and down several times with a rubbing motion. At the gumline, the floss is curved first around one tooth and then the other with gentle sliding into the space between the tooth and gum. After each tooth contact is cleaned, a fresh section of floss is unwrapped from one hand as the used section of floss is wrapped around the third finger of the opposite hand. Flossing proceeds between all teeth and behind the last teeth. Flossing should also be performed around the abutment (support) teeth of a bridge and under any artificial teeth using a device called a floss threader.

Dental floss comes in many varieties (waxed, unwaxed, flavored, tape) and may be chosen on personal preference. For people who have difficulty handling floss, floss holders and other types of interdental (between the teeth) cleaning aids, such as brushes and picks, are available.

Risks

Negative consequences arise from improper or infrequent brushing and flossing. The five major oral health problems are plaque, tartar, gingivitis, periodontitis, and tooth decay.

Plaque is a soft, sticky, colorless bacterial film that grows on the hard, rough surfaces of teeth. These bacteria use the sugar and starch from food particles in the mouth to produce acid. Left to accumulate, this acid destroys the outer enamel of the tooth, irritates the gums to the point of bleeding, and produces foul breath. Plaque starts forming again on teeth four to 12 hours after brushing, so brushing a minimum of twice a day is necessary for adequate oral hygiene.

When plaque is not regularly removed by brushing and flossing, it hardens into a yellow or brown mineral deposit called tartar or calculus. This formation is crusty and provides additional rough surfaces for the growth of plaque. When tartar forms below the gumline, it can lead to periodontal (gum) disease.

Gingivitis is an early form of periodontal disease, characterized by inflammation of the gums with painless bleeding during brushing and flossing. This common condition is reversible with proper dental care but

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KEY TERMS

Calculus—A hardened yellow or brown mineral deposit from unremoved plaque; also called tartar.

Cavity—A hole or weak spot in the tooth surface caused by decay.

Gingivitis—Inflammation of the gums, seen as painless bleeding during brushing and flossing.

Interdental—Between the teeth.

Periodontal—Pertaining to the gums.

Periodontitis—A gum disease that destroys the structures supporting the teeth, including bone.

Plaque—A thin, sticky, colorless film of bacteria that forms on teeth.

Tartar—A hardened yellow or brown mineral deposit from unremoved plaque; also called calculus.

if left untreated, it will progress into a more serious periodontal disease, periodontitis.

Periodontitis is a gum disease that destroys the structures supporting the teeth, including bone. Without support, the teeth will loosen and may fall out or have to be removed. To diagnose periodontitis, a dentist looks for gums that are red, swollen, bleeding, and shrinking away from the teeth, leaving widening spaces between teeth and exposed root surfaces vulnerable to decay.

Tooth decay, also called dental caries or cavities, is a common dental problem that results when the acid produced by plaque bacteria destroys the outer surface of a tooth. A dentist will remove the decay and fill the cavity with an appropriate dental material to restore and protect the tooth; left untreated, the decay will expand, destroying the entire tooth and causing significant **pain**.

Normal results

With proper brushing and flossing, oral hygiene may be maintained and oral health problems may be avoided. Older adults may no longer assume that they will lose all of their teeth in their lifetime. Regular oral care preserves speech and eating functions, thus prolonging the quality of life.

ORGANIZATIONS

American Dental Association, 211 E. Chicago Ave., Chicago, IL, 60611-2678, (312)440-2500, http://www.ada.org.

American Dental Hygienists' Association, 444 North Michigan Avenue, Suite 3400, Chicago, IL, 60611, (312)440-8900, mail@adha.net, http://www.adha.org/.

Bethany Thivierge

Oral hypoglycemics *see* **Antidiabetic drugs**

Orbital and periorbital cellulitis

Definition

Periorbital **cellulitis** is an inflammation and infection of the eyelid and the skin surrounding the eye. Orbital cellulitis affects the eye socket (orbit) as well as the skin closest to it.

Description

Inside the eyelid is a septum. The septum divides the eyelid into outer and inner areas. This orbital septum helps prevent the spread of infection to the eye socket. Periorbital and orbital cellulitis are more common in children than in adults. Periorbital cellulitis, which accounts for 85–90% of all ocular cellulitis, usually occurs in children under the age of five. Responsible for the remaining 10–15% of these infections, orbital cellulitis is most common in children over the age of five.

These conditions usually begin with swelling or inflammation of one eye. Infection spreads rapidly and can cause serious problems that affect the eye or the whole body.

Causes and symptoms

Orbital and periorbital cellulitis are usually caused by infection of the sinuses near the nose. Insect **bites** or injuries that break the skin cause about one-third of these cellulitis infections. Orbital and periorbital cellulitis may also occur in people with a history of dental infections.

The blood of about 33 of every 100 patients with orbital or periorbital cellulitis contains bacteria known to cause:

- acute ear infections
- inflammation of the epiglottis (the cartilage flap that covers the opening of the windpipe during swallowing)
- meningitis (inflammation of the membranes that enclose and protect the brain)

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- pneumonia
- sinus infection

People with periorbital cellulitis will have swollen, painful lids and redness, but probably no **fever**. About one child in five has a runny nose, and 20% have **conjunctivitis**. Conjunctivitis, also called pinkeye, is an inflammation of the mucous membrane that lines the eyelid and covers the front white part of the eye. It can be caused by allergy, irritation, or bacterial or viral infection.

As well as a swollen lid, other symptoms of orbital cellulitis include:

- bulging or displacement of the eyeball (proptosis)
- chemosis (swelling of the mucous membrane of the eyeball and eyelid as a result of infection, injury, or systemic disorders like anemia or kidney disease)
- diminished ability to see clearly
- eye pain
- fever
- paralysis of nerves that control eye movements (ophthalmoplegia)

Diagnosis

An eye doctor may use special instruments to open a swollen lid in order to:

- examine the position of the eyeball
- evaluate eye movement
- test the patient's vision.

If the source of infection is not apparent, the position of the eyeball may suggest its location. **Computed tomography scans** (CT scans) can indicate which sinuses and bones are involved or whether abscesses have developed.

Treatment

A child who has orbital or periorbital cellulitis should be hospitalized without delay. **Antibiotics** are used to stop the spread of infection and prevent damage to the optic nerve, which transmits visual images to the brain.

Symptoms of optic-nerve damage or infection that has spread to sinus cavities close to the brain include:

- very limited ability to move the eye
- impaired response of the pupil to light and other stimulus
- loss of visual acuity
- papilledema (swelling of the optic disk—where the optic nerve enters the eye)

One or both eyes may be affected, and eye sockets or sinus cavities may have to be drained. These surgical procedures should be performed by an ophthalmologist or otolaryngologist.

Prognosis

If diagnosed promptly and treated with antibiotics, most orbital and periorbital cellulitis can be cured. These conditions are serious and need prompt treatment.

Infections that spread beyond the eye socket can cause:

- abscesses in the brain or in the protective membranes that enclose it
- bacterial meningitis
- blood clots
- vision loss

ORGANIZATIONS

American Academy of Ophthalmology (AAO), P. O. Box 7424, San Francisco, CA, 94120-7424, (415)561-8500, (415)561-8500, http://www.aao.org.

American Optometric Association, 243 North Lindbergh Blvd., St. Louis, MO, 63141, (314)991-4100, (314)991-4101, (800)365-2219, http://www.aoa.org/.

Maureen Haggerty

Orchiectomy *see* **Testicular surgery**

Orchiopexy *see* **Testicular surgery**

Orchitis

Definition

Orchitis is an inflammation of the testis, accompanied by swelling, **pain**, **fever**, and a sensation of heaviness in the affected area.

Description

Viral **mumps** is the most common cause of orchitis. Bacterial infections associated with the disorder are **tuberculosis**, **syphilis**, **gonorrhea**, and chlamydia. A mechanical injury to the groin area may also cause orchitis. Fifteen to twenty-five % of males past the age of **puberty** with mumps develop orchitis. Epididymo-orchitis (inflammation of both testes and part of the spermatic duct) is the most common bacterial type of orchitis. This form of the

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condition occurs most often in sexually active males 15 years and older, and in men over 45 with enlarged prostates.

Causes and symptoms

The people most susceptible to orchitis are those with inadequate mumps inoculation and, in the case of sexually transmitted orchitis, those who practice unsafe sex or have a history of sexually transmitted disease. Inadequate protection of the groin area during contact sports or other potentially harmful physical activities may result in injury leading to orchitis. Symptoms of orchitis include swelling of one or both testicles, tenderness in the groin area, fever, **headache**, and **nausea**. Symptoms may also include bloody discharge from the penis, and pain during urination, intercourse, or ejaculation.

Diagnosis

In most cases, Orchitis can be diagnosed by an urologist, general practitioner, or emergency room physician. Diagnosis is usually based on the results of a **physical examination** and patient history. Other testing may include a **urinalysis** and **urine culture**, screening for chlamydia and gonorrhea, ultrasound imaging, or blood tests.

Treatment

Elevation and support of the scrotum, and the application of cold packs to the groin area give some relief from the pain of orchitis. Medication for pain such as codeine and meperidine may be given. Only the symptoms of viral mumps orchitis are treated. **Antibiotics** are used to alleviate orchitis that is bacterial in origin. Sexually transmitted orchitis (especially when resultant from chlamydia or gonorrhea) is often treated with the antibiotic Ceftriaxone in conjunction with azithromycin or doxycycline.

Alternative treatment

For relief from swelling, the drinking of dandelion tea is recommended in **traditional Chinese medicine** (TCM). Another traditional Chinese treatment for swelling is the application of a poultice of ground dandelion and aloe to the affected area. Homeopathic remedies to reduce swelling include apis mel, belladonna, and pulsatilla. Consult a homeopathic physician before taking or administering these remedies to ensure safe and correct dosage.

KEY TERMS

Atrophy—A wasting away or withering.

Epididymo-orchitis—Inflammation of both the testes and a part of the spermatic duct system.

Unilateral—Affecting only one side.

Prognosis

Orchitis is usually unilateral and lasts between one and two weeks. Atrophy of the scrotum occurs in 60% of orchitis cases. However, hormonal function is not affected and resulting sterility is rare from mumps.

Prevention

Keeping mumps inoculations current and diligently practicing safe sex are the best ways to prevent orchitis from occurring. For males involved in contact sports or other potentially harmful physical activities, the wearing of a protective cup over the genitals will help guard against mechanical injuries that could lead to orchitis.

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Mary Jane Tenerelli, MS

Organ donation

Definition

Organ donation is the giving of a healthy body part from either a living or dead individual to another person.

Purpose

The purpose of organ donation is to improve and prolong the life of an ill or impaired individual.

Demographics

In the United States there is a mismatch between the number of people needing donated organs and the number of donors. At the end of June 2010, according

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to the United Network for Organ Sharing (UNOS), about 108,000 people were awaiting donor organs. Of those, about 85,000 needed a kidney donation and about 16,000 needed a liver donation. This compares to 1,892 deceased donors and 1,548 living donors who provided organs for donation in the first three months of 2010. Deceased donors often provided more than one organ for donation and accounted for 5,162 transplantations during that three month period.

There is a special need for donors from minority ethnic groups. For example, about 12% of African Americans become organ donors but about 23% of individuals on the waiting list for a donated kidney are African American because of higher rates of **kidney disease** in the African American community. Although it is possible to make a match between people of different ethnic or racial groups, the likelihood of an appropriate genetic match (to prevent organ rejection) is much higher within ethnic groups.

Internationally, the rate of organ donation varies with religious and cultural norms and the level of sophistication of medical care. Many countries, such as the United States, are opt-in donation countries. This means that an individual must positively state his or her desire to donate body parts after **death**. A few countries have an opt-out donor system where individuals must state before death that they *do not* want to donate organs when they die. In all cases, individuals can specify which organs they wish to donate.

Description

Organ donation involves the matching of a person willing to give a healthy body part to an ill person who needs that part. There are two types of organ donation: living donation and donation after death (cadaver donation). In the United States and in many other countries, the costs of the donation to both donor and recipient are paid by health insurance. In the United States, it is illegal to buy an organ or receive money for a donated organ. Both citizens and non-citizens can donate and receive body parts.

All organ donations in the United States are regulated by UNOS. A person approved for an organ donation is registered with UNOS and placed on their waiting list. UNOS has organ transplant specialists who run a national computer network that connects all the transplant centers and organ-donation organizations. Patients are grouped in terms of priority based on how long they can live without a transplant. The list is national and independent of the medical transplant center where the surgery will take place.

When a donor organ becomes available, information about the donor organ is entered into the UNOS computer and compared to information about patients on the waiting list. The computer program produces a list of patients ranked according to blood type and how urgently they need the organ. Because some organs (e.g., the heart) must be transplanted as quickly as possible, a list of local patients may be checked first for a good match. After that, a regional list and then a national list are checked. The patient's transplant team and transplant specialists at UNOS make the final decision as to whether a donor is suitable for a specific recipient.

Living donation

Donation of a body part by a living person is the less common type of organ donation. Usually, but not always, the person who donates is biologically related to the recipient (e.g., parent, sibling, cousin). Related individuals are more likely to have the same blood type and similar immune system markers. This helps prevent organ rejection by the recipient's body. Sometimes a relative is willing to donate an organ, but is not an adequate match for the recipient. In this case, UNOS may be able to arrange a paired organ exchange with another donor-recipient pair. Living donor transplants are slightly more successful (rejected less frequently) than after-death donations.

To be a living donor, the individual cannot have certain diseases such as **cancer**, HIV infection, hepatitis, or major organ disease. Minors must have parental permission to donate, and all donors undergo extensive medical testing before the donation occurs. The type of body parts that can be donated by a living person include.

- kidney (most common)
- liver (second most common)
- lung
- intestine
- pancreas
- bone marrow

Donation after death

Individuals who want to donate body parts after death should indicate this desire on their driver's license and in a living will or medical directive, as well as making their wishes known to relatives. Donation after death does not disfigure the body and a regular funeral can be held. There is no age limit to donation after death; the suitability of body parts is determined at the time of death. Individuals can specify in advance which organs they want or do not want to donate. Agreeing to donate after death does not

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KEY TERMS

Cornea—The clear tissue covering the eye.

Pancreas—A gland near the liver and stomach that secretes digestive fluid into the intestine and the hormones insulin and glucagon into the bloodstream.

compromise the quality of medical care the individual receives before death.

Organs and tissues that can be transplanted after death include:

- kidneys
- liver
- lungs
- heart
- pancreas
- intestines
- cornea
- skin
- bone
- cartilage
- tendons
- ligaments
- veins
- heart valves
- middle ear

Benefits

The benefit to the recipient is an extended and improved life. Many living donors and the families of deceased donors find satisfaction in knowing that their donation has given the gift of life to another person.

Precautions

Living donors undergo extensive medical testing in order to assure that they are healthy enough to make a donation and that the donated material is compatible with the recipient, as organ and tissue rejection is the most common cause for transplant failure.

Preparation

Living donors receive counseling and must sign a statement of informed consent. Minors must have parental consent to be living donors. Living donors receive a standard pre-operative work up as well as extensive cross matching with the recipient to assure tissue compatibility.

Individuals who wish to donate after death should make this known in advance in writing as well as informing their families and their doctors.

Aftercare

The length of the hospital stay and specific aftercare for living donors depends on the organ donated.

Risks

For living donors, the risks are the same as with any operation, mainly infection at the surgical site, uncontrolled bleeding, and adverse reaction to anesthesia. People can live healthy, active lives after donating a kidney, lung, or part of a liver or pancreas. There is always the risk, however, that damage by disease or injury to the remaining organ may result in medical problems.

Research and general acceptance

Ethical organ donation is accepted by the medical community as a positive, life-saving procedure. Most religions support organ donation, but when in doubt, individuals should consult their religious leaders.

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ORGANIZATIONS

Donate Life America, 700 N. Fourth Street, Richmond, VA, 23219, (804) 782-4920, (804) 782-4643, http://www.donatelife.net.

National Living Donor Assistance Center, 2461 S. Clark Street, Suite 640, Arlington, VA, 22202, (703) 414-1600, (703) 414-7874, NLDCA@livingdonorassistance.org, http://www.livingdonorassistance.org.

United Network for Organ sharing, P.O. Box 2484, Richmond, VA, 23218, (804) 782-4800, (888)894-6361, (804) 782-4800, http://www.unos.org.

Tish Davidson, AM

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Organic food

Definition

Organic foods are not specific foods, but are any foods that are grown and handled after harvesting in a particular way. In the United States, organic foods are crops that are raised without using synthetic pesticides, synthetic fertilizers, or sewage sludge fertilizer, and they have not been altered by genetic engineering. Organic animal products come from animals that have been fed 100% organic feed and raised without the use of growth hormones or **antibiotics** in an environment where they have access to the outdoors. Standards for organic foods vary from country to country. The requirements in Canada and Western Europe are similar to those in the United States. Many developing countries have no standards for certifying food as "organic."

Purpose

The organic food movement has the following goals:

- improve human health by decreasing the level of chemical toxins in food
- decrease the level of agricultural chemicals in the environment, especially in groundwater
- promote sustainable agriculture
- promote biodiversity
- promote genetic diversity among plants and animals by rejecting genetically modified organisms (GMOs)
- provide fresh, healthy, safe food at competitive prices

Description

Organic farming is the oldest method of farming. Before the 1940s, what is today called organic farming was the standard method of raising crops and animals. World War II accelerated research into new chemicals that could be used either in fighting the war or as replacements for resources that were in short supply because of their usefulness to the military. After the war ended, many of the new technological discoveries were applied to civilian uses and synthetic fertilizers, new insecticides, and herbicides became available. Fertilizers increased the yield per acre, and pesticides encouraged the development of single-crop mega-farms, resulting in the consolidation of agricultural land and the decline of the family farm.

Organic farming, although only a tiny part of American agriculture, originally offered a niche market for smaller, family-style farms. In the early 1980s this method of food production began to gain popularity, especially in California, Oregon, and Washington. The first commercial organic crops were vegetables that were usually sold locally at farmers' markets and health food stores.

By the late 1980s interest in organic food had reached a level of public awareness high enough that the United States Congress took action and passed the Organic Food Production Act of 1990. This act established the National Organic Standards Board (NOSB) under the United States Department of Agriculture (USDA). NOSB has developed regulations and enforcement procedures for the growing and handling of all agricultural products that are labeled "organic." These regulations went into effect on October 21, 2002.

Since the 1990s, the market for organic food has expanded from primarily fruits and vegetables to eggs, dairy products, meat, poultry, and commercially processed frozen and canned foods. In 2000, for the first time, more organic food was purchased in mainstream supermarkets than in specialty food outlets. By 2005, every state had some farmland that was certified organic, and some supermarket chains had begun selling their own brand-name organic foods. The demand for organic food was expected to continue to grow rapidly through at least 2010.

Organic certification is voluntary and applies to anyone who sells more than $5,000 worth of organic produce annually. (This exempts most small farmers who sell organic produce from their own farm stands). If a product carries the USDA Organic Seal indicating that it is "certified organic" it must meet the following conditions:

- The product must be raised or produced under an Organic Systems Plan that demonstrates and documents that the food meets the standards for growing, harvesting, transporting, processing, and selling an organic product.
- The producer and/or processor are subject to audits and evaluations by agents certified to enforce organic standards.
- The grower must have distinct boundaries between organic crops and non-organic crops to prevent accidental contamination with forbidden substances through wind drift or water runoff.
- No forbidden substances can have been applied to the land organic food is raised on for three years prior to organic certification.
- Seed should be organic, when available, and never genetically altered through bioengineering.
- Good soil, crop, and animal management practices must be followed to prevent contamination of groundwater, contamination of the product by living

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pathogens, heavy metals, or forbidden chemicals, and to reduce soil erosion and environmental pollution.

To meet these requirements, organic farmers use natural fertilizers such as composted manure to add nutrients to the soil. They control pests by crop rotation and interplanting. Interplanting is growing several different species of plants in an alternating pattern in the same field to slow the spread of disease. Pest control is also achieved by using natural insect predators, traps, and physical barriers. If these methods do not control pests, organic farmers may apply certain non-synthetic pesticides made from substances that occur naturally in plants. Weed control is achieved by mulching, hand or mechanical weeding, the use of cover crops, and selective burning.

Animals products that are USDA certified organic must come from animals that are fed only organic feed, are not given growth hormones, antibiotics, or other drugs for the purpose of preventing disease, and have access to the outdoors. This last requirement is rather vague, as regulations set neither a minimum amount of time the animal must spend outdoors nor any minimums concerning the amount of outdoor space available per animal.

Selecting organic food

The USDA allows three label statements to help consumers determine if a food is organic.

- Labels stating "100% organic" indicate that all of the ingredients in the product are certified organic. These items have the USDA Organic Seal on the label.
- Labels stating "organic" indicate that at least 95% of the ingredients are certified organic. These items also carry the USDA Organic Seal on the label.
- Labels stating "made with organic ingredients" indicate that at least 70% of the ingredients are certified organic. These items are not permitted to have the USDA Organic Seal on the label.
- Items that contain fewer than 70% organic ingredients are not permitted to use either the word "organic" or the USDA Organic Seal on the label.

Consumers may be bewildered by other words on food labels such as "natural" or "grass-fed" that may be confused with organic. Natural and organic are not interchangeable. "Natural" foods are minimally processed foods but, they are not necessarily grown or raised under the strict conditions of organic foods. "Grass-fed" indicates that the livestock were fed natural forage ("grass"), but not necessarily in open pasture or for their entire lives.

Debate continues about the exact requirements to label animal products "cage-free," "free-range," or "open pasture." Cage-free simply means the animals were not kept caged, but does not necessarily mean that they were raised outdoors or allowed to roam freely. There is no certification process for the designation "cage-free." Animals can spend as little as five minutes per day outdoors and still be considered "free-range." Animal rights organizations are working to clarify these designations and improve the conditions under which all animals, are raised.

Organic food and health

Certified organic food requires more labor to produce, which generally makes it more expensive than non-certified food. Some consumers buy organic food primarily because the way it is raised benefits the environment. Others believe absolutely in the health benefits of organic food. A larger group of consumers are uncertain if organic food offers enough health benefits to justify the additional cost.

Discussions of the health benefits of organic food can become quite heated and emotional. Advocates of buying organic foods firmly believe that they are preserving their health by preventing their bodies from becoming receptacles for poisonous chemicals that can cause **cancer**, **asthma**, and other chronic diseases. Non-organic food buyers take the position that the level pesticide and fertilizer residue in non-organic food is small and harmless. Neither side is likely to change the other's view. However, below are some conclusions from studies done comparing organic and non-organic foods.

- The food supply in the United States, whether organic or non-organic, is extremely safe.
- Fresh organic and non-organic produce are equally likely to become contaminated with pathogens such as *E. coli* that cause health concerns.
- Many, but not all, chemical contaminants can be removed from non-organic food by peeling or thorough washing in cool running water.
- Organic foods are not 100% pesticide- and chemical-free. However, their chemical load appears to be lower than that of non-organic foods.
- The nutrient value of identical organic and non-organic foods is the same.
- The long-term effect on humans of trace amounts of hormones, antibiotics, and drugs found in milk, meat, and other non-organic animal products is unclear.
- The long-term effect of genetically modified foods on both humans and the environment cannot yet be known.

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Precautions

Individuals should be informed about food labeling requirements and read food labels carefully so that they can make informed decisions about their purchases.

Interactions

Organic food does not interact with drugs or other foods in a way that is different from non-organic foods.

Complications

No complications are expected from eating organic food.

Parental concerns

Chemicals found in foods may have a greater effect on the growth and development of younger children than older ones. Young children are rapidly growing while still developing their nervous system, immune system, and other organs. Chemicals may have a greater effect on these developing tissues than on adult tissues.

Resources

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ORGANIZATIONS

National Organic Program, USDA-AMS-TM-NOP, Room 4008-S. Bldg, Ag Stop 0268, 1400 Independence Avenue, S.W., Room 1180, Washington, DC, 20250, (202)720-3252, http://www.ams.usda.gov/nop.

Organic Trade Association, P.O. Box 547, Greenfield, MA, 01302, (413)774-7511, (413) 774-6432, http://www.ota.com.

Helen M. Davidson

Organophosphates *see* **Insecticide poisoning**

Oriental sore *see* **Leishmaniasis**

Ornithosis *see* **Parrot fever**

Oroya fever *see* **Bartonellosis**

Orthodontics

Definition

Orthodontics is a specialized branch of dentistry that diagnoses, prevents, and treats dental and facial irregularities called malocclusions. Orthodontics includes dentofacial orthopedics, which is used to correct problems involving the growth of the jaw.

Purpose

Humans have attempted to straighten teeth for thousands of years before orthodontics became a dental specialty in 1900. Although orthodontic treatment often improves facial appearance and occasionally is performed for solely cosmetic reasons, it is used primarily to correct health problems and to ensure the proper functioning of the mouth. Properly aligned teeth, which close together correctly, simplify **oral hygiene** and enable children to chew their food efficiently. Orthodontic treatment provides the following:

- straightens teeth that are rotated, tilted, or otherwise improperly aligned
- corrects crowded or unevenly spaced teeth
- corrects bite problems
- aligns the upper and lower jaws

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An orthodontist attaches braces to the teeth of a teenage patient. *(Antonia Reeve/Photo Researchers, Inc.)*

Malocclusions

Few children have perfectly symmetrical teeth and a perfect bite. In an ideal bite, the following are characteristics:

- All of the teeth fit easily without crowding or spacing.
- The teeth are not rotated, twisted, or leaning forward or backward.
- The teeth of the upper jaw slightly overlap those of the lower jaw.
- The points of the molars fit into the grooves of the opposite molars.

Types of malocclusions include the following:

- crowded, crooked, or misaligned teeth
- extra or missing teeth
- bite problems
- jaws that are out of alignment

Causes of malocclusion

Most malocclusions are caused by hereditary factors that affect the contours of the face and the size of the teeth and jaw. The most common cause of **malocclusion** is a disproportion in size between the jaw and teeth or between the upper and lower jaws. A child who inherits a mother's small jaw and a father's large teeth may have teeth that are too big for the jaw, causing overcrowding. Specific inherited malocclusions include:

- overcrowded teeth
- too much space between teeth
- extra or missing teeth
- various irregularities in the teeth, jaw, or face

Malocclusions can be acquired through the following:

- accidents such as a jaw fracture that causes misalignment
- prolonged sucking on thumbs, fingers, or pacifiers, particularly after the age of four
- fingernail or lip biting
- a lost tooth that causes nearby teeth to move into the empty space, throwing them out of alignment
- airways that are obstructed by tonsils or adenoids
- dental disease
- tumors in the mouth or jaw
- improperly fitted fillings, crowns, or braces
- premature loss of baby teeth or permanent teeth
- late loss of baby teeth

Symptoms of malocclusion

Occasionally children have mild, temporary symptoms of malocclusion resulting from a growth spurt. However, symptoms of malocclusion usually develop gradually beginning at the age of six. Symptoms may include the following:

- crowded or misaligned teeth
- abnormal spacing between teeth, most often occurring because teeth are small or missing or the dental arch (the arch-shaped jawbone that supports the teeth) is very wide
- incisors (front teeth) that do not meet
- an open bite, occurring when the upper and lower incisors do not touch each other during biting, thereby putting all of the chewing pressure on the back teeth and resulting in inefficient chewing and excessive tooth wear
- an overbite or overjet, in which the upper incisors protrude, often caused by a lower jaw that is significantly shorter than the upper jaw

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- a deep or closed bite, an excessive overbite in which the lower incisors bite too closely to or into the gum tissue or palate behind the upper teeth
- a crossbite, in which a protruding lower jaw that is longer than the upper jaw causes the upper front or back teeth to bite inside the lower teeth

Early intervention

Although orthodontic treatment can be performed at any age, children are easier, faster, and less expensive to treat than adults. Most often orthodontic treatment is used on older children and adolescents whose teeth are still developing. However some types of problems are corrected more readily before all of the permanent teeth have erupted and facial growth is complete. If a child's permanent lower incisors erupt behind each other, braces may be required at a young age. Crossbites are usually treated early because they can interfere with biting and chewing. Early treatment also is used when thumb- or finger-sucking has affected teeth positioning.

Early orthodontic intervention can provide the following:

- straighten crooked teeth
- preserve or create space for incoming permanent teeth
- guide erupting permanent teeth into the correct positions
- prevent impacted permanent teeth, those that remain partially covered by gum tissue, or partially or completely buried in the jawbone
- correct harmful habits such as thumb- or finger-sucking
- lower the risk of accidents to protruding upper incisors

Other advantages of early orthodontic treatment include the following:

- correction of bite problems by guiding jaw growth and controlling the width of the upper and lower dental arches
- reduction or elimination of abnormal swallowing or speech problems
- shortening and simplification of later orthodontic treatment
- prevention of later tooth extractions
- improvements in appearance and self-esteem

Untreated malocclusions

Minor misalignment or crowding may not require treatment. However untreated malocclusions can cause the following:

- teeth that are partially impacted or fail to erupt
- lips, tongue, or cheeks that contact biting surfaces due to poor tooth alignment
- inefficient or uncomfortable biting, chewing, and digestion
- speech impairments
- teeth that are hard to clean, leading to cavities and gum disease
- abnormal wear of tooth surfaces
- chipped teeth
- loosening or fracturing of a misaligned tooth that is overstrained
- injury to a protruding upper incisor
- thinning and receding of bone and gums covering the roots of very crowded teeth
- accelerated gum disease and bone loss
- temporomandibular joint (TMJ) misalignments at the point where the lower jaw attaches to the skull
- stress and trauma to the teeth, gum tissue, ligaments, muscles, jawbone, and jaw joints
- premature loss of teeth
- adverse effects on facial development and appearance
- the need for surgery

Untreated malocclusions often worsen with time. TMJ problems can cause chronic headaches or **pain** in the face and neck. A deep overbite can cause significant pain and bone damage and may contribute to excessive wear on the incisors.

Orthodontics in young children

Alignment problems usually become apparent as the permanent teeth begin erupting at about age six. Dentists monitor the development of a child's permanent teeth and refer the child to an orthodontist if a problem is suspected. The American Association of Orthodontists recommends that all children be screened by an orthodontist by the age of seven.

Once a child's lower baby incisors have erupted, an orthodontist can measure the child's jaw and tooth size, project their growth rate, and possibly predict whether the child will have orthodontic problems with their permanent teeth. The orthodontist may be able to perform preventative or interceptive orthodontics that can reduce or eliminate the need for braces later.

In a procedure called selective serial extraction, the orthodontist removes one or more baby or permanent teeth. Doing so creates space for the permanent teeth, especially unerupted canine teeth that might become impacted or erupt in the wrong position. After the removal or loss of a tooth, braces or another

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orthodontic appliance may be used to prevent the remaining teeth from moving into the empty space. If a baby molar that acts as a space-holder for later permanent teeth is lost, a fixed orthodontic wire is inserted between the teeth to keep the space available.

Preparation

The orthodontist compiles pretreatment records that are used for diagnosis, determining the course of treatment, and measuring the progress of treatment. These records may include:

- a complete medical and dental history
- a clinical examination
- x-rays revealing the positions of erupted and unerupted teeth, development of unerupted teeth, any missing or impacted teeth, shortened or damaged tooth roots, and the amount of bone supporting the teeth
- a facial-profile x-ray or cephalometric film revealing the sizes, positions, and relationships of the teeth and jaw, as well as facial form, growth pattern, and the inclinations of tipped or tilted incisors
- plastic impressions of the bite and plaster models made from the impressions
- photographs and other measurements of the teeth and face

Based on the diagnosis the orthodontist develops a custom treatment plan and designs the appropriate corrective appliances that will gradually straighten or move the teeth. Severe overcrowding may necessitate the extraction of permanent teeth, usually the premolars, to create space prior to using braces to move teeth.

Braces and other orthodontic appliances

By applying constant gentle pressure in a specific direction, braces can slowly move teeth through the supporting bone to a new position. Springs and wires put pressure on teeth in order to straighten them. The pressure causes bone in the jaw to dissolve in front of the moving tooth as new bone grows behind the tooth. Braces and other appliances may be removable or fixed and are made of clear or colored metal, ceramic, or plastic. Removable appliances are often plastic plates that fit into the roof of the mouth and clip onto a tooth.

Fixed braces exert more pressure than removable braces and can achieve more complex movements. They consist of wires and springs that are held in place by small brackets glued to the outside surfaces of the incisors and sometimes the premolars. Lingual braces have brackets bonded to the back of the teeth. Bands encircling the molars also can be used for attachments. The wires, springs, and other devices attached to the brackets or bands put pressure on the teeth, gradually shifting them into new positions. The nickel-titanium wires are very light, and some are heat-activated. These are very flexible at room temperature and actively begin to move the teeth as they warm to body temperature. Elastic bands sometimes connect the upper and lower teeth to create tension.

Appliances used to direct jaw growth and development in growing children and adolescents include:

- Headgear attached to braces and usually worn for 10 to 12 hours at night puts pressure on the upper teeth and jaw and influences the direction and speed of upper jaw growth and upper teeth eruption.
- Herbst appliances attached to the upper and lower molars correct a severe overbite by holding the lower jaw forward, influencing jaw growth and tooth position; they force the jaw muscles to work in ways that promote forward development of the lower jaw; treatment with Herbst appliances must begin several years before the jaw stops growing and they must remain in place throughout the treatment.
- Palatal or upper jaw expansion devices can widen a narrow upper jaw and correct a crossbite within months.
- Removable bionators hold the lower jaw forward and guide tooth eruption while helping the upper and lower jaws to grow proportionately.

Headgear and Herbst appliances can significantly reduce protrusion of the four top incisors and enable the growing lower jaw to catch up with the upper jaw, eliminating swallowing problems.

Duration of treatment

Orthodontic treatment usually continues until the desired outcome is reached. Active orthodontic treatment lasts an average of two years, with a range of one to three years. Some children respond to treatment faster than others and interceptive or early treatments may continue for only a few months. Appliances are adjusted periodically during treatment. Factors affecting the duration of treatment include:

- the growth of the mouth and face
- the severity of the problem
- the health of the teeth, gums, and supporting bones
- the child's level of cooperation

Precautions

Orthodontic appliances trap food, bacteria, and plaque, leading to **tooth decay**. Extra brushing with specially shaped and/or electric toothbrush and

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KEY TERMS

Active treatment stage—The period during which orthodontic appliances or braces are used.

Bicuspid—Premolar; the two-cupped tooth between the first molar and the cuspid.

Canines—The two sharp teeth located next to the front incisor teeth in mammals that are used to grip and tear. Also called cuspids.

Crossbite—The condition in which the upper teeth bite inside the lower teeth.

Crown—The natural part of the tooth covered by enamel. A restorative crown is a protective shell that fits over a tooth.

Deep bite—A closed bite; a deep or excessive overbite in which the lower incisors bite too closely to or into the gum tissue or palate behind the upper teeth.

Eruption—The process of a tooth breaking through the gum tissue to grow into place in the mouth.

Impacted tooth—Any tooth that is prevented from reaching its normal position in the mouth by another tooth, bone, or soft tissue.

Incisors—The eight front teeth.

Interceptive orthodontics—Preventative orthodontics; early, simpler orthodontic treatment.

Malocclusion—The misalignment of opposing teeth in the upper and lower jaws.

Molars—The teeth behind the primary canines or the permanent premolars, with large crowns and broad chewing surfaces for grinding food.

Open bite—A malocclusion in which some teeth do not meet the opposing teeth.

Orthognathic surgery—Surgery to alter the relationships of the teeth and/or supporting bones, usually in conjunction with orthodontic treatment.

Overbite—Protrusion of the upper teeth over the lower teeth.

Plaque—A sticky film of saliva, food particles, and bacteria that attaches to the tooth surface and causes decay.

Retainer—An orthodontic appliance that is worn to stabilize teeth in a new position.

Retention treatment stage—The passive treatment period following orthodontic treatment, when retainers may be used to stabilize the teeth.

Temporomandibular joint (TMJ)—One of a pair of joints that attaches the mandible of the jaw to the temporal bone of the skull. It is a combination of a hinge and a gliding joint.

fluoride toothpaste is required around the areas where the braces or appliances attach to the teeth. Both the tops and bottoms of braces must be brushed and irrigated with a water jet directed from the top down and the bottom up. If possible, teeth should be flossed. A fluoride mouthwash may be recommended. Removable appliances should be brushed every time the teeth are brushed. Regular dental check-ups and cleanings must be continued.

Children with braces should eat raw fruits and vegetables and avoid soft, processed, and refined foods that attract bacteria, as well as hard or sticky foods, including gum, caramels, peanuts, ice chips, and popcorn. Chewing on hard items, such as fingernails or pencils, can damage braces. Children with braces should wear a protective mouth guard while playing contact sports.

Aftercare

After braces are removed the teeth must be stabilized in their new positions. This phase of treatment commonly takes two to three years. Occasionally it continues indefinitely. Types of retainers used for stabilization include:

- positioners, rubber-like mouthpieces that are worn at night and bitten into for a few hours during the day
- removable retainers with a plastic plate that snaps onto the roof of the mouth and wires on the outside of the teeth
- removable, clear, plastic retainers that completely cover the sides and biting surfaces of the teeth
- semi-rigid wires that are bonded onto the inside of the incisors.

Risks

Braces may cause discomfort when they are first installed or adjusted during treatment. For the first three to five days teeth may hurt during biting. Lips, cheeks, and tongue may be irritated for one to two weeks before they toughen and adapt to the braces. Some appliances may interfere with speech for the first day or two. Damaged appliances can extend the length of treatment and negatively affect the outcome.

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Food particles and plaque deposits around orthodontic appliances can cause demineralization of the tooth enamel, leading to cavities and permanent whitish **scars** on the teeth.

Normal results

Orthodontic treatment is usually very successful at correcting malocclusions. Even a significant size discrepancy between the upper and lower jaws often can be corrected. Sometimes, particularly in adults, corrective orthognathic surgery is required to shorten or lengthen a jawbone. The height of the lower face also can be shortened or lengthened. Sometimes surgery reduces the duration of the orthodontic treatment.

Maturational change can cause teeth to gradually shift with age—at least until one's early 20s—causing crowding. Nighttime retainers can prevent maturational movement.

Parental concerns

In general the earlier an orthodontic problem is detected, the easier and less expensive it is to correct. Parents can compare their child's dental development with standard charts and pictures.

Children with problems involving the width or length of the jaws should be evaluated no later than age 10 for girls and age 12 for boys. For children receiving orthodontic care, the orthodontist should be notified immediately if an appliance breaks. Indications that children may need an early orthodontic examination include:

- early or late loss of baby teeth
- crowded, misplaced, or blocked-out teeth
- upper and lower teeth that do not meet normally
- thumb- or finger-sucking
- biting of the cheek or roof of the mouth
- difficulty biting or chewing
- breathing through the mouth
- jaws that shift or make noise
- jaws and teeth that are out of proportion to the rest of the face

Resources

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ORGANIZATIONS

American Academy of Pediatric Dentistry, 211 East Chicago Avenue, Suite 1700, Chicago, IL, 60611-2637, (312) 337-2169, (312) 337-6329, www.aapd.org.

American Association of Orthodontists, 401 N. Lindbergh Boulevard, St. Louis, MO, 63141-7816, www.braces.org.

American Dental Association, 211 East Chicago Avenue, Chicago, IL, 60611-2678, (312) 440-2500, http://www.ada.org.

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Orthopedic surgery

Definition

Orthopedic (sometimes spelled orthopaedic) surgery is an operation performed by a medical specialist such as an orthopedist or orthopedic surgeon, who is trained to assess and treat problems that develop in the bones, joints, and ligaments of the human body.

Purpose

Orthopedic surgery addresses and attempts to correct problems that arise in the skeleton and its attachments, the ligaments and tendons. It may also include some problems of the nervous system, such as those that arise from injury of the spine. These problems can occur at birth, through injury, or as the result of **aging**. They may be acute, as in an accident or injury, or chronic, as in many problems related to aging.

Orthopedics comes from two Greek words, *ortho*, meaning straight, and *pais*, meaning child. Originally, orthopedic surgeons treated skeletal deformities in children, using braces to straighten the child's bones. With the development of anesthesia and an understanding of the importance of aseptic technique in surgery, orthopedic surgeons extended their role to

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KEY TERMS

Arthroplasty—The surgical reconstruction or replacement of a joint.

Prosthesis—A synthetic replacement for a missing part of the body such as a knee or a hip.

Range of motion—The normal extent of movement (flexion and extension) of a joint.

include surgery involving the bones and related nerves and connective tissue.

The terms orthopedic surgeon and orthopedist are used interchangeably today to indicate a medical doctor with special training and certification in orthopedics.

Many orthopedic surgeons maintain a general practice, while some specialize in one particular aspect of orthopedics such as hand surgery, joint replacements, or disorders of the spine. Orthopedists treat both acute and chronic disorders. Some orthopedic surgeons specialize in trauma medicine and can be found in emergency rooms and trauma centers, treating injuries. Others find their work overlapping with plastic surgeons, geriatric specialists, pediatricians, or podiatrists (**foot care** specialists). A rapidly growing area of orthopedics is sports medicine, and many sports medicine doctors are board certified in orthopedic surgery.

Demographics

The American Academy of Orthopedic Surgeons reported that in January 2008, there were 31,309 members within all categories of orthopedic surgeons in the United States.

Description

The range of treatments provided by orthopedists is extensive. They include procedures such as **traction**, **amputation**, hand reconstruction, spinal fusion, and joint replacements. They also treat strains and sprains, broken bones, and **dislocations**. Some specific procedures performed by orthopedic surgeons are listed as separate entries in this book, including **arthroplasty**, **arthroscopic surgery**, **bone grafting**, **fasciotomy**, **fracture repair**, **kneecap removal**, and traction.

In general, orthopedists are employed by hospitals, medical centers, trauma centers, or free-standing surgical centers where they work closely with a surgical team, including an anesthesiologist and surgical nurse. Orthopedic surgery can be performed under general, regional, or **local anesthesia**.

Much of the work of an orthopedic surgeon involves adding foreign material to the body in the form of screws, wires, pins, tongs, and prosthetics to hold damaged bones in their proper alignment or to replace damaged bone or connective tissue. Great improvements have been made in the development of artificial limbs and joints, and in the materials available to repair damage to bones and connective tissue. As developments occur in the fields of metallurgy and plastics, changes will take place in orthopedic surgery that will allow surgeons to more nearly duplicate the natural functions of bones, joints, and ligaments, and to more accurately restore damaged parts to their original ranges of motion.

Diagnosis/Preparation

Persons are usually referred to an orthopedic surgeon by a primary care physician, emergency room physician, or other doctor. Prior to any surgery, candidates undergo extensive testing to determine appropriate corrective procedures. Tests may include x-rays, computed tomography (CT) scans, **magnetic resonance imaging** (MRI), myelograms, diagnostic arthroplasty, and blood tests. The orthopedist will determine the history of the disorder and any treatments that were previously tried. A period of rest to the injured part may be recommended before surgery is undertaken.

Surgical candidates undergo standard blood and urine tests before surgery and, for major procedures, may be given an electrocardiogram or other diagnostic tests prior to the operation. Individuals may choose to donate some of their own blood to be held in reserve for their use in major surgery such as knee replacement, during which heavy bleeding is common.

Aftercare

Rehabilitation from orthopedic injuries can require long periods of time. Rehabilitation is usually physically and mentally taxing. Orthopedic surgeons will work closely with physical therapists to ensure that patients receive treatment that will enhance the range of motion and return function to all affected body parts.

Risks

As with any surgery, there is always the risk of excessive bleeding, infection, and allergic reaction to anesthesia. Risks specifically associated with orthopedic surgery include inflammation at the site where foreign materials (pins, prostheses, or wires) are

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introduced into the body, infection as the result of surgery, and damage to nerves or to the spinal cord.

Normal results

Thousands of people have successful orthopedic surgery each year to recover from injuries or to restore lost function. The degree of success in individual recoveries depends on an individual's age and general health, the medical problem being treated, and a person's willingness to comply with rehabilitative therapy after the surgery.

Abnormal results from orthopedic surgery include persistent **pain**, swelling, redness, drainage or bleeding in the surgical area, surgical wound infection resulting in slow healing, and incomplete restoration of pre-surgical function.

Morbidity and mortality rates

Mortality from orthopedic surgical procedures is not common. The most common causes for mortality are adverse reactions to anesthetic agents or drugs used to control pain, post-surgical clot formation in the veins, and post-surgical heart attacks or strokes.

Alternatives

For the removal of diseased, non-functional, or non-vital tissue, there is no alternative to orthopedic surgery. Alternatives to orthopedic surgery depend on the condition being treated. Medications, **acupuncture**, or hypnosis are used to relieve pain. Radiation is an occasional alternative for shrinking growths. **Chemotherapy** may be used to treat bone **cancer**. Some foreign bodies may remain in the body without harm.

Resources

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ORGANIZATIONS

American Academy of Orthopedic Surgeons, 6300 North River Road, Rosemont, IL, 60018-4262, (847) 823-7186, (800) 346-2267, (847) 823-8125, http://www.aaos.org.

American College of Sports Medicine, P.O. Box 1440, Indianapolis, IN, 46206-1440, (317) 637-9200, (317) 634-7817, MSSR@Online, http://acsm.org.

American College of Surgeons, 633 North Saint Claire Street, Chicago, IL, 60611, (312) 202-5000, (800) 621-4111, 312-202-5001, postmaster@facs.org, http://www.facs.org.

American Society for Bone and Mineral Research, 2025 M Street NW, Suite 800, Washington, DC, 20036-3309, (202) 367-1161, (202) 367-2161, asbmr@asbmr.org, http://www.asbmr.org.

Orthopedic Trauma Association, 6300 N. River Road, Suite 727, Rosemont, IL, 60018-4226, (847) 698-1631, (847) 823-0536, OTA@aaos.org, http://www.ota.org.

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Orthopedic x rays *see* **Bone x rays**

Orthostatic hypotension

Definition

Orthostatic **hypotension** is an abnormal decrease in blood pressure when a person stands up. This may lead to **fainting**.

Description

When a person stands upright, a certain amount of blood normally pools in the veins of the ankles and legs. This pooling means that there is slightly less blood for the heart to pump and causes a drop in blood pressure. Usually, the body responds to this drop so quickly, a person is unaware of the change. The brain tells the blood vessels to constrict so they have less capacity to carry blood, and at the same time tells the heart to beat faster and harder. These responses last for a very brief time. If the body's response to a change in vertical position is slow or absent, the result is orthostatic hypotension. It is not a true disease, but the inability to regulate blood pressure quickly.

Causes and symptoms

Orthostatic hypotension has many possible causes. The most common cause is medications used to treat other conditions. **Diuretics** reduce the amount of fluid in the body which reduces the volume of blood. Medicines

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used to expand the blood vessels increase the vessel's ability to carry blood and so lower blood pressure.

If there is a severe loss of body fluid from **vomiting**, **diarrhea**, untreated diabetes, or even excessive sweating, blood volume will be reduced enough to lower blood pressure. Severe bleeding can also result in orthostatic hypotension.

Any disease or **spinal cord injury** that damages the nerves which control blood vessel diameter can cause orthostatic hypotension.

Symptoms of orthostatic hypotension include faintness, **dizziness**, confusion, or blurry vision, when standing up quickly. An excessive loss of blood pressure can cause a person to pass out.

Diagnosis

When a person experiences any of the symptoms above, a physician can confirm orthostatic hypotension if the person's blood pressure falls significantly on standing up and returns to normal when lying down. The physician will then look for the cause of the condition.

Treatment

When the cause of orthostatic hypotension is related to medication, it is often possible to treat it by reducing dosage or changing the prescription. If it is caused by low blood volume, an increase in fluid intake and retention will solve the problem.

Medications designed to keep blood pressure from falling can be used when they will not interfere with other medical problems.

When orthostatic hypotension cannot be treated, the symptoms can be significantly reduced by remembering to stand up slowly or by wearing elastic stockings.

Prognosis

The prognosis for people who have orthostatic hypotension depends on the underlying cause of the problem.

Prevention

There is no way to prevent orthostatic hypotension, since it is usually the result of another medical condition.

ORGANIZATIONS

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301)592-8573, (240)629-3246, http://www.nhlbi.nih.gov.

National Organization for Rare Disorders, 55 Kenosia Avenue, P.O. Box 1968, Danbury, CT, 06813-1968, (203) 744-0100, http://www.rarediseases.org.

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Orthotopic transplantation *see* **Liver transplantation**

Osgood-Schlatter disease *see* **Osteochondroses**

Osteitis deformans *see* **Paget's disease of bone**

Osteoarthritis

Definition

Osteoarthritis is a degenerative joint disease characterized by the breakdown of the joint's cartilage.

Demographics

According to the American College of Rheumatology, osteoarthritis affects people of all ages, but is more common in older populations, with 70% of people over the age of 70 showing x–ray evidence of the disease. Of this number, only half ever develop symptoms. Before age 45, more men than women have osteoarthritis; after age 45, it is more common in women, affecting especially their fingers and knees. The condition is also more likely to occur in people who are overweight and in people with jobs that stress particular joints. As of 2009, the National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS) estimates that osteoarthritis is by far the most common type of arthritis, with some 12.1% of Americans (nearly 27 million) aged 25 and older affected. By 2030, 20% of Americans, or some 72 million people, will be older than 65 and will be at high risk for the disease.

Studies are indicative of some ethnic and geographical differences in prevalence. African American females are more prone than Caucasian females to osteoarthritis of the knee, but not for the hip. Osteoarthritis of the hip occurs more often in European Caucasians than in Jamaican blacks, African or South African blacks, Chinese, or Asian Indians.

Description

Osteoarthritis is one of the oldest and most common types of arthritis that mostly affects cartilage, the slippery part of the joint that cushions the ends of bones. Unlike some other types of arthritis,

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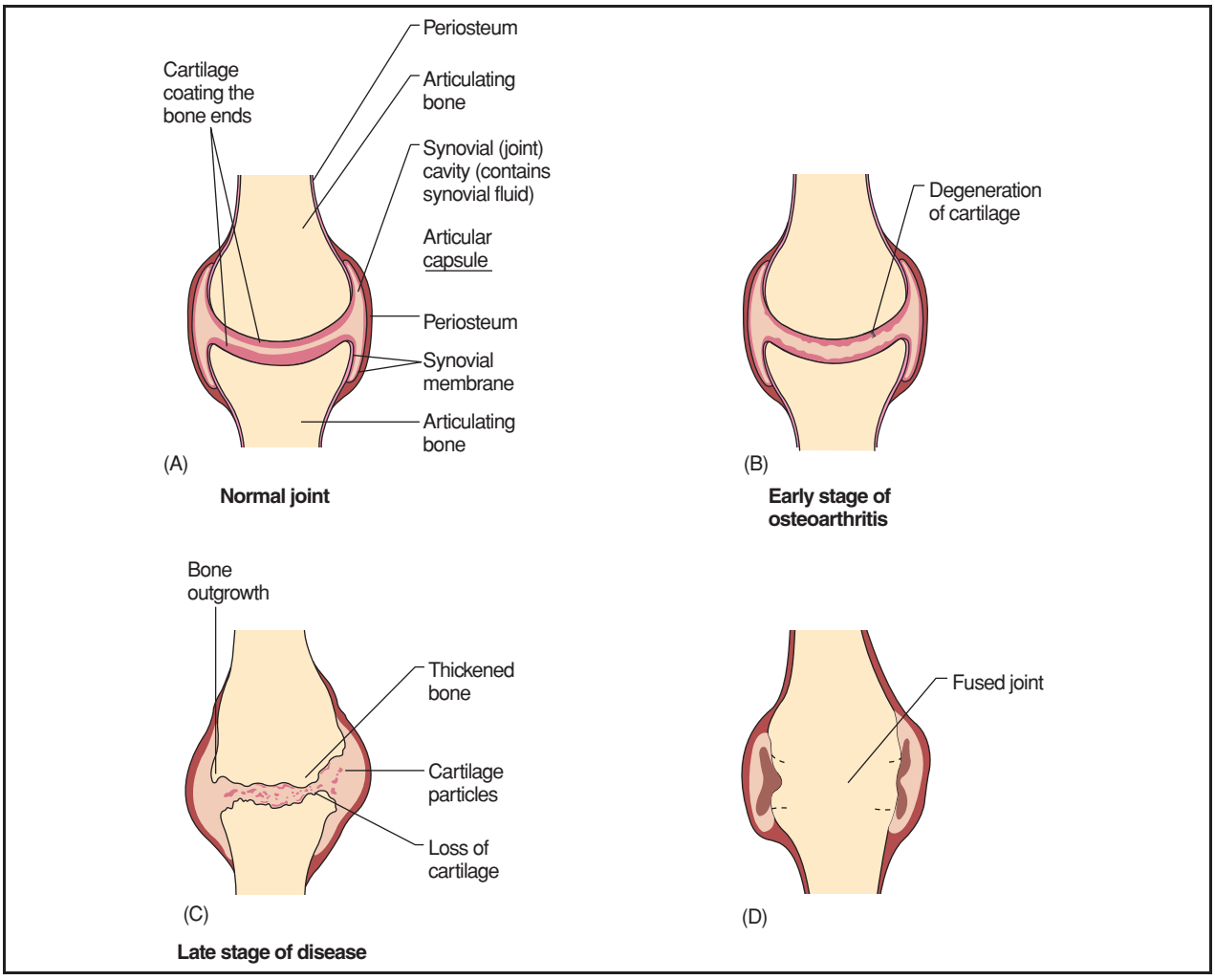

The progression of osteoarthritis. *(Illustration by Hans & Cassady, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

osteoarthritis affects only joints and not internal organs. With the breakdown of cartilage, bones rub against each other, causing **pain** and loss of movement. Over time, the affected joint may lose its normal shape. Also, bone spurs may grow on the edges of the joint. Bone or cartilage can break off and migrate inside the joint space, causing more pain and damage.

Osteoarthritis can occur in any joint, but commonly affects hands, knees, hips or spine.

Risk factors

Age increases the risk of osteoarthritis, which typically occurs in older adults. Women are also more likely to develop osteoarthritis. People born with malformed joints or defective cartilage are also at increased risk. **Obesity** is another factor, as more body weight places more stress on weight–bearing joints. Diseases such as **gout**, **rheumatoid arthritis**, **Paget's disease of bone** or septic arthritis can also increase the risk of developing osteoarthritis.

People with joint injuries from sports, work–related activity, or accidents may also be at increased risk. Individuals with mismatched surfaces on the joints that could be damaged over time by abnormal stress may be prone to osteoarthritis. One study reported that wearing shoes with 2.5 in (6.3 cm) heels or higher may also be a contributing factor. High heels force women to alter the way they normally maintain balance, putting strain on the areas between the kneecap and thigh bone and on the inside of the knee joint.

Causes and symptoms

The biological causes of the disorder are currently unknown. Although osteoarthritis is generally more prevalent in the older population, it does not appear to

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be caused by **aging** itself, since osteoarthritic cartilage has been shown to be chemically different from normal aged cartilage.

Genetics plays a role in the development of osteoarthritis, particularly in the hands and hips. One study found that heredity may be involved in 30% of people with osteoarthritic hands and 65% of those with osteoarthritic knees. Another study found a higher correlation of osteoarthritis between parents and children and between siblings than between spouses. Other research has shown that a genetic abnormality may promote a breakdown in the protective structure of cartilage.

Abnormal collagen genes have been identified in some families with osteoarthritis. One recent study found that the type IX collagen gene COL9A1 (6q12–q13) may be a susceptibility locus for female hip osteoarthritis. Other research has suggested that mutations in the COL2A1 gene may be associated with osteoarthritis.

Some evidence also suggests that a female–specific susceptibility gene for idiopathic osteoarthritis is located on 11q. There is some evidence of genetic abnormality at the IL1R1 marker on gene 2q12 in individuals with severe osteoarthritis and Heberden nodes (bony lumps on the end joint of fingers).

Although many people over 70 show evidence of osteoarthritis on x–ray, only 50% experience symptoms. Symptoms range from very mild to very severe, affecting hands and weight–bearing joints such as knees, hips, feet, and the back. The pain of osteoarthritis usually begins gradually and progresses slowly over many years.

Osteoarthritis is commonly identified by aching pain in one or more joints, stiffness, and loss of mobility. The disease can cause significant trouble walking and stair climbing. Inflammation may or may not be present. Extensive use of the joint often exacerbates pain in the joints. Osteoarthritis is often more bothersome at night than in the morning and in humid weather than dry weather. Periods of inactivity, such as sleeping or sitting, may result in stiffness, which can be eased by stretching and **exercise**. Osteoarthritis pain tends to fade within a year of appearing.

Bony lumps on the end joint of the finger, called Herberden's nodes, and on the middle joint of the finger, called Bouchard's nodes, may also develop.

KEY TERMS

Cartilage—Supportive connective tissue which cushions bone at the joints or which connects muscle to bone.

Collagen—The main supportive protein of cartilage, connective tissue, tendon, skin, and bone.

Corticosteroids—Anti-inflammatory medications. Related to cortisol, a naturally produced hormone that controls many body functions.

Diagnosis

Examination

A diagnosis of osteoarthritis is made based on a physical exam and history of symptoms.

It is possible to distinguish osteoarthritis from other joint diseases by considering a number of factors together:

- Osteoarthritis usually occurs in older people.
- It is usually located in only one or a few joints.
- The joints are less inflamed than in other arthritic conditions.
- Progression of pain is almost always gradual.

A few of the most common disorders that might be confused with osteoarthritis are rheumatoid arthritis, chondrocalcinosis, and **Charcot's joints**.

Tests

X–rays are used to confirm diagnosis. In people over 60, the disease can often be observed on x–ray. An indication of cartilage loss arises if the normal space between the bones in a joint is narrowed, if there is an abnormal increase in bone density, or if bony projections or erosions are evident. Any cysts that might develop in osteoarthritic joints are also detectable by x–ray.

Additional tests can be performed if other conditions are suspected or if the diagnosis is uncertain. Blood tests can rule out rheumatoid arthritis or other forms of arthritis. Synovial fluid analysis may also be performed to detect crystals that may be present in the joint and to look for signs of joint infection. MRI (**magnetic resonance imaging**) may also be used to examine affected joints.

Treatment

Traditional

There is no known way to prevent osteoarthritis or slow its progression. Some lifestyle changes can

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reduce or delay symptoms. Treatment often focuses on decreasing pain and improving joint movement. Prevention and treatment measures may include:

- Exercises to maintain joint flexibility and improve muscle strength. By strengthening the supporting muscles, tendons, and ligaments, regular weight–bearing exercise helps protect joints, even possibly stimulating growth of the cartilage.
- Joint protection, which prevents strain and stress on painful joints.
- Heat/cold therapy for temporary pain relief.
- Weight control, which prevents extra stress on weight–bearing joints. One study reported that weight loss seemed to reduce the risk for symptomatic osteoarthritis of the knee in women, and in another, women who lost 11 pounds or more cut their risk for developing osteoarthritis in half.
- Surgery may be needed to relieve chronic pain in damaged joints. Osteoarthritis is the most common indication for total joint replacement of the hip and knee.

Drugs

Various pain control medications, including **corticosteroids** and NSAIDs (nonsteroidal anti–inflammatory drugs such as **aspirin**, **acetaminophen**, ibuprofen, and naproxen) are available. For inflamed joints that are not responsive to NSAIDS, injectable glucocorticoids may be used. For mild pain without inflammation, acetaminophen is commonly used.

Alternative

Clinical trials for the treatment of osteoarthritis are currently sponsored by the National Institutes of Health (NIH) and other agencies. In 2009, NIH reported 236 on going studies. Some examples include the following:

- A pilot study of group physical therapy for knee osteoarthritis. (NCT00642772)
- The evaluation of whether implanting gold beads extra–articularly in five acupuncture points around a knee improves pain, stiffness and function in patients with knee osteoarthritis. (NCT00487370)
- The evaluation of the effectiveness of a novel biomechanical device consisting of four individually calibrated elements attached onto foot–worn platforms in reducing pain and improving function in patients with knee osteoarthritis. (NCT00457132)
- The evaluation of certain exercises designed to improve knee stability, reduce pain, and improve physical function in people with knee osteoarthritis. (NCT00078624)

Clinical trial information is constantly updated by NIH and the most recent information on osteoarthritis trials can be found at: http://clinicaltrials.gov/search/open/condition=%22Osteoarthritis%22

Home remedies

Glucosamine and chondroitin sulfate are popular **nutritional supplements** that may diminish the symptoms of osteoarthritis. According to some reports, a daily dose of 750–1,500 mg of glucosamine and chondroitin sulfate may result in reduced joint pain, stiffness, and swelling, however these supplements are not approved by the U.S. Food and Drug Administration as effective treatment of osteoarthritis. A person with osteoarthritis should consult with a doctor before using dietary supplements to treat symptoms.

Prognosis

Osteoarthritis is not life-threatening, but quality of life can deteriorate significantly due to the pain and loss of mobility that it causes. Advanced osteoarthritis can force the patient to forgo activities, even walking, unless the condition is alleviated by medication or corrected by surgery.

There is no cure for osteoarthritis, and no treatment alters its progression with any certainty. Only heart disease has a greater impact on work, and 5% of those who leave the work force do so because of osteoarthritis.

Prevention

Preventive measures include maintaining an ideal body weight, exercising, standing straight, avoiding repetitive stress on the joints, using the strongest joints and muscles to lift or move big objects, and avoiding injuries to joints, as articular cartilage wears away in previously injured joints. It has also been reported that deficiencies in vitamin D in older people may worsen their condition, so individuals with osteoarthritis should strive to get the recommended 400 IU a day. To protect bones, adults should also consume at least 1,000 mg of **calcium** daily.

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ORGANIZATIONS

American College of Rheumatology, 2200 Lake Blvd. NE, Atlanta, GA, 30319, (404) 633 3777, (404) 633 1870, http://www.rheumatology.org.

Arthritis Foundation, P.O. Box 7669, Atlanta, GA, 30357-0669, (800) 283-7800, http://www.arthritis.org.

National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS), 31 Center Dr., Rm. 4C02, MSC 2350, Bethesda, MD, 20892-2350, (301) 496-8190, (877) 22-NIAMS, NIAMSinfo@mail.nih.gov, http://www.niams.nih.gov.

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Osteoarthrosis *see* **Osteoarthritis**

Osteochondroses

Definition

Osteochondroses comprise group of diseases of children and adolescents in which localized tissue **death** (necrosis) occurs, usually followed by full regeneration of healthy bone tissue. The singular term is osteochondrosis.

Description

During the years of rapid bone growth, blood supply to the growing ends of bones (epiphyses) may become insufficient resulting in necrotic bone, usually near joints. The term avascular necrosis is used to describe osteochondrosis. Since bone is normally undergoing a continuous rebuilding process, the necrotic areas are most often self-repaired over a period of weeks or months.

Osteochondrosis can affect different areas of the body and is often categorized by one of three locations: articular, non-articular, and physeal.

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Physeal osteochondrosis is known as Scheuermann's disease. It occurs in the spine at the intervertebral joints (physes), especially in the chest (thoracic) region.

Articular disease occurs at the joints (articulations). One of the more common forms is Legg-Calvé-Perthes disease, occurring at the hip. Other forms include Köhler's disease (foot), Freiberg's disease (second toe), and Panner's disease (elbow). Freiberg's disease is the one type of osteochondrosis that is more common in females than in males. All others affect the sexes equally.

Non-articular osteochondrosis occurs at any other skeletal location. For instance, Osgood-Schlatter disease of the tibia (the large inner bone of the leg between the knee and ankle) is relatively common.

Osteochondritis dissecans is a form of osteochondrosis in which loose bone fragments may form in a joint.

Causes and symptoms

Many theories have been advanced to account for osteochondrosis, but none has proven fully satisfactory. **Stress** and **ischemia** (reduced blood supply) are two of the most commonly mentioned factors. Athletic young children are often affected when they overstress their developing limbs with a particular repetitive motion. Many cases are idiopathic, meaning that no specific cause is known.

The most common symptom for most types of osteochondrosis is simply **pain** at the affected joint, especially when pressure is applied. Locking of a joint or limited range of motion at a joint can also occur.

Scheuermann's disease can lead to serious **kyphosis** (hunchback condition) due to erosion of the vertebral bodies. Usually, however, the kyphosis is mild, causing no further symptoms and requiring no special treatment.

Diagnosis

Diagnosis can be confirmed by x-ray findings.

Treatment

Conservative treatment is usually attempted first. In many cases, simply resting the affected body part for a period of days or weeks will bring relief. A cast may be applied if needed to prevent movement of a joint.

Surgical intervention may be needed in some cases of osteochondritis dissecans to remove abnormal bone fragments in a joint.

Prognosis

Accurate prediction of the outcome for individual patients is difficult with osteochondrosis. Some patients will heal spontaneously. Others will heal with little treatment other than keeping weight or stress off the affected limb. The earlier the age of onset, the better the prospects for full recovery. Surgical intervention is often successful in osteochondritis dissecans.

Prevention

No preventive measures are known.

Resources

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Victor Leipzig, PhD

Osteogenesis imperfecta

Definition

Osteogenesis imperfecta (OI) is a group of genetic diseases of collagen in which the bones are formed improperly, making them fragile and prone to breaking.

Description

Collagen is a fibrous protein material. It serves as the structural foundation of skin, bone, cartilage, and ligaments. In osteogenesis imperfecta, the collagen produced is abnormal and disorganized. This results in a number of abnormalities throughout the body, the most notable being fragile, easily broken bones.

There are four forms of OI, Types I through IV. Of these, Type II is the most severe, and is usually fatal within a short time after birth. Types I, III, and IV have some overlapping and some distinctive symptoms, particularly weak bones.

Evidence suggests that OI results from abnormalities in the collagen gene COL1A1 or COL1A2, and possibly abnormalities in other genes. In OI Type I, II, and III, the gene map locus is 17q21.31-q22, 7q22.1, and in OI Type IV, the gene map locus is 17q21.31-q22.

In OI, the genetic abnormality causes one of two things to occur. It may direct cells to make an altered collagen protein and the presence of this altered

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collagen causes OI Type II, III, or IV. Alternately, the dominant altered gene may fail to direct cells to make any collagen protein. Although some collagen is produced by instructions from the normal gene, an overall decrease in the total amount of collagen produced results in OI Type I.

A child with only one parent who is a carrier of a single altered copy of the gene has no chance of actually having the disease, but a 50% chance of being a carrier.

If both parents have OI caused by an autosomal dominant gene change, there is a 75% chance that the child will inherit one or both OI genes. In other words, there is a 25% chance the child will inherit only the mother's OI gene (and the father's unaffected gene), a 25% chance the child will inherit only the father's OI gene (and the mother's unaffected gene), and a 25% chance the child will inherit both parents' OI genes. Because this situation has been uncommon, the outcome of a child inheriting two OI genes is hard to predict. It is likely that the child would have a severe, possibly lethal, form of the disorder.

About 25% of children with OI are born into a family with no history of the disorder. This occurs when the gene spontaneously mutates in either the sperm or the egg before the child's conception. No triggers for this type of mutation are known. This is called a new dominant mutation. The child has a 50% chance of passing the disorder on to his or her children. In most cases, when a family with no history of OI has a child with OI, they are not at greater risk than the general population for having a second child with OI, and unaffected siblings of a person with OI are at no greater risk of having children with OI than the general population.

In studies of families into which infants with OI Type II were born, most of the babies had a new dominant mutation in a collagen gene. In some of these families, however, more than one infant was born with OI. Previously, researchers had seen this recurrence as evidence of recessive inheritance of this form of OI. More recently, however, researchers have concluded that the rare recurrence of OI to a couple with a child with autosomal dominant OI is more likely due to gonadal mosaicism. Instead of mutation occurring in an individual sperm or egg, it occurs in a percentage of the cells that give rise to a parent's multiple sperm or eggs. This mutation, present in a percentage of his or her reproductive cells, can result in more than one affected child without affecting the parent with the disorder. An estimated 2%–4% of families into which an infant with OI Type II is born are at risk of having another affected child because of gonadal mosaicism.

Demographics

OI affects equal numbers of males and females. It occurs in about one of every 20,000 births.

Causes and symptoms

OI is usually inherited as an autosomal dominant condition. In autosomal dominant inheritance, a single abnormal gene on one of the autosomal chromosomes (one of the first 22 "non-sex" chromosomes) from either parent can cause the disease. One of the parents will have the disease (since it is dominant) and is the carrier. Only one parent needs to be a carrier in order for the child to inherit the disease. A child who has one parent with the disease has a 50% chance of also having the disease.

Type I

This is the most common and mildest type. Among the common features of Type I are the following:

- Bones are predisposed to fracture, with most fractures occurring before puberty; people with OI type I typically have about 20–40 fractures before puberty.
- Stature is normal or near-normal.
- Joints are loose and muscle tone is low.
- Usually sclera (whites of the eyes) have blue, purple, or gray tint.
- Face shape is triangular.
- Tendency toward scoliosis (a curvature of the spine).
- Bone deformity is absent or minimal.
- Dentinogenesis imperfecta may occur, causing brittle teeth.
- Hearing loss is a possible symptom, often beginning in the early 20s or 30s.
- Structure of collagen is normal, but the amount is less than normal.

Type II

Sometimes called the lethal form, Type II is the most severe form of OI. Among the common features of Type II are the following:

- Frequently, OI Type II is lethal at or shortly after birth, often as a result of respiratory problems.
- Fractures are numerous and bone deformity is severe.
- Stature is small with underdeveloped lungs.
- Collagen is formed improperly.

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Type III

Among the common features of Type III are the following:

- Bones fracture easily (fractures are often present at birth, and x-rays may reveal healed fractures that occurred before birth; people with OI Type III may have more than 100 fractures before puberty).
- Stature is significantly shorter than normal.
- Sclera (whites of the eyes) have blue, purple, or gray tint.
- Joints are loose and muscle development is poor in arms and legs.
- Rib cage is barrel-shaped.
- Face shape is triangular.
- Scoliosis (a curvature of the spine) is present.
- Respiratory problems are possible.
- Bones are deformed and deformity is often severe.
- Dentinogenesis imperfecta may occur, causing brittle teeth.
- Hearing loss is possible.
- Collagen is formed improperly.

Type IV

OI Type IV falls between Type I and Type III in severity. Among the common features of Type IV are the following:

- Bones fracture easily, with most fractures occurring before puberty.
- Stature is shorter than average.
- Sclera (whites of the eyes) are normal in color, appearing white or near-white.
- Bone deformity is mild to moderate.
- Scoliosis (curvature of the spine) is likely.
- Rib cage is barrel-shaped.
- Face is triangular in shape.
- Dentinogenesis imperfecta may occur, causing brittle teeth.
- Hearing loss is possible.
- Collagen is formed improperly.

Diagnosis

It is often possible to diagnose OI solely on clinical features and x-ray findings. Collagen or DNA tests may help confirm a diagnosis of OI. These tests generally require several weeks before results are known. Approximately 10–15% of individuals with mild OI who have collagen testing, and approximately 5% of those who have **genetic testing**, test negative for OI despite having the disorder.

Diagnosis is usually suspected when a baby has bone **fractures** after having suffered no apparent injury. Another indication is small, irregular, isolated bones in the sutures between the bones of the skull (wormian bones). Sometimes the bluish sclera serves as a diagnostic clue. Unfortunately, because of the unusual nature of the fractures occurring in a baby who cannot yet move, some parents have been accused of **child abuse** before the actual diagnosis of osteogenesis imperfecta was reached.

Prenatal diagnosis

Testing is available to assist in prenatal diagnosis. Women with OI who become pregnant, or women who conceive a child with a man who has OI, may wish to explore prenatal diagnosis. Because of the relatively small risk (2–4%) of recurrence of OI Type II in a family, families may opt for ultrasound studies to determine if a developing fetus has the disorder.

Ultrasound is the least-invasive procedure for prenatal diagnosis, and carries the least risk. Using ultrasound, a doctor can examine the fetus's skeleton for bowing of the leg or arm bones, fractures, shortening, or other bone abnormalities that may indicate OI. Different forms of OI may be detected by ultrasound in the second trimester. The reality is that when it occurs as a new dominant mutation, it is found inadvertantly on ultrasound, and it may be difficult to know the diagnosis until after delivery since other genetic conditions can cause bowing and/or fractures prenatally.

Chorionic villus sampling is a procedure to obtain chorionic villi tissue for testing. Examination of fetal collagen proteins in the tissue can reveal information about the quantitative or qualitative collagen defects that leads to OI. When a parent has OI, it is necessary for the affected parent to have the results of his or her own collagen test available. Chorionic villus sampling can be performed at 10–12 weeks of **pregnancy**.

Amniocentesis is a procedure that involves inserting a thin needle into the uterus, into the amniotic sac, and withdrawing a small amount of amniotic fluid. DNA can be extracted from the fetal cells contained in the amniotic fluid and tested for the specific mutation known to cause OI in that family. This technique is useful only when the mutation causing OI in a particular family has been identified through previous genetic testing of affected family members, including previous

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KEY TERMS

Collagen—The main supportive protein of cartilage, connective tissue, tendon, skin, and bone.

Ligament—A type of connective tissue that connects bones or cartilage and provides support and strength to joints.

Mutation—A permanent change in the genetic material that may alter a trait or characteristic of an individual, or manifest as disease, and can be transmitted to offspring.

Sclera—The tough white membrane that forms the outer layer of the eyeball.

Scoliosis—An abnormal, side-to-side curvature of the spine.

pregnancies involving a baby with OI. Amniocentesis is performed at 16–18 weeks of pregnancy.

Treatment

There are no treatments available to cure OI, nor to prevent most of its complications. Most treatments are aimed at treating the fractures and bone deformities caused by OI. Splints, casts, braces, and rods are all used. Rodding refers to a surgical procedure in which a metal rod is implanted within a bone (usually the long bones of the thigh and leg). This is done when bowing or repeated fractures of these bones has interfered with a child's ability to begin to walk.

Other treatments include **hearing aids** and early capping of teeth. Patients may require the use of a walker or wheelchair. **Pain** may be treated with a variety of medications. **Exercise** is encouraged as a means to promote muscle and bone strength. Swimming is a form of exercise that puts a minimal amount of strain on muscles, joints, and bones. Walking is encouraged for those who are able.

Smoking, excessive alcohol and **caffeine** consumption, and steroid medications may deplete bone and exacerbate bone fragility.

Alternative treatment such as **acupuncture**, naturopathic therapies, hypnosis, relaxation training, visual imagery, and **biofeedback** have all been used to try to decrease the constant pain of fractures.

Prognosis

Lifespan for people with OI Type I, III, and IV is not generally shortened. The prognosis for people with these types of OI is quite variable, depending on the severity of the disorder and the number and severity of the fractures and bony deformities.

Fifty percent of all babies with OI Type II are stillborn. The rest of these babies usually die within a very short time after birth. In recent years, some people with Type II have lived into young adulthood.

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ORGANIZATIONS

Children's Brittle Bone Foundation, 7701 95th St, Pleasant Prairie, WI, 53158, (773)263-2223, (262)947-0724, bonelink@oif.org, http://www.cbbf.org.

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Osteogenic sarcoma *see* **Sarcomas**

Osteomalacia *see* **Vitamin D deficiency**

Osteomyelitis

Definition

Osteomyelitis refers to a bone infection, almost always caused by a bacteria. Over time, the result can be destruction of the bone itself.

Description

Bone infections may occur at any age. Certain conditions increase the risk of developing such an infection, including sickle cell anemia, injury, the presence of a foreign body (such as a bullet or a screw placed to hold together a broken bone), intravenous drug use (such as heroin), diabetes, **kidney dialysis**, surgical procedures to bony areas, untreated infections of tissue near a bone (for example, extreme cases of untreated sinus infections have led to osteomyelitis of the bones of the skull).

Causes and symptoms

Staphylococcus aureus, a bacterium, is the most common organism involved in osteomyelitis. Other

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types of organisms include the mycobacterium which causes **tuberculosis**, a type of *Salmonella* bacteria in patients with sickle cell anemia, *Pseudomonas aeurginosa* in drug addicts, and organisms which usually reside in the gastrointestinal tract in the elderly. Extremely rarely, the viruses which cause **chickenpox** and **smallpox** have been found to cause a viral osteomyelitis.

There are two main ways that infecting bacteria find their way to bone, resulting in the development of osteomyelitis. These include:

- Spread via the bloodstream; 95% of these types of infections are due to *Staphylococcus aureus*. In this situation, the bacteria travels through the bloodstream to reach the bone. In children, the most likely site of infection is within one of the long bones, particularly the thigh bone (femur), one of the bones of the lower leg (tibia), or the bone of the upper arm (humerus). This is because in children these bones have particularly extensive blood circulation, making them more susceptible to invasion by bacteria. Different patterns of blood circulation in adults make the long bones less well-served by the circulatory system. These bones are therefore unlikely to develop osteomyelitis in adult patients. Instead, the bones of the spine (vertebrae) receive a lot of blood flow. Therefore, osteomyelitis in adults is most likely to affect a vertebra. Drug addicts may have osteomyelitis in the pubic bone or clavicle.
- Spread from adjacent infected soft tissue; about 50% of all such cases are infected by *Staphylococcus aureus*. This often occurs in cases where recent surgery or injury has resulted in a soft tissue infection. The bacteria can then spread to nearby bone, resulting in osteomyelitis. Patients with diabetes are particularly susceptible to this source of osteomyelitis. The diabetes interferes with both nerve sensation and good blood flow to the feet. Diabetic patients are therefore prone to developing poorly healing wounds to their feet, which can then spread to bone, causing osteomyelitis.

Acute osteomyelitis refers to an infection which develops and peaks over a relatively short period of time. In children, acute osteomyelitis usually presents itself as **pain** in the affected bone, tenderness to pressure over the infected area, **fever** and chills. Patients who develop osteomyelitis, due to spread from a nearby area of soft tissue infection, may only note poor healing of the original wound or infection.

Adult patients with osteomyelitis of the spine usually have a longer period of dull, aching pain in the back, and no fever. Some patients note pain in the chest, abdomen, arm, or leg. This occurs when the inflammation in the spine causes pressure on a nerve root serving one of these other areas. The lower back is the most common location for osteomyelitis. When caused by tuberculosis, osteomyelitis usually affects the thoracic spine (that section of the spine running approximately from the base of the neck down to where the ribs stop).

When osteomyelitis is not properly treated, a chronic (long-term) type of infection may occur. In this case, the infection may wax and wane indefinitely, despite treatment during its active phases. An abnormal opening in the skin overlaying the area of bone infection (called a sinus tract) may occasionally drain pus. This type of smoldering infection may also result in areas of dead bone, called sequestra. These areas occur when the infection interferes with blood flow to a particular part of the bone. Such sequestra lack cells called osteocytes, which in normal bone are continuously involved in the process of producing bony material.

Diagnosis

Diagnosis of osteomyelitis involves several procedures. Blood is usually drawn and tested to demonstrate an increased number of the infection-fighting white blood cells (particularly elevated in children with acute osteomyelitis). Blood is also cultured in a laboratory, a process which allows any bacteria present to multiply. A specimen from the culture is then specially treated, and examined under a microscope to try to identify the causative bacteria.

Injection of certain radioactive elements into the bloodstream, followed by a series of x-ray pictures, called a scan (radionuclide scanning), will reveal areas of bone inflammation. Another type of scan used to diagnose osteomyelitis is called **magnetic resonance imaging**, or MRI

When pockets of pus are available, or overlaying soft tissue infection exists, these can serve as sources for samples which can be cultured to allow identification of bacteria present. A long, sharp needle can be used to obtain a specimen of bone (biopsy), which can then be tested to attempt to identify any bacteria present.

Treatment

Antibiotics are medications used to kill bacteria. These medications are usually given through a needle in a vein (intravenously) for at least part of the time. In children, these antibiotics can be given by mouth after initial treatment by vein. In adults, four to six weeks of intravenous antibiotic treatment is usually recommended, along with bed-rest for part or all of that time. Occasionally, a patient will have such extensive

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KEY TERMS

Abscess—A pus-filled pocket of infection.

Femur—The thighbone.

Humerus—The bone of the upper arm.

Thoracic—Pertaining to the area bounded by the rib cage.

Tibia—One of the two bones of the lower leg.

ostemyelitis that surgery will be required to drain any pockets of pus, and to clean the infected area.

Alternative treatment

General recommendations for the treatment of infections include increasing vitamin supplements, such as **vitamins** A and C. Liquid garlic extract is sometimes suggested. **Guided imagery** can help induce relaxation and improve pain, both of which are considered to improve healing. Herbs such as **echinacea** (*Echinacea* spp.), goldenseal (*Hydrastis canadensis*), Siberian **ginseng** (*Eleutherococcus senticosus*), and myrrh (*Commiphora molmol*) are all suggested for infections. Juice therapists recommend drinking combinations of carrot, celery, beet, and cantaloupe juices. A variety of homeopathic remedies may be helpful, especially those used to counter inflammation.

Prognosis

Prognosis varies depending on how quickly an infection is identified, and what other underlying conditions exist to complicate the infection. With quick, appropriate treatment, only about 5% of all cases of acute osteomyelitis will eventually become chronic osteomyelitis. Patients with chronic osteomyelitis may require antibiotics periodically for the rest of their lives.

Prevention

About the only way to have any impact on the development of osteomyelitis involves excellent care of any **wounds** or injuries.

Resources

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Rosalyn Carson-DeWitt, MD

Osteopathic medicine *see* **Osteopathy**

Osteopathy

Definition

Osteopathy is a system and philosophy of health care that separated from traditional (allopathic) medical practice about a century ago. It places emphasis on the musculoskeletal system, hence the name—*osteo* refers to bone and *path* refers to disease. Osteopaths also believe strongly in the healing power of the body and do their best to facilitate that strength. During this century, the disciplines of osteopathy and allopathic medicine have been converging.

Purpose

Osteopathy shares many of the same goals as traditional medicine, but places greater emphasis on the relationship between the organs and the musculoskeletal system as well as on treating the whole individual rather than just the disease.

Precautions

Pain is the chief reason patients seek musculoskeletal treatment. Pain is a symptom, not a disease by itself. Of critical importance is first to determine the cause of the pain. Cancers, brain or spinal cord disease, and many other causes may be lying beneath this symptom. Once it is clear that the pain is originating in the musculoskeletal system, treatment that includes manipulation is appropriate.

Description

History

Osteopathy was founded in the 1890s by Dr. Andrew Taylor, who believed that the musculoskeletal system was central to health. The primacy of the musculoskeletal system is also fundamental to **chiropractic**, a related health discipline. The original theory behind both approaches presumed that energy flowing through the nervous system is influenced by the supporting structure that encase and protect it—the skull and vertebral column. A defect in the musculoskeletal system was believed to alter the flow of this energy and cause disease. Correcting the defect cured the disease. Defects were thought to be misalignments—parts out of place by tiny distances. Treating misalignments became a matter of restoring the parts to their natural arrangement by adjusting them.

As medical science advanced, defining causes of disease and discovering cures, schools of osteopathy adopted modern science, incorporated it into their

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Osteopathic physician demonstrating the articulation of a foot. *(Photo Researchers, Inc.)*

curriculum, and redefined their original theory of disease in light of these discoveries. Near the middle of the 20th century the equivalance of medical education between osteopathy and allopathic medicine was recognized, and the DO degree (doctor of osteopathy) was granted official parity with the MD (doctor of medicine) degree. Physicians could adopt either set of initials.

However, osteopaths have continued their emphasis on the musculoskeletal system and their traditional focus on "whole person" medicine. Osteopaths constitute 5.5% of U.S. physicians, approximately 45,000. They provide 100 million patient visits a year. From its origins in the United States, osteopathy has spread to countries all over the world.

Practice

Osteopaths, chiropractors, and physical therapists are the experts in manipulations (adjustments). The place of manipulation in medical care is far from settled, but millions of patients find relief from it. Particularly backs, but also necks, command most of the attention of the musculoskeletal community. This community includes orthopedic surgeons, osteopaths, general and family physicians, orthopedic physicians, chiropractors, physical therapists, massage therapists, specialists in orthotics and prosthetics, and even some dentists and podiatrists. Many types of headaches also originate in the musculoskeletal system. Studies comparing different methods of treating musculoskeletal back, head, and neck pain have not reached a consensus, in spite of the huge numbers of people that suffer from it.

The theory behind manipulation focuses on joints, mostly those of the vertebrae and ribs. Some believe there is a very slight offset of the joint members—a subluxation. Others believe there is a vacuum lock of the joint surfaces, similar to two suction cups stuck together. Such a condition would squeeze joint lubricant out and produce abrasion of the joint surfaces with movement. Another theory focuses on weakness of the ligaments that support the joint, allowing it freedom to get into trouble. Everyone agrees that the result produces pain, that pain produces **muscle spasms and cramps**, which further aggravates the pain.

Some, but not all, practitioners in this field believe that the skull bones can also be manipulated. The skull is, in fact, several bones that are all moveable in infants. Whether they can be moved in adults is controversial. Other practitioners manipulate peripheral joints to relieve arthritis and similar afflictions.

Manipulation returns the joint to its normal configuration. There are several approaches. Techniques vary among practitioners more than between disciplines. Muscle relaxation of some degree is often required for the manipulation to be successful. This can be done with heat or medication. Muscles can also be induced to relax by gentle but persistent stretching. The manipulation is most often done by a short, fast motion called a thrust, precisely in the right direction. A satisfying "pop" is evidence of success. Others prefer steady force until relaxation permits movement.

Return of the joint to its normal status may be only the first step in treating these disorders. There is a reason for the initial event. It may be a fall, a stumble, or a mild impact, in which case the manipulation is a cure. On the other hand, there may be a postural misalignment (such as a short leg), a limp, or a stretched ligament that permits the joint to slip back into dysfunction. Tension, as well as pain, for emotional reasons causes muscles to tighten. If the pain has been present for any length of time, there will also be muscle deterioration. The osteopathic approach to the whole person takes all these factors into account in returning the patient to a state of health.

Other repairs may be needed. A short leg is thought by some to be a subluxation in the pelvis that may be manipulated back into position. Other short legs may require a lift in one shoe. Long-standing pain requires

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KEY TERMS

Orthotics—Mechanical devices that assist function.

Prosthetics—Mechanical devices that replace missing body parts.

additional methods of **physical therapy** to rehabilitate muscles, correct posture, and extinguish habits that arose to compensate for the pain. Medications that relieve muscle spasm and pain are usually part of the treatment. Psychological problems may need attention and medication.

Risks

Manipulation has rarely caused problems. Once in a while too forceful a thrust has damaged structures in the neck and caused serious problems. The most common adverse event, though, is misdiagnosis. Cancers have been missed; surgical back disease has been ignored until spinal nerves have been permanently damaged.

Normal results

Many patients find that one or a series of manipulations cures long-standing pain. Other patients need repeated treatments. Some do not respond at all. It is always a good idea to reassess any treatment that is not producing the expected results.

ORGANIZATIONS

American Association of Colleges of Osteopathic Medicine, 5550 Friendship Blvd., Suite 310, Chevy Chase, MD, 20815-7231, (301)968-4100, (301)968-4101, http://www.aacom.org.

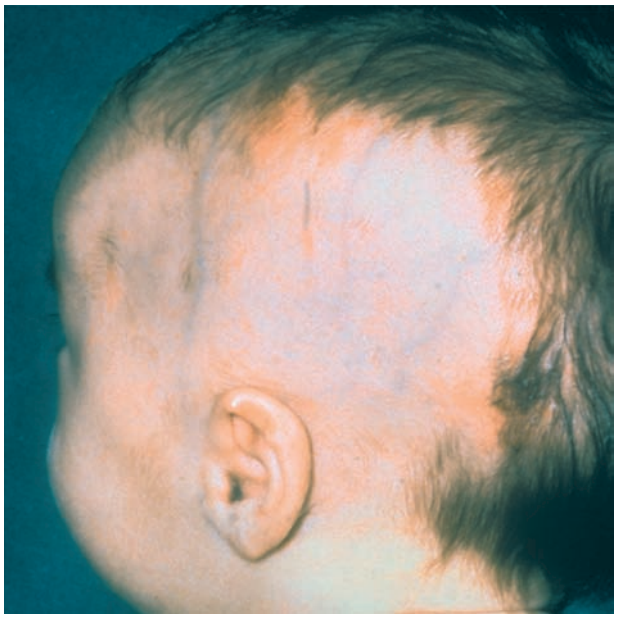
American Osteopathic Association (AOA), 142 East Ontario Street, Chicago, IL, 60611, (312)202-8000, (312)202-8200, (800)621-1773, info@osteotech.org, http://www.osteopathic.org/.

J. Ricker Polsdorfer, MD

Osteopetroses

Definition

Osteopetrosis (plural osteopetroses) is a rare hereditary disorder that makes bones increase in both density and fragility. A potentially fatal condition that can deform bone structure and distort the appearance, osteopetrosis is also called chalk bones, ivory bones, or marble bones.



This infant has osteopetrosis, a condition which thickens and hardens the bone. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Description

Osteopetrosis occurs when bones are spongy or porous, or new bone is repeatedly added to calcified cartilage (hardened connective tissue).

Bone density begins to increase at birth or earlier, but symptoms may not become evident until adulthood. In mild cases, bone density increases at gradual, irregular intervals until full adult height is attained. Some bones are not affected.

More severe osteopetrosis progresses at a rapid pace and destroys bone structure. This condition involves bones throughout the body, but the lower jaw is never affected.

Types of osteopetroses

In early-onset osteopetrosis ends of the long bones of the arms and legs appear clubbed (widened and thickened) at birth, and bone density continues to increase sporadically or without pause. Early-onset osteopetroses can be a fatal condition, resulting in **death** before the age of two.

Malignant infantile osteopetrosis is most often discovered by the time a baby is a few months old. One-third of all malignant infantile osteopetroses cases result in death before the age of 10.

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Intermediate osteopetrosis generally appears in children under 10. This condition, usually less severe than early-onset or malignant infantile osteopetrosis, is not life-threatening.

Symptoms of adult or delayed-onset osteopetrosis may not become evident until the child becomes a teenager or adult.

Relatively common in many parts of the world, Albers-Schönberg disease is a mild form of this condition. People who have this disease are born with normal bone structure. Bone density increases as they age but does not affect appearance, health, intelligence, or life span.

Causes and symptoms

Osteopetrosis is the result of a genetic defect that causes the body to add new bone more rapidly than existing bone disintegrates.

When fibrous or bony tissue invades bone marrow and displaces red blood cells, the patient may develop anemia. Infection results when excess bone impairs the immune system, and hemorrhage can occur when platelet production is disrupted. When the skeleton grows so thick that nerves are unable to pass between bones, the patient may have a **stroke** or become blind or deaf.

Other symptoms associated with osteopetrosis include:

- bones that break easily and do not heal properly
- bruising
- convulsions
- enlargement of the liver, lymph glands, or spleen
- failure to thrive (delayed growth, weight gain, and development)
- hydrocephalus (fluid on the brain)
- macrocephaly (abnormal enlargement of the head)
- paralysis or loss of control of muscles in the face or eyes

Diagnosis

Osteopetrosis is usually diagnosed when x-rays reveal abnormalities or increases in bone density. **Bone biopsy** can confirm the presence of osteopetrosis, but additional tests may be needed to distinguish one type of the disorder from another.

Treatment

High doses of vitamin D can stimulate cells responsible for disintegration of old bone and significantly alleviate symptoms of severe disease. Experimental interferon gamma 1-b therapy has been shown to reduce the risk of infection experienced by patients who are severely ill.

When bone overgrowth deforms the shape of the skull, surgery may be required to relieve pressure on the brain. Orthodontic treatment is sometimes necessary to correct **malocclusion** (a condition that shifts the position of the teeth and makes closing the mouth impossible).

Professional counseling can help patients cope with the emotional aspects of deformed features.

Bone marrow transplants (BMT) have cured some cases of early-onset and malignant infantile osteopetrosis. Because 30–60% of children who undergo BMT do not survive, this procedure is rarely performed.

Prognosis

The severity of anemia seems to determine the course of an individual's osteopetrosis. When pronounced symptoms are present at the time of birth, the child's condition deteriorates rapidly. Death usually occurs within two years. When mild or moderate disease develops in older children or adults, and symptoms can be controlled, the patient is likely to survive.

ORGANIZATIONS

Osteoporosis and Related Bone Diseases—National Resource Center, 2 AMS Circle, Bethesda, MD, 20892-3676, (202)223-0344, (202)293-2356, NIAMS BoneInfo@mail.nih.gov, http://www.niams.nih.gov/Health_Info/ bone/default.asp.

Maureen Haggerty

Osteoporosis

Definition

Osteoporosis is a disease characterized by low bone mass and deterioration of bone tissues, leading to bone fragility and, consequently, an increase in fracture risk. The term osteoporosis comes from the Greek word *osteon*, meaning bone, and *porus*, meaning pore or passage. Osteoporosis literally makes bones porous. The amount of **calcium** stored in human bones decreases over time, causing the skeleton to weaken.

Demographics

The National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS) estimates that 10

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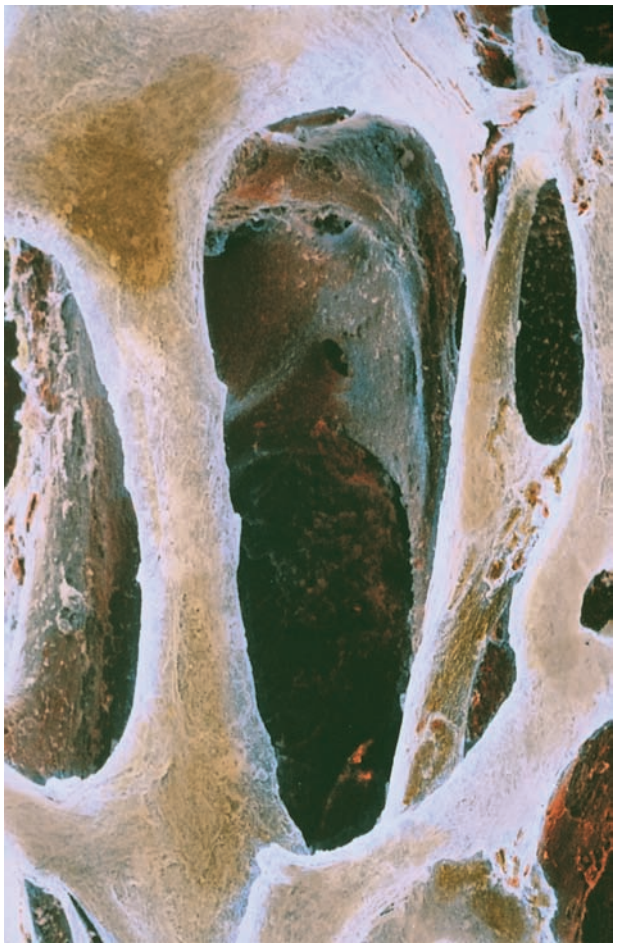

A scanning electron microscopy (SEM) image of cancellous (spongy) bone from an osteoporosis patient. Osteoporosis is characterized by increased brittleness of the bones and a greater risk of fractures. This is reflected here in the thin appearance of the bony network of the cancellous bone that forms the core of the body's long bones. *(Professor P. Motta/ Photo Researchers, Inc.)*

million people (8 million women and 2 million men) in the United States have osteoporosis as of 2009, with another 34 million adults having low bone density, a condition called **osteopenia**. Osteopenia can develop into osteoporosis if it is not treated. Osteoporosis is responsible for more than 1.5 million **fractures** annually in the United States, including 300,000 hip fractures, 700,000 vertebral fractures, 250,000 wrist fractures, and more than 300,000 fractures in other parts of the body. The costs of treating osteoporosis and the fractures that it causes come to $14 billion each year. An osteoporosis-related fracture will occur in one in two women and one in eight men over the age of 50.

Although osteoporosis is often thought of as a woman's disease, it affects men, too. Men who take certain medications—particularly cortisone and other steroid drugs— have the same risk of developing osteoporosis as women who take these medications. Each year, 80,000 American men with osteoporosis will suffer a hip fracture, and one-third of them will die within a year.

Worldwide, osteoporosis is estimated to affect one in three women and one in 12 men over the age of 50. It is the most common metabolic bone disease in the world.

Osteoporosis in children is very unusual. There is a rare condition called juvenile idiopathic osteoporosis: About 60 cases have been reported worldwide. The word idiopathic means that the cause of the condition is unknown.

Description

Osteoporosis is a disease that has no noticeable symptoms until the weakening of the bones leads to problems with posture, lower back **pain**, and brittle or easily broken bones. Although osteoporosis can appear at any age, it is most commonly a disease of adults. It develops when the wearing-out and removal of old bone—a process known as resorption—outpaces the production of new bone tissue.

Bone is living material. It is constantly broken down by cells called osteoclasts and built up again by cells called osteoblasts. This process is called bone remodeling, and it continues throughout an individual's life. Normally, more bone is built up than is broken down from birth through adolescence. In the late teens or early 20s, people reach their peak bone mass—the most bone that they will ever have. For 20 or so years, bone gain and bone loss remain approximately balanced in healthy people with good **nutrition**. However, when women enter **menopause**, usually in their mid to late forties, for the first five to seven years bone loss occurs at a rate of 1–5% a year. Men tend to lose less bone, and the loss often begins later in life. Osteoporosis occurs when bone loss continues and bones become so thin and their internal structure is so damaged that they break easily.

Bone remodeling occurs because bone is made primarily of calcium and phosphorous. Calcium is critically involved in muscle contraction, nerve impulse transmission, and many metabolic activities within cells. To remain healthy, the body must keep the level of free calcium ions (Ca^{2+}) within a very narrow concentration range. Besides providing a framework for the body, bone acts as a calcium "bank." When excess calcium is present in the blood, osteoblasts deposit it into bones where it is stored. When too little calcium is present, osteoblasts dissolve calcium from bones and

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move it into the blood. This process is controlled mainly by parathyroid hormone (PTH) secreted by the parathyroid glands in the neck. As people age, various conditions cause them to take more calcium out of the "bone bank" than they deposit, and osteoporosis (which literally means porous bones) eventually develops. A person's peak bone mass and the rate at which they lose it in later life affects their risk of developing osteoporosis; the higher the peak bone mass at age 30, the lower the risk of osteoporosis later on.

Doctors divide osteoporosis into three categories or types. Types 1 and 2 are considered primary because they are not caused by other diseases or conditions. Type 3 osteoporosis is sometimes called secondary osteoporosis because it results from taking certain drugs or having other diseases.

- Type 1: This type occurs in women after menopause and results from declining levels of estrogen and other sex hormones in the body. Sometimes called postmenopausal osteoporosis, it is the most common type of the disease. Type 1 may also occur in older men due to low levels of the sex hormone testosterone.
- Type 2: Sometimes called senile osteoporosis, this type of osteoporosis occurs in elderly men as well as elderly women because of decreased bone formation due to aging.
- Type 3: Type 3 osteoporosis is caused by long-term use of certain medications, particularly steroids and drugs given to treat epilepsy; and by such conditions as malnutrition, Klinefelter syndrome, Turner syndrome, thyroid disorders, hemophilia, Marfan syndrome, rheumatoid arthritis, lupus, and lymphoma. Some studies indicate that people receiving chemotherapy for cancer are also at increased risk for this type of osteoporosis.

Risk factors

There are two basic categories of risk factors for osteoporosis. Some of these risk factors can be changed, while others cannot be altered. Risk factors that cannot be changed include:

- Sex. Women have four times the risk of the disease as men, particularly after the menopause.
- Race/ethnicity. Asian and Caucasian women have a higher risk of osteoporosis than African American or Hispanic women. Although their risk is smaller, African-American and Hispanic-American women should still take precautions against osteoporosis. An estimated 10% of African-American women over age 50 have osteoporosis and an additional 30% have low bone density that puts them at risk of developing osteoporosis.
- Body build. Small-boned people of either sex are at greater risk of osteoporosis than people with average or heavy bones.
- Age. Both men and women have an increased risk of osteoporosis as they get older. The highest incidence of the disease is found among those men and women aged 80 or older.
- Genetic factors. A tendency for bones to fracture easily is thought to run in some families.

Risk factors for osteoporosis that people can change include:

- Low sex hormone levels. These can be raised in both men and women by hormone replacement therapy.
- Eating disorders, particularly anorexia.
- Depression. Emotional depression can be treated, most often with a combination of medication and psychotherapy.
- Low intake of calcium and vitamin D. People can change their eating habits and take vitamin or calcium supplements.
- Smoking and alcohol intake. People can quit smoking and drink in moderation.
- Getting the right amount of exercise. Bed rest or inadequate exercise can weaken bones, but so can too much exercise (such as marathon running).
- Medications. People who are taking medications that increase their risk of osteoporosis can ask their doctor about alternatives.

Certain diseases also increase a person's risk of developing osteoporosis:

- hyperthyroidism
- hyperparathyroidism
- celiac disease
- inflammatory bowel disease (IBD)
- cystic fibrosis
- diabetes
- chronic liver disease

Causes and symptoms

The basic cause of osteoporosis is that the loss of bone tissue occurs faster than the production of replacement bone. The increased rate of bone loss can be particularly critical if the person had a low or inadequate peak bone mass to begin with. A low peak bone mass can result from **malnutrition** in childhood; inadequate intake of calcium or vitamin D (necessary for the body to make use of calcium in the diet); an eating

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disorder in adolescence, when the body's need for calcium is at its height; or not getting enough **exercise**.

Genetic profile

Osteoporosis results from a complex interaction between genetic and environmental factors throughout life. Evidence suggests that peak bone mass is inherited, but current genetic markers are able to explain only a small proportion of the variation in individual bone mass or fracture risk. As of 2009, no specific mode of inheritance has been identified. Heritability of bone mass has been estimated to account for 60–90% of its variance. Studies have shown reduced bone mass in daughters of osteoporotic women when compared with controls; in men and women who have first-degree relatives with osteoporosis; and in perimenopausal women who have a family history of hip fracture. Body weight in infancy may be a determinant of adult bone mineral area.

Some scientists think that environmental influences during early life interact with the genome to establish the functional level of a variety of metabolic processes involved in skeletal growth.

Many candidate genes exist for osteoporosis, however relatively few have been studied. The first candidate gene to be identified was the vitamin D receptor (VDR) gene, and studies are ongoing as to how much this gene accounts for variance in bone mass. The response of bone mass to dietary supplementation with vitamin D and calcium is known to be dependent, in part, on VDR polymorphisms. Other genes may aid in establishing who would benefit from treatments like **hormone replacement therapy**, bisphosophonates, or exercise. Associations between bone mass and polymorphisms have also been found in the estrogen receptor gene, the interleukin-6 genes, the transforming growth factor beta, and a binding site of the collagen type I alpha1 (COLIA1) gene.

The risk of osteoporosis is greatly determined by peak bone mass, and any gene linked to fractures in the elderly may possibly be associated with low bone mass in children as well.

Symptoms

Osteoporosis can proceed for a long time without any noticeable symptoms. Some older adults simply notice that their height is shrinking. This loss of height is caused by compression of the bones in the spinal column. Sometimes the vertebrae fracture as they come closer together; this type of injury is called a compression fracture and may produce noticeable back pain.

Over many years, a sequence of spinal compression fractures may cause **kyphosis**, the bent-over posture known as dowager's or widow's hump. These fractures rarely require surgery, and they can range from causing minor discomfort to severe painful episodes of backache. In either case, pain generally subsides gradually over one to two months.

Another common symptom of osteoporosis is a fragility fracture. Fragility fractures occur when a person falls from their standing position or a lower height and breaks a bone that would not break in a person with healthy bone. The most common locations of fragility fractures in people with osteoporosis are the wrists, the hips, and the vertebrae in the spine. The patient may experience the pain in various ways; some describe it as sharp while others describe it as dull or nagging. In some cases the pain gets worse when the patient is trying to walk or move around.

Diagnosis

Since osteoporosis can develop undetected for decades until a fracture occurs, early diagnosis is important. Osteoporosis is most likely to be diagnosed following a fragility fracture. The doctor will take a careful history of the patient's risk factors, including a possible family history of easily broken bones as well as a medication history and questions about such lifestyle factors as exercise, diet, **smoking**, and drinking.

Examination

The **physical examination** should include measurement of the patient's height, evaluation of possible loss of height, and assessment for evidence of kyphosis.

Tests

The doctor may order a blood test to rule out a thyroid disorder or to check the levels of sex hormones in the patient's blood.

A bone mineral density test (BMD) is the only way to diagnose osteoporosis and determine risk for future fracture. The painless, noninvasive test measures bone density and helps determine whether medication is needed to help maintain bone mass, prevent further bone loss, and reduce fracture risk. To take this test, the patient lies on an examination table while two x-ray beams of different intensities are aimed at the bones. The result is called a T-score. It is calculated by comparing the patient's bone mineral density to that of a healthy 30-year-old of the same sex and race. A T-score of -1.0 or higher is normal; a score between -1.0 and -2.5 indicates osteopenia; a score below -2.5 indicates osteoporosis.

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KEY TERMS

Alendronate—A non-hormonal drug used to treat osteoporosis in postmenopausal women.

Bisphosphonates—Compounds that slow bone loss and increase bone density.

Calcitonin—A naturally occurring hormone made by the thyroid gland that can be used as a drug to treat osteoporosis and Paget's disease of the bone.

Compression fracture—A fracture caused by the collapse of a vertebra in the spinal column, usually caused either by trauma or by weakening of the bone in osteoporosis.

Fragility fracture—A fracture that occurs as a result of a fall from standing height or less. A person with healthy bones would not suffer a broken bone falling from a standing position.

Glucocorticoids—A general class of adrenal cortical hormones that are mainly active in protecting against stress and in protein and carbohydrate metabolism. They are widely used in medicine as anti-inflammatories and immunosuppresives.

Kyphosis—The medical term for curvature of the upper spine. Osteoporosis is a common cause of kyphosis in older adults.

Osteoblast—A type of bone cell that is responsible for bone formation. The number of osteoblasts in a person's body decreases with age.

Osteoclast—A type of bone cell that removes bone tissue.

Osteopenia—The medical name for low bone mass, a condition that often precedes osteoporosis.

Polymorphism—A change in the base pair sequence of DNA that may or may not be associated with a disease.

Resorption—The removal of old bone from the body.

Selective estrogen receptor modulator—A hormonal preparation that offers the beneficial effects of hormone replacement therapy (HRT) without the increased risk of breast and uterine cancer associated with HRT.

T-score—The score on a bone densitometry test, calculated by comparing the patient's bone mineral density to that of a healthy 30-year-old of the same sex and race.

Vertebra (plural, vertebrae)—One of the segments of bone that make up the spinal column.

Several different machines measure bone density. Central machines, such as the dual energy x-ray absorptiometry (DXA or DEXA) and quantitative computed tomography (QCT), measure density in the hip, spine and total body. Peripheral machines, such as radiographic absorptiometry (RA), peripheral dual energy x-ray absorptiometry (pDXA), and peripheral quantitative computed tomography (pQCT), measure density in the finger, wrist, kneecap, shin bone, and heel.

A physician may be able to observe osteoporotic bone in a routine spinal x-ray, however, BMD tests are more accurate and can measure small percentages of lost bone density. In an x-ray, osteoporotic bone appears less dense and the image is less distinct, suggesting weaker bone.

As of 2009, the U.S. Preventive Services Task Force recommends using dual energy x-ray absorptiometry to screen all women 65 years and older and women 60 to 64 years of age who have increased fracture risk. Some physicians also recommend bone density testing at menopause at whatever age it occurs to begin preventive treatment if necessary. The major risk factors are low body weight, low calcium intake, poor health, and a history of osteoporosis in the family.

Some health care organizations recommend considering screening in all men 70 years and older, as well as for men with one of the following risk factors: bone fracture, poor health, or low testosterone levels.

Treatment

Traditional

Drugs

Medications are an important part of treatment for osteoporosis. Various drugs have been shown to be effective in preventing or slowing bone loss and increasing bone mass. These include:

- *Hormone replacement therapy*. For women with postmenopausal osteoporosis, estrogen replacement therapy helps halt bone loss and exerts a modest bone-building effect. Stopping hormone therapy restarts bone loss, so long-term treatment is usually recommended. HRT used to be considered the mainstay of treating osteoporosis in women. But

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with newer studies indicating that HRT increases the risk of heart disease and cancer in some women, other medications that work by slowing the process of bone loss or by increasing bone density over time are more widely prescribed as of 2009. Some of these medications have the additional advantage of working well in men with osteoporosis and in people who must take steroid drugs for other health problems.

- *Raloxifene*. One of a class of drugs called selective estrogen receptor modulators (SERMs) that appear to prevent bone loss, raloxifene (Evista) produces small increases in bone mass. It is approved for the prevention and treatment of osteoporosis. Like estrogens, SERMs produce changes in blood lipids that may protect against heart disease, although the effects are not as potent as that of estrogen. Unlike estrogens, SERMs do not appear to stimulate uterine or breast tissue.
- *Alendronate*. One of a class of medications called bisphosphonates, alendronate (Fosamax) may prevent bone loss, increase bone mass, and reduce the risk of fractures. Patients receiving any bisphosphonate, however, should take calcium and vitamin D before and during treatment with a bisphosphonate to lower the risk of side effects from these drugs.
- *Risedronate*. Also from the bisphosphonate family, risedronate (Actonel) has been shown to reduce bone loss, increase bone density, and reduce the risk of fractures.
- *Calcitonin*. A hormone that regulates calcium levels in the blood, calcitonin may prevent bone loss. It is approved for treatment of diagnosed osteoporosis.

Lifestyle changes

Recommended lifestyle changes that can reduce the rate of bone loss include regular exercise, particularly weight-bearing forms of exercise like walking, dancing, treadmill exercises, and jumping. Other measures include quitting smoking, taking supplemental vitamin D and calcium, and watching one's alcohol intake.

Surgery

Unfortunately, surgical treatment for osteoporosis is often necessary. It is usually tied to fractures that result from advanced stages of the disease. For complicated fractures, such as broken hips, hospitalization and a surgical procedure are required. In hip replacement surgery, the broken hip is removed and replaced with a new hip made of plastic, or metal and plastic. Though the surgery itself is usually successful, complications of the hip fracture can be serious. Those individuals have a 5–20% greater risk of dying within the first year following that injury than do others in their age group. A large percentage of those who survive are unable to return to their previous level of activity, and many end up moving from self-care to a supervised living situation or nursing home. Getting early treatment and taking steps to reduce bone loss are vital.

Alternative

Alternative treatments for osteoporosis focus on maintaining or building strong bones. They include nutritional and herbal therapies and homeopathy.

NUTRITIONAL THERAPY. A healthful diet low in fats and animal products and containing whole grains, fresh fruits and vegetables, and calcium-rich foods (such as dairy products, dark-green leafy vegetables, sardines, salmon, and almonds), along with **nutritional supplements** (such as calcium, magnesium, and vitamin D) are important components of nutritional approaches to treating this disease.

Women should also eat more soy products such as tofu, soy burgers, other soy-based products, or miso. Soy beans contain a substance called isoflavones which have estrogen-like activity. Isoflavones may help to increase bone density, alleviate hot flashes and other menopausal symptoms, lower the risk of **cancer**, and even reduce the risk of heart attacks. Natural hormone therapy, such as the use of soy products, is a safer alternative to synthetic estrogenic hormones, which may increase the risk of **breast cancer**.

In addition, women should avoid foods that may accelerate bone loss. They should avoid having too much salt in their diet, not only because salt raises the blood pressure but also because it may contribute to osteoporosis. They should also cut down on coffee, caffeinated sodas, and alcohol. High consumption of these beverages, studies have shown, are associated with accelerated drop in bone density and increase risk of bone fracture in old age. Caffeinated sodas are especially bad for the bones because in addition to containing **caffeine**, they have high amounts of phosphoric acid. Phosphoric acid increases bone resorption, thus decreasing bone density.

HERBAL SUPPLEMENTS. Herbal supplements for osteoporosis emphasize such calcium-containing plants as horsetail (*Equisetum arvense*), oat straw (*Avena sativa*), alfalfa (*Medicago sativa*), licorice (*Glycyrrhiza glabra*), marsh mallow (*Althaea officinalis*), and sourdock (*Rumex crispus*). There are, however, few data from clinical trials to support the use of these herbs.

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HOMEOPATHY. Homeopathic remedies for osteoporosis focus on treatments believed to help the body absorb calcium. These remedies may include such substances as *Calcarea carbonica* (calcium carbonate) or *Silica* (flint). Again, there are few data other than isolated case reports regarding the effectiveness of these remedies.

Prognosis

The prognosis for osteoporosis depends on its type and cause; the patient's age, sex, and ethnicity; the presence of other diseases or disorders; and the patient's willingness to follow the doctor's recommendations about medications and lifestyle changes.

People do not die from osteoporosis itself but from complications from bone fractures. These complications can include chronic pain, **pneumonia**, **blood clots** in the deep veins of the leg, or breathing disorders caused by the stooped posture resulting from compression fractures in the spine. The **death** rate within the first six months after a hip fracture is 14 %. Even patients who survive often have a greatly lowered quality of life.

Osteoporosis is likely to continue to be a serious health concern because of the **aging** of the American population. As people continue to live longer, the number of people with Type 2 (age-related) osteoporosis will increase. In addition, people who are at risk for osteoporosis because of sex, race, or a family history of weak bones may not be completely able to prevent the disease even by careful attention to diet and exercise. It is possible that more effective medications to prevent bone loss or restore bone density will be developed.

Prevention

People cannot change such risk factors for osteoporosis as age, sex, and race, but they can eat properly, exercise regularly, and ask their doctor about vitamin D and calcium supplements. Male as well as female adolescents should participate in sports and get adequate calcium in the diet in order to build up a high peak bone mass before midlife. Women who have not yet gone through menopause should get at least 1,000 milligrams (mg) of elemental calcium and a minimum of 800 international units (IU) of vitamin D every day; women who have completed menopause, anyone who must take steroid medications, and all men and women over 65 should aim for 1,500 mg of elemental calcium and at least 800 IU of vitamin D daily.

Other recommendations for lowering the risk of osteoporosis in older adults include:

- Participate in regular weight-bearing exercise, such as walking, jogging, tennis, weight-lifting, and cross-county skiing to strengthen bones.
- Stop smoking.
- Reduce intake of caffeine to not more than three cups a day.
- Limit alcohol intake to not more than two drinks per day.
- Avoid excessive amounts of dietary fiber as it binds to calcium and may interfere with absorption.

Older adults should also try to reduce their risk of falls whether or not they have osteoporosis. There are balance and strength exercises that older adults can practice at home. In addition, such safety measures as wearing properly fitted shoes with non-slip soles, checking one's house for loose rugs, poor lighting, and other hazards, installing grab bars in shower stalls, and keeping a cordless phone within easy reach in case of an accident are all good forms of fall prevention.

Nutrition/Dietetic concerns

Calcium and vitamin D are both essential to building and maintaining strong bones. Dairy products are a good source of these nutrients. Calcium supplements are recommended for many women who have difficulty getting enough calcium in their diet. Recommended dietary allowances (RDAs) and lists of foods that are high in calcium and vitamin D can be found in their individual entries. Fluoride also is needed to develop healthy bones and teeth.

Young people with the eating disorder **anorexia nervosa** are at especially high risk of developing osteoporosis later in life because they have poor, unbalanced **diets**. The menstrual cycle in girls with anorexia is often delayed in starting or if it has started, stops. In addition, people with anorexia almost never get enough calcium to build strong bones during adolescence and they make unusually larger amounts of cortisol, a corticosteroid made by the adrenal gland that causes bone loss. Although the effect of this eating disorder on bones will not be seen until the individual is older, failure to build strong, dense bones during the teen years substantially increases the risk of osteoporosis later.

Health care team roles

Doctors, nurses, physical therapists, radiation technologists, and dietitians all play roles in the process of controlling osteoporosis. Because osteoporosis is treatable but not curable, the main responsibility for controlling the progress of the disease rests with the patient. All of these team members play an important

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role in identifying risk of osteoporosis before it strikes and in convincing the patient to take appropriate steps (including lifestyle modification) to minimize the dangers of fracturing major bones.

Caregiver concerns

A survey conducted by the International Osteoporosis Foundation (IOF) in 11 countries showed widespread denial of personal risk by postmenopausal women, lack of discussion about osteoporosis with their primary care physician, and restricted access to diagnosis and treatment before occurrence of the first fracture. The unfortunate result is that osteoporosis is too often underdiagnosed and undertreated in this population group.

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National Institutes of Health (NIH). *Check Up on Your Bones*. http://www.niams.nih.gov/Health_Info/Bone/Optool/index.asp. This is an interactive website for people of all ages to identify personal risk factors for osteoporosis and suggest possible approaches for reducing risk.

National Osteoporosis Foundation (NOF). *Osteoporosis: What Is It?* http://www.nof.org/osteoporosis/index.htm

ORGANIZATIONS

Arthritis Foundation, P.O. Box 7669, Atlanta, GA, 30357-0669, (800) 283-7800, http://www.arthritis.org/index.php.

National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS), 1 AMS Circle, Bethesda, MD, 20892-3675, (301) 495-4484, (877) 22-NIAMS, (301) 718-6366, NIAMSinfo@mail.nih.gov, http://www.niams. nih.gov/.

National Osteoporosis Foundation (NOF), 1232 22nd Street N.W., Washington, DC, 20037-1202, (202) 223-2226, (800) 231-4222, http://www.nof.org/.

Osteoporosis Canada, 1090 Don Mills Road, Suite 301, Toronto, Ontario, Canada, M3C 3R6, 416-696-2663, (800) 463-6842 (English), (800) 977-1778 (French), (416) 696-2673, http://www.osteoporosis.ca/.

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Osteosarcoma *see* **Sarcomas**

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Ostomy

Definition

A surgical procedure creating an opening in the body for the discharge of body wastes.

Purpose

Certain diseases of the bowel or urinary tract involve removing all or part of the intestine or bladder. This creates a need for an alternate way for feces or urine to leave the body. To fill that need, an opening is surgically created in the abdomen for body wastes to pass through. The surgical procedure is called an ostomy. The opening that is created at the end of the bowel or ureter is called a stoma, which is pulled through the abdominal wall.

Description

Different types of ostomy are performed depending on how much and what part of the intestines or bladder is removed.

The three most common types of ostomies are:

- colostomy
- ileostomy
- urostomy

Colostomy

A **colostomy** is a when a small portion of the colon (large intestine) is brought to the surface of the abdominal wall to allow stool to be eliminated. A colostomy may be temporary or permanent. A permanent colostomy usually involves the loss of the rectum.

A colostomy might be performed due to **cancer**, **diverticulitis**, imperforate anus, **Hirschsprung's disease**, or trauma to the affected area.

Ileostomy

An ileostomy is an opening created in the small intestine to bypass the colon for stool elimination. The end of the ileum, which is the lowest part of the small intestine, is brought through the abdominal wall to form a stoma.

Ileoanal reservoir surgery is an alternative to a permanent ileostomy. It requires two surgical procedures. The first removes the colon and rectum, and creates a temporary ileostomy. The second procedure creates an internal pouch from a portion of the small intestine to hold stool. This is then attached to the anus. Since the muscle of the rectum is left in place, there is control over bowel movements.

An ileostomy might be performed due to ulcerative **colitis**, **Crohn's disease**, or **familial polyposis**.

Urostomy

A urostomy is a surgical procedure that diverts urine away from a diseased or defective bladder. Among several methods to create the urostomy, the most common method is called an ileal or cecal conduit. Either a section at the end of the small intestine (ileum) or at the beginning of the large intestine (cecum) is relocated surgically to form a stoma for urine to pass out of the body. Other common names for this procedure are ileal loop or colon conduit.

A urostomy may be performed due to **bladder cancer**, spinal cord injuries, malfunction of the bladder, and **birth defects** such as **spina bifida**.

Since colostomy, ileostomy, and usotomy bypass the sphincter muscle, the patient has no voluntary control over bowel movements and must wear an external pouch to catch the discharge.

Preparation

Aftercare

The skin around the stoma, called the peristomal skin, must be protected from direct contact with discharge. The discharge can be irritating to the stoma since it is very high in digestive enzymes. The peristomal skin should be cleansed with plain soap and rinsed with water at each change of the pouch.

The stoma can change in size due to weight gain/loss or several other situations. To ensure proper fit of discharge pouch the stoma should be measured each time supplies are purchased.

Risks

People with ostomies can be prone to certain types of skin infections. Skin irritations or **rashes** around the stoma may be caused by leakage from around the pouch due to an improperly fitted pouch. Correctly fitting the pouch and carefully cleaning the skin around the stoma after each change are the best ways of preventing skin irritation.

Urinary tract infections are common among people who have urostomies. Preventative measures include drinking plenty of fluids, emptying the pouch regularly and using a pouch with an anti-reflux valve to prohibit the discharge from moving back into the stoma.

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KEY TERMS

Crohn's disease—A chronic inflammatory disease, primarily involving the small and large intestine, but which can affect other parts of the digestive system as well.

Diverticulitis—Inflammation of the diverticula (small outpouchings) along the wall of the colon, the large intestine.

Familial polyposis—An inherited condition in which several hundred polyps develop in the colon and rectum.

Hirschsprung disease—Hirschsprung disease is a congenital abnormality (birth defect) of the bowel in which there is absence of the ganglia (nerves) in the wall of the bowel. Nerves are missing starting at the anus and extending a variable distance up the bowel. This results in megacolon (massive enlargement of the bowel) above the point where the nerves are missing. (The nerves are needed to assist in the natural movement of the muscles in the lining of the bowels that move bowel contents through.)

Ileum—The lowest part of the small intestine, located beyond the duodenum and jejunum, just before the large intestine (the colon).

Imperforate anus—A congenital malformation (a birth defect) in which the rectum is a blind alley (a cul-de-sac) and there is no anus.

Spina bifida—A birth defect (a congenital malformation) in which there is a bony defect in the vertebral column so that part of the spinal cord, which is normally protected within the vertebral column, is exposed. People with spina bifida can suffer from bladder and bowel incontinence, cognitive (learning) problems and limited mobility.

Normal results

Most ostomy pouches are inconspicuous and can be worn under almost any kind of clothing. There are typically no restrictions of activity, sport, or travel with an ostomy. Certain contact sports would warrant special protection for the stoma.

After recovery from surgery, most people with ostomies can resume a balanced diet.

Ostomy surgery does not generally interfere with a person's sexual or reproductive capacities.

Abnormal results

After an ileostomy, water and electrolyte loss may occur. It may be necessary to drink a significant amount of fluid or fruit juice each day to prevent **dehydration**.

After any type of ostomy surgery digestion and absorbtion of medications may also be affected.

High-fiber foods can cause blockages in the ileum, especially after surgery. Chewing food well helps break fiber into smaller pieces and makes it less likely to accumulate at a narrow point in the bowel. Drinking plenty of fluids can also help.

ORGANIZATIONS

Crohn's and Colitis Foundation of America, 386 Park Avenue South, 17th Floor, New York, NY, 10016, (800)932-2423, info@ccfa.org, http://www.ccfa.org.

International Foundation for Functional Gastrointestinal Disorders, P.O. Box 17864, Milwaukee, WI, 53217-8076, (414)964-1799, (414)964-7176, (888) 964-2001, iffd@iffgd.org, http://www.iffgd.org/.

National Diabetes Information Clearinghouse (NDIC), 1 Information Way, Bethesda, MD, 20892-3560, (703)738-4929, (800)860-8747, ndic@info.niddk.nih.gov, http://diabetes.niddk.nih.gov/.

United Ostomy Association, Inc. (UOA), P.O. Box 512, Northfield, MN, 55057-0512, (800)826-0826, info@ostomy.org, http://www.ostomy.org.

Gary Gilles

Otitis externa

Definition

Otitis externa refers to an infection of the ear canal, the tube leading from the outside opening of the ear in towards the ear drum.

Description

The external ear canal is a tube approximately 1 in (2.5 cm) in length. It runs from the outside opening of the ear to the start of the middle ear, designated by the ear drum or tympanic membrane. The canal is partly cartilage and partly bone. In early childhood, the first two-thirds of the canal is made of cartilage, and the last one-third is made of bone. By late

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A close-up image of the ear of an elderly man suffering from non-infectious otitis externa. The skin in the ear canal and outer ear is scaly. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

childhood, and lasting throughout all of adulthood, this proportion is reversed, so that the first one-third is cartilage, and the last two-thirds is bone. The lining of the ear canal is skin, which is attached directly to the covering of the bone. Glands within the skin of the canal produce a waxy substance called cerumen (popularly called earwax). Cerumen is designed to protect the ear canal, repel water, and keep the ear canal too acidic to allow bacteria to grow.

Causes and symptoms

Bacteria, fungi, and viruses have all been implicated in causing ear infections called otitis externa. The most common cause of otitis externa is bacterial infection. The usual offenders include *Pseudomonas aeruginosa*, *Enterobacter aerogenes*, *Proteus mirabilis*, *Klebsiella pneumoniae*, *Staphylococcus epidermidis*, and bacteria of the family called Streptococci. Occasionally, fungi may cause otitis externa. These include *Candida* and *Aspergillus*. Two types of viruses, called herpesvirus hominis and varicella-zoster virus, have also been identified as causing otitis externa.

Otitis externa occurs most often in the summer months, when people are frequenting swimming pools and lakes. Continually exposing the ear canal to moisture may cause significant loss of cerumen. The delicate skin of the ear canal, unprotected by cerumen, retains moisture and becomes irritated. Without cerumen, the ear canal stops being appropriately acidic, which allows bacteria the opportunity to multiply. Thus, the warm, moist, dark environment of the ear canal becomes a breeding ground for bacteria.

Other conditions predisposing to otitis externa include the use of cotton swabs to clean the ear canals. This pushes cerumen and normal skin debris back into the ear canal, instead of allowing the ear canal's normal cleaning mechanism to work, which would ordinarily move accumulations of cerumen and debris out of the ear. Also, putting other items into the ear can scratch the canal, making it more susceptible to infection.

The first symptom of otitis externa is often **itching** of the ear canal. Eventually, the ear begins to feel extremely painful. Any touch, movement, or pressure on the outside structure of the ear (auricle) may cause quite severe **pain**. This is because of the way in which the skin lining the ear canal is directly attached to the covering of the underlying bone. If the canal is sufficiently swollen, hearing may become muffled. The canal may appear swollen and red, and there may be evidence of greenish-yellow pus.

In severe cases, otitis externa may have an accompanying **fever**. Often, this indicates that the outside ear structure (auricle) has become infected as well. It will become red and swollen, and there may be enlarged and tender lymph nodes in front of, or behind, the auricle.

A serious and life-threatening otitis externa is called malignant otitis externa. This is an infection which most commonly affects patients who have diabetes, especially the elderly. It can also occur in other patients who have weakened immune systems. In malignant otitis externa, a patient has usually had minor symptoms of otitis externa for some months, with pain and drainage. The causative bacteria is usually *Pseudomonas aeruginosa.* In malignant otitis externa, this bacteria spreads from the external canal into all of the nearby tissues, including the bones of the skull. Swelling and destruction of these tissues may lead to damage of certain nerves, resulting in spasms of the jaw muscles or **paralysis** of the facial muscles. Other, more severe, complications of this very destructive infection include **meningitis**

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(swelling and infection of the coverings of the spinal cord and brain), brain infection, or **brain abscess** (the development of a pocket of infection with pus).

Diagnosis

Diagnosis of uncomplicated otitis externa is usually quite simple. The symptoms alone, of ear pain worsened by any touch to the auricle, are characteristic of otitis externa. Attempts to examine the ear canal will usually reveal redness and swelling. It may be impossible (due to pain and swelling) to see much of the ear canal, but this inability itself is diagnostic.

If there is any confusion about the types of organisms causing otitis externa, the canal can be gently swabbed to obtain a specimen. The organisms present in the specimen can then be cultured (allowed to multiply) in a laboratory, and then viewed under a microscope to allow identification of the causative organisms.

If the rare disease malignant otitis externa is suspected, computed tomography scan (CT scan) or **magnetic resonance imaging** (MRI) scans will be performed to determine how widely the infection has spread within bone and tissue. A swab of the external canal will not necessarily reveal the actual causative organism, so some other tissue sample (biopsy) will need to be obtained. The CT or MRI will help the practitioner decide where the most severe focus of infection is located, in order to guide the choice of a biopsy site.

Treatment

Antibiotics which can be applied directly to the skin of the ear canal (**topical antibiotics**) are usually excellent for treatment of otitis externa. These are often combined in a preparation which includes a steroid medication. The steroid helps cut down on the inflammation and swelling within the ear canal. Some practitioners prefer to insert a cotton wick into the ear canal, leaving it there for about 48 hours. The medications are applied directly to the wick, enough times per day to allow the wick to remain continuously saturated. After the wick is removed, the medications are then put directly into the ear canal three to four times each day.

In malignant otitis externa, antibiotics will almost always need to be given through a needle in the vein (intravenously or IV). If the CT or MRI scan reveals that the infection has spread extensively, these IV antibiotics will need to be continued for six to eight weeks. If the infection is in an earlier stage, two weeks of IV antibiotics can be followed by six weeks of antibiotics by mouth.

KEY TERMS

Auricle—The external structure of the ear.

Biopsy—The removal and examination, usually under a microscope, of tissue from the living body. Biopsy is used for diagnosis.

Cerumen—Earwax.

Prognosis

The prognosis is excellent for otitis externa. It is usually easily treated, although it may tend to recur in certain susceptible individuals. Left untreated, malignant otitis externa may spread sufficiently to cause **death**.

Prevention

Keeping the ear dry is an important aspect of prevention of otitis externa. Several drops of a mixture of alcohol and acetic acid can be put into the ear canal after swimming to insure that it dries adequately.

The most serious complications of malignant otitis externa can be avoided by careful attention to early symptoms of ear pain and drainage from the ear canal. Patients with conditions that put them at higher risk for this infection (diabetes, conditions which weakened the immune system) should always report new symptoms immediately.

ORGANIZATIONS

American Academy of Otolaryngology—Head and Neck Surgery, 1650 Diagonal Road, Alexandria, VA, 22314-2857, (703)836-4444, http://www.entnet.org.

Rosalyn Carson-DeWitt, MD

Otitis media

Definition

Otitis media is an infection of the middle ear space, behind the eardrum (tympanic membrane). It is characterized by **pain**, **dizziness**, and partial loss of hearing.

Description

A little knowledge of the basic anatomy of the middle ear will be helpful for understanding the

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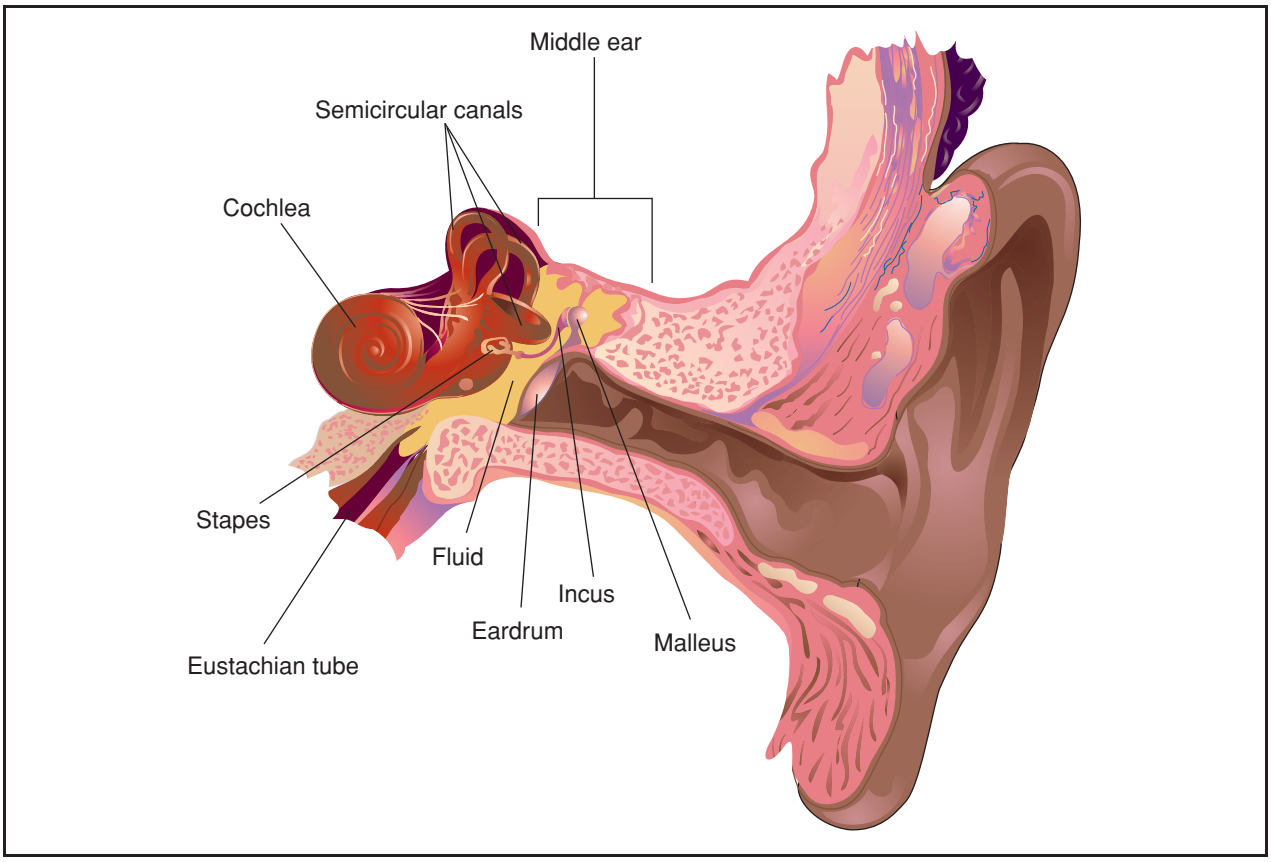

Otitis media is an ear infection in which fluid accumulates within the middle ear. A common condition occurring in childhood, it is estimated that 85% of all U.S. children will develop otitis media at least once. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

development of otitis media. The external ear canal is that tube which leads from the outside opening of the ear to the structure called the tympanic membrane. Behind the tympanic membrane is the space called the middle ear. Within the middle ear are three tiny bones, called ossicles. Sound (in the form of vibration) causes movement in the eardrum, and then the ossicles. The ossicles transmit the sound to a structure within the inner ear, which sends it to the brain for processing.

The nasopharynx is that passageway behind the nose which takes inhaled air into the breathing tubes leading to the lungs. The eustachian tube is a canal which runs between the middle ear and the nasopharynx. One of the functions of the eustachian tube is to keep the air pressure in the middle ear equal to that outside. This allows the eardrum and ossicles to vibrate appropriately, so that hearing is normal.

By age three, almost 85% of all children will have had otitis media at least once. Babies and children between the ages of six months and six years are most likely to develop otitis media. Children at higher risk factors for otitis media include boys, children from poor families, Native Americans, Native Alaskans, children born with **cleft palate** or other defects of the structures of the head and face, and children with **Down syndrome**. Exposure to cigarette smoke significantly increases the risk of otitis media as well as other problems affecting the respiratory system. Also, children who enter daycare at an early age have more upper respiratory infections (URIs or colds), and thus more cases of otitis media. The most usual times of year for otitis media to strike are in winter and early spring (the same times URIs are most common).

Otitis media is an important problem, because it often results in fluid accumulation within the middle ear (effusion). The effusion can last for weeks to months. Effusion within the middle ear can cause significant hearing impairment. When such hearing impairment occurs in a young child, it may interfere with the development of normal speech.

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In adults, acute otitis media can lead to such complications as **paralysis** of the facial nerves. Recovery from these complications may take from two weeks to as long as three months.

Causes and symptoms

The first precondition for the development of acute otitis media is exposure to an organism capable of causing the infection. Otitis media can be caused by either viruses or bacteria. Virus infections account for about 15% of cases. The three most common bacterial pathogens are *Streptococcus pneumoniae*, *Haemophilus influenzae*, or *Moraxella catarrhalis*. About 75% of ear infections caused by *S. pneumoniae* are reported to be penicillin-resistant.

Otitis media may also be caused by other disease organisms, including *Bordetella pertussis*, the causative agent of **whooping cough**, and *Pneumocystis carinii*, which often causes opportunistic infections in patients with **AIDS**.

There are other factors which make the development of an ear infection more likely. Because the eustachian tube has a more horizontal orientation and is considerably shorter in early childhood, material from the nasopharynx (including infection-causing organisms) is better able to reach the middle ear. Children also have a lot of lymph tissue (commonly called the adenoids) in the area of the eustachian tube. These adenoids may enlarge with repeated respiratory tract infections (colds), ultimately blocking the eustachian tubes. When the eustachian tube is blocked, the middle ear is more likely to fill with fluid. This fluid, then, increases the risk of infection, and the risk of **hearing loss** and delayed speech development.

Most cases of acute otitis media occur during the course of a URI. Symptoms include **fever**, ear pain, and problems with hearing. Babies may have difficulty feeding. When significant fluid is present within the middle ear, pain may increase depending on position. Lying down may cause an increase in painful pressure within the middle ear, so that babies may fuss if not held upright. If the fluid build-up behind the eardrum is sufficient, the eardrum may develop a hole (perforate), causing bloody fluid or greenish-yellow pus to drip from the ear. Although pain may be significant leading up to such a perforation, the pain is usually relieved by the reduction of pressure brought on by a perforation.

Recent advances in gene mapping have led to the discovery of genetic factors that increase a child's susceptibility to otitis media. Researchers are hoping to develop molecular diagnostic assays that will help to identify children at risk for severe ear infections.

Diagnosis

Diagnosis is usually made simply by looking at the eardrum through a special lighted instrument called an otoscope. The eardrum will appear red and swollen, and may appear either abnormally drawn inward, or bulging outward. Under normal conditions, the ossicles create a particular pattern on the eardrum, referred to as "landmarks." These landmarks may be obscured. Normally, the light from the otoscope reflects off of the eardrum in a characteristic fashion. This is called the "cone of light." In an infection, this cone of light may be shifted or absent.

A special attachment to the otoscope allows a puff of air to be blown lightly into the ear. Normally, this should cause movement of the eardrum. In an infection, or when there is fluid behind the eardrum, this movement may be decreased or absent.

If fluid or pus is draining from the ear, it can be collected. This sample can then be processed in a laboratory to allow any organisms present to multiply sufficiently (cultured) to permit the organisms to be viewed under a microscope and identified.

Treatment

Medications

Antibiotics are the treatment of choice for acute otitis media (AOM). Different antibiotics are used depending on the type of bacteria most likely to be causing the infection. This decision involves knowledge of the types of antibiotics that have worked on other ear infections occurring within a particular community at a particular time. Options include sulfa-based antibiotics, as well as a variety of **penicillins**, **cephalosporins**, and others. The patient's sensitivity to certain medications, as well as previously demonstrated resistant strains, also contributes to the choice of antibiotic. A 0.3% topical solution of ofloxacin has been recommended as a more effective medication than other oral or **topical antibiotics**.

Some controversy exists regarding whether overuse of antibiotics is actually contributing to the development of bacteria, which may evolve and become able to avoid being killed by antibiotics. Research is being done to try to help determine whether there may be some ear infections that will clear up without antibiotic treatment. In the meantime, the classic treatment of an ear infection continues to involve a seven- to 10-day course of antibiotic medication.

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Some medical practitioners prescribe the use of special nosedrops, **decongestants**, or **antihistamines** to improve the functioning of the eustachian tube.

Whether or not antibiotics are used, such pain relievers as Tylenol or Motrin can be very helpful in reducing the pain and inflammation associated with otitis media.

Surgery

In a few rare cases, a surgical perforation to drain the middle ear of pus may be performed. This procedure is called a **myringotomy**. The hole created by the myringotomy generally heals itself in about a week. In 2002 a new minimally invasive procedure was introduced that uses a laser to perform the myringotomy. It can be performed in the doctor's office and heals more rapidly than the standard myringotomy.

Although some doctors have recommended removing the adenoids to prevent recurrent otitis media in young children, recent studies indicate that surgical removal of the adenoids does not appear to offer any advantages over a myringotomy as a preventive measure.

Alternative treatment

Some practitioners believe that **food allergies** may increase the risk of ear infections, and they suggest eliminating suspected food allergens from the diet. The top food allergens are wheat, dairy products, corn, peanuts, citrus fruits, and eggs. Elimination of sugar and sugar products can allow the immune system to work more effectively. A number of herbal treatments have been recommended, including ear drops made with goldenseal (*Hydrastis canadensis*), mullein (*Verbascum thapsus*), **St. John's wort** (*Hypericum perforatum*), and **echinacea** (*Echinacea* spp.). Among the herbs often recommended for oral treatment of otitis media are echinacea and cleavers (*Galium aparine*), or black cohosh (*Cimicifuga racemosa*) and ginkgo (*Ginkgo biloba*). Homeopathic remedies that may be prescribed include aconite (*Acontium napellus*), *Ferrum phosphoricum,* belladonna, chamomile, *Lycopodium,* pulsatilla (*Pulsatilla nigricans*), or silica. **Craniosacral therapy** uses gentle manipulation of the bones of the skull to relieve pressure and improve eustachian tube function.

Prognosis

With treatment, the prognosis for acute otitis media is very good. However, long-lasting accumulations of fluid within the middle ear are a risk both for difficulties with hearing and speech, and for the repeated development of ear infections. Furthermore, without treatment, otitis media can lead to an infection within the nearby mastoid bone, called **mastoiditis**.

Prevention

Although otitis media seems somewhat inevitable in childhood, some measures can be taken to decrease the chance of repeated infections and fluid accumulation. **Breastfeeding** provides some protection against URIs, which in turn protects against the development of otitis media. If a child is bottle-fed, parents should be advised to feed him or her upright, rather than allowing the baby to lie down with the bottle. General good hygiene practices (especially handwashing) help to decrease the number of upper respiratory infections in a household or daycare center.

The use of pacifiers should be avoided or limited. They may act as fomites (inanimate object that can transmit infectious organisms), particularly in a daycare setting. In children who are more susceptible to otitis media, pacifier use can increase by as much as 50% the number of ear infections experienced.

Two vaccines can prevent otitis media associated with certain strains of bacteria. One is designed to prevent **meningitis** and other diseases, including otitis media, that result from infection with *Haemophilus influenzae* type B. Another is a vaccine against *Streptococcus pneumoniae*, a very common cause of otitis media. Children who are at high risk or have had severe or chronic infections may be good candidates for these vaccines; in fact, a recent consensus report among pediatricians recommended routine administration of the pneumococcal conjugate vaccine to children younger than two years, as well as those at high risk for AOM. Parents should consult a health care provider concerning the advisability of this treatment.

Another vaccine that appears to lower the risk of AOM in children is the intranasal vaccine that was recently introduced for preventing **influenza**. Although the flu vaccine was not developed to prevent AOM directly, one team of researchers found that children who were given the vaccine before the start of flu season were 43% less likely to develop AOM than children who were not vaccinated.

As of early 2003, there is no vaccine effective against *M. catarrhalis*. Researchers are working on developing such a vaccine, as well as a tribacterial vaccine that would be effective against all three pathogens that commonly cause otitis media.

A nutrition-based approach to preventive treatment is undergoing clinical trials. This treatment involves giving children a dietary supplement of lemon-flavored cod liver oil plus a multivitamin formula containing

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KEY TERMS

Adenoid—A collection of lymph tissue located in the nasopharynx.

Effusion—A collection of fluid which has leaked out into some body cavity or tissue.

Eustachian tube—A small tube which runs between the middle ear space and the nasopharynx.

Fomite—An inanimate object that can transmit infectious organisms.

Myringotomy—A surgical procedure performed to drain an infected middle ear. A newer type of myringotomy uses a laser instead of a scalpel.

Nasopharynx—The part of the airway into which the nose leads.

Ossicles—Tiny bones located within the middle ear which are responsible for conveying the vibrations of sound through to the inner ear.

Perforation—A hole.

Topical—Referring to a medication applied to the skin or outward surface of the body. Ear drops are one type of topical medication.

selenium. The pilot study found that children receiving the supplement had fewer cases of otitis media, and that those who did develop it recovered with a shorter course of antibiotic treatment than children who were not receiving the supplement.

After a child has completed treatment for otitis media, a return visit to the practitioner should be scheduled. This visit should occur after the antibiotic has been completed, and allows the practitioner to evaluate the patient for the persistent presence of fluid within the middle ear. In children who have a problem with recurrent otitis media, a small daily dose of an antibiotic may prevent repeated full attacks of otitis media. In children who have persistent fluid, a procedure to place tiny tubes within the eardrum may help equalize pressure between the middle ear and the outside, thus preventing further fluid accumulation.

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ORGANIZATIONS

American Academy of Otolaryngology—Head and Neck Surgery, 1650 Diagonal Road, Alexandria, VA, 22314-2857, (703)836-4444, http://www.entnet.org.

American Academy of Pediatrics (AAP), 141 Northwest Point Boulevard, Elk Grove Village, IL, 60007-1098, (847)434-4000, (847)424-8000, kidsdocs@aap.org, http://www.aap.org.

American Osteopathic Association (AOA), 142 East Ontario Street, Chicago, IL, 60611, (312)202-8000, (312)202-8200, (800)621-1773, info@osteotech.org, http://www.osteopathic.org/.

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Otosclerosis

Definition

Otosclerosis is an excessive growth in the bones of the middle ear which interferes with the transmission of sound.

Description

The middle ear consists of the eardrum and a chamber which contains three bones called the hammer, the anvil, and the stirrup (or stapes). Sound waves passing through the ear cause the ear drum to vibrate. This vibration is transmitted to the inner ear by the three bones. In the inner ear, the vibrations are changed into impulses which are carried by the nerves, to the brain. If excessive bone growth interferes with the stapes ability to vibrate and transmit sound waves, **hearing loss** will result.

Otosclerosis is classified as a conductive disorder because it involves the bones of the ear. These bones conduct the sound to the nerve. If a person has hearing loss classified as neural, the nerve conducting the impulses to the brain is involved.

Otosclerosis is a common hereditary condition. About 10% of the Caucasion population has some form of otosclerosis, however, it is rare among other ethnic backgrounds. Women are more likely than men to suffer from otosclerosis. It is the most common cause of conductive hearing loss between the ages of 15–50, but if the bony growth affects only the hammer or anvil, there are no symptoms and the condition goes undetected. Disease affecting the stapes is also associated with progressive hearing loss.

Causes and symptoms

Otosclerosis is hereditary. Acquired illness and accidents have no relationship to its development.

The primary symptom of otosclerosis is loss of hearing. In addition, many people experience **tinnitus** (noice originating inside the ear). The amount of tinnitus is not necessarily related to the kind or severity of hearing loss.

Diagnosis

Hearing loss due to otosclerosis is usually first noticed in the late teens or early twenties. Hearing loss usually occurs in the low frequencies first, followed by high frequencies, then middle frequencies. Extensive hearing tests will confirm the diagnosis.

KEY TERMS

Tinnitus—Tinnitus is noise originating in the ear, not in the environment. The noise can range from faint ringing to roaring.

Treatment

People with otosclerosis often benefit from a properly fitted hearing aid.

The surgical replacement of the stapes has become a common procedure to improve conductive hearing problems. During this operation, called a **stapedectomy**, the stapes is removed and replaced with an artificial device. The operation is performed under **local anesthesia** and is usually an outpatient procedure. Surgery is done on only one ear at a time, with a one year wait between procedures. The degree of hearing improvement reaches its maximum about four months after the surgery. More than 80% of these procedures successfully improve or restore hearing.

Prognosis

People with otosclerosis almost never become totally deaf, and will usually be able to hear with a hearing aid or with surgery plus a hearing aid. In older people, the tendency for additional hearing loss is diminished due to the hardening of the bones.

Prevention

Otosclerosis cannot be prevented.

ORGANIZATIONS

American Tinnitus Association, P.O. Box 5, Portland, OR, 97207-0005, (503)248-0024, (503)248-0024, (800)634-8978, tinnitus@ata.org, http://www.ata.org/.

Hearing Loss Association of America, 7910 Woodmont Ave., Suite 1200, Behtesda, MD, 20814, (301)657-2248, http://www.hearingloss.org.

National Association of the Deaf, 8630 Fenton St, #820, Silver Spring, MD, 20910, (301)587-1788, (301)587-1791, http://www.nad.org.

Self Help for Hard of Hearing People, Inc. , 7910 Woodmont Ave., Suite 1200 , Bethesda, MD, 20814, (301)657-2248, http://www.shhh.org.

Dorothy Elinor Stonely

Otoscopic examination *see* **Ear exam with an otoscope**

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Ototoxicity

Definition

Ototoxicity is damage to the hearing or balance functions of the ear by drugs or chemicals.

Description

Ototoxicity is drug or chemical damage to the inner ear. This section of the ear contains both the hearing mechanism and the vestibulocochlear nerve, the nerve that sends hearing and balance information to the brain. Because of this, ototoxic drugs may cause lack of hearing, and loss of sense of balance.

The extent of ototoxicity varies with the drug, the dose, and other conditions. In some cases, there is full recovery after the drug has been discontinued. In other cases, the extent of damage is limited, and may even be too small to be noticed. This may occur in high-frequency **hearing loss**, where the damage to the ear makes it difficult to hear high pitched musical notes, but does not affect the ability to hear the spoken word, or carry on a conversation. In extreme cases, there may be permanent and complete deafness.

Although ototoxicity is undesirable, the ear damage can actually be used to help people with **Ménière's disease**. This is a disease of no known cause that is marked by sudden episodes of **dizziness** and vertigo. Other symptoms include a feeling of "fullness" in the ears, roaring in the ears, and ringing in the ears. While most people with this condition can be controlled with medication, about 10% require surgery. However, use of some ototoxic drugs can actually improve this condition, while causing less damage to the hearing mechanism than traditional treatments.

Causes and symptoms

Many drugs can cause ototoxicity.

Antibiotics

- amikacin (Amikin)
- streptomycin
- neomycin
- gentamicin (Garamycin)
- erythromycin (E-Mycin, Eryc)
- kanamycin (Kantrex)
- tobramycin (Nebcin)
- netilmycin (Netromycin)
- vancomycin (Vancocin)

Anti-cancer drugs

- cisplatin (Platinol AQ)
- bleomycin (Blenoxane)
- vincristine (Oncovin)

Diuretics

- acetazolamide (Diamox)
- furosemide (Lasix)
- bumetanide (Bumex)
- ethacrynic acid (Edecrine)

A number of other drugs and chemicals may also cause ototoxicity. **Aspirin** overdose causes ringing in the ears. The **antimalarial drugs** quinine and chloroquine may also cause ear damage. Among the environmental chemicals that can cause ear damage are tin, lead, mercury, carbon monoxide, and carbon disulfide. This list is not complete, and many other drugs and chemicals, such as industrial solvents, may cause ear problems.

Diagnosis

Ototoxicity often goes undiagnosed. This occurs when the hearing loss is slight, or when it is restricted to the higher frequencies. Patients may notice a change in their hearing, but it may not be significant enough to report.

In other cases, the loss of hearing may be very significant, or the ototoxicity may take the form of ringing in the ears, or other sensations.

When physicians are administering medications that are known to cause hearing loss, it is often recommended that the patient receive regular hearing tests. By monitoring hearing on a regular basis, it may be possible to discontinue the medication, or reduce the dose so that no further damage is done.

Ototoxicity that causes loss of balance may be even more difficult to diagnose. These changes may take place gradually, over time, and may be confused with the effects of the condition the drugs are meant to treat. If ototoxicity is suspected, **balance tests** are available, including a platform balance test, and a rotary chair. These, and other tests, determine how a patient responds to motion and changes in body position.

Treatment

There are no current treatments to reverse the effects of ototoxicity.

People who suffer permanent hearing loss may elect to use **hearing aids**, or, when appropriate, receive a cochlear implant. For those who have balance

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KEY TERMS

Antibiotic—Drugs that kill or inhibit the growth of bacteria.

Cochlea—A division of the inner ear.

Diuretic—A drug that increases water loss through increased urination.

Ménière's disease—A disorder of the membranous labyrinth of the inner ear that is marked by recurrent attacks of dizziness, tinnitus, and deafness—also called Ménière's syndrome. It is named after Prosper Ménière (1799–1862), a French physician who was among the first people to study diseases of the ear, nose, and throat.

Tinnitus—Ringing sounds in the ears.

problems, **physical therapy** may often be helpful. Physical therapists can help people with balance problems learn to rely more on vision and the sensations from muscles to achieve balance.

Prognosis

The prognosis depends on the drugs that caused the ototoxicity, and their dose.

The aminoglycoside **antibiotics**, gentamicin, kanamycin, netilmycin and tobramycin all cause hearing loss to varying degrees. These drugs may be used to treat life-threatening infections that are resistant to other classes of drugs, and so there may be no choice but to use them. Careful dosing can minimize, but not eliminate the risk. It is estimated that the chances of recovery are 10-15%. The hearing loss usually begins at the higher frequencies, and is usually not recognized immediately.

Erythromycin may cause hearing loss that affects all frequencies. This hearing loss usually reverses itself over time.

Aspirin and the non-steroidal anti-inflammatory drugs (NSAIDS) may cause ringing in the ears (**tinnitus**). This stops when the drug is discontinued.

The **diuretics** may cause a hearing loss with a rapid onset. This will usually, but not always, reverse itself when the drugs are stopped.

In some cases, the prognosis is not really clear. Vancomycin appears to cause hearing loss, but this may only occur when vancomycin is used at the same time as other ototoxic drugs, such as gentamicin or erythromycin.

Prevention

Since most ototoxicity occurs when the harmful drugs are used in high doses, careful dose calculations are the best method of prevention. Sometimes it is possible to replace the ototoxic drugs with drugs that have less severe adverse effects.

Resources

BOOKS

Campbell, Kathleen. *Pharmacology and Ototoxicity for Audiologists*.

ORGANIZATIONS

Deafness Research Foundation, 641 Lexington Avenue, Fl 15, New York, NY, 10022-4503, (212)328-9480, (212)328-9484, http://www.drf.org.

EAR Foundation of Arizona, 668 North 44th Street, Suite 300, Phoenix, AZ, 85008 , (602)685-1050, (602)239-5117, melissa@earfoundationaz.com, http://www.earfoundationaz.com.

National Institute on Deafness and Other Communication Disorders, National Institutes of Health, 31 Center Drive, MSC 2320, Bethesda, MD, 20892-2320, (301)496-7243, (301)402-0018, nidcdinfo@nidcd.nih.gov, http://www.nidcd.nih.gov/.

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Ova & parasites collection *see* **Stool O & P test**

Ovarian cancer

Definition

Ovarian **cancer** is cancer of the ovaries, the egg–releasing and hormone–producing organs of the female reproductive tract. In ovarian cancer, malignant (cancerous) cells divide and multiply in an uncontrolled, abnormal fashion to form a tumor.

Demographics

Ovarian cancer can develop at any age, but is most likely to occur in women who are 50 years or older; most women are diagnosed after **menopause**. More than half the cases of ovarian cancer are among women who are over age 63. Industrialized countries have the highest incidence of ovarian cancer. Caucasian women, especially those of Ashkenazi Jewish descent, are at somewhat higher risk. African–American and Asian women are at a slightly lower risk.

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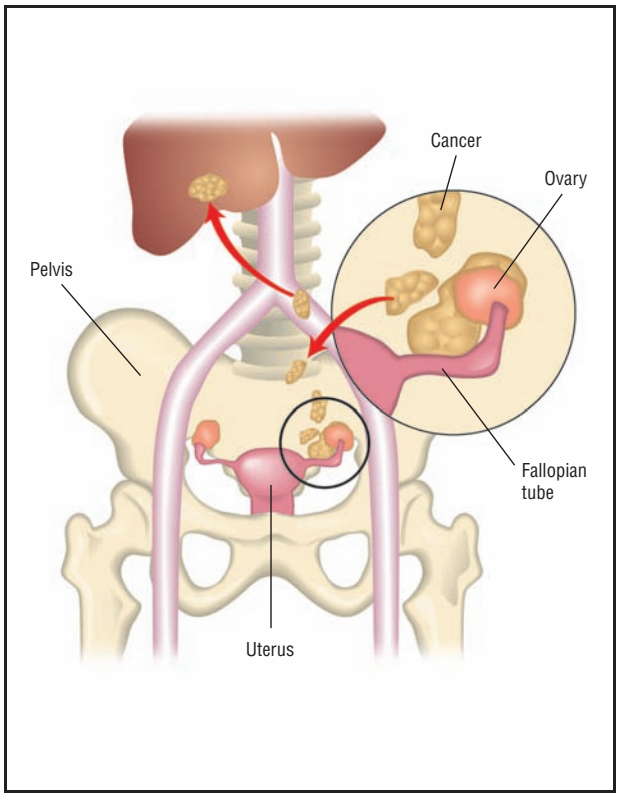

Diagram of the pelvic region with a cancerous growth on the ovary. *(Illustration by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)*

In 2009, ovarian cancer was the eighth most common cancer among women in the United States. It accounted for about 3.3% of all new cancers in American women. However, because of poor early detection, ovarian cancer is the fifth most common cause of cancer **death** among women. About one in 71 American women will develop ovarian cancer during her lifetime, and one in 95 will die from it. Rates are thought to be similar worldwide. The American Cancer Society estimated about 21,550 new cases of ovarian cancer would be diagnosed in the United States in 2009, and the cancer would cause about 14,600 deaths that year.

Description

The ovaries are small, almond–shaped organs located in the pelvic region, one on either side of the uterus. During a woman's childbearing years, the ovaries generally alternate to produce and release one egg each month as part of the normal menstrual cycle. The released egg is shunted into the adjacent fallopian tube and moves downward to the uterus where, if fertilized, it will implant and develop into an embryo, and if unfertilized will be shed along with menstrual blood. The ovaries also secrete the female hormones estrogen and progesterone, which help regulate the menstrual cycle and **pregnancy**, as well as support the development of the secondary female sexual characteristics (i.e., breasts, body shape, and body hair). During pregnancy and when women take certain medications, mainly **oral contraceptives**, the ovaries do not produce eggs.

Types of ovarian tumors

The ovaries contain three main types of cells: epithelial cells, stromal cells, and germ cells. About 90% of all ovarian cancers develop from epithelial cells lining the surface of the ovaries. About 15% of tumors that develop from epithelial cells are considered to be low malignant potential (LMP) tumors. These tumors occur more often in younger women, are more likely to be diagnosed early, and thus have a better prognosis.

Stromal cells are located inside the ovary and produce the hormones estrogen and progesterone. About 5% of ovarian cancers begin in the stromal cells.

Germ cells also are located within the ovary. **Germ cell tumors** develop in the cells that would become eggs (ova). They account for about 2% of ovarian tumors. Many germ cell tumors are benign (noncancerous). These tumors often occur in teenaged girls and young women. The prognosis is good if they are found early, but as with other ovarian cancers, early detection is difficult.

Risk factors

Age is one of the greatest risk factors in developing ovarian cancer, with risk increasing significantly after menopause. Another risk factor is a family or personal history of cancers of the female reproductive tract or breast that are caused by an inherited genetic mutation at the chromosomal sites BRCA1 or BRCA2. Not all women with BRCA1 or BRCA2 mutations will develop ovarian cancer. By age 70, a woman who has the BRCA1 mutation carries about a 40–60% risk of developing ovarian cancer. Women with the genetic mutation BRCA2 have a 15% risk of developing ovarian cancer. However, these gene mutations play a role only in about 5% of all ovarian cancer cases.

Early first menstruation (before age 12) and late menopause also seem to put women at a higher risk of ovarian cancer. The use of talcum powder in the genital

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area has been implicated in ovarian cancer in many studies. It may be because talc contains particles of asbestos, a known carcinogen. Female workers exposed to asbestos have a higher–than–normal risk of developing ovarian cancer. Genital deodorant sprays may also present an increased risk; however, not all studies have produced consistent results. Other risk factors include a diet high in saturated fats, treatment with androgens (male hormones), and never having been pregnant (nulliparity). Conversely, having been pregnant, **breastfeeding**, and using oral contraceptives decrease the risk of developing ovarian cancer.

Causes and symptoms

Cells in ovarian tissue normally divide and grow according to controls and instructions by proteins produced by various genes. If certain genes develop changes (mutations), instructions for cellular growth and division may go awry. Abnormal, uncontrolled cell growth may occur, causing cancer. Most of these genetic changes are not inherited. Instead, they are sporadic, still unexplained changes. Most ovarian cancers occur later in life after years of exposure to various environmental factors (e.g., the body's own hormones, asbestos exposure, or **smoking**) that may cause sporadic genetic alterations.

Ovarian cancer often is called a silent killer because it produces few symptoms in its early stages. Most women are unaware they have the disease until it has progressed to advanced stages. Most early symptoms are vague and either abdominal or gastrointestinal in nature. These symptoms may not be properly diagnosed or may recognized as ovarian in nature only after a significant length of time had passed and ovarian cancer has advanced.

The following symptoms are possible indications of ovarian cancer, although these symptoms may also be due to many other causes. Symptoms that persist for two to three weeks or symptoms that are unusual for a particular woman should be evaluated by a doctor.

- digestive symptoms, such as gas, indigestion, constipation, or a feeling of fullness after a light meal
- bloating, distention or cramping
- abdominal or low–back discomfort
- pelvic pressure or frequent urination
- unexplained changes in bowel habits
- nausea or vomiting
- pain or swelling in the abdomen
- loss of appetite (anorexia)
- fatigue
- unexplained weight gain or loss
- pain during intercourse
- vaginal bleeding in post–menopausal women

KEY TERMS

Adjuvant therapy—Treatment involving radiation, chemotherapy (drug treatment), hormone therapy, biotherapeutics, or a combination of any of these given after the primary treatment in order to rid the body of residual microscopic cancer.

Biomarker—A biochemical substance that can be detected in blood samples and indicates the presence of a cancerous tumor.

Estrogen—Any of several steroid hormones, produced mainly in the ovaries, that stimulate the development of the endometrium and the development of female secondary sexual characteristics.

Lymphatic system—A connected network of nodes, or glands that carry lymph throughout the body. Lymph is a fluid that contains the infection–fighting white blood cells that form part of the body's immune system. Because the network goes throughout the body, cancer cells that enter the lymphatic system can travel to and be deposited at any point into the tissues and organs and form new tumors there.

Placebo—A pill or liquid given during the study of a drug or dietary supplement that contains no medication or active ingredient. Usually study participants do not know if they are receiving a pill containing the drug or an identical–appearing placebo.

Diagnosis

In the best–case scenario a woman is diagnosed with ovarian cancer while it is still contained in just one ovary. Early detection can bring five–year survival to about 93%. Unfortunately, about three out of four women have advanced ovarian cancer at the time of diagnosis. Advanced ovarian cancer is at stage III or stage IV, and it has already spread (metastasized) to other organs.) A **physical examination** and **pelvic exam** generally do not reveal early–stage ovarian cancer.

Tests

If ovarian cancer is suspected, several of the following tests and examinations will be necessary to make a definitive diagnosis.

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- a complete medical history to assess all risk factors
- a thorough bi–manual pelvic examination
- CA–125 assay
- one or more various imaging procedures
- a lower GI series, or barium enema
- diagnostic laparoscopy for definitive diagnosis

BI–MANUAL PELVIC EXAMINATION. The exam should include palpating (feeling) the following organs for any abnormalities in shape or size: the ovaries, Fallopian tubes, uterus, vagina, bladder, and rectum. Because the ovaries are located deep within the pelvic area, it is unlikely that a manual exam will detect any abnormality while the cancer is still localized. However, a full examination provides the practitioner with a more complete picture. An enlarged ovary does not confirm cancer, as the ovary may be large because of a cyst or **endometriosis**. While women should have an annual **Pap test** to detect **cervical cancer**, this test is ineffective in detecting ovarian cancer.

CA–125 ASSAY. This is a blood test to determine the level of CA–125 (cancer antigen–125), a biomarker or tumor marker. A tumor marker is a measurable protein–based substance given off by the tumor. A series of CA–125 tests may be done to see if the amount of the marker in the blood is stable, increasing, or decreasing. A rising CA–125 level often indicates cancer, while a stable or declining value is more characteristic of a cyst. The CA–125 level should never be used alone to diagnose ovarian cancer. It can be normal in 50% of women with early–stage ovarian cancer. It is elevated in about 80% of women with late–stage ovarian cancer, but in 20% of cases is not elevated. In addition, this is a general biomarker and can be elevated because of a non–ovarian cancer, or from a non–malignant gynecologic conditions such as endometriosis or **ectopic pregnancy**. During menstruation the CA–125 level may be elevated, so the test is best done when the woman is not menstruating period.

IMAGING. Several different imaging techniques are used in evaluating ovarian cancer. Ultrasound uses high–frequency sound waves that create a visual pattern of echoes of the structures at which they are aimed. It often can distinguish between a fluid–filled structure such as a cyst and a solid structure, such as a tumor. Ultrasound is painless and harmless; it is the same technique used to check a developing fetus in the womb. Ultrasound may be done externally through the abdomen and lower pelvic area, or with a transvaginal probe (**transvaginal ultrasound**).

Other painless imaging techniques are computed tomography (CT) and **magnetic resonance imaging** (MRI). Color Doppler analysis provides additional contrast and accuracy in distinguishing masses. These imaging techniques allow better visualization of the internal organs and can detect abnormalities without having to perform surgery.

LOWER GI SERIES. A lower GI series, or **barium enema**, uses a series of x-rays to highlight the colon and rectum. To provide contrast, the patient drinks a chalky liquid containing barium. This test might be done to see if cancer has spread to these areas.

DIAGNOSTIC LAPAROSCOPY. This technique uses a thin hollow lighted instrument inserted through a small incision in abdomen to visualize the organs inside of the abdominal cavity. If the ovary is believed to be malignant, the entire ovary may be removed (**oophorectomy**) and its tissue sent for evaluation to the pathologist, even though only a small piece of the tissue is needed for evaluation. If cancer is present, great care must be taken not to cause the rupture of the malignant tumor, as this could spread cancer cells to adjacent organs. If the cancer is completely contained in the ovary, its removal also functions as the treatment. If the cancer has spread or is suspected to have spread, then a saline solution may be instilled into the cavity and then drawn out again. This technique is called peritoneal lavage. The aspirated fluid will be evaluated for the presence of cancer cells. If peritoneal fluid is present, called **ascites**, a sample of this material will also be drawn and examined for malignant cells. If cancer cells are present in the peritoneum, then treatment will be directed at the abdominal cavity as well.

Treatment

Treatment is based on the stage of cancer at diagnosis and the woman's age.

Clinical staging

Staging is the term used to determine if the cancer is localized or has spread, and if so, how far and to which region(s) of the body. Staging helps define the cancer and will determine the course of suggested treatment. Staging involves examining any tissue samples (biopsies) that have been taken from the ovary, nearby lymph nodes, and any structures where metastasis may be suspected. This may include the diaphragm, lungs, stomach, intestines, and omentum (the tissue covering internal organs), and any fluid, as described above.

The National Cancer Institute Stages uses the Tumor/Node/Metastasis (TNM) system for staging ovarian cancer. Other staging systems such as the International Federation of Gynecology and

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Obstetrics (FIGO) staging system also may be used. The TNM staging system is summarized as follows:

- Stage I: Cancer is confined to one or both ovaries.
- Stage II: Cancer is found in one or both ovaries and/or has spread to the uterus, Fallopian tubes, and/or other body parts within the pelvic cavity.
- Stage III: Cancer is found in one or both ovaries and has spread to lymph nodes or other body parts within the abdominal cavity, such as the surfaces of the liver or intestines.
- Stage IV: Cancer is found in one or both ovaries and has spread to other distant organs such as the lungs.

Individual stages are further subdivided. Accurate staging is important in determining a treatment plan.

Surgery

Surgery is done to remove as much of the tumor as possible (called tissue debulking), usually followed by **chemotherapy** and/or radiation (adjuvant therapy) to target cancer cells that have remained in the body without jeopardizing the woman's health. This can be hard to achieve once the cancer has spread. Removal of the ovary is called oophorectomy, and removal of both ovaries is called bilateral oophorectomy. Unless it is very clear that the cancer has not spread, the Fallopian tubes are removed as well (**salpingo–oophorectomy**). Removal of the uterus is called **hysterectomy**.

If a woman is young and wishes to have children, all attempts will be made to spare the uterus. It is crucial that a woman discuss with her surgeon her childbearing plans before surgery. Ovarian cancer spreads easily and often spreads swiftly throughout the reproductive tract, so may be necessary to remove all reproductive organs as well as part of the lining of the peritoneum to provide the woman with the best possible chance of long–term survival. Fertility–sparing surgery can be successful if the ovarian cancer is diagnosed very early.

Side effects of the surgery will depend on the extent of the surgery, but may include **pain** and temporary difficulty with bladder and bowel function, as well as reaction to the loss of hormones produced by the organs removed. A hormone replacement patch may be applied to the woman's skin in the recovery room to help with the transition. An emotional side effect involve the feeling of loss stemming from the removal of reproductive organs.

Chemotherapy

Chemotherapy is used to target cells that have traveled to other organs, and throughout the body via the lymphatic system or the blood stream (metastasized). Chemotherapy drugs are designed to kill cancer cells, but they also harm to healthy cells. Chemotherapy may be administered through a vein in the arm (intravenous, IV), may be taken in tablet form (orally), and/or may be given through a thin tube called a catheter directly into the abdominal cavity (intraperitoneal). IV and oral chemotherapy drugs travel throughout the body; intraperitoneal chemotherapy is localized in the abdominal cavity.

Side effects of chemotherapy vary greatly depending on the drugs used. Currently, chemotherapy drugs are often used in combinations to treat advanced ovarian cancer, and usually the combination includes a platinum–based drug (such as cisplatin) with a taxol agent, such as paclitaxel. Some of the combinations used or being studied include: carboplatin/paclitaxel, cisplatin/paclitaxel, cisplatin/topotecan, and cisplatin/carboplatin. Antineoplastic agents such as topotecan (Hycamtin) or gemcitabine (Gemzar) that interfere with the ability of the tumor cells to reproduce also may be given. The goal of chemotherapy is to maximize effectiveness with minimum of side effects. Side effects include **nausea and vomiting**, **diarrhea**, decreased appetite and resulting weight loss, **fatigue**, headaches, loss of hair, and **numbness and tingling** (parethesia) in the hands or feet. Managing these side effects is an important part of cancer treatment.

After the full course of chemotherapy has been given, the surgeon may perform a "second look" surgery to examine the abdominal cavity again to evaluate the success of treatment.

Radiation

Radiation uses high–energy, highly focused x-rays to target very specific areas of cancer. This is done using a machine that generates an external energy beam. Careful measurements are taken so that the targeted area can be as focused and small as possible. Another form of radiation uses a radioactive liquid that is administered into the abdominal cavity in the same fashion as intraperitoneal chemotherapy. Radiation usually is given on a daily Monday though Friday schedule and for several weeks. Radiation is not painful, but side effects can include skin damage at the area exposed to the external beam and extreme fatigue. Fatigue may hit suddenly around the third week of treatment and may take a while to resolve even after treatments have terminated. Other side

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effects may include **nausea**, **vomiting**, diarrhea, loss of appetite, weight loss, and urinary difficulties. For patients with incurable ovarian cancer, radiation may be used to shrink tumor masses to provide pain relief and improve quality of life (**palliative care**).

Following treatment, regular follow–up appointments will be scheduled to monitor for any long–term side effects, relapse, or metastases.

Clinical trials

Clinical trials are human research studies. Their goal is to evaluate the effectiveness of new ways to treat cancer. There are many different designs, and they target different aspects of care. For example, some may investigate the response of different chemotherapy drugs, while another study may compare different types of treatment/chemotherapy combinations.

Research studies often are designed to compare the effectiveness of a new treatment method against the standard method or the effectiveness of a drug against a placebo (an inert substance that would be expected to have no effect on the outcome). Since the research is experimental in nature, there are no guarantees about the outcome. New drugs being used may have harmful, unknown side effects. Some people participate to help further knowledge about their disease. For others, the study may provide a possible treatment that is not yet available otherwise. Although there is no cost to participate, participants have to meet certain criteria before being admitted into the study. It is important to fully understand one's role in the study, and weigh the potential risks versus benefits when deciding whether or not to participate. A list of clinical trials currently enrolling patients can be found at http://clinicaltrials.gov.

Alternative and complementary therapies

The term alternative therapy refers to therapy used instead of conventional treatment. By definition, these treatments have not been scientifically proven or investigated as thoroughly and by the same standards as conventional treatments. The terms complementary or integrative therapy denote practices used in conjunction with rather than instead of conventional treatment. Patients should inform their doctors of any alternative or complementary therapies being used or considered as some alternative and complementary therapies adversely affect the effectiveness of conventional treatments. Some common complementary and alternative medicine therapies include:

- prayer and faith healing
- meditation
- mind/body techniques such as support groups, visualization, guided imagery and hypnosis
- energy work such as Therapeutic Touch and Reiki
- acupuncture and traditional Chinese medicine
- body work such as yoga, massage, and t'ai chi
- vitamin, mineral, and/or herbal supplements
- special diets such as vegetarian, vegan, or macrobiotic

Mind/body techniques along with **meditation**, prayer, **yoga**, t'ai chi, and **acupuncture** have been shown to reduce **stress** levels, and the relaxation provided may help boost the body's immune system. The effectiveness of some other complementary and alternative treatments is being studied by the National Institutes of Health's National Center for Complementary and Alternative Medicine (NCCAM). For a current list of the research studies, recent results and publications, patients can visit the NCCAM web site at http://nccam.nih.gov or call (888) 644-6226.

Coping with cancer treatment

While the cancer may only be in part of the body, it is very much a full mind/body experience. Strategies for coping with the treatment need to address the entire range of the experience. Each woman will have different needs. She might want to create a personal support team of friends. They can provide support by:

- Finding helpful information in the library or on the Internet about clinical trials, new therapies or treatments, different treatment centers, etc.
- Providing transportation to and from appointments. A diagnosis of cancer can be overwhelming. In such a stressful and distracted state it is often hard to remember what a doctor has said, or even to remember the questions to be asked. Having a second set of ears during this stressful time can be helpful.
- Helping with household duties so that the woman can rest after treatments and have more energy to devote to her family.
- Assisting with childcare. Children are very much affected by a parent's cancer diagnosis, whether or not they have been fully informed of what is taking place. For a child to go to a friend's house can provide a sense of normalcy and security.
- Being available to participate in activities and conversations not centering on the cancer. While in the midst of cancer treatments, it is important to talk about non–cancer issues as well and to maintain social relationships and activities.

A woman may wish to join a support group of women with ovarian cancer. This group can provide the environment to talk about the diagnosis, the

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treatments, the side effects, and the impact the diagnosis has on her life with others who can empathize. If there is no support group nearby, she may be able to join one on the Internet. Support groups also may exist for caregivers and loved ones.

Prognosis

Prognosis for ovarian cancer depends largely on the stage at which it is first diagnosed. Stage I ovarian cancer has the best survival rate, although ovarian cancer is rarely diagnosed at this stage. The 2009 five–year survival rates for the four stages of ovarian cancer are: stage I, 92.8%; stage II, 78.6%; stage III, 50%; stage IV, 17.5%.

Prevention

Since the cause of ovarian cancer is not known, it is not possible to fully prevent the disease. However, there are ways to reduce one's risks of developing the disease.

Decrease ovulation

Pregnancy temporarily stops ovulation, and multiple pregnancies appear to further reduce the risk of ovarian cancer. The research is not clear as to whether the pregnancy must result in a term delivery to have full benefit. Women who breastfeed their children also appear to have a lower risk of developing the disease. Since oral contraceptives also suppress ovulation, women who take birth-control pills have a lower incidence of ovarian cancer. It appears that the longer a woman takes oral contraceptives, the lower her risk for ovarian cancer. However, since oral contraceptives alter a woman's hormonal status, her risk for other hormonally related cancers may change. The woman should discuss the risks and benefits of oral contraceptives with her health care provider.

Genetic testing

Genetic testing is available that can help determine whether a woman who carries certain genes that increase her risk of breast and ovarian cancer. If a woman tests positive for a BRCA1 or BRCA2 mutation, then she may be able to consider having their ovaries removed as a preventative measure (prophylactic oophorectomy).

Surgery

Procedures such as **tubal ligation** (in which the Fallopian tubes are blocked or tied) and hysterectomy (in which the uterus is removed) appear to reduce the risk of ovarian cancer. However, any removal of the reproductive organs has surgical as well as hormonal side effects.

Screening.

There are no definitive tests or screening procedures as of late 2009 to detect ovarian cancer in its early stages. Women at high risk should consult their physicians about possible regular screenings, which may include transvaginal ultrasound and a blood test for the CA–125 protein. The American Cancer Society recommends annual pelvic examinations for all women after age 40, in order to increase the chances of early detection of both cervical and ovarian cancer.

Early detection remains the key focal point in increasing survival rates for ovarian cancer because the more ovarian cancer has spread, the poorer the chance for survival past one or two years. As women and practitioners become more alert to vague early warning signs and seek out more accurate family histories, earlier awareness may begin to lead to earlier detection and improved survival rates.

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ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd., NE, Atlanta, GA, 30329, (404) 320-3333, (800) ACS-2345, http://www.cancer.org.

Cancer Research and Prevention Foundation, 1600 Duke Street, Suite 500, Alexandria, VA, 22314, (703) 836-4412, (800) 227-2732, info@preventcancer.org, http://www.preventcancer.org.

Gynecologic Cancer Foundation, 230 W. Monroe, Suite 2528, Chicago, IL, 60606, (312) 578-1439, (800) 444-4441, (312) 578-9769, info@thegcf.org, http://www. wcn.org/gcf.

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National Cancer Institute Public Inquires Office., 6116 Executive Boulevard, Room 3036A, Bethesda, MD, 20892-8322, (800) 4-CANCER. TTY (800) 332-8615, http://www.cancer.gov.

National Center for Complementary and Alternative Medicine Clearinghouse, P.O. Box 7923, Gaithersburg, MD, 20898, (301) 519-3153. TTY: (866) 464-3615, (888) 644-6226, (866) 464-3616, info@nccam.nih.gov, http://nccam.nih.gov.

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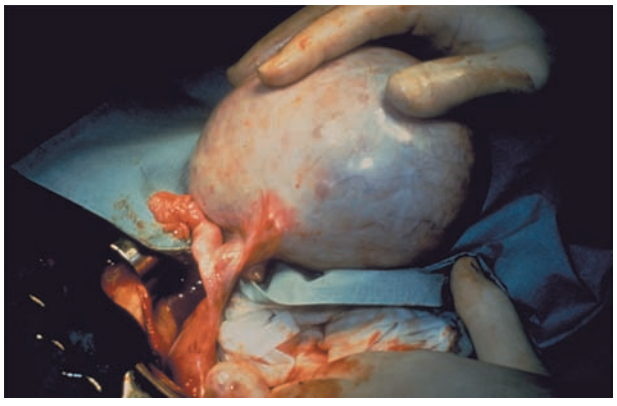
Ovarian cysts

Definition

Ovarian cysts are sacs containing fluid or semisolid material that develop in or on the surface of an ovary.

Description

Ovarian cysts are common, and the vast majority are harmless. Because they cause symptoms that may be the same as ovarian tumors that may be cancerous, ovarian cysts should always be checked out. The most common types of ovarian cysts are follicular and corpus luteum, which are related to the menstrual cycle. Follicular cysts occur when the cyst-like follicle on the ovary in which the egg develops does not burst and release the egg. They are usually small and harmless, disappearing within two to three menstrual cycles. Corpus luteum cysts occur when the corpus luteum—a small, yellow body that secretes hormones—does not dissolve after the egg is released. They usually disappear in a few weeks but can grow to more than 4 in (10 cm) in diameter and may twist the ovary.



An ovarian cyst is being surgically removed from a 25-year-old female patient. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Ovarian cysts can develop at any time in a female's life from infancy to **puberty** to **menopause**, including during **pregnancy**. Follicular cysts occur frequently during the years when a woman is menstruating, and are nonexistent in postmenopausal women or any woman who is not ovulating. Corpus luteum cysts occur occasionally during the menstrual years and during early pregnancy. (Dermoid cysts, which may contain hair, teeth, or skin derived from the outer layer of cells of an embryo, are also occasionally found in the ovary.)

Causes and symptoms

Causes

Follicular cysts are caused by the formation of too much fluid around a developing egg. Corpus luteum cysts are caused by excessive accumulation of blood during the menstrual cycle, hormone therapy, or other types of ovarian tumors.

There is also a condition known as **polycystic ovary syndrome** (PCOS) in which the eggs and follicles are not released from the ovaries and instead form multiple cysts. **Obesity** is linked to this condition, as 50% of women with PCOS are also obese. Hormonal imbalances play a major role in this condition, including high levels of the hormone androgen and low levels of progesterone, the female hormone necessary for egg release. High levels of insulin, the hormone that regulates blood sugar, are often found in women with PCOS. PCOS is also characterized by irregular menstrual periods, **infertility**, and **hirsutism** (excessive hair growth on the body and face). Although PCOS was formerly thought to be an adult-onset condition, more recent research indicates that it begins in childhood, possibly even during fetal development.

PCOS is also known to run in families, which suggests that genetic factors contribute to its development. The specific gene or genes responsible for PCOS have not yet been identified; however, several groups of researchers in different countries have been investigating genetic variations associated with increased risk of type 2 diabetes in order to determine whether the same genetic variations may be involved in PCOS.

In adolescent girls, ovarian cysts may be associated with a genetic disorder known as McCune-Albright syndrome, which is characterized by abnormal bone growth, discoloration of the skin, and early onset of puberty. The ovarian cysts are responsible for the early sexual maturation.

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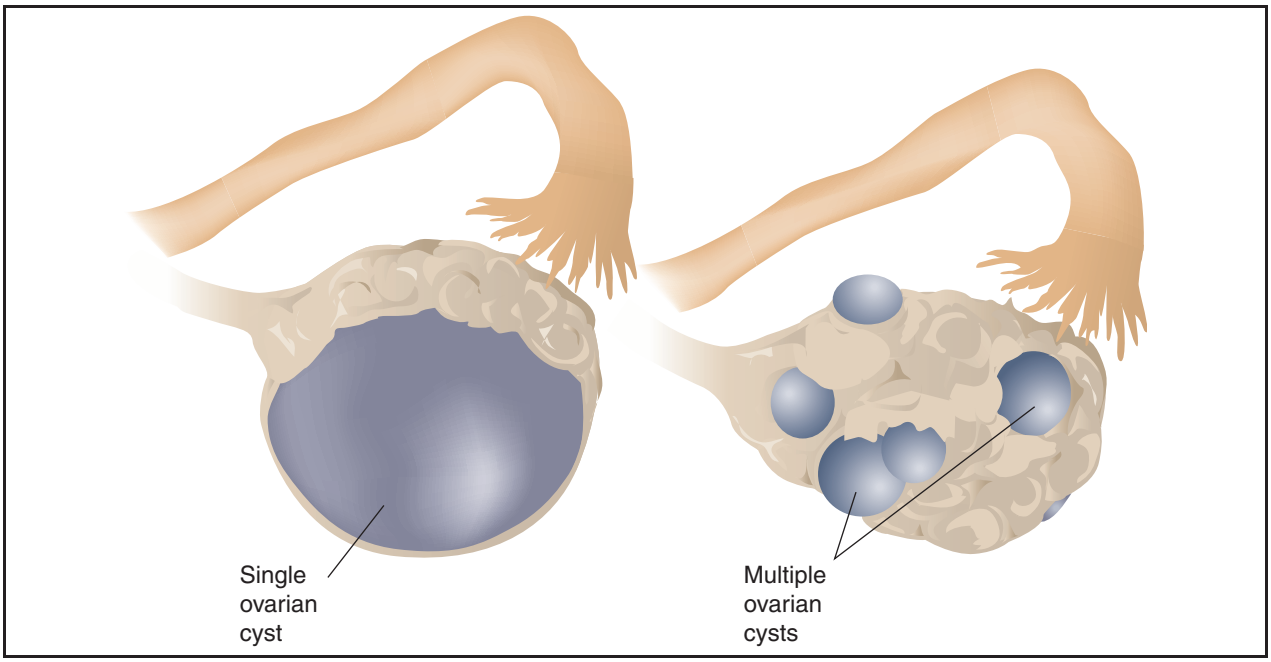

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As of early 2003, McCune-Albright syndrome is known to be associated with mutations in the GNAS1 gene. The mutation is sporadic, which means that it occurs during the child's development in the womb and that the syndrome is not inherited.

Symptoms

Many ovarian cysts have no symptoms. When the growth is large or there are multiple cysts, the patient may experience any of the following symptoms:

- Fullness or heaviness in the abdomen.
- Pressure on the rectum or bladder.
- Pelvic pain that is a constant dull ache and may spread to the lower back and thighs, occurs shortly before the beginning or end of menstruation, or occurs during intercourse.

Diagnosis

Non-symptomatic ovarian cysts are often felt by a doctor examining the ovaries during a routine **pelvic exam**. Symptomatic ovarian cysts are diagnosed through a pelvic exam and ultrasound. Ultrasonography is a painless test that uses a hand-held wand to send and receive sound waves to create images of the ovaries on a computer screen. The images are photographed for later analysis. It takes about 15 minutes and is usually done in a hospital or a physician's office.

Ovarian cysts can be diagnosed in female fetuses by transabdominal ultrasound during the mother's pregnancy.

Treatment

Watchful waiting

Many follicular and corpus luteum cysts require no treatment and disappear on their own. Often the physician will wait and re-examine the patient in four to six weeks before taking any action. Follicular cysts do not require treatment, but birth-control pills may be taken if the cysts interfere with the patient's daily activities.

Most uncomplicated ovarian cysts in female infants resolve on their own shortly after delivery. Complicated cysts are treated by **laparoscopy** or laparotomy after the baby is born.

Medications

McCune-Albright syndrome is treated with testolactone (Teslac), an anti-estrogen drug that corrects the hormonal imbalance caused by the ovarian cysts.

Long-term management of PCOS has been complicated in the past by lack of a clear understanding of the causes of the disorder. Most commonly, hormonal therapy has been recommended, including estrogen and progesterone and such other hormone-regulating

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drugs as ganirelix (Antagon). Birth-control pills have also been prescribed by doctors to regulate the menstrual cycle and to shrink functional cysts.

More recent studies have shown that increasing sensitivity to insulin in women with PCOS leads to improvement in both the hormonal and metabolic symptoms of the disorder. This sensitivity is increased by either weight loss and **exercise** programs or by medications. Metformin (Glucophage), a drug originally developed to treat type 2 diabetes, has been shown to be effective in reducing the symptoms of hyperandrogenism as well as **insulin resistance** in women with PCOS.

Another strategy that is being tried with PCOS is administration of flutamide (Eulexin), a drug normally used to treat **prostate cancer** in men. Preliminary results indicate that the antiandrogenic effects of flutamide benefit patients with PCOS by increasing blood flow to the uterus and ovaries.

Surgery

Surgery is usually indicated for patients who have not reached puberty and have an ovarian mass and in postmenopausal patients. Surgery is also indicated if the growth is larger than 4 in (10 cm), complex, growing, persistent, solid and irregularly shaped, on both ovaries, or causes **pain** or other symptoms. Ovarian cysts are curable with surgery but often recur without it.

Surgical options include removal of the cyst or removal of one or both ovaries. More than 90% of benign ovarian cysts can be removed using laparoscopy, a minimally invasive outpatient procedure. In laparoscopic **cystectomy**, the patient receives a general or local anesthetic, then a small incision is made in the abdomen. The laparoscope is inserted into the incision and the cyst or the entire ovary is removed. Laparoscopic cystectomy enables the patient to return to normal activities within two weeks. Surgical cystectomy to remove cysts and/or ovaries is performed under **general anesthesia** in a hospital and requires a stay of five to seven days. After an incision is made in the abdomen, the muscles are separated and the membrane surrounding the abdominal cavity (peritoneum) is opened. Blood vessels to the ovaries are clamped and tied. The cyst is located and removed. The peritoneum is closed, and the abdominal muscles and skin are closed with sutures or clips. Recovery takes four weeks.

A surgical procedure known as ovarian wedge resection appears to improve fertility in women with PCOS who have not responded to drug treatments. In an ovarian wedge resection, the surgeon removes a portion of the polycystic ovary in order to induce ovulation.

KEY TERMS

Corpus luteum—A small, yellow structure that forms in the ovary after an egg has been released.

Cystectomy—Surgical removal of a cyst.

Dermoid—A skin-like benign growth that may appear on the ovary and resemble a cyst.

Endocrine—Internal secretions, usually in the systemic circulation.

Follicular—Relating to one of the round cells in the ovary that contain an ovum.

Hirsutism—A condition marked by excessive hair growth on the face and body.

Functional cyst—A benign cyst that forms on the ovary and resolves on its own without treatment.

McCune-Albright syndrome (MCAS)—A genetic syndrome characterized in girls by the development of ovarian cysts and puberty before the age of eight, together with abnormalities of bone structure and skin pigmentation.

Ovulation—The phase of the female monthly cycle when a developed egg is released from the ovary into the fallopian tube for possible fertilization.

Polycystic ovarian syndrome (PCOS)—A condition in which the eggs are not released from the ovaries and instead form multiple cysts.

Alternative treatment

Alternative treatments for ovarian problems—herbal therapies, **nutrition** and diet, and homeopathy—should be used to supplement, not replace, conventional treatment. General herbal tonics for female reproductive organs that can be taken in tea or tincture (an alcohol-based herbal extract) form include blue cohosh (*Caulophylum thalictroides*) and false unicorn root (*Chamaelirium luteum*). Recommendations to help prevent and treat ovarian cysts include a vegan diet (no dairy or animal products) that includes beets, carrots, dark-green leafy vegetables, and lemons; anitoxidant supplements including zinc and **vitamins** A, E, and C; as well as black currant oil, borage oil, and evening primrose oil (*Oenothera biennis*) supplements. Homeopathic treatments—tablets, powders, and liquids prepared from plant, mineral, and animal extracts—may also be effective in treating ovarian cysts. Castor oil packs can help

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reduce inflammation. **Hydrotherapy** applied to the abdomen can help prevent rupture of the cyst and assist its reabsorption.

Prognosis

The prognosis for non-cancerous ovarian cysts is excellent.

Prevention

Ovarian cysts cannot be prevented.

Resources

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ORGANIZATIONS

American College of Obstetricians and Gynecologists (ACOG), P.O. Box 96920, Washington, DC, 20090-6920, (202)638-5577, http://www.acog.org.

American Institute of Ultrasound in Medicine, 14750 Sweitzer Lane, Suite 100, Laurel, MD, 20707-5906, (301)498-4100, (301)498-4450, http://www.aium.org.

Polycystic Ovarian Syndrome Association, P.O. Box 3403, Englewood, CO, 80155-3403, info@pcosupport.org, http://www.pcosupport.org.

Lori De Milto
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Ovarian torsion

Definition

Ovarian torsion is the twisting of the ovary due to the influence of another condition or disease. This results in extreme lower abdominal **pain**.

Description

Ovarian torsion occurs infrequently only in females. In can occur in women of all ages, but most women who experience this are younger. Approximately 70-75% of cases occur in women under 30 years old. About 20% of all reported cases are in pregnant women. It is the fifth most common gynecological emergency which can include surgical intervention.

Ovarian torsion usually arises in only one ovary at a time. They can occur in either normal or enlarged ovaries and fallopian tubes, and occasionally they develop in both.

Causes and symptoms

A variety of conditions that can cause torsion of the ovary ranging from changes in normal ovaries to congenital and developmental abnormalities or even a

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KEY TERMS

Congenital—Condition present at birth.

Laparoscopy—Endoscope used to observe structures in the abdomen.

Mesosalpinx—A ligament connected to the fallopian tube.

Ovary—Female reproductive gland that contains the ova (eggs).

Tachycardia—Rapidly beating heart.

Torsion—The action of twisting.

disease that affects the tube or ovary. Normal ovaries that experience spasms or changes in the blood vessels in the mesosalpinx can become twisted. For example, if the veins in the mesosalpinx become congested, the ovaries will undergo torsion.

Developmental abnormalities of the fallopian tube such as extremely longer-than-normal tubes or a missing mesosalpinx will cause ovarian torsion. Diseases such as **ovarian cysts** or fibromas, tumor of the ovary or tubes, and trauma to either the ovaries or the tubes will also cause ovarian torsion.

The characteristic symptom of ovarian torsion is the sudden onset of extreme lower abdominal pain that radiates to the back, side and thigh. **Nausea**, **vomiting**, **diarrhea**, and **constipation** can accompany the pain. The patient may also experience tenderness in the lower abdominal area, a mild **fever** and tachycardia.

Diagnosis

The diagnosis of ovarian torsions usually occurs in an emergency room due to the suddenness of extreme pain. Emergency room physicians may consult with another physician specializing in obstetrics and gynecology. Since 20% of ovarian torsions occur in pregnant women, physicians will order a **pregnancy** test. Visualization with an ultrasound and CT scan (computed tomography) will help pinpoint the ovarian structures and allow physicians to diagnose. Diagnosis is often confirmed through **laparoscopy**.

Treatment

Ovarian torsions need to be repaired. This is done through surgery, and for less severe cases laparoscopic surgery is used. Medications such as NSAIDs are given to control pain.

Prognosis

If ovarian torsions are diagnosed and treated early, then the prognosis is favorable. However, if diagnosis is delayed, the torsions can worsen and cut off arterial blood flow into and venous blood flow out of the ovary. This results in necrosis (**death**) of the ovarian tissue. Delayed diagnosis can also result in problems when trying to conceive due to **infertility**.

Prevention

Currently, there are no known methods for prevention of ovarian torsion.

Sally C. McFarlane-Parrott

Ovary and fallopian tube removal *see* **Salpingo-oophorectomy**

Ovary removal *see* **Oophorectomy**

Overactive bladder

Definition

Overactive bladder is the leakage of large amounts of urine at unexpected times, including during sleep.

Description

People who lose urine for no apparent reason while suddenly feeling the need or urge to urinate may have overactive bladder. The condition effects 17 million in the United States. The most common cause of overactive bladder is inappropriate bladder contractions. Medical professionals describe such a bladder as "unstable," "spastic," or "overactive." A doctor might call the condition "reflex incontinence" if it results from overactive nerves controlling the bladder. Having an overactive bladder can mean that the bladder empties during sleep, after drinking a small amount of water, or when touching water or hearing it running (as when someone else is taking a shower or washing dishes). Involuntary actions of bladder muscles can occur because of damage to the nerves of the bladder, to the nervous system (spinal cord and brain), or to muscles themselves. **Multiple sclerosis**, Parkinson's disease, **Alzheimer's disease**, **stroke**, brain tumors, and injury—including injury that occurs during surgery—all can harm bladder nerves or muscles.

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KEY TERMS

Alzheimer's disease—A degenerative disorder that affects the brain and causes dementia, especially late in life.

Biofeedback—The use of monitoring devices that display information about the operation of a bodily function, for example, heart rate or blood pressure, that is not normally consciously controlled.

Cystoscopy—The use of a narrow tubular instrument that is passed through the urethra to examine the interior of the urethra and the urinary bladder.

Estrogen—Any of several steroid hormones, produced mainly in the ovaries, that stimulate estrus and the development of female secondary sexual characteristics.

Multiple sclerosis—A serious progressive disease of the central nervous system.

Parkinson's disease—An incurable nervous disorder marked by the symptoms of trembling hands, lifeless face, monotone voice, and a slow, shuffling walk.

Sphincter—A circular band of muscle that surrounds an opening or passage in the body and narrows or closes the opening by contracting.

Urethal—Referring to the tube in humans that carries urine from the bladder out of the body.

Urogynecologist—A physician that deals with women's health, especially with the health of women's reproductive organs and urinary tract.

Urologist—A physician who deals with the study and treatment of disorders of the urinary tract in women and the urogenital system in men.

Causes and symptoms

People with overactive bladder lose urine as soon as they feel a strong need to go to the bathroom. People with overactive bladder may leak urine:

- when they can not get to the bathroom quickly enough
- when they drink even a small amount of liquid
- when they hear or touch running water

People with overactive bladder may also go to the bathroom very often; for example, every two hours during the day and night. They may even wet the bed.

Diagnosis

To diagnose the problem, a doctor will first ask about symptoms and medical history. Other obvious factors that can help define the problem include straining and discomfort, use of drugs, recent surgery, and illness. If the patient's medical history does not define the problem, it will at least suggest which tests are needed. The doctor will physically examine the patient for signs of medical conditions causing the overactive bladder, such as tumors that block the urinary tract, stool impaction, and poor reflexes or sensations, which may be evidence of a nerve-related cause. Overactive bladder is often treated by general or family practicioners but the patient may be referred to a urologist, who specializes in the urinary tract, or a urogynecologist, who focuses on urological problems in women.

Common tests used to diagnose overactive bladder include:

- blood tests to examine blood for levels of various chemicals
- cystoscopy to look for abnormalities in the bladder and lower urinary tract. It works by inserting a small tube into the bladder that has a telescope for the doctor to look through.
- post-void residual (PVR) measurement to see how much urine is left in the bladder after urinating by placing a small soft tube into the bladder or by using ultrasound (sound waves)
- urinalysis to examine urine for signs of infection, blood, or other abnormalities
- urodynamic testing to examine bladder and urethral sphincter function (may involve inserting a small tube into the bladder; x-rays also can be used to see the bladder)

Treatment

Medications can reduce many types of leakage. Some drugs inhibit contractions of an overactive bladder. Others, such as solifenacin succinate (Vesicare), relax muscles, leading to more complete bladder emptying during urination. Some drugs tighten muscles at the bladder neck and urethra, preventing leakage. Among the drugs used are oxybutynin (Ditropan XL), 5-30 mg daily; solifenacin (Vesicare), 5-10 mg a day; darifenacin (Enablex), 3.75-15 mg daily; and tolterodine (Detrol), 2-4 mg daily. A one-month supply of these drugs costs $90-

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125. Some medications, especially hormones such as estrogen, are believed to cause muscles involved in urination to function normally. Some of these medications can produce harmful side effects if used for long periods. In particular, estrogen therapy has been associated with an increased risk for cancers of the breast and the lining of the uterus. Patients should talk to their doctor about the risks and benefits of long-term use of medications.

Alternative treatment

Adjusting dietary habits and avoiding acidic and spicy foods, alcohol, **caffeine**, and other bladder irritants can help to prevent urinary leaking. Eat recommended amounts of whole grains, fruits, and vegetables to avoid **constipation**. **Bladder training**, used to treat urge incontinence, can also be a useful treatment tool. The technique involves placing a patient on a toileting schedule. The time interval between urination is then gradually increased until an acceptable time period between bathroom breaks is consistently achieved.

Biofeedback techniques can teach overactive bladder patients to control the urge to urinate. Biofeedback uses sensors to monitor temperature and muscle contractions in the vagina to help overactive bladder patients learn to increase their control over the pelvic muscles.

An infusion, or tea, of horsetail *(Equisetum arvense)*, agrimony *(Agrimonia eupatoria)*, and sweet sumach *(Rhus aromatica)* may be prescribed by an herbalist or naturopath to an overactive bladder. These herbs are natural astringents, and encourage toning of the digestive and urinary tracts. Other herbs, such as urtica, or stinging nettle *(Urtica urens)*, plantain *(Plantago major)*, or maize *(Zea mays)* may be helpful. Homeopathic remedies may include pulsatilla and causticum. Chinese herbalists might recommend golden lock tea, a mixture of several herbs that helps the body retain fluids.

Prognosis

With proper treatment, the prognosis for controlling the disorder is very good. There is no cure for overactive bladder.

Prevention

There are no known preventative measures for overactive bladder.

Resources

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ORGANIZATIONS

National Bladder and Bowel Foundation, www.bladderandbowelfoundation.org.

Ken R. Wells

Overhydration

Definition

Overhydration, also called water excess or water intoxication, is a condition in which the body contains too much water.

Description

Overhydration occurs when the body takes in more water than it excretes and its normal **sodium** level is diluted. This can result in digestive problems, behavioral changes, brain damage, seizures, or **coma**. An adult whose heart, kidneys, and pituitary gland are functioning properly would have to drink more than two gallons of water a day to develop water intoxication. This condition is most common in patients whose kidney function is impaired and may occur when doctors, nurses, or other healthcare professionals administer greater amounts of water-producing fluids and medications than the patient's body can excrete. Overhydration is the most common electrolyte imbalance in hospitals, occurring in about 2% of all patients.

Infants seem to be at greater risk for developing overhydration. The Centers for Disease Control and Prevention has declared that babies are especially

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susceptible to oral overhydration during the first month of life, when the kidneys' filtering mechanism is too immature to excrete fluid as rapidly as older infants do. Breast milk or formula provide all the fluids a healthy baby needs. Water should be given slowly, sparingly, and only during extremely hot weather. Overhydration, which has been cited as a hazard of infant swimming lessons, occurs whenever a baby drinks too much water, excretes too little fluid, or consumes and retains too much water.

Causes and symptoms

Drinking too much water rarely causes overhydration when the body's systems are working normally. People with heart, kidney, or **liver disease** are more likely to develop overhydration because their kidneys are unable to excrete water normally. It may be necessary for people with these disorders to restrict the amount of water they drink and/or adjust the amount of salt in their **diets**.

Since the brain is the organ most susceptible to overhydration, a change in behavior is usually the first symptom of water intoxication. The patient may become confused, drowsy, or inattentive. Shouting and **delirium** are common. Other symptoms of overhydration may include blurred vision, **muscle cramps** and twitching, **paralysis** on one side of the body, poor coordination, **nausea and vomiting**, rapid breathing, sudden weight gain, and weakness. The patient's complexion is normal or flushed. Blood pressure is sometimes higher than normal, but elevations may not be noticed even when the degree of water intoxication is serious.

Overhydration can cause acidosis (a condition in which blood and body tissues have an abnormally high acid content), anemia, **cyanosis** (a condition that occurs when oxygen levels in the blood drop sharply), hemorrhage, and **shock**. The brain is the organ most vulnerable to the effects of overhydration. If excess fluid levels accumulate gradually, the brain may be able to adapt to them and the patient will have only a few symptoms. If the condition develops rapidly, confusion, seizures, and coma are likely to occur.

Risk factors

Chronic illness, **malnutrition**, a tendency to retain water, and kidney diseases and disorders increase the likelihood of becoming overhydrated. Infants and the elderly seem to be at increased risk for overhydration, as are people with certain mental disorders or **alcoholism**.

Diagnosis

Before treatment can begin, a doctor must determine whether a patient's symptoms are due to overhydration, in which excess water is found within and outside cells, or excess blood volume, in which high sodium levels prevent the body from storing excess water inside the cells. Overhydration is characterized by excess water both within and around the body's cells, while excess blood volume occurs when the body has too much sodium and cannot move water to reservoirs within the cells. In cases of overhydration, symptoms of fluid accumulation do not usually occur. On the other hand, in cases of excess blood volume, fluid tends to accumulate around cells in the lower legs, abdomen, and chest. Overhydration can occur alone or in conjunction with excess blood volume, and differentiating between these two conditions may be difficult.

Treatment

Mild overhydration can generally be corrected by following a doctor's instructions to limit fluid intake. In more serious cases, **diuretics** may be prescribed to increase urination, although these drugs tend to be most effective in the treatment of excess blood volume. Identifying and treating any underlying condition (such as impaired heart or kidney function) is a priority, and fluid restrictions are a critical component of every treatment plan.

In patients with severe neurologic symptoms, fluid imbalances must be corrected without delay. A powerful diuretic and fluids to restore normal sodium concentrations are administered rapidly at first. When the patient has absorbed 50% of the therapeutic substances, blood levels are measured. Therapy is continued at a more moderate pace in order to prevent brain damage as a result of sudden changes in blood chemistry.

Prognosis

Mild water intoxication is usually corrected by drinking less than a quart of water a day for several days. Untreated water intoxication can be fatal, but this outcome is quite rare.

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American College of Sports Medicine (ACSM), 401 West Michigan Street, P.O. Box 1440, Indianapolis, IN, 46202-3233, (317)637-9200, (317)634-7817, http://www.acsm.org.

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Oxycodone *see* **Analgesics, opioid**

Oxygen inhalation therapy *see* **Oxygen/ozone therapy**

Oxygen/ozone therapy

Definition

Oxygen/ozone therapy is a term that describes a number of different practices in which oxygen, ozone, or hydrogen peroxide are administered via gas or water to kill disease microorganisms, improve cellular function, and promote the healing of damaged tissues. The rationale behind bio-oxidative therapies, as they are sometimes known, is the notion that as long as the body's needs for **antioxidants** are met, the use of certain oxidative substances will stimulate the movement of oxygen atoms from the bloodstream to the cells. With higher levels of oxygen in the tissues, bacteria and viruses are killed along with defective tissue cells. The healthy cells survive and multiply more rapidly. The result is a stronger immune system.

Ozone itself is a form of oxygen, O_3, produced when ultraviolet light or an electric spark passes through air or oxygen. It is a toxic gas that creates free radicals, the opposite of what antioxidant **vitamins** do. Oxidation, however, is good when it occurs in harmful foreign organisms that have invaded the body. Ozone inactivates many disease bacteria and viruses.

Purpose

Oxygen and ozone therapies are thought to benefit patients in the following ways:

- stimulating white blood cell production
- killing viruses (ozone and hydrogen peroxide)
- improving the delivery of oxygen from the blood stream to the tissues of the body
- speeding up the breakdown of petrochemicals
- increasing the production of interferon and tumor necrosis factor, thus helping the body to fight infections and cancers
- increasing the efficiency of antioxidant enzymes
- increasing the flexibility and efficiency of the membranes of red blood cells
- speeding up the citric acid cycle, which in turn stimulates the body's basic metabolism

Description

Origins

The various forms of oxygen and ozone therapy have been in use since the late nineteenth century. The earliest recorded use of oxygen to treat a patient was by Dr. J. A. Fontaine in 1879. In the 1950s, hyperbaric oxygen treatment was used by **cancer** researchers. The term "hyperbaric" means that the oxygen is given under pressure higher than normal air pressure. Recently, oxygen therapy has also been touted as a quick purification treatment for mass-market consumers. Oxygen bars can be found in airports and large cities, and provide pure oxygen in 20-minute sessions for approximately $16. While proponents claim that breathing oxygen will purify the body, most medical doctors do not agree. What is more, oxygen can be harmful to people with severe lung diseases, and these people should never self-treat with oxygen.

Ozone has been used since 1856 to disinfect operating rooms in European hospitals, and since 1860 to purify the water supplies of several large German cities. Ozone was not, however, used to treat patients until 1915, when a German doctor named Albert Wolff began to use it to treat skin diseases. During World War I, the German Army used ozone to treat **wounds** and **anaerobic infections**. In the 1950s, several German physicians used ozone to treat cancer alongside mainstream therapeutic methods. It is estimated that as of the late 1990s, about 8,000 practitioners in Germany were using ozone in their practices. This figure includes medical doctors as well as naturopaths and homeopaths.

Hydrogen peroxide is familiar to most people as an over-the-counter preparation that is easily available at supermarkets as well as pharmacies, and is used as an antiseptic for cleansing minor cuts and scrapes. It was first used as an intravenous infusion in 1920 by a British physician in India, T. H. Oliver, to treat a group of 25 Indian patients who were critically ill with **pneumonia**. Oliver's patients had a mortality rate of 48%, compared to the standard mortality rate of 80% for the disease. In the 1920s, a U.S. physician named William Koch experimented with hydrogen

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peroxide as a treatment for cancer. He left the United States after a legal battle with the FDA. In the early 1960s, researchers at Baylor University studied the effects of hydrogen peroxide in removing plaque from the arteries as well as its usefulness in treating cancer, but their findings were largely ignored.

Oxygen, ozone, and hydrogen peroxide are used therapeutically in a variety of different ways.

Hyperbaric oxygen therapy (HBO)

Hyperbaric oxygen therapy (HBO) involves putting the patient in a pressurized chamber in which he or she breathes pure oxygen for a period of 90 minutes to two hours. HBO may also be administered by using a tight-fitting mask, similar to the masks used for anesthesia. A nasal catheter may be used for small children.

Ozone therapy

Ozone therapy may be administered in a variety of ways.

- Intramuscular injection: A mixture of oxygen and ozone is injected into the muscles of the buttocks.
- Rectal insufflation: A mixture of oxygen and ozone is introduced into the rectum and absorbed through the intestines.
- Autohemotherapy: Between 10–15 mL of the patient's blood is removed, treated with a mixture of oxygen and ozone and reinjected into the patient.
- Intra-articular injection: Ozone-treated water is injected into the patient's joints to treat arthritis, rheumatism and other joint diseases.
- Ozonated water: Ozone is bubbled through water that is used to cleanse wounds, burns, and skin infections, or to treat the mouth after dental surgery.
- Ozonated oil: Ozone is bubbled through olive or safflower oil, forming a cream that is used to treat fungal infections, insect bites, acne, and skin problems.
- Ozone bagging: Ozone and oxygen are pumped into an airtight bag that surrounds the area to be treated, allowing the body tissues to absorb the mixture.

Hydrogen peroxide

Hydrogen peroxide may be administered intravenously in a 0.03% solution. It is infused slowly into the patient's vein over a period of one to three hours. Treatments are given about once a week for chronic illness but may be given daily for such acute illnesses as pneumonia or **influenza**. A course of intravenous hydrogen peroxide therapy may range from one to 20 treatments, depending on the patient's condition and the type of illness being treated. Injections of 0.03% hydrogen peroxide have also been used to treat rheumatoid and **osteoarthritis**. The solution is injected directly into the inflamed joint.

Hydrogen peroxide is also used externally to treat stiff joints, **psoriasis**, and fungal infections. The patient soaks for a minimum of 20 minutes in a tub of warm water to which one pint of 35% food-grade hydrogen peroxide (a preparation used by the food industry as a disinfectant) has been added.

Preparations

Oxygen is usually delivered to the patient as a gas; ozone as a gas mixed with oxygen or bubbled through oil or water; and hydrogen peroxide as an 0.03% solution for intravenous injection or a 35% solution for external **hydrotherapy**.

Precautions

Patients interested in oxygen/ozone therapies must consult with a physician before receiving treatment. Hyperbaric oxygen treatment should not be given to patients with untreated **pneumothorax**, a condition in which air or gas is present in the cavity surrounding the lungs. Patients with a history of pneumothorax, chest surgery, **emphysema**, middle **ear surgery**, uncontrolled high fevers, upper respitory infections, seizures, or disorders of the red blood cells are not suitable candidates for oxygen/ozone therapy. In addition, patients should be aware that oxygen is highly flammable. If treatments are administered incorrectly or by an unskilled person, there is a risk of fire.

Side effects

Typical side effects of oxygen or ozone therapy can include elevated blood pressure and ear pressure similar to that experienced while flying. Side effects may also include **headache**, **numbness** in the fingers, temporary changes in the lens of the eye, and seizures.

Research and general acceptance

Oxygen/ozone therapies are far more widely accepted in Europe than in the United States. The most intensive research in these therapies is presently being conducted in the former Soviet Union and in Cuba. In the United States, the work of the Baylor researchers was not followed up. In 2000, the Office of Alternative Medicine of the National Institutes of Health (presently the National Center for Complementary and Alternative Medicine, or NCCAM) indicated interest in conducting clinical trials of oxygen/

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KEY TERMS

Autohemotherapy—A form of ozone therapy in which a small quantity of the patient's blood is withdrawn, treated with a mixture of ozone and oxygen, and reinfused into the patient.

Hydrogen peroxide—A colorless, unstable compound of hydrogen and oxygen (H_2O_2). An aqueous solution of hydrogen peroxide is used as an antiseptic and bleaching agent.

Hyperbaric oxygen therapy (HBO)—A form of oxygen therapy in which the patient breathes oxygen in a pressurized chamber.

Ozone—A form of oxygen with three atoms in its molecule (O_3), produced by an electric spark or ultraviolet light passing through air or oxygen. Ozone is used therapeutically as a disinfectant and oxidative agent.

ozone therapies; as of 2008, however, these studies have not been carried out.

In 2006, the National Heart, Lung, and Blood Institute (NHLBI), part of the National Institutes of Health (NIH), and the Centers for Medicare and Medicaid Services launched a large-scale clinical trial of the effectiveness and safety of long-term, home oxygen therapy for people with **chronic obstructive pulmonary disease** (COPD). The six-year study of about 3,500 people with moderate COPD is being conducted at 14 medical facilities in the United States, including Ohio State University, Los Angeles Biomedical Research Institute, and Duke University.

Recent European research in ozone therapy includes studies in the oxygenation of resting muscles, the treatment of vascular disorders, and the relief of **pain** from herniated lumbar disks. No corresponding studies are being done in the United States as of early 2008.

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ORGANIZATIONS

American Institute of Homeopathy, 101 South Whiting Street, Suite 16, Alexandria, VA, 22304, (888)445-9988, admin@homeopathyusa.org, http://www.homeopathyusa.org.

Australian Homeopathic Association, P.O. Box 7108, Toowoomba, Australia, (07)4646 4380, (07)4646 4393, admin@homeopathyoz.org, http://www.homeopathyoz.org.

Council for Homeopathic Certification, PMB 187, 16915 SE 272nd St., Suite 100, Covington, WA, 98042, (815)366-7622, (866)242-3399, http://www.homeopathicdirectory.com.

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Oxymetazoline *see* **Decongestants**

Oxytocin *see* **Drugs used in labor**

Ozone therapy *see* **Oxygen/ozone therapy**

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P

PAC *see* **Atrial ectopic beats**

Pacemaker implantation *see* **Pacemakers**

Pacemakers

Definition

A pacemaker is a surgically implanted electronic device that regulates a slow or erratic heartbeat.

Purpose

Pacemakers are implanted to regulate irregular contractions of the heart (arrhythmia). They are most frequently prescribed to speed the heartbeat of patients who have a heart rate well under 60 beats per minute (severe symptomatic bradycardia). They are also used in some cases to slow a fast heart rate (tachycardia).

Precautions

The symptoms of **fatigue** and lightheadedness that are characteristic of bradycardia can also be caused by a number of other medical conditions, including anemia. Certain prescription medications can also slow the heart rate. A doctor should take a complete medical history and perform a full physical work-up to rule out all non-cardiac causes of bradycardia.

Patients with cardiac pacemakers should not undergo a **magnetic resonance imaging** (MRI) procedure. Devices that emit electromagnetic waves (including magnets) may alter pacemaker programming or functioning. A 1997 study found that cellular phones often interfere with pacemaker programming and cause irregular heart rhythm. However, advances in pacemaker design and materials have greatly reduced the risk of pacemaker interference from electromagnetic fields.

Description

Approximately 500,000 Americans have an implantable permanent pacemaker device. A pacemaker implantation is performed under **local anesthesia** in a hospital by a surgeon assisted by a cardiologist. An insulated wire called a lead is inserted into an incision above the collarbone and guided through a large vein into the chambers of the heart. Depending on the configuration of the pacemaker and the clinical needs of the patient, as many as three leads may be used in a pacing system. Current pacemakers have a double, or bipolar, electrode attached to the end of each lead. The electrodes deliver an electrical charge to the heart to regulate heartbeat. They are positioned on the areas of the heart that require stimulation. The leads are then attached to the pacemaker device, which is implanted under the skin of the patient's chest.

Patients undergoing surgical pacemaker implantation usually stay in the hospital overnight. Once the procedure is complete, the patient's vital signs are monitored and a **chest x ray** is taken to ensure that the pacemaker and leads are properly positioned.

Modern pacemakers have sophisticated programming capabilities and are extremely compact. The smallest weigh less than 13 grams (under half an ounce) and are the size of two stacked silver dollars. The actual pacing device contains a pulse generator, circuitry programmed to monitor heart rate and deliver stimulation, and a lithiumiodide battery. Battery life typically ranges from seven to 15 years, depending on the number of leads the pacemaker is configured with and how much energy the pacemaker uses. When a new battery is required, the unit can be exchanged in a simple outpatient procedure.

A temporary pacing system is sometimes recommended for patients who are experiencing irregular heartbeats as a result of a recent **heart attack** or other acute medical condition. The implantation procedure for the pacemaker leads is similar to that for a

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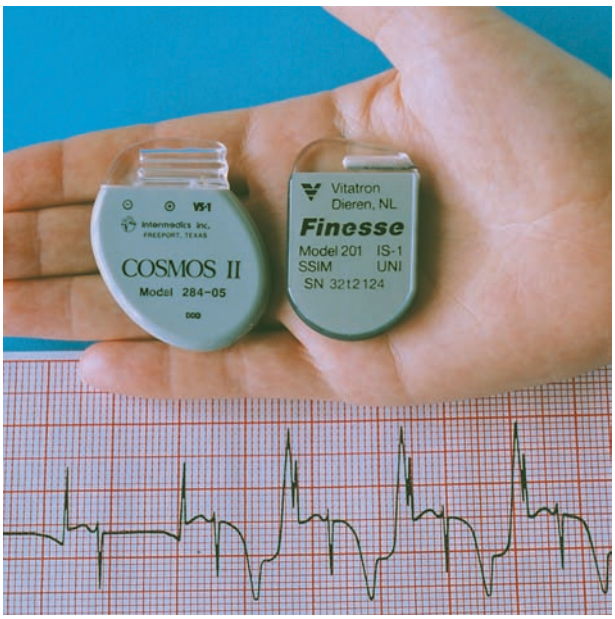

Pacemakers like these are usually implanted under the skin below the collarbone. The pacemaker is connected to the heart by a wire inserted into a major vein in the neck and guided down into the heart. *(Eamonn McNulty/Photo Researchers, Inc.)*

KEY TERMS

Electrocardiogram (ECG)—A recording of the electrical activity of the heart. An ECG uses externally attached electrodes to detect the electrical signals of the heart.

Electrophysiological study—A test that monitors the electrical activity of the heart in order to diagnose arrhythmia. An electrophysiological study measures electrical signals through a cardiac catheter that is inserted into an artery in the leg and guided up into the atrium and ventricle of the heart.

Embolism—A blood clot, air bubble, or clot of foreign material that blocks the flow of blood in an artery. When an embolism blocks the blood supply to a tissue or organ, the tissue the artery feeds dies (infarction). Without immediate and appropriate treatment, an embolism can be fatal.

Magnetic resonance imaging (MRI)—An imaging technique that uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

permanent pacing system, but the actual pacemaker unit housing the pulse generator remains outside the patient's body. Temporary pacing systems may be replaced with a permanent device at a later date.

Preparation

Patients being considered for pacemaker implantation will undergo a full battery of cardiac tests, including an electrocardiogram (ECG) or an electrophysiological study or both to fully evaluate the bradycardia or tachycardia.

Patients are advised to abstain from eating 6-8 hours before the surgical procedure. The patient is usually given a sedative to help him or her relax for the procedure. An intravenous (IV) line will also be inserted into a vein in the patient's arm before the procedure begins in case medication or blood products are required during the insertion.

Aftercare

Pacemaker patients should schedule a follow-up visit with their cardiologist approximately six weeks after the surgery. During this visit, the doctor will make any necessary adjustments to the settings of the pacemaker. Pacemakers are programmed externally with a handheld electromagnetic device. Pacemaker batteries must be checked regularly. Some pacing systems allow patients to monitor battery life through a special telephone monitoring service that can read pacemaker signals.

Risks

Because pacemaker implantation is an invasive surgical procedure, internal bleeding, infection, hemorrhage, and **embolism** are all possible complications. Infection is more common in patients with temporary pacing systems. Antibiotic therapy given as a precautionary measure can reduce the risk of pacemaker infection. If infection does occur, the entire pacing system may have to be removed.

The placing of the leads and electrodes during the implantation procedure also presents certain risks for the patient. The lead or electrode could perforate the heart or cause scarring or other damage. The electrodes can also cause involuntary stimulation of nearby skeletal muscles.

A complication known as *pacemaker syndrome* develops in approximately 7% of pacemaker patients with single-chamber pacing systems. The syndrome is characterized by the low blood pressure and **dizziness** that are symptomatic of bradycardia. It can usually be

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corrected by the implantation of a dual-chamber pacing system.

Normal results

Pacemakers that are properly implanted and programmed can correct a patient's arrhythmia and resolve related symptoms.

ORGANIZATIONS

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Paula Anne Ford-Martin

Packed cell volume *see* **Hematocrit**

Packed red blood cell volume *see* **Hematocrit**

Paget's disease of bone

Definition

Paget's disease of bone (*osteitis deformans*) is the abnormal formation of bone tissue that results in weakened and deformed bones.

Description

Named for Sir James Paget (1814–1899), this disease affects 1–3% of people over 50 years of age, but affects over 10% of people over 80 years of age. Paget's disease can affect one or more bones in the body. Most often, the pelvis, bones in the skull, the long bones (the large bones that make up the arms and legs), and the collarbones are affected by Paget's disease. In addition, the joints between bones (the knees or elbows, for example) can develop arthritis because of this condition.

Paget's disease is characterized by changes in the normal mechanism of bone formation. Bone is a living material made by the body through the continual processes of formation and breakdown (resorption). The combination of these two actions is called remodeling and is used by the body to build bone tissue that is strong and healthy. Strong bones are formed when bone tissue is made up of plate-shaped crystals of **minerals** called hydroxyapatite. Normal wear and tear on the skeletal system is repaired throughout life by the ongoing process of remodeling. In fact, the entire human skeleton is remodeled every five years.

This woman's legs are bowed due to Paget's disease. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Healthy bone tissue has an ordered structure that gives the bone its strength. Bones affected by Paget's disease, however, have a structure that is disorganized. This disorganized structure weakens the diseased bone and makes people suffering from this disease more likely to have **fractures**. These fractures are slow to heal.

Paget's disease of bone is most commonly found in Europe, England, Australia, New Zealand, and North America. In these areas, up to 3% of all people over 55 years of age are affected with the disease. It is interesting to note that Paget's disease is rare in Asia, possibly showing that this disease may affect some ethnic groups and geographic areas more than others.

Causes and symptoms

The cause of Paget's disease is not known. Various viruses have been suggested to be involved in this disease, but the relationship between viral infections

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and Paget's disease remains uncertain. There also may to be a genetic component to this disease since it may appear in more than one person within the same family.

Paget's disease usually begins without any symptoms. And, in its early stages, the symptoms that do occur are often confused with symptoms of arthritis. However, as the disease progresses, bone and joint **pain** develop. A unique feature of Paget's disease is the enlargement of areas of affected bone. This type of enlargement is clearly identifiable on an x ray.

If the bones of the skull are affected by Paget's disease, enlargement of the skull can occur and may result in a loss of hearing. When the long bones in the legs are affected, they can become bent under the body's weight because of their weakness. Little or no injury to a bone can cause fractures in the weakened bones. Fractures that occur when no traumatic injury is present are known as spontaneous fractures.

Although rare, bone **cancer** occurs in less than 1% of patients with Paget's disease. Such cancer is often accompanied by an abrupt increase in the intensity of pain at the diseased site. Unfortunately, this type of cancer has a poor prognosis; the average survival time from the onset of symptoms is generally one to three years.

Diagnosis

Paget's disease is often found when an individual is having x rays taken for medical reasons unrelated to this bone disease. A diagnosis of Paget's disease can also be made when higher than normal levels of a chemical called alkaline phosphatase are found in the blood. Alkaline phosphatase is a substance involved in the bone formation process, so if its levels are abnormally high this indicates that the balance between bone formation and resorption is upset.

Treatment

Treatment, given only when symptoms are present, consists of the following types:

Drugs

Paget's disease is most often treated with drug therapy, with bone pain lessening within weeks of starting the treatment. While non-steroidal anti-inflammatory drugs can reduce bone pain, two additional categories of drugs are used to treat this disease.

HORMONE TREATMENT. Calcitonin, a hormone which is made naturally by the thyroid gland, is used to treat Paget's disease. This chemical rapidly decreases the amount of bone breakdown or loss (resorption). After approximately two to three weeks of treatment with extra calcitonin, bone pain lessens and new bone tissue forms. Calcitonin is commonly given as daily injections for one month, followed by three injections each week for several additional months. The total dose of calcitonin given to an individual depends upon the amount of disease present and how well the individual's condition responds to the treatment.

Although calcitonin is effective in slowing the progression of Paget's disease, the favorable effects of the drug do not continue for very long once administration of the drug is stopped. In addition, some temporary side effects can occur with this drug. **Nausea** and flushing are the most common side effects and have been found in 20–30% of individuals taking calcitonin. **Vomiting**, **diarrhea**, and abdominal pain can also occur, but these effects are also temporary. A form of calcitonin taken nasally causes fewer side effects, but requires higher doses because less of the drug reaches the diseased bone.

BISPHOSPHONATES. The bisphosphonate group of drugs are drugs that bind directly to bone minerals because of their specific chemical structure. Once bound to the bone, these drugs inhibit bone loss by reducing the action of bone cells that normally degrade bone during the remodeling process. Unlike treatment with calcitonin, the positive effects of increased bone formation and reduced pain can continue for many months or even years after bisphosphonate treatment is stopped. Bisphosphonates are considered the treatment of choice for Paget's disease and are usually given for 3–6 months at a time.

Bisphosphonate drugs suitable for the treatment of Paget's disease are alendronate, clodronate, etidronate, pamidronate, risedronate, and tiludronate. The main side effects of these drugs include a flu-like reaction (pamidronate), gastrointestinal disturbances (alendronate, clodronate), and abnormal bone formation (etidronate, when taken in high doses). Risedronate is the newest of these drugs. It is about 1,000 times more potent than etidronate and 3 to 5 times more potent than alendronate. Because of the greater potency of this drug, lower doses and a shorter duration of treatment are required. This leads to fewer side effects with similar, or better, clinical results in the patient.

Surgery

Treatment of Paget's disease usually begins with drug therapy. However, various surgical treatments

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KEY TERMS

Bisphosphonate—A class of drugs used to treat Paget's disease. These drugs bind to the minerals in bone tissue and lessen the amount of bone loss associated with Paget's disease.

Calcitonin—A naturally occurring hormone made by the thyroid gland that can be used as a drug to treat Paget's disease.

Remodeling—The ongoing process of bone formation and breakdown that results in healthy bone development.

can also be used to treat skeletal conditions that occur in patients with Paget's disease.

In patients with severe arthritis of the hip or knee, a **joint replacement** operation can be beneficial. However, in addition to the malformation of bone tissue caused by this condition, there are greater numbers of blood vessels that form in the diseased bone relative to a healthy bone. This makes surgery on bones affected with Paget's disease more difficult.

Prognosis

There is no cure for Paget's disease. However, the development of potent bisphosphonate drugs like risedronate has resulted in the ability to slow the progress of the disease.

Paul A. Johnson, Ed.M.

Paget's disease of the breast

Definition

Paget's disease of the breast is a rare form of **breast cancer** which makes up approximately 1–4 % of all breast tumors. While sharing its name with **Paget's disease of bone**, these are two medically unrelated conditions. They are simply named after the same doctor who first described them.

Description

Paget's disease of the breast is generally associated with an underlying breast **cancer**. It is generally seen in people between the ages of 40 and 80 years. Cases in men have been identified, but they are extremely rare.

Paget's disease of the breast may also be called mammary Paget's disease (MPD). There is a much rarer form of this disease called extramammary Paget's disease (EMPD). MPD affects the breast nipple and is also called Paget's disease of the nipple. EMPD can affect the skin of the external genital tissues in both women and men, as well as the skin of the eyelids and external ear canal. MPD is believed to develop from a tumor growth within the milk ducts of the breast. EMPD may represent a spreading (metastasis) of MPD to other parts of the body.

Causes and symptoms

The cause of Paget's disease of the breast is unknown, but it is usually associated with an underlying cancer of the breast.

The symptoms of Paget's disease of the breast include:

- red scaly patches of skin on the nipple and sometimes also on the dark area of skin around the nipple (areola)
- crusting, bleeding, or ulceration of the skin of the affected area
- a discharge of fluid from the nipple
- a turning inward (inversion) of the nipple

In approximately 30–40% of cases of Paget's disease of the breast, there is also a detectable lump in the breast.

Diagnosis

Paget's disease of the breast is often confused with other skin conditions, such as **eczema**, **dermatitis**, or **psoriasis**. These misdiagnoses often lead to delays in appropriate treatment. Misdiagnosis is more common when both breast are affected and no lump in the breast is detected. When only one breast is affected, or when the presence of a lump in the breast is also detected, a correct initial diagnosis is more likely to occur.

Once Paget's disease of the breast is suspected, it can be definitively confirmed by biopsy of the affected tissue. In this procedure, a small piece of the affected skin and the underlying tissue is removed and sent to a laboratory for examination under a microscope. The shape and other characteristics of the cells in the biopsied sample will allow the laboratory personnel to determine if the sample is affected with Paget's disease of the breast, or some other condition.

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KEY TERMS

Metastasis—The spread of a cancer from one part of the body (where the cancer originated) to another part of the body.

Ulceration—The formation of an ulcer, a patch of tissue that is discontinuous with the surrounding tissue because the tissue within the ulcer has decayed or died and been swept away.

Topical steroid creams are usually used to treat eczema, dermatitis, and psoriasis. These creams will have no effect on the skin conditions caused by Paget's disease of the breast.

Treatment

Surgery is the main treatment for Paget's disease of the breast. Removal of the breast (**mastectomy**) may be recommended if the cancer is seen in a wide area away from the nipple or appears to be deep into the breast tissue. Breast conservation surgery, aimed at keeping as much of the breast as possible, may be recommended in cases where the disease is diagnosed early enough and the cancer has not spread far from the surface of the nipple.

Some people will require further treatment after surgery. This treatment may include **radiation therapy**, **chemotherapy**, or a combination of both. Radiation therapy involves using high-energy x rays to destroy any cancer cells that may remain after surgical removal of the primary tumor. Radiation therapy is most common after breast conservation surgery. Chemotherapy involves the use of medicinal drugs to destroy the growth of any cancer cells that may remain after removal of the primary cancer. Chemotherapy treatments are most common after mastectomy.

Alternative treatment

Alternative treatments for Paget's disease of the breast include: the use of cartilage from cows or sharks; a diet known as Gerson therapy; administration of the chemicals hydrazine sulfate or laetrile; and, the injection of solutions derived from the mistletoe plant.

Prognosis

The prognosis for Paget's disease of the breast depends on the underlying cancer that is causing this condition and whether or not this cancer has spread (metastasized) to other parts of the body.

Prevention

Because the cause of Paget's disease of the breast is not known, prevention of this disease is not possible. In instances where this conditions arises from other underlying cancers of the breast, it may be possible to prevent Paget's disease of the breast from occurring if the underlying cause is diagnosed and successfully treated prior to the development of Paget's disease of the breast.

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ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (800) 227-2345, http://www.cancer.org.

National Breast Cancer Coalition, 1101 17th Street, NW, Suite 1300, Washington, DC, 20036, (202) 296-7477, (202) 265-6854, (800) 622-2838, http://stopbreastcancer.org.

Paul A. Johnson, Ed.M.

Pain

Definition

Pain is an unpleasant feeling that is conveyed to the brain by sensory neurons. The discomfort signals actual or potential injury to the body. However, pain is more than a sensation, or the physical awareness of pain; it also includes perception, the subjective interpretation of the discomfort. Perception gives information on the pain's location, intensity, and something about its nature. The various conscious and unconscious responses to both sensation and perception, including

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the emotional response, add further definition to the overall concept of pain.

Description

Pain arises from any number of situations. Injury is a major cause, but pain may also arise from an illness. It may accompany a psychological condition, such as depression, or may even occur in the absence of a recognizable trigger.

Acute pain

Acute pain often results from tissue damage, such as a skin burn or broken bone. Acute pain can also be associated with headaches or **muscle cramps**. This type of pain usually goes away as the injury heals or the cause of the pain (stimulus) is removed.

To understand acute pain, it is necessary to understand the nerves that support it. Nerve cells, or neurons, perform many functions in the body. Although their general purpose, providing an interface between the brain and the body, remain constant, their capabilities vary widely. Certain types of neurons are capable of transmitting a pain signal to the brain.

As a group, these pain-sensing neurons are called nociceptors, and virtually every surface and organ of the body is wired with them. The central part of these cells is located in the spine, and they send threadlike projections to every part of the body. Nociceptors are classified according to the stimulus that prompts them to transmit a pain signal. Thermoreceptive nociceptors are stimulated by temperatures that are potentially tissue damaging. Mechanoreceptive nociceptors respond to a pressure stimulus that may cause injury. Polymodal nociceptors are the most sensitive and can respond to temperature and pressure. Polymodal nociceptors also respond to chemicals released by the cells in the area from which the pain originates.

Nerve cell endings, or receptors, are at the front end of pain sensation. A stimulus at this part of the nociceptor unleashes a cascade of neurotransmitters (chemicals that transmit information within the nervous system) in the spine. Each neurotransmitter has a purpose. For example, substance P relays the pain message to nerves leading to the spinal cord and brain. These neurotransmitters may also stimulate nerves leading back to the site of the injury. This response prompts cells in the injured area to release chemicals that not only trigger an immune response, but also influence the intensity and duration of the pain.

Chronic and abnormal pain

Chronic pain refers to pain that persists after an injury heals, **cancer** pain, pain related to a persistent or degenerative disease, and long-term pain from an unidentifiable cause. It is estimated that one in three people in the United States will experience chronic pain at some point in their lives. Of these people, approximately 50 million are either partially or completely disabled.

Chronic pain may be caused by the body's response to acute pain. In the presence of continued stimulation of nociceptors, changes occur within the nervous system. Changes at the molecular level are dramatic and may include alterations in genetic transcription of neurotransmitters and receptors. These changes may also occur in the absence of an identifiable cause; one of the frustrating aspects of chronic pain is that the stimulus may be unknown. For example, the stimulus cannot be identified in as many as 85% of individuals suffering lower back pain.

Scientists have long recognized a relationship between depression and chronic pain. In 2004, a survey of California adults diagnosed with major depressive disorder revealed that more than one-half of them also suffered from chronic pain.

Other types of abnormal pain include allodynia, hyperalgesia, and phantom limb pain. These types of pain often arise from some damage to the nervous system (neuropathic). Allodynia refers to a feeling of pain in response to a normally harmless stimulus. For example, some individuals who have suffered nerve damage as a result of viral infection experience unbearable pain from just the light weight of their clothing. Hyperalgesia is somewhat related to allodynia in that the response to a painful stimulus is extreme. In this case, a mild pain stimulus, such as a pin prick, causes a maximum pain response. Phantom limb pain occurs after a limb is amputated; although an individual may be missing the limb, the nervous system continues to perceive pain originating from the area.

Causes and symptoms

Pain is the most common symptom of injury and disease, and descriptions can range in intensity from a mere ache to unbearable agony. Nociceptors have the ability to convey information to the brain that indicates the location, nature, and intensity of the pain. For example, stepping on a nail sends an information-packed message to the brain: the foot has experienced a puncture wound that hurts a lot.

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Pain perception also varies depending on the location of the pain. The kinds of stimuli that cause a pain response on the skin include pricking, cutting, crushing, burning, and freezing. These same stimuli would not generate much of a response in the intestine. Intestinal pain arises from stimuli such as swelling, inflammation, and distension.

Diagnosis

Pain is considered in view of other symptoms and individual experiences. An observable injury, such as a broken bone, may be a clear indicator of the type of pain a person is suffering. Determining the specific cause of internal pain is more difficult. Other symptoms, such as **fever** or **nausea**, help narrow down the possibilities. In some cases, such as lower back pain, a specific cause may not be identifiable. Diagnosis of the disease causing a specific pain is further complicated by the fact that pain can be referred to (felt at) a skin site that does not seem to be connected to the site of the pain's origin. For example, pain arising from fluid accumulating at the base of the lung may be referred to the shoulder.

Since pain is a subjective experience, it may be very difficult to communicate its exact quality and intensity to other people. There are no diagnostic tests that can determine the quality or intensity of an individual's pain. Therefore, a medical examination will include a lot of questions about where the pain is located, its intensity, and its nature. Questions are also directed at what kinds of things increase or relieve the pain, how long it has lasted, and whether there are any variations in it. An individual may be asked to use a pain scale to describe the pain. One such scale assigns a number to the pain intensity; for example, 0 may indicate no pain, and 10 may indicate the worst pain the person has ever experienced. Scales are modified for infants and children to accommodate their level of comprehension.

Treatment

There are many drugs aimed at preventing or treating pain. Nonopioid **analgesics**, narcotic analgesics, **anticonvulsant drugs**, and **tricyclic antidepressants** work by blocking the production, release, or uptake of neurotransmitters. Drugs from different classes may be combined to handle certain types of pain.

Nonopioid analgesics include common over-the-counter medications such as **aspirin**, **acetaminophen** (Tylenol), and ibuprofen (Advil). These are most often used for minor pain, but there are some prescription-strength medications in this class.

Narcotic analgesics are only available with a doctor's prescription and are used for more severe pain, such as cancer pain. These drugs include codeine, morphine, and **methadone**. **Addiction** to these painkillers is not as common as once thought. Many people who genuinely need these drugs for pain control typically do not become addicted. However, narcotic use is usually limited to patients thought to have a short life span (such as people with terminal cancer) or patients whose pain is only expected to last for a short time (such as people recovering from surgery). In 2004, the Drug Enforcement Administration (DEA) issued new guidelines to help physicians prescribe **narcotics** appropriately without fear of being arrested for prescribing the drugs beyond the scope of their medical practice. DEA is trying to work with physicians to ensure that those who need to drugs receive them but to ensure opioids are not abused.

Anticonvulsants, as well as **antidepressant drugs**, were initially developed to treat seizures and depression, respectively. However, it was discovered that these drugs also have pain-killing applications. Furthermore, since in cases of chronic or extreme pain, it is not unusual for an individual to suffer some degree of depression; antidepressants may serve a dual role. Commonly prescribed anticonvulsants for pain include phenytoin, carbamazepine, and clonazepam. Tricyclic antidepressants include doxepin, amitriptyline, and imipramine.

Intractable (unrelenting) pain may be treated by injections directly into or near the nerve that is transmitting the pain signal. These root blocks may also be useful in determining the site of pain generation. As the underlying mechanisms of abnormal pain are uncovered, other pain medications are being developed.

Drugs are not always effective in controlling pain. Surgical methods are used as a last resort if drugs and local anesthetics fail. The least destructive surgical procedure involves implanting a device that emits electrical signals. These signals disrupt the nerve and prevent it from transmitting the pain message. However, this method may not completely control pain and is not used frequently. Other surgical techniques involve destroying or severing the nerve, but the use of this technique is limited by side effects, including unpleasant **numbness**.

Two effective **pain management** treatments that have been used for generations are heat and cold. Both are used to treat acute and chronic pain. Ice is

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generally used to treat inflammation, especially acute injuries to knees and other joints. Treatment usually lasts three to five days. Often it is used as part of the RICE regimen: rest, ice, compression, and elevation. Heat therapy is generally used for increasing tensile strength, increasing blood flow to the injured area, and helping muscles and tendons to relax. Sometimes ice is used in the early stages of an acute injury and then heat for the remainder of treatment. In recent years, scientists have identified heat and cold receptors in the body. This has allowed the development of medications, including patches, creams, and gels, that directly target these receptors, increasing the effectiveness of heat and cold treatments.

Alternative treatment

Both physical and psychological aspects of pain can be dealt with through alternative treatment. Some of the most popular treatment options include **acupressure** and **acupuncture**, massage, **chiropractic**, and relaxation techniques such as **yoga**, hypnosis, and **meditation**. Herbal therapies are gaining increased recognition as viable options; for example, capsaicin, the component that makes cayenne peppers spicy, is used in ointments to relieve the joint pain associated with arthritis. Contrast **hydrotherapy** can also be very beneficial for pain relief.

Lifestyles can be changed to incorporate a healthier diet and regular **exercise**. Regular exercise, aside from relieving **stress**, has been shown to increase endorphins, painkillers naturally produced in the body.

Prognosis

Successful pain treatment is highly dependent on successful resolution of the pain's cause. Acute pain will stop when an injury heals or when an underlying problem is treated successfully. Chronic pain and abnormal pain are more difficult to treat, and it may take longer to find a successful resolution. Some pain is intractable and will require extreme measures for relief.

Prevention

Pain is generally preventable only to the degree that the cause of the pain is preventable. For example, improved surgical procedures, such as those done through a thin tube called a laparascope, minimize post-operative pain. Anesthesia techniques for surgeries also continuously improve. Some disease and injuries are often unavoidable. However, pain from some surgeries and other medical procedures and continuing pain are preventable through drug treatments and alternative therapies.

KEY TERMS

Acute pain—Pain in response to injury or another stimulus that resolves when the injury heals or the stimulus is removed.

Chronic pain—Pain that lasts beyond the term of an injury or painful stimulus. Can also refer to cancer pain, pain from a chronic or degenerative disease, and pain from an unidentified cause.

Neuron—A nerve cell.

Neurotransmitters—Chemicals within the nervous system that transmit information from or between nerve cells.

Nociceptor—A neuron that is capable of sensing pain.

Referred pain—Pain felt at a site different from the location of the injured or diseased part of the body. Referred pain is due to the fact that nerve signals from several areas of the body may "feed" the same nerve pathway leading to the spinal cord and brain.

Stimulus—A factor capable of eliciting a response in a nerve.

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ORGANIZATIONS

American Chronic Pain Association, PO Box 850, Rocklin, CA, 95677, (916) 632-3208, (800) 533-3231, APA@pacbell.net, http://www.theacpa.org.

American Pain Society, 4700 W. Lake Ave., Glenview, IL, 60025, (847) 375-4715, (866) 574-2654, info@ampainsoc.org, http://www.ampainsoc.org/.

Canadian Pain Society, 1143 Wentworth Street West, Suite 202, Oshawa, Canada, Ontario, L1J 8P7, (905) 404-9545, (905) 404-3727, http://www.canadianpainsociety.ca.

Julia Barrett
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Pain management

Definition

Pain itself is defined by the International Association for the Study of Pain (IASP) as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage." Thus, pain management encompasses all interventions used to understand and ease pain, and if possible to alleviate the cause of the pain.

Purpose

Pain serves to alert a person to potential or actual damage to the body. The definition of damage is quite broad: pain can arise from injury as well as disease. After the message is received and interpreted, further pain can be counterproductive. Pain can have a negative impact on a person's quality of life and impede recovery from illness or injury, thus contributing to escalating health care costs. Unrelieved pain can become a syndrome in its own right and cause a downward spiral in a person's health and emotional outlook. Managing pain properly facilitates recovery, prevents additional health complications, and improves an individual's quality of life.

Yet the experiencing of pain is a completely unique occurrence for each person, a complex combination of several factors other than the pain itself. It is influenced by:

- Ethnic and cultural values. In some cultures, tolerating pain is related to showing strength and endurance. In others, pain is considered punishment for misdeeds.
- Age. Many people have been taught that grownups never cry. On the other hand, in some cultures, the elderly are allowed to complain freely about pain and discomfort.
- Anxiety and stress. This factor is related to being in a strange or unfamiliar place such as a hospital, and the fear of the unknown consequences of the pain and the condition causing it, which can all combined to make pain feel more severe. For patients being treated for pain, knowing the duration of activity of an analgesic leads to anxiety about the return of pain when the drug wears off. This anxiety can make the pain more severe. In addition, patients who interpret their pain as meaning that their disease is recurring or getting worse often experience pain as more severe.
- Fatigue and depression. It is known that pain in itself can actually cause emotional depression. Fatigue from lack of sleep or the illness itself also contributes to depressed feelings.

Precautions

The perception of pain is an individual experience. Healthcare providers play an important role in understanding their patients' pain. All too often, both physicians and nurses have been found to incorrectly assess the severity of pain. A study reported in the *Journal of Advanced Nursing* evaluated nurses' perceptions of a select group of white American and Mexican-American women patients' pain following gallbladder surgery. Objective assessments of each patient's pain showed little difference between the perceived severities for each group. Yet, the nurses involved in the study consistently rated all patients' pain as less than the patients reported, and with equal consistency, believed that better-educated women born in the United States were suffering more than less-educated Mexican-American women. Nurses from a northern European background were more apt to minimize the severity of pain than nurses from eastern and southern Europe or Africa. The study indicated how healthcare staff, and especially nursing staff, need to be aware of how their own background and experience contributes to how they perceive a person's pain.

Some patient populations are particularly susceptible to inadequate pain management. These include **cancer** patients; children; trauma victims receiving treatment in hospital emergency departments; and the elderly in nursing homes.

Description

Before considering pain management, a review of pain definitions and mechanisms may be useful. Pain is the means by which the peripheral nervous system

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KEY TERMS

Acute—Referring to pain in response to injury or other stimulus that resolves when the injury heals or the stimulus is removed.

Central nervous system (CNS)—The part of the nervous system that includes the brain and the spinal cord.

Chronic—Referring to pain that endures beyond the term of an injury or painful stimulus. Can also refer to cancer pain, pain from a chronic or degenerative disease, and pain from an unidentified cause.

Iatrogenic—Resulting from the activity of the physician.

Neuropathy—Nerve damage.

Neurotransmitter—Chemicals within the nervous system that transmit information from or between nerve cells.

Nociceptor—A nerve cell that is capable of sensing pain and transmitting a pain signal.

Nonpharmacological—Referring to therapy that does not involve drugs.

Parasympathetic nervous system—That part of the autonomic nervous system consisting of nerves that arise from the cranial and sacral regions and function in opposition to the sympathetic nervous system.

Peripheral nervous system (PNS)—Nerves that are outside of the brain and spinal cord.

Pharmacological—Referring to therapy that relies on drugs.

Stimulus—A factor capable of eliciting a response in a nerve.

Sympathetic nervous system—That portion of the autonomic nervous system consisting of nerves that originate in the thoracic and lumbar spinal cord and function in opposition to the parasympathetic nervous system.

(PNS) warns the central nervous system (CNS) of injury or potential injury to the body. The CNS comprises the brain and spinal cord, and the PNS is composed of the nerves that stem from and lead into the CNS. PNS includes all nerves throughout the body, except the brain and spinal cord. Pain is sometimes categorized by its site of origin, either cutaneous (originating in the skin, or subcutaneous tissue, such as a shaving nick or paper cut), deep somatic pain (arising from bone, ligaments and tendons, nerves, or veins and arteries), or visceral (appearing as a result of stimulation of pain receptor nerves around such organs as the brain, lungs, or stomach and intestines).

A pain message is transmitted to the CNS by special PNS nerve cells called nociceptors, which are distributed throughout the body and respond to different stimuli depending on their location. For example, nociceptors that extend from the skin are stimulated by such sensations as pressure, temperature, and chemical changes.

When a nociceptor is stimulated, neurotransmitters are released within the cell. Neurotransmitters are chemicals found within the nervous system that facilitate nerve cell communication. The nociceptor transmits its signal to nerve cells within the spinal cord, which conveys the pain message to the thalamus, a specific region in the brain.

Once the brain has received and processed the pain message and coordinated an appropriate response, pain has served its purpose. The body uses natural painkillers called endorphins to derail further pain messages from the same source. However, these natural painkillers may not adequately dampen a continuing pain message. Also, depending on how the brain has processed the pain information, certain hormones such as prostaglandins may be released. These hormones enhance the pain message and play a role in immune system responses to injury, such as inflammation. Certain neurotransmitters, especially substance P and calcitonin gene-related peptide, actively enhance the pain message at the injury site and within the spinal cord.

Pain is generally divided into two additional categories: acute and chronic. Nociceptive pain, or the pain that is transmitted by nociceptors, is typically called acute pain. This kind of pain is associated with injury, headaches, disease, and many other conditions. Response to acute pain is made by the sympathetic nervous system (the nerves responsible for the fight-or-flight response of the body). It normally resolves once the condition that precipitated it is resolved.

There are some disorders that produce pain that does not resolve following the disorder. Even after healing or a cure has been achieved, the brain continues to perceive pain. In this situation, the pain may be considered chronic. Chronic pain is within the province of the parasympathetic nervous system, and the changeover occurs as the body attempts to adapt to the pain. The time limit used to define chronic pain typically ranges from three to six months, although some healthcare professionals prefer a more flexible

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definition and consider chronic pain as pain that endures beyond a normal healing time. The pain associated with cancer, persistent and degenerative conditions, and neuropathy, or nerve damage, is included in the chronic category. Also, unremitting pain that lacks an identifiable physical cause such as the majority of cases of **low back pain** may be considered chronic. The underlying biochemistry of chronic pain appears to be different from that of acute nociceptive pain.

It has been hypothesized that uninterrupted and unrelenting pain can induce changes in the spinal cord. In the past, severing a nerve's connection to the CNS has treated intractable pain. However, the lack of any sensory information being relayed by that nerve can cause pain transmission in the spinal cord to go into overdrive, as evidenced by the phantom limb pain experienced by amputees. Evidence is accumulating that unrelenting pain or the complete lack of nerve signals increases the number of pain receptors in the spinal cord. Nerve cells in the spinal cord may also begin secreting pain-amplifying neurotransmitters independent of actual pain signals from the body. Immune chemicals, primarily cytokines, may play a prominent role in such changes.

Managing pain

Considering the different causes and types of pain, as well as its nature and intensity, management usually requires a multidisciplinary approach. The elements of this approach include treating the underlying cause of pain, pharmacological and non-pharmacological therapies, and some invasive (surgical) procedures.

Treating the cause of pain underlies the basic strategy of pain management. Injuries are repaired, diseases are diagnosed, and certain encounters with pain can be anticipated and treated prophylactically (by prevention). However, there are no guarantees of immediate relief from pain. Recovery can be impeded by pain and quality of life can be damaged. Therefore, pharmacological and other therapies have developed over time to address these aspects of disease and injury.

PHARMACOLOGICAL OPTIONS. General guidelines developed by the World Health Organization (WHO) have been developed for pain management. These guidelines operate upon the three-step ladder approach, including:

- Mild pain is alleviated with acetaminophen or a non-steroidal anti-inflammatory drug (NSAID). NSAIDs and acetaminophen are available as over-the-counter (OTC) and prescription medications, and are frequently the initial pharmacological treatment for pain. These drugs can also be used as adjuncts to the other drug therapies that might require a doctor's prescription. NSAIDs include aspirin, ibuprofen (Motrin, Advil, Nuprin), naproxen sodium (Aleve), and ketoprofen (Orudis KT). These drugs are used to treat pain from inflammation and work by blocking production of pain-enhancing neurotransmitters. Acetaminophen is also effective against pain, but its ability to reduce inflammation is limited. NSAIDs and acetaminophen are effective for most forms of acute (sharp, but of a short duration) pain.
- Mild to moderate pain is eased with a milder opioid medication, plus acetaminophen or NSAIDs. Opioids include both drugs derived from the opium poppy, such as morphine and codeine, and synthetic drugs based on the structure of opium. This drug class includes drugs such as oxycodone, methadone, and meperidine (Demerol). They provide pain relief by binding to specific opioid receptors in the brain and spinal cord. One drawback of opioids, however, is that they frequently cause constipation because they slow down the rhythmic muscular contractions of the intestines that push food along during the process of digestion.
- Moderate to severe pain is treated with stronger opioid drugs, plus acetaminophen or NSAIDs. Morphine is sometimes referred to as the gold standard of palliative care as it is not expensive; can be given by starting with smaller doses and gradually increased; and is highly effective over a long period of time. It can also be given by a number of different routes, including by mouth, rectally, or by injection.

Although **antidepressant drugs** were developed to treat depression, it has been discovered that they are also effective in combating chronic headaches, cancer pain, and pain associated with nerve damage. Antidepressants that have been shown to have analgesic (pain-reducing) properties include amitriptyline (Elavil), trazodone (Desyrel), and imipramine (Tofranil). **Anticonvulsant drugs** share a similar background with antidepressants. Developed to treat **epilepsy**, anticonvulsants were found to relieve pain as well. Drugs such as phenytoin (Dilantin) and carbamazepine (Tegretol) are prescribed to treat the pain associated with nerve damage.

In some cases, chronic pain caused by complications of diabetes or cancer can be eased by administering local anesthetics. The most commonly used are mexiletine (Mexitil) and a lidocaine patch.

Corticosteroids are another class of drugs commonly given to manage chronic pain caused by

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arthritis or other diseases affecting the muscles and joints; they may also be given to control **nausea**. Dexamethasone (Decadron) and prednisone are the most commonly used corticosteroids in pain management. They work by reducing inflammation and suppressing the immune system.

Close monitoring of the effects of pain medications is required in order to assure that adequate amounts of medication are given to produce the desired pain relief. When a person is comfortable with a certain dosage of medication, oncologists typically convert to a long-acting version of that medication. Transdermal fentanyl patches (Duragesic) are a common example of a long-acting opioid drug often used for cancer pain management. A patch containing the drug is applied to the skin and continues to deliver the drug to the person for an average of three days. Pumps are also available that provide an opioid medication upon demand when the person is experiencing pain. By pressing a button, they can release a set dose of medication into an intravenous solution or an implanted catheter. Another mode of administration involves implanted catheters that deliver pain medication directly to the spinal cord. Because these pumps offer the patient some degree of control over the amount of analgesic administered, the system, commonly called patient-controlled analgesia (PCA), reduces the level of **anxiety** about availability of pain medication. Delivering drugs in this way can reduce side effects and increase the effectiveness of the drug. Research is underway to develop toxic substances that act selectively on nerve cells that carry pain messages to the brain. These substances would kill the selected cells and stop transmission of the pain message.

NONPHARMACOLOGICAL OPTIONS. Pain treatment options that do not use drugs are often used as adjuncts to, rather than replacements for, drug therapy. One of the benefits of nondrug therapies is that an individual can take a more active role in pain management. Such relaxation techniques as **yoga** and **meditation** are used to focus the brain elsewhere than on the pain, decrease muscle tension, and reduce **stress**. Tension and stress can also be reduced through **biofeedback**, in which an individual consciously attempts to modify skin temperature, muscle tension, blood pressure, and heart rate.

Hypnosis is another nonpharmacological option for pain relief. Although doctors do not yet fully understand how hypnosis works, it is used successfully in some patients to manage pain related to **childbirth**, oral surgery, burn treatment, and other procedures that require the patient to remain conscious.

Participating in normal activities and exercising can also help control pain levels. Through **physical therapy**, an individual learns beneficial exercises for reducing stress, strengthening muscles, and staying fit. Regular **exercise** has been linked to production of endorphins, the body's natural painkillers.

Acupuncture involves the insertion of small needles into the skin at key points. **Acupressure** uses these same key points, but involves applying pressure rather than inserting needles. Both of these methods may work by prompting the body to release endorphins. Applying heat or being massaged are very relaxing and help reduce stress. Transcutaneous **electrical nerve stimulation** (TENS) applies a small electric current to certain parts of nerves, potentially interrupting pain signals and inducing release of endorphins. To be effective, use of TENS should be medically supervised.

INVASIVE PROCEDURES. There are three types of invasive procedures that may be used to manage or treat pain: anatomic, augmentative, and ablative. These procedures involve surgery, and certain guidelines should be followed before carrying out a procedure with permanent effects. First, the cause of the pain must be clearly identified. Next, surgery should be done only if noninvasive procedures are ineffective. Third, any psychological issues should be addressed. Finally, there should be a reasonable expectation of success.

Anatomic procedures involve correcting the injury or removing the cause of pain. Relatively common anatomic procedures are decompression surgeries such as repairing a **herniated disk** in the lower back or relieving the nerve compression related to **carpal tunnel syndrome**. Another anatomic procedure is neurolysis, also called a nerve block, which involves destroying a portion of a peripheral nerve.

Augmentative procedures include electrical stimulation or direct application of drugs to the nerves that are transmitting the pain signals. Electrical stimulation works on the same principle as TENS. In this procedure, instead of applying the current across the skin, electrodes are implanted to stimulate peripheral nerves or nerves in the spinal cord. Augmentative procedures also include implanted drug-delivery systems. In these systems, catheters are implanted in the spine to allow direct delivery of drugs to the CNS.

Ablative procedures are characterized by severing a nerve and disconnecting it from the CNS. However, this method may not address potential alterations within the spinal cord. These changes perpetuate

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pain messages and do not cease, even when the connection between the sensory nerve and the CNS is severed. With growing understanding of neuropathic pain and development of less invasive procedures, ablative procedures are used less frequently. However, they do have applications in select cases of **peripheral neuropathy**, cancer pain, and other disorders.

Preparation

Prior to beginning management, the patient's pain should be thoroughly evaluated, including a psychosocial as well as a physical assessment. Pain scales or questionnaires can be administered by a member of the healthcare team, although there is no single questionnaire that is universally accepted. Some questionnaires are verbal, while others use pictures or drawings to help the patient describe the pain. Some questionnaires are filled out by the patient, while others may be given to relatives or friends to complete. It is often necessary to ask other family members to complete a pain questionnaire if the patient is cognitively impaired.

In spite of their limitations, questionnaires and self-report forms do allow healthcare workers to better understand the pain being suffered by the patient. Evaluation also includes physical examinations and diagnostic tests to determine the underlying physical causes of the pain. Some evaluations require assessments from several viewpoints, including neurology, psychiatry and psychology, and physical therapy. If the pain is caused by a medical procedure, management consists of anticipating the type and intensity of associated pain and managing it preemptively.

Nurses or physicians often take what is called a pain history. This history will help to provide important information that can help health care providers to better manage the patient's pain. A typical pain history includes the following questions:

- Where is the pain located?
- On a scale of 1 to 10, with 1 indicating the least pain, how would the person rate the pain being experienced?
- What does the pain feel like?
- When did (or does) the pain start?
- How long has the person had it?
- Is the person sometimes free of pain?
- Is the pain constant, or is it episodic?
- Does the person know of anything that triggers the pain or makes it worse?
- Does the person have other symptoms (nausea, dizziness, blurred vision, etc.) during or after the pain?
- What pain medications or other measures has the person found to help in easing the pain?
- How does the pain affect the person's ability to carry on normal activities?
- What does it mean to the person that he or she is experiencing pain?

Aftercare

An assessment by nursing staff as well as other healthcare providers should be made to determine the effectiveness of the pain management interventions employed. There are objective, measurable signs and symptoms of pain that can be looked for. The goal of good pain management is the absence of these signs. Signs of acute pain include:

- rise in pulse and blood pressure
- more rapid breathing
- perspiring profusely, clammy skin
- taut muscles
- more tense appearance, fast speech, very alert
- unusually pale skin
- dilated pupils of the eye

Signs of chronic pain include:

- lower pulse and blood pressure
- changeable breathing pattern
- warm, dry skin
- nausea and vomiting
- slow or monotone speech
- inability or difficulty in getting out of bed and performing activities of daily living (ADLs)
- constricted pupils of the eye

When these signs are absent and the patient appears to be comfortable, healthcare providers can consider their interventions to have been successful. It is also important to document interventions used, and which ones were successful.

Risks

Owing to toxicity over the long term, some drugs can only be used for acute pain or as adjuncts in chronic pain management. NSAIDs have the well-known side effect of causing gastrointestinal bleeding, and long-term use of **acetaminophen** has been linked to kidney and liver damage. Other drugs, especially **narcotics**, have such serious side effects as **constipation**, drowsiness, and nausea. Serious side effects can

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also accompany pharmacological therapies; mood swings, confusion, bone thinning, cataract formation, increased blood pressure, and other problems may discourage or prevent use of some **analgesics**.

Nonpharmacological therapies carry little or no risks. However, individuals recovering from serious illness or injury should consult with the health care providers or physical therapists before making use of adjunct therapies. Invasive procedures carry risks similar to other surgical procedures, such as infection, reaction to anesthesia, and iatrogenic (injury as a result of treatment) injury.

A traditional concern about narcotics use has been the risk of promoting **addiction**. As narcotic use continues over time, the body becomes accustomed to the drug and adjusts normal functions to accommodate to its presence. Therefore, to elicit the same level of action, it is necessary to increase dosage over time. As dosage increases, an individual may become physically dependent on narcotic drugs.

However, physical dependence is different from psychological addiction. Physical dependence is characterized by discomfort if drug administration suddenly stops, while psychological addiction is characterized by an overpowering craving for the drug for reasons other than pain relief. Psychological addiction is a very real and necessary concern in some instances, but it should not interfere with a genuine need for narcotic pain relief. However, caution must be taken with people who have a history of addictive behavior.

Normal results

Effective application of pain management techniques reduces or eliminates acute or chronic pain. This treatment can improve an individual's quality of life and aid in recovery from injury and disease.

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American Pain Society, 4700 West Lake Avenue, Glenview, IL, 60025, (847) 375-4715, (866) 574-2654, info@ampainsoc.org, http://www.ampainsoc.org.

International Association for the Study of Pain (IASP), 111 Queen Anne Avenue North, Suite 501, Seattle, WA, 98109-4955, (206) 283-0311, (206)283-9403, http://www.iasp-pain.org.

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Pain relievers *see* **Analgesics**

Painful menstruation *see* **Dysmenorrhea**

Palliative cancer therapy *see* **Cancer therapy, palliative**

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Palliative care

Definition

Palliative care is a multidisciplinary approach to relieving physical, psychological, emotional, social, and spiritual suffering in patients with chronic or terminal illnesses. Palliative care for children includes providing comfort and support for the entire family, regardless of whether the child is in home or hospice care.

Purpose

The purpose of palliative care is to improve the quality of life for patients and their families. The primary goal is to relieve **pain** and other physical symptoms—such as **nausea** or fatigue—caused by diseases, conditions, and treatments. Palliative care also attempts to minimize side effects from medical interventions. In addition, palliative care aims to relieve psychological symptoms, such as **anxiety** or depression, and to provide comfort and support for patients and their families. Pediatric palliative care helps children lead lives that are as normal and happy as possible under the circumstances.

Demographics

It has been estimated that, worldwide, seven million children and their families could benefit from palliative care. In the United States, approximately 27,000 children die annually from illness or other medical conditions. Although the number of pediatric palliative care programs is growing, the number of parents who are solely responsible for overseeing their children's **pain management** and recovery is also increasing, as most children are sent home from the hospital within hours of surgery. Approximately 84% of pediatric surgeries in the United States are performed on an outpatient basis.

Although some children receive treatment and services from adult palliative care programs, of the approximately 2,500 home-, freestanding-, and hospital-based hospice programs in the United States, only about 10% are pediatric. It has been estimated that hospice care is available to less than 1% of American children in need of it.

Description

Children living with serious chronic illnesses—including certain cancers, HIV/AIDS, **cystic fibrosis**, heart disease, lung disease, or kidney failure—can suffer from significant physical symptoms, pain, and emotional distress. Children undergoing medical treatments can also have physical, psychological, and emotional symptoms that require palliative care. In addition to pain, symptoms such as nausea, weakness, bowel and bladder problems, **constipation**, breathing difficulties, **fatigue**, and mental confusion are treated through palliative care. Although palliative care usually intensifies toward the end of a terminal illness, children may receive palliative care at any stage of—and throughout—any illness.

Palliative care for **cancer** may include **chemotherapy**, **radiation therapy**, or surgery. Although these treatments may not cure cancer that has metastasized or spread, they can diminish the cancer, improve or eliminate symptoms, at least for a period of time, and extend life.

Pediatric illness can have a devastating impact on families. Because many serious childhood illnesses are quite rare, parents and children are often forced to travel to specialized treatment centers. Jobs and support systems can be lost and financial resources depleted. Parents may be at risk for **alcoholism** or drug **abuse**. The sick child's siblings may experience lack of attention. Therefore, pediatric palliative care uses a holistic approach to address the physical, cultural, psychological, emotional, spiritual, and practical needs of the entire family.

Pediatric palliative care differs from adult palliative care for a variety of reasons:

- Serious illnesses in children are relatively rare in developed countries and the course of disease in children is often unpredictable.
- There are often large uncertainties in the prognoses and survival times for life-threatening illnesses in children.
- Children are very resilient and sometimes recover after being close to death.
- Even children with conditions that ultimately prove fatal often have periods of relative health during which they lead comparatively normal lives.
- Pediatricians are strongly committed to their patients and usually want to remain in charge of their care plans.
- Most parents both want and need to be involved in—and have at least some control over—their child's care. Pediatric palliative care encourages their participation.
- Parents are usually not willing to choose between treatments aimed at disease management or a cure and those aimed at making the child comfortable.

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- Childhood diseases are usually treated very aggressively with the goal of extending life at any cost. For these reasons, parents often choose "heroic" medical treatments that have only a small chance of success

There are other significant differences between pediatric and adult palliative care:

- Children have unique developmental and psychosocial needs.
- Children are strongly connected to their families and their schools.
- Children may lack verbal skills for expressing their feelings and needs.
- Identifying sources of pain and the drugs and therapies that can effectively manage the pain can be difficult with young children.
- Children are usually dependent on their parents for medical decision-making. However, children as young as seven to ten can often articulate informed opinions about their medical care. Adolescents expect to participate in medical decision-making. Members of a palliative care team may help children and teens to understand their condition and to participate in discussions of treatment options.
- Siblings and grandparents may complicate medical decision-making and other family issues.
- Pediatric palliative care focuses on the entire family rather than on the patient alone.
- Because the initial diagnosis is often the most emotionally difficult time for families, pediatric palliative care usually begins at the time of diagnosis.
- Pediatric palliative care may be much more integrated with medical treatment than adult palliative care, and it can be an important component of any remission or cure.

Pediatric palliative care is being increasingly integrated into treatment protocols and therapies. A palliative care team may include:

- physicians
- specialists
- nurses
- therapists
- social workers
- child-life specialists
- chaplains

Pediatric palliative care is more likely to take place in the home than in a hospital or hospice for a variety of reasons:

- Although hospice care always includes palliative care, it is generally defined as end-of-life care for patients with a six-month prognosis who will receive no further lifesaving treatments. This definition is often not applicable to children.
- Most hospices do not have pediatric-specific services.
- There is little or no financial reimbursement for pediatric hospice or home care.
- Many families prefer to have their child die at home and many pediatric palliative care programs include end-of-life planning.
- Studies have found that the overall quality of care is generally better in the home than in a hospital or hospice.

Origins

Pediatric palliative care is a relatively new medical subspecialty. The first pediatric palliative home care program in the United States was established in Connecticut in 1974. Since the 1980s a variety of home- and hospice-based pediatric palliative care programs have been established across the United States and around the world. In 1984, Dr. Burton Grebin opened St. Mary's Hospital for Children as a comprehensive palliative care center in Bayside, New York. Grebin sought to normalize the children's environment: St. Mary's has its own New York City Public School; the children wear street clothes and play and socialize; families are encouraged to visit and spend the night. The St. Mary's program includes counseling for parents and siblings.

Benefits

Palliative care can:

- ensure that discomfort and pain are managed adequately
- help normalize life for seriously ill children and their families
- encourage parental participation and ease emotional stress and grief
- promote informed medical decision-making
- promote coordinated medical care and services
- lead to better medical outcomes
- reduce hospital and emergency-room visits, thereby making more efficient use of healthcare spending
- provide families with improved access to resources and services, such as therapy and respite care
- provide children with the most peaceful end of life as possible

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Precautions

New medical technologies have complicated treatment decisions for parents. Newborns are often subjected to stressful and painful tests and procedures, even when their condition or illness is incompatible with life. Overwhelmed parents are often unaware of the long-term consequences of the medical decisions that they are asked to make, especially when they are dealing with multiple specialists. In addition, language and cultural barriers can exacerbate communication problems between parents, physicians, and palliative care providers.

It can be very difficult for young children to understand why they are undergoing painful procedures for diagnosis and treatment and many parents want to protect their child from a serious prognosis. However, studies have found that even very young children can understand the seriousness of their disease and that open communication between children and their parents and care providers can help alleviate their fears and maintain hope.

Infants and children are often unable to communicate symptoms and specific sources of discomfort and pain. A major component of pediatric palliative care is the identification and treatment of such symptoms. Prescribing pain medications for children is a specialized skill, because dosages are based on body weight and because children's bodies metabolize medications differently than adults. Furthermore, children often cannot swallow pills. Palliative caregivers must work closely with pharmacists to develop syrups, dissolvable capsules, or skin patches. It is helpful for children to take a medication before leaving the hospital to ensure that they can swallow it. Parents can also request that their pharmacists add their child's favorite flavor to medications.

Parents are often reluctant to administer pain medications, either because they fear that the child will become addicted to **narcotics** or because they are waiting for the child to cry or complain of severe pain. However, pain can interfere with a child's recovery by triggering the body's **stress** response. Prescriptions for painkillers should be filled immediately, so that the medication is available in the middle of the night. Parents must also learn to recognize signs that their child is in pain. These may include:

- fussiness
- refusing to eat or drink
- becoming quiet or withdrawn
- sleep disturbances
- mood or behavior changes

KEY TERMS

Children's hospice—A holistic philosophy that addresses the physical, emotional, social, and spiritual needs of children with life-threatening illnesses, as well as the needs of their families.

Chronic—An illness or condition of long duration, frequent recurrence, or slow progression.

Hospice—A facility or program that provides for the physical and emotional needs of the terminally ill in a caring environment.

Opiate—A drug containing or derived from opium—such as codeine, morphine, and heroin—that alleviates pain and induces sleep.

Palliative treatment—Treatments—such as chemotherapy, radiation therapy, or surgery—that ease the symptoms of a disease without curing it.

Respite care—Temporary care of a patient to provide parents or other caregivers with a period of physical, mental, and emotional rest.

Although medical associations, including the American Academy of Pediatrics, have endorsed pediatric palliative care, it is not universally supported. Some physicians do not believe it is medically necessary and many hospitals claim they cannot afford it. Palliative care is poorly reimbursed by Medicaid and it has been more difficult to demonstrate cost savings from reduced emergency care and hospital stays with pediatric palliative care than with adult programs.

Preparation

Palliative care for children usually begins with the diagnosis of a chronic or life-threatening illness. Preparation may include:

- educating family members about the child's disease or condition
- informing family members about treatment and care options
- advising on various aspects of home care, including administering medication and recognizing symptoms that require immediate attention
- arranging home support services, possibly including transportation, shopping, and meal preparation
- arranging respite care
- helping the family plan for financial strains caused by the child's illness
- helping the family develop a support network

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Aftercare

Palliative aftercare may include:

- helping families prepare for a child's death
- helping with funeral and other arrangements
- grief and bereavement counseling and support groups

Risks

Physicians who are inexperienced in treating pain in terminally ill children may be reluctant to prescribe opiates, including morphine. Even when prescribed, parents may withhold medication because of fear of side effects or **addiction**. Parents may consider hastening a suffering child's **death** because they are unaware of the legal options for pain relief, including sedating a child into unconsciousness.

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Children's Hospice International, 1101 King Street, Suite 360, Alexandria, VA, 22314, (703) 684-0330, (800) 2-4-CHILD, info@chionline.org, http://www.chioline.org.

Department of Pain Medicine & Palliative Care, Beth Israel Medical Center, First Avenue at 16th Street, New York, NY, 10003, (877) 620-9999, (212) 844-1503, stoppain@chpnet.org , http://www.stoppain.org.

European Association for Palliative Care, National Cancer Institute Milano, Via Venezian 1, Milano, Italy, 20133, 02-2390-3390, 02-2390-3393, http://www.eapcnet.org.

International Association for Hospice and Palliative Care, 5535 Memorial Dr. Suite F, PMB 509, Houston, TX, 77007, (936) 321-9846, (866) 374-2472, (713) 880-2948 , http://www.hospicecare.com.

National Hospice & Palliative Care Organization, 1731 King Street, Suite 100, Alexandria, VA, 22314, (703) 837-1500, (703) 837-1233, nhpco@AEA-nhpco.org, http://www.nhpco.org.

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Palpitations

Definition

The term palpitation refers to a sensation in which a person is aware of an irregular, hard, or rapid heartbeat.

Description

Palpitations mean that the heart is not behaving normally. It can appear to skip beats, beat rapidly, beat irregularly, or thump in the chest. Although palpitations are very common and often harmless, they can be frightening to a person, who is usually unaware of his or her heartbeat.

Palpitations can also be a sign of serious heart trouble. Palpitations that are caused by certain types of abnormal heart rhythms (**arrhythmias**) can be serious, and even fatal if left untreated. Recognizable arrhythmias are present in a small number of patients who have palpitations. Immediate medical attention should be sought for palpitations that feel like a very fast series of heartbeats, last more than two or three minutes, and are unrelated to strenuous physical activity, obvious fright, or anger. Medical attention should also be sought if palpitations are accompanied by chest **pain**, **dizziness**, **shortness of breath**, or an overall feeling of weakness.

Most people have experienced a skipped or missed heartbeat, which is really an early beat and not a skipped beat at all. After a premature heartbeat, the heart rests for an instant then beats with extra force, making a person feel as if the heart has skipped a beat. This type of palpitation is nothing to worry about unless it occurs frequently. Severe palpitations feel like a thudding or fluttering sensation in the chest. After chest pain, palpitations are the most common reason that people are referred for cardiology evaluation.

Causes and symptoms

Palpitations can be caused by **anxiety**, arrhythmias, **caffeine**, certain medications, **cocaine** and amphetamines, emotional **stress**, overeating, panic, somatization, and vigorous **exercise**. There may be no other symptoms. But, anxiety, dizziness, shortness of breath, and chest pain may be signs of more severe arrhythmias.

Diagnosis

Palpitations are diagnosed through a medical history, a **physical examination**, an electrocardiogram (ECG), and screening for psychiatric disorders. It is often difficult to distinguish palpitations from **panic disorder**, a common problem in which a person experiences frequent and unexplained "fight-or-flight" responses, which is the body's natural physical reaction to extreme danger or physical exertion, but without the obvious external stimulus.

To accurately diagnose palpitations, one of the irregular heartbeats must be "captured" on an EKG, which shows the heart's activity. Electrodes covered with a type of gel that conducts electrical impulses are placed on the patient's chest, arms, and legs. These electrodes send impulses of the heart's activity to a recorder, which traces them on paper. This **electrocardiography** test takes about 10 minutes and is performed in a physician's office or hospital. Because palpitations are unlikely to occur during a standard EKG, **Holter monitoring** is often performed. In this procedure, the patient wears a small, portable tape recorder that is attached to a belt or shoulder strap and connected to electrode disks on his or her chest. The Holter monitor records the heart's rhythm during normal activities. Some medical centers are now using event recorders that the patient can carry for weeks or months. When palpitations occur, the patient presses a button on the device, which captures the information about the palpitations for physician evaluation. Later the recording can be transmitted over the telephone line for analysis.

Treatment

Most palpitations require no treatment. Persistent palpitations can be treated with small doses of a beta blocker. **Beta blockers** are drugs that tend to lower blood pressure. They slow the heart rate and decrease the force with which the heart pumps. If the cause of the palpitations is determined to be an arrhythmia, medical or surgical treatment may be indicated, although surgery is rarely needed.

Alternative treatment

Alternative treatments for palpitations should be used only as a complement to traditional medicine. Alternative treatments include: **aromatherapy**, Chinese herbs, herbal therapies, **homeopathic medicine**, exercise, mind/body medicine, and diet and **nutrition**. In aromatherapy, adding citrus oils to bath water may help with minor palpitations. Some Chinese herbs can also help, but others can worsen arrhythmias, so a qualified herbalist should be consulted. Herbal therapies such as hawthorn (*Crataegus laevigata*) and motherwort (*Leonurus cardiaca*) can help with palpitations.

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KEY TERMS

Arrhythmia—Any variation from the normal heartbeat. Some arrhythmias are harmless, while others, such as ventricular tachycardia, ventricular fibrillation, and ventricular standstill, can be fatal.

Somatization—Anxiety converted into physical symptoms. Somatization is a sign of panic disorder.

Homeopathic remedies such as *Lachesis, Digitalis,* and *Aconite* (*Aconitum nnapellus*) may be used to control palpitations but should be taken only when prescribed by a homeopathic physician. Mind/body medicine such as **meditation** and **yoga** can help the person relax, eliminating or reducing palpitations caused by anxiety or stress. Reducing or eliminating tea, cola, coffee, and chocolate, and consuming adequate amounts of the **minerals calcium**, magnesium, and potassium can help reduce or eliminate palpitations. Alternative treatments should be used with care, as the benefits of many such treatments have not been confirmed by scientific research.

Prognosis

Most palpitations are harmless, but some can be a sign of heart trouble, which could be fatal if left untreated.

Prevention

Palpitations not caused by arrhythmias can be prevented by reducing or eliminating anxiety and emotional stress, and reducing or eliminating consumption of tea, cola, coffee, and chocolate. Exercise can also help, but a treadmill **stress test** performed by a physician should be considered first to make sure that exercise is safe.

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American Heart Association, 7272 Greenville Ave., Dallas, TX, 75231, (301) 223–2307, (800) 242–8721, http://www.americanheart.org.

American Institute of Stress, 124 Park Ave., Yonkers, NY, 10703, (914) 963–1200, http://www.stress.org.

Center for Disease Control (CDC). Division for Heart Disease and Stroke Prevention, 4770 Buford Hwy NE, Atlanta, GA, 30341–3717, (770) 488–2424, ww.cdc.gov/cholesterol/faqs.htm.

European Society of Cardiology, The European Heart House, 2035 Route des Colles, B.P. 179–Les Templiers, Sophia–Antipolis, France, 06903, 33 4 9294 7600, 33 4 9294 7601, http://www.escardio.org.

Heart Foundation, 80 William St., Level 3, SydneyNSW, Australia, 2011, 02 9219 2444, 300 36 27 87, http://www.heartfoundation.org.au.

National Heart, Lung, and Blood Institute, PO Box 30105, Bethesda, MD, 20824–0105, (301) 592–8573, (204) 629–3246, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi.nih.gov.

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Panax quinquefolius see **Ginseng**

Pancreas removal *see* **Pancreatectomy**

Pancreas transplantation

Definition

Pancreas transplantation is a surgical procedure in which a diseased pancreas is replaced with a healthy pancreas that has been obtained from an immunologically compatible cadavear or living donor.

Purpose

The pancreas is an organ that secretes insulin, a peptide hormone that regulates glucose (blood sugar) metabolism. Patients with type 1 diabetes have experienced partial or complete damage to the insulin-producing beta cells of the pancreas. Consequently, they are unable to generate sufficient insulin to control blood glucose levels. Long-term uncontrolled high blood glucose levels can cause damage to every system of the body, so type 1 patients must inject insulin to do the work of the beta cells. Pancreas transplantation allows the body to once again make and secrete its own

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KEY TERMS

Cadaver organ—A pancreas, kidney, or other organ from a brain-dead organ donor.

Duodenum—The section of the small intestine immediately after the stomach.

insulin, and establishes insulin independence for these individuals.

Demographics

It is estimated that about 1.4 million people in the United States have type 1 **diabetes mellitus** (also called insulin-dependant diabetes or juvenile diabetes). Among these individuals, the best candidates for pancreas transplantation are typically:

- between the ages of 20 and 40
- those who have extreme difficulty regulating their glucose levels with insulin therapy (a condition called brittle diabetes)
- those who have few secondary complications of diabetes
- those who are in good cardiovascular health

Pancreas-only transplants account for about 10% of the 1200 pancreas transplants performed each year in the United States as of 2010. More common is the combined kidney-pancreas transplant, or simultaneous pancreas-kidney transplantation (SPK), which is performed in about 75% of patients. The remaining 15% of patients receive a PAK, or pancreas after kidney transplant, according to the United Network for Organ Sharing (UNOS). There are about 100 medical centers in the United States that perform pancreas transplantations as of early 2010.

Description

Once a donor pancreas is located and **tissue typing** deems it compatible, the patient is contacted and prepared for surgery. Blood tests, a **chest x ray**, and an electrocardiogram (ECG) are performed and an intravenous (IV) line is started for fluid and medication administration. Once the transplant procedure is ready to start, **general anesthesia** is administered.

The surgeon makes an incision under the ribs and locates the pancreas and duodenum. The pancreas and duodenum (part of the small intestine) are removed. The new pancreas and duodenum are then connected to the patient's duodenum, and the blood vessels are sutured together to restore blood flow to the new pancreas. The patient's original pancreas is left in place.

Replacing the duodenum allows the pancreas to drain into the gastrointestinal system. The transplant can also be done creating bladder drainage. Bladder drainage makes it easier to monitor organ rejection because pancreatic secretions can be measured in the patient's urine. Once the new pancreas is in place, the abdomen and skin are sutured closed. This surgery is often done at the same time as kidney **transplant surgery**.

Diagnosis/Preparation

After the patient and doctor have decided on a pancreas transplant, a complete immunological study is performed to match the patient to a donor. An extensive medical history and **physical examination** is performed, including radiological exams, blood and urine tests, and psychological evaluation. Once the patient is approved for transplant, he or she will be placed on the United Network for Organ Sharing (UNOS) Organ Center waiting list. The timing of surgery depends on the availability of a donated living or cadaver organ.

Aftercare

Patients receiving a pancreas transplantation are monitored closely for organ rejection. The average hospital stay is three weeks, and it takes about six months to recover from surgery. Patients will take **immunosuppressant drugs** for the rest of their lives.

Risks

Diabetes and poor kidney function greatly increase the risk of complications from anesthesia during surgery. Organ rejection, excessive bleeding, and infection are other major risks associated with this surgery.

The reason that simultaneous kidney-pancreas transplants and pancreas-after-kidney transplants are performed more frequently than pancreas-only transplants is the relative risk of immunosuppressant drugs in people with diabetes. People with type 1 diabetes are already at risk for autoimmune problems, are more prone to infections, and have a complicated medical history that makes suppressing the immune system unadvisable.

On the other hand, diabetes is also the number one cause of **chronic kidney failure**, or end-stage renal disease (ESRD), which makes this group more likely to eventually require a kidney transplant for survival.

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In those patients with diabetes who will receive or are already receiving immunosuppressive treatment for a life-saving kidney transplant, a pancreas transplant can return their ability to self-produce insulin.

Patients with type 1 diabetes considering pancreas transplantation alone must weigh the risks and benefits of the procedure and decide with their doctors whether life-long treatment with immunosuppressive drugs is preferable to life-long insulin dependence.

Normal results

In a successful transplant, the pancreas begins producing insulin, bringing the regulation of glucose back under control. Natural availability of insulin prevents the development of additional complications associated with diabetes, including kidney damage, vision loss, and nerve damage. Many patients report an improved quality of life.

Morbidity and mortality rates

According to the Mayo Clinic, as of 2009, the transplanted pancreas is still functioning after one year in about 87 percent of people who receive a simultaneous pancreas-kidney transplant. After five years, the rate drops to 72 percent. In about 77 percent of people who receive a pancreas-after-kidney transplant, the transplanted pancreas is still functioning after one year; five years after transplant, the rate drops to 59 percent. In about 85 percent of people who receive a pancreas-only transplant, the transplanted pancreas is still functioning after one year. That rate is about 52 percent after five years.

Alternatives

Innovations in islet cell transplants, a procedure that involves transplanting a culture of the insulin-producing islet cells of a healthy pancreas to a patient with type 1 diabetes, have increased the frequency of this procedure. The Edmonton Protocol, a type of islet cell transplant developed in 1999 by Dr. James Shapiro at the University of Alberta (Canada), uses a unique immunosuppresant drug regimen that has dramatically improved success rates of the islet transplant procedure. As of early 2010, the Edmonton Protocol is still considered investigational in the United States, and a number of clinical trials are ongoing. One center that is recruiting patients for clinical trials of islet transplantation is the Schulze Diabetes Institute of the University of Minnesota.

Researchers in Japan and elsewhere are also investigating stem cells as a possible source of insulin-producing cells available for transplantation. This research is still in its early stages as of 2010.

National transplant waiting list by organ type (June 2010)

Organ needed	Persons waiting
Kidney	85,296
Liver	16,031
Heart	3,141
Kidney/Pancreas	2,199
Lung	1,802
Pancreas	1,450
Intestine	242
Heart/Lung	79

SOURCE: U.S. Department of Health and Human Services, Organ Procurement and Transplantation Network. Available online at: http://optn.transplant.hrsa.gov/data/default.asp (accessed June 8, 2010).

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ORGANIZATIONS

American Diabetes Association, 1701 North Beauregard Street, Alexandria, VA, 22311, (800) 342-2383, http://www.diabetes.org.

Schulze Diabetes Institute, 420 Delaware Street S.E, Minneapolis, MN, 55455, (612) 626-3016, http://www.surg.umn.edu/diabinst/home.html.

United Network for Organ Sharing (UNOS), 700 North 4th St., Richmond, VA, 23219, (888) 894-6361, http://www.transplantliving.org.

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Pancreatectomy

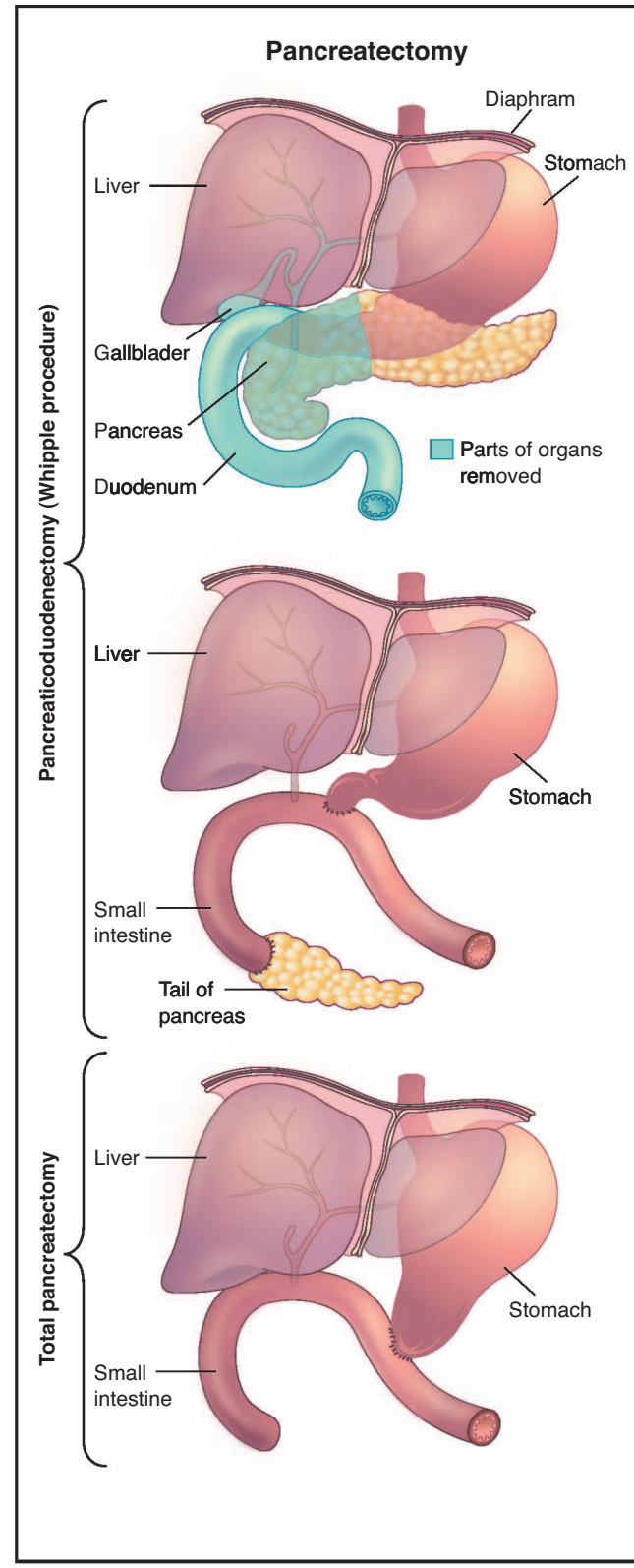
Definition

A pancreatectomy is the surgical removal of the pancreas. A pancreatectomy may be total, in which case the entire organ is removed, usually along with the spleen, gallbladder, common bile duct, and portions of the small intestine and stomach. A pancreatectomy may also be distal, meaning that only the body and tail of the pancreas are removed, leaving the head of the organ attached. When the duodenum is removed along with all or part of the pancreas, the procedure is called a pancreaticoduodenectomy, which surgeons sometimes refer to as Whipple's procedure. Pancreaticoduodenectomies are increasingly used to treat a variety of malignant and benign diseases of the pancreas. This procedure often involves removal of the regional lymph nodes as well.

Purpose

A pancreatectomy is the most effective treatment for **cancer** of the pancreas, an abdominal organ that secretes digestive enzymes, insulin, and other hormones. The thickest part of the pancreas near the duodenum (a part of the small intestine) is called the head, the middle part is called the body, and the thinnest part adjacent to the spleen is called the tail.

While surgical removal of tumors in the pancreas is the preferred treatment, it is only possible in the 10–15% of patients who are diagnosed early enough for a potential cure. Patients who are considered suitable for surgery usually have small tumors in the head of the pancreas (close to the duodenum, or first part of the small intestine), have **jaundice** as their initial



Two types of pancreatectomies: pancreaticoduodenectomy (top, also known as the Whipple procedure) and total pancreatectomy (bottom). *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

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KEY TERMS

Chemotherapy—A cancer treatment that uses synthetic drugs to destroy the tumor either by inhibiting the growth of the cancerous cells or by killing the cancer cells.

Computed tomography (CT) scan—An imaging technique that creates a series of pictures of areas inside the body, taken from different angles. The pictures are created by a computer linked to an x-ray machine.

Endoscopic retrograde cholangiopancreatography (ERCP)—A procedure to x-ray the ducts (tubes) that carry bile from the liver to the gallbladder and from the gallbladder to the small intestine.

Laparoscopy—In this procedure, a laparoscope (a thin, lighted tube) is inserted through an incision in the abdominal wall to determine if the cancer is within the pancreas only or has spread to nearby tissues and if it can be removed by surgery later. Tissue samples may be removed for biopsy.

Magnetic resonance imaging (MRI)—A procedure in which a magnet linked to a computer is used to create detailed pictures of areas inside the body.

Pancreas—A large gland located on the back wall of the abdomen, extending from the duodenum (first part of the small intestine) to the spleen. The pancreas produces enzymes essential for digestion, and the hormones insulin and glucagon, which play a role in diabetes.

Pancreaticoduodenectomy—Removal of all or part of the pancreas along with the duodenum. Also known as "Whipple's procedure" or "Whipple's operation."

Pancreatitis—Inflammation of the pancreas, either acute (sudden and episodic) or chronic, usually caused by excessive alcohol intake or gallbladder disease.

Positron emission tomography (PET) scan—An imaging system that creates a picture showing the location of tumor cells in the body. A substance called radionuclide dye is injected into a vein, and the PET scanner rotates around the body to create the picture. Malignant tumor cells show up brighter in the picture because they are more active and take up more dye than normal cells.

Radiation therapy—A treatment using high energy radiation from x-ray machines, cobalt, radium, or other sources.

Ultrasonogram—A procedure where high-frequency sound waves that cannot be heard by human ears are bounced off internal organs and tissues. These sound waves produce a pattern of echoes which are then used by the computer to create sonograms, or pictures of areas inside the body.

symptom, and have no evidence of metastatic disease (spread of cancer to other sites). The stage of the cancer will determine whether the pancreatectomy to be performed should be total or distal.

A partial pancreatectomy may be indicated when the pancreas has been severely injured by trauma, especially injury to the body and tail of the pancreas. While such surgery removes normal pancreatic tissue as well, the long-term consequences of this surgery are minimal, with virtually no effects on the production of insulin, digestive enzymes, and other hormones.

Chronic **pancreatitis** is another condition for which a pancreatectomy is occasionally performed. Chronic pancreatitis—or continuing inflammation of the pancreas that results in permanent damage to this organ—can develop from long-standing, recurring episodes of acute (periodic) pancreatitis. This painful condition usually results from alcohol **abuse** or the presence of **gallstones**. In most patients with the alcohol-induced disease, the pancreas is widely involved, therefore, surgical correction is almost impossible.

Description

A pancreatectomy can be performed through an open surgery technique, in which case one large incision is made, or it can be performed laparoscopically, in which case the surgeon makes four small incisions to insert tube-like surgical instruments. The abdomen is filled with gas, usually carbon dioxide, to help the surgeon view the abdominal cavity. A camera is inserted through one of the tubes and displays images on a monitor in the operating room. Other instruments are placed through the additional tubes. The laparoscopic approach allows the surgeon to work inside the patient's abdomen without making a large incision.

If the pancreatectomy is partial, the surgeon clamps and cuts the blood vessels, and the pancreas is stapled and divided for removal. If the disease affects the splenic artery or vein, the spleen is also removed.

If the pancreatectomy is total, the surgeon removes the entire pancreas and attached organs. He

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or she starts by dividing and detaching the end of the stomach. This part of the stomach leads to the small intestine, where the pancreas and bile duct both attach. In the next step, he removes the pancreas along with the connected section of the small intestine. The common bile duct and the gallbladder are also removed. To reconnect the intestinal tract, the stomach and the bile duct are then connected to the small intestine.

During a pancreatectomy procedure, several tubes are also inserted for postoperative care. To prevent tissue fluid from accumulating in the operated site, a temporary drain leading out of the body is inserted, as well as a **gastrostomy** or g-tube leading out of the stomach in order to help prevent **nausea and vomiting**. A jejunostomy or j-tube may also be inserted into the small intestine as a pathway for supplementary feeding.

Diagnosis/Preparation

Patients with symptoms of a pancreatic disorder undergo a number of tests before surgery is even considered. These can include ultrasonography, x-ray examinations, **computed tomography scans** (CT scan), and **endoscopic retrograde cholangiopancreatography** (ERCP), a specialized imaging technique to visualize the ducts that carry bile from the liver to the gallbladder. Tests may also include **angiography**, another imaging technique used to visualize the arteries feeding the pancreas, and needle aspiration cytology, in which cells are drawn from areas suspected to contain cancer. Such tests are required to establish a correct diagnosis for the pancreatic disorder and in the planning the surgery.

Since many patients with pancreatic cancer are undernourished, appropriate nutritional support, sometimes by **tube feedings**, may be required prior to surgery.

Some patients with pancreatic cancer deemed suitable for a pancreatectomy will also undergo **chemotherapy** and/or **radiation therapy**. This treatment is aimed at shrinking the tumor, which will improve the chances for successful surgical removal. Sometimes, patients who are not initially considered surgical candidates may respond so well to chemoradiation that surgical treatment becomes possible. Radiation therapy may also be applied during the surgery (intraoperatively) to improve the patient's chances of survival, but this treatment is not yet in routine use. Some studies have shown that intraoperative radiation therapy extends survival by several months.

Patients undergoing **distal pancreatectomy** that involves removal of the spleen may receive preoperative medication to decrease the risk of infection.

Aftercare

Pancreatectomy is major surgery. Therefore, extended hospitalization is usually required with an average hospital stay of two to three weeks.

Some pancreatic cancer patients may also receive combined chemotherapy and radiation therapy after surgery. This additional treatment has been clearly shown to enhance survival rates.

After surgery, patients experience **pain** in the abdomen and are prescribed pain medication. Follow-up exams are required to monitor the patient's recovery and remove implanted tubes.

A total pancreatectomy leads to a condition called pancreatic insufficiency, because food can no longer be normally processed with the enzymes normally produced by the pancreas. Insulin secretion is likewise no longer possible. These conditions are treated with pancreatic enzyme replacement therapy, which supplies digestive enzymes; and with insulin injections. In some case, distal pancreatectomies may also lead to pancreatic insufficiency, depending on the patient's general health condition before surgery and on the extent of pancreatic tissue removal.

Risks

There is a fairly high risk of complications associated with any pancreatectomy procedure. A recent Johns Hopkins study documented complications in 41% of cases. The most devastating complication is postoperative bleeding, which increases the mortality risk to 20–50%. In cases of postoperative bleeding, the patient may be returned to surgery to find the source of hemorrhage, or may undergo other procedures to stop the bleeding.

One of the most common complications from a pancreaticoduodenectomy is delayed gastric emptying, a condition in which food and liquids are slow to leave the stomach. This complication occurred in 19% of patients in the Johns Hopkins study. To manage this problem, many surgeons insert feeding tubes at the original operation site, through which nutrients can be fed directly into the patient's intestines. This procedure, called enteral **nutrition**, maintains the patient's nutrition if the stomach is slow to recover normal function. Certain medications, called promotility agents, can help move the nutritional contents through the gastrointestinal tract.

The other most common complication is pancreatic anastomotic leak. This is a leak in the connection that the surgeon makes between the remainder of the pancreas and the other structures in the abdomen.

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Most surgeons handle the potential for this problem by checking the connection during surgery.

Normal results

After a total pancreatectomy, the body loses the ability to secrete insulin, enzymes, and other substances; therefore, the patient has to take supplements for the rest of his or her life.

Patients usually resume normal activities within a month after surgery, although they are asked to avoid heavy lifting for six to eight weeks and not to drive as long as they take narcotic medication.

When a pancreatectomy is performed for chronic pancreatitis, the majority of patients obtain some relief from pain. Some studies report that one-half to three-quarters of patients become free of pain.

Morbidity and mortality rates

The mortality rate for pancreatectomy has decreased in recent years to 5–10%, depending on the extent of the surgery and the experience of the surgeon. A study of 650 patients at Johns Hopkins Medical Institution, Baltimore, found that only nine patients, or 1.4%, died from complications related to surgery.

Unfortunately, pancreatic cancer is the most lethal form of gastrointestinal malignancy. However, for a highly selective group of patients, a pancreatectomy offers a chance for cure, especially when performed by experienced surgeons. The overall five-year survival rate for patients who undergo pancreatectomy for pancreatic cancer is about 10%; patients who undergo pancreaticoduodenectomy have a 4–5% survival at five years. The risk for tumor recurrence is thought to be unaffected by whether the patient undergoes a total pancreatectomy or a pancreaticoduodenectomy, but is increased when the tumor is larger than 1.2 in (3 cm) and the cancer has spread to the lymph nodes or surrounding tissue.

Alternatives

Depending on the medical condition, a **pancreas transplantation** may be considered as an alternative for some patients.

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ORGANIZATIONS

American College of Gastroenterology, P.O. Box 342260, Bethesda, MD, 20827-2260, (301) 263-9000, http://www.acg.gi.org.

American Gastroenterological Association (AGA), 4930 Del Ray Avenue, Bethesda, MD, 20814, (301) 654-2055, (301) 654-5920, member@gastro.org, http://www.gastro.org.

National Cancer Institute, NCI Public Inquiries Office, 6116 Executive Boulevard, Bethesda, MD, 20892-8322, (800) 422-6237, http://www.cancer.gov.

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Pancreatic cancer, endocrine

Definition

Endocrine pancreatic **cancer** is a disease in which cancerous cells originate within the tissues of the pancreas that produce hormones.

Description

The pancreas is a 6–8 in (15–20 cm) long, slipper-shaped gland located in the abdomen. It lies behind the stomach, within a loop formed by the small intestine. Other nearby organs include the gallbladder, spleen, and liver. The pancreas has a wide end (head), a narrow end (tail), and a middle section (body). A healthy pancreas is important for normal food digestion and plays a critical role in the body's metabolic processes. The pancreas has two main functions, each performed by distinct types of tissue. The exocrine tissue secretes fluids into the other organs of the digestive system, while the endocrine tissue secretes substances that are circulated in the bloodstream. The exocrine pancreas makes up the vast majority of the gland; it produces pancreatic juices containing enzymes that help break down proteins and fatty food. The endocrine tissue of the pancreas makes up only 2% of the gland's total mass. It consists of small patches of cells that produce hormones (like insulin) that control how the body stores and uses nutrients. These patches are called islets (islands)

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of Langerhans or islet cells and are interspersed evenly throughout the pancreas. Each islet contains approximately 1,000 endocrine cells and a dense network of capillaries (tiny blood vessels), which allows immediate entry of hormones into the circulatory system.

Pancreatic tumors are classified as either exocrine or endocrine tumors depending on which type of tissue they arise from within the gland. Endocrine tumors of the pancreas are very rare, accounting for only 5% of all pancreatic cancers. The majority of endocrine pancreatic tumors are functional adenocarcinomas that overproduce a specific hormone. There are several types of islet cells and each produces its own hormone or peptide (small protein molecule). Functional endocrine tumors are named after the hormone they secrete. Insulinoma is the most common tumor of the endocrine pancreas. Patients with this disease usually develop **hypoglycemia** due to increased insulin production that leads to abnormally low blood sugar levels. **Gastrinoma**, a disease in which gastrin (hormone that stimulates stomach acid production) is overproduced, causes multiple ulcers in the upper gastrointestinal (GI) tract. Gastrinoma was first described in patients with a rare form of severe peptic ulcer disease known as Zollinger-Ellison syndrome (ZES). The less common glucagonoma causes mild diabetes due to excess glucagon (hormone that stimulates glucose production) secretion. Other rare islet cell tumors include vipoma (vasoactive intestinal peptide) and somatostatinoma. Nonfunctional pancreatic endocrine tumors are not associated with an excess production of any hormone and can be difficult to distinguish from **exocrine pancreatic cancer**. Cancers of the endocrine pancreas are relatively slow-growing compared to the more common ductal adenocarcinomas of the exocrine pancreas.

Between one and four cases of insulinoma occur per million people per year, and 90% of these tumors are benign. They occur mostly between the ages of 50 and 60 and affect men and women equally. Less than three cases of gastrinoma per million people are diagnosed each year, but it is the most common functional islet cell tumor in patients with multiple endocrine tumors, a condition known as multiple endocrine neoplasia (MEN) syndrome. Vipoma and glucagonoma are even rarer and they occur more frequently in women. Somatostatinoma is exceedingly uncommon, and less than 100 cases have been reported worldwide. Nonfunctional islet cell cancers account for approximately one-third of all cancers of the endocrine pancreas, and the majority of these are malignant.

Causes and symptoms

There are no known causes of islet cell cancer, but a small percentage of cases occur due to hereditary syndromes such as MEN. This is a condition that frequently causes more than one tumor in several endocrine glands, such as the parathyroid and pituitary, in addition to the islet cells of the pancreas. Twenty-five percent of gastrinomas and less than 10% of insulinomas occur in MEN patients. Von Hippel-Lindau (VHL) syndrome is another genetic disorder that causes multiple tumors, and 10–15% of VHL patients will develop islet cell cancer.

Symptoms vary among the different islet cell cancer types. Insulinoma causes repeated episodes of hypoglycemia, sweating, and **tremors**, while patients with gastrinoma have inflammation of the esophagus, epigastric **pain**, multiple ulcers, and possibly **diarrhea**. Symptoms of glucagonoma include a distinctive skin rash, inflammation of the stomach, glucose intolerance, weight loss, weakness, and anemia (less common). Patients with vipoma have episodes of profuse, watery diarrhea, even after **fasting**. Somatostatinoma causes mild diabetes, diarrhea/steatorrhea (fatty stools), weight loss, and gallbladder disease. Nonfunctional endocrine tumors frequently produce the same symptoms as cancer of the exocrine pancreas such as abdominal pain, **jaundice**, and weight loss.

Diagnosis

A thorough physical exam is usually performed when a patient presents with the above symptoms, however, functional endocrine tumors of the pancreas tend to be small and are not detected by palpating the abdomen. Once other illnesses such as infection are ruled out, the doctor will order a series of blood and urine tests. The functional endocrine tumors can be identified through increased levels of hormone in the bloodstream.

Functional endocrine tumors can occur in multiple sites in the pancreas and are often small (less than 1 cm), making them difficult to diagnose. Nonfunctional tumors tend to be larger, which makes them difficult to distinguish from tumors of the exocrine pancreas. Methods such as computed tomography (CT) scan and **magnetic resonance imaging** (MRI) are used to take pictures of the internal organs and allow the doctor to determine whether a tumor is present. Somatostatin receptor scintigraphy (trade name OctreoScan) is an imaging system used to localize endocrine tumors, especially gastrinomas and somatostatinomas. Endoscopic ultrasound (EUS) is

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a more sensitive technique that may be used if a CT scan fails to detect a tumor. Endocrine tumors usually have many blood vessels, so **angiography** may be useful in the doctor's assessment and staging of the tumor. Surgical exploration is sometimes necessary in order to locate very small tumors that occur in multiple sites. These techniques also help the doctor evaluate how far the tumor has spread. A biopsy can be taken to confirm diagnosis, but more often, doctors look at the size and local invasion of the tumor in order to plan a treatment strategy.

Treatment

Staging

The staging system for islet cell cancer is still evolving, but the tumors typically fall into three categories: cancers that arise in one location within the pancreas, cancers that arise in several locations within the pancreas, and cancers that have spread to nearby lymph nodes or to other organs in the body.

Surgery is the only curative method for islet cell cancers, and studies have shown that an aggressive surgical approach can improve survival and alleviate symptoms of the disease. As with most forms of cancer, the earlier it is diagnosed, the greater the chance for survival. With the exception of insulinoma, the majority of islet cell tumors are malignant at the time of diagnosis, and more than half are metastatic. However, surgery and **chemotherapy** have been shown to improve the outcome of patients even if they have metastatic disease. Surgery may include partial or total removal of the pancreas, and in patients with gastrinoma, the stomach may be removed as well. Streptozotocin, doxorubicin, and 5-fluorouracil (5-FU) are chemotherapeutic agents commonly used in the treatment of islet cell cancer. Patients may experience **nausea and vomiting** as well as kidney toxicity from streptozotocin, and bone marrow suppression from doxorubicin. Hormone therapy is used to relieve the symptoms of functional tumors by inhibiting excess hormone production. Other techniques may be used to block blood flow to the liver in an attempt to kill the cancer cells that have spread there. Abdominal pain, **nausea**, **vomiting** and **fever** may result from this type of treatment. Radiation has little if any role in the treatment of islet cell cancer.

Prognosis

Islet cell cancers overall have a more favorable prognosis than cancers of the exocrine pancreas, and the median survival from diagnosis is three and a half years. This is mainly due to their slow-growing nature. Insulinomas have a five-year survival rate of 80% and gastrinomas have 65%. When malignant, islet cell cancers do not generally respond well to chemotherapy, and the treatment is mainly palliative. Most patients with metastasis do not survive five years. Islet cell cancer tends to spread to the surrounding lymph nodes, stomach, small intestine, and liver.

KEY TERMS

Adenocarcinoma—A malignant tumor that arises within the tissues of a gland and retains its glandular structure.

Angiography—Diagnostic technique used to study blood vessels in a tumor.

Biopsy—Removal and microscopic examination of cells to determine whether they are cancerous.

Chemotherapy—Drug treatment administered to kill cancerous cells.

Endocrine—Refers to glands that secrete hormones circulated in the bloodstream.

Endoscopic ultrasonography (EUS)—Diagnostic imaging technique where an ultrasound probe is inserted down a patient's throat to determine if a tumor is present.

Gastrinoma—Tumor that arises from the gastrin-producing cells in the pancreas.

Insulinoma—Tumor that arises from the insulin-producing cells in the pancreas.

Islets of Langerhans—Clusters of cells in the pancreas that make up the endocrine tissue.

Prevention

There are no known risk factors associated with sporadic islet cell cancer. Therefore, it is not clear how to prevent its occurrence. Individuals with MEN syndrome or VHL, however, have a genetic predisposition to developing islet cell cancer and should be screened regularly in an effort to catch the disease early.

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ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd., NE, Atlanta, GA 30329, (404) 320-3333, (800) ACS-2345. http://www.cancer.org.
Cancer Research and Prevention Foundation, 1600 Duke Street, Suite 500, Alexandria, VA 22314, (703) 836-4412, (800) 227-2732, info@preventcancer.org, http://www.preventcancer.org.
National Cancer Institute, 9000 Rockville Pike, Bldg. 31, Rm.10A16, Bethesda, MD, 20892, (800) 422-6237, http://www.nci.nih.gov.
National Familial Pancreas Tumor Registry, The Johns Hopkins Hospital, 600 North Wolfe St, Baltimore, MD, 21287-6417, (410) 377-7450
National Organization for Rare Disorders, 100 Route 37, PO Box 8923, New Fairfield, CT, 06812, (203) 746-6518, http://www.nord-rdb.com/~orphan.
National Pancreas Foundation, 101 Federal Street, Suite 1900, Boston, MA 02110, (617) 578-0382, (866) 726-2737, (617) 578-0383. http://www.pancreasfoundation.org.

Elizabeth Pulcini, M.Sc.

Pancreatic cancer, exocrine

Definition

Exocrine pancreatic **cancer** is a disease in which cancerous cells originate within the tissues of the pancreas that produce digestive juices.

Description

The pancreas is a 6–8 in (15–20 cm) long, slipper-shaped gland located in the abdomen. It lies behind the stomach, within a loop formed by the small intestine. Other nearby organs include the gallbladder, spleen, and liver. The pancreas has a wide end (head), a narrow end (tail), and a middle section (body). A healthy pancreas is important for normal food digestion and also plays a critical role in the body's metabolic processes. The pancreas has two main functions, and each are performed by distinct types of tissue. The exocrine tissue makes up the vast majority of the gland and secretes fluids into the other organs of the digestive system. The endocrine tissue secretes hormones (like insulin) that are circulated in the bloodstream, and these substances control how the body stores and uses nutrients. The exocrine tissue of the pancreas, comprised mostly of acinar cells and ductal cells, produces pancreatic (digestive) juices. These juices contain several enzymes that help break down proteins and fatty foods. The exocrine pancreas forms an intricate system of channels or ducts, which are tubular structures that carry pancreatic juices to the small intestine where they are used for digestion.

Pancreatic tumors are classified as either exocrine or endocrine tumors depending on which type of tissue they arise from within the gland. Ninety-five percent of pancreatic cancers occur in the tissues of the exocrine pancreas. Ductal adenocarcinomas arise in the cells that line the ducts of the exocrine pancreas and account for 80% to 90% of all tumors of the pancreas. Unless specified, nearly all reports on pancreatic cancer refer to ductal adenocarcinomas. Less common types of pancreatic exocrine tumors include acinar cell carcinoma, cystic tumors that are typically benign but may become cancerous, and papillary tumors that grow within the pancreatic ducts. Pancreatoblastoma is a very rare disease that primarily affects young children. Two-thirds of pancreatic tumors occur in the head of the pancreas, and tumor growth in this area can lead to the obstruction of the nearby common bile duct that empties bile fluid into the small intestine. When bile cannot be passed into the intestine, patients may develop yellowing of the skin and eyes (**jaundice**) due to the buildup of bilirubin (a component of bile) in the bloodstream. Tumor blockage of bile or pancreatic ducts may also cause digestive problems since these fluids contain critical enzymes in the digestive process. Depending on their size, pancreatic tumors may cause abdominal **pain** by pressing on the surrounding nerves. Because of its location deep within the abdomen, pancreatic cancer often remains undetected until it has spread to other organs such as the liver or lung. Pancreatic cancer tends to rapidly spread to other organs, even when the primary (original) tumor is relatively small.

Though pancreatic cancer accounts for only 3% of all cancers, it is the fifth most frequent cause of cancer deaths. In 2010, an estimated 43,140 new cases of pancreatic cancer were diagnosed in the United States. Pancreatic cancer is primarily a disease associated with advanced age, with 80% of cases occurring between the ages of 60 and 80. Men are almost twice as likely to develop this disease than women. Countries

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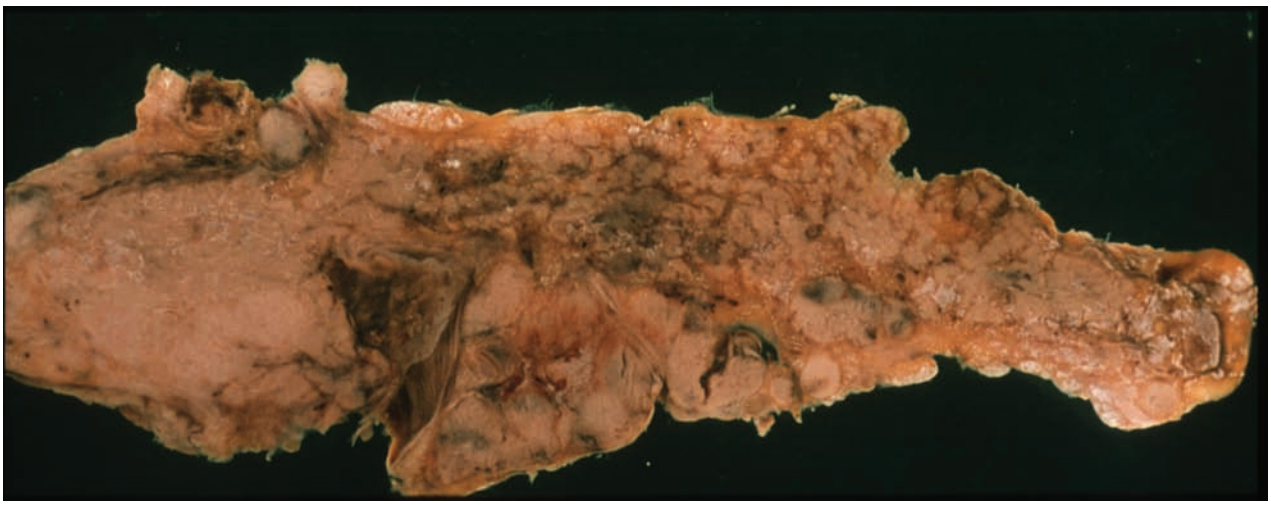

Carcinoma of the head of the pancreas. Tumors appear as gritty, gray, hard nodules, invading the adjacent gland. *(Biophoto Associates/Science Source/Photo Researchers, Inc.)*

with the highest frequencies of pancreatic cancer include the United States, New Zealand, Western European nations, and Scandinavia. The lowest occurrences of the disease are reported in India, Kuwait and Singapore. African Americans have the highest incidence of pancreatic cancer of any ethnic group worldwide. Whether this difference is due to diet or environmental factors remains unclear.

Causes and symptoms

Although the exact cause for pancreatic cancer is not known, several risk factors have been shown to increase susceptibility to this particular cancer, the greatest of which is cigarette **smoking**. Approximately one-third of pancreatic cancer cases occur among smokers. People who have diabetes develop pancreatic cancer twice as often as non-diabetics. Numerous studies suggest that a family history of pancreatic cancer is another strong risk factor for developing the disease, particularly if two or more relatives in the immediate family have the disease. Other risk factors include chronic (long-term) inflammation of the pancreas (**pancreatitis**), **diets** high in fat, and occupational exposure to certain chemicals such as petroleum.

Pancreatic cancer often does not produce symptoms until it reaches an advanced stage. Patients may then present with the following signs and symptoms:

- upper abdominal and/or back pain
- jaundice
- weight loss
- loss of appetite
- diarrhea
- weakness
- nausea

These symptoms may also be caused by other illnesses; therefore, it is important to consult a doctor for an accurate diagnosis.

Diagnosis

Pancreatic cancer is difficult to diagnose, especially in the absence of symptoms, and there is no current screening method for early detection. The most sophisticated techniques available often do not detect very small tumors that are localized (have not begun to spread). At advanced stages where patients show symptoms, a number of tests may be performed to confirm diagnosis and to assess the stage of the disease. Approximately half of all pancreatic cancers are metastatic (have spread to other sites) at the time of diagnosis.

The first step in diagnosing pancreatic cancer is a thorough medical history and complete **physical examination**. The abdomen will be palpated to check for fluid accumulation, lumps, or masses. If there are signs of jaundice, blood tests will be performed to rule out the possibility of liver diseases such as hepatitis. Urine and stool tests may be performed as well.

Non-invasive imaging tools such as computed tomography (CT) scans and **magnetic resonance imaging** (MRI) can be used to produce detailed pictures of the internal organs. CT is the tool most often

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used to diagnose pancreatic cancer, as it allows the doctor to determine if the tumor can be removed by surgery or not. It is also useful in staging a tumor by showing the extent to which the tumor has spread. During a CT scan, patients receive an intravenous injection of a contrast dye so the organs can be visualized more clearly. MRI may be performed instead of CT if a patient has an allergy to the CT contrast dye. In some cases where the tumor is impinging on blood vessels or nearby ducts, MRI may be used to generate an image of the pancreatic ducts.

If the doctor suspects pancreatic cancer and no visible masses are seen with a CT scan, a patient may undergo a combination of invasive tests to confirm the presence of a pancreatic tumor. Endoscopic ultrasound (EUS) involves the use of an ultrasound probe at the end of a long, flexible tube that is passed down the patient's throat and into the stomach. This instrument can detect a tumor mass through high frequency sound waves and echoes. EUS can be accompanied by fine needle aspiration (FNA), where a long needle, guided by the ultrasound, is inserted into the tumor mass in order to take a biopsy sample. **Endoscopic retrograde cholangiopancreatography** (ERCP) is a technique often used in patients with severe jaundice because it enables the doctor to relieve blockage of the pancreatic ducts. The doctor, guided by **endoscopy** and x rays, inserts a small metal or plastic stent into the duct to keep it open. During ERCP, a biopsy can be done by collecting cells from the pancreas with a small brush. The cells are then examined under the microscope by a pathologist, who determines the presence of any cancerous cells.

In some cases, a biopsy may be performed during a type of surgery called **laparoscopy**, which is done under **general anesthesia**. Doctors insert a small camera and instruments into the abdomen after a minor incision is made. Tissue samples are removed for examination under the microscope. This procedure allows a doctor to determine the extent to which the disease has spread and decide if the tumor can be removed by further surgery.

An **angiography** is a type of test that studies the blood vessels in and around the pancreas. This test may be done before surgery so that the doctor can determine the extent to which the tumor invades and interacts with the blood vessels within the pancreas. The test requires **local anesthesia** and a catheter is inserted into the patient's upper thigh. A dye is then injected into blood vessels that lead into the pancreas, and x rays are taken.

In April 2001, doctors at major cancer research institutions such as Memorial Sloan-Kettering Cancer Center in New York were investigating CT angiography, an imaging technique that is less invasive than angiography alone. CT angiography is similar to a standard CT scan, but allows doctors to take a series of pictures of the blood vessels that support tumor growth. A dye is injected as in a CT scan (but at rapid intervals) and no catheter or **sedation** is required. A computer generates 3D images from the pictures that are taken, and the information is gathered by the surgical team who will develop an appropriate strategy if the patient's disease can be operated on.

Treatment

Staging

After cancer of the pancreas has been diagnosed, doctors typically use a TNM staging system to classify the tumor based on its size and the degree to which it has spread to other areas in the body. T indicates the size and local advancement of the primary tumor. Since cancers often invade the lymphatic system before spreading to other organs, regional lymph node involvement (N) is an important factor in staging. M indicates whether the tumor has metastasized (spread) to distant organs. In stage I, the tumor is localized to the pancreas and has not spread to surrounding lymph nodes or other organs. Stage II pancreatic cancer has spread to nearby organs such as the small intestine or bile duct, but not the surrounding lymph nodes. Stage III indicates lymph node involvement, whether the cancer has spread to nearby organs or not. Stage IVA pancreatic cancer has spread to organs near the pancreas such as the stomach, spleen, or colon. Stage IVB is a cancer that has spread to distant sites (liver, lung). If pancreatic cancer has been treated with success and then appears again in the pancreas or in other organs, it is referred to as recurrent disease.

Treatment of pancreatic cancer will depend on several factors, including the stage of the disease and the patient's age and overall health status. A combination of therapies is often employed in the treatment of this disease to improve the patient's chances for survival. Surgery is used whenever possible and is the only means by which cancer of the pancreas can be cured. However, less than 15% of pancreatic tumors can be removed by surgery. By the time the disease is diagnosed (usually at stage III), therapies such as radiation and **chemotherapy** or both are used in addition to surgery to relieve a patient's symptoms and

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enhance quality of life. For patients with metastatic disease, chemotherapy and radiation are used mainly as palliative (pain alleviating) treatments.

Surgery

Three types of surgery are used in the treatment of pancreatic cancer, depending on what section of the pancreas the tumor is located in. A Whipple procedure removes the head of the pancreas, part of the small intestine and some of the surrounding tissues. This procedure is most common since the majority of pancreatic cancers occur in the head of the organ. A total **pancreatectomy** removes the entire pancreas and the organs around it. **Distal pancreatectomy** removes only the body and tail of the pancreas. Chemotherapy and radiation may precede surgery (neoadjuvant therapy) or follow surgery (adjuvant therapy). Surgery is also used to relieve symptoms of pancreatic cancer by draining fluids or bypassing obstructions. Side effects from surgery can include pain, weakness, **fatigue**, and digestive problems. Some patients may develop diabetes or malabsorption as a result of partial or total removal of the pancreas.

Radiation therapy

Radiation therapy is sometimes used to shrink a tumor before surgery or to remove remaining cancer cells after surgery. Radiation may also be used to relieve pain or digestive problems caused by the tumor if it cannot be removed by surgery. External radiation therapy refers to radiation applied externally to the abdomen using a beam of high-energy x rays. High-dose intraoperative radiation therapy is sometimes used during surgery on tumors that have spread to nearby organs. Internal radiation therapy refers to the use of small radioactive seeds implanted in the tumor tissue. The seeds emit radiation over a period of time to kill tumor cells. Radiation treatment may cause side effects such as fatigue, tender or itchy skin, **nausea**, **vomiting**, and digestive problems.

Chemotherapy

Chemotherapeutic agents are powerful drugs that are used to kill cancer cells. They are classified according to the mechanism by which they induce cancer cell **death**. Multiple agents are often used to increase the chances of tumor cell death. Gemcitabine is the standard drug used to treat pancreatic cancers and can be used alone or in combination with other drugs, such as 5-flourouracil (5-FU). Other drugs are being tested in combination with gemcitabine in several ongoing clinical trials, specifically irinotecan (CPT-11) and oxaliplatin. Chemotherapy may be administered orally or intravenously in a series of doses over several weeks. During treatment, patients may experience fatigue, nausea, **vomiting**, hair loss, and mouth sores, depending on which drugs are used.

Biological treatments

Numerous vaccine treatments are being developed in an effort to stimulate the body's immune system into attacking cancer cells. This is also referred to as immunotherapy. Another type of biological treatment involves using a targeted monoclonal antibody to inhibit the growth of cancer cells. The antibody is thought to bind to and neutralize a protein that contributes to the growth of the cancer cells. Investigational treatments such as these may be considered by patients with metastatic disease who would like to participate in a clinical trial. Biological treatments typically cause flu-like symptoms (chills, **fever**, loss of appetite) during the treatment period.

Alternative treatment

Acupuncture or **hypnotherapy** may be used in addition to standard therapies to help relieve the pain associated with pancreatic cancer. Because of the poor prognosis associated with pancreatic cancer, some patients may try special diets with vitamin supplements, certain **exercise** programs, or unconventional treatments not yet approved by the FDA. Patients should always inform their doctors of any alternative treatments they are using as they could interfere with standard therapies. The National Cancer Institute (NCI) is funding phase III clinical trials of a controversial treatment for pancreatic cancer that involves the use of supplemental pancreatic enzymes (to digest cancerous cells) and coffee **enemas** (to stimulate the liver to detoxify the cancer). These theories remain unproven and the study is widely criticized in the medical community. It remains to been seen whether this method of treatment has any advantage over the standard chemotherapeutic regimen in prolonging patient survival or improving quality of life.

Prognosis

Unfortunately, cancer of the pancreas is often fatal, and median survival from diagnosis is less than six months, while the five-year survival rate is 4%. This is mainly due to the lack of screening methods available for early detection of the disease. Yet, even when localized tumors can be removed by surgery, patient survival after five years is only 10% to 15%. These statistics demonstrate the aggressive nature of most pancreatic cancers and their tendency to recur. Pancreatic cancers tend to be resistant to radiation

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KEY TERMS

Acinar cell carcinoma—A malignant tumor arising from the acinar cells of the pancreas.

Angiography—Diagnostic technique used to study blood vessels in a tumor.

Biopsy—Removal and microscopic examination of cells to determine whether they are cancerous.

Cancer vaccines—A treatment that uses the patient's immune system to attack cancer cells.

Chemotherapy—Drug treatment administered to kill cancerous cells.

Ductal adenocarcinoma—A malignant tumor arising from the duct cells within a gland.

Endoscopic retrograde cholangiopancreatography (ERCP)—Diagnostic technique used to obtain a biopsy. Also a surgical method of relieving biliary obstruction caused by a tumor.

Endoscopic ultrasonography (EUS)—Diagnostic imaging technique in which an ultrasound probe is inserted down a patient's throat to determine if a tumor is present.

Exocrine—Refers to glands which secrete their products through a duct.

Laparoscopic surgery—Minimally invasive surgery in which a camera and surgical instruments are inserted through a small incision.

Pancreatectomy—Partial or total surgical removal of the pancreas.

Radiation therapy—Use of radioisotopes to kill tumor cells. Applied externally through a beam of x rays, intraoperatively (during surgery), or deposited internally by implanting radioactive seeds in tumor tissue.

Whipple procedure—Surgical removal of the head of the pancreas, part of the small intestine, and some surrounding tissue.

and chemotherapy and these modes of treatment are mainly used to relieve pain and tumor burden.

Prevention

Although the exact cause of pancreatic cancer is not known, there are certain risk factors that may increase a person's chances of developing the disease. Quitting smoking will certainly reduce the risk for pancreatic cancer and many other cancers. The American Cancer Society recommends a diet rich in fruits, vegetables, and dietary fiber in order to reduce the risk of pancreatic cancer. According to the NCI, workers who are exposed to petroleum and other chemicals may be at greater risk for developing the disease and should follow their employer's safety precautions. People with a family history of pancreatic cancer are at greater risk than the general population, as a small percentage of pancreatic cancers are considered hereditary.

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ORGANIZATIONS

CancerNet, National Cancer Institute, 9000 Rockville Pike, Bldg. 31, Rm.10A16, Bethesda, MD, 20892, (800) 422-6237, http://wwwicic.nci.nih.gov.

Hirshberg Foundation for Pancreatic Cancer Research, 375 Homewood Rd, Los Angeles, CA, 90049, (310) 472-6310, http://www.pancreatic.org.

National Pancreas Foundation, P.O. Box 935, Wexford, PA, 15090-0935, http://www.pancreasfoundation.org.

Pancreatic Cancer Action Network, P.O. Box 1010, Torrance, CA, 90505, (877) 272-6226, http://www.pancan.org.

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Pancreatitis

Definition

Pancreatitis is an inflammation of the pancreas, an organ that is important in digestion. Pancreatitis can be acute (beginning suddenly, usually with the patient recovering fully) or chronic (progressing slowly with continued, permanent injury to the pancreas).

Demographics

The incidence of acute pancreatitis is approximately 40 cases per year per 100,000 adults, with the United States and Finland being the two most predominant countries of its occurrence. Mild forms of pancreatitis account for approximately 80% of the cases, with a mortality rate as low as 1%, while severe pancreatitis (approximately 20%) has as high as a 30% rate of mortality. African Americans have the highest incidence (approximately 20.5%), Caucasians approximately 5.5%, and Native Americans, approximately 4% per 100,000 population. The most common age for pancreatitis to occur is between 35–64 years of age.

Description

The pancreas is located in the midline of the back of the abdomen, closely associated with the liver, stomach, and duodenum (the first part of the small intestine). The pancreas is considered a gland. A gland is an organ whose primary function is to produce chemicals that pass either into the main blood circulation (called an endocrine function), or pass into another organ (called an exocrine function). The pancreas is unusual because it has both endocrine and exocrine functions. Its endocrine function produces three hormones. Two of these hormones, insulin and glucagon, are central to the processing of sugars in the diet (carbohydrate metabolism or breakdown). The third hormone produced by the endocrine cells of the pancreas affects gastrointestinal functioning. This hormone is called vasoactive intestinal polypeptide (VIP). The pancreas's exocrine function produces a variety of digestive enzymes (trypsin, chymotrypsin, lipase, and amylase, among others). These enzymes are passed into the duodenum through a channel called the pancreatic duct. In the duodenum, the enzymes begin the process of breaking down a variety of food components, including, proteins, fats, and starches.

Acute pancreatitis occurs when the pancreas suddenly becomes inflamed but improves. Patients recover fully from the disease, and in almost 90% of cases the symptoms disappear within about a week after treatment. The pancreas returns to its normal architecture and functioning after healing from the illness. After an attack of acute pancreatitis, tissue and cells of the pancreas return to normal. With chronic pancreatitis, damage to the pancreas occurs slowly over time. Symptoms may be persistent or sporadic, but the condition does not disappear and the pancreas is permanently impaired. Pancreatic tissue is damaged, and the tissue and cells function poorly.

Causes and symptoms

There are a number of causes of acute pancreatitis. The most common, however, are gallbladder disease and **alcoholism**. These two diseases are responsible for more than 80% of all hospitalizations for acute pancreatitis. Other factors in the development of pancreatitis include:

- certain drugs
- infections
- structural problems of the pancreatic duct and bile ducts (channels leading from the gallbladder to the duodenum)
- injury to the abdomen resulting in injury to the pancreas (including injuries occurring during surgery)
- abnormally high levels of circulating fats in the bloodstream
- malfunction of the parathyroid gland, with high blood levels of calcium
- complications from kidney transplants
- a hereditary tendency toward pancreatitis.

Pancreatitis caused by drugs accounts for about 5% of all cases. Some drugs that are definitely related to pancreatitis include:

- Azathioprine, 6-mercaptopurine (Imuran)
- Dideoxyinosine (Videx)
- Estrogens (birth control pills)
- Furosemide (Lasix)
- Pentamidine (NebuPent)
- Sulfonamides (Urobak, Azulfidine)
- Tetracycline
- Thiazide diuretics (Diuril, Enduron)
- Valproic acid (Depakote).

Some drugs that are probably related to pancreatitis include:

- Acetaminophen (Tylenol)
- Angiotensin-converting enzyme (ACE) inhibitors (Capoten, Vasotec)

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- Erythromycin
- Methyldopa (Aldomet)
- Metronidazole (Flagyl, Protostat)
- Nitrofurantoin (Furadantin, Furan)
- Nonsteroidal anti-inflammatory drugs (NSAIDs) (Aleve, Naprosyn, Motrin)
- Salicylates (aspirin).

All of these causes of pancreatitis seem to have a similar mechanism in common. Under normal circumstances, many of the extremely potent enzymes produced by the pancreas are not active until they are passed into the duodenum, where contact with certain other chemicals allow them to function. In pancreatitis, something allows these enzymes to become prematurely activated, so that they actually begin their digestive functions within the pancreas. The pancreas, in essence, begins digesting itself. A cycle of inflammation begins, including swelling and loss of function. Digestion of the blood vessels in the pancreas results in bleeding. Other active pancreatic chemicals cause blood vessels to become leaky, and fluid begins leaking out of the normal circulation into the abdominal cavity. The activated enzymes also gain access to the bloodstream through leaky, eroded blood vessels, and begin circulating throughout the body.

Pain is a major symptom in pancreatitis. The pain is usually quite intense and steady, located in the upper right hand corner of the abdomen, and often described as "boring." This pain is also often felt all the way through to the patient's back. The patient's breathing may become quite shallow because deeper breathing tends to cause more pain. Relief of pain by sitting up and bending forward is characteristic of pancreatic pain. **Nausea and vomiting**, and abdominal swelling are all common as well. A patient will often have a slight **fever**, with an increased heart rate and low blood pressure.

Classic signs of **shock** may appear in more severely ill patients. Shock is a very serious syndrome that occurs when the volume (quantity) of fluid in the blood is very low. In shock, a patient's arms and legs become extremely cold, the blood pressure drops dangerously low, the heart rate is quite fast, and the patient may begin to experience changes in mental status.

In very severe cases of pancreatitis (called necrotizing pancreatitis), the pancreatic tissue begins to die, and bleeding increases. Due to the bleeding into the abdomen, two distinctive signs may be noted in patients with necrotizing pancreatitis. Turner's sign is a reddish-purple or greenish-brown color to the flank area (the area between the ribs and the hip bone). Cullen's sign is a bluish color around the navel.

Some of the complications of pancreatitis are due to shock. When shock occurs, all of the body's major organs are deprived of blood (and, therefore, oxygen), resulting in damage. Kidney, respiratory, and **heart failure** are serious risks of shock. The pancreatic enzymes that have begun circulating throughout the body (as well as various poisons created by the abnormal digestion of the pancreas by those enzymes) have severe effects on the major body systems. Any number of complications can occur, including damage to the heart, lungs, kidneys, lining of the gastrointestinal tract, liver, eyes, bones, and skin. As the pancreatic enzymes work on blood vessels surrounding the pancreas, and even blood vessels located at a distance, the risk of **blood clots** increases. These blood clots complicate the situation by blocking blood flow in the vessels. When blood flow is blocked, the supply of oxygen is decreased to various organs and the organ can be damaged.

The pancreas may develop additional problems, even after the pancreatitis decreases. When the entire organ becomes swollen and suffers extensive cell **death** (pancreatic necrosis), the pancreas becomes extremely susceptible to serious infection. A local collection of pus (called a pancreatic **abscess**) may develop several weeks after the illness subsides, and may result in increased fever and a return of pain. Another late complication of pancreatitis, occurring several weeks after the illness begins, is called a pancreatic pseudocyst. This occurs when dead pancreatic tissue, blood, white blood cells, enzymes, and fluid leaked from the circulatory system accumulate. In an attempt to enclose and organize this abnormal accumulation, a kind of wall forms from the dead tissue and the growing scar tissue in the area. Pseudocysts cause additional abdominal pain by putting pressure on and displacing pancreatic tissue (resulting in more pancreatic damage). Pseudocysts also press on other nearby structures in the gastrointestinal tract, causing more disruption of function. Pseudocysts are life-threatening when they become infected (abscess) and when they rupture. Simple rupture of a pseudocyst causes death 14% of the time. Rupture complicated by bleeding causes death 60% of the time.

As the pancreatic tissue is increasingly destroyed in chronic pancreatitis, many digestive functions become disturbed. The quantity of hormones and enzymes normally produced by the pancreas begins to seriously decrease. Decreases in the production of enzymes result in the inability to appropriately digest food. Fat digestion, in particular, is impaired. A patient's stools become greasy as fats are passed out

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of the body. The inability to digest and use proteins results in smaller muscles (wasting) and weakness. The inability to digest and use the nutrients in food leads to **malnutrition**, and a generally weakened condition. As the disease progresses, permanent injury to the pancreas can lead to diabetes.

Diagnosis

Diagnosis of pancreatitis can be made very early in the disease by noting high levels of pancreatic enzymes circulating in the blood (amylase and lipase). Later in the disease, and in chronic pancreatitis, these enzyme levels will no longer be elevated. Because of this fact, and because increased amylase and lipase can also occur in other diseases, the discovery of such elevations are helpful but not mandatory in the diagnosis of pancreatitis. Other abnormalities in the blood may also point to pancreatitis, including increased white blood cells (occurring with inflammation and/or infection), changes due to **dehydration** from fluid loss, and abnormalities in the blood concentration of **calcium**, magnesium, **sodium**, potassium, bicarbonate, and sugars.

X rays or ultrasound examination of the abdomen may reveal **gallstones**, perhaps responsible for blocking the pancreatic duct. The gastrointestinal tract will show signs of inactivity (**ileus**) due to the presence of pancreatitis. Chest x rays may reveal abnormalities due to air trapping from shallow breathing, or due to lung complications from the circulating pancreatic enzyme irritants. **Computed tomography scans** (CT scans) of the abdomen may reveal the inflammation and fluid accumulation of pancreatitis, and may also be useful when complications like an abscess or a pseudocyst are suspected.

In the case of chronic pancreatitis, a number of blood tests will reveal the loss of pancreatic function that occurs over time. Blood sugar (glucose) levels will rise, eventually reaching the levels present in diabetes. The levels of various pancreatic enzymes will fall, as the organ is increasingly destroyed and replaced by nonfunctioning scar tissue. Calcification of the pancreas can also be seen on x rays. **Endoscopic retrograde cholangiopancreatography** (ERCP) may be used to diagnose chronic pancreatitis in severe cases. In this procedure, the doctor uses a medical instrument fitted with a fiber-optic camera to inspect the pancreas. A magnified image of the area is shown on a television screen viewed by the doctor. Many endoscopes also allow the doctor to retrieve a small sample (biopsy) of pancreatic tissue to examine under a microscope. A contrast product may also be used for radiographic examination of the area.

Treatment

Treatment of pancreatitis involves quickly and sufficiently replacing lost fluids by giving the patient new fluids through a needle inserted in a vein (intravenous or IV fluids). These IV solutions need to contain appropriate amounts of salts, sugars, and sometimes even proteins, in order to correct the patient's disturbances in blood chemistry. Pain is treated with a variety of medications. In order to decrease pancreatic function (and decrease the discharge of more potentially harmful enzymes into the bloodstream), the patient is not allowed to eat. A thin, flexible tube (nasogastric tube) may be inserted through the patient's nose and down into his or her stomach. The nasogastric tube can empty the stomach of fluid and air, which may accumulate due to the inactivity of the gastrointestinal tract. Oxygen may need to be administered by nasal prongs or by a mask.

The patient will need careful monitoring in order to identify complications that may develop. Infections (often occurring in cases of necrotizing pancreatitis, abscesses, and pseudocysts) will require **antibiotics** through the IV. Severe necrotizing pancreatitis may require surgery to remove part of the dying pancreas. A pancreatic abscess can be drained by a needle inserted through the abdomen and into the collection of pus (percutaneous needle aspiration). If this is not sufficient, an abscess may also require surgical removal. Pancreatic pseudocysts may shrink on their own (in 25–40% of cases) or may continue to expand, requiring needle aspiration or surgery. When diagnostic exams reveal the presence of gallstones, surgery may be necessary for their removal. When a patient is extremely ill from pancreatitis, however, such surgery may need to be delayed until any infection is treated, and the patient's condition stabilizes.

Because chronic pancreatitis often includes repeated flares of acute pancreatitis, the same kinds of basic treatment are necessary. Patients cannot take solids or fluids by mouth. They receive IV replacement fluids, receive pain medication, and are monitored for complications. Treatment of chronic pancreatitis caused by alcohol consumption requires that the patient stop drinking alcohol entirely. As chronic pancreatitis continues and insulin levels drop, a patient may require insulin injections in order to be able to process sugars in his or her diet. Pancreatic enzymes can be replaced with oral medicines, and patients

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sometimes have to take as many as eight pills with each meal. As the pancreas is progressively destroyed, some patients stop feeling the abdominal pain that was initially so severe. Others continue to have constant abdominal pain, and may even require a surgical procedure for relief. Drugs can be used to reduce the pain, but when **narcotics** are used for pain relief there is danger of the patient becoming addicted.

Prognosis

A number of systems have been developed to help determine the prognosis of an individual with pancreatitis. A very basic evaluation of a patient will allow some prediction to be made based on the presence of dying pancreatic tissue (necrosis) and bleeding. When necrosis and bleeding are present, as many as 50% of patients may die.

More elaborate systems have been created to help determine the prognosis of patients with pancreatitis. The most commonly used system identifies 11 different signs (Ranson's signs) that can be used to determine the severity of the disease. The first five categories are evaluated when the patient is admitted to the hospital:

- age over 55 years
- blood sugar level over 200 mg/Dl
- serum lactic dehydrogenase over 350 IU/L (increased with increased breakdown of blood, as would occur with internal bleeding, and with heart or liver damage)
- AST over 250 mu (a measure of liver function, as well as a gauge of damage to the heart, muscle, brain, and kidney)
- white blood count over 16,000 u L

The next six of Ranson's signs are reviewed 48 hours after admission to the hospital. These are:

- greater than 10% decrease in hematocrit (a measure of red blood cell volume)
- increase in BUN greater than 5 mg/dL (blood urea nitrogen, an indicator of kidney function)
- blood calcium less than 8 mg/dL
- PaO_2 less than 60 mm Hg (a measure of oxygen in the blood)
- base deficit greater than 4 mEg/L (a measure of change in the normal acidity of the blood)
- fluid sequestration greater than 6 L (an estimation of the quantity of fluid that has leaked out of the blood circulation and into other body spaces)

Once a doctor determines how many of Ranson's signs are present and gives the patient a score, the doctor can better predict the risk of death. The more signs present, the greater the chance of fatal complications. A patient with less than three positive Ranson's signs has a 95% survival rate. A patient with three to four positive Ranson's signs has an 80–85% survival rate.

The results of a CT scan can also be used to predict the severity of pancreatitis. Slight swelling of the pancreas indicates mild illness. Significant swelling, especially with evidence of destruction of the pancreas and/or fluid build-up in the abdominal cavity, indicates more severe illness. With severe illness, there is a worse prognosis.

KEY TERMS

Abscess—A pocket of infection; pus.

Acute—Of short and sharp course. Illnesses that are acute appear quickly and can be serious or life-threatening. The illness ends and the patient usually recovers fully.

Chronic—Of long duration and slow progression. Illnesses that are chronic develop slowly over time, and do not end. Symptoms may be continual or intermittent, but the patient usually has the condition for life.

Diabetes—A disease characterized by an inability to process sugars in the diet, due to a decrease in or total absence of insulin production. May require injections of insulin before meals to aid in the metabolism of sugars.

Duodenum—The first section of the small intestine that receives partly digested material from the stomach.

Endocrine—A system of organs that produces chemicals that go into the bloodstream to reach other organs whose functioning they affect.

Enzyme—A chemical that speeds up or makes a particular chemical reaction more efficient. In the digestive system, enzymes are involved in breaking down large food molecules into smaller molecules that can be processed and utilized by the body.

Exocrine—A system of organs that produces chemicals that go through a duct (or tube) to reach other organs whose functioning they affect.

Gland—Collections of tissue that produce chemicals needed for chemical reactions elsewhere in the body.

Hormone—A chemical produced in one part of the body that travels to another part of the body in order to exert an effect.

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Prevention

Alcoholism is essentially the only preventable cause of pancreatitis. Patients with chronic pancreatitis must stop drinking alcohol entirely. The drugs that cause or may cause pancreatitis should also be avoided.

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National Institutes of Health (NIH), 9000 Rockville Pike, Bethesda, MD, 20892, 301-496-4000, http://www.nih.gov/index.html.

U.S. National Library of Medicine, 8600 Rockville Pike, Bethesda, MD, 20894, http://www.nlm.nih.gov/medlineplus/medlineplus.html.

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Panic attack *see* **Panic disorder**

Panic disorder

Definition

A panic disorder is a psychological state characterizedby acute (rapid onset) feelings, which engulf a person with a deep sense of destruction, **death** and imminent doom. The main feature of panic disorder (PD) is a history of previous panic attacks (PA). The PA symptoms are pronounced and the affected person will gasp for air, have increased breathing (hyperventilate), feel dizzy (light headed), and develop a loss of sensation (parasthesia). Most patients will run outside and symptoms like increased breathing will slow and the PA symptoms will subside. Most PA last three to ten minutes. It is rare for PA to extend in duration over 30 minutes.

Description

The essential characteristics of panic disorder , consist of specific and common criteria. The affected person usually has recurrent and unexpected panic attacks (the active presentation of panic disorder). The PA is characterized by a discrete, rapid onset feeling of intense fear or discomfort. Affected persons have several somatic (referring to physical signs) or cognitive (thinking) symptoms. Affected persons usually react in a manner that indicates impending doom. They commonly exhibit signs of a sweating, racing heart beat, chest **pain**, **shortness of breath**, and the perception of feeling smothered. The panic attack (PA) is usually followed by one month (or more) of one or more of the following thought processes:

- Persistent concern or preoccupation about having future attacks
- Worry about the possible consequences, complications, or behavioral changes associated with attacks (e.g. losing control, going crazy, or having a serious medical condition like a heart attack).

Genetic profile

Panic disorder definitely runs in families and twin studies suggest that about 20% of patients who have the criteria for diagnosis have first-degree relatives with the disorder. In families with no history of affected first-degree relatives the prevalence decreases to 4%. The ratio between monozygotic twins (identical) to dizygotic (non-identical) twins is 5:1 for PD. Recent evidence suggests that there is a genetic mutation in the SLC6A4 gene. This gene is related to a brain chemical called serotonin, a chemical in the brain, which is known to effect mood. If the transport of serotonin is imbalanced then certain parts of the brain may not receive the correct stimulus causing alterations in mood. Some studies have demonstrated that there is no positive family history in about 50% of patients diagnosed with PD. Other possible causes of PD include social learning and autonomic responsiveness (the attack will affect the body and hypersensitizes nerve cells in the brain). Another gene possibly associated with panic disorder is the COMT gene that provides instructions for making an enzyme called catechol-O-methyltransferase. Mutations in this gene have been associated with other disorders that affect

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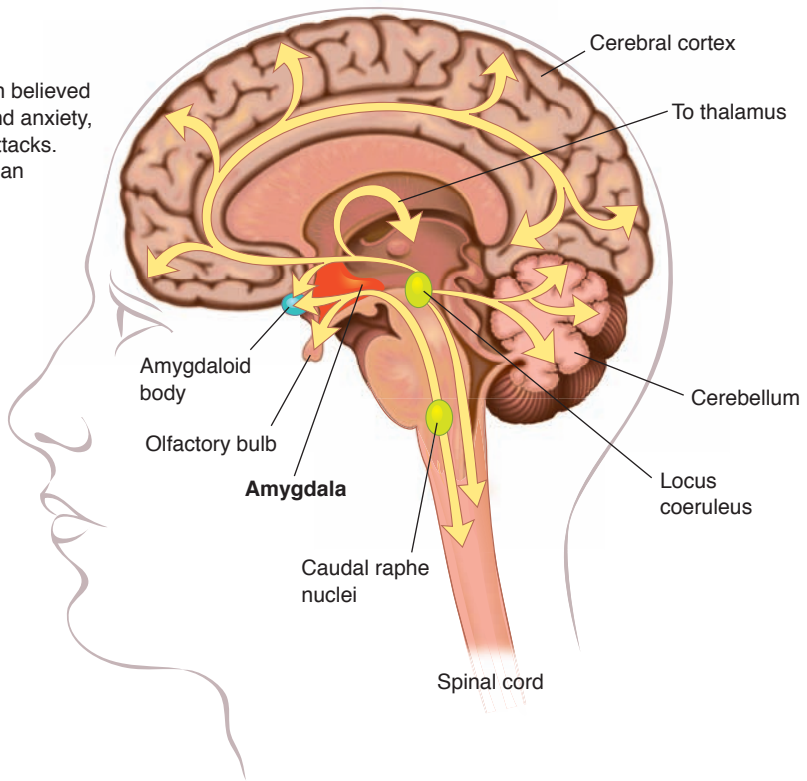
Panic disorder

The amygdala is the area of the brain believed to regulate emotions, such as fear and anxiety, both of which are involved in panic attacks. Panic disorder may also be linked to an imbalance of serotonin, a chemical that helps control mood.



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thought and emotion, with studies suggesting that these conditions may be due to inefficient processing of information in the prefrontal cortex.

Demographics

PD usually begins during the affected persons late teens or in the twenties, and is uncommon after age 35 and unusual after age 45 years. Global studies suggest that the lifetime prevalence of PD is between 1.5% and 3.5%. In the United States, the National Institute of Mental Health (NIMH) estimates that panic disorder affects about 6 million American adults and is twice as common in women as men.

Agoraphobia (**anxiety** state about being in situations or places that might make escape embarrassing or difficult) is seen in approximately one-third to one-half of persons who meet the criteria for PD diagnosis. Other reports indicate that about 95% of persons affected with agoraphobia also have a previous history or current diagnosis of PD. In some cultures PA is believed to be associated with magic or witchcraft. Additional causes of PA may include intentional suppression of one's freedoms or public life.

Signs and symptoms

Criteria for panic attack:

1. Cardiac palpitations (pounding, racing or accelerated heart rate).
2. Sweating.
3. Shaking (trembling).
4. Breathing difficulties, including shortness of breath or perceptions of being smothered.
5. Feeling of choking.
6. Chest discomfort or pain.
7. Feeling light–headed (faint, dizzy or unsteady).
8. Stomach discomfort or nausea.

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9. Affected individuals may lose contact with reality during the attack.
10. A feeling of being detached and out of contact with oneself.
11. Fear of losing control of oneself (going "crazy").
12. Fear of dying.
13. Tingling or numbness sensations.

Criteria for panic disorder:

1. Recurrent and unexpected PA.
2. Worry about the consequences, implications, or behavioral changes associated with PA (perceptions of going "crazy," losing control of actions, or suffering from a life threatening condition, such as a heart attack).
3. PA is not caused by or associated with a medical condition.
4. PA is not associated with another mental disorder, such as phobia (an exaggerated fear to something like spiders or heights). Exposure to a specific phobia situation or object can promote a PA.

Criteria for agoraphobia:

1. The essential feature of agoraphobia is anxiety about being in situations or places that make escape embarrassing or difficult. These fears usually involve characteristic clusters of situations that include being on a bridge, being in a crowd, standing in line in a department store, or traveling in a train, bus, or automobile. Elevators are another common cause promoting the occurrence of PA. These situations, which lead to the PA, are often difficult or embarrassing to abruptly flee from.
2. Avoidance of the affected person's fear, which usually limits travel away from home, causing impaired functioning.

Criteria for PD without agoraphobia:

Recurrent unexpected PA; at least one attack followed by one month or more of one or more of the following symptoms:

- Persistent concern about having future attacks
- Worry about consequences associated with attacks
- A change in behavioral patterns related to the attacks (e.g., the affected person avoids travel).
- Absence of agoraphobia
- PA are not due to a medical condition
- PA not associated with another mental disorder (e.g., phobias).

Criteria for panic disorder with agoraphobia:

1. Criteria 1, 2, and 5 for PD without agoraphobia must be present.
2. The presence of agoraphobia.

KEY TERMS

Palpitation—An irregular heartbeat.
Phobia—An exaggerated fear.

Diagnosis

There are no specific laboratory findings associated with diagnosing PD. However, evidence suggests that some affected persons may have low levels of carbon dioxide and an important ion in the human body called bicarbonate (helps in regulating blood from becoming to acidic or alkaline). These chemical changes may hypersensitize (making cells excessively sensitive) nerve cells, which can increase the activity of other structures throughout the body, such as sweat glands (sweating) and the heart (racing, accelerated or pounding rate). Additionally, lactic acid (a chemical made in the body from sugar) plays a role in nerve cell hypersensivity. The diagnosis of PD can be made accurately if the specific symptoms and criteria are established.

Neuroimaging studies indicate that the arteries (vessels that deliver oxygen rich blood to cells and tissues) are constricted (smaller diameter) as a result of increased breathing rates during a PA.

The consulting clinician must exclude other possible causes of panic attacks such as intoxication with stimulant drugs (**cocaine**, **caffeine**, amphetamines [speed]). Withdrawal from alcohol and **barbiturates** can also induce panic-like behaviors. Additionally, the consulting therapist should obtain a comprehensive medical history and examination to determine if the PA is caused by a medical condition frequently observed in hormonal diseases (overactive thyroid), tumors that secrete chemicals causing a person to have pronounced "hyper" changes (racing heartbeat, sweating, shaking). Other causes include a possible cardiac (heart) disease such as an irregularly beating heart.

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Treatment and management

Moderate to severe PD is characterized by frequent PA ranging from five to seven times a week or with significant disability associated with anxiety between episodes. In addition to **cognitive-behavioral therapy** an affected person will usually require medications. There are three classes of medications commonly prescribed for PD patients.

Tricyclic antidepressants

Tricyclic antidepressants are a class of medications used to treat depression and other closely related mental disorders. Individuals affected with PD are usually given imipramine, which has been shown in some studies to be effective in approximately 70% of cases. Medications in this category usually have a prolonged lag time until a positive response is observed. This is primarily due to adverse side effects, which prevent rapid increases of dosage and also because they act on specific chemical imbalances in the brain, which take time to stabilize.

The first choice of medication treatment for PD is tricyclics (imipramine, desipramine and nortriptyline). These medications require careful dosing and monitoring. The actual blood level (therapeutic level necessary to make improvements) may vary in special populations who have the disorder. Elderly patients may require a smaller dose, due to decrease in metabolism (in this context metabolism refers to the breakdown of large chemicals to smaller ones for usage) and kidney function, which are part of **aging**. Some patients may develop gastrointestinal (stomach) side effects, which may interfere with absorption from the gut, thereby decreasing beneficial blood levels. Furthermore, patients who receive tricyclics may develop **dry mouth** and low blood pressure. The heart may be adversely affected (altered rate and rhythm) especially in patients with preexisting diseases, causing direct damage or strain in the heart. Affected persons receiving tricyclics also commonly experience changes in sexual functioning, including loss of desire and ejaculation. Adverse (negative) side effects usually decrease patient compliance (the person stops taking medications to avoid side effects). Recently, a new group of tricyclics was made available. These tricyclics (fluoxetine, sertraline, paroxetine and fluvoxamine) act on specific areas in the brain to correct potential chemical imbalances.

Monoamine oxidase inhibitors (MAOIs)

A second line category of medications used to treat PD are the monoamine oxidase (a chemical that assists in storing certain chemicals in nerve cells) inhibitors (MAOI). MAOI will stop the action of MAO, thereby decreasing the amount of certain chemicals in the brain that may influence PAs. This group of medications is effective in approximately 75–80% of cases, especially for refractory (not active) depression. Affected individuals using MAOI must avoid specific foods to prevent a hypertensive crisis (when the blood pressure rapidly increases). These foods include cheeses (except cream cheese, cottage cheese, and fresh yogurt); liver of all types; meat and yeast extracts; fermented or aged meats (such as salami and bologna); broad and Chinese bean pods; all types of alcohol-containing products; soy sauce; shrimp and shrimp paste; and sauerkraut. Although MAOI are effective medications for treatment of PD, they are underutilized due to strict dietary limitations.

Benzodiazepines

Benzodiazepines are another class of medications used to treat PD. They include medications such as diazepam (Valium), lorazepam, and clonazepam. They have been reported to be effective in 70–90% of patients with PD. However, the effective dose is approximately two to three times higher for PD than milder forms of simple anxiety (these medications are usually indicated for mild anxiety). This increased dosing in patients with PD is undesirable since there is risk of physical dependence and withdrawal (commonly exhibited when the medication is rapidly tapered down or stopped). However, they are indicated when PD affected patients respond poorly to tricyclics or have a fear of taking MAOIs due to dietary restrictions and problems associated with eating the wrong foods accidentally.

Long term management

Reassuring the PD patient that anticipated panic attacks are unlikely while taking medication is essential for long-term maintenance. Cognitive-behavioral therapy is also important for long-term treatment. Weaning off medications must be done slowly since patients develop a sense of security that they will not have an attack while actively dosing.

Clinical trials

Clinical trials on panic disorder are currently sponsored by the National Institutes of Health (NIH) and other agencies. As of 2009, NIH was reporting 98 on-going and completed studies.

Examples include:

- The evaluation of the effectiveness of psychodynamic psychotherapy in treating adults with panic disorder. (NCT00128388)

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- A study to identify genes that increase the risk of developing panic disorder. (NCT00083265)
- A study to examine brain and noradrenaline function in panic disorder. (NCT00103987)
- The evaluation of the relative effectiveness of three psychotherapies in treating people with a panic disorder. (NCT00353470)

Clinical trial information is constantly updated by NIH and the most recent information on panic disorder trials can be found at: http://clinicaltrials.gov/ct2/results?term=panic+disorder.

Prognosis

The course of PD and agoraphobia varies considerably over time. Some cases may experience spontaneous remissions (the disorder is present but it is not active). The course can be so variable that an affected person may go on for years without a PA, then have several attacks, and then enter a second phase of remission, which may last for years. In some cases a decrease in PA may be closely related to a decrease and avoidance of anxiety-associated situations, which promote agoraphobia. Agoraphobia itself may become chronic (long term or permanent) with or without PA. In general, approximately 50–60% will recover substantially five to 20 years after the initial attack. Approximately 20% will still have long term impairment, which will stay the same or slightly worsen. Generally, the earlier treatment is sought, the better the outcome. The course in children and adolescents is chronic (long term), usually lasting about three years. Generally, PD shows the highest risk of developing new psychological disorders during follow up visits. If PA is treated early, anticipatory anxiety and phobia may be more manageable and responsive to treatment.

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American Psychiatric Association, 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209, (888) 357-7924, http://www.psych.org.

American Psychological Association (APA), 750 First St. NE, Washington, DC, 20002-4242, (800) 374-2721, (202) 336-5568, http://www.apa.org.

Mental Health America, 2000 N. Beauregard Street, 6th Floor, Alexandria, VA, 22311, (800) 969-6642, (703) 684-5968, http://www.nmha.org.

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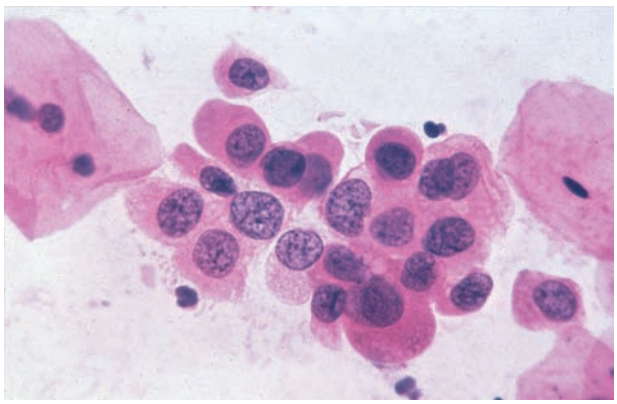
National Institute of Mental Health (NIMH), 6001 Executive Boulevard, Bethesda, MD, 20892-9663, (866) 615-6464, http://www.nimh.nih.gov.

Laith Farid Gulli, MD
Bilal Nasser, MS

Pap test

Definition

The Pap test is a procedure in which a physician scrapes cells from the cervix or vagina to check for **cervical cancer**, vaginal **cancer**, or abnormal changes that could lead to cancer. It often is called a Pap smear.



These malignant cells were taken from a woman's cervix during a Pap test. *(Parviz M. Pour/Photo Researchers, Inc.)*

Purpose

The Pap test is used to detect abnormal growth of cervical cells at an early stage so that treatment can be started when the condition is easiest to treat. This microscopic analysis of cells can detect cervical cancer, precancerous changes, inflammation (vaginitis), infections, and some **sexually transmitted diseases** (STDs). The Pap test can occasionally detect endometrial (uterine) cancer or **ovarian cancer**, although it was not designed for this purpose.

Women should begin to have Pap tests at the age of 21 or within three years of becoming sexually active, whichever comes first. Young people are more likely to have multiple sex partners, which increases their risk of certain diseases that can cause cancer, such as human papillomavirus (HPV).

The American Cancer Society (ACS) updated its guidelines concerning Pap test frequency in late 2002. In brief, women should continue screening every year with regular Pap tests until age 30, every two years if using the liquid-based Pap test. Once a woman age 30 and older has had three normal results in a row, she may get screened every two to three years. A doctor may suggest more frequent screening if a woman has certain risk factors for cervical cancer. Women who have had total hysterectomies including the removal of the cervix do not need Pap tests unless the **hysterectomy** resulted from cervical cancer. Those over age 70 who have had three normal results generally do not need to continue having Pap tests under the new guidelines.

Women with certain risk factors may have yearly tests. Those at highest risk for cervical cancer are women who started having sex before age 18, those with many sex partners (especially if they did not use **condoms**, which protect against STDs), those who have had STDs such as **genital herpes** or **genital warts**, and those who smoke. Women older than 40 may have the test yearly, if experiencing bleeding after **menopause**. Women who have had a positive test result in the past may need screening every six months. Women who have had cervical cancer or precancer should have regular Pap smears.

Other women also benefit from the Pap test. Women over age 65 account for 25% of all cases of cervical cancer and 41% of deaths from this disease. Women over age 65 who have never had a Pap smear benefit the most from the test. Some women have the cervix left in place after hysterectomy and will continue to receive regular Pap tests. Finally, a pregnant woman should have a Pap test as part of her first prenatal examination.

The Pap smear is a screening test. It identifies women who are at increased risk of cervical dysplasia (abnormal cells) or cervical cancer. Only an examination of the cervix with a special lighted instrument (**colposcopy**) and samples of cervical tissue (biopsies) can actually diagnose these problems.

Precautions

The Pap test is usually not done during the menstrual period because of the presence of blood cells. The best time is in the middle of the menstrual cycle.

Description

The Pap test is an extremely cost-effective and beneficial exam. Cervical cancer used to be a leading cause of cancer deaths in American women, but widespread use of this diagnostic procedure reduced the **death** rate from this disease by 74% between 1955 and

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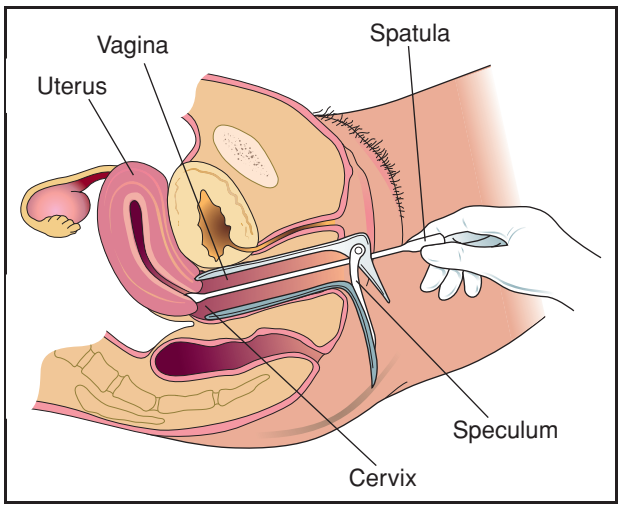

The Pap test is a procedure used to detect abnormal growth of cervical cells which may be a precursor to cancer of the cervix. It is administered by a physician who inserts a speculum into the vagina to open and separate the vaginal walls. A spatula is then inserted to scrape cells from the cervix. These cells are transferred onto glass slides for laboratory analysis. The Pap test may also identify vaginitis, some sexually transmitted diseases, and cancers of the uterus and ovaries. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

1992. A 2003 study reported that the test reduces rates of invasive cervical cancer by as much as 94%. In 2003, the FDA approved a new screening test that combines DNA testing for the HPV type that causes the most cases of cervical cancer with the standard Pap test, increasing its screening value.

The Pap test, sometimes called a cervical smear, is the microscopic examination of cells scraped from both the outer cervix and the cervical canal. (The cervix is the opening between the vagina and the uterus, or womb.) It is called the "Pap" test after its developer, Dr. George N. Papanicolaou. This simple procedure is performed during a gynecologic examination and is usually covered by insurance. For those with coverage, Medicare will pay for one screening Pap smear every three years.

During the pelvic examination, an instrument called a speculum is inserted into the vagina to open it. The doctor then uses a tiny brush, or a cotton-tipped swab and a small spatula to wipe loose cells off the cervix and to scrape them from the inside of the cervix. The cells are transferred or "smeared" onto glass slides, the slides are treated to stabilize the cells, and the slides are sent to a laboratory for microscopic examination. The entire procedure is usually painless and takes five to 10 minutes at most.

The newer method called liquid-based cytology, or the liquid-based Pap test, involves spreading the cells more evenly on a slide after removing them from the sample. The liquid-based method prevents cells from drying out and becoming distorted. Studies show that liquid-based testing slightly improves cancer detection and greatly improves detection of precancers, but it costs more than the traditional Pap test. Trade names in 2003 for liquid-based Pap smears were ThinPrep and AutoCyte.

Preparation

The Pap test may show abnormal results when a woman is healthy or normal results in women with cervical abnormalities as much as 25% of the time. It may even miss up to 5% of cervical cancers. Some simple preparations may help to ensure that the results are reliable. Among the measures that may help increase test reliability are:

- avoiding sexual intercourse for two days before the test
- not using douches for two or three days before the test
- avoiding tampons, vaginal creams, or birth control foams or jellies for two to three days before the test
- scheduling the Pap smear when not menstruating.

However, most women are not routinely advised to make any special preparations for a Pap test.

If possible, women may want to ensure that their test is performed by an experienced gynecologist, physician, or provider and sent to a reputable laboratory. The physician should be confident in the accuracy of the chosen lab.

Before the exam, the physician will take a complete sexual history to determine a woman's risk status for cervical cancer. Questions may include date and results of the last Pap test, any history of abnormal Pap tests, date of last menstrual period and any irregularity, use of hormones and birth control, family history of gynecologic disorders, and any vaginal symptoms. These topics are relevant to the interpretation of the Pap test, especially if any abnormalities are detected. Immediately before the Pap test, the woman should empty her bladder to avoid discomfort during the procedure.

Aftercare

Harmless cervical bleeding is possible immediately after the test; a woman may need to use a sanitary napkin. She should also be sure to comply with her doctor's orders for follow-up visits.

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Risks

No appreciable health risks are associated with the Pap test. However, abnormal results (whether valid or due to technical error) can cause significant **anxiety**. Women may wish to have their sample double-checked, either by the same laboratory or by the new technique of computer-assisted rescreening. The Food and Drug Administration (FDA) has approved the use of AutoPap and PAPNET to doublecheck samples that have been examined by technologists. AutoPap may also be used to perform initial screening of slides, which are then checked by a technologist. Any abnormal Pap test should be followed by colposcopy, not by double checking the Pap test.

Normal results

Normal (negative) results from the laboratory exam mean that no atypical, dysplastic, or cancer cells were detected, and the cervix is normal.

Abnormal results

Terminology

Abnormal cells found on the Pap test may be described using two different grading systems. Although this can be confusing, the systems are quite similar. The Bethesda system is based on the term "squamous intraepithelial lesion" (SIL). Precancerous cells are classified as atypical squamous cells of undetermined significance, low-grade SIL, or high-grade SIL. Low-grade SIL includes mild dysplasia (abnormal cell growth) and abnormalities caused by HPV; high-grade SIL includes moderate or severe dysplasia and carcinoma in situ (cancer that has not spread beyond the cervix).

Another term that may be used is "cervical intraepithelial neoplasia" (CIN). In this classification system, mild dysplasia is called CIN I, moderate is CIN II, and severe dysplasia or carcinoma in situ is CIN III.

Regardless of terminology, it is important to remember that an abnormal (positive) result does not necessarily indicate cancer. Results may be falsely abnormal after infection or irritation of the cervix. Up to 40% of mild dysplasia reverts to normal tissue without treatment, and only 1% of mild abnormalities ever develop into cancer.

Changes of unknown cause

ASCUS or LSIL cells are found in 5%–10% of all Pap tests. The most common abnormality is atypical squamous cells of undetermined significance, which are found in 4% of all Pap tests. Sometimes these results are described further as either reactive or precancerous. Reactive changes suggest that the cervical cells are responding to inflammation, such as from a yeast infection. These women may be treated for infection and then undergo repeat Pap testing in three to six months. If those results are negative, no further treatment is necessary. This category may also include atypical "glandular" cells, which could imply a more severe type of cancer and requires repeat testing and further evaluation.

Dysplasia

The next most common finding (in about 25 of every 1,000 tests) is low-grade SIL, which includes mild dysplasia or CIN I and changes caused by HPV. Unlike cancer cells, these cells do not invade normal tissues. Women are most susceptible to cervical dysplasia between the ages of 25 and 35. Typically, dysplasia causes no symptoms, although women may experience abnormal vaginal bleeding. Because dysplasia is precancerous, it should be treated if it is moderate or severe.

Treatment of dysplasia depends on the degree of abnormality. In women with no other risk factors for cervical cancer, mild precancerous changes may be simply observed over time with repeat testing, perhaps every four to six months. This strategy works only if women are diligent about keeping later appointments. Premalignant cells may remain that way without causing cancer for five to ten years, and may never become malignant.

In women with positive results or risk factors, the gynecologist must perform colposcopy and biopsy. A colposcope is an instrument that looks like binoculars, with a light and a magnifier, used to view the cervix. Biopsy, or removal of a small piece of abnormal cervical or vaginal tissue for analysis, is usually done at the same time.

High-grade SIL (found in three of every 50 Pap tests) includes moderate to severe dysplasia or carcinoma in situ (CIN II or III). After confirmation by colposcopy and biopsy, it must be removed or destroyed to prevent further growth. Several outpatient techniques are available: conization (removal of a cone-shaped piece of tissue), **laser surgery**, **cryotherapy** (freezing), or the "loop electrosurgical excision procedure." Cure rates are nearly 100% after prompt and appropriate treatment of carcinoma in situ. Of course, frequent checkups are then necessary.

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KEY TERMS

Carcinoma in situ—Malignant cells that are present only in the outer layer of the cervix.

Cervical intraepithelial neoplasia (CIN)—A term used to categorize degrees of dysplasia arising in the epithelium, or outer layer, of the cervix.

Dysplasia—Abnormal changes in cells.

Human papillomavirus (HPV)—The most common STD in the United States. Various types of HPV are known to cause cancer.

Neoplasia—Abnormal growth of cells, which may lead to a neoplasm, or tumor.

Squamous intraepithelial lesion (SIL)—A term used to categorize the severity of abnormal changes arising in the squamous, or outermost, layer of the cervix.

Cancer

HPV, the most common STD in the United States, may be responsible for many cervical cancers. Cancer may be manifested by unusual vaginal bleeding or discharge, bowel and bladder problems, and **pain**. Women are at greatest risk of developing cervical cancer between the ages of 30 and 40 and between the ages of 50 and 60. Most new cancers are diagnosed in women between 50 and 55. Although the likelihood of developing this disease begins to level off for Caucasian women at the age of 45, it increases steadily for African Americans for another 40 years. Biopsy is indicated when any abnormal growth is found on the cervix, even if the Pap test is negative.

Doctors have traditionally used **radiation therapy** and surgery to treat cervical cancer that has spread within the cervix or throughout the pelvis. In severe cases, postoperative radiation is administered to kill any remaining cancer cells, and **chemotherapy** may be used if cancer has spread to other organs. Recent studies have shown that giving chemotherapy and radiation at the same time improves a patient's chance of survival. The National Cancer Institute has urged physicians to strongly consider using both chemotherapy and radiation to treat patients with invasive cervical cancer. The survival rate at five years after treatment of early invasive cancer is 91%; rates are below 70% for more severe invasive cancer. That is why prevention, risk reduction, and frequent Pap tests are the best defense for a woman's gynecologic health.

The Pap test is a procedure used to detect abnormal growth of cervical cells which may be a precursor to cancer of the cervix. It is administered by a physician who inserts a speculum into the vagina to open and separate the vaginal walls. A spatula is then inserted to scrape cells from the cervix. These cells are transferred onto glass slides for laboratory analysis. The Pap test may also identify vaginitis, some sexually transmitted diseases, and cancers of the uterus and ovaries.

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American Cancer Society, 1599 Clifton Road NE, Atlanta, GA, 30329-4251, (800) 227-2345, http://www.cancer.org.

American College of Obstetricians and Gynecologists, 409 Twelfth Street SW, P.O. Box 96920, Washington, DC, 20090-6920, (202) 638-5577, http://www.acog.org.

National Cancer Institute, Building 31, Room 10A31, 31 Center Drive, MSC 2580, Bethesda, MD, 20892-2580, (800) 422-6237, http://www.nci.nih.gov.

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Papanicolaou test *see* **Pap test**

Papilledema

Definition

Papilledema is a swelling of the optic nerve, at the point where this nerve joins the eye, that is caused by an increase in fluid pressure within the skull (intracranial pressure). Swelling of the optic nerve due to other causes such as infection or inflammatory disease is not called papilledema.

Description

The optic nerve is the nerve that transmits signals from the eye to the brain. Papilledema is a swelling

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of this nerve where it meets the eye (the optic disc) caused by an increase in intracranial pressure. Almost all cases of papilledema are bilateral (affect both eyes). Papilledema can be observed in people of any age, but is relatively uncommon in infants because the bones of the skull are not fully fused together at this age.

Causes and symptoms

Papilledema is caused by an increase in the pressure of the fluid (cerebrospinal fluid) that is present between the brain and the skull, inside the head. This increase in intracranial pressure may be caused by any of a variety of conditions within the skull, brain, or spinal cord. The most common causes of papilledema are:

- tumor of the brain, spinal cord, skull, spinal column, or optic nerve
- abscess (the accumulation of pus within a confined space)
- craniosynostosis (an abnormal closure of the bones of the skull)
- hemorrhage (bleeding)
- hydrocephalus (an accumulation of cerebrospinal fluid within the skull)
- intracranial infection (any infection within the skull such as meningitis and encephalitis)
- head injury

The symptoms of papilledema include:

- headaches, which are usually worse upon awakening and exacerbated by coughing, holding the breath, or other maneuvers that tend to increase intracranial pressure.
- nausea and vomiting.
- changes in vision, such as temporary and transient blurring, graying, flickering, or double vision

Diagnosis

A diagnosis of papilledema is achieved by visual examination of the eye with an ophthalmoscope. This instrument shines light through the pupil of the eye and illuminates the retina while the clinician looks through it. Eye drops to dilate the pupils are used to insure a thorough examination.

Treatment

Treatment of papilledema is generally aimed at the treatment of the underlying disorder that is causing papilledema.

KEY TERMS

Craniosynostosis—A premature closure of one or more of the joints (fissures) between the bones of the skull, which causes an abnormally shaped skull.

Hydrocephalus—The accumulation of cerebrospinal fluid within the skull.

Ophthalmoscope—A medical instrument which shines a light through the pupil of the patient's eye and illuminates the retina (back) of the eye, allowing a visual examination of the interior of the eye.

Diuretic drugs combined with a weight reduction program may be useful in cases of papilledema that are caused by an abnormally high production of cerebrospinal fluid.

Corticosteroids have been shown to be effective in relieving the symptoms in some patients with papilledema caused by inflammatory disorders.

Alternative treatment

Alternative treatments for conditions that cause the occurrence of papilledema include **acupuncture**, **aromatherapy**, **hydrotherapy**, massage, and herbal remedies.

Prognosis

With prompt medical care to treat the underlying cause of papilledema, a person affected with papilledema will not have permanent damage to his or her eye-sight. However, prolonged papilledema can result in permanent damage to the optic nerve which could lead to blindness.

Prevention

Preventing papilledema is only possible if the underlying condition causing the papilledema can be found. Treatment of this underlying condition may prevent recurrences of papilledema.

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ORGANIZATIONS

National Eye Institute, 31 Center Drive MSC 2510, Bethesda, MD, (301) 496-5248, http://www.nei.nih.gov.

Paul A. Johnson, Ed.M.

Papillomavirus infection *see* **Genital warts**

Papule *see* **Skin lesions**

Paracentesis

Definition

Paracentesis is a procedure during which fluid from the abdomen is removed through a needle.

Purpose

There are two reasons to take fluid out of the abdomen. One is to analyze it. The other is to relieve pressure.

Liquid that accumulates in the abdomen is called **ascites**. Ascites seeps out of organs for several reasons related either to disease in the organ or fluid pressures that are changing.

Liver disease

All the blood flowing through the intestines passes through the liver on its way back to the heart. When progressive disease such as alcohol damage or hepatitis destroys enough liver tissue, the scarring that results shrinks the liver and constricts the blood flow. Such scarring of the liver is called **cirrhosis**. Pressure builds up in the intestinal circulation, slowing flow and pushing fluid into the tissues. Slowly the fluid accumulates in areas with the lowest pressure and greatest capacity. The free space around abdominal organs receives most of it. This space is called the peritoneal space because it is enclosed by a thin membrane called the peritoneum. The peritoneum wraps around nearly every organ in the abdomen, providing many folds and spaces for the fluid to gather.

Infections

Peritonitis is an infection of the peritoneum. Infection changes the dynamics of body fluids, causing them to seep into tissues and spaces. Peritonitis can develop in several ways. Many abdominal organs contain germs that do not belong elsewhere in the body. If they spill their contents into the peritoneum, infection is the result. The gall bladder, the stomach, any part of the intestine, and especially the appendix all cause peritonitis when they leak or rupture. **Tuberculosis** can infect many organs in the body; it is not confined to the lungs. Tuberculous peritonitis causes ascites.

Other inflammations

Peritoneal fluid is not just produced by infections. The pancreas can cause a massive sterile peritonitis when it leaks its digestive enzymes into the abdomen.

Cancer

Any **cancer** that begins in or spreads to the abdomen can leak fluid. One particular tumor of the ovary that leaks fluid, the resulting presentation of the disease, is Meigs' syndrome.

Kidney disease

Since the kidneys are intimately involved with the body's fluid balance, diseases of the kidney often cause excessive fluid to accumulate. Nephrosis and **nephrotic syndrome** are the general terms for diseases that cause the kidneys to retain water and provoke its movement into body tissues and spaces.

Heart failure

The ultimate source of fluid pressure in the body is the heart, which generates blood pressure. All other pressures in the body are related to blood pressure. As the heart starts to fail, blood backs up, waiting to be pumped. This increases back pressure upstream, particularly below the heart where gravity is also pulling blood away from the heart. The extra fluid from **heart failure** is first noticed in the feet and ankles, where gravitational effects are most potent. In the abdomen, the liver swells first, then it and other abdominal organs start to leak.

Pleural fluid

The other major body cavity is the chest. The tissue in the chest corresponding to the peritoneum is called the pleura, and the space contained within the pleura, between the ribs and the lungs, is called the pleural space. Fluid is often found in both cavities, and fluid from one cavity can find its way into the other.

Fluid that accumulates in the abdomen creates abnormal pressures on organs in the abdomen. Digestion is hindered; blood flow is slowed. Pressure upward on the chest compromises breathing. The

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KEY TERMS

Ectopic pregnancy—A pregnancy occurring outside the womb that often ruptures and requires surgical removal.

kidneys function poorly in the presence of such external pressures and may even fail with tense, massive ascites.

Description

During paracentesis, special needles puncture the abdominal wall, being careful not to hit internal organs. If fluid is needed only for analysis, just a bit is removed. If pressure relief is an additional goal, many quarts may be removed. Rapid removal of large amounts of fluid can cause blood pressure to drop suddenly. For this reason, the physician will often leave a tube in place so that fluid can be removed slowly, giving the circulation time to adapt.

A related procedure called culpocentesis removes ascitic fluid from the very bottom of the abdominal cavity through the back of the vagina. This is used mostly to diagnose female genital disorders like **ectopic pregnancy** that bleed or exude fluid into the peritoneal space.

Fluid is sent to the laboratory for testing, where cancer and blood cells can be detected, infections identified, and chemical analysis can direct further investigations.

Aftercare

An adhesive bandage and perhaps a single stitch close the hole. Nothing more is required.

Risks

Risks are negligible. It is remotely possible that an organ could be punctured and bleed or that an infection could be introduced.

Normal results

A diagnosis of the cause and/or relief from accumulated fluid pressure are the expected results.

Abnormal results

Fluid will continue to accumulate until the cause is corrected. Repeat procedures may be needed.

Resources

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J. Ricker Polsdorfer, MD

Paracoccidioidomycosis *see* **South American blastomycosis**

Paragonamiasis *see* **Fluke infections**

Paralysis

Definition

Paralysis is defined as complete loss of strength in an affected limb or muscle group.

Description

The chain of nerve cells that runs from the brain through the spinal cord out to the muscle is called the motor pathway. Normal muscle function requires intact connections all along this motor pathway. Damage at any point reduces the brain's ability to control the muscle's movements. This reduced efficiency causes weakness, also called paresis. Complete loss of communication prevents any willed movement at all. This lack of control is called paralysis. Certain inherited abnormalities in muscle cause **periodic paralysis**, in which the weakness comes and goes.

The line between weakness and paralysis is not absolute. A condition causing weakness may progress to paralysis. On the other hand, strength may be restored to a paralyzed limb. Nerve regeneration or regrowth is one way in which strength can return to a paralyzed muscle. Paralysis almost always causes a change in muscle tone. Paralyzed muscle may be flaccid, flabby, and without appreciable tone, or it may be spastic, tight, and with abnormally high tone that increases when the muscle is moved.

Paralysis may affect an individual muscle, but it usually affects an entire body region. The distribution of weakness is an important clue to the location of the nerve damage that is causing the paralysis. Words describing the distribution of paralysis use the suffix "-plegia," from the Greek word for "stroke." The types of paralysis are classified by region:

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- monoplegia, affecting only one limb
- diplegia, affecting the same body region on both sides of the body (both arms, for example, or both sides of the face)
- hemiplegia, affecting one side of the body
- paraplegia, affecting both legs and the trunk
- quadriplegia, affecting all four limbs and the trunk

Causes and symptoms

Causes

The nerve damage that causes paralysis may be in the brain or spinal cord (the central nervous system) or it may be in the nerves outside the spinal cord (the peripheral nervous system). The most common causes of damage to the brain are:

- stroke
- tumor
- trauma (caused by a fall or a blow)
- Multiple sclerosis (a disease that destroys the protective sheath covering nerve cells)
- cerebral palsy (a condition caused by a defect or injury to the brain that occurs at or shortly after birth)
- metabolic disorder (a disorder that interferes with the body's ability to maintain itself)

Damage to the spinal cord is most often caused by trauma, such as a fall or a car crash. Other conditions that may damage nerves within or immediately adjacent to the spine include:

- tumor
- herniated disk (also called a ruptured or slipped disk)
- spondylosis (a disease that causes stiffness in the joints of the spine)
- rheumatoid arthritis of the spine
- neurodegenerative disease (a disease that damages nerve cells)
- multiple sclerosis

Damage to peripheral nerves may be caused by:

- trauma
- compression or entrapment (such as carpal tunnel syndrome)
- Guillain-Barré syndrome (a disease of the nerves that sometimes follows fever caused by a viral infection or immunization)
- chronic inflammatory demyelinating polyradiculoneuropathy (CIDP) (a condition that causes pain and swelling in the protective sheath covering nerve cells)
- radiation
- inherited demyelinating disease (a condition that destroys the protective sheath around the nerve cell)
- toxins or poisons

Symptoms

The distribution of paralysis offers important clues to the site of nerve damage. Hemiplegia is almost always caused by brain damage on the side opposite the paralysis, often from a **stroke**. Paraplegia occurs after injury to the lower spinal cord, and quadriplegia occurs after damage to the upper spinal cord at the level of the shoulders or higher (the nerves controlling the arms leave the spine at that level). Diplegia usually indicates brain damage, most often from **cerebral palsy**. Monoplegia may be caused by isolated damage to either the central or the peripheral nervous system. Weakness or paralysis that occurs only in the arms and legs may indicate demyelinating disease. Fluctuating symptoms in different parts of the body may be caused by **multiple sclerosis**.

Sudden paralysis is most often caused by injury or stroke. Spreading paralysis may indicate degenerative disease, inflammatory disease such as **Guillain-Barré syndrome** or CIDP, metabolic disorders, or inherited demyelinating disease.

Other symptoms often accompany paralysis from any cause. These symptoms may include **numbness and tingling**, **pain**, changes in vision, difficulties with speech, or problems with balance. **Spinal cord injury** often causes loss of function in the bladder, bowel, and sexual organs. High spinal cord injuries may cause difficulties in breathing.

Diagnosis

Careful attention should be paid to any events in the patient's history that might reveal the cause of the paralysis. The examiner should look for incidents such as falls or other traumas, exposure to toxins, recent infections or surgery, unexplained **headache**, preexisting metabolic disease, and family history of weakness or other neurologic conditions. A neurologic examination tests strength, reflexes, and sensation in the affected area and normal areas.

Imaging studies, including **computed tomography scans** (CT scans), **magnetic resonance imaging** (MRI) scans, or **myelography** may reveal the site of the injury. **Electromyography** and nerve conduction velocity tests are performed to test the function of the muscles and peripheral nerves.

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KEY TERMS

Computed tomography (CT)—An imaging technique in which cross-sectional x rays of the body are compiled to create a three-dimensional image of the body's internal structures.

Electromyography—A test that uses electrodes to record the electrical activity of muscle. The information gathered is used to diagnose neuromuscular disorders.

Magnetic resonance imaging (MRI)—An imaging technique that uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

Myelin—The insulation covering nerve cells. Demyelinating disease causes a breakdown of myelin.

Myelography—An x-ray process that uses a dye or contrast medium injected into the space around the spine.

Nerve conduction velocity test—A test that measures the time it takes a nerve impulse to travel a specific distance over the nerve after electronic stimulation.

Treatment

The only treatment for paralysis is to treat its underlying cause. The loss of function caused by long-term paralysis can be treated through a comprehensive **rehabilitation** program. Rehabilitation includes:

- Physical therapy. The physical therapist focuses on mobility. Physical therapy helps develop strategies to compensate for paralysis by using those muscles that still have normal function, helps maintain and build any strength and control that remain in the affected muscles, and helps maintain range of motion in the affected limbs to prevent muscles from shortening (contracture) and becoming deformed. If nerve regrowth is expected, physical therapy is used to retrain affected limbs during recovery. A physical therapist also suggests adaptive equipment such as braces, canes, or wheelchairs.
- Occupational therapy. The occupational therapist focuses on daily activities such as eating and bathing. Occupational therapy develops special tools and techniques that permit self-care and suggests ways to modify the home and workplace so that a patient with an impairment may live a normal life.
- Other specialties. The nature of the impairment may mean that the patient needs the services of a respiratory therapist, vocational rehabilitation counselor, social worker, speech-language pathologist, nutritionist, special education teacher, recreation therapist, or clinical psychologist.

Prognosis

The likelihood of recovery from paralysis depends on what is causing it and how much damage has been done to the nervous system.

Prevention

Prevention of paralysis depends on prevention of the underlying causes. Risk of stroke can be reduced by controlling high blood pressure and cholesterol levels. Seatbelts, air bags, and helmets reduce the risk of injury from motor vehicle accidents and falls. Good prenatal care can help prevent premature birth, which is a common cause of cerebral palsy.

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Richard Robinson

Paralysis agitans *see* **Parkinson's disease**

Paralytic shellfish poisoning *see* **Fish and shellfish poisoning**

Paranoia

Definition

Paranoia is an unfounded or exaggerated distrust of others, sometimes reaching delusional proportions. Paranoid individuals constantly suspect the motives of those around them, and believe that certain individuals, or people in general, are "out to get them."

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Description

Paranoid perceptions and behavior may appear as features of a number of mental illnesses, including depression and **dementia**, but are most prominent in three types of psychological disorders: paranoid **schizophrenia**, delusional disorder (persecutory type), and paranoid personality disorder (PPD).

Individuals with paranoid schizophrenia and persecutory delusional disorder experience what is known as persecutory **delusions**: an irrational, yet unshakable, belief that someone is plotting against them. Persecutory delusions in paranoid schizophrenia are bizarre, sometimes grandiose, and often accompanied by auditory **hallucinations**. Delusions experienced by individuals with delusional disorder are more plausible than those experienced by paranoid schizophrenics; not bizarre, though still unjustified. Individuals with delusional disorder may seem offbeat or quirky rather than mentally ill, and, as such, may never seek treatment.

Persons with paranoid personality disorder tend to be self-centered, self-important, defensive, and emotionally distant. Their paranoia manifests itself in constant suspicions rather than full-blown delusions. The disorder often impedes social and personal relationships and career advancement. Some individuals with PPD are described as "litigious," as they are constantly initiating frivolous law suits. PPD is more common in men than in women, and typically begins in early adulthood.

Causes and symptoms

The exact cause of paranoia is unknown. Potential causal factors may be genetics, neurological abnormalities, changes in brain chemistry, and **stress**. Paranoia is also a possible side effect of drug use and **abuse** (for example, alcohol, **marijuana**, amphetamines, **cocaine**, PCP). Acute, or short term, paranoia may occur in some individuals overwhelmed by stress.

The *Diagnostic and Statistical Manual of Mental Disorders*, fourth edition (*DSM-IV*), the diagnostic standard for mental health professionals in the United States, lists the following symptoms for paranoid personality disorder:

- suspicious; unfounded suspicions; believes others are plotting against him/her
- preoccupied with unsupported doubts about friends or associates
- reluctant to confide in others due to a fear that information may be used against him/her
- reads negative meanings into innocuous remarks
- bears grudges
- perceives attacks on his/her reputation that are not clear to others, and is quick to counterattack
- maintains unfounded suspicions regarding the fidelity of a spouse or significant other

KEY TERMS

Persecutory delusion—A fixed, false, and inflexible belief that others are engaging in a plot or plan to harm an individual.

Diagnosis

Patients with paranoid symptoms should undergo a thorough **physical examination** and patient history to rule out possible organic causes (such as dementia) or environmental causes (such as extreme stress). If a psychological cause is suspected, a psychologist will conduct an interview with the patient and may administer one of several clinical inventories, or tests, to evaluate mental status.

Treatment

Paranoia that is symptomatic of paranoid schizophrenia, delusional disorder, or paranoid personality disorder should be treated by a psychologist and/or psychiatrist. Antipsychotic medication such as thioridazine (Mellaril), haloperidol (Haldol), chlorpromazine (Thorazine), clozapine (Clozaril), or risperidone (Risperdal) may be prescribed, and cognitive therapy or **psychotherapy** may be employed to help the patient cope with their paranoia and/or persecutory delusions. Antipsychotic medication, however, is of uncertain benefit to individuals with paranoid personality disorder and may pose long-term risks.

If an underlying condition, such as depression or drug abuse, is found to be triggering the paranoia, an appropriate course of medication and/or psychosocial therapy is employed to treat the primary disorder.

Prognosis

Because of the inherent mistrust felt by paranoid individuals, they often must be coerced into entering treatment. As unwilling participants, their recovery may be hampered by efforts to sabotage treatment (for example, not taking medication or not being forthcoming with a therapist), a lack of insight into their condition, or the belief that the therapist is plotting against them. Albeit with restricted lifestyles,

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some patients with PPD or persecutory delusional disorder continue to function in society without treatment.

ORGANIZATIONS

American Psychiatric Association (APA), 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209, (888) 357-7924, apa@psych.org, http://www.psych.org.

American Psychological Association (APA), 750 First St. NE, Washington, DC, 20002-4242, (202) 336-5500, (800) 374-2721, http://www.apa.org/.

National Alliance for the Mentally Ill (NAMI), 3803 N. Fairfax Dr., Ste. 100, Arlington, VA, 22203, 703 524-7600, (703) 524-9094, (800) 950-6264, http://www.nami.org.

National Institute of Mental Health (NIMH), 6001 Executive Boulevard, Bethesda, MD 20892, 301-443-4513, 1-866-615-6464, 301-443-8431 (TTY), 1-866-415-8051 (TTY toll-free), 301-443-4279 (Fax), nimhinfo@nih.gov, http://www.nimh.nih.gov/index.shtml.

Paula Anne Ford-Martin

Parapharyngeal abscess *see* **Abscess**

Paraphilias *see* **Sexual perversions**

Paraplegia *see* **Paralysis**

Parasomnia *see* **Sleep disorders**

Parathyroid gland removal *see* **Parathyroidectomy**

Parathyroid hormone test

Definition

The parathyroid hormone (PTH) test is a blood test performed to determine the serum levels of a hormone secreted by the parathyroid gland in response to low blood **calcium** levels. PTH works together with vitamin D to maintain healthy bones. The parathyroid glands are small paired glands located near the thyroid gland at the base of the neck.

Purpose

The PTH level is measured to evaluate the level of blood calcium. It is routinely monitored in patients with a kidney disorder called chronic renal failure (CRF). Because PTH is one of the major factors affecting calcium metabolism, the PTH test helps to distinguish nonparathyroid from parathyroid causes of too much calcium in the blood (**hypercalcemia**).

Differential diagnosis of hyperparathyroidism

PTH is also useful in the differential diagnosis of overactive parathyroid glands (**hyperparathyroidism**). Primary hyperparathyroidism is most often caused by a benign tumor in one or more of the parathyroid glands. It is rarely caused by parathyroid **cancer**. Patients with this condition have high PTH and calcium levels.

Secondary hyperparathyroidism is often seen in patients with chronic renal failure (CRF). The kidneys fail to excrete sufficient phosphate, and the parathyroid gland secretes PTH in an effort to lower calcium levels to balance the calcium-phosphate ratio. Because of the constant stimulation of the parathyroid, CRF patients have high PTH and normal or slightly low calcium levels.

Tertiary hyperparathyroidism occurs when CRF causes a severe imbalance in the calcium-phosphate ratio, leading to very high PTH production that results in hypercalcemia. Patients with this condition have high PTH and high calcium levels.

Specific PTH assays

PTH is broken down in the body into three different molecular forms: the intact PTH molecule and several smaller fragments which include an amino acid or N-terminal, a midregion or midmolecule, and a carboxyl or C-terminal. Two tests are currently used to measure intact PTH and its terminal fragments. While both tests are used to diagnose hyper or **hypoparathyroidism**, each test also has specific applications as well. The C-terminal PTH assay is used to diagnose the ongoing disturbances in PTH metabolism that occur with secondary and tertiary hyperparathyroidism. The assay for intact PTH and the N-terminal fragment, which are both measured at the same time, is more accurate in detecting sudden changes in the PTH level. For this reason, the N-terminal PTH assay is used to monitor a patient's response to therapy.

Precautions

Drug interactions

Some prescription drugs affect the results of PTH tests. Drugs that *increase* PTH levels include phosphates, anticonvulsants, **steroids**, isoniazid, lithium, and rifampin. Drugs that *decrease* PTH include cimetidine and propranolol.

Timing

PTH levels are subject to daily variation, ranging from a peak around 2:00 a.m. to a low point around

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KEY TERMS

Assay—An analysis of the chemical composition or strength of a substance.

Hypercalcemia—Abnormally high levels of blood calcium.

Hyperparathyroidism—Overactivity of the parathyroid glands. Symptoms include generalized aches and pains, depression, and abdominal pain.

Hypoparathyroidism—Insufficient production of parathyroid hormone, which results in low levels of blood calcium.

2:00 p.m. Specimens are usually drawn at 8:00 a.m. The laboratory should be notified if the patient works a night shift so that this difference in biological rhythm can be taken into account.

Other serum level tests

Due to the relationship between PTH and calcium, calcium levels should be tested at the same time as PTH. Most laboratories have established reference values to indicate what PTH level is normal for a particular calcium level. In addition, the effects of PTH on kidney function and bone strength indicate that serum calcium, phosphorus, and creatinine levels should be measured together with PTH. The **creatinine test** measures kidney function and aids in the diagnosis of parathyroid dysfunction.

Description

The PTH test is performed on a sample of the patient's blood, withdrawn from a vein into a vacuum tube. The procedure, which is called a venipuncture, takes about five minutes.

Preparation

The patient should have nothing to eat or drink from midnight of the day of the test.

Risks

Risks for this test are minimal, but may include slight bleeding from the puncture site, a small bruise or swelling in the area, or **fainting** or feeling lightheaded.

Normal results

Reference ranges for PTH tests vary somewhat depending on the laboratory, and must be interpreted in association with calcium results. The following ranges are typical:

- Intact PTH: 10–65 pg/mL
- PTH N-terminal (includes intact PTH): 8–24 pg/mL
- PTH C-terminal (includes C-terminal, intact PTH, and midmolecule): 50–330 pg/mL.

Abnormal results

When measured with serum calcium levels, abnormally *high* PTH values may indicate primary, secondary, or tertiary hyperparathyroidism, chronic renal failure, **malabsorption syndrome**, and **vitamin D deficiency**. Abnormally *low* PTH levels may indicate hypoparathyroidism, hypercalcemia, and certain malignancies.

Resources

BOOKS

Pagana, Kathleen Deska, and Timothy J. Pagana. *Mosby's Manual of Diagnostic and Laboratory Tests*. 4th ed. St. Louis: Mosby, 2009.

Janis O. Flores

Parathyroid scan

Definition

A parathyroid scan is sometimes called a parathyroid localization scan or parathyroid scintigraphy. This scan uses radioactive pharmaceuticals that are readily taken up by cells in the parathyroid glands to obtain an image of the glands and any abnormally active areas within them.

Purpose

The parathyroid glands, embedded in the thyroid gland in the neck, but separate from the thyroid in function, control **calcium** metabolism in the body. The parathyroid glands produce parathyroid hormone (PTH). PTH regulates the level of calcium in the blood.

Calcium is critical to cellular metabolism, as well as being the main component of bones. If too much PTH is secreted, the bones release calcium into the bloodstream. Over time, the bones become brittle and more likely to break. A person with levels of calcium in the blood that are too high feels tired, run down, irritable, and has difficulty sleeping. Additional signs of too much calcium in the blood are **nausea and vomiting**, frequent urination, **kidney stones** and bone **pain**. A parathyroid scan is administered when the

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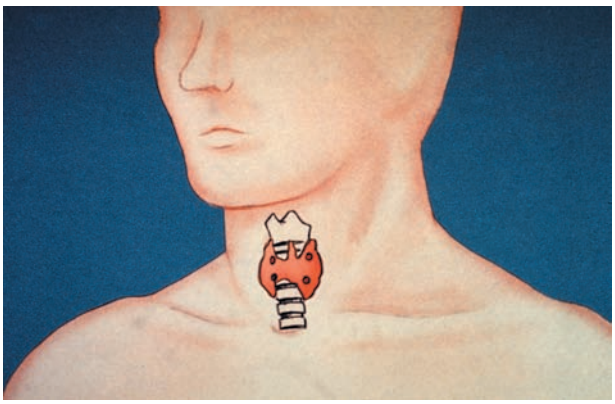

The parathyroid glands, embedded in the thyroid gland in the neck but separate from the thyroid gland in function, control calcium metabolism in the body by producing parathyroid hormone, or PTH. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

parathyroid appears to be overactive and a tumor is suspected.

Precautions

Parathyroid scans are not recommended for pregnant women because of the potential harm to the developing fetus. People who have had another recent nuclear medicine procedure or an intravenous contrast test may need to wait until the earlier radioactive markers have been eliminated from their system in order to obtain accurate results from the parathyroid scan.

Description

A parathyroid scan is a non-invasive procedure that uses two radiopharmaceuticals (drugs with a radioactive marker) to obtain an image of highly active areas of the parathyroid glands. The test can be done in two ways.

Immediate scan

If the test is to be performed immediately, the patient lies down on an imaging table with his head and neck extended and immobilized. The patient is injected with the first radiopharmaceutical. After waiting 20 minutes, the patient is positioned under the camera for imaging. Each image takes five minutes. It is essential that the patient remain still during imaging.

After the first image, the patient is injected with a second radiopharmaceutical, and imaging continues for another 25 minutes. Total time for the test is about one hour: injection 10 minutes, waiting period 20 minutes, and imaging 30 minutes.

KEY TERMS

Cyst—An abnormal sac containing fluid or semi-solid material.

Goiter—Chronic enlargement of the thyroid gland.

Neoplasm—An uncontrolled growth of new tissue.

Another way to do this test is as follows. After the first images are acquired, the patient returns two hours later for additional images. Time for this procedure totals about three hours: injection 10 minutes, waiting period two hours and 20 minutes, and imaging 30 minutes.

Delayed scan

In a delayed parathyroid scan, the patient is asked to swallow capsules containing the first radiopharmaceutical. The patient returns after a four hour waiting period, and the initial image is made. Then the patient is injected with the second radiopharmaceutical. Imaging continues for another 25 minutes. The total time is about four hours and 40 minutes: waiting period four hours, injection 10 minutes, and imaging 30 minutes.

Preparation

No special preparations are necessary for this test. It is not necessary to fast or maintain a special diet. The patient should wear comfortable clothing and no metal jewelry around the neck.

Aftercare

The patient should not feel any adverse effects of the test and can resume normal activities immediately.

Risks

The only risk associated with this test is to the fetus of a pregnant woman.

Normal results

Normal results will show no unusual activity in the parathyroid glands.

Abnormal results

A concentration of radioactive materials in the parathyroid gland beyond background levels suggests excessive activity and the presence of a tumor. False positive results sometimes result from the presence of multinodular **goiter**, neoplasm, or cysts. False positive

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tests are tests that interpret the results as abnormal when this is not true.

Resources

OTHER

"Parathyroid Scan." Cleveland Clinic. August 23, 2010. http://my.clevelandclinic.org/Documents/Radiology/CCF_NuclearMedicine_ParathyroidScan.pdf (accessed December 3, 2010).

Tish Davidson, A.M.

Parathyroidectomy

Definition

Parathyroidectomy is the removal of one or more of the parathyroid glands. The parathyroid glands are usually four in number, although the exact number may vary from three to seven. They are located in the neck in front of the Adam's apple and are closely linked to the thyroid gland. The parathyroid glands regulate the balance of **calcium** in the body.

Purpose

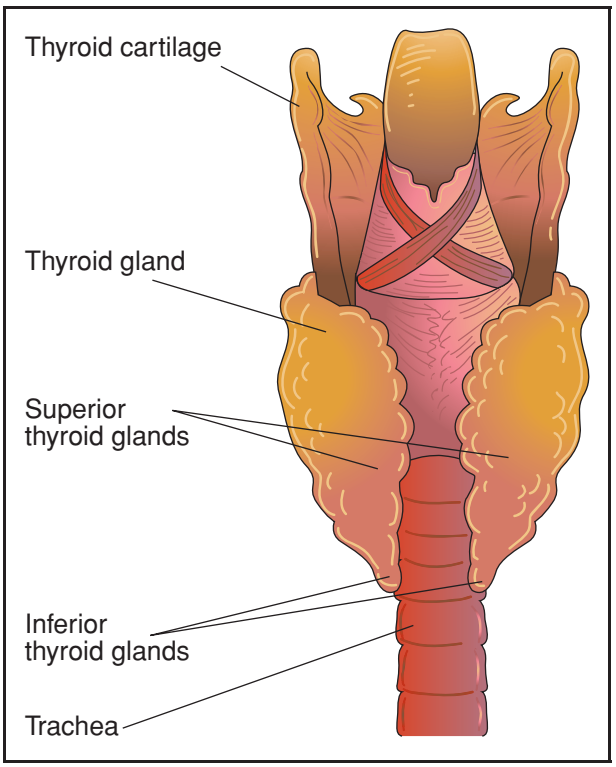
Parathyroidectomy is usually done to treat **hyperparathyroidism** (abnormal over-functioning of the parathyroid glands).

Precautions

Parathyroidectomy should only be done when other non-operative methods have failed to control the patient's hyperparathyroidism.

Description

Parathyroidectomy is an operation done most commonly by a general surgeon, or occasionally by an otolaryngologist, in the operating room of a hospital. The operation begins when the anesthesiologist anesthetizes or puts the patient to sleep. The surgeon makes an incision in the front of the neck where a tight-fitting necklace would rest. All of the parathyroid glands are identified. The surgeon then identifies the gland or glands with the disease and confirms the diagnosis by sending a piece of the gland(s) to the pathology department for immediate microscopic examination. The glands are then removed and the incision is closed and a dressing is placed over the incision.



Parathyroidectomy refers to the surgical removal of one or more of the parathyroid glands due to hyperparathyroidism (an abnormal over-functioning of the parathyroid glands). It is usually done after other non-operative methods have failed to control or correct this condition. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Patients generally stay overnight in the hospital after completion of the operation and may remain for one or two additional days. These procedures are reimbursed by insurance companies. Surgeon's fees typically range from $1,000–$2,000. Anesthesiologists charge for their services based on the medical status of the patient and the length of the operative procedure. Hospitals charge for use of the operating suite, equipment, lab and diagnostic tests, and medications.

Preparation

Prior to the operation, the diagnosis of hyperparathyroidism should be confirmed using lab tests. Occasionally, physicians order **computed tomography scans** (CT scans), ultrasound exams, and/or **magnetic resonance imaging** (MRI) tests to determine the total number of parathyroid glands and their location prior to the procedure.

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KEY TERMS

Anesthesiologist—A physician who specializes in anesthetizing patients for operations.

Ectopic parathyroid tissue—A condition where the thyroid tissue is located in an abnormal place.

Hyperparathyroidism—Abnormal over-functioning of the parathyroid glands.

Hypoparathyroidism—Abnormal under-functioning of the parathyroid glands.

Otolaryngologist—A surgeon who treats people with abnormalities in the head and neck regions of the body.

Aftercare

The incision should be watched for signs of infection. In general, no specific wound care is required.

The level of calcium in the body should be monitored during the first 48 hours after the operation by obtaining frequent blood samples for laboratory analysis.

Risks

The major risk of parathyroidectomy is injury to the recurrent laryngeal nerve (a nerve that lies very near the parathyroid glands and serves the larynx or voice box). If this nerve is injured, the voice may become hoarse or weak.

Occasionally, too much parathyroid tissue is removed, and the patient may develop **hypoparathyroidism** (under-functioning of the parathyroid glands). If this occurs, the patient will require daily calcium supplements.

Sometimes not all of the parathyroid glands are found in the initial operation. A fifth or sixth gland may be located in an aberrant location such as the chest (ectopic parathroid). If this occurs, the patient's hyperparathyroidism may not be corrected, and a second procedure may be required to find the other gland(s).

Hematoma formation (collection of blood under the incision) is a possible complication of any operative procedure. However, in procedures that involve the neck it is of particular concern, because a rapidly enlarging hematoma can obstruct the airway.

Infection of the surgical incision may occur, as with any operative procedure, but this is not common.

Normal results

Most patients require only two or three days of hospitalization to recover from the operation. They usually can resume most of their normal activities within one to two weeks.

Resources

OTHER

"Parathyroid gland removal." MedlinePlus Medical Encyclopedia. January 30, 2009. http://www.nlm.nih.gov/medlineplus/ency/article/002931.htm (accessed December 20, 2010).

"Parathyroid Surgery." Cleveland Clinic. http://my.clevelandclinic.org/services/Parathyroidectomy/hic_Parathyroid_Surgery.aspx (accessed December 20, 2010).

Mary Jeanne Krob, MD, FACS

Paratyphoid fever

Definition

Paratyphoid fever, which is sometimes called *Salmonella paratyphi* infection, is a serious contagious disease caused by a gram-negative bacterium. It is also grouped together with **typhoid fever** under the name enteric fever.

Description

Enteric fever is increasingly rare in the United States. Of the 500 cases reported in an average year, about 60% are infections acquired during travel in Mexico, India, or South America.

Paratyphoid fever has three stages: an early stage marked by high fever; a toxic stage with abdominal **pain** and intestinal symptoms, and a long period of recovery from fever (defervescence). In adults, these three phases may cover a period of four to six weeks; in children, they are shorter and may cover 10 days to two weeks. During the toxic stage there is a 1–10% chance of intestinal perforation or hemorrhage.

Causes and symptoms

Paratyphoid fever is caused by any of three strains of *Salmonella paratyphi*: *S. paratyphi A*; *S. schottmuelleri* (also called *S. paratyphi C*); or *S. hirschfeldii* (also called *S. paratyphi B*). It can be transmitted from animals or animal products to humans or from person to person. The incubation

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period is one to two weeks but is often shorter in children. Symptom onset may be gradual in adults but is often sudden in children.

Paratyphoid fever is marked by high fever, **headache**, loss of appetite, **vomiting**, and **constipation** or **diarrhea**. The patient typically develops an enlarged spleen. About 30% of patients have rose spots on the front of the chest during the first week of illness. The rose spots develop into small hemorrhages that may be hard to see in African or Native Americans.

Patients with intestinal complications have symptoms resembling those of **appendicitis**: intense cramping pain with soreness in the right lower quadrant of the abdomen.

Diagnosis

The diagnosis is usually made on the basis of a history of recent travel and culturing the paratyphoid organism. Because the disease is unusual in the United States, the doctor may not consider paratyphoid in the diagnosis unless the patient has the classic symptoms of an enlarged spleen and rose spots. The doctor will need to rule out other diseases with high fevers, including **typhus**, **brucellosis**, **tularemia** (rabbit fever), psittacosis (parrot fever), mononucleosis, and **Kawasaki syndrome**. *S. paratyphi* is easily cultured from samples of blood, stool, urine, or bone marrow.

Treatment

Medications

Paratyphoid fever is treated with **antibiotics** over a two- to three-week period with trimethoprim-sulfamethoxazole (Bactrim, Septra); amoxicillin (Amoxil, Novamoxin); and ampicillin (Amcill). Third-generation **cephalosporins** (ceftriaxone [Rocephin], cefotaxime [Claforan], or cefixime [Suprax]) or chloramphenicol (Chloromycetin) may be given if the specific strain is resistant to other antibiotics.

Surgery

Patients with intestinal perforation or hemorrhage may need surgery if the infection cannot be controlled by antibiotics.

Supportive care

Patients with paratyphoid fever need careful monitoring for signs of complications as well as bed rest and nutritional support. Patients with severe infections may require fluid replacement or blood transfusions.

KEY TERMS

Defervescence—Return to normal body temperature after high fever.

Enteric fever—A term that is sometimes used for either typhoid or paratyphoid fever.

Rose spots—Small slightly raised reddish pimples that are a distinguishing feature of typhoid or paratyphoid infection.

Prognosis

Most patients with paratyphoid fever recover completely, although intestinal complications can result in **death**. With early treatment, the mortality rate is less than 1%.

Prevention

Immunization

Vaccination against paratyphoid fever is not necessary within the United States but is recommended for travel to countries with high rates of enteric fever.

Hygienic measures

Travelers in countries with high rates of paratyphoid fever should be careful to wash hands before eating and to avoid meat, egg, or poultry dishes unless they have been thoroughly cooked.

Resources

BOOKS

Fauci, Anthony S., et al., eds. *Harrison's Principles of Internal Medicine*. 17th ed. New York: McGraw–Hill Professional, 2008.

Rebecca J. Frey, PhD

Paresthesias *see* **Numbness and tingling**

Parkinson's disease

Definition

Parkinson's disease (PD) is a progressive degenerative brain disorder marked by **tremors**, rigidity, slow movements (bradykinesia), and posture instability. It occurs when cells in one of the movement-control

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centers of the brain begin to die for unknown reasons. PD was first described by British physician James Parkinson in the early 1817.

Demographics

About 1% of people over age 60 develop PD with an approximate prevalence of 120 cases per 100,000 population. The likelihood of developing PD increases with age with an estimated 15% of those ages 65–74, and almost 30% of those ages 75–84 showing symptoms. Because PD is difficult to diagnose accurately, these numbers are only estimates. PD is about 1.5 times more common in men than in women. Average age of onset is 60 years; the disease is uncommon in people under age 40.

Description

Usually beginning in a person's late fifties or early sixties, Parkinson's disease causes a progressive decline in movement control, affecting the ability to control initiation, speed, and smoothness of motion. Many cases of PD are sporadic. This means that there is a spontaneous and permanent change in nucleotide sequences (the building blocks of genes). Sporadic mutations also involve unknown environmental factors in combination with genetic defects. The abnormal gene (mutated gene) will form an altered end product or protein. This will cause abnormalities in specific areas in the body where the protein is used. Some evidence suggests that there is also a genetic component that predisposes some people to develop the disease when exposed to certain (as yet undiscovered) environmental factors. Recent research has linked PD with a gene that codes for a protein called alpha-synuclein. Further research is attempting to fully understand the relationship with this protein and nerve cell degeneration.

Risk factors

Age is the greatest risk factor for developing PD. Gender also is a risk factor, as men are more likely to be diagnosed with the disease. Family history can increase risk; people with a first-degree relative (parent, sibling, child) with PD have double the chance of developing the disease compared to people without PD in the immediate family.

Smoking tobacco has consistently been shown to protect against the development of PD as has **caffeine** consumption. However, other health risks of smoking far outweigh the potential protective effect.

Causes and symptoms

The immediate cause of PD is degeneration of brain cells in the area known as the substantia nigra, one of the movement control centers of the brain. Damage to this area leads to the cluster of symptoms known as "parkinsonism." In PD, degenerating brain cells contain Lewy bodies which are not found in healthy brain cells and which help to identify the disease. The cell **death** leading to parkinsonism may be caused by a number of conditions, including infection, trauma, and **poisoning**. Some drugs given for **psychosis**, such as haloperidol (Haldol) or chlorpromazine (Thorazine, Largactil), may cause parkinsonism. When no cause for nigral cell degeneration can be found, the disorder is called idiopathic parkinsonism, or Parkinson's disease. Parkinsonism may be seen in other degenerative conditions, known as the "parkinsonism plus" syndromes, such as **progressive supranuclear palsy**.

The substantia nigra, or "black substance," is one of the principal movement control centers in the brain. By releasing the neurotransmitter dopamine, it helps to refine movement patterns throughout the body. The dopamine released by nerve cells of substantia nigra stimulates another brain region, the corpus striatum. Without enough dopamine, the corpus striatum cannot control its targets, and so on down the line. Ultimately, the movement patterns of walking, writing, reaching for objects, and other basic programs cannot operate properly, and the symptoms of parkinsonism are the result.

Some known toxins can cause parkinsonism, most notoriously a chemical called MPTP, found as an impurity in some illegal drugs. Parkinsonian symptoms appear within hours of ingestion and are permanent. MPTP may exert its effects through generation of toxic molecular fragments called free radicals, and reducing free radicals has been a target of several experimental treatments for PD using **antioxidants**.

It is possible that early exposure to some as-yet-unidentified environmental toxin or virus leads to undetected nigral cell death, and PD then manifests as normal age-related decline brings the number of functioning nigral cells below the threshold needed for normal movement. It is also possible that, for genetic reasons, some people are simply born with fewer cells in their substantia nigra than others, and they develop PD as a consequence of normal decline.

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KEY TERMS

AADC inhibitors—Drugs that block the amino acid decarboxylase; one type of enzyme that breaks down dopamine. Also called DC inhibitors, they include carbidopa and benserazide.

Akinesia—A loss of the ability to move; freezing in place.

Antioxidant—A molecule that prevents oxidation. In the body antioxidants attach to other molecules called free radicals and prevent the free radicals from causing damage to cell walls, DNA, and other parts of the cell.

Bradykinesia—Extremely slow movement.

COMT inhibitors—Drugs that block catechol-o-methyl transferase, an enzyme that breaks down dopamine. COMT inhibitors include entacapone and tolcapone.

Dopamine—A neurochemical made in the brain that is involved in many brain activities, including movement and emotion.

Dyskinesia—Impaired ability to make voluntary movements.

Free radical—A molecule with an unpaired electron that has a strong tendency to react with other molecules in DNA (genetic material), proteins, and lipids (fats), resulting in damage to cells. Free radicals are neutralized by antioxidants.

Idiopathic—Of unknown origin; without a known cause.

MAO-B inhibitors—Inhibitors of the enzyme monoamine oxidase B. MAO-B helps break down dopamine; inhibiting it prolongs the action of dopamine in the brain. Selegiline is an MAO-B inhibitor.

Orthostatic hypotension—A sudden decrease in blood pressure upon sitting up or standing. May be a side effect of several types of drugs.

Substantia nigra—One of the movement control centers of the brain.

Symptoms

The identifying symptoms of PD include:

- Tremors, usually beginning in the hands, often occurring on one side before the other. The classic tremor of PD is called a "pill-rolling tremor," because the movement resembles rolling a pill between the thumb and forefinger. This tremor occurs at a frequency of about three per second.
- Slow movements (bradykinesia) occur, which may involve slowing down or stopping in the middle of familiar tasks such as walking, eating, or shaving. This may include freezing in place during movements (akinesia).
- Muscle rigidity or stiffness, occurring with jerky movements replacing smooth motion.
- Postural instability or balance difficulty occurs. This may lead to a rapid, shuffling gait (festination) to prevent falling.
- In most cases, there is a "masked face," with little facial expression and decreased eye-blinking.

In addition, a wide range of other symptoms may often be seen, some beginning earlier than others:

- depression (reported in about half of all individuals with PD)
- speech changes, including rapid speech without inflection changes
- problems with sleep, including restlessness and nightmares
- emotional changes, including fear, irritability, and insecurity
- incontinence
- constipation
- handwriting changes, with letters becoming smaller across the page (micrographia)
- progressive problems with intellectual function (dementia)

Diagnosis

The diagnosis of Parkinson's disease involves a careful medical history and a **neurological exam** to look for characteristic symptoms. There are no definitive tests for PD, although a variety of lab tests may be done to rule out other causes of symptoms, especially if only some of the identifying symptoms are present. Tests for other causes of parkinsonism may include brain scans, blood tests, **lumbar puncture**, and x rays.

Treatment

There is no cure for Parkinson's disease. Treatment can be complicated and is based on the individual's age, level of impairment, cognitive function and response to treatment.

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Exercise, nutrition, and physical therapy

Regular, moderate **exercise** has been shown to improve motor function without an increase in medication for a person with PD. Exercise helps maintain range of motion in stiff muscles, improve circulation, and stimulate appetite. An exercise program designed by a physical therapist has the best chance of meeting the specific needs of the person with PD. A physical therapist may also suggest strategies for balance compensation and techniques to stimulate movement during slowdowns or freezes.

Good **nutrition** is important to maintenance of general health. A person with PD may lose some interest in food, especially if depressed, and may have **nausea** from the disease or from medications, especially those known as dopamine agonists. Slow movements may make it difficult to eat quickly, and delayed gastric emptying may lead to a feeling of fullness without having eaten much. Increasing fiber in the diet can improve **constipation**, soft foods can reduce the amount of needed chewing, and a prokinetic drug can increase the movement of food through the digestive system.

People with PD may need to limit the amount of protein in their **diets**. The main drug used to treat PD, L-dopa, is an amino acid, and is absorbed by the digestive system by the same transporters that pick up other amino acids broken down from proteins in the diet. Limiting protein, under the direction of the physician or a nutritionist, can improve the absorption of L-dopa.

No evidence indicates that vitamin or mineral supplements can have any effect on the disease other than in the improvement of the patient's general health. No antioxidants used to date have shown promise as a treatment except for selegiline, an MAO-B inhibitor that is discussed below. A large, carefully controlled study of vitamin E demonstrated that it could not halt disease progression. However, in a preliminary study, the antioxidant co-enzyme Q10 appeared to slow the progression of PD. Co-enzyme Q10 remains under investigation.

Drugs

The pharmacological treatment of Parkinson's disease is complex. While there are a large number of drugs that can be effective, their effectiveness varies with the patient, disease progression, and the length of time the drug has been used. Dose-related side effects may preclude using the most effective dose, or require the introduction of a new drug to counteract them. Response to drug therapy is monitored and drugs may be adjusted in an attempt to find a treatment regimen that provides the most benefits with the fewest side effects. Research is ongoing in an effort to find drugs to treat PD. Individuals should consult their doctor about advances in drug therapy and clinical trials underway to test new PD drugs. There are six classes of drugs currently used to treat PD.

DRUGS THAT REPLACE DOPAMINE. One drug that helps replace dopamine, levodopa (L-dopa), is the single most effective treatment for the symptoms of PD. L-dopa is a derivative of dopamine, and is converted into dopamine by the brain. It may be started when symptoms begin, or when they become serious enough to interfere with work or daily living.

L-dopa therapy usually remains effective for five years or longer. Following this, many patients develop motor fluctuations, including peak-dose "dyskinesias" (abnormal movements such as tics, twisting, or restlessness), rapid loss of response after dosing (known as the "on-off" phenomenon), and unpredictable drug response. Higher doses may be tried, but often lead to an increase in dyskinesias. In addition, side effects of L-dopa include **nausea and vomiting**, and low blood pressure upon standing (**orthostatic hypotension**), which can cause **dizziness**. These effects may lessen after several weeks of therapy.

ENZYME INHIBITORS. Dopamine is broken down by several enzyme systems in the brain and elsewhere in the body, and blocking these enzymes is a key strategy to prolonging the effect of dopamine. The two most commonly prescribed forms of L-dopa contain a drug to inhibit the amino acid decarboxylase (an AADC inhibitor), one type of enzyme that breaks down dopamine. These combination drugs are Sinemet and Parcopa (L-dopa plus carbidopa) and Madopar (L-dopa plus benzaseride). Controlled-release formulations also aid in prolonging the effective interval of an L-dopa dose.

The enzyme monoamine oxidase B (MAO-B) inhibitor selegiline(Eldepryl) may be given as add-on therapy for L-dopa. Selegiline appears to have a neuroprotective effect, sparing nigral cells from damage by free radicals. Because of this, and the fact that it has few side effects, it is frequently prescribed early in the disease before L-dopa is begun. Rasagiline (Azilect) is a second-generation MAO-B inhibitor with fewer potential side effects than selegiline. Entacapone (Comtan) and tolcapone (Tasmar), two inhibitors of another enzyme system called catechol-o-methyl transferase (COMT) are also available to treat PD symptoms with fewer motor fluctuations and decreased daily L-dopa requirements.

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CHOLINESTERASE INHIBITORS. The cholinesterase inhibitor Exelon (rivastigmine) both as a tablet an a transdermal patch is used to treat **dementia** in mild to moderate PD.

DOPAMINE AGONISTS. Dopamine works by stimulating receptors on the surface of corpus striatum cells. Drugs that also stimulate these cells are called dopamine agonists, or DAs. DAs may be used before L-dopa therapy, or added on to avoid requirements for higher L-dopa doses late in the disease. DAs available in the United States as of 2009 include Apomorphine (Apokyn), a short-acting DA, bromocriptine (Parlodel), ropinirole (Requip), and pramipexole (Mirapex). In 2007, the U.S. Food and Drug Administration (FDA) approved cabergoline (Dostinex) for treatment of PD. Other dopamine agonists in use elsewhere include lisuride (Dopergine) and apomorphine. Side effects of all the DAs are similar to those of dopamine, plus confusion and **hallucinations** at higher doses. In 2007, the drug pergolide (Permax) was withdrawn from sale in the United States and elsewhere after studies showed it increased the risk of serious heart valve damage.

ANTICHOLINERGIC DRUGS. Anticholinergics maintain dopamine balance as levels decrease. However, the side effects of anticholinergics (**dry mouth**, constipation, confusion, and blurred vision) are usually too severe in older patients or in patients with dementia. In addition, anticholinergics rarely work for very long. They are often prescribed for younger patients who have predominant shaking. Trihexyphenidyl (Artane) is the drug most commonly prescribed.

DRUGS WHOSE MODE OF ACTION IS UNCERTAIN. Amantadine (Symmetrel) is sometimes used as an early therapy before L-dopa is begun, and as an add-on later in the disease. Its anti-Parkinsonian effects are mild, and are not seen in many patients. Clozapine (Clozaril) is effective especially against psychiatric symptoms of late PD, including psychosis and hallucinations.

Surgery

Two surgical procedures are used for treatment of PD that cannot be controlled adequately with drug therapy. In PD, a brain structure called the globus pallidus (GPi) receives excess stimulation from the corpus striatum. In a pallidotomy, the GPi is destroyed by heat, delivered by long thin needles inserted under anesthesia. Electrical stimulation of the GPi is another way to reduce its action. In this procedure, fine electrodes are inserted to deliver the stimulation, which may be adjusted or turned off as the response dictates. Other regions of the brain may also be stimulated by electrodes inserted elsewhere. In most patients, these procedures lead to significant improvement for some motor symptoms, including peak-dose dyskinesias. This allows the patient to receive more L-dopa, since these dyskinesias are usually what causes an upper limit on the L-dopa dose.

A third procedure, transplant of fetal nigral cells, is still highly experimental. Its benefits to date have been modest, although improvements in technique and patient selection are likely to change that. Also, **gene therapy** is showing promise as a future treatment for PD. In one trial by Cornell University scientists involving 12 patients with PD, all had their symptoms improved by at least 25% for up to a year after gene therapy. Further research is being conducted.

Alternative treatment

Currently, the best treatments for PD involve the use of conventional drugs such as levodopa. Alternative therapies, including **acupuncture**, massage, and **yoga**, can help relieve some symptoms of the disease and loosen tight muscles. Alternative practitioners have also applied herbal and dietary therapies, including amino acid supplementation, antioxidant (**vitamins** A, C, E, selenium, and zinc) therapy, B vitamin supplementation, and **calcium** and magnesium supplementation, to the treatment of PD. Anyone using these therapies in conjunction with conventional drugs should check with their doctor to avoid the possibility of adverse interactions. For example, vitamin B_6 (either as a supplement or from foods such as whole grains, bananas, beef, fish, liver, and potatoes) can interfere with the action of L-dopa when the drug is taken without carbidopa.

Prognosis

Despite medical treatment, the symptoms of Parkinson's disease worsen over time, and become less responsive to drug therapy. Late-stage psychiatric symptoms are often the most troubling, including difficulty sleeping, nightmares, intellectual impairment (dementia), hallucinations, and loss of contact with reality (psychosis).

Prevention

There is no known way to prevent Parkinson's disease.

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ORGANIZATIONS

American Parkinson Disease Association, 135 Parkinson Ave., Staten Island, NY, 10305, (718) 981-8001, (800) 223-2732, (718) 981-4399, adpa@adpaparkinson.org, http://www.apdaparkinson.org.

National Institute of Neurological Disorders and Stroke (NINDS), P.O. Box 5801, Bethesda, MD, 20828, (301) 496-5751. TTY: (301) 468-5981, (800) 352-9424, http://www.ninds.nih.gov.

National Parkinson Foundation, 1501 N.W. 9th Avenue/Bob Hope Road, Miami, FL, 33136-1494, (305) 243-6666, (800) 327-4545, (305) 243-5595, contact@parkinson.org, http://www.parkinson.org.

Parkinson's Disease Foundation, 1359 Broadway, Suite 1509, New York, NY, 10018, (212) 923-4700, (800) 457-6676, (212) 923-4778, info@pdf.org, http://www.pdf.org.

The Parkinson's Institute and Clinical Center, 672 Almanor Ave, Sunnyvale, CA, 94068, (408) 734-2800 , (800) 655-2273, info2@thepi.org, http://www.thepi.org.

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Parkinsonism *see* **Parkinson's disease**

Parotid gland removal *see* **Parotidectomy**

Parotid gland scan *see* **Salivary gland scan**

Parotidectomy

Definition

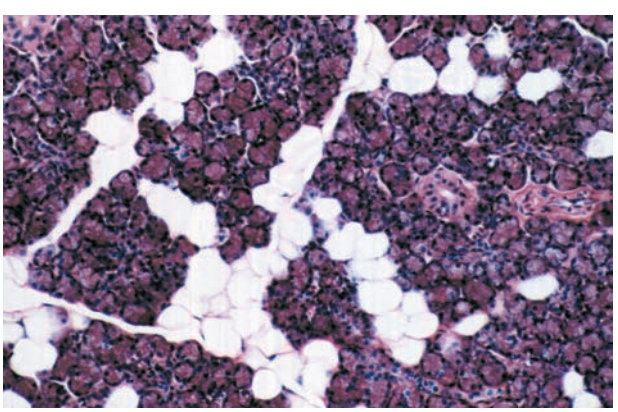
Parotidectomy is the removal of the parotid gland, a salivary gland near the ear.

Purpose

The main purpose of parotidectomy is to remove cancerous tumors in the parotid gland. A number of tumors can develop in the parotid gland. Many of these are tumors that have spread from other areas of the body, entering the parotid gland by way of the lymphatic system. Among the tumors seen in the parotid gland are lymphoma, melanoma, and squamous cell carcinoma.

Description

The parotid gland is the largest of the salivary glands. There are two parotid glands, one on each side of the face. They lie just in front of the ears and a duct runs from each to the inside of the cheek. Each parotid gland has several lobes. Surgery is recommend as part of the treatment for all cancers in the parotid gland. Superficial or localized parotidectomy is recommended by some authorities, unless a lipoma or Warthin's tumor is present. One of the advantages to this approach is that nerves to facial muscles are left intact. Many facial nerves run through the same area as the parotid gland and can be damaged during more complete parotidectomies. Most authorities recommend total parotidectomy, especially if **cancer** is



A micrograph of a normal human parotid gland. One of the salivary glands, the parotid consists of acini arranged in lobes. This image shows a junction between several lobes; the clear spaces represent the interlobular connective tissue. The masses of secretory cells produce a watery secretion which is passed to the intralobular. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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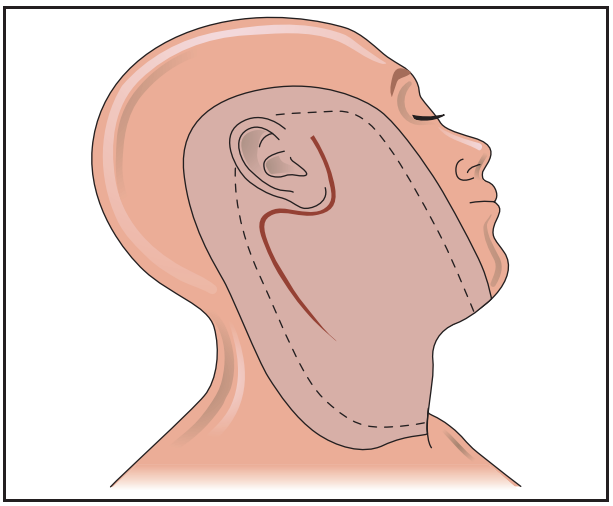

Parotidectomy is a surgical procedure performed to remove cancerous tumors in the parotid gland, a salivary gland near the ear. Among the tumors seen in the parotid gland are lymphoma, melanoma, and squamous cell carcinoma. The illustration above shows the facial incision sites for this procedure. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

found in both the superficial and deep lobes of the parotid gland. If the tumor has spread to involve the facial nerve, the operation is expanded to include parts of bone behind the ear (mastoid) to remove as much tumor as possible. Some authorities recommend post-surgery radiation as follow-up treatment for cancer.

Aftercare

After surgery, the patient will remain in the hospital for one to three days. The site of incision will be watched closely for signs of infection and heavy bleeding (hemorrhage). The incision site should be kept clean and dry until it is completely healed. The patient should not wash their hair until the stitches have been removed. If the patient has difficulty smiling, winking, or drinking fluids, the physician should be contacted immediately. These are signs of facial nerve damage.

Risks

There are a number of complications that follow parotidectomy. Facial nerve **paralysis** after minor surgery should be minimal. During surgery, it is possible to repair cut nerves. After major surgery, a graft is attempted to restore nerve function to facial muscles. Salivary fistulas can occur when saliva collects in the incision site or drains through the incision. Reoccurrence of cancer is the single most important consideration for patients who have undergone parotidectomy. Long term survival rates are largely dependent on the tumor types and the stage of tumor development at the time of the operation.

Other risks include **blood clots** (hematoma) and infection. The most common long-term complication of parotidectomy is redness and sweating in the cheek, known as Frey's syndrome. Rarely, paralysis may extend throughout all the branches of the facial nervous system.

KEY TERMS

Fistula—An abnormal opening or duct through tissue that results from injury, disease, or other trauma.

Salivary gland—Three pairs of glands that secrete into the mouth and aid digestion.

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Mary K. Fyke

Parotitis, epidemic *see* **Mumps**

Paroxetine *see* **Selective serotonin reuptake inhibitors**

Paroxysmal atrial tachycardia

Definition

A period of very rapid and regular heart beats that begins and ends abruptly. The heart rate is usually between 160 and 200 beats per minute. This condition is also known as paroxysmal supraventricular tachycardia.

Description

The term paroxysmal means that the event begins suddenly, without warning and ends abruptly. Atrial tachycardia means that the upper chambers of the heart are beating abnormally fast. Paroxysmal atrial

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tachycardia can occur without any heart disease being present. It is usually more annoying than dangerous.

Causes and symptoms

Paroxysmal atrial tachycardia may be caused by several different things. The fast rate may be triggered by a premature atrial beat that sends an impulse along an abnormal electrical path to the ventricles. Other causes stem from **anxiety**, stimulants, overactive thyroid, and in some women, the onset of menstruation.

Though seldom life-threatening, paroxysmal atrial tachycardia produces annoying symptoms which can include lightheadedness, chest **pain**, **palpitations**, anxiety, sweating, and **shortness of breath**.

Diagnosis

Diagnosis is not always easy, because the event is usually over by the time the patient sees a doctor. A careful description of the episode will aid the doctor in his diagnosis. If the rapid heart rate is still occurring, an electrocardiograph (ECG) will show the condition. If the event is over, physicians often recommend a period of ambulatory electrocardiographic monitoring (called **Holter monitoring**) to confirm the diagnosis.

Treatment

The doctor may suggest that during an episode of paroxysmal atrial tachycardia the following practice may help. Briefly hold the nose and mouth closed and breathe out, or by bearing down, as though straining at a bowel movement. The doctor may try to stop the episode by gently massaging an area in the neck called the carotid sinus.

If these conservative measures do not work, an injection of the drug verapamil or adenosine should stop the episode quickly.

In rare cases, the drugs do not work and electrical shock (**cardioversion**) may be necessary, particularly if serious symptoms are also present with the tachycardia.

Prognosis

Paroxysmal atrial tachycardia is not a disease, and is seldom life-threatening. The episodes are usually more unpleasant than they are dangerous, and the prognosis is generally good.

Prevention

Frequent episodes are usually cause for medication. In rare cases, the doctor may recommend a procedure called **catheter ablation**, which will remove (or ablate) the precise area of the heart responsible for triggering the fast heart rate.

In a catheter ablation procedure, the doctor will place a special catheter against the area of the heart responsible for the problem. Radio-frequency energy is then passed to the tip of the catheter, so that it heats up and destroys the target area. Catheter ablation is considered a non-surgical technique.

KEY TERMS

Premature atrial beat—A beat that occurs before it would normally be expected.

Supraventricular—A term for an event that occurs in the upper chambers (atria) of the heart.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

Dorothy Elinor Stonely

Paroxysmal supraventricular tachycardia *see* **Paroxysmal atrial tachycardia**

Parrot fever

Definition

Parrot **fever** is a rare **infectious disease** that causes **pneumonia** in humans. It is transmitted from pet birds or poultry. The illness is caused by a chlamydia, which is a type of intracellular parasite closely related to bacteria. Parrot fever is also called chlamydiosis, psittacosis, or ornithosis.

Description

Parrot fever, which is referred to as avian psittacosis when it infects birds, is caused by *Chlamydia psittaci*. Pet birds in the parrot family, including parrots, parakeets, macaws, and cockatiels, are the most common carriers of the infection. Other birds that may also spread *Chlamydia psittaci* include pigeons, doves, mynah birds, and turkeys. Birds that are carrying the organism may appear healthy, but can shed it in their feces. The symptoms of avian psittacosis include inactivity, loss of appetite and ruffled feathers,

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diarrhea, runny eyes and nasal discharge, and green or yellow-green urine. Sick birds can be treated with **antibiotics** by a veterinarian.

Chlamydia psittaci is usually spread from birds to humans through exposure to infected bird feces during cage cleaning or by handling infected birds. In humans, parrot fever ranges in severity from minor flu-like symptoms to severe and life-threatening pneumonia.

Causes and symptoms

Parrot fever is usually transmitted by inhaling dust from dried bird droppings or by handling infected birds. Humans can also spread the disease by person-to-person contact, but that is very rare. The symptoms usually develop within five to 14 days of exposure and include fever, **headache**, chills, loss of appetite, **cough**, and tiredness. In the most severe cases of parrot fever, the patient develops pneumonia. People who work in pet shops or who keep pet birds are the most likely individuals to become infected.

Diagnosis

Only 100–200 cases of parrot fever are reported each year in the United States. It is possible, however, that the illness is more common since it is easily confused with other types of **influenza** or pneumonia. Doctors are most likely to consider a diagnosis of parrot fever if the patient has a recent history of exposure to birds. The diagnosis can be confirmed by blood tests for antibodies, usually complement fixation or immunofluorescence tests. The organism is difficult to culture. A **chest x ray** may also be used to diagnose the pneumonia caused by *Chlamydia psittaci*.

Treatment

Psittacosis is treated with an antibiotic, usually tetracycline (Achromycin, Sumycin); doxycycline (Doxy, Vibramycin); or erythromycin (Eryc, Ilotycin). Oral medication is typically prescribed for at least 10–14 days. Severely ill patients may be given intravenous antibiotics for the first few days of therapy.

Prognosis

The prognosis for recovery is excellent; with antibiotic treatment, more than 99% of patients with parrot fever will recover. Severe infections, however, may be fatal to the elderly, untreated persons, and persons with weak immune systems.

KEY TERMS

Avian chlamydiosis—An illness in pet birds and poultry caused by *Chlamydia psittaci*. It is also known as parrot fever in birds.

***Chlamydia psittaci*—**An organism related to bacteria that infects some types of birds and can be transmitted to humans to cause parrot fever.

Chlamydiosis, psittacosis, or ornithosis—Other names for parrot fever in humans.

Prevention

There is no vaccine that is effective against parrot fever. Birds that are imported into the country as pets should be quarantined to ensure that they are not infected before they can be sold. Health authorities recommend that breeders and importers feed imported birds a special blend of feed mixed with antibiotics for 45 days to ensure that any *Chlamydia psittaci* organisms are destroyed. In addition, bird cages and food and water bowls should be cleaned daily.

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ORGANIZATIONS

Centers for Disease Control and Prevention, 1600 Clifton Rd., Atlanta, GA, 30333, (404) 639–3311, (800) 311–3435, http://www.cdc.gov.

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Partial birth abortion *see* **Abortion, partial birth**

Partial thromboplastin time

Definition

The partial thromboplastin time (PTT) test is a blood test that is done to investigate bleeding disorders and to monitor patients taking an anticlotting drug (heparin).

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KEY TERMS

Activated partial thromboplastin time—Partial thromboplastin time test that uses activators to shorten the clotting time, making it more useful for heparin monitoring.

Clotting factors—Substances in the blood that act in sequence to stop bleeding by forming a clot.

Coagulation—The process of blood clotting.

Coagulation cascade—The sequence of biochemical activities, involving clotting factors, that stop bleeding by forming a clot.

Common pathway—The pathway that results from the merging of the extrinsic and intrinsic pathways. The common pathway includes the final steps before a clot is formed.

Extrinsic pathway—One of three pathways in the coagulation cascade.

Heparin—A medication that prevents blood clots.

Intrinsic pathway—One of three pathways in the coagulation cascade.

Partial thromboplastin time—A test that checks the clotting factors of the intrinsic pathway.

Plasma—The fluid part of blood, as distinguished from blood cells.

Purpose

Diagnosis

Blood clotting (coagulation) depends on the action of substances in the blood called clotting factors. Measuring the partial thromboplastin time helps to assess which specific clotting factors may be missing or defective.

Monitoring

Certain surgical procedures and diseases cause **blood clots** to form within blood vessels. Heparin is used to treat these clots. The PTT test can be used to monitor the effect of heparin on a patient's coagulation system.

Precautions

Certain medications besides heparin can affect the results of the PPT test. These include **antihistamines**, vitamin C (ascorbic acid), **aspirin**, and chlorpromazine (Thorazine).

Description

When a body tissue is injured and begins to bleed, it starts a sequence of clotting factor activities called the coagulation cascade, which leads to the formation of a blood clot. The cascade has three pathways: extrinsic, intrinsic, and common. Many of the thirteen known clotting factors in human blood are shared by both pathways; several are found in only one. The PTT test evaluates the factors found in the intrinsic and common pathways. It is usually done in combination with other tests, such as the prothrombin test, which evaluate the factors of the extrinsic pathway. The combination of tests narrows the list of possible missing or defective factors.

Heparin prevents clotting by blocking certain factors in the intrinsic pathway. The PTT test allows a doctor to check that there is enough heparin in the blood to prevent clotting, but not so much as to cause bleeding. The test is done before the first dose of heparin or whenever the dosage level is changed; and again when the heparin has reached a constant level in the blood. The PTT test is repeated at scheduled intervals.

The PTT test uses blood to which a chemical has been added to prevent clotting before the test begins. About 5 mL of blood are drawn from a vein in the patient's inner elbow region. Collection of the sample takes only a few minutes. The blood is spun in a centrifuge, which separates the pale yellow liquid part of blood (plasma) from the cells. **Calcium** and activating substances are added to the plasma to start the intrinsic pathway of the coagulation cascade. The partial thromboplastin time is the time it takes for a clot to form, measured in seconds.

The test can be done without activators, but they are usually added to shorten the clotting time, making the test more useful for monitoring heparin levels. When activators are used, the test is called activated partial thromboplastin time or APTT.

Test results can be obtained in less than one hour. The test is usually covered by insurance.

Preparation

The doctor should check to see if the patient is taking any of the medications that may influence the test results. If the patient is on heparin therapy, the blood sample is drawn one hour before the next dose of heparin.

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Aftercare

Aftercare includes routine care of the puncture site. In addition, patients on heparin therapy must be watched for signs of spontaneous bleeding. The patient should not be left alone until the doctor or nurse is sure that bleeding has stopped. Patients should also be advised to watch for bleeding gums, bruising easily, and other signs of clotting problems; to avoid activities that might cause minor cuts or **bruises**; and to avoid using aspirin.

Risks

The patient may develop a bruise or swelling around the puncture site, which can be treated with moist warm compresses. People with coagulation problems may bleed for a longer period than normal.

Normal results

Normal results vary based on the method and activators used. Normal APTT results are usually between 25–40 seconds; PTT results are between 60–70 seconds. APTT results for a patient on heparin should be 1.5–2.5 times normal values. An APTT longer than 100 seconds indicates spontaneous bleeding.

Abnormal results

Increased levels in a person with a bleeding disorder indicate a clotting factor may be missing or defective. Further tests are done to identify the factor involved. **Liver disease** decreases production of factors, increasing the PTT.

Low levels in a patient on heparin indicate too little heparin is in the blood to prevent clots. High levels indicate too much heparin is present, placing the person at risk of excessive bleeding.

Resources

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Nancy J. Nordenson

Paruresis

Definition

The inability to urinate in the presence of others.

Description

Paruresis, also known as shy or bashful bladder, is the inability or difficulty to urinate in the presence of other people, when under time pressure, or on vehicles such as trains or airplanes. Urination is normal when those constraints or factors are absent, typically when in the bathroom at home. Research suggests up to 17 million Americans, 3.25 million Canadians, and 51 million Europeans suffer from the social **anxiety** disorder. Paruresis ranges in intensity from mild, in which the person can urinate in public facilities under certain circumstances, to severe, in which the person can only urinate when alone at home. The condition almost exclusively affects males although it can occur in females.

Paruresis can be socially disabling and can often completely take over a person's life. Examples include avoiding travel, social functions, and sports arenas. Just as serious are the psychological consequences, such as depression, and anxiety. Job choices and career decisions are often adversely affected. People with the condition often avoid jobs where there is mandatory drug testing done by the supervised collection of a urine sample.

Causes and symptoms

Paruretics (people who suffer from paruresis) commonly refer to three triggers that influence them when in public restrooms. For the typical paruretic, these triggers must be removed, or the person must try another toilet, for urination to occur on a particular occasion. First, the condition occurs much more frequently when strangers are present in the restroom as opposed to friends or relatives. Second, proximity plays a role in the problem. Proximity for the paruretic is both physical, involving the relative closeness of others in or near the restroom, and psychological, involving the need for privacy. The most frequent complaint about physical stimuli in public facilities is the absence of suitable partitions and doors on urinals or stalls. Third, temporary psychological states, especially anxiety, anger, and fear can interfere with urination.

Diagnosis

The condition is diagnosed on the basis of the sufferer's account of their symptoms. In severe cases,

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sufferers can waste considerable time waiting for everyone else to leave the toilet before they can urinate, and might totally avoid urinating in public toilets. The condition is usually self-diagnosed when any or all of the three main triggers of paruresis are present and the condition is chronic.

Treatment

The most well documented current treatment is based upon **cognitive-behavioral therapy**, of which the aim is to reorganize the "abnormal" emotional schemes arising from the anxiety generating elements that trigger this problem. This can be done individually in a self-help situation, in a support group, or through **psychotherapy** with a psychologist or psychiatrist.

Therapy includes three separate but linked components:

- Cognitive—An attempt to modify the abnormal thoughts and ideas around the object of anxiety, such as the thought, "When I use a toilet, everybody looks at me and wonders what I'm doing."
- Behavioral—Step by step desensitization by very gradual exposure to the feared situation, the aim being to achieve a series of small successes, and thus reassure the subconscious mind that it is "safe" to urinate in a situation that previously led to panic and failure. This can be thought of as relearning urination in a social situation.
- Relaxation—Learning techniques that facilitate relaxation, both mental and physical, such as sphincter relaxation exercises.

Drug treatments, usually with medications used to treat benign prostate hyperplasia (BPH), an enlargement of the prostate gland, such as *terazosin* (Hytrin), *tamsulosin* (Flomax), and *alfuzosin* (Uroxatral) are the subject of much debate and usually produce poor results.

Alternative treatment

One possible alternative medicine treatment is **saw palmetto**, used to treat urinary problems in men with BPH, an enlargement of the prostate gland. BPH results in a swelling of the prostate gland that obstructs the urethra. This causes painful urination, reduced urine flow, difficulty starting or stopping the flow, dribbling after urination, and more frequent nighttime urination. A typical dose is 320 mg per day of standardized extract. It may take up to four weeks of use before beneficial effects are seen.

KEY TERMS

Benign prostate hyperplasia (BPH)—Enlargement of the prostate gland.

Psychotherapy—The treatment of mental disorders by psychological methods, usually by a psychiatrist or psychologist.

Sphincter—A circular band of muscle that surrounds an opening or passage in the body and narrows or closes the opening by contracting.

Urethra—The tube in humans that carries urine from the bladder out of the body.

Prognosis

Most people who suffer from the condition never seek help or treatment. Many never even discuss the problem with anyone. But anecdotal evidence suggests that those who do seek help have a good success rate at overcoming their fear or anxiety over time, sometimes a year or longer.

Prevention

There is no known way to prevent a person from developing paruresis. Anecdotal evidence suggests it often does not occur until around the age of **puberty**. One suggestion for prevention is to condition children from an early age to urinate in public restrooms.

Resources

PERIODICALS

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International Paruresis Association, P.O. Box 65111, Baltimore, MD, 21209, (410) 367-1253, (410) 367-1254, (800) 247-3864, http://www.paruresis.org/.

Ken R. Wells

Parvovirus B19 infection *see* **Fifth disease**

Pasteurellosis *see* **Animal bite infections**

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Patau syndrome

Definition

Patau syndrome, also called trisomy 13, is a congenital (present at birth) disorder associated with the presence of an extra copy of chromosome 13. The extra chromosome 13 causes numerous physical and mental abnormalities, especially heart defects. Patau syndrome is named for Dr. Klaus Patau, who reported the syndrome and its association with trisomy in 1960. It is sometimes called Bartholin-Patau syndrome, named in part for Thomas Bartholin, a French physician who described an infant with the syndrome in 1656.

Description

Children normally inherit 23 chromosomes from each parent, for a total of 46 chromosomes. A typical human being has 46 chromosomes: 22 pairs of non-sex linked chromosomes and one pair of sex-linked chromosomes, that determine that child's sex. Sometimes a child may end up with more than 46 chromosomes because of problems with the father's sperm or the mother's egg; or, because of mutations that occurred after the sperm and the egg fused to form the embryo (conception).

Normally, there are two copies of each of the 23 chromosomes: one from each parent. A condition called trisomy occurs when three, instead of two, copies of a chromosome are present in a developing human embryo. An extra copy of a particular chromosome can come either from the egg or sperm, or because of mutations that occur after conception.

The best-known trisomy-related disorder is **Down syndrome** (trisomy 21), in which the developing embryo has an extra copy of chromosome 21. Patau syndrome is trisomy 13, in which the developing embryo has three copies of chromosome 13.

An extra copy of chromosome 13 is not the only cause of Patau syndrome. Other changes in chromosome 13, such as mispositioning (translocation), can also result in the characteristics classified as Patau syndrome. In these cases, an error occurs that causes a portion of chromosome 13 to be exchanged for a portion of another chromosome. There is no production of extra chromosomes, but a portion of each affected chromosome is "misplaced" (translocated) to another chromosome.

Patau syndrome causes serious physical and mental abnormalities including: heart defects; incomplete brain development; such unusual facial features as a sloping forehead, a smaller than average head (microcephaly), small or missing eyes, low-set ears, and **cleft palate** or hare lip; extra fingers and toes (**polydactyly**); abnormal genitalia; spinal defects; seizures; gastrointestinal hernias, particularly at the navel (omphalocele); and **mental retardation**. Due to the severity of these conditions, fewer than 20% of those affected with Patau syndrome survive beyond infancy. Most infants with the syndrome die within the first three months of life; the average life expectancy of the survivors is about 10 years.

Genetic profile

When an extra copy (trisomy) of a chromosome is made, it may either be a total trisomy (in which an extra copy of the entire chromosome is made), or partial trisomy (in which only one part of the chromosome is made an extra time).

In most cases of trisomy, errors in chromosome duplication occur at conception because of problems with the egg or the sperm that are coming together to produce an offspring. In these cases, every cell in the body of the offspring has an extra copy of the affected chromosome. However, errors in chromosome duplication may also occur during the rapid cell division that takes place immediately after conception. In these cases, only some cells of the body have the extra chromosome error. The condition in which only some of the cells in the body have the extra chromosome is called mosaicism.

Seventy-five to 80 percent of the cases of Patau syndrome are caused by a trisomy of chromosome 13. Some of these cases are the result of a total trisomy, while others are the result of a partial trisomy. Partial trisomy generally causes less severe physical symptoms than full trisomy. Ten percent of these cases are of the mosaic type, in which only some of the body's cells have the extra chromosome. The physical symptoms of the mosaic form of Patau syndrome depends on the number and type of cells that carry the trisomy.

Most cases of trisomy are not passed on from one generation to the next. Usually they result from a malfunction in the cell division (mitosis) that occurs after conception. At least 75% of the cases of Patau syndrome are caused by errors in chromosome replication that occur after conception. The remaining 25% are caused by the inheritance of translocations of chromosome 13 with other chromosomes within the parental chromosomes. In these cases, a portion of another chromosome switches places with a portion of chromosome 13. This leads to errors in the genes on

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both chromosome 13 and the chromosome from which the translocated portion originated.

Patau syndrome occurs in approximately one in 8,000–12,000 live births in the United States. In many cases, spontaneous abortion (**miscarriage**) occurs and the fetus does not survive to term. In other cases, the affected individual is stillborn. As appears to be the case in all trisonomies, the risks of Patau syndrome seem to increase with the mother's age, particularly if she is over 30 when pregnant. Male and female children are equally affected, and the syndrome occurs in all races and ethnic groups. Females with Patau syndrome, however, have a better chance of surviving past infancy than males.

Causes and symptoms

The severity and symptoms of Patau syndrome vary with the type of chromosomal anomaly, from extremely serious conditions to nearly normal appearance and functioning.

Full trisomy 13, which is present in the majority of the cases, results in the most severe and numerous internal and external abnormalities. Commonly, the forebrain fails to divide into lobes or hemispheres (holoprosencephaly) and the entire head is unusually small (microcephaly). The spinal cord may protrude through a defect in the vertebrae of the spinal column (myelomeningocele). Children who survive infancy have profound mental retardation and may experience seizures. In a few rare cases Patau syndrome may coexist with Klinefelter's syndrome or other chromosomal abnormalities.

Incomplete development of the optic (sight) and olfactory (smell) nerves often accompany the brain defects described above. The eyes may be unusually small (**microphthalmia**) or one eye may be absent (**anophthalmia**). The eyes are sometimes set close together (hypotelorism) or even fused into a single structure. Incomplete development of any structures in the eye (coloboma) or failure of the retina to develop properly (retinal dysplasia) will also produce vision problems. Patau syndrome affected individuals may be born either partially or totally deaf and many are subject to recurring ear infections.

The facial features of many Patau syndrome-affected individuals appear flattened. The ears are generally malformed and lowset. Frequently, a child with trisomy 13 has a **cleft lip**, a cleft palate, or both. Other physical characteristics include loose folds of skin at the back of the neck, extra fingers or toes (polydactyly), permanently flexed (closed) fingers (camptodactyly), noticeably prominent heels, "rocker-bottom foot," and missing ribs. Genital malformations are common in individuals affected with Patau syndrome and include undescended testicles (cryptorchidism), an abnormally developed scrotum, and ambiguous genitalia in males, or an abnormally formed uterus (bicornuate uterus) in females.

In nearly all cases, Patau syndrome affected infants have respiratory difficulties and heart defects, including atrial and ventricular septal defects (holes between chambers of the heart); malformed ducts that cause abnormal direction of blood flow (**patent ductus arteriosus**); holes in the valves of the lungs and the heart (pulmonary and aortic valves); and misplacement of the heart in the right, rather than the left, side of the chest (dextrocardia). The kidneys and gastrointestinal system may also be affected with cysts similar to those seen in **polycystic kidney disease**. These defects are frequently severe and life-threatening.

Partial trisomy of the distal segment of chromosome 13 results in generally less severe, but still serious, symptoms and a distinctive facial appearance including a short upturned nose, a longer than usual area between the nose and upper lip (philtrum), bushy eyebrows, and tumors made up of blood capillaries on the forehead (frontal capillary hemangiomata). Partial trisomy of the proximal segment of chromosome 13 is much less likely to be fatal and has been associated with a variety of facial features including a large nose, a short upper lip, and a receding jaw. Both forms of partial trisomy also result in severe mental retardation.

Beyond one month of age, other symptoms that are seen in individuals with Patau syndrome are: feeding difficulties and **constipation**, reflux disease, slow growth rates, curvature of the spine (**scoliosis**), irritability, sensitivity to sunlight, low muscle tone, high blood pressure, sinus infections, urinary tract infections, and ear and eye infections.

Diagnosis

Patau syndrome is detectable during **pregnancy** through the use of ultrasound imaging, **amniocentesis**, and **chorionic villus sampling** (CVS). At birth, the newborn's numerous malformations indicate a possible chromosomal abnormality. Trisomy 13 is confirmed by examining the infant's chromosomal pattern through karyotyping or another procedure. Karyotyping involves the separation and isolation of the chromosomes present in cells taken from an individual. These cells are generally extracted from cells found in a blood sample. The 22 non-sex linked chromosomes are identified by size, from largest to smallest, as chromosomes 1 through 22. The sex-determining chromosomes are also

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KEY TERMS

Amniocentesis—A procedure performed at 16–18 weeks of pregnancy in which a needle is inserted through a woman's abdomen into her uterus to draw out a small sample of the amniotic fluid from around the baby. Either the fluid itself or cells from the fluid can be used for a variety of tests to obtain information about genetic disorders and other medical conditions in the fetus.

Chorionic villus sampling (CVS)—A procedure used for prenatal diagnosis at 10–12 weeks gestation. Under ultrasound guidance a needle is inserted either through the mother's vagina or abdominal wall and a sample of cells is collected from around the fetus. These cells are then tested for chromosome abnormalities or other genetic diseases.

Chromosome—A microscopic thread-like structure found within each cell of the body consisting of a complex of proteins and DNA. Humans have 46 chromosomes arranged into 23 pairs. Changes in either the total number of chromosomes or their shape and size (structure) may lead to physical or mental abnormalities.

Karyotyping—A laboratory procedure in which chromosomes are separated from cells, stained, and arranged so that their structure can be studied under the microscope.

Mosaicism—A genetic condition resulting from a mutation, crossing over, or nondisjunction of chromosomes during cell division, causing a variation in the number of chromosomes in the cells.

Translocation—The transfer of one part of a chromosome to another chromosome during cell division. A balanced translocation occurs when pieces from two different chromosomes exchange places without loss or gain of any chromosome material. An unbalanced translocation involves the unequal loss or gain of genetic information between two chromosomes.

Trisomy—The condition of having three identical chromosomes instead of the normal two in a cell.

Ultrasound—An imaging technique that uses sound waves to help visualize internal structures in the body.

identified. The diagnosis of Patau syndrome is confirmed by the presence of three, rather than the normal two, copies of the thirteenth largest chromosome.

A newer method of diagnosing trisomies that has the advantages of speed and lower cost is the quantitative fluorescent PCR (QF-PCR) assay. QF-PCR testing allows a doctor to determine the presence of a chromosomal abnormality within 24 hours with a very high degree of accuracy.

Treatment

Some infants born with Patau syndrome have severe and incurable **birth defects**. However, children with better prognoses require medical treatment to correct structural abnormalities and associated complications. For feeding problems, special formulas, positions, and techniques may be used. Tube feeding or the placement of a gastric tube (**gastrostomy**) may be required. Structural abnormalities such as cleft lip and cleft palate can be corrected through surgery. Special **diets**, **hearing aids**, and vision aids can be used to mitigate the symptoms of Patau syndrome. **Physical therapy**, **speech therapy**, and other types of developmental therapy will help the child reach his or her potential.

Since the translocation form of Patau syndrome is genetically transmitted, **genetic counseling** for the parents should be part of the management of the disease.

Prognosis

Approximately 45% of trisomy 13 babies die within their first month of life; up to 70% in the first six months; and over 70% by one year of age. Survival to adulthood is very rare. Only one adult is known to have survived to age 33.

Most survivors have profound mental and physical disabilities; however, the capacity for learning in children with Patau syndrome varies from case to case. Older children may be able to walk with or without a walker. They may also be able to understand words and phrases, follow simple commands, use a few words or signs, and recognize and interact with others.

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National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923, (800) 999-6673, http://www.rarediseases.org.

Rainbows Down Under—A Trisomy 18 and Trisomy 13 Resource. SOFT Australia., 198 Oak Road, Kirrawee, Australia, NSW 2232, 029521-6031, SOFTAus@optushome.com.au, http://members.optushome.com.au.

Support Organization for Trisomy 18, 13, and Related Disorders (SOFT), 2982 South Union Street, Rochester, NY, 14624, (585) 594-4621, (800) 716-7638, barbsoft@rochester.rr.com, http://www.trisomy.org.

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Patent ductus arteriosus

Definition

Patent ductus arteriosus (PDA) is a heart defect that occurs when the ductus arteriosus (the temporary fetal blood vessel that connects the aorta and the pulmonary artery) does not close at birth.

Description

The ductus arteriosus is a temporary fetal blood vessel that connects the aorta and the pulmonary artery before birth. The ductus arteriosus should be present and open before birth while the fetus is developing in the uterus. Since oxygen and nutrients are received from the placenta and the umbilical cord instead of the lungs, the ductus arteriosus acts as a "short cut" that allows blood to bypass the deflated lungs and go straight out to the body. After birth, when the lungs are needed to add oxygen to the blood, the ductus arteriosus normally closes. The closure of the ductus arteriosus ensures that blood goes to the lungs to pick up oxygen before going out to the body. Closure of the ductus arteriosus usually occurs at birth as levels of certain chemicals, called prostagladins, change and the lungs fill with air. If the ductus arteriosus closes correctly, the blood pumped from the heart goes to the lungs, back into the heart, and then out to the body through the aorta. The blood returning from the lungs and moving out of the aorta carries oxygen to the cells of the body.

In some infants, the ductus arteriosus remains open (or patent) and the resulting heart defect is known as patent ductus arteriosus. In most cases, a small PDA does not result in physical symptoms. If the PDA is larger, health complications may occur.

In an average individual's body, the power of blood being pumped by the heart and other forces leads to a certain level of pressure between the heart and lungs. The pressure between the heart and lungs of an individual affected by PDA causes some of the oxygenated blood that should go out to the body (through the aorta) to return back through the PDA into the pulmonary artery. The pulmonary artery takes the blood immediately back to the lungs. The recycling of the already oxygenated blood forces the heart to work harder as it tries to supply enough oxygenated blood to the body. In this case, usually the left side of the heart grows larger as it works harder and must contain all of the extra blood moving back into the heart. This is know as a left-to-right or aortic-pulmonary shunt.

As noted, the size of the PDA determines how much harder the heart has to work and how much bigger the heart becomes. If the PDA is large, the bottom left side of the heart is forced to pump twice as much blood because it must supply enough blood to recycle back to the lungs and move out to the body. As the heart responds to the increased demands for more oxygenated blood by pumping harder, the pulmonary artery has to change in size and shape in order to adapt to the increased amount and force of the blood. In some cases, the increase in size and shape changes the pressure in the pulmonary artery and lungs. If the pressure in the lungs is higher than that of the heart

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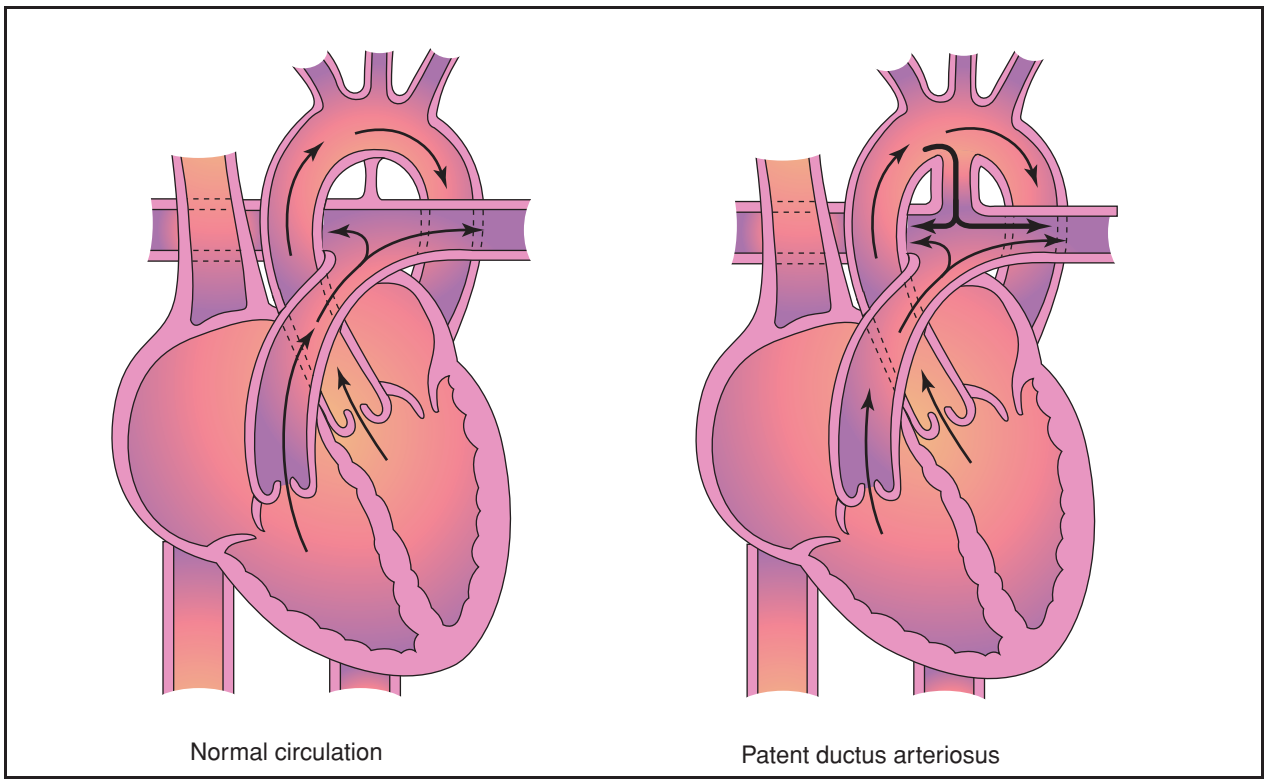

Patent ductus arteriosus (PDA) is the failure of the ductus arteriosus to close after birth, allowing blood to inappropriately flow from the aorta into the pulmonary artery. *((Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

and body, blood returning to the heart will take the short cut back into the aorta from the pulmonary artery through the PDA instead of going to the lungs. This backward flowing of blood does not carry much oxygen. If blood without much oxygen is being delivered to the body, the legs and toes will turn blue or cyanotic. This is called a shunt reversal.

When a PDA results in a large amount of blood being cycled in the wrong order, either through a left-to-right shunt or shunt reversal, the overworked, enlarged heart may stop working (congestive **heart failure**) and the lungs can become filled with too much fluid (**pulmonary edema**). At this time, there is also an increased risk for a bacterial infection that can inflame the lining of the heart (**endocarditis**). These three complications are very serious.

PDA is a very common heart defect. Though an exact incidence of PDA is difficult to determine, one review in 1990 found that approximately 8% of live births were found to be affected by PDA. PDA can occur in full-term infants, but it seen most frequently in preterm infants, infants born at a high altitude, and babies whose mothers were affected by the German **measles** (**rubella**) during **pregnancy**. PDA is two to three times more common in females than males. PDA occurs in individuals of every ethnic origin and does not occur more frequently in any one country or ethnic population.

Causes and symptoms

PDA can be a result of an environmental exposure before birth, inheriting a specific changed or mutated gene or genes, a symptom of a genetic syndrome, or be caused by a combination of genetic and environmental factors (multifactorial).

Environmental exposures that can increase the chance for a baby to be affected by PDA include fetal exposure to rubella before birth, preterm delivery, and birth at a high altitude location.

PDA can be an inherited condition running in families as isolated PDA or part of a genetic syndrome. In either case, there are specific gene changes or mutations which lead to a defect in the elastic tissue forming the walls of the ductus arteriosus. The genes causing isolated PDA have not been identified, but it is

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KEY TERMS

Aorta—The main artery located above the heart which pumps oxygenated blood out into the body. Many congenital heart defects affect the aorta.

Catheterization—The process of inserting a hollow tube into a body cavity or blood vessel.

Ductus arteriosus—The temporary channel or blood vessel between the aorta and pulmonary artery in the fetus.

Echocardiograph—A record of the internal structures of the heart obtained from beams of ultrasonic waves directed through the wall of the chest.

Electrocardiogram (ECG, EKG)—A test used to measure electrical impulses coming from the heart in order to gain information about its structure or function.

Endocarditis—A dangerous infection of the heart valves caused by certain bacteria.

Oxygenated blood—Blood carrying oxygen through the body.

Pulmonary artery—An artery that carries blood from the heart to the lungs.

Pulmonary edema—A problem caused when fluid backs up into the veins of the lungs. Increased pressure in these veins forces fluid out of the vein and into the air spaces (alveoli). This interferes with the exchange of oxygen and carbon dioxide in the alveoli.

known that PDA can be inherited through a family in an autosomal dominant pattern or an autosomal recessive pattern.

Every person has approximately 30,000 genes, which tell our bodies how to grow and develop correctly. Each gene is present in pairs since one is inherited from our mother, and one is inherited from our father. In an autosomal dominant condition, only one specific changed or mutated copy of the gene for PDA is necessary for a person to have PDA. If a parent has an autosomal dominant form of PDA, there is a 50% chance for each child to have the same or similar condition.

PDA can also be inherited in an autosomal recessive manner. A recessive condition occurs when a child receives two changed or mutated copies of the gene for a particular condition, such as PDA (one copy from each parent). Individuals with a single changed or mutated copy of a gene for a recessive condition, are known as "carriers," and have no health problems related to the condition. In fact, each of us carries between five and 10 genes for harmful, recessive conditions. However, when two people who each carry a changed or mutated copy of the same gene for a recessive condition meet, there is a chance, with each pregnancy, for the child to inherit the two changed or mutated copies from each parent. In this case, the child would have PDA. For two known carriers, there is a 25% risk with each child to have a child with PDA, a 50% chance to have a child who is a carrier, and a 25% chance to have a child who is neither affected nor a carrier.

Most cases of PDA occur as the result of multifactorial inheritance which is caused by the combination of genetic factors and environmental factors. The combined factors lead to isolated defects in the elastic tissue forming the walls of the ductus arteriosus. Family studies can provide different recurrence risks depending on the family member affected by multifactorial PDA. If an individual is affected by isolated, multifactorial PDA, they have a 2–4% chance of having a child affected by PDA. If a couple has one child with isolated, multifactorial PDA, there is a 3% chance that another of their children could be affected by PDA. If a couple has two children affected by isolated, multifactorial PDA, there is a 10–25% chance that they could have another child affected by PDA.

Unless a specific pattern of inheritance, preterm delivery, or known exposure is found through the examination of a detailed pregnancy and family history, the multifactorial family studies are used to estimated the possible risk of recurrence of PDA in a family.

The main sign of PDA is a constant heart murmur that sounds like the hum of a refrigerator or other machinery. This murmur is usually heard by the doctor using a stethoscope. Otherwise, there are no specific symptoms of PDA, unless the ductus arteriosus size is large. Children and adults with a large ductus arteriosus can show difficulty in breathing during moderate physical **exercise**, an enlarged heart, and failure to gain weight. In some cases, heart failure and pulmonary congestion can indicate a PDA.

Diagnosis

Diagnosis is most often made by detecting the characteristic "machinery" heart murmur heard by a

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doctor through a stethoscope. Tests such as a **chest x ray**, echocardiograph, and ECG are used to support the initial diagnosis. Other indications of PDA include failure to gain weight, frequent chest infections, heavy breathing during mild physical exertion, congestive heart failure, and pulmonary **edema**. Prenatal ultrasounds are unable to detect PDA because the heart defect does not occur until the time of birth.

Treatment

The treatment and management of PDA depends upon the size of the PDA and symptoms being experienced by the affected individual. In some cases, a PDA can correct itself in the first months of life. In preterm infants experiencing symptoms, the first step in correcting a PDA is treatment through medications such as indomethacin. In preterm infants whose PDA is not closed through medication, full term infants affected by PDA, and adults, surgery is an option for closing the ductus arteriosus. In 2000 and 2001, researchers developed and reviewed alternatives to surgical closure such as interventional **cardiac catheterization** and video-assisted thorascopic surgical repair. A cardiologist can help individuals determine the best method for treatment based on their physical symptoms and medical history.

Prognosis

Adults and children can survive with a small opening remaining in the ductus arteriosus. Treatment, including surgery, of a larger PDA is usually successful and frequently occurs without complications. Proper treatment allows children and adults to lead normal lives.

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American Society of Cataract and Refractive Surgery, 2112 North Wilkins Road, Swanton, OH, 43558, (419) 825-5575, (419) 825-2880, CHASER@compuserve.com, http://www.csun.edu.

Kids With Heart, National Association for Children's Heart Disorders, Inc., P.O. Box 12504, Green Bay, WI, 54307-2504, (920) 498-0058, (800) 538-5390, michelle@kidswithheart.org, http://www.kidswithheart.org/.

Dawn A. Jacob

PCV *see* **Hematocrit**

Pediculosis *see* **Lice infestation**

Pedophilia *see* **Sexual perversions**

Pellagra

Definition

Pellagra is a disorder brought on by a deficiency of the nutrient called niacin or nicotinic acid, one of the B-complex **vitamins**.

Description

Nicotinic acid plays a crucial role in the cellular process called respiration. Respiration is the process by which nutrients (specifically sugar, or glucose) and oxygen are taken in, chemical reactions take place, energy is produced and stored, and carbon dioxide and wastes are given off. This process is absolutely central to basic cell functioning, and thus the functioning of the body as a whole.

Niacin is a B vitamin found in such foods as yeast, liver, meat, fish, whole-grain cereals and breads, and legumes. Niacin can also be produced within the body from the essential amino acid called tryptophan. Dietary requirements for niacin depend on the age, gender, size, and activity level of the individual. Niacin requirements range from 5 mg in infants up to 20 mg in certain adults.

Causes and symptoms

Pellagra can be either primary or secondary. Primary pellagra results when the diet is extremely deficient in niacin-rich foods. A classic example occurs in geographic locations where Indian corn (maize) is the dietary staple. Maize does contain niacin, but in a form which cannot be absorbed from the intestine (except when it has been treated with alkali, as happens in the preparation of tortillas). People who rely on maize as their major food source often develop pellagra. Pellagra can also occur when a hospitalized patient, unable to eat for a very prolonged period of time, is given fluids devoid of vitamins through a needle in the vein (intravenous or IV fluids).

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Secondary pellagra occurs when adequate quantities of niacin are present in the diet, but other diseases or conditions interfere with its absorption and/or processing. This is seen in various diseases that cause prolonged **diarrhea**, with **cirrhosis** of the liver and **alcoholism**, with long-term use of the anti-tuberculosis drug called isoniazid, in patients with malignant carcinoid tumor, and in patients suffering from **Hartnup disease** (an inherited disorder which results in disordered absorption of amino acids from the intestine and kidney).

Pellagra causes a variety of symptoms affecting the skin; mucous membranes (moist linings of the mouth, organs, etc.); central nervous system (including the brain and nerves); and the gastrointestinal system. The classic collection of symptoms includes redness and swelling of the mouth and tongue, diarrhea, skin rash, and abnormal mental functioning, including **memory loss**. While early patients may simply have a light skin rash, over time the skin becomes increasingly thickened, pigmented, and may slough off in places. Areas of the skin may become prone to bacterial infection. The mouth and tongue, and sometimes the vagina, become increasingly thick, swollen, and red. Abdominal **pain** and bloating occur, with **nausea and vomiting**, and bloody diarrhea to follow. Initial mental changes appear as inability to sleep (**insomnia**), **fatigue**, and a sense of disconnectedness (apathy). These mental changes progress to memory loss, confusion, depression, and **hallucinations** (in which the individual sees sights or hears sounds that do not really exist). The most severe states include stiffness of the arms and legs, with resistance to attempts to move the limbs; variations in level of consciousness; and the development of involuntary sucking and grasping motions. This collection of symptoms is called "encephalopathic syndrome."

Diagnosis

Diagnosis is purely based on the patient's collection of symptoms, together with information regarding the patient's diet. When this information points to niacin deficiency, replacement is started, and the diagnosis is then partly made by evaluating the patient's response to increased amounts of niacin. There are no chemical tests available to definitively diagnose pellagra.

Treatment

Treatment of pellagra usually involves supplementing the individual's diet with a form of niacin called niacinamide (niacin itself in pure supplementation form causes a number of unpleasant side effects, including sensations of **itching**, burning, and flushing). The niacinamide can be given by mouth (orally) or by injection (when diarrhea would interfere with its absorption). The usual oral dosage is 300–500 mg each day; the usual dosage of an injection is 100–250 mg, administered two to three times each day. When pellagra has progressed to the point of the encephalopathic syndrome, a patient will require 1,000 mg of niacinamide orally, and 100–250 mg of niacinamide by injection. Once the symptoms of pellagra have subsided, a maintenance dose of niacin can be calculated, along with attempting (where possible) to make appropriate changes in the diet. Because many B-complex vitamin deficiencies occur simultaneously, patients will usually require the administration of other B-complex vitamins as well.

KEY TERMS

Niacinamide—A form of niacin, which is usually used as a dietary supplement for people with insufficient niacin.

Respiration—Respiration is the process by which nutrients (specifically sugar, or glucose) and oxygen are taken in to a cell; chemical reactions take place; energy is produce and stored; and carbon dioxide and wastes are given off.

Prognosis

Untreated pellagra will continue progressing over the course of several years, and is ultimately fatal. Often, **death** is due to complications from infections, massive **malnutrition** brought on by continuous diarrhea, blood loss due to bleeding from the gastrointestinal tract, or severe encephalopathic syndrome.

Prevention

Prevention of pellagra is completely possible; what is required is either a diet adequate in niacin-rich foods, or appropriate supplementation. However, in many geographic locations in the world such foods are unavailable to the general population, and pellagra becomes an unavoidable complication of poverty.

ORGANIZATIONS

American Dietetic Association, 120 S. Riverside Plaza, Suite 2000, Chicago, IL, 60606-6995, (312) 899-0040, (800) 877-1600, http://www.eatright.org/.

Rosalyn Carson-DeWitt, MD

Pelvic endoscopy *see* **Laparoscopy**

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Pelvic exam

Definition

A pelvic examination is a routine procedure used to assess the well being of the female patient's lower genito-urinary tract. This is done as part of a usual health screening and prevention tool, and is an element of the total health care for the female patient.

Purpose

Pelvic exams are useful as a screening tool for **sexually transmitted diseases** such as **gonorrhea**, chlamydia, **genital warts**, herpes, and **syphilis**. In addition, exams detect some forms of **cancer** that may affect the genitalia. By analyzing the cervical region with a Papanicolaou or Pap smear, clinicians are able to look for signs of **cervical cancer**. The American Cancer Society and the American College of Obstetricians and Gynecologists recommend pelvic exams with Pap tests for women starting at age 18. It is also recommended that exams start earlier if the teenager requests oral **contraception**. Pap smears should continue once yearly for three years and at the physicians discretion following this time. Various groups differ in opinions on when to discontinue screening for cervical cancer, however, the United States Preventative Services Task Force recommends screening continue until age 65 if the patient has not had previous abnormal results. Women who have undergone a total **hysterectomy** for reasons other than cervical cancer do not need to be screened.

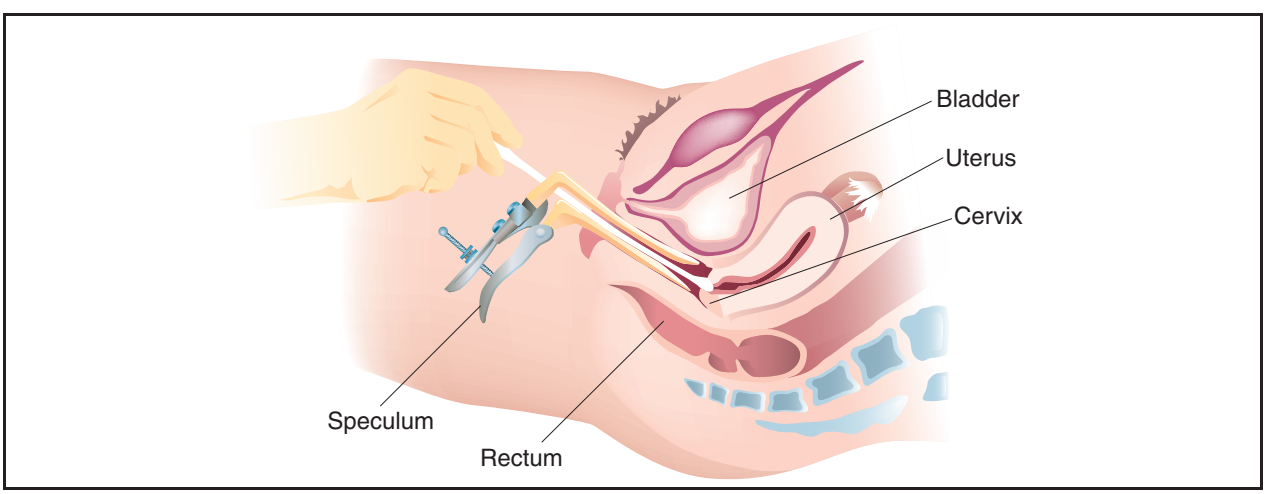
Precautions

Pelvic examinations are safe procedures, thus no precautions are necessary.

Description

The first part of the examination involves visual inspection and palpation of the external genitalia. The examiner will note the characteristics of the labia majora, labia minora, clitoris, urethral orifice, and the Skene's and Bartholin's glands. In addition, the perineum and anus will be checked. The clinician will be examining these areas for any indication of swelling, inflammation, abnormal discharge, polyps, abnormal odor, or other lesions.

The next part involves examining the internal genitalia. The examiner will first insert a gloved finger into the vagina in order to palpate the cervix. Next an instrument called a speculum is inserted. This device is made of plastic or metal and used to open the vaginal cavity in order for the examiner to be able to view the vaginal walls and cervix. Any lesions, bleeding, or abnormal discharge can be visualized with the speculum in place. If indicated, a Pap smear will then be performed. With the speculum still in place, the examiner gently scrapes the patient's cervix with a wooden or plastic spatula as well as a cylindrical-type brush. The spatula collects cells from the outer surface of the cervix, while the brush is used to collect cells from the inner-cervix. The collected cells are then spread on a glass slide, sprayed with a fixative, and sent to a laboratory for analysis. The examiner may then insert a cotton or Dacron swab



During a pelvic exam, cells from the cervix are scraped on a spatula and are tested for abnormalities. *((Illustration by Argosy, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

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KEY TERMS

Bacterial vaginitis—This is the term for inflammation of the vagina due to a bacterial infection.

Bartholin's glands—These glands are embedded in the vestibule of the vagina and function to maintain moisture.

Cervical dysplasia—Dysplasia is the abnormal growth of the epithelial cells. This is what a Pap smear will detect in the cervix.

Colposcopy—This procedure is done when a Pap smear reveals abnormal results. With an endoscope placed through the vagina and into the cervix, a physician can determine exactly where lesions of the cervix are.

Hematoma—Hematomas are masses of blood (or clotted blood) that accumulate in tissues and may result from trauma.

Myoma—These are benign (non-malignant) tumors of the uterus.

Papanicolaou or Pap smear—This is a screening test for cancer of the cervix. Cells are scraped from the cervix, smeared on a glass plate, and sent to a laboratory to examine for any abnormal cells or dysplasia. This test may also detect other cells seen in certain vaginal infections.

Skene's glands—These are the glands of the female urethra.

Speculum—A speculum is an instrument that is used during the internal genitalia examination. It can be made of plastic or metal and is used to open up the vaginal cavity in order for the examiner to view the walls of the vagina and the cervix.

Urethral meatus—This is the external opening of the urethra.

into the cervix. This will be held in place for 10–30 seconds and when withdrawn spread on a plastic plate or into a tube containing a reagent for the specimen. This procedure may be repeated again with the anus. Such swab tests are used to check for gonorrhea and chlamydia, or bacterial vaginitis, which is a bacterial infection resulting in inflammation of the vagina.

Following the Pap smear is the bimanual examination during which the examiner will place an index and middle finger into the vagina to first examine the vaginal walls for any irregularities or tenderness. The cervix will then be palpated in order to note its shape, consistency, mobility, and any tenderness. The examiner will then place his or her other hand on the abdomen and gently push down while pushing the cervix up. This is done to assess the size and shape of the uterus, and also to note any tenderness or abnormal lesions. During this time, the ovaries are also checked for any masses, or tenderness.

The last part of the pelvic exam is the rectovaginal examination. This allows the clinician to better examine the pelvic organs and structures. The examiner will place their index finger into the vagina and a lubricated, gloved middle finger against the anus. During this part, the patient may feel an urgency to have a bowel movement. However, this is a natural feeling and a bowel movement will not occur. The patient will then be asked to strain down in order for the anal sphincter to relax. As relaxation occurs the examiner will insert the middle finger into the rectum, enabling the position and shape of the uterus to be better assessed. In addition, any masses or tenderness can be evaluated at this point. The anal canal and rectum can also be examined for any polyps, or other lesions at this time. After the rectovaginal exam, the patient will be allowed clean off any excess lubricant and get dressed. The examiner will then discuss the procedure and any findings with the patient.

Preparation

Pelvic exams require the patient to void prior to starting, as a full bladder can add to discomfort and make palpation difficult for the examiner. Even though some tests cannot be done on a menstruating patient, an examination can still be performed. Any tampons should be removed prior to the exam. Douching is not recommended before an exam due to the hazard of washing away cells that are needed for examination. If a Pap smear is to be done, the patients should also refrain from sexual intercourse or using vaginal suppositories for 24 to 48 hours prior to the exam. The patient will be asked to undress and put on a gown. The examiner will instruct the patient to lie on the examination table on her back and may assist her in putting her feet in stirrups. The buttocks are then slid to the edge of the table in order for a full view of the area to be examined.

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Aftercare

Even with the invasiveness of this procedure, the patient should be able to immediately resume normal daily activities.

Risks

Other than minor discomfort, there are no risks associated with a routine pelvic examination.

Normal results

No significant findings by the examiner indicate a normal pelvic examination. The external and internal genitalia will be free of any lesions or abnormal discharge. The Pap smear will not reveal cervical dysplasia or abnormal tissue development, and there will not be any abnormal masses or tenderness upon palpation.

Abnormal results

The examiner may discover abnormal lesions during the course of the exam that may require additional tests. Ulcerations, bumps, sores, blisters, or vesicles on the external genitalia may be signs of a sexually transmitted disease. Some of the sexually transmitted diseases that may cause lesions to the external genitalia include venereal **warts**, syphilis, and **genital herpes**. Gonorrhea or chlamydia may also cause inflammation to the urethral meatus or the external opening of the urethra. These, in addition to bacterial infections, can also cause inflammation of the Skene's glands, Bartholin's glands, and vulva. Infections may result in an irritating discharge. Discharge may also be noted in yeast infections. Other abnormal findings of the external genitalia include carcinomas, vulvar tumors, or hematomas. Hematomas are masses of accumulated blood that appears as a bluish swelling of the labium that may occur following trauma to this area. Examination of the internal genitalia may reveal similar findings in regards to sexually transmitted diseases and carcinomas. Cervical abnormalities can also be found and may include lacerations, infections, ulcers, cysts, and polyps. All of these will require further evaluation in order to determine the underlying cause.

Since Pap smears screen for cervical cancer, abnormal results require special attention. Due to the incidence of false-positives or false-negatives, the test may be repeated or the physician may choose to have the patient undergo a **colposcopy**. This procedure uses an endoscope and will examine the vagina and cervix in more depth. This will identify 100% of lesions present. A biopsy may then be taken of the lesion in order to determine the exact type of abnormality. Several new techniques are now available that improve the accuracy of the Pap smear including automated analysis machines. Bimanual and rectovaginal exams may reveal abnormalities of the uterus or other pelvic structures. One commonly encountered finding is a myoma, which is a benign uterine tumor. In addition, the uterus may be positioned abnormally by being angled too far forward or backward. **Ovarian cysts** and tumors, as well as some disorders of the fallopian tubes, can be findings of these two exams.

Resources

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Pelvic fracture

Definition

A pelvic fracture is a break in one or more bones of the pelvis.

Description

The pelvis is a butterfly-shaped group of bones located at the base of the spine. The pelvis consists of the pubis, ilium, and ischium bones (among others) held together by tough ligaments. With a cavity in its

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center, the pelvis forms one major ring and two smaller rings of bone that support and protect internal organs such as the bladder, intestines, and rectum. In women, the pelvis also surrounds the uterus and vagina. The pelvis is wider and has a larger cavity in females than in males because it must accommodate **childbirth**.

Fractures of the pelvis are uncommon, accounting for only 0.3–6% of all fractures. Pelvic rings often break in more than one place. Pelvic fractures range widely in severity. Disruption of the major ring is usually a severe injury, while disruption of a minor ring is often not serious. A mild fracture (for example, one that occurs due to the impact of jogging) may heal in several weeks without surgery. However, a serious pelvic fracture can be a life-threatening event requiring emergency medical care and lengthy **rehabilitation**. The latter type of injury may involve damage to nearby internal organs.

Pelvic fractures are classified as stable or unstable, and as open or closed. A stable fracture is one in which the pelvis remains stable and involves one break-point in the pelvic ring with minimal hemorrhage. An unstable fracture is one in which the pelvis is unstable with two or more break-points in the pelvic ring with moderate to severe hemorrhage. All types of pelvic fractures are further divided into "open" or "closed," depending on whether open skin **wounds** in the lower abdomen are present, or not present.

Causes and symptoms

Most pelvic fractures occur during high–speed accidents (such as car or motorcycle crashes) or falls from great heights. The greater the force, the greater the opportunity for a severe fracture. Pelvic fractures can also occur spontaneously or after minor falls in people with bone-weakening diseases such as **osteoporosis**. Less commonly, pelvic fractures may occur during athletic activities such as football, hockey, skiing, and long-distance running.

The primary symptom of a pelvic fracture is **pain** in the groin, hip, or lower back, which may worsen when walking or moving the legs. Other symptoms may include abdominal pain; numbness/tingling in the groin or legs; bleeding from the vagina, urethra (urine tube), or rectum; difficulty urinating; and difficulty walking or standing. A stress fracture that occurs while jogging may cause pain in the thigh or buttock.

Diagnosis

A pelvic fracture is typically diagnosed by an emergency physician looking for bone tenderness, limitations of movement, difficulty walking, and any loss of nerve function in the lower part of the body. In addition, the physician looks for signs of injury to nearby organs of the intestinal or genitourinary systems. This search may include checking the rectum, vagina, and urethra for signs of bleeding. The physician will order a plain x ray of the pelvis; this test will usually detect the presence of a fracture. Blood and urine tests may also be done. A computed tomography (CT) scan will be performed in complicated cases. Depending on the severity of the fracture, other imaging procedures may be required as well, such as contrasting studies involving the injection of a radioactive dye. The pictures can be used to evaluate organs and structures in the pelvic area, such as the urethra, bladder, and blood vessels.

Treatment

In the case of a potentially serious pelvic fracture (such as that occurring after an accident or high fall), emergency assistance should be summoned. The person with the injury should be covered with a blanket or jacket (to maintain body heat), and should not be moved by non-trained personnel, especially if there is severe pain or signs of possible nerve injury.

Treatment depends on the severity of the injury. In the case of a minor fracture, treatment may consist of bed rest and over-the-counter (OTC) or prescription pain killers. **Physical therapy**, the use of crutches, and surgery may also be recommended. Healing can take anywhere from a few weeks to several months.

Severe injuries to the pelvis (such as those involving more than one break) can be life threatening, resulting in **shock**, extensive internal bleeding, and damage to internal organs. In these situations, the immediate goal is to control bleeding and stabilize the injured person's condition. Resuscitation procedures may be required, as well as large amounts of intravenous fluids and blood transfusions if internal bleeding is present. These injuries often require extensive surgery as well as lengthy rehabilitation.

Alternative treatment

To speed up the healing process, some practitioners of alternative medicine recommend **magnetic field therapy**, hydrogen peroxide therapy, **calcium**, vitamin D, vitamin B complex, and zinc.

Prognosis

The prognosis for minor pelvic fractures is excellent, with most people gaining full mobility in a matter of weeks or months. Severe pelvic fractures can be fatal due to internal bleeding or damage to

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KEY TERMS

Computed tomography (CT) scan—An imaging procedure that produces a series of thin x-ray slices of internal body organs or structures.

Fracture—A break in a bone.

Orthopedist—A doctor who specializes in disorders of the musculoskeletal system.

Osteoporosis—A decrease in the amount of bone mass, leading to fractures.

Shock—A condition of profound physiological disturbance characterized by failure of the circulatory system to maintain adequate blood supply to vital organs.

Stress fracture—A crack in a bone (usually the result of overuse).

nearby organs, or result in chronic pain and physical disabilities.

Prevention

People with bone–weakening conditions such as osteoporosis or **cancer**, or tendencies to fall are more vulnerable to bone fractures. They should follow their treatment regimens and make use of canes and other walking aids as well as safety devices in the home (bars, non-skidding mats) and avoid climbing up, even on a small stool.

Resources

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ORGANIZATIONS

American Academy of Orthopaedic Surgeons, 6300 North River Rd., Rosemont, IL, 60018–4262, (800) 346–AAOS, http://www.aaos.org.

American College of Surgeons, 633 North Saint Claire St., Chicago, IL, 60611, (312) 202–5000, http://www.facs.org.

American Pain Society, 4700 W. Lake Ave., Glenview, IL, 60025, (847) 375–4715. , http://www.ampainsoc.org.

American Society for Bone and Mineral Research, 2025 M St., NW, Suite 800, Washington, DC, 20036–3309, (202) 367–1161, http://www.asbmr.org.

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Pelvic gynecologic sonogram *see* **Pelvic ultrasound**

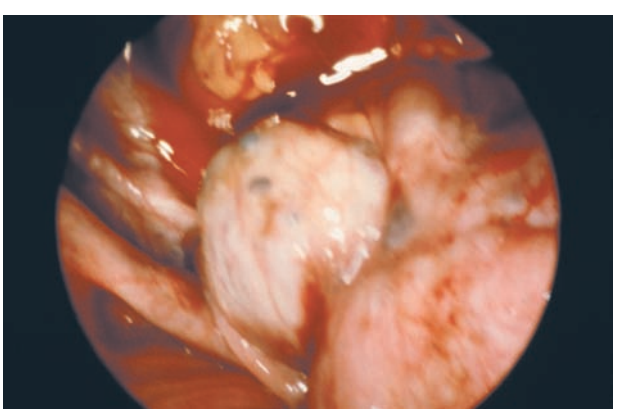
Pelvic inflammatory disease

Definition

Pelvic inflammatory disease (PID) is a term used to describe any infection in the lower female reproductive tract that spreads to the upper female reproductive tract. The lower female genital tract consists of the vagina and the cervix. The upper female genital tract consists of the body of the uterus, the fallopian or uterine tubes, and the ovaries.

Demographics

PID is the most common and the most serious consequence of infection with **sexually transmitted diseases** (STD) in women. Over one million cases of PID are diagnosed annually in the United States, and it is the most common cause for hospitalization of reproductive-age women. Sexually active women aged 15–25 are at highest risk for developing PID. The disease can also occur, although less frequently, in women having monogamous sexual relationships. The most serious consequences of PID are increased risk of **infertility** and **ectopic pregnancy**.



Laparoscopic view of pelvic inflammatory disease. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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Description

To understand PID, it is helpful to understand the basics of inflammation. Inflammation is the body's response to disease-causing (pathogenic) microorganisms. The affected body part may swell due to accumulation of fluid in the tissue or may become reddened due to an excessive accumulation of blood. A discharge (pus) may be produced that consists of white blood cells and dead tissue. Following inflammation, scar tissue may form by the proliferation of scar-forming cells and is called fibrosis. **Adhesions** of fibrous tissue form and cause organs or parts of organs to stick together.

PID may be used synonymously with the following terms:

- salpingitis (inflammation of the fallopian tubes)
- endometritis (inflammation of the inside lining of the body of the uterus)
- tubo-ovarian abscesses (abscesses in the tubes and ovaries)
- pelvic peritonitis (inflammation inside of the abdominal cavity surrounding the female reproductive organs)

Causes and symptoms

The two major causes of STDs are the organisms *Neisseria gonorrhoeae* and *Chlamydia trachomatis*. The main symptom of *N. gonorrheae* infection (**gonorrhea**) is a vaginal discharge of mucus and pus. Sometimes bacteria from the colon normally in the vaginal cavity may travel upward to infect the upper female genital organs, facilitated by the infection with gonorrhea. Infections with *C. trachomatis* and other nongonoccal organisms are more likely to have mild or no symptoms.

Normally, the cervix produces mucus, which acts as a barrier to prevent disease-causing microorganisms (called pathogens) from entering the uterus and moving upward to the tubes and ovaries. This barrier may be breached in two ways. A sexually transmitted pathogen, usually a single organism, invades the lining cells, alters them, and gains entry. Another way for organisms to gain entry happens when trauma or alteration to the cervix occurs. **Childbirth**, spontaneous or induced abortion, or use of an intrauterine contraceptive device (**IUD**) are all conditions that may alter or weaken the normal lining cells, making them susceptible to infection, usually by several organisms. During menstruation, the cervix widens and may allow pathogens entry into the uterine cavity.

Recent evidence suggests that **bacterial vaginosis** (BV), a bacterial infection of the vagina, may be associated with PID. BV results from the alteration of the balance of normal organisms in the vagina, by douching, for example. While the balance is altered, conditions are formed that favor the overgrowth of anaerobic bacteria, which thrive in the absence of free oxygen. A copious discharge is usually present. Should some trauma occur in the presence of anaerobic bacteria, such as menses, abortion, intercourse, or childbirth, these organisms may gain entrance to the upper genital organs.

The most common symptom of PID is pelvic **pain**. However, many women with PID have symptoms so mild that they may be unaware that an infection exists.

In acute salpingitis, a common form of PID, swelling of the fallopian tubes may cause tenderness on **physical examination**. **Fever** may be present. Abscesses may develop in the tubes, ovaries, or in the surrounding pelvic cavity. Infectious discharge may leak into the peritoneal cavity and cause **peritonitis**, or abscesses may rupture causing a life-threatening surgical emergency.

Chronic salpingitis may follow an acute attack. Subsequent to inflammation, scarring and resulting adhesions may result in chronic pain and irregular menses. Due to blockage of the tubes by scar tissue, women with chronic salpingitis are at high risk of having an ectopic **pregnancy**. The fertilized ovum is unable to travel down the fallopian tube to the uterus and implants itself in the tube, on the ovary, or in the peritoneal cavity. This condition can also be a life-threatening surgical emergency.

IUD

IUD usage has been strongly associated with the development of PID. Bacteria may be introduced to the uterine cavity while the IUD is being inserted or may travel up the tail of the IUD from the cervix into the uterus. Uterine tissue in association with the IUD shows areas of inflammation that may increase its susceptibility to pathogens.

Susceptibility to STDs

Susceptibility to STDs involves many factors, some of which are not known. The ability of the organism to produce disease and the circumstances that place the organism in the right place at a time

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KEY TERMS

Adhesion—The joining or sticking together of parts of an organ that are not normally joined together.

C-reactive protein (CRP)—A protein present in blood serum in various abnormal states, like inflammation.

Ectopic—Located away from normal position; ectopic pregnancy results in the attachment and growth of the fertilized egg outside of the uterus, a life-threatening condition.

Endometriosis—The presence and growth of functioning endometrial tissue in places other than the uterus; often results in severe pain and infertility.

Erythrocyte sedimentation rate (ESR)—The rate at which red blood cells settle out in a tube of unclotted blood, expressed in millimeters per hour; elevated sedimentation rates indicate the presence of inflammation.

Fibrosis—The formation of fibrous, or scar, tissue that may follow inflammation and destruction of normal tissue.

Hysterectomy—Surgical removal of the uterus.

Laparoscope—A thin flexible tube with a light on the end that is used to examine the inside of the abdomen; the tube is inserted into the abdomen by way of a small incision just below the navel.

when a trauma or alteration to the lining cells has occurred are factors. The individual's own immune response also helps to determine whether infection occurs.

Risk factors

A number of factors affect the risk of developing PID. They include:

- Age—The incidence of PID is very high in younger women and decreases as a woman ages.
- Race—The incidence of PID is 8–10 times higher in nonwhites than in whites.
- Socioeconomic status—The higher incidence of PID in women of lower socioeconomic status is due in part to a woman's lack of education and awareness of health and disease and her accessibility to medical care.
- Contraception—Induced abortion, use of an IUD, non-use of barrier contraceptives such as condoms, and frequent douching are all associated with a higher risk of developing PID.
- Lifestyle—High risk behaviors, such as drug and alcohol abuse, early age of first intercourse, number of sexual partners, and smoking all are associated with a higher risk of developing PID.
- Types of sexual practices—Intercourse during menses and frequent intercourse may offer more opportunities for the admission of pathogenic organisms to the inside of the uterus.
- Disease—Sixty to 75% of cases of PID are associated with STDs. A prior episode of PID increases the chances of developing subsequent infections.

Diagnosis

Examination

If PID is suspected, a physician will take a complete medical history and perform an internal pelvic examination. Other diseases that may cause pelvic pain, such as **appendicitis** and **endometriosis**, must be ruled out. If pelvic examination reveals tenderness or pain in that region, or tenderness on movement of the cervix, these are good physical signs that PID is present.

Tests

Specific diagnosis of PID is difficult to make because the upper pelvic organs are hard to reach for samplings. The physician may take samples directly from the cervix to identify the organisms that may be responsible for infection. Two blood tests may help to establish the existence of an inflammatory process. A positive **C-reactive protein** (CRP) and an elevated **erythrocyte sedimentation rate** (ESR) indicate the presence of inflammation. The physician may take fluid from the cavity surrounding the ovaries called the *cul de sac*; this fluid may be examined directly for bacteria or may be used for culture.

Procedures

Diagnosis of PID may also be done by performing a surgical **laparoscopy**, which allows the doctor to view the pelvic organs. Equipment for this procedure includes a camera, and a narrow scope that has a light on the end of it for visual purposes. The procedure enables the doctor to take photos and also to take fluid or tissue specimens to send to the lab for further evaluation.

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Treatment

Traditional

The goals of treatment are to reduce or eliminate the clinical symptoms and abnormal physical findings, to get rid of the microorganisms, and to prevent long term consequences such as infertility and the possibility of ectopic pregnancy.

Drugs

If acute salpingitis is suspected, treatment with **antibiotics** should begin immediately. Early intervention is crucial to keep the fallopian tubes undamaged. The patient is usually treated with at least two broad spectrum antibiotics that can kill both *N. gonorrhoeae* and *C. trachomatis* plus other types of bacteria that may have the potential to cause infection. Hospitalization may be required to ensure compliance. Treatment for chronic PID may involve **hysterectomy**, which may be helpful in some cases.

If a woman is diagnosed with PID, she should see that her sexual partner is also treated to prevent the possibility of reinfection.

Alternative

Alternative therapy should be complementary to antibiotic therapy. For pain relief, an experienced practitioner may apply castor oil packs, or use **acupressure** or **acupuncture**. Some herbs, such as *Echinacea* (*Echinacea* spp.) and calendula (*Calendula officinalis*) are believed to have antimicrobial activity and may be taken to augment the action of prescribed antibiotics. General tonic herbs, as well as good **nutrition** and rest, are important in recovery and strengthening after an episode of PID. Blue cohosh (*Caulophyllum thalictroides*) and false unicorn root (*Chamaelirium luteum*) are recommended as tonics for the general well-being of the female genital tract.

Prognosis

PID can be cured if the initial infection is treated immediately. If infection is not recognized, as frequently happens, the process of tissue destruction and scarring that result from inflammation of the tubes results in irreversible changes in the tube structure that cannot be restored to normal. Subsequent bouts of PID increase a woman's risks manyfold. Thirty to forty percent of cases of female infertility are due to acute salpingitis.

With modern antibiotic therapy, **death** from PID is almost nonexistent. In rare instances, death may occur from the rupture of tubo-ovarian abscesses and the resulting infection in the abdominal cavity. One recent study has linked infertility, a consequence of PID, with a higher risk of **ovarian cancer**.

Prevention

The prevention of PID is a direct result of the prevention and prompt recognition and treatment of STDs or of any suspected infection involving the female genital tract. The main symptom of infection is an abnormal discharge. To distinguish an abnormal discharge from the mild fluctuations of normal discharge associated with the menstrual cycle takes vigilance and self-awareness. Sexually active women must be able to detect symptoms of lower genital tract disease. Ideally, these women will be able to have a frank dialogue regarding their sexual history, risks for PID, and treatment options with their physicians. Also, these women should have open discussions with their sexual partners regarding disclosure of significant symptoms of possible infection.

Lifestyle changes should be geared toward preventing the transfer of organisms when the body's delicate lining cells are unprotected or compromised. Barrier contraceptives, such as **condoms**, diaphragms, and cervical caps should be used. Women in monogamous relationships should use barrier contraceptives during menses and take their physician's advice regarding intercourse following abortion, childbirth, or biopsy procedures.

Resources

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Wilson, Michael R. *Pelvic Inflammatory Disease*. New York: Rosen Publishing Group, 2009.

ORGANIZATIONS

American Society for Reproductive Medicine, 1209 Montgomery Highway, Birmingham, AL, 35216-2809, (205) 978-5000, http://www.asrm.com.

International Center for Infertility Information Dissemination, P.O. Box 6836, Arlington, VA, 22206, (703) 379-9178, http://www.asrm.org.

National Institutes of Health (NIH), 9000 Rockville Pike, Bethesda, MD, 20892, (301) 496-4000, http://www.nih.gov.

National Women's Health Network, 514 10th Street NW, Suite 400, Washington, DC, 20004, (202) 628-7814, http://www.nwhn.org.

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RESOLVE, 8405 Greensboro Drive, Suite 800, McLean, VA, 22102-5120, (703) 556-7172, http://www.resolve.org.

U.S. National Library of Medicine, 8600 Rockville Pike, Bethesda, MD, 20894, http://www.nlm.nih.gov/medlineplus/medlineplus.html.

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Pelvic relaxation

Definition

Pelvic relaxation is a weakening of the supportive muscles and ligaments of the pelvic floor. This condition, which affects women and is usually caused by **childbirth**, **aging**, and problems with support, causes the pelvic floor to sag and press into the wall of the vagina.

Demographics

Pelvic relaxation is a common condition in adult females and may affect one in three women, especially those who have had children.

Description

The pelvic floor normally holds the uterus and the bladder in position above the vagina. When the pelvic floor becomes stretched and damaged, these organs can sag into the vagina, sometimes bulging out through the vaginal opening. A sagging uterus is referred to as a uterine prolapse, pelvic floor **hernia**, or pudendal hernia. A sagging bladder is referred to as a bladder prolapse, or cystocele. Other organs, such as the rectum and intestine, can also sag into the vagina as a result of a weakened pelvic floor.

Causes and symptoms

Childbirth increases the risk of pelvic relaxation. Other causes include **constipation**, a chronic **cough**, **obesity**, and heavy lifting. Some women develop the condition after **menopause**, when the body loses the estrogen that helps maintain muscle tone. Mild pelvic relaxation may cause no symptoms. More severe pelvic relaxation can cause the following symptoms:

- an aching sensation in the vagina, lower abdomen, groin or lower back
- heaviness or pressure in the vaginal area, as if something is about to "fall out" of the vagina
- bladder control problems that worsen with heavy lifting, coughing, or sneezing
- frequent urinary tract infections
- difficulty having a bowel movement

KEY TERMS

Cystocele—Bulging of the bladder into the vagina.

Cystourethrocele—Bulging of the bladder neck into the vagina.

Enterocele—Bulging of the intestine into the upper part of the vagina.

Kegel exercises—Pelvic muscle exercises that strengthen bladder and bowel control.

Pessary—A device inserted into the vagina to support sagging organs.

Rectocele—Bulging of the rectum into the vaginal wall.

Uterine prolapse—Bulging of the uterus into the vagina.

Vaginal prolapse—Bulging of the top of the vagina into the lower vagina or outside the opening of the vagina.

Diagnosis

A thorough **pelvic exam** can help diagnose pelvic relaxation, as can tests of bladder function.

Treatment

Exercises called Kegel exercises can strengthen pelvic floor muscles and lessen the symptoms of pelvic relaxation. These exercises involve squeezing the muscles that stop the flow of urine. The pelvic floor can also be strengthened by estrogen supplements. Physicians sometimes prescribe the insertion of a supportive ring-shaped device called a pessary into the vagina, to prevent the uterus and bladder from pressing into the vagina. Sometimes surgery is recommended to repair a sagging bladder or uterus, and sometimes surgical removal of the uterus (**hysterectomy**) is recommended. Patients are often advised to adhere to a high-fiber diet to reduce the strain of bowel movements, maintain a moderate weight, and avoid activities that strain the pelvic floor. They are sometimes prescribed medications to help control urination and prevent leakage.

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Prognosis

Mild cases of pelvic relaxation can sometimes be reversed through Kegel exercises, while severe cases usually do not respond to **exercise** or estrogen therapy, but usually require pessary support or surgery.

Prevention

To limit **stress** on the pelvic support system, women are advised to maintain a normal body weight, limit heavy lifting, and avoid unnecessary straining to have bowel movements.

Resources

BOOKS

Nelson, Miriam, and Jennifer Ackerman. *The Strong Women's Guide to Total Health*. New York, NY: Rodale Books, 2010.

Rosenfeld, Jo Ann, editor. *Handbook of Women's Health,* 2nd ed. New York, NY: Cambridge University Press, 2009.

Thacker, Holly. *The Cleveland Clinic Guide to Menopause*. New York, NY: Kaplan Publishing, 2009.

ORGANIZATIONS

American College of Obstetricians and Gynecologists (ACOG), 409 12th St., S.W., PO Box 96920, Washington, DC, 20090–6920, http://www.acog.org.

National Association For Continence (NAFC), PO Box 1019, Charleston, SC, 29402–1019, (800) BLADDER, http://www.nafc.org.

National Kidney and Urologic Diseases Information Clearinghouse (NIDDK), 3 Information Way, Bethesda, MD, 20892, (800) 891–5390, http://kidney.niddk.nih.gov.

Ann Quigley
Laura Jean Cataldo, RN, Ed.D.

Pelvic ultrasound

Definition

Pelvic ultrasound is a procedure where harmless, high-frequency sound waves are projected into the abdomen. These waves reflect off of the internal structures and create shadowy black and white pictures on a display screen.

Purpose

Ultrasound is performed routinely during **pregnancy**. Early in the pregnancy (at about seven weeks), it might be used to determine the size of the uterus or the fetus, to detect multiple or **ectopic pregnancy**, to confirm that the fetus is alive (or viable), or to confirm the due date. Toward the middle of the pregnancy (at about 16–20 weeks), ultrasound may be used to confirm fetal growth, to reveal defects in the anatomy of the fetus, and to check the placenta. Toward the end of pregnancy, it may be used to evaluate fetal size, position, growth, or to check the placenta. Doctors may use ultrasound during diagnostic procedures like **amniocentesis** and **chorionic villus sampling**. Both of these tests use long needles inserted through the mother's abdomen into the uterus or placenta to gather cells. Ultrasound can also be used in men or women to examine other internal organs, such as the liver, gallbladder, kidney, and heart. The procedure can be useful in detecting cysts, tumors, and **cancer** of the uterus, ovaries, and breasts.

Precautions

There are no special precautions recommended before an ultrasound examination. Unlike x rays, ultrasound does not produce any harmful radiation and does not pose a risk to the mother or the fetus. While many woman have an ultrasound as part of their prenatal care, there may be no medical need to perform the procedure.

Description

Ultrasound examinations can be done in a doctor's office, clinic, or hospital setting. Typically, the pregnant woman will lie on an examination table with her abdomen exposed. Gel or oil is applied to the area. The doctor or technician will move a hand-held scanner (called a transducer) over the abdomen. The transducer emits high-frequency sound waves (usually in the range of 3.5–7.0 megahertz) into the abdomen. The waves are reflected back to the transducer and the wave patterns are shown as an image on a display screen. An ultrasound scan reveals the shapes, densities, and even movements of organs and tissues. Although the pictures transmitted by an ultrasound scan appear gray and grainy, a trained technician can identify the fetus within the uterus, monitor its heartbeat, and sometimes determine its sex. Using computerized tools, the technician can measure various structures shown on the screen. For example, the length of the upper thigh bone (femur) or the distance between the two sides of the skull can indicate the age of the fetus.

Ultrasound technology has been used safely in medical settings for over 30 years, and several significant

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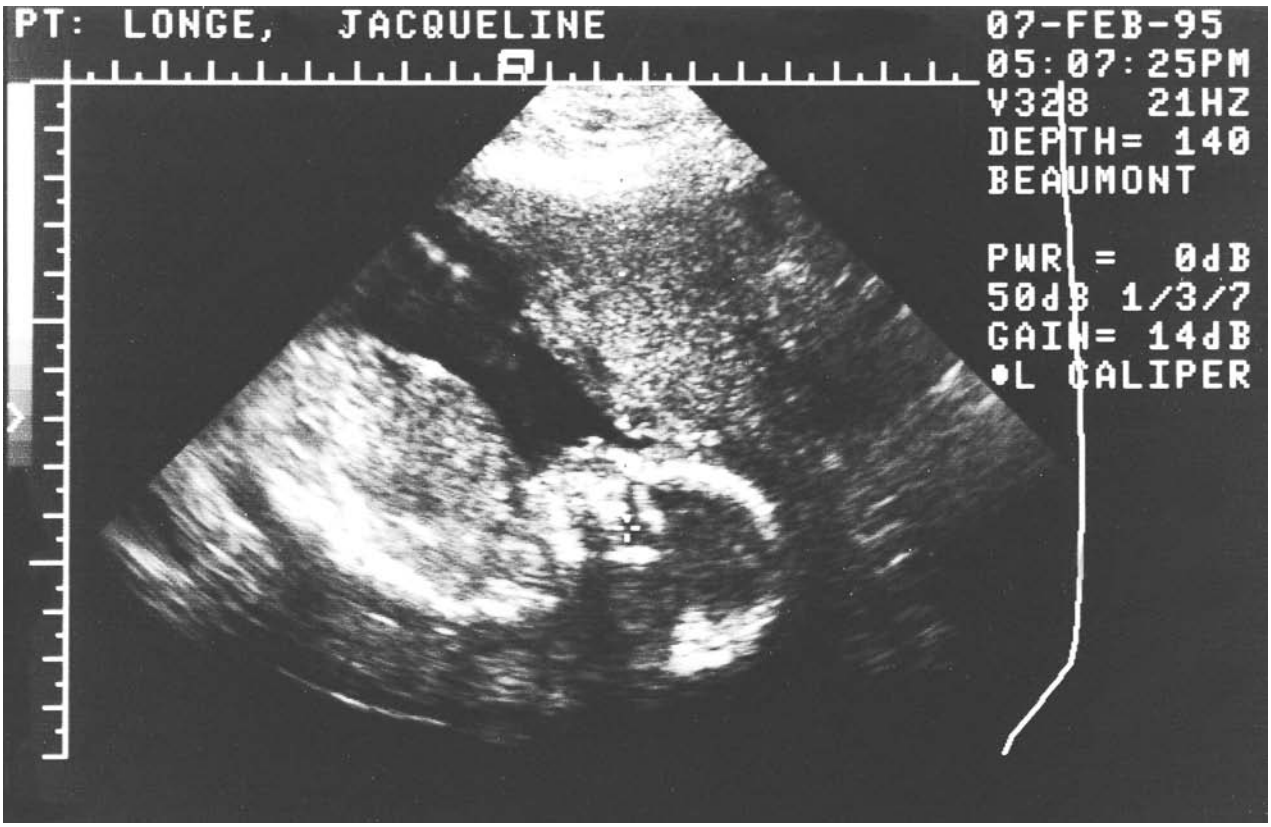

An ultrasound image of Anabelle Ashlyn Longe at 20 weeks. *(Courtesy of Jacqueline Longe.)*

improvements have been made to the procedure. A specially designed transducer probe can be placed in the vagina to provide better ultrasound images. This transvaginal or endovaginal scan is particularly useful in early pregnancy or in cases where ectopic pregnancy is suspected. Doppler ultrasound uses enhanced sound waves to monitor subtle events, like the flow of fetal blood through the heart and arteries. Color imaging is a recent addition to ultrasound technology. With this process, color can be assigned to the various shades of gray for better visualization of subtle tissue details. A new technology under development is three-dimensional ultrasound, which has the potential for detecting even very subtle fetal defects.

Preparation

Before undergoing a pelvic ultrasound, a woman may be asked to drink several glasses of water and to avoid urinating for about one hour before the examination. When the bladder is full, the uterus and fetus are easier to see. A lubricating gel or mineral oil may be applied to the area to make moving the transducer easier.

Aftercare

The lubricating jelly or oil applied to the abdomen is wiped off at the end of the procedure. After an ultrasound examination, a patient can immediately resume normal activities.

Risks

There are no known risks, to either the mother or the fetus, associated with the use of ultrasound.

Normal results

The reliability of ultrasound readings depends on the skill of the technician or doctor performing the scan. Patients should be aware that fetal abnormalities cannot be detected with 100% accuracy using ultrasound. A normal ultrasound result does not necessarily guarantee that the fetus will be normal.

Abnormal results

Ultrasound examinations in obstetrics may detect abnormalities or defects in the fetus. This information may reveal that the fetus cannot survive on its own

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KEY TERMS

Amniocentesis—A procedure where a needle is inserted through the pregnant mother's abdomen and into the uterus to draw off some of the amniotic fluid surrounding the fetus.

Chorionic villus sampling—A procedure where a needle is inserted into the placenta to draw off some of the placenta's inner wall cells surrounding the fetus.

Ectopic pregnancy—A pregnancy where the fertilized egg becomes implanted somewhere other than in the uterus. A tubal pregnancy is when the fertilized egg implants in the fallopian tube.

Fetus—A term for an unborn baby, usually from the end of week eight to the moment of birth.

Placenta—The organ that allows interchange between the fetus and the mother. Blood from the fetus and the mother do not directly mix, but the thin placental membrane allows the fetus to absorb nutrients and oxygen from the mother. Waste products from the fetus can exit through the placenta.

Ultrasonography—Another term for ultrasound.

after birth or that it will require extensive treatment or care. Some surgical procedures can be performed to correct defects while the fetus is still in the uterus. Parents faced with information regarding possible **birth defects** may require counseling to consider their choice to either continue or end the pregnancy.

The diagnostic use of ultrasound may reveal the presence of cysts, tumors, or cancer in internal organs.

ORGANIZATIONS

American Institute of Ultrasound in Medicine, 14750 Sweitzer Lane, Suite 100, Laurel, MD, 20707-5906, (301) 498-4100, (301) 498-4450, http://www.aium.org.

Altha Roberts Edgren

Penicillin V *see* **Penicillins**

Penicillins

Definition

Penicillins are antibiotic medicines that kill bacteria and prevent their growth and spread.

Purpose

Penicillins are used to treat infections in the middle ears, sinuses, mouth, throat and lungs, and urinary system. They are also used as part of a multi-drug treatment program for peptic ulcers caused by the Helicobacter pylori bacterium.

These drugs are also used to prevent infections in people who are susceptible to recurrent heart or **kidney disease** prior to having dental and other procedures.

Penicillins will *not* cure or prevent colds, flu, and other infections caused by viruses.

Description

Examples of penicillins include penicillin V (Pen-Vee K, V-cillin K), cloxicillin, amoxicillin (Amoxil, Polymox, Trimox), and carbenicillin. Penicillin can be combined with clavulanic acid (Augmentin) to broaden the scope of its effectiveness.

Recommended dosage

Available only by prescription, penicillins come as capsules, tablets (regular and chewable), liquids and injectables.

Antibiotics should always be taken as directed for as long as they are prescribed. Do not stop taking them when symptoms improve.

Precautions

A full ten days of treatment must be taken when treating beta-streptococcal infections to prevent the secondary development of **rheumatic fever** or kidney disease (**glomerulonephritis**).

When using these drugs to treat **sexually transmitted diseases** (STD), follow up blood tests for syphlis should be done monthly for four months to assure that this disease, requiring longer term treatment, is not present.

Penicillins may change the results of the urine test for glucose.

ALLERGIES. People who have hay **fever**, **asthma**, **eczema**, or other **allergies** (or who have had such allergies in the past) may be more likely to be allergic to the penicillins.

Anyone who has had unusual reactions to penicillins or **cephalosporins** in the past should let his or her physician know before taking the drugs again. Physicians should also know about allergies to foods, dyes, preservatives, or other substances.

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Special conditions

DIABETES. Penicillins may cause false positive results on urine sugar tests.

PHENYLKETONURIA. Augmentin chewable tablets contain phenylalanine. People with **phenylketonuria** (PKU) should consult their physician before taking this medicine.

Side effects

The most common adverse effects from penicillins are abdominal **pain**, **nausea**, upset stomach, mild **diarrhea** or skin rash with **itching**.

Rarely, there may be soreness of the mouth or tongue or severe diarrhea.

Severe allergic reactions rarely occur, but require immediate medical attention. Those symptoms include:

- difficulty breathing
- fever
- lightheadedness or faintness
- joint pain
- hives, itching, or red, scaly skin
- swelling or puffiness in the face, mouth or throat

Interactions

Tetracycline antibiotics reduce the effectiveness of penicillins.

Some penicillins reduce the effectiveness of birth control pills. Secondary methods of preventing **pregnancy** are advised while taking them.

Penicillins may reduce the blood pressure effects of beta-blocker drugs, like atenalol, used to treat high blood pressure.

Penicillins may increase the blood levels of methotrexate.

Allopurinol (Zyloprem) may increase the blood levels of penicillins.

James Waun, MD, RPh

Penile cancer

Definition

Penile **cancer** is the growth of malignant cells on the external skin and in the tissues of the penis.

Description

Penile cancer is a disease in which cancerous cells appear on the penis. If left untreated, this cancer can grow and spread from the penis to the lymph nodes in the groin and eventually to other parts of the body.

Demographics

Penile cancer is a rare form of cancer that develops in about one out of 100,000 men per year in the United States. Penile cancer is more common in other parts of the world, particularly Africa and Asia. In Uganda, penile cancer is the most common form of cancer for men.

Causes and symptoms

The cause of penile cancer is unknown. The most common symptoms of penile cancer are:

- a tender spot, an open sore, or a wart-like lump on the penis
- unusual liquid discharges from the penis
- pain or bleeding in the genital area

Diagnosis

In order to diagnose penile cancer, the doctor examines the patient's penis for lumps or other abnormalities. A tissue sample, or biopsy, may be ordered to distinguish cancerous cells from **syphilis** and penile **warts**. If the results confirm a diagnosis of cancer, additional tests are done to determine whether the disease has spread to other parts of the body.

Treatment

In Stage I penile cancer, malignant cells are found only on the surface of the head (glans) and on the foreskin of the penis. If the cancer is limited to the foreskin, treatment may involve wide local excision and **circumcision**. Wide local excision is a form of surgery that removes only cancer cells and a small amount of normal tissue adjacent to them. Circumcision is removal of the foreskin.

If the Stage I cancer is only on the glans, treatment may involve the use of a fluorouracil cream (Adrucil, Efudex), and/or microsurgery. Microsurgery removes cancerous tissue and the smallest possible amount of normal tissue. During microsurgery, the doctor uses a special instrument that provides a comprehensive view of the area where cancer cells are located and makes it possible to determine that all malignant cells have been removed.

In Stage II, the penile cancer has spread to the surface of the glans, tissues beneath the surface, and the shaft of the penis. The treatment recommended may be

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amputation of all or part of the penis (total or partial penectomy). If the disease is diagnosed early enough, surgeons are often able to preserve enough of the organ for urination and sexual activity. Treatment may also include microsurgery and external **radiation therapy**, in which a machine provides radiation to the affected area. **Laser surgery** is an experimental treatment for Stage II cancers. Laser surgery uses an intense precisely focused beam of light to dissolve or burn away cancer cells.

In Stage III, malignant cells have spread to lymph nodes in the groin, where they cause swelling. The recommended treatment may include amputation of the penis and removal of the lymph nodes on both sides. Radiation therapy may also be suggested. More advanced disease requires systemic treatments using drugs (**chemotherapy**). In chemotherapy, medicines are administered intravenously or taken by mouth. These drugs enter the bloodstream and kill cancer cells that have spread to any part of the body.

In Stage IV, the disease has spread throughout the penis and lymph nodes in the groin, or has traveled to other parts of the body. Treatments are similar to that for Stage III cancer.

Recurrent penile cancer is disease that recurs in the penis or develops in another part of the body after treatment has eradicated the original cancer cells.

Cure rates are high for cancers diagnosed in Stage I or II, but much lower for Stages III and IV, by which time cancer cells have spread to the lymph nodes.

Alternative treatment

In addition to the treatments previously described, biological therapy is another treatment that is currently being studied. Biological therapy is a type of treatment that is sometimes called biological response modifier (BRM) therapy. It uses natural or artificial substances to boost, focus, or reinforce the body's disease-fighting resources.

Prevention

Conditions which increase a person's chance of getting penile cancer include:

- infection with genital warts (human papillomavirus, or HPV)
- a skin disease called psoriasis
- a condition called phimosis, in which the foreskin becomes difficult to retract
- other conditions that result in repeated irritation of the penis.
- a history of smoking.

KEY TERMS

Circumcision—Surgical removal of the foreskin of the penis. It is usually performed shortly after birth.

Fluorouracil—A cell-killing (cytotoxic) medication that can be applied in cream form to treat cancer of the penis.

There appears to be a connection between development of the disease and lack of personal hygiene. Failure to regularly and thoroughly cleanse the part of the penis covered by the foreskin increases the risk of developing the disease. Penile cancer is also more common in uncircumcised men.

Resources

OTHER

"What is penile cancer?" American Cancer Society. July 20, 2010. http://www.cancer.org/Cancer/PenileCancer/DetailedGuide/penile-cancer-what-is-penile-cancer (accessed December 20, 2010).

ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (800) 227-2345, http://www.cancer.org.

Cancer Group Institute, 17620 9th Ave. NE, Miami, FL, 33162, (305) 493-1980, http://www.cancergroup.com/.

Maureen Haggerty
Paul A. Johnson, Ed.M.

Penile implant surgery *see* **Penile prostheses**

Penile prostheses

Definition

Penile prostheses are semirigid or inflatable devices that are implanted into penises to alleviate **impotence**.

Purpose

The penis is composed of one channel for urine and semen and three compartments with tough, fibrous walls containing "erectile tissue." With appropriate stimulation, the blood vessels that lead out of these compartments constrict, trapping blood. Blood pressure fills and hardens the compartments producing an erection of sufficient firmness to perform sexual intercourse. Additional stimulation leads to ejaculation, where semen is pumped out of the urethra. When this

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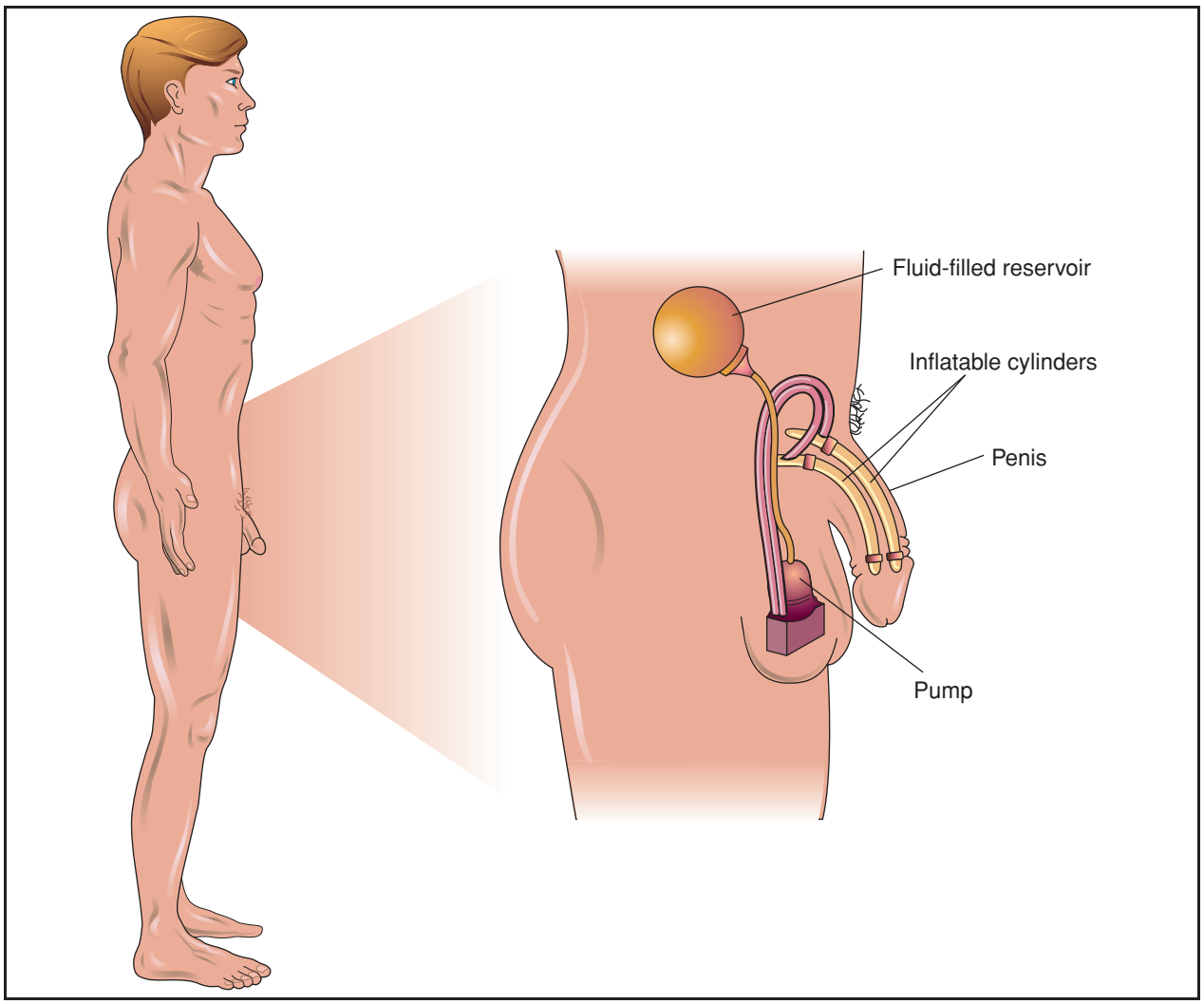

The inflatable implant is a common penile prosthesis. This device connects through a tube to a flexible fluid reservoir and a pump. The pump is shaped like a testicle and inserted in the scrotum. When the pump is squeezed, the fluid is forced into the inflatable cylinders implanted inside the penis, producing an erection. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

system fails, impotence (failure to create and maintain an erection) occurs.

Impotence can be caused by a number of conditions, including diabetes, **spinal cord injury**, prolonged drug **abuse**, and removal of a prostate gland. If the medical condition is irreversible, a penile prosthesis may be considered. Patients whose impotence is caused by psychological problems are not recommended for implant surgery.

Description

Penile implant surgery is conducted on patients who have exhausted all other areas of treatment. The semirigid device consists of two rods that are easier and less expensive to implant than the inflatable cylinders. Once implanted, the semirigid device needs no follow-up adjustments, however it produces a penis which constantly remains semi-erect. The inflatable cylinders produce a more natural effect. The patient is able to simulate an erection by using a pump located in the scrotum.

With the patient asleep under **general anesthesia**, the device is inserted into the erectile tissue of the penis through an incision in the fibrous wall. In order to implant the pump for the inflatable implant, incisions are made in the abdomen and the perineum (area between the anus and the genitals). A fluid reservoir is inserted into the groin and the pump is placed in the scrotum. The cylinders, reservoir, and pump are

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KEY TERMS

General anesthesia—Deep sleep induced by a combination of medicines that allows surgery to be performed.

Genital—Sexual organ.

Perineum—Area between the anus and genitals.

Scrotum—The external pouch containing the male reproductive glands (testes) and part of the spermatic cord.

connected by tubes and tested before the incisions are closed.

Preparation

Surgery always requires an adequately informed patient, both as to risks and benefits. In this case, the sexual partner should also be involved in the discussion. Prior to surgery, antibacterial cleansing occurs and the surrounding areas are shaved.

Aftercare

To minimize swelling, ice packs are applied to the penis for the first 24 hours following surgery. The incision sites are cleansed daily to prevent infection. **Pain** relievers may be taken.

Risks

With any implant, there is a slightly greater risk of infection. The implant may irritate the penis and cause continuous pain. The inflatable prosthesis may need follow-up surgery to repair leaks in the reservoir or to reconnect the tubing.

Resources

BOOKS

Tanagho, Emil A., Jack W McAninch, and Donald Ridgeway Smith. *Smith's General Urology*. New York: McGraw–Hill Medical, 2008.

J. Ricker Polsdorfer, MD

Pentoxifylline *see* **Blood-viscosity reducing drugs**

Peptic ulcer disease *see* **Heliobacteriosis**

Percutaneous renal biopsy *see* **Kidney biopsy**

Percutaneous transhepatic cholangiography

Definition

Percutaneous transhepatic cholangiography (PTHC) is an x-ray test used to identify obstructions either in the liver or bile ducts that slow or stop the flow of bile from the liver to the digestive system.

Purpose

Because the liver and bile ducts are not normally seen on x rays, the doctor injects the liver with a special dye that will show up on the resulting picture. This dye distributes evenly to fill the whole liver drainage system. If the dye does not distribute evenly, this is indicative of a blockage, which may be caused by a gallstone or a tumor in the liver, bile ducts, or pancreas.

Precautions

Patients should report allergic reactions to:

- anesthetics
- dyes used in medical tests
- iodine
- shellfish

PTHC should not be performed on anyone who has **cholangitis** (inflammation of the bile duct), massive **ascites**, a severe allergy to iodine, or a serious uncorrectable or uncontrollable bleeding disorder. Patients who have diabetes should inform their doctor.

Description

PTHC is performed in a hospital, doctor's office, or outpatient surgical or x-ray facility. The patient lies on a movable x-ray table and is given a local anesthetic. The patient will be told to hold his or her breath, and a doctor, nurse, or laboratory technician will inject a special dye into the liver as the patient exhales.

The patient may feel a twinge when the needle penetrates the liver, a pressure or fullness, or brief discomfort in the upper right side of the back. Hands and feet may become numb during the 30–60 minute procedure.

The x-ray table will be rotated several times during the test, and the patient helped to assume a variety of positions. A special x-ray machine called a fluoroscope will track the dye's movement through the bile

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ducts and show whether the fluid is moving freely or if its passage is obstructed.

PTHC costs about $1,600. The test may have to be repeated if the patient moves while x rays are being taken.

Preparation

An intravenous antibiotic may be given every 4–6 hours during the 24 hours before the test. The patient will be told to fast overnight. Having an empty stomach is a safety measure in case of complications, such as bleeding, that might require emergency repair surgery. Medications such as **aspirin**, or non-steroidal anti-inflammatory drugs that thin the blood, should be stopped three–seven days prior to taking the PRHC test. Patients may also be given a sedative a few minutes before the test begins.

Aftercare

A nurse will monitor the patient's vital signs and watch for:

- itching
- flushing
- nausea and vomiting
- sweating
- excessive flow of saliva
- possible serious allergic reactions to contrast dye

The patient should stay in bed for at least six hours after the test, lying on the right side to prevent bleeding from the injection site. The patient may resume normal eating habits and gradually resume normal activities. The doctor should be informed right away if **pain** develops in the right abdomen or shoulder or in case of **fever**, **dizziness**, or a change in stool color to black or red.

Risks

Septicemia (blood poisoning) and bile **peritonitis** (a potentially fatal infection or inflammation of the membrane covering the walls of the abdomen) are rare but serious complications of this procedure. Dye occasionally leaks from the liver into the abdomen, and there is a slight risk of bleeding or infection.

Normal results

Normal x rays show dye evenly distributed throughout the bile ducts. **Obesity**, gas, and failure to fast can affect test results.

KEY TERMS

Ascites—Abnormal accumulation of fluid in the abdomen.

Bile ducts—Tubes that carry bile, a thick yellowish-green fluid that is made by the liver, stored in the gallbladder, and helps the body digest fats.

Cholangitis—Inflammation of the bile duct.

Fluoroscope—An x-ray machine that projects images of organs.

Granulomatous disease—Characterized by growth of tiny blood vessels and connective tissue.

Jaundice—Disease that causes bile to accumulate in the blood, causing the skin and whites of the eyes to turn yellow. Obstructive jaundice is caused by blockage of bile ducts, while non-obstructive jaundice is caused by disease or infection of the liver.

Abnormal results

Enlargement of bile ducts may indicate:

- obstructive or non-obstructive jaundice
- cholelithiasis (gallstones)
- hepatitis (inflammation of the liver)
- cirrhosis (chronic liver disease)
- granulomatous disease
- pancreatic cancer
- bile duct or gallbladder cancers

Resources

BOOKS

Komaroff, Anthony L. *The Harvard Medical School Family Health Guide*. New York: Free Press, 2005.

Maureen Haggerty

Perforated eardrum

Definition

A perforated eardrum exists when there is a hole or rupture in the eardrum, the thin membrane that separates the outer ear canal from the middle ear. A perforated eardrum may cause temporary **hearing loss** and occasional discharge.

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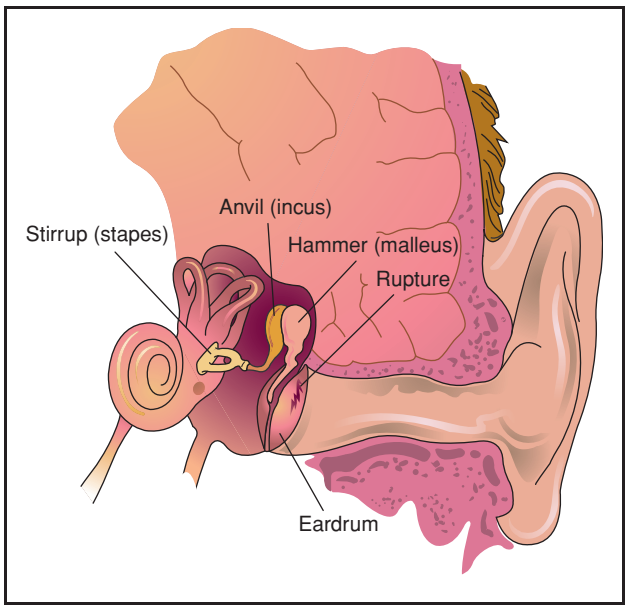

A perforated eardrum is caused by a hole or rupture in the eardrum, the thin membrane that separates the outer ear canal from the middle ear. It may result in temporary hearing loss and occasional discharge. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Demographics

Perforated eardrum can affect individuals of all ages. However, it is most commonly associated with individuals who have frequent colds and upper respiratory ailments (especially children). Young children (up to two years of age) are more susceptible to perforated eardrum due to the frequency of middle ear infections they experience.

Description

The eardrum (tympanic membrane) is a thin wall that separates the outer ear from the middle ear, vibrating when sound waves strike the membrane. The middle ear is connected to the nose by the Eustachian tube.

In addition to conducting sound, the eardrum also protects the middle ear from bacteria. When it is perforated, bacteria can more easily get into this part of the ear, causing ear infections.

In general, the larger the hole in the eardrum, the greater the temporary loss of hearing. The location of the perforation also affects the degree of hearing loss. Severe hearing loss may follow a skull fracture that disrupts the bones in the middle ear. Eardrum perforation caused by a loud noise may result in ringing in the ear (**tinnitus**), in addition to a temporary hearing loss. Over time, this hearing loss improves and the ringing usually fades in a few days.

Causes and symptoms

The eardrum can become damaged by a direct injury. It is possible to perforate the eardrum:

- with a cotton-tipped swab or another foreign object
- by hitting the ear with an open hand
- after a skull fracture
- after a loud explosion or other loud noise

In addition, an ear infection can rupture the eardrum as pressure within the middle ear rises when fluid builds up. If the eardrum is punctured by pressure from an ear infection, there may be infected or bloody drainage from the ear.

Rarely, a small hole may remain in the eardrum after a pressure-equalizing tube falls out or is removed by a doctor.

Symptoms include an earache or **pain** in the ear, which may be severe, or a sudden decrease in ear pain, followed by ear drainage of clear, bloody, or pus-filled fluid, hearing loss, or ear noise/buzzing.

Diagnosis

A doctor can diagnose a perforated eardrum by direct inspection with an otoscope. Hearing tests may reveal a hearing loss.

Treatment

A perforated eardrum usually heals by itself within two months. **Antibiotics** may be given to prevent infection or to treat an existing ear infection. Painkillers can relieve any ear pain.

Sometimes, a paper patch is placed over the eardrum until the membrane heals. Three or four patches may be needed before the perforation closes completely. If the eardrum does not heal on its own, surgical repair (tympanoplasty) may be necessary.

The ear should be kept clean and dry while the eardrum heals. Patients should insert cotton balls into the ear when showering or shampooing to block any water from getting into the ear. Pain in the ear may be eased by applying warm compresses.

Prognosis

While a perforated eardrum may be uncomfortable, it usually heals on its own. Any hearing loss that accompanies the perforation is usually temporary.

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KEY TERMS

Eustachian tube—The air duct that connects the area behind the nose to the middle ear.

Otoscope—An instrument used to examine the ear, to inspect the outer ear canal and the eardrum, and to detect diseases in the middle ear.

Prevention

A perforated eardrum can be prevented by avoiding insertion of any object into the ear to clean it. If a foreign object becomes lodged in the ear, only a doctor should try to remove it.

Promptly treating all ear infections is another way to guard against a ruptured eardrum.

Resources

BOOKS

Plack, Christopher. *Oxford Handbook of Auditory Science: Hearing*. New York, NY: Oxford University Press, 2010.

ORGANIZATIONS

American Academy of Otolaryngology–Head and Neck Surgery, Inc., One Prince St., Alexandria, VA, 22314–3357, (703) 836–4444, http://www.entnet.org.

American Hearing Research Foundation (AHRF), 55 E. Washington St., Suite 2022, Chicago, IL, 60602, (312) 726–9670, http://www.american–hearing.org.

American Speech–Language–Hearing Association (ASHA), 10801 Rockville Pike, Rockville, MD, 20852, (800) 638–8255, http://www.asha.org.

Better Hearing Institute (BHI), 515 King St., Suite 420, Alexandria, VA, 22314, (703) 684–3391, http://www.betterhearing.org.

Carol A. Turkington
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Perforated septum

Definition

A perforated septum is a hole in the nasal septum, the vertical plane of tissue that separates the nostrils.

Description

The nasal septum is a thin structure in the middle of the nose. In front, it is cartilage, further back it is bone. On either side, it is covered with mucus membranes. The cartilage depends upon the blood vessels in the mucus membranes on either side for its **nutrition**. If that blood supply is shut off, the cartilage dies, producing a hole or perforation.

Causes and symptoms

There are several causes of a perforated septum.

- Wearing ornaments in the nose. To hang an ornament from the middle of the nose requires that the tissue directly in front of the septal cartilage be pierced or perforated.
- Sniffing cocaine. Cocaine is a potent vasoconstrictor, which means that it causes small blood vessels to close. It is used in nose surgery because it shrinks mucus membranes, permitting better visualization and access into the nose. Used continuously, tissues are deprived of blood and die. The nasal septum is the most vulnerable to this effect of sniffing cocaine.
- Getting the septum cauterized. Nosebleeds usually come from the front part of the nasal septum, which is rich in blood vessels. Uncontrolled repeated bleeding from these vessels may require cautery-burning the vessels with electricity or chemicals to close them off. Injudicious cautery of both sides of the septum has in the past led to death of tissue and consequent perforation.
- More and more people are having cosmetic surgery done on their nose. The procedure, called rhinoplasty, occasionally damages the septum's blood supply.
- Contracting certain diseases. Several diseases—typhoid, syphilis, systemic lupus erythematosus, and tuberculosis—can infect this tissue and destroy it.
- Being exposed to harmful vapors. Toxic air pollutant-like acid fumes, phosphorus, and copper vapor—and sometimes even cortisone sprays—can destroy nasal tissue.

Perforation is not serious. It causes irritation, mostly complaints of dryness and crusting. Sometimes air blowing past it whistles. Picking at the crusts can cause bleeding.

Treatment

Surgical repair is not difficult. The surgeon may devise a plastic button that fits exactly into the defect and stays in place like a collar button.

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KEY TERMS

Systemic lupus erythematosus—A collagen-vascular disease in the autoimmune category that causes damage to many different parts of the body.

Alternative treatment

Saline nasal sprays may be sufficient to control symptoms and prevent the need for surgery.

Prevention

Nosebleeds from the septum can usually be controlled with pinching. Vaginal estrogen cream has also been used successfully to toughen the blood vessels.

Resources

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J. Ricker Polsdorfer, MD

Pericardiocentesis

Definition

Pericardiocentesis is the removal by needle of pericardial fluid from the sac surrounding the heart for diagnostic or therapeutic purposes.

Purpose

The pericardium, the sac (or membrane) that surrounds the heart muscle, normally contains a small amount of fluid that cushions and lubricates the heart as the heart expands and contracts. When too much fluid gathers in the pericardial cavity, the space between the pericardium and the outer layers of the heart, a condition known as pericardial effusion occurs. Abnormal amounts of fluid may result from:

- pericarditis (caused by infection, inflammation)
- trauma (producing blood in the pericardial sac)
- surgery or other invasive procedures performed on the heart
- cancer (producing malignant effusions)
- myocardial infarction, congestive heart failure
- renal failure

Possible causes of **pericarditis** include chest trauma, systemic infection (bacterial, viral, or fungal), myocardial infarction (**heart attack**), or **tuberculosis**. When pericarditis is suspected, pericardiocentesis may be advisable in order to obtain a fluid sample for laboratory analysis to identify the underlying cause of the condition.

Pericardiocentesis is also used in emergency situations to remove excessive accumulations of blood or fluid from the pericardial sac, such as with **cardiac tamponade**. When fluid builds up too rapidly or excessively in the pericardial cavity, the resulting compression on the heart impairs the pumping action of the vascular system. Cardiac tamponade is a life-threatening condition that requires immediate treatment.

Precautions

Whenever possible, an echocardiogram (ultrasound test) should be performed to confirm the presence of the pericardial effusion and to guide the pericardiocentesis needle during the procedure. Because of the risk of accidental puncture to major arteries or organs in pericardiocentesis, surgical drainage may be a preferred treatment option for pericardial effusion in non-emergency situations.

Description

The patient's vital signs are monitored throughout the procedure, and an ECG tracing is continuously run. If time allows, **sedation** is administered, the puncture site is cleaned with an antiseptic iodine solution, and a local anesthetic is injected into the skin to numb the area. The patient is instructed to remain still. The physician performing pericardiocentesis will insert a syringe with an attached cardiac needle slowly into the chest wall until the needle tip reaches the pericardial sac. The patient may experience a sensation of pressure as the needle enters the membrane. When the needle is in the correct position, the physician will aspirate, or withdraw, fluid from the pericardial sac.

When the procedure is performed for diagnostic purposes, the fluid will be collected into specimen tubes for laboratory analysis. If the pericardiocentesis is performed to treat a cardiac tamponade or other significant fluid build-up, a pericardial catheter may be attached to the needle to allow for continuous drainage.

After the cardiac needle is removed, pressure is applied to the puncture site for approximately five minutes, and the site is then bandaged.

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Preparation

Prior to pericardiocentesis, the test procedure is explained to the patient, along with the risks and possible complications involved, and the patient is asked to sign an informed consent form. If the patient is incapacitated, the same steps are followed with a family member.

No special diet or **fasting** is required for the test. After the patient changes into a hospital gown, an intravenous line is inserted into a vein in the arm. The IV will be used to administer sedation, and any required medications or blood products. Leads for an electrocardiogram (ECG) tracing are attached to the patient's right and left arms and legs, and the fifth lead is attached to the cardiac needle used for the procedure. The patient is instructed to lie flat on the table, with the upper body elevated to a 60-degree angle.

Aftercare

The site of the puncture and any drainage catheter should be checked regularly for signs of infection such as redness and swelling. Blood pressure and pulse are also monitored following the procedure. Patients who experience continued bleeding or abnormal swelling of the puncture site, sudden **dizziness**, difficulty breathing, or chest pains in the days following a pericardiocentesis procedure should seek immediate medical attention.

Risks

Pericardiocentesis is an invasive procedure, and infection of the puncture site or pericardium is always a risk. Possible complications include perforation of a major artery, lung, or liver. The myocardium, the outer muscle layer of the heart, could also be damaged if the cardiac needle is inserted too deeply.

Normal results

Normal pericardial fluid is clear to straw-colored in appearance with no bacteria, blood, **cancer** cells or pathogens. There is typically a minimal amount of the fluid (10–50 mL) in the pericardial cavity.

Abnormal results

A large volume of pericardial fluid (over 50 mL) indicates the presence of pericardial effusion. Laboratory analysis of the fluid can aid in the diagnosis of the cause of pericarditis. The presence of an infectious organism such as *staphylococcus aureus* is a sign of bacterial pericarditis. Excessive protein is present in cases of **systemic lupus erythematosus** or myocardial infarction (heart attack). An elevated white blood count may point to a fungal infection. If the patient has a hemorrhage, a cardiac rupture, or cancer, there may be blood in the pericardial fluid.

KEY TERMS

Cardiac tamponade—Compression and restriction of the heart that occurs when the pericardium fills with blood or fluid. This increase in pressure outside the heart interferes with heart function and can result in shock and/or death.

Catheter—A long, thin, flexible tube used to drain or administer fluids.

Echocardiogram—An imaging test using high-frequency sound waves to obtain pictures of the heart and surrounding tissues.

Electrocardiogram—A cardiac test that measures the electrical activity of the heart.

Myocardium—The middle layer of the heart wall.

Pericardium—A double membranous sac that envelops and protects the heart.

Resources

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ORGANIZATIONS

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Paula Anne Ford-Martin

Pericarditis

Definition

Pericarditis is an inflammation of the two layers of the thin, sac-like membrane that surrounds the heart. This membrane is called the pericardium, so the term pericarditis means inflammation of the pericardium.

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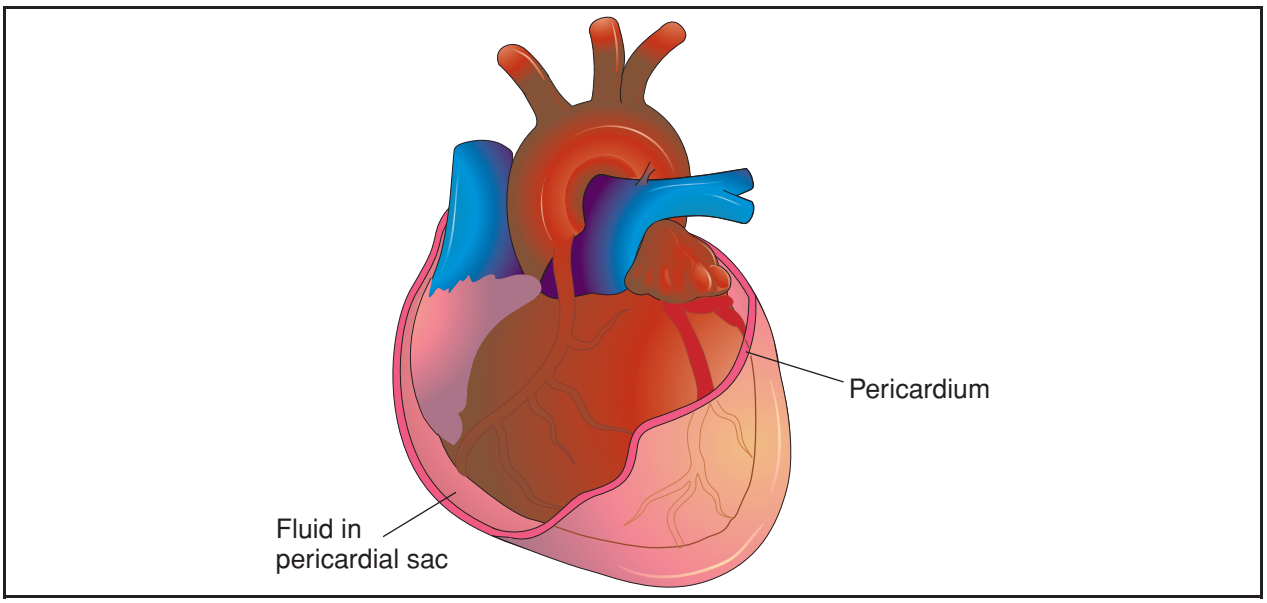

Cardiac tamponade occurs when fluid collects in the pericardial sac between the heart and the surrounding pericardium. A medical emergency, cardiac tamponade deprives the body of oxygen and requires immediate treatment. *((Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Description

Pericarditis is fairly common. It affects approximately one in 1,000 people. The most common form is caused by infection with a virus. People in their 20s and 30s who have had a recent upper respiratory infection are most likely to be affected, along with men aged 20–50. One out of every four people who have had pericarditis will get it again, but after two years these relapses are less likely.

Causes and symptoms

The viruses that cause pericarditis include those that cause **influenza**, **polio**, and **rubella** (German **measles**). In children, the most common viruses that cause pericarditis are the adenovirus and the cocksackievirus (which is most likely to affect children during warmer weather).

Although pericarditis is usually caused by a virus, it also can be caused by an injury to the heart or it can follow a **heart attack**. It may also be caused by certain inflammatory diseases such as **rheumatoid arthritis** or **systemic lupus erythematosus**. Bacteria, fungi, parasites, **tuberculosis**, **cancer** or kidney failure may also affect the pericardium. Sometimes the cause is unknown.

There are several forms of pericarditis, depending on the cause.

Acute pericarditis

This is caused by infection with a virus, bacteria, or fungus—usually in the lungs and upper respiratory tract. This form of the disease causes a sharp, severe **pain** that starts in the region of the breastbone. If the pericarditis is caused by a bacteria, it is called bacterial or purulent pericarditis.

Cardiac tamponade

Sometimes fluid collects between the heart and the pericardium. This is called pericardial effusion, and may lead to a condition called **cardiac tamponade**. When the fluid accumulates, it can squeeze the heart and prevent it from filling with blood. This keeps the rest of the body from getting the necessary supply of oxygen and can cause dangerously low blood pressure. A cardiac tamponade can happen when the chest is injured during surgery, **radiation therapy**, or an accident. Cardiac tamponade is a serious medical emergency and must be treated immediately.

Constrictive pericarditis

When the pericardium is scarred or thickened, the heart has difficulty contracting. This is because the pericardium has shrunken or tightened around the heart, constricting the muscle's heart movement. This usually occurs as a result of tuberculosis, which now is rarely

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KEY TERMS

Computed tomography (CT) scan—A CT scan uses x rays to scan the body from many angles. A computer compiles the x rays into a picture of the area being studied. The images are viewed on a monitor and printed-out.

Echocardiogram—An echocardiogram bounces sound waves off the heart to create a picture of its chambers and valves.

Electrocardiogram (ECG)—An ECG is a test to measure electrical activity in the heart.

Heart catheterization—A heart catheterization is used to view the heart's chamber and valves. A tube (catheter) is inserted into an artery, usually in the groin. A dye is then put into the artery through the tube. The dye makes its way to the heart to create an image of the heart on x-ray film. The image is photographed and stored for further examination.

Pericardiocentesis—Pericardiocentesis is a procedure used to test for viruses, bacteria, and fungus. The physician puts a small tube through the skin, directly into the pericardial sac, and withdraws fluid. The fluid then is tested for viruses, bacteria, and fungus.

Pericardium—The pericardium is the thin, sac-like membrane that surrounds the heart. It has two layers: the serous pericardium and the fibrous pericardium.

found in the United States, except in immigrant, **AIDS**, and prison populations.

Symptoms of pericarditis

Symptoms likely to be associated with pericarditis include:

- rapid breathing
- breathlessness
- dry cough
- fever and chills
- weakness
- broken blood vessels (hemorrhages) in the mucus membrane of the eyes, the back, the chest, fingers, and toes
- feelings of anxiety
- A sharp or dull pain that starts in the front of the chest under the breastbone and radiates to the left side of the neck, upper abdomen, and left shoulder the pain is less intense when the patient sits up or leans forward and worsens when lying down; it may worsen with a deep breath, like pleurisy, which may accompany pericarditis

In cardiac tamponade, neck veins may be swollen and blood pressure may be very low.

Diagnosis

The heart of a person with pericarditis is likely to produce a grating sound (friction rub) when heard through a stethoscope. This sound occurs because the roughened pericardium surfaces are rubbing against each other.

The following tests will also help diagnose pericarditis and what is causing it:

- electrocardiograph (ECG) and echocardiogram to distinguish between pericarditis and a heart attack.
- x ray to show the traditional "water bottle" shadow around the heart that is often seen in pericarditis where there is a sufficient fluid build up.
- computed tomography scan (CT scan) of the chest.
- heart catheterization to view the heart's chambers and valves.
- pericardiocentesis to test for viruses, bacteria, fungus, cancer, and tuberculosis.
- blood tests such as LDH and CPK to measure cardiac enzymes and distinguish between a heart attack and pericarditis, as well as a complete blood count (CBC) to look for infection.

Treatment

Since most pericarditis is caused by a virus and will heal naturally, there is no specific, curative treatment. Ordinary **antibiotics** do not work against viruses. Pericarditis that comes from a virus usually clears up in two weeks to three months. Medications may be used to reduce inflammation, however. They include **nonsteroidal anti-inflammatory drugs** (NSAIDs), such as ibuprofen and **aspirin**. **Corticosteroids** are helpful if the pericarditis was caused by a heart attack or systemic lupus erythematosus. **Analgesics** (painkillers such as aspirin or **acetaminophen**) also may be given.

If the pericarditis recurs, removal of all or part of the pericardium (pericardiectomy) may be necessary. In the case of constrictive pericarditis, the pericardiectomy

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may be necessary to remove the stiffened parts of the pericardium that are preventing the heart from beating correctly.

If a cardiac tamponade is present, it may be necessary to drain excess fluid from the pericardium. **Pericardiocentesis**, the same procedure used for testing, will be used to withdraw the fluid.

For most people, home care with rest and medications to relieve pain are sufficient. A warm heating pad or compress also may help relieve pain. Sitting in an upright position and bending forward helps relieve discomfort. A person with pericarditis may also be kept in bed, with the head of the bed elevated to reduce the heart's need to work hard as it pumps blood. Along with painkillers and antibiotics, diuretic drugs ("water pills") to reduce fluids may also be used judiciously.

Prognosis

Prognosis is good. Most people recover within three weeks to several months and do not need any additional treatment.

Prevention

There is no way to prevent pericarditis, but a healthy lifestyle with proper **nutrition** and **exercise** will help keep the body's immune system strong and more likely to fight off invading microorganisms.

ORGANIZATIONS

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National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

Christine Kuehn Kelly

Perinatal infection

Definition

An infection caused by a bacteria or virus that can be passed from a mother to her baby during **pregnancy** or delivery is called a perinatal infection.

Description

Perinatal infections include bacterial or viral illnesses that can be passed from a mother to her baby either while the baby is still in the uterus, during the delivery process, or shortly after birth. Maternal infection can, in some cases, cause complications at birth. The mother may or may not experience active symptoms of the infection during the pregnancy. The most serious and most common perinatal infections, and the impact of these diseases on the mother and infant, are discussed below in alphabetical order. It is important to note that men can become infected and can transmit many of these infections to other women. The sexual partners of women who have these infections also should seek medical treatment.

Causes and symptoms

Chlamydia

Chlamydia trachomatis is the most common bacterial sexually transmitted disease in the United States, causing more than 4 million infections each year. The majority of women with chlamydial infection experience no obvious symptoms. The infection affects the reproductive tract and causes **pelvic inflammatory disease**, **infertility**, and **ectopic pregnancy** (the fertilized egg implants somewhere other than in the uterus). This infection can cause premature rupture of the membranes and early labor. It can be passed to the infant during delivery and can cause ophthalmia neonatorum (an eye infection) within the first month of life and **pneumonia** within one to three months of age. Symptoms of **chlamydial pneumonia** are a repetitive **cough** and rapid breathing. **Wheezing** is rare and the infant does not develop a **fever**.

Cytomegalovirus

Cytomegalovirus (CMV) is a common virus in the herpes virus family. It is found in saliva, urine, and other body fluids and can be spread through sexual contact or other more casual forms of physical contact like kissing. In adults, CMV may cause mild symptoms of swollen lymph glands, fever, and **fatigue**. Many people who carry the virus experience no symptoms at all. Infants can become infected with CMV while still in the uterus if the mother becomes infected or develops a recurrence of the infection during pregnancy. Most infants exposed to CMV before birth develop normally and do not show any symptoms. As many as 6,000 infants who were exposed to CMV before birth are born with serious complications each year. CMV interferes with normal fetal development and can cause **mental retardation**, blindness, deafness, or **epilepsy** in these infants.

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Genital herpes

Genital herpes, which is usually caused by herpes simplex virus type 2 (HSV-2), is a sexually transmitted disease that causes painful sores on the genitals. Women who have their first outbreak of genital herpes during pregnancy are at high risk of **miscarriage** or delivering a low birth weight baby. The infection can be passed to the infant at the time of delivery if the mother has an active sore. The most serious risk to the infant is the possibility of developing HSV-2 **encephalitis**, an inflammation of the brain, with symptoms of irritability and poor feeding.

Hepatitis B

Hepatitis B is a contagious virus that causes liver damage and is a leading cause of chronic **liver disease** and **cirrhosis**. Approximately 20,000 infants are born each year to mothers who test positive for the hepatitis B virus. These infants are at high risk for developing hepatitis B infection through exposure to their mothers' blood during delivery.

Human immunodeficiency virus (HIV)

Human **immunodeficiency** virus (HIV) is a serious, contagious virus that causes acquired immunodeficiency syndrome (**AIDS**). About one-fourth of pregnant women with HIV pass the infection on to their newborn infants. An infant with HIV usually develops AIDS and dies before the age of two.

Human papillomavirus

Human papillomavirus (HPV) is a sexually transmitted disease that causes **genital warts** and can increase the risk of developing some cancers. HPV appears to be transferred from the mother to the infant during the birth process.

Rubella (German measles)

Rubella is a virus that causes German **measles**, an illness that includes rash, fever, and symptoms of an upper respiratory tract infection. Most people are exposed to rubella during childhood and develop antibodies to the virus so they will never get it again. Rubella infection during early pregnancy can pass through the placenta to the developing infant and cause serious **birth defects** including heart abnormalities, mental retardation, blindness, and deafness.

Streptococcus

Group B streptococcus (GBS) infection is the most common bacterial cause of infection and **death** in newborn infants. Although rates have declined in the United States since the introduction of **antibiotics** to at-risk women during labor in the 1980s, about 1,600 cases and 80 newborn deaths still occur each year. In women, GBS can cause vaginitis and urinary tract infections. Both infections can cause premature birth and the bacteria can be transferred to the infant in the uterus or during delivery. GBS causes pneumonia, **meningitis**, and other serious infections in infants.

Syphilis

Syphilis is a sexually transmitted bacterial infection that can be transferred from a mother to an infant through the placenta before birth. Up to 50% of infants born to mothers with syphilis will be premature, stillborn, or will die shortly after birth. Infected infants may have severe birth defects. Those infants who survive infancy may develop symptoms of syphilis up to two years later.

Diagnosis

Chlamydia

Chlamydial bacteria can be diagnosed by taking a cotton swab sample of the cervix and vagina during the third trimester of the pregnancy. Chlamydial cell cultures take three to seven days to grow but many laboratories are not equipped to run the tests necessary to confirm the diagnosis.

Cytomegalovirus

Past or recent infection with CMV can be identified by antibody tests and CMV can be grown from body fluids.

Genital herpes

The appearance of a genital sore is enough to suspect an outbreak of genital herpes. The sore can be cultured and tested to confirm that HSV-2 is present.

Hepatitis B

A blood test can be used to screen pregnant women for the hepatitis B surface antigen (HBsAg) in prenatal health programs.

Human immunodeficiency virus (HIV)

HIV can be detected using a blood test and is part of most prenatal screening programs.

Human papillomavirus

HPV causes the growth of **warts** in the genital area. The wart tissue can be removed with a scalpel

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and tested to determine what type of HPV virus caused the infection.

Rubella (German measles)

Pregnant women are usually tested for antibodies to rubella, which would indicate that they have been previously exposed to the virus and therefore would not develop infection during pregnancy if exposed.

Streptococcus

GBS can be detected by a vaginal or rectal swab culture, and sometimes from a **urine culture**. Blood tests can be used to confirm GBS infection in infants who exhibit symptoms.

Syphilis

Pregnant women are usually tested for syphilis as part of the prenatal screening.

Treatment

Chlamydia

Pregnant women can be treated during the third trimester with oral erythromycin, for seven–14 days depending on the dose used. Newborn infants can be treated with erythromycin liquid for 10–14 days at a dosage determined by their body weight.

Cytomegalovirus

No drugs or vaccines are currently available for prevention or treatment of CMV.

Genital herpes

The **antiviral drugs** acyclovir or famciclovir can be administered to the mother during pregnancy. Little is known about the risks of these drugs to the fetus, however, the risk of birth defects does not seem to be any higher than for women who do not take these medications. Infants with suspected HSV-2 can be treated with acyclovir. Delivery of the infant by **cesarean section** is recommended if the mother has an active case of genital herpes.

Hepatitis B

Infants born to mothers who test positive to the HBsAg test should be treated with hepatitis B immune globulin at birth to give them immediate protection against developing hepatitis B. These infants, as well as all infants, should also receive a series of three hepatitis B vaccine injections as part of their routine immunizations.

Human immunodeficiency virus (HIV)

Recent studies have shown that prenatal care and HIV testing before delivery are major opportunities to prevent perinatal HIV infection. Pregnant women with HIV should be treated as early in the pregnancy as possible with zidovudine (AZT). Other newer drugs designed to treat HIV/AIDS also may be used during pregnancy with the knowledge that these drugs may have unknown effects on the infant. The risks and benefits of such treatments need to be discussed. Infants born with HIV should receive aggressive drug treatment to prevent development of AIDS.

Human papillomavirus

Genital warts are very difficult to treat and frequently recur even after treatment. They can be removed by **cryotherapy** (freezing), laser or electrocauterization (burning), or surgical excision (cutting) of the warts. Some medications (imiquimod 5% cream, podophyllin, trichloroacetic acid or topical 5-fluorouracil) can be applied to help dissolve genital warts. Cesarean delivery rather than vaginal delivery seems to reduce the risk of transmission of HPV from mothers to infants.

Rubella (German measles)

No treatment is available. Some health care providers may recommend giving the mother an injection of immune globulin (to boost the immune system to fight off the virus) if she is exposed to rubella early in the pregnancy. However, no evidence to support the use of these injections exists. Exposure to rubella early in pregnancy poses a high risk that the infant will have serious birth defects. Termination of the pregnancy may be considered. Women who have not been previously exposed to rubella will usually be vaccinated immediately after the first pregnancy to protect infants of future pregnancies.

Streptococcus

Pregnant women diagnosed with GBS late in the pregnancy should be treated with antibiotics injected intravenously to prevent **premature labor**. In 2003, the Centers for Disease Control and Prevention (CDC) issued revised guidelines for preventing perinatal GBS disease. They began recommending that women not only be tested as soon as they learn of their pregnancy, but again at 35 to 37 weeks gestation. The CDC also recommended updated **prophylaxis** regimens for women with penicillin **allergies**, as well as new guidelines for patients with threatened preterm deliveries and other new recommendations. If transmission of

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GBS to the newborn infant already is suspected or if the baby develops symptoms of infection, infants often are treated with antibiotics.

Syphilis

Antibiotic therapy, usually penicillin, given early in the pregnancy can be used to treat the infection and may prevent transmission to the infant.

Prognosis

Chlamydia

Without treatment, the most serious consequences of chlamydial infection are related to complications of premature delivery. Treatment of the mother with antibiotics during the third trimester can prevent premature delivery and the transfer of the infection to the baby. Infants treated with antibiotics for eye infection or pneumonia generally recover.

Cytomegalovirus

The chance for recovery after exposure to CMV is very good for both the mother and the infant. Exposure to CMV can be serious and even life threatening for mothers and infants whose immune systems are compromised, for example those receiving **chemotherapy** or who have HIV/AIDS. Those infants who develop birth defects after CMV exposure may have serious, lifelong complications.

Genital herpes

Once a woman or infant is infected, outbreaks of genital herpes sores can recur at any point during their lifetimes.

Hepatitis B

Infants treated at birth with immune globulin and the series of vaccinations will be protected from development of hepatitis B infection. Infants infected with hepatitis B develop a chronic, mild form of hepatitis and are at increased risk for developing liver disease.

Human immunodeficiency virus (HIV)

Treatment with AZT during pregnancy significantly reduces the chance that the infant will be infected with HIV from the mother.

Human papillomavirus

Once infected with HPV, there is a lifelong risk of developing warts and an increased risk of some cancers.

KEY TERMS

Cesarean section—A surgical procedure in which an incision is made in a woman's abdomen to deliver the infant from the uterus.

Ectopic pregnancy—A condition that ends in miscarriage, in which the fertilized ovum attaches somewhere other than in the uterus (for example in the fallopian tube or abdomen).

Encephalitis—Inflammation or swelling of the brain.

Perinatal—The period of time around the time of pregnancy and delivery.

Pneumonia—An infection and inflammation of the lungs that usually causes shortness of breath, cough, fever, and chest pain.

Rubella (German measles)

Infants exposed to rubella virus in the uterus are at high risk for severe birth defects including heart defects, blindness, and deafness.

Streptococcus

Infection of the urinary tract or genital tract of pregnant women can cause premature birth. Infants infected with GBS can develop serious, life-threatening infections.

Syphilis

Premature birth, birth defects, or the development of serious syphilis symptoms is likely to occur in untreated pregnant women.

Prevention

Use of a barrier method of contraceptive (condom) can prevent transmission of some of the infections. Intravenous drug use and sexual intercourse with infected partners increases the risks of exposure to most of these infections. Pregnant women can be tested for many of the bacterial or viral infections described; however, effective treatment may not be available to protect the infant. New studies show that a woman's nutritional status may contribute to her ability to fight off infections, particularly in cases of **malnutrition**. Proper prenatal care may improve outcomes and prevent some infections.

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Resources

PERIODICALS

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Altha Roberts Edgren
Teresa G. Odle

Periodic paralysis

Definition

Periodic **paralysis** (PP) is the name for several rare, inherited muscle disorders marked by temporary weakness, especially following rest, sleep, or **exercise**.

Description

Periodic paralysis disorders are genetic disorders that affect muscle strength. There are two major forms, hypokalemic and hyperkalemic, each caused by defects in different genes.

In hypokalemic PP, the level of potassium in the blood falls in the early stages of a paralytic attack, while in hyperkalemic PP, it rises slightly or is normal. (The root of both words, "kali," refers to potassium.) Hyperkalemic PP is also called potassium-sensitive PP.

Causes and symptoms

Causes

Both forms of PP are caused by inheritance of defective genes. Both genes are dominant, meaning that only one copy of the defective gene is needed for a person to develop the disease. A parent with the gene has a 50% chance of passing it along to each offspring, and the likelihood of passing it on is unaffected by the results of previous pregnancies.

The gene for hypokalemic PP is present equally in both sexes, but leads to noticeable symptoms more often in men than in women. The normal gene is responsible for a muscle protein controlling the flow of **calcium** during muscle contraction.

The gene for hyperkalemic PP affects virtually all who inherit it, with no difference in male-vs.-female expression. The normal gene is responsible for a muscle protein controlling the flow of **sodium** during muscle contraction.

Symptoms

The attacks of weakness in hypokalemic PP usually begin in late childhood or early adolescence and often become less frequent during middle age. The majority of patients develop symptoms before age 16. Since they begin in the school years, the symptoms of hypokalemic PP are often first seen during physical education classes or after-school sports, and may be mistaken for laziness, or lack of interest on the part of the child.

Attacks are most commonly brought on by:

- strenuous exercise followed by a short period of rest
- large meals, especially ones rich in carbohydrates or salt
- emotional stress
- alcohol use
- infection
- pregnancy

The weakness from a particular attack may last from several hours to as long as several days, and may be localized to a particular limb, or might involve the entire body.

The attacks of weakness of hyperkalemic PP usually begin in infancy or early childhood, and may become less severe later in life. As in the hypokalemic form, attacks are brought on by **stress**, **pregnancy**, and exercise followed by rest. In contrast, though, hyperkalemic attacks are not associated with a heavy meal but rather with missing a meal, with high potassium intake, or use of glucocorticoid drugs such as prednisone. (Glucocorticoids are a group of **steroids** that regulate metabolism and affect muscle tone.)

Weakness usually lasts less than three hours, and often persists for only several minutes. The attacks are usually less severe, but more frequent, than those of the hypokalemic form. Weakness usually progresses from the lower limbs to the upper, and may involve the facial muscles as well.

Diagnosis

Diagnosis of either form of PP begins with a careful medical history and a complete physical and **neurological exam**. A family medical history may reveal other affected relatives. Blood and urine tests done at

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the onset of an attack show whether there are elevated or depressed levels of potassium. Electrical tests of muscle and a muscle biopsy show characteristic changes.

Challenge tests, to aid in diagnosis, differ for the two forms. In hypokalemic PP, an attack of weakness can be brought on by administration of glucose and insulin, with exercise if necessary. An attack of hyperkalemic PP can be induced with administration of potassium after exercise during **fasting**. These tests are potentially hazardous and require careful monitoring.

Genetic tests are available at some research centers and are usually recommended for patients with a known family history. However, the number of different possible mutations leading to each form is too great to allow a single comprehensive test for either form, thus limiting the usefulness of **genetic testing**.

Treatment

Severe respiratory weakness from hypokalemic PP may require intensive care to ensure adequate ventilation. Potassium chloride may be given by mouth or intravenously to normalize blood levels.

Attacks requiring treatment are much less common in hyperkalemic PP. Glucose and insulin may be prescribed. Eating carbohydrates may also relieve attacks.

Prognosis

Most patients learn to prevent their attacks well enough that no significant deterioration in the quality of life occurs. Strenuous exercise must be avoided, however. Attacks often lessen in severity and frequency during middle age. Frequent or severe attacks increase the likelihood of permanent residual weakness, a risk in both forms of periodic paralysis.

Prevention

There is no way to prevent the occurrence of either disease in a person with the gene for the disease. The likelihood of an attack of either form of PP may be lessened by avoiding the triggers (the events or combinations of circumstances which cause an attack) for each.

Hypokalemic PP attacks may be prevented with use of acetazolamide (or another carbonic anhydrase inhibitor drug) or a diuretic to help retain potassium in the bloodstream. These attacks may also be prevented by avoiding such triggers as salty food, large meals, a high-carbohydrate diet, and strenuous exercise.

KEY TERMS

Gene—A biologic unit of heredity transmitted from parents to offspring.

Attacks of hyperkalemic PP may be prevented with frequent small meals high in carbohydrates, and the avoidance of foods high in potassium such as orange juice or bananas. Acetazolamide or thiazide (a diuretic) may be prescribed.

ORGANIZATIONS

Muscular Dystrophy Association, 3300 East Sunrise Drive, Tucson, AZ, 85718, (800) 572-1717, http://www.mdausa.org.

Periodic Paralysis Association, 155 West 68th St., Suite 17, New York, NY, 10023, (407) 339-9499, http://www.periodicparalysis.org.

Richard Robinson

Periodontal disease

Definition

Periodontal diseases are a group of diseases that affect the tissues that support and anchor the teeth. Left untreated, periodontal disease results in the destruction of the gums, alveolar bone (the part of the jaws where the teeth arise), and the outer layer of the tooth root.

Description

Periodontal disease is usually seen as a chronic inflammatory disease. An acute infection of the periodontal tissue may occur, but is not usually reported to the dentist. The tissues that are involved in periodontal diseases are the gums, which include the gingiva, periodontal ligament, cementum, and alveolar bone. The gingiva is a pink-colored mucus membrane that covers parts of the teeth and the alveolar bone. The periodontal ligament is the main part of the gums. The cementum is a calcified structure that covers the lower parts of the teeth. The alveolar bone is a set of ridges from the jaw bones (maxillary and mandible) in which the teeth are embedded. The main area involved in periodontal disease is the gingival sulcus, a pocket between the teeth and the gums. Several distinct forms of periodontal disease

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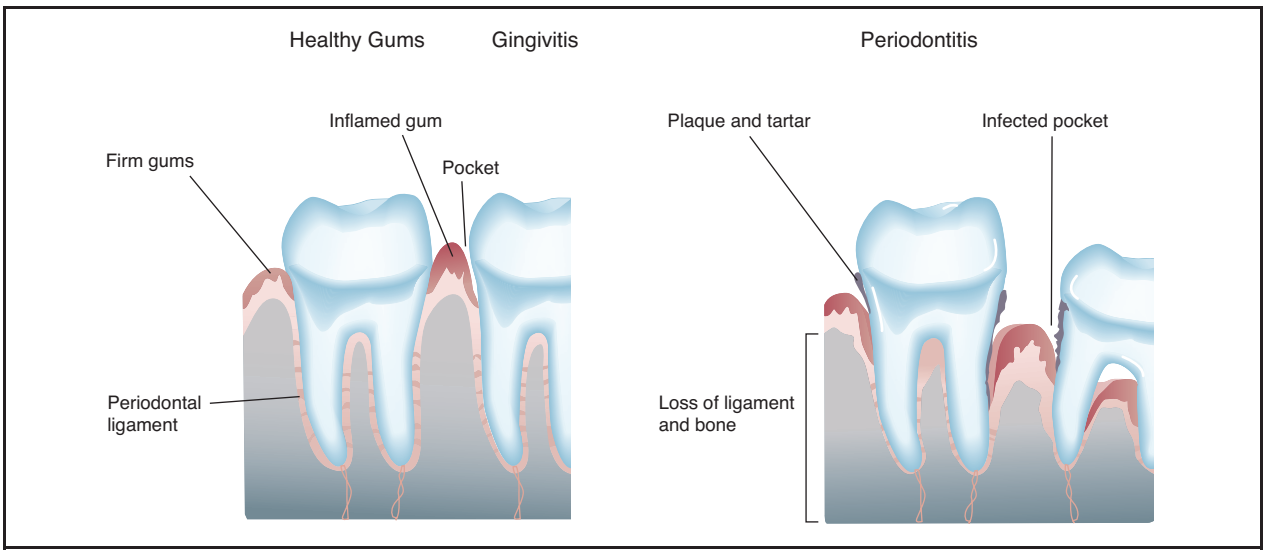

Healthy gums support the teeth. When gingivitis goes untreated, the gums become weak and pockets form around the teeth. Plaque and tartar build up in the pockets, the gum recedes, and periodontitis occurs. *((Illustration by Argosy, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

are known. These are gingivitis, acute necrotizing ulcerative gingivitis, adult periodontitis, and localized juvenile periodontitis. Although periodontal disease is thought to be widespread, serious cases of periodontitis are not common. Gingivitis is also one of the early signs of leukemia in some children.

Gingivitis

Gingivitis is an inflammation of the outermost soft tissue of the gums. The gingivae become red and inflamed, lose their normal shape, and bleed easily. Gingivitis may remain a chronic disease for years without affecting other periodontal tissues. Chronic gingivitis may lead to a deepening of the gingival sulcus. Acute necrotizing ulcerative gingivitis is mainly seen in young adults. This form of gingivitis is characterized by painful, bleeding gums, and **death** (necrosis) and erosion of gingival tissue between the teeth. It is thought that **stress**, **malnutrition**, **fatigue**, and poor **oral hygiene** are among the causes for acute necrotizing ulcerative gingivitis.

Adult periodontitis

Adult periodontitis is the most serious form of the periodontal diseases. It involves the gingiva, periodontal ligament, and alveolar bone. A deep periodontal pocket forms between the teeth, the cementum, and the gums. Plaque, calculus, and debris from food and other sources collect in the pocket. Without treatment, the periodontal ligament can be destroyed and resorption of the alveolar bone occurs. This allows the teeth to move more freely and eventually results in the loss of teeth. Most cases of adult periodontitis are chronic, but some cases occur in episodes or periods of tissue destruction.

Localized juvenile periodontitis

Localized juvenile periodontitis is a less common form of periodontal disease and is seen mainly in young people. Primarily, localized juvenile periodontitis affects the molars and incisors. Among the distinctions that separate this form of periodontitis are the low incidence of bacteria in the periodontal pocket, minimal plaque formation, and mild inflammation.

Herpetic gingivostomatitis

Herpes infection of the gums and other parts of the mouth is called herpetic gingivostomatitis and is frequently grouped with periodontal diseases. The infected areas of the gums turn red in color and have whitish herpetic lesions. There are two principal differences between this form of periodontal diseases and most other forms. Herpetic gingivostomatitis is caused by a virus, Herpes simplex, not by bacteria, and the viral infection tends to heal by itself in approximately two weeks. Also, herpetic gingivostomatitis is infectious to other people who come in contact with the herpes lesions or saliva that contains virus from the lesion.

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An extreme case of juvenile periodontitis. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Gingivitis, an inflammation of the gums, is a common periodontal disease. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Pericoronitis

Pericoronitis is a condition found in children who are in the process of producing molar teeth. The disease is seen more frequently in the lower molar teeth. As the molar emerges, a flap of gum still covers the tooth. The flap of gum traps bacteria and food, leading to a mild irritation. If the upper molar fully emerges before the lower one, it may bite down on the flap during chewing. This can increase the irritation of the flap and lead to an infection. In bad cases, the infection can spread to the neck and cheeks.

Desquamative gingivitis

Desquamative gingivitis occurs mainly in postmenopausal women. The cause of the disease is not understood. The outer layers of the gums slough off, leaving raw tissue and exposed nerves.

Trench mouth

Trench mouth is an acute, necrotizing (causing tissue death), ulcerating (causing open sores) form of gingivitis. It causes **pain** in the affected gums. **Fever** and fatigue are usually present also. Trench mouth, also known as Vincent's disease, is a complication of mild cases of gingivitis. Frequently, poor oral hygiene is the main cause. Stress, an unbalanced diet, or lack of sleep are frequent cofactors in the development of trench mouth. This form of periodontal disease is more common in people who smoke. The term "trench mouth" was created in World War I, when the disease was common in soldiers who lived in the trenches. Symptoms of trench mouth appear suddenly. The initial symptoms include painful gums and foul breath. Gum tissue between teeth becomes infected and dies, and starts to disappear. Often, what appears to be remaining gum is dead tissue. Usually, the gums bleed easily, especially when chewing. The pain can increase to the point where eating and swallowing become difficult. Inflammation or infection from trench mouth can spread to nearby tissues of the face and neck.

Periodontitis

Periodontitis is a condition in which gingivitis has extended down around the tooth and into the supporting bone structure. Periodontitis is also called pyorrhea. Plaque and tarter buildup sometimes lead to the formation of large pockets between the gums and teeth. When this happens, anaerobic bacteria grow in the pockets. The pockets eventually extend down around the roots of the teeth where the bacteria cause damage to the bone structure supporting the teeth. The teeth become loose and tooth loss can result. Some medical conditions are associated with an increased likelihood of developing periodontitis. These diseases include diabetes, **Down syndrome**, Crohn's disease, **AIDS**, and any disease that reduces the number of white blood cells in the body for extended periods of time.

Causes and symptoms

Several factors play a role in the development of periodontal disease. The most important are age and oral hygiene. The number and type of bacteria present on the gingival tissues also play a role in the development of periodontal diseases. The presence of certain species of bacteria in large enough numbers in the gingival pocket and related areas correlates with the development of periodontal disease. Also, removal of the bacteria correlates with reduction or elimination of

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disease. In most cases of periodontal disease, the bacteria remain in the periodontal pocket and do not invade surrounding tissue.

The mechanisms by which bacteria in the periodontal pocket cause tissue destruction in the surrounding region are not fully understood. Several bacterial products that diffuse through tissue are thought to play a role in disease formation. Bacterial endotoxin is a toxin produced by some bacteria that can kill cells. Studies show that the amount of endotoxin present correlates with the severity of periodontal disease. Other bacterial products include proteolytic enzymes, molecules that digest protein found in cells, thereby causing cell destruction. The immune response has also been implicated in tissue destruction. As part of the normal immune response, white blood cells enter regions of inflammation to destroy bacteria. In the process of destroying bacteria, periodontal tissue is also destroyed.

Gingivitis usually results from inadequate oral hygiene. Proper brushing of the teeth and flossing decreases plaque buildup. The bacteria responsible for causing gingivitis reside in the plaque. Plaque is a sticky film that is largely made from bacteria. Tartar is plaque that has hardened. Plaque can turn into tartar in as little as three days if not brushed off. Tartar is difficult to remove by brushing. Gingivitis can be aggravated by hormones, and sometimes becomes temporarily worse during **pregnancy**, **puberty**, and when the patient is taking birth control pills. Interestingly, some drugs used to treat other conditions can cause an overgrowth of the gingival tissue that can result in gingivitis because plaque builds up more easily. Drugs associated with this condition are phenytoin, used to treat seizures; cyclosporin, given to organ transplant patients to reduce the likelihood of organ rejection; and **calcium** blockers, used to treat several different heart conditions. **Scurvy**, a vitamin C deficiency, and **pellagra**, a niacin deficiency, can also lead to bleeding gums and gingivitis.

The initial symptoms of periodontitis are bleeding and inflamed gums, and **bad breath**. Periodontitis follows cases of gingivitis, which may not be severe enough to cause a patient to seek dental help. Although the symptoms of periodontitis are also seen in other forms of periodontal diseases, the key characteristic in periodontitis is a large pocket that forms between the teeth and gums. Another characteristic of periodontitis is that pain usually does not develop until late in the disease, when a tooth loosens or an **abscess** forms.

KEY TERMS

Anaerobic bacteria—Microorganisms that grow in the absence of oxygen.

Inflammation—A painful redness and swelling of an area of tissue in response to infection or injury.

Diagnosis

Diagnosis is made by observation of infected gums. Usually, a dentist is the person to diagnose and characterize the various types of periodontal disease. In cases such as acute herpetic gingivostomatitis, there are characteristic herpetic lesions. Many of the periodontal diseases are distinguished based on the severity of the infection and the number and type of tissues involved.

Diagnosis of periodontitis includes measuring the size of the pockets formed between the gums and teeth. Normal gingival pockets are shallow. If periodontal disease is severe, jaw bone loss will be detected in x-ray images of the teeth. If too much bone is lost, the teeth become loose and can change position. This will also be seen in x-ray images.

Treatment

Tartar can only be removed by professional dental treatment. Following treatment, periodontal tissues usually heal quickly. Gingivitis caused by vitamin deficiencies is treated by administering the needed vitamin. There are no useful drugs to treat herpetic gingivostomatitis. Because of the pain associated with the herpes lesions, patients may not brush their teeth while the lesions are present. Herpes lesions heal by themselves without treatment. After the herpetic lesions have disappeared, the gums usually return to normal if good oral hygiene is resumed. Pericoronitis is treated by removing debris under the flap of gum covering the molar. This operation is usually performed by a dentist. Surgery is used to remove molars that are not likely to form properly.

Treatment for trench mouth starts with a complete cleaning of the teeth, removal of all plaque, tartar, and dead tissue on the gums. For the first few days after cleaning, the patient uses hydrogen peroxide mouth washes instead of brushing. After cleaning, the gum tissue will be very raw and rinsing minimizes damage to the gums that might be caused by the toothbrush. For the first few days, the patient should visit the dentist daily for checkups and then every second or third day for the next two weeks. Occasionally, antibiotic treatment is used to supplement dental cleaning of the teeth

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and gums. Surgery may be needed if the damage to the gums is extensive and they do not heal properly.

Treatment of periodontitis requires professional dental care. The pockets around the teeth must be cleaned, and all tartar and plaque removed. In periodontitis, tartar and plaque can extend far down the tooth root. Normal dental hygiene, brushing and flossing, cannot reach deep enough to be effective in treating periodontitis. In cases where pockets are very deep (more than 0.25 in [0.64 cm] deep), surgery is required to clean the pocket. This is performed in a dental office. Sections of gum that are not likely to reattach to the teeth may be removed to promote healing by healthy sections of gum. Abscesses are treated with a combination of **antibiotics** and surgery. The antibiotics may be delivered directly to the infected gum and bone tissues to ensure that high concentrations of the antibiotic reach the infected area. Abscess infections, especially of bone, are difficult to treat and require long term antibiotic treatments to prevent a reoccurrence of infection.

Prognosis

Periodontal diseases can be easily treated. The gums usually heal and resume their normal shape and function. In cases where they do not, prostheses or surgery can restore most of the support for proper functioning of the teeth.

Prevention

Most forms of periodontal disease can be prevented with good dental hygiene. Daily use of a toothbrush and flossing is sufficient to prevent most cases of periodontal disease. Tartar control toothpastes help prevent tartar formation, but do not remove tartar once it has formed.

Resources

BOOKS

Mandell, Gerald L., et al. *Mandell, Douglas, and Bennett's Principles and Practice of Infectious Diseases*.

John T. Lohr, PhD

Periodontitis *see* **Periodontal disease**

Periorbital cellulitis *see* **Orbital and periorbital cellulitis**

Peripheral arterial disease *see* **Peripheral vascular disease**

Peripheral neuritis *see* **Peripheral neuropathy**

Peripheral neuropathy

Definition

The term peripheral neuropathy encompasses a wide range of disorders in which the nerves outside of the brain and spinal cord—peripheral nerves—have been damaged. Peripheral neuropathy may also be referred to as peripheral neuritis, or if many nerves are involved, the terms polyneuropathy or polyneuritis may be used.

Description

Peripheral neuropathy is a widespread disorder, and there are many underlying causes. Some of these causes are common, such as diabetes, and others are extremely rare, such as acrylamide **poisoning** and certain inherited disorders. The most common worldwide cause of peripheral neuropathy is **leprosy**. Leprosy is caused by the bacterium *Mycobacterium leprae*, which attacks the peripheral nerves of affected people. According to statistics gathered by the World Health Organization, an estimated 1.15 million people have leprosy worldwide.

Leprosy is extremely rare in the United States, where diabetes is the most commonly known cause of peripheral neuropathy. It has been estimated that more than 17 million people in the United States and Europe have diabetes-related polyneuropathy. Many neuropathies are idiopathic, meaning that no known cause can be found. The most common of the inherited peripheral neuropathies in the United States is Charcot-Marie-Tooth disease, which affects approximately 125,000 persons.

Another of the better known peripheral neuropathies is **Guillain-Barré syndrome**, which arises from complications associated with viral illnesses, such as cytomegalovirus, **Epstein-Barr virus**, and human **immunodeficiency** virus (HIV), or bacterial infection, including *Campylobacter jejuni* and **Lyme disease**. The worldwide incidence rate is approximately 1.7 cases per 100,000 people annually. Other well-known causes of peripheral neuropathies include chronic **alcoholism**, infection of the varicella-zoster virus, **botulism**, and poliomyelitis. Peripheral neuropathy may develop as a primary symptom, or it may be due to another disease. For example, peripheral neuropathy is only one symptom of diseases such as amyloid neuropathy, certain cancers, or inherited neurologic disorders. Such diseases may affect the peripheral nervous system (PNS) and the central nervous system (CNS), as well as other body tissues.

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To understand peripheral neuropathy and its underlying causes, it may be helpful to review the structures and arrangement of the PNS.

Nerve cells and nerves

Nerve cells are the basic building block of the nervous system. In the PNS, nerve cells can be threadlike–their width is microscopic, but their length can be measured in feet. The long, spidery extensions of nerve cells are called axons. When a nerve cell is stimulated, by touch or **pain**, for example, the message is carried along the axon, and neurotransmitters are released within the cell. Neurotransmitters are chemicals within the nervous system that direct nerve cell communication.

Certain nerve cell axons, such as the ones in the PNS, are covered with a substance called myelin. The myelin sheath may be compared to the plastic coating on electrical wires–it is there both to protect the cells and to prevent interference with the signals being transmitted. Protection is also given by Schwann cells, special cells within the nervous system that wrap around both myelinated and unmyelinated axons. The effect is similar to beads threaded on a necklace.

Nerve cell axons leading to the same areas of the body may be bundled together into nerves. Continuing the comparison to electrical wires, nerves may be compared to an electrical cord–the individual components are coated in their own sheaths and then encased together inside a larger protective covering.

Peripheral nervous system

The nervous system is classified into two parts: the CNS and the PNS. The CNS is made up of the brain and the spinal cord, and the PNS is composed of the nerves that lead to or branch off from the CNS.

The peripheral nerves handle a diverse array of functions in the body. This diversity is reflected in the major divisions of the PNS–the afferent and the efferent divisions. The afferent division is in charge of sending sensory information from the body to the CNS. When afferent nerve cell endings, called receptors, are stimulated, they release neurotransmitters. These neurotransmitters relay a signal to the brain, which interprets it and reacts by releasing other neurotransmitters.

Some of the neurotransmitters released by the brain are directed at the efferent division of the PNS. The efferent nerves control voluntary movements, such as moving the arms and legs, and involuntary movements, such as making the heart pump blood. The nerves controlling voluntary movements are called motor nerves, and the nerves controlling involuntary actions are referred to as autonomic nerves. The afferent and efferent divisions continually interact with each other. For example, if a person were to touch a hot stove, the receptors in the skin would transmit a message of heat and pain through the sensory nerves to the brain. The message would be processed in the brain and a reaction, such as pulling back the hand, would be transmitted via a motor nerve.

Neuropathy

NERVE DAMAGE. When an individual has a peripheral neuropathy, nerves of the PNS have been damaged. Nerve damage can arise from a number of causes, such as disease, physical injury, poisoning, or **malnutrition**. These agents may affect either afferent or efferent nerves. Depending on the cause of damage, the nerve cell axon, its protective myelin sheath, or both may be injured or destroyed.

CLASSIFICATION. There are hundreds of peripheral neuropathies. Reflecting the scope of PNS activity, symptoms may involve sensory, motor, or autonomic functions. To aid in diagnosis and treatment, the symptoms are classified into principal neuropathic syndromes based on the type of affected nerves and how long symptoms have been developing. Acute development refers to symptoms that have appeared within days, and subacute refers to those that have evolved over a number of weeks. Early chronic symptoms are those that take months to a few years to develop, and late chronic symptoms have been present for several years.

The classification system is composed of six principal neuropathic syndromes, which are subdivided into more specific categories. By narrowing down the possible diagnoses in this way, specific medical tests can be used more efficiently and effectively. The six syndromes and a few associated causes are listed below:

- Acute motor paralysis, accompanied by variable problems with sensory and autonomic functions. Neuropathies associated with this syndrome are mainly accompanied by motor nerve problems, but the sensory and autonomic nerves may also be involved. Associated disorders include Guillain-Barré syndrome, diphtheritic polyneuropathy, and porphyritic neuropathy.
- Subacute sensorimotor paralysis. The term sensorimotor refers to neuropathies that are mainly characterized by sensory symptoms, but also have a minor component of motor nerve problems. Poisoning with heavy metals (e.g., lead, mercury, and arsenic),

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chemicals, or drugs are linked to this syndrome. Diabetes, Lyme disease, and malnutrition are also possible causes.

- Chronic sensorimotor paralysis. Physical symptoms may resemble those in the above syndrome, but the time scale of symptom development is extended. This syndrome encompasses neuropathies arising from cancers, diabetes, leprosy, inherited neurologic and metabolic disorders, and hypothyroidism.
- Neuropathy associated with mitochondrial diseases. Mitochondria are organelles–structures within cells–responsible for handling a cell's energy requirements. If the mitochondria are damaged or destroyed, the cell's energy requirements are not met and it can die.
- Recurrent or relapsing polyneuropathy. This syndrome covers neuropathies that affect several nerves and may come and go, such as Guillain-Barré syndrome, porphyria, and chronic inflammatory demyelinating polyneuropathy.
- Mononeuropathy or plexopathy. Nerve damage associated with this syndrome is limited to a single nerve or a few closely associated nerves. Neuropathies related to physical injury to the nerve, such as carpal tunnel syndrome and sciatica, are included in this syndrome.

Causes and symptoms

Typical symptoms of neuropathy are related to the type of affected nerve. If a sensory nerve is damaged, common symptoms include **numbness**, **tingling** in the area, a prickling sensation, or pain. Pain associated with neuropathy can be quite intense and may be described as cutting, stabbing, crushing, or burning. In some cases, a nonpainful stimulus may be perceived as excruciating or pain may be felt even in the absence of a stimulus. Damage to a motor nerve is usually indicated by weakness in the affected area. If the problem with the motor nerve has continued over a length of time, muscle shrinkage (atrophy) or lack of muscle tone may be noticeable. Autonomic nerve damage is most noticeable when an individual stands upright and experiences problems such as light-headedness or changes in blood pressure. Other indicators of autonomic nerve damage are lack of sweat, tears, and saliva; **constipation**; urinary retention; and **impotence**. In some cases, heart beat irregularities and respiratory problems can develop.

Symptoms may appear over days, weeks, months, or years. Their duration and the ultimate outcome of the neuropathy are linked to the cause of the nerve damage. Potential causes include diseases, physical injuries, poisoning, and malnutrition or alcohol **abuse**. In some cases, neuropathy is not the primary disorder, but a symptom of an underlying disease.

Disease

Diseases that cause peripheral neuropathies may either be acquired or inherited; in some cases, it is difficult to make that distinction. The diabetes-peripheral neuropathy link has been well established. A typical pattern of diabetes-associated neuropathic symptoms includes sensory effects that first begin in the feet. The associated pain or pins-and-needles, burning, crawling, or prickling sensations form a typical "stocking" distribution in the feet and lower legs. Other diabetic neuropathies affect the autonomic nerves and have potentially fatal cardiovascular complications.

Several other metabolic diseases have a strong association with peripheral neuropathy. Uremia, or **chronic kidney failure**, carries a 10–90% risk of eventually developing neuropathy, and there may be an association between liver failure and peripheral neuropathy. Accumulation of lipids inside blood vessels (**atherosclerosis**) can choke-off blood supply to certain peripheral nerves. Without oxygen and nutrients, the nerves slowly die. Mild polyneuropathy may develop in persons with low thyroid hormone levels. Individuals with abnormally enlarged skeletal extremities (acromegaly), caused by an overabundance of growth hormone, may also develop mild polyneuropathy.

Neuropathy can also result from severe vasculitides, a group of disorders in which blood vessels are inflamed. When the blood vessels are inflamed or damaged, blood supply to the nerve can be affected, injuring the nerve.

Both viral and bacterial infections have been implicated in peripheral neuropathy. Leprosy is caused by the bacteria *M. leprae*, which directly attack sensory nerves. Other bacterial illness may set the stage for an immune-mediated attack on the nerves. For example, one theory about Guillain-Barré syndrome involves complications following infection with *Campylobacter jejuni*, a bacterium commonly associated with **food poisoning**. This bacterium carries a protein that closely resembles components of myelin. The immune system launches an attack against the bacteria; but, according to the theory, the immune system confuses the myelin with the bacteria in some cases and attacks the myelin sheath as well. The underlying cause of neuropathy associated with Lyme disease is unknown; the bacteria may either promote

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an immune-mediated attack on the nerve or inflict damage directly.

Infection with certain viruses is associated with extremely painful sensory neuropathies. A primary example of such a neuropathy is caused by **shingles**. After a case of **chickenpox**, the causative virus, varicella-zoster virus, becomes inactive in sensory nerves. Years later, the virus may be reactivated. Once reactivated, it attacks and destroys axons. Infection with HIV is also associated with peripheral neuropathy, but the type of neuropathy that develops can vary. Some HIV-linked neuropathies are noted for myelin destruction rather than axonal degradation. Also, HIV infection is frequently accompanied by other infections, both bacterial and viral, that are associated with neuropathy.

Several types of peripheral neuropathies are associated with inherited disorders. These inherited disorders may primarily involve the nervous system, or the effects on the nervous system may be secondary to an inherited metabolic disorder. Inherited neuropathies can fall into several of the principal syndromes, because symptoms may be sensory, motor, or autonomic. The inheritance patterns also vary, depending on the specific disorder. The development of inherited disorders is typically drawn out over several years and may herald a degenerative condition–that is, a condition that becomes progressively worse over time. Even among specific disorders, there may be a degree of variability in inheritance patterns and symptoms. For example, Charcot-Marie-Tooth disease is usually inherited as an autosomal dominant disorder, but it can be autosomal recessive or, in rare cases, linked to the X chromosome. Its estimated frequency is approximately one in 2,500 people. Age of onset and sensory nerve involvement can vary between cases. The main symptom is a degeneration of the motor nerves in legs and arms, and resultant muscle atrophy. Other inherited neuropathies have a distinctly metabolic component. For example, in familial amyloid polyneuropathies, protein components that make up the myelin are constructed and deposited incorrectly.

Physical injury

Accidental falls and mishaps during sports and recreational activities are common causes of physical injuries that can result in peripheral neuropathy. The common types of injuries in these situations occur from placing too much pressure on the nerve, exceeding the nerve's capacity to stretch, blocking adequate blood supply of oxygen and nutrients to the nerve, and tearing the nerve. Pain may not always be immediately noticeable, and obvious signs of damage may take a while to develop.

These injuries usually affect one nerve or a group of closely associated nerves. For example, a common injury encountered in contact sports such as football is the "burner," or "stinger," syndrome. Typically, a stinger is caused by overstretching the main nerves that span from the neck into the arm. Immediate symptoms are numbness, tingling, and pain that travels down the arm, lasting only a minute or two. A single incident of a stinger is not dangerous, but recurrences can eventually cause permanent motor and sensory loss.

Poisoning

The poisons, or toxins, that cause peripheral neuropathy include drugs, industrial chemicals, and environmental toxins. Neuropathy that is caused by drugs usually involves sensory nerves on both sides of the body, particularly in the hands and feet, and pain is a common symptom. Neuropathy is an unusual side effect of medications; therefore, most people can use these drugs safely. A few of the drugs that have been linked with peripheral neuropathy include metronidazole, an antibiotic; phenytoin, an anticonvulsant; and simvastatin, a cholesterol-lowering medication.

Certain industrial chemicals have been shown to be poisonous to nerves (neurotoxic) following work-related exposures. Chemicals such as acrylamide, allyl chloride, and carbon disulfide have all been strongly linked to development of peripheral neuropathy. Organic compounds, such as N-hexane and toluene, are also encountered in work-related settings, as well as in glue-sniffing and solvent abuse. Either route of exposure can produce severe sensorimotor neuropathy that develops rapidly.

Heavy metals are the third group of toxins that cause peripheral neuropathy. Lead, arsenic, thallium, and mercury usually are not toxic in their elemental form, but rather as components in organic or inorganic compounds. The types of metal-induced neuropathies vary widely. Arsenic poisoning may mimic Guillain-Barré syndrome; lead affects motor nerves more than sensory nerves; thallium produces painful sensorimotor neuropathy; and the effects of mercury are seen in both the CNS and PNS.

Malnutrition and alcohol abuse

Burning, stabbing pains and numbness in the feet, and sometimes in the hands, are distinguishing features of alcoholic neuropathy. The level of alcohol consumption associated with this variety of peripheral neuropathy has been estimated as approximately 3 L of beer or 300 mL of liquor daily for three years. However, it is unclear whether alcohol alone is responsible for the

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neuropathic symptoms, because chronic alcoholism is strongly associated with malnutrition.

Malnutrition refers to an extreme lack of nutrients in the diet. It is unknown precisely which nutrient deficiencies cause peripheral neuropathies in alcoholics and famine and **starvation** patients, but it is suspected that the B **vitamins** have a significant role. For example, thiamine (vitamin B_1) deficiency is the cause of **beriberi**, a neuropathic disease characterized by **heart failure** and painful polyneuropathy of sensory nerves. **Vitamin E deficiency** seems to have a role in both CNS and PNS neuropathy.

Diagnosis

Clinical symptoms can indicate peripheral neuropathy, but an exact diagnosis requires a combination of medical history, medical tests, and possibly a process of exclusion. Certain symptoms can suggest a diagnosis, but more information is commonly needed. For example, painful, burning feet may be a symptom of alcohol abuse, diabetes, HIV infection, or an underlying malignant tumor, among other causes. Without further details, effective treatment would be difficult.

During a **physical examination**, an individual is asked to describe the symptoms very carefully. Detailed information about the location, nature, and duration of symptoms can help exclude some causes or even pinpoint the actual problem. The person's medical history may also provide clues as to the cause, because certain diseases and medications are linked to specific peripheral neuropathies. A medical history should also include information about diseases that run in the family, because some peripheral neuropathies are genetically linked. Information about hobbies, recreational activities, alcohol consumption, and work place activities can uncover possible injuries or exposures to poisonous substances.

The physical examination also includes blood tests, such as those that check levels of glucose and creatinine to detect diabetes and kidney problems, respectively. A blood count is also done to determine levels of different blood cell types. Iron, vitamin B_{12}, and other factors may be measured as well, to rule out malnutrition. More specific tests, such as an assay for heavy metals or poisonous substances, or tests to detect **vasculitis**, are not typically done unless there is reason to suspect a particular cause.

An individual with neuropathy may be sent to a doctor that specializes in nervous system disorders (neurologist). By considering the results of the physical examination and observations of the referring doctor, the neurologist may be able to narrow down the possible diagnoses. Additional tests, such as nerve conduction studies and **electromyography**, which tests muscle reactions, can confirm that nerve damage has occurred and may also be able to indicate the nature of the damage. For example, some neuropathies are characterized by destruction of the myelin. This type of damage is shown by slowed nerve conduction. If the axon itself has suffered damage, the nerve conduction may be slowed, but it will also be diminished in strength. Electromyography adds further information by measuring nerve conduction and muscle response, which determines whether the symptoms are due to a neuropathy or to a muscle disorder.

In approximately 10% of peripheral neuropathy cases, a nerve biopsy may be helpful. In this test, a small part of the nerve is surgically removed and examined under a microscope. This procedure is usually the most helpful in confirming a suspected diagnosis, rather than as a diagnostic procedure by itself.

Treatment

Treat the cause

Attacking the underlying cause of the neuropathy can prevent further nerve damage and may allow for a better recovery. For example, in cases of bacterial infection such as leprosy or Lyme disease, **antibiotics** may be given to destroy the infectious bacteria. Viral infections are more difficult to treat, because antibiotics are not effective against them. Neuropathies associated with drugs, chemicals, and toxins are treated in part by stopping exposure to the damaging agent. Chemicals such as ethylenediaminetetraacetic acid (EDTA) are used to help the body concentrate and excrete some toxins. Diabetic neuropathies may be treated by gaining better control of blood sugar levels, but chronic kidney failure may require dialysis or even kidney transplant to prevent or reduce nerve damage. In some cases, such as compression injury or tumors, surgery may be considered to relieve pressure on a nerve.

In a crisis situation, as in the onset of Guillain-Barré syndrome, plasma exchange, intravenous immunoglobulin, and **steroids** may be given. Intubation, in which a tube is inserted into the trachea to maintain an open airway, and ventilation may be required to support the respiratory system. Treatment may focus more on symptom management than on combating the underlying cause, at least until a definitive diagnosis has been made.

Supportive care and long-term therapy

Some peripheral neuropathies cannot be resolved or require time for resolution. In these cases, long-term

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KEY TERMS

Afferent—Refers to peripheral nerves that transmit signals to the spinal cord and the brain. These nerves carry out sensory function.

Autonomic—Refers to peripheral nerves that carry signals from the brain and that control involuntary actions in the body, such as the beating of the heart.

Autosomal dominant or autosomal recessive—Refers to the inheritance pattern of a gene on a chromosome other than X or Y. Genes are inherited in pairs–one gene from each parent. However, the inheritance may not be equal, and one gene may overshadow the other in determining the final form of the encoded characteristic. The gene that overshadows the other is called the dominant gene; the overshadowed gene is the recessive one.

Axon—A long, threadlike projection that is part of a nerve cell.

Central nervous system (CNS)—The part of the nervous system that includes the brain and the spinal cord.

Efferent—Refers to peripheral nerves that carry signals away from the brain and spinal cord. These nerves carry out motor and autonomic functions.

Electromyography—A medical test that assesses nerve signals and muscle reactions. It can determine if there is a disorder with the nerve or if the muscle is not capable of responding.

Inheritance pattern—Refers to dominant or recessive inheritance.

Motor—Refers to peripheral nerves that control voluntary movements, such as moving the arms and legs.

Myelin—The protective coating on axons.

Nerve biopsy—A medical test in which a small portion of a damaged nerve is surgically removed and examined under a microscope.

Nerve conduction—The speed and strength of a signal being transmitted by nerve cells. Testing these factors can reveal the nature of nerve injury, such as damage to nerve cells or to the protective myelin sheath.

Neurotransmitter—Chemicals within the nervous system that transmit information from or between nerve cells.

Peripheral nervous system (PNS)—Nerves that are outside of the brain and spinal cord.

Sensory—Refers to peripheral nerves that transmit information from the senses to the brain.

monitoring and supportive care is necessary. Medical tests may be repeated to chart the progress of the neuropathy. If autonomic nerve involvement is a concern, regular monitoring of the cardiovascular system may be carried out.

Because pain is associated with many of the neuropathies, a **pain management** plan may need to be mapped out, especially if the pain becomes chronic. As in any chronic disease, **narcotics** are best avoided. Agents that may be helpful in neuropathic pain include amitriptyline, carbamazepine, and capsaicin cream. **Physical therapy** and physician-directed exercises can help maintain or improve function. In cases in which motor nerves are affected, braces and other supportive equipment can aid an individual's ability to move about.

Prognosis

The outcome for peripheral neuropathy depends heavily on the cause. Peripheral neuropathy ranges from a reversible problem to a potentially fatal complication. In the best cases, a damaged nerve regenerates. Nerve cells cannot be replaced if they are killed, but they are capable of recovering from damage. The extent of recovery is tied to the extent of the damage and a person's age and general health status. Recovery can take weeks to years, because neurons grow very slowly. Full recovery may not be possible and it may also not be possible to determine the prognosis at the outset.

If the neuropathy is a degenerative condition, such as Charcot-Marie-Tooth disease, an individual's condition will become worse. There may be periods of time when the disease seems to reach a plateau, but cures have not yet been discovered for many of these degenerative diseases. Therefore, continued symptoms, potentially worsening to disabilities are to be expected.

A few peripheral neuropathies are eventually fatal. Fatalities have been associated with some cases

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of **diphtheria**, botulism, and others. Some diseases associated with neuropathy may also be fatal, but the ultimate cause of **death** is not necessarily related to the neuropathy, such as with **cancer**.

Prevention

Peripheral neuropathies are preventable only to the extent that the underlying causes are preventable. Steps that a person can take to prevent potential problems include vaccines against diseases that cause neuropathy, such as **polio** and diphtheria. Treatment for physical injuries in a timely manner can help prevent permanent or worsening damage to nerves. Precautions when using certain chemicals and drugs are well advised in order to prevent exposure to neurotoxic agents. Control of chronic diseases such as diabetes may also reduce the chances of developing peripheral neuropathy.

Although not a preventive measure, genetic screening can serve as an early warning for potential problems. Genetic screening is available for some inherited conditions, but not all. In some cases, presence of a particular gene may not mean that a person will necessarily develop the disease, because there may be environmental and other components involved.

ORGANIZATIONS

American Diabetes Association, 1701 North Beauregard Street, Alexandria, VA, 22311, (800) 342-2383, AskADA @diabetes.org, http://www.diabetes.org/.

The Myelin Project, P.O. Box 39, Pacific Palisades, 90272-0039, (310) 459-6218, (310) 230-4298, patti.chapman@myelin.org, http://www.myelin.org/contact.

The Neuropathy Association, Inc, 60 East 42nd Street, Suite 942, New York, NY, 10165, (212) 692-0662, (212) 692-0668, info@neuropathy.org, http://www.neuropathy.org.

Julia Barrett

Peripheral vascular disease

Definition

Peripheral **vascular disease** is a narrowing of blood vessels that restricts blood flow. It mostly occurs in the legs, but is sometimes seen in the arms.

Description

Peripheral vascular disease includes a group of diseases in which blood vessels become restricted or blocked. Typically, the patient has peripheral vascular disease from **atherosclerosis**. Atherosclerosis is a disease in which fatty plaques form in the inside walls of blood vessels. Other processes, such as **blood clots**, further restrict blood flow in the blood vessels. Both veins and arteries may be affected, but the disease is usually arterial. All the symptoms and consequences of peripheral vascular disease are related to restricted blood flow. Peripheral vascular disease is a progressive disease that can lead to **gangrene** of the affected area. Peripheral vascular disease may also occur suddenly if an **embolism** occurs or when a blot clot rapidly develops in a blood vessel already restricted by an atherosclerotic plaque, and the blood flow is quickly cut off.

Causes and symptoms

There are many causes of peripheral vascular disease. One major risk factor is **smoking** cigarettes. Other diseases predispose patients to develop peripheral vascular disease. These include diabetes, **Buerger's disease**, **hypertension**, and **Raynaud's disease**. The main symptom is **pain** in the affected area. Early symptoms include an achy, tired sensation in the affected muscles. Since this disease is seen mainly in the legs, these sensations usually occur when walking. The symptoms may disappear when resting. As the disease becomes worse, symptoms occur even during light exertion and, eventually, occur all the time, even at rest. In the severe stages of the disease the leg and foot may be cold to the touch and will feel numb. The skin may become dry and scaly. If the leg is even slightly injured, ulcers may form because, without a good blood supply, proper healing cannot take place. At the most severe stage of the disease, when the blood flow is greatly restricted, gangrene can develop in those areas lacking blood supply. In some cases, peripheral vascular disease occurs suddenly. This happens when an embolism rapidly blocks blood flow to a blood vessel. The patient will experience a sharp pain. followed by a loss of sensation in the affected area. The limb will become cold and numb, and loose color or turn bluish.

Diagnosis

Peripheral vascular disease can be diagnosed by comparing blood pressures taken above and below the point of pain. The area below the pain (downstream from the obstruction) will have a much lower or undetectable blood pressure reading. **Doppler ultrasonography** and **angiography** can also be used to diagnose and define this disease.

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KEY TERMS

Embolism—The blockage of a blood vessel by air, blood clot, or other foreign body.

Plaque—A deposit, usually of fatty material, on the inside wall of a blood vessel.

Treatment

If the person is a smoker, they should stop smoking immediately. **Exercise** is essential to treating this disease. The patient should walk until pain appears, rest until the pain disappears, and then resume walking. The amount of walking a patient can do should increase gradually as the symptoms improve. Ideally, the patient should walk 30–60 minutes per day. Infections in the affected area should be treated promptly. Surgery may be required to attempt to treat clogged blood vessels. Limbs with gangrene must be amputated to prevent the **death** of the patient.

Prognosis

The prognosis depends on the underlying disease and the stage at which peripheral vascular disease is discovered. Removal of risk factors, such as smoking, should be done immediately. In many cases, peripheral vascular disease can be treated successfully but coexisting cardiovascular problems may ultimately prove to be fatal.

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Avoid Deep Vein Thrombosis: Keep the Blood Flowing. MedicineNet Website, 2010. *www.medicinenet. com/script/main/art.asp?articlekey=40582* .

ORGANIZATIONS

American Heart Association, 7272 Greenville Ave., Dallas, TX, 75231, (301) 223-2307, (800) 242-8721, http://www.americanheart.org.

Centers for Disease Control (CDC). Division for Heart Disease and Stroke Prevention, 4770 Buford Hwy NE, Atlanta, GA, 30341-3717, 770-488-2424, www.cdc.gov/cholesterol/faqs.htm.

National Heart, Lung, and Blood Institute, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (204) 629-3246, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi.nih.gov.

Society of Interventional Radiology, 10201 Lee Highway, Suite 500, Fairfax, VA, 22030, 703-691-1805, http://www.sirweb.org.

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Peritoneal dialysis *see* **Dialysis, kidney**
Peritoneal endoscopy *see* **Laparoscopy**
Peritoneal fluid analysis *see* **Paracentesis**

Peritonitis

Definition

Peritonitis is an inflammation of the membrane which lines the inside of the abdomen and all of the internal organs. This membrane is called the peritoneum.

Description

Peritonitis may be primary (meaning that it occurs spontaneously, and not as the result of some other medical problem) or secondary (meaning that it results from some other condition). It is most often due to infection by bacteria, but may also be due to some kind of a chemical irritant (such as spillage of acid from the stomach, bile from the gall bladder and biliary tract, or enzymes from the pancreas during the illness called **pancreatitis**). Peritonitis has even been seen in patients who develop a reaction to the cornstarch used to powder gloves worn during surgery. Peritonitis with no evidence of bacteria, chemical irritant, or foreign body has occurred in such diseases as **systemic lupus erythematosus**, porphyria, and **familial Mediterranean fever**. When the peritoneum is contaminated by blood, the blood can both irritate the peritoneum and serve as a source of bacteria to cause an infection. Blood may leak into the abdomen due to a burst tubal **pregnancy**, an injury, or bleeding after surgery.

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Causes and symptoms

Primary peritonitis usually occurs in people who have an accumulation of fluid in their abdomens (**ascites**). Ascites is a common complication of severe **cirrhosis** of the liver (a disease in which the liver grows increasingly scarred and dysfunctional). The fluid that accumulates creates a good environment for the growth of bacteria.

Secondary peritonitis most commonly occurs when some other medical condition causes bacteria to spill into the abdominal cavity. Bacteria are normal residents of a healthy intestine, but they should have no way to escape and enter the abdomen, where they could cause an infection. Bacteria can infect the peritoneum due to conditions in which a hole (perforation) develops in the stomach (due to an ulcer eating its way through the stomach wall) or intestine (due to a large number of causes, including a ruptured appendix or a ruptured diverticulum). Bacteria can infect the peritoneum due to a severe case of **pelvic inflammatory disease** (a massive infection of the female organs, including the uterus and fallopian tubes). Bacteria can also escape into the abdominal cavity due to an injury that causes the intestine to burst, or an injury to an internal organ which bleeds into the abdominal cavity.

Symptoms of peritonitis include **fever** and abdominal **pain**. An acutely ill patient usually tries to lie very still, because any amount of movement causes excruciating pain. Often, the patient lies with the knees bent, to decrease strain on the tender peritoneum. There is often **nausea and vomiting**. The usual sounds made by the active intestine and heard during examination with a stethoscope will be absent, because the intestine usually stops functioning. The abdomen may be rigid and boardlike. Accumulations of fluid will be notable in primary peritonitis due to ascites. Other signs and symptoms of the underlying cause of secondary peritonitis may be present.

Diagnosis

A diagnosis of peritonitis is usually based on symptoms. Discovering the underlying reason for the peritonitis, however, may require some work. A blood sample will be drawn in order to determine the **white blood cell count**. Because white blood cells are produced by the body in an effort to combat foreign invaders, the white blood cell count will be elevated in the case of an infection. A long, thin needle can be used to take a sample of fluid from the abdomen in an effort to diagnose primary peritonitis. The types of immune cells present are usually characteristic in this form of peritonitis. X-ray films may be taken if there is some suspicion that a perforation exists. In the case of a perforation, air will have escaped into the abdomen and will be visible on the picture. When a cause for peritonitis cannot be found, an open exploratory operation on the abdomen (laparotomy) is considered to be a crucial diagnostic procedure, and at the same time provides the opportunity to begin treatment.

KEY TERMS

Ascites—An accumulation of fluid within the abdominal cavity.

Cirrhosis—A progressive liver disease in which the liver grows increasingly more scarred. The presence of scar tissue then interferes with liver function.

Diverticulum—An outpouching of the intestine.

Laparotomy—An open operation on the abdomen.

Pancreatitis—An inflammation of the pancreas.

Perforation—A hole.

Peritoneum—The membrane that lines the inside of the abdominal cavity, and all of the internal organs.

Treatment

Treatment depends on the source of the peritonitis, but an emergency laparotomy is usually performed. Any perforated or damaged organ is usually repaired at this time. If a clear diagnosis of pelvic inflammatory disease or pancreatitis can be made, however, surgery is not usually performed. Peritonitis from any cause is treated with **antibiotics** given through a needle in the vein, along with fluids to prevent **dehydration**.

Prognosis

Prognosis for untreated peritonitis is poor, usually resulting in **death**. With treatment, the prognosis is variable, dependent on the underlying cause.

Prevention

There is no way to prevent peritonitis, since the diseases it accompanies are usually not under the voluntary control of an individual. However, prompt treatment can prevent complications.

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Resources

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Fauci, Anthony S., et al., eds. *Harrison's Principles of Internal Medicine*. 17th ed. New York: McGraw–Hill Professional, 2008.

Rosalyn Carson-DeWitt, MD

Permanent pacemakers *see* **Pacemakers**

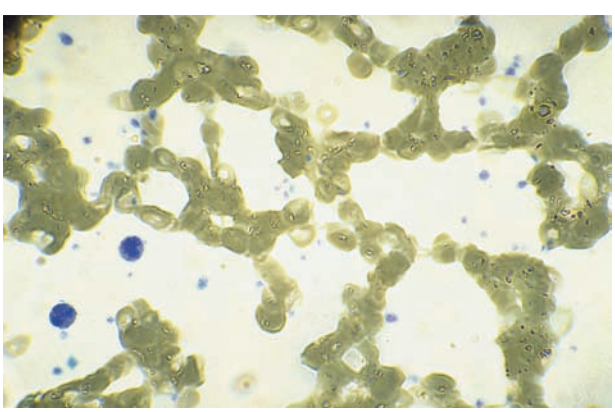
Pernicious anemia

Definition

Pernicious anemia is a disease in which the red blood cells are abnormally formed, due to an inability to absorb vitamin B_{12}. True pernicious anemia refers specifically to a disorder of atrophied parietal cells leading to absent intrinsic factor, resulting in an inability to absorb B_{12}.

Description

Vitamin B_{12}, or cobalamin, plays an important role in the development of red blood cells. It is found in significant quantities in liver, meats, milk and milk products, and legumes. During the course of the digestion of foods containing B_{12}, the B_{12} becomes attached to a substance called intrinsic factor. Intrinsic factor is produced by parietal cells that line the stomach. The B_{12}-intrinsic factor complex then enters the intestine, where the vitamin is absorbed into the bloodstream. In fact, B_{12} can only be absorbed when it is attached to intrinsic factor.



A smear of red blood cells indicating folic acid (vitamin B_{12}) deficiency. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

In pernicious anemia, the parietal cells stop producing intrinsic factor. The intestine is then completely unable to absorb B_{12}. So, the vitamin passes out of the body as waste. Although the body has significant amounts of stored B_{12}, this will eventually be used up. At this point, the symptoms of pernicious anemia will develop.

Pernicious anemia is most common among people from northern Europe and among African Americans. It is far less frequently seen among people from southern Europe and Asia. Pernicious anemia occurs in equal numbers in both men and women. Most patients with pernicious anemia are older, usually over 60. Occasionally, a child will have an inherited condition that results in defective intrinsic factor. Pernicious anemia seems to run in families, so that anyone with a relative diagnosed with the disease has a greater likelihood of developing it as well.

Causes and symptoms

Intrinsic factor is produced by specialized cells within the stomach called parietal cells. When these parietal cells shrink in size (atrophy), they produce less and less intrinsic factor. Eventually, the parietal cells stop functioning altogether. Other important products of parietal cells are also lessened, including stomach acid, and an enzyme involved in the digestion of proteins.

People with pernicious anemia seem to have a greater chance of having certain other conditions. These conditions include **autoimmune disorders**, particularly those affecting the thyroid, parathyroid, and adrenals. It is thought that the immune system, already out of control in these diseases, incorrectly becomes directed against the parietal cells. Ultimately, the parietal cells seem to be destroyed by the actions of the immune system.

As noted, true pernicious anemia refers specifically to a disorder of atrophied parietal cells leading to absent intrinsic factor, resulting in an inability to absorb B_{12}. However, there are other related conditions that result in decreased absorption of B_{12}. These conditions cause the same types of symptoms as true pernicious anemia. Other conditions that interfere with either the production of intrinsic factor, or the body's use of B_{12}, include conditions that require surgical removal of the stomach, or poisonings with corrosive substances which destroy the lining of the stomach. Certain structural defects of the intestinal system can result in an overgrowth of normal bacteria. These bacteria then absorb B_{12} themselves, for use in their own growth. Intestinal worms (especially one

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KEY TERMS

Anemia—A condition in which those elements of the blood responsible for oxygen delivery throughout the body (red blood cells, hemoglobin) are decreased in quantity or defective in some way.

Atrophy—Refers to the shrinking in size of an organ or cell.

Autoimmune disorder—A disorder in which the immune system, (responsible for fighting off such foreign invaders as bacteria and viruses), begins to attack and damage a part of the body as if it were foreign.

Hematopoietic system—The system in the body which is responsible for the production of blood cells.

Intrinsic factor—A substance produced by the parietal cells of the stomach. In order to be absorbed by the intestine, vitamin B_{12} must form a complex with intrinsic factor.

Parietal cells—Specific cells which line the inside of the stomach. These cells are responsible for producing intrinsic factor and hydrochloric acid.

Reticulocyte—An early, immature form of a red blood cell. Over time, the reticulocyte develops to become a mature, oxygen-carrying red blood cell.

called fish tapeworm) may also use B_{12}, resulting in anemia. Various conditions that affect the first part of the intestine (the ileum), from which B_{12} is absorbed, can also cause anemia due to B_{12} deficiency. These ilium-related disorders include tropical sprue, Whipple's disease, **Crohn's disease**, **tuberculosis**, and the Zollinger-Ellison syndrome.

Symptoms of pernicious anemia and decreased B_{12} affect three systems of the body: the system that is involved in the formation of blood cells (hematopoietic system); the gastrointestinal system; and the nervous system.

The hematopoietic system is harmed because B_{12} is required for the proper formation of red blood cells. Without B_{12}, red blood cell production is greatly reduced. Those red blood cells that are produced are abnormally large and abnormal in shape. Because red blood cells are responsible for carrying oxygen around the body, decreased numbers (termed anemia) result in a number of symptoms, including **fatigue**, **dizziness**, ringing in the ears, pale or yellowish skin, fast heart rate, enlarged heart with an abnormal heart sound (murmur) evident on examination, and chest **pain**.

Symptoms that affect the gastrointestinal system include a sore and brightly red tongue, loss of appetite, weight loss, **diarrhea**, and abdominal cramping.

The nervous system is severely affected when pernicious anemia goes untreated. Symptoms include **numbness**, **tingling**, or burning in the arms, legs, hands, and feet; muscle weakness; difficulty and loss of balance while walking; changes in reflexes; irritability, confusion, and depression.

Diagnosis

Diagnosis of pernicious anemia is suggested when a blood test reveals abnormally large red blood cells. Many of these will also be abnormally shaped. The earliest, least mature forms of red blood cells (reticulocytes) will also be low in number. White blood cells and platelets may also be decreased in number. Measurements of the quantity of B_{12} circulating in the bloodstream will be low.

Once these determinations are made, it will be important to diagnose the cause of the anemia. True pernicious anemia means that the parietal cells of the stomach are atrophied, resulting in decreased production of intrinsic factor. This diagnosis is made by the Schilling test. In this test, a patient is given radioactive B_{12} under two different sets of conditions: once alone, and once attached to intrinsic factor. Normally, large amounts of B_{12} are absorbed through the intestine, then circulate through the blood, and enter the kidneys, where a certain amount of B_{12} is then passed out in the urine. When a patient has pernicious anemia, the dose of B_{12} given by itself will not be absorbed by the intestine, so it will not pass into the urine. Therefore, levels of B_{12} in the urine will be low. When the B_{12} is given along with intrinsic factor, the intestine is able to absorb the vitamin. Urine levels of B_{12} will therefore be higher.

Treatment

Treatment of pernicious anemia requires the administration of lifelong injections of B_{12}. Vitamin B_{12} given by injection enters the bloodstream directly, and does not require intrinsic factor. At first, injections may need to be given several times a week, in

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order to build up adequate stores of the vitamin. After this, the injections can be given on a monthly basis. Other substances required for blood cell production may also need to be given, iron and vitamin C.

Prognosis

Prognosis is generally good for patients with pernicious anemia. Many of the symptoms improve within just a few days of beginning treatment, although some of the nervous system symptoms may take up to 18 months to improve. Occasionally, when diagnosis and treatment have been delayed for a long time, some of the nervous system symptoms may be permanent.

Because an increased risk of **stomach cancer** has been noted in patients with pernicious anemia, careful monitoring is necessary, even when all the symptoms of the original disorder have improved.

Resources

BOOKS

Fauci, Anthony S., et al., eds. *Harrison's Principles of Internal Medicine*. 17th ed. New York: McGraw–Hill Professional, 2008.

Rosalyn Carson-DeWitt, MD

Peroneal muscular atrophy *see* **Charcot-Marie-Tooth disease**

Peroxisomal disorders

Definition

Peroxisomal disorders are a group of congenital (existing from birth) diseases characterized by the absence of normal peroxisomes in the cells of the body. Peroxisomes are special parts (organelles) within a cell that contain enzymes responsible for critical cellular processes, including oxidation of fatty acids, biosynthesis of membrane phospholipids (plasmalogens), cholesterol, and bile acids, conversion of amino acids into glucose, reduction of hydrogen peroxide by catalase, and prevention of excess synthesis of oxalate (which can form crystals with **calcium**, resulting in **kidney stones**). Peroxisomal disorders are subdivided into two major categories. The first are disorders resulting from a failure to form intact, normal peroxisomes, resulting in multiple metabolic abnormalities, which are referred to as peroxisome biogenesis disorders (PBD) or as generalized peroxisomal disorders. The second category includes those disorders resulting from the deficiency of a single peroxisomal enzyme. There are about 25 peroxisomal disorders known, although the number of diseases that are considered to be separate, distinct peroxisomal disorders varies among researchers and health care practitioners.

Description

A cell can contain several hundred peroxisomes, which are round or oval bodies with diameters of about 0.5 micron, that contain proteins that function as enzymes in metabolic processes. By definition, a peroxisome must contain catalase, which is an enzyme that breaks down hydrogen peroxide.

Approximately 50 different biochemical reactions occur entirely or partially within a peroxisome. Some of the processes are anabolic, or constructive, resulting in the synthesis of essential biochemical compounds, including bile acids, cholesterol, plasmalogens, and docosahexanoic acid (DHA), which is a long chain fatty acid that is a component of complex lipids, including the membranes of the central nervous system. Other reactions are catabolic, or destructive, and lead to the destruction of some fatty acids, including very long chain fatty acids (VLCFAs, fatty acids with more than 22 carbon atoms in their chains), phytanic acid, pipecolic acid, and the prostoglandins. The peroxisome is involved in breaking down VLCFAs to lengths that the body can use or get rid of.

When VLCFAs accumulate due to abnormal functioning of the peroxisomes, they are disruptive to the structure and stability of certain cells, especially those associated with the central nervous system and the myelin sheath, which is the fatty covering of nerve fibers. The peroxisomal disorders that include effects on the growth of the myelin sheath are considered to be part of a group of genetic disorders referred to as leukodystrophies. While metachromatic leukodystrophy (MLD) usually has its onset in infants or juveniles, there have been reports of its onset in young adults.

There are many other metabolic deficiencies that can occur in those who have peroxisomal disorders, which result in other types of detrimental effects, and together result in the abnormalities associated with the peroxisomal disorders. Unfortunately, it is not known how these abnormalities, and combinations of abnormalities, cause the disabilities seen in those afflicted with the disease.

Peroxisomal disorders form a heterogeneous disease group, with different degrees of severity. Included in the group referred to as PBD are:

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- Zellweger syndrome (ZS), which is usually fatal within the first year of life,
- neonatal adrenoleukodystrophy (NALD), which is usually fatal within the first 10 years,
- infantile Refsum disease (IRD), which is not as devastating as ZS and NALD, as the children with this disorder with time and patience can develop some degree of motor, cognitive, and communication skills, although death generally occurs during the second decade of life.
- rhizomelic chondrodysplasia punctata (RCDP), which in its most severe form is fatal within the first year or two of life. However, survival into the teens has been known to occur. It is characterized by shortening of the proximal limbs (i.e., the legs from knee to foot, and the arms from elbow to hand).
- Zellweger-like syndrome, which is fatal in infancy, and is known to be a defect of three particular enzymes.

The differences among these disorders are continuous, with overlap between abnormalities. The range of disease abnormalities may be a result of a corresponding range of peroxisome failure; that is, in severe cases of ZS, the failure is nearly complete, while in IRD, there is some degree of peroxisome activity.

In peroxisomal single-enzyme disorders, the peroxisome is intact and functioning, but there is a defect in only one enzymatic process, with only one corresponding biochemical abnormality. However, these disorders can be as severe as those in which peroxisomal activity is nearly or completely absent.

X-linked **adrenoleukodystrophy** (X-ALD) is the most common of the peroxisomal disorders, affecting about one in 20,000 males. It is estimated that there are about 1,400 people in the United States with the disorder. In X–ALD there is a deficiency in the enzyme that breaks down VLCFAs, which then accumulate in the myelin and adrenal glands. Onset of X-ALD-related neurological symptoms occurs at about five–12 years of age, with **death** occurring within one to 10 years after onset of symptoms. In addition to physical abnormalities seen in other types of peroxisomal disorders, common symptoms of X-ALD also include behavioral changes such as abnormal withdrawal or aggression, poor memory, **dementia**, and poor academic performance. Other symptoms are muscle weakness and difficulties with hearing, speech, and vision. As the disease progresses, muscle tone deteriorates, swallowing becomes difficult and the patient becomes comatose. Unless treated with a diet that includes Lorenzo's oil, the disease will result in **paralysis**, **hearing loss**, blindness, **vegetative state**, and death. There are also milder forms of X-ALD: an adult onset ALD that typically begins between the ages of 21 and 35, and a form that is occasionally seen in women who are carriers of the disorder. In addition to X-ALD, there are at least 10 other single-enzyme peroxisomal disorders, each with its own specific abnormalities.

Causes and symptoms

Most peroxisomal disorders are inherited autosomal recessive diseases, with X-ALD as an exception. They occur in all countries, among all races and ethnic groups. They are extremely rare, with frequencies reported at one in 30,000 to one in 150,000, although these numbers are only estimates.

In general, developmental delay, **mental retardation**, and vision and hearing impairment are common in those who have these disorders. Acquisition of speech appears to be especially difficult, and because of the reduced communication abilities, **autism** is common in those who live longer. Peroxisomal disorder patients have decreased muscle tone (hypotonia), which in the most severe cases is generalized, while in less severe cases, is usually restricted to the neck and trunk muscles. Sometimes this lack of control is only noticeable by a curved back in the sitting position. Head control and independent sitting is delayed, with most patients unable to walk independently.

Failure to thrive is a common characteristic of patients with peroxisomal disorder, along with an enlarged liver, abnormalities in liver enzyme function, and loss of fats in stools (steatorrhea).

Peroxisomal disorders are also associated with facial abnormalities, including high forehead, frontal bossing (swelling), small face, low set ears, and slanted eyes. These characteristics may not be prominent in some children, and are especially difficult to identify in an infant.

Diagnosis

Since hearing and vision deficiencies may be difficult to identify in infants, peroxisomal disorders are usually detected by observations of failure to thrive, hypotonia, mental retardation, widely open fontanel, abnormalities in liver enzymes, and an enlarged liver. If peroxisomal disorders are suspected, blood plasma assays for VLCFAs, phytanic acid, and pipecolic acid are conducted. Additional tests include plasmalogen biosynthesis potential.

Treatment

For many of the peroxisomal disorders, there is no standard course of treatment, with supportive treatment

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KEY TERMS

Autosomal recessive inheritance—Two copies of an altered gene located on one of the autosomes must be present for an individual to be affected with the trait or condition determined by that gene. An affected individual (homozygote) has two parents who are unaffected but each parent carries the altered gene (heterozygote). The risk of two heterozygotes, or carriers, having an affected child is 25%, one in four, for each child that they have; similarly, there is a three in four chance that each child will not be affected. Males and females are at equal risk for being affected. Two affected individuals usually produce children, all of whom are affected as well.

Autosome—A chromosome not involved in sex determination.

Fontanel—One of the membranous intervals between the uncompleted angles of the parietal and neighboring bones of a fetal or young skull; so called because it exhibits a rhythmical pulsation.

Metabolic—Relating to the chemical changes in living cells.

Organelle—Specialized structure within a cell, which is separated from the rest of the cell by a membrane composed of lipids and proteins, where chemical and metabolic functions take place.

strategies focusing on alleviation of complications and symptoms. In general, most treatments that are attempted are dietary, whereby attempts are made to artificially correct biochemical abnormalities associated with the disorders. Therapies include supplementation of the diet with antioxidant **vitamins**, or limitation of intake of fatty acids, especially VLCFAs.

Another area of dietary therapy that is being investigated is the supplementation of the diet with pure DHA, given as early in life as possible, in conjunction with a normal well-balanced diet. Some results have indicated that if given soon enough during development, DHA therapy may prevent some of the devastating consequences of peroxisomal disorders, including brain damage and the loss of vision.

Other treatment strategies include addition of important missing chemicals. For example, in disorders where there is faulty adrenal function, replacement adrenal hormone therapy is used.

Any dietary changes should be monitored biochemically to determine if the supplements are having their desired effects and are not causing additional adverse effects.

Bone marrow transplants may be used to treat X-ALD, and can be effective if done early in the course of the childhood form of the disease.

Physical and psychological therapies are important for all types of peroxisomal disorders.

Alternative treatment

Patients with peroxisomal disorders, and particularly X-ALD, have been treated with a mixture of glycerol trioleate-glycerol trieucate (4:1 by volume), prepared from olive and rapeseed oils, and referred to as Lorenzo's oil (developed by parents of a son, Lorenzo, who had X-ALD, whose story was documented in the 1992 movie, *Lorenzo's Oil*), to decrease the levels of VLCFA. Other **diets** that have been tried include dietary supplementation with plasmalogen precursors to increase plasmalogen levels and with cholic acid to normalize bile acids. However, there has been only limited success demonstrated with the use of these treatments. More research is needed to determine the long-term safety and effectiveness of these treatment strategies.

Prognosis

Peroxisomal disorders range from life-threatening to cases in which people may function with some degree of mental and motor retardation. There is not yet a cure. Enzyme replacement therapies, including enzyme infusion, transplantation, and **gene therapy**, may hold promise for future advances in the treatment of these disorders. Research is being conducted to increase scientific understanding of these disorders and to find ways to prevent, treat, and cure them.

Prevention

Unfortunately not enough is yet known about these diseases to develop comprehensive strategies for prevention. **Genetic counseling** is recommended for known or suspected carriers. As genes are identified that result in the disorders, **genetic testing** is being developed to identify carriers, who then can manage their reproduction to avoid the possibility of children being born with these deficiencies. As the genetic bases for the disorders are defined, prenatal diagnosis and

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identification of carriers will be facilitated. For example, for X-ALD, diagnosis can be made from cultured skin fibroblasts or amniotic fluid cells. This allows prenatal diagnosis and carrier identification in 90% of those affected. More recently it has been shown that biochemical diagnosis can be performed through chorionic villi biopsy, a procedure performed very early in the first trimester of **pregnancy**.

Animal models of ZS and X-ADL have been developed and are providing researchers with methods to define pathogenic mechanisms and to evaluate new therapies.

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PeroxisomeDB Home. http://www.peroxisomedb.org/.

ORGANIZATIONS

National Institute of Neurological Disorders and Stroke (NINDS), NIH Neurological Institute, P. O. Box 5801, Bethesda, MD, 20824, (301) 496-5751, (800) 352-9424, http://www.ninds.nih.gov/.

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923, (800) 999-6673, http://www.rarediseases.org.

Judith Sims
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Persantine-thallium heart scan *see* **Thallium heart scan**

Personality disorders

Definition

Personality disorders are a group of mental disturbances defined by the fourth edition, text revision (2000) of the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM–IV*) as "enduring pattern[s] of inner experience and behavior" that are sufficiently rigid and deep–seated to bring a person into repeated conflicts with his or her social and occupational environment. *DSM–IV* specifies that these dysfunctional patterns must be regarded as nonconforming or deviant by the person's culture, and cause significant emotional **pain** and/or difficulties in relationships and occupational performance. In addition, the patient usually sees the disorder as being consistent with his or her self–image (ego–syntonic) and may blame others for his or her social, educational, or work–related problems.

Demographics

Personality disorders have their onset in late adolescence or early adulthood. Doctors rarely give a diagnosis of personality disorder to children on the grounds that children's personalities are still in the process of formation and may change considerably by the time they are in their late teens. In retrospect, however, many individuals with personality disorders could be judged to have shown evidence of the problems in childhood.

It is difficult to give close estimates of the percentage of the population that has personality disorders. Patients with certain personality disorders, including antisocial and borderline disorders, are more likely to get into trouble with the law or otherwise attract attention than are patients whose disorders chiefly affect their capacity for intimacy. On the other hand, some patients, such as those with narcissistic or obsessive–compulsive personality disorders, may be outwardly successful because their symptoms are useful within their particular occupations. It has, however, been estimated that about 15% of the general population of the United States has a personality disorder, with higher rates in poor or troubled neighborhoods. The rate of personality disorders among patients in psychiatric treatment is between 30% and 50%. It is possible for patients to have a so–called dual diagnosis; for example, they may have more than one personality disorder, or a personality disorder together with a substance–abuse problem.

Description

To meet the diagnosis of personality disorder, which is sometimes called character disorder, the patient's problematic behaviors must appear in two or more of the following areas:

- perception and interpretation of the self and other people
- intensity and duration of feelings and their appropriateness to situations
- relationships with others
- ability to control impulses

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The *DSM–IV* classifies personality disorders into three clusters based on symptom similarities:

- Cluster A (paranoid, schizoid, schizotypal): Patients appear odd or eccentric to others.
- Cluster B (antisocial, borderline, histrionic, narcissistic): Patients appear overly emotional, unstable, or self–dramatizing to others.
- Cluster C (avoidant, dependent, obsessive–compulsive): Patients appear tense and anxiety–ridden to others.

The *DSM–IV* clustering system does not mean that all patients can be fitted neatly into one of the three clusters. It is possible for patients to have symptoms of more than one personality disorder or to have symptoms from different clusters.

Some psychiatrists maintain that the DSM–IV classification is inadequate and should be expanded to include three additional categories: passive–aggressive personality disorder, characterized by a need to control or punish others through frustrating them or sabotaging plans; cyclothymic personality disorder, characterized by intense mood swings alternating between high spirits and moroseness or gloom; and depressive personality disorder, characterized by a negative and pessimistic approach to life.

Since the criteria for personality disorders include friction or conflict between the patient and his or her social environment, these syndromes are open to redefinition as societies change. Successive editions of *DSM* have tried to be sensitive to cultural differences, including changes over time, when defining personality disorders. One category that had been proposed for *DSM–III–R,* self–defeating personality disorder, was excluded from *DSM–IV* on the grounds that its definition reflected prejudice against women. *DSM–IV* recommends that doctors take a patient's background, especially recent immigration, into account before deciding that he or she has a personality disorder. One criticism that has been made of the general category of personality disorder is that it is based on Western notions of individual uniqueness. Its applicability to people from cultures with different definitions of human personhood is thus open to question. Furthermore, even within a culture, it can be difficult to define the limits of "normalcy."

The personality disorders defined by *DSM–IV* are as follows:

Paranoid

Patients with paranoid personality disorder are characterized by suspiciousness and a belief that others are out to harm or cheat them. They have problems with intimacy and may join cults or groups with paranoid belief systems. Some are litigious, bringing lawsuits against those they believe have wronged them. Although not ordinarily delusional, these patients may develop psychotic symptoms under severe **stress**. It is estimated that 0.5–2.5% of the general population meet the criteria for paranoid personality disorder.

Schizoid

Schizoid patients are perceived by others as "loners" without close family relationships or social contacts. Indeed, they are aloof and really do prefer to be alone. They may appear cold to others because they rarely display strong emotions. They may, however, be successful in occupations that do not require personal interaction. About two percent of the general population has this disorder. It is slightly more common in men than in women.

Schizotypal

Patients diagnosed as schizotypal are often considered odd or eccentric because they pay little attention to their clothing and sometimes have peculiar speech mannerisms. They are socially isolated and uncomfortable in parties or other social gatherings. In addition, people with schizotypal personality disorder often have oddities of thought, including "magical" beliefs or peculiar ideas (for example, a belief in telepathy or UFOs) that are outside of their cultural norms. It is thought that three percent of the general population has schizotypal personality disorder. It is slightly more common in males. Schizotypal disorder should not be confused with **schizophrenia**, although there is some evidence that the disorders are genetically related.

Antisocial

Patients with antisocial personality disorder are sometimes referred to as sociopaths or psychopaths. They are characterized by lying, manipulativeness, and a selfish disregard for the rights of others; some may act impulsively. People with antisocial personality disorder are frequently chemically dependent and sexually promiscuous. It is estimated that three percent of males in the general population and one percent of females have antisocial personality disorder.

Borderline

Patients with **borderline personality disorder** (BPD) are highly unstable, with wide mood swings, a

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history of intense but stormy relationships, impulsive behavior, and confusion about career goals, personal values, or sexual orientation. These often highly conflictual ideas may correspond to an even deeper confusion about their sense of self (identity). People with BPD frequently cut or burn themselves, or threaten or attempt **suicide**. Many of these patients have histories of severe childhood **abuse** or neglect. About two percent of the general population have BPD; 75% of these patients are female.

Histrionic

Patients diagnosed with this disorder impress others as overly emotional, overly dramatic, and hungry for attention. They may be flirtatious or seductive as a way of drawing attention to themselves, yet they are emotionally shallow. Histrionic patients often live in a romantic fantasy world and are easily bored with routine. About two to three percent of the population is thought to have this disorder. Although historically the disorder has been more associated with women in clinical settings, there may be bias toward diagnosing women with the histrionic personality disorder.

Narcissistic

Narcissistic patients are characterized by self–importance, a craving for admiration, and exploitative attitudes toward others. They have unrealistically inflated views of their talents and accomplishments, and may become extremely angry if they are criticized or outshone by others. Narcissists may be professionally successful but rarely have long–lasting intimate relationships. Fewer than one percent of the population has this disorder; about 75% of those diagnosed with it are male.

Avoidant

Patients with avoidant personality disorder are fearful of rejection and shy away from situations or occupations that might expose their supposed inadequacy. They may reject opportunities to develop close relationships because of their fears of criticism or humiliation. Patients with this personality disorder are often diagnosed with dependent personality disorder as well. Many also fit the criteria for social phobia. Between 0.5–1.0% of the population have avoidant personality disorder.

Dependent

Dependent patients are afraid of being on their own and typically develop submissive or compliant behaviors in order to avoid displeasing people. They are afraid to question authority and often ask others for guidance or direction. Dependent personality disorder is diagnosed more often in women, but it has been suggested that this finding reflects social pressures on women to conform to gender stereotyping or bias on the part of clinicians.

Obsessive–compulsive

Patients diagnosed with this disorder are preoccupied with keeping order, attaining perfection, and maintaining mental and interpersonal control. They may spend a great deal of time adhering to plans, schedules, or rules from which they will not deviate, even at the expense of openness, flexibility, and efficiency. These patients are often unable to relax and may become "workaholics." They may have problems in employment as well as in intimate relationships because they are very stiff and formal, and insist on doing everything their way. About one percent of the population has obsessive–compulsive personality disorder; the male/female ratio is about two to one.

Causes and symptoms

Personality disorders are thought to result from a bad interface, so to speak, between a child's temperament and character on one hand and his or her family environment on the other. Temperament can be defined as a person's innate or biologically shaped basic disposition. Human infants vary in their sensitivity to light or noise, their level of physical activity, their adaptability to schedules, and similar traits. Even such traits as **shyness** or novelty–seeking may be at least in part determined by the biology of the brain and the genes one inherits.

Character is defined as the set of attitudes and behavior patterns that the individual acquires or learns over time. It includes such personal qualities as work and study habits, moral convictions, neatness or cleanliness, and consideration of others. Since children must learn to adapt to their specific families, they may develop personality disorders in the course of struggling to survive psychologically in disturbed or stressful families. For example, nervous or high–strung parents might be unhappy with a baby who is very active and try to restrain him or her at every opportunity. The child might then develop an avoidant personality disorder as the outcome of coping with constant frustration and parental disapproval. As another example, **child abuse** is believed to play a role in shaping borderline personality disorder. One reason that some therapists use the term developmental damage instead of personality disorder is that it

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takes the presumed source of the person's problems into account.

Some patients with personality disorders come from families that appear to be stable and healthy. It has been suggested that these patients are biologically hypersensitive to normal family stress levels. Levels of the brain chemical (neurotransmitter) dopamine may influence a person's level of novelty–seeking, and serotonin levels may influence aggression.

Other factors that have been cited as affecting children's personality development are the mass media and social or group **hysteria**, particularly after the events of September 11, 2001. Cases of so–called mass sociogenic illness have been identified, in which a group of children began to vomit or have other physical symptoms brought on in response to an imaginary threat. In two such cases, the children were reacting to the suggestion that toxic fumes were spreading through their school. Some authors believe that overly frequent or age–inappropriate discussions of terrorist attacks or bioterrorism may make children more susceptible to sociogenic illness as well as other distortions of personality.

Diagnosis

Diagnosis of personality disorders is complicated by the fact that affected persons rarely seek help until they are in serious trouble or until their families (or the law) pressure them to get treatment. The reason for this slowness is that the problematic traits are so deeply entrenched that they seem normal (ego–syntonic) to the patient. Diagnosis of a personality disorder depends in part on the patient's age. Although personality disorders originate during the childhood years, they are considered adult disorders. Some patients, in fact, are not diagnosed until late in life because their symptoms had been modified by the demands of their job or by marriage. After retirement or the spouse's **death**, however, these patients' personality disorders become fully apparent. In general, however, if the onset of the patient's problem is in mid–or late–life, the doctor will rule out **substance abuse** or personality change caused by medical or neurological problems before considering the diagnosis of a personality disorder. It is unusual for people to develop personality disorders "out of the blue" in mid–life.

There are no tests that can provide a definitive diagnosis of personality disorder. Most doctors will evaluate a patient on the basis of several sources of information collected over a period of time in order to determine how long the patient has been having difficulties, how many areas of life are affected, and how severe the dysfunction is. These sources of information may include:

Interviews

The doctor may schedule two or three interviews with the patient, spaced over several weeks or months, in order to rule out an adjustment disorder caused by job loss, **bereavement**, or a similar problem. An office interview allows the doctor to form an impression of the patient's overall personality as well as obtain information about his or her occupation and family. During the interview, the doctor will note the patient's appearance, tone of voice, body language, eye contact, and other important non–verbal signals, as well as the content of the conversation. In some cases, the doctor may contact other people (family members, employers, close friends) who know the patient well in order to assess the accuracy of the patient's perception of his or her difficulties. It is quite common for people with personality disorders to have distorted views of their situations or to be unaware of the impact of their behavior on others.

Psychologic testing

Doctors use psychologic testing to help in the diagnosis of a personality disorder. Most of these tests require interpretation by a professional with specialized training. Doctors usually refer patients to a clinical psychologist for this type of test.

PERSONALITY INVENTORIES. Personality inventories are tests with true/false or yes/no answers that can be used to compare the patient's scores with those of people with known personality distortions. The single most commonly used test of this type is the **Minnesota Multiphasic Personality Inventory**, or MMPI. Another test that is often used is the Millon Clinical Multiaxial Inventory, or MCMI.

PROJECTIVE TESTS. Projective tests are unstructured. Unstructured means that instead of giving one–word answers to questions, the patient is asked to talk at some length about a picture that the psychologist has shown him or her, or to supply an ending for the beginning of a story. Projective tests allow the clinician to assess the patient's patterns of thinking, fantasies, worries or anxieties, moral concerns, values, and habits. Common projective tests include the Rorschach, in which the patient responds to a set of ten inkblots; and the **Thematic Apperception Test** (TAT), in which the patient is shown drawings of people in different situations and then tells a story about the picture.

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Treatment

At one time psychiatrists thought that personality disorders did not respond very well to treatment. This opinion was derived from the notion that human personality is fixed for life once it has been molded in childhood, and from the belief among people with personality disorders that their own views and behaviors are correct, and that others are the ones at fault. More recently, however, doctors have recognized that humans can continue to grow and change throughout life. Most patients with personality disorders are now considered to be treatable, although the degree of improvement may vary. The type of treatment recommended depends on the personality characteristics associated with the specific disorder.

Hospitalization

Inpatient treatment is rarely required for patients with personality disorders, with two major exceptions: borderline patients who are threatening suicide or suffering from drug or alcohol withdrawal; and patients with paranoid personality disorder who are having psychotic symptoms.

Psychotherapy

Psychoanalytic **psychotherapy** is suggested for patients who can benefit from insight–oriented treatment. These patients typically include those with dependent, obsessive–compulsive, and avoidant personality disorders. Doctors usually recommend individual psychotherapy for narcissistic and borderline patients, but often refer these patients to therapists with specialized training in these disorders. Psychotherapeutic treatment for personality disorders may take as long as three to five years.

Insight–oriented approaches are not recommended for patients with paranoid or antisocial personality disorders. These patients are likely to resent the therapist and see him or her as trying to control or dominate them.

Supportive therapy is regarded as the most helpful form of psychotherapy for patients with schizoid personality disorder.

Cognitive–behavioral therapy

Cognitive–behavioral approaches are often recommended for patients with avoidant or dependent personality disorders. Patients in these groups typically have mistaken beliefs about their competence or likableness. These assumptions can be successfully challenged by cognitive–behavioral methods. More recently, American psychiatrist Aaron Beck and his coworkers have successfully extended their approach to cognitive therapy to all ten personality disorders as defined by DSM–IV.

Group therapy

Group therapy is frequently useful for patients with schizoid or avoidant personality disorders because it helps them to break out of their social isolation. It has also been recommended for patients with histrionic and antisocial personality disorders. These patients tend to act out, and pressure from peers in group treatment can motivate them to change. Because patients with antisocial personality disorder can destabilize groups that include people with other disorders, it is usually best if these people meet exclusively with others who have APD in homogeneous groups.

Family therapy

Family therapy may be suggested for patients whose personality disorders cause serious problems for members of their families. It is also sometimes recommended for borderline patients from over–involved or possessive families.

Medications

Medications may be prescribed for patients with specific personality disorders. The type of medication depends on the disorder. In general, however, patients with personality disorders are helped only moderately by medications.

ANTIPSYCHOTIC DRUGS. **Antipsychotic drugs**, such as haloperidol (Haldol), may be given to patients with paranoid personality disorder if they are having brief psychotic episodes. Patients with borderline or schizotypal personality disorder are sometimes given antipsychotic drugs in low doses; however, the efficacy of these drugs in treating personality disorder is less clear than in schizophrenia.

MOOD STABILIZERS. Carbamazepine (Tegretol) is a drug that is commonly used to treat seizures, but is also helpful for borderline patients with rage outbursts and similar behavioral problems. Lithium and valproate may also be used as mood stabilizers, especially among people with borderline personality disorder.

ANTIDEPRESSANTS AMD ANTI–ANXIETY MEDICATIONS. Medications in these categories are sometimes prescribed for patients with schizoid personality disorder to help them manage **anxiety** symptoms while they are in psychotherapy. Antidepressants are also commonly used to treat people with borderline personality disorder.

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KEY TERMS

Character—An individual's set of emotional, cognitive, and behavioral patterns learned and accumulated over time.

Character disorder—Another name for personality disorder.

Cognitive therapy—A form of psychotherapy that focuses on changing people's patterns of emotional reaction by correcting distorted patterns of thinking and perception.

Developmental damage—A term that some therapists prefer to personality disorder, on the grounds that it is more respectful of the patient's capacity for growth and change.

Ego–syntonic—Consistent with one's sense of self, as opposed to ego–alien or dystonic (foreign to one's sense of self). Ego–syntonic traits typify patients with personality disorders.

Neuroleptic—Another name for older antipsychotic medications, such as haloperidol. The term does not apply to such newer atypical agents as clozapine (Clozaril).

Personality—The organized pattern of behaviors and attitudes that makes a human being distinctive. Personality is formed by the ongoing interaction of temperament, character, and environment.

Projective tests—Psychological tests that probe into personality by obtaining open–ended responses to such materials as pictures or stories. Projective tests are often used to evaluate patients with personality disorders.

Rorschach test—A well–known projective test that requires the patient to describe what he or she sees in each of 10 inkblots. It is named for the Swiss psychiatrist who invented it.

Temperament—A person's natural or genetically determined disposition.

Treatment with medications is not recommended for patients with avoidant, histrionic, dependent, or narcissistic personality disorders. The use of potentially addictive medications should be avoided in people with borderline or antisocial personality disorders. However, some avoidant patients who also have social phobia may benefit from **monoamine oxidase inhibitors** (MAO inhibitors), a particular class of antidepressant.

Prognosis

The prognosis for recovery depends in part on the specific disorder. Although some patients improve as they grow older and have positive experiences in life, personality disorders are generally life–long disturbances with periods of worsening (exacerbations) and periods of improvement (remissions). Others, particularly schizoid patients, have better prognoses if they are given appropriate treatment. Beck and his coworkers estimate that effective cognitive therapy with patients with personality disorders takes two to three years on average. Patients with paranoid personality disorder are at some risk for developing delusional disorders or schizophrenia.

The personality disorders with the poorest prognoses are the antisocial and the borderline. Borderline patients are at high risk for developing substance abuse disorders or bulimia. About 80% of hospitalized borderline patients attempt suicide at some point during treatment, and about five percent succeed in committing suicide. Borderline patients are also the most likely to sue their mental health professional for malpractice.

Prevention

The most effective preventive strategy for personality disorders is early identification and treatment of children at risk. High–risk groups include abused children, children from troubled families, children with close relatives diagnosed with personality disorders, children of substance abusers, and children who grow up in cults or extremist political groups.

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ORGANIZATIONS

American Academy of Child and Adolescent Psychiatry (AACAP), 3615 Wisconsin Ave., NW, Washington, DC, 20016–3007, (202) 966–7300, (202) 966–2891, http://www.aacap.org.
American Psychiatric Association (APA), 1000 Wilson Blvd., Suite 1825, Arlington, VA, 22209, (703) 907–7300, apa@psych.org, http://www.psych.org/.
American Psychological Association (APA), 750 First St. NE, Washington, DC, 20002–4242, (202) 336–5700, http://www.apa.org.
National Alliance on Mental Illness (NAMI), Colonial Place Three, 2107 Wilson Blvd., Suite 300, Arlington, VA, 22201, (703) 524–7600, (800) 950–NAMI (6264), (703) 524–9094, http://www.nami.org/Hometemplate.cfm.
National Institute of Mental Health (NIMH), 6001 Executive Blvd., Room 8184, MSC 9663, Bethesda, MD, 20892, (301) 443–4513, (866) 615–6464, (301) 443–4279, nim hinfo@nih.gov, http://www.nimh.nih.gov/index.shtml.
National Mental Health Association (NMHA), 2000 N. Beauregard St., 6th Floor, Alexandria, VA, 22311, (703) 684–7722, (800) 969–NMHA, (703) 684–5968, http://www1.nmha.org/.

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Perthes disease *see* **Osteochondroses**
Pertussis *see* **Whooping cough**

Pervasive developmental disorders

Definition

Pervasive developmental disorders include five different conditions: Asperger's syndrome, autistic disorder, childhood disintegrative disorder (CDD), pervasive developmental disorder not otherwise specified (PDDNOS), and Rett's syndrome. They are grouped together because of the similarities among them. The three most common shared problems involve communication skills, motor skills, and social skills. Since there are no clear diagnostic boundaries separating these conditions, it is sometimes difficult to distinguish one from the other for diagnostic purposes.

Demographics

Asperger's syndrome, autistic disorder, and childhood disintegrative disorder are four to five times more common in boys, and Rett's syndrome has been diagnosed primarily in girls. All of these disorders are rare.

Description

Asperger's syndrome

Children afflicted with Asperger's syndrome exhibit difficulties in social relationships and communication. They are reluctant to make eye contact, do not respond to social or emotional contacts, do not initiate play activities with peers, and do not give or receive attention or affection. To receive this diagnosis the individual must demonstrate normal development of language, thinking, and coping skills. Due to an impaired coordination of muscle movements, they appear to be clumsy. They usually become deeply involved in very few interests, which tend to occupy most of their time and attention.

Autistic disorder

Autistic disorder is frequently evident within the first year of life, and must be diagnosed before age three. It is associated with moderate **mental retardation** in three out of four cases. These children do not want to be held, rocked, cuddled, or played with. They are unresponsive to affection, show no interest in peers or adults, and have few interests. Other traits include avoidance of eye contact, an expressionless face, and the use of gestures to express needs. Their actions are repetitive, routine, and restricted. Rocking, hand and arm flapping, unusual hand and finger movements, and attachment to objects rather than pets and people are common. Speech, play, and other behaviors are repetitive and without imagination. They tend to be overactive, aggressive, and self–injurious. They are often highly sensitive to touch, noise, and smells and do not like changes in routine. **Autism** and several disorders classified with it have increased significantly in recent years so that they now are diagnosed more often in children than **spina bifida**, **cancer**, or **Down**

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syndrome. This change may be due partly to improved recognition and diagnosis.

Childhood disintegrative disorder

Childhood disintegrative disorder is also called Heller's disease and most often develops between two and 10 years of age. Children with CDD develop normally until two to three years of age and then begin to disintegrate rapidly. Signs and symptoms include deterioration of the ability to use and understand language to the point where they are unable to carry on a conversation. This is accompanied by loss of control of the bladder and bowels. Any interest or ability to play and engage in social activities is lost. The behaviors are nearly identical with those that are characteristic of autistic disorder. However, childhood disintegrative disorder becomes evident later in life and results in developmental regression, or loss of previously attained skills, whereas autistic disorder can be detected as early as the first month of life and results in a failure to progress.

Pervasive developmental disorder not otherwise specified

The term pervasive developmental disorder not otherwise specified (PDDNOS) is also referred to as atypical personality development, atypical PDD, or atypical autism. Individuals with this disorder share some of the same signs and symptoms of autism or other conditions under the category of pervasive developmental disorders, but do not meet all of the criteria for diagnosis for any of the four syndromes included in this group of diseases. Because the children diagnosed with PDDNOS do not all exhibit the same combination of characteristics, it is difficult to do research on this disorder, but the limited evidence available suggests that patients are seen by medical professionals later in life than is the case for autistic children, and they are less likely to have intellectual deficits.

Rett's syndrome

Rett's syndrome was first described in 1966 and is found almost exclusively in girls. It is a disease in which cells in the brain experience difficulty in communicating with each other. At the same time the growth of the head falls behind the growth of the body so that these children are usually mentally retarded. These conditions are accompanied by deficits in movement (motor) skills and a loss of interest in social activities.

The course of the illness has been divided into four stages. In stage one the child develops normally for six to 18 months. In stage two, development slows down and stops. Stage three is characterized by a loss of the speech and motor skills already acquired. Typically this happens between nine months and three years of age. Stage four begins with a return to learning that will continue across the lifespan, but at a very slow rate. Problems with coordination and walking are likely to continue and even worsen. Other conditions that can occur with Rett's syndrome are convulsions, **constipation**, breathing problems, impaired circulation in the feet and legs, and difficulty chewing or swallowing.

Causes and symptoms

The causes of these disorders are unknown although brain structure abnormalities, genetic mutation, and alterations in brain function are believed to play a role. Still, no single brain abnormality or location has been connected to a cause. In 2004, scientists reported finding a gene mutation (on gene MECP2) that is present in 80% of people affected with Rett's syndrome. In 2004, a comprehensive review of research on twins revealed that interactions between multiple genes may play a role in the cause of autism. A number of neurological conditions, such as convulsions, are commonly found to accompany these disorders.

Diagnosis

The diagnosis of pervasive developmental disorder is made by medical specialists based on a thorough examination of the patient, including observing behavior and gathering information from parents and caregivers. Because many symptoms are common to more than one condition, distinctions between conditions must be carefully made. The following summary describes the distinction between three common disorders.

PDDNOS:

- impairment of two–way social interaction
- Repetitive and predictable behavior patterns and activities

Autism:

- all listed for PDDNOS
- severe impairment in communication
- abnormal social interaction and use of language for social communication or imaginative play before age of three
- not better accounted for by another psychiatric order

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Asperger's disorder:

- all listed for PDDNOS
- clinically significant impairment in social, occupational, or other areas of functioning
- no general delay in language
- no delay in cognitive development, self–help skills, or adaptive behavior
- not better accounted for by another pervasive developmental disorder or schizophrenia

Rett's syndrome:

- a period of normal development between six and 18 months
- normal head circumference at birth, followed by a slowing of head growth
- mental retardation
- repetitive hand movements

CDD:

- normal development for at least two years
- loss of skills in at least two of the following areas: language, social skills, bowel or bladder control, play, movement skills
- abnormal functioning in at least two of the following areas: social interaction, communication, behavior patterns
- not better accounted for by another PDD or mental illness

Treatment

Treatment for children with pervasive developmental disorders is limited. Those who can be enrolled in educational programs will need a highly structured learning environment, a teacher–student ratio of not more than 1:2, and a high level of parental involvement that provides consistent care at home. **Psychotherapy** and social skills training can prove helpful to some. There is no specific medication available for treating the core symptoms of any of these disorders, though research is promising. Some psychiatric medications may be helpful in controlling particular behavior difficulties, such as agitation, mood instability, and self–injury. Music, massage, and **hydrotherapy** may exert a calming effect on behavior. Treatment may also include physical and **occupational therapy**.

Prognosis

In general, the prognosis in all of these conditions is tied to the severity of the illness.

The prognosis for Asperger's syndrome is more hopeful than that for other diseases in this cluster. These children are likely to grow up to be functional independent adults, but will always have problems with social relationships. They are also at greater risk for developing serious mental illness than the general population.

The prognosis for autistic disorder is not as good, although great strides have been made in recent years in its treatment. The higher the patient's IQ (intelligence quotient) and ability to communicate, the better the prognosis. However, many patients will always need some level of custodial care. In the past, most of these individuals were confined to institutions, but many are now able to live in group homes or supervised apartments. The prognosis for childhood disintegrative disorder is even less favorable. These children will require intensive and long–term care. Children diagnosed with PDDNOS have a better prognosis because their initial symptoms are usually milder, IQ scores are higher, and language development is stronger.

KEY TERMS

Hydrotherapy—This term literally means "water treatment" and involves the use of water in physical therapy as well as treatment of physical and emotional illness.

Mutation—A change in a gene. Since genes determine how a body is structured and functions, any change in a gene will produce some change in these areas.

Neurological conditions—A condition that has its origin in some part of the patient's nervous system.

Prevention

The causes of pervasive developmental disorders are not understood, although research efforts are getting closer to understanding the problem. Until the causes are discovered, it will remain impossible to prevent these conditions.

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ORGANIZATIONS

Autism Society of America (ASA), 7910 4340 East–West Hwy., Suite 350, Bethesda, MD, 20814, (800) 328–8476, http://www.autism–society.org.
International Rett Syndrome Association (IRSA), 4600 Devitt Dr., Cincinnati, OH, 45246, (800) 818–7388, http://www.rettsyndrome.org.
Learning Disabilities Association of America (LDAA), 4156 Library Rd., Pittsburgh, PA, 15234, (412) 341–1515, http://www.ldanatl.org.
National Organization for Rare Disorders (NORD), 55 Kenosia Ave., PO Box 1968, Danbury, CT, 06813–1968, (800) 999–6673, http://www.rarediseases.org.

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PET scan *see* **Positron emission tomography (PET)**

Pet therapy

Definition

Animal-assisted therapy (AAT), also known as pet therapy, utilizes trained animals and handlers to achieve specific physical, social, cognitive, and emotional goals with patients.

KEY TERMS

Endorphins—A group of chemicals resembling opiates that are released in the body in response to trauma or stress. Endorphins react with opiate receptors in the brain to reduce pain sensations.

Purpose

Studies have shown that physical contact with a pet can lower high blood pressure, and improve survival rates for **heart attack** victims. There is also evidence that petting an animal can cause endorphins to be released. Endorphins are chemicals in the body that suppress the **pain** response. These are benefits that can be enjoyed from pet ownership, as well as from visiting therapeutic animals.

Many skills can be learned or improved with the assistance of a therapy animal. Patient **rehabilitation** can be encouraged by such activities as walking or running with a dog, or throwing objects for the animal to retrieve. Fine motor skills may be developed by petting, grooming, or feeding the animal. Patient communication is encouraged by the response of the animal to either verbal or physical commands. Activities such as writing or talking about the therapy animals or past pets also develop cognitive skills and communication. Creative inclusion of an animal in the life or therapy of a patient can make a major difference in the patient's comfort, progress, and recovery.

Description

Origins

The enjoyment of animals as companions dates back many centuries, perhaps even to prehistoric times. The first known therapeutic use of animals started in Gheel, Belgium in the ninth century. In this town, learning to care for farm animals has long been an important part of an assisted living program designed for people with disabilities.

Some of the earliest uses of animal-assisted healing in the United States were for psychiatric patients. The presence of the therapy animals produced a beneficial effect on both children and adults with mental health issues. It is only in the last few decades that AAT has been more formally applied in a variety of therapeutic settings, including schools and prisons, as well as hospitals, hospices, nursing homes, and outpatient care programs.

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This autistic child is encouraged to interact with the guinea pig in an effort to improve his social interaction. *(Helen B. Senisi/ Photo Researchers, Inc.)*

The way in which AAT is undertaken depends on the needs and abilities of the individual patient. Dogs are the most common visiting therapy animals, but cats, horses, birds, rabbits, and other domestic pets can be used as long as they are appropriately screened and trained.

For patients who are confined, small animals can be brought to the bed if the patient is willing and is not allergic to the animal. A therapeutic plan may include a simple interaction aimed at improving communication and small motor skills, or a demonstration with educational content to engage the patient cognitively.

If the patient is able to walk or move around, more options are available. Patients can walk small animals outside, or learn how to care for farm animals. Both of these activities develop confidence and motor abilities. Horseback riding has recently gained great therapeutic popularity. It offers an opportunity to work on balance, trunk control, and other skills. Many patients who walk with difficulty, or not at all, get great emotional benefit from interacting with and controlling a large animal.

One advantage of having volunteers provide this service is that cost and insurance are not at issue.

Precautions

AAT does not involve just any pet interacting with a patient. Standards for the training of the volunteers and their animals are crucial in order to promote a safe, positive experience for the patient. Trained volunteers will understand how to work with other medical professionals to set goals for the patient and keep records of progress. Animals that have been appropriately trained are well socialized to people, other animals, and medical equipment. They are not distracted by the food and odors that may be present in the therapy environment and will not chew inappropriate objects or mark territory.

Animals participating in AAT should be covered by some form of liability insurance.

Research and general acceptance

While the research evidence supporting the efficacy of AAT is slim, the anecdotal support is vast.

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Although it may not be given much credence by medical personnel as a therapy with the potential to assist the progress of the patients, some institutions do at least allow it as something that will uplift the patients or distract them from their discomforts.

ORGANIZATIONS

Delta Society, 875 124th Ave NE #101, Bellevue, WA, 98005, (425) 679-5500, (425) 679-5539, info@Delta Society. org, http://www.deltasociety.org.

Judith Turner

Peyronie's disease

Definition

Peyronie's disease is an acquired inflammatory condition in which the erect penis is bent because of plaque—a hard lump of scar tissue—that prevents the area from stretching. Peyronie's is a variable and poorly understood urological condition. It is also called curvature of the penis or induratio plastica penis.

Demographics

Until recently Peyronie's disease was thought to be relatively uncommon, affecting less than 1% of men. However newer estimates range as high as 23%. One recent study found that 3.2% of German men between the ages of 30 and 80 were affected by Peyronie's. Although embarrassment prevents many men from seeking help, the number of diagnosed cases of Peyronie's disease has increased markedly in recent years. This is probably due to the availability of new drugs for treating **erectile dysfunction** (ED), which has encouraged many more men to seek treatment for sexual problems. Thus the number of diagnosed cases of Peyronie's disease is expected to continue to increase. The condition most often affects men over age 40.

Description

Penises vary in shape and size and erect penises are often slightly bent. However Peyronie's disease is characterized by a bent penis that causes **pain** and/or interferes with sex. In 1743 Francois Gigot de la Peyronie, personal physician to King Louis XV of France, wrote the first detailed description of the disorder that bears his name. Earlier writers had classified it as a form of **impotence** or ED.

The bulk of the penis consists of two tubular chambers called the corpora cavernosa that fill with blood during an erection, causing the penis to expand, stiffen, and straighten. The corpora cavernosa are enclosed within a sheath of elastic tissue called the tunica albuginea, which stretches during an erection. With Peyronie's disease flat fibrous scar tissue called plaque forms in the tunica albuginea and prevents stretching, so that the corpora cavernosa expand unevenly. This causes the penis to bend or curve in the direction of the plaque. Almost one third of men with Peyronie's disease have similar scar tissue on their hands, a disease called Dupuytren's contracture. However, although Dupuytren's contracture is fairly common in white men over age 50, only a small percentage of these men develop Peyronie's disease.

Peyronie's disease is frequently mild and does not progress pass the inflammation stage, disappearing within months. However it can also develop into a severe condition in which sexual intercourse is painful or impossible. Peyronie's disease can affect sexual desire, as well as function, and may interfere with intimate relationships. Studies indicate that more than 75% of men with Peyronie's disease suffer from **anxiety** and emotional distress related to their condition.

Risk factors

Known risk factors for Peyronie's disease include:

- a father or brother with the disease
- connective tissue disorders such as Dupuytren's contracture
- age-related changes that cause tissues to be more easily injured and/or less readily healed
- diabetes
- tobacco use
- prostate surgery, catheterization, or pelvic injury

Causes and symptoms

The exact cause of Peyronie's disease is unclear. It most often seems to result from a minor trauma incurred during sexual activity, such as bending the penis during intercourse or pressure from the partner's pubic bone. It also can result from an accident or sports injury. Injury to the tunica albuginea can cause bleeding, inflammation, and tissue damage. If the wound does not heal properly, fibrosis—excess scar tissue formation—can occur, leading to inflexible plaques. Peyronie's disease that occurs suddenly and disappears without treatment is most often

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due to such trauma that causes bleeding inside the penis. However many severe cases of Peyronie's disease develop slowly without apparent cause. Likewise, associated conditions such as Dupuytren's contracture do not appear to result from trauma. Other suggested causes of Peyronie's disease include vasculitis—an inflammation of blood or lymphatic vessels that leads to scar tissue formation—or other connective-tissue disorders involving the thickening or hardening of skin, cartilage, or bone. Some researchers have suggested that Peyronie's may be an autoimmune disorder. Because Peyronie's tends to run in families and because men with the disease have a particular immune cell marker, it has been suggested that the condition is inherited.

Symptoms of Peyronie's disease vary considerably. They can appear suddenly or develop gradually. Symptoms include:

- a bend in the erect penis
- narrowing of the penis with erection
- shortening of the penis
- lumps in the penis
- painful erections
- pain during intercourse
- soft erections
- ED—difficulty achieving or maintaining an erection
- difficult penetration due to curvature of the penis

Plaque formation may originate with a localized irritation and inflammation or swelling, which then hardens and reduces elasticity, causing the penis to bend in the direction of the plaque. Plaque also can cause indentation, shrinking, or shortening of the penis.

Plaque most often develops on the upper side of the penis, causing the erect penis to bend or curve upward., but it can also develop on the underside or lateral sides, causing a downward or sideways bend to the penis, respectively. Multiple plaques can cause complex curvatures. Sometimes there is a "hinge" effect, in which the erect penis bends sharply down at the base. Extensive plaque that encircles the penis usually results in an "hourglass," "waisting," or "bottleneck" deformity with a tight narrow band around the shaft rather than a curvature. In severe cases the plaque may accumulate **calcium** and become extremely hard.

The acute phase of Peyronie's disease lasts for six to 18 months. As the plaque forms, increasing penile curvature is accompanied by painful erections. However sometimes pain occurs whenever the penis is touched, even if it is not erect, or only with orgasm. In the chronic phase of Peyronie's the deformity remains stable and erections are usually painless. However both acute and chronic Peyronie's can interfere with sexual activity and result in ED.

KEY TERMS

Autoimmune disorder—Disorders such as rheumatoid arthritis that are caused by the immune system's antibodies or T cells attacking the body's own proteins, cells, or tissues.

Calcification—Hardening or stiffening due to calcium accumulation.

Catheterization—The placing of a flexible tube into the urethra or other body part.

Corpora cavernosa—Erectile tissues that form the bulk of the penis and become distended with blood during an erection.

Dupuytren's contracture—Shortening and thickening of connective tissue in the palm causing the fingers to pull in.

Erectile dysfunction (ED)—The consistent inability to achieve or maintain a penile erection.

Fibrosis—An abnormal thickening and scarring of connective tissue, most often following injury, infection, lack of oxygen, or surgery.

Plaque—A localized abnormal patch on a body part or surface.

Prostate—A gland that surrounds the outlet of the male bladder.

Tunica albuginea—The sheath of elastic tissue enclosing the corpora cavernosa.

Diagnosis

Examination

Curvature of the penis can be diagnosed by a **physical examination**. Erection-producing drugs may be injected under **local anesthesia** or the physician may examine a picture of the erect penis. Erection-producing medication is also used to evaluate erectile function. Hard plaques or scar tissue can be felt under the skin of either a flaccid or erect penis as flat lumps or a band of hard tissue. The length of the penis may be measured to provide a baseline if the condition worsens and the penis shortens. A family doctor or general practitioner may refer the patient to a urologist.

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Tests

The patient may be asked to complete a survey, such as the International Index of Erectile Function, to determine how the disorder is affecting sexual activity.

Procedures

Ultrasound or x-ray examination can be used to detect and characterize plaque and any calcification. Ultrasound following the injection of erection-producing medication can determine blood flow to the penis, detect any abnormalities, and measure the degree of penile curvature.

Treatment

Treatment for Peyronie's disease depends on the duration and severity of the condition. The goals of treatment are to relieve pain, restore normal penile anatomy so that intercourse is comfortable, and restore any lost erectile function. No treatment is required if:

- There is no pain.
- Plaques are small.
- The curvature is minor and no longer worsening
- Sexual function is satisfactory.

Traditional

Surgery is the traditional treatment for Peyronie's disease. Because the condition is so often lessens or disappears completely on its own and because surgery can lead to ED, it is usually only performed after at least two years, when the condition has stabilized—the curvature is no longer changing and erections have been painless for at least six months. Even then surgery is usually only performed if the penile deformity prevents satisfactory sexual activity.

There are several types of surgery for Peyronie's disease:

- Shortening the unaffected side: The Nesbit procedure or plication removes or pinches the tunica on the unaffected side to correct the bending. This results in an overall shortening of the erect penis, so it is generally used only when the penis is of adequate length and the curvature is less severe. These procedures are generally safe, relatively easy, and have a low risk of complications; however they cannot restore the length or girth of the penis.
- Lengthening of the affected side: The scar tissue may be cut or removed to allow the tunica albuginea to stretch and the penis to straighten. A graft of skin or synthetic material replaces the removed tissue. This procedure is used when the penis is short or there is severe curvature or a complicated deformity. It is more difficult surgery and can worsen ED or cause penile numbness.
- Penile implants to replace the corpora cavernosa: Semi-rigid implants are bent up manually for intercourse and bent down to appear flaccid. Inflatable implants are inflated for an erection with a pump implanted in the groin or scrotum. Implants are generally when Peyronie's disease coexists with ED. The surgery usually includes incisions in the scar tissue to relieve tension in the tunica albuginea.

Non-surgical treatments for Peyronie's disease include:

- external penile traction therapy, which can improve girth, length, and curvature
- radiation therapy, which seems to reduce pain but has no effect on the plaque and may cause ED
- shock wave lithotripsy, which can break up the plaque

Drugs

Early-phase Peyronie's disease is treated with oral medications and/or plaque injections. Oral medications include colchicine (an anti-inflammatory), carnitine (an antioxidant), tamoxifen, and pentoxifylline. However none of these have been proven to be effective. Drugs may be injected directly into the plaque over a period of several months, under a local anesthetic, to attempt to soften the tissue, ease pain, and correct curvature. Sometimes these drugs are delivered into the plaque by ontophoresis, a painless electrical current:

- Verapamil is a calcium-channel blocker that is used to treat high blood pressure. It also disrupts collagen production. Collagen is a connective-tissue protein that is thought to be important in Peyronie's scar tissue formation.
- Interferon alpha-2b is a human protein that appears to disrupt production of collagen and promote its breakdown.
- Collagenase is an enzyme that breaks down collagen.
- Corticosteroids are sometimes injected but have undesirable side effects.

Alternative

There are a large number of alternative treatments for Peyronie's disease. Vitamin E, an antioxidant, has been a popular treatment for acute-stage Peyronie's since at least 1948. It inexpensive and has few side

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effects, but there is little evidence for its effectiveness. Potassium aminobenzoate (Potaba) is a member of the vitamin B complex and has been shown to reduce plaque size but not curvature. However it is expensive, requires taking 24 pills daily for several months, and has gastrointestinal side effects. Other treatments include:

- topical verapamil
- high-intensity focused ultrasound
- hyperthermia

Home remedies

It is important to maintain an open and honest relationship with one's sexual partner while coping with Peyronie's disease and to explore alternative means for physical and emotional intimacy. A psychotherapist specializing in sexual function and personal relationships can be helpful in this regard.

Prognosis

Mild Peyronie's disease often resolves without treatment in six to 15 months. However in many cases, although pain decreases over time, the bend in the penis makes sexual intercourse difficult. Severe cases of Peyronie's disease can last for years and may continue to worsen, making intercourse impossible or leading to ED. Surgical treatments yield satisfactory results in 60–80% of cases. However surgery can result in complications and cannot correct problems such as penile shortening.

Prevention

There is no known prevention for Peyronie's disease.

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Newell, Mark M. *A Guide to Peyronie's Disease, Current Research and Emerging Treatments.http://www.peyroniesassociation.org/images/UserFiles/File/AGuide2.pdf*

ORGANIZATIONS

American Urological Association, 1000 Corporate Boulevard, Linthicum, MD, 21090, (410) 689-3700, (866) RING-AUA (746-4282), (410) 689-3800, aua@AUAnet.org, http://www.auanet.org.

Association of Peyronie's Disease Advocates, PO Box 62865, Colorado Springs, CO, 80962-2865, information@peyroniesassociation.org, http://www.peyroniesassociation.org.

National Kidney and Urologic Diseases Information Clearinghouse, 3 Information Way, Bethesda, MD, 20892-3580, (703) 738-4929, (800) 891-5390, (703) 738-4929, nkudic@info.niddk.nih.gov, http://kidney.niddk.nih.gov.

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Pharmacogenetics

Definition

Pharmacogenetics is the study of how the actions of and reactions to drugs vary with the patient's genes.

Description

Genes are the portions of chromosomes that determine many of the traits in every living thing. In humans, genes influence race, hair and eye color, gender, height, weight, aspects of behavior, and even the likelihood of developing certain diseases. Although some traits are a

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combination of genetics and environment, researchers are still discovering new ways in which people are affected by their genes.

Pharmacogenetics is the study of how people respond to drug therapy. Although this science is still new, there have been many useful discoveries. It has long been known that genes influence the risk of developing certain diseases, or that genes could determine traits such as hair and eye color. Genes can also alter the risk of developing different diseases. It has long been known that people of African descent were more likely to have sickle cell anemia than people of other races. People of Armenian, Arab, and Turkish heritage are more prone to familiar Mediterranean **fever** than people of other nationalities. More recently, discoveries have shown that genes can determine other aspects of each individual, down to the level of the enzymes produced in the liver. Since these enzymes determine how quickly a drug is removed from the body, they can make major differences in the way people respond to drugs. Some of the most basic work concerns the way race and gender influence drug reactions—and race and gender are genetically determined.

Women often respond differently than men to drugs at the same dose levels. For example, women are more likely to have a good response to the **antidepressant drugs** that act as serotonin specific reuptake inhibitors (SSRIs, the group that includes Prozac and Paxil) than they are to the older group of **tricyclic antidepressants** (the group that includes Elavil and Tofranil). Women have a greater response to some narcotic **pain** reliving drugs than do men, but get less relief from some non-narcotic pain medications. Women may show a greater response to some steroid hormones than men do, but have a lower level of response to some anti-anxiety medications than men.

Race may also affect the way people respond to some medications. In this case, race implies specific genetic factors that are generally, but not always, found among members of specific ethnic groups. For example, the angiotensin II inhibitor enalopril (Vasotec), which is used to lower blood pressure, works better in Caucasians than in Blacks. Carvedilol (Coreg), a beta-adrenergic blocking agent that is also used to lower blood pressure, is more effective than other drugs in the same class when used to treat Black patients. Black patients with **heart failure** appear to respond better to a combination of hydralazine and isosorbide than do Caucasian patients using the same medication.

More specific research has identified individual genes than may influence drugs response, without relying on group information such as gender and race. Specific genes have been identified that may determine how patients will respond to specific drugs. For example, some genes may determine whether people will get pain relief from codeine, or how well they will respond to drugs used to treat **cancer**.

Causes and symptoms

Genes alter responses to drugs because the genes influence many parts of the body iteself. One of the simplest examples is the gene that influences body weight. Since many drugs are soluble in body fat, people with large amounts of fat will have these drug deposited into their fat stores. This means that there are lower levels of the drug that can reach the actual organs on which they work.

In the case of gender responses to antidepressants, women show greater response to serotonin specific antidepressants because women naturally have lower levels of serotonin than men do. This makes women more likely to develop a type of depression marked by low serotonin levels, but it also means that women will respond better to replacement of serotonin.

Because people of the same race carry similar genes, studies based on race were the earliest types of pharmacogenetic studies. One study evaluated the levels of alcohol dehydrogenase in people of different nationalities. This is an enzyme involved in the metabolism of alcohol. When people with high levels of this enzyme, or people in whom the enzyme acts more rapidly than in other people, drink alcohol, they are subject to facial flushing and slowing of the heartbeat. The activity of this enzyme is determined by genetics, and different levels can be seen in different races because these people belong to the same gene pools. Among Asiatic people, 85% have high levels of this enzyme, compared to 20% of Swiss people, and only 5–10% of British people.

Another trait that is influenced by genes is a liver enzyme, CYP2D6. This enzyme metabolizes some drugs, convert them to a form that can be removed from the body. Genes determine the level of this enzyme in the liver. People with low levels of CYP2D6 will metabolize drugs slowly. Slow metabolism means the drugs will act for a longer period of time. Slow metabolizers reaspond to smaller doses of medications that are eliminated by this enzyme, while fast metabolizers, people who have a lot of the enzyme, will need larger drug doses to get the same effects. At the same time, low levels of CYP2D6 means that people taking the drugs that are metabolized by

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this enzyme will have higher drug levels, and are more likely to have unwanted side effects.

Another enzyme that can be important in drug dosing is called 2C9, and this enzyme is responsible for metabolizing the anticoagulant drug warfarin (Coumadin). Most people take warfarin in a dose of about 5 milligrams a day, but people who have low levels of 2C9 normally require a dose of only 1–5 milligrams a week.

Yet another mechanism of drug activity is the presence or absence of a specific drug receptor site. Drugs act by binding to specific chemicals, receptor sites, within body cells. Genes may help determine how many of these cells there are. The action of the widely used antipsychotic drug haloperidol (Haldol) depends on its ability to bind to the dopamine (D2) receptor site. The number of these sites are determined by genetics. In one study, 63% of patients whose genes caused a large number of these receptor sites had a response to treatment with haloperidol, while only about 29% of patients with a smaller number of dopamine (D2) receptor sites did well on the drug.

Other genetic studies indicate that genes may affect how people respond to foods as well as to drugs. An Australian study of **osteoporosis** (softening of the bones that often occurs in elderly people), reported that separate genes may affect response to vitamin D, **calcium**, and estrogens.

Implications

Although the study is still new, pharmacogenetics promises to offer great benefits in drug effectiveness and safety.

At the present time, most drug treatment is done by trial and error. Physicians prescribe medication, and the patient tries the drug. The drug may work, or it may not. It may cause adverse effects, or it may be safe. If the drug does not work, the dose is increased. If it causes harmful or unpleasant effects, a new drug is tried until, finally, the right drug is found. In some cases this procedure may take weeks or even months.

In other cases, drugs are carefully tested, and appear to be safe and effective. Only after they are approved for general use are reports of serious adverse effects that did not appear in the initial studies documented. This can occur if there is a rare gene that affects the way in which the drug acts, or the way in which the drug is metabolized.

With increasing understanding of how genes determine the way people respond to drugs, it will be possible to select drugs and doses based on a greater understanding of each individual patient. This promises more effective drug therapy, with greater safety and fewer treatment failures.

Physicians may be able to compare the person's genetic make-up with the properties of specific drugs, and make informed decisions about which drug in a group will work most effectively or most safely.

KEY TERMS

Enzyme—Proteins produced by living cells that help produce specific biochemical reactions in the body.

Metabolism—The process by which foods and drugs are broken down for use and removal from the body.

Sickle cell anemia—A severe, inheritable disease, most common among people of African descent, marked by deformation and destruction of red blood cells, and by adherence of blood cells to the walls of blood vessels.

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National Institute of General Medical Sciences, 45 Center Drive MSC 6200, Bethesda, MD, 20892-6200, (301) 496-7301, http://www.nigms.nih.gov.

University of California, Los Angeles Harbor-UCLA Medical Center Research and Education Institute, 1124 W Carson St., B-4, South Torrance, CA, 90502.

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Pharyngeal pouch *see* **Esophageal pouches**

Pharyngitis *see* **Sore throat**

Phenelzine *see* **Monoamine oxidase inhibitors**

Phenobarbital *see* **Barbiturates**

Phenol *see* **Antiseptics**

Phenolphthalein *see* **Laxatives**

Phenylalaninemia *see* **Phenylketonuria**

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Phenylketonuria

Definition

Phenylketonuria (PKU) can be defined as a rare metabolic disorder caused by a deficiency in the production of the hepatic (liver) enzyme phenylalanine hydroxylase (PAH). PKU is the most serious form of a class of diseases referred to as "hyperphenylalaninemia," all of which involve above normal (elevated) levels of phenylalanine in the blood. The primary symptom of untreated PKU, **mental retardation**, is the result of consuming foods that contain the amino acid phenylalanine, which is toxic to brain tissue.

PKU is an inherited, autosomal recessive disorder. It is the most common genetic disease involving "amino acid metabolism." PKU is incurable, but early, effective treatment can prevent the development of serious mental incapacity.

Description

PKU is a disease caused by the liver's inability to produce a particular type of PAH enzyme. This enzyme converts (metabolizes) the amino acid called phenylalanine into another amino acid, tyrosine. This is the only role of PAH in the body. A lack of PAH results in the buildup of abnormally high phenylalanine concentrations (or levels) in the blood and brain. Above normal levels of phenylalanine are toxic to the cells that make up the nervous system and causes irreversible abnormalities in brain structure and function in PKU patients. Phenylalanine is a type of teratogen. Teratogens are any substance or organism that can cause **birth defects** in a developing fetus.

The liver is the body's chief protein processing center. Proteins are one of the major food nutrients. They are generally very large molecules composed of strings of smaller building blocks or molecules called amino acids. About twenty amino acids exist in nature. The body breaks down proteins from food into individual amino acids and then reassembles them into "human" proteins. Proteins are needed for growth and repair of cells and tissues, and are the key components of enzymes, antibodies, and other essential substances.

Phenylketonuria (PKU) diet

A PKU diet is based on consuming foods low in protein. Foods that should be avoided include:

- Beans
- Chocolate
- Dairy products
- Fish
- Foods and beverages sweetened with aspartame
- Nuts or nut butters
- Peas
- Poultry
- Red meat
- Soy

(Table by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)

PKU affects on the human nervous system

The extensive network of nerves in the brain and the rest of the nervous system are made up of nerve cells. Nerve cells have specialized extensions called dendrites and axons. Stimulating a nerve cell triggers nerve impulses, or signals, that speed down the axon. These nerve impulses then stimulate the end of an axon to release chemicals called "neurotransmitters" that spread out and communicate with the dendrites of neighboring nerve cells.

Many nerve cells have long, wire-like axons that are covered by an insulating layer called the myelin sheath. This covering helps speed nerve impulses along the axon. In untreated PKU patients, abnormally high phenylalanine levels in the blood and brain can produce nerve cells with "deformed" axons and dendrites, and cause imperfections in the myelin sheath referred to as hypomyelination and demylenation. This loss of myelin can "short circuit" nerve impulses (messages) and interrupt cell communication. A number of brain scan studies also indicate a degeneration of the "white matter" in the brains of older patients who have not maintained adequate dietary control.

PKU can also affect the production of one of the major neurotransmitters in the brain, called dopamine. The brain makes dopamine from the amino acid tyrosine. PKU patients who do not consume enough tyrosine in their diet cannot produce sufficient amounts of dopamine. Low dopamine levels in the brain disrupt normal communication between nerve cells, which results in impaired cognitive (mental) function.

Some preliminary research suggests that nerve cells of PKU patients also have difficulty absorbing tyrosine. This abnormality may explain why many PKU patients who receive sufficient dietary tyrosine still experience some form of learning disability.

Behavior and academic performance

IQ (intelligence quotient) tests provide a measure of cognitive function. The IQ of PKU patients is generally lower than the IQ of their healthy peers. Students with PKU often find academic tasks difficult and must struggle harder to succeed than their non-PKU peers.

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They may require special tutoring and need to repeat some of their courses. Even patients undergoing treatment programs may experience problems with typical academic tasks as math, reading, and spelling. Visual perception, visual-motor skills, and critical thinking skills can also be affected. Ten years of age seems to be an important milestone for PKU patients. After age 10, variations in a patient's diet seems to have less influence on their IQ development.

People with PKU tend to avoid contact with others, appear anxious and show signs of depression. However, some patients may be much more expressive and tend to have hyperactive, talkative, and impulsive personalities. It is also interesting to note that people with PKU are less likely to display such "antisocial" habits as lying, teasing, and active disobedience. It should be emphasized that current research findings are still quite preliminary and more extensive research is needed to clearly show how abnormal phenylalanine levels in the blood and brain might affect behavior and academic performance.

One in fifty individuals in the United States have inherited a gene for PKU. About five million Americans are PKU carriers. About one in 15,000 babies test positive for PKU in the United States. Studies indicate that the incidence of this disease in Caucasian and Native American populations is higher than in African-American, Hispanic, and Asian populations.

Causes and symptoms

PKU symptoms are caused by alterations or "mutations" in the genetic code for the PAH enzyme. Mutations in the PAH gene prevent the liver from producing adequate levels of the PAH enzyme needed to break down phenylalanine. The PAH gene and its PKU mutations are found on chromosome 12 in the human genome. In more detail, PKU mutations can involve many different types of changes, such as deletions and insertions, in the DNA of the gene that codes for the PAH enzyme.

PKU is described as an inherited, autosomal recessive disorder. The term autosomal means that the gene for PKU is not located on either the X or Y sex chromosome. The normal PAH gene is dominant to recessive PKU mutations. A recessive genetic trait, such as PKU, is one that is expressed—or shows up—only when two copies are inherited (one from each parent).

A person with one normal and one PKU gene is called a carrier. A carrier does not display any symptoms of the disease because their liver produces normal quantities of the PAH enzyme. However, PKU carriers can pass the PKU genetic mutation onto their children. Two carrier parents have a 25% chance of producing a baby with PKU symptoms, and a 50% chance having a baby that is a carrier for the disease. Although PKU conforms to these basic genetic patterns of inheritance, the actual expression, or phenotype, of the disease is not strictly an "either/or" situation. This is because there are at least 400 different types of PKU mutations. Although some PKU mutations cause rather mild forms of the disease, others can initiate much more severe symptoms in untreated individuals. The more severe the PKU mutation, the greater the effect on cognitive development and performance (mental ability).

Untreated PKU patients develop a broad range of symptoms related to severely impaired cognitive function, sometimes referred to as mental retardation. Other symptoms can include extreme patterns of behavior, delayed speech development, seizures, a characteristic body odor, and light body pigmentation. The light pigmentation is due to a lack of melanin, which normally colors the hair, skin and eyes. Melanin is made from the amino acid tyrosine, which is lacking in untreated cases of PKU. Physiologically, PKU patients show high levels of phenylalanine and low levels of tyrosine in the blood. Babies do not show any visible symptoms of the disease for the first few months of life. However, typical PKU symptoms usually do show up by a baby's first birthday.

Diagnosis

The primary diagnostic test for PKU is the measurement of phenylalanine levels in a drop of blood taken from the heel of a newborn baby's foot. This screening procedure is referred to as the Guthrie test (Guthrie bacterial inhibition assay). In this test, PKU is confirmed by the appearance of bacteria growing around high concentrations of phenylalanine in the blood spot. PKU testing was introduced in the early 1960s and is the largest genetic screening program in the United States. It is required by law in all 50 states. Early diagnosis is critical. It ensures early the treatment PKU babies need to develop normally and avoid the ravages of PKU.

The American Academy of Pediatrics recommends that this test should be performed on infants between 24 hours and seven days after birth. The preferred time for testing is after the baby's first feeding. If the initial PKU test produces a positive result, then follow-up tests are performed to confirm the diagnosis and to determine if the elevated phenylalanine levels may be caused by some medical condition other than PKU. Treatment for PKU is recommended

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KEY TERMS

Amino acid—Organic compounds that form the building blocks of protein. There are 20 types of amino acids (eight are "essential amino acids" which the body cannot make and must therefore be obtained from food).

Axon—Skinny, wire-like extension of nerve cells.

Enzyme—A protein that catalyzes a biochemical reaction or change without changing its own structure or function.

Gene—A building block of inheritance, which contains the instructions for the production of a particular protein, and is made up of a molecular sequence found on a section of DNA. Each gene is found on a precise location on a chromosome.

Genetic disease—A disease that is (partly or completely) the result of the abnormal function or expression of a gene; a disease caused by the inheritance and expression of a genetic mutation.

IQ—Abbreviation for Intelligence Quotient. Compares an individual's mental age to his/her true or chronological age and multiplies that ratio by 100.

Metabolism—The total combination of all of the chemical processes that occur within cells and tissues of a living body.

Mutation—A permanent change in the genetic material that may alter a trait or characteristic of an individual, or manifest as disease, and can be transmitted to offspring.

Myelin—A fatty sheath surrounding nerves in the peripheral nervous system, which help them conduct impulses more quickly.

Nervous system—The complete network of nerves, sense organs, and brain in the body.

Phenylalanine—An essential amino acid that must be obtained from food since the human body cannot manufacture it.

Protein—Important building blocks of the body, composed of amino acids, involved in the formation of body structures and controlling the basic functions of the human body.

Recessive—Genetic trait expressed only when present on both members of a pair of chromosomes, one inherited from each parent.

for babies that show a blood phenylalanine level of 7–10 mg/dL or higher for more than a few consecutive days. Another, more accurate test procedure for PKU measures the ratio (comparison) of the amount of phenylalanine to the amount of tyrosine in the blood.

Newer diagnostic procedures (called mutation analysis and genotype determination) can actually identify the specific types of PAH gene mutations inherited by PKU infants. Large-scale studies have helped to clarify how various mutations affect the ability of patients to process phenylalanine. This information can help doctors develop more effective customized treatment plans for each of their PKU patients.

Treatment

The severity of the PKU symptoms experienced by people with this disease is determined by both lifestyle as well as genetic factors. In the early 1950s, researchers first demonstrated that phenylalanine-restricted **diets** could eliminate most of the typical PKU symptoms—except for mental retardation. Today, dietary therapy (also called **nutrition** therapy) is the most common form of treatment for PKU patients. PKU patients who receive early and consistent dietary therapy can develop fairly normal mental capacity to within about five IQ points of their healthy peers. By comparison, untreated PKU patients generally have IQ scores below 50.

Infants with PKU should be put on a specialized diet as soon as they are diagnosed to avoid progressive brain damage and other problems caused by an accumulation of phenylalanine in the body. A PKU diet helps patients maintain very low blood levels of phenylalanine by restricting the intake of natural foods that contain this amino acid. Even breast milk is a problem for PKU babies. Special PKU dietary mixtures or formulas are usually obtained from medical clinics or pharmacies.

Phenylalanine is actually an essential amino acid. This means that it has to be obtained from food because the body cannot produce this substance on its own. Typical diets prescribed for PKU patients provide very small amounts of phenylalanine and higher quantities of other amino acids, including tyrosine. The amount of allowable phenylalanine can be increased slightly as a child becomes older.

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In addition, PKU diets include all the nutrients normally required for good health and normal growth, such as carbohydrates, fats, **vitamins**, and **minerals**. High protein foods like meat, fish, chicken, eggs, nuts, beans, milk, and other dairy products are banned from PKU diets. Small amounts of moderate protein foods (such as grains and potatoes) and low protein foods (some fruits and vegetables, low protein breads and pastas) are allowed. Sugar-free foods, such as diet soda, which contain the artificial sweetener aspartame, are also prohibited foods for PKU patients. That is because aspartame contains the amino acid phenylalanine.

Ideally, school-age children with PKU should be taught to assume responsibility for managing their diet, recording food intake, and for performing simple blood tests to monitor their phenylalanine levels. Blood tests should be done in the early morning when phenylalanine levels are highest. Infants and young children require more frequent blood tests than older children and adults. The amount of natural foods allowed in a diet could be adjusted to ensure that the level of phenylalanine in the blood is kept within a safe range—two to 6 mg/dL before 12 years of age and 2–15 mg/dL for PKU patients over 12 years old.

A specialized PKU diet can cause abnormal fluctuations in tyrosine levels throughout the day. Thus, some health professionals recommend adding time released tyrosine that can provide a more constant supply of this amino acid to the body. It should be noted that some PKU patients show signs of learning disabilities even with a special diet containing extra tyrosine. Research studies suggests that these PKU patients may not be able to process tyrosine normally.

For PKU caregivers, providing a diet that is appealing as well as healthy and nutritious is a constant challenge. Many PKU patients, especially teenagers, find it difficult to stick to the relatively bland PKU diet for extended periods of time. Some older patients decide to go off their diet plan simply because they feel healthy. However, many patients who abandon careful nutritional management develop cognitive problems, such as difficulties remembering, maintaining focus, and paying attention. Many PKU health professionals contend that all PKU patients should adhere to a strictly controlled diet for life.

One promising line of PKU research involves the synthesis (manufacturing) of a new type of enzyme that can break down phenylalanine in food consumed by the patient. This medication would be taken orally and could prevent the absorption of digested phenylalanine into the patient's bloodstream.

In general, medical researchers express concern about the great variation in treatment programs currently available to PKU patients around the world. They have highlighted the urgent need for new, consistent international standards for proper management of PKU patients, which should emphasize comprehensive psychological as well as physiological monitoring and assessment.

PKU and Pregnancy

Women with PKU must be especially careful with their diets if they want to have children. They should ensure that phenylalanine blood levels are under control before conception and throughout her **pregnancy**. Mothers with elevated (higher than normal) phenylalanine levels are high risk for having babies with significant birth defects, such as microencephaly (smaller than normal head size), and **congenital heart disease** (abnormal heart structure and function), stunted growth, mental retardation, and psychomotor (coordination) difficulties. This condition is referred to as maternal PKU and can even affect babies who do not have the PKU disease.

Prognosis

Early newborn screening, careful monitoring, and a life-long strict dietary management can help PKU patients to live normal, healthy, and long lives.

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American Academy of Allergy, Asthma & Immunology, 555 East Wells Street, Suite 1100, Milwaukee, WI, 53202-3823, (414) 272-6071, http://www.aaaai.org.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, New York, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

Children's PKU Network (CPN), 3790 Via De La Valle, Ste 120, Del Mar, CA, 92014, (858) 509-0767, (858) 509-0768, (800) 377-6677, pkunetwork@aol.com, http://www.pkunetwork.org/.

March of Dimes Birth Defects Foundation, 1275 Mamaroneck Ave., White Plains, NY, 10605, (914) 997-4488, http://www.modimes.org.

National Society for Phenylketonuria, PO Box 26642, London, England, N14 4ZF, 440208364 3010, info@nspku.org, http://www.nspku.org/.

University of Washington PKU Clinic, CHDD, Box 357920, University of Washington, Seattle, WA, 206 685-3015, http://depts.washington.edu/pku/contact.html.

Marshall G. Letcher, MA

Phenylpropanolamine *see* **Decongestants**

Phenytoin *see* **Anticonvulsant drugs**

Pheochromocytoma

Definition

Pheochromocytoma is a tumor of special cells (called chromaffin cells), most often found in the middle of the adrenal gland.

Description

Because pheochromocytomas arise from chromaffin cells, they are occasionally called chromaffin tumors. Most (90%) are benign tumors so they do not spread to other parts of the body. However, these tumors can cause many problems and if they are not treated and can result in **death**.

Pheochromocytomas can be found anywhere chromaffin cells are found. They may be found in the heart and in the area around the bladder, but most (90%) are found in the adrenal glands. Every individual has two adrenal glands that are located above the kidneys in the back of the abdomen. Each adrenal gland is made up of two parts: the outer part (called the adrenal cortex) and the inner part (called the adrenal medulla). Pheochromocytomas are found in the adrenal medulla. The adrenal medulla normally secretes two substances, or hormones, called norepinephrine and epinephrine. These two substances, when considered together, are known as adrenaline. Adrenaline is released from the adrenal gland, enters the bloodstream and helps to regulate many things in the body including blood pressure and heart rate. Pheochromocytomas cause the adrenal medulla to secrete too much adrenaline, which in turn causes high blood pressure. The high blood pressure usually causes the other symptoms of the disease.

Pheochromocytomas are rare tumors. They have been reported in babies as young as five days old as well as adults 92 years old. Although they can be found at any time during life, they usually occur in adults between 30 and 40 years of age. Pheochromocytomas are somewhat more common in women than in men.

Causes and symptoms

The cause of most pheochromocytomas is not known. A small minority (about 10-20%) of pheochromocytomas arise because a person has an inherited susceptibility to them. Inherited pheochromocytomas are associated with four separate syndromes: Multiple Endocrine Neoplasia, type 2A (MEN2A), Multiple Endocrine Neoplasia, type 2B (MEN2B), von Hippel-Lindau disease (VHL) and **Neurofibromatosis** type 1 (NF1).

Individuals with pheochromocytomas as part of any of these four syndromes usually have other medical conditions as well. People with MEN2A often have **cancer** (usually **thyroid cancer**) and other hormonal problems. Individuals with MEN2B can also have cancer and hormonal problems, but also have other abnormal physical features. Both MEN2A and MEN2B are due to genetic alterations or mutations in a gene called RET, found at chromosome 10q11.2. Individuals with VHL often have other benign tumors of the central nervous system and pancreas, and can sometimes have renal cell cancer. This syndrome is caused by a mutation in the VHL gene, found at chromosome 3p25-26. Individuals with NF1 often have neurofibromas (benign tumors of the peripheral nervous system). NF1 is caused by mutations in the NF1 gene, found at chromosome 17q11.

All of these disorders are inherited in an autosomal dominant inheritance pattern. With autosomal dominant inheritance, men and women are equally likely to inherit the syndrome. In addition, children

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of individuals with the disease are at 50% risk of inheriting it. **Genetic testing** is available for these four syndromes (MEN2A, MEN2B, VHL and NF1) but, due to the complexity, **genetic counseling** should be considered before testing.

Most people (90%) with pheochromocytoma have **hypertension**, or high blood pressure. The other symptoms of the disease are extremely variable. These symptoms usually occur in episodes (or attacks) called paroxysms and include:

- headaches
- excess sweating
- racing heart
- rapid breathing
- anxiety/nervousness
- nervous shaking
- pain in the lower chest or upper abdomen
- nausea
- heat intolerance

The episodes can occur as often as 25 times a day or, as infrequently as once every few months. They can last a few minutes, several hours, or days. Usually, the attacks occur several times a week and last for about 15 minutes. After the episode is over, the person feels exhausted and fatigued.

Between the attacks, people with pheochromocytoma can experience the following:

- increased sweating
- cold hands and feet
- weight loss
- constipation

Diagnosis

If a pheochromocytoma is suspected, urine and/or a blood test are usually recommended. A test called "24-hour urinary catacholamines and metanephrines" will be done. This test is designed to look for adrenaline and the break-down products of adrenaline. Since the body gets rid of these hormones in the urine, those testing will need to collect their urine for 24 hours. The laboratory will determine whether or not the levels of hormones are too high. This test is very good at making the diagnosis of pheochromocytoma. Another test called "serum catacholamines" measures the level of adrenaline compounds in the blood. It is not as sensitive as the 24-hour urine test, but can still provide some key information if it shows that the level of adrenaline compounds is too high.

One of the difficulties with these tests is that a person needs to have an attack of symptoms either during the 24-hour urine collection time period or shortly before the blood is drawn for a serum test to ensure the test's accuracy. If a person did not have an episode during that time, the test can be a "false negative." If a doctor suspects the patient has had a "false negative" test, additional tests called "pharmacologic tests" can be ordered. During these tests, a specific drug is given to the patient (usually through an IV) and the levels of hormones are monitored from the patient's blood. These types of tests are only done rarely.

Once a person has been diagnosed with a pheochromocytoma, he or she will undergo tests to identify exactly where in the body the tumor is located. The imaging techniques used are usually computed tomography scan (CT scan) and magnetic resonsance imaging (MRI). A CT scan creates pictures of the interior of the body from computer-analyzed differences in x rays passing through the body. CT scans are performed at a hospital or clinic and take only a few minutes. An MRI is a computerized scanning method that creates pictures of the interior of the body using radio waves and a magnet. An MRI is usually performed at a hospital and takes about 30 minutes.

Treatment

Once a pheochromocytoma is found, more tests will be done to see if the tumor is benign (not cancer) or malignant (cancer). If the tumor is malignant, tests will be done to see how far the cancer has spread. There is no accepted staging system for pheochromocytoma; but an observation of the tumor could provide one of these four indications:

- Localized benign pheochromocytoma means that the tumor is found only in one area, is not cancer, and cannot spread to other tissues of the body.
- Regional pheochromocytoma means that the tumor is malignant and has spread to the lymph nodes around the original cancer. Lymph nodes are small structures found all over the body that make and store infection-fighting cells.
- Metastatic pheochromocytoma means that the tumor is malignant and has spread to other, more distant parts of the body.
- Recurrent pheochromocytoma means that a malignant tumor that was removed has come back.

Treatment in all cases begins with surgical removal of the tumor. Before surgery, medications such as alpha-adrenergic blockers are given to block the effect of the hormones and normalize blood

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KEY TERMS

Adrenal medulla—The central core of the adrenal gland.

Laparoscope—An instrument used to examine body cavities during certain types of surgery; for example, surgeries to remove fibroid tumors, or gall bladders, are often removed through the navel rather than cutting into the body.

Paroxysm—A sudden attack of symptoms.

pressure. These medications are usually started seven to 10 days prior to surgery. The surgery of choice is laparoscopic laparotomy, which is a minimally invasive outpatient procedure performed under general or **local anesthesia**. A small incision is made in the abdomen, the laparoscope is inserted, and the tumor is removed. The patient can usually return to normal activities within two weeks. If a laparoscopic laparotomy cannot be done, a traditional laparotomy will be performed. This is a more invasive surgery done under spinal or **general anesthesia** and requires five to seven days in the hospital. Usually patients are able to return to normal activities after four weeks. After surgery, blood and urine tests will be done to make sure hormone levels return to normal. If the hormone levels are still above normal, it may mean that some tumor tissue was not removed. If not all tumor can be removed (as in malignant pheochromocytoma, for example) drugs will be given to control high blood pressure.

If a pheochromocytoma is malignant, **radiation therapy** and/or **chemotherapy** may be used. Radiation therapy uses high-energy x rays to kill cancer cells and shrink tumors. Because there is no evidence that radiation therapy is effective in the treatment of malignant pheochromocytoma, it is not often used for treatment. However, it is useful in the treatment of painful bone metastases if the tumor has spread to the bones. Chemotherapy uses drugs to kill cancer cells. Like radiation therapy, it has not been shown to be effective in the treatment of malignant pheochromocytoma. Chemotherapy, therefore, is only used in rare instances.

Untreated pheochromocytoma can be fatal due to complications of the high blood pressure. In the vast majority of cases, when the tumor is surgically removed, pheochromocytoma is cured. In the minority of cases (10%) where pheochromocytoma is malignant, prognosis depends on how far the cancer has spread, and the patient's age and general health. The overall median five-year survival from the initial time of surgery and diagnosis is approximately 43%.

Prevention

Unfortunately, little is known about environmental and other causes of pheochromocytoma. Some of the tumors are due to inherited predisposition. Because of these factors, pheochromocytoma can not be prevented.

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Phimosis

Definition

A tightening of the foreskin of the penis that may close the opening of the penis.

Description

The foreskin of a newborn boy is always closely contracted around the penis head (glans). Only a small passage allows the urine to pass through. In the first months the foreskin is stuck to the glans and cannot be pulled back and one should not attempt to do so. During the first couple of years, the foreskin will become gradually looser and in many boys it can in time be pulled back without trouble. Half of all three-year-olds can pull back their foreskin. It is not advisable to try pulling the foreskin back using force, since this may cause small cuts in the foreskin with **scars** which could finally cause a regular foreskin contraction.

Foreskin contraction, called phimosis, can last throughout life and not cause any trouble at all. It is a voluntary decision whether to have a **circumcision** operation or not. If any problems do arise, they happen after **puberty**. The contraction may occur for the

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first time as an adult and usually requires circumcision, the surgical removal of the foreskin.

Causes & symptoms

Phimosis is caused by the inability of the foreskin to retract from around the opening of the penis. In adults, phimosis can lead to chronic inflammation and **cancer**.

Diagnosis

A physician usually diagnoses phimosis when there are persistent problems urinating, when there are recurrent infections under the foreskin, or when the opening to the penis is completely blocked by the foreskin. Phimosis is a tight ring of foreskin often made of scar tissue preventing retraction of the foreskin. It may be primary, or secondary to recurrent infection. It may produce urinary obstruction with ballooning of the foreskin. Phimosis is different than having a non-retractable foreskin, which is normal in many boys.

Treatment

If the foreskin cannot be pulled back into place treatment should be sought. If the blood flow to the penis is restricted then emergency treatment is required and if the foreskin cannot be pulled back a surgical cut to the trapped foreskin may be required. Failure to seek treatment can result in permanent damage to the penis. Once phimosis is diagnosed, the available treatments include topical **corticosteroids**, manual stretching, foreskin surgical repair or **plastic surgery**, and circumcision. Conservative treatments should be tried in the first instance and surgery used as the treatment of last resort.

A number of studies show that phimosis can be safely and effectively treated by the application of topical **steroids** in 80–90% of cases. Betamethasone cream 0.05% should be applied to the exterior and interior of the tip of the foreskin two or three times a day. The treatment should be discontinued as ineffective after three months if the foreskin has not become retractile during this time.

A number of corrections are available for the adult or adolescent non-retractable foreskin. These include surgery to repair the foreskin, in which an incision is made through the constrictive band of the foreskin. The underlying tissue is spread with forceps to expose the Buck's fascia (the deep, connective tissue of the penis) and the incision is closed with absorbable sutures. This procedure has less risk of disease and infection than circumcision, and allows the foreskin to be retained.

Circumcision is very traumatic to a child. It is essentially irreversible and should be the treatment of last resort. Phimosis due to *balanitis xerotica obliterans* (BXO), a chronic, progressive, hardening skin inflammation of the penis, has been considered the one common absolute indication for circumcision.

KEY TERMS

Balanitis xerotica obliterans (BXO)—A chronic, progressive, hardening skin inflammation of the penis.

Buck's fascia—The deep connective tissue of the penis.

Circumcision—The removal of all or part of the foreskin from the penis.

Corticosteroids—A synthetic drug similar or identical to a natural corticosteroid, used to reduce inflammation.

Glans—The head of the penis.

Paraphimosis—The entrapment of a retracted foreskin behind the coronal sulcus, a groove that separates the shaft and head of the penis.

Alternative treatment

There are no alternative medicine treatments for phimosis.

Prognosis

In most men, phimosis is not a serious problem and will not require treatment. However, it is not expected to improve on its own. With treatment, phimosis in most males can be managed or corrected.

Prevention

Proper hygiene is the most important preventative measure. The American Academy of Pediatrics recommends that the immature foreskin of boys not be forced back for cleaning. The only person who should clean and retract the foreskin is the boy himself. Bubble bath products and other chemical irritants can cause the foreskin to tighten and it is recommended they should be avoided by males with foreskins.

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American Urological Association Foundation, 1000 Corporate Blvd., Linthicum, MD, 21090, (410) 689-3700, (410) 689-3800, (866) 746-4282, auafoundation@auafoundation.org, http://www.urologyhealth.org/.

Ken R. Wells,

Phlebitis *see* **Thrombophlebitis**

Phlebotomy

Definition

Phlebotomy is the act of drawing or removing blood from the circulatory system through a cut (incision) or puncture in order to obtain a sample for analysis and diagnosis. Phlebotomy is also done as part of the patient's treatment for certain blood disorders.

Purpose

Treatment

Phlebotomy that is part of treatment (therapeutic phlebotomy) is performed to treat **polycythemia vera**, a condition that causes an elevated red blood cell volume (**hematocrit**). Phlebotomy is also prescribed for patients with disorders that increase the amount of iron in their blood to dangerous levels, such as **hemochromatosis**, **hepatitis B**, and **hepatitis C**. Patients with **pulmonary edema** may undergo phlebotomy procedures to decrease their total blood volume.

Diagnosis

Phlebotomy is also used to remove blood from the body during **blood donation** and for analysis of the substances contained within it.

Precautions

Patients who are anemic or have a history of cardiovascular disease may not be good candidates for phlebotomy.

Description

Phlebotomy, which is also known as venesection, is performed by a nurse or a technician known as a phlebotomist. Blood is usually taken from a vein on the back of the hand or inside of the elbow. Some blood tests, however, may require blood from an artery. The skin over the area is wiped with an antiseptic, and an elastic band is tied around the arm. The band acts as a tourniquet, slowing the blood flow in the arm and making the veins more visible. The patient is asked to make a fist, and the technician feels the veins in order to select an appropriate one. When a vein is selected, the technician inserts a needle into the vein and releases the elastic band. The appropriate amount of blood is drawn and the needle is withdrawn from the vein. The patient's pulse and blood pressure may be monitored during the procedure.

For some tests requiring very small amounts of blood for analysis, the technician uses a finger stick. A lance, or small needle, makes a small cut in the surface of the fingertip, and a small amount of blood is collected in a narrow glass tube. The fingertip may be squeezed to get additional blood to surface.

The amount of blood drawn depends on the purpose of the phlebotomy. Blood donors usually contribute a unit of blood (500 mL) in a session. The volume of blood needed for laboratory analysis varies widely with the type of test being conducted. Therapeutic phlebotomy removes a larger amount of blood than donation and blood analysis require. Phlebotomy for treatment of hemochromatosis typically involves removing a unit of blood–or 250 mg of iron–once a week. Phlebotomy sessions are required until iron levels return to a consistently normal level, which may take several months to several years. Phlebotomy for polycythemia vera removes enough blood to keep the patient's hematocrit below 45%. The frequency and duration of sessions depends on the patient's individual needs.

Preparation

Patients having their blood drawn for analysis may be asked to discontinue medications or to avoid food (to fast) for a period of time before the blood test. Patients donating blood will be asked for a brief medical history, have their blood pressure taken, and have

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KEY TERMS

Finger stick—A technique for collecting a very small amount of blood from the fingertip area.

Hemochromatosis—A genetic disorder known as iron overload disease. Untreated hemochromatosis may cause osteoporosis, arthritis, cirrhosis, heart disease, or diabetes.

Thrombocytosis—A vascular condition characterized by high blood platelet counts.

Tourniquet—Any device that is used to compress a blood vessel to stop bleeding or as part of collecting a blood sample. Phlebotomists usually use an elastic band as a tourniquet.

Venesection—Another name for phlebotomy.

their hematocrit checked with a finger stick test prior to donation.

Aftercare

After blood is drawn and the needle is removed, pressure is placed on the puncture site with a cotton ball to stop bleeding, and a bandage is applied. It is not uncommon for a patient to feel dizzy or nauseated during or after phlebotomy. The patient may be encouraged to rest for a short period once the procedure is completed. Patients are also instructed to drink plenty of fluids and eat regularly over the next 24 hours to replace lost blood volume. Patients who experience swelling of the puncture site or continued bleeding after phlebotomy should get medical help at once.

Risks

Most patients will have a small bruise or mild soreness at the puncture site for several days. Therapeutic phlebotomy may cause **thrombocytosis** and chronic iron deficiency (anemia) in some patients. As with any invasive procedure, infection is also a risk. This risk can be minimized by the use of prepackaged sterilized equipment and careful attention to proper technique.

Normal results

Normal results include obtaining the needed amount of blood with the minimum of discomfort to the patient.

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Paula Anne Ford-Martin

Phobias

Definition

A phobia is an intense but unrealistic fear that can interfere with the ability to socialize, work, or go about everyday life, brought on by an object, event, or situation.

Demographics

Phobias occur in all races, with social phobia being the most common type of phobia and **agoraphobia** being the least common. Women are more likely to suffer from a phobia than men at a ratio of about two to one. Simple and social phobias appear earlier in life (at a median age of 15 and 16) than agoraphobia (which appears at a median age of 29).

Description

Just about everyone is afraid of something such as an upcoming job interview or being alone outside after dark, but about 18% of all Americans are tormented by irrational fears that interfere with their daily lives. They are not "crazy"—they know their fear is unreasonable, but they cannot control the fear. These people have phobias.

Phobias belong to a large group of mental problems known as **anxiety disorders** that include **obsessive-compulsive disorder** (OCD), **panic disorder**, and **post-traumatic stress disorder** (PTSD). Phobias themselves can be divided into three types:

- specific phobias (formerly called "simple phobias")
- social phobia
- agoraphobia

Specific phobias

As its name suggests, a specific phobia is the fear of a particular situation or object, including anything from airplane travel to dental visits. Found in one out of every 10 Americans, specific phobias seem to run in families and are roughly twice as likely to appear in females. If the person rarely encounters the feared

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object, the phobia does not cause much harm. However, if the feared object or situation is common, it can seriously disrupt everyday life. Common examples of specific phobias, which can begin at any age, include fear of snakes, flying, dogs, escalators, elevators, high places, or open spaces.

Social phobia

People with social phobia have deep fears of being watched or judged by others and being embarrassed in public. This may extend to a general fear of social situations or be more specific or circumscribed, such as a fear of giving speeches or of performing (stage fright). More rarely, people with social phobia may have trouble using a public restroom, eating in a restaurant, or signing their name in front of others.

Social phobia is not the same as **shyness**. Shy people may feel uncomfortable with others, but they do not experience severe **anxiety**, do not worry excessively about social situations beforehand, and do not avoid events that make them feel self-conscious. On the other hand, people with social phobia may not be shy; they may feel perfectly comfortable with people except in specific situations. Social phobias may be only mildly irritating, or they may significantly interfere with daily life. It is not unusual for people with social phobia to turn down job offers or avoid relationships because of their fears.

Agoraphobia

Agoraphobia is the intense fear of feeling trapped and having a panic attack in a public place. This type of phobia usually begins between ages 15 and 35, and affects three times as many women as men, or about 3% of the population.

An episode of spontaneous panic is usually the initial trigger for the development of agoraphobia. After an initial panic attack, the person becomes afraid of experiencing a second one. Individuals "fear the fear," and worry incessantly about when and where the next attack may occur. As they begin to avoid the places or situations in which the panic attack occurred, their fear generalizes. Eventually the person completely avoids public places. In severe cases, people with agoraphobia can no longer leave their homes for fear of experiencing a panic attack.

Causes and symptoms

Experts do not really know why phobias develop, although research suggests the tendency to develop phobias may be a complex interaction between heredity and environment. Some hypersensitive people have unique chemical reactions in the brain that cause them to respond much more strongly to **stress**. These people also may be especially sensitive to **caffeine**, which triggers certain brain chemical responses.

While experts believe the tendency to develop phobias runs in families and may be hereditary, a specific stressful event usually triggers the development of a specific phobia or agoraphobia. For example, someone predisposed to develop phobias who experiences severe turbulence during a flight might go on to develop a phobia about flying. What scientists do not understand is why some people who experience a frightening or stressful event develop a phobia and others do not.

Social phobia typically appears in childhood or adolescence, sometimes following an upsetting or humiliating experience. Certain vulnerable children who have had unpleasant social experiences (e.g., being rejected) or who have poor social skills may develop social phobias. The condition also may be related to low self-esteem, unassertive personality, and feelings of inferiority.

A person with agoraphobia may have a panic attack at any time, for no apparent reason. While the attack may last only a minute or so, the person remembers the feelings of panic so strongly that the possibility of another attack becomes terrifying. For this reason, people with agoraphobia avoid places where they might not be able to escape if a panic attack occurs. As the fear of an attack escalates, the person's world narrows.

While the specific trigger may differ, the symptoms of different phobias are remarkably similar. These include feelings of terror and impending doom, rapid heartbeat (tachycardia) and rapid breathing, sweaty palms, and other features of a panic attack. Individuals may experience severe anxiety symptoms in anticipating a phobic trigger. For example, someone who is afraid to fly may begin having episodes of pounding heart and sweating palms at the mere thought of getting on a plane in two weeks.

Diagnosis

A mental health professional can diagnose phobias after a detailed interview and discussion of both mental and physical symptoms. Social phobia is often associated with other anxiety disorders, depression, or **substance abuse**.

Treatment

People who have a specific phobia that is easy to avoid (e.g. fear of snakes) and that does not interfere much with their lives may not need to get help. When phobias do interfere with a person's daily life, a

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KEY TERMS

Agoraphobia—An intense fear of being trapped in a crowded, open, or public space where it may be hard to escape, combined with the dread of having a panic attack.

Benzodiazepine—A class of drugs that have a hypnotic and sedative action, used mainly as tranquilizers to control symptoms of anxiety.

Beta blockers—A group of drugs that are usually prescribed to treat heart conditions, but that also are used to reduce the physical symptoms of anxiety and phobias, such as sweating and palpitations.

MAO-B inhibitors—Inhibitors of the enzyme monoamine oxidase B. MAO-B helps break down dopamine; inhibiting it prolongs the action of dopamine in the brain. MAOs can be used to treat social phobia.

Selective serotonin reuptake inhibitors (SSRIs)—A class of antidepressants that work by blocking the reabsorption of serotonin in the brain, raising the levels of serotonin. SSRIs include Prozac, Zoloft, and Paxil.

Serotonin—5-Hydroxytryptamine; a substance that occurs throughout the body with numerous effects including neurotransmission in the brain. Inadequate amounts of serotonin are implicated in some forms of depression, obsessive-compulsive disorder, and anxiety disorders.

Social phobia—Fear of being judged or ridiculed by others; fear of being embarrassed in public.

combination of **psychotherapy** and medication can be quite effective in reducing the phobia to manageable levels.

Psychotherapy

Cognitive-behavioral therapy adds a cognitive approach to more traditional behavioral therapy. It teaches individuals how to change their thoughts, behavior, and attitudes, while providing techniques to lessen anxiety, such as deep breathing, muscle relaxation, and refocusing. One cognitive-behavioral approach is desensitization (also known as exposure therapy), in which people gradually are exposed to the frightening object or event until they become used to it and their physical symptoms decrease. For example, someone who is afraid of snakes might first be shown a photo of a snake. Once the person can look at a photo without anxiety, he or she might then be shown a video of a snake. Each step is repeated until the physical symptoms of fear, such as pounding heart and sweating palms, disappear. Eventually, the person might reach the point where he or she can touch a live snake. Three-fourths of patients are significantly improved with this type of treatment.

Another more dramatic cognitive-behavioral approach is called flooding. It exposes the person immediately to the feared object or situation. The person remains in the situation until the anxiety lessens.

Drugs

Medication can block the feelings of panic and when combined with cognitive-behavioral therapy, can be effective in reducing phobias. Drug therapy is individualized based on the age of the patient, severity of the phobia, co-existing physical and/or mental disorders, and history of drug or alcohol addition.

Several drugs are used to treat specific phobias and social phobia by controlling symptoms and helping to prevent panic attacks. Treating agoraphobia is more difficult than treating other phobias because there are often so many fears involved, such as open spaces, traffic, elevators, and escalators.

Drugs often used to treat phobias include antianxiety drugs such as buspirone (BuSpar) and **benzodiazepines** such as such as alprazolam (Xanax), lorazepam (Ativan), clonazepam (Klonopin), and diazepam (Valium). Antihypertensive beta-blockers (drugs that lower blood pressure), such as propranolol (Inderal), atenolol (Tenormin), and nadolol (Corgard), appear to work well in the treatment of circumscribed social phobia when anxiety gets in the way of performance, such as public speaking. These drugs reduce overstimulation, thereby controlling the physical symptoms of anxiety.

In addition, some antidepressants may be effective when used together with cognitive-behavioral therapy. These include venlafaxine (Effexor), imipramine (Tofranil), desipramine (Norpramin), nortriptyline (Pamelor), duloxetine (Cymbalta), clomipramine (Anafranil), citalopram (Celexa), escitalopram (Lexapro), fluoxetine (Prozac), paroxetine (Paxil), sertraline (Zoloft) and fluvoxamine (Luvox). The monoamine oxidase inhibitor (MAO inhibitor) phenelzine (Nardil) may be used when treatment with antidepressants fails or is not tolerated.

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Home remedies

In all types of phobias, symptoms may be eased by lifestyle changes, such as:

- eliminating caffeine
- reducing or eliminating alcohol use
- eating a healthy diet
- getting plenty of exercise
- reducing stress

Prognosis

Phobias are among the most treatable mental health problems. Depending on the severity of the condition and the type of phobia, most properly treated individuals can go on to lead normal lives. Research suggests that once a person overcomes the phobia, the problem may not return for many years, if at all.

Although phobias are highly treatable, only about 20% of specific phobias will go away without treatment, and agoraphobia will get worse with time if untreated. Social phobias tend to be chronic and are not likely go away without treatment. Moreover, untreated phobias can lead to other problems, including depression, **alcoholism**, and feelings of shame and low self-esteem. Unfortunately, only about 25% of people with phobias seek help to deal with their condition.

Prevention

There is no known way to prevent the development of phobias. Medication and cognitive-behavioral therapy may help prevent the recurrence of symptoms once they have been diagnosed.

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ORGANIZATIONS

American Psychiatric Association, 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209-3901, (703)907-7300, apa@psych.org, http://www.psych.org.

Anxiety Disorders Association of America, 8730 Georgia Ave., Suite 600, Silver Spring, MD, 20910, (240) 485-1001, (240) 485-1035, information@adaa.org, http://www.adaa.org.

National Anxiety Foundation, 3135 Custer Dr., Lexington, KY, 40517, 606-272-7166, http://www.lexington-online.com/naf.html.

National Institute of Mental Health, 6001 Executive Boulevard, Room 8184, MSC 9663, Bethesda, MD, 20892-9663, (301) 443-4513. TTY (301) 443-8431, (866) 615-6464 TTY (866) 415-8051 , (301) 443-4279, nimhinfo@ nimh.gov, http://www.nih.nih.gov.

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Phospholipidosis *see* **Pulmonary alveolar proteinosis**

Phosphorus imbalance

Definition

Phosphorus imbalance refers to conditions in which the element phosphorus is present in the body at too high a level (hyperphosphatemia) or too low a level (hypophosphatemia).

Description

Almost all of the phosphorus in the body occurs as phosphate (phosphorus combined with four oxygen atoms), and most of the body's phosphate (85%) is located in the skeletal system, where it combines with **calcium** to give bones their hardness. The remaining amount (15%) exists in the cells of the body, where it plays an important role in the formation of key nucleic acids, such as DNA, and in the process by which the body turns food into energy (metabolism). The body regulates phosphate levels in the blood through the controlled release of parathyroid hormone (PTH) from the parathyroid gland and calcitonin from the thyroid gland. PTH keeps phosphate levels from becoming too high by stimulating the excretion of phosphate in urine and causing the release of calcium from bones (phosphate blood levels are inversely proportional to calcium blood levels). Calcitonin keeps phosphate blood levels in check by moving phosphates

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out of the blood and into the bone matrix to form a mineral salt with calcium.

Most phosphorus imbalances develop gradually and are the result of other conditions or disorders, such as **malnutrition**, poor kidney function, or a malfunctioning gland.

Causes and symptoms

Hypophosphatemia

Hypophosphatemia (low blood phosphate) has various causes. **Hyperparathyroidism**, a condition in which the parathyroid gland produces too much PTH, is one primary cause. Poor kidney function, in which the renal tubules do not adequately reabsorb phosphorus, can result in hypophosphatemia, as can overuse of **diuretics**, such as theophylline, and **antacids** containing aluminum hydroxide. Problems involving the intestinal absorption of phosphate, such as chronic **diarrhea** or a deficiency of vitamin D (needed by the intestines to properly absorb phosphates) can cause the condition. Malnutrition due to chronic **alcoholism** can result in an inadequate intake of phosphorus. Recovery from conditions such as **diabetic ketoacidosis** or severe **burns** can provoke hypophosphatemia, since the body must use larger-than-normal amounts of phosphate. Respiratory alkylosis, brought on by hyperventilation, can also result in temporary hypophosphatemia.

Symptoms generally occur only when phosphate levels have decreased profoundly. They include muscle weakness, **tingling** sensations, **tremors**, and bone weakness. Hypophosphatemia may also result in confusion and **memory loss**, seizures, and **coma**.

Hyperphosphatemia

Hyperphosphatemia (high blood phosphate) also has various causes. It is most often caused by a decline in the normal excretion of phosphate in urine as a result of kidney failure or impaired function. **Hypoparathyroidism**, a condition in which the parathyroid gland does not produce enough PTH, or pseudoparathyroidism, a condition in which the kidneys lose their ability to respond to PTH, can also contribute to decreased phosphate excretion. Hyperphosphatemia can also result from the overuse of **laxatives** or **enemas** that contain phosphate. **Hypocalcemia** (abnormally low blood calcium) can cause phosphate blood levels to increase abnormally. A side-effect of hyperphosphatemia is the formation of calcium-phosphate crystals in the blood and soft tissue.

Hyperphosphatemia is generally asymptomatic; however, it can occur in conjunction with hypocalcemia, the symptoms of which are **numbness and tingling** in the extemities, **muscle cramps** and spasms, depression, memory loss, and convulsions. When calcium-phosphate crystals build up in the blood vessels, they can cause arteriosclerosis, which can lead to heart attacks or strokes. When the crystals build up in the skin, they can cause severe **itching**.

Diagnosis

Disorders of phosphate metabolism are assessed by measuring serum or plasma levels of phosphate and calcium. Hypophosphatemia is diagnosed if the blood phosphate level is less than 2.5 milligrams per deciliter of blood. Hyperphosphatemia is diagnosed if the blood phosphate level is above 4.5 milligrams per deciliter of blood. Appropriate tests are also used to determine if the underlying cause of the imbalance, including assessments of kidney function, dietary intake, and appropriate hormone levels.

Treatment

Treatment of phosphorus imbalances focuses on correcting the underlying cause of the imbalance and restoring equilibrium. Treating the underlying condition may involve surgical removal of the parathyroid gland in the case of hypophosphatemia caused by hyperparathyroidism; initiating hormone therapy in cases of hyperphosphatemia caused by hypoparathyroidism; ceasing intake of drugs or medications that contribute to phosphorus imbalance; or instigating measures to restore proper kidney function.

Restoring phosphorus equilibrium in cases of mild hypophosphatemia may include drinking a prescribed solution that is rich in phosphorus; however, since this solution can cause diarrhea, many doctors recommend that patients drink 1 qt (0.9 L) of skim milk per day instead, since milk and other diary products are significant sources of phosphate. Other phosphate-rich foods include green, leafy vegetables; peas and beans; nuts; chocolate; beef liver; turkey; and some cola drinks. Severe hypophosphatemia may be treated with the administration of an intravenous solution containing phosphate.

Restoring phosphorus equilibrium in cases of mild hyperphosphatemia involves restricting intake of phosphorus-rich foods and taking a calcium-based antacid that binds to the phosphate and blocks its absorption in the intestines. In cases of severe hyperphosphatemia, an intravenous infusion of calcium gluconate may be administered. Dialysis may also be

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required in severe cases to help remove excess phosphate from the blood.

Prognosis

The prognosis for treating hyperphosphatemia and hypophosphatemia are excellent, though in cases where these problems are due to genetic disease, lifelong hormone treatment may be necessary.

Prevention

Phosphorus imbalances caused by hormonal disorders or other genetically determined conditions cannot be prevented. Hypophosphatemia resulting from poor dietary intake can be prevented by eating foods rich in phosphates, and hypophosphatemia caused by overuse of diuretics or antacids can be prevented by strictly following instructions concerning proper dosages, as can hyperphosphatemia due to excessive use of enemas or laxative. Finally, patients on dialysis or who are being fed intravenously should be monitored closely to prevent phosphorus imbalances.

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Tom Brody, PhD

Photoallergy *see* **Photosensitivity**

Photodynamic therapy

Definition

Photodynamic therapy (PDT) is a form of nonsurgical **cancer** treatment available since the early 1990s that combines a photosensitizing medication with exposure to a laser or other specific light wavelength to kill cancer cells. It can be used before or after surgery and other forms of cancer treatment. In some cases, PDT can even be administered during surgery to kill any cancer cells that were not removed by excision.

Purpose

Photodynamic therapy is still evolving, both in terms of the types of cancer it is approved to treat and the specific drugs that are used. PDT with a drug called porfimer **sodium** (Photofrin) was first approved as a treatment for **esophageal cancer** in 1995. The Food and Drug Administration (FDA) then extended its approval of this drug to cover **non-small cell lung cancer** in 1998. The FDA has also approved porfimer sodium for the treatment of tumors located in the bronchi of the lungs and for palliative treatment of advanced cancers of the esophagus. Some cancer centers in the United States administer PDT with porfimer sodium for the treatment of certain types of skin cancer (squamous cell carcinoma, **basal cell carcinoma**, and Bowen's disease), recurrences of **breast cancer** following **mastectomy**, colorectal cancer, and cancers of the vulva and cervix, but these applications of PDT are still considered experimental as of early 2010.

In December 1999, the FDA approved a compound called aminolevulinic acid (ALA or Levulan Kerastick) for the treatment of actinic keratosis, a precancerous skin disorder caused by sun exposure. Verteporfin (Visudyne) was approved in 2000 as a photosensitizing agent for the treatment of eye disorders.

Porfimer sodium, ALA, and verteporfin are the only photosensitizing agents approved by the FDA for use in the United States as of 2010. Several newer drugs for PDT are being tested in cancer centers in the United States and Europe. The most important of these will be described below.

In addition to cancer therapy, PDT is used to treat such conditions as wet **macular degeneration**, an eye disorder that can lead to blindness, as well as such benign skin conditions as **psoriasis**, **acne**, and skin disorders caused by the **human papilloma virus**. In addition, PDT is under investigation as a possible treatment for certain forms of **coronary artery disease**.

Precautions

Precautions for porfimer sodium (Photofrin):

- Porfimer sodium cannot be used in patients who are allergic to hematoporphyrin, a blood pigment used to make the drug.
- It cannot be used in pregnant or nursing women because its safety during pregnancy or lactation has not been established.
- It cannot be used to treat children.
- Lung tumors treated with Photofrin must be located in an airway where the doctor can reach them with a brochoscope.
- Photofrin cannot be used to treat tumors in the esophagus or bronchi that are beginning to break into the patient's windpipe or a major blood vessel.

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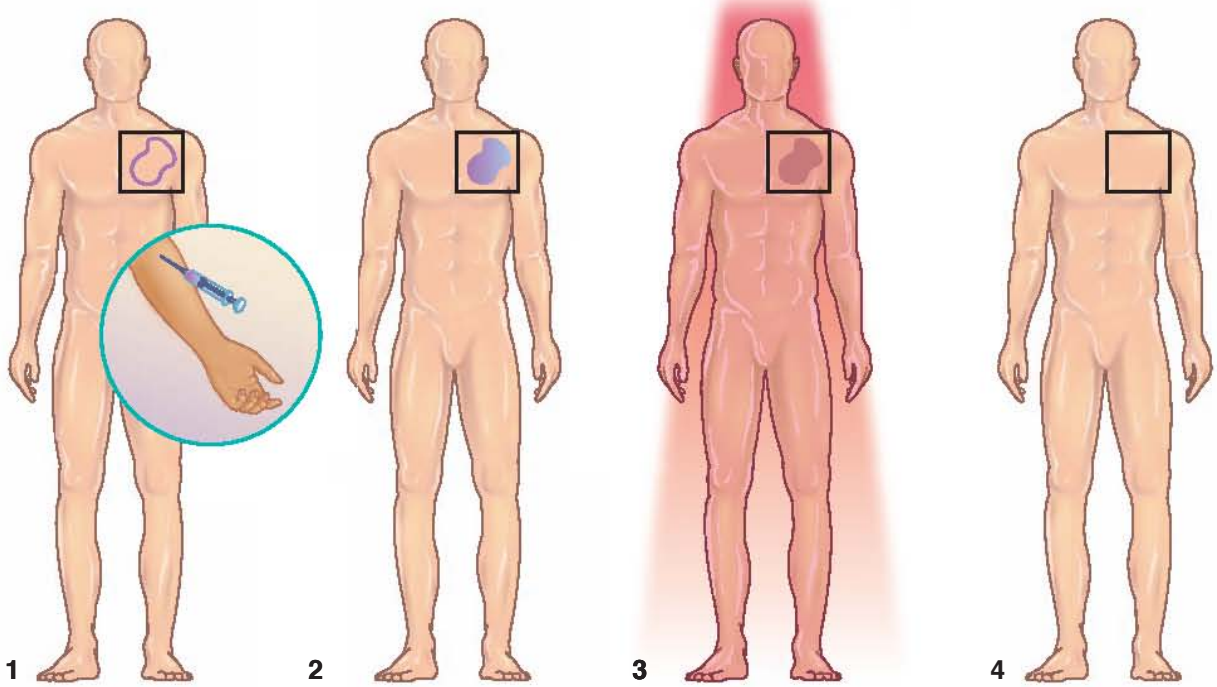
How photodynamic therapy works

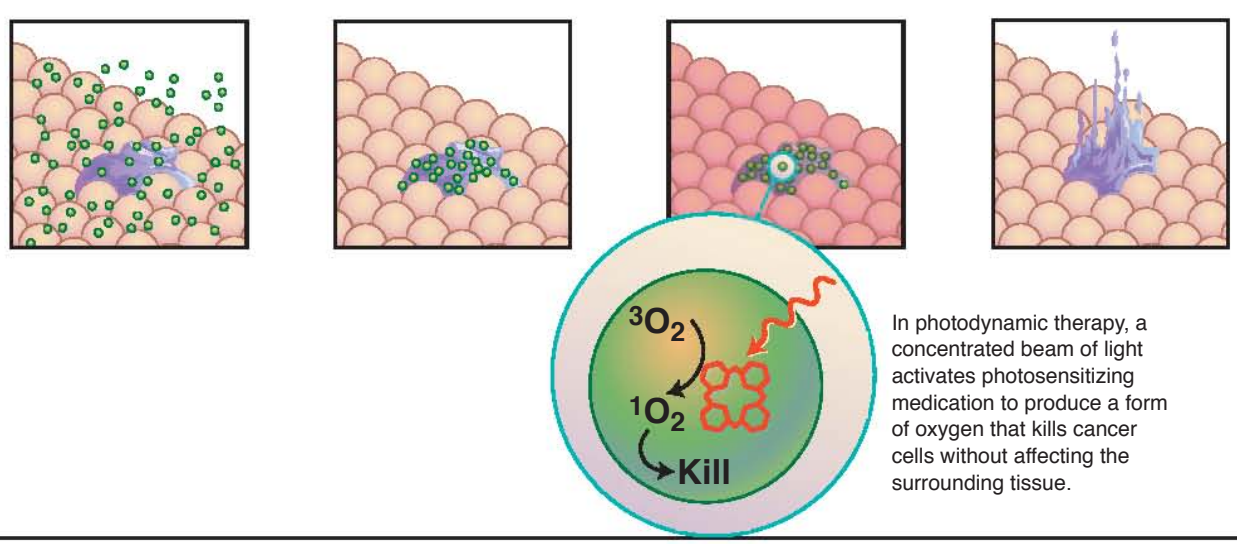


1
The photosentisitizing medication is given intravenously or applied topically several hours before the procedure.

2
The medication is absorbed by both normal and cancerous cells, but it leaves the normal cells within 72 hours, remaining only in the cancer cells.

3
Red (intravenous) or blue (topical) light is focused on the tumor. The light source activates the photosensitizing medication, which releases free radicals and singlet oxygen.

4
The free radicals and singlet oxygen interact to destroy the cancer cells.



In photodynamic therapy, a concentrated beam of light activates photosensitizing medication to produce a form of oxygen that kills cancer cells without affecting the surrounding tissue.

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KEY TERMS

Actinic keratosis (plural, keratoses)—A type of precancerous skin growth with a scaly or bumpy surface caused by overexposure to the sun.

Barrett's esophagus—A precancerous condition of the esophagus that may develop as a complication of gastroesophageal reflux disease (GERD).

Bronchi (singular, bronchus)—The larger air passages inside the lungs.

Fiberoptics—Bundles of specially treated glass or plastic fibers that intensify light from a light source by internal reflection. Fiberoptics can be attached to lasers for use in PDT.

Free radicals—Molecules that contain at least one unpaired electron. They are highly reactive and can destroy cells by disrupting their normal biological processes. Free radicals are released during PDT and help to kill tumor cells.

Hematoporphyrin—A dark reddish-purple pigment found in blood. A purified form of hematoporphyrin is used to make porfimer sodium.

Nanometer—A measurement of length equal to 10^{-9} meters, or one billionth of a meter. It is used as a unit of measurement for light waves.

Orphan drug—A drug that treats a rare disease—"rare disease" being defined by the Food and Drug Association as one affecting fewer than 200,000 Americans. The category of orphan drug includes experimental as well as approved medications. Some photosensitizing drugs used in Europe are considered orphan drugs in the United States.

Palliative—Referring to treatment used to relieve the symptoms of a disease or disorder rather than to cure it.

Photosensitizer—A chemical compound that can be excited (activated) by light of a specific wavelength.

Singlet oxygen—A highly reactive form of the oxygen molecule (O_2) formed during PDT that helps to destroy cancer cells by attacking their cell membranes.

The drug should also be used cautiously in treating bronchial tumors that could block the airway if they develop inflammation following PDT.

- Patients who are receiving radiotherapy should not have PDT with porfimer sodium until four weeks after their last radiation treatment. They should also not be treated with radiotherapy until two to four weeks after a PDT treatment.

Precautions for aminolevulinic acid (ALA):

- Patients being treated with ALA must protect their skin from exposure to sunlight or bright indoor light in the short time period between application of the drug to the skin and the PDT treatment.
- ALA should be used cautiously in pregnant women or nursing mothers.
- If a second treatment is necessary, it should not be done before eight weeks after the first treatment.

Description

How PDT works

Photodynamic therapy is based on a series of chemical reactions involving a specific wavelength of visible light, a photosensitizing drug, and oxygen. There is no standard wavelength of light, light source, exposure period, or method of administering the medication that covers all forms of PDT. Most photosensitizing drugs are given intravenously, but some are applied to the skin or taken by mouth. Photosensitizers given by injection are activated by light in the red portion of the visible light spectrum, around 630–700 nanometers (nm; a nanometer is a measure of length, one billionth of a meter), while those applied to the skin are usually activated by blue light.

In general, cancerous tumors inside the body need more concentrated doses of light than abnormal growths on the body surface. Lasers are usually used to deliver highly concentrated light at one specific wavelength, while light sources that provide a larger area of illumination, such as light-emitting diodes (LEDs), are more efficient for treating skin tumors.

In contrast to their uses in surgery, lasers are not used in PDT to remove tissue or seal blood vessels with heat; rather they are used to start a chemical reaction. As a result, they do not become hot enough to burn tissue. The burning or stinging sensation that some patients experience during PDT is caused by the release of oxygen stimulating nearby nerve endings rather than heat from the laser itself.

Lasers can be attached to fiberoptics for treating tumors inside the body. Fiberoptics are thin strands of plastic or glass with special optical properties that can

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be threaded through a bronchoscope or endoscope, which are special tubes that allow the doctor to see into the patient's lungs or esophagus. Light from the laser is then transmitted along the special fibers to the tumor, thus allowing the doctor to activate the photosensitizing medication in a very small area of tissue without damaging normal tissue nearby.

PDT is a two-step form of therapy. First, the photosensitizing medication is injected into a vein or applied to the skin several days or hours before the scheduled treatment. The drug is absorbed by all body tissues but remains in cancer cells longer than in normal cells because the cancer cells are multiplying faster. After the medication has had time to collect in the malignant cells, the doctor directs a light source of the proper wavelength on the targeted area. When the light source strikes tissue containing the photosensitizing medication in the presence of oxygen, the medication is activated and produces free radicals and a highly reactive form of oxygen called singlet oxygen. The free radicals and singlet oxygen interact with the cell membranes of the cancer cells to destroy the energy-producing structures inside the cancer cells. In addition to killing the cancer cells directly, PDT works by closing blood vessels inside the tumor, thereby shutting off its supply of nutrients, and by stimulating the immune system to produce interleukins (nonantibody proteins) and other substances that attack the cancer.

Photosensitizing drugs

PORFIMER SODIUM. Porfimer sodium, or Photofrin, was the first medication used for PDT. It is a purified derivative of hematoporphyrin, a dark reddish-purple pigment found in blood. Photofrin is activated by red light at a wavelength of 630 nm; one disadvantage of this short wavelength is that it cannot penetrate tissue deeper than about a third of an inch, thus making Photofrin unsuitable for treating large solid tumors or tumors that lie deep beneath the surface. The light used to activate Photofrin is usually generated by a laser.

Porfimer sodium has several other disadvantages for PDT: It is a complex chemical mixture that tends to break down over time; it has limited ability to penetrate tissue; and it takes four to six weeks to be cleared from the skin, thus leaving patients susceptible to a **photosensitivity** reaction for a long period of time after their PDT treatment. A photosensitivity reaction occurs when sensitized skin is exposed to sunlight or other bright light and is characterized by redness, swelling, and blistering of the exposed skin. As a result of Photofrin's disadvantages, researchers have been studying other photosensitizers with the following characteristics:

- They are single compounds rather than mixtures of chemicals.
- They are more effective in absorbing the red region of the visible light spectrum.
- They are more selective in targeting malignant tissue.
- They are more efficient in generating singlet oxygen.

AMINOLEVULINIC ACID. Aminolevulinic acid, or ALA, is a short-lived photosensitizer that is applied to the skin as a 5–20% oil-in-water mixture. It is activated by either a special blue light illuminator or by light at 630–635 nm.

SECOND-GENERATION PHOTOSENSITIZERS. Newer photosensitizing agents include:

- HPPH (2-[1-hexyloethyl]-2-devinyl-pyropheophorbide-a). HPPH, also called Photochlor, is a photosensitizer that is activated by light more efficiently than Photofrin. In addition, patients treated with HPPH do not have the long-term photosensitivity reactions associated with Photofrin. HPPH has been used experimentally since 2003 at the Roswell Park Cancer Institute in Buffalo, New York, to treat esophageal cancer, Barrett's esophagus, basal cell carcinoma, and recurrent breast cancer following mastectomy. It is also undergoing clinical trials in schools of veterinary medicine as a possible treatment for cancers in cats and dogs. Like Photofrin, HPPH is given intravenously. There are 12 clinical trials of HPPH under way as of 2010.
- Verteporfin (also known as BPD-MA [benzoporphyrin derivative monoacid ring A]; brand name Visudyne). Verteporfin is a second-generation photosensitizer used primarily to treat eye disorders, including age-related macular degeneration, other abnormal formations of blood vessels within the eye, and histoplasmosis (an eye infection caused by a fungus). It was approved for these uses by the FDA in 2000. Verteporfin is also being investigated as a possible treatment for skin cancer and psoriasis.
- Temoporfin (Meta-tetra hydroxyphenyl chlorin; brand name Foscan). Temoporfin is a chlorin-type photosensitizer developed in the United Kingdom. It was approved by the European Union in 2001 for the treatment of head and neck cancers and certain types of lung cancer, but is categorized as an orphan drug in the United States. The FDA lists temoporfin as an orphan drug for the palliative treatment of inoperable head and neck cancers. There are two clinical trials of temoporfin under way as of 2010.

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- Motexafin lutetium (brand name Lu-Tex). Lu-Tex is an injectable dye that has been used in clinical trials to treat malignant melanoma. It has a high degree of selectivity for cancer cells. It also shows promise as a treatment for recurrent breast cancer and atherosclerosis. There were three clinical trials of Lu-Tex in the treatment of cervical and prostate cancer being conducted as of 2010.

Clinical trials

As of 2010, the National Cancer Institute (NCI) was conducting 213 different clinical studies of PDT as a treatment for macular degeneration and for cancers of the brain, skin, prostate, cervix, liver, gallbladder, urinary bladder, and the abdominal cavity. Other researchers are investigating photosensitizers that are stronger than Photofrin or better able to penetrate large solid tumors. Still another area of research is improving the effectiveness of PDT in treating metastatic cancers. At present, photodynamic therapy is usually used only to treat primary cancers.

Preparation

PDT for skin conditions

A patient receiving PDT for skin cancer or a precancerous skin disorder will have ALA applied to the affected area three to six hours before the scheduled treatment. The skin may or may not be covered with a dressing. The patient does not need to fast or make any other special preparations. If the affected area of skin is on the face, the patient may be given goggles to wear to protect the eyes from the blue light used to activate the drug.

PDT for internal cancers

The photosensitizing agents used for PDT or palliative treatment of esophageal or lung cancers are given by injection, usually two to three days before treatment. The patient may return home after the injection, but must avoid sunlight and bright light indoors before the light treatment. The patient does not need to fast or discontinue other medications, but should cover the windows and skylights in his or her home before receiving the light treatment to prevent exposure to bright light after returning home.

Patients undergoing PDT for esophageal or lung cancers are given a local or general anesthetic before the doctor inserts the bronchoscope or endoscope. They may also be given a mild tranquilizer to relieve **anxiety**.

Aftercare

Aftercare following PDT with porfimer sodium involves four to six weeks of protection from sunlight and other sources of bright light, including **tanning** lamps or the examination lamps found in doctors' and dentists' offices. During this period, the patient should wear dark glasses: long-sleeved shirts of light-color, and tightly woven fabric; long pants or slacks; and a wide-brimmed hat to protect the skin and eyes outdoors for at least 30 days after treatment. Sunscreen creams and lotions do not provide enough protection. It is best to run necessary errands after sundown or ask someone else in the household to drive the car. Women should not use helmet-type hair dryers or hand-held dryers on a high setting, as the drug remains in the scalp for several weeks and may cause **burns** if exposed to high heat. Exposure to low levels of indoor light is necessary, however, in order to break down the Photofrin remaining in the skin. After 30 days, the doctor will give the patient instructions on testing the skin for any remaining sensitivity to light.

Patients who have received PDT for cancers in the lining of the bronchi must return two days after the treatment for a follow-up **bronchoscopy**, in which the doctor will remove dead tumor cells and other pieces of tissue from the treated area. This follow-up procedure is necessary to prevent inflammation and possible blockage of the patient's airway. Treated tumor sites require between four and eight weeks for complete healing.

Patients who receive PDT with ALA do not need to take special precautions regarding sun exposure after treatment because the drug is short-lived. The treated skin will usually form a crust or scale for several days before healing completely.

Risks

Porfimer sodium

Risks of PDT with porfimer sodium include photosensitivity reactions if the patient fails to observe the guidelines for aftercare; chest **pain** or a burning sensation in the chest or throat; difficulty swallowing; **itching**; the formation of ulcers or scar tissue; and discomfort in the eyes when exposed to sunlight, bright lights, or car headlights. Breast cancer and lung cancer patients who have severe chest pain after PDT can be given medications to control the pain.

Aminolevulinic acid

Some patients experience a stinging or burning sensation in the skin during the blue light treatment,

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but this usually goes away as soon as the light is turned off. Some patients also report temporary swelling or redness of the skin in the treated areas, or minor changes in the pigmentation of their skin.

Normal results

Normal results of PDT of the esophagus or the lining of the bronchi are shrinkage of the tumor and destruction of cancer cells. Normal results of palliative treatment for cancer of the esophagus are sufficient shrinkage of the tumor to allow the patient to swallow again.

Normal results for PDT of the skin include shrinkage and destruction of the tumor, although large skin tumors may require a second treatment for complete removal.

Abnormal results

Abnormal results include allergic reactions to the photosensitizing medication or failure of the tumor to respond to PDT.

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Photokeratitis *see* **Keratitis**

Photorefractive keratectomy and laser-assisted in-situ keratomileusis

Definition

Photorefractive keratectomy (PRK) and laser-assisted in-situ keratomileusis (LASIK) are two similar surgical techniques that use an excimer laser to correct nearsightedness (**myopia**) by reshaping the cornea. The cornea is the clear outer structure of the eye that lies in front of the colored part of the eye (iris). PRK and LASIK are two forms of vision-correcting (refractive) surgery. The two techniques differ in how the surface layer of the cornea is treated. As of mid 1998, two eximer lasers (Summit and Visx) had been approved for laser vision correction (refractive surgery using a laser) in the PRK procedure. Since then, Visx, Summit, and other lasers have received approval by the Food and Drug Administration (FDA) for use in LASIK procedures.

Purpose

The purpose of both LASIK and PRK is to correct nearsightedness in persons who don't want to, or can't, wear **eye glasses** or **contact lenses**. Most patients are able to see well enough to pass a driver's license exam without glasses or contact lenses after the operation. After approximately age 40, the lens in the

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eye stiffens making it harder to focus up close. Because laser vision correction only affects the cornea, the procedures do not eliminate the need for reading glasses. Patients should be wary of any ads that "guarantee" 20/20 vision. Patients should also make sure that the laser being used is approved by the FDA.

Precautions

Patients should be over 18 years of age, have healthy corneas, and have vision that has been stable for the past year. People who may not be good candidates for these procedures are pregnant women or women who are **breastfeeding** (vision may not be stable); people with scarred corneas or macular disease; people with autoimmune diseases (i.e., **systemic lupus erythematosus** or **rheumatoid arthritis**); or people with diabetes. Patients with glaucoma should not have LASIK because the intraocular pressure (IOP) of the eye is raised during the procedure. A patient with persistent lid infections (i.e., blepharitis) may not be a good candidate because of an increased risk of infection. An ophthalmologist who specializes in laser vision correction can determine who would be likely to benefit from the operation and suggest which of the two operations might be more appropriate for any given patient.

If a patient is thinking of having **cataract surgery**, they should discuss it with the doctor. During cataract surgery an intracocular lens (IOL) will be inserted and that alone may correct distance vision.

Description

PRK and LASIK are both performed with an excimer laser, which uses a cold beam of ultraviolet light to sculpt or reshape the cornea so that light will focus properly on the retina. The cornea is the major focusing structure of the eye. The retina sends the image focused on it to the brain. In myopia, the cornea is either too steep or the eye is too long for a clear image to be focused on the retina. PRK and LASIK flatten out the cornea so that the image will focus more precisely on the retina.

In PRK, the surface of the cornea is removed by the laser. In LASIK, the outer layer of the cornea is sliced, lifted, moved aside while the cornea is reshaped with the laser, then replaced to speed healing. Both procedures cause the cornea to become flatter, which corrects the nearsighted vision.

At least one laser has been approved to treat mild **astigmatism**. Correcting farsightedness (**hyperopia**) may be possible in the future.

These laser vision-correcting procedures are rapidly replacing **radial keratotomy** (RK), an earlier form of refractive surgery that involved cutting the cornea with a scalpel in a pattern of radiating spokes. RK has declined in popularity since the approval of the excimer laser in 1995, falling from a high of 250,000 procedures performed per year in 1994 to 50,000 in 1997.

For both LASIK and PRK, the patient's eye is numbed with anesthetic drops. No injections are necessary. The patient is awake and relaxed during the procedure.

LASIK is sometimes referred to as a "flap and zap" procedure because a thin flap of tissue is temporarily removed from the surface of the cornea and the underlying cornea is then "zapped" with a laser. Prior to the surgery, the surface of the cornea is marked with a dye marker so that the flap of cornea can be precisely aligned when it is replaced. The doctor places a suction ring on the eye to hold it steady. During this part of the operation, which lasts only a few seconds, the patient is not able to see. A surgical instrument called a microkeratome is passed over the cornea to create a very thin flap of tissue. The IOP is increased at this time which is why it is contraindicated in patients with glaucoma. This thin tissue layer is folded back. The cornea is reshaped with the laser beam and the cell layer is replaced. Because the cell layer is not permanently removed, patients have a faster recovery time and experience far less discomfort than with PRK. An antibiotic drop is put in and the eye is patched until the following day's checkup.

In PRK, a small area of the surface layer of the cornea is vaporized. It takes about three days for the surface cells to grow back and vision will be blurred. Some patients describe it as "looking through Vaseline." PRK is generally recommended for patient's with mild to moderate myopia (usually under -5.00 diopters).

With both PRK and LASIK, there is a loud tapping sound from the laser and a burning smell as the cornea is reshaped. The surgery itself is painless and takes only a minute or two. Patients are usually able to return home immediately after surgery. Most patients wait (up to six months) before they have the second one done. This allows the first eye to heal and to see if there were complications from the surgery.

The cost of these procedures can vary with geographic area and the doctor. In general, the procedure costs $1,350–$2,500 per eye for PRK and about $500 more per eye for LASIK. PRK and LASIK are generally not covered by insurance. However, insurance

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KEY TERMS

Blepharitits— An inflammation of the eyelid.

Cataract—A condition in which the lens of the eye turns cloudy and interferes with vision.

Cornea—The clear, curved tissue layer in front of the eye. It lies in front of the colored part of the eye (iris) and the black hole in the center of the iris (pupil).

Diopter (D)—A unit of measure of the power or strength of a lens.

Excimer laser—An instrument that is used to vaporize tissue with a cold, coherent beam of light with a single wavelength in the ultraviolet range.

Intraocular lens (IOL) implant—A small, plastic device (IOL) that is usually implanted in the lens capsule of the eye to correct vision after the lens of the eye is removed. This is the implant is used in cataract surgery.

Macular degeneration—A condition usually associated with age in which the area of the retina called the macula is impaired due to hardening of the arteries (arteriosclerosis). This condition interferes with vision.

Microkeratome—A precision surgical instrument that can slice an extremely thin layer of tissue from the surface of the cornea.

Myopia—A vision problem in which distant objects appear blurry. Myopia results when the cornea is too steep or the eye is too long and the light doesn't focus properly on the retina. People who are myopic or nearsighted can usually see near objects clearly, but not far objects.

Refractive surgery—A surgical procedure that corrects visual defects.

Retina—The sensory tissue in the back of the eye that is responsible for collecting visual images and sending them to the brain.

may cover these procedures for people in certain occupations, such as police officers and firefighters.

Preparation

If a patient wears contact lenses, they should not be worn for a few weeks prior to surgery. It also is important to discontinue contact lens wear prior to the visual exams to make sure vision is stable. The doctor should be advised of contact lens wear.

Upon arrival at the doctor's office on the day of surgery, patients are given some eye drops and a sedative, such as Valium, to relax them. Their vision is tested. They rest while waiting for the sedative to take effect. Immediately before the surgery, patients are given local anesthetic eye drops.

Aftercare

After surgery, antibiotic drops are placed in the eye and the eye may be patched. The patient returns for a follow-up visit the next day. The patient is usually given a prescription for eyedrops (usually antibiotic and anti-inflammatory). Patients who have had PRK usually feel mild discomfort for one to three days after the procedure. They may need a bandage contact lens. Patients who have had LASIK generally have less, or even no discomfort after the surgery. After LASIK, antibiotic and anti-inflammatory drops are generally necessary for one week. After PRK, steroidal eye drops may be necessary for months. Because **steroids** may increase the possibility of glaucoma or **cataracts**, it is a big drawback to the procedure. The patient should speak with the doctor to see how long follow-up medications will be necessary.

Most patients return to work within one to three days after the procedure, although visual recovery from PRK may take as long as four weeks. An eye shield may be used for about one week at night and patients may be sensitive to bright light for a few days. Patients may be asked by their doctor to keep water out of their eye for a week and to avoid mascara or eyeliner during this period.

Risks

There is a risk of under- or over-correction with either of these procedures. If vision is under-corrected, a second procedure can be performed to achieve results that may be closer to 20/20 vision. About 5–10% of PRK patients return for an adjustment, as do 10–25% of LASIK patients. People with higher degrees of myopia have vision that is harder to correct and usually have LASIK surgery rather than PRK. This may account for the higher incidence of adjustments for LASIK patients. Patients with very high myopia (over -15.00 diopters) may experience improvement after LASIK, but they are not likely to achieve 20/40 vision without glasses. However, their glasses will not need to be as thick or heavy after the surgery. However, most

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patients, especially those with less extreme myopia, do not need glasses after the surgery.

Haze is another possible side effect. Although hazy vision is unlikely, it is more likely to occur after PRK than after LASIK. This haze usually clears up. Corneal scarring, halos, or glare at night, or an irritating bump on the cornea are other possible side effects. As with any eye surgery, infection is possible, but rare. Loss of vision is possible with these procedures, but this complication is extremely rare.

Most complications from LASIK are related to the creation and realignment of the flap. The microkeratome must be in good-working order and sharp. LASIK requires a great deal of skill on the part of the surgeon and the complication rate is related to the experience level of the surgeon. In one study, the rate of LASIK complications declined from 3% for surgeons during their first three months using this technique, to 1% after a year's experience in the technique, to 0% after 18 months experience.

Normal results

Most patients experience improvement in their vision immediately after the operation and about half of LASIK patients are able to see 20/30 within one day of the surgery. Vision tends to become sharper over the next few days and then stabilizes; however, it is possible to have shifts in myopia for the next few months. Vision clears and stabilizes faster after LASIK than after PRK. Final vision is achieved within three to six months with LASIK and six to eight months with PRK. The vast majority of patients (95% for people with low to moderate myopia and 75% for people with high levels of myopia) are able to see 20/40 after either of these procedures and are able to pass a driver's license test without glasses or contact lenses.

LASIK is more complicated than PRK because of the addition of the microkeratome procedure. However, LASIK generally has faster recovery time, less **pain**, and less chance of halos and scarring than PRK. LASIK can treat higher degrees of myopia (-5.00–25.00 diopters). LASIK also requires less use of steroids. Patients need to speak with qualified, experienced eye surgeons to help in choosing the procedure that is right for them.

ORGANIZATIONS

American Academy of Ophthalmology (AAO), P. O. Box 7424, San Francisco, CA, 94120-7424, (415) 561-8500, (415) 561-8500, http://www.aao.org.

American Society of Cataract and Refractive Surgery, 4000 Legato Road, Suite 700, Fairfax, VA, 22033, (703) 591-2220, (703) 591-0614, http://www.ascrs.org.

Louann W. Murray, PhD

Photosensitivity

Definition

Photosensitivity refers to any increase in the reactivity of the skin to sunlight.

Description

The skin is a carefully designed interface between our bodies and the outside world. It is infection-proof when intact, nearly waterproof, and filled with protective mechanisms. Sunlight threatens the health of the skin. Normal skin is highly variable in its ability to resist sun damage. Natural skin pigmentation is its main protection. The term photosensitivity refers to any increase beyond what is considered normal variation.

Causes and symptoms

There are over three dozen diseases, two dozen drugs, a variety of herbal preparations, and several perfume and cosmetic components that can cause photosensitivity. There are also several different types of reaction to sunlight—phototoxicity, photoallergy, and polymorphous light eruption. In addition, prolonged exposure to sunlight, even in normal skin,

A skin rash on the front of a woman's neck caused by a photosensitive reaction to sunlight. *(Dr. P. Marazzi/Photo Researchers, Inc.)*

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This person had a phototoxic reaction after taking an antibiotic drug. *(Photo Researchers, Inc.)*

leads to skin aging and **cancer**. These effects are accelerated in patients who have photosensitivity.

- Phototoxicity is a severely exaggerated reaction to sunlight caused by a new chemical in the skin. The primary symptom is sunburn, which is rapid and can be severe enough to blister (a second degree burn). The chemicals associated with phototoxicity are usually drugs. The list includes several common antibiotics—quinolones, sulfonamides, and tetracyclines; diuretics (water pills); major tranquilizers; oral diabetes medication; and cancer medicines. There are also some dermatologic drugs, both topical and oral, that can sensitize skin.
- Photoallergy produces an intense itching rash on exposure to sunlight. Patients develop chronic skin changes (lichen simplex) as a result of scratching. Some of the agents that cause phototoxicity can also cause photoallergy. Some cosmetic and perfume ingredients, including a compound that was formerly used in sunscreens—para-amino benzoic acid (PABA)—can do this. Most sunscreen preparations in the early 2000s, however, no longer include PABA.
- Polymorphous light eruption (PLE) resembles photoallergy in its production of intensely itching rashes in sunlight. However, this condition lessens with continued light exposure, and so is seen mostly in the spring. Also, there does not seem to be an identifiable chemical involved. PLE is most likely to develop in fair-skinned individuals. It is estimated to affect about 10% of the United States population compared to 21% of the Swedish population. The female: male ratio is 2.5: 1, but it is thought that the imbalance may be due to the fact that women are more likely than men to seek treatment for PLE.
- There is a form of inherited PLE that affects Native Americans. The inheritance pattern is autosomal dominant.

KEY TERMS

Albino—A person or animal lacking normal coloring in the eyes, hair, and skin due to a hereditary inability to produce the skin pigment melanin. The condition itself is called albinism.

Biopsy—Surgical removal of tissue for examination.

Rosacea—A chronic skin disease characterized by persistent redness of the skin and periodic outbreaks of pustules, usually affecting the middle third of the face.

Diseases of several kinds increase skin sensitivity:

- A hereditary disease called xeroderma pigmentosum includes a defect in repair mechanisms that greatly accelerates skin damage from sunlight.
- A family of metabolic diseases called porphyrias produce chemicals (porphyrins) that absorb sunlight in the skin and thereby cause damage.
- Albinos lack skin pigment through a genetic defect and are thus very sensitive to light.
- Malnutrition, specifically a deficiency of niacin known as pellagra, sensitizes the skin.
- Several diseases like acne, systemic lupus erythematosus, rosacea, and herpes simplex (fever blisters) decrease the resistance of the skin to sun damage. Rosacea is sometimes described as a photoaggravated skin disorder because its symptoms increase in severity when patients are exposed to sunlight.
- Photosensitivity is increasingly recognized as a common development in HIV-positive patients. Risk factors for photosensitivity in this group include African American ethnicity and treatment with highly active antiretroviral therapy (HAART).

Diagnosis

The pattern of appearance on the skin, a history of drug or chemical exposure, and the timing of the symptoms often suggests a diagnosis. A **skin biopsy** may be needed for further clarification.

Treatment

Removal of the offending drug or chemical is primary. Direct sunlight exposure should be limited. Some people must avoid sunlight altogether, while others can tolerate some direct sunlight with the aid of **sunscreens**.

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Prevention

A sunscreen with an SPF of 15 or greater protects most skin from damage. Such protective garments as hats and long-sleeved shirts are highly recommended in addition.

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American Academy of Dermatology, PO Box 4014, Schaumburg, IL, 60168-4014, (847) 240-1859, (866) 503-SKIN (7546), http://www.aad.org.

United States Food and Drug Administration (FDA), 10903 New Hampshire Ave, Silver Spring, MD, 02993-0002, (888) 463-6332, http://www.fda.gov.

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Phototherapy

Definition

Phototherapy, or **light therapy**, is the administration of doses of bright light in order to normalize the body's internal clock and/or relieve depression.

Purpose

Phototherapy is prescribed primarily to treat **seasonal affective disorder** (SAD), a mood disorder characterized by depression in the winter months, and is occasionally employed to treat **insomnia** and **jet lag**. The exact mechanisms by which the treatment works are not known, but the bright light employed in phototherapy may act to readjust the body's circadian (daily) rhythms, or internal clock. Other popular theories are that light triggers the production of serotonin, a neurotransmitter believed to be related to **depressive disorders**, or that it influences the body's production of melatonin, a hormone derived from serotonin that may be related to circadian rhythms.

Precautions

Patients with eye problems should see an ophthalmologist regularly, both before and during phototherapy. Because some ultraviolet rays are emitted by the light boxes used in phototherapy, patients taking photosensitizing medications (medications making the skin more sensitive to light) and those who have sun-sensitive skin should consult with their physician before beginning treatment. Patients with medical conditions that make them sensitive to ultraviolet rays should also be seen by a physician before starting phototherapy. Patients who have a history of mood swings or **mania** should be monitored closely, since phototherapy may cause excessive mood elevation in some individuals.

Description

Phototherapy is generally administered at home. The most commonly used phototherapy equipment is a portable lighting device known as a light box. The box may be mounted upright to a wall, or slanted downwards towards a table. The patient sits in front of the box for a prescribed period of time (anywhere from 15 minutes to several hours). Some patients with SAD undergo phototherapy sessions two or three times a day, others only once. The time of day and number of times treatment is administered depend on the physical needs and lifestyle of the individual patient. If phototherapy has been prescribed for the treatment of SAD, it typically begins in the fall months as the days begin to shorten, and continues throughout the winter and possibly the early spring.

The light from a slanted light box is designed to focus on the table it sits upon, so patients may look down to read or do other sedentary activities during therapy. Patients using an upright light box must face the light source (although they need not look directly into the light). The light sources in these light boxes typically range from 2,500–10,000 lux. (In contrast, average indoor lighting is 300–500 lux; a sunny summer day is about 100,000 lux).

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KEY TERMS

Circadian rhythm—The rhythmic repetition of certain phenomena in living organisms at about the same time each day.

Lux—A standard unit of measure for illumination.

Neurotransmitter—A chemical in the brain that transmits messages between neurons, or nerve cells.

Photosensitivity—An abnormally heightened reaction to light.

Seasonal affective disorder (SAD)—A mood disorder characterized by depression during the winter months. An estimated 11 million Americans experience SAD.

Phototherapy prescribed for the treatment of SAD may be covered by insurance. Individuals requiring phototherapy should check with their insurance company to see if the cost of renting or purchasing a light box is covered.

Aftercare

Patients beginning light therapy for SAD may need to adjust the length, frequency, and timing of their phototherapy sessions to achieve the maximum benefit. These patients should keep their doctor informed of their progress and the status of their depressive symptoms. Occasionally, antidepressants and/or **psychotherapy** may be recommended as an adjunct to phototherapy.

Risks

An abnormally elevated or expansive mood (hypomania) may occur, but it is usually temporary. Some patients undergoing phototherapy treatment report side effects of eyestrain, headaches, insomnia, **fatigue**, **sunburn**, and dry eyes or nose. Most of these effects can be managed by adjusting the timing and duration of the phototherapy sessions. A strong sun block and eye and nose drops can alleviate the other problems. Long-term studies have shown no negative effects to the eye function of individuals undergoing phototherapy treatments.

Normal results

Patients with SAD typically report an alleviation of depressive symptoms within two to 14 days after beginning phototherapy.

ORGANIZATIONS

National Institute of Mental Health (NIMH).

Society for Light Treatment and Biological Rhythms, P.O. Box 591687, 174 Cook St, San Francisco, CA, 4159-1687, http://www.sltbr.org.

Paula Anne Ford-Martin

Phototoxic reaction *see* **Photosensitivity**

Phycomycosis *see* **Mucormycosis**

Physical allergy

Definition

Physical **allergies** are allergic reactions to cold, sunlight, heat, or minor injury.

Description

The immune system is designed to protect the body from harmful invaders such as germs. Occasionally, it goes awry and attacks harmless or mildly noxious agents, doing more harm than good. This event is termed allergy if the target is from the outside—like pollen or bee venom—and autoimmunity if it is caused by one of the body's own components.

The immune system usually responds only to certain kinds of chemicals, namely proteins. However, non-proteins can trigger the same sort of response, probably by altering a protein to make it look like a target. Physical allergy refers to reactions in which a protein is not the initial inciting agent.

Sometimes it takes a combination of elements to produce an allergic reaction. A classic example is drugs that are capable of sensitizing the skin to sunlight. The result is phototoxicity, which appears as an increased sensitivity to sunlight or as localized skin **rashes** on sun-exposed areas.

Causes and symptoms

- Minor injury, such as scratching, causes itchy welts to develop in about 5% of people. The presence of itchy welts (urticaria) is a condition called dermographism.
- Cold can change certain proteins in the blood so that they induce an immune reaction. This may indicate that there are abnormal proteins in the blood from a disease of the bone marrow. The reaction may also involve the lungs and circulation, producing wheezing and fainting.

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KEY TERMS

Antihistamine—Drugs that block histamine, a major cause of itching.

Hemolysis—Destruction of red blood cells.

Inflammation—Heat, redness, swelling, and pain caused by an immune response.

- Heat allergies can be caused by exercise or even strong emotions in sensitive people.
- Sunlight, even without drugs, causes immediate urticaria in some people. This may be a symptom of porphyria—a genetic metabolic defect.
- Elements like nickel and chromium, although not proteins, commonly cause skin rashes, and iodine allergy causes skin rashes and sores in the mouth in allergic individuals.
- Pressure or vibration can also cause urticaria.
- Water contact can cause aquagenic urticaria, presumably due to chlorine or some other trace chemical in the water, although distilled water has been known to cause this reaction.

When the inflammatory reaction involves deeper layers of the skin, urticaria becomes angioedema. The skin, especially the lips and eyelids, swells. The tongue, throat, and parts of the digestive tract may also be involved. Angioedema may be due to physical agents. Often the cause remains unknown.

Diagnosis

Visual examination of the symptoms usually diagnoses the reaction. Further skin tests and review of the patient's **photosensitivity** may reveal a cause.

Treatment

Removing the offending agent is the first step to treatment. If sun is involved, shade and **sunscreens** are necessary. The reaction can usually be controlled with epinephrine, **antihistamines**, or cortisone-like drugs. Urticaria may be treated with antihistamines such as diphenhydramine (Benadryl) or desloratadine (Clarinex). Clarinex is non-sedating, meaning it will not make patients drowsy. **Itching** can be controlled with cold packs or commercial topical agents that contain menthol, camphor, eucalyptus oil, aloe, antihistamines, or cortisone preparations.

Prognosis

If the causative agent has been diagnosed, avoidance of or protection against the allergen cures the allergy. Usually, allergies can be managed through treatment.

Resources

PERIODICALS

Ventura, M.T., et al. "Sensitization, asthma, and allergic disease in young soccer players." *Allergy* (April 2009): 556–559.

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Teresa G. Odle

Physical examination

Definition

A physical examination is an evaluation of the body and its functions using inspection, palpation (feeling with the hands), percussion (tapping with the fingers), and auscultation (listening). A complete health assessment also includes gathering information about a person's medical history and lifestyle, doing laboratory tests, and screening for disease.

Purpose

The annual physical examination has been replaced by the periodic health examination. How often this is done depends on the patient's age, sex, and risk factors for disease. The United States Preventative Services Task Force (USPSTF) has developed guidelines for preventative health examinations that health care professionals widely follow. Organizations that promote detection and prevention of specific diseases, like the American **Cancer** Society, generally recommend more intensive or frequent examinations.

A comprehensive physical examination provides an opportunity for the healthcare professional to obtain baseline information about the patient for future use, and to establish a relationship before problems happen. It provides an opportunity to answer questions and teach good health practices. Detecting a problem in its early stages can have good long-term results.

Precautions

The patient should be comfortable and treated with respect throughout the examination. As the

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examination proceeds, the examiner should explain what he or she is doing and share any relevant findings.

Description

A complete physical examination usually starts at the head and proceeds all the way to the toes. However, the exact procedure will vary according to the needs of the patient and the preferences of the examiner. An average examination takes about 30 minutes. The cost of the examination will depend on the charge for the professional's time and any tests that are done. Most health plans cover routine physical examinations including some tests.

The examination

First, the examiner will observe the patient's appearance, general health, and behavior, along with measuring height and weight. The vital signs—including pulse, breathing rate, body temperature, and blood pressure—are recorded.

With the patient sitting up, the following systems are reviewed:

- Skin. The exposed areas of the skin are observed; the size and shape of any lesions are noted.
- Head. The hair, scalp, skull, and face are examined.
- Eyes. The external structures are observed. The internal structures can be observed using an ophthalmoscope (a lighted instrument) in a darkened room.
- Ears. The external structures are inspected. A lighted instrument called an otoscope may be used to inspect internal structures.
- Nose and sinuses. The external nose is examined. The nasal mucosa and internal structures can be observed with the use of a penlight and a nasal speculum.
- Mouth and pharynx. The lips, gums, teeth, roof of the mouth, tongue, and pharynx are inspected.
- Neck. The lymph nodes on both sides of the neck and the thyroid gland are palpated (examined by feeling with the fingers).
- Back. The spine and muscles of the back are palpated and checked for tenderness. The upper back, where the lungs are located, is palpated on the right and left sides and a stethoscope is used to listen for breath sounds.
- Breasts and armpits. A woman's breasts are inspected with the arms relaxed and then raised. In both men and women, the lymph nodes in the armpits are felt with the examiner's hands.While the patient is still sitting, movement of the joints in the hands, arms, shoulders, neck, and jaw can be checked.

Then while the patient is lying down on the examining table, the examination includes:

- Breasts. The breasts are palpated and inspected for lumps.
- Front of chest and lungs. The area is inspected with the fingers, using palpation and percussion. A stethoscope is used to listen to the internal breath sounds.

The head should be slightly raised for:

- Heart. A stethoscope is used to listen to the heart's rate and rhythm. The blood vessels in the neck are observed and palpated.

The patient should lie flat for:

- Abdomen. Light and deep palpation is used on the abdomen to feel the outlines of internal organs including the liver, spleen, kidneys, and aorta, a large blood vessel.
- Rectum and anus. With the patient lying on the left side, the outside areas are observed. An internal digital examination (using a finger), is usually done if the patient is over 40 years old. In men, the prostate gland is also palpated.
- Reproductive organs. The external sex organs are inspected and the area is examined for hernias. In men, the scrotum is palpated. In women, a pelvic examination is done using a speculum and a Papanicolaou test (Pap test) may be taken.
- Legs. With the patient lying flat, the legs are inspected for swelling, and pulses in the knee, thigh, and foot area are found. The groin area is palpated for the presence of lymph nodes. The joints and muscles are observed.
- Musculoskeletal system. With the patient standing, the straightness of the spine and the alignment of the legs and feet is noted.
- Blood vessels. The presence of any abnormally enlarged veins (varicose), usually in the legs, is noted.

In addition to evaluating the patient's alertness and mental ability during the initial conversation, additional inspection of the nervous system may be indicated:

- Neurologic screen. The patient's ability to take a few steps, hop, and do deep knee bends is observed. The strength of the hand grip is felt. With the patient sitting down, the reflexes in the knees and feet can be tested with a small hammer. The sense of touch in the hands and feet can be evaluated by testing reaction to pain and vibration.

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KEY TERMS

Auscultation—The process of listening to sounds that are produced in the body. Direct auscultation uses the ear alone, such as when listening to the grating of a moving joint. Indirect auscultation involves the use of a stethoscope to amplify the sounds from within the body, like a heartbeat.

Hernia—The bulging of an organ, or part of an organ, through the tissues normally containing it; also called a rupture.

Inspection—The visual examination of the body using the eyes and a lighted instrument if needed. The sense of smell may also be used.

Ophthalmoscope—Lighted device for studying the interior of the eyeball.

Otoscope—An instrument with a light for examining the internal ear.

Palpation—The examination of the body using the sense of touch. There are two types: light and deep.

Percussion—An assessment method in which the surface of the body is struck with the fingertips to obtain sounds that can be heard or vibrations that can be felt. It can determine the position, size, and consistency of an internal organ. It is done over the chest to determine the presence of normal air content in the lungs, and over the abdomen to evaluate air in the loops of the intestine.

Reflex—An automatic response to a stimulus.

Speculum—An instrument for enlarging the opening of any canal or cavity in order to facilitate inspection of its interior.

Stethoscope—A Y-shaped instrument that amplifies body sounds such as heartbeat, breathing, and air in the intestine. Used in auscultation.

Varicose veins—The permanent enlargement and twisting of veins, usually in the legs. They are most often seen in people with occupations requiring long periods of standing, and in pregnant women.

- Sometimes additional time is spent examining the 12 nerves in the head (cranial) that are connected directly to the brain. They control the sense of smell, strength of muscles in the head, reflexes in the eye, facial movements, gag reflex, and muscles in the jaw. General muscle tone and coordination, and the reaction of the abdominal area to stimulants like pain, temperature, and touch would also be evaluated.

Preparation

Before visiting the health care professional, the patient should write down important facts and dates about his or her own medical history, as well as those of family members. He or she should have a list of all medications with their doses or bring the actual bottles of medicine along. If there are specific concerns about anything, writing them down is a good idea.

Before the physical examination begins, the bladder should be emptied and a urine specimen can be collected in a small container. For some blood tests, the patient may be told ahead of time not to eat or drink after midnight.

The patient usually removes all clothing and puts on a loose-fitting hospital gown. An additional sheet is provided to keep the patient covered and comfortable during the examination.

Aftercare

Once the physical examination has been completed, the patient and the examiner should review what laboratory tests have been ordered and how the results will be shared with the patient. The medical professional should discuss any recommendations for treatment and follow-up visits. Special instructions should be put in writing. This is also an opportunity for the patient to ask any remaining questions about his or her own health concerns.

Risks

Other than discovering an unknown condition or health problem, which is the reason for performing a physical examination, there are no risks associated with the procedure.

Normal results

Normal results of a physical examination correspond to the healthy appearance and normal functioning of the body. For example, appropriate reflexes will be present, no suspicious lumps or lesions will be found, and vital signs will be normal.

Abnormal results

Abnormal results of a physical examination include any findings that indicated the presence of a

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disorder, disease, or underlying condition. For example, the presence of lumps or lesions, **fever**, muscle weakness or lack of tone, poor reflex response, heart arhythmia, or swelling of lymph nodes will point to a possible health problem.

Resources

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ORGANIZATIONS

American Academy of Family Physicians, 11400 Tomahawk Creek Parkway, Leawood, KS, 66211-2672, (913) 906-6000, fp@aafp.org, http://www.aafp.org.

American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, IL, 60007-1098, (847) 434-4000, (847) 434-8000, kidsdoc@aap.org, http://www.aap.org.

American College of Physicians, 190 N. Independence Mall West, Philadelphia, PA, 19106-1572, (215) 351-2600, (800) 523-1546, http://www.acponline.org.

American Medical Association, 515 N. State Street, Chicago, IL, 60610, (312) 464-5000, http://www.ama-assn.org.

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Physical therapy

Definition

Physical therapy, also called physiotherapy, is the prevention and treatment of medical conditions by physical and mechanical means, including **exercise**, body manipulation, water, light, heat, and electricity.

Purpose

The purpose of physical therapy is to restore function, improve mobility, relieve **pain**, and prevent or limit permanent physical disabilities, with the goal of improving a patient's functioning at school or work and in daily life. Physical therapists treat patients with a variety of conditions and diseases, including:

- all types of injuries, including sprains, strains, fractures, and head injuries
- back and neck pain
- knee pain
- shoulder pain
- repetitive stress and overuse injuries
- poor posture
- arthritis
- heart disease
- stroke
- diabetes
- osteoporosis
- lymphedema

Common applications of physical therapy include:

- retraining muscles and adjusting to the use of artificial joints

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- strengthening leg muscles following a hip fracture
- assessing and fitting walking aids such as canes and walkers
- strengthening arm muscles for using walking aids
- treating pain from tendinitis/bursitis and arthritis to avoid the use of prescription pain medications in patients at risk for heart disease
- rehabilitating stroke victims for walking safely, with or without a walking aid

Pediatric physical therapy is commonly used for children with:

- birth defects such as spina bifida
- genetic disorders
- prenatal drug or alcohol exposure
- cerebral palsy
- orthopedic disabilities and limb deficiencies
- developmental delays
- heart and lung conditions
- muscle diseases
- head injuries
- acute trauma

Demographics

The use of physical therapy to treat patients of all ages—from newborns to the elderly—is becoming increasingly widespread:

- As of 2008, there were some 33.1 million non-institutionalized adult Americans with some degree of difficulty in physical functioning—15% of the non-institutionalized adult population.
- Lower back pain affects as many as 80% of all Americans at some point in their lives.
- Improper use or fitting of walking aids by senior citizens accounts for 47,000 emergency rooms visits annually in the United States.
- An estimated 17.9 million American children and adults have been diagnosed with diabetes.
- Secondary lymphedema resulting in fluid retention and arm swelling affects 71% of women who undergo surgery for breast cancer.
- As of 2008, there were about 185,000 physical therapy jobs in the United States.
- By 2018 employment of physical therapists is expected to have grown by 30%, much more than the average for all occupations.

There are several reasons for the growth of physical therapy:

- The increasingly elderly population in the United States is especially vulnerable to chronic and debilitating conditions that require physical therapy.
- The huge generation of baby boomers is reaching the age of susceptibility to heart attacks and strokes, which require physical rehabilitation.
- Medical and technological developments have led to greatly increased survival of newborns with birth defects and casualties of war and other traumas, many of whom require physical therapy, often for the remainder of their lives.
- Advances in physical therapy have led to treatments for many disabling conditions that were previously untreatable.
- The federally mandated Individuals with Disabilities Education Act guarantees student access to physical therapy.
- A growing number of employers are using physical therapists to evaluate worksites, develop exercise programs, and teach safe work habits to reduce injuries.

Description

Physical therapy is performed by physical therapists, physical therapy assistants, and physical therapy aides. Physical therapists take medical histories, perform physical exams, and assess the ability of patients to function independently. They use a variety of tests and measurements for evaluation. Range of motion is determined using a goniometer—an instrument that measures the largest angle through which a joint can move. The therapist determines whether restricted motion is due to tight muscles or tight ligaments and tendons. The therapist also evaluates:

- strength
- coordination and balance
- posture
- motor function
- muscle performance
- respiration

Based on these evaluations, physical therapists develop treatment plans, including purpose, strategy, and anticipated outcomes. During the course of physical therapy a patient's progress is tracked with periodic examinations and tests.

Physical therapists may treat a wide range of conditions or specialize in certain areas. They often consult or collaborate with physicians, nurses, dentists, occupational therapists, speech-language pathologists, audiologists, educators, and/or social workers. Working under the direct supervision of a physical

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therapist, physical therapy assistants often implement treatment plans and record patient responses.

About 60% of physical therapists work in hospitals or in the offices of other healthcare practitioners, especially physicians. Physical therapy also can take place in:

- nursing homes
- outpatient clinics
- dedicated physical therapy and rehabilitation facilities
- adult daycare facilities
- private physical therapy practices
- child care centers, preschools, and schools
- sports and fitness facilities
- recreation centers
- workplaces
- the patient's home

Physical therapy exercises are aimed at improving flexibility, range of motion, muscle strength, balance, coordination, ambulation (walking), and/or endurance. Patients are often taught exercises to perform at home. Activities can include water walking and swimming. Physical therapy also teaches patients to use assistive and adaptive devices such as crutches, wheelchairs, and prostheses.

For range-of-motion stretches the muscles are often first warmed with heat to improve effectiveness and reduce pain. Tight ligaments or tendons require gentle stretching, whereas the joint can be stretched more vigorously if tight muscles are causing poor range of motion. An affected joint must be moved beyond the point of pain, but should not cause residual pain after the movement is stopped. Sustained moderate stretching may be applied with weights and pulleys. There are three types of range-of-motion exercises:

- active exercise for patients who can move their limbs and exercise a muscle or joint without assistance
- active-assistive exercise for patients who need some help moving their limbs and exercising muscles or for whom moving joints is painful
- passive exercise in which the therapist moves the limbs

There are a variety of other physical therapy exercises:

- There are many muscle-strengthening exercises, all of which progressively increase resistance. Muscle-strengthening exercises also increase muscle mass and endurance. Movement against gravity is used for very weak muscles and the resistance is gradually increased using stretchy bands or weights.
- Rehabilitation from a stroke or brain damage often requires coordination exercises that involve specific tasks that work multiple joints and muscles, such as picking up an object.
- Rehabilitation may also require balance exercises, beginning with shifting one's weight from side to side and front to back using parallel bars.
- Once a patient can balance while standing, ambulation exercises begin with walking using parallel bars and progressing to a walker, crutches or a cane, possibly wearing a brace or assistive belt to prevent falls.
- Once a patient can walk on a level surface, ambulation exercises involve stepping over curbs or climbing stairs. This may include teaching family members and caregivers how to correctly support the patient.
- General conditioning exercises combine range-of-motion, muscle-strengthening, and ambulation exercises to counter the effects of prolonged bed rest or immobilization, improve cardiovascular fitness, and maintain flexibility and muscle strength.

Transfer training—moving safely and independently from bed to chair, chair to toilet, or chair to standing—is a critical component of physical therapy. It is often required for patients who have had a hip fracture, **amputation**, or **stroke**. Transfer training techniques depend on whether the patient:

- can bear weight on one or both legs
- can balance well
- is paralyzed on one side
- can use assistive devices

Tilt tables are used for patients who have had strict bed rest for several weeks or have had a **spinal cord injury**, since they can become dizzy when standing up. Tilt tables retrain blood vessels to narrow and widen appropriately with changes in posture. The patient lies face-up on a padded table with a footboard and is held in place with a safety belt as the table is slowly tilted.

To decrease lower back pain and restore mobility, physical therapy utilizes:

- manual therapies, including spinal manipulation, to improve the mobility of joints and soft tissues
- specific strengthening and/or flexibility exercises
- training for sitting, sleeping, bending, lifting, and performing chores
- education about back care

Physical therapy for diabetes includes:

- testing sensation in the feet
- teaching patients how to protect feet that have lost sensation

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- recommending footwear or assistive devices
- adapting shoes or orthotic devices for walking
- decreasing cramping during walking
- caring for skin ulcers and sores
- supervising exercise programs

Physical therapists design exercise programs to prevent knee or other injuries, beginning with an evaluation of body traits that predispose a patient to injury. Physical therapy can also help prevent and treat **osteoporosis**. A 2009 study found that physical therapy started soon after **breast cancer** surgery, including massage and shoulder exercises, can reduce or prevent the common complication of **lymphedema**.

Physical therapy uses a variety of techniques to reduce swelling and relieve pain, including:

- hot and cold packs
- paraffin baths
- electrical stimulation
- ultrasound
- massage, including deep-tissue massage
- traction

Pediatric physical therapists evaluate children in the context of their daily routines and activities. Evaluation may include:

- mobility
- analyzing gait (walking and running)
- sensory and neuromotor development
- muscle and joint function
- strength and endurance
- posture and balance
- cardiopulmonary status
- oral motor skills
- use of assistive technologies

Physical therapy for children can include:

- movement and mobility
- posture, positioning, and lifting
- strengthening
- motor learning
- coordination and balance
- cardiopulmonary endurance
- developmental activities
- adapting daily routines and activities
- fitting and use of assistive technology
- orthotics and prosthetics
- burn and wound care
- safety, health, and prevention programs

Pediatric physical therapy utilizes many of the same evaluation and therapeutic techniques as adult physical therapy, but often includes toys and pediatric therapy gyms with balls, benches, swings, and slides. Pediatric physical therapy may also include:

- identifying existing and potential problems
- developmental activities such as crawling and walking
- adaptive play
- aquatic therapy
- recommending safe sports and other activities
- consulting with medical, psychiatric, and school personnel on individual education plans

Benefits

Physical therapy can help patients gain and maintain mobility, independence, and quality of life. It can help prevent and manage medical conditions and motivate patients to improve on their own. A study published in 2008 found that exercises developed by physical therapists could reduce the risk of athletic injuries by 41%. Physical therapy can prevent loss of mobility by designing exercise programs based on individual characteristics. Physical therapy does not usually require a referral from a physician.

Physical therapy often can eliminate the need for prescription drugs or surgery. A 2008 study found that physical therapy and medical management were as effective as knee surgery for relieving stiffness and pain from moderate to severe **osteoarthritis**.

Precautions

Physical therapy can be painful and patients often must do much of the hard work on their own. For some conditions, such as tight ligaments or tendons, range of motion often cannot be increased by gentle stretching until after surgical intervention.

Preparation

Patient attitude and cooperation are key to successful physical therapy. Patients must be active participants in their treatment, aware of the short-term and long-term goals of their therapy, and able to communicate with their therapists.

Aftercare

Physical therapy often requires patients to follow a specially designed exercise program. Practicing on one's own can be an essential component of successful physical therapy.

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KEY TERMS

Ambulation—Moving from place to place.

Goniometer—An instrument for measuring angles of a joint.

Lymphedema—Swelling (edema) due to damaged lymphatic drainage.

Orthotics—Support or bracing of weak or ineffectual muscles or joints.

Prosthesis—An artificial device that replaces or augments a body part.

Repetitive stress injury; repetitive strain injury (RSI)—Any of various musculoskeletal disorders—such as tendonitis or carpal tunnel syndrome—that are caused by cumulative damage to muscles, tendons, ligaments, nerves, or joints from highly repetitive movements, such as of the hand, wrist, arm, or shoulder.

Stroke—A sudden diminishing or loss of consciousness, sensation, or voluntary movement from a rupture or obstruction of a blood vessel in the brain.

Tilt table; tiltboard—An apparatus for rotating a person from horizontal to an oblique or vertical position.

Traction—Pulling force exerted on a skeletal structure by a special device or piece of equipment.

Risks

Risks of physical therapy can include pain, falls, bruising, or injury.

Training and certification

Physical therapists have master's degrees or clinical doctorates in physical therapy. As of 2009 there were 212 accredited physical therapist education programs in the United States—12 awarding master's degrees and 200 awarding doctoral degrees. In 2008 more than 75% of all physical therapy graduates were doctors of physical therapy (DPTs). The programs include basic medical and clinical coursework and supervised clinical experience. Physical therapists are required to pass a national licensure exam and must be licensed in each state in which they practice. Physical therapists participate in continuing education courses and workshops. Some physical therapists are board-certified in cardiovascular and pulmonary, clinical electrophysiologic, geriatric, neurologic, orthopedic, pediatric, sports, or **women's health** specialties.

Physical therapy assistants usually have an associate degree from an accredited physical therapist assistant program. They are also required to have clinical and first-aid experience and certification in **cardiopulmonary resuscitation** (CPR). Physical therapy aides are usually required to have a high school diploma and are trained on the job. Because they are not licensed, aides are able to perform only a limited range of tasks.

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AGS Foundation for Health in Aging, The Empire State Building, 350 Fifth Avenue, Suite 801, New York, NY, 10118, (212) 755-6810, (800) 563-4916, (212) 832-8646, www.healthinaging.org.

American Physical Therapy Association, 1111 North Fairfax Street, Fairfax, VA, 22314-1488, (703) 684-APTA (2782), (800) 999-APTA (2782), (703) 684-7343, http://www.apta.org.

National Rehabilitation Information Center, 8201 Corporate Drive, Suite 600, Landover, MD, 20785, (301) 459-5900, (800) 346-2742, (301) 459-4263, naricinfo@heitechservices.com, http://www.naric.com/.

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Pica

Definition

Pica is the persistent craving and compulsive eating of nonfood substances. The Diagnostic and Statistical Manual of Mental Disorders, fourth edition, classifies it as a feeding and eating disorder of childhood.

Description

The puzzling phenomenon of pica has been recognized and described since ancient times. Pica has been observed in ethnic groups worldwide, in both primitive and modernized cultures, in both sexes, and in all age groups. The word pica comes from the Latin name for magpie, a bird known for its unusual and indiscriminate eating habits. In addition to humans, pica has been observed in other animals, including the chimpanzee.

Pica in humans has many different subgroups, defined by the substance that is ingested. Some of the most commonly described types of pica are eating earth, soil or clay (geophagia), ice (pagophagia) and starch (amylophagia). However, pica involving dozens of other substances, including cigarette butts and ashes, hair, paint chips, and paper have also been reported. In one unusual case, the patient ingested transdermal patches of fentanyl, an opioid medication given for severe **pain**. Eating the skin patch increased the patient's dose of the drug by a factor of 10.

Although pica can occur in individuals of any background, a higher incidence of pica is associated with:

- pregnancy
- developmental delay and mental retardation
- psychiatric disease and autism
- early childhood
- poor nutrition or low blood levels of iron and other minerals
- certain cultural or religious traditions

Causes and symptoms

Evidence suggests that there may be several causes of pica. One widely held theory points to iron deficiency as a major cause of pica. Several reports have described pica in individuals with documented iron deficiency, although there has been uncertainty as to whether the iron deficiency was a cause of pica or a result of it. Because some substances, such as clay, are believed to block the absorption of iron into the bloodstream, it was thought that low blood levels of iron could be the direct result of pica. However, some studies have shown that pica cravings in individuals with iron deficiency stop once iron supplements are given to correct the deficiency. Another study looked specifically at the rate of iron absorption during pica conditions and normal dietary behavior, and showed that the iron absorption was not decreased by pica. In addition, low blood levels of iron commonly occur in pregnant women and those with poor **nutrition**, two populations at higher risk for pica. Such findings offer strong support of iron deficiency as a cause, rather than result, of pica.

Other reports suggest that pica may have a psychological basis and may even fall into the spectrum of **obsessive-compulsive disorder**. Pica has a higher incidence in populations with an underlying diagnosis involving mental functioning. These diagnoses include psychiatric conditions like **schizophrenia**, developmental disorders including **autism**, and conditions with **mental retardation**. These conditions are not characterized by iron deficiency, which supports a psychological component in the cause of pica.

Cultural and religious traditions may also play a role in pica behavior. In some cultures, nonfood substances are believed to have positive health or spiritual effects. Among some African Americans in the south, ingesting a particular kind of white clay is believed to promote health and reduce morning sickness during **pregnancy**. Other cultures practice pica out of belief that eating a particular substance may promote fertility or bring good luck.

The hallmark feature of pica, consistently consuming nonfood substances, often does not present publicly. People may be embarrassed to admit to these unusual eating habits, and may hide it from their family and physician. In other cases, an individual may not report the pica to a physician simply because of a lack of knowledge of pica's potential medical significance.

Because the eating behaviors of pica are not usually detected or reported, it is the complications of the behavior that bring it to attention. Complications vary, depending on the type of pica. Geophagia has potential side effects that most commonly affect the intestine and bowel. Complications can include **constipation**, cramping, pain, obstruction caused by formation of an indigestible mass, perforation from sharp objects like rocks or gravel, and contamination and infection from soil-dwelling parasites.

Amylophagia usually involves the consumption of cornstarch and, less frequently, laundry starch. The high caloric content of starch can cause excessive

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weight gain, while at the same time leading to **malnutrition**, as starch contributes "empty" calories lacking **vitamins** and **minerals**. Amylophagia during pregnancy can mimic **gestational diabetes** in its presentation and even in its potential harmful effects on the fetus.

Pica involving the ingestion of substances such as lead-based paint or paper containing mercury can cause symptoms of toxic **poisoning**. Compulsive consumption of even a seemingly harmless substance like ice (pagophagia) can have negative side effects, including decreased absorption of nutrients by the gut.

Diagnosis

In order for the diagnosis of pica to be made, there must be a history of persistent consumption of a nonfood substance continuing for a minimum period of one month. Infants and toddlers are typically excluded from this diagnosis since mouthing objects is a normal developmental behavior at that age. Individuals with mental retardation who function at or below an approximate cognitive level of 18 months may also be exempt form this diagnosis.

Pica is most often diagnosed when a report of such behaviors can be provided by the patient or documented by another individual. In other cases, pica is diagnosed after studies have been performed to assess the presenting symptoms. For example, imaging studies ordered to assess severe gastrointestinal complaints may reveal intestinal blockage with an opaque substance; such a finding is suggestive of pica. Biopsy of intestinal contents can also reveal findings, such as parasitic infection, consistent with pica. Pica may also be suspected if abnormal levels of certain minerals or chemicals are detected in the blood.

Pica in pregnant women is sometimes diagnosed after **childbirth** because of a health problem in the newborn caused by the substance(s) ingested by the mother. In one instance reported in Chicago, a newborn girl was treated for **lead poisoning** caused by her mother's eating fragments of lead-glazed pottery during pregnancy.

Treatment

Treatment of pica will often depend on the cause and type of pica. Conventional medical treatment may be appropriate in certain situations. For example, supplementation with iron-containing vitamins has been shown to cause the unusual cravings to subside in some iron-deficient patients.

Medical complications and health threats, including high lead levels, bowel perforation or intestinal obstruction, will require additional medical management, beyond addressing the underlying issue of pica.

KEY TERMS

Amylophagia—The compulsive eating of purified starch, typically cornstarch or laundry starch.

Geophagia—The compulsive eating of earthy substances, including sand, soil, and clay.

Pagophagia—The compulsive eating of ice.

Alternative treatment

Because most cases of pica do not have an obvious medical cause, treatment with counseling, education, and nutritional management is often more successful and more appropriate than treatment with medication. Some therapists specializing in **eating disorders** may have expertise in treating pica.

Prognosis

The prognosis for individuals with pica varies greatly, according to the type and amount of substance ingested, the extent of presenting side effects, and the success of treatment. Many of the side effects and complications of pica can be reversed once the behavior is stopped, while other complications, including infection and bowel perforation, pose significant health threats and if not successfully treated may result in **death**.

When seen in children, pica behavior tends to lessen with age. However, individuals with a history of pica are more likely to experience it again. Counseling and nutritional education can reduce the risk of recurrence.

Prevention

There are no known methods of preventing pica. However, once pica is known or suspected, measures can be taken to reduce further ingestion of nonfood substances. Removing the particular substance from readily accessible areas can be helpful. Close observation of the individual with pica may limit inappropriate eating behaviors.

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American Academy of Child and Adolescent Psychiatry (AACAP), 3615 Wisconsin Ave. NW, Washington, DC, 20013-3007, (202) 966-7300, (202) 966-2891, communications@aacap.org, http://www.aacap.org/.

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Pickwickian syndrome

Definition

A group of symptoms that generally accompany massive **obesity**.

Description

Pickwickian syndrome is a complex of symptoms that primarily affect patients with extreme obesity. The syndrome is named after a character in a Charles Dickens novel, *The Pickwick Papers*, who seemed to show some of the traits of this disease.

The major health problem that occurs in patients with this disease is **sleep apnea**. This is caused in part by the excess amounts of fatty tissue surrounding the chest muscles. This excess fat places a strain on the heart, lungs, and diaphragm of the patient, making it difficult to breathe.

KEY TERMS

Latency—The period of inactivity between the time a stimulus is provided and the time a response occurs.

Obesity—Exceeding one's normal weight by 20%. A person suffering from extreme obesity would exceed their normal weight by a much higher percentage.

Pulmonary system—Lungs and respiratory system of the body.

Causes and symptoms

The major cause of Pickwickian syndrome is extreme obesity. This obesity places an excessive load on the pulmonary system. The role of genetics is also being studied. Symptoms of Pickwickian syndrome include excessive daytime sleepiness, **shortness of breath** due to elevated blood carbon dioxide pressure, disturbed sleep at night, and flushed face. The skin can also have a bluish tint, and the patient may have high blood pressure, an enlarged liver, and an abnormally high red blood cell count.

Diagnosis

Some tests that can be used to diagnose this condition include **echocardiography** to determine heart enlargement or **pulmonary hypertension**. Giving the patient multiple sleep latency tests can help give an objective measurement of daytime sleepiness. **Magnetic resonance imaging** (MRI), computed tomography (CT) scans, or fiberoptic evaluation of the upper airway may also be used.

Treatment

The primary treatment for Pickwickian syndrome is focused on weight loss and increased physical activity. Also, medroxyprogesterone may help improve the condition.

Prognosis

Pickwickian sydnrome is entirely reversible if it is diagnosed and treated properly. If the problem goes undiagnosed, the outcome can be fatal.

Prevention

Prevention of Pickwickian syndrome can be achieved by maintaining a healthy body weight and

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getting the proper amount of **exercise**. For prevention of the sleep apnea that generally accompanies Pickwickian syndrome, there are several possible treatments. If the sleep apnea is only present when the patient is flat on their back, a tennis ball can be sewn into the sleep clothes to remind the patient not to sleep on their back. For more severe cases of sleep apnea, a **tonsillectomy** or the use of dental appliances may be recommended.

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PID *see* **Pelvic inflammatory disease**

Piercing and tattoos

Definition

Piercing and tattoos are popular forms of body art that have been practiced throughout history. Piercing involves punching a hole in the earlobe or another body part for the insertion of jewelry. Tattoos are temporary or permanent writing or designs anywhere on the body. Permanent tattoos involve the insertion of pigments through pricks in the skin.

Demographics

Although piercing of the female earlobe and male tattooing have long been common in Western societies, in recent decades the piercing of various body parts, as well as tattooing, have become increasingly popular among both males and females, although body piercing is more common in females. The reported prevalence of body piercing ranges from 6.8–14% in the general population and from 4.3–51% among teenagers and young adults. Increases in piercing and tattooing have resulted in an increase in medical complications. A Mayo Clinic study reported that 17% of college students with piercings suffered complications such as infection or tearing. African Americans often develop thick **scars** called **keloids** after body piercing.

Tattoo artist Michael Wilson displaying his own tattoos and piercings. *(Susan McCartney/Photo Researchers, Inc.)*

Description

Body piercing and tattooing have been practiced throughout human history as emblems of beauty and as symbols. The 4,000-year-old body of a tattooed man was discovered preserved in an Alpine glacier in 1992. Egyptians tattoos in the period from 4000–2000 BC symbolized fertility and nobility. Body piercing often connoted royalty and courage. In some hunting and gathering societies body piercing and tattoos have long been used in initiation rites and as socialization/enculturation symbols. In today's industrialized societies piercing and tattoos are a popular art form practiced by people of all ages. They can signify beauty, independence, defiance, a psychology of **self-mutilation**, or membership in social groups, such as prison or gang cultures. Oral and genital piercing are sometimes thought to enhance sexuality.

Piercing and tattooing are performed by amateurs on themselves or others or by professionals in tattoo

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or beauty parlors or shops selling jewelry. In the United States commercial piercing and tattooing are usually regulated at the state or local level.

Although earlobe piercing remains the most common form, other popular piercing sites include the cartilage of the ears, nasal septa, eyebrows, tongue, lips, cheeks, the uvula (the fleshy lobe at the back of the palate), nipples, the naval, labia, and the penis. After cleaning the skin the needle and jewelry are quickly inserted through the tissue in one motion, without anesthesia. Earlobes are normally pierced using a sterile, single-use, spring-loaded piercing gun. Other body parts are pieced using hollow, six-gauge to 18-gauge needles.

The word "tattoo" comes from the Tahitian word "tattau," meaning "to mark." Permanent tattoos are colored inks injected into small deep holes in the skin. This process can take several hours and cause a small amount bleeding and some degree of **pain**. None of the more than 50 pigments and shades in tattoo inks has been approved by the U.S. Food and Drug Administration (FDA) for injection into the skin. Many of them are not even approved for contact with skin and some are industrial-grade colors for printers' ink or automobile paint.

There are various types of permanent tattoos:

- Professional tattoos are produced by a tattoo artist with a special electric needle gun that repeatedly punctures the skin and inserts tiny drops of ink.
- Amateur tattoos are most often India ink imbedded beneath the skin with a pin. Pen ink, charcoal, or ashes are also used as pigment. Amateur tattoos are often crude.
- Cultural tattoos are produced according to specific ethnic or cultural traditions.
- Cosmetic tattoos or permanent makeup replace the use of a cosmetic such as an eyebrow pencil, eyeliner, lip liner, or blush. Cosmetic tattoos can also replace a nipple after breast surgery or cover up an non-pigmented patch of skin or another tattoo.
- Medical tattoos are placed by a physician, usually as a guide for radiation therapy.
- Traumatic tattoos are pigmentations remaining after dirt or other debris becomes imbedded in the skin as the result of an accident or puncture wound.

Temporary tattoos are produced with either stickers or a natural plant dye called henna or mehndi. Sticker-type tattoos are designs on coated paper that are applied to the skin with water or by rubbing. They last only a few days. In the United States they contain only colors that are approved for use in cosmetics. Henna tattoos are drawn on the skin and last for two or three weeks. The FDA has not approved henna for use on the skin.

Although they can be attractive body adornments, piercing and tattoos can also be problematical:

- The most common medical problems are infections, keloids, and allergic reactions.
- Fashions, personal taste, or the body itself can change, making a piercing or tattoo undesirable; however a piercing may leave a permanent hole and tattoos can be difficult or impossible to remove.
- If tattoo pigments are injected too deeply, they can migrate and blur the design.

Risk factors

Several recent studies have suggested that piercing and tattoos may be associated with negative and antisocial behaviors teenagers and young adults. Body piercing has been associated with a variety of potentially harmful behaviors, including alcohol and drug use, **smoking**, problem gambling, high-risk sex, and Russian roulette. Body piercing has been found to be more common in young females who are compulsive, thrill-seeking, and/or emotionally negative. A survey of 1753 American college students found that those with at least four tattoos, at least seven piercings, or piercings in the nipples or genitals were significantly more likely to use **marijuana** regularly, to occasionally use other illegal drugs, and to have been arrested for a crime. They were also more likely to cheat in school, binge drink, and report having multiple sex partners.

Causes and symptoms

Piercing and tattooing under non-sterile conditions can transmit infections. The most common bacterial skin infections are caused by *Streptococcus* and *Staphylococcus aureus* and antibiotic-resistant "staph" has been reported among tattoo recipients. Transmission of **tetanus** and **tuberculosis** from ear piercing has been reported. Piercing and tattooing can theoretically transmit serious viral infections, such as hepatitis and HIV, although there has never been a known HIV transmission by a professional experienced tattoo artist.

Piercing and tattoos can cause scarring and keloid or granuloma formation. Granulomas are nodules that can form around foreign material, such as particles of tattoo pigment.

Other potential complications of piercing include:

- abscesses from serious infection
- infections that spread throughout the body

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- endocarditis, a serious inflammation of the heart lining and valves
- weakening and tearing of fleshy tissue leading to disfigurement
- damage to the delicate cartilage of the upper ear, sometimes requiring surgical intervention
- contact dermatitis
- allergic reactions to jewelry containing brass plating or a nickel alloy
- skin that grows over the jewelry, often from studs that are too tight
- disfigurement from the forcible removal of jewelry
- urethral rupture from genital piercing

Oral piercing carries additional risks including:

- gum injury, receding tissues, or damage to teeth or fillings from contact with jewelry
- drooling or interference with speech, chewing, or swallowing from excessive saliva production
- nerve damage from tongue piercing, causing numbness or changes in the sense of taste
- tongue swelling that can block the airway
- severe blood loss from tongue piercing
- slow healing due to constant tongue movement
- unfastened jewelry that is a choking hazard or can be swallowed, injuring the digestive tract
- jewelry that interferes with dental x rays

Allergic reactions can occur to compounds used in tattoo pigments, including organic dyes and oxides of iron, mercury, chromium, cadmium, and cobalt. Sometimes an allergic reaction can develop to a tattoo that has been in place for years. Allergic reactions can cause serious problems because the pigments are hard to remove. Tattoos also occasionally interfere with **magnetic resonance imaging** (MRI) or other medical tests.

Although henna tattoos do not pierce the skin, black henna, which contains para-phenylenediamine, frequently causes **contact dermatitis**. It can be absorbed through the skin of some people and has been known to cause renal (kidney) failure and even **death**. It is particularly dangerous for young children.

Symptoms of a localized bacterial infection include redness, swelling, pain, and pus. Allergic skin reactions include swelling, redness, and severe **itching**.

Diagnosis

Examination

Bacterial infection or allergic reactions in a pierced or tattooed area are usually apparent upon **physical examination**. However signs of blood-borne infections may not be obvious.

KEY TERMS

Contact dermatitis—Skin inflammation resulting from contact with an allergen or other substance.

Endocarditis—Inflammation of the heart lining and valves.

Granuloma—A nodule or mass of chronically inflamed tissue.

Henna—Mehndi; a reddish-brown dye from the leaves of the henna plant; used for hair dye and temporary tattoos.

Hepatitis—Inflammation of the liver, often caused by a virus.

Keloid—A thick scar.

Socialization—Process by which new members are integrated into a social group.

Treatment

Traditional

- Keloids may require surgery, including cryosurgery.
- Pus-producing granulomas must also be surgically removed.
- Plastic surgery may be required to correct holes or disfigurements from piercing.
- Damage to teeth from oral jewelry may require restorative dentistry.

Methods for removing tattoos include:

- laser surgery
- excision (surgical cutting)
- dermabrasion—sanding the skin with a wire brush
- salabrasion—soaking with a salt solution
- scarification—using an acid solution to replace the tattoo with scar tissue
- cosmetic over-tattooing

Drugs

- over-the-counter antibiotic ointments for minor infections
- oral antibiotics for serious infections
- topical steroids or other medications for allergic reactions
- steroid or interferon injections for keloids

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Home remedies

New piercings should be cleaned with a medicated cleanser while gently moving the jewelry around. The area should also be cleaned twice daily with soap and warm water. An antibacterial mouth rinse should be used after meals with oral piercing.

The bandage should be removed from a new tattoo after 24 hours. The skin should be kept clean with plain soap and water and patted dry. Antibiotic ointment should be applied to the tattoo during healing. A mild moisturizer should be applied to newly tattooed skin several times a day.

Minor localized infections can be treated with warm compresses or by soaking with mild sea salt. Jewelry should remain in an infected piercing to ensure proper drainage and prevent **abscess** formation.

Prognosis

Healing time for piercing ranges from a few months to two years. Tattoos take up to two weeks to heal. Minor infections respond well to antibiotic therapy and can usually be treated without losing the piercing. However blood-borne infections can have life-altering and life-threatening consequences. Disfigurements from piercing may be correctable with **plastic surgery**. Allergic reactions are only rarely life-threatening but can lead to permanent scarring or altered pigmentation. Tattoo removal is expensive, usually involves several treatments, is not always successful, and rarely leaves the skin as pristine as before the tattoo.

Prevention

- Piercing and tattooing should be performed sterilely by an experienced professional who complies with local regulations and inspections and always wears a new pair of sterile gloves.
- New sterile needles and tubes should be unwrapped in front of the customer.
- All non-disposable equipment should be heat sterilized in an autoclave.
- Drawer handles, tables, and sinks should be washed with a commercial disinfectant or bleach solution after each use.
- Piercing guns should be single-use or take sterile disposable cassettes.
- Piercing guns should be used only on the ear.
- Piercing should be completed with smoothly polished jewelry made of 14-carat or 18-carat gold, titanium, surgical steel, or niobium.
- Jewelry should be handled as little as possible.
- Jewelry should never be pulled.
- A new tattoo should not be exposed to sunlight for at least a few weeks.
- Clothing should not be allowed to stick to a new tattoo.
- Scabs should not be picked.

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American Academy of Dermatology, PO Box 4014, Schaumburg, IL, 60168, (847) 240-1280, (866) 503-SKIN (7546), (847) 240-1859, http://www.aad.org.

American Academy of Family Physicians, 11400 Tomahawk Creek Parkway, Leawood, KS, 66211-2680, (913) 906-6000, (800) 274-6000, (913) 906-6075, http://www.aafp.org/online/en/home.html.

American Dental Association, 211 East Chicago Ave., Chicago, IL, 60611-2678, (312) 440-2500, http://www.ada.org.

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U.S. Food and Drug Administration, 10903 New Hampshire Ave., Silver Spring, MD, 20993-0002, (888) INFO-FDA, http://www.fda.gov.

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Pilates

Definition

Pilates or Physical Mind method, is a series of non-impact exercises designed by Joseph Pilates to develop strength, flexibility, balance, and inner awareness.

Purpose

Pilates is a form of strength and flexibility training that can be done by someone at any level of fitness. The exercises can also be adapted for people who have limited movement or who use wheel chairs. It is an engaging **exercise** program that people want to do. Pilates promotes a feeling of physical and mental well-being and also develops inner physical awareness. Since this method strengthens and lengthens the muscles without creating bulk, it is particularly beneficial for dancers and actors. Pilates is also helpful in preventing and rehabilitating from injuries, improving posture, and increasing flexibility, circulation, and balance. Pregnant women who do these exercises can develop body alignment, improve concentration, and develop body shape and tone after **pregnancy**. According to Joseph Pilates, "You will feel better in 10 sessions, look better in 20 sessions and have a completely new body in 30 sessions."

Although Pilates is often associated with dancers, athletes, and younger people in general who are interested in improving their physical strength and flexibility, a simplified version of some Pilates exercises is also being used to lower the risk of hospital-related deconditioning in older adults. A Canadian study of hospitalized patients over the age of 70 found that those who were given a set of Pilates exercises that could be performed in bed recovered more rapidly than a control group given a set of passive range-of-motion exercises.

Woman performing Pilates exercises with the aid of a Pilates reformer. *(© Jim Cummins/Corbis.)*

Description

Origins

Joseph Pilates (pronounced pie-LAH-tes), the founder of the Pilates method (also simply referred to as "the method") was born in Germany in 1880. As a frail child with **rickets**, **asthma**, and **rheumatic fever**, he was determined to become stronger. He dedicated himself to building both his body and his mind through practices which included **yoga**, zen, and ancient Roman and Greek exercises. His conditioning regime worked and he became an accomplished gymnast, skier, boxer, and diver.

While interned in England during World War I for being a German citizen, Pilates became a nurse. During this time, he designed a unique system of hooking springs and straps to a hospital bed in order to help his disabled and immobilized patients regain strength and movement. It was through these experiments that he recognized the importance of training the core abdominal and back muscles to stabilize the torso and allow the entire body to move freely. This experimentation provided the foundation for his style of conditioning and the specialized exercise equipment associated with the Pilates method.

Pilates emigrated to the United States in 1926 after the German government invited him to use his conditioning methods to train the army. That same year he opened the first Pilates studio in New York City. Over the years, dancers, actors, and athletes flocked to his studio to heal, condition, and align their bodies.

Joseph Pilates died at age 87 in a fire at his studio. Although his strength enabled him to escape the flames by hanging from the rafters for over an hour,

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he died from **smoke inhalation**. He believed that ideal fitness is "the attainment and maintenance of a uniformly developed body with a sound mind fully capable of naturally, easily, and satisfactorily preforming our many and varied daily tasks with spontaneous zest and pleasure."

During the initial meeting, an instructor will analyze the client's posture and movement and design a specific training program. Once the program has been created, the sessions usually follow a basic pattern. A session generally begins with mat work and passive and active stretching. In passive stretching, the instructor moves and presses the client's body to stretch and elongate the muscles. During the active stretching period, the client preforms the stretches while the instructor watches their form and breathing. These exercises warm up the muscles in preparation for the machine work. The machines help the client to maintain the correct positioning required for each exercise.

There are over 500 exercises that were developed by Joseph Pilates. "Classical" exercises, according to the Pilates Studio in New York involve several principles. These include concentration, centering, flowing movement, and breath. Some instructors teach only the classical exercises originally taught by Joseph Pilates. Others design new exercises that are variations upon these classical forms in order to make the exercises more accessible for a specific person.

There are two primary exercise machines used for Pilates, the Universal Reformer and the Cadillac, and several smaller pieces of equipment. The Reformer resembles a single bed frame and is equipped with a carriage that slides back and forth and adjustable springs that are used to regulate tension and resistance. Cables, bars, straps, and pulleys allow the exercises to be done from a variety of positions. Instructors usually work with their clients on the machines for 20–45 minutes. During this time, they are observing and giving feedback about alignment, breathing, and precision of movement. The exercises are done slowly and carefully so that the movements are smooth and flowing. This requires focused concentration and muscle control. The session ends with light stretching and a cool-down period.

Once the basics are learned from an instructor, from either one-on-one lessons or in a class, it is possible to train at home using videos. Exercise equipment for use at home is also available and many exercises can be preformed on a mat.

KEY TERMS

Yoga—A system of physical, mental, and breathing exercises developed in India.

Zen—A form of meditation that emphasizes direct experience.

A private session costs between $45–75 dollars, depending on the part of the country one is in. This method is not specifically covered by insurance although it may be covered when the instructor is a licensed physical therapist.

Precautions

The Pilates method is not a substitute for good **physical therapy**, although it has been increasingly used and recommended by physical therapists since the mid-1980s. People with chronic injuries are advised to see a physician.

Research and general acceptance

As of early 2004, several physical therapists and gerontologists have done research studies on the Pilates method, although much more work needs to be done in this area. One recent finding is that the method should not be used by patients with lower back **pain**, as it appears to be ineffective in treating this condition.

The appeal of the Pilates method to a wide population, coupled with a new interest in it on the part of **rehabilitation** therapists, suggests that further studies may soon be underway. Dancers and actors originally embraced the Pilates method as a form of strength training that did not create muscle bulk. Professional and amateur athletes also use these exercises to prevent reinjury. Sedentary people find Pilates to be a gentle, non-impact approach to conditioning. Pilates equipment and classes can be found in hospitals, health clubs, spas, and gyms.

Resources

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ORGANIZATIONS

Pilates Method Alliance, P.O. Box 370906, Miami, FL, 33137-0906, (305) 573-4461, (866) 573-4945, info@pilatesmethodalliance.org, http://www.pilatesmethodalliance.org.
United States Pilates Association, 1500 East Broward Blvd. Suite 250, Ft. Lauderdale, FL, 33301, (888) 484-8772, info@unitedstatespilatesassociation.com, http://www.unitedstatespilatesassociation.com.

Linda Chrisman
Rebecca J. Frey, PhD

Piles *see* **Hemorrhoids**

Pinguecula and pterygium

Definition

Pinguecula and pterygium are both non-malignant, slow-growing proliferations of conjunctival connective tissue in the eye. Pterygia, but not pingueculae, extend over the cornea.

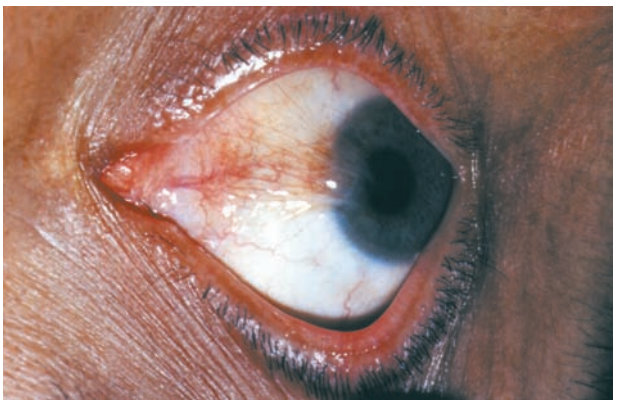
Description

The outer layer of the eyeball consists of the tough white sclera and the transparent cornea. The cornea lies in front of the colored part of the eye (iris). Overlying the sclera is a transparent mucous membrane called the conjunctiva. The conjunctiva lines the inside of the lids (palpebral conjunctiva) and covers the sclera (bulbar conjunctiva).

Pingueculae and pterygia are common in adults, and their incidence increases with age. Pterygia are less common than pingueculae.

Pingueculae are seen as small, raised, thickenings of the conjunctiva. They may be yellow, gray, white, or colorless. They are almost always to one side of the iris–not above or below–and usually on the side closest to the nose. A pinguecula may develop into a pterygium.

Pterygia are conjunctival thickenings that may have blood vessels associated with them. They often have a triangular-shaped appearance. The pterygia may also grow over the cornea and may therefore affect vision.



Pterygium, an overgrowth of the cornea, is usually on the inner side of the eye by thickened and degenerative conjunctiva. *(Photo Researchers, Inc.)*

Causes and symptoms

Causes

The cause or causes of these disorders are unknown, but they are more frequent in people who live in sunny and windy climates and people whose jobs expose them to ultraviolet (UV) light (for example, farmers and arc welders). Pingueculae and pterygia also occur in older people. It is thought these growths are the result of UV or infrared light and irritation. It is also believed that prolonged exposure to these risk factors (that is, UV light) increases the chances of occurrence.

Symptoms

Although some people with pinguecula constantly feel like they have a foreign body in their eye, most are asymptomatic. Because the lids can no longer spread the tears over a smooth area, dry areas may result. Some people with a pterygium are also asymptomatic; some feel like they have a foreign body in their eye. Because a pterygium can stretch and distort the cornea, some people acquire **astigmatism** from a pterygium.

Diagnosis

An eye doctor (ophthalmologist or optometrist) can usually diagnose pingueculae and pterygia by external observation, generally using an instrument called a slit lamp. A slit lamp is a microscope with a

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KEY TERMS

Astigmatism—Asymetric vision problems due to irregularities in the cornea.

Beta radiation—Streams of electrons emitted by beta emitters like carbon-14 and radium.

Conjuctiva—The mucous membrane that covers the white part of the eyes and lines the eyelids.

Cornea—The clear outer covering of the front of the eye. It is in front of the colored part of the eye (iris) and the iris's central black hole (pupil).

light source and magnifies the structures of the eye for the examiner. However, because pingueculae and pterygia can sometimes look similar to more serious eye growths, it is important for people to have them checked by an eye care professional.

Treatment

Usually, no treatment is needed. Artificial tears can be used to relieve the sensation of a foreign body in the eye and to protect against dryness. Surgery to remove the pinguecula or pterygium is advisable when the effect on the cornea causes visual defects or when the thickening is causing excessive and recurrent discomfort or inflammation. Sometimes surgical removal is also performed for cosmetic reasons. However, healing from this type of surgery, although usually painless, takes many weeks, and there is a high rate of recurrence (as high as 50–60% in some regions). Accordingly, surgery is avoided unless problems due to the pinguecula or pterygium are significant.

Several methods have been used to attempt to reduce the recurrence of the pinguecula or pterygium after surgery. One method that should be abandoned is beta radiation. Although it is effective at slowing the regrowth of pingueculae and pterygia, it can cause **cataracts**. A preferable method is the topical application of the anticancer drug, mitomycin-C.

Prognosis

Most pingueculae and pterygia grow slowly and almost never cause significant damage, so the prognosis is excellent. Again, a diagnosis must be made to rule out other more serious disorders.

Prevention

There is nothing that has been clearly shown to prevent these disorders, or to prevent a pinguecula from progressing to a pterygium. However, the presence of pingueculae and pterygia have been linked to exposure to UV radiation. For that reason, UV exposure should be reduced. The American Optometric Association (AOA) suggests that sunglasses should block 99–100% of UV-A and UV-B rays. Patients should speak to their eye care professionals about protective coatings on sunglasses or regular spectacles. Protecting the eyes from sunlight, dust, and other environmental irritants is a good idea.

ORGANIZATIONS

New York University Department of Ophthalmology, 462 First Avenue, NBV 5N 18, New York, NY, 10016, (212) 263-6434, (212) 263-8749 , http://www.med.nyu.edu.

Lorraine Lica, PhD

Pinkeye *see* **Conjunctivitis**

Pinta

Definition

A bacterial infection of the skin which causes red to bluish-black colored spots.

Description

Pinta is a skin infection caused by the bacterium *Treponema carateum*, a relative of the bacterium which causes **syphilis**. The word "pinta" comes from the Spanish and means "painted." Pinta is also known as "azula" (blue), and "mal de pinto" (pinto sickness). It is one of several infections caused by different *Treponema* bacteria, which are called "endemic" or "nonvenereal" treponematoses.

Pinta is primarily found in rural, poverty-stricken areas of northern South America, Mexico, and the Caribbean. The disease is usually acquired during childhood and is spread from one person to another by direct skin-to-skin contact. The bacteria enter the skin through a small cut, scratch, or other skin damage. Once inside the skin, the warmth and moisture allow the bacteria to multiply. The bacterial infection causes red, scaly lesions on the skin.

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KEY TERMS

Lesion—An abnormal change in skin due to disease.

Causes and symptoms

Pinta is caused by an infection with the bacterium *Treponema carateum*. Persons at risk for pinta are those who live in rural, poverty-stricken, overcrowded regions of South America, Mexico, and the Caribbean. Symptoms of pinta occur within two to four weeks after exposure to the bacteria. The first sign of infection is a red, scaly, slowly enlarging bump on the skin. This is called the "primary lesion." The primary lesion usually appears at the site where the bacteria entered the skin. This is often on the arms, legs, or face. The smaller lesions which form around the primary lesion are called "satellite lesions." Lymph nodes located near the infected area will become enlarged, but are painless.

The second stage of pinta occurs between one and 12 months after the primary lesion stage. Many flat, red, scaly, itchy lesions called "pintids" occur either near the primary lesion, or scattered around the body. Pintid lesions progress through a range of color changes, from red to bluish-black. The skin of older lesions will become depigmented (loss of normal color).

Diagnosis

Pinta can be diagnosed by dermatologists (doctors who specialize in skin diseases) and **infectious disease** specialists. The appearance of the lesions helps in the diagnosis. A blood sample will be taken from the patient's arm to test for antibodies to *Treponema carateum*. A scraping of a lesion will be examined under the microscope to look for *Treponema* bacteria. The results of these tests should be available within one to two days.

Treatment

Pinta is treated with benzathine penicillin G (Bicillin), given as a single injection.

Prognosis

Treatment will result in a complete cure but will not undo any skin damage caused by the late stages of disease. Spread of pinta to the eyes can cause eyelid deformities.

Prevention

Good personal hygiene and general health may help prevent infections. In general, avoid physical contact with persons who have **skin lesions**.

Belinda Rowland, PhD

Pinworm infection *see* **Enterobiasis**
Pituitary adenoma *see* **Pituitary tumors**

Pituitary dwarfism

Definition

Dwarfism is a condition in which the growth of the individual is very slow or delayed. There are many forms of dwarfism. The word pituitary is in reference to the pituitary gland in the body. This gland regulates certain chemicals (hormones) in the body. Therefore, pituitary dwarfism is decreased bodily growth due to hormonal problems. The end result is a proportionate little person, because the height as well as the growth of all other structures of the individual are decreased.

Description

Pituitary dwarfism is caused by problems arising in the pituitary gland. The pituitary gland is also called the hypophysis. The pituitary gland is divided into two halves: the anterior (front) and posterior (back) halves. The anterior half produces six hormones: growth hormone, adrenocorticotropin (corticotropin), thyroid stimulating homone (thyrotropin), prolactin, follicle stimulating hormone, and lutenizing hormone. The posterior pituitary gland only produces two hormones. It produces antidiuretic hormone (vasopressin) and oxytocin.

Most forms of dwarfism are a result of decreased production of hormones from the anterior half of the pituitary gland. The most common form is due to decreases of growth hormone which will be discussed here. These decreases during childhood cause the individual's arms, legs, and other structures to develop normal proportions for their bodies, but at a decreased rate.

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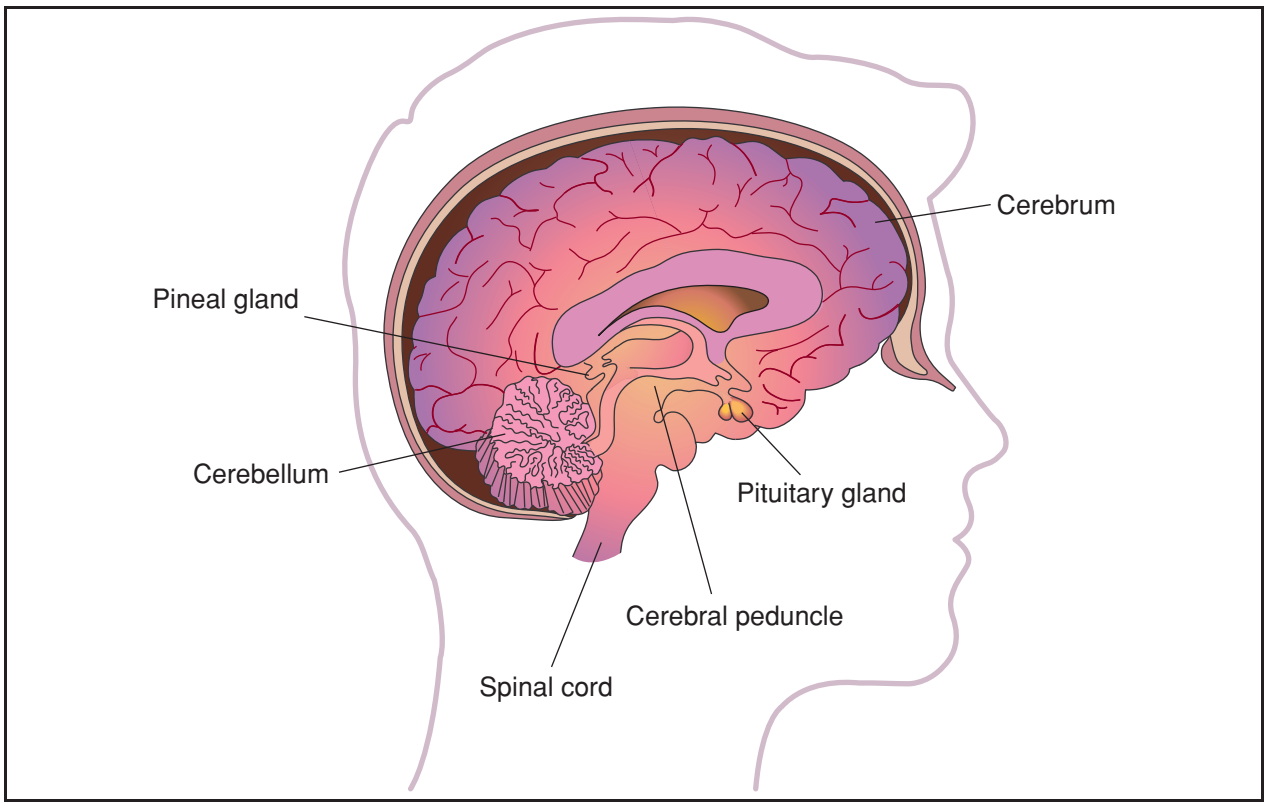

Pituitary dwarfism is a condition of growth retardation characterized by patients who are very short but have normal body proportions. It is caused by a dysfunction of the pituitary gland, the pea-sized mass of tissue located at the base of the brain. *((Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

When all of the hormones of the anterior pituitary gland are not produced, this is called panhypopituitarism. Another type of dwarfism occurs when only the growth hormone is decreased. Dwarfism can also result from a lack of somatomedin C (also called insulin like growth factor, IGF-1) production. Somatomedin C is a hormone produced in the liver that increases bone growth when growth hormone is present. The African pygmy and the Levi-Lorain dwarfs lack the ability to produce somatomedin C in response to growth hormone. All causes of dwarfism lead to a proportionate little person.

Growth is the body's response to different hormones. The forebrain contains a small organ called the hypothalamus, which is responsible for releasing hormones in response to the body's needs for purposes of regulation. Growth hormone is produced in the anterior pituitary gland when growth hormone-releasing hormone (GHRH), is released by the hypothalamus. Growth hormone is then released and stimulates the liver to produce IGF-1. In return, IGF-1 stimulates the long bones to grow in length. Thus, growth can be slowed down or stopped if there is a problem making any of these hormones or if there is a problem with the cells receiving these hormones.

Some estimates show that there are between 10,000 and 15,000 children in the United States who have growth problems due to a deficiency of growth hormone.

Causes and symptoms

Pituitary dwarfism has been shown to run in families. New investigations are underway to determine the specific cause and location of the gene responsible for dwarfism. The human cell contains 46 chromosomes arranged in 23 pairs. Most of the genes in the two chromosomes of each pair are identical or almost identical with each other. However, with dwarfism, there appears to be disruption on different areas of chromosome 3 and 7. Some studies have isolated defects for the production of pituitary hormones to the short arm (the "p" end) of chromosome 3 at a specific location of 3p11. Other studies have found changes on the short arm of chromosome 7.

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KEY TERMS

Adrenocorticotropin (corticotrophin)—A hormone that acts on cells of the adrenal cortex, causing them to produce male sex hormones and hormones that control water and mineral balance in the body.

Antidiuretic hormone (vasopressin)—A hormone that acts on the kidneys to regulate water balance.

Craniopharyngioma—A tumor near the pituitary gland in the craniopharyngeal canal that often results in intracranial pressure.

Deprivational dwarfism—A condition where emotional disturbances are associated with growth failure and abnormalities of pituitary function.

Follicle-stimulating hormone (FSH)—A hormone that in females stimulates estrogen and in males stimulates sperm production.

Growth hormone—A hormone that eventually stimulates growth. Also called somatotropin.

Hormone—A chemical messenger produced by the body that is involved in regulating specific bodily functions such as growth, development, and reproduction.

Luteinizing hormone—A hormone secreted by the pituitary gland that regulates the menstrual cycle and triggers ovulation in females. In males it stimulates the testes to produce testosterone.

Oxytocin—A hormone that stimulates the uterus to contract during child birth and the breasts to release milk.

Panhypopituitarism—Generalized decrease of all of the anterior pituitary hormones.

Prolactin—A hormone that helps the breast prepare for milk production during pregnancy.

Puberty—Point in development when the gonads begin to function and secondary sexual characteristics begin to appear.

Thyroid stimulating hormone (thyrotropin)—A hormone that stimulates the thyroid gland to produce hormones that regulate metabolism.

A child with a growth hormone deficiency is often small with an immature face and chubby body build. The child's growth will slow down and not follow the normal growth curve patterns. In cases of tumor, most commonly **craniopharyngioma** (a tumor near the pituitary gland), children and adolescents may present with neurological symptoms such as headaches, **vomiting**, and problems with vision. The patient may also have symptoms of double vision. Symptoms such as truly bizarre and excessive drinking behaviors (polydipsia) and sleep disturbances may be common.

Diagnosis

The primary symptom of pituitary dwarfism is lack of height. Therefore, a change in the individual's growth habits will help lead to a diagnosis. Another diagnostic technique uses an x ray of the child's hand to determine the child's bone age by comparing this to the child's actual chronological age. The bone age in affected children is usually two years or more behind the chronological age. This means that if a child is ten years old, his or her bones will look like they are those of an eight-year-old child. The levels of growth hormone and somatomedin C must also be measured with blood tests.

Hypopituitarism may be gained or acquired following birth for several reasons. It could be due to trauma to the pituitary gland such as a fall or following surgery to the brain for removal of a tumor. It may also be due to the child's environment (deprivational dwarfism).

On examination by the doctor there may be optic nerve atrophy, if the dwarfism is due to a type of tumor. X rays of the area where the pituitary gland is located (sella turcica) or more advanced imaging such as **magnetic resonance imaging** (MRI) or computed tomography CT may show changes of the pituitary gland itself. Computed tomography, is an advanced form of x ray that will help determine the integrity of the bone and how much calcification the tumor is producing. Magnetic resonance imaging will also help in the diagnosis. MRI is a type of imaging device that can visualize soft tissues such as muscle and fat.

If the dwarfism is due to environmental and emotional problems, the individual may be hospitalized to monitor hormone levels. Following a few days of hospitalization, hormone levels may become normal due to avoidance of the original environment.

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Treatment

The main course of therapy is growth **hormone replacement therapy** when there is lack of growth hormone in the body. A pediatric endocrinologist, a doctor specializing in the hormones of children, usually administers this type of therapy before a child's growth plates have fused or joined together. Once the growth plates have fused, GH replacement therapy is rarely effective.

Growth hormone used to be collected from recently deceased humans. However, frequent disease complications resulting from human growth hormone collected from deceased bodies, lead to the banning of this method. In the mid-1980s, techniques were discovered that could produce growth hormones in the lab. Now, the only growth hormone used for treatment is that made in a laboratory.

A careful balancing of all of the hormones produced by the pituitary gland is necessary for patients with panhypopituitarism. This form of dwarfism is very difficult to manage.

Prognosis

The prognosis for each type of dwarfism varies. A panhypopituitarism dwarf does not pass through the initial onset of adult sexual development (**puberty**) and never produces enough gonadotropic hormones to develop adult sexual function. These individuals also have several other medical conditions. Dwarfism due to only growth hormone deficiency has a different prognosis. These individuals do pass through puberty and mature sexually, however, they remain proportionately small in stature.

If the individual is lacking only growth hormone then growth hormone replacement therapy can be administered. The success of treatment with growth hormone varies however. An increase in height of 4–6 in (10–15 cm) can occur in the first year of treatment. Following this first year, the response to the hormone is not as successful. Therefore the amount of growth hormone administered must be tripled to maintain this rate. Long-term use is considered successful if the individual grows at least 0.75 in (2 cm) per year more than they would without the hormone. However, if the growth hormone treatment is not administered before the long bones—such as the legs and arms—fuse, then the individual will never grow. This fusion is completed by adult age.

Improvement for individuals with dwarfism due to other causes such as a tumor, varies greatly. If the dwarfism is due to deprevational causes, then removing a child from that environment should help to alleviate the problem.

Resources

BOOKS

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OTHER

"Clinical Growth Charts by the National Center for Health Statistics." *Center for Disease Control*. http://www.cdc.gov/nchs/about/major/nhanes/growthcharts/clinical_charts.htm.

"Entry 312000: Panhypopituitarism; PHP." *OMIM—Online Mendelian Inhericance in Man*. National Institutes of Health. http://www.ncbi.nlm.nih.gov/htbin-post/Omim/dispmim?312000.

Hill, Mark. "Development of the Endocrine System—Pituitary." *The University of New South Wales, Sydney, Australia—Department of Embryology*. http://anatomy.med.unsw.edu.au/CBL/Embryo/OMIMfind/endocrine/pitlist.htm.

ORGANIZATIONS

The Human Growth Foundation, 997 Glen Cove Ave., Suite 5, Glen Head, NY, 11545, (516) 671-4055, (800) 451-6434, http://www.hgfound.org/.

Little People of America, Inc., 250 El Camino Real, Suite 201, Tustin, CA, 92780, (714) 368-3689, (714) 368-3367, 888 LPA-2001 (572-2001), http://www.lpaonline.org.

Jason S. Schliesser, DC

Pituitary gland removal *see* **Hypophysectomy**

Pituitary tumors

Definition

Pituitary tumors are abnormal growths on the pituitary gland. Some tumors secrete hormones normally made by the pituitary gland.

Description

Located in the center of the brain, the pituitary gland manufactures and secretes hormones that regulate growth, sexual development and functioning, and the fluid balance of the body. About 10% of all cancers in the skull are pituitary tumors. Pituitary adenomas (adenomas are tumors that grow from gland tissues) and pituitary tumors in children and adolescencents (craniopharyngiomas) are the most common types of

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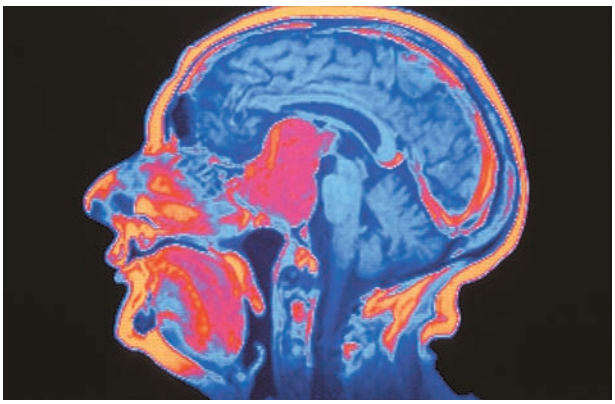

Colorized MRI showing large pituitary tumor at center in pink. *(Mehau Kulyk/Photo Researchers, Inc.)*

pituitary tumors. They are usually benign and grow slowly. Even malignant pituitary tumors rarely spread to other parts of the body.

Pituitary adenomas do not secrete hormones but are likely to be larger and more invasive than tumors that do. Craniopharyngiomas are benign tumors that are extremely difficult to remove. Radiation does not stop them from spreading throughout the pituitary gland. Craniopharyngiomas account for less than 5% of all brain tumors. Pituitary tumors usually develop between the ages of 30 and 40, but half of all craniopharyngiomas occur in children, with symptoms most often appearing between the ages of five and ten.

Causes and symptoms

The cause of pituitary tumors is not known, but may be genetic. Symptoms related to tumor location, size, and pressure on neighboring structures include:

- persistent headache on one or both sides, or in the center of the forehead
- blurred or double vision; loss of peripheral vision
- drooping eyelid caused by pressure on nerves leading to the eye
- seizures

Symptoms related to hormonal imbalance include:

- excessive sweating
- loss of appetite
- loss of interest in sex
- inability to tolerate cold temperatures
- nausea
- high levels of sodium in the blood
- menstrual problems
- excessive thirst
- frequent urination
- dry skin
- constipation
- premature or delayed puberty
- delayed growth in children
- galactorrea (milk secretion in the absence of pregnancy or breast feeding)
- low blood pressure
- low blood sugar

Diagnosis

As many as 40% of all pituitary tumors do not release excessive quantities of hormones into the blood. Known as clinically nonfunctioning, these tumors are difficult to distinguish from tumors that produce similar symptoms. They may grow to be quite large before they are diagnosed.

Endocrinologists and neuroendocrinologists base the diagnosis of pituitary tumors on:

- the patient's own observations and medical history
- physical examination
- laboratory studies of the patient's blood and cerebrospinal fluid
- x rays of the skull and other studies that provide images of the inside of the brain (CT, MRI)
- vision tests
- urinalysis

Treatment

Some pituitary tumors stabilize without treatment, but a neurosurgeon will operate at once to remove the tumor (adenectomy) or pituitary gland (**hypophysectomy**) of a patient whose vision is deteriorating rapidly. Patients who have pituitary apoplexy may experience very severe headaches, have symptoms of stiff neck, and sensitivity to light. This condition is considered an emergency. **Magnetic resonance imaging** (MRI) is the best imaging technique for patients with these symptoms. If the tumor is small, surgery may be done through the nose. If the tumor is large, it may require opening the skull for **tumor removal**. Selected patients do well with proton beam radiosurgery (the use of high energy particles in the form of a high energy beam to destroy an overactive gland).

Treatment is determined by the type of tumor and by whether it has invaded tissues adjacent to the pituitary gland. Hormone-secreting tumors can be successfully treated with surgery, radiation, bromocriptine (Parlodel), Sandostatin (Octreotide), or other

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KEY TERMS

Agonist—A drug that increases the effectiveness of another drug.

Analogue—A drug that is similar to the drug from which it is derived.

somatostatin analogues (drugs similar to somatostatin). Surgery is usually used to remove all or part of a tumor within the gland or the area surrounding it, and may be combined with **radiation therapy** to treat tumors that extend beyond the pituitary gland. Removal of the pituitary gland requires life-long **hormone replacement therapy**.

Radiation therapy can provide long-term control of the disease if it recurs after surgery, and radioactive pellets can be implanted in the brain to treat craniopharyngiomas. CV205-502, a new dopamine agonist (a drug that increases the effect of another, in this instance dopamine) can control symptoms of patients who do not respond to bromocriptine.

Prognosis

Pituitary tumors are usually curable. Following surgery, adults may gradually resume their normal activities, and children may return to school when the effects of the operation have diminished, and appetite and sense of well-being have returned. Patients should wear medical identification tags identifying their condition and the hormonal replacement medicines they take.

ORGANIZATIONS

American Brain Tumor Association, 2720 River Road, Des Plaines, IL, 60018, (847) 827-9910, (847) 827-9918, (800) 886-2282, info@abta.org, http://www.abta.org/.

Pituitary Network Association, P.O. Box 1958, Thousand Oaks, CA, 91358, (805) 499-9973, (805) 480-0633, info@pituitary.org, http://www.pituitary.org.

Maureen Haggerty

Pityriasis rosea

Definition

Pityriasis rosea is a mild, noncontagious skin disorder common among children and young adults, and characterized by a single round spot on the body, followed later by a rash of colored spots on the body and upper arms.

The torso of a man covered with pityriasis rosea. The cause of this disorder is thought to be due to a viral infection. It often appears on the torso and upper parts of the limbs of young people and may be contagious. *(Dr. P. Marazzi/SPL/Photo Researchers, Inc.)*

Description

Pityriasis rosea is most common in young adults, and appears up to 50% more often in women. Its cause is unknown; however, some scientists believe that the rash is an immune response to some type of infection in the body.

Causes and symptoms

Doctors do not think that pityriasis rosea is contagious, but the cause is unknown. Some experts suspect the rash, which is most common in spring and fall, may be triggered by a virus, but no infectious agent has ever been found.

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KEY TERMS

Antihistamines—A group of drugs that block the effects of histamine, a chemical released during an allergic reaction.

Steroids—A group of drugs that includes the corticosteroids, similar to hormones produced by the adrenal glands, and used to relieve inflammation and itching.

It is not sexually transmitted, and does not appear to be contagious from one person to the next.

Sometimes, before the symptoms appear, people experience preliminary sensations including **fever**, malaise, **sore throat**, or **headache**. Symptoms begin with a single, large round spot called a "herald patch" on the body, followed days or weeks later by slightly raised, scaly-edged round or oval pink-copper colored spots on the trunk and upper arms. The spots, which have a wrinkled center and a sharp border, sometimes resemble a Christmas tree. They may be mild to severely itchy, and they can spread to other parts of the body.

Diagnosis

A physician can diagnose the condition with blood tests, skin scrapings, or a biopsy of the lesion.

Treatment

The rash usually clears up on its own, although a physician should rule out other conditions that may cause a similar rash (such as **syphilis**).

Treatment includes external and internal medications for **itching** and inflammation. Mild inflammation and itching can be relieved with antihistamine drugs or calamine lotion, zinc oxide, or other mild lubricants or anti-itching creams. Gentle, soothing strokes should be used to apply the ointments, since vigorous rubbing may cause the lesions to spread. More severe itching and inflammation is treated with topical **steroids**. Moderate exposure to sun or ultraviolet light may help heal the lesions, but patients should avoid being sunburned.

Soap makes the rash more uncomfortable; patients should bathe or shower with plain lukewarm water, and apply a thin coating of bath oil to freshly-dried skin afterwards.

Prognosis

These spots, which may be itchy, last for 3–12 weeks. Symptoms rarely recur.

ORGANIZATIONS

American Academy of Dermatology, PO Box 4014, Schaumburg, IL, 60168-4014, (847) 240-1859, (866) 503-SKIN (7546), http://www.aad.org.

Carol A. Turkington

PKU *see* **Phenylketonuria**

Placenta previa

Definition

Placenta previa is a condition that occurs during **pregnancy** when the placenta is abnormally placed, and partially or totally covers the cervix.

Description

The uterus is the muscular organ that contains the developing baby during pregnancy. The lowest segment of the uterus is a narrowed portion called the cervix. The cervix has an opening (the os) that leads into the vagina, or birth canal. The placenta is the organ that attaches to the wall of the uterus during pregnancy. The placenta allows nutrients and oxygen from the mother's blood circulation to pass into the developing baby (the fetus) via the umbilical cord.

During labor, the muscles of the uterus contract repeatedly. This allows the cervix to begin to grow thinner (called effacement) and more open (dilatation). Eventually, the cervix will become completely effaced and dilated, and the baby can leave the uterus and enter the birth canal. Under normal circumstances, the baby will emerge through the mother's vagina during birth.

In placenta previa, the placenta develops in an abnormal location. Normally, the placenta should develop relatively high up in the uterus, on the front or back wall. In about one in 200 births, the placenta will be located low in the uterus, partially or totally covering the os. This causes particular problems in late pregnancy, when the lower part of the uterus begins to take on a new formation in preparation for delivery. As the cervix begins to efface and dilate, the attachments of the placenta to the uterus are damaged, resulting in bleeding.

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Causes and symptoms

While the actual cause of placenta previa is unknown, certain factors increase the risk of a woman developing the condition. These factors include:

- having abnormalities of the uterus
- being older in age
- having had other babies
- having a prior delivery by cesarean section
- smoking cigarettes

When a pregnancy involves more than one baby (twins, triplets, etc.), the placenta will be considerably larger than for a single pregnancy. This also increases the chance of placenta previa.

Placenta previa may cause a number of problems. It is thought to be responsible for about 5% of all miscarriages. It frequently causes very light bleeding (spotting) early in pregnancy. Sometime after 28 weeks of pregnancy (most pregnancies last about 40 weeks), placenta previa can cause episodes of significant bleeding. Usually, the bleeding occurs suddenly and is bright red. The woman rarely experiences any accompanying **pain**, although about 10% of the time the placenta may begin separating from the uterine wall (called abruptio placentae), resulting in pain. The bleeding usually stops on its own. About 25% of such patients will go into labor within the next several days. Sometimes, placenta previa does not cause bleeding until labor has already begun.

Placenta previa puts both the mother and the fetus at high risk. The mother is at risk of severe and uncontrollable bleeding (hemorrhage), with dangerous blood loss. If the mother's bleeding is quite severe, this puts the fetus at risk of becoming oxygen deprived. The fetus' only source of oxygen is the mother's blood. The mother's blood loss, coupled with certain changes that take place in response to that blood loss, decreases the amount of blood going to the placenta, and ultimately to the fetus. Furthermore, placenta previa increases the risk of preterm labor, and the possibility that the baby will be delivered prematurely.

Diagnosis

Diagnosis of placenta previa is suspected whenever bright red, painless vaginal bleeding occurs during the course of a pregnancy. The diagnosis can be confirmed by performing an ultrasound examination. This will allow the location of the placenta to be evaluated.

While many conditions during pregnancy require a pelvic examination, in which the health care provider's fingers are inserted into the patient's vagina, such an examination should never be performed if there is any suspicion of placenta previa. Such an examination can disturb the already susceptible placenta, resulting in hemorrhage.

Sometimes placenta previa is found early in a pregnancy, during an ultrasound examination performed for another reason. In these cases, it is wise to have a repeat ultrasound performed later in pregnancy (during the last third of the pregnancy, called the third trimester). A large percentage of these women will have a low-lying placenta, but not a true placenta previa where some or all of the os is covered.

KEY TERMS

Cesarean section—Delivery of a baby through an incision in the mother's abdomen instead of through the vagina.

Labor—The process during which the uterus contracts, and the cervix opens to allow the passage of a baby into the vagina.

Placenta—The organ that provides oxygen and nutrition from the mother to the baby during pregnancy. The placenta is attached to the wall of the uterus and leads to the baby via the umbilical cord.

Umbilical cord—The blood vessels that allow the developing baby to receive nutrition and oxygen from its mother; the blood vessels also eliminate the baby's waste products. One end of the umbilical cord is attached to the placenta and the other end is attached to the baby's belly button (umbilicus).

Vagina—The birth canal; the passage from the cervix of the uterus to the opening leading outside of a woman's body.

Treatment

Treatment depends on how far along in the pregnancy the bleeding occurs. When the pregnancy is less than 36 weeks along, the fetus is not sufficiently developed to allow delivery without a high risk of complications. Therefore, a woman with placenta previa is treated with bed rest, blood transfusions as necessary, and medications to prevent labor. After 36 weeks, the baby can be delivered via **cesarean section**. This is almost always the preferred method of delivery in order to avoid further bleeding from the low-lying placenta.

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Prognosis

In cases of placenta previa, the prognosis for the mother is very good. However, there is a 15–20% chance the infant will not survive. This is 10 times the **death** rate associated with normal pregnancies. About 60% of these deaths occur because the baby delivered was too premature to survive.

Prevention

There are no known ways to insure the appropriate placement of the placenta in the uterus. However, careful treatment of the problem can result in the best chance for a good outcome for both mother and baby.

ORGANIZATIONS

American College of Obstetricians and Gynecologists (ACOG), PO Box 96920, Washington, DC, 20090-6920, (202) 638-5577, http://www.acog.org.

Rosalyn Carson-DeWitt, MD

Placental abruption

Definition

Placental abruption occurs when the placenta separates from the wall of the uterus prior to the birth of the baby. This can result in severe, uncontrollable bleeding (hemorrhage).

Description

The uterus is the muscular organ that contains the developing baby during **pregnancy**. The lowest segment of the uterus is a narrowed portion called the cervix. The cervix has an opening (the os) that leads into the vagina, or birth canal. The placenta is the organ that attaches to the wall of the uterus during pregnancy. The placenta allows nutrients and oxygen from the mother's blood circulation to pass into the developing baby (the fetus) via the umbilical cord.

During labor, the muscles of the uterus contract repeatedly. This allows the cervix to begin to grow thinner (called effacement) and more open (dilatation). Eventually, the cervix will become completely effaced and dilated, and the baby can leave the uterus and enter the birth canal. Under normal circumstances, the baby will go through the mother's vagina during birth.

During a normal labor and delivery, the baby is born first. Several minutes to 30 minutes later, the placenta separates from the wall of the uterus and is delivered. This sequence is necessary because the baby relies on the placenta to provide oxygen until he or she begins to breathe independently.

Placental abruption occurs when the placenta separates from the uterus before the birth of the baby. Placental abruption occurs in about one out of every 200 deliveries. African-American and Latin-American women have a greater risk of this complication than do Caucasian women. It was once believed that the risk of placental abruption increased in women who gave birth to many children, but this association is still being researched.

Causes and symptoms

The cause of placental abruption is unknown. However, a number of risk factors have been identified. These factors include:

- older age of the mother
- history of placental abruption during a previous pregnancy
- high blood pressure
- certain disease states (diabetes, collagen vascular diseases)
- the presence of a type of uterine tumor called a leiomyoma
- twins, triplets, or other multiple pregnancies
- cigarette smoking
- heavy alcohol use
- cocaine use
- malformations of the uterus
- malformations of the placenta
- injury to the abdomen (as might occur in a car accident)

Symptoms of placental abruption include bleeding from the vagina, severe **pain** in the abdomen or back, and tenderness of the uterus. Depending on the severity of the bleeding, the mother may experience a drop in blood pressure, followed by symptoms of organ failure as her organs are deprived of oxygen. Sometimes, there is no visible vaginal bleeding. Instead, the bleeding is said to be "concealed." In this case, the bleeding is trapped behind the placenta, or there may be bleeding into the muscle of the uterus. Many patients will have abnormal contractions of the uterus, particularly extremely hard, prolonged contractions. Placental abruption can be

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total (in which case the fetus will almost always die in the uterus), or partial.

Placental abruption can also cause a very serious complication called consumptive coagulopathy. A series of reactions begin that involve the elements of the blood responsible for clotting. These clotting elements are bound together and used up by these reactions. This increases the risk of uncontrollable bleeding and may contribute to severe bleeding from the uterus, as well as causing bleeding from other locations (nose, urinary tract, etc.).

Placental abruption is risky for both the mother and the fetus. It is dangerous for the mother because of blood loss, loss of clotting ability, and oxygen deprivation to her organs (especially the kidneys and heart). This condition is dangerous for the fetus because of oxygen deprivation, too, since the mother's blood is the fetus' only source of oxygen. Because the abrupting placenta is attached to the umbilical cord, and the umbilical cord is an extension of the fetus' circulatory system, the fetus is also at risk of hemorrhaging. The fetus may die from these stresses, or may be born with damage due to oxygen deprivation. If the abruption occurs well before the baby was due to be delivered, early delivery may cause the baby to suffer complications of premature birth.

KEY TERMS

Cesarean section—Delivery of a baby through an incision in the mother's abdomen, instead of through the vagina.

Labor—The process during which the uterus contracts, and the cervix opens to allow the passage of a baby into the vagina.

Placenta—The organ that provides oxygen and nutrition from the mother to the baby during pregnancy. The placenta is attached to the wall of the uterus and leads to the baby via the umbilical cord.

Umbilical cord—The blood vessels that allow the developing baby to receive nutrition and oxygen from its mother; the blood vessels also eliminate the baby's waste products. One end of the umbilical cord is attached to the placenta and the other end is attached to the baby's belly button (umbilicus).

Uterus—The muscular organ that contains the developing baby during pregnancy.

Vagina—The birth canal; the passage from the cervix of the uterus to the opening leading outside of a woman's body.

Diagnosis

Diagnosis of placental abruption relies heavily on the patient's report of her symptoms and a **physical examination** performed by a health care provider. Ultrasound can sometimes be used to diagnose an abruption, but there is a high rate of missed or incorrect diagnoses associated with this tool when used for this purpose. Blood will be taken from the mother and tested to evaluate the possibility of life-threatening problems with the mother's clotting system.

Treatment

The first line of treatment for placental abruption involves replacing the mother's lost blood with blood transfusions and fluids given through a needle in a vein. Oxygen will be administered, usually by a mask or through tubes leading to the nose. When the placental separation is severe, treatment may require prompt delivery of the baby. However, delivery may be delayed when the placental separation is not as severe, and when the fetus is too immature to insure a healthy baby if delivered. The baby is delivered vaginally when possible. However, a **cesarean section** may be performed to deliver the baby more quickly if the abruption is quite severe or if the baby is in distress.

Prognosis

The prognosis for cases of placental abruption varies, depending on the severity of the abruption. The risk of **death** for the mother ranges up to 5%, usually due to severe blood loss, **heart failure**, and kidney failure. In cases of severe abruption, 50–80% of all fetuses die. Among those who survive, nearly half will have lifelong problems due to oxygen deprivation in the uterus and premature birth.

Prevention

Some of the causes of placental abruption are preventable. These include cigarette **smoking**, alcohol **abuse**, and **cocaine** use. Other causes of abruption may not be avoidable, like diabetes or high blood pressure. These diseases should be carefully treated. Patients with conditions known to increase the risk of placental abruption should be carefully monitored for signs and symptoms of this complication.

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ORGANIZATIONS

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Plague

Definition

Plague is a serious, potentially life-threatening **infectious disease** that is usually transmitted to humans by the **bites** of rodent fleas. It was one of the scourges of early human history. There are three major forms of the disease: bubonic, septicemic, and pneumonic.

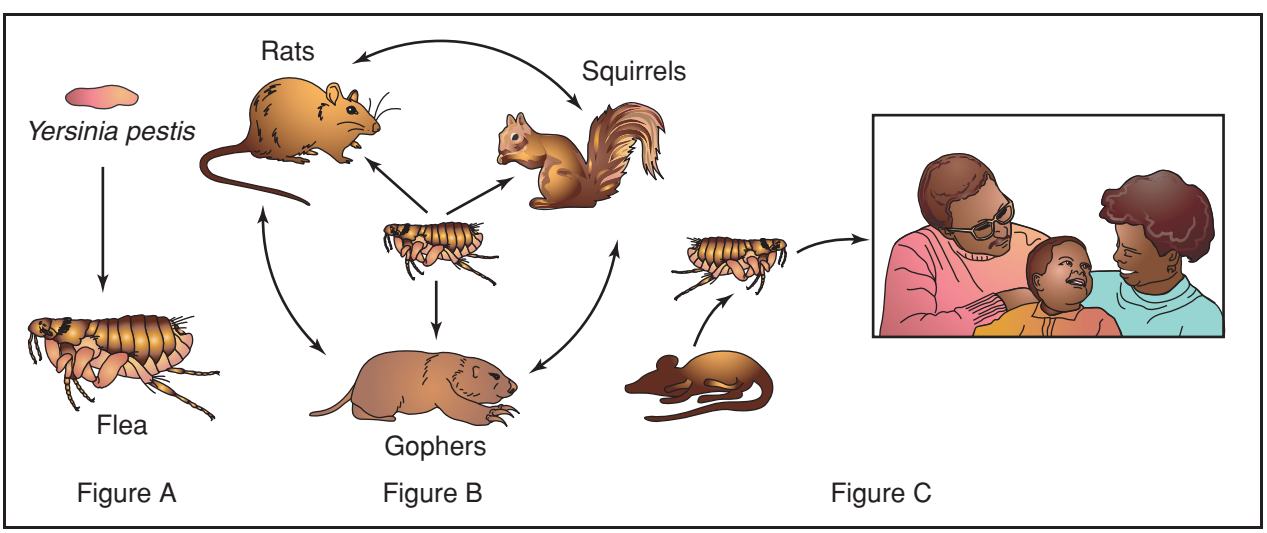
Description

Plague has been responsible for three great world pandemics, which caused millions of deaths and significantly altered the course of history. A pandemic is a disease occurring in epidemic form throughout the entire population of a country, a people, or the world. Although the cause of the plague was not identified until the third pandemic in 1894, scientists are virtually certain that the first two pandemics were plague because a number of the survivors wrote about their experiences and described the symptoms.

The first great pandemic appeared in AD 542 and lasted for 60 years. It killed millions of citizens, particularly people living along the Mediterranean Sea. This sea was the busiest coastal trade route at that time and connected what is now southern Europe, northern Africa, and parts of coastal Asia. This pandemic is sometimes referred to as the Plague of Justinian, named for the great emperor of Byzantium who was ruling at the beginning of the outbreak. According to the historian Procopius, this outbreak of plague killed 10,000 people per day at its height just within the city of Constantinople.

The second pandemic occurred during the fourteenth century, and was called the Black **Death** because its main symptom was the appearance of black patches (caused by bleeding) on the skin. It was also a subject found in many European paintings, drawings, plays, and writings of that time. The connections between large active trading ports, rats coming off the ships, and the severe outbreaks of the plague were understood by people at the time. This was the most severe of the three, beginning in the mid-1300s with an origin in central Asia and lasting for 400 years. Between a fourth and a third of the entire European population died within a few years after plague was first introduced. Some smaller villages and towns were completely wiped out.

The final pandemic began in northern China, reaching Canton and Hong Kong by 1894. From there, it spread to all continents, killing millions.



Plague is a serious infectious disease transmitted by the bites of rat fleas. There are three major forms of plague: bubonic, pneumonic, and septicemic. As illustrated above, fleas carry the bacterium *Yersinia pestis*. When a flea bites an infected rodent, it becomes a vector and then passes the plague bacteria when it bites a human. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

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The great pandemics of the past occurred when wild rodents spread the disease to rats in cities, and then to humans when the rats died. Another route for infection came from rats coming off ships that had traveled from heavily infected areas. Generally, these were busy coastal or inland trade routes. Plague was introduced into the United States during this pandemic and it spread from the West towards the Midwest and became endemic in the Southwest of the United States.

About 10–15 Americans living in the southwestern United States contract plague each year during the spring and summer. The last rat-borne epidemic in the United States occurred in Los Angeles in 1924–25. Since then, all plague cases in this country have been sporadic, acquired from wild rodents or their fleas. Plague can also be acquired from ground squirrels and prairie dogs in parts of Arizona, New Mexico, California, Colorado, and Nevada. Around the world, there are between 1,000 and 2,000 cases of plague each year. Recent outbreaks in humans occurred in Africa, South America, and Southeast Asia.

Some people and/or animals with bubonic plague go on to develop **pneumonia** (pneumonic plague). This can spread to others via infected droplets during coughing or sneezing.

Plague is one of three diseases still subject to international health regulations. These rules require that all confirmed cases be reported to the World Health Organization (WHO) within 24 hours of diagnosis. According to the regulations, passengers on an international voyage who have been to an area where there is an epidemic of pneumonic plague must be placed in **isolation** for six days before being allowed to leave.

While plague is found in several countries, there is little risk to United States travelers within endemic areas (limited locales where a disease is known to be present) if they restrict their travel to urban areas with modern hotel accommodations.

Over the past few years, this infection primarily of antiquity has become a modern issue. This change has occurred because of the concerns about the use of plague as a weapon of biological warfare or terrorism (bioterrorism). Along with **anthrax** and **smallpox**, plague is considered to be a significant risk. In this scenario, the primary manifestation is likely to be pneumonic plague transmitted by clandestine aerosols. It has been reported that during World War II the Japanese dropped "bombs" containing plague-infected fleas in China as a form of biowarfare.

Causes and symptoms

Fleas carry the bacterium *Yersinia pestis*, formerly known as *Pasteurella pestis*. The plague bacillus can be stained with Giemsa stain and typically looks like a safety pin under the microscope. When a flea bites an infected rodent, it swallows the plague bacteria. The bacteria are passed on when the fleas, in turn, bite a human. Interestingly, the plague bacterium grows in the gullet of the flea, obstructing it and not allowing the flea to eat. Transmission occurs during abortive feeding with regurgitation of bacteria into the feeding site. Humans also may become infected if they have a break or cut in the skin and come in direct contact with body fluids or tissues of infected animals.

More than 100 species of fleas have been reported to be naturally infected with plague; in the western United States, the most common source of plague is the golden-manteled ground squirrel flea. Chipmunks and prairie dogs have also been identified as hosts of infected fleas.

Since 1924, there have been no documented cases in the United States of human-to-human spread of plague from droplets. All but one of the few pneumonic cases have been associated with handling infected cats. While dogs and cats can become infected, dogs rarely show signs of illness and are not believed to spread disease to humans. However, plague has been spread from infected coyotes (wild dogs) to humans. In parts of central Asia, gerbils have been identified as the source of cases of bubonic plague in humans.

Bubonic plague

Two to five days after infection, patients experience a sudden **fever**, chills, seizures, and severe headaches, followed by the appearance of swellings or "buboes" in armpits, groin, and neck. The most commonly affected sites are the lymph glands near the site of the first infection. As the bacteria multiply in the glands, the lymph node becomes swollen. As the nodes collect fluid, they become extremely tender. Occasionally, the bacteria will cause an ulcer at the point of the first infection.

Septicemic plague

Bacteria that invade the bloodstream directly (without involving the lymph nodes) cause septicemic plague. (Bubonic plague also can progress to septicemic plague if not treated appropriately.) Septicemic

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plague that does not involve the lymph glands is particularly dangerous because it can be hard to diagnose the disease. The bacteria usually spread to other sites, including the liver, kidneys, spleen, lungs, and sometimes the eyes, or the lining of the brain. Symptoms include fever, chills, prostration, abdominal **pain**, **shock**, and bleeding into the skin and organs.

Pneumonic plague

Pneumonic plague may occur as a direct infection (primary) or as a result of untreated bubonic or septicemic plague (secondary). Primary pneumonic plague is caused by inhaling infective drops from another person or animal with pneumonic plague. Symptoms, which appear within one to three days after infection, include a severe, overwhelming pneumonia, with **shortness of breath**, high fever, and blood in the phlegm. If untreated, half the patients will die; if blood poisoning occurs as an early complication, patients may die even before the buboes appear.

Life-threatening complications of plague include shock, high fever, problems with blood clotting, and convulsions.

Diagnosis

Plague should be suspected if there are painful buboes, fever, exhaustion, and a history of possible exposure to rodents, rabbits, or fleas in the West or Southwest. The patient should be isolated. Chest x rays are taken, as well as blood cultures, antigen testing, and examination of lymph node specimens. Blood cultures should be taken 30 minutes apart, before treatment.

A group of German researchers reported in 2004 on a standardized enzyme-linked immunosorbent assay (ELISA) kit for the rapid diagnosis of plague. The test kit was developed by the German military and has a high degree of accuracy as well as speed in identifying the plague bacillus. The kit could be useful in the event of a bioterrorist attack as well as in countries without advanced microbiology laboratories.

Treatment

As soon as plague is suspected, the patient should be isolated, and local and state departments notified. Drug treatment reduces the risk of death to less than 5%. The preferred treatment is streptomycin administered as soon as possible. Alternatives include gentamicin, chloramphenicol, tetracycline, or trimethoprim/sulfamethoxazole.

KEY TERMS

Bioterrorism—The use of disease agents to terrorize or intimidate a civilian population.

Buboes—Smooth, oval, reddened, and very painful swellings in the armpits, groin, or neck that occur as a result of infection with the plague.

Endemic—A disease that occurs naturally in a geographic area or population group.

Epidemic—A disease that occurs throughout part of the population of a country.

Pandemic—A disease that occurs throughout a regional group, the population of a country, or the world.

Septicemia—The medical term for blood poisoning, in which bacteria have invaded the bloodstream and circulates throughout the body.

Prognosis

Plague can be treated successfully if it is caught early; the mortality rate for treated disease is 1–15% but 40–60% in untreated cases. Untreated pneumonic plague is almost always fatal, however, and the chances of survival are very low unless specific antibiotic treatment is started within 15–18 hours after symptoms appear. The presence of plague bacteria in a blood smear is a grave sign and indicates septicemic plague. Septicemic plague has a mortality rate of 40% in treated cases and 100% in untreated cases.

Prevention

Anyone who has come in contact with a plague pneumonia victim should be given **antibiotics**, since untreated pneumonic plague patients can pass on their illness to close contacts throughout the course of the illness. All plague patients should be isolated for 48 hours after antibiotic treatment begins. Pneumonic plague patients should be completely isolated until sputum cultures show no sign of infection.

Residents of areas where plague is found should keep rodents out of their homes. Anyone working in a rodent-infested area should wear insect repellent on skin and clothing. Pets can be treated with insecticidal dust and kept indoors. Handling sick or dead animals (especially rodents and cats) should be avoided.

Plague vaccines have been used with varying effectiveness since the late nineteenth century. Experts

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believe that **vaccination** lowers the chance of infection and the severity of the disease. However, the effectiveness of the vaccine against pneumonic plague is not clearly known.

Vaccinations against plague are not required to enter any country. Because immunization requires multiple doses over a 6–10 month period, plague vaccine is not recommended for quick protection during outbreaks. Moreover, its unpleasant side effects make it a poor choice unless there is a substantial long-term risk of infection. The safety of the vaccine for those under age 18 has not been established. Pregnant women should not be vaccinated unless the need for protection is greater than the risk to the unborn child. Even those who receive the vaccine may not be completely protected. The inadequacy of the vaccines available as of the early 2000s explains why it is important to protect against rodents, fleas, and people with plague. A team of researchers in the United Kingdom reported in the summer of 2004 that an injected subunit vaccine is likely to offer the best protection against both bubonic and pneumonic forms of plague.

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Infectious Diseases Weblink. http://webpages.charter.net/deziel/.

International Society of Travel Medicine. http://www.istm.org.

World Health Organization. http://www.who.ch/.

ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

National Institute of Allergies and Infectious Diseases, 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-6612, (301) 496-5717, (301) 402-3573, (866) 284-4107, ocpostoffice@niaid.nih.gov, http://www.niaid.nih.gov.

World Health Organization (WHO), Avenue Appia 201211, Geneva, Switzerland, 27, 4122791-2111, info@who.int, http://www.who.int.

Arnold Cua, MD
Rebecca J. Frey, PhD

Plaque *see* **Skin lesions**

Plasma cell myeloma *see* **Multiple myeloma**

Plasma renin activity

Definition

Renin is an enzyme released by the kidney to help control the body's sodium-potassium balance, fluid volume, and blood pressure.

Purpose

Plasma renin activity (PRA), also called plasma renin assay, may be used to screen for high blood pressure (**hypertension**) of kidney origin, and may help plan treatment of essential hypertension, a genetic disease often aggravated by excess **sodium** intake. PRA is also used to further evaluate a diagnosis of excess aldosterone, a hormone secreted by the adrenal cortex, in a condition called Conn's syndrome.

Precautions

Patients taking **diuretics**, antihypertensives, **vasodilators**, **oral contraceptives**, and licorice should discontinue use of these substances for two to four weeks before the test. It should be noted that renin is increased in **pregnancy** and in **diets** with reduced salt intake. Also, since renin is affected by body position, as well as by diurnal (daily) variation, blood samples should be drawn in the morning, and the position of the patient (sitting or lying down) should be noted.

Description

When the kidneys release the enzyme renin in response to certain conditions (high blood potassium, low blood sodium, decreased blood volume), it is the first step in what is called the renin-angiotensin-aldosterone cycle. This cycle includes the conversion of angiotensinogen to angiotensin I, which in turn is

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KEY TERMS

Aldosteronism—A disorder caused by excessive production of the hormone aldosterone, which is produced by a part of the adrenal glands called the adrenal cortex. Causes include a tumor of the adrenal gland (Conn's syndrome), or a disorder reducing the blood flow through the kidney. This leads to overproduction of renin and angiotensin, and in turn causes excessive aldosterone production. Symptoms include hypertension, impaired kidney function, thirst and muscle weakness.

Conn's syndrome—A disorder caused by excessive aldosterone secretion by a benign tumor of one of the adrenal glands. This results in malfunction of the body's salt and water balance and subsequently causes hypertension. Symptoms include thirst, muscle weakness, and excessive urination.

converted to angiotensin II, in the lung. Angiotensin II is a powerful blood vessel constrictor, and its action stimulates the release of aldosterone from an area of the adrenal glands called the adrenal cortex. Together, angiotensin and aldosterone increase the blood volume, the blood pressure, and the blood sodium to re-establish the body's sodium-potassium and fluid volume balance. Primary aldosteronism, the symptoms of which include hypertension and low blood potassium (**hypokalemia**), is considered "low-renin aldosteronism."

Renin itself is not actually measured in the PRA test, because renin can be measured only with great difficulty even in research laboratories. In the most commonly used renin assay, the test actually determines, by a procedure called radioimmunoassay, the rate of angiotensin I generation per unit time, while the PRC (plasma renin concentration) measures the maximum renin effect.

Both the PRA and the PRC are extremely difficult to perform. Not only is renin itself unstable, but the patient's body position and the time of day affect the results. Also, the sample must be collected properly: drawn into a chilled syringe and collection tube, placed on ice, and sent to the performing laboratory immediately. Even if all these procedures are followed, results can vary significantly.

A determination of the PRA and a measurement of the plasma aldosterone level are used in the differential diagnosis of primary and secondary **hyperaldosteronism**. Patients with primary hyperaldosteronism (caused by an adrenal tumor that overproduces aldosterone) will have an increased aldosterone level with decreased renin activity. Conversely, patients with secondary hyperaldosteronism (caused by certain types of **kidney disease**) will have increased levels of renin.

Renin stimulation test

The renin stimulation test is performed to help diagnose and distinguish the two forms of hyperaldosteronism. With the patient having been on a low-salt diet and lying down for the test, a blood sample for PRA is obtained. The PRA is repeated with the patient still on the low salt diet but now standing upright. In cases of primary hyperaldosteronism, the blood volume is greatly expanded, and a change in position or reduced salt intake does not result in decreased kidney blood flow or decreased blood sodium. As a result, renin levels do not increase. However, in secondary hyperaldosteronism, blood sodium levels decrease with a lowered salt intake, and when the patient is standing upright, the kidney blood flow decreases as well. Consequently, renin levels do increase.

Captopril test

The captopril test is a screening test for hypertension of kidney origin (**renovascular hypertension**). For this test, a baseline PRA test is done first, then the patient receives an oral dose of captopril, which is an angiotensin-converting enzyme (ACE) inhibitor. Blood pressure measurements are taken at this time and again at 60 minutes when another PRA test is done. Patients with kidney-based hypertension demonstrate greater falls in blood pressure and increases in PRA after captopril administration than do those with essential hypertension. Consequently, the captopril test is an excellent screening procedure to determine the need for a more invasive radiographic evaluation such as renal arteriography.

Preparation

This test requires a blood sample. For the PRA, the patient should maintain a normal diet with a restricted amount of sodium (approximately 3 g per day) for three days before the test. It is recommended

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that the patient be **fasting** (nothing to eat or drink) from midnight the day of the test.

Risks

Risks for this test are minimal, but may include slight bleeding from the puncture site, **fainting** or feeling lightheaded after venipuncture, or hematoma (blood accumulating under the puncture site).

Normal results

Reference values for the PRA test are laboratory-specific and depend upon the kind of diet (sodium restricted or normal), the age of the patient, and the patient's posture at the time of the test. Values are also affected if renin has been stimulated or if the patient has received an ACE inhibitor, like captopril.

Abnormal results

Increased PRA levels are seen in essential hypertension (uncommon), malignant hypertension, and kidney-based (renovascular) hypertension. Renin-producing renal tumors, while rare, can also cause elevated levels, as can **cirrhosis**, low blood volume due to hemorrhage, and diminished adrenal function (**Addison's disease**). Decreased renin levels may indicate increased blood volume due to a high-sodium diet, salt-retaining **steroids**, primary aldosteronism, licorice ingestion syndrome, or essential hypertension with low renin levels.

Resources

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Janis O. Flores

Plasmapheresis

Definition

Plasmapheresis is a blood purification procedure used to treat several autoimmune diseases. It is also known as therapeutic plasma exchange.

Purpose

In an autoimmune disease, the immune system attacks the body's own tissues. In many autoimmune diseases, the chief weapons of attack are antibodies, proteins that circulate in the bloodstream until they meet and bind with the target tissue. Once bound, they impair the functions of the target, and signal other immune components to respond as well.

Plasmapheresis is used to remove antibodies from the bloodstream, thereby preventing them from attacking their targets. It does not directly affect the immune system's ability to make more antibodies, and therefore may only offer temporary benefit. This procedure is most useful in acute, self-limited disorders such as **Guillain-Barré syndrome**, or when chronic disorders, such as **myasthenia gravis**, become more severe in symptoms. In these instances, a rapid improvement could save the patient's life. Neurologic diseases comprise 90% of the diseases that could profit from plasmapheresis.

Precautions

Patients with clotting disorders may not be suitable candidates for plasmapheresis.

Description

The basic procedure consists of removal of blood, separation of blood cells from plasma, and return of these blood cells to the body's circulation, diluted with fresh plasma or a substitute. Because of concerns over viral infection and allergic reaction, fresh plasma is not routinely used. Instead, the most common substitute is saline solution with sterilized human albumin protein. During the course of a single session, two to three liters of plasma is removed and replaced.

Plasmapheresis requires insertion of a venous catheter, either in a limb or central vein. Central veins allow higher flow rates and are more convenient for repeat procedures, but are more often the site of complications, especially bacterial infection.

When blood is outside the body, it must be treated to prevent it from clotting. While most of the anticlotting agent is removed from the blood during treatment, some is returned to the patient.

Three procedures are available:

- "Discontinuous flow centrifugation." Only one venous catheter line is required. Approximately 300 mL of blood is removed at a time and centrifuged to separate plasma from blood cells.
- "Continuous flow centrifugation." Two venous lines are used. This method requires slightly less blood volume to be out of the body at any one time.
- "Plasma filtration." Two venous lines are used. The pasma is filtered using standard hemodialysis equipment.

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KEY TERMS

Anaphylaxis—Also called anaphylactic shock, it is a severe allergic reaction to a foreign substance that the patient has had contact with. Penicillin is an example of a substance that causes severe allergic reactions for some people.

Antibody—Chemicals produced by the body to defend it against bacteria, viruses, or other cells foreign to the body (antigens). Each specific antibody reacts against a specific foreign body. Antibodies are also termed immunoglobulins.

Autoimmune—Autoimmune refers to the body's development of intolerance of the antigens on its own cells.

Hemodialysis—A method to take out unwanted parts of the blood. The patient's blood is run through a catheter and tubing into a machine called a dialyzer, which filters out the unwanted blood component.

Plasma—Plasma makes up 50% of human blood. It is a watery fluid that carries red cells, white cells, and platelets throughout the body.

It requires less than 100 mL of blood to be outside the body at one time.

A single plasmapheresis session may be effective, although it is more common to have several sessions per week over the course of two weeks or more.

Preparation

Good **nutrition** and plenty of rest make the procedure less stressful. The treating physician determines which of the patient's medications should be discontinued before the plasmapheresis session.

Aftercare

The patient may experience **dizziness**, **nausea**, **numbness**, **tingling**, or lightheadedness during or after the procedure. These effects usually pass quickly, allowing the patient to return to normal activities the same day.

Risks

Reinfusion (replacement) with human plasma may cause **anaphylaxis**, a life threatening allergic reaction. All procedures may cause a mild allergic reaction, leading to **fever**, chills, and rash. Bacterial infection is a risk, especially when a central venous catheter is used. Reaction to the citrate anticoagulant used may cause cramps and numbness, though these usually resolve on their own. Patients with impaired kidney function may require drug treatment for the effects of citrate metabolism.

Plasma contains clotting agents, chemicals that allow the blood to coagulate into a solid clot. Plasma exchange removes these. Bleeding complications are rare following plasmapheresis, but may require replacement of clotting factors.

Normal results

Plasmapheresis is an effective temporary treatment for:

- Guillain-Barré syndrome (an acute neurological disorder following a viral infection that produces progressive muscle weakness and paralysis)
- Myasthenia gravis (an autoimmune disease that causes muscle weakness)
- chronic inflammatory demyelinating polyneuropathy (a chronic neurological disorder caused by destruction of the myelin sheath of peripheral nerves, which produces symptoms similar to Guillain-Barré syndrome)
- thrombotic thrombocytopenic purpura (a rare blood disorder)
- Paraproteinemic peripheral neuropathies (a neurological disorder affecting the peripheral nerves)
- blood that is too thick (hyperviscosity)

Other conditions may respond to plasmapheresis as well. Beneficial effects are usually seen within several days. Effects commonly last up to several months, although longer-lasting changes are possible, presumably by inducing shifts in immune response.

Resources

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Richard Robinson

Plasmodium infection *see* **Malaria**

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Plastic, reconstructive, and cosmetic surgery

Definition

Plastic, reconstructive, and cosmetic surgery procedures are a variety of operations performed in order to repair or restore body parts to look normal, or to change a body part to look better. These types of surgery are highly specialized. They are characterized by careful preparation of a person's skin and tissues, by precise cutting and suturing techniques, and by care taken to minimize scarring. Recent advances in the development of miniaturized instruments, new materials for artificial limbs and body parts, and improved surgical techniques have expanded the range of plastic surgery procedures that can be performed.

Purpose

Although these three types of surgery share some common techniques and approaches, they have somewhat different emphases. Plastic surgery is usually performed to treat **birth defects** and to remove skin blemishes such as **warts**, **acne scars**, or **birthmarks**. Cosmetic surgery procedures are performed to make persons look younger or enhance their appearance in other ways. Reconstructive surgery is used to reattach body parts severed in combat or accidents, to perform skin grafts after severe **burns**, or to reconstruct parts of person's body that were missing at birth or removed by surgery. Reconstructive surgery is the oldest form of plastic surgery, having developed out of the need to treat wounded soldiers in wartime.

Demographics

The top 10 most commonly performed elective cosmetic surgeries in the United States include the following:

- liposuction
- breast augmentation
- eyelid surgery
- face lift
- tummy tuck
- collagen injections
- chemical peel
- laser skin resurfacing

A patient undergoing abdominoplasty. *(Photo Researchers, Inc.)*

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Top elective cosmetic surgeries and procedures in the United States

Surgical procedures	Nonsurgical procedures
Breast augmentation (311,957)	Botulinum toxin type A injection (2,557,068)
Liposuction (283,785)	Hyaluronic acid injection (1,313,038)
Cosmetic eyelid surgery (149,943)	Laser hair removal (1,280,031)
Nose reshaping (138,258)	Microdermabrasion (621,943)
Tummy tuck (127,923)	Chemical peel (529,285)
Breast reduction (113,511)	Laser skin resurfacing (512,318)
Breast lift (98,279)	Sclerotherapy (452,924)
Facelift (94,247)	IPL Laser treatment (452,210)
Forehead lift (30,789)	Noninvasive tightening (275,119)
Cosmetic ear surgery (21,817)	Laser treatment of leg veins (119,939)

SOURCE: The American Society for Aesthetic Plastic Surgery (ASAPS), 2009 ASAPS Statistics. Available online at: http://www.surgery.org/media/statistics (accessed June 9, 2010).

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- rhinoplasty
- forehead lift

There were approximately 31 million surgical procedures performed in the United States in 2006. Because many plastic and reconstructive surgical procedures are performed in private professional offices or as outpatient procedures, accurate statistics concerning the number of procedures performed are not available.

Description

Plastic surgery

Plastic surgery includes a number of different procedures that usually involve skin. Operations to remove excess fat from the abdomen ("tummy tucks"), dermabrasion to remove acne scars or **tattoos**, and reshaping the cartilage in children's ears (otoplasty) are common applications of plastic surgery.

Cosmetic surgery

Most cosmetic surgery is done on the face. It is intended either to correct disfigurement or to enhance a person's features. The most common cosmetic procedure for children is correction of a **cleft lip** or palate. In adults, the most common procedures are remodeling of the nose (**rhinoplasty**), removal of baggy skin around the eyelids (**blepharoplasty**), face lifts (rhytidectomy), or changing the size or shape of the breasts (mammoplasty). Although many people still think of cosmetic surgery as only for women, growing numbers of men are choosing to have face lifts and eyelid surgery, as well as hair transplants and "tummy tucks."

Reconstructive surgery

Reconstructive surgery is often performed on burn and accident victims. It may involve the rebuilding of severely fractured bones, as well as **skin grafting**. Reconstructive surgery includes such procedures as the reattachment of an amputated finger or toe, or implanting a prosthesis. Prostheses are artificial structures and materials that are used to replace missing limbs or teeth, or arthritic hip and knee joints.

Diagnosis/Preparation

General preparation

Preparation for nonemergency plastic or reconstructive surgery includes individual education, as well as medical considerations. Some operations, such as nose reshaping or the removal of warts, small birthmarks, and tattoos can be done as outpatient procedures under **local anesthesia**. Most plastic and reconstructive surgery, however, involves a stay in the hospital and **general anesthesia**.

Medical preparation

Preparation for plastic surgery includes the surgeon's detailed assessment of the parts of an individual's body that will be involved. Skin grafts require evaluating suitable areas of skin for the right color and texture to match the skin at the graft site. Face lifts and cosmetic surgery in the eye area require very close attention to the texture of the skin and the placement of surgical cuts (incisions).

Persons scheduled for plastic surgery under general anesthesia will be given a **physical examination**, blood and urine tests, and other tests to make sure that they do not have any previously undetected health problems or blood clotting disorders. The surgeon will check the list of prescription medications that the prospective patient may be taking to make sure that none of them will interfere with normal blood clotting or interact with the anesthetic.

Individuals are asked to avoid using **aspirin** or medications containing aspirin for a week to two weeks before surgery, because these drugs lengthen the time of blood clotting. Smokers are asked to stop **smoking** two weeks before surgery because smoking interferes with the healing process. For some types of plastic surgery, individuals may be asked to donate several units of their own blood before the procedure, in case a **transfusion** is needed during the operation.

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KEY TERMS

Blepharoplasty—Surgical reshaping of the eyelid.

Dermabrasion—A technique for removing the upper layers of skin with planing wheels powered by compressed air.

Face lift—Plastic surgery performed to remove sagging skin and wrinkles from an individual's face.

Liposuction—A surgical technique for removing fat from under the skin by vacuum suctioning.

Mammoplasty—Surgery performed to change the size or shape of breasts.

Rhinoplasty—Surgery performed to change the shape of the nose.

The prospective patient will be asked to sign a consent form before the operation.

Personal education

The surgeon will meet with the prospective patient before the operation is scheduled, in order to explain the procedure and to be sure that the individual is realistic about the expected results. This consideration is particularly important for people undergoing cosmetic surgery.

Medical considerations

Some people should not have plastic surgery because of certain medical risks. These groups include:

- persons recovering from a heart attack, severe infection (for example, pneumonia), or other serious illnesses
- people with infectious hepatitis or HIV infections
- individuals with cancer whose cancer might spread (metastasize)
- people who are extremely overweight (Individuals who are more than 30% overweight should not have liposuction.)
- persons with blood clotting disorders

Psychological

Plastic, cosmetic, and reconstructive surgeries have an important psychological dimension because of the high value placed on outward appearance in Western society. Many people who are born with visible deformities or disfigured by accidents later in life develop emotional problems related to social rejection. Other people work in fields such as acting, modeling, media journalism, and even politics, where their employment depends on how they look. Some people have unrealistic expectations of cosmetic surgery and think that it will solve all their life problems. It is important for anyone considering non-emergency plastic or cosmetic surgery to be realistic about its results. One type of psychiatric disorder, called **body dysmorphic disorder**, is characterized by an excessive preoccupation with imaginary or minor flaws in appearance. Persons with this disorder frequently seek unnecessary plastic surgery.

Aftercare

Medical

Medical aftercare following plastic surgery under general anesthesia includes bringing patients to a recovery room, monitoring their vital signs, and giving medications to relieve **pain** as necessary. Persons who have had fat removed from the abdomen may be kept in bed for as long as two weeks. Individuals who have had mammoplasties, **breast reconstruction**, and some types of facial surgery typically remain in the hospital for a week after the operation. Those who have had **liposuction** or eyelid surgery are usually sent home in a day or two.

People who have had outpatient procedures are usually given **antibiotics** to prevent infection and are sent home as soon as their vital signs are normal.

Psychological

Some individuals may need follow-up **psychotherapy** or counseling after plastic or reconstructive surgery. These people typically include children whose schooling and social relationships have been affected by birth defects, as well as persons of any age whose deformities or disfigurements were caused by trauma from accidents, war injuries, or violent crimes.

Risks

The risks associated with plastic, cosmetic, and reconstructive surgery include the postoperative complications that can occur with any surgical operation under anesthesia. These complications include wound infection, internal bleeding, **pneumonia**, and reactions to the anesthesia.

In addition to these general risks, some plastic, cosmetic, and reconstructive surgical procedures carry specific risks:

- formation of undesirable scar tissue
- development of persistent pain, redness, or swelling in the area of the surgery

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- infection inside the body related to inserting a prosthesis (These infections can result from contamination at the time of surgery or from bacteria migrating into the area around the prosthesis at a later time.)
- anemia or fat embolisms from liposuction
- rejection of skin grafts or tissue transplants
- loss of normal feeling or function in the area of the operation (For example, it is not unusual for women who have had mammoplasties to lose sensation in their nipples.)
- complications resulting from unforeseen technological problems (The best-known example of this problem was the discovery in the mid-1990s that breast implants made with silicone gel could leak into the recipient's body.)

Normal results

Normal results include an individual's recovery from the surgery with satisfactory results and without complications.

Morbidity and mortality rates

Morbidity and mortality rates vary with the complexity and severity of different procedures. Mortality is similar to that associated with all surgical procedures. Morbidity is influenced by personal expectations. From a surgical perspective, most morbidity is due to errors associated with anesthesia, procedure, pain medications, and after care. From an individual's perspective, morbidity involves the degree to which actual results compared to expected outcomes. The latter distinction is very subjective.

Alternatives

Alternatives to plastic, reconstructive, and cosmetic surgical procedures include using various products that may be affixed to articles of clothing or the surface of the body.

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ORGANIZATIONS

American Academy of Facial Plastic and Reconstructive Surgery, 310 S. Henry Street, Alexandria, VA, 22314, (703) 299-9291, http://www.aafprs.org.

American Board of Plastic Surgery, Seven Penn Center, Suite 400, 1635 Market Street, Philadelphia, PA, 19103-2204, (215) 587-9322, http://www.abplsurg.org.

American Society for Aesthetic Plastic Surgery, 11081 Winners Circle, Los Alamitos, CA, 90720, (888) 272-7711, http://www.surgery.org.

American Society of Plastic Surgeons, 444 E. Algonquin Road, Arlington Heights, IL, 60005, (847) 228-9900, http://www.plasticsurgery.org.

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Platelet aggregation test

Definition

Platelets are disk-shaped blood cells that are also called thrombocytes. They play a major role in the blood-clotting process. The platelet aggregation test is a measure of platelet function.

Purpose

The platelet aggregation test aids in the evaluation of bleeding disorders by measuring the rate and degree to which platelets form a clump (aggregate) after the addition of a chemical that stimulates clumping (aggregation).

Precautions

There are many medications that can affect the results of the platelet aggregation test. The patient should discontinue as many as possible beforehand. Some of the drugs that can decrease platelet aggregation include **aspirin**, some **antibiotics**, **beta blockers**, dextran (Macrodex), alcohol, heparin (Lipo-Hepin), **nonsteroidal anti-inflammatory drugs** (NSAIDs), **tricyclic antidepressants**, and warfarin (Coumadin).

Description

There are many factors involved in blood clotting (coagulation). One of the first steps in the process involves small cells in the bloodstream called platelets, which are produced in the bone marrow. Platelets gather at the site of an injury and clump together to form a plug, or aggregate, that helps to limit the loss of blood and promote healing.

Inherited bleeding disorders (e.g., **hemophilia** or von Willebrand's disease) and acquired bleeding problems that occur because of another disorder or a medication can affect the number of platelets and their level of function. When these problems are present, the result is a drop in platelet aggregation and a lengthened **bleeding time**.

The platelet aggregation test uses a machine called an aggregometer to measure the cloudiness (turbidity) of blood plasma. Several different substances called agonists are used in the test. These agonists include adenosine diphosphate, epinephrine, thrombin, collagen, and ristocetin. The addition of an agonist to a plasma sample causes the platelets to clump together, making the fluid more transparent. The aggregometer then measures the increased light transmission through the specimen.

KEY TERMS

Aggregation—The blood cell clumping process that is measured in the platelet aggregation test.

Agonist—A chemical that is added to the blood sample in the platelet aggregation test to stimulate the clumping process.

Hemophilia—An inherited bleeding disorder caused by a deficiency of factor VIII, one of a series of blood proteins essential for blood clotting.

Platelets—Small, round, disk-shaped blood cells that are involved in clot formation. The platelet aggregation test measures the clumping ability of platelets.

Turbidity—The cloudiness or lack of transparency of a solution.

von Willebrand's disease—An inherited lifelong bleeding disorder caused by an abnormal gene, similar to hemophilia. The gene defect results in a decreased blood concentration of a substance called von Willebrand's factor (vWF).

Preparation

The test requires a blood sample. The patient should either avoid food and drink altogether for eight hours before the test, or eat only nonfat foods. High levels of fatty substances in the blood can affect test results.

Because the use of aspirin and/or aspirin compounds can directly affect test results, the patient should avoid these medications for two weeks before the test. If the patient must take aspirin and the test cannot be postponed, the laboratory should be notified and asked to verify the presence of aspirin in the blood plasma. If the results are abnormal, aspirin use must be discontinued and the test repeated in two weeks.

Aftercare

Because the platelet aggregation test is ordered when some type of bleeding problem is suspected, the patient should be cautioned to watch the puncture site for signs of additional bleeding.

Risks

Risks for this test are minimal in normal individuals. Patients with bleeding disorders, however, may have prolonged bleeding from the puncture wound or the formation of a bruise (hematoma) under the skin where the blood was withdrawn.

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Normal results

The normal time for platelet aggregation varies somewhat depending on the laboratory, the temperature, the shape of the vial in which the test is performed, and the patient's response to different agonists. For example, the difference between the response to ristocetin and other products should be noted because ristocetin triggers aggregation through a different mechanism than other agonists.

Abnormal results

Prolonged platelet aggregation time can be found in such congenital disorders as hemophilia and von Willebrand's disease, as well as in some connective tissue disorders. Prolonged aggregation times can also occur in leukemia or myeloma; after recent heart/lung bypass or **kidney dialysis**; and after taking certain drugs.

Resources

BOOKS

Pagana, Kathleen Deska, and Timothy J. Pagana. *Mosby's Manual of Diagnostic and Laboratory Tests*. 4th ed. St. Louis: Mosby, 2009.

Janis O. Flores

Platelet count

Definition

A platelet count is a diagnostic test that determines the number of platelets in the patient's blood. Platelets, which are also called thrombocytes, are small disk–shaped blood cells produced in the bone marrow and involved in the process of blood clotting. There are normally between 150,000–450,000 platelets in each microliter of blood. Low platelet counts or abnormally shaped platelets are associated with bleeding disorders. High platelet counts sometimes indicate disorders of the bone marrow.

Purpose

The primary functions of a platelet count are to assist in the diagnosis of bleeding disorders and to monitor patients who are being treated for any disease involving bone marrow failure. Patients who have leukemia, **polycythemia vera**, or **aplastic anemia** are given periodic platelet count tests to monitor their health or to ascertain the bone marrow's response to treatment.

Description

Blood collection and storage

Platelet counts use a freshly–collected blood specimen to which a chemical called EDTA has been added to prevent clotting before the test begins. About 5 mL of blood are drawn from a vein in the patient's inner elbow region. Blood drawn from a vein helps to produce a more accurate count than blood drawn from a fingertip. Collection of the sample takes only a few minutes.

After collection, the mean platelet volume of EDTA–blood will increase over time. This increase is caused by a change in the shape of the platelets after removal from the body. The changing volume is relatively stable for a period of one to three hours after collection. This period is the best time to count the sample when using electronic instruments, because the platelets will be within a standard size range.

Counting methods

Platelets can be observed in a direct blood smear for approximate quantity and shape. A direct smear is made by placing a drop of blood onto a microscope slide and spreading it into a thin layer. After staining to make the various blood cells easier to see and distinguish, a laboratory technician views the smear through a light microscope. Accurate assessment of the number of platelets requires other methods of counting. There are three methods used to count platelets; hemacytometer, voltage–pulse counting, and electro–optical counting.

HEMACYTOMETER COUNTING. The microscopic method uses a phase contrast microscope to view blood on a hemacytometer slide. A sample of the diluted blood mixture is placed in a hemacytometer, which is an instrument with a grid etched into its surface to guide the counting. For a proper count, the platelets should be evenly distributed in the hemacytometer. Counts made from samples with platelet clumping are considered unreliable. Clumping can be caused by several factors, such as clotting before addition of the anticoagulant and allowing the blood to remain in contact with a capillary blood vessel during collection. Errors in platelet counting are more common when blood is collected from capillaries than from veins.

ELECTRONIC COUNTING. Electronic counting of platelets is the most common method. There are two

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types of electronic counting, voltage–pulse and electro–optical counting systems. In both systems, the collected blood is diluted and counted by passing the blood through an electronic counter. The instruments are set to count only particles within the proper size range for platelets. The upper and lower levels of the size range are called size exclusion limits. Any cells or material larger or smaller than the size exclusion limits will not be counted. Any object in the proper size range is counted, however, even if it is not a platelet. For these instruments to work properly, the sample must not contain other material that might mistakenly be counted as platelets. Electronic counting instruments sometimes produce artificially low platelet counts. If a platelet and another blood cell pass through the counter at the same time, the instrument will not count the larger cell because of the size exclusion limits, which will cause the instrument to accidentally miss the platelet. Clumps of platelets will not be counted because clumps exceed the upper size exclusion limit for platelets. In addition, if the patient has a high **white blood cell count**, electronic counting may yield an unusually low platelet count because white blood cells may filter out some of the platelets before the sample is counted. On the other hand, if the red blood cells in the sample have burst, their fragments will be falsely counted as platelets.

Preparation

There is no specific preparation required for this test.

Aftercare

Because platelet counts are sometimes ordered to diagnose or monitor bleeding disorders, patients with these disorders should be cautioned to watch the puncture site for signs of additional bleeding.

Risks

Risks for a platelet count test are minimal in normal individuals. Patients with bleeding disorders, however, may have prolonged bleeding from the puncture wound or the formation of a bruise (hematoma) under the skin where the blood was withdrawn.

Results

Normal results

The normal range for a platelet count is 150,000–450,000 platelets per microliter of blood.

KEY TERMS

Capillaries—The smallest of the blood vessels that bring oxygenated blood to tissues.

EDTA—A colorless compound used to keep blood samples from clotting before tests are run. Its chemical name is ethylenediaminetetraacetic acid.

Hemocytometer—An instrument used to count platelets or other blood cells.

Phase contrast microscope—A light microscope in which light is focused on the sample at an angle to produce a clearer image.

Thrombocyte—Another name for platelet.

Thrombocytopenia—An abnormally low platelet count.

Thrombocytosis—An abnormally high platelet count. It occurs in polycythemia vera and other disorders in which the bone marrow produces too many platelets.

Abnormal results

An abnormally low platelet level (**thrombocytopenia**) is a condition that may result from increased destruction of platelets, decreased production, or increased usage of platelets. In **idiopathic thrombocytopenic purpura** (ITP), platelets are destroyed at abnormally high rates. **Hypersplenism** is characterized by the collection (sequestration) of platelets in the spleen. Disseminated intravascular coagulation (DIC) is a condition in which **blood clots** occur within blood vessels in a number of tissues. All of these diseases produce reduced platelet counts.

Abnormally high platelet levels (**thrombocytosis**) may indicate either a benign reaction to an infection, surgery, or certain medications; or a disease like polycythemia vera, in which the bone marrow produces too many platelets too quickly.

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Platelet function disorders

Definition

Platelets are cells within the bloodstream that recognize and cling to damaged areas inside blood vessels. When they do this, the platelets trigger a series of chemical changes that result in the formation of a blood clot. There are certain hereditary disorders that affect platelet function and impair their ability to start the process of blood clot formation. One result is the possibility of excessive bleeding from minor injuries or from menstrual flow.

Description

Platelets are formed in the bone marrow—a spongy tissue located inside the long bones of the body—as fragments of a large precursor cell (a megakaryocyte). These fragments circulate in the bloodstream and form the first line of defense against blood escaping from injured blood vessels.

Damaged blood vessels release a chemical signal that increases the stickiness of platelets in the area of the injury. The sticky platelets adhere to the damaged area and gradually form a platelet plug. At the same time, the platelets release a series of chemical signals that prompt other factors in the blood to reinforce the platelet plug. Between the platelet and its reinforcements, a sturdy clot is created that acts as a patch while the damaged area heals.

There are several hereditary disorders characterized by some impairment of the platelet's action. Examples include von Willebrand disease, Glanzmann's thrombasthenia, and Bernard–Soulier syndrome. Vulnerable aspects of platelet function include errors in the production of the platelets themselves or errors in the formation, storage, or release of their chemical signals. These defects can prevent platelets from responding to injuries or from prompting the action of other factors involved in clot formation.

Causes and symptoms

Platelet function disorders can be inherited, but they may also occur as a symptom of acquired diseases or as a side effect of certain drugs, including **aspirin** and **nonsteroidal anti-inflammatory drugs** (NSAIDS). The most common inherited bleeding disorder is von Willebrand disease, a relatively minor condition, which is thought to affect as many as one in every 1,000 people. There are several variants of this disorder.

KEY TERMS

Anemia—A condition in which inadequate quantities of hemoglobin and red blood cells are produced.

Bone marrow—A spongy tissue located within the body's flat bones, including the hip and breast bones and the skull. Marrow contains stem cells, the precursors to platelets and red and white blood cells.

Hemoglobin—The substance inside red blood cells that enables them to carry oxygen.

Megakaryocyte—A large bone marrow cell with a lobed nucleus that is the precursor cell of blood platelets.

Platelets—Fragments of a large precursor cell (a megakaryocyte) found in the bone marrow. These fragments adhere to areas of blood vessel damage and release chemical signals that direct the formation of a blood clot.

Symptoms of platelet function disorders vary in severity depending on the etiology of the condition and can include bleeding from the nose, gums, vagina, or anus; pinpoint **bruises** and purplish patches on the skin; and abnormally heavy menstrual bleeding.

Diagnosis

In diagnosing platelet function disorders, specific tests are needed to determine whether the problem is caused by low numbers of platelets or impaired platelet function. A blood smear, a **platelet count**, and **bleeding time** are common screening tests. If these tests confirm that the symptoms are due to impaired platelet function, further tests are done—such as platelet aggregation or an analysis of the platelet proteins—that pinpoint the exact nature of the defect.

Treatment

Treatment is intended to prevent bleeding and stop it quickly when it occurs. For example, patients are advised to be careful when they brush their teeth to reduce damage to the gums. They are also warned against taking medications that interfere with platelet function. Some patients may require iron and folate supplements to counteract potential anemia. Some patients diagnosed with immune or idiopathic platelet disorders can be treated with **corticosteroids**. Platelet

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transfusions may be necessary to prevent life–threatening hemorrhaging in some cases. Hormone therapy is useful in treating heavy menstrual bleeding. Von Willebrand's disease can be treated with desmopressin (DDAVP, Stimate).

Prognosis

Outcome depends on the specific disorder and the severity of its symptoms. Platelet function disorders range from life–threatening conditions to easily treated or little–noticed problems.

Prevention

Inherited platelet function disorders cannot be prevented except by **genetic counseling**; however, some acquired function disorders may be guarded against by avoiding substances that trigger the disorder.

Resources

PERIODICALS

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Pleural biopsy

Definition

The pleura is the membrane that lines the lungs and chest cavity. A pleural biopsy is the removal of pleural tissue for examination.

Purpose

Pleural biopsy is done to differentiate between benign and malignant disease, to diagnose viral, fungal, or parasitic diseases, and to identify a condition called collagen vascular disease of the pleura. It is also ordered when a **chest x ray** indicates a pleural-based tumor, reaction, or thickening of the lining.

Precautions

Because pleural biopsy is an invasive procedure, it is not recommended for patients with severe bleeding disorders.

Description

Pleural biopsy is usually ordered when pleural fluid obtained by another procedure called **thoracentesis** (aspiration of pleural fluid) suggests infection, signs of **cancer**, or **tuberculosis**. Pleural biopsies are 85–90% accurate in diagnosing these diseases.

The procedure most often performed for pleural biopsy is called a percutaneous (passage through the skin by needle puncture) needle biopsy. The procedure takes 30–45 minutes, although the biopsy needle itself remains in the pleura for less than one minute. This type of biopsy is usually performed by a physician at bedside, if the patient is hospitalized, or in the doctor's office under local anesthetic.

The actual procedure begins with the patient in a sitting position, shoulders and arms elevated and supported. The skin overlying the biopsy site is anesthetized and a small incision is made to allow insertion of the biopsy needle. This needle is inserted with a cannula (a plastic or metal tube) until fluid is removed. Then the inner needle is removed and a trocar (an instrument for withdrawing fluid from a cavity) is inserted to obtain the actual biopsy specimen. As many as three separate specimens are taken from different sites during the procedure. These specimens are then placed into a fixative solution and sent to the laboratory for tissue (histologic) examination.

Preparation

Preparations for this procedure vary, depending on the type of procedure requested. Pleural biopsy can be performed in several ways: percutaneous needle biopsy (described above), by **thoracoscopy** (insertion of a visual device called a laparoscope into the pleural space for inspection), or by open pleural biopsy, which requires **general anesthesia**.

Aftercare

Potential complications of this procedure include bleeding or injury to the lung, or a condition called **pneumothorax**, in which air enters the pleural cavity (the space between the two layers of pleura lining the lungs and the chest wall). Because of these possibilities, the patient is to report any **shortness of breath**, and to note any signs of bleeding, decreased blood pressure, or increased pulse rate.

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Risks

Risks for this procedure include respiratory distress on the side of the biopsy, as well as bleeding, possible shoulder **pain**, pneumothorax (immediate) or **pneumonia** (delayed).

Normal results

Normal findings indicate no evidence of any pathologic or disease conditions.

Abnormal results

Abnormal findings include tumors called neoplasms (any new or abnormal growth) that can be either benign or malignant. Pleural tumors are divided into two classifications: primary (**mesothelioma**), or metastatic (arising from cancer sites elsewhere in the body). These tumors are often associated with an accumulation of fluid between the pleural layers called a **pleural effusion**, which itself may be caused by pneumonia, **heart failure**, cancer, or blood clot in the lungs (**pulmonary embolism**).

Other causes of abnormal findings include viral, fungal, or parasitic infections, and tuberculosis.

Resources

BOOKS

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Pleural effusion

Definition

Pleural effusion occurs when too much fluid collects in the pleural space (the space between the two layers of the pleura). It is commonly known as "water on the lungs." It is characterized by **shortness of breath**, chest **pain**, gastric discomfort (**dyspepsia**), and **cough**.

Description

There are two thin membranes in the chest, one (the visceral pleura) lining the lungs, and the other (the parietal pleura) covering the inside of the chest wall. Normally, small blood vessels in the pleural linings produce a small amount of fluid that lubricates the opposed pleural membranes so that they can glide smoothly against one another during breathing movements. Any extra fluid is taken up by blood and lymph vessels, maintaining a balance. When either too much fluid forms or something prevents its removal, the result is an excess of pleural fluid–an effusion. The most common causes are disease of the heart or lungs, and inflammation or infection of the pleura.

Pleural effusion itself is not a disease as much as a result of many different diseases. For this reason, there is no "typical" patient in terms of age, sex, or other characteristics. Instead, anyone who develops one of the many conditions that can produce an effusion may be affected.

There are two types of pleural effusion: the transudate and the exudate. This is a very important point because the two types of fluid are very different, and which type is present points to what sort of disease is likely to have produced the effusion. It also can suggest the best approach to treatment.

Transudates

A transudate is a clear fluid, similar to blood serum, that forms not because the pleural surfaces themselves are diseased, but because the forces that normally produce and remove pleural fluid at the same rate are out of balance. When the heart fails, pressure in the small blood vessels that remove pleural fluid is increased and fluid "backs up" in the pleural space, forming an effusion. Or, if too little protein is present in the blood, the vessels are less able to hold the fluid part of blood within them and it leaks out into the pleural space. This can result from disease of the liver or kidneys, or from **malnutrition**.

Exudates

An exudate—which often is a cloudy fluid, containing cells and much protein—results from disease of the pleura itself. The causes are many and varied. Among the most common are infections such as bacterial **pneumonia** and **tuberculosis**; **blood clots** in the lungs; and connective tissue diseases, such as **rheumatoid arthritis**. **Cancer** and disease in organs such as the pancreas also may give rise to an exudative pleural effusion.

Special types of pleural effusion

Some of the pleural disorders that produce an exudate also cause bleeding into the pleural space. If the effusion contains half or more of the number of red blood cells present in the blood itself, it is called hemothorax. When a pleural effusion has a milky

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appearance and contains a large amount of fat, it is called chylothorax. Lymph fluid that drains from tissues throughout the body into small lymph vessels finally collects in a large duct (the thoracic duct) running through the chest to empty into a major vein. When this fluid, or chyle, leaks out of the duct into the pleural space, chylothorax is the result. Cancer in the chest is a common cause.

Causes and symptoms

Causes of transudative pleural effusion

Among the most important specific causes of a transudative pleural effusion are:

- Congestive heart failure. This causes pleural effusions in about 40% of patients and is often present on both sides of the chest. Heart failure is the most common cause of bilateral (two-sided) effusion. When only one side is affected it usually is the right (because patients usually lie on their right side).
- Pericarditis. This is an inflammation of the pericardium, the membrane covering the heart.
- Too much fluid in the body tissues, which spills over into the pleural space. This is seen in some forms of kidney disease; when patients have bowel disease and absorb too little of what they eat; and when an excessive amount of fluid is given intravenously.
- Liver disease. About 5% of patients with a chronic scarring disease of the liver called cirrhosis develop pleural effusion.

Causes of exudative pleural effusions

A wide range of conditions may be the cause of an exudative pleural effusion:

- Pleural tumors account for up to 40% of one-sided pleural effusions. They may arise in the pleura itself (mesothelioma), or from other sites, notably the lung.
- Tuberculosis in the lungs may produce a long-lasting exudative pleural effusion.
- Pneumonia affects about three million persons each year, and four of every ten patients will develop pleural effusion. If effective treatment is not provided, an extensive effusion can form that is very difficult to treat.
- Patients with any of a wide range of infections by a virus, fungus, or parasite that involve the lungs may have pleural effusion.
- Up to half of all patients who develop blood clots in their lungs (pulmonary embolism) will have pleural effusion, and this sometimes is the only sign of embolism.
- Connective tissue diseases, including rheumatoid arthritis, lupus, and Sjögren's syndrome may be complicated by pleural effusion.
- Patients with disease of the liver or pancreas may have an exudative effusion, and the same is true for any patient who undergoes extensive abdominal surgery. About 30% of patients who undergo heart surgery will develop an effusion.
- Injury to the chest may produce pleural effusion in the form of either hemothorax or chylothorax.

Symptoms

The key symptom of a pleural effusion is shortness of breath. Fluid filling the pleural space makes it hard for the lungs to fully expand, causing the patient to take many breaths so as to get enough oxygen. When the parietal pleura is irritated, the patient may have mild pain that quickly passes or, sometimes, a sharp, stabbing pleuritic type of pain. Some patients will have a dry cough. Occasionally a patient will have no symptoms at all. This is more likely when the effusion results from recent abdominal surgery, cancer, or tuberculosis. Tapping on the chest will show that the usual crisp sounds have become dull, and on listening with a stethoscope the normal breath sounds are muted. If the pleura is inflamed, there may be a scratchy sound called a "pleural friction rub."

Diagnosis

When pleural effusion is suspected, the best way to confirm it is to take chest x rays, both straight-on and from the side. The fluid itself can be seen at the bottom of the lung or lungs, hiding the normal lung structure. If **heart failure** is present, the x-ray shadow of the heart will be enlarged. An ultrasound scan may disclose a small effusion that caused no abnormal findings during chest examination. A computed tomography scan is very helpful if the lungs themselves are diseased.

In order to learn what has caused the effusion, a needle or catheter is often used to obtain a fluid sample, which is examined for cells and its chemical makeup. This procedure, called a **thoracentesis**, is the way to determine whether an effusion is a transudate or exudate, giving a clue as to the underlying cause. In some cases–for instance when cancer or bacterial infection is present–the specific cause can be determined and the correct treatment planned. Culturing a fluid sample can identify the bacteria that cause tuberculosis or other forms of pleural infection. The next diagnostic step is to take a tissue sample, or **pleural biopsy**, and examine it under a microscope. If the effusion is caused by lung disease, placing a

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KEY TERMS

Culture—A test that exposes a sample of body fluid or tissue to special material to see whether bacteria or another type of microorganism is present.

Dyspepsia—A vague feeling of being too full and having heartburn, bloating, and nausea. Usually felt after eating.

Exudate—The type of pleural effusion that results from inflammation or other disease of the pleura itself. It features cloudy fluid containing cells and proteins.

Pleura or pleurae—A delicate membrane that encloses the lungs. The pleura is divided into two areas separated by fluid–the visceral pleura, which covers the lungs, and the parietal pleura, which lines the chest wall and covers the diaphragm.

Pleural cavity—The area of the thorax that contains the lungs.

Pleural space—The potential area between the visceral and parietal layers of the pleurae.

Pneumonia—An acute inflammation of the lungs, usually caused by bacterial infection.

Sclerosis—The process by which an irritating material is placed in the pleural space in order to inflame the pleural membranes and cause them to stick together, eliminating the pleural space and recurrent effusions.

Thoracentesis—Placing a needle, tube, or catheter in the pleural space to remove the fluid of pleural effusion. Used for both diagnosis and treatment.

Transudate—The type of pleural effusion seen with heart failure or other disorders of the circulation. It features clear fluid containing few cells and little protein.

viewing tube (bronchoscope) through the large air passages will allow the examiner to see the abnormal appearance of the lungs.

Treatment

The best way to clear up a pleural effusion is to direct treatment at what is causing it, rather than treating the effusion itself. If heart failure is reversed or a lung infection is cured by **antibiotics**, the effusion will usually resolve. However, if the cause is not known, even after extensive tests, or no effective treatment is at hand, the fluid can be drained away by placing a large-bore needle or catheter into the pleural space, just as in diagnostic thoracentesis. If necessary, this can be repeated as often as is needed to control the amount of fluid in the pleural space. If large effusions continue to recur, a drug or material that irritates the pleural membranes can be injected to deliberately inflame them and cause them to adhere close together–a process called sclerosis. This will prevent further effusion by eliminating the pleural space. In the most severe cases, open surgery with removal of a rib may be necessary to drain all the fluid and close the pleural space.

Prognosis

When the cause of pleural effusion can be determined and effectively treated, the effusion itself will reliably clear up and should not recur. In many other cases, sclerosis will prevent sizable effusions from recurring. Whenever a large effusion causes a patient to be short of breath, thoracentesis will make breathing easier, and it may be repeated if necessary. To a great extent, the outlook for patients with pleural effusion depends on the primary cause of effusion and whether it can be eliminated. Some forms of pleural effusion, such as that seen after abdominal surgery, are only temporary and will clear without specific treatment. If heart failure can be controlled, the patient will remain free of pleural effusion. If, on the other hand, effusion is caused by cancer that cannot be controlled, other effects of the disease probably will become more important.

Prevention

Because pleural effusion is a secondary effect of many different conditions, the key to preventing it is to promptly diagnose the primary disease and provide effective treatment. Timely treatment of infections such as tuberculosis and pneumonia will prevent many effusions. When effusion occurs as a drug side-effect, withdrawing the drug or using a different one may solve the problem. On rare occasions, an effusion occurs because fluid meant for a vein is mistakenly injected into the pleural space. This can be prevented by making sure that proper technique is used.

ORGANIZATIONS

American Lung Association, 1301 Pennsylvania Ave. NW, Suite 800, Washington, DC, 20001, (202) 758-3355, (202) 452-1805, (800) 548-8252, info@lungusa.org, http://www.lungusa.org.

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National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

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Pleural fluid analysis *see* **Thoracentesis**

Pleurisy

Definition

Pleurisy is an inflammation of the membrane that surrounds and protects the lungs (the pleura). Inflammation occurs when an infection or damaging agent irritates the pleural surface. As a consequence, sharp chest pains are the primary symptom of pleurisy.

Demographics

Pleurisy may affect any individual but a higher incidence is observed in those with an underlying lung condition such as a lung tumor or **abscess**, **tuberculosis**, or **pneumonia**.

Description

Pleurisy, also called pleuritis, is a condition that generally stems from an existing respiratory infection, disease, or injury. In people who have otherwise good health, respiratory infections or pneumonia are the main causes of pleurisy. This condition used to be more common, but with the advent of **antibiotics** and modern disease therapies, pleurisy has become less prevalent.

The pleura is a double–layered structure made up of an inner membrane, which surrounds the lungs, and an outer membrane, which lines the chest cavity. The pleural membranes are very thin, close together, and have a fluid coating in the narrow space between them. This liquid acts as a lubricant, so that when the lungs inflate and deflate during breathing, the pleural surfaces can easily glide over one another.

Pleurisy occurs when the pleural surfaces rub against one another, due to irritation and inflammation. Infection within the pleural space is the most common irritant, although the abnormal presence of air, blood, or cells can also initiate pleurisy. These disturbances all act to displace the normal pleural fluid, which forces the membranes to rub, rather than glide, against one another. This rubbing irritates nerve endings in the outer membrane and causes **pain**. Pleurisy also causes a chest noise that ranges from a faint squeak to a loud creak. This characteristic sound is called a "friction rub."

Pleurisy cases are classified either as having **pleural effusion** or as being "dry." Pleural effusion is more common and refers to an accumulation of fluid within the pleural space; dry pleurisy is inflammation without fluid build–up. Less pain occurs with pleural effusion because the fluid forces the membrane surfaces apart. However, pleural effusion causes additional complications because it places pressure on the lungs. This leads to respiratory distress and possible lung collapse.

Causes and symptoms

A variety of conditions can give rise to pleurisy. The following list represents the most common sources of pleural inflammation.

- infections, including pneumonia, tuberculosis, and other bacterial or viral respiratory infections
- immune disorders, including systemic lupus erythematosus, rheumatoid arthritis, and sarcoidosis
- diseases, including cancer, pancreatitis, liver cirrhosis, and heart or kidney failure
- injury, from a rib fracture, collapsed lung, esophagus rupture, blood clot, or material such as asbestos
- drug reactions, from certain drugs used to treat tuberculosis (isoniazid), cancer (methotrexate, procarbazine), or the immune disorders mentioned above (hydralazine, procainamide, phenytoin, quinidine)

Symptomatic pain

The hallmark symptom of pleurisy is sudden, intense chest pain that is usually located over the area of inflammation. Although the pain can be constant, it is usually most severe when the lungs move during breathing, coughing, sneezing, or even talking. The pain is usually described as shooting or stabbing, but in minor cases it resembles a mild cramp. When pleurisy occurs in certain locations, such as near the diaphragm, the pain may be felt in other areas such as the neck, shoulder, or abdomen (referred pain). Another indication of pleurisy is that holding one's breath or exerting pressure against the chest causes pain relief.

Breathing difficulties

Pleurisy is also characterized by certain respiratory symptoms. In response to the pain, pleurisy

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patients commonly have a rapid, shallow breathing pattern. Pleural effusion can also cause **shortness of breath**, as excess fluid makes expanding the lungs difficult. If severe breathing difficulties persist, patients may experience a blue colored complexion (**cyanosis**).

Additional symptoms of pleurisy are specific to the illness that triggers the condition. Thus, if infection is the cause, then chills, **fever**, and **fatigue** will be likely pleurisy symptoms.

Diagnosis

The distinctive pain of pleurisy is normally the first clue physicians use for diagnosis. Doctors usually feel the chest to find the most painful area, which is the likely site of inflammation. A stethoscope is also used to listen for abnormal chest sounds as the patient breathes. If the doctor hears the characteristic friction rub, the diagnosis of pleurisy can be confirmed. Sometimes, a friction rub is masked by the presence of pleural effusion and further examination is needed for an accurate diagnosis.

Identifying the actual illness that causes pleurisy is more difficult. To make this diagnosis, doctors must evaluate the patient's history, additional symptoms, and laboratory test results. A **chest x ray** may also be taken to look for signs of accumulated fluid and other abnormalities. Possible causes, such as pneumonia, fractured ribs, esophagus rupture, and lung tumors may be detected on an x ray. Computed tomography scan (CT scan) and ultrasound scans are more powerful diagnostic tools used to visualize the chest cavity. Images from these techniques more clearly pinpoint the location of excess fluid or other suspected problems.

The most helpful information in diagnosing the cause of pleurisy is a fluid analysis. Once the doctor knows the precise location of fluid accumulation, a sample is removed using a procedure called **thoracentesis**. In this technique, a fine needle is inserted into the chest to reach the pleural space and extract fluid. The fluid's appearance and composition is thoroughly examined to help doctors understand how the fluid was produced. Several laboratory tests are performed to analyze the chemical components of the fluid. These tests also determine whether infection–causing bacteria or viruses are present. In addition, cells within the fluid are identified and counted. Cancerous cells can also be detected to learn whether the pleurisy is caused by a malignancy.

In certain instances, such as dry pleurisy, or when a fluid analysis is not informative, a biopsy of the pleura may be needed for microscopic analysis. A sample of pleural tissue can be obtained several ways: with a biopsy needle, by making a small incision in the chest wall, or by using a thoracoscope (a video–assisted instrument for viewing the pleural space and collecting samples).

Treatment

Pain management

The pain of pleurisy is usually treated with analgesic and anti–inflammatory drugs, such as **acetaminophen**, ibuprofen, and indomethacin. People with pleurisy may also receive relief from lying on the painful side. Sometimes, a painful **cough** will be controlled with codeine–based cough syrups. However, as the pain eases, a person with pleurisy should try to breathe deeply and cough to clear any congestion; otherwise pneumonia may occur. Rest is also important to aid in the recovery process.

Treating the source

The treatment used to cure pleurisy is ultimately defined by the underlying cause. Thus, pleurisy from a bacterial infection can be successfully treated with antibiotics, while no treatment is given for viral infections that must run their course. Specific therapies designed for more chronic illnesses can often cause pleurisy to subside. For example, tuberculosis pleurisy is treated with standard anti–tuberculosis drugs. With some illnesses, excess fluid continues to accumulate and causes severe respiratory distress. In these individuals, the fluid may be removed by thoracentesis, or the doctor may insert a chest tube to drain large amounts. If left untreated, a more serious infection may develop within the fluid, called **empyema**.

Alternative treatment

Alternative treatments can be used in conjunction with conventional treatment to help heal pleurisy. **Acupuncture** and botanical medicines are alternative approaches for alleviating pleural pain and breathing problems. An herbal remedy commonly recommended is pleurisy root (*Asclepias tuberosa*), so named because of its use by early American settlers who learned of this medicinal plant from Native Americans. Pleurisy root helps to ease pain, inflammation, and breathing difficulties brought on by pleurisy. This herb is often used in conjunction with mullein (*Verbascum thapsus*) or elecampane

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KEY TERMS

Effusion—The accumulation of fluid within a cavity, such as the pleural space.

Empyema—An infection that causes pus to accumulate in the pleural space. The pus may cause a tear in the pleural membrane, which allows the infection to spread to other areas in the body. Intravenous antibiotics are often given to control the infection.

Inflammation—An accumulation of fluid and cells within tissue that is often caused by infection and the immune response that occurs as a result.

Pneumonia—A condition caused by bacterial or viral infection that is characterized by inflammation of the lungs and fluid within the air passages. Pneumonia is often an underlying cause of pleurisy.

Referred pain—The presence of pain in an area other than where it originates. In some pleurisy cases, referred pain occurs in the neck, shoulder, or abdomen.

(*Inula helenium*), which serve as **expectorants** to clear excess mucus from the lungs. In addition, there are many other respiratory herbs that are used as expectorants or for other actions on the respiratory system. Herbs thought to combat infection, such as **echinacea** (*Echinacea* spp.) are also included in herbal pleurisy remedies. Anitviral herbs, such as *Lomatium dissectum* and *Ligusticum porteri*, can be used if the pleurisy is of viral origin. **Traditional Chinese medicine** uses the herb ephedra (*Ephedra sinica*), which acts to open air passages and alleviate respiratory difficulties in pleurisy patients. Dietary recommendations include eating fresh fruits and vegetables, adequate protein, and good quality fats (**omega–3 fatty acids** are anti–inflammatory and are found in fish and flax oil). Taking certain **nutritional supplements**, especially large doses of vitamin C, may also provide health benefits to people with pleurisy. Contrast **hydrotherapy** applied to the chest and back, along with compresses (cloths soaked in an herbal solution) or poultices (crushed herbs applied directly to the skin) of respiratory herbs, can assist in the healing process. Homeopathic treatment, guided by a trained practitioner, can be effective in resolving pleurisy. Alternative treatments should be used with care, as the benefits of many such treatments have not been confirmed by scientific research.

Prognosis

Prompt diagnosis, followed by appropriate treatment, ensures a good recovery for most pleurisy patients. Generally speaking, the prognosis for pleurisy is linked to the seriousness of its cause. Therefore, the outcome of pleurisy caused by a disease such as **cancer** will vary depending on the type and location of the tumor.

Prevention

Preventing pleurisy is often a matter of providing early medical attention to conditions that can cause pleural inflammation. Along this line, appropriate antibiotic treatment of bacterial respiratory infections may successfully prevent some cases of pleurisy. Maintaining a healthy lifestyle and avoiding exposure to harmful substances (for example, asbestos) are more general preventative measures.

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Miller, Max. *The Quit Smoking Companion: The Daily Guide to Freedom from Cigarettes*. Charleston, SC: BookSurge Publishing, 2009.

Petty, Thomas, and James S. Seebass, editors. *Pulmonary Disorders of the Elderly: Diagnosis, Prevention, and Treatment*. Philadelphia, PA: American College of Physicians, 2007.

ORGANIZATIONS

American Lung Association (ALA), 1301 Pennsylvania Ave. NW , Washington, DC, 20004, (202) 785 3355 , (202) 452 1805, http://www.lungusa.org.

American Thoracic Society (ATS), 61 Broadway, 6th Floor, New York, NY, 10000, (212) 315–8600, http://www.thoracic.org.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Rd., Atlanta, GA, 30333, (404) 639–3311, (800) 311–3435, http://www.cdc.gov.

National Heart Lung and Blood Institute (NHLBI), PO Box 30105, Bethesda, MD, 20824–0105, (301) 592–8573. TTY: (240) 629–3255, http://www.nhlbi.nih.gov.

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Pleuritis *see* **Pleurisy**

Plumbism *see* **Lead poisoning**

PMDD *see* **Premenstrual dysphoric disorder**

PMS *see* **Premenstrual syndrome**

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Pneumococcal pneumonia

Definition

Pneumococcal **pneumonia** is a common but serious infection and inflammation of the lungs. It is caused by the bacterium *Streptococcus pneumoniae*.

Description

The gram-positive, spherical bacteria, *Streptococcus pneumoniae*, is the cause of many human diseases, including pneumonia. Although the bacteria can normally be found in the nose and throat of healthy individuals, it can grow and cause infection when the immune system is weakened. Infection usually begins with the upper respiratory tract and then travels into the lungs. Pneumonia occurs when the bacteria find their way deep into the lungs, to the area called the alveoli, or air sacs. This is the functional part of the lungs where oxygen is absorbed into the blood. Once in the alveoli, *Streptococcus pneumoniae* begin to grow and multiply. White blood cells and immune proteins from the blood also accumulate at the site of infection in the alveoli. As the alveoli fill with these substances and fluid, they can no longer function in the exchange of oxygen. This fluid filling of the lungs is how pneumonia is defined.

Those people most at risk of developing pneumococcal pneumonia have a weakened immune system. This includes the elderly, infants, **cancer** patients, **AIDS** patients, post-operative patients, alcoholics, and those with diabetes. Pneumococcal pneumonia is a disease that has a high rate of hospital transmission, putting hospital patients at greater risk. Prior lung infections also makes someone more likely to develop pneumococcal pneumonia. The disease can be most severe in patients who have had their spleen removed. It is the spleen that is responsible for removing the bacteria from the blood. Cases of pneumonia, which is spread by close contact, seem to occur most often between November through April. If not treated, the disease can spread, causing continually decreasing lung function, heart problems, and arthritis.

Causes and symptoms

Symptoms of bacterial pneumonia include a **cough**, sputum (mucus) production that may be pus-like or bloody, shaking and chills, **fever**, and chest **pain**. Symptoms often have an abrupt beginning and occur after an upper respiratory infection such as a cold. Symptoms may differ somewhat in the elderly, with minimal cough, no sputum and no fever, but rather tiredness and confusion leading to **hypothermia** and **shock**.

Diagnosis

The presence of symptoms and a physical exam that reveals abnormal lung sounds usually suggest the presence of pneumonia. Diagnosis is typically made from an x ray of the lungs, which indicates the accumulation of fluid. Additional tests that may be done include a **complete blood count**, a sputum sample for microscopic examination and culture for *Streptococcus pneumoniae*, and possibly blood cultures.

Treatment

Depending on the severity of the disease, **antibiotics** are given either at home or in the hospital. Historically, the treatment for pneumococcal pneumonia has been penicillin. An increasing number of cases of pneumococcal pneumonia have become partially or completely resistant to penicillin, making it less effective in treating this disease. Other effective antibiotics include amoxicillin and erythromycin. If these antibiotics are not effective, vancomycin or cephalosporin may alternatively be used.

Symptoms associated with pneumococcal pneumonia can also be treated. For instance, fever can be treated with **aspirin** or **acetaminophen**. Supplemental oxygen and intravenous fluids may help. Patients are advised to get plenty of rest and take increased amounts of fluids. Coughing should be promoted because it helps to clear the lungs of fluid.

Alternative treatment

Being a serious, sometimes fatal disease, pneumococcal pneumonia is best treated as soon as possible with antibiotics. However, there are alternative treatments that both support this conventional treatment and prevent recurrences. Maintaining a healthy immune system is important. One way to do this is by taking the herb, **echinacea** (*Echinacea* spp.). Getting plenty of rest and reducing **stress** can help the body heal. Some practitioners feel that mucus-producing foods (including dairy products, eggs, gluten-rich grains such as wheat, oats, rye, as well as sugar) can contribute to the lung congestion that accompanies pneumonia. Decreasing these foods and increasing the amount of fresh fruits and vegetables may help to decrease lung congestion. Adequate protein in the diet is also essential for the body to produce antibodies. Contrast and constitutional **hydrotherapy** can be very helpful in treating cases of pneumonia. Other alternative therapies, including **acupuncture**, Chinese herbal

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KEY TERMS

Acetaminophen—A drug used for pain relief as well as to decrease fever. A common trade name for the drug is Tylenol.

Aspirin—A commonly used drug for pain relief and to decrease fever.

Bronchi—Two main branches of the trachea that go into the lungs. This then further divides into the bronchioles and alveoli.

Sputum—A substance that comes up from the throat when coughing or clearing the throat. It is important since it contains materials from the lungs.

medicine, and homeopathy, can be very useful during the recovery phase, helping the body to rebuild after the illness and contributing to the prevention of recurrences.

Prognosis

Simple, uncomplicated cases of pneumococcal pneumonia will begin to respond to antibiotics in 48 to72 hours. Full recovery from pneumonia, however, is greatly dependent on the age and overall health of the individual. Normally, healthy and younger patients can recover in only a few days, while the elderly or otherwise weakened individuals may not recover for several weeks. Complications may develop which give a poorer prognosis. Even when promptly and properly diagnosed, such weakened patients may die of their pneumonia.

Prevention

Vaccination

Recently, a **vaccination** has become available for the prevention of pneumococcal pneumonia. This vaccination is generally recommended for people with a high likelihood of developing pneumococcal infection or for those in whom a serious complication of infection is likely to develop. This would include persons over the age of 65, as well as those with:

- chronic pulmonary disease
- advanced cardiovascular disease
- diabetes mellitus
- alcoholism
- cirrhosis
- chronic kidney disease
- spleen dysfunction, or removal of spleen
- immunosuppression (cancer, organ transplant or AIDS)
- sickle cell anemia

Unfortunately, those people for whom the vaccination is most recommended are also those who are least likely to respond favorably to a vaccination. Therefore, the overall effectiveness of this vaccine remains questionable.

Antibiotics

The use of oral penicillin to prevent infection may be recommended for some patients at high risk, such as children with **sickle cell disease** and those with a spleen removed. This treatment, however, must be weighed with the increased likelihood of developing penicillin-resistant infections.

ORGANIZATIONS

American Lung Association, 1301 Pennsylvania Ave. NW, Suite 800, Washington, DC, 20001, (202) 758-3355, (202) 452-1805, (800) 548-8252, info@lungusa.org, http://www.lungusa.org.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

Cindy L. A. Jones, PhD

Pneumocystis pneumonia

Definition

Pneumocystis **pneumonia** is a lung infection that occurs primarily in people with weakened immune systems–especially people who are HIV-positive. The disease agent is an organism whose biological classification is still uncertain. *Pneumocystis carinii* was originally thought to be a one-celled organism (a protozoan), but more recent research suggests that it is a fungus. Although its life cycle is known to have three stages, its method of reproduction is not yet completely understood. The complete name of the disease is *Pneumocystis carinii* pneumonia, often shortened to PCP. It is also sometimes called pneumocystosis.

Description

Pneumonia as a general term refers to a severe lung inflammation. In pneumocystis pneumonia, this

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inflammation is caused by the growth of *Pneumocystis carinii*, a fungus-like organism that is widespread in the environment. PCP is ordinarily a rare disease, affecting only people with weakened immune systems. Many of these people are patients receiving drugs for organ transplants or **cancer** treatment. With the rising incidence of **AIDS**, however, PCP has become primarily associated with AIDS patients. In fact, as many as 75% of AIDS patients have developed PCP. It has also been the leading cause of **death** in AIDS patients.

Transmission

The organism that causes PCP is widely distributed in nature and is transmitted through the air. When the organism is inhaled, it enters the upper respiratory tract and infects the tiny air sacs at the ends of the smaller air tubes (bronchioles) in the lungs. These tiny air sacs are called alveoli. Under a microscope, alveoli look like groups of hollow spheres resembling grape clusters. The exchange of oxygen with the blood takes place in the alveoli. It appears that *P. carinii* lives in the fluid in the lining of the alveoli.

Person-to-person infection does not appear to be very common; however, clusters of PCP outbreaks in hospitals and groups of immunocompromised people indicate that patients with active PCP should not be exposed to others with weakened immune systems. It is thought that many people actually acquire mild *Pneumocystis carinii* infections from time to time, but are protected by their immune systems from developing a full-blown case of the disease.

Causes and symptoms

Causes

P. carinii is an opportunistic organism. This means that it causes disease only under certain conditions, as when a person is immunocompromised. Under these circumstances, *P. carinii* can multiply and cause pneumonia. The mechanisms of the organism's growth within the alveoli are not fully understood. As the pneumocystis organism continues to replicate, it gradually fills the alveoli. As the pneumonia becomes more severe, fluid accumulates and tissue scarring occurs. These changes result in decreased respiratory function and lower levels of oxygen in the blood.

High-risk groups

Some patients are at greater risk of developing PCP. These high-risk groups include:

- premature infants
- patients with immunodeficiency diseases, including severe combined immunodeficiency disease (SCID) and acquired immunodeficiency syndrome (AIDS),
- patients receiving immunosuppressive drugs, especially cortisone-like drugs (corticosteroids)
- Patients with protein malnutrition.

AIDS is currently the most common risk factor for PCP in the United States. PCP is, however, also found in countries with widespread hunger and poor hygiene.

Symptoms

The incubation period of PCP is not definitely known, but is thought to be between four and eight weeks. The major symptoms include **shortness of breath**, **fever**, and a nonproductive **cough**. Less common symptoms include production of sputum, blood in the sputum, difficulty breathing, and chest **pain**. Most patients will have symptoms for one to two weeks before seeing a physician. Occasionally, the disease will spread outside of the lung to other organs, including the lymph nodes, spleen, liver, or bone marrow.

Diagnosis

The diagnosis of PCP begins with a thorough **physical examination** and blood tests. Although imaging studies are helpful in identifying abnormal areas in the lungs, the diagnosis of PCP must be confirmed by microscopic identification of the organism in the lung. Samples may be taken from the patient's sputum, or may be obtained via **bronchoscopy** or **lung biopsy**. Because of the severity of the disease, many physicians will proceed to treat patients with symptoms of pneumocystis pneumonia if they belong to a high-risk group, without the formality of an actual diagnosis. The severity of PCP can be measured by x-ray studies and by determining the amount of oxygen and carbon dioxide present in the patient's blood.

Treatment

Treatment for PCP involves the use of **antibiotics**. These include trimethoprim-sulfamethoxazole (TMP-SMX, Bactrim, Septra) and pentamidine isoethionate (Nebupent, Pentam 300). Both of these anti-microbial drugs are equally effective. AIDS patients are typically treated for 21 days, whereas non-AIDS patients are treated for 14 days. TMP-SMX may be highly toxic in AIDS patients, causing severe side effects that include fever, rash, decreased numbers of white blood cells and platelets, and hepatitis. Pentamidine also causes

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KEY TERMS

Alveoli—Small, hollow air sacs found in the lungs at the end of the smaller airways (bronchioles). Air exchange occurs in the alveoli.

Azotemia—The presence of excess nitrogenous wastes in the blood.

Biopsy—A procedure in which a piece of tissue is obtained for microscopic study.

Bronchoscopy—A procedure that uses a fiber-optic scope to view the airways in the lung.

Fungus—A member of a group of simple organisms related to yeasts and molds.

Pentamidine isoethionate—An antibiotic used to treat and prevent PCP.

Pneumocystosis—Another name for active PCP infection.

Protozoan—A microorganism belonging to the Protista, which includes the simplest one-celled organisms.

Sputum—A substance obtained from the lungs and bronchial tubes by clearing the throat or coughing. Sputum can be tested for evidence of PCP infection.

Trimethoprim-sulfamethoxazole (TMP-SMX)—An antibiotic used to treat and prevent PCP.

side effects in immunocompromised patients. These side effects include decreased blood pressure, irregular heart beats, the accumulation of nitrogenous waste products in the blood (azotemia), and electrolyte imbalances. Pentamidine can be given in aerosol form to minimize side effects. Alternative drugs can be used for patients experiencing these side effects.

P. carinii appears to be developing resistance to TMP-SMX. In addition, some patients are allergic to the standard antibiotics given for PCP. As a result, other antibiotics for the treatment of PCP are continually under investigation. Some drugs proven to be effective against *P. carinii* include dapsone (DDS) with trimethoprim (Trimpex), clindamycin (Cleocin) with primaquine, as well as atovaquone (Mepron). Paradoxically, **corticosteroids** have been found to improve the ability of TMP-SMX or pentamidine to treat PCP. As a treatment of last resort, trimetrexate with leucovorin (Wellcovorin) can also be used.

Prognosis

If left untreated, PCP will cause breathing difficulties that will eventually cause death. The prognosis for this disease depends on the amount of damage to the patient's lungs prior to treatment. Prognosis is usually better at a facility that specializes in caring for AIDS patients. Antibiotic treatment of PCP is about 80% effective.

Prevention

Medications

For patients at serious risk for PCP infection, low doses of TMP-SMX, given daily or three times a week, are effective in preventing PCP. The drug is, however, highly toxic. Researchers are currently evaluating the effectiveness and toxicity of aerosol pentamidine and dapsone in preventing PCP.

Lifestyle modifications

Patients who have previously had PCP often experience a recurrence. Healthy lifestyle choices, including exercising, eating well, and giving up **smoking** may keep the disease at bay.

ORGANIZATIONS

American Lung Association, 1301 Pennsylvania Ave. NW, Suite 800, Washington, DC, 20001, (202) 758-3355, (202) 452-1805, (800) 548-8252, info@lungusa.org, http://www.lungusa.org.

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Cindy L. A. Jones, PhD

Pneumonectomy

Definition

Pneumonectomy is the medical term for the surgical removal of a lung.

Purpose

A pneumonectomy is most often used to treat lung **cancer** when less radical surgery cannot achieve satisfactory results. It may also be the most appropriate treatment for a tumor located near the center of the lung that affects the pulmonary artery or veins, which transport

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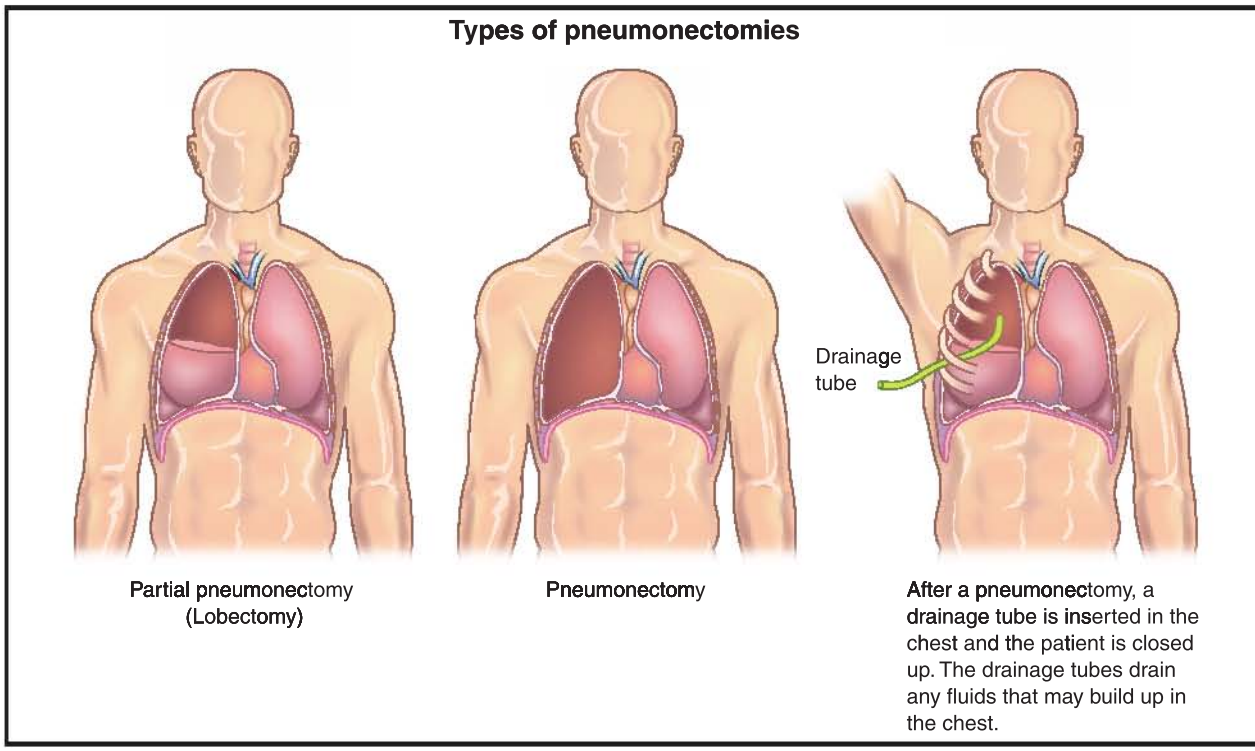

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blood between the heart and lungs. In addition, pneumonectomy may be the treatment of choice when the patient has a traumatic chest injury that has damaged the main air passage (bronchus) or the lung's major blood vessels so severely that they cannot be repaired.

Demographics

Pneumonectomies are usually performed on patients with lung cancer, as well as patients with such noncancerous diseases as **chronic obstructive pulmonary disease** (COPD), which includes **emphysema** and chronic **bronchitis**. These diseases cause airway obstruction.

Approximately 342,000 Americans die of lung disease every year. Lung disease is responsible for one in seven deaths in the United States, according to the American Lung Association. This makes lung disease America's number three killer. More than 35 million Americans are now living with chronic lung disease.

Lung cancer

Lung cancer is the leading cause of cancer-related deaths in the United States, accounting for a third of all cancer-related deaths. It is projected to claim more than 1.3 million lives worldwide in 2010, 170,000 of these deaths in the United States. Lung cancer kills more people than cancers of the breast, prostate, colon, and pancreas combined. Cigarette **smoking** accounts for nearly 90% of cases of lung cancer in the United States.

Lung cancer is the second most common cancer among both men and women and is the leading cause of **death** from cancer in both sexes. In addition to the use of tobacco as a major cause of lung cancer among smokers, second-hand smoke contributes to the development of lung cancer among nonsmokers. Exposure to asbestos and other hazardous substances is also known to cause lung cancer. Air pollution is also a probable cause, but makes a relatively small contribution to incidence and mortality rates. Indoor exposure to radon may also make a small contribution to the total incidence of lung cancer in certain geographic areas of the United States.

In each of the major racial/ethnic groups in the United States, the rates of lung cancer among men are about two to three times greater than the rates among women. Among men, age-adjusted lung cancer incidence rates (per 100,000) range from a low of about 14 among Native

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KEY TERMS

Bronchodilator—A drug that relaxes bronchial muscles resulting in expansion of the bronchial air passages.

Bronchopleural fistula—An abnormal connection between an air passage and the membrane that covers the lungs.

Corticosteroids—Any of various adrenal-cortex steroids used as anti-inflammatory agents.

Emphysema—A chronic disease characterized by loss of elasticity and abnormal accumulation of air in lung tissue.

Empyema—An accumulation of pus in the lung cavity, usually as a result of infection.

Malignant mesothelioma—A cancer of the pleura (the membrane lining the chest cavity and covering the lungs) that typically is related to asbestos exposure.

Pleural space—The small space between the two layers of the membrane that covers the lungs and lines the inner surface of the chest.

Pulmonary embolism—Blockage of a pulmonary artery by a blood clot or foreign matter.

Pulmonary rehabilitation—A program to treat COPD, which generally includes education and counseling, exercise, nutritional guidance, techniques to improve breathing, and emotional support.

Americans to a high of 117 among African Americans, an eight-fold difference. For women, the rates range from approximately 15 per 100,000 among Japanese Americans to nearly 51 among Native Alaskans, only a three-fold difference.

Chronic obstructive pulmonary disease

The following are risk factors for COPD:

- current smoking or a long-term history of heavy smoking
- employment that requires working around dust and irritating fumes
- long-term exposure to second-hand smoke at home or in the workplace
- a productive cough (with phlegm or sputum) most of the time
- shortness of breath during vigorous activity
- shortness of breath that grows worse even at lower levels of activity
- a family history of early COPD (before age 45)

Diagnosis/Preparation

Diagnosis

In some cases, the diagnosis of a lung disorder is made when the patient consults a physician about chest pains or other symptoms. The symptoms of lung cancer vary somewhat according to the location of the tumor; they may include persistent coughing, coughing up blood, **wheezing**, **fever**, and weight loss. In cases involving direct trauma to the lung, the decision to perform a pneumonectomy may be made in the emergency room. Before scheduling a pneumonectomy, however, the surgeon reviews the patient's medical and surgical history and orders a number of tests to determine how successful the surgery is likely to be.

In the case of lung cancer, blood tests, a **bone scan**, and **computed tomography scans** of the head and abdomen indicate whether the cancer has spread beyond the lungs. **Positron emission tomography (PET)** scanning is also used to help stage the disease. Cardiac screening indicates how well the patient's heart will tolerate the procedure, and extensive pulmonary testing (e.g., breathing tests and quantitative ventilation/perfusion scans) predicts whether the remaining lung will be able to make up for the patient's diminished ability to breathe.

Preparation

A patient who smokes must stop as soon as a lung disease is diagnosed. Patients should not take **aspirin** or ibuprofen for seven to 10 days before surgery. Patients should also consult their physician about discontinuing any blood-thinning medications such as Coumadin or warfarin. The night before surgery, patients should not eat or drink anything after midnight.

Description

In a conventional pneumonectomy, the surgeon removes only the diseased lung itself. In a partial pneumonectomy, one or more lobes of a lung are removed. In an extrapleural pneumonectomy, the surgeon removes the lung, part of the membrane covering the heart (pericaridium), part of the diaphragm, and the membrane lining the chest cavity (parietal pleura). Either operation is extensive, and require that the patient be given **general anesthesia**. An intravenous line inserted into one arm supplies fluids and

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medication throughout the operation, which usually lasts one to three hours.

The surgeon begins the operation by cutting a large opening on the same side of the chest as the diseased lung. This posterolateral thoracotomy incision extends from a point below the shoulder blade around the side of the patient's body along the curvature of the ribs at the front of the chest. Sometimes the surgeon removes part of the fifth rib in order to have a clearer view of the lung and greater ease in removing the diseased organ.

A surgeon performing a traditional pneumonectomy then:

- deflates (collapses) the diseased lung
- ties off the lung's major blood vessels to prevent bleeding into the chest cavity
- clamps the main bronchus to prevent fluid from entering the air passage
- cuts through the bronchus
- removes the lung
- staples or sutures the end of the bronchus that has been cut
- makes sure that air is not escaping from the bronchus
- inserts a temporary drainage tube between the layers of the pleura (pleural space) to draw air, fluid, and blood out of the surgical cavity
- closes the chest incision

Aftercare

Chest tubes drain fluid from the incision and a respirator helps the patient breathe for at least 24 hours after the operation. The patient may be fed and medicated intravenously. If no complications arise, the patient is transferred from the surgical intensive care unit to a regular hospital room within one to two days.

A patient who has had a conventional pneumonectomy will usually leave the hospital within 10 days. Aftercare during hospitalization is focused on:

- relieving pain
- monitoring the patient's blood oxygen levels
- encouraging the patient to walk in order to prevent formation of blood clots
- encouraging the patient to cough productively in order to clear accumulated lung secretions

If the patient cannot **cough** productively, the doctor uses a flexible tube (bronchoscope) to remove the lung secretions and fluids.

Recovery is usually a slow process, with the remaining lung gradually taking on the work of the lung that has been removed. The patient may gradually resume normal non-strenuous activities. A pneumonectomy patient who does not experience postoperative problems may be well enough within eight weeks to return to a job that is not physically demanding; however, 60% of all pneumonectomy patients continue to struggle with **shortness of breath** six months after having surgery.

Risks

The risks for any surgical procedure requiring anesthesia include reactions to the medications and breathing problems. The risks for any surgical procedure include bleeding and infection.

Between 40% and 60% of pneumonectomy patients experience such short-term postoperative difficulties as:

- prolonged need for a mechanical respirator
- abnormal heart rhythm (cardiac arrhythmia); heart attack (myocardial infarction); or other heart problem
- pneumonia
- infection at the site of the incision
- a blood clot in the remaining lung (pulmonary embolism)
- an abnormal connection between the stump of the cut bronchus and the pleural space due to a leak in the stump (bronchopleural fistula)
- accumulation of pus in the pleural space (empyema)
- kidney or other organ failure

Over time, the remaining organs in the patient's chest may move into the space left by the surgery. This condition is called postpneumonectomy syndrome; the surgeon can correct it by inserting a fluid-filled prosthesis into the space formerly occupied by the diseased lung.

Normal results

The doctor will probably advise the patient to refrain from strenuous activities for a few weeks after the operation. The patient's rib cage will remain sore for some time.

A patient whose lungs have been weakened by noncancerous diseases like emphysema or chronic bronchitis may experience long-term shortness of breath as a result of this surgery. On the other hand, a patient who develops a fever, chest pain, persistent cough, or shortness of breath, or whose incision bleeds

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or becomes inflamed, should notify his or her doctor immediately.

Morbidity and mortality rates

In the United States, the immediate survival rate from surgery for patients who have had the left lung removed is between 96% and 98%. Due to the greater risk of complications involving the stump of the cut bronchus in the right lung, between 88% and 90% of patients survive removal of this organ. Following lung volume reduction surgery, most investigators now report mortality rates of 5–9%.

Alternatives

Lung cancer

The treatment options for lung cancer are surgery, **radiation therapy**, and **chemotherapy**, either alone or in combination, depending on the stage of the cancer.

After the cancer is found and staged, the cancer care team discusses the treatment options with the patient. In choosing a treatment plan, the most significant factors to consider are the type of lung cancer (small cell or non-small cell) and the stage of the cancer. It is very important that the doctor order all the tests needed to determine the stage of the cancer. Other factors to consider include the patient's overall physical health; the likely side effects of the treatment; and the probability of curing the disease, extending the patient's life, or relieving his or her symptoms.

Chronic obstructive pulmonary disease

Although surgery is rarely used to treat COPD, it may be considered for people who have severe symptoms that have not improved with medication therapy. A significant number of patients with advanced COPD face a miserable existence and are at high risk of death, despite advances in medical technology. This group includes patients who remain symptomatic despite the following:

- smoking cessation
- use of inhaled bronchodilators
- treatment with antibiotics for acute bacterial infections, and inhaled or oral corticosteroids
- use of supplemental oxygen with rest or exertion
- pulmonary rehabilitation

After the severity of the patient's airflow obstruction has been evaluated, and the foregoing interventions implemented, a pulmonary disease specialist should examine him or her, with consideration given to surgical treatment.

Surgical options for treating COPD include laser therapy or the following procedures:

- Bullectomy. This procedure removes the part of the lung that has been damaged by the formation of large air-filled sacs called bullae.
- Lung volume reduction surgery. In this procedure, the surgeon removes a portion of one or both lungs, making room for the remaining lung tissue to work more efficiently. Its use is considered experimental, although it has been used in selected patients with severe emphysema.
- Lung transplant. In this procedure a healthy lung from a donor who has recently died is given to a person with COPD.

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ORGANIZATIONS

American Cancer Society., 1599 Clifton Road, N.E, Atlanta, GA, 30329-4251, (800) 227-2345, www.cancer.org.

American Lung Association, 1301 Pennsylvania Ave. NW, Washington, DC, 20004, (202) 785-3355, www.lungusa.org.

National Cancer Institute (NCI), Building 31, Room 10A03, 31 Center Drive, Bethesda, MD, 20892-2580, (301) 435-3848, (800) 4-CANCER, www.nci.nih.gov.

National Comprehensive Cancer Network, 275 Commerce Drive, Suite 300, Fort Washington, PA, 19034, (215) 690-0300, www.nccn.org.

National Heart, Lung and Blood Institute (NHLBI)., 6701 Rockledge Drive, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, www.nhlhi.nih.gov.

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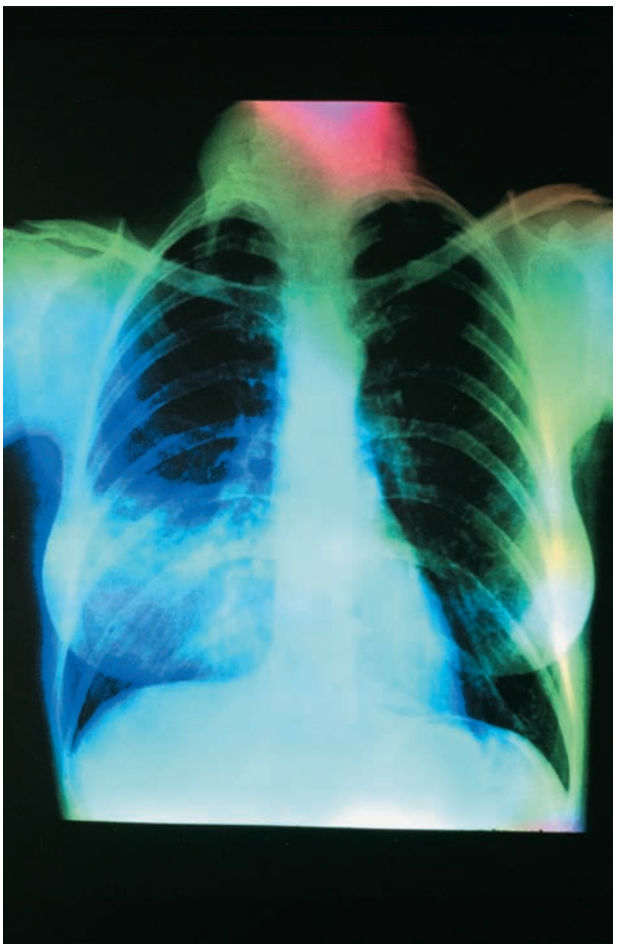
Pneumonia

Definition

Pneumonia is an infection of the lung that can be caused by nearly any class of organism known to cause human infections. These include bacteria, amoebae, viruses, fungi, and parasites. Pneumonia may also result from non-infectious causes, such as inhalation of food, liquids, gases, or dust. Pneumonia often develops as a complication of a pre-existing condition or infection or when a patient's immune system is weakened by a condition such as a simple viral respiratory tract infection or by **influenza**. Pneumonia and influenza together are ranked as the eighth leading cause of **death** in the United States, with pneumonia accounting for most of those deaths. In the elderly, pneumonia is the fourth leading cause of death and the leading infectious cause of death. In 2006, 55,477 people in the United States died of pneumonia.

When a person has pneumonia, the air sacs in the lungs become filled with pus and other liquids, and oxygen transfer from the lungs to the blood stream is inhibited. Without sufficient oxygen, body cells cannot function properly. Lobar pneumonia affects a section (lobe) of a lung while bronchial pneumonia affects patches throughout both lungs.



A chest x ray showing lobar pneumonia in the lower lobe of a patient's right lung. The alveoli (air sacs) of the lung become blocked with pus, which forces air out and causes the lung to become solidified. *(Photo Researchers, Inc.)*

Description

Anatomy of the lung

To better understand pneumonia, it is important to understand the basic anatomic features of the respiratory system. The human respiratory system begins at the nose and mouth, where air is breathed in (inspired) and out (expired). The air tube extending from the nose is called the nasopharynx. The tube carrying air breathed in through the mouth is called the oropharynx. The nasopharynx and the oropharynx merge into the larynx. The oropharynx also carries swallowed substances, including food, water, and salivary secretion, which must pass into the esophagus and then the stomach. The larynx is protected by a

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trap door called the epiglottis. The epiglottis prevents substances that have been swallowed, as well as substances that have been regurgitated (thrown up), from heading down into the larynx and toward the lungs.

A useful method of picturing the respiratory system is to imagine an upside-down tree. The larynx flows into the trachea, which is the tree trunk, and thus the broadest part of the respiratory tree. The trachea divides into two tree limbs, the right and left bronchi. Each one of these branches off into multiple smaller bronchi, which course through the tissue of the lung. Each bronchus divides into tubes of smaller and smaller diameter, finally ending in the terminal bronchioles. The air sacs of the lung, in which oxygen-carbon dioxide exchange actually takes place, are clustered at the ends of the bronchioles like the leaves of a tree. They are called alveoli.

The tissue of the lung which serves only a supportive role for the bronchi, bronchioles, and alveoli is called the lung stroma (or lung parenchyma).

Function of the respiratory system

The main function of the respiratory system is to provide oxygen, the most important energy source for the body's cells. Inspired air (the air we breath in) contains the oxygen, and travels down the respiratory tree to the alveoli. The oxygen moves out of the alveoli and is sent into circulation throughout the body as part of the red blood cells. The oxygen in the inspired air is exchanged within the alveoli for the waste product of human metabolism, carbon dioxide. The air we breathe out contains the gas called carbon dioxide. This gas leaves the alveoli during expiration. To restate this exchange of gases simply, we breathe in oxygen, we breathe out carbon dioxide.

Respiratory system defenses

The healthy human lung is sterile. There are no normally resident bacteria or viruses (unlike the upper respiratory system and parts of the gastrointestinal system, where bacteria dwell even in a healthy state). There are multiple safeguards along the path of the respiratory system. These are designed to keep invading organisms from leading to infection.

The first line of defense includes the hair in the nostrils, which serves as a filter for large particles. The epiglottis is a trap door of sorts, designed to prevent food and other swallowed substances from entering the larynx and then trachea. Sneezing and coughing, both provoked by the presence of irritants within the respiratory system, help to clear such irritants from the respiratory tract.

Mucus, produced through the respiratory system, also serves to trap dust and infectious organisms. Tiny hair like projections (cilia) from cells lining the respiratory tract beat constantly. They move debris trapped by mucus upwards and out of the respiratory tract. This mechanism of protection is referred to as the mucociliary escalator.

Cells lining the respiratory tract produce several types of immune substances which protect against various organisms. Other cells (called macrophages) along the respiratory tract actually ingest and kill invading organisms.

The organisms that cause pneumonia, then, are usually carefully kept from entering the lungs by virtue of these host defenses. However, when an individual encounters a large number of organisms at once, the usual defenses may be overwhelmed, and infection may occur. This can happen either by inhaling contaminated air droplets, or by aspiration of organisms inhabiting the upper airways.

Conditions predisposing to pneumonia

In addition to exposure to sufficient quantities of causative organisms, certain conditions may make an individual more likely to become ill with pneumonia. Various conditions are listed below.

Cigarette smoke, inhaled directly by a smoker or second-hand by a innocent bystander, interferes significantly with ciliary function, as well as inhibiting macrophage function, thus predisposing in individual to pneumonia.

Stroke, seizures, alcohol, and various drugs interfere with the function of the epiglottis. This leads to a leaky seal on the trap door, with possible contamination by swallowed substances and/or regurgitated stomach contents. Alcohol and drugs also interfere with the normal **cough** reflex. This further decreases the chance of clearing unwanted debris from the respiratory tract.

Viruses may interfere with ciliary function, allowing themselves or other microorganism invaders (such as bacteria) access to the lower respiratory tract. One of the most important viruses is HIV (human **immunodeficiency** virus), the causative virus in **AIDS** (acquired immunodeficiency syndrome). In recent years this virus has resulted in a huge increase in the incidence of pneumonia. Because AIDS results in a general decreased effectiveness of many aspects of the host's immune system, a patient with AIDS is susceptible to all kinds of pneumonia. This includes some previously rare parasitic types which would be unable

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to cause illness in an individual possessing a normal immune system.

Pneumonia is sometimes a pulmonary condition affecting **cancer** patients, and may indicate that the cancer is progressing or that the patient has developed a new problem. Both cancer and the therapies used to treat it can injure the lungs or weaken the immune system in ways that make cancer patients especially susceptible to the bacteria, fungi, viruses, and other organisms that cause pneumonia. Tumors and infections can block the patient's airway or limit the lungs' ability to rid themselves of fluid and other accumulated secretions that make breathing difficult. Radiation treatment for **breast cancer** increases the risk of pneumonia in some patients by weakening lung tissue. Other factors that increase a cancer patient's risk of developing pneumonia include:

- radiation therapy
- chemotherapy
- surgery
- depressed white blood cell count (neutropenia)
- antibiotics
- steroids
- malnutrition
- limited mobility
- splenectomy-immune system deficits

Various chronic conditions predispose a person to infection with pneumonia. These include **asthma**, **cystic fibrosis**, and neuromuscular diseases which may interfere with the seal of the epiglottis. **Esophageal disorders** may result in stomach contents passing upwards into the esophagus. This increases the risk of aspiration into the lungs of those stomach contents with their resident bacteria. Diabetes, sickle cell anemia, lymphoma, leukemia, and **emphysema** also predispose a person to pneumonia.

Pneumonia is also one of the most frequent infectious complications of all types of surgery. Many drugs used during and after surgery may increase the risk of aspiration, impair the cough reflex, and cause a patient to under fill their lungs with air. **Pain** after surgery also discourages a patient from breathing deeply enough, and from coughing effectively.

Certain other conditions can increase the risk of pneumonia. These include the following:

- abnormal anatomical structure, particularly of the chest or lungs
- advanced age and associated immune system weakness
- esophageal disorders that may result in stomach contents passing upwards
- genetic factors and associated changes in DNA
- malnutrition

Pneumonia in children

Pneumonia can develop gradually in children after exposure to the causative organism, or it can develop quickly after another illness, reducing the lungs' ability to receive and distribute oxygen. It can be mild and easily cured with **antibiotics** and rest, or it can be severe and require hospitalization. The onset, duration, and severity of pneumonia depend upon the type of infective organism invading the body and the response of the child's immune system in fighting the infection. Respiratory distress represents 20% of all admissions of children to hospitals, and pneumonia is the underlying cause of most of these admissions.

Bacterial pneumonia develops after the child inhales or aspirates pathogens. Viral pneumonia stems primarily from inhaling infected droplets from the upper airway into the lungs. In neonates, pneumonia may result from colonization of the infant's nasopharynx by organisms that were in the birth canal at the time of delivery.

Pneumonia in the elderly

Pneumonia is one of the common and significant diseases of the elderly, especially those over the age of seventy. In general, the elderly are more susceptible to pneumonia than younger people. The elderly are also more likely to be hospitalized for pneumonia and need mechanical ventilation, resulting in a longer hospital stay than younger persons. In addition, many elderly people contract pneumonia while staying in a hospital for other conditions, because their immune systems are often compromised due to the condition that initially required treatment.

The elderly have a less effective mucociliary escalator, as well as changes in their immune system. This causes this age group to be more at risk for the development of pneumonia.

The intensity of symptoms and clinical manifestations of pneumonia are often less in the elderly than in younger patients, thus complicating diagnosis of the disease. The elderly may lose lung capacity as they age, making it harder for them to cough productively. They are also often used to feeling ill so may not recognize new symptoms of illness. Elderly people with pneumonia commonly exhibit acute confusion or **delirium** and deterioration of base metabolic functions.

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Incidence

In the United States, pneumonia is the sixth most common disease leading to death; 2 million Americans develop pneumonia each year, and 40,000–70,000 die from it. Pneumonia is also the most common fatal infection acquired by already hospitalized patients. In developing countries, pneumonia ties with **diarrhea** as the most common cause of death. According to the Centers for Disease Control and Prevention (CDC), the number of deaths from pneumonia in the United States has declined slightly since 2001, however, even in nonfatal cases, pneumonia is a significant economic burden on the health care system. One study estimates that people in the American workforce who develop pneumonia cost employers five times as much in health care as the average worker.

The epidemic of HIV, has resulted in a huge increase in the incidence of pneumonia. Because AIDS results in immune system suppression, individuals with AIDS are highly susceptible to all kinds of pneumonia, including some previously rare parasitic types that would not cause illness in someone with a normal immune system.

Demographics

Every year in the United States, two million people of all ages develop pneumonia, including 4% of all the children in the country. It is the sixth most common disease leading to death and the fourth leading cause of death in the elderly; 40,000 to 70,000 people die from pneumonia each year. The incidence of pneumonia in children younger than one year of age is 35 to 40 per 1,000; 30 to 35 per 1,000 children ages two to four; and 15 per 1,000 children between ages five and nine. Fewer than 10 children in 1,000 over age nine are reported to develop pneumonia.

One sixth of the six million pneumonia cases that develop each year occur primarily in persons aged 65 years and older. Over 90% of all deaths from pneumonia occur in the older population. The incidence of development of pneumonia in the elderly is 20 to 40 illnesses per 1000 persons for pneumonia acquired in community settings, while the incidence rises to 100 to 250 per 1000 persons in cases acquired in long-term care facilities. An estimated 2.1% of elderly residents in long-term care facilities at any one time have pneumonia. About one billion dollars per year are spent on medical therapy to treat bacterial pneumonia in the elderly.

Causes

The list of organisms which can cause pneumonia is very large, and includes nearly every class of infecting organism: viruses, bacteria, bacteria-like organisms, fungi, and parasites. Some organisms are more frequently encountered by specific age groups. In addition, some characteristics of an individual may place him or her at greater risk for infection by particular types of organisms:

- Viruses cause the majority of pneumonias in young children (especially respiratory syncytial virus, parainfluenza and influenza viruses, and adenovirus).
- Adults are more frequently infected with bacteria (such as *Streptococcus pneumoniae*, *Haemophilus influenzae,* and *Staphylococcus aureus*).
- Pneumonia in older children and young adults is often caused by the bacteria-like *Mycoplasma pneumoniae* (often referred to as "walking" pneumonia).
- *Pneumocystis carinii pneumonia* (PCP) is an important cause of pneumonia in patients with immune problems (such as patients being treated for cancer with chemotherapy, or patients with AIDS). Classically considered a parasite, it appears to be more related to fungi.
- People who have reason to come into contact with bird droppings, such as poultry workers, are at risk for pneumonia caused by the organism *Chlamydia psittaci*.
- A very large, serious outbreak of pneumonia occurred in 1976, when individuals attending an American Legion convention were infected by a previously unknown organism. The outbreak caused twenty nine deaths among American Legion members who were staying at a Philadelphia hotel. Subsequently named *Legionella pneumophila,* it causes what is now called "Legionnaire's disease." The Legionella bacteria can live in water and can spread through air conditioning systems in hotels and hospitals. Susceptibility to the disease increases with increasing age.

Other bacteria that cause pneumonia, especially in institutional settings, include *Klebsiella*, *Pseudomonas aeruginosa*, *Enterobacter* species, *Proteus* species, ***Escherichia coli***, and other gram negative bacteria. Strains of anaerobic bacteria can be aspirated into the lungs by the elderly due to conditions associated with **aging** (such as sedative use or neurological conditions) and cause pneumonia. *Haemophilus influenzae* is a bacteria that causes pneumonia more frequently in patients with chronic **bronchitis**.

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Pneumonia caused by *Mycoplasma pneumoniae* is a common cause of pneumonia that is usually not a significant threat to the health of the elderly, as it usually affects people younger than 40. Persons at highest risk for mycoplasma pneumonia are those living or working in crowded areas such as schools and homeless shelters, although many people who contract mycoplasma pneumonia have no identifiable risk factor. Symptoms typical of pneumonia are usually mild and appear over a period of one to three weeks. They may become more severe in some people.

PCP is caused by a fungus, *Pneumocystis jiroveci*. PCP develops in persons with weakened immune systems from causes such as cancer, chronic use of **corticosteroids** or other medications that affect the immune system, HIV/AIDS, or solid organ and/or bone marrow transplants. Symptoms of PCP include a mild and dry cough, **fever**, rapid breathing, and **shortness of breath**, especially upon **exercise** or activity. PCP was a rare disease before the AIDS disease developed. This type of pneumonia may also be referred to as **pneumocystis pneumonia**.

Chemical pneumonia is an unusual type of lung irritation. Although pneumonia usually is caused by a bacteria or virus, in chemical pneumonia, inflammation of lung tissue can be caused by many types of chemicals, including liquids, gases, and small particles, such as dust or fumes. Only a small percentage of pneumonias are caused by chemicals. Some chemicals only harm the lungs; however, some toxic chemicals may affect other organs in addition to the lungs and can result in serious organ damage or death. Aspiration pneumonia is another form of chemical pneumonia, where oral secretions or stomach contents are aspirated into the lungs. Inflammation develops from the toxic effects of stomach acid and enzymes on lung tissue. Symptoms of chemical pneumonia may include:

- burning of the nose, eyes, lips, mouth, and throat
- dry cough
- wet cough producing clear, yellow, or green mucus
- cough producing blood or frothy pink matter
- nausea or abdominal pain
- chest pain
- shortness of breath
- painful breathing or pleuritis (an inflammation of the outside covering of the lungs)
- headache
- flu symptoms
- weakness or a general ill feeling
- delirium or disorientation

Half of all pneumonia cases are caused by viruses, including the influenza virus, parainfluenza virus, adenovirus, rhinovirus, herpes simplex virus, respiratory synctial virus, hantavirus, and cytomegalovirus. Many of these pneumonia infections are mild and may last only a short time. However pneumonia caused by the influenza virus may be severe and occasionally fatal. The symptoms of influenza pneumonia are similar to those of influenza, including fever, dry cough, **headache**, muscle pain, and weakness. However, within 12 to 36 hours, breathlessness develops, and the coughing increases, with a small amount of mucus produced. Patients have a high fever and may develop blueness of the lips. Eighty percent of deaths in recent influenza epidemics occurred in persons aged 65 and older, mostly due to development of complications such as **sepsis** or acute **respiratory distress syndrome**. Viral pneumonia can be further complicated by development of bacterial pneumonia.

Symptoms

Pneumonia is suspected in any patient who has fever, cough, chest pain, shortness of breath, and increased respirations (number of breaths per minute). Fever with a shaking chill is even more suspicious. Many patients cough up clumps of sputum, commonly known as spit. These secretions are produced in the alveoli during an infection or other inflammatory condition. They may appear streaked with pus or blood. Severe pneumonia results in the signs of oxygen deprivation. This includes blue appearance of the nail beds or lips (**cyanosis**).

The invading organism causes symptoms, in part, by provoking an overly-strong immune response in the lungs. In other words, the immune system, which should help fight off infections, kicks into such high gear, that it damages the lung tissue and makes it more susceptible to infection. The small blood vessels in the lungs (capillaries) become leaky, and protein-rich fluid seeps into the alveoli. This results in less functional area for oxygen-carbon dioxide exchange. The patient becomes relatively oxygen deprived, while retaining potentially damaging carbon dioxide. The patient breathes faster and faster, in an effort to bring in more oxygen and blow off more carbon dioxide.

Mucus production is increased, and the leaky capillaries may tinge the mucus with blood. Mucus

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plugs actually further decrease the efficiency of gas exchange in the lung. The alveoli fill further with fluid and debris from the large number of white blood cells being produced to fight the infection.

Consolidation, a feature of bacterial pneumonias, occurs when the alveoli, which are normally hollow air spaces within the lung, instead, become solid due to quantities of fluid and debris.

Viral pneumonias and mycoplasma pneumonias do not result in consolidation. These types of pneumonia primarily infect the walls of the alveoli and the stroma of the lung.

Severe acute respiratory syndrome (SARS)

Severe acute respiratory syndrome, or SARS, is a contagious and potentially fatal disease that first appeared in the form of a multi-country outbreak in early February 2003. Later that month, the CDC began to work with the World Health Organization (WHO) to investigate the cause(s) of SARS and to develop guidelines for **infection control**. SARS has been described as an "atypical pneumonia of unknown etiology;" by the end of March 2003, the disease agent was identified as a previously unknown coronavirus.

The early symptoms of SARS include a high fever with chills, headache, **muscle cramps**, and weakness. This early phase is followed by respiratory symptoms, usually a dry cough and painful or difficult breathing. Some patients require mechanical ventilation. The mortality rate of SARS is thought to be about 3%.

Diagnosis

For the most part, diagnosis is based on the patient's report of symptoms, combined with examination of the chest. Listening with a stethoscope will reveal abnormal sounds, and tapping on the patient's back (which should yield a resonant sound due to air filling the alveoli) may instead yield a dull thump if the alveoli are filled with fluid and debris.

Laboratory diagnosis can be made of some bacterial pneumonias by obtaining a sputum specimen and staining the sputum with special chemicals and looking at it under a microscope. Identification of the specific type of bacteria may require culturing the sputum (using the sputum sample to grow greater numbers of the bacteria in a lab dish).

X-ray examination of the chest may reveal certain abnormal changes associated with pneumonia. Localized shadows obscuring areas of the lung may indicate a bacterial pneumonia, while streaky or patchy appearing changes in the x-ray picture may indicate viral or mycoplasma pneumonia. These changes on x ray, however, are known to lag in time behind the patient's actual symptoms.

The doctor may do a **bronchoscopy** (visualizing inside the airway via a scope), or may remove a small piece of lung tissue (transbronchial biopsy) for microscopic examination and cultures. If the patient's condition continues to worsen, the doctor may remove additional lung tissue via thoracic needle biopsy or open **lung biopsy**, for microscopic analysis and cultures.

Treatment

Prior to the discovery of penicillin antibiotics, bacterial pneumonia was almost always fatal. Today, antibiotics, especially given early in the course of the disease, are very effective against bacterial causes of pneumonia. Erythromycin and tetracycline improve recovery time for symptoms of mycoplasma pneumonia. They do not, however, eradicate the organisms. Amantadine and acyclovir may be helpful against certain viral pneumonias.

A newer antibiotic named linezolid (Zyvox) is being used to treat penicillin-resistant organisms that cause pneumonia. Linezolid is the first of a new line of antibiotics known as oxazolidinones. Another new drug known as ertapenem (Invanz) is reported to be effective in treating bacterial pneumonia.

Patients may also be given fluids and possibly drug therapy to thin mucus secretions (mucolytic agents) or medication to open the airways of the lung (brochodilators). **Cough suppressants** may be given as well as pain medication and fever-reducing medication. Hospitalized patients often receive oxygen, respiratory therapy, and intravenous antibiotics and fluids.

Pneumonia in cancer patients must be treated promptly in order to speed recovery and prevent complications that could arise if the inflammation were allowed to linger. Treatment always includes bed rest and coughing to expel phlegm and other fluids from the lungs (productive cough). To determine which course of treatment would be most appropriate, a doctor considers when symptoms first appeared, what pattern the illness has followed, and whether cancer or its treatments have diminished the patient's infection-fighting ability (immune response).

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KEY TERMS

Acute respiratory distress syndrome—A serious reaction to various forms of injuries to the lung, which is characterized by inflammation of the lung, leading to impaired gas exchange and release of inflammatory mediators causing inflammation and low blood oxygen and frequently resulting in multiple organ failure. This condition is life threatening and often lethal, usually requiring mechanical ventilation and admission to an intensive care unit.

Alveoli—The little air sacs clustered at the ends of the bronchioles, in which oxygen-carbon dioxide exchange takes place.

Aspiration—A situation in which solids or liquids which should be swallowed into the stomach are instead breathed into the respiratory system.

Bronchoscopy—The examination of the bronchi (the main airways of the lungs) using a flexible tube (bronchoscope). Bronchoscopy helps to evaluate and diagnose lung problems, assess blockages, obtain samples of tissue and/or fluid, and/or to help remove a foreign body.

CD4 count—A measure of the strength of the immune system. HIV continually kills CD4 cells. Over time, the body can not replace these lost CD4 cells and their number declines. AS this happens, the body becomes more susceptible to infections. A normal CD4 count is 1000. The body starts to get more frequent common infections at around a count of 400. At around a CD4 count of 200, the body becomes susceptible to many unusual infections. It is best to start medications for HIV before the CD4 count drops below 200 to prevent these infections from developing.

Cilia—Hair-like projections from certain types of cells.

Consolidation—A condition in which lung tissue becomes firm and solid rather than elastic and air-filled because it has accumulated fluids and tissue debris.

Coronavirus—One of a family of RNA-containing viruses known to cause severe respiratory illnesses. In March 2003, a previously unknown coronavirus was identified as the causative agent of severe acute respiratory syndrome, or SARS.

Cyanosis—A bluish tinge to the skin that can occur when the blood oxygen level drops too low.

Sepsis—Presence of various pus-forming and other pathogenic organisms, or their toxins, in the blood or tissues.

Sputum—Material produced within the alveoli in response to an infectious or inflammatory process.

Stroma—A term used to describe the supportive tissue surrounding a particular structure. An example is that tissue which surrounds and supports the actually functional lung tissue.

Prognosis

Prognosis varies according to the type of organism causing the infection. Recovery following pneumonia with *Mycoplasma pneumoniae* is nearly 100%. *Staphylococcus pneumoniae* has a death rate of 30–40%. Similarly, infections with a number of gram negative bacteria (such as those in the gastrointestinal tract which can cause infection following aspiration) have a death rate of 25–50%. *Streptococcus pneumoniae,* (also referred to as **pneumococcal pneumonia**), the most common organism causing pneumonia, produces a death rate of about 5%. More complications occur in the very young or very old individuals who have multiple areas of the lung infected simultaneously. Individuals with other chronic illnesses (including **cirrhosis** of the liver, congestive **heart failure**, individuals without a functioning spleen, and individuals who have other diseases that result in a weakened immune system, experience complications. Patients with immune disorders, various types of cancer, transplant patients, and AIDS patients also experience complications.

The chances of an early recovery (within two to three weeks) from pneumonia are enhanced if the pneumonia is detected early, if the patient has a strong immune system, if the infection has not spread throughout the body, and if the patient is not suffering from other diseases.

Prevention

Measures that can be taken to prevent pneumonia include frequent washing of hands, elimination of the use of tobacco (which damages the ability of the lungs to withstand infections), and wearing of masks in dusty or moldy areas. Since pneumonia often follows common respiratory infections such as the cold or flu,

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an important preventive measure is to be alert to any symptoms of respiratory illness that last for more than a few days. The practice of deep breathing for patients recovering in the hospital from various diseases or surgeries is recommended to help prevent them from developing pneumonia.

Because many bacterial pneumonias occur in patients who are first infected with the influenza virus (the flu), yearly **vaccination** against influenza can decrease the risk of pneumonia for certain patients. This is particularly true of the elderly and people with chronic diseases (such as asthma, cystic fibrosis, other lung or heart diseases, **sickle cell disease**, diabetes, **kidney disease**, and forms of cancer).

A specific vaccine against *Streptococcus pneumoniae* is very protective, and should also be administered to patients with chronic illnesses.

Patients who have decreased immune resistance are at higher risk for infection with *Pneumocystis carinii*. They are frequently put on a regular drug regimen of trimethoprim sulfa and/or inhaled pentamidine to avoid pneumocystis pneumonia.

The flu vaccine helps prevent pneumonia caused by influenza viruses. This vaccine must be given yearly to protect against new viral strains.

Additional preventive therapy may be necessary for:

- AIDS patients with CD4 counts below 200
- People on chronic high-doses of corticosteroids
- People who have had previous episodes of PCP

Health care team roles

In most cases, a diagnosis of pneumonia is made in a physician's office, a general medical clinic, or emergency room by a primary care practitioner. Children and adolescents with pneumonia are most likely to be diagnosed by their primary care physician or pediatrician.

When patients are hospitalized for pneumonia, good nursing assessment and observation are primary requirements. These include monitoring vital signs, including oxygen saturation (the amount of oxygen circulating in the blood), encouraging the patient to move, breathe deeply, cough, and get out of bed with assistance (if indicated) to facilitate good lung expansion. The nurse should also provide education to the patient about the importance of coughing, breathing deeply, and taking in adequate fluid.

When at home, patient should be encouraged to drink fluids to loosen secretions and bring up phlegm. Both patients and care givers should be made aware of potential **drug interactions** with other medications that the patient may be taking (for example, warfarin and antibiotics). Regular communication between the physician and the care giver is essential.

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ORGANIZATIONS

American Lung Association, 1301 Pennsylvania Ave. NW, Washington, DC, 20004, (202) 785 3355 , (202) 452 1805, http://www.lungusa.org.

American Thoracic Society, 61 Broadway, 6th Floor, New York, NY, 10006-2755, (212) 315-8600, http://www.thoracic.org.

Centers for Disease Control and Prevention, 1600 Clifton Rd., NE, Atlanta, GA, 30333, (404) 639-3311, (800) 311-3435, http://www.cdc.gov.org.

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National Heart, Lung, and Blood Institute (NHLBI), P. O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3255 (TTY), http://www.nhlbi.nih.gov.

World Health Organization, Communicable Diseases, 20 Avenue Appia, 1211, Geneva 27, Switzerland, +4122791 4140, http://www.who.int/gtb.

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Pneumonitis *see* **Pneumonia**

Pneumothorax

Definition

Pneumothorax is a collection of air or gas in the chest or pleural space that causes part or all of a lung to collapse.

Description

Normally, the pressure in the lungs is greater than the pressure in the pleural space surrounding the lungs. However, if air enters the pleural space, the pressure in the pleura then becomes greater than the pressure in the lungs, causing the lung to collapse partially or completely. Pneumothorax can be either spontaneous or due to trauma.

If a pneumothorax occurs suddenly or for no known reason, it is called a spontaneous pneumothorax. This condition most often strikes tall, thin men between the ages of 20 to 40. In addition, people with lung disorders, such as **emphysema**, **cystic fibrosis**, and **tuberculosis**, are at higher risk for spontaneous pneumothorax. Traumatic pneumothorax is the result of accident or injury due to medical procedures performed to the chest cavity, such as **thoracentesis** or mechanical ventilation. Tension pneumothorax is a serious and potentially life-threatening condition that may be caused by traumatic injury, chronic lung disease, or as a complication of a medical procedure. In this type of pneumothorax, air enters the chest cavity, but cannot escape. This greatly increased pressure in the pleural space causes the lung to collapse completely, compresses the heart, and pushes the heart and associated blood vessels toward the unaffected side.

An x ray of a patient undergoing pneumothorax treatment. ECG electrodes attached to chest monitor heartbeat while endotracheal tube is inserted in windpipe. *(Photo Researchers, Inc.)*

Causes and symptoms

The symptoms of pneumothrax depend on how much air enters the chest, how much the lung collapses, and the extent of lung disease. Symptoms include the following, according to the cause of the pneumothorax:

- Spontaneous pneumothorax. Simple spontaneous pneumothorax is caused by a rupture of a small air sac or fluid-filled sac in the lung. It may be related to activity in otherwise healthy people or may occur during scuba diving or flying at high altitudes. Complicated spontaneous pneumothorax, also generally caused by rupture of a small sac in the lung, occurs in people with lung diseases. The symptoms of complicated spontaneous pneumothorax tend to be worse than those of simple pneumothorax, due to the underlying lung disease. Spontaneous pneumothorax is characterized by dull, sharp, or stabbing chest pain that begins suddenly and becomes worse with deep breathing or coughing. Other symptoms are shortness of breath, rapid breathing, abnormal breathing

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movement (that is, little chest wall movement when breathing), and cough.

- Tension pneumothorax. Following trauma, air may enter the chest cavity. A penetrating chest wound allows outside air to enter the chest, causing the lung to collapse. Certain medical procedures performed in the chest cavity, such as thoracentesis, also may cause a lung to collapse. Tension pneumothorax may be the immediate result of an injury; the delayed complication of a hidden injury, such as a fractured rib, that punctures the lung; or the result of lung damage from asthma, chronic bronchitis, or emphysema. Symptoms of tension pneumothorax tend to be severe with sudden onset. There is marked anxiety, distended neck veins, weak pulse, decreased breath sounds on the affected side, and a shift of the mediastinum to the opposite side.

Diagnosis

To diagnose pneumothorax, it is necessary for the health care provider to listen to the chest (auscultation) during a **physical examination**. By using a stethoscope, the physician may note that one part of the chest does not transmit the normal sounds of breathing. A **chest x ray** will show the air pocket and the collapsed lung. An electrocardiogram (ECG) will be performed to record the electrical impulses that control the heart's activity. Blood samples may be taken to check for the level of arterial blood gases.

Treatment

A small pneumothorax may resolve on its own, but most require medical treatment. The object of treatment is to remove air from the chest and allow the lung to re-expand. This is done by inserting a needle and syringe (if the pneumothorax is small) or chest tube through the chest wall. This allows the air to escape without allowing any air back in. The lung will then re-expand itself within a few days. Surgery may be needed for repeat occurrences.

Prognosis

Most people recover fully from spontaneous pneumothorax. Up to half of patients with spontaneous pneumothorax experience recurrence. Recovery from a collapsed lung generally takes one to two weeks. Tension pneumothorax can cause **death** rapidly due to inadequate heart output or insufficient blood oxygen (hypoxemia), and must be treated as a medical emergency.

KEY TERMS

Electrocardiagram—A test that provides a typical record of normal heart action.

Mediastinum—The space between the right and left lung.

Pleural—Pleural refers to the pleura or membrane that enfolds the lungs.

Thoracentesis—Also called a pleural fluid tap, this procedure involves aspiration of fluid from the pleural space using a long, thin needle inserted between the ribs.

Prevention

Preventive measures for a non-injury related pneumothorax include stopping **smoking** and seeking medical attention for respiratory problems. If the pneumothorax occurs in both lungs or more than once in the same lung, surgery may be needed to prevent it from occurring again.

ORGANIZATIONS

American Association for Respiratory Care, 9425 N. MacArthur Blvd, Suite 100, Irving, TX, 75063-4706, (972) 243-2272, (972) 484-2720, info@aarc.org, http://ww.aarc.org.

American Lung Association, 1301 Pennsylvania Ave. NW, Suite 800, Washington, DC, 20001, (202) 758-3355, (202) 452-1805, (800) 548-8252, info@lungusa.org, http://www.lungusa.org.

Lorraine Steefel, RN

Podiatry *see* **Foot care**

Poison ivy and poison oak

Definition

Poison ivy and poison oak are plants that cause an allergic skin reaction in most people who are exposed to them.

Demographics

An estimated 85 percent of the population is allergic to the urushiol oil found in poison ivy, oak, and sumac, according to the American Academy of Dermatology. Annually, up to 50 million Americans develop a

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Poison oak plant. *(© iStockPhoto/Joe Potato Photo.)*

poison ivy, oak, or sumac rash. The chance of developing an allergic sensitivity to these poison plants decreases with age, and adults who have never been exposed to urushiol only have a 50 percent chance of developing **contact dermatitis** when exposed to poison ivy, oak, or sumac. It is possible for children who are highly reactive to urushiol to grow into adults who are barely sensitive to poison ivy, oak, or sumac, regardless of how many times they have been exposed to the plant oil.

Description

Poison ivy, which is generally thought of as a climbing vine, can also grow as a shrub or bush. It has leaves that are elliptical in shape and grow in groups of three on a stem. Poison ivy is common in the United States, except in the southwest, Alaska, and Hawaii. Poison oak, which grows as a shrub, has leaves that are shaped like oak leaves and also grow in groups of three to a stem. Poison oak is common in the United States, especially on the west coast from Mexico to Canada.

Not everyone is sensitive to poison ivy and poison oak; however, nine out of ten people who come in contact with either of the plants will have an allergic reaction to some degree. All parts of the plants are poisonous and the amount of time it takes for an allergic reaction to develop varies from person to person. The extent and severity of the reaction depends on the length of exposure, type of contact, and how sensitive the person is to the plants. If a person is going to have an allergic reaction, it will usually occur within one or two days of exposure. However, some people have a reaction within an hour, whereas others don't experience a reaction until five days after the exposure.

Causes and symptoms

The substance that causes the allergic reaction is the same for both plants. It is an oily resin called urushiol. It only takes a small amount of the resin to cause a reaction. The resin can be transferred to the skin by directly touching the plant or indirectly by coming in contact with something that has touched the plant, such as tools, animals, or clothing. Although animals are rarely affected, they can carry the resin on their fur and transfer it to humans. According to the experts at the University of Maryland Medical Center, the "chemical [resin] can remain active for more than a year."

The symptoms for poison ivy and poison oak are the same. Usually the first symptoms to appear are itchiness and swelling in the areas of contact. The itchy rash that follows is made up of small pimple-like bumps (sometimes referred to as papules), as well as blisters that later break open, ooze, and crust over.

Diagnosis

A diagnosis is made based on the symptoms and a **physical examination** of the patient.

Treatment

Anyone who comes in contact with either plant should wash the exposed area with soap and water immediately. Taking a bath immediately after contact is not recommended, because that could spread the resin to other areas of the body. All clothing, including shoes and shoelaces, should be removed carefully and either washed separately or discarded.

For minor cases, hydrocortisone cream and Calamine lotion can provide relief until the symptoms disappear. Over-the-counter Benadryl capsules help with the **itching**. Some people find oatmeal or baking soda baths to be soothing as well. Oral **steroids**, such as prednisone, are available for more serious cases, especially those affecting the face, eyes, mouth, or genitals. If signs of infection develop, such as pus and a **fever**, patients should contact their doctors.

Patients should consult their physicians before they use any ointments that contain benzocaine or zirconium, because they can cause an allergic reaction that worsens the condition. Antihistamine

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Poison ivy plant. *(© iStockPhoto/norcon.)*

ointments are not recommended for the same reason. The experts at the Alabama Cooperative Extension System caution that "some people have severe allergic reactions to these plants and can have swelling in the throat, breathing problems, weakness, **dizziness**, and bluish lips." Emergency medical care should be sought if any serious reactions occur.

Prognosis

In most cases, the condition goes away in two weeks.

Prevention

The best prevention is know what the plants look like and to avoid them. A common saying should be kept in mind: Leaves of three, let them be.

People who plan to be in an area where poison ivy and poison oak might be found should wear protective clothing, such as long-sleeved shirts and long pants.

Eradication of the plants should be handled with care. As stated by the experts at the Alabama Cooperative Extension System, "burning can be dangerous and is not recommended for disposal or as a control measure, because the toxic oil from the plant can be carried in the smoke." Instead they recommend spraying the plants with glyphosate, which is commonly known as the brands Roundup or Kleenup.

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Poisoning

Definition

Poisoning occurs when any substance interferes with normal body functions after it is swallowed, inhaled, injected, or absorbed. The branch of medicine that deals with the detection and treatment of poisons is known as toxicology.

Demographics

Poisonings are a common occurrence and can be intentional or unintentional. About 10 million cases of poisoning occur in the United States each year. In 80% of the cases, the victim is a child under the age of five. About 50 children die each year from poisonings. Curiosity, inability to read warning labels, a desire to imitate adults, and inadequate supervision lead to childhood poisonings.

The elderly are the second most likely group to be poisoned. Mental confusion, poor eyesight, and the use of multiple drugs are the leading reasons that this group has a high rate of accidental poisoning. A substantial number of poisonings also occur as **suicide** attempts or drug overdoses.

According to the Centers for Disease Control (CDC), In 2008, unintentional poisoning caused about 732,316 emergency department (ED) visits, and 23% of those unintentional poisonings (166,015) resulted in hospitalization or transfer to another facility.

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Common household, industrial, and agricultural products containing toxic substances

Alcohol (rubbing)
Antifreeze
Arsenic
Art and craft supplies
Automotive fluids
Batteries, automotive
Batteries, household
Building products
Cleaning products
Cosmetics/personal care items
Cyanide
Daffodil bulbs
Dieffenbachia
Disinfectants/air fresheners
Drain openers
English nightshade
Ethanol
Flea collars/insect repellent
Floor/furniture polish
Foxglove
Gasoline
Glues/adhesives
Hemlock
Kerosene
Mercury
Metal primers
Metalworking materials
Mothballs
Oven cleaners
Paints, oil-based or alkyds
Paints, water-based or latex
Paint strippers/thinners
Pesticides
Stains/finishes
Strychnine
Wood preservatives

(Table by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)

Description

Poisons are common in the home and workplace, yet there are basically two major types. One group consists of products that were never meant to be ingested or inhaled, such as shampoo, paint thinner, pesticides, houseplant leaves, and carbon monoxide. The other group contains products that can be ingested in small quantities, but which are harmful if taken in large amounts, such as pharmaceuticals, medicinal herbs, or alcohol. Other types of poisons include the bacterial toxins that cause **food poisoning**, such as ***Escherichia coli***; heavy metals, such as the lead found in the paint on older houses; and the venom found in the **bites and stings** of some animals and insects. The staff at a poison control center and emergency room doctors have the most experience diagnosing and treating poisoning cases.

Causes and symptoms

The effects of poisons are as varied as the poisons themselves. However, the exact mechanisms of only a few are understood. Some poisons interfere with metabolism. Others destroy the liver or kidneys. Some examples include heavy metals and some **pain** relief medications, including **acetaminophen** (Tylenol) and nonsteroidal anti–inflammatory drugs (Advil, Ibuprofen). A poison may severely depress the central nervous system, leading to **coma** and eventual respiratory and circulatory failure. Potential poisons in this category include anesthetics (e.g. ether and chloroform), opiates (e.g., morphine and codeine), and **barbiturates**. Some poisons directly affect the respiratory and circulatory systems. Carbon monoxide causes **death** by binding with hemoglobin that normally transports oxygen throughout the body. Certain corrosive vapors trigger the body to flood the lungs with fluids, effectively drowning the person. Cyanide interferes with respiration at the cellular level. Another group of poisons interferes with the electrochemical impulses that travel between neurons in the nervous system. Yet another group, including **cocaine**, ergot, strychnine, and some snake venoms, causes potentially fatal seizures.

Severity of symptoms can range from **headache** and **nausea** to convulsions and death. The type of poison; the amount and time of exposure; and the age, size, and health of the victim are all factors that determine the severity of symptoms and the chances for recovery.

Plant poisoning

There are more than 700 species of poisonous plants in the United States. Plants are second only to medicines in causing serious poisoning in children under age five. There is no way to tell by looking at a plant if it is poisonous. Some plants, such as the yew shrub, are almost entirely toxic: needles, bark, seeds, and berries. In other plants, only certain parts are poisonous. The bulb of the hyacinth and daffodil are toxic, but the flowers are not, while the flowers of the jasmine plant are the poisonous part. Moreover, some plants are confusing because portions of them are eaten as food while other parts are poisonous. For example, the fleshy stem (tuber) of the potato plant is nutritious. However, its roots, sprouts, and vines are poisonous. The leaves of tomatoes are poisonous, while the fruit is not. Rhubarb stalks are good to eat, but the leaves are poisonous. Apricots, cherries, peaches, and apples all produce healthful fruit, but their seeds contain a form of cyanide that can kill a child if chewed in sufficient quantities. One hundred milligrams of moist, crushed apricot seeds can produce 217 mg of cyanide.

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Common houseplants that contain some poisonous parts include:

- Aloe
- Amaryllis
- Cyclamen
- Dumb cane (also called Dieffenbachia)
- Philodendron

Common outdoor plants that contain some poisonous part include:

- Bird of paradise flower
- Buttercup
- Castor bean
- Chinaberry tree
- Daffodil
- English ivy
- Eucalyptus
- Foxglove
- Holly
- Horse chestnut
- Iris
- Jack–in–the–pulpit
- Jimsonweed (also called thornapple)
- Larkspur
- Lily–of–the–valley
- Morning glory
- Nightshade (several varieties)
- Oleander
- Potato
- Rhododendron
- Rhubarb
- Sweet pea
- Tomato
- Wisteria
- Yew

Symptoms of plant poisoning range from irritation of the skin or mucous membranes of the mouth and throat to nausea, **vomiting**, convulsions, irregular heartbeat, and even death. It is often difficult to tell if a person has eaten a poisonous plant because there are no tell–tale empty containers and no unusual lesions or odors around the mouth.

Many cases of plant poisoning involve plants that contain hallucinogens, such as peyote cactus buttons, certain types of mushrooms, and **marijuana**. A recent case of plant poisoning in France concerned *Datura*, or moonflower, a plant that has become popular with young people trying to imitate Native American **puberty** rites.

Other cases of plant poisoning result from the use of herbal dietary supplements that have been contaminated by toxic substances. The Food and Drug Administration (FDA) has the authority to monitor herbal products on the market and issue warnings about accidental poisoning or other adverse affects associated with these products. For example, in 2002 a manufacturer of nettle capsules found to contain lead recalled the product following a warning from the FDA. Other dietary supplements have been found to contain small quantities of prescription medications or even toxic plants.

Household chemicals

Many products used daily in the home are poisonous if swallowed. These products often contain strong acids or strong bases (alkalis). Toxic household cleaning products include:

- ammonia
- bleach
- dishwashing liquids
- drain openers
- floor waxes and furniture polishes
- laundry detergents, spot cleaners, and fabric softeners
- mildew removers
- oven cleaners
- toilet bowl cleaners

Personal care products found in the home can also be poisonous. These include:

- deodorant
- hairspray
- hair straighteners
- nail polish and polish remover
- perfume
- shampoo

Signs that a person has swallowed one of these substances include evidence of an empty container nearby, nausea or **vomiting**, and **burns** on the lips and skin around the mouth if the substance was a strong acid or alkali. The chemicals in some of these products may leave a distinctive odor on the breath.

Pharmaceuticals

Both over–the–counter and prescription medicines can help the body heal if taken as directed.

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However, when taken in large quantities, or with other drugs where there may be an adverse interaction, they can act as poisons. Drug overdoses, both accidental and intentional, are the leading cause of poisoning in adults. Medicinal herbs should be treated like pharmaceuticals and taken only in designated quantities under the supervision of a knowledgeable person. Herbs that have healing qualities when taken in small doses can be toxic in larger doses, or may interact with prescription medications in unpredictable ways.

Drug overdoses cause a range of symptoms, including excitability, sleepiness, confusion, unconsciousness, rapid heartbeat, convulsions, nausea, and changes in blood pressure. The best initial evidence of a **drug overdose** is the presence of an empty container near the victim.

Other causes of poisonings

People can be poisoned by fumes they inhale. Carbon monoxide is the most common form of inhaled poison. Other toxic substances that can be inhaled include:

- farm and garden insecticides and herbicides
- gasoline fumes
- insect repellent
- paint thinner fumes

Diagnosis

Initially, poisoning is suspected if the victim shows changes in behavior and signs or symptoms previously described. **Hallucinations** or other psychiatric symptoms may indicate poisoning by a hallucinogenic plant. Evidence of an empty container or information from the victim are helpful in determining exactly what substance has caused the poisoning. Some acids and alkalis leave burns on the mouth. Petroleum products, such as lighter fluid or kerosene, leave a distinctive odor on the breath. The vomit may be tested to determine the exact composition of the poison. Once hospitalized, the patient may be given blood and urine tests to determine his or her metabolic condition.

Treatment

Treatment for poisoning depends on the poison swallowed or inhaled. Contacting the poison control center or hospital emergency room is the first step in getting proper treatment. The poison control center's telephone number is often listed with emergency numbers on the inside cover of the telephone book, or it can be reached by dialing the operator. The poison control center will ask for specific information about the victim and the poison, then give appropriate **first aid** instructions. If the patient is to be taken to a hospital, a sample of vomit and the poison container should be taken along, if they are available.

Most cases of plant poisoning are treated by inducing vomiting, if the patient is fully conscious. Vomiting can be induced by taking syrup of **ipecac**, an over–the–counter emetic available at any pharmacy.

For acid, alkali, or petroleum product poisonings, the patient should not vomit. Acids and alkalis can burn the esophagus if they are vomited, and petroleum products can be inhaled into the lungs during vomiting, resulting in **pneumonia**.

Once under medical care, doctors have the option of treating the patient with a specific remedy to counteract the poison (antidote) or with **activated charcoal** to absorb the substance inside the patient's digestive system. In some instances, pumping the stomach may be required. This technique, which is known as gastric lavage, involves introducing 20–30 mL of tap water or nine percent saline solution into the patient's digestive tract and removing the stomach contents with a siphon or syringe. The process is repeated until the washings are free of poison. Medical personnel will also provide supportive care as needed, such as intravenous fluids or mechanical ventilation.

If the doctor suspects that the poisoning was not accidental, he or she is required to notify law enforcement authorities. Most cases of malicious poisoning concern family members or acquaintances of the victim, but the number of intentional random poisonings of the general public has increased in recent years. A case reported in 2003 involved the use of nicotine to poison 1700 pounds of ground beef in a Michigan supermarket. Over a hundred persons fell ill after eating the poisoned beef.

Prognosis

The outcome of poisoning varies from complete recovery to death, and depends on the type and amount of the poison, the health of the victim, and the speed with which medical care is obtained.

Prevention

Most accidental poisonings are preventable. The number of deaths of children from poisoning has declined from about 450 per year in the 1960s to less than 50 each year since the 1990s. This decline has occurred mainly because of better packaging of toxic materials and better public education.

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KEY TERMS

Antidote—A medication or remedy for counteracting the effects of a poison.

Emetic—A medication or substance given to induce vomiting.

Gastric lavage—A technique for washing poison out of the stomach by instilling water or saline solution through a tube, removing the stomach contents by suction, and repeating the process until the washings are free of poison. The procedure is also called stomach pumping.

Toxicology—The branch of medicine that deals with the effects, detection, and treatment of poisons.

Actions to prevent poisonings include:

- removing plants that are poisonous
- keeping medicines and household chemicals locked and in a place inaccessible to children
- keeping medications in child–resistant containers
- never referring to medicine as "candy"
- keeping cleaners and other poisons in their original containers
- disposing of outdated prescription medicines
- not purchasing over–the–counter medications with damaged protective seals or packaging
- avoiding the use of herbal preparations not made by a reputable manufacturer

Resources

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ORGANIZATIONS

American Association of Poison Control Centers (AAPCC), 3201 New Mexico Ave., Suite 330, Washington, DC, 20016, (202) 362–7217, POISONING EMERGENCIES: (800) 222–1222, http://www.aapcc.org.

National Toxicology Program (NTP) of the National Institute of Environmental Health Sciences (NIEHS), PO Box 12233, Research Triangle Park, NC, 27709, (919) 541–3419, http://www.ntp–server.niehs.nih.gov.

U. S. Food and Drug Administration (FDA), 5600 Fishers Ln., Rockville, MD, 20857, (888) 463–6332, http://www.fda.gov.

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Polarity therapy

Definition

Polarity therapy is a holistic, energy-based system that includes bodywork, diet, **exercise**, and lifestyle counseling for the purpose of restoring and maintaining proper energy flows throughout the body. The underlying concept of polarity therapy is that all energy within the human body is based in electromagnetic force and that disease results from improperly dissipated energy.

Purpose

Polarity therapy unblocks and recharges the flow of life energy and realigns unbalanced energy as a means of eliminating disease. Patients learn to release

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KEY TERMS

Apana—Life sustaining energy centered in the larger intestine; the fifth of the five airs of Ayurvedic philosophy; the life force governing expulsion activity.

Ayurveda—(Sanskrit, *Ayur,* life, and *veda,* knowledge) Translated as ''knowledge of life'' or ''science of longevity.'' It became established as the traditional Hindu system of medicine.

Caduceus—The ancient and universal symbol of medicine consisting of the winged staff of Mercury and two intertwining serpents.

Primary energy pattern—A spiral motion that radiates from the umbilicus; the energy pattern associated with a child in the womb.

Prana—Life sustaining energy centered in the human brain; the first of the five airs of Ayurvedic philosophy; the life force governing inspiration and the conscious intellect.

QV—Quantum vacuum, a theory coined by physicists, which defines the interactions of energy that combine to form reality.

Reflexology—Belief that reflex areas in the feet correspond to every part of the body, including organs and glands, and that stimulating the correct reflex area can affect the body part.

Samana—Life sustaining energy of the smaller intestine; the fourth of the five airs of Ayurvedic philosophy; the life force governing side-to-side motion.

Tridosha—The combination of three basic principles of energy, or biological humor, that comprise life, according to Ayurvedic philosophy.

Udana—Life sustaining energy of the diaphragm, the third of the five airs of Ayurvedic philosophy, the life force governing upward motion.

Vyana—Life sustaining energy of the heart and lungs; the second of the five airs of Ayurvedic philosophy; the life force governing circular motion.

tension by addressing the source of the **stress** and by maintaining a healthy demeanor accordingly.

This treatment may be effective to promote health and healing to anyone willing to embrace the appropriate lifestyle. Polarity therapy is reportedly effective for anyone who has been exposed to toxic poisons. Likewise, HIV-positive individuals may find comfort in polarity therapy. Additionally this is an appropriate therapy for relieving general stress, back **pain**, stomach cramps, and other recurring maladies and conditions.

Description

Origins

Austrian-American chiropractor, osteopath, and naturopath Randolph Stone (1888–1981) developed polarity therapy as an integration of Eastern and Western principles and techniques of healing. Stone discovered the ancient principles of the Ayurvedic philosophy in the course of his travels during a sojourn in India. On a life-long quest to learn the fundamentals of human vitality, he also studied **reflexology** and **traditional Chinese medicine**.

Stone became committed to the principles of **Ayurvedic medicine**, which he interpreted in conjunction with his scientific and medical knowledge to define polarity therapy. According to the philosophy of Ayurved, which is based in a set of principles called the tridosha—the energy of the human body is centered in five organs or regions (the brain; the cardiopulmonary [heart and lungs] region, the diaphragm, the smaller intestine, and the larger intestine). One of five airs or energy forms controls each respective region: prana in the brain, vyana in the heart and lungs, udana in the diaphragm, samana in the smaller intestine, and apana in the larger intestine. The five airs control all directional motion in the body, with each air in command of a different type of movement. Stone established further that the prana, centered in the brain, ultimately controlled the combined forces of the body. Any impediment or restriction to the flow of prana in turn affects the health of the entire body. The prana force is nurtured through the flow of food and air into the body as well as through our interactions with other living beings and through the intake of the five sensory organs.

Stone devoted much of his life to defining an elaborately detailed cause and effect relationship between the human anatomy and illness, based on the energy flow of the prana. He further attributed electromagnetic energy as the basis of the energy forces. He used the medical symbol of the Caduceus to define the patterns of the flow and described the energy movement in detail in charts of the human body. Polarity therapy is based in charted energy

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flows. The primary energy pattern is defined in a spiral motion that radiates from the umbilicus and defines the original energy flow of the fetus in the womb.

After determining the exact source of a patient's energy imbalance, the therapist begins the first of a series of bodywork sessions designed to rechannel and release the patient's misdirected prana. This therapy, akin to massage, is based in energetic pressure and involves circulating motions. In performing the regimen, the therapist pays strict attention to the pressure exerted at each location—even to which finger is used to apply pressure at any given point of the patient's anatomy. This technique, which comprises the central regimen or focal point of polarity therapy is very gentle and is unique to polarity therapy. It typically involves subtle rocking movements and cranial holds to stimulate body energy. Although firm, deep pushing touches are employed in conjunction with the massage technique, the polarity therapist never exerts a particularly forceful contact.

To support the bodywork, the therapist often prescribes a diet for the patient, to encourage cleansing and eliminate waste. The precepts of polarity therapy take into consideration specific interactions between different foods and the human energy fields.

Likewise, a series of exercises is frequently prescribed. These exercises, called polarity **yoga** include squats, stretches, rhythmic movements, deep breathing, and expression of sounds. They can be both energizing and relaxing. Counseling may be included whenever appropriate as a part of a patient's highly individual therapy regimen to promote balance.

Preparations

Therapists take a comprehensive case history from every patient prior to beginning treatment. This preliminary verbal examination often monopolizes the first therapy session. Depending upon circumstances, a therapist might have a need to assess the patient's physical structural balance through observation and **physical examination**.

Precautions

Polarity therapy is safe for virtually anyone, even the elderly and the most frail patients, because of the intrinsic gentleness of the **massage therapy**.

Side effects

Highly emotional releases of energy (laughter, tears, or a combination of both) are associated with this therapy.

Research and general acceptance

This is a complementary therapy of holistic, spiritually based treatment, which may be used in conjunction with a medical approach. Polarity therapy is practiced worldwide, but the majority of practitioners are based in the United States. Modern physicists employ concepts similar to Stone's basic theories of polarity in defining the quantum vacuum (QV) as a foundation of all reality. Still, this holistic regimen had not achieved the widespread acceptance anticipated by Stone before his death in 1981.

Resources

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ORGANIZATIONS

American Polarity Therapy Association, 122 N. Elm Street, Suite 512, Greensboro, NC, 27401, (336) 574-1121, (336) 574-1151, APTAoffices@polaritytherapy.org, http://www.polaritytherapy.org.

Trans-Hyperboreau Institute of Science, P.O. Box 2344, Sausalito, CA, 94966, (415) 331-0230, (415) 331-0231, (800) 485-8095.

Gloria Cooksey

Polio

Definition

Polio, or poliomyelitis, is an **infectious disease** caused by a virus that normally lives in the human digestive tract. About 90 percent of persons infected by the virus have no symptoms at all; in the other 10 percent, the polio virus causes an infection with symptoms ranging from a mild flu-like illness to **paralysis** of the lower limbs or **death** from paralysis of the muscles that control breathing. The term poliomyelitis comes from the Greek words *polio*, meaning gray, and *myelon*, referring to the spinal cord. The term is accurate, as an important consequence of the disease is the involvement of the spinal cord.

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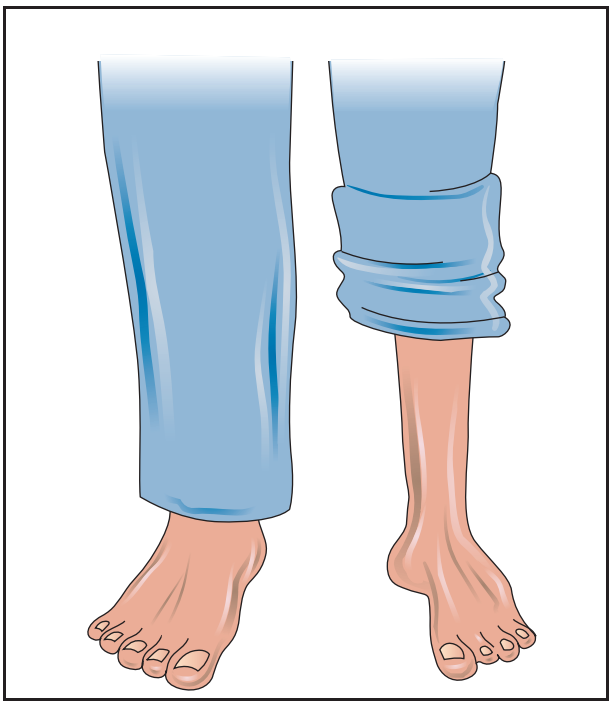

In its most severe form, polio causes paralysis of the muscles of the legs, arms, and respiratory system. All muscle tone is lost in the affected limb, and the muscle becomes flaccid and begins to atrophy, as shown in the illustration above. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Demographics

Polio was widespread in the developed countries of Europe and North America in the first part of the twentieth century. The epidemics not only became more severe, but also affected adolescents and adults rather than mostly children. The older average age of patients was also marked by increased severity of symptoms. Since the introduction of effective vaccines, paralytic polio is almost unknown in the United States except among recent immigrants and other groups (such as the Amish) that do not routinely participate in community-wide **vaccination** programs. According to the Centers for Disease Prevention and Control (CDC), the incidence rate has been less than 0.01 cases per 100,000 people in the United States since 1965. The last case of wild-type polio in the country was reported in 1979. Only a few cases of paralytic poliomyelitis are reported each year in the United States.

Worldwide, polio epidemics are most common in tropical countries during the months of July through September. Both sexes and all races are equally likely to get the disease if they are not protected by immunization.

There is hope that polio will soon follow **smallpox** as a disease that humankind has completely wiped out. In 1994 both North and South America were declared polio-free, followed by Australia, Japan, China and other countries around the Pacific Ocean in 2000, and Europe in 2002.

Description

There are three known types of polioviruses (called 1, 2, and 3), each causing a different strain of the disease. All are members of the viral family of enteroviruses (viruses that infect the gastrointestinal tract). Type 1 is the cause of epidemics and many cases of paralysis, which is the most severe manifestation of the infection. The virus is usually a harmless parasite of human beings.

The most recent statistics indicate that of acute poliovirus infections, 4–8% lead only to nonspecific illness; 1–2% of infections finally result in neurologic symptoms. When the poliovirus does reach the central nervous system, inflammation and destruction of the spinal cord motor cells (anterior horn cells) occurs, which prevents them from sending out impulses to muscles. Loss of impulse transmission causes the muscles to become limp or soft and they cannot contract. This condition is referred to as flaccid paralysis and is the type found in polio. The extent of the paralysis depends on where the virus strikes and the number of cells that it destroys. Usually, some of the limb muscles are paralyzed; the abdominal muscles or muscles of the back may be paralyzed, affecting the person's posture. The neck muscles may become too weak for the head to be lifted. Paralysis of the face muscles may cause the mouth to twist or the eyelids to droop. Life may be threatened if paralysis of the throat or of the breathing muscles occurs.

Risk factors

Human beings are the only natural host of polioviruses; these viruses are not transmitted by animals. Some people are more likely than others to develop the paralytic form of the disease if they do become infected:

- Young children.
- Elderly adults.
- People who engage in hard physical labor or strenuous exercise.
- People who have recently had a tonsillectomy or dental surgery.
- Pregnant women.

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DR. JONAS E. SALK (1914–1995)

(The Library of Congress.)

Jonas Salk was born in New York, New York, on October 28, 1914. He received his medical degree from New York University in 1939. In 1942, Salk began working for a former teacher, Thomas Francis, Jr., to produce influenza vaccines, a project that continued until 1949. That year, as a research professor, Salk began a three-year project sponsored by the National Foundation for Infantile Paralysis, also known as the March of Dimes. Caused by the poliomyelitis virus, polio was also known as infantile paralysis. Periodic outbreaks of the disease, which attacks the nervous system, caused death or a lifetime of paralysis, especially in children. It was a difficult disease to study because sufficient viruses could not be obtained. Unlike bacteria, which can be grown in cultures, viruses need living tissue on which to grow. Once a method for preparing viruses was discovered and improved, sufficient viruses became available for research.

Salk first set out to confirm that there were three virus types responsible for polio and then began to experiment with ways to kill the virus and yet retain its ability to produce an immune response. By 1952, he had produced a dead virus vaccine that worked against the three virus types. He began testing. First the vaccine was tested on monkeys, then on children who had recovered from the disease, and finally on Salk's own family and children, none of whom had ever had the disease. Following large-scale trials in 1954, the vaccine was finally released for public use in 1955. The Salk vaccine was not the first vaccine against polio, but it was the first to be found safe and effective. By 1961, there was a 96 percent reduction in polio cases in the United States.

- People who travel frequently to areas where polio is still endemic. There are six such countries as of 2009, according to the World Health Organization (WHO): Afghanistan, Egypt, India, Niger, Nigeria, and Pakistan.
- An immune system weakened by HIV or certain types of cancer treatment.

Causes and symptoms

Polio is caused by a virus that enters the mouth through food or water that has been contaminated by fecal matter. It is an extremely contagious illness; anyone living with a recently infected person is likely to become infected too. Although people carrying the poliovirus are most contagious for 7–10 days before and after symptoms (if any) appear, they can spread the virus for weeks in their bowel movements.

Once inside the body, the polio virus takes between 6 and 20 days to incubate. It finds its way to the tissues lining the throat and the intestinal tract, where it multiplies rapidly. After about a week in the intestines, the virus travels to the tonsils and the lymph nodes, where it multiplies further and then enters the bloodstream. It can remain within the blood and lymphatic system for as long as 17 weeks. In a minority of cases, the virus enters the central nervous system from the blood and lymph. It then multiplies in and destroys the nerve cells in the brain that control the movements of the muscles. These nerve cells are known as motor neurons. The location and severity of the paralytic polio that results when the motor neurons are damaged varies with the part of the central nervous system that is affected.

Minor forms of acute polio infection

Between 4 and 8 percent of acute polio infections are characterized by flu-like symptoms known as abortive poliomyelitis. People with this form of polio infection experience **sore throat** and **fever**, **nausea**, **vomiting**, abdominal **pain**, **constipation**, or **diarrhea**. Abortive polio is difficult to distinguish from the flu or other viral infections. Patients recover completely in about a week.

About 10% of people infected with poliovirus develop severe **headache** and pain and stiffness of

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the neck and back. These symptoms are due to an inflammation of the meninges (tissues which cover the spinal cord and brain). This syndrome is called nonparalytic or aseptic **meningitis**. The term "aseptic" is used to differentiate this type of meningitis from those caused by bacteria. Patients with nonparalytic meningitis may experience a brief period of general illness followed by stiffness in the neck, back, or legs. They may also experience other abnormal sensations for a period of 2–10 days. As with abortive polio, patients with nonparalytic meningitis recover completely.

Paralytic polio

Between 1 and 2 percent of people infected with poliovirus develop the most severe form, paralytic polio. Some of these patients may have 2–3 symptom-free days between the minor illness and the major illness but the symptoms often appear without any previous minor illness. Symptoms again include headache and back and neck pain. The major symptoms, however, are due to invasion of the motor nerves, which are responsible for movement of the muscles.

Paralytic polio is usually divided into three types, depending on whether the paralysis affects the arms and legs (spinal polio; accounts for 79 percent of cases of paralytic polio); breathing, speaking, and swallowing (bulbar polio; 2 percent of cases); or the limbs as well as breathing and other functions (bulbospinal polio; 19 percent of cases). Bulbar polio is particularly likely to lead to death if the patient is not placed on a respirator because the virus affects the brain stem—the part of the brain that controls heartbeat as well as breathing and other vital functions.

The maximum state of paralysis in paralytic polio is usually reached within just a few days. The remaining unaffected nerves then begin the process of attempting to grow branches to compensate for the destroyed nerves. Fortunately, the nerve cells are not always completely destroyed. By the end of a month, the nerve impulses start to return to the apparently paralyzed muscle and by the end of six months, recovery is almost complete. If the nerve cells are completely destroyed, however, paralysis is permanent.

Diagnosis

The diagnosis of polio is based on a combination of the patient's history and the type and location of symptoms—particularly such symptoms as a stiff neck, difficulty breathing, or abnormal reflexes. Fever and asymmetric flaccid paralysis without sensory loss in a child or young adult almost always indicate poliomyelitis. Nonparalytic poliomyelitis cannot be distinguished clinically from aseptic meningitis due to other agents. Virus isolated from a throat swab and/or feces or blood tests demonstrating the rise in a specific antibody is required to confirm the diagnosis.

KEY TERMS

Aseptic—Sterile; containing no microorganisms, especially no bacteria.

Asymptomatic—Having no symptoms of a disease even though the person may be infected by the organism that causes the disease.

Brainstem—The stalk of the brain that connects the two cerebral hemispheres to the spinal cord.

Endemic—A term applied to a disease that maintains itself in a particular area without reinforcement from outside sources of infection.

Flaccid—Weak, soft, or floppy.

Gastrointestinal—Pertaining to the stomach and intestines.

Lymph/lymphatic—One of the three body fluids that is transparent and a slightly yellow liquid that is collected from the capillary walls into the tissues and circulates back to the blood supply.

Meningitis—Inflammation of the membranes that cover the brain and spinal cord.

Motor neuron—A type of cell in the central nervous system that controls the movement of muscles either directly or indirectly.

Neurologic—Pertaining to the nervous system.

Paralysis—The inability to voluntarily move.

Examination

Tests

To confirm the diagnosis, samples of the patient's stool, spinal fluid, or throat mucus may be collected and sent to a laboratory for analysis to see whether the sample contains the virus itself. A blood sample early in the infection may also be analyzed for evidence of antibodies to the poliovirus.

Procedures

A **lumbar puncture** is the procedure performed in order to obtain a sample of the patient's spinal fluid. A long, thin needle is inserted into the lower back between the vertebrae to withdraw spinal fluid. This test can be used to reveal an increased number of white blood cells and no bacteria (aseptic meningitis).

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Treatment

Traditional

There is no drug that can cure polio as of 2010. **Antibiotics** are ineffective against any viral infection, including polio. Patients with abortive polio or non-paralytic meningitis do not usually need treatment other than resting at home.

Patients with paralytic polio may be placed on a respirator to help them breathe, particularly if they are diagnosed with bulbar polio. Other treatments include painkillers and hot packs for muscle aches, **physical therapy** to restore muscle strength, and occupational or **speech therapy** as needed. Physical therapy is the most important part of management of paralytic polio during recovery. Braces or special shoes may be recommended for some patients. A few patients may undergo surgery to restore limb function.

Prognosis

The overall prognosis for recovery from an acute attack of paralytic polio is generally good. Mortality is about 5–10 percent, mostly in elderly and very young patients; however, the death rate can reach 20–60 percent in cases of bulbar involvement. Half the patients with spinal polio recover fully; 25 percent have mild disabilities; and the remaining 25 percent are left with severe disabilities. Most patients recover from breathing problems, and only a small percentage of patients need long-term treatment on a respirator. Patients with muscle paralysis typically recover about 60 percent of their strength in the first 3–4 months of treatment.

About a quarter of patients who have recovered from paralytic polio develop a disorder called post-polio syndrome (PPS) between 10 and 40 years after the initial infection. PPS is not a reinfection although its cause is not completely understood as of 2009. PPS is marked by:

- Muscular weakness.
- Fatigue.
- Being easily exhausted after even small amounts of activity.
- Joint pain.
- Sleep disorders.
- Difficulty breathing or swallowing.
- Inability to tolerate cold temperatures.

PPS is treated with rest and such supportive measures as powered wheelchairs, pain relievers, and medications to help the patient sleep. Patients are also encouraged to simplify their work habits and take frequent rest breaks.

Prevention

Polio can easily be prevented by administration of either the Salk vaccine, which contains an inactivated poliovirus, or the Sabin oral vaccine, which contains a weakened live virus. The Salk vaccine (also called the killed polio vaccine or inactivated polio vaccine) consists of a series of three shots that are given just under the skin as two doses 4–8 weeks apart followed by a third dose 6–12 months after the second dose. This immunization contains no live virus, just the components of the virus that provoke the recipient's immune system to react as if the recipient were actually infected with the poliovirus. The recipient thus becomes immune to infection with the poliovirus in the future. The Salk vaccine is the only polio vaccine that is given to people with weakened immune systems.

The Sabin vaccine (also called the oral polio vaccine or OPV) is given to infants by mouth at the same intervals as the diphtheria-pertussis-tetanus (DPT) immunization (three doses). It contains the live, but weakened, poliovirus, which make the recipient immune to future infections with poliovirus. It is given to adults in a single dose by mouth. It is not routinely given to people with weakened immune systems because it contains a live virus.

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ORGANIZATIONS

American Physical Therapy Association (APTA), 1111 North Fairfax Street, Alexandria, VA, 22314-1488, 703-684-APTA (2782), 800-999-APTA (2782), 703-684-7343, http://www.apta.org//AM/Template.cfm?Section=Home.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, 800-232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

March of Dimes, 1275 Mamaroneck Avenue, White Plains, NY, 10605, 914-997-4488, http://www.marchofdimes.com.

U.S. National Institute of Allergy and Infectious Diseases (NIAID), 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-6612, 301-496-5717, 866-284-4107, 301-402-3573, http://www3.niaid.nih.gov.

World Health Organization (WHO), Avenue Appia 20, 1211 Geneva 27, Switzerland, + 41 22 791 21 11, + 41 22 791 31 11, info@who.int, http://www.who.int/en.

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Poliomyelitis *see* **Polio**

Polyangiitis overlap syndrome *see* **Vasculitis**

Polyarteritis nodosa *see* **Vasculitis**

Polycystic kidney disease

Definition

Polycystic kidney disease (PKD) is one of the most common of all life-threatening human genetic disorders. It is an incurable genetic disorder characterized by the formation of fluid-filled cysts in the kidneys of affected individuals. These cysts multiply over time. It was originally believed that the cysts eventually caused kidney failure by crowding out the healthy kidney tissue. It is now thought that the kidney damage seen in PKD is actually the result of the body's immune system. The immune system, in its attempts to rid the kidney of the cysts, instead progressively destroys the formerly healthy kidney tissue.

A pair of human kidneys. The left is a polycystic kidney, and the right is a normal kidney. *(A. Glauberman/Photo Researchers, Inc.)*

Demographics

One of the most common of all life-threatening genetic diseases, PKD affects more than 60,000 Americans. Over 12.5 million people worldwide are affected with PKD. Approximately one in every 400 to 1,000 people is affected with Autosomal Dominant Polycystic Kidney Disease (ADPKD). Another one in 10,000 affected with Autosomal Recessive Polycystic Kidney Disease (ARPKD). PKD is observed in equal numbers in both males and females. PKD is also observed with equal frequency among ethnic groups.

Description

A healthy kidney is about the same size as a human fist. PKD cysts, which can be as small as the head of a pin or as large as a grapefruit, can expand the kidneys until each one is bigger than a football and weighs as much as 38lb (17 kg).

There are two types of PKD: infantile PKD, which generally shows symptoms prior to birth; and adult onset PKD. Individuals affected with infantile PKD are often stillborn. Among the liveborn individuals affected with infantile PKD, very few of these children survive to the age of two. The adult onset form of PKD is much more common. The time and degree of symptom onset in the adult form of PKD can vary widely, even within a single family with two or more affected individuals. Symptoms of this form of

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PKD usually start to appear between the ages of 20 and 50. Organ deterioration progresses more slowly in adult onset PKD than it does in the infantile form; but, if left untreated, adult onset PKD also eventually leads to kidney failure.

Causes and symptoms

Polycystic kidney disease is expressed as both a recessive and a dominant trait. A recessive genetic trait will not cause disease in a child unless it is inherited from both parents. A dominant genetic trait can be inherited from just one parent. Those people affected with autosomal dominant polycystic kidney disease (ADPKD) have the much more common adult onset form. Those with autosomal recessive polycystic kidney disease (ARPKD) have the infantile form.

There are mutations on at least three genes that cause adult onset PKD. Approximately 85% of these cases are known to arise from mutations in the PKD1 gene that has been mapped to a region on the short arm of chromosome 16 (16p13.3-p13.12). Another 10–15% of cases of adult onset PKD are thought to be caused by mutations in the PKD2 gene that has been mapped to a region on the long arm of chromosome 4 (4q21-q23). As of 2010, it is thought that the remainder of the cases of PKD are caused by mutations in the PKD3 gene.

Adult onset PKD is transmitted from parents to their offspring as a non-sex linked (autosomal) dominant trait. This means that if either parent carries this genetic mutation, there is a 50% chance their child will inherit this disease. In the case of two affected parents, there is a 75% probability that their children will be affected with adult onset PKD.

Infantile PKD is caused by a non-sex linked (autosomal) recessive genetic mutation that has been mapped to a region on the short arm of chromosome 6 (6p21). Both parents must be carriers of this mutation for their children to be affected with infantile PKD. In the case of two carrier parents, the probability is 25% that their child will be affected by infantile PKD.

A baby born with infantile PKD has floppy, low-set ears, a pointed nose, a small chin, and folds of skin surrounding the eyes (epicanthal folds). Large, rigid masses can be felt on the back of both thighs (flanks), and the baby usually has trouble breathing.

In the early stages of adult onset PKD, many people show no symptoms. Generally, the first symptoms to develop are high blood pressure (**hypertension**), general **fatigue**, **pain** in the lower back or the backs of the thighs, headaches, and/or urinary tract infections accompanied by frequent urination.

As PKD becomes more advanced, the kidneys' inability to function properly becomes more pronounced. The cysts on the kidney may begin to rupture and the kidneys tend to be much larger than normal. Individuals affected with PKD have a much higher rate of **kidney stones** than the rest of the population at this, and later stages, of the disease. Approximately 60% of individuals affected with PKD develop cysts in the liver, while 10% develop cysts in the pancreas.

Because the kidneys are primarily responsible for cleaning the blood, individuals affected with PKD often have problems involving the circulatory system. These include an underproduction of red blood cells, which results in an insufficient supply of oxygen to the tissues and organs (anemia); an enlarged heart (cardiac hypertrophy) probably caused by long term hypertension; and a leakage of the valve between the left chambers (auricle and ventricle) of the heart (**mitral valve prolapse**). Less common (affecting approximately 5% of PKD patients) are brain aneurysms. An aneurysm is an abnormal and localized bulging of the wall of a blood vessel. If an aneurysm within the brain leaks or bursts, it may cause a **stroke** or even **death**.

Other health problems associated with adult onset PKD include chronic leg or back pain, frequent infections, and herniations of the groin and abdomen, including herniation of the colon (diverticular disease). A herniation, or **hernia**, is caused when a tissue, designed to hold the shape of an underlying tissue, becomes weakened at a particular spot. The underlying tissue pushes against this weakened area until the area is no longer able to hold back the underlying tissue and the area forms an abnormal bulge through which the underlying tissue projects. Diverticular disease is caused by a weakening of the muscles that hold the shape of the organs of the digestive tract. These muscles weaken allowing these organs, particularly one section of the colon, to form sac-like projections that can trap feces and become infected, or rupture.

In the final stages of PKD, the major symptom is kidney (renal) failure. Renal failure is indicated by an increase of nitrogen (in the form of urea) in the blood (uremia, or uremic poisoning). Uremia is a rapidly fatal condition without treatment.

Diagnosis

Many patients who have PKD do not have any symptoms. Their condition may not be discovered unless tests that detect it are performed for other reasons.

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KEY TERMS

Biopsy—The surgical removal and microscopic examination of living tissue for diagnostic purposes.

Cancer—A disease caused by uncontrolled growth of the body's cells.

Computed tomography (CT) scan—An imaging procedure that produces a three-dimensional picture of organs or structures inside the body, such as the brain.

Cyst—An abnormal sac or closed cavity filled with liquid or semisolid matter.

Diuretics—Medications that increase the excretion of urine.

Kidney—Either of two organs in the lumbar region that filter the blood, excreting the end products of the body's metabolism in the form of urine and regulating the concentrations of hydrogen, sodium, potassium, phosphate and other ions in the body.

Magnetic resonance imaging (MRI)—A technique that employs magnetic fields and radio waves to create detailed images of internal body structures and organs, including the brain.

Ultrasonogram—A procedure where high-frequency sound waves that cannot be heard by human ears are bounced off internal organs and tissues. These sound waves produce a pattern of echoes, which are then used by the computer to create sonograms or pictures of areas inside the body.

Uremic poisoning—Accumulation of waste products in the body.

Examination

When symptoms of PKD are present, the diagnostic procedure begins with a family medical history and **physical examination** of the patient. If several family members have PKD, there is a strong likelihood that the patient has it too. If the disease is advanced, the doctor will be able to feel the patient's enlarged kidneys. Heart murmur, high blood pressure, and other signs of cardiac impairment can also be detected.

Tests

Urinalysis and a blood test called creatinine clearance can indicate how effectively the kidneys are functioning. Scanning procedures using intravenous dye reveal kidney enlargement or deformity and scarring caused by cysts. Ultrasound and **computed tomography scans** (CT scans) can reveal kidney enlargement and the cysts that caused it. CT scans can highlight cyst-damaged areas of the kidneys.

Procedures

A sampling of the kidney cells (biopsy) may be performed to verify the diagnosis.

Treatment

There is no way to prevent cysts from forming or becoming enlarged, or to prevent PKD from progressing to kidney failure. Treatment goals include preserving healthy kidney tissue; controlling symptoms and, preventing infection and other complications.

Drugs

If adult PKD is diagnosed before symptoms become evident, urinalysis and other diagnostic tests are performed at six-week intervals to monitor the patient's health status. If results indicate the presence of infection or another PKD-related health problem, aggressive antibiotic therapy is initiated to prevent inflammation that can accelerate disease progression; iron supplements or infusion of red blood cells are used to treat anemia; and surgery may be needed to drain cysts that bleed, cause pain, have become infected, or interfere with normal kidney function.

Lowering high blood pressure can slow loss of kidney function. Blood-pressure control, which is the cornerstone of PKD treatment, is difficult to achieve. Therapy may include antihypertensive medications, diuretic medications, and/or a low-salt diet. As kidney function declines, some patients need dialysis and/or a kidney transplant.

Home remedies

There is no known way to prevent PKD, but certain lifestyle modifications can help control symptoms. People who have PKD should not drink heavily or smoke. They should not use **aspirin**, non-steroidal anti-inflammatory drugs (NSAIDs), or other prescription or over-the-counter medications that can impair

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kidney function. Individuals affected with PKD should eat a balanced diet, **exercise** regularly, and maintain a weight appropriate for their height, age, and body type. Regular medical monitoring is also recommended.

Prognosis

There is no known cure for PKD. Those affected with infantile PKD generally die before the age of two. In adults, untreated disease can be rapidly fatal or continue to progress slowly, even after symptoms of kidney failure appear. About half of all adults with PKD also develop kidney failure. Unless the patient undergoes dialysis or has a kidney transplant, this condition usually leads to death within four years of diagnosis.

Although medical treatment can temporarily alleviate symptoms of PKD, the expanding cysts continue to increase pressure on the kidneys. Kidney failure and uremic poisoning (accumulation of waste products the body is unable to eliminate) generally cause death about 10 years after symptoms first appear.

Medications used to fight **cancer** and reduce elevated cholesterol levels have slowed the advance of PKD in laboratory animals. They may soon be used to treat adults and children who have the disease. Researchers are also evaluating the potential benefits of anti-inflammatory drugs, which may prevent the scarring that destroys kidney function.

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ORGANIZATIONS

American Association of Kidney Patients, 3505 E. Frontage Rd., Suite 315, Tampa, FL, 33607, (800) 749-2257, info@aakp.org, http://www.aakp.org.

American Kidney Fund (AKF), 6110 Executive Blvd., Suite 1010, Rockville, MD, 20852, (800) 638-8299, http://www.kidneyfund.org.

American Society of Pediatric Nephrology, 3400 Research Forest Drive, Suite B-7, The Woodlands, TX, 77381, (281) 419-0052, info@aspneph.com, www.aspneph.com.

National Kidney and Urologic Disease Information Clearinghouse, 3 Information Way, Bethesda, MD, 20892, (301) 654-4415, www.niddk.nih.gov.

National Kidney Foundation, 30 East 33rd St. , New York, NY, 10016, (800) 622-9010, http://www.kidney.org.

National Organization for Rare Diseases (NORD), 55 Kenosia Ave. P.O. Box 1968, Danbury, CT, 06813, (203) 744-0100, orphan@rarediseases.org, http://www.rarediseases.org.

Polycystic Kidney Disease Foundation, 8330 Ward Parkway, Suite 510, Kansas City, MO, 64114, (816) 931-2600, (800) PKD-CURE, pdkcure@pdkcure.org, http://www.pkdcure.org.

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Polycystic ovary syndrome

Definition

Polycystic ovary syndrome (PCOS) is a condition characterized by the accumulation of numerous cysts (fluid-filled sacs) on the ovaries associated with high male hormone levels, chronic anovulation (absent ovulation), and other metabolic disturbances. Classic symptoms include excess facial and body hair, **acne**, **obesity**, irregular menstrual cycles, and **infertility**.

Description

PCOS, also called Stein-Leventhal syndrome, is a group of symptoms caused by underlying hormonal and metabolic disturbances that affect about 6% of premenopausal women. PCOS symptoms appear as early as adolescence in the form of **amenorrhea** (missed periods), obesity, and **hirsutism**, the abnormal growth of body hair.

A disturbance in normal hormonal signals prevents ovulation in women with PCOS. Throughout

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the cycle, estrogen levels remain steady, luteinizing hormone (LH) levels are high, and follide stimulating hormone (FSH) and progesterone levels are low. Since eggs are rarely or never released from their follicles, multiple **ovarian cysts** develop over time.

One of the most important characteristics of PCOS is hyperandrogenism, the excessive production of male hormones (androgens), particularly testosterone, by the ovaries. This accounts for the male hair-growth patterns and acne in women with PCOS. Hyperandrogenism has been linked with **insulin resistance** (the inability of the body to respond to insulin) and hyperinsulinemia (high blood insulin levels), both of which are common in PCOS.

Causes and symptoms

While the exact cause of PCOS is unknown, it runs in families, so the tendency to develop the syndrome may be inherited. The interaction of hyperinsulinemia and hyperandrogenism is believed to play a role in chronic anovulation in susceptible women.

The numbers and types of PCOS symptoms that appear vary among women. These include:

- Hirsutism. Related to hyperandrogenism, this occurs in 70% of women.
- Obesity. Approximately 40–70% of persons with PCOS are overweight.
- Anovulation and menstrual disturbances. Anovulation appears as amenorrhea in 50% of women, and as heavy uterine bleeding in 30% of women. However, 20% of women with PCOS have normal menstruation.
- Male-pattern hair loss. Some women with PCOS develop bald spots.
- Infertility. Achieving pregnancy is difficult for many women with PCOS.
- Polycystic ovaries. Most, but not all, women with PCOS have multiple cysts on their ovaries.
- Skin discoloration. Some women with PCOS have dark patches on their skin.
- Abnormal blood chemistry. Women with PCOS have high levels of low-density lipoprotein (LDL or "bad") cholesterol and triglycerides, and low levels of high-density lipoprotein (HDL or "good") cholesterol.
- Hyperinsulinemia. Some women with PCOS have high blood insulin levels, particularly if they are overweight.

Diagnosis

PCOS is diagnosed when a woman visits her doctor for treatment of symptoms such as hirsutism, obesity, menstrual irregularities, or infertility. Women with PCOS are treated by a gynecologist, a doctor who treats diseases of the female reproductive organs, or a reproductive endocrinologist, a specialist who treats diseases of the body's endocrine (hormones and glands) system and infertility.

PCOS can be difficult to diagnose because its symptoms are similar to those of many other diseases or conditions, and because all of its symptoms may not occur. A doctor takes a complete medical history, including questions about menstruation and reproduction, and weight gain. **Physical examination** includes a pelvic examination to determine the size of the ovaries, and visual inspection of the skin for hirsutism, acne, or other changes. Blood tests are performed to measure levels of luteinizing hormone, follicle stimulating hormone, estrogens, androgens, glucose, and insulin. A glucose-tolerance test may be administered. An ultrasound examination of the ovaries is performed to evaluate their size and shape. Most insurance plans cover the costs of diagnosing and treating PCOS and its related problems.

Treatment

PCOS treatment is aimed at correcting anovulation, restoring normal menstrual periods, improving fertility, eliminating hirsutism and acne, and preventing future complications related to high insulin and blood lipid (fat) levels. Treatment consists of weight loss, drugs or surgery, and hair removal, depending upon which symptoms are most bothersome, and whether a woman desires **pregnancy**.

Weight loss

In overweight women, weight loss (as little as 5%) through diet and **exercise** may correct hyperandrogenism, and restore normal ovulation and fertility. This is often tried first.

Drugs

HORMONAL DRUGS. Women who do not want to become pregnant and require **contraception** (spontaneous ovulation occurs occasionally among women with PCOS) are treated with low-dose oral contraceptive pills (OCPs). OCPs bring on regular menstrual periods and correct heavy uterine bleeding, as well as hirsutism, although improvement may not be seen for up to a year.

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If an infertile woman desires to become pregnant, the first drug usually given to help induce ovulation is clomiphene citrate (Clomid), which results in pregnancy in about 70% of women but can cause multiple births. In the 20–25% of women who do not respond to clomiphene, other drugs that stimulate follicle development and induce ovulation, such as human menstrual gonadotropin (Pergonal) and human chorionic gonadotropin (HCG), are given. However, these drugs have a lower pregnancy rate (less than 30%), a higher rate of **multiple pregnancy** (from 5–30%, depending on the dose of the drug), and a higher risk of medical problems. Women with PCOS have a high rate of **miscarriage** (30%), and may be treated with the gonadotropin-releasing hormone agonist leuprolide (Lupron) to reduce this risk.

Since women with PCOS do not have regular endometrial shedding due to high estrogen levels, they are at increased risk for overgrowth of this tissue and **endometrial cancer**. The drug medroxyprogesterone acetate, when taken for the first 10 days of each month, causes regular shedding of the endometrium, and reduces the risk of **cancer**. However, in most cases, oral contraceptive pills are used instead to bring about regular menstruation.

OTHER DRUGS. Another drug that helps to trigger ovulation is the steroid hormone dexamethasone. This drug acts by reducing the production of androgens by the adrenal glands.

The antiandrogen spironolactone (Aldactazide), which is usually given with an oral contraceptive, improves hirsutism and male-pattern baldness by reducing androgen production, but has no effect on fertility. The drug causes abnormal uterine bleeding and is linked with **birth defects** if taken during pregnancy. Another antiandrogen used to treat hirsutism, flutamide (Eulexin), can cause liver abnormalities, **fatigue**, mood swings, and loss of sexual desire. A drug used to reduce insulin levels, metformin (Glucophage), has shown promising results in women with PCOS hirsutism, but its effects on infertility and other PCOS symptoms are unknown. Drug treatment of hirsutism is long-term, and improvement may not be seen for up to a year or longer.

Acne is treated with **antibiotics**, antiandrogens, and other drugs such as retinoic acids (vitamin A compounds).

Surgical treatment

Surgical treatment of PCOS may be performed if drug treatment fails, but it is not common. A wedge resection, the surgical removal of part of the ovary and cysts through a laparoscope (an instrument inserted into the pelvis through a small incision), or an abdominal incision, reduces androgen production and restores ovulation. Although laparoscopic surgery is less likely to cause scar tissue formation than abdominal surgery, both are associated with the potential for scarring that may require additional surgery. Laparoscopic ovarian drilling is another type of laparoscopic surgery used to treat PCOS. The ovarian cysts are penetrated with a laser beam and some of the fluid is drained off. Between 50–65% of women may become pregnant after either type of surgery.

Some cases of severe hirsutism are treated by removal of the uterus (**hysterectomy**) and the ovaries (oopherectomy), followed by estrogen replacement therapy.

Other treatment

Hirsutism may be treated by hair removal techniques such as shaving, depilatories (chemicals that break down the structure of the hair), tweezing, waxing, electrolysis (destruction of the hair root by an electrical current), or the destruction of hair follicles by laser therapy. However, the treatments may have to be repeated.

Alternative treatment

PCOS can be addressed using many types of alternative treatment. The rebalancing of hormones is a primary focus of all these therapies. **Acupuncture** works on the body's energy flow according to the meridian system. Chinese herbs, such as *gui zhi fu ling wan*, can be effective. In **naturopathic medicine**, treatment focuses on helping the liver function more optimally in the horomonal balancing process. Dietary changes, including reducing animal products and fats, while increasing foods that nourish the liver such as carrots, dark green vegetables, lemons, and beets, can be beneficial. Essential fatty acids, including flax oil, evening primrose oil (*Oenothera biennis*), and black currant oil, act as anti-inflammatories and hormonal regulators. Western herbal medicine uses phytoestrogen and phytoprogesteronic herbs, such as blue cohosh (*Caulophyllum thalictroides*) and false unicorn root (*Chamaelirium luteum*), as well as liver herbs, like dandelion (*Taraxacum mongolicum*), to work toward hormonal balance. Supplementation with **antioxidants**, including zinc, and **vitamins** A, E, and C, is also recommended. Constitutional homeopathy can

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KEY TERMS

Androgens—Male sex hormones produced by the adrenal glands and testes, the male sex glands.

Anovulation—The absence of ovulation.

Antiandrogens—Drugs that inhibit androgen production.

Estrogens—Hormones produced by the ovaries, the female sex glands.

Follicle stimulating hormone—A hormone that stimulates the growth and maturation of mature eggs in the ovary.

Gynecologist—A physician with specialized training in diseases and conditions of the female reproductive system.

Hirsutism—An abnormal growth of hair on the face and other parts of the body caused by an excess of androgens.

Hyperandrogenism—The excessive secretion of androgens.

Hyperinsulinemia—High blood insulin levels.

Insulin resistance—An inability to respond to insulin, a hormone produced by the pancreas that helps the body to use glucose.

Laparoscope—An instrument inserted into the pelvis through a small incision.

Luteinizing hormone—A hormone that stimulates the secretion of sex hormones by the ovary.

Ovarian follicles—Structures found within the ovary that produce eggs.

bring about a deep level of healing with the correct remedies.

Prognosis

With proper diagnosis and treatment, most PCOS symptoms can be adequately controlled or eliminated. Infertility can be corrected and pregnancy achieved in most women although, in some, hormonal disturbances and anovulation may recur. Women should be monitored for endometrial cancer. Because of the high rate of hyperinsulinemia seen in PCOS, women with the disorder should have their glucose levels checked regularly to watch for the development of diabetes. Blood pressure and cholesterol screening are also needed because these women also tend to have high levels of LDL cholesterol and **triglycerides**, which put them at risk for developing heart disease.

Prevention

There is no known way to prevent PCOS, but if diagnosed and treated early, risks for complications such as and heart disease and diabetes may be minimized. Weight control through diet and exercise stabilizes hormones and lowers insulin levels.

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Vanderbilt University School of Medicine. http://www.mc.vanderbilt.edu/peds/pidl/adolesc/polcysov.htm.

Women's Health-UK. http://www.womens-health.co.uk.

ORGANIZATIONS

American Academy of Family Physicians (AAFP), 11400 Tomahawk Creek Parkway, Leawood, KS, 66211-2680, (913) 906-6000, (913) 906-6075, 800 271-2237, http://www.aafp.org.

American Medical Association, 515 N. State St., Chicago, IL, 60654, (800) 621-8335, http://www.ama-assn.org.

Polycystic Ovarian Syndrome Association, P.O. Box 3403, Englewood, CO, 80155-3403, info@pcosupport.org, http://www.pcosupport.org.

L. Fleming Fallon, Jr., MD, DrPH

Polycythemia *see* **Secondary polycythemia**

Polycythemia rubra vera *see* **Polycythemia vera**

Polycythemia vera

Definition

Polycythemia vera (PV) is a chronic blood disorder marked by an abnormal increase in three types of blood cells produced by bone marrow: red blood cells (RBCs), white blood cells (WBCs), and platelets. PV is called a myeloproliferative disorder, which means that the bone marrow is producing too many cells too quickly. Most of the symptoms of PV are related to the increased volume of the patient's blood and its greater thickness (high viscosity). PV sometimes evolves into a different myeloproliferative disorder or into acute leukemia.

Description

Polycythemia vera is a relatively common progressive disorder that develops over a course of 10–20 years. In the United States, PV affects about one person in every 200,000. PV has several other names, including splenomegalic polycythemia, Vaquez-Osler syndrome, erythremia, and primary polycythemia. Primary polycythemia means that the disorder is not caused or triggered by other illnesses. PV most commonly affects middle-aged adults. It is rarely seen in children or young adults and does not appear to run in families. The male/female ratio is 2:1.

Risk factors for polycythemia vera include:

- Caucasian race
- male sex
- age between 40 and 60

Causes and symptoms

The cause of PV remains uncertain. In general, the increased mass of red blood cells in the patient's blood causes both hemorrhage and abnormal formation of **blood clots** in the circulatory system (thrombosis). The reasons for these changes in clotting patterns are not yet fully understood.

Early symptoms

The symptoms of early PV may be minimal–it is not unusual for the disorder to be discovered during a routine blood test. More often, however, patients have symptoms that include headaches, ringing in the ears, tiring easily, memory problems, difficulty breathing, giddiness or lightheadedness, **hypertension**, visual problems, or **tingling** or burning sensations in their hands or feet. Another common symptom is **itching** (pruritus). Pruritus related to PV is often worse after the patient takes a warm bath or shower.

Some patients' early symptoms include unusually heavy bleeding from minor cuts, nosebleeds, stomach ulcers, or bone **pain**. In a few cases, the first symptom is the development of blood clots in an unusual part of the circulatory system (e.g., the liver).

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Later symptoms and complications

As the disease progresses, patients with PV may have episodes of hemorrhage or thrombosis. Thrombosis is the most frequent cause of **death** from PV. Other complications include a high level of uric acid in the blood and an increased risk of peptic ulcer disease. About 10% of PV patients eventually develop **gout**; another 10% develop peptic ulcers.

Spent phase

The spent phase is a development in late PV that affects about 30% of patients. The bone marrow eventually fails and the patient becomes severely anemic, requiring repeated blood transfusions. The spleen and liver become greatly enlarged–in the later stages of PV, the patient's spleen may fill the entire left side of the abdomen.

Diagnosis

Physical examination

PV is often a diagnosis of exclusion, which means that the doctor will first rule out other possible causes of the patient's symptoms. The doctor can detect some signs of the disorder during a **physical examination**. Patients with PV will have an enlarged spleen (splenomegaly) in 75% of cases. About 50% will have a slightly enlarged liver. The doctor can feel these changes when he or she presses on (palpates) the patient's abdomen while the patient is lying flat. An **eye examination** will usually reveal swollen veins at the back of the eye. Patients with PV often have unusually red complexions; mottled red patches on their legs, feet, or hands; or swelling at the ends of the fingers.

Diagnostic criteria for PV

Accurate diagnosis of PV is critical because its treatment may require the use of drugs with the potential to cause leukemia. The results of the patient's blood tests are evaluated according to criteria worked out around 1970 by the Polycythemia Vera Study Group. The patient is considered to have PV if all three major criteria are met; or if the first two major criteria and any two minor criteria are met.

Major criteria:

- red blood cell mass greater than 36 mL/kg in males, greater than 32 mL/kg in females
- arterial oxygen level greater than 92%
- splenomegaly

Minor criteria:

- platelet count greater than 400,000/mm^3
- WBC greater than 12,000/mm^3 without fever or infection
- leukocyte alkaline phosphatase (LAP) score greater than 100 with increased blood serum levels of vitamin B_{12}

Laboratory testing

BLOOD TESTS. The diagnosis of PV depends on a set of findings from blood tests. The most important single measurement is the patient's red blood cell mass as a proportion of the total blood volume. This measurement is made by tagging RBCs with radioactive chromium (^{51}Cr) in order to determine the patient's RBC volume. While a few patients with PV may have a red cell mass level within the normal range if they have had recent heavy bleeding, a high score may eliminate the need for some other tests. A score higher than 36 mL/kg for males and 32 mL/kg for females on the ^{51}Cr test suggests PV. Measurements of the oxygen level in the patient's arterial blood, of the concentration of vitamin B_{12} in the blood serum, and of leukocyte alkaline phosphatase (LAP) staining can be used to distinguish PV from certain types of leukemia or from other types of polycythemia. LAP staining measures the intensity of enzyme activity in a type of white blood cell called a neutrophil. In PV, the LAP score is higher than normal whereas in leukemia it is below normal.

BONE MARROW TESTS. Bone marrow testing can be used as part of the diagnostic process. A sample of marrow can be cultured to see if red blood cell colonies develop without the addition of a hormone that stimulates RBC production. The growth of a cell colony without added hormone indicates PV. Bone marrow testing is also important in monitoring the progress of the disease, particularly during the spent phase.

GENETIC TESTING. **Genetic testing** can be used to rule out the possibility of chronic myeloid leukemia. Patients with this disease have a characteristic chromosomal abnormality called the Philadelphia chromosome. The Philadelphia chromosome does *not* occur in patients with PV.

Imaging studies

Imaging studies are not necessary to make the diagnosis of PV. In some cases, however, imaging studies can detect enlargement of the spleen that the doctor may not be able to feel during the physical examination.

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KEY TERMS

Anagrelide—An orphan drug that is approved for treating PV patients on an investigational basis. Anagrelide works by controlling the level of platelets in the blood.

Leukocyte alkaline phosphatase (LAP) test—A blood test that measures the level of enzyme activity in a type of white blood cell called neutrophils.

Myeloproliferative disorder—A disorder in which the bone marrow produces too many cells too rapidly.

Myelosuppressive therapy—Any form of treatment that is aimed at slowing down the rate of blood cell production.

Orphan drug—A drug that is known to be useful in treatment but lacks sufficient funding for further research and development.

Philadelphia chromosome—An abnormal chromosome that is found in patients with a chronic form of leukemia but not in PV patients.

Phlebotomy—Drawing blood from a patient's vein as part of diagnosis or therapy. Phlebotomy is sometimes called venesection. It is an important part of the treatment of PV.

Pruritus—An itching sensation or feeling. In PV the itching is not confined to a specific part of the body and is usually worse after a warm bath or shower.

Spent phase—A late development in PV leading to failure of the bone marrow and severe anemia.

Splenomegaly—Abnormal enlargement of the spleen. Splenomegaly is a major diagnostic criterion of PV.

Treatment

Treatment of PV is tailored to the individual patient according to his or her age, the severity of the symptoms and complications, and the stage of the disease.

Phlebotomy

Phlebotomy is the withdrawal of blood from a vein. It is the first line of treatment for patients with PV. Phlebotomy is used to bring down the ratio of red blood cells to fluid volume (the **hematocrit**) in the patient's blood to a level below 45%. In most cases the doctor will withdraw about 500 mL of blood (about 15 fluid ounces) once or twice a week until the hematocrit is low enough. Phlebotomy is considered the best course of treatment for patients younger than 60 and for women of childbearing age. Its drawback is that patients remain at some risk for either thrombosis or hemorrhage.

Myelosuppression

Myelosuppressive therapies are used to slow down the body's production of blood cells. They are given to patients who are older than 60 and at high risk for thrombosis. These therapies, however, increase the patient's risk of developing leukemia. The substances most frequently used include hydroxyurea (Hydrea), interferon alfa (Intron), or radioactive phosphorus (^{32}P). ^{32}P is used only in elderly patients with life expectancies of less than five years because it causes leukemia in about 10% of patients. Interferon alfa is expensive and causes side effects resembling the symptoms of **influenza** but is an option for some younger PV patients.

Investigational treatment

The Food and Drug Administration (FDA) has approved the use of anagrelide, an orphan drug, for investigational use in the treatment of PV. Anagrelide has moderate side effects and controls the platelet level in over 90% of patients.

Treatment of complications

The itching caused by PV is often difficult to control. Patients with pruritus are given diphenhydramine (Benadryl) or another antihistamine. Patients with high levels of uric acid are usually given allopurinol (Lopurin, Zyloprim) by mouth. Supportive care includes advice about diet–splenomegaly often makes patients feel full after eating only a little food. This problem can be minimized by advising patients to eat small meals followed by rest periods.

Because of the clotting problems related to PV, patients should not undergo surgery until their blood counts are close to normal levels. Female patients of childbearing age should be warned about the dangers of **pregnancy** related to their clotting abnormalities.

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Prognosis

The prognosis for untreated polycythemia vera is poor; 50% of patients die within 18 months after diagnosis. Death usually results from **heart failure**, leukemia, or hemorrhage. Patients being treated for PV can expect to live between 11 and 15 years on average after diagnosis.

ORGANIZATIONS

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923, (800) 999-6673, http://www.rarediseases.org.

Rebecca J. Frey, PhD

Polydactyly is the occurrence of extra or partial fingers or toes. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Polydactyly and syndactyly

Definition

Polydactyly and syndactyly are congenital irregularities of the hands and feet. Polydactyly is the occurrence of extra fingers or toes, and syndactyly is the webbing or fusing together of two or more fingers or toes.

Description

Polydactyly can vary from an unnoticeable rudimentary finger or toe to fully developed extra digits.

Syndactyly also exhibits a large degree of variation. Digits can be partially fused or fused along their entire length. The fusion can be simple with the digits connected only by skin, or it can be complicated with shared bones, nerves, vessels, or nails.

Syndactyly is the webbing or fusing together of two or more fingers or toes. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Polydactyly and syndactyly can occur simultaneously when extra digits are fused. This condition is known as polysyndactyly.

Causes and symptoms

Polydactyly and syndactyly are due to errors in the process of fetal development. For example, syndactyly results from the failure of the programmed cell **death** that normally occurs between digits. Most often these errors are due to genetic defects.

Polydactyly and syndactyly can both occur by themselves as isolated conditions or in conjunction with other symptoms as one aspect of a multi-symptom disease. There are several forms of isolated syndactyly and several forms of isolated polydactyly; each of these, where the genetics is understood, is caused by an autosomal dominant gene. This means that since the gene is autosomal (not sex-linked), males and females are equally likely to inherit the trait. This also means that since the gene is dominant, children who have only one parent with the trait have a 50% chance

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KEY TERMS

Autosomal chromosome—One of the non-X or non-Y chromosomes.

Congenital—A condition present at birth.

Digit—A finger or a toe.

Dominant trait—A genetic trait that will always express itself when present as one of a pair of genes (as opposed to a recessive trait where two copies of the gene are necessary to give the individual the trait).

Gene—A portion of a DNA molecule that either codes for a protein or RNA molecule or has a regulatory function.

Triploidy—The condition where an individual has three entire sets of chromosomes instead of the usual two.

Trisomy—An abnormal condition where three copies of one chromosome are present in the cells of an individual's body instead of two, the normal number.

of inheriting it. However, people in the same family carrying the same gene can have different degrees of polydactyly or syndactyly.

Polydactyly and syndactyly are also possible outcomes of a large number of rare inherited and developmental disorders. One or both of them can be present in over 100 different disorders where they are minor features compared to other characteristics of these diseases.

For example, polydactyly is a characteristic of Meckel syndrome and Laurence-Moon-Biedl syndrome. Polydactyly may also be present in Patau's syndrome, asphyxiating thoracic dystrophy, hereditary spherocytic **hemolytic anemia**, Moebius syndrome, VACTERL association, and Klippel-Trenaunay syndrome.

Syndactyly is a characteristic of Apert syndrome, Poland syndrome, Jarcho-Levin syndrome, oral-facial-digital syndrome, Pfeiffer syndrome, and Edwards syndrome. Syndactyly may also occur with Gordon syndrome, Fraser syndrome, Greig cephalopolysyndactyly, **phenylketonuria**, Saethre-Chotzen syndrome, Russell-Silver syndrome, and triploidy.

In some isolated cases of polydactyly or syndactyly, it is not possible to determine the cause. Some of these cases might nevertheless be due to genetic defects; sometimes there is too little information to demonstrate a genetic cause. Some cases might be due to external factors like exposure to toxins or womb anomalies.

Diagnosis

Polydactyly and syndactyly can be diagnosed by external observation, x ray, and fetal sonogram.

Treatment

Polydactyly can be corrected by surgical removal of the extra digit or partial digit. Syndactyly can also be corrected surgically, usually with the addition of a skin graft from the groin.

Prognosis

The prognosis for isolated polydactyly and syndactyly is excellent. When polydactyly or syndactyly are part of a larger condition, the prognosis depends on the condition. Many of these conditions are quite serious, and early death may be the outcome.

Prevention

There is no known prevention for these conditions.

Resources

OTHER

OMIM Home Page, Online Mendelian Inheritance in Man. http://www.ncbi.nlm.nih.gov/Omim.

ORGANIZATIONS

March of Dimes Birth Defects Foundation, 1275 Mamaroneck Ave., White Plains, NY, 10605, (914) 997-4488, http://www.modimes.org.

National Institute of Child Health and Human Development, Bldg 31, Room 2A32, MSC 2425, 31 Center Drive, Bethesda, MD, 20892-2425, 8666 760-5947, (800) 370-2943, http://www.nichd.nih.gov.

Lorraine Lica, PhD

Polyendocrine deficiency syndromes *see* **Polyglandular deficiency syndromes**

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Polyglandular deficiency syndromes

Definition

Polyglandular deficiency syndromes are disorders characterized by the failure of more than one endocrine gland to make hormones in sufficient quantities for the body to function normally.

Description

the endocrine system is a diverse group of glands located all over the body that work together to regulate the body's metabolic activities. It includes:

- the pituitary gland, located deep in the brain, is considered the "master gland" that regulates many of the others
- the thyroid gland is located in the neck and sets the metabolic speed of many processes,
- the parathyroid glands, attached to the back of the thyroid, regulate calcium balance,
- the adrenal glands are located on top of the kidneys and make four separate kinds of hormones,
- the gonads (sex organs) produce sex hormones,
- the pancreas is responsible for the production of digestive juices, insulin, and glucagon.

There are over a dozen different syndromes that involve failure of more than one endocrine gland.

Causes and symptoms

The cause of polyglandular deficiency syndromes is usually an autoimmune response—a condition in which the body generates antibodies to its own tissues. The immune system may attack one or more glands; however, because of their inter dependence, the destruction of one gland can often lead to the impairment of another. Other causes may include **infectious disease**; insufficient blood flow to the glands due to an obstruction such as a blood clot; or the presence of a tumor.

Doctors usually group polyglandular deficiency syndromes into three types:

- Type I occurs during childhood and is characterized by failure of the adrenals, parathyroids, thyroid, and gonads combined with hepatitis, hair loss, skin pigment changes, and inability of the bowel to absorb adequate nutrition. These children also get a persistent skin fungus infection called candidiasis.
- Type II occurs during adulthood and is characterized by failure of the adrenals, thyroid (Schmidt's syndrome), and gonads combined with similar nutritional failures and hair and skin changes. These patients also have myasthenia gravis. This type of polyglandular deficiency syndrome often produces insulin-dependent diabetes mellitus (IDDM).
- Type III disease may produce diabetes or adrenal failure combined with thyroid problems. It may also include baldness (alopecia), anemia, and vitiligo (condition characterized by white patches on normally pigmented skin).

Not all symptoms of any syndrome appear at once or in the same patient.

KEY TERMS

Antibody—A weapon in the body's immune defense arsenal that attacks a specific antigen.

Congenital—Present at birth.

Myasthenia gravis—A disease that causes muscle weakness.

Rubella—German measles.

Syndrome—A collection of abnormalities that occur often enough to suggest they have a common cause.

Diagnosis

Because these diseases evolve over time, the final diagnosis may not appear for years. A family history is very helpful in knowing what to expect. Any single endocrine abnormality should heighten suspicion that there are others, since they so often occur together, both as underproduction and overproduction of hormones. Most hormone levels can be monitored through blood tests. Many of the antibodies that characterize these conditions can also be found by blood testing.

Treatment

Fortunately there are replacements available for all the missing hormones. Careful balancing of them all can provide a reasonably comfortable quality of life for these patients.

Resources

BOOKS

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J. Ricker Polsdorfer, MD

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Polyhydramnios and oligohydramnios

Definition

Polyhydramnios and oligohydramnios are amniotic fluid abnormalities. Polyhydramnios is an excess of amniotic fluid and oligohydramnios is a deficiency of amniotic fluid.

Description

Amniotic fluid is the liquid that surrounds the developing fetus during **pregnancy**. It is contained within the amniotic membrane that forms the amniotic sac (bag of waters). During the first three months after conception (first trimester), amniotic fluid is mainly derived from the blood plasma that diffuses through the thin tissues of the fetus into the surrounding space. After the fetal kidneys form and become functional at about 10–11 weeks, fetal urine becomes the main source of amniotic fluid and remains so for the rest of the pregnancy. In addition, the lungs also produce liquid that becomes part of the amniotic fluid. Other contributions come from fetal oral and nasal secretions and from the fetal surface of the placenta. Amniotic fluid removal is largely due to fetal swallowing and absorption into the fetal blood. Uptake also occurs across the placental surface. The volume of amniotic fluid normally increases throughout pregnancy, reaching a peak at about 32–33 weeks and remaining fairly constant or decreasing slightly thereafter. There is a wide range of normal fluid volumes with an average of 700–800 mL at 32–33 weeks. Through the processes of swallowing and urination, a fetus can recycle the entire volume in less than 24 hours. Because the normal values for amniotic fluid volume increase during pregnancy, the actual volume that constitutes polyhydramnios is dependent on the gestational age of the fetus. During the last two months of pregnancy, polyhydramnios usually refers to amniotic fluid volumes greater than 1,700–1,900 mL. Severe cases are associated with much greater fluid volume excesses. The range of fluid values diagnostic of oligohydramnios is not as wide as that for polyhydramnios. Less than 300 mL, or lower than the 5% percentile for gestational age, is usually considered the upper threshold.

Causes and symptoms

Polyhydramnios, also referred to as hydramnios, can have any one of a number of causes related either to an underlying maternal or fetal condition. Maternal diabetes, which is associated with a macrosomic (enlarged) fetus, is a common cause. The medication lithium, used to treat depression, can also increase amniotic fluid levels. Twin gestations are prone to polyhydramnios. Infections passed from mother to fetus such as **rubella**, cytomegalovirus, and **toxoplasmosis**, can also result in damage to the fetus and elevated amniotic fluid levels. Fetal abnormalities, including many that are life-threatening or lead to a significant impairment in the quality of life, are found in up to a quarter of all patients. For this reason, the initial finding of excess amniotic fluid should be followed by thorough diagnostic studies to determine the cause and the prognosis.

Because fetal swallowing is a major factor in amniotic fluid removal, fetal abnormalities that prevent fluid uptake should be investigated. These include gastrointestinal obstructions such as **esophageal atresia** and duodenal atresia, as well as neurological conditions that affect swallowing including anencephaly. Certain cardiac abnormalities, kidney disorders, and genetic conditions such as **myotonic dystrophy** and alpha-thalassemia can also cause polyhydramnios. Fetal chromosome abnormalities are frequently associated with elevated amniotic fluid levels. The more severe the polyhydramnios the more likely it is that fetal abnormalities will be present. In addition, there are other, infrequent causes, and in a number of cases, no cause can be found. Polyhydramnios can lead to maternal abdominal discomfort and respiratory difficulties as well as preterm labor. When polyhydramnios is associated with fetal abnormalities, perinatal mortality is significantly increased.

Oligohydramnios is most commonly associated with abnormalities of the fetal kidneys. Since fetal urine is the main source of amniotic fluid in the latter two-thirds of pregnancy, any condition that interferes with fetal urine production can lead to oligohydramnios. Renal agenesis, cystic kidneys, and bladder outlet obstructions are common. Meckel-Gruber syndrome, a lethal autosomal recessive genetic disorder featuring brain and kidney abnormalities and extra digits is one specific cause. Placental insufficiency and fetal growh retardation can also result in oligohydramnios. **Premature rupture of membranes**, especially between 16 and 24 weeks is another cause and, because amniotic fluid is important in lung growth, it can lead to underdevelopment of the lungs (pulmonary hypoplasia). In general, regardless of the cause, oligohydramnios that arises early in a pregnancy, can cause hypoplastic lungs. It can also result in space limitations within the amniotic sac that cause fetal compression and orthopedic abnormalities such as clubbed feet in the newborn. In general, oligohydramnios that begins near the time of delivery is associated with a better outcome than cases than have an onset earlier in pregnancy.

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KEY TERMS

Alpha-thalassemia—An inherited disorder that interferes with the normal production of hemoglobin.

Anencephaly—Congenital absence of the brain. Occurs during the first month of embryonic development.

Autosomal recessive—A pattern of inheritance in which both copies of an autosomal gene must be abnormal for a genetic condition or disease to occur. An autosomal gene is one that is located on one of the autosomes or non-sex chromosomes. When both parents have one abnormal copy of the same gene, they have a 25% chance with each pregnancy that their offspring will have the disorder.

Congenital—Present at birth.

Duodenal atresia—Closure or blockage of the duodenum, the upper section of the small intestine.

Esophageal atresia—Blockage or closure of the esophagus, the tube leading from the mouth to the stomach.

Gestational age—The estimated age of a fetus expressed in weeks, calculated from the first day of the last normal menstrual period.

Myotonic dystrophy—A genetic defect resulting in abnormal muscle function.

Placenta—The flat, spongy structure that forms within the uterus during pregnancy and provides nourishment to the developing fetus.

Renal agenesis—Failure of the fetal kidneys to form. Oligohydramnios usually associated with absence of both kidneys.

Diagnosis

In current obstetrical practice, polyhydramnios and oligohydramnios are usually detected during a routine prenatal ultrasound. If the ultrasonographer suspects that excess or reduced fluid is present, it is customary to take measurements of pockets of fluid visualized around the fetus, calculate the amniotic fluid index (AFI), and compare it to AFI values found in standard tables. Subsequent ultrasound measurements can then be used to track the increase or decrease in fluid.

It is extremely important that the cause of an abnormal AFI be sought. Because of the high risk of fetal abnormalities, detailed ultrasound exams (targeted exams) should then be performed. The mother should be counseled about the possible complications and offered additional testing as necessary. For example, an **amniocentesis** for prenatal chromosome analysis may be important because of the high risk of fetal chromosome abnormalities. This test is usually indicated if fetal abnormalities are suspected on the basis of the ultrasound exam. An amniocentesis can also be used to check for fetal infections and some rare single gene defects.

Treatment

Effective treatments for polyhydramnios and oligohydramnios are limited. To relieve maternal discomfort, an excess fluid level can be reduced by inserting a needle into the amniotic sac and using a syringe to withdraw excess fluid. This can be done repeatedly, if necessary. In oligohydramnios, the opposite approach of adding fluid either by increasing oral intake in the mother or by directly infusing saline into the amniotic sac has been tried in select cases. If the cause of oligohydramnios is a fetal bladder obstruction, it may be possible to place a small tube in the bladder to shunt the fluid into the amniotic sac.

Alternative treatment

In select cases where polyhydramnios is thought to be due to an increased output of fetal urine, the drug indomethicin has been used with some success, but there is concern about side effects, particularly on the fetus. Another similar drug, sulindac, is currently being investigated. If oligohydramnios is due to premature rupture of the membranes, a protocol to manage complications should be instituted.

Prognosis

The prognosis for both polyhydramnios and oligohydramnios depends on the cause. If excess or reduced amniotic fluid is the result of an underlying fetal abnormality, the nature of that abnormality will determine the prognosis. This is one reason why it is important to perform the necessary follow-up studies. A woman who has been diagnosed with polyhydramnios or oligohydramnios needs to be made fully aware of the types of testing available and carefully counseled about the diagnosis and its impact on the chance for a successful pregnancy outcome and a healthy infant.

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Prevention

In order to prevent polyhydramnios or oligohydramnios, it would be necessary to prevent the underlying cause. Good control of maternal diabetes and the prevention of infections transmittable from mother to fetus are two approaches for a subset of cases, but, in general, prevention is not possible.

Resources

BOOKS

Cunningham, F. Gary, et al. *Williams Obstetrics*. 23rd ed. New York: McGraw–Hill Medical, 2010.

Rodeck, Charles H., and Martin J. Whittle. *Fetal Medicine: Basic Science and Clinical Practice*. 2nd ed. New York: Churchill Livingstone, 2009.

Sallie Boineau Freeman, PhD

KEY TERMS

Anemia—A condition in which the blood lacks enough red blood cells (hemoglobin).

Atrophy—Wasting away of a body part.

Frozen shoulder—A shoulder that becomes scarred and cannot move.

Giant cell arteritis—Also called temporal arteritis. A condition which causes the inflammation of temporal arteries. It can cause blindness when the inflammation effects the ophthalmic artery.

NSAIDs—Nonsteroidal anti-inflammatory drugs like aspirin, ibuprofen, and naproxen.

Syndrome—A collection of abnormalities that occur often enough to suggest they have a common cause.

Polymyalgia rheumatica

Definition

Polymyalgia rheumatica is a syndrome that causes **pain** and stiffness in the hips and shoulders of people over the age of 50.

Description

Although the major characteristics of this condition are just pain and stiffness, there are reasons to believe it is more than just rheumatism. Patients are commonly so afflicted that their muscles atrophy from disuse. A similar complaint of such weakness is also seen in serious muscle diseases. Moreover, some patients develop arthritis or a disease called giant cell arteritis or **temporal arteritis**.

Causes and symptoms

This condition may arise as often as once in every 2,000 people. Rarely does it affect people under 50 years old. The average age is 70; women are afflicted twice as often as men. Along with the pain and stiffness of larger muscles, **headache** may add to the discomfort. The scalp is often tender. Pain is usually worse at night. There may be **fever** and weight loss before the full disease appears. Patients complain that stiffness is worse in the morning and returns if they have been inactive for any period of time, a condition called gelling. Sometimes the stiffness is severe enough that it causes frozen shoulder.

Diagnosis

Symptoms are usually present for over a month by the time patients seek medical attention. A mild anemia is often is often present. One blood test, called an **erythrocyte sedimentation rate**, is very high, much more so than in most other diseases. The most important issue in evaluating polymyalgia rheumatica is to check for giant cell arteritis. Giant cell arteritis can lead to blindness if lift untreated.

Treatment

Polymyalgia rheumatica responds dramatically to cortisone-like drugs in modest doses. In fact, one part of confirming the diagnosis is to observe the response to this treatment. It may also respond to **nonsteroidal anti-inflammatory drugs** (NSAIDs). Temporal arteritis is also treated with cortisone, but in higher doses.

Prognosis

The disease often remits after time, with no further treatment required.

Resources

BOOKS

Fauci, Anthony S., et al., eds. *Harrison's Principles of Internal Medicine*. 17th ed. New York: McGraw-Hill Professional, 2008.

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Polymyositis

Definition

Polymyositis is an inflammatory muscle disease causing weakness and **pain**. **Dermatomyositis** is identical to polymyositis with the addition of a characteristic skin rash.

Description

Polymyositis (PM) is an inflammatory disorder in which muscle tissue becomes inflamed and deteriorates, causing weakness and pain. It is one of several types of inflammatory muscle disease, or myopathy. Others include dermatomyositis (DM) and inclusion body **myositis**. All three types are progressive conditions, usually beginning in adulthood. A fourth type, juvenile dermatomyositis, occurs in children. Although PM and DM can occur at any age, 60% of cases appear between the ages of 30 and 60. Females are affected twice as often as males.

Causes and symptoms

Causes

The cause of PM and DM is not known, but it is suspected that a variety of factors may play a role in the development of these diseases. PM and DM may be autoimmune diseases, caused by the immune system's attack on the body's own tissue. The reason for this attack is unknown, although some researchers believe that a combination of immune system susceptibility and an environmental trigger may explain at least some cases. Known environmental agents associated with PM and DM include infectious agents such as *Toxoplasma*, *Borrella* (**Lyme disease** bacterium), and coxsackievirus. Most cases, however, have no obvious triggers (direct causative agents). There may also be a genetic component in the development of PM and DM.

Symptoms

The early symptoms of PM and DM are slowly progressing muscle weakness, usually symmetrical between the two sides of the body. PM and DM affect primarily the muscles of the trunk and those closest to the trunk, while the hands, feet, and face usually are not involved. Weakness may cause difficulty walking, standing, and lifting objects. Rarely, the muscles of breathing may be affected. Weakness of the muscles used for swallowing can cause difficulty with swallowing (dysphagia). Joint pain and/or swelling also may be present. Later in the course of these diseases, muscle wasting or shortening (contracture) may develop in the arms or legs. Heart abnormalities, including electrocardiogram (ECG) changes and **arrhythmias**, develop at some time during the coursed of these diseases in about 30% of patients.

Dermatomyositis is marked by a skin rash. The rash is dusky, reddish, or lilac in color, and is most often seen on the eyelids, cheeks, bridge of the nose, and knuckles, as well as on the back, upper chest, knees, and elbows. The rash often appears before the muscle weakness.

Diagnosis

PM and DM are often difficult diseases to diagnose, because they are rare, because symptoms come on slowly, and because they can be mistaken for other diseases that cause muscle weakness, especially limb girdle **muscular dystrophy**.

Accurate diagnosis involves:

- A neurological exam.
- Blood tests to determine the level of the muscle enzyme creatine kinase, whose presence in the circulation indicates muscle damage.
- Electromyography, an electrical test of muscle function.
- Muscle biopsy, in which a small sample of affected muscle is surgically removed for microscopic analysis. A biopsy revealing muscle cells surrounded by immune system cells is a strong indicator of myositis.

Treatment

PM and DM respond to high doses of **immunosuppressant drugs** in most cases. The most common medication used is the corticosteroid prednisone. Prednisone therapy usually leads to improvement within two or three months, at which point the dose can be tapered to a lower level to avoid the significant side effects associated with high doses of prednisone. Unresponsive patients are often given a replacement or supplementary immunosuppressant, such as azathioprine, cyclosporine, or methotrexate. Intravenous immunoglobulin treatments may help some people who are unresponsive to other immunosuppressants.

Pain can usually be controlled with an over-the-counter analgesic, such as **aspirin**, ibuprofen, or naproxen. A speech-language therapist can help suggest exercises and tips to improve difficulty in swallowing. Avoiding weight gain helps prevent overtaxing weakened muscles.

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KEY TERMS

Autoimmune disease—A diseases in which the body's immune system, responsible for fighting off foreign invaders such as bacteria and viruses, begins to attack and damage a part of the body as if it were foreign.

Immunosuppressant—A drug that reduces the body's natural immunity by suppressing the natural functioning of the immune system.

Alternative treatment

As with all autoimmune conditions, food allergies or intolerances and environmental triggers may be contributing factors. For **food allergies** and intolerances, an elimination challenge diet can be used under the supervision of a trained practitioner, naturopath, or nutritionist, to identify trigger foods. These foods can then be eliminated from the person's diet. For environmental triggers, it is helpful to identify the source so that it can be avoided or eliminated. A thorough **detoxification** program can help alleviate symptoms and change the course of the disease. Dietary changes from processed foods to whole foods that do not include allergen triggers can have significant results. Nutrient supplements, especially the **antioxidants** zinc, selenium, and **vitamins** A, C, and E, can be beneficial. Constitutional homeopathic treatment can work at a deep level to rebalance the whole person. **Acupuncture** and Chinese herbs can be effective in symptom alleviation and deep healing. Visualization, **guided imagery**, and hypnosis for **pain management** are also useful.

Prognosis

The progression of PM and DM varies considerably from person to person. Immunosuppressants can improve strength, although not all patients respond, and relapses may occur. PM and DM can lead to increasing weakness and disability, although the life span usually is not significantly affected. About half of the patients recover and can discontinue treatment within five years of the onset of their symptoms. About 20% still have active disease requiring ongoing treatment after five years, and about 30% have inactive disease but some remaining muscle weakness.

Prevention

There is no known way to prevent myositis, except to avoid exposure to those environmental agents that may be associated with some cases.

ORGANIZATIONS

Muscular Dystrophy Association, 3300 East Sunrise Drive, Tucson, AZ, 85718, (800) 572-1717, http://www.mdausa.org.

The Myositis Association, 1737 King Street, Suite 600, Alexandria, VA, 22314, (800) 821-7356, TMA@myositis.org, http://www.myositis.org.

Myositis Support Group, 146 Newtown Road, Southampton, England, SO19 9HR, 44023 8044 9708, 44023 8039 6402, msg@myositis.org.uk, http://www.myositis.org.uk.

National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS), 1 AMS Circle, Bethesda, MD, 20892-3675, 301 495-4484, (301) 718-6366, (877) 226-4267, NIAMSinfo@mail.nih.gov, http://www.niams.nih.gov.

Richard Robinson

Polyneuritis *see* **Peripheral neuropathy**

Polysomnography

Definition

The word polysomnography, derived from the Greek roots "poly," meaning many, "somno," meaning sleep, and "graphy" meaning to write, refers to multiple tests performed on patients while they sleep. Polysomnography is an overnight test to evaluate **sleep disorders**. Polysomnography generally includes monitoring of the patient's airflow through the nose and mouth, blood pressure, electrocardiographic activity, blood oxygen level, brain wave pattern, eye movement, and the movement of respiratory muscle and limbs.

Purpose

Polysomnography is used to help diagnose and evaluate a number of sleep disorders. For instance, it can help diagnose **sleep apnea**, a common disorder in middle-aged and elderly obese men, in which the muscles of the soft palate in the back of the throat relax and close off the airway during sleep. This may cause the person to snore loudly and gasp for air at night, and to be excessively sleepy and doze off during the day. Another syndrome often evaluated by polysomnography is **narcolepsy**. In narcolepsy, people have sudden attacks of sleep and/or cataplexy (temporary loss of muscle tone caused by moments of emotion, such as fear, anger, or surprise, which causes people to slump or fall over), sleep **paralysis**

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or **hallucinations** at the onset of sleep. Polysomnography is often used to evaluate parasomnias (abnormal behaviors or movements during sleep), such as sleep walking, talking in one's sleep, nightmares, and **bedwetting**. It can also be used to detect or evaluate seizures that occur in the middle of the night, when the patient and his or her family are unlikely to be aware of them.

Precautions

Polysomnography is extremely safe and no special precautions need to be taken.

Description

Polysomnography requires an overnight stay in a sleep laboratory. During this stay, while the patient sleeps, he or she is monitored in a number of ways that can provide very useful information.

One form of monitoring is **electroencephalography** (EEG), in which electrodes are attached to the patient's scalp in order to record his or her brain wave activity. The electroencephalograph records brain wave activity from different parts of the brain and charts them on a graph. The EEG not only helps doctors establish what stage of sleep the patient is in, but may also detect seizures.

Another form of monitoring is continuous electro-oculography (EOG), which records eye movement and is used to determine when the patient is going through a stage of sleep called rapid-eye-movement (REM) sleep. Both EEG and EOG can be helpful in determining sleep latency (the time that transpires between lights out and the onset of sleep), total sleep time, the time spent in each sleep stage, and the number of arousals from sleep.

The air flow through the patient's nose and mouth are measured by heat-sensitive devices called thermistors. This can help detect episodes of apnea (stopped breathing), or hypnopea (inadequate breathing). Another test called pulse oximetry measures the amount of oxygen in the blood, and can be used to assess the degree of oxygen **starvation** during episodes of hypnopea or apnea.

The electrical activity of the patient's heart is also measured on an electrocardiogram, or ECG. Electrodes are affixed to the patient's chest and they pick up electrical activity from various areas of the heart. They help detect cardiac arrythmias (abnormal heart rhythms), which may occur during periods of sleep apnea. Blood pressure is also measured: sometimes episodes of sleep apnea can dangerously elevate blood pressure.

In some cases, sleep laboratories monitor the movement of limbs during sleep. This can be helpful in detecting such sleep disorders as periodic limb movements.

Preparation

The patient may be asked to discontinue taking any medications used to help him/her sleep. Before the patient goes to sleep, the technician hooks him or her up to all of the monitors being used.

Aftercare

Once the test is over, the monitors are detached from the patient. No special measures need to be taken after polysomnography.

Normal results

A normal result in polysomnography shows normal results for all parameters (EEG, ECG, blood pressure, eye movement, air flow, pulse oximetry, etc.) monitored throughout all stages of sleep.

Abnormal results

Polysomnography may yield a number of abnormal results, indicating a number of potential disorders. For instance, abnormal transitions in and out of various stages of sleep, as documented by the EEG and the EOG, may be a sign of narcolepsy. Reduced air flow through the nose and mouth, along with a fall in oxygenation of the blood, may indicate apnea or hypopnea. If apnea is accompanied by abnormalities in ECG or elevations in blood pressure, this can indicate that sleep apnea may be particularly harmful. Frequent movement of limbs may indicate a sleep disorder called periodic limb movement.

ORGANIZATIONS

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

Robert Scott Dinsmoor

Pompe's disease *see* **Glycogen storage diseases**

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Porphyrias

Definition

The porphyrias are disorders in which the body produces too much porphyrin and insufficient heme (an iron-containing nonprotein portion of the hemoglobin molecule). Porphyrin is a foundation structure for heme and certain enzymes. Excess porphyrins are excreted as waste in the urine and stool. Overproduction and overexcretion of porphyrins causes low, unhealthy levels of heme and certain important enzymes, creating various physical symptoms.

Description

Biosynthesis of heme is a multistep process that begins with simple molecules and ends with a large, complex heme molecule. Each step of the chemical pathway is directed by its own task-specific protein, called an enzyme. As a heme precursor molecule moves through each step, an enzyme modifies the precursor in some way. If a precursor molecule is not modified, it cannot proceed to the next step, causing a buildup of that specific precursor.

This situation is the main characteristic of the porphyrias. Owing to a defect in one of the enzymes of the heme biosynthesis pathway, protoporphyrins or porphyrins (heme precursors) are prevented from proceeding further along the pathway. These precursors accumulate at the stage of the enzyme defect causing an array of physical symptoms in an affected person. Specific symptoms depend on the point at which heme biosynthesis is blocked and which precursors accumulate. In general, the porphyrias primarily affect the skin and the nervous system. Symptoms can be debilitating or life threatening in some cases. Porphyria is most commonly an inherited condition. It can also, however, be acquired after exposure to poisonous substances.

Heme

Heme is produced in several tissues in the body, but its primary biosynthesis sites are the liver and the bone marrow. Heme synthesis for immature red blood cells, namely the erythroblasts and the reticulocytes, occurs in the bone marrow.

Although production is concentrated in the liver and bone marrow, heme is utilized in various capacities in virtually every tissue in the body. In most cells, heme is a key building block in the construction of factors that oversee metabolism and transport of oxygen and energy. In the liver, heme is a component of several vital enzymes, particularly cytochrome P450. Cytochrome P450 is involved in the metabolism of chemicals, **vitamins**, fatty acids, and hormones; it is very important in transforming toxic substances into easily excretable materials. In immature red blood cells, heme is the featured component of hemoglobin. Hemoglobin is the red pigment that gives red blood cells their characteristic color and their essential ability to transport oxygen.

Heme biosynthesis

The heme molecule is composed of porphyrin and an iron atom. Much of the heme biosynthesis pathway is dedicated to constructing the porphyrin molecule. Porphyrin is a large molecule shaped like a four-leaf clover. An iron atom is placed at its center point in the last step of heme biosynthesis.

The production of heme may be compared to a factory assembly line. At the start of the line, raw materials are fed into the process. At specific points along the line, an addition or adjustment is made to further development. Once additions and adjustments are complete, the final product rolls off the end of the line.

The heme "assembly line" is an eight-step process, requiring eight different and properly functioning enzymes:

1. delta-aminolevulinic acid synthase
2. delta-aminolevulinic acid dehydratase
3. porphobilogen deaminase
4. uroporphyrinogen III cosynthase
5. uroporphyrinogen decarboxylase
6. coproporphyrinogen oxidase
7. protoporphyrinogen oxidase
8. ferrochelatase

The control of heme biosynthesis is complex. Various chemical signals can trigger increased or decreased production. These signals can affect the enzymes themselves or the production of these enzymes, starting at the genetic level. For example, one point at which heme biosynthesis may be controlled is at the first step. When heme levels are low, greater quantities of delta-aminolevulinic acid (ALA) synthase are produced. As a result, larger quantities of heme precursors are fed into the biosynthesis pathway to step up heme production.

Porphyrias

Under normal circumstances, when heme concentrations are at an appropriate level, precursor production decreases. However, a glitch in the biosynthesis pathway—represented by a defective enzyme—means that heme biosynthesis does not reach completion.

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Because heme levels remain low, the synthesis pathway continues to churn out precursor molecules in an attempt to correct the heme deficit.

The net effect of this continued production is an abnormal accumulation of precursor molecules and development of some type of porphyria. Each type of porphyria corresponds with a specific enzyme defect and an accumulation of the associated precursor. Although there are eight steps in heme biosynthesis, there are only seven types of porphyrias; a defect in ALA synthase activity does not have a corresponding porphyria.

Enzymes involved in heme biosynthesis display subtle, tissue-specific variations; therefore, heme biosynthesis may be impeded in the liver, but normal in the immature red blood cells, or vice versa. Incidence of porphyria varies widely between types and occasionally by geographic location. Although certain porphyrias are more common than others, their greater frequency is only relative to other types. All porphyrias are considered to be rare disorders.

In the past, the porphyrias were divided into two general categories based on the location of the porphyrin production. Porphyrias affecting heme biosynthesis in the liver were referred to as hepatic porphyrias. Porphyrias that affect heme biosynthesis in immature red blood cells were referred to as erythropoietic porphyrias (erythropoiesis is the process through which red blood cells are produced). Porphyrias were usually grouped into acute and non-acute types. Acute porphyrias produce severe attacks of **pain** and neurological effects. Non-acute porphyrias present as chronic diseases.

The acute porphyrias, and the heme biosynthesis steps at which enzyme defects occur, are:

- ALA dehydratase deficiency porphyria (step 2). This porphyria type is very rare. The inheritance pattern appears to be autosomal recessive. In autosomal recessively inherited disorders, a person must inherit two defective genes, one from each parent. A parent with only one gene for an autosomal recessive disorder does not display symptoms of the disease.
- Acute intermittent porphyria (step 3). Acute intermittent porphyria (AIP) is also known as Swedish porphyria, pyrroloporphyria, and intermittent acute porphyria. AIP is inherited as an autosomal dominant trait, which means that only one copy of the defective gene needs to be present for the disorder to occur. Simply inheriting this gene, however, does not necessarily mean that a person will develop the disease. Approximately five to 10 per 100,000 people in the United States carry a gene for AIP, but only 10% of these people ever develop symptoms of the disease.
- Hereditary coproporphyria (step 6). Hereditary coproporphyria (HCP) is inherited in an autosomal dominant manner. As with all porphyrias, it is an uncommon ailment. By 1977, only 111 cases of HCP were recorded; in Denmark, the estimated incidence is two in one million people.
- Variegate porphyria (step 7). Variegate porphyria (VP) is also known as porphyria variegata, protocoproporphyria, South African genetic porphyria, and Royal malady (supposedly King George III of England and Mary, Queen of Scots, suffered from VP). VP is inherited in an autosomal dominant manner and is especially prominent in South Africans of Dutch descent. Among that population, the incidence is approximately three in 1,000 persons. It is estimated that there are 10,000 cases of VP in South Africa. Interestingly, it appears that the affected South Africans are descendants of two Dutch settlers who came to South Africa in 1680. Among other populations, the incidence of VP is estimated to be one to two cases per 100,000 persons.

The non-acute porphyrias, and the steps of heme biosynthesis at which they occur, are:

- Congenital erythropoietic porphyria (step 4). Congenital erythropoietic porphyria (CEP) is also called Gunther's disease, erythropoietic porphyria, congenital porphyria, congenital hematoporphyria, and erythropoietic uroporphyria. CEP is inherited in an autosomal recessive manner. It is a rare disease, estimated to affect fewer than one in one million people. Onset of dramatic symptoms usually occurs in infancy, but may hold off until adulthood.
- Porphyria cutanea tarda (step 5). Porphyria cutanea tarda (PCT) is also called symptomatic porphyria, porphyria cutanea symptomatica, and idiosyncratic porphyria. PCT may be acquired, typically as a result of disease (especially hepatitis C), drug or alcohol use, or exposure to certain poisons. PCT may also be inherited as an autosomal dominant disorder, however most people remain latent—that is, symptoms never develop. PCT is the most common of the porphyrias, but the incidence of PCT is not well defined.
- Hepatoerythopoietic porphyria (step 5). Hepatoerythopoietic porphyria (HEP) affects heme biosynthesis in both the liver and the bone marrow. HEP results from a defect in uroporphyrinogen decarboxylase activity (step 5), and is caused by defects in the same gene as PCT. Disease symptoms, however, strongly resemble congenital erythropoietic porphyria. HEP seems to be inherited in an autosomal recessive manner.

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- Erythropoietic protoporphyria (step 8). Also known as protoporphyria and erythrohepatic protoporphyria, erythropoietic protoporphyria (EPP) is more common than CEP; more than 300 cases have been reported. In these cases, onset of symptoms typically occurred in childhood.

Causes and symptoms

General characteristics

The underlying cause of all porphyrias is a defective enzyme important to the heme biosynthesis pathway. Porphyrias are inheritable conditions. In virtually all cases of porphyria an inherited factor causes the enzyme's defect. An environmental trigger—such as diet, drugs, or sun exposure—may be necessary before any symptoms develop. In many cases, symptoms do not develop. These asymptomatic individuals may be completely unaware that they have a gene for porphyria.

All of the hepatic porphyrias—except porphyria cutanea tarda—follow a pattern of acute attacks separated by periods during which no symptoms are present. For this reason, this group is often referred to as the acute porphyrias. The erythropoietic porphyrias and porphyria cutanea tarda do not follow this pattern and are considered to be chronic conditions.

The specific symptoms of each porphyria vary based on which enzyme is affected and whether that enzyme occurs in the liver or in the bone marrow. The severity of symptoms can vary widely, even within the same type of porphyria. If the porphyria becomes symptomatic, the common factor between all types is an abnormal accumulation of protoporphyrins or porphyrin.

ALA dehydratase porphyria (ADP)

ADP is characterized by a deficiency of ALA dehydratase. ADP is caused by mutations in the delta-aminolevulinate dehydratase gene (ALAD) at 9q34. Of the few cases on record, the prominent symptoms are **vomiting**, pain in the abdomen, arms, and legs, and neuropathy. (Neuropathy refers to nerve damage that can cause pain, **numbness**, or paralysis.) The nerve damage associated with ADP could cause breathing impairment or lead to weakness or **paralysis** of the arms and legs.

Acute intermittent porphyria (AIP)

AIP is caused by a deficiency of porphobilogen deaminase, which occurs due to mutations in the hydroxymethylbilane synthase gene (HMBS) located at 11q23.3. Symptoms of AIP usually do not occur unless a person with the deficiency encounters a trigger substance. Trigger substances can include hormones (for example **oral contraceptives**, menstruation, **pregnancy**), drugs, and dietary factors. Most people with this deficiency never develop symptoms.

Attacks occur after **puberty** and commonly feature severe abdominal pain, **nausea**, **vomiting**, and **constipation**. Muscle weakness and pain in the back, arms, and legs are also typical symptoms. During an attack, the urine is a deep reddish color. The central nervous system may also be involved. Possible psychological symptoms include **hallucinations**, confusion, seizures, and mood changes.

Congenital erythropoietic porphyria (CEP)

CEP is caused by a deficiency of uroporphyrinogen III cosynthase due to mutations in the uroporphyrinogen III cosynthase gene (UROS) located at 10q25.2-q26.3. Symptoms are often apparent in infancy and include reddish urine and possibly an enlarged spleen. The skin is unusually sensitive to light and blisters easily if exposed to sunlight. (Sunlight induces protoporphyrin changes in the plasma and skin. These altered protoporphyrin molecules can cause skin damage.) Increased hair growth is common. Damage from recurrent blistering and associated skin infections can be severe. In some cases facial features and fingers may be lost to recurrent damage and infection. Deposits of protoporphyrins can sometimes lead to red staining of the teeth and bones.

Porphyria cutanea tarda (PCT)

PCT is caused by deficient uroporphyrinogen decarboxylase. PCT is caused by mutations in the uroporphyrinogen decarboxylase gene (UROD) located at 1p34. PCT may occur as an acquired or an inherited condition. The acquired form usually does not appear until adulthood. The inherited form may appear in childhood, but often demonstrates no symptoms. Early symptoms include blistering on the hands, face, and arms following minor injuries or exposure to sunlight. Lightening or darkening of the skin may occur along with increased hair growth or loss of hair. Liver function is abnormal but the signs are mild.

Hepatoerythopoietic porphyria (HEP)

HEP is linked to a deficiency of uroporphyrinogen decarboxylase in both the liver and the bone marrow. HEP is an autosomal recessive disease caused by mutations in the gene responsible for PCT, the uroporphyrinogen decarboxylase gene (UROD), located

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at 1p34. The gene is shared, but the mutations, inheritance, and specific symptoms of these two diseases are different. The symptoms of HEP resemble those of CEP.

Hereditary coproporphyria (HCP)

HCP is similar to AIP, but the symptoms are typically milder. HCP is caused by a deficiency of coproporphyrinogen oxidase due to mutations in a gene by the same name at 3q12. The greatest difference between HCP and AIP is that people with HCP may have some skin sensitivity to sunlight. However, extensive damage to the skin is rarely seen.

Variegate porphyria (VP)

VP is caused by a deficiency of protoporphyrinogen oxidase. There is scientific evidence that VP is caused by mutation in the gene for protoporphyrinogen oxidase located at 1q22. Like AIP, symptoms of VP occur only during attacks. Major symptoms of this type of porphyria include neurological problems and sensitivity to light. Areas of the skin that are exposed to sunlight are susceptible to burning, blistering, and scarring.

Erythropoietic protoporphyria (EPP)

Owing to deficient ferrochelatase, the last step in the heme biosynthesis pathway—the insertion of an iron atom into a porphyrin molecule—cannot be completed. This enzyme deficiency is caused by mutations in the ferrochelatase gene (FECH) located at 18q21.3. The major symptoms of this disorder are related to sensitivity to light—including both artificial and natural light sources. Following exposure to light, a person with EPP experiences burning, **itching**, swelling, and reddening of the skin. Blistering and scarring may occur but are neither common nor severe. EPP is associated with increased risks for **gallstones** and liver complications. Symptoms can appear in childhood and tend to be more severe during the summer when exposure to sunlight is more likely.

Diagnosis

Depending on the array of symptoms an individual may exhibit, the possibility of porphyria may not immediately come to a physician's mind. In the absence of a family history of porphyria, non-specific symptoms, such as abdominal pain and vomiting, may be attributed to other disorders. Neurological symptoms, including confusion and hallucinations, can lead to an initial suspicion of psychiatric disease. Diagnosis is more easily accomplished in cases in which non-specific symptoms appear in combination with symptoms more specific to porphyria, like neuropathy, sensitivity to sunlight, or certain other manifestations. Certain symptoms, such as urine the color of port wine, are hallmark signs very specific to porphyria. DNA analysis is not yet of routine diagnostic value.

A common initial test measures protoporphyrins in the urine. However, if skin sensitivity to light is a symptom, a blood plasma test is indicated. If these tests reveal abnormal levels of protoporphyrins, further tests are done to measure heme precursor levels in red blood cells and the stool. The presence and estimated quantity of porphyrin and protoporphyrins in biological samples are easily detected using spectrofluorometric testing. Spectrofluorometric testing uses a spectrofluorometer that directs light of a specific strength at a fluid sample. The porphyrins and protoporphyrins in the sample absorb the light energy and fluoresce, or glow. The spectrofluorometer detects and measures fluorescence, which indicates the amount of porphyrins and protoporphyrins in the sample.

Whether heme precursors occur in the blood, urine, or stool gives some indication of the type of porphyria, but more detailed biochemical testing is required to determine their exact identity. Making this determination yields a strong indicator of which enzyme in the heme biosynthesis pathway is defective; which, in turn, allows a diagnosis of the particular type of porphyria.

Biochemical tests rely on the color, chemical properties, and other unique features of each heme precursor. For example, a screening test for acute intermittent porphyria (AIP) is the Watson-Schwartz test. In this test, a special dye is added to a urine sample. If one of two heme precursors—porphobilinogen or urobilinogen—is present, the sample turns pink or red. Further testing is necessary to determine whether the precursor present is porphobilinogen or urobilinogen—only porphobilinogen is indicative of AIP.

Other biochemical tests rely on the fact that heme precursors become less soluble in water (able to be dissolved in water) as they progress further through the heme biosynthesis pathway. For example, to determine whether the Watson-Schwartz urine test is positive for porphobilinogen or urobilinogen, chloroform is added to the test tube. Chloroform is a water-insoluble substance. Even after vigorous mixing, the water and chloroform separate into two distinct layers. Urobilinogen is slightly insoluble in water, while porphobilinogen tends to be water soluble. The porphobilinogen mixes more readily in water than chloroform, so if the water layer is pink (from the dye added to the urine

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sample), that indicates the presence of porphobilinogen, and a diagnosis of AIP is probable.

As a final test, measuring specific enzymes and their activities may be done for some types of porphyrias; however, such tests are not done as a screening method. Certain enzymes, such as porphobilinogen deaminase (the defective enzyme in AIP), can be easily extracted from red blood cells; other enzymes, however, are less readily collected or tested. Basically, an enzyme test involves adding a certain amount of the enzyme to a test tube that contains the precursor it is supposed to modify. Both the production of modified precursor and the rate at which it appears can be measured using laboratory equipment. If a modified precursor is produced, the test indicates that the enzyme is doing its job. The rate at which the modified precursor is produced can be compared to a standard to measure the efficiency of the enzyme.

Treatment

Treatment for porphyria revolves around avoiding acute attacks, limiting potential effects, and treating symptoms. Treatment options vary depending on the specific type of porphyria diagnosed. **Gene therapy** has been successful for both CEP and EPP. In the future, scientists expect development of gene therapy for the remaining porphyrias. Given the rarity of ALA dehydratase porphyria, definitive treatment guidelines for this rare type have not been developed.

Acute intermittent porphyria, hereditary coproporphyria, and variegate porphyria

Treatment for acute intermittent porphyria, hereditary coproporphyria, and variegate porphyria follows the same basic regime. A person who has been diagnosed with one of these porphyrias can prevent most attacks by avoiding precipitating factors, such as certain drugs that have been identified as triggers for acute porphyria attacks. Individuals must maintain adequate **nutrition**, particularly with respect to carbohydrates. In some cases, an attack can be stopped by increasing carbohydrate consumption or by receiving carbohydrates intravenously. In 2004, a report from Turkey revealed successful treatment of an acute intermittent porphyria attack with a drug called fluoxetine.

When attacks occur prompt medical attention is necessary. Pain is usually severe, and narcotic **analgesics** are the best option for relief. Phenothiazines can be used to counter nausea, vomiting, and **anxiety**, and chloral hydrate or diazepam is useful for **sedation** or to induce sleep. Hematin, a drug administered intravenously, may be used to halt an attack. Hematin seems to work by signaling the pathway of heme biosynthesis to slow production of precursors. Women, who tend to develop symptoms more frequently than men owing to hormonal fluctuations, may find ovulation-inhibiting hormone therapy to be helpful.

Gene therapy is a possible future treatment for these porphyrias. An experimental animal model of AIP has been developed and research is in progress.

Congenital erythropoietic porphyria

The key points of congenital erythropoietic porphyria treatment are avoiding exposure to sunlight and prevention of skin trauma or skin infection. Liberal use of **sunscreens** and consumption of beta-carotene supplements can provide some protection from sun-induced damage. Medical treatments such as removing the spleen or administering transfusions of red blood cells can create short-term benefits, but these treatments do not offer a cure. Remission can sometimes be achieved after treatment with oral doses of **activated charcoal**. Severely affected patients may be offered **bone marrow transplantation** which appears to confer long-term benefit.

Porphyria cutanea tarda

As with other porphyrias, the first line of defense is avoidance of factors, especially alcohol, that could bring about symptoms. Regular blood withdrawal is a proven therapy for pushing symptoms into remission. If an individual is anemic or cannot have blood drawn for other reasons, chloroquine therapy may be used.

Erythropoietic protoporphyria

Avoiding sunlight, using sunscreens, and taking beta-carotene supplements are typical treatment options for erythropoietic protoporphyria. The drug cholestyramine may reduce the skin's sensitivity to sunlight as well as the accumulated heme precursors in the liver. **Liver transplantation** has been used in cases of liver failure. In 2004, a report in a medical journal told of one case of successful treatment of a 19-year-old patient with acute intermittent porphyria with liver transplantation. While she had only been studied for 1.5 years, the authors said her quality of life was good and they hoped that the procedure would offer cure for select patients with severe forms of the disease.

Alternative treatment

Acute porphyria attacks can be life-threatening events, so attempts at self-treatment can be dangerous.

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KEY TERMS

Autosomal dominant—A pattern of genetic inheritance in which only one abnormal gene is needed to display the trait or disease.

Autosomal recessive—A pattern of genetic inheritance in which two abnormal genes are needed to display the trait or disease.

Biosynthesis—The manufacture of materials in a biological system.

Bone marrow—A spongy tissue located in the hollow centers of certain bones, such as the skull and hip bones. Bone marrow is the site of blood cell generation.

Enzyme—A protein that catalyzes a biochemical reaction or change without changing its own structure or function.

Erythropoiesis—The process through which new red blood cells are created; it begins in the bone marrow.

Erythropoietic—Referring to the creation of new red blood cells.

Gene—A building block of inheritance, which contains the instructions for the production of a particular protein, and is made up of a molecular sequence found at a section of DNA. Each gene is found on a precise location on a chromosome.

Hematin—A drug administered intravenously to halt an acute porphyria attack. It causes heme biosynthesis to decrease, preventing the further accumulation of heme precursors.

Heme—The iron-containing molecule in hemoglobin that serves as the site for oxygen binding.

Hemoglobin—Protein-iron compound in the blood that carries oxygen to the cells and carries carbon dioxide away from the cells.

Hepatic—Referring to the liver.

Neuropathy—A condition caused by nerve damage. Major symptoms include weakness, numbness, paralysis, or pain in the affected area.

Porphyrin—A large molecule shaped like a four-leaf clover. Combined with an iron atom, it forms a heme molecule.

Protoporphyrin—A precursor molecule to the porphyrin molecule.

Alternative treatments can be useful adjuncts to conventional therapy. For example, some people may find relief for the pain associated with acute intermittent porphyria, hereditary coproporphyria, or variegate porphyria through **acupuncture** or hypnosis. Relaxation techniques, such as **yoga** or **meditation**, may also prove helpful in **pain management**.

Prognosis

Even when porphyria is inherited, symptom development depends on a variety of factors. In the majority of cases, a person remains asymptomatic throughout life. About one percent of acute attacks can be fatal. Other symptoms may be associated with temporarily debilitating or permanently disfiguring consequences. Measures to avoid these consequences are not always successful, regardless of how diligently they are pursued. Although pregnancy has been known to trigger porphyria attacks, dangers associated with pregnancy as not as great as was once thought.

Prevention

For the most part, the porphyrias are attributable to inherited genes; such inheritance cannot be prevented. However, symptoms can be limited or prevented by avoiding factors that trigger symptom development.

People with a family history of an acute porphyria should be screened for the disease. Even if symptoms are absent, it is useful to know about the presence of the gene to assess the risks of developing the associated porphyria. This knowledge also reveals whether a person's offspring may be at risk. Prenatal testing for certain porphyrias is possible. Prenatal diagnosis of congenital erythropoietic porphyria has been successfully accomplished. Any prenatal tests, however, would not indicate whether a child would develop porphyria symptoms; only that the potential is there.

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Online Mendelian Inheritance in Man (OMIM). http://www. ncbi.nlm.nih.gov/omim.

ORGANIZATIONS

The American Porphyria Foundation, 4900 Woodway, Suite 780, Houston, TX, 77056-1837, (713) 266-9617, (713) 840-9552, (866) 273-3635, http://www.porphyriafoundation.com.

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Port-wine stain *see* **Birthmarks**
Portacaval shunting *see* **Portal vein bypass**
Portal-systemic encephalopathy *see* **Liver encephalopathy**

Portal vein bypass

Definition

Portal vein bypass surgery diverts blood from the portal vein into another vein. It is performed when pressure in the portal vein is so high that it causes internal bleeding from blood vessels in the esophagus.

Purpose

The portal vein carries blood from the stomach and abdominal organs to the liver. It is a major vein that splits into many branches. High pressure in the portal vein causes swelling and bleeding from blood vessels in the esophagus. This situation occurs when the liver is damaged from **cirrhosis** of the liver, a condition usually caused by prolonged, excessive alcohol consumption.

Massive internal bleeding caused by high pressure in the portal vein occurs in about 40% of patients with cirrhosis. It is initially fatal in at least half of these patients. Patients who survive are likely to experience bleeding recurrence. Portal vein bypass, also called portacaval shunting, is performed on these surviving patients to control bleeding.

Precautions

Most patients who need portal vein bypass surgery not only have **liver disease** and poor liver function, but also suffer from an enlarged spleen, **jaundice**, and damage to the vascular system brought on by years of **alcoholism**. They are likely to experience serious complications during surgery. Some patients are aggressively uncooperative with medical personnel. Under these conditions, half the patients may not survive the operation.

Description

A choice of portal vein bypasses is available. Portal vein bypass is usually performed as an emergency operation in a hospital under **general anesthesia**. The surgeon makes an abdominal incision and finds the portal vein. In portacaval shunting, blood from the portal vein is diverted into the inferior vena cava. This is the most common bypass. In splenorenal shunting, the splenic vein (a part of the portal vein), is connected to the renal vein. A mesocaval shunt connects the superior mesenteric vein (another part of the portal vein) to the inferior vena cava.

Portal pressure can also be reduced in a procedure called transvenous intrahepatic portosystemic shunt (TIPS). A catheter is threaded into the portal vein, and an expandable balloon or wire mesh is inserted to divert blood from the portal vein to the hepatic vein. The rate of serious complications in TIPS is only 1–2%. The operation cannot be performed at all hospitals, but is becoming the preferred treatment for reducing portal pressure.

Preparation

Standard preoperative blood and urine tests are performed, and liver function is evaluated. The heart and arterial blood pressure are monitored both during and after the operation.

Aftercare

The patient will be connected to a heart monitor and fed through a nasogastric tube. Vital functions are monitored through blood and urine tests. Patients receive **pain** medication and **antibiotics**. Once released from the hospital, patients are expected to abstain from alcohol and follow a diet and medication schedule designed to reduce the risks of re-bleeding.

Risks

Portal vein bypass surgery is high risk because it is performed on patients who are generally in poor health. Only half the patients survive, although the chances of survival are greater with TIPS surgery.

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KEY TERMS

Cirrhosis—A chronic degenerative liver disease common among alcoholics.

Inferior vena cava—A large vein that returns blood from the legs, pelvis, and abdomen to the heart.

Portal vein—Formed by a fusion of small veins that end in a network of capillaries, the portal vein delivers blood to the liver.

Those patients who survive the operation still face the risk of **heart failure**, brain disease due to a decrease in the liver's conversion of waste products (**liver encephalopathy**), hemorrhage, lung complications, infection, **coma**, and **death**.

Normal results

The survival rate is directly related to the amount of liver damage patients have. The less damage, the more likely the patient is to recover. Cooperation with restrictions on alcohol and diet affect long-term survival.

Resources

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Tish Davidson, A.M.

Positron emission tomography (PET)

Definition

Positron emission tomography (PET) is a non-invasive scanning technique that utilizes small amounts of radioactive positrons (positively charged particles) to visualize body function and metabolism.

Purpose

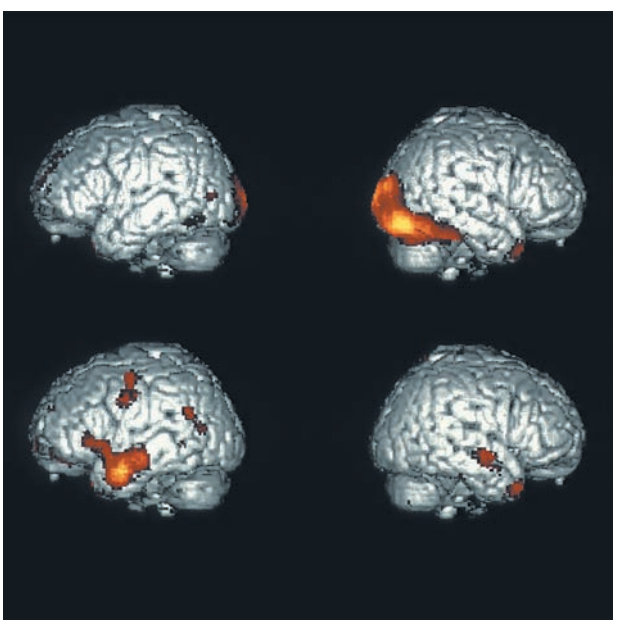
PET is the fastest growing nuclear medicine tool in terms of increasing acceptance and applications. It is useful in the diagnosis, staging, and treatment of **cancer** because it provides information that cannot be obtained by other techniques such as computed tomography (CT) and **magnetic resonance imaging** (MRI).

PET scans are performed at medical centers equipped with a small cyclotron. Smaller cyclotrons and increasing availability of certain radiopharmaceuticals are making PET a more widely used imaging modality.

Physicians first used PET to obtain information about brain function, and to study brain activity in various neurological diseases and disorders including **stroke**, **epilepsy**, **Alzheimer's disease**, Parkinson's disease, and Huntington's disease; and in psychiatric disorders such as **schizophrenia**, depression, **obsessive-compulsive disorder**, **attention deficit hyperactivity disorder (ADHD)**, and **Tourette syndrome**. PET is now used to evaluate patients for these cancers: head and neck, lymphoma, melanoma, lung, colorectal, breast, and esophageal. PET also is used to evaluate heart muscle function in patients with **coronary artery disease** or **cardiomyopathy**.

Description

PET involves injecting a patient with a radiopharmaceutical similar to glucose. An hour after injection of this tracer, a PET scanner images a specific metabolic function by measuring the concentration and distribution of the tracer throughout the body.



A PET scan showing brain activity while patient recognizes faces—left sides at left/right sides at right. Activity is prevalent in temporal lobe (bottom scans). *(Photo Researchers, Inc.)*

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KEY TERMS

Electron—One of the small particles that make up an atom. An electron has the same mass and amount of charge as a positron, but the electron has a negative charge.

Gamma ray—A high-energy photon emitted by radioactive substances.

Half-life—The time required for half of the atoms in a radioactive substance to disintegrate.

Photon—A light particle.

Positron—One of the small particles that make up an atom. A positron has the same mass and amount of charge as an electron, but the positron has a positive charge.

When it enters the body, the tracer courses through the bloodstream to the target organ, where it emits positrons. The positively charged positrons collide with negatively charged electrons, producing gamma rays. The gamma rays are detected by photomultiplier-scintillator combinations positioned on opposite sides of the patient. These signals are processed by the computer and images are generated.

PET provides an advantage over CT and MRI because it can determine if a lesion is malignant. The two other modalities provide images of anatomical structures, but often cannot provide a determination of malignancy. CT and MRI show structure, while PET shows function. PET has been used in combination with CT and MRI to identify abnormalities with more precision and indicate areas of most active metabolism. This additional information allows for more accurate evaluation of cancer treatment and management.

Resources

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ORGANIZATIONS

American College of Physicians, 190 N. Independence Mall West, Philadelphia, PA, 19106-1572, (215) 351-2600, (800) 523-1546, http://www.acponline.org.

American Heart Association, 7272 Greenville Avenue, Dallas, TX, 75231, (214) 373-6300, (800) 242-8721, http://www.americanheart.org.

American Medical Association, 515 N. State Street, Chicago, IL, 60610, (312) 464-5000, http://www.ama-assn.org.

National Cancer Institute, Building 31, Room 10A31, 31 Center Drive, MSC 2580, Bethesda, MD, 20892-2580, (800) 422-6237, http://www.nci.nih.gov.

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Post-concussion syndrome

Definition

Post-concussion syndrome (PCS) is a common but controversial disorder that presents with variety of symptoms including—but not limited to—headache, **dizziness**, **fatigue**, and personality changes.

Description

PCS occurs in approximately 23–93% of persons with mild to severe head injuries. It is estimated that a neurologist (a physician who specializes in nerve and brain disorders) sees five patients with PCS per month. There is no accurate correlation between the severity of injury and the development of PCS symptoms, since signs of the disorder can occur in someone who was just dazed by an injury. Some studies suggest that PCS symptoms occur at a higher rate in patients who were unconscious after trauma.

Causes and symptoms

PCS is most commonly caused by minor **head injury** called a **concussion**. The majority of patients with minor head injury characteristically develop PCS with distinct symptoms. Patients may report problems with concentration, recent memory, and abstract thinking. Additionally, patients may develop dizziness, irritability, fatigue, and personality changes. Elderly patients are particularly affected by disequilibrium and chronic dizziness even after minor trauma.

Diagnosis

There are no specific or reliable tests to diagnose PCS. A neuropsychologist can perform an in-depth neuropsychologic assessment that can determine

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KEY TERMS

Disequilibrium—Difficulty with equilibrium that can mean a deficiency in balance and/or orientation.

Neuropsychologist—A clinical psychologist who specializes in assessing psychological status caused by a brain disorder.

presence or absence and extent of impairment. These tests may be performed for medical purposes.

Treatment

Treatment for PCS can be extensive. Medications for **headache** and **pain** may be indicated (**analgesics** and **muscle relaxants**). Antidepressants may be given to improve **insomnia**, irritability, or **anxiety**. Pain control could be achieved with **acupuncture**, nerve blocks, or transcutaneous **electrical nerve stimulation** (TENS, electrical stimulation of muscle groups). It is important for clinicians to educate caretakers and to provide referrals for **family therapy** and cognitive **rehabilitation** for the affected person.

Prognosis

The overall outcome is difficult to assess. Limited interpretation in literature is primarily due to the subjective nature of symptoms. Patient recovery is directed and evaluated by cognitive function changes, subjective symptoms, and return to work. Most cases of PCS can be a financial strain and threaten family stability. There may be compensation and litigation claims, which is often stressful and aggravates symptoms.

Resources

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Laith Farid Gulli, M.D.

Post-herpetic neuralgia *see* **Neuralgia**

Post-traumatic stress disorder

Definition

Post-traumatic **stress** disorder (PTSD) is a complex **anxiety** disorder that may occur when a person experiences or witnesses an event perceived as a threat and in which he or she experiences fear, terror, or helplessness. PTSD is sometimes summarized as "a normal reaction to abnormal events." It was first defined as a distinctive disorder in 1980. Originally diagnosed in veterans of the Vietnam War, it is now recognized in civilian survivors of **rape** or other criminal assaults; natural disasters; plane crashes, train collisions, or industrial explosions; acts of terrorism; **child abuse**; or war.

Demographics

PTSD can develop in almost anyone in any age group exposed to a sufficiently terrifying event or chain of events. The National Institute of Mental Health (NIMH) estimated in 2007 that about 7.7 million adults in the United States have PTSD. One study found that 3.7 percent of a sample of teenage boys and 6.3 percent of adolescent girls had PTSD. It is estimated that a person's risk of developing PTSD over the course of their life is between 8 and 10 percent. On average, 30 percent of soldiers who have been in a war zone develop PTSD. Women are at greater risk of PTSD following **sexual assault** or domestic violence, while men are at greater risk of developing PTSD following military combat.

Traumatic experiences are surprisingly common in the general North American population. More than 10% of the men and 6% of the women in one survey reported experiencing four or more types of trauma in their lives. The most frequently mentioned traumas are:

- witnessing someone being badly hurt or killed
- involvement in a fire, flood, earthquake, severe hurricane, or other natural disaster
- involvement in a life-threatening accident (workplace explosion or transportation accident)
- military combat

PTSD is more likely to develop in response to an intentional human act of violence or cruelty such as a rape or mugging than as a reaction to an impersonal catastrophe like a flood or hurricane. It is not surprising that the traumatic events most frequently mentioned by men diagnosed with PTSD are rape, combat exposure, childhood neglect, and childhood

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physical **abuse**. For women diagnosed with PTSD, the most common traumas are rape, sexual molestation, physical attack, being threatened with a weapon, and childhood physical abuse.

PTSD can also develop in therapists, rescue workers, or witnesses of a frightening event as well as in those who were directly involved. This process is called vicarious traumatization.

Description

The experience of PTSD has sometimes been described as like being in a horror film that keeps replaying and can't be shut off. It is common for people with PTSD to feel intense fear and helplessness, and to relive the frightening event in nightmares or in their waking hours. Sometimes the memory is triggered by a sound, smell, or image that reminds the sufferer of the traumatic event. These reexperiences of the event are called flashbacks. A person with PTSD is also likely to be jumpy and easily startled or to go numb emotionally and lose interest in activities they used to enjoy. They may have problems with memory and with getting enough sleep. In some cases they may feel disconnected from the real world or have moments in which their own bodies seem unreal; these symptoms are indications of dissociation, a process in which the mind splits off certain memories or thoughts from conscious awareness. Many people with PTSD turn to alcohol or drugs in order to escape the flashbacks and other symptoms of the disorder, even if only for a few minutes.

Risk factors

Factors that influence the likelihood of a person's developing PTSD include:

- The nature, intensity, and duration of the traumatic experience. For example, someone who just barely escaped from the World Trade Center before the towers collapsed is at greater risk of PTSD than someone who saw the collapse from a distance or on television.
- The person's previous history. People who were abused as children, who were separated from their parents at an early age, or who have a previous history of anxiety or depression are at increased risk of PTSD.
- Genetic factors. Vulnerability to PTSD is known to run in families.
- The availability of social support after the event. People who have no family or friends are more likely to develop PTSD than those who do.

HIGH-RISK POPULATIONS. Some subpopulations in the United States are at greater risk of developing PTSD. The lifetime prevalence of PTSD among persons living in depressed urban areas or on Native American reservations is estimated at 23%. For victims of violent crimes, the estimated rate is 58%.

PTSD also appears to be more common in seniors than in younger people. Thirteen percent of the senior population reports they are affected by PTSD in comparison to 7–10% of the entire population. Reports of **elder abuse** crimes have gone up by 200% since 1986. Also, the incidence of PTSD is known to be higher in Holocaust survivors, war veterans, and **cancer** or heart surgery survivors, which accounts for a significant portion of older Americans. Of those seniors who are military veterans, there is an increasing number who are isolated and/or in poor health as a result of PTSD.

Children are also susceptible to PTSD and their risk is increased exponentially as their exposure to the event increases. Children experiencing abuse, the **death** of a parent, or those located in a community suffering a traumatic event can develop PTSD. Two years after the Oklahoma City bombing of 1995, 16% of children within a 100-mile radius of Oklahoma City with no direct exposure to the bombing had increased symptoms of PTSD. Weak parental response to the event, having a parent suffering from PTSD symptoms, and intensified exposure to the event via the media all increase the possibility of a child's developing PTSD symptoms. In addition, a developmentally inappropriate sexual experience for a child may be considered a traumatic event, even though it may not have actually involved violence or physical injury.

MILITARY VETERANS. Studies conducted between 2004 and 2006 with veteran participants from Operation Iraqi Freedom and Operation Enduring Freedom (Afghanistan) found a strong correlation between duration of combat exposure and PTSD. Veterans of combat in Iraq reported a higher rate of PTSD than those deployed to Afghanistan because of longer exposure to warfare.

Information about PTSD in veterans of the Vietnam era is derived from the National Vietnam Veterans Readjustment Survey (NVVRS), conducted between1986 and 1988. The estimated lifetime prevalence of PTSD among American veterans of this war is 30.9% for men and 26.9% for women. An additional 22.5% of the men and 21.2% of the women have been diagnosed with partial PTSD at some point in their lives. The lifetime prevalence of PTSD among veterans of World War II and the Korean War is estimated at 20%.

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CROSS-CULTURAL ISSUES. Further research needs to be done on the effects of ethnicity and culture on post-traumatic symptoms. As of the early 2000s, most PTSD research has been done by Western clinicians working with patients from a similar background. Researchers do not yet know whether persons from non-Western societies have the same psychological reactions to specific traumas or whether they develop the same symptom patterns.

Causes and symptoms

The causes of PTSD are not completely understood. One major question that has not been answered as of 2009 is why some people involved in a major disaster develop PTSD and other survivors of the same event do not. For example, a survey of 988 adults living close to the World Trade Center conducted in November 2001 found that only 7 percent had been diagnosed with PTSD following the events of September 11; the other 93 percent were anxious and upset, but they did not develop PTSD. Research into this question is ongoing.

Causes

When PTSD was first suggested as a diagnostic category for *DSM-III* in 1980, it was controversial precisely because of the central role of outside stressors as causes of the disorder. Psychiatry has generally emphasized the internal abnormalities of individuals as the source of mental disorders; prior to the 1970s, war veterans, rape victims, and other trauma survivors were often blamed for their symptoms and regarded as cowards, moral weaklings, or masochists. The high rate of psychiatric casualties among Vietnam veterans, however, led to studies conducted by the Veterans Administration. These studies helped to establish PTSD as a legitimate diagnostic entity with a complex set of causes.

BIOCHEMICAL/PHYSIOLOGICAL CAUSES. Present neurobiological research indicates that traumatic events cause lasting changes in the human nervous system, including abnormal levels of secretion of stress hormones. In addition, in PTSD patients, researchers have found changes in the amygdala and the hippocampus—the parts of the brain that form links between fear and memory. Experiments with ketamine, a drug that inactivates one of the neurotransmitters in the central nervous system, suggest that trauma works in a similar way to damage associative pathways in the brain. **Positron emission tomography (PET)** scans of PTSD patients suggest that trauma affects the parts of the brain that govern speech and language.

SOCIOCULTURAL CAUSES. Studies of specific populations of PTSD patients (combat veterans, survivors of rape or genocide, former political hostages or prisoners, etc.) have shed light on the social and cultural causes of PTSD. In general, societies that are highly authoritarian, glorify violence, or sexualize violence have high rates of PTSD even among civilians.

OCCUPATIONAL FACTORS. Persons whose work exposes them to traumatic events or who treat trauma survivors may develop secondary PTSD (also known as compassion **fatigue** or burnout). These occupations include specialists in emergency medicine, police officers, firefighters, search-and-rescue personnel, psychotherapists, disaster investigators, etc. The degree of risk for PTSD is related to three factors: the amount and intensity of exposure to the suffering of trauma victims, the worker's degree of empathy and sensitivity, and unresolved issues from the worker's personal history.

PERSONAL VARIABLES. Although the most important causal factor in PTSD is the traumatic event itself, individuals differ in the intensity of their cognitive and emotional responses to trauma; some persons appear to be more vulnerable than others. In some cases, this greater vulnerability is related to temperament or natural disposition, with shy or introverted people being at greater risk. In other cases, the person's vulnerability results from chronic illness, a physical disability, or previous traumatization—particularly abuse in childhood. As of 2009, researchers have not found any correlation between race or ethnicity and biological vulnerability to PTSD.

Symptoms

DSM-IV-TR specifies six diagnostic criteria for PTSD:

- Traumatic stressor: The patient has been exposed to a catastrophic event involving actual or threatened death or injury, or a threat to the physical integrity of the self or others. During exposure to the trauma, the person's emotional response was marked by intense fear, feelings of helplessness, or horror. In general, stressors caused intentionally by human beings (genocide, rape, torture, abuse, etc.) are experienced as more traumatic than accidents, natural disasters, or "acts of God."
- Intrusive symptoms: The patient experiences flashbacks, traumatic daydreams, or nightmares, in which he or she relives the trauma as if it were recurring in the present. Intrusive symptoms result from an abnormal process of memory formation. Traumatic memories have two distinctive characteristics: 1) they can be triggered by stimuli that remind the patient of

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the traumatic event; 2) they have a "frozen" or wordless quality, consisting of images and sensations rather than verbal descriptions.

- Avoidant symptoms: The patient attempts to reduce the possibility of exposure to anything that might trigger memories of the trauma, and to minimize his or her reactions to such memories. This cluster of symptoms includes feeling disconnected from other people, psychic numbing, and avoidance of places, persons, or things associated with the trauma. Patients with PTSD are at increased risk of substance abuse as a form of self-medication to numb painful memories.
- Hyperarousal: Hyperarousal is a condition in which the patient's nervous system is always on "red alert" for the return of danger. This symptom cluster includes hypervigilance, insomnia, difficulty concentrating, general irritability, and an extreme startle response. Some clinicians think that this abnormally intense startle response may be the most characteristic symptom of PTSD.
- Duration of symptoms: The symptoms must persist for at least one month.
- Significance: The patient suffers from significant social, interpersonal, or work-related problems as a result of the PTSD symptoms. A common social symptom of PTSD is a feeling of disconnection from other people (including loved ones), from the larger society, and from spiritual, religious, or other significant sources of meaning.

KEY TERMS

Benzodiazepines—A class of drugs that have a hypnotic and sedative action, used mainly as tranquilizers to control symptoms of anxiety.

Cognitive-behavioral therapy—A type of psychotherapy used to treat anxiety disorders (including PTSD) that emphasizes behavioral change as well as alteration of negative thought patterns.

Cortisol—A hormone produced by the adrenal glands near the kidneys in response to stress.

Dissociation—The splitting off of certain mental processes from conscious awareness. Many PTSD patients have dissociative symptoms.

Flashback—A temporary reliving of a traumatic event.

Hyperarousal—A state of increased emotional tension and anxiety, often including jitteriness and being easily startled.

Hypervigilance—A condition of abnormally intense watchfulness or wariness. Hypervigilance is one of the most common symptoms of PTSD.

Prevalence—The percentage of a population that is affected by a specific disease at a given time.

Selective serotonin reuptake inhibitors (SSRIs)—A class of antidepressants that work by blocking the reabsorption of serotonin in the brain, raising the levels of serotonin. SSRIs include Prozac, Zoloft, and Paxil.

Trauma—A severe injury or shock to a person's body or mind.

Diagnosis

The diagnosis of PTSD is based on the patient's history, including the timing of the traumatic event and the duration of the patient's symptoms.

Examination

Consultation with a mental health professional for diagnosis and a plan of treatment is always advised. Many of the responses to trauma, such as **shock**, terror, irritability, blame, guilt, grief, sadness, emotional numbing, and feelings of helplessness, are natural reactions. For most people, resilience is an overriding factor and trauma effects diminish within six to sixteen months. It is when these responses continue or become debilitating that PTSD is often diagnosed.

As outlined in DSM-IV, the exposure to a traumatic stressor means that an individual experienced, witnessed or was confronted by an event or events involving death or threat of death, serious injury or the threat of bodily harm to oneself or others. The individual's response must involve intense fear, helplessness, or horror. A two-pronged approach to evaluation is considered the best way to make a valid diagnosis because it can gauge under-reporting or over-reporting of symptoms. The two primary forms are structured interviews and self-report questionnaires. Spouses, partners and other family members may also be interviewed. Because the evaluation may involve subtle reminders of the trauma in order to gauge a patient's reactions, individuals should ask for a full description of the evaluation process beforehand. Asking what results can be expected from the evaluation is also advised.

A number of structured interview forms have been devised to facilitate the diagnosis of post traumatic stress disorder:

- The Clinician Administered PTSD Scale (CAPS) developed by the National Center for PTSD
- The Structured Clinical Interview for DSM (SCID)

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- Anxiety Disorders Interview Schedule-Revised (ADIS)
- PTSD-Interview
- Structured Interview for PTSD (SI-PTSD)
- PTSD Symptom Scale Interview (PSS-I)

Self-reporting checklists provide scores to represent the level of stress experienced. Some of the most commonly used checklists are:

- The PTSD Checklist (PCL), which has one list for civilians and one for military personnel and veterans
- Impact of Event Scale-Revised (IES-R)
- Keane PTSD Scale of the MMPI-2
- The Mississippi Scale for Combat Related PTSD and the Mississippi Scale for Civilians
- The Post Traumatic Diagnostic Scale (PDS)
- The Penn Inventory for Post-Traumatic Stress
- Los Angeles Symptom Checklist (LASC)

Tests

There are no laboratory or imaging tests that can detect PTSD, although the doctor may order imaging studies of the brain to rule out head injuries or other physical causes of the patient's symptoms.

Treatment

Traditional

Treatment for PTSD usually involves a combination of medications and **psychotherapy**. If the patient has started to abuse alcohol or drugs, they must be treated for the substance abuse before being treated for PTSD. If the patient is diagnosed with coexisting depression, treatment should focus on the PTSD because its course, biology, and treatment response are different from those associated with major depression. Patients with the disorder are usually treated as outpatients; they are not hospitalized unless they are threatening to commit **suicide** or harm other people.

Mainstream forms of psychotherapy used to treat patients who have already developed PTSD include:

- Cognitive-behavioral therapy. There are two treatment approaches to PTSD included under this heading: exposure therapy, which seeks to desensitize the patient to reminders of the trauma; and anxiety management training, which teaches the patient strategies for reducing anxiety. These strategies may include relaxation training, biofeedback, social skills training, distraction techniques, or cognitive restructuring.
- Psychodynamic psychotherapy. This approach helps the patient recover a sense of self and learn new coping strategies and ways to deal with intense emotions related to the trauma. Typically, it consists of three phases: 1) establishing a sense of safety for the patient; 2) exploring the trauma itself in depth; 3) helping the patient re-establish connections with family, friends, the wider society, and other sources of meaning.
- Discussion groups or peer-counseling groups. These groups are usually formed for survivors of specific traumas, such as combat, rape/incest, and natural or transportation disasters. They help patients to recognize that other survivors of the shared experience have had the same emotions and reacted to the trauma in similar ways. They appear to be especially beneficial for patients with guilt issues about their behavior during the trauma (e.g., submitting to rape to save one's life, or surviving the event when others did not).
- Family therapy. This form of treatment is recommended for PTSD patients whose family life has been affected by the PTSD symptoms.

Drugs

In general, medications are used most often in patients with severe PTSD to treat the intrusive symptoms of the disorder as well as feelings of anxiety and depression. These drugs are usually given as one part of a treatment plan that includes psychotherapy or **group therapy**. As of 2009, there is no single medication that appears to be a "magic bullet" for PTSD. The **selective serotonin reuptake inhibitors** (SSRIs) appear to help the core symptoms when given in higher doses for five to eight weeks, while the tricyclic antidepressants (TCAs) or the **monoamine oxidase inhibitors** (MAOIs) are most useful in treating anxiety and depression.

Sleep problems can be lessened with brief treatment with an anti-anxiety drug, such as a benzodiazepine like alprazolam (Xanax), but long-term usage can lead to disturbing side effects, such as increased anger, drug tolerance, dependency, and abuse. **Benzodiazepines** are also not given to PTSD patients diagnosed with coexisting drug or alcohol abuse.

Alternative

Relaxation training, which is sometimes called anxiety management training, includes breathing exercises and similar techniques intended to help the patient prevent hyperventilation and relieve the muscle tension associated with the fight-or-flight

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reaction of anxiety. **Yoga**, aikido,t'ai chi, and dance therapy help patients work with the physical as well as the emotional tensions that either promote anxiety or are created by the anxiety.

Other alternative or complementary therapies are based on physiological and/or energetic understanding of how the trauma is imprinted in the body. These therapies affect a release of stored emotions and resolution of them by working with the body rather than merely talking through the experience. One example of such a therapy is Somatic Experiencing (SE), developed by Dr. Peter Levine. SE is a short-term, biological, body-oriented approach to PTSD or other trauma. This approach heals by emphasizing physiological and emotional responses, without re-traumatizing the person, without placing the person on medication, and without the long hours of conventional therapy.

When used in conjunction with therapies that address the underlying cause of PTSD, such relaxation therapies as **hydrotherapy**, **massage therapy**, and **aromatherapy** are useful to some patients in easing PTSD symptoms. Essential oils of lavender, chamomile, neroli, sweet marjoram, and ylang-ylang are commonly recommended by aromatherapists for stress relief and anxiety reduction.

Some patients benefit from spiritual or religious counseling. Because traumatic experiences often affect patients' spiritual views and beliefs, counseling with a trusted religious or spiritual advisor may be part of a treatment plan. A growing number of pastoral counselors in the major Christian and Jewish bodies in North America have advanced credentials in trauma therapy. Native Americans are often helped to recover from PTSD by participating in traditional tribal rituals for cleansing memories of war and other traumatic events. These rituals may include sweat lodges, prayers and chants, or consultation with a shaman or tribal healer.

Several controversial methods of treatment for PTSD have been introduced since the mid-1980s. Some have been developed by mainstream medical researchers while others are derived from various forms of alternative medicine. These methods are controversial because they do not offer any scientifically validated explanations for their effectiveness. They include:

- Eye Movement Desensitization and Reprocessing (EMDR). This is a technique in which the patient reimagines the trauma while focusing visually on movements of the therapist's finger. It is claimed that the movements of the patient's eyes reprogram the brain and allow emotional healing.
- Tapas Acupressure Technique (TAT). TAT was developed in 1993 by a licensed acupuncturist named Tapas Fleming. It is derived from traditional Chinese medicine (TCM), and its practitioners maintain that a large number of acupuncture meridians enter the brain at certain points on the face, especially around the eyes. Pressure on these points is thought to release traumatic stress.
- Thought Field Therapy. This therapy combines the acupuncture meridians of TCM with analysis of the patient's voice over the telephone. The therapist then provides an individualized treatment for the patient.
- Traumatic Incident Reduction. This is a technique in which the patient treats the trauma like a videotape and "runs through" it repeatedly with the therapist until all negative emotions have been discharged.
- Emotional Freedom Techniques (EFT). EFT is similar to TAT in that it uses the body's acupuncture meridians, but it emphasizes the body's entire "energy field" rather than just the face.
- Counting Technique. Developed by a physician, this treatment consists of a preparation phase, a counting phase in which the therapist counts from 1 to 100 while the patient reimagines the trauma, and a review phase. Like Traumatic Incident Reduction, it is intended to reduce the patient's hyperarousal.

Prognosis

The prognosis of PTSD is difficult to determine because patients' personalities and the experiences they undergo vary widely. A majority of patients get better, including some who do not receive treatment. One study reported that the average length of PTSD symptoms in patients who get treatment is 32 months, compared to 64 months in patients who are not treated.

Factors that improve a patient's chances for full recovery include prompt treatment, early and ongoing support from family and friends, a high level of functioning before the frightening event, and an absence of alcohol or substance abuse.

About 30 percent of people with PTSD never recover completely, however. A few commit suicide because their symptoms get worse rather than improving.

Health care team roles

It is essential for all treatment team members to know their roles and execute them properly throughout the treatment and recovery phases of this disorder. Depending on whether outpatient or inpatient treatment is being provided, the team leaders may include

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psychiatrists, psychologists, nursing staff, behavior specialists, physical therapists, and other medical/behavioral staff. In some cases it may be appropriate to include the patient's religious or spiritual advisor as a member of the team.

Prevention

PTSD is impossible to prevent completely because natural disasters and human acts of violence will continue to occur. In addition, it is not possible to tell beforehand how any given individual will react to a specific type of trauma. Prompt treatment after a traumatic event may lower the survivor's risk of developing severe symptoms.

Resources

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National Center for Posttraumatic Stress Disorder Fact Sheet. *What Is PTSD?* http://www.ncptsd.va.gov/ncmain/ncdocs/fact_shts/fs_what_is_ptsd.html

National Institute of Mental Health (NIMH). *Helping Children Cope with Violence and Disasters: What Parents Can Do*. http://www.nimh.nih.gov/health/publications/helping-children-and-adolescents-cope-with-violence-and-disasters-what-parents-can-do/index.shtml.

ORGANIZATIONS

American Psychiatric Association, 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209-3901, 703-907-7300, apa@psych.org, http://www.psych.org.

Anxiety Disorders Association of America (ADAA), 8730 Georgia Ave., Suite 600, Silver Spring, MD, 20910, 240-485-1001, 240-485-1035, information@adaa.org, http://www.adaa.org.

International Society for Traumatic Stress Studies (ISTSS), 111 Deer Lake Road, Suite 100, DeerfieldIL, United States, 60015, 847-480-9028, 847-480-9282, istss@istss.org, http://www.istss.org.

National Alliance on Mental Illness (NAMI), 2107 Wilson Blvd., Suite 300, Arlington, VA, 22201-3042, 703-524-7600, Hotline: 800-950-NAMI (6264), 703-524-9094, http://www.nami.org/Hometemplate.cfm.

National Center for Posttraumatic Stress Disorder (NCPTSD), Information line: 802-296-6300, ncptsd@va.gov, http://www.ncptsd.va.gov/ncmain/index.jsp.

National Institute of Mental Health (NIMH), 6001 Executive Boulevard, Room 8184, MSC 9663, Bethesda, MD, 20892-9663, 301-443-4513, 866-615-6464, 301-443-4279, nimhinfo@nih.gov, http://www.nimh.nih.gov/index.shtml.

Rebecca J. Frey, PhD

Postmenopausal bleeding

Definition

Postmenopausal bleeding is bleeding from the reproductive system that occurs six months or more after menstrual periods have stopped due to **menopause**.

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Description

Menopause, the end of ovulation and menstrual periods, naturally occurs for most women age 40–55 years. The process of ending ovulation and menstruation is gradual, spanning one to two years.

Postmenopausal bleeding is bleeding that occurs after menopause has been established for at least six months. It is different from infrequent, irregular periods (**oligomenorrhea**) that occur around the time of menopause.

Many women experience some postmenopausal bleeding. However, postmenopausal bleeding is not normal. Because it can be a symptom of a serious medical condition, any episodes of postmenopausal bleeding should be brought to the attention of a woman's doctor.

Women taking estrogen (called **hormone replacement therapy** or HRT) are more likely to experience postmenopausal bleeding. So are obese women, because fat cells transform male hormones (androgens) secreted by the adrenal gland into estrogen.

Causes and symptoms

Postmenopausal bleeding can originate in different parts of the reproductive system. Bleeding from the vagina may occur because when estrogen secretion stops, the vagina dries out and can diminish (atrophy). This is the most common cause of bleeding from the lower reproductive tract.

Lesions and cracks on the vulva may also bleed. Sometimes bleeding occurs after intercourse. Bleeding can occur with or without an associated infection.

Bleeding from the upper reproductive system can be caused by:

- hormone replacements
- endometrial cancer
- endometrial polyps
- cervical cancer
- cervical lesions
- uterine tumors
- ovarian cancer
- estrogen-secreting tumors in other parts of the body

The most common cause of postmenopausal bleeding is HRT. The estrogen in the replacement therapy eases the symptoms of menopause (like hot flashes), and decreases the risk of **osteoporosis**. Sometimes this supplemental estrogen stimulates the uterine lining to grow. When the lining is shed, postmenopausal bleeding occurs. Most women on HRT usually take the hormone progesterone with the estrogen, and may have monthly withdrawal bleeding. This is a normal side effect.

About 5–10% of postmenopausal bleeding is due to **endometrial cancer** or its precursors. Uterine hyperplasia, the abnormal growth of uterine cells, can be a precursor to **cancer**.

Diagnosis

Diagnosis of postmenopausal bleeding begins with the patient. The doctor will ask for a detailed history of how long postmenopausal bleeding has occurred. A woman can assist the doctor by keeping a record of the time, frequency, length, and quantity of bleeding. She should also tell the doctor about any medications she is taking, especially any estrogens or **steroids**.

After taking the woman's history, the doctor does a pelvic examination and **Pap test**. The doctor will examine the vulva and vagina for signs of atrophy, and will feel for any sign of uterine polyps. Depending on the results of this examination, the doctor may want to do more extensive testing.

Invasive diagnostic procedures

Endometrial biopsy allows the doctor to sample small areas of the uterine lining, while cervical biopsy allows the cervix to be sampled. Tissues are then examined for any abnormalities. This is a simple office procedure.

Dilatation and curettage (D & C) is often necessary for definitive diagnosis. This is done under either general or **local anesthesia**. After examining the tissues collected by an endometrial biopsy or D & C, the doctor may order additional tests to determine if an estrogen-secreting tumor is present on the ovaries or in another part of the body.

Non-invasive diagnostic procedures

With concerns about the rising cost of health care, vaginal probe ultrasound is increasingly being used more than endometrial biopsy to evaluate women with postmenopausal bleeding. Vaginal ultrasound measures the thickness of the endometrium. When the endometrial stripe is less than 0.2 in (5 mm) thick, the chance of cancer is less than 1%. The disadvantage of vaginal ultrasound is that it often does not show polyps and fibroids in the uterus.

A refinement of vaginal probe ultrasound is saline infusion sonography (SIS). A salt water (saline) solution is injected into the uterus with a small tube (catheter) before the vaginal probe is inserted. The presence

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KEY TERMS

Dilatation and curettage (D & C)—A procedure performed under anesthesia during which the cervix is opened more (or dilated) and tissue lining the uterus is scraped out with a metal, spoon-shaped instrument or a suction tube. The procedure can be used to diagnose a problem or to remove growths (polyps).

Endometrial biopsy—The removal of uterine tissue samples either by suction or scraping; the cervix is not dilated. The procedure has a lower rate of diagnostic accuracy than D & C, but can be done as an office procedure under local anesthesia.

Endometrium—The tissue lining the inside of the uterus.

Fibroid tumors—Non-cancerous (benign) growths in the uterus. These growths occur in 30–40% of women over age 40, and do not need to be removed unless they are causing symptoms that interfere with a woman's normal activities.

Osteoporosis—The excessive loss of calcium from the bones, causing the bones to become fragile and break easily. Postmenopausal women are especially vulnerable to this condition because estrogen, a hormone that protects bones against calcium loss, decreases drastically after menopause.

of liquid in the uterus helps make any structural abnormalities more distinct. These two non-invasive procedures cause less discomfort than endometrial biopsies and D & Cs, but D & C still remains the definitive test for diagnosing uterine cancer.

Treatment

It is common for women just beginning HRT to experience some bleeding. Most women who are on HRT also take progesterone with the estrogen and may have monthly withdrawal bleeding. Again, this is a normal side effect that usually does not require treatment.

Postmenopausal bleeding due to bleeding of the vagina or vulva can be treated with local application of estrogen or HRT.

When diagnosis indicates cancer, some form of surgery is required. The uterus, cervix, ovaries, and fallopian tubes may all be removed depending on the type and location of the cancer. If the problem is estrogen- or androgen-producing tumors elsewhere in the body, these must also be surgically removed. Postmenopausal bleeding that is not due to cancer and cannot be controlled by any other treatment usually requires a **hysterectomy**.

Prognosis

Response to treatment for postmenopausal bleeding is highly individual and is not easy to predict. The outcome depends largely on the reason for the bleeding. Many women are successfully treated with hormones. As a last resort, hysterectomy removes the source of the problem by removing the uterus. However, this operation is not without risk and the possibility of complications. The prognosis for women who have various kinds of reproductive cancer varies with the type of cancer and the stage at which the cancer is diagnosed.

Prevention

Postmenopausal bleeding is not a preventable disorder. However, maintaining a healthy weight will decrease the chances of it occurring.

ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, 800 227-2345, http://www.cancer.org.

National Cancer Institute (National Institutes of Health), NCI Office of Communications and Education, 6116 Executive Blvd. Suite 300, Bethesda, MD, 20892-8322, 800 4-CANCER (422-6237), cancergovstaff@mail.nih.gov, http://www.cancer.gov.

Tish Davidson, A.M.

Postpartum blues *see* **Postpartum depression**

Postpartum depression

Definition

Postpartum depression is a mood disorder that begins after **childbirth** and usually lasts at least six weeks.

Description

Postpartum depression, or PPD, affects approximately 15% of all childbearing women. The onset of postpartum depression tends to be gradual and may persist for many months or develop into a second bout following a subsequent **pregnancy**. Mild to moderate cases are sometimes unrecognized by women themselves. Many women feel ashamed and may conceal their difficulties. This is a serious problem that disrupts women's lives and can have effects on the baby,

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KEY TERMS

Hyperemesis—Severe vomiting during pregnancy. Hyperemesis appears to increase a woman's risk of postpartum depression.

Postpartum—Following childbirth.

other children, partners, and other relationships. Levels of depression for fathers can also increase significantly.

Postpartum depression is often divided into two types: early onset and late onset. Early-onset PPD most often seems like the "blues," a mild brief experience during the first days or weeks after birth. During the first week after the birth, up to 80% of mothers experience the "baby blues." This period is usually a time of extra sensitivity; symptoms include tearfulness, irritability, **anxiety**, and mood changes, which tend to peak between three to five days after childbirth. The symptoms normally disappear within two weeks without requiring specific treatment apart from understanding, support, skills, and practice. In short, some depression, **fatigue**, and anxiety may fall within the "normal" range of reactions to giving birth.

Late-onset PPD appears several weeks after birth. It involves slowly growing feelings of sadness, depression, lack of energy, chronic fatigue, inability to sleep, change in appetite, significant weight loss or gain, and difficulty caring for the baby.

Causes and symptoms

The cause of postpartum depression has been extensively studied. Alterations of hormone levels of prolactin, progesterone, estrogen, and cortisol are not significantly different from those of patients who do not suffer from postpartum depression. However, some research indicates a change in a brain chemical that controls the release of cortisol.

Research seems to indicate that postpartum depression is unlikely to occur in a patient with an otherwise psychologically uncomplicated pregnancy and past history. There is no association of postpartum depression with marital status, social class, or the number of live children born to the mother. However, there seems to be an increased chance to develop this disorder after pregnancy loss.

Certain characteristics have been associated with increased risk of developing postpartum depression. These risk factors include:

- medical indigence—being in need of health care and not being able to receive it, possibly due to lack of medical insurance
- being younger than 20 years old at time of delivery
- being unmarried
- having been separated from one or both parents in childhood or adolescence
- receiving poor parental support and attention in childhood
- having had limited parental support in adulthood
- poor relationship with husband or boyfriend
- economic problem with housing or income
- dissatisfaction with amount of education
- low self-esteem
- past or current emotional problem(s)
- family history of depression

Experts cannot always say what causes postpartum depression. Most likely, it is caused by a combination of factors that vary from person to person. Some researchers think that women are vulnerable to depression at all major turning points in their reproductive cycle, childbirth being only one of these markers. Factors before the baby's birth that are associated with a higher risk of PPD include severe **vomiting** (hyperemesis), **premature labor** contractions, and psychiatric disorders in the mother. In addition, new mothers commonly experience some degree of depression during the first weeks after birth. Pregnancy and birth are accompanied by sudden hormonal changes that affect emotions. Additionally, the 24-hour responsibility for a newborn infant represents a major psychological and lifestyle adjustment for most mothers, even after the first child. These physical and emotional stresses are usually accompanied by inadequate rest until the baby's routine stabilizes, so fatigue and depression are not unusual.

In addition to hormonal changes and disrupted sleep, certain cultural expectations appear to place women from those cultures at increased risk of postpartum depression. For example, women who bear daughters in societies with a strong preference for sons (such as Communist China) are at increased risk of postpartum depression. In other cultures, a strained relationship with the husband's family is a risk factor. In Western countries, domestic violence is associated with a higher rate of PPD.

Experiences of PPD vary considerably but usually include several symptoms.

Feelings:

- persistent low mood
- inadequacy, failure, hopelessness, helplessness

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- exhaustion, emptiness, sadness, tearfulness
- guilt, shame, worthlessness
- confusion, anxiety, and panic
- fear for the baby and of the baby
- fear of being alone or going out

Behaviors:

- lack of interest or pleasure in usual activities
- insomnia or excessive sleep, nightmares
- not eating or overeating
- decreased energy and motivation
- withdrawal from social contact
- poor self-care
- inability to cope with routine tasks

Thoughts:

- inability to think clearly and make decisions
- lack of concentration and poor memory
- running away from everything
- fear of being rejected by the partner
- worry about harm or death to partner or baby
- ideas about suicide

Some symptoms may not indicate a severe problem. However, persistent low mood or loss of interest or pleasure in activities, along with four other symptoms occurring together for a period of at least two weeks, indicate clinical depression and require adequate treatment.

There are several important risk factors for postpartum depression, including the following:

- stress
- lack of sleep
- poor nutrition
- lack of support from one's partner, family, or friends
- family history of depression
- labor/delivery complications for mother or baby
- premature or postmature delivery
- problems with the baby's health
- separation of mother and baby
- a difficult baby (temperament, feeding, sleeping problems)
- pre-existing neurosis or psychosis

Physical and emotional **stress** during delivery in conjunction with great demands for infant care may cause the patient to neglect other family members, increasing the woman's feelings of self-worthlessness, isolation, and being trapped. Patients may also feel as if they are inadequate mothers, causing them guilt and embarrassment.

Demographics

There is a 20% to 30% risk of postpartum depression for women who had a previous depressive episode that was not associated with pregnancy. Additionally, there is an increased risk of recurrence in subsequent pregnancies since more than half of patients will have more than one episode.

Diagnosis

Diagnosis of postpartum depression entails a clinical interview with the patient to assess symptoms. A doctor or other professional healthcare provider may ask the mother about thoughts and feelings, and take a detailed personal history. Clinical assessment may be conducted by a psychologist or psychiatrist, who can determine the risk factors and diagnose the condition. A comprehensive psychological assessment interview could reveal a previous depressive cycle or a family history of depression—important risk factors. The most widely used standard for diagnosis is the Edinburgh Postnatal Depression Scale (EPDS). This is a simple and short 10-question scale. A score of 12 or greater on the EPDS is considered high risk for postpartum depression.

Treatment

Several treatment options exist, including medication, **psychotherapy**, counseling, and group treatment and support strategies. Treatment should begin as soon as the diagnosis is established. One effective treatment combines antidepressant medication and psychotherapy. These types of medication are often effective when used for three to four weeks. Any medication use must be carefully considered if the woman is **breastfeeding**, but with some medications, continuing breastfeeding is safe. There are many classes of antidepression medications. Two of the most commonly prescribed for PPD are **selective serotonin reuptake inhibitors** (SSRIs) such as citalopram (Celexa), escitalopram (Lexapro), fluoxetine (Prozac), paroxetine (Paxil, Pexeva), and sertraline (Zoloft), and tricyclids, such as amitriptyline (Elavil), desipramine (Norpramin), imipramine (Tofranil), and nortriptyline (Aventyl, Pamelor). Nevertheless, medication alone is never sufficient and should always be accompanied by counseling or other support services. Also, many women with postpartum depression feel isolated. It is important for these women to know that they are not alone in their feelings. There are various postpartum depression support groups available in local communities, often sponsored by non-profit

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organizations or hospitals. For women who have thoughts of **suicide**, it is imperative to seek help immediately.

When medications are combined with psychological therapy, the rates for successful treatment are increased. Interpersonal therapy and **cognitive-behavioral therapy** have been found to be effective.

Adjunct therapies such as **Acupuncture**, **traditional Chinese medicine**, **yoga**, **meditation**, and herbs may be considered to help the mother suffering from postpartum depression.

Some strategies that may help new mothers cope with the stress of becoming a parent include:

- Valuing her role as a mother and trusting her own judgment.
- Making each day as simple as possible.
- Avoiding extra pressures or unnecessary tasks.
- Trying to involve her partner more in the care of the baby from the beginning.
- Discussing with her partner how both can share the household chores and responsibilities.
- Scheduling frequent outings, such as walks and short visits with friends.
- Sharing her feelings with her partner or a friend who is a good listener.
- Talking with other mothers to help keep problems in perspective.
- Trying to sleep or rest when the baby is sleeping.
- Taking care of her health and well being.

Exercise, including yoga, can help enhance a new mother's emotional wellbeing. New mothers should also try to cultivate good sleeping habits and learn to rest when they feel physically or emotionally tired. It is important for a woman to learn to recognize her own warning signs of fatigue and respond to them by taking a break.

Expected results

When a woman has supportive friends and family, mild postpartum depression usually disappears quickly. If depression becomes severe and a mother cannot care for herself and the baby, hospitalization may be necessary. Medication, counseling, and support from others usually resolve even severe depression in three to six months. The prognosis for postpartum depression is better if it is detected early during its clinical course and a combination of SSRIs and psychotherapy is available and initiated.

Prevention

Mothers should be advised prior to hospital discharge that if the "maternity blues" last longer than two weeks or pose tough difficulties with family interactions, they should call the hospital where their baby was delivered and pursue a referral for a psychological evaluation. Education concerning risk factors and reduction of these is important. Prophylactic (preventive) use of SSRIs is indicated two to three weeks before delivery to prevent the disorder in a patient with a past history of depression, since recurrence rates are high if the mother had a previous depressive episode.

Resources

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ORGANIZATIONS

Kristin Brooks Hope Center, 615 Seventh St. NE, Washington, DC, 20002, (202) 536-3200, (800) 442-4673, http://www.hopeline.com.
National Institute of Mental Health, 6001 Executive Blvd., Room 8184, MSC 9663, Bethesda, MD, 20892, (866) 615-6464, http://www.nimh.nih.gov.
Online PPD Support Group, P.O. Box 611, Issaquah, WA, 98027, http://www.ppdsupportpage.com.
Postpartum Support International., PO Box 60931, Santa Barbara, CA, 93160, (805) 967-7636, (800) 944-4773, http://www.postpartum.net.

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Postpartum psychosis *see* **Postpartum depression**

Postpolio syndrome

Definition

Postpolio syndrome (PPS) is a condition that strikes survivors of the disease **polio**. PPS occurs about 20–30 years after the original bout with polio, and causes slow but progressive weakening of muscles.

Description

Polio is a disease caused by the poliovirus. It most commonly infects younger children, although it can also infect older children and adults. About 90% of people infected by poliovirus develop only a mild case or no illness at all. However, infected people can continue to spread the virus to others. In its most severe form polio causes **paralysis** of the muscles of the legs, arms, and respiratory system.

About 1% of all people infected with poliovirus develop the actual disease known as polio. In these cases, the virus (which enters the person's body through the mouth) multiplies rapidly within the intestine. The viruses then invade the nearby lymphatic system. Eventually, poliovirus enters the bloodstream, which allows it to gain access to the central nervous system or CNS (the brain and spinal cord). The virus may actually infect a nerve elsewhere in the body, and then spread along that nerve to enter the brain.

The major illness associated with poliovirus often follows a mild illness, which has symptoms of **fever**, **nausea**, and **vomiting**. However, after a symptom-free interval of several days, the patient who is on the way to a major illness develops new symptoms such as **headache** and back and neck **pain**. These symptoms are due to invasion of the nervous system. The motor nerves (those nerves responsible for movement of the muscles) become inflamed, injured, and destroyed. The muscles, therefore, no longer receive any messages from the brain or spinal cord. The muscles become weak, floppy, and then totally paralyzed (unable to move). All muscle tone is lost in the affected limb, and the muscle begins to decrease in size (atrophy). The affected muscles are often only on one side (asymmetric paralysis) of the body. Sensation (the person's ability to feel) is not affected in these paralyzed limbs.

The maximum state of paralysis is usually reached within just a few days. The remaining, unaffected nerves then begin the process of attempting to grow branches to compensate (make up for) the destroyed nerves. This process continues for about six months. Whatever function has not been regained in this amount of time will usually be permanently lost.

Causes and symptoms

PPS occurs in about 25% of patients, several decades after their original infection with polio. However, long-term follow-up indicates that two thirds of polio survivors may experience new weakness. Several theories exist as to the cause of this syndrome.

One such theory has looked at the way function is regained by polio survivors. Three mechanisms seem to be at work:

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- injured nerves recuperate and begin functioning again
- muscles that still have working nerve connections grow in size and strength, in order to take over for other paralyzed muscles
- working nerves begin to send small branches out to muscles whose original nerves were destroyed by polio

As a person ages, injured nerves that were able to regain function may fail again, as may muscles that have been over-worked for years in order to compensate for other paralyzed muscles. Even the uninjured nerves that provided new nerve twigs to the muscles may begin to falter after years of relative over-activity. This theory, then, suggests that the body's ability to compensate for destroyed nerves may eventually begin to fail. The compensating nerves and muscles grow older, and because they've been working so much harder over the years, they wear out relatively sooner than would be expected of normal nerves and muscles. Some researchers look at this situation as a form of premature **aging**, brought on by overuse.

Other researchers note that normal aging includes the loss of a fair number of motor nerves. When a patient has already lost motor nerves through polio, normal loss of motor nerves through aging may cause the number of remaining working nerves to drop low enough to cause symptoms of weakness.

Other theories of PPS include the possibility that particles of the original polioviruses remain in the body. These particles may exert a negative effect, decades later, or they may cause the body's immune system to produce substances originally intended to fight the invading virus, but which may accidentally set off a variety of reactions within the body that actually serve to interfere with the normal functioning of the nerves and muscles.

Still other researchers are looking at the possibility that polio patients have important spinal cord changes which, over time, affect the nerves responsible for movement.

The symptoms of PPS include generalized **fatigue**, low energy, progressively increasing muscle weakness, shrinking muscle size (atrophy), involuntary twitching of the muscle fibers (fasciculations), painful muscles and joints, difficulties with breathing and swallowing, and sleep problems.

Survivors of polio may also develop arthritis of the spine, shoulders, or arms, related to the long-term use of crutches or overcompensation for weak leg muscles.

KEY TERMS

Asymmetric—Not occurring equally on both sides of the body.

Atrophy—Shrinking, growing smaller in size.

Flaccid—Weak, soft, floppy.

Paralysis—The inability to voluntarily move.

Diagnosis

Diagnosis is primarily through history. When a patient who has recovered from polio some decades previously begins to experience muscle weakness, PPS must be strongly suspected.

Treatment

Just as there are no treatments available to reverse the original damage of polio, there are also no treatments available to reverse the damaging effects of postpolio syndrome. Attempts can be made to relieve some of the symptoms, however.

Pain and inflammation of the muscles and joints can be treated with anti-inflammatory medications, application of hot packs, stretching exercises, and **physical therapy**. Exercises to maintain/increase flexibility are particularly important. However, an **exercise** regimen must be carefully designed, so as not to strain already fatigued muscles and nerves.

Some patients will require new types of braces to provide support for weakening muscles. Others will need to use wheelchairs or motorized scooters to maintain mobility.

Sleep problems and respiratory difficulties may be related to each other. If breathing is labored during sleep, the blood's oxygen content may drop low enough to interfere with the quality of sleep. This may require oxygen supplementation, or even the use of a machine to aid in breathing.

Prognosis

Prognosis for patients with postpolio syndrome is relatively good. It is a very slow, gradually progressing syndrome. Only about 20% of all patients with PPS will need to rely on new aids for mobility or breathing. It appears that the PPS symptoms reach their most severe about 30–34 years after original diagnosis of polio.

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Prevention

There is no way to prevent PPS. However, paying attention to what types of exertion worsen symptoms may slow the progression of the syndrome.

ORGANIZATIONS

March of Dimes Birth Defects Foundation, 1275 Mamaroneck Ave., White Plains, NY, 10605, (914) 997-4488, http://www.modimes.org.

Polio Survivors Association, 12720 Lareina Ave., Downey, CA, 90242, (562) 862-4508, info@polioassociation.org, http://polioassociation.org.

Post-Polio Health International (PHI), 4207 Lindell Blvd., Suite 110, St. Louis, MO, 63108-2930, (314) 534-0475, (314) 534-5070, info@post-polio.org, http://www.post-polio.org.

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Postpoliomyelitis muscular atrophy *see* **Postpolio syndrome**

Postpoliomyelitis syndrome *see* **Postpolio syndrome**

Poststreptococcal glomerulonephritis *see* **Acute poststreptococcal glomerulonephritis**

Postural drainage *see* **Chest physical therapy**

Postural hypotension *see* **Orthostatic hypotension**

Postviral thrombocytopenia *see* **Idiopathic thrombocytopenic purpura**

Potassium hydroxide test *see* **KOH test**

Potassium imbalance *see* **Hyperkalemia; Hypokalemia**

PPD skin test *see* **Tuberculin skin test**

Prader-Willi syndrome

Definition

Prader-Willi syndrome (PWS) is a genetic condition caused by the absence of chromosomal material from chromosome 15. The genetic basis of PWS is complex. Characteristics of the syndrome include developmental delay, poor muscle tone, short stature, small hands and feet, incomplete sexual development, and unique facial features. Insatiable appetite is a classic feature of PWS. This uncontrollable appetite can lead to health problems and behavior disturbances.

Description

The first patients with features of PWS were described by Dr. Prader, Dr. Willi, and Dr. Lambert in 1956. Since that time, the complex genetic basis of PWS has begun to be understood. Initially, scientists found that individuals with PWS have a portion of genetic material deleted (erased) from chromosome 15. In order to have PWS, the genetic material must be deleted from the chromosome 15 received from one's father. If the deletion is on the chromosome 15 inherited from one's mother a different syndrome develops. This was an important discovery. It demonstrated for the first time that the genes inherited from one's mother can be expressed differently than the genes inherited from one's father.

Over time, scientists realized that some individuals with PWS do not have genetic material deleted from chromosome 15. Further studies found that these patients inherit both copies of chromosome 15 from their mother. This is not typical. Normally, an individual receives one chromosome 15 from their father and one chromosome 15 from their mother. When a person receives both chromosomes from the same parent it is called "uniparental disomy." When a person receives both chromosomes from his or her mother it is called "maternal uniparental disomy."

Scientists are still discovering other causes of PWS. A small number of patients with PWS have a change (mutation) in the genetic material on the chromosome 15 inherited from their father. This mutation prevents certain genes on chromosome 15 from working properly. PWS develops when these genes do not work normally.

Newborns with PWS generally have poor muscle tone, (hypotonia) and do not feed well. This can lead to poor weight gain and **failure to thrive**. Genitalia can be smaller than normal. Hands and feet are also typically smaller than normal. Some patients with PWS have unique facial characteristics. These unique facial features are typically subtle and detectable only by physicians.

As children with PWS age, development is typically slower than normal. Developmental milestones, such as crawling, walking and talking occur later than usual. Developmental delay continues into adulthood for approximately 50% of individuals with PWS. At about one to two years of age, children with PWS

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develop an uncontrollable, insatiable appetite. Left to their own devices, individuals with PWS will eat until they suffer from life-threatening **obesity**. The desire to eat can lead to significant behavior problems.

The symptoms and features of PWS require life long support and care. If food intake is strictly monitored and various therapies provided, individuals with PWS have a normal life expectancy.

PWS affects approximately 1 in 10,000 to 25,000 live births. It is the most common genetic cause of life-threatening obesity. It affects both males and females. PWS can be seen in all races and ethnic groups.

Causes and symptoms

In order to comprehend the various causes of PWS, the nature of chromosomes and genes must be well understood. Human beings have 46 chromosomes in the cells of their body. Chromosomes contain genes, which regulate the function and development of the body. An individual's chromosomes are inherited from his/her parents. Each parent normally gives a child 23 chromosomes. A child receives 23 chromosomes from the egg and 23 chromosomes from the sperm.

The 46 chromosomes in the human body are divided into pairs based on their physical characteristics. Each pair is assigned a number or a letter. When viewed under a microscope, chromosomes within the same pair appear identical because they contain the same genes.

Most chromosomes have a constriction near the center called the centromere. The centromere separates the chromosome into long and short arms. The short arm of a chromosome is called the "p arm," and the long arm is called the "q arm."

Chromosomes in the same pair contain the same genes. However, some genes work differently depending on if they were inherited from the egg or the sperm. Sometimes, genes are silenced when inherited from the mother. Other times, genes are silenced when inherited from the father. When genes in a certain region on a chromosome are silenced, they are said to be "imprinted." Imprinting is a normal process that does not typically cause disease. If normal imprinting is disrupted a genetic disease can develop.

Individuals have two complete copies of chromosome 15. One chromosome 15 is inherited from the mother, or "maternal" in origin. The other chromosome 15 is inherited from the father, or is "paternal" in origin.

Chromosome 15 contains many different genes. There are several genes found on the q arm of chromosome 15 that are imprinted. A gene called "SNPRN" is an example of one of these genes. It is normally imprinted, or silenced, if inherited from the mother. The imprinting of this group of maternal genes does not typically cause disease. The genes in this region should not be imprinted if paternal in origin. Normal development depends on these paternal genes being present and active. If these genes are deleted, not inherited, or incorrectly imprinted PWS develops.

Seventy percent of the cases of PWS are caused when a piece of material is deleted, or erased, from the paternal chromosome 15. This deletion occurs in a specific region on the q arm of chromosome 15. The piece of chromosomal material that is deleted contains genes that must be present for normal development. These paternal genes must be working normally, because the same genes on the chromosome 15 inherited from the mother are imprinted. When these paternal genes are missing, the brain and other parts of the body do not develop as expected. This is what causes the symptoms associated with PWS.

In 99% of the cases of PWS the deletion is sporadic. This means that it happens randomly and there is not an apparent cause. It does not run in the family. If a child has PWS due to a sporadic deletion in the paternal chromosome 15, the chance the parents could have another child with PWS is less than 1%. In fewer than 1% of the cases of PWS there is a chromosomal rearrangement in the family which causes the deletion. This chromosomal rearrangement is called a "translocation." If a parent has a translocation the risk of having a child with PWS is higher than 1%.

PWS can also develop if a child receives both chromosome 15s from his/her mother. This is seen in approximately 25% of the cases of PWS. Maternal uniparental disomy for chromosome 15 leads to PWS because the genes on chromosome 15 that should have been inherited from the father are missing, and the genes on both the chromosome 15s inherited from the mother are imprinted.

PWS caused by maternal uniparental is sporadic. This means that it occurs randomly and there is not an apparent cause. If a child has PWS due to maternal uniparental disomy the chance the parents could have another child with PWS is less than 1%.

Approximately 3–4% of patients with PWS have a change (mutation) in a gene located on the q arm of chromosome 15. This mutation leads to incorrect

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imprinting. This mutation causes genes inherited from the father to be imprinted or silenced, which should not normally be imprinted. If a child has PWS due to a mutation that changes imprinting, the chance the parents could have another child with PWS is approximately 5%.

Infants with PWS have weak muscle tone (hypotonia). This hypotonia causes problems with sucking and eating. Infants with PWS may have problems gaining weight. Some infants with PWS are diagnosed with "failure to thrive" due to slow growth and development. During infancy, babies with PWS may also sleep more than normal and have problems controlling their temperature.

Some of the unique physical features associated with PWS can be seen during infancy. Genitalia that is smaller than normal is common. This may be more evident in males with PWS. Hands and feet may also be smaller than average. The unique facial features seen in some patients with PWS may be difficult to detect in infancy. These facial features are very mild and do not cause physical problems.

As early as six months, but more commonly at one to two years a compulsive desire to eat develops. This uncontrollable appetite is a classic feature of PWS. Individuals with PWS lack the ability to feel full or satiated. This uncontrollable desire to eat is thought to be related to a difference in the brain, which controls hunger. Over-eating (hyperpahgia), a lack of a desire to **exercise**, and a slow metabolism places individuals with PWS at high risk for severe obesity. Some individuals with PWS may also have a reduced ability to vomit.

Behavior problems are a common feature of PWS. Some behavior problems develop from the desire to eat. Other reported problems include obsessive/compulsive behaviors, depression, and temper tantrums. Individuals with PWS may also pick their own skin (skin picking). This unusual behavior may be due to a reduced **pain** threshold.

Developmental delay, learning disabilities, and **mental retardation** are associated with PWS. Approximately 50% of individuals with PWS have developmental delay. The remaining 50% are described as having mild mental retardation. The mental retardation can occasionally be more severe. Infants and children with PWS are often delayed in development.

Puberty may occur early or late, but it is usually incomplete. In addition to the effects on sexual development and fertility, individuals do not undergo the normal adolescent growth spurt and may be short as adults. Muscles often remain underdeveloped and body fat is increased.

Diagnosis

During infancy the diagnosis of PWS may be suspected if poor muscle tone, feeding problems, small genitalia, or the unique facial features are present. If an infant has these features, testing for PWS should be performed. This testing should also be offered to children and adults who display features commonly seen in PWS (developmental delay, uncontrollable appetite, small genitalia, etc.). There are several different genetic tests that can detect PWS. All of these tests can be performed from a blood sample.

Methylation testing detects 99% of the cases of PWS. Methylation testing can detect the absence of the paternal genes that should be normally active on chromosome 15. Although methylation testing can accurately diagnose PWS, it can not determine if the PWS is caused by a deletion, maternal uniparental disomy, or a mutation that disrupts imprinting. This information is important for **genetic counseling**. Therefore, additional testing should be performed.

Chromosome analysis can determine if the PWS is the result of a deletion in the q arm of chromosome 15. Chromosome analysis, also called "karyotyping," involves staining the chromosomes and examining them under a microscope. In some cases the deletion of material from chromosome 15 can be easily seen. In other cases, further testing must be performed. FISH (fluorescence in-situ hybridization) is a special technique that detects small deletions that cause PWS.

More specialized DNA testing is required to detect maternal uniparental disomy or a mutation that disrupts imprinting. This DNA testing identifies unique DNA patterns in the mother and father. The unique DNA patterns are then compared with the DNA from the child with PWS.

PWS can be detected before birth if the mother undergoes **amniocentesis** testing or **chorionic villus sampling** (CVS). This testing is only recommended if the mother or father is known to have a chromosome rearrangement, or if they already have a child with PWS syndrome.

Treatment

There is currently not a cure for PWS. Treatment during infancy includes therapies to improve muscle tone. Some infants with PWS also require special nipples and feeding techniques to improve weight gain.

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KEY TERMS

Amniocentesis—A procedure in which a needle is inserted through a pregnant woman's abdomen and into her uterus. Amniotic fluid is then removed from around the fetus and may be used for genetic testing.

Centromere—Major constriction in a chromosome.

Deletion—Removal of a piece of genetic material.

DNA—Deoxyribonucleic acid. Genes are made of sections of DNA.

FISH—(flourescence in-situ hybridization) Technique used to detect small deletions or rearrangements in chromosomes.

Gene—Segment of DNA that controls the development and function of the body. Genes are contained within chromosomes.

Hyperphagia—Over-eating.

Hypotonia—Low muscle tone.

Imprinting—Process that silences a gene or group of genes. The genes are silenced depending on if they are inherited through the egg or the sperm.

Maternal—From one's mother.

Maternal uniparental disomy—Chromosome abnormality in which both chromosomes in a pair are inherited from one's mother.

Methylation testing—DNA testing that detects if a gene is active or imprinted.

Mutation—A change in a gene.

Paternal—From one's father.

Translocation—Chromosome abnormality in which chromosomes are rearranged and placed together.

Uniparental disomy—Chromosome abnormality in which both chromosomes in a pair are inherited from the same parent.

Treatment and management during childhood, adolescence, and adulthood is typically focused on weight control. Strict control of food intake is vital to prevent severe obesity. In many cases food must be made inaccessible. This may involve unconventional measures such as locking the refrigerator or kitchen cabinets. A lifelong restricted-calorie diet and regular exercise program are also suggested. Unfortunately, diet medications have not been shown to significantly prevent obesity in PWS. However, growth hormone therapy has been shown to improve the poor muscle tone and reduced height typically associated with PWS.

Special education may be helpful in treating developmental delays and behavior problems. Individuals with PWS typically excel in highly structured environments.

Prognosis

Life expectancy is normal and the prognosis good, if weight gain is well controlled.

Resources

BOOKS

Whittington, Joyce, and Tony Holland. *Prader–Willi Syndrome: Development and Manifestations*. Cambridge, UK: Cambridge University Press, 2010.

OTHER

Gene Clinics. http://www.geneclinics.org/profiles/pws/details.html.

OMIM. http://www.ncbi.nlm.nih.gov/omim/176270.

ORGANIZATIONS

Genetic Alliance, Inc., 4301 Connecticut Ave., NW, Suite 404, Washington, DC, 20008-2369, (202) 966-5557, (202) 966-8553, info@geneticalliance.org, http://www.geneticalliance.org.

International Prader-Willi Syndrome Organization, c/o BIRD Foundation Onlus, Via Bartolomeo Bizio I, 1-36023 Costozza (VI), Italy, http://www.ipwso.org.

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923, (800) 999-6673, http://www.rarediseases.org.

Prader-Willi Foundation, PO BOX 222, Baldwinsville, NY, 13027, (716) 276-2211, (800) 442-1655, alliance@prader-willi.org, http://www.prader-willi.org.

Prader-Willi Syndrome Association, 8588 Potter Park Drive, Suite 500, Sarasota, FL, 34238, (941) 312-0142, (800) 926-4797, pwsausa@pwsausa.org, http://www.pwsausa.org.

Holly Ann Ishmael, M.S.

Praziquantel *see* **Antihelminthic drugs**

Precocious puberty

Definition

Precocious **puberty** is defined as sexual development before the age of 7 in girls, and age 9 in boys. The American Academy of Pediatrics (AAP) identifies the specific signs of precocious puberty as the emergence of breast buds in girls of 6 or 7, or an increase in the

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size of a boy's testicle before his ninth birthday. Another definition of precocious puberty is population-specific; it states that precocious puberty is puberty that occurs at an age 2.5 standard deviations below the mean in a given population under consideration. It is important to keep in mind, however, that puberty appears to be occurring earlier in children in the early twenty-first century than in previous generations, so that definitions of "early" puberty may change over time.

Precocious puberty is subdivided into two types, central precocious puberty and peripheral precocious puberty (also called precocious pseudopuberty). In central precocious puberty (CPP), the condition is caused by the early maturation of the hypothalamic-pituitary-gonadal (HPG) axis. The HPG axis is a term used by doctors to refer to the combined effects of the hypothalamus, the pituitary gland, and the gonads. This group of glands controls sexual development, reproduction, and **aging** in humans and other animals. Most cases (80%) of precocious puberty are classified as CPP.

In peripheral precocious puberty (or precocious pseudopuberty), the sex hormones producing early signs of sexual maturation in the child come from sources other than the HPG axis. The hormones may be released from tumors in the adrenal gland or the pituitary gland, or they may be present in the child's body as the result of consuming soy products or using creams or ointments containing estrogen or testosterone. Other causes of precocious pseudopuberty include **ovarian cysts** or tumors (in girls) or **germ cell tumors** or a rare genetic mutation (in boys).

Demographics

According to the AAP, precocious puberty affects about 1 in every 160 otherwise healthy children—the same proportion as the number of youngsters who experience belated puberty. Exact figures for precocious puberty are difficult to obtain, however, because the condition is defined as a departure from the "normal" age of puberty, and that age has dropped since statistics were first kept in the 1840s. The drop in the average age at puberty since the early 2000s has been most noticeable in China, southern Europe, and other countries with warm climates.

Girls are much more likely to develop central precocious puberty than boys, the sex ratio being variously given as 5:1 or 8:1. In the United States, 25% of African American girls are reported to develop CPP, compared to 8% for Hispanic and Caucasian girls. The reason for this difference is not known as of 2010.

About 80% of all cases of precocious puberty are central precocious puberty, the remaining 20% being precocious pseudopuberty.

Description

Not every child in North America reaches puberty at the same time, but in most cases it's safe to predict that sexual development will begin at about age 11 in girls and 12 or 13 in boys. Precocious puberty often begins before age 8 in girls, triggering the development of breasts and hair under the arms and in the genital region. The onset of ovulation and menstruation also may occur. In boys, the condition triggers the development of a large penis and testicles, with spontaneous erections and the production of sperm. Hair grows on the face, under arms and in the pubic area, and **acne** may become a complexion problem. Children with precocious puberty may also develop adult body odor when they perspire.

While the early onset of puberty may seem fairly benign, in fact it can cause problems when hormones trigger changes in the growth pattern, essentially halting growth before the child has reached normal adult height. Girls may never grow taller than 5 ft (152 cm) and boys often stop growing by about 5 ft 2 in (157 cm).

Abnormal growth patterns are not the only problem, however. Children with this condition look noticeably different from their peers, and may feel rejected by their friends and socially isolated. Adults may expect these children to act more maturely simply because they look so much older. As a result, many of these children—especially boys—are much more aggressive than others their own age, leading to behavior problems both at home and at school. Girls who mature early are at increased risk of **sexual abuse**.

Risk factors

Risk factors for precocious puberty include:

- Sex. Girls are five times more likely to develop CPP than boys.
- Race. African American girls are three times as likely to develop CPP as Caucasian girls. This racial difference, however, does not hold true for boys.
- Obesity, particularly in girls. One study found that obese girls had an 80% chance of developing breasts before their ninth birthday and starting menstruation before age 12.
- History of injury to the central nervous system caused by trauma, surgery, or radiation therapy.
- History of brain tumors or structural abnormalities in the brain.

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- Exposure to products containing sex hormones, including skin or hair products, vitamins, or dietary supplements. Heavy consumption of soy products (including tofu) is a risk factor for precocious pseudopuberty in that soy contains phytoestrogens, substances found in certain plants that cause estrogen-like effects in humans.
- History of precocious puberty in other family members.

Causes and symptoms

Puberty begins when the part of the brain called the hypothalamus secretes a hormone (gonadotropin-releasing hormone or Gn-RH) that triggers the pituitary gland to release gonadotropins. These protein hormones in turn stimulate the gonads (ovaries or testes) to produce sex hormones. These sex hormones (especially estrogen in girls and testosterone in boys) are what causes the onset of sexual maturity.

The hormonal changes of central precocious puberty are normal—it is just that the whole process begins a few years too soon. In 90% of girls with precocious puberty, there is no underlying problem that causes the process of sexual maturation to begin too soon. About 50% of boys, however, do have an underlying condition. Some inherit the condition; the responsible gene may be passed directly from father to son, or inherited indirectly from the maternal grandfather through the mother, who does not begin early puberty herself. This condition is called familial male precocious puberty. This genetic condition in girls can be traced in only about 1% of cases.

Other conditions or disorders that may be associated with precocious puberty include:

- Tumors, cysts, or other abnormalities of the thyroid gland (in both sexes).
- History of radiation therapy for childhood cancer.
- McCune-Albright syndrome. This is a disorder that affects the bones, skin, and endocrine system. It is caused by a mutation on a single gene and cannot be passed down to the next generation. Girls with this syndrome may have their first menstrual period as early as two years of age.
- Disorders of the central nervous system, including cerebral palsy, neurofibromatosis, brain tumors, and tuberous sclerosis.
- Congenital adrenal hyperplasia (CAH). This is a genetic disorder in which the adrenal glands produce too much of the male sex hormone androgen.

Precocious puberty that cannot be traced to a specified cause is termed idiopathic or constitutional.

KEY TERMS

Central precocious puberty (CPP)—Precocious puberty resulting from the early maturation of the HPG axis.

Endocrine system—A system of ductless glands that secrete hormones that regulate a variety of body processes, including growth and sexual maturation. A doctor who specializes in diseases and disorders of these glands is called an endocrinologist.

Gonadotropins—Protein hormones secreted by the pituitary gland.

Hypothalamic-pituitary-gonadal (HPG) axis—A term used by doctors to refer to the combined effects of the hypothalamus, the pituitary gland, and the gonads. This group of glands controls sexual maturation in humans as well as other processes.

Idiopathic—Of unknown cause or spontaneous origin.

Peripheral precocious puberty—Precocious puberty resulting from the presence of sex steroids independent of the activation of the HPG axis. It is also called precocious pseudopuberty.

Precocious—Developing at an unusually early age.

Puberty—The process of maturation in which a child's body turns into an adult body capable of reproduction. The English word comes from a Latin word that means "age of maturity" or "adulthood."

Diagnosis

Parents should consult their child's pediatrician if their child shows any of the signs or symptoms of precocious puberty. The pediatrician may refer the child to an endocrinologist (doctor who specializes in disorders of the glands that regulate growth and sexual maturation as well as other body processes), because it is important to distinguish between central precocious puberty and precocious pseudopuberty—the two conditions are treated very differently.

Examination

An office **physical examination** can reveal the development of sexual characteristics in a young child. The doctor will weigh the child and compare his or her development to charts of normal development for the child's sex and age. If the child has been referred to an endocrinologist, the specialist will take a

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careful family history as well as a history of the child's development, including any surgeries or radiation treatments. **Bone x rays** can reveal bone age, and **pelvic ultrasound** may show an enlarged uterus and rule out ovarian or adrenal tumors. MRI or CAT scans should be considered to rule out intracranial tumors.

Tests

Blood tests can highlight higher-than-normal levels of hormones. To distinguish between CPP and precocious pseudopuberty, the doctor will administer an injection of Gn-RH hormone and then take a blood sample 30–60 minutes later. If the child has central precocious puberty, levels of two other hormones in the blood will rise. If the child has precocious pseudopuberty, the levels of these other hormones will remain the same.

The doctor may take another blood sample to test for levels of thyroid hormone if an abnormality of the thyroid gland is suspected.

Procedures

In the case of girls with precocious puberty, the doctor may perform a pelvic ultrasound to check for an ovarian cyst or tumor.

Treatment

Traditional

Treatment of precocious puberty aims to halt or reverse sexual development so as to stop the accompanying rapid growth that will limit a child's height. There are two possible approaches: either treat the underlying condition (such as an ovarian or intracranial tumor) or change the hormonal balance to stop sexual development. Tumors in the central nervous system can sometimes be successfully removed by surgery; however, it may not be possible to treat the underlying condition. Treatment of central precocious puberty is usually aimed at adjusting hormone levels by giving an analogue of Gn-RH, most commonly leuprolide (Lupron). Monthly injections of such medications slow down the HPG axis until the child reaches the normal age of puberty. Once the injections are stopped, puberty will begin again.

Drugs

There are several drugs that have been developed to treat precocious puberty:

- histrelin (Supprelin LA)
- nafarelin (Synarel)
- synthetic gonadotropin-releasing hormone agonist
- progestin (Depo-Provera)
- leuprolide (Lupron)

Prognosis

Drug treatments can slow growth to 2–3 in (5–7.5 cm) a year, allowing these children to reach normal adult height, although the long-term effects are not yet known. As of 2010, few prospective studies on these drugs have been performed; their psychosocial effects and their possible side effects of weight gain and reduced bone mineral density require further study. Children taking drugs to suppress early puberty should be seen for follow-up visits every 4–6 months to check on bone growth and (in girls) a decrease or at least no increase in breast size.

The prognosis of precocious pseudopuberty depends on its cause. Recovery from McCune-Albright syndrome depends on the extent of bone disease, but most girls have a good prognosis. The prognosis of CAH is excellent with proper treatment. The prognosis of girls with ovarian tumors depends on the stage at which the tumors were discovered.

Prevention

Some risk factors for precocious puberty, such as sex, race, or family history of early puberty, cannot be avoided. Parents can, however, keep children away from dietary supplements or adult medications containing sex hormones; limit the amount of soy products in the diet; and help their children maintain healthy weight levels.

Resources

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ORGANIZATIONS

American Academy of Pediatrics (AAP), 141 Northwest Point Boulevard, Elk Grove Village, IL, 60007, 847-434-4000, 847-434-8000, http://www.aap.org.
National Institute of Child Health and Human Development (NICHD)., Bldg 31, Room 2A32, MSC 2425, 31 Center Drive, Bethesda, MD, 20892, 800-370-2943, 866-760-5947, NICHDInformationResourceCenter@mail.nih.gov, http://www.nichd.nih.gov.

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Prednisone *see* **Corticosteroids**

Preeclampsia and eclampsia

Definition

Preeclampsia and eclampsia are complications of **pregnancy**. In preeclampsia, the woman has dangerously high blood pressure, swelling, and protein in the urine. If allowed to progress, this syndrome will lead to eclampsia.

Description

Blood pressure is a measurement of the pressure of blood on the walls of blood vessels called arteries. The arteries deliver blood from the heart to all of the tissues in the body. Blood pressure is reported as two numbers. For example, a normal blood pressure is reported as 110/70 mm Hg (read as 110 over 70 millimeters of mercury; or just 110 over 70). These two numbers represent two measurements, the systolic pressure and the diastolic pressure. The systolic pressure (the first number in the example; 110/70 mm Hg) measures the peak pressure of the blood against the artery walls. This higher pressure occurs as blood is being pumped out of the heart and into the circulatory system. The pumping chambers of the heart (ventricles) squeeze to force the blood out of the heart. The diastolic pressure (the second number in the example 110/70 mm Hg) measures the pressure, during the filling of the ventricles. At this point, the atria contract to fill the ventricles. Because the ventricles are relatively relaaxed, and are not pumping blood into the arteries, pressure in the arteries is lower as well.

High blood pressure in pregnancy (**hypertension**) is a very serious complication. It puts both the mother and the fetus at risk for a number of problems. Hypertension can exist in several different forms:

- The preeclampsia-eclampsia continuum (also called pregnancy-induced hypertension or PIH). In this type of hypertension, high blood pressure is first noted sometime after week 20 of pregnancy and is accompanied by protein in the urine and swelling.
- Chronic hypertension. This type of hypertension usually exists before pregnancy or may develop before week 20 of pregnancy.
- Chronic hypertension with superimposed preeclampsia. This syndrome occurs when a woman with pre-existing chronic hypertension begins to have protein in the urine after week 20 of pregnancy.
- Late hypertension. This is a form of high blood pressure occurring after week 20 of pregnancy and is unaccompanied by protein in the urine and does not progress the way preeclampsia-eclampsia does.

Preeclampsia is most common among women who have never given birth to a baby (called nulliparas). About 7% of all nulliparas develop preeclampsia. The disease is most common in mothers under the age of 20, or over the age of 35. African-American women have higher rates of preeclampsia than do Caucasian women. Other risk factors include poverty, multiple pregnancies (twins, triplets, etc.), pre-existing chronic

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hypertension or **kidney disease**, diabetes, excess amniotic fluid, and a condition of the fetus called nonimmune hydrops. The tendency to develop preeclampsia appears to run in families. The daughters and sisters of women who have had preeclampsia are more likely to develop the condition.

Causes and symptoms

Experts are still trying to understand the exact causes of preeclampsia and eclampsia. It is generally accepted that preeclampsia and eclampsia are problematic because these conditions cause blood vessels to leak. The effects are seen throughout the body.

- General body tissues. When blood vessels leak, they allow fluid to flow out into the tissues of the body. The result is swelling in the hands, feet, legs, arms, and face. While many pregnant women experience swelling in their feet, and sometimes in their hands, swelling of the upper limbs and face is a sign of a more serious problem. As fluid is retained in these tissues, the woman may experience significant weight gain (two or more pounds per week).
- Brain. Leaky vessels can cause damage within the brain, resulting in seizures or coma.
- Eyes. The woman may experience problems seeing, and may have blurry vision or may see spots. The retina may become detached.
- Lungs. Fluid may leak into the tissues of the lungs, resulting in shortness of breath.
- Liver. Leaky vessels within the liver may cause it to swell. The liver may be involved in a serious complication of preeclampsia, called the HELLP syndrome. In this syndrome, red blood cells are abnormally destroyed, chemicals called liver enzymes are abnormally high, and cells involved in the clotting of blood (platelets) are low.
- Kidneys. The small capillaries within the kidneys can leak. Normally, the filtration system within the kidney is too fine to allow protein (which is relatively large) to leave the bloodstream and enter the urine. In preeclampsia, however, the leaky capillaries allow protein to be dumped into the urine. The development of protein in the urine is very serious, and often results in a low birth weight baby. These babies have a higher risk of complications, including death.
- Blood pressure. In preeclampsia, the volume of circulating blood is lower than normal because fluid is leaking into other parts of the body. The heart tries to make up for this by pumping a larger quantity of blood with each contraction. Blood vessels usually expand in diameter (dilate) in this situation to decrease the work load on the heart. In preeclampsia, however, the blood vessels are abnormally constricted, causing the heart to work even harder to pump against the small diameters of the vessels. This causes an increase in blood pressure.

The most serious consequences of preeclampsia and eclampsia include brain damage in the mother due to brain swelling and oxygen deprivation during seizures. Mothers can also experience blindness, kidney failure, liver rupture, and **placental abruption**. Babies born to preeclamptic mothers are often smaller than normal, which makes them more susceptible to complications during labor, delivery, and in early infancy. Babies of preeclamptic mothers are also at risk of being born prematurely, and can suffer the complications associated with **prematurity**.

Diagnosis

Diagnosing preeclampsia may be accomplished by noting painless swelling of the arms, legs, and/or face, in addition to abnormal weight gain. The patient's blood pressure is taken during every doctor's visit during pregnancy. An increase of 30 mm Hg in the systolic pressure, or 15 mm Hg in the diastolic pressure, or a blood pressure reading greater than 140/90 mm Hg is considered indicative of preeclampsia. A simple laboratory test in the doctor's office can indicate the presence of protein in a urine sample (a dipstick test). A more exact measurement of the amount of protein in the urine can be obtained by collecting urine for 24 hours, and then testing it in a laboratory to determine the actual quantity of protein present. A 24-hour urine specimen containing more than 500 mg of protein is considered indicative of preeclampsia.

Treatment

With mild preeclampsia, treatment may be limited to bed rest, with careful daily monitoring of weight, blood pressure, and urine protein via dipstick. This careful monitoring will be required throughout pregnancy, labor, delivery, and even for 2–4 days after the baby has been born. About 25% of all cases of eclampsia develop in the first few days after the baby's birth. If the diastolic pressure does not rise over 100 mm Hg prior to delivery, and no other symptoms develop, the woman can continue pregnancy until the fetus is mature enough to be delivered safely. Ultrasound tests can be performed to monitor the health and development of the fetus.

If the diastolic blood pressure continues to rise over 100 mm Hg, or if other symptoms like **headache**, vision problems, abdominal **pain**, or blood abnormalities

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KEY TERMS

Capillary—The tiniest blood vessels with the smallest diameter. These vessels receive blood from the arterioles and deliver blood to the venules.

Diastolic—The phase of blood circulation in which the heart's pumping chambers (ventricles) are being filled with blood. During this phase, the ventricles are at their most relaxed, and the pressure against the walls of the arteries is at its lowest.

Placenta—The organ that provides oxygen and nutrition from the mother to the fetus during pregnancy. The placenta is attached to the wall of the uterus and leads to the fetus via the umbilical cord.

Placental abruption—An abnormal separation of the placenta from the uterus before the birth of the baby, with subsequent heavy uterine bleeding. Normally, the baby is born first and then the placenta is delivered within a half hour.

Systolic—The phase of blood circulation in which the heart's pumping chambers (ventricles) are actively pumping blood. The ventricles are squeezing (contracting) forcefully, and the pressure against the walls of the arteries is at its highest.

Urine dipstick test—A test using a small, chemically treated strip that is dipped into a urine sample; when testing for protein, an area on the strip changes color depending on the amount of protein (if any) in the urine.

Uterus—The muscular organ that contains the developing baby during pregnancy.

Ventricles—The two chambers of the heart that are involved in pumping blood. The right ventricle pumps blood into the lungs to receive oxygen. The left ventricle pumps blood into the circulation of the body to deliver oxygen to all of the body's organs and tissues.

develop, then the patient may require medications to prevent seizures. Magnesium sulfate is commonly given through a needle in a vein (intravenous, or IV). Medications that lower blood pressure (**antihypertensive drugs**) are reserved for patients with very high diastolic pressures (over 110 mm Hg), because lowering the blood pressure will decrease the amount of blood reaching the fetus. This places the fetus at risk for oxygen deprivation. If preeclampsia appears to be progressing toward true eclampsia, then medications may be given in order to start labor. Babies can usually be delivered vaginally. After the baby is delivered, the woman's blood pressure and other vital signs will usually begin to return to normal quickly.

Prognosis

The prognosis in preeeclampsia and eclampsia depends on how carefully a patient is monitored. Very careful, consistent monitoring allows quick decisions to be made, and improves the woman's prognosis. Still, the most common causes of **death** in pregnant women are related to high blood pressure.

About 33% of all patients with preeclampsia will have the condition again with later pregnancies. Eclampsia occurs in about 1 out of every 200 women with preeclampsia. If not treated, eclampsia is almost always fatal.

Prevention

More information on how preeclampsia and eclampsia develop is needed before recommendations can be made on how to prevent these conditions. Research is being done with patients in high risk groups to see if **calcium** supplementation, **aspirin**, or fish oil supplementation may help prevent preeclampsia. Most importantly, it is clear that careful monitoring during pregnancy is necessary to diagnose preeclampsia early. Although even carefully monitored patients may develop preeclampsia and eclampsia, close monitoring by practitioners will help decrease the complications of these conditions.

ORGANIZATIONS

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Pregnancy

Definition

The period from conception to birth. After the egg is fertilized by a sperm and then implanted in the lining of the uterus, it develops into the placenta and embryo, and later into a fetus. Pregnancy usually lasts 40 weeks, beginning from the first day of the woman's last menstrual period, and is divided into three trimesters, each lasting three months.

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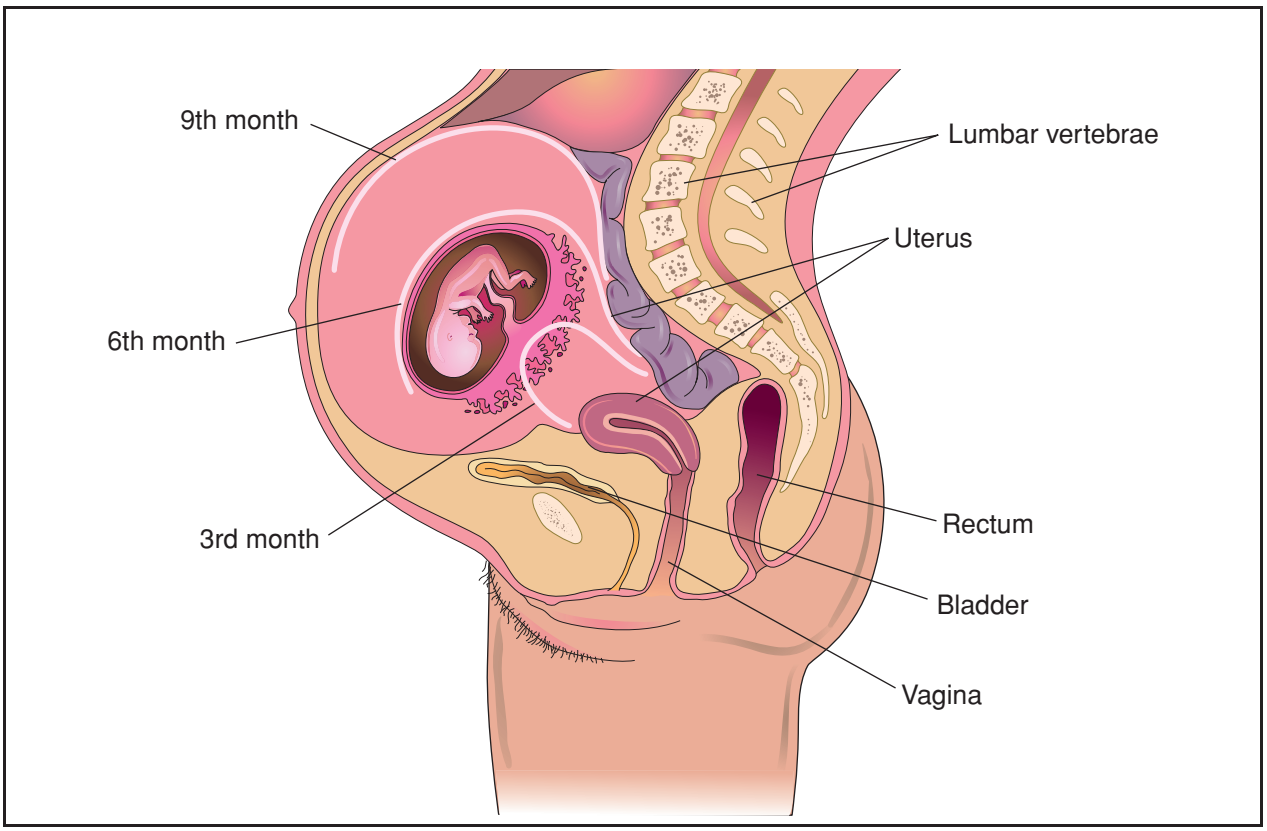

Pregnancy usually lasts 40 weeks in humans, beginning from the first day of the woman's last menstrual period, and is divided into three trimesters. The illustration above depicts the position of the developing fetus during each trimester. *((Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Description

Pregnancy is a state in which a woman carries a fertilized egg inside her body. Due to technological advances, pregnancy is increasingly occurring among older women in the United States.

First month

At the end of the first month, the embryo is about a third of an inch long, and its head and trunk—plus the beginnings of arms and legs—have started to develop. The embryo receives nutrients and eliminates waste through the umbilical cord and placenta. By the end of the first month, the liver and digestive system begin to develop, and the heart starts to beat.

Second month

In this month, the heart starts to pump and the nervous system (including the brain and spinal cord) begins to develop. The 1 in (2.5 cm) long fetus has a complete cartilage skeleton, which is replaced by bone cells by month's end. Arms, legs and all of the major organs begin to appear. Facial features begin to form.

Third month

By now, the fetus has grown to 4 in (10 cm) and weighs a little more than an ounce (28 g). The major blood vessels and the roof of the mouth are almost completed, and the face starts to take on a more recognizably human appearance. Fingers and toes appear. All the major organs are now beginning to form; the kidneys are now functional and the four chambers of the heart are complete.

Fourth month

The fetus begins to kick and swallow, although most women still can not feel the baby move at this point. Now 4 oz (112 g), the fetus can hear and urinate, and has established sleep-wake cycles. All organs are now fully formed, although they will continue to grow for the next five months. The fetus has skin, eyebrows, and hair.

Fifth month

Now weighing up to a 1 lb (454 g) and measuring 8–12 in (20–30 cm), the fetus experiences rapid growth

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as its internal organs continue to grow. At this point, the mother may feel her baby move, and she can hear the heartbeat with a stethoscope.

Sixth month

Even though its lungs are not fully developed, a fetus born during this month can survive with intensive care. Weighing 1–1.5 lbs (454–681 g), the fetus is red, wrinkly, and covered with fine hair all over its body. The fetus will grow very fast during this month as its organs continue to develop.

Seventh month

There is a better chance that a fetus born during this month will survive. The fetus continues to grow rapidly, and may weigh as much as 3 lb (1.3 kg) by now. Now the fetus can suck its thumb and look around its watery womb with open eyes.

Eighth month

Growth continues but slows down as the baby begins to take up most of the room inside the uterus. Now weighing 4–5 lbs (1.8–2.3 kg) and measuring 16–18 in (40–45 cm) long, the fetus may at this time prepare for delivery next month by moving into the head-down position.

Ninth month

Adding 0.5 lb (227 g) a week as the due date approaches, the fetus drops lower into the mother's abdomen and prepares for the onset of labor, which may begin any time between the 37th and 42nd week of gestation. Most healthy babies will weigh 6–9 lb (2.7–4 kg) at birth, and will be about 20 in. long.

Causes and symptoms

The first sign of pregnancy is usually a missed menstrual period, although some women bleed in the beginning. A woman's breasts swell and may become tender as the mammary glands prepare for eventual **breastfeeding**. Nipples begin to enlarge and the veins over the surface of the breasts become more noticeable.

Nausea and vomiting are very common symptoms and are usually worse in the morning and during the first trimester of pregnancy. They are usually caused by hormonal changes, in particular, increased levels of progesterone. Women may feel worse when their stomach is empty, so it is a good idea to eat several small meals throughout the day, and to keep things like crackers on hand to eat even before getting out of bed in the morning.

Many women also feel extremely tired during the early weeks. Frequent urination is common, and there may be a creamy white discharge from the vagina. Some women crave certain foods, and an extreme sensitivity to smell may worsen the **nausea**. Weight begins to increase.

In the second trimester (13–28 weeks) a woman begins to look noticeably pregnant and the enlarged uterus is easy to feel. The nipples get bigger and darker, skin may darken, and some women may feel flushed and warm. Appetite may increase. By the 22nd week, most women have felt the baby move. During the second trimester, nausea and **vomiting** often fade away, and the pregnant woman often feels much better and more energetic. Heart rate increases as does the volume of blood in the body.

By the third trimester (29–40 weeks), many women begin to experience a range of common symptoms. Stretch marks may develop on abdomen, breasts, and thighs, and a dark line may appear from the navel to pubic hair. A thin fluid may be discharged from the nipples. Many women feel hot, sweat easily and often find it hard to get comfortable. Kicks from an active baby may cause sharp pains, and lower backaches are common. More rest is needed as the woman copes with the added **stress** of extra weight. Braxton Hicks contractions may get stronger.

At about the 36th week in a first pregnancy (later in repeat pregnancies), the baby's head drops down low into the pelvis. This may relieve pressure on the upper abdomen and the lungs, allowing a woman to breathe more easily. However, the new position places more pressure on the bladder.

A healthy weight gain for most women is between 25 and 35 pounds. Women who are overweight should gain less; and women who are underweight should gain more. On average, pregnant women need an additional 300 calories a day. Generally, women will gain three to five pounds in the first three months, and then add one to two pounds a week until the baby is born. An average, healthy full-term baby at birth weighs 7.5 lb (3.4 kg), and the placenta and fluid together weigh another 3.5 lb. The remaining weight that a woman gains during pregnancy is mostly due to water retention and fat stores. Her breasts, for instance, gain about 2 lb. in weight, and she gains another 4 lb due to increased blood volume.

In addition to the typical, common symptoms of pregnancy, some women experience other problems that may be annoying, but which usually disappear after delivery. **Constipation** may develop as a result of food passing more slowly through the intestine.

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Hemorrhoids and **heartburn** are fairly common during late pregnancy. Gums may become more sensitive and bleed more easily; eyes may dry out, making **contact lenses** feel painful. **Pica** (a craving to eat substances other than food) may occur. Swollen ankles and **varicose veins** may be a problem in the second half of pregnancy, and chloasma may appear on the face.

Chloasma, also known as the "mask of pregnancy" or melasma, is caused by hormonal changes that result in blotches of pale brown skin appearing on the forehead, cheeks, and nose. These blotches may merge into one dark mask. It usually fades gradually after pregnancy, but it may become permanent or recur with subsequent pregnancies. Some women also find that the line running from the top to the bottom of their abdomen darkens. This is called the linea nigra.

While the above symptoms are all considered to be normal, there are some symptoms that could be a sign of a more dangerous underlying problem. A pregnant woman with any of the following signs should contact her doctor immediately:

- abdominal pain
- rupture of the amniotic sac or leaking of fluid from the vagina
- bleeding from the vagina
- no fetal movement for 24 hours (after the fifth month)
- continuous headaches
- marked, sudden swelling of eyelids, hands, or face during the last three months
- dim or blurry vision during last three months
- persistent vomiting

Diagnosis

Many women first discover they are pregnant after a positive home pregnancy test. Pregnancy urine tests check for the presence of human chorionic gonadotropin (hCG), which is produced by a placenta. The newest home tests can detect pregnancy on the day of the missed menstrual period.

Home pregnancy tests are more than 97% accurate if the result is positive, and about 80% accurate if the result is negative. If the result is negative and there is no menstrual period within another week, the pregnancy test should be repeated. While home pregnancy tests are very accurate, they are less accurate than a pregnancy test conducted at a lab. For this reason, women may want to consider having a second pregnancy test conducted at their doctor's office to be sure of the accuracy of the result.

Blood tests to determine pregnancy are usually used only when a very early diagnosis of pregnancy is needed. This more expensive test, which also looks for hCG, can produce a result within nine to 12 days after conception.

Once pregnancy has been confirmed, there are a range of screening tests that can be done to screen for **birth defects**, which affect about 3% of unborn children. Two tests are recommended for all pregnant women: alpha-fetoprotein (AFP) and the triple marker test.

Other tests are recommended for women at higher risk for having a child with a birth defect. This includes women over age 35, who had another child or a close relative with a birth defect, or who have been exposed to certain drugs or high levels of radiation. Women with any of these risk factors may want to consider **amniocentesis**, **chorionic villus sampling** (CVS) or ultrasound.

Other prenatal tests

There are a range of other prenatal tests that are routinely performed, including:

- PAP test
- gestational diabetes screening test at 24–28 weeks
- tests for sexually transmitted diseases
- urinalysis
- blood tests for anemia or blood type
- screening for immunity to various diseases, such as German measles

Treatment

Prenatal care is vitally important for the health of the unborn baby. A pregnant woman should be sure to eat a balanced, nutritious diet of frequent, small meals. Women should begin taking 400 mcg of **folic acid** several months before becoming pregnant, as folic acid has been shown to reduce the risk of spinal cord defects, such as **spina bifida**.

No medication (not even a nonprescription drug) should be taken except under medical supervision, since it could pass from the mother through the placenta to the developing baby. Some drugs, called teratogens, have been proven harmful to a fetus, but no drug should be considered completely safe (especially during early pregnancy). Drugs taken during the first three months of a pregnancy may interfere with the normal formation of the baby's organs, leading to birth defects. Drugs taken later on in pregnancy may slow the baby's growth rate, or they may damage specific fetal tissue (such as the developing teeth), or cause preterm birth. Herbal supplements and other "natural" remedies can also be extremely harmful to

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KEY TERMS

Alpha-fetoprotein—A substance produced by a fetus' liver that can be found in the amniotic fluid and in the mother's blood. Abnormally high levels of this substance suggests there may be defects in the fetal neural tube, a structure that will include the brain and spinal cord when completely developed. Abnormally low levels suggest the possibility of Down' syndrome.

Braxton Hicks' contractions—Short, fairly painless uterine contractions during pregnancy that may be mistaken for labor pains. They allow the uterus to grow and help circulate blood through the uterine blood vessels.

Chloasma—A skin discoloration common during pregnancy, also known as the "mask of pregnancy" or melasma, in which blotches of pale brown skin appear on the face. It is usually caused by hormonal changes. The blotches may appear in the forehead, cheeks, and nose, and may merge into one dark mask. It usually fades gradually after pregnancy, but it may become permanent or recur with subsequent pregnancies. Some women may also find that the line running from the top to the bottom of their abdomen darkens. This is called the linea nigra.

Embryo—An unborn child during the first eight weeks of development following conception (fertilization with sperm). For the rest of pregnancy, the embryo is known as a fetus.

Fetus—An unborn child from the end of the eights week after fertilization until birth.

Human chorionic gonadotropin (hCG)—A hormone produced by the placenta during pregnancy.

Placenta—The organ that develops in the uterus during pregnancy that links the blood supplies of the mother and baby.

Rhythm method—The oldest method of contraception with a very high failure rate, in which partners periodically refrain from having sex during ovulation. Ovulation is predicted on the basis of a woman's previous menstrual cycle.

Spina bifida—A congenital defect in which part of the vertebrae fail to develop completely, leaving a portion of the spinal cord exposed.

an unborn baby and should not be taken during pregnancy without close supervision by a physician.

To have the best chance of having a healthy baby, a pregnant woman should avoid:

- smoking
- alcohol
- street drugs
- large amounts of caffeine
- artificial sweeteners

Nutrition

Women should begin following a healthy diet even before they become pregnant. This means cutting back on high-calorie, high-fat, high-sugar snacks, and increasing the amount of fruits, vegetables, and whole grains in her diet. Once she becomes pregnant, she should make sure to eat at least six to 11 servings of breads and other whole grains, three to five servings of vegetables, two to four servings of fruits, four to six servings of milk and milk products, three to four servings of meat and protein foods, and to drink six to eight glasses of water each day. She should limit **caffeine** to no more than one soft drink or cup of coffee per day.

Prognosis

Pregnancy is a natural condition that usually causes little discomfort provided the woman takes care of herself and gets adequate prenatal care. **Childbirth** education classes for the woman and her partner help prepare the couple for labor and delivery.

Prevention

There are many ways to avoid pregnancy. A woman has a choice of many methods of **contraception** which will prevent pregnancy, including (in order of least to most effective):

- spermicide alone
- natural (rhythm) method
- diaphragm or cap alone
- condom alone
- diaphragm with spermicide
- condom with spermicide
- intrauterine device (IUD)
- contraceptive pill
- sterilization (either a man or woman)
- avoiding intercourse

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Resources

BOOKS

Kitzinger, Sheila. *The Complete Book of Pregnancy and Childbirth*. New York: Alfred A. Knopf, 2004.

OTHER

Doulas of North America. http://www.dona.com.
Planned Parenthood. http://www.plannedparenthood.org.
Pregnancy Information. http://www.childbirth.org.

ORGANIZATIONS

National Healthy Mothers, Healthy Babies Coalition, 2000 N. Beauregard Street, 6th Floor, Alexandria, VA, 22311, (703) 837-4792, (703) 684-5968, info@hmhb.org, http://www.hmhb.org.

National Institute of Child Health and Human Development, Bldg 31, Room 2A32, MSC 2425, 31 Center Drive, Bethesda, MD, 20892-2425, (800) 370-2943, http://www.nichd.nih.gov.

Debra Gordon

Pregnancy-induced high blood pressure *see* **Preeclampsia and eclampsia**

Pregnancy test *see* **Human chorionic gonadotropin pregnancy test**

Preleukemia *see* **Myelodysplastic syndrome**

Premature atrial contractions *see* **Atrial ectopic beats**

Premature birth *see* **Prematurity**

Premature ejaculation

Definition

Premature ejaculation occurs when male sexual climax (orgasm) occurs before a man wishes it or too quickly during intercourse to satisfy his partner.

Description

Premature ejaculation is the most commonly reported sexual complaint of men and couples. The highest number of complaints is among teenage, young adult, and sexually inexperienced males. Increased risk is associated with sexual inexperience and lack of knowledge of normal male sexual responses.

Causes and symptoms

There are several reasons why a man may ejaculate prematurely. For some men, the cause is due to an innate reflex or psychological predisposition of the nervous system. Sometimes it can be caused by certain drugs, such as non-prescription cold medications. Psychological factors, such as **stress**, fear, or guilt can also play a role. Examples of psychological factors include guilt that the sexual activity is wrong or sinful, fear of getting caught, or stress from problems at work or home.

In general, symptoms are when a male reaches climax in less than two minutes or when it occurs before the male or couple want it to occur.

Diagnosis

There are no tests used to diagnose premature ejaculation. It is usually determined by the male involved based on his belief that he reached orgasm too quickly. General guidelines for premature ejaculation is if it occurs in two minutes or less, or prior to about 15 thrusts during sexual intercourse.

Treatment

In 1966, William H. Masters and Virginia E. Johnson published *Human Sexual Response,* in which they broke the first ground in approaching this topic from a new perspective. Their method was devised by Dr. James Seman and has been modified subsequently by Dr. Helen Singer Kaplan and others.

A competent and orthodox sex therapist will spend much more time focusing on the personal than the sexual relationship between the two people who come for treatment. Without emotional intimacy, sexual relations are superficial and sexual problems such as premature ejaculation are not always overcome.

With that foremost in mind, a careful plan is outlined that requires dedication, patience, and commitment by both partners. It necessarily begins by prohibiting intercourse for an extended period of time—at least a week, often a month. This is very important to the man because "performance anxiety" is the greatest enemy of performance. If he knows he cannot have intercourse he is able to relax and focus on the exercises. The first stage is called "sensate focus" and involves his concentration on the process of sexual arousal and climax. He should learn to recognize each step in the process, most particularly the moment just before the "point of no return." Ideally, this stage of treatment requires the man's partner to be devoted to his sensations. In order to regain equality,

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he should in turn spend separate time stimulating and pleasing his mate, without intercourse.

At this point the techniques diverge. The original "squeeze technique" requires that the partner become expert at squeezing the head of the penis at intervals to prevent orgasm. The modified procedure, described by Dr. Ruth Westheimer, calls upon the man to instruct the partner when to stop stimulating him to give him a chance to draw back. A series of stages follows, each offering greater stimulation as the couple gains greater control over his arousal. This whole process has been called "outercourse." After a period of weeks, they will have together retrained his response and gained satisfactory control over it. In addition, they will each have learned much about the other's unique sexuality and ways to increase each other's pleasure.

With either technique, the emphasis is on the mutual goal of satisfactory sexual relations for both partners.

However, the 1990s ushered in a new era in the treatment of premature ejaculation when physicians discovered that certain antidepression drugs had a side effect of delaying ejaculation. Clinical studies have shown that a class of antidepressants called selective seratonin reuptake inhibitors (SSRIs) can be very effective in prolonging the time to ejaculation. The individual drugs and the average amount of time they delay ejaculation are fluoxetine (Prozac), one to two minutes with doses of 20–40 milligrams per day (mg/day) and eight minutes with 60 mg/day; paroxetine (Paxil), three to 10 minutes with doses of 20–40 mg/day; and sertraline (Zoloft), two to five minutes with doses of 50–200 mg/day.

Alternative treatment

There are several alternative products, usually found in health food and **nutrition** stores, designed to be sprayed or rubbed on the penis to delay ejaculation. Although the products promise results, there are no valid clinical studies to support the claims. A device called a testicular restraint, sold through erotic mail-order magazines, sometimes helps men delay ejaculation. The Velcro-like device restrains the testicles from their natural tendency to move during sex. Testicular movement can cause premature ejaculation.

Prognosis

The "squeeze technique" has elicited a 95% success rate, whereby the patient is able to control ejaculation. Treatment with SSRIs is effective in 85–90% of cases. However, the effectiveness begins to decrease after five weeks of daily administration. Although more studies are needed, this suggests the SSRIs are more effective when used on an as-needed basis.

Prevention

The best prevention is obtaining adequate information on normal sexual responses of males before having sex. It is also helpful to have sex in a comfortable, relaxed, private setting, free of guilt, stress, and fear.

ORGANIZATIONS

American Association for Marriage and Family Therapy, 112 South Alfred Street, Alexandria, VA, 22314-3061, (703) 838-9808, (703) 838-9805, http://www.aamft.org.

American Association of Sex Educators, Counselors, and Therapists, 1444 I Street NW, Suite 700, Washington, DC, 20005, (202) 449-1099, (202) 216-9646, http://www.aasect.org.

Sexuality Information and Education Council of the U.S., 90 John St. Suite 402, New York, NY, (212) 819-9770, (212) 819-9770, (212) 819-9776, pmalone@siecus.org. http://www.siecus.org.

Ken R. Wells

Premature labor

Definition

Premature labor is the term to describe contractions of the uterus that begin at weeks 20–36 of a **pregnancy**.

Description

The usual length of a human pregnancy is 38–42 weeks after the first day of the last menstrual period. Labor is a natural series of events that indicate that the birth process is starting. Premature labor is defined as contractions that occur after 20 weeks and before 37 weeks during the term of pregnancy. The baby is more likely to survive and be healthy if it remains in the uterus for the full term of the pregnancy. It is estimated that around 10% of births in the United States occur during the premature period. Premature birth is the greatest cause of newborn illness and **death**. In the United States, prematurity has a greater impact on African Americans.

Causes and symptoms

The causes of premature labor cannot always be determined. Some research suggests that infection of the urinary or reproductive tract may stimulate

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premature labor and premature births. Multiple pregnancies (twins, triplets, etc.) are more likely to result in premature labor. **Smoking**, alcohol use, drug **abuse**, and poor **nutrition** can increase the risk of premature labor and birth. Adolescent mothers are also at higher risk for premature delivery. Women whose mothers took diethylstilbestrol (DES) when they carried them are more likely to deliver prematurely, as are women who have had previous surgery on the cervix.

The symptoms of premature labor can include contractions of the uterus or tightening of the abdomen, which occurs every ten minutes or more frequently. These contractions usually increase in frequency, duration, and intensity, and may or may not be painful. Other symptoms associated with premature labor can include menstrual-like cramps, abdominal cramping with or without **diarrhea**, pressure or pain in the pelvic region, low backache, or a change in the color or amount of vaginal discharge. As labor progresses, the cervix or opening of the uterus will open (dilate) and the tissue around it will become thinner (efface). **Premature rupture of membranes** (when the water breaks) may also occur.

An occasional contraction can occur anytime during the pregnancy and does not necessarily indicate that labor is starting. Premature contractions are sometimes confused with Braxton Hicks contractions, which can occur throughout the pregnancy. Braxton Hicks contractions do not cause the cervix to open or efface, and are considered "false labor."

Diagnosis

The health care provider will conduct a **physical examination** and ask about the timing and intensity of the contractions. A vaginal examination is the only way to determine if the cervix has started to dilate or efface. Urine and blood samples may be collected to screen for infection. A vaginal culture (a cotton-tipped swab is used to collect some fluid and cells from the vagina) may be done to look for a vaginal infection. A fetal heart monitor may be placed on the mother's abdomen to record the heartbeat of the fetus and to time the contractions. A fetal ultrasound may be performed to determine the age and weight of the fetus, the condition of the placenta, and to see if there is more than one fetus present. **Amniocentesis** will sometimes be performed. This is a procedure where a needle-like tube is inserted through the mother's abdomen to draw out some of the fluid surrounding the fetus. Analysis of the amniotic fluid can determine if the baby's lungs are mature. A baby with mature lungs is much more likely to survive outside the uterus.

KEY TERMS

Braxton Hicks contractions—Tightening of the uterus or abdomen that can occur throughout pregnancy. These contractions do not cause changes to the cervix and are sometimes called false labor or practice contractions.

Cervix—The opening at the bottom of the uterus, which dilates or opens in order for the fetus to pass into the vagina or birth canal during the delivery process.

Contraction—A tightening of the uterus during pregnancy. Contractions may or may not be painful and may or may not indicate labor.

Treatment

The goal of treatment is to stop the premature labor and prevent the fetus from being delivered before it is full term. A first recommendation may be for the woman with premature contractions to lie down with feet elevated and to drink juice or other fluids. If contractions continue or increase, medical attention should be sought. In addition to bed rest, medical care may include intravenous fluids. Sometimes, this extra fluid is enough to stop contractions. In some cases, oral or injectable drugs like terbutaline sulfate, ritodrine, magnesium sulfate, or nifedipine must be given to stop the contractions. These are generally very effective; however, as with any drug therapy, there are risks of side effects. Some women may need to continue on medication for the duration of the pregnancy. **Antibiotics** may be prescribed if a vaginal or **urinary tract infection** is detected. If the membranes have already ruptured, it may be difficult or impossible to stop premature labor. If infection of the membranes that cover the fetus (chorioamnionitis) develops, the baby must be delivered.

Prognosis

If premature labor is managed successfully, the pregnancy may continue normally for the delivery of a healthy infant. Once symptoms of preterm labor occur during the pregnancy, the mother and fetus need to be monitored regularly since it is likely that premature labor will occur again. If the preterm labor cannot be stopped or controlled, the infant will be delivered prematurely. Infants that are born prematurely have an increased risk of health problems including **birth defects**, lung problems, **mental retardation**, blindness, deafness, and developmental disabilities. If the infant is

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born too early, its body systems may not be mature enough for it to survive. Evaluating the infant's lung maturity is one of the keys to determining the baby's chance of survival. Fetuses delivered further into pregnancy and those with more mature lungs are more likely to survive.

Prevention

Smoking, poor nutrition, and drug or alcohol abuse can increase the risk of premature labor and early delivery. Smoking and drug or alcohol use should be stopped. A healthy diet and prenatal vitamin supplements (prescribed by the health care provider) are important for the growth of the fetus and the health of the mother. Pregnant women are advised to see a health care provider early in the pregnancy and receive regular prenatal examinations throughout the pregnancy. The health care provider should be informed of any medications that the mother is receiving and any health conditions that exist before and during the pregnancy.

Resources

OTHER

"Am I in Labor?" *The Virtual Hospital Page*. University of Iowa. http://www.vh.org.

ORGANIZATIONS

March of Dimes Birth Defects Foundation, 1275 Mamaroneck Ave., White Plains, NY, 10605, (914) 997-4488, http://www.modimes.org.

Altha Roberts Edgren

Premature menopause

Definition

The average age at which American women go through **menopause** is 51 years. If menopause (hormonal changes at the end of the female reproductive years) occurs before age 40, it is said to be premature menopause. Possible causes include autoimmune problems and common **cancer** treatments.

Description

About half of all women will go through menopause before age 51 and the rest will go through it after. Most women will finish menopause between the ages of 42 and 58. A small number of women will find that their periods stop prematurely, before age 40.

Causes and symptoms

There are many possible causes of premature menopause. Women who have premature menopause often have **autoimmune disorders** like thyroid disease or **diabetes mellitus**. In these diseases, the body produces antibodies to one or more of its own organs. These antibodies interfere with the normal function of the organ. Just as antibodies might attack the thyroid or the pancreas (causing thyroid disease or diabetes), antibodies may attack the ovaries and stop the production of female hormones.

Cancer treatments like **chemotherapy** or radiation can cause premature menopause. The risk depends on the type and length of treatment and the age of the woman when she first begins radiation or chemotherapy.

If the ovaries are surgically removed (during a **hysterectomy**, for example) menopause will occur within a few days, no matter how old the woman is.

The symptoms of premature menopause are similar to those of regular menopause. Menstrual periods stop and women may notice hot flashes, vaginal dryness, mood swings, and sleep problems. Sometimes the first symptom of premature menopause is **infertility**. A woman may find that she cannot become pregnant because she is not ovulating (producing eggs) anymore.

When menopause occurs after the ovaries are surgically removed, the symptoms begin within several days after surgery and tend to be more severe. This happens because the drop in the level of estrogen is dramatic, unlike the gradual drop that usually occurs.

Diagnosis

Premature menopause can be confirmed by blood tests to measure the levels of follicle-stimulating hormone (FSH) and luteinizing hormone (LH). The levels of these hormones will be higher if menopause has occurred.

Because premature menopause is often associated with other hormonal problems, women who have premature menopause should be screened for diabetes, thyroid disease, and similar diseases.

Treatment

There is no treatment to reverse premature menopause. **Hormone replacement therapy** (HRT) can prevent the common symptoms of menopause and lower the long-term risk of **osteoporosis**. Women who have premature menopause should take HRT. Estrogen relieves the unpleasant symptoms of menopause, including the hot flashes and the vaginal dryness. Estrogen is especially important for women who go through

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KEY TERMS

Autoimmune diseases—Diseases in which the body creates antibodies that attack one of its own organs.

Follicle-stimulating hormone (FSH)—A female hormone that regulates ovulation and menstruation.

Hormone replacement therapy (HRT)—Replacement of estrogen and progesterone lost by women who have gone through menopause. Hormone replacement therapy has been shown to lower the risk of osteoporosis and heart disease in elderly women.

Luteinizing hormone (LH)—A female hormone that regulates ovulation and menstruation.

Menopause—The end of a woman's reproductive years. The hormonal changes that accompany menopause include hot flashes, vaginal dryness, mood swings, sleep problems, and the end of menstrual periods.

premature menopause. The long-term health risks of menopause (osteoporosis and increased risk of heart disease) are even more likely to occur after premature menopause. However, women who have certain medical conditions (like **liver disease**, uterine cancer, or **breast cancer**) may not be candidates for estrogen.

If a woman still has her uterus after premature menopause, she will also need to take progesterone along with the estrogen. If her uterus has been removed, estrogen alone will be enough.

Women who wish to become pregnant after premature menopause now have the option of fertility treatments using donor eggs. This is similar to **in vitro fertilization**, but the eggs come from a donor instead of the woman who is trying to become pregnant.

Prevention

Premature menopause cannot be prevented.

Resources

BOOKS

Hackley, Barbara, Jan M. Kriebs, and Mary Ellen Rousseau. *Primary Care of Women: A Guide for Midwives and Women's Health Providers*. Sudbury, MA: Jones and Bartlett Publishers, 2007.

Amy B. Tuteur, MD

Premature rupture of membranes

Definition

Premature rupture of membranes (PROM) is an event that occurs during **pregnancy** when the sac containing the developing baby (fetus) and the amniotic fluid bursts or develops a hole prior to the start of labor.

Description

During pregnancy, the unborn baby (fetus) is surrounded and cushioned by a liquid called amniotic fluid. This fluid, along with the fetus and the placenta, is enclosed within a sac called the amniotic membrane. The amniotic fluid is important for several reasons. It cushions and protects the fetus, allowing the fetus to move freely. The amniotic fluid also allows the umbilical cord to float, preventing it from being compressed and cutting off the fetus's supply of oxygen and nutrients. The amniotic membrane contains the amniotic fluid and protects the fetal environment from the outside world. This barrier protects the fetus from organisms (like bacteria or viruses) that could travel up the vagina and potentially cause infection.

Although the fetus is almost always mature at 36–40 weeks and can be born during that period without complication, a normal pregnancy lasts an average of 40 weeks. At the end of 40 weeks, the pregnancy is referred to as being "term." At term, labor usually begins. During labor, the muscles of the uterus contract repeatedly. This allows the cervix to begin to grow thinner (called effacement) and more open (dilatation). Eventually, the cervix will become completely effaced and dilated. In the most common sequence of events (about 90% of all deliveries), the amniotic membrane breaks (ruptures) around this time. The baby then leaves the uterus and enters the birth canal. Ultimately, the baby will be delivered out of the mother's vagina. In the 30 minutes after the birth of the baby, the placenta should separate from the wall of the uterus and be delivered out of the vagina.

Sometimes the membranes burst before the start of labor, and this is called premature rupture of membranes (PROM). There are two types of PROM. One occurs at a point in pregnancy before normal labor and delivery should take place. This is called preterm

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PROM. The other type of PROM occurs at 36–40 weeks of pregnancy.

PROM occurs in about 10% of all pregnancies. Only about 20% of these cases are preterm PROM. Preterm PROM is responsible for about 34% of all premature births.

Causes and symptoms

The causes of PROM have not been clearly identified. Some risk factors include **smoking**, multiple pregnancies (twins, triplets, etc.), and excess amniotic fluid (**polyhydramnios**). Certain procedures carry an increased risk of PROM, including **amniocentesis** (a diagnostic test involving extraction and examination of amniotic fluid) and cervical cerclage (a procedure in which the uterus is sewn shut to avoid **premature labor**). A condition called **placental abruption** is also associated with PROM, although it is not known which condition occurs first. In some cases of preterm PROM, it is believed that bacterial infection of the amniotic membrane causes it to weaken and then break. However, most cases of PROM and infection occur in the opposite order, with PROM occurring first followed by an infection.

The main symptom of PROM is fluid leaking from the vagina. It may be a sudden, large gush of fluid, or it may be a slow, constant trickle of fluid. The complications that may follow PROM include premature labor and delivery of the fetus, infections of the mother and/or the fetus, and compression of the umbilical cord (leading to oxygen deprivation in the fetus).

Labor almost always follows PROM, although the delay between PROM and the onset of labor varies. When PROM occurs at term, labor almost always begins within 24 hours. Earlier in pregnancy, labor can be delayed up to a week or more after PROM. The chance of infection increases as the time between PROM and labor increases. While this may cause doctors to encourage labor in the patient who has reached term, the risk of complications in a premature infant may cause doctors to try delaying labor and delivery in the case of preterm PROM.

The types of infections that can complicate PROM include amnionitis and endometritis. Amnionitis is an infection of the amniotic membrane. Endometritis is an infection of the innermost lining of the uterus. Amnionitis occurs in 0.5%–1% of all pregnancies. In the case of PROM at term, amnionitis complicates about 3%–15% of pregnancies. About 15%–23% of all cases of preterm PROM will be complicated by amnionitis. The presence of amnionitis puts the fetus at great risk of developing an overwhelming infection (**sepsis**) circulating throughout its bloodstream. Preterm babies are the most susceptible to this life-threatening infection. One type of bacteria responsible for overwhelming infections in newborn babies is called group B streptococci.

Diagnosis

Depending on the amount of amniotic fluid leaking from the vagina, diagnosing PROM may be easy. Some doctors note that amniotic fluid has a very characteristic musty smell. A **pelvic exam** using a sterile medical instrument (speculum) may reveal a trickle of amniotic fluid leaving the cervix, or a pool of amniotic fluid collected behind the cervix. One of two easy tests can be performed to confirm that the liquid is amniotic fluid. A drop of the fluid can be placed on nitrazine paper. Nitrazine paper is made so that it turns from yellowish green to dark blue when it comes in contact with amniotic fluid. Another test involves smearing a little of the fluid on a slide, allowing it to dry, and then viewing it under a microscope. When viewed under the microscope, dried amniotic fluid will be easy to identify because it will look "feathery" like a fern.

Once PROM has been diagnosed, efforts are made to accurately determine the age of the fetus and the maturity of its lungs. Premature babies are at great risk if they have immature lungs. These evaluations can be made using amniocentesis and ultrasound measurements of the fetus's size. Amniocentesis also allows the practitioner to check for infection. Other indications of infection include a **fever** in the mother, increased heart rate of the mother and/or the fetus, high **white blood cell count** in the mother, foul smelling or pus-filled discharge from the vagina, and a tender uterus.

Treatment

Treatment of PROM depends on the stage of the patient's pregnancy. In PROM occurring at term, the mother and baby will be watched closely for the first 24 hours to see if labor will begin naturally. If no labor begins after 24 hours, most doctors will use medications to start labor. This is called inducing labor. Labor is induced to avoid a prolonged gap between PROM and delivery because of the increased risk of infection.

Preterm PROM presents more difficult treatment decisions. The younger the fetus, the more likely it may die or suffer serious permanent damage if

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KEY TERMS

Amniocentesis—A medical procedure during which a long, thin needle is inserted through the abdominal and uterine walls, and into the amniotic sac. A sample of amniotic fluid is withdrawn through the needle for examination.

Amniotic fluid—The fluid within the amniotic sac; the fluid surrounds, cushions, and protects the fetus.

Amniotic membrane—The thin tissue that creates the walls of the amniotic sac.

Cervical cerclage—A procedure in which the cervix is sewn closed; used in cases when the cervix starts to dilate too early in a pregnancy to allow the birth of a healthy baby.

Placenta—The organ that provides oxygen and nutrition from the mother to the fetus during pregnancy. The placenta is attached to the wall of the uterus, and leads to the fetus via the umbilical cord.

delivered prematurely. Yet the risk of infection to the mother and/or the fetus increases as the length of time from PROM to delivery increases. Depending on the age of the fetus and signs of infection, the doctor must decide either to try to prevent labor and delivery until the fetus is more mature, or to induce labor and prepare to treat the complications of **prematurity**. However, the baby will need to be delivered to avoid serious risks to both it and the mother if infection is present, regardless of the risks of prematurity.

A variety of medications may be used in PROM:

- Medication to induce labor (oxytocin) may be used, either in the case of PROM occurring at term or in the case of preterm PROM and infection.
- Tocolytics may be given to halt or prevent the start of labor. These may be used in the case of preterm PROM, when there are no signs of infection. Delaying the start of labor may give the fetus time to develop more mature lungs.
- Steroids may be used to help the fetus's lungs mature early. Steroids may be given in preterm PROM if the fetus must be delivered early because of infection or labor that cannot be stopped.
- Antibiotics can be given to fight infections. Research is being done to determine whether antibiotics should be given prior to any symptoms of infection to avoid the development of infection.

Prognosis

The prognosis in PROM varies. It depends in large part on the maturity of the fetus and the development of infection.

Prevention

The only controllable factor associated with PROM is smoking. Cigarette smoking should always be discontinued during a pregnancy.

ORGANIZATIONS

American College of Obstetricians and Gynecologists (ACOG), PO Box 96920, Washington, DC, 20090-6920, (202) 638-5577, http://www.acog.org.

Rosalyn Carson-DeWitt, MD

Premature ventricular contractions *see* **Ventricular ectopic beats**

Prematurity

Definition

The length of a normal **pregnancy** or gestation is considered to be 40 weeks (280 days) from the date of conception. Infants born before 37 weeks gestation are considered premature and may be at risk for complications.

Description

More than one out of every ten infants born in the United States is born prematurely. Advances in medical technology have made it possible for infants born as young as 23 weeks gestational age (17 weeks premature) to survive. These premature infants, however, are at higher risk for **death** or serious complications, which include heart defects, respiratory problems, blindness, and brain damage.

Causes and symptoms

The birth of a premature baby can be brought on by several different factors, including **premature labor**; **placental abruption**, in which the placenta detaches from the uterus; **placenta previa**, in which the placenta grows too low in the uterus; **premature rupture of membranes**, in which the amniotic sac is torn, causing the amniotic fluid to leak out; **incompetent cervix**, in which the opening to the uterus opens too soon; and maternal toxemia, or blood

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poisoning. While one of these conditions is often the immediate reason for a premature birth, the underlying cause is usually unknown. Prematurity is much more common in **multiple pregnancy** and for mothers who have a history of miscarriages or who have given birth to a premature infant in the past. One of the few, and most important, identifiable causes of prematurity is drug **abuse**, particularly **cocaine**, by the mother.

Infants born prematurely may experience major complications due to their low birth weight and the immaturity of their body systems. Some of the common problems among premature infants are **jaundice** (yellow discoloration of the skin and whites of the eyes), apnea (a long pause in breathing), and inability to breast- or bottle-feed. Body temperature, blood pressure, and heart rate may be difficult to regulate in premature infants. The lungs, digestive system, and nervous system (including the brain) are underdeveloped in premature babies, and are particularly vulnerable to complications. Some of the more common risks and complications of prematurity are described below.

Respiratory distress syndrome (RDS) is the most common problem seen in premature infants. Babies born too soon have immature lungs that have not developed **surfactant**, a protective film that helps air sacs in the lungs stay open. With RDS, breathing is rapid and the center of the chest and rib cage pull inward with each breath. Extra oxygen can be supplied to the infant through tubes that fit into the nostrils of the nose, or by placing the baby under an oxygen hood. In more serious cases, the baby may have to have a breathing tube inserted and receive air from a respirator or ventilator. A surfactant drug can be given in some cases to coat the lung tissue. Extra oxygen may be needed for a few days or weeks, depending on how small and premature the baby was at birth. Bronchopulmonary dysplasia is the development of scar tissue in the lungs, and can occur in severe cases of RDS.

Necrotizing enterocolitis (NEC) is a further complication of prematurity. In this condition, part of the baby's intestines are destroyed as a result of bacterial infection. In cases where only the innermost lining of the bowel dies, the infant's body can regenerate it over time; however, if the full thickness of a portion dies, it must be removed surgically and an opening (ostomy) must be made for the passage of wastes until the infant is healthy enough for the remaining ends to be sewn together. Because NEC is potentially fatal, doctors are quick to respond to its symptoms, which include lethargy, **vomiting**, a swollen and/or red abdomen, **fever**, and blood in the stool. Measures include taking the infant off mouth feedings and feeding him or her intravenously; administering **antibiotics**; and removing air and fluids from the digestive tract via a nasal tube. Approximately 70% of NEC cases can be successfully treated without surgery.

Intraventricular hemorrhage (IVH) is another serious complication of prematurity. It is a condition in which immature and fragile blood vessels within the brain burst and bleed into the hollow chambers (ventricles) normally reserved for cerebrospinal fluid and into the tissue surrounding them. Physicians grade the severity of IVH according to a scale of I–IV, with I being bleeding confined to a small area around the burst vessels and IV being an extensive collection of blood not only in the ventricles, but in the brain tissue itself. Grades I and II are not uncommon, and the baby's body usually reabsorbs the blood with no ill effects. However, more severe IVH can result in **hydrocephalus**, a potentially fatal condition in which too much fluid collects in the ventricles, exerting increased pressure on the brain and causing the baby's head to expand abnormally. To drain fluid and relieve pressure on the brain, doctors will either perform lumbar punctures, a procedure in which a needle is inserted into the spinal canal to drain fluids; install a reservoir, a tube that drains fluid from a ventricle and into an artificial chamber under or on top of the scalp; or install a **ventricular shunt**, a tube that drains fluid from the ventricles and into the abdomen, where it is reabsorbed by the body. Infants who are at high risk for IVH usually have an ultrasound taken of their brain in the first week after birth, followed by others if bleeding is detected. IVH cannot be prevented; however, close monitoring can ensure that procedures to reduce fluid in the brain are implemented quickly to minimize possible damage.

Apnea of prematurity is a condition in which the infant stops breathing for periods lasting up to 20 seconds. It is often associated with a slowing of the heart rate. The baby may become pale, or the skin color may change to a blue or purplish hue. Apnea occurs most commonly when the infant is asleep. Infants with serious apnea may need medications to stimulate breathing or oxygen through a tube inserted in the nose. Some infants may be placed on a ventilator or respirator with a breathing tube inserted into the airway. As the baby gets older, and the lungs and brain tissues mature, the breathing usually becomes more

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regular. A group of researchers in Cleveland reported in 2003, however, that children who are born prematurely are 3–5 times more likely to develop sleep-disordered breathing by age 10 than children who were full-term babies.

As the fetus develops, it receives the oxygen it needs from the mother's blood system. Most of the blood in the infant's system bypasses the lungs. Once the baby is born, its own blood must start pumping through the lungs to get oxygen. Normally, this bypass duct closes within the first few hours or days after birth. If it does not close, the baby may have trouble getting enough oxygen on its own. **Patent ductus arteriosus** is a condition in which the duct that channels blood between two main arteries does not close after the baby is born. In some cases, a drug, indomethacin, can be given to close the duct. Surgery may be required if the duct does not close on its own as the baby develops.

Retinopathy of prematurity is a condition in which the blood vessels in the baby's eyes do not develop normally, which can, in some cases, result in blindness. Premature infants are also more susceptible to infections. They are born with fewer antibodies, which are necessary to fight off infections.

Diagnosis

Many of the problems associated with prematurity depend on how early the baby is born and how much it weighs at birth. The most accurate way of determining the gestational age of an infant in utero is calculating from a known date of conception or using ultrasound imaging to observe development. When a baby is born, doctors can use the Dubowitz exam to estimate gestational age. This standardized test scores responses to 33 specific neurological stimuli to estimate the infant's neural development. Once the baby's gestational age and weight are determined, further tests and **electronic fetal monitoring** may need to be used to diagnose problems or to track the baby's condition. A blood pressure monitor may be wrapped around the arm or leg. Several types of monitors can be taped to the skin. A heart monitor or cardiorespiratory monitor may be attached to the baby's chest, abdomen, arms, or legs with adhesive patches to monitor breathing and heart rate. A thermometer probe may be taped on the skin to monitor body temperature. Blood samples may be taken from a vein or artery. X rays or ultrasound imaging may be used to examine the heart, lungs, and other internal organs.

Treatment

Treatment depends on the types of complications that are present. It is not unusual for a premature infant to be placed in a heat-controlled unit (an incubator) to maintain its body temperature. Infants that are having trouble breathing on their own may need oxygen either pumped into the incubator, administered through small tubes placed in their nostrils, or through a respirator or ventilator, which pumps air into a breathing tube inserted into the airway. The infant may require fluids and nutrients to be administered through an intravenous line in which a small needle is inserted into a vein in the hand, foot, arm, leg, or scalp. If the baby needs drugs or medications, they may also be administered through the intravenous line. Another type of line may be inserted into the baby's umbilical cord. This can be used to draw blood samples or to administer medications or nutrients. If heart rate is irregular, the baby may have heart monitor leads taped to the chest. Many premature infants require time and support with breathing and feeding until they mature enough to breathe and eat unassisted. Depending on the complications, the baby may require drugs or surgery.

A form of treatment that is being recommended by many mainstream practitioners is **massage therapy**. Research has shown that the risks of massaging preterm infants are minimal, and that the infants benefit from improved developmental scores, more rapid weight gain, and earlier discharge from the hospital. An additional benefit of massage therapy is closer bonding between the parents and their newborn child.

Prognosis

Advances in medical care have made it possible for many premature infants to survive and develop normally. However, whether or not a premature infant will survive is still intimately tied to his or her gestational age:

- 21 weeks or less: 0% survival rate
- 22 weeks: 0%–10% survival rate
- 23 weeks: 10%–35% survival rate
- 24 weeks: 40%–70% survival rate
- 25 weeks: 50%–80% survival rate
- 26 weeks: 80%–90% survival rate
- 27 weeks: greater than 90% survival rate

Physicians cannot predict long-term complications of prematurity; some consequences may not become evident until the child is school-aged. Minor disabilities like learning problems, poor coordination,

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KEY TERMS

Apnea—A long pause in breathing.

Dubowitz exam—A standardized test that scores responses to 33 specific neurological stimuli to estimate an infant's neural development and gestational age.

Intraventricular hemorrhage (IVH)—A condition in which blood vessels within the brain burst and bleed into the hollow chambers (ventricles) normally reserved for cerebrospinal fluid and into the tissue surrounding them.

Jaundice—Yellow discoloration of skin and whites of the eyes that results from excess bilirubin in the body's system.

Necrotizing enterocolitis (NEC)—A condition in which part of the intestines are destroyed as a result of bacterial infection.

Respiratory distress syndrome (RDS)—Condition in which a premature infant with immature lungs does not develop surfactant. RDS is the most common problem seen in premature infants.

Retinopathy of prematurity—A condition in which the blood vessels in a premature infant's eyes do not develop normally, which can, in some cases, result in blindness.

Surfactant—A protective film that helps air sacs in the lungs stay open. Premature infants may not have developed this protective layer before birth and are more susceptible to respiratory problems without it. Some surfactant drugs are available. These can be given through a respirator and will coat the lungs when the baby breathes the drug in.

or short attention span may be the result of premature birth, but can be overcome with early intervention. The risks of serious long-term complications depend on many factors, including how premature the infant was at birth, weight at birth, and the presence or absence of breathing problems. Gender is a definite factor: a Swedish study published in 2003 found that boys are at greater risk of death or serious long-term consequences of prematurity than girls; for example, 60% of boys born at 24 weeks' gestation die, compared to 38% mortality for girls. The development of infection or the presence of a birth defect can also affect long-term prognosis. Infections in premature and very low birth weight infants are a risk factor for later disorders of the nervous system; a study done at Johns Hopkins reported that 77 out of a group of 213 premature infants developed neurologic disorders. Severe disabilities like brain damage, blindness, and chronic lung problems are possible and may require ongoing care.

Prevention

Some of the risks and complications of premature delivery can be reduced if the mother receives good prenatal care, follows a healthy diet, avoids alcohol or drug consumption, and refrains from cigarette **smoking**. In some cases of premature labor, the mother may be placed on bed rest or given drugs that can stop labor contractions for days or weeks, giving the developing infant more time to develop before delivery. The physician may prescribe a steroid medication to be given to the mother before the delivery to help speed up the baby's lung development. The availability of a neonatal intensive care unit, a special hospital unit equipped and trained to deal with premature infants, can also increase the chances of survival.

A new medication may help to prevent spontaneous premature births. Researchers at Wake Forest University reported in June 2003 that a drug known as 17 alpha-hydroxyprogesterone caproate not only reduced the number of premature births in a group of women who received weekly injections of the drug compared to a placebo group, but also lowered the rates of necrotizing enterocolitis, intraventricular hemorrhage, and need for supplemental oxygen in their infants. However, research is still ongoing.

Resources

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ORGANIZATIONS

American Academy of Pediatrics (AAP), 141 Northwest Point Boulevard, Elk Grove Village, IL, 60007-1098, (847) 434-4000, (847) 424-8000, kidsdocs@aap.org, http://www.aap.org.

National Institute of Child Health and Human Development, Bldg 31, Room 2A32, MSC 2425, 31 Center Drive, Bethesda, MD, 20892-2425, (866) 760-5947, (800) 370-2943, http://www.nichd.nih.gov/.

Altha Roberts Edgren
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Premenstrual dysphoric disorder

Definition

Premenstrual syndrome (PMS) is a collection of physical and emotional symptoms that occurs 5 to 11 days before a woman's period begins and goes away once menstruation starts. The most severe form of PMS is premenstrual dysphoric disorder (PMDD).

Description

PMS is estimated to affect 70%–90% of women of childbearing age. The more severe form of the disorder, PMDD, affects 3%–5% of women of childbearing age. Up to 40% of women have PMDD symptoms that are so severe they interfere with their daily activities. It is more common in women in their late 20s and early 40s, who have at least one child and a history of depression, anxiety/tension, affective lability, or irritability/anger.

Causes and symptoms

Although the actual cause of PMDD is not known, it is believed to be related to hormonal changes that occur before menstruation. There are more than 150 signs and symptoms attributed to PMDD, and every woman experiences different ones at different times. There seem to be socioeconomic and genetic factors that precipitate PMDD. Twin studies have demonstrated a positive correlation with heritability and PMDD symptoms. Antianxiety medications have been shown to help improve symptoms associated with PMDD. The most common symptoms include **headache**; swelling of ankles, feet, and hands; backache; abdominal cramps, heaviness or **pain**; bloating and/or gas; **muscle spasms**; breast tenderness; weight gain; recurrent **cold sores**; **acne**; **nausea**; **constipation** or **diarrhea**; food cravings; anxiety or panic; confusion; difficulty concentrating; forgetfulness; poor judgment; and depression.

Diagnosis

PMDD is diagnosed when symptoms occur during the second half of the menstrual cycle (14 days or more after the first day of a woman's period), are absent for about seven days after the period ends, increase in severity as the cycle progresses, go away when the menstrual flow begins or shortly thereafter, and occur for at least three consecutive menstrual cycles. There are no tests to diagnose it. The diagnosis of PMDD emphasizes and requires psychologically important mood symptoms.

Treatment

The first prescription drug approved by the U.S. Food and Drug Administration for the treatment of PMDD was Sarafem (fluoxetine). Other prescription drugs approved for the treatment of PMDD include Paxil CR (paroxetine), Zoloft (sertraline), and the oral contraceptive Yaz (a combination of drospirenone and ethinyl estradiol). **Nonsteroidal anti-inflammatory drugs**, such as ibuprofen and **aspirin**, may help with bloating and pain.

Alternative treatment

Non-pharmaceutical treatments include a variety of lifestyle changes, such as following a healthy diet, **exercise**, **stress** relief therapies, and even such alternative therapies as **aromatherapy**. Certain **vitamins** and supplements may also help, such as vitamin B6, **calcium**, magnesium, and vitamin E. Certain herbs may also help with symptom relief, including vitex, black cohosh, valerian, kava kava, and **St. John's wort**.

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KEY TERMS

Antidepressant—A medication used to relieve the symptoms of clinical depression.

Beta blockers—Class of drug, including Corgard (nadolol) and Lanoxin (digoxin), that primarily works by blunting the action of adrenaline, the body's natural fight-or-flight chemical.

Nonsteroidal anti-inflammatory drugs—This class of drugs includes aspirin and ibuprofen, and primarily works by interfering with the formation of prostaglandins, enzymes implicated in pain and inflammation.

Prognosis

The prognosis varies for each woman, and is largely dependent on how much work she is willing to do in terms of lifestyle changes. Additionally, planning for PMDD symptoms, joining a support group, and communicating with family members can help minimize the negative effects of PMDD and its impact on a woman's home and work environments.

Prevention

Some women may find their PMDD disappears periodically. Diet and **nutritional supplements** can have the greatest impact in preventing PMDD.

ORGANIZATIONS

National Association for Premenstrual Syndrome, 41 Old Road East Peckham, Kent, England, TN12 5AP, 4408815-7311, http://www.pms.org.uk.

Society for Women's Health Research, 1025 Connecticut Ave. NW, Suite 701, Washington, DC, 20036, (202) 223-8224, (202) 833-3472, info@swhr.org, http://www.womenshealthresearch.org.

Premenstrual syndrome

Definition

Premenstrual syndrome (PMS) refers to a set of physical and psychological symptoms that occur between ovulation and the onset of menstruation. Severe forms of this syndrome are referred to as **premenstrual dysphoric disorder** (PMDD). These symptoms may be related to hormones and emotional disorders.

Description

Approximately 75% of all menstruating women experience some symptoms that occur before or during menstruation. PMS encompasses symptoms severe enough to interfere with daily life. About 3%–8% of women experience the more severe PMDD. These symptoms can last 4–10 days and can have a substantial impact on a woman's life.

The reason some women get severe PMS while others have none is not understood. PMS symptoms usually begin when a woman is in her 20s. The disease may run in families and is also more prone to occur in women with a history of psychological problems. Overall, however, it is difficult to predict who is most at risk for PMS.

Causes and symptoms

Because PMS is restricted to the second half of a woman's menstrual cycle (after ovulation), it is thought that hormones play a role. During a woman's monthly menstrual cycle, which lasts 24–35 days, hormone levels change. The hormone estrogen gradually rises during the first half of a woman's cycle (the preovulatory phase) and falls dramatically at ovulation. After ovulation (the postovulatory phase), progesterone levels gradually increase until menstruation occurs. Both estrogen and progesterone are secreted by the ovaries, which are responsible for producing the eggs. The main role of these hormones is to cause thickening of the lining of the uterus (endometrium). However, estrogen and progesterone also affect other parts of the body, including the brain. In the brain and nervous system, estrogen can affect the levels of neurotransmitters, such as serotonin. Serotonin has long been known to have an effect on emotions, as well as eating behavior. It is thought that when estrogen levels go down during the postovulatory phase of the menstrual cycle, decreases in serotonin levels follow. Whether these changes in estrogen, progesterone, and serotonin are responsible for the emotional aspects of PMS is not known with certainty. However, most researchers agree that the chemical transmission of signals in the brain and nervous system is in some way related to PMS. This is supported by the fact that the times following **childbirth** and **menopause** are also associated with both depression and low estrogen levels.

Symptoms for PMS are varied and many, including both physical and emotional aspects that range from mild to severe. The physical symptoms include bloating, **headache**, food cravings, abdominal cramps,

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KEY TERMS

Antidepressant—A drug used to control depression.

Estrogen—A female hormone important in the menstrual cycle.

Neurotransmitter—A chemical messenger used to transmit an impulse from one nerve to the next.

Phytoestrogens—Compounds found in plants that can mimic the effects of estrogen in the body.

Progesterone—A female hormone important in the menstrual cycle.

Serotonin—A neurotransmitter important in regulating mood.

back **pain**, tension, and breast tenderness. Psychological or emotional aspects include mood swings, irritability, anxiety, and depression.

Diagnosis

The best way to diagnose PMS is to track a woman's symptoms for several months. PMS is diagnosed by the presence of physical, psychological, and behavioral symptoms that are cyclic and occur in association with the premenstrual period of time. PMDD, which is far less common, was officially recognized as a disease in 1987. Its diagnosis depends on the presence of at least five symptoms related to mood that disappear within the first few days of menstruation. These symptoms must interfere with normal functions and activities of the individual. The diagnosis of PMDD has caused controversy in fear that it may be used against women, labeling them as being impaired by their menstrual cycles.

Treatment

There are many treatments for PMS and PMDD depending on the symptoms and their severity. For mild cases, treatment includes **vitamins**, **diuretics**, and pain relievers. Vitamins E and B_6 may decrease breast tenderness and help with **fatigue** and mood swings in some women. Diuretics that remove excess fluid from the body seem to work for some women. For more severe cases and for PMDD, treatments available include **antidepressant drugs**, hormone treatment, or (only in extreme cases) surgery to remove the ovaries. Hormone treatment usually involves **oral contraceptives**. This treatment, as well as removal of the ovaries, is used to prevent ovulation and the changes in hormones that accompany ovulation. Recent studies, however, indicate that hormone treatment has little effect over placebo.

Antidepressants

The most progress in the treatment of PMS and PMDD has been through the use of antidepressant drugs. The most effective of these include sertraline (Zoloft), fluoxetine (Prozac), and paroxetine (Paxil). They are termed **selective serotonin reuptake inhibitors** (SSRIs) and act by indirectly increasing the brain's serotonin levels, thus stabilizing emotions. Some doctors prescribe antidepressant treatment for PMS throughout the cycle, while others direct patients to take the drug only during the latter half of the cycle. Antidepressants should be avoided by women wanting to become pregnant. A recent clinical study found that women who took sertraline had a significant improvement in productivity, social activities, and relationships compared with a placebo group. Side effects of sertraline were found to include **nausea**, **diarrhea**, and decreased libido.

Alternative treatment

There are alternative treatments that can both affect serotonin and hormone responses, as well as some of the physical symptoms of PMS.

Vitamins and minerals

Some women find relief with the use of vitamin and mineral supplements. Magnesium can reduce the fluid retention that causes bloating, while **calcium** may decrease both irritability and bloating. Magnesium and calcium also help relax smooth muscles and this may reduce cramping. Vitamin E may reduce breast tenderness, nervous tension, fatigue, and **insomnia**. Vitamin B_6 may decrease fluid retention, fatigue, irritability, and mood swings. Vitamin B_5 supports the adrenal glands and may help reduce fatigue.

Phytoestrogens and natural progesterone

The Mexican wild yam (*Dioscorea villosa*) contains a substance that may be converted to progesterone in the body. Because this substance is readily absorbed through the skin, it can be found as an ingredient in many skin creams. (Some products also have natural progesterone added to them.) Some herbalists believe that these products can have a progesterone-like effect on the body and decrease some of the symptoms of PMS.

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The most important way to alter hormone levels may be by eating more phytoestrogens. These plant-derived compounds have an effect similar to estrogen in the body. One of the richest sources of phytoestrogens is soy products, such as tofu. Additionally, many supplements can be found that contain black cohosh (*Cimicifugaracemosa*) or dong quai (*Angelica sinensis*), which are herbs high in phytoestrogens. Red clover (*Trifolium pratense*), alfalfa (*Medicago sativa*), licorice (*Glycyrrhiza glabra*), hops (*Humulus lupulus*), and legumes are also high in phytoestrogens. Increasing the consumption of phytoestrogens is also associated with decreased risks of **osteoporosis**, **cancer**, and heart disease.

Antidepressant alternatives

Many antidepressants act by increasing serotonin levels. An alternative means of achieving this is to eat more carbohydrates. For instance, two cups of cereal or a cup of pasta has enough carbohydrates to effectively increase serotonin levels. An herb known as **St. John's wort** (*Hypericum perforatum*) has stood up to scientific trials as an effective antidepressant. As with the standard antidepressants, however, it must be taken continuously and does not show an effect until used for 46 weeks. There are also herbs, such as skullcap (*Scutellaria lateriflora*) and kava (*Piper methysticum*), that can relieve the anxiety and irritability that often accompany depression. An advantage of these herbs is that they can be taken when symptoms occur rather than continually. Chaste tree (*Vitex agnus-castus*), in addition to helping rebalance estrogen and progesterone in the body, also may relieve the anxiety and depression associated with PMS.

Prognosis

The prognosis for women with both PMS and PMDD is good. Most women who are treated for these disorders do well.

Prevention

Maintaining a good diet, one low in sugars and fats and high in phytoestrogens and complex carbohydrates, may prevent some of the symptoms of PMS. Women should try to **exercise** three times a week and keep in generally good health. Avoidance of **caffeine** and/or alcohol may help some women. Because PMS is often associated with **stress**, avoidance of stress or developing better means to deal with stress can be important.

Resources

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ORGANIZATIONS

Advancement of Women's Health Research, 1828 L Street, N.W., Suite 625, Washington, DC, 20036, (202) 223-8224, http://www.womens-health.org.

National Association for Premenstrual Syndrome, 7 Swift's Court, High Street, Seal, Kent, England, TN15 0EG, +4401732 760011, http://www.PMDD.org.uk.

Cindy L. A. Jones, PhD

Prenatal surgery

Definition

Prenatal surgery is a surgical procedure performed on a fetus prior to birth.

Purpose

In most cases prenatal surgery is performed only when the fetus is not expected to survive delivery or live long after birth without prenatal intervention. The most common prenatal surgeries are for conditions in which the newborn will not be able to breathe on its own.

Most prenatal surgeries are performed for:

- Urinary tract obstructions in males, usually caused by a narrowing of the urinary tract, in which urine backs up and injures the kidneys. About 10% of fetal urinary tract obstructions require prenatal surgery to prevent multiple abnormalities and depleted amniotic fluid.
- Congenital diaphragmatic hernia (CDH), a condition in which the diaphragm—the muscle that separates the chest and the abdomen—does not form completely. Without surgery about 50% of fetuses with CDH do not survive after birth because of underdeveloped lungs.
- Congenital cystic adenomatoid malformation (CCAM), a condition in which one or more lobes

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of the lungs become fluid-filled sacs called cysts. Large CCAMs may prevent lung development, cause heart failure, or prevent the fetus from ingesting amniotic fluid.

- Sacrococcygeal teratoma (SCT), tumors at the base of the tailbone. The most common tumor in newborns, occurring in one out of every 35,000–40,000 births, some prenatal SCTs are very large, hard, and full of blood vessels, and can stress the heart.
- Twin-to-twin transfusion syndrome (TTTS), a condition in which, because of abnormal blood-vessel connections in the placenta, one twin pumps the circulating blood for both twins. Affecting up to 15% of twins sharing a placenta (monochorionic), TTTS can lead to a variety of problems including heart failure.
- Twin reversed arterial perfusion (TRAP) sequence, a condition in which one twin lacks a heart. Occurring in about 1% of monochorionic twins, the healthy twin pumps all of the blood and, if untreated, 50–75% of these normal twins die.

Other conditions that may be treated by prenatal surgery include:

- various congenital defects that block air passages and will prevent the newborn from breathing on its own
- various lung malformations
- omphalocele, a birth defect in which portions of the stomach, liver, and intestines protrude through an opening in the abdominal wall
- fetal gastroschisis—a birth defect in which the stomach and intestines protrude through improperly formed abdominal wall muscles and float in the amniotic fluid
- bowel obstructions, usually caused by a narrowing in the small intestine
- hypoplastic left heart syndrome, in which the blood flow through the left side of the heart is obstructed
- X-linked severe combined immunodeficiency syndrome
- spina bifida (myelomeningocele)—the second most common birth defect in the United States, affecting one out of every 2,000 newborns. It is a lesion or hole where the nerves of the spinal cord are not completely enclosed and is not considered to be life-threatening.

Precautions

Prenatal surgery involves:

- serious risks for the mother and fetus
- travel to a hospital that performs the procedure
- possibly having to stay near the hospital until delivery
- extended postoperative bed rest, sometimes until delivery
- a significant financial commitment

Description

Prenatal surgery may be referred to as fetal surgery, antenatal surgery, or maternal-fetal surgery. There are only about 600 candidates for prenatal surgery in the United States each year. Of these, only about 10% actually undergo the procedure. Most prenatal surgeries are performed between 18 and 26 weeks of gestation. Some surgeries may not be covered by insurance.

Prenatal surgery usually requires a general anesthetic, although sometimes an epidural anesthetic to numb the abdominal region may be used. The fetus receives the anesthetic via the mother's blood. An anesthesiologist and a perinatologist monitor the heart rates of the mother and fetus during the procedure.

Prenatal surgeries include:

- inserting a device into the fetal bladder to drain urine into the amniotic sac for treating urinary tract obstruction
- draining or removing CCAMs
- destroying blood vessels leading to a large SCT
- amnioreduction for TTTS, in which a syringe through the mother's abdomen is used to remove fluid from the overfilled amniotic sac and replace it in the depleted sac of the twin pumping the blood
- destroying abnormal blood vessel connections in the placenta of TTTS twins
- severing the connections between TRAP sequence twins
- experimental hematopoietic-stem-cell transplants for X-linked severe combined immunodeficiency syndrome
- closing the lesion in spina bifida

Open surgeries

In open prenatal surgeries incisions are made through the mother's abdominal wall and the fetus is partially removed from the uterus or the entire uterus is removed through the mother's abdomen. Using ultrasound as a guide, the surgeon feels for the affected fetal part. The surgeon may knead and push on the uterus to move or flip the fetus away from the placenta, the disk-shaped organ within the uterus that

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supplies the fetal blood. A narrow tube is placed through a tiny hole in the uterine wall to drain and collect the amniotic fluid. Opening the uterus is the riskiest part of prenatal surgery. The first incision is made at a point away from the placenta to prevent damaging it. Following the procedure the fetus is replaced in the uterus and the incision is stitched. Prior to the final stitch the amniotic fluid is re-injected into the uterus. The uterus is repositioned in the mother's body cavity and her abdominal wall is closed.

The first successful open fetal surgery was performed in 1981 for a urinary tract obstruction. The first successful open fetal surgery for CDH was performed in 1989.

Prenatal open surgery for CCAM requires opening the fetus's chest. If a large cyst does not have a hard component, procedures called thoracoamniotic shunting or catheter decompression may be used to drain it. Otherwise the surgeon must remove part or all of the cyst. The first successful resection (removal) of a CCAM from a fetal lung was performed in 1990. The first resectioning of a fetal SCT was performed in 1992.

In prenatal surgery for **spina bifida**, an incision the size of a small fist is made in the uterus. The surgeon loosens and lifts the tissues of the spinal-canal lesion and stitches them closed. Between 1997 and 2004, more than 200 open surgeries were performed for spina bifida. The surgery was available only as part of a prospective randomized clinical trial.

Less invasive procedures

For urinary tract obstructions, a needle may be used to insert a catheter through the mother's abdomen and uterus and into the fetal bladder where it drains the urine into the amniotic fluid. The catheter may have a wire mesh that expands in the bladder to prevent it from plugging up or dislodging.

The first successful fetoscopic temporary tracheal occlusion for CDH was performed in 1996. Small openings are made in the uterus and a tiny fiber-optic fetoscope is inserted to guide the operation. A needle-like instrument is used to place a balloon in the fetus's trachea to prevent lung fluid from escaping through the mouth, enabling the lungs to expand, grow, and push the abdominal organs out of the chest. The balloon is removed at birth.

Hypoplastic left heart syndrome is treated by passing a needle, guided by ultrasound, through the mother's abdominal wall, into the uterus, and into the fetal heart. A catheter is passed through the needle across the fetus's aortic valve. A balloon is inflated, opening the valve and allowing blood to flow through the left side of the heart.

RADIOFREQUENCY ABLATION. Radiofrequency ablation (RFA) sometimes is used for SCT. Guided by ultrasound, a needle is inserted through the mother's abdomen and uterus and into the tumor. Radiofrequency waves sent through the needle destroy the blood supply to the tumor with heat. This slows the tumor's growth and may enable the fetus to survive until delivery. The first RFA of an SCT was performed in 1998.

TRAP sequence also may be treated by RFA. A 3-mm needle targets the exact point where the blood enters the twin without a heart. Using an echocardiographic device, RFA is applied until the blood vessels and surrounding tissue are destroyed and the blood flow is halted. This procedure has eliminated the need for open surgery to treat TRAP sequence.

LASER TREATMENT. If TTTS does not respond to amnioreduction, laser treatment to halt the abnormal blood circulation may be attempted. A thin fetoscope is inserted through the mother's abdominal and uterine walls and into the amniotic cavity of the recipient twin to examine the surface placental blood vessels. The abnormal blood vessel connections are located and eliminated with a laser beam. The first successful fetoscopic laser treatment for TTTS was performed in 1999.

EXIT. Ex utero intrapartum treatment (EXIT) is a surgery performed for a congenital defect that blocks a fetal airway. The fetus is removed from the womb by **cesarean section** but the umbilical cord is left intact so that the mother's placenta continues to sustain the fetus. After the air passage is cleared, the umbilical cord is cut and the newborn can breathe on its own. The EXIT procedure is used for various types of airway obstruction including CCAM.

Preparation

The decision to perform prenatal surgery is made on the basis of detailed ultrasound imaging of the fetus—including echocardiograms that use ultrasound to obtain images of the heart—as well as other diagnostic tools. Consultations include a perinatologist, a neonatologist, a pediatric surgeon, a clinical nurse specialist, and a social worker. Since additional congenital defects preclude prenatal surgery, **amniocentesis** or chorionic villi sampling (CVS) are used to check for chromosomal abnormalities in the fetus.

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Prior to surgery the mother must:

- arrange for postoperative bed rest to prevent preterm labor
- prepare for the possibility of remaining near the hospital until delivery
- receive betamethasone, a steroid, in two intramuscular injections 12–24 hours apart to accelerate fetal lung maturation
- wear a fetal/uterine monitor

The mother usually receives medications called tocolytics to prevent contractions and labor during and after surgery. These include:

- terbutalin
- indocin suppositories before surgery and up to 48 hours after surgery
- magnesium sulfate for one to two days after surgery with careful monitoring
- nifedipine every four to six hours as the indocin is decreased, continuing until 37 weeks of gestation or delivery

Aftercare

In addition to usual postsurgical care, the mother:

- usually remains in the hospital for four to seven days
- lies on her side to help prevent contractions and ensure the best possible fetal circulation
- has a transparent dressing over the abdominal incision for fetal monitoring
- has continuous electronic fetal/uterine monitoring to check the fetal heart, the uterine response to tocolytics, and to watch for signs of preterm labor

After discharge from the hospital the mother is on modified bed rest, lying on her side, until 37 weeks of gestation. This increases blood flow to the fetus and reduces pressure on the cervix to help prevent uterine contractions. She sees a perinatologist once a week and has at least one ultrasound per week.

Risks

Most prenatal surgeries are high risk and may be considered experimental. The greatest risk is that the placenta will be nicked during surgery, causing blood hemorrhaging, uterine contractions, and birth of a premature infant who may not survive. Preterm labor is the most common complication of prenatal surgery. Fetoscopic surgeries are less dangerous and traumatic than open fetal surgery and reduce the risk of **premature labor**. Subsequent children of a mother who has undergone prenatal surgery usually are delivered by cesarean section because of uterine scarring.

Maternal risks

Risks to the mother include:

- extensive blood loss
- complications from general anesthesia
- side effects—potentially fatal—from medications to control premature labor
- rupture of the uterine incision
- infection of the wound or uterus
- psychological stress
- inability to have additional children
- death

Fetal risks

All fetuses that undergo surgery are born prematurely. Those born even six weeks early are at risk for walking and talking delays and learning disabilities. Infants born at 30 weeks of gestation or less are at risk for blindness, **cerebral palsy**, and brain hemorrhages.

About 25% of women undergoing prenatal surgery lose some amniotic fluid, often because of leakage at the uterine incision. Amniotic fluid is essential for lung development and protects the fetus from injury and infection. If all of the amniotic fluid is lost, the fetal lungs may not develop properly. Without the fluid cushion in which the fetus floats, the umbilical cord may be compressed, causing **death**.

Other risks to the fetus include:

- birth during surgery
- separation of the tissues surrounding the amniotic fluid sac and the uterus, causing early delivery or interference with blood flow to some fetal body part such as an arm or leg
- intrauterine infection requiring immediate birth of the fetus
- further damage to the spinal cord and nerves during surgery to treat spina bifida
- brain damage
- physical deformities
- death

Normal results

Although fetal surgeries heal without scarring, it is difficult to predict their outcome because relatively few have been performed. Results for specific conditions include:

- Fetal surgery for CDH lessens the severity of the condition so that the fetus usually survives delivery and lives long enough to undergo corrective surgery.

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KEY TERMS

Amniocentesis—Withdrawal of amniotic fluid through the mother's abdominal wall, using a needle and syringe, to test for fetal disorders.

Amniotic fluid—The watery fluid within the amniotic sac that surrounds the fetus.

Cesarean section—C-section; incision through the abdominal and uterine walls to deliver a baby.

Chorion—The outermost membrane of the sac enclosing the fetus.

Chorionic villus sampling (CVS)—The removal of fetal cells from the chorion for the diagnosis of genetic disorders.

Congenital cystic adenomatoid malformation (CCAM)—A condition in which one or more lobes of the fetal lungs develop into fluid-filled sacs called cysts.

Congenital diaphragmatic hernia (CDH)—A condition in which the fetal diaphragm—the muscle dividing the chest and abdominal cavity—does not close completely.

Echocardiography—Ultrasonic examination of the heart.

Ex utero intrapartum treatment (EXIT)—A cesarean section in which the infant is removed from the uterus but the umbilical cord is not cut until after surgery; treats congenital defects that block an air passage.

Fetoscope—A fiber-optic instrument for viewing the fetus inside the uterus.

Monochorionic twins—Twins that share a single placenta.

Omphalocele—A congenital hernia in which a small portion of the fetal abdominal contents, covered by a membrane sac, protrudes into the base of the umbilical cord.

Placenta—The organ within the uterus that provides nourishment to the fetus.

Radiofrequency ablation (RFA)—A procedure in which radiofrequency waves are used to destroy blood vessels and tissues.

Sacrococcygeal teratoma (SCT)—A tumor occurring at the base of the fetus's tailbone.

Spina bifida—Myelomeningocele; a congenital defect in which the fetal backbone and spinal canal do not close completely, allowing the spinal cord and its surrounding membranes to protrude.

Tocolytic—A medication that inhibits uterine contractions.

Twin reversed arterial perfusion (TRAP) sequence—A condition in which one fetus lacks a heart and the other fetus pumps the blood for both.

Twin-to-twin transfusion syndrome (TTTS)—A condition in monochorionic twins in which there is a connection between the two circulatory systems so that the donor twin pumps the blood to the recipient twin without a return of blood to the donor.

Ultrasound—A procedure that uses high-frequency sound waves to image a fetus.

- Thoracoamniotic shunting for CCAM usually results in infant survival.
- The infant survival rate following prenatal removal of solid CCAMs is about 50%.
- RFA to slow the growth of a tumor usually enables the fetus to survive delivery, after which the tumor can be removed.
- The infant survival rate following prenatal treatment for TTTS is about 70%. Since TTTS is a progressive disorder, early intervention may prevent later complications.

Spina bifida arises during the first month of fetal development. Fluid leaking from the spinal cord and exposure of the cord to amniotic fluid causes damage throughout gestation. Lesions higher up in the spinal cord can cause severe deformities, **paralysis**, and **mental retardation**. Prenatal surgery may reduce the abnormalities, although it does not cure the condition. Babies who survive prenatal surgery appear to be 33%–50% less likely to have **hydrocephalus**, a condition that requires surgically implanted tubes or shunts to remove fluid from the ventricles (cavities) of the brain. The surgery also appears to reverse hindbrain herniation, in which the back of the brain slips down into the spinal canal, causing breathing and swallowing problems and death in 15% of affected children. Children who had prenatal surgery to treat spina bifida appear to have better brain function than those who did not. However prenatal surgery does not prevent two of the most serious conditions associated with spina bifida: leg movement and bladder and bowel control.

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The long-term prognosis for these children is not known.

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ORGANIZATIONS

Fetal Treatment Center, University of California at San Francisco Children's Hospital, 505 Parnassus Ave., San Francisco, CA, 94143, (888) 689-8273, referral.center@ucsfmedctr.org, https://www.ucsfbenioffchildrens.org.

Management of Myelomeningocele Study (MOMS), the GWU Biostatistics Center, 6110 Executive Blvd., Suite 750, Rockville, MD, 20852, (866) 458-4621, (866) 275-6667, MOMS@biostat.bsc.gwu.edu, http://www.spinabifidamoms.com/english/index.html.

Margaret Alic, Ph.D.

Preparing for surgery

Definition

Preparing for a planned surgery includes selecting a surgery center and surgeon to perform the procedure, scheduling the surgery, undergoing presurgical testing, meeting with health-care professionals and the surgical team, receiving education about the procedure, receiving and following all of the appropriate preoperative instructions, and signing a consent form.

Purpose

Preparing for surgery helps the patient understand what to expect before surgery and ensures the patient is physically and psychologically ready for the surgery.

Description

Most patients go to the surgery center or hospital the same day as the scheduled surgery; thus, many of the steps involved in preparing for surgery will take place from one to four weeks before the scheduled surgery. Many surgeries are performed on an outpatient basis, which means that the patient goes home the same day as the surgery.

Selecting a surgeon and surgery center

SURGEON. A surgeon, along with a multi-disciplinary team of surgical specialists, will perform the surgery. The surgeon should be board certified by the American Board of Surgery, as well as certified by the medical specialty board or boards related to the type of surgery performed. Certification from a medical specialty board means that the surgeon has completed an approved educational training program (including three to seven years of full-time training in an accredited residency program). Certification also includes examinations that assess the surgeon's knowledge, skills, and experience.

There are 24 certifying boards recognized by the American Board of Member Specialties (ABMS) and the American Medical Association (AMA). Most of the ABMS boards issue time-limited certificates, valid for six to 10 years. This requires physicians to become re-certified to maintain their board certification—a process that includes a credential review, continuing education in the specialty, and additional examinations. Even though board certification is not required for an individual physician to practice medicine, most hospitals require that a certain percentage of their staff be board certified.

The letters FACS (Fellow of the American College of Surgeons) after a surgeon's name are a further indication of a surgeon's qualifications. Those who become Fellows of the American College of Surgeons have passed a comprehensive evaluation of their surgical training and skills; they also have demonstrated their commitment to high standards of ethical conduct. This evaluation is conducted according to national standards that were

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KEY TERMS

Case manager—A health-care professional who can provide assistance with a patient's needs beyond the hospital.

Discharge planner—A health-care professional who helps patients arrange for health and home care needs after they go home from the hospital.

Electrocardiogram (ECG, EKG)—A test that records the electrical activity of the heart using small electrode patches attached to the skin on the chest.

Infectious disease team—A team of physicians who help control the hospital environment to protect patients against harmful sources of infection.

Informed consent—An educational process between health-care providers and patients intended to instruct the patient about the nature and purpose of the procedure or treatment, the risks and benefits of the procedure, and alternatives, including the option of not proceeding with the test or treatment.

Inpatient surgery—Surgery that requires an overnight stay of one or more days in the hospital.

NPO—A term that means nothing by mouth. NPO refers to the time after which the patient is not allowed to eat or drink prior to a procedure or treatment.

Outpatient surgery—Also called same-day or ambulatory surgery. The patient arrives for surgery and returns home on the same day.

established to ensure that patients receive the best possible surgical care.

A surgeon's membership in professional societies is also an important consideration. Professional societies provide an independent forum for medical specialists to discuss issues of national interest and mutual concern. Examples of professional societies include the Society of Thoracic Surgeons (STS) and the American College of Physicians–American Society of Internal Medicine (ACP-ASIM).

To find information about a surgeon's qualifications, the patient can call a state or county medical association for assistance. A reference book is also available: *The Official ABMS Directory of Board Certified Medical Specialists*, which lists all surgeons who are certified by approved boards. This publication also contains brief information about each surgeon's medical education and training, and it can be found in many libraries.

SURGERY CENTER. The surgeon will arrange for the procedure to be performed in a hospital where he or she has staff privileges. The patient should make sure the hospital has been accredited by the Joint Commission on Accreditation of Healthcare Organizations, a professionally sponsored program that stimulates a high quality of patient care in health-care facilities. Joint Commission accreditation means the hospital voluntarily sought accreditation and met national health and safety standards. There is also an accreditation option that is available for ambulatory surgery centers.

Selecting a surgery center that has a multi-disciplinary team of specialists is important. The surgery team should include surgeons, **infectious disease** specialists, pharmacologists, and advanced care registered nurses. Other surgical team members may include fellows and residents, clinical coordinators, physical therapists, respiratory therapists, registered dietitians, social workers, and financial counselors.

Choosing a surgery center with experience is important. Some questions to consider when choosing a surgery center or hospital include:

- How many surgeries are performed annually and what are the outcomes/survival rates of those surgeries?
- How do the surgery center's outcomes compare with the national average?
- Does the surgery center offer treatment for a patient's specific condition? How experienced is the staff in treating that condition?
- What is the center's success record in providing the specific medical treatment or procedure?
- Does the surgery center have experience treating patients the same age as the inquiring patient?
- Does the surgery center explain the patient's rights and responsibilities?
- Does the surgery center have a written description of its services and fees?
- How much does the patient's type of treatment cost at this surgery center?
- Is financial help available?
- Who will be responsible for the patient's specific care plan while he or she is in the hospital?
- If the center is far from the patient's home, will accommodations be provided for caregivers?

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- What type of services are available during the patient's hospital stay?
- Will a discharge plan be developed before the patient goes home from the hospital?
- Does the hospital provide training to help the patient care for his or her condition at home?

Scheduling the surgery

Depending on the nature of the surgery, it may be scheduled within days or weeks after the surgery is determined to be the appropriate treatment option for the patient. The patient's surgery time may not be determined until the business day before the scheduled surgery. The patient may be instructed to call the surgical center to find out the time of the scheduled surgery.

The time the patient is told to report to the surgery center (arrival time) is not the time when the surgery will take place. Patients are told to arrive at the surgery center far enough in advance (usually about two hours prior to the scheduled surgery time) so they can be properly prepared for surgery. In some cases, the patient's surgery may need to be rescheduled if another patient requires emergency surgery at the patient's scheduled time.

The patient should ask the health-care providers if the scheduled surgery will be performed on an outpatient or inpatient basis. Outpatient means the patient goes home the same day as the surgery; inpatient means a hospital stay is required.

Presurgical testing

Presurgical testing, also called preoperative testing or surgical consultation, includes a review of the patient's medical history, a complete **physical examination**, a variety of tests, patient education, and meetings with the health-care team. The review of the patient's medical history includes an evaluation of the patient's previous and current medical conditions, surgeries and procedures, medications, and any other health conditions such as **allergies** that may impact the surgery. Presurgical testing is generally scheduled one week before the surgery.

The patient may find it helpful to bring along a family member or friend to the presurgical testing appointments. This caregiver can help the patient remember important details to prepare for surgery.

After attending the surgical consultation, the patient may desire to seek a second opinion to confirm the first doctor's treatment recommendations. The patient should check with his or her insurance provider to determine if the second opinion consultation is covered.

Meeting with the surgical team

During the surgical consultation, the patient meets with the surgeon or a member of the surgeon's health-care team to discuss the surgery and other potential treatment options for the patient's medical condition. At some time before the surgery, the patient will meet with other health-care providers, including the anesthesiologist, nurse clinicians, and sometimes a dietitian, social worker, or **rehabilitation** specialist.

Patient education

The surgical team will ensure that the patient understands the potential benefits and risks of the procedure as well as what to expect before the procedure and during the recovery. Patient education may include one-on-one instruction from a health-care provider, educational sessions in a group setting, or self-guided learning videos or modules. Informative and instructional handouts are usually provided to explain specific presurgical requirements.

Some surgery centers offer services such as **guided imagery** and relaxation tapes, **massage therapy**, **aromatherapy**, or other complementary techniques to reduce a patient's level of **stress** and **anxiety** before a surgical procedure. Guided imagery is a form of focused relaxation that coaches the patient to visualize calm, peaceful images. Several research studies have proven that guided imagery can significantly reduce stress and anxiety before and after surgical and medical procedures and help the patient recover more rapidly. Guided imagery and relaxation tapes are available at many major bookstores and from some surgery centers. The patient may be able to listen to the tapes during the procedure, depending on the type of procedure being performed.

Preoperative instructions

Preoperative instructions include information about reserving blood products for surgery, taking or discontinuing medications before the surgery, eating and drinking before surgery, quitting **smoking**, limiting activities before surgery, and preparing items to bring to the hospital the day of surgery.

BLOOD TRANSFUSIONS AND BLOOD DONATION. Blood transfusions may be necessary during surgery. A blood **transfusion** is the delivery of whole blood or blood components to replace blood lost through trauma, surgery, or disease. About one in three hospitalized patients will require a blood transfusion. The

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surgeon can provide an estimate of how much blood the patient's procedure may require.

To decrease the risk of infection and immunologic complications, some surgery centers offer a preoperative **blood donation** program. Autologous blood (from the patient) is the safest blood available for transfusion, since there is no risk of disease transmission. Methods of autologous donation or collection include:

- Intraoperative blood collection: the blood lost during surgery is processed, and the red blood cells are re-infused during or immediately after surgery.
- Preoperative donation: the patient donates blood once a week for one to three weeks before surgery. The blood is separated and the blood components needed are re-infused during surgery.
- Immediate preoperative hemodilution: the patient donates blood immediately before surgery to decrease the loss of red blood cells during surgery. Immediately after donating, the patient receives fluids to compensate for the amount of blood removed. Since the blood is diluted, fewer red blood cells are lost from bleeding during surgery.
- Postoperative blood collection: blood lost from the surgical site right after surgery is collected and re-infused after the surgical site has been closed.

The surgeon determines what type of blood collection process, if any, is appropriate.

MEDICATION GUIDELINES. Depending on the type of surgery scheduled, certain medications may be prescribed or restricted before the surgery. The health-care team will provide specific guidelines. If certain medications need to be restricted before surgery, the patient will receive a complete list of the medications (including prescription, over-the-counter, and herbal medications) to avoid taking before the scheduled surgery.

If the physician advises the patient to take prescribed medication within 12 hours before surgery, it should be taken with small sips of water.

The patient should not bring any medications to the hospital; all necessary medications, as ordered by the doctor, will be provided in the hospital.

EATING AND DRINKING BEFORE SURGERY. Before most surgeries, the patient is advised not to eat or drink anything after midnight the evening before the surgery. This includes no smoking and no gum chewing. The patient should not drink any alcoholic beverages for at least 24 hours before surgery, unless instructed otherwise. If the patient has diabetes or if the surgery is to be performed on a child, the patient should ask the health-care team for specific guidelines about eating and drinking before surgery.

Smoking cessation

Patients who will undergo any surgical procedure are encouraged to quit smoking and stop using tobacco products at least two weeks before the procedure, and to make a commitment to be a nonsmoker after the procedure. Ideally, the patient should quit smoking at least eight weeks prior to surgery. Quitting smoking before surgery helps the patient recover more quickly from surgery. There are several smoking cessation programs available in the community. The patient should ask a health-care provider for more information if he or she needs help quitting smoking.

Activity before surgery

The patient should eat right, rest, and **exercise** as normal before surgery, unless given other instructions. The patient should try to get enough sleep to build up energy for the surgery. The health-care team may advise the patient to scrub the planned surgical site with a special disinfecting soap the evening before the surgery.

MAKING PLANS FOR HOME AND WORK. The patient should make arrangements ahead of time for someone to care for children and take care of any other necessary activities at home such as getting the mail or newspapers. The patient should inform family members about the scheduled surgery in advance, so they can provide help and support before, during, and after surgery.

The patient should ask the health-care team what supplies may be needed after surgery during recovery at home so these items can be purchased or rented ahead of time. Some supplies that may be needed include an adaptive chair for the toilet or bathtub, or supplies for changing the wound dressing at home. Ask the health care providers if home care assistance (in which a visiting nurse visits the home to provide medical care) will be needed after surgery.

Items to bring to the hospital

The patient should bring a list of current medications, allergies, and appropriate medical records upon admission to the surgery center. The patient should also bring a prepared list of questions to ask.

The patient should not bring valuables such as jewelry, credit cards, or other items. A small amount of cash (no more than $20) may be packed to purchase items such as newspapers or magazines.

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Women should not wear nail polish or makeup the day of surgery.

If a hospital stay is expected after surgery, the patient should only pack what is needed. Some essential items include a toothbrush, toothpaste, comb or brush, deodorant, razor, eyeglasses (if applicable), slippers, robe, pajamas, and one change of comfortable clothes to wear when going home. The patient should also bring a list of family members' names and phone numbers to contact in an emergency.

Transportation

The patient should arrange for transportation home, since the effects of anesthesia and other medications given before surgery make it unsafe to drive.

Preoperative preparation

Upon arriving at the hospital or surgery center, the patient will be required to complete paperwork and show an insurance identification card, if insured. An identification bracelet that includes the patient's name and doctor's name will be placed on the patient's wrist.

INFORMED CONSENT. The health-care provider will review the informed consent form and ask the patient to sign it. Informed consent is an educational process between health-care providers and patients. Before any procedure is performed, the patient is asked to sign a consent form. Before signing the form, the patient should understand the nature and purpose of the procedure or treatment, the risks and benefits of the procedure, and alternatives, including the option of not proceeding with the procedure. Signing the informed consent form indicates that the patient permits the surgery or procedure to be performed. During the discussion about the procedure, the health-care providers are available to answer the patient's questions about the consent form or procedure.

ADVANCED DIRECTIVES. The health-care provider will ask the patient if he or she has any advance directives to be included in the patient's file. Advance directives are legal documents that increase a patient's control over medical decisions. A patient may decide medical treatment in advance, in the event that he or she becomes physically or mentally unable to communicate his or her wishes. Advance directives either state what kind of treatment the patient wants to receive (living will), or authorize another person to make medical decisions for the patient when he or she is unable to do so (durable power of attorney). Advance directives are not required and may be changed or canceled at any time. Any change should be written, signed and dated in accordance with state law, and copies should be given to the physician and to others who received original copies. Advance directives can be revoked either in writing or by destroying the document. Advance directives include do-not-resuscitate (DNR) orders. A DNR order indicates that a person—usually with a terminal illness or other serious medical condition—has decided not to have **cardiopulmonary resuscitation** (CPR) performed in the event that his or her heart or breathing stops.

TESTS AND PREOPERATIVE EVALUATION. Some routine tests will be performed, including blood pressure, temperature, pulse, and weight checks; blood tests; **urinalysis**; **chest x ray**; and electrocardiogram (ECG). A brief physical exam will be performed. In some cases, an enema may be required. The health-care team will ask several questions to evaluate the patient's condition and to complete the final preparations for surgery. The patient should inform the health-care team if he or she drinks alcohol on a daily basis so precautions can be taken to avoid complications during and after surgery.

FINAL SURGICAL PREPARATION. Preoperative preparation generally includes these steps:

- The patient changes into a hospital gown.
- The patient removes (as applicable) contact lenses and glasses, dentures, hearing aids, nail polish, and jewelry.
- The patient empties his or her bladder.
- The health-care providers clean and possibly shave the area on the body where the surgery will be performed.
- The patient may receive medication to aid relaxation.
- An intravenous catheter will be placed in a vein in the patient's arm to deliver fluids, medications, or blood during surgery.
- In some hospitals, the patient may wait in an area called a holding area until the operating room and surgical team are ready. Depending on the hospital's policy, one or two of the patient's family members may wait with the patient.
- The patient is taken to the operating room in a wheelchair or on a bed (also called a gurney) where monitors are placed to evaluate the patient's condition during surgery.
- Anesthesia is administered; the type of anesthesia administered will depend upon the procedure, the patient's general health, and medications.
- A catheter may be placed in the patient's bladder to drain urine.

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- The patient's vital signs, including the blood oxygen level, electrical activity of the heart, blood pressure, pulse, temperature, breathing, mental status, and level of consciousness, are continuously monitored during and after the surgery.

Information for families

While the patient is in surgery, the family members wait in a designated waiting area. Some hospitals or surgery centers offer a pager to the patient's family so they can be contacted for updates about the progress of the surgery. It may be helpful for the patient to select a spokesperson from the family to communicate with the health-care providers. This may improve communication with the health-care providers as well as to other family members. The patient should also communicate his or her wishes regarding the spokesperson's telephone communications to other family members.

Educational classes may be available for family members to learn more about the patient's surgery and what to expect during the recovery.

When the surgery is complete, the surgeon usually contacts the family members to provide information about the surgery. If a problem or complication occurs during surgery, the family members are notified immediately.

Normal results

Patients who receive proper preparation for surgery, including physical and psychological preparation, experience less anxiety and are more likely to make a quicker recovery at home, with fewer complications. Patients who perceive their surgical and postoperative experiences as positive report that they had minimal **pain** and **nausea**, were relaxed, had confidence in the skills of their health-care team, felt they had some control over their care, and returned to their normal activities within the expected timeframe.

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ORGANIZATIONS

Agency for Health Care Policy and Research (AHCPR), Publications Clearinghouse, P.O. Box 8547, Silver Spring, MD, 20907, (800) 358-9295.

American Association of Nurse Anesthetists (AANA), 222 South Prospect Avenue, Park Ridge, IL, 60068-4001, (847) 692-7050, http://www.aana.com.

American Board of Surgery, 1617 John F. Kennedy Boulevard, Suite 860, Philadelphia, PA, 19103, (215) 568-4000, http://www.absurgery.org.

American College of Surgeons, 633 N. Saint Clair Street, Chicago, IL, 60611-3211, (312) 202-5000, http://www.facs.org.

American Society of Anesthesiologists (ASA), 520 North Northwest Highway, Park Ridge, IL, 60068-2573, (847) 825-5586, http://www.asahq.org.

National Heart, Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 251-2222, http://www.nhlbi.nih.gov.

Angela M. Costello
Robert Bockstiegel

Prepregnancy counseling

Definition

Prepregnancy counseling is advice supplied by an obstetrician, nurse, certified nurse-midwife, or **childbirth** educator about those steps a mother-to-be and father-to-be can take in preparation for pregnancy. Basically, it is a checklist for people to see if they are living lives that are most accommodating to having a healthy pregnancy. Prepregnancy counseling gives time for one to make changes before pregnancy.

Purpose

The purpose and goal of prepregnancy counseling is to help patients have full-term, healthy pregnancies and babies. The counseling and education are important because lifestyle habits such as **smoking** or alcohol usage can be hazardous to a developing fetus.

Precautions

Women who have diabetes should take special precautions before pregnancy. This counseling, usually provided by a team of professionals including a registered dietitian, diabetes educators, an

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obstetrician, and others, helps to prevent early pregnancy loss and congenital malformations in infants of diabetic mothers.

Women who have a history of genetic disease can opt to have **genetic testing**. Prepregnancy counseling can include referrals to those specialists.

Women who are over 40 have higher **cesarean section** rates. They are also more likely than younger women to have conditions such as high blood pressure, and are more likely to have babies with genetic problems, such as **Down syndrome**.

Women who are considering pregnancy should avoid exposure to hazards such as chemicals, illicit drugs, alcohol, and smoking. They should reduce their **caffeine** intake and be careful not to let their body temperatures rise to dangerous levels.

Description

Prepregnancy counseling involves communicating important aspects about **nutrition**, medication use, and lifestyle months in advance of getting pregnant. Issues include diet, nutrition, **exercise**, smoking, alcohol, drugs, emotional health, and referral to **genetic counseling** if a patient knows of a history of inherited disease.

Preparation

The mother-to-be should stop using birth control pills to allow for at least two regular menstrual cycles before conception. This requires that she stop taking birth control pills several months before getting pregnant.

Other steps to prepare for pregnancy include:

Being at optimal weight. Women should not go on prepregnancy weight loss **diets** unless they are under the care of a physician; abrupt weight loss can affect the mother's menstrual cycle and reduce fertility.

Eating a balanced diet. This is achieved by taking a prenatal vitamin provided by a health care provider and focusing on nutrients that are important for a developing fetus. These include folate, or **folic acid**, which is important for the development of the baby's brain and spinal cord. Folate can be found in fortified cereals, citrus fruits, and green leafy vegetables. **Calcium** is important for baby and mother. It helps the baby's bones to develop normally and keeps the mother from suffering a calcium deficiency during pregnancy. Iron keeps the mother from developing anemia during pregnancy. Good sources of iron are green leafy vegetables, red meat, beans, and fortified cereal. Fiber helps mothers avoid **constipation**, a common occurrence during pregnancy. Good sources of fiber include beans, fruits, and vegetables.

KEY TERMS

Preeclampsia—Also called toxemia, preeclampsia is a condition during pregnancy that results in high blood pressure, swelling that doesn't go away, and large amounts of protein in the urine. Without treatment, it can progress to a dangerous condition called eclampsia, in which a woman goes into convulsions.

Exercising on a regular basis. Exercise promotes general overall health.

Undergoing routine physical and dental exams. These include having a physical and breast examination and **Pap test**. Other tests might be recommended according to a woman's health and genetic history. They should also report any prescription drugs, over-the-counter medications, or natural **vitamins** and herbs they are taking. This is the time for a woman to make sure she is up to date on her immunizations. A dental exam, with x rays, can eliminate the need to have x rays while pregnant.

Getting psychological support. Mental support is also important in the prepregnancy stage. This can help a woman to relax and better prepare mentally and physically for what lies ahead.

Risks

About 10%–15% of couples in the United States experience **infertility**. When couples should seek medical evaluation and an infertility workup depends on their ages. Generally, it takes longer for older couples to conceive. Prepregnancy counseling might include a referral to a fertility specialist. While infertility is often treatable, treatment can be expensive, emotionally difficult, and time consuming. About 10% of the time, doctors cannot detect a reason for the infertility.

There always is the risk that a pregnancy goes awry or a baby is born with a medical condition, regardless of whether or not a person has had prepregnancy counseling.

Normal results

Prepregnancy counseling can provide guidelines for people so that they can maximize their chances to

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have emotionally and physically healthy pregnancies and healthy babies.

Abnormal results

Many abnormal results, such as genetic conditions, **miscarriage**, **preeclampsia** (also known as toxemia), and preterm births, cannot be avoided even with prepregnancy counseling. Still, some abnormal results, such as miscarriages and preterm births, may occur when mothers and fathers lead unhealthy lifestyles despite their counseling.

Resources

OTHER

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Lisette Hilton

Presbyopia

Definition

The term presbyopia means "old eye" and is a vision condition involving the loss of the eye's ability to focus on close objects.

Description

Presbyopia is a condition that occurs as a part of normal **aging** and is not considered to be an eye disease. The process occurs gradually over a number of years. Symptoms are usually noticeable by age 40–45 and continue to develop until the process stabilizes some 10–20 years later. Presbyopia occurs without regard to other eye conditions.

Causes and symptoms

In the eye, the crystalline lens is located just behind the iris and the pupil. Tiny ciliary muscles pull and push the lens, adjusting its curvature and thereby adjusting the eye's focal power to bring objects into focus. As individuals age, the lens becomes less flexible and elastic, and the muscles become less powerful. Because these changes result in inadequate adjustment of the lens of the eye for various distances, objects that are close will appear blurry. The major cause of presbyopia is loss of elasticity of the lens of the eye. Loss of ciliary muscle power, however, is also believed to contribute to the problem.

Symptoms of presbyopia result in the inability to focus on objects close at hand. As the lens hardens, it is unable to focus the rays of light that come from nearby objects. Individuals typically have difficulty reading small print, such as that in telephone directories and newspaper advertisements, and may need to hold reading materials at arm's length. Symptoms include **headache** and eyestrain when doing close work, blurry vision, and eye **fatigue**. Symptoms may be worse early in the morning or when individuals are fatigued. Dim lighting may also aggravate the problem.

Diagnosis

Presbyopia is officially diagnosed during an **eye examination** conducted by eye specialists, such as optometrists or ophthalmologists. After completing optometric college, doctors of optometry screen patients for eye problems and prescribe glasses and **contact lenses**. In contrast, ophthalmologists are medical doctors who specialize in eye diseases. They perform eye surgery, treat eye diseases, and also prescribe glasses and contact lenses.

A comprehensive eye examination requires at least 30 minutes. Part of the examination will assess vision while reading by using various strength lenses. If the pupils are dilated with drugs to permit a thorough examination of the retina, an additional hour is required. The cost of eye examinations can range from $40 to $250 depending on the complexity and site of the examination and the qualifications and reputation of the examiner. Some insurers cover the cost of routine eye examinations, while others do not. A thorough eye examination is recommended at regular intervals during the adult and aging years to monitor and diagnose eye conditions. However, individuals frequently self-diagnose presbyopia by trying on inexpensive mass-produced reading glasses until they find a pair that permits reading without strain.

Treatment

Presbyopia cannot be cured, but individuals can compensate for it by wearing reading, bifocal, or trifocal eyeglasses. A convex lens is used to make up for the lost automatic focusing power of the eye.

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KEY TERMS

Accommodation—The ability of the eye to change its focus from near to distant objects.

Binocular vision—Using both eyes at the same time to see an image.

Ciliary muscles—The small muscles that permit the lens to change its shape in order to focus on near or distant objects.

Lens (or crystalline lens)—The eye structure behind the iris and pupil that helps focus light on the retina.

Visual acuity—Sharpness or clearness of vision.

Half-glasses can be worn, which leave the top open and uncorrected for distance vision. Bifocals achieve the same goal by allowing correction of other refractive errors (improper focusing of images on the retina of the eye).

In addition to glasses, contact lenses have also been found to be useful in the treatment of presbyopia. The two common types of contact lenses prescribed for this condition are bifocal and monovision contact lenses. Bifocal contact lenses are similar to bifocal glasses. The top portion of the lens serves as the distance lens while the lower serves as the near vision lens. To prevent rotation while in the eye, bifocal contacts use a specially manufactured type of lens. Good candidates for bifocal lenses are those patients who have a good tear film (moist eyes), good binocular vision (ability to focus both eyes together) and visual acuity in each eye, and no disease or abnormalities in the eyelids. The bifocal contact lens wearer must be motivated to invest the time it requires to maintain contact lenses and be involved in occupations that do not impose high visual demands. Further, bifocal contact lenses may limit binocular vision. Bifocal contact lenses are relatively expensive, in part due to the time it takes the patient to be accurately fitted.

An alternative to wearing eyeglasses or bifocal contact lenses is monovision contact lenses. Monovision fitting provides one contact lens that corrects for near vision and a second contact lens for the alternate eye that corrects for distance vision. If distance vision is normal, the individual wears only a single contact lens for near vision. Monovision works by having one eye focus for distant objects while the other eye becomes the reading eye. The brain learns to adapt to this and will automatically use the correct eye depending on the location of material in view. Advantages of monovision are patient acceptability, convenience, and lower cost.

Several problems exist with the use of contact lenses in the treatment of presbyopia. Some individuals experience headache and fatigue during the adjustment period or find the slight decrease in visual acuity unacceptable. Monovision contact lenses usually result in a small reduction in high-contrast visual acuity when compared with bifocal contact lenses.

Prognosis

The changes in vision due to aging usually start in a person's early 40s and continue for several decades. At some point, there is no further development of presbyopia, as the ability to accommodate is virtually gone.

Prevention

There is no known way to prevent presbyopia.

ORGANIZATIONS

American Academy of Ophthalmology (AAO), P. O. Box 7424, San Francisco, CA, 94120-7424, (415) 561-8500, (415) 561-8500, http://www.aao.org.

American Optometric Association, 243 North Lindbergh Blvd., St. Louis, MO, 63141, (314) 991-4100, (314) 991-4101, (800) 365-2219, http://www.aoa.org/.

Lighthouse International, 111 East 59th Street, New York, NY, 10022-120, (212) 821-9200, (212) 821-9707, (800) 829-0500, info@lighthouse.org, http://www.lighthouse.org.

National Eye Institute, 2020 Vision Place, Bethesda, MD, (301) 496-5248, http://www.nei.nih.gov/.

Elaine Souder, PhD

Presenile dementia *see* **Alzheimer's disease**

Pressure sores *see* **Bedsores**

Preterm labor *see* **Premature labor**

Priapism

Definition

Priapism is a persistent, unwanted, and usually painful penile erection that is not caused by sexual stimulation or arousal and is not relieved by orgasm.

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Demographics

Priapism is uncommon, with a worldwide overall incidence of 1.5 cases per 100,000 men each year, increasing to 2.9 cases per 100,000 in men over age 40. Priapism can occur in males of any age, from newborns to the elderly, but is most common in boys between the ages of 5 and 10 and in men aged 20–50.

In younger males, priapism is more often associated with **sickle cell disease** (SCD) and is a common problem among African American males with SCD. The incidence of priapism is as high as 27% in male children with SCD. Estimates of the occurrence of priapism in adult males with SCD range from 10%–89% and the incidence is highest in men aged 19–21. Among older men, priapism is more often associated with drugs. Between 0.05% and 6% of men treating **erectile dysfunction** with drugs experience priapism.

Description

During a normal erection, the spongy tissues in the penis fill with blood as the blood vessels relax and expand in response to physical or psychological stimulation. The blood is trapped in the penis by the contraction of blood vessels that drain the blood. Following sexual activity or withdrawal of stimulation, the blood drains from the penis and it becomes non-rigid or flaccid. Priapism occurs when the blood in the penile shaft does not drain properly after sexual stimulation and the shaft remains hard. Priapism persisting for more than four hours is a medical emergency. It can permanently damage the tissues of the penis and lead to erectile dysfunction (ED)—the inability to achieve or maintain a normal erection.

There are three types of priapism:

- Ischemic or low-flow priapism is the most common type. It occurs when the blood cannot exit the penis after an erection.
- Stuttering or recurring priapism is a form of ischemic priapism that occurs intermittently.
- Nonischemic or high-flow priapism results from too much blood flowing into the penis.

Risk factors

The major risk factors for priapism are sickle cell disease and drugs used to counteract erectile dysfunction. At least 25% of men who inject ED drugs for more than three months develop priapism.

Causes and symptoms

Priapism is caused by abnormalities in the blood, blood vessels, or nerves that interfere with normal blood flow into or out of the penis. Ischemic priapism is most often caused by diseases of the blood such as SCD, leukemia, or **malaria** or by medications for treating ED. About two-thirds of all pediatric patients with priapism have SCD. The abnormally shaped red blood cells of SCD can clump, preventing them from flowing out of the penis. In developed countries, ED drugs are the most common cause of adult priapism.

Priapism—usually ischemic priapism—can be a side effect of a variety of drugs including:

- oral ED medications, such as sildenafil (Viagra) and vardenafil (Levitra)
- recreational use of ED drugs
- overdoses of vasodilators, such as papaverine, which are injected directly into the penis to induce an immediate erection in men with ED
- antidepressants, such as trazadone (Desyrel), fluoxetine (Prozac), and bupropion (Wellbutrin)
- antipsychotics, such as thorazine, risperidone (Risperdal), and olanzapine (Zyprexa)
- anti-anxiety medications, such as diazepam (Valium)
- blood thinners, such as warfarin (Coumadin) and heparin
- some blood pressure medications
- cocaine, marijuana, and ecstasy
- excessive alcohol consumption

Nonischemic priapism is usually the result of a ruptured artery or other injury or trauma to the genitals, perineum (the area between the scrotum and anus), or pelvis that interferes with normal blood circulation in the penis.

Other factors that can contribute to the occurrence of priapism include:

- spinal cord injury
- anesthesia
- nervous system diseases, such as multiple sclerosis
- metabolic diseases, such as diabetes
- blood clots
- poisonous venom from scorpions or black widow spiders
- carbon monoxide poisoning
- rarely, cancers affecting the penis

Sometimes the cause of priapism cannot be determined.

The major symptom of priapism is an unwanted erection lasting more than four hours that is not associated with sexual stimulation or that persists after stimulation is completed; however, **stuttering** priapism usually lasts less than three hours. Ischemic or stuttering priapism is usually painful. At the very

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KEY TERMS

Antineoplastic—A drug used to inhibit the growth and spread of cancerous cells.

Doppler ultrasound—An imaging technique that can detect moving fluids.

Erectile dysfunction (ED)—The consistent inability to achieve or maintain a penile erection.

Infarction—Death of tissue due to inadequate blood supply.

Nuclear scanning—Use of injected radioactive elements to analyze blood flow.

Sickle cell disease (SCD)—A hereditary abnormality causing deformed red blood cells that can plug up small blood vessels.

least it causes penile tenderness. With these types of priapism the penile shaft is rigid but the tip (glans) is usually soft. Nonischemic priapism is usually painless and, although the penile shaft is erect, it is not rigid.

Diagnosis

Examination

An ischemic erection lasting more than four hours requires immediate emergency room treatment. The physician may be able to determine the type of priapism based on the rigidity and sensitivity of the penis. A persistent erection that resolves in less than four hours or recurring or stuttering priapism also requires diagnosis to prevent further episodes. A family physician or general practitioner may refer the patient to a urologist. Diagnosis includes a **physical examination** of the genitals, perineum, rectum, and abdomen. It also includes a medical and sexual history, a list of medications and other drug use, and symptoms. The physician will look for signs of injury or tumors that could be causing priapism.

Tests

Laboratory tests are used to determine causes underlying priapism:

- Laboratory blood gas measurements are performed on blood removed from the penis with a tiny needle. The visible appearance of the blood can indicate the type of priapism—dark blood indicates oxygen deprivation and ischemic priapism and bright red blood indicates nonischemic priapism.
- Red blood cell and platelet counts and other blood tests can indicate SCD, other blood disorders, or certain cancers.
- Toxicology tests on blood or urine samples can screen for illicit or prescription drug use.

Procedures

Nuclear scanning, Doppler ultrasound, or color duplex ultrasonography may be used to evaluate penile blood flow and distinguish between ischemic and nonischemic priapism. They may also reveal an injury, tumor, or other abnormality that may be an underlying cause of the priapism.

Treatment

Traditional

Aspiration is the emergency treatment for ischemic priapism that does not respond to the injection of medications. Under local anesthetic the excess blood is drained from the penis with a small needle and syringe. The penile veins may also be flushed with saline solution. This relieves **pain**, clears the tissues of dangerous oxygen-depleted blood, and may relieve the erection. However the procedure may have to be repeated frequently over several hours to completely end the erection. A urinary catheter may be inserted to drain the bladder. Patients with SCD also may receive supplemental oxygen, a blood **transfusion**, intravenous fluids, or other treatments for sickle-cell crises. Surgical procedures are used as a last resort for treating ischemic priapism. One procedure blocks much of the blood supply to the penis, enabling it to relax.

Nonischemic priapism often does not require treatment. If the priapism is caused by a ruptured artery, surgical ligation may be used to tie off the artery and restore normal blood flow. Sometimes surgery is used to insert material that temporarily blocks blood flow to the penis. Surgery may also be necessary to repair arteries or tissue damage resulting from an injury.

Both ischemic and nonischemic priapism are sometimes treated with a surgical shunt implanted in the penis to reroute the blood and restore normal circulation.

Drugs

Initial treatment of ischemic priapism usually involves the injection of an alpha-agonist or alpha-adrenergic sympathomimetic drug, such as phenylephrine, into the spongy tissue of the penis (intracavernous injection). This constricts blood vessels coming into the penis, limiting the inflow of blood and enabling the outgoing blood vessels to dilate and

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the blood to flow out. Sometimes these injections must be repeated often over a period of several hours.

Home remedies

Placing ice and pressure on the perineum can sometimes help end an erection. Cold packs applied to the penis may alleviate nonischemic priapism.

Prognosis

If priapism is relieved within the first 12–24 hours, there is usually no residual damage to the penis. However, untreated priapism can last for several days. The blood that is trapped in the penis is deprived of oxygen and begins to damage or destroy tissues (infarction). This can lead to permanent ED or disfigurement of the penis. A recent study found that 92% of men with priapism lasting less than 24 hours retained erectile function, compared with only 22% of those with priapism lasting more than seven days.

Prevention

Measures for preventing priapism include:

- treatment of any underlying medical or substance abuse problems
- avoiding triggers such as alcohol or illicit drugs
- changing a prescription medication that may be causing priapism
- hormone treatment for adult men
- a prescription muscle relaxant, such as baclofen (Lioresal)
- self-injection of phenylephrine to halt a prolonged erection
- an antineoplastic drug called hydroxyurea for patients with sickle cell disease
- insertion of a penile prosthesis for permanent prevention of ischemic priapism

Resources

BOOKS

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ORGANIZATIONS

American Urological Association, 1000 Corporate Boulevard, Linthicum, MD, 21090, (410) 689-3700, (866) RING-AUA (746-4282), (410) 689-3800, aua@AUAnet.org, http://www.auanet.org.

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Margaret Alic, PhD

Prickly heat

Definition

Also known as sweat retention syndrome or miliaria rubra, prickly heat is a common disorder of the sweat glands.

Description

The skin contains two types of glands: one produces oil and the other produces sweat. Sweat glands are coil-shaped and extend deep into the skin. They are capable of plugging up at several different depths, producing four distinct skin **rashes**.

- Miliaria crystallina is the most superficial of the occlusions. At this level, only the thin upper layer of skin is affected. Little blisters of sweat that cannot escape to the surface form. A bad sunburn as it just starts to blister can look exactly like this.
- Deeper plugging causes miliaria rubra as the sweat seeps into the living layers of skin, where it irritates and itches.
- Miliaria pustulosais (a complication of miliaria rubra) occurs when the sweat is infected with pyogenic bacteria and turns to pus.
- Deeper still is miliaria profunda. The skin is dry, and goose bumps may or may not appear.

There are two requirements for each of these phases of sweat retention: hot enough weather to

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induce sweating, and failure of the sweat to reach the surface.

Causes and symptoms

Best evidence suggests that bacteria form the plugs in the sweat glands. These bacteria are probably normal inhabitants of the skin, and why they suddenly interfere with sweat flow is still not known.

Infants are more likely to get miliaria rubra than adults. All the sweat retention rashes are also more likely to occur in hot, humid weather.

Besides **itching**, these conditions prevent sweat from cooling the body, which it is supposed to do by evaporating from the skin surface. Sweating is the most important cooling mechanism available in hot environments. If it does not work effectively, the body can rapidly become too hot, with severe and even lethal consequences. Before entering this phase of heat **stroke**, there will be a period of heat exhaustion symptoms—dizziness, thirst, weakness—when the body is still effectively maintaining its temperature. Then the temperature rises, often rapidly, to 104°F (40°C) and beyond. This is an emergency of the first order, necessitating immediate and rapid cooling. The best method is immersion in ice water.

Diagnosis

Rash and dry skin in hot weather are usually sufficient to diagnose these conditions.

Treatment

The rash itself may be treated with topical antipruritics (itch relievers). Preparations containing aloe, menthol, camphor, eucalyptus oil, and similar ingredients are available commercially. Even more effective, particularly for widespread itching in hot weather, are cool baths mixed with corn starch and/or oatmeal (about 0.5 lb [224 g] of each).

Dermatologists can peel off the upper layers of skin using a special ultraviolet light. This will remove the plugs and restore sweating, but is not necessary in most cases.

The primary concern of prickly heat is that the body cannot cool itself adequately without sweating. Careful monitoring for symptoms of heat disease is important. If they appear, some decrease in the ambient temperature must be achieved by moving to the shade, taking a cool bath or shower, or turning up the air conditioner.

KEY TERMS

Ambient—Surrounding.

Pyogenic—Capable of generating pus. *Streptococcus, Staphococcus,* and bowel bacteria are the primary pyogenic organisms.

Syndrome—A collection of abnormalities that occur together often enough to suggest they have a common cause.

Prognosis

The rash disappears in a day with cooler temperatures, but the skin may not recover its ability to sweat for two weeks—the time needed to replace the top layers of skin with new growth from below.

Prevention

Experimental application of topical **antiseptics** like hexachlorophene almost completely prevented these rashes.

Resources

BOOKS

McPhee, Stephen, and Maxine Papadakis. *Current Medical Diagnosis and Treatment, 2010*, 49th ed. New York: McGraw-Hill Medical, 2009.

J. Ricker Polsdorfer, MD

Primaquine *see* **Antimalarial drugs**

Primary biliary cirrhosis

Definition

Primary biliary **cirrhosis** is the gradual destruction of the biliary system for unknown reasons.

Description

Although the cause of this serious condition is not known, it has many features to suggest that it is an autoimmune disease. Autoimmunity describes the process whereby the body's defense mechanisms are turned against itself. The immune system is supposed to recognize and attack only dangerous foreign invaders like germs, but many times it attacks, for no apparent reason, the cells of the body itself.

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A close-up image indicating biliary cirrhosis of the liver. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Autoimmune reactions occur in many different tissues of the body, creating a great variety of diseases.

Primary biliary cirrhosis progressively destroys the system that drains bile from the liver into the intestines. Bile is a collection of waste products excreted by the liver. As the disease progresses it also **scars** the liver, leading to cirrhosis. In some patients, the disease destroys the liver in as little as five years. In others, it may lie dormant for a decade or more.

Causes and symptoms

Ninety percent of patients with this disease are women between the ages of 35 and 60. The first sign of primary biliary cirrhosis may be an abnormal blood test on routine examination. **Itching** is a common early symptom, caused by a buildup of bile in the skin. **Fatigue** is also common in the early stages of the disease. Later symptoms include **jaundice** from the accumulation of bile and signs of specific nutritional deficiencies—bruising from **vitamin K deficiency**, bone **pain** from **vitamin D deficiency**, night blindness from **vitamin A deficiency**, and skin **rashes**, possibly from vitamin E or essential fatty acid deficiency. All these vitamin problems are related to the absence of bile to assist in the absorption of nutrients from the intestines.

Diagnosis

Blood tests strongly suggest the correct diagnosis, but a **liver biopsy** is needed for confirmation. It is also usually necessary to x ray the biliary system to look for other causes of obstruction.

KEY TERMS

Biopsy—Surgical removal of tissue for examination.

Cirrhosis—Scarring, usually referring to the liver.

Immunosuppression—Techniques to prevent transplant graft rejection by the body's immune system.

Treatment

Of the many medicines tried to relieve the symptoms and slow the progress of this disease, only one has had consistently positive results. Ursodeoxycholic acid, a chemical that dissolves gallstones, provides substantial symptomatic relief. It is still unclear if it slows liver damage.

Primary biliary cirrhosis is a major reason for **liver transplantation**. Patients do so well that this is becoming the treatment of choice. As experience, technique, and immunosuppression progressively improve, patients with this disease will come to **transplant surgery** earlier and earlier in their disease course.

Prognosis

So far, this disease has not returned in a transplanted liver.

ORGANIZATIONS

American Liver Foundation, 75 Maiden Lane, Suite 603, New York, NY, 10038, (212) 668-1000, (212) 483-8179, http://www.liverfoundation.org/.

J. Ricker Polsdorfer, MD

Primary degenerative dementia *see* **Alzheimer's disease**

Primary polycythemia *see* **Polycythemia vera**

Primary pulmonary hypertension *see* **Pulmonary hypertension**

PRK *see* **Photorefractive keratectomy and laser-assisted in-situ keratomileusis**

Pro time *see* **Prothrombin time**

Probenecid *see* **Gout drugs**

Procainamide *see* **Antiarrhythmic drugs**

Prochlorperazine *see* **Antinausea drugs**

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Proctitis

Definition

Proctitis is an inflammation of the rectum.

Description

Proctitis affects mainly adolescents and adults. It is most common in men around age 30. Proctitis is caused by several different **sexually transmitted diseases**. Male homosexuals and people who practice anal intercourse are more likely to suffer from proctitis. Patients who have **AIDS** or who are immunocompromised are also more at risk.

KEY TERMS

Candidiasis—A common fungal infection caused by yeast that thrives in moist, warm areas of the body.

Chlamydia—A gonorrhea-like bacterial infection.

Proctoscopy—A procedure in which a thin tube containing a camera and a light is inserted into the rectum so that the doctor can visually inspect it.

Rectum—The final section of the large intestine.

Ulcerative colitis—Chronic ulceration of the colon and rectum.

Causes and symptoms

Proctitis is caused most often by sexually transmitted diseases, including **gonorrhea**, **syphilis**, herpes simplex (**genital herpes**), **candidiasis**, and chlamydia. It can also be caused by inflammatory bowel diseases, such as **Crohn's disease**, or ulcerative **colitis**, a chronic recurrent ulceration in the colon. Occasionally it is caused by an amoeba that causes **dysentery**.

Discharge of blood and mucus and intense **pain** in the area of the rectum and anus are all signs of proctitis. Patients feel the urge to have frequent bowel movements even when there is nothing present to eliminate. They may also have **constipation**, **diarrhea**, **fever**, and open sores around the anus. Other symptoms include cramping, lower back pain, difficulty urinating, and **impotence**.

Diagnosis

Proctitis is diagnosed by a patient history and **physical examination**. It is confirmed by a proctoscopy (examination of the rectum with an endoscope inserted through the anus). Proctoscopy usually shows a red, sore, inflamed lining of the rectum. Biopsies, smears, and lab cultures of rectal material are used to determine the exact cause of the inflammation so that the underlying cause can be treated appropriately.

Since the two problems often occur together, in the presence of proctitis, the large bowel should be examined for ulcerative colitis.

Treatment

Once the underlying cause of the inflammation is diagnosed, appropriate treatment begins. **Antibiotics** are given for bacterial infections. There is no cure for genital herpes, but the antiviral drug acyclovir is often prescribed to reduce symptoms. Corticosteroid suppositories or ointments such as hydrocortisone are used to lessen discomfort, and the patient is encouraged to take warm baths to ease painful symptoms. Ulcerative proctitis often responds well to corticosteroid **enemas** or foam, or to sulfasalazine and related drugs.

Alternative treatment

Depending on the cause of proctitis, alternative medicine has several types of treatments available. If proctitis is related to gonorrhea, syphilis, or chlamydia, appropriate antibiotic treatment is recommended. Supplementation with *Lactobacillus acidophilus* is also recommended during and following antibiotic therapy to help rebuild normal gut flora that is destroyed by antibiotics. If proctitis is herpes related, antiviral herbs taken internally, as well as applied topically, can be be helpful. Sitz baths and compresses of herbal infusions (herbs steeped in hot water) and decoctions (herbal extracts prepared by boiling the herb in water) can be very effective. Among the herbs recommended are calendula (*Calendula officinalis*), comfrey (*Symphytum officinale*), and plantain (*Plantago major*). Proctitis related to candidiasis requires dietary alterations, especially elimination of sugar from the diet. Any immunocompromised person needs close medical attention. If proctitis is related to inflammatory bowel diseases, the resolution of the underlying condition should contribute to resolution of the proctitis. **Acupuncture** and homeopathic treatment can be very useful in resolving inflammatory bowel diseases.

Prognosis

Proctitis caused by bacteria is curable with antibiotics. Genital herpes is not curable. Although

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symptoms can be suppressed, proctitis may reoccur. Patients with AIDS are especially susceptible to candidiasis infections, which may be hard to control. Recovering from proctitis caused by inflammatory bowel diseases is variable and depends on successful management of those diseases. Severe proctitis can result in permanent narrowing of the anus.

Prevention

Proctitis is best prevented by using **condoms** and practicing safer sex to prevent acquiring sexually transmitted diseases. Avoiding anal intercourse also helps prevent damage to the rectum.

Resources

OTHER

"Proctitis." MedlinePlus. http://www.nlm.nih.gov/medlineplus/ency/article/001139.htm (accessed December 3, 2010).

Tish Davidson, A.M.

Proctosigmoidoscopy *see* **Sigmoidoscopy**

Progesterone assay *see* **Sex hormones tests**

Progressive multifocal leukoencephalopathy

Definition

Progressive multifocal leukoencephalopathy (PML) is a rapidly progressive neuromuscular disease caused by opportunistic infection of brain cells (oligodendrocytes and astrocytes) by the JC virus (JCV).

Description

PML is an opportunistic infection associated with **AIDS** and certain cancers. It occurs in people with inadequate immune response and carries a poor prognosis. The incidence of PML, once quite rare, is rising as the numbers of people living with persistently compromised immune systems rises. An estimated 2%–7% of people with HIV disease will develop PML. The infection also occurs among people undergoing long-term **chemotherapy** for **cancer**. PML is not considered a contagious disease. According to the Centers for Disease Control definition of AIDS, PML in the presence of HIV infection is sufficient to form a diagnosis of AIDS.

KEY TERMS

Multifocal—Having many focal points. In progressive multifocal leukoencephalopathy, it means that damage caused by the disease occurs at multiple sites.

Opportunistic infection—An illness caused by infecting organisms that would not be able to produce disease in a person with a healthy immune system but are able to take advantage of an impaired immune response.

Causes and symptoms

Although at least 80% of the adults in the United States have been exposed to JC virus (as evidenced by the presence of antibodies to this virus), very few will develop PML. Little is certain about what causes JCV to produce active disease, but the virus persists in the kidneys of otherwise healthy people without making them ill. Recent evidence suggests that after prolonged compromise of the immune system, the virus changes into a form that can reach brain tissue and cause disease. In PML, the JCV infects and kills the cells (oligodendrocytes) that produce myelin, which is needed to form the sheath that surrounds and protects nerves.

About 45% of people with PML experience vision problems, most often a blindness affecting half of the visual field of each eye. Mental impairment affects about 38% of people with PML. Eventually, about 75% experience extreme weakness. Other symptoms include lack of coordination, **paralysis** on one side of the body (hemiparesis), and problems in speaking or using language.

Diagnosis

Diagnosis is difficult but usually relies on a neurologist and radiologist assessing the white matter of the brain on a computed tomography or **magnetic resonance imaging** (MRI) scan. Tests of the cerebrospinal fluid can help distinguish between PML and other diseases, such as **multiple sclerosis** and acute hemorrhagic leukoencephalopathy. The rapid clinical progression in immunocompromised patients is another distinguishing factor.

Treatment

Currently, there is no known cure for PML, although it sometimes responds to treatment in patients with AIDS who are taking anti-HIV drugs

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(such as AZT, alpha-interferon, and peptide T). Although several agents have shown some potential in the last few years, such as the highly toxic cancer drug cytarabine, none are safe enough or sufficiently effective to be approved for PML.

Prognosis

PML is usually a very aggressive disease. The time between the onset of symptoms and **death** can be as little as one to six months. However, some patients infected with HIV have improved without receiving treatment specifically for PML.

Resources

OTHER

"NINDS Progressive Multifocal Leukoencephalopathy Information Page." National Institute of Neurological Disorders and Stroke. http://www.ninds.nih.gov/disorders/pml/pml.htm (accessed January 5, 2011).

Jill S. Lasker

Progressive supranuclear ophthalmoplegia
see **Progressive supranuclear palsy**

Progressive supranuclear palsy

Definition

Progressive supranuclear palsy (PSP; also known as Steele-Richardson-Olszewski syndrome) is a rare disease that gradually destroys nerve cells in the parts of the brain that control eye movements, breathing, and muscle coordination. The loss of nerve cells causes palsy, or **paralysis**, that slowly gets worse as the disease progresses. The palsy affects ability to move the eyes, relax the muscles, and control balance.

Description

Progressive supranuclear palsy is a disease of middle age. Symptoms usually begin in the 60s, rarely before age 45 or after age 75. Men develop PSP more often than women do. It affects three to four people per million each year.

Causes and symptoms

PSP affects the brainstem, the basal ganglia, and the cerebellum. The brainstem is located at the top of the spinal cord. It controls the most basic functions needed for survival—the involuntary (unwilled) movements such as breathing, blood pressure, and heart rate. The brainstem has three parts: the medulla oblongata, the pons, and the midbrain. The parts affected by PSP are the pons, which controls facial nerves and the muscles that turn the eye outward, and the midbrain, the visual center. The basal ganglia are islands of nerve cells located deep within the brain. They are involved in the initiation of voluntary (willed) movement and control of emotion. Damage to the basal ganglia causes muscle stiffness (spasticity) and **tremors**. The cerebellum is located at the base of the skull. It controls balance and muscle coordination.

Vision is controlled by groups of cells called *nuclei* in the brainstem. In PSP, the nuclei continue to function, but the mechanisms that control the nuclei are destroyed. The term *supranuclear* means that the damage is done above (*supra*) the nuclei. Patients with PSP have difficulty with voluntary (willed) eye movement. At first, the difficulty only occurs in trying to look down. As the disease progresses, ability to move the eyes right and left is also affected. However, reflex or unwilled eye movements remain normal. Thus, when the patient's head is tilted upwards, the eyes move to look down. These reflex movements remain normal until late in the course of the disease. The upper eyelids may be pulled back, the eyebrows raised, and the brow wrinkled, causing a typical wide-eyed stare. Rate of blinking may decrease from the normal 20–30 per minute to three to five per minute. It becomes difficult to walk downstairs, to maintain eye contact during conversation, or to move the eyes up and down to read.

The earliest symptoms of PSP may be frequent falls or stiff, slow movements of the arms and legs. These symptoms may appear as much as five years before the characteristic vision problems. Walking becomes increasingly awkward, and some patients tend to lean and fall backward. Facial muscles may be weak, causing slurred speech and difficulty swallowing. Sleep may be disturbed and thought processes slowed. Although memory remains intact, the slowed speech and thought patterns and the rigid facial expression may be mistaken for senile **dementia** or **Alzheimer's disease**. Emotional responses may become exaggerated and inappropriate, and the patient may experience **anxiety**, depression, and agitation.

The cause of PSP is not known. Most people who develop PSP come from families with no history of the disease, so it does not seem to be inherited, except in certain rare instances. People who have PSP seem to lack the neurotransmitters dopamine and homovanillic acid in the basal ganglia. Neurotransmitters are chemicals that help carry electrical impulses along the nervous system. Transmitting structures in brain cells called neurofibrils become disorganized (neurofibrillary

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tangles). Neurofibrillary tangles are also found in Alzheimer's disease, but the pattern is somewhat different.

Diagnosis

PSP is sometimes mistaken for **Parkinson's disease**, which is also associated with stiffness, frequent falls, slurred speech, difficulty swallowing, and decreased spontaneous movement. The facial expression in Parkinson's, however, is blank or mask-like, whereas in PSP it is a grimace and wide-eyed stare. PSP does not cause the uncontrolled shaking (tremor) in muscles at rest that is associated with Parkinson's disease. Posture is stooped in Parkinson's disease, but erect in PSP. Speech is of low volume in both diseases, but is more slurred and irregular in rhythm in PSP.

Multiple strokes or abnormal accumulations of fluid within the skull (**hydrocephalus**) can also cause balance problems similar to PSP. **Magnetic resonance imaging** (MRI) scans of the brain may be needed to rule out these conditions. In advanced cases, MRI shows characteristic abnormalities in the brainstem described as "mouse ears."

Treatment

PSP cannot be cured. Drugs are sometimes given to relieve symptoms, but drug treatment is usually disappointing. Dopaminergic medications used in Parkinson's disease, such as levodopa (Sinemet), sometimes decrease stiffness and ease spontaneous movement. Anticholinergic medications, such as trihexyphenidyl (Artane), which restore function to neurotransmitters, or tricyclic drugs, such as amitriptyline (Elavil), may improve speech, walking, and inappropriate emotional responses.

Speech therapy may help manage the swallowing and speech difficulty in PSP. As the disease progresses, the difficulty in swallowing may cause the patient to choke and get small amounts of food in the lungs. This condition can cause aspiration **pneumonia**. The patient may also lose too much weight. In these cases, a feeding tube may be needed. The home environment should be modified to decrease potential injury from falls. Walkers can be weighted in front, to prevent backward falls and handrails can be installed in the bathroom. Because the patient cannot look down, low objects like throw rugs and coffee tables should be removed. Dry eyes from infrequent blinking can be treated with drops or ointments.

Prognosis

The patient's condition gradually deteriorates. After about seven years, balance problems and stiffness make it nearly impossible for the patient to walk. Persons with PSP become more and more immobile and unable to care for themselves. **Death** is not caused by the PSP itself. It is usually caused by pneumonia related to **choking** on secretions or by **starvation** related to swallowing difficulty. It usually occurs within 10 years, but if good general health and **nutrition** are maintained, the patient may survive longer.

KEY TERMS

Basal ganglia—Brain structure at the base of the cerebral hemispheres, involved in controlling movement.

Brainstem—Brain structure closest to the spinal cord, involved in controlling vital functions, movement, sensation, and nerves supplying the head and neck.

Cerebellum—The part of the brain involved in coordination of movement, walking, and balance.

Magnetic resonance imaging (MRI)—An imaging technique that uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

Parkinson's disease—A slowly progressive disease that destroys nerve cells. Parkinson's is characterized by shaking in resting muscles, a stooping posture, slurred speech, muscular stiffness, and weakness.

Prevention

PSP cannot be prevented.

ORGANIZATIONS

American Academy of Neurology, 1080 Montreal Ave., St. Paul, MN, 55116, (651) 695-2717, (651) 695-2791, (800) 879-1960, memberservices@aan.com, http://www.aan.com/.

Society for Progressive Supranuclear Palsy, Inc., Suite #5065 Johns Hopkins Outpatient Center, 601 N. Caroline St., Baltimore, MD, 21287, (800) 457-4777, http://www.psp.org.

Laurie Barclay, MD

Progressive systemic sclerosis *see* **Scleroderma**

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Prolactin test

Definition

Prolactin is a hormone secreted by the anterior portion of the pituitary gland (sometimes called the "master gland"). Its role in the male has not been demonstrated, but in females, prolactin promotes **lactation**, or milk production, after **childbirth**.

Purpose

The prolactin test is used to diagnose pituitary dysfunction that might be caused by a tumor called an adenoma. In some circumstances, the test is also used to evaluate absence of menstrual periods (**amenorrhea**), or spontaneous production of milk (**galactorrhea**) by a woman who is not pregnant or lactating.

Precautions

Stress from trauma, illness, surgery, or even nervousness about a blood test can elevate prolactin levels. Drugs that may increase prolactin include phenothiazines, **oral contraceptives**, opiates, histamine antagonists, **monoamine oxidase inhibitors** (MAO inhibitors), estrogen, and **antihistamines**. Drugs that can decrease values include levodopa and dopamine.

Description

Prolactin is also known as the lactogenic hormone or lactogen. It is essential for the development of the mammary glands for lactation during **pregnancy**, and for stimulating and maintaining lactation after childbirth. Like the human growth hormone, prolactin acts directly on tissues, and its levels rise in response to sleep and to physical or emotional stress. During sleep, prolactin levels can increase to the circulating levels found in pregnant women (as high as ten to twenty times the normal level).

Prolactin secretion is controlled by prolactin-releasing and prolactin-inhibiting chemicals (factors) secreted by an area of the brain called the hypothalamus. Another hormone, thyroid-releasing hormone, or TRH, can also stimulate prolactin.

Tumors of the pituitary, called adenomas, are the most common cause of excessive levels of prolactin. Depending on the type of cell involved, these tumors are also called prolactin-secreting pituitary acidophilic or chromophobic adenomas. Moderately high prolactin levels are found to a lesser extent in women with secondary amenorrhea, galactorrhea, low thyroid, anorexia, and a disorder known as **polycystic ovary syndrome**, a disease whose cause is not well known.

Because high prolactin levels are more likely due to pituitary adenoma than other causes, the prolactin level is used to diagnose and monitor this type of tumor. Several stimulation and suppression tests, with TRH or levodopa, respectively, have been designed to differentiate pituitary adenoma from other causes of prolactin overproduction.

KEY TERMS

Adenoma—A benign tumor.

Amenorrhea—The absence or abnormal stoppage of menstrual periods.

Factor—Any of several substances necessary to produce a result or activity in the body. The term is used when the chemical nature of the substance is unknown. In endocrinology, when the chemical nature is known, factors are renamed hormones.

Galactorrhea—Excessive or spontaneous flow of milk.

Pituitary gland—A gland located at the base of the brain and controlled by the hypothalamus. It controls most endocrine functions and is responsible for things such as kidney function, lactation, and growth and development.

Preparation

This test requires a blood sample that should be drawn in the morning at least two hours after the patient wakes (samples drawn earlier may show sleep-induced peak levels). The patient need not restrict food or fluids nor limit physical activity, but should relax for approximately 30 minutes before the test.

Risks

Risks posed by this test are minimal, but may include slight bleeding from the blood-drawing site, **fainting** or lightheadedness after venipuncture, or hematoma (blood accumulating under the puncture site).

Normal results

Reference ranges vary from laboratory to laboratory but are generally within the following values:

- adult male: 0–20 ng/mL
- adult female: 0–20 ng/mL
- pregnant female: 20–400 ng/mL

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Abnormal results

Increased prolactin levels are found in galactorrhea, amenorrhea, prolactin-secreting pituitary tumor, infiltrative diseases of the hypothalamus, and metastatic **cancer** of the pituitary gland. Higher levels than normal are seen in stress related to **anorexia nervosa**, surgery, strenuous **exercise**, trauma, and renal (kidney) failure.

Decreased prolactin levels are seen in Sheehan's syndrome, a condition of severe hemorrhage after obstetric delivery that causes decreased blood supply to the pituitary.

Resources

BOOKS

Pagana, Kathleen Deska, and Timothy J. Pagana. *Mosby's Manual of Diagnostic and Laboratory Tests*. 4th ed. St. Louis: Mosby, 2009.

Janis O. Flores

Prolactinoma *see* **Galactorrhea**
Prolapsed disk *see* **Herniated disk**

Prolonged QT syndrome

Definition

Prolonged QT syndrome, also known as long QT syndrome (LQTS), refers to a group of disorders that increase the risk for sudden **death** due to an abnormal heartbeat.

Description

Abnormal heartbeats (cardiac **arrhythmias**) are a primary cause of sudden death, especially in the young population. In the United States, an estimated 1 in 300,000 individuals per year die suddenly due to irregular heart rhythms. One of the better understood causes of these arrhythmias is LQTS.

The QT of LQTS refers to an interval between two points (Q and T) on the common electrocardiogram (ECG, EKG) used to record the electrical activity of the heart. This electrical activity, in turn, is the result of small molecules (ions such as **sodium** and potassium) passing in and out of channels in the membranes surrounding heart cells. A prolonged QT interval indicates an abnormality in electrical activity that leads to irregularities in heart muscle contraction. One of these irregularities is a specific pattern of very rapid contractions (tachycardia) of the lower chambers of the heart called torsade de pointes, a type of **ventricular tachycardia**. The rapid contractions, which are not effective in pumping blood to the body, result in a decreased flow of oxygen-rich blood to the brain. This can result in a sudden loss of consciousness (syncope) and death.

Causes and symptoms

Both inherited and acquired forms of LQTS have been identified. Most acquired forms are thought to be due to certain drugs including adrenaline (epinephrine), several **antihistamines** and **antibiotics**, specific heart medications, **diuretics**, and others. It has been proposed, but not yet documented, that individuals who experience LQTS after using one of these medications may actually have a genetic defect that increases their tendency to cardiac arrhythmias. Severe weight loss such as is associated with **anorexia nervosa** can also disrupt ion balances in the heart and result in prolongation of the QT interval.

Four inherited forms of LQTS have been described to date. Jervell and Lange-Neilsen syndrome, named for the physicians who described the condition in 1957, is associated with congenital deafness and is inherited as an autosomal recessive trait. Romano-Ward syndrome, the most common inherited form of LQTS, was first described in the 1960s. It is inherited in an autosomal dominant pattern and is not associated with other physical impairments such as deafness. The remaining two forms are Timothy syndrome and Andersen syndrome.

At least 10 different genes have been associated with the inherited forms of LQTS. The genes involved in LQTS play important roles in the formation of ion channels in the cell membrane, and, thus, mutations in these genes disrupt normal cardiac rhythms.

LQTS usually presents with symptoms that constitute a life-threatening emergency. Sudden loss of consciousness or cardiac arrest can be brought on by emotional or physical **stress** in young and otherwise healthy individuals, both female and male. Fright, anger, surprise, sudden awakening as a result of loud sounds (alarm clock, telephone), and physical activities, especially swimming, have all been reported to precipitate an episode of cardiac arrhythmia in susceptible individuals. Sudden death often occurs. Although the information is preliminary,

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KEY TERMS

Anorexia nervosa—Eating disorder marked by malnutrition and weight loss commonly occurring in young women.

Autosomal dominant—A pattern of inheritance in which only one of the two copies of an autosomal gene must be abnormal for a genetic condition or disease to occur. An autosomal gene is a gene that is located on one of the autosomes or non-sex chromosomes. A person with an autosomal dominant disorder has a 50% chance of passing it to each of their offspring.

Autosomal recessive—A pattern of inheritance in which both copies of an autosomal gene must be abnormal for a genetic condition or disease to occur. An autosomal gene is a gene that is located on one of the autosomes or non-sex chromosomes. When both parents have one abnormal copy of the same gene, they have a 25% chance with each pregnancy that their offspring will have the disorder.

Diuretic—An agent that increases the production of urine.

Electrocardiogram—A record of the electrical activity of the heart showing certain waves called P, Q, R, S, and T waves. The Q, R, S, T waves are associated with contraction of the ventricles, the lower two chambers of the heart.

Sympathetic nervous system—A division of the autonomic nervous sytem, the portion of the nervous system that controls involuntary bodily functions such as heart rate.

Syndactyly—A fusion of two or more toes or fingers.

recent research has also suggested that a small number of SIDS (**sudden infant death syndrome**) cases may be due to mutations in one or more of the genes associated with LQTS.

Diagnosis

Problems exist in diagnosing LQTS. Although the method of diagnosis is the electrocardiogram, most young, healthy people do not routinely undergo this test, and thus their first, and possibly fatal, episode of LQTS comes without warning. In some cases, a non-fatal episode is mistakenly treated as a seizure, and so the follow-up assessment does not include an electrocardiogram. In addition, some cases of LQTS cannot be diagnosed by a routine electrocardiogram. That is, the QT interval is not found to be prolonged in routine testing. If LQTS is suspected either because of a previous episode of syncope or because of a family member with LQTS, an **exercise** electrocardiogram should be performed. In all instances where an individual is diagnosed with LQTS, family members should be thoroughly evaluated, and a detailed family history should be taken noting any individuals with episodes of sudden loss of consciousness and any cases of unexplained sudden death. Because many of the genes involved in LQTS have been identified, **genetic testing** can offer a more reliable means of diagnosis of other family members at risk. The first step in determining if this type of testing is appropriate in any particular situation is to consult a genetic counselor or medical geneticist.

Treatment

A conventional treatment is the oral administration of beta blockers, medications that decrease the input from the sympathetic nervous system to the heart. Although beta blockers do not correct the abnormalities in the ion channels of the heart cells, they do appear to decrease the occurrence of cardiac arrhythmias. However, these medications are not helpful in all cases, and are actually contraindicated in some individuals. Potassium supplementation is also being explored as a treatment in certain cases. As the genetics of LQTS becomes better understood, it should be possible to tailor treatments that will be effective for each of the various gene mutations.

Alternative treatment

In some patients, severing of the sympathetic nerve to the heart has decreased the occurrence of arrhythmias. **Pacemakers** and defibrillators appear to hold promise as new forms of treatment. As devices of this type are developed that are smaller in size, they may come into more widespread use, either alone or in conjunction with specific medications.

Prognosis

LQTS is a lifelong condition. Individuals who are not diagnosed and treated are at an increased risk of syncope and sudden death. Adequate treatment can

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decrease this risk. There is no cure. Individuals with one of the inherited forms of LQTS are at risk of passing the mutation and the disease to their offspring.

Prevention

The risk of cardiac arrhythmias due to acquired forms of LQTS can be decreased by avoiding the medications and situations that trigger episodes. At present there is no genetic therapy to correct the gene mutations present in the inherited forms of LQTS, but individuals who are known to have an inherited form may also be able to lessen the risk of a life-threatening episode by avoiding such environmental triggers and by taking the appropriate medications.

Resources

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Towbin, Jeffrey A., and Vatta, Matteo. "Molecular Biology and the Prolonged QT Syndromes" *American Journal of Medicine* 110 (April 2001): 385–398.

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ORGANIZATIONS

National Organization for Rare Disorders (NORD), 55 Kenosia Avenue, PO Box 1968, Danbury, CT 06813-1968, (203) 744-0100, (800) 999-6673, TTD: (203) 797-9590, http://www.rarediseases.org.

Sudden Arrhythmia Death Syndromes Foundation, 508 E. South Temple, Suite #20, Salt Lake City, UT, 84102, (800) 786-7723, http://www.sads.org.

Sallie Boineau Freeman, PhD

PROM *see* **Premature rupture of membranes**

Promethaz *see* **Antihistamines**

Prophylaxis

Definition

A prophylaxis is a measure taken to maintain health and prevent the spread of disease. Antibiotic prophylaxis is the focus of this article and refers to the use of **antibiotics** to prevent infections.

Purpose

Antibiotics are well known for their ability to treat infections. But some antibiotics also are prescribed to *prevent* infections. This usually is done only in certain situations or for people with particular medical problems. For example, people with abnormal heart valves have a high risk of developing heart valve infections after even minor surgery. This happens because bacteria from other parts of the body get into the bloodstream during surgery and travel to the heart valves. To prevent these infections, people with heart valve problems often take antibiotics before having any kind of surgery, including dental surgery.

Antibiotics also may be prescribed to prevent infections in people with weakened immune systems, such as people with **AIDS** or people who are having **chemotherapy** treatments for **cancer**. But even healthy people with strong immune systems may occasionally be given preventive antibiotics—if they are having certain kinds of surgery that carry a high risk of infection, or if they are traveling to parts of the world where they are likely to get an infection that causes **diarrhea**, for example.

In all of these situations, a physician should be the one to decide whether antibiotics are necessary. Unless a physician says to do so, it is not a good idea to take antibiotics to prevent ordinary infections.

Because the overuse of antibiotics can lead to resistance, drugs taken to prevent infection should be used only for a short time.

Description

Among the drugs used for antibiotic prophylaxis are amoxicillin (a type of penicillin) and **fluoroquinolones** such as ciprofloxacin (Cipro) and trovafloxacin (Trovan). These drugs are available only with a physician's prescription and come in tablet, capsule, liquid, and injectable forms.

Recommended dosage

The recommended dosage depends on the type of antibiotic prescribed and the reason it is being used. For the correct dosage, check with the physician or dentist who prescribed the medicine or the pharmacist who filled the prescription. Be sure to take the medicine exactly as prescribed. Do not take more or less than directed, and take the medicine only for as long as the physician or dentist says to take it.

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KEY TERMS

AIDS—Acquired immunodeficiency syndrome. A disease caused by infection with the human immunodeficiency virus (HIV). In people with this disease, the immune system breaks down, opening the door to other infections and some types of cancer.

Antibiotic—A medicine used to treat infections.

Chemotherapy—Treatment of an illness with chemical agents. The term is usually used to describe the treatment of cancer with drugs.

Immune system—The body's natural defenses against disease and infection.

Precautions

If the medicine causes **nausea**, **vomiting**, or diarrhea, check with the physician or dentist who prescribed it as soon as possible. Patients who are taking antibiotics before surgery should not wait until the day of the surgery to report problems with the medicine. The physician or dentist needs to know right away if problems occur.

For other specific precautions, see the entry on the type of drug prescribed such as **penicillins** or fluoroquinolones.

Side effects

Antibiotics may cause a number of side effects. For details, see entries on specific types of antibiotics. Anyone who has unusual or disturbing symptoms after taking antibiotics should get in touch with his or her physician.

Interactions

Whether used to treat or to prevent infection, antibiotics may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes antibiotics for any reason should inform the physician about all the other medicines he or she is taking and should ask whether any possible interactions may interfere with drugs' effects. For details of **drug interactions**, see entries on specific types of antibiotics.

Nancy Ross-Flanigan

Proportionate dwarfism *see* **Pituitary dwarfism**

Proptosis *see* **Exophthalmos**

Prostaglandins *see* **Drugs used in labor**

Prostate biopsy

Definition

Prostate biopsy is a surgical procedure that involves removing a small piece of prostate tissue for microscopic examination.

Purpose

This test is usually done to determine whether the patient has **prostate cancer**. Occasionally, it may also be used to diagnose a condition called benign prostatic hyperplasia that causes enlargement of the prostate. In the United States, prostate **cancer** is the most common cancer among men over 50, and is the second leading cause of cancer deaths. According to statistics released by the American Cancer Society in 2010, African American men in the United States have 1.6 times the risk of developing prostate cancer after age 50 than Caucasian or Asian American men. On the other hand, the rate of deaths from prostate cancer has declined further among African American men than among men of other races since 2000.

Prostate biopsy is recommended when a **digital rectal examination** (a routine screening test for prostate diseases) reveals a lump or some other abnormality in the prostate. In addition, if blood tests reveal that the levels of certain markers, such as PSA, are higher than normal, the doctor may order a biopsy.

Description

The prostate gland is one of the three male sex glands and lies just below the urinary bladder, in the area behind the penis and in front of the rectum. It secretes semen, the liquid portion of the ejaculate. The urethra carries the urine from the urinary bladder and the semen from the sex glands to the outside of the body.

Prostate biopsies can be performed in three different ways. They can be performed by inserting a needle through the perineum (the area between the base of the penis and the rectum), by inserting a needle through the wall of the rectum, or by cytoscopy. Before the procedure is performed, the patient may be given a sedative to help him relax. Patients undergoing cytoscopy may

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be given either **general anesthesia** or **local anesthesia**. The doctor will ask the patient to have an enema before carrying out the biopsy. The patient is also given **antibiotics** to prevent any possible infection.

Needle biopsy via the perineum

The patient lies either on one side or on his back with his knees up. The skin of the perineum is thoroughly cleansed with an iodine solution. A local anesthetic is injected at the site where the biopsy is performed. Once the area is numb, the doctor makes a small (1 in.) incision in the perineum. The doctor places one finger in the rectum to guide the placement of the needle. The needle is then inserted into the prostate, a small amount of tissue is collected, and the needle is withdrawn. The needle is then re-inserted into another part of the prostate. Tissue may be taken from several areas. Pressure is then applied at the biopsy site to stop the bleeding. The procedure generally takes 15–30 minutes and is usually done in a physician's office or in a hospital operating room. Although it sounds painful, it typically causes only slight discomfort.

Needle biopsy via the rectum

This procedure is also done in the physician's office or in the hospital operating room, and is usually done without any anesthetic, although some doctors prefer to inject a local anesthetic, usually lidocaine. The patient is asked to lie on his side or on his back with his legs in stirrups. The doctor attaches a curved needle guide to his finger and then inserts the finger into the rectum. After firmly placing the needle guide in the rectum, the biopsy needle is pushed along the guide, through the wall of the rectum and into the prostate. The needle is rotated gently, prostate tissue samples are collected and the needle is withdrawn. When an ultrasound probe is used to guide the needle, the procedure is called a transrectal ultrasound-guided biopsy, or TRUS.

Cytoscopy

For this procedure, the patient is given either a general or a local anesthetic. An instrument called a cytoscope (a thin-lighted tube with telescopic lenses) is passed through the urethra. By looking through the cytoscope, the doctor can see if there is any blockage in the urethra and remove it. Tissue samples from the urinary bladder or the prostate can be collected for microscopic examination.

This test is generally performed in an operating room or in a physician's office. An hour before the procedure, the patient is given a sedative to help him relax. An intravenous (IV) line will be placed in a vein in the arm to give medications and fluids if necessary. The patient is asked to lie on a special table with his knees apart and stirrups are used to support his feet and thighs. The genital area is cleansed with an antiseptic solution. If general anesthesia is being used, the patient is given the medication through the IV tube or inhaled gases or both. If a local anesthetic is being used, the anesthetic solution is gently instilled into the urethra.

After the area is numb, a cytoscope is inserted into the urethra and slowly pushed into the prostate. Tiny forceps or scissors are inserted through the cytoscope to collect small pieces of tissue that are used for biopsy. The cytoscope is then withdrawn. The entire procedure may take 30–45 minutes. Sometimes a catheter (tube) is left in the urinary bladder to help the urine drain out, until the swelling in the urethra has subsided.

Alternate procedures

Many different tests can be performed to diagnose prostate diseases and cancer. A routine screening test called digital **rectal examination** (DRE) can identify any lumps or abnormality with the prostate. Blood tests that measure the levels of certain protein markers, such as PSA, can indicate the presence of prostate cancer cells. X rays and other imaging techniques (such as **computed tomography scans**, **magnetic resonance imaging** [MRI], and ultrasonograms), where detailed pictures of areas inside the body are put together by a computer, can also be used to determine the extent and spread of the disease. However, a prostate biopsy and examination of the cells under a microscope remains the most definitive test for diagnosing and grading prostate cancer as of 2010.

Preparation

Before scheduling the biopsy, the doctor should be informed of all the medications that the patient is taking; whether the patient is allergic to any medication; and whether he has any bleeding problems. The patient may be given an antibiotic shortly before the test to reduce the risk of any infection afterwards. If the biopsy is done through the perineum, there are no special preparations. If it is being done through the rectum, the patient is asked to take an enema and is instructed on how to do it.

If a cytoscopy is being performed, the patient is asked to sign a consent form. The patient is also asked to take antibiotics before and for several days after the

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KEY TERMS

Benign prostatic hyperplasia (BPH)—A noncancerous condition of the prostate that causes overgrowth of the prostate tissue, thus enlarging the prostate and obstructing urination.

Biopsy—The surgical removal and microscopic examination of living tissue for diagnostic purposes.

Computed tomography (CT) scan—A medical procedure in which a series of x rays are taken and put together by a computer in order to form detailed pictures of areas inside the body.

Digital rectal examination—A routine screening test that is used to detect any lumps in the prostate gland or any hardening or other abnormality of the prostate tissue. The doctor inserts a gloved and lubricated finger (digit) into the patient's rectum, which lies just behind the prostate. Typically, since a majority of tumors develop in the posterior region of the prostate, they can be detected through the rectum.

Magnetic resonance imaging (MRI)—A medical procedure used for diagnostic purposes where pictures of areas inside the body are created using a magnet linked to a computer.

Pathologist—A doctor who specializes in the diagnosis of disease by studying cells and tissues under a microscope.

Ultrasonogram—A procedure in which high-frequency sound waves that cannot be heard by human ears are bounced off internal organs and tissues. These sound waves produce a pattern of echoes that are then used by the computer to create sonograms or pictures of areas inside the body.

Urethra—The tube that carries the urine from the urinary bladder and (in males) the semen from the sex glands to the outside of the body.

test to prevent infection due to insertion of the instruments. If a general anesthetic is going to be used, food and liquids will be restricted for at least eight hours before the test.

Aftercare

Following a needle biopsy, the patient may experience some **pain** and discomfort. He should avoid strenuous activities for the rest of the day. He may also notice some blood in his urine for two to three days after the test and some amount of rectal bleeding. If there is persistent bleeding, pain, or **fever**, and if the patient is unable to urinate for 24 hours, the doctor should be notified immediately.

When a cytoscopy is performed under a local anesthetic, the patient is asked to lie down for 30 minutes after the test and is then allowed to go. If general anesthesia is used, the patient is taken to the recovery room and kept there until he wakes up and is able to walk. He is allowed food and liquids after he wakes up. After general anesthesia, the patient may experience some tiredness and aching of the muscles throughout the body. If local anesthesia was administered, there is a brief burning sensation and a strong urge to urinate when the cytoscope is removed.

After the procedure, it is common to experience frequent urination with a burning sensation for a few days. Drinking a lot of fluids will help reduce the burning sensation and the chances of an infection. There may also be some blood in the urine. However, if **blood clots** are seen, or if the patient is unable to pass urine eight hours after the cytoscopy, the doctor should be notified. In addition, if the patient develops a high fever, and complains of chills or abdominal pain after the procedure, he should see the doctor right away. Although serious infections are rare, a few patients develop such severe illnesses as **meningitis** following a prostate biopsy.

Risks

Prostate biopsy performed with a needle is a low-risk procedure. The possible complications include some bleeding into the urethra, bleeding from the rectum, an infection, a temporarily lowered sperm count, or an inability to urinate. These complications are treatable and the doctor should be notified of them.

Cytoscopy is generally a very safe procedure. The most common complication is an inability to urinate due to a swelling of the urethra. A catheter (tube) may have to be inserted to help drain out the urine. If there is an infection after the procedure, antibiotics are given to treat it. In very rare instances, the urethra or the urinary bladder may be perforated because of the insertion of the instrument. If this complication occurs, surgery may be needed to repair the damage.

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Normal results

If the prostate tissue samples show no sign of inflammation, and if no cancerous cells are detected, the results are normal.

Abnormal results

Analysis of the prostate tissue under the microscope reveals any abnormalities. In addition, the presence of cancerous cells can be detected. If a tumor is present, the pathologist "grades" the tumor, in order to estimate how aggressive the tumor is. The most commonly used grading system is called the "Gleason system."

Normal prostate tissue has certain characteristic features that the cancerous tissue lacks. In the Gleason system, prostate cancers are graded by how closely they resemble normal prostate tissue. The system assigns a grade ranging from one to five. The grades assigned to two areas of cancer are added up for a combined score that is between two and ten. A score between two and four is considered low and implies that the cancer is a slow-growing one. A Gleason score of eight to ten is high and indicates that the cancer is aggressive. The higher the Gleason score, the more likely it is that the cancer is fast-growing and may have already grown out of the prostate and spread to other areas (metastasized).

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American Cancer Society, 1599 Clifton Rd., NE, Atlanta, GA, 30329-4251, (800) 227-2345, http://www.cancer.org.

American Urological Association, 1000 Corporate Blvd., Linthicum, MD, 21090, 866 RING-AUA.

New Prostate Cancer InfoLink, http://prostatecancerinfolink.net.

ZERO: The Project to End Prostate Cancer, 10 G Street NE, Suite 601, Washington, DC, 20002, (888) 245-9455, http://www.zerocancer.org/index.html.

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Prostate cancer

Definition

Prostate **cancer** is a disease in which cells in the prostate gland become abnormal and start to grow uncontrollably, forming tumors.

Demographics

Prostate cancer is the most commonly diagnosed malignancy among adult males in Western countries. Although prostate cancer is often very slow growing, it can be aggressive, especially in younger men. Given its slow growing nature, many men with the disease die of other causes rather than from the cancer itself.

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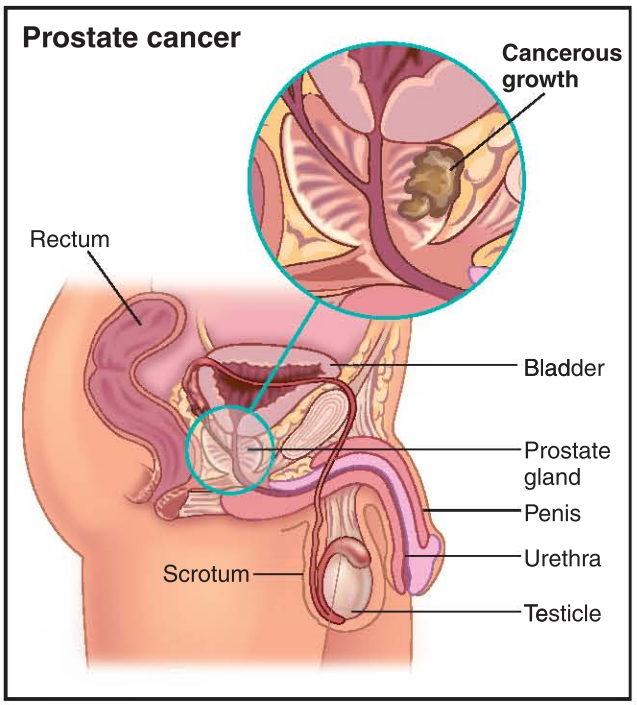

This illustration shows the anatomy of the prostate and surrounding organs, with a cancerous growth on the prostate. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

About 190,000 new cases of prostate cancer are diagnosed in the United States every year. It is projected that one in every six American men will develop prostate cancer at some point during a lifetime. Prostate cancer is second only to lung cancer as a leading cause of **death** from cancer in American men. Almost 10% of deaths from cancer are caused by prostate cancer.

Description

Risk factors

The precise cause of prostate cancer is not known. However, there are several known risk factors for disease including age over 50, African American heritage, a family history of the disease, and possibly **diets** high in fat and red meat.

Prostate cancer is a malignancy of one of the major male sex glands. Along with the testicles and the seminal vesicles, the prostate secretes the fluid that makes up semen. The prostate is about the size of a walnut and lies just behind the urinary bladder. A tumor in the prostate interferes with proper control of the bladder and normal sexual functioning. Often the first symptom of prostate cancer is difficulty in urinating. However, because a very common, non-cancerous condition of the prostate, benign prostatic hyperplasia (BPH), also causes the same problem, difficulty in urination is not necessarily due to cancer.

Cancerous cells within the prostate itself are generally not deadly on their own. However, as the tumor grows, some of the cells break off and spread to other parts of the body through the lymph or the blood, a process known as metastasis. The most common sites for prostate cancer to metastasize are the seminal vesicles, the lymph nodes, the lungs, and various bones around the hips and the pelvic region. The effects of these new tumors are what can cause death.

Prostate cancer affects African American men twice as often as Caucasian men; the mortality rate among African Americans is also two times as high. African Americans have the highest rate of prostate cancer of any world population group.

Causes and symptoms

Frequently, prostate cancer has no symptoms and the disease is diagnosed when the patient goes for a routine screening examination. However, when the tumor is big or the cancer has spread to the nearby tissues, the following symptoms may be seen:

- weak or interrupted flow of the urine
- frequent urination (especially at night)
- difficulty starting urination
- inability to urinate
- pain or burning sensation when urinating
- blood in the urine
- persistent pain in lower back, hips, or thighs (bone pain)
- impotence (trouble achieving an erection)
- painful ejaculation

Diagnosis

Prostate cancer is curable when detected early. However, the early stages of prostate cancer are often asymptomatic, so the disease often goes undetected until the patient has a routine **physical examination**. Diagnosis of prostate cancer can be made using some or all of the following tests.

Digital rectal examination (DRE)

In order to perform this test, the doctor puts a gloved and lubricated finger (digit) into the rectum to feel for any lumps in the prostate. The rectum lies just behind the prostate gland, and a majority of prostate tumors begin in the posterior region of the prostate. If

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KEY TERMS

Antiandrogen—A substance that blocks the action of androgens, the hormones responsible for male characteristics. Used to treat prostate cancers that require male hormones for growth.

Benign prostate hyperplasia (BPH)—A noncancerous swelling of the prostate.

Brachytherapy—A method of treating cancers, such as prostate cancer, involving the implantation near the tumor of radioactive seeds.

Gleason Grading System—A method of predicting the tendency of a tumor in the prostate to metastasize based on how similar the tumor is to normal prostate tissue.

Granulocyte/macrophage colony stimulating factor (GM–CSF)—Also known as sargramostim, a substance produced by cells of the immune system that stimulates an attack upon foreign cells. Used to treat prostate cancers as a genetically engineered component of a vaccine that stimulates the body to attack prostate tissue.

Histopathology—The study of diseased tissues at a minute (microscopic) level.

Luteinizing hormone-releasing hormone (LH-RH) agonist—A substance that blocks the action of LHRH, a hormone that stimulates the production of testosterone (a male hormone) in men. Used to treat prostate cancers that require testosterone for growth.

Orchiectomy—Surgical removal of the testes as a way of treating prostate cancer by eliminating the production of testosterone.

Prostate-specific antigen—A protein made by the cells of the prostate that is increased by both BPH and prostate cancer.

Radical prostatectomy—Surgical removal of the entire prostate, a common method of treating prostate cancer.

Transurethral resection of the prostate (TURP)—Surgical removal of a portion of the prostate through the urethra, a method of treating the symptoms of an enlarged prostate, whether from BPH or cancer.

the doctor does detect an abnormality, he or she may order more tests in order to confirm these findings. DRE is less effective than the prostate specific antigen (PSA) test in detecting prostate cancer, but use of DRE may facilitate detection of prostate cancer in men whose PSA levels are within normal limits.

Blood tests

Blood tests are used to measure the amounts of certain protein markers, such as PSA, found circulating in the blood. The cells lining the prostate generally make this protein, and a small amount can be detected normally in the bloodstream. In contrast, prostate cancers often produce a lot of this protein, significantly raising the circulating levels. A finding of a high PSA may indicate that cancer is present.

Transrectal ultrasound (TRUS)

A small probe is placed in the rectum and sound waves are released from the probe. These sound waves bounce off the prostate tissue and an image is created. Though the insertion of the probe into the rectum may be slightly uncomfortable, the procedure is generally painless and only takes 20 minutes. TRUS is not used as a screening test because it may not be sensitive enough to detect cancer in its earliest stages. TRUS is most commonly used during a biopsy of the prostate.

Prostate biopsy

If cancer is suspected from the results of any of the above tests, the doctor will remove a small piece of prostate tissue with a hollow needle, a procedure known as core needle biopsy. Most urologists will take multiple samples, sometimes as many as 18, of the suspicious lesion. These samples are then checked under the microscope for the presence of cancerous cells. **Prostate biopsy** is the most definitive diagnostic tool for prostate cancer, and this procedure is done quickly and with little **pain** or discomfort.

X rays and imaging techniques

A **chest x ray** may be ordered to determine whether the cancer has spread to the lungs. Imaging techniques (such as **computer tomography scans** [CT scans] and **magnetic resonance imaging** [MRI]), where a computer is used to generate a detailed picture of the prostate and areas nearby, may be done to get a clearer view of the internal organs. A **bone scan** may be used to check whether the cancer has spread to the bone.

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Treatment

Once cancer is detected during the microscopic examination of the prostate tissue during a biopsy, doctors will determine two different numerical scores that will help define the patient's treatment and prognosis.

Tumor grading

Initially, the pathologist will grade the tumor based on his or her examination of the biopsy tissue. The pathologist scores the appearance of the biopsy sample using the Gleason system. This system uses a scale of one to five based on the sample's similarity or dissimilarity to normal prostate tissue. If the tissue is very similar to normal tissue, it is still well differentiated and given a low grading number, such as one or two. As the tissue becomes more and more abnormal (less and less differentiated), the grading number increases, up to five. Less differentiated tissue is considered more aggressive and more likely to be the source of metastases.

The Gleason grading system is best predictive of the prognosis of a patient if the pathologist gives two scores to a particular sample: a primary and a secondary pattern. The two numbers are then added together and that is the Gleason score reported to the patient. Thus, the lowest Gleason score available is two (a primary and secondary pattern score of one each). A typical Gleason score is five (which can be a primary score of two and a secondary score of three or vice versa). The highest score available is ten, with a pure pattern of very undifferentiated tissue—that is, of grade five. The higher the score, the more abnormal behavior of the tissue, the greater the chance for metastases, and the more serious the prognosis after surgical treatment. A study found that the 10-year cancer survival rate without evidence of disease for grade two, three, and four cancers is 94% of patients. The rate is 91% for grade five cancers, 78% for grade six, 46% for grade seven, and 23% for grade eight, nine, and ten cancers.

Cancer staging

The second numeric score determined by the doctor will be the stage of the cancer (Stages I–IV), which takes into account the grade of the tumor determined by the pathologist. Based on the recommendations of the American Joint Committee on Cancer (AJCC), two kinds of data are used for staging prostate cancer. Clinical data is based on the external symptoms of the cancer, while histopathological data is based on surgical removal of the prostate and examination of its tissues. Clinical data is most useful to make treatment decisions, while pathological data is the best predictor of prognosis. For this reason, the staging of prostate cancer takes into account both clinical and histopathologic information. Specifically, doctors look at tumor size, lymph node involvement, the presence of visceral (internal organ) involvement, and the grade of the tumor.

Treatment options

The doctor and the patient will decide on the treatment mode after considering many factors. For example, the patient's age, the stage of the disease, his general health, and the presence of any co-existing illnesses have to be considered. In addition, the patient's personal preferences and the risks and benefits of each treatment protocol are also taken into account before any decision is made.

SURGERY. For stage I and stage II prostate cancer, surgery is the most common method of treatment because it theoretically offers the chance of completely removing the cancer from the body. Radical **prostatectomy** involves complete removal of the prostate. The surgery can be done using a perineal approach, where the incision is made between the scrotum and the anus, or using a retropubic approach, where the incision is made in the lower abdomen. Perineal approach is also known as nerve-sparing prostatectomy, as it is thought to reduce the effect on the nerves and thus reduce the side effects of **impotence** and incontinence. However, the retropubic approach allows for the simultaneous removal of the pelvic lymph nodes, which can give important pathological information about the tumor's spread.

The drawback to surgical treatment for early prostate cancer is the significant risk of side effects that impact the quality of life of the patient. Studies by the National Cancer Institute (NCI) found that, even when using nerve-sparing techniques, 60% to 80% of men treated with radical prostatectomy reported themselves as impotent (unable to achieve an erection sufficient for sexual intercourse) two years after surgery. This side effect can be sometimes countered by prescribing **sildenafil citrate** (Viagra). Furthermore, 8% to 10% of patients were incontinent in that time span. Despite the side effects, the majority of men were reported as satisfied with their treatment choice. Additionally, there is some evidence that the skill and the experience of the surgeon are central factors in the occurrence and severity of side effects.

Newer surgical options used to treat prostate cancer include laparoscopic radical prostatectomy (LRP) and robotic-assisted LRP. LRP uses smaller incisions,

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which typically results in decreased blood loss, less pain, shorter hospital stays, and faster recovery times as compared to more traditional surgical approaches. Robotic LRP involves the surgeon using robotic arms (using a device known as the da Vinci System) to perform the operation through small incisions made in the patient's abdomen. The advantage of using this method is enhanced maneuverability and precision. The device is expensive, however, and may not be available in many communities. Patients deciding on these newer approaches are advised to seek out surgeons with significant experience in LRP techniques.

Another treatment for prostate cancer is cryosurgery, or **cryotherapy**. Guided by ultrasound, surgeons insert up to eight cryoprobes through the skin and into close proximity with the tumor. Liquid nitrogen (temperature of -321 degrees F, or -196°C) is circulated through the probe, freezing the tumor tissue. In prostate surgery, a warming tube is also used to keep the urethra from freezing. Patients currently spend a day or two in the hospital following the surgery, but it could be an outpatient procedure in the near future. Recovery time is about one week. Side effects have been reduced in recent years, although impotence still affects almost all who have had cryosurgery for prostate cancer. Cryosurgery is considered a good alternative for those too old or sick to have traditional surgery or radiation treatments or when these more traditional treatments are unsuccessful. There is limited information about the long-term efficacy of this treatment for prostate cancer. Cryosurgery is not used as a first-line treatment for prostate cancer.

RADIATION THERAPY. **Radiation therapy** involves the use of high-energy x rays to kill cancer cells or to shrink tumors. It can be used instead of surgery for stage I and II cancer. The radiation can either be administered from a machine outside the body (external beam radiation), or small radioactive pellets can be implanted in the prostate gland in the area surrounding the tumor, called brachytherapy or interstitial implantation. Pellets containing radioactive iodine (I–125) or palladium (Pd–103) can be implanted on an outpatient basis, where they remain permanently. The radioactive effect of the seeds lasts only about a year.

A newer technique is temporary or high-dose brachytherapy, in which radioactive needles are inserted into implanted catheters in prostate tissue. Treatments typically take 5 to 15 minutes, after which the radioactive source is removed. Once therapy is completed, the catheters are removed.

Other newer radiation techniques that are delivered from outside of the body include three-dimensional radiation therapy (3D–CRT), intensity modulated radiation therapy (IMRT), conformal proton beam radiation therapy, and stereotactic radiosurgery (also known by names such as Gamma Knife, Novalis, and Cyberknife).

The side effects of radiation depend on the method of delivery and can include inflammation of the bladder, rectum, and small intestine as well as disorders of blood clotting (coagulopathies). Impotence and incontinence are often delayed side effects of the treatment. A study indicated that bowel control problems were more likely after radiation therapy when compared to surgery, but impotence and incontinence were more likely after surgical treatment. Long-term results with radiation therapy are dependent on stage.

HORMONE THERAPY. Hormone therapy, also called androgen deprivation therapy or androgen suppression therapy, is commonly used when the cancer is in an advanced stage and has spread to other parts of the body, such as stage III or stage IV. Prostate cells need the male hormone testosterone to grow. Decreasing the levels of this hormone or inhibiting its activity will cause the cancer to shrink. Hormone levels can be decreased in several ways.

Orchiectomy is a surgical procedure that involves complete removal of the testicles, leading to a decrease in the levels of testosterone. Drugs that may be given to decrease the amount of testosterone made by the testicles include luteinizing hormone-releasing hormone (LHRH) analogs or agonists, such as leuprolide (Lupron, Viadur, Eligard), goserelin (Zoladex), triptorelin (Trelstar), and histrelin (Vantas), and luteinizing hormone-releasing hormone antagonists, such as degarelix (Firmagon). Anti-androgens, which block the body's ability to use androgens (such as testosterone), may be prescribed in combination with orchiectomy or with LHRH analogs as first-line hormone therapy. Anti-androgens include flutamide (Eulexin), bicalutamide (Casodex), and nilutamide (Nilandron).

There are some serious and unpleasant side effects to hormone therapy. Men may have "hot flashes," enlargement and tenderness of the breasts, or impotence and loss of sexual desire. Another side effect is **osteoporosis**, or loss of bone mass leading to brittle and easily fractured bones.

EXPECTANT MANAGEMENT (WATCHFUL WAITING AND ACTIVE SURVEILLANCE). Watchful waiting means

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no immediate treatment is recommended, but doctors keep the patient under careful observation. This is often done using regular PSA testing. This option is generally used in older patients when the tumor is not very aggressive and the patients have other, more life-threatening illnesses. Prostate cancer in older men tends to be slow growing. Therefore, the risk of the patient dying from prostate cancer, rather than from other causes, is relatively small.

Active surveillance, as the name implies, takes a more aggressive approach. The cancer is more closely monitored, typically every three to six months.

Prognosis

The prognosis for cancers at Stages I and II is very good. For men treated with stage I or stage II disease, almost 100% are alive after five years. Although the cancers of Stage III are more advanced, the five-year prognosis is still good, with 70% of men diagnosed at this stage still living.

Once the cancer has spread outside of the prostate to distant organs, the cancer cannot be cured by current treatment options. Median survival for patients in this advanced stage is typically one to three years, although some men with slower growing tumors may live for much longer.

The spread of the cancer into the pelvis, lymph system, or distant locations are very significant events, as the five-year survival rate drops to about 31% for prostate cancers in Stage IV at time of diagnosis.

Prevention

Because the cause of the cancer is not known, there is no definite way to prevent prostate cancer. However, mandatory screening for prostate cancer is controversial. Because the cancer is so slow growing, and the side effects of the treatment can have significant impact on patient quality of life, some medical organizations question the wisdom of yearly exams. Nevertheless, the National Cancer Institute reports that aggressive screening methods have achieved a reduction in the death rate of prostate cancer of about 2.3% for African Americans and about 4.6% for Caucasians since the mid-1990s, with a 20% increase in overall survival rate during that period.

Current recommendations for men who choose to be screened for prostate cancer are directed to men ages 50 and over whose life expectancy is 10 years or longer, men at high risk (African American men and men with a first-degree relative such as a father or a brother who were diagnosed with prostate cancer prior to age 65) who are aged 45 or older, and men considered to be at highest risk (age of 40 to 45 with several first-degree relatives diagnosed with prostate cancer prior to age 65). For men who choose to be screened, testing with PSA and DRE is recommended. If the PSA level result is 2.5 ng/mL, the man may only need to be retested every two years. If the PSA level is 1.5 ng/mL, the current recommendation is for yearly retesting.

A low-fat diet may slow the progression of prostate cancer. To reduce the risk or progression of prostate cancer, the American Cancer Society recommends a diet rich in fruits, vegetables and dietary fiber, and low in red meat and saturated fats.

Current clinical studies are researching the effects of isoflavones (soy proteins) on prostate cancer risk. The outcomes of this research are not yet available.

Two recent clinical trials, the Prostate Cancer Prevention Trial and the Reduction by Dutasteride of Prostate Cancer Events (REDUCE) study, looked at the effects of administering drugs known as 5 alpha-reductase inhibitors (**finasteride** or dutasteride) for the prevention of prostate cancer. Men who took these drugs as part of participation in the trials developed less prostate cancers than men who did not receive the drugs. However, some men in the REDUCE trial who did develop prostate cancer developed cancers with higher Gleason scores than men who developed prostate cancer and did not take dutasteride. The results of these trials are still being analyzed.

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National Cancer Institute, 6116 Executive Blvd., Suite 300, Bethesda, MD, 20892–8322, (800) 4–CANCER (422–6237), cancergovstaff@mail.nih.gov, http://www.cancer.gov.

The Prostate Cancer Foundation, 1250 Fourth St., Santa Monica, CA, 90401, (800) 757–CURE (2873), info@pcf.org, http://www.capcure.org.

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Prostate gland removal *see* **Prostatectomy**
Prostate sonogram *see* **Prostate ultrasound**

Prostate ultrasound

Definition

A prostate ultrasound is a diagnostic test used to detect potential problems with a man's prostate. An ultrasound test uses very high frequency sound waves that are passed through the body. The pattern of reflected sound waves, or "echoes," shows the outline of the prostate. This test can show whether the prostate is enlarged, and whether an abnormal growth that might be **cancer** is present.

Purpose

The prostate is a chestnut-shaped organ surrounding the beginning of the urethra in men. It produces a milky fluid that is part of the seminal fluid discharged during ejaculation. An ultrasound can see if the prostate has become enlarged, which occurs most in men over age 50. Cancer of the prostate also tends to affect older men.

During a **physical examination**, a doctor may perform a **digital rectal examination**. In this examination, the doctor uses a gloved and lubricated finger inserted in the rectum to feel for any abnormalities. If this examination shows that the prostate is enlarged or a hard lump is present, an ultrasound may be done. Another reason a doctor might perform an ultrasound is if a blood test shows abnormal levels of a substance called prostate-specific antigen (PSA). Abnormal levels of PSA may indicate the presence of cancer.

If there is a suspicious lump, the doctor will want to take a sample of some of the tissue (**prostate biopsy**) to test it to see whether it is in fact cancer. Doing an ultrasound first will show the doctor what part of the prostate should be taken as a sample. Ultrasound can also show whether cancerous tissue is still only within the prostate or whether it has begun to spread to other locations. If **prostate cancer** is present and the doctor decides to treat it with a surgical freezing procedure, ultrasound is used as an aid in the procedure.

An ultrasound can reveal other types of prostate disease as well. For example, it can show if there is inflammation of the prostate (**prostatitis**). Sometimes it is used to determine why a man is unable to father children (**infertility**).

Precautions

A prostate ultrasound study is generally not performed on men who have recently had surgery on their lower bowel. This is because the test requires placing an ultrasound probe about the size of a finger into the rectum.

Description

Prostate ultrasound is generally done using a technique called the transrectal method. This procedure can be done in an outpatient clinic. The cylinder-shaped ultrasound probe is gently placed in the rectum as the patient lies on his left side with the knees bent. The probe is rocked back and forth to obtain images of the entire prostate. The procedure takes about 15–25 minutes to perform. After the test, the patient's doctor can be notified right away, and usually he or she will have a written report within 36 hours.

Preparation

To prepare for a prostate ultrasound, an enema is taken two to four hours before the exam. The patient should not urinate for one hour before the test. If biopsies may be done, the doctor will prescribe an antibiotic that usually is taken in four doses starting the night before the biopsy, the morning of the test, that evening, and the following morning.

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KEY TERMS

Benign prostatic hypertrophy (BPH)—Benign prostatic hypertrophy is an enlargement of the prostate that is not cancerous. However, it may cause problems with urinating or other symptoms.

Prostate-specific antigen (PSA)—A substance that often is produced by cancers of the prostate. It can be detected in a blood test.

Urethra—The tube through which urine passes from the bladder and is excreted to outside the body.

Aftercare

There is some discomfort, but less than most patients expect. In fact, worrying ahead of time is usually the hardest part. Generally, the patient is allowed to leave after a radiologist or urologist has reviewed the results. There may be some mucus or a small amount of bleeding from the rectum after the ultrasound. Some patients notice a small amount of blood in the urine for up to two days after the test. Blood may also be present in the semen. As long as the amount of blood is small, there is no cause for concern.

Risks

There are no serious risks from a prostate ultrasound study. Infection is rare and probably is a result of biopsy rather than the sonogram itself. If the ultrasound probe is moved too vigorously, some bleeding may continue for a few days.

Normal results

Modern ultrasound techniques can display both the smooth-surfaced outer shell of the prostate and the core tissues surrounding the urethra. The entire volume of the prostate should be less than 20 milliliters, and its outline should appear as a smooth, echo-reflecting (echogenic) rim. Some irregularities within the substance of the gland and **calcium** deposits are normal findings.

Abnormal results

An **enlarged prostate** with dimmed echoes may indicate either prostatitis or benign enlargement of the gland, called benign prostatic hypertrophy (BPH). A distinct lump of tissue more likely means cancer. Cancer also often appears as an irregular area within the gland that distorts the normal pattern of echoes. In either case, a biopsy should clarify the diagnosis.

ORGANIZATIONS

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Prostatectomy

Definition

Prostatectomy refers to the surgical removal of part of the prostate gland (transurethral resection, a procedure performed to relieve urinary symptoms caused by benign enlargement), or all of the prostate (radical prostatectomy, the curative surgery most often used to treat **prostate cancer**).

Purpose

Benign disease

When men reach their mid-40s, the prostate gland begins to enlarge. This condition, benign prostatic hyperplasia (BPH), is present in more than half of men in their 60s and as many as 90% of those over 90. Because the prostate surrounds the urethra, the tube leading urine from the bladder out of the body, the enlarging prostate narrows this passage and makes urination difficult. The bladder does not empty completely each time a man urinates, and, as a result, he must urinate with greater frequency, night and day. In time, the bladder can overfill, and urine escapes from the urethra, resulting in incontinence. An operation called transurethral resection of the prostate (TURP) relieves symptoms of BPH by removing the prostate tissue that is blocking the urethra. No incision is needed. Instead a tube (retroscope) is passed through the penis to the level of the prostate, and tissue is either removed or destroyed so that urine can freely pass from the body.

Malignant disease

Prostate **cancer** is the single most common form of non-skin cancer in the United States and the most common cancer in men over 50. Half of men over 70 and almost all men over the age of 90 have prostate

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cancer, and the American Cancer Society estimates that almost 218,000 new cases will be diagnosed in 2010. This condition does not always require surgery. In fact, many elderly men adopt a policy of "watchful waiting," especially if their cancer is growing slowly. Younger men often elect to have their prostate gland totally removed along with the cancer it contains—an operation called radical prostatectomy. The two main types of this surgery, radical retropubic prostatectomy and radical perineal prostatectomy, are performed only on patients whose cancer is limited to the prostate. If cancer has broken out of the capsule surrounding the prostate gland and spread in the area or to distant sites, removing the prostate will not prevent the remaining cancer from growing and spreading throughout the body.

Precautions

Potential complications of TURP include bleeding, infection, and reactions to general or **local anesthesia**. About one man in five will need to have the operation again within 10 years.

Open (incisional) prostatectomy for cancer should not be done if the cancer has spread beyond the prostate, as serious side effects may occur without the benefit of removing all the cancer. If the bladder is retaining urine, it is necessary to insert a catheter before starting surgery. Patients should be in the best possible general condition before radical prostatectomy. Before surgery, the bladder is inspected using an instrument called a cystoscope to help determine the best surgical technique to use, and to rule out other local problems.

Description

TURP

This procedure does not require an abdominal incision. With the patient under either general or spinal anesthesia, a cutting instrument or heated wire loop is inserted to remove as much prostate tissue as possible and seal blood vessels. The excised tissue is washed into the bladder, then flushed out at the end of the operation. A catheter is left in the bladder for one to five days to drain urine and blood. Advanced laser technology enables surgeons to safely and effectively burn off excess prostate tissue blocking the bladder opening with fewer of the early and late complications associated with other forms of prostate surgery. This procedure can be performed on an outpatient basis, but urinary symptoms do not improve until swelling subsides several weeks after surgery.

Radical prostatectomy

RADICAL RETROPUBIC PROSTATECTOMY. This is a useful approach if the prostate is very large or cancer is suspected. With the patient under general or spinal anesthesia or an epidural, a horizontal incision is made in the center of the lower abdomen. Some surgeons begin the operation by removing pelvic lymph nodes to determine whether cancer has invaded them, but recent findings suggest there is no need to sample them in patients whose likelihood of lymph node metastases is less than 18%. A doctor who removes the lymph nodes for examination will not continue the operation if they contain cancer cells, because the surgery will not cure the patient. Other surgeons remove the prostate gland before examining the lymph nodes. A tube (catheter) inserted into the penis to drain fluid from the body is left in place for 14–21 days.

Originally, this operation also removed a thin rim of bladder tissue in the area of the urethral sphincter—a muscular structure that keeps urine from escaping from the bladder. In addition, the nerves supplying the penis often were damaged, and many men found themselves impotent (unable to achieve erections) after prostatectomy. A newer surgical method called potency-sparing radical prostatectomy preserves sexual potency in 75% of patients and fewer than 5% become incontinent following this procedure.

RADICAL PERINEAL PROSTATECTOMY. This procedure is just as curative as radical retropubic prostatectomy but is performed less often because it does not allow the surgeon to spare the nerves associated with erection or, because the incision is made above the rectum and below the scrotum, to remove lymph nodes. Radical perineal prostatectomy is sometimes used when the cancer is limited to the prostate and there is no need to spare nerves or when the patient's health might be compromised by the longer procedure. The perineal operation is less invasive than retropubic prostatectomy. Some parts of the prostate can be seen better, and blood loss is limited. The absence of an abdominal incision allows patients to recover more rapidly. Many urologic surgeons have not been trained to perform this procedure. Radical prostatectomy procedures last one to four hours, with radical perineal prostatectomy taking less time than radical retropubic prostatectomy. The patient remains in the hospital three to five days following surgery and can return to work in three to five weeks. Ongoing research indicates that laparoscopic radical prostatectomy may be as effective as open surgery in treatment of early-stage disease.

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Cryosurgery

Also called **cryotherapy** or cryoablation, this minimally invasive procedure uses very low temperatures to freeze and destroy cancer cells in and around the prostate gland. A catheter circulates warm fluid through the urethra to protect it from the cold. When used in connection with ultrasound imaging, cryosurgery permits very precise tissue destruction. Traditionally used only in patients whose cancer had not responded to radiation, but now approved by Medicare as a primary treatment for prostate cancer, cryosurgery can safely be performed on older men, on patients who are not in good enough general health to undergo radical prostatectomy, or to treat recurrent disease. Recent studies have shown that total cryosurgery, which destroys the prostate, is at least as effective as radical prostatectomy without the trauma of major surgery.

Preparation

As with any type of major surgery done under **general anesthesia**, the patient should be in optimal condition. Most patients having prostatectomy are in the age range when cardiovascular problems are frequent, making it especially important to be sure that the heart is beating strongly, and that the patient is not retaining too much fluid. Because long-standing prostate disease may cause kidney problems from urine "backing up," it also is necessary to be sure that the kidneys are working properly. If not, a period of catheter drainage may be necessary before doing the surgery.

Aftercare

Following TURP, a catheter is placed in the bladder to drain urine and remains in place for two to three days. A solution is used to irrigate the bladder and urethra until the urine is clear of blood, usually within 48 hours after surgery. Whether **antibiotics** should be routinely given remains an open question. Catheter drainage also is used after open prostatectomy. The bladder is irrigated only if **blood clots** block the flow of urine through the catheter. Patients are given intravenous fluids for the first 24 hours, to ensure good urine flow. Patients resting in bed for long periods are prone to blood clots in their legs (which can pass to the lungs and cause serious breathing problems). This can be prevented by elastic stockings and by periodically exercising the patient's legs. The patient remains in the hospital one to two days following surgery and can return to work in one to two weeks.

KEY TERMS

BPH—Benign prostatic hypertrophy, a very common noncancerous cause of prostatic enlargement in older men.

Catheter—A tube that is placed through the urethra into the bladder in order to provide free drainage of urine and blood following either TURP or open prostatectomy.

Cryosurgery—In prostatectomy, the use of a very low-temperature probe to freeze and thereby destroy prostatic tissue.

Impotence—The inability to achieve and sustain penile erections.

Incontinence—The inability to retain urine in the bladder until a person is ready to urinate voluntarily.

Prostate gland—The gland surrounding the male urethra just below the base of the bladder. It secretes a fluid that constitutes a major portion of the semen.

Urethra—The tube running from the bladder to the tip of the penis that provides a passage for eliminating urine from the body.

Risks

The complications and side effects that may occur during and after prostatectomy include:

- Excessive bleeding, which in rare cases may require blood transfusion.
- Incontinence caused by damage to the sphincter (the muscular valve that keeps urine in the bladder) during retropubic prostatectomy.
- Impotence, occurring when nerves to the penis are injured during the retropubic operation. The "nerve-sparing" technique has drastically cut down on this problem.
- Some patients who receive a large volume of irrigating fluid after TURP develop high blood pressure, vomiting, trouble with their vision, and mental confusion. This condition is caused by a low salt level in the blood, and is reversed by giving salt solution.
- A permanent narrowing of the urethra called a stricture occasionally develops when the urethra is damaged during TURP.
- There is about a 34% chance that the cancer will recur within 10 years of the procedure. In addition, about 25% of patients experience what is known as

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biochemical recurrence, which means that the level of prostate-specific antigen (PSA) in the patient's blood serum begins to rise rapidly. Recurrence of the tumor or biochemical recurrence can be treated with radiation therapy or androgen deprivation therapy.

Normal results

In patients with BPH who have the TURP operation, urination should become much easier and less frequent, and dribbling or incontinence should cease. In patients having radical prostatectomy for cancer, a successful operation will remove the tumor and prevent its spread to other areas of the body (metastasis). If examination of lymph nodes shows that cancer has spread beyond the prostate at the time of surgery, other measures are available to control the tumor.

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American Urological Association Foundation, 1000 Corporate Blvd., Linthicum, MD, 21090, (410) 689-3700, (410) 689-3800, (866) 746-4282, auafoundation@auafoundation.org, http://www.urologyhealth.org.

Cancer Research Institute (National Headquarters), One Exchange Plaza, 55 Broadway, Suite 1802, New York, NY, 10006, (212) 688-7515, (212) 832-9376, (800) 992-2623, http://www.cancerresearch.org.

National Prostate Cancer Coalition, 1154 Fifteenth Street, NW, Washington, DC, 20005, (202) 463-9455, (202) 463-9456, (888) 245-9455, info@fightprostatecancer.org, http://www.zerocancer.org.

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Prostate-specific antigen test

Definition

Prostate-specific antigen, or PSA, is a protein produced by the prostate gland that may be found in elevated levels in the blood when a person develops certain diseases of the prostate, notably **prostate cancer**. PSA is *specific*, because it is present only in prostate tissue. It is not specific for prostate *cancer*, however, as it may also be elevated in men with benign enlargement of this organ.

Purpose

The blood test for PSA is used to screen men to detect prostate **cancer** at an early stage, and also to monitor its response to treatment. After lung cancer, prostate cancer is the most common form of cancer in men in the United States. Any routine physical exam of a man aged 50 and older should include a **digital rectal examination** (DRE), in which the doctor's finger probes the surface of the prostate gland to detect any suspicious area of hardness or a tumor mass. PSA testing may be ordered with or without DRE. If the PSA test is positive, a sample of prostate tissue (biopsy) may be taken to confirm that cancer is present. If negative, the test may be repeated immediately to confirm the diagnosis, or repeated the next year. Many physicians today routinely do both a DRE and a PSA test each year on their older male patients, so that if cancer does develop, it will be found at an early stage, making it easier to treat. These tests may be ordered in men younger than age 50 if they are considered to be at high risk for the development of prostate cancer. The combination of a DRE and a PSA test can detect approximately 80% of all prostate cancers.

At present, the PSA test is widely accepted as a way of telling whether a patient with cancer is

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KEY TERMS

Antibody—A substance formed in the body in reaction to some foreign material invading the body, or sometimes to diseased body tissue such as prostate cancer. An antibody also may be prepared in the laboratory and used to measure the amount of antigen in the blood.

Antigen—Either a foreign substance such as a virus or bacterium, or a protein produced by diseased or injured body tissue.

Biopsy—A procedure using a hollow needle to obtain a small sample of tissue, such as from the prostate. Often done to determine whether cancer is present.

BPH—Benign prostatic hyperplasia, a noncancerous disorder that causes the prostate to enlarge.

responding to treatment. Because only the prostate produces PSA, its presence in the blood following complete removal of the prostate (radical **prostatectomy**) indicates that some cancer has been left behind.

Description

The PSA test is a radioimmunoassay. Any antigen causes the body to produce antibodies in an attempt to neutralize or eliminate the antigen, often a substance that harms body tissues. In the laboratory, a sample of the patient's blood is exposed to the antibody against PSA, so that the amount of antigen (PSA) can be measured. The results generally are available the next day.

Preparation

No special measures are needed when doing a PSA test other than taking the usual precautions to prevent infection at the needle puncture site.

Aftercare

There are no specific aftercare requirements related to this test.

Risks

There are no specific risks associated with the PSA test.

Although the level of PSA usually is elevated in men with prostate cancer, it also may be abnormally high (though usually not *as* high) in men with non cancerous enlargement of the prostate (benign prostatic hyperplasia or BPH). If thousands of men have the PSA test routinely each year, many of them will have unnecessary tests (such as biopsy or an ultrasound study) to confirm cancer. If a "false-positive" result is obtained, where the PSA level seems high but really is not, some men may even be treated for prostate cancer when no cancer is present.

Results

Normal results

Each laboratory has its own normal range for PSA. In fact, laboratories may redefine the normal range whenever starting to use a new batch of test chemicals. A PSA level of 4.0 ng/mL or greater in men who are not considered to be at high risk for the development of prostate cancer is a common level that may trigger a need for additional testing to rule out or confirm the presence of prostate cancer. A PSA level that falls between 2.5 and 4.0 ng/mL, especially in men who are considered to be at high risk for the development of prostate cancer, may indicate a need for additional testing in this high risk group.

Abnormal results

Some experts believe that more than 90% of men with prostate cancer will have an elevated PSA level. Others claim that as many as one-third of cancers will be missed. The amount of PSA in the blood drops when cancer is successfully treated, but rises again if the tumor recurs, especially if it spreads to other parts of the body. A new variation of the PSA test shows how much of the material is bound to other protein in the blood and how much is "free." This procedure may be more accurate and could well indicate whether either prostate cancer or BPH is present.

Resources

PERIODICALS

Wolf, A., et al. "American Cancer Society Guidelines for the Early Detection of Prostate Cancer: Update 2010." *CA: A Cancer Journal for Clinicians*. 60 (March/April 2010): 70–98.

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Prostatic acid phosphatase test *see* **Acid phosphatase test**

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Prostatitis

Definition

Prostatitis is an inflammation of the male prostate gland. There are three types of prostatitis:

- Acute bacterial prostatitis develops rapidly.
- Chronic bacterial prostatitis develops gradually, lasts longer, and usually has less severe symptoms.
- Chronic nonbacterial or type III prostatitis, which used to be called prostatodynia and is now referred to as chronic pelvic pain syndrome, is the most common type of prostatitis.

Demographics

Prostatitis is one of the most common urologic diseases, accounting for about 40% of visits to a urologist in the United States. As many as 50% of men may experience prostatitis at some point in their lives. It is estimated that chronic prostatitis accounts for up to two million physician visits each year in the United States, primarily for the nonbacterial form. Although prostatitis is rare in young boys, bacterial prostatitis can affect males of any age. Chronic bacterial prostatitis is most common in young and middle-aged men. Acute bacterial prostatitis is the least common type.

Description

The prostate is a walnut-shaped male reproductive gland that surrounds the urethra at the neck of the bladder and supplies fluid for semen. The urethra is the tube that carries urine from the bladder to the outside of the body. Inflammation of the prostate from prostatitis results in blockages in its tiny ducts, causing the build up of secretions and swelling of the prostate. Prostatitis is one of the three major disorders of the prostate. The others are prostate enlargement and **cancer**.

Risk factors

Risk factors for bacterial prostatitis include:

- multiple sexual partners
- anal intercourse, especially without a condom
- recent catheterization or insertion of another instrument into the urethra
- recent urinary tract infection
- abnormality of the urinary tract

Additional risk factors for chronic bacterial prostatitis include:

- age over 30
- excessive alcohol use
- injury to the perineum—the area between the scrotum and anus

Possible risk factors for nonbacterial prostatitis include:

- infection from bacteria, viruses, fungi, or parasites called trichomonads
- irritation from urine backing up into the prostate
- exposure to chemicals
- a nerve disorder affecting the lower urinary tract
- problems with toilet training
- sexual abuse
- stress

Causes and symptoms

Bacterial prostatitis is caused by bacteria from infected urine flowing backward from the urethra into the prostate ducts. Acute bacterial prostatitis can be caused by any bacterium that causes a **urinary tract infection**, including:

- *Escherichia coli* (*E. coli*)
- *Staphylococcus aureus*
- *Pseudomonas aeruginosa*
- *Klebsiella pneumonia*
- *Proteus mirabilis*
- *Enterococci*

Prostatitis caused by *E. coli* or other bacteria can occur spontaneously or in association with:

- anal intercourse
- urinary tract infections
- epididymitis—an inflammation of the ducts from the testes
- urethritis—inflammation of the urethra
- obstruction of the bladder outlet
- catheterization
- cystoscopy
- prostate biopsy
- trauma
- abnormality of the foreskin
- transurethral surgery

Some sexually transmitted infections (STIs) can cause acute prostatitis, typically in men younger than age 35. These STIs include:

- gonorrhea
- chlamydia
- trichomonas
- *Ureaplasma urealyticum*

Chronic bacterial prostatitis is most often caused by:

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- *E. coli*
- *Klebsiella pneumonia*
- *Enterobacter cloacae*
- *Proteus* species

Chronic bacterial prostatitis often develops from an acute prostatitis infection or is associated with:

- recurrent urinary tract infections
- epididymitis
- urethritis

The exact cause of chronic nonbacterial prostatitis/chronic pelvic **pain** syndrome is unknown. Possible causes include:

- persistent infection with a bacteria, virus, or yeast
- pelvic inflammation or nerve or muscle abnormalities or spasms
- an autoimmune disorder or other inappropriate immune system response
- a uric acid disorder
- prostate stones
- constriction of the urethra
- benign prostatic hyperplasia (BPH)—a noncancerous growth
- prostate cancer
- food allergy
- stress
- irregular sexual activity

Symptoms of prostatitis vary greatly. Inflammation of the prostate can also occur without symptoms. Acute bacterial prostatitis usually develops rapidly with urinary symptoms, pain in the perineum or lower back, and **fever** and chills. Chronic prostatitis symptoms usually develop more slowly and are less severe. Some patients have ongoing mild symptoms or symptomatic episodes.

Signs and symptoms of prostatitis may include:

- Difficulties with urination. Most urinary problems are caused by the swollen prostate blocking the urethra. Patients feel the need to urinate frequently, often urgently and at night. Urination may be painful. It is difficult to start the flow of urine and to totally empty the bladder. The urine stream may be weak or split. Dribbling or incontinence may occur after attempts to urinate. Urination may also be infrequent. With severe prostatitis blood or small stones of calcium may be passed in the urine.
- Pain. In addition to pain when urinating caused by prostate swelling, stimulation of nerves in the prostate gland may cause pain in the penis, one or both testicles, the lower stomach, the lower back, and the perineum. Some patients experience pain during or after ejaculation, while sitting or walking, or during bowel movements.
- Sex and fertility. Prostatitis pain can make it impossible to enjoy sex. Men with prostatitis may be troubled by early release of sperm (premature ejaculation). Occasionally there is blood in the semen. Some of the drugs prescribed to ease the flow of the urine can dampen sexual desire. Because normal prostate secretions contribute to semen, prostatitis may severely reduce the number of sperm and make them less mobile, thereby lowering fertility.
- General health and psychological problems. These include fatigue, malaise, and depression.

KEY TERMS

Catheterization—The placing of a flexible tube into the urethra or other body part.

Culture—A test in which a sample of body fluid, such as prostatic fluid, is grown to identify an organism causing infection.

Cystoscopy—The passing of a viewing instrument called a cystoscope up the urethra into the region of the prostate.

Ejaculation—The process by which semen is ejected by the erect penis.

Granuloma—A mass of chronically inflamed tissue.

Perineum—An area close to the prostate, between the scrotum and anus.

Prostate—The walnut-shaped gland that surrounds the urethra at the neck of the bladder in males and supplies fluid for semen.

Urethra—The tube in the penis that discharges urine from the bladder to the outside of the body.

Diagnosis

Examination

Acute prostatitis can usually be diagnosed from the symptoms and a **physical examination**. Diagnosis of chronic prostatitis can be much more difficult. The family physician or urologist will perform a digital rectal exam (DRE) using a lubricated gloved finger in the rectum to feel the prostate, which may be enlarged or tender. Physical examination may also reveal:

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- urethral discharge
- enlarged or tender lymph nodes in the groin
- swelling and tenderness of the scrotum

Tests

Gently squeezing the prostate produces a few drops of fluid that can be cultured to identify organisms that are causing infection and determine an appropriate treatment. Infected fluid also typically contains a large number of white blood cells for fighting infection. However, excessive pressure on the prostate can force bacteria into the blood and cause serious systemic or general infection. Other tests may include:

- examining and culturing a urine sample for concurrent infection
- a prostate specific antigen (PSA) blood test, since prostatitis, as well as prostate cancer, can increase PSA levels
- semen analysis

Procedures

Procedures used to check for prostatitis include:

- cystoscopy—the insertion of a special instrument called a cystoscope into the penis to directly examine the prostate for inflammation
- transrectal ultrasound
- urine flow studies to measure the pressure of the flow and detect problems with the prostate, urethra, or pelvic muscles

Treatment

Traditional

Nonbacterial prostatitis or prostatitis that does not respond to **antibiotics** may require other treatment:

- Balloon dilation—in which a collapsed balloon is inserted at the obstructed site and inflated—can temporarily widen a narrowed urethra.
- Suprapubic catheterization can drain the bladder through the abdomen if the swollen prostate is severely restricting urine flow through the urethra.
- Rarely—and usually only in older men—the prostate is surgically removed, sometimes by a minimally invasive laparoscopic prostatectomy.
- Psychiatric treatment may be required for serious psychological problems resulting from prostatitis.

Drugs

Acute bacterial prostatitis is usually initially treated with broad-spectrum antibiotics—most often trimethoprim-sulfamethoxazole (Bactrim or Septra), **fluoroquinolones** (Floxin or Cipro), or tetracycline or a tetracycline derivative such as doxycycline—for at least four weeks. Prostatitis caused by an STI is usually treated with a ceftriaxone injection, followed by a seven-day course of doxycycline. Severe acute prostatitis may require intravenous antibiotics and hospitalization. Chronic bacterial prostatitis is usually treated with antibiotics for one to three months or longer. Drugs are also used to treat fungal and parasitic infections of the prostate.

Other drugs used to treat prostatitis include:

- nonsteroidal anti–inflammatory medications (NSAIDs), such as aspirin or ibuprofen
- steroidal anti-inflammatories
- alpha-adrenergic blockers or muscle relaxants to reduce muscle tension and ease urine flow, including doxazosin (Cardura), tamulosin (Flomax), or terazosin (Hytrin)
- pain medication
- allopurinol to reduce uric acid levels
- stool softeners to ease painful bowel movements
- diazepam (Valium) or another tranquilizer for stress

Alternative

There are various alternative treatments for prostatitis, which may be used in conjunction with antibiotics for bacterial infections:

- prostate drainage or massage, in which a finger is inserted into the rectum at regular intervals to exert pressure on the prostate and drain the ducts
- acupuncture and Chinese herbal medicine
- saw palmetto (*Serenoa repens*) to support the prostate
- quercetin and/or pollen extract (Cernitin)
- nutritional supplements thought to support the prostate and help reduce pain and promote healing, including zinc, omega-3 fatty acids, several amino acids, and anti-inflammatory nutrients and herbs
- hot and cold contrast sitz baths to help reduce inflammation
- biofeedback or relaxation techniques
- pelvic physical therapy including trigger point release
- pelvic floor muscle relaxation and strengthening techniques

Alternative treatments should be used with caution, as the benefits of many such treatments have not been confirmed by scientific research.

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Home remedies

Home remedies for relieving symptoms of prostatitis are especially helpful for chronic prostatitis or until antibiotics have taken effect. Home remedies include:

- Heat. Exposing the perineum to very hot water with a sitz bath or hot water bottle or using a heating pad for 20 minutes or longer can relieve pain.
- Ice. When heat is ineffectual, ice packs or simply placing a small ice cube in the rectum may relieve pain for hours.
- Water. Although the discomfort of frequent urination may cause a patient to reduce his fluid intake, this can cause dehydration and increase the risk of bladder infection Patients should continue to drink plenty of water (64–128 ounces daily) and urinate frequently and completely.
- Diet. Most doctors recommend reducing or eliminating caffeine (as in coffee or tea), alcohol, citrus juices, and all hot, spicy, or acidic foods, which may irritate the bladder. Constipation should be avoided because large, hard bowel movements may press on the swollen prostate and cause severe pain. Bran cereals and whole-grain breads are helpful for constipation.
- Exercise. It is especially important for patients with chronic prostatitis to maintain their activity levels. Walking is often helpful, although sometimes it can make the pain worse. Some exercises, such as bicycle riding, should be avoided.
- Frequent ejaculation. Ejaculating two or three times a week is often recommended, especially when taking antibiotics.

Prognosis

Acute bacterial prostatitis is usually relieved rapidly with antibiotics. Approximately 75% of chronic bacterial prostatitis cases are cured with a long course of antibiotics. Antibiotics often relieve symptoms of nonbacterial prostatitis as well, because many of them have direct anti-inflammatory actions. However, most antibiotics do not readily reach the prostate, and infection may recur or develop into chronic prostatitis, which has a much worse prognosis. Failure to control acute prostatitis can lead to complications including a prostatic **abscess**, kidney infection, or blood infection (septicemia). Even when chronic prostatitis cannot be cured, urinary symptoms can be controlled and quality of life can usually be maintained with low doses of antibiotics and other measures.

Prevention

The best prevention for bacterial prostatitis is to avoid potential sources of infection. This includes good perineal hygiene to prevent urinary tract infections and practicing safer sex to avoid STIs. Sex should be avoided whenever a female partner has an active bacterial infection of the vagina. Prompt treatment for infections of the kidneys, bladder, or other genitourinary organs can prevent prostatitis. The best way to prevent chronic prostatitis is to treat an initial acute episode promptly and effectively with a full course of antibiotics.

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American Urological Association (AUA), 1000 Corporate Blvd., Linthicum, MD, 21090, (410) 689–3700, (866)

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National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), Building 31, Room 9A06, 31 Center Dr., MSC 2560, Bethesda, MD, 20892–2560, (301) 496–3583, http://www2.niddk.nih.gov.

Prostatitis Foundation (PF), 1063 30th St., Smithshire, IL, 61478, (888) 891–4200, http://www.prostatitis.org/.

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Prosthetic joint infection *see* **Infectious arthritis**

Protease inhibitors

Definition

A protease inhibitor is a type of drug that cripples the enzyme protease. An enzyme is a substance that triggers chemical reactions in the body. The human **immunodeficiency** virus (HIV) uses protease in the final stages of its reproduction (replication) process.

Purpose

The drug is used to treat selected patients with HIV infection. Blocking protease interferes with HIV reproduction, causing it to make copies of itself that cannot infect new cells. The drug may improve symptoms and suppress the infection but does not cure it.

Precautions

Patients should not discontinue this drug even if symptoms improve without consulting a doctor.

These drugs do not necessarily reduce the risk of transmitting HIV to others through sexual contact, so patients should avoid sexual activities or use **condoms**.

Description

Protease inhibitors are considered one of the most potent medications for HIV developed so far.

This class of drugs includes indinavir (Crixivan), ritonavir (Norvir), nelfinavir (Viracept), amprenavir (Agenerase), lopinavir plus ritonavir (Kaletra), saquinavir (Fortovase), and atazanavir (Reyataz). Reyataz received approval from the U.S. Food and Drug Administration (FDA) in mid-2003 and was the first protease inhibitor approved for once-daily dosing. Several weeks or months of drug therapy may be required before the full benefits are apparent.

KEY TERMS

Human immunodeficiency virus (HIV)—The virus that causes AIDS.

The drug should be taken at the same time each day. Some types should be taken with a meal to help the body absorb them. Each of the types of protease inhibitor may have to be taken in a different way. In most cases, protease inhibitors are part of a combination therapy, used in conjunction with other classes of HIV drugs.

Risks

Common side effects include **diarrhea**, stomach discomfort, **nausea**, and mouth sores. Less often, patients may experience rash, muscle **pain**, **headache**, or weakness. Rarely, there may be confusion, severe skin reaction, or seizures. Some of these drugs can have interactions with other medication, and indinavir can be associated with **kidney stones**. Diabetes or high blood pressure may become worse when these drugs are taken. Reyatraz has been shown to have fewer side effects than some protease inhibitors, though it can interact with other medications, including certain heart medications and antidepressants.

Experts do not know whether the drugs pass into breast milk, so **breastfeeding** mothers should avoid them or should stop nursing until the treatment is completed.

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National AIDS Treatment Advocacy Project, 580 Broadway, Ste. 1010, New York, NY, 10012, (212) 219-0106, (212) 219-8473, (866) 26-NATAP, info@natap.org, http://www.natap.org.

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Protein-calorie malnutrition *see* **Protein-energy malnutrition**

Protein components test

Definition

Protein components tests measure the amounts and types of protein in the blood. Proteins are constituents of muscle, enzymes, hormones, transport proteins, hemoglobin, and other functional and structural elements of the body. Albumin and globulin make up most of the protein within the body and are measured in the total protein of the blood and other body fluids. Thus, the serum (blood) protein components test measures the total protein, as well as its albumin and globulin components in the blood.

Purpose

The protein components test is used to diagnose diseases that either affect proteins as a whole, or that involve a single type of protein. The test is also used to monitor the course of disease in certain cancers, intestinal and kidney protein-wasting states, immune disorders, liver dysfunction, and impaired **nutrition**.

Precautions

Drugs that may cause increased protein levels include the anabolic **steroids**, androgens (male hormones), growth hormone, insulin, and progesterone. Drugs that may decrease protein levels include estrogen, drugs poisonous to the liver, and **oral contraceptives**.

Description

Proteins are large molecules (complex organic compounds) that consist of amino acids, sugars, and lipids. There are two main types of proteins: those that are made of fiber and form the structural basis of body tissues, such as hair, skin, muscle, tendons, and cartilage; and globular proteins (generally water soluble), which interact with hormones, various other proteins in the blood (including hemoglobin and antibodies), and all the enzymes (substances that promote biochemical reactions in the body).

Proteins are needed in the diet to supply the body with amino acids. Ingested proteins are broken down in the digestive system to amino acids, which are then absorbed and rebuilt into new body proteins. One of the most important functions of proteins in the body is to contribute to the osmotic pressure (the movement of water between the bloodstream and tissues). An example of this is seen in diseases that result in damage to the filtering units of the kidneys (**nephrotic syndrome**). A severe loss of protein from the bloodstream into the urine (proteinuria) results, lowering the protein content of the blood and resulting in fluid retention, or **edema**.

Albumin and globulin are two key components of protein. Albumin is made in the liver and constitutes approximately 60% of the total protein. The main function of albumin is to maintain osmotic pressure and to help transport certain blood constituents around the body via the bloodstream. Because albumin is made in the liver, it is one element that is used to monitor liver function.

Globulin is the basis for antibodies, glycoproteins (protein-carbohydrate compounds), lipoproteins (proteins involved in fat transport), and clotting factors. Globulins are divided into three main groups, the alpha, beta, and gamma globulins. Alpha globulins include enzymes produced by the lungs and liver, and haptoglobin, which binds hemoglobin together. The beta globulins consist mostly of low-density lipoproteins (LDLs), substances involved in fat transport. All of the gamma globulins are antibodies, proteins produced by the immune system in response to infection, during allergic reaction, and after organ transplants.

Both serum albumin and globulin are measures of nutrition. Malnourished patients, especially after surgery, demonstrate greatly decreased protein levels, while burn patients and those who have protein-losing syndromes show low levels despite normal synthesis. **Pregnancy** in the third trimester is also associated with reduced protein levels.

The relationship of albumin to globulin is determined by ratio, so when certain diseases cause the albumin levels to drop, the globulin level will be increased by the body in an effort to maintain a normal total protein level. For example, when the liver is unable to synthesize sufficient albumin in chronic **liver disease**, the albumin level will be low, but the globulin levels will be normal or higher than normal. In such cases, the protein components test is an especially valuable diagnostic aid because it determines the ratio of albumin to globulin, as well as the total protein level. It should be noted, however, that when globulin is provided as a calculation (total protein – albumin = globulin), the result is much less definitive than other methods of determining globulin.

Consequently, when the albumin/globulin ratio (A/G ratio) is less than 1.0, more precise tests should

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KEY TERMS

Nephrotic syndromes—A collection of symptoms that result from damage to the filtering units of the kidney (glomeruli), causing severe loss of protein from the blood into the urine.

be ordered. These tests include **protein electrophoresis**, a method of separating the different blood proteins into groups. If the protein electrophoresis indicates a rise, or "spike" at the globulin level, an even more specific test for globulins, called **immunoelectrophoresis**, should be ordered to separate out the various globulins according to type. Some diseases characterized by dysproteinemia (derangement of the protein content of the blood) have typical electrophoretic globulin peaks.

Preparation

Unless this is requested by the physician, there is no need that the patient restrict food or fluids before the test.

Risks

Risks posed by this test are minimal, but may include slight bleeding from the blood-drawing site, **fainting** or lightheadedness after venipuncture, or hematoma (blood accumulating under the puncture site).

Normal results

Reference values vary from laboratory to laboratory, but can generally be found within the following ranges: total protein: 6.4–8.3 g/dL; albumin: 3.5–5.0 g/dL; globulin: 2.3–3.4 g/dL.

Abnormal results

Increased total protein levels are seen in **dehydration**, in some cases of chronic liver disease (like **autoimmune hepatitis** and **cirrhosis**), and in certain tropical diseases (for example, **leprosy**). Very low total protein levels (less than 4.0 g/dL) and low albumin cause the edema (water retention) usually seen in nephrotic syndromes. Decreased protein levels may be seen in pregnancy, chronic **alcoholism**, prolonged **immobilization**, **heart failure**, **starvation**, and malabsorption or **malnutrition**.

Increased albumin levels are found in dehydration. Decreased albumin levels are indicative of liver disease, protein-losing syndromes, malnutrition, inflammatory disease, and familial idiopathic (of unknown cause) dysproteinemia, a genetic disease in which the albumin is significantly reduced and globulins increased.

Increased globulin levels are found in **multiple myeloma** and **Waldenström's macroglobulinemia**, two cancers characterized by overproduction of gammaglobulin from proliferating plasma cells. Increased globulin levels are also found in chronic inflammatory diseases such as **rheumatoid arthritis**, acute and chronic infection, and cirrhosis. Decreased globulin levels are seen in genetic immune disorders and secondary immune deficiency.

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Janis O. Flores

Protein electrophoresis

Definition

Electrophoresis is a technique used to separate different elements (fractions) of a blood sample into individual components. Serum protein electrophoresis (SPEP) is a screening test that measures the major blood proteins by separating them into five distinct fractions: albumin, alpha$_1$, alpha$_2$, beta, and gamma proteins. Protein electrophoresis can also be performed on urine.

Purpose

Protein electrophoresis is used to evaluate, diagnose, and monitor a variety of diseases and conditions. It can be used for these purposes because the levels of different blood proteins rise or fall in response to such disorders as **cancer**, intestinal or kidney protein-wasting syndromes, disorders of the immune system, liver dysfunction, impaired **nutrition**, and chronic fluid-retaining conditions.

Precautions

Certain other diagnostic tests or prescription medications can affect the results of SPEP tests. The administration of a contrast dye used in some other tests may falsely elevate protein levels. Drugs that can

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alter results include **aspirin**, bicarbonates, chlorpromazine (Thorazine), **corticosteroids**, isoniazid (INH), and neomycin (Mycifradin).

Description

Proteins are major components of muscle, enzymes, hormones, hemoglobin, and other body tissues. Proteins are composed of elements that can be separated from one another by several different techniques: chemical methods, ultracentrifuge, or electrophoresis. There are two major types of electrophoresis: protein electrophoresis and **immunoelectrophoresis**. Immunoelectrophoresis is used to assess the blood levels of specific types of proteins called immunoglobulins. An immunoelectrophoresis test is usually ordered if a SPEP test has a "spike," or rise, at the immunoglobulin level. Protein electrophoresis is used to determine the total amount of protein in the blood, and to establish the levels of other types of proteins called albumin, alpha$_1$ globulin, alpha$_2$ globulin, and beta globulin.

Blood proteins

ALBUMIN. Albumin is a protein that is made in the liver. It helps to retain elements like **calcium**, some hormones, and certain drugs in the circulation by binding to them to prevent their being filtered out by the kidneys. Albumin also acts to regulate the movement of water between the tissues and the bloodstream by attracting water to areas with higher concentrations of salts or proteins.

GLOBULINS. Globulins are another type of protein, larger in size than albumin. They are divided into three main groups: alpha, beta, and gamma.

- Alpha globulins. These proteins include alpha$_1$ and alpha$_2$ globulins. Alpha$_1$ globulin is predominantly alpha$_1$ antitrypsin, an enzyme produced by the lungs and liver. Alpha$_2$ globulin, which includes serum haptoglobin, is a protein that binds hemoglobin to prevent its excretion by the kidneys. Various other alpha globulins are produced as a result of inflammation, tissue damage, autoimmune disorders, or certain cancers.
- Beta globulins. These include low-density substances involved in fat transport (lipoproteins), iron transport (transferrin), and blood clotting (plasminogen and complement).
- Gamma globulins. All of the gamma globulins are antibodies—proteins produced by the immune system in response to infection, allergic reactions, and organ transplants. If serum protein electrophoresis has demonstrated a significant rise at the gamma globulin level, immunoelectrophoresis is done to identify the specific globulin that is involved.

Electrophoretic measurement of proteins

All proteins have an electrical charge. The SPEP test is designed to make use of this characteristic. There is some difference in method, but basically the sample is placed in or on a special medium (e.g., a gel), and an electric current is applied to the gel. The protein particles move through the gel according to the strength of their electrical charges, forming bands or zones. An instrument called a densitometer measures these bands, which can be identified and associated with specific diseases. For example, a decrease in albumin with a rise in the alpha$_2$ globulin usually indicates an acute reaction of the type that occurs in infections, **burns**, **stress**, or **heart attack**. On the other hand, a slight decrease in albumin with a slight increase in gamma globulin and a normal alpha$_2$ globulin is more indicative of a chronic inflammatory condition, as might be seen in **cirrhosis** of the liver.

Protein electrophoresis is performed on urine samples to classify kidney disorders that cause protein loss. Certain band patterns are specific to different diseases. For example, the identification of a specific protein called the Bence Jones protein (by performing the **Bence Jones protein test**) during the procedure suggests **multiple myeloma**.

Preparation

The serum protein electrophoresis test requires a blood sample. It is not necessary for the patient to restrict food or fluids before the test. The urine protein electrophoresis test requires either an early morning urine sample or a 24-hour urine sample according to the physician's request. The doctor should check to see if the patient is taking any medications that may affect test results.

Risks

Risks posed by the blood test are minimal but may include slight bleeding from the puncture site, **fainting** or lightheadedness after the blood is drawn, or the development of a small bruise at the puncture site.

Normal results

The following values are representative, although there is some variation among laboratories and specific

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KEY TERMS

Albumin—A blood protein that is made in the liver and helps to regulate water movement in the body.

Electrophoresis—A technique for separating various blood fractions by running an electric current through a gel containing a blood sample.

Globulins—A group of proteins in blood plasma whose levels can be measured by electrophoresis in order to diagnose or monitor a variety of serious illnesses.

Haptoglobin—A protein in blood plasma that binds hemoglobin.

Immunoglobulins—Any of several types of globulin proteins that function as antibodies.

methods. These values are based on the agarose system:

- total protein: 5.9–8.0 g/dL
- albumin: 4.0–5.5 g/dL
- alpha$_1$ globulin: 0.15–0.25 g/dL
- alpha$_2$ globulin: 0.43–0.75 g/dL
- beta globulin: 0.5–1.0 g/dL
- gamma globulin: 0.6–1.3 g/dL

Abnormal results

Albumin levels are increased in **dehydration**. They are decreased in **malnutrition**, **pregnancy**, **liver disease**, inflammatory diseases, and such protein-losing syndromes as **malabsorption syndrome** and certain kidney disorders.

Alpha$_1$ globulins are increased in inflammatory diseases. They are decreased or absent in juvenile pulmonary **emphysema**, which is a genetic disease.

Alpha$_2$ globulins are increased in a kidney disorder called **nephrotic syndrome**. They are decreased in patients with an overactive thyroid gland (**hyperthyroidism**) or severe liver dysfunction.

Beta globulin levels are increased in conditions of high cholesterol levels (**hypercholesterolemia**) and **iron deficiency anemia**. They are decreased in malnutrition.

Gamma globulin levels are increased in chronic inflammatory disease (for example, **rheumatoid arthritis**, **systemic lupus erythematosus**), cirrhosis, acute and chronic infection, and a cancerous disease characterized by uncontrolled multiplication of plasma cells in the bone marrow (multiple myeloma). Gammaglobulins are decreased in a variety of genetic immune disorders, and in secondary immune deficiency related to steroid use, leukemia, or severe infection.

Resources

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Pagana, Kathleen Deska, and Timothy J. Pagana. *Mosby's Manual of Diagnostic and Laboratory Tests*. 4th ed. St. Louis: Mosby, 2009.

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Protein-energy malnutrition

Definition

Protein-energy **malnutrition** (PEM) is a potentially fatal body-depletion disorder. It is the leading cause of **death** in children in developing countries.

Demographics

Although PEM is not prevalent among the general population of the United States, it is often seen in elderly people who live in nursing homes and in children whose parents are poor. PEM occurs in one of every two surgical patients and in 48% of all other hospital patients.

Description

PEM is also referred to as protein–calorie malnutrition. It develops in children and adults whose consumption of protein and energy (measured by calories) is insufficient to satisfy the body's nutritional needs. While pure protein deficiency can occur when a person's diet provides enough energy but lacks the protein minimum, in most cases the deficiency will be dual. PEM may also occur in persons who are unable to absorb vital nutrients or convert them to energy essential for healthy tissue formation and organ function.

Types of PEM

Primary PEM results from a diet that lacks sufficient sources of protein and/or energy. Secondary PEM is more common in the United States, where it usually occurs as a complication of **AIDS**, **cancer**, **chronic kidney failure**, inflammatory bowel disease, or other illnesses that impair the body's ability to absorb or use nutrients or to compensate for nutrient

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losses. PEM can develop gradually in a patient who has a chronic illness or experiences chronic semi-starvation. It may appear suddenly in a patient who has an acute illness.

Kwashiorkor

Kwashiorkor, also called wet protein-energy malnutrition, is a form of PEM characterized primarily by protein deficiency. This condition usually appears at the age of about 12 months when **breastfeeding** is discontinued, but it can develop at any time during a child's formative years. It causes fluid retention (**edema**); dry, peeling skin; and hair discoloration.

Marasmus

Primarily caused by energy deficiency, marasmus is characterized by stunted growth and wasting of muscle and tissue. Marasmus usually develops between the ages of six months and one year in children who have been weaned from breast milk or who suffer from weakening conditions like chronic **diarrhea**.

Causes and symptoms

Secondary PEM symptoms range from mild to severe, and can alter the form or function of almost every organ in the body. The type and intensity of symptoms depend on the patient's prior nutritional status and on the nature of the underlying disease and the speed at which it is progressing.

Mild, moderate, and severe classifications have not been precisely defined, but patients who lose 10%–20% of their body weight without trying are usually said to have moderate PEM. This condition is also characterized by a weakened grip and inability to perform high-energy tasks.

Losing 20% of body weight or more is generally classified as severe PEM. People with this condition can't eat normal-sized meals. They have slow heart rates and low blood pressure and body temperatures. Other symptoms of severe secondary PEM include baggy, wrinkled skin; **constipation**; dry, thin, brittle hair; lethargy; and pressure sores or other **skin lesions**.

Kwashiorkor

People who have kwashiorkor often have extremely thin arms and legs, but liver enlargement and **ascites** (abnormal accumulation of fluid) can distend the abdomen and disguise weight loss. Hair may turn red or yellow. Anemia, diarrhea, and fluid and **electrolyte disorders** are common. The body's immune system is often weakened, behavioral development is slow, and **mental retardation** may occur. Children may grow to normal height but are abnormally thin.

Kwashiorkor-like secondary PEM usually develops in patients who have been severely burned, suffered trauma, or had **sepsis** (tissue-destroying infection) or another life-threatening illness. The condition's onset is so sudden that body fat and muscle mass of normal-weight people may not change. Some obese patients even gain weight.

Marasmus

Profound weakness accompanies severe marasmus. Since the body breaks down its own tissue to use as calories, people with this condition lose all their body fat and muscle strength, and acquire a skeletal appearance most noticeable in the hands and in the temporal muscle in front of and above each ear. Children with marasmus are small for their age. Since their immune systems are weakened, they suffer from frequent infections. Other symptoms include loss of appetite, diarrhea, skin that is dry and baggy, sparse hair that is dull brown or reddish yellow, mental retardation, behavioral retardation, low body temperature (**hypothermia**), and slow pulse and breathing rates.

The absence of edema distinguishes marasmus-like secondary PEM, a gradual wasting process that begins with weight loss and progresses to mild, moderate, or severe malnutrition (cachexia). It is usually associated with cancer, **chronic obstructive pulmonary disease** (COPD), or another chronic disease that is inactive or progressing very slowly.

Some individuals have both kwashiorkor and marasmus at the same time. This most often occurs when a person who has a chronic, inactive condition develops symptoms of an acute illness.

Hospitalized patients

Difficulty chewing, swallowing, and digesting food, as well as **pain**, **nausea**, and lack of appetite are among the most common reasons that many hospital patients don't consume enough nutrients. Nutrient loss can be accelerated by bleeding, diarrhea, abnormally high sugar levels (glycosuria), **kidney disease**, malabsorption disorders, and other factors. **Fever**, infection, surgery, and benign or malignant tumors increase the amount of nutrients hospitalized patients need. So do trauma, **burns**, and some medications.

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KEY TERMS

Ascites—Abnormal accumulation of fluid in the abdomen, making the abdomen appear distended.

Cachexia—Severe malnutrition involving muscle wasting and organ damage.

Edema—Fluid retention, generally seen in the limbs.

Hypothermia—Low body temperature.

Diagnosis

A thorough **physical examination** and a health history that probes eating habits and weight changes, checks body-fat composition and muscle strength, and assesses gastrointestinal symptoms, underlying illness, and nutritional status is often as accurate as blood tests and urinalyses used to detect and document abnormalities.

Some doctors further quantify a patient's nutritional status by:

- comparing height and weight to standardized norms
- calculating body mass index (BMI)
- measuring skinfold thickness or the circumference of the upper arm

Treatment

Treatment is designed to provide adequate **nutrition**, restore normal body composition, and cure the condition that caused the deficiency. Tube feeding or intravenous feeding is used to supply nutrients to patients who can't or won't eat protein-rich foods.

In patients with severe PEM, the first stage of treatment consists of correcting fluid and electrolyte imbalances, treating infection with **antibiotics** that don't affect protein synthesis, and addressing related medical problems. The second phase involves replenishing essential nutrients slowly to prevent taxing the patient's weakened system with more food than it can handle. **Physical therapy** may be beneficial to patients whose muscles have deteriorated significantly.

Prognosis

Most people can lose up to 10% of their body weight without side effects, but losing more than 40% is almost always fatal. Death usually results from **heart failure**, an electrolyte imbalance, or low body temperature. Patients with certain symptoms, including semi-consciousness, persistent diarrhea, **jaundice**, and low blood **sodium** levels, have a poorer prognosis than other patients. Recovery from marasmus usually takes longer than recovery from kwashiorkor. The long-term effects of childhood malnutrition are uncertain. Some children recover completely, while others may have a variety of lifelong impairments, including an inability to properly absorb nutrients in the intestines and mental retardation. The outcome appears to be related to the length and severity of the malnutrition, as well as to the age of the child when the malnutrition occurred.

Prevention

Breastfeeding a baby for at least six months is considered the best way to prevent early childhood malnutrition. Preventing malnutrition in developing countries is a complicated and challenging problem. Providing food directly during famine can help in the short term, but more long-term solutions are needed, including agricultural development, public health programs (especially programs that monitor growth and development, as well as programs that provide nutritional information and supplements), and improved food distribution systems. Programs that distribute infant formula and discourage breastfeeding should be discontinued, except in areas where many mothers are infected with HIV.

Every patient being admitted to a hospital should be screened for the presence of illnesses and conditions that could lead to PEM. The nutritional status of patients at higher-than-average risk should be more thoroughly assessed and periodically reevaluated during extended hospital stays or nursing home residence.

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American Academy of Family Physicians, P. O. Box 11210, Shawnee Mission, KS, 66207, (913) 906-6000, (913) 906-6075, (800) 274-2237, http://www.aafp.org.

American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, IL, 60007-1098, (847) 434-4000, http://www.aap.org.

American College of Nutrition, 722 Robert E. Lee Drive, Wilmington, NC, 20412-0927, (919) 152-1222.

American Institute of Nutrition, 9650 Rockville Pike, Bethesda, MD, 20814-3990, (301) 530-7050.

Food and Nutrition Information Center. National Agricultural Library, 10301 Baltimore Avenue, Room 105, Beltsville, MD, 20705, http://www.nalusda.gov/fnic.

National Institute of Child Health and Human Development (NICHD), P.O. Box 3006, Rockville, MD, 30847, (866) 760-5947, (800) 370-2943, (800) 320-6942 (TTY), NICHDInformationResourceCenter@mail.nih.gov, http://www.nichd.nih.gov.

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Protein-modified diet *see* **Diets**

Prothrombin time

Definition

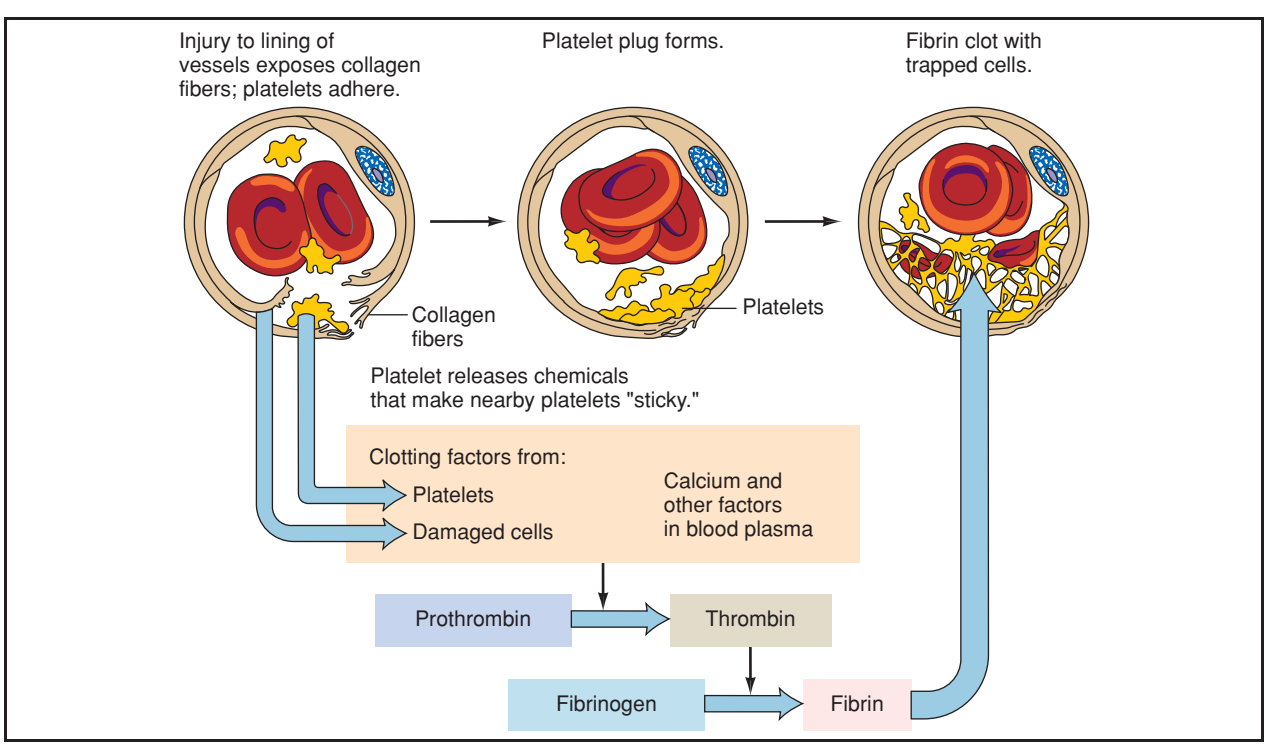
The prothrombin time test belongs to a group of blood tests that assess the clotting ability of blood. The test is also known as the pro time or PT test.

Purpose

The PT test is used to monitor patients taking certain medications as well as to help diagnose clotting disorders.

Diagnosis

Patients who have problems with delayed blood clotting are given a number of tests to determine the cause of the problem. The prothrombin test specifically evaluates the presence of factors VII, V, and X; prothrombin; and fibrinogen. Prothrombin is a protein in the liquid part of blood (plasma) that is converted to thrombin as part of the clotting process. Fibrinogen is a type of blood protein called a globulin; it is converted to fibrin during the clotting process. A drop in the concentration of any of these factors will



The blood clotting process. *((Illustration by Hans & Cassady, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

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KEY TERMS

Disseminated intravascular coagulation (DIC)—A condition in which spontaneous bleeding and clot formation occur throughout the circulatory system. DIC can be caused by transfusion reactions and a number of serious illnesses.

Fibrin—The protein formed as the end product of the blood clotting process when fibrinogen interacts with thrombin.

Fibrinogen—A type of blood protein called a globulin that interacts with thrombin to form fibrin.

Plasma—The liquid part of blood, as distinct from blood cells.

Prothrombin—A protein in blood plasma that is converted to thrombin during the clotting process.

Thrombin—An enzyme in blood plasma that helps to convert fibrinogen to fibrin during the last stage of the clotting process.

Thromboplastin—A protein in blood that converts prothrombin to thrombin.

Warfarin—A drug given to control the formation of blood clots. The PT test can be used to monitor patients being treated with warfarin.

cause the blood to take longer to clot. The PT test is used in combination with the **partial thromboplastin time** (PTT) test to screen for **hemophilia** and other hereditary clotting disorders.

Monitoring

The PT test is also used to monitor the condition of patients who are taking warfarin (Coumadin). Warfarin is a drug that is given to prevent clots in the deep veins of the legs and to treat **pulmonary embolism**. It interferes with blood clotting by lowering the liver's production of certain clotting factors.

Description

A sample of the patient's blood is obtained by venipuncture. The blood is collected in a tube that contains **sodium** citrate to prevent the clotting process from starting before the test. The blood cells are separated from the liquid part of blood (plasma). The PT test is performed by adding the patient's plasma to a protein in the blood (thromboplastin) that converts prothrombin to thrombin. The mixture is then kept in a warm water bath at 37°C for one to two minutes. **Calcium** chloride is added to the mixture in order to counteract the sodium citrate and allow clotting to proceed. The test is timed from the addition of the calcium chloride until the plasma clots. This time is called the prothrombin time.

Preparation

The doctor should check to see if the patient is taking any medications that may affect test results. This precaution is particularly important if the patient is taking warfarin, because there are a number of medications that can interact with warfarin to increase or decrease the PT time.

Aftercare

Aftercare consists of routine care of the area around the puncture mark. Pressure is applied for a few seconds and the wound is covered with a bandage.

Risks

The primary risk is mild **dizziness** and the possibility of a bruise or swelling in the area where the blood was drawn. The patient can apply moist warm compresses.

Normal results

The normal prothrombin time is 11–15 seconds, although there is some variation depending on the source of the thromboplastin used in the test. (For this reason, laboratories report a normal control value along with patient results.) A prothrombin time within this range indicates that the patient has normal amounts of clotting factors VII and X.

Abnormal results

A prolonged PT time is considered abnormal. The prothrombin time will be prolonged if the concentration of any of the tested factors is 10% or more below normal plasma values. A prolonged prothrombin time indicates a deficiency in any of factors VII, X, V, prothrombin, or fibrinogen. It may mean that the patient has a **vitamin K deficiency**, a **liver disease**, or disseminated intravascular coagulation (DIC). The prothrombin time of patients receiving warfarin therapy will also be prolonged—usually in the range

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of one and one half to two times the normal PT time. A PT time that exceeds approximately two and a half times the control value (usually 30 seconds or longer) is grounds for concern, as abnormal bleeding may occur.

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John T. Lohr, PhD

Proton pump inhibitors

Definition

Proton pump inhibitors are drugs that reduce the secretion of acid in the stomach by temporarily disabling an enzyme, sometimes referred to as the proton pump, in parietal cells of the stomach wall that produces acid.

Purpose

These drugs are approved for short-term use (4–8 weeks) in treating the excessive production of stomach acid in peptic ulcer disease, gastroesophageal reflux (GERD), and Zollinger-Ellison Syndrome.

Proton pump inhibitors are also approved for longer-term use in conditions where there are abnormally high secretions of stomach acid, and as part of a multi-drug treatment program for reducing the recurrence of duodenal ulcers.

Proton pump inhibitors may be used to protect the stomach against ulcers in patients who regularly take **nonsteroidal anti-inflammatory drugs** or who take corticosteroid drugs long term.

Description

The class of proton pump inhibitors includes esomeprazole (Nexium), lansoprazole (Prevacid), omeprazole (Prilosec), pantoprazole (Protonix), and rabeprazole (Aciphex).

The drugs are usually formulated to be absorbed in the intestine after leaving the stomach. They do not provide immediate relief from symptoms of stomach distress or reflux (**heartburn**), and are not suitable alternatives to prompt-acting **antacids**.

Proton pump inhibitors disable the acid-producing enzyme and reduce acid production for 24 hours.

Recommended dosage

Doses of these drugs may vary, depending on conditions being treated.

Commonly prescribed doses include:

- Esomeprazole: 20 to 40 mg once a day
- Lansoprazole: 15 to 30 mg once a day
- Omeprazole: 20 to 40 mg once a day
- Pantoprazole: 40 mg once or twice a day
- Rabeprazole: 20 mg once a day

Lower doses are usually adequate for treating gastroesophageal reflux (GERD)

Higher doses for longer durations of time are sometimes required for treating chronic peptic ulcers or other conditions where there are abnormally high amounts of acid produced.

Precautions

Proton pump inhibitors should not be used in patients who have severe **liver disease**.

Though their effects in fetuses and nursing babies have not been thoroughly studied, these drugs cross the placenta and pass into breast milk. They should be used in **pregnancy** only when their value outweighs potential risks.

These drugs may increase the risk of intestinal bacterial infections.

Proton pump inhibitors may relieve the symptoms and mask the presence of **stomach cancer**.

People should not use the proton pump inhibitors that are available without prescription for more than two weeks without consulting a physician.

Treatment programs using these drugs should not be repeated more often than every four months.

Side effects

Adverse effects from these drugs include appetite changes, abdominal **pain**, **constipation**, **diarrhea**, **dizziness**, **headache**, and skin rash.

Interactions

Proton pump inhibitors interfere with and reduce the effects of clopidogrel (Plavix), taken to reduce the recurrence of heart attacks.

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KEY TERMS

Antacids—Substances that counteract or neutralize acidity. They act promptly and have short durations of actions.

GERD—A condition where gastric acid refluxes or regurgitates into the esophagus, causing heartburn and acid indigestion. Over time, this can injure the esophageal lining and may lead to cancer.

Parietal cells—Cells of the gastric glands in the stomach lining that secrete hydrochloric acid.

Recurrent ulcer—Peptic ulcers that flare up after healing. They may be caused a *helicobacter pylori* bacterial infection and are treated with a combination of antibiotics and gastric acid–reducing medications, like proton pump inhibitors.

Proton pump inhibitors may reduce the effectiveness of atazanavir (Ratataz) and indinavir (Crixivan), **antiretroviral drugs** used to treat **AIDS**.

By reducing the amount of acid in the stomach, this class of drugs may reduce the effectiveness of antifungal drugs like itraconazole (Sporonox) or ketoconazole (Nizoral).

Lansoprazole (Prevacid) may increase the likelihood of adverse effects from taking the antibiotic clarithromycin (Biaxin).

St John's Wort may reduce the effectiveness of omeprazole (Prilosec).

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International Foundation for Functional Gastrointestinal Disorders, P.O. Box 17864, Milwaukee, WI, 53217-8076, (414) 964-1799, (414) 964-7176, (888) 964-2001, iffd @iffgd.org, http://www.iffgd.org.

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Provenge (sipuleucel-T)

Definition

Provenge (sipuleucel-T) is the first drug to be developed and approved in a new class of drugs called autologous cellular immunotherapies.

Purpose

Sipuleucel-T was approved by the U.S. Food and Drug Administration (FDA) in 2010 for the treatment of advanced **prostate cancer** in men whose **cancer** is not yet causing symptoms and for men whose prostate cancer has metastasized and is causing minimal symptoms but has been resistant to treatment with hormonal therapies designed to treat prostate cancer.

Description

The exact mechanism of action of sipuleucel-T is not yet known. Sipuleucel-T works by harnessing the actions of the patient's own immune cells to target and treat that patient's biologically unique prostate cancer. Each dose of the drug is designed specifically for an individual patient using the process of leukapheresis, which is scheduled three days prior to a scheduled treatment with Provenge. In leukapheresis, a cell collection process, some of the patient's own immune cells are collected. The collected cells are then packaged, labeled, and shipped to a drug manufacturing facility. Once at the facility, the patient's cells are placed in a culture with a human recombinant protein. This protein works to activate the patient's immune cells to function specifically as a prostate-associated antigen whose purpose is to trigger the patient's own immune system to recognize and kill prostate cancer cells. Another purpose of the end product is to stimulate the immune system. Once the process is completed at the drug manufacturing facility, the

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activated cells are shipped back to a treatment center and are reinfused into the patient from whom they were originally collected. The patient's immune system is then activated to destroy prostate cancer cells.

Biologically active components of Provenge include autologous presenting cells (APCs) and remnants of a recombinant human protein designated as PAP–GM–CSF. PAP–GM–CSF consists of prostatic acid phosphatase (PAP), an antigen expressed by prostate cancer tissue, which is then combined with granulocyte-macrophage colony-stimulating factor (GM–CSF). GM–CSF stimulates immune cells to activate. In addition to the components derived from the recombinant human protein, the precise cellular composition of Provenge varies depending on the exact composition of the cells obtained from the patient during leukapheresis. The resulting product will likely contain immune cells such as T cells, B cells, natural killer cells and other cells, in addition to the autologous APCs.

Each dose of the drug is placed in suspension in 250 milliliters of Ringer's Lactate solution in a sealed infusion bag that is to be administered intravenously to one specific patient. No additives or preservatives are added to the solution during the manufacturing process.

The completed product can not be administered to any patient other than the original patient whose immune cells were collected during the leukapheresis process.

Recommended dosage

According to the manufacturer, each dose of Provenge contains a mimimum of 50 million CD54+ cells that have been activated by human recombinant protein technology. The exact number of cells present in each dose varies. CD54 is a molecule on the surface of cells and is considered to be a marker of immune cell activity.

Administration of Provenge occurs in a three-dose schedule at intervals spaced about every two weeks. The drug is administered intravenously over a period of about an hour. No further treatment with Provenge is required after the initial three doses.

Precautions

This drug is not to be administered to patients other than the patient from whom immune cells were collected during leukapheresis. The identity of the patient receiving Provenge must match the patient identifying information on the infusion bag.

KEY TERMS

Antigen—A substance such as bacteria, enzymes, or other toxins that causes the body's immune system to react by stimulating production of antibodies.

Autologous—Derived from the same individual's body.

Immunotherapy—Therapy that stimulates, enhances, or suppresses the body's immune response; includes products such as monoclonal antibodies, vaccines, and growth factors.

Recombinant protein—A manipulated or modified form of a protein that results in the ability to produce the modified protein on a large scale.

A cell filter must not be used during infusion of Provenge.

Prior to infusion, the patient should be premedicated with oral **acetaminophen** and an antihistamine such as diphenhydramine. The infusion time may have to be slowed or stopped if severe infusion reactions occur during administration of this product.

The product has not been tested for infectious diseases that can be transmitted to others. Therefore, any infectious diseases that are present may be transmitted to health care workers during product handling or administration. Universal precautions should be adhered to by health care workers when handling this product.

If a patient is unable to receive a scheduled dose of Provenge, the patient will be required to undergo an additional leukapheresis procedure if treatment is to be continued. Patients should be informed of this possibility prior to the beginning of the treatment process.

Side effects

In clinical trials, the most common adverse reactions associated with Provenge administration included chills, **fever**, **fatigue**, back **pain**, **nausea**, pain in the joints, and **headache**. Some patients may experience acute and severe infusion reactions during administration of Provenge. Should these occur, the infusion may be slowed or stopped depending on the severity of the reaction. Severe reactions may occur after the administration is complete and typically occur within one day of drug administration.

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Interactions

The concurrent use of **chemotherapy** and other medications that have the potential to suppress the immune system with Provenge has not been studied. The use of immunosuppressive drugs concurrently with the use of Provenge may result in decreased effectiveness of Provenge. Patients on immunosuppressive drugs such as **corticosteroids** may be required to reduce or discontinue the use of these drugs during therapy with Provenge.

Resources

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Melinda Granger Oberleitner
RN, DNS, APRN, CNS

Pruritus *see* **Itching**

PSA test *see* **Prostate-specific antigen test**

Pseudoephedrine *see* **Decongestants**

Pseudogout

Definition

Pseudogout is a form of arthritis that causes **pain**, redness, and inflammation in one or more joints.

Description

Pseudogout is also known by another name: **calcium** pyrophosphate dihydrate deposition disease (CPPD), the basis of which is derived from the calcium deposits that collect in the joint. The deposits or crystals, as they are sometimes called, cause pain and inflammation in the joint. According to the Arthritis Foundation, this can eventually weaken the cartilage, which serves as padding between the bones, "allowing bone to rub against bone." Pseudogout typically affects the large joints, such as the knees, wrists, and ankles. In general, it occurs with equal frequency in men and women.

Most often seen in older adults, pseudogout can also affect younger patients, especially those with diseases that put them at a greater risk of developing it, such as **hemochromatosis**, **hypercalcemia**, **hypothyroidism**, ochronosis, or Wilson's disease. Some people, according to an article for the American College of Rheumatology, experience attacks of pseudogout "following joint surgery or other surgery. Because many older people have calcium crystal deposits in their joints, any kind of insult to the joint can trigger the release of the calcium crystals, which then induce a painful inflammatory response." Pseudogout affects about 3% of elderly people. Not all will experience severe attacks. By their 90s, 50% of people will have joint deposits. Although researchers have noticed that some people with pseudogout also have a family history of the disease, it is not clear what role genetics might play in its development.

Causes and symptoms

As the Arthritis Foundation points out, it is unclear what causes the crystals to form, but some speculation exists that "an abnormality in the cartilage cells or connective tissue could be responsible" for their development. Acute pain and fluid accumulation that leads to joint swelling are typical symptoms of pseudogout. When the crystals move into a joint, the Arthritis Foundation categorizes the pain as "sudden and severe." Many patients report that joint motion is limited. In 50% of the cases, the patient will run a **fever**. Half of all the acute pseudogout attacks will involve a knee. The experts at MedlinePlus identify "chronic (long term) arthritis" as a symptom that can be present at the time of an acute pseudogout attack. The word "acute" implies short term; therefore, acute attacks of pseudogout will come and go, but chronic arthritis may remain. In addition, progressive degenerative arthritis is sometimes seen in numerous joints.

Diagnosis

Pseudogout and **gout** have similar symptoms, which can be confusing. However, uric acid is associated with gout, whereas calcium pyrophosphate crystals are associated with pseudogout. After a patient's detailed medical history is obtained, a diagnosis can be made based on the symptoms and medical tests.

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Using a needle, the physician can take a sample of the synovial fluid from the swollen or painful joint to ascertain the presence of calcium pyrophosphate crystals. The fluid will also contain white blood cells, which can be counted to assist in the diagnosis. Synovial fluid is the lubricating fluid that's secreted by the membranes that line the joints.

X rays may also be taken to confirm the presence of crystals. The x rays may show joint damage or that crystals have led to a condition called chondrocalcinosis, which is calcification of the cartilage. Other possible causes such as gout, **rheumatoid arthritis**, or infection must be ruled out. Blood tests can also help to confirm the diagnosis.

KEY TERMS

Hemochromatosis—A condition where the body absorbs too much iron.

Hypercalcemia—A condition where the bones absorb too much calcium.

Hypothyroidism—A disease of the thyroid caused by an underactive thyroid gland.

Ochronosis—A rare hereditary condition that usually leads to arthritis in adulthood.

Wilson's disease—Wilson's disease causes the body to retain copper, which ultimately can lead to liver damage.

Treatment

There are a variety of treatment options. If patients have an adequate support system, such as family and friends willing to help, it makes it easier for patients to recover faster. Patients are often advised to avoid putting pressure on the affected joint. In some cases, it is appropriate for the patient to engage in special isometric exercises designed to help their specific condition heal faster. Once the inflammation and pain subsides, exercises are sometimes suggested to regain range of motion.

Medications can be prescribed to ease the pain, typically **nonsteroidal anti-inflammatory drugs** (NSAIDS). Ibuprofen (Motrin) and naproxen (Aleve) are two NSAIDs that are used often, as they are generally well tolerated and highly effective. Patients with kidney problems, stomach ulcers, or those on blood thinners may not be able to take NSAIDs. Indomethacin (Indocin) may be prescribed for those patients.

When no infection is present, **steroids**, such as prednisone, may be prescribed. Much of the literature discussing treatment options also suggests a medication called colchicine, which is only available as a generic. It is generally prescribed in low doses and should not be used by anyone with significant bone marrow dysfunction or renal insufficiency. Patients should talk with their physicians regarding any other reasons why colchicine may not be suitable for them.

In order to relieve some of the pressure, the excess fluid around the joint can be removed (aspirated) with a needle.

Anti-inflammatory treatments help slow joint degeneration, a consequence of untreated pseudogout. If joint degeneration does occur, surgery is available to replace or repair damaged joints; however, it is better for patients to engage in preventative measures that will help them avoid the need for surgery.

Prognosis

With regard to an acute attack of pseudogout, the prognosis is usually very good. The symptoms usually go away within two weeks. However, over time, joint degeneration may occur.

Prevention

There are no specific techniques applicable to every patient to prevent the formulation of the crystals; however, some patients with certain diseases are at greater risk of developing them. Diagnoses and treatment of underlying disorders is one of the most important aspects of managing crystal-induced arthopathies. Once a causative crystal is identified and a diagnosis has been established, a long-term management plan can be devised.

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Lee Ann Paradise

Pseudohermaphroditism *see* **Intersex states**

Pseudomembraneous enterocolitis *see* **Antibiotic-associated colitis**

Pseudomonas aeruginosa infection *see* **Pseudomonas infections**

Pseudomonas infections

Definition

A pseudomonas infection is caused by a bacterium, *Pseudomonas aeruginosa*, and may affect any part of the body. In most cases, however, pseudomonas infections strike only persons who are very ill, usually those who are hospitalized.

Description

P. aeruginosa is a rod-shaped organism that can be found in soil, water, plants, and animals. Because it rarely causes disease in healthy persons, but infects those who are already sick or who have weakened immune systems, it is called an opportunistic pathogen. Opportunistic pathogens are organisms that do not ordinarily cause disease, but multiply freely in persons whose immune systems are weakened by illness or medication. Such persons are said to be immunocompromised. Patients with **AIDS** have an increased risk of developing serious pseudomonas infections. Hospitalized patients are another high-risk group, because *P. aeruginosa* is often found in hospitals. Infections that can be acquired in the hospital are sometimes called nosocomial diseases.

Of the two million nosocomial infections each year, 10% are caused by *P. aeruginosa*. The bacterium is the second most common cause of nosocomial **pneumonia** and the most common cause of intensive care unit (ICU) pneumonia. Pseudomonas infections can be spread within hospitals by health care workers, medical equipment, sinks, disinfectant solutions, and food. These infections are a very serious problem in hospitals for two reasons. First, patients who are critically ill can die from a pseudomonas infection. Second, many *Pseudomonas* bacteria are resistant to certain **antibiotics**, which makes them difficult to treat.

P. aeruginosa is able to infect many different parts of the body. Several factors make it a strong opponent. These factors include:

- the ability to stick to cells
- minimal food requirements
- resistance to many antibiotics
- production of proteins that damage tissue
- a protective outer coat

Infections that can occur in specific body sites include:

- Heart and blood. *P. aeruginosa* is the fourth most common cause of bacterial infections of the blood (bacteremia). Bacteremia is common in patients with blood cancer and patients who have pseudomonas infections elsewhere in the body. *P. aeruginosa* infects the heart valves of intravenous drug abusers and persons with artificial heart valves.
- Bones and joints. Pseudomonas infections in these parts of the body can result from injury, the spread of infection from other body tissues, or bacteremia. Persons at risk for pseudomonas infections of the bones and joints include diabetics, intravenous drug abusers, and bone surgery patients.
- Central nervous system. *P. aeruginosa* can cause inflammation of the tissues covering the brain and spinal cord (meningitis) and brain abscesses. These infections may result from brain injury or surgery, the spread of infection from other parts of the body, or bacteremia.
- Eye and ear. *P. aeruginosa* can cause infections in the external ear canal—so-called "swimmer's ear"—that usually disappear without treatment. The bacterium can cause a more serious ear infection in elderly patients, possibly leading to hearing problems, facial paralysis, or even death. Pseudomonas infections of the eye usually follow an injury. They can cause ulcers of the cornea that may cause rapid tissue destruction and eventual blindness. Risk factors for pseudomonas eye infections include wearing soft extended-wear contact lenses, using topical corticosteroid eye medications, being in a coma, having extensive burns, undergoing treatment in an ICU, and having a tracheostomy or endotracheal tube.
- Urinary tract. Urinary tract infections can be caused by catheterization, medical instruments, and surgery.
- Lung. Risk factors for *P. aeruginosa* pneumonia include cystic fibrosis, chronic lung disease, immunocompromised condition, being on antibiotic

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therapy or a respirator, and congestive heart failure. Patients with cystic fibrosis often develop pseudomonas infections as children and suffer recurrent attacks of pneumonia.

- Skin and soft tissue. Even healthy persons can develop a pseudomonas skin rash following exposure to the bacterium in contaminated hot tubs, water parks, whirlpools, or spas. This skin disorder is called pseudomonas or "hot tub" folliculitis, and is often confused with chickenpox. Severe skin infection may occur in patients with *P. aeruginosa* bacteremia. The bacterium is the second most common cause of burn wound infections in hospitalized patients.

Causes and symptoms

P. aeruginosa can be sudden and severe, or slow in onset and cause little **pain**. Risk factors for acquiring a pseudomonas infection include having a serious illness, being hospitalized, undergoing an invasive procedure such as surgery, having a weakened immune system, and being treated with antibiotics that kill many different kinds of bacteria (broad-spectrum antibiotics).

Each of the infections listed above has its own set of symptoms. *Pseudomonas* **bacteremia** resembles other bacteremias, producing **fever**, tiredness, muscle pains, joint pains, and chills. Bone infections are marked by swelling, redness, and pain at the infected site and possibly fever. *Pseudomonas* **meningitis** causes fever, **headache**, irritability, and clouded consciousness. Ear infection is associated with pain, ear drainage, facial **paralysis**, and reduced hearing. Pseudomonas infections of the eye cause ulcers that may spread to cover the entire eye, pain, reduced vision, swelling of the eyelids, and pus accumulation within the eye.

P. aeruginosa pneumonia is marked by chills, fever, productive **cough**, difficult breathing, and blue-tinted skin. Patients with **cystic fibrosis** with pseudomonas lung infections experience coughing, decreased appetite, weight loss, tiredness, **wheezing**, rapid breathing, fever, blue-tinted skin, and abdominal enlargement. Skin infections can cause a range of symptoms from a mild rash to large bleeding ulcers. Symptoms of pseudomonas **folliculitis** include a red itchy rash; headache; **dizziness**; earache; sore eyes, nose, and throat; breast tenderness; and stomach pain. Pseudomonas wound infections may secrete a blue-green colored fluid and have a fruity smell. Burn wound infections usually occur one to two weeks after the burn and cause discoloration of the burn scab, destruction of the tissue below the scab, early scab loss, bleeding, swelling, and a blue-green drainage.

Diagnosis

Diagnosis and treatment of pseudomonas infections can be performed by specialists in **infectious disease**. Because *P. aeruginosa* is commonly found in hospitals, many patients carry the bacterium without having a full-blown infection. Consequently, the mere presence of *P. aeruginosa* in patients does not constitute a diagnostic finding. Cultures, however, can be easily done for test purposes. The organism grows readily in laboratory media; results are usually available in two to three days. Depending on the location of the infection, body fluids that can be tested for *P. aeruginosa* include blood, urine, cerebrospinal fluid, sputum, pus, and drainage from an infected ear or eye. X rays and other imaging techniques can be used to assess infections in deep organ tissues.

Treatment

Medications

Because *P. aeruginosa* is commonly resistant to antibiotics, infections are usually treated with two antibiotics at once. Pseudomonas infections may be treated with combinations of ceftazidime (Ceftaz, Fortraz, Tazicef), ciprofloxacin (Cipro), imipenem (Primaxin), gentamicin (Garamycin), tobramycin (Nebcin), ticarcillin-clavulanate (Timentin), or piperacillin-tazobactam (Zosyn). Most antibiotics are administered intravenously or orally for two to six weeks. Treatment of an eye infection requires local application of antibiotic drops.

Surgery

Surgical treatment of pseudomonas infections is sometimes necessary to remove infected and damaged tissue. Surgery may be required for brain abscesses, eye infections, bone and joint infections, ear infections, heart infections, and wound infections. Infected **wounds** and **burns** may cause permanent damage requiring arm or leg **amputation**.

Prognosis

Most pseudomonas infections can be successfully treated with antibiotics and surgery. In immunocompromised persons, however, *P. aeruginosa* infections have a high mortality rate, particularly following

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KEY TERMS

Bacteremia—Bacterial infection of the blood.

"Hot tub" folliculitis—A skin infection caused by *P. aeruginosa* that often follows bathing in a hot tub or public swimming pool.

Immunocompromised—Having a weak immune system due to disease or the use of certain medications.

Nosocomial infection—An infection that is acquired in the hospital.

Opportunistic—Causing disease only under certain conditions, as when a person is already sick or has a weak immune system.

Pathogen—Any microorganism that produces disease.

bacteremia or infections of the lower lung. Mortality rates range from 15% to 20% of patients with severe ear infections to 89% of patients with infections of the left side of the heart.

Prevention

Most hospitals have programs for the prevention of nosocomial infections. Patients with cystic fibrosis may be given periodic doses of antibiotics to prevent episodes of pseudomonas pneumonia.

Minor skin infections can be prevented by avoiding hot tubs with cloudy water; avoiding public swimming pools at the end of the day; removing wet swimsuits as soon as possible; bathing after sharing a hot tub or using a public pool; cleaning hot tub filters every six weeks; and using appropriate amounts of chlorine in the water.

Resources

OTHER

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Belinda Rowland, PhD

Pseudomonas pseudomallei infection *see* **Melioidosis**

Pseudostrabismus *see* **Strabismus**

Pseudotuberculosis *see* **Sarcoidosis**

Pseudoxanthoma elasticum

Definition

Pseudoxanthoma elascticum (PXE) is an inherited connective tissue disorder in which the elastic fibers present in the skin, eyes, and cardiovascular system gradually become calcified and inelastic.

Description

PXE was first reported in 1881 by Rigal, but the defect in elastic fibers was described in 1986 by Darier, who gave the condition its name. PXE is also known as Grönblad-Strandberg-Touraine syndrome and systemic elastorrhexis.

The course of PXE varies greatly between individuals. Typically it is first noticed during adolescence as yellow-orange bumps on the side of the neck. Similar bumps may appear at other places where the skin bends a lot, like the backs of the knees and the insides of the elbows. The skin in these areas tends to get thick, leathery, inelastic, and acquire extra folds. These skin problems have no serious consequences, and for some people, the disease progresses no further.

Bruch's membrane, a layer of elastic fibers in front of the retina, becomes calcified in some people with PXE. Calcification causes cracks in Bruch's membrane, which can be seen through an ophthalmoscope as red, brown, or gray streaks called angioid streaks. The cracks can eventually (in 10–20 years) cause bleeding, and the usual resultant scarring leads to central vision deterioration. However, peripheral vision is unaffected.

Arterial walls and heart valves contain elastic fibers that can become calcified. This leads to a greater susceptibility to the conditions that are associated with hardening of the arteries in the normal **aging** population—high blood pressure, **heart attack**, **stroke**, and arterial obstruction—and, similarly, **mitral valve prolapse**. Heart disease and **hypertension** associated with PXE have been reported in children as young as 4 to 13 years of age. Although often appearing at a younger age, the overall incidence of these conditions is only slightly higher for people with PXE than it is in the general population.

Arterial inelasticity can lead to bleeding from the gastrointestinal tract and, rarely, acute **vomiting** of blood.

PXE is rare and occurs in about 1 in every 160,000 people in the general population. It is likely, though, that PXE is underdiagnosed, because of the presence

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of mild symptoms in some affected persons and the lack of awareness of the condition among primary care physicians.

Causes and symptoms

PXE is caused by changes in the genetic material, called mutations, that are inherited in either a dominant or recessive mode. A person with the recessive form of the disease (which is most common) must possess two copies of the PXE gene to be affected, and, therefore, must have received one from each parent. In the dominant form, one copy of the defective gene is sufficient to cause the disease. In some cases, a person with the dominant form inherits the abnormal gene from a parent with PXE. More commonly, the mutation arises as a spontaneous change in the genetic material of the affected person. These cases are called "sporadic" and do not affect parents or siblings, although each child of a person with sporadic PXE has a 50% risk to inherit the condition.

Both males and females develop PXE, although the skin findings seem to be somewhat more common in females.

The actual genetic causes of this condition were not discovered until 2000. The recessive, dominant, and sporadic forms of PXE all appear to be caused by different mutations or deletions in a single gene called ABCC6 (also known as MRP6), located on chromosome 16. Although the responsible gene has been identified, how it causes PXE is still unknown.

Genetic researchers have since identified mutations in a number of persons with PXE, most of whom have been found to have the recessive type. Affected individuals in these families had mutations in both copies of the gene and parents, who are obligate carriers, had a mutation in only one copy. Contrary to the usual lack of symptoms in carriers of recessive genes, some carriers of recessive PXE have been found to have cardiovascular symptoms typical of PXE.

Although the recessive type is the most common, there are also familial and sporadic cases that have been found to be caused by dominant mutations in the ABCC6 gene.

A wide range in the type and severity of symptoms exists between people with PXE. The age of onset also varies, although most people notice initial symptoms during adolescence or early adulthood. Often, the first symptoms to appear are thickened skin with yellow bumps in localized areas such as the folds of the groin, arms, knees, and armpits. These changes can also occur in the mucous membranes, most often in the inner portion of the lower lip. The appearance of the skin in PXE has been likened to a plucked chicken or Moroccan leather.

Angioid streaks in front of the retina are present in most people with PXE and an ophthalmologic examination can be used as an initial screen for the condition. Persons with PXE often complain of sensitivity to light. Because of the progressive breakdown of Bruch's membrane, affected persons are at increased risk for bleeding and scarring of the retina, which can lead to decreased central vision but does not usually cause complete blindness.

Calcium deposits in the artery walls contribute to early-onset **atherosclerosis**, and another condition called claudication, inadequate blood flow that results in **pain** in the legs after exertion. Abnormal bleeding, caused by calcification of the inner layer of the arteries, can occur in the brain, retina, uterus, bladder, and joints, but is most common in the gastrointestinal tract.

Diagnosis

The presence of calcium in elastic fibers, as revealed by microscopic examination of biopsied skin, unequivocally establishes the diagnosis of PXE.

Treatment

PXE cannot be cured, but **plastic surgery** can treat PXE **skin lesions**, and **laser surgery** is used to prevent or slow the progression of vision loss. Excessive blood loss due to bleeding into the gastrointestinal tract or other organ systems may be treated by **transfusion**. Mitral valve prolapse (protrusion of one or both cusps of the mitral heart valve back into the atrium during heart beating) can be corrected by surgery, if necessary.

Measures should be taken to prevent or lessen cardiovascular complications. People with PXE should control their cholesterol and blood pressure and maintain normal weight. They should **exercise** for cardiovascular health and to prevent or reduce claudication later in life. They should also avoid the use of tobacco, thiazide **antihypertensive drugs**, blood thinners like Coumadin, and **nonsteroidal anti-inflammatory drugs** like **aspirin** and ibuprofen. In addition, they should avoid strain, heavy lifting, and contact sports, since these activities could trigger retinal and gastrointestinal bleeding.

People with PXE should have regular eye examinations by an ophthalmologist and report any eye problems immediately. Regular checkups with a

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KEY TERMS

Angioid streaks—Gray, orange, or red wavy branching lines in Bruch's membrane.

Bruch's membrane—A membrane in the eye between the choroid membrane and the retina.

Carrier—A person who possesses a gene for an abnormal trait without showing signs of the disorder. The person may pass the abnormal gene on to offspring.

Claudication—Pain in the lower legs after exercise caused by insufficient blood supply.

Connective tissue—A group of tissues responsible for support throughout the body; includes cartilage, bone, fat, tissue underlying skin, and tissues that support organs, blood vessels, and nerves throughout the body.

Deletion—The absence of genetic material that is normally found in a chromosome. Often, the genetic material is missing due to an error in replication of an egg or sperm cell.

Dominant trait—A genetic trait in which one copy of the gene is sufficient to yield an outward display of the trait. Dominant genes mask the presence of recessive genes and can be inherited from a single parent.

Elastic fiber—Fibrous, stretchable connective tissue made primarily from proteins, elastin, collagen, and fibrillin.

Gene—A building block of inheritance, which contains the instructions for the production of a particular protein and is made up of a molecular sequence found on a section of DNA. Each gene is found on a precise location on a chromosome.

Mitral valve—The heart valve that prevents blood from flowing backwards from the left ventricle into the left atrium. Also known as bicuspid valve.

Mutation—A permanent change in the genetic material that may alter a trait or characteristic of an individual, or manifest as disease, and can be transmitted to offspring.

Recessive trait—An inherited trait or characteristic that is outwardly obvious only when two copies of the gene for that trait are present.

physician are also recommended, including periodic blood pressure readings.

Some people have advocated a calcium-restricted diet, but it is not yet known whether this aids the problems brought about by PXE. It is known, however, that calcium-restriction can lead to bone disorders.

Prognosis

The prognosis for PXE is a normal life span with an increased chance of cardiovascular and circulatory problems, hypertension, gastrointestinal bleeding, and impaired vision. However, now that the gene for PXE has been identified, the groundwork for research to provide effective treatment has been laid. Studying the role of the ABCC6 protein in elastic fibers may lead to drugs that will ameliorate or arrest the problems caused by PXE.

Genetic tests are now available that can provide knowledge needed to both diagnose PXE in symptomatic persons and predict it prior to the onset of symptoms in persons at risk. Prenatal diagnosis of PXE, by testing fetal cells for mutations in the ABCC6 gene, can be done in early **pregnancy** by procedures such as **amniocentesis** or **chorionic villus sampling**. For most people, PXE is compatible with a reasonably normal life, and prenatal diagnosis is not likely to be highly desired.

Genetic testing to predict whether an at-risk child will develop PXE may be helpful for medical management. A child who is found to carry a mutation can be monitored more closely for eye problems and bleeding, and can begin the appropriate lifestyle changes to prevent cardiovascular problems.

ORGANIZATIONS

National Association for Pseudoxanthoma Elasticum, 8760 Manchester Road, St. Louis, MO, 63144-2724, (314) 962-0100, napestlouis@sbcglobal.net, http://www.pxenape.org.

PXE International, 4301 Connecticut Ave, NW, Suite 404, Washington, DC, 20008-2369, (202) 362-9599, (202) 966-8553, info@pxe.org, http://www.pxe.org.

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Psittacosis *see* **Parrot fever**

Psoas abscess *see* **Abscess**

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Psoriasis

Definition

Named for the Greek word *psōra* meaning "itch," psoriasis is a chronic, non-contagious disease characterized by inflamed lesions covered with silvery-white scabs of dead skin.

Demographics

Psoriasis, which affects at least four million Americans, is slightly more common in women than in men. Although the disease can develop at any time, 10%–15% of all cases are diagnosed in children under 10, and the average age at the onset of symptoms is 28. Psoriasis is most common in fair-skinned people and extremely rare in dark-skinned individuals.

Description

Normal skin cells mature and replace dead skin every 28–30 days. Psoriasis causes skin cells to mature in less than a week. Because the body can't shed old skin as rapidly as new cells are rising to the surface, raised patches of dead skin develop on the arms, back, chest, elbows, legs, nails, folds between the buttocks, and scalp.

Psoriasis is considered mild if it affects less than 5% of the surface of the body, moderate if 5%–30% of the skin is involved, and severe if the disease affects more than 30% of the body surface.

Types of psoriasis

Dermatologists distinguish different forms of psoriasis according to what part of the body is affected, how severe symptoms are, how long they last, and the pattern formed by the scales.

Psoriasis, a chronic skin disorder, may appear on any area of the body, including the elbow, as shown above. *(© Scott Camazine/Photo Researchers, Inc.)*

PLAQUE PSORIASIS. Plaque psoriasis (psoriasis vulgaris), the most common form of the disease, is characterized by small, red bumps that enlarge, become inflamed, and form scales. The top scales flake off easily and often, but those beneath the surface of the skin clump together. Removing these scales exposes tender skin, which bleeds and causes the plaques (inflamed patches) to grow.

Plaque psoriasis can develop on any part of the body, but most often occurs on the elbows, knees, scalp, and trunk.

SCALP PSORIASIS. At least 50 of every 100 people who have any form of psoriasis have scalp psoriasis. This form of the disease is characterized by scale-capped plaques on the surface of the skull.

NAIL PSORIASIS. The first sign of nail psoriasis is usually pitting of the fingernails or toenails. Size, shape, and depth of the marks vary, and affected nails may thicken, yellow, or crumble. The skin around an affected nail is sometimes inflamed, and the nail may peel away from the nail bed.

GUTTATE PSORIASIS. Named for the Latin word *gutta,* which means "a drop," guttate psoriasis is characterized by small, red, drop-like dots that enlarge rapidly and may be somewhat scaly. Often found on the arms, legs, and trunk and sometimes in the scalp, guttate psoriasis can clear up without treatment or disappear and resurface in the form of plaque psoriasis.

PUSTULAR PSORIASIS. Pustular psoriasis usually occurs in adults. It is characterized by blister-like lesions filled with non-infectious pus and surrounded by reddened skin. Pustular psoriasis, which can be limited to one part of the body (localized) or can be widespread, may be the first symptom of psoriasis or develop in a patient with chronic plaque psoriasis.

Generalized pustular psoriasis is also known as Von Zumbusch pustular psoriasis. Widespread, acutely painful patches of inflamed skin develop suddenly. Pustules appear within a few hours, then dry and peel within two days.

Generalized pustular psoriasis can make life-threatening demands on the heart and kidneys.

Palomar-plantar pustulosis (PPP) generally appears between the ages of 20 and 60. PPP causes large pustules to form at the base of the thumb or on the sides of the heel. In time, the pustules turn brown and peel. The disease usually becomes much less active for a while after peeling.

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Acrodermatitis continua of Hallopeau is a form of PPP characterized by painful, often disabling, lesions on the fingertips or the tips of the toes. The nails may become deformed, and the disease can damage bone in the affected area.

INVERSE PSORIASIS. Inverse psoriasis occurs in the armpits and groin, under the breasts, and in other areas where skin flexes or folds. This disease is characterized by smooth, inflamed lesions and can be debilitating.

ERYTHRODERMIC PSORIASIS. Characterized by severe scaling, **itching**, and **pain** that affects most of the body, erythrodermic psoriasis disrupts the body's chemical balance and can cause severe illness. This particularly inflammatory form of psoriasis can be the first sign of the disease, but often develops in patients with a history of plaque psoriasis.

PSORIATIC ARTHRITIS. About 10% of partients with psoriasis develop a complication called **psoriatic arthritis**. This type of arthritis can be slow to develop and mild, or it can develop rapidly. Symptoms of psoriatic arthritis include:

- joint discomfort, swelling, stiffness, or throbbing
- swelling in the toes and ankles
- pain in the digits, lower back, wrists, knees, and ankles
- eye inflammation or pink eye (conjunctivitis)

Causes and symptoms

The cause of psoriasis is unknown, but research suggests that an immune-system malfunction triggers the disease. Factors that increase the risk of developing psoriasis include:

- family history
- stress
- exposure to cold temperatures
- injury, illness, or infection
- steroids and other medications
- race

Trauma and certain bacteria may trigger psoriatic arthritis in patients with psoriasis.

Diagnosis

A complete medical history and examination of the skin, nails, and scalp are the basis for a diagnosis of psoriasis. In some cases, a microscopic examination of skin cells is also performed.

Blood tests can distinguish psoriatic arthritis from other types of arthritis. **Rheumatoid arthritis**, in particular, is diagnosed by the presence of a particular antibody present in the blood. That antibody is not present in the blood of patients with psoriatic arthritis.

KEY TERMS

Arthritis—An inflammation of joints.

Treatment

Age, general health, lifestyle, and the severity and location of symptoms influence the type of treatment used to reduce inflammation and decrease the rate at which new skin cells are produced. Because the course of this disease varies with each individual, doctors must experiment with or combine different treatments to find the most effective therapy for a particular patient.

Mild-moderate psoriasis

Steroid creams and ointments are commonly used to treat mild or moderate psoriasis, and **steroids** are sometimes injected into the skin of patients with a limited number of lesions. In mid-1997, the United States Food and Drug Administration (FDA) approved the use of tazarotene (Tazorac) to treat mild-to-moderate plaque psoriasis. This water-based gel has chemical properties similar to vitamin A.

Brief daily doses of natural sunlight can significantly relieve symptoms. **Sunburn** has the opposite effect.

Moisturizers and bath oils can loosen scales, soften skin, and may eliminate the itch. So can adding a cup of oatmeal to a tub of bath water. Salicylic acid (an ingredient in **aspirin**) can be used to remove dead skin or increase the effectiveness of other therapies.

Moderate psoriasis

Administered under medical supervision, ultraviolet light B (UVB) is used to control psoriasis that covers many areas of the body or that has not responded to topical preparations. Doctors combine UVB treatments with topical medications to treat some patients and sometimes prescribe home **phototherapy**, in which the patient administers his or her own UVB treatments.

Photochemotherapy (PUVA) is a medically supervised procedure that combines medication with exposure to ultraviolet light (UVA) to treat localized or widespread psoriasis. An individual with wide-

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spread psoriasis that has not responded to treatment may enroll in one of the day treatment programs conducted at special facilities throughout the United States. Psoriasis patients who participate in these intensive sessions are exposed to UVB and given other treatments for six to eight hours a day for two to four weeks.

Severe psoriasis

Methotrexate (MTX) can be given as a pill or as an injection to alleviate symptoms of severe psoriasis or psoriatic arthritis. Patients who take MTX must be carefully monitored to prevent liver damage.

Psoriatic arthritis can also be treated with **nonsteroidal anti-inflammatory drugs** (NSAIDs), like **acetaminophen** (Tylenol) or aspirin. Hot compresses and warm water soaks may also provide some relief for painful joints.

Other medications used to treat severe psoriasis include etrentinate (Tegison) and isotretinoin (Accutane), whose chemical properties are similar to those of vitamin A. Most effective in treating pustular or erythrodermic psoriasis, Tegison also relieves some symptoms of plaque psoriasis. Tegison can enhance the effectiveness of UVB or PUVA treatments and reduce the amount of exposure necessary.

Accutane is a less effective psoriasis treatment than Tegison, but both have similar side effects, including nosebleeds, inflammation of the eyes and lips, bone spurs, hair loss, and **birth defects**. Tegison is stored in the body for an unknown length of time and should not be taken by a woman who is pregnant or planning to become pregnant. A woman should use reliable birth control while taking Accutane and for at least one month before and after her course of treatment.

Cyclosporin emulsion (Neoral) is used to treat stubborn cases of severe psoriasis. Cyclosporin is also used to prevent rejection of transplanted organs, and Neoral, approved by the FDA in 1997, should be particularly beneficial to psoriasis patients who are young children or African Americans, or those who have diabetes.

Other conventional treatments for psoriasis include:

- Capsaicin (*Capsicum frutecens*), an ointment that can stop production of the chemical that causes the skin to become inflamed and halts the runaway production of new skin cells. Capsaicin is available without a prescription, but should be used under a doctor's supervision to prevent burns and skin damage.
- Hydrocortisone creams, topical ointments containing a form of vitamin D called calcitriol, and coal-tar shampoos and ointments can relieve symptoms. Hydrocortisone creams have been associated with such side effects as folliculitis (inflammation of the hair follicles), while coal-tar preparations have been associated with a heightened risk of skin cancer.

Alternative treatment

Nontraditional psoriasis treatments include:

- Soaking in warm water and German chamomile (*Matricaria recutita*) or bathing in warm salt water.
- Drinking as many as three cups a day of hot tea made with one or a combination of the following herbs: burdock (*Arctium lappa*) root, dandelion (*Taraxacum mongolicum*) root, Oregon grape (*Mahonia aquifolium*), sarsaparilla (*Smilax officinalis*), and balsam pear (*Momardica charantia*).
- Taking two 500-mg capsules of evening primrose oil (*Oenothera biennis*) a day. Pregnant women should not use evening primrose oil, and patients with liver disease or high cholesterol should use it only under a doctor's supervision.
- Eating a diet that includes plenty of fish, turkey, celery (for cleansing the kidneys), parsley, lettuce, lemons (for cleansing the liver), limes, fiber, and fruit and vegetable juices.
- Eating a diet that eliminates animal products high in saturated fats, since they promote inflammation.
- Drinking plenty of water (at least eight glasses) each day.
- Taking nutritional supplements including folic acid, lecithin, vitamin A (specific for the skin), vitamin E, selenium, and zinc.

Other helpful alternative approaches include identifying and eliminating food allergens from the diet, enhancing the fuction of the liver, augmenting the hydrochloric acid in the stomach, and completing a **detoxification** program. Constitutional homeopathic treatment, if properly prescribed, may also help resolve psoriasis.

Prognosis

Most cases of psoriasis can be controlled, and most people who have psoriasis can live normal lives.

Some people who have psoriasis are so self-conscious and embarrassed about their appearance that they become depressed and withdrawn. The Social Security Administration grants disability benefits to about 400 psoriasis patients each year, and a

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comparable number die from complications of the disease.

Prevention

A doctor should be notified if:

- psoriasis symptoms appear or reappear after treatment
- pustules erupt on the skin and the patient experiences fatigue, muscle aches, and fever
- unfamiliar, unexplained symptoms appear

Resources

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Rakel, R.E., and Bope, E.T. *Conn's Current Therapy*. 60th ed. Philadelphia: Saunders Elsevier, 2009.

ORGANIZATIONS

American Academy of Dermatology, 930 N. Meacham Road, P.O. Box 4014, Schaumburg, IL, 60168-4014, (847) 330-0230, (847) 330-0050, http://www.aad.org.

American Skin Association, Inc., 150 E. 58th St., 3rd floor, New York, NY, 10155-0002, (212) 688-6547, http://www.americanskin.org.

National Psoriasis Foundation, 6600 S.W. 92nd Ave., Suite 300, Portland, OR, 97223, (800) 723-9166, http://www.psoriasis.org.

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Psoriatic arthritis

Definition

Psoriatic arthritis is a form of arthritic joint disease associated with the chronic skin scaling and fingernail changes seen in **psoriasis**.

Description

Physicians recognize a number of different forms of psoriatic arthritis. In some patients, the arthritic symptoms will affect the small joints at the ends of the fingers and toes. In others, symptoms will affect joints on one side of the body but not on the other. In addition, there are patients whose larger joints on both sides of the body simultaneously become affected, as in **rheumatoid arthritis**. Some people with psoriatic arthritis experience arthritis symptoms in the back and spine; in rare cases, called psoriatic arthritis mutilans, the disease destroys the joints and bones, leaving patients with gnarled and club-like hands and feet. In many patients, symptoms of psoriasis precede the arthritis symptoms; a clue to possible joint disease is pitting and other changes in the fingernails.

Most people develop psoriatic arthritis at ages 35–45, but it has been observed earlier in adults and children. Both the skin and joint symptoms will come and go; there is no clear relationship between the severity of the psoriasis symptoms and arthritis **pain** at any given time. It is unclear how common psoriatic arthritis is. Recent surveys suggest that between one in five people and one in two people with psoriasis may also have some arthritis symptoms.

Causes and symptoms

The cause of psoriatic arthritis is unknown. As in psoriasis, genetic factors appear to be involved. People with psoriatic arthritis are more likely than others to have close relatives with the disease, but they are just as likely to have relatives with psoriasis but no joint disease. Researchers believe genes increasing the susceptibility to developing psoriasis may be located on chromosome 6p and chromosome 17, but the specific genetic abnormality has not been identified. Like psoriasis and other forms of arthritis, psoriatic arthritis also appears to be an autoimmune disorder, triggered by an attack of the body's own immune system on itself.

Symptoms of psoriatic arthritis include dry, scaly, silver patches of skin combined with joint pain and destructive changes in the feet, hands, knees, and spine. Tendon pain and nail deformities are other hallmarks of psoriatic arthritis.

Diagnosis

Skin and nail changes characteristic of psoriasis with accompanying arthritic symptoms are the hallmarks of psoriatic arthritis. A blood test for rheumatoid factor, antibodies that suggest the presence of rheumatoid arthritis, is negative in nearly all patients with psoriatic arthritis. X rays may show characteristic damage to the larger joints on either side of the body, as well as fusion of the joints at the ends of the fingers and toes.

Treatment

Treatment for psoriatic arthritis is meant to control the **skin lesions** of psoriasis and the joint

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KEY TERMS

Psoriasis—A common recurring skin disease that is marked by dry, scaly, and silvery patches of skin that appear in a variety of sizes and locations on the body.

Psoriatic arthritis mutilans—A severe form of psoriatic arthritis that destroys the joints of the fingers and toes and causes the bones to fuse, leaving patients with gnarled and club-like hands and feet.

Rheumatoid arthritis—A systemic disease that primarily affects the joints, causing inflammation, changes in structure, and loss of function.

Rheumatoid factor—A series of antibodies that signal the presence of rheumatoid arthritis. May also be present in Sjögren's syndrome and systemic lupus erythematosus, among others.

inflammation of arthritis. **Nonsteroidal anti-inflammatory drugs**, gold salts, and sulfasalazine are standard arthritis treatments, but have no effect on psoriasis. Antimalaria drugs and **systemic corticosteroids** should be avoided because they can cause **dermatitis** or exacerbate psoriasis when they are discontinued.

Several treatments are useful for both the skin lesions and the joint inflammation of psoriatic arthritis. Etretinate, a vitamin A derivative; methotrexate, a potent suppressor of the immune system; and ultraviolet **light therapy** have all been successfully used to treat psoriatic arthritis.

Alternative treatment

Food allergies/intolerances are believed to play a role in most **autoimmune disorders**, including psoriatic arthritis. Identification and elimination of food allergens from the diet can be helpful. Constitutional homeopathy can work deeply and effectively with this condition, if the proper prescription is given. **Acupuncture**, Chinese herbal medicine, and Western herbal medicine can all be useful in managing the symptoms of psoriatic arthritis. **Nutritional supplements** can contribute added support to the healing process. Alternative treatments recommended for psoriasis and rheumatoid arthritis may also be helpful in treating psoriatic arthritis.

Prognosis

The prognosis for most patients with psoriatic arthritis is good. For many, the joint and other arthritis symptoms are much milder than those experienced in rheumatoid arthritis. One in five people with psoriatic arthritis, however, face potentially crippling joint disease. In some cases, the course of the arthritis can be far more mutilating than in rheumatoid arthritis.

Prevention

There are no preventive measures for psoriatic arthritis.

ORGANIZATIONS

American Academy of Dermatology, PO Box 4014, Schaumburg, IL, 60168-4014, (847) 240-1859, (866) 503-SKIN (7546), http://www.aad.org.

American College of Rheumatology, 2200 Lake Boulevard NE, Atlanta, GA, 30319, (404) 633-3777, (404) 633-1870, acr@rheumatology.org, http://www.rheumatology.org.

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PSP *see* **Progressive supranuclear palsy**

Psychiatric confinement

Definition

Psychiatric confinement is the use of restraints to detain a person in need of care and further evaluation.

Purpose

The primary purpose for psychiatric confinement is typically an urgent or emergent condition that could cause danger to the affected person or others, or cause severe disability to the extent whereby the affected person is unable to care for his/herself.

Precautions

Because psychiatric restraint has medicolegal implications, clinicians utilizing this form of patient and public safety should perform a comprehensive **mental status examination** and document the findings. This approach helps provide clear records establishing the specific presenting problems and symptoms, avoiding future ambiguities .

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Description

Confinement with restraints can be categorized as urgent or emergent. Emergent causes can include patients exhibiting abnormal vital signs (breathing, pulse rate, temperature, blood pressure), threatening or violent behavior, and those who present with signs and symptoms of alcohol or illicit drug intoxication. Urgent use of confinement is indicated in patients showing suicidal thoughts, extreme **anxiety**, homicidal tendencies, violence, or a danger to self or the public at large.

Preparation

Those categorized as emergent should be prepared for further testing, which can include blood chemistry and psychological assessment and evaluation. Initially the patient is restrained with four-point leather restraints (both arms and both legs) and placed in a quiet room with a sitter. For those with urgent needs, restraint is initiated and initial management is directed to assess for an underlying medical cause and address psychological needs.

Aftercare

Further assessment, testing, and evaluation is necessary for a definitive diagnosis and to devise an appropriate treatment plan.

Risks

A deficiency in record-keeping can lead to legal problems. The criteria and specifications for confinement should be clearly indicated. Meticulous clinical examination and documentation is essential for a definitive diagnosis. Persons who are confined due to **substance abuse** problems may have legal issues. There is proposed legislation concerning the misuse of restraints for psychiatric inpatients, which in the past has been responsible for numerous wrongful deaths. There are currently no federal laws that regulate the use of inpatient restraints nor any requirements for reporting injuries or **death**.

Resources

PERIODICALS

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Psychoanalysis

Definition

Psychoanalysis is a method of talk therapy for mental, emotional, and behavioral dysfunctions developed by Sigmund Freud (1856-1939), a Viennese physician. Psychoanalysis is classified as an insight-oriented rather than a supportive form of therapy, because it is based on the notion that people are better able to make changes in their lives when they have improved their understanding of themselves through identifying their assumptions about life and the early life experiences that gave rise to them. In the words of the American Psychoanalytic Association, "Psychoanalytic treatment gives patients the opportunity to examine these assumptions, understand their origins in their lives, modify them if necessary, and make better choices for themselves."

Purpose

The basic purpose of psychoanalysis is to help people move forward in their lives by resolving inner conflicts leading to a range of mental and emotional problems. Psychoanalysts maintain that they can successfully treat **phobias**, **anxiety** attacks, obsessions and compulsions, **mood disorders**, repetitive patterns of failure in relationships and employment, unresolved grief, and a more general feeling of alienation or estrangement from others.

Demographics

As of 2010, there are 35 training institutes for psychoanalysts in the United States approved by the American Psychoanalytic Association and between 75 and 100 independent training institutes. It is difficult to obtain precise statistics on the number of patients who undergo psychoanalysis in an average year; however, because of the time and expense involved in this form of mental health treatment, considerably fewer people consult psychoanalysts than other mental health professionals.

Description

Origins

Developed by Sigmund Freud (1856–1939), a Viennese neurologist and professor of medicine, psychoanalysis is based on an approach in which the therapist helps the patient better understand him- or herself through examination of the deeply hidden feelings, relationships, and events that have shaped

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the patient's motivations and behavior. Freud's interest began when he encountered patients who were clearly suffering physical symptoms for which he could find no organic (biological) cause. Freud's first attempt to uncover the psychological causes of his patients' **pain** was through hypnosis, which he studied in Paris in 1885 under Jean-Martin Charcot, a French neurologist who specialized in research in what were then called hysterical disorders. Freud found Charcot's approach, which depended heavily on hypnosis, to be less fruitful than he had hoped, however, and he soon borrowed from a Viennese contemporary the idea of getting a patient to simply talk about his or her problems. Freud expanded upon this practice by introducing a method that he called free association, in which a patient is encouraged to speak in a nonnarrative or rambling manner under the expectation that he or she will eventually reveal or uncover the unconscious heart of the problem. This sort of undirected self-exploration became one of the signature tenets of psychoanalysis.

Continuing his research into the mind and the unconscious, Freud published *The Interpretation of Dreams* in 1900. In this work he outlined his ideas about the construction of the mind and human personality. This book was followed by the major publications of the Freudian canon: *The Psychopathology of Everyday Life* in 1904, and *A Case of Hysteria* as well as *Three Essays on the Theory of Sexuality* in 1905. By the second decade of the twentieth century, Freud had become an internationally renowned thinker, largely as a result of his accepting an invitation to give a series of lectures at Clark University in Massachusetts in September 1909. Although Freud delivered his talks in German, they were translated into English within weeks and made his name a household word among English-speaking physicians and psychologists. Psychoanalysis had emerged as a significant intellectual achievement on a par with the work of Albert Einstein in physics and in many ways comparable to the modernist movement in the visual arts. Psychoanalysis was in its prime by the 1920s; after the shock and disillusionment following World War I, Western intellectuals made undergoing psychoanalysis a fashionable form of treatment.

Major concepts

Freud believed that human personality is constructed of three parts: the id, the ego, and the superego. The id, according to this schema, is comprised largely of such instinctual drives as desires for food or sexual pleasure. These drives are essentially unconscious, yielding satisfaction when they are fulfilled and frustration or anxiety when they are thwarted. The ego is linked to the id, but because the ego is the component that has undergone socialization and recognizes that instant gratification of the id's urges is not always possible, a person may experience inner conflicts. The superego acts in many ways like the ego, as a moderator of behavior—but whereas the ego moderates urges based on social constraints, the superego operates as an arbiter of right and wrong. It moderates the id's urges on the basis of a moral code. Having constructed this framework of human personality, Freud used it to demonstrate the ways in which instinctual drives inevitably run aground on strictly social codes (upheld by the ego) and notions of morality (upheld by the superego). The resultant conflicts, according to psychoanalytic theory, lie at the heart of most **anxiety disorders** and other neurotic problems.

In dealing with these conflicts, Freud's psychoanalytic theory suggests that the human mind constructs three forms of adaptive mechanisms: namely, defense mechanisms, neurotic symptoms, and dreams. Freud believed dreams were vivid representations of repressed urges; they emanate from the id's speaking out in wildly incongruous nighttime parables. He considered dreams to have two parts: the manifest content, which is the narrative that one is able to remember upon waking; and the latent content, which is the underlying and largely symbolic message of the dream. Because Freud believed dreams to represent unfulfilled longings of the id, psychoanalysis deals heavily with dream interpretation.

Psychoanalytic theory also regards various neurotic symptoms as symbolic acts representing the repressed longings of the id. For Freud, a neurotic symptom was what we now consider a psychosomatic disorder; that is, some physical symptom that has a psychological, or in Freud's terms, neurological, origin. Psychoanalytic theory suggests that conditions like blindness, **paralysis**, and severe headaches can result from unfulfilled longings that the patient is unable to confront on a conscious level. Because of this inability, the patient develops some acceptable symptom, such as headaches, for which he or she can then seek medical attention.

The final adaptive mechanisms that Freud described are defense mechanisms. Freud identified several defense mechanisms, such as repression, displacement, denial, rationalization, projection, and identification. Each has its own peculiar dynamic, but all work to distance a person from a conflict that is too difficult to confront realistically. These conflicts, according to psychoanalytic theory, originate during one of the four developmental stages Freud identified.

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CARL GUSTAV JUNG (1875–1961)

(The Library of Congress.)

Carl Gustav Jung was born in Kesswil, Switzerland, on July 26, 1875, to a Protestant clergyman who moved his family to Basel when Jung was four. While growing up, Jung exhibited an interest in many diverse areas of study but finally decided to pursue medicine at the University of Basel and the University of Zurich, earning his degree in 1902. He also studied psychology in Paris. In 1903, Jung married Emma Rauschenbach, his companion and collaborator. The couple had five children.

Jung's professional career began in 1900 at the University of Zurich where he worked as an assistant to Eugene Blueler in the psychiatric clinic. During his internship, he and some coworkers used an experiment that revealed groups of ideas in the unconscious psyche, which he named *complexes*. Jung sent his publication *Studies in Word Association* (1904) to Sigmund Freud after finding his own beliefs confirmed by Freud's work. Jung and Freud became friends and collaborators until 1913, when Jung's ideas began to conflict with Freud's. During the time following this split, Jung published *Two Essays on Analytical Psychology* (1916, 1917) and *Psychological Types* (1921). Jung's later work developed from the concepts in his *Two Essays* publication and he became known as a founder of modern depth psychology.

In 1944, Jung gave up his psychological practice and his explorations after he suffered a severe heart attack. Jung received honorary doctorates from numerous universities and in 1948 he founded the C. G. Jung Institute in Zurich. Jung died on June 6, 1961.

These stages, and the infantile sexuality he identified as occurring within them, are some of the most controversial aspects of psychoanalytic theory. Freud suggested that adult neuroses result from and can be traced back to frustrated sexual drives during these stages. Freud defined the stages as the oral stage, birth to one year; the anal stage, one to three years; the phallic stage, three to five years; and latency, five years to the beginning of **puberty**. Each of these stages is in turn divided into substages. In each of the major stages, the infant has sexual longings which, because of social mores, are left largely unfulfilled and lead to the formation of neuroses.

Freud hypothesized that children in the phallic stage of development form the Oedipus complex, easily the most renowned and controversial theoretical construction of the Freudian canon. The Oedipus complex refers to the notion that a child begins associating his genitals with sexual pleasure during the phallic stage and becomes erotically attracted to the parent of the opposite sex while at the same time developing an intense jealousy of the same-sex parent. Freud derived the name of the complex from Oedipus, a figure in Greek mythology who ended up murdering his father and marrying his mother. While Freud's original theory excludes consideration of females, his contemporary, Carl Jung (1875–1961), expanded this particular dynamic and described an Electra complex for women in which the same psychodrama of erotic attraction and jealousy is played out from the young girl's point of view. Electra is the name of the Greek princess who, according to legend, killed her mother Clytemnaestra in order to avenge her mother's murder of her father, Agamemnon.

Criticisms of Freudian psychoanalysis

From nearly the beginning, Freud and his construction of psychoanalytic theory have faced intense criticism. His most famous dissenter is Carl Jung, his former disciple. Jung split with Freud in 1913 over a variety of issues including, but certainly not limited to, Freud's emphasis on infantile sexuality. Jung had a different view of the construction of human personality and had different ideas about how dreams should be interpreted and viewed as part of psychoanalysis.

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Alfred Adler (1870–1937), another early disciple of Freud, broke with the master over the concept of infantile sexuality, positing a view that infants and children are driven primarily by a need for self-affirmation rather than sexual gratification.

More recently, Freud has been the target of criticism from many corners. Feminists especially criticize his understanding of **hysteria** and his notion of penis envy, which postulates that women feel inferior to men from the moment they discover that the male genitalia differ from their own, and spend the rest of their lives trying to compensate in various ways for the perceived lack of a penis.

In addition, many historians regard Freud's theories as shaped by his particular culture. Vienna was the capital of an empire that held together a loose assortment of nationalities and languages and underwent a number of economic and political crises from the 1870s up to the outbreak of World War I in 1914. Freud himself was an outsider, a Jew in an anti-Semitic society in which professional advancement in medicine was difficult for Jews. Many of his patients suffered from neurotic disorders that were byproducts of very strict methods of childrearing rather than outgrowths of universal characteristics of human nature. Historians of medicine in particular have observed that some of the emotional disorders that Freud regarded as common or widespread in the Europe of his day are rarely seen in contemporary patients.

Recent developments

Psychoanalysis has lost favor since the 1980s as an approach to therapy for a number of reasons. One is the expense; in traditional psychoanalysis, the patient sees the psychoanalyst several times a week, often for years on end. The cost of a classical analysis can easily run into thousands of dollars very quickly. With the coming of managed care, most health maintenance organizations (HMOs) will not reimburse patients for the cost of psychoanalytic therapy. Other approaches, such as **cognitive-behavioral therapy** (CBT), are preferred because they are short-term. It is significant that the National Institute of Mental Health (NIMH)'s 2010 pamphlet on different approaches to **psychotherapy** does not even mention classical psychoanalysis as a treatment option.

Another reason for growing opposition to psychoanalysis in the United States in the early 1990s was the publicity given to several malpractice scandals involving psychoanalysts, including one in which the analyst was forced to surrender her medical license following the **suicide** of a medical student with whom she had a highly sexualized relationship. A male analyst was also forced to surrender his license in 1992 following lawsuits from five patients that he had sexually abused.

Next, a series of outcome studies in the 1980s and 1990s, following the lead of Hans J. Eysenck (1916–1997), a psychologist opposed to Freudian theory, found that psychoanalysis is not necessarily more effective than treatment with medications, short-term psychotherapy, or a placebo. Although many psychoanalysts still maintain that the Freudian approach is more comprehensive and hence more powerful in easing the patient's psychological suffering, proof of its superiority in these respects has not been established to the satisfaction of therapists from other schools of thought.

The other major change that has led to a decline in interest in traditional psychoanalysis is the rise of biological psychiatry as an alternative to talk therapies in general. Biological psychiatry is an approach to therapy that seeks to understand mental disorders in terms of biological dysfunction in the nervous system, whether alterations in the levels of various neurotransmitters, organic changes in brain tissue (as in Alzheimer's disease), or the effects of such contagious diseases as **syphilis** on the brain. Biological psychiatry has pioneered the use of drugs to treat a range of mental disorders from **schizophrenia** to depression. While most psychiatrists combine medications with some form of psychotherapy in ordinary practice, it is nonetheless true that increasing interest in biological explanations for mental disorders is another reason for the decline of classical psychoanalysis.

Psychoanalysis of children

Although traditional Freudian psychoanalysis was developed for adults and is not frequently used with children in its unmodified form, long-term therapy for problems of childhood and adolescence may be based on an approach that shares the Freudian emphasis on uncovering unconscious motivations and analyzing defenses. Freud's youngest daughter, Anna Freud (1895–1982), became a noteworthy child psychiatrist, beginning her practice with children in 1923.

With younger children, the psychoanalytic process takes place through play or storytelling. Young children, guided in play by a therapist, create situations or tell stories in which they reenact their problems. The therapist helps the child understand the feelings she expresses through her play scenarios, and assists the child in developing strategies for changing behavior. Older children and adolescents are

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KEY TERMS

Analysand—A person undergoing psychoanalysis.

Biological psychiatry—An approach to psychiatry that aims to understand mental disorders in terms of the biological and biochemical functions of the central nervous system.

Cognitive-behavioral therapy (CBT)—An approach to psychotherapy that emphasizes the correction of distorted thinking patterns and changing one's behaviors accordingly.

Countertransference—The analyst's emotional reaction to or entanglement with the analysand.

Insight-oriented therapy—An approach to psychotherapy based on helping the client understand the existence of previously unconscious conflicts and the origin of maladaptive behavior in order to change it. Psychoanalysis is one form of insight-oriented therapy.

Psychodynamic psychotherapy—A less intensive form of insight-oriented therapy than psychoanalysis that typically involves greater interaction between therapist and patient than classical psychoanalysis.

Psychosis—A severe mental disorder characterized by loss of contact with reality, as evidenced by delusions and hallucinations.

Supportive therapy—An approach to psychotherapy that seeks to encourage the patient or offer emotional support to him or her, as distinct from insight-oriented or educational approaches to treatment.

Talk therapy—A general term for any form of psychotherapy based on conversational interaction between a trained therapist and a client. It includes psychodynamic therapy, humanistic therapy, and the various behavioral therapies as well as psychoanalysis.

Transference—The redirection of feelings and thoughts from early childhood experiences toward a person in the present, usually the analyst.

encouraged to talk about their feelings and the situations that are causing them problems.

Benefits

Many therapists maintain that psychoanalysis is the most effective technique to identify and deal with internal conflicts and feelings that contribute to dysfunctional behavior. Through psychoanalysis, the patient increases his understanding of himself and his internal conflicts so that they will no longer exert as much influence on mental and emotional health. Psychoanalysis appears to be most beneficial, however, to people with moderate to severe problems who have not been helped by briefer or less intense forms of therapy.

Precautions

Some groups of people do not benefit from traditional psychoanalysis:

- People diagnosed as psychotic. While some analysts have adapted psychoanalysis to working with people diagnosed with schizophrenia and other psychoses, most analysts limit their practices to people less severely disturbed.
- People actively abusing alcohol or other drugs.
- People with limited intelligence or verbal ability. Insight-oriented therapies work best with people who feel comfortable with verbal discussion and are able to describe their problems in detail.
- Very young children. Some psychoanalysts do practice psychoanalysis of children and adolescents as noted above, consulting the parents (except in the case of older adolescents) in order to obtain a full picture of the child's problems. Children who are too young to talk with some fluency, however, generally do not benefit from a psychoanalytic approach.
- People who are emotionally fragile. Psychoanalysis requires a willingness to challenge oneself in depth; some people do not have the emotional sturdiness to cope with the results of questioning the beliefs or persons who have given structure to their lives.
- People who have severe difficulty trusting others. Psychoanalysis requires the analysand to form a stable long-term working relationship with the analyst.

Preparation

Preparation for psychoanalysis should include a consultation with either an analyst or another mental health professional to see whether a shorter-term form of therapy might be equally beneficial. Given the investment of time and money involved in psychoanalysis, most people should at least acquaint

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themselves with other forms of talk therapy, particularly if their health insurance limits the number of sessions allowed for a mental health provider. The American Psychoanalytic Association also maintains a list of low-fee clinics on its website for those whose finances are limited.

The next step is an appointment with a credentialed psychoanalyst, who will make the decision as to whether the patient is a suitable candidate for this type of therapy and whether there is a good "fit" between the patient and the analyst. If the only issue is interpersonal compatibility, most psychoanalysts will refer the patient to a colleague. In some cases the patient will be advised to undertake a course of psychodynamic psychotherapy (a less intense type of insight-oriented therapy) prior to beginning a full psychoanalysis. Psychoanalysis itself typically involves scheduling regular sessions of 45–50 minutes in length with the analyst, three to five times each week for a number of years.

Aftercare

Aftercare may include occasional sessions after the analysis is complete to evaluate the patient's progress or explore the impact of major life changes on the patient's adjustment.

Risks

The chief risk of psychoanalysis is an unsatisfactory relationship between analyst and analysand. The analysand is expected to reenact feelings and sometimes behaviors from earlier relationships (usually with parents and other family members) by unconsciously redirecting early experiences to the analyst. This phenomenon is called transference. The analyst's response (including emotions) toward the analysand is called the countertransference. One focus in psychoanalysis is identifying the transference in the relationship and exploring its meaning in order to shed light on the analysand's unconscious. If the relationship between analyst and analysand is either fragile or distorted in some way, however, the analysis will not be productive or successful.

Research and general acceptance

There are relatively few research studies comparing psychoanalysis with other forms of treatment or other talk therapies. As of mid-2010, there are five clinical research studies of psychoanalysis under way, compared to 19 studies of psychodynamic psychotherapy and 834 studies of cognitive-behavioral therapy.

Training and certification

In the early years of psychoanalysis, credentialed analysts were all medical doctors (psychiatrists). Since 1978, however, the profession has been opened to clinical psychologists with doctorates (Psy.D.), social workers holding an M.S.W., or other mental health professionals holding a Ph.D. Training is long and rigorous; a candidate must undergo a personal analysis and complete 600 hours of classroom instruction over a four-year period. The trainee must then conduct between two and four cases, the exact number depending on the specific institute, under a supervising analyst. The cases must include both men and women. The supervision usually continues for several years and takes place in the supervisor's office.

Resources

PERIODICALS

Blass, R. B. "On Ethical Issues at the Foundation of the Debate Over the Goals of Psychoanalysis." *International Journal of Psychoanalysis* 84 (August 2003): 929–943.

Gabbard, G. O., and D. Westen. "Rethinking Therapeutic Action." *International Journal of Psychoanalysis* 84 (August 2003): 823–841.

Lombardi, R. "Mental Models and Language Registers in the Psychoanalysis of Psychosis: An Overview of a Thirteen-Year Analysis." *International Journal of Psychoanalysis* 84 (August 2003): 843–863.

Roland, A. "Psychoanalysis Across Civilizations: A Personal Journey." *Journal of the American Academy of Psychoanalysis and Dynamic Psychiatry* 31 (Summer 2003): 275–295.

ORGANIZATIONS

American Academy of Child and Adolescent Psychiatry (AACAP), 3615 Wisconsin Avenue, N.W., Washington, DC, 20016-3007, 202-966-7300, 202-966-2891, http://www.aacap.org.

American Academy of Psychoanalysis and Psychodynamic Psychiatry, One Regency Drive, Bloomfield, CT, 06002, 888-691-8281, 860-286-0787, info@AAPDP.org, http://www.aapdp.org.

American College of Psychoanalysts (ACOPSA), P.O. Box 570218, Dallas, TX, 75357, 972-613-0985, http://www.acopsa.org/index.php.

American Psychoanalytic Association (APsaA), 309 East 49th Street, New York, NY, 10017, 212-752-0450, 212-593-0571, info@apsa.org, http://www.apsa.org.

Association for Child Psychoanalysis (ACP), 7820 Enchanted Hills Blvd., #A-233, Rio Rancho, NM, 87144, 505-771-0372, http://www.childanalysis.org.

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International Psychoanalytic Association (IPA), Broomhills, Woodside Lane, London, United Kingdom, N12 8UD, +44 20 8446 8324, +44 20 8445 4729, ipa@ipa.og.uk, http://www.ipa.org.uk/Public.

National Institute of Mental Health (NIMH), 6001 Executive Boulevard, Room 8184, MSC 9663, Bethesda, MD, 20892-9663, 301-443-4513, 866-615-6464, 301-443-4279, nimhinfo@nih.gov, http://www.nimh.nih.gov/index.shtml.

Rebecca J. Frey, PhD

Psychogenic disorder *see* **Somatoform disorders**

Psychological tests

Definition

Psychological tests are written, visual, or verbal evaluations administered to assess the cognitive and emotional functioning of children and adults.

Purpose

Psychological tests are used to assess a variety of mental abilities and attributes, including achievement and ability, personality, and neurological functioning.

Achievement and ability tests

For children, academic achievement, ability, and intelligence tests may be used as a tool in school placement, in determining the presence of a learning disability or a developmental delay, in identifying giftedness, or in tracking intellectual development. Intelligence testing may be used with adults to determine vocational ability (e.g., in career counseling) or to assess adult intellectual ability in the classroom.

Personality tests

Personality tests are administered for a wide variety of reasons, from diagnosing psychopathology (e.g., personality disorder, depressive disorder) to screening job candidates. They may be used in an educational or vocational setting to determine personality strengths and weaknesses, or in the legal system to evaluate parolees.

Neuropsychological tests

Patients who have experienced a traumatic brain injury, brain damage, or organic neurological problems (for example, **dementia**) are administered neuropsychological tests to assess their level of functioning and identify areas of mental impairment. They may also be used to evaluate the progress of a patient who has undergone treatment or **rehabilitation** for a neurological injury or illness. In addition, certain neuropsychological measures may be used to screen children for developmental delays and/or learning disabilities.

Precautions

Psychological testing requires a clinically trained examiner. All psychological tests should be administered, scored, and interpreted by a trained professional, preferably a psychologist or psychiatrist with expertise in the appropriate area.

Psychological tests are only one element of a psychological assessment. They should never be used alone as the sole basis for a diagnosis. A detailed history of the test subject and a review of psychological, medical, educational, or other relevant records are required to lay the groundwork for interpreting the results of any psychological measurement.

Cultural and language differences in the test subject may affect test performance and may result in inaccurate test results. The test administrator should be informed before psychological testing begins if the test taker is not fluent in English and/or belongs to a minority culture. In addition, the subject's motivation and motives may also affect test results.

Description

Psychological tests are formalized measures of mental functioning. Most are objective and quantifiable; however, certain projective tests may involve some level of subjective interpretation. Also known as inventories, measurements, questionnaires, and scales, psychological tests are administered in a variety of settings, including preschools, primary and secondary schools, colleges and universities, hospitals, outpatient health care settings, social agencies, prisons, and employment or human resource offices. They come in a variety of formats, including written, verbal, and computer administered.

Achievement and ability tests

Achievement and ability tests are designed to measure the level of an individual's intellectual functioning and cognitive ability. Most achievement and ability tests are standardized, meaning that norms were established during the design phase of the test by administering the test to a large representative sample of the test population. Achievement and ability tests follow a uniform testing protocol or procedure (i.e., test instructions, test conditions, and scoring procedures) and their scores can be interpreted in relation to established norms. Common achievement

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and ability tests include the **Wechsler intelligence test** (WISC-III and WAIS) and the **Stanford-Binet intelligence scales**.

Personality tests

Personality tests and inventories evaluate the thoughts, emotions, attitudes, and behavioral traits that comprise personality. The results of these tests determine an individual's personality strengths and weaknesses, and may identify certain disturbances in personality, or psychopathology. Tests such as the **Minnesota multiphasic personality inventory (MMPI-2)** and the Millon clinical multiaxial inventory III (MMPI-III), are used to screen individuals for specific psychopathologies or emotional problems.

Another type of personality test is the projective personality assessment. A projective test asks a subject to interpret some ambiguous stimuli, such as a series of inkblots. The subject's responses provide insight into his or her thought processes and personality traits. For example, the Rorschach inkblot test and the **Holtzman ink blot test** (HIT) use a series of inkblots that the test subject is asked to identify. Another projective assessment, the **Thematic apperception test** (TAT), asks the subject to tell a story about a series of pictures. Some consider projective tests to be less reliable than objective personality tests. If the examiner is not well-trained in psychometric evaluation, subjective interpretations may affect the evaluation of these tests.

Neuropsychological tests

Many insurance plans cover all or a portion of diagnostic neuropsychological or psychological testing. Medicare reimburses for psychological and neuropsychological testing. Billing time typically includes test administration, scoring and interpretation, and reporting.

Preparation

Prior to the administration of any psychological test, the administrator should provide the test subject with information on the nature of the test and its intended use, complete standardized instructions for taking the test (including any time limits and penalties for incorrect responses), and information on the confidentiality of the results. After these disclosures are made, informed consent should be obtained from the test subject before testing begins (except in cases of legally mandated testing, where consent is not required of the subject).

KEY TERMS

Norms—A fixed or ideal standard; normative or mean score for a particular age group.

Psychopathology—A mental disorder or illness, such as schizophrenia, personality disorder, or major depressive disorder.

Quantifiable—Can be expressed as a number. The results of quantifiable psychological tests can be translated into numerical values, or scores.

Representative sample—A random sample of people that adequately represent the test taking population in age, gender, race, and socioeconomic standing.

Standardization—The process of determining established norms and procedures for a test to act as a standard reference point for future test results.

Normal results

All psychological and neuropsychological assessments should be administered, scored, and interpreted by a trained professional. When interpreting test results for test subjects, the test administrator will review with subjects what the test evaluates, its precision in evaluation, any margins of error involved in scoring, and what the individual scores mean in the context of overall test norms and the background of the test subject.

ORGANIZATIONS

American Psychological Association (APA), 750 First St. NE, Washington, DC, 20002-4242, (202) 336-5500, (800) 374-2721, http://www.apa.org.

Paula Anne Ford-Martin

Psychosis

Definition

Psychosis is a symptom or feature of mental illness typically characterized by radical changes in personality, impaired functioning, and a distorted or nonexistent sense of objective reality.

Description

Patients suffering from psychosis have impaired reality testing; that is, they are unable to distinguish

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personal subjective experience from the reality of the external world. They experience **hallucinations** and/or **delusions** that they believe are real, and may behave and communicate in an inappropriate and incoherent fashion. Psychosis may appear as a symptom of a number of mental disorders, including mood and **personality disorders**. It is also the defining feature of **schizophrenia**, schizophreniform disorder, **schizoaffective disorder**, delusional disorder, and the psychotic disorders (i.e., brief psychotic disorder, shared psychotic disorder, psychotic disorder due to a general medical condition, and substance-induced psychotic disorder).

Causes and symptoms

Psychosis may be caused by the interaction of biological and psychosocial factors, depending on the disorder in which it presents; psychosis can also be caused by purely social factors, with no biological component.

Biological factors that are regarded as contributing to the development of psychosis include genetic abnormalities and substance use. With regard to chromosomal abnormalities, studies indicate that 30% of patients diagnosed with a psychotic disorder have a microdeletion at chromosome 22q11. Another group of researchers has identified the gene G72/G30 at chromosome 13q33.2 as a susceptibility gene for childhood-onset schizophrenia and psychosis not otherwise specified.

With regard to **substance abuse**, several different research groups reported in 2004 that cannabis (**marijuana**) use is a risk factor for the onset of psychosis.

Migration is a social factor that influences people's susceptibility to psychotic disorders. Psychiatrists in Europe have noted the increasing rate of schizophrenia and other psychotic disorders among immigrants to almost all Western European countries. Black immigrants from Africa or the Caribbean appear to be especially vulnerable. The stresses involved in migration include family breakup, the need to adjust to living in large urban areas, and social inequalities in the new country.

Schizophrenia, schizophreniform disorder, and schizoaffective disorder

Psychosis in schizophrenia and perhaps schizophreniform disorder appears to be related to abnormalities in the structure and chemistry of the brain, and appears to have strong genetic links, but its course and severity can be altered by social factors such as **stress** or a lack of support within the family. The cause of schizoaffective disorder is less clear cut, but biological factors are also suspected.

Delusional disorder

The exact cause of delusional disorder has not been conclusively determined, but potential causes include heredity, neurological abnormalities, and changes in brain chemistry. Some studies have indicated that delusions are generated by abnormalities in the limbic system, the portion of the brain on the inner edge of the cerebral cortex that is believed to regulate emotions. Delusional disorder is also more likely to develop in persons who are isolated from others in their society by language difficulties and/or cultural differences.

Brief psychotic disorder

Trauma and stress can cause a short-term psychosis (less than a month's duration) known as brief psychotic disorder. Major life-changing events such as the **death** of a family member or a natural disaster have been known to stimulate brief psychotic disorder in patients with no prior history of mental illness.

Psychotic disorder due to a general medical condition

Psychosis may also be triggered by an organic cause, termed a psychotic disorder due to a general medical condition. Organic sources of psychosis include neurological conditions (for example, **epilepsy** and cerebrovascular disease), metabolic conditions (for example, porphyria), endocrine conditions (for example, hyper- or **hypothyroidism**), renal failure, electrolyte imbalance, or **autoimmune disorders**.

Substance-induced psychotic disorder

Psychosis is also a known side effect of the use, **abuse**, and withdrawal from certain drugs. So-called recreational drugs, such as hallucinogenics, PCP, amphetamines, **cocaine**, marijuana, and alcohol, may cause a psychotic reaction during use or withdrawal. Certain prescription medications such as **steroids**, anticonvulsants, chemotherapeutic agents, and antiparkinsonian medications may also induce psychotic symptoms. Toxic substances such as carbon monoxide have also been reported to cause substance-induced psychotic disorder.

Shared psychotic disorder

Shared psychotic disorder, also known as *folie à deux* or psychosis by association, is a relatively rare delusional disorder involving two (or more) people with close emotional ties. In the West, shared

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KEY TERMS

Brief psychotic disorder—An acute, short-term episode of psychosis lasting no longer than one month. This disorder may occur in response to a stressful event.

Delirium—An acute but temporary disturbance of consciousness marked by confusion, difficulty paying attention, delusions, hallucinations, or restlessness. Delirium may be caused by drug intoxication, high fever related to infection, head trauma, brain tumors, kidney or liver failure, or various metabolic disturbances.

Delusional disorder—Individuals with delusional disorder suffer from long-term, complex delusions that fall into one of six categories: persecutory, grandiose, jealous, erotomanic, somatic, or mixed.

Delusions—An unshakable belief in something untrue that cannot be explained by religious or cultural factors. These irrational beliefs defy normal reasoning and remain firm even when overwhelming proof is presented to refute them.

Hallucinations—False or distorted sensory experiences that appear to be real perceptions to the person experiencing them.

Paranoia—An unfounded or exaggerated distrust of others, sometimes reaching delusional proportions.

Porphyria—A disease of the metabolism characterized by skin lesions, urine problems, neurologic disorders, and/or abdominal pain.

Schizoaffective disorder—Schizophrenic symptoms occurring concurrently with a major depressive or manic episode.

Schizophrenia—A debilitating mental illness characterized by delusions, hallucinations, disorganized speech and behavior, and inappropriate or flattened affect (a lack of emotions) that seriously hampers the afflicted individual's social and occupational functioning. Approximately 2 million Americans suffer from schizophrenia.

Schizophreniform disorder—A short-term variation of schizophrenia that has a total duration of one to six months.

Shared psychotic disorder—Also known as *folie à deux,* shared psychotic disorder is an uncommon disorder in which the same delusion is shared by two or more individuals.

Tardive dyskinesia— Involuntary movements of the face and/or body that are a side effect of the long-term use of some older antipsychotic (neuroleptic) drugs. Tardive dyskinesia affects 15%-20% of patients on long-term neuroleptic treatment.

psychosis most commonly develops between two sisters or between husband and wife, while in Japan the most common form involves a parent and a son or daughter. Shared psychosis occasionally involves an entire nuclear family.

Psychosis is characterized by the following symptoms:

- Delusions. Those delusions that occur in schizophrenia and its related forms are typically bizarre (i.e., they could not occur in real life). Delusions occurring in delusional disorder are more plausible, but still patently untrue. In some cases, delusions may be accompanied by feelings of paranoia.
- Hallucinations. Psychotic patients see, hear, smell, taste, or feel things that aren't there. Schizophrenic hallucinations are typically auditory or, less commonly, visual; but psychotic hallucinations can involve any of the five senses.
- Disorganized speech. Psychotic patients, especially those with schizophrenia, often ramble on in incoherent, nonsensical speech patterns.
- Disorganized or catatonic behavior. The catatonic patient reacts inappropriately to his/her environment by either remaining rigid and immobile or by engaging in excessive motor activity. Disorganized behavior is behavior or activity that is inappropriate for the situation, or unpredictable.

Diagnosis

Patients with psychotic symptoms should undergo a thorough **physical examination** and history to rule out such possible organic causes as seizures, **delirium**, or alcohol withdrawal, and such other psychiatric conditions as dissociation or panic attacks. If a psychiatric cause such as schizophrenia is suspected, a mental health professional will typically conduct an interview with the patient and administer one of several clinical inventories, or tests, to evaluate mental status. This assessment takes place in either an outpatient or hospital setting.

Psychotic symptoms and behaviors are considered psychiatric emergencies, and persons showing signs of

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psychosis are frequently taken by family, friends, or the police to a hospital emergency room. A person diagnosed as psychotic can be legally hospitalized against his or her will, particularly if he or she is violent, threatening to commit **suicide**, or threatening to harm another person. A psychotic person may also be hospitalized if he or she has become malnourished or ill as a result of failure to feed, dress appropriately for the climate, or otherwise take care of him- or herself.

Treatment

Psychosis that is symptomatic of schizophrenia or another psychiatric disorder should be treated by a psychologist and/or psychiatrist. An appropriate course of medication and/or psychosocial therapy is employed to treat the underlying primary disorder. If the patient is considered to be at risk for harming himself or others, inpatient treatment is usually recommended.

Treatment of shared psychotic disorder involves separating the affected persons from one another as well as using antipsychotic medications and **psychotherapy**.

Antipsychotic medication such as thioridazine (Mellaril), haloperidol (Haldol), chlorpromazine (Thorazine), clozapine (Clozaril), sertindole (Serlect), olanzapine (Zyprexa), or risperidone (Risperdal) is usually prescribed to bring psychotic symptoms under control and into remission. Possible side effects of antipsychotics include **dry mouth**, drowsiness, muscle stiffness, and **tardive dyskinesia** (involuntary movements of the body). Agranulocytosis, a potentially serious but reversible health condition in which the white blood cells that fight infection in the body are destroyed, is a possible side effect of clozapine. Patients treated with this drug should undergo weekly blood tests to monitor white blood cell counts for the first six months, then every two weeks thereafter.

After an acute psychotic episode has subsided, antipsychotic drug maintenance treatment is typically employed and psychosocial therapy and living and vocational skills training may be attempted.

Prognosis

Prognosis for brief psychotic disorder is quite good; for schizophrenia, less so. Generally, the longer and more severe a psychotic episode, the poorer the prognosis is for the patient. Early diagnosis and treatment are critical to improving outcomes for the patient across all psychotic disorders.

Approximately 10% of America's permanently disabled population is comprised of schizophrenic individuals. The mortality rate of schizophrenic individuals is also high—approximately 10% of schizophrenics commit suicide, and 20% attempt it. However, early diagnosis and long-term follow up care can improve the outlook for these patients considerably. Roughly 60% of patients with schizophrenia will show substantial improvement with appropriate treatment.

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ORGANIZATIONS

American Psychiatric Association (APA), 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209, (888) 357-7924, apa@psych.org, http://www.psych.org.

American Psychological Association (APA), 750 First St. NE, Washington, DC, 20002-4242, (202) 336-5500, (800) 374-2721, http://www.apa.org.

National Alliance for the Mentally Ill (NAMI), 3803 N. Fairfax Dr., Ste. 100, Arlington, VA, 22203, (703) 524-7600, (703) 524-9094, (800) 950-6264, http://www.nami.org.

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National Institute of Mental Health (NIMH), 6001 Executive Boulevard, Bethesda, MD, 20892, (301) 443-4513, (301) 443-4279, (866) 615-6464, nimhinfo@nih.gov, http://www.nimh.nih.gov.

Paula Anne Ford-Martin
Rebecca Frey, PhD

Psychosocial disorders

Definition

A psychosocial disorder is a mental illness caused or influenced by life experiences, as well as maladjusted cognitive and behavioral processes.

Description

The term psychosocial refers to the psychological and social factors that influence mental health. Social influences such as peer pressure, parental support, cultural and religious background, socioeconomic status, and interpersonal relationships all help to shape personality and influence psychological makeup. Individuals with psychosocial disorders frequently have difficulty functioning in social situations and may have problems effectively communicating with others.

The American Psychiatric Association distinguishes 16 different subtypes (or categories) of mental illness. Although psychosocial variables arguably have some degree of influence on all subtypes of mental illness, the major categories of mental disorders thought to involve significant psychosocial factors include:

- Substance-related disorders. Disorders related to alcohol and drug use, abuse, dependence, and withdrawal.
- Schizophrenia and other psychotic disorders. These include the schizoid disorders (schizophrenia, schizophreniform, and schizoaffective disorder), delusional disorder, and psychotic disorders.
- Mood disorders. Affective disorders such as depression (major, dysthymic) and bipolar disorders.
- Anxiety disorders. Disorders in which a certain situation or place triggers excessive fear and/or anxiety symptoms (e.g., dizziness, racing heart), such as panic disorder, agoraphobia, social phobia, obsessive-compulsive disorder, post-traumatic stress disorder, and generalized anxiety disorders.
- Somatoform disorders. Somatoform disorders involve clinically significant physical symptoms that cannot be explained by a medical condition (e.g., somatization disorder, conversion disorder, pain disorder, hypochondriasis, and body dysmorphic disorder).
- Factitious disorders. Disorders in which an individual creates and complains of symptoms of a nonexistent illness in order to assume the role of a patient (or sick role).
- Sexual and gender identity disorders. Disorders of sexual desire, arousal, and performance. It should be noted that the categorization of gender identity disorder as a mental illness has been a point of some contention among mental health professionals.
- Eating disorders. Anorexia and bulimia nervosa.
- Adjustment disorders. Adjustment disorders involve an excessive emotional or behavioral reaction to a stressful event.
- Personality disorders. Maladjustments of personality, including paranoid, schizoid, schizotypal, antisocial, borderline, histrionic, narcissistic, avoidant, dependent, and obsessive-compulsive personality disorders (the latter not to be confused with the anxiety disorder OCD).
- Disorders usually first diagnosed in infancy, childhood, or adolescence. Some learning and developmental disorders (e.g., ADHD) may be partially psychosocial in nature.

Causes and symptoms

It is important to note that the causes of mental illness are diverse and not completely understood. The majority of psychological disorders are thought to be caused by a complex combination of biological, genetic (hereditary), familial, and social factors or biopsychosocial influences. In addition, the role that each of these play can differ from person to person, so that a disorder such as depression that is caused by genetic factors in one person may be caused by a traumatic life event in another.

The symptoms of psychosocial disorders vary depending on the diagnosis in question. In addition to disorder-specific symptoms, individuals with psychosocial dysfunction usually have difficulty functioning normally in social situations and may have trouble forming and maintaining close interpersonal relationships.

Diagnosis

Patients with symptoms of psychosocial disorders or other mental illness should undergo a thorough **physical examination** and patient history to rule out

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an organic cause for the illness (such as a neurological disorder). If no organic cause is suspected, a psychologist or other mental health care professional will meet with the patient to conduct an interview and take a detailed social and medical history. If the patient is a minor, interviews with a parent or guardian may also be part of the diagnostic process. The physician may also administer one or more **psychological tests** (also called clinical inventories, scales, or assessments).

Treatment

Counseling is typically a front-line treatment for psychosocial disorders. A number of counseling or talk therapy approaches exist, including **psychotherapy**, cognitive therapy, behavioral therapy, and **group therapy**. Therapy or counseling may be administered by social workers, nurses, licensed counselors and therapists, psychologists, or psychiatrists.

Psychoactive medication may also be prescribed for symptom relief in patients with mental disorders considered psychosocial in nature. For disorders such as major depression or **bipolar disorder**, which may have psychosocial aspects but also have known organic causes, drug therapy is a primary treatment approach. In cases such as personality disorder that are thought to not have biological roots, psychoactive medications are usually considered a secondary, or companion, treatment to psychotherapy.

Many individuals are successful in treating psychosocial disorders through regular attendance in self-help groups or 12-step programs such as Alcoholics Anonymous. This approach, which allows individuals to seek advice and counsel from others in similar circumstances, can be extremely effective.

In some cases, treating mental illness requires hospitalization of the patient. This hospitalization, also known as inpatient treatment, is usually employed in situations where a controlled therapeutic environment is critical for the patient's recovery (e.g., **rehabilitation** treatment for **alcoholism** or other drug addictions), or when there is a risk that the patient may harm himself (**suicide**) or others. It may also be necessary when the patient's physical health has deteriorated to a point where life-sustaining treatment is necessary, such as with severe **malnutrition** associated with **anorexia nervosa**.

Alternative treatment

Therapeutic approaches such as **art therapy** that encourage self-discovery and empowerment may be useful in treating psychosocial disorders. **Art therapy**, the use of the creative process to express and understand emotion, encompasses a broad range of humanistic disciplines, including visual arts, dance, drama, music, film, writing, literature, and other artistic genres. This use of the creative process is believed to provide the patient with a means to gain insight to emotions and thoughts they might otherwise have difficulty expressing. After the artwork is created, the patient continues the therapeutic journey by interpreting its meaning under the guidance of a trained therapist.

KEY TERMS

Affective disorder—An emotional disorder involving abnormal highs and/or lows in mood.

Bipolar disorder—An affective mental illness that causes radical emotional changes and mood swings, from manic highs to depressive lows. The majority of bipolar individuals experience alternating episodes of mania and depression.

Bulimia—An eating disorder characterized by binge eating and inappropriate compensatory behavior such as vomiting, misusing laxatives, or excessive exercise.

Cognitive processes—Thought processes (e.g., reasoning, perception, judgment, memory).

Learning disorders—Academic difficulties experienced by children and adults of average to above-average intelligence that involve reading, writing, and/or mathematics, and which significantly interfere with academic achievement or daily living.

Schizophrenia—A debilitating mental illness characterized by delusions, hallucinations, disorganized speech and behavior, and flattened affect (i.e., a lack of emotions) that seriously hampers normal functioning.

Prognosis

According to the National Institute of Mental Health, more than 90% of Americans who commit suicide have a diagnosable mental disorder, so swift and appropriate treatment is important. Because of the diversity of the types of mental disorders influenced by psychosocial factors, and the complexity of diagnosis and treatment, the prognosis for psychosocial disorders is highly variable. In some cases, they can be effectively managed with therapy and/or medication. In others, mental illness can cause long-term disability.

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Prevention

Participating in therapy or self-help groups can encourage patients to take an active part in their treatment program and to recognize symptoms of a relapse of their condition. In addition, educating friends and family members on the nature of the psychosocial disorder can assist them in knowing how and when to provide support to the patient.

Resources

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ORGANIZATIONS

National Institute of Mental Health (NIMH), 6001 Executive Boulevard, Room 8184, MSC 9663, Bethesda, MD 20892-9663, (866) 615-6464, nimhinfo@nih.gov, http://www.nimh.nih.gov/site-info/contact-nimh.shtml.

Paula Anne Ford-Martin

Psychosurgery

Definition

Psychosurgery involves severing or otherwise disabling areas of the brain to treat a personality disorder, behavior disorder, or other mental illness. Modern psychosurgical techniques target the pathways between the limbic system (the portion of the brain on the inner edge of the cerebral cortex), which is believed to regulate emotions, and the frontal cortex, where thought processes are seated.

Purpose

Lobotomy is a psychosurgical procedure involving selective destruction of connective nerve fibers or tissue. It is performed on the frontal lobe of the brain and its purpose is to alleviate mental illness and chronic **pain** symptoms. The bilateral cingulotomy, a modern psychosurgical technique that has replaced the lobotomy, is performed to alleviate mental disorders such as major depression, **bipolar disorder**, or **obsessive-compulsive disorder** (OCD), which have not responded to **psychotherapy**, behavioral therapy, electroshock, or pharmacologic treatment. Bilateral cingulotomies are also performed to treat chronic pain in **cancer** patients.

Precautions

Psychosurgery should be considered only after all other nonsurgical psychiatric therapies have been fully explored. Much is still unknown about the biology of the brain and how psychosurgery affects brain function.

Description

Psychosurgery, and lobotomy in particular, reached the height of use just after World War II. Between 1946 and 1949, the use of the lobotomy grew from 500 to 5,000 annual procedures in the United States. At that time, the procedure was viewed as a possible solution to the overcrowded and understaffed conditions in state-run mental hospitals and asylums. Known as prefrontal or transorbital lobotomy, depending on the surgical technique used and area of the brain targeted, these early operations were performed with surgical knives, electrodes, suction, or ice picks, to cut or sweep out portions of the frontal lobe.

Today's psychosurgical techniques are much more refined. Instead of going in "blind" to remove large sections on the frontal lobe, as in these early operations, neurosurgeons use a computer-based process called stereotactic **magnetic resonance imaging** to guide a small electrode to the limbic system (brain structures involved in autonomic or automatic body functions and some emotion and behavior). There, an electrical current **burns** in a small lesion (usually 0.5 in. [1.3 cm] in size). In a bilateral cingulotomy, the cingulate gyrus, a small section of brain that connects the limbic region of the brain with the frontal lobes, is targeted. Another surgical technique uses a noninvasive tool known as a gamma knife to focus beams of radiation at the brain. A lesion forms at the spot where the beams converge in the brain.

Preparation

Candidates for cingulotomies or other forms of psychosurgery undergo a rigorous screening process to ensure that all possible nonsurgical psychiatric treatment options have been explored. Psychosurgery is only performed with the patient's informed consent.

Aftercare

Ongoing behavioral and medication therapy is often required in OCD patients who undergo cingulotomy. All psychosurgery patients should remain under a psychiatrist's care for follow-up evaluations and treatment.

Risks

As with any type of brain surgery, psychosurgery carries the risk of permanent brain damage, though

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KEY TERMS

Gamma knife—A surgical tool that focuses beams of radiation at the head, which converge in the brain to form a lesion.

Lesion—Any discontinuity of tissue. Often a cut or wound.

Limbic system—A portion of the brain on the inner edge of the cerebral cortex that is thought to regulate emotions.

Psychosurgery—Brain surgery performed to alleviate chronic psychological conditions such as obsessive-compulsive disorder (OCD), depression, and bipolar disorder.

Stereotactic technique—A technique used by neurosurgeons to pinpoint locations within the brain. It employs computer imaging to create an external frame of reference.

the advent of non-invasive neurosurgical techniques, such as the gamma knife, has reduced the risk of brain damage significantly.

Normal results

In a 1996 study at Massachusetts General Hospital, over one-third of patients undergoing cingulotomy demonstrated significant improvements after the surgery. In contrast to the bizarre behavior and personality changes reported with lobotomy patients in the 1940s and 1950s, modern psychosurgery patients have demonstrated little post-surgical losses of memory or other high-level thought processes.

ORGANIZATIONS

International OCD Foundation, PO Box 961029, Boston, MA, 60219, (617) 973-5801, (617) 973-5803, info@ocfoundation.org, http://www.ocfoundation.org.

Massachusetts General Hospital. Functional and Stereotactic Neurosurgery Cingulotomy Unit, 55 Fruit St., Gray 502, Boston, MA, 02114, (617) 724-6590, (617) 724-0339, http://neurosurgery.mgh.harvard.edu/functional.

National Alliance for the Mentally Ill (NAMI), 3803 N. Fairfax Dr., Ste. 100, Arlington, VA, 22203, (703) 524-7600, (703) 524-9094, (800) 950-6264, http://www.nami.org.

Paula Anne Ford-Martin

Psychotherapy

Definition

Psychotherapy is the treatment of mental or emotional disorders and adjustment problems through the use of psychological techniques rather than through physical or biological means.

Description

Psychoanalysis, the first modern form of psychotherapy, was called the "talking cure," and the many varieties of therapy practiced today are still characterized by their common dependence on a verbal exchange between the counselor or therapist and the person seeking help. The therapeutic interaction is characterized by mutual trust, with the goal of helping individuals change destructive or unhealthy behaviors, thoughts, and emotions. It is common for experienced therapists to combine several different approaches or techniques. Therapy is terminated when the treatment goals have been met or if the client and/or therapist conclude that it is not working. It can be effective to phase out treatment by gradually reducing the frequency of therapy sessions. Even after regular therapy has ended, the client may return for periodic follow-up and reassessment sessions.

Psychodynamic approach

Freudian psychoanalysis places emphasis on uncovering unconscious motivations and breaking down defenses. Therapy sessions may be scheduled once or even twice a week for a year or more. This type of therapy is appropriate when internal conflicts contribute significantly to a person's problems.

Behavioral techniques

In contrast to the psychodynamic approach, behavior-oriented therapy is geared toward helping people see their problems as learned behaviors that can be modified, without looking for unconscious motivations or hidden meanings. According to the theory behind this approach, once behavior is changed, feelings will change as well. Probably the best-known type of behavioral therapy is behavior modification, which focuses on eliminating undesirable habits by providing positive reinforcement for the more desirable behaviors.

Another behavioral technique is systematic desensitization, in which people are deliberately and gradually exposed to a feared object or experience to help them overcome their fears. A person who is afraid of

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dogs may first be told to visualize a dog, then is given a stuffed toy dog, then exposed to a real dog seen at a distance, and eventually forced to interact with a dog at close range. Relaxation training is another popular form of behavior therapy. Through such techniques as deep breathing, visualization, and progressive muscle relaxation, clients learn to control fear and **anxiety**.

Cognitive methods

Some behavior-oriented therapy methods are used to alter not only overt behavior, but also the thought patterns that drive it. This type of treatment is known as **cognitive-behavioral therapy** (or just cognitive therapy). Its goal is to help people break out of distorted, harmful patterns of thinking and replace them with healthier ones. Common examples of negative thought patterns include: magnifying or minimizing the extent of a problem, "all or nothing" thinking (e.g., a person regards himself as either perfect or worthless), overgeneralization (arriving at broad conclusions based on one incident, for example), and personalization (continually seeing oneself as the cause or focus of events).

In cognitive-behavioral therapy, a therapist may talk to the client, pointing out illogical thought patterns, or use a variety of techniques, such as thought substitution, in which a frightening or otherwise negative thought is driven out by substituting a pleasant thought in its place. Clients may also be taught to use positive self-talk, a repetition of positive affirmations. Cognitive therapy usually takes a longer amount of time as it treats more serious problems.

Couples therapy

Couples therapy focuses on the relationship between two people, typically who have a romantic or sexual connection. The aim of the therapy is to concentrate on the problems of the relationship and make each partner feel that they have an equal role. The therapy can be administered by either a male or female therapist, but many couples feel that having both a male and female therapist in the session is beneficial.

Family and group therapy

Family therapy has proven effective in treating a number of emotional and adjustment problems. While the client's immediate complaint is the initial focus of attention, the ultimate goal of family therapy is to improve the interaction between all family members and enhance communication and coping skills on a long-term basis (although therapy itself need not cover an extended time period). **Group therapy**, which is often combined with individual therapy, offers the support and companionship of other people experiencing the same or similar problems and issues.

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ORGANIZATIONS

American Psychological Association, 750 First Street NE, Washington, DC, 20002-4242, 202-336-5500, 800-374-2721, http://www.apa.org.

Association for Psychological Science, 1133 Fifteenth Street NW, Suite 1000, Washington, DC, 20005, (202) 293-9300, (202) 293-9350, http://www.psychologicalscience.org.

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Psyllium preparations *see* **Laxatives**

PT *see* **Prothrombin time**

Pterygium *see* **Pinguecula and pterygium**

Ptomaine poisoning *see* **Food poisoning**

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Ptosis

Definition

Ptosis is the term used for a drooping upper eyelid. Ptosis, also called blepharoptosis, can affect one or both eyes.

Description

The eyelids serve to protect and lubricate the outer eye. The upper eyelid is lifted by a muscle called the levator muscle. Inside the back part of the lid is a tarsal plate which adds rigidity to the lid. The levator muscle is attached to the tarsal plate by a flat tendon called the levator aponeurosis. When the muscle cannot lift the eyelid or lifts it only partially, the person is said to have a ptosis.

There are two types of ptosis, acquired and congenital. Acquired ptosis is more common. Congenital ptosis is present at birth. Both congenital and acquired ptosis can be, but are not necessarily, hereditary.

Causes and symptoms

Ptosis may occur because the levator muscle's attachment to the lid is weakening with age. Acquired ptosis can also be caused by a number of different things, such as disease that impairs the nerves, diabetes, injury, tumors, inflammation, or aneurysms. Congenital ptosis may be caused by a problem with nerve innervation or a weak muscle. Drooping eyelids may also be the result of diseases such as **myotonic dystrophy** or **myasthenia gravis**.

A close-up view of a drooping upper eyelid (ptosis) on an elderly woman's face. Ptosis is normally due to a weakness of the levator muscle of the upper eyelid or to interference with the nerve supply to the muscle. *(Dr. P. Marazzi/Photo Researchers, Inc.)*

KEY TERMS

Congenital—A condition existing at birth.

Hereditary—A condition passed from parent to child; a genetic condition.

The primary symptom of ptosis is a drooping eyelid. Adults will notice a loss of visual field because the upper portion of the eye is covered. Children who are born with a ptosis usually tilt their head back in an effort to see under the obstruction. Some people raise their eyebrows in order to lift the lid slightly and therefore may appear to be frowning.

Diagnosis

Diagnosis of ptosis is usually made by observing the drooping eyelid. Finding the cause of the condition will require testing for any of the illnesses or injuries known to have this effect. Some possible tests include x rays and blood tests.

Treatment

Ptosis is usually treated surgically. Surgery can generally be done on an outpatient basis under local anesthetic. For minor drooping, a small amount of the eyelid tissue can be removed. For more pronounced ptosis, the approach is to surgically shorten the levator muscle or connect the lid to the muscles of the eyebrow. If the aponeurosis has separated from the tarsal plate, it can be reattached. Correcting the ptosis is usually done only after determining the cause of the condition. For example, myasthenia gravis must be ruled out before performing any surgery. As with any surgery, there are risks, and they should be discussed with the surgeon.

Children with ptosis need not have surgery immediately, but their vision should be checked periodically to prevent lazy eye (**amblyopia**).

"Ptosis crutches" are also available. These can be attached to the frame of eyeglasses to hold up the eyelid. These devices are uncomfortable and usually not well tolerated.

Prognosis

After diagnosing the cause of a drooping eyelid, then correcting the condition, most people have no further problems related to the ptosis. The correction, however, may still not make the eyes symmetrical.

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Patients should have reasonable expectations and discuss the outcome with their doctor prior to surgery.

Prevention

Ptosis cannot be prevented.

ORGANIZATIONS

American Academy of Ophthalmology (AAO), P. O. Box 7424, San Francisco, CA, 94120-7424, (415) 561-8500, (415) 561-8500, http://www.aao.org.

American Medical Association, 515 N. State St., Chicago, IL, 60654, (800) 621-8335, http://www.ama-assn.org.

American Optometric Association, 243 North Lindbergh Blvd., St. Louis, MO, 63141, (314) 991-4100, (314) 991-4101, (800) 365-2219, http://www.aoa.org.

Dorothy Elinor Stonely

PTSD *see* **Post-traumatic stress disorder**

PTT *see* **Partial thromboplastin time**

Puberty

Definition

Puberty is the period of human development during which physical growth and sexual maturation occurs. The English word *puberty* is derived from a Latin word, *puberatum*, which means "age of maturity."

Puberty is a term that refers primarily to the physical changes in the human body during the transition from childhood to adulthood. In contrast, *adolescence* is a social or cultural term referring to the interval of emotional and psychological development between childhood and adulthood. Although adolescence largely overlaps with puberty in terms of time frame, its boundaries are less distinct.

Demographics

The age at onset of puberty is partly population-specific. In the United States, the first sign of puberty occurs on average at age 11 in girls, with menstruation and fertility following about a year and a half later. On the other hand, African American girls begin puberty about a full year earlier than Caucasian and Hispanic girls in the United States. The reason for this difference is not known as of 2010.

Boys lag behind girls by about two years. Puberty may not begin until age 16 in boys and continue in a desultory fashion on past age 20. Unlike girls, African American boys begin puberty at roughly the same age as their counterparts in other racial groups.

The age at onset of puberty can be affected by such factors as nutritional status and geography. In general, malnourished youngsters begin puberty at later ages than those who are adequately nourished. Diseases that affect the digestive tract, such as inflammatory bowel disease (IBD) and intestinal parasites, are known to postpone the onset of puberty. **Tuberculosis** is another disease associated with later onset of puberty.

Puberty also begins later among people living at higher altitudes. As of 2010, the highest average age at onset of puberty is found among groups that practice subsistence farming in the high deserts of central Asia. In Europe, children living in the warmer climates of the countries bordering the Mediterranean begin puberty about six months earlier on average than those living in Scandinavia.

There has also been a general shift toward earlier puberty in the developed countries for the past century and a half. From 1840 to 1950 there was an average drop of four months per decade in the age of menarche (first menstrual period) in girls in Europe and North America. For example, Norwegian girls had their first period at the average age of 17 in 1840; the average age in Great Britain at that time was 16.5 years, and it was 15.3 years in southern France. In Japan, the shift toward earlier puberty took place later than in the West but was more rapid when it did occur; between 1945 and 1975, the average age of menarche in Japanese girls dropped by 11 months per decade. As of 2010, the average age of menarche in girls worldwide is 11.75 years; in the United States and Canada, it is 12.5 years.

It is thought that genetic factors account for about 46% of the variation in the timing of puberty in both boys and girls. Both early and delayed puberty are known to run in families; however, the genetic association for the timing of puberty is stronger between mothers and daughters than between fathers and sons. The remaining 54% of variation is thought to be accounted for by environmental factors.

Description

Beginning as early as age eight in girls—and two years later, on average, in boys—a group of endocrine glands known as the hypothalamic-pituitary-gonadal (HPG) axis signals the beginning of puberty. The hypothalamus (part of the brain) releases a hormone

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called gonadotropin-releasing hormone (Gn-RH) that stimulates the pituitary gland. In turn, the pituitary releases its own hormones called gonadotropins that stimulate the gonads and adrenals. From these glands come a flood of sex hormones—androgens and testosterone in the male, estrogens and progestins in the female—that regulate the growth and function of the sex organs. It is interesting to note that the gonadotropins are the same for males and females, but the sex hormones they induce are different.

Risk factors

Risk factors for differences in the timing of puberty include:

- Sex. Girls are more like to develop precocious puberty than boys, but boys are more likely to have delayed puberty than girls.
- Race. African American girls are three times more likely to develop precocious puberty than Caucasian or Hispanic girls. This racial difference, however, does not hold true for boys.
- Obesity, particularly in girls, is a risk factor for early puberty. One study found that obese girls had an 80% chance of developing breasts before their ninth birthday and starting menstruation before age 12.
- History of injury to the central nervous system caused by trauma, surgery, or radiation therapy.
- History of brain tumors or structural abnormalities in the brain.
- Exposure to products containing sex hormones, including skin or hair products, vitamins, contraceptive pills, or dietary supplements.
- History of either precocious or delayed puberty in other family members.

Causes and symptoms

Puberty begins when the part of the brain called the hypothalamus secretes a hormone (gonadotropin-releasing hormone or Gn-RH) that triggers the pituitary gland to release gonadotropins. These protein hormones in turn stimulate the gonads (ovaries or testes) to produce sex hormones. These sex hormones (especially estrogen in girls and testosterone in boys) are what causes the onset of sexual maturity.

The signs of puberty in girls according to the Tanner stages (described below) are:

- Stage 1: Prepubertal; no development of sexual characteristics
- Stage 2: Thelarche, body odor, growth spurt, first pubic hair
- Stage 3: Breasts enlarge, pubic hair becomes curly, vaginal discharge appears
- Stage 4: Menarche, breasts assume mature female shape
- Stage 5: Adult sexual maturity; pubic hair extends to inner thighs, growth in height slows then stops

The signs of puberty in boys according to the Tanner stages are:

- Stage 1: Prepubertal; no development of sexual characteristics
- Stage 2: Testes enlarge, adult body odor develops
- Stage 3: Penis enlarges, nocturnal emissions (wet dreams) begin, pubic hair appears
- Stage 4: Height spurt, enlargement of penis and scrotum, pubic hair becomes coarser and curlier, male breasts develop
- Stage 5: Adult sexual maturity; pubic hair extends to inner thighs, growth in height slows then stops

Diagnosis

Puberty falling outside the age limits considered normal for any given population should prompt a search for the cause. Parents should consult their child's pediatrician if their child shows any of the signs or symptoms of either precocious or delayed puberty. The pediatrician may refer the child to an endocrinologist (doctor who specializes in disorders of the glands that regulate growth and sexual maturation as well as other body processes).

Some of the possible disturbances of normal puberty include:

- Excess hormone stimulation is the cause for precocious puberty. It can come from the brain in the form of gonadotrophins or from the gonads and adrenals. Overproduction may be caused by functioning tumors or simple overactivity. Brain overproduction can also be the result of brain infections or injury.
- Likewise, delayed puberty is due to insufficient hormone. If the pituitary output is inadequate, so will be the output from the gonads and adrenals. On the other hand, a normal pituitary will overproduce if it senses there are not enough hormones in the circulation.
- There are several congenital disorders (polyglandular deficiency syndromes) that include failure of hormone output. These children do not experience normal puberty, but it may be induced by giving them the proper hormones at the proper time.

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KEY TERMS

Adrenals—Glands on top of the kidneys that produce four different types of hormones.

Computed tomography scan (CT)—A method of creating images of internal organs using x rays.

Embryo—The life in the womb during the first two months.

Endocrine system—A system of ductless glands that secrete hormones that regulate a variety of body processes, including growth and sexual maturation. A doctor who specializes in diseases and disorders of these glands is called an endocrinologist.

Gonadotropins—Protein hormones secreted by the pituitary gland.

Hormone—A chemical produced in one place that has an effect somewhere else in the body.

Hypothalamic-pituitary-gonadal (HPG) axis—A term used by doctors to refer to the combined effects of the hypothalamus, the pituitary gland, and the gonads. This group of glands controls sexual maturation in humans as well as other processes.

Hypothalamus—Part of the brain located deep in the center of the skull and just above the pituitary.

Gonads—Glands that make sex hormones and reproductive cells—testes in the male, ovaries in the female.

Magnetic resonance imaging (MRI)—A method of creating images of internal organs. Magnetic resonance imaging (MRI) uses magnet fields and radiofrequency signals.

Menarche—The first menstrual period in a human female, considered the central event of puberty in girls.

Pituitary—The "master gland" of the body, controlling many of the others by releasing stimulating hormones.

Precocious—Developing at an unusually early age.

Syndrome—A collection of abnormalities that occur often enough to suggest they have a common cause.

Tanner stages—A set of scales to measure sexual development during puberty, named for James Tanner (1920–2010), the British pediatrician who devised it.

Thelarche—The onset of breast development in girls. It is usually first noticed as a firm but tender lump directly under the center of the nipple.

- Finally, some females have abnormalities in hormone production that produce male characteristics—so called virilizing syndromes. Should one of these appear during adolescence, it will disturb the normal progress of puberty. Notice that virilizing requires abnormal hormones in the female, while feminizing results from absent hormones in the male. Each embryo starts out life as female. Male hormones transform it if they are present.

Examination

An office **physical examination** can reveal the development of sexual characteristics in a child. The doctor will weigh the child and compare his or her development to charts of normal development for the child's sex and age. Puberty has been divided into five sexual maturity rating (SMR) stages by two British doctors, W. Marshall and J. M. Tanner. These ratings are often referred to as Tanner stages 1–5. Staging is based on pubic hair growth, on male genital development, and female breast development. In girls, breast development precedes menarche in most cases; the medical term for this change in girls is called thelarche. Staging helps determine whether the child's development is normal for a given age.

Both sexes also grow axillary (armpit) hair and pimples. Males develop muscle mass, a deeper voice, and facial hair. Females redistribute body fat. Along with the maturing of the sex organs, there is a pronounced growth spurt averaging 3–4 in. (8–10 cm) and culminating in full adult stature. Puberty can be precocious (early) or delayed. It all depends upon the timing of the release of sex hormones. **Precocious puberty** is usually defined in North American populations as puberty beginning before age 8 in girls and age 9 in boys; delayed puberty is defined as no menarche in girls by age 16 or no testicular enlargement in boys by age 14.

Tests

Delayed or precocious puberty requires measurement of the several hormones involved to determine which are lacking or which are in excess. There are blood tests for each one. If a tumor is suspected, imaging of the suspect organ needs to be done with x rays, **computed tomography scans** (CT scans), or **magnetic resonance imaging** (MRI).

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Procedures

In the case of girls with precocious puberty, the doctor may perform a **pelvic ultrasound** to check for the presence of an ovarian cyst or tumor.

Treatment

Children who begin puberty within the normal age range and at roughly the same time as their peers do not ordinarily need treatment. Those who experience either precocious or delayed puberty may need hormonal therapy. Those whose signs of maturation are different from the usual order (for example, a girl who gets her first period long before any changes in her figure, or a boy whose voice changes abruptly before he begins to grow taller and develop facial hair) may benefit from psychological counseling.

Most teenagers experience some discomfort or embarrassment associated with the changes taking place in their bodies, ranging from **acne** and the development of adult body odor to sudden growth spurts and temporary loss of physical coordination as a result. Those who develop much earlier or later than their peers or show the signs of puberty in a different order from the usual pattern for their sex may become acutely self-conscious or anxious. Parents and other family members can help by focusing on the child's personal qualities rather than on physical appearance, and by not teasing the child about the changes taking place in his or her body. In many cases the child's doctor can provide additional reassurance and advice.

Traditional

Drugs

In precocious puberty, the offending gland or tumor may require surgical attention, although there are several drugs now that counteract the effects of hormones released too early. Drugs that have been developed to treat precocious puberty include:

- histrelin (Supprelin LA)
- nafarelin (Synarel)
- synthetic gonadotropin-releasing hormone agonist
- progestin (Depo-Provera)
- leuprolide (Lupron)

If delayed, puberty can be stimulated with the correct hormones. Treatment should not be delayed because necessary bone growth is also affected.

Some doctors, however, prefer to monitor the child's growth for a few months rather than prescribing hormones right away, particularly if there is a family history of either precocious or delayed puberty.

Prognosis

More than 99% of children begin puberty during the normal range of timing for their sex, and the small percentage of those who have precocious puberty (about 1 in every 160 children) or delayed puberty (about the same number) can usually be treated successfully.

Prevention

Some of the factors that influence the timing of puberty, like sex, race, and family history, cannot be changed. Parents can, however, keep children away from dietary supplements or adult medications containing sex hormones, and help their children maintain healthy weight levels.

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ORGANIZATIONS

American Academy of Child and Adolescent Psychiatry (AACAP), 3615 Wisconsin Avenue, N.W., Washington, DC, 20016-3007, (202) 966-7300, (202) 966-2891, http://www.aacap.org.

American Academy of Pediatrics (AAP), 141 Northwest Point Boulevard, Elk Grove Village, IL, 60007, (847) 434-4000, (847) 434-8000, http://www.aap.org.

National Institute of Child Health and Human Development (NICHD)., Bldg 31, Room 2A32, MSC 2425, 31 Center Drive, Bethesda, MD, 20892, (800) 370-2943, (866) 760-5947, NICHDInformationResourceCenter@mail.nih.gov, http://www.nichd.nih.gov.

J. Ricker Polsdorfer, MD
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Pubic lice *see* **Lice infestation**

Puerperal infection

Definition

The term puerperal infection refers to a bacterial infection following **childbirth**. The infection may also be referred to as puerperal or postpartum fever. The genital tract, particularly the uterus, is the most commonly infected site. In some cases infection can spread to other points in the body. Widespread infection, or **sepsis**, is a rare, but potentially fatal complication.

Description

Puerperal infection affects an estimated 1–8% of new mothers in the United States. Given modern medical treatment and **antibiotics**, it very rarely advances to the point of threatening a woman's life. An estimated 2–4% of new mothers who deliver vaginally suffer some form of puerperal infection, but for cesarean sections, the figure is five to ten times that high.

Deaths related to puerperal infection are very rare in the industrialized world. It is estimated three in 100,000 births result in maternal **death** due to infection. However, the death rate in developing nations may be 100 times higher.

Postpartum fever may arise from several causes, not necessarily infection. If the **fever** is related to infection, it often results from endometritis, an inflammation of the uterus. Urinary tract, breast, and wound infections are also possible, as well as septic **thrombophlebitis**, a blood clot-associated inflammation of veins. A woman's susceptibility to developing an infection is related to such factors as **cesarean section**, extended labor, **obesity**, anemia, and poor prenatal **nutrition**.

Causes and symptoms

The primary symptom of puerperal infection is a fever at any point between birth and 10 days postpartum. A temperature of 100.4°F (38°C) on any two days during this period, or a fever of 101.6°F (38.6 °C) in the first 24 hours postpartum, is cause for suspicion. An assortment of bacterial species may cause puerperal infection. Many of these bacteria are normally found in the mother's genital tract, but other bacteria may be introduced from the woman's intestine and skin or from a health care provider.

The associated symptoms depend on the site and nature of the infection. The most typical site of infection is the genital tract. Endometritis, which affects the uterus, is the most prominent of these infections. Endometritis is much more common if a small part of the placenta has been retained in the uterus. Typically, several species of bacteria are involved and may act synergistically—that is, the bacteria's negative effects are multiplied rather than simply added together. Synergistic action by the bacteria can result in a stubborn infection such as an **abscess**. The major symptoms of a genital tract infection include fever, malaise, abdominal **pain**, uterine tenderness, and abnormal vaginal discharge. If these symptoms do not respond to antibiotic therapy, an abscess or blood clot may be suspected.

Other causes of postpartum fever include urinary tract infections, wound infections, septic thrombophlebitis, and **mastitis**. Mastitis, or breast infection, is indicated by fever, malaise, achy muscles, and reddened skin on the affected breast. It is usually caused by a clogged milk duct that becomes infected. Infections of the urinary tract are indicated by fever, frequent and painful urination, and back pain. An **episiotomy** and a cesarean section carry the risk of a

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KEY TERMS

Abscess—A pus-filled area with definite borders.

Blood clot—A dense mat formed by certain components of the blood stream to prevent blood loss.

Cesarean section—Incision through the abdomen and uterus to facilitate delivery.

Computed tomography scan (CT scan)—Cross-sectional x rays of the body are compiled to create a three-dimensional image of the body's internal structures.

Episiotomy—Incision of the vulva (external female genitalia) during vaginal delivery to prevent tissue tearing.

Heparin—A blood component that controls the amount of clotting. It can be used as a drug to reduce blood clot formation.

Heparin challenge test—A medical test to evaluate how readily the blood clots.

Magnetic resonance imaging (MRI)—An imaging technique that uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

Postpartum—Referring to the time period following childbirth.

Prophylactic—Measures taken to prevent disease.

Sepsis—The presence of viable bacteria in the blood or body tissues.

Septic—Referring to the presence of infection.

Thrombophlebitis—An inflammation of veins accompanied by the formation of blood clots.

Ultrasound examination—A medical test in which high frequency sound waves are directed at a particular internal area of the body. As the sound waves are reflected by internal structures, a computer uses the data to construct an image of the structures.

Warfarin—A drug that reduces the ability of the blood to clot.

wound infection. Such infections are suggested by a fever and pus-like discharge, inflammation, and swelling at wound sites.

Diagnosis

Fever is not an automatic indicator of puerperal infection. A new mother may have a fever owing to prior illness or an illness unconnected to childbirth. However, any fever within 10 days postpartum is aggressively investigated. Physical symptoms such as pain, malaise, loss of appetite, and others point to infection.

Many doctors initiate antibiotic therapy early in the fever period to stop an infection before it advances. A pelvic examination is done and samples are taken from the genital tract to identify the bacteria involved in the infection. The pelvic examination can reveal the extent of infection and possibly the cause. Blood samples may also be taken for blood counts and to test for the presence of infectious bacteria. A **urinalysis** may also be ordered, especially if the symptoms are indicative of a **urinary tract infection**.

If the fever and other symptoms resist antibiotic therapy, an ultrasound examination or computed tomography scan (CT scan) is done to locate potential abscesses or **blood clots** in the pelvic region. **Magnetic resonance imaging** (MRI) may be useful as well, in addition to a heparin challenge test if blood clots are suspected. If a lung infection is suspected, a **chest x ray** may also be ordered.

Treatment

Antibiotic therapy is the backbone of puerperal infection treatment. Initial antibiotic therapy may consist of clindamycin and gentamicin, which fight a broad array of bacteria types. If the fever and other symptoms do not respond to these antibiotics, a third, such as ampicillin, is added. Other antibiotics may be used depending on the identity of the infective bacteria and the possibility of an allergic reaction to certain antibiotics.

Antibiotics taken together are effective against a wide range of bacteria, but may not be capable of clearing up the infection alone, especially if an abscess or blood clot is present. Heparin is combined with the antibiotic therapy in order to break apart blood clots. Heparin is used for five–seven days, and may be followed by warfarin for the following month. If the infection is complicated, it may be necessary to surgically drain the infected site. Infected episiotomies can be opened and allowed to drain, but abscesses and blood clots may require surgery.

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Prognosis

Antibiotic therapy and other treatment measures are virtually always successful in curing puerperal infections.

Prevention

Careful attention to antiseptic procedures during childbirth is the basic underpinning of preventing infection. With some procedures, such as cesarean section, a doctor may administer prophylactic antibiotics as a preemptive strike against infectious bacteria.

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Julia Barrett

Pulmonary alveolar proteinosis

Definition

Pulmonary alveolar proteinosis (PAP) is a rare disease of the lungs.

Description

In this disease, also called alveolar proteinosis or phospholipidosis, gas exchange in the lungs is progressively impaired by the accumulation of phospholipids, compounds widely found in other living cells of the body. The alveoli are filled with this substance that renders them less effective in protecting the lung. This may explain why infections are often associated with the disease.

Pulmonary alveolar proteinosis most commonly affects people ages 20–50, although it has been reported in children and the elderly. The incidence is 5 out of every 1 million people. The disease is more common among males.

KEY TERMS

Alveoli—The small cavities, or air sacs, in the lungs.

Bronchoscopy—A bronchoscopy is the examination of the bronchi, the primary divisions of the trachea that penetrate the lung, through a tube called a bronchoscope.

Clubbing—Clubbing is the rounding of the ends and swelling of fingers found in people with lung disease.

Remission—Lessening of severity, or abatement of symptoms.

Transtracheal biopsy—A transtracheal biopsy is the removal of a small piece of tissue from across the trachea or windpipe for examination under a microscope.

Causes and symptoms

The cause of this disease is unknown. In some people, however, it appears to result from infection, immune deficiency, or from exposure to silica, aluminum oxide, and a variety of dusts and fumes.

Symptoms include mild **shortness of breath** associated with a nonproductive or minimally productive **cough**, weight loss, and **fatigue**. Acute symptoms such as **fever** or progressive shortness of breath suggest a complicating infection.

Diagnosis

Physical examination may reveal clubbing of the fingers or a bluish coloration of the skin as a result of decreased oxygen.

A **chest x ray** may show alveolar disease. An arterial blood gas reveals low oxygen levels in the blood. **Bronchoscopy** with transtracheal biopsy shows alveolar proteinosis. Specific diagnosis requires a **lung biopsy**.

Treatment

Treatment consists of periodic whole-lung lavage, a washing out of the phospholipids from the lung with a special tube placed in the trachea. This is performed under **general anesthesia**.

Prognosis

In some, spontaneous remission occurs, while in others progressive **respiratory failure** develops.

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Disability from respiratory insufficiency is common, but **death** rarely occurs. Repeated lavage may be necessary. Lung transplant is a last resort option.

Prevention

There is no known prevention for this very rare disorder.

ORGANIZATIONS

American Association for Respiratory Care, 9425 N. MacArthur Blvd, Suite 100, Irving, TX, 75063-4706, (972) 243-2272, (972) 484-2720, info@aarc.org, http://ww.aarc.org.

American Lung Association, 1301 Pennsylvania Ave. NW, Suite 800, Washington, DC, 20001, (202) 758-3355, (202) 452-1805, (800) 548-8252, info@lungusa.org, http://www.lungusa.org/.

Lorraine Steefel, RN

Pulmonary artery catheterization

Definition

Pulmonary artery catheterization is a diagnostic procedure in which a small catheter is inserted through a neck, arm, chest, or thigh vein and maneuvered into the right side of the heart, in order to measure pressures at different spots in the heart.

Purpose

Pulmonary artery catheterization is performed to:

- evaluate heart failure
- monitor therapy after a heart attack
- check the fluid balance of a patient with serious burns, kidney disease, or after heart surgery
- check the effect of medications on the heart

Precautions

Pulmonary artery catheterization is a potentially complicated and invasive procedure. The doctor must decide if the value of the information obtained will outweigh the risk of catheterization.

Description

Pulmonary artery catheterization, sometimes called Swan-Ganz catheterization, is usually performed at the bedside of a patient in the intensive care unit. A catheter is threaded through a vein in the arm, thigh, chest, or neck until it passes through the right side of the heart. This procedure takes about 30 minutes. **Local anesthesia** is given to reduce discomfort.

Once the catheter is in place, the doctor briefly inflates a tiny balloon at its end. This temporarily blocks the blood flow and allows the doctor to make a pressure measurement in the pulmonary artery system. Pressure measurements are usually recorded for the next 48–72 hours in different parts of the heart. During this time, the patient must stay in bed so the catheter stays in place. Once the pressure measurements are no longer needed, the catheter is removed.

Preparation

Before and during the test, the patient will be connected to an electrocardiograph, which makes a recording of the electrical stimuli that cause the heart to contract. The insertion site is sterilized and prepared. The catheter is often sutured to the skin to prevent dislodgment.

Aftercare

The patient is observed for any signs of infection or complications from the procedure.

Risks

Pulmonary artery catheterization is not without risks. Possible complications from the procedure include:

- infection at the site where the catheter was inserted
- pulmonary artery perforation
- blood clots in the lungs
- irregular heartbeat

Normal results

Normal pressures reflect a normally functioning heart with no fluid accumulation. These normal pressure readings are:

- right atrium: 1–6 mm of mercury (mm Hg)
- right ventricle during contraction (systolic): 20–30 mm Hg
- right ventricle at the end of relaxation (end diastolic): less than 5 mm Hg
- pulmonary artery during contraction (systolic): 20–30 mm Hg
- pulmonary artery during relaxation (diastolic): about 10 mm Hg
- mean pulmonary artery: less than 20 mm Hg
- pulmonary artery wedge pressure: 6–12 mm Hg
- left atrium: about 10 mm Hg

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KEY TERMS

Cardiac shunt—A defect in the wall of the heart that allows blood from different chambers to mix.

Abnormal results

Abnormally high right atrium pressure can indicate:

- pulmonary disease
- right side heart failure
- fluid accumulation
- compression of the heart after hemorrhage (cardiac tamponade)
- right heart valve abnormalities
- pulmonary hypertension (high blood pressure)

Abnormally high right ventricle pressure may indicate:

- pulmonary hypertension (high blood pressure)
- pulmonary valve abnormalities
- right ventricle failure
- defects in the wall between the right and left ventricle
- congestive heart failure
- serious heart inflammation

Abnormally high pulmonary artery pressure may indicate:

- diversion of blood from a left-to-right cardiac shunt
- pulmonary artery hypertension
- chronic obstructive pulmonary disease or emphysema
- blood clots in the lungs
- fluid accumulation in the lungs
- left ventricle failure

Abnormally high pulmonary artery wedge pressure may indicate:

- left ventricle failure
- mitral valve abnormalities
- cardiac insufficiency
- compression of the heart after hemorrhage

Resources

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Tish Davidson, A.M.

Pulmonary edema

Definition

Pulmonary **edema** is a condition in which fluid accumulates in the lungs, usually because the heart's left ventricle does not pump adequately.

Description

The build-up of fluid in the spaces outside the blood vessels of the lungs is called pulmonary edema. Pulmonary edema is a common complication of heart disorders, and most cases of the condition are associated with **heart failure**. Pulmonary edema can be a chronic condition, or it can develop suddenly and quickly become life threatening. The life-threatening type of pulmonary edema occurs when a large amount of fluid suddenly shifts from the pulmonary blood vessels into the lung, due to lung problems, **heart attack**, trauma, or toxic chemicals. It can also be the first sign of coronary heart disease.

In heart-related pulmonary edema, the heart's main chamber, the left ventricle, is weakened and does not function properly. The ventricle does not completely eject its contents, causing blood to back up and cardiac output to drop. The body responds by increasing blood pressure and fluid volume to compensate for the reduced cardiac output. This, in turn, increases the force against which the ventricle must expel blood. Blood backs up, forming a pool in the pulmonary blood vessels. Fluid leaks into the spaces between the tissues of the lungs and begins to accumulate. This process makes it more difficult for the lungs to expand. It also impedes the exchange of air and gases between the lungs and blood moving through lung blood vessels.

Causes and symptoms

Most cases of pulmonary edema are caused by failure of the heart's main chamber, the left ventricle. It can be brought on by an acute heart attack, severe **ischemia**, volume overload of the heart's left ventricle, and mitral stenosis. Non-heart-related pulmonary edema is caused by lung problems like **pneumonia**, an excess of intravenous fluids, some types of **kidney disease**, bad **burns**, **liver disease**, nutritional problems, and **Hodgkin's disease**. Non-heart-related pulmonary edema can also be caused by conditions where the lungs do not drain properly, and other conditions where the respiratory veins are blocked.

Early symptoms of pulmonary edema include:

- shortness of breath upon exertion
- sudden respiratory distress after sleep

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- difficulty breathing, except when sitting upright
- coughing

In cases of severe pulmonary edema, these symptoms will worsen to:

- labored and rapid breathing
- frothy, bloody fluid containing pus coughed from the lungs (sputum)
- a fast pulse and possibly serious disturbances in the heart's rhythm (atrial fibrillation, for example)
- cold, clammy, sweaty, and bluish skin
- a drop in blood pressure resulting in a thready pulse

Diagnosis

A doctor can usually diagnose pulmonary edema based on the patient's symptoms and a physical exam. Patients with pulmonary edema will have a rapid pulse, rapid breathing, abnormal breath and heart sounds, and enlarged neck veins. A **chest x ray** is often used to confirm the diagnosis. Arterial blood gas testing may be done. Sometimes **pulmonary artery catheterization** is performed to confirm that the patient has pulmonary edema and not a disease with similar symptoms (called **adult respiratory distress syndrome** or "noncardiogenic pulmonary edema").

Treatment

Pulmonary edema requires immediate emergency treatment. Treatment includes: placing the patient in a sitting position, oxygen, assisted or mechanical ventilation (in some cases), and drug therapy. The goal of treatment is to reduce the amount of fluid in the lungs, improve gas exchange and heart function, and, where possible, to correct the underlying disease.

To help the patient breathe better, he/she is placed in a sitting position. High concentrations of oxygen are administered. In cases where respiratory distress is severe, a mechanical ventilator and a tube down the throat (tracheal intubation) will be used to improve the delivery of oxygen. Non-invasive pressure support ventilation is a new treatment for pulmonary edema in which the patient breathes against a continuous flow of positive airway pressure, delivered through a face or nasal mask. Non-invasive pressure support ventilation decreases the effort required to breath, enhances oxygen and carbon dioxide exchange, and increases cardiac output.

Drug therapy could include morphine, nitroglycerin, **diuretics**, angiotensin-converting enzyme (ACE) inhibitors, and **vasodilators**. Vasopressors are used for cardiogenic shock. Morphine is very effective in reducing the patient's **anxiety**, easing breathing, and improving blood flow. Nitroglycerin reduces pulmonary blood flow and decreases the volume of fluid entering the overloaded blood vessels. Diuretics, like furosemide (Lasix), promote the elimination of fluids through urination, helping to reduce pressure and fluids in the blood vessels. ACE inhibitors reduce the pressure against which the left ventricle must expel blood. In patients who have severe **hypertension**, a vasodilator such as nitroprusside sodium (Nipride) may be used. For cardiogenic shock, an adrenergic agent (like dopamine hydrochloride [Intropin], dobutamine hydrochloride [Dobutrex], or epinephrine) or a bipyridine (like amrinone lactate [Inocor] or milrinone lactate [Primacor]) are given.

KEY TERMS

Edema—Swelling caused by accumulation of fluid in body tissues.

Ischemia—A condition in which the heart muscle receives an insufficient supply of blood and slowly starves.

Left ventricle—The large chamber on the lower left side of the heart. The left ventricle sends blood to the aorta and the rest of the body.

Mitral stenosis—Narrowing or constricting of the mitral valve, which separates the left atrium from the left ventricle.

Pulmonary—Referring to the lungs and respiratory system.

Prognosis

Most patients with pulmonary edema who seek immediate treatment can be treated quickly and effectively.

Prevention

Cardiogenic pulmonary edema can sometimes be prevented by treating the underlying heart disease. These treatments can include maintaining a healthy diet, taking appropriate medications correctly, and avoiding excess alcohol and salt.

Resources

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Lori De Milto

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Pulmonary embolism

Definition

Pulmonary **embolism** is an obstruction of a blood vessel in the lungs, usually due to a blood clot, which blocks a coronary artery.

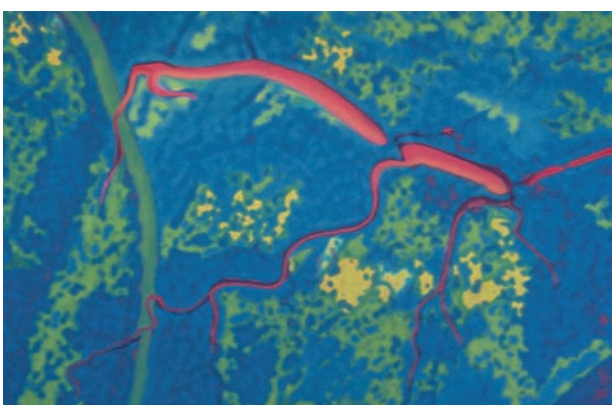
Description

Pulmonary embolism is a fairly common condition that can be fatal. According to the American Heart Association, an estimated 600,000 Americans develop pulmonary embolism annually; 60,000 die from it. As many as 25,000 Americans are hospitalized each year for pulmonary embolism, which is a relatively common complication in hospitalized patients. Even without warning symptoms, pulmonary embolism can cause sudden **death**. Treatment is not always successful.

Pulmonary embolism is difficult to diagnose. Less than 10% of patients who die from pulmonary embolism were diagnosed with the condition. It occurs when emboli block a pulmonary artery, usually due to a blood clot that breaks off from a large vein and travels to the lungs. More than 90% of cases of pulmonary embolism are complications of **deep vein thrombosis**, **blood clots** from the leg or pelvic veins. Emboli can also be comprised of fat, air, or tumor tissue. When emboli block the main pulmonary artery, pulmonary embolism can quickly become fatal.

Causes and symptoms

Pulmonary embolism is caused by emboli that travel through the blood stream to the lungs and block a pulmonary artery. When this occurs, circulation and oxygenation of blood is compromised. The emboli are usually formed from blood clots but are occasionally comprised of air, fat, or tumor tissue. Risk factors include: prolonged bed rest, surgery, **childbirth**, **heart attack**, **stroke**, congestive **heart failure**, **cancer**, **obesity**, a broken hip or leg, **oral contraceptives**, sickle cell anemia, congenital **coagulation disorders**, chest trauma, certain congenital heart defects, and old age.



An angiography of a pulmonary embolism. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Common symptoms of pulmonary embolism include:

- labored breathing, sometimes accompanied by chest pain
- a rapid pulse
- a cough that produces bloody sputum
- a low fever
- fluid build-up in the lungs

Less common symptoms include:

- coughing up a lot of blood
- pain caused by movement
- leg swelling
- bluish skin
- fainting
- swollen neck veins

In some cases there are no symptoms.

Diagnosis

Pulmonary embolism can be diagnosed through the patient's history, a physical exam, and diagnostic tests including **chest x ray**, lung scan, pulmonary **angiography**, **electrocardiography**, arterial blood gas measurements, and leg vein ultrasonography or **venography**.

A chest x ray can be normal or show fluid or other signs and rule out other diseases. The lung scan shows poor flow of blood in areas beyond blocked arteries. The patient inhales a small amount of a radiopharmaceutical and pictures of airflow into the lungs are taken with a gamma camera. Then a different radiopharmaceutical is injected into an arm vein and lung blood flow is scanned. A normal result essentially rules out pulmonary embolism. A lung scan can be performed in a hospital or an outpatient facility and takes about 45 minutes.

Pulmonary angiography is the most reliable test for diagnosing pulmonary embolism but it is not used often, because it carries some risk and is expensive, invasive, and not readily available in many hospitals. Pulmonary angiography is a radiographic test which involves injection of a pharmaceutical "contrast agent" to show up the pulmonary arteries. A cinematic camera records the blood flow through the lungs of the

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patient, who lies on a table. Pulmonary angiography is usually performed in a hospital's radiology department and takes 30 minutes to one hour.

An electrocardiograph shows the heart's electrical activity and helps distinguish pulmonary embolism from a heart attack. Electrodes covered with conducting jelly are placed on the patient's chest, arms, and legs. Impulses of the heart's activity are traced on paper. The test takes about 10 minutes and can be performed in a physician's office or hospital lab.

Arterial blood gas measurements can be helpful, but they are rarely diagnostic for pulmonary embolism. Blood is taken from an artery instead of a vein, usually in the wrist and it is analyzed for oxygen, carbon dioxide and acid levels.

Venography is used to look for deep vein thrombosis, the most likely source of pulmonary embolism. It is very accurate, but it is not used often, because it is painful, expensive, exposes the patient to a fairly high dose of radiation, and can cause complications. Venography identifies the location, extent, and degree of attachment of the blood clots and enables the condition of the deep leg veins to be assessed. A contrast solution is injected into a foot vein through a catheter. The physician observes the movement of the solution through the vein with a fluoroscope while a series of x rays are taken. Venography takes between 30–45 minutes and can be done in a physician's office, a laboratory, or a hospital. Radionuclide venography, in which a radioactive isotope is injected, is occasionally used, especially if a patient has had reactions to contrast solutions. Most commonly performed tests are ultrasound and Doppler studies of leg veins.

Treatment

Patients with pulmonary embolism are hospitalized and generally treated with clot-dissolving and clot-preventing drugs. **Oxygen therapy** is often needed to maintain normal oxygen concentrations. For people who can't take anticoagulants and in some other cases, surgery may be needed to insert a device that filters blood returning to the heart and lungs. The goal of treatment is to maintain the patient's cardiovascular and respiratory functions while the blockage resolves, which takes 10–14 days, and to prevent the formation of other emboli.

Thrombolytic therapy to dissolve blood clots is the aggressive treatment for very severe pulmonary embolism. Streptokinase, urokinase, and recombinant tissue plasminogen activator (TPA) are thrombolytic agents. Heparin is the injectable anticoagulant (clot-preventing) drug of choice for preventing formation of blood clots. Warfarin, an oral anticoagulant, is usually continued when the patient leaves the hospital and doesn't need heparin any longer.

KEY TERMS

Deep vein thrombosis—A blood clot in the calf's deep vein. This frequently leads to pulmonary embolism if untreated.

Emboli—Clots or other substances that travel through the blood stream and get stuck in an artery, blocking circulation.

Thrombosis—The development of a blood clot inside a blood vessel.

Prognosis

About 10% of patients with pulmonary embolism die suddenly within the first hour of onset of the condition. The outcome for all other patients is generally good; only 3% of patients who are properly diagnosed and treated die. In cases of undiagnosed pulmonary embolism, about 30% of patients die.

Prevention

Pulmonary embolism risk can be reduced in certain patients through judicious use of antithrombotic drugs such as heparin, venous interruption, gradient elastic stockings and/or intermittent pneumatic compression of the legs.

ORGANIZATIONS

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Lori De Milto

Pulmonary fibrosis

Definition

Pulmonary fibrosis is scarring in the lungs.

Description

Pulmonary fibrosis develops when the alveoli, tiny air sacs that transfer oxygen to the blood, become damaged and inflamed. The body tries to heal the

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KEY TERMS

Alveoli—Tiny air sacs in the lungs where oxygen and carbon dioxide are exchanged with the blood.

Autoimmune disease—A disease that develops when the immune system attacks normal cells or organs.

Bronchoscopy scan—The examination of the air passages through a flexible or rigid tube inserted into the nostril (or mouth). Sometimes cells are collected by washing the lungs with a small amount of fluid.

Computed tomography (CT)—A special x-ray technique that produces a cross sectional image of the organs inside the body.

Corticosteroids—A class of drugs, related to hormones naturally found in the body, that suppress the immune system. One example is prednisone, sold under many brand names including Deltasone.

End-stage lung disease—The final stages of lung disease, when the lung can no longer keep the blood supplied with oxygen. End-stage lungs in pulmonary fibrosis have large air spaces separated by bands of inflammation and scarring.

Farmer's lung—An allergic reaction to moldy hay, most often seen in farmers, that results in lung disease.

Immune suppressant drug—Any drug that dampens immune responses and decreases inflammation.

Inflammation—The body's reaction to an irritant, characterized by the accumulation of immune cells, redness, and swelling.

Lung function tests—Tests of how much air the lungs can move in and out, and how quickly and efficiently this can be done. Lung function tests are usually done by breathing into a device that measures air flow.

Mucous membranes—The moist coverings that line the mouth, nose, intestines, and other internal organs.

Pulmonary artery—The blood vessel that delivers blood from the heart to the lungs.

Sarcoidosis—A disease of unknown origin that results in clumps of immune cells and inflammation in organs throughout the body.

damage with **scars**, but these scars collapse the alveoli and make the lungs less elastic. If the cycle of inflammation and scarring continues, the lungs become increasingly unable to deliver oxygen to the blood. Changes in the lungs can also increase the blood pressure in the pulmonary artery. This condition, called **pulmonary hypertension**, makes the heart work harder and it may cause **heart failure**.

Pulmonary fibrosis can result from many different lung diseases including **sarcoidosis**, drug reactions, autoimmune diseases, environmental **allergies** such as Farmer's lung, and exposure to toxic dusts and gases.

Pulmonary fibrosis that develops without a known cause is called idiopathic pulmonary fibrosis. This disease is equally common in men and women. It is usually diagnosed between the ages of 40 and 60.

Causes and symptoms

The causes and risk factors vary with the underlying disease. They may include genetics, environmental factors, and infections.

The first symptom of pulmonary fibrosis is usually shortness of breath—at first, during **exercise**, but later also while resting. Patients may also have a dry **cough**, a rapid heartbeat, or enlargement of the fingertips and ends of the toes. Some people feel tired or have a **fever**, weight loss, muscle or joint pains. In late stages of the disease, the lack of oxygen in the blood can give the skin and mucus membranes a blue tinge known as **cyanosis**.

Diagnosis

Pulmonary fibrosis is often referred to a lung specialist. Several tests are usually needed to diagnose this disease and determine its cause. They include a **physical examination**, detailed history of the symptoms, chest x rays, lung function tests, and blood tests, including a measurement of the amount of oxygen in the blood. Computed tomography (CT scan) may give a more detailed picture of the lungs. **Bronchoscopy** may be done to examine the air passages and analyze the cells found deep in the lungs.

Lung biopsies are necessary to diagnose some diseases. Lung biopsies can be done through a needle

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inserted into the chest through the skin, during bronchoscopy, or as a surgical procedure under **general anesthesia**.

Treatment

The treatment of pulmonary fibrosis depends on the underlying cause. Many diseases are treated by suppressing inflammation with **corticosteroids**. Stronger immune suppressants such as cyclophosphamide (Cytoxan) or azathioprine (Imuran) may also be tried. Some patients need supplemental oxygen. A lung transplant may be an option for incurable diseases. Approximately 60–80% of patients live for at least two years after the transplant.

There is no good treatment for idiopathic pulmonary fibrosis. Only 10–20% of patients with this disease respond to corticosteroids.

Alternative treatment

Anxiety and fear can make breathing difficulties worse. Some patients find that activities such as **yoga**, prayer or **meditation**, **music therapy**, or **biofeedback** help to relax them.

Prognosis

The prognosis depends on the specific disease. Some cases may stop progressing or improve, particularly if the cause can be identified and treated. Others may develop quickly or slowly into end-stage lung disease. The course of idiopathic pulmonary fibrosis is very difficult to predict; however, average survival is approximately five to seven years.

Prevention

There is no known prevention for idiopathic pulmonary fibrosis.

Some ways to prevent other causes of pulmonary fibrosis are:

- avoid exposure to particle dust such as asbestos, coal dust, and silica
- avoid exposure to chemical fumes
- do not smoke

Resources

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ORGANIZATIONS

American Lung Association, 1301 Pennsylvania Ave. NW, Suite 800, Washington, DC, 20001, (202) 758-3355, (202) 452-1805, (800) 548-8252, info@lungusa.org, http://www.lungusa.org/.

Pulmonary Fibrosis Association, 811 W Evergreen Avenue, Suite 303, Chicago, IL, 60642-2642, (888) 733-6741, info@pulmonaryfibrosis.org, http://www.pulmonaryfibrosis.org.

Anna Rovid Spickler, D.V.M., Ph.D.

Pulmonary function tests

Definition

Pulmonary function tests are a group of procedures that measure the function of the lungs, revealing problems in the way a patient breathes. The tests can determine the cause of **shortness of breath** and may help confirm the diagnosis of such lung diseases as **asthma**, **bronchitis**, or **emphysema**. The tests also are performed before any major **lung surgery** to make sure the person won't be disabled by having a reduced lung capacity.

Purpose

Pulmonary function tests can help a doctor diagnose a range of respiratory diseases that might not otherwise be obvious to the doctor or the patient. The tests are important since many kinds of lung problems can be successfully treated if detected early. The tests are also used to measure how a lung disease is progressing, and how serious the lung disease has become. Pulmonary function tests can also be used to assess how a patient is responding to different treatments.

The basic pulmonary function test is **spirometry** (from the Greco-Latin term meaning "to measure breathing"). This test, which can be given in a hospital or doctor's office, measures how much and how fast the air is moving in and out of the lungs. Specific measurements taken during the test include the volume of air from start to finish (the forced vital capacity or FVC); the fastest flow that is achieved; and the volume of air exhaled in the first second of the test.

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Adult woman using a peak flow meter. *(Edwige/Age Fotostock.)*

This third measurement is known as the forced expiratory volume or FEV1.

Precautions

Pulmonary function tests shouldn't be given to patients who have had a recent **heart attack**, or who have certain other types of heart disease. It is crucial that the patient cooperate with the health care team if accurate results are to be obtained.

Description

For a basic pulmonary function test (PFT), the patient places a clip over the nose and breathes through the mouth into a tube connected to a machine known as a spirometer. First the patient breathes in deeply and then exhales as quickly and forcefully as possible into the tube. The exhalation must last at least 6 seconds for the machine to work properly. Usually the patient repeats this test three times, and the best of the three results is considered to be the measure of the patient's lung function. The results will help a doctor figure out which type of treatment to pursue.

A peak flow meter can determine how much a patient's airways have narrowed. The peak flow meter is a small handheld device that measures how rapidly a person suspected of asthma can exhale air. This measurement is called the peak expiratory flow rate or PEFR. The peak flow test is not considered the best way to evaluate a patient for asthma, however, as accurate measurement of PEFR requires training to use the meter correctly. Moreover, the normal expected value depends on the patient's sex, age and height and can be quite variable even under ordinary circumstances. Peak flow meters appear to be most useful to a small subset of asthma patients who need to monitor their use of medications.

Another test that can be given to evaluate patients with asthma is the inhalation challenge test. The patient is asked to inhale either cold air or a drug (usually histamine or methacholine) known to irritate the upper airway and produce bronchoconstriction, or narrowing of the airway. Patients with asthma will react to lower doses of the irritant than those with normal lungs.

A test of blood gases is a measurement of the concentration of oxygen and carbon dioxide in the blood, which shows how efficient the gas exchange is in the lungs.

Another type of lung function test reveals how efficient the lungs are in absorbing gas from the blood. This is measured by testing the volume of carbon monoxide a person breathes out after a known volume of the gas has been inhaled. Called the carbon monoxide diffusing test or the transfer factor test, this test consists of asking the patient to first breathe out as much air as possible. The patient is then asked to take a deep breath of a mixture of carbon monoxide (usually about 0.3%) and helium or some other inert tracer gas. The patient holds the gas mixture in the lungs for 10 seconds and then exhales it. The first part of the exhaled gas is discarded; the second portion, which represents the part of the gas that reached the alveoli in the lungs, is analyzed for its carbon monoxide content. This measurement allows the doctor to calculate how much carbon monoxide was taken up by the alveoli while the patient was holding his or her breath.

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KEY TERMS

Alveoli (singular, alveolus)—Small spherical sacs at the ends of the bronchioles in the lungs in which blood gases are exchanged.

Body plethysmography—A very sensitive test given to measure damage to the lungs that might be missed by routine pulmonary function tests. The patient sits within a so-called airtight body box while various devices measure both the air pressure in the patient's alveoli and the airflow through the respiratory system.

Carbon monoxide diffusing test—Also called the transfer factor test, this test measures the ability of the patient's lungs to transfer blood gases.

Emphysema—A disease in which the small air sacs in the lungs become damaged, causing shortness of breath. In severe cases it can lead to respiratory or heart failure.

Forced expiratory volume (FEV1)—The maximum volume of air that the patient can forcibly blow out in the first second during the forced vital capacity (FVC) test.

Forced vital capacity (FVC)—A measurement of the volume of air that the patient can exhale from the lungs after taking a deep breath. To measure the FVC, the patient is asked to take the deepest breath they can and then exhale into a sensor as hard as possible for as long as possible.

Functional residual capacity (FRC)—The volume of air left in the lungs at the end of passive expiration (breathing out). It can be measured by body plethysmography.

Inhalation challenge test—A test given to diagnose asthma by asking the patient to breathe cold air, methacholine, histamine, or another airway irritant and measuring the decline (if any) in the forced expiratory volume (FEV1).

Peak flow—A measurement of the maximum speed of the patient's expiration (breathing out). It is also known as the peak expiratory flow rate or PEFR. Peak flow is measured by a small handheld device called a peak flow meter.

Spirometer—A device used to measure the volume of air inhaled and exhaled by the patient's lungs. It can also be used to measure the rate at which the air in breathed in and out over a specified period of time.

Total lung capacity—The volume of air in the lungs at the end of a deep breath. The normal value in adults is between 4 and 6 quarts.

Body plethysmography is a sophisticated and highly sensitive test used to measure the volume of air in the lungs or the amount of airflow in patients who are too weak to perform multi-breath pulmonary function tests or whose loss of lung function might not be detected by conventional PFTs. The patient sits inside an airtight "body box" and breathes or pants into a mouthpiece connected to a transducer mounted in the wall of the box. Body plethysmography can be used to measure the total volume of air in the patient's lungs and the lungs' resistance to airflow. It can also be used to measure the patient's functional residual capacity (FRC), which is the amount of air remaining in the lungs at the end of a passive (unforced) exhalation. This information can help the doctor to distinguish between obstructive and restrictive lung disease, or to evaluate the patient's response to an inhalation challenge test.

Preparation

The patient should not eat a heavy meal before the test, nor smoke for four to six hours beforehand. The patient's doctor will issue specific instructions about whether or not to use specific medications, including **bronchodilators** or inhalers, before the test. Sometimes medication may be administered as part of the test.

Patients preparing for an inhalation challenge test should tell their doctor if they have recently had a cold or other viral infection, or shots or immunizations, as these can affect the results of the test.

Body plethysmography requires a period of coaching and somewhat complex instructions for the subject prior to the test. It must also be conducted by a specially trained and certified pulmonary function technologist.

Risks

The risk is minimal for most people, although the test carries a slight risk of a collapsed lung in some patients with lung disease.

Normal results

Normal results are based on a person's age, height, and sex. Normal results are expressed as a percentage of

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the predicted lung capacity. The prediction takes into account the patient's age, height, and sex.

Abnormal results

Abnormal results mean that the person's lung capacity is less than 80% of the predicted value. Such findings usually mean that there is some degree of chest or lung disease.

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ORGANIZATIONS

American Lung Association, 1301 Pennsylvania Ave. NW, Washington, DC, 20004, (202) 785-3355, http://www.lungusa.org.

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Pulmonary heart disease *see* **Cor pulmonale**

Pulmonary hypertension

Definition

Pulmonary **hypertension** is a rare lung disorder characterized by increased pressure in the pulmonary artery. The pulmonary artery carries oxygen-poor blood from the lower chamber on the right side of the heart (right ventricle) to the lungs where it picks up oxygen.

Description

Pulmonary hypertension is present when the blood pressure in the circulation of the lungs is measured at greater than 25 mm of mercury (Hg) at rest or 30 mm Hg during **exercise**. Pulmonary hypertension can be either primary or secondary:

- Primary pulmonary hypertension. The cause of pulmonary hypertension is unknown. It is rare, affecting one person per million. The illness most often occurs in young adults, especially women.
- Secondary pulmonary hypertension. Secondary pulmonary hypertension is increased pressure of the blood vessels of the lungs as a result of other medical conditions.

Regardless of whether pulmonary hypertension is primary or secondary, the disorder results in thickening of the pulmonary arteries and narrowing of these blood vessels. In response, the right side of the heart works harder to move the blood through these arteries and it becomes enlarged. Eventually overworking the right side of the heart may lead to right-sided **heart failure**, resulting in **death**.

Causes and symptoms

While the cause of primary pulmonary hypertension is uncertain, researchers think that in most people who develop the disease, the blood vessels are sensitive to certain factors that cause them to narrow. Diet suppressants, **cocaine**, and **pregnancy** are some of the factors that are thought to trigger constriction or narrowing of the pulmonary artery. In about 6–10% of cases, primary pulmonary hypertension is inherited.

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Secondary pulmonary hypertension can be associated with breathing disorders such as **emphysema** and **bronchitis**, or diseases such as **scleroderma**, **systemic lupus erythematosus** (SLE) or **congenital heart disease** involving heart valves, and pulmonary thromboembolism.

Symptoms of pulmonary hypertension include **shortness of breath** with minimal exertion, general **fatigue**, **dizziness**, and **fainting**. Swelling of the ankles, bluish lips and skin, and chest **pain** are among other symptoms of the disease.

Diagnosis

Pulmonary hypertension is rarely detected during routine physical examinations and, therefore, often progresses to later stages before being diagnosed. In addition to listening to heart sounds with a stethoscope, physicians also use electrocardiogram, **pulmonary function tests**, perfusion lung scan, and/or right-heart **cardiac catheterization** to diagnose pulmonary hypertension.

Treatment

The aim of treatment for pulmonary hypertension is to treat the underlying cause, if it is known. For example, thromboendarterectomy is a surgical procedure performed to remove a blood clot on the lung that is causing the pulmonary hypertension. Lung transplants are another surgical treatment.

Some patients are helped by taking medicines that make the work of the heart easier. Anticoagulants, drugs that thin the blood, decrease the tendency of the blood to clot and allow blood to flow more freely. **Diuretics** decrease the amount of fluid in the body and reduce the amount of work the heart has to do. **Calcium channel blockers** relax the smooth muscle in the walls of the heart and blood vessels and improve the ability of the heart to pump blood.

One effective medical treatment that dilates blood vessels and seems to help prevent **blood clots** from forming is epoprostenol (prostacyclin). Prostacyclin is given intravenously to improve survival, exercise duration, and well-being. It is sometimes used as a bridge to help people who are waiting for a lung transplant. In other cases it is used for long-term treatment.

Some people require supplemental oxygen through nasal prongs or a mask if breathing becomes difficult.

Prognosis

Pulmonary hypertension is chronic and incurable with an unpredictable survival rate. Length of survival has been improving, with some patients able to live 15–20 years or longer with the disorder.

KEY TERMS

Hypertension—The medical term for abnormally high blood pressure.

Perfusion lung scan—A scan that shows the pattern of blood flow in the lungs.

Pulmonary—Having to do with the lungs.

Pulmonary function test—A test that measures how much air the lungs hold and the air flow in and out of the lungs.

Right-heart cardiac catherization—A medical procedure during which a physician threads a catheter into the right side of the heart to measure the blood pressure in the right side of the heart and the pulmonary artery. The right heart's pumping ability can also be evaluated.

Prevention

Since the cause of primary pulmonary hypertension is still unknown, there is no way to prevent or cure this disease. A change in lifestyle may assist patients with daily activities. For example, relaxation exercises help to reduce **stress**. Good health habits such as a healthy diet, not **smoking**, and getting plenty of rest should be maintained.

Resources

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ORGANIZATIONS

American Association for Respiratory Care, 9425 N. MacArthur Blvd, Suite 100, Irving, TX, 75063-4706, (972) 243-2272, (972) 484-2720, info@aarc.org, http://ww.aarc.org.

Pulmonary Hypertension Association, 801 Roeder Road, Ste. 1000, Silver Spring, MD, 20910, (301) 565-3004, (301) 565-3994, http://www.phassociation.org.

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Pulmonary incompetence *see* **Pulmonary valve insufficiency**

Pulmonary regurgitation *see* **Pulmonary valve insufficiency**

Pulmonary stenosis *see* **Pulmonary valve stenosis**

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Pulmonary valve insufficiency

Definition

Pulmonary valve insufficiency is a disorder involving a defect of the valve located in the pulmonary artery.

Description

This disorder is also known as pulmonary valve regurgitation or pulmonary incompetence. The pulmonary valve is the structure in the pulmonary artery consisting of three flaps, which open and close during each heartbeat. The flaps keep blood from flowing back into the heart from the pulmonary artery—the artery that supplies blood to the lungs. With pulmonary valve insufficiency, the flaps may allow the blood to flow backward, resulting in a distinct murmur. The disorder may be congenital, but also often occurs in patients with severe **pulmonary hypertension**.

Causes and symptoms

There are generally few to no symptoms with pulmonary valve insufficiency. It may be initially noticed as a murmur in a routine exam of the heart and chest with a stethoscope. The most common causes of the disorder are severe pulmonary **hypertension**, or the presence of high pressure in the arteries and veins of the lungs. Pulmonary hypertension is usually caused by chronic lung disease, lung **blood clots**, and sometimes other diseases, such as **endocarditis**, an inflammation of the lining of the heart and valves. Previous surgery for **congenital heart disease** may also cause pulmonary valve insufficiency.

Diagnosis

The pitch and location of the murmur will help a physician determine if the cause is pulmonary valve insufficiency. An electrocardiogram (EKG) can detect flow changes. **Echocardiography** with color Doppler can usually detect regurgitation of blood in the area. This exam is done with ultrasound imaging. A **chest x ray** may show prominence of the pulmonary artery. In some cases, angiocardiography, or x ray of the arteries and vessels with injection of a dye, may be ordered.

Treatment

On its own, pulmonary valve insufficiency is seldom severe enough to require treatment. **Antibiotics** are usually recommended before dental work to reduce the possibility of bacterial endocarditis. Management of the primary condition, such as medications to manage pulmonary hypertension, may help control pulmonary valve insufficiency.

KEY TERMS

Congenital—Used to describe a condition or defect present at birth.

Endocarditis—Inflammation of the lining of the heart and valves.

Prophylaxis—Preventive. Antibiotic prophylaxis is the use of antibiotics to prevent a possible infection.

Pulmonary—Refers to the lungs and the breathing system and function.

Pulmonary hypertension—High blood pressure in the veins and arteries of the lungs.

Alternative treatment

Since there are few or no symptoms and the disorder is a structural defect, alternative treatment may have only limited usefulness. Proper diet, **exercise**, and **stress reduction** may help control hypertension. Coenzyme Q10 and hawthorn (*Crataegus laevigata*) are two important nutrients to nourish the heart. Antioxidant supplements (including **vitamins** A, C, and E, selenium, and zinc) can help keep the tissues of the whole body, including the heart, in optimal condition.

Prognosis

Patients with this disorder may never experience limitations from pulmonary valve insufficiency. The disorder may only show up if complicated by pulmonary hypertension. There is an increased incidence of bacterial endocarditis in patients with pulmonary valve insufficiency. Endocarditis can progress rapidly and be fatal.

Prevention

Pulmonary valve insufficiency resulting from chronic lung diseases can be prevented by behaviors and interventions to prevent those primary diseases. Bacterial endocarditis resulting from pulmonary valve insufficiency can usually be prevented with the use of antibiotic **prophylaxis** in preparation for dental procedures or other procedures which may introduce bacteria into the bloodstream.

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ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

Teresa Odle

KEY TERMS

Congenital—Present at birth.

Pulmonary—Relating to the opening leading from the right large chamber of the heart into the lung artery.

Stenosis—A narrowing or constriction, in this case of various heart valves. Stenosis reduces or cuts off the flow of blood.

Valve—Tissue between the heart's upper and lower chambers that controls blood flow.

Pulmonary valve stenosis

Definition

Pulmonary valve stenosis is a congenital heart defect in which blood flow from the heart to the pulmonary artery is blocked.

Description

Pulmonary valve stenosis is an obstruction in the pulmonary valve, located between the right ventricle and the pulmonary artery. Normally, the pulmonary valve opens to let blood flow from the right ventricle to the lungs. When the pulmonary valve is malformed, it forces the right ventricle to pump harder to overcome the obstruction. In its most severe form, pulmonary valve stenosis can be life-threatening.

Patients with pulmonary valve stenosis are at increased risk for getting valve infections and must take antiobiotics to help prevent this before certain dental and surgical procedures. Pulmonary valve stenosis is also called pulmonary stenosis.

Causes and symptoms

Pulmonary valve stenosis is caused by a congenital malformation in which the pulmonary valve does not open properly. In most cases, scientists don't know why it occurs. In cases of mild or moderate stenosis, there are often no symptoms. With more severe obstruction, symptoms include a bluish skin tint and signs of **heart failure**.

Diagnosis

Diagnosis of pulmonary valve stenosis begins with the patient's medical history and a **physical examination**. Tests to confirm the diagnosis include **chest x ray**, echocardiogram, electrocardiogram, and catherization. An electrocardiograph shows the heart's activity. Electrodes covered with conducting jelly are placed on the patient. The electrodes send impulses that are traced on a recorder. **Echocardiography** uses sound waves to create an image of the heart's chambers and valves. The technician applies gel to a wand (transducer) and presses it against the patient's chest. The returning sound waves are converted into an image displayed on a monitor. Catherization is an invasive procedure used to diagnose, and in some cases treat, heart problems. A thin tube, called a catheter, is inserted into a blood vessel and threaded up into the heart, enabling physicians to see and sometimes correct the problems.

Treatment

Patients with mild to moderate pulmonary valve stenosis, and few or no symptoms, do not require treatment. In more severe cases, the blocked valve will be opened surgically, either through **balloon valvuloplasty** or surgical valvulotomy. For initial treatment, balloon valvuloplasty is the procedure of choice. This is a catherization procedure in which a special catheter containing a deflated balloon is inserted in a blood vessel and threaded up into the heart. The catheter is positioned in the narrowed heart valve and the balloon is inflated to stretch the valve open.

In some cases, surgical valvulotomy may be necessary. This is open heart surgery performed with a heart-lung machine. The valve is opened with an incision and in some cases, hypertrophied muscle in the right ventricle is removed. Rarely does the pulmonary valve need to be replaced.

Alternative treatment

Pulmonary valve stenosis can be life threatening and always requires a physician's care. In mild to

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moderate cases of pulmonary valve stenosis, general lifestyle changes, including dietary modifications, **exercise**, and **stress reduction**, can contribute to maintaining optimal wellness.

Prognosis

Patients with the most severe form of pulmonary valve stenosis may die in infancy. The prognosis for children with more severe stenosis who undergo balloon valvuloplasty or surgical valvulotomy is favorable. Patients with mild to moderate pulmonary stenosis can lead a normal life, but they require regular medical care.

Prevention

Pulmonary valve stenosis cannot be prevented.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

CHASER (Congenital Heart Anomalies Support, Education, and Resources), 2112 North Wilkins Road, Swanton, OH, 43558, (419) 825-5575, (419) 825-2880, CHASER@compuserve.com, http://www.csun.edu.

Congenital Heart Information Network (C.H.I.N.), 101 N. Washington Ave., Suite 1A, Margate City, NJ, 08402-1195, (609) 882-1572, (609) 822-1574, mb@tchin.org, http://tchin.org/.

Texas Heart Institute. Heart Information Service, MC 3-116, PO Box 20345, Houston, TX, 77225, (832) 355-4011, (800) 292-2221, http://www.texasheart.org.

Lori De Milto

Punctures *see* **Wounds**

Purple coneflower *see* **Echinacea**

Purpura hemorrhagica *see* **Idiopathic thrombocytopenic purpura**

Pustule *see* **Skin lesions**

Pyelography *see* **Intravenous urography**

Pyelonephritis

Definition

Pyelonephritis is an inflammation of the kidney and upper urinary tract that usually results from noncontagious bacterial infection of the bladder (**cystitis**).

Description

Acute pyelonephritis is most common in adult females but can affect people of either sex and any age. Its onset is usually sudden, with symptoms that often are mistaken as the results of straining the lower back. Pyelonephritis often is complicated by systemic infection. Left untreated or unresolved, it can progress to a chronic condition that lasts for months or years, leading to scarring and possible loss of kidney function.

Causes and symptoms

The most common cause of pyelonephritis is the backward flow (reflux) of infected urine from the bladder to the upper urinary tract. Bacterial infections also may be carried to one or both kidneys through the bloodstream or lymph glands from infection that began in the bladder. Kidney infection sometimes results from urine that becomes stagnant due to obstruction of free urinary flow. A blockage or abnormality of the urinary system, such as those caused by stones, tumors, congenital deformities, or loss of bladder function from nerve disease, increases a person's risk of pyelonephritis. Other risk factors include **diabetes mellitus**, **pregnancy**, chronic bladder infections, a history of analgesic **abuse**, **paralysis** from **spinal cord injury**, or tumors. Catheters, tubes, or surgical procedures may also trigger a kidney infection.

The bacteria most likely to cause pyelonephritis are those that normally occur in the feces. ***Escherichia coli*** causes about 85% of acute bladder and kidney infections in patients with no obstruction or history of surgical procedures. *Klebsiella*, *Enterobacter*, *Proteus*, or *Pseudomonas* are other common causes of infection. Once these organisms enter the urinary tract, they cling to the tissues that line the tract and multiply in them.

Symptoms of acute pyelonephritis typically include **fever** and chills, burning or frequent urination, aching **pain** on one or both sides of the lower back or abdomen, cloudy or bloody urine, and **fatigue**. The patient also may have **nausea**, **vomiting**, and **diarrhea**. The flank pain may be extreme. The symptoms of chronic pyelonephritis include weakness, loss of appetite, **hypertension**, anemia, and protein and blood in the urine.

Diagnosis

The diagnosis of pyelonephritis is based on the patient's history, a **physical examination**, and the

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results of laboratory and imaging tests. During the physical examination, the doctor will touch (palpate) the patient's abdomen carefully in order to rule out **appendicitis** or other causes of severe abdominal pain.

Laboratory tests

In addition to collecting urine samples for **urinalysis** and **urine culture** and sensitivity tests, the doctor will take a sample of the patient's blood for a blood cell count. If the patient has pyelonephritis, the urine tests will show the presence of white blood cells, and bacteria in the urine. Bacterial counts of 100,000 organisms or higher per milliliter of urine point to a **urinary tract infection**. The presence of antibody-coated bacteria (ACB) in the urine sample distinguishes kidney infection from bladder infection, because bacteria in the kidney trigger an antibody response that coats the bacteria. The blood cell count usually indicates a sharp increase in the number of white blood cells.

Imaging studies

The doctor may order ultrasound imaging of the kidney area if he or she suspects that there is an obstruction blocking the flow of urine. X rays may demonstrate scarring of the kidneys and ureters resulting from long-standing infection.

Treatment

Treatment of acute pyelonephritis may require hospitalization if the patient is severely ill or has complications. Therapy most often involves a 2- to 3-week course of **antibiotics**, with the first few days of treatment given intravenously. The choice of antibiotic is based on laboratory sensitivity studies. The antibiotics used most often include ciprofloxacin (Cipro), ampicillin (Omnipen), or trimethoprim-sulfamethoxazole (Bactrim, Septra). Several advances in antibiotic therapy have been made in recent years. In 2003, the U.S. Food and Drug Administration (FDA) approved Cipro extended release tablets (Cipro XR) that could be taken once daily for acute uncomplicated pyelonephritis. A study in Europe also showed that a shorter course than that normally used in the United States could eradicate the bacteria that cause the disease. The primary objective of antimicrobial therapy is the permanent eradication of bacteria from the urinary tract. The early symptoms of pyelonephritis usually disappear within 48 to 72 hours of the start of antibacterial treatment. Repeat urine cultures are done in order to evaluate the effectiveness of the medication.

KEY TERMS

Bacteremia—The presence of bacteria in the bloodstream.

Cystitis—Inflammation of the bladder, usually caused by bacterial infection.

Reflux—The backward flow of a fluid in the body. Pyelonephritis is often associated with the reflux of urine from the bladder to the upper urinary tract.

Chronic pyelonephritis may require high doses of antibiotics for as long as 6 months to clear the infection. Other medications may be given to control fever, nausea, and pain. Patients are encouraged to drink extra fluid to prevent **dehydration** and increase urine output. Surgery sometimes is necessary if the patient has complications caused by **kidney stones** or other obstructions, or to eradicate infection. Urine cultures are repeated as part of the follow-up of patients with chronic pyelonephritis. These repeat tests are necessary to evaluate the possibility that the patient's urinary tract is infected with a second organism as well as to assess the patient's response to the antibiotic. Some persons are highly susceptible to reinfection, and a second antibiotic may be necessary to treat the organism.

Prognosis

The prognosis for most patients with acute pyelonephritis is quite good if the infection is caught early and treated promptly. The patient is considered cured if the urine remains sterile for a year. Untreated or recurrent kidney infection can lead to bacterial invasion of the bloodstream (**bacteremia**), hypertension, chronic pyelonephritis with scarring of the kidneys, and permanent kidney damage.

Prevention

Persons with a history of urinary tract infections should urinate frequently, and drink plenty of fluids at the first sign of infection. Women should void after intercourse which may help flush bacteria from the bladder. Girls should be taught to wipe their genital area from front to back after urinating to avoid getting fecal matter into the opening of the urinary tract.

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Resources

PERIODICALS

Jancin, Bruce. "Short-course Cipro for Pyelonephritis: Unapproved Regimen Shows Promise." *OB GYN News* November 1, 2003: 5.

Mangan, Doreen. "The FDA Has Approved Ciprofloxacin Extended Release Tablets (Cipro XR), a Once-daily Formulation, for the Treatment of Complicated Urinary Tract Infections (cUTIs) and Acute Pyelonephritis (AUP), or Kidney Infection." *RN* November 2003: 97.

Raz, Paul, et al. "Long-term Follow-up of Women Hospitalized for Acute Pyelonephritis." *Clinical Infectious Diseases* (October 15, 2003):1014–1017.

ORGANIZATIONS

American Urological Association Foundation, 1000 Corporate Blvd., Linthicum, MD, 21090, (410) 689-3700, (410) 689-3800, (866) 746-4282, auafoundation@auafoundation.org, http://www.urologyhealth.org/.

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Pyloric stenosis

Definition

Pyloric stenosis refers to a narrowing of the passage between the stomach and the small intestine. The condition, which affects infants during the first several weeks of life, can be corrected effectively with surgery.

Demographics

The condition affects one in 4,000 infants. Most are diagnosed between three and five weeks old, though some babies may show symptoms during the first or second week of life. Infants with a family history of pyloric stenosis are more at risk for the condition, which tends to occur less often in females, blacks, and Asians. Pyloric stenosis is also referred to as hypertrophic pyloric stenosis.

Description

Frequent **vomiting** may be an indication of pyloric stenosis. The pylorus is the passage between the stomach and the small intestine. During the digestive process food passes through the pylorus, which is located near the bottom of the stomach, on its way to the intestines. In pyloric stenosis, the muscular wall of the passage becomes abnormally thickened. This causes the pylorus to become too narrow, which prevents food from emptying out of the stomach in a normal fashion. The partially digested contents of the stomach are forced upwards into the mouth. As a result, a baby with pyloric stenosis often vomits after feedings.

Causes and symptoms

The cause of pyloric stenosis is not known. The main symptom is **vomiting** after feedings. These episodes of vomiting usually get worse over time, happening more often and becoming more forceful (forceful vomiting is often called "projectile" vomiting). Other symptoms include increased appetite, weight loss, infrequent bowel movements, belching, and **diarrhea**. Due to **dehydration**, the infant may also have fewer wet diapers.

Diagnosis

The clinician will examine the baby and talk with the parents about their infant's symptoms. If a child has the condition, the doctor should be able to feel a hard mass (about an inch [two centimeters] wide and olive shaped) in the area above the belly button. If the doctor cannot detect the mass, ultrasonography will be done to confirm the diagnosis. A blood test may also be performed to see if the infant is dehydrated, in which case intravenous fluids can be used to correct the problem.

Treatment

Pyloric stenosis can be cured with a surgical procedure called a pyloromyotomy. In this operation, the surgeon makes an incision in the baby's abdomen. Then a small cut is made in the thickened muscle of the pylorus and it is spread apart. In this manner, the passage can be widened without removing any tissue. (The procedure may be performed with the aid of a laparoscope.) After surgery, the pylorus will heal itself. The thickening gradually goes away and the passage resumes a normal shape. The whole procedure (including anesthesia) takes about an hour.

Most babies go home one or two days after surgery. Any mild discomfort can be controlled with **acetaminophen** (Tylenol). The infant may still vomit occasionally after surgery, but this is not usually a cause for alarm. However, if vomiting occurs three or more times a day, or for several consecutive days, the baby's pediatrician should be notified.

Alternative treatment

None known.

Prognosis

Surgery often provides a complete cure. Most infants do not experience complications or long-term effects.

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KEY TERMS

Laparoscope—A thin, camera–fitted tube that can be inserted into the abdomen in order to view internal organs.

Stenosis—The narrowing of a passage (such as the pylorus).

Ultrasonography—A non–invasive imaging procedure that uses high–frequency sound waves.

Prevention

It is not known how to prevent pyloric stenosis.

Resources

BOOKS

American Academy of Pediatrics. *Your Baby's First Year,* 3rd ed. New York, NY: Bantam, 2010.

Jana, Laura A., and Jennifer Shu. *Heading Home with Your Newborn: From Birth to Reality,* 2nd ed. New York, NY: American Academy of Pediatrics, 2010.

Liebmann–Smith, Joan, and Jacqueline Egan. *Baby Body Signs: The Head–to–Toe Guide to Your Child's Health, from Birth Through the Toddler Years.* New York, NY: Bantam, 2010.

PERIODICALS

Yoshizawa J, et al. "Ultrasonographic Features of Normalization of the Pylorus after Pyloromyotomy for Hypertrophic Pyloric Stenosis." *Journal of Pediatric Surgery* 36 (April 2001): 582–6.

ORGANIZATIONS

American Academy of Family Physicians (AAFP), 11400 Tomahawk Creek Pkwy., Leawood, KS, 66211–2672, (913) 906–6000, http://www.aafp.org.

American Academy of Pediatrics (AAP), 141 Northwest Point Blvd., Elk Grove Village, IL, 60007–1098, (847) 434–4000, http://www.aap.org.

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Pyloroplasty

Definition

Pyloroplasty is an elective surgical procedure in which the lower portion of the stomach, the pylorus, is cut and resutured, to relax the muscle and widen the opening into the intestine. Pyloroplasty is a treatment for high-risk patients for gastric or peptic ulcer disease. A peptic ulcer is a well-defined sore on the stomach where the lining of the stomach or duodenum has been eaten away by stomach acid and digestive juices.

Purpose

The end of the pylorus is surrounded by a strong band of muscle (pyloric sphincter), through which stomach contents are emptied into the duodenum (the first part of the small intestine). Pyloroplasty widens this opening into the duodenum.

A pyloroplasty is performed to treat complications of gastric ulcer disease, or when conservative treatment is unsatisfactory. The longitudinal cut made in the pylorus is closed transversely, permitting the muscle to relax. By establishing an enlarged outlet from the stomach into the intestine, the stomach empties more quickly. A pyloroplasty is often done in conjunction with a **vagotomy**, a procedure in which the nerves that stimulate stomach acid production and gastric motility (movement) are cut. As these nerves are cut, gastric emptying may be delayed and the pyloroplasty compensates for that effect.

Preparation

As with any surgical procedure, the patient will be required to sign a consent form after the procedure is explained thoroughly. Blood and urine studies, along with various x rays, may be ordered as the doctor deems necessary. Food and fluids will be prohibited after midnight before the procedure. Cleansing **enemas** may be ordered to empty the intestine. If **nausea** or **vomiting** are present, a suction tube to empty the stomach may be used.

Aftercare

Post-operative care for the patient who has had a pyloroplasty, as for those who have had any major surgery, involves monitoring of blood pressure, pulse, respiration, and temperature. Breathing tends to be shallow because of the effect of anesthesia and the patient's reluctance to breathe deeply and experience **pain** that is caused by the abdominal incision. The patient is shown how to support the operative site while breathing deeply and coughing, and given pain medication as necessary. Fluid intake and output is measured, and the operative site is observed for color and wound drainage. Fluids are given intravenously for 24–48 hours, until the patient's diet is gradually advanced as bowel activity resumes. The patient is generally allowed to walk approximately eight hours after surgery and the average hospital stay, dependent

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KEY TERMS

Gastric (or peptic) ulcer—An ulcer (sore) of the stomach, duodenum or other part of the gastrointestinal system. Though the causes are not fully understood, they include excessive secretion of gastric acid, stress, heredity, and the use of certain drugs, especially acetylsalicylic acid and nonsteroidal anti-inflammatory drugs.

Pylorus—The valve which releases food from the stomach into the intestines.

Vagotomy—Cutting of the vagus nerve. If the vagus nerves are cut as they enter the stomach (truncal vagotomy), gastric secretions are decreased, as is intestinal motility (movement) and stomach emptying. In a selective vagotomy, only those branches of the vagus nerve are cut that stimulate the secretory cells.

upon overall recovery status, ranges from six to eight days.

Risks

Potential complications of this abdominal surgery include:

- excessive bleeding
- surgical wound infection
- incisional hernia
- recurrence of gastric ulcer
- chronic diarrhea
- malnutrition

Normal results

Complete healing is expected without complications. Four to six weeks should be allowed for recovery from the surgery.

Abnormal results

The doctor should be made aware of any of the following problems after surgery:

- increased pain, swelling, redness, drainage, or bleeding in the surgical area
- headache, muscle aches, dizziness, or fever
- increased abdominal pain or swelling, constipation, nausea or vomiting, rectal bleeding, or black, tarry stools

Resources

OTHER

"Pyloroplasty." MedlinePlus. http://www.nlm.nih.gov/medlineplus/ency/article/002922.htm [accessed December 1, 2010].

ORGANIZATIONS

American Gastroenterological Association (AGA), 4930 Del Ray Avenue, Bethesda, MD 20814, (301) 654-2055, http://www.gastro.org/.

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Pylorus repair *see* **Pyloroplasty**

Pyorrhea *see* **Periodontal disease**

Pyrazinamide *see* **Antituberculosis drugs**

Pyridoxine deficiency *see* **Vitamin B_6 deficiency**

Pyrimethamine *see* **Antimalarial drugs**

Pyruvate kinase deficiency

Definition

Pyruvate kinase deficiency (PKD) is part of a group of disorders called hereditary nonspherocytic hemolytic **anemias**. Hereditary nonspherocytic anemias are rare genetic conditions that affect red blood cells. PKD is caused by a deficiency in the enzyme, pyruvate kinase.

Demographics

Although PKD is the second most common of the hereditary nonspherocytic anemias, it is still rare with the incidence estimated to be 51 cases per million in the Caucasian population.

In general, PKD not does appear to affect one gender more than another or be more common in certain regions. However, there are studies of an Amish group in Pennsylvania where a severe form of PKD is more common. Three mutations found in the PKLR gene have been linked to individuals of specific descents. Caucasians of northern and central European decent are more likely to have the 1529A mutations, individuals of southern European descent usually have the 1456T mutation, and individuals of Asian descent are more likely to have the 1468T mutation.

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Description

In PKD, there is a functional abnormality with the enzyme pyruvate kinase. Pyruvate kinase acts as a catalyst in the glycolysis pathway and is considered an essential component in this pathway. Glycolysis is the method by which cells produce energy. A problem with any of the key components in glycolysis can alter the amount of energy produced. In red blood cells, glycolysis is the only method available to produce energy. Without the proper amount of energy, red blood cells do not function normally. Since pyruvate kinase is one of the key components in glycolysis, when there is a problem with this enzyme in red blood cells, there is a problem with the production of energy, causing red blood cells not to function properly.

There are four different forms of the pyruvate kinase enzyme in the human body. These forms, called isozymes, all perform the same function but each isozyme of pyruvate kinase is structurally different and works in different tissues and organs. The four isozymes of pyruvate kinase are labeled M1, M2, L, and R. The isozyme M1 is found in the skeletal muscle and the brain, isozyme M2 can be found in most fetal and adult tissues, isozyme L works in the liver, and isozyme R works in red blood cells. In PKD, only the pyruvate kinase isozyme found in red blood cells, called PKR, is abnormal. Therefore, PKD affects red blood cells only and does not directly affect energy production in other organs and tissues of the body.

Causes and symptoms

There are two PK genes and each gene produces two of the four isozymes of pyruvate kinase. The M1 and M2 isozymes are produced by the pyruvate kinase gene called PKM2 and pyruvate kinase isozymes, L and R, are products of the pyruvate kinase gene, PKLR. The PKLR gene is located on chromosome 1, on the q arm (the top half of the chromosome), in region 21 (written as 1q21). There have been over 125 different mutations described in the PKLR gene that have been detected in individuals with PKD.

PKD is inherited mainly in an autosomal recessive manner. There have been a few families where it appeared that PKD was inherited in either an autosomal dominant manner or where the carriers of PKD exhibited mild problems with their red blood cells. As with all autosomal recessive conditions, affected individuals have a mutation in both pair of genes. Most individuals with PKD are compound heterozygotes, meaning that each PKLR gene in a pair contains a different mutation. There are individuals who have the same mutation on each PKLR gene, but these individuals tend to be children of parents who are related to each other.

There are three mutations in the PKLR gene called, 1529A, 1456T, and 1468T, that are seen more frequently in individuals with PKD than the other mutations. The mutation 1529A is most frequently seen in Caucasians of northern and central European descent and is the most common mutation seen in PKD. The mutation 1456T is more common in individuals of southern European descent and the mutation 1468T is more common in individuals of Asian descent.

In general, the more severe the PKD, the earlier in life symptoms tend to be detected. Individuals with the more severe form of PKD often show symptoms soon after birth, but most individuals with PKD begin to exhibit symptoms during infancy or childhood. In individuals with the milder form of PKD, the condition is sometimes not diagnosed until late adulthood, after an acute illness, or during a **pregnancy** evaluation.

For most of the mutations seen in the PKLR gene, no correlation between the specific mutation and the severity of the disorder has been observed. However, for two of the mutations, there has been speculation on their effect on the severity of PKD. When the mutation 1456T has been seen in the homozygous state (when both PKLR genes contain the same mutation), those rare individuals experienced very mild symptoms of PKD. Also, there have been individuals who were homozygous for the 1529A mutation. These individuals had a very severe form of PKD. Therefore, it is thought that the 1456T mutation is associated with a milder form of the disease and the 1529A mutation is associated with a more severe form of the disease. It is not known how these mutations affect the severity of PKD when paired with different mutations.

Symptoms of PKD are similar to those symptoms seen in individuals who have long–term **hemolytic anemia**. The more common symptoms include variable degrees of **jaundice** (a yellowish pigment of the skin and eyes), slightly to moderately enlarged spleen (splenomegaly), and increased incidence of **gallstones**. Other physical effects of PKD can include smaller head size and a prominent and rounded forehead (called frontal bossing). If children with PKD have their spleen removed, growth tends to improve. Even within the same family, individuals can have different symptoms and severity of PKD.

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KEY TERMS

Anemia—A condition in which the amount of red blood cells is less than normal.

Catalyst—A substance that changes the rate of a reaction, but is not changed by the process.

Compound heterozygotes—Individuals who have one gene in a pair with one mutation and the other gene in the pair has a different mutation.

Enzyme—A protein produced by cells that acts as a catalyst in a biological reaction.

Glycolysis—The pathway in which a cell breaks down glucose into energy.

Hemolytic anemia—Anemia that results from red blood cells being destroyed sooner than normal.

Heterozygote—An individual who has one gene in a pair that has a mutation while the other gene in the pair is unaffected.

Homozygote—An individual who has both genes in a pair with the same mutation.

Homozygous—A condition in which both genes in a pair have the same mutation.

Isozyme—One of a group of enzymes that perform the same function, but are different from one another in their structure or the way in which they move.

Mutation—A change in a gene that causes it to alter its function.

Nonspherocytic—Not sphere shaped. Often in inherited hemolytic anemias, red blood cells are sphere shaped. In nonspherocytic hemolytic anemias, red blood cells are not sphere shaped.

In individuals with PKD, red blood cells are taken out of circulation earlier than normal (shorten life–span). Because of this change, individuals with PKD will have hemolytic anemia. Additionally, the anemia or other symptoms of PKD may worsen during a sudden illness or pregnancy.

Diagnosis

A diagnosis of PKD can be made by measuring the amount of pyruvate kinase in red blood cells. Individuals with PKD tend to have 5–25% of the normal amount of pyruvate kinase. Carriers of PKD also can have less pyruvate kinase in their red blood cells, approximately 40–60% of the normal value. However, there is an overlap between the normal range of pyruvate kinase and the ranges seen with carriers of PKD. Therefore, measuring the amount of pyruvate kinase in red blood cells is not a good method of detecting carriers of PKD. If the mutations causing PKD in a family are known, it may be possible to perform mutation analysis to determine carrier status of an individual and to help diagnose individuals with PKD.

Treatment

In the severest cases, individuals with PKD will require multiple blood transfusions. In some of those cases, the spleen may be removed (**splenectomy**). Red blood cells are normally removed from circulation by the spleen. By removing the spleen of an individual (usually a child), red blood cells are allowed to stay in circulation longer than normal, thereby reducing the severity of the anemia. After a splenectomy, or once an individual with PKD is older, the number of transfusions tends to decrease.

Prognosis

The prognosis for PKD is extremely variable. Early intervention and treatment of symptoms frequently improves the individual's health. Without treatment, individuals may experience severe complications that may become lethal. Individuals with a mild form of PKD may appear to have no symptoms at all.

Resources

BOOKS

Bennett, Robin L. *The Practical Guide to the Genetic Family History,* 2nd ed. New York, NY: Wiley-Blackwell, 2010.

PERIODICALS

Beutler, Ernest, and Terri Gelbart. "Estimating the Prevalence of Pyruvate Kinase Deficiency from the Gene Frequency in the General White Population." *Blood* 95 (June 2000): 3585–88.

Kugler, W., et. al. "Eight Novel Mutations and Consequences of mRNA and Protein Level in Pyruvate Kinase Deficient Patients with Nonspherocytic Hemolytic Anemia." *Human Mutation* 15 (2000): 261–272.

ORGANIZATIONS

National Heart, Lung, and Blood Institute (NHLBI), PO Box 30105, Bethesda, MD, 20824–0105, (301) 592–8573. TTY: (240) 629–3255, http://www.nhlbi.nih.gov.

National Institutes of Health (NIH), 9000 Rockville Pike, Bethesda, MD, 20892, (301) 496-4000, http://www.nih.gov/index.html.

National Library of Medicine (NLM), 8600 Rockville Pike, Bethesda, MD, 20894, http://www.nlm.nih.gov/.

National Organization for Rare Diseases (NORD), PO Box 8923, Fairfield, CT, 06812, (213) 745–6518, http://www.rarediseases.org.

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Q

Q fever

Definition

Q **fever** is an illness caused by a type of bacteria, *Coxiella burnetii*, resulting in a fever and rash.

Description

C. burnetii lives in many different kinds of animals, including cattle, sheep, goats, ticks, cats, rabbits, birds, and dogs. In sheep and cattle the bacteria tends to accumulate in large numbers in the female's uterus (the organ where lambs and calves develop) and udder. Other animals have similar patterns of bacterial accumulation within the females. As a result, *C. burnetii* can cause infection through contaminated milk, or when humans come into contact with the fluids or tissues produced when a cow or sheep gives birth. The bacteria can also survive in dry dust for months; therefore, if the female's fluids contaminate the ground, humans may become infected when they come in contact with the contaminated dust.

Persons most at risk for Q fever include anybody who works with cattle or sheep, or products produced from them. These include farm workers, slaughterhouse workers, workers in meat-packing plants, veterinarians, and wool workers. Since September 2001, however, Q fever has become an additional concern because of its potential as an agent of bioterrorism.

Q fever has been found all over the world, except in some areas of Scandinavia, Antarctica, and New Zealand.

Causes and symptoms

C. burnetii causes infection when a human breathes in tiny droplets, or drinks milk, containing the bacteria. After 3 to 30 days, symptoms of the illness appear.

The usual symptoms of Q fever include fever, chills, heavy sweating, **headache**, **nausea and vomiting**, **diarrhea**, **fatigue**, and **cough**. Also, a number of other problems may present themselves, including inflammation of the liver (hepatitis); inflammation of the sac containing the heart (**pericarditis**); inflammation of the heart muscle itself (**myocarditis**); inflammation of the coverings of the brain and spinal cord, or of the brain itself (meningoencephalitis); and **pneumonia**.

Chronic Q fever occurs most frequently in patients with other medical problems, including diseased heart valves, weakened immune systems, or **kidney disease**. Such patients usually have about a year's worth of vague symptoms, including a low fever, enlargement of the spleen and/or liver, and fatigue. Testing almost always reveals that these patients have inflammation of the lining of the heart (**endocarditis**).

Diagnosis

Q fever is diagnosed by demonstrating that the patient's immune system is making increasing numbers of antibodies (special immune cells) against markers (antigens) that are found on *C. burnetii*.

Treatment

Doxycycline and quinolone **antibiotics** are effective for treatment of Q fever. Treatment usually lasts for two weeks. Rifampin and doxycycline together are given for chronic Q fever. Chronic Q fever requires treatment for at least three years.

Minocycline has been found to be useful in treating post-Q fever fatigue. The dosage is 100 mg per day for three months.

Prognosis

Death is rare from Q fever. Most people recover completely, although some patients with endocarditis will require surgery to replace their damaged heart valves.

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KEY TERMS

Antibodies—Specialized cells of the immune system that can recognize organisms that invade the body (such as bacteria, viruses, and fungi). The antibodies are then able to set off a complex chain of events designed to kill these foreign invaders.

Antigens—Markers on the outside of bacteria or viruses, which can be recognized by antibodies.

Bioterrorism—The use of disease microorganisms to intimidate or terrorize a civilian population.

Immune system—The system of specialized organs, lymph nodes, and blood cells throughout the body, which work together to prevent foreign invaders (bacteria, viruses, fungi, etc.) from taking hold and growing.

Inflammation—The body's response to tissue damage. Includes increased heat, swelling, redness, and pain in the affected part.

Prevention

Q fever can be prevented by the appropriate handling of potentially infective substances. For example, milk should always be pasteurized, and people who work with animals giving birth should carefully dispose of the tissues and fluids associated with birth. Industries which process animal materials (meat, wool) should take care to prevent the contamination of dust within the plant.

Vaccines are available for workers at risk for Q fever.

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Qigong

Definition

Qigong (pronounced "chee-gung," also spelled *chi kung*) is translated from the Chinese to mean "energy cultivation" or "working with the life energy." Qigong is an ancient Chinese system of postures, exercises, breathing techniques, and meditations. Its techniques are designed to improve and enhance the body's *qi*. According to traditional Chinese philosophy, qi is the fundamental life energy responsible for health and vitality.

Purpose

Qigong may be used as a daily routine to increase overall health and well-being, as well as for disease prevention and longevity. It can be used to increase energy and reduce **stress**. In China, qigong is used in conjunction with other medical therapies for many chronic conditions, including **asthma**, **allergies**, **AIDS**, **cancer**, headaches, **hypertension**, depression, mental illness, strokes, heart disease, and **obesity**.

Qigong is presently being used in Hong Kong to relieve depression and improve the overall psychological and social well-being of elderly people with chronic physical illnesses.

Description

Origins

Qigong originated before recorded history. Scholars estimate qigong to be as old as 5,000–7,000 years. Tracing the exact historical development of qigong is difficult because it was passed down in secrecy among monks and teachers for many generations. Qigong survived through many years before paper was invented, and it also survived the Cultural Revolutions in China of the 1960s and 1970s, which banned many traditional practices.

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Qigong has influenced and been influenced by many of the major strands of Chinese philosophy. The Taoist philosophy states that the universe operates within laws of balance and harmony, and that people must live within the rhythms of nature—ideas that pervade qigong. When Buddhism was brought from India to China around the seventh century A.D., **yoga** techniques and concepts of mental and spiritual awareness were introduced to qigong masters. The Confucian school was concerned with how people should live their daily lives, a concern of qigong as well. The martial arts were highly influenced by qigong and many of them, such as t'ai chi and kung fu, developed directly from it. **Traditional Chinese medicine** also shares many of the central concepts of qigong, such as the patterns of energy flow in the body. **Acupuncture** and **acupressure** use the same points on the body that qigong seeks to stimulate. In China, qigong masters have been renowned physicians and healers. Qigong is often prescribed by Chinese physicians as part of the treatment.

Due to the political isolation of China, many Chinese concepts have been shrouded from the Western world. Acupuncture was "discovered" by American doctors only in the 1970s, although it had been in use for thousands of years. With an increased exchange of information, more Americans have gained access to the once-secret teachings of qigong. In 1988, the First World Conference for Academic Exchange of Medical Qigong was held in Beijing, China, where many studies were presented to attendees from around the world. In 1990, Berkeley, California, hosted the First International Congress of Qigong. In the past decade, more Americans have begun to discover the beneficial effects of qigong, which motivate an estimated 60 million Chinese to practice it every day.

Basic concepts

In Chinese thought, qi, or chi, is the fundamental life energy of the universe. It is invisible but present in air, water, food and sunlight. In the body, qi is the unseen vital force that sustains life. We are all born with inherited amounts of qi, and we also get acquired qi from the food we eat and the air we breathe. In qigong, the breath is believed to account for the largest quantity of acquired qi, because the body uses air more than any other substance. The balance of our physical, mental, and emotional levels also affect qi levels in the body.

Qi travels through the body along channels called meridians. There are 12 main meridians, corresponding to the 12 principal organs as defined by the traditional Chinese system: the lungs, large intestines, stomach, spleen, heart, small intestines, urinary bladder, kidneys, liver, gallbladder, pericardium, and the "triple warmer," which represents the entire torso region. Each organ has qi associated with it, and each organ interacts with particular emotions on the mental level. Qigong techniques are designed to improve the balance and flow of energy throughout the meridians, and to increase the overall quantity and volume of qi. In qigong philosophy, mind and body are not separated as they often are in Western medicine. In qigong, the mind is present in all parts of the body, and the mind can be used to move qi throughout the body.

Yin and yang are also important concepts in qigong. The universe and the body can be described by these two separate but complementary principles, which are always interacting, opposing, and influencing each other. One goal of qigong is to balance yin and yang within the body. Strong movements or techniques are balanced by soft ones, leftward movements by rightward, internal techniques by external ones, and so on.

Practicing qigong

There are thousands of qigong exercises. The specific ones used may vary depending on the teacher, school, and objective of the practitioner. Qigong is used for physical fitness, as a martial art, and most frequently for health and healing. Internal qigong is performed by those wishing to increase their own energy and health. Some qigong masters are renowned for being able to perform external qigong, by which the energy from one person is passed on to another for healing. This transfer may sound suspect to Western logic, but in the world of qigong there are some amazing accounts of healing and extraordinary capabilities demonstrated by qigong masters. Qigong masters generally have deep knowledge of the concepts of Chinese medicine and healing. In China, there are hospitals that use medical qigong to heal patients, along with herbs, acupuncture, and other techniques. In these hospitals, qigong healers use external qigong and also design specific internal qigong exercises for patients' problems.

There are basic components of internal qigong sessions. All sessions require warm-up and concluding exercises. Qigong consists of postures, movements, breathing techniques, and mental exercises. Postures may involve standing, sitting, or lying down. Movements include stretches, slow motions, quick thrusts, jumping, and bending. Postures and movements are designed to strengthen, stretch, and tone the body to improve the flow of energy. One sequence of postures and movements is known as the "Eight Figures for Every Day." This sequence is designed to quickly and

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effectively work the entire body, and is commonly performed daily by millions in China.

Breathing techniques include deep abdominal breathing, chest breathing, relaxed breathing, and holding breaths. One breathing technique is called the "Six Healing Sounds." This technique uses particular breathing sounds for each of six major organs. These sounds are believed to stimulate and heal the organs.

Meditations and mind exercises are used to enhance the mind and move qi throughout the body. These exercises are often visualizations that focus on different body parts, words, ideas, objects, or energy flowing along the meridians. One mental exercise is called the "Inner Smile," during which the practitioner visualizes joyful, healing energy being sent sequentially to each organ in the body. Another mental exercise is called the "Microscopic Orbit Meditation," in which the practitioner intently meditates on increasing and connecting the flow of qi throughout major channels.

Discipline is an important dimension of qigong. Exercises are meant to be performed every morning and evening. Sessions can take from 15 minutes to hours. Beginners are recommended to practice between 15–30 minutes twice a day. Beginners may take classes once or twice per week, with practice outside of class. Classes generally cost between $10–$20 per session.

Preparations

Qigong should be practiced in a clean, pleasant environment, preferably outdoors in fresh air. Loose and comfortable clothing is recommended. Jewelry should be removed. Practitioners can prepare for success at qigong by practicing at regular hours each day to promote discipline. Qigong teachers also recommend that students prepare by adopting lifestyles that promote balance, moderation, proper rest, and healthy **diets**, all of which are facets of qigong practice.

Precautions

Beginners should learn from an experienced teacher, as performing qigong exercises in the wrong manner may cause harm. Practitioners should not perform qigong on either full or completely empty stomachs. Qigong should not be performed during extreme weather, which may have negative effects on the body's energy systems. Menstruating and pregnant women should perform only certain exercises.

Side effects

Side effects may occur during or after qigong exercises for beginners, or for those performing exercises incorrectly. Side effects may include **dizziness**, **dry mouth**, **fatigue**, headaches, **insomnia**, rapid heartbeat, **shortness of breath**, heaviness or **numbness** in areas of the body, emotional instability, **anxiety**, or decreased concentration. Side effects generally clear up with rest and instruction from a knowledgeable teacher.

Research and general acceptance

Western medicine generally does not endorse any of the traditional Chinese healing systems that utilize the concept of energy flow in the body, largely because this energy has yet to be isolated and measured scientifically. New research is being conducted using sophisticated equipment that may verify the existence of energy channels as defined by the Chinese system. Despite the lack of scientific validation, the results of energy techniques including qigong and acupuncture have gained widespread interest and respect. One California group of qigong practitioners now conducts twice-yearly retreats to improve their skills and energy level. Furthermore, qigong masters have demonstrated to Western observers astounding control over many physical functions, and some have even shown the ability to increase electrical voltage measured on their skin's surface. Most of the research and documentation of qigong's effectiveness for medical conditions has been conducted in China, and is slowly becoming more available to English readers. Papers from the World Conferences for Academic Exchange of Medical Qigong are available in English, and address many medical studies and uses of qigong. A video is now available that presents the basic concepts of medical qigong as well as specific **exercise** prescriptions for the treatment of **breast cancer**. The exercise prescriptions consist of movements, postures, visualizations, and positive affirmations.

In terms of mainstream research in the United States, the first ongoing long-term study of qigong began in 1999 at the Center for Alternative and Complementary Medicine Research in Heart Disease at the University of Michigan; it focuses on the speed of healing of graft **wounds** in patients undergoing coronary bypass surgery. The National Center for Complementary and Alternative Medicine (NCCAM) has been funding studies of qigong since 2000. The first such study was conducted by a researcher in Arizona with patients using heart devices (**pacemakers**, etc.).

The breathing techniques of qigong are being studied intensively by Western physicians as a form of

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KEY TERMS

Martial arts—Group of diverse activities originating from the ancient fighting techniques of the Orient.

Meridians—Channels or conduits through which Qi travels in the body.

Qi—Basic life energy, according to traditional Chinese medicine.

Yin/Yang—Universal characteristics used to describe aspects of the natural world.

therapy for anxiety-related problems and for disorders involving the vocal cords. Qigong is also being used in the **rehabilitation** of patients with severe asthma or **chronic obstructive pulmonary disease** (COPD).

Training and certification

In China, qigong has been subject to much government regulation, from banning to increased requirements for teachers. In the United States at this time, qigong has not been regulated. Different schools may provide teacher training, but there are no generally accepted training standards. Qigong teachings may vary, depending on the founder of the school, who is often an acknowledged Chinese master. Qigong organizations can provide further information.

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ORGANIZATIONS

National Center for Complementary and Alternative Medicine (NCCAM), P.O. Box 7923, Gaitherburg, MD, 20898, (866) 464-3616, (888) 644-6226, info@nccam.nih.gov, http://nccam.nih.gov/.

National Qigong Association, P.O. Box 270065, St. Paul, MN, 55127, (888) 359-9526, (888) 815-1893, http://nqa.org.

The Qigong Institute, 617 Hawthorne Avenue, Los Altos, CA, 94024, http://www.qigonginstitute.or.

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Quadriplegia *see* **Paralysis**

Quarantine *see* **Isolation**

Quinidine *see* **Antiarrhythmic drugs**

Quinine *see* **Antimalarial drugs**

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R

Rabbit fever *see* **Tularemia**

Rabies

Definition

Rabies is an acute viral disease of the central nervous system that affects humans and other mammals but is most common in carnivores (flesh-eaters). It is sometimes referred to as a **zoonosis**, or disease of animals that can be communicated to humans. Rabies is almost exclusively transmitted through saliva from the bite of an infected animal. Another name for the disease is *hydrophobia*, which literally means "fear of water," a symptom shared by half of all people infected with rabies. Other symptoms include **fever**, depression, confusion, painful **muscle spasms**, sensitivity to touch, loud noise, and light, extreme thirst, painful swallowing, excessive salivation, and loss of muscle tone. If rabies is not prevented by immunization, it is almost always fatal.

Description

Cases of rabies in humans are very infrequent in the United States and Canada, averaging one or two a year (down from over 100 cases annually in 1900), but, according to the World Health Organization, about 55,000 people worldwide die of the infection each year; about one person every ten minutes. Rabies is most common in developing countries in Africa, Latin America, and Asia, particularly India. Dog **bites** are the major origin of infection for humans in developing countries, but other important host animals may include the wolf, mongoose, raccoon, jackal, and bat. A group of researchers in India found that monkeys as well as dogs were frequent vectors of rabies. The team also reported that the male:female ratio of rabies patients in India is 4:1.

Most deaths from rabies in the United States and Canada result from bat. The **death** of a nine-year-old girl in Quebec in the fall of 2000 was the first case of human rabies in Canada since 1985. Public health officials eventually determined that the girl had been bitten while she was sleeping by a silver-haired bat that had gotten into the family's home.

On October 18, 2004, a Wisconsin teenager was diagnosed with full-blown rabies after suffering from a minor bat bite on September 12, 2004. Miraculously, she was cured of rabies after doctors induced **coma** and administered four **antiviral drugs** to her.

People whose work frequently brings them in contact with animals are considered to be at higher risk than the general population. This would include those in the fields of veterinary medicine, animal control, wildlife work, and laboratory work involving live rabies virus. People in these occupations and residents of or travelers to areas where rabies is a widespread problem should consider being immunized.

In late 2002, rabies re-emerged as an important public health issue. Dr. Charles E. Rupprecht, director of the World Health Organization (WHO) Collaborating Center for Rabies Reference and Research, has listed several factors responsible for the increase in the number of rabies cases worldwide:

- Rapid evolution of the rabies virus. Bats in the United States have developed a particularly infectious form of the virus
- Increased diversity of animal hosts for the disease
- Changes in the environment that are bringing people and domestic pets into closer contact with infected wildlife
- Increased movement of people and animals across international borders. In one recent case, a man who

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KEY TERMS

Active immunization—Treatment that provides immunity by challenging an individual's own immune system to produce antibody against a particular organism, in this case the rabies virus.

Antibody—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

Biopsy—The removal of a small sample of tissue for diagnostic purposes.

Efferent nerves—Nerves that convey impulses away from the central nervous system to the periphery.

Fluorescent antibody test (FA test)—A test in which a fluorescent dye is linked to an antibody for diagnostic purposes.

Lumbar puncture—A procedure that involves withdrawing a small sample of cerebrospinal fluid from the back around the spinal cord.

Lyssavirus—A genus of viruses that includes the rabies virus and related viruses that infect insects as well as mammals.

Passive immunization—Treatment that provides immunity through the transfer of antibodies obtained from an immune individual.

Rhabdovirus—A type of virus named for its rod- or bullet-like shape. The rabies virus belongs to a family of viruses called Rhabdoviridae.

Vector—An animal or insect that carries a disease-producing organism.

Zoonosis—Any disease of animals that can be transmitted to humans. Rabies is an example of a zoonosis.

had contracted rabies in the Philippines was not diagnosed until he began to feel ill in the United Kingdom

- Lack of advocacy about rabies

Causes and symptoms

Rabies is caused by a rod- or bullet-shaped virus that belongs to the family Rhabdoviridae. The rabies virus is a member of a genus of viruses called lyssaviruses, which include several related viruses that infect insects as well as mammals. The rabies virus is usually transmitted via an animal bite, however, cases have also been reported in which the virus penetrated the body through infected saliva, moist tissues such as the eyes or lips, a scratch on the skin, or the transplantation of infected tissues. Inhalation of the virus in the air, as might occur in a highly populated bat cave, is also thought to occur.

From the bite or other area of penetration, the virus multiplies as it spreads along nerves that travel away from the spinal cord and brain (efferent nerves) and into the salivary glands. The rabies virus may lie dormant in the body for several weeks or months, but rarely much longer, before symptoms appear. Initially, the area around the bite may burn and be painful. Early symptoms may also include a **sore throat**, low-grade fever, **headache**, loss of appetite, **nausea and vomiting**, and **diarrhea**. Painful spasms develop in the muscles that control breathing and swallowing. The individual may begin to drool thick saliva and may have dilated or irregular pupils, increased tears and perspiration, and low blood pressure.

Later, as the disease progresses, the patient becomes agitated and combative and may exhibit increased mental confusion. The affected person usually becomes sensitive to touch, loud noises, and bright lights. The victim also becomes extremely thirsty, but is unable to drink because swallowing is painful. Some patients begin to dread water because of the painful spasms that occur. Other severe symptoms during the later stage of the disease include excessive salivation, **dehydration**, and loss of muscle tone. Death usually occurs three to 20 days after symptoms have developed. Unfortunately, recovery is very rare.

Diagnosis

After the onset of symptoms, blood tests and **cerebrospinal fluid (CSF) analysis** tests will be conducted. CSF will be collected during a procedure called a **lumbar puncture** in which a needle is used to withdraw a sample of CSF from the area around the spinal cord. The CSF tests do not confirm diagnosis but are useful in ruling out other potential causes for the patient's altered mental state.

The two most common diagnostic tests are the fluorescent antibody test and isolation of the rabies virus from an individual's saliva or **throat culture**. The fluorescent antibody test involves taking a small sample of skin (biopsy) from the back of the neck of the patient. If specific proteins, called antibodies,

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that are produced only in response to the rabies virus are present, they will bind with the fluorescent dye and become visible. Another diagnostic procedure involves taking a corneal impression in which a swab or slide is pressed lightly against the cornea of the eye to determine whether viral material is present.

Treatment

Until the most recent successful cure of a late-term rabies case can be validated with further success and validation from the medical community, the historic treatment options for rabies prevention immediately following a bite remains the most viable treatment. Because of the extremely serious nature of a rabies infection, the need for rabies immunizations will be carefully considered for anyone who has been bitten by an animal, based on a personal history and results of diagnostic tests.

If necessary, treatment includes the following:

- The wound is washed thoroughly with medicinal soap and water. Deep puncture wounds should be flushed with a catheter and soapy water. Unless absolutely necessary, a wound should not be sutured.
- Tetanus toxoid and antibiotics will usually be administered.
- Rabies vaccination may or not be given, based on the available information. If the individual was bitten by a domestic animal and the animal was captured, the animal will be placed under observation in quarantine for ten days. If the animal does not develop rabies within four to seven days, then no immunizations are required. If the animal is suspected of being rabid, it is killed, and the brain is examined for evidence of rabies infection. In cases involving bites from domestic animals where the animal is not available for examination, the decision for vaccination is made based on the prevalence of rabies within the region where the bite occurred. If the bite was from a wild animal and the animal was captured, it is generally killed because the incubation period of rabies is unknown in most wild animals.
- If necessary, the patient is vaccinated immediately, generally through the administration of human rabies immune globulin (HRIG) for passive immunization, followed by human diploid cell vaccine (HDCV) or rabies vaccine adsorbed (RVA) for active immunization. Passive immunization is designed to provide the individual with antibodies from an already immunized individual, while active immunization involves stimulating the individual's own immune system to produce antibodies against the rabies virus. Both rabies vaccines are equally effective and carry a lower risk of side effects than some earlier treatments. Unfortunately, however, in underdeveloped countries, these newer vaccines are usually not available. Antibodies are administered to the patient in a process called passive immunization. To do this, the HRIG vaccine is administered once, at the beginning of treatment. Half of the dose is given around the bite area, and the rest is given in the muscle. Inactivated viral material (antigenic) is then given to stimulate the patient's own immune system to produce antibodies against rabies. For active immunization, either the HDCV or RVA vaccine is given in a series of five injections. Immunizations are typically given on days one, three, seven, 14, and 28.

In those rare instances in which rabies has progressed beyond the point where immunization would be effective, the groundbreaking treatment involving a drug-induced coma and the administration of four different antiviral drugs will most likely be a radical treatment option. The traditional approach prior to October 2004 was to provide as much relief from **pain** and suffering as possible through medical intervention while waiting to see if survival was possible. The patient would be given medication to prevent seizures, relieve some of the **anxiety**, and relieve painful muscle spasms. Pain relievers would also be given. In the later stages, aggressive supportive care would be provided to maintain breathing and heart function. Survival via the traditional treatment is rare but can occur.

Prognosis

If preventative treatment is sought promptly, rabies need not be fatal. Immunization is almost always effective if started within two days of the bite. Chance of effectiveness declines, however, the longer **vaccination** is put off. It is, however, important to start immunizations, even if it has been weeks or months following a suspected rabid animal bite, because the vaccine can be effective even in these cases. If immunizations do not prove effective or are not received, rabies is nearly always fatal with a few days of the onset of symptoms.

Prevention

One promising preventive strategy that has been used since the early 2000s is the distribution of wildlife baits containing an oral vaccine against rabies.

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This strategy has been used in Germany to vaccinate wild foxes, which are frequent carriers of the disease in Europe. In the United States, veterinary researchers at Kansas State University have developed an oral vaccine for fruit bats; early trials of the vaccine have given promising results. The cost of rabies prevention in the United States (mostly attributable to the vaccination of domestic animals) was estimated at $300 million.

The following precautions should be observed in environments where humans and animals may likely come into contact.

- Domesticated animals, including household pets, should be vaccinated against rabies. If a pet is bitten by an animal suspected to have rabies, its owner should contact a veterinarian immediately and notify the local animal control authorities. Domestic pets with current vaccinations should be revaccinated immediately; unvaccinated dogs, cats, or ferrets are usually euthanized (put to sleep). Further information about domestic pets and rabies is available on the American Veterinary Medical Association (AVMA) web site.
- Wild animals should not be touched or petted, no matter how friendly they may appear. It is also important not to touch an animal that appears ill or passive, or whose behavior seems odd, such as failing to show the normal fear of humans. These are all possible signs of rabies. Many animals, such as raccoons and skunks, are nocturnal and their activity during the day should be regarded as suspicious.
- People should not interfere in fights between animals.
- Because rabies is transmitted through saliva, a person should wear rubber gloves when handling a pet that has had an encounter with a wild animal.
- Garbage or pet food should not be left outside the house or camp site because it may attract wild or stray animals.
- Windows and doors should be screened. Some victims of rabies have been attacked by infected animals, particularly bats, that entered through unprotected openings.
- State or county health departments should be consulted for information about the prevalence of rabies in an area. Some areas, such as New York City, have been rabies-free, only to have the disease reintroduced at a later time.
- Preventative vaccination against rabies should be considered if one's occupation involves frequent contact with wild animals or non-immunized domestic animals.
- Bites from mice, rats, or squirrels rarely require rabies prevention because these rodents are typically killed by any encounter with a larger, rabid animal, and would, therefore, not be carriers.
- Travelers should ask about the prevalence of the disease in countries they plan to visit.

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ORGANIZATIONS

American Veterinary Medical Association (AVMA), 1931 North Meacham Road, Suite 100, Schaumburg, IL, 60173-4360, http://www.avma.org.

Centers for Disease Control and Prevention, 1600 Clifton Rd., NE, Atlanta, GA, 30333, (404) 639-3311, (800) 311-3435, http://www.cdc.gov.

Institut Pasteur, 25-28, Rue du Dr. Roux, 75015, Paris, France, +3301 45 68 80 00, http://www.pasteur.fr/haut_ext.html.

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Radial keratotomy

Definition

Radial keratotomy (RK) is a type of eye surgery used to correct **myopia** (nearsightedness). It works by changing the shape of the cornea–the transparent part of the eye that covers the iris and the pupil.

Purpose

About 25-30% of all people in the world are nearsighted and need eyeglasses or **contact lenses** for distance vision to be clear. For a number of reasons, some people don't like wearing corrective lenses. Some feel unattractive in eyeglasses while others worry about not being able to see without their glasses in an emergency, such as a house fire or a burglary. Both glasses and contact lenses can be scratched, broken, or lost. Contact lenses require special care and can irritate the eyes.

Radial keratotomy was introduced in North America in 1978. Since then doctors have improved the technique, and its results have become more predictable. Radial keratotomy is one of several surgical techniques to correct nearsightedness, reducing or eliminating the need for corrective lenses. It is most successful in patients with a low to moderate amount of nearsightedness–people whose eyes require up to -5.00 diopters of correction. A diopter (D) is a unit of measure of focusing power. Minus lenses correct nearsightedness.

Precautions

Not every nearsighted person is a good candidate for radial keratotomy. This type of surgery cannot help people whose nearsightedness is caused by keratoconus, a rare condition in which the cornea is cone shaped. The procedure usually is not done on patients under 18, because their eyes are still growing and changing shape. It is important that visual status is stable. Women who are pregnant, have just given birth, or are breast-feeding should not have the surgery because hormonal changes may cause temporary changes in the cornea. In addition, anyone with glaucoma or with any disease that interferes with healing (e.g., **rheumatoid arthritis**, lupus erythematosus, or uncontrolled diabetes) should not have RK.

Radial keratotomy weakens the cornea, making it vulnerable to injuries even long after the surgery. Getting hit in the head after having RK can cause the cornea to tear and can lead to blindness. For this reason, the procedure is not recommended for people who engage in sports that could result in a blow to the head (i.e., karate or racquetball).

It is important to keep in mind that RK is a permanent procedure and that success cannot be guaranteed. An experienced eye surgeon can estimate how likely it is that the surgery will help a particular patient, but that is just an estimate. There is no way to know for sure whether the surgery will improve eyesight enough to eliminate the need for corrective lenses. Vision usually improves after RK, but it is not always perfect. Anyone who decides to have RK should be prepared to accept less-than-perfect vision after surgery, which may necessitate the continued use of glasses or contact lenses. This surgery does not eliminate the need for reading glasses. Actually, someone who didn't need reading glasses before surgery because their myopia allowed near vision to be clear may find themselves needing reading glasses. Patients must ask about this prior to surgery.

Anyone considering RK should also be aware that certain professions, including branches of the military, are not open to people who have had the procedure.

A reputable ophthalmologist will discuss the risks of the procedure and should tell anyone considering it that perfect vision can't be guaranteed. Patients should be wary of any doctor who tries too hard to "sell" them on RK.

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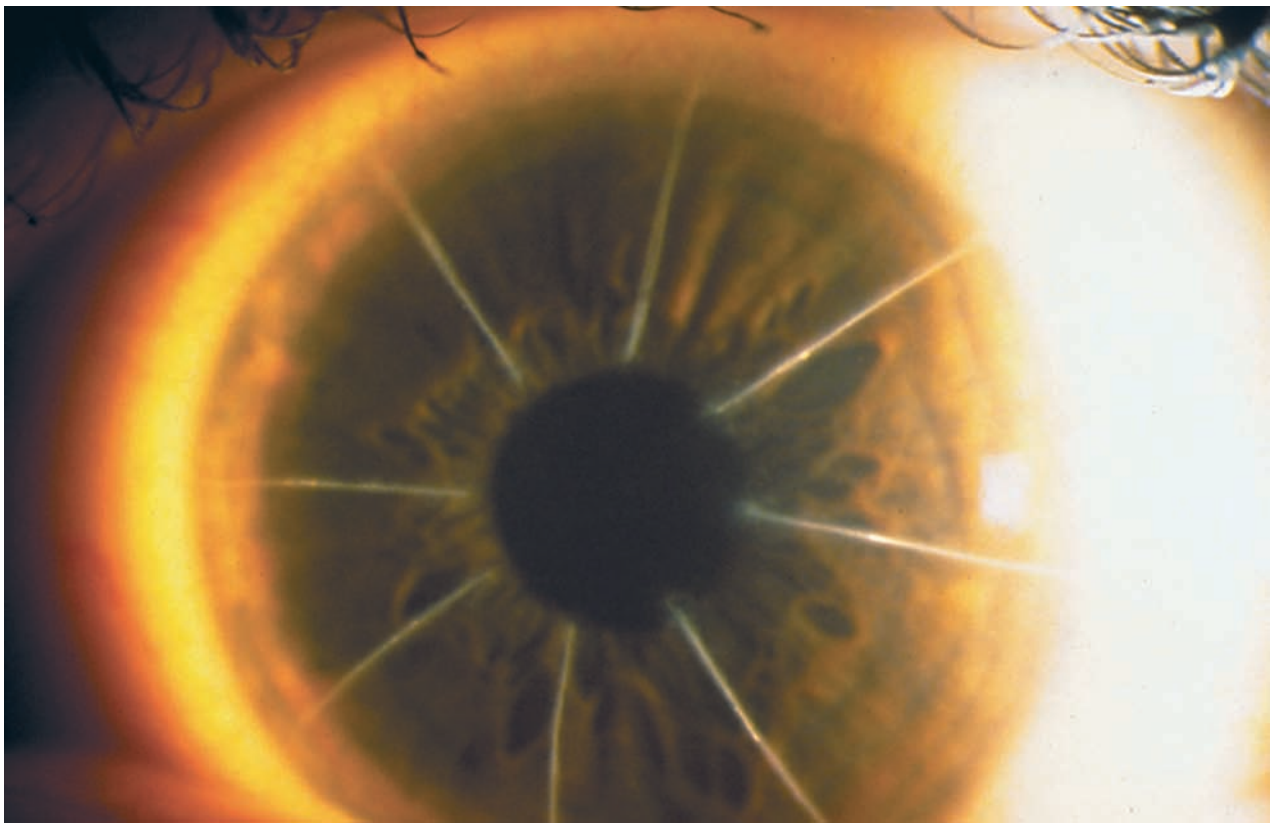

Radial keratotomy scars on the cornea of an eye. *(© Bob Masini/Phototake. — All rights reserved.)*

Description

In a person with clear vision, light passes through the cornea and the lens of the eye and focuses on a membrane lining the back of the eye called the retina. In a person with myopia, the eyeball is usually too long, so light focuses in front of the retina. Radial keratotomy reduces myopia by flattening the cornea. This reduces the focusing power of the cornea allowing light to focus further back onto the retina (or at least closer to it), forming a clearer image.

A surgeon performing RK uses a very small diamond-blade knife to makes four to eight radial incisions around the edge of the cornea. These slits are made in a pattern that resembles the spokes of wheel. As the cornea heals, its center flattens out.

Radial keratotomy is usually performed in an ophthalmologist's office. Before the surgery begins, the patient may be given medicine to help him or her relax. A local anesthetic–usually in the form of eye drops–is used to numb the eye, but the patient remains conscious during the procedure. The surgeon looks through a surgical microscope while making the slits. The treatment usually takes no more than 30 minutes.

Some ophthalmologists will perform RK on both eyes at once but others prefer to do one eye at a time. It once was thought that surgeons could use the results of the first eye to predict how the well the procedure would work on the second eye. However, a study published in 1997 found that this was not the case. The authors of the study cautioned that there might be other reasons not to operate on both eyes at once, such as increased risk of infection and other complications.

The cost for RK depends on the surgeon, but usually ranges from $1,000–$1,500 per eye. Medical insurance usually does not cover RK, because it is considered an elective procedure–one that people choose to have done.

Preparation

Before beginning the procedure, the surgeon marks an area in the center of the cornea called the optical zone. This is the part of the cornea that one sees through (it is the area over the pupil). No cuts are made in this region. The surgeon also measures the cornea's thickness, to decide how deep the slits should be.

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KEY TERMS

Cornea—The transparent part of the eye that covers the iris and the pupil.

Diopter (D)—Unit describing the amount of focusing power of a lens.

Iris—The colored part of the eye.

Laser-assisted in situ keratomileusis (LASIK)—A type of refractive eye surgery using a laser and another instrument to change the shape of the cornea.

Local anesthetic—Used to numb an area where surgery or another procedure is to be done, without causing the patient to lose consciousness.

Myopia—Nearsightedness. People with myopia cannot see distant objects clearly.

Ophthalmologist—A physician who specializes in treating eyes.

Photorefractive keratectomy (PRK)—A type of refractive eye surgery using a laser to change the shape of the cornea.

Pupil—The part of the eye that looks like a black circle in the center of the iris. It is actually an opening through which light passes.

Retina—A membrane lining the back of the eye onto which light is focused to form images.

Aftercare

After the surgery is over, the anesthetic wears off. Some patients feel slight **pain** and are given eye drops and medications to relieve their discomfort. For several days after the surgery, the eye that was treated may feel scratchy and look red. This is normal. The eye may also water, burn slightly, and be sensitive to light.

As with any type of surgery, it is important to guard against infection. Patients are given eye drops to protect against infection and may be told to use them for several weeks after the surgery. Because RK weakens the cornea it is important to protect the head and eyes.

The cornea heals slowly, and full recovery can take several months (another reason not to have the surgery done on both eyes at the same time). While the cornea is healing, patients may experience these problems:

- Variations in vision
- Temporary pain
- Increased glare
- Starburst or halo effects
- Hyperopic shift

As the cornea flattens, vision may become more farsighted (hyperopic). For this reason, the surgeon may initially undercorrect the patient. This gradual shift may occur over several years.

If RK does not completely correct a person's nearsightedness, glasses or contact lenses may be needed. In general, people who were able to wear contact lenses before the procedure can still wear them afterward. Even patients whose nearsightedness was corrected may still need glasses for reading. This is especially true for middle-aged and older patients. The lens of the eye stiffens with age, making reading glasses necessary (**presbyopia**). Radial keratotomy does not correct this problem.

The surgeon who performs the RK procedure will tell the patient how often to return for follow-up visits. Often, two to four visits are needed, including one the day after surgery. It is also important to know what side effects should be reported immediately to the surgeon (e.g., pain or **nausea**).

Risks

Complications from RK are rare, but they can occur. These include:

- cataract a clouding of the lens of the eye, resulting in partial or total loss of vision
- serious infection
- lasting pain
- rips along an incision, especially after being hit in the head or eye
- loss of vision
- chance of overcorrection (hyperopic shift)

The chances of complications are reduced when the surgery is done by an ophthalmologist with a lot of experience in RK. Younger patients also tend to heal faster.

Normal results

The desired result of radial keratotomy is a reduction in myopia. A major study by the National Eye Institute, reported in 1994, tracked the success of RK in 374 patients who had had the procedure done 10 years earlier. The study found that:

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- 85% had at least 20/40 vision (the acuity considered good enough to drive without glasses)
- 70% did not need glasses or contact lenses for distance vision
- 53% had 20/20 vision without glasses
- 30% still needed glasses or contact lenses to see clearly
- 1–3% had worse vision than before they had RK
- 40% had a hyperopic shift.

As with all surgeries, RK has risks. These risks include having worse vision than before the surgery; halos; glare; and although rare, blindness. Some aftereffects, such as halos or glare may last for years. Other refractive surgeries, such as photorefractive keratectomy (PRK) and laser-assisted in situ keratomileusis (LASIK) use lasers to change the shape of the cornea and they may produce fewer side effects. It is important to speak with an experienced eye surgeon who has done many refractive surgeries to fully understand the options and risks involved before making a decision.

ORGANIZATIONS

American Academy of Ophthalmology (AAO), P. O. Box 7424, San Francisco, CA, 94120-7424, (415) 561-8500, 415 561-8500, http://www.aao.org.

American Optometric Association, 243 North Lindbergh Blvd., St. Louis, MO, 63141, 314 991-4100, (314) 991-4101, 800 365-2219, http://www.aoa.org/.

American Society of Cataract and Refractive Surgery, 4000 Legato Road, Suite 700, Fairfax, VA, 22033, (703) 591-2220, (703) 591-0614, http://www.ascrs.org.

Nancy Ross-Flanigan

Radiation injuries

Definition

Radiation injuries are caused by ionizing radiation emitted by sources such as the sun, x-ray and other diagnostic machines, **tanning** beds, and radioactive elements released in nuclear power plant accidents and detonation of nuclear weapons during war and as terrorist acts.

Description

Ionizing radiation is made up of unstable atoms that contain an excess amount of energy. In an attempt to stabilize, the atoms emit the excess energy into the atmosphere, creating radiation. Radiation can either be electromagnetic or particulate.

This person's nose is inflamed and scaly due to radiation exposure. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

The energy of electromagnetic radiation is a direct function of its frequency. The high-energy, high-frequency waves that can penetrate solids to various depths cause damage by separating molecules into electrically charged pieces, a process known as ionization. X rays are a type of electromagnetic radiation. Atomic particles come from radioactive isotopes as they decay to stable elements. Electrons are called beta particles when they radiate. Alpha particles are the nuclei of helium atoms—two protons and two neutrons—without the surrounding electrons. Alpha particles are too large to penetrate a piece of paper unless they are greatly accelerated in electric and magnetic fields. Both beta and alpha particles are types of particulate radiation. When over-exposure to ionizing radiation occurs, there is chromosomal damage in deoxyribonucleic acid (DNA). DNA is very good at repairing itself; both strands of the double helix must be broken to produce genetic damage.

Because radiation is energy, it can be measured. There are a number of units used to quantify radiation energy. Some refer to effects on air, others to effects on living tissue. The roentgen, named after Wilhelm Conrad Roentgen, who discovered x rays in 1895, measures ionizing energy in air. A rad expresses the energy transferred to tissue. The rem measures tissue response. A roentgen generates about a rad of effect and produces about a rem of response. The gray and the sievert are international units equivalent to 100 rads and rems, respectively. A curie, named after French physicists who experimented with radiation, is a measure of actual radioactivity given off by a radioactive element, not a measure of its effect. The average annual human

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exposure to natural background radiation is roughly 3 milliSieverts (mSv).

Any amount of ionizing radiation will produce some damage, however, there is radiation everywhere, from the sun (cosmic rays) and from traces of radioactive elements in the air (radon) and the ground (uranium, radium, carbon-14, potassium-40 and many others). Earth's atmosphere protects us from most of the sun's radiation. Living at 5,000 feet altitude in Denver, Colorado, doubles exposure to radiation, and flight in a commercial airliner increases it 150-fold by lifting us above 80% of that atmosphere. Because no amount of radiation is perfectly safe and because radiation is ever present, arbitrary limits have been established to provide some measure of safety for those exposed to unusual amounts. Less than 1% of them reach the current annual permissible maximum of 20 mSv.

A 2001 ruling by the Federal Court of Australia indicated that two soldiers died from **cancer** caused by minimal exposure to radiation while occupying Hiroshima in 1945. The soldiers were exposed to less than 5 mSv of radiation. The international recommendation for workers is safety level of up to 20 mSv. The ruling and its support by many international agencies suggests that even extremely low doses of radiation can be potentially harmful.

Ultraviolet (UV) radiation exposure from the sun and tanning beds

UV radiation from the sun and tanning beds and lamps can cause skin damage, premature **aging**, and skin cancers. **Malignant melanoma** is the most dangerous of skin cancers and there is a definite link between type UVA exposure used in tanning beds and its occurrence. UVB type UV radiation is associated with **sunburn**, and while not as penetrating as UVA, it still damages the skin with over exposure. Skin damage accumulates over time, and effects do not often manifest until individuals reach middle age. Light-skinned people who most often burn rather than tan are at a greater risk of skin damage than darker-skinned individuals that almost never burn. The U.S. Food and Drug Administration (FDA) and the Centers for Disease Control (CDC) discourage the use of tanning beds and sun lamps and encourage the use of sunscreen with at least an SPF of 15 or greater.

Over exposure during medical procedures

Ionizing radiation has many uses in medicine, both in diagnosis and in treatment. X rays, CT scanners, and fluoroscopes use it to form images of the body's insides. Nuclear medicine uses radioactive isotopes to diagnose and to treat medical conditions. In the body, radioactive elements localize to specific tissues and give off tiny amounts of radiation. Detecting that radiation provides information on both anatomy and function. During the past 10 years, skin injuries caused by too much exposure during a medical procedure have been documented. In 1995, the FDA issued a recommendation to physicians and medical institutions to record and monitor the dosage of radiation used during medical procedures on patients in order to minimize the amount of skin injuries. The FDA suggested doses of radiation not exceed 1 Grey (Gy), which is roughly equivalent to a sievert. The FDA prepared further guidelines for fluoroscopy, the procedure most often associated with medical-related radiation skin injuries such as **rashes** and more serious **burns** and tissue **death**. Injuries occurred most often during **angioplasty** procedures using fluoroscopy.

CT scans of children have also been problematic. Oftentimes the dosage of radiation used for an adult isn't decreased for a child, leading to radiation over exposure. Children are more sensitive to radiation and a February 2001 study indicates 1,500 out of 1.6 million children under 15 years of age receiving CT scans annually will develop cancer. Studies show that decreasing the radiation by half for CT scans of children will effectively decrease the possibility of over exposure while still providing an effective diagnostic image. The benefits to receiving the medical treatment utilizing radiation is still greater than the risks involved, however, more stringent control over the amount of radiation used during the procedures will go far to minimize the risk of radiation injury to the patient.

Radiation exposure from nuclear accidents, weaponry, and terrorist acts

Between 1945 and 1987, there were 285 nuclear reactor accidents, injuring more than 1,550 people and killing 64. The most striking example was the meltdown of the graphite core nuclear reactor at Chernobyl in 1986, which spread a cloud of radioactive particles across the entire continent of Europe. Information about radiation effects is still being gathered from that disaster, however 31 people were killed in the immediate accident and 1,800 children have thus far been diagnosed with **thyroid cancer**. In a study published in May 2001 by the British Royal Society, children born to individuals involved in the cleanup of Chernobyl and born after the accident are 600% more likely to have genetic mutations than children born before the accident. These findings indicate that exposure to low doses of radiation can cause inheritable effects.

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Since the terrorist attack on the World Trade Center and the Pentagon on September 11, 2001, the possibility of terrorist-caused nuclear accidents has been a growing concern. All 103 active nuclear power plants in the United States are on full alert, but they are still vulnerable to sabotage such as bombing or attack from the air. A no-fly zone of 12 miles below 18,000 feet has been established around nuclear power plants by the Federal Aviation Administration (FAA). There is also growing concern over the security of spent nuclear fuel—more than 40,000 tons of spent fuel is housed in buildings at closed plants around the country. Unlike the active nuclear reactors that are enclosed in concrete-reinforced buildings, the spent fuel is stored in non-reinforced buildings. Housed in cooling pools, the spent fuel could emit dangerous levels of radioactive material if exploded or used in makeshift weaponry. Radioactive medical and industrial waste could also be used to make "dirty bombs." Since 1993, the Nuclear Regulatory Commission (NRC) has reported approximately 400 cases of stolen radioactive materials.

Causes and symptoms

Radiation can damage every tissue in the body. The particular manifestation will depend upon the amount of radiation, the time over which it is absorbed, and the susceptibility of the tissue. The fastest growing tissues are the most vulnerable, because radiation as much as triples its effects during the growth phase. Bone marrow cells that make blood are the fastest growing cells in the body. A fetus in the womb is equally sensitive. The germinal cells in the testes and ovaries are only slightly less sensitive. Both can be rendered useless with very small doses of radiation. More resistant are the lining cells of the body—skin and intestines. Most resistant are the brain cells, because they grow the slowest.

The length of exposure makes a big difference in what happens. Over time the accumulating damage, if not enough to kill cells outright, distorts their growth and causes scarring and/or cancers. In addition to leukemias, cancers of the thyroid, brain, bone, breast, skin, stomach, and lung all arise after radiation. Damage depends, too, on the ability of the tissue to repair itself. Some tissues and some types of damage produce much greater consequences than others.

There are three types of radiation injuries.

- External irradiation: as with x-ray exposure, all or part of the body is exposed to radiation that either is absorbed or passes through the body
- Contamination: as with a nuclear accident, the environment and its inhabitants are exposed to radiation. People are affected internally, externally, or with both internal and external exposure
- Incorporation: dependent on contamination, the bodies of individuals affected incorporate the radiation chemicals within cells, organs, and tissues and the radiation is dispersed throughout the body

Immediately after sudden irradiation, the fate of those affected depends mostly on the total dose absorbed. This information comes mostly from survivors of the atomic bomb blasts over Japan in 1945.

- Massive doses incinerate immediately and are not distinguishable from the heat of the source
- A sudden whole body dose over 50 Sv produces such profound neurological, heart, and circulatory damage that patients die within the first two days
- Doses in the 10–20 Sv range affect the intestines, stripping their lining and leading to death within three months from vomiting, diarrhea, starvation, and infection
- Victims receiving 6–10 Sv all at once usually escape an intestinal death, facing instead bone marrow failure and death within two months from loss of blood coagulation factors and the protection against infection provided by white blood cells
- Between 2–6 Sv gives a fighting chance for survival if victims are supported with blood transfusions and antibiotics
- One or two Sv produces a brief, non-lethal sickness with vomiting, loss of appetite, and generalized discomfort

Treatment

It is clearly important to have some idea of the dose received as early as possible, so that attention can be directed to those victims in the 2–10 Sv range that might survive with treatment. Blood transfusions, protection from infection in damaged organs, and possibly the use of newer stimulants to blood formation can save many victims in this category.

Local radiation exposures usually damage the skin and require careful wound care, removal of dead tissue, and **skin grafting** if the area is large. Again **infection control** is imperative.

One of the best known, and perhaps even mainstream, treatments of radiation injury is the use of *Aloe vera* preparations on damaged areas of skin. It has demonstrated remarkable healing properties even for chronic ulcerations resulting from radiation exposure.

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KEY TERMS

DNA—Deoxyribonucleic acid. The chemical of chromosomes and hence the vehicle of heredity.

Isotope—An unstable form of an element that gives off radiation to become stable. Elements are characterized by the number of electrons around each atom. One electron's negative charge balances the positive charge of each proton in the nucleus. To keep all those positive charges in the nucleus from repelling each other (like the same poles of magnets), neutrons are added. Only certain numbers of neutrons work. Other numbers cannot hold the nucleus together, so it splits apart, giving off ionizing radiation. Sometimes one of the split products is not stable either, so another split takes place. The process is called radioactivity.

Alternative treatment

There is considerable interest these days in benevolent chemicals called "free radical scavengers." How well they work is yet to be determined, but population studies strongly suggest that certain **diets** are better than others, and that those diets are full of free radical scavengers, otherwise known as **antioxidants**. The recommended ingredients are beta-carotene, **vitamins** E and C, and selenium, all available as commercial preparations. Beta-carotene is yellow-orange and is present in yellow and orange fruits and vegetables. Vitamin C can be found naturally in citrus fruits. **Traditional Chinese medicine** (TCM) and **acupuncture**, botanical medicine, and homeopathy all have contributions to make to recovery from the damage of radiation injuries. The level of recovery will depend on the exposure. Consulting practitioners trained in these modalities will result in the greatest benefit.

Resources

PERIODICALS

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Vergano, Dan. "'Dirty' Bombs Latest Fear." *USA Today* November 3, 2001.

Jacqueline L. Longe

Radiation sickness *see* **Radiation injuries**

Radiation therapy

Definition

Radiation therapy, sometimes called radiotherapy, x-ray therapy radiation treatment, cobalt therapy, electron beam therapy, or irradiation uses high energy, penetrating waves or particles such as x rays, gamma rays, proton rays, or neutron rays to destroy **cancer** cells or keep them from reproducing.

Purpose

The purpose of radiation therapy is to kill or damage cancer cells. Radiation therapy is a common form of cancer therapy. It is used in more than half of all cancer cases. Radiation therapy can be used:

- alone to kill cancer
- to prevent cancer cells from spreading into the area of tissue receiving radiation (prophylactic treatment)
- before surgery to shrink a tumor and make it easier to remove
- during surgery to kill cancer cells that may remain in surrounding tissue after the surgery (called intraoperative radiation)
- after surgery to kill cancer cells remaining in the body
- to shrink an inoperable tumor in order to reduce pain and improve quality of life (palliative treatment)
- in combination with chemotherapy or hormone therapy

For some kinds of cancers such as early-stage Hodgkin's disease, non-Hodgkin's lymphomas, and certain types of prostate or brain cancer, radiation therapy alone may cure the disease. In other cases, radiation therapy used in conjunction with surgery, **chemotherapy**, hormone therapy, or all three, increases survival rates over any of these therapies used alone.

Precautions

External radiation therapy does not make the body of the person having the treatments radioactive. In almost all cases, the benefits of this therapy outweigh the risks. However, radiation therapy can have serious consequences, so anyone contemplating it should be sure to understand why the treatment team believes it is the best possible treatment option for their cancer. Radiation therapy is often not appropriate for pregnant women, because the radiation can damage the cells of the developing baby. Women who think they might be pregnant should discuss this with their doctor.

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KEY TERMS

Anemia—Insufficient red blood cells in the body.

Antibody—Protein molecule that recognizes and binds specifically to a foreign substance in the body in order to eliminate it.

Chemotherapy—Injecting drugs into the body where they circulate and kill cancer cells.

Computed tomography (CT or CAT) scan—Using X rays taken from many angles and computer modeling, CT scans help locate and size tumors and provide information on whether they can be surgically removed.

Fractionation—A procedure for dividing a dose of radiation into smaller treatment doses.

Gamma rays—Short wavelength, high energy electromagnetic radiation emitted by radioactive substances.

Hodgkin's disease—Cancer of the lymphatic system, characterized by lymph node enlargement and the presence of a large polyploid cells called Reed-Sternberg cells.

Magnetic resonance imaging (MRI)—MRI uses magnets and radio waves to create detailed cross-sectional pictures of the interior of the body.

Palliative—Referring to treatment intended to relieve pain rather than effect a cure.

Prophylactic—A medication or treatment intended to protect against or ward off disease.

Radiopharmaceuticals—Radioactive drugs used as tracers in the diagnosis and treatment of cancers. The most common element used in radiopharmaceuticals is an isotope of technetium known as Tc-99m.

Stereotactic—Characterized by precise positioning in space. When applied to radiosurgery, stereotactic refers to a system of three-dimensional coordinates for locating the target site.

Description

Radiation therapy is a local treatment that is painless. The radiation acts only on the part of the body that is exposed to the radiation. This form of treatment is very different from chemotherapy in which drugs circulate throughout the whole body. There are two main types of radiation therapy. In external radiation therapy a beam of radiation is directed from outside the body at the cancer. In internal radiation therapy, called brachytherapy or implant therapy, a source of radioactivity is surgically placed inside the body near the cancer.

How radiation therapy works

The protein that carries the code controlling most activities in the cell is called deoxyribonucleic acid or DNA. When a cell divides, its DNA must also double and divide. High-energy radiation kills cells by damaging their DNA. This blocks their ability to grow and increase in number.

One of the characteristics of cancer cells is that they grow and divide faster than normal cells. This makes them particularly vulnerable to radiation. Radiation also damages normal cells, but because normal cells are growing more slowly, they are better able to repair radiation damage than are cancer cells. In order to give normal cells time to heal and reduce side effects, radiation treatments are often given in small doses over a six- or seven-week period.

External radiation therapy

External radiation therapy is the most common kind of radiation therapy. It is usually done during outpatient visits to a hospital clinic and is usually covered by insurance.

Once a doctor called a radiation oncologist determines the proper dose of radiation for a particular cancer, the dose is divided into smaller doses called fractions. One fraction is usually given each day, five days a week for six to seven weeks. However, each radiation plan is individualized depending on the type and location of the cancer and what other treatments are also being used. The actual administration of the therapy usually takes about half an hour daily, although radiation is only administered for one to five minutes at each session. It is important to attend every scheduled treatment to get the most benefit from radiation therapy.

Recently, trials have begun to determine if there are ways to deliver radiation fractions so that they kill more cancer cells or have fewer side effects. Some trials use smaller doses given more often. Up-to-date information on voluntary participation in clinical trials and where they are being held is available by entering the search term "radiation therapy" at the following web sites:

- National Cancer Institute: http://cancertrials.nci.nih.gov or (800) 4-CANCER
- National Institutes of Health Clinical Trials: http://clinicaltrials.gov
- Center Watch: A Clinical Trials Listing: http://www.centerwatch.com

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The type of machines used to administer external radiation therapy and the material that provides the radiation vary depending on the type and location of the cancer. Generally, the patient puts on a hospital gown and lies down or sits in a special chair. Parts of the body not receiving radiation are covered with special shields that block the rays. A technician then directs a beam of radiation to a predetermined spot on the body where the cancer is located. The patient must remain still during the administration of the radiation so that no other parts of the body are affected. As an extra precaution in some treatments, special molds are made to make sure the body is in the same position for each treatment. However, the treatment itself is painless, like having a bone x-rayed.

Internal radiation therapy

Internal radiation therapy is called brachytherapy, implant therapy, interstitial radiation, or intracavitary radiation. With internal radiation therapy, a small amount of radioactive material is sealed in an implant (sometimes called a seed or capsule). The implant is then placed very close to the cancer. The advantage of internal radiation therapy is that it concentrates the radiation near the cancer and lessens the chance of damage to normal cells. Many different types of radioactive materials can be used in the implant, including cesium, iridium, iodine, phosphorus, and palladium.

The way in which the implant is positioned near the cancer depends on the size and location of the cancer. Internal radiation therapy is used for some cancers of the head, neck, thyroid, breast, female reproductive system, and prostate. Most people will have the radioactive capsule implanted by a surgeon while under either general or **local anesthesia** at a hospital or surgical clinic.

Patients receiving internal radiation therapy do become temporarily radioactive. They must remain in the hospital during the time that the implant stays in place. The length of time is determined by the type of cancer and the dose of radioactivity to be delivered. During the time the implant is in place, the patient will have to stay in bed and remain reasonably still.

While the implant is in place, the patient's contact with other people will be limited. Health care workers will make their visits as brief as possible to avoid exposure to radiation, and visitors, especially children and pregnant women, will be limited.

The implant usually can be removed in a simple procedure without an anesthetic. As soon as the implant is out of the body, the patient is no longer radioactive, and restrictions on being with other people are lifted. Generally people can return to a level of activity that feels comfortable to them as soon as the implant is removed. Occasionally the site of the implant is sore for some time afterwards. This discomfort may limit specific activities.

In some cases, an implant is left permanently inside the body. People who have permanent implants need to stay in the hospital and away from other people for the first few days. Gradually the radioactivity of the implant decreases, and it is safe to be around other people.

Radioimmunotherapy

Radioimmunotherapy is a promising way to treat cancer that has spread (metastasized) to multiple locations throughout the body. Antibodies are immune system proteins that specifically recognize and bind to only one type of cell. They can be designed to bind only with a certain type of cancer cell. To carry out radioimmunotherapy, antibodies with the ability to bind specifically to a patient's cancer cells are attached to radioactive material and injected into the patient's bloodstream. When these human-made antibodies find a cancer cell, they bind to it. Then the radiation kills the cancer cell. This process is still experimental, but because it can be used to selectively attack only cancer cells, it holds promise for eliminating cancers that have spread beyond the primary tumor.

Types of radiation used to treat cancer

PHOTON RADIATION. Early radiation therapy used x rays like those used to take pictures of bones, or gamma rays. X rays and gamma rays are high-energy rays composed of massless particles of energy (like light) called photons. The distinction between the two is that gamma rays originate from the decay of radioactive substances (like radium and cobalt-60), while x rays are generated by devices that excite electrons (such as cathode ray tubes and linear accelerators). These high-energy rays act on cells by disrupting the electrons of atoms within the molecules inside cells, disrupting cell functions, and, most importantly, by stopping their ability to divide and make new cells.

PARTICLE RADIATION. Particle radiation is radiation delivered by particles that have mass. Proton therapy has been used since the early 1990s. Proton rays consist of protons, a type of positively charged

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atomic particle, rather than photons, which have neither mass nor charge. Like x rays and gamma rays, proton rays disrupt cellular activity. The advantage of using proton rays is that they can be shaped to conform to the irregular shape of the tumor more precisely than x rays and gamma rays. They allow delivery of higher radiation doses to tumors without increasing damage to the surrounding tissue.

Neutron therapy is another type of particle radiation. Neutron rays are very high-energy rays. They are composed of neutrons, which are particles with mass but no charge. The type of damage they cause to cells is much less likely to be repaired than that caused by x rays, gamma rays, or proton rays.

Neutron therapy can treat larger tumors than conventional radiation therapy. Conventional radiation therapy depends on the presence of oxygen to work. The center of large tumors lack sufficient oxygen to be susceptible to damage from conventional radiation. Neutron radiation works in the absence of oxygen, making it especially effective for the treatment of inoperable **salivary gland tumors**, bone cancers, and some kinds of advanced cancers of the pancreas, bladder, lung, prostate, and uterus.

Recent advances in radiation therapy

A newer mode of treating brain cancers with radiation therapy is known as stereotactic radiosurgery. Stereotactic radiosurgery allows the doctor to deliver a single high-level dose of precisely directed radiation to the tumor without damaging nearby healthy brain tissue. The treatment is planned with the help of three-dimensional computer-aided analysis of CT and MRI scans. The patient's head and neck are held steady in a skeletal fixation device during the actual treatment. Stereotactic radiosurgery can be used in addition to standard surgery to treat a recurrent **brain tumor**, or in place of surgery if the tumor cannot be reached by standard surgical techniques.

Three major forms of stereotactic radiosurgery are in use. The gamma knife is a stationary machine that is most useful for small tumors, blood vessels, or similar targets. Because it does not move, it can deliver a small, highly localized and precise beam of radiation. Gamma knife treatment is done all at once in a single hospital stay. The second type of radiosurgery uses a movable linear accelerator-based machine or LINAC that is preferred for larger tumors. This treatment is delivered in several small doses given over several weeks. The third form, in limited use in North America, is proton-beam radiosurgery. This form of radiosurgery uses a cyclotron to generate protons, which are then steered by magnets toward the targeted tumor. Proton-beam radiosurgery can be used to treat cancers of the lung and prostate as well as cancers of the head and neck. Radiosurgery that is performed with divided doses is known as fractionated radiosurgery. The total dose of radiation is higher with a linear accelerator-based machine than with gamma knife treatment.

Another advance in intraoperative radiotherapy (IORT) is the introduction of mobile devices that allow the surgeon to use radiotherapy in early-stage disease and to operate in locations where it would be difficult to transport the patient during surgery for radiation treatment. Mobile IORT units have been used successfully in treating early-stage **breast cancer** and **rectal cancer**.

Radiation sensitizers are another recent innovation in radiation therapy. Sensitizers are medications that are given to make cancer cells easier to kill by radiation than normal calls. Gemcitabine (Gemzar) is one of the drugs most commonly used for this purpose.

3-D conformal radiation therapy and intensity-modulated radiation therapy (IMRT) are two newer techniques used to improve the effectiveness of external radiation therapy. 3-D conformal radiation therapy uses computers to enable doctors to measure the depth as well as the height and width of a tumor. CT scans or **magnetic resonance imaging** (MRI) can be used to obtain a three-dimensional image of the tumor. Special computer programs then design radiation beams that conform closely to the actual shape of the tumor. 3-D conformal radiation therapy has been reported to improve treatment outcomes for nasopharyngeal, prostate, lung, liver, and brain cancers.

IMRT is the most recent type of 3-D conformal radiation therapy. It uses x rays of different intensities to deliver different doses of radiation to small areas of tissue simultaneously. This technique allows the doctor to deliver larger doses of radiation to cancerous tissue and lower doses to nearby healthy tissue at the same time, thus reducing the risk of side effects. IMRT is delivered by a linear accelerator that rotates around the patient. Because the equipment is the size of a small car and is highly specialized, IMRT is not available in all cancer centers. It is used most often to treat cancers of the head, neck, and central nervous system, but has also been used to treat cancers of the breast, lung, uterus, thyroid, and digestive tract.

Radiopharmaceuticals

Radiopharmaceuticals are drugs containing radioactive materials that can be used as tracers in the

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diagnosis as well as the treatment of cancer. There are about 28 different elements that can be used in radiopharmaceuticals; however, the element in most common use in cancer diagnosis is technetium. Its radioactive form is an isotope known as Tc99-m. Tc99-m is used to image the thyroid gland, bone marrow, lymph nodes, kidneys, lungs, and blood flow to the brain. Other radiopharmaceuticals include samarium 153 and strontium 89, approved by the FDA to treat **pain** caused by cancer that has metastasized to the bone.

Other drugs used as part of radiation therapy are radiosensitizers, used to make cancerous tissue more sensitive to radiation, and radioprotectors, used to protect healthy tissue from damage caused by radiation therapy. Amifostine is the only drug approved by the FDA as a radioprotector. It is used during radiation therapy of the head and neck to protect the patient's salivary glands and reduce the risk of **dry mouth**.

Preparation

Before radiation therapy, the size and location of the patient's tumor are determined very precisely using magnetic resonance imaging (MRI) and/or **computed tomography scans** (CT scans). The correct radiation dose, the number of sessions, the interval between sessions, and the method of application are calculated by a radiation oncologist based on the tumor type, its size, and the sensitivity of the nearby tissues.

The patient's skin is marked with a semi-permanent ink to help the radiation technologist achieve correct positioning for each treatment. Molds may be built to hold tissues in exactly the right place each time.

Aftercare

Many patients experience skin burn, **fatigue**, **nausea**, and **vomiting** after radiation therapy regardless of where the radiation is applied. After treatment, the skin around the site of the treatment may also become sore. Affected skin should be kept clean and can be treated like **sunburn**, with skin lotion or vitamin A and D ointment. Patients should avoid perfume and scented skin products and protect affected areas from the sun.

Nausea and vomiting are most likely to occur when the radiation dose is high or if the abdomen or another part of the digestive tract is irradiated. Sometimes nausea and **vomiting** occur after radiation to other regions, but in these cases the symptoms usually disappear within a few hours after treatment. Nausea and vomiting can be treated with **antacids**, Compazine, Tigan, or Zofran.

Fatigue frequently starts after the second week of therapy and may continue until about two weeks after the therapy is finished. Patients may need to limit their activities, take naps, and get extra sleep at night.

Patients should see their oncologist (cancer doctor) at least once within the first few weeks after their final radiation treatment. They should also see an oncologist every six to twelve months for the rest of their lives so they can be checked to see if the tumor has reappeared or spread.

Risks

Radiation therapy can cause anemia, nausea, vomiting, **diarrhea**, hair loss (**alopecia**), skin burn, sterility, and rarely **death**. However, the benefits of radiation therapy almost always exceed the risks. Patients should discuss the risks with their doctor and get a second opinion about their treatment plan.

Normal results

The outcome of radiation treatment varies depending on the type, location, and stage of the cancer. For some cancers such as Hodgkin's disease, about 75% of the patients are cured. **Prostate cancer** also responds well to radiation therapy. Radiation to painful bony metastases is usually a dramatically effective form of pain control. Other cancers may be less sensitive to the benefits of radiation.

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ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329-4251, (800) ACS-2345, http://www.cancer.org.
International Radiosurgery Support Association (IRSA), 3002 North Second Street, Harrisburg, PA, 17110, (717) 260-9808, http://www.irsa.org.
National Association for Proton Therapy, 1301 Highland Drive, Silver Spring, MD, 20910, (301) 587-6100, http://www.proton-therapy.org.

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Radiation treatments *see* **Radiation therapy**

A digitized illustration of the human head and chest showing nasal passages, sinuses, trachea, vascular nerves, as well as ribs and parts of the lungs. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Radical neck dissection

Definition

Radical neck dissection is an operation used to remove cancerous tissue in the head and neck.

Purpose

The purpose of radical neck dissection is to remove lymph nodes and other structures in the head and neck that are likely or proven to be malignant. Variations on neck dissections exist depending on the extent of the **cancer**. A radical neck dissection removes the most tissue. It is done when the cancer has spread widely in the neck. A modified neck dissection removes less tissue, and a selective neck dissection even less.

Precautions

This operation should not be done if cancer has metastasized (spread) beyond the head and neck, or if the cancer has invaded the bones of the cervical vertebrae (the first seven vertebrae of the spinal column) or the skull. In these cases, the surgery will not effectively contain the cancer.

Description

Cancers of the head and neck (sometimes inaccurately called throat cancer) often spread to nearby tissues and into the lymph nodes. Removing these structures is one way of controlling the cancer.

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KEY TERMS

Barium swallow—Barium is used to coat the throat in order to take x-ray pictures of the tissues lining the throat.

Computed tomography (CT or CAT) scan—Using x rays taken from many angles and computer modeling, CT scans help size and locate tumors and provide information on whether they can be surgically removed.

Lymph nodes—Small, bean-shaped collections of tissue found in lymph vessels. They produce cells and proteins that fight infection and filter lymph. Nodes are sometimes called lymph glands.

Lymphatic system—Primary defense against infection in the body. The tissues, organs, and channels (similar to veins) that produce, store, and transport lymph and white blood cells to fight infection.

Magnetic resonance imaging (MRI)—MRI uses magnets and radio waves to create detailed cross-sectional pictures of the interior of the body.

Malignant—Cancerous. Cells tend to reproduce without normal controls on growth and form tumors or invade other tissues.

Metastasize—Spread of cells from the original site of the cancer to other parts of the body where secondary tumors are formed.

Of the 600 hundred lymph nodes in the body, about 200 are in the neck. Only a small number of these are removed during a neck dissection. In addition, other structures such as muscles, veins, and nerves may be removed during a radical neck dissection. These include the sternocleidomastoid muscle (one of the muscles that functions to flex the head), internal jugular (neck) vein, submandibular gland (one of the salivary glands), and the spinal accessory nerve (a nerve that helps control speech, swallowing and certain movements of the head and neck). The goal is always to remove all the cancer but to save as many components surrounding the nodes as possible.

Radical neck dissections are done in a hospital under **general anesthesia** by a head and neck surgeon. An incision is made in the neck, and the skin is pulled back to reveal the muscles and lymph nodes. The surgeon is guided in what to remove by tests done prior to surgery and by examination of the size and texture of the lymph nodes.

Preparation

Radical neck dissection is a major operation. Extensive tests are done before the operation to try to determine where and how far the cancer has spread. These may include lymph node biopsies, CT (computed tomography) scans, MRI scans, and barium swallows. In addition, standard pre-operative blood and **liver function tests** are performed, and the patient will meet with an anesthesiologist before the operation. The patient should tell the anesthesiologist about all drug **allergies** and all medication (prescription, non-prescription, or herbal) that he or she is taking.

Aftercare

A person who has had a radical neck dissection will stay in the hospital several days after the operation, and sometimes longer if surgery to remove the primary tumor was done at the same time. Drains are inserted under the skin to remove the fluid that accumulates in the neck area. Once the drains are removed and the incision appears to be healing well, patients are usually discharged from the hospital, but will require follow-up doctor visits. Depending on how many structures are removed, a person who has had a radical neck dissection may require **physical therapy** to regain use of the arm and shoulder.

Risks

The greatest risk in a radical neck dissection is damage to the nerves, muscles, and veins in the neck. Nerve damage can result in **numbness** (either temporary or permanent) to different regions on the neck and loss of function (temporary or permanent) to parts of the neck, throat, and shoulder. The more extensive the neck dissection, the more function the patient is likely to lose. As a result, it is common following radical neck dissection for a person to have stooped shoulders, limited ability to lift the arm, and limited head and neck rotation and flexion due to the removal of nerves and muscles. Other risks are the same as for all major surgery: potential bleeding, infection, and allergic reaction to anesthesia.

Normal results

Normal lymph nodes are small and show no cancerous cells under the microscope.

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Abnormal results

Abnormal lymph nodes may be enlarged and show malignant cells when examined under the microscope.

Resources

OTHER

The Voice Center at Eastern Virginia Medical School. http://www.voice-center.com.

ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (800) 227-2345, http://www.cancer.org.

NCI Office of Communications and Education, 6116 Executive Blvd. Suite 300, Bethesda, MD, 20892-8322, (800) 4-CANCER (422-6237), cancergovstaff@mail.nih.gov, http://www.cancer.gov/aboutnci/cis.

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Radioactive implants

Definition

Radioactive implants are devices that are placed directly within cancerous tissue or tumors in order to deliver radiation intended to kill cancerous cells. The practice of internal **radiation therapy** is also referred to as brachytherapy. The two main types of brachytherapy are intracavitary radiation, in which the radioactive source is placed in a body cavity, and interstitial radiation, which involves the placement of radioactive material into or near cancerous tissue but not in a body cavity.

Purpose

With the use of radioactive implants, a tumor is subjected to radioactive activity over a longer period of time and often at higher doses, as compared to radiation therapy that is delivered via external beam radiation therapy.

Description

Internal radiation therapy places the sources of radiation directly into the tumor and surrounding tissue. Brachytherapy can be used to treat many different types of **cancer** including tumors of the head, neck, prostate, cervix, skin, breast and other types of cancer.

Radioactive implants can be used alone or they can be used in combination with external radiation therapy. The implant may be permanent or removable. For example, a permanent implant of radioactive seeds, such as gold seeds, is placed directly into the organ. These seeds are usually very small in size, about the size of a grain of rice. Over several weeks or months, the seeds slowly deliver radiation to the tumor. This type of implant typically remains in the body permanently.

KEY TERMS

External beam radiation therapy—Radiation therapy delivered from a source external to the body such as from a radiation therapy machine.

Sealed radioactive sources—A radioactive source contained or sealed within a ribbon, wire, needle, balloon, tube or catheter.

Depending on the type and location of the cancer being treated, brachytherapy implants can remain in place for a few minutes or for several days. Sealed radioactive sources, such as radioactive ribbons, wires, needles, balloons, and tubes, are placed into body cavities or tissues using devices called applicators. Applicators are usually put into the body in the operating room while the patient is under general or **local anesthesia**. Placement of applicators is done very precisely using x rays or **magnetic resonance imaging** (MRI)to guide the location of placement. The radioactive source is then placed into the applicators once the actual treatment is to begin. Some implants may require hospitalization and may necessitate as little movement as possible to minimize movement of the implant which is placed to target radiation precisely to the tumor. Other implants are left permanently in the body. In this situation, the applicator is removed once the implant is placed.

High–dose–rate brachtherapy is a technique which allows for treatment with a radioactive source which is placed in an applicator over a very short period of time, usually only a few minutes. Once the treatment time has elapsed, the radioactive materials are removed from the body. The applicator may or may not be removed. The treatment period ranges from several days to several weeks. This type of procedure is usually done in an outpatient radiation therapy center.

Preparation

The planning and procedures used for treatment with radioactive implants is becoming increasingly accurate and sophisticated as technology develops. Special imaging tools and computer software used by radiation physicists help radiation oncologists and radiation therapists visualize implant placements which very precisely target the cancerous tissue which is to be treated while minimizing radiation effects to non-cancerous tissue.

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Aftercare

If an applicator is to remain in place, there may be some discomfort in the area of the applicator. Medications may be prescribed to minimize the discomfort.

In some cases, patients may be required to remain on bedrest with limited movement during brachytherapy treatments. The goal is to maintain precise placement of the applicator and of the radioactive source to ensure the radiation remains targeted to the site of the cancer while minimizing radiation to surrounding tissue.

Risks

To minimize radiation exposure to others, some patients who have received internal radiation may be required to remain in the hospital so that radiation levels can be monitored. Visitors may not be allowed during this time and staff is allowed in the room for only short periods of time. Pregnant women and children are not allowed to come into contact with the patient because of the exposure to radiation.

Patients who have received permanent implants may emit small doses of radiation for several weeks or months after the implants are placed. The risk to others is minimal. However, the patient may be asked to have little or no contact with children or pregnant women, especially when the implant is first placed.

Results

The goal of treatment with radioactive implants is to treat the cancer. Normal cells in or near the treatment site are subjected to the effects of radiation; any tissue near the radiation site may be damaged or destroyed. Some side effects are acute and temporary, while others develop over time and may be permanent.

In general, as compared to radiation that is delivered using external beam radiation therapy, radiation delivered using brachytherapy techniques usually results in less toxicity and has fewer side effects since the radiation is precisely targeted and delivered directly to the tumor.

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Radioactive iodine uptake test *see* **Thyroid nuclear medicine scan**

Radioallergosorbent test (RAST) *see* **Allergy tests**

Radiotherapy *see* **Radiation therapy**

Raloxifene *see* **Bone disorder drugs**

Range-of-motion exercises *see* **Exercise**

Rape and sexual assault

Definition

The various definitions of rape range from the broad (coercing a person to engage in any sexual act) to the specific (forcing a woman to submit to sexual intercourse). The United States Code includes the crime of rape under the more comprehensive term "sexual abuse." Two types of sexual assault are defined in the code: **sexual abuse** and aggravated sexual **abuse**. Sexual abuse includes acts in which an individual is forced to engage in sexual activity by use of threats or other fear tactics (and when the individual does not, or is unable to provide, consent), or instances in which an individual is physically unable to decline. Aggravated sexual abuse occurs when an individual is forced to submit to sexual acts by use of physical force; threats of **death**, injury, or kidnapping; or substances that

Victim response to a rape or sexual assault

- Don't blame yourself
- Seek immediate medical attention
- Don't bathe or change your clothing
- Retain all evidence
- Avoid urinating before seeing a doctor, especially if you think you've been drugged
- Consider the "morning-after" pill

SOURCE: U.S. Department of Health and Human Safety, Office on Women's Health.

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render that individual unconscious or impaired. In both cases, the act may be completed or may only be only attempted, but it still considered a sexual assault.

Demographics

The rape or sexual attack can happen to anyone—women, men, or children. The attacker can be anyone—a stranger, friend or acquaintance, family member, former or current partner, or person that is in a position of trust, confidence, authority, or power (such as clergies, teachers, or superiors). A man most commonly commits rape onto a woman. However, rape can also occur by a woman onto a man. Rape performed by a man onto another man, or by a woman onto another woman is also a type of rape. Such instances typically occur in closed environments, such as in prisons. According to *The New York Times,* the typical rape victim is a 16 to 24 years old woman and the average sexual attacker, or rapist, is a 25 to 44 year old man. From data provided to law enforcement across the country, the Federal Bureau of Investigation (FBI) estimates that a forcible rape occurs every 5.8 minutes in the United States.

Description

Many misconceptions exist about rape and sexual assault. It is often assumed that rape victims are all women who have been attacked by a total stranger and forced into having sexual intercourse. In reality, sexual assault can take many forms—it may be violent or nonviolent; the victim may be male or female, child or adult; the offender may be a stranger, relative, friend, authority figure, or spouse.

The number of sexual assaults reported depends on how those abuses are defined. The United States Code uses two terms to distinguish between different sexual activities:

- Sexual act: contact between penis and vagina or penis and anus that involves penetration; contact between the mouth and genitals or anus; penetration of the vagina or anus with an object; or direct touching (not through clothing) of the genitals of an individual under the age of 16 years.
- Sexual contact: intentional touching of the genitals, breasts, buttocks, anus, inner thigh, or groin without sexual penetration.

National statistics

According to the FBI's *Uniform Crime Reports*, there were an estimated 89,000 forcible rapes reported to U.S. law enforcement agencies in 2008. The FBI reports that the figure is the lowest number in the last twenty years. When compared to the 2007 estimate, the 2008 estimate was 1.6% less. Just under 58 out of every 100,000 women were reported to be victims of rape in 2008, down 2.4% from 2007 (when it was just above 59 per 100,000). The actual number of rapes and sexual assaults, however, is in reality much larger; estimates of unreported rape range between 2 and 10 times the number reported to law enforcement. The National Violence Against Women Survey, jointly sponsored by the Centers for Disease Control and Prevention (CDC) and the National Institute of Justice (NIJ) and conducted in the latter part of the 2000s, found that one in six women (18%) and one in 34 men (about 3%) has experienced an attempted or completed rape. The survey estimated that nearly 18 million women and almost 3 million men in the United States have been raped or have had rape attempted as a child or adult, and that more than 300,000 women and about 93,000 men are estimated to have been raped in any given year.

The survey also stated that only one in five adult women report rapes to the police. There are numerous reasons why the majority of sexual assaults are never reported. Often the victim fears retaliation from the offender. He or she may be afraid of family, friends, the community, or the media learning about the offense. There may be a concern about being judged or blamed by others. The victim may think that no one will believe the assault occurred.

THE VICTIMS. The "Victim, Incident, and Offender Characteristics" published by the National Center for Juvenile Justice (NCJJ), analyzed sexual assault data collected by law enforcement agencies over a five-year span. The following characteristics were found to be significant among victims of sexual assault:

- Age: More than two-thirds of reported victims of sexual assault were juveniles under the age of 18 years. Twelve to 18 year olds represented the largest group of victims at 33%; 20% were between the ages of six and 11; children less than five years old and adults between 18 and 24 years of age each constituted 14% of victims; 12% were between the ages of 25 and 34; and 7% were over the age of 34. Persons over the age of 54 represented 1% of all victims. One out of every seven victims surveyed in the study were under the age of six.
- Gender: Females were more than six times more likely to be a victim of sexual assault then males; more than 86% of victims were females. The great majority (99%) of the victims of forcible rapes were women, while men constituted the majority (54%) of the victims of forcible sodomy (oral or anal intercourse). Females are most likely to be the victim of

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sexual assault at age 14, while males are at most risk at age four.

- Location: The residence of the victim was the most commonly noted location of sexual assault (70%). Other common locations included schools, hotels/motels, fields, woods, parking lots, roadways, and commercial/office buildings.
- Weapons: A personal weapon (hands, feet, or fists) was used in 77% of cases. No weapon was noted in 14% of assaults; other weapons (knifes, clubs, etc.) were used in 6% of cases. Firearms were involved in only 2% of assaults.

THE OFFENDERS. Similar statistics were gathered by the NCJJ regarding the perpetrators of rape and sexual assault. These characteristics included:

- Age: More than 23% of offenders were under the age of 18 years; juveniles were more likely to be perpetrators of forcible sodomy and fondling. The remaining 77% of offenders were adults and were responsible for 67% of juvenile victims. For younger juvenile victims (under the age of 12), juvenile offenders were responsible for approximately 40% of assaults.
- Gender: The great majority of all reported offenders were male (96%). The number of female offenders rose for victims under the age of six (12%), in contrast to 6% for victims aged six through 12, 3% for victims aged 12 through 17, and 1% for adult victims.
- Relationship with offender: Approximately 59% of offenders were acquaintances of their victims, compared to family members (27%) or strangers (14%). Family members were more likely to be perpetrators against juveniles (34%) than against adults (12%). In contrast, strangers accounted for 27% of adult victims and 7% of juveniles.
- Past offenses: In 19% of juvenile cases, the victim was not the only individual to be assaulted by the offender, compared to only 4% of adult cases.

Consequences

Victims of sexual assault may sustain a range of injuries; male victims are more likely than females to suffer severe physical trauma. The National Women's Study, funded by the National Institute of Drug Abuse, found that more than 70% of rape victims did not report any physical injuries as a result of their assault; only 4% sustain serious injuries that require hospitalization. At least 49% of victims, however, state that they feared severe injuries or death during their assault. Fatalities occur in approximately 0.1% of rape cases.

Sexually transmitted diseases (STDs) are a source of concern for many victims of sexual assault. The most commonly transmitted diseases are **gonorrhea** (caused by *Neisseria gonorrhoeae*), chlamydia (caused by *Chlamydia trachomatis*), **trichomoniasis**) (caused by *Trichomonas vaginalis*), and **genital warts** (caused by human papillomavirus). **Syphilis** (caused by *Treponema pallidum*) and human **immunodeficiency** virus (HIV) are also noted among some sexual assault victims. The transmission rate of STDs is estimated to be between 3.6% and 30% of rapes.

According to the National Women's Study, approximately 5% of adult female rape victims become pregnant as a result of their assault, leading to 32,100 pregnancies a year among women 18 years of age or older. Approximately 50% of pregnant rape victims had an abortion, 6% put the child up for adoption, and 33% kept the child (the remaining pregnancies resulted in **miscarriage**).

MENTAL HEALTH PROBLEMS. Also known as rape trauma syndrome, **post-traumatic stress disorder** (PTSD) is a mental health disorder that describes a range of symptoms often experienced by someone who has undergone a severely traumatic event. Approximately 31% of rape victims develop PTSD as a result of their assault; victims are more than six times more likely to develop PTSD than women who have not been victimized.

The symptoms of PTSD include:

- recurrent memories or flashbacks of the incident
- nightmares
- insomnia
- mood swings
- difficulty concentrating
- panic attacks
- emotional numbness
- depression
- anxiety

Persons who have been sexually assaulted have also been noted to have increased risk for developing other mental health problems. Over those who have not been victimized, rape victims are:

- three times more likely to have a major depressive episode
- four times more likely to have contemplated suicide
- thirteen times more likely to develop alcohol dependency problems
- twenty-six times more likely to develop drug abuse problems

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Causes and symptoms

There is not a conclusive explanation as to why some people rape and sexually assault others. Some explanations include: desire for power and dominance, anger and hostility, need to inflict **pain**, and sexual gratification. Some sociologists point to the evolution of males in their role to propagate the species as one reason for sexual assault; that is, if they cannot convince a woman to copulate (have sexual intercourse), then they attempt violent means to accomplish the act.

Symptoms vary after being raped or sexually assaulted. Some of the more common symptoms include:

- confusion
- withdrawing from social events
- nervousness
- crying without apparent reason
- hostilities
- fearfulness
- inappropriate behaviors

Diagnosis

Sometimes a rape or sexual assault victim will not initially tell the medical profession of the attack. They will visit the doctor for presumably other reasons. In other cases, the victim will admit to the attack. In the former case, the assault may never be known by the doctor, or may be identified as the examination progresses. In the latter case, the medical professional should be supportive of the victim and help in any way possible. Many larger medical facilities possess special teams to deal with the emotional, physical, and legal issues involved with such assaults.

Law enforcement officials recommend that rape and sexual assault victims go to the hospital immediately after the attack. Ideally, the visit of the hospital or medical facility should occur without changing clothing, showering, or urinating so that evidence left by the perpetrator will not be removed. Psychologists recommend that a friend be present to help support the victim. If not possible, a nurse or other professional is often provided to assist.

Information about the attack should be provided, such as date and time of the rape, the location, and what happened. The presence of members of the local law enforcement agency may be recommended or required. In other cases, the police may be made aware of the situation after the diagnosis is complete.

The medical professional should ask about any existing or previous illnesses or injuries, along with any current medications. If the information is not previously available, the doctor should ask the female victim for the date of her last menstrual period, along with her gynecological history. If the victim is a female, the possibility of **pregnancy** should be considered, both before and after the attack. A complete **physical examination** should be performed, including analysis of any suspected trauma or injury to the body. Samples of clothing, public hair, and fingernail scrapings may be taken. Evidence of sperm within the body's orifices may also be collected by the doctor Tests for sexually transmitted diseases will also be taken.

Treatment

Once a victim of sexual assault reports the crime to local authorities, calls a rape crisis hotline, or arrives at the emergency room to be treated for injuries, a multidisciplinary team is often formed to address his or her physical, psychological, and judicial needs. This team usually includes law enforcement officers, physicians, nurses, mental health professionals, victim advocates, and/or prosecutors.

The victim of sexual assault may continue to feel fear and **anxiety** for some time after the incident, and in some instances this may significantly impact his or her personal or professional life. Follow-up counseling should therefore be provided for the victim, particularly if symptoms of PTSD become evident.

If the rapist has the possibility of being infected with HIV (human immunodeficiency virus), the doctor may recommend that an antiretroviral medication, generally called a post-exposure **prophylaxis** (PEP), be used to reduce the chance of infection.

After the examination is complete, the medical professional may also recommend the victim be referred to a local rape crisis center for further advice, counseling, and information. Medications to relieve symptoms, such as for depression and anxiety, are often also prescribed.

Forensic medical examination

Because rape is a crime, there are certain requirements for medical evaluation of the patient and for record keeping. The forensic medical examination is an invaluable tool for collecting evidence against a perpetrator that may be admissible in court. Since the great majority of victims know their assailant, the purpose of the medical examination is often not to establish identity but to establish nonconsensual sexual contact. The Sexual Assault Nurse Examiner program is an effective model that is used in many U.S. hospitals and clinics to collect and document evidence, evaluate and treat for STDs and pregnancy, and refer victims to follow-up medical care and counseling. The "Sexual Assault Nurse Examiner Development and Operation

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Guide," prepared by the Sexual Assault Resource Service, describes the ideal protocol for collecting evidence from a sexual assault victim. This includes:

- performing the medical examination within 72 hours of the assault
- taking a history of the assault
- documenting the general health of the victim, including menstrual cycle, potential allergies, and pregnancy status
- assessment for trauma and taking photographic evidence of injuries
- taking fingernail clippings or scrapings
- taking samples for sperm or seminal fluid
- combing head/pubic hair for foreign hairs, fibers, and other substances
- collection of bloody, torn, or stained clothing
- taking samples for blood typing and DNA screening

Prognosis

Emotional and health problems may arise after the attack has occurred. It is important to seek help after being assaulted. A medical care facility or hospital may be such a place to first seek assistance. A safe house (a place that is free of danger, safe from further abuse) may be contacted as a place to stay. Dialing 911 on the telephone will also bring assistance. Counseling is often helpful in dealing with the situation and its consequences. The prognosis for rape and sexual assault victims varies. Its outcome is more positive when the victim realizes that the fault lies with the attacker, not themselves.

Two phases after the assault are common. The acute phase occurs immediately after the assault. Here, the victim feels the physical pain and the mental emotions of the attack. The victim must cope with the situation over the first few days of the attack. The reorganization phase occurs about one week or so after the attack. It may last for several months or years. The victim continues to cope with the reality of the attack and how it affects one's life. Psychological studies have shown that both phases can be handled better when **psychotherapy** and other counseling is provided to the victim.

Some victims never recover emotionally from the attack. Complications from PTSD often occur, such as nightmares, flashbacks, depression and anxiety, and inappropriate or deadened emotions. Alcohol or **substance abuse** may occur. Relationships with friends and family may also be adversely affected. Suicidal tendencies also happen. Therapies and medications usually help the victim recover.

Prevention

The prevention of rape and sexual assault can be achieved, according to law enforcement agencies, by education—making people aware of the possibility that rape and sexual assault can happen to anyone. The police suggest the following to minimize the risk of rape and sexual assault:

- Secure all home windows and doors with sturdy locks and other safety devices. Home security companies also provide security systems that can be installed
- Stay away from isolated or secluded areas when alone and outside (especially at night)
- Lock all car doors while driving and be aware of the immediate surroundings while driving and getting into and out of the vehicle
- Sit as near to the driver when taking public transportation
- Carry items that can help to alert others (such as whistles and personal alarms)
- Carry items that can provide defense if attacked (such as pepper spray)
- Do not hitchhike in any situation
- If having vehicle problems, call for assistance and wait inside the vehicle until help arrives
- Take a course in self-defense; know how to defend oneself

STD Prevention

While the concern of sexual assault victims of contracting an STD is often high, the actual risk of transmission is relatively low. The CDC estimates that the risk of contracting gonorrhea from an offender is between six and 12%, chlamydia between four and 17%, syphilis between 0.5 and 3%, and HIV less than 1%. Nonetheless, post-exposure prophylaxis (preventative treatment) against certain STDs is often provided for the victim. Treatment with zidovudine, for example, is recommended for individuals who are at a high risk of exposure to HIV. The CDC recommends the following prophylactic regimen be provided for victims of sexual assaults in which vaginal, oral, or anal penetration took place:

- a single dose of ceftriaxone, an antibiotic effective against *Neisseria gonorrhoeae*
- a single dose of metronidazole, an antibiotic effective against *Trichomonas vaginalis*
- a single dose of azithromycin or doxycycline, antibiotics effective against *Chlamydia trachomatis*
- inoculation with the post-exposure hepatitis B vaccine

In some instances, cultures may be taken during the medical examination and at time points afterward to test for gonorrhea or chlamydia. It is important that

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KEY TERMS

Aggravated sexual abuse—When an individual is forced to submit to sexual acts by use of physical force; threats of death, injury, or kidnapping; or substances that render that individual unconscious or impaired.

Forcible sodomy—Forced oral or anal intercourse.

Forensic—Pertaining to or used during legal proceedings.

Post-traumatic stress disorder (PTSD)—Also known as rape trauma syndrome; a mental health disorder that describes a range of symptoms often experienced by someone who has undergone a severely traumatic event.

Sexual abuse—When an individual is forced to engage in sexual activity by use of threats or other fear tactics, or instances in which an individual is physically unable to refuse.

Sexual assault nurse examiner (SANE)—A registered nurse who is trained to collect and document evidence from a sexual assault victim, evaluate and treat for STDs and pregnancy, and refer victims to follow-up medical care and counseling.

Yupze regimen—A form of emergency contraception in which two oral contraceptive pills that contain both of the hormones estrogen and progestin are taken to prevent pregnancy.

the victim receive information regarding the symptoms of STDs and be counseled to return for further examination if any of these symptoms occur.

Pregnancy prevention

Female victims at risk for becoming pregnant after an assault should be counseled on the availability of **emergency contraception**. According to the Food and Drug Administration (FDA), emergency **contraception** is not effective if there is a pregnancy does not exist but works to prevent pregnancy from occurring by delaying or preventing ovulation, by affecting the transport of sperm, and/or by thinning the inner layer of the uterus (endometrium) so that implantation is prevented. It is therefore not a form of abortion.

A number of options are available for women if they choose to use emergency contraceptives to prevent pregnancy following a sexual assault. The Yupze regimen uses two oral contraceptive pills that contain the hormones estrogen and progestin. The risk of pregnancy is reduced by 75% after use of the Yupze regimen, reducing the average number of pregnancies after unprotected sex from eight in 100 to two in 100. Progestin-only **oral contraceptives** are also available and reduce the risk of pregnancy by 89 to 95%.

Resources

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ORGANIZATIONS

American Psychiatric Association, 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209-3901, (703) 907-7300, apa@psych.org, http://www.psych.org.

Federal Bureau of Investigation, J. Edgar Hoover Building, 935 Pennsylvania Avenue NW, Washington, DC, 20535-0001, (202) 324-3000, http://www.fbi.gov.

Office for Victims of Crime, U.S. Department of Justice, 810 7th Street NW, Washington, DC, 20531, (202) 544-1034, (800) 656-4673, http://www.ojp.usdoj.gov/ovc/.

Rape, Abuse, and Incest National Network, 2000 L Street NW, Washington, DC, 20036, (202) 544-1034, (800) 656-4673, info@rainn.org, http://www.rainn.org/.

Stéphanie Dionne
Rebecca J. Frey, PhD

Rashes

Definition

The popular term for a group of spots or red, inflamed skin that is usually a symptom of an underlying condition or disorder. Often temporary, a rash is only rarely a sign of a serious problem.

Description

A rash may occur on only one area of the skin, or it could cover almost all of the body. Also, a rash may or may not be itchy. Depending on how it looks, a rash may be described as:

- blistering (raised oval or round collections of fluid within or beneath the outer layer of skin)
- macular (flat spots)
- nodular (small, firm, knotty rounded mass)
- papular (small solid slightly raised areas)
- pustular (pus-containing skin blister)

Causes and symptoms

There are many theories as to the development of skin rashes, but experts are not completely clear what causes some of them. Generally a skin rash is an intermittent symptom, fading and reappearing. Rashes may accompany a range of disorders and conditions, such as:

- Infectious illness. A rash is symptom of many different kinds of childhood infectious illnesses, including chickenpox and scarlet fever. It may be triggered by other infections, such as Rocky Mountain spotted fever or ringworm.

An unidentified rash on a young boy's back. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

- Allergic reactions. One of the most common symptoms of an allergic reaction is an itchy rash. Contact dermatitis is a rash that appears after the skin is exposed to an allergen, such as metal, rubber, some cosmetics or lotions, or some types of plants (e.g. poison ivy). Drug reactions are another common allergic cause of rash; in this case, a rash is only one of a variety of possible symptoms, including fever, seizures, nausea and vomiting, diarrhea, heartbeat irregularities, and breathing problems. This rash usually appears soon after the first dose of the course of medicine is taken.
- Autoimmune disorders. Conditions in which the immune system turns on the body itself, such as systemic lupus erythematosus or purpura, often have a characteristic rash.
- nutritional disorders. For example, scurvy, a disease caused by a lack of Vitamin C, has a rash as one of its symptoms.

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KEY TERMS

Purpura—A group of disorders characterized by purple or red brown areas of discoloration visible through the skin.

Scurvy—A nutritional disorder that causes skin bruising and hemorrhages.

- cancer. A few types of cancer, such as chronic lymphocytic leukemia, can be the underlying cause of a rash.

Rashes in infancy

Rashes are extremely common in infancy, and are usually not serious at all and can be treated at home.

Diaper rash is caused by prolonged skin contact with bacteria and the baby's waste products in a damp diaper. This rash has red, spotty sores and there may be an ammonia smell. In most cases the rash will respond within three days to drying efforts. A diaper rash that does not improve in this time may be a yeast infection requiring prescription medication. A doctor should be consulted if the rash is solid, bright red, causes **fever**, or the skin develops blisters, **boils**, or pus.

Infants also can get a rash on cheeks and chin caused by contact with food and stomach contents. This rash will come and go, but usually responds to a good cleaning after meals. About a third of all infants develop "acne" usually after the third week of life in response to their mothers' hormones before birth. This rash will disappear between weeks and a few months. Heat rash is a mass of tiny pink bumps on the back of the neck and upper back caused by blocked sweat glands. The rash usually appears during hot, humid weather, although a baby with a fever can also develop the rash.

A baby should see a doctor immediately if the rash:

- appears suddenly and looks purple or blood-colored
- looks like a burn
- appears while the infant seems to be sick

Diagnosis

A physician can make a diagnosis based on the medical history and the appearance of the rash, where it appears, and any other accompanying symptoms.

Treatment

Treatment of rashes focuses on resolving the underlying disorder and providing relief of the **itching** that often accompanies them. Soothing lotions or oral **antihistamines** can provide some relief, and **topical antibiotics** may be administered if the patient, particularly a child, has caused a secondary infection by scratching. The rash triggered by **allergies** should disappear as soon as the allergen is removed; drug rashes will fade when the patient stops taking the drug causing the allergy. For the treatment of diaper rash, the infant's skin should be exposed to the air as much as possible; ointments are not needed unless the skin is dry and cracked. Experts also recommend switching to cloth diapers and cleaning affected skin with plain water.

Prognosis

Most rashes that have an acute cause, such as an infection or an allergic reaction, will disappear as soon as the infection or irritant is removed from the body's system. Rashes that are caused by chronic conditions, such as **autoimmune disorders**, may remain indefinitely or fade and return periodically.

Prevention

Some rashes can be prevented, depending on the triggering factor. A person known to be allergic to certain drugs or substances should avoid those things in order to prevent a rash. Diaper rash can be prevented by using cloth diapers and keeping the diaper area very clean, breast feeding, and changing diapers often.

ORGANIZATIONS

American Academy of Dermatology, P.O. Box 4014, Schaumburg, IL, 60168-4014, 847 240-1859, (866) 503-SKIN (7546), http://www.aad.org.

Carol A. Turkington

Rat-bite fever

Definition

Rat-bite fever refers to an infection which develops after having been bitten or scratched by an infected animal.

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Description

Rat-bite fever occurs most often among laboratory workers who handle lab rats in their jobs, and among people who live in poor conditions, with rodent infestation. Children are particularly likely to be bitten by rodents infesting their home, and are therefore most likely to contract rat-bite fever. Other animals that can carry the types of bacteria responsible for this illness include mice, squirrels, weasels, dogs, and cats. One of the causative bacteria can cause the same illness if it is ingested, for example in unpasteurized milk.

Causes and symptoms

There are two variations of rat-bite fever, caused by two different organisms. In the United States, the bacteria *Streptobacillus moniliformis* is the most common cause (causing streptobacillary rat-bite fever). In other countries, especially Africa, *Spirillum minus* causes a different form of the infection (called spirillary rat-bite fever).

Streptobacillary rat-bite fever occurs up to 22 days after the initial bite or scratch. The patient becomes ill with fever, chills, **nausea and vomiting**, **headache**, and **pain** in the back and joints. A rash made up of tiny pink bumps develops, covering the palms of the hands and the soles of the feet. Without treatment, the patient is at risk of developing serious infections of the lining of the heart (**endocarditis**), the sac containing the heart (**pericarditis**), the coverings of the brain and spinal cord (**meningitis**), or lungs (**pneumonia**). Any tissue or organ throughout the body may develop a pocket of infection and pus, called an **abscess**.

Spirillary rat-bite fever occurs some time after the initial injury has already healed, up to about 28 days after the bite or scratch. Although the wound had appeared completely healed, it suddenly grows red and swollen again. The patient develops a fever. Lymph nodes in the area become swollen and tender, and the patient suffers from fever, chills, and headache. The skin in the area of the original wound sloughs off. Although rash is less common than with streptobacillary rat-bite fever, there may be a lightly rosy, itchy rash all over the body. Joint and muscle pain rarely occur. If left untreated, the fever usually subsides, only to return again in repeated two- to four-day cycles. This can go on for up to a year, although, even without treatment, the illness usually resolves within four to eight weeks.

Diagnosis

In streptobacillary rat-bite fever, found in the United States, diagnosis can be made by taking a sample of blood or fluid from a painful joint. In a laboratory, the sample can be cultured, to allow the growth of organisms. Examination under a microscope will then allow identification of the bacteria *Streptobacillus moniliformis*.

In spirillary rat-bite fever, diagnosis can be made by examining blood or a sample of tissue from the wound for evidence of *Spirillum minus*.

KEY TERMS

Abscess—A pocket of infection; a collection of pus.

Endocarditis—An inflammation of the lining of the heart.

Meningitis—An inflammation of the tissues covering the brain and spinal cord.

Pasteurization—A process during which milk is heated up and maintained at a particular temperature long enough to kill bacteria.

Pericarditis—An inflammation of the sac containing the heart.

Treatment

Shots of procaine penicillin G or penicillin V by mouth are effective against both streptobacillary and spirillary rat-bite fever. When a patient is allergic to the **penicillins**, erythromycin may be given by mouth for streptobacillary infection, or tetracycline by mouth for spirillary infection.

Prognosis

With treatment, prognosis is excellent for both types of rat-bite fever. Without treatment, the spirillary form usually resolves on its own, although it may take up to a year to do so.

The streptobacillary form, found in the United States, however, can progress to cause extremely serious, potentially fatal complications. In fact, before **antibiotics** were available to treat the infection, streptobacillary rat-bite fever frequently resulted in **death**.

Prevention

Prevention involves avoiding contact with those animals capable of passing on the causative organisms. This can be an unfortunately difficult task for people whose economic situations do not allow them to move out of rat-infested buildings. Because streptobacillary rat-bite fever can occur after drinking contaminated

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milk or water, only pasteurized milk, and water from safe sources, should be ingested.

ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

Rosalyn Carson-DeWitt, MD

Rational-emotive therapy *see* **Cognitive-behavioral therapy**

Raynaud's disease

Definition

Raynaud's disease refers to a disorder in which the fingers or toes (digits) suddenly experience decreased blood circulation. It is characterized by repeated episodes of color changes of the skin of digits on cold exposure or emotional **stress**.

Demographics

Women are five times more likely than men to develop primary Raynaud's disease. The average age of diagnosis is between 20 and 40 years. Approximately three out of ten people with primary Raynaud's disease eventually progress to secondary Raynaud's disease after diagnosis. About 15% of individuals improve.

A close-up view of a patient's fingers afflicted with Raynaud's disease. While this disorder may initially only affect the tips of the fingers and toes, eventually blood circulation of the entire finger or toe is affected. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Description

Raynaud's disease can be classified as one of two types: primary (or idiopathic) and secondary (also called Raynaud's phenomenon). Primary Raynaud's disease has no predisposing factor, is more mild, and causes fewer complications. About half of all cases of Raynaud's disease are of this type.

Secondary Raynaud's disease is the same as primary Raynaud's disease, but occurs in individuals with a predisposing factor, usually a form of collagen **vascular disease**. What is typically identified as primary Raynaud's is later identified as secondary once a predisposing disease is diagnosed. This occurs in approximately 30% of patients. As a result, the secondary type is often more complicated and severe, and is more likely to worsen.

Several related conditions that predispose persons to secondary Raynaud's disease include **scleroderma**, **systemic lupus erythematosus**, **rheumatoid arthritis**, and **polymyositis**. **Pulmonary hypertension** and some nervous system disorders such as herniated discs and tumors within the spinal column, strokes, and **polio** can progress to Raynaud's disease. Finally, injuries due to mechanical trauma caused by vibration (such as that associated with chain saws and jackhammers), repetitive motion (**carpal tunnel syndrome**), electrical shock, and exposure to extreme cold can led to the development of Raynaud's disease. Some drugs used to control high blood pressure or migraine headaches have been known to cause Raynaud's disease.

The prevalence of Raynaud's phenomena in the general population varies 4-15%. Females are seven times more likely to develop Raynaud's diseases than are men. The problem has not been correlated with coffee consumption, dietary habits, occupational history (excepting exposure to vibration), or exposure to most drugs. An association between Raynaud's disease and migraine headaches has been reported. Secondary Raynaud's disease is common among individuals with systemic lupus erythematosus in tropical countries.

Causes and symptoms

There is significant familial aggregation of primary Raynaud's disease. However, no causative gene has been identified.

Risk factors

Risk factors for Raynaud's disease differ between males and females. Age and **smoking** seem to be associated with Raynaud's disease only in men, while the associations of marital status and alcohol use with Raynaud's disease are usually only observed in

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KEY TERMS

Arteriole—The smallest type of artery.

Artery—A blood vessel that carries blood away from the heart to peripheral tissues.

Gangrene—Death of a tissue, usually caused by insufficient blood supply and followed by bacterial infection of the tissue.

Idiopathic—Of unknown origin.

Polymyositis—An inflammation of many muscles.

Pulmonary hypertension—A severe form of high blood pressure caused by diseased arteries in the lung.

Rheumatoid arthritis—Chronic, autoimmune disease marked by inflammation of the membranes surrounding joints.

Scleroderma—A relatively rare autoimmune disease affecting blood vessels and connective tissue that makes skin appear thickened.

Systemic lupus erythematosus—A chronic inflammatory disease that affects many tissues and parts of the body including the skin.

women. These findings suggest that different mechanisms influence the expression of Raynaud's disease in men and women.

Both primary and secondary Raynaud's disease signs and symptoms are thought to be due to arterioles over-reacting to stimuli. Cold normally causes the tiny muscles in the walls of arteries to contract, thus reducing the amount of blood that can flow through them. In people with Raynaud's disease, the extent of constriction is extreme, thus severely restricting blood flow. Attacks or their effects may be brought on or worsened by **anxiety** or emotional distress.

There are three distinct phases to an episode of Raynaud's disease. When first exposed to cold, small arteries respond with intense contractions (vasoconstriction). The affected fingers or toes (in rare instances, the tip of the nose or tongue) become pale and white because they are deprived of blood and, thus, oxygen. In response, capillaries and veins expand (dilate). Because these vessels are carrying deoxygenated blood, the affected area then becomes blue in color. The area often feels cold and tingly or numb. After the area begins to warm up, the arteries dilate. Blood flow is significantly increased. This changes the color of the area to a bright red. During this phase, persons often describe the affected area as feeling warm and throbbing painfully.

Raynaud's disease may initially affect only the tips of fingers or toes. As the disease progresses, it may eventually involve all of one or two digits. Ultimately, all the fingers or toes may be affected. About one person in ten, will experience a complication called sclerodactyly. In sclerodactyly, the skin over the involved digits becomes tight, white, thick, smooth and shiny. In approximately 1% of cases of Raynaud's disease, deep sores (ulcers) may develop in the skin. In rare cases of frequent, repetitive bouts of severe **ischemia** (decreased supply of oxygenated blood to tissues or organs), tissue loss, or **gangrene** may result and **amputation** may be required.

Diagnosis

Examination

Primary Raynaud's disease is diagnosed following the Allen Brown criteria. There are four components. The certainty of the diagnosis and severity of the disease increase as more criteria are met. The first is that at least two of the three color changes must occur during attacks provoked by cold and or stress. The second is that episodes must periodically occur for at least two years. The third is that attacks must occur in both the hands and the feet in the absence of vascular occlusive disease. The last is that there is no other identifiable cause for the Raynaud's episodes.

Tests

A cold stimulation test may also be performed to help confirm a diagnosis of Raynaud's disease. The temperature of affected fingers or toes is taken. The hand or foot is then placed completely into a container of ice water for 20 seconds. After removal from the water, the temperature of the affected digits is immediately recorded. The temperature is retaken every five minutes until it returns to the pre-immersion level. Most individuals recover normal temperature within 15 minutes. People with Raynaud's disease may require 20 minutes or more to reach their pre-immersion temperature. However, these results are often inconclusive for several reasons. Provocative testing such as the cold stimulation test, is difficult to interpret because there is considerable overlap between normal and abnormal results.

Laboratory testing is performed frequently. The **antinuclear antibody test** of blood is usually negative in Raynaud's disease. Capillary beds under finger nails usually appear normal. Erythrocyte sedimentation rates are often abnormal in people with connective tissue diseases. Unfortunately, this finding is not consistent in people with Raynaud's disease.

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Treatment

There is no known cure for this condition. Avoidance of the trigger is the best supportive management available. Most cases of primary Raynaud's disease can be controlled with proper medical care and avoidance.

Drugs

People with severe cases of Raynaud's disease may need to be treated with medications to help keep the arterioles relaxed and dilated. Medications such as calcium-channel blockers, reserpine, or nitroglycerin may be prescribed to relax artery walls and improve blood flow.

Alternative

Because episodes of Raynaud's disease have been associated with stress and emotional upset, the condition may be improved by learning to manage stress. Regular **exercise** is known to decrease stress and lower anxiety. Hypnosis, relaxation techniques, and visualization are also useful methods to help control emotions.

Biofeedback training is a technique during which a patient is given continuous information on the temperature of his or her digits, and then taught to voluntarily control this temperature. Some alternative practitioners believe that certain dietary supplements and herbs may be helpful in decreasing the vessel spasm of Raynaud's disease. Suggested supplements include vitamin E (found in fruits, vegetables, seeds, and nuts), magnesium (found in seeds, nuts, fish, beans, and dark green vegetables), and fish oils. The circulatory herbs cayenne, ginger and prickly ash may help enhance circulation to affected areas.

Home remedies

Many people are able to find relief by simply adjusting their lifestyles. Affected individuals need to stay warm, and keep their hands and feet well covered in cold weather. Layered clothing, scarves, heavy coats, heavy socks, and mittens under gloves are suggested because gloves alone allow heat to escape. It is also recommended that patients cover or close the space between their sleeves and mittens. Indoors, they should wear socks and comfortable shoes. Smokers should quit as nicotine will worsen the problem. Avoid the use of vibrating tools as well.

Prognosis

The prognosis for most people with Raynaud's disease is very good. In general, primary Raynaud's disease has the best prognosis, with a relatively small chance (1%) of serious complications. Approximately half of all affected individuals do well by taking simple precautions, and never require medication. The prognosis for people with secondary Raynaud's disease (or phenomenon) is less predictable. This prognosis depends greatly on the severity of other associated conditions such as scleroderma, lupus, or Sjögren syndrome.

Prevention

There is no way to prevent the development of Raynaud's disease. Once an individual realizes that he or she has the disorder, however, steps can be taken to reduce the frequency and severity of episodes.

Resources

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American Heart Association, 7272 Greenville Ave., Dallas, TX, 75231-4596, (214) 373-6300, (800) 242-8721, inquire@heart.org, http://www.heart.org.

Association of Applied Psychophysiology and Biofeedback, 10200 W. 44th Avenue, Suite 304, Wheat Ridge, CO, 80033, (303) 422-8436, (800) 477-8892, aapb@resourcecenter.com, http://www.aapb.org.

Biofeedback Certification International Alliance, 10200 W. 44th Avenue, Suite 310, Wheat Ridge, CO, 80033, (303) 420-2902, (866) 908-8713, info@bcia.org, http://www.bcia.org.

Irish Raynaud's and Scleroderma Society, P.O. Box 2958 Foxrock, Dublin, Ireland, 18, (01) 2020184, info@irishraynauds.com, http://www.irishraynauds.com.

National Heart, Lung, and Blood Institute, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi.nih.gov.

National Institute of Arthritis and Musculoskeletal and Skin Disease Information Clearinghouse, National Institutes of Health, 1 AMS Circle, Bethesda, MD, 20892-3675, (877) 226-4267, NIAMSinfo@mail.nih.gov, http://www.niams.nih.gov.

National Organization for Rare Disorders (NORD), 55Kenosia Ave., P.O. Box 1968, Danbury, CT, 06813, (203) 744-0100, (800) 999-6673, (203) 798-2291, orphan@rarediseases.org, http://www.rarediseases.org.

Raynaud's & Scleroderma Association (UK) , 112 Crewe Road, AlsagerCheshire, UK, ST7 2JA, 01270 872776, info@raynauds.org.uk, http://www.raynauds.org.uk.

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RDS *see* **Respiratory distress syndrome**

Reactive airway disease *see* **Asthma**

Reactive polycythemia *see* **Secondary polycythemia**

Reading disorder *see* **Learning disorders**

Recompression treatment

Definition

Recompression treatment is the use of elevated pressure to treat conditions within the body after it has been subjected to a rapid decrease in pressure. It also includes hyperbaric **oxygen** therapy.

Purpose

Recompression treatment is used to overcome the adverse effects of **gas embolism** and **decompression sickness** (sometimes called the bends) in underwater divers who breathe compressed air. It is also approved for treatment of severe **smoke inhalation**, **carbon monoxide poisoning**, gas **gangrene**, radiation tissue damage, thermal **burns**, extreme blood loss, crush injuries, and **wounds** that won't heal.

Precautions

Hyperbaric oxygen therapy delivers greater amounts of oxygen more quickly to the body than breathing room air (which is only 21% oxygen) at regular pressure. Unmonitored, increased oxygen can produce toxic effects. Treatments must follow safe time-dose limits and may only be administered by a doctor.

Description

Recompression treatment is performed in a **hyperbaric chamber**, a sealed compartment in which the patient breathes normal air or "enhanced" air with up to 100% oxygen while exposed to controlled pressures up to three times normal atmospheric pressure. The patient may receive the oxygen through a face mask, a hood or tent around the head, or an endotracheal tube down the windpipe if the patient is already on a ventilator. When used to treat decompression sickness or gas **embolism**, the increased pressure reduces the size of gas bubbles in the patient's body. The increased oxygen concentration speeds the diffusion of the nitrogen within the bubbles out of the patient's body. As gas bubbles deflate, the trauma of gas embolism and decompression sickness begins to resolve. Treatment for diving emergencies typically involves one session, lasting four to six hours, at three atmospheres of pressure.

When used to treat other conditions, the increased pressure allows oxygen and other gases to dissolve more rapidly into the blood and thus be carried to oxygen-starved tissues to enhance healing. Elevated oxygen levels can also purge toxins such as carbon monoxide from the body. In addition, when body tissues are super-saturated with oxygen, the destruction of some bacteria is enhanced and the spread of certain toxins is halted. This makes hyperbaric oxygen therapy useful in treating gas gangrene and infections that cause tissue necrosis (death). Hyperbaric oxygen therapy also promotes the growth of new blood vessels.

Preparation

Oxygen is often administered to a patient as **first aid** while he or she is being transported to a hyperbaric chamber. The treatment begins with chamber compression; as the pressure of the chamber atmosphere increases, the temperature also rises and the patient's ears may fill as they would during an airplane landing. Swallowing and yawning are ways to relieve the inner

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KEY TERMS

Atmosphere—A measurement of pressure. One atmosphere equals the pressure of air at sea level (14.7 pounds per square inch [psi]).

Compressed air—Air that is held under pressure in a tank to be breathed underwater by divers. A tank of compressed air is part of a diver's scuba (self-contained underwater breathing apparatus) gear.

Decompression—A decrease in pressure from the surrounding water that occurs with decreasing diving depth.

Decompression sickness—A condition found in divers in which gas bubbles of nitrogen form in tissues and blood vessels as a result of decreasing surrounding pressure, such as in ascent from a dive. It may be a painful condition, especially as nitrogen bubbles invade the joints; persons stricken may walk stooped over in pain, in a bent stance that led to it being called "the bends."

Gas embolism—The presence of gas bubbles in the bloodstream that obstruct circulation. Also called air embolism.

Hyperbaric chamber—A sealed compartment in which patients are exposed to controlled pressures up to three times normal atmospheric pressure. Hyperbaric treatment may be used to regulate blood gases, reduce gas bubbles, and provide higher levels of oxygen more quickly.

Recompression—Restoring the elevated pressure of the diving environment to treat decompression sickness and gas embolism by decreasing bubble size.

ear pressure. Once the desired pressure is achieved, the patient is given pure oxygen to breathe. Because treatment is lengthy, patients are encouraged to sleep or listen to music. In larger chambers, patients may also read or watch videos.

Aftercare

Depending on the reason for treatment and the treatment outcome, the patient may be taken to a hospital for further care, or examined and released.

Risks

There is minimal risk when recompression treatment is administered by a competent physician. However, some common side effects are sinus **pain**, temporary changes in vision, and **fatigue**.

Normal results

With prompt and appropriate recompression treatment, most patients show marked improvement in their blood oxygen levels and tissue circulation, as well as other signs of healing. Divers treated for gas embolism or decompression sickness may recover with no lasting effects.

Abnormal results

When recompression treatment is not begun promptly or not conducted at adequate time-dose levels, patients with decompression sickness may develop bone necrosis. This significant destruction of bone, most commonly found in the hip and shoulder, produces chronic pain and severe disability. Another result of delayed or inadequate treatment may be permanent neurological damage. When decompression sickness involves the spinal cord, partial **paralysis** may occur.

ORGANIZATIONS

American College of Hyperbaric Medicine, 9875 South Franklin Drive, Suite 300, Franklin, Wisconsin, 53132, (414) 385-2943, (414) 385-8721, http://www.achm.org.

Divers Alert Network, 6 West Colony Place, Durham, NC, 27705, 919 684-2948, 919 490-6630, (800) 446-2671, http://www.diversalertnetwork.org.

Undersea and Hyperbaric Medical Society, 21 West Colony Place, Suite 280, Durham, NC, 27705, (919) 490-5140, (919) 490-5149, (877) 533-UHMS (8467), uhms@uhms@org, http://www.uhms.org.

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Reconstructive surgery *see* **Plastic, cosmetic, and reconstructive surgery**

Rectal cancer

Definition

The rectum is the portion of the large bowel that lies in the pelvis, terminating at the anus. **Cancer** of the rectum is the disease characterized by the development

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of malignant cells in the lining or epithelium of the rectum. Malignant cells have changed such that they lose normal control mechanisms governing growth. These cells may invade surrounding local tissue or they may spread throughout the body and invade other organ systems.

Description

The rectum is the continuation of the colon (part of the large bowel) after it leaves the abdomen and descends into the pelvis. It is divided into equal thirds: the upper, mid, and lower rectum.

The pelvis and other organs in the pelvis form boundaries to the rectum. Behind, or posterior to the rectum is the sacrum (the lowest portion of the spine, closest to the pelvis). Laterally, on the sides, the rectum is bounded by soft tissue and bone. In front, the rectum is bounded by different organs in the male and female. In the male, the bladder and prostate are present. In the female, the vagina, uterus, and ovaries are present.

The upper rectum receives its blood supply from branches of the inferior mesenteric artery from the abdomen. The lower rectum has blood vessels entering from the sides of the pelvis. Lymph, a protein-rich fluid that bathes the cells of the body, is transported in small channels known as lymphatics. These channels run with the blood supply of the rectum. Lymph nodes are small filters through which the lymph flows on its way back to the blood stream. Cancer spreads elsewhere in the body by invading the lymph and vascular systems.

When a cell or cells lining the rectum become malignant, they first grow locally and may invade partially or totally through the wall of the rectum. The tumor here may invade surrounding tissue or the organs that bound it, a process known as local invasion. In this process, the tumor penetrates and may invade the lymphatics or the capillaries locally and gain access to the circulation in this way. As the malignant cells work their way to other areas of the body, they again become locally invasive in the new area to which they have spread. These tumor deposits, originating in the primary tumor in the rectum, are then known as metastasis. If metastases are found in the regional lymph nodes, they are known as regional metastases. If they are distant from the primary tumor, they are known as distant metastases. The patient with distant metastases may have widespread disease, also referred to as systemic disease. Thus the cancer originating in the rectum begins locally and, given time, may become systemic.

By the time the primary tumor is originally detected, it is usually larger than 1 cm (about 0.39 in) in size and has over one million cells. This amount of growth is estimated to take about three to seven years. Each time the cells double in number, the size of the tumor quadruples. Thus like most cancers, the part that is identified clinically is later in the progression than would be desired. Screening becomes a very important endeavor to aid in earlier detection of this disease.

Passage of red blood with the stool, (noticeable bleeding with defecation), is much more common in rectal cancer than that originating in the colon because the tumor is much closer to the anus. Other symptoms (**constipation** and/ or **diarrhea**) are caused by obstruction and, less often, by local invasion of the tumor into pelvic organs or the sacrum. When the tumor has spread to distant sites, these metastases may cause dysfunction of the organ they have spread to. Distant metastasis usually occurs in the liver, less often to the lung(s), and rarely to the brain.

There are about 36,500 cases of rectal cancer diagnosed per year in the United States. Together, colon and rectal cancers account for 10% of cancers in men and 11% of cancers in women. It is the second most common site-specific cancer affecting both men and women. Nearly 57,000 people died from colon and rectal cancer in the United States in 2003. In recent years the incidence of this disease is decreasing very slightly, as has the mortality rate. It is difficult to tell if the decrease in mortality reflects earlier diagnosis, less **death** related to the actual treatment of the disease, or a combination of both factors.

Cancer of the rectum is felt to arise sporadically in about 80% of those who develop the disease. About 20% of cases probably arise from genetic predisposition; some people have a family history of rectal cancer occurring in a first-degree relative. Development of rectal cancer at an early age suggests a genetically transmitted form of the disease as opposed to the sporadic form.

Causes and symptoms

Causes of rectal cancer are probably environmental in sporadic cases (80%), and genetic in the heredity-predisposed (20%) cases. Since malignant cells have a changed genetic makeup, this means that in 80% of cases, the environment spontaneously induces change. Those born with a genetic predisposition are either destined to get the cancer, or it will take less environmental exposure to induce the cancer. Exposure to agents in the environment that may induce mutation is the process of carcinogenesis and is caused by agents known as **carcinogens**. Specific carcinogens have been difficult to identify; dietary factors, however, seem to be involved.

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Rectal cancer is more common in industrialized nations. Dietary factors may be the reason. **Diets** high in fat, red meat, total calories, and alcohol seem to add to increased risk. Diets high in fiber are associated with a decreased risk. High-fiber diets may be related to less exposure of the rectal epithelium to carcinogens from the environment as the transit time through the bowel is faster with a high-fiber diet than with a low-fiber diet.

Age plays a definite role in rectal cancer risk. Rectal cancer is rare before age 40. This incidence increases substantially after age 50 and doubles with each succeeding decade.

There also is a slight increase of risk for rectal cancer in the individual who smokes.

Patients who suffer from an inflammatory disease of the colon known as ulcerative **colitis** are also at increased risk.

On chromosome 5 is the APC gene associated with familial adenomatous polyposis (FAP) syndrome. There are multiple mutations that occur at this site, yet they all cause a defect in tumor suppression that results in early and frequent development of **colon cancer**. This is transmitted to 50% of offspring and each of those affected will develop colon or rectal cancer, usually at an early age. Another syndrome, hereditary non-polyposis colon cancer (HNPCC), is related to mutations in any of four genes responsible for DNA mismatch repair. In patients with colon or rectal cancer, the p53 gene is mutated 70% of the time. When the p53 gene is mutated and ineffective, cells with damaged DNA escape repair or destruction, allowing the damaged cell to multiply. Continued replication of the damaged DNA may lead to tumor development. Though these syndromes (FAP and HNPCC) have a very high incidence of colon or rectal cancer, family history without the syndromes is also a substantial risk factor. When considering first-degree relatives, history of one with colon or rectal cancer raises the baseline risk from 2% to 6%; the presence of a second raises the risk to 17%.

The development of polyps of the colon or rectum commonly precedes the development of rectal cancer. Polyps are growths of the rectal lining. They can be unrelated to cancer, pre-cancerous, or malignant. Polyps, when identified, are removed for diagnosis. If the polyp, or polyps, are benign, the patient should undergo careful surveillance for the development of more polyps or the development of colon or rectal cancer.

Symptoms of rectal cancer most often result from the local presence of the tumor and its capacity to invade surrounding pelvic structure:

- bright red blood present with stool
- abdominal distention (stretching from internal pressure), bloating, inability to have a bowel movement
- narrowing of the stool, so-called ribbon stools
- pelvic pain
- unexplained weight loss
- persistent chronic fatigue
- rarely, urinary infection or passage of air in urine in males (late symptom)
- rarely, passage of feces through vagina in females (late symptom)

If the tumor is large and obstructing the rectum, the patient will not be evacuating stool normally and will get bloated and have abdominal discomfort. The tumor itself may bleed and, since it is near the anus, the patient may see bright red blood on the surface of the stool. Blood alone (without stool) may also be passed. Thus, **hemorrhoids** are often incorrectly blamed for bleeding, delaying the diagnosis. If anemia develops, which is rare, the patient will experience chronic **fatigue**. If the tumor invades the bladder in the male or the vagina in the female, stool will get where it does not belong and cause infection or discharge. (This condition is also rare.) Patients with widespread disease lose weight secondary to the chronic illness.

Diagnosis

Screening evaluation of the colon and rectum are accomplished together. Screening involves physical exam, simple laboratory tests, and the visualization of the lining of the rectum and colon. X rays (indirect visualization) and **endoscopy** (direct visualization) are used to visualize the organs' lining.

The **physical examination** involves the performance of a digital rectal exam (DRE). At the time of this exam, the physician checks the stool on the examining glove with a chemical to see if any occult (invisible), blood is present. At home, after having a bowel movement, the patient is asked to swipe a sample of stool obtained with a small stick on a card. After three such specimens are on the card, the card is then easily chemically tested for occult blood. These exams are accomplished as an easy part of a routine yearly physical exam.

Proteins are sometimes produced by cancers and these may be elevated in the patients blood. When this occurs the protein produced is known as a tumor marker. There is a tumor marker for cancer of the colon and rectum; it is known as carcinoembryonic antigen, (CEA). Unfortunately, this may be made by other adenocarcinomas as well, or it may not be

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produced by a particular colon or rectal cancer. Therefore, screening by chemical analysis for CEA has not been helpful. CEA has been helpful in patients treated for colon or rectal cancer if their tumor makes the protein. It is used in a follow-up role, not a screening role.

Direct visualization of the lining of the rectum is accomplished using a scope or endoscope. The physician introduces the instrument into the rectum and is able to see the epithelium of the rectum directly. A simple rigid tubular scope may be used to see the rectal epithelium; however, screening of the colon is done at the same time. The lower colon may be visualized using a fiberoptic flexible scope in a procedure known as flexible **sigmoidoscopy**. When the entire colon is visualized, the procedure is known as total **colonoscopy**. Each type of endoscopy requires preprocedure preparation (evacuation) of the rectum and colon.

The American Cancer Society has recommended the following screening protocol for colon and rectal cancers those over age 50:

- yearly fecal occult blood test
- flexible sigmoidoscopy at age 50
- flexible sigmoidoscopy repeated every 5 years
- double contrast barium enema every five years
- colonoscopy every 10 years

If there are predisposing factors such as positive family history, history of polyps, or a familial syndrome, screening evaluations should start sooner.

Evaluation of patients with symptoms

When patients visit their physician because they are experiencing symptoms that could possibly be related to colon or rectal cancer, the entire colon and rectum must be visualized. Even if a rectal lesion is identified, the entire colon must be screened to rule out a syndromous polyp or cancer of the colon. The combination of a flexible sigmoidoscopy and double contrast **barium enema** may be performed, but the much preferred evaluation of the entire colon and rectum is that of complete colonoscopy. Colonoscopy allows direct visualization, photography, as well as the opportunity to obtain a biopsy, (a sample of tissue), of any abnormality visualized. If, for technical reasons the entire colon is not visualized endoscopically, a double contrast barium enema should complement the colonoscopy. A patient who is identified to have a problem in one area of the colon or rectum is at greater risk to have a similar problem in area of the colon or rectum. Therefore the entire colon and rectum need to be visualized during the evaluation.

The diagnosis of rectal cancer is actually made by the performance of a biopsy of any abnormal lesion in the rectum. Many rectal cancers are within reach of the examiner's finger. Identifying how close to the anus the cancer has developed is very important in planning the treatment. Another characteristic ascertained by exam is whether the tumor is mobile or fixed to surrounding structure. Again, this will have implications related to primary treatment. As a general rule, it is easier to identify and adequately obtain tissue for evaluation in the rectum as opposed to the colon. This is because the lesion is closer to the anus.

If the patient has advanced disease, areas where the tumor has spread, such as the liver, may require biopsy. Such biopsies are usually obtained using a special needle under **local anesthesia**.

Once a diagnosis of rectal cancer has been established by biopsy, in addition to the physical exam, an **endorectal ultrasound** will be performed to assess the extent of the disease. For rectal cancer, endorectal ultrasound is the most preferred method for staging both depth of tumor penetration and local lymph node status. Endorectal ultrasound:

- differentiates areas of invasion within large rectal adenomas that seem benign
- determines the depth of tumor penetration into the rectal wall
- determines the extent of regional lymph node invasion
- can be combined with other tests (chest x rays and computed tomography scans, or CT scans) to determine the extent of cancer spread to distant organs, such as the lungs or liver

The resulting rectal cancer staging allows physicians to determine the need for—and order of—radiation, surgery, and **chemotherapy**. In 2003, it was reported that **magnetic resonance imaging** (MRI) also may be useful in staging rectal cancer. MRI may help physicians determine if a tumor can be resected and risk of cancer recurrence.

Treatment

Once the diagnosis has been confirmed by biopsy and the endorectal ultrasound has been performed, the clinical stage of the cancer is assigned. The treating physicians use staging to plan the specific treatment protocol for the patient. In addition, the stage of the cancer at the time of presentation gives a statistical likelihood of the treatment outcome (prognosis).

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Clinical staging

Rectal cancer first invades locally and then progresses to spread to regional lymph nodes or to other organs. Stage is derived using the characteristics of the primary tumor, its depth of penetration through the rectum, local invasion into pelvic structure, and the presence or absence of regional or distant metastases. A CT scan of the pelvis is helpful in staging because tumor invasion into the sacrum or pelvic sidewalls may mean surgical therapy is not initially possible. On this basis, clinical staging is used to begin treatment. The pathologic stage is defined when the results of analyzing the surgical specimen are available. (typically stage I and II).

Rectal cancer is assigned stages I through IV, based on the following general criteria:

- Stage I: the tumor is confined to the epithelium or has not penetrated through the first layer of muscle in the rectal wall
- Stage II: the tumor has penetrated through to the outer wall of the rectum or has gone through it, possibly invading other local tissue or organs
- Stage III: Any depth or size of tumor associated with regional lymph node involvement
- Stage IV: any of previous criteria associated with distant metastasis

Surgery

The first, or primary, treatment modality utilized in the treatment of rectal cancer is surgery. Stage I, II, and even suspected stage III disease are treated by surgical removal of the involved section of the rectum along with the complete vascular and lymphatic supply. Most Stage II and Stage III rectal cancers (based on endorectal ultrasound, CT scan, and **chest x ray**) are treated with radiation and possibly chemotherapy prior to surgery.

When determining primary treatment for rectal cancer, the surgeon's ability to reconnect the ends of the rectum. The pelvis is a confining space that makes the performance of the hook-up more difficult to do safely when the tumor is in the lower rectum. The upper rectum does not usually present a substantial problem to the surgeon restoring bowel continuity after the cancer has been removed. Mid-rectal tumors, (especially in males where the pelvis is usually smaller than a woman's), may present technical difficulties in hooking the proximal bowel to the remaining rectum. Technical advances in stapling instrumentation have largely overcome these difficulties. If the anastomosis (hook-up) leaks postoperatively, infection can occur. In the past, this was a major cause of complications in resection of rectal cancers. Today, utilizing the stapling instrumentation, a hook-up at the time of original surgery is much safer. If the surgeon feels that the hook-up is compromised or may leak, a **colostomy** may be performed. A colostomy is performed by bringing the colon through the abdominal wall and sewing it to the skin. In these cases the stool is diverted away from the hook-up, allowing it to heal and preventing the infectious complications associated with leak. Later, when the hook-up has completely healed, the colostomy can be taken down and bowel continuity restored.

Stapling devices have allowed the surgeon to get closer to the anus and still allow the technical performance of a hook-up, but there are limits. It is generally felt that there should be at least three centimeters of normal rectum below the tumor or the risk of recurrence locally will be excessive. In addition, if there is no residual native rectum, the patient will not have normal sensation or control and will have problems with uncontrollable soilage, (incontinence). For these reasons, patients presenting with low rectal tumors may undergo total removal of the rectum and anus. This procedure is known as an abdominal-perineal resection. A permanent colostomy is performed in the lower left abdomen.

Radiation

As mentioned, for many late stage II or stage III tumors, **radiation therapy** can shrink the tumor prior to surgery. The other roles for radiation therapy are as an aid to surgical therapy in locally advanced disease that has been removed, and in the treatment of certain distant metastases. Especially when utilized in combination with chemotherapy, radiation used postoperatively has been shown to reduce the risk of local recurrence in the pelvis by 46% and death rates by 29%. Such combined therapy is recommended in patients with locally advanced primary tumors that have been removed surgically. Radiation has been helpful in treating effects of distant metastases, particularly in the brain. In very few cases, radiation alone may be the curative treatment for rectal cancer.

Chemotherapy

Adjuvant chemotherapy, (treating the patient who has no evidence of residual disease but who is at high risk for recurrence), is considered in patients whose tumors deeply penetrate or locally invade (late stage II and stage III). If the tumor was not locally advanced, this form of chemotherapeutic adjuvant therapy may be recommended without radiation. This therapy is identical to that of colon cancer and

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KEY TERMS

Adenocarcinoma—Type of cancer beginning in glandular epithelium.

Adjuvant therapy—Treatment involving radiation, chemotherapy (drug treatment), or hormone therapy, or a combination of all three given after the primary treatment for the possibility of residual microscopic disease.

Anastomosis—Surgical re-connection of the ends of the bowel after removal of a portion of the bowel.

Anemia—The condition caused by too few circulating red blood cells, often manifest in part by fatigue.

Carcinogens—Substances in the environment that cause cancer, presumably by inducing mutations, with prolonged exposure.

Defecation—The act of having a bowel movement.

Epithelium—Cells composing the lining of an organ.

Lymphatics—Channels that are conduits for lymph.

Lymph nodes—Cellular filters through which lymphatics flow.

Malignant—Cells that have been altered such that they have lost normal control mechanisms and are capable of local invasion and spread to other areas of the body.

Metastasis—Site of invasive tumor growth that originated from a malignancy elsewhere in the body.

Mutation—A change in the genetic makeup of a cell that may occur spontaneously or be environmentally induced.

Occult blood—Presence of blood that cannot be appreciated visually.

Polyps—Localized growths of the epithelium that can be benign, pre-cancerous, or harbor malignancy.

Resect—To remove surgically.

Sacrum—Posterior bony wall of the pelvis.

Systemic—Referring to throughout the body.

leads to similar results. Standard therapy is treatment with 5-fluorouracil, (5-FU) combined with leucovorin for a period of six to 12 months. 5-FU is an antimetabolite and leucovorin improves the response rate. Another agent, levamisole, (which seems to stimulate the immune system), may be substituted for leucovorin. These protocols reduce rate of recurrence by about 15% and reduce mortality by about 10%. The regimens have some toxicity but usually are tolerated fairly well.

Similar chemotherapy is administered for stage IV disease or if a cancer progresses and metastasis develops. Results show response rates of about 20%. A response is a temporary regression of the cancer in response to the chemotherapy. Unfortunately, these patients eventually succumb to the disease. Clinical trials have now shown that the results can be improved with the addition of another agent to this regimen. Irinotecan does not seem to increase toxicity but has improved response rates to 39%, added two to three months to disease free survival, and prolonged overall survival by a little more than two months.

Alternative treatment

Most alternative therapies have not been studied in clinical trials. Large doses of **vitamins**, fiber, and green tea are among therapies tried. A 2003 report on a large Harvard University study showed that people who took multivitamins for at least 15 years had a 34% reduction in risk of rectal cancer. Before initiating any alternative therapies, the patient should consult his or her physician to be sure that these therapies do not complicate or interfere with the recommended therapy.

Prognosis

Prognosis is the long-term outlook or survival after therapy. Overall, about 50% of patients treated for colon and rectal cancer survive the disease. As expected, the survival rates are dependent upon the stage of the cancer at the time of diagnosis, making early detection crucial.

About 15% of patients present with stage I disease, or are diagnosed with Stage I disease when they initially visit a doctor, and 85-90% survive. Stage II represents 20-30% of cases and 65-75% survive; 30-40% comprise the stage III presentation, of which 55% survive. The remaining 20-25% present with stage IV disease and are rarely cured.

Prevention

There is not an absolute method for preventing colon or rectal cancer. An individual can lessen risk or

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identify the precursors of colon and rectal cancer. The patient with a familial history can enter screening and surveillance programs earlier than the general population. High-fiber diets and vitamins, avoiding **obesity**, and staying active lessen the risk. In fact, a 2003 report said that vigorous **exercise** (to the point of sweating or feeling out of breath) lowered risk of rectal cancer by nearly 40% compared to those who exercised less. Avoiding cigarettes and alcohol may be helpful. By controlling these environmental factors, an individual can lessen risk and to this degree prevent the disease.

By undergoing appropriate screening when uncontrollable genetic risk factors have been identified, an individual may be rewarded by the identification of benign polyps that can be treated as opposed to having these growths degenerate into a malignancy.

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National Cancer Institute Clinical Trials. http://www.cancer.gov/clinicaltrials.

ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (800) 227-2345, http://www.cancer.org.

NCI Office of Communications and Education, 6116 Executive Blvd. Suite 300, Bethesda, MD, 20892-8322, (800) 4-CANCER (422-6237), cancergovstaff@mail.nih.gov, http://www.cancer.gov/aboutnci/cis.

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Teresa G. Odle

Rectal examination

Definition

Rectal examination or **digital rectal examination** (DRE) is performed by means of inserting a gloved, lubricated finger into the rectum and palpating (feeling) for lumps.

Purpose

DRE is used as a screening tool to locate **rectal cancer** and **prostate cancer**. It is also used as a diagnostic test to find non-cancerous abnormalities within the rectum like **hemorrhoids**, anal fissures, or congenital deformities that can cause chronic **constipation**.

Precautions

There are no precautions when performing DRE, aside from routine sanitary procedures.

Description

DRE is performed in most instances as an annual routine procedure in colorectal **cancer** screening. Digital palpitation of the rectum can often find abnormal growths which may require further testing or commonplace hemorrhoids. It is a critical initial clinical test and is important in the assessment of the size and location of tumors.

This procedure is often not performed routinely on patients over 70, even though this population is at high risk for colorectal cancer. It also is not done as often in elderly women as in elderly men.

DRE has also been used as a screening tool for prostate cancer. It seems to be very effective for larger masses found in the prostate and correlated well with higher prostate-specific antigens.

Of less predictive value was DRE in routine rectovaginal examinations of women under the age of 50. These instances of DRE did not locate colorectal cancer or any other abnormality.

More gastroenterologists are recommending that pediatricians and family physicians perform DRE on pediatric patients exhibiting chronic constipation before those patients are referred to intestinal specialists. The pediatrician or family physician could identify fecal compaction and treat it themselves, and then only refer patients who have a specific abnormality to gastroenterologists.

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KEY TERMS

DRE—Digital rectal examination.

Gastroenterologist—A physician who specializes in diseases of the digestive system.

Rectum—The last eight to ten inches of the colon, of which the anus is a part and the opening through which wastes are removed from the body.

Preparation

The physician must conduct DRE using a gloved hand. Some sort of lubricant should be used so that penetration of the rectum is easier and does not create the damage that the procedure is seeking.

Aftercare

There is no aftercare after a DRE is performed.

Risks

There are no risks to DRE and it is virtually painless.

Normal results

The physician finds a normal rectal canal with no abnormalities.

Abnormal results

Growths, tears, anal fissures, or congenital structural defects can be found inside the rectum with DRE.

Resources

PERIODICALS

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Janie F. Franz

Rectal polyps

Definition

Rectal polyps are tissue growths that arise from the wall of the rectum and protrude into it. They may be either benign or malignant (cancerous).

Description

The rectum is the last segment of the large intestine, ending in the anus, the opening to the exterior of the body. Rectal polyps are quite common. They occur in 7-50% of all people, and in two thirds of people over age 60.

Rectal polyps can be either benign or malignant, large or small. There are several different types of polyps. The type is determined by taking a sample of the polyp and examining it microscopically. Most polyps are benign. They are of concern, however, because 90% of colon and rectal cancers arise from polyps that are initially benign. For this reason, rectal polyps are usually removed when they are discovered.

Causes and symptoms

The cause of most rectal polyps is unknown, however a diet high in animal fat and red meat, and low in fiber, is thought to encourage polyp formation. Some types of polyps are hereditary. In an inherited disease called **familial polyposis**, hundreds of small, malignant and pre-malignant polyps are produced before the age of 40. Also, inflammatory bowel disease may cause growth of polyps and pseudo-polyps. Juvenile polyps (polyps in children) are usually benign and often outgrow their blood supply and disappear at **puberty**.

Most rectal polyps produce no symptoms and are discovered on routine digital or endoscopic examination of the rectum. Rectal bleeding is the most common complaint when symptoms do occur. Abdominal cramps, **pain**, or obstruction of the intestine occur with some large polyps. Certain types of polyps cause mucous-filled or watery **diarrhea**.

Diagnosis

Rectal polyps are commonly found by **sigmoidoscopy** (visual inspection with an instrument consisting of a tube and a light) or **colonoscopy**. If polyps are found in the rectum, a complete examination of the large intestine is done, as multiple polyps are common.

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KEY TERMS

Colon—The part of the large intestine that extends from the cecum to the rectum. The sigmoid colon is the area of the intestine just above the rectum; linking the descending colon with the rectum. It is shaped like the letter S.

Rectum—The final part of the large intestine, ending in the anus.

Sigmoidoscopy—A procedure where a thin tube containing a camera and a light is inserted into the lower section of the large intestine so that the doctor can visually inspect the lower (sigmoid) colon and rectum. Colonoscopy examines the entire large intestine using the same techniques.

Polyps do not show up on regular x rays, but they do appear on **barium enema** x rays.

Treatment

Normally polyps are removed when they are found. Polypectomy is the name for the surgery that removes these growths. Polypectomy is performed at a hospital, outpatient surgical facility or in a doctor's office, depending on the number and type of polyps to be removed, and the age and health of the patient. The procedure can be done by a surgeon, gastroenterologist, or family practitioner.

Before the operation, a colonoscopy (examination of the intestine with an endoscope) is performed, and standard pre-operative blood and urine studies are done. The patient is also given medicated **enemas** to cleanse the bowel.

The patient is given a sedative and a narcotic pain killer. A colonoscope is inserted into the rectum. The polyps are located and removed with a wire snare, ultrasound, or laser beam. After they are removed, the polyps are examined to determine if they are malignant or benign. When polyps are malignant, it may be necessary to remove a portion of the rectum or colon to completely remove cancerous tissue.

Alternative treatment

In addition to a diet low in animal fat and high in fiber, nutritionists recommend anitoxidant supplements (including **vitamins** A, C, and E, selenium, and zinc) to reduce rectal polyps.

Prognosis

For most people, the removal of polyps is an uncomplicated procedure. Benign polyps that are left in place can give rise to **rectal cancer**. People who have had rectal polyps once are more likely to have them again and should have regular screening examinations.

Prevention

Eating a diet low in red meat and animal fat and high in fiber is thought to help prevent rectal polyps.

ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (800) 227-2345, http://www.cancer.org.

National Cancer Institute (National Institutes of Health), NCI Office of Communications and Education, 6116 Executive Blvd. Suite 300, Bethesda, MD, 20892-8322, (800) 4-CANCER (422-6237), cancergovstaff@mail.nih.gov, http://www.cancer.gov/.

Tish Davidson, A.M.

Rectal prolapse

Definition

Rectal prolapse is protrusion of rectal tissue through the anus to the exterior of the body. The rectum is the final section of the large intestine.

Description

Rectal prolapse can be either partial or complete. In partial prolapse, only the mucosa layer (mucous membrane) of the rectum extends outside the body. The projection is generally 0.75-1.5 in (2-4 cm) long. In complete prolapse, called procidentia, the full thickness of the rectum protrudes for up to 4.5 in (12 cm).

Rectal prolapse is most common in people over age 60, and occurs much more frequently in women than in men. It is also more common in psychiatric patients. Prolapse can occur in normal infants, where it is usually transient. In children it is often an early sign of **cystic fibrosis** or is due to neurological or anatomical abnormalities.

Although rectal prolapse in adults may initially reduce spontaneously after bowel movements, it eventually becomes permanent. Adults who have had prior rectal or vaginal surgery, who have chronic **constipation**, regularly depend on **laxatives**, have **multiple**

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sclerosis or other neurologic diseases, **stroke**, or **paralysis** are more likely to experience rectal prolapse.

Causes and symptoms

Rectal prolapse in adults is caused by a weakening of the sphincter muscle or ligaments that hold the rectum in place. Weakening can occur because of **aging**, disease, or in rare cases, surgical trauma. Prolapse is brought on by straining to have bowel movements, chronic laxative use, or severe **diarrhea**.

Symptoms of rectal prolapse include discharge of mucus or blood, **pain** during bowel movements, and inability to control bowel movements (**fecal incontinence**). Patients may also feel the mass of tissue protruding from the anus. With large prolapses, the patient may lose the normal urge to have a bowel movement.

Diagnosis

Prolapse is initially diagnosed by taking a patient history and giving a **rectal examination** while the patient is in a squatting position. It is confirmed by **sigmoidoscopy** (inspection of the colon with a viewing instrument called a endoscope) **Barium enema** x rays and other tests are done to rule out neurologic (nerve) disorders or disease as the primary cause of prolapse.

Treatment

In infants, conservative treatment, consisting of strapping the buttocks together between bowel movements and eliminating any causes of bowel straining, usually produces a spontaneous resolution of prolapse. For partial prolapse in adults, excess tissue is surgically tied off with special bands causing the tissue to wither in a few days.

Complete prolapse requires surgery. Different surgical techniques are used, but all involve anchoring the rectum to other parts of the body, and using plastic mesh to reinforce and support the rectum. In patients too old, or ill, to tolerate surgery, a wire or plastic loop can be inserted to hold the sphincter closed and prevent prolapse. Treatment should be undertaken as soon as prolapse is diagnosed, since the longer the condition exists, the more difficult it is to reverse.

Alternative treatment

Alternative therapies can act as support for conventional threatment, especially if surgery is required. **Acupuncture**, homeopathy, and botanical medicine can all be used to assist in resolution of the prolapse or in recovery from surgery.

KEY TERMS

Rectum—The part of the large intestine that ends at the anal canal.

Prognosis

Successful resolution of rectal prolapse involves prompt treatment and the elimination of any underlying causes of prolapse. Infants and children usually recover completely without complications. Recovery in adults depends on age, general health, and the extent of the prolapse.

Prevention

Reducing constipation by eating a diet high in fiber, drinking plenty of fluids, and avoiding straining during bowel movements help prevent the onset of prolapse. Exercises that strengthen the anal sphincter may also be helpful.

Resources

OTHER

"Rectal Prolapse." *ThriveOnline*. http://thriveonline.oxygen.com.

Tish Davidson, A.M.

Recurrent fever *see* **Relapsing fever**

Recurrent miscarriage

Definition

Recurrent **miscarriage** is defined as three or more miscarriages of a fetus before 20 weeks of gestation (i.e., before the fetus can live outside the womb).

Description

Also referred to as spontaneous abortion, miscarriage occurs in 15-20% of all conceptions. The majority of miscarriages occur during the first trimester. The number of previous miscarriages does not affect subsequent full-term pregnancies.

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Causes and symptoms

Recurrent miscarriage can be caused by several factors, including fetal, placental, or maternal abnormalities.

- In over half of all miscarriages, the fetus is abnormal. The abnormality can either be genetic or developmental. The fetus is very sensitive to ionizing radiation. Tobacco and even moderate alcohol consumption are known to cause fetal damage that may lead to miscarriage. There is some evidence that over four cups of coffee a day, because of the caffeine, adversely affect pregnancy, as well.
- Placental abnormalities, including abnormal implantation in the placental wall and premature separation of the placenta, can cause miscarriage.
- Maternal abnormalities include insufficient hormones (usually progesterone) to support the pregnancy, an incompetent cervix (mouth of the womb does not stay closed), or a deformed uterus (womb). A deformed uterus can be caused by diethylstilbestrol (DES) given to the mother's mother during her pregnancy. Some immunologic abnormalities may cause the mother to reject the fetus as if it were an infection or a transplant. Maternal blood clotting abnormalities may cut-off blood supply to the fetus, causing miscarriage.
- Maternal diabetes mellitus causes miscarriage if the diabetes is poorly controlled. Maternal infections may occasionally lead to miscarriage. There is some evidence that conceptions that take place between old eggs (several days after ovulation) or old sperm (that start out several days before ovulation) may be more likely to miscarry.

Symptoms of miscarriage include pink or brown colored discharge for several weeks, which develops into painful cramping and increased vaginal bleeding; dilation of the cervix; and expulsion of the fetus.

Diagnosis

A pelvic examination can detect a deformed uterus, and frequent examinations during **pregnancy** can detect an **incompetent cervix**. Blood tests can detect the presence of immunologic or blood-clotting problems in the mother. **Genetic testing** can also determine if chromosomal abnormalities may be causing the miscarriages.

Treatment

If a uterus is deformed, it may be surgically repaired. If a cervix is incompetent, it can be surgically fortified, until the fetus matures, by a procedure known as circlage (tying the cervix closed). Supplemental progesterone may also help sustain a pregnancy. Experimental treatment of maternal immunologic abnormalities with white cell immunization (injecting the mother with white cells from the father) has been successful in some cases of recurrent miscarriage. Clotting abnormalities can be treated with **anticoagulant drugs**, such as heparin and **aspirin**, to keep blood flowing to the fetus.

KEY TERMS

Fetus—A developing embryo in the womb after the first eight weeks of gestation.

Ionizing radiation—Radiation produced by x rays and radioactivity.

Ovulation—Release of an egg for fertilization from the ovary that happens about fourteen days before each menstrual period.

Prognosis

If there is no underlying disease or abnormality present, the rate of successful pregnancy after several miscarriages approaches normal. Seventy to eighty-five percent of women with three or more miscarriages will go on to complete a healthy pregnancy.

Resources

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J. Ricker Polsdorfer, MD

Red blood cell indices

Definition

Red blood cell indices are measurements that describe the size and oxygen-carrying protein (hemoglobin) content of red blood cells. The indices are used to help in the differential diagnosis of anemia. They are also called red cell absolute values or erythrocyte indices.

Purpose

Anemia includes a variety of conditions with the same outcome: a person's blood cannot carry as much oxygen as it should. A healthy person has an adequate

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number of correctly sized red blood cells that contain enough hemoglobin to carry sufficient oxygen to all the body's tissues. An anemic person has red blood cells that are either too small or too few in number. As a result, the heart and lungs must work harder to make up for the lack of oxygen delivered to the tissues by the blood.

Anemia is caused by many different diseases or disorders. The first step in finding the cause is to determine what type of anemia the person has. Red blood cell indices help to classify the **anemias**.

Precautions

Certain prescription medications may affect the test results. These drugs include zidovudine (Retrovir), phenytoin (Dilantin), and azathioprine (Imuran).

Description

Overview

Anemia has several general causes: blood loss; a drop in production of red blood cells; or a rise in the number of red blood cells destroyed. Blood loss can result from severe hemorrhage or a chronic slow bleed, such as the result of an accident or an ulcer. Lack of iron, vitamin B_{12}, or **folic acid** in the diet, as well as certain chronic diseases, lower the number of red blood cells produced by the bone marrow. Inherited disorders affecting hemoglobin, severe reactions to blood transfusions, prescription medications, or poisons can cause red blood cells to burst (hemolyze) well before the end of their usual 120-day lifespan.

Anemia of any type affects the results of one or more of the common blood tests. These tests are the **hematocrit**, hemoglobin, and red blood cell count. The hematocrit is a measure of red blood cell mass, or how much space in the blood is occupied by red blood cells. The **hemoglobin test** is a measure of how much hemoglobin protein is in the blood. The red blood cell count (RBC) measures the number of red blood cells present in the blood. Red blood cell indices are additional measurements of red blood cells based on the relationship of these three test results.

The relationships between the hematocrit, the hemoglobin level, and the RBC are converted to red blood cell indices through mathematical formulas. These formulas were worked out and first applied to the classification of anemias by Maxwell Wintrobe in 1934.

The indices include these measurements: mean corpuscular volume (MCV); mean corpuscular hemoglobin (MCH); mean corpuscular hemoglobin concentration (MCHC); and red cell distribution width (RDW). They are usually calculated by an automated instrument as part of a **complete blood count** (CBC). Indices are covered by insurance when medically necessary. Results are available the same day that the blood is drawn or the following day.

Mean corpuscular volume (MCV)

MCV is the index most often used. It measures the average volume of a red blood cell by dividing the hematocrit by the RBC. The MCV categorizes red blood cells by size. Cells of normal size are called normocytic, smaller cells are microcytic, and larger cells are macrocytic. These size categories are used to classify anemias. Normocytic anemias have normal-sized cells and a normal MCV; microcytic anemias have small cells and a decreased MCV; and macrocytic anemias have large cells and an increased MCV. Under a microscope, stained red blood cells with a high MCV appear larger than cells with a normal or low MCV.

Mean corpuscular hemoglobin concentration (MCHC)

The MCHC measures the average concentration of hemoglobin in a red blood cell. This index is calculated by dividing the hemoglobin by the hematocrit. The MCHC categorizes red blood cells according to their concentration of hemoglobin. Cells with a normal concentration of hemoglobin are called normochromic; cells with a lower than normal concentration are called hypochromic. Because there is a physical limit to the amount of hemoglobin that can fit in a cell, there is no hyperchromic category.

Just as MCV relates to the size of the cells, MCHC relates to the color of the cells. Hemoglobin contains iron, which gives blood its characteristic red color. When examined under a microscope, normal red blood cells that contain a normal amount of hemoglobin stain pinkish red with a paler area in the center. These normochromic cells have a normal MCHC. Cells with too little hemoglobin are lighter in color with a larger pale area in the center. These hypochromic cells have a low MCHC. Anemias are categorized as hypochromic or normochromic according to the MCHC index.

Mean corpuscular hemoglobin (MCH)

The average weight of hemoglobin in a red blood cell is measured by the MCH. The formula for this index is the sum of the hemoglobin multiplied by 10 and divided by the RBC. MCH values usually rise or fall as the MCV is increased or decreased.

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KEY TERMS

Anemia—A variety of conditions in which a person's blood can't carry as much oxygen as it should due to a decreased number or size of red blood cells.

Hypochromic—A descriptive term applied to a red blood cell with a decreased concentration of hemoglobin.

Macrocytic—A descriptive term applied to a larger than normal red blood cell.

Mean corpuscular hemoglobin (MCH)—A measurement of the average weight of hemoglobin in a red blood cell.

Mean corpuscular hemoglobin concentration (MCHC)—The measurement of the average concentration of hemoglobin in a red blood cell.

Mean corpuscular volume (MCV)—A measure of the average volume of a red blood cell.

Microcytic—A descriptive term applied to a smaller than normal red blood cell.

Normochromic—A descriptive term applied to a red blood cell with a normal concentration of hemoglobin.

Normocytic—A descriptive term applied to a red blood cell of normal size.

Red blood cell indices—Measurements that describe the size and hemoglobin content of red blood cells.

Red cell distribution width (RDW)—A measure of the variation in size of red blood cells.

Red cell distribution width (RDW)

The RDW measures the variation in size of the red blood cells. Usually red blood cells are a standard size. Certain disorders, however, cause a significant variation in cell size.

Obtaining the blood sample

The RBC indices test requires 0.17–24 oz (5–7 mL) of blood. A healthcare worker ties a tourniquet on the person's upper arm, locates a vein in the inner elbow region, and inserts a needle into that vein. Vacuum action draws the blood through the needle into an attached tube. Collection of the sample takes only a few minutes.

Preparation

The doctor should check to see if the patient is taking any medications that may affect test results. The patient does not need to fast before the test.

Aftercare

Aftercare consists of routine care of the area around the puncture mark. Pressure is applied for a few seconds and the wound is covered with a bandage.

Risks

The primary risk is mild **dizziness** and the possibility of a bruise or swelling in the area where the blood was drawn. The patient can apply moist warm compresses.

Normal results

Normal results for red blood cell indices are as follows:

- MCV 82–98 fl (femtoliters)
- MCHC 31–37 g/dl
- MCH 26–34 pg (picograms)
- RDW 11.5–14.5%

Abnormal results

The category into which a person's anemia is placed based on the indices provides a significant clue as to the cause of the anemia, but further testing is needed to confirm a specific diagnosis.

The most common causes of macrocytic anemia (high MCV) are vitamin B_{12} and folic acid deficiencies. Lack of iron in the diet, **thalassemia** (a type of hereditary anemia), and chronic illness are the most common causes of microcytic anemia (low MCV). Normocytic anemia (normal MCV) can be caused by kidney and **liver disease**, bone marrow disorders, or excessive bleeding or hemolysis of the red blood cells.

Lack of iron in the diet and thalassemia are the most common causes of hypochromic anemia (low MCHC). Normocytic anemias are usually also normochromic and share the same causes (normal MCHC).

The RDW is increased in anemias caused by deficiencies of iron, vitamin B_{12}, or folic acid. Abnormal hemoglobins, such as in sickle cell anemia, can change the shape of red blood cells as well as cause them to hemolyze. The abnormal shape and the cell fragments resulting from hemolysis increase the RDW. Conditions that cause more immature cells to be released into the bloodstream, such as severe blood loss, will increase the RDW. The larger size of immature cells creates a distinct size variation.

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Resources

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Pagana, Kathleen Deska, and Timothy J. Pagana. *Mosby's Manual of Diagnostic and Laboratory Tests*. 4th ed. St. Louis: Mosby, 2009.

Nancy J. Nordenson

Red blood cell test *see* **Hemoglobin test**

Red reflex testing

Definition

Red reflex (RR) testing is an examination of the red reflex—light reflected back from the retina at the rear of the eye, which causes the pupil of the eye to appear red, as in flash photographs. RR testing is used to screen for abnormalities or obstructions of the retina—such as a cataract or tumor—that distort or eliminate the red reflex. The red reflex test is also called a light reaction test.

Purpose

Red reflex testing is considered to be an essential component of all healthcare visits for newborns, infants, and children through five years of age or until they are old enough to read an eye chart. Basic eye examinations in newborns, including RR testing, have become even more important as the number of premature and medically fragile infants born in the United States continues to increase. Although many more of these children are surviving, they often suffer **visual impairment**.

The primary purpose of RR testing is to screen for vision–threatening and life–threatening conditions, especially **retinoblastoma** and congenital, infantile, or juvenile **cataracts**. Retinoblastoma is an inherited malignant (cancerous) tumor of the retina that can grow to fill much of the eye and spread to other parts of the body. A cataract is a clouding of the lens of the eye or its surrounding transparent membrane that prevents the passage of light into the eye. Although these conditions are rare, they are much more likely to be successfully treated with early detection. However detection of and referral for these conditions are often delayed. It is estimated that 75% of American children under age five have never had a comprehensive eye exam and only about 22% of preschoolers have had any type of vision screening.

A toddler is evaluated by an orthoptist to detect any abnormalities in the eye. *(Phanie/Photo Researchers, Inc.)*

About 60% of children who develop retinoblastoma have no known family history that would cause them to be screened. As many as 80% of retinoblastomas are initially detected by the child's family or friends, often by noticing that the child has one red eye and one white eye in a flash photograph. However by the time the condition is this obvious, it is often too late to save the affected eye. The American Academy of Pediatrics (AAP) recommends RR testing with an ophthalmoscope for all infants within the first two months of life, in a darkened room to maximize pupil dilation. Pediatricians often fail to diagnose retinoblastoma early because the exams are conducted in well–lit rooms in which the pupils are very small. For this reason, some states have considered legislation that would mandate RR testing of eye–drop–dilated pupils for all newborns, and possibly at all six–week to eight–week and six–month to nine–month well–baby exams.

RR testing can detect other abnormalities in addition to retinoblastoma and cataracts, including:

- other opacities—areas of the eye that are not transparent to light—and abnormalities of the retina
- white spots in the eye
- strabismus—misalignment of the eyes caused by an imbalance in the muscles of the eyeball and resulting in an eye that turns in toward the nose (cross–eyed) or outward away from the nose (walleyed)
- high refractive error—the inability of an eye to focus light properly due to an irregularly shaped cornea, causing blurry vision and including nearsightedness, farsightedness, or astigmatism
- asymmetric refractive error—significant differences in refractive error between the two eyes

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- congenital glaucoma—a disease characterized by increased pressure within the eyeball
- lenticonus, a rare, usually congenital condition, in which the lens of the eye has a conical surface
- certain systemic diseases that affect the eyes

Description

In red reflex testing, a bright light is transmitted from an ophthalmoscope through all of the parts of the eye that are normally transparent, including the tear film, cornea, aqueous humor (the transparent fluid in the space between the cornea and lens), crystalline lens, and vitreous body (the transparent jelly that fills the eyeball behind the lens). The light reflects off the ocular fundus—the part of the eye opposite the pupil—and is transmitted back through the eye and the aperture of the ophthalmoscope. Any obstruction of this optical pathway results in an abnormal red reflex.

RR testing is quick and is usually performed by a pediatrician or other primary care provider who has been trained in the technique. It should be performed in a dim or darkened room so that the baby's pupils dilate or widen to increase the retinal reflection and provide the examiner with a better view. A direct ophthalmoscope or retinoscope is used to detect the red reflex in each eye individually and then in both eyes simultaneously to compare the red light reflection from each pupil. The ophthalmoscope is held close to the examiner's eye, about 12–18 inches (30–46 cm) from the child's eye. Sometimes RR testing is performed at two different distances and lens settings. If the baby's eyelids do not open adequately, a lid speculum may be used to hold them open.

A Bruckner test is RR testing combined with a simultaneous corneal light reflex test. The latter involves observing the location of a shined light on each cornea with respect to the pupil to check for ocular misalignment or other abnormalities. With a Bruckner test, the direct ophthalmoscope is held 2–3 feet (60–90 cm) from the child and the red reflexes and corneal light reflexes of both eyes are viewed simultaneously.

Photoscreening is a newer type of RR testing in which a photograph of a child's eyes are analyzed for anomalies. It is especially useful for children who have trouble keeping still during an exam. RR testing for leukocoria—a white pupil reflex—is also sometimes performed by taking a flash photograph of the eyes after the child has been in a dark room for three to five minutes. Leukocoria may be more apparent in flash photographs because the pupil is exposed to a large amount of light only briefly, so that it does not have time to contract.

Infants and children who are at high risk due to family history of retinoblastoma, congenital, infantile, or juvenile cataracts, congenital retinal dysplasia (abnormal growth in the retina), glaucoma, or other congenital disorders of the lens or retina should have initial RR testing performed with eye–drop–dilation of the pupils. These children should be examined by an experienced pediatric ophthalmologist, even when their RR test results are normal.

Preparation

Sometimes, particularly with high–risk infants and children or when an abnormality is suspected, the pupils are artificially dilated with ophthalmic eye drops or sprays called mydriatic agents prior to RR testing. This ensures that the pupils remain dilated when exposed to bright light. Mydriatic agents are administered about 15 minutes prior to RR testing.

- In infants younger than nine months, combination medication containing 0.2% or 0.25% cyclopentolate and 1% or 2.5% phenylephrine (Cyclomydril) are used.
- Lower concentrations are used for preterm infants.
- In babies older than nine months, one drop of 1% or less tropicamide and/or 2.5% phenylephrine are used.

Aftercare

There is no necessary aftercare for red reflex testing.

Risks

The use of mydriatic agents to dilate infants' pupils for RR testing is somewhat controversial. Some experts contend that infant pupils are so small that there is only a 30% chance of detecting retinoblastoma and other abnormal conditions inside the eye unless the pupil is dilated. Pediatric ophthalmologists routinely use mydriatic agents on infants older than two weeks and they are often used on premature infants in neonatal intensive care units. However, rare, but significant, medical complications have been reported in infants with all commercially available dilating agents and preterm infants may be particularly sensitive. Some practitioners believe that these side effects occur more often than the retinoblastomas detected by

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KEY TERMS

Amblyopia—Lazy eye; poor vision in one eye with no apparent structural cause.

Aqueous humor—The clear, watery fluid between the cornea and the crystalline lens of the eye.

Astigmatism—A refractive error caused by an irregular–shaped cornea.

Cataract—Opacity or cloudiness of the eye lens, which can prevent a clear image from forming on the retina.

Cornea—The transparent covering of the iris and pupil that admits light to the interior of the eye.

Glaucoma—Damage to the optic nerve resulting in vision loss and usually accompanied by inflammation and increased pressure in the eye (intraocular pressure).

Iris—Pigmented tissue behind the cornea that gives color to the eye and varies the size of the pupil to control the amount of light entering the eye.

Lens—The transparent biconvex crystalline tissue that focuses light rays on the retina of the eye.

Lenticonus—A rare, usually congenital, condition in which the surface of the lens of the eye is conical.

Leukocoria—A pupil reflex that is white instead of red or that has white spots.

Mydriatic—Causing dilation or widening of the pupil of the eye.

Ocular fundus—The part of the eye opposite the pupil.

Opacity—An opaque spot in a normally transparent structure, such as the lens of the eye.

Ophthalmoscope—An instrument for examining the inner structure of the eye.

Pupil—The black circular opening at the center of the iris that regulates the amount of light that enters the eye.

Refractive error—The inability of the eye to properly focus light due to an irregularly shaped cornea, resulting in blurry vision, nearsightedness, farsightedness, or astigmatism.

Retina—The light–sensitive tissue at the back of the eye.

Retinoblastoma—A hereditary malignant tumor of the retina that develops during childhood.

Retinoscope—An instrument for determining the state of refraction of the eye by illuminating the retina with a mirror.

Strabismus—An imbalance of the eyeball muscles that prevents one eye from attaining binocular vision with the other.

Vitreous body—The transparent jelly that fills the eyeball behind the lens.

RR testing. The AAP recommends dilation with mydriatic agents only if there is evidence of an abnormality.

Reported complications of mydriatic agents include:

- increased blood pressure
- slowed or increased heart rate
- heart arrhythmias
- respiratory depression
- behavioral disturbances
- hives (urticaria)
- contact dermatitis
- discomfort or pain

Results

Results of red reflex testing are considered to be negative or normal if the reflections from the two eyes, viewed both individually and simultaneously, are symmetrical—equivalent in color, brightness or intensity, size, and clarity—and without opacities or leukocoria (white spots). The reflected color is usually a bright reddish yellow. However the red reflex can vary significantly depending on the child's racial or ethnic background, because of differing levels of pigmentation of the ocular fundus. The reflex may be light gray in dark pigmented, brown–eyed children.

Normal red reflexes indicate that:

- the ocular media are free of opacities
- there are no large refractive errors
- the eyes are aligned

Positive or abnormal RR testing results that require referral to an ophthalmologist include:

- dark spots in the red reflex
- a diminished or blunted red reflex
- opacities or dark spots or white spots in one area of the red reflex
- a white reflex (leukocoria)

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- absence of a red reflex
- any differences in red reflex between the two eyes

Abnormalities in red reflexes or asymmetries between the two eyes can be due to:

- mucus or other foreign bodies in the tear film, which move and disappear upon blinking
- unequal or high refractive errors that indicate the need for glasses
- strabismus (eye misalignment)
- opacities in the cornea or aqueous or vitreous media
- abnormalities of the iris that affect the pupil
- cataracts
- glaucoma
- retinoblastoma
- other retinal abnormalities

Specific abnormalities in red reflexes may suggest certain conditions:

- A brighter red reflex in one eye may suggest that the eye is misaligned or strabismic.
- A difference in red reflex color between the two eyes may indicate unequal refractive power in the eyes (anisometropia) and a risk for amblyopia.
- Leukocoria or a white pupil reflex is the most common symptom of retinoblastoma.
- Strabismus is the second most common sign of retinoblastoma.
- Leukocoria can also be due to coloboma—a congenital cleft, fissure, or slit in the eye.
- An absent, dull, or patchy red reflex may suggest a cataract. Cataracts can also cause the pupil to appear white or yellow.
- Although lenticonus is usually detected by a slit–lamp examination, it also appears as a dimple or oil droplet that moves with eye movement in the red reflex.

An abnormal RR testing result is usually followed by RR testing after pupil dilation of each eye and/or referral to a pediatric ophthalmologist. The ophthalmologist will conduct a complete eye exam including an ocular fundus examination by indirect ophthalmoscopy with pupil dilation.

All infants and children with a positive family history of retinoblastoma, congenital, infantile, or juvenile cataracts, glaucoma, or retinal abnormalities should be referred to a pediatric ophthalmologist, regardless of the results of RR testing. The age at which the child should be referred depends on the specific risk factor. However any infant with consistently white pupils requires examination for retinoblastoma. Any infant with large eyes, excessive tearing, and cloudy corneas should be tested for congenital glaucoma, which can also lead to blindness.

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"Red Reflex Vision Exam Should Be Given to All Newborns, Report Recommends." *Cancer Weekly* (November 17, 2009): 716.

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ORGANIZATIONS

American Academy of Ophthalmology (AAO), PO Box 7424, San Francisco, CA, 94120–7424, (415) 561–8500, (415) 561–8533, http://www.aao.org.

American Academy of Pediatrics (AAP), 141 Northwest Point Blvd., Elk Grove Village, IL, 60007–1098, (874) 434–4000, (874) 434–8000, kidsdocs@aap.org, http://www.aap.org.

National Eye Institute (NEI), 31 Center Drive MSC 2510, Bethesda, MD, 20992–3655, (301) 496–5248, 2020@nei.nih.gov, http://www.nei.nih.gov.

Margaret Alic, PhD

Reflex sympathetic dystrophy

Definition

Reflex sympathetic dystrophy is the feeling of **pain** associated with evidence of minor nerve injury.

Description

Historically, reflex sympathetic dystrophy (RSD) was noticed during the civil war in patients who suffered pain following gunshot **wounds** that affected the median nerve (a major nerve in the arm). In 1867 the condition was called causalgia form the Greek term meaning "burning pain." Causalgia refers to pain

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associated with major nerve injury. The exact causes of RSD are still unclear. Patients usually develop a triad of phases. In the first phase, pain and sympathetic activity is increased. Patients will typically present with swelling (**edema**), stiffness, pain, increased vascularity (increasing warmth), hyperhydrosis, and x-ray changes demonstrating loss of **minerals** in bone (demineralization). The second phase develops three to nine months later, It is characterized by increased stiffness and changes in the extremity that include a decrease in warmth and atrophy of the skin and muscles. The late phase commencing several months to years later presents with a pale, cold, painful, and atrophic extremity. Patients at this stage will also have **osteoporosis**.

It has been thought that each phase relates to a specific nerve defect that involves nerve tracts from the periphery spinal cord to the brain. Both sexes are affected, but the number of new cases is higher in women, adolescents, and young adults. RDS has been associated with other terms such as Sudeck's atrophy, post-traumatic osteoporosis, causalgia, shoulder-hand syndrome, and reflex neuromuscular dystrophy.

Causes and symptoms

The exact causes of RSD at present is not clearly understood. There are several theories such as sympathetic overflow (over activity), abnormal circuitry in nerve impulses through the sympathetic system, and as a post-operative complication for both elective and traumatic surgical procedures. Patients typically develop pain, swelling, temperature, color changes, and skin and muscle wasting.

Diagnosis

The diagnosis is simple and confirmed by a local anesthetic block along sympathetic nerve paths in the hand or foot, depending on whether an arm or leg is affected. A test called the **erythrocyte sedimentation rate** (ESR) can be performed to rule out diseases with similar presentation and arising from other causes.

Treatment

The preferred method to treat RSD includes sympathetic block and **physical therapy**. Pain is improved as motion of the affected limb improves. Patients may also require tranquilizers and mild **analgesics**. Patients who received repeated blocks should consider surgical symathectomy (removal of the nerves causing pain).

KEY TERMS

Atrophy—Abnormal changes in a cell that lead to loss of cell structure and function.

Osteoporosis—Reduction in the quantity of bone.

Prognosis

The prognosis for treatment during phase one is favorable. As the disease progresses undetected into phase two or three the prognosis for recovery is poor.

Prevention

There is no known prevention since the cause is not clearly understood.

Resources

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Ingle–Taylor. *RSD in Me! A Patient and Caretaker Guide to Reflex Sympathetic Dystrophy and Other Chronic Pain Conditions*. Seattle: CreateSpace, 2009.

OTHER

Reflex Sympathetic Dystrophy Syndrome Association of America. http://www.rsds.org.

Laith Farid Gulli, M.D.
Robert Ramirez, B.S.

Reflex tests

Definition

Reflex tests are simple physical tests of nervous system function.

Purpose

A reflex is a simple nerve circuit. A stimulus, such as a light tap with a rubber hammer, causes sensory neurons (nerve cells) to send signals to the spinal cord. Here, the signals are conveyed both to the brain and to nerves that control muscles affected by the stimulus. Without any brain intervention, these muscles may respond to an appropriate stimulus by contracting.

Reflex tests measure the presence and strength of a number of reflexes. In so doing, they help to assess the integrity of the nerve circuits involved. Reflex tests

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are performed as part of a **neurological exam**, either a "mini-exam" done to quickly confirm integrity of the spinal cord, or a more complete exam performed to diagnose the presence and location of **spinal cord injury** or neuromuscular disease.

Deep tendon reflexes are responses to muscle stretch. The familiar "knee-jerk" reflex is an example; this reflex tests the integrity of the spinal cord in the lower back region. The usual set of deep tendon reflexes tested, involving increasingly higher regions of the spinal cord, are:

- ankle
- knee
- abdomen
- forearm
- biceps
- triceps

Another type of reflex test is called the Babinski test, which involves gently stroking the sole of the foot to assess proper development of the spine and cerebral cortex.

Precautions

Reflex tests are entirely safe, and no special precautions are needed.

Description

The examiner positions the patient in a comfortable position, usually seated on the examination table with legs hanging free. The examiner uses a rubber mallet to strike different points on the patient's body, and observes the response. The examiner may position, or hold, one of the limbs during testing, and may require exposure of the ankles, knees, abdomen, and arms. Reflexes can be difficult to elicit if the patient is paying too much attention to the stimulus. To compensate for this, the patient may be asked to perform some muscle contraction, such as clenching teeth or grasping and pulling the two hands apart. When performing the Babinski reflex test, the doctor will gently **stroke** the outer soles of the patient's feet with the mallet while checking to see whether or not the big toe extends out as a result.

Normal results

The strength of the response depends partly on the strength of the stimulus. For this reason, the examiner will attempt to elicit the response with the smallest stimulus possible. Learning the range of normal responses requires some clinical training. Responses should be the same for both sides of the body. A normal response to the Babinski reflex test depends upon the age of the person being examined. In children under the age of one and a half years, the big toe will extend out with or without the other toes. This is due to the fact that the fibers in the spinal cord and cerebral cortex have not been completely covered in myelin, the protein and lipid sheath that aids in processing neural signals. In adults and children over the age of one and a half years, the myelin sheath should be completely formed, and, as a result, all the toes will curl under (planter flexion reflex).

Abnormal results

Weak or absent response may indicate damage to the nerves outside the spinal cord (**peripheral neuropathy**), damage to the motor neurons just before or just after they leave the spinal cord (motor neuron disease), or muscle disease. Excessive response may indicate spinal cord damage above the level controlling the hyperactive response. Different responses on the two sides of the body may indicate early onset of progressive disease, or localized nerve damage, as from trauma. An adult or older child who responds to the Babinski with an extended big toe may have a lesion in the spinal cord or cerebral cortex.

Resources

OTHER

Rathe, Richard. "The Neurological Exam." *A Healthy Me Page*. http://www.ahealthyme.com.

Richard Robinson

Reflexology

Definition

Reflexology is a therapeutic method of relieving **pain** by stimulating predefined pressure points on the feet and hands. This controlled pressure alleviates the source of the discomfort. In the absence of any particular malady or abnormality, reflexology may be as effective for promoting good health and for preventing illness as it may be for relieving symptoms of **stress**, injury, and illness.

Reflexologists work from maps of predefined pressure points that are located on the hands and feet. These pressure points are reputed to connect directly through the nervous system and affect the bodily organs and glands. The reflexologist manipulates the pressure points according to specific techniques of reflexology

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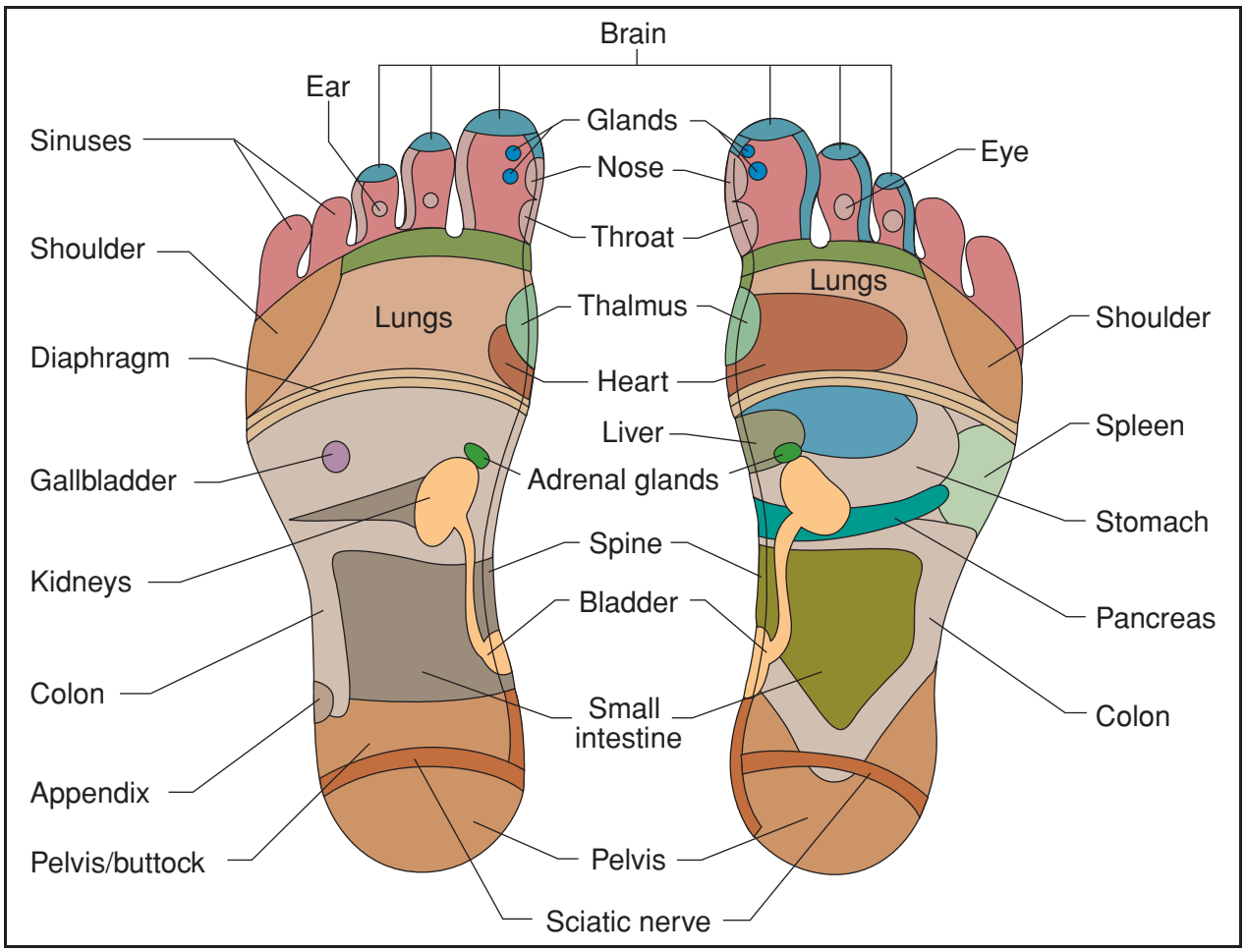

Reflexology employs the principle that the reflex points on the feet, when hand pressure is applied, will reflexively stimulate energy to a related muscle or organ in the body and promote healing. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

therapy. By means of this touching therapy, any part of the body that is the source of pain, illness, or potential debility can be strengthened through the application of pressure at the respective foot or hand location.

Purpose

Reflexology promotes healing by stimulating the nerves in the body and encouraging the flow of blood. In the process, reflexology not only quells the sensation of pain, but relieves the source of the pain as well.

Anecdotally, reflexologists claim success in the treatment of a variety of conditions and injuries. One condition is fibromyalgia. People with this disease are encouraged to undergo reflexology therapy to alleviate any of a number of chronic bowel syndromes associated with the condition. Frequent brief sessions of reflexology therapy are also recommended as an alternative to drug therapy for controlling the muscle pain associated with fibromyalgia and for relieving difficult breathing caused by tightness in the muscles of the patient's neck and throat.

Reflexology applied properly can alleviate allergy symptoms, as well as stress, back pain, and chronic **fatigue**. The techniques of reflexology can be performed conveniently on the hand in situations where a session on the feet is not practical, although the effectiveness of limited hand therapy is less pronounced than with the foot pressure therapy.

Description

Origins

Reflexology is a healing art of ancient origin. Although its origins are not well documented, there

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are reliefs on the walls of a Sixth Dynasty Egyptian tomb (c. 2450 B.C.) that depict two seated men receiving massage on their hands and feet. From Egypt, the practice may have entered the Western world during the conquests of the Roman Empire. The concepts of reflexology have also been traced to pre-dynastic China (possibly as early as 3000 B.C.) and to ancient Indian medicine. The Inca civilization may have subscribed to the theories of reflexology and passed on the practice of this treatment to the Native Americans in the territories that eventually entered the United States.

In recent times, Sir Henry Head first investigated the concepts underlying reflexology in England in the 1890s. Therapists in Germany and Russia were researching similar notions at approximately the same time, although with a different focus. Less than two decades later, a physician named William H. Fitzgerald presented a similar concept that he called zone analgesia or zone therapy. Fitzgerald's zone analgesia was a method of relieving pain through the application of pressure to specific locations throughout the entire body. Fitzgerald divided the body into 10 vertical zones, five on each side, that extended from the head to the fingertips and toes, and from front toback. Every aspect of the human body appears in one of these 10 zones, and each zone has a reflex area on the hands and feet. Fitzgerald and his colleague, Dr. Edwin Bowers, demonstrated that by applying pressure on one area of the body, they could anesthetize or reduce pain in a corresponding part. In 1917, Fitzgerald and Bowers published *Relieving Pain at Home*, an explanation of zone therapy.

Later, in the 1930s, a physical therapist, Eunice D. Ingham, explored the direction of the therapy and made the startling discovery that pressure points on the human foot were situated in a mirror image of the corresponding organs of the body with which the respective pressure points were associated. Ingham documented her findings, which formed the basis of reflexology, in *Stories the Feet Can Tell*, published in 1938. Although Ingham's work in reflexology was inaccurately described as zone therapy by some, there are differences between the two therapies of pressure analgesia. Among the more marked differences, reflexology defines a precise correlation between pressure points and afflicted areas of the body. Furthermore, Ingham divided each foot and hand into 12 respective pressure zones, in contrast to the 10 vertical divisions that encompass the entire body in Fitzgerald's zone therapy.

In 1968 two siblings, Dwight Byers and Eusebia Messenger, established the National Institute of Reflexology. By the early 1970s the institute had grown and was renamed the International Institute of Reflexology.

EUNICE INGHAM (1889–1974)

Eunice D. Ingham was born on February 24, 1889. A physical therapist by occupation, she was a colleague of Dr. Shelby Riley, who along with Dr. W. H. Fitzgerald actively developed zone therapy, a similar but distinct therapy from reflexology. Unlike reflexology, zone therapy does not connect the zones with the body as a whole. In the 1930s, Ingham discovered an unmistakable pattern of reflexes on the human foot; she subsequently devoted the rest of her life to publicizing the message of reflexology until shortly before her death on December 10, 1974.

Ingham traveled and lectured widely about reflexology, initially to audiences of extremely desperate or aging patients who had lost hope in finding relief. Because of their sometimes astonishing improvement, reflexology became better known and respected among the medical community and gained credibility for its therapeutic value. Ingham described her theories of reflexology in her 1938 book, entitled *Stories the Feet Can Tell,* which included a map of the reflex points on the feet and the organs that they parallel. The book was translated into seven languages, although it was erroneously published as *Zone Therapy* in some countries, an error which led to misunderstanding about the true nature of reflexology and inaccurately linked it to zone therapy.

In a typical reflexology treatment, the therapist and patient have a preliminary discussion prior to therapy, to enable the therapist to focus more accurately on the patient's specific complaints and to determine the appropriate pressure points for treatment.

A reflexology session involves pressure treatment that is most commonly administered in foot therapy sessions of approximately 40–45 minutes in duration. The foot therapy may be followed by a brief 15-minute hand therapy session. No artificial devices or special equipment are associated with this therapy. The human hand is the primary tool used in reflexology. The therapist applies controlled pressure with the thumb and forefinger, generally working toward the heel of the foot or the outer palm of the hand. Most reflexologists apply pressure with their thumbs bent; however, some also use simple implements, such as the eraser end of a pencil. Reflexology therapy is not massage, and it is not a substitute for medical treatment.

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Reflexology is a complex system that identifies and addresses the mass of 7,000 nerve endings that are contained in the foot. Additional reflexology addresses the nerves that are located in the hand. This is a completely natural therapy that affords relief without the use of drugs. The Reflexology Association of America (RAA) formally discourages the use of oils or other preparations in performing this hands-on therapy.

Preparations

In order to realize maximum benefit from a reflexology session, the therapist as well as the patient should be situated so as to afford optimal comfort for both. Patients in general receive treatment in a reclining position, with the therapist positioned as necessary—to work on the bare feet, or alternately on the bare hands.

A reflexology patient removes both shoes and socks in order to receive treatment. No other preparation is involved. No prescription drugs, creams, oils, or lotions are used on the skin.

Precautions

Reflexology is extremely safe. It may even be self-administered in a limited form whenever desired. The qualified reflexologist offers a clear and open disclaimer that reflexology does not constitute medical treatment in any form, nor is reflexology given as a substitute for medical advice or treatment. The ultimate purpose of the therapy is to promote wellness; fundamentally it is a form of preventive therapy.

People with serious and long-term medical problems are urged to seek the advice of a physician. Diabetes patients in particular are urged to approach this therapy cautiously. Likewise pregnant women are cautioned emphatically to avoid reflexology during the early phases of **pregnancy** altogether, as accidentally induced labor and subsequent premature delivery can result from reflexology treatment.

A consultation with a reflexologist is recommended in order to determine the safety and appropriateness of reflexology therapy for a specific health problem or condition.

Side effects

Because reflexology is intended to normalize the body functions, the therapy does not cause a condition to worsen. Most patients find that pain diminishes over the course of the therapy. It has been noted, however, that some patients experience greater discomfort in the second session than in the first session, because a significant easing of pain and tension is generally associated with the initial therapy session. As a result, when pressure is reapplied to the tender points of the foot during the second session, the sensitivity has been heightened. This increase in sensitivity may cause minor additional discomfort for the patient.

Research and general acceptance

Although only one controlled trial of reflexology therapy, done in 1993, has been documented in medical journals, this therapy is practiced worldwide at different levels of medical care. In Russia, for example, only licensed physicians may legally perform reflexology treatment. In contrast, the practice is a commonplace homestyle remedy in the Netherlands. The Internet "Home of Reflexology" lists at least 66 professional organizations worldwide, including New Zealand and Malaysia. Associations include the following:

- Academy of Reflexology Austria
- Association of Finnish Reflexologists
- Chinese Society of Reflexologists
- Hellenic Association of Reflexologists
- Indian Society for Promotion of Reflexology
- International Council of Reflexologists (HQ: San Diego, USA)
- Israeli Reflexology Association
- New Zealand Reflexology Association
- Polish Instytut of Reflexology (Polish Language)
- Reflexology Association of America
- Reflexology Association of Australia
- Rwo-Shr Health Institute International (Malaysia)
- The South African Reflexology Society

Regulatory status

Ongoing legislative debate ensued during the 1990s regarding the legal status of the reflexology trade. The reflexology community, along with legislators and other bodywork practitioners, engaged in reassessment of the reflexology business and its relationship to **massage therapy** and massage parlors. Organizations and individuals brought judicial appeals of certain court cases that threatened the legitimate licensing of reflexologists as practitioners of alternative medicine. Such professional reflexology interests as the RAA documented in detail the disparities between reflexology and massage, citing the purpose of reflexology, which is to stimulate internal body functions (glands and

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organs) as opposed to the topical muscular and joint relief associated with massage. In a status update in 1998 the Association reported that 19 states had laws requiring the licensing of massage/reflexology therapists. Licensing laws established educational requirements and required candidates to pass written, oral, and/or practical examinations.

Also at issue was a trend among municipalities to license massage parlors (and reflexologists) under the business codes affecting the adult entertainment business. B. and K. Kunz reported that judicial decisions in two states—Tennessee and New Mexico—had excluded the practice of reflexology practice from the laws pertaining to massage parlors. Those courts held that reflexology is a business separate and distinct from massage parlors, and deserving of its own respective licensing standards. In Sacramento, California, reflexologists petitioned successfully to become licensed as practitioners of somatic therapy rather than as providers of adult entertainment. Likewise, in the Canadian province of Ontario, a nonprofit organization to register reflexology practitioners was established in order to define a distinct classification for therapists separate from erotic body rubbers, which was the original classification given to reflexologists. Other states where court proceedings or legislative attempts to legitimize reflexology have stalled include Pennsylvania, Florida, New Jersey, and New York

Training and certification

Training programs

Reflexology is taught by means of a series of seminars, classes, and training films. Certification is earned after a six month program that includes 200 hours of training. The certification training breaks down as follows: 28 hours of preliminary seminar training; 14 hours of advanced seminar training; 58 hours of self-directed study; and 100 hours of practical experience, including administering reflexology to a minimum of 15 people.

Specific aspects of the training include instruction in the assessment of the pressure points on the feet and hands through a study of human anatomy. Students also learn to give reflexology sessions to patients along with specific techniques for working with the hands.

Certification and advanced certification

As part if its function, the independently organized American Reflexology Certification Board (ARCB) certifies the competency of reflexology practitioners on an individual basis. The ARCB does not evaluate schools and teachers. Prerequisites for individual certification include completion of educational requirements and passing a standard qualifying examiniation. Successful candidates receive the title of Board Certified Reflexologist.

Minimum qualifications to take the certification examination include attendance at an advanced seminar within two years prior to taking the examination. In addition, the applicant must have attended preliminary seminars for two full days—in addition to the required day of advanced seminar training—and the applicant is required to have a minimum of six months of practical experience in administering the therapy. Applicants are examined by means of both written tests and practical demonstrations.

Continuing education certification is available. Advanced training focuses on mastering the ability to perform hand reflexology. The therapist also receives instruction in new and advanced techniques of basic reflexology. Some reflexology training classes may be applied toward degree programs in other disciplines, depending on the specific course of study and the certification of the respective training institutions involved.

The RAA provides published standards of practice for reflexologists.

KEY TERMS

Pressure points—Specific locations on the feet and hands that correspond to nerve endings that connect to the organs and glands of the human body via the spinal cord.

Zone therapy—Also called zone analgesia, a method of relieving pain by applying pressure to specific points on the body. It was developed in the early twentieth century by Dr. William Fitzgerald.

ORGANIZATIONS

International Institute of Reflexology, P.O. Box 12642, St. Petersburg, FL, 33733-2642, (727) 343-4811, (727) 381-2807, info@reflexology-usa.net, http://www.reflexology-usa.net/.

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Reflexology Association of America, P.O. Box 714, Chepachet, RI, 02814, (980) 234-0159, (401) 568-6449, InfoRAA@ reflexology-usa.org, http://www.reflexology- usa.org.

Gloria Cooksey

Refsum's syndrome *see* **Lipidoses**

Regional anesthetic *see* **Anesthesia, local**

Regional enteritis *see* **Crohn's disease**

Rehabilitation

Definition

Rehabilitation is a treatment or treatments designed to facilitate the process of recovery from injury, illness, or disease to as normal a condition as possible.

Purpose

The purpose of rehabilitation is to restore some or all of the patient's physical, sensory, and mental capabilities that were lost due to injury, illness, or disease. Rehabilitation includes assisting the patient to compensate for deficits that cannot be reversed medically. It is prescribed after many types of injury, illness, or disease, including amputations, arthritis, **cancer**, cardiac disease, neurological problems, orthopedic injuries, spinal cord injuries, **stroke**, and traumatic brain injuries.The Institute of Medicine has estimated that as many as 14% of all Americans may be disabled at any given time.

Precautions

Rehabilitation should be carried out only by qualified therapists. Exercises and other physical interventions must take into account the patient's deficit. An example of a deficit is the loss of a limb.

Description

A proper and adequate rehabilitation program can reverse many disabling conditions or can help patients cope with deficits that cannot be reversed by medical care. Rehabilitation addresses the patient's physical, psychological, and environmental needs. It is achieved by restoring the patient's physical functions and/or modifying the patient's physical and social environment. The main types of rehabilitation are physical, occupational, and **speech therapy**.

A man who suffered a stroke is helped with his rehabilitation by a physical therapist. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Each rehabilitation program is tailored to the individual patient's needs and can include one or more types of therapy. The patient's physician usually coordinates the efforts of the rehabilitation team, which can include physical, occupational, speech, or other therapists; nurses; engineers; physiatrists (physical medicine); psychologists; orthotists (makes devices such as braces to straighten out curved or poorly shaped bones); prosthetists (a therapist who makes artificial limbs or protheses); and vocational counselors. Family members are often actively involved in the patient's rehabilitation program.

Physical therapy

Physical therapy helps the patient restore the use of muscles, bones, and the nervous system through the use of heat, cold, massage, whirlpool baths, ultrasound, **exercise**, and other techniques. It seeks to relieve **pain**, improve strength and mobility, and train the patient to perform important everyday tasks. Physical therapy may be prescribed to rehabilitate a patient after amputations, arthritis, **burns**, cancer, cardiac disease, cervical

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and lumbar dysfunction, neurological problems, orthopedic injuries, pulmonary disease, spinal cord injuries, stroke, traumatic brain injuries, and other injuries/illnesses. The duration of the physical therapy program varies depending on the injury/illness being treated and the patient's response to therapy.

Exercise is the most widely used and best known type of physical therapy. Depending on the patient's condition, exercises may be performed by the patient alone or with the therapist's help, or with the therapist moving the patient's limbs. Exercise equipment for physical therapy could include an exercise table or mat, a stationary bicycle, walking aids, a wheelchair, practice stairs, parallel bars, and pulleys and weights.

Heat treatment, applied with hot-water compresses, infrared lamps, short-wave radiation, high frequency electrical current, ultrasound, paraffin wax, or warm baths, is used to stimulate the patient's circulation, relax muscles, and relieve pain. Cold treatment is applied with ice packs or cold-water soaking. Soaking in a whirlpool can ease muscle spasm pain and help strengthen movements. Massage aids circulation, helps the patient relax, relieves pain and **muscle spasms**, and reduces swelling. Very low strength electrical currents applied through the skin stimulate muscles and make them contract, helping paralyzed or weakened muscles respond again.

Occupational therapy

Occupational therapy helps the patient regain the ability to do normal everyday tasks. This may be achieved by restoring old skills or teaching the patient new skills to adjust to disabilities through adaptive equipment, orthotics, and modification of the patient's home environment. Occupational therapy may be prescribed to rehabilitate a patient after **amputation**, arthritis, cancer, cardiac disease, head injuries, neurological injuries, orthopedic injuries, pulmonary disease, spinal cord disease, stroke, and other injuries/illnesses. The duration of the occupational therapy program varies depending on the injury/illness being treated and the patient's response to therapy.

Occupational therapy includes learning how to use devices to assist in walking (artificial limbs, canes, crutches, walkers), getting around without walking (wheelchairs or motorized scooters), or moving from one spot to another (boards, lifts, and bars). The therapist will visit the patient's home and analyze what the patient can and cannot do. Suggestions on modifications to the home, such as rearranging furniture or adding a wheelchair ramp, will be made. Health aids to bathing and grooming could also be recommended.

KEY TERMS

Orthotist—A health care professional who is skilled in making and fitting orthopedic appliances.

Physiatrist—A physician who specializes in physical medicine.

Prosthetist—A health care professional who is skilled in making and fitting artificial parts (prosthetics) for the human body.

Speech therapy

Speech therapy helps the patient correct **speech disorders** or restore speech. Speech therapy may be prescribed to rehabilitate a patient after a brain injury, cancer, neuromuscular diseases, stroke, and other injuries/illnesses. The duration of the speech therapy program varies depending on the injury/illness being treated and the patient's response to therapy.

Performed by a speech pathologist, speech therapy involves regular meetings with the therapist in an individual or group setting and home exercises. To strengthen muscles, the patient might be asked to say words, smile, close his mouth, or stick out his tongue. Picture cards may be used to help the patient remember everyday objects and increase his vocabulary. The patient might use picture boards of everyday activities or objects to communicate with others. Workbooks might be used to help the patient recall the names of objects and practice reading, writing, and listening. Computer programs are available to help sharpen speech, reading, recall, and listening skills.

Other types of therapists

Inhalation therapists, audiologists, and registered dietitians are other types of therapists. Inhalation therapists help the patient learn to use respirators and other breathing aids to restore or support breathing. Audiologists help diagnose the patient's **hearing loss** and recommend solutions. Dietitians provide dietary advice to help the patient recover from or avoid specific problems or diseases.

Rehabiltation centers

Rehabilitation services are provided in a variety of settings including clinical and office practices, hospitals, skilled-care nursing homes, sports medicine clinics, and some health maintenance organizations. Some therapists make home visits. Advice on choosing the

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appropriate type of therapy and therapist is provided by the patient's medical team.

ORGANIZATIONS

National Rehabilitation Association, 633 S. Washington St., Alexandria, VA, 22314, (703) 836-0850.

National Rehabilitation Information Center, 8201 Corporate Drive, Suite 600, Landover, MD, 20785, (800) 346-2742, naricinfo@heitechservices.com, http://www.naric.com.

Rehabilitation International, 25 East 21st Street, 4th floor, New York, NY, 10010, (212) 420-1500, 212 505-0871, ri@riglobal.org, http://www.riglobal.org.

Lori De Milto

Rehydration *see* **Intravenous rehydration**

Reiki

Definition

Reiki is a form of therapy that uses simple hands-on, no-touch, and visualization techniques, with the goal of improving the flow of life energy in a person. Reiki (pronounced *ray-key*) means "universal life energy" in Japanese, and Reiki practitioners are trained to detect and alleviate problems of energy flow on the physical, emotional, and spiritual level. Reiki touch therapy is used in much the same way to achieve similar effects that traditional **massage therapy** is used—to relieve **stress** and **pain**, and to improve the symptoms of various health conditions.

Purpose

Reiki claims to provide many of the same benefits as traditional massage therapy, such as reducing stress, stimulating the immune system, increasing energy, and relieving the pain and symptoms of health conditions. Practitioners have reported success in helping patients with acute and chronic illnesses, from **asthma** and arthritis to trauma and recovery from surgery. Reiki is a gentle and safe technique, and has been used successfully in some hospitals. It has been found to be very calming and reassuring for those suffering from severe or fatal conditions. Reiki can been used by doctors, nurses, psychologists and other health professionals to bring touch and deeper caring into their healing practices.

Description

Origins

Reiki was developed in the mid-1800s by Dr. Mikao Usui, a Japanese scholar of religion. According to the story that has been passed down among reiki teachers, Usui was a Christian who was intrigued by the idea that Christ could heal sick people by touching them with his hands. Searching for clues that would explain the secrets of healing with hands, Usui made a long pilgrimage around the world, visiting many ancient religious sects and studying ancient books. Some reiki teachers claim that Usui found clues leading back nearly 10,000 years to healing arts that originated in ancient Tibet. During his intense studies, Usui claimed he had a spiritual experience, which enabled him to heal with his own hands by becoming aware of and tapping into the universal life force. After that, he dedicated his life to helping the sick and poor. His reputation grew as he healed sick people for many years in Kyoto, Japan. Before his **death**, Usui passed on his healing insights using universal life energy to Dr. Chujiru Hayashi, a close acquaintance. Hayashi, in turn, passed on the healing techniques in 1938 to Hawayo Takata, a Japanese woman from Hawaii, whom he had cured of life-threatening illness using reiki methods. Takata became a firm believer and proponent of reiki, and during the 1970s formed an initiation program for training reiki masters to preserve Usui's teachings. Before she died, she prepared her granddaughter, Phyllis Lei Furumoto, to continue the lineage. Takata had personally trained 21 practitioners before she died at the age of 80 in 1980. Along with other reiki masters authorized by Takata, Furumoto formed the reiki Alliance. A faction led by Barbara Ray, formed the American Reiki Association, which was known as Radiance Technique Association International. Today, there are over 1,000 reiki masters practicing around the world, whose methods can all be traced back directly to Dr. Usui.

The basic philosophy of reiki

The basic concept underlying reiki is that the body has an energy field that is central to its health and proper functioning, and this energy travels in certain pathways that can become blocked or weakened. This idea of energy flow in the body is also a central concept in **Ayurvedic medicine** and **traditional Chinese medicine**, including **acupuncture**.

Reiki practitioners believe that everyone has the potential to access the universal life energy, but that over time most people's systems become blocked and the energy becomes weakened in them. A reiki

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MIKAO USUI (1865–1926)

Mikao Usui, born in the Gifu Prefecture (Japan), was an ethereal child who sought to unravel the mysteries of the universe. As an adult he developed an interest in the metaphysical healing talent of Buddha. Usui became determined to regenerate the healing secrets of Buddha in order to improve the lot of humanity. He traveled to many temples and spoke with holy people, but all said that the secret of Buddha's powers were lost to the world due to lack of use.

Eventually the abbot of a Zen monastery encouraged Usui to study the ancient writings containing the secrets on healing. Usui learned two new languages, Chinese and Sanskrit, in order to understand the writings better, and from his reading he obtained the formula for healing. The Sutras in particular provided the enlightenment that he sought.

Usui next set out to obtain the power to heal. It is widely believed that he developed that ability after spending 21 days in retreat and in fasting on the holy Mountain of Kori-yama, where he had a vision of light and received the knowledge of the symbols of reiki and their use in healing. He officially formulated Usui Reiki therapy in 1922 and touted as many as one million followers during his lifetime.

Prior to the transition (death) of Usui, he imparted the secrets of healing to 16 teachers in order that the secrets would not be lost again.

practitioner is trained to be able to detect these blockages, and practitioners will use their hands, thoughts, and own energy fields to improve the energy flow in a patient. Reiki is one of the more esoteric alternative medical practices, because no one is sure exactly how it works on the physiological level. Practitioners claim that it works on very subtle energy levels, or possibly works on the *chakra* system. The chakras are the system of seven energy centers along the middle of the body believed to be connected with the nervous and endocrine systems, as defined by **yoga** and Ayurvedic medicine. Reiki masters claim that healing energy can even be sent to a person from far away, noting that reiki works on the same principles that enables praying to work for some patients, although a practitioner needs advanced training to be able to send energy from afar.

According to the original principles of Usui, patients must also have a proper attitude for reiki to work most effectively. Patients must take responsibility for their own health, and must want to be healed. Furthermore, when energy is received from a reiki healer, patients must be willing to give back energy to others, and to compensate the healer in some way, as well. Finally, Usui claimed that a healing attitude was free from worry and fear, was filled with gratitude for life and for others, and placed emphasis on each person finding honest and meaningful work in their lives—all this, in order to complete the picture of overall health.

A reiki session

Reiki sessions can take various forms, but most commonly resemble typical bodywork appointments, where the receiver lies clothed on his or her back on a flat surface or massage table. A session generally lasts from an hour to an hour and a half. Reiki is a simple procedure, consisting of calm and concentrated touching, with the practitioner focusing on healing and giving energy to specific areas on the receiver's body. Practitioners place their hands over positions on the body where the organs and endocrine glands reside, and the areas that correspond to the chakra centers. Practitioners also use mental visualization to send healing energy to areas of the receiver's body that need it. In special cases or with injuries, a no-touch technique is used, where the practitioner's hands are sometimes held just above the body without touching it. Advanced practitioners rely on intuition and experience to determine which areas of a body need the most energy healing.

The practitioner's hands are held flat against the receiver's body, with the fingertips touching. There can be more than 20 positions on both sides of the body where the hands are placed. The positions begin at the crown of the head and move towards the feet. The receiver usually turns over once during the session. The practitioner's hands are held in each position for a usually five minutes, to allow the transfer of energy and the healing process to take place. In each position, the hands are kept stationary, unlike typical massage where the hands move, and both the giver and receiver attempt to maintain an attitude of awareness, openness, and caring.

Reiki practitioners recommend that those receiving reiki for the first time go through a series of three to four initial treatments over the course of about a week, to allow for cleansing and the initial readjustment of energy. Reiki sessions can cost from $30–100 per session. Insurance coverage is rare, and consumers should consult their individual policies as to whether or not such therapies are included.

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Self-treatment with reiki

Although reiki practitioners believe that formal training is necessary to learn the proper methods of energy channeling and healing, individuals can still use some of the basic positions of reiki to relieve stress and to stimulate healing on themselves or another. The positions can be performed anywhere and for however long they are needed. Positions generally move from the top of the body down, but positions can be used wherever there is pain or stress. Mental attitude is important during reiki; the mind should be cleared of all stressful thoughts and concentrated on compassion, love, and peace as forms of energy that are surrounding, entering, and healing the body.

The following positions are illustrated in *Reiki: Energy Medicine:*

- Position one: Hands are placed on the top of the head, with the wrists near the ears and the fingertips touching on the crown of the head. Eyes should be closed. Hold for five minutes or more, until the mind feels clear and calm.
- Position two: Cup the hands slightly and place the palms over the closed eyes, with the fingers resting on the forehead.
- Position three: Place the hands on the sides of the head, with the thumbs behind the ear and the palms over the lower jaws, with the fingers covering the temples.
- Position four: Place one hand on the back of the neck, at the base of the skull, and put the other hand on the head just above it, parallel to it.
- Position five: Wrap the hands around the front of the throat, and rest them there gently with the heels of the hands touching in front.
- Position six: Place each hand on top of a shoulder, close to the side of neck, on top of the trapezius muscle.
- Position seven: Form a T-shape with the hands over the chest, with the left hand covering the heart and the right hand above it, covering the upper part of the chest.
- Position eight: The hands are placed flat against the front of the body with fingertips touching. Hold for five minutes or so, and repeat four or five times, moving down a hand-width each time until the pelvic region is reached, which is covered with a v-shape of the hands. Then, for the final position, repeat this technique on the back, beginning as close to the shoulders as the hands can reach, and ending by forming a T-shape with the hands at the base of the spine.

KEY TERMS

Attunement—Life energy teaching given by Reiki master to a student.

Chakra—One of seven major energy centers in the body, as defined by Hindu and yoga philosophy.

Relaxation response—The human body's response to relaxation techniques, during which metabolism and stress levels decrease and immune response increases.

Side effects

Reiki generally has no side effects, as it is a very low impact and gentle procedure. Some receivers report **tingling** or sensations of heat or cold during treatment. Others have reported sadness or **anxiety** during treatment, which practitioners claim are buried or repressed emotions being released by the new energy flow.

Research and general acceptance

Reiki has been used in major clinics and hospitals as part of alternative healing practice, and doctors, dentists, nurses and other health professionals have been trained to use its gentle touch techniques as part of their practice. To date, the little scientific research that has been conducted with reiki implies that its techniques bring about the *relaxation response*, in which stress levels decrease, and immune response increases. Reiki practitioners claim that the most important measurement of their technique is whether the individual feels better after treatment. They also claim that science cannot measure the subtle energy changes that they are attempting to bring about.

There are differences of opinion within the mainstream medical community regarding the acceptability of reiki. On the one hand, medical professionals in Canada have proposed strategies to limit the popularity of reiki as well as several other alternative therapies by resisting the integration of these therapies with mainstream treatments and by opposing government research in complementary and alternative medicine. On the other hand, the U. S. National Center for Complementary and Alternative Medicine (NCCAM) is conducting a series of clinical trials to evaluate the efficacy of reiki. As of the summer of 2004, there were four NCCAM trials for reiki, measuring

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its effectiveness in treating such disorders as fibromyalgia, neuropathy, **prostate cancer**, and advanced **AIDS**.

Training and certification

Reiki practitioners undergo a series of *attunements*, which are sessions with reiki masters that teach the basic methods of energy healing. Several organizations provide resources for reiki training. Reiki practitioners believe these attunements are necessary for correct technique. The masters teach each person how to activate the universal life energy in themselves before they can pass it on to others. These initiations often are held during weekend workshops. Trainees can achieve up to four levels of attunements, until they reach the level of master themselves. The certification process is not a formal one; masters approve students when they feel satisfied with their progress.

Resources

PERIODICALS

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Kelner, M., B. Wellman, H. Boon, and S. Welch. "Responses of Established Healthcare to the Professionalization of Complementary and Alternative Medicine in Ontario." *Social Science and Medicine* 59 (September 2004): 915–930.

OTHER

American Reiki Masters Association (ARMA). P.O. Box 130, Lake City, FL 32056-0130. (904) 755-9638.

Global Reiki Healing Network. http://www.reiki.org.

NCCAM Reiki Clinical Trials. http://nccam.nih.gov/clinicaltrials/reiki.htm.

Reiki Alliance. P.O. Box 41, Cataldo, ID 83810-1041, phone (208) 682-3535.

ORGANIZATIONS

International Association of Reiki Professionals, info@iarp.org, http://www.iarpreiki.org/.

The International Center for Reiki Training, 21421 Hilltop Street, Unit #28, Southfield, MI, 48033, (248) 948-8112, (248) 948-9534, (800) 332-8112, center@reiki.org, http://www.reiki.org/.

National Center for Complementary and Alternative Medicine (NCCAM), P.O. Box 7923, Gaitherburg, MD, 20898, (866) 464-3616, (888) 644-6226, info@nccam.nih.gov, http://nccam.nih.gov/.

Douglas Dupler, MA
Rebecca J. Frey, PhD

Reiter's syndrome

Definition

Reiter's syndrome (RS), which is also known as arthritis urethritica, venereal arthritis, reactive arthritis, and polyarteritis enterica, is a form of arthritis that affects the eyes, urethra, and skin, as well as the joints. It was first described by Hans Reiter, a German physician, during World War I.

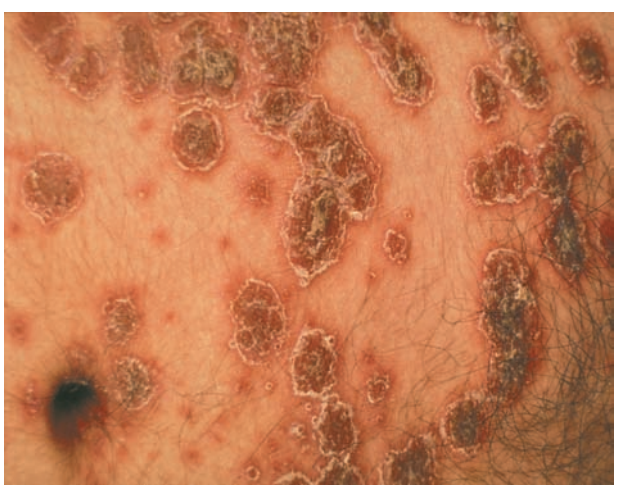
Description

Reiter's syndrome is marked by a cluster of symptoms in different organ systems of the body that may or may not appear simultaneously. The disease may be acute or chronic, with spontaneous remissions or recurrences.

RS primarily affects sexually active males between ages 20-40, particularly males who are HIV positive. Most women and children who develop RS acquire the disease in its intestinal form.

Causes and symptoms

The cause of Reiter's syndrome was unknown as of early 1998, but scientists think the disease results from a combination of genetic vulnerability and various disease agents. More than 80% of Caucasian patients and 50-60% of African Americans test positive for HLA-B27, which suggests that the disease has a genetic component. In sexually active males, most cases of RS follow infection with *Chlamydia trachomatis* or *Ureaplasma urealyticum*. Other patients develop the



Keratoderma, a skin condition characterized by horny patches, is one symptom of Reiter's syndrome. *(© Dr. Milton Reisch/Corbis.)*

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symptoms following gastrointestinal infection with *Shigella*, *Salmonella*, *Yersinia*, or *Campylobacter* bacteria.

The initial symptoms of RS are inflammation either of the urethra or the intestines, followed by acute arthritis four to 28 days later. The arthritis usually affects the fingers, toes, and weight-bearing joints in the legs. Other symptoms include:

- inflammation of the urethra, with painful urination and a discharge from the penis
- mouth ulcers
- inflammation of the eye
- keratoderma blennorrhagica, these are patches of scaly skin on the palms, soles, trunk, or scalp of RS patients

Diagnosis

Patient history

Diagnosis of Reiter's syndrome can be complicated by the fact that different symptoms often occur several weeks apart. The patient does not usually draw a connection between the arthritis and previous sexual activity. The doctor is likely to consider Reiter's syndrome when the patient's arthritis occurs together with or shortly following inflammation of the eye and the genitourinary tract lasting a month or longer.

Laboratory tests

There is no specific test for diagnosing RS, but the physician may have the urethral discharge cultured to rule out **gonorrhea**. Blood tests of RS patients are typically positive for the HLA-B27 genetic marker, with an elevated white blood cell (WBC) count and an increased sedimentation rate of red blood cells. The patient may also be mildly anemic.

Diagnostic imaging

X rays do not usually reveal any abnormalities unless the patient has had recurrent episodes of the disease. Joints that have been repeatedly inflamed may show eroded areas, signs of **osteoporosis**, or bony spurs when x rayed.

Treatment

There is no specific treatment for RS. Joint inflammation is usually treated with **nonsteroidal anti-inflammatory drugs** (NSAIDs.) Skin eruptions and eye inflammation can be treated with **corticosteroids**. Gold treatments may be given for eroded bone.

Patients with chronic arthritis are also given **physical therapy** and advised to **exercise** regularly.

KEY TERMS

Acute—Having a sudden onset and lasting a short time.

Chronic—Of long duration.

Keratoderma blennorrhagica—The medical name for the patches of scaly skin that occur on the arms, legs, and trunk of RS patients.

Reactive arthritis—Another name for Reiter's syndrome.

Prognosis

The prognosis varies. Most patients recover in three to four months, but about 50% have recurrences for several years. Some patients develop complications that include inflammation of the heart muscle, stiffening inflammation of the vertebrae, glaucoma, eventual blindness, deformities of the feet, or accumulation of fluid in the lungs.

Prevention

In males, Reiter's syndrome can be prevented by sexual abstinence or the use of **condoms**.

Resources

BOOKS

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McPhee, Stephen, and Maxine Papadakis. *Current Medical Diagnosis and Treatment, 2010*, 49th ed. New York: McGraw–Hill Medical, 2009.

Rebecca J. Frey, PhD

Relapsing fever

Definition

Relapsing **fever** refers to two similar illnesses, both of which cause high fevers. The fevers resolve, only to recur again within about a week.

Description

Relapsing fever is caused by spiral-shaped bacteria of the genus *Borrelia*. This bacterium lives in

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rodents and in insects, specifically ticks and body lice. The form of relapsing fever acquired from ticks is slightly different from that acquired from body lice.

In tick-borne relapsing fever (TBRF), rodents (rats, mice, chipmunks, and squirrels) which carry *Borrelia* are fed upon by ticks. The ticks then acquire the bacteria, and are able to pass it on to humans. TBRF is most common in sub-Saharan Africa, parts of the Mediterranean, areas in the Middle East, India, China, and the south of Russia. Also, *Borrelia* causing TBRF exist in the western regions of the United States, particularly in mountainous areas. The disease is said to be endemic to these areas, meaning that the causative agents occur naturally and consistently within these locations.

In louse-borne relapsing fever (LBRF), lice acquire *Borrelia* from humans who are already infected. These lice can then go on to infect other humans. LBRF is said to be epidemic, as opposed to endemic, meaning that it can occur suddenly in large numbers in specific communities of people. LBRF occurs in places where poverty and overcrowding predispose to human infestation with lice. LBRF has flared during wars, when conditions are crowded and good hygiene is next to impossible. At this time, LBRF is found in areas of east and central Africa, China, and in the Andes Mountains of Peru.

Causes and symptoms

In TBRF, humans contract *Borrelia* when they are fed upon by ticks. Ticks often feed on humans at night, so many people who have been bitten are unaware that they have been. The bacteria is passed on to humans through the infected body fluids of the tick.

In LBRF, a louse must be crushed or smashed in order for *Borrelia* to be released. The bacteria then enter the human body through areas where the person may have scratched him or herself.

Both types of relapsing fever occur some days after having acquired the bacteria. About a week after becoming infected, symptoms begin. The patient spikes a very high fever, with chills, sweating, terrible **headache**, **nausea**, **vomiting**, severe **pain** in the muscles and joints, and extreme weakness. The patient may become dizzy and confused. The eyes may be bloodshot and very sensitive to light. A **cough** may develop. The heart rate is greatly increased, and the liver and spleen may be swollen. Because the substances responsible for blood clotting may be disturbed during the illness, tiny purple marks may appear on the skin, which are evidence of minor bleeding occurring under the skin. The patient may suffer from a **nosebleed**, or may cough up bloody sputum. All of these symptoms last for about three days in TBRF, and about five days in LBRF.

KEY TERMS

Endemic—Refers to a particular organism which consistently exists in a particular location under normal conditions.

Epidemic—Refers to a condition suddenly acquired by a large number of people within a specific community, and which spreads rapidly throughout that community.

Shock—A state in which the blood pressure is so low that organs and tissues are not receiving an appropriate flow of blood.

With or without treatment, a crisis may occur as the bacteria are cleared from the blood. This crisis, called a Jarisch-Herxheimer reaction, results in a new spike in fever, chills, and an initial rise in blood pressure. The blood pressure then falls drastically, which may deprive tissues and organs of appropriate blood flow (shock). This reaction usually lasts for about a day.

Recurrent episodes of fever with less severe symptoms occur after about a week. In untreated infections, fevers recur about three times in TBRF, and only once or twice in LBRF.

Diagnosis

Diagnosis of relapsing fever is relatively easy, because the causative bacteria can be found by examining a sample of blood under the microscope. The characteristically spiral-shaped bacteria are easily identifiable. The blood is best drawn during the period of high fever, because the bacteria are present in the blood in great numbers at that time.

Treatment

Either tetracycline or erythromycin is effective against both forms of relapsing fever. The medications are given for about a week for cases of TBRF; LBRF requires only a single dose. Children and pregnant women should receive either erythromycin or penicillin. Because of the risk of the Jarish-Herxheimer reaction, patients must be very carefully monitored during the initial administration of antibiotic medications. Solutions containing salts must be given through a needle in the vein (intravenously) to keep the blood pressure from dropping too drastically. Patients with

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extreme reactions may need medications to improve blood circulation until the reaction resolves.

Prognosis

In epidemics of LBRF, **death** rates among untreated victims have run as high as 30%. With treatment, and careful monitoring for the development of the Jarish-Herxheimer reaction, prognosis is good for both LBRF and TBRF.

Prevention

Prevention of TBRF requires rodent control, especially in and near homes. Careful use of insecticides on skin and clothing is important for people who may be enjoying outdoor recreation in areas known to harbor the disease-carrying ticks.

Prevention of LBRF is possible, but probably more difficult. Good hygiene and decent living conditions would prevent the spread of LBRF, but these may be difficult for those people most at risk for the disease.

ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

Rosalyn Carson-DeWitt, MD

Relapsing polychondritis

Definition

Relapsing polychondritis is a disease characterized by autoimmune-like episodic or progressive inflammation of cartilage and other connective tissue, such as the nose, ears, throat, joints, kidneys, and heart.

Description

Cartilage is a tough, flexible tissue that turns into bone in many places in the body. Bones all start out as cartilage in the fetus. Consequently, children have more cartilage than adults. Cartilage persists in adults in the linings of joints, the ears, the nose, the airway and the ribs near the breast bone. All these sites are attacked by relapsing polychondritis, which usually occurs equally in middle-aged males and females. It is frequently diagnosed along with **rheumatoid arthritis**, **systemic lupus erythematosus**, and other connective tissue diseases.

KEY TERMS

Aorta—The biggest artery in the body, receiving blood directly from the heart.

Connective tissue—Several types of tissue that hold the body's parts together–tendons, ligaments, fascia, and cartilage.

Inflammation—The body's immune reaction to presumed foreign substances like germs. Inflammation is characterized by increased blood supply and activation of defense mechanisms. It produces redness, swelling, heat, and pain.

Causes and symptoms

The most common first symptom of relapsing polychondritis is **pain** and swelling of the external ear. Usually, both ears turn red or purple and are tender to the touch. The swelling can extend into the ear canal and beyond, causing ear infections, **hearing loss**, balance disturbances with vertigo and **vomiting**, and eventually a droopy ear. The nose is often afflicted as well and can deteriorate into a flattened nose bridge called saddle nose. Inflammation of the eye occurs less frequently, but can lead to blindness.

As relapsing polychondritis advances, it causes more dangerous symptoms such as deterioration of the cartilage that holds the windpipe open. Progressive disease can destroy the integrity of the airway and compromise breathing. Destruction of the rib cartilage can collapse the chest, again hindering breathing. Joints everywhere are involved in episodes of arthritis, with pain and swelling. Other tissues besides cartilage are also involved, leading to a variety of problems with the skin and other tissues. Occasionally, the aorta or heart valves are damaged.

The disease may occur in episodes with complete remission between, or it may smolder along for years, causing progressive destruction.

Diagnosis

A characteristic array of symptoms and physical findings will yield a diagnosis of relapsing polychondritis. Laboratory tests are sometime helpful. Biopsies of the affected cartilage may confirm the diagnosis. Further diagnostic tests are done to confirm other associated conditions such as rheumatoid arthritis. It is important to evaluate the airway, although only 10% of patients will die from airway complications.

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Treatment

Mild inflammations can be treated with **aspirin** or **nonsteroidal anti-inflammatory drugs** (NSAIDs) such as ibuprofen. **Corticosteroids** (most often prednisone) are usually prescribed for more advanced conditions and do improve the disease. They may have to be continued over long periods of time, in which case their usage must be closely watched to avoid complications. Immune suppression with cyclophosphamide, azathioprine, cyclosporine, or dapsone is reserved for more aggressive cases. A collapsed chest or airway may require surgical support, and a heart valve or aorta may need repair or replacing.

Prognosis

There is no known cure for relapsing polychondritis. It can only be combated with each onset of inflammation and deterioration of cartilaginous tissue. As the disease progresses over a period of years, the mortality rate increases. At five years duration, relapsing polychondritis has a 30% mortality rate.

Resources

BOOKS

Fauci, Anthony S., et al., eds. *Harrison's Principles of Internal Medicine*. 17th ed. New York: McGraw-Hill Professional, 2008.

J. Ricker Polsdorfer, MD

Renal artery occlusion

Definition

Renal artery occlusion is a blockage of the major arteries that supply blood to the kidneys caused by thrombosis or **embolism**.

Description

Renal artery occlusion occurs when the flow of blood from the arteries leading to the kidneys becomes blocked by a blood clot or cholesterol emboli. The lack of oxygenation can lead to necrosis (tissue **death**) and ultimately, **chronic kidney failure**.

Causes and symptoms

Renal arterial occlusion occurs when a thrombus or embolism (blood clot or cholesterol plaque) breaks free and blocks the arteries leading to one or both kidneys.

Symptoms of an acute renal arterial occlusion may include:

- hypertension
- fever
- sudden pain in the lower back or flank
- nausea and vomiting
- protein and/or blood in the urine

An individual with renal arterial occlusion may have no overt symptoms, particularly if only one kidney is affected or if the blockage is only partial. Health problems from secondary complications such as chronic kidney failure may be the first indication that something is wrong.

Diagnosis

The high blood pressure that is sometimes associated with a renal artery blockage may be the first sign that it is present, particularly if the **hypertension** is not responding to standard treatment. Urine and blood tests may or may not be useful in diagnosing this condition. Blood tests may show an elevated plasma creatinine level. If kidney tissue infarction (cell death caused by a lack of blood supply) has occurred, lactic dehydrogenase (LDH) may also be present in the urine and blood.

An arteriogram, an x-ray study of the arteries that uses a radiopaque substance, or dye, to make the arteries visible under x ray, may also be performed. This test is used with caution in patients with impaired kidney function, as the contrast medium can cause further kidney damage. In patients with whom this is not an issue, a spiral computed tomography (CT) scan with contrast medium may also be used.

Treatment

Occlusions may be treated with anticoagulant (blood thinning) or thrombolytic (clot destroying) drugs. If the blockage is significant, surgical intervention or **angioplasty** may be required. Between 1996 and 2000, the number of these procedures performed on Medicare patients more than doubled, according to a 2004 report.

Alternative treatment

Renal arterial occlusion is a serious and potentially life-threatening condition, and should always be treated by a healthcare professional familiar with the disorder.

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KEY TERMS

Angioplasty—A non-surgical procedure that uses a balloon-tipped catheter to open a blocked artery.

Artherosclerotic plaque—A deposit of fatty and calcium substances that accumulate in the lining of the artery wall, restricting blood flow.

Atrophy—Cell or tissue wasting or death.

Chronic kidney failure—End-stage renal disease (ESRD); chronic kidney failure is diagnosed as ESRD when kidney function falls to 5–10% of capacity.

Embolism—Blood vessel obstruction by a blood clot or other substance (i.e., air).

Thrombus—Formation of a blood clot within the vascular system. A thrombus becomes an embolism if it breaks away and blocks a blood vessel.

Prognosis

The outcome of renal arterial occlusion depends on the speed with which it is treated. Once the blood supply is minimized or cut off to the kidney, tissue death soon results, ultimately leading to chronic kidney failure (end-stage renal disease).

Prevention

Atherosclerosis may encourage the formation of cholesterol emboli, a potential cause of renal artery occlusion. Strategies for avoiding **vascular disease** include eating right, maintaining a desirable weight, quitting **smoking**, managing **stress**, and exercising regularly. People prone to emboli from **blood clots** can take blood thinning drugs to prevent potential emboli from loding in the renal artery.

Resources

PERIODICALS

"Explosive Growth Seen in Renal Artery Interventional Procedures." *Heart Disease Weekly* September 26, 2004: 20.

Truelove, Christiane. "First for Pulmonary Embolism." *Med Ad News* August 2004: 82.

ORGANIZATIONS

American Kidney Fund (AKF), 6110 Executive Boulevard, Suite 1010, Rockville, MD, 20852, (800) 638-8299, http://www.kidneyfund.org.

National Institute of Diabetes and Digestive and Kidney Diseases, NIDDK, NIH Bldg 31, Rm 9A06 31 Center Drive, MSC 2560, Bethesda, MD, 20892-2560, (301) 496.3583, http://www2.niddk.nih.gov/Footer.

National Kidney Foundation, Inc., 30 East 33rd Street, New York, NY, 10016, (212) 889-2210, (212) 689-9261, (800) 622-9010, http://www.kidney.org/.

Paula Anne Ford-Martin
Teresa G. Odle

Renal artery stenosis

Definition

Renal artery stenosis is a blockage or narrowing of the major arteries that supply blood to the kidneys.

Description

Renal artery stenosis occurs when the flow of blood from the arteries leading to the kidneys is constricted by tissue or artherosclerotic plaque. This narrowing of the arteries diminishes the blood supply to the kidneys, which can cause them to atrophy and may ultimately lead to kidney failure. It may also cause **renovascular hypertension**, or high blood pressure related to renal artery blockage.

Causes and symptoms

The two main causes of renal artery stenosis are **atherosclerosis** and fibromuscular disease. Fibromuscular diseases such as fibromuscular dysplasia cause growth of fibrous tissues on the arterial wall. Stenosis may also occur when scar tissue forms in the renal artery after trauma to the kidney.

Renal arterial stenosis has no overt symptoms. Eventually, untreated renal arterial stenosis causes secondary complications such as **chronic kidney failure**, which may be characterized by frequent urination, anemia, **edema**, headaches, **hypertension**, lower back **pain**, and other signs and symptoms.

Diagnosis

The high blood pressure that is sometimes associated with renal artery stenosis may be the first sign that it is present, particularly if the hypertension is not responding to standard treatment. Presence of a *bruit*, a swooshing sound from the artery that indicates an obstruction, may be heard through a stethoscope.

An arteriogram, an x-ray study of the arteries that uses a radiopaque substance, or dye, to make the arteries visible under x ray, may also be performed. This test is used with caution in patients with impaired kidney function, as the contrast medium may cause further kidney damage.

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KEY TERMS

Artherosclerotic plaque—A deposit of fatty and calcium substances that accumulate in the lining of the artery wall, restricting blood flow.

Atrophy—Cell or tissue wasting or death.

Chronic kidney failure—End-stage renal disease (ESRD); chronic kidney failure is diagnosed as ESRD when kidney function falls to 5-10% of capacity.

Edema—Swelling which occurs when body tissues retain fluid.

Stent—An expandable "scaffold-like" device, usually constructed of a stainless steel material, that is inserted into an artery to expand the inside passage and improve blood flow.

Treatment

Treatment for renal artery stenosis is either surgical, pharmaceutical, or with **angioplasty** or stenting. Angioplasty involves guiding a balloon catheter down into the renal artery and inflating the balloon to clear the blockage. A stent may be inserted into the artery to widen the opening. Some patients may be candidates for surgical revascularization, which involves restoring blood flow with an arterial bypass. Drugs known as angiotension-converting enzyme (ACE) inhibitors may be prescribed for some patients. The chosen treatment approach depends on the cause of the stenosis and factors such as the patient's kidney function and blood pressure control.

Alternative treatment

Renal artery stenosis is a serious and potentially life-threatening condition, and should always be treated by a healthcare professional familiar with the disorder.

Prognosis

Untreated renal artery stenosis can cause hypertension (high blood pressure) and may ultimately lead to chronic kidney failure (end-stage renal disease).

Prevention

Maintaining a heart healthy lifestyle can help to prevent cases of renal arterial stenosis attributable to artherosclerosis. Strategies for avoiding **vascular disease** include eating right, maintaining a desirable weight, quitting **smoking**, managing **stress**, and exercising regularly.

ORGANIZATIONS

American Kidney Fund (AKF), 6110 Executive Boulevard, Suite 1010, Rockville, MD, 20852, (800) 638-8299, http://www.kidneyfund.org.

National Institute of Diabetes and Digestive and Kidney Diseases, NIDDK, NIH Bldg 31, Rm 9A06 31 Center Drive, MSC 2560, Bethesda, MD, 20892-2560, (301) 496-3583, http://www2.niddk.nih.gov/Footer.

National Kidney Foundation, Inc. , 30 East 33rd Street, New York, NY, 10016, 212 889-2210, 212 689-9261, (800) 622-9010, http://www. kidney.org/.

Paula Anne Ford-Martin

Renal calculi *see* **Kidney stones**

Renal failure *see* **Acute kidney failure; Chronic kidney failure**

Renal nuclear medicine scan *see* **Kidney nuclear medicine scan**

Renal tubular acidosis

Definition

Renal tubular acidosis (RTA) is a group of metabolic disorders in which acid accumulates in the body because the kidneys fail to keep the urine at a proper level of acidity. This condition is a form of metabolic acidosis—a condition in which there is too much acid in the body fluids. Although kidney failure may also be characterized by acidosis, the term RTA is applied only to patients with poor acidification of the urine whose kidneys are otherwise functioning normally. RTA was identified as a distinctive disorder only in the twentieth century, being first described in children in 1936 and in adults in 1945.

Demographics

Renal tubular acidosis is a relatively uncommon condition, although some of its types are rarer than others:

- Type I: Type I may be inherited as a result of genetic mutations or may be sporadic, associated with such autoimmune disorders as Sjögren syndrome or lupus. It appears to be more common in women than in men.

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- Type II: This type of RTA is very rare, most often occurs in infancy, and is usually found in association with Fanconi syndrome or as a reaction to certain drugs.
- Type III: This type is extremely rare and is thought to occur primarily in the Maghreb region of West Africa as the result of a genetic mutation.
- Type IV: Type IV is thought to be the most common form of RTA but is still rare in the general population.

Description

Renal tubular acidosis is a disorder in which acid produced by the breakdown of food in the body accumulates in the blood instead of being removed from the blood during filtration by the kidneys. Under normal circumstances, as blood passes through the tubules of the kidneys, this acid is removed and excreted into the urine, and an alkaline substance called bicarbonate is returned to the blood. In RTA, the ability of the tubules to either remove the acid from the blood or to return the bicarbonate is partially impaired.

There are four basic types of RTA:

- Type I: Type I RTA, also called classical distal RTA or dRTA, is caused by a failure of the cells in the lower (distal) section of the kidney tubule to secrete enough hydrogen ions into the filtrate. The result is increased acidity of the urine, low potassium levels in the blood (hypokalemia), and leakage of calcium into the urine.
- Type II: Type II RTA is called proximal RTA or pRTA because the part of the kidney tubule that is defective lies closest to the point where fluid and wastes from the blood enter the tubule. In pRTA, this portion of the tubule fails to return bicarbonate to the blood.
- Type III: Type III RTA, a combination of dRTA and pRTA, is extremely rare and is not often used as a classification as of 2010 because it is thought to be a combination of Type I and Type II RTA.
- Type IV: Type IV RTA is sometimes called generalized RTA or hyperkalemic RTA. It is characterized by a general impairment of the distal portion of the renal tubule in transporting potassium, chloride, and sodium across cell membranes. This type of RTA is distinguished from dRTA by abnormally high levels of potassium in the blood (hyperkalemia) rather than low levels. It occurs when a person has low levels of a hormone called aldosterone or when the kidneys do not respond properly to the aldosterone that is produced in the body. Type IV RTA is not a genetic disorder; it may be secondary to certain kidney disorders or to exposure to certain medications.

Risk factors

The risk factors for RTA include a wide range of inherited and acquired disorders, various prescription medications, and environmental factors.

Causes and symptoms

Causes

The causes of RTA vary according to its type. RTA may be either a primary or a secondary disorder; that is, it may arise by itself or as a complication of another disease.

- Type I: Type I RTA can be caused by certain genetic disorders or associated with such autoimmune disorders as lupus or Sjögren syndrome, or with sickle cell anemia. Other diseases and disorders associated with dRTA include cirrhosis, hyperparathyroidism, hyperthyroidism, rejection of a transplanted kidney, chronic urinary tract infections, and a hereditary form of deafness. Some of these disorders cause calcium to build up in the kidney tubule, which interferes with the functioning of the distal tubule. Drugs that may cause dRTA include lithium, amphotericin B, and ifosfamide.
- Type II: Type II, or pRTA, can be caused by such hereditary disorders as cystinosis, fructose intolerance, or Wilson's disease; by such acquired disorders as multiple myeloma; by exposure to heavy metals, particularly lead and cadmium; or by exposure to certain drugs, including ifosfamide, acetazolamide, or outdated tetracycline antibiotics.
- Type IV: Type IV RTA is not caused by genetic abnormalities but by a deficiency of the hormone aldosterone (primary aldosterone deficiency), or by certain diseases or disorders that affect kidney functioning and the body's ability to use the hormone. These include diabetes, HIV infection, and blockages of the urinary tract; lupus, amyloidosis, removal or destruction of both adrenal glands, and kidney transplant rejection. Type IV RTA can be worsened by such drugs as NSAIDs, cyclosporine (an immunosuppressant), ACE inhibitors (blood pressure drugs), potassium-sparing diuretics, trimethoprim or pentamidine (antibiotics), or heparin (a blood thinner).

Symptoms

Metabolic acidosis—of which RTA is one type—does not have any unique symptoms or signs. It does, however, affect the functioning of the body's muscles,

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KEY TERMS

Acidosis—A condition in which the blood becomes increasingly acid.

Aldosterone—A hormone produced in the cortex of the adrenal gland that increases the reabsorption of sodium and water and the release of potassium in the kidneys.

Cystinosis—A genetic disorder characterized by a buildup of an amino acid called cystine in the body. It leads to abnormal amounts of carbohydrates and amino acids in the urine, excessive urination, and low blood levels of potassium and phosphates.

Distal tubule—The portion of the kidney tubule that lies furthest away from the point at which fluid from the blood enters the tubule.

Fanconi syndrome—A kidney disorder in which glucose, amino acids, uric acid, phosphate, and bicarbonate are passed into the urine instead of being reabsorbed into the blood.

Filtrate—The medical term for the water and small molecules filtered in the nephron of the kidney.

Hyperkalemia—An abnormally high level of potassium in the blood.

Hypokalemia—An abnormally low level of potassium in the blood.

Nephron—The basic structural unit of the kidney, responsible for regulating the concentration of water and soluble chemicals in the blood by filtering the blood, reabsorbing the compounds needed by the body, and excreting the rest in the urine. Each kidney in humans contains between 800,000 and one million nephrons.

Osteomalacia—Softening or weakening of the bones due to either a lack of vitamin D or the body's inability to make use of this vitamin.

Proximal tubule—The portion of the kidney tubule that lies closest to the point at which fluid from the blood enters the tubule.

Sjögren syndrome—An autoimmune disorder in which the body's immune system attacks the glands that produce saliva and tears.

Sporadic—Referring to a disease or disorder that occurs in isolated instances.

Tubule—A very small tube-shaped structure in the nephron of the kidney that removes certain ions and molecules from the blood and deposits them into the fluid within the tubule.

Wilson's disease—A genetic disorder in which copper accumulates in the body, leading to liver disease and a variety of neurological and psychiatric symptoms.

bones, heart, lungs, and nervous system; patients may have a variety of symptoms ranging from headaches, **fatigue**, and weakened bones or muscles to irregular heartbeat, **nausea and vomiting**, skeletal abnormalities, confusion, and rapid breathing.

Many patients with RTA have no symptoms for years; when symptoms do develop, the characteristic symptoms of the different types of RTA include:

- Type I: The hypokalemia characteristic of dRTA affects the muscles, including the heart, leading to weakness, irregular heartbeat, paralysis, and even death. Untreated Type I RTA causes growth retardation in children and progressive kidney and bone disease (osteomalacia) in adults because the acid levels in the blood lead to demineralization of bone. Calcium may build up in the kidneys, leading to the formation of kidney stones and eventual kidney failure.
- Type II: Symptoms of Type II RTA may include bone pain, muscle cramps, and bone demineralization due to the loss of phosphates in the urine. Children can develop growth retardation with this type of RTA as well as with Type I.
- Type IV: This type of RTA is usually asymptomatic if the acidosis is mild; however, an irregular heartbeat or paralysis may develop if the hyperkalemia is severe.

Diagnosis

The diagnosis of RTA is based on the results of laboratory tests.

Examination

Since many patients are asymptomatic, an office **physical examination** is usually unrevealing unless the person has extreme muscle weakness and diminished reflexes.

Tests

The most common types of tests used to diagnose RTA are blood and urine tests:

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- Acid-base tests of blood and urine samples. These measure the acidity or alkalinity of body fluids. If the blood is more acidic than normal or the urine is less acidic, RTA is a possible diagnosis but additional tests are needed to confirm the diagnosis and determine a patient's specific type of RTA.
- Urinalysis. This test measures the level of electrolytes in the blood and may show abnormal levels of phosphate, calcium, glucose, and amino acids.
- Acid loading test. This test is done to measure the ability of the kidney tubules to acidify the urine. The patient is given capsules of a chemical called ammonium chloride to take over a three-day period and urine and blood samples are then taken. Failure to acidify the urine indicates dRTA.
- Measure of blood potassium level. This test can help to distinguish between Type I RTA, in which blood potassium levels are low, and Type IV, in which they are higher than normal.
- Aldosterone test. This is a test done to measure the levels of aldosterone in the patient's blood. It can be used to evaluate patients suspected of having Type IV RTA.
- Bicarbonate infusion. To confirm the diagnosis of Type II RTA, the doctor may infuse a solution of sodium bicarbonate into the patient's vein and then measure the acidity of the patient's urine and the amount of bicarbonate that is excreted. If the urine turns alkaline and there is a large amount of bicarbonate excreted, the patient has Type II RTA.

Treatment

The primary goal of therapy in RTA is to neutralize the acid in the patient's blood, but the specific method of treatment depends on the underlying cause of the acidosis.

Traditional

The most common form of treatment for RTA is use of medications that can reduce the acidity of the patient's blood.

Drugs

RTA is treated primarily with medications:

- Type I: Type I RTA is treated by administering sodium bicarbonate and sodium citrate. These chemicals correct the low blood potassium levels, leakage of calcium into the urine, and salt depletion found in dRTA. They also reduce the risk of kidney stone formation and eventual kidney failure. Infants with Type I RTA occasionally need potassium supplements.
- Type II: Children with pRTA are usually given large doses of sodium bicarbonate or potassium citrate to treat acidosis and prevent bone disorders, kidney stones, and growth failure. They may be given vitamin D supplements to reduce the risk of bone deformities.
- Type IV: Type IV RTA is treated with alkaline chemicals to lower the acidity of the blood and a diuretic like furosemide to lower the levels of potassium in the blood. The patient may also be asked to minimize their intake of foods that are high in potassium, such as meats and fish, apricots, bananas, cantaloupe, lima beans, citrus fruits, and tomatoes.

Prognosis

Most patients with RTA get better with treatment. Early recognition and prompt treatment is essential to prevent kidney failure. Patients require maintenance therapy and periodic monitoring of blood acidity throughout their lives.

Prevention

Most of the disorders that cause RTA are not preventable. Risk of Type II can be reduced by limiting exposure to heavy metals.

Resources

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ORGANIZATIONS

American Kidney Fund (AKF), 6110 Executive Blvd., Suite 1010, Rockville, MD, 20852, (800) 638-8299, http://www.kidneyfund.org.

American Society of Nephrology (ASN), 1725 I Street, NW, Suite 510, Washington, DC, 20006, (202) 659-0599, (202) 659-0709, email@asn-online.org, http://www.asn-online.org.

American Urological Association (AUA), 1000 Corporate Boulevard, Linthicum, MD, 21090, (410) 689-3700, (866) RING AUA, (410) 689-3800, http://www.auanet.org.

National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), Building 31. Rm 9A06, 31 Center Drive, MSC 2560, Bethesda, MD, 20892-2560, (301) 496-3583, http://www2.niddk.nih.gov/Footer/ContactNIDDK.htm, http://www2.niddk.nih.gov.

National Kidney Foundation (NKF), 30 East 33rd Street, New York, NY, 10016, (212) 889-2210, (800) 622-9010, (212) 689-9261, http://www.kidney.org.

Rebecca J. Frey, PhD

Renal ultrasound *see* **Abdominal ultrasound**

Renal vein thrombosis

Definition

Renal vein thrombosis develops when a blood clot forms in the renal vein, which carries blood from the kidneys back to the heart. The disorder is not common.

Description

Renal vein thrombosis occurs in both infants and adults. Onset of the disorder can be rapid (acute) or gradual. The number of people who suffer from renal vein thrombosis is difficult to determine, as many people do not show symptoms, and the disorder is diagnosed only by specific tests. Ninety percent of childhood cases occur in children under one year old, and 75% occur in infants under one month of age. In adult women, oral contraceptive use increases the risk of renal vein thrombosis.

Causes and symptoms

In children, renal vein thrombosis almost always occurs rapidly after an episode of severe **dehydration**. Severe dehydration decreases blood volume and causes the blood to clot more readily.

In adults, renal vein thrombosis can be caused by injury to the abdomen or back, as a result of malignant kidney tumors growing into the renal vein, or as a result of kidney diseases that cause degenerative changes in the cells of the renal tubules (**nephrotic syndrome**).

Acute onset of renal vein thrombosis at any age causes **pain** in the lower back and side, **fever**, bloody urine, decreased urine output, and sometimes kidney failure. In adults, when the onset of the disorder is gradual, there is a slow decrease in kidney function, and protein appears in the urine. Many adults with renal vein thrombosis show few symptoms.

Diagnosis

Renal **venography**, where a contrast material (dye) is injected into the renal vein before x rays are taken, is one of the best ways to detect renal vein thrombosis. Other useful tests to detect a clot include **computed tomography scans** (CT scans), **magnetic resonance imaging** (MRI), and ultrasound.

Treatment

One of the major goals of treatment is to prevent the blood clot in the renal vein from detaching and moving into the lungs, where it can cause serious complications as a **pulmonary embolism**. The enzyme streptokinase may be given to help dissolve the renal clot. Anticoagulant medications are usually prescribed to prevent clots from recurring. Rarely, when there is a complete blockage of the renal vein in infants, the kidney must be surgically removed.

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Prognosis

Most cases of renal vein thrombosis resolve without any permanent damage. **Death** from renal vein thrombosis is rare, and is often caused by the blood clot detaching and lodging in the heart or lungs.

Prevention

There is no specific prevention for renal vein thrombosis. Preventing dehydration reduces the risk that it will occur.

ORGANIZATIONS

National Kidney Foundation, Inc. , 30 East 33rd Street, New York, NY, 10016, 212 889-2210, 212 689-9261, (800) 622-9010, http://www.kidney.org/.

Tish Davidson, A.M.

Rendu-Osler-Weber disease *see* **Hereditary hemorrhagic telangiectasia**

Renin assay *see* **Plasma renin activity**

Renovascular hypertension

Definition

Renovascular **hypertension** is a secondary form of high blood pressure caused by a narrowing of the renal artery.

Description

Primary hypertension, or high blood pressure, affects millions of Americans. It accounts for over 90% of all cases of hypertension and develops without apparent causes. It is helpful for the clinician to know if a secondary disease is present and may be contributing to the high pressure. If clinical tests indicate this is so, the term used for the rise in blood pressure is secondary hypertension.

Renal hypertension is the most common form of secondary hypertension and affects no more than one percent of all adults with primary hypertension. There are two forms of renovascular hypertension.

In atherosclerotic renovascular hypertension disease, plaque is deposited in the renal artery. The deposits narrow the artery, disrupting blood flow. Atherosclerotic renovascular hypertension is most often seen in men over age 45 and accounts for two-thirds of the cases of renovascular hypertension. In most patients, it affects the renal arteries to both kidneys.

Renovascular hypertension caused by fibromuscular dysplasia occurs mainly in women under age 45. It is also the cause of hypertension in 10% of children with the disorder. In fibromuscular dysplasia, cells from the artery wall overgrow and cause a narrowing of the artery channel.

The risk of having hypertension is related to age, lifestyle, environment, and genetics. **Smoking**, **stress**, **obesity**, a diet high in salt, exposure to heavy metals, and an inherited predisposition toward hypertension all increase the chances that a person will develop both primary and renovascular hypertension.

Causes and symptoms

Narrowing of the renal artery reduces the flow of blood to the kidney. In response, the kidney produces the protein renin. Renin is released into the blood stream. Through a series of steps, renin is converted into an enzyme that causes **sodium** (salt) retention and constriction of the arterioles. In addition to atherosclerotic and fibromuscular dysplasia, narrowing of the renal artery can be caused by compression from an injury or tumor, or by **blood clots**.

Renovascular hypertension is suspected when hypertension develops suddenly in patients under 30 or over 55 years of age or abruptly worsens in any patient. Symptoms are often absent or subtle.

Diagnosis

No single test for renovascular hypertension is definitive. About half of patients with renovascular hypertension have a specific cardiovascular sound that is heard when a doctor listens to the upper abdomen with a stethoscope. Other diagnostic tests give occasional false positive and false negative results. Most tests are expensive, and some involve serious risks.

Imaging studies are used to diagnose renovascular hypertension. In **intravenous urography**, a dye is injected into the kidney, pictures are made, and the kidneys compared. In renal arteriography, contrast material is inserted into the renal artery and cinematic x rays (showing motion within the kidney) are taken. Studies of kidney function are performed. Tests are done to measure renin production. The results of these tests taken together are used to diagnose renovascular hypertension.

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Treatment

Renovascular hypertension may not respond well to anti-hypertensive drugs. Percutaneous transluminal **angioplasty** (PTA), where a balloon catheter is used to dilate the renal artery and remove the blockage, is effective in improving the condition of about 90% of patients with fibromuscular dysplasia. One year later, 60% remain cured. It is less successful in patients with **atherosclerosis**, where renovascular hypertension recurs in half the patients. Where kidney damage occurs, surgery to repair or bypass the renal artery blockage is often effective. In some cases, the damaged kidney must be removed.

Alternative treatment

Alternative treatment stresses eliminating the root causes of hypertension. With renovascular hypertension, as with primary hypertension, the root causes generally cannot be totally reversed by any method. Lifestyle changes are recommended. These include stopping smoking, eating a diet low in animal fats and salt, avoiding exposure to heavy metals, stress control through **meditation**, and anger management. Herbal medicine practitioners recommend garlic (*Allium sativum*) to help lower blood pressure. Constitutional homeopathy and **acupuncture** also can be helpful in lowering blood pressure.

Prognosis

PTA is effective in many younger patients with fibromuscular dysplasia. Older patients are less responsive to this treatment. Surgery is also more risky and less successful in older patients.

Prevention

Renovascular hypertension is possibly preventable through lifestyles that prevent atherosclerosis and primary hypertension. It is unknown how to prevent fibromuscular hyperplasia

ORGANIZATIONS

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Respiratory acidosis

Definition

Respiratory acidosis is a condition in which a build-up of carbon dioxide in the blood produces a shift in the body's pH balance and causes the body's system to become more acidic. This condition is brought about by a problem either involving the lungs and respiratory system or signals from the brain that control breathing.

Description

Respiratory acidosis is an acid imbalance in the body caused by a problem related to breathing. In the lungs, oxygen from inhaled air is exchanged for carbon dioxide from the blood. This process takes place between the alveoli (tiny air pockets in the lungs) and the blood vessels that connect to them. When this exchange of oxygen for carbon dioxide is impaired, the excess carbon dioxide forms an acid in the blood. The condition can be acute with a sudden onset, or it can develop gradually as lung function deteriorates.

Causes and symptoms

Respiratory acidosis can be caused by diseases or conditions that affect the lungs themselves, such as **emphysema**, chronic **bronchitis**, **asthma**, or severe **pneumonia**. Blockage of the airway due to swelling, a foreign object, or vomit can induce respiratory acidosis. Drugs like anesthetics, sedatives, and **narcotics** can interfere with breathing by depressing the respiratory center in the brain. Head injuries or brain tumors can also interfere with signals sent by the brain to the lungs. Such neuromuscular diseases as **Guillain-Barré syndrome** or **myasthenia gravis** can impair the muscles around the lungs making it more difficult to breathe. Conditions that cause chronic **metabolic alkalosis** can also trigger respiratory acidosis.

The most notable symptom will be slowed or difficult breathing. **Headache**, drowsiness, restlessness, tremor, and confusion may also occur. A rapid heart rate, changes in blood pressure, and swelling of blood vessels in the eyes may be noted upon examination. This condition can trigger the body to respond with symptoms of metabolic alkalosis, which may include **cyanosis**, a bluish or purplish discoloration of the skin due to inadequate oxygen intake. Severe cases of respiratory acidosis can lead to **coma** and **death**.

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KEY TERMS

pH—A measurement of acid or alkali (base) of a solution based on the amount of hydrogen ions available. Based on a scale of 14, a pH of 7.0 is neutral. A pH below 7.0 is an acid; the lower the number, the stronger the acid. A pH above 7.0 is a base; the higher the number, the stronger the base. Blood pH is slightly alkali with a normal range of 7.36–7.44.

Diagnosis

Respiratory acidosis may be suspected based on symptoms. A blood sample to test for pH and arterial blood gases can be used to confirm the diagnosis. In this type of acidosis, the pH will be below 7.35. The pressure of carbon dioxide in the blood will be high, usually over 45 mmHg.

Treatment

Treatment focuses on correcting the underlying condition that caused the acidosis. In patients with chronic lung diseases, this may include use of a bronchodilator or steroid drugs. Supplemental oxygen supplied through a mask or small tubes inserted into the nostrils may be used in some conditions, however, an oversupply of oxygen in patients with lung disease can make the acidosis worse. **Antibiotics** may be used to treat infections. If the acidosis is related to an overdose of narcotics, or a **drug overdose** is suspected, the patient may be given a dose of naloxone, a drug that will block the respiratory-depressing effects of narcotics. Use of mechanical ventilation like a respirator may be necessary. If the respiratory acidosis has triggered the body to compensate by developing metabolic alkalosis, symptoms of that condition may need to be treated as well.

Prognosis

If the underlying condition that caused the respiratory acidosis is treated and corrected, there may be no long term effects. Respiratory acidosis may occur chronically along with the development of lung disease or **respiratory failure**. In these severe conditions, the patient may require the assistance of a respirator or ventilator. In extreme cases, the patient may experience coma and death.

Prevention

Patients with chronic lung diseases and those who receive sedatives and narcotics need to be monitored closely for development of respiratory acidosis.

Resources

BOOKS

West, John B. *Respiratory Physiology: The Essentials.* 7th ed. Philadelphia: Lippincott Williams & Wilkins, 2005.

Altha Roberts Edgren

Respiratory alkalosis

Definition

Respiratory alkalosis is a condition where the amount of carbon dioxide found in the blood drops to a level below normal range. This condition produces a shift in the body's pH balance and causes the body's system to become more alkaline (basic). This condition is brought on by rapid, deep breathing called hyperventilation.

Description

Respiratory alkalosis is an alkali imbalance in the body caused by a lower-than-normal level of carbon dioxide in the blood. In the lungs, oxygen from inhaled air is exchanged for carbon dioxide from the blood. This process takes place between the alveoli (tiny air pockets in the lungs) and the blood vessels that connect to them. When a person hyperventilates, this exchange of oxygen for carbon dioxide is speeded up, and the person exhales too much carbon dioxide. This lowered level of carbon dioxide causes the pH of the blood to increase, leading to alkalosis.

Causes and symptoms

The primary cause of respiratory alkalosis is hyperventilation. This rapid, deep breathing can be caused by conditions related to the lungs like **pneumonia**, lung disease, or **asthma**. More commonly, hyperventilation is associated with **anxiety**, **fever**, **drug overdose**, **carbon monoxide poisoning**, or serious infections. Tumors or swelling in the brain or nervous system can also cause this type of respiration. Other stresses to the body, including **pregnancy**, liver failure, high elevations, or

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KEY TERMS

Hyperventilation—Rapid, deep breathing, possibly exceeding 40 breaths/minute. The most common cause is anxiety, although fever, aspirin overdose, serious infections, stroke, or other diseases of the brain or nervous system.

pH—A measurement of acid or alkali (base) of a solution based on the amount of hydrogen ions available. Based on a scale of 14, a pH of 7.0 is neutral. A pH below 7.0 is an acid; the lower the number, the stronger the acid. A pH above 7.0 is a base; the higher the number, the stronger the base. Blood pH is slightly alkali with a normal range of 7.36-7.44.

metabolic acidosis can also trigger hyperventilation leading to respiratory alkalosis.

Hyperventilation, the primary cause of respiratory alkalosis, is also the primary symptom. This symptom is accompanied by **dizziness**, light headedness, agitation, and **tingling** or numbing around the mouth and in the fingers and hands. Muscle twitching, spasms, and weakness may be noted. Seizures, irregular heart beats, and tetany (**muscle spasms** so severe that the muscle locks in a rigid position) can result from severe respiratory alkalosis.

Diagnosis

Respiratory alkalosis may be suspected based on symptoms. A blood sample to test for pH and arterial blood gases can be used to confirm the diagnosis. In this type of alkalosis, the pH will be elevated above 7.44. The pressure of carbon dioxide in the blood will be low, usually under 35 mmHg.

Treatment

Treatment focuses on correcting the underlying condition that caused the alkalosis. Hyperventilation due to anxiety may be relieved by having the patient breath into a paper bag. By rebreathing the air that was exhaled, the patient will inhale a higher amount of carbon dioxide than he or she would normally. **Antibiotics** may be used to treat pneumonia or other infections. Other medications may be required to treat fever, seizures, or irregular heart beats. If the alkalosis is related to a drug overdose, the patient may require treatment for **poisoning**. Use of mechanical ventilation like a respirator may be necessary. If the respiratory alkalosis has triggered the body to compensate by developing metabolic acidosis, symptoms of that condition may need to be treated, as well.

Prognosis

If the underlying condition that caused the respiratory alkalosis is treated and corrected, there may be no long-term effects. In severe cases of respiratory alkalosis, the patient may experience seizures or heart beat irregularities that may be serious and life threatening.

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Altha Roberts Edgren

Respiratory distress syndrome

Definition

Respiratory distress syndrome (RDS) of the newborn, also known as infant RDS, is an acute lung disease present at birth, which usually affects premature babies. Layers of tissue called hyaline membranes keep the oxygen that is breathed in from passing into the blood. The lungs are said to be "airless." Without treatment, the infant will die within a few days after birth. If oxygen can be provided, and the infant receives modern treatment in a neonatal intensive care unit, complete recovery with no after–effects can be expected.

Demographics

RDS nearly always occurs in premature infants, and the more premature the birth, the greater is the chance that RDS will develop. RDS also is seen in some infants whose mothers are diabetic. Paradoxically, RDS is less likely in the presence of certain states or conditions which themselves are harmful: abnormally slow growth of the fetus; high blood pressure, a condition called **preeclampsia** in the mother; and early rupture of the birth membranes.

Description

If a newborn infant is to breathe properly, the small air sacs (alveoli) at the ends of the breathing tubes must remain open so that oxygen in the air can get into the tiny blood vessels that surround the

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alveoli. Normally, in the last months of **pregnancy**, cells in the alveoli produce a substance called **surfactant**, which keep surface tension inside the alveoli low so that the sacs can expand at the moment of birth, and the infant can breathe normally. Surfactant is produced starting at about 34 weeks of pregnancy and, by the time the fetal lungs mature at 37 weeks, a normal amount is present.

If an infant is born prematurely, enough surfactant might not have formed in the alveoli, causing the lungs to collapse and making it very difficult for the baby to get enough air (and the oxygen it contains). Sometimes a layer of fibrous tissue called a hyaline membrane forms in the air sacs, making it even harder for oxygen to get through to the blood vessels. RDS in newborn infants used to be called hyaline membrane disease.

Causes and symptoms

Labored breathing (the "respiratory distress" of RDS) may begin as soon as the infant is born, or within a few hours. Breathing becomes very rapid, the nostrils flare, and the infant grunts with each breath. The ribs, which are very flexible in young infants, move inwards each time a breath is taken. Before long the muscles that move the ribs and diaphragm, so that air is drawn into the lungs, become fatigued. When the oxygen level in the blood drops severely the infant's skin turns bluish in color. Tiny, very premature infants may not even have signs of trouble breathing. Their lungs may be so stiff that they cannot even start breathing when born.

There are two major complications of RDS. One is called **pneumothorax**, which means "air in the chest." When the infant itself or a breathing machine applies pressure on the lungs in an attempt to expand them, a lung may rupture, causing air to leak into the chest cavity. This air causes the lung to collapse further, making breathing even harder and interfering with blood flow in the lung arteries. The blood pressure can drop suddenly, cutting the blood supply to the brain. The other complication is called intraventricular hemorrhage, bleeding into the cavities (ventricles) of the brain, which may be fatal.

Diagnosis

When a premature infant has obvious trouble breathing at birth or within a few hours of birth, RDS is an obvious possibility. If premature birth is expected, or there is some condition that calls for delivery as soon as possible, the amount of surfactant in the amniotic fluid will indicate how well the lungs have matured. If little surfactant is found in an amniotic fluid sample taken by placing a needle in the uterus (**amniocentesis**), there is a definite risk of RDS. Often this test is done at regular intervals so that the infant can be delivered as soon as the lungs are mature. If the membranes have ruptured, surfactant can easily be measured in a sample of vaginal fluid.

The other major diagnostic test is a **chest x ray**. Collapsed lung tissue has a typical appearance, and the more lung tissue is collapsed, the more severe the RDS. An x ray also can demonstrate pneumothorax (air or gas in the area around the lung), if this complication has occurred. The level of oxygen in the blood can be measured by taking a blood sample from an artery, or, more easily, using a device called an oximeter, which is clipped to an earlobe. Pneumothorax may have occurred if the infant suddenly becomes worse while on ventilation; x rays can help make the diagnosis.

Treatment

If only a mild degree of RDS is present at birth, placing the infant in an oxygen hood may be the only treatment required. It is important to guard against too much oxygen, as this may damage the retina and cause loss of vision. Using an oximeter to keep track of the blood oxygen level, repeated artery punctures or heel sticks can be avoided. In more severe cases a drug very like natural surfactant (Exosurf Neonatal or Survanta), can be dripped into the lungs through a fine tube (endotracheal tube) placed in the infant's windpipe (trachea). Typically the infant will be able to breathe more easily within a few days at the most, and complications such as lung rupture are less likely to occur. The drug is continued until the infant starts producing its own surfactant. There is a risk of bleeding into the lungs from surfactant treatment; about 10% of the smallest infants are affected.

Infants with severe RDS may require treatment with a ventilator, a machine that takes over the work of the lungs and delivers air under pressure. In tiny infants who do not breathe when born, ventilation through a tracheal tube is an emergency procedure. Assisted ventilation must be closely supervised, as too much pressure can cause further lung damage. A gentler way of assisting breathing, continuous positive airway pressure (CPAP), delivers an oxygen mixture through nasal prongs or a tube placed through the nose rather than an endotracheal tube. CPAP may be tried before resorting to a ventilator, or after an infant placed on a ventilator begins to improve. Drugs that stimulate breathing may speed the recovery process.

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KEY TERMS

Alveoli—The small air sacs located at the ends of the breathing tubes of the lung, where oxygen normally passes from inhaled air to blood vessels.

Amniotic fluid—The fluid bathing the fetus, which may be sampled using a needle to determine whether the fetus is making enough surfactant.

Endotracheal tube—A metal or plastic tube inserted in the windpipe which may be attached to a ventilator. It also may be used to deliver medications such as surfactant.

Hyaline membranes—A fibrous layer that settles in the alveoli in RDS and prevents oxygen from escaping from inhaled air to the bloodstream.

Pneumothorax—Air in the chest, often a result of the lung' rupturing when oxygen is delivered under too high a pressure.

Preeclampsia—A disease of pregnancy in which the mother's blood pressure is elevated; associated with both maternal and fetal complications, and sometimes with fetal death.

Steroid—A natural body substance that often is given to women before delivering a very premature infant to stimulate the fetal lungs to produce surfactant, hopefully preventing RDS (or making it less severe).

Surfactant—A material normally produced in the fetal lungs in the last months of pregnancy, which helps the air sacs to open up at the time of birth so that the newborn infant can breathe freely.

Ventilator—A machine that can breathe for an infant having RDS until its lungs are producing enough surfactant and are able to function normally.

Pneumothorax is an emergency that must be treated right away. Air may be removed from the chest using a needle and syringe. A tube then is inserted into the lung cavity, and suction applied.

Prognosis

If an infant born with RDS is not promptly treated, lack of an adequate oxygen supply will damage the body's organs and eventually cause them to stop functioning altogether. **Death** is the result. The central nervous system (the brain and spinal cord) in particular is very dependent on a steady oxygen supply and is one of the first organ systems to feel the effects of RDS. On the other hand, if the infant's breathing is supported until the lungs mature and make their own surfactant, complete recovery within three to five days is the rule.

If an air leak causes pneumothorax, immediate removal of air from the chest will allow the lungs to re-expand. Bleeding into the brain is a very serious condition that worsens the outlook for an infant with RDS.

Prevention

The best way of preventing RDS is to delay delivery until the fetal lungs have matured and are producing enough surfactant—generally at about 37 weeks of pregnancy. If delivery cannot be delayed, the mother may be given a steroid hormone, similar to a natural substance produced in the body, which crosses the barrier of the placenta and helps the fetal lungs to produce surfactant. The steroid should be given at least 24 hours before the expected time of delivery. If the infant does develop RDS, the risk of bleeding into the brain will be much less if the mother has been given a dose of steroid.

If a very premature infant is born without symptoms of RDS, it may be wise to deliver surfactant to its lungs. This may prevent RDS, or make it less severe if it does develop. An alternative is to wait until the first symptoms of RDS appear and then immediately give surfactant. Pneumothorax may be prevented by frequently checking the blood oxygen content, and limiting oxygen treatment under pressure to the minimum needed.

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American Lung Association, 1301 Pennsylvania Ave. NW, Washington, DC, 20004, (202) 785-3355 , (202) 452-1805, http://www.lungusa.org.

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National Heart Lung and Blood Institute (NHLBI), P.O. Box 30105, Bethesda, MD, 20824–0105, (301) 592-8573. TTY: (240) 629–3255, http://www.nhlbi.nih.gov.

National Institutes of Health (NIH), 9000 Rockville Pike, Bethesda, MD, 20892, (301) 496-4000, http://www.nih.gov/index.html.

National Library of Medicine (NLM), 8600 Rockville Pike, Bethesda, MD, 20894, http://www.nlm.nih.gov.

National Organization for Rare Diseases (NORD), P.O. Box 8923, Fairfield, CT, 06812, (213) 745-6518, http://www. rarediseases.org.

Respiratory Distress Syndrome Foundation (RDSF), P.O. Box 723, Montgomeryville, PA, 18936, http://membrane.com/philanet/rds/index.html.

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Respiratory failure

Definition

Respiratory failure is nearly any condition that affects breathing function or the lungs themselves and can result in failure of the lungs to function properly. The main tasks of the lungs and chest are to get oxygen from the air that is inhaled into the bloodstream, and, at the same to time, to eliminate carbon dioxide ($C0_2$) from the blood through air that is breathed out. In respiratory failure, the level of oxygen in the blood becomes dangerously low, and/or the level of $C0_2$ becomes dangerously high. There are two ways in which this can happen. Either the process by which oxygen and $C0_2$ are exchanged between the blood and the air spaces of the lungs (a process called "gas exchange") breaks down, or the movement of air in and out of the lungs (ventilation) does not take place properly.

Description

Respiratory failure often is divided into two main types. One of them, called hypoxemic respiratory failure, occurs when something interferes with normal gas exchange. Too little oxygen gets into the blood (hypoxemia), and all organs and tissues in the body suffer as a result. One common type of hypoxemic failure, occurring in both adults and prematurely born infants, is **respiratory distress syndrome**, a condition in which fluid or tissue changes prevent oxygen from passing out of the air sacs of the lungs into the circulating blood. Hypoxemia also may result from spending time at high altitudes (where there is less oxygen in the air); various forms of lung disease that separate oxygen from blood in the lungs; severe anemia ("low blood"); and blood vessel disorders that shunt blood away from the lungs, thus precluding the lungs from picking up oxygen.

The other main type of respiratory failure is ventilatory failure, occurring when, for any reason, breathing is not strong enough to rid the body of $C0_2$. Then CO_2 builds up in the blood (hypercapnia). Ventilatory failure can result when the respiratory center in the brainstem fails to drive breathing; when muscle disease keeps the chest wall from expanding when breathing in; or when a patient has chronic obstructive lung disease that makes it very difficult to exhale air with its $C0_2$. Many of the specific diseases and conditions that cause respiratory failure cause both too little oxygen in the blood (hypoxemia) and abnormal ventilation.

Causes and symptoms

Several different abnormalities of breathing function can cause respiratory failure. The major categories, with specific examples of each, are:

- Obstruction of the airways. Examples are chronic bronchitis with heavy secretions; emphysema; cystic fibrosis; asthma (a condition in which it is very hard to get air in and out through narrowed breathing tubes).
- Weak breathing. This can be caused by drugs or alcohol, which depress the respiratory center; extreme obesity; or sleep apnea, where patients stop breathing for long periods while sleeping.
- Muscle weakness. This can be caused by a muscle disease called myasthenia; muscular dystrophy; polio; a stroke that paralyzes the respiratory muscles; injury of the spinal cord; or Lou Gehrig's disease.
- Lung diseases, including severe pneumonia. Pulmonary edema, or fluid in the lungs, can be the source of respiratory failure. Also, it can often be a result of heart disease; respiratory distress syndrome; pulmonary fibrosis and other scarring diseases of the lung; radiation exposure; burn injury when smoke is inhaled; and widespread lung cancer.
- An abnormal chest wall (a condition that can be caused by scoliosis or severe injury of the chest wall).

A majority of patients with respiratory failure are short of breath. Both low oxygen and high carbon dioxide can impair mental functions. Patients may

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become confused and disoriented and find it impossible to carry out their normal activities or do their work. Marked $C0_2$ excess can cause headaches and, in time, a semi-conscious state, or even **coma**. Low blood oxygen causes the skin to take on a bluish tinge. It also can cause an abnormal heart rhythm (arrhythmia). **Physical examination** may show a patient who is breathing rapidly, is restless, and has a rapid pulse. Lung disease may cause abnormal sounds heard when listening to the chest with a stethoscope: **wheezing** in **asthma**, "crackles" in obstructive lung disease. A patient with ventilatory failure is prone to gasp for breath, and may use the neck muscles to help expand the chest.

Diagnosis

The symptoms and signs of respiratory failure are not specific. Rather, they depend on what is causing the failure and on the patient's condition before it developed. Good general health and some degree of "reserve" lung function will help see a patient through an episode of respiratory failure. The key diagnostic determination is to measure the amount of oxygen, carbon dioxide, and acid in the blood at regular intervals. A sudden low oxygen level in the lung tissue may cause the arteries of the lungs to narrow. This, in turn, causes the resistance in these vessels to increase, which can be measured using a special catheter. A high blood level of $C0_2$ may cause increased pressure in the fluid surrounding the brain and spinal cord; this, too, can be measured.

Treatment

Nearly all patients are given oxygen as the first treatment. Then the underlying cause of respiratory failure must be treated. For example, **antibiotics** are used to fight a lung infection, or, for an asthmatic patient, a drug to open up the airways is commonly prescribed.

A patient whose breathing remains very poor will require a ventilator to aid breathing. A plastic tube is placed through the nose or mouth into the windpipe and is attached to a machine that forces air into the lungs. This can be a lifesaving treatment and should be continued until the patient's own lungs can take over the work of breathing. It is very important to use no more pressure than is necessary to provide sufficient oxygen; otherwise ventilation may cause further lung damage. Drugs are given to keep the patient calm, and the amount of fluid in the body is carefully adjusted so that the heart and lungs can function as normally as possible. **Steroids**, which combat inflammation, may sometimes be helpful but they can cause complications, including weakening the breathing muscles.

The respiratory therapist has a number of methods available to help patients overcome respiratory failure. They include:

- Suctioning the lungs through a small plastic tube passed through the nose, in order to remove secretions from the airways that the patient cannot cough up.
- Postural drainage, in which the patient is propped up at an angle or tilted to help secretions drain out of the lungs. The therapist may clap the patient on the chest or back to loosen the secretions, or a vibrator may be used for the same purpose.
- Breathing exercises often are prescribed after the patient recovers. They make the patient feel better and help to strengthen the muscles that aid breathing. One useful method is for the patient to suck on a tube attached to a clear plastic hosing containing a ball so as to keep the ball lifted. Regular deep breathing exercises are simpler and often just as helpful. Another technique is to have the patient breathe out against pursed lips to increase pressure in the airways and keep them from collapsing.

Prognosis

The outlook for patients with respiratory failure depends chiefly on its cause. If the underlying

KEY TERMS

Chronic obstructive lung disease—A common form of lung disease in which breathing, and therefore gas exchange, is labored and increasingly difficult.

Gas exchange—The process by which oxygen is extracted from inhaled air into the bloodstream, and, at the same time, carbon dioxide is eliminated from the blood and exhaled.

Hypoxemia—An abnormally low amount of oxygen in the blood, the major consequence of respiratory failure, when the lungs no longer are able to perform their chief function of gas exchange.

Pulmonary fibrosis—An end result of many forms of lung disease (especially chronic inflammatory conditions). Normal lung tissue is converted to scarred, "fibrotic" tissue that cannot carry out gas exchange.

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disease can be effectively treated, with the patient's breathing supported in the meantime, the outlook is usually good.

Care is needed not to expose the patient to polluting substances in the atmosphere while recovering from respiratory failure; this could tip the balance against recovery. When respiratory failure develops slowly, pressure may build up in the lung's blood vessels, a condition called **pulmonary hypertension**. This condition may damage the vessels, worsen hypoxemia, and cause the heart to fail. If it is not possible to provide enough oxygen to the body, complications involving either the brain or the heart may prove fatal.

If the kidneys fail or the diseased lungs become infected, the prognosis is worse. In some cases, the primary disease causing the lungs to fail is irreversible. The patient, family, and physician together then must decide whether to prolong life by ventilator support. Occasionally, **lung transplantation** is a possibility, but it is a highly complex procedure and is not widely available

Prevention

Because respiratory failure is not a disease itself, but the end result of many lung disorders, the best prevention is to treat any lung disease promptly and effectively. It is also important to make sure that any patient who has had lung disease is promptly treated for any respiratory infection (even of the upper respiratory tract). Patients with lung problems should also avoid exposure to pollutants, as much as is possible. Once respiratory failure is present, it is best for a patient to receive treatment in an intensive care unit, where specialized personnel and all the needed equipment are available. Close supervision of treatment, especially mechanical ventilation, will help minimize complications that would compound the problem.

ORGANIZATIONS

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

National Respiratory Distress Syndrome Foundation, P.O. Box 723, Montgomeryville, PA, 18936, (215) 822-3585, http://membrane.com/philanet/rds/.

David A. Cramer, MD

Respiratory syncytial virus infection

Definition

Respiratory syncytial virus (RSV) is a virus that can cause severe lower respiratory infections in children under the age of two, and milder upper respiratory infections in older children and adults. RSV infection is also called **bronchiolitis**, because it is marked in young children by inflammation of the bronchioles. Bronchioles are the narrow airways that lead from the bronchi to the tiny air sacs (alveoli) in the lungs. The result is **wheezing**, difficulty breathing, and sometimes fatal **respiratory failure**.

Demographics

In the United States, RSV infections generally occur during the fall, winter, and early spring. Almost all children will be infected with RSV by their second birthday. RSV causes respiratory illness in infants and young children, and is the most important cause of bronchiolitis; it is responsible for about 120,000 hospitalizations of children every year. Currently, there is no effective vaccine against RSV; however, palivizumab, a medication that contains virus-fighting antibodies to RSV, can help prevent severe RSV disease, such as **pneumonia** or bronchiolitis in high-risk infants or young children. Certain people are more likely to have problems with RSV: Babies younger than 6 months, especially preemies; people with immune system problems, people with heart or lung problems, and adults older than 65.

Description

RSV infection is caused by a group of viruses found worldwide. There are two different subtypes of the virus with numerous different strains. Taken together, these viruses account for a significant number of deaths in infants.

RSV infection is primarily a disease of winter or early spring, with waves of illness sweeping through a community. The rate of RSV infection is estimated to be 11.4 cases in every 100 children during their first year of life. In the United States, RSV infection occurs most frequently in infants between the ages of two months and six months.

RSV infection shows distinctly different symptoms, depending on the age of the infected person. In children under two, the virus causes a serious lower respiratory infection in the lungs. In older children and healthy adults, it causes a mild upper respiratory infection often mistaken for the **common cold**.

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KEY TERMS

Alveoli—Small air sacs or cavities in the lung that give the tissue a honeycomb appearance and expand its surface area for the exchange of oxygen and carbon dioxide.

Antibody—A protein produced by specialized white blood cells in response to the presence of a foreign protein such as a virus. Antibodies help the body fight infection.

Reye's syndrome—A rare disorder in children that follows a viral infection and is associated with a reaction to aspirin. Its symptoms include vomiting, damaged liver function, and swelling of the brain.

Although anyone can get this disease, infants suffer the most serious symptoms and complications. Breast feeding seems to provide partial protection from the virus. Conditions in infants that increase their risk of infection include:

- premature birth
- lower socio-economic environment
- congenital heart disease
- chronic lung diseases, such as cystic fibrosis
- immune system deficiencies, including HIV infection
- immunosuppressive therapy given to organ transplant patients

Many older children and adults get RSV infection, but the symptoms are so similar to the common cold that the true cause is undiagnosed. People of any age with weakened immune systems, either from such diseases as **AIDS** or leukemia, or as the result of **chemotherapy** or corticosteroid medications, are more at risk for serious RSV infections. So are people with chronic lung disease.

Causes and symptoms

Respiratory syncytial virus is spread through close contact with an infected person. It has been shown that if a person with RSV infection sneezes, the virus can be carried to others within a radius of 6 f (1.8 m). This group of viruses is hardy. They can live on the hands for up to half an hour and on toys or other inanimate objects for several hours.

Scientists have yet to understand why RSV viruses attack the lower respiratory system in infants and the upper respiratory system in adults. In infants, RSV begins with such cold symptoms as a low **fever**, runny nose, and **sore throat**. Soon, other symptoms appear that suggest an infection which involves the lower airways. Some of these symptoms resemble those of **asthma**. RSV infection is suggested by:

- wheezing and high-pitched, whistling breathing
- rapid breathing (more than 40 breaths per minute)
- shortness of breath
- labored breathing out (exhalations)
- bluish tinge to the skin (cyanosis)
- croupy, seal-like, barking cough
- high fever

Breathing problems occur in RSV infections because the bronchioles swell, making it difficult for air to get in and out of the lungs. If the child is having trouble breathing, immediate medical care is needed. Breathing problems are most common in infants under one year of age; they can develop rapidly.

Diagnosis

Physical examination and imaging studies

RSV infection is usually diagnosed during a **physical examination** by the pediatrician or primary care doctor. The doctor listens with a stethoscope for wheezing and other abnormal lung sounds in the patient's chest. The doctor will also take into consideration whether there is a known outbreak of RSV infection in the area. Chest x rays give some indication of whether the lungs are hyperinflated from an effort to move air in and out. X rays may also show the presence of a secondary bacterial infection, such as pneumonia.

Laboratory tests

A blood test can also detect RSV infection. This test measures the level of antibodies the body has formed against the virus. The blood test is less reliable in infants than in older children because antibodies in the infant's blood may have come from the mother during **pregnancy**. If infants are hospitalized, other tests such as an arterial **blood gas analysis** are done to determine if the child is receiving enough oxygen.

Treatment

Home care

Home treatment for RSV infection is primarily supportive. It involves taking steps to ease the child's

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breathing. **Dehydration** can be a problem, so children should be encouraged to drink plenty of fluids. **Antibiotics** have no effect on viral illnesses. In time, the body will make antibodies to fight the infection and return itself to health.

Home care for keeping a child with RSV comfortable and breathing more easily includes:

- Use a cool mist room humidifier to ease congestion and sore throat.
- Raise the baby's head by putting books under the head end of the crib.
- Give acetaminophen (Tylenol, Pandol, Tempra) for fever. Aspirin should not be given to children because of its association with Reye's syndrome, a serious disease.
- For babies too young to blow their noses, suction away any mucus with an infant nasal aspirator.

Hospital treatment

In the United States, RSV infections are responsible for 90,000 hospitalizations and 4,500 deaths each year. Children who are hospitalized receive oxygen and humidity through a mist tent or vaporizer. They also are given intravenous fluids to prevent dehydration. Mechanical ventilation may be necessary. Blood gases are monitored to assure that the child is receiving enough oxygen.

Medications

Bronchiodilators, such as albuterol (Proventil, Ventilin), may be used to keep the airways open. Ribavirin (Virazole) is used for desperately ill children to stop the growth of the virus. Ribavirin is both expensive and has toxic side effects, so its use is restricted to the most severe cases.

Alternative treatment

Alternative medicine has little to say specifically about bronchiolitis, especially in very young children. Practitioners emphasize that people get viral illnesses because their immune systems are weak. Prevention focuses on strengthening the immune system by eating a healthy diet low in sugars and high in fresh fruits and vegetables, reducing **stress**, and getting regular, moderate **exercise**. Like traditional practitioners, alternative practitioners recommend **breastfeeding** infants so that the child may benefit from the positive state of health of the mother. Inhaling a steaming mixture of lemon oil, thyme oil, eucalyptus, and tea tree oil (**aromatherapy**) may make breathing easier.

Prognosis

RSV infection usually runs its course in seven to 14 days. The **cough** may linger weeks longer. There are no medications that can speed the body's production of antibodies against the virus. Opportunistic bacterial infections that take advantage of a weakened respiratory system may cause ear, sinus, and throat infections or pneumonia.

Hospitalization and **death** are much more likely to occur in children whose immune systems are weakened or who have underlying diseases of the lungs and heart. People do not gain permanent immunity to respiratory syncytial virus and can be infected many times. Children who suffer repeated infections seem to be more likely to develop asthma in later life.

Prevention

There are no vaccines against RSV. Respiratory syncytial virus infection is so common that prevention is impossible. However, steps can be taken to reduce a child's contact with the disease. People with RSV symptoms should stay at least six feet away from young children. Frequent handwashing, especially after contact with respiratory secretions, and the correct disposal of used tissues help keep the disease from spreading. Parents should try to keep their children under 18 month old away from crowded environments–for example, shopping malls during holiday seasons–where they are likely to come in contact with older people who have only mild symptoms of the disease. Child care centers should regularly disinfect surfaces that children touch.

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Restless legs syndrome

Definition

Restless legs syndrome (RLS) is a neurological disorder characterized by uncomfortable sensations in the legs and, less commonly, the arms. These sensations are exacerbated (heightened) when the person with RLS is at rest. The sensations are described as crawly, tingly, prickly and occasionally painful. They result in a nearly insuppressible urge to move around. Symptoms are often associated with sleep disturbances.

Demographics

As much as 10% of the population of the United States and Europe may suffer from some degree of restless legs syndrome. Fewer cases are indicated in India, Japan and Singapore, suggesting racial or ethnic factors play a role in the disorder. Although the demographics can vary greatly, the majority of people suffering from RLS are female. The age of onset also varies greatly, but the number of people suffering from RLS increases with age. However, many people with RLS report that they had symptoms of the disorder in their childhood. These symptoms were often disregarded as growing pains or hyperactivity.

Description

Restless legs syndrome is a sensory-motor disorder that causes uncomfortable feelings in the legs, especially during periods of inactivity. Some people also report sensations in the arms, but this occurs much more rarely. The sensations occur deep in the legs and are usually described with terms that imply movement such as prickly, creepy-crawly, boring, **itching**, achy, pulling, tugging and painful. The symptoms result in an irrepressible urge to move the leg and are relieved when the person suffering from RLS voluntarily moves. Symptoms tend to be worse in the evening or at night.

Restless legs syndrome is associated with another disorder called periodic limb movements in sleep (PLMS). It is estimated that four out of five patients with RLS also suffer from PLMS. PLMS is characterized by jerking leg movements while sleeping that may occur as frequently as every 20 seconds. These jerks disrupt sleep by causing continual arousals throughout the night.

People with both RLS and PLMS are prone to abnormal levels of exhaustion during the day because they are unable to sleep properly at night. They may have trouble concentrating at work, at school or during social activities. They may also have mood swings and difficulty with interpersonal relationships. Depression and **anxiety** may also result from the lack of sleep. RLS affects people who want to travel or attend events that require sitting for long periods of time.

Causes and symptoms

Restless legs syndrome is categorized in two ways. Primary RLS occurs in the absence of other medical symptoms, while secondary RLS is usually associated with some other medical disorder. Although the cause of primary RLS is currently unknown, a large amount of research into the cause of RLS is taking place. Researchers at Johns Hopkins University published a study in July 2003 suggesting that iron deficiencies may be related to the disorder. They dissected brains from cadavers of people who suffered from RLS and found that the cells in the midbrain were not receiving enough iron. Other researchers suggest that RLS may be related to a chemical imbalance of the neurotransmitter dopamine in the brain. There is also evidence that RLS has a genetic component. RLS occurs three to five times more frequently in an immediate family member of someone who has RLS than in the general population. A site on a chromosome that may contain a gene for RLS has been identified by molecular biologists.

In many people, other medical conditions play a role in RLS and the disorder is therefore termed secondary RLS. People with peripheral neuropathies (injury to nerves in the arms and legs) may experience RLS. Such neuropathies may result from diabetes or **alcoholism**. Other chronic diseases such as kidney disorders and **rheumatoid arthritis** may result in RLS. Iron deficiencies and blood **anemias** are often associated with RLS and symptoms of the disease usually decrease once blood iron levels have been corrected. Attention deficit/hyperactivity disorder has also been implicated in RLS. Pregnant women often suffer from RLS, especially in the third trimester. Some people find that high levels of **caffeine** intake may result in RLS.

The symptoms of RLS are all associated with unpleasant feelings in the limbs. The words used to describe these feelings are various, but include such adjectives as deep-seated crawling, jittery, **tingling**, burning, aching, pulling, painful, itchy or prickly. They are usually not described as a muscle cramp or **numbness**. Most often the sensations occur during

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KEY TERMS

Anemia—A condition that affects the size and number of red blood cells. It often results from lack of iron or certain B vitamins and may be treated with iron or vitamin supplements.

Insomnia—Trouble sleeping. People who suffer from RLS often lose sleep either because they spend time walking to relieve discomfort or because they have PLMS, which causes them to wake often during the night.

Periodic limb movements in sleep (PLMS)—Random movements of the arms or legs that occur at regular intervals of time during sleep.

periods of inactivity. They are characterized by an urge to get up and move. Such movements include stretching, walking, jogging or simply jiggling the legs. The feelings worsen in the evening.

A variety of symptoms are associated with RLS, but may not be characteristic of every case. Some people with RLS report involuntary arm and leg movements during the night. Others have difficulty falling asleep and are sleepy or fatigued during the day. Many people with RLS have leg discomfort that is not explained by routine medical exams.

Eighty-five percent of RLS patients either have difficulty falling asleep or wake several times during the night, and almost half experience daytime **fatigue** or sleepiness. It is common for the symptoms to be intermittent. They may disappear for several months and then return for no apparent reason. Two-thirds of patients report that their symptoms become worse with time. Some older patients claim to have had symptoms since they were in their early 20s, but were not diagnosed until their 50s. Suspected under-diagnosis of RLS may be attributed to the difficulty experienced by patients in describing their symptoms.

Diagnosis

A careful history enables the physician to distinguish RLS from similar types of disorders that cause night time discomfort in the limbs, such as **muscle cramps**, burning feet syndrome, and damage to nerves that detect sensations or cause movement (polyneuropathy).

The most important tool the doctor has in diagnosis is the history obtained from the patient. There are several common medical conditions that are known to either cause or to be closely associated with RLS. The doctor may link the patient's symptoms to one of these conditions, which include anemia, diabetes, disease of the spinal nerve roots (lumbosacral radiculopathy), Parkinson's disease, late-stage **pregnancy**, kidney failure (uremia), and complications of stomach surgery. In order to identify or eliminate such a primary cause, blood tests may be performed to determine the presence of serum iron, ferritin, folate, vitamin B_{12}, creatinine, and thyroid-stimulating hormones. The physician may also ask if symptoms are present in any close family members, since it is common for RLS to run in families and this type is sometimes more difficult to treat.

In some cases, sleep studies such as **polysomnography** are undertaken to identify the presence of PLMS that are reported to affect 70–80% of people who suffer from RLS. The patient is often unaware of these movements, since they may not cause him to wake. However, the presence of PLMS with RLS can leave the person more tired, because it interferes with deep sleep. A patient who also displays evidence of some neurologic disease may undergo **electromyography** (EMG). During EMG, a very small, thin needle is inserted into the muscle and electrical activity of the muscle is recorded. A doctor or technician usually performs this test at a hospital outpatient department.

Treatment

The first step in treatment is to treat existing conditions that are known to be associated with RLS and that will be identified by blood tests. If the patient is anemic, iron (iron sulfate) or vitamin supplements (folate or vitamin B_{12}) will be prescribed. If **kidney disease** is identified as a cause, treatment of the kidney problem will take priority.

After treating underlying disorders, treatment for restless legs syndrome is generally two-pronged, consisting of making lifestyle changes and using medications to relieve some of the symptoms. Lifestyle changes involve making changes to the diet, exercising and performing other self-directed activities, and practicing good sleep hygiene. Although the United States Food and Drug Administration has not yet approved any drugs for treating RLS, four classes of pharmaceuticals have been found effective for treating RLS: dopaminergic agents, **benzodiazepines**, opioids and anticonvulsants.

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Medications

Dopaminergic agents are the first type of drug prescribed in the treatment of RLS. Most commonly doctors prescribe dopamine-receptor agonists that are used to treat Parkinson's disease such as Mirapex (pramipexole), Permax (pergolide) and Requip (ropinirole). Sinemet (carbidopa/levodopa), which is a drug that adds dopamine to the nervous system, is also commonly prescribed. Sinemet has been used the more frequently than other drugs in treating RLS, but recently a problem known as augmentation has been associated with its use. When augmentation develops, symptoms of RLS will return earlier in the day and increasing the dose will not improve the symptoms.

Antiepileptic drugs are those used for people with seizures. These are also useful in the treatment of RLS, and include Neurontin (gabapentin), Carbatrol (carbamazepine), Keppra (levetiracetam), and Topamax (topiramate).

Benzodiazepines are drugs that sedate and are typically taken before bedtime so that a patient with RLS can sleep more soundly. The most commonly prescribed sedative in RLS is Klonopin (clonazepam).

Opioids are synthetic **narcotics** that relieve **pain** and cause drowsiness. They are usually taken in the evening. The most commonly used opioids prescribed for RLS include Darvon or Darvocet (propoxyphene), Dolophine (**methadone**), Percocet (oxycodone), Ultram (Tramadol) and Vicodin (hydrocodone). One danger associated with opioids is that they can be addicting.

A few drugs have been found to worsen symptoms of RLS and they should be avoided by patients exhibiting RLS symptoms. These include anti-nausea drugs such as Antivert, Atarax, Compazine and Phenergan. **Calcium channel blockers** that are often used to treat heart conditions should be avoided. In addition, most anti-depressants tend to exacerbate symptoms of RLS. Finally, **antihistamines** such as Benadryl have been found to aggravate RLS symptoms in some people.

Lifestyle changes

Simple changes to the diet have proven effective for some people suffering from RLS. Vitamin deficiencies are a common problem in RLA patients. In patients with RLS, most physicians will check the levels of blood serum ferritin, which can indicate low iron storage. If these levels are below 50 mcg/L, then supplemental iron should be added to the diet. Other physicians have found that supplements of vitamin E, **folic acid** and B **vitamins**, and magnesium provide relief to symptoms or RLS. Reducing or eliminating caffeine and alcohol consumption has been effective in other patients.

Alternative treatment

It is likely that the best alternative therapy will combine both conventional and alternative approaches. Levodopa may be combined with a therapy that relieves pain, relaxes muscles, or focuses in general on the nervous system and the brain. Any such combined therapy that allows a reduction in dosage of levodopa is advantageous, since this will reduce the likelihood of unacceptable levels of drug side effects. Of course, the physician who prescribes the medication should monitor any combined therapy. Alternative methods may include:

- Acupuncture. Patients who also suffer from rheumatoid arthritis may especially benefit from acupuncture to relieve RLS symptoms. Acupuncture is believed to be effective in arthritis treatment and may also stimulate those parts of the brain that are involved in RLS.
- Homeopathy. Homeopaths believe that disorders of the nervous system are especially important because the brain controls so many other bodily functions. The remedy is tailored to the individual patient and is based on individual symptoms as well as the general symptoms of RLS.
- Reflexology. Reflexologists claim that the brain, head, and spine all respond to indirect massage of specific parts of the feet.
- Nutritional supplements. Supplementation of the diet with vitamin E, calcium, magnesium, and folic acid may be helpful for people with RLS.

Some alternative methods may treat the associated condition that is suspected to cause restless legs. These include:

- Anemia or low ferritin levels. Chinese medicine will emphasize stimulation of the spleen as a means of improving blood circulation and vitamin absorption. Other treatments may include acupuncture and herbal therapies, such as ginseng (*Panax ginseng*) for anemia-related fatigue.
- Late-stage pregnancy. There are few conventional therapies available to pregnant women, since most of the drugs prescribed are not recommended for use during pregnancy. Pregnant women may benefit from alternative techniques that focus on body work, including yoga, reflexology, and acupuncture.

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Prognosis

RLS usually does not indicate the onset of other neurological disease. It may remain static, although two-thirds of patients get worse with time. The symptoms usually progress gradually. Treatment with Levodopa is effective in moderate to severe cases that may include significant PLMS. However, this drug produces significant side effects, and continued successful treatment may depend on carefully monitored use of combination drug therapy. The prognosis is usually best if RLS symptoms are recent and can be traced to another treatable condition that is associated with RLS. Some associated conditions are not treatable. In these cases, such as for rheumatoid arthritis, alternative therapies such as **acupuncture** may be helpful.

Prevention

Diet is key in preventing RLS. A preventive diet will include an adequate intake of iron and the B vitamins, especially B_{12} and folic acid. Strict vegetarians should take vitamin supplements to obtain sufficient vitamin B_{12}. Ferrous gluconate may be easier on the digestive system than ferrous sulfate, if iron supplements are prescribed. Some medications may cause symptoms of RLS. Patients should check with their doctor about these possible side effects, especially if symptoms first occur after starting a new medication. Caffeine, alcohol, and nicotine use should be minimized or eliminated. Even a hot bath before bed has been shown to prevent symptoms for some sufferers.

Resources

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ORGANIZATIONS

Restless Legs Syndrome Foundation, 1904 Banbury Road, Raleigh, NC, 27608-4428, (919) 781-4428, http://www.rls.org.

Ann M. Haren

Restrictive cardiomyopathy

Definition

Cardiomyopathy is an ongoing disease process that damages the muscle wall of the lower chambers of the heart. Restrictive cardiomyopathy is a form of cardiomyopathy in which the walls of the heart become rigid.

Description

Restrictive cardiomyopathy is the least common type of cardiomyopathy in the United States. The stiffened heart walls cannot stretch properly to allow enough blood to fill the ventricles between heartbeats. As the stiffening worsens, **heart failure** occurs. The blood backs up into the blood vessels, causing fluid buildup in tissues (congestion and **edema**).

Causes and symptoms

Restrictive cardiomyopathy can be caused by a number of diseases. Often, the cause is unknown. The rigidity of the heart walls may be caused by fibrosis, the replacement of muscle cells with tough, fibrous tissue. In some disorders, proteins and other substances are deposited in the heart wall. **Amyloidosis** is the accumulation of a protein material, called amyloid, in the tissue of the heart wall and other organs. In **hemochromatosis**, there is too much iron in the body and some of the excess iron can build up in the heart. **Sarcoidosis** causes the formation of many small lesions, called granulomas, in the heart wall and other tissues of the body. These granulomas contain inflammatory white blood cells and other cells that decrease the flexibility of the heart.

People with restrictive cardiomyopathy usually feel tired and weak, and have **shortness of breath**, especially during **exercise**. If blood is backing up in the circulation they may also experience edema (large amounts of fluid in tissues) of the legs and feet.

Diagnosis

The diagnosis is usually based on a **physical examination**, **echocardiography**, and other tests as needed. The physician listens to the heart with a stethoscope to detect abnormal heart rhythms and heart sounds.

Echocardiography uses sound waves to make images of the heart. These images provide information about the structures of the heart and its heart valves. Echocardiography can also be used to find out how much blood the heart is pumping. It determines the

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KEY TERMS

Amyloidosis—Build up of amyloid, a protein substance, in tissues of the body, including the heart.

Cardiac catheterization—A diagnostic test for evaluating heart disease; a catheter is inserted into an artery and passed into the heart.

Edema—Swelling caused by fluid buildup in tissues.

Fibrosis—Replacement of normal tissue with tough, fibrous tissue.

Hemochromatosis—A disease in which there is too much iron in the body; iron deposits can build up in the heart muscle and other tissues.

Sarcoidosis—A chronic disease causing the formation of many small lesions called granulomas in the heart wall and other tissues of the body.

amount of blood in the ventricle, called the ventricular volume, and the amount of blood the ventricle pumps each time it beats, called the ejection fraction. A healthy heart pumps at least one half the amount of blood in the left ventricle with each heartbeat.

Computed tomography scan (CT scan) and **magnetic resonance imaging** (MRI) are imaging tests that can also provide information about the structure of the heart. However, these tests are rarely needed for diagnosis.

Cardiac catheterization may be needed to confirm a diagnosis or cause. In cardiac catheterization, a small tube called a catheter is inserted into an artery and passed into the heart. It is used to measure pressure in the heart and the amount of blood pumped by the heart. A small tissue sample (biopsy) of the heart muscle can be removed through the catheter for microscopic examination. Fibrous tissue or deposits in the heart muscle can be identified in this biopsy.

Treatment

There is no effective treatment for restrictive cardiomyopathy. Treatment of a causative disease may reduce or stop the damage to the heart, but existing damage cannot be reversed. Medications may be used to lessen the workload on the heart and to control the heart rhythm. Drugs normally used to treat other types of cardiomyopathy and heart failure may cause problems for patients with restrictive cardiomyopathy. For example, medicines that reduce the heart's workload may lower blood pressure too much.

A heart transplant may be necessary for patients who develop severe heart failure.

Prognosis

The prognosis for patients with restrictive cardiomyopathy is poor. If the disease process causing the problem can be treated, the damage to the heart muscle may be stopped. Also, medicines may relieve symptoms. However, for most patients, restrictive cardiomyopathy eventually causes heart failure. A heart transplant may be necessary when heart failure becomes too severe to treat with medicines.

Prevention

Obtaining early treatment for diseases that might cause restrictive cardiomyopathy might prevent or slow the development of heart wall stiffness. Anyone experiencing symptoms of shortness of breath, tiredness, and weakness should see a physician.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, 240 629-3246, http://www.nhlbi.nih.gov.

Texas Heart Institute. Heart Information Service, MC 3-116, P.O. Box 20345, Houston, TX, 77225, 832 355-4011, (800) 292-2221, http://www.texasheart.org.

Toni Rizzo

Reticulocyte count

Definition

A reticulocyte count is a blood test performed to assess the body's production of immature red blood cells (reticulocytes). A reticulocyte count is usually performed when patients are evaluated for anemia and response to its treatment. It is sometimes called a retic count.

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Purpose

Diagnosis

A reticulocyte count provides information about the rate at which the bone marrow is producing red cells. A normal count means that the production is adequate; a decreased count means it is not. This information helps determine whether a lack of red cells in an anemic person is caused by a bone marrow problem, by excessive bleeding, or by red cell destruction.

Monitoring

The test is also used to monitor the response of bone marrow response to treatment for anemia. The reticulocyte count rises within days if the treatment is successful. It is also used following bone marrow transplant to evaluate the new marrow's cell production.

Description

Reticulocytes were first described as transitional forms of red blood cells by Wilhelm H. Erb in 1865. A red cell begins in the bone marrow as a large bluish cell filled with ribonucleic acid (RNA). As the cell matures, it shrinks. Its color gradually changes from blue to pink as its load of oxygen-carrying protein (hemoglobin) increases and the RNA decreases. The center of the cell (nucleus) becomes clumped. It is expelled three days before the cell leaves the bone marrow. The cell is now a reticulocyte. On its fourth and final day of maturation, the reticulocyte enters the bloodstream. One day later, it is a mature red blood cell.

The first step in a retic count is drawing the patient's blood sample. About 17 oz (5 mL) of blood is withdrawn from a vein into a vacuum tube. The procedure, which is called a venipuncture, takes about five minutes.

After the sample is collected, the blood is mixed with a dye (methylene blue) in a test tube. The RNA remaining in the reticulocytes picks up a deep blue stain. Drops of the mixture are smeared on slides and examined under a microscope. Reticulocytes appear as cells containing dark blue granules or a blue network. The laboratory technologist counts 1,000 red cells, keeping track of the number of reticulocytes. The number of reticulocytes is reported as a percentage of the total red cells. When the red cell count is low, the percentage of reticulocytes is inaccurately high, suggesting that more reticulocytes are present than there are in reality. The percentage is mathematically corrected for greater accuracy. This figure is called the corrected reticulocyte count or reticulocyte index.

KEY TERMS

Anemia—A condition marked by a decrease in the number or size of red blood cells

Methylene blue—A dye that is used to stain the blood cells for the reticulocyte count.

Reticulocyte—An immature red blood cell.

Reticulocyte counts can also be done on automated instruments, such as flow cytometers, using fluorescent stains. These instruments are able to detect small changes in the reticulocyte count because they count a larger number of cells (10,000–50,000).

Preparation

The doctor should make a note of any prescription medications that the patient is taking. Some drugs lower the red blood cell count.

Aftercare

Aftercare consists of routine care of the area around the puncture mark. Pressure is applied for a few seconds and the wound is covered with a bandage.

Risks

The primary risk is mild **dizziness** and the possibility of a bruise or swelling in the area where the blood was drawn. The patient can apply moist warm compresses.

Normal results

Adults have reticulocyte counts of 0.5–2.5%. Women and children usually have higher reticulocyte counts than men.

Abnormal results

A low reticulocyte count indicates that the bone marrow is not producing a normal number of red blood cells. Low production may be caused by a lack of vitamin B_{12}, **folic acid**, or iron in the diet; or by an illness affecting the bone marrow (for example, **cancer**). Further tests are needed to diagnose the specific cause.

The reticulocyte count rises when the bone marrow makes more red cells in response to blood loss or treatment of anemia.

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PERIODICALS

Rowan, R. M., et al. "The Reticulocyte Count: Progress Towards the Resurrection of a Useful Clinical Test." *Clinical and Laboratory Haematology* 18, no. 1 (1996): 3-8.

Nancy J. Nordenson

Retinal artery occlusion

Definition

Retinal artery occlusion refers to the closure of the central retinal artery and usually results in complete loss of vision in one eye. Occlusion of its branches causes loss of vision in only a portion of the field of vision.

Description

Retinal artery occlusion (RAO) occurs when the central retinal artery, the main source of blood supply to the retina, or one of its branches becomes blocked.

Causes and symptoms

The main causes of RAO are the following:

- embolism (the sudden obstruction of a blood vessel by a blood clot)
- atherosclerotic disease that results in the progressive narrowing of the arteries over time
- endarteritis (the chronic inflammation of the inner layer of arteries)
- angiospasm (a spasmodic contraction of a blood vessel with increase in blood pressure)

The most common symptom of RAO is an acute, painless loss of vision in one eye. The degree of loss depends on the location of the occlusion. If the occlusion occurs in the central artery of the retina, damage usually results in complete loss of vision in the affected eye. If occlusion occurs in a branch artery, vision loss will be partial and may even go unnoticed if only a section of the peripheral vision is affected.

People affected by RAO typically have high blood pressure, heart disease, or diabetes as an underlying condition. Other conditions that may increase the risk of RAO include high cholesterol and glaucoma. Incidence is slightly more common in men and in people age 60 or older.

Diagnosis

RAO is diagnosed by examination of the retina with an ophtalmoscope.

Treatment

Central retinal artery occlusion (CRAO) is an emergency. If treatment begins within an hour, the patient has the highest possibility of regaining vision in the affected eye, although complete restoration is unlikely.

A common treatment is inhalation of carbon dioxide so as to dilate the retinal vessels and move the occlusion from the central retinal artery to a branch artery. This movement reduces the area of the retina affected and may restore a certain amount of vision. Eyeball massage may also be performed, also in an effort to remove the occlusion. The physician may also consider puncturing the eyeball.

Drug therapy includes the use of carbonic anhydrase inhibitors to reduce the internal eye pressure and enhance movement of the occlusion. Both of the treatments would be used within the first 24 hours of noticeable vision loss.

Alternative treatment

Hyperbaric **oxygen therapy** may be beneficial if started within 90 minutes of the onset of symptoms. Some studies indicate a 40% improvement of visual acuity using this method.

Prognosis

The prognosis for central retinal visual acuity is poor with only about one-third of patients recovering useful vision. The longest delay in getting treatment that has been associated with significant visual recovery was approximately 72 hours.

Branch retinal artery occlusions (BRAO) have a recovery rate of 80% where vision is restored to 20/40 or better.

Prevention

Individuals affected by underlying conditions such as high blood pressure, heart disease, diabetes, glaucoma, and elevated cholesterol should treat their conditions appropriately to minimize the possibility of a retinal artery occlusion.

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KEY TERMS

Angiospasm—Spasmodic contraction of a blood vessel with increase in blood pressure.

Arterioles—Small blood vessels that carry arterial (oxygenated) blood.

Atherosclerotic disease—The progressive narrowing and hardening of the arteries over time.

Central retinal artery—A branch of the ophthalmic artery that supplies blood to the retina and branches to form the arterioles of the retina.

Embolism—The sudden obstruction of a blood vessel by a blood clot.

Endarteritis—Chronic inflammation of the inner layer of arteries.

Hyperbaric oxygenation—Administration of oxygen in a compression chamber at an ambient pressure greater than 1 atmosphere, in order to increase the amount of oxygen in organs and tissues.

Occlusion—Momentary complete closure of some area or channel of the body.

Ophthalmic artery—The artery supplying the eye and adjacent structures with blood.

Ophthalmoscope—An instrument used for viewing the inside of the eye that consists of a concave mirror with a hole in the middle through which the physician examines the eye, and a light source that is reflected into the eye by the mirror.

Retina—Light sensitive layer of the eye, that consists of four major layers: the outer neural layer, containing nerve cells and blood vessels, the photoreceptor layer, a single layer that contains the light sensing rods and cones, the pigmented retinal epithelium (PRE) and the choroid, consisting of connective tissue and capillaries.

ORGANIZATIONS

American Academy of Ophthalmology (AAO), P. O. Box 7424, San Francisco, CA, 94120-7424, (415) 561-8500, 415 561-8500, http://www.aao.org.

American Diabetes Association, 1701 North Beauregard Street, Alexandria, VA, 22311, (800) 342-2383, Ask ADA@diabetes.org, http://www.diabetes.org/.

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review. personal.info@heart.org.

Gary Gilles

Retinal detachment

Definition

Retinal detachment is movement of the transparent sensory part of the retina away from the outer pigmented layer of the retina. In other words, the moving away of the retina from the outer wall of the eyeball.

Description

There are three layers of the eyeball. The outer, tough, white sclera. Lining the sclera is the choroid, a thin membrane that supplies nutrients to part of the retina. The innermost layer is the retina.

The retina is the light-sensitive membrane that receives images and transmits them to the brain. It is made up of several layers. One layer contains the photoreceptors. The photoreceptors, the rods and cones, send the visual message to the brain. Between the photoreceptor layer (also called the sensory layer) and the choroid is the pigmented epithelium.

The vitreous is a clear gel-like substance that fills up most of the inner space of the eyeball. It lies behind the lens and is in contact with the retina.

A retinal detachment occurs between the two outermost layers of the retina—the photoreceptor layer and the outermost pigmented epithelium. Because the choroid supplies the photoreceptors with nutrients, a detachment can basically starve the photoreceptors. If a detachment is not repaired within 24-72 hours, permanent damage may occur.

Causes and symptoms

Several conditions may cause retinal detachment:

- Scarring or shrinkage of the vitreous can pull the retina inward.
- Small tears in the retina allow liquid to seep behind the retina and push it forward.
- Injury to the eye can simply knock the retina loose.

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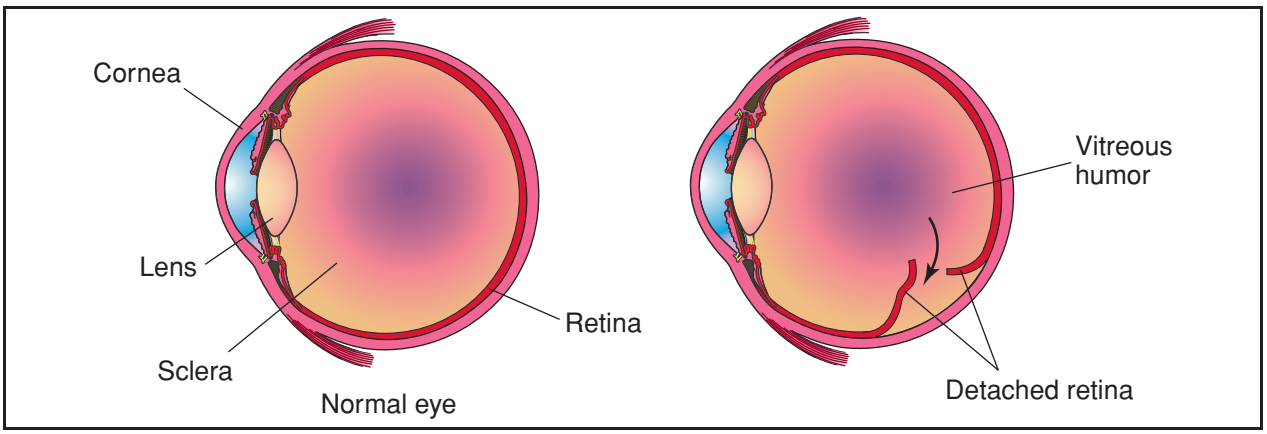

Retinal detachment refers to the movement of the retina away from the inner wall of the eyeball, resulting in a sudden defect in vision. Persons suffering from diabetes have a high incidence of developing retinal disease. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

- Bleeding behind the retina, most often due to diabetic retinopathy or injury, can push it forward.
- Retinal detachment may be spontaneous. This occurs more often in the elderly or in very nearsighted (myopic) eyes.
- Cataract surgery causes retinal detachment 2% of the time.
- Tumors can cause the retina to detach.

Retinal detachment will cause a sudden defect in vision. It may look as if a curtain or shadow has just descended before the eye. If most of the retina is detached, there may be only a small hole of vision remaining. If just a part of the retina is involved, there will be a blind spot that may not even be noticed. It is often associated with *floaters*–little dark spots that float across the eye and can be mistaken for flies in the room. There may also be *flashes* of light. Anyone experiencing a sudden onset of flashes and/or floaters should contact their eye doctor immediately, as this may signal a detachment.

Diagnosis

If the eye is clear–that is, if there is no clouding of the liquids inside the eye–the detachment can be seen by looking into the eye with a hand-held instrument called an ophthalmoscope. To evaluate the blood vessels in the retina, a fluorescent dye (fluorescein) may be injected into a vein and photographed with ultraviolet light as it passes through the retina. Further studies may include computed tomography scan (CT scan), **magnetic resonance imaging** (MRI), or ultrasound study. Other lenses may be used to examine the back of the eyes. One example is binocular indirect ophthalmoscopy. The doctor dilates the patient's eyes with eyedrops and then examines the back of the eyes with a handheld lens.

Treatment

Reattaching the retina to the inner surface of the eye requires making a scar that will hold it in place and then bringing the retina close to the scarred area. The scar can be made from the outside, through the sclera, using either a laser or a freezing cold probe (cryopexy). Bringing the retina close to the scar can be done in two ways. A tiny belt tightened around the eyeball will bring the sclera in until it reaches the retina. This procedure is called scleral buckling and may be done under **general anesthesia**. Using this procedure permits the repair of retinal detachments without entering the eyeball. Sometimes, the eye must be entered to pump in air or gas, forcing the retina outward against the sclera and its scar. This is called pneumatic retinopexy and can generally be done under **local anesthesia**.

If all else fails, and especially if there is disease in the vitreous, the vitreous may have to be removed in a procedure called **vitrectomy**. This can be done through tiny holes in the eye, through which equally tiny instruments are placed to suck out the vitreous and replace it with saline, a salt solution. The procedure must maintain pressure inside the eye so that the eye does not collapse.

Prognosis

Retinal reattachment has an 80-90% success rate.

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KEY TERMS

Cauterize—To damage with heat or cold so that tissues shrink. It is an effective way to stop bleeding.

Diabetic retinopathy—Disease that damages the blood vessels in the back of the eye caused by diabetes.

Saline—A salt solution equivalent to that in the body–0.9% salt in water.

Prevention

In diseases such as diabetes, with a high incidence of retinal disease, routine eye examinations can detect early changes. Early treatment can prevent both progressing to detachment and blindness from other events like hemorrhage. The most common problem is weakness of blood vessels that causes them to break down and bleed. When enough vessels have been damaged, new vessels grow to replace them. These new vessels may grow into the vitreous, producing blind spots and scarring. The scarring can in turn pull the retina loose. Other diseases can cause the tiny holes and tears in the retina through which fluid can leak. Preventive treatment uses a laser to cauterize the blood vessels, so that they do not bleed and the holes, so they do not leak.

Good control of diabetes can help prevent diabetic eye disease. Blood pressure control can prevent **hypertension** from damaging the retinal blood vessels. Eye protection can prevent direct injury to the eyes. Regular eye exams can also detect changes that the patient may not be aware of. This is important for patients with high **myopia** who may be more prone to detachment.

ORGANIZATIONS

American Academy of Ophthalmology (AAO), P. O. Box 7424, San Francisco, CA, 94120-7424, (415) 561-8500, 415 561-8500, http://www.aao.org.

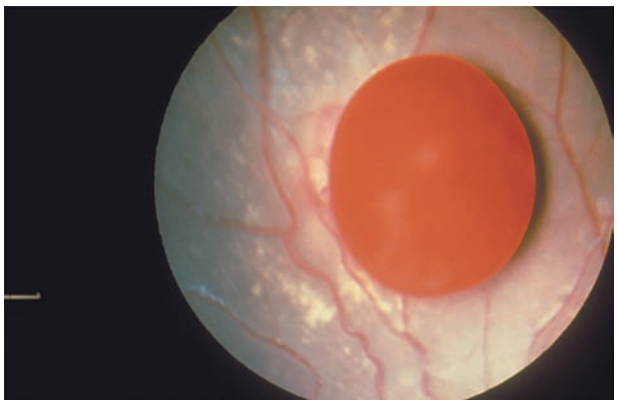
American Optometric Association, 243 North Lindbergh Blvd., St. Louis, MO, 63141, 314 991-4100, (314) 991-4101, 800 365-2219, http://www.aoa.org/.

J. Ricker Polsdorfer, MD

Retinal hemorrhage

Definition

Retinal hemorrhage is the abnormal bleeding of the blood vessels in the retina, the membrane in the back of the eye.



A close-up view of a human eye following retinal hemorrhage. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Description

The retina is the part of the eye that converts light into nerve signals that are processed by the brain into visual images. The retina is the inside surface of the back of the eye, consisting of millions of densely arranged, light-sensitive cells called rods and cones. Blood flow to the retina is maintained by the retinal vein and artery, and a dense network of small blood vessels (capillaries) supplies the area with circulation. These blood vessels can become damaged by injury and disease and may bleed (hemorrhage) and cause temporary or permanent loss of visual accuracy. Because the cells of the retina are so dense and sensitive, even small injuries to the blood vessels can translate into vision problems. Diseases that affect the health of the circulatory system, such as diabetes and high blood pressure, also affect the blood vessels of the eye. Damage to the blood vessels in the retina, including hemorrhage, is termed retinopathy.

Causes and symptoms

Retinal hemorrhages can be caused by injuries, usually forceful blows to the head during accidents and falls, as well as by adverse health conditions. In infants, retinal hemorrhage is frequently associated with **child abuse** and has been termed **shaken baby syndrome**. A condition called retinopathy of **prematurity** occurs in prematurely born infants or infants with low birth weights. When children are born prematurely, the blood vessels in the eye may not have had time to fully develop and may become damaged easily, leaking or hemorrhaging. The condition must be determined by an opthalmologist, as the symptoms are not readily observable.

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Diabetic retinopathy is a common eye problem associated with diabetes. Diabetes, by stressing the circulatory system, can cause damage, including hemorrhaging, to the small blood vessels of the retina. Non-proliferative retinopathy occurs when the damaged or leaking blood vessels do not spread. Symptoms of this disorder include vision spots, floaters (floating areas of blurred vision), decreased or loss of vision, or loss of fine vision for detailed activities such as reading. Proliferative retinopathy occurs when new blood vessels begin to form in damaged areas of the retina, and may lead to spots, floaters, decreased vision, or sudden loss of vision. Sudden vision loss may occur if one of the newly formed blood vessels ruptures. Due to increased pressure in the area, the retina may detach from the back of the eye, a serious condition and a cause of blindness.

People with high blood pressure (**hypertension**) may develop hypertensive retinopathy, in which blood vessels in the retina become damaged from increased blood pressure. Symptoms are typically not pronounced, but blurred or decreased vision may be caused by the disorder.

Central serous retinopathy is a condition in which the vessels behind the retina leak and cause fluid to collect in small blisters behind the retina. Symptoms include sudden blurry areas in the vision, blind spots, distorted vision areas, and loss of vision. This condition is most common in males between 20 and 50 years of age.

Diagnosis

Diagnosis of retinopathy is performed by an opthalmologist, particularly one who specializes in disorders of the retina (retinal specialist). The opthalmologist may perform an opthalmoscopy, using an instrument called an opthalmoscope to examine the inside of the eye. For a detailed view of the blood vessels of the retina, a fluorescein **angiography** test might be performed, in which a florescent dye is injected into the patient's bloodstream and photographs record the status of the blood vessels in the retina. Vision tests, patient history, and blood tests might also be ordered by the diagnosing physician.

Treatment

Laser surgery by an opthalmologist is a common treatment for retinal hemorrhages, in which a laser beam is used to remove or seal off damaged or bleeding blood vessels in the retina. Some vision loss occurs with this technique. For retinal hemorrhages associated with diabetes and high blood pressure, treating the overall condition is required.

KEY TERMS

Diabetes—Disease in which the body does not properly produce or use insulin, resulting in fluctuating blood sugar levels.

Hypertension—Condition caused by high blood pressure.

Opthalmologist—Physician specializing in the diagnosis and treatment of disorders of the eye.

Alternative treatment

Alternative treatment of retinal hemorrhages focuses on providing nutrients to strengthen and heal the injured blood vessels. **Nutritional supplements** include antioxidant **vitamins** A, C, and E; vitamin B-complex including B_6 and B_{12}; the mineral zinc; and essential fatty acids including omega-3 from fish oil and flaxseed oil. Herbal supplements include bilberry, grape seed extract, pine bark extract (pycnogenol), and lutein.

Prognosis

For retinal hemorrhages associated with retinopathy of prematurity, nearly 85 percent of cases heal without treatment. Diabetic retinopathy is the leading cause of blindness for those between 20 and 65 years old in the U.S. Diabetic retinopathy typically takes years to develop in people with diabetes, but occurs in nearly 80 percent of those with diabetes for over 20 years and who are treated with insulin. Regular monitoring and treatments can slow the degeneration of the eye, while advanced cases of the disorder lead to blindness. **Retinopathies** requiring laser treatment have a partial loss of vision due to the surgery. For hypertensive retinopathy, most vision problems go away when high blood pressure is treated and lowered. The majority of cases of central sirous retinopathy disappear after three to four months, and full vision generally returns within six months, although recurrence of the disorder is common.

Prevention

The first step in sound prevention is for people with vision problems, including visual spots, flashes or floaters in the vision, and loss or distortion of visual accuracy, to see an opthalmologist as soon as possible. To prevent complications of retinal hemorrhages in infants, the prevention includes regular prenatal care and monitoring of infants with high risks of the

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disorder (born prematurely or with weight less than four pounds and six ounces). For diabetic retinopathy, control of blood sugar and blood pressure fluctuations is necessary, as well as frequently scheduled eye exams by an opthalmologist. For retinal hemorrhages associated with hypertension, controlling high blood pressure through diet, **exercise**, and **stress reduction** is recommended. Central sirous retinopathy has been associated with high **stress** levels, so preventative care for this disorder includes stress management practices.

Resources

BOOKS

Dick, Andrew D., John V. Forrester, and Annabelle Ayame Okada. *Practical Manual of Intraocular Inflammation*. New York: Informa Healthcare, 2008.

ORGANIZATIONS

American Academy of Ophthalmology (AAO), P. O. Box 7424, San Francisco, CA, 94120-7424, (415) 561-8500, 415 561-8500, http://www.aao.org.

National Eye Institute, 2020 Vision Place, Bethesda, MD, (301) 496-5248, http://www.nei.nih.gov.

Douglas Dupler

Retinal vein occlusion

Definition

Retinal vein occlusion refers to the closure of the central retinal vein that drains the retina or to that of one of its branches.

Description

Retinal vein occlusion (RVO) occurs when the central retinal vein, the blood vessel that drains the retina, or one of its branches becomes blocked. RVO may be categorized by the anatomy of the occluded vein and the degree of **ischemia** produced. The two major RVO types are central retinal vein occlusion (CRVO) and branch retinal vein occlusion (BRVO). CRVO has been diagnosed in patients as young as nine months to patients of 90 years. The age of affected individuals is usually low to mid 60s. Approximately 90% of patients are over 50 at the time of diagnosis, with 57% of them being male and 43% being female. BRVO accounts for some 30% of all vein occlusions.

Causes and symptoms

CRVO is a painless loss of vision that can be caused by a swollen optic disk, the small area in the retina where the optic nerve enters the eye, by dilated retinal veins, and by retinal hemorrhages. CRVO is also called venous stasis retinopathy, or hemorrhagic retinopathy.

In BRVO, the superotemporal branch vein is the most often affected vessel. Retinal hemorrhages follows, often occurring at the crossing of two vessels near the optic disk. Initially the hemorrhage may be extensive and underlie the fovea.

The exact cause of RVO is not yet identified, but the following mechanisms been proposed:

- external compression between the central connective strand and the cribriform plate
- venous disease
- blood clot formation

Conditions associated with RVO risk include:

- hypertension
- hyperlipidemia
- diabetes mellitus
- hyperviscosity
- hypercoagulability
- glaucoma
- trauma

Diagnosis

A complete physical evaluation is recommended for CRVO and BRVO, including complete blood tests, and glucose tolerance test (for non-diabetics). In the case of a **head injury** when bleeding around the optic nerve is a possibility, an MRI may be performed.

Treatment

Following a patient with RVO is vital. Patients should be seen at least monthly for the first three months to monitor for signs of other complications, such as the abnormal formation of blood vessels (neovascularization) in the iris of the eye or glaucoma.

The treatment for retinal vein occlusion varies for each case and should be given based on the doctor's best recommendation. Although treatments for occlusion itself are limited, surgical treatment of the occlusion provides an option.

Treatments may include anticoagulants with heparin, bishydroxycoumarin, and streptokinase. When the blood is highly viscous, dilution of the blood may be useful. Ideally, an alternate pathway is needed to allow venous drainage. Recent reports published in 1999 suggest that use of a laser to create a retinal choroidal hole may be useful to treat CRVO. Laser therapy depends

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KEY TERMS

Anticoagulants—Drugs that act by lowering the capacity of the blood to coagulate, thus facilitating removal of blood clots.

Central retinal vein—Central blood vessel and its branches that drains the retina.

Cribriform plate—The horizontal bone plate perforated with several holes for the passage of olfactory nerve filaments from the nasal cavity.

Fovea—A small area of the retina responsible for acute vision.

Glaucoma—A group of eye diseases characterized by an increase in eyeball pressure.

Hyperlipidemia—A general term for elevated concentrations of any or all of the lipids in the plasma.

Iris—The contractile diaphragm located in the fluid in front of the lens of the eye and is perforated by the eye pupil.

Ischemia—A state of low oxygen in a tissue usually due to organ dysfunction.

Neovascularization—Abnormal or excessive formation of blood vessels as in some retinal disorders.

Occlusion—Momentary complete closure of some area or channel of the body.

Optic disk—The small area in the retina where the optic nerve enters the eye that is not sensitive to light. Also called the blind spot.

Retina—Light sensitive layer of the eye, that consists of four major layers: the outer neural layer, containing nerve cells and blood vessels, the photoreceptor layer, a single layer that contains the light sensing rods and cones, the pigmented retinal epithelium (PRE) and the choroid, consisting of connective tissue and capillaries.

on the type of occlusion. The management of laser therapy should be controlled by an ophthalmologist.

Alternative treatment

There are no documented alternative treatment methods.

Prognosis

The outlook for people with RVO is fairly good whether it is treated early or not. With no treatment at all, approximately 60% of all patients recover 20/40 vision or better within a year.

Prevention

Retinal vein occlusion is difficult to prevent because the exact cause is still uncertain. Ethnic factors may play a role since in the UK the disease is rare in Asians and West Indians.

Resources

BOOKS

Yanoff, Myron, et al, eds. *Ophthalmology*. 3rd ed. Edinburgh: Mosby International, 2009.

Michael Sherwin Walston
Ronald Watson, PhD

Retinitis pigmentosa

Definition

Retinitis pigmentosa (RP) refers to a group of inherited disorders that slowly lead to blindness due to abnormalities of the photoreceptors (primarily the rods) in the retina.

Description

The retina lines the interior surface of the back of the eye. The retina is made up of several layers. One layer contains two types of photoreceptor cells referred to as the rods and cones. The cones are responsible for sharp, central vision and color vision and are primarily located in a small area of the retina called the fovea. The area surrounding the fovea contains the rods, which are necessary for peripheral vision and night vision (scotopic vision). The number of rods increases in the periphery. The rod and cone photoreceptors convert light into electrical impulses and send the message to the brain via the optic nerve. Another layer of the retina is called the retinal pigmented epithelium (RPE).

In RP, the photoreceptors (primarily the rods) begin to deteriorate and lose their ability to function. Because the rods are primarily affected, it becomes harder to see in dim light, thus causing a loss of night

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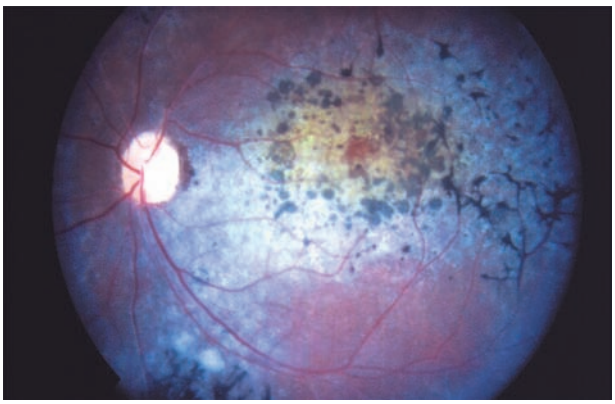

A fundus camera image showing the degeneration of the retina due to retinitis pigmentosa. The pattern of dark spots across the retina corresponds to the extent of loss of vision. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

vision. As the condition worsens, peripheral vision disappears, which results in tunnel vision. The ability to see color is eventually lost. In the late stages of the disease, there is only a small area of central vision remaining. Ultimately, this too is lost.

There are many forms of retinitis pigmentosa. Sometimes the disorder is classified by the age of onset or the inheritance pattern. RP can also accompany other conditions. This entry discusses "non-syndromic" RP, the type that is not associated with other organ or tissue dysfunction.

Approximately 100,000 Americans have RP. It is estimated to affect about one in every 4,000 Americans and Europeans. For other parts of the world, there are no published data. Nor is there any known ethnic difference in the occurrence of RP.

Causes and symptoms

Retinitis pigmentosa is an inherited disease that has many different modes of inheritance. It is known to be caused by more than 100 different genetic mutations. RP, with any inheritance pattern, may be either familial (multiple family members affected) or isolated (only one affected person). In the non-sex-linked, or autosomal, form, it can either be a dominant or recessive trait. In the sex-linked form, called x-linked recessive, it is a recessive trait. This x-linked form is more severe than the autosomal forms. Two rare forms of RP are the digenic and mitochondrial forms.

Isolated RP cases represent 10-40% of all cases. Some of these cases may be the result of new gene mutations (changes in the genes). Other isolated cases are those in which the person has a relative with a mutation in the gene, but the relative is not affected by the condition.

Autosomal dominant RP (AdRP) occurs in about 15–25% of affected individuals. At least 12 different genes have been identified as causing AdRP. People with AdRP will usually have an affected parent. The risk for affected siblings or children is 50%.

Autosomal recessive RP (ArRP) occurs in about 5–20% of affected individuals. More than 16 genes have been identified that cause this type of RP. In ArRP, each parent of the affected person is a carrier of an abnormal gene that causes RP. Neither of these carrier parents is affected. There is a two-thirds chance that an unaffected sibling is a carrier of RP. All of the children of an affected person would be a carrier of the ArRP gene.

Five to 15% of individuals with RP have x-linked recessive RP (XLRP). Six different genes have been identified as the cause of this type of RP. Usually in this type of inheritance, males are affected carriers, while females are unaffected carriers or have a milder form of the disease. The mother may be a carrier of the mutation on the X-chromosome. It is also possible that a new mutation can occur for the first time in an affected person. For families with one affected male, there is a mathematical formula called the Baysean analysis that can be applied to the family history. It takes into account the number of unaffected males to determine whether a female is likely to be a carrier or not. If a mother is a carrier, her children have a 50% chance of inheriting the RP gene. For affected males, all of their daughters will be carriers but none of their sons will be affected.

The digenic form of RP occurs when the affected person has inherited one copy of an altered ROM1 gene from one parent and one copy of an altered peripherin/RDS gene from the other parent. The parents are asymptomatic. Mitochondrial inheritance occurs when the gene mutation is in a mitochondrial gene. People with this type of RP have progressive **hearing loss** and mild myopathy. Both of these types of RP are very rare.

The first symptoms, a loss of night vision followed by a loss of peripheral vision, usually begin in early adolescence or young adulthood. Occasionally, the loss of the ability to see color occurs before the loss of peripheral vision. Another possible symptom is seeing twinkling lights or small flashes of lights.

Diagnosis

When a person complains of a loss of night vision, a doctor will examine the interior of the eye with an

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KEY TERMS

Ophthalmoscope—An instrument, with special lighting, designed to view structures in the back of the eye.

ophthalmoscope to determine if there are changes in the retina. For people with advanced RP, the condition is characterized by the presence of clumps of black pigment in the inner retina (intraretinal). However, the appearance of the retina is not enough for an RP diagnosis since there are other disorders that may give the retina a similar appearance. There are also other reasons someone may have night blindness. Consequently, certain electrodiagnostic tests must be performed. An electroretinogram (ERG) determines the functional status of the photoreceptors by exposing the retina to light. The ERG uses a contact lens in the eye, and the output is measured on a special instrument called an oscilloscope. The functional assessments of visual fields, visual acuity, or color vision may also be performed.

The diagnosis of RP can be established when the following criteria are met:

- rod dysfunction measured by dark adaptation test or ERG,
- progressive loss in photoreceptor function,
- loss of peripheral (side) vision,
- both eyes affected (bilaterality).

Molecular **genetic testing** is available on a research basis. Prenatal diagnosis for this condition has not yet been achieved.

Treatment

There are no medications or surgery to treat RP. However, researchers continue to seek possible treatments. In 2004, scientists injected stem cells to the back of mouse eyes and stopped retinal degeneration. Scientists are also exploring the possibility of retinal transplantation. Some doctors believe **vitamins** A and E will slightly slow the progression of the disease in some people. However, large doses of certain vitamins may be toxic and affected individuals should speak to their doctors before taking supplements.

If a person with RP must be exposed to bright sunlight, some doctors recommend wearing dark sunglasses to reduce the effect on the retina. Affected people should talk to their eye doctors about the correct lenses to wear outdoors.

Because there is no cure for RP, the affected person should be monitored for visual function and counseled about low-vision aids (for example, field-expansion devices). **Genetic counseling** is also appropriate. A three-generation family history with attention to other relatives with possible RP can help to clarify the inheritance pattern. For some people however, the inheritance pattern cannot be discerned.

Prognosis

There is no known cure for RP, which will eventually lead to blindness. The more severe forms will lead to blindness sooner than milder forms.

Resources

PERIODICALS

"Grant Boosts RP Research Into Transplantation." *Ophthalmology TImes* August 1, 2004: 6.

"Stem Cells Delivered Into Back of Eye Hold Promise for People With Retinitis Pigmentosa, Other Retinal Degenerations; Potential Treatment for Untreatable Blindness Shows Promise in Mice." *Ascribe Health News Service* September 15, 2004.

OTHER

Genetic Alliance. http://www.geneticalliance.org.

National Federation of the Blind. http://www.nfb.org.

"OMIM—Online Mendelian Inheritance in Man." National Center for Biotechnology Information. http://www.ncbi.nlm.nih.gov/Omim/searchomim.html.

Retinitis Pigmentosa International. http://www.rpinternational.org.

ORGANIZATIONS

American Academy of Ophthalmology (AAO), P. O. Box 7424, San Francisco, CA, 94120-7424, (415) 561-8500, 415 561-8500, http://www.aao.org.

American Association of the Deaf-Blind (AADB), 8630 Fenton Street, Suite 121, Silver Spring, MD, 20910-3803, (301) 495-4403, 301 495-4404, aadb-info@aadb.org, http://www.aadb.org.

American Optometric Association, 243 North Lindbergh Blvd., St. Louis, MO, 63141, (314) 991-4100, 314 991-4101, 800 365-2219, http://www.aoa.org/.

Foundation Fighting Blindness, 7168 Columbia Gateway Drive, Suite 100, Columbia, MD, 21046, (800) 683-5555, info@FightBlindness.org, http://www.blindness.org.

Prevent Blindness America, 211 West Wacker Drive, Suite 1700, Chicago, IL, 60606, 636 947-7486, (800) 331-2020, http://www.nationalshare.org, http://www.preventblindness.org.

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Retinoblastoma

Definition

Retinoblastoma is a malignant tumor of the retina that occurs predominantly in young children.

Description

The eye has three layers, the sclera, the choroid, and the retina. The sclera is the outer protective white coating of the eye. The choroid is the middle layer and contains blood vessels that nourish the eye. The front portion of the choroid is colored and is called the iris. The opening in the iris is called the pupil. The pupil is responsible for allowing light into the eye and usually appears black. When the pupil is exposed to bright light it contracts (closes), and when it is exposed to low light conditions it dilates (opens) so that the appropriate amount of light enters the eye. Light that enters through the pupil hits the lens of the eye. The lens then focuses the light onto the retina, the innermost of the three layers. The job of the retina is to transform the light into information that can be transmitted to the optic nerve, which will transmit this information to the brain. It is through this process that people are able to see the world around them.

Occasionally a tumor, called a retinoblastoma, will develop in the retina of the eye. Usually this tumor forms in young children but it can occasionally occur in adults. Most people with retinoblastoma develop only one tumor (unifocal) in only one eye (unilateral). Some, however, develop multiple tumors (multifocal) in one or both eyes. When retinoblastoma occurs independently in both eyes, it is then called bilateral retinoblastoma.

Occasionally, children with retinoblastoma develop trilateral retinoblastoma. Trilateral retinoblastoma results from the development of an independent **brain tumor** that often forms in a part of the brain called the pineal gland. In order for retinoblastoma to be classified as trilateral retinoblastoma, the tumor must have developed independently and not as the result of the spread of the retinal **cancer**. The prognosis for trilateral retinoblastoma is quite poor.

The retinal tumor which characterizes retinoblastoma is malignant, meaning that it can metastasize (spread) to other parts of the eye and eventually other parts of the body. In most cases, however, retinoblastoma is diagnosed before it spreads past the eye to other parts of the body (intraocular) and the prognosis is quite good. The prognosis is poorer if the cancer has spread beyond the eye (extraocular).

Retinoblastoma can be inherited or can arise spontaneously. Approximately 40% of people with retinoblastoma have an inherited form of the condition and approximately 60% have a sporadic (not inherited) form. Individuals with multiple independent tumors, bilateral retinoblastoma, or trilateral retinoblastoma are more likely to be affected with the inherited form of retinoblastoma.

Approximately 1 in 15,000 to 1 in 30,000 infants in Western countries are born with retinoblastoma, making it the most common childhood **eye cancer**. It is, however, a relatively rare childhood cancer and accounts for approximately 3% of childhood cancers. The American Academy of Ophthalmology estimates that 300-350 cases of retinoblastoma occur in the United States each year.

Retinoblastoma is found mainly in children under the age of five but can occasionally be seen in older children and adults. Retinoblastoma is found in individuals of all ethnic backgrounds and is found equally frequently in males and females. The incidence of bilaterial retinoblastoma in the United States is thought to be slightly higher among black children than among either Caucasian or Asian American children.

This child's right eye is completely covered with a tumor associated with retinoblastoma. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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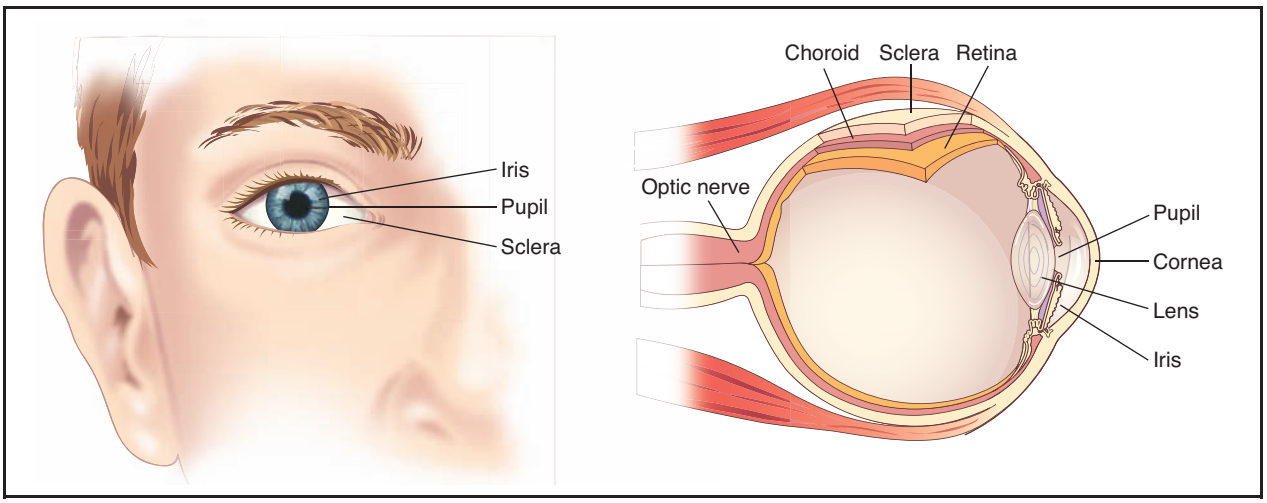

An illustration of both the inner and outer eye. The illustration on the left shows the outer view of the eye, and the illustration on the right shows the inner anatomy of the eye. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Causes and symptoms

Causes

Retinoblastoma is caused by changes in or absence of a gene called RB1. RB1 is located on the long arm of chromosome 13. Cells of the body, with the exception of the egg and sperm cells, contain 23 pairs of chromosomes. All of the cells of the body excluding the egg and the sperm cells are called the somatic cells. The somatic cells contain two of each chromosome 13 and therefore two copies of the RB1 gene. Each egg and sperm cell contains only one copy of chromosome and therefore only one copy of the RB1 gene.

RB1 produces a tumor suppressor protein that normally helps to regulate the cell cycle of cells such as those of the retina. A normal cell of the retina goes through a growth cycle during which it produces new cells. Genes such as tumor suppressor genes tightly regulate this growth cycle.

Cells that lose control of their cell cycle and replicate out of control are called cancer cells. These undergo many cell divisions, often at a quicker rate than normal cells, and do not have a limited lifespan. A group of adjacent cancer cells can form a mass called a tumor. Malignant (cancerous) tumors can spread to other parts of the body. A malignant tumor of the retina (retinoblastoma) can result when just one retinal cell loses control of it's cell cycle and replicates out of control.

Normally the tumor suppressor protein produced by RB1 prevents a retinal cell from becoming cancerous. Each RB1 gene produces tumor suppressor protein. Only one functioning RB1 gene in a retinal cell is necessary to prevent the cell from becoming cancerous. If both RB1 genes in a retinal cell become non-functional, then a retinal cell can become cancerous and retinoblastoma can result. An RB1 gene is non-functional when it is changed or missing (deleted) and no longer produces normal tumor suppressor protein.

Approximately 40% of people with retinoblastoma have inherited a non-functional or deleted RB1 gene from either their mother or father. Therefore, they have a changed/deleted RB1 gene in every somatic cell. A person with an inherited missing or non-functional RB1 gene will develop a retinal tumor if the remaining RB1 gene becomes changed or deleted in a retinal cell. The remaining RB1 gene can become non-functional when exposed to environmental triggers such as chemicals and radiation. In most cases, however, the triggers are unknown. Approximately 90% of people who inherit a changed or missing RB1 gene will develop retinoblastoma.

People with an inherited form of retinoblastoma are more likely to have a tumor in both eyes (bilateral) and are more likely to have more than one independent tumor (multifocal) in one or both eyes. The average age of onset for the inherited form of retinoblastoma is one year, which is earlier than the sporadic form of retinoblastoma. Although most people with the inherited form of retinoblastoma develop bilateral tumors, approximately 15% of people with a tumor in only one eye (unilateral) are affected with an inherited form of retinoblastoma.

A person with an inherited missing or non-functional RB1 gene has a 50% chance of passing on this abnormal gene to his or her offspring. The chance that their children will inherit the changed/

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deleted gene and actually develop retinoblastoma is approximately 45%.

Some people with retinoblastoma have inherited a non-functioning or missing RB1 gene from either their mother or father even though their parents have never developed retinoblastoma. It is possible that one parent has a changed or missing RB1 gene in every somatic cell but has not developed retinoblastoma because their remaining RB1 gene has remained functional. It is also possible that the parent had developed a retinal tumor that was destroyed by the body. In other cases, one parent has two normal RB1 genes in every somatic cell, but some of their egg or sperm cells contain a changed or missing RB1 gene. This is called gonadal mosaicism.

Retinoblastoma can also result when both RB1 genes become spontaneously changed or deleted in a retinal cell but the RB1 genes are normal in all the other cells of the body. Approximately 60% of people with retinoblastoma have this type of disease, called sporadic retinoblastoma. A person with sporadic retinoblastoma does not have a higher chance of having children with the disease. Their relatives do not have a higher risk of developing retinoblastoma themselves or having children who develop retinoblastoma. Sporadic retinoblastoma is usually unifocal and has an average age of onset of approximately two years.

Symptoms

The most common symptom of retinoblastoma is leukocoria. Leukocoria results when the pupil reflects a white color rather than the normal black or red color that is seen on a flash photograph. It is often most obvious in flash photographs; since the pupil is exposed to a lot of light and the duration of the exposure is so short, the pupil does not have time to constrict. Children with retinoblastoma can also have problems seeing and this can cause them to appear cross-eyed (**strabismus**). People with retinoblastoma may also experience red, painful, and irritated eyes, inflamed tissue around the eye, enlarged pupils, and possibly different-colored eyes.

Diagnosis

Children who have symptoms of retinoblastoma are usually first evaluated by their pediatrician. The pediatrician will often perform a red reflex test to diagnose or confirm leukocoria. Prior to this test the doctor inserts medicated eye drops into the child's eyes so that the pupils will remain dilated and not contract when exposed to bright light. The doctor then examines the eyes with an ophthalmoscope, which shines a bright light into the eyes and allows the doctor to check for leukocoria. Leukocoria can also be diagnosed by taking a flash Polaroid photograph of a patient who has been in a dark room for three to five minutes.

If the pediatrician suspects retinoblastoma on the basis of these evaluations, he or she will most likely refer the patient to an ophthalmologist (eye doctor) who has experience with retinoblastoma. The ophthalmologist will examine the eye using an indirect ophthalmoscope. The opthalmoscope shines a bright light into the eye, which helps the doctor to visualize the retina. This evaluation is usually done under general anesthetic, although some very young or older patients may not require it. Prior to the examination, medicated drops are put into the eyes to dilate the pupils, and anesthetic drops may also be used. A metal clip is used to keep the eyes open during the evaluation. During the examination, a cotton swab or a metal instrument with a flattened tip is used to press on the outer lens of the eye so that a better view of the front areas of the retina can be obtained. Sketches or photographs of the tumor as seen through the ophthalmoscope are taken during the procedure.

An ultrasound evaluation is used to confirm the presence of the tumor and to evaluate its size. Computed axial tomography (CT scan) is used to determine whether the tumor has spread outside of the eye and to the brain. Sometimes **magnetic resonance imaging** (MRI) is also used to look at the eyes, eye sockets, and the brain to see if the cancer has spread.

In most cases the cancer has not spread beyond the eye, and other evaluations are unnecessary. If the cancer appears to have spread beyond the eye, then other assessments such as a blood test, spinal tap (**lumbar puncture**), and/or **bone marrow biopsy** may be recommended. During a spinal tap, a needle is inserted between the vertebrae of the spinal column and a small sample of the fluid surrounding the spinal cord is obtained. In a bone marrow biopsy, a small amount of tissue (bone marrow) is taken from inside the hip or breast bone for examination.

Genetic testing

Establishing whether someone is affected with an inherited or non-inherited form of retinoblastoma can help to ascertain whether other family members such as siblings, cousins, and offspring are at increased risk for developing retinoblastoma. It can also sometimes help guide treatment choices, since patients with an inherited form of retinoblastoma may be at increased risk for developing recurrent tumors or other types of cancers, particularly when treated with radiation. It is helpful for the families of a child diagnosed with retinoblastoma to meet with a genetic specialist such as a genetic counselor and/or geneticist. These specialists

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can help to ascertain the chances that the retinoblastoma is inherited and facilitate **genetic testing** if desired.

If a patient with unilateral or bilateral retinoblastoma has a relative or relatives with retinoblastoma, it can be assumed that they have an inherited form of retinoblastoma. However, it cannot be assumed that a patient without a family history of the disease has a sporadic form.

Even when there is no family history, most cases of bilateral and trilateral retinoblastoma are inherited, as are most cases of unilateral, multifocal retinoblastoma. However, only 15% of unilateral, unifocal retinoblastoma cases are inherited.

The only way to establish whether someone has an inherited form of retinoblastoma is to see if the retinoblastoma gene is changed or deleted in the blood cells obtained from a blood sample. Approximately 5–8% of individuals with retinoblastoma possess a chromosomal abnormality involving the RB1 gene that can be detected by looking at their chromosomes under the microscope. The chromosomes can be seen by obtaining a blood sample. If this type of chromosomal abnormality is detected in a child, then analysis of the parents' chromosomes should be performed. If one of the parents possesses a chromosomal abnormality, then they are at higher risk for having other offspring with retinoblastoma. Chromosome testing would be recommended for the blood relatives of the parent with the abnormality.

Usually, however, a chromosomal abnormality is not detected in a child with retinoblastoma. In this case, specialized DNA tests that look for small RB1 gene changes need to be performed on the blood cells. DNA testing can be difficult, time consuming, and expensive, since there are many possible RB1 gene changes that can cause the gene to become nonfunctional.

If a sample of tumor is available, then it is recommended that DNA testing be performed on the tumor cells prior to DNA testing of the blood cells. This testing can usually identify the gene changes/deletions in the RB1 genes that caused the tumor to develop. In some cases, RB1 gene changes/deletions are not found in the tumor cells (approximately 20% of RB1 gene changes or deletions are not detectable). In these cases, DNA testing of the blood cells will not be able to ascertain whether someone is affected with an inherited or non-inherited form of retinoblastoma.

If the changes in both RB1 genes are detected in the tumor cell, then these same changes can be looked for in the blood cells. If an RB1 gene is deleted or changed in all of the blood cells tested, the patient can be assumed to have been born with a changed/deleted RB1 gene in all of their cells. This person has a 50% chance of passing the RB1 gene change/deletion on to his or her children. Most of the time, this change/deletion has been inherited from a parent. Occasionally the gene change/deletion occurred spontaneously in the original cell that was formed when the egg and sperm came together at conception (de novo).

If an RB1 gene change/deletion is found in all of the blood cells tested, both parents should undergo blood testing to check for the same RB1 gene change/deletion. If the RB1 gene change/deletion is identified in one of the parents, it can be assumed that the retinoblastoma was inherited and that siblings have a 50% chance of inheriting the altered gene. More distant blood relatives of the parent with the identified RB1 gene change/deletion may also be at risk for developing retinoblastoma. Siblings and other relatives could undergo DNA testing to see if they have inherited the RB1 gene change/deletion.

If the RB1 gene change/deletion is not identified in either parent, then the results can be more difficult to interpret. In this case, there is a 90–94% chance that the retinoblastoma was not inherited.

In some cases, a person with retinoblastoma will have an RB1 gene change/deletion detected in some of their blood cells and not others. It can be assumed that this person did not inherit the retinoblastoma from either parent. Siblings and other relatives would therefore not be at increased risk for developing retinoblastoma. Offspring would be at increased risk since some of the egg or sperm cells could have the changed/deleted RB1 gene. The risks to offspring would probably be less than 50%.

In families where there are multiple family members affected with retinoblastoma, blood samples from multiple family members are often analyzed and compared through DNA testing. Ninety-five percent of the time, this type of analysis is able to detect patterns in the DNA that are associated with a changed RB1 gene in that particular family. When a pattern is detected, at-risk relatives can be tested to establish whether they have inherited an RB1 gene change/deletion.

PRENATAL TESTING. If chromosome or DNA testing identifies an RB1 gene/deletion in someone's blood cells, then prenatal testing can be performed on this person's offspring. An **amniocentesis** or **chorionic villus sampling** can be used to obtain fetal cells which can be analyzed for the RB1 gene change/deletion or chromosomal abnormality.

Treatment

A number of different classification (staging) systems are used to establish the severity of retinoblastoma and aid in choosing an appropriate treatment plan. The most widely used staging system is the Reese-Ellsworth

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system. This system is used to classify intraocular tumors and predict which tumors are favorable enough that sight can be maintained. The Reese-Ellsworth classification system is divided into:

- Group I (very favorable for maintenance of sight): small solitary or multiple tumors, less than 6.4 mm in size (1 inch = 25.4 mm), located at or below the equator of the eye
- Group II (favorable for maintenance of sight): solitary or multiple tumors, 6.4–16 mm in size, located at or behind the equator of the eye
- Group III (possible for maintenance of sight): any tumor located in front of the equator of the eye, or a solitary tumor larger than 16 mm in size and located behind the equator of the eye
- Group IV (unfavorable for maintenance of sight): multiple tumors, some larger than 16 mm in size, or any tumor extending in front of the outer rim of the retina (ora serrata)
- Group V (very unfavorable for maintenance of sight): large tumors involving more than half of the retina, or vitreous seeding, in which small pieces of tumor are broken off and floating around the inside of the eye

When choosing a treatment plan, the first important criteria to ascertain is whether the cancer is localized within the eye (intralocular) or has spread to other parts of the body (extralocular). An intraocular retinoblastoma may only involve the retina or could involve other parts of the eye. An extraocular retinoblastoma could involve only the tissues around the eye or could result from the spread of cancer to the brain or other parts of the body.

It is also important to establish whether the cancer is unilateral (one eye) or bilateral (both eyes), multifocal or unifocal. In order for the tumors to be considered multifocal, they must have arisen independently and not as the result of the spread of cancer cells. It is also important to check for trilateral retinoblastoma.

Treatments

The treatment chosen depends on the size and number of tumors, whether the cancer is unilateral or bilateral, and whether the cancer has spread to other parts of the body. The goal of treatment is to cure the cancer and prevent as much loss of vision as possible. Since the late 1990s, doctors treating patients with retinoblastoma have tended to avoid enucleation and external beam **radiation therapy** whenever possible, in favor of **chemotherapy** to reduce the tumor in addition to focal therapies. Improved methods of chemoreduction have led to increasing success in saving patients' eyes, often with some visual function.

TREATMENT OF INTRAOCULAR TUMORS. Surgical removal of the affected eye (enucleation) is used when the tumor(s) are so large and extensive that preservation of sight is not possible. This surgery is performed under general anesthetic and usually takes less than an hour. Most children who have undergone this surgery can leave the hospital on the same day. A temporary ball is placed in the eye socket after the surgery. Approximately three weeks after the operation, a plastic artificial eye (prosthesis) that looks like the normal eye is inserted into the eye socket.

Radiation therapy is often used for treatment of large tumors when preservation of sight is possible. External beam radiation therapy involves focusing a beam of radiation on the eye. If the tumor has not spread extensively, the radiation beam can be focused on the cancerous retinal cells. If the cancer is extensive, radiation treatment of the entire eye may be necessary. External beam radiation is performed on an outpatient basis and usually occurs over a period of three to four weeks. Some children may need sedatives prior to the treatment. This type of therapy can result in a temporary loss of a patch of hair on the back of the head and a small area of "sun-burned" skin. Long-term side effects of radiation treatment can include **cataracts**, vision problems, bleeding from the retina, and decreased growth of the bones on the side of the head. People with an inherited form of retinoblastoma have an increased risk of developing other cancers as a result of this therapy. Some consideration should therefore be given to alternative treatment therapies for those with an inherited form of retinoblastoma.

Photocoagulation therapy is often used in conjunction with radiation therapy but may be used alone to treat small tumors that are located on the back of the eye. Photocoagulation involves using a laser to destroy the cancer cells. This type of treatment is done under local or **general anesthesia** and is usually not associated with post-procedural **pain**.

Thermotherapy is also often used in conjunction with radiation therapy or drug therapy (chemotherapy). Thermotherapy involves the use of heat to help shrink tumor cells. The heat is either used on the whole eye or localized to the tumor area. It is done under local or general anesthesia and is usually not painful.

Cryotherapy is a treatment often used in conjunction with radiation therapy but can also be used alone on small tumors located on the front part of the retina. Cryotherapy involves the use of intense cold to destroy cancer cells and can result in harmless, temporary swelling of the external eye and eyelids that can last for up to five days. Eye drops or ointment are sometimes provided to reduce the swelling.

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KEY TERMS

Amniocentesis—Prenatal testing performed at 16 to 20 weeks of pregnancy that involves inserting a needle through the abdomen of a pregnant mother and obtaining a small sample of fluid from the amniotic sack, which contains the fetus. Often is used to obtain a sample of the fetus' cells for biochemical or DNA testing.

Benign tumor—An abnormal proliferation of cells that does not spread to other parts of the body.

Bilateral—Affecting both eyes.

Brachytherapy—Cancer treatment that involves the application of radioactive material to the site of the tumor.

Cryotherapy—Cancer treatment in which the tumor is destroyed by exposure to intense cold.

Chromosome—A microscopic structure found within each cell of the body, made of a complex of proteins and DNA.

Chorionic villus sampling (CVS)—Prenatal testing performed at 10 to 12 weeks of pregnancy, which involves inserting a catheter through the vagina of a pregnant mother or inserting a needle through the abdomen of the mother and obtaining a sample of placenta. Often is used to obtain a sample of the fetus' cells for biochemical or DNA testing.

DNA (deoxyribonucleic acid)—The hereditary material that makes up genes; influences the development and functioning of the body.

DNA testing—Testing for a change or changes in a gene or genes.

Enucleation—Surgical removal of the eye.

Equator—Imaginary line encircling the eyeball and dividing the eye into a front and back half.

Extraocular retinoblastoma—Cancer that has spread from the eye to other parts of the body.

Gene—A building block of inheritance, made up of a compound called DNA (deoxyribonucleic acid) and containing the instructions for the production of a particular protein. Each gene is found in a specific location on a chromosome.

Brachytherapy involves the application of radioactive material to the outer surface of the eye at the base of the tumor. It is generally used for tumors of medium size. A patient undergoing this type of procedure is usually hospitalized for three to seven days. During that time, he or she undergoes one surgery to attach the radioactive material and one surgery to remove it. Eye drops are often administered for three to four weeks following the operation to prevent inflammation and infection. The long-term side effects of this treatment can include cataracts and damage to the retina, which can lead to impaired vision.

Intravenous treatment with one or more drugs (chemotherapy) is often used for treatment of both large and small tumors. Chemotherapy is sometimes used to shrink tumors prior to other treatments such as radiation therapy or brachytherapy. Occasionally, it is also used alone to treat very small tumors.

TREATMENT OF INTRAOCULAR AND UNILATERAL RETINOBLASTOMA. Often, by the time that unilateral retinoblastoma is diagnosed, the tumor is so large that useful vision cannot be preserved. In these cases removal of the eye (enucleation) is the treatment of choice. Other therapies are unnecessary if enucleation is used to treat intraocular unilateral retinoblastoma. If the tumor is small enough, other therapies such as external beam radiation therapy, photocoagulation, cryotherapy, thermotherapy, chemotherapy, and brachytherapy may be considered.

TREATMENT OF INTRAOCULAR AND BILATERAL RETINOBLASTOMA. If vision can be preserved in both eyes, radiation therapy of both eyes may be recommended. Smaller, more localized tumors can sometimes be treated by local therapies such as cryotherapy, photocoagulation therapy, thermotherapy or brachytherapy. Some centers may use chemotherapy in place of radiation therapy when the tumors are too large to be treated by local therapies or are found over the optic nerve of the eye. Many centers are moving away from radiation treatment and toward chemotherapy because it is less likely to induce future tumors. Enucleation is performed on the more severely affected eye if sight cannot be preserved in both.

EXTRAOCULAR RETINOBLASTOMA. There is no proven effective therapy for the treatment of extraocular retinoblastomas. Commonly, radiation treatment of the eyes and chemotherapy is provided.

Alternative treatment

There are no alternative or complementary therapies specific to the treatment of retinoblastoma. Since

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Intraocular retinoblastoma—Cancer that is limited to the eye and has not spread to other parts of the body.

Malignant tumor—An abnormal proliferation of cells that can spread to other sites.

Multifocal—More than one tumor present.

Ophthalmologist—Physician specializing in the diseases of the eye.

Optic nerve—The part of the eye which contains nerve fibers that transmit signals from the eye to the brain.

Oncologist—A physician specializing in the diagnosis and treatment of cancer.

Photocoagulation—Cancer treatment in which the tumor is destroyed by an intense beam of laser light.

Prenatal testing—Testing for a disease such as a genetic condition in an unborn baby.

Protein—A substance produced by a gene that is involved in creating the traits of the human body, such as hair and eye color, or is involved in controlling the basic functions of the human body, such as control of the cell cycle.

Retina—The light-sensitive layer of the eye that receives images and sends them to the brain.

Scotoma—An area of lost or depressed vision within the visual field surrounded by an area of normal vision. Survivors of retinoblastoma frequently develop scotomas.

Somatic cells—All the cells of the body with the exception of the egg and sperm cells.

Tumor—A growth of tissue resulting from the uncontrolled proliferation of cells.

Tumor-suppressor gene—Gene involved in controlling normal cell growth and preventing cancer.

Unifocal—Only one tumor present in one eye.

Unilateral—Affecting only one eye.

Vitreous—The transparent gel that fills the back part of the eye.

Vitreous seeding—When small pieces of tumor have broken off and are floating around the vitreous.

most people diagnosed with retinoblastoma are small children, most drug-based alternative therapies designed to treat general cancer would not be recommended. Many specialists would, however, **stress** the importance of establishing a well-balanced diet, including certain fruits, vegetables, and vitamin supplements, to ensure that the body is strengthened in its fight against cancer. Some advocate the use of visualization strategies, in which patients would visualize the immune cells of their body attacking and destroying the cancer cells.

Prognosis

Individuals with intraocular retinoblastoma who do not have trilateral retinoblastoma usually have a good survival rate with a 90% chance of disease-free survival for five years. Those with extraocular retinoblastoma have less than a 10% chance of disease-free survival for the same amount of time. Trilateral retinoblastoma generally has a very poor prognosis. Patients with trilateral retinoblastoma who receive treatment have an average survival rate of approximately eight months, while those who remain untreated have an average survival rate of approximately one month. Patients with trilateral retinoblastoma who are asymptomatic at the time of diagnosis may have a better prognosis then those who experience symptoms.

Patients with an inherited form of unilateral retinoblastoma have a 70% chance of developing retinoblastoma in the other eye. Retinoblastoma reoccurs in the other eye in approximately 5% of people with a non-inherited form of retinoblastoma, so it is advisable for even these patients to be closely monitored. People with an inherited form of retinoblastoma who have not undergone radiation treatment have approximately a 26% chance of developing cancer in another part of the body within 50 years of the initial diagnosis. Those with an inherited form who have undergone radiation treatment have a 58% chance of developing a secondary cancer by 50 years after the initial diagnosis. Most of the secondary cancers are skin cancers, bone tumors (osteosarcomas), and soft-tissue **sarcomas**. Soft-tissue sarcomas are malignant tumors of the muscle, nerves, joints, blood vessels, deep skin tissues, or fat. The prognosis for retinoblastoma patients who develop secondary cancers, however, is very poor.

Survivors of retinoblastoma are likely to have visual field defects after their cancer treatment is completed, most commonly scotomas, which are areas of lost or depressed vision within an area of normal vision. The size and type of these visual defects are determined by the size and type of the original tumor and the form of therapy used to treat it.

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Prevention

Although retinoblastoma cannot be prevented, appropriate screening and surveillance should be applied to all at-risk individuals to ensure that the tumor(s) are diagnosed at an early stage. The earlier the diagnosis, the more likely that an eye can be salvaged and vision maintained.

Screening of people diagnosed with retinoblastoma

Children who have been diagnosed with retinoblastoma should receive periodic dilated retinal examinations until the age of five. Young children will need to undergo these evaluations under anesthetic. After five years of age, periodic eye examinations are recommended. It may be advisable for patients with bilateral retinoblastoma or an inherited form of retinoblastoma to undergo periodic screening for the brain tumors found in trilateral retinoblastoma. There are no specific screening protocols designed to detect non-ocular tumors. All lumps and complaints of bone pain, however, should be thoroughly evaluated.

Screening of relatives

When a child is diagnosed with retinoblastoma, it is recommended that parents and siblings receive a dilated retinal examination by an ophthalmologist who is experienced in the diagnosis and treatment of the disease. It is also recommended that siblings continue to undergo periodic retinal examinations under anesthetic until they are three years of age. From three to seven years of age, periodic eye examinations are recommended. The retinal examinations can be avoided if DNA testing indicates that the patient has a non-inherited form of retinoblastoma or if the sibling has not inherited the RB1 gene change/deletion. Any relatives who are found through DNA testing to have inherited an RB1 gene change/deletion should undergo the same surveillance procedures as siblings.

The children of someone diagnosed with retinoblastoma should also undergo periodic retinal examinations under anesthetic. Retinal surveillance should be performed unless DNA testing proves that their child does not possess the RB1 gene change/deletion. If desired, prenatal detection of tumors using ultrasound may also be performed. During the ultrasound procedure, a hand-held instrument is placed on the maternal abdomen or inserted vaginally. The ultrasound produces sound waves that are reflected back from the body structures of the fetus, producing a picture that can be seen on a video screen. If a tumor is detected through this evaluation, the affected baby may be delivered a couple of weeks earlier. This can allow for earlier intervention and treatment.

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Retinoblastoma International. http://www.retinoblastoma.net/.

Solutions by Sequence. http://www.solutionsbysequence.com.

ORGANIZATIONS

American Academy of Ophthalmology (AAO), P. O. Box 7424, San Francisco, CA, 94120-7424, (415) 561-8500, 415 561-8500, http://www.aao.org.

Canadian Retinoblastoma Society, 59 Bannockburn Avenue, Toronto, Canada, Ontario, M5M 2M9, (306) 642-4993, 306 642-3809, info@rbsociety.ca, http://www.rbsociety.ca.

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Institute for Families with Blind Children, 4650 Sunset Blvd, Mail Stop 111, Los Angeles, CA, 90027, (323) 361-4649, (323) 665-7869, info@instituteforfamilies.org, http://www.instituteforfamilies.org.

Retinoblastoma International, 18030 Brookhurst Street, P.O. Box 408, Fountain Valley, CA, 92708, info@retinoblastoma.net, http://www.retinoblastoma.net.

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Retinol deficiency *see* **Vitamin A deficiency**

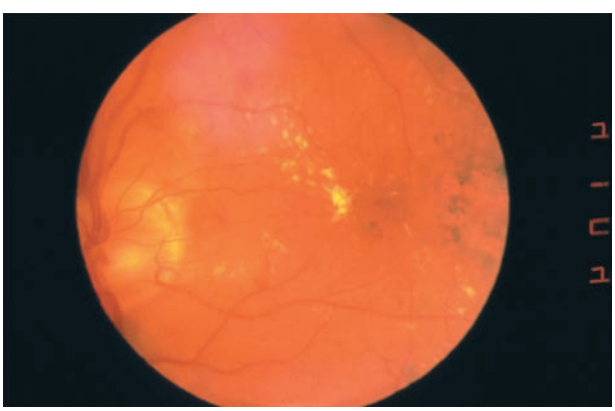
Retinopathies

Definition

Retinopathy is a noninflammatory disease of the retina. There are many causes and types of retinopathy.

Demographics

Diabetic retinopathy is the leading cause of blindness in people ages 20 to 74. Diabetic retinopathy occurs in 90% of persons with type 1 diabetes (insulin-dependent, or insulin requiring) and 65% of persons with type II diabetes (non-insulin-dependent, or not requiring insulin) by about ten years after the onset of diabetes. In the United States, new cases of blindness most often are caused by diabetic retinopathy. Among these new cases of blindness, 12% are people between the ages of 20 to 44 years, and 19% are people between the ages of 45 to 64 years.



A slit lamp view of a human eye with diabetic retinopathy.
(Custom Medical Stock Photo, Inc. Reproduced by permission.)

Description

The retina is the thin membrane that lines the back of the eye and contains light-sensitive cells (photoreceptors). Light enters the eye and is focused onto the retina. The photoreceptors send a message to the brain via the optic nerve. The brain then "interprets" the electrical message sent to it, resulting in vision. The macula is a specific area of the retina responsible for central vision. The fovea is about 1.5 mm in size and located in the macula. The fovea is responsible for sharp vision. When looking at something, the fovea should be directed at the object.

Retinopathy, or damage to the retina, has various causes. A hardening or thickening of the retinal arteries is called arteriosclerotic retinopathy. High blood pressure in the arteries of the body can damage the retinal arteries and is called hypertensive retinopathy. The spreading of a **syphilis** infection to the retinal blood vessels causes syphilitic retinopathy, and diabetes damages the retinal vessels resulting in a condition called diabetic retinopathy. Sickle cell anemia also affects the blood vessels in the eyes. Exposure to the sun (or looking at the sun during an eclipse) can cause damage (solar retinopathy), as well as certain drugs (for example, chloroquine, thioridazine, and large doses of tamoxifen). The arteries and veins can become blocked, resulting in a retinal artery or vein occlusion. These are just some of the causes of the various retinopathies.

Retinopathies are divided into two broad categories, simple (or nonproliferative) retinopathies and proliferative retinopathies. The simple retinopathies include the defects identified by bulging of the vessel walls, bleeding into the eye, small clumps of dead retinal cells called cotton wool exudates, and closed vessels. This form of retinopathy is considered mild. The proliferative, or severe, forms of retinopathies include the defects identified by newly grown blood vessels, scar tissue formed within the eye, closed-off blood vessels that are badly damaged, and by the retina breaking away from the mesh of blood vessels that nourish it (**retinal detachment**).

While each disease has its own specific effect on the retina, many of the retinopathies follow the same general scenario. Blood flow to the retina is disrupted, either by blockage or breakdown of the various vessels (not all retinopathies necessarily affect the blood vessels). This can lead to bleeding (hemorrhage) and fluids, cells, and proteins leaking into the area (exudates). There can be a lack of oxygen to surrounding tissues (hypoxia) or decreased blood flow (**ischemia**). Chemicals produced by the body then cause new blood vessels to grow (neovascularization), however, these new vessels generally leak and cause more problems.

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Neovascularization even can grow on the colored part of the eye (iris). The retina can swell and vision will be affected.

Causes and symptoms

There are many causes of retinopathy. Some of the more common causes are discussed here.

Diabetic retinopathy

Diabetes is a complex disorder characterized by an inability of the body to properly regulate the levels of sugar and insulin (a hormone made by the pancreas) in the blood. As diabetes progresses, the blood vessels that feed the retina become damaged in different ways. The damaged vessels can have bulges in their walls (aneurysms); they can leak blood into the surrounding jelly-like material (vitreous) that fills the inside of the eyeball; they can become completely closed; or new vessels can begin to grow where there would not normally be blood vessels. Although these new blood vessels are growing in the eye, they cannot nourish the retina and they bleed easily, releasing blood into the inner region of the eyeball, which can cause dark spots and cloudy vision.

Diabetic retinopathy begins prior to any outward signs of disease being noticed. Once symptoms are noticed, they include poorer than normal vision, fluctuating or distorted vision, cloudy vision, dark spots, episodes of temporary blindness, or permanent blindness.

Hypertensive retinopathy

High blood pressure can affect the vessels in the eyes. Some blood vessels can narrow. The blood vessels can thicken and harden (arteriosclerosis). There will be flame-shaped hemorrhages and macular swelling (**edema**). This edema may cause distorted or decreased vision.

Sickle cell retinopathy

Sickle cell anemia occurs mostly in individuals of African descent and is a hereditary disease that affects the red blood cells. The sickle-shaped blood cell reduces blood flow. People do not have visual symptoms early in the disease. However, patients need to be followed closely in case neovascularization occurs.

Retinal vein and artery occlusion

Retinal vein occlusion generally occurs in the elderly. There is usually a history of other systemic disease, such as diabetes or high blood pressure. The central retinal vein (CRV), or the retinal veins branching off of the CRV, can become compressed, stopping the drainage of blood from the retina. This may occur if the central retinal artery hardens.

Symptoms of retinal vein occlusion include a sudden, painless loss of vision or field of vision in one eye. There may be a sudden onset of floating spots (floaters) or flashing lights. Vision may be unchanged or decrease dramatically.

Retinal artery occlusion generally is the result of an **embolism** that dislodges from somewhere else in the body and travels to the eye. Transient loss of vision may precede an occlusion. Symptoms of a central retinal artery or branch occlusion include a sudden, painless loss of vision or decrease in visual field. Ten percent of the cases of a retinal artery occlusion occur because of giant cell arteritis (a chronic **vascular disease**).

Solar retinopathy

Looking directly at the sun or watching an eclipse can cause damage. There may be a loss of the central visual field or decreased vision. The symptoms can occur hours to days after the incident.

Drug-related retinopathies

Certain medications can affect different areas of the retina. Doses of 20–40 mg a day of tamoxifen usually do not cause a problem, but much higher doses may cause irreversible damage.

Patients taking chloroquine for lupus, **rheumatoid arthritis**, or other disorders may notice a decrease in vision. If so, discontinuing medication will stop, but not reverse, any damage. Patients should never discontinue medication without the advice of their physician.

Patients taking thioridazine may notice a decrease in vision or color vision.

These drug-related retinopathies generally only affect patients taking large doses. However, patients

KEY TERMS

Exudate—Cells, protein, fluid, or other material that passes through blood vessel walls and accumulates in the surrounding tissue.

Neovascularization—New blood vessel formation; usually leaky vessels.

Nonproliferative retinopathy—Retinopathy without the growth of new blood vessels.

Proliferative retinopathy—Retinopathy with the growth of new blood vessels (neovascularization).

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need to be aware if any medication they are taking will affect the eyes. Patients should inform their doctors of any visual effects.

Diagnosis

The damaged retinal blood vessels and other retinal changes are visible to an eye doctor when an examination of the retina (fundus exam) is done. This can be done using a hand-held instrument called an ophthalmoscope or another instrument called a binocular indirect ophthalmoscope. This allows the doctor to see the back of the eye. Certain retinopathies have classic signs (for example, vascular "sea fans" in sickle cell, dot and blot hemorrhages in diabetes, flame-shaped hemorrhages in high blood pressure). Patients then may be referred for other tests to confirm the underlying cause of the retinopathy. These tests include blood tests and measurement of blood pressure.

Fluorescein **angiography**, where a dye is injected into the patient and the back of the eyes are viewed and photographed, helps to locate leaky vessels. Sometimes patients may become nauseated from the dye.

A newer diagnostic method called digital retinal photography can be used to screen those at high risk for retinopathies, in particular, diabetics. Some researchers say the technique could lead to more cost-effective screening for people with diabetic retinopathy.

Treatment

Retinal specialists are ophthalmologists who specialize in retinal disorders. Retinopathy is a disorder of the retina that can result from different underlying systemic causes, so general physicians should be consulted as well. For drug-related retinopathies, the treatment generally is discontinuation of the drug (only under the care of a physician).

Surgery with lasers can help to prevent blindness or lessen any losses in vision. The high-energy light from a laser is aimed at the weakened blood vessels in the eye, destroying them. **Scars** will remain where the laser treatment was performed. For that reason, laser treatment cannot be performed everywhere. For example, laser photocoagulation at the fovea would destroy the area for sharp vision. In panretinal photocoagulation, a larger area of the periphery of the retina is treated in hopes of decreasing neovascularization. Prompt treatment of proliferative retinopathy may reduce the risk of severe vision loss by 50%.

Patients with retinal artery occlusion should be referred to a cardiologist. Patients with retinal vein occlusion need to be referred to a physician, as they may have an underlying systemic disorder, such as high blood pressure.

Prognosis

Nonproliferative retinopathy has a better prognosis than proliferative retinopathy. Prognosis depends on the extent of the retinopathy, the cause, and promptness of treatment.

Prevention

Complete eye examinations done regularly can help detect early signs of retinopathy. Patients on certain medications should have more frequent eye exams. They also should have a baseline eye exam when starting the drug. People with diabetes must take extra care to have thorough, periodic eye exams, especially if early signs of **visual impairment** are noticed. It is recommended that people with diabetes have re-screening eye exams every two years if their blood sugar has remained in control and more frequent exams if visual symptoms appear. Anyone experiencing a sudden loss of vision, decrease in vision or visual field, flashes of light, or floating spots should contact their eye doctor right away.

Proper medical treatment for any of the systemic diseases known to cause retinal damage will help prevent retinopathy. For diabetics, maintaining proper blood sugar and blood pressure levels is important as well; however, some form of retinopathy usually occurs in diabetics, given enough time. A proper diet, particularly for people with diabetes, and stopping **smoking** also help delay retinopathy.

Frequent, thorough eye exams and control of systemic disorders are the best prevention.

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Usher, David, et al. "Automated Detection of Diabetic Retinopathy in Digital Retinal Images." *Diabetes* (June 2003): A204.

ORGANIZATIONS

American Academy of Ophthalmology, P.O. Box 7424, San Francisco, CA, 94120-7424, (415) 561-8549, patientinfo@aao.org, http://www.aao.org.

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American Diabetes Association, 1701 North Beauregard Street, Alexandria, VA, 22311, (800) 342-2383, askada@diabetes.org, http://www.diabetes.org.
American Optometric Association, 243 North Lindbergh Blvd., St. Louis, MO, 63141, (800) 365-2219, http://www.aoa.org.
Foundation Fighting Blindness, 7168 Columbia Gateway Dr. Suite 100, Columbia, MD, 21046, (800) 683-5555, http://www.blindness.org.
National Eye Institute, 2020 Vision Place, Bethesda, MD, 20892-3655, (301) 496-5248, http://www.nei.nih.gov/index.asp.
Prevent Blindness America, 211 West Wacker Dr., Suite 1700, Chicago, IL, 60606, (800) 331-2020, http://www.preventblindness.org.

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Retrocaval ureter *see* **Congenital ureter anomalies**

KEY TERMS

Bladder—A balloon-like organ located in the lower abdomen that stores urine.

Catheter—A thin tube used to inject or withdraw fluids from the body.

Stones—Also known as calculi, stones result from an excessive build-up of mineral crystals in the kidney. Symptoms of stones include intense pain in the lower back or abdomen, urinary tract infection, fever, burning sensation on urination, and/or blood in the urine.

Ureter—Tube that carries urine from the kidney to the bladder.

Urethra—Tube that empties urine from the bladder to outside the body.

Retrograde cystography

Definition

A retrograde cystogram provides x-ray visualization of the bladder with injection of sterile dye.

Purpose

A retrograde cystogram is performed to evaluate the structure of the bladder and identify bladder disorders, such as tumors, or recurrent urinary tract infections. The presence of urine reflux (backward flow) into the ureters may also be visualized with this x-ray study.

Precautions

The doctor should be made aware of any previous history of reactions to shellfish, iodine, or any iodine-containing foods or dyes. Allergic reactions during previous dye studies is not necessarily a contraindication, as dye is not infused into the bloodstream for this study. Other conditions to be considered by the physician prior to proceeding with the test include active **urinary tract infection**, **pregnancy**, recent bladder surgery, or presence of obstruction that interferes with passage of a urinary catheter.

Description

After administration of anesthesia, the doctor will insert a thin, tubelike instrument called a catheter through the patient's urethra and into the bladder. The contrast medium is then injected through the catheter into the bladder. X-ray pictures are taken at various stages of filling, from various angles, to visualize the bladder. Additional films are taken after drainage of the dye. The procedure takes approximately one to one and one-half hours and the patient may be asked to wait while films are developed.

Alternately, instead of a contrast dye and x-ray pictures, the test can be done with a radioactive tracer and a different camera. This is known as a "radionuclide" retrograde cystogram.

Preparation

The patient will be required to sign a consent form after the risks and benefits of the procedure have been explained. **Laxatives** or **enemas** may be necessary before the procedure, as the bowel must be relatively empty of stool and gas to provide visualization of the urinary tract. Immediately before the procedure, the patient should remove all clothing and jewelry and put on a surgical gown.

Aftercare

Sometimes, pulse, blood pressure, breathing status, and temperature are checked at regular intervals

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after the procedure, until they are stable. The patient may have some burning on urination for a few hours after the test, due to the irritation of the urethra from the catheter. The discomfort can be reduced by liberal fluid intake, in order to dilute the urine. The appearance and amount of urine output should be noted, and the doctor should be notified if blood appears in the urine after three urinations. Also, patients should report any signs of urinary infection, including chills, **fever**, rapid pulse, and rapid breathing rate.

Normal results

A normal result would reveal no anatomical or functional abnormalities.

Abnormal results

Abnormal results may indicate:

- stones
- blood clots
- tumors
- reflex (urine passing backward from the bladder into the ureters)

ORGANIZATIONS

American Kidney Fund (AKF), 6110 Executive Boulevard, Suite 1010, Rockville, MD, 20852, (800) 638-8299, http://www.kidneyfund.org.

National Kidney Foundation, Inc. , 30 East 33rd Street, New York, NY, 10016, (212) 889-2210, (212) 689-9261, (800) 622-9010, http://www.kidney.org/.

Kathleen D. Wright, RN

Retrograde ureteropyelography

Definition

A retrograde ureteropyelogram provides x-ray visualization of the bladder, ureters, and the kidney (renal) pelvis by injection of sterile dye into the renal collecting system.

Purpose

A retrograde ureteropyelogram is performed to determine the exact location of a ureteral obstruction when it cannot be visualized on an intravenous pyelogram (a dye is injected and an x ray taken of the kidneys and the tubes that carry urine to the bladder). This may occur due to poor renal function and inadequate excretion of the contrast medium (dye).

Precautions

The doctor should be made aware of any previous history of reactions to shellfish, iodine, or any iodine-containing foods or dyes. Allergic reactions during previous dye studies is not necessarily a contraindication, as dye is not infused into the bloodstream for this study. Other conditions to be considered by the physician prior to proceeding with the test include **pregnancy** and active **urinary tract infection**.

Description

After administration of anesthesia, the doctor will insert a thin, tubelike instrument (catheter) through the patient's urethra and into the bladder. A catheter is then placed into the affected ureter to instill the contrast medium. X-ray pictures are taken to visualize the ureter. If complete obstruction is found, a ureteral catheter may be left in place and secured to an indwelling urethral catheter to facilitate drainage of urine. The procedure takes approximately one hour.

Preparation

Laxatives or **enemas** may be necessary before the procedure, as the bowel must be relatively empty to provide visualization of the urinary tract. When **general anesthesia** is used for insertion of the ureteral catheter, there should be no eating and drinking after midnight prior to the procedure.

Aftercare

Even if no catheters are left in place after the procedure, the patient may have some burning on urination for a few hours after the procedure due to the irritation of the urethra. The discomfort can be reduced by liberal fluid intake, in order to dilute the urine. The appearance and amount of urine output should be noted for 24 hours after the procedure. If a stone was found, all urine should be strained to allow chemical analysis of any stones passed spontaneously. This will allow the doctor to provide advise on measures to prevent recurrent stone formation. **Antibiotics** are usually given after the procedure to prevent urinary tract infection.

Normal results

A normal result would reveal no anatomical or functional abnormalities.

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Abnormal results

Abnormal results may indicate:

- congenital abnormalities
- fistulas or false passages
- renal stones
- strictures
- tumors

ORGANIZATIONS

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KEY TERMS

Bladder—The balloonlike organ in the lower abdomen that holds urine.

Catheter—Tube used to inject into or withdraw fluids from the bladder.

Renal—Relating to the kidneys, from the Latin word for kidneys, *renes*.

Urethra—Tube that carries the urine from the bladder out of the body.

Visualization—The process of making an internal organ visible. A radiopaque substance is introduced into the body, then an x-ray picture of the desired organ is taken.

Retrograde urethrography

Definition

Retrograde urethrography involves the use of x-ray pictures to provide visualization of structural problems or injuries to the urethra.

Purpose

Retrograde urethrography is used, in combination with a doctor's observation and other tests, to establish a diagnosis for individuals, almost exclusively men, who may have structural problems of the urethra.

Precautions

The doctor should be made aware of any previous history of reactions to shellfish, iodine, or any iodine-containing foods or dyes. An earlier allergic reaction during a dye study is not necessarily something that makes the test inadvisable (a contraindication) as no dye is injected into the bloodstream for this study. Other conditions that should be considered by the physician before the test is done include **pregnancy**, recent urethral surgery, or severe inflammation of the urethra, bladder, or prostate.

Description

The urethra is first visually examined by the doctor, and the opening is cleansed with an antiseptic solution. A flexible rubber or plastic catheter is then inserted into the urethra, and dye is injected into the catheter. A clamp is applied to hold the dye in place while x-ray pictures are taken of the urethral structure. The clamp and catheter are then removed. The procedure takes approximately 15 minutes. However, the patient may be asked to wait while films are developed, which also permits the patient to be observed for any immediate side effects from the dye. The test may be performed in a hospital, doctor's office, outpatient center, or freestanding surgical facility. The time involved for reporting of test results to the doctor may vary from a few minutes to a few days.

Preparation

The patient will be asked to sign a consent form after the risks and benefits of the procedure have been explained. No diet or activity changes are necessary in preparation for the procedure. The patient will be asked to remove all clothing and put on a surgical gown before the test begins.

Normal results

The presence of no anatomical or functional abnormalities is considered a normal result.

Abnormal results

Abnormal findings may indicate:

- congenital abormalities
- fistulas or false passages
- lacerations
- strictures
- valves, known as "posterior urethral valves"
- tumors

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ORGANIZATIONS

American Kidney Fund (AKF), 6110 Executive Boulevard, Suite 1010, Rockville, MD, 20852, (800) 638-8299, http://www.kidneyfund.org.

National Kidney Foundation, Inc. , 30 East 33rd Street, New York, NY, 10016, (212) 889-2210, (212) 689-9261, (800) 622-9010, http://www.kidney.org/.

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Retrograde urography *see* **Retrograde urethrography**

Retropharyngeal abscess *see* **Abscess**

Retropubic suspension

Definition

Retropubic suspension refers to the surgical procedures used to correct incontinence by supporting and stabilizing the bladder and urethra. The Burch procedure, also known as retropubic urethropexy procedure or Burch colosuspension, and **Marshall-Marchetti-Krantz procedure** (MMK) are the two primary surgeries for treating **stress** incontinence. The major difference between these procedures is the method for supporting the bladder. The Burch procedure uses sutures to attach the urethra and bladder to muscle tissue in the pelvic area. MMK uses sutures to attach these organs to the pelvic cartilage. Laparoscopic retropubic surgery can be performed with a video laparoscope through small incisions in the belly button and above the pubic hairline.

Purpose

The urinary system expels a quart and a half of urine per day. The amount of urine produced depends upon diet and medications taken, as well as **exercise** and loss of water due to sweating. The ureters, two tubes connecting the kidneys and the bladder, pass urine almost continually and when the bladder is full the brain sends a signal to the bladder to relax and let urine pass from the bladder to the urethra. People who are continent control the release of urine from the urethra via the sphincter muscles. These two sets of muscles act like rubber bands to keep the bladder closed until a conscious decision is made to urinate. The intrinsic sphincter or urethral sphincter muscles keep the bladder closed and the extrinsic sphincter muscles surround the urethra and prevent leakage. Incontinence is common when either the urethra lacks tautness and stability (genuine stress urine incontinence, SUI) and/or the sphincter muscles are unable to keep the bladder closed (intrinsic sphincter deficiency, ISD).

Incontinence occurs in many forms with four primary types related to anatomic, neurological, and dietary causes; or disease and injury.

Stress incontinence

The most frequent form of incontinence is stress incontinence. This relates to leakage of the urethra with activity that puts stress on the abdominal muscles. The primary sign of stress incontinence is this leakage at sneezing, coughing, exercise, or other straining activities, which indicates a lack of support for the urethra due to weakened muscles, fascia, or ligaments. Pressure from the abdomen with movement, like exercising, uncompensated by tautness or stability in the urethra, causes the urethra to be displaced or mobile leading to leakage. Essentially, this hypermobility of the urethra is an indication that it is moving down or herniating through weakened pelvic structures.

To diagnose incontinence and determine treatment, three grades of severity for stress incontinence are used.

- Type I: Moderate movement of the urethra, with no hernia or cystocele.
- Type II: Severe or hypermobility in the urethra of more than 0.8 in (2 cm), with or without decent of the urethra into pelvic structures.
- Type III: Hypermobility of the urethra where the primary source of incontinence is the inability of the sphincter muscles to keep the bladder closed. This is due to weakness or deficiency in the intrinsic sphincter muscles.

Urge incontinence

Urge incontinence relates to the frequent need to urinate and may involve going to the bathroom every two hours. Accidents are common when not reaching a bathroom in time. Urge incontinence is not due to general changes in the urethra or supporting muscles. It is often linked to other disorders that produce **muscle spasms** in the bladder, such as infections. Urge incontinence can also be due to underlying illnesses like **stroke**, **spinal cord injury**, **multiple sclerosis** and **Alzheimer's disease**, which cause detrusor hyperflexia—the contracting of the bladder muscle responsible for sending urine from the bladder to the

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KEY TERMS

Genuine urinary stress incontinence (USI)—Stress incontinence due to hypermobility of the urethra.

Intrinsic sphincter deficiency (ISD)—A factor in severe stress incontinence due to the inadequacy of the sphincter muscles to keep the bladder closed.

Retropubic urethropexy—A generic term for the Burch procedure and its variants that treat mild stress incontinence by stabilizing the urethra with retropubic surgery.

Stress incontinence—Leakage of urine upon movements that put pressure on the abdominal muscles such as coughing, sneezing, laughing, or exercise. One of four types of incontinence.

Urethra hypermobility—Main factor in stress urinary incontinence, with severity based upon how far the urethra has descended into the pelvic floor through herniation or cystocele.

urethra. Urge incontinence is very common in the elderly, especially those in long term care facilities.

Mixed incontinence

Mixed incontinence is a combination of stress incontinence and urge incontinence, especially in older women. Since each form of incontinence pertains to different functions or anatomy, it is very important to distinguish which part of the incontinence is to be treated by surgery.

Overflow incontinence

Overflow incontinence results in leakage from a bladder that never completely empties due to weakened bladder muscles. Overflow incontinence is involuntary and not accompanied by the urge to urinate. Many causes exist for overflow incontinence, including weak bladder muscles due to diabetes, nerve damage, or a blocked urethra. Men are more frequently affected than women.

Demographics

Over 15 million Americans have **urinary incontinence** and women comprise 85% of all cases. It affects 25% of women of reproductive age and 50% of women past **menopause**. Due to the female anatomy, women have twice the risk for stress incontinence compared to men. In addition, **childbirth** places pressure and burden on the pelvic muscles that often weaken with age, thereby weakening urethra stability. Women are more prone to surgeries for urological changes than men and severe urinary incontinence is often associated with these surgeries as well as hysterectomies. The majority of women with incontinence have stress incontinence or mixed incontinence. Male incontinence occurs primarily in response to blockage in the prostate or after prostate surgery. It is usually treated with implants and/or an artificial sphincter insert.

Description

There are a variety of retropubic suspension surgeries available to treat stress incontinence. The variations differ by the types of structures used to support the urethra and bladder. In all procedures, parts of the pelvic anatomy (pubic bone, ligaments) serve as an anchor or wall upon which the urethra is tacked for stability. The surgery is called a suspension surgery because it stabilizes the urethra from tilting by suspending it against a part of the pelvic anatomy. The Burch procedure is often performed when other surgery is needed such as repair of the urethra for cystoceles and urethral reconstruction. However, this procedure is the most difficult of the anti-incontinent surgeries and is more common in mild forms of stress incontinence where intrinsic sphincter deficiency is not present.

The Burch procedure can be done through open abdominal surgery, which requires a long incision at the bikini line, or surgery performed through the vagina. The patient, in stirrups, receives **general anesthesia**. Within the retropubic area, the anterior vaginal wall is separated from the bladder manually. The bladder neck is identified and old **adhesions** or fatty tissues are removed. The neck of the bladder is sutured to pubic ligaments where it will form adhesions and thereby gain stability. The surgeon examines for bladder injury and the surgery is completed. Urethral position is tested by placing a cotton-tipped swab in the urethra and measuring the angle. With abdominal surgery or vaginal surgery a catheter may be put in place by the surgeon for postoperative voiding and to decrease the risks of infection. A suction drain may be placed in the retropubic space for bleeding. The drain is removed one to three days after surgery.

Recently, laparoscopic surgery has been used to perform retropubic suspensions. Laparoscopic surgery requires only three or four 0.25-inch (0.6-cm) incisions in the belly button, pubic hairline, or groin area and uses small instruments without opening the abdominal cavity. A shorter healing time is seen with

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this procedure. the hospital stay is usually not more than 24 hours and recovery to normal activities takes about 7 to 14 days. However, the Burch procedure performed using laparoscopic techniques requires great skill on the part of the surgeon and research indicates that the results may not be as long lasting as those developed with abdominal or vaginal surgery.

Diagnosis/Preparation

A patient with incontinence may have multiple factors that induce transient or chronic incontinence. It is crucial that the physician obtain a complete history, physical, clinical, neurological and medication evaluation of the patient, as well as a radiographic assessment before continuing urological tests aimed at a surgical solution. The specific indications for the Burch colosuspension procedure or its variants is the correction of stress urinary incontinence. This can be a patient who also requires abdominal surgery that cannot be performed vaginally, like **hysterectomy** or sigmoid surgery, as well as patients who have SUI without ISD.

A urodynamic study with a point pressure leak test will allow a diagnosis to be made that can distinguish the patient who has a hypermobile urethra from the patient who also has ISD. The point pressure leak test, also known as the Valsalva leak test, measures the amount of abdominal pressure required to induce leakage. The patient is asked to **cough** or strain in order to encourage leakage. The point at which the patient leaks helps determine if stress incontinence with ISD contribution is present. Obese patients and patients that engage in high impact exercise regimens are not considered good candidates for retropubic suspension.

Aftercare

Patients with open retropubic procedures are given **pain** medication postoperatively that is tapered down over the next two days. A suprapubic catheter stays in place for approximately five days with voiding difficulties encountered initially in many patients. Patients with laparoscopic suspensions are reported to have less blood loss during surgery, less postoperative narcotic requirements, and shorter hospital stays. Patients are expected to refrain from strenuous activity for three months and to have a follow-up visit within three weeks after surgery.

Risks

As with any major abdominal or pelvic surgical procedures, complications that may occur after a retropubic suspension include bleeding; injury to the bladder, urethra, and ureters; wound infection; and **blood clots**. Specific to the Burch procedure are complications that involve urethral obstruction because of urethral kinking due to elevation of the vagina or bladder base. Postoperative voiding difficulties are common and depend upon the suture tension of the urethral axis. Corrective surgery and the release of the urethra to a more anatomic position resolves voiding issues with a very high rate of success. Vaginal prolapse is also a risk of this procedure.

Normal results

The patient can expect more than 80–90% cure or great improvement in their incontinence. There is a large body of literature documenting the success of the Burch procedure. Published research shows a cure rate ranging from 63%–93%, according to the actual version of colosuspension used. Laparoscopic surgery has not produced the long term results that open surgery has and there is the possibility that the fibrosis (adhesion) necessary for a successful outcome does not occur as easily with the laparoscopic procedure. Patients not carefully screened out for ISD will not have a high level of success with the Burch procedure since the source of the incontinence will not have been treated. Sling procedures are recommended for patients with ISD instead of colosuspension surgery.

Morbidity and mortality rates

The Burch procedure may aggravate vaginal wall weakness or vaginal prolapse. This incident varies between 3% and 17%. Research on the Marshall-Marchetti-Krantz procedure pertaining to 2,712 patients found a complication rate of 21%, with wound complications and infections making up the majority, 5.5% and 3.9% respectively. Direct wound injury occurred in 1.6% and obstructions in 0.3% overall.

Alternatives

General or simple severe stress incontinence related primarily to weakening of the urethral support can be remedied with changes in diet, weight loss, and certain behavioral and rehabilitative measures. These include:

- Regular, daily exercising of the pelvic muscles called Kegel exercises, requiring 30–200 contractions a day for eight weeks.

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- Biofeedback to gain awareness and control of pelvic muscles.
- Vaginal weight training in which small weights are inserted in the vagina to tighten vaginal muscles.
- Mild electrical stimulation to increase contractions in pelvic muscles.
- Bladder retraining in which the patient is taught how to resist the urge to urinate and expand the intervals between urinations.

There are also medications that can facilitate continence for those experiencing stress or urge incontinence. These include some kinds of antidepressants, although the mechanism of action is not quite understood, as well as antispasmodic medication and estrogen therapy. Finally, should behavioral, rehabilitative, and surgical procedures fail, there remain alternatives through the use of vaginal cones and urethral plugs that can be inserted and removed by the patient.

Resources

BOOKS

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Taneja, Samir S. *Complications of Urologic Surgery*. Philadelphia: Saunders Elsevier, 2010.

Wein, Alan J. *Campbell-Walsh Urology Review Manual*. 3rd ed. Philadelphia: Saunders, 2007.

ORGANIZATIONS

American Foundation for Urologic Disease, 1000 Corporate Boulevard, Suite 410, Linthicum, MD, 21090, (410) 689-3990, (800) 828-7866, http://www.afud.org.

National Kidney and Urologic Diseases Information Clearinghouse, 3 Information Way, Bethesda, MD, 20892-3580, (301) 654-4415, (800) 891-5390, http://www.niddk.nih.gov.

Simon Foundation for Continence, P.O. Box 835, Wilmette, IL, 60091, (847) 864-3913, (800) 237-4666, http://www.simonfoundation.org.

Nancy McKenzie, PhD
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Reye's syndrome

Definition

Reye's syndrome or Reye syndrome (RS) is a very rare, poorly understood condition that is associated with the use of **aspirin** in children and teens following a viral infection. It primarily affects the blood, liver, and brain and is characterized by the rapid development of life-threatening neurological symptoms.

Demographics

After it was first described as a distinct condition in 1963 by the Australian pathologist R. Douglas Reye, the incidence of Reye's syndrome in the United States peaked with 555 reported cases in 1980. Thereafter the number of cases declined dramatically. There are now less than two reported cases per year in the United States. This decline was due to the association of RS with the use of aspirin to treat childhood **fever** and a corresponding drop in such use. However the true incidence of RS may be somewhat higher because the condition can sometimes be very mild and go undetected. Furthermore because of its rarity, RS may be misdiagnosed as **encephalitis**, **meningitis**, diabetes, **drug overdose**, **poisoning**, **sudden infant death syndrome**, or psychiatric illness.

Although RS can affect people of any age at any time, it primarily affects children between the ages of 4 and 14 and is most common during flu season—January, February, and March. Flu or **chickenpox** epidemics are often followed by an increase in RS. Nevertheless RS is extremely rare in adults and in the absence of aspirin use.

Description

RS develops following a viral illness such as a cold, **influenza** B, or chickenpox. Because of this it is referred to as a two-phase illness. It usually develops very rapidly and without warning, most often during recovery from the viral illness, but also within three to five days of onset of a viral infection. RA can affect most of the body's organ systems. Blood sugar levels typically drop as the ammonia levels and acidity of the blood rise. The liver may simultaneously swell, with massive accumulations of fat in both the liver and other organs. Fluid accumulation and swelling (**edema**) in the brain increases intracranial pressure. This squeezes the blood vessels, preventing blood from reaching the brain. Without treatment RA can lead to rapid brain damage and **death**.

Risk factors

The major risk factor for RA is the use of aspirin to treat fever-inducing viral illnesses—such as flu, chickenpox or an upper respiratory infection—in children under age 19 who have an underlying fatty acid oxidation disorder.

Causes and symptoms

Although the cause of Reye's syndrome is still unknown, it appears to be triggered by the use of

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KEY TERMS

Aspirin—A derivative of salicylic acid used to relieve pain and fever.

Edema—Swelling; the abnormal accumulation of fluid in the interstitial spaces of tissues.

Salicylic acid; salicylate; acetylsalicylate—Aspirin; medications used as topical disinfectants and orally to relieve pain and fever.

aspirin to treat a viral illness or infection in children and teenagers who have an underlying fatty acid oxidation disorder. These are a group of inherited metabolic disorders in which the body is unable to breakdown fatty acids due to a missing or abnormal enzyme. It has been suggested that RS is an underlying metabolic condition that is unmasked by viral illness. RS has also been linked to exposure to certain toxins, such as insecticides, herbicides, and paint thinner. A "Reye's-like" illness has been known to occur in children with certain inherited metabolic or other toxic disorders.

Symptoms of Reye's syndrome usually develop during recovery from a viral illness. The affected child suddenly worsens and develops persistent or continuous **vomiting**. There is usually no fever. However in infants **diarrhea** is more common than **vomiting** and respiratory symptoms—such as hyperventilation or apneic episodes (breathing cessations)—are common. In addition to vomiting, stage I Reye's syndrome includes early signs of brain dysfunction such as listlessness, lethargy, and drowsiness. Symptoms of stage II Reye's syndrome include personality changes, such as irritability and aggressiveness, followed by disorientation—confusion, irrational behavior, combativeness, **delirium**, seizures, and **coma**.

Diagnosis

Examination

Reye's syndrome may be suspected if a child begins vomiting, followed by neurological symptoms, during recovery from or three to six days after onset of a viral illness.

Tests

Tests for RS include blood and urine analysis, as well as tests for metabolic disorders including those of fatty acid metabolism. Blood tests may indicate:

- elevated levels of certain liver enzymes in the absence of jaundice
- increased levels of ammonia and amino acids
- low blood sugar
- increased clotting time

Procedures

Diagnostic procedures to rule out other causes of the symptoms may include:

- a liver biopsy after clotting abnormalities are corrected with vitamin K or blood products
- a skin biopsy to test for disorders of fatty acid oxidation or other metabolic functions
- lumbar puncture (spinal tap) to rule out meningitis (infection of the lining that surrounds the brain and spinal cord) or encephalitis (inflammation or infection of the brain)
- Computed tomography (CT) or magnetic resonance imaging (MRI) of the head

Treatment

Traditional

Reye's syndrome is a life-threatening emergency that requires management in a hospital intensive-care unit. There is no cure. Treatment focuses on preventing brain damage:

- intravenous 10% glucose in an electrolyte solution to return blood sugar levels to normal
- plasma transfusions to restore normal clotting time
- monitoring of intracranial pressure and blood pressure
- intravenous mannitol and hyperventilation to lower intracranial pressure
- mechanical ventilation with a breathing machine or respirator if breathing becomes sluggish

Drugs

- vitamin K, plasma, and/or platelets for clotting abnormalities
- corticosteroids to reduce brain swelling
- diuretics to decrease intracranial pressure and increase fluid loss through urination
- barbiturates if intracranial pressure remains elevated
- anti-seizure medications
- small amounts of insulin to increase glucose metabolism

Prognosis

Sometimes RS is mild and resolves on its own. However at the time that the condition was first

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recognized mortality was 80%. Earlier diagnosis and better treatment have now increased the survival rate to 80–90%. Almost all surviving children recover fully, although recovery may be slow. If Reye's syndrome progresses rapidly and the child lapses into a coma the prognosis is poorer: there may be permanent neurologic damage, requiring special physical and/or educational equipment and services.

Prevention

The best prevention for Reye's syndrome is to avoid the use of aspirin for treating fever in children and teenagers. Although aspirin is approved for use in children over age two, it should never be taken by children and teens who are recovering from flu-like symptoms or chickenpox. Teenagers who take medications without parental consultation should be warned about aspirin-containing drugs. It is also recommended that women who are **breastfeeding** not take aspirin-containing products, since salicylate can pass into breast milk. Aspirin is an ingredient in many over-the-counter and prescription drugs, including remedies for **headache**, fever, menstrual cramps, muscle **pain**, **nausea**, upset stomach, and arthritis. It is used in oral drugs, suppositories, and topical medications. It may also be an ingredient in alternative or herbal remedies. Therefore it is important to always check the list of ingredients on any medication or remedy. Aspirin can be found in unlikely products, such as Alka-Seltzer. Aspirin may be referred to by any of the following names:

- aspirin
- salicylic acid
- salicylate
- acetylsalicylate
- acetylsalicylic acid

Medications such as **acetaminophen** (Tylenol), ibuprofen (Advil, Motrin), or naproxen **sodium** (Aleve) can be used to reduce a high fever or relieve pain. However administering anti-nausea medicines can mask symptoms of RS.

Children with known fatty acid oxidation disorders should not take aspirin or aspirin-containing products. A screening test can identify a fatty acid oxidation disorder. Some hospitals and medical facilities screen newborns for fatty acid oxidation disorders to identify children who are at greater risk for developing Reye's syndrome.

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ORGANIZATIONS

National Institute of Neurological Disorders and Stroke (NINDS), NIH Neurological Institute, P.O. Box 5801, Bethesda, MD, 20824, (301) 496-5751, (800) 352-9424, http://www.ninds.nih.gov/index.htm.

National Reye's Syndrome Foundation, P.O. Box 829, Bryan, OH, 43506, (800) 233-7393, nrsf@reyessyndrome.org, http://www.reyessyndrome.org/.

Richard Robinson
Margaret Alic, PhD

Rh disease *see* **Erythroblastosis fetalis**

Rh incompatibility *see* **Erythroblastosis fetalis**

Rh typing *see* **Blood typing and crossmatching**

Rheumatic fever

Definition

Rheumatic **fever** (RF) is an illness which arises as a complication of untreated or inadequately treated **strep throat** infection. Rheumatic fever can seriously damage the valves of the heart.

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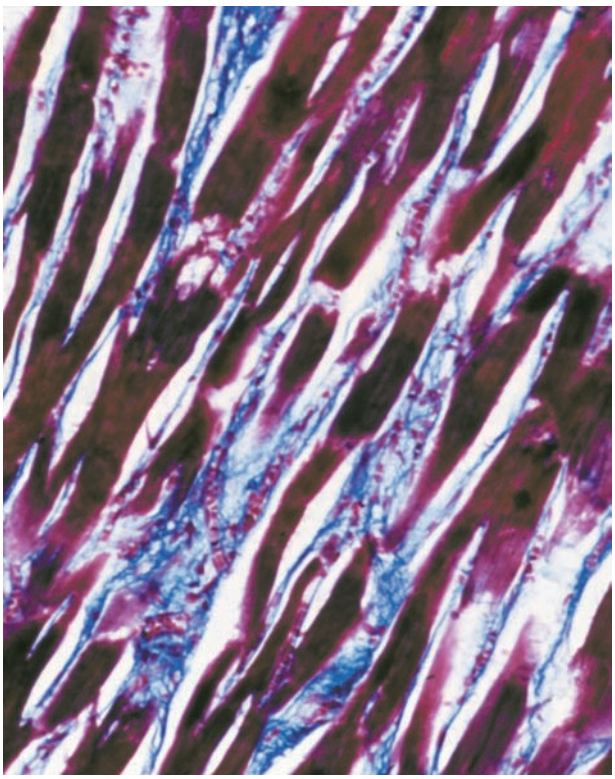

A magnified image of cardiac muscle damaged by chronic myocarditis caused by rheumatic fever. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Description

Throat infection with a member of the Group A streptococcus (strep) bacteria is a common problem among school-aged children. It is easily treated with a 10-day course of **antibiotics** by mouth. However, when such a throat infection occurs without symptoms, or when a course of medication is not taken for the full 10 days, there is a 3% chance of that person developing rheumatic fever. Other types of strep infections (such as of the skin) do not put the patient at risk for RF.

Children between the ages of 5 and 15 are most susceptible to strep throat, and therefore most susceptible to rheumatic fever. Other risk factors include poverty, overcrowding (as in military camps), and lack of access to good medical care. Just as strep throat occurs most frequently in fall, winter, and early spring, so does rheumatic fever.

Causes and symptoms

Two different theories exist as to how a bacterial throat infection can develop into the disease called rheumatic fever. One theory, less supported by research evidence, suggests that the bacteria produce some kind of poisonous chemical (toxin). This toxin is sent into circulation throughout the bloodstream, thus affecting other systems of the body.

Research seems to point to a different theory, however. This theory suggests that the disease is caused by the body's immune system acting inappropriately. The body produces immune cells (called antibodies), which are specifically designed to recognize and destroy invading agents; in this case, streptococcal bacteria. The antibodies are able to recognize the bacteria because the bacteria contain special markers called antigens. Due to a resemblance between Group A streptococcus bacteria's antigens and antigens present on the body's own cells, the antibodies mistakenly attack the body itself.

It is interesting to note that members of certain families seem to have a greater tendency to develop rheumatic fever than do others. This could be related to the above theory, in that these families may have cell antigens which more closely resemble streptococcal antigens than do members of other families.

In addition to fever, in about 75% of all cases of RF one of the first symptoms is arthritis. The joints (especially those of the ankles, knees, elbows, and wrists) become red, hot, swollen, shiny, and extraordinarily painful. Unlike many other forms of arthritis, the arthritis may not occur symmetrically (affecting a particular joint on both the right and left sides, simultaneously). The arthritis of RF rarely strikes the fingers, toes, or spine. The joints become so tender that even the touch of bedsheets or clothing is terribly painful.

A peculiar type of involuntary movement, coupled with emotional instability, occurs in about 10% of all RF patients (the figure used to be about 50%). The patient begins experiencing a change in coordination, often first noted by changes in handwriting. The arms or legs may flail or jerk uncontrollably. The patient seems to develop a low threshold for anger and sadness. This feature of RF is called **Sydenham's chorea** or St. Vitus' Dance.

A number of skin changes are common to RF. A rash called erythema marginatum develops (especially in those patients who will develop heart problems from their illness), composed of pink splotches, which may eventually spread into each other. It does not itch. Bumps the size of peas may occur under the skin. These are called subcutaneous nodules; they are hard to the touch, but not painful. These nodules most commonly occur over the knee and elbow joint, as well as over the spine.

The most serious problem occurring in RF is called pancarditis ("pan" means total; "carditis" refers to

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KEY TERMS

Antibodies—Specialized cells of the immune system which can recognize organisms that invade the body (such as bacteria, viruses, and fungi). The antibodies are then able to set off a complex chain of events designed to kill these foreign invaders.

Antigen—A special, identifying marker on the outside of cells.

Arthritis—Inflammation of the joints.

Autoimmune disorder—A disorder in which the body's antibodies mistake the body's own tissues for foreign invaders. The immune system therefore attacks and causes damage to these tissues.

Chorea—Involuntary movements in which the arms or legs may jerk or flail uncontrollably.

Immune system—The system of specialized organs, lymph nodes, and blood cells throughout the body, which work together to prevent foreign invaders (bacteria, viruses, fungi, etc.) from taking hold and growing.

Inflammation—The body's response to tissue damage. Includes hotness, swelling, redness, and pain in the affected part.

Pancarditis—Inflammation of the lining of the heart, the sac around the heart, and the muscle of the heart.

inflammation of the heart). Pancarditis is an inflammation that affects all aspects of the heart, including the lining of the heart (endocardium), the sac containing the heart (pericardium), and the heart muscle itself (myocardium). About 40–80% of all RF patients develop pancarditis. This RF complication has the most serious, long-term effects. The valves within the heart (structures which allow the blood to flow only in the correct direction, and only at the correct time in the heart's pumping cycle) are frequently damaged during the course of pancarditis. This may result in blood which either leaks back in the wrong direction, or has a difficult time passing a stiff, poorly moving valve. Either way, damage to a valve can result in the heart having to work very hard in order to move the blood properly. The heart may not be able to "work around" the damaged valve, which may result in a consistently inadequate amount of blood entering the circulation.

Diagnosis

Diagnosis of RF is done by carefully examining the patient. A list of diagnostic criteria has been created. These "Jones Criteria" are divided into major and minor criteria. A patient can be diagnosed with RF if he or she has either two major criteria (conditions), or one major and two minor criteria. In either case, it must also be proved that the individual has had a previous infection with streptococcus.

The major criteria include:

- carditis
- arthritis
- chorea
- subcutaneous nodules
- erythema marginatum

The minor criteria include:

- fever
- joint pain (without actual arthritis)
- evidence of electrical changes in the heart (determined by measuring electrical characteristics of the heart's functioning during a test called an electrocardiogram, or EKG)
- evidence (through a blood test) of the presence in the blood of certain proteins, which are produced early in an inflammatory/infectious disease.

Tests are also performed to provide evidence of recent infection with group A streptococcal bacteria. A swab of the throat can be taken, and smeared on a substance in a petri dish, to see if bacteria will multiply and grow over 24–72 hours. These bacteria can then be specially processed, and examined under a microscope, to identify streptococcal bacteria. Other tests can be performed to see if the patient is producing specific antibodies; that are only made in response to a recent strep infection.

Treatment

A 10-day course of penicillin by mouth, or a single injection of penicillin G-is the first line of treatment for RF. Patients will need to remain on some regular dose of penicillin to prevent recurrence of RF. This can mean a small daily dose of penicillin by mouth, or an injection every three weeks. Some practitioners keep patients on this regimen for five years, or until they reach 18 years of age (whichever comes first). Other practitioners prefer to continue treating those patients who will be regularly exposed to streptococcal bacteria (teachers, medical workers), as well as those patients with known RF heart disease.

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Arthritis quickly improves when the patient is given a preparation containing **aspirin**, or some other anti-inflammatory agent (ibuprofen). Mild carditis will also improve with such anti-inflammatory agents, although more severe cases of carditis will require steroid medications. A number of medications are available to treat the involuntary movements of chorea, including diazepam for mild cases, and haloperidol for more severe cases.

Prognosis

The long-term prognosis of an RF patient depends primarily on whether he or she develops carditis. This is the only manifestation of RF which can have permanent effects. Those patients with no or mild carditis have an excellent prognosis. Those with more severe carditis have a risk of **heart failure**, as well as a risk of future heart problems, which may lead to the need for valve replacement surgery.

Prevention

Prevention of the development of RF involves proper diagnosis of initial strep throat infections, and adequate treatment within 10 days with an appropriate antibiotic. Prevention of RF recurrence requires continued antibiotic treatment, perhaps for life. Prevention of complications of already-existing RF heart disease requires that the patient always take a special course of antibiotics when he or she undergoes any kind of procedure (even dental cleanings) that might allow bacteria to gain access to the bloodstream.

ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

Rosalyn Carson-DeWitt, MD

Rheumatoid arthritis

Definition

Rheumatoid arthritis is an autoimmune disease that primarily damages the lining of joints. Other problems throughout the body (systemic problems) may also develop, including inflammation of blood vessels (**vasculitis**), the development of bumps (called rheumatoid nodules) in various parts of the body, lung disease, blood disorders, and weakening of the bones (**osteoporosis**).

Description

Rheumatoid arthritis (RA) is a disease mainly characterized by chronic inflammation of the tissue lining the joints (synovium). A joint is a point of connection between two bones that allows motion. For example, an elbow joint connects an arm to the forearm allowing motion of the arm, and a knee joint connects a thigh to the lower leg, allowing the straightening and bending of the knee. RA can affect almost any joint of the body, including those of the fingers, wrists, shoulders, elbows, hips, knees, ankles, feet, and neck. It can lead to long-term joint damage, resulting in chronic **pain** and disability. RA does not only affect joints. It is a systemic disease, because it can affect other organs in the body, such as the heart, muscles, blood vessels, nervous system, and eyes.

In RA, the synovial membrane becomes severely inflamed. Usually thin and delicate, the synovium becomes thick and stiff, with numerous infoldings on its surface. The membrane is invaded by white blood cells, which produce a variety of destructive chemicals. The cartilage along the articular surfaces of the bones may be attacked and destroyed, and the bone, articular capsule, and ligaments may begin to wear away (erode). These processes severely interfere with movement in the joint.

RA is also a progressive disease. The first stage of the disease is inflammation of the synovium of the affected joint, which causes pain, warmth, stiffness, redness and swelling around the joint that can last for hours. The arthritis usually begins in the small joints of the hands and the feet, spreading later to the larger joints. In the second stage, there is an overgrowth of connective tissue on the articular surface of the affected joint resulting in a thickening of the affected synovium (pannus). Finally, as part of the autoimmune response, the inflamed cells release substances that start destroying bone and cartilage, causing joint deformity, more pain, and loss of function.

Demographics

According to the World Health Organization (WHO), RA is the most common chronic inflammatory joint disease. The incidence and prevalence of RA appear to have fallen in Europe, North America and Japan in the last 50 years. The prevalence of RA is estimated as relatively constant in many populations, at 0.5–1.0%, with low occurrences reported in

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KEY TERMS

Anorexia—Loss of or markedly reduced appetite or total aversion to food.

Antibody—A protein produced by the body's immune system in response to a foreign substance.

Articular bones—Two or more bones connected to each other via a joint.

Autoimmune disease—Disease characterized by the involvement of an inappropriate immune response that leads the body to attack its own cells and tissues.

Autoimmune response—A condition in which a person's immune system fails to recognize its own cells as being "self" and attacks its own body.

Disease-modifying antirheumatic drug (DMARD)—Medication belonging to a group of medications commonly used in patients with rheumatoid arthritis that acts by lowering the autoimmune response.

Immune system—The organs and cells that defends the body against infections and other diseases.

Immunosuppressant—Medication that can block the body's immune response.

Joint—The point of connection between two bones that allows motion.

Nonsteroidal anti–inflammatory drug (NSAID)—Medication that does not contain cortisone used to reduce the symptoms of the pain and inflammation of arthritis.

Osteoarthritis—A non–inflammatory wearing away of bone and cartilage most often associated with aging.

Pannus—Overgrowth of connective tissue on the articular surface of a joint.

Pauciarticular juvenile RA—Rheumatoid arthritis found in children that affects less than four joints.

Polyarticular juvenile RA—Rheumatoid arthritis found in children that affects more than four joints.

Rheumatoid factor (RF)—An antibody present in the blood serum of many individuals affected by rheumatoid arthritis.

Synovial fluid—A lubricating fluid secreted by the synovial membrane.

Synovial membrane—A layer of connective tissue that lines the cavities of joints.

Synovium—A fibrous envelope that produces a fluid to help to reduce friction and wear in a joint.

Systemic disease—A disease that affects the entire body instead of a specific organ.

populations from China and Japan. According to the Arthritis Foundation, approximately 1.3 million Americans are afflicted by RA. The disease can affect anyone, including children, but 70% of people with RA are women. RA onset usually occurs between 30 and 50 years of age. A high prevalence of RA has been reported in the Pima (5.3%) and in the Chippewa (6.8%) Indians. Older age and female gender are risk factors both for the development of RA and for a poor outcome.

Causes and symptoms

The cause of RA remains unknown but most medical researchers believe that it is an autoimmune disease, meaning a disease characterized by the involvement of an inappropriate immune response that leads the body to attack the lining of its own joints. How this autoimmune response develops is not known but it causes the inflammation that produces the pain, swelling, and stiffness associated with RA. Other research has proposed that susceptibility to RA may be genetic or environmental.

Many researchers are examining the possibility that exposure to an organism (like a bacteria or virus) may be the first event in the development of RA. The body's normal response to such an organism is to produce cells that can attack and kill the organism, protecting the body from the foreign invader. In an autoimmune disease like RA, this immune cycle spins out of control. The body produces misdirected immune cells, which accidentally identify parts of the person's body as foreign. These immune cells then produce a variety of chemicals that injure and destroy parts of the body.

Symptoms vary from person to person and can mimic other bone and joint diseases such as **osteoarthritis**. For most people, the symptoms of rheumatoid arthritis appear gradually, although about one-third of individuals develop serious symptoms within a few months. In many people, symptoms tend to change from day to day, with periods of improvement followed by periods of worsening symptoms. In more serious cases, symptoms simply worsen progressively without periods of improvement. The wrists and hand joints are affected in more than 85% of individuals with rheumatoid arthritis. Usually if a joint on one side of the body

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is inflamed, the same joint on the other side will also be affected.

The symptoms of RA are the same as for all forms of arthritis and usually include morning stiffness, lasting joint pain, joint swelling, joint stiffness, tenderness or pain when touching a joint, difficulty using or moving a joint normally, and warmth and redness in a joint.

Many patients also notice increased **fatigue**, loss of appetite, weight loss, and sometimes **fever**. Rheumatoid nodules are bumps that appear under the skin around the joints and on the top of the arms and legs. These nodules can also occur in the tissue covering the outside of the lungs and lining the chest cavity (pleura), and in the tissue covering the brain and spinal cord (meninges). Lung involvement may cause **shortness of breath** and is seen more in men. Vasculitis (inflammation of the blood vessels) may interfere with blood circulation. This can result in irritated pits (ulcers) in the skin, tissue **death** (**gangrene**), and interference with nerve functioning that causes **numbness and tingling**.

Juvenile RA is a chronic inflammatory disease that affects the joints of children less than 16 years old. It is estimated to affect as many as 250,000 children in the United States alone. Most children with juvenile RA have arthritis when the illness starts, which affects multiple joints in 50% of these children, and only one joint in 30%. In all, 20% of the children affected by juvenile RA have the acute systemic form of the disease, which is characterized by fever, joint inflammation, rash, **liver disease**, and gastrointestinal disease.

Two periods of childhood are associated with an increased incidence of onset of juvenile RA. The first is from one to three years of age, and the second, from 8 to 12 years. When more than four joints are affected, the disease is described as being polyarticular. If less than four joints are affected, the disease is known as pauciarticular. juvenile RA and this particular manifestation falls into two categories. The first occurs in girls aged one to four years old, and the onset of joint involvement is in the knees, ankles, or elbows. The second form occurs in boys aged eight years and older, and involves the larger joints, such as those of the hips and legs.

Diagnosis

The RA diagnosis may be difficult to establish, because there is no single test that can be performed to confirm RA. The diagnosis is based upon an individual's history of clinical symptoms and a complete **physical examination**. A specialized physician, often a rheumatologist, reviews all signs and symptoms experienced by a person, so as to rule out other joint diseases. This often requires various tests, which may include:

- Rheumatoid factor (RF) test: This diagnostic test measures the presence and amounts of rheumatoid factor in the blood. The test looks for distinctive antibodies released in the blood by people with RA to distinguish it from other forms of arthritis and other conditions that cause similar symptoms of joint pain, inflammation, and stiffness. Rheumatoid factor is an autoantibody found in about 80% of patients with RA. It is often not very specific however, because it is found in about 5% of all healthy people and in 10–20% of healthy people over the age of 65. In addition, rheumatoid factor is also positive in a large number of other autoimmune diseases and other infectious diseases, including systemic lupus erythematosus, bacterial endocarditis, malaria, and syphilis. In addition, young people who have a process called juvenile rheumatoid arthritis often have no rheumatoid factor present in their blood.
- Antinuclear antibody (ANA) test: This test is performed to help screen for autoimmune disorders. A small percentage of healthy people, however, have a positive ANA.
- C-Reactive protein (CRP) test: The CRP test is used to evaluate how active the inflammation is. CRP tests are not specific enough to diagnose RA, but provide a general marker of infection and inflammation levels.
- Synovial fluid exam: The clinician may examine the synovial fluid, by inserting a thin needle into a synovial joint. In RA, this fluid has certain characteristics that indicate active inflammation. The fluid is cloudy, with increased protein and decreased or normal glucose. It also contains a higher than normal number of white blood cells. While these findings suggest inflammatory arthritis, they are not specific to RA.

Other tests, including x rays and **magnetic resonance imaging** (MRI), may be used to determine the cause of chronic back pain or examine internal organs that may be affected by RA.

The American Rheumatology Association designates that at least four of the following seven criteria must be present for at least six weeks to diagnose rheumatoid arthritis.

- morning joint stiffness lasting more than one hour
- pain simultaneously in three or more joint areas
- arthritis in the wrist or hand
- joint pain in symmetrical joint areas (e.g. both wrists, both knees)
- presence of rheumatoid nodules
- presence of serum rheumatoid factor, a protein found in blood
- x rays that show typical rheumatoid arthritis changes in the affected joints

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Treatment

There is presently no cure for rheumatoid arthritis. However, treatment is available to combat the inflammation in order to prevent destruction of the joints and to prevent other complications of the disease. Efforts are also made to maintain flexibility and mobility of the joints. In addition to pain and anti-inflammatory medicines, RA is treated with **antirheumatic drugs**. Rest is prescribed for severely inflamed joints, as using them can aggravate the inflammation. Regular rest periods can often relieve pain, with short periods of bed rest considered helpful to relieve a severe flare-up in its most painful stage.

Treatment is divided into two categories: treatment of symptoms and treatment to stop or slow joint damage. Treatment to improve symptoms includes the use of various pain medications including **nonsteroidal anti-inflammatory drugs** (e.g., **aspirin**, ibuprophen, naproxen **sodium**) and **analgesics** (**acetaminophen**, tramadol), either alone or in combination with narcotic pain medications. **Corticosteroids** such as prednisone and cortisone are also used in the lowest effective dose to control pain and stiffness. Also beneficial is **exercise** and **physical therapy** (PT) to increase strength and flexibility.

Drugs to stop or slow joint damage are collectively called disease-modifying antirheumatic drugs (DMARDs). These drugs, especially when given early in the course of the disease, interfere with the disease process in ways that slow or stop joint damage. DMARDs are often given in combination with drugs to improve symptoms. Some common DMARDs include methotrexate (Rheumatrex, Trexall), hydroxychloroquinine (Plaquenil), sulfasalazine (Azulfidine), leflunomide (Arava), D-pencillamine (Dpen, Cuprimine), azathioprine (Imuran), cyclosporine (Neoral, Sandimmune) and minocycline (Minocin, Dynacin). All these drugs have potentially serious side effects and may require regular blood or other tests.

Rheumatoid arthritis can also be treated with biologic response modifiers (BRMs). BRMs target specific proteins of the immune system that are involved in rheumatoid arthritis. They work to reduce joint inflammation by blocking a substance called tumor necrosis factor (TNF). TNF is a protein that triggers inflammation during the body's normal immune responses. When TNF production is not regulated, the excess TNF can cause inflammation. Most BRMs are approved for use in adults only. The exception is etanercept (Enbrel), which is approved for individuals over age four. Other BRMs used to treat rheumatoid arthritis include infliximab (Remicade), anakinra (Kineret), and adalimumab (Humira). BRMs interfere with and may weaken the immune system. Individuals should not receive live-virus vaccinations while taking BRMs. Other side effects are also possible.

Hydrotherapy can help to greatly reduce pain and inflammation. Moist heat is more effective than dry heat, and cold packs are useful during acute flare-ups. Total bed rest is sometimes prescribed during the very active, painful phases of RA. Splints may be used to support and rest painful joints. Later, after inflammation has somewhat subsided, physical therapists may provide a careful exercise regimen in an attempt to maintain the maximum degree of flexibility and mobility. **Joint replacement** surgery, particularly for the knee and the hip joints, is sometimes recommended when these joints have been severely damaged.

Many complementary and alternative cures are heavily advertised for rheumatoid arthritis. The National Center for Complementary and Alternative Medicine has investigated many of these alternative cures. Most do not provide any benefit to individuals with rheumatoid arthritis. Those complementary and alternative treatments that may have possible benefit include thunder god vine (*Tripteryguim wilfordii*, not available in the United States as of September 2005), gamma-linolenic acid (GLA), fish oil, glucosamine and chondroitin (effective in animals, but unproven in humans), and mind-body **stress reduction** techniques. The National Arthritis Foundation provides information on alternative and complementary therapies; persons with RA may benefit from massage, **acupuncture**, **acupressure**, and various herbs and supplements. Individuals should not replace conventional treatment with alternative therapies, and before adding any herbal or other complementary treatments should consult their physician, as some complementary therapies may interfere with the conventional treatment and/or have serious side effects.

RA patients can also undergo **occupational therapy** (OT), where they are instructed on how to protect affected joints, and how to reduce strain on the joints during daily activities. For instance, special shoes and the use of a cane can help alleviate pain in the feet, knees, and hips when walking. Occupational therapy also seeks to restore abilities that may have been lost, and to suggest approaches to maintain independence and fitness.

When treatment fails to control pain and joint damage, joint replacement surgery followed by guided **rehabilitation** may be necessary. Knee and hip replacement surgery are the most common types of surgery done on individuals with rheumatoid arthritis.

Nutrition/Dietetic concerns

There is presently no scientific evidence showing conclusively that any particular foods may have a

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beneficial effect on joint inflammation, although some reports have proposed that oranges and some fish oils may reduce joint inflammation in some people with RA. A healthy, balanced diet aimed at maintaining a normal weight is important for people afflicted with RA because excess weight increases **stress** on the weight-bearing joints, contributing to joint pain, stiffness and inflammation.

Prognosis

There is no cure for rheumatoid arthritis. The course of the disease is variable. Some people have the disease for only a year or two, and then it goes away on its own without joint damage. Many other people have periods when the disease is quiet and symptoms disappear, only to flare up again for unknown reasons. For some people the disease is continuous, chronic, and progressively worsens.

A number of factors are considered to suggest the likelihood of a worse prognosis. These include:

- race and gender (female and Caucasian).
- more than 20 joints involved.
- extremely high erythrocyte sedimentation rate.
- extremely high levels of rheumatoid factor.
- consistent, lasting inflammation.
- evidence of erosion of bone, joint, or cartilage on x rays.
- poverty.
- older age at diagnosis.
- rheumatoid nodules.
- other coexisting diseases.
- certain genetic characteristics, diagnosable through testing.

In general, the long-term prognosis is poor. The irreversible destruction of joints usually begins within the first 2 years of disease onset in the majority of people with RA. Treatment can manage the pain and swelling caused by RA, and joint damage may even slow down or stop. Treatment can bring relief of symptoms to 75% of those afflicted. However, at least 1 of 10 people eventually becomes severely disabled, and the average life expectancy for a patient with RA may be shortened by 3–7 years.

Prevention

Rheumatoid arthritis cannot be prevented. Early detection and treatment can help slow the disease. Clinical trials of new medications and complementary and alternative therapies for rheumatoid arthritis are ongoing. A list of clinical trials currently enrolling patients is available at www.clinicaltrials.gov.

Health care team roles

A rheumatologist normally oversees the health care team treating an individual with rheumatoid arthritis. Nurses play an important role in patient education by teaching individuals with rheumatoid arthritis how to balance activity and rest. Physical therapists evaluate an individual's range of motion and teach appropriate exercises to promote joint mobility and muscle fitness and the appropriate use of heat and cold treatments. Physical therapists also have special equipment that can provide electrical stimulation to reduce pain and improve joint movement. Occupational therapists teach individuals how to move in ways that protect their joints and how to perform tasks of daily living in ways that reduce pain and stress on he joints. Both PT and OT are essential after surgery but may also be helpful to individuals with advanced rheumatoid arthritis undergoing non-surgical treatments.

Caregiver concerns

The prevalence of RA increases up to age 80 and represents an important cause of disability in elderly persons. In many senior patients, RA first starts during middle age. Some of these patients have secondary joint deformities and deterioration even though the inflammation may be inactive. In most patients of this age group, the arthritis is accompanied by mild or moderate generalized feelings of discomfort (malaise) and anorexia. Fever and night sweats are also occasionally reported. Elderly-onset rheumatoid arthritis (EORA), defined as RA with onset at age 60 years or over, differs slightly from RA. It is characterized by a more equal gender distribution, a higher frequency of acute systemic symptoms with involvement of the shoulder, a higher rate of disease progression, and, in later stages, more joint damage and functional disability. The efficacy and tolerability of medications is similar in both older and younger patient groups, but in the elderly, caution is required with the use of NSAIDs.

Resources

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Arthritis Foundation, P.O. Box 7669, Atlanta, GA, 30357-0669, (800)-283-7800, http://www.arthritis.org.

National Institute of Arthritis and Musculoskeletal Diseases (NIAMS), 1 AMS Circle, Bethesda, MD, 20892-3675, (301)-495-4484, (877)-22-NIAMS, (301)-718-6366, NIAMSinfo@mail.nih.gov, http://www.niams.nih.gov.

Monique Laberge, Ph.D.
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Rheumatoid spondylit *see* **Ankylosing spondylitis**

Rhinitis

Definition

Rhinitis is inflammation of the mucous lining of the nose.

Description

Rhinitis is a nonspecific term that covers infections, **allergies**, and other disorders whose common feature is the location of their symptoms. In rhinitis, the mucous membranes become infected or irritated, producing a discharge, congestion, and swelling of the tissues. The most widespread form of infectious rhinitis is the **common cold**.

The common cold is the most frequent viral infection in the general population, causing more absenteeism from school or work than any other illness. Colds are self-limited, lasting about 3–10 days, although they are sometimes followed by a bacterial infection. Children are more susceptible than adults; teenage boys more susceptible than teenage girls; and adult women more susceptible than adult men. In the United States, colds are most frequent during the late fall and winter.

Causes and symptoms

Colds can be caused by as many as 200 different viruses. The viruses are transmitted by sneezing and coughing, by contact with soiled tissues or handkerchiefs, or by close contact with an infected person. Colds are easily spread in schools, offices, or any place where people live or work in groups. The incubation period ranges between 24 and 72 hours.

The onset of a cold is usually sudden. The virus causes the lining of the nose to become inflamed and produce large quantities of thin, watery mucus. Children

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sometimes run a **fever** with a cold. The inflammation spreads from the nasal passages to the throat and upper airway, producing a dry **cough**, **headache**, and watery eyes. Some people develop muscle or joint aches and feel generally tired or weak. After several days, the nose becomes less inflamed and the watery discharge is replaced by a thick, sticky mucus. This change in the appearance of the nasal discharge helps to distinguish rhinitis caused by a viral infection from rhinitis caused by an allergy.

Diagnosis

There is no specific test for viral rhinitis. The diagnosis is based on the symptoms. In children, the doctor will examine the child's throat and glands to rule out **measles** and other childhood illnesses that have similar early symptoms. Adults whose symptoms last longer than a week may require further testing to rule out a secondary bacterial infection, or an allergy. Bacterial infections can usually be identified from a laboratory culture of the patient's nasal discharge. Allergies can be evaluated by blood tests, skin testing for specific substances, or nasal smears.

Treatment

There is no cure for the common cold; treatment is given for symptom relief. Medications include **aspirin** or **nonsteroidal anti-inflammatory drugs** (NSAIDs) for headache and muscle **pain**, and **decongestants** to relieve stuffiness or runny nose. Patients should be warned against overusing decongestants, because they can cause a rebound effect. Over-the-counter (OTC) **antihistamines** are also available; however, most antihistamines carry warnings of drowsiness and the inability to do some tasks while medicated. Claritin is a prescription-strength OTC non-drowsy antihistamine that helps relieve symptoms of rhinitis. **Antibiotics** are not given for colds because they do not kill viruses.

Supportive care includes bed rest and drinking plenty of fluid.

Treatments under investigation include the use of ultraviolet light and injections of interferon.

Many prescription and over-the-counter drugs are available to help control the symptoms of **allergic rhinitis**. The most common class is antihistamines.

Alternative treatment

Homeopaths might prescribe any of 10 different remedies, depending on the appearance of the nasal discharge, the patient's emotional state, and the stage of infection. Naturopaths would recommend vitamin A and zinc supplements, together with botanical preparations made from goldenseal (*Hydrastis canadensis*), licorice (*Glycyrrhiza glabra*), or astragalus (*Astragalus membraneceus*) root.

KEY TERMS

Interferon—A protein produced by cells infected by a virus that stimulates the body's resistance to the virus.

At one time, the herb (*Echinacea* spp.) was touted as a remedy to relieve cold and rhinitis symptoms. However, a study published in 2004 reported that the herb failed to relieve cold symptoms in 400 children taking it and caused skin **rashes** in some children.

Prognosis

Most colds resolve completely in about a week. Complications are unusual but may include **sinusitis** (inflammation of the nasal sinuses), bacterial infections, or infections of the middle ear.

Prevention

There is no vaccine effective against colds, and infection does not confer immunity. Prevention depends on:

- washing hands often, especially before touching the face
- minimizing contact with people already infected
- not sharing hand towels, eating utensils, or water glasses.

Resources

PERIODICALS

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Rebecca J. Frey, PhD
Teresa G. Odle

Rhinoplasty

Definition

The term rhinoplasty means "nose molding" or "nose forming." It refers to a procedure in **plastic surgery** in which the structure of the nose is changed. The change can be made by adding or removing bone

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or cartilage, grafting tissue from another part of the body, or implanting synthetic material to alter the shape of the nose.

Rhinoplasty is the most frequently performed cosmetic surgical procedure in the United States as of the early 2000s. According to the American Society of Plastic Surgeons (ASPS), 356,554 rhinoplasties were performed in the United States in 2003, compared to 254,140 breast augmentations and 128,667 facelifts.

Purpose

Rhinoplasty is most often performed for cosmetic reasons. A nose that is too large, crooked, misshapen, malformed at birth, or deformed by an injury or **cancer** surgery can be given a more pleasing appearance. If breathing is impaired due to the form of the nose or to an injury, it can often be improved with rhinoplasty.

Precautions

The best candidates for rhinoplasty are those with relatively minor deformities. Nasal anatomy and proportions are quite varied and the final look of any rhinoplasty operation is the result of the patient's anatomy, as well as of the surgeon's skill.

The quality of the skin plays a major role in the outcome of rhinoplasty. Patients with extremely thick skin may not see a definite change in the underlying bone structure after surgery. On the other hand, thin skin provides almost no cushion to hide the most minor of bone irregularities or imperfections.

A cosmetic change in the shape of the nose will change a person's appearance but it will not change self-image. A person who expects a different lifestyle after rhinoplasty is likely to be disappointed.

Rhinoplasty should not be performed until the pubertal growth spurt is complete, between ages 14–15 for girls and older for boys.

The cost of rhinoplasty depends on the difficulty of the work required and on the specialist chosen. Prices run from about $3,000 to over $6,000. If the problem was caused by an injury, insurance will usually cover the cost. A rhinoplasty done only to change a person's appearance is not usually covered by insurance.

Description

The external nose is composed of a series of interrelated parts which include the skin, the bony pyramid, cartilage, and the tip of the nose, which is both cartilage and skin. The strip of skin separating the nostrils is called the columella.

Surgical approaches to nasal reconstruction are varied. Internal rhinoplasty involves making all incisions inside the nasal cavity. The external or "open" technique involves a skin incision across the base of the nasal columella. An external incision allows the surgeon to expose the bone and cartilage more fully and is most often used for complicated procedures. During surgery, the surgeon will separate the skin from the bone and cartilage support. The framework of the nose is then reshaped in the desired form. Shape can be altered by removing bone, cartilage, or skin. The remaining skin is then replaced over the new framework. If the procedure requires adding to the structure of the nose, the donated bone, cartilage, or skin can come from the patient or from a synthetic source.

When the operation is over, the surgeon will apply a splint to help the bones maintain their new shape. The nose may also be packed or stuffed with a dressing, to help stabilize the septum.

When a local anesthetic is used, light **sedation** is usually given first, after which the operative area is numbed. It will remain insensitive to **pain** for the length of the surgery. A general anesthetic is used for lengthy or complex procedures or if the doctor and patient agree that it is the best option.

Simple rhinoplasty is usually performed in an outpatient surgery center or in the surgeon's office. Most procedures take only an hour or two, and patients may return home right away. Complex procedures may be done in the hospital and require a short stay.

Preparation

During the initial consultation, the patient and surgeon will determine what changes can be made in the shape of the nose. Most doctors take photographs at the same time. The surgeon will also explain the techniques and anesthesia options available to the patient.

For legal reasons, many plastic surgeons now screen patients for psychological stability as well as general physical fitness for surgery. When a person consults a plastic surgeon about a rhinoplasty, the doctor will spend some time talking with the patient about his or her motives for facial surgery. The following are considered psychological warning signs:

- The patient is considering surgery to please someone else, most often a spouse or partner.
- The patient expects facial surgery to guarantee career advancement.
- The patient has a history of multiple cosmetic procedures and/or complaints about previous surgeons.

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- The patient thinks that the surgery will solve all his or her life problems.
- The patient has an unrealistic notion of what he or she will look like after surgery.
- The patient seems otherwise emotionally unstable.

The patient and surgeon should also discuss guidelines for eating, drinking, **smoking**, taking or avoiding certain medications, and washing of the face.

Aftercare

Patients usually feel fine immediately after surgery; however, most surgery centers do not allow patients to drive themselves home after an operation.

The first day after surgery there will be some swelling of the face. Patients should stay in bed with their heads elevated for at least a day. The nose may hurt and a **headache** is not uncommon. The surgeon will prescribe medication to relieve these conditions. Swelling and bruising around the eyes will increase for a few days but will begin to diminish after about the third day. Slight bleeding and stuffiness are normal, and vary according to the extensiveness of the surgery performed. Most people are up in two days and back to school or work in a week. No strenuous activities are allowed for two to three weeks.

Patients are given a list of postoperative instructions, which include requirements for hygiene, **exercise**, eating, and follow-up visits to the doctor. Patients should not blow their noses for the first week to avoid disruption of healing. It is extremely important to keep the surgical dressing dry. **Dressings**, splints, and stitches are removed in one to two weeks. Patients should avoid **sunburn**.

Patients should remember that it may take as long as a year for the nose to assume its final shape; the tip of the nose in particular may be mildly swollen for several months.

Risks

Any type of surgery carries a degree of risk. There is always the possibility of unexpected events, such as an infection or a reaction to the anesthesia. Some patients may have a so-called foreign body reaction to a nasal implant made from synthetic materials. In these cases the surgeon can replace the implant with a piece of cartilage from the patient's own body.

Some risks of rhinoplasty are social or psychological. The ASPS patient brochure about rhinoplasty mentions the possibility of criticism or rejection by friends or family if they feel threatened by the patient's new look. This type of reaction sometimes occurs with rhinoplasty if the friends or relatives consider the shape of the nose an important family or ethnic trait.

KEY TERMS

Cartilage—Firm supporting tissue that does not contain blood vessels.

Columella—The strip of skin running from the tip of the nose to the upper lip, which separates the nostrils.

Septum—The dividing wall in the nose.

When the nose is reshaped or repaired from inside, the **scars** are not visible, but if the surgeon needs to make the incision on the outside of the nose, there will be some slight scarring. In addition, tiny blood vessels may burst, leaving small red spots on the skin. These spots are barely visible but may be permanent.

About 10% of patients require a second procedure; however, the corrections required are usually minor.

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ORGANIZATIONS

American Academy of Facial Plastic and Reconstructive Surgery (AAFPRS), 310 South Henry Street, Alexandria, VA, 22314, (703) 299-9291, info@aafprs.org, http://www.aafprs.org/.

American Society of Plastic Surgeons, 444 E. Algonquin Rd, Arlington Heights, IL, 60005, (847) 228-9900, http://www.plasticsurgery.org/.

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Rhinovirus infection *see* **Common cold**

Rhytidoplasty *see* **Face lift**

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Riboflavin deficiency

Definition

Riboflavin deficiency occurs when the chronic failure to eat sufficient amounts of foods that contain riboflavin produces lesions of the skin, lesions of smooth surfaces in the digestive tract, or nervous disorders.

Description

Riboflavin, also called vitamin B_2, is a water-soluble vitamin. The recommended dietary allowance (RDA) for riboflavin is 1.7 mg/day for an adult man and 1.3 mg/day for an adult woman. The best sources of this vitamin are meat, dairy products, and dark green vegetables, especially broccoli. Grains and legumes (beans and peas) also contribute riboflavin to the diet. Riboflavin is required for the processing of dietary fats, carbohydrates, and proteins to convert these nutrients to energy. Riboflavin is also used for the continual process of renewal and regeneration of all cells and tissues in the body.

Riboflavin is sensitive to light. For this reason, commercially available milk is sometimes supplied in cartons, rather than in clear bottles. Riboflavin is not rapidly destroyed by cooking. Milk contains about 1.7 mg riboflavin/kg. Cheese contains about 4.3 mg/kg, while beef has 2.4 mg/kg and broccoli has about 2.0 mg/kg. Apples, a food that is low in all nutrients, except water, contains only 0.1 mg riboflavin per kg.

Causes and symptoms

A deficiency only in riboflavin has never occurred in the natural environment. In contrast, diseases where people are deficient in one vitamin, such as thiamin, vitamin C, and vitamin D, for example, have been clearly documented. Poorer populations in the United States may be deficient in riboflavin, but when this happens, they are also deficient in a number of other nutrients as well. When riboflavin deficiency is actually detected, it is often associated with low consumption of milk, chronic **alcoholism**, or chronic **diarrhea**.

The symptoms of riboflavin deficiency include:

- swelling and fissuring of the lips (cheilosis)
- ulceration and cracking of the angles of the mouth (angular stomatitisis)
- oily, scaly skin rashes on the scrotum, vulva, or area between the nose and lips
- inflammation of the tongue
- red, itchy eyes that are sensitive to light

KEY TERMS

Recommended dietary allowance—The recommended daily allowances (RDAs) are quantities of nutrients of the diet that are required to maintain human health. RDAs are established by the Food and Nutrition Board of the National Academy of Sciences and may be revised every few years. A separate RDA value exists for each nutrient. The RDA values refer to the amount of nutrient needed to maintain health in a population of people. The actual amounts of each nutrient required to maintain health in any specific individual differs from person to person.

Water-soluble vitamin—Water-soluble vitamins can be dissolved in water or juice. Fat-soluble vitamins can be dissolved in oil or in melted fat.

The nervous symptoms of riboflavin deficiency include:

- numbness of the hands
- decreased sensitivity to touch, temperature, and vibration

Diagnosis

Riboflavin status is diagnosed using a test conducted on red blood cells that measures the activity of an enzyme called glutathione reductase. An extract of the red blood cells is placed in two test tubes. One test tube contains no added riboflavin, while the second test tube contains a derivative of riboflavin, called flavin adenine dinucleotide. The added riboflavin derivative results in little or no stimulation of enzyme activity in patients with normal riboflavin levels. A stimulation of 20% or less is considered normal. A stimulation of over 20% means that the patient is deficient in riboflavin.

Treatment

Riboflavin deficiency can be treated with supplemental riboflavin (0.5 mg/kg body weight per day) until the symptoms disappear.

Prognosis

The prognosis for correcting riboflavin deficiency is excellent.

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Prevention

Riboflavin deficiency can be prevented by including milk, cheese, yogurt, meat, and/or certain vegetables in the daily diet. Of the vegetables, broccoli, asparagus, and spinach are highest in riboflavin. These vegetables have a riboflavin content that is similar to that of milk, yogurt, or meat.

Resources

BOOKS

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Tom Brody, PhD

Rickets

Definition

Rickets is a childhood condition caused by serious **vitamin D deficiency**. This lacking in vitamin D results in weak, soft bones, along with slowed growth and skeletal development. Rickets is, by definition, a disorder which begins in childhood. If this problem occurs only later in life it is known as osteomalacia.

Description

Rickets occurs when the body has a severe lack of vitamin D during the developmental years. Vitamin D is essential to the development of strong, healthy bones. A child with rickets can experience stunted growth and will most likely be short in stature as an adult. This is because, without proper vitamin D levels, decreased mineralization of the bones at the growth plate level affects the strength, size and shape of the bones. A related condition called osteomalacia can occur in adults with the same sort of vitamin D deficiency, but osteomalacia occurs only in adulthood after the growth plates of the bones have closed.

Most vitamin D is produced by the body, although some can be directly supplied by diet. In order to accomplish production of vitamin D, the body requires both cholesterol and ultraviolet light. Most often, the cholesterol comes from digesting animal tissue, oils, fats, and egg yolks. The ultraviolet light is usually supplied by direct sunlight. Only when this light is available can the skin alter the cholesterol molecule to make vitamin D. Children who do not receive enough sunlight are at greater risk of developing rickets, as are children with darker skin, which can block the ultraviolet rays. Vitamin D is found naturally in the foods listed above, but more often children receive vitamin D supplements through foods which have had the vitamin added, as in milk or infant formula.

Vitamin D is necessary in the body, because it can be converted into a hormone which stimulates **calcium** intake by the intestines. This conversion begins in the liver, where vitamin D becomes a hormone called 25-OH-D, and is completed when the kidneys convert 25-OH-D into a hormone called 1,25-diOH-D. This is the hormone that causes the intestines to absorb calcium from the person's diet. Without proper levels of vitamin D, there is not enough 1,25-diOH-D produced, which results in lower levels of calcium in the body. Adequate calcium is needed by the bones for both development and maintenance.

Causes and symptoms

Rickets is directly caused by insufficient calcium for bone mineralization during growth and development. This is caused by vitamin D deficiency which can be a result of too little cholesterol, ultraviolet light, or vitamin D supplement. During the Industrial Revolution, rickets was quite common in cities because pollution in the air blocked much of the sunlight needed for vitamin D production in the body. There is also a hereditary type of rickets, called X-linked hypophosphatemia, that causes the kidneys bo be unable to retain phosphate.

The most commonly recognized symptoms of rickets occur in the arms and legs, where **stress** on the underdeveloped bones can cause bowing. Children with rickets may feel **pain** or tenderness in the bones of their arms, legs, spine, pelvis, and ribs. The skull may develop an odd or asymmetrical shape. Calcium levels in the blood will be low and overall growth is often impaired.

Diagnosis

The initial approach to diagnosing rickets involves a musculoskeletal examination followed by an x ray is often. Affected children may have obviously widened spaces between their joints or bowing of the bones in their arms and legs. Some children may not experience normal dental development as well. A doctor may also assess levels of serum calcium, alkaline phosphatase and other indicator chemicals by using a blood test. While calcium levels can be normal or slightly low, alkaline phosphatase levels in a child with rickets can be high even compared to a normal

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KEY TERMS

25-hydroxy-vitamin D—This is the form of vitamin D that is measured in order to assess vitamin D deficiency.

Cholesterol—A fat-soluble steroid alcohol (sterol) found in animal fats and oils, and in egg yolks. The human body needs cholesterol to produce vitamin D.

Growth plate—The place in long bones where growth occurs during childhood.

International unit (IU)—A measurement of biological activity in which one IU is equal to one mg (milligram).

Mineralization—The process by which the body uses minerals to build bone structure.

X-linked hypophosphatemia—A type of rickets caused by genetic factors which prevent the kidneys from retaining phosphate.

adult. While x rays can prove misleading, diagnosis by chemical analysis is highly accurate.

Treatment

The treatment for rickets primarily involves corrections of the conditions which led to the disorder. This can be as simple as a change in diet to include foods high in vitamin D such as milk, fish, or liver. Treatment might also mean a gradual increase in the amount sunlight received by the child. In more severe cases, bracing or surgery may be necessary to aid in the correction and repair of bones. Treatment is usually mild and bone deformities usually reduce over time.

Alternative Treatment

There is currently little known about any alternative method for treating rickets. Treatments which involve raising vitamin D levels and ultraviolet light exposure are usually simple and effective.

Prognosis

Children with rickets are likely to suffer from stunted growth, bone abnormalities and bone pain, however these symptoms often disappear with treatment. In women, deformation of the pelvic bone structure can prevent vaginal **childbirth** later in life. Most deformities correct with growth when proper levels of vitamin D are restored and normal bone calcification is maintained.

Prevention

Rickets caused by vitamin D deficiency is simple to prevent. Commercially available infant formula is usually fortified with more than enough vitamin D for infants. For parents who breastfeed their children, it is recommended by the U.S. Department of Health and Human Services that children also receive 400 international units (10 micrograms) of vitamin D supplement. This is because human breast milk contains little vitamin D. It is also important that children are allowed decent amounts of sunlight. As little as twenty minutes each day can be sufficient. For children living in cities, where pollution is likely to block ultraviolet light, and children with dark skin, which can block ultraviolet light, vitamin D supplement is especially important.

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Tish Davidson, A.M.

Rickets *see* **Vitamin D deficiency**

Rickettsia rickettsii infection *see* **Rocky Mountain spotted fever**

Rickettsialpox

Definition

Rickettsialpox is a relatively mild disease caused by a member of the bacterial family called Rickettsia. Rickettsialpox causes rash, **fever**, chills, heavy sweating, **headache**, eye **pain** (especially when exposed to light), weakness, and achy muscles.

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Description

Like other members of the family of Rickettsia, the bacteria causing rickettsialpox live in mice. Tiny mites feed on these infected mice, thus acquiring the organism. When these mites feed on humans, the bacteria can be transmitted.

Rickettsialpox occurs mostly within cities. In the United States, the disease has cropped up in such places as New York City, Boston, Philadelphia, Pittsburgh, and Cleveland. It has also been identified in Russia, Korea, and Africa.

Causes and symptoms

The specific bacteria responsible for rickettsialpox is called *Rickettsia akari*. A person contracts this bacteria through the bite of an infected mite. After a person has been bitten by an infected mite, there is a delay of about 10 days to three weeks prior to the onset of symptoms.

The first symptom is a bump which appears at the site of the original bite. The bump (papule) develops a tiny, fluid-filled head (vesicle). The vesicle sloughs away, leaving a crusty black scab in its place (eschar). In about a week, the patient develops a fever, chills, heavy sweating, headache, eye pain (especially when exposed to light), weakness, and achy muscles. The fever rises and falls over the course of about a weak. A bumpy rash spreads across the body. Each individual papule follows the same progression: papule, then vesicle, then eschar. The rash does not affect the palms of the hands or the soles of the feet.

Diagnosis

Most practitioners are able to diagnose rickettsialpox simply on the basis of its rising and falling fever, and its characteristic rash. Occasionally, blood will be drawn and tests performed to demonstrate the presence of antibodies (immune cells directed against specific bacterial agents) which would confirm a diagnosis of rickettsialpox.

Treatment

Because rickettsialpox is such a mild illness, some practitioners choose to simply treat the symptoms (giving **acetaminophen** for fever and achiness, pushing fluids to avoid **dehydration**). Others will give their patients a course of the antibiotic tetracycline, which will shorten the course of the illness to about one to two days.

KEY TERMS

Eschar—A crusty, blackish scab.

Papule—A bump on the skin.

Vesicle—A fluid-filled head on a papule.

Prognosis

Prognosis for full recovery from rickettsialpox is excellent. No deaths have ever been reported from this illness, and even the skin rash heals without scarring.

Prevention

As with all mite- or tick-borne illnesses, prevention includes avoidance of areas known to harbor the insects, and/or careful application of insect repellents. Furthermore, because mice pass the bacteria on to the mites, it is important to keep mice from nesting in or around residences.

ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

Rosalyn Carson-DeWitt, MD

Rifampin *see* **Antituberculosis drugs**

Ringing ears *see* **Tinnitus**

Ringworm

Definition

Ringworm is a common fungal infection of the skin. The name is a misnomer, however, since the disease is not caused by a worm. Ringworm may also be referred to as dermatophyte infection or dermatophytosis. Dermatophytes are parasitic fungi that live on keratin, a fibrous structural protein found in hair, nails, and the outer layer of skin.

Ringworm is often classified as a **zoonosis** because humans can contract it from infected animals (as well as from other humans).

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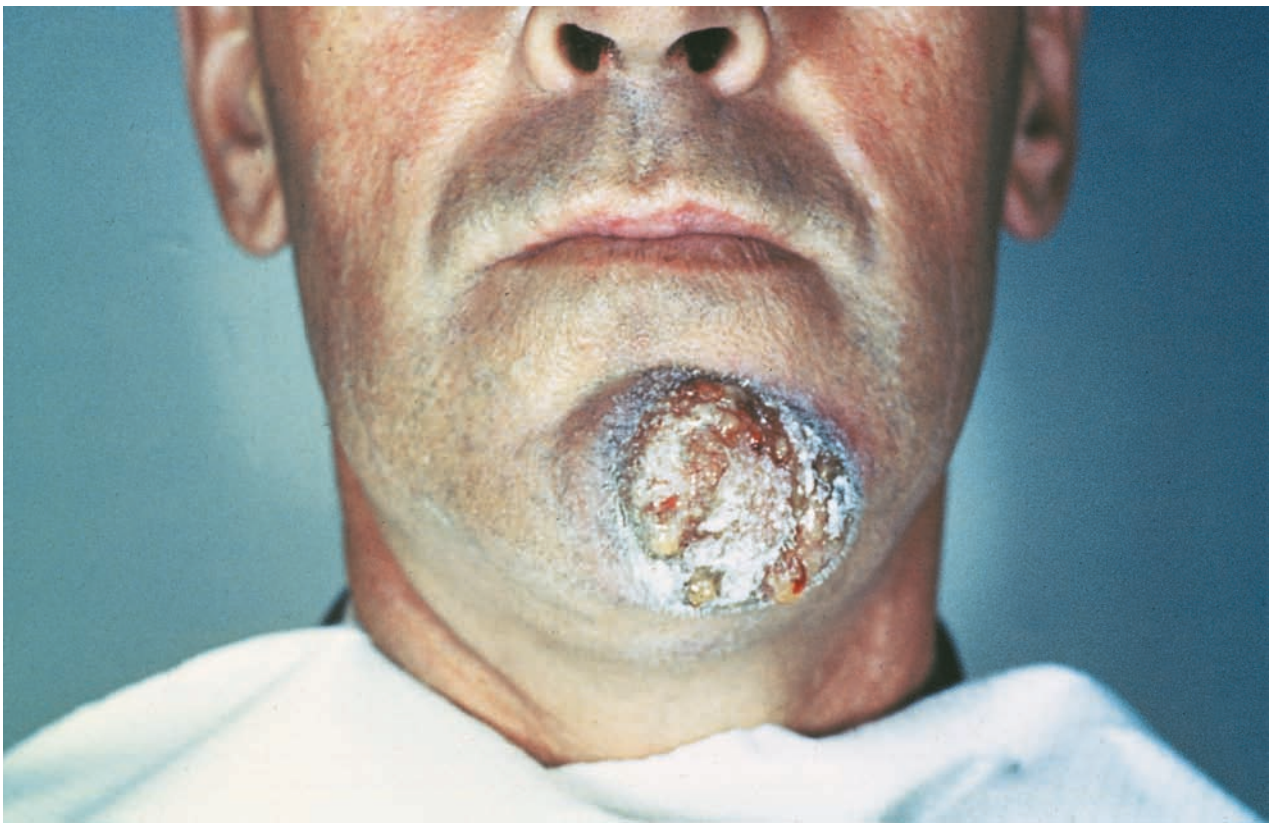

Ringworm on a man's chin. These infections are most common on the feet, scalp, or in toenails, but they can infect any part of the skin. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Demographics

Ringworm is a common fungal infection found in all countries around the world. It is estimated that between 14% and 20% of the world's population has some form of ringworm at any given time. There are an estimated 4.3 million outpatient visits in the United States each year for treatment of ringworm infections; 22% of these visits are for infections of the nails, 20% for body ringworm, 19% for athlete's foot, 15% for ringworm of the scalp, and nine percent for ringworm of the groin (**jock itch**).

The single most common type of ringworm worldwide is infection of the feet, sometimes called tinea pedis or athlete's foot. This type of ringworm is characterized by **itching**, scaly patches, and a burning sensation between the toes; itchy blisters; or unusually dry skin on the sides and soles of the feet.

Some forms of ringworm are more common in certain age groups than in others. As noted below, ringworm of the scalp and hair commonly affects children but is rare after **puberty**. One study of schoolchildren in the American Midwest reported in 2010 that rates of scalp ringworm in schoolchildren range from one percent in some schools to as high as 30% in others. African American children are at particularly high risk of this type of ringworm. One reason why younger children are more susceptible to ringworm of the scalp is that sebum, a waxy substance secreted by skin glands that protects the skin and hair against fungi and some bacteria, is not produced in humans in significant quantities until puberty. Tinea pedis, tinea cruris (jock itch), and nail infections are much more common in adults. About 3% of adult males worldwide and 1.4% of females have fungal nail infections.

Description

Ringworm is characterized by itchy patches of rough, reddened skin. Raised eruptions usually form the circular pattern that gives the condition its name. As the lesions grow, the centers start to heal. The inflamed borders expand and spread the infection. Ringworm is usually a superficial infection confined to the upper layers of the skin or scalp. In some cases, however, it can invade deeper layers of tissue, producing raised areas of boggy and reddened skin known as kerion.

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Types of ringworm

Ringworm is a term that is commonly used to encompass several types of fungal infection. Sometimes, however, only body ringworm is classified as true ringworm.

Body ringworm (tinea corporis) can affect any part of the body except the scalp, feet, and facial area where a man's beard grows (tinea barbae). The well–defined flaky sores can be dry and scaly or moist and crusty.

Scalp ringworm (tinea capitis) is most common in children. It causes scaly, swollen blisters or a rash that looks like black dots. Sometimes inflamed and filled with pus, scalp ringworm lesions can cause crusting, flaking, and round bald patches. Most common in black children, scalp ringworm can cause scarring and permanent hair loss.

Ringworm of the groin (tinea cruris or jock itch) produces raised red sores with well-marked edges. It can spread to the buttocks, inner thighs, and external genitals.

Ringworm of the nails (tinea unguium) generally starts at the tip of one or more toenails, which gradually thicken and discolor. The nail may deteriorate or pull away from the nail bed. Fingernail infection is far less common than toenail infection.

Risk factors

Risk factors for ringworm infections include:

- Living in a hot, humid climate or having a personal tendency to heavy sweating.
- Participating in contact sports, particularly wrestling, football, or rugby.
- Wearing closely fitted clothes or clothing made from synthetic fabrics that do not "breathe."
- Pet ownership. According to the American Academy of Family Physicians (AAFP), there are about two million cases each year in the United States of ringworm acquired from a pet cat or dog.
- Living in a college dormitory, military barracks, or other group housing situation.
- Having AIDS or any other disorder that weakens the immune system.
- Having diabetes mellitus.
- Having cuts, scrapes, or minor breaks in the skin.
- Using greasy hair gels or oils to groom the hair.
- Male sex. Men are more likely than women to contract ringworm infections, particularly athlete's foot and jock itch. Fungal nail infections are twice as common in men as in women.

Causes and symptoms

Causes

Ringworm is caused by parasitic fungi belonging to one of three genera: *Trichophyton* , *Microsporum*, or *Epidermophyton*. Humans can acquire the parasites through any of three routes of transmission: pe2r-son–to–person contact, including contact with sheets, towels, sports equipment, or other personal items used by an infected person; contact with an infected animal; or contact with contaminated soil, including garden soil. *Trichophyton rubrum* and *Trichophyton tonsurans* are most commonly spread from person to person, while *Microsporum canis* is most commonly transmitted to humans from infected household pets. Cats are the most common carriers of *Microsporum canis*, but the fungus is also frequently carried by dogs, horses, pet mice and rabbits, and farm animals.

When dermatophytes are transmitted to a human or animal's skin, fur, nails, or hair, they obtain nutrients from keratin, a protein found in these tissues. The rash and other symptoms of ringworm are caused by the immune system's reaction to the metabolic byproducts of the fungi.

Symptoms

The symptoms of ringworm typically begin between 4 and 14 days after exposure and include one or more of the following:

- Itchy red patches of scaly skin that may also blister and ooze tissue fluid. The patches are often ring-shaped, with normal-appearing skin in the center of the ring.
- Nearby skin may appear darker or lighter than normal.
- Ringworm infections of the scalp or beard area (in adult males) typically produce bald spots or areas of hair loss. In some cases the hair loss may be permanent. Severe cases of ringworm on the scalp may be marked by raised nodules or pustules.
- Infections of the nails may produce thickened, discolored, and crumbly nails. In some cases the entire nail may detach from the underlying nail bed. Infections of the toenails are more common than infections of the fingernails.
- It is possible for a secondary bacterial infection to develop in areas of the body infected by the ringworm fungi, often as a result of scratching itchy areas. The person may then develop a fever along with increased reddening of the affected area, a discharge of pus, and swelling. *A doctor should be*

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KEY TERMS

Dermatologist—A doctor who specializes in diagnosing and treating diseases of the skin.

Dermatophyte—The medical name for three genera of fungi that cause ringworm in humans and domestic pets. The name is derived from two Greek words that mean "skin" and "plant."

Keratin—A type of protein that provides structure to the nails, hair, and outer layer of skin.

Kerion—A raised boggy or swollen patch of reddened skin that develops as a complication of ringworm.

Pustule—A small elevation of the skin containing pus or cloudy tissue fluid.

Sebum—An oily or waxy substance secreted by certain glands in the skin that protects hair and skin against fungi and some bacteria.

Tinea—The general medical term for a fungal infection of the skin. It is often used as a synonym for ringworm.

Wood's lamp—A special ultraviolet lamp used by dermatologists to diagnose ringworm and other skin disorders.

Zoonosis (plural, zoonoses)—Any disease that can be transmitted to humans by animals. Ringworm is a zoonosis caused by fungi.

contacted at once if these symptoms of bacterial infection develop.

Household pets carrying dermatophytes often do not have any noticeable symptoms, although they may develop circular bare patches of skin.

Diagnosis

Diagnosis of ringworm is based on a combination of patient history, an office examination, and laboratory tests.

Examination

In many cases the diagnosis of ringworm can be made by a primary care physician, but the patient may also be referred to a dermatologist (a doctor who specializes in treating skin disorders). The doctor will usually ask some questions about the patient's living situation (including pets); school or work history; participation in sports or other outdoor activities; and any history of immune disorders.

Tests

The doctor will begin with a visual examination of the patient's skin or other affected areas of the body. He or she may also use a Wood's lamp, which is a special kind of ultraviolet lamp named for the doctor who invented it in 1903. The patient sits in a darkened room while the doctor shines the ultraviolet light about four or five inches away from the affected area. Normal skin or hair will not change color under the lamp. While ringworm caused by *Trichophyton tonsurans* will not fluoresce under a Wood's lamp, ringworm caused by *Microsporum canis* will appear as blue–green or greenish patches.

Procedures

The doctor may also take a scraping of material from the affected area and dissolve it in a solution of potassium hydroxide. The resultant mixture can be examined under a microscope. When dermatophytes are present, the doctor will be able to see their spores or other characteristic structures. If it is important to identify the particular species of fungus, the doctor can use a special medium called dermatophyte test medium or DTM. A scraping of material from the patient's hair or skin is embedded in the DTM and cultured at room temperature for 10–14 days. If dermatophytes are present, the DTM will turn bright red. Other fungi will not cause a color change.

The tests used by veterinarians to diagnose ringworm in pets are the same as those used in humans.

Treatment

Traditional

A person with body ringworm should wear loose clothing and check daily for raw, open sores. Wet **dressings** applied to moist sores two or three times a day can lessen inflammation and loosen scales. The doctor may suggest placing special pads between folds of infected skin, and anything the patient has touched or worn should be sterilized in boiling water. Patients should see their doctor if symptoms do not improve after four weeks of self-care.

Infected nails should be cut short and straight and carefully cleared of dead cells with an emery board.

Patients with jock itch should:

- wear cotton underwear and change it more than once a day

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- keep the infected area dry
- apply antifungal ointment over a thin film of antifungal powder

Patients should wash their sheets, pillowcases, and pajamas every day while infected.

Drugs

Some ringworm infections disappear without treatment. Others respond to such topical antifungal medications as naftifine (Caldesene Medicated Powder) or tinactin (Desenex). Ringworm that covers large areas of the body is usually treated with either prescription topical or oral medications. Topical prescription drugs include butenafine (Mentax), ciclopirox (Loprox), miconazole (Monistat-Derm), oxiconazole (Oxistat), or terbinafine (Lamisil). Oral medications for ringworm include traconazole (Sporanox), fluconazole (Diflucan), and ketoconazole (Nizoral). Medications should be continued for two weeks after lesions disappear.

Oral medications for ringworm do have side effects, the most common of which are digestive upsets, abnormal liver functioning, and skin **rashes**. In addition, people taking these drugs should avoid taking **antacids** for **indigestion** or peptic ulcer disease during treatment for ringworm, as antacids interfere with the effectiveness of oral antifungal drugs.

Shampoo containing selenium sulfide can help prevent spread of scalp ringworm, but prescription shampoo or oral medication is usually needed to cure hair or scalp infections. Ketoconazole is particularly effective in treating ringworm of the hair or scalp.

The doctor will also prescribe oral **antibiotics** if the patient has developed a secondary bacterial infection.

Pets with ringworm are treated with many of the same medications used to treat the fungi in humans, particularly terbinafine and fluconazole. The veterinarian will also often recommend trimming or clipping the pet's fur during treatment. Close shaving is not recommended, however, because of the risk of causing breaks or small cuts in the cat or dog's skin. Another treatment for infected pets is twice-weekly dips in a diluted solution of lime sulfur over a three– to eight–week period to eliminate the fungal spores.

Alternative

The fungal infection ringworm can be treated with homeopathic remedies. Among the homeopathic remedies recommended are:

- *sepia* for brown, scaly patches
- *tellurium* for prominent, well–defined, reddish sores
- *graphites* for thick scales or heavy discharge
- *sulphur* for excessive itching.

Topical applications of antifungal herbs and essential oils also can help resolve ringworm. Tea tree oil (*Melaleuca* spp.), thuja (*Thuja occidentalis*), and lavender (*Lavandula officinalis*) are the most common. Two drops of essential oil in 1/4 oz of carrier oil is the dose recommended for topical application. Essential oils should not be applied to the skin undiluted. Botanical medicine can be taken internally to enhance the body's immune response. A person must be susceptible to exhibit this overgrowth of fungus on the skin. Echinacea(*Echinacea* spp.) and astragalus (*Astragalus membranaceus*) are the two most common immune-enhancing herbs. A well-balanced diet, including protein, complex carbohydrates, fresh fruits and vegetables, and good quality fats, is also important in maintaining optimal immune function. Alternative treatments should be used with care, as the benefits of many such treatments have not been confirmed by scientific research.

Prognosis

Ringworm can usually be cured but recurrence is common. Chronic infection develops in one patient in five. Patients with weakened immune systems may develop invasive dermatophyte infections that are difficult to treat.

It can take six to 12 months for new hair to cover bald patches, and three to 12 months to cure infected fingernails. Toenail infections do not always respond to treatment.

Prevention

The following precautions may help to lower the risk of dermatophyte infections:

- Maintain good personal hygiene, including frequent handwashing.
- Do not share towels, bedding, sports equipment, hair brushes, or other similar items.
- Stay cool and dry during hot, sticky weather or when traveling to tropical climates. Wear cotton, linen, or other natural fabrics that absorb perspiration rather than holding it against the body, and wear loose rather than closely fitted garments.
- Make sure household pets have regular veterinary checkups, and vacuum the household regularly so that shed fur does not accumulate.
- Keep common areas in the house or school clean; be particularly careful about the cleanliness of locker rooms, gyms, and swimming pools.

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- Notify local public health authorities if there is an outbreak of ringworm in your child's school or day-care center.
- Use a dilute solution of chlorine bleach (1/4 cup per gallon of water) to disinfect counter tops and other hard surfaces that are safe to bleach.

Resources

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ORGANIZATIONS

American Academy of Dermatology (AAD), P.O. Box 4014, Schaumburg, IL, 60168, (847) 330-0230, (866) 503-SKIN, (847) 240-1859, http://www.aad.org/.

American College of Sports Medicine (ACSM), P.O. Box 1440, Indianapolis, IN, 46206, (317) 637-9200, (317) 634-7817, http://www.acsm.org/.

American Veterinary Medical Association (AVMA), 1931 North Meacham Rd., Suite 100, Schaumburg, IL, 60173-4360, (847) 925-8070, (847) 925-1329, avmainfo@avma.org, http://www.avma.org/.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Rd., Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

National Institute of Allergy and Infectious Diseases (NIAID), 6610 Rockledge Dr., MSC 6612, Bethesda, MD, 20892-6612, (301) 496-5717, (866 284-4107, (301) 402-3573, http://www3.niaid.nih.gov.

Maureen Haggerty
Rebecca J. Frey, PhD

Rinne test *see* **Hearing tests with a tuning fork**

Ritonavir *see* **Protease inhibitors**

River blindness *see* **Filariasis**

RMSF *see* **Rocky Mountain spotted fever**

Rocky Mountain spotted fever

Definition

Rocky Mountain spotted fever (RMSF) is a tick-borne illness caused by a bacteria, resulting in a high fever and a characteristic rash.

Description

The bacteria causing RMSF is passed to humans through the bite of an infected tick. The illness begins within about two weeks of such a bite. RMSF is the most widespread tick-borne illness in the United States, occurring in every state except Alaska and Hawaii. The states in the mid-Atlantic region, the Carolinas, and the Virginias have a great deal of tick activity during the spring and summer months, and the largest number of RMSF cases come from those states. About 5% of all ticks carry the causative bacteria. Children under the age of 15 years have the majority of RMSF infections.

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Causes and symptoms

The bacterial culprit in RMSF is called *Rickettsia rickettsii*. It causes no illness in the tick carrying it, and can be passed on to the tick's offspring. When a tick attaches to a human, the bacteria is passed. The tick must be attached to the human for about six hours for this passage to occur. Although prompt tick removal will cut down on the chance of contracting RMSF, removal requires great care. If the tick's head and body are squashed during the course of removal, the bacteria can be inadvertently rubbed into the tiny bite wound.

Symptoms of RMSF begin within two weeks of the bite of the infected tick. Symptoms usually begin suddenly, with high fever, chills, **headache**, severe weakness, and muscle **pain**. Pain in the large muscle of the calf is very common, and may be particularly severe. The patient may be somewhat confused and delirious. Without treatment, these symptoms may last two weeks or more.

The rash of RMSF is quite characteristic. It usually begins on the fourth day of the illness, and occurs in at least 90% of all patients with RMSF. It starts around the wrists and ankles, as flat pink marks (called macules). The rash spreads up the arms and legs, toward the chest, abdomen, and back. Unlike **rashes** which accompany various viral infections, the rash of RMSF does spread to the palms of the hands and the soles of the feet. Over a couple of days, the macules turn a reddish-purple color. They are now called petechiae, which are tiny areas of bleeding under the skin (pinpoint hemorrhages). This signifies a new phase of the illness. Over the next several days, the individual petechiae may spread into each other, resulting in larger patches of hemorrhage.

The most severe effects of RMSF occur due to damage to the blood vessels, which become leaky. This accounts for the production of petechiae. As blood and fluid leak out of the injured blood vessels, other tissues and organs may swell and become damaged, and:

- breathing difficulties may arise as the lungs are affected.
- heart rhythms may become abnormal
- kidney failure occurs in very ill patients
- liver function drops
- the patient may experience nausea, vomiting, abdominal pain, and diarrhea
- the brain may swell (encephalitis) in about 25% of all RMSF patients (brain injury can result in seizures, changes in consciousness, actual coma, loss of coordination, imbalance on walking, muscle spasms, loss of bladder control, and various degrees of paralysis)
- the clotting system becomes impaired, and blood may be evident in the stools or vomit

Diagnosis

Diagnosis of RMSF is almost always made on the basis of the characteristic symptoms, coupled with either a known tick bite (noted by about 60–70% of patients) or exposure to an area known to harbor ticks. Complex tests exist to nail down a diagnosis of RMSF, but these are performed in only a few laboratories. Because the results of these tests take so long to obtain, they are seldom used. This is because delaying treatment is the main cause of **death** in patients with RMSF.

Treatment

It is essential to begin treatment absolutely as soon as RMSF is seriously suspected. Delaying treatment can result in death.

Antibiotics are used to treat RMSF. The first choice is a form of tetracycline; the second choice (used in young children and pregnant women) is chloramphenicol. If the patient is well enough, treatment by oral intake of medicine is perfectly effective. Sicker patients will need to be given the medication through a needle in the vein (intravenously). Penicillin and sulfa drugs are not suitable for treatment of RMSF, and their use may increase the death rate by delaying the use of truly effective medications.

Very ill patients will need to be hospitalized in an intensive care unit. Depending on the types of complications a particular patient experiences, a variety of treatments may be necessary, including intravenous fluids, blood transfusions, anti-seizure medications, **kidney dialysis**, and mechanical ventilation (a breathing machine).

Alternative treatment

Although alternative treatments should never be used in place of conventional treatment with antibiotics, they can be useful adjuncts to antibiotic therapy. The use of *Lactobacillus acidophilus* and *L. bifidus* supplementaion during and after antibiotic treatment can help rebalance the intestinal flora. **Acupuncture**, homeopathy, and botanical medicine can all be beneficial supportive therapies during recovery from this disease.

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KEY TERMS

Encephalitis—Inflammation of the tissues of the brain.

Macule—A flat, discolored area on the skin.

Petechia—A small, round, reddish purple spot on the skin, representing a tiny area of bleeding under the skin.

Prognosis

Prior to the regular use of antibiotics to treat RMSF, the death rate was about 25%. Although the death rate from RMSF has improved greatly with an understanding of the importance of early use of antibiotics, there is still a 5% death rate. This rate is believed to be due to delays in the administration of appropriate medications.

Certain risk factors suggest a worse outcome in RMSF. Death rates are higher in males and increase as people age. It is considered a bad prognostic sign to develop symptoms of RMSF within only two to five days of a tick bite.

Prevention

The mainstay of prevention involves avoiding areas known to harbor ticks. However, because many people enjoy recreational activities in just such areas, the following steps can be taken:

- Wear light colored clothing (so that attached ticks are more easily noticed).
- Wear long sleeved shirts and long pants; tuck the pants legs into socks.
- Spray clothing with appropriate tick repellents.
- Examine. Anybody who has been outside for any amount of time in an area known to have a population of ticks should examine his or her body carefully for ticks. Parents should examine their children at the end of the day.
- Remove any ticks using tweezers, so that infection doesn't occur due to handling the tick. Grasp the tick's head with the tweezers, and pull gently but firmly so that the head and body are entirely removed.
- Keep areas around homes clear of brush, which may serve to harbor ticks.

ORGANIZATIONS

Centers for Disease Control and Prevention, 1600 Clifton Rd., NE, Atlanta, GA, 30333, (404) 639-3311, (800) 311-3435, http://www.cdc.gov.

Rosalyn Carson-DeWitt, MD

Rogaine *see* **Minoxidil**

Rolfing

Definition

Rolfing, also called Rolf therapy or structural integration, is a holistic system of bodywork that uses deep manipulation of the body's soft tissue to realign and balance the body's myofascial structure. Rolfing improves posture, relieves chronic **pain**, and reduces **stress**.

Purpose

Rolfing helps to improve posture and bring the body's natural structure into proper balance and alignment. This can bring relief from general aches and pains, improve breathing, increase energy, improve self-confidence, and relieve physical and mental stress. Rolfing has also been used to treat such specific physical problems as chronic back, neck, shoulder, and joint pain, and repetitive stress injuries, including **carpal tunnel syndrome**. Many amateur and professional athletes, including Olympic skaters and skiers, use Rolfing to keep in top condition, to prevent injuries, and to more quickly recover from injuries.

Description

Origins

Ida Pauline Rolf (1896–1979) was a biochemist from New York who developed structural integration over the course of many years after an accident as a young woman. She was kicked by a horse's hoof on a trip out West and developed symptoms resembling those of acute **pneumonia**. She made her way to a hospital in Montana, where she was treated by a physician who called in an osteopath to assist in her treatment. After the osteopath treated her, she was able to breathe normally. After her return to New York, her mother took her to a blind osteopath for further treatment. He taught her about the body's structure and function, after which Rolf became

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IDA P. ROLF, PH.D. (1896–1979)

Born in New York City and raised in the Bronx, Ida P. Rolf attended school in the New York area, graduating from Barnard College in 1916. In 1920, she graduated from the Columbia University College of Physicians and Surgeons with a doctorate in biological chemistry. For the next 12 years, she worked in the departments of chemotherapy and organic chemistry at the Rockefeller Institute. During an extended leave of absence, she studied atomic physics and mathematics at the Swiss Technical University in Zurich and homeopathic medicine in Geneva. During the 1930s, she studied osteopathy, chiropractic medicine, tantric yoga, the Alexander Technique of tension reduction through body movement, and the philosophy of altered states of consciousness of Alfred H.S. Korzybski.

Her interest in body structure, movement, and manipulation began after being kicked by a horse shortly after graduating from Barnard. The accident left her with acute pneumonia. Dissatisfied with conventional medical treatment, she began her quest for more natural and effective ways of treating the body.

By 1940, Dr. Rolf had developed a technique of body movement she called structural integration, also known today as Rolfing. The therapy reshapes the body's muscular structure by applying pressure and energy, freeing the body from physical and emotional traumas. In 1977, she authored *Rolfing: The Integration of Human Structures*. She continued to teach and refine her therapy until her death in 1979. Dr. Rolf's desire to teach her work to others led to her establishing the Guild for Structural Engineering, now known as the Rolf Institute of Structural Integration: http://www.rolf.org/

dissatisfied with conventional medical treatment. Following completion of a doctorate in biochemistry from Columbia University in 1920, Rolf studied atomic physics, mathematics, and **homeopathic medicine** in Europe. After 1928, when her father died and left her an inheritance that allowed her to pursue her own studies, she explored various forms of alternative treatment, including **osteopathy**, **chiropractic** medicine, tantric **yoga**, the **Alexander technique** of tension reduction through body movement, and Alfred Korzybski's philosophy of altered states of consciousness.

By 1940, Rolf had synthesized what she had learned from these various disciplines into her own technique of body movement that she called structural integration, which later became known as Rolfing. During the Second World War, Rolf continued to study with an osteopath in California named Amy Cochran. In the mid-1960s, Gestalt therapist Fritz Perls invited Rolf to Esalen, where she began to develop a following among people involved in the human potential movement. In 1977, she published *Rolfing: The Integration of Human Structures*, the definitive book on structural integration bodywork. She continued to refine the therapy until her **death** in 1979. Rolf's work is carried on through her Guild for Structural Integration, now known as the Rolf Institute of Structural Integration, which she founded in 1971 in Boulder, Colo.

Rolfing is more than just a massage of the body's surface. It is a system that reshapes the body's myofascial structure by applying pressure and energy, thereby freeing the body from the effects of physical and emotional traumas. Although Rolfing is used extensively to treat **sports injuries** and back pain, it is not designed as a therapy for any particular condition. Rather, it is a systematic approach to overall wellness. It works by counteracting the effects of gravity, which over time pulls the body out of alignment. This pull causes the body's connective tissue to become harder and stiffer, and the muscles to atrophy. Signs of this stiffening and contraction include slouching or an overly erect posture.

Rolfing identifies the vertical line as the ideal that the body should approximate. The mission statement of the Guild for Structural Integration describes Rolfing as "a method and a philosophy of personal growth and integrity . . .The vertical line is our fundamental concept. The physical and psychological embodiment of the vertical line is a way of Being in the physical world [that] forms a basis for personal growth and integrity."

The basic ten

Basic Rolfing treatment consists of 10 sessions, each lasting 60–90 minutes and costing about $100 each. The sessions are spaced a week or longer apart. After a period of integration, specialized or advanced treatment sessions are available. A "tuneup" session is recommended every six months. In each session, the Rolfer uses his or her fingers, hands, knuckles, and elbows to rework the connective tissue over the entire body. The tissues are worked until they become pliable, allowing the muscles to lengthen and return to their normal alignment. The deep tissue manipulation improves posture and agility, and increases the body's range

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KEY TERMS

Atrophy—A progressive wasting and loss of function of any part of the body.

Carpal tunnel syndrome—A condition caused by compression of the median nerve in the carpal tunnel of the hand, characterized by pain.

Fascia—The sheet of connective tissue that covers the body under the skin and envelops every muscle, bone, nerve, gland, organ, and blood vessel. Fascia helps the body to retain its basic shape.

Osteopathy—A system of medical practice that believes that the human body can make its own remedies to heal infection. It originally used manipulative techniques but also added surgical, hygienic, and medicinal methods when needed.

Parasympathetic nervous system—A part of the autonomic nervous system that is concerned with conserving and restoring energy. It is the part of the nervous system that predominates in a state of relaxation.

Structural integration—The term used to describe the method and philosophy of life associated with Rolfing. Its fundamental concept is the vertical line.

of movement. Rolfers also believe that the blocked energy accumulated in the tissue from emotional tension is released through Rolfing treatment, causing the patient to feel more energetic and have a more positive frame of mind.

Clients are asked to wait for a period of six to 12 months before scheduling advanced work, known as the PostTen/Advanced Series. This period allows the body to integrate the work done in the "Basic Ten."

Rolfing movement integration

Rolfing movement integration, or RMI, is intended to help clients develop better awareness of their vertical alignment and customary movement patterns. They learn to release tension and discover better ways to use body movement effectively.

Rolfing rhythms

Rolfing rhythms are a series of exercises intended to remind participants of the basic principles of Rolfing: ease, length, balance, and harmony with gravity. In addition, Rolfing rhythms improve the client's flexibility as well as muscle tone and coordination.

Preparations

No pre-procedure preparations are needed to begin Rolfing treatment. The treatment is usually done on a massage table with the patient wearing only undergarments. Prior to the first session, however, the client is asked to complete a health questionnaire, and photographs are taken to assist with evaluation of his or her progress.

Precautions

Since Rolfing involves vigorous deep tissue manipulation, it is often described as uncomfortable and sometimes painful, especially during the first several sessions. In the past decade, however, Rolfers have developed newer techniques that cause less discomfort to participants. Since Rolfing is a bodywork treatment that requires the use of hands, it may be a problem for people who do not like or are afraid of being touched. It is not recommended as a treatment for any disease or a chronic inflammatory condition such as arthritis, and can worsen such a condition. Anyone with a serious medical condition, including heart disease, diabetes, or respiratory problems, should consult with a medical practitioner before undergoing Rolfing.

Side effects

There are no reported serious side effects associated with Rolfing when delivered by a certified practitioner to adults and juveniles.

Research and general acceptance

There is a growing amount of mainstream scientific research documenting the effectiveness of Rolf therapy. A 1988 study published in the *Journal of the American Physical Therapy Association* indicated that Rolfing stimulates the parasympathetic nervous system, which can help speed the recovery of damaged tissue. Other studies done in the 1980s concerned the effectiveness of Rolfing in treating figure skaters and children with **cerebral palsy**. In 1992 a presentation was made to the National Center of Medical **Rehabilitation** Research regarding Rolfing in the treatment of degenerative joint disease. A 1997 article in *The Journal of Orthopedic*

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and Sports Physical Therapy reported that Rolfing can provide effective and sustained pain relief from lower back problems.

Resources

BOOKS

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ORGANIZATIONS

Rolf Institute of Structural Integration, 5055 Chaparral Ct. Suite 103, Boulder, CO, 80301, (303) 449-5903, (303) 449-5978, (800) 530-8875, http://www.rolf.org.

Ken R. Wells

Root canal treatment

Definition

Root canal treatment, also known as endodontic treatment, is a dental procedure in which the diseased or damaged pulp (central core) of a tooth is removed and the inside areas (the pulp chamber and root canals) are filled and sealed.

Purpose

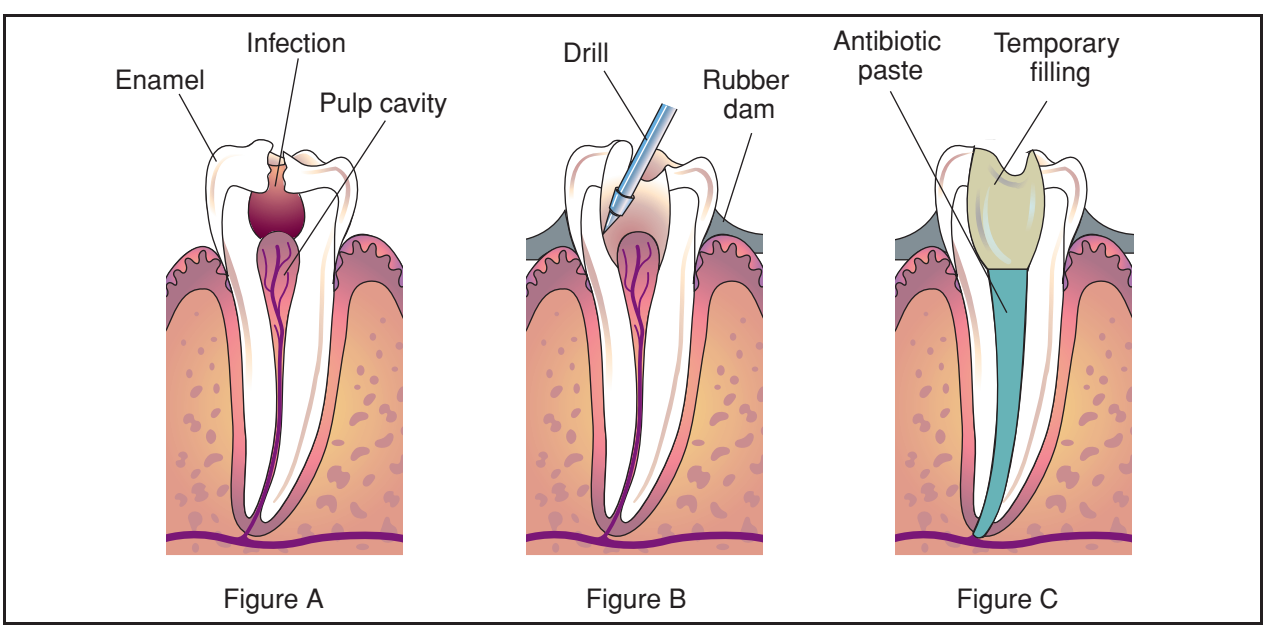
An inflamed or infected pulp is called pulpitis. It is the most common cause of a **toothache**. To relieve the **pain** and prevent further complications, the tooth may be extracted (surgically removed) or saved by root canal treatment.

Demographics

Root canal treatment has become a common dental procedure. According to the American Association of Endodontists, more than 15 million root canal treatments are performed every year in North America as of 2010, with a 97% success rate.

Description

Inside the tooth, the pulp of a tooth is comprised of soft tissue that contains the blood supply, by which the tooth receives its nutrients; and the nerve, by which the tooth senses hot and cold. This tissue is vulnerable to damage from deep dental decay, accidental injury, tooth fracture, or trauma from repeated dental procedures such as multiple fillings or restorations over time. If a tooth becomes diseased or injured, bacteria may build up inside the pulp, spreading infection from the natural crown of the tooth to the root tips in the jawbone. Pus



Root canal treatment is a dental procedure in which the diseased pulp of a tooth is removed and the inside areas are filled and sealed. In figure A, the infection can be seen above the pulp cavity. The dentist drills into the enamel and the pulp cavity is extracted (figure B). Finally, the dentist fills the pulp cavity with antibiotic paste and a temporary filling (figure C). *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

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KEY TERMS

Abscess—A cavity or space in tooth or gum tissue filled with pus as the result of infection. Its swelling exerts pressure on the surrounding tissues, causing pain.

Apicoectomy—Also called root resectioning. The root tip of a tooth is accessed in the bone and a small amount is shaved away. The diseased tissue is removed and a filling is placed to reseal the canal.

Crown—The natural crown of a tooth is that part of the tooth covered by enamel. Also, a restorative crown is a protective shell that fits over a tooth.

Endodontic—Pertaining to the inside structures of the tooth, including the dental pulp and tooth root, and the periapical tissue surrounding the root.

Endodontist—A dentist who specializes in the diagnosis and treatment of disorders affecting the inside structures of teeth.

Extraction—The surgical removal of a tooth from its socket in a bone.

Gutta percha—An inert, latex-like substance used for filling root canals.

Pulp—The soft innermost layer of a tooth, containing blood vessels and nerves.

Pulp chamber—The area within the tooth occupied by dental pulp.

Pulpitis—Inflammation of the pulp of a tooth involving the blood vessels and nerves.

Root canal—The space within a tooth that runs from the pulp chamber to the tip of the root.

Root canal treatment—The process of removing diseased or damaged pulp from a tooth, then filling and sealing the pulp chamber and root canals.

Smear layer—A layer of organic and inorganic material produced on teeth by dental instrumentation that may also contain bacteria and their by-products.

accumulating at the ends of the roots can form a painful **abscess** that can damage the bone supporting the teeth. Such an infection may produce pain that is severe, constant, or throbbing. It can also result in prolonged sensitivity to heat or cold, swelling, and tenderness in the surrounding gums, facial swelling, or discoloration of the tooth. In some cases, however, the pulp may die so gradually that there is little noticeable pain.

Root canal treatment is performed under **local anesthesia**. A thin sheet of rubber called a rubber dam is placed in the mouth and around the base of the tooth to isolate the tooth and help to keep the operative field dry. The dentist removes any **tooth decay** and makes an opening through the natural crown of the tooth into the pulp chamber. Creating this access also relieves the pressure inside the tooth and can dramatically ease pain.

The dentist determines the length of the root canals, usually with a series of x rays. Small wire-like files are then used to clean the entire canal space of diseased pulp tissue and bacteria. The debris is flushed out with large amounts of water (irrigation). The canals are also slightly enlarged and shaped to receive an inert (non-reactive) filling material called gutta percha. However, the tooth is not filled and permanently sealed until it is completely free of active infection. The dentist may place a temporary seal, or leave the tooth open to drain, and prescribe an antibiotic to counter any spread of infection from the tooth. This is why root canal treatment may require several visits to the dentist.

Once the canals are completely clean, they are filled with gutta percha and a sealer cement to prevent bacteria from entering the tooth in the future. A metal post may be placed in the pulp chamber for added structural support and better retention of the crown restoration. The tooth is protected by a temporary filling or crown until a permanent restoration may be made. This restoration is usually a gold or porcelain crown, although it may be a gold inlay, or an amalgam or composite filling (paste fillings that harden).

The use of lasers to perform root canal therapy is a recent but controversial innovation, although it has been approved by the Food and Drug Administration (FDA). In theory, the beam of intense light from the erbium laser that the dentist uses melts the debris (also called the smear layer) inside the tooth, cleansing it completely. It is possible, however, for a laser beam to miss some of the infection within the tooth, particularly if the root canal itself is unusually shaped or has a number of small crevices. In addition, the use of lasers in root canal treatment has been reported to occasionally damage the tooth.

Diagnosis/Preparation

Signs that a root canal treatment is necessary include severe pain while chewing, prolonged sensitivity

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to heat or cold, or a darkening of the tooth. Swelling and tenderness of the gums or pimples appearing on the gums are also common symptoms. However, it is also possible that no symptoms will be noticed. The dentist will take an x ray of the tooth to determine if there is any sign of infection in the surrounding bone.

Aftercare

Once a root canal treatment is performed, the recipient must have a crown placed over the tooth to protect it. The cost of the treatment and the crown may be expensive. However, replacing an extracted tooth with a fixed bridge, a removable partial denture, or an implant to maintain the space and restore the chewing function is typically even more expensive.

During the time when **antibiotics** are being used, care should be taken to avoid using the tooth to chew food. The tooth has been structurally weakened and may break, or there is a possibility of the interior of the tooth becoming reinfected.

If the tooth feels sensitive following the procedure, a standard over-the-counter pain medication such as ibuprofen or naproxen may be taken. This sensitivity will fade after a few days. In most cases the patient can resume regular activity the following day.

Risks

There is a possibility that a root canal treatment will not be successful the first time. If infection and inflammation recur and an x ray indicates a repeat treatment is feasible, the old filling material is removed and the canals are thoroughly cleaned out. The dentist will try to identify and correct problems with the first root canal treatment before filling and sealing the tooth a second time.

In cases where an x ray indicates that another root canal treatment cannot correct the problem, endodontic surgery may be performed. In a procedure called an apicoectomy, or root resectioning, the root end of the tooth is accessed in the bone, and a small amount is shaved away. The area is cleaned of diseased tissue and a filling is placed to reseal the canal.

Normal results

With successful root canal treatment, the tooth will no longer cause pain. However, because it does not contain an internal nerve, it no longer has sensitivity to hot, cold, or sweets. Because these are signs of dental decay, the root canal recipient must receive regular dental check-ups with periodic x rays to avoid further disease in the tooth. The restored tooth may last a lifetime. However, with routine wear, the filling or crown may eventually need to be replaced.

Morbidity and mortality rates

About 5% of patients will experience persistent pain after root canal therapy. In some cases, despite proper root canal treatment and endodontic surgery, the tooth dies and must be extracted. This outcome, however, is relatively uncommon.

Alternatives

The only alternative to performing a root canal procedure is to extract the diseased tooth. After restoration or extraction, the two main goals are to allow normal chewing and to maintain proper alignment and spacing between teeth. A fixed bridge, a removable partial denture or an implant will accomplish both goals. However, these are usually more expensive than a root canal treatment.

Resources

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Erbium Laser Disinfection of Root Canal Complex. This is a 4-minute video of laser-assisted root canal therapy. http://www.youtube.com/watch?v=UfHqZs1bWzM.

Mayo Clinic. *Slide Show: Root Canal Treatment*. http://www.mayoclinic.com/health/root-canal/DE00010.

ORGANIZATIONS

Academy of General Dentistry, 211 East Chicago Avenue, Chicago, IL, 60611, (312) 440-4300, http://www.agd.org.

American Academy of Pediatric Dentistry, 211 East Chicago Avenue, #700, Chicago, IL, 60611-2663, (312) 337-2169, (312) 337-6329, http://www.aapd.org.

American Association of Endodontists, 211 E. Chicago Ave., Suite 1100, Chicago, IL, 60611-2691, (312) 266-7255, (312) 266-9867, (866) 451-9020, (800) 872-3636, info@aae.org, http://www.aae.org.

American Dental Association, 211 E. Chicago Avenue, Chicago, IL, 60611, (312) 440-2500, (312) 440-7494, http://www.ada.org.

L. Fleming Fallon, Jr., MD, DrPH
Rebecca J. Frey, PhD
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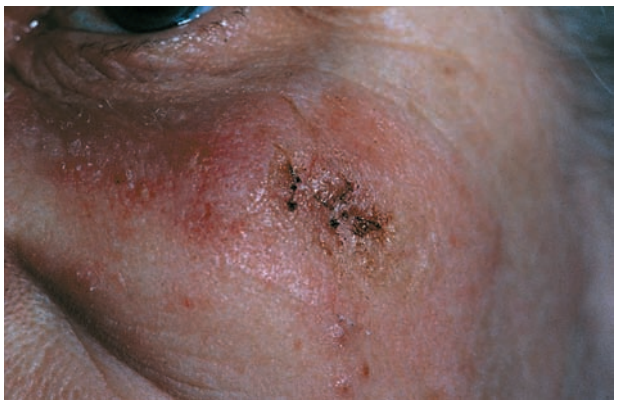
Rosacea

Definition

Rosacea is a skin disease typically appearing in people during their 30s and 40s. It is marked by redness (erythema) of the face, flushing of the skin, and the presence of hard pimples (papules) or pus-filled pimples (pustules), and small visible spider-like veins called telangiectasias. In later stages of the disease, the face may swell and the nose may take on a bulb-like appearance called rhinophyma.

Description

Rosacea produces redness and flushing of the skin, as well as pustules and papules. Areas of the face, including the nose, cheeks, forehead, and chin, are the primary sites, but some people experience symptoms on their necks, backs, scalp, arms, and legs.



Rosacea on a woman's cheek. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

The similarity in appearance of rosacea to **acne** led people in the past to erroneously call the disease acne rosacea or adult acne. Like acne, the skin can have pimples and papules. Unlike acne, however, people with rosacea do not have blackheads.

In early stages of rosacea, people typically experience repeated episodes of flushing. Later, areas of the face are persistently red, telangiectasia appear on the nose and cheeks, as well as inflamed papules and pustules. Over time, the skin may take on a roughened, orange peel texture. Very late in the disorder, a small group of patients with rosacea will develop rhinophyma, which can give the nose a bulb-like look.

Up to one half of patients with rosacea may experience symptoms related to their eyes. Ocular rosacea, as it is called, frequently precedes the other manifestations on the skin. Most of these eye symptoms do not threaten sight, however. Telangiectasia may appear around the borders of the eyelid, the eyelids may be chronically inflamed, and small lumps called chalazions may develop. The cornea of the eye, the transparent covering over the lens, can also be affected, and in some cases vision will be affected.

Causes and symptoms

There is no known specific cause of rosacea. A history of redness and flushing precedes the disease in most patients. The consensus among many experts is that multiple factors may lead to an overreaction of the facial blood vessels, which triggers flushing. Over time, persistent episodes of redness and flushing leave the face continually inflamed. Pimples and blood-vessel changes follow.

Certain genetic factors may also come into play, although these have not been fully described. The

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disease is more common in women and light-skinned, fair-haired people. It may be more common in people of Celtic background, although this is an area of disagreement among experts.

Certain **antibiotics** are useful in the treatment of rosacea, leading some researchers to suspect a bacterium or other infectious agent may be the cause. One of the newest suspects is a bacterium called *Helicobacter pylori*, which has been implicated in causing many cases of stomach ulcers but the evidence here is mixed.

Other investigators have observed that a particular parasite, the mite *Demodex folliculorum*, can be found in areas of the skin affected by rosacea. The mite can also be detected, however, in the skin of people who do not have the disease. It is likely that the mite does not cause rosacea, but merely aggravates it.

Diagnosis

Diagnosis of rosacea is made by the presence of clinical symptoms. There is no specific test for the disease. Episodes of persistent flushing, redness (erythema) of the nose, cheeks, chin, and forehead, accompanied by pustules and papules are hallmarks of the disease. A dermatologist will attempt to rule out a number of other diseases that have similar symptoms. Acne vulgaris is perhaps the disorder most commonly mistaken for rosacea, but redness and spider-like veins are not observed in patients with acne. Blackheads and cysts, however, are seen in acne patients, but not in those with rosacea.

Other diseases that produce some of the same symptoms as rosacea include perioral **dermatitis** and **systemic lupus erythematosus**.

Treatment

The mainstay of treatment for rosacea is oral antibiotics. These appear to work by reducing inflammation in the small blood vessels and structure of the skin, not by destroying bacteria that are present. Among the more widely used oral antibiotics is tetracycline. In many patients, antibiotics are effective against the papules and pustules that can appear on the face, but they appear less effective against the background redness, and they have no effect on telangiectasia. Patients frequently take a relatively high dose of antibiotics until their symptoms are controlled, and then they slowly reduce their daily dose to a level that just keeps their symptoms in check. Other oral antibiotics used include erythromycin and minocycline.

Some patients are concerned about long-term use of oral antibiotics. For them, a topical agent applied directly to the face may be tried in addition to an oral antibiotic, or in its place. **Topical antibiotics** are also useful for controlling the papules and pustules of rosacea, but do not control the redness, flushing, and telangiectasias. The newest of these topical agents is metronidazole gel, which can be applied twice daily. Like the oral antibiotics, topical preparations appear to work by reducing inflammation, not by killing bacteria.

Vitamin A derivatives, called retinoids, also appear useful in the treatment of rosacea. An oral retinoid, called isotretinoin, which is used in severe cases of acne also reduces the pustules and papules in severe cases of rosacea that do not respond to antibiotics. Isotretinoin must be taken with care, however, particularly in women of childbearing age. They must agree to a reliable form of **contraception**, because the drug is known to cause **birth defects**.

Topical vitamin A derivatives that are used in the treatment of acne also may have a role in the treatment of rosacea. Accumulating evidence suggests that topical isotretinoin and topical azelaic acid can reduce the redness and pimples. Some patients who use these medications experience skin irritation that tends to resolve with time.

For later stages of the disorder, a surgical procedure may be needed to improve the appearance of the skin. To remove the telangiectasias, a dermatologist may use an electrocautery device to apply a current to the blood vessel in order to destroy it. Special lasers, called tunable dye lasers, can also be adjusted to selectively destroy these tiny blood vessels.

A variety of surgical techniques can be used to improve the shape and appearance of a bulbous nose in the later stages of the disease. Surgeons may use a scalpel or laser to remove excess tissue from the nose and restore a more natural appearance.

Alternative treatment

Alternative treatments have not been extensively studied in rosacea. Some reports advocate gentle circular massage for several minutes daily to the nose, cheeks, and forehead. Scientifically controlled studies are lacking, however.

Many people are able to avoid outbreaks by reducing things that trigger flushing. Alcoholic beverages, hot beverages, and spicy foods are among the more common factors in the diet that can provoke flushing. Reducing or eliminating these items in the diet can help limit rosacea outbreaks in many people.

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KEY TERMS

Blackhead—A plug of fatty cells capped with a blackened mass.

Erythema—A diffuse red and inflamed area of the skin.

Papule—A small hard elevation of the skin.

Pustule—A small pus-filled elevation of the skin.

Retinoid—A synthetic vitamin A derivative used in the treatment of a variety of skin disorders.

Rhinophyma—Long-term swelling and overgrowth in skin tissue of the nose that leaves it with a knobby bulb-like look.

Telangiectasia—Small blood veins visible at the surface of the skin of the nose and cheeks.

Exposure to heat, cold, and sunlight are also known triggers of flushing. The specific things that provoke flushing vary considerably from person to person, however. It usually takes some trial and error to figure these out.

A deficiency in hydrochloric acid (HCl) in the stomach may be a cause of rosacea, and supplementation with HCl capsules may bring relief in some cases.

Prognosis

The prognosis for controlling symptoms of rosacea and improving the appearance of the face is good. Many people require life-long treatment and achieve good results. There is no known cure for the disorder.

Prevention

Rosacea cannot be prevented but once correctly diagnosed, outbreaks can be treated and repeated episodes can be limited.

Use mild soaps

Avoiding anything that irritates the skin is a good preventive measure for people with rosacea. Mild soaps and cleansers are recommended. Astringents and alcohol should be avoided.

Learn what triggers flushing

Reducing factors in the diet and environment that cause flushing of the face is another good preventive strategy. Alcoholic and hot beverages, and spicy foods are among the more common triggers.

Use sunscreen

Limiting exposure of the face to excesses of heat and cold can also help. A sunscreen with a skin protection factor (SPF) of 15 or greater used daily can limit the damage to the skin and small blood vessels caused by the sun, and reduce outbreaks.

ORGANIZATIONS

American Academy of Dermatology, PO Box 4014, Schaumburg, IL, 60168-4014, (847) 240-1859, (866) 503-SKIN (7546), http://www.aad.org.

National Rosacea Society, 198 James St/, Barrington, IL, 60010, (888) 662-5874, rosaceas@aol.com, http://www.rosacea.org.

Richard H. Camer

Rosary bead esophagus *see* **Diffuse esophageal spasm**

Roseola

Definition

Roseola is a common disease of babies or young children, in which several days of very high **fever** are followed by a rash.

Description

Roseola is an extraordinarily common infection, caused by a virus. About 90% of all children have been exposed to the virus, with about 33% actually demonstrating the syndrome of fever followed by rash.

The most common age for a child to contract roseola is between six and twelve months. Roseola infection strikes boys and girls equally. The infection may occur at any time of year, although late spring and early summer seem to be peak times for it.

Causes and symptoms

About 85% of the time, roseola is caused by a virus called Human Herpesvirus 6, or HHV-6. Although the virus is related to those herpesviruses known to cause

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Roseola rash on infant's back. *(© PHOTOTAKE Inc./Alamy.)*

sores on the lips or genitalia, HHV-6 causes a very different type of infection. HHV-6 is believed to be passed between people via infected saliva. A few other viruses (called enteroviruses) can produce a similar fever-then-rash illness, which is usually also called roseola.

Researchers believe that it takes about 5–15 days to develop illness after having been infected by HHV-6. Roseola strikes suddenly, when a previously-well child spikes an impressively high fever. The temperature may reach 106°F. As is always the case with sudden fever spikes, the extreme change in temperature may cause certain children to have seizures. About 5–35% of all children with roseola will have these "febrile seizures."

The most notable thing about this early phase of roseola is the absence of symptoms, other than the high fever. Although some children have a slightly reddened throat, or a slightly runny nose, most children have no symptoms whatsoever, other than the sudden development of high fever. This fever lasts for between three and five days.

KEY TERMS

Jaundice—The development of a yellowish tone to the skin and the whites of the eyes, caused by poor liver function.

Mononuclosis—An infection which causes swelling of lymph nodes, spleen, and liver, usually accompanied by extremely sore throat, fever, headache, and intense long-lasting fatigue.

Somewhere around the fifth day, a rash begins on the body. The rash is usually composed of flat pink patches or spots, although there may be some raised patches as well. The rash usually starts on the chest, back, and abdomen, and then spreads out to the arms and neck. It may or may not reach the legs and face. The rash lasts for about three days, then fades.

Very rarely, roseola will cause more serious disease. Patients so afflicted will experience significant swelling of the lymph nodes, the liver, and the spleen. The liver may become sufficiently inflamed to interfere with its functioning, resulting in a yellowish color to the whites of the eyes and the skin (**jaundice**). This syndrome (called a mononucleosis-like syndrome, after the disease called mononucleosis that causes many of the same symptoms) has occurred in both infants and adults.

Diagnosis

The diagnosis of roseola is often made by carefully examining the feverish child to make sure that other illnesses are not causing the temperature spike. Once it is clear that no **pneumonia**, ear infection, **strep throat**, or other common childhood illness is present, the practitioner usually feels comfortable waiting to see if the characteristic rash of roseola begins.

Treatment

There are no treatments available to stop the course of roseola. **Acetaminophen** or ibuprofen is usually given to try to lower the fever. Children who are susceptible to seizures may be given a sedative medication when the fever first spikes, in an attempt to prevent such a seizure.

Prognosis

Children recover quickly and completely from roseola. The only complications are those associated with seizures, or the rare mononucleosis-like syndrome.

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Prevention

Other than the usual good hygiene practices always recommended to decrease the spread of viral illness, no methods are available to specifically prevent roseola.

Resources

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Rosalyn Carson-DeWitt, MD

Roseola infantum *see* **Roseola**

Ross River Virus

Definition

Ross River Virus (RRV) is Australia's most common and widespread mosquito-borne pathogen. Also known as RRV disease, it can cause debilitating polyarthritis, rash, **fever**, and constitutional symptoms.

Description

Originally known as epidemic polyarthritis, RRV is a member of the *Togaviridae* family of arboviruses. RRV is transmitted in an animal host-vector-human cycle, where the vector is the mosquito. Serological investigations have indicated that native macropods are the main vertebrate hosts of RRV, although other animals can become infected as well. The RRV lives in the blood stream of an infected animal. When a mosquito feeds on the infected animal, the virus is transmitted to the insect where it rapidly multiplies. The virus is then passed onto the next animal or person the mosquito **bites**. It has been proposed that human-mosquito-human transmission can occur during RRV epidemics. One-third of all humans bitten by an infected mosquito will develop the RRV disease.

The RRV disease occurs throughout continental Australia. However, the majority of RRV infections occur in the northern states and along costal areas; in particular, the state of Queensland. Of the 4,800 cases reported annually in Australia, approximately 2,700 of these occur in Queensland. In addition to these cases, many more go unreported. Infection can occur year round, but outbreaks typically coincide with the increased mosquito activity of the wet season (between late November and the end of April). Also, areas with intensive irrigation and those near salt marches have higher mosquito populations, and, thus, tend to exhibit a higher number of RRV cases.

In addition to continental Australia, RRV is endemic to the Solomon Islands, East Timor, Papua New Guinea, and the adjacent islands of Indonesia. Epidemics have also been reported in the Cook Islands, Fiji, French Polynesia, New Caledonia, and Western Samoa.

Causes and symptoms

Many people that are infected with RRV will never develop symptoms. However, 25% to 45% of cases will develop symptoms within three days to three weeks (averaging nine days) of the infection. Symptoms will vary between patients, but typically include arthralgia, arthritis, myalgia, skin rash, fever, **fatigue**, **headache**, and swollen lymph nodes. **Tingling** and **pain** in the palms of the hands and soles of the feet can accompany these symptoms. Other, less frequent, symptoms can include general malaise, **nausea**, sore eyes, and **sore throat**.

Most patients with RRV disease (83% to 98%) experience symptoms of polyarthritis involving the wrists, knees, ankles, and small joints of the extremities. Less frequently affected joints include the elbows, toes, tarsal joints, vertebral joints, shoulders, and hips. Symptoms can range from restricted joint movement to prominent swell and severe pain. Although severe joint pain can last for only 2 to 6 weeks, over half of patients will continue to experience joint pain for 6 to 12 months after RRV infection. Symptoms typically diminish over time, but relapses are common and have been known to persist for several years. This persistent polyarthritis can lead to fatigue and myalgia, contributing to RRV diseases high morbidity.

Diagnosis

Diagnosis usually consists of serological tests to determine the presence and increase of RRV antibodies. Samples should be taken during the acute or convalescent stages of the illness. Testing will help clinicians differentiate between RRV disease and Barmah Forest virus disease, a very similar arbovirus. Virological tests can help distinguish between RRV disease and other causes of arthritis.

Treatment

No cure for RRV disease currently exists, so only its symptoms can be treated. In one of the few studies

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KEY TERMS

Arthralgia—Sharp, severe pain, extending along a nerve or group of nerves, experienced in a joint and/or joints.

Abrovirus viruses—Also known as arthropod-borne viruses, these viruses are maintained in nature through biological transmission between vertebrate hosts and blood-feeding arthropods. Infection occurs when an infected arthropod, such as a mosquito, feeds off a vertebrate, such as a human.

Macropods—Derived from the Greek, macropod literally means "large footed." Macropods are marsupials belonging to the family Macropodidae, which includes kangaroos, wallabies, tree kangaroos, pademelons, and several others.

Myalgia—Muscular pain or tenderness, typically of a diffuse and/or nonspecific nature.

Polyarthritis—A nonspecific term for arthritis involving two or more joints, typically associated with autoimmune forms of arthritis. Symptoms usually include pain, inflammation, and/or swelling in multiple joints.

on RRV disease treatment, Cordon and Rouse (1995) found that roughly one-third of patients (36.4%) reported that **nonsteroidal anti-inflammatory drugs** (NSAIDS) provided them with the best symptomatic relief. In addition to NSAIDS, others patients found that rest (24.1%), **aspirin** and paracetamol (16.4%), or physical therapies (10.3%), such as **hydrotherapy**, massage, and physiotherapy, were their only source of symptom relief. Unfortunately, 20% of patients found none of these interventions effective. Health providers typically use one or a combination of these treatments for their patients. In particular, paracetamol has been found to be effective for treating the pain and fever associated with RRV disease.

Although some clinicians have found the use of oral corticosteroid useful and effective, this practice is considered unwise and unnecessary. The adverse effects associated with **corticosteroids** may outweigh their benefits, and may even worsen the RRV disease. More study is required on this and other treatment interventions of RRV disease.

Prognosis

Patients infected with RRV disease will fully recover within four to seven months. Although milder cases can recover within a few weeks, many cases have persisted for several years. Only the symptoms can be treated during this time, not the disease. Fortunately, RRV infection usually provides the patient with life-long immunity to future infection.

Prevention

Prevention techniques of RRV typically coincide with measures used to avoid mosquito bites; the primary source of the virus. These include the use of insect repellant (with 5% to 20% DEET) on exposed body parts, wearing loose-fitting clothes over the limbs and torso while outdoors, using mosquito coils and/or citronella candles outdoors, and limiting outdoor activities during peak biting periods and/or in areas with high mosquito density. While camping outdoors, knockdown spray or bed netting with pyrethrum is suggested. Additional steps for reducing risk of being bitten include using screens in homes and removing mosquito-breeding areas near the home, such as uncovered water containers and old tires. Mosquito eradication programs can assist in reducing insect populations. An RRV vaccine is currently being developed.

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Jason Fryer

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Rotator cuff injury

Definition

A rotator cuff injury is a tear or inflammation of the rotator cuff tendons in the shoulder.

Description

Rotator cuff injury is known by several names, including pitcher's shoulder, swimmer's shoulder, and tennis shoulder. As these names imply, the injury occurs most frequently in athletes practicing sports that require the arm to be moved over the head repeatedly, such as pitching, swimming, tennis, and weight lifting. Rotator cuff tendonitis is an inflammation of the shoulder tendons while a rotator cuff tear is a ripping of one or more of the tendons.

The tendons of four muscles make up the rotator cuff. The muscles are the supraspinatus, infraspinatus, teres minor, and subscapularis. The tendons attach the muscles to four shoulder bones: the shoulder blade (scapula), the upper arm bone (humerus), and the collarbone (clavicle.) The rotator cuff tendons can also degenerate due to age, usually starting around age 40. Rotator cuff injury may also be caused by falling on the outstretched arm or joint of the elbow. Either of these may produce enough force to drive the humerus into the shoulder socket.

Causes and symptoms

Some areas of the rotator cuff tendons have poor blood supply. Thus, the tissue is very slow to heal and maintain itself during normal use. Tearing and inflammation in athletes is usually due to hard and repetitive use, especially in baseball pitchers. In non-athletes over age 40, the injuries usually occur as a result of lifting heavy objects. The two primary symptoms are **pain** and weakness in the shoulder or arm, especially with arm movement or at night. A partial tear may cause pain but still allow normal arm movement. A complete tear usually leaves the injured person unable to raise the arm away from the side.

Diagnosis

Diagnosis is usually made after a **physical examination**, often by a sports medicine physician. X rays are also sometimes used in diagnosis as well as an arthrogram. However, the arthrogram is an invasive procedure and may be painful afterwards. For this reason, **magnetic resonance imaging** (MRI) is preferred to determine tendon tears as it also show greater detail than the arthrogram.

KEY TERMS

Arthrogram—A test done by injecting dye into the shoulder joint and then taking x-rays. Areas where the dye leaks out indicate a tear in the tendons.

Arthroscope—An instrument for the visual examination of the interior of a joint.

Arthroscopy—Examination of a joint with an arthroscope or joint surgery using an arthroscope.

Cortisone—A hormone produced naturally by the adrenal glands or made synthetically.

Magnetic resonance imaging (MRI) scan—A special radiological test that uses magnetic waves to create pictures of an area, including bones, muscles, and tendons.

Spur—Any projection from a bone.

Treatment

The primary treatment is resting the shoulder and, for minor tears and inflammation, applying ice packs. Anti-inflammatory medications may also be prescribed. As soon as pain decreases, **physical therapy** is usually started to help regain normal motion. If pain persists after several weeks, the physician may inject cortisone into the affected area.

Serious tears to the rotator cuff tendons usually require surgery to repair. An instrument called an arthroscope is used to view the shoulder joint and confirm the presence of a tear. The arthroscope can also be used to remove any bone spurs that may be present in the shoulder area. Current arthroscopic procedures usually involve a 2 in (5.1 cm) incision in the outer shoulder. Through this incision the torn rotator edge may be reattached to the humerus with stitches.

Alternative treatment

There are no effective alternative medicine treatments for rotator cuff injuries.

Prognosis

The prognosis for recovery from minor rotator cuff injuries is excellent. For serious injuries, the prognosis is usually good, some six weeks of physical therapy being required following surgery. Full recovery

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may take several more months. In some cases, the injury is so severe that it requires tendon grafts and muscle transfers. In rare cases, a severe injury is not repairable, usually because the tendon has been torn for too long a time.

Prevention

The best prevention is to avoid repetitive overhead arm movements and to develop shoulder strength.

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ORGANIZATIONS

American Academy of Orthopaedic Surgeons, 6300 North River Road, Rosemont, IL, 60018-4262, (847) 823-7186, (847) 823-8125, pemr@aaos.org, http://www. aaos.org.

American Orthopaedic Society for Sports Medicine, 6300 N. River Road, Ste. 500, Rosemont, IL, 60018, (847) 292-4900, http://www.sportsmed.org.

Ken R. Wells

Rotavirus infections

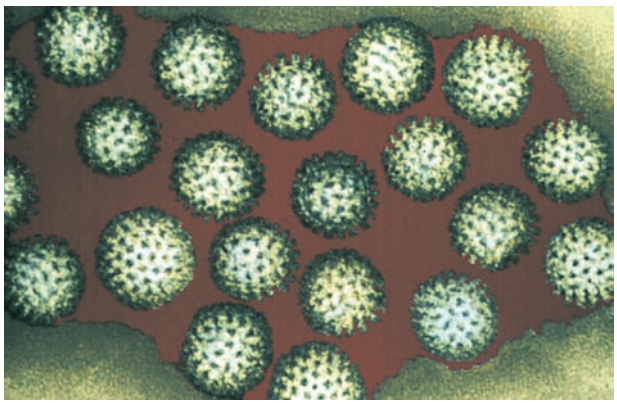
Definition

Rotavirus is the major cause of **diarrhea** and **vomiting** in young children worldwide. The infection is highly contagious and may lead to severe **dehydration** (loss of body fluids) and even **death**. In the United States, more than 50,000 children are hospitalized and up to 125 die each year as a result of rotavirus infection.

Description

Gastroenteritis, or inflammation of the stomach and the intestine, is the second most common illness in the United States, after the **common cold**. More than one-third of such cases are caused by viruses. Many different viruses can cause gastroenteritis, but the most common ones are the rotavirus and the Norwalk virus.

The name rotavirus comes from the Latin word "rota" for wheel and is given because the viruses have a distinct wheel-like shape. Rotavirus infection is also known as infantile diarrhea, or winter diarrhea, because it mainly targets infants and young children. The outbreaks are usually in the cooler months of winter.



Rotaviruses are probably the most common viruses to infect humans and animals. These viruses are associated with gastroenteritis and diarrhea in humans and other animals. *(Dr. Linda Stannard/SPL/Photo Researchers, Inc.)*

The virus is classified into different groups (Group A through group G), depending on the type of protein marker (antigen) that is present on its surface. The diarrheal infection of children is caused by the Group A rotaviruses. Group B rotaviruses have caused major epidemics of adult diarrhea in China. Group C rotavirus has been associated with rare cases of diarrheal outbreaks in Japan and England. Groups D through G have not been detected in humans.

Causes and symptoms

The main symptoms of the rotavirus infection are **fever**, stomach cramps, **vomiting**, and diarrhea (this could lead to severe dehydration). The symptoms last anywhere from four to six days. If a child has dry lips and tongue, dry skin, sunken eyes, and wets fewer than six diapers a day, it is a sign of dehydration and a physician needs to be notified. Because of the excellence of healthcare in this country, rotavirus is rarely fatal to American children. However, it causes deaths of up to a million children in the third world countries, every year.

The virus is usually spread by the "fecal-oral route." In other words, a child can catch a rotavirus infection if she puts her finger in her mouth after touching toys or things that have been contaminated by the stool of another infected child. This usually happens when children do not wash their hands after using the toilet, or before eating food.

The viruses can also spread by way of contaminated food and drinking water. Infected food handlers who prepare salads, sandwiches, and other foods that require no cooking can spread the disease. Generally,

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symptoms appear within 4–48 hours after exposure to the contaminated food or water.

Children between the ages of six months and two years, especially in a daycare setting, are the most susceptible to this infection. Breastfed babies may be less likely to become infected, because breast milk contains antibodies (proteins produced by the white blood cells of the immune system) that fight the illness. Nearly every child by the age of four has been infected by this virus, and has rotavirus antibodies in their body. The disease also targets the elderly and people who have weak immune systems.

Children who have been infected once can be infected again. However, second infections are less severe than the first infections. By the time a child has had two infections, the chances of subsequent severe infection is remote.

Diagnosis

The rotavirus infection is diagnosed by identifying the virus in the patient's stool. This is done using electron microscopy. Immunological tests such as ELISA (Enzyme-linked immunosorbent assay) are also widely used for diagnosis, and several commercial kits are available.

Treatment

"Oral rehydration therapy," or drinking enough fluids to replace those lost through bowel movements and vomiting, is the primary aim of the treatment. Electrolyte and fluid replacement solutions are available over the counter in food and drug stores. Dehydration is one of the greatest dangers for infants and young children. If the diarrhea becomes severe, it may be necessary to hospitalize the patient so that fluids can be administered intravenously.

Anti-diarrheal medication should not be given to children unless directed to do so by the physician. Antibiotic therapy is not useful in viral illness. Specific drugs for the virus are not available.

Prognosis

Most of the infections resolve spontaneously. Dehydration due to severe diarrhea is one of the major complications.

Prevention

The best way to prevent the disease is by proper food handling and thorough hand washing, after using the toilet and whenever hands are soiled. In child care centers and hospital settings, the staff should be educated about personal and environmental hygiene. All dirty diapers should be regarded as infectious and disposed of in a sanitary manner.

Vaccines that prevent rotavirus in young children have been tested in nationwide trials. Researchers report that the vaccines appear to prevent the infection in 80% of the tested children. The vaccine is intended to be given orally (by mouth) at two, four, and six months of age. The only side effect of the vaccine is a low-grade fever in a small percentage of the children, three to four days after the **vaccination**. Within the next few years, a rotavirus vaccine may become part of every child's immunization schedule.

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Lata Cherath, PhD

Roundworm infections

Definition

Roundworm infections are diseases of the digestive tract and other organ systems caused by nematodes. Nematodes are parasitic worms with long, cylindrical bodies.

Description

Roundworm infections are widespread throughout the world, with some regional differences. Ascariasis and trichuriasis are more common in warm, moist climates where people use human or animal feces for fertilizer. Anisakiasis is most common in countries where raw or pickled fish or squid is a popular food item.

Causes and symptoms

The causes and symptoms of roundworm infection vary according to the species. Humans acquire most types of roundworm infection from contaminated food or by touching the mouth with unwashed hands.

Anisakiasis

Anisakiasis is caused by anisakid roundworms. Humans are not the primary host for these parasites. Anisakid roundworms infest whales, seals, and

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dolphins; crabs then ingest roundworm eggs from the feces of these animals. In the crabs, the eggs hatch into larvae that can infect fish. The larvae enter the muscles of marine animals further up the food chain, including squid, mackerel, herring, cod, salmon, tuna, and halibut. Humans become accidental hosts when they eat raw or undercooked fish containing anisakid larvae. The larvae attach themselves to the tissues lining the stomach and intestine, and eventually die inside the inflamed tissue.

In humans, anisakiasis can produce a severe syndrome that affects the stomach and intestines, or a mild chronic disease that may last for weeks or years. In acute anisakiasis, symptoms begin within one to seven hours after the patient eats infected seafood. Patients are often violently sick, with **nausea**, **vomiting**, **diarrhea**, and severe abdominal **pain** that may resemble **appendicitis**. In chronic anisakiasis, the patient has milder forms of stomach or intestinal irritation that resemble stomach ulcers or **irritable bowel syndrome**. In some cases, the acute form of the disease is followed by chronic infestation.

Ascariasis

Ascariasis, which is caused by *Ascaris lumbricoides*, is one of the most widespread parasitic infections in humans, affecting over 1.3 billion people worldwide. Ascarid roundworms cause a larger burden on the human host than any other parasite; adult worms can grow as long as 12 or 14 inches, and release 200,000 eggs per day. The eggs infect people who eat unwashed vegetables from contaminated soil or touch their mouths with unwashed hands. Once inside the digestive tract, the eggs release larvae that penetrate the intestinal wall and migrate to the lungs through the liver and the bloodstream. After about 10 days in the lungs, the larvae migrate further into the patient's upper lung passages and airway, where they are swallowed. When they return to the intestine, they mature into adults and reproduce. The time period from the beginning of the infection to egg production is 60–75 days.

The first symptoms of infection may occur when the larvae reach the lungs. The patient may develop chest pain, coughing, difficulty breathing, and inflammation of the lungs. In some cases, the patient's sputum is streaked with blood. This phase of the disease is sometimes called Loeffler's syndrome. It is marked by an accumulation of parasites in the lung tissue and by eosinophilia (an abnormal increase in the number of a specific type of white blood cell). The intestinal phase of ascariasis is marked by stomach pain, cramping, nausea, and intestinal blockage in severe cases.

Toxocariasis

Toxocariasis is sometimes called visceral larva migrans (VLM) because the larval form of the organism hatches inside the intestines and migrates throughout the body to other organs (viscera). The disease is caused by *Toxocara canis* and *T. cati*, which live within the intestines of dogs and cats. Most human patients are children between the ages of two and four years, who become infected after playing in sandboxes or soil contaminated by pet feces, although adults are also susceptible. The eggs can survive in soil for as long as seven years.

The organism's eggs hatch inside the human intestine and release larvae that are carried in the bloodstream to all parts of the body, including the eyes, liver, lungs, heart, and brain. The patient usually has a **fever**, with coughing or **wheezing** and a swollen liver. Some patients develop skin **rashes** and inflammation of the lungs. The larvae may survive inside the body for months, producing allergic reactions and small granulomas, which are tissue swellings or growths produced in response to inflammation. Infection of the eye can produce ocular larva migrans (OLM), which is the first symptom of toxocariasis in some patients.

Trichuriasis

Trichuriasis, caused by *Trichuris trichiura*, is sometimes called whipworm because the organism has a long, slender, whiplike front end. The adult worm is slightly less than an inch long. Trichuriasis is most common in warm, humid climates, including the southeastern United States. The number of people with trichuriasis may be as high as 800 million worldwide.

Whipworm larvae hatch from swallowed eggs in the small intestine and move on to the upper part of the large intestine, where they attach themselves to the lining. The adult worms produce eggs that are passed in the feces and mature in the soil. Patients with mild infections may have few or no symptoms. In cases of heavy infestation, the patient may have abdominal cramps and other symptoms resembling amebic **dysentery**. In children, severe trichuriasis may cause anemia and developmental retardation.

Diagnosis

Since the first symptoms of roundworm infection are common to a number of illnesses, a doctor is most likely to consider the possibility of a parasitic disease on the basis of the patient's history–especially in children. The definite diagnosis is based on the results of

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KEY TERMS

Eosinophilia—An abnormal increase in the number of a specific type of white blood cell. Eosinophilia is a characteristic of all types of roundworm infections.

Granuloma—A tissue swelling produced in response to inflammation. Granulomas are important in diagnosing toxocariasis.

Loeffler's syndrome—The respiratory phase of ascariasis, marked by inflammation of the lungs and eosinophilia.

Nematode—A parasitic roundworm with a long, cylindrical body.

Ocular larva migrans (OLM)—A syndrome associated with toxocariasis, in which the eye is invaded by migrating larvae.

Visceral larva migrans (VLM)—Another name for toxocariasis. The name is derived from the life cycle of the organism.

Whipworm—Another name for trichuriasis. The name comes from the organism's long whiplike front end.

stool or tissue tests. In trichuriasis, adult worms may also be visible in the lining of the patient's rectum. In ascariasis, adult worms may appear in the patient's feces or vomit; they can also be detected by x ray and ultrasound. In toxocariasis, larvae are sometimes found in tissue samples taken from a granuloma. If a patient with toxocariasis develops OLM, it is important to obtain a granuloma sample in order to distinguish between OLM and **retinoblastoma** (a type of eye tumor).

Anisakiasis is one of two roundworm infections that cannot be diagnosed from stool specimens. Instead, the diagnosis is made by x rays of the patient's stomach and small intestine. The larvae may appear as small threads when double contrast x rays are used. In acute cases, the doctor may use an endoscope (an instrument for examining the interior of a body cavity) to look for or remove larvae.

Blood tests cannot be used to differentiate among different types of roundworm infections, but the presence of eosinophilia can help to confirm the diagnosis.

Patients with trichuriasis or ascariasis should be examined for signs of infection by other roundworm species; many patients are infected by several parasites at the same time.

Treatment

Trichuriasis, ascariasis, and toxocariasis are treated with anthelminthic medications. These are drugs that destroy roundworms either by paralyzing them or by blocking them from feeding. Anthelminthic drugs include pyrantel pamoate, piperazine, albendazole, and mebendazole. Mebendazole cannot be given to pregnant women because it may harm the fetus. Treatment with anthelminthic drugs does not prevent reinfection.

There is no drug treatment for anisakiasis; however, symptoms usually resolve in one to two weeks when the larvae die. In some cases, the larvae are removed with an endoscope or by surgery.

Patients with an intestinal obstruction caused by ascariasis may be given **nasogastric suction**, followed by anthelminthic drugs, in order to avoid surgery. If suction fails, the worms must be removed surgically to prevent intestinal rupture or blockage.

Prognosis

The prognosis for recovery from roundworm infections is good for most patients. The severity of infection, however, varies considerably from person to person. Children are more likely to have heavy infestations and are also more likely to suffer from malabsorption and **malnutrition** than adults.

Ascariasis is the only roundworm infection with a significant mortality rate. *A. lumbricoides* grows large enough to perforate the bile or pancreatic ducts; in addition, a mass of worms in the digestive tract can cause rupture or blockage of the intestines. It is estimated that 20,000 children die every year from intestinal ascariasis.

Prevention

There are no effective vaccines against any of the soil-transmitted roundworms, nor does infection confer immunity. Prevention of infection or reinfection requires adequate hygiene and sanitation measures, including regular and careful handwashing before eating or touching the mouth with the hands.

With respect to specific infections, anisakiasis can be prevented by avoiding raw or improperly prepared fish or squid. Trichuriasis, ascariasis, and toxocariasis can be prevented by keeping children from playing in

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soil contaminated by human or animal feces; by teaching children to wash their hands before eating; and by having pets dewormed regularly by a veterinarian.

Resources

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Rebecca J. Frey, PhD

Routine urinalysis *see* **Urinalysis**
RSV *see* **Respiratory syncytial virus infection**
RTA *see* **Renal tubular acidosis**
RU-486 *see* **Mifepristone**

Rubella

Definition

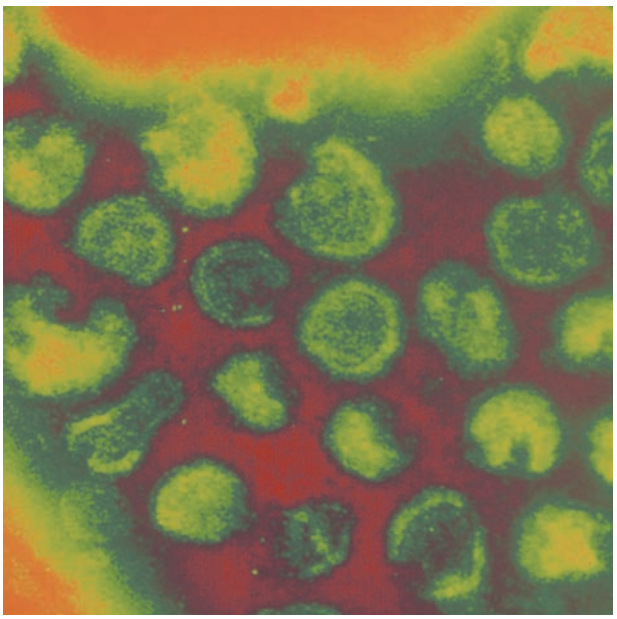
Rubella is a highly contagious viral disease, spread through contact with discharges from the nose and throat of an infected person. Although rubella causes only mild symptoms of low **fever**, **swollen glands**, joint **pain**, and a fine red rash in most children and adults, it can have severe complications for women in their first trimester of **pregnancy**. These complications include severe **birth defects** or **death** of the fetus.

Description

Rubella is also called German **measles** or three-day measles. This disease was once a common childhood illness, but its occurrence has been drastically reduced since vaccine against rubella became available in 1969. In the 20 years following the introduction of the vaccine, reported rubella cases dropped 99.6%. Only 229 cases of rubella were reported in the United States in 1996.

Rubella is spread through contact with fluid droplets expelled from the nose or throat of an infected person. A person infected with the rubella virus is contagious for about seven days before any symptoms appear and continues to be able to spread the disease for about four days after the appearance of symptoms. Rubella has an incubation period of 12–23 days.

Although rubella is generally considered a childhood illness, people of any age who have not been vaccinated or previously caught the disease can become infected. Having rubella once or being immunized against rubella normally gives lifetime immunity. This is why **vaccination** is so effective in reducing the number of rubella cases.



A digitized image of rubella virus particles. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Women of childbearing age who do not have immunity against rubella should be the most concerned about getting the disease. Rubella infection during the first three months of pregnancy can cause a woman to miscarry or cause her baby to be born with birth defects. Although it has been practically eradicated in the United States, rubella is still common in less developed countries because of poor immunization penetration, creating a risk to susceptible travelers. Some countries have chosen to target rubella vaccination to females only and outbreaks in foreign-born males have occurred on cruise ships and at U.S. summer camps.

Causes and symptoms

Rubella is caused by the rubella virus (*Rubivirus*). Symptoms are generally mild, and complications are rare in anyone who is not pregnant.

The first visible sign of rubella is a fine red rash that begins on the face and rapidly moves downward to cover the whole body within 24 hours. The rash lasts about three days, which is why rubella is sometimes called the three-day measles. A low fever and swollen glands, especially in the head (around the ears) and neck, often accompany the rash. Joint pain and sometimes joint

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A red rash is one characteristic of rubella, or German measles, as seen on this man's arm. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

swelling can occur, more often in women. It is quite common to get rubella and not show any symptoms (subclinical infection).

Symptoms disappear within three to four days, except for joint pain, which may linger for a week or two. Most people recover fully with no complications. However, severe complications may arise in the unborn children of women who get rubella during the first three months of their pregnancy. These babies may be miscarried or stillborn. A high percentage are born with birth defects. Birth defects are reported to occur in 50% of women who contract the disease during the first month of pregnancy, 20% of those who contract it in the second month, and 10% of those who contract it in the third month.

The most common birth defects resulting from congenital rubella infection are eye defects such as **cataracts**, glaucoma, and blindness; deafness; congenital heart defects; and **mental retardation**. Taken together, these conditions are called congenital rubella syndrome (CRS). The risk of birth defects drops after the first trimester, and by the 20th week there are rarely any complications.

Diagnosis

The rash caused by the rubella virus and the accompanying symptoms are so similar to other viral infections that it is impossible for a physician to make a confirmed diagnosis on visual examination alone. The only sure way to confirm a case of rubella is by isolating the virus with a blood test or in a laboratory culture.

A blood test is done to check for rubella antibodies. When the body is infected with the rubella virus, it produces both immunoglobulin G (IgG) and immunoglobulin M (IgM) antibodies to fight the infection. Once IgG exists, it persists for a lifetime, but the special IgM antibody usually wanes over six months. A blood test can be used either to confirm a recent infection (IgG and IgM) or determine whether a person has immunity to rubella (IgG only). The lack of antibodies indicates that a person is susceptible to rubella.

All pregnant women should be tested for rubella early in pregnancy, whether or not they have a history of vaccination. If the woman lacks immunity, she is counseled to avoid anyone with the disease and to be vaccinated after giving birth.

Treatment

There is no drug treatment for rubella. Bed rest, fluids, and **acetaminophen** for pain and temperatures over 102°F (38.9°C) are usually all that is necessary.

Babies born with suspected CRS are isolated and cared for only by people who are sure they are immune to rubella. Congenital heart defects are treated with surgery.

Alternative treatment

Rather than vaccinating a healthy child against rubella, many alternative practitioners recommend allowing the child to contract the disease naturally at the age of five or six years, since the immunity conferred by contracting the disease naturally lasts a lifetime. It is, however, difficult for a child to contract rubella naturally when everyone around him or her has been vaccinated.

Ayurvedic practitioners recommend making the patient comfortable and giving the patient ginger or clove tea to hasten the progress of the disease.

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KEY TERMS

Incubation period—The time it takes for a person to become sick after being exposed to a disease.

Trimester—The first third, or thirteen weeks, of pregnancy.

Traditional Chinese medicine uses a similar approach. Believing that inducing the skin rash associated with rubella hastens the progress of the disease, traditional Chinese practitioners prescribe herbs such as peppermint (*Mentha piperita*) and *chai-hu* (*Bupleurum chinense*). Cicada is often prescribed as well. Western herbal remedies may be used to alleviate rubella symptoms. Distilled witch hazel (*Hamamelis virginiana*) helps calm the **itching** associated with the skin rash and an eyewash made from a filtered diffusion of eyebright (*Euphrasia officinalis*) can relieve eye discomfort. Antiviral western herbal or Chinese remedies can be used to assist the immune system in establishing equilibrium during the healing process. Depending on the patient's symptoms, among the remedies a homeopath may prescribe are *Belladonna, Pulsatilla,* or *Phytolacca*.

Prognosis

Complications from rubella infection are rare in children, pregnant women past the 20th week of pregnancy, and other adults. For women in the first trimester of pregnancy, there is a high likelihood of the child being born with one or more birth defect. Unborn children exposed to rubella early in pregnancy are also more likely to be miscarried, stillborn, or have a low birthweight. Although the symptoms of rubella pass quickly for the mother, the consequences to the unborn child can last a lifetime.

Prevention

Vaccination is the best way to prevent rubella and is normally required by law for children entering school. Rubella vaccine is usually given in conjunction with measles and **mumps** vaccines in a shot referred to as MMR (mumps, measles, and rubella). Children receive one dose of MMR vaccine at 12-15 months and another dose at four to six years.

Pregnant women should not be vaccinated, and women who are not pregnant should avoid conceiving for at least three months following vaccination. To date, however, accidental rubella vaccinations during pregnancy have not clearly been associated with the same risk as the natural infection itself. Women may be vaccinated while they are **breastfeeding**. People whose immune systems are compromised, either by the use of drugs such as **steroids** or by disease, should discuss possible complications with their doctor before being vaccinated.

ORGANIZATIONS

March of Dimes Birth Defects Foundation, 1275 Mamaroneck Ave., White Plains, NY, 10605, (914) 997-4488, http://www.modimes.org.

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923, (800) 999-6673, http://www.rarediseases.org.

Tish Davidson, A.M.

Rubella test

Definition

The **rubella** test is a routine blood test performed as part of prenatal care of pregnant women. It is sometimes also used to screen women of childbearing age before the first **pregnancy**.

Purpose

The test is given to evaluate whether a woman is immune to rubella (German **measles**) as a result of childhood exposure or immunization, or whether she may be presently infected with the disease. The question of a current infection is particularly urgent for pregnant women. Although the disease itself is not serious in adults, it can cause **miscarriage**, **stillbirth**, or damage to the fetus during the first trimester (three months) of pregnancy. The rubella test is regarded as a more reliable indication of the patient's immune status than her history because reinfection with rubella is possible even after immunization. The results of the test may influence decisions to terminate a pregnancy.

Description

The rubella test belongs to a category of blood tests called hemagglutination inhibition (HI) tests. Hemagglutination refers to the clumping or clustering of red blood cells caused by a disease antibody, virus, or certain other substances. Inhibition refers to interference with the clumping process. The presence of rubella antibodies inhibits the cell clumping caused

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by the rubella virus. Thus, the addition of the virus to a sample of the patient's blood allows a doctor to determine the presence and concentration of rubella antibodies and the patient's immunity to the disease.

When a person is infected with the rubella virus, the body produces both immunoglobulin G (IgG) and immunoglobulin M (IgM) antibodies to fight the infection. Once IgG exists, it persists for a lifetime, but the special IgM antibody usually wanes over six months. The rubella test can either confirm that a recent infection has occurred (both IgG and IgM are present) or that a patient has immunity to rubella (IgG only is present).

When the test is performed to confirm the diagnosis of rubella in a woman already pregnant, two blood samples are drawn. One is drawn during the acute phase of the illness about three days after the rash breaks out, and the second is drawn during the convalescent phase about three weeks later. The specimens are then tested simultaneously by a single laboratory. Alternatively, a pregnant woman with a rash suspected to be rubella can be tested for IgM antibody. If the test shows that IgM antibody is present, then a recent rubella infection has occurred.

Because there have been cases of children born with rubella syndrome even though the mother's blood test indicated that she was sufficiently immune to rubella, some researchers are presently recommending a second test, known as a synthetic peptide enzyme-linked immunosorbent assay (ELISA). This test screens for the presence of rubella virus neutralizing (RVN) antibodies in the mother's blood.

Normal results

If the patient has been successfully immunized against rubella or has had the disease, the HI antibody titer (concentration) will be greater than 1:10–1:20. The red blood cells will fail to clump when the rubella virus is added to the blood serum.

In the case of paired testing for pregnant women, a fourfold rise in antibody titer between the first and second blood samples indicates the suspicious rash was caused by rubella. The alternative test for IgM antibody confirms recent rubella infection if IgM is found in the patient's blood.

Abnormal results

If the patient has little or no immunity to rubella, her HI antibody titer will be 1:8 or less. Women without immunity should receive immunization against rubella provided that they avoid pregnancy for a period of three months following immunization. Women with disease of the immune system or who are taking corticosteroid medications should receive immune serum globulin rather than rubella vaccine to prevent infection.

KEY TERMS

Antibody—A protein molecule produced by the immune system that is specific to a virus, such as the rubella virus. The antibody combines with the virus and disables it.

Hemagglutination—The clumping or clustering of red blood cells caused by certain viruses, antibodies, or other substances.

Inhibition—Restraint of or interference with a biological process, such as the clumping of blood cells.

Titer—The concentration of a substance in a given sample of blood or other tissue fluid.

Resources

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ORGANIZATIONS

American Academy of Family Physicians (AAFP), 11400 Tomahawk Creek Parkway, Leawood, KS, 66211-2680, (913) 906-6000, (913) 906-6075, (800) 271-2237, http://www.aafp.org/.

Rebecca J. Frey, PhD

Rubeola *see* **Measles**

Ruptured disk *see* **Herniated disk**

RVT *see* **Renal vein thrombosis**

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S

Sacroiliac disease

Definition

Sacroiliac disease is high-impact trauma to the sacroiliac joint that can cause **death**, or bone, and nerve damage.

Description

The sacroiliac joint is a strong, weight bearing synovial joint between the ilium and sacrum bones of the pelvis. The bones are held in place and allowed limited movements by a system of sacroiliac ligaments. Relaxation of this and other joints and ligaments is important during **pregnancy** and is accomplished by a special hormone called relaxin. Usually the sacroiliac is damaged by high-impact injuries. These injuries may be life threatening and mortality is approximately 20% if neighboring structures are also damaged. Injuries to this area often includes neurological deficits. Dislocation and nerve damage are frequently missed in the diagnosis.

Causes and symptoms

The primary cause of **dislocations**, **fractures**, and accompanying damage is usually a traumatic accident. Patients receiving such injuries require emergency medical attention. There may be severe blood loss due to breakage of large bones and resuscitative measures may be required for stabilization.

Diagnosis

The diagnosis can be difficult since nerve damage can mimic other conditions with similar symptoms (i.e., **low back pain** in persons with **sciatica**). Additionally imaging studies and **physical examination** maneuvers will miss the diagnosis. The definitive method for diagnosing sacroiliac pathology would be injection of local anesthetic in the correct area of the affected sacroiliac joint. This procedure is usually performed using advance guidance systems (CT or fluoroscopic assisted guidance). If the **pain** is relieved by anesthetic injection, then the diagnosis is confirmed. There are three typical patterns of pain: pain directly over the joint, pain in the groin extending down the affected leg that can mimic the signs associated with a herniated lumbar disc, and pain widely dispersed in the affected leg.

Treatment

Treatment initially can include emergency interventions, but usually is conservative. Treatment includes **physical therapy**, manipulation, and medications for pain control. In some cases a sacroiliac belt can help with symptoms. In sacroiliac joint disease that has already progressed and is chronic and severe, corrective joint fusion may be indicated.

Prognosis

Outcome is variable and takes into account the extent of injuries, early diagnosis, and responsiveness to conservative treatment.

Prevention

There is no known prevention since the disease is secondary to an accident.

Resources

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KEY TERMS

Herniated disk—A protrusion in a disk located in the spinal column.

Ligament—Fibrous tissue which connect bones.

Synovial joint—A joint that allows for bone movement.

ORGANIZATIONS

American Academy of Orthopaedic Surgeons, 6300 North River Road, Rosemont, IL 60018-4262, (847) 823-7186, (847) 823-8125, http://www. aaos.org.

Laith Farid Gulli, M.D.

SAD *see* **Seasonal affective disorder**

Salivary gland scan

Definition

A salivary gland scan is a nuclear medicine test that examines the uptake and secretion in the salivary glands of a radioactively labeled marker substance. The pattern of uptake and secretion shows if these glands are functioning normally.

Purpose

A salivary gland scan is done to help diagnose the cause of **dry mouth**. It is a test that is done when Sjogren's syndrome, salivary duct obstruction, asymmetric hypertrophy, or growths such as Warthin's tumors are suspected.

Precautions

Salivary gland scans are a safe and effective way to diagnose problems associated with dry mouth. The level of radioactivity in the marker substance is low and poses no threat to health. The only people who should not undergo this test are pregnant women.

Other recent nuclear medicine tests may affect the results of this scan. It may be necessary to wait until earlier radiopharmaceuticals have been cleared from the body before undergoing this scan.

Description

A salivary gland scan, also called a parotid gland scan, is a noninvasive test. The patient is positioned under a gamma scintillation camera that detects radiation. The patient then is injected with a low-level radioactive marker, usually technetium-99m or technetium pertechnetate.

Immediately after the injection, imaging begins. For accurate results, the patient must stay still during imaging. After several images, the patient is given lemon drop candies to suck on, which stimulate the salivary glands. Another set of images is made for comparison purposes. The entire process takes about ten minutes for the injection and 30–45 minutes for the scan.

Preparation

No special preparations are needed for this test. It is not necessary to fast or to restrict medications before testing. Any blood that needs to be drawn for other tests should be taken before the radiopharmaceutical is injected.

Aftercare

Patients can return to normal activities immediately.

Risks

A salivary gland scan is a safe test. The only risk is to the fetus of a pregnant woman. Women who are pregnant should discuss the risks and benefits of this procedure with their doctor.

Normal results

Normally functioning salivary glands take up the radiopharmaceutical then secrete it when stimulated by the lemon drops.

Abnormal results

Abnormally functioning salivary glands fail to exhibit a normal uptake and secretion pattern. This test does not differentiate between benign and malignant lesions.

Resources

BOOKS

Beers, Mark H., Robert S. Porter, and Thomas V. Jones, eds. *The Merck Manual of Diagnosis and Therapy*. 18th ed. Whitehouse Station, NJ: Merck Research Laboratories, 2006.

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KEY TERMS

Hypertrophy—Overgrowth of tissue not due to a tumor.

Parotid gland—The salivary gland that lies below and in front of each ear.

Radiopharmaceutical—A radioactive pharmaceutical or chemical (usually radioactive iodine or cobalt) used for diagnostic or therapeutic purposes.

Sjögren's syndrome—A disease often associated with rheumatoid arthritis, that causes dry mouth, lesions on the skin, and enlargement of the parotid glands. It is often seen in menopausal women.

Technetium—A synthetic element used in nuclear medicine; it is obtained from the fission of uranium.

Warthin's tumor—A benign tumor of the parotid gland.

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ORGANIZATIONS

Society of Nuclear Medicine (SNM), 1850 Samuel Morse Dr., Reston, VA, 20190, (703) 708-9000, (703) 708-9015, http://www.snm.org.

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Salivary gland tumors

Definition

A salivary gland tumor is an uncontrolled growth of cells that originates in one of the many saliva-producing glands in the mouth.

Description

The tongue, cheeks, and palate (the hard and soft areas at the roof of the mouth) contain many glands that produce saliva. In saliva there are enzymes, or catalysts, that begin the breakdown (digestion) of food while it is still in the mouth. The glands are called salivary glands because of their function.

There are three big pairs of salivary glands in addition to many smaller ones. The parotid glands, submandibular glands and sublingual glands are the large, paired salivary glands. The parotids are located inside the cheeks, one below each ear. The submandibular glands are located on the floor of the mouth, with one on the inner side of each part of the lower jaw, or mandible. The sublingual glands are also in the floor of the mouth, but they are under the tongue.

The parotids are the salivary glands most often affected by tumors. Yet most of the tumors that grow in the parotid glands are benign, or not cancerous. Approximately 8 out of 10 salivary tumors diagnosed are in a parotid gland. One in 10 diagnosed is in a submandibular gland. The remaining 10% are diagnosed in other salivary glands.

In general, glands more likely to show tumor growth are also glands least likely to show malignant tumor growth. Thus, although tumors of the sublingual glands are rare, almost all of them are malignant. In contrast, about one in four tumors of the parotid glands is malignant.

Cancers of the salivary glands begin to grow in epithelial cells, or the flat cells that cover body surfaces. Thus, they are called carcinomas, cancers that by definition begin in epithelial cells.

Demographics

Cancers in the mouth account for fewer than 2% of all cases of **cancer** and about 1.5% of cancer deaths. About 7% of all cancers diagnosed in the head and neck region are diagnosed in a salivary gland. Men and women are at equal risk.

Mortality from salivary gland tumors in the United States is higher among male African Americans below the age of 50 than among older workers of any race or either sex.

Causes and symptoms

When survivors of the 1945 atomic bombings of Nagasaki and Hiroshima began to develop salivary gland tumors at a high rate, radiation was suspected as a cause. Ionizing radiation, particularly gamma radiation, is a factor that contributes to tumor development. So is **radiation therapy**. Adults who received radiation therapy for enlarged adenoids or tonsils when they were children are at greater risk for salivary gland tumors.

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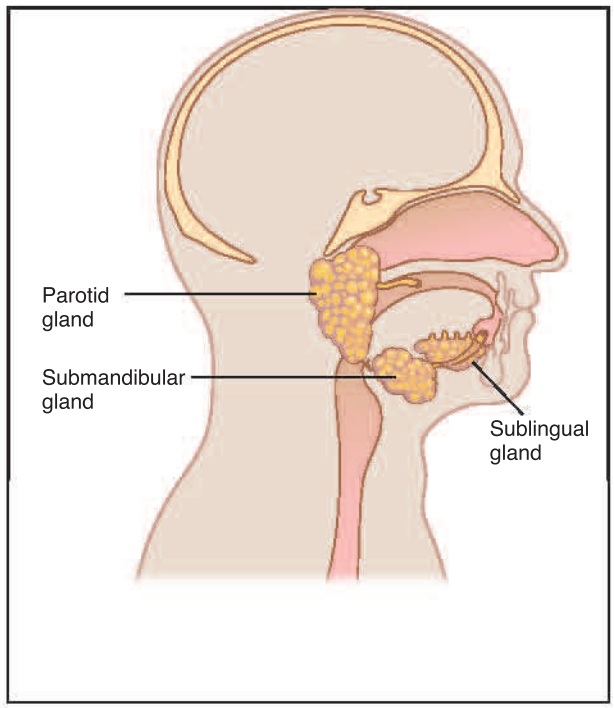

Location of the three main salivary glands. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Another reported risk factor is an association between wood dust inhalation and adenocarcinoma of the minor salivary glands of the nose and paranasal sinuses. There is also evidence that people infected with herpes viruses may be at greater risk for salivary gland tumors. And individuals infected with human **immunodeficiency** virus (HIV) have more salivary gland disease in general, and may be at greater risk for salivary gland tumors.

Although there has been speculation that the electromagnetic fields generated by cell phones increase the risk of salivary gland tumors, a recent study done in Denmark has concluded that the use of cell phones, pagers, and similar devices is not a risk factor.

There seems to be some link between **breast cancer** and salivary gland tumors. Women with breast cancer are more likely to be diagnosed with salivary gland tumors. Also linked to salivary gland tumors is alcohol use, exposure to sunlight (ultraviolet radiation) and hair dye use. There is evidence that people infected with herpes viruses may be at greater risk for salivary gland tumors. Individuals infected with human immunodeficiency virus (HIV) have more salivary gland disease in general, and may be at greater risk for salivary gland tumors.

Symptoms are often absent until the tumor is large or has metastasized (spread to other sites). In many cases, the tumor is first discovered by the patient's dentist. During regular dental examinations, the dentist looks for masses on the palate or under the tongue or in the cheeks, and such checkups are a good way to detect tumors early. Some symptoms are:

- a lump or mass in the mouth
- swelling in the face
- pain in the jaw or the side of the face
- difficulty swallowing
- difficulty breathing
- difficulty speaking

Diagnosis

A tissue sample will be taken for study via a biopsy. Usually an incision is necessary to take the tissue sample. Sometimes it is possible to take a tissue sample with a needle.

Magnetic resonance imaging (MRI) and computed tomography (CT) scans are also used to evaluate the tumor. They help determine whether the cancer has spread to sites adjacent to the salivary gland where it is found. MRI offers a good way to examine the tonsils and the back of the tongue, which are soft tissues. CT is tapped as a way of studying the jaw, which is bone.

Treatment

To assess the stage of growth of a salivary gland tumor, many features are examined, including how big it is and the type of abnormal cell growth. Analysis of the types of abnormal cell growth in tissue is so specific that many salivary gland tumors are given unique names.

In stage I cancer the tumor is less than one inch in size and it has not spread. Stage II salivary gland cancers are larger than one inch and smaller than two and one-half inches, but they have not spread. Stage III cancers are smaller than one inch, but they have spread to a lymph node. Stage IV cancers have spread to adjacent sites in the head, which may include the base of the skull and nearby nerves, or they are larger than two and one-half inches and have invaded a lymph node.

Surgical removal (excision) of the tumor is the most common treatment. **Chemotherapy** and radiation therapy may be part of the treatment, particularly if the cancer has metastasized, or spread to other sites; chemotherapy of salivary gland cancers, however, does not appear to extend survival or improve the patient's quality of life. Because there are many nerves

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KEY TERMS

Adenoids—Common name for the pharyngeal tonsils, which are lymph masses in the wall of the air passageway (pharynx) just behind the nose.

Biopsy—Tissue sample is taken from the body for examination.

Computed tomography (CT)—X rays are aimed at slices of the body (by rotating equipment) and results are assembled with a computer to give a three-dimensional picture of a structure.

Lymph—Tissue that is part of the lymphatic system, the system that collects and returns fluid to the blood vessels and produces substances that fight infection.

Magnetic resonance imaging (MRI)—Magnetic fields and radio frequency waves are used to take pictures of the inside of the body.

Tonsils—Common name for the palatine tonsils, which are lymph masses in the back of the mouth, on either side of the tongue.

and blood vessels near the three major pairs of salivary glands, particularly the parotids, the surgery can be quite complicated. A complex surgery is especially true if the tumor has spread.

A promising form of treatment for patients at high risk of tumor recurrence in the salivary glands near the base of the skull is **gamma knife surgery**. Used as a booster treatment following standard neutron radiotherapy, gamma knife surgery appears to be well tolerated by the patients and to have minimal side effects.

Alternative treatment

Any technique, such as **yoga**, **meditation** or **biofeedback**, that helps a patient cope with **anxiety** over the condition and discomfort from treatment is useful and should be explored as an option.

Prognosis

Tumors in small salivary glands that are localized can usually be removed without much difficulty. The outlook for survival once the tumor is removed is very good if it has not metastasized.

For parotid cancers, the five-year survival rate is more than 85% whether or not a lymph node is involved at diagnosis. Ten-year survival rate is just under 50%.

Most early stage salivary gland tumors are removed, and they do not return. Those that do return, or recur, are the most troublesome and reduce the chance an individual will remain cancer-free.

Prevention

Minimizing intake of beverages containing alcohol may be important. Avoiding unnecessary exposure of the head to radiation and to sunlight may also be considered preventative. Anything that reduces the risk of contracting a sexually transmitted disease, such as the use of **condoms**, also may lower the risk of salivary gland cancer.

Resources

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OTHER

"Oral Cavity and Pharyngeal Cancer." American Cancer Society. Revised October 7, 2010. http://www.cancer.org/cancer/oralcavityandoropharyngealcancer/index.

ORGANIZATIONS

SPOHNC, Support for People with Oral and Head and Neck Cancer, PO Box 53, Locust Valley, NY, 11560-0053, (516) 671-8794, (800) 377-0928, info@spohnc. org, http://www.spohnc.org.

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Salmonella food poisoning

Definition

Salmonella **food poisoning** is a bacterial food poisoning caused by the *Salmonella* bacterium. It results in the swelling of the lining of the stomach and intestines (**gastroenteritis**). While domestic and wild animals, including poultry, pigs, cattle, and pets such as turtles, iguanas, chicks, dogs, and cats can transmit this illness, most people become infected by ingesting foods contaminated with significant amounts of *Salmonella*.

Demographics

Salmonella food poisoning occurs worldwide, however it is most frequently reported in North America and Europe. Only a small proportion of infected people are tested and diagnosed, and as few as 1% of cases are actually reported. While the infection rate may seem relatively low, even an attack rate of less than 0.5% in such a large number of exposures results in many infected individuals. The poisoning typically occurs in small, localized outbreaks in the general population or in large outbreaks in hospitals, restaurants, or institutions for children or the elderly. In the United States, *Salmonella* is responsible for about 15% of all cases of food poisoning.

Salmonella enteritidis. **Exposure to this bacterium usually occurs by contact with contaminated food.** *(© Oliver Meckes/ Photo Researchers, Inc.)*

Description

Improperly handled or undercooked poultry and eggs are the foods which most frequently cause Salmonella food poisoning. Chickens are a major carrier of *Salmonella* bacteria, which accounts for its prominence in poultry products. However, identifying foods which may be contaminated with *Salmonella* is particularly difficult because infected chickens typically show no signs or symptoms. Since infected chickens have no identifying characteristics, these chickens go on to lay eggs or to be used as meat.

At one time, it was thought that *Salmonella* bacteria were only found in eggs which had cracked, thus allowing the bacteria to enter. Ultimately, it was learned that, because the egg shell has tiny pores, even uncracked eggs which sat for a time on a surface (nest) contaminated with *Salmonella* could themselves become contaminated. It is known also that the bacteria can be passed from the infected female chicken directly into the substance of the egg before the shell has formed around it.

Anyone may contract Salmonella food poisoning, but the disease is most serious in infants, the elderly, and individuals with weakened immune systems. In these individuals, the infection may spread from the intestines to the blood stream, and then to other body sites, causing **death** unless the person is treated promptly with **antibiotics**. In addition, people who have had part or all of their stomach or their spleens removed, or who have sickle cell anemia, **cirrhosis** of the liver, leukemia, lymphoma, **malaria**, louse-borne **relapsing fever**, or Acquired **Immunodeficiency** Syndrome (**AIDS**) are particularly susceptible to Salmonella food poisoning.

Causes and symptoms

Salmonella food poisoning can occur when someone drinks unpasteurized milk or eats undercooked chicken or eggs, or salad **dressings** or desserts which contain raw eggs. Even if *Salmonella*-containing foods such as chicken are thoroughly cooked, any food can become contaminated during preparation if conditions and equipment for food preparation are unsanitary.

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Other foods can then be accidentally contaminated if they come into contact with infected surfaces. In addition, children have become ill after playing with turtles or iguanas, and then eating without washing their hands. Because the bacteria are shed in the feces for weeks after infection with *Salmonella*, poor hygiene can allow such a carrier to spread the infection to others.

Symptoms appear about one-two days after infection, and include **fever** (in 50% of patients), **nausea and vomiting**, **diarrhea**, and abdominal cramps and **pain**. The diarrhea is usually very liquid, and rarely contains mucus or blood. Diarrhea usually lasts for about four days. The illness usually ends in about five-seven days.

Serious complications are rare, occurring most often in individuals with other medical illnesses. Complications occur when the *Salmonella* bacteria make their way into the bloodstream (**bacteremia**). Once in the bloodstream, the bacteria can enter any organ system throughout the body, causing disease. Other infections which can be caused by *Salmonella* include:

- bone infections (osteomyelitis)
- joint infections (arthritis)
- infection of the sac containing the heart (pericarditis)
- infection of the tissues which cover the brain and spinal cord (meningitis)
- infection of the liver (hepatitis)
- lung infections (pneumonia)
- infection of aneurysms (aneurysms are abnormal outpouchings which occur in weak areas of the walls of blood vessels)
- infections in the center of already-existing tumors or cysts.

Diagnosis

Under appropriate laboratory conditions, *Salmonella* can be grown and then viewed under a microscope for identification. Early in the infection, the blood is far more likely to positively show a presence of the *Salmonella* bacterium when a sample is grown on a nutrient substance (culture) for identification purposes. Eventually, however, positive cultures can be obtained from the stool and in some cases from a **urine culture**.

Treatment

Even though Salmonella food poisoning is a bacterial infection, most practitioners do not treat simple cases with antibiotics. Studies have shown that using antibiotics does not usually reduce the length of time that the patient is ill. Paradoxically, it appears that antibiotics do, however, cause the patient to shed bacteria in their feces for a *longer* period of time. In order to decrease the length of time that a particular individual is a carrier who can spread the disease, antibiotics are generally not given.

KEY TERMS

Carrier—Someone who has an organism (bacteria, virus, fungi) in his or her body, without signs of illness. The individual may therefore pass the organism on to others.

Gastroenteritis—Inflammation of the stomach and intestines. Usually causes nausea, vomiting, diarrhea, abdominal pain and cramps.

In situations where an individual has a more severe type of infection with *Salmonella* bacteria, a number of antibiotics may be used. Chloramphenicol was the first antibiotic successfully used to treat Salmonella food poisoning. It is still a drug of choice in developing countries because it is so inexpensive, although some resistance has developed to it. Ampicillin and trimethoprim-sulfonamide have been used successfully in the treatment of infections caused by chloramphenicol-resistant strains. Newer types of antibiotics, such as cephalosporin or quinolone, are also effective. These drugs can be given by mouth or through a needle in the vein (intravenously) for very ill patients. With effective antibiotic therapy, patients feel better in 24–48 hours, the temperature returns to normal in three-five days, and the patient is generally recovered by 10–14 days.

Alternative treatment

A number of alternative treatments have been recommended for food poisoning. One very effective treatment that is strongly recommended is supplementation with *Lactobacillus acidophilus*, *L. bulgaricus*, and/or *Bifidobacterium* to restore essential bacteria in the digestive tract. These preparations are available as powders, tablets, or capsules from health food stores; yogurt with live *L. acidophilus* cultures can also be eaten.

Fasting or a liquid-only diet is often used for food poisoning. Homeopathic treatment can work very effectively in the treatment of Salmonella food

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poisoning. The appropriate remedy for the individual and his/her symptoms must be used to get the desired results. Some examples of remedies commonly used are *Chamomilla*, *Nux vomica*, *Ipecac*, and *Colchicum*.

Juice therapy, including carrot, beet, and garlic juices, is sometimes recommended, although it can cause discomfort for some people. Charcoal tablets can help absorb toxins and remove them from the digestive tract through bowel elimination. A variety of herbs with antibiotic action, including citrus seed extract, goldenseal (*Hydrastis canadensis*), and Oregon grape (*Mahonia aquifolium*), may also be effective in helping to resolve cases of food poisoning.

Prognosis

The prognosis for uncomplicated cases of Salmonella food poisoning is excellent. Most people recover completely within a week's time. In cases where other medical problems complicate the illness, prognosis depends on the severity of the other medical conditions, as well as the specific organ system infected with *Salmonella*.

Prevention

Prevention of Salmonella food poisoning involves the proper handling and cooking of foods likely to carry the bacteria. This means that recipes utilizing uncooked eggs (Caesar salad dressing, meringue toppings, mousses) need to be modified to eliminate the raw eggs. Not only should chicken be cooked thoroughly, until no pink juices flow, but all surfaces and utensils used on raw chicken must be carefully cleaned to prevent *Salmonella* from contaminating other foods. Careful handwashing is a must before, during, and after all food preparation involving eggs and poultry. Handwashing is also important after handling and playing with pets such as turtles, iguanas, chicks, dogs and cats.

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ORGANIZATIONS

Centers for Disease Control and Prevention, 1600 Clifton Rd., NE, Atlanta, GA, 30333, (404) 639-3311, (800) 311-3435, http://www.cdc.gov.

Rosalyn Carson-DeWitt, MD
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Salmonella paratyphi infection *see* **Paratyphoid fever**

Salmonella typhi infection *see* **Typhoid fever**

Salpingectomy

Definition

Salpingectomy is the removal of one or both of a woman's fallopian tubes, the tubes through which an egg travels from the ovary to the uterus.

Purpose

A salpingectomy may be performed for several different reasons. Removal of one tube (unilateral salpingectomy) is usually performed if the tube has become infected (a condition known as salpingitis).

Salpingectomy is also used to treat an **ectopic pregnancy**, a condition in which a fertilized egg has implanted in the tube instead of inside the uterus. In most cases, the tube is removed only after drug treatments designed to save the structure have failed. (Women with one remaining fallopian tube are still able to get pregnant and carry a **pregnancy** to term.) The other alternative to salpingectomy is surgery to remove the fetus from the fallopian tube, followed by surgery to repair the tube.

A bilateral salpingectomy (removal of both the tubes) is usually done if the ovaries and uterus are also going to be removed. If the fallopian tubes and the ovaries are both removed at the same time, this is called a **salpingo-oophorectomy**. A salpingo-oophorectomy is necessary when treating ovarian and **endometrial cancer** because the fallopian tubes and ovaries are the most common sites to which **cancer** may spread.

Description

Regional or **general anesthesia** may be used. Often a laparoscope (a hollow tube with a light on one end) is used in this type of operation, which means

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KEY TERMS

Ectopic pregnancy—The development of a fetus at a site other than the inside of the uterus; most commonly, the egg implants itself in the fallopian tube.

Laparoscope—A surgical instrument with a light attached that is inserted through the abdominal wall to allow the surgeon to see the organs in the abdomen.

that the incision can be much smaller and the recovery time much shorter.

In this procedure, the surgeon makes a small incision just beneath the navel. The surgeon inserts a short hollow tube into the abdomen and, if necessary, pumps in carbon dioxide gas in order to move intestines out of the way and better view the organs. After a wider double tube is inserted on one side for the laparoscope, another small incision is made on the other side through which other instruments can be inserted. After the operation is completed, the tubes and instruments are withdrawn. The tiny incisions are sutured and there is very little scarring.

In the case of a pelvic infection, the surgeon makes a horizontal (bikini) incision 4-6 in (10-15 cm) long in the abdomen right above the pubic hairline. This allows the doctor to remove the scar tissue. (Alternatively, a surgeon may use a vertical incision from the pubic bone toward the navel, although this is less common.)

Preparation

The patient is given an injection an hour before surgery to encourage drowsiness.

Aftercare

Aftercare varies depending on whether the tube was removed by **laparoscopy** or through an abdominal incision. Even when major surgery is performed, most women are out of bed and walking around within three days. Within a month or two, a woman can slowly return to normal activities such as driving, exercising, and working.

Risks

All surgery, especially under general anesthesia, carries certain risks, such as the risk of scarring, hemorrhaging, infection, and reactions to the anesthesia. Pelvic surgery can also cause internal scarring which can lead to discomfort years afterward.

ORGANIZATIONS

American College of Obstetricians and Gynecologists, PO Box 96920, Washington, DC, 20090-6920, (202) 638-5577, http://www.acog.org.

Carol A. Turkington

Salpingitis *see* **Pelvic inflammatory disease**

Salpingo-oophorectomy

Definition

Unilateral salpingo-oophorectomy is the surgical removal of a fallopian tube and an ovary. If both sets of fallopian tubes and ovaries are removed, the procedure is called a bilateral salpingo-oophorectomy.

Purpose

This surgery is performed to treat ovarian or other gynecological cancers, or infections caused by **pelvic inflammatory disease**. Occasionally, removal of one or both ovaries may be done to treat **endometriosis**, a condition in which the lining of the uterus (the endometrium) grows outside of the uterus (usually on and around the pelvic organs). The procedure may also be performed if a woman has been diagnosed with an **ectopic pregnancy** in a fallopian tube and a salpingostomy (an incision into the fallopian tube to remove the **pregnancy**) cannot be done. If only one fallopian tube and ovary are removed, the woman may still be able to conceive and carry a pregnancy to term. If both are removed, however, the woman is rendered permanently infertile. This procedure is commonly combined with a **hysterectomy** (surgical removal of the uterus); the ovaries and fallopian tubes are removed in about one-third of hysterectomies.

Until the 1980s, women over age 40 having hysterectomies routinely had healthy ovaries and fallopian tubes removed at the same time. Many physicians reasoned that a woman over 40 was approaching **menopause** and soon her ovaries would stop secreting estrogen and releasing eggs. Removing the ovaries would eliminate the risk of **ovarian cancer** and only accelerate menopause by a few years.

In the 1990s, the approach to routine salpingo-oophorectomy began to change. The risk of ovarian **cancer** in women who have no family history of the disease is less than 1%. Moreover, removing the ovaries increases the risk of cardiovascular disease and

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KEY TERMS

BRCA1 or BRCA2 genetic mutation—A genetic mutation that predisposes otherwise healthy women to breast cancer.

Endometriosis—A painful disease in which cells from the lining of the uterus (endometrium) become attached to other organs in the pelvic cavity. The condition is hard to diagnose and often causes severe pain as well as infertility.

Fallopian tubes—Tubes that extend from either end of the uterus that convey the egg from the ovary to the uterus during each monthly cycle.

Hysterectomy—The surgical removal of the uterus.

Ureter—The tube that carries urine from the bladder to the kidneys.

accelerates **osteoporosis** unless a woman takes prescribed hormone replacements.

Demographics

Overall, ovarian cancer accounts for only 4% of all cancers in women. For women at increased risk, **oophorectomy** may be considered after the age of 35 if childbearing is complete. Factors that increase a woman's risk of developing ovarian cancer include age (most ovarian cancers occur after menopause), the presence of a mutation in the BRCA1 or BRCA2 gene, the number of menstrual periods a woman has had (affected by age of onset, pregnancy, **breastfeeding**, and oral contraceptive use), history of **breast cancer**, diet, and family history. The incidence of ovarian cancer is highest among Native American (17.5 cases per 100,000 population), Caucasian (15.8 per 100,000), Vietnamese (13.8 per 100,000), Hispanic (12.1 per 100,000), and Hawaiian (11.8 per 100,000) women; it is lowest among Korean (7.0 per 100,000) and Chinese (9.3 per 100,000) women. African American women have an ovarian cancer incidence of 10.2 per 100,000 population.

Endometriosis, another reason why salpingo-oophorectomy may be performed, has been estimated to affect up to 10% of women. Approximately four out of every 1,000 women are hospitalized as a result of endometriosis each year. Women 25–35 years of age are affected most, with 27 being the average age of diagnosis.

Description

General or regional anesthesia will be given to the patient before the procedure begins. If the procedure is performed through a laparoscope, the surgeon can avoid a large abdominal incision and can shorten recovery. With this technique, the surgeon makes a small cut through the abdominal wall just below the navel. A tube containing a tiny lens and light source (a laparoscope) is then inserted through the incision. A camera can be attached that allows the surgeon to see the abdominal cavity on a video monitor. When the ovaries and fallopian tubes are detached, they are removed though a small incision at the top of the vagina. The organs can also be cut into smaller sections and removed. When the laparoscope is used, the patient can be given either regional or **general anesthesia**; if there are no complications, the patient can leave the hospital in a day or two.

If a laparoscope is not used, the surgery involves an incision 4–6 in (10–15 cm) long into the abdomen extending either vertically up from the pubic bone toward the navel, or horizontally (the "bikini incision") across the pubic hairline. The scar from a bikini incision is less noticeable, but some surgeons prefer the vertical incision because it provides greater visibility while operating. A disadvantage to abdominal salpingo-oophorectomy is that bleeding is more likely to be a complication of this type of operation. The procedure is more painful than a laparoscopic operation and the recovery period is longer. A woman can expect to be in the hospital two to five days and will need three to six weeks to return to normal activities.

Diagnosis/preparation

Before surgery, the doctor will order blood and urine tests, and any additional tests such as ultrasound or x rays to help the surgeon visualize the woman's condition. The woman may also meet with the anesthesiologist to evaluate any special conditions that might affect the administration of anesthesia. A colon preparation may be done, if extensive surgery is anticipated.

On the evening before the operation, the woman should eat a light dinner, then take nothing by mouth, including water or other liquids, after midnight.

Aftercare

If performed through an abdominal incision, salpingo-oophorectomy is major surgery that requires three to six weeks for full recovery. However, if performed laparoscopically, the recovery time can be much shorter. There may be some discomfort around the incision for the first few days after surgery, but most women are walking around by the third day. Within a month or so, patients can gradually resume normal activities such as driving, exercising, and working.

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Immediately following the operation, the patient should avoid sharply flexing the thighs or the knees. Persistent back **pain** or bloody or scanty urine indicates that a ureter may have been injured during surgery.

If both ovaries are removed in a premenopausal woman as part of the operation, the sudden loss of estrogen will trigger an abrupt **premature menopause** that may involve severe symptoms of hot flashes, vaginal dryness, painful intercourse, and loss of sex drive. (This is also called "surgical menopause.") In addition to these symptoms, women who lose both ovaries also lose the protection these hormones provide against heart disease and osteoporosis many years earlier than if they had experienced natural menopause. Women who have had their ovaries removed are seven times more likely to develop coronary heart disease and much more likely to develop bone problems at an early age than are premenopausal women whose ovaries are intact. For these reasons, some form of **hormone replacement therapy** (HRT) may be prescribed to relieve the symptoms of surgical menopause and to help prevent heart and bone disease.

Reaction to the removal of fallopian tubes and ovaries depends on a wide variety of factors, including the woman's age, the condition that required the surgery, her reproductive history, how much social support she has, and any previous history of depression. Women who have had many gynecological surgeries or chronic pelvic pain seem to have a higher tendency to develop psychological problems after the surgery.

Risks

Major surgery always involves some risk, including infection, reactions to the anesthesia, hemorrhage, and **scars** at the incision site. Almost all pelvic surgery causes some internal scars, which in some cases can cause discomfort years after surgery.

Potential complications after a salpingo-oophorectomy include changes in sex drive, hot flashes, and other symptoms of menopause if both ovaries are removed. Women who have both ovaries removed and who do not take estrogen replacement therapy run an increased risk for cardiovascular disease and osteoporosis. Women with a history of psychological and emotional problems before an oophorectomy are more likely to experience psychological difficulties after the operation.

Results

If the surgery is successful, the fallopian tubes and ovaries will be removed without complication, and the underlying problem resolved. In the case of cancer, all the cancer will be removed. A woman will become infertile following a bilateral salpingo-oophorectomy.

Morbidity and mortality rates

Studies have shown that the complication rate following salpingo-oophorectomy is essentially the same as that following hysterectomy. The rate of complications differs by the type of hysterectomy performed. Abdominal hysterectomy is associated with a higher rate of complications (9.3%), while the overall complication rate for vaginal hysterectomy is 5.3%, and 3.6% for laparoscopic vaginal hysterectomy. The risk of **death** is about one in every 1,000 (1/1,000) women having a hysterectomy. The rates of some of the more commonly reported complications are:

- excessive bleeding (hemorrhaging): 1.8–3.4%
- fever or infection: 0.8–4.0%
- accidental injury to another organ or structure: 1.5–1.8%

Because of the cessation of hormone production that occurs with a bilateral oophorectomy, women who lose both ovaries also prematurely lose the protection these hormones provide against heart disease and osteoporosis. Women who have undergone bilateral oophorectomy are seven times more likely to develop coronary heart disease and much more likely to develop bone problems at an early age than are premenopausal women whose ovaries are intact.

Alternatives

Depending on the specific condition that warrants an oophorectomy, it may be possible to modify the surgery so at least a portion of one ovary remains, allowing the woman to avoid early menopause. In the case of endometriosis, there are a number of alternative treatments that are usually pursued before a salpingo-oophorectomy (with or without hysterectomy) is performed. These include excising the growths without removing any organs, blocking or destroying the nerves that provide sensation to some of the pelvic structures, or prescribing drugs that decrease estrogen levels.

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Resources

OTHER

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"Oophorectomy (ovary removal surgery)." Mayo Clinic, April 16, 2009. http://www.mayoclinic.com/health/oophorectomy/MY00554/METHOD=print

"Ovarian Cancer." Medline Plus, November 5, 2009. http://www.nlm.nih.gov/medlineplus/ency/article/000889.htm

ORGANIZATIONS

American Cancer Society, 1599 Clifton Road NE, Atlanta, GA, 30329-4251, (800) 227-2345, http://www.cancer.org.

American College of Obstetricians and Gynecologists, 409 Twelfth Street SW, P.O. Box 96920, Washington, DC, 20090-6920, (202) 638-5577, http://www.acog.org.

National Cancer Institute, Building 31, Room 10A31, 31 Center Drive, MSC 2580, Bethesda, MD, 20892-2580, (800) 422-6237, http://www.nci.nih.gov.

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San Joaquin fever *see* **Coccidioidomycosis**
Sanfilippo's syndrome *see* **Mucopolysaccharidoses**
Saquinavir *see* **Protease inhibitors**

Sarcoidosis

Definition

Sarcoidosis is a disease which can affect many organs within the body. It causes the development of granulomas. Granulomas are masses resembling little tumors. They are made up of clumps of cells from the immune system.

Description

Sarcoidosis is a very puzzling disorder. In addition to having no clear-cut understanding of the cause of sarcoidosis, researchers are also puzzled by its distribution in the world population. In the United States, for example, 10-17 times as many African-Americans are affected as white Americans. In Europe, whites are primarily affected.

Prevalence is a way of measuring the number of people affected per 100,000 people in a given population. The prevalence figures for sarcoidosis are very unusual. In the United States, prevalence figures range from five (5/100,000 in the United States) for whites to 40 for blacks. In Europe, prevalence ranges from three in Poland, to 10 in France, to 64 in Sweden, to 200 for Irish women living in London. Furthermore, a person from a group with very low prevalence who leaves his or her native land for a second location with a higher prevalence will then have the same risk as anyone living in that second location.

Sarcoidosis affects both men and women, although women are more likely to have the disorder. The average age for diagnosis is around 20–40 years.

Causes and symptoms

The cause of sarcoidosis is not known. Because the granulomas are primarily made up of cells from the immune system (macrophages and lymphocytes), an immune connection is strongly suspected. One of the theories which has been put forth suggests that exposure to some toxic or infectious material starts up an immune response. For some reason, the body is unable to stop the response, and it spreads from the original organ to other organs.

Because sarcoidosis has been noted to occur in family groups, a genetic cause has also been suggested. Research shows that identical twins are more likely to both have sarcoidosis than are nonidentical twins or other siblings.

Some cases of sarcoidosis occur without the patient even noting any symptoms. These cases are often discovered by chance during routine chest x rays. Most cases of sarcoidosis, however, begin with very nonspecific symptoms, such as decreased energy, weakness, and a dry **cough**. Occasionally, the cough is accompanied by some mild **pain** in the breastbone (sternum). Some patients note that they are having unusual **shortness of breath** while exercising. Some patients develop **fever**, decreased appetite, and weight loss.

Virtually every system of the body has the potential to suffer the effects of sarcoidosis:

- tender reddish bumps (nodules) or patches often appear on the skin
- the eyes may become red and teary, and the vision blurry
- the joints may become swollen and painful (arthritis)
- lymph nodes in the neck, armpits, and groin become enlarged and tender, lymph nodes within the chest, around the lungs, also become enlarged
- fluid may accumulate around the lungs (pleural effusion), making breathing increasingly difficult

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- nasal stuffiness is common, as well as a hoarse sound to the voice
- cysts in the bone may cause pain in the hands and feet, or in other bony areas
- the bone marrow may decrease the production of all blood cells; decreased number of red blood cells causes anemia, fewer white blood cells increases the chance of infections, fewer platelets can increase the chance of bleeding
- the body's ability to process calcium often becomes abnormal, so that excess calcium passes through the kidneys and into the urine; this may cause kidney stones to form
- the liver may become enlarged
- the heart may suffer a variety of complications, including abnormal or missed beats (arrhythmias), inflammation of the covering of the heart (pericarditis), and an increasing tendency toward weak, ineffective pumping of the blood (heart failure)
- the nervous system may display the effects of sarcoidosis by hearing loss, chronic inflammation of the coverings of the brain and spinal cord (meningitis), abnormalities of the nerve that is involved in vision (optic nerve dysfunction), seizures, and the development of psychiatric disorders

Any, all, or even none of the above symptoms may be present in sarcoidosis.

Diagnosis

Diagnosis depends on information from a number of sources, including the patient's symptoms, the **physical examination**, x-ray pictures of the chest, and a number of other laboratory examinations of blood or other tissue. None of these categories of information are sufficient to make the diagnosis of sarcoidosis. There is no one test or sign or symptom which clearly points to sarcoidosis, excluding all other types of diseases. This is because nearly all of the symptoms and laboratory results in sarcoidosis also occur in other diseases. Diagnosis, then, requires careful consideration of many facts.

The physical examination in sarcoidosis may reveal the characteristic **skin lesions**. Wheezes may be heard throughout the lungs. The liver may be enlarged. Examination of the eyes using a special light called a slit-lamp may reveal changes indicative of sarcoidosis.

The **chest x ray** will show some pattern of abnormalities, which may include enlargement of the lymph nodes which drain the lung, scarring and abnormalities to the tissue of the lungs, and fluid accumulation around the lungs.

KEY TERMS

Granuloma—Masses made up of a variety of immune cells, as well as fibroblasts (cells which make up connective tissue).

Immune system—The system of specialized organs, lymph nodes, and blood cells throughout the body which work together to prevent foreign invaders (bacteria, viruses, fungi, etc.) from taking hold and growing.

Lung function tests measure such things as the amount of air an individual can breathe in and breathe out, the speed at which the air flows in and out, and the amount of air left in the lung after blowing out as much as possible in one second. A variety of lung function tests may show abnormal results in sarcoidosis.

Other types of tests may be abnormal in sarcoidosis. The abnormal test results may also indicate other diseases. They include an elevation of a substance called angiotensin-converting enzyme in the blood, and an increased amount of **calcium** present in 24 hours worth of urine.

Bronchoscopy is a very helpful diagnostic test. This involves passing a tiny tube (bronchoscope) through the nose or mouth, down the trachea, and into the airways (bronchial tubes). The bronchial tubes can be inspected through the bronchoscope. The bronchoscope is also designed in such a way as to allow biopsies to be obtained. Bronchoalveolar lavage involves washing the surfaces with a sterile saltwater (saline) solution. The saline is then retrieved and examined in a laboratory. Cells and debris from within the bronchial tubes and the tiny sacs of the lung (the alveoli) will be obtained in this way, and can be studied for the presence of an abnormally large number of white blood cells. A tiny piece of the lung tissue can also be obtained through the bronchosocope. This can be studied under a microscope to look for the characteristic granulomas and inflammation of sarcoidosis.

A gallium 67 scan involves the injection of a radioactive material called gallium 67. In sarcoidosis, areas of the body which are inflamed will retain the gallium 67. These areas will then show up on the scan.

Treatment

Many cases of sarcoidosis resolve without treatment. If treatment is needed, the most effective one for sarcoidosis is the administration of steroid medications. These medications work to decrease

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inflammation throughout the body. The long-term use of steroid medications has serious potential side-effects. Patients are only treated with **steroids** when the problems caused by sarcoidosis are particularly serious. Many cases of sarcoidosis resolve without treatment.

Prognosis

The prognosis for sarcoidosis is quite good. About 60–70% of the time, sarcoidosis cures itself within a year or two. In about 20–30% of patients, permanent damage occurs to the lungs. About 15–20% of all patients go on to develop a chronic, relapsing form of sarcoidosis. **Death** can be blamed on sarcoidosis in about 10% of all sarcoidosis cases.

Prevention

Until researchers are able to pinpoint the cause of sarcoidosis, there will be no available recommendations for how to prevent it.

Resources

PERIODICALS

Zitkus, Bruce S. "Sarcoidosis: Varied Symptoms Often Impede Diagnosis of this Multisystem Disorder." *American Journal of Nursing* 97, no. 10 (October 1997): 40+.

Rosalyn Carson-DeWitt, MD

Sarcomas

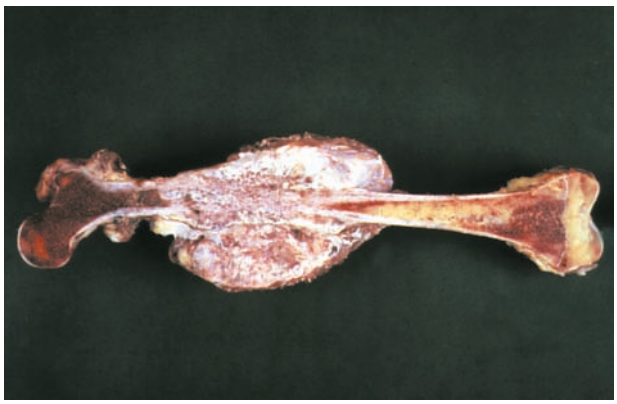
Definition

A sarcoma is a bone tumor that contains **cancer** (malignant) cells. A benign bone tumor is an abnormal growth of noncancerous cells.

Description

A primary bone tumor originates in or near a bone. Most primary bone tumors are benign, and the cells that compose them do not spread (metastasize) to nearby tissue or to other parts of the body.

Malignant primary bone tumors account for fewer than 1% of all cancers diagnosed in the United States. They can infiltrate nearby tissues, enter the bloodstream, and metastasize to bones, tissues, and organs far from the original malignancy. Malignant primary bone tumors are characterized as either:



A specimen of a femur bone indicating the cancerous growth around the knee. Osteosarcoma is the most common primary cancer of the bone. *(SPL/Photo Researchers, Inc.)*

- bone cancers which originate in the hard material of the bone.
- soft-tissue sarcomas which begin in blood vessels, nerves, or tissues containing muscles, fat, or fiber.

Types of bone tumors

Osteogenic sarcoma, or osteosarcoma, is the most common form of bone cancer, accounts for 6% of all instances of the disease, and for about 5% of all cancers that occur in children. Nine hundred new cases of osteosarcoma are diagnosed in the United States every year. The disease usually affects teenagers, and is almost twice as common in boys as in girls.

Osteosarcomas, which grow very rapidly, can develop in any bone but most often occur along the edge or on the end of one of the fast-growing long bones that support the arms and legs. About 80% of all osteosarcomas develop in the parts of the upper and lower leg nearest the knee (the distal femur or in the proximal tibia). The next likely location for an osteosarcoma is the bone of the upper arm closest to the shoulder (the proximal humerus).

Ewing's sarcoma is the second most common form of childhood bone cancer. Accounting for fewer than 5% of bone tumors in children, Ewing's sarcoma usually begins in the soft tissue (the marrow) inside bones of the leg, hips, ribs, and arms. It rapidly infiltrates the lungs, and may metastasize to bones in other parts of the body.

More than 80% of patients who have Ewing's sarcoma are white, and the disease most frequently affects children between ages 5–9, and young adults between ages 20–30. About 27% of all cases of Ewing's

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sarcoma occur in children under age 10, and 64% occur in adolescents between ages 10–20.

Chondrosarcomas are cancerous bone tumors that most often appear in middle age. Usually originating in strong connective tissue (cartilage) in ribs or leg or hip bones, chondrosarcomas grow slowly. They rarely spread to the lungs. It takes years for a chondrosarcoma to metastasize to other parts of the body, and some of these tumors never spread.

Parosteal osteogenic sarcomas, fibrosarcomas, and chordomas are rare. Parosteal osteosarcomas generally involve both the bone and the membrane that covers it. Fibrosarcomas originate in the ends of the bones in the arm or leg, and then spread to soft tissue. Chordomas develop on the skull or spinal cord.

Osteochondromas, which usually develop between age 10-20, are the most common noncancerous primary bone tumors. Giant cell tumors generally develop in a section of the thigh bone near the knee. Giant cell tumors are originally benign but sometimes become malignant.

Causes and symptoms

The cause of bone cancer is unknown, but the tendency to develop it may be inherited. Children who have bone tumors are often tall for their age, and the disease seems to be associated with growth spurts that occur during childhood and adolescence. Injuries can make the presence of tumors more apparent but do not cause them.

A bone that has been broken or exposed to high doses of radiation used to treat other cancers is more likely than other bones to develop osteosarcoma. A history of noncancerous bone disease also increases bone-cancer risk.

The amount of radiation in diagnostic x rays poses little or no danger of bone-cancer development, but children who have a family history of the most common childhood cancer of the eye (**retinoblastoma**), or who have inherited rare cancer syndromes have a greater-than-average risk of developing bone cancer. Exposure to chemicals found in some paints and dyes can slightly raise the risk.

Both benign and malignant bone tumors can distort and weaken bone and cause **pain**, but benign tumors are generally painless and asymptomatic.

It is sometimes possible to feel a lump or mass, but pain in the affected area is the most common early symptom of bone cancer. Pain is not constant in the initial stages of the disease, but it is aggravated by activity and may be worse at night. If the tumor is located on a leg bone, the patient may limp. Swelling and weakness of the limb may not be noticed until weeks after the pain began.

Other symptoms of bone cancer include:

- a bone that breaks for no apparent reason
- difficulty moving the affected part of the body
- fatigue
- fever
- a lump on the trunk, an arm or leg, or another bone
- persistent, unexplained back pain
- weight loss

Diagnosis

Physical examination and routine x rays may yield enough evidence to diagnose benign bone tumors, but removal of tumor tissue for microscopic analysis (biopsy) is the only sure way to rule out malignancy.

A needle biopsy involves using a fine, thin needle to remove small bits of tumor, or a thick needle to extract tissue samples from the innermost part (the core) of the growth. An excisional biopsy is the surgical removal of a small, accessible tumor. An incisional biopsy is performed on tumors too large or inaccessible to be completely removed. The surgeon performing an incisional biopsy cuts into the patient's skin and removes a portion of the exposed tumor. Performed under local or general anesthetic, biopsy reveals whether a tumor is benign or malignant and identifies the type of cancer cells the malignant tumor contains.

Bone cancer is usually diagnosed about three months after symptoms first appear, and 20% of malignant tumors have metastasized to the lungs or other parts of the body by that time.

Imaging techniques

The following procedures are used, in conjunction with biopsy, to diagnose bone cancer:

- Bone x rays. These x rays usually provide a clear image of osteosarcomas.
- Computerized axial tomography (CAT scan) is a specialized x ray that uses a rotating beam to obtain detailed information about an abnormality and its physical relationship to other parts of the body. A CAT scan can differentiate between osteosarcomas and other types of bone tumors, illustrate how tumor cells have infiltrated other tissues, and help surgeons decide which portion of a growth would be best to biopsy. Because more than four of every five malignant bone tumors metastasize to the lungs, a CAT scan of the chest is performed to see if these

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organs have been affected. Chest and abdominal CAT scans are used to determine whether Ewing's sarcoma has spread to the lungs, liver, or lymph nodes.

- Magnetic resonance imaging (MRI) is a specialized scan that relies on radio waves and powerful magnets to reflect energy patterns created by tissue abnormalities and specific diseases. An MRI provides more detailed information than does a CAT scan about tumors and marrow cavities of the bone, and can sometimes detect clusters of cancerous cells that have separated from the original tumor. This valuable information helps surgeons select the most appropriate approach for treatment.
- Radionuclide bone scans. These scans involve injecting a small amount of radioactive material into a vein. Primary tumors or cells that have metastasized absorb the radioactive material and show up as dark spots on the scan.

Cytogenic and molecular genetic studies, which assess the structure and composition of chromosomes and genes, may also be used to diagnose osteosarcoma. These tests can sometimes indicate what form of treatment is most appropriate.

Laboratory studies

A **complete blood count** (CBC) reveals abnormalities in the blood, and may indicate whether bone marrow has been affected. A blood test that measures levels of the enzyme lactate dehydrogenase (LDH) can predict the likelihood of a specific patient's survival.

Immunohistochemistry involves adding special antibodies and chemicals, or stains, to tumor samples. This technique is effective in identifying cells that are found in Ewing's sarcoma but are not present in other malignant tumors.

Reverse transcription polymerase chain reaction (RTPCR) relies on chemical analysis of the substance in the body that transmits genetic information (RNA) to:

- evaluate the effectiveness of cancer therapies
- identify mutations consistent with the presence of Ewing's sarcoma
- reveal cancer that recurs after treatment has been completed

Staging

Once bone cancer has been diagnosed, the tumor is staged. This process indicates how far the tumor has spread from its original location. The stage of a tumor suggests which form of treatment is most appropriate, and predicts how the condition will probably respond to therapy.

An osteosarcoma may be localized or metastatic. A localized osteosarcoma has not spread beyond the bone where it arose or beyond nearby muscles, tendons, and other tissues. A metastatic osteosarcoma has spread to the lungs, to bones not directly connected to the bone in which the tumor originated, or to other tissues or organs.

Treatment

Since the 1960s, when **amputation** was the only treatment for bone cancer, new **chemotherapy** drugs and innovative surgical techniques have improved survival with intact limbs. Because osteosarcoma is so rare, patients should consider undergoing treatment at a major cancer center staffed by specialists familiar with the disease.

A treatment plan for bone cancer, developed after the tumor has been diagnosed and staged, may include:

- Amputation. Amputation may be the only therapeutic option for large tumors involving nerves or blood vessels that have not responded to chemotherapy. MRI scans indicate how much of the diseased limb must be removed, and surgery is planned to create a cuff, formed of muscles and skin, around the amputated bone. Following surgery, an artificial (prosthetic) leg is fitted over the cuff. A patient who actively participates in the rehabilitation process may be walking independently as soon as three months after the amputation.
- Chemotherapy. Chemotherapy is usually administered in addition to surgery, to kill cancer cells that have separated from the original tumor and spread to other parts of the body. Although chemotherapy can increase the likelihood of later development of another form of cancer, the American Cancer Society maintains that the need for chemotherapeutic bone-cancer treatment is much greater than the potential risk.
- Surgery. Surgery, coordinated with diagnostic biopsy, enhances the probability that limb-salvage surgery can be used to remove the cancer while preserving nearby blood vessels and bones. A metal rod or bone graft is used to replace the area of bone removed, and subsequent surgery may be needed to repair or replace rods that have loosened or broken. Patients who have undergone limb-salvage surgery need intensive rehabilitation. It may take as long as a year for a patient to regain full use of a leg following limb-salvage surgery, and patients who have this operation may eventually have to undergo amputation.

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- Radiation therapy. Radiation therapy is used often to treat Ewing's sarcoma.
- Rotationoplasty. Rotationoplasty, sometimes performed after a leg amputation, involves attaching the lower leg and foot to the thigh bone, so that the ankle replaces the knee. A prosthetic is later added to make the leg as long as it should be. Prosthetic devices are not used to lengthen limbs that remain functional after amputation to remove osteosarcomas located on the upper arm. When an osteosarcoma develops in the jaw bone, the entire lower jaw is removed. Bones from other parts of the body are later grafted on remaining bone to create a new jaw.

Follow-up treatments

After a patient completes the final course of chemotherapy, CAT scans, bone scans, x rays, and other diagnostic tests may be repeated to determine if any traces of tumor remain. If none are found, treatment is discontinued, but patients are advised to see their oncologist and orthopedic surgeon every two or three months for the next year. X rays of the chest and affected bone are taken every four months. An annual echocardiogram is recommended to evaluate any adverse effect chemotherapy may have had on the heart, and CT scans are performed every six months.

Patients who have received treatment for Ewing's sarcoma are examined often - at gradually lengthening intervals - after completing therapy. Accurate growth measurements are taken during each visit and blood is drawn to be tested for side effects of treatment. X rays, CT scans, bone scans, and other imaging studies are generally performed every three months during the first year. If no evidence of tumor growth or recurrence is indicated, these tests are performed less frequently in the following years.

Some benign bone tumors shrink or disappear without treatment. However, regular examinations are recommended to determine whether these tumors have changed in any way.

Alternative treatment

Alternative treatments should never be substituted for conventional bone-cancer treatments or used without the approval of a physician. However, some alternative treatments can be used as adjunctive and supportive therapies during and following conventional treatments.

Dietary adjustments can be very helpful for patients with cancer. Whole foods, including grains, beans, fresh fruits and vegetables, and high quality fats, should be emphasized in the diet, while processed foods should be avoided. Increased consumption of fish, especially cold water fish like salmon, mackerel, halibut, and tuna, provides a good source of **omega-3 fatty acids**. **Nutritional supplements** can build strength and help maintain it during and following chemotherapy, radiation, or surgery. These supplements should be individually prescribed by an alternative practitioner who has experience working with cancer patients.

Many cancer patients claim that **acupuncture** alleviates pain, **nausea**, and **vomiting**. It can also be effective in helping to maintain energy and relative wellness during surgery, chemotherapy, and radiation. Massage, **reflexology**, and relaxation techniques are said to relieve pain, tension, **anxiety**, and depression. **Exercise** can be an effective means of reducing mental and emotional **stress**, while increasing physical strength. **Guided imagery**, **biofeedback**, hypnosis, body work, and progressive relaxation can also enhance quality of life.

Claims of effectiveness in fighting cancer have been made for a variety of herbal medicines. These botanical remedies work on an individual basis and should only be used when prescribed by a practitioner familiar with cancer treatment.

Treating cancer is a complex and individual task. It should be undertaken by a team of support practitioners with varying specialities who can work together for healing the person with cancer.

Prognosis

Benign brain tumors rarely recur, but sarcomas can reappear after treatment was believed to have eliminated every cell.

Likelihood of long-term survival depends on:

- the type and location of the tumor
- how much the tumor has metastasized, and on what organs, bones, or tissues have been affected

More than 85% of patients survive for more than five years after complete surgical removal of low-grade osteosarcomas (tumors that arise in mature tissue and contain a small number of cancerous cells). About 25–30% of patients diagnosed with high-grade osteosarcomas (tumors that develop in immature tissue and contain a large number of cancer cells) will die of the disease.

Two-thirds of all children diagnosed with Ewing's sarcoma will live for more than five years after the disease is detected. The outlook is most favorable for children under age 10, and least favorable in patients whose cancer is not diagnosed until after it has metastasized: fewer than three of every 10 of these patients remain alive five years later. More than 80% of patients whose Ewing's sarcoma is confined to a small area and surgically removed live, for at least

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five years. Postsurgical radiation and chemotherapy add years to their lives. More than 70% of patients live five years or more with a small Ewing's sarcoma that cannot be removed, but only three out of five patients with large, unremovable tumors survive that long.

Prevention

There is no known way to prevent bone cancer.

ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329 (800) 227-2345, http://www.cancer.org.

CancerCare, 275 Seventh Ave. Floor 22, New York, NY, 10001, (212) 712-8400, (212) 712-8495, (800) 813-4673, info@cancercare.org, http://www.cancercare.org.

National Cancer Institute (National Institutes of Health), NCI Office of Communications and Education, 6116 Executive Blvd. Suite 300, Bethesda, MD, 20892-8322, (800) 4-CANCER (422-6237), cancergovstaff@mail.nih.gov, http://www.cancer.gov/.

Maureen Haggerty

Saw palmetto

Definition

Saw palmetto, also known as Cabbage Palm and American dwarf palm, is a scrubby palm plant found in coastal regions of the southern United States and southern California.

Purpose

Saw palmetto is widely used in Europe to treat benign prostatic hypertrophy, and is the most popularly used herbal treatment for that condition in the United States. Some natural health practitioners use it to treat coughs and respiratory congestion.

In controlled clinical studies, the preponderance of evidence indicates that Saw palmetto is equally as effective, and better tolerated, at a tiny fraction of the cost, than brand drugs Proscar and Avodart for treating mild to moderate benign prostatic hypertrophy.

Saw palmetto does not act by reducing the size of the prostate gland. Like Proscar and Avodart, it

Saw palmetto leaves. *(Photo Researchers, Inc.)*

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interferes with enzymes that transform testosterone, the male hormone, into a form that maintains and increases prostate size.

Preparations

Ripe Saw palmetto plant berries are used whole, as liquid extracts, dried and ground and placed in tablet or capsule form, or as a tea.

A typical dose is 320 mg per day.

Precautions

Though used as medicines, herbal products are regulated like dietary supplements in the United States. Manufacturers are responsible only for their production processes. Manufacturing standards, and combinations of herbs within herbal products, may vary.

Many herbal products sold in stores vary from stated label potency.

Side effects

Side effects of Saw palmetto are dose related and vary from mild abdominal discomfort to cramps, **nausea**, **vomiting** and **diarrhea**.

Interactions

Saw palmetto can increase the blood-thinning effects actions of Ginko, warfarin, **aspirin**, non steroidal anti inflammatory drugs like ibuprofen, and Plavix.

Saw palmetto may alter the effectiveness of testosterone-replacement therapy and reduce the effectiveness of female hormone therapies like birth control.

Drug-herbal and herbal-herbal interactions are not well understood and have not been thoroughly tested. People must be careful observers of themselves as they take new drugs or herbs, or as they take these products regularly over many months

Resources

OTHER

"Saw Palmetto." *Herbs at a Glance*. National Center for Complementary and Alternative Medicine. http://nccam.nih.gov/health/palmetto.

James Waun, MD, RPh

Scabies

Definition

Scabies is a relatively contagious infection caused by a tiny mite (*Sarcoptes scabiei*).

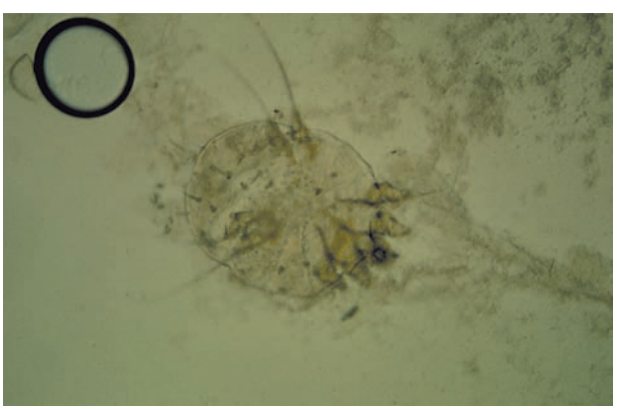
Demographics

Scabies is most common among people who live in overcrowded conditions, and whose ability to practice good hygiene is limited. Scabies can be passed between people by close skin contact. Although the mites can live only away from human skin for about three days, sharing clothing or bedclothes can pass scabies among family members or close contacts. In May 2002, the Centers for Disease Control (CDC) included scabies in its updated guidelines for the treatment of sexually transmitted infections (STI).

Description

Scabies is caused by a tiny insect about 0.3 mm long called a mite. When a human comes in contact with the female mite, the mite burrows under the skin, laying eggs along the line of its burrow. These eggs hatch, and the resulting offspring rise to the surface of the skin, mate, and repeat the cycle either within the skin of the original host, or within the skin of its next victim.

The intense **itching** almost always caused by scabies is due to a reaction within the skin to the feces of the mite. The first time someone is infected with scabies, he or she may not notice any itching for a number of weeks (four to six weeks). With subsequent infections, the itchiness will begin within hours of picking up the first mite.



An enhanced image of a scab mite. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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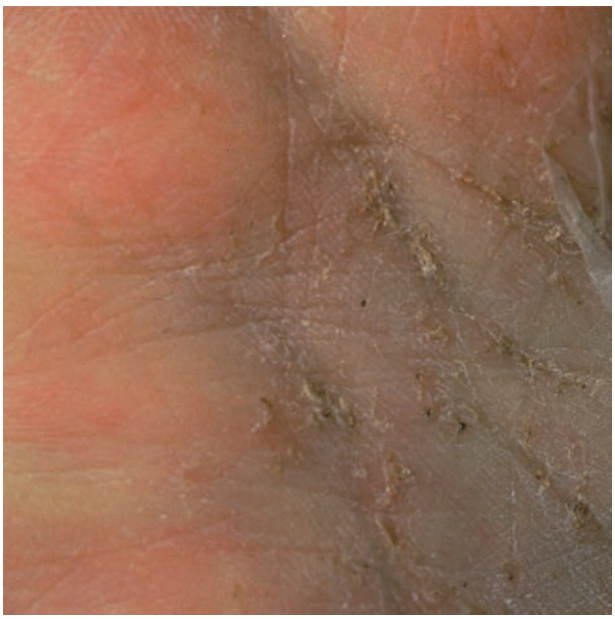

Scab mites have penetrated under the skin of this person's hand. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Causes and symptoms

The itching, or pruritus, from scabies is worse after a hot shower and at night. Burrows are seen as winding, slightly raised gray lines along the skin. The female mite may be seen at one end of the burrow, as a tiny pearl-like bump underneath the skin. Because of the intense itching, burrows may be obscured by scratch marks left by the patient. The most common locations for burrows include the sides of the fingers, between the fingers, the top of the wrists, around the elbows and armpits, around the nipples of the breasts in women, in the genitalia of men, around the waist (beltline), and on the lower part of the buttocks. Babies may have burrows on the soles of their feet, palms of their hands, and faces.

Scratching seems to serve some purpose in scabies, as the mites are apparently often inadvertently removed. Most infestations with scabies are caused by no more than 15 mites altogether.

Infestation with huge numbers of mites (on the order of thousands to millions) occurs when an individual does not scratch, or when an individual has a weakened immune system. These patients include those who live in institutions; are mentally retarded, or physically infirm; have other diseases which affect the amount of sensation they have in their skin (**leprosy** or syringomyelia); have leukemia or diabetes; are taking medications which lower their immune response (**cancerchemotherapy**, drugs given after organ transplantation); or have other diseases which lower their immune response (such as acquired **immunodeficiency** syndrome, or **AIDS**). This form of scabies, with its major infestation, is referred to as crusted scabies or Norwegian scabies. Infected patients have thickened, crusty areas all over their bodies, including over the scalp. Their skin is scaly. Their fingernails may be thickened and horny.

Diagnosis

Diagnosis can be made simply by observing the characteristic burrows of the mites causing scabies. A sterilized needle can be used to explore the pearly bump at the end of a burrow, remove its contents, and place it on a slide to be examined. The mite itself may then be identified under a microscope.

Occasionally, a type of mite carried on dogs (*Sarcoptes scabiei var. canis*) may infect humans. These mites cannot survive for very long on humans, and so the infection is very light.

Treatment

Several types of lotions (usually containing five percent permethrin) can be applied to the body, and left on for 12–24 hours. One topical application is usually sufficient, although the scabicide may be reapplied after a week if mites remain. Preparations containing lindane are no longer recommended for treating scabies because of the potential for damage to the nervous system by lindane. Itching can be lessened by the use of calamine lotion or antihistamine medications.

In addition to topical medications, the doctor may prescribe oral ivermectin. Ivermectin is a drug that was originally developed for veterinary practice as a broad-spectrum antiparasite agent. Studies done in humans, however, have found that ivermectin is as safe and effective as topical medications for treating scabies. A study published in 2003 reported that ivermectin is safe for people in high-risk categories, including those with compromised immune systems.

Prognosis

The prognosis for complete recovery from scabies infestation is excellent. In patients with weak immune systems, the biggest danger is that the areas of skin involved with scabies will become secondarily infected with bacteria.

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KEY TERMS

Mite—An insect parasite belonging to the order Acarina. The organism that causes scabies is a mite.

Pruritus—An unpleasant itching sensation. Scabies is characterized by intense pruritus.

Topical—A type of medication applied to the skin or body surface.

Prevention

Good hygiene is essential in the prevention of scabies. When a member of a household is diagnosed with scabies, all that person's recently-worn clothing and bedding should be washed in very hot water.

Resources

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ORGANIZATIONS

American Academy of Dermatology (AAD), 930 East Woodfield Rd., Schaumburg, IL, 60173, (847) 330–0230, http://www.aad.org.

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Scarlatina *see* **Scarlet fever**

Scarlet fever

Definition

Scarlet fever is an infection that is caused by a bacteria called streptococcus. The disease is characterized by a **sore throat**, fever, and a sandpaper-like rash on reddened skin. It is primarily a childhood disease. If scarlet fever is untreated, serious complications such as **rheumatic fever** (a heart disease) or kidney inflammation (**glomerulonephritis**) can develop.

Description

Scarlet fever, also known as scarlatina, gets its name from the fact that the patient's skin, especially on the cheeks, is flushed. A sore throat and raised rash over much of the body are accompanied by fever and sluggishness (lethargy). The fever usually subsides within a few days and recovery is complete by two weeks. After the fever is gone, the skin on the face and body flakes; the skin on the palms of the hands and soles of the feet peels more dramatically.

This disease primarily affects children ages two to ten. It is highly contagious and is spread by sneezing, coughing, or direct contact. The incubation period is three to five days, with symptoms usually beginning on the second day of the disease, and lasting from four to ten days.

Early in the twentieth century, severe scarlet fever epidemics were common. Today, the disease is rare. Although this decline is due in part to the availability of **antibiotics**, that is not the entire reason since the decline began before the widespread use of antibiotics. One theory is that the strain of bacteria that causes scarlet fever has become weaker with time.

Causes and symptoms

Scarlet fever is caused by Group A streptococcal bacteria (*S. pyogenes*). Group A streptococci can be highly toxic microbes that can cause **strep throat**, wound or skin infections, **pneumonia**, and serious kidney infections, as well as scarlet fever. The Group A streptococci are; hemolytic bacteria, which means that the bacteria have the ability to lyse or break red blood cells. The strain of streptococcus that causes scarlet fever is slightly different from the strain that causes most strep throats. The scarlet fever strain of bacteria produces a toxin, called an erythrogenic toxin. This toxin is what causes the skin to flush.

The main symptoms and signs of scarlet fever are fever, lethargy, sore throat, and a bumpy rash that blanches under pressure. The rash appears first on the upper chest and spreads to the neck, abdomen, legs, arms, and in folds of skin such as under the arm or groin. In scarlet fever, the skin around the mouth tends to be pale, while the cheeks are flushed. The patient usually has a "strawberry tongue," in which inflamed bumps on the tongue rise above a bright red

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GLADYS DICK (1881–1963)

Before 1922, not much was known about the then-endemic disease of scarlet fever, which primarily affected children in Europe and North America, killing about 25% of the children who contracted it. Additionally, scarlet fever had many complications, some of which were severe and could be crippling. Gladys Dick, with her husband, George Dick, successfully isolated the bacteria which caused scarlet fever, developed a test for human vulnerability to the disease, and devised preventive methods. The couple patented their findings, specifically the way their scarlet fever toxin and antitoxin were prepared, although this decision was controversial at the time.

In 1923, the Dicks published papers in which they proved that scarlet fever was caused by hemolytic streptococcus. Within a few years, the Dicks also published papers on how to prevent, test, diagnose, and treat scarlet fever. Their groundbreaking work ensured that the disease was finally understood and brought under control.

Dick and her husband announced the development of what came to be known as the Dick test in 1924. This skin test showed whether the patient was susceptible or immune to scarlet fever. The test involved injecting a toxin-containing substance in the arm and determining if the skin around the area became inflamed. If it did, the patient was vulnerable to scarlet fever. This test was also useful in predicting if pregnant women would develop puerperal infection during childbirth.

coating. Finally, dark red lines (called Pastia's lines) may appear in the creases of skin folds.

Diagnosis

Cases of scarlet fever are usually diagnosed and treated by pediatricians or family medicine practitioners. The chief diagnostic signs of scarlet fever are the characteristic rash, which spares the palms and soles of the feet, and the presence of a strawberry tongue in children. Strawberry tongue is rarely seen in adults.

The doctor will take note of the signs and symptoms to eliminate the possibility of other diseases. Scarlet fever can be distinguished from **measles**, a viral infection that is also associated with a fever and rash, by the quality of the rash, the presence of a sore throat in scarlet fever, and the absence of the severe eye inflammation and severe runny nose that usually accompany measles.

The doctor will also distinguish between a strep throat, a viral infection of the throat, and scarlet fever. With a strep infection, the throat is sore and appears beefy and red. White spots appear on the tonsils. Lymph nodes under the jawline may swell and become tender. However, none of these symptoms are specific for strep throat and may also occur with a viral infection. Other signs are more characteristic of bacterial infections. For example, inflammation of the lymph nodes in the neck is typical in strep infections, but not viral infections. On the other hand, **cough**, **laryngitis**, and stuffy nose tend to be associated with viral infections rather than strep infections. The main feature that distinguishes scarlet fever from a mere strep throat is the presence of the sandpaper-red rash.

Laboratory tests are needed to make a definitive diagnosis of a strep infection and to distinguish a strep throat from a viral sore throat. One test that can be performed is a blood cell count. Bacterial infections are associated with an elevated **white blood cell count**. In viral infections, the white blood cell count is generally below normal.

A **throat culture** can distinguish between a strep infection and a viral infection. A throat swab from the infected person is brushed over a nutrient gel (a sheep blood agar plate) and incubated overnight to detect the presence of hemolytic bacteria. In a positive culture, a clear zone will appear in the gel surrounding the bacterium, indicating that a strep infection is present.

Treatment

Although scarlet fever will often clear up spontaneously within a few days, antibiotic treatment with either oral or injectable penicillin is usually recommended to reduce the severity of symptoms, prevent complications, and prevent spread to others. Antibiotic treatment will shorten the course of the illness in small children but may not do so in adolescents or adults. Nevertheless, treatment with antibiotics is important to prevent complications.

Since penicillin injections are painful, oral penicillin may be preferable. If the patient is unable to tolerate penicillin, alternative antibiotics such as erythromycin or clindamycin may be used. However, the entire course of antibiotics, usually 10 days, will need to be followed for the therapy to be effective. Because symptoms subside quickly, there is a temptation to stop therapy prematurely. It is important to take all of the pills in order to kill the bacteria. Not completing the course of therapy increases the risk of developing rheumatic fever and kidney inflammation.

If the patient is considered too unreliable to take all of the pills or is unable to take oral medication, daily injections of procaine penicillin can be given in the hip or thigh muscle. Procaine is an anesthetic that makes the injections less painful.

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KEY TERMS

Clindamycin—An antibiotic that can be used instead of penicillin.

Erythrogenic toxin—A toxin or agent produced by the scarlet fever-causing bacteria that causes the skin to turn red.

Erythromycin—An antibiotic that can be used instead of penicillin.

Glomerulonephritis—A serious inflammation of the kidneys that can be caused by streptococcal bacteria; a potential complication of untreated scarlet fever.

Hemolytic bacteria—Bacteria that are able to burst red blood cells.

Lethargy—The state of being sluggish.

Pastia's lines—Red lines in the folds of the skin, especially in the armpit and groin, that are characteristic of scarlet fever.

Penicillin—An antibiotic that is used to treat bacterial infections.

Procaine penicillin—An injectable form of penicillin that contains an anesthetic to reduce the pain of the injection.

Rheumatic fever—A heart disease that is a complication of a strep infection.

Sheep blood agar plate—A petri dish filled with a nutrient gel containing red blood cells that is used to detect the presence of streptococcal bacteria in a throat culture. Streptococcal bacteria will lyse or break the red blood cells, leaving a clear spot around the bacterial colony.

Strawberry tongue—A sign of scarlet fever in which the tongue appears to have a red coating with large raised bumps.

Bed rest is not necessary, nor is **isolation** of the patient. **Aspirin** or Tylenol (**acetaminophen**) may be given for fever or relief of **pain**.

Prognosis

If treated promptly with antibiotics, full recovery is expected. Once a patient has had scarlet fever, they develop immunity and cannot develop it again.

Prevention

Avoiding exposure to children who have the disease will help prevent the spread of scarlet fever.

Resources

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Sally J. Jacobs, EdD

Scars

Definition

Scars are marks created during the healing of damage to the skin or tissues.

Description

A scar is a manifestation of the skin's healing process. After skin or tissue is wounded, the body releases collagen to mend the damage. Collagen, a protein, reattaches the damaged skin. As the wound heals, a temporary crust forms and covers it. The crust is a scab that protects the damaged area.

Causes of scars include cuts, sores, surgery, and **burns**. Severe **acne** and chicken pox may also scar skin. The degree that skin scars depends on more than the size and depth of the wound. Age also affects the process. The healing process is stronger in younger skin. That results in scars that are thicker than those of older people. Other factors affecting the type of scar are ethnicity, heredity, and the location of the injury.

Children are active and susceptible to cuts and injuries. They and people with fair complexions tend to get hypertophic scars. While Asians and blacks are likely to have keloid scars, people from other ethnic groups also experience this form of scarring.

Keloid and hypertophic scars have similar appearances. However, the keloid scar expands beyond the original wound.

The location of the wound also has an effect on its size. If the scar is located on places like the knee or shoulder, it will eventually widen because these areas are in motion.

Treatment could minimize a scar but will not erase the mark.

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Causes and symptoms

Scarring is the natural process of repairing an open wound, injury, surgical incision, or other conditions like acne. Initially, a scar is red because blood vessels are created while the body forms scar tissue. The damaged area is covered by a protective scab that eventually falls off. The scar may become brown or pink. It generally fades over time and becomes less visible.

The healing process takes from one year to 18 months. Some scars heal naturally. Other scars require additional treatment.

Hypertophic scars and keloids

Hypertophic scars and **keloids** are caused by an over-active healing process. This produces an excessive amount of collagen at the wound site. Both types of scars are red, thick, and raised above the wound.

Hypertophic scars do not extend beyond the wound site. The scar may itch and usually heals without professional treatment in about a year.

Keloids are large scars that could form after surgery, an injury, burn, or body **piercing**. This scarring often occurs on the ear lobe or chest. Sometimes keloids develop spontaneously.

The keloid is raised, rigid, and grows beyond the wound. The keloid can continue to grow. Scars are generally harmless, but may itch or feel tender. In addition, a person may feel self-conscious about the scar's appearance.

Contracture scars

Contracture scars are caused by the loss of a large section of skin due to burns or other injury. The scar contracts or tightens around the wound. This contraction could impact a person's mobility. If the scar deepens, it could affect muscles and nerves.

Acne scars

Acne scars may appear after the severe stage of acne, a skin condition usually caused by hormonal changes. The inflammatory condition is seen in adolescence, but acne can occur later in life.

Severe acne is triggered by clogged pores that cause bacteria to multiply. It occurs more frequently in adolescent boys than girls. If the acne is not treated, there could be scarring. The types of scars include pit-like pockmarks.

Diagnosis

Since visible scars could make people self-conscious, they will probably seek treatment rather than a diagnosis. Medical professionals who treat scars include dermatologists and plastic surgeons. Dermatologists are physicians who care for the skin. Their expertise includes three or more years of medical and surgical training.

Scar treatment is usually not covered by insurance. Cosmetic procedures, those done to improve a person's appearance, are considered elective surgery and are paid for by the patient. However, if scars cause a physical impairment, coverage may be issued. Examples of impairments include burn scars and keloids that restrict motion. For coverage to be approved, it is helpful for the primary care doctor to document the patient's case in writing.

Treatment

A scar is permanent and cannot be completely removed. However, treatment can alter a scar's appearance. These procedures range from the application of over-the-counter ointment to surgery. Scar treatment should start after an injury because wound care affects scarring. The wound should be cleaned and covered. Picking at the scab breaks the collagen and allows germs to enter the wound. Time also helps with healing. Scars become smaller, and the color fades.

However, additional treatment is required for some scars. While some procedures are more effective for keloids and hypertrophic scars, the procedure for acne scars is based on the type of scarring. Treatment for burn scars may include skin grafts surgery.

Surgery

The surgical procedure for scars is referred to as scar revision because the procedure modifies the scar's appearance. The cost of scar revision averages $500–3,000 in 2010, according to http://www.plasticsurgeons.com.

This procedure works well on scars that are wide or long. Other treatments may be recommended for keloids because a surgical incision could cause a new scar and create another keloid. To reduce the risk of another scar, surgery may be followed by the injection of cortisone **steroids**.

Steroid Injections

Steroid injection is a singular form of treatment for scars, particularly keloid and hypertophic scars.

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Corticosteroids are an anti-inflammatory drug that helps to lessen the scar's red color and thickness. The treatment flattens the scar and helps with **itching**. Injection costs vary and could cost $150 per scar, according to a member of the American Academy of Dermatologists (AAD).

Cyrosurgery

Cryosurgery involves the freezing of freezes tissue with a probe containing nitrous oxide. It is used to modify scars, especially keloid and hypertrophic scars. Treatment vary could cost $175 per lesion, according to the AAD member.

Dermabrasion

Dermabrasion is the removal of a layer of the skin's surface. Scars including those caused by acne are smoothed or sanded by an instrument. The procedure costs approximately $150 per treatment.

Silicone gel sheets

Silicone gel sheets can be purchased over-the-counter. The sheets are worn over the scar area to seal moisture. The treatment helps with itching and to reduce scar thickness and color. Cost of sheets for small **wounds** ranges from $30–50.

Alternative treatment

Alternate methods of treating scars range from applying Vitamin E to massaging the skin. People should consult with a doctor or other health care professional before starting treatment involving contact with the scarred area.

These procedures include applying obtained Vitamin E, aloe vera, or cocoa butter to the scar. Vitamin E is sold as an oil or obtained by opening a vitamin capsule. Aloe is an African plant and is sold I capsule form and as a skin care product. Cocoa butter is a fat made from cacao seeds.

Those items are thought to help with healing so that a scar is less visible. However, time also helps to lessen the scar's appearance. Those substances should be applied only after a scar is well-healed.

Massaging mild scars is done to relax rigid scar tissue. The scar is massaged for about two minutes. Afterwards, Vitamin E oil is applied to the skin. The process should be discontinued if the area becomes sore or red.

Prognosis

The prognosis for scar treatment depends on factors including the type and severity of the scar. Keloids may return, and all scars are permanent. If treatment does not completely minimize a scar to the patient's satisfaction, the person can apply make-up to the scarred area.

Prevention

The primary way to prevent scarring is to avoid injuries. People should wear protective gear when participating in sports. Furthermore, acne should be treated before the condition reaches the severe stage.

If injured, a person should immediately treat the wound because this reduces the risk of scarring. The wound should be cleaned and covered. If stitches aren't needed, a butterfly bandage is effective at keeping the wound closed. Moreover, a balanced diet also helps with the healing process.

Picking at the scab should be avoided because this interferes with the healing process and raises the risk of scarring.

Resources

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ORGANIZATIONS

American Academy of Dermatology, PO Box 4014, Schaumburg, IL, 60168-4014, (847) 240-1859, (866) 503-SKIN (7546), http://www.aad.org.

American Academy of Facial Plastic and Reconstructive Surgery (AAFPRS), 310 South Henry Street, Alexandria, VA, 22314, (703) 299-9291, info@aafprs.org, http://www.aafprs.org/.

American Society of Plastic Surgeons, 444 E. Algonquin Rd, Arlington Heights, IL, 60005, (847) 228-9900, http://www.plasticsurgery.org/.

Liz Swain

Schatzki's ring *see* **Lower esophageal ring**

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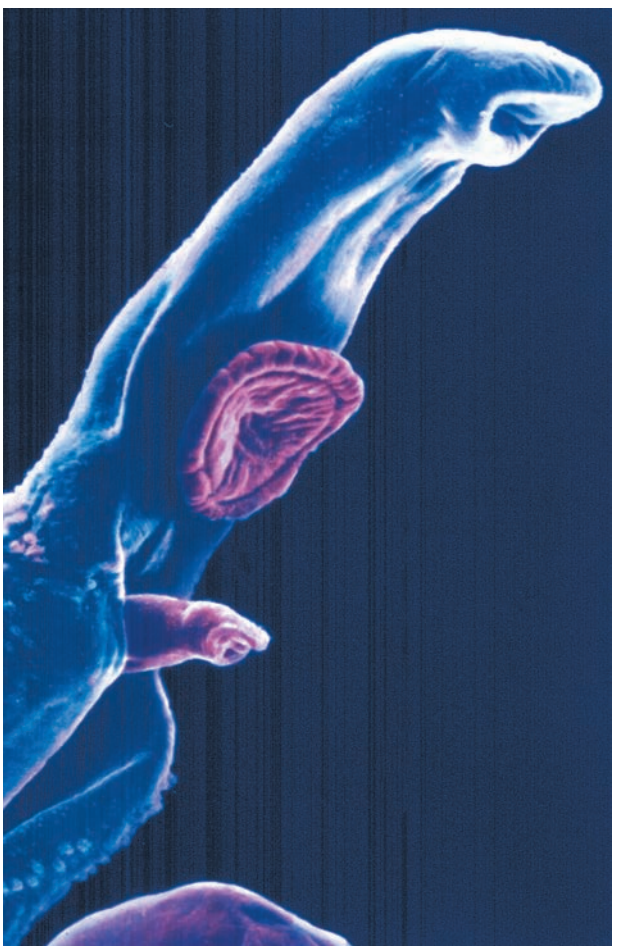
Schistosomiasis

Definition

Schistosomiasis, also known as bilharziasis or snail **fever**, is a primarily tropical parasitic disease caused by the larvae of one or more of five types of flatworms or blood flukes known as schistosomes. The name bilharziasis comes from Theodor Bilharz, a German pathologist, who identified the worms in 1851.

Description

Infections associated with worms present some of the most universal health problems in the world. In fact, only **malaria** accounts for more diseases than schistosomiasis. The World Health Organization (WHO) estimates that 200 million people are infected and 120 million display symptoms. Another 600 million people are at risk of infection. Schistosomes are prevalent in rural and outlying city areas of 74 countries in Africa, Asia, and Latin America. In Central China and Egypt, the disease poses a major health risk.



A scanning electron microscopy (SEM) of the head region of the male and female adult flukes of *Schistosoma sp.* These worms cause schistosomiasis (bilharziasis) in humans. Flukes live in human blood vessels and their eggs contaminate freshwater. *(Photo Researchers, Inc.)*

There are five species of schistosomes that are prevalent in different areas of the world and produce somewhat different symptoms:

- *Schistosoma mansoni* is widespread in Africa, the Eastern-Mediterranean, the Caribbean, and South America and can only infect humans and rodents.
- *S. mekongi* is prevalent only in the Mekong river basin in Asia.
- *S. japonicum* is limited to China and the Philippines and can infect other mammals, in addition to humans, such as pigs, dogs, and water buffalos. As a result, it can be harder to control disease caused by this species.
- *S. intercalatum* is found in central Africa.
- *S. haematobium* occurs predominantly in Africa and the Eastern Mediterranean.

Intestinal schistosomiasis, caused by *Schistosoma japonicum, S. mekongi, S. mansoni*, and *S. intercalatum*, can lead to serious complications of the liver and spleen. Urinary schistosomiasis is caused by *S. haematobium*.

It is difficult to know how many individuals die of schistomiasis each year because **death** certificates and patient records seldom identify schistosomiasis as the primary cause of death. Mortality estimates vary related to the type of schistosome infection but is generally low, for example, 2.4 of 100,000 die each year from infection with *S. mansoni*.

Causes and symptoms

All five species are contracted in the same way, through direct contact with fresh water infested with the free-living form of the parasite known as cercariae. The building of dams, irrigation systems, and reservoirs, and the movements of refugee groups introduce and spread schistosomiasis.

Eggs are excreted in human urine and feces and, in areas with poor sanitation, contaminate freshwater sources. The eggs break open to release a form of the parasite called miracidium. Freshwater snails become infested with the miracidium, which multiply inside the snail and mature into multiple cercariae that the snail ejects into the water. The cercariae, which survive outside a host for 48 hours, quickly penetrate unbroken skin, the lining of the mouth, or the gastrointestinal tract. Once inside the human body, the worms penetrate the wall of the nearest vein and travel to

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the liver where they grow and sexually mature. Mature male and female worms pair and migrate either to the intestines or the bladder where egg production occurs. One female worm may lay an average of 200 to 2,000 eggs per day for up to twenty years. Most eggs leave the blood stream and body through the intestines. Some of the eggs are not excreted, however, and can lodge in the tissues. It is the presence of these eggs, rather than the worms themselves, that causes the disease.

Early symptoms of infection

Many individuals do not experience symptoms. If present, it usually takes four to six weeks for symptoms to appear. The first symptom of the disease may be a general ill feeling. Within twelve hours of infection, an individual may complain of a **tingling** sensation or light rash, commonly referred to as "swimmer's itch," due to irritation at the point of entrance. The rash that may develop can mimic **scabies** and other types of **rashes**. Other symptoms can occur two to ten weeks later and can include fever, aching, **cough**, **diarrhea**, or gland enlargement. These symptoms can also be related to avian schistosomiasis, which does not cause any further symptoms in humans.

Katayama fever

Another primary condition, called Katayama fever, may also develop from infection with these worms, and it can be very difficult to recognize. Symptoms include fever, lethargy, the eruption of pale temporary bumps associated with severe **itching** (urticarial) rash, liver and spleen enlargement, and bronchospasm.

Intestinal schistosomiasis

In intestinal schistosomiasis, eggs become lodged in the intestinal wall and cause an immune system reaction called a granulomatous reaction. This immune response can lead to obstruction of the colon and blood loss. The infected individual may have what appears to be a potbelly. Eggs can also become lodged in the liver, leading to high blood pressure through the liver, enlarged spleen, the build-up of fluid in the abdomen (**ascites**), and potentially life-threatening dilations or swollen areas in the esophagus or gastrointestinal tract that can tear and bleed profusely (esophageal varices). Rarely, the central nervous system may be affected. Individuals with chronic active schistosomiasis may not complain of typical symptoms.

Urinary tract schistosomiasis

Urinary tract schistosomiasis is characterized by blood in the urine, **pain** or difficulty urinating, and frequent urination and are associated with *S. haematobium*. The loss of blood can lead to **iron deficiency anemia**. A large percentage of persons, especially children, who are moderately to heavily infected experience urinary tract damage that can lead to blocking of the urinary tract and **bladder cancer**.

Diagnosis

Proper diagnosis and treatment may require a tropical disease specialist because the disease can be confused with malaria or typhoid in the early stages. The healthcare provider should do a thorough history of travel in endemic areas. The rash, if present, can mimic scabies or other rashes, and the gastrointestinal symptoms may be confused with those caused by bacterial illnesses or other intestinal parasites. These other conditions will need to be excluded before an accurate diagnosis can be made. As a result, clinical evidence of exposure to infected water along with physical findings, a negative test for malaria, and an increased number of one type of immune cell, called an eosinophil, are necessary to diagnose acute schistosomiasis.

Eggs may be detected in the feces or urine. Repeated stool tests may be required to concentrate and identify the eggs. Blood tests may be used to detect a particular antigen or particle associated with the schistosome that induces an immune response. Persons infected with schistosomiasis may not test positive for six months, and as a result, tests may need to be repeated to obtain an accurate diagnosis. Blood can be detected visually in the urine or with chemical strips that react to small amounts of blood.

Sophisticated imaging techniques, such as ultrasound, computed tomography scan (CT scan), and **magnetic resonance imaging** (MRI), can detect damage to the blood vessels in the liver and visualize polyps and ulcers of the urinary tract, for example, that occur in the more advanced stages. *S. haematobium* is difficult to diagnose with ultrasound in pregnant women.

Treatment

The use of medications against schistosomiasis, such as praziquantel (Biltricide), oxamniquine, and metrifonate, have been shown to be safe and effective. Praziquantel is effective against all forms of schistosomiasis and has few side effects. This drug is given in either two or three doses over the course of a single day. Oxamniquine is typically used in Africa and South America to treat intestinal schistosomiasis. Metrifonate has been found to be safe and effective in the treatment of urinary schistosomiasis. Patients are typically checked for the presence of living eggs at

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KEY TERMS

Ascites—The condition that occurs when the liver and kidneys are not functioning properly and a clear, straw-colored fluid is excreted by the membrane that lines the abdominal cavity (peritoneum).

Cercariae—The free-living form of the schistosome worm that has a tail, swims, and has suckers on its head for penetration into a host.

Miracidium—The form of the schistosome worm that infects freshwater snails.

three and six months after treatment. If the number of eggs excreted has not significantly decreased, the patient may require another course of medication.

Prognosis

If treated early, prognosis is very good and complete recovery is expected. The illness is treatable, but people can die from the effects of untreated schistosomiasis. The severity of the disease depends on the number of worms, or worm load, in addition to how long the person has been infected. With treatment, the number of worms can be substantially reduced, and the secondary conditions can be treated. The goal of the World Health Organization is to reduce the severity of the disease rather than to completely stop transmission of the disease. There is, however, little natural immunity to reinfection. Treated individuals do not usually require retreatment for two to five years in areas of low transmission. The World Health Organization has made research to develop a vaccine against the disease one of its priorities.

Prevention

Prevention of the disease involves several targets and requires long term community commitment. Infected patients require diagnosis, treatment, and education about how to avoid reinfecting themselves and others. Adequate healthcare facilities need to be available, water systems must be treated to kill the worms and control snail populations, and sanitation must be improved to prevent the spread of the disease.

To avoid schistosomiasis in endemic areas:

- contact the CDC for current health information on travel destinations.
- upon arrival, ask an informed local authority about the infestation of schistosomiasis before being exposed to freshwater in countries that are likely to have the disease.
- do not swim, stand, wade, or take baths in untreated water.
- treat all water used for drinking or bathing. Water can be treated by letting it stand for three days, heating it for five minutes to around 122°F (around 50°C), or filtering or treating water chemically, with chlorine or iodine, as with drinking water.
- Should accidental exposure occur, infection can be prevented by hastily drying off or applying rubbing alcohol to the exposed area.

ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

Ruth E. Mawyer, RN

Schizencephaly *see* **Congenital brain defects**

Schizoaffective disorder

Definition

Schizoaffective disorder is a mental illness that shares the psychotic symptoms of **schizophrenia** and the mood disturbances of depression or **bipolar disorder**.

Demographics

Females tend to suffer from schizoaffective disorder more so than men. However, due to the broad clinical manifestations associated with this mental illness, the actual rate of schizoaffective disorder in adults is unknown.

Description

The term schizoaffective disorder was first used in the 1930s to describe patients with acute psychotic symptoms such as **hallucinations** and **delusions** along with disturbed mood. These patients tended to function well before becoming psychotic; their psychotic symptoms lasted relatively briefly; and they tended to do well afterward. Over the years, however, the term schizoaffective disorder has been applied to a variety of patient groups. The current definition contained in the American Psychiatric Association's *Diagnostic and Statistical Manual of Mental Disorders IV* (*DSM-IV*) recognizes patients with schizoaffective disorder as those whose mood symptoms are

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sufficiently severe to warrant a diagnosis of depression or other full-blown mood disorder and whose mood symptoms overlap at some period with psychotic symptoms that satisfy the diagnosis of schizophrenia (e.g. hallucinations, delusions, or thought process disorder).

Causes and symptoms

The cause of schizoaffective disorder remains unknown and subject to continuing speculation. Some investigators believe schizoaffective disorder is associated with schizophrenia and may be caused by a similar biological predisposition. Others disagree, stressing the disorder's similarities to **mood disorders** such as depression and bipolar disorder (manic depression). They believe its more favorable course and less intense psychotic episodes are evidence that schizoaffective disorder and mood disorders share a similar cause.

Many researchers, however, believe schizoaffective disorder may owe its existence to both disorders. These researchers believe that some people have a biologic predisposition to symptoms of schizophrenia that varies along a continuum of severity. On one end of the continuum are people who are predisposed to psychotic symptoms but never display them. On the other end of the continuum are people who are destined to develop outright schizophrenia. In the middle are those who may at some time show symptoms of schizophrenia, but require some other major trauma to set the progression of the disease into motion. It may be an early brain injury, either through a complicated delivery, prenatal exposure to the flu virus or illicit drugs; or it may be emotional, nutritional, or other type of deprivation in early childhood. In this view, major life stresses, or a mood disorder like depression or bipolar disorder, may be sufficient to trigger the psychotic symptoms. In fact, patients with schizoaffective disorder frequently experience depressed mood or **mania** within days of the appearance of psychotic symptoms. Some clinicians believe that "schizomanic" patients are fundamentally different from "schizodepressed" types; the former are similar to bipolar patients, while the latter are a very heterogeneous group.

Symptoms of schizoaffective disorder vary considerably from patient to patient. Delusions, hallucinations, and evidence of disturbances in thinking—as observed in full-blown schizophrenia—may be seen. Similarly, mood fluctuations such as those observed in major depression or bipolar disorder may also be seen. These symptoms tend to appear in distinct episodes that impair the individual's ability to function well in daily life. But between episodes, some patients with schizoaffective disorder remain chronically impaired while some may do quite well in day-to-day living.

Diagnosis

There are no accepted tissue or brain imaging tests or techniques to diagnose schizophrenia, mood disorders, or schizoaffective disorder. Instead, physicians look for the hallmark signs and symptoms of schizoaffective disorder described above, and they attempt to rule out other illnesses or conditions that may produce similar symptoms. These include:

- Mania. True manic patients can experience episodes of hallucinations and delusions similar to those seen in schizoaffective disorder; but these episodes do not persist for long periods after the mania recedes, as they do in schizoaffective disorder.
- Psychotic depression. Patients with psychotic depression experience hallucinations and delusions similar to those seen in schizoaffective disorder; but these symptoms do not persist after the depressive symptoms recede, as they do in schizoaffective disorder.
- Schizophrenia. Depressed mood, mania, or other symptoms may be present in patients with schizophrenia, but patients with schizoaffective disorder meet all the criteria set out for a full–blown mood disorder.
- Medical and neurological disorders that mimic psychotic/affective disorders.

Treatment

Antipsychotic medications used to treat schizophrenia and the **antidepressant drugs** and mood stabilizers used in depression and bipolar disorder are the primary treatments for schizoaffective disorder.

These treatments have not been well studied in controlled investigations. Studies suggest that traditional antipsychotics such as haloperidol are effective in treating psychotic symptoms. Newer generation antipsychotics, such as clozaril and risperidone, have not been as well studied, but also appear effective. For patients with symptoms of bipolar disorder, lithium is often the mood stabilizer of choice, and it is often augmented with an anticonvulsant such as valproate. For those with depressive symptoms, the evidence supporting the use of antidepressant medications in addition to antipsychotic medications is more mixed. **Electroconvulsive therapy** (electric shock) is frequently tried in patients who otherwise do not respond to antidepressant or mood stabilizing drugs.

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KEY TERMS

Bipolar disorder—A mood disorder marked by alternating episodes of extremely low mood (depression) and exuberant highs (mania). Also known as manic–depression disorder.

Mood disorder—A collection of disorders that includes major depression and bipolar disorder. They are all characterized by major disruptions in patients' moods and emotions.

Schizophrenia—A major mental illness marked by psychotic symptoms, including hallucinations, delusions, and severe disruptions in thinking.

While the mainstay of treatment for schizoaffective disorder is antipsychotic medications and mood stabilizers, certain forms of **psychotherapy** for both patients and family members can be useful. Therapy designed to provide structure and help augment patients' ability to solve problems may aid in improving patients' ability to function in the day-to-day world, reducing **stress** and the risk of recurrence. Vocational and other rehabilitative training can help patients to work on skills they need to develop. Whereas hospitalization may be necessary for acute psychotic episodes, halfway houses and day hospitals can provide needed treatment while serving as a bridge for patients to reenter the community.

Alternative treatment

While alternative therapies should never be considered a replacement for medication, these treatments can help support people with schizoaffectve disorder and other mental illnesses. Dietary modifications that eliminate processed foods and emphasize whole foods, along with nutritional supplementation, may be helpful. **Acupuncture**, homeopathy, and botanical medicine can support many aspects of the person's life and may help decrease the side effects of any medications prescribed.

Prognosis

In general, patients with schizoaffective disorder have a more favorable prognosis than do those with schizophrenia, but a less favorable course than those with a pure mood disorder. Medication and other interventions can help quell psychotic symptoms and stabilize mood in many patients, but there is great variability in outcome from patient to patient.

Prevention

There is no known way to prevent schizoaffective disorder. Treatment with antipsychotic and mood stabilizing drugs may prevent recurrences. Some researchers believe prompt treatment can prevent the development of full-blown schizophrenia, but this hypothesis remains the subject of some disagreement.

Resources

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ORGANIZATIONS

American Psychiatric Association (APA), 1000 Wilson Blvd., Suite 1825, Arlington, VA, 22209, (703) 907–7300, apa@psych.org, http://www.psych.org/.

American Psychological Association (APA), 750 First St. NE, Washington, DC, 20002-4242, (202) 336-5700, http://www.apa.org.

National Alliance for Research on Schizophrenia and Depression (NARSAD), 60 Cutter Mill Rd., Suite 404, Great Neck, NY, 11021, (516) 829-0091, http://www.mhsource.com.

National Alliance on Mental Illness (NAMI), Colonial Place Three, 2107 Wilson Blvd., Suite 300, Arlington, VA, 22201, (703) 524-7600, (800) 950-NAMI (6264), (703) 524-9094, http://www.nami.org/Hometemplate.cfm.

National Institute of Mental Health (NIMH), 6001 Executive Blvd., Room 8184, MSC 9663, Bethesda, MD, 20892, (301) 443-4513, (866) 615-6464, (301) 443-4279, nimhinfo@nih.gov, http://www.nimh.nih.gov/index.shtml.

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National Mental Health Association (NMHA), 2000 N. Beauregard St., 6th Floor, Alexandria, VA, 22311, (703) 684–7722, (800) 969-NMHA, (703) 684-5968, http://www1.nmha.org/.

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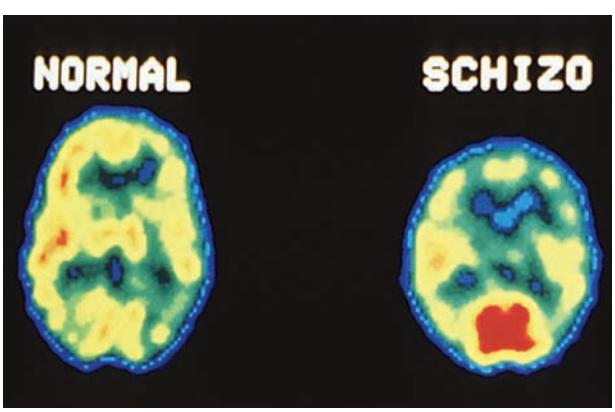
Schizophrenia

Definition

Schizophrenia is a psychotic disorder (or a group of disorders) marked by severely impaired thinking, emotions, and behaviors. Schizophrenic patients are typically unable to filter sensory stimuli and may have enhanced perceptions of sounds, colors, and other features of their environment. Most schizophrenics, if untreated, gradually withdraw from interactions with other people and lose their ability to take care of personal needs and grooming.

Demographics

According to the World Health Organization (WHO), schizophrenia is estimated to afflict about 24 million people wordwide, mostly in the 15–35 year age group. Though the incidence is low (3 in 10,000), the prevalence is high due to chronicity. It is also estimated that more than 50% of persons with schizophrenia are not receiving appropriate care and that 90% of people with untreated schizophrenia live in developing countries. Schizophrenia affects 2.2 million people in the United States, some 280,000 in Canada, 285,000 in Australia, and 250,000 in the United Kingdom. It ranks among the top 10 causes of disability in developed countries worldwide.



Positron emission tomography (PET) scans comparing a normal brain (left) with the brain of a schizophrenic. *(Photo Researchers, Inc.)*

The disease typically begins in early adulthood between the ages of 15 and 25. Men tend to develop schizophrenia slightly earlier than women: most men become ill between 16 and 25 years old, while most women develop symptoms several years later. The average age of onset is 18 in men and 25 in women. Schizophrenia onset is quite rare in children under the age of 10, and in people over 40 years of age.

Description

The course of schizophrenia in adults can be divided into three phases or stages. In the acute phase, the patient has an overt loss of contact with reality (psychotic episode) that requires intervention and treatment. In the second or stabilization phase, the initial psychotic symptoms have been brought under control but the patient is at risk for relapse if treatment is interrupted. In the third or maintenance phase, the patient is relatively stable and can be kept indefinitely on antipsychotic medications. Even in the maintenance phase, however, relapses are not unusual and patients do not always return to full functioning.

The term schizophrenia comes from two Greek words that mean "split mind." It was observed around 1908, by a Swiss doctor named Eugen Bleuler, to describe the splitting apart of mental functions that he regarded as the central characteristic of schizophrenia.

Recently, some psychotherapists have begun to use a classification of schizophrenia based on two main types. People with Type I, or positive schizophrenia, have a rapid (acute) onset of symptoms and tend to respond well to drugs. They also tend to suffer more from the "positive" symptoms, such as **delusions** and **hallucinations**. People with Type II, or negative schizophrenia, are usually described as poorly adjusted before their schizophrenia slowly overtakes them. They have predominantly "negative" symptoms, such as withdrawal from others and a slowing of mental and physical reactions (psychomotor retardation).

The fourth (1994) edition of the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM-IV*) specifies five subtypes of schizophrenia.

Paranoid

The key feature of this subtype of schizophrenia is the combination of false beliefs (delusions) and hearing voices (auditory hallucinations), with more nearly normal emotions and cognitive functioning (cognitive functions include reasoning, judgment, and memory).

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The delusions of paranoid schizophrenics usually involve thoughts of being persecuted or harmed by others or exaggerated opinions of their own importance, but may also reflect feelings of jealousy or excessive religiosity. The delusions are typically organized into a coherent framework. Paranoid schizophrenics function at a higher level than other subtypes, but are at risk for suicidal or violent behavior under the influence of their delusions.

Disorganized

Disorganized schizophrenia (formerly called hebephrenic schizophrenia) is marked by disorganized speech, thinking, and behavior on the patient's part, coupled with flat or inappropriate emotional responses to a situation (affect). The patient may act silly or withdraw socially to an extreme extent. Most patients in this category have weak personality structures prior to their initial acute psychotic episode.

Catatonic

Catatonic schizophrenia is characterized by disturbances of movement that may include rigidity, stupor, agitation, bizarre posturing, and repetitive imitations of the movements or speech of other people. These patients are at risk for **malnutrition**, exhaustion, or self-injury. This subtype is presently uncommon in Europe and the United States. **Catatonia** as a symptom is most commonly associated with **mood disorders**.

Undifferentiated

Patients in this category have the characteristic positive and negative symptoms of schizophrenia but do not meet the specific criteria for the paranoid, disorganized, or catatonic subtypes.

Residual

This category is used for patients who have had at least one acute schizophrenic episode but do not presently have strong positive psychotic symptoms, such as delusions and hallucinations. They may have negative symptoms, such as withdrawal from others, or mild forms of positive symptoms, which indicate that the disorder has not completely resolved.

Risk factors

The risk of schizophrenia among first-degree biological relatives is ten times greater than that observed in the general population. The incidence of schizophrenia in most developed countries also appears to be higher among people born in cities than among those born in rural areas.

Causes and symptoms

One of the reasons for the ongoing difficulty in classifying schizophrenic disorders is incomplete understanding of their causes. As of 2009, it is thought that these disorders are the end result of a combination of genetic, neurobiological, and environmental causes. A leading neurobiological hypothesis looks at the connection between the disease and excessive levels of dopamine, a chemical that transmits signals in the brain (neurotransmitter). The genetic factor in schizophrenia has been underscored by recent findings that first-degree biological relatives of schizophrenics are ten times as likely to develop the disorder as are members of the general population.

Prior to recent findings of abnormalities in the brain structure of schizophrenic patients, several generations of psychotherapists advanced a number of psychoanalytic and sociological theories about the origins of schizophrenia. These theories ranged from hypotheses about the patient's problems with **anxiety** or aggression to theories about **stress** reactions or interactions with disturbed parents. Psychosocial factors are now thought to influence the expression or severity of schizophrenia, rather than cause it directly.

Another hypothesis suggests that schizophrenia may be caused by a virus that attacks the hippocampus, a part of the brain that processes sense perceptions. Damage to the hippocampus would account for schizophrenic patients' vulnerability to sensory overload.

Symptoms of schizophrenia

Patients with a possible diagnosis of schizophrenia are evaluated on the basis of a set or constellation of symptoms; there is no single symptom that is unique to schizophrenia. In 1959, the German psychiatrist Kurt Schneider proposed a list of so-called first-rank symptoms, which he regarded as diagnostic of the disorder.

These symptoms include:

- delusions
- somatic hallucinations
- hearing voices commenting on the patient's behavior
- thought insertion or thought withdrawal

Somatic hallucinations refer to sensations or perceptions concerning body organs that have no known medical cause or reason, such as the notion that one's brain is radioactive. Thought insertion and/or withdrawal refers to delusions that an outside force (for example, the FBI, the CIA, Martians, etc.) has the power to put thoughts into one's mind or remove them.

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Positive symptoms

The positive symptoms of schizophrenia are those that represent an excessive or distorted version of normal functions. Positive symptoms include Schneider's first-rank symptoms as well as disorganized thought processes (reflected mainly in speech) and disorganized or catatonic behavior. Disorganized thought processes are marked by such characteristics as looseness of associations, in which the patient rambles from topic to topic in a disconnected way; tangentially, which means that the patient gives unrelated answers to questions; and "word salad," in which the patient's speech is so incoherent that it makes no grammatical or linguistic sense. Disorganized behavior means that the patient has difficulty with any type of purposeful or goal-oriented behavior, including personal self-care or preparing meals. Other forms of disorganized behavior may include dressing in odd or inappropriate ways, sexual self-stimulation in public, or agitated shouting or cursing.

Negative symptoms

The *DSM-IV* definition of schizophrenia includes three so-called negative symptoms. They are called negative because they represent the lack or absence of behaviors. The negative symptoms that are considered diagnostic of schizophrenia are a lack of emotional response (affective flattening), poverty of speech, and absence of volition or will. In general, the negative symptoms are more difficult for doctors to evaluate than the positive symptoms.

Diagnosis

Examination

A doctor must make a diagnosis of schizophrenia on the basis of a standardized list of outwardly observable symptoms, not on the basis of internal psychological processes. There are no specific laboratory tests that can be used to diagnose schizophrenia. Researchers have, however, discovered that patients with schizophrenia have certain abnormalities in the structure and functioning of the brain compared to normal test subjects. These discoveries have been made with the help of imaging techniques such as **computed tomography scans** (CT scans).

When a psychiatrist assesses a patient for schizophrenia, he or she will begin by excluding physical conditions that can cause abnormal thinking and some other behaviors associated with schizophrenia. These conditions include organic brain disorders (including traumatic injuries of the brain) temporal lobe **epilepsy**, **Wilson disease**, Huntington's chorea, and **encephalitis**. The doctor will also need to rule out **substance abuse** disorders, especially amphetamine use.

After ruling out organic disorders, the clinician will consider other psychiatric conditions that may include psychotic symptoms or symptoms resembling **psychosis**. These disorders include mood disorders with psychotic features; delusional disorder; dissociative disorder not otherwise specified (DDNOS) or **multiple personality disorder**; schizotypal, schizoid, or paranoid **personality disorders**; and atypical reactive disorders. In the past, many individuals were incorrectly diagnosed as schizophrenic. Some patients who were diagnosed prior to the changes in categorization introduced by *DSM-IV* should have their diagnoses, and treatment, reevaluated. In children, the doctor must distinguish between psychotic symptoms and a vivid fantasy life, and also identify learning problems or disorders. After other conditions have been ruled out, the patient must meet a set of criteria specified by *DSM-IV*:

- *Characteristic symptoms*. The patient must have two (or more) of the following symptoms during a one-month period: delusions; hallucinations; disorganized speech; disorganized or catatonic behavior; negative symptoms.
- Decline in social, interpersonal, or occupational functioning, including self-care.
- *Duration*. The disturbed behavior must last for at least six months.
- *Diagnostic exclusions*. Mood disorders, substance abuse disorders, medical conditions, and developmental disorders have been ruled out.

Treatment

Traditional

The treatment of schizophrenia depends in part on the patient's stage or phase. Patients in the acute phase are hospitalized in most cases, to prevent harm to the patient or others and to begin treatment with antipsychotic medications. A patient having a first psychotic episode may be given a CT or MRI (**magnetic resonance imaging**) scan to rule out structural brain disease.

Most schizophrenics can benefit from **psychotherapy** once their acute symptoms have been brought under control by antipsychotic medication. Psychoanalytic approaches are not recommended. Behavior therapy, however, is often helpful in assisting patients to acquire skills for daily living and social interaction. It can be combined with **occupational therapy** to prepare the patient for eventual employment.

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KEY TERMS

Affective flattening—A loss or lack of emotional expressiveness. It is sometimes called blunted or restricted affect.

Akathisia—Agitated or restless movement, usually affecting the legs and accompanied by a sense of discomfort. It is a common side effect of neuroleptic medications.

Catatonic behavior—Behavior characterized by muscular tightness or rigidity and lack of response to the environment. In some patients rigidity alternates with excited or hyperactive behavior.

Delusion—A fixed, false belief that is resistant to reason or factual disproof.

Depot dosage—A form of medication that can be stored in the patient's body tissues for several days or weeks, thus minimizing the risk of the patient forgetting daily doses. Haloperidol and fluphenazine can be given in depot form.

Dopamine receptor antagonists (DAs)—The older class of antipsychotic medications, also called neuroleptics. These primarily block the site on nerve cells that normally receive the brain chemical dopamine.

Dystonia—Painful involuntary muscle cramps or spasms.

Extrapyramidal symptoms (EPS)—A group of side effects associated with antipsychotic medications. EPS include parkinsonism, akathisia, dystonia, and tardive dyskinesia.

First-rank symptoms—A set of symptoms designated by Kurt Schneider in 1959 as the most important diagnostic indicators of schizophrenia. These symptoms include delusions, hallucinations, thought insertion or removal, and thought broadcasting. First–rank symptoms are sometimes referred to as Schneiderian symptoms.

Hallucination—A sensory experience of something that does not exist outside the mind. A person can experience a hallucination in any of the five senses. Auditory hallucinations are a common symptom of schizophrenia.

Huntington's chorea—A hereditary disease that typically appears in midlife, marked by gradual loss of brain function and voluntary movement. Some of its symptoms resemble those of schizophrenia.

Negative symptoms—Symptoms of schizophrenia characterized by the absence or elimination of certain behaviors. DSM-IV specifies three negative symptoms: affective flattening, poverty of speech, and loss of will or initiative.

Neuroleptic—Another name for the older type of antipsychotic medications given to schizophrenic patients.

Parkinsonism—A set of symptoms originally associated with Parkinson's disease that can occur as side effects of neuroleptic medications. The symptoms include trembling of the fingers or hands, a shuffling gait, and tight or rigid muscles.

Positive symptoms—Symptoms of schizophrenia that are characterized by the production or presence of behaviors that are grossly abnormal or excessive, including hallucinations and thought-process disorder. DSM-IV subdivides positive symptoms into psychotic and disorganized.

Poverty of speech—A negative symptom of schizophrenia, characterized by brief and empty replies to questions. It should not be confused with shyness or reluctance to talk.

Psychotic disorder—A mental disorder characterized by delusions, hallucinations, or other symptoms of lack of contact with reality. The schizophrenias are psychotic disorders.

Serotonin dopamine antagonist (SDA)—The newer second-generation antipsychotic drugs, also called atypical antipsychotics. SDAs include clozapine (Clozaril), risperidone (Risperdal), and olanzapine (Zyprexa).

Wilson disease—A rare hereditary disease marked by high levels of copper deposits in the brain and liver. It can cause psychiatric symptoms resembling schizophrenia.

Word salad—Speech that is so disorganized that it makes no linguistic or grammatical sense.

Family therapy is often recommended for the families of schizophrenic patients, to relieve the feelings of guilt that they often have as well as to help them understand the patient's disorder. The family's attitude and behaviors toward the patient are key factors in minimizing relapses (for example, by reducing stress in the patient's life), and family therapy can often strengthen the family's ability to cope with

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the stresses caused by the schizophrenic's illness. Family therapy focused on communication skills and problem-solving strategies is particularly helpful. In addition to formal treatment, many families benefit from support groups and similar mutual help organizations for relatives of schizophrenics.

Drugs

The primary form of treatment of schizophrenia is antipsychotic medication. **Antipsychotic drugs** help to control almost all the positive symptoms of the disorder. They have minimal effects on disorganized behavior and negative symptoms. Between 60–70% of schizophrenics will respond to antipsychotics. In the acute phase of the illness, patients are usually given medications by mouth or by intramuscular injection. After the patient has been stabilized, the antipsychotic drug may be given in a long-acting form called a depot dose. Depot medications last two to four weeks; they have the advantage of protecting the patient against the consequences of forgetting or skipping daily doses. In addition, some patients who do not respond to oral neuroleptics have better results with depot form. Patients whose long-term treatment includes depot medications are introduced to the depot form gradually during their stabilization period. Most people with schizophrenia are kept on antipsychotic medications indefinitely during the maintenance phase of their disorder to minimize the possibility of relapse.

The most frequently used antipsychotics fall into two classes: the older dopamine receptor antagonists, or DAs, and the newer serotonin dopamine antagonists, or SDAs. (Antagonists block the action of some other substance; for example, dopamine antagonists counteract the action of dopamine.) The exact mechanisms of action of these medications are not known, but it is thought that they lower the patient's sensitivity to sensory stimuli and so indirectly improve the patient's ability to interact with others.

DOPAMINE RECEPTOR ANTAGONIST. The dopamine antagonists include the older antipsychotic (also called neuroleptic) drugs, such as haloperidol (Haldol), chlorpromazine (Thorazine), and fluphenazine (Prolixin). These drugs have two major drawbacks: it is often difficult to find the best dosage level for the individual patient, and a dosage level high enough to control psychotic symptoms frequently produces extrapyramidal side effects, or EPS. EPSs include parkinsonism, in which the patient cannot walk normally and usually develops a tremor; dystonia, or painful **muscle spasms** of the head, tongue, or neck; and akathisia, or restlessness. A type of long-term EPS is called **tardive dyskinesia**, which features slow, rhythmic, automatic movements. Schizophrenics with **AIDS** are especially vulnerable to developing EPS.

SERATONIN DOPANINE ANTAGONISTS. The serotonin dopamine antagonists, also called atypical antipsychotics, are newer medications that include clozapine (Clozaril), risperidone (Risperdal), and olanzapine (Zyprexa). The SDAs have a better effect on the negative symptoms of schizophrenia than do the older drugs and are less likely to produce EPS than the older compounds. The newer drugs are significantly more expensive in the short term, although the SDAs may reduce long-term costs by reducing the need for hospitalization. They are also presently unavailable in injectable forms. The SDAs are commonly used to treat patients who respond poorly to the DAs. However, many psychotherapists now regard the use of these atypical antipsychotics as the treatment of first choice.

ANTIDEPRESSANTS. Patients with schizophrenia have a lifetime prevalence of 80% for major depression; others suffer from **phobias** or other **anxiety disorders**. These patients may be prescribed antidepressants or a short course of **benzodiazepines** along with their antipsychotic medications.

Alternative

Alternative and complementary therapies that are being investigated for the treatment of schizophrenia include gingko biloba, an Asian shrub, and vitamin therapy. One Chinese study reported that a group of patients who had not responded to conventional antipsychotic medications benefited from a thirteen-week trial of gingko extract, with significantly fewer side effects. Vitamin therapy is recommended by naturopathic practitioners on the grounds that many hospitalized patients with schizophrenia suffer from nutritional deficiencies. The supplements recommended include **folic acid**, niacin, vitamin B_6, and vitamin C.

Many clinical trials for the treatment of schizophrenia are currently sponsored by the National Institutes of Health (NIH) and other agencies. In 2009, NIH reported 400 ongoing or recently completed studies.

A few examples include:

- The safety and effectiveness of an investigational drug (MK0557) for the treatment of cognitive impairment in patients with schizophrenia. (NCT00482430)
- The efficacy of preventative treatment with sarcosine to reduce symptoms and delay or avoid disease progression in individuals defined as being at high risk for schizophrenia. (NCT00276263)

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- The role of genetics in the development of schizophrenia by studying heritable traits in families where at least one member has schizophrenia. (NCT00001486)
- The effectiveness of D-cycloserine and glycine for treating negative symptoms (such as loss of interest, loss of energy, loss of warmth, and loss of humor) which occur between phases of positive symptoms (marked by hallucinations, delusions, and thought confusions) in schizophrenics. (NCT00000372)
- Study of the biological basis of schizophrenia to determine which symptoms are related to the illness itself and which are related to medications used to treat the illness.(NCT00001247)
- The use of single photon emission computed tomography (SPECT) to study brain nicotine receptors (proteins on the surface of brain cells) in healthy subjects and in patients with schizophrenia. (NCT00061789)

Clinical trial information is constantly updated by NIH and the most recent information on schizophrenia trials can be found at: http://clinicaltrials.gov/search/open/condition=%22Schizophrenia%22

Prognosis

One important prognostic sign is the patient's age at onset of psychotic symptoms. Patients with early onset of schizophrenia are more often male, have a lower level of functioning prior to onset, a higher rate of brain abnormalities, more noticeable negative symptoms, and worse outcomes. Patients with later onset are more likely to be female, with fewer brain abnormalities and thought impairment, and more hopeful prognoses.

The average course and outcome for schizophrenics are less favorable than those for most other mental disorders, although as many as 30% of patients diagnosed with schizophrenia recover completely and the majority experience some improvement. Two factors that influence outcomes are stressful life events and a hostile or emotionally intense family environment. Schizophrenics with a high number of stressful changes in their lives, or who have frequent contacts with critical or emotionally over-involved family members, are more likely to relapse. Overall, the most important component of long-term care of schizophrenic patients is complying with their regimen of antipsychotic medications.

Prevention

There is no proven way to prevent onset of schizophrenia. Researchers have investigated the possibility of treating schizophrenia before symptoms start (such as when the likelihood of hereditary transmission is high). Other areas of research include the links between schizophrenia and family stress, drug use, and exposure to certain infectious agents.

Resources

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ORGANIZATIONS

American Psychiatric Association (APA), 1000 Wilson Blvd., Suite 1825, Arlington, VA, 22209, (888) 357-7924, apa@psych.org, http://www.psych.org.

National Alliance on Mental Health (NAMI), 3803 N. Fairfax Dr., Suite 100, Arlington, VA, 22203, (703) 524-7600, (888) 999-NAMI (6264), (703) 524-9094, http://www.nami.org.

National Institute of Mental Health (NIMH) , 6001 Executive Blvd., Rm 8184, MSC 9663, Rockville, MD, 20892-9663, (301) 443-4513, nimhinfo@nih.gov, http://www.nimh.nih.gov.

National Mental Health Association (NMHA), 2001 North Beauregard St., 12th Floor, Alexandria, VA, 22311, (703) 684-7722, (800) 969-6642, infoctr@nmha.org, http://www.nmha.org.

Schizophrenia Society of Canada, 100-4 Fort Street, Winnipeg, MB, Canada, R3C1C4, (204) 786-1616, (800) 263-5545, (204) 783-4898, info@schizophrenia.ca, http://www.schizophrenia.ca.

Laith Farid Gulli, MD
Monique Laberge, PhD

Schwannoma *see* **Brain tumor**

Sciatic nerve pain *see* **Sciatica**

Sciatica

Definition

Sciatica refers to **pain** or discomfort associated with the sciatic nerve. This nerve runs from the lower part of the spinal cord, down the back of the leg, to the foot. Injury to or pressure on the sciatic nerve can cause the characteristic pain of sciatica: a sharp or burning pain that radiates from the lower back or hip, possibly following the path of the sciatic nerve to the foot.

Description

The sciatic nerve is the largest and longest nerve in the body. About the thickness of a person's thumb, it spans from the lower back to the foot. The nerve originates in the lower part of the spinal cord, the so-called lumbar region. As it branches off from the spinal cord, it passes between the bony vertebrae (the component bones of the spine) and runs through the pelvic girdle, or hip bones. The nerve passes through the hip joint and continues down the back of the leg to the foot.

Sciatica is a fairly common disorder and approximately 40% of the population experiences it at some point in their lives. However, only about 1% have coexisting sensory or motor deficits. Sciatic pain has several root causes and treatment may hinge upon the underlying problem.

Of the identifiable causes of sciatic pain, lumbosacral radiculopathy and back strain are the most frequently suspected. The term lumbosacral refers to the lower part of the spine, and radiculopathy describes a problem with the spinal nerve roots that pass between the vertebrae and give rise to the sciatic nerve. This area between the vertebrae is cushioned with a disk of shock- absorbing tissue. If this disk shifts or is damaged through injury or disease, the spinal nerve root may be compressed by the shifted tissue or the vertebrae.

This compression of the nerve roots sends a pain signal to the brain. Although the actual injury is to the nerve roots, the pain may be perceived as coming from anywhere along the sciatic nerve.

The sciatic nerve can be compressed in other ways. Back strain may cause **muscle spasms** in the lower back, placing pressure on the sciatic nerve. In rare cases, infection, **cancer**, bone inflammation, or other diseases may be causing the pressure. More likely, but often overlooked, is the piriformis syndrome. As the sciatic nerve passes through the hip joint, it shares the space with several muscles. One of these muscles, the piriformis muscle, is closely associated with the sciatic nerve. In some people, the nerve actually runs through the muscle. If this muscle is injured or has a spasm, it places pressure on the sciatic nerve, in effect, compressing it.

In many sciatica cases, the specific cause is never identified. About half of affected individuals recover from an episode within a month. Some cases can linger a few weeks longer and may require aggressive treatment. In some cases, the pain may return or potentially become chronic.

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Causes and symptoms

Individuals with sciatica may experience some lower back pain, but the most common symptom is pain that radiates through one buttock and down the back of that leg. The most identified cause of the pain is compression or pressure on the sciatic nerve. The extent of the pain varies between individuals. Some people describe pain that centers in the area of the hip, and others perceive discomfort all the way to the foot. The quality of the pain also varies; it may be described as **tingling**, burning, prickly, aching, or stabbing.

Onset of sciatica can be sudden, but it can also develop gradually. The pain may be intermittent or continuous, and certain activities, such as bending, coughing, sneezing, or sitting, may make the pain worse.

Chronic pain may arise from more than just compression on the nerve. According to some pain researchers, physical damage to a nerve is only half of the equation. A developing theory proposes that some nerve injuries result in a release of neurotransmitters and immune system chemicals that enhance and sustain a pain message. Even after the injury has healed, or the damage has been repaired, the pain continues. Control of this abnormal type of pain is difficult.

Diagnosis

Before treating sciatic pain, as much information as possible is collected. The individual is asked to recount the location and nature of the pain, how long it has continued, and any accidents or unusual activities prior to its onset. This information provides clues that may point to back strain or injury to a specific location. Back pain from disk disease, piriformis syndrome, and back strain must be differentiated from more serious conditions such as cancer or infection. Lumbar stenosis, an overgrowth of the covering layers of the vertebrae that narrows the spinal canal, must also be considered. The possibility that a difference in leg lengths is causing the pain should be evaluated; the problem can be easily be treated with a foot orthotic or built-up shoe.

Often, a straight-leg-raising test is done, in which the person lies face upward and the health-care provider raises the affected leg to various heights. This test pinpoints the location of the pain and may reveal whether it is caused by a disk problem. Other tests, such as having the individual rotate the hip joint, assess the hip muscles. Any pain caused by these movements may provide information about involvement of the piriformis muscle, and piriformis weakness is tested with additional leg-strength maneuvers.

Further tests may be done depending on the results of the **physical examination** and initial pain treatment. Such tests might include **magnetic resonance imaging** (MRI) and **computed tomography scans** (CT scans). Other tests examine the conduction of electricity through nerve tissues, and include studies of the electrical activity generated as muscles contract (**electromyography**), nerve conduction velocity, and evoked potential testing. A more invasive test involves injecting a contrast substance into the space between the vertebrae and making x-ray images of the spinal cord (**myelography**), but this procedure is usually done only if surgery is being considered. All of these tests can reveal problems with the vertebrae, the disk, or the nerve itself.

Treatment

Initial treatment for sciatica focuses on pain relief. For acute or very painful flare-ups, bed rest is advised for up to a week in conjunction with medication for the pain. Pain medication includes **acetaminophen**, **nonsteroidal anti-inflammatory drugs** (NSAIDs), such as **aspirin**, or **muscle relaxants**. If the pain is unremitting, opioids may be prescribed for short-term use or a local anesthetic will be injected directly into the lower back. Massage and heat application may be suggested as adjuncts.

If the pain is chronic, different pain relief medications are used to avoid long-term dosing of NSAIDs, muscle relaxants, and opioids. **Antidepressant drugs**, which have been shown to be effective in treating pain, may be prescribed alongside short-term use of muscle relaxants or NSAIDs. Local anesthetic injections or epidural **steroids** are used in selected cases.

As the pain allows, **physical therapy** is introduced into the treatment regime. Stretching exercises that focus on the lower back, buttock, and hamstring muscles are suggested. The exercises also include finding comfortable, pain-reducing positions. Corsets and braces may be useful in some cases, but evidence for their general effectiveness is lacking. However, they may be helpful to prevent exacerbations related to certain activities.

With less pain and the success of early therapy, the individual is encouraged to follow a long-term program to maintain a healthy back and prevent re-injury. A physical therapist may suggest exercises and regular activity, such as water **exercise** or walking. Patients are instructed in proper body mechanics to minimize symptoms during light lifting or other activities.

If the pain is chronic and conservative treatment fails, surgery to repair a **herniated disk** or cut out part or all of the piriformis muscle may be suggested,

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KEY TERMS

Disk—Dense tissue between the vertebrae that acts as a shock absorber and prevents damage to nerves and blood vessels along the spine.

Electromyography—A medical test in which a nerve's ability to conduct an impulse is measured.

Lumbosacral—Referring to the lower part of the backbone or spine.

Myelography—A medical test in which a special dye is injected into a nerve to make it visible on an x ray.

Piriformis—A muscle in the pelvic girdle that is closely associated with the sciatic nerve.

Radiculopathy—A condition in which the spinal nerve root of a nerve has been injured or damaged.

Spasm—Involuntary contraction of a muscle.

Vertebrae—The component bones of the spine.

particularly if there is neurologic evidence of nerve or nerve-root damage.

Alternative treatment

Massage is a recommended form of therapy, especially if the sciatic pain arises from muscle spasm. Symptoms may also be relieved by icing the painful area as soon as the pain occurs. Ice should be left on the area for 30-60 minutes several times a day. After 2–3 days, a hot water bottle or heating pad can replace the ice. **Chiropractic** or **osteopathy** may offer possible solutions for relieving pressure on the sciatic nerve and the accompanying pain. **Acupuncture** and **biofeedback** may also be useful as pain control methods. Body work, such as the **Alexander technique**, can assist an individual in improving posture and preventing further episodes of sciatic pain.

Prognosis

Most cases of sciatica are treatable with pain medication and physical therapy. After 4–6 weeks of treatment, an individual should be able to resume normal activities.

Prevention

Some sources of sciatica are not preventable, such as disk degeneration, back strain due to **pregnancy**, or accidental falls. Other sources of back strain, such as poor posture, overexertion, being overweight, or wearing high heels, can be corrected or avoided. Cigarette **smoking** may also predispose people to pain, and should be discontinued.

General suggestions for avoiding sciatica, or preventing a repeat episode, include sleeping on a firm mattress, using chairs with firm back support, and sitting with both feet flat on the floor. Habitually crossing the legs while sitting can place excess pressure on the sciatic nerve. Sitting a lot can also place pressure on the sciatic nerves, so it's a good idea to take short breaks and move around during the work day, long trips, or any other situation that requires sitting for an extended length of time. If lifting is required, the back should be kept straight and the legs should provide the lift. Regular exercise, such as swimming and walking, can strengthen back muscles and improve posture. Exercise can also help maintain a healthy weight and lessen the likelihood of back strain.

Resources

PERIODICALS

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Julia Barrett

SCID *see* **Severe combined immunodeficiency**

Scleral buckling *see* **Retinal detachment**

Scleroderma

Definition

Scleroderma is a progressive disease that affects the skin and connective tissue (including cartilage, bone, fat, and the tissue that supports the nerves and blood vessels throughout the body). There are two major forms of the disorder. The type known as localized scleroderma affects the skin mainly. Systemic scleroderma, which is also called systemic sclerosis, affects the smaller blood vessels and internal organs of the body.

Demographics

Scleroderma occurs in all races of people all over the world, but it affects about four females for every male. Among children, localized scleroderma is more common, and systemic sclerosis is comparatively rare. Most patients with systemic sclerosis are diagnosed between ages 30 and 50. In the United States, about 300,000

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Scleroderma is a serious, progressive disease caused by the overproduction and accumulation of collagen throughout the body, resulting in hardening (sclerosis) and scarring (fibrosis) of the skin and connective tissue. *(Photo Researchers, Inc.)*

people have scleroderma. Young African-American women and Native Americans of the Choctaw tribe have especially high rates of the disease. In 2003, researchers reported that they had identified 12 different genetic markers associated with scleroderma in the Choctaw population.

Description

Scleroderma is an autoimmune disorder, which means that the body's immune system turns against itself. In scleroderma, there is an overproduction of abnormal collagen (a type of protein fiber present in connective tissue). This collagen accumulates throughout the body, causing hardening (sclerosis), scarring (fibrosis), and other damage. The damage may affect the appearance of the skin, or it may involve only the internal organs. The symptoms and severity of scleroderma vary from person to person.

Causes and symptoms

The cause of scleroderma is still a puzzle. Although the accumulation of collagen appears to be a hallmark of the disease, researchers do not know why it occurs. Some theories suggest that damage to blood vessels may cause the tissues of the body to receive an inadequate amount of oxygen, a condition called **ischemia**. Some researchers believe that the resulting damage causes the immune system to overreact, producing an autoimmune disorder. According to this theory of scleroderma, the immune system gears up to fight an invader, but no invader is actually present. Cells in the immune system called antibodies react to the body's own tissues as if they were foreign. The antibodies turn against the already damaged blood vessels and the vessels' supporting tissues. These immune cells are designed to deliver potent chemicals in order to kill foreign invaders. Some of these cells dump these chemicals on the body's own tissues instead, causing inflammation, swelling, damage, and scarring.

Most cases of scleroderma have no recognizable triggering event. Some cases, however, have been traced to exposure to toxic (poisonous) substances. For example, coal miners and gold miners, who are exposed to high levels of silica dust, have above-average rates of scleroderma. Other chemicals associated with the disease include polyvinyl chloride, benzene, toluene, and epoxy resins. In 1981, 20,000 people in Spain were stricken with a syndrome similar to scleroderma when their cooking oil was accidentally contaminated. Certain medications, especially a drug used in **cancer** treatment called bleomycin (Blenoxane), may lead to scleroderma. Some claims of a scleroderma-like illness have been made by women with silicone **breast implants**, but a link has not been proven in numerous studies.

Symptoms of systemic scleroderma

A condition called Raynaud's phenomenon is the first symptom in about 95% of all patients with systemic scleroderma. In Raynaud's phenomenon, blood vessels of the fingers and/or toes (the digits) react to cold in an abnormal way. The vessels clamp down, preventing blood flow to the tip of the digit. Eventually, the flow is cut off to the entire finger or toe. Over time, oxygen deprivation may result in open ulcers on the skin surface. These ulcers can lead to tissue **death** (**gangrene**) and loss of the digit. When Raynaud's phenomenon is the first sign of scleroderma, the next symptoms usually appear within two years.

SKIN AND EXTREMITIES. Involvement of the skin leads to swelling underneath the skin of the hands, feet, legs, arms, and face. Swelling is followed by thickening and tightening of the skin, which becomes taut and shiny. Severe tightening may lead to abnormalities. For example, tightening of the skin on the hands may cause the fingers to become permanently curled (flexed). Structures within the skin are damaged (including those producing hair, oil, and sweat), and the skin becomes dry and scaly. Ulcers may form, with the danger of infection. **Calcium** deposits often appear under the skin.

In systemic scleroderma, the mouth and nose may become smaller as the skin on the face tightens. The small mouth may interfere with eating and dental hygiene. Blood vessels under the skin may become enlarged and show through the skin, appearing as purplish marks or

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red spots. This chronic dilation of the small blood vessels is called telangiectasis.

Muscle weakness, joint **pain** and stiffness, and **carpal tunnel syndrome** are common in scleroderma. Carpal tunnel syndrome involves scarring in the wrist, which puts pressure on the median nerve running through that area. Pressure on the nerve causes **numbness**, **tingling**, and weakness in some of the fingers.

DIGESTIVE TRACT. The tube leading from the mouth to the stomach (the esophagus) becomes stiff and scarred. Patients may have trouble swallowing food. The acid contents of the stomach may start to flow backward into the esophagus (esophageal reflux), causing a very uncomfortable condition known as **heartburn**. The esophagus may also become inflamed.

The intestine becomes sluggish in processing food, causing bloating and pain. Foods are not digested properly, resulting in **diarrhea**, weight loss, and anemia. Telangiectasis in the stomach or intestine may cause rupture and bleeding.

RESPIRATORY AND CIRCULATORY SYSTEMS. The lungs are affected in about 66% of all people with systemic scleroderma. Complications include **shortness of breath**, coughing, difficulty breathing due to tightening of the tissue around the chest, inflammation of the air sacs in the lungs (alveolitis), increased risk of **pneumonia**, and an increased risk of cancer. For these reasons, lung disease is the most likely cause of death associated with scleroderma.

The lining around the heart (pericardium) may become inflamed. The heart may have greater difficulty pumping blood effectively (**heart failure**). Irregular heart rhythms and enlargement of the heart also occur in scleroderma.

Kidney disease is another common complication. Damage to blood vessels in the kidneys often causes a major rise in the person's blood pressure. The blood pressure may be so high that there is swelling of the brain, causing severe headaches, damage to the retinas of the eyes, seizures, and failure of the heart to pump blood into the body's circulatory system. The kidneys may also stop filtering blood and go into failure. Treatments for high blood pressure have greatly improved these kidney complications. Before these treatments were available, kidney problems were the most common cause of death for people with scleroderma.

Other problems associated with scleroderma include painful dryness of the eyes and mouth, enlargement and destruction of the liver, and a low-functioning thyroid gland.

Diagnosis

Diagnosis of scleroderma is complicated by the fact that some of its symptoms can accompany other connective-tissue diseases. The most important symptom is thickened or hardened skin on the fingers, hands, forearms, or face. This symptom is found in 98% of people with scleroderma. It can be detected in the course of a **physical examination**. The person's medical history may also contain important clues, such as exposure to toxic substances on the job. There are a number of nonspecific laboratory tests on blood samples that may indicate the presence of an inflammatory disorder (but not specifically scleroderma). The antinuclear antibody (ANA) test is positive in more than 95% of people with scleroderma.

Other tests can be performed to evaluate the extent of the disease. These include a test of the electrical system of the heart (an electrocardiogram), lung-function tests, and x-ray studies of the gastrointestinal tract. Various blood tests can be given to study kidney function.

Treatment

Mainstream treatments

As of 2010, there is no cure for scleroderma. A drug called D-penicillamine has been used to interfere with the production of abnormal collagen. Experts believe the drug helps decrease the degree of skin thickening and tightening, and slow the progress of the disease in other organs. Taking vitamin D and using ultraviolet light may be helpful for localized scleroderma. One group of British researchers reported in 2003 that long-wavelength ultraviolet A light is particularly effective in treating localized scleroderma. **Corticosteroids** have been used to treat joint pain, **muscle cramps**, and other symptoms of inflammation. Other drugs have been studied that reduce the activity of the immune system (immunosuppressants). Because these medications can have serious side effects, they are used in only the most severe cases of scleroderma.

The various complications of scleroderma are treated individually. Raynaud's phenomenon requires that people try to keep their hands and feet warm constantly. Nifedipine is a medication that is sometimes given to help control Raynaud's. Thick ointments and creams are used to treat dry skin. **Exercise** and massage may help joint involvement. They may also help people retain more movement despite skin tightening. An exercise regimen for stretching the mouth opening has been reported to be a helpful alternative to surgery in managing this condition. Skin ulcers need prompt attention and may require **antibiotics**. People with esophageal reflux

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KEY TERMS

Autoimmune disorder—A disorder in which the body's immune cells mistake the body's own tissues as foreign invaders. The immune cells then work to destroy tissues in the body.

Collagen—The main supportive protein of cartilage, connective tissue, tendon, skin, and bone.

Connective tissue—A group of tissues responsible for support throughout the body, including cartilage, bone, fat, tissue underlying skin, and tissues that support organs, blood vessels, and nerves throughout the body.

Fibrosis—The abnormal development of fibrous tissue; scarring.

Limited scleroderma—A subtype of systemic scleroderma with limited skin involvement. It is sometimes called the CREST form of scleroderma, after the initials of its five major symptoms.

Localized scleroderma—Thickening of the skin from overproduction of collagen.

Morphea—The most common form of localized scleroderma.

Raynaud phenomenon/Raynaud disease—A condition in which blood flow to the body's tissues is reduced by a malfunction of the nerves that regulate the constriction of blood vessels. When attacks of Raynaud's occur in the absence of other medical conditions, it is called Raynaud disease. When attacks occur as part of a disease (as in scleroderma), it is called Raynaud phenomenon.

Sclerosis—Hardening.

Systemic sclerosis—A rare disorder that causes thickening and scarring of multiple organ systems.

Telangiectasias—Very small arteriovenous malformations, or connections between the arteries and veins. The result is small red spots on the skin known as "spider veins."

will be advised to eat small amounts more often, rather than several large meals a day. They should also avoid spicy foods and items containing **caffeine**. Some patients with esophageal reflux have been successfully treated with surgery. Acid-reducing medications may be given for heartburn. People must be monitored for the development of high blood pressure. If found, they should be promptly treated with appropriate medications, usually angiotensin-converting enzyme inhibitors (ACE inhibitors) or other **vasodilators**. When fluid accumulates due to heart failure, **diuretics** can be given to get rid of the excess fluid.

Patients with scleroderma may also benefit from some form of counseling or **psychotherapy**, as they are at increased risk of depression. One study found that 46% of patients in its sample met the criteria for a depressive disorder.

Alternative treatments

One alternative therapy that some naturopaths have used in treating patients with scleroderma is superoxide dismutase (SOD), an antioxidant enzyme used in its injectable form. More research, however, needs to be done on the benefits of this treatment.

Prognosis

The prognosis for people with scleroderma varies. Some have a very limited form of the disease called morphea, which affects only the skin. These individuals have a very good prognosis. Other people have a subtype of systemic scleroderma called limited scleroderma. For them, the prognosis is relatively good. Limited scleroderma is characterized by limited involvement of the patient's skin and a cluster of five symptoms called the CREST syndrome. CREST stands for:

- C = Calcinosis
- R = Raynaud's disease (phenomenon)
- E = Esophageal dysmotility (stiffness and malfunctioning of the esophagus)
- S = Sclerodactyly (thick, hard, rigid skin over the fingers)
- T = Telangiectasias

In general, people with very widespread skin involvement have the worst prognosis. This level of disease is usually accompanied by involvement of other organs and the most severe complications. Although women are more commonly stricken with scleroderma, men more often die of the disease. The two factors that negatively affect survival are male sex and older age at diagnosis. The most common causes of death include heart, kidney, and lung diseases. About 65% of all patients survive 11 years or more following a diagnosis of scleroderma.

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Prevention

There are no known ways to prevent scleroderma. People can try to decrease occupational exposure to high-risk substances.

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ORGANIZATIONS

American Academy of Family Physicians (AAFP), 114 Tomahawk Creek Parkway, Leawood, KS, 66211-2672, (800) 274-2237, (913) 906-6269, fp@aafp.org, www.familydoctor.org.

American College of Rheumatology (ACR), 2200 Lake Blvd. NE, Atlanta, GA, 30319, (404) 633-3777, http://www.rheumatology.org.

National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMSD), 1 AMS Circle, Bethesda, MD, 20892–3675, (301) 495-4484, (877) 226-4267, (301) 718–6366, NIAMSinfo@mail.nih.gov, http://www.niams.nih.gov.

National Institutes of Health (NIH), 9000 Rockville Pike, Bethesda, MD, 20892, (301) 496-4000, http://www.nih.gov/index.html.

National Library of Medicine (NLM), 8600 Rockville Pike, Bethesda, MD, 20894, http://www.nlm.nih.gov/.

National Organization for Rare Disorders, Inc. (NORD), 55 Kenosia Ave., PO Box 1968, Danbury, CT, 06813, (203) 744–0100, (800) 999–6673, http://www.rarediseases.org.

Scleroderma Foundation, 300 Rosewood Dr., Suite 105, Danvers, MA, 01923, (978) 463–5843, (800) 722–HOPE, (978) 463–5809, http://www.scleroderma.org.

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Sclerotherapy for esophageal varices

Definition

Sclerotherapy for esophageal varices (also called endoscopic sclerotherapy) is a treatment for esophageal bleeding that involves the use of an endoscope and the injection of a sclerosing solution into veins.

Purpose

In most hospitals, sclerotherapy for esophageal varices is the treatment of choice to stop esophageal bleeding during acute episodes, and to prevent further incidences of bleeding. Emergency sclerotherapy is often followed by preventive treatments to eradicate distended esophageal veins.

Precautions

Sclerotherapy for esophageal varices cannot be performed on an uncooperative patient, since movement during the procedure could cause the vein to tear or the esophagus to perforate and bleed. It should not be performed on a patient with a perforated gastrointestinal tract.

Description

Esophageal varices are enlarged or swollen veins on the lining of the esophagus which are prone to bleeding. They are life-threatening, and can be fatal in up to 50% of patients. They usually appear in patients with severe **liver disease**. Sclerotherapy for esophageal varices involves injecting a strong and irritating solution (a sclerosant) into the veins and/or the area beside the distended vein. The sclerosant injected into the vein causes **blood clots** to form and stops the bleeding. The sclerosant injected into the area beside the distended vein stops the bleeding by thickening and swelling the vein to compress the blood vessel.

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KEY TERMS

Endoscope—An instrument used to examine the inside of a canal or hollow organ. Endoscopic surgery is less invasive than traditional surgery.

Esophagus—The part of the digestive canal located between the pharynx (part of the digestive tube) and the stomach.

Sclerosant—An irritating solution that stops bleeding by hardening the blood or vein it is injected into.

Varices—Swollen or enlarged veins, in this case on the lining of the esophagus.

Most physicians inject the sclerosant directly into the vein, although injections into the vein and the surrounding area are both effective. Once bleeding has been stopped, the treatment can be used to significantly reduce or destroy the varices.

Sclerotherapy for esophageal varices is performed by a physician in a hospital, with the patient awake but sedated. Hyoscine butylbromide (Buscopan) may be administered to freeze the esophagus, making injection of the sclerosant easier. During the procedure, an endoscope is passed through the patient's mouth to the esophagus to view the inside. The branches of the blood vessels at or just above where the stomach and esophagus come together, the usual site of variceal bleeding, are located. After the bleeding vein is identified, a long, flexible sclerotherapy needle is passed through the endoscope. When the tip of the needle's sheath is in place, the needle is advanced, and the sclerosant is injected into the vein or the surrounding area. The most commonly used sclerosants are ethanolamine and **sodium** tetradecyl sulfate. The needle is withdrawn. The procedure is repeated as many times as necessary to eradicate all distended veins.

Sclerotherapy for esophageal varices controls acute bleeding in about 90% of patients, but it may have to be repeated within the first 48 hours to achieve this success rate. During the initial hospitalization, sclerotherapy is usually performed two or three times. Preventive treatments are scheduled every few weeks or so, depending on the patient's risk level and healing rate. Several studies have shown that the risk of recurrent bleeding is much lower in patients treated with sclerotherapy: 30–50%, as opposed to 70–80% for patients not treated with sclerotherapy.

Preparation

Before sclerotherapy for esophageal varices, the patient's vital signs and other pertinent data are recorded, an intravenous line is inserted to administer fluid or blood, and a sedative is prescribed.

Aftercare

After sclerotherapy for esophageal varices, the patient will be observed for signs of blood loss, lung complications, **fever**, a perforated esophagus, or other complications. Vital signs are monitored, and the intravenous line maintained. **Pain** medication is usually prescribed. After leaving the hospital, the patient follows a diet prescribed by the physician, and, if appropriate, can take mild pain relievers.

Risks

Sclerotherapy for esophageal varices has a 20–40% incidence of complications, and a 1–2% percent mortality rate. Complications can arise from the sclerosant or the endoscopic procedure. Minor complications, which are uncomfortable but do not require active treatment or prolonged hospitalization, include transient chest pain, difficulty swallowing, and fever, which usually go away after a few days. Some people have allergic reactions to the solution. Infection occurs in up to 50% of cases. In 2–10% of patients, the esophagus tightens, but this can usually be treated with dilatation. More serious complications may occur in 10–15% of patients treated with sclerotherapy. These include perforation or bleeding of the esophagus and lung problems, such as aspiration **pneumonia**. Long-term sclerotherapy can damage the esophagus, and increase the patient's risk of developing **cancer**.

Patients with advanced liver disease complicated by bleeding are very poor risks for this procedure. The surgery, premedications, and anesthesia may be sufficient to tip the patient into protein intoxication and hepatic **coma**. The blood in the bowels acts like a high protein meal; therefore, protein intoxication may be induced.

Resources

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Lori De Milto

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Scoliosis

Definition

Scoliosis is a S- or C-shaped sideways curvature of the spine of 10 degrees or greater.

Demographics

According to the American Academy of Orthopaedic Surgeons (AAOS), in 2009, scoliosis was estimated to affect approximately 2% of the population in the United States. The incidence is much higher (approximately 20%) if a family member has curvature of the spine. The National Scoliosis Foundation reports that scoliosis affects infants, adolescents, and adults worldwide irrespective of race or socio-economic status. The primary age of onset for scoliosis is 10–15 years old, and it occurs equally among both genders. However, females are eight times more likely to progress to a curve magnitude that requires treatment.

Normal spine compared to a spine affected by scoliosis. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Description

When viewed from the rear, the spine usually appears to form a straight vertical line. Scoliosis is a lateral (side-to-side) curve in the spine, usually combined with a rotation of the vertebrae. (The lateral curvature of scoliosis should not be confused with the normal set of front-to-back spinal curves visible from the side.) While a small degree of lateral curvature does not cause any medical problems, larger curves can cause postural imbalance and lead to muscle **fatigue** and **pain**. More severe scoliosis can interfere with breathing and lead to arthritis of the spine (spondylosis).

Four out of five cases of scoliosis are *idiopathic*, meaning the cause is unknown. Children with idiopathic scoliosis appear to be otherwise entirely healthy, and have not had any bone or joint disease early in life. Scoliosis is not caused by poor posture, diet, or carrying a heavy book bag exclusively on one shoulder.

Idiopathic scoliosis is further classified according to age of onset:

- Infantile. Curvature appears before age three. This type is quite rare in the United States, but is more common in Europe.
- Juvenile. Curvature appears between ages three and 10. This type may be equivalent to the adolescent type, except for the age of onset.
- Adolescent. Curvature appears between ages of 10 and 13, near the beginning of puberty. This is the most common type of idiopathic scoliosis.
- Adult. Curvature begins after physical maturation is completed.

Three other types of scoliosis can also occur:

- Congenital scoliosis, due to congenital birth defects in the spine, and often associated with other structural abnormalities.
- Neuromuscular scoliosis, due to loss of control of the nerves or muscles that support the spine. The most common causes of this type of scoliosis are cerebral palsy and muscular dystrophy.
- Degenerative scoliosis, typically caused by degeneration of the discs that separate the vertebrae or arthritis in the joints that link them.

Risk factors

Scoliosis curves are more likely to worsen in girls than in boys. The younger the child when scoliosis appears, the greater the chance the curve will worsen. Children who are born with scoliosis are also at greater risk of worsening of the curve. A number of medical conditions are also known to predispose children to

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scoliosis, such as Turner's syndrome, **muscular dystrophy**, **cerebral palsy**, **Marfan syndrome**, **Friedreich's ataxia**, **rheumatoid arthritis**, osteogenesis imperfect, and **spina bifida**.

Causes and symptoms

As mentioned above, the cause of scoliosis is unknown in 80–85% of cases (iodiopathic scoliosis). For this reason, causes of curves are typically classified as either nonstructural or structural.

In nonstructural scoliosis, the spine is structurally normal but appears curved. This is a temporary, changing curve, caused by an underlying condition, such as unequal leg length, **muscle spasms**, or inflammatory conditions.

In structural scoliosis, the curve is fixed. Sometimes structural scoliosis is one part of a syndrome or disease, such as Marfan syndrome, an inherited connective tissue disorder. In some cases, it occurs by itself. Structural scoliosis can be caused by neuromuscular diseases (such as cerebral palsy, poliomyelitis, or muscular dystrophy), **birth defects** (such as hemivertebra), injury, certain infections, tumors, metabolic diseases, connective tissue disorders, or rheumatic diseases.

Idiopathic scoliosis has long been observed to run in families. Twin and family studies have consistently indicated a genetic contribution to the condition. However, no consistent pattern of transmission has been observed in familial cases. As of 2009, no genes have been identified that specifically cause the idiopathic form of scoliosis.

Most researchers have concluded that scoliosis is a complex trait. As such, there are likely to be multiple genetic, environmental, and potentially additional factors that contribute to the etiology of the condition. Complex traits are difficult to study due to the difficulty in identifying and isolating these multiple factors.

Scoliosis causes a noticeable asymmetry in the torso when viewed from the front or back. The first sign of scoliosis is often seen when a child is wearing a bathing suit or underwear. A child may appear to be standing with one shoulder higher than the other, or to have a tilt in the waistline. One shoulder blade may appear more prominent than the other due to rotation. In girls, one breast may appear higher than the other, or larger if rotation pushes that side forward.

Curve progression is greatest near the adolescent growth spurt. Scoliosis that begins early on is more likely to progress significantly than scoliosis that begins later in **puberty**.

KEY TERMS

Cobb angle—A measure of the curvature of scoliosis, determined by measurements made on x rays.

Hemivertebra—Condition in which one side of a vertebra fails to form normally before birth.

Marfan syndrome—Inherited connective tissue disorder.

Muscular dystrophy—Group of inherited disorders in which strength and muscle bulk gradually decline.

Narcotic—Medication derived from opium or synthetic opium.

Scoliometer—A tool for measuring trunk asymmetry; it includes a bubble level and angle measure.

Spondylosis—Arthritis of the spine.

More than 30 states have screening programs in schools for adolescent scoliosis, usually conducted by trained school nurses or gym teachers.

Diagnosis

Examination

Diagnosis for scoliosis is done by an orthopedist. A complete medical history is taken, including questions about family history of scoliosis. The **physical examination** includes determination of pubertal development in adolescents, a **neurological exam** that may reveal a neuromuscular cause, and measurements of trunk asymmetry. Examination of the trunk is done while the patient is standing, bending over, and lying down, and involves both visual inspection and use of a simple mechanical device called a scoliometer.

Tests

If a curve is detected, one or more x rays will usually be taken to define the curve or curves more precisely. An x ray is used to document spinal maturity, any pelvic tilt or hip asymmetry, and the location, extent, and degree of curvature. The curve is defined in terms of where it begins and ends, in which direction it bends, and by an angle measure known as the Cobb angle. The Cobb angle is found by projecting lines parallel to the vertebrae tops at the extremes of the curve; projecting perpendiculars from these lines; and measuring the angle of intersection. To properly track the progress of scoliosis, it is important to project from the same points of the spine each time.

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Occasionally, **magnetic resonance imaging** (MRI) is used, primarily to look more closely at the condition of the spinal cord and nerve roots extending from it if neurological problems are suspected.

Treatment

Treatment decisions for scoliosis are based on the degree of curvature, the likelihood of significant progression, and the presence of pain, if any.

Traditional

Curves less than 20 degrees are not usually treated, except by regular follow-up for children who are still growing. Watchful waiting is usually all that is required in adolescents with curves of 20–25 degrees, or adults with curves up to 40 degrees or slightly more, as long as there is no pain.

For children or adolescents whose curves progress to 25 degrees, and who have a year or more of growth left, bracing may be required. Bracing cannot correct curvature, but may be effective in halting or slowing progression. Bracing is rarely used in adults, except where pain is significant and surgery is not an option, as in some elderly patients.

There are two different categories of braces, those designed for nearly 24 hour per day use and those designed for night use. The full-time brace styles are designed to hold the spine in a vertical position, while the night use braces are designed to bend the spine in the direction opposite the curve.

The Milwaukee brace is a full-time brace which consists of metal uprights attached to pads at the hips, rib cage, and neck. Other types of full-time braces, such as the Boston brace, involve underarm rigid plastic molding to encircle the lower rib cage, abdomen, and hips. Because they can be worn out of sight beneath clothing, the underarm braces are better tolerated and often leads to better compliance. The Boston brace is currently the most commonly used. Full-time braces are often prescribed to be worn for 22–23 hours per day, though some clinicians believe that recommending brace use of 16 hours leads to better compliance and results.

Night use braces bend the patient's scoliosis into a correct angle, and are prescribed for 8 hours of use during sleep. Some investigators have found that night use braces are not as effective as the day use types.

Bracing may be appropriate for scoliosis due to some types of neuromuscular disease, including spinal muscular atrophy, before growth is finished. Duchenne muscular dystrophy is not treated by bracing, since surgery is likely to be required, and since later surgery is complicated by loss of respiratory capacity.

Surgery for idiopathic scoliosis is usually recommended if:

- the curve has progressed despite bracing
- the curve is greater than 40–50 degrees before growth has stopped in an adolescent
- the curve is greater than 50 degrees and continues to increase in an adult
- there is significant pain

Orthopedic surgery for neuromuscular scoliosis is often done earlier. The goals of surgery are to correct the deformity as much as possible, to prevent further deformity, and to eliminate pain as much as possible. Surgery can usually correct 40–50% of the curve, and sometimes as much as 80%. Surgery cannot always completely remove pain.

The surgical procedure for scoliosis is called *spinal fusion*, because the goal is to straighten the spine as much as possible, and then to fuse the vertebrae together to prevent further curvature. To achieve fusion, the involved vertebra are first exposed, and then scraped to promote regrowth. Bone chips are usually used to splint together the vertebrae to increase the likelihood of fusion. To maintain the proper spinal posture before fusion occurs, metal rods are inserted alongside the spine, and are attached to the vertebrae by hooks, screws, or wires. Fusion of the spine makes it rigid and resistant to further curvature. The metal rods are no longer needed once fusion is complete, but are rarely removed unless their presence leads to complications.

Spinal fusion leaves the involved portion of the spine permanently stiff and inflexible. While this leads to some loss of normal motion, most functional activities are not strongly affected, unless the very lowest portion of the spine (the lumbar region) is fused. Normal mobility, **exercise**, and even contact sports are usually all possible after spinal fusion. Full recovery takes approximately six months.

Drugs

Pain relievers such as ibuprofen (Tylenol), **sodium**, and **acetaminophen** are used to relieve pain. Non-steroidal anti-inflammatory medications (NSAID) such as **aspirin** are also used to treat both pain and treat inflammation. For severe pain, a narcotic pain medication may be prescribed. In some cases, a nerve block may be performed, involving the injection of pain-relieving medications into the tissues around an affected nerve. The block numbs the nerves and surrounding area and removes the pain sensation.

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Alternative

Clinical trials for the treatment of scoliosis are currently sponsored by the National Institutes of Health (NIH) and other agencies. In 2009, NIH reported 25 ongoing or recently completed studies. Some examples include the following:

- A pilot study to determine the presence, frequency, and severity of mental health disorders amongst adolescents undergoing spinal surgery for scoliosis. (NCT00445393)
- The evaluation of the amount of radiographic correction obtained using different spinal instrumentation rods in use for the surgical correction of juvenile and adolescent idiopathic scoliosis. (NCT00510575)
- The evaluation of the risk of curve progression in adolescents with scoliosis who wear a brace versus those who do not and the study of whether there are reliable factors that can predict the usefulness of bracing for a particular individual with scoliosis. (NCT00448448)
- The evaluation of gabapentin to improve postoperative analgesia and reduce narcotic consumption and side effects in children undergoing corrective spinal surgery for idiopathic scoliosis. (NCT00684112)

Clinical trial information is constantly updated by NIH and the most recent information on scoliosis trials can be found at: http://clinicaltrials.gov.

Prognosis

The prognosis for a person with scoliosis depends on many factors, including the age at which scoliosis begins and the treatment received. Most cases of mild adolescent idiopathic scoliosis need no treatment, do not progress, and do not cause pain or functional limitations. Untreated severe scoliosis often leads to spondylosis, and may impair breathing.

Prevention

There is no known way to prevent scoliosis. The progression of scoliosis, however, may be prevented through bracing or surgery.

Resources

BOOKS

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"What is Scoliosis?" *Scoliosis Research Society*. Information Page. http://www.srs.org/patients (accessed December 12, 2009)

ORGANIZATIONS

American Academy of Orthopaedic Surgeons (AAOS), 317 Massachusetts Ave NE, 1st Floor, Washington, DC, 20002, (202) 546-4430, (202) 546-5051, http://www.aaos.org.

National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS), 31 Center Dr., Rm. 4C02, MSC 2350, Bethesda, MD, 20892-2350, (301) 496-8190, (877) 22-NIAMS, NIAMSinfo@mail.nih.gov, http://www. niams.nih.gov.

National Scoliosis Foundation, 5 Cabot Place, Stoughton, MA, 02072, (781) 341-8333, (800) NSF-MYBACK (673-6922) , nsf@scoliosis.org, http://www.scoliosis.org.

Scoliosis Research Society, 555 East Wells Street, Suite 1100, Milwaukee, WI, 53202-3823, (414) 289-9107, (414) 276-3349, info@srs.org, http://www.srs.org.

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Scrotal nuclear medicine scan

Definition

Scrotal nuclear medicine scan is a study of the blood circulation in the scrotum using radioactive contrast agent to highlight obstruction.

Purpose

This test is used almost exclusively to differentiate infection in the testis (testicle) from twisting and infarction. Infection is called **epididymitis** because it mostly involves a collection of tubules on top of the testicle called the epididymis. Twisting of the testis shuts off its blood supply and is called **testicular torsion**. Both conditions cause a very painful, swollen testis on one side. Both occur most often in young men, although infection usually occurs at a slightly greater age. The infection increases the blood supply, and the torsion cuts off the blood supply. This is an ideal situation for a blood flow study.

The distinction is critically important, because testicular torsion must be untwisted immediately or the testis will die. On the other hand, epididymitis responds to **antibiotics**, and surgery might further injure it.

KEY TERMS

Radioisotope—An unstable form of an element that gives off radiation to become stable.

Scrotum—The bag of skin below the penis that contains the testes.

Description

A radioisotope, technetium-99, combined in a chemical (pertechnate) is injected intravenously while the patient is under a special machine that detects radiation. This radiation detector, called a gamma camera, scans the scrotum at one minute intervals for about five minutes, then less often for another 10 or 15 minutes. It then creates pictures (either x ray or polaroid) that reveal where the isotope went in the scrotum. Since both sides are scanned, even greater accuracy is obtained by comparison.

Preparation

This procedure is usually done as an emergency to determine the need for immediate surgery.

Risks

The amount of radiation is so slight that even the sensitive testicular tissue is at minimum risk.

Normal results

Blood flow appears unobstructed.

Abnormal results

Three possible possible images appear. They are:

- Increased blood flow indicating infection
- No blood flow indicating testicular torsion
- Blood flow illuminated in a "donut" shaped pattern that indicates torsion that has resolved itself within the last few days.

Resources

BOOKS

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J. Ricker Polsdorfer, MD

Scrotal sonogram *see* **Scrotal ultrasound**

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Scrotal ultrasound

Definition

Scrotal ultrasound is an imaging technique used for the diagnosis of suspected abnormalities of the scrotum. It uses harmless, high-frequency sound waves to form an image. The sound waves are reflected by scrotal tissue to form a picture of internal structures. It is not invasive and involves no radiation.

Purpose

Ultrasound of the scrotum is the primary imaging method used to evaluate disorders of the testicles and surrounding tissues. It is used when a patient has acute **pain** in the scrotum. Some of the problems for which the use of scrotal ultrasound is valuable include an absent or undescended testicle, an inflammation problem, **testicular torsion**, a fluid collection, abnormal blood vessels, or a mass (lump or tumor).

A sudden onset of pain in the scrotum is considered a serious problem, as delay in diagnosis and treatment can lead to loss of function. **Epididymitis** is the most common cause of this type of pain. Epididymitis is an inflammation of the epididymis, a tubular structure that transports sperm from the testes. It is most often caused by bacterial infection, but may occur after injury, or arise from an unknown cause. Epididymitis is treatable with **antibiotics**, which usually resolves pain quickly. Left untreated, this condition can lead to **abscess** formation or loss of blood supply to the testicle.

Testicular torsion is the twisting of the spermatic cord that contains the blood vessels which supply the testicles. It is caused by abnormally loose attachments of tissues that are formed during fetal development. Torsion can be complete, incomplete, or intermittent. Spontaneous detorsion, or untwisting, can occur, making diagnosis difficult. Testicular torsion arises most commonly during adolescence, and is acutely painful. Scrotal ultrasound is used to distinguish this condition from inflammatory problems, such as epididymitis. Testicular torsion is a surgical emergency; it should be operated on as soon as possible to avoid permanent damage to the testes.

A scrotal sac with an absent testicle may be the result of a congenital anomaly (an abnormality present at birth), where a testicle fails to develop. More often, it is due to an undescended testicle. In the fetus, the testicles normally develop just outside the abdomen and descend into the scrotum during the seventh month. Approximately 3% of full-term baby boys have undescended testicles. It is important to distinguish between an undescended testicle and an absent testicle, as an undescended testicle has a very high probability of developing **cancer**.

KEY TERMS

Hydrocele—A collection of fluid between two layers of tissue surrounding the testicle; the most common cause of painless scrotal swelling.

Varicocele—An abnormal enlargement of the veins which drain the testicles.

Ultrasound can be used to locate and evaluate masses in the scrotum. Most masses within the testicle are malignant or cancerous, and most outside the testicle are benign. Primary cancer of the testicles is the most common malignancy in men between the ages of 15-35. Fluid collections and abnormalities of the blood vessels in the scrotum may appear to the physician as masses and need evaluation by ultrasound. A hydrocele, the most common cause of painless scrotal swelling, is a collection of fluid between two layers of tissue surrounding the testicle. An abnormal enlargement of the veins which drain the testicles is called a varicocele. It can cause discomfort and swelling, which can be examined by touch (palpated). Varicocele is a common cause of male **infertility**.

Precautions

Clear scrotal ultrasound images are difficult to obtain if a patient is unable to remain still.

Description

The patient lies on his back on an examining table. The technologist will usually take a history of the problem, then gently palpate the scrotum. A rolled towel is placed between the patient's legs to support the scrotum. The penis is lifted up onto the abdomen and covered. A gel that enhances sound transmission is put directly on the scrotum. The technologist then gently places a transducer (an electronic imaging device) against the skin. It is moved over the area creating images from reflected sound waves, which appear on a monitor screen. There is no discomfort from the study itself. However, if the scrotum is very tender, even the slight pressure involved may be painful.

Normal results

A normal study would reveal testicles of normal size and shape, with no masses.

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Abnormal results

An abnormal result of an ultrasound of the scrotum may reveal an absent or undescended testicle, an inflammation problem, testicular torsion, a fluid collection, abnormal blood vessels, or a mass.

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Scrub typhus

Definition

Scrub **typhus** is an **infectious disease** that is transmitted to humans from field mice and rats through the bite of mites that live on the animals. The main symptoms of the disease are **fever**, a wound at the site of the bite, a spotted rash on the trunk, and swelling of the lymph glands.

Description

Scrub typhus is caused by *Rickettsia tsutsugamushi*, a tiny parasite about the size of bacteria that belongs to the family Rickettsiaceae. Under the microscope, rickettsiae are either rod-like (bacilli) or spherical (cocci) in shape. Because they are intracellular parasites, they can live only within the cells of other animals.

R. tsutsugamushi lives primarily in mites that belong to the species *Leptotrombidium (Trombicula) akamushi* and *Leptotrombidium deliense*. In Japan, some cases of scrub typhus have been reportedly transmitted by mites of the species *Leptotrombidium scutellare* and *Leptotrombidium pallidum*. The mites have four-stage life cycles: egg, larva, nymph, and adult. The larva is the only stage that can transmit the disease to humans and other vertebrates.

The tiny chiggers (mite larvae) attach themselves to the skin. During the process of obtaining a meal, they may either acquire the infection from the host or transmit the rickettsiae to other mammals or humans. In regions where scrub typhus is a constant threat, a natural cycle of *R. tsutsugamushi* transmission occurs between mite larvae and small mammals (e.g., field mice and rats). Humans enter a cycle of rickettsial infection only accidentally.

Scrub typhus is also known as *tsutsugamushi disease*. The name tsutsugamushi is derived from two Japanese words: tsutsuga, meaning something small and dangerous, and mushi, meaning creature. The infection is called scrub typhus because it generally occurs after exposure to areas with secondary (scrub) vegetation. It has recently been found, however, that the disease can also be prevalent in such areas as sandy beaches, mountain deserts, and equatorial rain forests. Therefore, it has been suggested that the names mite-borne typhus, or chigger-borne typhus, are more appropriate. Since the disease is limited to eastern and southeastern Asia, India, northern Australia and the adjacent islands, it is also commonly referred to as tropical typhus.

The seasonal occurrence of scrub typhus varies with the climate in different countries. It occurs more frequently during the rainy season. Certain areas such as forest clearings, riverbanks, and grassy regions provide optimal conditions for the infected mites to thrive. These small geographic regions are high-risk areas for humans and have been called scrub-typhus islands.

Causes and symptoms

The incubation period of scrub typhus is about 10 to 12 days after the initial bite. The illness begins rather suddenly with shaking chills, fever, severe **headache**, infection of the mucous membrane lining the eyes (the conjunctiva), and swelling of the lymph nodes (lymphadenopathy). A wound (lesion) is often seen at the site of the chigger bite. Bite **wounds** are common in whites but rare in Asians.

The initial lesion, which is about 1 cm (0.4 in) in diameter and flat, eventually becomes elevated and filled with fluid. After it ruptures, it becomes covered with a black scab (eschar). The patient's fever rises during the first week, generally reaching 40–40.5°C (104–105°F). About the fifth day of fever, a red spotted rash develops on the trunk, often extending to the arms and legs. It may either fade away in a few days or may become spotted and elevated (maculopapular) and brightly colored. **Cough** is present during the first week of the fever. An infection of the lung (pneumonitis) may develop during the second week.

In severe cases, the patient's pulse rate increases and blood pressure drops. The patient may become delirious and lose consciousness. Muscular twitching may develop. Enlargement of the spleen is observed. Inflammation of the heart muscle (interstitial **myocarditis**) is more common in scrub typhus than in other rickettsial diseases. In untreated patients, high fever may last for more than two weeks. With specific therapy, however,

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the fever breaks within 36 hours. The patient's recovery is prompt and uneventful.

Diagnosis

Patient history and physical examination

Differentiating scrub typhus from other forms of typhus as well as from fever, typhoid and meningococcal infections is often difficult during the first several days before the initial rash appears. The geographical location of scrub typhus, the initial sore caused by the chigger bite, and the occurrence of specific proteins capable of destroying the organism (antibodies) in the blood, provide helpful clues and are useful in establishing the diagnosis.

Laboratory tests

Diagnostic procedures involving the actual isolation of rickettsiae from the blood or other body tissues are usually expensive, time-consuming, and hazardous to laboratory workers. As a result, several types of tests known as serological (immunological) tests are used widely to confirm the clinical diagnosis in the laboratory.

Specific antibodies develop in the body in response to an infection. The development of antibodies during the recovery period indicates that an immune response is present. The formation of antibodies is the basic principle of a serological test. Three different tests are available to diagnose rickettsial infections. The most widely used is the Weil-Felix test. This test is based on the fact that some of the antibodies that are formed in the body during a rickettsial infection can react with certain strains (OX-2 and OX-19) of *Proteus* bacteria and cause them to clump (agglutinate). The clumping is easily seen under the microscope. The Weil-Felix test is easy and inexpensive to perform, with the result that it is widely used. The Weil- Felix test, however, is not very specific. In addition, the clumping is not detectable until the second week of the illness, which limits the test's usefulness in early diagnosis.

A second test known as a complement fixation (CF) test is based on the principle that if antibodies are formed in the body in response to the illness, then the antigen and the antibody will form complexes. These antigen-antibody complexes have the ability to inactivate, or fix, a protein that is found in blood serum (serum complement). The serum complement fixation can be measured using standardized biochemical tests and confirms the presence of antibodies. A third test known as the fluorescent antibody test uses fluorescent tags that are attached to antibodies for easy detection. This test has been developed using three strains of *Rickettsia tsutsugamushi* and has proven to be the most specific for diagnosis.

KEY TERMS

Agglutinin—An antibody that causes particulate antigens such as bacteria or other cells to clump together.

Endemic area—A geographical region where a particular disease is prevalent.

Eschar—A hard crust or scab. In scrub typhus, an eschar forms over the initial sore from the chigger bite.

Intracellular parasite—An organism which can only feed and live within the cell of a different animal.

Maculopapular rash—A rash characterized by raised, spotted lesions.

Prophylactic dosage—Giving medications to prevent or protect against diseases.

Rickettsia—A rod-shaped infectious microorganism that can reproduce only inside a living cell. Scrub typhus is a rickettsial disease.

Serological tests—Tests of immune function that are performed using the clear yellow liquid part of blood.

Treatment

Scrub typhus is treated with **antibiotics**. Chloramphenicol (Chloromycetin, Fenicol) and tetracycline (Achromycin, Tetracyn) are the drugs of choice. They bring about prompt disappearance of the fever and dramatic clinical improvement. If the antibiotic treatment is discontinued too quickly, especially in patients treated within the first few days of the fever, relapses may occur. In patients treated in the second week of illness, the antibiotics may be stopped one to two days after the fever disappears.

Antibiotics are given intravenously to patients too sick to take them by mouth. Patients who are severely ill and whose treatment was delayed may be given **corticosteroids** in combination with antibiotics for three days.

Prognosis

Before the use of antibiotics, the mortality rate for scrub typhus varied from 1–60%, depending on the geographic area and the rickettsial strain. Recovery also

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took a long time. With modern treatment methods, however, deaths are rare and the recovery period is short.

Prevention

General precautions

There are no effective vaccines for scrub typhus. In endemic areas, precautions include wearing protective clothing. Insect repellents containing dibutyl phthalate, benzyl benzoate, diethyl toluamide, and other substances can be applied to the skin and clothing to prevent chigger **bites**. Clearing of vegetation and chemical treatment of the soil may help to break up the cycle of transmission from chiggers to humans to other chiggers.

Prophylactic antibiotic dosage

It has been shown that a single oral dose of chloramphenicol or tetracycline given every 5 days for a total of 35 days, with 5-day nontreatment intervals, actually produces active immunity to scrub typhus. This procedure is recommended under special circumstances in certain areas where the disease is endemic.

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ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

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Scurvy

Definition

Scurvy is a condition caused by a lack of vitamin C (ascorbic acid) in the diet. Signs of scurvy include tiredness, muscle weakness, joint and muscle aches, a rash on the legs, and bleeding gums. In the past, scurvy was common among sailors and other people deprived of fresh fruits and vegetables for long periods of time.

Description

Scurvy is very rare in countries where fresh fruits and vegetables are readily available and where processed foods have vitamin C added. Vitamin C is an important antioxidant vitamin involved in the development of connective tissues, lipid and vitamin metabolism, biosynthesis of neurotransmitters, immune function, and wound healing. It is found in fruits, especially citrus fruits like oranges, lemons, and grapefruit, and in green leafy vegetables like broccoli and spinach. In adults, it may take several months of vitamin C deficiency before symptoms of scurvy develop.

Currently, the recommended dietary allowance (RDA) for vitamin C is 50–60 mg/day for adults; 35 mg/day for infants; 40–45 mg/day for children 1–14; 70 mg/day during **pregnancy**; and 90–95 mg/day during **lactation**. The body's need for vitamin C

An x-ray image of an infant suffering from scurvy. *(© Lester V. Bergman/Corbis.)*

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KEY TERMS

Ascorbic acid—Another term for vitamin C, a nutrient found in fresh fruits and vegetables. Good sources of vitamin C in the diet are citrus fruits like oranges, lemons, limes, and grapefruits, berries, tomatoes, green peppers, cabbage, broccoli, and spinach.

Recommended dietary allowance (RDA)—The daily amount of a vitamin the average person needs to maintain good health.

increases when a person is under **stress**, **smoking**, or taking certain medications.

Causes and symptoms

A lack of vitamin C in the diet is the primary cause of scurvy. This can occur in people on very restricted **diets**, who are under extreme physiological stress (for example, during an infection or after an injury), and in chronic alcoholics. Infants can develop scurvy if they are weaned from breast milk and switched to cow's milk without an additional supplement of vitamin C. Babies of mothers who took extremely high doses of vitamin C during pregnancy can develop infantile scurvy. In children, the deficiency can cause painful swelling of the legs along with **fever**, **diarrhea**, and **vomiting**. In adults, early signs of scurvy include feeling weak, tired, and achy. The appearance of tiny red blood-blisters to larger purplish blotches on the skin of the legs is a common symptom. Wound healing may be delayed and **scars** that had healed may start to break down. The gums swell and bleed easily, eventually leading to loosened teeth. Muscle and joint **pain** may also occur.

Diagnosis

Scurvy is often diagnosed based on the symptoms present. A dietary history showing little or no fresh fruits or vegetables are eaten may help to diagnose vitamin C deficiency. A blood test can also be used to check the level of ascorbic acid in the body.

Treatment

Adult treatment is usually 300–1,000 mg of ascorbic acid per day. Infants should be treated with 50 mg of ascorbic acid up to four times per day.

Prognosis

Treatment with vitamin C is usually successful, if the deficiency is recognized early enough. Left untreated, the condition can cause **death**.

Prevention

Eating foods rich in vitamin C every day prevents scurvy. A supplement containing the RDA of vitamin C will also prevent a deficiency. Infants who are being weaned from breast milk to cow's milk need a supplement containing vitamin C.

Resources

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Altha Roberts Edgren

Seafood poisoning *see* **Fish and shellfish poisoning**

Seasonal affective disorder

Definition

Seasonal affective disorder (SAD) is a mood disorder in which major depressive episodes and/or manic episodes occur at predictable times of the year, with depressive episodes typically occurring during the fall and winter months. The term SAD can also be applied to depressive episodes with a seasonal pattern that do not meet the criteria for major depressive disorder or a **bipolar disorder** (i.e., subsyndromal). SAD is also sometimes called seasonal mood disorder.

Demographics

SAD is more likely to occur in higher latitudes where there is less light during the fall and winter months. In addition, younger individuals are at higher risk for seasonal depressive episodes than are older persons. Although 60–90% of individuals with a seasonal component to their depressive disorder are women, it is currently unclear whether this reflects a gender factor specifically for SAD or merely reflects the underlying risks associated with recurrent major depressive disorder. Although cases of SAD have been seen in children and adolescents, the disorder usually begins when one is in one's twenties.

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Seasonal affective disorder is believed to be relatively common. It is estimated that up to 6% of the population may experience SAD, and up to 20% of Americans may suffer from a mild version of the symptoms (subsyndromal) associated with SAD.

As of 2009, it is not known whether a seasonal pattern is more likely in recurrent major depressive disorder or in bipolar disorders. However, the seasonal pattern is more likely to occur bipolar I disorder (BID) than bipolar II disorder (BIID).

Description

According to the *Diagnostic and Statistic Manual, Fourth Edition*, text revision (*DSM-IV-TR*) of the American Psychiatric Association, a seasonal pattern can exist with major depressive disorder or with major depressive episodes in bipolar I disorder or bipolar II disorder. To be characterized as a seasonal disorder, the onset and remission of the major depressive episodes must occur at characteristic times of year. In most cases of SAD, major depressive episodes occur in the fall and winter months and remit during the spring and summer. Less frequently, some individuals suffer from predictable major depressive episodes during the summer.

Risk factors

Studies have found that women are more likely to be diagnosed with seasonal affective disorder than men, however men with the disorder are more likely to have severe symptoms. SAD is believed to have a hereditary component, so having a close family member who has been diagnosed with SAD is a significant risk factor for the disorder. SAD is more likely to be diagnosed in young adults than in older adults. Individuals who live in areas far from the equator where the duration of sunlight changes substantially during the year are at higher risk for SAD.

Causes and symptoms

It is not known with certainty what causes SAD. Most theories concerning the origins of SAD postulate that it is caused by irregularities in an individual's biological rhythms that are triggered by lengthening or shortening of daylight that occurs with the changing seasons. Among these theories, the phase shift hypothesis (PSH) theorizes that most SAD patients become depressed in the fall and winter because the later dawn at this time of year causes circadian rhythms to become out of synchronization with respect to clock time and the body's sleep-wake cycle. Specifically, the PSH theorizes that SAD is a result of a mismatch between an individual's circadian rhythms related to the sleep-wake cycle and the biological circadian pacemaker in the hypothalamus of the brain.

KEY TERMS

Bipolar disorder— Formerly called manic-depressive disorder. A mood disorder characterized alternating periods of overconfidence and activity (manic highs) and depressive lows.

Melatonin—A naturally occurring hormone involved in regulating the body's "internal clock."

Phototherapy—Also called light therapy, the patient is exposed to a bright light to compensate for reduced exposure to sunlight.

Serotonin—5-Hydroxytryptamine; a substance that occurs throughout the body with numerous effects including neurotransmission. Inadequate amounts of serotonin are implicated in some forms of depression and obsessive-compulsive disorder.

Another suggested cause of SAD is related to the body's melatonin levels. The body produces more melatonin at night than during the day, and scientists believe it helps people feel sleepy at nighttime. There is also more melatonin in the body during winter, when the days are shorter. Some researchers believe that excessive melatonin release during winter in people with SAD may account for their feelings of drowsiness or depression.

Researchers have also suggested that SAD may be caused at least in part by reduced serotonin levels. Serotonin is a neurotransmitter important for the regulation of mood. Reduced levels of sunlight have been shown to be linked to drops in serotonin levels in the brain, which can cause symptoms of depression.

Common symptoms of SAD include:

- depression and irritability
- lack of energy
- excessive sleepiness during the day or abnormally prolonged sleep at night (hypersomnia)
- tendency to overeat (hyperphagia), including weight gain and/or craving for carbohydrates
- significant impairment of social and occupational functioning (e.g., lack of interest in social interactions, increased sensitivity to negative reactions from others, or lack of interest in normally enjoyable activities)

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Diagnosis

Four criteria must be met for a major depressive disorder, BID, or BIID to be characterized as seasonal. First, there must be a regular relationship between the onset of the depressive episodes and the time of year. For most cases of SAD, depressive episodes occur during the fall and winter seasons. Second, full remission of the depressive episodes (or a change from depression to **mania** or hypomania in the case of bipolar disorders) must also occur at predictable times of the year. Third, the seasonal cycle of onset and remission of major depressive episodes must have occurred within the last two years without any nonseasonal depressive episodes during that time. Fourth, seasonal episodes of depression must occur significantly more frequently than nonseasonal depressive episodes over the course of the person' lifetime.

When diagnosing SAD, it is important to distinguish it from depression caused by other factors that may cause depression such as seasonal unemployment or school schedule. In addition, SAD should be distinguished from the "holiday blues." The holiday blues are not related to circadian rhythms but to such psychosocial factors as increased obligations, expectations that one should be joyous, or early childhood memories or unresolved childhood conflicts.

Treatment

The goal of treatment for SAD is to alleviate the symptoms associated with the disorder. In most cases, the prescribed treatment regimen needs to be followed for the months in which the SAD occurs and can be stopped during the remainder of the year. Many people with SAD can be treated effectively with **light therapy**, although some may require the addition of other therapies or medications.

Traditional

The first-line treatment for seasonal affective disorder is **phototherapy**, also called light therapy, which exposes the patient to bright artificial light to compensate for the gloominess of winter. Light therapy uses a device called a light box that contains a set of fluorescent or incandescent lights in front of a reflector. Typically, the patient sits for 30 minutes next to a 10,000-lux box (which is about 50 times brighter than ordinary indoor light). Light therapy appears to be safe for most people. However, it may be harmful for those with eye diseases. The most common side effects are vision problems such as eyestrain, headaches, irritability, and **insomnia**. In addition, hypomania (elevated or expansive mood, characterized by hyperactivity and inflated self esteem) may occasionally occur.

Drugs

When a major depressive disorder or a bipolar disorder has seasonal characteristics, it may be treated with antidepressant medication. Research has found that fluoxetine (Prozac) is as effective as light therapy in controlled clinical trials. In 2006, the U.S. Food and Drug Administration approved the prescription medication Wellbutrin XL (bupropion HCl extended release tablets) for the prevention of SAD. The effectiveness of Wellbutrin XL has been demonstrated in clinical trials with adults having a history of a major depressive disorder occurring in the fall and winter months. Wellbutrin XL, however, is recommended only for individuals whose SAD symptoms meet the criteria for a major depressive disorder. Other antidepressants may also be prescribed for SAD.

Alternative

The literature also suggests that the over-the-counter compound melatonin may be of help in alleviating SAD symptoms. Melatonin is a hormone produced by the pineal gland that helps regulate the body' seasonal changes. Research funded by the National Institute of Mental Health suggests that a low dose of synthetic or pharmacy-grade melatonin taken in the evening along with exposure to bright light in the morning may be effective in relieving the symptoms of SAD. However, more research needs to be done to determine the safety and effectiveness of such treatment.

Home remedies

Cases of SAD that do not meet all the criteria for formal diagnosis (subsyndromal cases) may also be improved with phototherapy, Activities such as getting outdoors in the sunshine in the morning or rearranging one's home or office to maximize exposure to sunlight during the day may help mild SAD symptoms. Although a trip to the tropics or other sunny place is also of help in overcoming the effects of SAD, the problem returns once the individual is again exposed to shortened daylight hours.

Prognosis

For cases of subsyndromal SAD, the prognosis for control of symptoms through phototherapy treatment is good. For cases in which SAD is a seasonal characteristic of a major depressive disorder or bipolar disorder, the prognosis is generally the same as for the underlying disorder.

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Prevention

There is no known way to prevent SAD with certainty. Spending time during waking hours in direct sunlight may help to prevent or reduce symptoms. If an individual has experienced SAD in the past, a doctor or therapist may recommend beginning treatment before the symptoms are expected to occur to help control the symptoms and to minimize the negative effects of the disorder.

Resources

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Rohan, Kelly J., et al. "Winter Depression Recurrence One Year After Cognitive-Behavioral Therapy, Light Therapy, or Combination Treatment." *Behavior Therapy* (September 2009), 225-238.

ORGANIZATIONS

Depression and Bipolar Support Alliance (DBSA), 730 N. Franklin Street, Suite 501, Chicago, IL, 60654-7225 , (800) 826-3632, (312) 642-7234, http://www.dbsalliance.org.

Mental Health America, 2000 N. Beauregard St., 6th Floor, Alexandria, VA, 22311, (703) 684-7722, (800) 969-6642, (703) 684-5968, http://www.nmha.org.

National Institute of Mental Health, 6001 Executive Boulevard, Room 8184, MSC 9663, Bethesda, MD, 20892-9663, (301) 443-4513. TTY (301) 443-8431, (866) 615-6464 TTY (866) 415-8051 , (301) 443-4279, http://www.nimh.nih.gov.

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Seasonal depression *see* **Seasonal affective disorder**

Seatworm infection *see* **Enterobiasis**

Seborrheic dermatitis

Definition

Seborrheic **dermatitis** is a common inflammatory disease of the skin characterized by scaly lesions usually on the scalp, hairline, and face.

This young boy is afflicted with seborrheic dermatitis. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Description

Seborrheic dermatitis appears as red, inflamed skin covered by greasy or dry scales that may be white, yellowish, or gray. It can effect the scalp, eyebrows, forehead, face, folds around the nose and ears, the chest, armpits (axilla), and groin. Dandruff and cradle cap are mild forms of seborrheic dermatitis, and appear as fine white scales without inflammation.

Causes and symptoms

The cause of seborrheic dermatitis is unclear, though it is has been linked to genetic or environmental factors. *Pityrosporum ovale*, a species of yeast normally found in hair follicles, has been proposed as one possible causative factor. A high fat diet and alcohol ingestion are thought to play some role. Other possible risk factors include:

- stress and fatigue
- weather extremes (e. g. hot, humid weather or cold, dry weather)
- oily skin
- infrequent shampoos

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KEY TERMS

Acne—A chronic inflammation of the sebaceous glands that manifests as blackheads, whiteheads, and/or pustules on the face or trunk.

Psoriasis— A skin disorder of chronic, itchy scaling most commonly at sites of repeated minor trauma (e.g. elbows, knees, and skin folds). It affects up to 2% of the population in Western countries—males and females equally.

Rosacea—A chronic inflammation of the face, with associated scattered round nodules and increased reactivity of the facial capillaries to heat. It is most common in females, aged 30–50 years.

- obesity
- Parkinson's disease
- AIDS
- use of drying lotions that contain alcohol
- other skin disorders (for example acne, rosacea, or psoriasis)

Mild forms of the disorder may be asymptomatic. Symptoms also disappear and reappear, and vary in intensity over time. When scaling is present, it may be accompanied by **itching** that can lead to secondary infection.

Diagnosis

The diagnosis of seborrheic dermatitis is based on assessment of symptoms, accompanied by consideration of medical history.

Treatment

Treatment consists of vigorous shampoos with preparations that assist with softening and removing the scaly accumulations. For mild cases, a non-prescription shampoo with selenium sulfide or zinc pyrithione may be used. For more severe problems, the doctor may prescribe shampoos containing coal tar or scalp creams containing cortisone. The antiseborrheic shampoo should be left on the scalp for approximately five minutes before rinsing out. Hydrocortisone cream may also be ordered for application to the affected areas on the face and body. Application of the hydrocortisone should be discontinued when the condition clears and restarted with recurrence.

Prognosis

This chronic condition may be characterized by long periods of inactivity. Symptoms in the acute phase can be controlled with appropriate treatment.

Prevention

The condition cannot be prevented. The severity and frequency of flare-ups may be minimized with frequent shampoos, thorough drying of skin folds after bathing, and wearing of loose, ventilating clothing. Foods that appear to worsen the condition should be avoided.

Resources

BOOKS

James, William D., et al. *Andrews' Diseases of the Skin: Clinical Dermatology*. 10th ed. Philadelphia: Saunders Elsevier, 2006.

Kathleen D. Wright, RN

Secobarbital *see* **Barbiturates**

Secondary erythrocytosis *see* **Secondary polycythemia**

Secondary polycythemia

Definition

Secondary polycythemia is an acquired form of a rare disorder characterized by an abnormal increase in the number of mature red cells in the blood.

Secondary polycythemia is also called secondary erythrocytosis.

Description

Polycythemia means too many red blood cells. The resulting excess of red cells thickens the blood and impedes its passage through small blood vessels.

Secondary polycythemia usually affects people between the ages of 40 and 60.

Types of secondary polycythemia

Known as spurious polycythemia, stress polycythemia, or Gaisbock's syndrome, relative polycythemia is characterized by normal numbers of red blood cells but decreased levels of plasma (the fluid part of the blood). Overweight, middle-aged white men who smoke, have high blood pressure, and are on diuretic medicines to

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remove excess water from their bodies may develop Gaisbock's syndrome.

In smoker's polycythemia, the number of red blood cells is elevated. Plasma levels are abnormally low.

Causes and symptoms

Smoking, which impairs red blood cells' ability to deliver oxygen to body tissues, can cause secondary polycythemia. So can the following conditions:

- carbon monoxide poisoning
- chronic heart or lung disease
- hormonal (endocrine) disorders
- exposure to high altitudes
- kidney cysts
- tumors of the brain, liver, or uterus.

Causes of spurious polycythemia include:

- burns
- diarrhea
- hemoconcentration (higher-than-normal concentration of cells and solids in the blood, usually due to becoming dehydrated or taking diuretics)
- stress

Weakness, headaches, and **fatigue** are usually the first symptoms of secondary polycythemia. Patients may feel lightheaded or experience **shortness of breath**.

Visual disturbances associated with this disorder include distorted vision, blind spots, and flashes of light. The gums and small cuts are likely to bleed, and the hands and feet may burn. Extensive **itching** often occurs after taking a bath or shower.

Pain in the chest or leg muscles is common. The face often becomes ruddy, then turns blue after **exercise** or other exertion. Confusion and ringing in the ears (**tinnitus**) may also occur.

Diagnosis

A very important part of diagnosing secondary polycythemia is differentiating it from primary polycythemia (also called polycythemia rubra vera or Vaquez' disease). Unlike secondary polycythemia, primary polycythemia cannot be traced to an underlying condition such as smoking, high altitude, or chronic lung disease.

Doctors diagnose polycythemia by measuring oxygen levels in blood drawn from an artery. A patient whose oxygen level is abnormally low probably has secondary polycythemia. Erythropoietin may also be measured. Levels of this hormone, which stimulates the bone marrow to produce red blood cells, may be normal or elevated in a patient with secondary polycythemia. Red blood cell mass is also frequently measured in diagnosing the disorder.

Imaging studies are sometimes performed to determine whether the spleen and liver are enlarged and to detect erythropoietin-producing kidney lesions. Other diagnostic procedures include chest x rays and an electrocardiogram (EKG).

Treatment

Secondary polycythemia is treated primarily by treating the underlying condition causing the disorder. For example, patients with Gaisbock's syndrome are often taken off **diuretics** and encouraged to lose weight. Lung disorders, such as **chronic obstructive pulmonary disease** (COPD), may cause secondary polycythemia; treating the lung disorder generally improves the polycythemia.

Some medications may also be taken to treat symptoms caused by polycythemia. For example, **antihistamines** can alleviate itching, and **aspirin** can soothe burning sensations and bone pain.

Until the underlying condition is controlled, doctors use bloodletting (**phlebotomy**) to reduce the number of red blood cells in the patient's body. In most instances, a pint of blood is drained from the patient as needed and tolerated, until the **hematocrit** (the proportion of red cells in the blood) reaches an acceptable level. **Chemotherapy** is not used to treat secondary polycythemia; however, it may be used to treat the primary form.

Prognosis

Curing or removing the underlying cause of this disorder generally eliminates the symptoms.

Resources

OTHER

"Secondary Erythrocytosis." General Practice Notebook. 2010. http://www.gpnotebook.co.uk/simplepage.cfm?ID=-919273435 (accessed December 16, 2010).

Maureen Haggerty

SED rate *see* **Erythrocyte sedimentation rate**

Sedation

Definition

Sedation is the act of calming by administration of a sedative. A sedative is a medication that commonly induces the nervous system to calm.

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Purpose

The process of sedation has two primary intentions. First, sedation is recommended to allow patients the ability to tolerate unpleasant diagnostic or surgical procedures and to relieve **anxiety** and discomfort. Second, sedation for uncooperative patients may expedite and simplify special procedures that require little or no movement. Additionally, sedation is often desirable to diminish fear associated with operative procedures. Sedation is typically used for common diagnostic tests that require prolonged **immobilization** such as **magnetic resonance imaging** (MRI) and computed axial tomography (CAT) scanning. Some cases that require sedation may also necessitate the use of **analgesics** to decrease **pain** associated with a procedure or test.

Precautions

Benzodiazepines (common sedative medication) have a cumulative effect. This means that if the patient has not had time to metabolize the previous dose and ingests more, then the sedative effect may increase. Because of these additive effects, these medications taken with other sedatives or alcohol (also a sedative hypnotic drug) may increase chances for accidental **death**. In general, most of the medications that induce sedation may alter breathing and cardiac stability. In patients with preexisting lung and/or heart disease, these medications should be monitored closely or not prescribed.

Description

The future of anesthetic care involves the simultaneous administration of several drugs including IV medications and inhaled anesthetics. An extensive survey of death in 100,000 cases published in 1988 revealed that death within seven days was 2.9 times greater when one or two anesthetic drugs were used than when using three or more medications. This study is accepted as standard practice and multiple IV anesthetics is the preferable recommendation for optimal patient care.

The procedure for sedation is usually explained to the patient by an attending clinician. An IV access line is set in place for fluid replacement and injection of medications. A history is usually taken to assess risk and choice of medication. The patient typically signs consent forms and the possible side effects are explained. The day before the test, the patient may be required to maintain specified dietary restriction.

For outpatient surgery there are two types of sedation, conscious and unconscious sedation. Patients receiving conscious sedation are capable of rational responses, and they are able to maintain their airway for ventilation. The hallmark of conscious sedation is that it does not alter respiratory, cardiac, or reflex functions (nerve reflexes from the brain) to the level that requires external support for these vital functions. Patients receiving conscious sedation are cooperative, have stable vital signs (pulse, respiratory rate, and temperature), shorter recovery room convalescence, and lower risk of developing drug-induced complications. Unconscious sedation is a controlled state of anesthesia, characterized by partial or complete loss of protective nerve reflexes, including the ability to independently breathe and respond to commands. The patient is unable to cooperate, has labile (fluctuating) vital signs, prolonged recovery room convalescence, and higher risk of anesthetic complications.

Preparation

Usually procedures for conscious sedation do not require preoperative or pre-testing orders. Clinical situations for unconscious sedation typically involve eating and drinking protocols starting the day before the procedure.

The age and physical status of the patient is useful in determining sensitivity. A detailed past history, especially prior experiences with sedatives and other anesthetics is an important part of preparatory assessment. It is important to determine if there were any untoward side effects associated with a previous medication. Patient positioning is important to prevent blood pressure changes or nerve damage associated with abnormal position.

Patients are also monitored for pulse rate, respiration, blood pressure, and temperature. Additionally, the heart is monitored using **electrocardiography** (ECG). Ventilation is assessed using a pulse oximeter. This machine is clipped with a special probe on one finger and can measure the levels of oxygen and carbon dioxide, which are reliable indicators of respiratory status.

Aftercare

The major goal for recovery room monitoring is assessment of residual drug effects. Recovery room monitoring primarily focuses on heart stability, respiratory adequacy and return to previous brain functioning.

Risks

The original forms of diazepam (Valium, a very common sedative) caused irritation of veins and phlebitis. Newer forms of diazepam (Dizac) are chemically improved to lower the possibility of vein irritation. Age and physical health are important risk factors. Preexisting medical conditions such as high blood pressure and

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KEY TERMS

Baseline— A return to an original state.

Diazepam— One of the most commonly used sedative-hypnotic medications.

heart and lung disease may increase the chance of developing undesirable side effects.

Normal results

Normal or uncomplicated results for sedation include alleviation of anxiety and discomfort. Coupled with analgesic, patients are usually pain-free. The normal progression post procedure or post operatively would be to return to baseline brain functioning, unassisted breathing, and normal heart rate and rhythm.

Abnormal results

Patients may have excessive **nausea and vomiting** associated with narcotic analgesia (if this is indicated). Excessive drowsiness can occur secondary to benzodiazepine-induced sedation. The patient can also develop hypoventilation (a decrease in ventilation), airway obstruction, high or low blood pressure, abnormal heart rhythms, **nausea**, **vomiting**, and shivering.

Resources

BOOKS

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Laith Farid Gulli, M.D.
Bilal Nasser, M.Sc.

Sedative-hypnotic drugs *see* **Anti-insomnia drugs**

Sedimentation rate *see* **Erythrocyte sedimentation rate**

Seizure disorder

Definition

A seizure is a sudden disruption of the brain's normal electrical activity accompanied by altered consciousness and/or other neurological and behavioral manifestations. **Epilepsy** is a condition characterized by recurrent seizures that may include repetitive muscle jerking called convulsions.

This patient's brain is exposed during surgery in order for surgeons to remove the mass responsible for his epilepsy. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Description

There are more than 20 different seizure disorders. One in ten Americans will have a seizure at some time during their lifetime. More than 3 million Americans are affected by seizures.

Epilepsy affects 1–2% of the population of the United States. About 2.7 million Americans have active epilepsy, meaning that in the past 5 years they have had a seizure or been on medication for epilepsy.) Epilepsy becomes more prevalent with increased age. About 1% of people under age 20 have epilepsy, and about 3% of people over age 75 have it. About 200,000 new cases of epilepsy are diagnosed each year.

Most seizures are benign, but a seizure that lasts a long time can lead to status epilepticus, a life-threatening condition characterized by continuous seizures, sustained loss of consciousness, and respiratory distress. Non-convulsive epilepsy can impair physical coordination, vision, and other senses. Undiagnosed seizures can lead to conditions that are more serious and more difficult to manage.

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This abstract artwork is based on a patient's description of what an epileptic seizure feels like. Epileptic seizures are caused by chaotic electrical activity in the brain. They can be triggered by a variety of factors, such as illness or stress, although the underlying causes are not completely understood. *(John Bavosi/Photo Researchers, Inc.)*

Types of seizures

Generalized epileptic seizures occur when electrical abnormalities occur throughout the brain. A partial seizure does not involve the entire brain. The are in which the seizure begins is called the epileptic focus. Many seizures stay localized, but some spread to other parts of the brain and cause a generalized seizure. Some people who have epilepsy have more than one type of seizure.

Seizures which involve areas of the brain necessary for motor control can cause parts of the body to jerk repeatedly. This type of seizure can last can seconds or minutes, or rarely, more than an hour. Seizures that last more than a few minutes can cause serious long-term disability and even **death**. Sensory seizures begin with **numbness** or **tingling** in one area. The sensation may move along one side of the body or the back before subsiding.

Visual seizures, which affect the area of the brain that controls sight, cause people to see things that are not there. Auditory seizures affect the part of the brain that controls hearing and may cause the individual to imagine voices, music, or other sounds. Other types of seizures can cause confusion, upset stomach, or emotional distress.

GENERALIZED SEIZURES. A generalized tonic-clonic (grand-mal) seizure begins with a loud cry before the person having the seizure loses consciousness and falls to the ground. The muscles become rigid for about 30 seconds during the tonic phase of the seizure and alternately contract and relax during the clonic phase, which lasts 30–60 seconds. The skin sometimes acquires a bluish tint and the person may bite his tongue, lose bowel or bladder control, or have trouble breathing.

A grand mal seizure usually last one to two minutes, and the person may be confused or have trouble talking when consciousness is regained (postictal state). The individual may complain of head or muscle aches, weakness in the arms or legs, or be extremely drowsy or fatigued.

PRIMARY GENERALIZED SEIZURES. A primary generalized seizure occurs when electrical discharges begin in both halves (hemispheres) of the brain at the same time. Primary generalized seizures are more likely to be major motor attacks than to be absence seizures.

ABSENCE SEIZURES. Absence (petit mal) seizures generally begin between the ages of 5 and 15. The seizures usually begin with a brief loss of consciousness and last between 2 and 3 seconds. Sometimes the episodes may last up to 30 seconds. An individual having a petit mal seizure becomes very quiet and may blink or stare blankly and may exhibit facial twitching, eye rolling, or lip movement. When it ends, the individual who had the seizure resumes whatever he or she was doing before the seizure began. The individual will not remember the seizure and may not realize that anything unusual has happened. Untreated, petit mal seizures can recur as many as 100 times a day and may progress to grand mal seizures.

MYOCLONIC SEIZURES. Myoclonic seizures are characterized by brief, involuntary spasms of the tongue or muscles of the face, arms, or legs. Myoclonic seizures are most apt to occur when waking after a night's sleep. These seizures do not generally cause loss of consciousness.

A Jacksonian seizure is a partial seizure characterized by tingling, stiffening, or jerking of an arm or leg. Loss of consciousness is rare. The seizure may progress in characteristic fashion along the limb.

Limp posture and a brief period of unconsciousness are features of atonic seizures, which occur in young children. Atonic seizures, which cause the child to fall, also are called drop attacks.

PARTIAL SEIZURES. Simple partial seizures do not spread from the focal area where they arise. Symptoms are determined by the part of the brain affected. The

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individual usually remains conscious during the seizure and may be able to describe it later.

COMPLEX PARTIAL SEIZURES. A distinctive smell, taste, or other unusual sensation (aura) may signal the start of a complex partial seizure. These seizures start as simple partial seizures, but move beyond the focal area and cause loss of consciousness. Complex partial seizures can become major motor seizures. Although a person having a complex partial seizure may not seem to be unconscious, he or she does not know what is happening and may behave strangely or inappropriately. The individual will not remember the seizure, and may seem confused or intoxicated for a few minutes after it ends.

Causes and symptoms

The origin of 50–70% of all cases of epilepsy is unknown. Epilepsy sometimes is the result of trauma at birth. Such causes include insufficient oxygen to the brain; **head injury**; heavy bleeding or incompatibility between a woman's blood and the blood of her newborn baby; and infection immediately before, after, or at the time of birth.

Other causes of epilepsy include:

- head trauma resulting from a car accident, gunshot wound, or other injury.
- alcoholism
- brain abscess or inflammation of membranes covering the brain or spinal cord
- phenylketonuria (PKU, a disease that is present at birth, often is characterized by seizures, and can result in mental retardation) and other inherited disorders
- infectious diseases like measles, mumps, and diphtheria
- degenerative disease
- lead poisoning, mercury poisoning, carbon monoxide poisoning, or ingestion of some other poisonous substance
- genetic factors

Status epilepticus, a condition in which a person suffers from continuous seizures and may have trouble breathing, can be caused by:

- suddenly discontinuing anti-seizure medication
- hypoxic or metabolic encephalopathy (brain disease resulting from lack of oxygen or malfunctioning of other physical or chemical processes)
- acute head injury
- blood infection caused by inflammation of the brain or the membranes that cover it

Diagnosis

Personal and family medical history, description of seizure activity, and physical and neurological examinations help primary care physicians, neurologists, and epileptologists diagnose this disorder. Doctors rule out conditions that cause symptoms that resemble epilepsy, including small strokes (transient ischemic attacks, or TIAs), **fainting**, (syncope), pseudoseizures, and sleep attacks (narcolepsy.) It is often helpful for a family member or other person present during the seizure to describe the event to the physician, as the individual who had the seizure may not remember it.

Neuropsychological testing can uncover any learning or memory problems that may be related to the seizure or seizures. Neuroimaging provides views of brain areas involved in seizure activity.

The electroencephalogram (EEG) is the main test used to diagnose epilepsy. EEGs use electrodes placed on or within the skull to record the brain's electrical activity and pinpoint the exact location of abnormal discharges.

The patient may be asked to remain motionless during a short-term EEG or to go about his normal activities during extended monitoring. Some patients are deprived of sleep or exposed to seizure triggers, such as rapid, deep breathing (hyperventilation) or flashing lights (photic stimulation). In some cases, people may be hospitalized for EEG monitoring that can last as long as two weeks. Video EEGs also document what the patient was doing when the seizure occurred and how the seizure changed his or her behavior.

Other techniques used to diagnose epilepsy include:

- Magnetic resonance imaging (MRI), which provides clear, detailed images of the brain. Functional MRI (fMRI), performed while the patient does various tasks, can measure shifts in electrical intensity and blood flow and indicate which brain region each activity affects.
- Positron emission tomography (PET) and single photon emission tomography (SPECT) monitor blood flow and chemical activity in the brain area being tested. PET and SPECT are very effective in locating the brain region where metabolic changes take place between seizures.

Treatment

The goal of epilepsy treatment is to eliminate seizures or make the symptoms less frequent and less severe. Long-term anticonvulsant drug therapy is the most common form of epilepsy treatment.

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Medication

A combination of drugs may be needed to control some symptoms, but most patients who have epilepsy take one of the following medications:

- Dilantin (phenytoin)
- Tegretol (carbamazepine)
- Barbita (phenobarbital)
- Mysoline (primidone)
- Depakene (valproic acid, sodium valproate)
- Klonopin (clonazepam)
- Zarontin (ethosuximide).

Dilantin, Tegretol, Barbita, and Mysoline are frequently used to manage or control generalized tonic-clonic and complex partial seizures. Depakene, Klonopin, and Zarontin are often prescribed for patients who have absence seizures.

Neurontin (gabapentin), Lamictal (lamotrigine), and topiramate (Topamax) are among the medications more recently approved in the United States to treat adults who have partial seizures or partial and grand mal seizures. Another new medication called Levetiracetam (Keppra) has been approved and shows particularly good results in reducing partial seizures among elderly patients with few side effects. This is important, because elderly patients often have other conditions and must take other medications that might interact with seizure medications. Available medications frequently change, and it the physician will determine the best treatment for an individual patient. It is believed that monotherapy, or using just one medication rather than a combination, may work better for most patients. The less complicated the treatment, the more likely the patient will comply and better manager the seizure disorder.

Even an individual whose seizures are well controlled should have regular blood tests to measure levels of anti-seizure medication in his or her system and to check to see if the medication is causing any changes in the blood or liver. A doctor should be notified if any signs of drug toxicity appear, including uncontrolled eye movements; sluggishness, **dizziness**, or hyperactivity; inability to see clearly or speak distinctly; **nausea** or **vomiting**; or sleep problems.

Status epilepticus requires emergency treatment, usually with Valium (Ativan), Dilantin, or Barbita. An intravenous dextrose (sugar) solution is given to patients whose condition is due to low blood sugar, and a vitamin B_1 preparation is administered intravenously when status epilepticus results from chronic alcohol withdrawal. Because dextrose and thiamine are essentially harmless and because delay in treatment can be disastrous, these medications are given routinely, as it is usually difficult to obtain an adequate history from a patient suffering from status epilepticus.

Intractable seizures are seizures that cannot be controlled with medication or without **sedation** or other unacceptable side effects. Surgery may be used to eliminate or control intractable seizures.

Surgery

Surgery can be used to treat patients whose intractable seizures stem from small focal lesions that can be removed without endangering the patient, changing the patient's personality, dulling the patient's senses, or reducing the patient's ability to function.

Each year, as many as 5,000 new patients may become suitable candidates for surgery, which most often is performed at a comprehensive epilepsy center. Potential surgical candidates include patients with:

- partial seizures and secondarily generalized seizures (attacks that begin in one area and spread to both sides of the brain)
- seizures and childhood paralysis on one side of the body (hemiplegia)
- complex partial seizures originating in the temporal lobe (the part of the brain associated with speech, hearing, and smell) or other focal seizures. (However, the risk of surgery involving the speech centers is that the patient will lose speech function.)
- Generalized myoclonic seizures or generalized seizures featuring temporary paralysis (akinetic) or loss of muscle tone (atonal)

A **physical examination** is conducted to verify that a patient's seizures are caused by epilepsy. Surgery is not used to treat patients with severe psychiatric disturbances or medical problems that raise risk factors to unacceptable levels.

Surgery is never indicated unless:

- the best available anti-seizure medications have failed to control the patient's symptoms satisfactorily
- the origin of the patient's seizures has been precisely located
- there is good reason to believe that surgery will significantly improve the patient's health and quality of life.

Every patient considering epilepsy surgery is carefully evaluated by one or more neurologists, neurosurgeons, neuropsychologists, and/or social workers. A psychiatrist, chaplain, or other spiritual advisor may help the patient and his family cope with the **stress** that occurs during and after the selection process.

TYPES OF SURGERY. Surgical techniques used to treat intractable epilepsy include:

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- Lesionectomy. Removing the lesion (diseased brain tissue) and some surrounding brain tissue is very effective in controlling seizures. Lesionectomy is generally more successful than surgery performed on individuals whose seizures are not caused by clearly defined lesions. Removing only part of the lesion lessens the effectiveness of the procedure.
- Temporal resections. Removing part of the temporal lobe and the part of the brain associated with feelings, memory, and emotions (the hippocampus) provides good or excellent seizure control in 75–80% of properly selected patients with appropriate types of temporal lobe epilepsy. Some patients experience post-operative speech and memory problems.
- Extra-temporal resection. This procedure involves removing some or all of the frontal lobe, the part of the brain directly behind the forehead. The frontal lobe helps regulate movement, planning, judgment, and personality. Special care must be taken to prevent post-operative problems with movement and speech. Extra-temporal resection is most successful in patients whose seizures are not widespread.
- Hemispherectomy. This method of removing brain tissue is restricted to patients with severe epilepsy and abnormal discharges that often extend from one side of the brain to the other. Hemispherectomies most often are performed on infants or young children who have had an extensive brain disease or disorder since birth or from a very young age.
- Corpus callosotomy. This procedure, an alternative to hemispherectomy in patients with congenital hemiplegia, removes some or all of the white matter that separates the two halves of the brain. Corpus callosotomy is performed almost exclusively on children who are frequently injured during falls caused by seizures. If removing two-thirds of the corpus callosum does not produce lasting improvement in the patient's condition, the remaining one-third will be removed during another operation.
- Multiple subpial transection. This procedure is used to control the spread of seizures that originate in or affect the "eloquent" cortex, the area of the brain responsible for complex thought and reasoning.

Other forms of treatment

KETOGENIC DIET. A special high-fat, low-protein, low-carbohydrate diet sometimes is used to treat patients whose severe seizures have not responded to other treatment. Calculated according to age, height, and weight, the ketogenic diet induces mild **starvation** and **dehydration**. This forces the body to create an excessive supply of ketones, natural chemicals with seizure-suppressing properties.

The goal of this controversial approach is to maintain or improve seizure control while reducing medication. The ketogenic diet works best with children between the ages of one and 10. It is introduced over a period of several days, and most children are hospitalized during the early stages of treatment.

If a child following this diet remains seizure-free for at least six months, increased amounts of carbohydrates and protein gradually are added. If the child shows no improvement after three months, the diet is gradually discontinued.

Introduced in the 1920s, the ketogenic diet has had limited, short-term success in controlling seizure activity. Its use exposes patients to such potentially harmful side effects as:

- staphylococcal infections
- stunted or delayed growth
- low blood sugar (hypoglycemia)
- excess fat in the blood (hyperlipidemia)
- disease resulting from calcium deposits in the urinary tract (urolithiasis)
- disease of the optic nerve (optic neuropathy)

VAGUS NERVE STIMULATION. The United States Food and Drug Administration (FDA) has approved the use of vagus nerve stimulation (VNS) in patients over the age of 16 who have intractable partial seizures. This non-surgical procedure uses a pacemaker-like device implanted under the skin in the upper left chest, to provide intermittent stimulation to the vagus nerve. Stretching from the side of the neck into the brain, the vagus nerve affects swallowing, speech, breathing, and many other functions, and VNS may prevent or shorten some seizures. Approximately 80% of patients experience fewer seizures after the procedure. Individuals having undergone this procedure may experience side effects such as dizziness, **memory loss**, weight gain, and slurred speech.

First aid for seizures

A person having a seizure should not be restrained, but sharp or dangerous objects should be moved out of reach. Anyone having a complex partial seizure may be warned away from danger by someone calling his or her name in a clear, calm voice.

A person having a grand mal seizure should be helped to lie down. Tight clothing should be loosened. A soft, flat object like a towel or the palm of a hand should be placed under the person's head. Forcing objects into the mouth of someone having a grand mal seizure could cause injuries or breathing problems, and the individual trying to help may be injured if the jaw

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KEY TERMS

Acupressure—Needleless acupuncture.

Acupuncture—An ancient Chinese method of relieving pain or treating illness by piercing specific areas of the body with fine needles.

Biofeedback—A learning technique that helps individuals influence automatic body functions.

Epileptologist—A physician who specializes in the treatment of epilepsy.

clenches shut. The individual having the seizure should be turned on his or her side if consciousness has been lost. This will ensure the individual is able to breathe. After a grand mal seizure has ended, the person who had the seizure should be calmly told what has happened and reminded of where he or she is.

Alternative treatment

Stress increases seizure activity in 30% of people who have epilepsy. Relaxation techniques can provide some sense of control over the disorder, but they should never be used instead of anti-seizure medication or used without the approval of the patient's doctor. **Yoga**, **meditation**, and favorite pastimes help some people relax and manage stress more successfully. **Biofeedback** can teach adults and older adolescents how to recognize an aura and what to do to stop its spread. Children under 14 are not usually able to understand and apply principles of biofeedback. **Acupuncture** treatments (acupuncture needles inserted for a few minutes or left in place for as long as 30 minutes) make some people feel pleasantly relaxed. **Acupressure** can have the same effect on children or on adults who dislike needles.

Aromatherapy involves mixing aromatic plant oils into water or other oils and massaging them into the skin or using a special burner to waft their fragrance throughout the room. Aromatherapy oils affect the body and the brain, and undiluted oils should never be applied directly to the skin. Ylang ylang, chamomile, or lavender can create a soothing mood. People who have epilepsy should not use rosemary, hyssop, sage or sweet fennel, which seem to make the brain more alert.

Dietary changes that emphasize whole foods and eliminate processed foods may be helpful. Homeopathic therapy also can work for people with seizures, especially constitutional homeopathic treatment that acts at the deepest levels to address the needs of the individual person.

Prognosis

People who have epilepsy have a higher-than-average rate of **suicide**; sudden, unexplained death; and drowning and other accidental fatalities.

Benign focal epilepsy of childhood and some absence seizures may disappear in time, but remission is unlikely if seizures occur several times a day, several times in a 48-hour period, or more frequently than in the past.

Seizures that occur repeatedly over time and always involve the same symptoms are called stereotypic seizures. The probability that stereotypic seizures will abate is poor.

About 85% of all seizure disorders can be partially or completely controlled if the patient takes anti-seizure medication according to directions, avoids seizure-inducing sights, sounds, and other triggers, gets enough sleep, and eats regular, balanced meals.

Anyone who has epilepsy should wear a bracelet or necklace identifying the seizure disorder and listing the medication that he or she takes.

Prevention

Eating properly, getting enough sleep, and controlling stress and fevers can help prevent seizures. A person who has epilepsy should be careful not to hyperventilate. A person who experiences an aura should find a safe place to lie down and stay there until the seizure passes. Anticonvulsant medications should not be stopped suddenly and, if other medications are prescribed or discontinued, the doctor treating the seizures should be notified. In some conditions, such as severe head injury, brain surgery, or **subarachnoid hemorrhage**, anticonvulsant medications may be given to the patient to prevent seizures.

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Liu, Yeou-Mei Christiana, et al. "A Prospetive Study: Growth and Nutritional Status of Children Treated With the Ketogenic Diet." *Journal of the American Dietetic Association* June 2003: 707.

"New Drug Candidate Shows Promise." *Clinical Trials Week* April 7, 2003: 26.

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ORGANIZATIONS

American Epilepsy Society (AES), 342 North Main Street, West Hartford, CY, 06117-2507, (860) 586-7505, (860) 586-7550, http://www.aesnet.org/.

Epilepsy Foundation of America, 8301 Professional Place, Landover, MD, 20785-7223, (301) 577-2684, (800) 332-1000, info@efa.org, http://www.efa.org.

Epilepsy Information Service, Medical Center Boulevard, Winston-Salem, NC, 27157, (800) 642-0500, pgibson@ wfubmc.edu, http://www.wfubmc.edu/Neurosciences/Comprehensive-Epilepsy-Center/Epilepsy-Information-Service.htm.

International Bureau for Epilepsy, 100 Priory Hall, Stillorgan, Blackrock, Dublin, Ireland, 3531210-8850, 3531210-8450, ibedublin@eircom.net, http://www.ibe-epilepsy.org.

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Teresa G. Odle

Selective abortion *see* **Abortion, selective**
Selective mutism *see* **Mutism**

Selective serotonin reuptake inhibitors

Definition

Selective serotonin reuptake inhibitors are medicines that relieve symptoms of depression.

Purpose

Selective serotonin reuptake inhibitors are used to treat serious, continuing depression that interferes with a person's ability to function. Like other **antidepressant drugs**, they help reduce the extreme sadness, hopelessness, and lack of interest in life that are typical in people with depression. Selective serotonin reuptake inhibitors also are used to treat **panic disorder**, obsessive compulsive disorder (OCD), and have shown promise for treating a variety of other conditions, such as **premenstrual syndrome**, **eating disorders**, **obesity**, **self-mutilation**, and **migraine headache**.

As of late 2003, SSRIs have been found to have other off-label applications, including treatment of **premature ejaculation** and **diabetic neuropathy**.

Description

Selective serotonin reuptake inhibitors, also known as SSRIs or serotonin boosters, are thought to work by correcting chemical imbalances in the brain. Normally, chemicals called neurotransmitters carry signals from one nerve cell to another. These chemicals are constantly being released and taken back up at the ends of nerve cells. Selective serotonin reuptake inhibitors act on one particular neurotransmitter, serotonin, reducing its re-entry into nerve cells and thus allowing serotonin to build up. Although scientists are not exactly sure how it works, serotonin is involved in the control of moods, as well as other functions such as sleep, body temperature, and appetite for sweets and other carbohydrates. Somehow, drugs that prevent the uptake of serotonin improve the moods of people with serious depression, OCD, and some types of **anxiety disorders**.

Selective serotonin reuptake inhibitors are available only with a doctor's prescription and are sold in tablet, capsule, and liquid forms. Commonly used selective serotonin reuptake inhibitors are fluoxetine (Prozac), paroxetine (Paxil), sertraline (Zoloft), and fluvoxamine (Luvox).

Recommended dosage

The recommended dosage depends on the type of SSRI and the type and severity of depression for which it is being taken. Dosages may be different for different people. It is important for people taking SSRIs to take the drug exactly as prescribed. Taking larger or more frequent doses or taking the drug for longer than directed, for example, can cause unwanted effects.

SSRIs are about as effective as other antidepressants. About 60–80% of people taking the drugs as directed will find that their conditions improve. However, it may take four weeks or more for the effects of this medicine to be felt. Therefore, when people begin SSRI therapy, it is important to continue taking the medication, even if an improvement in mood doesn't begin immediately.

People who take SSRIs should ask their doctors about how to stop taking the medication. Usually, doctors advise patients to taper down gradually to reduce the chance of withdrawal symptoms or SSRI discontinuation syndrome.

SSRIs may be taken with food to prevent stomach upset.

Precautions

There have been reports that some patients taking SSRIs have an increase in thoughts about **suicide**. It is not clear whether the medicine causes this effect because suicidal thoughts are very often a part of depression itself. While some patients may experience

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worsening of such thoughts early in the treatment of their depression, there is no credible evidence that SSRIs alone cause people to become suicidal or violent.

Serious and possibly life-threatening reactions may occur when SSRIs are used in combination with **monoamine oxidase inhibitors** (MAO inhibitors), such as Nardil and Parnate, which also are used to treat depression. These reactions also are possible when a person stops taking an SSRI and immediately begins taking an MAOI. SSRIs and MAO inhibitors should never be taken at the same time. When switching from an SSRI to an MAOI or vice versa, it may be necessary to allow two to five weeks or more between stopping one and starting the other. The physician prescribing the medications should tell the patient exactly how much time to allow before beginning the other medication.

People with a history of manic disorders should use any antidepressant, including an SSRI, with caution.

It is important to see a doctor regularly while taking SSRIs. The doctor will check to make sure the medicine is working as it should and will watch for unwanted side effects. The doctor may also need to adjust the dosage during this period.

Some people feel drowsy, dizzy, or lightheaded when using SSRIs. The drugs may also cause blurred vision in some people. Since SSRIs can sometimes cause drowsiness, driving or operating heavy machinery should be undertaken cautiously, particularly when the person first begins taking the medication.

These medicines make some people feel lightheaded, dizzy, or faint when they get up after sitting or lying down, a condition known as **orthostatic hypotension**. People may try to lessen the problem by getting up gradually and holding onto something for support if possible. If the problem is severe or doesn't improve, the patient should discuss it with his or her doctor.

Because SSRIs work on the central nervous system, they may add to the effects of alcohol and other drugs that slow down the central nervous system, such as **antihistamines**, cold medicine, allergy medicine, sleep aids, medicine for seizures, tranquilizers, some **pain** relievers, and **muscle relaxants**. They may also add to the effects of anesthetics, including those used for dental procedures. Anyone taking SSRIs should check with his or her doctor before taking any of the drugs mentioned above.

SSRIs may occasionally cause **dry mouth**, although this side effect is much more common with an older class of antidepressants known as tricyclics. To temporarily relieve the discomfort, doctors sometimes suggest chewing sugarless gum, sucking on sugarless candy or ice chips, or using saliva substitutes, which come in liquid and tablet forms and are available without a prescription. If the problem continues for more than two weeks, check with a doctor or dentist. Mouth dryness that continues over a long time may contribute to **tooth decay** and other dental problems.

Changes in sexual functioning are among the more common side effects with SSRIs. Depending on the particular SSRI prescribed, 8–15% of patients may report these side effects. The most common problem for men is delayed ejaculation. Women may be unable to have orgasms. A doctor should be contacted if any changes in sexual functioning occur.

Special conditions

People with certain medical conditions or who are taking certain other medicines can have problems if they take SSRIs. Before taking these drugs, a patient should let the doctor know about any of these conditions:

ALLERGIES. Anyone who has had unusual reactions to SSRIs in the past should let his or her doctor know before taking the drugs again. The doctor should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. In studies of laboratory animals, some SSRIs have caused **miscarriage** and other problems in pregnant females and their offspring. However, at least two studies in humans (by Pastuszak in 1993 and Kuhlin in 1998) have shown SSRIs to be safe during **pregnancy**, and newer studies done in 2003 have reported that SSRIs do not appear to increase the risks of **birth defects** in the offspring. Still, women who are pregnant or who may become pregnant should check with their doctors before using SSRIs.

BREASTFEEDING. SSRIs pass into breast milk and some may occasionally cause unwanted side effects in nursing babies whose mothers take the drugs. These effects include **vomiting**, watery stools, crying, and sleep problems. Women who are **breastfeeding** should talk to their doctors about the use of SSRIs. They may need to switch to a different medicine while breastfeeding. If SSRIs must be taken, it may be necessary to stop breastfeeding while being treated with these drugs. However, several studies in people (for example, Yoshida in 1998) have indicated that SSRIs in breast milk have no effect on infant development.

DIABETES. SSRIs may affect blood sugar levels. People with diabetes who notice changes in their blood or urine tests while taking this medicine should check with their doctors.

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KEY TERMS

Anesthetic—Medicine that causes a loss of feeling, especially of pain. Some anesthetics also cause a loss of consciousness.

Anxiety—Worry or tension in response to real or imagined stress, danger, or dreaded situations. Physical reactions, such as fast pulse, sweating, trembling, fatigue, and weakness may accompany anxiety.

Central nervous system—The brain and spinal cord.

Depression—A mental condition in which people feel extremely sad and lose interest in life. People with depression may also have sleep problems and loss of appetite and may have trouble concentrating and carrying out everyday activities.

Metabolism—All the physical and chemical changes that occur in cells to allow growth and maintain body functions. These include processes that break down substances to yield energy and processes that build up other substances necessary for life.

Obsessive-compulsive disorder—An anxiety disorder in which people cannot prevent themselves from dwelling on unwanted thoughts, acting on urges, or performing repetitious rituals, such as washing their hands or checking to make sure they turned off the lights.

Off-label application—The use of a prescription medication to treat conditions outside the indications approved by the Food and Drug Administration (FDA).

Premenstrual syndrome—(PMS) A set of symptoms that occur in some women 2–14 days before they begin menstruating each month. Symptoms include headache, fatigue, irritability, depression, abdominal bloating, and breast tenderness.

OTHER MEDICAL CONDITIONS. Before using SSRIs, people with any of these medical problems should make sure their doctors are aware of their conditions: diabetes, **kidney disease**, **liver disease**, seizure disorders, current or past drug **abuse** or dependence, or diseases or conditions that affect the metabolism or blood circulation.

Side effects

The most common side effects are **anxiety** and nervousness (reported by 5–13% of people taking various SSRIs), tremor (5–14%), trouble sleeping (2–8%), tiredness or weakness (4–15%), **nausea** (11–26%), **diarrhea** (11–26%), **constipation** (1–8%), loss of appetite (3–18%), weight loss (1–13%), dry mouth (10–22%), **headache** (1–5%), sweating (5–9%), trouble urinating (1–2%), and decreased sexual ability (8–15%). Many of these problems diminish or disappear as the body adjusts to the drug and do not require medical treatment unless they interfere with normal activities. Persistent problems, such as **sexual dysfunction**, should be discussed with the doctor.

More serious side effects are possible, but extremely rare. People taking SSRIs who notice unusual joint or muscle pain; breathing problems; chills or **fever**; excessive excitement, fast talking, or actions that are out of control; or mood swings should contact their doctors. People who develop skin **rashes** or **hives** after taking an SSRI should stop taking the medication and contact their doctors as soon as possible. Other rare side effects may occur. Anyone who has unusual symptoms after taking an SSRI should get in touch with his or her doctor.

Side effects may continue for some time after treatment with this medicine ends. How long the effects continue depends on how long the drug was taken and how much of it was used. In most cases, doctors recommend that patients taper off SSRIs rather than abruptly stopping them, because of the risk of developing a condition known as SSRI discontinuation syndrome. This syndrome can mimic serious illness. People who experience agitation, confusion, or restlessness; **dizziness** or lightheadedness; vision problems; tremor; sleep problems; unusual tiredness or weakness; **nausea and vomiting** or diarrhea; headache; excessive sweating; runny nose; or muscle pain for more than a few days after stopping or tapering an SSRI should consult their doctors.

Interactions

SSRIs may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes SSRIs should let the doctor know about all other medicines he or she is taking. Among the drugs that may interact with SSRIs are:

- such central nervous system (CNS) depressants as medicine for allergies, colds, hay fever, and asthma;

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sedatives; tranquilizers; prescription pain medicine; muscle relaxants; medicine for seizures; sleep aids; barbiturates; and anesthetics.

- blood thinners (anticoagullants)
- such monoamine oxidase inhibitors (MAOIs) as Nardil or Parnate, used to treat conditions including depression and Parkinson's disease
- the antiseizure drug phenytoin (Dilantin)
- the food supplement (and sleep aid) tryptophan, which has been withdrawn from the United States market, but may be found in some herbal preparations
- digitalis and other heart medicines
- St. John's wort (*Hypericum perforatum*). St. John's wort is a herb used in Europe and the United States to relieve mild-to-moderate symptoms of depression. Research indicates that it acts as an SSRI and not as an MAO inhibitor, as previously believed. People who are using St. John's wort to relieve depression should not take a prescription SSRI at the same time.

The list above does not include every drug that may interact with SSRIs. Patients should be sure to check with a doctor or pharmacist before combining SSRIs with any other prescription or nonprescription (over-the-counter) medicine, including herbal preparations.

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ORGANIZATIONS

American Psychiatric Association (APA), 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209, (888) 357-7924, apa@psych.org, http://www.psych.org.

National Center for Complementary and Alternative Medicine (NCCAM), P.O. Box 7923, Gaitherburg, MD, 20898, (866) 464-3616, (888) 644-6226, info@nccam.nih.gov, http://nccam.nih.gov/.

National Institute of Mental Health (NIMH), 6001 Executive Boulevard, Bethesda, MD, 20892, (301) 443-4513, (301) 443-4279, (866) 615-6464, nimhinfo@nih.gov, http://www.nimh.nih.gov.

United States Food and Drug Administration (FDA), 10903 New Hampshire Ave, Silver Spring, MD, 02993-0002, (888) 463-6332, http://www.fda.gov.

Nancy Ross-Flanigan
Rebecca J. Frey, PhD

Self-mutilation

Definition

Self-mutilation is a general term for a variety of forms of intentional self-harm without the wish to die. Cutting one's skin with razors or knives is the most common pattern of self-mutilation. Others include biting, hitting, or bruising oneself; picking or pulling at skin or hair; burning oneself with lighted cigarettes, or amputating parts of the body.

Description

Self-mutilation has become a major public health concern as its incidence appears to have risen since the early 1990s. One source estimates that 0.75% of the general American population practices self-mutilation. The incidence of self-mutilation is highest among teenage females, patients diagnosed with **borderline personality disorder**, and patients diagnosed with one of the **dissociative disorders**. Over half of self-mutilators were sexually abused as children, and many also suffer from **eating disorders**.

Self-mutilation should not be confused with current fads for **tattoos** and body **piercing**. In some cases, however, it may be difficult to distinguish between an interest in these fads and the first indications of a disorder.

The relationship of self-mutilation to **suicide** is still debated even though statistics show that nearly 50% of individuals who injure themselves also attempt suicide at some point in their lives. Many researchers think

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that suicide attempts reflect feelings of rejection or hopelessness, while self-mutilation results from feelings of shame or a need to relieve tension.

Causes and symptoms

Several different theories have been proposed to explain self-mutilation:

- self-mutilation is an outlet for strong negative emotions, especially anger or shame, that the person is afraid to express in words or discuss with others.
- self-mutilation represents anger at someone else directed against the self.
- self-mutilation relieves unbearable tension or anxiety Many self-mutilators do report feeling relief after an episode of self-cutting or other injury.
- self-mutilation is a technique for triggering the body's biochemical responses to pain. Stress and trauma release endorphins, which are the body's natural pain-killing substances
- self-mutilation is a way of stopping a dissociative episode. Dissociation is a process in which the mind splits off, or dissociates, certain memories and thoughts that are too painful to keep in conscious awareness. Some people report that they feel "numb" or "dead" when they dissociate, and self-injury allows them to feel "alive."
- self-mutilation is a symbolic acting-out of the larger culture's mistreatment of women. This theory is sometimes offered to explain why the great majority (about 75%) of self-mutilators are girls and women

The symptoms of self-mutilation typically include wearing long-sleeved or baggy clothing, even in hot weather; and an unusual need for privacy. Self-mutilators are often hesitant to change their clothes or undress around others. In most cases the person has also shown signs of depression.

Diagnosis

Self-mutilation is usually diagnosed by a psychiatrist or psychotherapist. A family practitioner or nurse who notices **scars**, **bruises**, or other physical evidence of self-injury may refer the person to a specialist for evaluation.

Treatment

Persons who mutilate themselves should seek treatment from a therapist with some specialized training and experience with this behavior. Most self-mutilators are treated as outpatients, although there are some inpatient programs, such as S.A.F.E., for adolescent females. A number of different treatment approaches are used with self-mutilators, including psychodynamic **psychotherapy**, **group therapy**, journaling, and behavioral therapy.

Although there are no medications specifically for self-mutilation, antidepressants are often given, particularly if the patient meets the diagnostic criteria for a depressive disorder.

KEY TERMS

Borderline personality disorder (BPD)—A pattern of behavior characterized by impulsive acts, intense but chaotic relationships with others, identity problems, and emotional instability.

Dissociation—The splitting off of certain mental processes from conscious awareness.

Dissociative disorders—A group of mental disorders in which dissociation is a prominent symptom. Patients with dissociative disorders have a high rate of self-mutilation.

Endorphins—Pain-killing substances produced in the human body and released by stress or trauma. Some researchers think that people who mutilate themselves are trying to trigger the release of endorphins.

Alternative treatment

Mindfulness training, which is a form of **meditation**, has been used to teach self-mutilators to observe and identify their feelings in order to have some control over them.

Prognosis

The prognosis depends on the presence and severity of other emotional disorders, and a history of **sexual abuse** and/or suicide attempts. In general, teenagers without a history of abuse or other disorders have a good prognosis. Patients diagnosed with borderline personality disorder and/or a history of attempted suicide are considered to have the worst prognosis.

Prevention

Some society-wide factors that influence self-mutilation, such as the high rate of sexual abuse of children and media stereotypes of women, are difficult to change. In general, however, young people who have learned to express themselves in words or through art and other creative activities are less likely to deal with painful feelings by injuring their bodies.

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ORGANIZATIONS

American Psychiatric Association (APA), 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209, (888) 357-7924, apa@psych.org, http://www.psych.org.

Focus Adolescent Services, P. O. Box 4514, Salisbury, MD, 21803, (410) 341-4216, http://www.focusas.com.

National Institute of Mental Health (NIMH).

Rebecca J. Frey, PhD

Semen analysis

Definition

Semen analysis evaluates a man's sperm and semen. It is done to discover cause for **infertility** and to confirm success of **vasectomy**.

Purpose

Semen analysis is an initial step in investigating why a couple has been unable to conceive a child. Abnormalities of sperm and semen can cause male infertility. Semen is the thick yellow-white male ejaculate containing sperm. Sperm are the male sex cells that fertilize the female egg (ovum). They contain the genetic information that the male will pass on to a child.

Vasectomy is an operation done to sterilize a man by stopping the release of sperm into semen. Success of vasectomy is confirmed by the absence of sperm in semen.

Description

The semen analysis test is usually done manually, though computerized test systems are available. Many laboratories base their procedures on standards published by the World Health Organization (WHO).

The volume of semen in the entire ejaculate is measured. The appearance, color, thickness, and pH is noted. A pH test looks at the range from a very acid solution to a very alkaline solution. Semen, like many other body fluids, has a standard pH range that would be considered optimal for fertilization of the egg to take place. The thick semen is then allowed to liquify; this usually takes 20-60 minutes.

KEY TERMS

Infertility—The inability of a man and woman to conceive a child after 12 months of unprotected sexual intercourse.

Morphology—The size and shape of sperm.

Motility—The movement of sperm within the semen.

Drops of semen are placed on a microscope slide and examined under the microscope. Motility, or movement, of 100 sperm are observed and graded in categories, such as rapid progressive or immotile.

The structure of sperm (sperm morphology) is assessed by carefully examining sperm for abnormalities in the size and shape in the head, tail, and neck regions. WHO standards define normal as a specimen with less than 30% abnormal forms. An alternative classification system (Kruger's) measures the dimensions of sperm parts. Normal specimens are allowed 14% or less abnormalities.

Sperm are counted by placing semen in a special counting chamber. The sperm within the chamber are counted under a microscope. White blood cells are recorded; these may indicate a reproductive tract infection. Laboratories may test for other biochemicals such as fructose, zinc, and citric acid. These are believed to contribute to sperm health and fertility.

Results of semen analysis for infertility must be confirmed by a second analysis seven days to three months after the first. Sperm counts may vary from day to day.

Semen analysis to confirm success of vasectomy is concerned only with discovering if sperm are still present. Semen is collected six weeks after surgery. If sperm are seen, another specimen is collected 2 to 4 weeks later. The test is repeated until two consecutive specimens are free of sperm.

Preparation

A man should collect an entire ejaculate, by masturbation, into a container provided by his physician. To examine the best quality sperm, the specimen must be collected after two to three days of sexual abstinence, but not more than five to seven days. The specimen must not come into contact with any spermicidal agents used by a female partner for birth control purposes. The man should not have alcohol before the test.

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A semen specimen to investigate infertility must be brought to the testing laboratory within one hour of obtaining it. Timing is not as critical for the postvasectomy test but the semen must be kept at body temperature. The most satisfactory sample is one obtained in the lab rather than at home.

Normal results

WHO standards have established these normal values:

- volume less than or equal to 2.0 mL
- sperm count greater than or equal to 20 million per mL
- motility (movement of the sperm) value is greater than or equal to 50% with forward progression, or greater than or equal to 25% with rapid progression within 60 minutes of ejaculation
- morphology greater than or equal to 30% with normal forms
- white blood cell count less than 1 million per mL.

If infertility continues, despite normal semen analysis and female studies, further tests are done to evaluate sperm function.

Abnormal results

Abnormalities of semen volume and liquidity, and sperm number and morphology decrease fertility. These abnormalities may be inherited or caused by a hormone imbalance, medications, or a recent infection. Further tests may be done to determine the cause of abnormalities.

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Nancy J. Nordenson

Senile tremor *see* **Tremors**

Seniors' health

Definition

Seniors' health refers to the physical and mental conditions of senior citizens, those who are in their 60s and older.

Senior women in a Zumba class. *(AP Images.)*

Demographics

The proportion of people age 65 years and older in the United States is on the rise and will continue to increase through 2050. As of August 14, 2008 there were 40.2 million Americans age 65 and older, 13% of the total U.S. population, according to the U.S. Census Bureau. This will grow to 88.5 million, or 20% of the total U.S. population by 2050, the Census Bureau estimates. Worldwide, there were nearly 500 million people age 65 and older as of July 1, 2007, according to the United Nations Statistics Division. This represented 7.5% of the world's estimated population of 6.6 billion.

Description

For a senior, the **aging** process and a person's lifestyle will affect health. People who maintain a healthy weight, **exercise** regularly, eat nutritionally, and do not smoke reduce the risk for many health conditions. This wellness allows people to live longer and to remain independent for more years. **Smoking**, **obesity** (excess weight), and lack of exercise shorten life and increase the risk for many health conditions. According to the Centers for Disease Control and Prevention, about 80% of people in the United States age 65 and older have at least one chronic (long-lasting) condition and 50% have two.

Diet and exercise

Proper diet and regular exercise form the foundation of senior health. A nutritional diet and physical activity can help prevent diseases such as **cancer**, **stroke**, heart disease, and diabetes. A healthy diet also can help manage diabetes, high blood pressure, and heart disease.

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Leading causes of death in persons 65 and older

Cause of death	Number of deaths	Percentage of all deaths in age group (65+)
Heart disease	496,095	28.3%
Malignant neoplasms (Cancer)	389,730	22.2%
Cerebrovascular diseases	115,961	6.6%
Chronic lower respiratory diseases	109,562	6.2%
Alzheimer's disease	73,797	4.2%
Diabetes mellitus	51,528	2.9%
Influenza and pneumonia	45,941	2.6%
Nephritis	38,484	2.2%
Unintentional injury	38,292	2.2%
Septicemia	26,362	1.5%

SOURCE: Centers for Disease Control and Prevention, National Center for Injury Prevention and Control.

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As people age, there is more of a need to exercise on a regular basis. According to the American Heart Association, the inactive person loses from 3–5% of muscle fiber each decade after age 30. That loss would total 30% of lost muscle fiber at age 60. Exercise helps to boost muscle strength. It can help improve balance and coordination, and help to prevent falls.

Organizations including the American Heart Association advise that regular physical activity helps prevent bone loss (**osteoporosis**) and the risk of conditions such as heart disease, Type II diabetes, **colon cancer**, **stress**, and depression. In addition, exercise can help extend the lives of people with conditions such as diabetes, high blood pressure, and high cholesterol. Good health later in life helps to prevent serious illness or **death** from common infections as well. If a senior catches the flu, for instance, it can have more detrimental effects than in a healthier, younger person. When the SARS outbreak occurred in 2002 and 2003, clinicians expressed concern about the elderly Americans and again expressed the importance of diet and exercise. As people age, their immune system response weakens. Seniors need to be proactive in keeping their systems strong.

Causes and symptoms

A number of health problems begin to occur as an individual ages. Early recognition of these conditions and proper treatment can improve a senior's health and longevity.

Osteoporosis

Osteoporosis is a condition in which bones become less dense (solid). Bones become brittle, thinner, and break easily. Although osteoporosis is associated with aging, it is only the risk of osteoporosis that increases as a person ages. It is linked to approximately 70% of bone **fractures** in people age 46 and older. According to the National Institutes of Health (NIH), one out of two women over age 50 and one out of eight men over 50 will experience an osteoporosis-related fracture.

Osteoporosis is associated primarily with the changes that occur to women during **menopause**. During menopause, there is a decrease in the level of estrogen, the hormone that helps maintain bone mass. Other causes of osteoporosis include lack of exercise and a diet deficient in vitamin D.

Osteoporosis is largely preventable. However, there is increasing evidence to suggest that the condition starts as far back as in the womb. If this is true, it still is preventable, but by the behavior of the mother carrying a child. More research needs to be done, but it is clear that childhood growth rates are linked to hip fractures that happen decades later.

Osteoarthritis

Osteoarthritis is a joint disease in which cartilage wears out and bones rub against each other. This condition can occur gradually over time as activities performed throughout the years cause wear on joints. In addition, bones thin as a person ages.

Excess weight and injuries can aggravate this condition. About 16 million Americans experience some form of osteoarthritis. It generally affects the neck, fingers, lower back, knees, and toes. Symptoms include **pain**, stiffness, swelling, and creaking. The pain may disrupt sleep, and joint stiffness may make it difficult for a person to dress.

Falls

More than two million Americans each year fall and experience serious injuries, according to the American Academy of Otolaryngology-Head and Neck Surgery. For seniors, fall-related injuries can reduce mobility and hinder independence.

As people age, their reflexes slow down so it may be more difficult to prevent a fall. Deteriorating vision and hearing can affect balance, which can cause an accidental fall. Furthermore, conditions such as arthritis, **dizziness**, and sleeping disorders can increase the likelihood of a fall. In addition, a person may fall at the start of a condition such as a stroke or **heart attack**.

Falls can result in broken bones or fractures because bones are weakened by osteoporosis. In addition, healing takes longer. Head injuries could affect

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sight and hearing. Injuries sustained during falls could reduce an active person's mobility and independence.

Vision

Eyesight changes as people age. Generally, people are in their 40s when they experience **presbyopia**, a form of farsightedness. This is a progressive condition involving a decrease in the eye's ability to focus on close objects (near vision). By age 65, little near focusing ability remains.

Glaucoma is a condition caused by pressure from the build-up of a large amount of fluid in the eye. This progressive condition is often seen in people in their fifties. It starts with the gradual loss of peripheral vision. If not treated, it can lead to some vision loss.

People in their sixties may experience the first signs of age-related **macular degeneration** (AMD). It is a progressive condition affecting the retina. The macula in the retina distinguishes detail. Degeneration in the macula could cause scarring and a gradual reduction in vision. The person experiences a circle of blindness, an area of sightlessness that grows as the condition progress.

More than half of people age 65 or older will be diagnosed with **cataracts**. Cataract refers to the loss of the transparency in the lens of the eye. As the loss progresses, the person is able to see less detail. This condition generally affects both eyes.

Hearing

Presbycusis, age-related **hearing loss**, is a progressive condition. It usually starts with a difficulty in hearing high-frequency sound such as people talking. A senior has less trouble with low-frequency tones. Background noise makes it even more difficult to hear. Presbycusis affects approximately 25% of people between the ages of 65 and 75 and half of those over 75. Many people diagnosed with this condition say they have lost hearing in both ears. They also report feelings of dizziness and that they experience a ringing in their ears.

Sleep disorders

Sleep patterns change when a person ages. Many people in their sixties and seventies experience less time in the stages of deep sleep known as delta sleep. Despite this change, many healthy older people do not experience **sleep disorders**. Overall health plays a role in whether a senior experiences trouble sleeping.

Obesity is linked to **snoring** and **sleep apnea**. Snoring can turn into apnea. A person with apnea stops breathing for up to one minute until the brain restarts the breathing process. This action could be repeated several hundred times each night.

Furthermore, a senior's sleep can be disrupted by conditions such as arthritis, osteoporosis, and **Alzheimer's disease**. **Insomnia**, or the inability to stay asleep, is a symptom of conditions including depression, **anxiety**, chronic pain, and **restless legs syndrome** (RLS).

RLS involves movement of legs when a person is at rest. The person moves legs in response to a **tingling** sensation in the upper leg, calf, or foot. In other cases, legs move involuntarily. Sensations that trigger movement can re-occur within seconds.

A person with RLS is likely to have PLMD (periodic limb movement disorder). A sleeping person with this condition kicks their legs or moves their arms repeatedly. These involuntary movements can last from 20 seconds to an hour. Approximately 45% of the elderly have a mild form of PLMD, according to the National Sleep Foundation.

The cause of these disorders is not known. They are thought to be caused by a chemical reaction in the brain. In addition, the conditions may be hereditary.

Mental health

While age has little effect on the mind, social and emotional factors affect an older person's health. After a lifetime of work or raising a family, retirement brings several challenges. A person who has been identified for years by a profession may experience a sense of lost identity.

A senior may find that the thinking process has changed. Learning something new may take longer. However, older people have excellent recall of new information.

Memory loss may be a concern, particularly since this is a symptom of Alzheimer's disease.

Dementia

Alzheimer's disease is a form of **dementia**, a condition in which mental abilities decline. Symptoms of dementia include memory loss that goes beyond forgetting a word or where an item was placed. The person with dementia may never recognize family members or remember how to perform functions such as preparing a meal. Sometimes they experience a change in personality, with some uncharacteristic aggression or **paranoia**.

Alzheimer's disease is the most prevalent form of dementia. Although the cause of this condition is not known, the risk of Alzheimer's increases as a person ages. In 2010, the condition affected one in eight people

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over the age of 65. The ratio rises to one in three people age 85 and older.

Alzheimer's is a progressive condition. In most cases, after five to eight years, a patient with this condition is unable to perform basic functions. There is no known cure for Alzheimer's. However, as of 2008, the U.S. Food and Drug Administration (FDA) approved five medications that could help delay the degenerative process.

Precautions

A health condition may result in a doctor recommending against some forms of exercise. Even if a person cannot jog, other forms of exercise include those designed for people in wheelchairs and those who are bedridden.

Treatment

The cost of treatment varies. Cost of medical treatment is determined by the type of procedure and whether a person has medical insurance. Health plan and Medicare coverage and copayments impact an individual's cost for various preventions and treatments.

Osteoporosis

Prevention is the best method of treating osteoporosis. Methods of preventing osteoporosis include regular weight-bearing exercise such as walking, jogging, weight lifting, **yoga**, and stair climbing.

People should not smoke since smoking makes the body produce less estrogen. Care should be taken to avoid falling.

Diet should include 1,000–1,300 mg of **calcium** each day. Sources of calcium include:

- leafy, dark-green vegetables such as spinach, kale, mustard greens, and turnip greens
- low-fat dairy products such as milk, yogurt, and cheeses such as cheddar, Swiss, mozzarella, and parmesan; also foods made with milk such as pudding and soup
- canned fish such as salmon, sardine, and anchovies
- tortillas made from lime-processed corn
- tofu processed with calcium-sulfate
- calcium and vitamin D tablets

An x ray can indicate bone loss when much of the density has decreased. A more effective way of detecting osteoporosis is the DEXA-scan (dual-energy x-ray absorbtiometry). This whole-body scan indicates whether a person is at risk for fractures. It could be useful for people at risk for osteoporosis as well as women near the age of menopause or older. People should ask their doctors about whether this test is needed.

During menopause, a woman loses estrogen. A pill or skin patch containing estrogen and progesterone eases symptoms of menopause has been used to treat osteoporosis. This treatment is known as **hormone replacement therapy** (HRT). In 2002, the Women's Health Initiative found that HRT produced harmful effects in postmenopausal women, including increased incidence of **breast cancer**, heart disease, and dementia. The effects were bad enough to stop the study. Women and physicians are advised to closely weigh the risks and benefits of hormone therapy.

Several drugs are available to help reduce the risk of fractures in seniors with osteoporosis. In 2003, the FDA approved a new treatment option called Teriparatide. Some alternative treatments show promise in studies, including SAMe, (S-adenosylmethionine). Long-term safety and effectiveness of SAMe have yet to be established. Another treatment option for menopause and osteoporosis is Raloxifene, a medication that may cause **blood clots**.

Osteoarthritis

Treatments for osteoarthritis range from preventative measures such as walking to **joint replacement** surgery. Treatment costs vary from no cost for soaking a joint in cold water, the price of over-the-counter remedies, to fees for surgery.

If osteoarthritis is suspected, a doctor's diagnosis will include an assessment of whether joint pain is part of a patient's medical history. The doctor may take an x ray to determine the presence of cartilage loss and how much degeneration occurred.

Over-the-counter (OTC) remedies such as **aspirin** and ibuprofen and salves containing capsaicin can be helpful. A doctor may recommend anti-inflammatory medications.

In cases of severe osteoarthritis, joint replacement surgery or joint **immobilization** may be required. Joints are replaced with metal, plastic, or ceramic material.

The Arthritis Foundation recommends several remedies for easing pain. To treat inflammation, a person should use a cold treatment. Methods include soaking the affected area in cold water or applying an ice pack. To soothe aches and stimulate circulation, a person applies heat to the affected area for 20 minutes. This should be done three times a day.

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Acupuncture may be helpful in treating mild osteoarthritis. Generally, a person should have one to two treatments a week for several weeks. Afterward, one treatment is recommended. An assessment of results should be made after 10 treatments.

Preventive and maintenance remedies include low-impact exercise such as swimming and walking, along with maintaining proper posture. Nutritional aids include foods rich in vitamin C such as citrus fruits and broccoli. Daily consumption of 400 IU of Vitamin E is recommended. Cutting back on fats, sugar, salt, cholesterol, and alcohol helps relieve the symptoms of osteoarthritis.

Fall prevention

Fall prevention starts with regular exercise such as walking. This improves balance and muscles. The walk route should be on level ground. Other methods for preventing falls include:

- moving slowly when rising from a chair or bed to avoid dizziness
- quitting smoking
- wearing shoes with low heels and rubber soles
- monitoring medications because of side effects that increase the probability of a fall
- checking vision and hearing periodically
- fall-proofing the home, including the installation of lighting, especially on stairways, clearing clutter and electrical cords that can cause falls, and installing handrails and strips in bathtubs and rails on stairs

After a fall, a senior may need **first aid** treatment for cuts or fractures. The doctor may evaluate whether medications cause balance problems. If indicated, the doctor may examine the patient's central nervous system function, balance, and muscle/joint function. A hearing or vision test may be ordered.

Corrective measures include adjusting prescriptions, vision surgery or having the patient use a cane or walker.

Vision

A person diagnosed with presbyopia may need bifocals or reading glasses to read print that appears too small. These lenses may need to be changed as vision changes over the years. Eventually, a person relies on glasses to focus on items that are near. Other seniors who never needed corrective lenses may need to wear eyeglasses. Publishers aware of this condition produce books with large print.

A senior should schedule periodic vision exams because early treatment helps prevent or lessen a risk of cataracts or glaucoma. Diet also plays a role in vision care. Dark green vegetables like broccoli are said to help prevent cataracts from progressing. Physical exercise is thought to reduce the pressure associated with glaucoma.

Glaucoma can be treated with eye drops. For cataracts, surgery can remove the affected lens and replace it with a permanent synthetic lens called an intraocular lens. Macular degeneration is the leading cause of vision loss and blindness in Americans age 65 and older, affecting 1.75 million Americans. There are two types of macular degeneration: wet and dry. There was no successful treatment for dry macular degeneration as of 2008 but there are three FDA-approved medications for treating wet macular degeneration.

Hearing

An audiologist can administer tests to determine the amount of hearing loss. Although there is no cure for presbycusis, **hearing aids** can help a senior affected by age-related hearing loss. If this treatment is not effective, the person might need to learn to read lips.

Sleep disorders

Losing weight can help with conditions such as snoring and sleep apnea. A doctor may advise the senior to quit smoking, reduce alcohol consumption, or to sleep on his or her side. In some cases, a doctor may refer the senior to a sleep disorder clinic. The senior may be prescribed a continuous positive airway pressure device. Known as a CPAP, the device is placed over the nose and administers a continuous flow of air.

PLMD and restless leg syndrome may be treated with the prescription drugs Dopar, Requip, and Mirapex. These disorders could be signs of kidney or circulation conditions. Treatment of those conditions should end these sleeping disorders.

Insomnia treatments include exercising and treating depression, stress, and other causes of sleeplessness.

Mental health

After retirement, a senior must find activities and interests to provide a sense of fulfillment. Otherwise, feelings of loneliness and isolation can lead to depression and susceptibility to poor health.

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Activities that stimulate a person physically and intellectually contribute to good health. A senior can start an exercise program, take up hobbies, take classes, or volunteer. Senior centers offer numerous activities. Lunch programs provide nutritional meals and companionship. This is important because a senior living alone may not feel motivated to prepare healthy meals.

Dementia

Diagnosis of Alzheimer's disease starts with a thorough medical examination. The doctor should administer memory tests. Blood tests may be required, as well as a CT scan or MRI scan of the brain. If Alzheimer's is diagnosed, the doctor may prescribe medication to slow down progression of this form of dementia.

As of 2007, the FDA had approved five prescription medications for treatment of Alzheimer's Disease (AD). Tacrine, donepezil, riviastigmine, and galantamine are cholinesterase inhibitors that enhance memory. Modest improvement was reported in clinical trials on donepezil, riviastigmine, and galantamine. Tacrine's possible side effects include liver damage, so it is seldom prescribed. Namenda (memantine) is approved for moderate to severe AD. It is in a class of drugs called N-methyl D-aspertate (NMDA) antagonists.

Prognosis

Some recovery time may be needed after surgery. However, a healthy person will heal more quickly. A senior needs to maintain a schedule of regular exercise in order to remain mobile. Otherwise, a minor illness could make them dependent on others for daily care, according to the American Heart Association.

If mobility becomes limited due to a condition such as osteoarthritis, equipment like a walker and devices that make it easier to open bottles and grip cutlery can be helpful.

Exercising too long or too strenuously can be physically harmful. The over-exertion could cause the person to lose interest in exercise and put off establishing a regular routine. Experts recommend starting out slowly and building up to more intense or longer sessions. This is particularly important for a sedentary person.

Seniors who stay active and eat healthy are at less risk for conditions such as diabetes. A senior should seek mental stimulation and social interaction, which provide enjoyment, boost self-esteem, and help reduce feelings of isolation and depression. Although eyesight and hearing will weaken, glasses and hearing aids help seniors keep the senses of sight and hearing.

When surgery is required for osteoarthritis, hip replacement surgery is extremely successful. In about 98% of surgeries, flexibility returns and pain is eased. Knee replacement surgery also is effective.

If a person maintains a healthy lifestyle, the ability to avoid falls and recover from them is increased.

After a fall, seniors need to build up physical strength and confidence so they do not fear falling again. Care should be taken so that seniors do not feel isolated by their injuries. Isolation could lead to decreased mobility and loss of independence.

There is no cure for Alzheimer's disease. However, several medications have proved moderately effective in stopping memory loss. Since Alzheimer's is progressive, a person diagnosed with this condition should make arrangements for the future. Finances should be taken care of and plans should be made for future care. Family should be brought into the discussion.

After diagnosis, a person should stay active for as long as possible. Not only does this help with enjoying this stage of life, activities can help to fight depression. Alzheimer and other support groups can be helpful. In addition, modifications to environment can be effective.

Prevention

Nutrition

Nutrition plays an important role in senior health. Not only does a well-balanced diet keep a person from becoming obese, that same diet is a safeguard against health conditions that seniors face. Proper diet can help prevent a condition like diabetes or keep it from worsening.

The senior diet should consist of foods that are low in fat, particularly saturated fat and cholesterol. A person should choose foods that provide nutrients such as iron and calcium. Other healthy menu choices include:

- fish, skinless poultry, and lean meat
- proteins such as dry beans (red beans, navy beans, and soybeans), lentils, chickpeas, and peanuts
- low-fat dairy products
- vegetables, especially those that are dark green and leafy

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- citrus fruits or juices, melons, and berries
- whole grains like wheat, rice, oats, corn, and barley
- whole grain breads and cereals

Exercise

Physical activity should be rhythmic, repetitive, and should challenge the circulatory system. It also should be enjoyable so that a senior gets in the habit of exercising regularly for 30 minutes each day. It may be necessary to check with a doctor to determine the type of exercise that can be done.

Walking is recommended for weight loss, stress release, and many other conditions. Brisk walking is said to produce the same benefits as jogging. Other forms of exercise can include gardening, bicycling, hiking, swimming, dancing, skating, or ice-skating. If weather prohibits outdoor activities, a person can work out indoors with an exercise video.

Exercise also offers a chance to socialize. In some cities, groups of seniors meet for regular walks at shopping malls. Senior centers offer exercise classes ranging from line dancing to belly dancing.

Costs for exercise range from the price of walking shoes to the fees for joining a gym.

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American Academy of Otolaryngology—Head and Neck Surgery, 1650 Diagonal Road, Alexandria, VA, 22314-2857, (703) 836-4444, http://www.entnet.org.

American Dietetic Association, 120 S. Riverside Plaza, Suite 2000, Chicago, IL, 60606-6995, (312) 899-0040, (800) 877-1600, http://www.eatright.org/.

American Heart Association, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org, http://www.americanheart.org.

Division of Aging and Seniors, Health Canada, Public Health Agency of Canada 1908A1, Ottawa, Canada, Ontario, K1A 0K9, (613) 952-7606, (613) 957-9938, (800) 267-1245, seniors-aines@phac-aspc.gc.ca, http://www.phac-aspc.gc.ca/seniors-aines.

Foundation for Health in Aging, 350 Fifth Avenue, Suite 801, New York, NY, 10118, (212) 755-6810, http://www.healthinaging.org.

Meals on Wheels Association of America, 203 South Union, Alexandria, VA, 22314, (703) 548-55580, http://www.mowaa.org.

National Institute on Aging, Building 31, Room 5C27, 31 Center Dr., Bethesda, MD, 20892, (800) 222-2225, http://www.nia.nih.gov.

National Osteoporosis Foundation, 1150 17th St., NW, Suite 850, Washington, DC, 20036, (800) 231-4222, http://www.nof.org.

United States Administration on Aging, 330 Independence Avenue, SW, Washington, DC, 20201, (202) 619-07240, http://www.aoa.gov.

United States Department of Agriculture Food and Nutrition Information Center, 10301 Baltimore Avenue, Department of Agriculture, Beltsville, MD, 20705-2351, (301) 504-57190, http://www.nal.usda.gov.

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Sensory hearing loss *see* **Hearing loss**

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Sensory integration disorder

Definition

Sensory integration disorder or dysfunction (SID) is a neurological disorder that results from the brain's inability to integrate certain information received from the body's five basic sensory systems. These sensory systems are responsible for detecting sights, sounds, smell, tastes, temperatures, **pain**, and the position and movements of the body. The brain then forms a combined picture of this information in order for the body to make sense of its surroundings and react to them appropriately. The ongoing relationship between behavior and brain functioning is called sensory integration (SI), a theory that was first pioneered by A. Jean Ayres, Ph.D., OTR in the 1960s.

Description

Sensory experiences include touch, movement, body awareness, sight, sound, smell, taste, and the pull of gravity. Distinguishing between these is the process of sensory integration (SI). While the process of SI occurs automatically and without effort for most, for some the process is inefficient. Extensive effort and attention are required in these individuals for SI to occur, without a guarantee of it being accomplished. When this happens, goals are not easily completed, resulting in sensory integration disorder (SID).

The normal process of SI begins before birth and continues throughout life, with the majority of SI development occurring before the early teenage years. The ability for SI to become more refined and effective coincides with the **aging** process as it determines how well motor and speech skills, and emotional stability develop. The beginnings of the SI theory by Ayres instigated ongoing research that looks at the crucial foundation it provides for complex learning and behavior throughout life.

Causes and symptoms

The presence of a sensory integration disorder is typically detected in young children. While most children develop SI during the course of ordinary childhood activities, which helps establish such things as the ability for motor planning and adapting to incoming sensations, others' SI ability does not develop as efficiently. When their process is disordered, a variety of problems in learning, development, or behavior become obvious.

Those who have sensory integration dysfunction may be unable to respond to certain sensory information by planning and organizing what needs to be done in an appropriate and automatic manner. This may cause a primitive survival technique called "fright, flight, and fight," or withdrawal response, which originates from the "primitive" brain. This response often appears extreme and inappropriate for the particular situation.

The neurological disorganization resulting in SID occurs in three different ways: the brain does not receive messages due to a disconnection in the neuron cells; sensory messages are received inconsistently; or sensory messages are received consistently, but do not connect properly with other sensory messages. When the brain poorly processes sensory messages, inefficient motor, language, or emotional output is the result.

According to Sensory Integration International (SII), a non-profit corporation concerned with the impact of sensory integrative problems on people's lives, the following are some signs of sensory integration disorder (SID):

- oversensitivity to touch, movement, sights, or sounds
- underreactivity to touch, movement, sights, or sounds
- tendency to be easily distracted
- social and/or emotional problems
- activity level that is unusually high or unusually low
- physical clumsiness or apparent carelessness
- impulsive, lacking in self-control
- difficulty in making transitions from one situation to another
- inability to unwind or calm self
- poor self concept
- delays in speech, language, or motor skills
- delays in academic achievement

While research indicates that sensory integrative problems are found in up to 70% of children who are considered learning disabled by schools, the problems of sensory integration are not confined to children with learning disabilities. SID transfers through all age groups, as well as intellectual levels and socioeconomic groups. Factors that contribute to SID include: premature birth; **autism** and other developmental disorders; learning disabilities; delinquency and **substance abuse** due to learning disabilities; stress-related disorders; and brain injury. Two of the biggest contributing conditions are autism and attention-deficit hyperactivity disorder (**ADHD**).

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Diagnosis

In order to determine the presence of SID, an evaluation may be conducted by a qualified occupational or physical therapist. An evaluation normally consists of both standardized testing and structured observations of responses to sensory stimulation, posture, balance, coordination, and eye movements. These test results and assessment data, along with information from other professionals and parents, are carefully analyzed by the therapist who then makes recommendations about appropriate treatment.

Treatment

Occupational therapists play a key role in the conventional treatment of SID. By providing sensory integration therapy, occupational therapists are able to supply the vital sensory input and experiences that children with SID need to grow and learn. Also referred to as a "sensory diet," this type of therapy involves a planned and scheduled activity program implemented by an occupational therapist, with each "diet" being designed and developed to meet the needs of the child's nervous system. A sensory diet stimulates the "near" senses (tactile, vestibular, and proprioceptive) with a combination of alerting, organizing, and calming techniques.

Motor skills training methods that normally consist of adaptive physical education, movement education, and gymnastics are often used by occupational and physical therapists. While these are important skills to work on, the sensory integrative approach is vital to treating SID.

The sensory integrative approach is guided by one important aspect—the child's motivation in selection of the activities. By allowing them to be actively involved, and explore activities that provide sensory experiences most beneficial to them, children become more mature and efficient at organizing sensory information.

Alternative treatment

Sensory integration disorder (SID) is treatable with **occupational therapy**, but some alternative methods are emerging to complement the conventional methods used for SID.

Therapeutic body brushing is often used on children (not infants) who overreact to tactile stimulation. A specific non-scratching surgical brush is used to make firm, brisk movements over most of the body, especially the arms, legs, hands, back and soles of the feet. A technique of deep joint compression follows the brushing. Usually begun by an occupational therapist, the technique is taught to parents who need to complete the process for three to five minutes, six to eight times a day. The time needed for brushing is reduced as the child begins to respond more normally to touch. In order for this therapy to be effective, the correct brush and technique must be used.

KEY TERMS

Axon—A process of a neuron that conducts impulses away from the cell body. Axons are usually long and straight.

Cortical—Regarding the cortex, or the outer layer of the brain, as distinguished from the inner portion.

Neurotransmission—When a neurotransmitter, or chemical agent released by a particular brain cell, travels across the synapse to act on the target cell to either inhibit or excite it.

Proprioceptive—Pertaining to proprioception, or the awareness of posture, movement, and changes in equilibrium and the knowledge of position, weight, and resistance of objects as they relate to the body.

Tactile—The perception of touch.

Vestibular—Pertaining to the vestibule; regarding the vestibular nerve of the ear which is linked to the ability to hear sounds.

A report in 1998 indicated the use of cerebral electrical stimulation (CES) as being helpful to children with conditions such as moderate to severe autistic spectrum disorders, learning disabilities, and sensory integration dysfunction. CES is a modification of Transcutaneous **Electrical Nerve Stimulation** (TENS) technology that has been used to treat adults with various pain problems, including arthritis and **carpal tunnel syndrome**. TENS therapy uses a low voltage signal applied to the body through the skin with the goal of replacing painful impressions with a massage-like sensation. A much lower signal is used for CES than that used for traditional TENS, and the electrodes are placed on the scalp or ears. Occupational therapists who have studied the use of CES suggest that CES for children with SID can result in improved brain activity. The device is worn by children at home for 10 minutes at a time, twice per day.

Music therapy helps promote active listening. Hypnosis and **biofeedback** are sometimes used, along with **psychotherapy**, to help those with SID, particularly older patients.

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Prognosis

By providing treatment at an early age, sensory integration disorder may be managed successfully. The ultimate goal is for the individual to be better able to interact with his or her environment in a more successful and adaptive way.

Resources

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Sensory Integration International. http://www.sensoryint.com.
Sensory Integration Network. http://www.sinetwork.org.

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Sepsis

Definition

Sepsis refers to a bacterial infection in the bloodstream or body tissues. This very broad term covers the presence of many types of microscopic disease-causing organisms.

Demographics

In the general population, the incidence of sepsis is two people in 10,000. The number of deaths from sepsis each year has almost doubled in the United States since 1980 because more patients are developing the condition. There are three major factors responsible for this increase: a rise in the number of organ transplants and other surgical procedures that require suppressing the patient's immune system; the greater number of elderly people in the population; and the overuse of **antibiotics** to treat infectious illnesses, resulting in the development of drug-resistant bacteria.

Description

Sepsis is also called **bacteremia**. Closely related terms include septicemia and septic syndrome. In sepsis, there is active multiplication of bacteria in the bloodstream which may or may not result in organ dysfunction. If sepsis is not promptly recognized and treated, pulmonary, hepatic, and renal function may be impaired.

KEY TERMS

Bacteremia—The medical term for sepsis.

Prophylactic—Referring to medications or other treatments given to prevent disease.

Causes and symptoms

Sepsis can originate anywhere bacteria can gain entry to the body. Common sites include the genitourinary tract, the liver and its bile ducts, the gastrointestinal tract, and the lungs. Broken or ulcerated skin can also provide access to bacteria commonly present in the environment. Invasive medical procedures, including dental work, can introduce bacteria or permit them to accumulate in the body. Entry points and equipment left in place for any length of time present a particular risk. **Heart valve replacement**, catheters, **ostomy** sites, intravenous (IV) or arterial lines, surgical **wounds**, or surgical drains are examples. IV drug users are at high risk as well.

People with inefficient immune systems, such as those with HIV infection; spinal cord injuries; or blood disorders are at particular risk for sepsis and have a higher **death** rate (up to 60%). In people who have no underlying chronic disease, the death rate is far lower (about five percent). The growing problem of antibiotic resistance has increased the incidence of sepsis, partly because ordinary preventive measures (such as prophylactic antibiotics) are less effective.

Cancer patients are at an increased risk of developing sepsis because **chemotherapy** and other forms of treatment for cancer weaken their immune systems.

The most common symptom of sepsis is **fever**, often accompanied by chills or shaking, or other flu-like symptoms. A history of any recent invasive procedure or dental work should raise the suspicion of sepsis and medical help should be sought promptly.

Diagnosis

An accurate and detailed patient history is helpful in determining the source of the sepsis and in designing an appropriate course of treatment.

The presence of sepsis is indicated by blood tests showing particularly high or low white blood cell counts. The causative agent is determined by **blood culture**.

In some cases the doctor may order imaging studies to rule out **pneumonia**, or to determine whether

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the sepsis has developed from a ruptured appendix or other leakage from the digestive tract into the abdomen.

Treatment

Identifying the specific causative agent ultimately determines how sepsis is treated. However, time is of the essence, so a broad-spectrum antibiotic or multiple antibiotics will be administered until blood cultures reveal the culprit and treatment can be designed specific to the organism. Intravenous antibiotic therapy is usually necessary and is administered in a hospital setting.

Prognosis

The prognosis associated with sepsis is dependent on several factors such as the general condition of the patient, including the patient's immune status, and early recognition and initiation of prompt, appropriate treatment of the cause of the sepsis.

In severe cases, the patient's chances of survival are enhanced by rapid admission to an intensive care unit followed by aggressive treatment with antibiotics and by careful monitoring of response to treatment.

Prevention

Prompt recognition and appropriate treatment of bacterial infections can often prevent the progression of bacteremia to sepsis.

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American College of Epidemiology (ACE), 1500 Sunday Dr., Suite 102, Raleigh, NC, 27607, (919) 861-5573, http://www.acepidemiology.org.

American Public Health Association (APHA), 800 I St. NW, Washington, DC, 20001-3710, (202) 777-APHA, http://www.apha.org.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Rd., Atlanta, GA, 30333, (800) 232-4636, http://www.cdc.gov.

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Sepsis syndrome *see* **Septic shock**

Septal deviation *see* **Deviated septum**

Septic arthritis *see* **Infectious arthritis**

Septic shock

Definition

Septic shock is a potentially lethal drop in blood pressure due to the presence of bacteria in the blood.

Demographics

The incidence of septic shock in the United States continues to increase. Approximately 200,000 cases of septic shock are documented annually in the United States with 100,000 deaths caused by the condition. In the last ten years, the mortality rate from septic shock has declined. Individuals most susceptible to septic shock are people over the age of 60 years.

Description

Septic shock is a possible consequence of **bacteremia**, or bacteria in the bloodstream. Bacterial toxins, and the immune system response to them, cause a dramatic drop in blood pressure, preventing the delivery of blood to the organs. Septic shock can lead to multiple organ failure including **respiratory failure**, and may cause rapid **death**. **Toxic shock syndrome** is one type of septic shock.

Causes and symptoms

During an infection, certain types of bacteria can produce and release complex molecules, called cytokines (previously referred to as endotoxins), that may provoke a dramatic response by the body's immune system. Released in the bloodstream, cytokines are particularly dangerous, because they become widely dispersed and affect the blood vessels themselves. The most critical

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hemodynamic manifestation of septic shock is vasodilation of the arteries. Arteries and the smaller arterioles open wider, increasing the total volume of the circulatory system. At the same time, the walls of the blood vessels become leaky, allowing fluid to seep out into the tissues, lowering the amount of fluid left in circulation. This combination of increased system volume and decreased fluid causes a dramatic decrease in blood pressure and reduces the blood flow to the organs. Other changes brought on by immune response may cause coagulation of the blood in the extremities, which can further decrease circulation through the organs.

Septic shock is seen most often in patients with suppressed immune systems and is usually due to bacteria acquired during treatment at the hospital. The immune system is suppressed by drugs used to treat **cancer**, **autoimmune disorders**, organ transplants, and diseases of immune deficiency such as **AIDS**. **Malnutrition**, chronic drug **abuse**, and long-term illness increase the likelihood of succumbing to bacterial infection. Bacteremia is more likely with preexisting infections such as urinary or gastrointestinal tract infections, or skin ulcers. Bacteria may be introduced to the blood stream by surgical procedures, catheters, or intravenous equipment.

Toxic shock syndrome most often occurs in menstruating women using highly absorbent tampons. Left in place longer than other types, these tampons provide the breeding ground for *Staphylococcus* bacteria, which may then enter the bloodstream through small tears in the vaginal lining. The incidence of toxic shock syndrome has declined markedly since this type of tampon was withdrawn from the market.

Symptoms

Septic shock is usually preceded by bacteremia, which is marked by **fever**, malaise, chills, and **nausea**. The first sign of shock is often confusion and decreased consciousness. In this beginning stage, the extremities are usually warm. Later, they become cool, pale, and bluish. Fever may give way to lower than normal temperatures later on in **sepsis**.

Other symptoms include:

- rapid heartbeat
- shallow, rapid breathing
- decreased urination.
- reddish patches in the skin

Septic shock may progress to cause adult respiratory distress syndrome, in which fluid collects in the lungs, and breathing becomes very shallow and labored. This condition may lead to ventilatory collapse, in which the patient can no longer breathe adequately without assistance.

KEY TERMS

Bacteremia—Invasion of the bloodstream by bacteria.

Diagnosis

Diagnosis of septic shock is made by measuring blood pressure, heart rate, and respiration rate, as well as by a consideration of possible sources of infection. Central venous pressure and cardiac output may be monitored with a catheter device inserted into the pulmonary artery supplying the lungs (Swan–Ganz catheter). Blood cultures are done to determine the type of bacteria responsible. The levels of oxygen, carbon dioxide, and acidity in the blood are also monitored to assess changes in respiratory function.

Treatment

Septic shock is considered a medical emergency and is treated initially with a combination of **antibiotics** and fluid replacement administered intravenously, often in large amounts. The antibiotic is chosen based on the bacteria present, although two or more types of antibiotics may be used initially until the specific organism is identified. Intravenous fluids, either blood or protein solutions, replace the fluid lost by leakage. Coagulation and hemorrhage may be treated with transfusions of plasma or platelets. Dopamine may be given to increase blood pressure further if necessary.

Respiratory distress is treated with mechanical ventilation and supplemental oxygen, either using a nosepiece or a tube into the trachea inserted through the throat.

Rapid identification and treatment of the primary infection site is critical to prevent ongoing proliferation of bacteria.

Prognosis

Septic shock is most likely to develop in the hospital, since it follows infections which are likely to be the objects of treatment. Because of this fact, careful monitoring and early, aggressive therapy can minimize the likelihood of progression. Nonetheless, the mortality rate from septic shock remains high and death occurs in at least 40–75% of all cases.

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The likelihood of recovery from septic shock depends on many factors, including the degree of immunosuppression of the patient, underlying disease, promptness of treatment, and type of bacteria responsible. Mortality is highest in the very young and the elderly, those with persistent or recurrent infection, and those with compromised immune systems.

Prevention

The risk of developing septic shock can be minimized through treatment of underlying bacterial infections, and prompt attention to signs of bacteremia. In the hospital, scrupulous aseptic technique on the part of medical professionals lowers the risk of introducing bacteria into the bloodstream.

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American College of Epidemiology (ACE), 1500 Sunday Dr., Suite 102, Raleigh, NC, 27607, (919) 861-5573, http://www.acepidemiology.org.

American Public Health Association (APHA), 800 I St. NW, Washington, DC, 20001-3710, (202) 777-APHA, http://www.apha.org.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Rd., Atlanta, GA, 30333, (800) 232-4636, http://www.cdc.gov.

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Septoplasty

Definition

Septoplasty is a surgical procedure to correct the shape of the septum of the nose. The nasal septum is the separation between the two nostrils. In adults, the septum is composed partly of cartilage and partly of bone.

Purpose

Septoplasty is performed to correct a crooked (deviated) or dislocated septum, often as part of **plastic surgery** of the nose (**rhinoplasty**). The nasal septum has three functions: to support the nose, regulate air flow, and support the mucous membranes (mucosa) of the nose. Septoplasty is done to correct the shape of the nose caused by a deformed septum or correct deregulated air flow caused by a **deviated septum**. Septoplasty is often needed when the patient is having an operation to reduce the size of the nose (reductive rhinoplasty), because this operation usually reduces the amount of breathing space in the nose.

Septoplasty may also be done as a follow-up procedure following facial trauma, as the nose is frequently broken or dislocated by blows to the face resulting from automobile accidents, criminal assaults, or **sports injuries**.

Precautions

Septoplasty is ordinarily not performed within six months of a traumatic injury to the nose.

Description

Septoplasties are performed in the hospital with a combination of local and intravenous anesthesia. In some cases, hypnosis has been successfully used as anesthesia. After the patient is anesthetized, the surgeon makes a cut (incision) in the mucous tissue that covers the part of the septum that is made of cartilage. The tissue is lifted, exposing the cartilage and bony part of the septum. Usually, one side of the mucous tissue is left intact to provide support during healing. Cartilage is cut away as needed.

As the surgeon cuts away the cartilage, deformities tend to straighten themselves out, reducing the amount of cartilage that must be cut. Once the cartilage is cut, bony deformities can be corrected. For most patients, this is the extent of the surgery required to improve breathing through the nose and correct deformities. Some patients have bony obstructions at the base of the nasal chamber and require further surgery. These obstructions include bony spurs and ridges that contribute to drying, ulceration, or bleeding of the mucous tissue that covers the inside of the nasal passages. In these cases, the extent of the surgery depends on the nature of the deformities that need correcting.

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KEY TERMS

Cartilage—A tough, elastic connective tissue found in the joints, outer ear, nose, larynx, and other parts of the body.

Rhinoplasty—Plastic surgery of the nose.

Septum (plural, septa)—The dividing partition in the nose that separates the two nostrils. It is composed of bone and cartilage.

Splint—A thin piece of rigid material that is sometimes used during nasal surgery to hold certain structures in place until healing is underway.

During surgery, the patient's own cartilage that has been removed can be reused to provide support for the nose if needed. External septum supports are not usually needed. Splints may be needed occasionally to support cartilage when extensive cutting has been done. External splints can be used to support the cartilage for the first few days of healing. Tefla gauze is inserted in the nostril to support the flaps and cartilage and to absorb any bleeding or mucus.

A newer option for closing perforations in the septum is a button made of Silastic, a compound of silicone and rubber.

Preparation

Before performing a septoplasty, the surgeon will evaluate the difference in airflow between the two nostrils. In children, this assessment can be done very simply by asking the child to breathe out slowly on a small mirror held in front of the nose.

As with any other operation under **general anesthesia**, patients are evaluated for any physical conditions that might complicate surgery and for any medications that might affect blood clotting time.

Aftercare

Patients with septoplasties are usually sent home from the hospital later the same day or the morning after the surgery. All **dressings** inside the nose are removed before the patient leaves. Aftercare includes a list of detailed instructions for the patient that focus on preventing trauma to the nose.

Risks

The risks from a septoplasty are similar to those from other operations on the face: postoperative **pain** with some bleeding, swelling, bruising, or discoloration. A few patients may have allergic reactions to the anesthetics. The operation in itself, however, is relatively low-risk in that it does not involve major blood vessels or vital organs. Infection is unlikely if proper surgical technique is observed.

Results

Normal results include improved breathing and airflow through the nostrils, and an acceptable outward shape of the nose.

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American Academy of Facial Plastic and Reconstructive Surgery (AAFPRS), 310 South Henry Street, Alexandria, VA, 22314, (703) 299-9291, info@aafprs.org, http://www.aafprs.org/.

American Society of Plastic Surgeons, 444 E. Algonquin Rd, Arlington Heights, IL, 60005, (847) 228-9900, http://www.plasticsurgery.org/.

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Septum perforation *see* **Perforated septum**

Serenoa repens see **Saw palmetto**

Serotonin boosters *see* **Selective serotonin reuptake inhibitors**

Serum albumin test *see* **Protein components test**

Serum globulin test *see* **Protein components test**

Serum hepatitis *see* **Hepatitis B**

Serum protein electrophoresis *see* **Protein electrophoresis**

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Serum sickness

Definition

Serum sickness is a type of delayed allergic response, appearing four to 10 days after exposure to some **antibiotics** or antiserum, the portion of serum that contains antibodies, such as **gamma globulin**, which may be given to provide immunization against some diseases.

Description

Serum sickness is very similar to an allergic reaction. The patient's immune system recognizes the proteins in the drug or antiserum as foreign proteins, and produces its own antibodies to protect against the foreign proteins. The newly formed antibodies bind with the foreign protein to form immune complexes. These immune complexes may enter the walls of blood vessels where they set off an inflammatory reaction.

While other types of allergic reactions may produce a rapid response, the serum sickness reaction is delayed because it takes time for the body to produce antibodies to the new protein.

Causes and symptoms

The usual symptoms are severe skin reactions, often on the palms of the hands and soles of the feet. **Fever**, sometimes as high as 104o F, is always present and usually appears before the skin rash.

Joint **pain** may be reported in up to 50% of cases. This is usually seen in the larger joints, but occasionally the finger and toe joints may also be involved.

Swelling of lymph nodes, particularly around the site of the injection, is seen in 10–20% of cases. There may also be swelling of the head and neck.

Urine analysis may show traces of blood and protein in the urine.

Other symptoms may involve the heart and central nervous system. These may include changes in vision, and difficulty in movement. Breathing difficulty may occur.

Traditionally, antitoxins were the most common cause of serum sickness, but those reports date from a time when most antitoxins were made from horse serum. As many as 16% of the people who received antirabies serum derived from horses developed serum sickness. The risk of a reaction to antitoxins has dropped dramatically since manufacturers have started using human serum instead of horse serum to make their products.

Although antitoxins are the most common cause of serum sickness, a number of drugs have been reported to cause a serum sickness reaction. The following list is not complete, but indicates some of the drugs that have been associated with this type of reaction:

- allopurinol (Zyloprim)
- barbiturates
- captopril (Capoten)
- cephalosporin antibiotics
- griseofulvin (Fulvicin, Grifulvin)
- penicillins
- pehnytoin (Dilantin)
- procainamide (Procan SR, Procanbid, Pronestyl-SR)
- quinidine (Quinaglute, Quinidex, Quinora)
- streptokinase (Streptase, Kabikinase)
- sulfonamide antibacterial drugs

Of cases of serum sickness reported to the United States Food and Drug Administration, the drugs most commonly associated with the reaction have been the cephalosporin antibiotics, including cefaclor (Ceclor) and cefalexin (Keflex) and the sulfonamide combination trimethoprim-sulfamethoxazole (Bactrim, Septra.) This does not mean that these are high-risk drugs, since these drugs are very widely used, so that there are many people exposed to them.

In addition to these substances, allergenic extracts used for testing and immunization, hormones, and vaccines have been known to cause serum sickness.

Diagnosis

Diagnosis is made by observing the symptoms and reviewing the patient's medical and medication history. Although the symptoms of serum sickness may be similar to other conditions, patients who present with symptoms of serum sickness and who have a recent history of exposure to a drug or other product which may cause this type of reaction should be suspected of having serum sickness.

Treatment

The first step in treatment of serum sickness is always to discontinue the drug or other substance which is suspected of causing the reaction. After that, all treatment is symptomatic. **Antihistamines**, pain relievers, and **corticosteroids** may be given to relieve the symptoms. The choice of treatment depends on the severity of the reaction.

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KEY TERMS

Allergy—Altered body reaction, usually hypersensitivity, as a response to exposure to a specific substance.

Antibody—Any of a large number of proteins that are produced after stimulation by an antigen and act specifically against the antigen in an immune response.

Antihistamine—A drug that inhibits the actions of histamine. Histamine causes dilatation of capillaries, contraction of smooth muscle, and stimulation of gastric acid secretion.

Antitoxin—An antibody that is capable of neutralizing the specific toxin (a specific cause of disease) that stimulated its production in the body and is produced in animals for medical purposes by injection of a toxin or toxoid with the resulting serum being used to counteract the toxin in other individuals.

Serum—The clear yellowish fluid that remains from blood plasma after fibrinogen, prothrombin, and other clotting factors have been removed by clot formation—called also blood serum.

Sulfonamide—A sulfa drug, one of a large group of drugs used to treat bacterial infections.

Prognosis

Most serum sickness reactions are mild, and disappear on their own after one or two weeks as long as the cause is removed. Sometimes, symptoms of pain and discomfort may continue for several weeks, even after all the observable reactions such as skin rash and protein in the urine have disappeared. In very rare cases, however, there can be severe reactions and permanent damage. In very rare but extreme cases, serum sickness can lead to **shock**, permanent kidney damage, and even **death**.

Prevention

The most effective method of prevention is simple avoidance of antitoxins that may cause serum sickness. If patients have had a reaction in the past, particularly if the reaction was to a commonly used drug, they should be made aware of it, and be advised to alert physicians and hospitals in the future. Patients who have had particularly severe reactions may be advised to wear identification bracelets, or use other means to alert health care providers.

When it is necessary to administer an antitoxin, skin tests may be used to identify people who are at risk of a reaction. If the situation does not allow enough time for skin testing, the antitoxin should be given along with an intravenous antihistamine. Other drugs, such as epinephrine, which may be needed for an emergency, should be available.

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Action Against Allergy (AAA), PO Box 278, Middlesex, England, TW1 4QQ,44 (020) 8892-0711,44 (020) 8892-4950, AAA@actionagainstallergy.reeserve.co.uk, http://actionagainstallergy.co.uk.

American Acacdmy of Allergy & Immunology., 555 East Wells Street, Suite 1100, Milwaukee, WI, 53202-3823, (414) 272-6071, info@aaaai.org, http://www.aaaai.org.

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Serum therapy *see* **Gammaglobulin**

Severe acute respiratory syndrome (SARS)

Definition

Severe acute respiratory syndrome (SARS) is the first emergent and highly transmissible viral disease to appear during the twenty-first century.

Description

Patients with SARS develop flu-like **fever**, **headache**, malaise, dry **cough** and other breathing difficulties. Many patients develop **pneumonia**, and in 5–10% of cases, the pneumonia and other complications are severe enough to cause **death**. SARS is caused by a virus that is transmitted usually from person to person—predominantly by the aerosolized droplets of virus infected material.

The first known case of SARS was traced to a November 2002 case in Guangdong province, China.

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By mid-February 2003, Chinese health officials tracked more than 300 cases, including five deaths in Guangdong province from what was at the time described as an acute respiratory syndrome. Many flu-causing viruses have previously originated from Guangdong province because of cultural and exotic cuisine practices that bring animals, animal parts, and humans into close proximity. In such an environment, pathogens can more easily genetically mutate and make the leap from animal hosts to humans. The first cases of SARS showed high rates among Guangdong food handlers and chefs.

Chinese health officials initially remained silent about the outbreak, and no special precautions were taken to limit travel or prevent the spread of the disease. The world health community, therefore, had no chance to institute testing, **isolation**, and quarantine measures that might have prevented the subsequent global spread of the disease.

On February 21, Liu Jianlun, a 64-year-old Chinese physician from Zhongshan hospital (later determined to have been "super-spreader," a person capable of infecting unusually high numbers of contacts) traveled to Hong Kong to attend a family wedding despite the fact that he had a fever. Epidemiologists subsequently determined that, Jianlun passed on the SARS virus to other guests at the Metropole Hotel where he stayed—including an American businessman en route to Hanoi, three women from Singapore, two Canadians, and a Hong Kong resident. Jianlun's travel to Hong Kong and the subsequent travel of those he infected allowed SARS to spread from China to the infected travelers' destinations.

Johnny Chen, the American businessman, grew ill in Hanoi, Vietnam, and was admitted to a local hospital. Chen infected 20 health care workers at the hospital including noted Italian epidemiologist Carlo Urbani who worked at the Hanoi World Health Organization (WHO) office. Urbani provided medical care for Chen and first formally identified SARS as a unique disease on February 28, 2003. By early March, 22 hospital workers in Hanoi were ill with SARS.

Unaware of the problems in China, Urbani's report drew increased attention among epidemiologists when coupled with news reports in mid-March that Hong Kong health officials had also discovered an outbreak of an acute respiratory syndrome among health care workers. Unsuspecting hospital workers admitted the Hong Kong man infected by Jianlun to a general ward at the Prince of Wales Hospital because it was assumed he had a typical severe pneumonia—a fairly routine admission. The first notice that clinicians were dealing with an unusual illness came—not from health notices from China of increasing illnesses and deaths due to SARS—but from the observation that hospital staff, along with those subsequently determined to have been in close proximity to the infected persons, began to show signs of illness. Eventually, 138 people, including 34 nurses, 20 doctors, 16 medical students, and 15 other health care workers, contracted pneumonia.

One of the most intriguing aspects of the early Hong Kong cases was a cluster of more than 250 SARS cases that occurred in a cluster of high-rise apartment buildings—many housing health care workers—that provided evidence of a high rate of secondary transmission. Epidemiologists conducted extensive investigations to rule out the hypothesis that the illnesses were related to some form of local contamination (e.g., sewage, bacteria on the ventilation system, etc.). Rumors began that the illness was due to cockroaches or rodents, but no scientific evidence supported the hypothesis that the disease pathogen was carried by insects or animals.

Hong Kong authorities then decided that those suffering the flu-like symptoms would be given the option of self-isolation, with family members allowed to remain confined at home or in special camps. Compliance checks were conducted by police.

One of the Canadians infected in Hong Kong, Kwan Sui-Chu, return to Toronto, Ontario, and died in a Toronto hospital on March 5. As in Hong Kong, because there were no alert from China about the SARS outbreak, Canadian officials did not initially suspect that Sui-Chu had been infected with a highly contagious virus, until Sui-Chu's son and five health care workers showed similar symptoms. By mid-April, Canada reported more than 130 SARS cases and 15 fatalities.

Increasingly faced with reports that provided evidence of global dissemination, on March 15, 2003, the World Health Organization (WHO) took the unusual step of issuing a travel warning that described SARS is a "worldwide health threat." WHO officials announced that SARS cases, and potential cases, had been tracked from China to Singapore, Thailand, Vietnam, Indonesia, Philippines, and Canada. Although the exact cause of the "acute respiratory syndrome" had not, at that time, been determined, WHO officials issuance of the precautionary warning to travelers bound for Southeast Asia about the potential SARS risk served as notice to public health officials about the potential dangers of SARS.

Within days of the first WHO warning, SARS cases were reported in United Kingdom, Spain, Slovenia, Germany, and in the United States.

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WHO officials were initially encouraged that isolation procedures and alerts were working to stem the spread of SARS, as some countries reporting small numbers of cases experienced no further dissemination to hospital staff or others in contact with SARS victims. However, in some countries, including Canada, where SARS cases occurred before WHO alerts, SARS continued to spread beyond the bounds of isolated patients.

WHO officials responded by recommending increased screening and quarantine measures that included mandatory screening of persons returning from visits to the most severely affected areas in China, Southeast Asia, and Hong Kong.

In early April 2003, WHO took the controversial additional step of recommending against non-essential travel to Hong Kong and the Guangdong province of China. The recommendation, sought by **infectious disease** specialists, was not controversial within the medical community, but caused immediate concern regarding the potentially widespread economic impacts.

Mounting reports of SARS showed a increasing global dissemination of the virus. By April 9, the first confirmed reports of SARS cases in Africa reached WHO headquarters, and eight days later, a confirmed case was discovered in India.

Causes and symptoms

In mid-April 2003, Canadian scientists at the British Columbia **Cancer** Agency in Vancouver announced that they that sequenced the genome of the coronavirus most likely to be the cause of SARS. Within days, scientists at the Centers for Disease Control (CDC) in Atlanta, Georgia, offered a genomic map that confirmed more than 99% of the Canadian findings.

Both genetic maps were generated from studies of viruses isolated from SARS cases. The particular coronavirus mapped had a genomic sequence of 29,727 nucleotides—average for the family of coronavirus that typically contain between 29,000–31,000 nucleotides.

Proof that the coronavirus mapped was the specific virus responsible for SARS would eventually come from animal testing. Rhesus monkeys were exposed to the virus via injection and inhalation and then monitored to determine whether SARS like symptoms developed, and then if sick animals exhibited a histological pathology (i.e., an examination of the tissue and cellular level pathology) similar to findings in human patients. Other tests, including polymerase chain reaction (PCR) testing helped positively match the specific coronavirus present in the lung tissue, blood, and feces of infected animals to the exposure virus.

Identification of a specific pathogen can be a complex process, and positive identification requires thousands of tests. All testing is conducted with regard to testing Koch's postulates—the four conditions that must be met for an organism to be determined to the cause of a disease. First, the organism must be present in every case of the disease. Second, the organism must be able to be isolated from the host and grown in laboratory conditions. Third, the disease must be reproduced when the isolated organism is introduced into another, healthy host. The fourth postulate stipulates that the same organism must be able to be recovered and purified from the host that was experimentally infected.

Early data indicates that SARS has an incubation period range of two to 10 days, with an average incubation of about four days. Much of the inoculation period allows the virus to be both transported and spread by an asymptomatic carrier. With air travel, asymptotic carriers can travel to anywhere in the world. The initial symptoms are non-specific and common to the flu. Infected cases then typically spike a high fever 100.4°F (38°C) as they develop a cough, **shortness of breath**, and difficulty breathing. SARS often fulminates (reaches it maximum progression) in a severe pneumonia that can cause **respiratory failure** and death in about 10% of its victims.

Diagnosis

Currently, initial tests include blood cultures, Gram stain, chest radiograph, and tests for other viral respiratory pathogens such as **influenza** A and B. Other serologic techniques are used, and if SARS is suspected, samples are forwarded to state/local public health departments and/or the CDC for coronavirus antibody testing.

Treatment

As of May 1, 2003, no therapy was demonstrated to have clinical effectiveness against the virus that causes SARS, and physicians could offer only supportive therapy (e.g. administration of fluids, oxygen, ventilation, etc.).

Prognosis

By late April/early May 2003, WHO officials had confirmed reports of more than 3,000 cases of SARS from 18 different countries with 111 deaths attributed to the disease (about a 5–10% death rate). United States health officials reported 193 cases with no deaths. Significantly, all but 20 of the U.S. cases were linked to travel to infected areas, and the other 20 cases were

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accounted for by secondary transmission from infected patients to family members and health care workers.

Information on countries reporting SARS and the cumulative total of cases and deaths is updated each day on the WHO SARS web site at http;//www.who.int/csr/sarscountry/en/.

Prevention

Until a vaccine is developed, isolation and quarantine remain potent tools in the modern public health arsenal. Both procedures seek to control exposure to infected individuals or materials. Isolation procedures are used with patients with a confirmed illness. Quarantine rules and procedures apply to individuals who are not currently ill, but are known to have been exposed to the illness (e.g., been in the company of a infected person or come in contact with infected materials).

Isolation and quarantine both act to restrict movement and to slow or stop the spread of disease within a community. Depending on the illness, patients placed in isolation may be cared for in hospitals, specialized health care facilities, or in less severe cases, at home. Isolation is a standard procedure for TB patients. In most cases, isolation is voluntary; however, isolation can be compelled by federal, state, and some local law.

States governments within the United States have a general authority to set and enforce quarantine conditions. At the federal level, the Centers for Disease Control and Prevention's (CDC) Division of Global Migration and Quarantine is empowered to detain, examine, or conditionally release (release with restrictions on movement or with a required treatment protocol) individuals suspected of carrying certain listed communicable diseases.

As of April 27, 2003, the CDC in Atlanta recommended SARS patients be voluntarily isolated, but had not recommended enforced isolation or quarantine. Regardless, CDC and other public heath officials, including the Surgeon General, sought and secured increased powers to deal with SARS. On April 4, 2003, U.S. President George W. Bush signed Presidential Executive Order 13295 that added SARS to a list of quarantinable communicable diseases. The order provided health officials with the broader powers to seek "...apprehension, detention, or conditional release of individuals to prevent the introduction, transmission, or spread of suspected communicable diseases..."

Travel advisories issued by WHO should be reviewed and people who must travel to areas with SARS outbreaks should follow such preventative measures as frequent hand washing and avoidance of large crowds. Likewise, family members caring for suspected and/or confirmed SARS patients should wash hands frequently, avoid direct contact with the patient's bodily fluids, and monitor their own possible development of symptoms closely.

Brenda Wilmoth Lerner

Severe combined immunodeficiency

Definition

Severe combined **immunodeficiency** (SCID) is the most serious human immunodeficiency disorder(s). It is a group of congenital disorders in which both the humoral part of the patient's immune system and the cells involved in immune responses fail to work properly. Children with SCID are vulnerable to recurrent severe infections, retarded growth, and early **death**.

Description

SCID is thought to affect between one in every 100,000 persons, and one in every 500,000 infants. Several different immune system disorders are currently grouped under SCID:

- Swiss-type agammaglobulinemia. This was the first type of SCID discovered, in Switzerland in the 1950s.
- Adenosine deaminase deficiency (ADA). About 50% of SCID cases are of this type. ADA deficiency leads to low levels of B and T cells in the child's immune system.
- Autosomal recessive. About 40% of SCID cases are inherited from the parents in an autosomal recessive pattern.
- Bare lymphocyte syndrome. In this form of SCID, the white blood cells (lymphocytes) in the baby's blood are missing certain proteins. Without these proteins, the lymphocytes cannot activate the T cells in the immune system.
- SCID with leukopenia. Children with this form of SCID are lacking a type of white blood cell called a granulocyte.

In order to understand why SCID is considered the most severe immunodeficiency disorder, it is helpful to have an outline of the parts of the human immune system. It has three parts: cellular, humoral, and nonspecific. The cellular and humoral parts of the system are both needed to fight infections–they recognize disease agents and attack them. The cellular system is composed

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KEY TERMS

Adenosine deaminase (ADA)—An enzyme that is lacking in a specific type of SCID. Children with an ADA deficiency have low levels of both B and T cells.

Antigens—A substance that usually causes the formation of an antibody. A foreign invaders in the body.

Autosomal recessive inheritance—A pattern of inheritance of a recessive gene where, among other things, both parents may not show symptoms.

B cell—A type of lymphocyte or white blood cell that is derived from precursor cells in the bone marrow.

Congenital—Present at the time of birth. Most forms of SCID are hereditary as well as congenital.

Gene therapy—An experimental treatment for SCID that consists of implanting a gene for ADA into an activated virus and merging it with some of the patient's own T cells. The corrected T cells are infused back into the patient every few months.

Humoral—Pertaining to or derived from a body fluid. The humoral part of the immune system includes antibodies and immunoglobulins in blood serum.

Lymphocyte—A type of white blood cell that is important in the formation of antibodies.

Orphan drug—A drug that is known to be useful in treatment but lacks sufficient funding for further research and development.

PEG-ADA—An orphan drug that is useful in treating SCID related to ADA deficiency.

T cells—Lymphocytes that originate in the thymus gland. T cells regulate the immune system's response to infections. The thymus gland is small or underdeveloped in children with SCID.

Thrush—A disease of the mouth caused by a yeast, *Candida albicans*.

of many classes of T-lymphocytes (white blood cells that detect foreign invaders called antigens). The humoral system is made up of B cells, which are the only cells in the body that make antibodies. In SCID, neither the cellular nor the humoral part of the immune system is working properly.

Causes and symptoms

SCID is an inherited disorder. There are two ways in which a developing fetus' immune system can fail to develop normally. In the first type of genetic problem, both B and T cells are defective. In the second type, only the T cells are abnormal, but their defect affects the functioning of the B cells.

For the first few months of life, a child with SCID is protected by antibodies in the mother's blood. As early as three months of age, however, the SCID child begins to suffer from mouth infections (thrush), chronic **diarrhea**, **otitis media** and pulmonary infections, including **pneumocystis pneumonia**. The child loses weight, becomes very weak, and eventually dies from an opportunistic infection.

Diagnosis

SCID is diagnosed by the typing of T and B cells in the child's blood. B cells can be detected by immunofluorescence tests for surface markers (unique proteins)on the cells. T cells can be identified in tissue sections (samples) using enzyme-labeled antibodies.

Treatment

Patients with SCID can be treated with **antibiotics** and immune serum to protect them from infections, but these treatments cannot cure the disorder. Bone marrow transplants are currently regarded as one of the few effective standard treatments for SCID.

Investigational treatments

In 1990, the Food and Drug Administration (FDA) approved PEG-ADA, an orphan drug (not available in the United States but available elsewhere), for the treatment of SCID. PEG-ADA, which is also called pegademase bovine, works by replacing the ADA deficiency in children with this form of SCID. Children who receive weekly injections of PEG-ADA appear to have normal immune functions restored. Another treatment that is still in the experimental stage is **gene therapy**. In gene therapy, the children receive periodic infusions of their own T cells corrected with a gene for ADA that has been implanted in an activated virus.

Prognosis

Currently, there is no cure for SCID. Most untreated patients die before age two.

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Prevention

Genetic counseling is recommended for parents of a child with SCID.

ORGANIZATIONS

Immune Deficiency Foundation, 40 West Chesapeake Avenue, Suite 308, Towson, MD, 21204, (800) 296-4433, http://www.primaryimmune.org/.

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923, (800) 999-6673, http://www.rarediseases.org.

Rebecca J. Frey, PhD

Sex hormones tests

Definition

Sex hormones tests measure levels of the sex hormones, including estrogen, progesterone, and testosterone.

Purpose

The sex hormone tests are ordered to determine if secretion of these hormones is normal. Estrogen fraction test is done to evaluate sexual maturity, menstrual problems, and fertility problems in females. This test may also be used to test for tumors that excrete estrogen. In pregnant women it aids in determining fetal-placental health. Estrogen fraction is also used to evaluate males who have enlargement of one or both breasts (**gynecomastia**), or who have feminization syndromes, where they display female sex characteristics.

Progesterone assay test is ordered to evaluate women who are having difficulty becoming pregnant or maintaining a **pregnancy**, and to monitor high-risk pregnancies.

Testosterone levels are ordered to evaluate:

- ambiguous sex characteristics
- precocious puberty
- virilizing syndromes in the female
- infertility in the male
- rare tumors of the ovary and testicle

Description

The sex hormones control the development of primary and secondary sexual characteristics. They regulate the sex-related functions of the body, such as the menstrual cycle or the production of eggs or sperm. There are three main types of sex hormones:

- the female sex hormones (called the estrogen hormones)
- the progesterone hormones (which help the body prepare for and maintain pregnancy)
- the male sex hormones, or the androgen hormones

Female sex hormones are responsible for normal menstruation and the development of secondary female characteristics. Testosterone is a hormone that induces **puberty** in the male and maintains male secondary sex characteristics. In females, the adrenal glands and the ovaries secrete small amounts of testosterone.

Estrogen

Estrogen is tested to evaluate menstrual status, sexual maturity, and gynecomastia (or feminization syndromes). It is a tumor marker for patients with certain ovarian tumors. E1, a type of estrogen, is the most active estrogen in the nonpregnant female.

E3 (estriol) is the major estrogen in the pregnant female. It is produced in the placenta. Excretion of estriol increases around the eighth week of gestation and continues to rise until shortly before delivery. Serial urine and blood studies of this hormone are used to assess placental function and fetal normality in high-risk pregnancies. Falling values during pregnancy suggest feto-placental deterioration and require prompt reassessment of the pregnancy, including the possibility of early delivery.

Progesterone

Progesterone is essential for the healthy functioning of the female reproductive system. Produced in the ovaries during the second half of the menstrual cycle, and by the placenta during pregnancy, small amounts of progesterone are also produced in the adrenal glands and testes.

After ovulation, an increase of progesterone causes the uterine lining to thicken in preparation for the implantation of a fertilized egg. If this event does not take place, progesterone and estrogen levels fall, resulting in shedding of the uterine lining.

Progesterone is essential during pregnancy, not only ensuring normal functioning of the placenta, but passing into the developing baby's circulation, where it is converted in the adrenal glands to corticosteroid hormones.

Testosterone

Testosterone is the most important of the male sex hormones. It is responsible for stimulating bone and muscle growth, and sexual development. It is produced

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by the testes and in very small amounts by the ovaries. Most testosterone tests measure total testosterone.

Testosterone stimulates sperm production (spermatogenesis), and influences the development of male secondary sex characteristics. Overproduction of testosterone caused by testicular, adrenal, or **pituitary tumors** in the young male may result in **precocious puberty**.

Overproduction of testosterone in females, caused by ovarian and adrenal tumors, can result in masculinization, the symptoms of which include cessation of the menstrual cycle (**amenorrhea**) and excessive growth of body hair (**hirsutism**).

When reduced levels of testosterone in the male indicate underactivity of the testes (**hypogonadism**), testosterone stimulation tests may be ordered.

Preparation

The progesterone and testosterone tests require a blood sample; it is not necessary for the patient to restrict food or fluids before the test. Testosterone specimens should be drawn in the morning, as testosterone levels are highest in the early morning hours. The estrogen fraction test can be performed on blood and/or urine. It is not necessary for the patient to restrict food or fluids for either test. If a 24-hour urine test has been requested, the patient should call the laboratory for instructions.

Risks

Risks for these blood tests are minimal, but may include slight bleeding from the puncture site, **fainting** or feeling lightheaded after having blood drawn, or blood accumulating under the puncture site (hematoma).

Normal results

Estrogen levels vary in women, ranging from 24–149 picograms per mL of blood. In men, the normal range is between 12–34 picograms per mL of blood.

Progesterone levels vary from less than 150 nanograms per deciliter (ng/dL) of blood to 2,000 nanograms in menstruating women. During pregnancy, progesterone levels range from 1,500–20,000 ng/dL of blood.

Testosterone values vary from laboratory to laboratory, but can generally be found within the following levels:

- Men: 300–1,200 ng/dL
- Women: 30–95 ng/dL
- Prepubertal children: Less than 100 ng/dL (boys) less than 40 ng/dL (girls)

Abnormal results

Increased levels of estrogen are seen in feminization syndromes:

- when a male begins to develop female secondary sex characteristics
- during precocious puberty
- when children develop secondary sexual characteristics at an abnormally early age
- because of ovarian, testicular, or adrenal tumor
- During normal pregnancy, cirrhosis, and increased thyroid levels (hyperthyroidism)

Decreased levels of estrogen are found in the following conditions:

- a failing pregnancy
- during menopause
- anorexia nervosa
- primary and secondary hypogonadism
- turner's syndrome, seen in females with one missing X chromosome

Increased levels of progesterone are seen:

- during ovulation and pregnancy
- with certain types of ovarian cysts
- with a tumor of the ovary known as a choriocarcinoma

Decreased levels of progesterone are seen:

- in toxemia of pregnancy
- with a threatened abortion
- during placental failure
- after fetal death
- with amenorrhea
- due to ovarian dysfunction

Increased levels (male) of testosterone are found in:

- sexual precocity
- the viral infection of encephalitis
- tumors involving the adrenal glands
- testicular tumors
- excessive thyroid production (hyperthyroidism)
- testosterone resistance syndromes

Decreased levels (male) of testosterone are seen in:

- Klinefelter syndrome
- a chromosomal deficiency
- primary and secondary hypogonadism
- down syndrome
- surgical removal of the testicles
- cirrhosis

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Increased levels (females) of testosterone are found in ovarian and adrenal tumors and in the presence of excessive hair growth of unknown cause (hirsutism).

Resources

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Janis O. Flores

Sex reassignment surgery

Definition

Also known as sex change or **gender reassignment surgery**, sex reassignment surgery is a procedure that changes genital organs from one gender to another.

Purpose

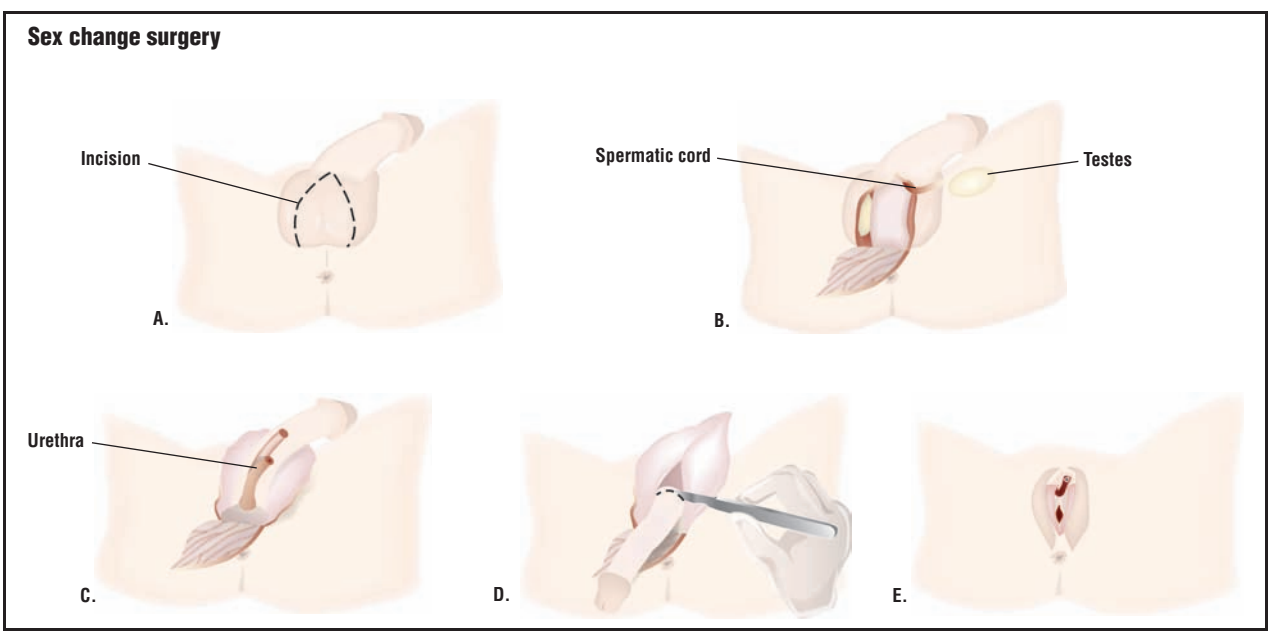
There are two main reasons to alter the genital organs from one sex to another.

- Newborns with intersex deformities must be assigned to one sex or the other. These deformities represent intermediate stages between the primordial female genitals and the change into male genitals caused by male hormone stimulation.
- Both men and women occasionally believe they are physically a different sex than they are mentally and emotionally. This dissonance is so profound that they are willing to be surgically altered.

In both cases, technical considerations favor successful conversion to a female rather than a male. Newborns with ambiguous organs will almost always be assigned to the female gender unless the penis is at least an inch (2.5 cm) long. Whatever their chromosomes, they are much more likely to be socially well-adjusted as females, even if they cannot have children.

Demographics

Reliable statistics are extremely difficult to obtain. Many sexual reassignment procedures are conducted in private facilities that are not subject to reporting requirements. Sexual reassignment surgery is often conducted outside of the United States. The number of gender reassignment procedures conducted in the United States each year is estimated at between 100 and 500. The number worldwide is estimated to be two to five times larger.



To change male genitalia to female genitalia, an incision is made into the scrotum (A). The flap of skin is pulled back, and the testes are removed (B). The skin is stripped from the penis but left attached, and a shorter urethra is cut (C). All but a stump of the penis is removed (D). The excess skin is used to create the labia (external genitalia) and vagina (E). *(Illustration by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)*

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KEY TERMS

Androgens—A class of chemical compounds (hormones) that stimulates the development of male secondary sexual characteristics.

Chromosomes—The carriers of genes that determine gender and other characteristics.

Estrogens—A class of chemical compounds (hormones) that stimulates the development of female secondary sexual characteristics.

Hysterectomy—Surgical removal of the uterus.

Oophorectomy—Surgical removal of the ovaries.

Description

Converting male to female anatomy requires removal of the penis, reshaping genital tissue to appear more female, and constructing a vagina. A vagina can be successfully formed from a skin graft or an isolated loop of intestine. Following the surgery, female hormones (estrogen) will reshape the body's contours and stimulate the growth of satisfactory breasts.

Female to male surgery has achieved lesser success due to the difficulty of creating a functioning penis from the much smaller clitoral tissue available in the female genitals. Penis construction is not attempted less than a year after the preliminary surgery to remove the female organs. One study in Singapore found that a third of the persons would not undergo the surgery again. Nevertheless, they were all pleased with the change of sex. Besides the genital organs, the breasts need to be surgically altered for a more male appearance. This can be successfully accomplished.

The capacity to experience an orgasm, or at least "a reasonable degree of erogenous sensitivity," can be expected by almost all persons after gender reassignment surgery.

Diagnosis/Preparation

Gender identity is an extremely important characteristic for human beings. Assigning sex must take place immediately after birth for the mental health of both children and their parents. Changing sexual identity is among the most significant changes that a human can experience. It should therefore be undertaken with extreme care and caution. By the time most adults come to surgery, they have lived for many years with a dissonant identity. The average in one study was 29 years. Nevertheless, even then they may not be fully aware of the implications of becoming a member of the opposite gender.

In-depth psychological counseling should precede and follow any gender reassignment surgical procedure.

Sex reassignment surgery is expensive. The cost for male to female reassignment is $10,000–$20,000. The cost for female to male reassignment can exceed $50,000.

Aftercare

Social support, particularly from one's family, is important for readjustment as a member of the opposite gender. If surgical candidates are socially or emotionally unstable before the operation, over the age of 30, or have an unsuitable body build for the new gender, they tend not to fare well after gender reassignment surgery; however, in no case studied did the gender reassignment procedure diminish the ability to work.

Risks

All surgery carries the risks of infection, bleeding, and a need to return for repairs. Gender reassignment surgery is irreversible, so a candidate must have no doubts about accepting the results and outcome.

Normal results

Persons undergoing gender reassignment surgery can expect to acquire the external genitalia of a member of the opposite gender. Persons having male to female gender reassignment surgery retain a prostate. Individuals undergoing female to male gender reassignment surgery undergo a **hysterectomy** to remove the uterus and **oophorectomy** to remove their ovaries. Developing the habits and mannerisms characteristic of the patient's new gender requires many months or years.

Morbidity and mortality rates

The risks that are associated with any surgical procedure are present in gender reassignment surgery. These include infection, postoperative **pain**, and dissatisfaction with anticipated results. Accurate statistics are extremely difficult to find. Intraoperative **death** has not been reported.

The most common complication of male to female surgery is narrowing of the new vagina. This can be corrected by dilation or using a portion of colon to form a vagina.

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A relatively common complication of female to male surgery is dysfunction of the penis. Implanting a penile prosthesis is technically difficult and does not have uniformly acceptable results.

Psychiatric care may be required for many years after sex-reassignment surgery.

The number of deaths in male-to-female transsexuals was five times the number expected, due to increased numbers of **suicide** and death from an unknown cause.

Alternatives

There is no alternative to surgical reassignment to alter one's external genitalia. The majority of persons who experience gender disorder problems never surgically alter their appearance. They dress as members of the desired gender, rather than gender of birth. Many use creams or pills that contain hormones appropriate to the desired gender to alter their bodily appearance. Estrogens (female hormones) will stimulate breast development, widening of the hips, loss of facial hair and a slight increase in voice pitch. Androgens (male hormones) will stimulate the development of facial and chest hair and cause the voice to deepen. Most individuals who undergo gender reassignment surgery lead happy and productive lives.

Resources

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ORGANIZATIONS

American Medical Association, 515 N. State Street, Chicago, IL, 60610, (800) 621-8335, http://www.ama-assn.org/.

American Psychiatric Association, 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209-3901, (703) 907-7300, apa@psych.org, http://www.psych.org/.

American Psychological Association, 750 First Street, NE, Washington, DC, 20002-4242, (202) 336-5500, (800) 374-2721, http://www.apa.org/.

American Urological Association, 1000 Corporate Boulevard, Linthicum, MD, 21090, (410) 689-3700, (866) 746-4282, http://www.auanet.org/.

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Sex therapy

Definition

Sex therapy is the treatment of **sexual dysfunction**.

Purpose

Sex therapy utilizes various techniques in order to relieve sexual dysfunction commonly caused by **premature ejaculation** or sexual **anxiety** and to improve the sexual health of the patient.

Precautions

Sexual dysfunction conjures up feelings of guilt, anger, insecurity, frustration, and rejection. Therapy is slow and requires open communication and understanding between sexual partners. Therapy may inadvertently address interpersonal communication problems.

Description

Sex therapy is conducted by a trained therapist, doctor, or psychologist. The initial sessions should cover a complete history not only of the sexual problem but of the entire relationship and each individual's background and personality. The sexual relationship should be discussed in the context of the entire relationship. In

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fact, sexual counseling may de-emphasize sex until other aspects of the relationship are better understood and communicated.

There are several techniques that combat sexual dysfunction and are used in sex therapy. They include:

- Semans' technique:which is used to help combat premature ejaculation with a "start-stop" approach to penis stimulation. By stimulating the man up to the point of ejaculation and then stopping, the man will become more aware of his response. More awareness leads to greater control, and open stimulation of both partners leads to greater communication and less anxiety. The start-stop technique is conducted four times until the man is allowed to ejaculate.
- Sensate focus therapy, the practice of nongenital and genital touching between partners in order to decrease sexual anxiety and build communication. First, partners explore each other's bodies without touching the genitals or breasts. Once the couple is comfortable with nongenital touching, they can expand to genital stimulation. Intercourse is prohibited in order to allow the partners to expand their intimacy and communication.
- Squeeze technique, which is used to treat premature ejaculation. When the man feels the urge to ejaculate, his partner squeezes his penis just below the head. This stops ejaculation and gives the man more control over his response.

Aftercare

Habits change slowly. All the techniques must be practiced faithfully for long periods of time to relearn behaviors. Communication is imperative.

Resources

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J. Ricker Polsdorfer, MD

Sexual abuse

Definition

Sexual **abuse** is defined as any nonconsensual sexual exposure or activity. Any inappropriate exposure or sexual behavior, contact, or activity between a child and an older child, teen, or adult is considered to be both sexual abuse and a form of **child abuse**.

Demographics

Of the estimated 3.2 million reports of child abuse in the United States in 2007, affecting about 5.8 million children, 7.6% involved sexual abuse. However the number of sexually abused children is much greater, since many—if not the majority of cases—go unreported. According to the U.S. Department of Justice (DOJ), as many as one out of three girls and one out of five boys under age 18 have been sexually abused. Serious underreporting of abuse occurs because children are too ashamed or afraid to tell anyone or because they think that they will not be believed. Legal procedures for corroborating sexual abuse can also be an impediment. However in recent years increased public awareness of child sexual abuse has resulted in more reporting and more prosecutions.

Although children of any age—from infants to teens—may be victims of sexual abuse, elementary–school-age children and the disabled are at particular risk. The vast majority of child sexual abuse—approximately 90%—is committed by someone the child knows and 68% of cases involve incest—abuse by a family member. The majority of sexual abusers are male and incest most often involves fathers or stepfathers abusing their daughters. However parents, stepparents, and foster parents of either gender abuse their daughters, sons, stepchildren, or foster children. Sexual abuse also occurs between siblings. Sexual abusers include other relatives, neighbors, caregivers, teachers, friends, and strangers. Sexual abuse occurs everywhere, among all racial, ethnic, religious, and socioeconomic groups.

Description

The definition of sexual abuse varies among cultures and has changed over time. Although most societies view sex between children and adults as inappropriate, mores concerning the appropriate ages and age differences for sexual partners vary. Feminist movements in Western countries have successfully promoted definitions of sexual abuse that include a wide range of interactions between a child and an older child or adult, including some interactions that do not involve bodily contact.

Sexual abuse includes:

- voyeurism, including pictures on a Web site
- exposing a child to erotic material or pornography

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- exposing one's genitals to a child
- sexual comments or gestures directed at a child
- solicitation of a child
- inappropriate touching, including oral, anal, breast, genital, or buttock contact
- forcing, pressuring, tricking, or talking a child into engaging in inappropriate touching, fondling, or other sexual activity
- rape or incest
- using objects for oral, vaginal, or anal fondling, stimulation, or penetration
- using a child for pornography, prostitution, Internet crimes, or other exploitive endeavors
- inadequately or inappropriately supervising a child's voluntary sexual activity

Although child sexual abuse can involve violence, it usually involves coercion. Whereas infants and young children are defenseless, older children may be susceptible to bribes or threats. However most often they acquiesce to the demands of adults who hold inherent power over them. Abusers may manipulate a child through a process called grooming, which can involve gaining the child's trust, confusing the child, preparing the child for sexual abuse, and ensuring that the child will not tell. Grooming can also involve creating a public persona in which the abuser is held in high regard by the child's family and community.

Sexual abuse can overwhelm a child with horror, confusion, disbelief, fear, and shame. Sometimes children become passive in an attempt to dissociate their minds from the physical reality. This passivity can be misconstrued as consent. Some children attempt to repress memories of the abuse or rationalize it into insignificance.

Sexual abuse can leave a child emotionally devastated. Even very young children, who may not understand what has happened, are unable to cope with the over-stimulation. Children aged five and older may feel caught between loyalty or affection toward their abuser and their knowledge that the sexual activity is wrong. If the abuser is a family member, the child may be afraid of breaking up the family. Some abusers threaten children with withdrawal of love. Children often feel that they are to blame for the abuse and this combination of shame and guilt reinforces the abuser's insistence on secrecy.

Risk factors

Risk factors for sexual abuse are similar to those for other types of child abuse, including family stresses, poverty, and alcohol and drug use. Many abusers were themselves physically or sexually abused as children.

Causes and symptoms

Perpetrators of sexual abuse often have multiple victims. They tend to be angry people with a need to control or dominate others. Some abusers suffer from **personality disorders** or are psychotic. Others have a psychiatric disorder known as pedophilia—sexual attraction to prepubescent children. Some sexual abuse is situational, such as parents who abuse their children only when they are under the influence of alcohol or drugs or are under severe **stress**.

Sometimes children report sexual abuse and occasionally there are physical signs, including:

- vaginal or rectal bleeding, pain, itching, redness, swelling, or discharge
- painful urination or bowel movements
- difficulty sitting or walking
- rarely, injury to the buttocks, lower abdomen, or extremities
- pregnancy or a sexually transmitted infection (STI), especially in a child under age 14

Symptoms of sexual abuse in children can be similar to symptoms of **post-traumatic stress disorder** (PTSD):

- stomachaches, headaches, or other vague complaints
- sleep disturbances
- sudden fear of the dark
- nightmares
- bedwetting
- soiling oneself or other bowel disorders
- difficulty eating or swallowing
- loss of appetite or eating disorders, such as anorexia nervosa
- severe nervousness or anxiety
- excessive fears
- poor concentration
- sudden or extreme mood swings, including fear anger or excessive crying
- lethargy
- depression
- withdrawal from family, friends, or usual activities

Other behavioral symptoms of sexual abuse may include:

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KEY TERMS

Hymen—A membrane that partially or completely covers the vaginal opening.

Incest—Sexual intercourse between people who are too closely related to legally marry.

Pedophilia—A sexual perversion in which children are the preferred sexual object.

Pornography—Sexually explicit pictures, writings, or other material produced for the purpose of sexual arousal.

Post-traumatic stress disorder (PTSD)—A psychological reaction that continues long after a highly stressful event and is characterized by depression, anxiety, flashbacks, and nightmares.

Sexually transmitted infection (STI)—An infectious disease that is transmitted through sexual activity.

Voyeurism—Sexual stimulation by visual means, usually by observing an unsuspecting individual.

- secretiveness
- talk of a new, older friend
- the sudden appearance of unexplained money or gifts
- a belief that their body is dirty or damaged or that there is something wrong with their genitals
- refusal to change into gym clothes or participate in physical activities
- poor school performance or refusal to attend school
- fear or avoidance of particular people, places, or activities
- excessive obedience
- aggression or other behavioral problems
- regression to earlier developmental stages, including infantile behaviors such as thumb sucking
- running away from home
- avoidance of anything sexual
- sexual interest, language, or knowledge that is inappropriate for the child's age
- unusual or aggressive sexual activities with other children or toys
- excessive or public masturbation

Additional signs of sexual abuse in an adolescent may include:

- high-risk sexual behaviors
- alcohol or drug use
- self-mutilation, such as cutting or burning

Children who are victims of prolonged sexual abuse may develop:

- low self-esteem and feelings of worthlessness
- distrust of adults
- abnormal attitudes toward sex
- difficulties relating to others on nonsexual terms
- multiple personality disorder
- suicidal tendencies

In a process called "secondary victimization," a non-abusive parent of a sexually abused child may develop many of these same symptoms. Possible signs of a sexually abusive parent or other adult may include:

- overprotection of a child
- severely limiting a child's interactions with others, especially children of the opposite sex
- secretiveness
- isolation
- jealous or controlling behaviors

Diagnosis

Examination

A child who reports sexual abuse or is suspected of having been abused should have a complete **physical examination** as soon as possible, preferably within 72 hours. An examination is ordered whenever a case of suspected sexual abuse is reported to the police or child protection agency. Medical professionals, teachers, and childcare professionals are required by law to report suspected cases of sexual abuse.

The physician will look for any signs of physical injury or sexual abuse, particularly in the mouth and throat and around the anus and penis or vagina. The hymen—a thin membrane covering the opening to the vagina—may be affected in abused girls. However most children are not physically harmed during sexual abuse; signs of abuse are usually temporary; and the abuse is often not reported or discovered until some time after the last occurrence. Therefore diagnostic findings from a physical exam are rare.

Evaluation of sexually abused children by a trained professional is essential to determine whether treatment is required. Children are often afraid to talk openly about their abuse and therefore must be made to feel very safe. The assessment includes the child's:

- abuse history and other life stresses, such as frequent moves or personal losses
- current stresses, such as medical problems or learning disabilities

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- emotional state
- coping strategies, such as withdrawal or behavioral symptoms
- strengths, such as creativity or athletic ability
- communication skills
- friendships
- attachments to adults

Tests

Blood and/or urine tests may be performed to check for STIs such as **syphilis** and HIV. Adolescent girls may be tested for **pregnancy**.

Procedures

If the sexual abuse included physical harm, injuries may be photographed for use in prosecution of the perpetrator. Serious injuries may require diagnostic imaging procedures.

Treatment

Traditional

The child will be treated for any physical injuries. Police and child protection agencies investigate reports of sexual abuse and are responsible for protecting the child from additional harm. This may involve placing a child with a non-abusive parent or other relative or in a foster home.

Sexually abused children and their families may receive mental health treatment from a counselor, therapist, social worker, psychologist, or psychiatrist:

- Individual therapy is geared to the child's age. It may involve traditional talk therapy or art, play, or music therapy for children who are unable to talk about their experiences.
- Group therapy with other sexually abused children can help a child feel less isolated and learn new skills through games, role playing, and discussions.
- Family therapy can improve parent-child communications and help parents and children learn new coping skills.

Drugs

A sexually abused child may require **antibiotics** or other drugs to prevent or treat STIs. Older girls may be treated with drugs to prevent pregnancy.

Alternative

Support groups for sexually abused children, as well as for their parents or caregivers, can provide an alternative to traditional treatments.

Home remedies

A child's family and home life are critical for recovery from sexual abuse. Important factors include:

- ongoing acceptance of the child's experiences and emotional responses
- respect for the child's level of comfort with physical contact, including touching, hugging, kissing, tickling, and playful wrestling
- encouraging children to respect the comfort levels and privacy preferences of others, including knocking before entering bedrooms and bathrooms and bathing and dressing in private, if possible
- preventing children's exposure to adolescent and adult sexual behaviors
- monitoring children's exposure to television, movies, music and music videos, video games, and magazines with sexual messages, including language and nudity
- monitoring children's Internet usage

Some abused children exhibit sexually aggressive behaviors that require extra safety precautions:

- supervision when playing with friends
- avoidance of sleepovers
- informing the school counselor or other personnel about the possibility of inappropriate behaviors
- extra supervision in other group situations such as daycare, after-school programs, or camp

Prognosis

Various factors influence the effects of sexual abuse on a child, including:

- the type of abuse
- the frequency and duration of the abuse
- the gender of the child and the abuser
- the child's age and emotional development, with younger children being more vulnerable
- the child's relationship to the abuser and the degree to which the abuse is a betrayal of trust
- the form of coercion or seduction
- threats of harm to the child or to the child's family, friends, or pets
- emphasis on secrecy
- the child's ability to cope with his or her physical and emotional responses
- the degree to which the child feels responsible for the abuse

If untreated, the emotional and psychological damage from sexual abuse can be devastating. Children who are coerced into hiding the abuse are most likely to suffer

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long-term effects. Fear, anger, guilt, and shame can continue into adulthood, resulting in:

- low self-esteem
- chronic feelings of guilt, helplessness, or hopelessness
- self-destructive behaviors
- anxiety disorders
- sleep disorders
- eating disorders
- depression
- problems with intimacy and trust
- sexual disorders
- unsafe sexual behaviors
- marital and family problems
- PTSD
- psychotic symptoms
- multiple personality disorder from attempts to dissociate from the experience
- suicidal tendencies

There may be other long-term consequences of childhood sexual abuse, including an increased risk for:

- teen pregnancy
- sexually abusing others
- prostitution
- homelessness
- alcohol abuse
- drug addiction

Sexually abused children who receive professional treatment and support from families and friends are much less likely to experience long-term consequences. Many sexually abused children grow up to live happy and productive lives. Most do not become adult abusers.

Prevention

- Parents should be aware that most sexual abuse is perpetrated by someone the child knows.
- Toddlers should be taught the proper names of body parts and that the parts covered by a bathing suit are private.
- Preschoolers should be taught about their private body parts and how to talk to and touch others respectfully.
- Children aged five to eight should be taught to respect the private parts of others and expect the same respect from others. They should also be taught how to recognize potentially dangerous situations, such as being accosted by a stranger.
- Parents should visit their child's caregivers unannounced.
- Children should be taught that if someone tries to touch their body, look at their private parts, show them their parts, or otherwise makes them uncomfortable, they should immediately say "no" and tell a parent or trusted adult.
- Children should not be taught to automatically obey adults.
- Children should be taught not to keep secrets.
- Children should be taught what to do if they are separated from their family in a public place.
- Children should be taught never to go with anyone without their parent's permission.
- Children should be taught to run away and scream if someone tries to take them.
- Children aged eight through 12 should be taught about personal safety when away from home, about sexual abuse, and about peer pressure.
- Parents should talk with their children about sex openly, honestly, and frequently, and give understandable, age-appropriate answers to questions.
- Children should feel that they can talk to their parents about anything that makes them uncomfortable, afraid, or confused.
- Parents should learn what sexual behaviors are normal at each age and be aware of any abnormal or aggressive behaviors.
- Parents should talk to their teenagers about types of sexual abuse, prevention of STIs and pregnancy, and drugs and alcohol.
- Teens should be taught to respect others and expect the same: No one should ever have to say "no" more than once.
- Parents should know the children and adults with whom their children associate.
- Parents should monitor their children's television and movie viewing and Internet use.

Most school systems have programs to teach young children about sexual abuse and its prevention. High schools usually teach students about avoiding **rape** and date rape.

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American Academy of Child & Adolescent Psychiatry (AACAP), 3615 Wisconsin Ave., NW, Washington, DC, 20016-3007, (202) 966-7300, (202) 966-2891, http://www.aacap.org.
Child Welfare Information Gateway, Children's Bureau/ACYF, 1250 Maryland Ave., SW, Eighth Floor, Washington, DC, 20024, (800) 394–3366, info@childwelfare.gov, http://www.childwelfare.gov.
Childhelp, 15757 N. 78th St., Suite B, Scottsdale, AZ, 85260, (480) 922–8212 , (800) 4-A-CHILD, (480) 922-7061, http://www.childhelpusa.org.
National Center for Missing & Exploited Children (NCMEP), Charles B. Wang International Children's Building, 699 Prince St., Alexandria, VA, 22314-3175, (703) 224-2150, (800) THE-LOST (843-5678), (703) 224–2122, http://www.missingkids.com.
RAINN/Rape, Abuse & Incest National Network, 2000 L St., NW, Suite 406, Washington, DC, 20036, (202) 544–1034, (800) 656-HOPE, info@rainn.org, http://www.rainn.org.

Margaret Alic, PhD

Sexual addiction

Definition

Psychiatrists do not agree on the exact definition of sexual addiction. The general elements of sexual addiction are a compulsive pattern of sexual behavior that arises from distorted thinking; sexual behavior that interferes with personal relationships, work, or other responsibilities; and often sex with multiple partners who are seen as objects to be used rather than people.

Demographics

Because there is no professional agreement on the definition of sexual addiction, the number of people who are sex addicts is unknown. What is known is that sexual addiction is much more common in men than women. Sex addicts are not necessarily sex offenders, nor are sexual molesters and rapists all sex addicts. Many sex addicts have other mental health and impulse control problems that contribute to their addictive behaviors.

Description

Although a healthy interest in sex is normal, sexual addiction goes well beyond normal healthy interest. For the sexual addict, thinking about sexual activity and having sex dominate thoughts to a degree that it interferes with healthy personal relationships and activities. According to the organization Sex Addicts Anonymous, this compulsive interest in sex covers a wide range of activities including

- compulsive masturbation
- compulsive viewing of pornography

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KEY TERMS

Bipolar disorder— Formerly called manic depressive disorder. A mood disorder characterized alternating periods of overconfidence and activity (manic highs) and depressive lows.

Dissociate—To separate or disconnect thoughts and feelings from oneself and one's actions, usually in response to a painful, traumatic or highly stressful situation.

Obsessive-compulsive disorder (OCD)—An anxiety disorder in which a person cannot prevent himself from dwelling on unwanted thoughts, acting on urges, or performing repetitious rituals, such as washing his hands or checking to make sure he turned off the lights.

Paraphilia—Recurring strong sexual arousal to fantasies, objects, situations, or individuals that are not considered normal in the individual's culture.

- compulsive phone sex
- multiple affairs outside of an established relationship
- frequent sex with anonymous partners
- multiple one-night stands
- prostitution or using prostitutes
- exhibitionism
- voyeurism
- sexual stalking
- sexual molestation or rape

Causes and symptoms

The cause of sexual addiction is not known. Some researchers have suggested that abnormal brain chemistry is responsible. Others suggest that early experiences and childhood **sexual abuse** contribute to the disorder. Nevertheless, there is general agreement among psychiatrists that sex addicts usually have one or more additional mental health disorders. Where experts disagree is over whether these mental health disorders alone are enough to cause the addict's behavior or whether sexual addiction is a separate disorder present in addition to other psychiatric disorders.

Common psychiatric disorders among individuals exhibiting sexually addictive behavior include

- obsessive-compulsive disorder (OCD)
- paraphilia
- bipolar disorder
- mania
- impulse control disorders
- substance abuse
- depression
- post traumatic stress disorder (PTSD)

Specific symptoms of sexual addiction vary with the sex act involved. However, a cycle of events appears to be common to sex addicts. In stage 1, the individual has some ongoing emotional stressor(s) (e.g., fear, **pain**, anger, and loneliness). The individual is unable to develop a healthy way to relieve or cope with the stressor(s). As a result, the individual moves on to stage 2. In stage 2, the individual begins to dissociate and separate thoughts and emotions from contemplated or anticipated actions. It is as if the and contemplated actions belong to someone else and will have no consequences for the individual. In stage 3, the individual moves from thinking about acting on his or her thoughts to actually acting on them. This may mean making obscene phone calls, viewing pornography, or searching for a sexual partner. The action culminates in sexual release, and then there is a period ranging from hours to weeks before the cycle starts again.

Diagnosis

Diagnosis of sexual addiction is difficult, as many sex addicts deny that they have a problem. It is also complicated by the fact that sexual addiction often is associated with other mental health disorders. Sexual addiction is not recognized as a specific diagnosis in the *Diagnostic and Statistical Manual of Mental Disorders-IV, Text Revision* (*DSM-IV-TR*) used by the American Psychiatric Association (APA) to classify mental disorders. Instead, it is classified as a sexual disorder not otherwise specified (NOS). This designation is intended to be used when other causes for the behavior, such as **impulse control disorders** and **obsessive-compulsive disorder**, have been eliminated. Within the APA, there is substantial controversy over whether sexual addiction should be classified as a separate psychiatric disorder in the upcoming *DSM-V*, which is to be released in 2013. The way this disorder is classified may effect both treatment and insurance coverage.

Treatment

There are two approaches to treating sexual addiction. Psychiatrists who see the disorder as mainly caused by compulsive disorder or as a variation on an impulse control disorder may treat the disorder with drugs such as fluoxetine (Prozac) or clomipramine (Anafranil) along with **psychotherapy**.

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Psychiatrists who see sexual addiction as its own disorder are more likely to use psychotherapy to help the individual control addictive behavior. However, unlike addiction to drugs or alcohol, the goal of treating sexual addiction is not complete abstinence from sex, but rather to develop a normal, healthy approach to sex. Psychotherapy for sexual addiction may involve treatment at a residential center or intensive outpatient therapy. Regardless of where the therapy takes place, the individual should be treated by professionals experienced in dealing with sexual compulsions. Some therapy may involve couples. Often, therapy is supplemented by a 12-step recovery program such as the one designed by Sex Addicts Anonymous. Since many sex addicts have other mental health disorders such as **substance abuse** or depression, these also are treated with drugs and psychotherapy.

Prognosis

Recovery from sexual addiction is difficult. The earlier the addiction is treated (i.e., stage 1 or 2 before thoughts have been translated into actions), the greater the chance for recovery. Most sex addicts, however, do not recognize their disorder in its early stages and thus do not receive early treatment. Often it takes a major life-altering event to propel the sex addicted individual into treatment. Even then, relapses are common. Prognosis is also affected by the success or failure of treatment for other disorders such as substance **abuse**.

Prevention

Since the causes of sexual addiction are not clear, there is no definitive form of prevention. Recognizing the problem and getting early treatment for stressors can help prevent behaviors from becoming full-blown sexual addiction.

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American Psychiatric Association, 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209-3901, (703)907-7300, (888) 35-PSYCH [(888) 357-7924], apa@psych. org, http://www.psych.org.

Sex Addicts Anonymous, P. O. Box 70949, Houston, TX, 77270, (800) 477-8191 [US and Canada} +1 713-869-4902 [other countries] , info@saa-recovery.org, http://saa-recovery.org.

Tish Davidson, AM

Sexual arousal disorders *see* **Sexual dysfunction**

Sexual desire disorders *see* **Sexual dysfunction**

Sexual dysfunction

Definition

Sexual dysfunction is broadly defined as the inability to fully enjoy sexual intercourse. Specifically, sexual dysfunctions are disorders that interfere with a full sexual response cycle. These disorders make it difficult for a person to enjoy or to have sexual intercourse. While sexual dysfunction rarely threatens physical health, it can take a heavy psychological toll, bringing depression, **anxiety**, and debilitating feelings of inadequacy.

Description

Sexual dysfunction takes different forms in men and women. A dysfunction can be life-long and always present; acquired; situational; or generalized, occurring despite the situation. A man may have a sexual problem if he:

- ejaculates before he or his partner desires
- does not ejaculate, or experiences delayed ejaculation
- is unable to have an erection sufficient for pleasurable intercourse

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- feels pain during intercourse
- lacks or loses sexual desire

A woman may have a sexual problem if she:

- lacks or loses sexual desire
- has difficulty achieving orgasm
- feels anxiety during intercourse
- feels pain during intercourse
- feels vaginal or other muscles contract involuntarily before or during sex
- has inadequate lubrication

The most common sexual dysfunctions in men include:

- Erectile dysfunction: an impairment of the erectile reflex. The man is unable to have or maintain an erection that is firm enough for coitus or intercourse.
- Premature ejaculation, or rapid ejaculation with minimal sexual stimulation before, on, or shortly after penetration and before the person wishes it.
- Ejaculatory incompetence: the inability to ejaculate within the vagina despite a firm erection and relatively high levels of sexual arousal.
- Retrograde ejaculation: a condition in which the bladder neck does not close off properly during orgasm so that the semen spurts backward into the bladder.

Until recently, it was presumed that women were less sexual than men. In the past two decades, traditional views of female sexuality were all but demolished, and women's sexual needs became accepted as legitimate in their own right.

Female sexual dysfunctions include:

- Sexual arousal disorder: the inhibition of the general arousal aspect of sexual response. A woman with this disorder does not lubricate, her vagina does not swell, and the muscle that surrounds the outer third of the vagina does not tighten—a series of changes that normally prepare the body for orgasm ("the orgasmic platform"). Also, in this disorder, the woman typically does not feel erotic sensations.
- Orgasmic disorder: the impairment of the orgasmic component of the female sexual response. The woman may be sexually aroused but never reach orgasm. Orgasmic capacity is less than would be reasonable for her age, sexual experience, and the adequacy of sexual stimulation she receives.
- Vaginismus: a condition in which the muscles around the outer third of the vagina have involuntary spasms in response to attempts at vaginal penetration.
- Painful intercourse: a condition that can occur at any age. Pain can appear at the start of intercourse, midway through coital activities, at the time of orgasm, or after intercourse is completed. The pain can be felt as burning, sharp searing, or cramping; it can be external, within the vagina, or deep in the pelvic region or abdomen.

Causes and symptoms

Many factors, of both physical and psychological natures, can affect sexual response and performance. Injuries, ailments, and drugs are among the physical influences; in addition, there is increasing evidence that chemicals and other environmental pollutants depress sexual function. As for psychological factors, sexual dysfunction may have roots in traumatic events such as **rape** or incest, feelings of guilt, a poor self-image, depression, chronic **fatigue**, certain religious beliefs, or marital problems. Dysfunction is often associated with anxiety. If a man operates under the misconception that all sexual activity must lead to intercourse and to orgasm by his partner, and if the expectation is not met, he may consider the act a failure.

Men

With **premature ejaculation**, physical causes are rare, although the problem is sometimes linked to a neurological disorder, prostate infection, or **urethritis**. Possible psychological causes include anxiety (mainly performance anxiety), guilty feelings about sex, and ambivalence toward women. However, research has failed to show a direct link between premature ejaculation and anxiety. Rather, premature ejaculation seems more related to sexual inexperience in learning to modulate arousal.

When men experience painful intercourse, the cause is usually physical; an infection of the prostate, urethra, or testes, or an allergic reaction to spermicide or **condoms**. Painful erections may be caused by **Peyronie's disease**, fibrous plaques on the upper side of the penis that often produce a bend during erection. **Cancer** of the penis or testis and arthritis of the lower back can also cause **pain**.

Retrograde ejaculation occurs in men who have had prostate or urethral surgery, take medication that keeps the bladder open, or suffer from diabetes, a disease that can injure the nerves that normally close the bladder during ejaculation.

Erectile dysfunction is more likely than other dysfunctions to have a physical cause. Drugs, diabetes (the most common physical cause), Parkinson's

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disease, **multiple sclerosis**, and spinal cord lesions can all be causes of erectile dysfunction. When physical causes are ruled out, anxiety is the most likely psychological cause of erectile dysfunction.

Female

Dysfunctions of arousal and orgasm in women also may be physical or psychological in origin. Among the most common causes are day-to-day discord with one's partner and inadequate stimulation by the partner. Finally, sexual desire can wane as one ages, although this varies greatly from person to person.

Pain during intercourse can occur for any number of reasons, and location is sometimes a clue to the cause. Pain in the vaginal area may be due to infection, such as urethritis; also, vaginal tissues may become thinner and more sensitive during **breastfeeding** and after **menopause**. Deeper pain may have a pelvic source, such as **endometriosis**, pelvic **adhesions**, or uterine abnormalities. Pain can also have a psychological cause, such as fear of injury, guilt feelings about sex, fear of **pregnancy** or injury to the fetus during pregnancy, or recollection of a previous painful experience.

Vaginismus may be provoked by these psychological causes as well, or it may begin as a response to pain, and continue after the pain is gone. Both partners should understand that the vaginal contraction is an involuntary response, outside the woman's control.

Similarly, insufficient lubrication is involuntary, and may be part of a complex cycle. Low sexual response may lead to inadequate lubrication, which may lead to discomfort, and so on.

Diagnosis

In deciding when a sexual dysfunction is present, it is necessary to remember that while some people may be interested in sex at almost any time, others have low or seemingly nonexistent levels of sexual interest. Only when it is a source of personal or relationship distress, instead of voluntary choice, is it classified as a sexual dysfunction.

The first step in diagnosing a sexual dysfunction is usually discussing the problem with a health care professional, who will need to ask further questions in an attempt to differentiate among the types of sexual dysfunction. A physical exam of the genitals may be performed, and further medical tests may be ordered, including measurement of hormone levels in the blood. Men may be referred to a specialist in diseases of the urinary and genital organs (urologist), and primary care physicians may refer women to a gynecologist.

In general, causes of sexual dysfunction are either physical or psychological. Physical causes often have an underlying condition that effect sexual function including:

- diabetes
- heart disease
- neurological disorders
- pelvic surgery or trauma
- alcoholism and drug abuse
- chronic disease such as kidney or liver failure
- side effects of medicines
- hormone imbalance
- heavy smoking

Psychological factors including the following:

- stress or anxiety
- insecurity about sexual performance
- relationship discord
- confusion regarding sexual orientation
- depression
- trauma in previous sexual experiences

The following agents have been associated with sexual dysfunction, so patients should speak to their doctors if they have concerns regarding: Tamoxifen, Luminal, Dilantin, Mysloine, Tegretol, Tricyclic, Anafranil, Prozac, Paxil, Inderal, Lopressor, Corgard, Blocadren, Tenormin, Cimetidine, Tagament, Thorazine, Haldol, Zyprexa, Xanax, Valium, and some progestin-dominant birth control pills. It is important to note that there may be alternate medications available that do not affect sexual function. Other agents may also be available to counteract any sexual dysfunctions experienced with these medications. Prescribed medication should not be discontinued without first speaking with a physician.

Treatment

Treatments break down into two main kinds, physical and behavioral **psychotherapy**.

In many cases, doctors or advance practice nurses may prescribe medications to treat an underlying physical cause or sexual dysfunction. Possible medical treatments include:

- Viagra (Sildenafil) is a treatment for erectile dysfunction in men.
- Papaverine and prostaglandin are used for erectile difficulties.
- MUSE (Medical Urethral System for Erection), a prostaglandin E-1 pellet which can be inserted into the urethra. In addition, Caverject and Edex are

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prostaglandin E-1 injection medications for erectile dysfunction.

- Surgically implanted inflatable penile prosthesis for erectile dysfunction.
- Androgel, a topical gel for testosterone/androgen replacement in men. Testosterone injections and patches may also be used in men and women to stimulate sexual desire.
- Clomipramine, fluoxetine, as well as serotonin reuptake inhibitors such as Prozac, Zoloft, and Anafranil for premature ejaculation.
- Hormone replacement therapy for female dysfunctions.
- EROS-CTD, a clitoral therapy device approved by the FDA in May 2000 is designed to enhance lubrication and sensation in women who have arousal disorders. With a gentle suction, it increases blood flow to the clitoris and surrounding area.

Other agents include:

- ICOS is an agent for treatment of erectile dysfunction.
- Uprima (apomorphine) claims to induce erection in men and arousal in women.
- Vasomax, an oral tablet, is said to facilitate an erection within 10–15 minutes. It is anticipated that Vasomax may aid women as well as men.
- Viagra for women.
- SS Cream is a topical agent with natural plant extracts which appears to desensitize the penis and is used to treat premature ejaculation.

In some cases, a specific technique may be used during intercourse to correct a dysfunction. One of the most common is the "squeeze technique" to prevent premature ejaculation. When a man feels that an orgasm is imminent, he withdraws from his partner. Then, the man or his partner gently squeezes the head of the penis to halt the orgasm. After 20–30 seconds, the couple may resume intercourse. The couple may do this several times before the man proceeds to ejaculation.

In cases where significant sexual dysfunction is linked to a broader emotional problem, such as depression or **substance abuse**, intensive psychotherapy and/or pharmaceutical intervention may be appropriate.

A variety of alternative therapies can be useful in the treatment of sexual dysfunction. Counseling or psychotherapy is highly recommended to address any emotional or mental components of the disorder. Botanical medicine, either western, Chinese, or ayurvedic, as well as nutritional supplementation, can help resolve biochemical causes of sexual dysfunction. **Acupuncture** and homeopathic treatment can be helpful by focusing on the energetic aspects of the disorder.

KEY TERMS

Ejaculatory incompetence—The inability to ejaculate within the vagina.

Erectile dysfunction—Difficulty achieving or maintaining an erect penis.

Impotence—The inability to achieve and sustain an erection suitable for intercourse.

Orgasmic disorder—The impairment of the ability to reach sexual climax.

Painful intercourse (dyspareunia)—Generally thought of as a female dysfunction but it also affects males. Pain can occur anywhere.

Premature ejaculation—Rapid ejaculation before the person wishes it, usually in less than one to two minutes after beginning intercourse.

Retrograde ejaculation—A condition in which the semen spurts backward into the bladder.

Sexual arousal disorder—The inhibition of the general arousal aspect of sexual response.

Vaginismus—Muscles around the outer third of the vagina have involuntary spasms in response to attempts at vaginal penetration, not allowing for penetration.

Some problems with sexual function are normal. For example, women starting a new or first relationship may feel sore or bruised after intercourse and find that an over-the-counter lubricant makes sex more pleasurable. Simple techniques, such as soaking in a warm bath, may relax a person before intercourse and improve the experience. **Yoga** and **meditation** provide needed mental and physical relaxation for several conditions, such as vaginismus. Relaxation therapy eases and relieves anxiety about dysfunction. Massage is extremely effective at reducing **stress**, especially if performed by the partner.

Prognosis

There is no single cure for sexual dysfunction, but almost all can be controlled. Most people who have a level of sexual dysfunction fare well once they get into a treatment program. For example, a high percentage of men with premature ejaculation can be successfully treated in two to three months. Furthermore, the gains made in **sex therapy** tend to be long-lasting rather than short-lived. Viagra produces an erection in 75% of men with erectile dysfunction. For men who are not responsive to drug treatment, studies with surgically

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implanted inflatable penile prosthesis claim a success rate at approximately 98%.

Health care team roles

Nursing and allied health professionals play a critical part in the diagnosis and treatment of sexual dysfunction. Sex therapy, which is ideally provided by a member of the American Association of Sexual Educators, Counselors, and Therapists (AASECT), universally emphasizes correcting sexual misinformation, the importance of improved partner communication and honesty, anxiety reduction, sensual experience and pleasure, and interpersonal tolerance and acceptance. Sex therapists believe that many sexual disorders are rooted in learned patterns and values. These are termed psychogenic. An underlying assumption of sex therapy is that relatively short-term outpatient therapy can alleviate learned patterns, restrict symptoms, and allow a greater satisfaction with sexual experiences.

Registered dietitians and nutritionists can be instrumental in giving dietary guidance and **nutrition** supplementation that may improve overall health and energy levels. Health improvements may impact general well-being and sexual function.

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ORGANIZATIONS

American Academy of Clinical Sexologists, 1929 18th Street NW, Suite 1166, Washington, DC, 20009, (202) 462-2122.

American Association for Marriage and Family Therapy, 1100 17th Street NW, 10th Floor, Washington, DC, 20036-4601, (202) 452-0109.

American Association of Sex Educators, Counselors & Therapists, P. O. Box 238, Mt. Vernon, IA, 52314.

American Foundation for Urologic Disease, Sexual Function Health Council, 1126 N. Charles Street, Baltimore, MD, 21201, (410) 468-1800, http://www.impotence.org.

National Kidney and Urologic Diseases, Information Clearinghouse, 3 Information Way, Bethesda, MD, 20892-3580, http://www.niddk.nih.gov.

Network for Excellence in Women's Sexual Health (NEWSHE), Female Sexual Medicine Center, UCLA Medical Center, 924 Westwood Blvd., Suite 520, Los Angeles, CA, 90095, (310) 825-0025, (310) 794-0211, http://www.newshe.com.

Crystal Heather Kaczkowski, MSc.

Sexual perversions

Definition

Sexual perversions are conditions in which sexual excitement or orgasm is associated with acts or imagery that are considered unusual within the culture. To avoid problems associated with the stigmatization of labels, the neutral term paraphilia, derived from Greek roots meaning "alongside of" and "love," is used to describe what used to be called sexual perversions. A paraphilia is a condition in which a person's sexual

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arousal and gratification depend on a fantasy theme of an unusual situation or object that becomes the principal focus of sexual behavior.

Description

Paraphilias can revolve around a particular sexual object or a particular act. They are defined by *DSM-IV* as "sexual impulse disorders characterized by intensely arousing, recurrent sexual fantasies, urges and behaviors considered deviant with respect to cultural norms and that produce clinically significant distress or impairment in social, occupational or other important areas of psychosocial functioning." The nature of a paraphilia is generally specific and unchanging, and most of the paraphilias are far more common in men than in women.

Paraphilias differ from what some people might consider "normal" sexual activity in that these behaviors cause significant distress or impairment in areas of life functioning. They do not refer to the normal use of sexual fantasy, activity, or objects to heighten sexual excitement where there is no distress or impairment. The most common signs of sexual activity that can be classified as paraphilia include: the inability to resist an impulse for the sexual act, the requirement of participation by non-consenting or under-aged individuals, legal consequences, resulting **sexual dysfunction**, and interference with normal social relationships.

Paraphilias include fantasies, behaviors, and/or urges which:

- involve nonhuman sexual objects, such as shoes or undergarments
- require the suffering or humiliation of oneself or partner
- involve children or other non-consenting partners

The most common paraphilias are:

- exhibitionism, or exposure of the genitals
- fetishism, or the use of nonliving objects
- frotteurism, or touching and rubbing against a non-consenting person
- pedophilia, or the focus on prepubescent children
- sexual masochism, or the receiving of humiliation or suffering
- sexual sadism, or the inflicting of humiliation or suffering
- transvestic fetishism, or cross-dressing
- voyeurism, or watching others engage in undressing or sexual activity

A paraphiliac often has more than one paraphilia. Paraphilias often result in a variety of associated problems, such as guilt, depression, shame, isolation, and impairment in the capacity for normal social and sexual relationships. A paraphilia can, and often does, become highly idiosyncratic and ritualized.

Causes and symptoms

There is very little certainty about what causes a paraphilia. Psychoanalysts generally theorize that these conditions represent a regression to or a fixation at an earlier level of psychosexual development resulting in a repetitive pattern of sexual behavior that is not mature in its application and expression. In other words, an individual repeats or reverts to a sexual habit arising early in life. Another psychoanalytic theory holds that these conditions are all expressions of hostility in which sexual fantasies or unusual sexual acts become a means of obtaining revenge for a childhood trauma. The persistent, repetitive nature of the paraphilia is caused by an inability to erase the underlying trauma completely. Indeed, a history of childhood **sexual abuse** is sometimes seen in individuals with paraphilias.

However, behaviorists suggest, instead, that the paraphilia begins via a process of conditioning. Nonsexual objects can become sexually arousing if they are frequently and repeatedly associated with a pleasurable sexual activity. The development of a paraphilia is not usually a matter of conditioning alone; there must usually be some predisposing factor, such as difficulty forming person-to-person sexual relationships or poor self-esteem.

The following are situations or causes that might lead someone in a paraphiliac direction:

- parents who humiliate and punish a small boy for strutting around with an erect penis
- a young boy who is sexually abused
- an individual who is dressed in a woman's clothes as a form of parental punishment
- fear of sexual performance or intimacy
- inadequate counseling
- excessive alcohol intake
- physiological problems
- sociocultural factors
- psychosexual trauma

Diagnosis

Whatever the cause, paraphiliacs apparently rarely seek treatment unless they are induced into it by an

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arrest or discovery by a family member. This makes diagnosis before a confrontation very difficult.

Paraphiliacs may select an occupation, or develop a hobby or volunteer work, that puts them in contact with the desired erotic stimuli, for example, selling women's shoes or lingerie in fetishism, or working with children in pedophilia. Other coexistent problems may be alcohol or drug **abuse**, intimacy problems, and personality disturbances, especially emotional immaturity. Additionally, there may be sexual dysfunctions. **Erectile dysfunction** and an inability to ejaculate may be common in attempts at sexual activity without the paraphiliac theme.

Paraphilias may be mild, moderate, or severe. An individual with mild paraphilia is markedly distressed by the recurrent paraphiliac urges but has never acted on them. The moderate has occasionally acted on the paraphilic urge. A severe paraphiliac has repeatedly acted on the urge.

KEY TERMS

Exhibitionism—Obtaining sexual arousal by exposing genitals to an unsuspecting stranger.

Fetishism—Obtaining sexual arousal using or thinking about an inanimate object or part of the body.

Frotteurism—Obtaining sexual arousal and gratification by rubbing one's genitals against others in public places.

Masochism—Sexual arousal by having pain and/or humiliation inflicted upon oneself.

Pedophilia—Sex or sexual activity with children who have not reached puberty.

Sadism—Sexual arousal through inflicting pain on another person.

Transvestitism—Sexual arousal from dressing in the clothes of the opposite sex.

Voyeurism—Sexual arousal by observing nude individuals without their knowledge.

Treatment

The literature describing treatment is fragmentary and incomplete. Traditional **psychoanalysis** has not been particularly effective with paraphilia and generally requires several years of treatment. Therapy with hypnosis has also had poor results. Current interests focus primarily on several behavioral techniques that include the following:

- Aversion imagery involves the pairing of a sexually arousing paraphilic stimulus with an unpleasant image, such as being arrested or having one's name appear in the newspaper.
- Desensitization procedures neutralize the anxiety-provoking aspects of nonparaphilic sexual situations and behavior by a process of gradual exposure. For example, a man afraid of having sexual contact with women his own age might be led through a series of relaxation procedures aimed at reducing his anxiety.
- Social skills training is used with either of the other approaches and is aimed at improving a person's ability to form interpersonal relationships.
- Orgasmic reconditioning may instruct a person to masturbate using his paraphilia fantasy and to switch to a more appropriate fantasy just at the moment of orgasm.

In addition to these therapies, drugs are sometimes prescribed to treat paraphilic behaviors. Drugs that drastically lower testosterone temporarily (antiandrogens) have been used for the control of repetitive deviant sexual behaviors and have been prescribed for paraphilia-related disorders as well. Cyproterone acetate inhibits testosterone directly at androgen receptor sites. In its oral form, the usual prescribed dosage range is 50–200 mg per day.

Serotonergics (drugs that boost levels of the brain chemical serotonin) are prescribed for anxious and depressive symptoms. Of the serotonergic agents reported, fluoxetine has received the most attention, although lithium, clomipramine, buspirone, and sertraline are reported as effective in case reports and open clinical trials with outpatients. Other alternative augmentation strategies that may be effective include adding a low dose of a secondary amine tricyclic antidepressant to the primary serotonergics, but these reports are only anecdotal.

Prognosis

Despite more than a decade of experience with psychotherapeutic treatment programs, most workers in the field are not convinced that they have a high degree of success. Furthermore, because some cases involve severe abuse, many in the general public would prefer to "lock up" the sex offender than to have him out in the community in a treatment program or on parole after the treatment program has been completed.

Paraphilia and paraphilia-related disorders are more prevalent than most clinicians suspect. Since these

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disorders are cloaked in shame and guilt, the presence of these conditions may not be adequately revealed until a therapeutic alliance is firmly established. Once a diagnosis is established, appropriate education about possible behavioral therapies and appropriate use of psychopharmacological agents can improve the prognosis for these conditions.

ORGANIZATIONS

American Academy of Clinical Sexologists, Inc., 3203 Lawton Road, Suite 170, Orlando, FL, 32803, (407) 645-1641, http://www.esextherapy.com.

American Association for Marriage and Family Therapy, 112 South Alfred Street, Alexandria, VA, 22314-3061, (703) 838-9808, (703) 838-9805, http://www.aamft.org.

David James Doermann

Sexually transmitted diseases

Definition

Sexually transmitted disease (STD) is a term used to describe more than 20 different infections that are transmitted through exchange of semen, blood, and other body fluids, or by direct contact with the affected body areas of people with an STD. Sexually transmitted diseases are also called venereal diseases.

Antibiotics used to treat STDs

Brand name (generic name)	Possible side effects
Ceftin (cefuroxime axetil)	Diarrhea, nausea and vomiting, skin irritation
Cipro (ciprofloxacin)	Headache, heartburn, nausea and vomiting, stomach pain
Doryx (doxycycline hyclate)	Diarrhea, itching (genital and/or rectal), loss of appetite, nausea and vomiting, swelling
Flagyl (metronidazole)	Numbness or tingling sensation in extremities, seizures
Floxin (ofloxacin)	Diarrhea, dizziness, genital itching, headache, nausea and vomiting
Minocin (minocycline hydrochloride)	Anemia, blurred vision, hives, rash, throat irritation
Noroxin (norfloxacin)	Dizziness, headache, nausea
Zithromax (azithromycin)	Abdominal pain, diarrhea, nausea and vomiting

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Demographics

The Centers for Disease Control and Prevention (CDC) has reported that 85% of the most prevalent infectious diseases in the United States are sexually transmitted. The rate of STDs in this country is 50 to 100 times higher than that of any other industrialized nation. One in four sexually active Americans will be affected by an STD at some time in his or her life.

The CDC estimates that about 19 million new STD infections occur in the United States each year. Almost half of these infections occurs in someone between the ages of 15 and 24. It is estimated that STDs have an economic cost of as much as $15.9billion dollars each year in the United States alone.

The two most commonly reported STDs are Chlamydia and **gonorrhea**, with more than 1.5 million new cases being reported annually. The most frequently affected group is girls between 15 and 19 years of age, and women between 20 and 24 years of age. Other STDs may occur more frequently than Chlamydia and gonorrhea, but because some STDs such as human papillomavirus (HPV) and **genital herpes** do not get reported to the CDC they tend to be undercounted.

Description

Types of STDs

Some of the most common and potentially serious STDs in the United States include:

- Chlamydia. This STD is caused by the bacterium *Chlamydia trachomatis*, a microscopic organism that lives as a parasite inside human cells. In 2008, there were 1,210,523 reported cases of Chlamydia. That means that Chlamydia affects more about 40 out of every 1000 people. Chlamydia has been increasing in frequency in the United States in recent years, with a 9.2% increase in reported cases from 2007 to 2008. Approximately 40% of women will develop pelvic inflammatory disease (PID) as a result of Chlamydia infection, a leading cause of infertility.
- Human papillomavirus (HPV). HPV causes genital warts and is the single most important risk factor for cervical cancer in women. Over 100 types of HPV exist, but only about 30 of them can cause genital warts and are spread through sexual contact. In some instances, warts are passed from mother to child during childbirth, leading to a potentially life-

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threatening condition for newborns in which warts develop in the throat (laryngeal papillomatosis).

- Genital herpes. Herpes is an incurable viral infection thought to be one of the most common STDs in the United States. It is caused by one of two types of herpes simplex viruses: HSV-1 (commonly causing oral herpes) or HSV-2 (usually causing genital herpes). The CDC estimates that there were 292,000 new cases of genital herpes in 2008. It is believed to affect more than 45 million Americans (one out of every five individuals 12 years of age or older) are infected with HSV-2; this number has increased 30% since the 1970s. HSV-2 infection is more common in women (one out of every four women) than men (one out of every five men) and in African Americans than Caucasians.
- Gonorrhea. The bacterium *Neisseria gonorrhoeae* is the causative agent of gonorrhea and can be spread by vaginal, oral, or anal contact. The CDC reports that 336,742 new cases of gonorrhea were reported in 2008. This is about 111.6 cases per 100,000 people. This was a decrease of 5.4% from 2007. Since 1975 reported cases of gonorrhea have declined more than 70%.
- Syphilis. Syphilis is a potentially life-threatening infection that increases the likelihood of acquiring or transmitting HIV. In 2008, the CDC reported approximately 13,500 new cases of syphilis in the United States. This was the highest number of new cases reported since 1995. The rate of primary and secondary syphilis is about 4.5 cases per 100,000 people, and the rate of congenital syphilis is about 10.1 per 100,000 live births. Congenital syphilis causes irreversible health problems or death in as many as 40% of all live babies born to women with untreated syphilis.
- Human immunodeficiencyvirus (HIV) infection. The CDC estimates that there are approximately 1,106,400 people in the United States living with HIV/AIDS, and that about one fifth of them were not aware of the HIV infection. In 2007 there were 35,962 diagnosed cases of AIDS in the United States, with 28 of them occurring in children under the age of 13. As of 2010 The World Health Organization estimated that there were 33.4 million people living with HIV worldwide. There is no cure for this STD.

STDs can have very painful long-term consequences as well as immediate health problems. They can cause:

- birth defects
- blindness
- bone deformities
- brain damage
- cancer
- heart disease
- infertility and other abnormalities of the reproductive system
- mental retardation
- death

Social groups and STDs

STDs affect certain population groups more severely than others. Women, young people, and members of minority groups are particularly affected. Women in any age bracket are more likely than men to develop medical complications related to STDs. Ethnic minorities are more likely to be affected by STDs than Caucasians, with African Americans especially at risk, although this may be changing. For example in 2008 the incidence of **syphilis** among white women was 0.5 cases per 100,000, while the incidence among African American women was 7.6 cases per 100,000.

Causes and symptoms

The symptoms of STDs vary according to the disease agent (virus or bacterium), the sex of the patient, and the body systems affected. The symptoms of some STDs are easy to identify, others produce infections that may either go unnoticed for some time or are easy to confuse with other diseases. Syphilis in particular can be confused with disorders ranging from **infectious mononucleosis** to allergic reactions to prescription medications. In addition, the incubation periods of STDs varies. Some produce symptoms close enough to the time of sexual contact—often less than 48 hours later—for the individual to recognize the connection between the behavior and the symptoms. Others have a longer incubation period, so that the individual may not recognize the early symptoms as those of a sexually transmitted infection.

Some symptoms of STDs affect the genitals and reproductive organs:

- A woman who has an STD may bleed when she is not menstruating or have abnormal vaginal discharge. Vaginal burning, itching, and odor are common, and she may experience pain in her pelvic area while having sex.
- A discharge from the tip of the penis may be a sign that a man has an STD. Males may also have painful or burning sensations when they urinate.
- There may be swelling of the lymph nodes near the groin area.
- Both men and women may develop skin rashes, sores, bumps, or blisters near the mouth or genitals.

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KEY TERMS

Chlamydia—A microorganism that resembles certain types of bacteria and causes several sexually transmitted diseases in humans.

Condom—A thin sheath worn over the penis during sexual intercourse to prevent pregnancy or the transmission of STDs. There are also female condoms.

Diaphragm—A dome-shaped device used to cover the back of a woman's vagina during intercourse in order to prevent pregnancy.

Pelvic inflammatory disease (PID)—An inflammation of the tubes leading from a woman's ovaries to the uterus (the Fallopian tubes), caused by a bacterial infection. PID is a leading cause of fertility problems in women.

Venereal disease—Another term for sexually transmitted disease.

Homosexual men frequently develop these symptoms in the area around the anus.

Other symptoms of STDs are systemic, which means that they affect the body as a whole. These symptoms may include:

- fever, chills, and similar flu-like symptoms
- skin rashes over large parts of the body
- arthritis-like pains or aching in the joints
- throat swelling and redness that lasts for three weeks or longer

Diagnosis

A sexually active person who has symptoms of an STD should be examined without delay by one of the following health care professionals:

- a specialist in women's health (gynecologist)
- a specialist in disorders of the urinary tract and the male sexual organs (urologist)
- a family physician
- a nurse practitioner
- a specialist in skin disorders (dermatologist).

The diagnostic process begins with a thorough **physical examination** and a detailed medical history that documents the patient's sexual history and assesses the risk of infection.

The doctor or other healthcare professional will:

- Describe the testing process. This includes all blood tests and other tests that may be relevant to the specific infection.
- Explain the meaning of the test results.
- Provide the patient with information regarding high-risk behaviors and any necessary treatments or procedures.

The doctor may suggest that a patient diagnosed with one STD be tested for others, as its possible to have more than one STD at a time. One infection may hide the symptoms of another or create a climate that fosters its growth. At present, it is particularly important that people who are HIV-positive be tested for syphilis as well.

Notification

The law in some parts of the United States requires public health officials to trace and contact the partners of people with some STDs. Minors, however, can get treatment without their parents' permission. Public health departments in most states can provide information about STD clinic locations, and Planned Parenthood facilities are available to provide testing and counseling. These agencies can also help with or assume the responsibility of notifying sexual partners who should be tested and may require treatment.

Treatment

Although self-care can relieve some of the **pain** of genital herpes or **genital warts** that has recurred after being diagnosed and treated by a physician, other STD symptoms require immediate medical attention.

Antibiotics are prescribed to treat gonorrhea, Chlamydia, syphilis, and other STDs caused by bacteria. Although prompt diagnosis and early treatment can almost always cure these STDs, new infections can develop if exposure continues or is renewed. Viral infections can be treated symptomatically and possibly with antiviral medications.

Prognosis

The prognosis for recovery from STDs varies among the different diseases. The prognosis for recovery from gonorrhea, syphilis, and other STDs caused by bacteria is generally good, provided that the disease is diagnosed early and treated promptly. Untreated syphilis in particular can lead to long-term complications and disability. Viral STDs (genital herpes, genital **warts**, HIV) cannot be cured but must be treated on a long-term basis to relieve symptoms and prevent life-threatening complications.

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Prevention

Vaccines

Vaccines for the prevention of **hepatitis A** and **hepatitis B** are currently available, and are recommended, especially for gay and bisexual men, users of illegal drugs, health care workers, and others at risk of contracting these diseases. Vaccine for HPV also is available and is recommended for young women. Vaccines to prevent other STDs are being actively researched and tested.

Research into vaccinations to prevent HIV infection are underway. Although some have undergone clinical trials as of 2010 there are no vaccines approved by the United States Food and Drug Administration (FDA) to prevent the disease.

Lifestyle choices

The risk of becoming infected with an STD can be reduced or eliminated by making certain choices. Abstaining from sexual contact, maintaining a mutually monogamous relationship, or being informed about a partner's medical status can all reduce the risk. The risk of contracting an STD can also be reduced by avoiding sexual contact with partners who are known to be infected with an STD, whose health status is unknown, who **abuse** drugs, or who are involved in the sex trade.

Use of condoms and other contraceptives

Condoms are the only known contraceptive method to reduce the risk of STD transmission. It is important to make sure a new condom is used every time there is genital, oral, or anal contact. Used correctly and consistently, male condoms provide good protection against HIV and other STDs such as gonorrhea, Chlamydia, and syphilis. Female condoms (lubricated sheaths inserted into the vagina) have also been shown to be effective in preventing HIV and other STDs. Condoms also provide a measure of protection against genital herpes, genital warts, and hepatitis B.

There is some evidence that spermicides and diaphragms may provide a small amount of protection from some STDs, but that claim remains extremely controversial, and it recommended that people do not use these instead of other methods of STD protection. They do not protect women from contracting HIV. Birth-control pills, patches, or injections do not prevent STDs. Neither do surgical sterilization or **hysterectomy**.

Hygienic measures

Urinating and washing the genital area with soap and water immediately after having sex may eliminate some germs before they cause infection. Douching, however, can spread infection deeper. It may also increase a woman's risk of developing **pelvic inflammatory disease** (PID).

Resources

BOOKS

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Grimes, Jill.*Seductive Delusions: How Everyday People Catch STDs*. Baltimore : Johns Hopkins University Press, 2008.

Marr, Lisa. *Sexually Transmitted Diseases: A Physician Tells You What You Need to Know* 2nd ed. Baltimore : The Johns Hopkins University Press, 2007.

Nack, Adina.*Damaged goods?: women living with incurable sexually transmitted diseases*. Philadelphia: Temple University Press, 2008.

OTHER

Medline Plus. Sexually Transmitted Diseases. February 3 2010. http://www.nlm.nih.gov/medlineplus/sexuallytransmitteddiseases.html

National STD and AIDS Hotline. (800)227-8922.

ORGANIZATIONS

AIDS Education and Training Centers (AETC) National Resource Center, 65 Bergen Street, 8th floor, Newark, NJ, 07101, info@aidsetc.org, http://www.aidsetc.org.

CDC National Prevention Information Network, P.O. Box 6003, Rockville, MD, 20849-6003, (404) 639-3113, (888)CDC-INFO (888) 232-4636, a 24-hour information number., cdcinfo@cdc.gov, http://www.cdc.gov.

Planned Parenthood Federation of America, 434 West 33rd St., New York, NY, 10001, (212) 541-7800, (800) 230-PLAN, (212) 245-1845, http://www.plannedparenthood.org.

United States Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (404) 639-3534, 800-CDC-INFO (800-232-4636). TTY: (888) 232-6348, inquiry@cdc.gov, http://www.cdc.gov.

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Sexually transmitted diseases cultures

Definition

Sexually transmitted diseases are infections spread from person to person through sexual contact. A culture is a test in which a laboratory attempts to grow and identify the microorganism causing an infection.

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Cultures on agar plates. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Purpose

Sexually transmitted diseases (STDs) produce symptoms such as genital discharge, **pain** during urination, bleeding, pelvic pain, skin ulcers, or **urethritis**. Often, however, they produce no immediate symptoms. Therefore, the decision to test for these diseases must be based not only the presence of symptoms, but on whether or not a person is at risk of having one or more of the diseases. Activities, such as drug use and sex with more than one partner, put a person at high risk for these diseases.

STD cultures are necessary to diagnose certain types of STDs. Only after the infection is diagnosed can it be treated and further spread of the infection prevented. Left untreated, consequences of these diseases range from discomfort to **infertility** to **death**. In addition, these diseases, if present in a pregnant woman, can be passed from mother to fetus.

Description

Gonorrhea, **syphilis**, chlamydia, **chancroid**, herpes, human papillomavirus, human **immunodeficiency** virus (HIV), and mycoplasma are common sexually transmitted diseases. Not all are diagnosed with a culture. For those that are, a sample of material is taken from the infection site, placed in a sterile container, and sent to the laboratory.

Bacterial cultures

In the laboratory, a portion of material from the infection site is spread over the surface of several different types of culture plates and placed in an incubator at body temperature for one to two days. Bacteria present in the sample will multiply and appear on the plates as visible colonies. They are identified by the appearance of their colonies and by the results of biochemical tests and a gram stain. The Gram stain is done by smearing part of a colony onto a microscope slide. After it dries, the slide is stained with purple and red stains, then examined under a microscope. The color of stain picked up by the bacteria (purple or red), the shape (such as round or rectangle), and the size provide valuable clues as to the identity and which **antibiotics** might work best. Bacteria that stain purple are called Gram-positive; those that stain red are called gram-negative.

The result of the gram stain is available the same day or in less than an hour if requested by the physician. An early report, known as a preliminary report, is usually available after one day. This report will tell if any microorganisms have been found yet, and if so, their Gram stain appearance—for example, a Gram-negative rod or a gram-positive cocci. The final report, usually available in one to seven days, includes complete identification and an estimate of the quantity of the microorganisms isolated.

A sensitivity test, also called antibiotic susceptibility test, commonly done on bacteria isolated from an infection site, is not always done on bacteria isolated from a sexually transmitted disease. These bacteria often are treated using antibiotics that are part of a standard treatment protocol.

GONORRHEA. *Neisseria gonorrhoeae*, also called gonococcus or GC, causes gonorrhea. It infects the surfaces of the genitourinary tract, primarily the urethra in males and the cervix in females. On a gram stain done on material taken from an infection site, the bacteria appear as small gram-negative diplococci (pairs of round bacteria) inside white blood cells. *Neisseria gonorrhoeae* grows on a special culture plate called Thayer-Martin (TM) media in an environment with low levels of oxygen and high levels of carbon dioxide.

The best specimen from which to culture *Neisseria gonorrhoeae* is a swab of the urethra in a male or the cervix in a female. Other possible specimens include vagina, body fluid discharge, swab of genital lesion, or the first urine of the day. Final results usually are available after two days. Rapid nonculture tests are available to test for GC and provide results on the same or following day.

CHANCROID. Chancroid is caused by *Haemophilus ducreyi*. It is characterized by genital ulcers with nearby swollen lymph nodes. The specimen is collected by swabbing one of these pus-filled ulcers. The gram stain may not be helpful as this bacteria looks just like other Haemophilus bacteria. This bacteria only grows on special culture plates, so the physician

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must request a specific culture for a person who has symptoms of chancroid. Even using special culture plates, *Haemophilus ducreyi* is isolated from less than 80% of the ulcers it infects. If a culture is negative, the physician must diagnose chancroid based on the person's symptoms and by ruling out other possible causes of these symptoms, such as syphilis.

MYCOPLASMA. Three types of mycoplasma organisms cause sexually transmitted urethritis in males and **pelvic inflammatory disease** and **cervicitis** in females: *Mycoplasma hominis*, *Mycoplasma gentialium*, and *Ureaplasma urealyticum*. These organisms require special culture plates and may take up to six days to grow. Samples are collected from the cervix in a female, the urethra or semen in a male, or urine.

SYPHILIS. Syphilis is caused by *Treponema pallidum*, one in a group of bacteria called spirochetes. It causes ulcers or chancres at the site of infection. The organism does not grow in culture. Using special techniques and stains, it is identified by looking at a sample of the ulcer or chancre under the microscope. Various blood tests also may be done to detect the treponema organism.

CHLAMYDIA. Chlamydia is caused by the gram-negative baterium *Chlamydia trachomatis*. It is one of the most common STDs in the United States and generally appears in sexually active adolescents and young adults. While chlamydia often does not have any initial symptoms, it can, if left untreated, lead to pelvic inflammatory disease and sterility. Samples are collected from one or more of these infection sites: cervix in a female, urethra in a male, or the rectum. A portion of specimen is combined with a specific type of cell and allowed to incubate. Special stains are performed on the cultured cells, looking for evidence of the chlamydia organism within the cells. A swab can also be taken from the woman's vulva. Men and women can now be screened for Chlamydia with a urine sample. Urine-based screening has increased screening significantly, especially among men.

Viral cultures

To culture or grow a virus in the laboratory, a portion of specimen is mixed with commercially prepared animal cells in a test tube. Characteristic changes to the cells caused by the growing virus help identify the virus. The time to complete a viral culture varies with the type of virus. It may take several days or up to several weeks.

HERPES VIRUS. Herpes simplex virus type 2 is the cause of **genital herpes**. Diagnosis is usually made based on the person's symptoms. If a diagnosis needs confirmation, a viral culture is performed using material taken from an ulcer. A Tzanck smear is a microscope test that can rapidly detect signs of herpes infection in cells taken from an ulcer. The culture takes up to 14 days. In 2004, the FDA approved a blood test to detect the antibodies to herpes virus.

HUMAN PAPILLOMAVIRUS. Human papillomavirus causes **genital warts**. This virus will not grow in culture; the diagnosis is based on the appearance of the **warts** and the person's symptoms. In late 2003, the U.S. Food and Drug Administration (FDA) approved a human papillomavirus (HPV) DNA test with a Pap smear for screening women age 30 and older. The combined test would help physicians determine which women were at extremely low risk for **cervical cancer** and which should be more closely monitored.

HIV. Human immunodeficiency virus (HIV) is usually diagnosed with a blood test. Cultures for HIV are possible, but rarely needed for diagnosis. However, newer rapid tests were developed in 2003 and approved by the FDA in 2004. These tests are cheaper and can deliver results in as little as three minutes. The FDA also approved an HIV test in 2004 that can detect HIV in saliva.

Preparation

Generally, the type of specimen depends on the type of infection. Cultures always should be collected before the person begins taking antibiotics. After collection of these specimens, each is placed into a sterile tube containing a liquid in which the organism can survive while in route to the laboratory. The new rapid HIV tests rely on blood samples collected from a finger stick or vein or on saliva collected from the mouth. Initial results are not sent to a lab but are processed onsite.

Urethral specimen

Men should not urinate one hour before collection of a urethral specimen. The physician inserts a sterile, cotton-tipped swab into the urethra.

Cervical specimen

Women should not douche or take a bath within 24 hours of collection of a cervical or vaginal culture. The physician inserts a moistened, nonlubricated vaginal speculum. After the cervix is exposed, the physician removes the cervical mucus using a cotton ball. Next, he or she inserts a sterile cotton-tipped swab into the endocervical canal and rotates the swab with firm pressure for about 30 seconds.

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KEY TERMS

Culture—A laboratory test done to grow and identify microorganisms causing infection.

Gram stain—Microsopic examination of a portion of a bacterial colony or sample from an infection site after it has been stained by special stains. Certain bacteria pick up the purple stain; these bacteria are called gram positive. Other bacteria pick up the red stain; these bacteria are called gram negative. The color of the bacteria, in addition to their size and shape, provide clues as to the identity of the bacteria.

Sensitivity test—A test that determines which antibiotics will kill the bacteria isolated from a culture.

Vulva—The external part of the woman's genital organs, including the vaginal vestibule.

Vaginal specimen

Women should not douche or take a bath within 24 hours of collection of a cervical or vaginal culture. The physician inserts a sterile, cotton-tipped swab into the vagina.

Anal specimen

The physician inserts a sterile, cotton-tipped swab about 1 inch into the anus and rotates the swab for 30 seconds. Stool must not contaminate the swab.

Oropharynx (throat) specimen

The person's tongue is held down with a tongue depressor, as a healthcare worker moves a sterile, cotton-tipped swab across the back of the throat and tonsil region.

Urine specimen

To collect a "clean-catch" urine, the person first washes the perineum, and the penis or labia and vulva. He or she begins urinating, letting the first portion pass into the toilet, then collecting the remainder into a sterile container.

Normal results

These microorganisms are not found in a normal culture. Many types of microorganisms, normally found on a person's skin and in the genitourinary tract, may contaminate the culture. If a mixture of these microorganisms grow in the culture, they are reported as normal flora.

Abnormal results

If a person has a positive culture for one or more of these microorganisms, treatment is started and his or her sexual partners should be notified and tested. Certain laws govern reporting and partner notification of various STDs. After treatment is completed, the person's physician may want a follow-up culture to confirm the infection is gone.

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ORGANIZATIONS

American Social Health Association, P.O. Box 13827, Research Triangle Park, NC, 27709, (919) 361-8400, (919) 361-8425, http://www.ashastd.org/.

Centers for Disease Control and Prevention. National Center for HIV, STD, and TB Prevention, 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov/nchhstp/.

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SGOT *see* **Aspartate aminotransferase test**

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Shaken baby syndrome

Definition

Shaken baby syndrome is a severe form of closed-head injury caused by the forcible shaking of a child. The force is sufficient to cause the brain to bounce against the baby's skull, causing injury or damage to the brain. It is also known as shaken infant syndrome, SBS, abusive head trauma, shaken brain trauma, pediatric traumatic brain injury, and whiplash shaken infant syndrome. The syndrome was first identified by Dr. John Caffey (1895–1978), a pediatric radiologist who published a landmark paper on the subject in 1972.

Demographics

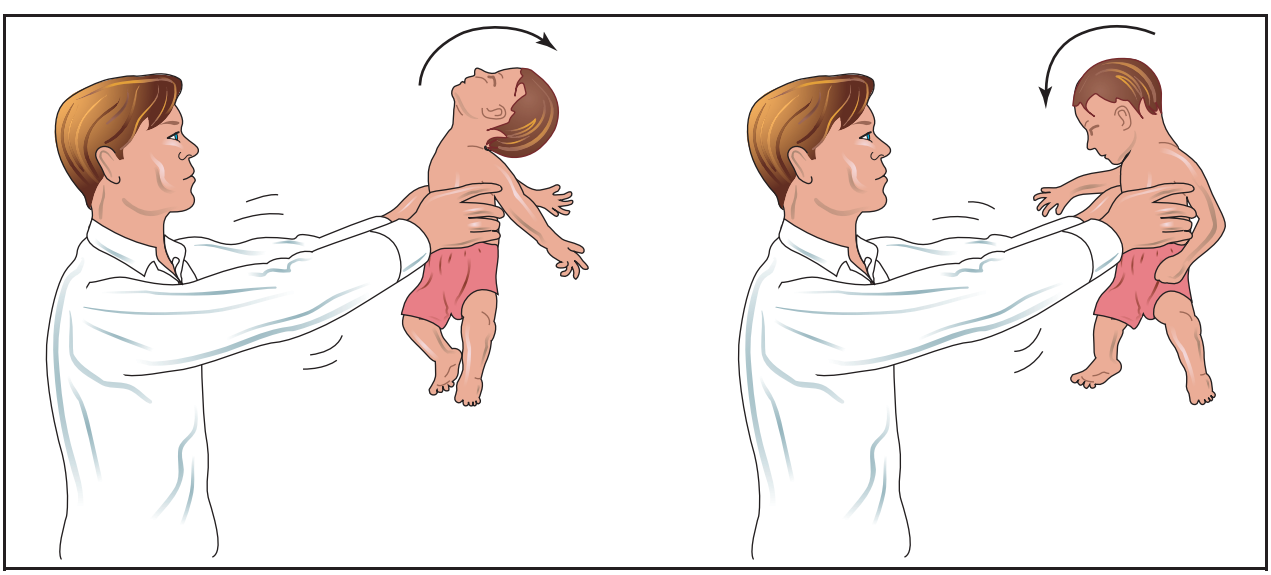
The American Academy of Pediatrics (AAP) estimates that there are between 600 and 1400 cases of SBS in the United States each year, though it is possible that the true number is higher because some cases are misdiagnosed as the result of accidental falls or auto accidents. The National Center on Shaken Baby Syndrome gives a figure of 1200 to 1400 cases annually in the United States. What is known is that shaken baby syndrome is the most common cause of mortality and long-term disability in infants and young children due to physical **abuse**. The syndrome has been reported in infants as young as 5 days and children as old as 5 years, but most victims are 2 years or younger.

SBS occurs in all racial groups in the United States but is more likely to be caused by males than by females. Adult males in their early 20s are the perpetrators in 65 to 90 % of cases; most often they are the baby's father or the mother's boyfriend. Female perpetrators are more likely to be a teenage babysitter or nanny than the baby's mother. The usual trigger for the abuse is crying lasting for several hours or repeated diaper soiling. In some cases involving men, the abuser is angry because he is jealous of the attention the baby receives from its mother.

Description

Shaking an infant forcibly transfers a great deal of energy to the infant. When the shaking occurs as the infant is being held, much of the force is transferred to the neck and the head. The force can be so great that the brain can move within the skull, rebounding back and forth from one side of the skull to the other. The bashing can be very destructive to the brain and neck because it can cause bruising, swelling, or bleeding. Bleeding of the brain is also called intracerebral hemorrhage.

As its name implies, shaken baby syndrome can often be a result of deliberate abuse. The brain damage can also be the result of an accident. The force and length of the force necessary to cause shaken baby syndrome is debatable. What is clear is that not much time is needed, since most shaking events likely tend to last only 20



Shaken baby syndrome is a collective term for the internal head injuries a baby or young child sustains from being violently shaken. Because of the fragile state of an infant's brain tissue and blood vessels, when a baby is vigorously shaken by the chest, as shown in the illustration above, the whiplash motion repeatedly jars the baby's brain with extreme force, causing serious internal damage and bleeding. Nearly 2,000 American children die annually from this condition. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

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seconds or less. It is the explosive violence of the shaking that exacts the damage.

Risk factors

Risk factors for shaken baby syndrome include:

- Male sex. Most perpetrators of SBS are male.
- Substance abuse. While alcohol and drug abuse do not cause violence in the strict sense of cause, they lower a person's internal inhibitions against violence.
- Lack of information about normal child development.
- Psychological role reversal in which the caregiver expects the baby to fulfill his or her emotional needs.
- Divorce, separation, or family breakup.
- Financial stress.
- Social isolation. Caregivers who do not have friends or neighbors they can talk to (geographical distance, language barriers, recent move) may take out their loneliness as well as other stressors on the baby.
- Caregiver has personal history of having been abused as a child.

KEY TERMS

Closed-head injury—An injury to the head in which the skull is not broken or penetrated.

Increased intracranial pressure—Increased overall pressure inside the skull.

Meningitis—Inflammation of the protective membranes that cover the brain and spinal cord.

Perpetrator—The legal term for a person who commits a crime.

Radiologist—A doctor who specializes in medical imaging techniques to diagnose or treat disease.

Retina—The layer of light-sensitive tissue at the back of the eyeball.

Subdural hematoma—A collection of blood or a clot trapped under the dura mater, the outermost membrane surrounding the brain and spinal cord, often causing neurological damage due to pressure on the brain.

Causes and symptoms

The cause of the brain, neck, and spine damage that can result from shaken baby syndrome is brute force. Brain damage results from bleeding beneath the skull and bruising of brain tissue due to the brain's moving up against the inside of the skull during shaking. In some cases the brain is also damaged by loss of its oxygen supply.

The violent shaking of a baby by a much stronger adult conveys a tremendous amount of energy to the infant. Part of the reason for the damage is because an infant's head is much larger than the rest of the body, in relation to an older child or an adult. This, combined with neck muscles that are still developing and are incapable of adequately supporting the head, can make shaking an explosively destructive event. The amount of brain damage depends on how hard the shaking is and how long an infant is shaken. If accidental, the force and length of the head trauma similarly determines the extent of injury. The normal tossing and light horse play that can occur between an adult and an infant is not sufficient to cause shaken baby syndrome.

The damage to the brain can have dire consequences that include permanent and severe brain damage or **death**. Other symptoms that can develop include behavioral changes, lack of energy or motivation, irritable behavior, loss of consciousness, paling of the skin color or development of a bluish tinge to the skin, **vomiting**, and convulsions. These symptoms are the result of the destruction of brain cells, which is primarily due to the trauma of the blow against the skull, and secondarily as a result of oxygen deprivation and swelling of the brain. The banging of the brain against the sides of the skull causes the inflammation and swelling as well as internal bleeding. Increased intracranial pressure can be damaging to the structure and function of the brain.

Additionally, because the neck and head can absorb a tremendous amount of energy due to the shaking force of the adult, bones in the neck and spine can be broken and muscles can be torn or pulled. The eyes can also be damaged by the explosive energy of shaking. Retinal damage occurs in 50–80% of cases. The damage can be so severe that it can permanently blind an infant.

Babies who are less severely injured when shaken may have symptoms that are easy to confuse with the symptoms of flu:

- Vomiting or other flu-like symptoms *without* fever or diarrhea.
- Crankiness and irritability over a period of time.
- Poor feeding, loss of appetite.
- Breathing problems.
- Unusual drowsiness.

Diagnosis

The doctor's greatest help in making a correct diagnosis of shaken baby syndrome is a description of what happened by the perpetrator or a witness. In

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many cases an abuser will tell the doctor that the child fell or was in a car accident, or that the abuser shook the baby trying to revive it. One important clue is that the injuries caused by SBS are usually much more severe than would be caused by a fall or other accidental **head injury**.

Examination

Diagnosis depends on the detection of a blood clot below the inner layer of the dura mater (a membrane that surrounds the brain), but external to the brain. The clot is also known as a **subdural hematoma**. Two other critical features of shaken baby syndrome that are used in diagnosis are brain swelling and hemorrhaging in the eyes.

An infant may also have external bruising on parts of the body that were used to grip him or her during shaking. Bone or rib **fractures** can also be apparent. However, these external features may not always be present and the abuse may not be detected during a routine office visit.

Tests

Diagnosis of SBS can also involve the nondestructive imaging of the brain using the techniques of computed tomography (CT), skull x ray, or **magnetic resonance imaging** (MRI). Typically, these procedures are done after an infant has been stabilized and survival is assured. X-rays of the ribs and long bones of the body may also be ordered if the doctor suspects the child was struck with an object, thrown against a wall, or shaken.

In some cases the doctor may order laboratory tests of blood or cerebrospinal fluid to rule out **meningitis** and other infectious diseases that can affect the brain and cause seizures or **coma**.

Treatment team

Treatment in an emergency setting typically involves nurses and emergency room physicians. A neurosurgeon is usually consulted when shaken baby syndrome is suspected. Depending on the extent of injury, neurosurgeons can become involved if surgery for brain repair is needed. An ophthalmologist may be consulted to examine the baby's eyes for evidence of bleeding into the retina.

Police officers and social workers also become involved in cases of shaken baby syndrome in order to ensure that the child is placed in a safe environment.

Treatment

Traditional

Children with severe injuries from shaken baby syndrome require emergency treatment, usually brain surgery to relieve pressure on the brain and respiratory support to help them breathe. Treatment of the blindness, **learning disorders**, **mental retardation**, and other long-term consequences of SBS may last for the rest of the child's life. These children often need special education services, **physical therapy**, **speech therapy**, eye treatment, **psychotherapy**, and **occupational therapy**. Medical costs associated with initial and long-term care for these children can range from $300,000 to more than $1,000,000.

Clinical trials

As of May 2010, there are three clinical trials on shaken baby syndrome underway. Two trials concern educational strategies to prevent SBS by teaching parents about the syndrome and how to cope with **stress**; the third is a trial of preventing **colic** in children, as colic is a common cause of the crying and fussiness that may lead to parents' losing self-control. Such other agencies as the National Institute of Neurological Disorders and Stroke (NINDS) also fund studies that seek to better understand the basis of the damage. Other agencies attempt to lessen the occurrence of the syndrome through counseling, anger management, and interventions in abusive situations.

Prognosis

SBS has a high mortality rate. It is estimated that a third of the babies who are abused in this way will die; twenty percent of cases result in death within the first few days after injury. Another third will suffer severe permanent injuries, and the remaining third will recover.

Prevention

Dr. Caffey believed in the value of education to prevent at least some instances of SBS. While some abusers are people with a history of **substance abuse** or poor impulse control, others do not understand how much an angry adolescent or adult can harm a baby by shaking it. Various prevention strategies that are used as of 2010 include showing videos about SBS to new parents; encouraging pediatricians to discuss the stresses of childrearing with parents and teach them some ways to soothe a crying child; asking social workers to help identify families at risk of **child abuse**;

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instructing workers in day care centers and others who work with small children about the syndrome; and advising parents to screen babysitters or nannies very carefully before hiring them for child care responsibilities.

The Arc, a community-based organization of and for people with developmental disabilities, offers three key words for caregivers to remember when dealing with a crying or fussy baby: Stop, Calm down, and Try again:

- Stop: Do not handle the baby if you are upset or angry. Place the child in a safe place like a crib or playpen.
- Calm down: Leave the room but stay close enough to hear the baby. Listen to calming music for a short time; then call a friend or a hotline for support or advice. Another approach is to run the vacuum cleaner; the noise will drown out the sound of the crying, and it also calms some babies. Keep in mind that the baby may be crying from an earache, teething, or other illness as well as hunger or a wet diaper. If the baby cannot be soothed and keeps crying for a long time, it is best to call the doctor.
- Try again: After calming down, try again to help the baby.

Keep the number of the Childhelp National Child Abuse Hotline on the refrigerator or near the telephone: 1-800-4-A-CHILD (1-800-422-4453). The hotline is staffed 24 hours a day, 365 days a year.

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National Institute of Neurological Disorders and Stroke (NINDS). *Shaken Baby Syndrome Information Page*. http://www.ninds.nih.gov/disorders/shakenbaby/shakenbaby.htm.

ORGANIZATIONS

American Academy of Neurology (AAN), 1080 Montreal Avenue, Saint Paul, MN, 55116, (651) 695-2717, (800) 879-1960, (651) 695-2791, http://www.aan.com/.

American Academy of Pediatrics (AAP), 141 Northwest Point Boulevard, Elk Grove Village, IL, 60007, (847) 434-4000, (847) 434-8000, http://www.aap.org/.

The Arc of the United States, 1660 L Street, NW, Suite 301, Washington, DC, 20036, (202) 534-3700, (800) 433-5255, (202) 534-3731, http://www.thearc.org/NetCommunity/Page.aspx?pid=1386.

Brain Trauma Foundation (BTF), 415 Madison Avenue, 14th Floor, New York, NY, 10017, (212) 772-0608, http://www.braintrauma.org/site/PageServer?pagename=homepage.

National Center on Shaken Baby Syndrome, 2955 Harrison Blvd #102, Ogden, UT, 84403, (801) 627-3399, (888) 273-0071, (801) 627-3321, mail@dontshake.org, http://www. dontshake.org/index.php.

National Institute of Neurological Disorders and Stroke (NINDS), P.O. Box 5801, Bethesda, MD, 20824, (800)352-9424,(301) 496-5751, http://www.ninds.nih.gov/index.htm.

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Shiatsu

Definition

Shiatsu is a manipulative therapy developed in Japan that incorporates techniques of *anma* (Japanese traditional massage), **acupressure**, stretching, and Western massage. Shiatsu involves applying pressure to special points or areas on the body in order to maintain physical and mental well being, treat disease, or alleviate discomfort. This therapy is considered holistic because it attempts to treat the whole person instead of a specific medical complaint. All types of acupressure generally focus on the same pressure points and so-called energy pathways but may differ in terms of massage technique. Shiatsu, which can be translated as finger pressure, has been described as needle-free **acupuncture**.

Purpose

Shiatsu has a strong reputation for reducing **stress** and relieving **nausea and vomiting**. Shiatsu is also believed to improve circulation and boost the immune system. Some people use it to treat **diarrhea**, **indigestion**, **constipation**, and other disorders of the gastrointestinal tract; menstrual and menopausal problems; chronic **pain**; migraine; arthritis; **toothache**; **anxiety**; and depression. Shiatsu can be used to relieve muscular pain or tension, especially neck and back pain. It also appears to have sedative effects and may alleviate **insomnia**. In a broader sense, shiatsu is believed to enhance physical vitality and emotional well being.

Description

Origins

Shiatsu is an offshoot of anma that developed during the period after the Meiji Restoration in 1868. Traditional massage (anma) used during the age of shoguns was being criticized, and practitioners of *koho anma* (ancient way) displeased with it introduced new practices and new names for their therapies.

During the twentieth century, shiatsu distinguished itself from anma through the merging of Western knowledge of anatomy, koho anma, *ampuku* (abdominal massage), acupressure, *Do-In* (breathing practices), and Buddhism. Based on the work of Tamai Tempaku, shiatsu established itself in Japan and worldwide. The Shiatsu Therapists Association was founded in 1925 and clinics and schools followed. Students of Tempaku began teaching their own brand of shiatsu, creating branch disciplines. By 1955, the Japanese Ministry of Health and Welfare acknowledged shiatsu as a beneficial treatment, and licensing was established for practitioners.

Shiatsu and other forms of Japanese acupressure are based on the concept of *ki*, the Japanese term for the all-pervading energy that flows through everything in the universe. (This notion is borrowed from the Chinese, who refer to the omnipresent energy as qi or chi.) Ki tends to flow through the body along special energy pathways called meridians, each of which is associated with a vital organ. In Asian systems of traditional medicine, diseases are often believed to occur due to disruptions in the flow this energy through the body. These disruptions may stem from emotional factors, climate, or a host of other causes including stress, the presence of impurities in the body, and physical trauma.

The aim of shiatsu is to restore the proper flow of bodily energy by massaging the surface of the skin along the meridian lines. Pressure may also be applied to any of the 600 or so acupoints. Acupoints, which are supposedly located just under the skin along the meridians, are tiny energy structures that affect the flow of ki through the body. When ki either stagnates and becomes deflected or accumulates in excess along one of these channels, stimulation to the acupoints, which are sensitive to pressure, can unblock and regulate the ki flow through toning or sedating treatment.

Western medicine has not proven the existence of meridians and acupoints. However, in one study, two French medical doctors conducted an experiment at Necher Hospital in Paris to test validity of the theory that energy is being transported along acupuncture meridians. They injected and traced isotpes with gamma-camera imaging. The meridians may actually correspond to nerve transmission lines. In this view, shiatsu and other forms of healing massage may trigger the emission of naturally occurring chemicals called neurotransmitters. Release of these chemical messengers may be responsible for some of the therapeutic effects associated with shiatsu, such as pain relief.

Preparations

People usually receive shiatsu therapy while lying on a floor mat or massage table or sitting up. The massage is performed through the clothing—preferably a thin garment made from natural fibers—and disrobing is not required. Pressure is often applied using the thumbs, though various other parts of the body may be employed, including fingertips, palms, knuckles, elbows, and knees—some therapists even use their feet. Shiatsu typically consists of sustained pressure (lasting up to 10 seconds at a time), squeezing, and stretching exercises. It

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KEY TERMS

Acupressure—An ancient form of Asian healing massage that involves applying pressure to special points or areas on the body in order to maintain good health, cure disease, and restore vitality.

Analgesic—Pain reliever.

Osteoporosis—A disease of the bones due to deficiency of bone matrix, occurring most frequently in postmenopausal women.

Palpate—Feel.

may also involve gentle holding as well as rocking motions. A treatment session lasts anywhere from 30 to 90 minutes.

Before shiatsu treatment begins, the therapist usually performs a general health assessment. This involves taking a family medical history and discussing the physical and emotional health of the person seeking therapy. Typically, the practitioner also conducts a diagnostic examination by palpating the abdomen or back for any energy imbalances present in other parts of the body.

Precautions

While shiatsu is generally considered safe, there are a few precautions to consider. Because it may increase blood flow, this type of therapy is not recommended in people with bleeding problems, heart disease, or **cancer**. **Massage therapy** should always be used with caution in those with **osteoporosis**, fresh **wounds** or scar tissue, bone **fractures**, or inflammation.

Applying pressure to areas of the head is not recommended in people with **epilepsy** or high blood pressure, according to some practitioners of shiatsu.

Shiatsu is not considered effective in the treatment of **fever**, **burns**, and infectious diseases.

Shiatsu should not be performed right after a meal.

Side effects

When performed properly, shiatsu is not associated with any significant side effects. Some people may experience mild discomfort, which usually disappears during the course of the treatment session.

Research and general acceptance

Like many forms of massage, shiatsu is widely believed to have a relaxing effect on the body. There is also a significant amount of research suggesting that acupressure techniques can relieve **nausea** and **vomiting** associated with a variety of causes, including **pregnancy**, anesthetics, and other drugs. In one study, acupressure was shown to significantly reduce the effects of nausea in 12 of 16 women suffering from morning sickness. Five days of this therapy also appeared to reduce anxiety and improve mood. Another investigation, published in 1999, studied the effects of acupressure on nausea resulting from the use of anesthetics. Pressure applied to an acupoint on the inside of the wrist appeared to alleviate nausea in patients who received anesthetics during the course of laparoscopic surgery.

Shiatsu may also produce sedative and analgesic effects. The sedative powers of acupressure were investigated in a study published in the *Journals of Gerontology* 1999, which involved over 80 elderly people who suffered from sleeping difficulties. Compared to the people in the control groups, the 28 participants who received acupressure were able to sleep better. They slept for longer periods of time and were less likely to wake up during the night. The researchers concluded that acupressure may improve the quality of sleep in older adults. The use of acupressure in postoperative pain was investigated in a study published in 1996. In this study, which involved 40 knee surgery patients, one group received acupressure (15 acupoints were stimulated) while the control group received sham acupressure. Within an hour of treatment, members of the acupressure group reported less pain than those in the control group. The pain-relieving effects associated with acupressure lasted for 24 hours.

Shiatsu may benefit **stroke** victims. The results of at least one study (which did not include a control group) suggest that shiatsu may be useful during stroke **rehabilitation** when combined with other treatments.

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MEDLINE. http://igm.nlm.nih.gov.

ORGANIZATIONS

Acupressure Institute, 1533 Shattuck Avenue, Berkeley, CA, 94709, (510) 845-1059, (800) 442-2232, unfo@acupressureinstitute.com, http://www.acupressureinstitute.com.

American Massage Therapy Association, 500 Davis Street, Suite 900, Evanston, IL, 60201-4695, (847) 864-0123, (847) 864-5196, (877) 905-2700, info@amtamassage.org, http://www.amtamassage.org/.

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American Organization for Bodywork Therapies of Asia, 1010 Haddonfield-Berlin Road, Suite 408, Voorhees, NJ, 08043-3514, (856) 782-1616, (856) 782-1653, office@aobta.org, http://www.aobta.org/.

International School of Shiatsu, 10 South Clinton Street, Doylestown, PA, 18901, (215) 340-9918, (215) 340-9181, http://www.shiatsubo.com.

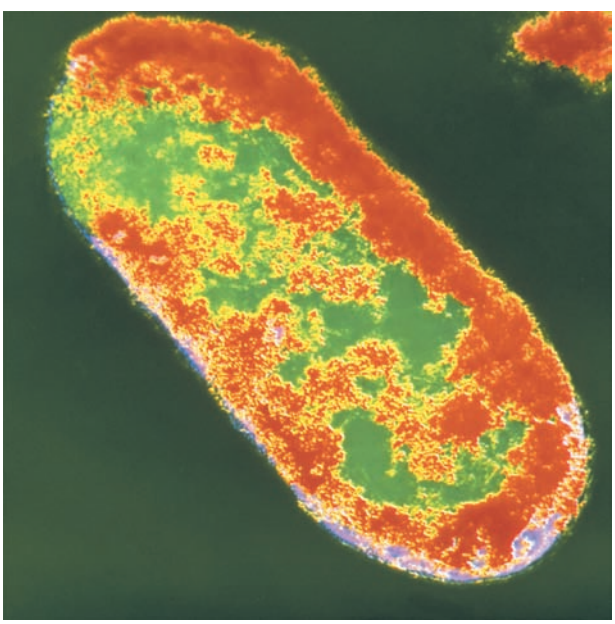
National Certification Board for Therapeutic Massage and Bodywork, 1901 South Meyers Road, Suite 240, Oak Brook, IL, 60181, (630) 627-8000, info@ncbtmb.org, http://www.ncbtmb.org.

Greg Annussek

Shigellosis

Definition

Shigellosis is an infection of the intestinal tract by a group of bacteria called *Shigella*. The bacteria is named in honor of Shiga, a Japanese researcher, who discovered the organism in 1897. The major symptoms are **diarrhea**, abdominal cramps, **fever**, and severe fluid loss (**dehydration**). Four different groups of *Shigella* can affect humans; of these, *S. dysenteriae* generally produces the most severe attacks, and *S. sonnei* the mildest.



A transmission electron microscopy (TEM) scan of *Shigella*, a genus of aerobic bacteria that causes dysentery in humans and animals. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Description

Shigellosis is a well-known cause of **traveler's diarrhea** and illness throughout the world. *Shigella* are extremely infectious bacteria and ingestion of just 10 organisms is enough to cause severe diarrhea and dehydration. *Shigella* accounts for 10-20% of all cases of diarrhea worldwide, and in any given year infects over 140 million persons and kills 600,000, mostly children and the elderly. The most serious form of the disease is called **dysentery**, which is characterized by severe watery (and often blood- and mucous-streaked) diarrhea, abdominal cramping, rectal **pain**, and fever. *Shigella* is only one of several organisms that can cause dysentery, but the term bacillary dysentery is usually another name for shigellosis.

Most deaths are in less-developed or developing countries, but even in the United States, shigellosis can be a dangerous and potentially deadly disease. Poor hygiene, overcrowding, and improper storage of food are leading causes of infection. The following statistics show the marked difference in the frequency of cases between developed and less-developed countries; in the United States, about 30,000 individuals are hit by the disease each year or about 10 cases/100,000 population. On the other hand, infection in some areas of South America is 1,000 times more frequent. Shigellosis is most common in children below age 5 and occurs less often in adults over 20.

Causes and symptoms

Shigella share several of the characteristics of a group of bacteria that inhabit the intestinal tract. *E coli,* another cause of food-borne illness, can be mistaken for *Shigella* both by physicians and the laboratory. Careful testing is needed to assure proper diagnosis and treatment.

Shigella are very resistant to the acid produced by the stomach, and this allows them to easily pass through the gastrointestinal tract and infect the colon (large intestine). The result is a **colitis** that produces multiple ulcers, which can bleed. *Shigella* also produce a number of toxins (Shiga toxin and others) that increase the amount of fluid secretion by the intestinal tract. This fluid secretion is a major cause of diarrhea symptoms.

Shigella infection spreads through food or water contaminated by human waste. Sources of transmission are:

- contaminated milk, ice cream, vegetables and other foods, which often cause epidemics
- household contacts (40% of adults and 20% of children will develop infection from such a source)
- poor hygiene and overcrowded living conditions
- day care centers

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- sexual practices which lead to oral-anal contact, directly or indirectly

Symptoms can be limited to only mild diarrhea or progress to full-blown dysentery. Dehydration results from the large fluid losses due to diarrhea, **vomiting**, and fever. Inability to eat or drink worsens the situation.

In developed countries, most infections are of the less severe type, and are often due to *S. sonnei*. The period between infection and symptoms (incubation period) varies from one to seven days. Shigellosis can last from a few days to several weeks, with an average of seven days.

Complications

Areas outside the intestine can be involved, including:

- nervous system (irritation of the meninges or meningitis, encephalitis, and seizures)
- kidneys (producing **hemolytic-uremic syndrome** or HUS, which leads to kidney failure)
- joints (leading to an unusual form of arthritis called **Reiter's syndrome**)
- skin (rash)

One of the most serious complications of this disease is HUS, which involves the kidney. The main findings are kidney failure and damage to red blood cells. As many as 15% of patients die from this complication, and half of the survivors develop **chronic kidney failure**, which requires dialysis.

Another life-threatening condition is toxic megacolon. Severe inflammation causes the colon to dilate or stretch, and the thin colon wall may eventually tear. Certain medications (particularly those that diminish intestinal contractions) may increase this risk but this interaction is unclear. Clues to this diagnosis include sudden decrease in diarrhea, swelling of the abdomen, and worsening abdominal pain.

Diagnosis

Shigellosis is one of the many causes of acute diarrhea. Culture (growing the bacteria in the laboratory) of freshly obtained diarrhea fluid is the only way to be certain of the diagnosis. But even this is not always positive, especially if the patient is already on **antibiotics**. *Shigella* are identified by a combination of their appearance under the microscope and various chemical tests. These studies take several days but quicker means to recognize the bacteria and its toxins are being developed.

Treatment

The first aim of treatment is to keep up **nutrition** and avoid dehydration. Ideally, a physician should be consulted before starting any treatment. Antibiotics may not be necessary, except for the more severe infections. Many cases resolve before the diagnosis is established by culture. Medications that control diarrhea by slowing intestinal contractions can cause problems and should be avoided by patients with bloody diarrhea or fever, especially if antibiotics have not been started.

Rehydration

The World Health Organization (WHO) has developed guidelines for a standard solution taken by mouth and prepared from ingredients readily available at home. This Oral Rehydration Solution (ORS) includes salt, baking powder, sugar, orange juice, and water. Commercial preparations, such as Pedialyte, are also available. In many patients with mild symptoms, this is the only treatment needed. Severe dehydration usually requires intravenous fluid replacement.

Antibiotics

In the early and mid-1990s, researchers began to realize that not all cases of bacterial dysentery needed antibiotic treatment. Therefore these drugs are indicated only for treatment of moderate or severe disease, as found in the tropics. Choice of antibiotic is based on the type of bacteria found in the geographical area and on laboratory results. Recommendations include ampicillin, sulfa derivatives such as Trimethoprim-Sulfamethoxazole (TMP-SMX) sold as Bactrim, or **fluoroquinolones** (such as Ciprofloxacin which is not FDA approved for use in children).

Prognosis

Many patients with mild infections need no specific treatment and recover completely. In those with severe infections, antibiotics will decrease the length of symptoms and the number of days bacteria appear in the feces. In rare cases, an individual may fail to clear the bacteria from the intestinal tract; the result is a persistent carrier state. This may be more frequent in **AIDS** (Acquired Immune Deficiency Syndrome) patients. Antibiotics are about 90% effective in eliminating these chronic infections.

In patients who have suffered particularly severe attacks, some degree of cramping and diarrhea can last for several weeks. This is usually due to damage to the intestinal tract, which requires some time to heal. Since antibiotics can also produce a form of colitis, this must be considered as a possible cause of persistent or recurrent symptoms.

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KEY TERMS

Antibiotic—A medication that is designed to kill or weaken bacteria.

Anti-motility medications—Medications such as loperamide (Imodium), dephenoxylate (Lomotil), or medications containing codeine or narcotics which decrease the ability of the intestine to contract. These may worsen the condition of a patient with dysentery or colitis.

Carrier state—The continued presence of an organism (bacteria, virus, or parasite) in the body that does not cause symptoms but is able to be transmitted and infect other persons.

Colitis—Inflammation of the colon or large bowel, which has several causes. The lining of the colon becomes swollen and ulcers often develop. The ability of the colon to absorb fluids is also affected and diarrhea often results.

Dialysis—A form of treatment for patients with kidneys that do not function properly. The treatment removes toxic wastes from the body that are normally removed by the kidneys.

Dysentery—A disease marked by frequent watery bowel movements, often with blood and mucus, and characterized by pain, urgency to have a bowel movement, fever, and dehydration.

Fluoroquinolones—A relatively new group of antibiotics that have had good success in treating infections with many gram-negative bacteria, such as *Shigella*. One drawback is that they should not be used in children under 17 years of age because of possible effects on bone and cartilage growth.

Food-borne illness—A disease that is transmitted by eating or handling contaminated food.

Meninges—Outer covering of the spinal cord and brain. Infection is called meningitis, which can lead to damage to the brain or spinal cord and lead to death.

Oral Rehydration Solution (ORS)—A liquid preparation developed by the World Health Organization that can decrease fluid loss in persons with diarrhea. Originally developed to be prepared with materials available in the home, commercial preparations have recently come into use.

Stool—Passage of fecal material; a bowel movement.

Traveler's diarrhea—An illness due to infection from a bacteria or parasite that occurs in persons traveling to areas where there is a high frequency of the illness. The disease is usually spread by contaminated food or water.

Prevention

Shigellosis is an extremely contagious disease; good hand washing techniques and proper precautions in food handling will help in avoiding the spread of infection. Children in day care centers need to be reminded about hand washing during an outbreak to minimize spread. *Shigellosis* in schools or day care settings almost always disappears when holiday breaks occur, which sever the chain of transmission.

Traveler's diarrhea (TD)

Shigella accounts for about 10% of diarrhea illness in travelers to Mexico, South America, and the tropics. Most cases of TD are more of a nuisance than a life-threatening disease. However, bloody diarrhea is an indication that *Shigella* may be responsible.

In some cases though, aside from ruining a well deserved vacation, these infections can interrupt business conference schedules and, in the worst instances, lead to a life-threatening illness. Therefore, researchers have tried to find a safe and effective way of preventing TD. One of the best means of prevention is to follow closely the rules outlined by the WHO and other groups regarding eating fresh fruits, vegetables, and other foods.

One safe and effective method of preventing TD is the use of large doses of Pepto Bismol. Tablets are now available which are easier for travel; usage must start a few days before departure. Patients should be aware that Bismuth will turn bowel movements black.

Antibiotics have also proven to be highly effective in preventing TD. They can also produce significant side effects, therefore a physician should be consulted before use. Like Pepto Bismol, antibiotics need to be started before beginning travel.

ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

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Shin splints

Definition

Shin splints refer to the sharp pains that occur down the front of the lower leg. They are a common complaint among runners and other athletes.

Description

Shin splints may refer to a number of lower leg complaints and injuries. In most cases, shin splints refer to the **pain** that results from overload on the tissues that connect muscles to the shin bone (tibia). They may come from the small bone of the lower leg and ankle, called the fibula. The medical term for shin splints is medial tibial stress syndrome.

Next to ankle sprains, shin splints are probably the most common complaint of injury to the lower body. Most shin splints occur in the front (anterior) portion of the tibia; some also occur in the inside of the leg, along the tibia. Runners probably suffer shin splints more than other people but they also occur in people who play basketball and tennis and those who walk long distances, particularly on treadmills.

Causes and symptoms

The most common cause of shin splints is overdoing activities that constantly pound on the legs and feet. This may include sports with many stops and starts, running down hills or other tilted surfaces, or repeated walking. Simply training too long or too hard, especially without proper stretching and warm-up, can cause shin splints. People with flat feet, high arches, or feet that turn outward may be more prone to shin splints. Shoes that are worn out or that do not provide proper foot support also add to the problem.

Diagnosis

The physician will check the leg for tenderness. If the pain is in a single area of the tibia and hurts to the touch, the cause may by a stress fracture. The physician may order an x ray to rule out a stress fracture, but shin splints can be diagnosed without x rays.

Treatment

Physicians usually recommend a period of rest for people with shin splints to let the area heal. Usually, about three to four weeks is recommended but the time varies depending on the patient and injury severity. Shin splints may be treated in phases, beginning with absolute rest and gradual return to activity. Ice and elevation of the foot may be used to help relieve pain and swelling in the first phase. If the person needs to keep in shape, stretching and water exercises that keep the foot from bearing weight may be allowed after initial treatment. As the patient returns to normal function, orthotic footwear and braces may be added to prevent re-injury.

KEY TERMS

Podiatrist—A physician who specializes in the medical care and treatment of the human foot.

Stress fracture—A hairline fracture (narrow crack along the surface of a bone) that is caused by repeated stress to the bone, such as from jogging, rather than from a single heavy blow.

Alternative treatment

Various massage techniques may help speed up recovery. Homeopathic physicians may recommend Rhus tox. Those using alternative remedies should ensure they are certified practitioners and should coordinate care with allopathic providers.

Prognosis

With proper rest, management, and prevention, people with shin splints can return to normal activity in a few weeks or more. However, continuing to perform the activity that caused the shin splints can lead to stress **fractures** of the tibia.

Prevention

Re-injury is most common in the first month after return to normal activity and patients who have had shin splints should return to previous activities cautiously. The following can help prevent shin splints from occurring in people who run and perform stop and start physical activities:

- Warming up and stretching calf muscles before running or jogging. A podiatrist specializing in sports medicine or other sports medicine specialist may recommend specific stretching exercises.
- Strengthening muscles in the front lower leg (anterior tibialis) with resistance exercises or by walking on the heels three times daily for about 30 yards.
- Wearing quality shoes with arch supports. Runners should purchase new shoes about every 400 miles. A

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podiatrist can design special arch supports or orthotics for people with flat feet.

- Runs should be started at a slow pace and gradually increased.
- Athletes can cross-train in a sport that does not impact the feet and lower legs as much, such as swimming or riding a bicycle.

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ORGANIZATIONS

American Academy of Podiatric Sports Medicine, (301) 845-9887, info@aapsm.org, http://www.aapsm.org.

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Shingles

Definition

Shingles, or herpes zoster, is a condition caused by the reactivation of the varicella zoster virus (VZV) that causes **chickenpox** (varicella). After a bout of chickenpox, the virus remains dormant in the sensory nerve ganglia that are adjacent to the spinal cord and brain. Years later the virus reemerges, traveling along the nerves to the skin where it causes red **rashes** that develop into blisters. In the process the virus can damage nerves, leading to a very painful inflammation called post-herpetic **neuralgia** (PHN), which can persist long after the rash disappears.

Demographics

Anyone who has had chickenpox or been vaccinated against varicella can develop shingles. Virtually all American adults have had chickenpox, even if the disease was so mild as to pass unnoticed. Nearly one in three Americans eventually develops shingles and there are at least one million cases in the United States each year.

Shingles, or herpes zoster, on patient's buttocks and thigh. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Although shingles can occur at any age, even in children, the incidence increases steadily with age. About half of all cases occur in people aged 60 or older. About 20% of people with shingles develop PHN. It is more common in women than in men. In the United States between 120,000 and 200,000 people suffer from PHN each year. It occurs more frequently among the elderly and is one of the most common causes of pain-related **suicide** in older adults. The incidence of PHN increases with age and tends to last longer in older patients:

- PHN is rare in those under age 30.
- By age 40 the risk of PHN lasting longer than one month is 33%.
- By age 70 the risk increases to 74%.

Some scientists believe that the incidence of shingles is likely to increase over the next 40–50 years due to the introduction of a childhood vaccine against chickenpox in 1995. With far fewer children contracting chickenpox, adults have far less exposure to the virus, which would otherwise boost the immunity they acquired during childhood and help prevent reactivation of latent virus in their bodies.

Description

Varicella zoster virus is a member of the herpes virus family. It causes chickenpox or varicella, which is

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highly contagious and spreads through the air. Following this initial or primary VZV infection, which usually occurs in childhood, the virus remains in an inactive or latent state in nerve tissue. Years later—usually after age 50—VZV can be reactivated to cause herpes zoster or shingles. The name "varicella" is derived from "variola," the Latin name for **smallpox**, a now-eradicated deadly disease, which can resemble chickenpox. "Zoster" is the Greek word for girdle and "shingles" derives from "cingulum," the Latin word for belt or girdle, which refer to the shingles lesions or blisters that form on one side of the waist. Scientists suspected as early as 1909 that chickenpox and shingles were caused by the same virus; this was confirmed in 1958.

Shingles is an infection of the central nervous system, particularly the dorsal root ganglia of the spine. From there the virus migrates through sensory nerve fibers to the skin, usually on the trunk, where it causes painful, fluid-filled eruptions or vesicles. Because the sensory nerves serve sharply bounded, non-overlapping areas of the skin called dermatomes, the shingles lesions appear within these dermatomes and do not cross the midline of the body.

Unlike chickenpox, shingles is not contagious because the virus is not usually in the lungs from which it could spread through the air. However the fluid-filled eruptions on the skin contain large amounts of virus, which can be transmitted through direct contact and infect a person, usually a child, who has not previously been exposed to VZV. The infected person will develop a case of primary chickenpox. A vaccine that prevents or ameliorates the symptoms of shingles became available in 2006. Immunization against chickenpox does not prevent shingles although it may reduce its incidence.

Risk factors

Anyone who has ever had chickenpox or been vaccinated against it is at risk for shingles. Overall approximately 20% of those who had chickenpox as children eventually develop shingles. Susceptibility to shingles appears to be genetically determined and the condition runs in families. The risk of shingles increases with age and with any condition that weakens the immune system. Those at particular risk for shingles include:

- children who had chickenpox in infancy or whose mothers had chickenpox late in pregnancy
- bone marrow and other transplant recipients
- those with compromised immune systems from diseases such as HIV/AIDS
- those with suppressed immune systems from chemotherapy drugs or other medications

Causes and symptoms

It is not clear why VZV reactivates to cause shingles, but it appears to be related to a decreased immune response due to advancing age, emotional or physical **stress**, **fatigue**, certain medications, **chemotherapy**, or diseases such as **cancer** or HIV/AIDS. Shingles is sometimes an early sign of **immunodeficiency** in people infected with HIV. In some cases the virus appears to be reactivated by mechanical irritation or minor surgical procedures.

Mild cases of shingles often go unnoticed. The earliest signs may be vague and can easily be mistaken for other illnesses. The condition may begin with **fever**, chills, gastrointestinal discomfort, and malaise (a vague feeling of weakness or discomfort). Lymph nodes may swell. Within two to four days, localized areas of intense **pain**, **itching**, and numbness/tingling (paresthesia) or extreme sensitivity to touch (hyperesthesia) can develop, usually on the trunk. The second most common place is on one side of the face around the eye (ophthalmic shingles) or on the forehead. However shingles can occur on the arms, legs, or elsewhere on the body. The pain may be continuous or intermittent, usually lasting from one to four weeks. The pain may accompany skin eruptions or precede the eruptions by days.

The red rash or oozing blisters appear along the course of the affected nerve. There is usually a vague streak or band from the spine along the path of the nerve on one side of the body. About five days after they appear, the vesicles begin to crust or scab and the disease resolves within the next two to three weeks. There may be no visible after effects or a slight scarring from the vesicles.

Shingles can be more debilitating in the elderly or those in poor health. The eruptions may be more extensive and inflammatory; they may also include bleeding blisters, areas of skin **death**, secondary bacterial infection, or extensive and permanent scarring. Ophthalmic shingles can cause painful eye infections and vision loss. Shingles infections within or near the ear can cause hearing or balance problems. Sometimes shingles can cause temporary or permanent **tremors** or **paralysis**; rarely, the condition spreads to the brain or spinal cord and causes **stroke** or **meningitis**.

Shingles pain usually subsides when the rash disappears, but it may last much longer, especially in the elderly. PHN can persist for months or years. It is caused by damage to the dorsal root ganglia, with the nerves becoming either spontaneously active—which is perceived as chronic pain—or hypersensitive to slight stimuli such as light touch. In the most severe cases, PHN can cause **insomnia**, weight loss, depression, and disability.

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KEY TERMS

Acyclovir—An antiviral drug that is available in oral, intravenous, and topical forms and that blocks replication of the varicella zoster virus.

Antibody—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

Capsaicin—An active ingredient from hot chili peppers that is used in topical ointments to relieve pain. It appears to work by reducing the levels of a chemical substance involved in transmitting pain signals from nerve endings to the brain.

Corticosteroids—A group of hormones produced by the adrenal glands or manufactured synthetically. They are often used to treat inflammation. Examples include cortisone and prednisone.

Famciclovir—An oral antiviral drug that blocks the replication of the varicella zoster virus.

Ganglion—A mass of nerve tissue outside of the central nervous system.

Immunocompromised—A weakened or poorly functioning immune system due to disease.

Immunosuppressed—Suppression of the immune system by medications during the treatment of diseases such as cancer or following an organ transplantation.

Post-herpetic neuralgia (PHN)—Long-lasting nerve pain caused by herpes zoster.

Tzanck preparation—A procedure in which skin cells from a blister are stained and examined under the microscope.

Valacyclovir—An oral antiviral drug that blocks the replication of the varicella zoster virus.

Vesicle—A small, raised lesion filled with clear fluid.

Diagnosis

Examination

Diagnosis of shingles is based on a medical history and **physical examination**. A definite diagnosis is difficult before eruption of the characteristic vesicles or bumps on the skin. The vesicles have a clear dermatome-bounded distribution usually on the midsection of the body.

Tests

Tests for shingles are rarely necessary but may include:

- polymerase chain reaction (PCR) testing for viral DNA
- viral culture of skin lesions
- a Tzanck preparation—stained cells from a blister, which will appear under the microscope to have many very large dark nuclei if infected with VZV
- a complete blood count (CBC) to test for elevated white blood cells that are indicative of infection
- blood serum levels of antibodies against VZV

Treatment

Traditional

Shingles almost always resolves spontaneously within a few weeks. Unless complicated by conditions such as HIV/AIDS or cancer, a primary care physician can provide treatment for easing painful symptoms. Rarely, transcutaneous **electrical nerve stimulation** (TENS) or a permanent nerve block is used to relieve the pain of PHN.

Drugs

The **antiviral drugs** acyclovir, valacyclovir, and famciclovir are used to treat shingles. These drugs can shorten the course of the illness. If started within 72 hours of the onset of the rash, antiviral therapy can heal the blisters more rapidly and sometimes even halt the disease. If taken after the disease has progressed, these drugs are less effective but may still lessen the pain. Antiviral drug treatment reduces the incidence of PHN by about one half and may also shorten its duration. Severely immunocompromised individuals, such as those with HIV/AIDS, may require intravenous administration of antiviral drugs or taking the drugs on an ongoing basis.

Various other drugs may be prescribed for shingles and PHN:

- corticosteroids, such as prednisone, to reduce inflammation from shingles, especially if the eye or other facial nerves are involved, and to reduce severe pain
- anticonvulsants such as pregabalin (Lyrica) or gabapentin to relieve pain
- the tricylcic antidepressants (TCAs) desipramine and nortriptyline
- opioid painkillers such as oxycodone, morphine, tramadol, or methadone
- tranquilizers or sedatives
- topical local anesthetics for application to the painful skin area and for post-herpetic itch; especially lidocaine, available as a cream, gel, spray, or patch

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- capsaicin cream, which is available without a prescription but usually causes burning pain during application

Alternative

Alternative remedies and therapies will not cure shingles but they may relieve pain, reduce inflammation, and speed recovery:

- The amino acid lysine has also been reported to ease the symptoms of shingles and other herpes infections. Foods that are high in lysine include soybeans, black bean sprouts, lentils, parsley, and peas.
- Vitamin B12 supplementation during the first two days of the illness and ongoing vitamin B complex, vitamin C with bioflavonoids, and calcium supplements may boost the immune system.
- Echinacea can boost the immune system and help fight viral infections.
- Red pepper (capsicum or cayenne) is an ingredient in commercial ointments including Zostrix and Capzasin-P. It should be applied only to healed blisters and is useful for treating painful PHN. Seasoning food with red pepper may also provide relief.
- Calendula or licorice (*Glycyrrhiza glabra*) ointment or lotion may help treat shingles.
- Topical applications of lemon balm (*Melissa officinalis*), licorice, or peppermint (*Mentha piperita*) may reduce pain and blistering. These can also be consumed as teas.
- Sedative herbs such as passionflower can be brewed for a tea to treat PHN.
- Vervain helps relieve pain and inflammation.
- St. John's wort, lavender, chamomile, and marjoram help relieve inflammation.
- Homeopathic remedies include *Rhus toxicodendron* for blisters, *Mezereum* and *Arsenicum album* for pain, and *Ranunculus* for itching.
- Several drops of "Rescue Remedy" placed under the tongue or taken in water throughout the day are prescribed for relieving stress.
- Ayurvedic treatments for shingles include the application of turmeric paste.
- Acupuncture and acupressure can alleviate pain and PHN.
- Biofeedback or spinal cord stimulators may help relieve PHN.
- Relaxation techniques such as hypnotherapy and yoga may help relieve pain.
- Reflexology may help balance the body.

Practitioners of **traditional Chinese medicine** (TCM) may recommend herbal remedies:

- Chinese gentian root is used to treat the liver.
- Skullcap root in water is a Chinese folk remedy for shingles.
- Long Dan Xie Gan Tang is used to quell the accumulation of damp, toxic heat in the liver.
- For damp, infected, painful eruptions on the torso, Huang Qin Gao can be applied to the surrounding area.

Home remedies

Home remedies for shingles include plenty of rest, a healthy diet, regular **exercise**, and minimizing stress. The skin should be kept clean and contaminated items should not be reused. Cool compresses may help reduce pain from blisters. Blisters or crusting can be treated with compresses made with one-quarter cup (60 mL) of white vinegar in two quarts (1.9 L) of lukewarm water and applied twice daily for 10 minutes. The compresses should be discontinued when the blisters have dried up. Soothing baths and lotions with colloidal oatmeal, starch, or calamine may help to relieve itching and discomfort. If the skin becomes dry, tight, and cracked as the crusts and scabs separate, a small amount of plain petroleum jelly can be applied three or four times daily. The pain of PHN may be relieved with hot and cold compresses.

Prognosis

Shingles is almost never life-threatening in otherwise healthy patients and usually resolves without treatment in a few weeks. Because shingles boosts the immune response to VZV, repeat episodes are rare, occurring in less than 4% of patients. Although PHN usually diminishes over time, it can be disabling and difficult to treat.

Shingles can be much more severe in immunocompromised patients. The condition can last for months, recur frequently, and spread to the lungs, liver, gastrointestinal tract, brain, or other vital organs. Complications of shingles in immunocompromised or immunosuppressed patients may resemble those of primary varicella infection in adults, including viral **pneumonia**, male sterility, acute liver failure, and **birth defects** in children born to infected mothers. Depletion of CD4+ T lymphocytes in HIV/AIDS patients is associated with severe and chronic or recurrent VZV infection.

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Prevention

A lifestyle that promotes immune system function and overall health may help prevent shingles. Factors include a well-balanced diet rich in essential **vitamins** and **minerals**, adequate sleep, regular exercise, and reduced stress. Patients with shingles should avoid contact with anyone who has not had chickenpox or been vaccinated against the disease, particularly pregnant women, newborns, and those with weakened immune systems.

In the United States it is now recommended that all children between 18 months and adolescence be immunized against chickenpox. Because a weakened (attenuated) form of the virus is used in this vaccine, it is thought that **vaccination** will reduce the likelihood of shingles later on in life. A single-dose vaccine against shingles (Zostavax) became available in 2006 and is recommended for most people aged 60 and older who have previously had chickenpox. It appears to prevent shingles in about 50% of vaccinated people and reduces the pain associated with shingles in others. It also can help prevent post-herpetic neuralgia.

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American Academy of Dermatology, PO Box 4014, Schaumburg, IL, 60168, (847) 240-1280, (866) 503-SKIN (7546), (847) 240-1859, http://www.aad.org.

American Botanical Council, 6200 Manor Rd., Austin, TX, 78723, (512) 926-4900, (512) 926-2345, abc@herbalgram.org, http://cms.herbalgram.org.

National Institute of Allergy and Infectious Diseases (NIAID), Office of Communications and Public Liaison, 6610 Rockledge Drive, Bethesda, MD, 20892-66123, (866) 284-4107, http://www3.niaid.nih.gov.

National Institute of Neurological Disorders and Stroke (NINDS), NIH Neurological Institute, PO Box 5801, Bethesda, MD, 20824, (301) 496-5751, (800) 352-9424, http://www.ninds.nih.gov.

National Shingles Foundation, 590 Madison Ave., 21st Floor, New York, NY, 10022, (212) 222-3390, (212) 222-8627, http://www.vzvfoundation.org.

U.S. Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800)-CDC-INFO (232-4636), cdcinfo@cdc.gov, http://www. cdc.gov.

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Shock

Definition

Shock is a medical emergency in which the organs and tissues of the body are not receiving an adequate flow of blood. This condition deprives organs and tissues of oxygen (carried in the blood) and allows the buildup of waste products. Shock can result in serious damage to the body, or even **death**.

Demographics

There are four grades of shock: Grade 1 causes up to 15% loss of effective blood volume or about 750 mL in the average adult; Grade 2 causes between 15–30% loss of blood volume or 750–1500 mL, provokes moderate tachycardia, and begins to narrow pulse pressure; Grade 3 causes about 30–40% loss of effective blood volume or 1500–2000 mL, compensatory mechanisms to fail, and **hypotension**, tachycardia, and low urine output to occur. Finally, Grade 4 causes about 40–50% loss of blood volume or 2000–2500 mL, and profound hypotension will develop and, if prolonged, will cause severe organ damage and death.

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Description

There are various stages of shock: Stage I (also called compensated, or nonprogressive), Stage II (also called decompensated or progressive), and Stage III (also called irreversible).

In Stage I of shock, when low blood flow (perfusion) is first detected, a number of systems are activated in order to maintain and/or restore perfusion. The result is that the heart beats faster, blood vessels throughout the body become slightly smaller in diameter, and the kidney works to retain fluid in the circulatory system. All these changes serve to maximize blood flow to the most important organs and systems in the body. The patient in this stage of shock has very few symptoms, and treatment can completely halt any progression.

In Stage II of shock, these methods of compensation begin to fail. The systems of the body are unable to improve perfusion any longer, and the patient's symptoms reflect that fact. Oxygen deprivation in the brain causes the patient to become confused and disoriented, while oxygen deprivation in the heart may cause chest **pain**. With quick and appropriate treatment, this stage of shock can be reversed.

In Stage III of shock, the length of time that poor perfusion has existed begins to take a permanent toll on the body's organs and tissues. The heart's functioning continues to spiral downward and the kidneys usually shut down completely. Cells in organs and tissues throughout the body are injured and dying. The endpoint of Stage III shock is the patient's death.

Causes and symptoms

Shock is caused by three major categories of problems: cardiogenic (meaning problems associated with the heart's functioning); hypovolemic (meaning that the total volume of blood available to circulate is low); and **septic shock** (caused by overwhelming infection, usually by bacteria).

Cardiogenic shock can be caused by any disease or event that prevents the heart muscle from pumping strongly and consistently enough to circulate the blood normally. **Heart attack**, conditions that cause inflammation of the heart muscle (**myocarditis**), disturbances of the electrical rhythm of the heart, and any kind of mass or fluid accumulation and/or blood clot that interferes with flow out of the heart can all significantly affect the heart's ability to adequately pump a normal quantity of blood.

Hypovolemic shock occurs when the total volume of blood in the body falls well below normal. This condition can occur when there is excess fluid loss, as in **dehydration** due to severe **vomiting** or **diarrhea**, diseases which cause excess urination (**diabetes insipidus**, **diabetes mellitus**, and kidney failure), extensive **burns**, blockage in the intestine, inflammation of the pancreas (**pancreatitis**), or severe bleeding of any kind.

Septic shock can occur when an untreated or inadequately treated infection (usually bacterial) is allowed to progress. Bacteria often produce poisonous chemicals (toxins), which can cause injury throughout the body. When large quantities of these bacteria, and their toxins, begin circulating in the bloodstream, every organ and tissue in the body is at risk of their damaging effects. The most serious consequences of these bacteria and toxins include poor functioning of the heart muscle; widening of the diameter of the blood vessels; a drop in blood pressure; activation of the blood clotting system, causing **blood clots**, followed by a risk of uncontrollable bleeding; damage to the lungs, causing acute **respiratory distress syndrome**; liver failure; kidney failure; and **coma**.

Initial symptoms of shock include cold, clammy hands and feet; pale or blue-tinged skin tone; weak, fast pulse rate; fast rate of breathing; low blood pressure. A variety of other symptoms may be present but they are dependent on the underlying cause of shock.

Diagnosis

Diagnosis of shock is based on the patient's symptoms as well as criteria including a significant drop in blood pressure, extremely low urine output, and blood tests that reveal overly acidic blood with a low circulating concentration of carbon dioxide. Other tests are performed, when appropriate, to try to determine the underlying condition responsible for the patient's state of shock.

Treatment

The most important goals in the treatment of shock include: quickly diagnosing the patient's state of shock; quickly intervening to halt the underlying condition (stopping bleeding, re-starting the heart, giving **antibiotics** to combat an infection, etc.); treating the effects of shock (low oxygen, increased acid in the blood, activation of the blood clotting system); and supporting vital functions (blood pressure, urine flow, heart function).

Treatment includes keeping the patient warm with legs raised and head down to improve blood flow to the brain; putting a needle in a vein in order to give fluids or blood transfusions, as necessary; giving the patient extra oxygen to breathe and medications to improve

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KEY TERMS

Cardiogenic—Originating with the heart.

Deprivation—A condition of having too little of something.

Hypovolemic—Having a low volume.

Perfusion—Blood flow through an organ or tissue.

Sepsis—An overwhelming infection throughout the body, usually caused by bacteria in the bloodstream.

the heart's functioning; and treating the underlying condition that led to shock.

Prognosis

The prognosis of an individual patient in shock depends on the stage of shock when treatment was initiated, the underlying condition causing shock, and the general medical state of the patient.

Prevention

The most preventable type of shock is caused by dehydration during illnesses with severe **vomiting** or diarrhea. Shock can be avoided by recognizing that a patient who is unable to drink in order to replace lost fluids needs to be given fluids intravenously (through a needle in a vein). Other types of shock are only preventable insofar as one can prevent his or her underlying conditions, or can monitor and manage those conditions well enough so that they never progress to the point of shock.

Resources

PERIODICALS

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Rapp J. et al., "Blood Vessel and Lymphatic Disorders." In: McPhee S., et al. *Current Medical Diagnosis and Treatment,* Los Altos, CA: McGraw-Hill, 2010.

Rosalyn Carson–DeWitt, MD
Karl Finley

Shock | *see* **Adult respiratory distress syndrome**

Shock therapy *see* **Electroconvulsive therapy**

Shortness of breath

Definition

Shortness of breath, or dyspnea, is a feeling of difficult or labored breathing that is out of proportion to the patient's level of physical activity. It is a symptom of a variety of different diseases or disorders and may be either acute or chronic.

Description

The experience of dyspnea depends on its severity and underlying causes. The feeling itself results from a combination of impulses relayed to the brain from nerve endings in the lungs, rib cage, chest muscles, or diaphragm, combined with the patient's perception and interpretation of the sensation. In some cases, the patient's sensation of breathlessness is intensified by **anxiety** about its cause. Patients describe dyspnea variously as unpleasant shortness of breath, a feeling of increased effort or tiredness in moving the chest muscles, a panicky feeling of being smothered, or a sense of tightness or cramping in the chest wall.

Causes and symptoms

ACUTE DYSPNEA. Acute dyspnea with sudden onset is a frequent cause of emergency room visits. Most cases of acute dyspnea involve pulmonary (lung and breathing) disorders, cardiovascular disease, or chest trauma.

PULMONARY DISORDERS. Pulmonary disorders that can cause dyspnea include airway obstruction by a foreign object, swelling due to infection, or anaphylactic shock; acute **pneumonia**; hemorrhage from the lungs; or severe bronchospasms associated with **asthma**.

CARDIOVASCULAR DISEASE. Acute dyspnea can be caused by disturbances of the heart rhythm, failure of the left ventricle, mitral valve (a heart valve) dysfunction, or an embolus (a clump of tissue, fat, or gas) that is blocking the pulmonary circulation. Most pulmonary emboli (**blood clots**) originate in the deep veins of the lower legs and eventually migrate to the pulmonary artery.

TRAUMA. Chest injuries, both closed injuries and penetrating **wounds**, can cause **pneumothorax** (the presence of air inside the chest cavity), **bruises**, or fractured ribs. **Pain** from these injuries results in dyspnea. The impact of the driver's chest against the steering wheel in auto accidents is a frequent cause of closed chest injuries.

OTHER CAUSES. Anxiety attacks sometimes cause acute dyspnea although they may or may not be associated

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with chest pain. Anxiety attacks are often accompanied by hyperventilation, which is a breathing pattern characterized by abnormally rapid and deep breaths. Hyperventilation raises the oxygen level in the blood, causing chest pain and **dizziness**.

Chronic dyspnea

PULMONARY DISORDERS. Chronic dyspnea can be caused by asthma, **chronic obstructive pulmonary disease** (COPD), **bronchitis**, **emphysema**, inflammation of the lungs, **pulmonary hypertension**, tumors, or disorders of the vocal cords.

HEART DISEASE. Disorders of the left side of the heart or inadequate supply of blood to the heart muscle can cause dyspnea. In some cases a tumor in the heart or inflammation of the membrane surrounding the heart may cause dyspnea.

NEUROMUSCULAR DISORDERS. Neuromuscular disorders cause dyspnea from progressive deterioration of the patient's chest muscles. They include **muscular dystrophy**, **myasthenia gravis**, and **amyotrophic lateral sclerosis**.

OTHER CAUSES. Patients who are severely anemic may develop dyspnea if they **exercise** vigorously. **Hyperthyroidism** or **hypothyroidism** may cause shortness of breath, and so may **gastroesophageal reflux disease** (GERD). Chronic **anxiety disorders** or physical fitness can also cause episodes of dyspnea. Deformities of the chest or **obesity** can cause dyspnea by limiting the movement of the chest wall and the ability to fill the lungs completely.

Diagnosis

Patient history

The patient's history provides the doctor with such necessary information as a history of gastroesophageal reflux disease (GERD), asthma, or other allergic conditions; the presence of chest pain as well as difficulty breathing; recent accidents or recent surgery; information about **smoking** habits; the patient's baseline level of physical activity and exercise habits; and a psychiatric history of panic attacks or anxiety disorders.

ASSESSMENT OF BODY POSITION. How a person's body position affects his/her dyspnea symptoms sometimes gives hints as to the underlying cause of the disorder. Dyspnea that is worse when the patient is sitting up is called platypnea and indicates the possibility of **liver disease**. Dyspnea that is worse when the patient is lying down is called orthopnea, and is associated with heart disease or **paralysis** of the diaphragm. Paroxysmal nocturnal dyspnea (PND) refers to dyspnea that occurs during sleep and forces the patient to awake gasping for breath. It is usually relieved if the patient sits up or stands. PND may point to dysfunction of the left ventricle of the heart, **hypertension**, or narrowing of the mitral valve.

Physical examination

The doctor will examine the patient's chest in order to determine the rate and depth of breathing, the effort required, the condition of the patient's breathing muscles, and any evidence of chest deformities or trauma. He or she will listen for **wheezing**, **stridor**, or signs of fluid in the lungs. If the patient has a **fever**, the doctor will look for other signs of pneumonia. The doctor will check the patient's heart functions, including blood pressure, pulse rate, and the presence of **heart murmurs** or other abnormal heart sounds. If the doctor suspects a blood clot in one of the large veins leading to the heart, he or she will examine the patient's legs for signs of swelling.

Diagnostic tests

BASIC DIAGNOSTIC TESTS. Patients who are seen in emergency rooms are given a **chest x ray** and electrocardiogram (ECG) to assist the doctor in evaluating abnormalities of the chest wall, also to determine the position of the diaphragm, possible rib **fractures** or pneumothorax, irregular heartbeat, or the adequacy of the supply of blood to the heart muscle. Also, the patient may be given a breathing test on an instrument called a spirometer to screen for airway disorders.

The doctor may order blood tests and arterial blood gas tests to rule out anemia, hyperventilation from an anxiety attack, or thyroid dysfunction. A **sputum culture** can be used to test for pneumonia.

SPECIALIZED TESTS. Specialized tests may be ordered for patients with normal results from basic diagnostic tests for dyspnea. High-resolution CT scans can be used for suspected airway obstruction or mild **emphysema**. Tissue biopsy performed with a bronchoscope can be used for patients with suspected lung disease.

If the doctor suspects a **pulmonary embolism**, he or she may order ventilation-perfusion scanning to inspect lung function, an angiogram of blood vessels, or ultrasound studies of the leg veins. **Echocardiography** can be used to test for pulmonary hypertension and heart disease.

Pulmonary function studies or **electromyography** (EMG) are used to assess neuromuscular diseases. Exercise testing is used to assess dyspnea related to COPD, anxiety attacks, poor physical fitness, and the severity of lung or heart disease. The level of acidity in

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the patient's esophagus may be monitored to rule out GERD.

Treatment

Treatment of dyspnea depends on its underlying cause.

Acute dyspnea

Patients with acute dyspnea are given oxygen in the emergency room with the following treatments for specific conditions:

- Asthma. Treatment with Alupent, epinephrine, or aminophylline.
- Anaphylactic shock. Treatment with Benadryl, steroids, or aminophylline, with hydrocortisone if necessary.
- Congestive heart failure. Treatment with oxygen, diuretics, and placing patient in upright position.
- Pneumonia. Treatment with antibiotics and removal of lung secretions.
- Anxiety attacks. Immediate treatment includes antidepressant medications. If the patient is hyperventilating, he or she may be asked to breathe into a paper bag to normalize breathing rhythm and the oxygen level of the blood.
- Pneumothorax. Surgical placement of a chest tube.

Chronic dyspnea

The treatment of chronic dyspnea depends on the underlying disorder. Asthma can often be managed with a combination of medications to reduce airway spasms and removal of allergens from the patient's environment. COPD requires both medication, lifestyle changes, and long-term physical **rehabilitation**. Anxiety disorders are usually treated with a combination of medication and **psychotherapy**. GERD can usually be managed with **antacids**, other medications, and dietary changes. There are no permanent cures for myasthenia gravis or muscular dystrophy.

Tumors and certain types of chest deformities can be treated surgically.

Alternative treatment

The appropriate alternative therapy for shortness of breath depends on the underlying cause of the condition. When dyspnea is acute and severe, **oxygen therapy** is used either in the doctor's office or in the emergency room. For shortness of breath with an underlying physical cause like asthma, anaphylactic shock, or pneumonia, the physical condition should be treated. Botanical and homeopathic remedies can be used for acute dyspnea, if the proper remedies and formulas are prescribed. If the dyspnea has a psychological basis (especially if it is caused by anxiety), **acupuncture**, botanical medicine, and homeopathy can help the patient heal at a deep level.

KEY TERMS

Anaphylactic shock—A severe systemic reaction to an allergen that occurs in hypersensitive individuals. It can cause spasms of the larynx that block the patient's airway and cause dyspnea.

Dyspnea—A sensation of difficult or labored breathing.

Electromyography—A technique for recording electric currents in an active muscle in order to measure its level of function.

Orthopnea—Difficulty in breathing that occurs while the patient is lying down.

Paroxysmal nocturnal dyspnea (PND)—A form of dyspnea characterized by the patient's waking from sleep unable to breathe.

Platypnea—Dyspnea that occurs when the patient is sitting up.

Pneumothorax—The presence of air or gas inside the chest cavity.

Spirometer—An instrument that is used to test lung capacity. It is used to screen patients with dyspnea.

Stridor—A harsh or crowing breath sound caused by partial blockage of the patient's upper airway.

Wheezing—A whistling or musical sound caused by tightening of the air passages inside the patient's chest. Wheezing is most commonly associated with asthma.

Prognosis

The prognosis for recovery depends on the underlying cause of the dyspnea, its severity, and the type of treatment required.

Prevention

Dyspnea caused by asthma can be minimized or prevented by removing dust and other triggers from the patient's environment. Long-term prevention of chronic dyspnea includes such lifestyle choices as regular aerobic exercise and avoidance of smoking.

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Resources

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Rebecca J. Frey, PhD

Shy-Drager syndrome

Definition

Shy-Drager syndrome (SDS) is a rare condition that causes progressive damage to the autonomic nervous system. The autonomic nervous system controls vital involuntary body functions such as heart rate, breathing, and intestinal, urinary, and sexual functions. The autonomic nervous system also controls skin and body temperature, and how the body responds to **stress**. Shy-Drager syndrome leads to **dizziness** or **fainting** when standing up, **urinary incontinence**, **impotence**, and muscle **tremors**.

Description

SDS was named for neurologists Milton Shy, M.D., from the National Institutes of Health, and Glenn Drager, M.D., from the Baylor College of Medicine, who first described the condition in 1960. It typically affects those between ages 50–70. It affects more men than women. In severe cases, the person cannot even stand up. Symptoms can be mild as well. Sometimes, people with mild cases are misdiagnosed as having **anxiety** or **hypertension**.

Many nonprescription drugs, such as cold medicines and diet capsules, can trigger extremely high blood pressure spikes in patients with SDS, even in very low doses. Therefore, these patients are at risk for strokes and excessive bleeding (hemorrhage) if they take even the recommended dosage of these drugs.

Causes and symptoms

The cause of SDS is unknown. Symptoms develop because of degeneration of certain groups of nerve cells in the spinal cord.

Patients with SDS usually have problems with the function of the autonomic nervous system. Progressive degeneration may occur in other areas of the nervous system as well. The hallmark of the syndrome is dizziness and fainting when arising or after standing still for a long time (postural **hypotension**). This is caused by low blood pressure and inadequate blood flow to the brain. When this problem becomes severe (for example, a blood pressure below 70/40 mmHg), it can lead to a momentary loss of consciousness. After the person faints, the blood pressure returns to normal and the person wakes up.

Many patients also notice impotence, urinary incontinence, **dry mouth** and skin, and trouble regulating body temperature because of abnormal sweating. Since the autonomic nervous system also controls the narrowing and widening of the iris, some patients with SDS have vision problems, such as trouble focusing.

In later stages, problems in the autonomic nervous system lead to breathing difficulties such as **sleep apnea**, loud breathing, and **snoring**. In advanced stages of the disease, patients can die from irregular heartbeat.

Other symptoms of SDS do not involve the autonomic nervous system. These include parkinsonism (muscle tremor, rigidity, and slow movements), double vision, problems controlling emotions, and wasting of muscles in the hands and feet. Eventually, patients may have problems chewing, swallowing, speaking, and breathing. There may be a loss of color pigment in the iris.

Diagnosis

While no blood test can reveal the disorder, a careful assessment of symptoms should alert a neurologist to suspect SDS. A combination of parkinsonism and certain autonomic problems (especially impotence, incontinence, and postural hypotension) are clear indications of the syndrome.

Tests of the autonomic nervous system may help diagnose the condition. In normal patients, blood levels of norepinephrine rise when they stand up. This doesn't happen in people with SDS. Norepinephrine is a hormone that helps maintain blood pressure by triggering certain blood vessels to constrict when blood pressure falls below normal. Another test for the condition is the **Valsalva maneuver**. In this test, the patient holds his or her breath and strains down as if having a bowel movement while the doctor monitors blood pressure and heart rate for 10 seconds. Patients with SDS will not have the normal increase in blood pressure and heart rate.

A variety of other tests can identify a broad range of autonomic problems in patients with SDS. Brain scans, however, do not usually reveal any problems.

Treatment

Medication can relieve many of the symptoms, especially the parkinsonism and low blood pressure.

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KEY TERMS

Autonomic nervous system—The part of the nervous system that controls the involuntary (apparently automatic) activities of organs, blood vessels, glands, and many other body tissues.

Degenerative—Degenerative disorders involve progressive impairment of both the structure and function of part of the body.

Gastrostomy—An artificial opening into the stomach through the abdomen to enable a patient to be fed via a feeding tube. The procedure is given to patients with SDS who are unable to chew or swallow.

Norepinephrine—A hormone that helps maintain blood pressure by triggering certain blood vessels to constrict when blood pressure falls below normal.

Sleep apnea—A sleep disorder characterized by periods of breathing cessation lasting for 10 seconds or more.

Tracheostomy—An opening through the neck into the trachea through which a tube may be inserted to maintain an effective airway and help a patient breathe.

However, typical antiparkinsonism drugs such as carbidopa-levodopa (Sinemet) should be used with caution, since they often worsen the postural low blood pressure and may cause fainting.

Because postural hypotension is the most troublesome of the symptoms in the early years, treatments center on relieving this problem. Patients are encouraged to eat a liberal salt diet and drink plenty of fluids. They are advised to wear waist-high elastic hosiery and to sleep with the head elevated at least 5 inches (13 centimeters). Other drug treatment includes fludrocortisone, indomethacin, **nonsteroidal anti-inflammatory drugs**, **beta blockers**, central stimulants, and other medications.

Occasionally, a pacemaker, **gastrostomy**, or tracheostomy may be needed. A pacemaker is a device that delivers electrical impulses to the heart to keep it beating regularly. A gastrostomy creates an opening in the stomach to connect a feeding tube from outside the body. In a tracheostomy an opening is made in the windpipe and a tube is inserted to maintain breathing.

Prognosis

While the course of the disease varies, and some patients live for up to 20 years after the symptoms first appear, most patients become severely disabled within 7 or 8 years. It is unusual for someone to survive more than 15 years after diagnosis.

Symptoms (especially tremor) often get worse if the patient smokes because of the nicotine.

Many patients develop swallowing problems which may lead to recurrent episodes of **pneumonia**, a frequent cause of **death**. Others experience Cheyne-Stokes (periodic breathing). One of the most common causes of death is pulmonary embolus. This is caused by a blood clot in the main artery in the lung.

Prevention

Since scientists do not know the cause of Shy-Drager syndrome, there is no way to prevent the condition.

ORGANIZATIONS

American Academy of Neurology, 1080 Montreal Ave., St. Paul, MN, 55116, (651) 695-2717, (651) 695-2791, (800) 879-1960, memberservices@aan.com, http://www.aan.com/.

Association for Neuro-Metabolic Disorders, 5223 Brookfield Lane, Sylvania, OH, 43560-1809, (419) 885-1809.

National Institute of Neurological Disorders and Stroke (NINDS), NIH Neurological Institute, P. O. Box 5801, Bethesda, MD, 20824, (301) 496-5751, (800) 352-9424, http://www.ninds.nih.gov/.

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923, (800) 999-6673, http://www.rarediseases.org.

SDS/MSA Support Group, 8311 Brier Creek Parkway, Suite 105-434, Raleigh, NC, 27617, (866) 737-5999, vjames@shy-drager.org, http://www.shy-drager.org.

Carol A. Turkington

Shyness

Definition

Shyness is a personality trait that produces behaviors ranging from feeling uncomfortable at a party to an extreme fear of being watched by others while talking on the telephone.

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Description

Shyness affects people of all ages. A toddler might run from strangers and cling to his or her parents. While kindergarten is frightening for many children, some students are anxious about the first day of school until they graduate from college. Job interviews are stressful for people uncomfortable talking about themselves. For some people, feelings of self-worth are related to their careers. Retirement may bring feelings of lower self-esteem.

Shyness is linked to brain activity, how a person was raised and other experiences, and the person's reaction to those experiences.

Social phobia

Extreme shyness is sometimes referred to as a social phobia. Also known as social **anxiety** disorder, a social phobia is a psychiatric condition defined as a "marked and persistent fear" of some situations. Social phobia may cause a person to remain unemployed, according to the National Mental Health Association (NMHA). True social phobia affects about 3% of people.

Introversion

The introvert enjoys being alone and intentionally avoids situations like parties. The shy person wants to be around people. However, shyness is stronger than the desire to be sociable. The shy person is afraid to go to the party and stays home alone.

Causes and symptoms

Temperament is related to the amygdala, the part of the brain related to emotions and new situations. The amygdala evaluates new situations based on memories of past experiences. If the new situation appears threatening, the amygdala sends a warning signal. The amygdala in a shy person is extremely sensitive and much more active than that of an outgoing person. The increased activity causes the person to withdraw either physically or emotionally. This withdrawal is known as inhibition.

The baby runs from strangers; the job applicant laughs nervously when talking about his accomplishments. Brain activity is one component of shyness. Environment also plays a role. If the inhibited child has outgoing, nurturing parents, she will probably imitate their behavior. If parents and teachers are mocking and critical, a child may have a lifelong fear of the first day of school. A person with that background may compare him or herself with others and feel they are more capable than he or she is. The person embarrassed in a job interview could become anxious in future interviews.

At the root of shyness is a feeling of self-consciousness. This may cause the person to blush, tense up, or start sweating. Those are some reactions caused when the brain signals its warning. The person may avoid eye contact, look down, become very quiet, or fumble over words.

Symptoms vary because there are degrees of shyness. A person might be very quiet when meeting new people, but then become talkative when she feels comfortable with them. The jobseeker may not be afraid of social gatherings.

Social Phobia

Social phobia causes an extreme fear of being humiliated or embarrassed in front of people, according to the according to the NMHA. It may be connected to low self-esteem or feelings of inferiority. The phobic is not fearful in all situations and may feel comfortable around people in most of the time.

However, social **phobias** have caused people to drop out of school, avoid making friends, and keep away from other fear-provoking situations. Phobic fears range from speaking in pubic and dating to using public restrooms or writing when other people are present.

According to the NMHA, a phobic may feel that everyone is looking at them, A trivial mistake is regarded as much more serious and blushing is painfully embarrassing. Social phobia is frequently accompanied by depression or **substance abuse**.

Diagnosis

In many cases, adults realize they are shy. In a sense they have diagnosed themselves, and may take steps to overcome their shyness. Teen agers may also try to remedy their situations.

Adults and youths may buy self-help books or take classes on subjects like overcoming shyness and assertiveness training. These classes may be taught by counselors, psychologists, or people with experience conquering shyness. Health-care providers often schedule these classes. They are also taught in settings ranging from adult schools to social service agencies. Costs will vary at these classes.

Children may not know there are treatment solutions for their shyness. Parents and educators should be alert for symptoms of shyness in younger children. Schools and family resource centers can provide referrals if it appears counseling will help get their child diagnosed.

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Medical diagnosis

Based on the child's circumstances, parents may take the child to their health care provider. Some insurance plans require an appointment with a doctor before a referral to a counselor or a psychologist. The health professional conducts an assessment and then recommends treatment.

Children and adults may need medical treatment for social phobia. The adult's diagnosis also starts with a medical exam to determine if there is a physical cause for symptoms. If that has been ruled out, the patient undergoes a psychiatric evaluation.

Diagnostic fees and the time allocated for evaluation vary for both shy and phobic people. Diagnosis could span several hour-long sessions that cover an initial evaluation, personality tests, and a meeting to set therapy goals. Each session could cost around $90. Insurance may cover part of the costs.

Treatment

Shyness treatment concentrates on changing behavior so the person feels more at ease in shyness-provoking situations. The person may be guided by a self-help book or participate in individual or **group therapy**.

Books and therapy generally focus on behavioral therapy and **cognitive-behavioral therapy**. One method of behavioral therapy is to expose the person to the situation that triggers fear. This could start with rehearsing a job interview with a friend or making eye contact with a store clerk. Over time, the person goes on interviews to get experience rather than to be hired. Another person might move from eye contact to attending an enjoyable event like a concert to become more at ease around strangers.

Therapy also focuses on developing skills to cope in new situations. These include taking deep breaths to relax and practicing small talk. Cognitive-therapy helps the person learn how thinking patterns contribute to symptoms, according to NMHA. The person is taught techniques to change those thoughts or stop symptoms. This association maintains this therapy is very effective for people with social phobias.

Treatment costs vary from the price of a self-help book to the fees for therapy. Therapy sessions may be led by a licensed marriage and family counselor, a psychologist or psychiatrist. The cost of group therapy is generally an hourly fee with therapy planned for a set time. The therapist might charge $80 an hour for a social phobia group that meets 3 hours a week for 16 weeks.

Treatment may include medication. Prescription drugs like Paxil (paroxetine) are generally only prescribed to people with social **anxiety disorders**. Paxil is prescribed for depression and other **mood disorders**. The patient takes one tablet daily. Costs will vary, and a 30-day order could be priced at $74 to $84.

Insurance may cover part of the costs of therapy and medicine.

Alternative treatment

Alternative treatments for shyness focus on symptoms like tension and **stress**. Relaxation tapes and CDs guide the listener through a series of actions to relieve tension. The activity starts with deep breathing and then the person progressively focuses on the head and different parts of the body. The exercise may start with the head, neck, shoulders, moving down to the one foot and then the other. Some techniques involve tightly tensing and then releasing each part. Another method is to concentrate on relaxing each part or imagine that it becomes warm.

Another self-treatment is **aromatherapy**. Lavender is a relaxing scent and is available in liquid form as an essential oil. Stress can be relieved by adding oil to a bath. Some people carry the oil with them. If they become anxious, the people can dab the oil on a cotton pad. They breathe in the lavender and feel calmer.

Prognosis

Shyness may not be a permanent. Children often outgrow shyness. Behavioral changes and therapy can help people feel more at ease. Furthermore, some aspects of shyness are positive. Shy people are frequently good listeners and are empathetic, aware of others' feelings.

Prevention

Shyness is a personality trait related to a person's biology and experiences. The part of shyness related to the brain cannot be changed. However, parents can provide a nurturing environment that helps prevent shyness. This will provide the child with a healthy mental attitude that helps prevent shyness. When faced with situations that could cause self-defeating shyness, children will have coping skills.

According to the National Mental Health Association, the basics of good mental health for children include:

- A family that provides unconditional love not related on accomplishments.
- Nurturing self-confidence and high self-esteem by praising children. Methods include encouraging a child to

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learn a new game. The parents should set realistic goals, assure children, and smile frequently. Parents should avoid sarcastic remarks, set realistic goals and let children know that all people make mistakes.

- Playing with other children helps the young learn how to develop friendships and problem-solving skills.
- Emphasizing that school is fun. Parents can play school with their child to demonstrate that learning is enjoyable. Enrolling children in preschool or children's programs allows them to learn, be creative, and develop social skills.
- When disciplining, parents should criticize the behavior, rather than berating the child.

Shyness prevention and adults

For adults prone to shyness, the issue is related more to treatment than prevention. Shyness for these people has probably been an issue, one that surfaces at various times in their lives. A move, a **death** in the family, job loss, and other unsettling changes could cause emotions that include the fear associated with shyness.

In some circumstances, the person must go through the grieving process. In other situations, the person needs to do things that build self-confidence. Like the child, the adult needs a support system. A network of friends helps with encouragement and listens to the person's concerns.

To combat the avoidance symptom caused by shyness, the person should look into enjoyable pursuits. Recreational activities like walking groups combine physical exercise with the opportunity to socialize. Enrolling in a class at an adult school or community college provides the opportunity to learn and make new friends. Class topics range from upholstery to mystery book discussions. Classes like these can boost confidence as a person learns a hands-on skill or discovers that other mystery readers value her or his opinion.

Resources

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ORGANIZATIONS

American Psychological Association (APA), 750 First St. NE, Washington, DC, 20002-4242, (202) 336-5500, (800) 374-2721, http://www.apa.org/.

Mental Health America, 2000 N. Beauregard Street, 6th Floor, Alexandria, VA, 22311, (703) 684-7722, (703) 684-5968, (800) 969-6642, infoctr@mentalhealthamerica.net, http://www.mentalhealthamerica.net.

Shyness Research Institute, 4201 Grant Line Rd., New Albany, IN, 47150, (812) 941-2295, (812) 941-2591, bcarducc@ius.edu, http://homepages.ius.edu.

Liz Swain

Sick sinus syndrome

Definition

Sick sinus syndrome is a disorder of the sinus node of the heart, which regulates heartbeat. With sick sinus syndrome, the sinus node fails to signal properly, resulting in changes in the heart rate.

Description

The sinus node in the heart functions as the heart's pacemaker, or beat regulator. In sick sinus syndrome, patients normally will experience bradycardia, or slowed heart rate. Also, it is not uncommon to see fluctuations between slow and rapid heart rate (tachycardia). This makes the diagnosis and treatment of sick sinus syndrome more complicated than most other cardiac **arrhythmias** (irregular heart beats). A sick sinus node may be responsible for starting beats too slowly, pausing too long between initiation of heartbeats, or not producing heartbeats at all.

Causes and symptoms

Sick sinus syndrome may be brought on by the use of certain drugs, but is most common in elderly patients. Cardiac **amyloidosis**, a condition in which amyloid, a kind of protein, builds up in heart tissue, may affect the sinus node. Other conditions, such as **sarcoidosis** (round bumps in the tissue surrounding the heart and other organs), **Chagas' disease** (resulting from the bite of a bloodsucking insect), or certain cardiac **myopathies** can cause fiber-like tissue to grow around the normal sinus node causing the node to malfunction.

A patient may not show any symptoms of sick sinus syndrome. In general the common symptoms are those associated with slow heart rate, such as light-headedness, or **dizziness**, **fatigue** and **fainting**. Patients may

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also experience confusion, heart **palpitations**, **angina**, or **heart failure**.

Diagnosis

A slow pulse, especially one that is irregular, may be the first indication of sick sinus syndrome. **Electrocardiography** (ECGs) is a commonly used method of detecting sick sinus syndrome. ECG monitoring for 24 hours is most useful, since with this syndrome, the heart rate may alternate between slow and fast and the determination of this fact can help differentiate sick sinus syndrome from other arrhythmias.

Treatment

If drugs are causing the problem, their withdrawal may effectively eliminate the disorder. However, the treatment of sick sinus syndrome is normally delayed until a patient shows symptoms. Once treatment is indicated, most patients will receive a pacemaker. This is a permanent treatment involving implantation of a small device under the skin below the collarbone. Small electrodes run from the device to the heart; they deliver and regulate the electrical signals that cause the heart to beat. Patients with sick sinus syndrome should generally receive dual chamber pacing systems to prevent **atrial fibrillation** (involuntary contraction of the muscles of the atria). Some drugs are used to treat sick sinus syndrome, but digitalis should be used with caution. Often the use of drugs to regulate the heartbeat should be implemented only after the pacemaker has been placed, since these drugs may further worsen the slow heart rate.

Alternative treatment

The reduction or elimination of certain foods and substances, such as alcohol or **caffeine**, may be advised to control heart rate. **Stress reduction** may also assist with changes in rate. Homeopathic treatment can work on a deep healing level, while **acupuncture** and botanical medicine can offer supportive treatment of symptoms.

Prognosis

Patients with sick sinus syndrome lead relatively normal lives if the disorder is controlled by a pacemaker. However, in some patients, the pacemaker does not adequately control the fluctuations in heart rate. If left untreated, or in severe cases, the heart could stop beating.

Prevention

Elimination of a drug therapy which aggravates sick sinus syndrome is the first line of treatment for some patients. Other causes of the syndrome are not preventable. However, proper treatment of those underlying conditions which affect the tissues of the heart may intervene to prevent sick sinus syndrome from becoming a significant problem.

KEY TERMS

Arrhythmia—Irregular heart beat.

Atria—Plural for atrium. The atria are the upper chambers of the heart.

Bradycardia—A heart rate slower than normal.

Electrocardiograph (ECG)—A test of a patient's heartbeat that involves placing leads, or detectors, on the patient's chest to record electrical impulses in the heart. This test will produce a strip, or picture record of the heart's electrical functioning.

Myopathy—Weakness of muscle.

Pacemaker—A device implanted under the skin, below the collarbone, to regulate heartbeat. Leads from the device to the heart stimulate the electrical functions of the heart. Pacemakers are often used to control bradycardia and are usually smaller than a silver dollar.

Resources

OTHER

"Sick Sinus Syndrome." Heart Rhythm Society. [Accessed December 3, 2010] http://www.hrspatients.org/patients/heart_disorders/sick_sinus/default.asp.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review. personal.info@heart.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

Teresa Odle

Sickle cell disease

Definition

Sickle cell disease describes a group of inherited blood disorders characterized by chronic anemia, painful events, and various complications due to associated tissue and organ damage.

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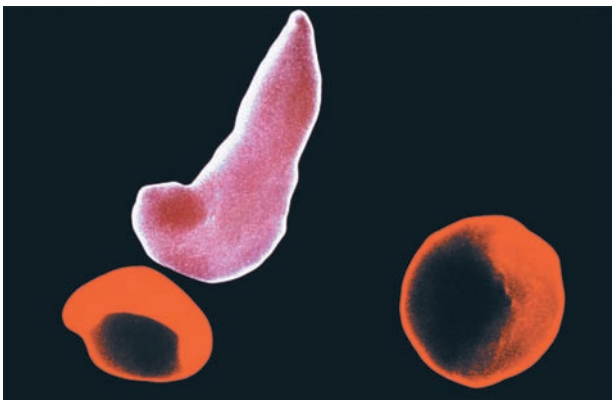

A scanning electron microscopy (SEM) scan of red blood cells taken from a person with sickle cell anemia. The blood cells at the bottom are normal; the diseased, sickle-shaped cells appear at the top. *(Dr. Gopal Murti/Photo Researchers, Inc.)*

Demographics

As of 2009, the National Heart, Lung and Blood Institute (NHLBI) estimates that sickle cell disease affects about 70,000 people in the United States. It mainly affects African Americans. The disease occurs in about 1 out of every 500 African American births. Sickle cell disease also affects Hispanic Americans, occurring in 1 out of every 36,000 births. Approximately 2 million Americans have the sickle cell trait. The condition occurs in about 1 in 12 African Americans. Sickle cell disease affects millions of people worldwide. Incidence is higher in people who come from Africa, South or Central America (Panama), the Caribbean islands, Mediterranean countries (Turkey, Greece, and Italy), India, and Saudi Arabia.

Description

Carriers of the sickle cell gene are said to have sickle cell trait. Unlike sickle cell disease, sickle cell trait does not cause health problems. In fact, sickle cell trait is protective against **malaria**, a disease caused by blood–borne parasites transmitted through mosquito **bites**. According to a widely accepted theory, the genetic mutation associated with the sickle cell trait occurred thousands of years ago. Coincidentally, this mutation increased the likelihood that carriers would survive malaria infection. Survivors then passed the mutation to their offspring and the trait became established throughout areas where malaria was common. As populations migrated, so did the sickle cell trait.

The most common and well-known type of sickle cell disease is sickle cell anemia, also called SS disease. All types of sickle cell disease are caused by a genetic change in hemoglobin, the oxygen-carrying protein inside the red blood cells. The red blood cells of affected individuals contain a predominance of a structural variant of the usual adult hemoglobin. This variant hemoglobin, called sickle hemoglobin (Hb-S), has a tendency to develop into rod-like structures that alter the shape of the usually flexible and round red blood cells. The cells take on a shape that resembles the curved blade of a sickle, an agricultural tool. Sickle cells have a shorter life span than normally-shaped red blood cells. This results in chronic anemia characterized by low levels of hemoglobin and decreased numbers of red blood cells. Sickle cells are also less flexible and more sticky than normal red blood cells and can become trapped in small blood vessels preventing blood flow. This compromises the delivery of oxygen, which can result in **pain** and damage to associated tissues and organs. Sickle cell disease presents with marked variability, even within families.

Risk factors

In each **pregnancy** of two parents who both have sickle cell trait, there is a 50% chance that the child will have the trait, a 25% chance that the child will have sickle cell disease, and a 25% chance that the child will have neither the trait nor the disease.

Causes and symptoms

Humans normally make several types of the oxygen-carrying protein hemoglobin. An individual's stage in development determines whether he or she makes primarily embryonic, fetal, or adult hemoglobins. All types of hemoglobin are made of three components: heme, alpha (or alpha-like) globin, and beta (or beta-like) globin. Sickle hemoglobin is the result of a genetic change in the beta globin component of normal adult hemoglobin. The beta globin gene is located on chromosome 11. The sickle cell form of the beta globin gene results from the substitution of a single DNA nucleotide, or genetic building-block. The change from adenine to thymine at codon (position) 6 of the beta globin gene leads to insertion of the amino acid valine—instead of glutamic acid—at this same position in the beta globin protein. As a result of this change, sickle hemoglobin has unique properties in comparison to the usual type of adult hemoglobin.

Most individuals have two normal copies of the beta globin gene, which make normal beta globin that is incorporated into adult hemoglobin. Individuals who have sickle cell trait (called sickle cell carriers) have one normal beta globin gene and one sickle cell gene. These individuals make both the usual adult hemoglobin and sickle hemoglobin in roughly equal proportions, so they do not experience any health problems as a result

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of having the trait. Although traces of blood in the urine and difficulty in concentrating the urine can occur, neither represents a significant health problem as a result of sickle cell trait. Of the millions of people with sickle cell trait worldwide, a small handful of individuals have experienced acute symptoms. In these very rare cases, individuals were subject to very severe physical strain.

Other types of sickle cell disease include SC disease, SD disease, and S/beta **thalassemia**. These conditions are caused by the co-inheritance of the sickle cell gene and another altered beta globin gene. For example, one parent may have sickle cell trait and the other parent may have hemoglobin C trait (another hemoglobin trait that does not cause health problems). For this couple, there would be a 25% chance of SC disease in each pregnancy.

Symptoms

Normal adult hemoglobin transports oxygen from the lungs to tissues throughout the body. Sickle hemoglobin can also transport oxygen. However, once the oxygen is released, sickle hemoglobin tends to polymerize (line–up) into rigid rods that alter the shape of the red blood cell. Sickling of the red blood cell can be triggered by low oxygen, which occurs in organs with slow blood flow. It can also be triggered by cold temperatures and **dehydration**.

Sickle cells have a decreased life span in comparison to normal red blood cells. Normal red blood cells survive for approximately 120 days in the bloodstream; sickle cells last only 10–12 days. As a result, the bloodstream is chronically short of red blood cells and hemoglobin and the affected individual develops anemia.

Sickle cells can create other complications. Due to their shape, they do not fit well through small blood vessels. As an aggravating factor, the outside surfaces of sickle cells may have altered chemical properties that increase the cells' stickiness. These sticky sickle cells are more likely to adhere to the inside surfaces of small blood vessels, as well as to other blood cells. As a result of the sickle cells' shape and stickiness, blockages form in small blood vessels. Such blockages prevent oxygenated blood from reaching areas where it is needed, causing pain as well as organ and tissue damage.

The severity of symptoms cannot be predicted based solely on the genetic inheritance. Some individuals with sickle cell disease develop health- or life-threatening problems in infancy but others may have only mild symptoms throughout their lives. Individuals may experience varying degrees of health at different stages in the lifecycle. For the most part, this clinical variability is unpredictable and the reasons for the observed variability cannot be determined. However, certain types of sickle cell disease (i.e. SC disease) tend to result in fewer and less severe symptoms on average than other types of sickle cell disease (i.e. SS disease). Some additional modifying factors are known. For example, elevated levels of fetal hemoglobin in a child or adult can decrease the quantity and severity of some symptoms and complications. Fetal hemoglobin is a normally occurring hemoglobin that usually decreases from over 90% of the total hemoglobin to under 1% during the first year of life. This change is genetically determined, although some individuals may experience elevated levels of fetal hemoglobin due to variation in the genes that control fetal hemoglobin production. Such individuals often experience a reduction in their symptoms and complications due to the ability of fetal hemoglobin to prevent the polymerization of sickle hemoglobin, which leads to sickling of the red blood cell.

There are several symptoms that warrant immediate medical attention, including the following:

- Signs of infection (fever 101°F or 38.3°C, coughs frequently or breathing trouble, unusual crankiness, feeding difficulties)
- Signs of severe anemia (pale skin or lips, yellowing of the skin or eyes, very tired, very weak)
- Signs indicating possible dehydration (vomiting, diarrhea, fewer wet diapers)
- Other signs (pain or swelling in the abdomen, swollen hands or feet, screams when touched).

These can be signs of various complications that occur in sickle cell disease.

INFECTIONS AND EFFECTS ON THE SPLEEN. Children with sickle cell disease who are under age three are particularly prone to life-threatening bacterial infections. *Streptococcus pneumoniae* is the most common offending bacteria and invasive infection from this organism leads to **death** in 15% of patients. The spleen, an organ that helps to fight bacterial infections, is particularly vulnerable to the effects of sickling. Sickle cells can impede blood flow through the spleen causing organ damage, which usually results in loss of spleen function by late childhood. The spleen can also become enlarged due to blockages and/or increased activity of the spleen. Rapid enlargement of the spleen may be a sign of another complication called *splenic sequestration*, which occurs mostly in young children and can be life-threatening. Widespread sickling in the spleen prevents adequate blood flow from the organ, removing

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increasing volumes of blood from the circulation and leading to accompanying signs of severe anemia.

PAINFUL EVENTS. Painful events, also known as *vaso–occlusive events*, are a hallmark symptom of sickle cell disease. The frequency and duration of the pain can vary tremendously from person to person and over an individual's lifecycle. Painful events are the most common cause of hospitalizations in sickle cell disease. However, only a small portion of individuals with sickle cell disease experience frequent and severe painful events. Most painful events can be managed at home. Pain results when small blood vessel blockages prevent oxygen from reaching tissues. Pain can affect any area of the body although the extremities, chest, abdomen, and bones are frequently affected sites. There is some evidence that cold temperatures or infection can trigger a painful event but most events occur for unknown reasons. The hand-foot syndrome, or *dactylitis*, is a particular type of painful event. Most common in toddlers, dactylitis results in pain and swelling in the hands and feet, sometimes accompanied by a **fever**.

ANEMIA. Sickle cells have a high turnover rate leading to a deficit of red blood cells in the bloodstream. Common symptoms of anemia include **fatigue**, paleness, and a **shortness of breath**. A particularly severe form of anemia—aplastic anemia—occurs following infection with parvovirus. Parvovirus causes extensive destruction of the bone marrow, bringing production of new red blood cells to a halt. Bone marrow production resumes after 7 to 10 days; however, given the short lives of sickle cells, even a brief shutdown in red blood cell production can cause a rapid decline in hemoglobin concentrations.

DELAYED GROWTH. The energy demands of the bone marrow for red blood cell production compete with the demands of a growing body. Children with sickle cell anemia may have delayed growth and reach **puberty** at a later age than normal. By early adulthood, they catch up on growth and attain normal height; however, weight typically remains below average.

STROKE. Children with sickle cell disease have a significantly elevated risk of having a **stroke**, which can be one of the most concerning complications of sickle cell disease. Approximately 11% of individuals with sickle cell disease will have a recognizable stroke by the age of 20. **Magnetic resonance imaging** studies have found that 17% of children with sickle cell anemia have evidence of a previous stroke or clinically 'silent' stroke-like events called *transient ischemic events*. Stroke in sickle cell disease is usually caused by a blockage of a blood vessel but about one fourth of the time may be caused by a hemorrhage (or rupture) of a blood vessel.

Strokes result in compromised delivery of oxygen to an area of the brain. The consequences of stroke can range from life-threatening, to severe physical or cognitive impairments, to apparent or subtle learning disabilities, to undetectable effects. Common stroke symptoms include weakness or **numbness** that affects one side of the body, sudden behavioral changes, loss of vision, confusion, loss of speech or the ability to understand spoken words, **dizziness**, **headache**, seizures, **vomiting**, or even **coma**.

Approximately two–thirds of the children who have a stroke will have at least one more. Transfusions have been shown to decrease the incidence of a second stroke. A recent study showed that children at highest risk to experience a first stroke were 10 times more likely to have a stroke if untreated when compared to high-risk children treated with chronic blood **transfusion** therapy. High-risk children were identified using transcranial doppler ultrasound technology to detect individuals with increased blood flow speeds due to constricted intracranial blood vessels.

ACUTE CHEST SYNDROME. Acute chest syndrome (ACS) is a leading cause of death for individuals with sickle cell disease, and recurrent attacks can lead to permanent lung damage. Therefore, rapid diagnosis and treatment is of great importance. ACS can occur at any age and is similar but distinct from **pneumonia**. Affected persons may experience fever, **cough**, chest pain, and shortness of breath. ACS seems to have multiple causes including infection, sickling in the small blood vessels of the lungs, fat embolisms in the lungs, or a combination of factors.

PRIAPISM. Males with sickle cell anemia may experience **priapism**, a condition characterized by a persistent and painful erection of the penis. Due to blood vessel blockage by sickle cells, blood is trapped in the tissue of the penis. Priapism may be short in duration or it may be prolonged. Priapism can be triggered by low oxygen (hypoxemia), alcohol consumption, or sexual intercourse. Since priapism can be extremely painful and result in damage to this tissue causing **impotence**, rapid treatment is essential.

KIDNEY DISEASE. The environment in the kidney is particularly prone to damage from sickle cells. Signs of kidney damage can include blood in the urine, incontinence, and enlarged kidneys. Adults with sickle cell disease often experience insufficient functioning of the kidneys, which can progress to kidney failure in a small percentage of adults with sickle cell disease.

JAUNDICE AND GALLSTONES. **Jaundice** is indicated by a yellow tone in the skin and eyes and alone it is not a health concern. Jaundice may occur if bilirubin levels increase, which can occur with high levels of red blood

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cell destruction. Bilirubin is the final product of hemoglobin degradation, and is typically removed from the bloodstream by the liver. Therefore, jaundice can also be a sign of a poorly functioning liver, which may also be evidenced by an enlarged liver. Increased bilirubin also leads to increased chance for **gallstones** in children with sickle cell disease. Treatment, which may include removal of the gall bladder, may be selected if the gallstones start causing symptoms.

RETINOPATHY. The blood vessels that supply oxygen to the retina—the tissue at the back of the eye—may be blocked by sickle cells, leading to a condition called retinopathy. This is one of the only complications that is actually more common in SC disease as compared to SS disease. Retinopathy can be identified through regular ophthalmology evaluations and effectively treated in order to avoid damage to vision.

Joint problems

Avascular necrosis of the hip and shoulder joints, in which bone damage occurs due to compromised blood flow due to sickling, can occur later in childhood. This complication can affect an individual's physical abilities and result in substantial pain.

Diagnosis

Examination

Sickle cell disease is typically diagnosed through genetic screening done when a baby is born. If sickle cell disease is diagnosed, the parents are referred to a doctor who specializes in blood disorders (hematologist) or a pediatric hematologist.

Tests

Testing for sickle cell is performed to identify the presence of hemoglobin S, and the presence of other abnormal hemoglobins. A **complete blood count** (CBC) will describe several aspects of an individual's blood cells. A person with sickle cell disease will have a lower than normal hemoglobin level, together with other characteristic red blood cell abnormalities. A *hemoglobin electrophoresis* is a test that can help identify the types and quantities of hemoglobin made by an individual. This test uses an electric field applied across a slab of gel-like material. Hemoglobins migrate through this gel at various rates and to specific locations, depending on their size, shape, and electrical charge. Although sickle hemoglobin (Hb S) and regular adult hemoglobin (called Hb A) differ by only one amino acid, they can be clearly separated using **hemoglobin electrophoresis**. *Isoelectric focusing* and *high-performance liquid chromatography (HPLC)* use similar principles to separate hemoglobins and can be used instead of or in various combinations with hemoglobin electrophoresis to determine the types of hemoglobin present.

Another test, called the 'sickledex' can help confirm the presence of sickle hemoglobin, although this test cannot provide accurate or reliable diagnosis when used alone. When Hb S is present but there is an absence or only a trace of Hb A, sickle cell anemia is a likely diagnosis. Additional beta globin DNA testing, which looks directly at the beta globin gene, can be performed to help confirm the diagnosis and establish the exact genetic type of sickle cell disease. CBC and hemoglobin electrophoresis are also typically used to diagnosis sickle cell trait and various other types of beta globin traits.

Diagnosis of sickle cell disease can occur under various circumstances. If an individual has symptoms that are suggestive of this diagnosis, the above–described screening tests can be performed followed by DNA testing, if indicated. Screening at birth using HPLC or a related technique offers the opportunity for early intervention. More than 40 states include sickle cell screening as part of the usual battery of blood tests done for newborns. This allows for early identification and treatment. Hemoglobin trait screening is recommended for any individual of a high-risk ethnic background who may be considering having children. When both members of a couple are found to have sickle cell trait, or other related hemoglobin traits, they can receive **genetic counseling** regarding the risk of sickle cell disease in their future children and various testing options.

Sickle cell disease can be identified before birth through the use of prenatal diagnosis. **Chorionic villus sampling** (CVS) can be offered as early as 10 weeks of pregnancy and involves removing a sample of the placenta made by the baby and testing the cells. CVS carries a risk of causing a **miscarriage** that is between 5% to 1%.

Amniocentesis is generally offered between 16 and 18 weeks of pregnancy but can sometimes be offered earlier. Two to three tablespoons of the fluid surrounding the baby is removed. This fluid contains fetal cells that can be tested. This test carries a risk of causing a miscarriage, which is less than 1%. Pregnant woman and couples may choose prenatal testing in order to prepare for the birth of a baby that may have sickle cell disease.

Preimplantation genetic diagnosis (PGD) is a relatively new technique that involves in-vitro fertilization followed by **genetic testing** of one cell from each developing embryo. Only the embryos unaffected by sickle cell disease are transferred back into the uterus. PGD is currently available on a research basis only, and is relatively expensive.

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KEY TERMS

Amino acid—Organic compounds that form the building blocks of protein. There are 20 types of amino acids (eight are "essential amino acids," which the body cannot make and must therefore be obtained from food).

Anemia—A blood condition in which the level of hemoglobin or the number of red blood cells falls below normal values. Common symptoms include paleness, fatigue, and shortness of breath.

Bilirubin—A yellow pigment that is the end result of hemoglobin breakdown. This pigment is metabolized in the liver and excreted from the body through the bile. Bloodstream levels are normally low; however, extensive red cell destruction leads to excessive bilirubin formation and jaundice.

Bone marrow—A spongy tissue located in the hollow centers of certain bones, such as the skull and hip bones. Bone marrow is the site of blood cell generation.

Bone marrow transplantation—A medical procedure used to treat some diseases that arise from defective blood cell formation in the bone marrow. Healthy bone marrow is extracted from a donor to replace the marrow in an ailing individual. Proteins on the surface of bone marrow cells must be identical or very closely matched between a donor and the recipient.

Globin—Protein component of hemoglobin. Normal adult hemoglobin has a pair each of alpha-globin and beta-globin molecules that each contain a heme group.

Heme—The iron-containing molecule in hemoglobin that serves as the site for oxygen binding. Normal hemoglobin has four hemes in four globin chains.

Hemoglobin—Iron-containing blood protein that carries oxygen to the cells and carries carbon dioxide away from the cells.

Hemoglobin A—Normal adult hemoglobin that contains four heme molecules, two alpha-globin molecules, and two beta-globin molecules.

Hemoglobin electrophoresis—A laboratory test that separates molecules based on their size, shape, or electrical charge.

Hemoglobin S—Hemoglobin produced in association with the sickle cell trait; the beta-globin molecules of hemoglobin S are defective.

Treatment

Traditional

There are several practices intended to prevent some of the symptoms and complications of sickle cell disease. These include preventative **antibiotics**, good hydration, immunizations, and access to comprehensive care. Maintaining good health through adequate **nutrition**, avoiding stresses and infection, and getting proper rest is also important. Following these guidelines is intended to improve the health of individuals with sickle cell disease.

As in any lifelong, chronic disease, comprehensive care is important. Assistance with the emotional, social, family-planning, economic, vocational, and other consequences of sickle cell disease can enable affected individuals to better access and benefit from their medical care.

Drugs

Infants are typically started on a course of penicillin that extends from infancy to age six. Use of this antibiotic is meant to ward off potentially fatal infections. Infections at any age are treated aggressively with antibiotics. Vaccines for common infections, such as *pneumococcal pneumonia*, are also recommended.

Pain is one of the primary symptoms of sickle cell anemia and controlling it is an important concern. The methods necessary for pain control are based on individual factors. Some people can gain adequate pain control through over-the-counter oral painkillers (**analgesics**). Other individuals, or painful events, may require stronger methods, which can include administration of **narcotics**. Alternative therapies may be useful in avoiding or controlling pain, including relaxation, hydration, avoiding extremes of temperature, and the application of local warmth.

Emphasis is being placed on developing drugs that treat sickle cell anemia directly. The most promising of these drugs since the late 1990s has been hydroxyurea, a drug that was originally designed for anticancer treatment. Hydroxyurea has been shown to reduce the frequency of painful crises and acute chest syndrome in adults, and to lessen the need for blood transfusions. Hydroxyurea, and other related medications, seem to work by inducing a higher production of fetal hemoglobin. The major side effects of the drug include decreased production of platelets, red blood

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Hydroxyurea—A drug that has been shown to induce production of fetal hemoglobin. Fetal hemoglobin has a pair of gamma-globin molecules in place of the typical beta-globins of adult hemoglobin. Higher-than-normal levels of fetal hemoglobin can prevent sickling from occurring.

Impotence—The inability to have a penile erection, which can be due to tissue damage resulting from sickling within the penis (priapism).

Iron overload—A side effect of frequent blood transfusions in which the body accumulates abnormally high levels of iron. Iron deposits can form in organs, particularly the heart, and cause life-threatening damage.

Jaundice—Yellowing of the skin or eyes due to excess of bilirubin in the blood.

Magnetic resonance imaging (MRI)—A technique that employs magnetic fields and radio waves to create detailed images of internal body structures and organs, including the brain.

Mutation—A permanent change in the genetic material that may alter a trait or characteristic of an individual, or manifest as disease, and can be transmitted to offspring.

Narcotics—Strong, prescription medication that can be effective in treating pain, but have the potential to be habit-forming if their use is not supervised correctly.

Nucleic acid—A type of chemical used as a component for building DNA. The nucleic acids found in DNA are adenine, thymine, guanine, and cytosine.

Ophthalmology—The medical specialty of vision and the eye.

Placenta—The organ responsible for oxygen and nutrition exchange between a pregnant mother and her developing baby.

Red blood cell—Hemoglobin-containing blood cells that transport oxygen from the lungs to tissues. In the tissues, the red blood cells exchange their oxygen for carbon dioxide, which is brought back to the lungs to be exhaled.

Screening—Process through which carriers of a trait may be identified within a population.

Sickle cell—A red blood cell that has assumed a elongated shape due to the presence of hemoglobin S.

cells, and certain white blood cells. The effects of long-term hydroxyurea treatment are unknown.

Alternative

BLOOD TRANSFUSIONS. Blood transfusions are not usually given on a regular basis but are used to treat individuals with frequent and severe painful events, severe anemia, and other emergencies. In some cases blood transfusions are given as a preventative measure, for example to treat spleen enlargement or prevent a second stroke (or a first stroke in an individual shown to be at high risk).

Regular blood transfusions have the potential to decrease formation of hemoglobin S and reduce associated symptoms. However, there are limitations and risks associated with regular blood transfusions, including the risk of blood-borne infection and sensitization to proteins in the transfused blood that can make future transfusions very difficult. Most importantly, chronic blood transfusions can lead to iron overload. The body tends to store excess iron, such as that received through transfusions, in various organs. Over time, this iron storage can cause damage to various tissues and organs, such as the heart and endocrine organs.

Some of this damage can be prevented by the administration of a medication called *desferoxamine* that helps the body to eliminate excess iron through the urine. Alternately, some individuals receive a new, non-standard treatment called *erythrocytapheresis*. This involves the automated removal of sickle cells and is used in conjunction with a reduced number of regular transfusions. This treatment helps to reduce iron overload.

BONE MARROW TRANSPLANTATION. Bone marrow transplantation has been shown to cure sickle cell anemia in some cases. This treatment is reserved primarily for severely affected children with a healthy donor whose marrow proteins match those of the recipient, namely a brother or sister who has inherited the same tissue type. Indications for a bone marrow transplant are stroke, recurrent acute chest syndrome, and chronic unrelieved pain.

Bone marrow transplantations tend to be the most successful in children; adults have a higher rate of

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transplant rejection and other complications. There is approximately a 10% fatality rate associated with bone marrow transplants done for sickle cell disease. Survivors face potential long-term complications, such as chronic graft-versus-host disease (an immune-mediated attack by the donor marrow against the recipient's tissues), **infertility**, and development of some forms of **cancer**. A relatively recent advance in transplantation involves the use of donor stem cells obtained from *cord blood*, the blood from the placenta that is otherwise discarded following the birth of a new baby. Cord blood cells, as opposed to fully mature bone marrow cells, appear to be less likely to result in graft-versus-;host disease in the recipient. This increases the safety and efficacy of the transplant procedure.

SURGERY. Certain surgical interventions are utilized in the treatment of specific sickle cell-related complications. Removal of a dysfunctioning gallbladder or spleen can often lead to improvements in health. Investigations are currently underway to establish the efficacy of hip coring surgery in which a portion of affected bone is removed to treat avascular necrosis of the hip. The hope is that this may provide an effective treatment to alleviate some pain and restore function in the affected hip.

CLINICAL TRIALS. Clinical trials for the treatment of sickle cell anemia are currently sponsored by the National Institutes of Health (NIH) and other agencies. In 2009, NIH reported 198 on-going or recently completed studies. Some examples include the following:

- The evaluation of the effect of L-glutamine therapy on exercise endurance and breath by breath exercise response of sickle cell anemia patients. (NCT00586209)
- The study of how often people with sickle cell anemia develop pulmonary hypertension, a serious disease in which blood pressure in the artery to the lungs is elevated. (NCT00011648)
- The evaluation of the effectiveness of the nutritional supplement arginine at improving blood cell function and disease symptoms in people with sickle cell anemia. (NCT00513617)
- A study evaluating the iron overload in sickle cell anemia patients using clinical parameters and laboratory studies to determine cardiac and liver iron. (NCT00512564)

Clinical trial information is constantly updated by NIH and the most recent information on sickle cell anemia trials can be found at: http://clinicaltrials.gov/ct2/results?term = sickle + cell + disease.

Prognosis

Sickle cell disease is characteristically variable between and within affected individuals. Predicting the course of the disorder based solely on genes is not possible. Several factors aside from genetic inheritance determine the prognosis for affected individuals, including the frequency, severity, and nature of specific complications in any given individual. The availability and access of comprehensive medical care also plays an important role in preventing and treating serious, acute complications, which cause the majority of sickle cell-related deaths. For those individuals who do not experience such acute events, life-expectancy is probably substantially greater than the average for all people with sickle cell disease. The impact of recent medical advances supports the hypothesis that current life-expectancies may be significantly greater than those estimated in the early 1990s. At that time, individuals with SS disease lived to the early–to mid–40s, and those with SC disease lived into the upper 50s on average. With early detection and comprehensive medical care, most people with sickle cell disease are in fairly good health most of the time. Most individuals can be expected to live well into adulthood, enjoying an improved quality of life including the ability to choose a variety of education, career, and family-planning options for themselves.

Prevention

Inheritance of sickle cell disease or trait cannot be prevented but it may be predicted. Screening is recommended for individuals in high-risk populations. In the United States, African Americans and Latino Americans have the highest risk of having the disease or trait. All 50 states in the United States have newborn screening programs for sickle cell disease.

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March of Dimes Foundation, 1275 Mamaroneck Avenue, White Plains, NY, 10605, (914) 428-7100, (888) MOD-IMES, (914) 428-8203, askus@marchofdimes.com, http://www.marchofdimes.com.

National Heart, Lung, and Blood Institute (NHLBI), Building 31, Room 5A52, 31 Center Drive MSC 2486, Bethesda, MD, 20892, (301) 592-8573, (240) 629-3246, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi.nih.gov.

Sickle Cell Disease Association of America, Inc., 231 East Baltimore St., Suite 800, Baltimore, MD, 21202, (410) 528-1555 , (800) 421-8453, (410) 528-1495, scdaa@sicklecelldisease.org, http://www. sicklecelldisease.org.

Sickle Cell Information Center, PO Box 109, Atlanta, GA, 30303, (404) 616-3572, (404) 616-5998, aplatt@emory.edu, http://www.scinfo.org.

Monique Laberge, PhD

Sideroblastic anemia

Definition

Sideroblastic anemia is a term used to describe a group of rare blood disorders characterized by the bone marrow's inability to manufacture normal red blood cells.

Description

Named for the Greek words for iron and germ, sideroblastic anemia is one of the principal types of iron-utilization anemia. Abnormal iron-saturated red cells are present in the blood of people who have this disease. Although the iron circulates normally from the plasma to the bone marrow, where new red blood cells are created, it is not properly incorporated into new red blood cells.

Sideroblastic anemia can be inherited but the disease is usually acquired as a result of illness or exposure to toxic substances.

Sideroblastic anemia is a disease of adults.

Causes and symptoms

The cause of sideroblastic anemia cannot always be identified. Drug toxicity, alcohol **abuse**, and **lead poisoning** are common causes of this condition.

Sideroblastic anemia is also associated with:

- leukemia
- lymphoma (cancer of the lymph glands)
- myeloma (cancer of the bone marrow)
- **rheumatoid arthritis**, and other inflammatory diseases

Symptoms of sideroblastic anemia are the same as symptoms of the disease that causes the condition, as well as anemia.

Complications

Possible complications of sideroblastic anemia include:

- congestive heart failure
- **diabetes mellitus**
- enlargement of the liver and spleen
- formation of liver nodules and scar tissue
- irregular heartbeat
- recurring inflammation of the sac that surrounds the heart
- secondary hypopituitarism (dwarfism)

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- skin darkening
- underactivity of the thyroid gland

Diagnosis

Blood tests are used to examine the appearance and other characteristics of red cells and to measure the amount of iron in the blood. **Bone marrow biopsy** is also used.

Treatment

Acquired sideroblastic anemia may be cured when the condition that causes it is treated or removed.

If the cause of a patient's anemia cannot be determined, blood transfusions may be necessary. Medications are prescribed to stimulate excretion or excess iron that accumulates as a result of these transfusions.

In rare instances, treatment with oral pyridoxine (a B-complex vitamin) benefits patients whose sideroblastic anemia was present at birth. This treatment improves the condition of some patients but does not cure the anemia.

Prognosis

Sideroblastic anemia of unknown origin may lead to leukemia. It may take as long as 10 years for this disease progression to take place.

Resources

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ORGANIZATIONS

Leukemia and Lymphoma Society, 1311 Mamaroneck Avenue, Suite 310, White Plains, NY, 10605, (800) 955-4572, http://www.leukemia-lymphoma.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi. nih.gov.

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923, (800) 999-6673, http://www.rarediseases.org.

SIDS *see* **Sudden infant death syndrome**

Sigmoidoscopy

Definition

Sigmoidoscopy is a diagnostic and screening procedure for colorectal **cancer** and inflammatory bowel disease in which a rigid or flexible tube with a camera on the end (a sigmoidoscope) is inserted into the anus to examine the rectum and lower colon (bowel) for bowel disease, cancer, precancerous conditions, or causes of bleeding or **pain**. As of 2010, however, sigmoidoscopy is being used less frequently for screening than **colonoscopy**.

Purpose

Sigmoidoscopy is used most often in screening for colorectal cancer or to determine the cause of rectal bleeding. It is also used in diagnosis of inflammatory bowel disease, microscopic and ulcerative **colitis**, and **Crohn's disease**.

Cancer of the rectum and colon is the second most common cancer in the United States. About 148,300 new cases are diagnosed annually. Between 55,000 and 60,000 Americans die each year of cancer in the colon or rectum. The lifetime risk of developing **colon cancer** in the United States is about 7%.

Experts recommend that people over 50 should be screened for colorectal cancer every one to two years. Various screening tests are used, ranging from fecal occult blood tests (FOBTs) and digital rectal examinations (DREs) in the doctor's office, to more invasive tests such as sigmoidoscopies and colonoscopies. Individuals with such inflammatory bowel conditions as Crohn's disease or ulcerative colitis, and thus at increased risk for colorectal cancer, may begin their screenings at a younger age, depending on when their disease was diagnosed. Screening should also be performed in people who have a family history of colon or **rectal cancer**, or small growths in the colon (polyps).

More and more physicians are performing invasive screening with a colonoscope, which allows them to see the entire colon, in contrast to a sigmoidoscope, which allows them to visualize only the rectum and the lower portion of the colon. Another newer option is virtual colonoscopy, also known as CT colonography, which uses computerized tomography (or **magnetic resonance imaging** in some cases) to obtain images of the interior of the colon and rectum. The patient must cleanse the bowel before this procedure but does not require **sedation** as virtual colonoscopy is not an invasive procedure.

Studies have shown that one-quarter to one-third of all precancerous or small cancerous growths can be

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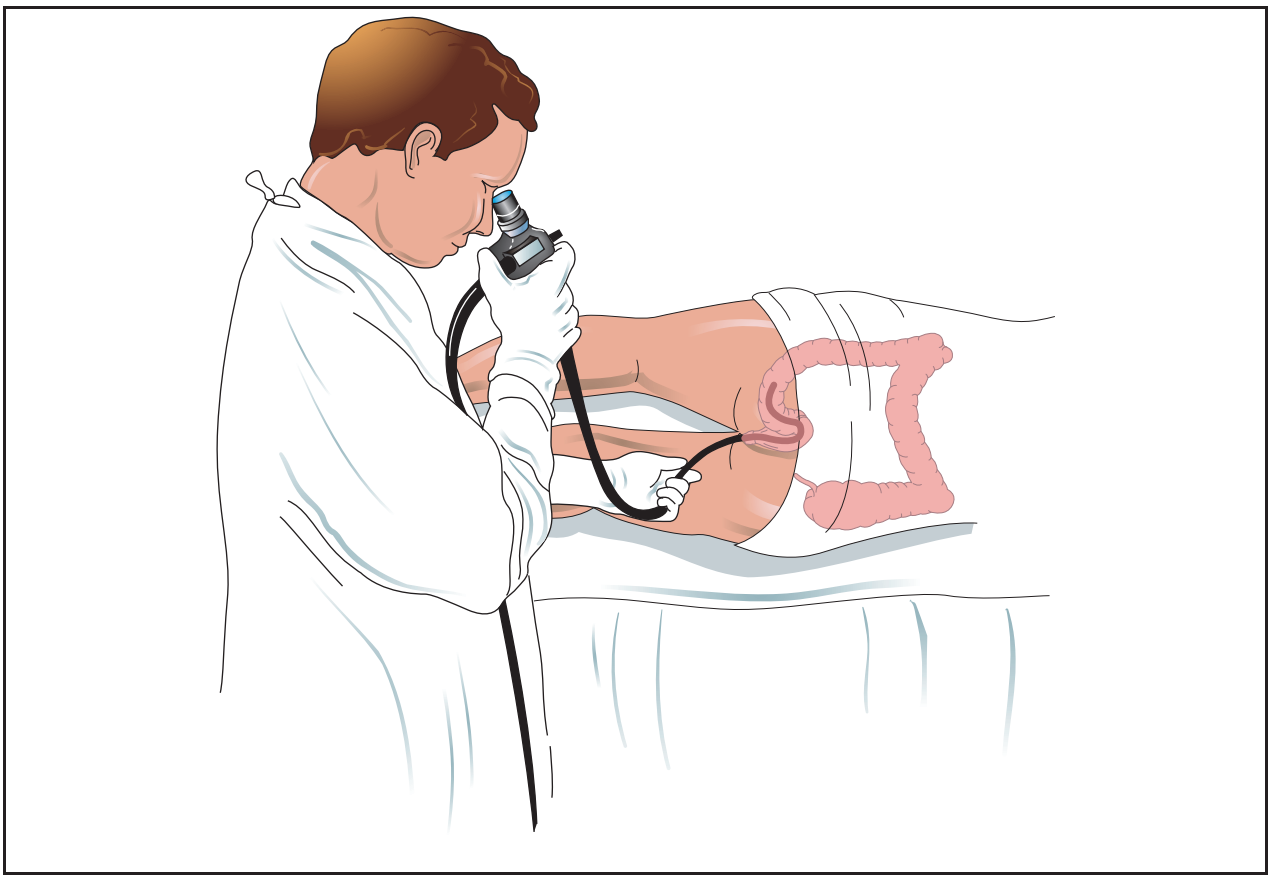

Sigmoidoscopy is a procedure most often used in screening for colorectal cancer and as a test in diagnosis of possible inflammatory bowel disease. As illustrated above, the physician can view the rectum and colon through a sigmoidoscope, a 12 inch (30 cm) or 24 inch (60 cm) flexible fiber-optic tube which contains a light source and a lens. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

seen with a sigmoidoscope. About one-half are found with a 1 ft (30 cm) scope, and two-thirds to three-quarters can be seen using a 2 ft (60 cm) scope.

In some cases, the sigmoidoscope can be used therapeutically in conjunction with such other equipment as electrosurgical devices to remove polyps and other lesions found during the sigmoidoscopy.

Demographics

According to the Centers for Disease Control and Prevention (CDC), approximately 2.8 million flexible sigmoidoscopies and 14.2 million colonoscopies are performed in an average year in the United States. This number includes most of the persons who are diagnosed with colon cancer each year, a greater number who are screened and receive negative results, persons who have been treated for colon conditions and receive a sigmoidoscopy as a follow-up procedure, and individuals who are diagnosed with other diseases of the large colon.

Description

Sigmoidoscopy may be performed using either a rigid or flexible sigmoidoscope, although rigid sigmoidoscopes are rarely used as of 2010. A sigmoidoscope is a thin tube with fiberoptics, electronics, a light source, and camera. A physician inserts the sigmoidoscope into the anus to examine the rectum (the first 1 ft [30 cm] of the colon) and its interior walls. If a 2 ft (60 cm) scope is used, the next portion of the colon can also be examined for any irregularities. The camera of the sigmoidoscope is connected to a viewing monitor, allowing the interior of the rectum and colon to be enlarged and viewed on the monitor. Images can then be recorded as still pictures or the entire procedure can be videotaped. The still pictures are useful for comparison purposes with the results of future sigmoidoscopic examinations.

If polyps, lesions, or other suspicious areas are found, the physician biopsies them for analysis. During the sigmoidoscopy, the physician may also use

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KEY TERMS

Biopsy—The removal of a small portion of tissue during sigmoidoscopy to perform laboratory tests to determine if the tissue is cancerous.

Colonoscopy—A diagnostic endoscopic procedure that uses a long flexible tube called a colonoscope to examine the inner lining of the entire colon; may be used for colorectal cancer screening or for a more thorough examination of the colon.

Colorectal cancer—Cancer of the large intestine, or colon, including the rectum.

Electrosurgical device—A medical device that uses electrical current to cauterize or coagulate tissue during surgical procedures, often used in conjunction with laparoscopy, colonoscopy, or sigmoidoscopy.

Inflammatory bowel diseases—Ulcerative colitis or Crohn's disease: chronic conditions characterized by periods of diarrhea, bloating, abdominal cramps, and pain, sometimes accompanied by weight loss and malnutrition because of the inability to absorb nutrients.

Pathologist—A doctor who specializes in the diagnosis of disease by studying cells and tissues under a microscope.

Polyp—A small growth, usually not cancerous, but often precancerous when it appears in the colon.

Virtual colonoscopy—A noninvasive form of colonoscopy that uses computed tomography (CT scanning) to obtain images of the interior of the patient's colon and rectum. It is also called CT colonography.

forceps, graspers, snares, or electrosurgical devices to remove polyps, lesions, or tumors.

A typical sigmoidoscopy procedure requires 15 to 20 minutes to perform. Preparation begins one day before the procedure. There is some discomfort when the scope is inserted and throughout the procedure, similar to that experienced when a physician performs a rectal exam using a finger to test for occult blood in the stool. Individuals may also feel some minor cramping pain. There is rarely severe pain, except for persons with active inflammatory bowel disease.

Private insurance plans almost always cover the cost of sigmoidoscopy examinations for screening in healthy individuals over 50 or for diagnostic purposes. Medicare covers the cost for diagnostic exams, and may cover the costs for screening exams. Medicaid benefits vary by state, but sigmoidoscopy is not a covered procedure in many states. Some community health clinics offer the procedure at reduced cost but this can only be done if a local gastroenterologist (a physician who specializes in treating stomach and intestinal disorders) is willing to donate personal time to perform the procedure.

Diagnosis/Preparation

The purpose of preparation for sigmoidoscopy is to cleanse the lower bowel of fecal material or stool so the physician can see the lining. Preparation begins 24 hours before the procedure when an individual must begin a clear liquid diet. Preparation kits are available in drug stores. In normal preparation, about 20 hours before the exam, a person begins taking a series of **laxatives**, which may be oral tablets or liquid. The individual must stop drinking any liquid four hours before the exam. An hour or two prior to the examination, the person uses an enema or laxative suppository to finish cleansing the lower bowel.

Patients must be careful about medications before having a sigmoidoscopy. They should not take **aspirin**, products containing aspirin, or products containing ibuprofen for one week prior to the exam, because these medications can exacerbate bleeding during the procedure. They should not take any iron or **vitamins** with iron for one week prior to the exam, since iron can cause color changes in the bowel lining that interfere with the examination. They should take any routine prescription medications but may need to stop certain medications. Prescribing physicians should be consulted regarding routine prescriptions and their possible effect(s) on sigmoidoscopy.

Individuals with renal insufficiency or congestive **heart failure** need to be prepared in an alternative way, and must be carefully monitored during the procedure.

Aftercare

There is no specific aftercare necessary following sigmoidoscopy. If a biopsy was taken, a small amount of blood may appear in the next stool. Persons should be encouraged to pass gas following the procedure to relieve any bloating or cramping that may occur after the procedure. In addition, an infection may develop following sigmoidoscopy. Persons should be instructed to call their physician if a **fever** or pain in the abdomen develops over the few days after the procedure.

Risks

There is a slight risk of bleeding from the procedure. This risk is heightened in individuals whose blood does not clot well, either due to disease or medication, and in those with active inflammatory bowel disease. Rarely,

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trauma to the bowel or other organs can occur, resulting in an injury (perforation) that must be repaired, or **peritonitis**, which must be treated with medication.

Sigmoidoscopy may be contraindicated in persons with severe active colitis or toxic megacolon (an extremely dilated colon). In general, people experiencing continuous ambulatory peritoneal dialysis are not candidates due to a high risk of developing intraperitoneal bleeding.

Normal results

The results of a normal examination reveal a smooth colon wall with sufficient blood vessels for good blood flow.

Morbidity and mortality rates

For a cancer screening sigmoidoscopy, an abnormal result is one or more noncancerous or precancerous polyps, or clearly cancerous polyps. People with polyps have an increased risk of developing colorectal cancer in the future and may be required to undergo additional procedures such as colonoscopy or more frequent sigmoidoscopic examinations.

Small polyps can be completely removed. Larger polyps may require the physician to remove a portion of the growth for laboratory biopsy. Depending on the laboratory results, a person is then scheduled to have the polyp removed surgically, either as an urgent matter if it is cancerous, or as an elective procedure within a few months if it is noncancerous.

In a diagnostic sigmoidoscopy, an abnormal result shows signs of active inflammatory bowel disease, either a thickening of the intestinal lining consistent with ulcerative colitis or ulcerations or fissures consistent with Crohn's disease.

Mortality from a sigmoidoscopy examination is rare and is usually due to uncontrolled bleeding or perforation of the colon.

Alternatives

A screening examination for colorectal cancer is a test for fecal occult blood. A dab of fecal material from toilet tissue is smeared onto a card. The card is treated in a laboratory to reveal the presence of bleeding. This test is normally performed prior to a sigmoidoscopic examination.

A less invasive alternative to a sigmoidoscopic examination is an X-ray of the colon and rectum. Barium is used to coat the inner walls of the colon. This lower GI (gastrointestinal) X-ray may reveal the outlines of suspicious or abnormal structures. It has the disadvantage of not allowing direct visualization of the colon. It is less costly than a sigmoidoscopic examination.

Another less invasive procedure is a virtual colonoscopy, described above. Virtual colonoscopy was endorsed by the American Cancer Society, the American College of Radiology and the U.S. Multisociety Task Force on Colorectal Cancer as an effective screening procedure for colorectal cancer in 2008.

A more invasive procedure is direct visualization of the colon during surgery. This procedure is rarely performed in the United States.

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ORGANIZATIONS

American Academy of Family Physicians, 11400 Tomahawk Creek Parkway, Leawood, KS, 66211-2672, (913) 906-6000, (800) 274-2237, http://www.aafp.org.
American College of Surgeons, 633 North Saint Claire Street, Chicago, IL, 60611, (312) 202-5000, http://www.facs.org/.
American Society for Gastrointestinal Endoscopy, 1520 Kensington Road, Suite 202, Oak Brook, IL, 60523, (866) 353-ASGE, http://www.asge.org.
Society of American Gastrointestinal Endoscopic Surgeons, 11300 West Olympic Boulevard, Suite 600, Los Angeles, CA, 90064, (310) 437-0544, (310) 437-0585, http://www.sages.org.

L. Fleming Fallon, Jr., M.D., Dr.P.H.
Rebecca J. Frey, PhD
Brenda W. Lerner

Sildenafil citrate

Definition

Sildenafil citrate (Viagra and Revatio), was originally developed in 1991 to improve circulation to the heart and treat **angina**, or chest **pain**. While it was not effective for that purpose, it increased circulation in the lungs and penis and is used to treat arterial **hypertension** in the lungs and **erectile dysfunction** in men.

Purpose

By increasing blood flow to the penis during sexual stimulation, men with erectile dysfunction who take Viagra are able to achieve stronger erections and/or maintain them longer. Erectile dysfunction can be caused by a host of emotional and psychological conditions, metabolic diseases, injuries to blood vessels and/or nerves supplying the penis, and by side effects of many medications.

For erectile dysfunction, Viagra is taken 30–60 minutes before intercourse. It should not be taken for this purpose more often than once every 24 hours.

Though it has not been clinically tested for this purpose, a significant number of men take Viagra in hopes of improving their sexual performance.

In pulmonary arterial hypertension, Revatio relaxes the blood vessels in the lung, increasing blood flow and improving **exercise** tolerance. For this purpose, it is taken more frequently and regularly.

Preparation

Viagra comes in 25, 50 and 100mg tablets.

Revatio comes in 20mg tablets.

Recommended dosage

The recommended starting dose of Viagra for treating erectile dysfunction is 50mg taken 30–60 minutes prior to sexual activity. If needed, the dose may be decreased to 25mg or increased to 100mg.

For treating **pulmonary hypertension**, 20mg of Revatio are taken three times daily.

Precautions

Viagra is not approved for use by women or children.

Sexual activity can stress the heart. A combination of high blood pressure and/or underlying heart or **vascular disease** plus Viagra and sexual activity may produce irregular heartbeat, **heart attack**, **stroke**, and/or sudden **death**.

Men who experience **shortness of breath**, **dizziness** or chest pain during sexual activity should not take Viagra and should consult a doctor.

Men who use nitrate medications to treat chest pain, like Isordil and nitroglycerine in any form, should not take Viagra. These drugs can act together to produce dangerous decreases in blood pressure.

Nitrate containing street drugs, poppers, should not be used with Viagra.

Many prescription and non-prescription medications, herbs, and **nutritional supplements** can alter the effects and toxicity of Viagra. Before taking Viagra, men should consult with a pharmacist or doctor and

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discuss the possible effects of medications they take on one another and on Viagra.

Men with deformed penises, or who have experienced prolonged or painful erections should discuss these problems with a doctor before taking Viagra.

Men who have circulation problems involving their eyes or vision, or family members with inherited vision problems, like **retinitis pigmentosa**, should discuss these problems with an eye specialist before taking Viagra.

Men who have recently been ill and/or lost body fluids through **vomiting**, **diarrhea**, or sweating, are more likely to have side effects from Viagra.

Men who have stomach, liver or **kidney disease**, myeloma, leukemia or other blood disorders should discuss with a doctor whether or not it is safe to take Viagra.

Side effects

Men who experience these symptoms should consult their physician. Side effects may be reduced or eliminated by adjusting the dose of Viagra.

The most commonly side effects of Viagra are mild **headache**, flushing of the face, upset stomach, and nasal congestion.

Some side effects of Viagra can be serious:

- heartburn
- chest pain
- shortness of breath
- nosebleed
- numbness, burning or tingling in the arms, hands, feet or legs
- muscle aches
- vision problems, including sudden loss of vision, sensitivity to light, blurred vision, and a blue or green color tinge to vision
- ringing in the ears or sudden decrease or loss of hearing
- itching and burning during urination
- diarrhea
- dizziness or fainting
- rash

Resources

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James Waun, MD, RPh

Silent thyroiditis *see* **Thyroiditis**

Silicosis

Definition

Silicosis is a progressive disease that belongs to a group of lung disorders called pneumoconioses. Silicosis is marked by the formation of lumps (nodules) and fibrous scar tissue in the lungs. It is the oldest known occupational lung disease and is caused by exposure to inhaled particles of silica, mostly from quartz in rocks, sand, and similar substances.

Description

It is estimated that there are 2 million workers in the United States employed in occupations at risk for the development of silicosis. These include miners, foundry workers, stonecutters, potters and ceramics workers, sandblasters, tunnel workers, and rock drillers. Silicosis is mostly found in adults over 40 years of age. It has four forms:

- Chronic. Chronic silicosis may take 15 or more years of exposure to develop. There is only mild impairment of lung functioning. Chronic silicosis may progress to more advanced forms.
- Complicated. Patients with complicated silicosis have noticeable shortness of breath, weight loss, and extensive formation of fibrous tissue (fibrosis) in the lungs. These patients are at risk for developing **tuberculosis** (TB).
- Accelerated. This form of silicosis appears after 5–10 years of intense exposure. The symptoms are similar to those of complicated silicosis. Patients in this group often develop rheumatoid arthritis and other autoimmune disorders.
- Acute. Acute silicosis develops within 6 months to 2 years of intense exposure to silica. The patient loses a great deal of weight and is constantly short of breath. These patients are at severe risk of TB.

Causes and symptoms

The precise mechanism that triggers the development of silicosis is still unclear. What is known is that particles of silica dust get trapped in the tiny sacs (alveoli) in the lungs where air exchange takes place. White blood cells called macrophages in the alveoli ingest the silica and die. The resulting inflammation attracts other macrophages to the region. The nodule forms when the immune system forms fibrous tissue to seal off the reactive area. The disease process may stop at this point or speed up and destroy large areas of the lung. The fibrosis may continue even after the worker is no longer exposed to silica.

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Early symptoms of silicosis include **shortness of breath** after exercising and a harsh, dry **cough**. Patients may have more trouble breathing and cough up blood as the disease progresses. Congestive **heart failure** can give their nails a bluish tint. Patients with advanced silicosis may have trouble sleeping and experience chest **pain**, hoarseness, and loss of appetite. Silicosis patients are at high risk for TB, and should be checked for the disease during the doctor's examination.

Diagnosis

Diagnosis of silicosis is based on:

- A detailed occupational history
- Chest x rays will usually show small round opaque areas in chronic silicosis; the round areas are larger in complicated and accelerated silicosis
- Bronchoscopy
- Lung function tests

It should be noted that the severity of the patient's symptoms does not always correlate with x-ray findings or lung function test results.

Treatment

Symptom management

There is no cure for silicosis. Therapy is intended to relieve symptoms, treat complications, and prevent respiratory infections. It includes careful monitoring for signs of TB. Respiratory symptoms may be treated with **bronchodilators**, increased fluid intake, steam inhalation, and **physical therapy**. Patients with severe breathing difficulties may be given **oxygen therapy** or placed on a mechanical ventilator. Acute silicosis may progress to complete **respiratory failure**. Heart-lung transplants are the only hope for some patients.

Patients with silicosis should call their doctor for any of the following symptoms:

- tiredness or mental confusion
- continued weight loss
- coughing up blood
- fever, chest pain, breathlessness, or new unexplained symptoms

Lifestyle changes

Patients with silicosis should be advised to quit **smoking**, prevent infections by avoiding crowds and persons with colds or similar infections, and receive vaccinations against **influenza** and **pneumonia**. They should be encouraged to increase their **exercise** capacity by keeping up regular activity and to learn to pace themselves with their daily routine.

KEY TERMS

Fibrosis—The development of excess fibrous connective tissue in an organ. Fibrosis of the lungs is a symptom of silicosis.

Pneumoconiosis (plural, pneumoconioses)—Any chronic lung disease caused by inhaling particles of silica or similar substances that lead to loss of lung function.

Silica—A substance (silicon dioxide) occurring in quartz sand, flint, and agate. It is used in making glass, scouring and grinding powders, pottery, etc.

Prognosis

Silicosis is currently incurable. The prognosis for patients with chronic silicosis is generally good. Acute silicosis, however, may progress rapidly to respiratory failure and **death**.

Prevention

Silicosis is a preventable disease. Preventive occupational safety measures include:

- Controls to minimize workplace exposure to silica dust.
- Substitution of substances—especially in sandblasting—that are less hazardous than silica.
- Clear identification of dangerous areas in the workplace.
- Informing workers about the dangers of overexposure to silica dust, training them in safety techniques, and giving them appropriate protective clothing and equipment.

Coworkers of anyone diagnosed with silicosis should be examined for symptoms of the disease. The state health department and the Occupational Safety and Health Administration (OSHA) or the Mine Safety and Health Administration (MSHA) must be notified whenever a diagnosis of silicosis is confirmed.

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Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

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Silo-filler's disease *see* **Lung diseases due to gas or chemical exposure**

Simethicone *see* **Antigas agents**

Singer's nodules *see* **Vocal cord nodules and polyps**

Single photon emission computed tomography

Definition

Single photon emission computed tomography (SPECT) is a type of imaging study used in nuclear medicine that uses radioactive materials injected through a vein that will pass into the brain or other organ generating a high-resolution brain image. SPECT relies on two technologies: computed tomography (CT) and the use of a radioactive material (radionuclide) to label a compound known as a tracer. Tracking the tracer's movement through body tissues and the rate of its radioactive decay allows the doctor to obtain 3-D images of blood flow in the heart, electrical activity in different areas of the brain, or to scan for tumors or bone disease by using a device called a gamma camera contained within the SPECT machine.

Purpose

SPECT is used to diagnose head trauma, **epilepsy**, **dementia**, and cerebrovascular disease. Development of a radiotracer called Tc99m (technetium-99) has increased the resolution of brain images generated from SPECT. The images yield very accurate spatial and contrast resolutions. Other radioactive isotopes used in SPECT are iodine-123, xenon-133, thallium-201, and fluorine-18. The resulting sharp images enable the clinician to visualize very small structures within the brain or other parts of the body. The accuracy of SPECT images makes it a very useful clinical and research tool.

Clinically, SPECT is useful for diagnosing the following disease states:

- Cerebrovascular disease or stroke: SPECT is useful to detect ischemia (reduced blood flow), determine causes of stroke, evaluate transient ischemia, determine prognosis, and monitor treatment.
- Such forms of dementia as Alzheimer's disease: SPECT studies can be used effectively to rule out other medical causes of dementia.
- Head trauma: Evidence suggests that SPECT is useful to detect greater number of lesions following the period after head trauma. It seems that the high resolution and accurate brain images of SPECT can detect lesions in the brain that are not possible to visualize using other techniques such as positron emission tomography (PET) scanning. SPECT images can give clinicians important information concerning prognosis (also sometimes called outcome) and treatment of persons affected with head injury.
- Epilepsy: The radioactive material injected before SPECT imaging concentrates at the seizure locus (the region that contains nerve cells that generate an abnormal impulse). This can help identify the location of seizures and assist clinicians concerning management and outcomes.
- SPECT allows clinicians to visualize a specific area of the brain called the corpus striatum, which contains a neurotransmitter (a chemical that communicates nerve impulses from one nerve cell to another) called dopamine. Circuitry in the corpus striatum and interaction with dopamine can help provide valuable information concerning movement disorders, schizophrenia, mood disorders, and hormone diseases (since hormones require control and regulation from the brain in structures called the pituitary gland and hypothalamus).

As a research tool, SPECT imaging seems to be sensitive tool to measure blood flow through the brain (cerebral blood flow), in persons who have psychological disorder such as **obsessive-compulsive disorder** (higher blood flow) and **alcoholism** (lower blood flow).

More recently, SPECT has been used in myocardial perfusion imaging (MPI), which is a test done to evaluate patients for **coronary artery disease**. It is based on the understanding that diseased heart tissue under stress receives less blood than normal heart tissue (myocardium). A special form of technetium-99 known as Tc-sestamibi is injected. The patient's heart is then stressed by either **exercise** or by the administration of a drug, usually dobutamine, adenosine, or dipyridamole. SPECT imaging performed after the stress will reveal the distribution of the Tc-sestamibi within the different regions of the heart muscle. The patient is usually asked to return between one and seven days after the **stress test** for another set of SPECT images taken while he or she is at rest. Doctors then compare the two sets of images. If the images following the stress test are normal, the patient does not have to return for a second SPECT scan.

Other SPECT diagnostic indications and procedures are similar to other imaging studies such as computed tomography, **magnetic resonance imaging**, and **positron emission tomography**.

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Precautions

Women who are pregnant or **breastfeeding** should not have SPECT scans because the radioactive tracer can be passed to the fetus or the nursing baby. Women of childbearing age may be asked to have a pregnancy test before a SPECT scan.

Description

In most cases, the SPECT scan involves injecting the patient with a compound containing the radioactive tracer or administering the tracer through an infusion given intravenously into a vein in the arm. In some cases, the patient may inhale the tracer through the nose. The patient is then asked to lie quietly in a room for 15–30 minutes while the radioactive tracer is absorbed by the body.

In the second phase of the scan, the patient is positioned by the health care team on a table in the room with the SPECT machine. The exact position depends on the part of the patient's body or the organ system that is being investigated. The SPECT machine itself contains a gamma camera, an imaging device that detects gamma rays given off by the radioactive tracer in the patient's body. The SPECT machine rotates around the patient while the gamma camera records a series of two-dimensional images of the patient's body organs. These images are then sent to a computer that produces 3-D images of the organs in question.

Preparation

Patients should wear comfortable clothing for a SPECT scan and expect to stay in the hospital for 1–3 hours. They do not need to fast beforehand or omit the medications they usually take.

Aftercare

Aftercare consists of drinking extra fluids to speed the excretion of the radioactive tracer in the urine. The tracer is usually flushed out in the patient's urine within a few hours after the scan. Any remaining tracer is broken down in the body within the next two days.

Risks

SPECT scans are generally safe and well tolerated by most patients. Some people, however, may experience bruising, bleeding, or **pain** at the point at which the needle was inserted into their vein. A small number of patients have allergic reactions to the radionuclide.

KEY TERMS

Gamma camera—A device inside the SPECT machine that forms images of the gamma rays emitted by the radionuclides used in tracers in nuclear medicine.

Gamma rays—Extremely short-wavelength electromagnetic radiation released during the process of radioactive decay.

Myocardium—The medical term for the specialized involuntary muscle tissue found in the walls of the heart.

Nuclear medicine—A branch of medicine that makes use of radioisotopes (also called radionuclides) to evaluate the rate of radioactive decay in diagnosing and treating various diseases.

Radionuclide—An atom with an unstable nucleus that emits gamma rays during the process of its radioactive decay. Radionuclides, also known as radioisotopes, are used to make the tracers used in SPECT. The most common radionuclides used in SPECT are iodine-123, technetium-99m, xenon-133, thallium-201, and fluorine-18.

Tracer—A substance containing a radioisotope, injected into the body and followed in order to obtain information about various metabolic processes in the body.

Normal results

Typical results of a SPECT scan show which parts of the patient's body or which areas within a specific organ absorbed larger amounts of the radionuclide and which absorbed less of the chemical. The images may be shown in different colors or in various shades of gray.

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Sinus endoscopy

Definition

An endoscope is a narrow flexible tube, which contains an optical device like a telescope or magnifying lens with a bright light. In sinus **endoscopy**, the endoscope is inserted into the nose and the interior of the nasal passages, sinuses, and throat is examined.

Purpose

Sinus endoscopy is used to help diagnose structural defects, infection or damage to the sinuses, or structures in the nose and throat. It may be used to view polyps and growths in the sinuses and to investigate causes of recurrent inflammation of the sinuses (**sinusitis**). During surgical procedures, an endoscope may be used to view the area to correct sinus-drainage problems or to remove polyps from the nose and throat.

Precautions

Insertion of the endoscope may cause a gag reflex and some discomfort, however, no special precautions are required to prepare for nasal endoscopy.

Description

This procedure can be done in a physician's office. The endoscope is inserted into a nostril and is threaded through the sinus passages to the throat. To make viewing of these areas easier, and to record the areas being examined, a camera, monitor, or other such viewing device is connected to the endoscope

Preparation

For the procedure, the patient is usually awake and seated upright in a chair. A local anesthetic spray or liquid may be applied to the throat to make insertion of the endoscope less uncomfortable.

Aftercare

After the endoscope is removed, the patient can return to most normal activities. If an anesthetic was used, the patient may have to wait until the **numbness** wears off to be able to eat or drink.

Risks

The insertion and removal of the endoscope may stimulate a gag reflex and can cause some discomfort. The procedure may also irritate the tissues of the nose and throat, which can cause a **nosebleed** or coughing.

Normal results

Under normal conditions no polyps or growths are found in the sinuses. There should also be no evidence of infection, swelling, injury, or any structural defect that would prevent normal draining of the sinuses.

Abnormal results

Polyps, growths, infections, or structural defects of the nasal passages are considered abnormal.

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American Academy of Otolaryngology—Head and Neck Surgery, 1650 Diagonal Road, Alexandria, VA, 22314-2857, (703) 836-4444, http://www.entnet.org.

EAR Foundation of Arizona, 668 North 44th Street, Suite 300, Phoenix, AZ, 85008 , (602) 685-1050, (602) 239-5117, melissa@earfoundationaz.com, http://www.earfoun dationaz.com.

Altha Roberts Edgren

Sinus x ray *see* **Skull x rays**

Sinusitis

Definition

Sinusitis refers to an inflammation of the tissues that line the sinuses, which are air spaces within the bones of the face close to the nose. Sinusitis is most often caused by an infection within these spaces.

Sinusitis is usually classified as either acute or chronic. Acute sinusitis usually has a rapid onset; it is often a complication of the **common cold** but can also be triggered by **allergies**, bacterial infections, or fungal infections. Sinusitis that lasts longer than eight weeks, or keeps recurring (four or more times per year), is called chronic sinusitis.

Demographics

Acute sinusitis is a very common condition in Canada and the United States with 31–37 million cases reported each year and 200,000 surgical procedures performed to treat the disorder. It is possible that the actual number of cases is much higher because the symptoms of bacterial sinusitis often mimic those of colds or allergies, and many patients never see a doctor for proper diagnosis and treatment. About half of all diagnosed cases of acute sinusitis are caused by bacteria. The cost to the U.S. economy of acute sinusitis is estimated at $3 billion per year.

About 90% of people will have an episode of sinusitis at some point in life. Most people diagnosed with sinusitis are young or middle-aged adults. Sinusitis is very rare in children younger than 18 months because the sinuses are not yet fully developed in infants.

Sinusitis is equally common in males and females and in all racial and ethnic groups.

Description

The sinuses are paired air pockets located within the bones of the face. They are:

- the frontal sinuses; located above the eyes, in the center region of each eyebrow
- the maxillary sinuses; located within the cheekbones, just to either side of the nose
- the ethmoid sinuses; located between the eyes, just behind the bridge of the nose.
- the sphenoid sinuses; located just behind the ethmoid sinuses and behind the eyes.

The sinuses are connected with the nose. They are lined with the same kind of skin found elsewhere within the respiratory tract. This skin has tiny little hairs projecting from it called cilia. The cilia beat constantly, to help move the mucus produced in the sinuses into the respiratory tract. The beating cilia sweeping the mucus along the respiratory tract help to clear the respiratory tract of any debris, or any organisms which may be present. When the lining of the sinuses is at all swollen, the swelling interferes with the normal flow of mucus. Trapped mucus can then fill the sinuses, causing an uncomfortable sensation of pressure and providing an excellent environment for the growth of infection-causing bacteria.

Risk factors

The risk factors for acute sinusitis and chronic sinusitis are similar. Risk factors for acute sinusitis include:

- A history of hay fever or other allergies affecting the nose.
- A structural abnormality in the nose, such as polyps or a deviated septum.
- Being a heavy smoker or being exposed to cigarette smoke in the home or at work.
- A history of cystic fibrosis, sarcoidosis, or gastroesophageal reflux disease (GERD).
- Having a disorder of the immune system or an antibody deficiency.
- Severe malnutrition, burns, liver disease, or cancer.
- Recent hospitalization, particularly in an intensive care unit.

In addition to these risk factors, there are two additional risk factors for chronic sinusitis:

- Asthma. About 20% of people with chronic sinusitis have asthma.
- Aspirin sensitivity that causes upper respiratory symptoms.

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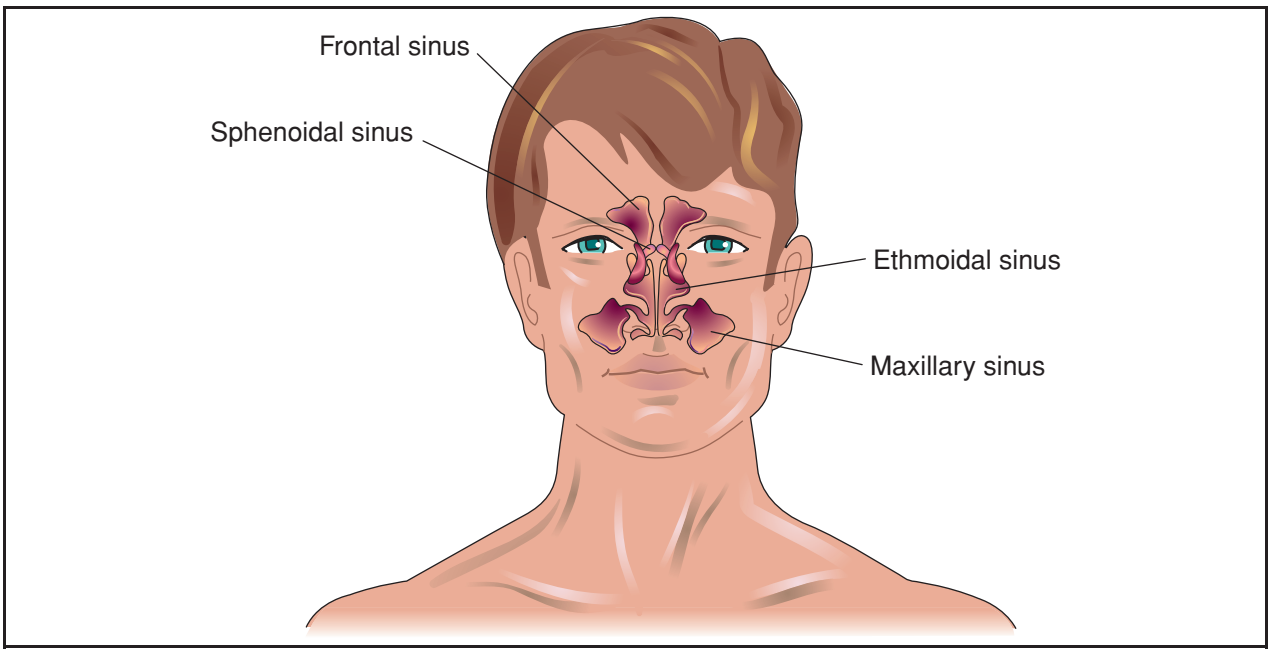

Sinusitis is the inflammation of the sinuses caused by a bacterial infection. Sometimes diagnosis may be problematic because the symptoms often mimic those of the common cold. Sinusitis is usually treated with antibiotics. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Causes and symptoms

Sinusitis is almost always due to an infection, although swelling from allergies can mimic the symptoms of pressure, **pain**, and congestion; and allergies can set the stage for a bacterial infection. Bacteria are the most common cause of sinus infection. *Streptococcus pneumoniae* causes about 33% of all cases, while *Haemophilus influenzae* causes about 25% of all cases. As of 2010, *Staphylococcus aureus* is seen more frequently as a cause of bacterial sinusitis in adults. About 2% of cases of viral sinusitis lead to secondary bacterial sinusitis. Some doctors think that nasal irritation from nose blowing leads to the secondary bacterial infection.

In some cases, sinusitis may result from a dental infection, a foreign body in the nose, **cocaine** abuse, or occupational exposure to such chemical irritants as chlorine gas.

Sinusitis in children may be caused by *Moraxella catarrhalis* (20%). In people with weakened immune systems (including patients with diabetes; acquired **immunodeficiency** syndrome or **AIDS**; and patients who are taking medications which lower their immune resistance, such as **cancer** and transplant patients), sinusitis may be caused by fungi such as *Aspergillus*, *Candida*, or *Mucorales*.

Acute sinusitis usually follows some type of upper respiratory tract infection or cold. Viral sinusitis generally lasts from 7–10 days, while bacterial sinusitis tends to be more persistent. Instead of ending, the "cold" seems to linger on, with constant or even worsening congestion. Drainage from the nose often changes from a clear color to a thicker, yellowish-green discharge. There may be **fever**. **Headache** and pain over the affected sinuses may occur, as well as a feeling of pressure which may worsen when the patient bends over or lies down. There may be pain in the jaws or teeth. Some children, in particular, get upset stomachs from the infected drainage going down the back of their throats, and being swallowed into their stomachs. Some patients develop a **cough**.

Chronic sinusitis occurs when the problem has existed for at least eight weeks. There is rarely a fever with chronic sinusitis. Sinus pain and pressure is frequent, as is nasal congestion. Because of the nature of the swelling in the sinuses, they may not be able to drain out the nose. Drainage, therefore, drips constantly down the back of the throat, resulting in a continuously **sore throat** and **bad breath**.

Sinusitis in children is harder to distinguish from ordinary colds. Children younger than 6 years rarely develop headaches with sinusitis. However, swelling around the eyes or unusual irritability and **fatigue** are often associated with sinusitis in children, as are a discharge of yellowish or green mucus, sore throat,

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KEY TERMS

Cilia (singular, cilium)—Tiny hair-like projections from a cell. Within the respiratory tract, the cilia act to move mucus along, in an effort to continually flush out and clean the respiratory tract.

Polyp—An abnormal growth of tissue projecting from a mucous membrane. Nasal polyps are tissue growths arising from the mucous membranes lining the nasal passages. They are a risk factor for sinusitis.

Septum—A structure comprised of cartilage and bony plates that separates the nasal cavity into two nostrils. A septum that is not in line with the center line of the nose is called a deviated septum and is a risk factor for sinusitis.

Sinus—An air-filled body cavity.

bad breath, fever above 100.4°F, and symptoms lasting longer than 10–14 days.

Diagnosis

Diagnosis of sinusitis can be made by a family doctor or by an otolaryngologist, a doctor who specializes in ear, nose, and throat disorders. In rare cases, the patient's dentist may be consulted to see whether a tooth infection is triggering the sinusitis.

Examination

Diagnosis of sinusitis is sometimes tricky because the symptoms so often resemble those of an uncomplicated cold. Sinusitis should be strongly suspected, however, when a cold lingers beyond a week's time. In some cases, the patient's history suggests the diagnosis, particularly a history of **asthma**, hay fever, **smoking**, or an occupational history of exposure to secondhand smoke or industrial chemicals. About 40% of cases of chronic sinusitis are associated with secondhand smoke.

Medical practitioners have differing levels of trust of certain basic examinations commonly conducted in the office. For example, tapping over the sinuses may cause pain in patients with sinusitis but it may not. A procedure called "sinus transillumination" may, or may not, also be helpful. Using a flashlight pressed up against the skin of the cheek, the practitioner will look in the patient's open mouth. When the sinuses are full of air (under normal conditions), the light will project through the sinus and will be visible on the roof of the mouth as a lit-up, reddened area. When the sinuses are full of mucus, the light will be blocked. While this simple test can be helpful, it is certainly not a perfect way to diagnose or rule out the diagnosis of sinusitis.

Tests

Imaging tests can be useful in diagnosing sinusitis. X-ray pictures and CT scans of the sinuses are helpful for both acute and chronic sinusitis. People with chronic sinusitis may require an examination with a nasal endoscope to see whether any kind of anatomic obstruction is causing their illness. For example, the septum (the cartilage which separates the two nasal cavities from each other) may be slightly displaced, which is called a **deviated septum**. This can result in chronic obstruction, setting the person up for the development of an infection.

Procedures

In some cases a sample of tissue from the patient's nasal passages can be taken for biopsy and culture. Tissue culture is particularly useful in detecting fungal sinusitis.

If the doctor suspects that a previously undiagnosed allergy is triggering chronic sinusitis, he or she may recommend an allergy skin test to identify the specific allergens responsible for the sinusitis.

Treatment

Traditional

Drugs

Antibiotic medications are used to treat acute sinusitis. Suitable **antibiotics** include sulfa drugs, amoxicillin, and a variety of **cephalosporins**. These medications are usually given for about two weeks but may be given for even longer periods of time. **Decongestants**, or the short-term use of decongestant nose sprays, can be useful. **Acetaminophen** and ibuprofen can decrease the pain and headache associated with sinusitis. Also, running a humidifier can prevent mucus within the nasal passages from drying out uncomfortably and can help soothe any accompanying sore throat or cough.

Surgery

Chronic sinusitis is often treated initially with antibiotics. Steroid nasal sprays may be used to decrease swelling in the nasal passages. If an anatomic reason is found for chronic sinusitis, it may need to be corrected with surgery. If a surgical procedure is necessary, samples are usually taken at the same time to allow identification of any organisms present that may be causing infection.

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Fungal sinusitis will require surgery to clean out the sinuses. Then, a relatively long course of a very strong antifungal medication called amphotericin B is given through a needle in the vein (intravenously).

Alternative

Chronic sinusitis is often associated with **food allergies**. An elimination/challenge diet is recommended to identify and eliminate allergenic foods. Irrigating the sinuses with a salt water solution is often recommended for sinusitis and allergies, in order to clear the nasal passages of mucus. Another solution for nasal lavage (washing) utilizes powdered goldenseal (*Hydrastis canadensis*). Other herbal treatments, taken internally, include a mixture made of eyebright (*Euphrasia officinalis*), goldenseal, yarrow (*Achillea millefolium*), horseradish, and ephedra (*Ephedra sinica*), or, when infection is present, a mixture made of **echinacea** (*Echinacea* spp.), wild indigo, and poke root (*Phytolacca decandra-Americana*).

Homeopathic practitioners find a number of remedies useful for treating sinusitis. Among those they recommend are: *Arsenicum album*, *Kalium bichromium*, *Nux vomica*, *Mercurius iodatus*, and *Silica*.

Acupuncture has been used to treat sinusitis, as have a variety of dietary supplements, including **vitamins** A, C, and E, and the mineral zinc. Contrast **hydrotherapy** (hot and cold compresses, alternating 3 minutes hot, 30 seconds cold, repeated 3 times always ending with cold) applied directly over the sinuses can relieve pressure and enhance healing. A direct inhalation of essential oils (2 drops of oil to 2 cups of water) using thyme, rosemary, and lavender can help open the sinuses and kill bacteria that cause infection.

Prognosis

Prognosis for sinus infections is usually excellent, although some individuals may find that they are particularly prone to contracting such infections after a cold. The chief risk for serious illness resulting from sinusitis is the closeness of the nasal passages to the central nervous system, the lymph nodes in the neck, and the blood vessels in the neck and throat. Complications of sinusitis can include **osteomyelitis**, an infection of the bone; **orbital cellulitis**, inflammation of the tissues surrounding the eye; and **meningitis**, inflammation of the membranes covering the brain and spinal cord. Fungal sinusitis, however, has a relatively high **death** rate.

Prevention

Prevention of sinusitis involves the usual standards of good hygiene to cut down on the number of colds an individual catches. Quitting smoking or avoiding exposure to cigarette smoke, identifying and treating allergies, and avoiding deep dives in swimming pools may help prevent sinus infections. During the winter, it is a good idea to use a humidifier. Dry nasal passages may crack, allowing bacteria to enter. When allergies are diagnosed, a number of nasal sprays are available to try to prevent inflammation within the nasal passageways, thus allowing the normal flow of mucus.

The American Academy of Otolaryngology—Head and Neck Surgery adds the following suggestions for preventing sinusitis:

- Blowing the nose gently, blocking one nostril while blowing through the other.
- Avoiding air travel when other methods of transportation are available. Those who must travel by air should use a nasal spray decongestant before takeoff to prevent blockage of the sinuses.
- People with allergies should minimize their exposure to known allergens as well as using decongestants.

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American Academy of Family Physicians (AAFP), P.O. Box 11210, Shawnee Mission, KS, 66207, (913) 906-6000, (800) 274-2237, (913) 906-6075, contactcenter@aafp.org, http://www.aafp.org/online/en/home.html.

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Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

National Institute of Allergy and Infectious Diseases (NIAID), 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-6612, (301) 496-5717, (866) 284-4107, (301) 402-3573, http://www3.niaid.nih.gov.

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Situs inversus

Definition

Situs inversus is a condition in which the organs of the chest and abdomen are arranged in a perfect mirror image reversal of the normal positioning.

Description

Normal human development results in an asymmetrical arrangement of the organs within the chest and abdomen. Typically, the heart lies on the left side of the body (*levocardia*), the liver and spleen lie on the right, and the lung on the left has two lobes while the lung on the right has three lobes. This normal arrangement is known as *situs solitus*.

However, in about 1 in 8,500 people, the organs of the chest and abdomen are arranged in the exact opposite position: the heart is on the right (*dextrocardia*), as is the two-lobed lung, and the liver, spleen, and three-lobed lung are on the left. Yet because this arrangement, called *situs inversus*, is a perfect mirror image, the relationship between the organs is not changed, so functional problems rarely occur.

Causes and symptoms

Early in the normal development of an embryo, the tube-like structure that becomes the heart forms a loop toward the left, identifying the left/right axis along which the other organs should be positioned. Although the mechanism that causes the heart loop to go left is not fully understood, at least one gene has been identified to have a role in this process. However, it is thought that many factors may be involved in causing situs inversus. Rarely, situs inversus can run in families but most often it is an isolated and accidental event occurring in an individual for the first time in the family.

Most people with situs inversus have no medical symptoms or complications resulting from the condition. Although only 3–5% of people with situs inversus have any type of functional heart defect, this is higher than the rate of heart defects in the general population, which is less than 1%.

It is estimated that about 25% of people with situs inversus have an underlying condition called primary ciliary dyskinesia (PCD). PCD, also known as Kartagener's syndrome, is characterized as situs inversus, chronic sinus infections, increased mucous secretions from the lungs, and increased susceptibility to respiratory infections. PCD is caused by a defect in the cilia that impairs their normal movements.

Diagnosis

Situs inversus should detected by a thorough **physical examination**. It is often picked up when a physician, using a stethoscope, hears otherwise normal heart sounds on the right side of the body instead of the left. To confirm the a suspected diagnosis of situs inversus, imaging studies such as MRI, CT, or ultrasound may

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KEY TERMS

Cilia—Tiny hairlike projections on certain cells within the body; cilia produce lashing or whipping movements to direct or cause motion of substances or fluids within the body.

CT—A special technique that uses a computer to create a cross-sectional image of the body from a series of x rays.

Gene—A single unit of genetic information, providing the body with instruction for a specific biological task.

MRI—An imaging study that uses magnetic forces to produce an image of the body's internal structures.

Ultrasound—An imaging study that uses high-frequency sound waves to form a visual image of the body's internal structures.

be ordered, and a referral may be made to a cardiologist or internist for completeness. Imaging studies will also rule out the possibility of random arrangement of the organs, or heterotaxy, which has a much higher risk for serious medical complications.

Treatment

There is no treatment for situs inversus. In the unlikely case that a heart defect is present, it should be treated accordingly by a cardiologist.

Individuals who have situs inversus should be sure to inform all physicians involved in their medical care. In addition to preventing unnecessary confusion, this will reduce the risk of missing a crucial diagnosis that presents with location-specific symptoms (such as **appendicitis**).

Alternative treatment

Not applicable.

Prognosis

The prognosis for an individual with situs inversus is good, and in the absence of a heart defect or other underlying diagnosis, life expectancy is normal.

Prevention

There is no known method of preventing situs inversus.

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ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

NIH/National Heart, Lung and Blood Institute, PO Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi. nih.gov.

Stefanie B. N. Dugan, M.S.

Sitz bath

Definition

A sitz bath (also called a hip bath) is a type of bath in which only the hips and buttocks are soaked in water or saline solution. Its name comes from the German verb "sitzen," meaning "to sit."

Purpose

A sitz bath is used for patients who have had surgery in the area of the rectum, or to ease the **pain** of **hemorrhoids**, uterine cramps, prostate infections, painful ovaries, and/or testicles. It is also used to ease discomfort from infections of the bladder, prostate, or vagina. Inflammatory bowel diseases are also treated with sitz baths.

Precautions

Some patients may become dizzy when standing up after sitting in hot water; it is best to have someone else present when doing a contrast sitz bath.

Description

The sitz bath is a European tradition in which only the pelvis and abdominal area are placed in water, with the upper body, arms, legs, and feet out of the water. The water can be warm or cool and one or two tubs may be used.

Warm sitz baths are one of the easiest and most effective ways to ease the pain of hemorrhoids. A warm bath is also effective in lessening the discomfort

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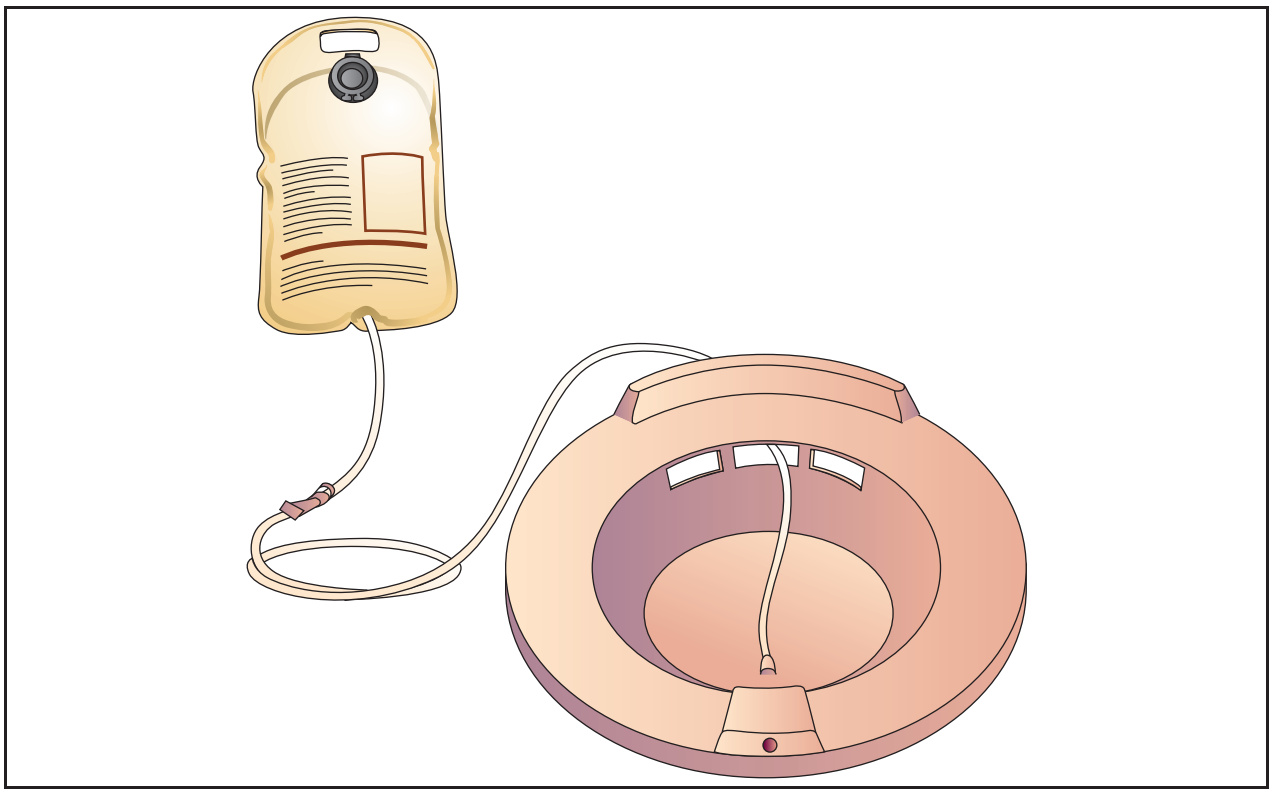

Equipment used for sitz baths. A sitz bath, in which only the hips and buttocks are soaked in water or saline solution, is used for patients who have had surgery in the rectal area or to ease discomfort from bladder, prostate, or vaginal infections. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

associated with **genital herpes**, uterine cramps, and other painful conditions in the pelvic area.

For prostate pain, patients should take two hot sitz baths a day, for about 15 minutes each.

To ease discomfort from a vaginal yeast infection, women should take a warm saline sitz bath. To prepare, fill the tub to hip height with warm water and add 1/2 cup of salt (enough to make the water taste salty) and 1/2 cup of vinegar. Sit in the bath for 20 minutes (or until the water gets cool). The vinegar will help bring the vaginal pH back to 4.5 (pH is a measurement of how acid or alkaline a fluid is).

A brief, cool sitz bath helps ease inflammation, **constipation**, and vaginal discharge. It can be used to tone the muscles in cases of bladder or bowel incontinence.

Other conditions respond to a "contrast bath" of both hot and cold. For this, a patient should have a tub of hot water (about 110°F/43°C) and one tub of ice water. The patient should sit in the hot water for 3–4 minutes and in the cold for 30–60 seconds. This is repeated 3–5 times, always ending with the cold water.

If two tubs are not handy, the patient may sit in a hot bath (up to the navel). Then the patient stands up in the water and pulls a cold towel between the legs and over the pelvis in front and back. The cold towel is held in place for up to 60 seconds. Then the patient should sit back into the hot bath, and repeat the process 3–5 times, ending with the cold towel.

Preparation

The bath should be filled with 3–4 in (8–10cm) of water. For most conditions, nothing else should be added (no bubble bath or oil).

Aftercare

The area should be carefully patted dry and, if necessary, clean **dressings** should be applied.

Risks

Sitz baths pose almost no risk. On rare occasions, patients can feel dizzy or experience rapid heart beat because of blood vessel dilation.

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KEY TERMS

pH—A standard laboratory test that measures how acidic or alkaline a solution is.

Saline solution—Another word for salt water.

Normal results

Swelling goes down; discomfort is eased; healing is promoted.

Carol A. Turkington

Sjögren's syndrome

Definition

Sjögren's syndrome (SS) is a disorder in which the mouth and eyes become extremely dry. Sjögren's syndrome is often associated with other **autoimmune disorders**. It is named for Henrik Sjögren, a Swedish ophthalmologist.

Description

Like other autoimmune disorders, Sjögren's syndrome occurs when the body's immune system mistakenly begins treating parts of the body as foreign invaders. While the immune cells should attack and kill invaders like bacteria, viruses, and fungi, these cells should not attack the body itself. In autoimmune disorders, however, cells called antibodies see tissues of the body as foreign, and help to start a chain of events that results in damage and destruction of those tissues.

There are three types of Sjögren's syndrome. Primary Sjögren's syndrome occurs by itself, with no other associated disorders. Secondary Sjögren's syndrome occurs along with other autoimmune disorders, like **systemic lupus erythematosus**, **rheumatoid arthritis**, **scleroderma**, **vasculitis**, or **polymyositis**. When the disorder is limited to involvement of the eyes, with no other organ or tissue involvement evident, it is called sicca complex.

Women are about nine times more likely to suffer from Sjögren's syndrome than are men. SS affects all age groups, although most patients are diagnosed when they are between 40 and 55 years old. Sjögren's syndrome is commonly associated with other autoimmune disorders. In fact, 30% of patients with certain autoimmune disorders will also have Sjögren's syndrome.

SS is found in all races and ethnic groups. It is thought to affect between 0.1% and 3% of the population in the United States; this range reflects the lack of a uniform set of diagnostic criteria. According to the American College of Rheumatology, between 1 million and 4 million Americans have Sjögren's syndrome.

Causes and symptoms

The cause of Sjögren's syndrome has not been clearly defined but several causes are suspected. The syndrome sometimes runs in families. Other potential causes include hormonal factors (since there are more women than men with the disease) and viral factors. The viral theory suggests that the immune system is activated in response to a viral invader but then fails to turn itself off. Some other immune malfunction then causes the overly active immune system to begin attacking the body's own tissues. In 2004 a group of Greek researchers presented evidence that a coxsackievirus may be the disease organism that triggers SS.

The main problem in Sjögren's syndrome is dryness. The salivary glands are often attacked and slowly destroyed, leaving the mouth extremely dry and sticky. Swallowing and talking become difficult. Normally, the saliva washes the teeth clean. Saliva cannot perform this function in Sjögren's syndrome, so the teeth develop many cavities and decay quickly. The parotid glands produce the majority of the mouth's saliva. They are located lying over the jaw bones behind the area of the cheeks and in front of the ears, and may become significantly enlarged in Sjögren's syndrome.

The eyes also become extremely dry as the tear glands (called glands of lacrimation) are slowly destroyed. Eye symptoms include **itching**, burning, redness, increased sensitivity to light, and thick secretions gathering at the eye corners closest to the nose. The cornea may have small irritated pits in its surface (ulcerations).

Destruction of glands in other areas of the body may cause a variety of symptoms. In the nose, dryness may result in nosebleeds. In the rest of the respiratory tract, the rates of ear infection, hoarseness, **bronchitis**, and **pneumonia** may increase. Vaginal dryness can be quite uncomfortable. Rarely, the pancreas may slow production of enzymes important for digestion. The kidney may malfunction. About 33% of all patients with Sjögren's syndrome have other symptoms unrelated to gland destruction. These symptoms include **fatigue**, decreased energy, fevers, muscle aches and pains, and joint **pain**.

Many patients with SS also develop a variety of skin problems that include dry patches, vasculitis, and cutaneous B-cell lymphoma. These and other

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dermatologic disorders are more common in SS than was previously thought.

Patients who also have other autoimmune diseases will suffer from the symptoms specific to those conditions.

In addition to physical symptoms, patients with SS appear to be at increased risk for depression and other **mood disorders**.

Diagnosis

Diagnosis of Sjögren's syndrome is based on the patient having at least three consecutive months of bothersome eye and/or mouth dryness. A variety of tests can then be done to determine the quantity of tears produced, the quantity of saliva produced, and the presence or absence of antibodies that could be involved in the destruction of glands.

Treatment

There is no cure for Sjögren's syndrome. Instead, treatment usually attempts to reduce the discomfort and complications associated with dryness of the eyes and mouth (and other areas). Artificial tears are available and may need to be used up to every 30 minutes. By using these types of products, the patient is more comfortable and avoids the complications associated with eyes that are overly dry. **Dry mouth** is treated by sipping fluids slowly but constantly throughout the day. Sugarless chewing gum can also be helpful. An artificial saliva is available for use as a mouthwash. Patients may also be given such drugs as pilocarpine (Salagen) or cevimeline (Evoxac) to increase saliva and tear secretions. Careful dental hygiene is important in order to avoid **tooth decay** and it is wise for patients to decrease sugar intake. Vaginal dryness can be treated with certain gel preparations. Steroid medications may be required when other symptoms of autoimmune disorders complicate Sjögren's syndrome. However, these medications should be avoided when possible because they may make the cornea thin and even more susceptible to injury.

Prognosis

The prognosis for patients with primary Sjögren's syndrome is particularly good; these patients have a normal life expectancy. Although the condition is quite annoying, serious complications rarely occur. The prognosis for patients with secondary Sjögren's syndrome varies since it depends on the prognosis for the accompanying autoimmune disorder.

KEY TERMS

Autoimmune disorder—A disorder in which the body's immune cells mistake the body's own tissues as foreign invaders; the immune cells then work to destroy tissues in the body.

Cornea—A transparent structure of the eye over the iris and pupil; light must pass through the cornea to make vision possible.

Coxsackievirus—Any of a group of enteroviruses that produce a disease in humans characterized by fever and rash. Coxsackieviruses are named for the town in upstate New York where they were first identified.

Immune system—The complex network of organs and blood cells that protect the body from foreign invaders, like bacteria, viruses, and fungi.

Prevention

Since the cause of Sjögren's syndrome is unknown, there are no known ways to prevent this syndrome.

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ORGANIZATIONS

American College of Rheumatology, 2200 Lake Boulevard NE, Atlanta, GA, 30319, (404) 633-3777, (404) 633-1870, acr@rheumatology.org, http://www.rheumatology. org/.

Rosalyn Carson-DeWitt, MD
Rebecca J. Frey, PhD

Skeletal traction *see* **Traction; Immobilization**

Skin abrasion *see* **Skin resurfacing**

Skin allergy test *see* **Allergy tests**

Skin biopsy

Definition

A skin biopsy is a procedure in which a small piece of living skin is removed from the body for examination, usually under a microscope, to establish a precise diagnosis. Skin biopsies are usually brief, straightforward procedures performed by a skin specialist (dermatologist) or family physician.

Purpose

The word *biopsy* is taken from Greek words that mean "to view life." The term describes what a specialist in identifying diseases (pathologist) does with tissue obtained from a skin biopsy. The pathologist *visually* examines the tissue under a microscope.

A skin biopsy is used to make a diagnosis of many skin disorders. Information from the biopsy also helps the doctor choose the best treatment for the patient.

Doctors perform skin biopsies to:

- make a diagnosis
- confirm a diagnosis made from the patient's medical history and a physical examination
- check whether a treatment prescribed for a previously diagnosed condition is working
- check the edges of tissue removed with a tumor to make certain it contains all the diseased tissue

Skin biopsies also can serve a therapeutic purpose. Many skin abnormalities (lesions) can be removed completely during the biopsy procedure.

Precautions

A patient taking **aspirin** or another blood thinner (anticoagulant) may be asked to stop taking them a week or more before the skin biopsy. This adjustment in medication will prevent excessive bleeding during the procedure and allow for normal blood clotting.

Some patients are allergic to lidocaine, the numbing agent most frequently used during a skin biopsy. The doctor can usually substitute another anesthetic agent.

Description

The first part of the skin biopsy test is obtaining a sample of tissue that best represents the lesion being evaluated. Many biopsy techniques are available. The choice of technique and precise location from which to take the biopsy material are determined by factors such as the type and shape of the lesion. Biopsies can be classified as excisional or incisional. In excisional biopsy, the lesion is completely removed; in incisional biopsy, a portion of the lesion is removed.

The most common biopsy techniques are:

- Shave biopsy. A scalpel or razor blade is used to shave off a thin layer of the lesion parallel to the skin.
- Punch biopsy. A small cylindrical punch is screwed into the lesion through the full thickness of the skin and a plug of tissue is removed. A stitch or two may be needed to close the wound.
- Scalpel biopsy. A scalpel is used to make a standard surgical incision or excision to remove tissue. This technique is most often used for large or deep lesions. The wound is closed with stitches.
- Scissors biopsy. Scissors are used to snip off surface (superficial) skin growths and lesions that grow from a stem or column of tissue. Such growths are sometimes seen on the eyelids or neck.

After the biopsy tissue is removed, bleeding may be controlled by applying pressure or by burning with electricity or chemicals. **Antibiotics** often are applied to the wound to prevent infection. Stitches may be placed in the wound, or the wound may be bandaged and allowed to heal on its own.

The second part of the skin biopsy test is handling and examining the tissue sample. Drying and structural damage to the tissue sample must be prevented, so it should be placed immediately in an appropriate preservative, such as formaldehyde.

The pathologist can use a variety of laboratory techniques to process the biopsy tissue. Tissue stains and several different kinds of microscopes are used. Because there are many skin disorders (broadly called

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KEY TERMS

Benign—Noncancerous.

Dermatitis—A skin disorder that causes inflammation, that is, redness, swelling, heat, and pain.

Dermatologist—A doctor who specializes in skin care and treatment.

Dermatosis—A noninflammatory skin disorder.

Lesion—An area of abnormal or injured skin.

Malignant—Cancerous.

Pathologist—A person who specializes in studying diseases. In particular, this person examines the structural and functional changes in the tissues and organs of the body that are caused by disease or that cause disease themselves.

dermatosis and **dermatitis**), the pathologist has extensive training in their accurate identification. Cases of melanoma, the most malignant kind of skin **cancer**, have almost tripled in the past 30 years. Because melanoma grows very rapidly in the skin, quick and accurate diagnosis is important.

Preparation

The area of the biopsy is cleansed thoroughly with alcohol or a disinfectant containing iodine. Sterile cloths (drapes) may be positioned, and a local anesthetic, usually lidocaine, is injected into the skin near the lesion. Sometimes the anesthetic contains epinephrine, a drug that helps reduce bleeding during the biopsy. Sterile gloves and surgical instruments are always used to reduce the risk of infection.

Aftercare

If stitches have been placed, they should be kept clean and dry until removed. Stitches are usually removed five to 10 days after the biopsy. Sometimes the patient is instructed to put protective ointment on the stitches before showering. **Wounds** that have not been stitched should be cleaned with soap and water daily until they heal. Adhesive strips should be left in place for two to three weeks. **Pain** medications usually are not necessary.

Risks

Infection and bleeding occur rarely after skin biopsy. If the skin biopsy may leave a scar, the patient usually is asked to give informed consent before the test.

Normal results

The biopsy reveals normal skin layers.

Abnormal results

The biopsy reveals a noncancerous (benign) or cancerous (malignant) lesion. Benign lesions may require treatment.

ORGANIZATIONS

American Academy of Dermatology, PO Box 4014, Schaumburg, IL, 60168-4014, (847) 240-1859, (866) 503-SKIN (7546), http://www.aad.org.

Collette L. Placek

Skin cancer *see* **Malignant melanoma**

Skin cancer, non-melanoma

Definition

Non-melanoma skin **cancer** is a malignant growth of the external surface or epithelial layer of the skin.

Demographics

Skin cancers are the most common type of cancer by far in the United States. Approximately 800,000 to 900,000 new cases of basal cell skin cancer are diagnosed each year. Squamous cell skin cancers are diagnosed less frequently with 200,000 to 300,000 new cases diagnosed annually. The number of new cases of non-melanoma skin cancers is increasing each year. This increase is attributed to improved detection capabilities, increased exposure to the sun, and increase in the lifespan of the general population. Most of the time, basal cell and squamous cell skin cancers are not fatal. The American Cancer Society reports a decline of about 30% in deaths from skin cancer over the last three decades.

Description

Risk factors

Exposure to sunlight is documented as the main cause of more than 1 million cases of non-melanoma skin cancers diagnosed each year in the United States. Incidence increases for those living where direct sunshine is plentiful, such as near the equator.

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A close-up image of a precancerous mole that could develop into a melanoma. Melanomas arise from pigment-producing cells, while non-melanoma skin cancer arises from squamous cells or basal cells. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Ultraviolet B (UVB) rays are thought to cause most basal cell and squamous cell skin cancers. Ultraviolet A (UVA) rays may also directly cause some skin cancers. In addition to sunlight, overexposure to UVB rays can occur from the use of **tanning** booths and beds and from sunlamps.

People who are at highest risk for the development of skin cancer includes individuals who have fair skin and light-colored eyes and who freckle or burn easily when exposed to UVB rays.

Other individuals at high risk include older adults because exposure increases over time. Males are two to three times as likely to develop skin cancer as females. Exposure to chemicals such as arsenic, industrial tar, coal, paraffin, and certain types of oil can lead to skin cancer. Other risk factors include a history of **smoking**, a history of previous skin cancer, and history of illnesses, diseases, or conditions which impair immunity.

Skin cancer is the growth of abnormal cells capable of invading and destroying other associated skin cells. Skin cancer is often subdivided into either melanoma or non-melanoma. Melanoma is a dark-pigmented, usually malignant tumor arising from a skin cell capable of making the pigment melanin (a melanocyte). Melanomas can also develop from benign tissue such as **moles**. Non-melanoma skin cancer most often originates from the outermost skin surface as a squamous cell carcinoma or from cells in the basal layer, the deepest part of the epidermis. Cancers of the latter type are termed basal cell carcinomas. Basal cell and squamous cell skin cancers may also be referred to as keratinocyte cancers.

Other types of skin cancers which occur less frequently are: Merkel cell carcinoma, Kaposi sarcoma, cutaneous lymphoma, skin adenexal tumors, and various types of **sarcomas**. Combined, the incidence of all of these rarer types of non–melanoma skin cancer account for less than one percent of skin cancer.

Basal cell carcinoma affects the skin's basal layer and has the potential to grow progressively larger in size, although it rarely spreads to distant areas (metastasizes). Basal cell carcinomas account for 80% of skin cancers (excluding melanoma), whereas squamous cell cancer makes up about 20%. Basal cell cancer tends to recur, with approximately 50% of people diagnosed with basal cell cancer developing a new skin cancer within five years. Squamous cell carcinoma is a malignant growth of the external surface of the skin. Squamous cell cancers metastasize at a rate of 2–6%, with up to 10% of lesions affecting the ear and lip. Squamous cell carcinomas appear to be more aggressive than basal cell cancers.

Causes and symptoms

Cumulative sun exposure is considered a significant risk factor for non-melanoma skin cancer. There is evidence suggesting that early, intense exposure causing blistering **sunburn** in childhood may also play an important role in the cause of non-melanoma skin cancer. Basal cell carcinoma most frequently affects the skin of the face, with the next most common sites being the ears, the backs of the hands, the shoulders, and the arms. It is prevalent in both sexes and most common in people over 40.

About 1–2% of all skin cancers develop within burn **scars**; squamous cell carcinomas account for about 95% of these cancers, with 3% being basal cell carcinomas and the remainder malignant melanomas.

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KEY TERMS

Autoimmune—Pertaining to an immune response by the body against one of its own tissues or types of cells.

Curettage—The removal of tissue or growths by scraping with a curette.

Dermatologist—A physician specializing in the branch of medicine concerned with skin.

Electrodesiccation—To make dry, dull, or lifeless with the use of electrical current.

Lesion—A patch of skin that has been infected or diseased.

Topical—Referring to a medication or other preparation applied to the skin or the outside of the body.

Basal cell carcinomas usually appear as small **skin lesions** that persist for at least three weeks. This form of non-melanomatous skin cancer looks flat and waxy with the edges of the lesion translucent and rounded. The edges also contain small fresh blood vessels. An ulcer in the center of the lesion gives it a dimpled appearance. Basal cell carcinoma lesions vary from four to six millimeters in size, but can slowly grow larger if untreated.

Squamous cell carcinoma also involves skin exposed to the sun, such as the face, ears, hands, or arms. This form of non-melanoma is also most common among people over 40. Squamous cell carcinoma presents as a small, scaling, raised bump on the skin with a crusting ulcer in the center, but without **pain** and **itching**. The lesion may also appear as flat, reddish, slow-growing patches.

Basal cell and squamous cell carcinomas can grow more easily when people have a suppressed immune system because they are taking immunosuppressive drugs or are exposed to radiation. Some people must take immunosuppressive drugs to prevent the rejection of a transplanted organ or because they have a disease in which the immune system attacks the body's own tissues (autoimmune illnesses); others may need **radiation therapy** to treat another form of cancer. Because of this, everyone taking immunosuppressive drugs or receiving radiation treatments should undergo complete skin examination at regular intervals. If proper treatment is delayed and the tumor continues to grow, tumor cells can spread (metastasize) to muscle, bone, nerves, and possibly the brain.

Diagnosis

Examination

To diagnose skin cancer, clinicians must carefully examine the lesion and ask the patient about how long it has been there, whether it itches or bleeds, and other questions about the patient's medical history. Lymph nodes in the vicinity of the suspicious lesion will be palpated.

The patient may be referred to a dermatologist for a more comprehensive examination. The dermatologist may use a device known as a dermatoscope to visualize spots on the skin more clearly.

Procedures

If skin cancer cannot be ruled out, a sample of tissue is removed and examined under a microscope (a biopsy). A definitive diagnosis of squamous or basal cell cancer can only be made with microscopic examination of the tumor cells. Once skin cancer has been diagnosed, the stage of the disease's development is determined. The information from the biopsy and staging allows the physician and patient to plan for treatment and possible surgical intervention.

Treatment

Traditional

A variety of treatment options are available for those diagnosed with non-melanoma skin cancer. Some carcinomas can be removed by cryosurgery, the process of freezing with liquid nitrogen. Uncomplicated and previously untreated basal cell carcinoma of the trunk and arms is often treated with curettage and electrodesiccation, which is the scraping of the lesion and the destruction of any remaining malignant cells with an electrical current. Removal of a lesion layer-by-layer down to normal margins (Mohs' surgery) is an effective treatment for both basal and squamous cell carcinoma. Removal of larger tumors may require **skin grafting** and **reconstructive surgery**.

Other treatments for non-melanoma skin cancer include **photodynamic therapy** (PDT), topical **chemotherapy** in which the anticancer drug is applied to the lesion as an ointment or as a cream, **laser surgery**, and the use of drugs such as imiquimod and interferon. These drugs are classified as immune response modifiers. The drugs work to boost the body's immune system to help decrease the size of the lesion and sometimes are effective in eliminating the skin cancer altogether.

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Radiation therapy is best reserved for older, debilitated patients or when the tumor is considered inoperable.

Prognosis

Both squamous and basal cell carcinoma are curable with appropriate treatment, although basal cell carcinomas have a higher rate of recurrence. Early detection remains critical for a positive prognosis. Although it is rare for basal cell carcinomas to metastasize, metastases can rapidly lead to **death** if the tumor cells invade the eyes, ears, mouth, or the membranes covering the brain.

Prevention

Not all skin cancers can be prevented. However, there are ways to reduce risk for skin cancer. Avoiding exposure to the sun reduces the incidence of non–melanoma skin cancer. Sunscreen and sunblock preparations provide protection against both UVA and UVB rays. These preparations should also be rated with a sun protection factor (SPF) of 30 or higher. They should be applied 30 minutes before going outdoors and then reapplied every two hours and after swimming. Other recommended practices are to wear a hat, sunglasses, and clothing to shield the skin from sun damage. The lips should be protected by wearing lip balm with sunscreen.

Other strategies include avoiding the outdoors during times of maximum UV effects which is typically between the hours of 10 a.m. until 4 p.m. especially on days when the UV index is high. Check online at www.epa.gov/sunwise/uvindex.html to determine the UV index in your area on any particular day. Avoiding tanning beds, tanning booths, and sunlamps is also strongly recommended. Adults should consider applying protective wear for children. Such wear is designed to cover the child from the neck to the knees with sun–protective fabric.

People should examine their skin monthly for unusual lesions, especially if previous skin cancers have been experienced.

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ORGANIZATIONS

American Academy of Dermatology (AAD), PO Box 4014, Schaumburg, IL, 60168, (866) 503-7546, http://www.aad.org.

American Cancer Society (ACS), (800) 227-2345, http://www.cancer.org.

Canadian Cancer Society (CCS), 10 Alcorn Ave., Suite 200, Toronto, ON, M4V 3B1, (416) 961-7223, http://www.cancer.ca.

National Cancer Institute (NCI), 6116 Executive Blvd., Suite 300, Bethesda MD, 20892-8322, (800) 422-6237, http://www.cancer.gov.

Skin Cancer Foundation (SCF), 149 Madison Ave., Suite 901, New York NY, 10016, (212) 725-5176, http://www.skincancer.org.

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Skin culture

Definition

A skin culture is a test that is done to identify the microorganism (bacteria, fungus, or virus) causing a skin infection and to determine the antibiotic or other treatment that will effectively treat the infection.

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Purpose

Microorganisms can infect healthy skin but more often they infect skin already damaged by an injury or abrasion. Skin infections are contagious and, if left untreated, can lead to serious complications. A culture enables a physician to diagnose and treat a skin infection.

Description

Several groups of microorganisms cause skin infections: bacteria, fungi (molds and yeast), and viruses. Based on the appearance of the infection, the physician determines what group of microorganisms is likely causing the infection, then he or she collects a specimen for one or more types of cultures. A sample of material—such as skin cells, pus, or fluid—is taken from the infection site, placed in a sterile container, and sent to the laboratory. In the laboratory, each type of culture is handled differently.

Bacterial infections are the most common. Bacteria cause lesions, ulcers, **cellulitis**, and **boils**. Pyoderma are pus-containing skin infections, such as **impetigo**, caused by *Staphylococcus* or group A *Streptococcus* bacteria. To culture bacteria, a portion of material from the infection site is spread over the surface of a culture plate and placed in an incubator at body temperature for one to two days. Bacteria in the skin sample multiply and appear on the plates as visible colonies. They are identified by noting the appearance of their colonies and by performing biochemical tests and a Gram's stain.

The Gram's stain is done by smearing part of a colony onto a microscope slide. After it dries, the slide is colored with purple and red stains, then examined under a microscope. The color of stain picked up and retained by the bacteria (purple or red), their shape (such as round or rectangle), and their size provide valuable clues as to their identity.

A sensitivity test, also called antibiotic susceptibility test, is also done. The bacteria are tested against different **antibiotics** to determine which will effectively treat the infection by killing the bacteria.

Fungal cultures are done less frequently. A group of fungi called dermatophytes cause a skin infection called **ringworm**. Yeast causes an infection called thrush. These infections are usually diagnosed using a method other than culture, such as the **KOH test**. A culture is done only when specific identification of the mold or yeast is necessary. The specimen is spread on a culture plate designed to grow fungi, then incubated. Several different biochemical tests and stains are used to identify molds and yeasts.

Viruses, such as herpes, can also cause skin infections. Specimens for viral cultures are mixed with commercially-prepared animal cells in a test tube. Characteristic changes to the cells caused by the growing virus help identify the virus.

Results for bacterial cultures are usually available in one to three days. Cultures for fungi and viruses may take longer—up to three weeks. Cultures are covered by insurance.

KEY TERMS

Pyoderma—A pus-containing skin infection, such as impetigo, caused by *Staphylococcus* or group A *Streptococcus* bacteria.

Sensitivity test—A test that determines which antibiotics will treat an infection by killing the bacteria.

Preparation

After cleaning the infected area with sterile saline and alcohol, the physician collects skin cells, pus, or fluid using a needle or swab. If necessary, the physician will open a lesion to collect the specimen. To collect a specimen for a fungal culture, the physician uses a scalpel to scrape skin cells into a sterile container.

Normal results

Many types of microorganisms are normally found on a person's skin. Presence of these microorganisms is noted on a skin culture report as "normal flora."

Abnormal results

A microorganism is considered to be a cause of the infection if it is either the only or predominant microorganism that grew, if it grew in large numbers, or if it is known to produce infection.

Resources

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Carroll, John A. "Common Bacterial Pyodermas." *Postgraduate Medicine* September 1996: 311–322.

Nancy J. Nordenson

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Skin grafting

Definition

Skin grafting is a surgical procedure by which skin or skin substitute is placed over a burn or non-healing wound to permanently replace damaged or missing skin or provide a temporary wound covering.

Purpose

Wounds such as third-degree **burns** must be covered as quickly as possible to prevent infection or loss of fluid. Wounds that are left to heal on their own can contract, often resulting in serious scarring; if the wound is large enough, the scar can actually prevent movement of limbs. Non-healing wounds, such as diabetic ulcers, venous ulcers, or pressure sores, can be treated with skin grafts to prevent infection and further progression of the wounded area.

Precautions

Skin grafting is generally not used for first- or second-degree burns, which generally heal with little or no scarring. Also, the tissue for grafting and the recipient site must be as sterile as possible to prevent later infection that could result in failure of the graft.

Description

The skin is the largest organ of the human body. It consists of two main layers: the epidermis is the outer layer, sitting on and nourished by the thicker dermis. These two layers are approximately 0.04–0.08 in (1–2 mm) thick. The epidermis consists of an outer layer of dead cells, which provides a tough, protective coating, and several layers of rapidly dividing cells called keratinocytes. The dermis contains the blood vessels, nerves, sweat glands, hair follicles, and oil glands. The dermis consists mainly of connective tissue, primarily the protein collagen, which gives the skin its flexibility and provides structural support. Fibroblasts, which make collagen, are the main cell type in the dermis.

Skin protects the body from fluid loss, aids in temperature regulation, and helps prevent disease-causing bacteria or viruses from entering the body. Skin that is damaged extensively by burns or non-healing wounds can compromise the health and well-being of the patient. More than 50,000 people are hospitalized for burn treatment each year in the United States, and 5,500 die. Approximately 4 million people suffer from non-healing wounds, including 1.5 million with venous ulcers and 800,000 with diabetic ulcers, which result in 55,000 amputations per year in the United States.

Skin for grafting can be obtained from another area of the patient's body, called an autograft, if there is enough undamaged skin available, and if the patient is healthy enough to undergo the additional surgery required. Alternatively, skin can be obtained from another person (donor skin from cadavers is frozen, stored, and available for use), called an allograft, or from an animal (usually a pig), called a xenograft. Allografts and xenografts provide only temporary covering–they are rejected by the patient's immune system within seven to 10 days and must be replaced with an autograft.

A split-thickness skin graft takes mainly the epidermis and a little of the dermis and usually heals within several days. The wound must not be too deep if a split-thickness graft is going to be successful, since the blood vessels that will nourish the grafted tissue must come from the dermis of the wound itself.

A full-thickness graft involves both layers of the skin. Full-thickness autografts provide better contour, more natural color, and less contraction at the grafted site. The main disadvantage of full-thickness skin grafts is that the wound at the donor site is larger and requires more careful management; often a split-thickness graft must be used to cover the donor site.

A composite skin graft is sometime used, consisting of combinations of skin and fat, skin and cartilage, or dermis and fat. Composite grafts are used where three-dimensional reconstruction is necessary. For example, a wedge of ear containing skin and cartilage can be used to repair the nose.

Several artificial skin products are available for burns or non-healing wounds. Unlike allographs and xenographs, these products are not rejected by the patient's body and actually encourage the generation of new tissue. Artificial skin usually consists of a synthetic epidermis and a collagen-based dermis. This artificial dermis, the fibers of which are arranged in a lattice, acts as a template for the formation of new tissue. Fibroblasts, blood vessels, nerve fibers, and lymph vessels from surrounding healthy tissue cross into the collagen lattice, which eventually degrades as these cells and structures build a new dermis. The synthetic epidermis, which acts as a temporary barrier during this process, is eventually replaced with a split-thickness autograft or with an epidermis cultured in the laboratory from the patient's own epithelial cells. The cost for the synthetic products in about $1,000 for a 40 in (100 cm) square piece of artificial skin, in addition to the costs of the surgery. This procedure is covered by insurance.

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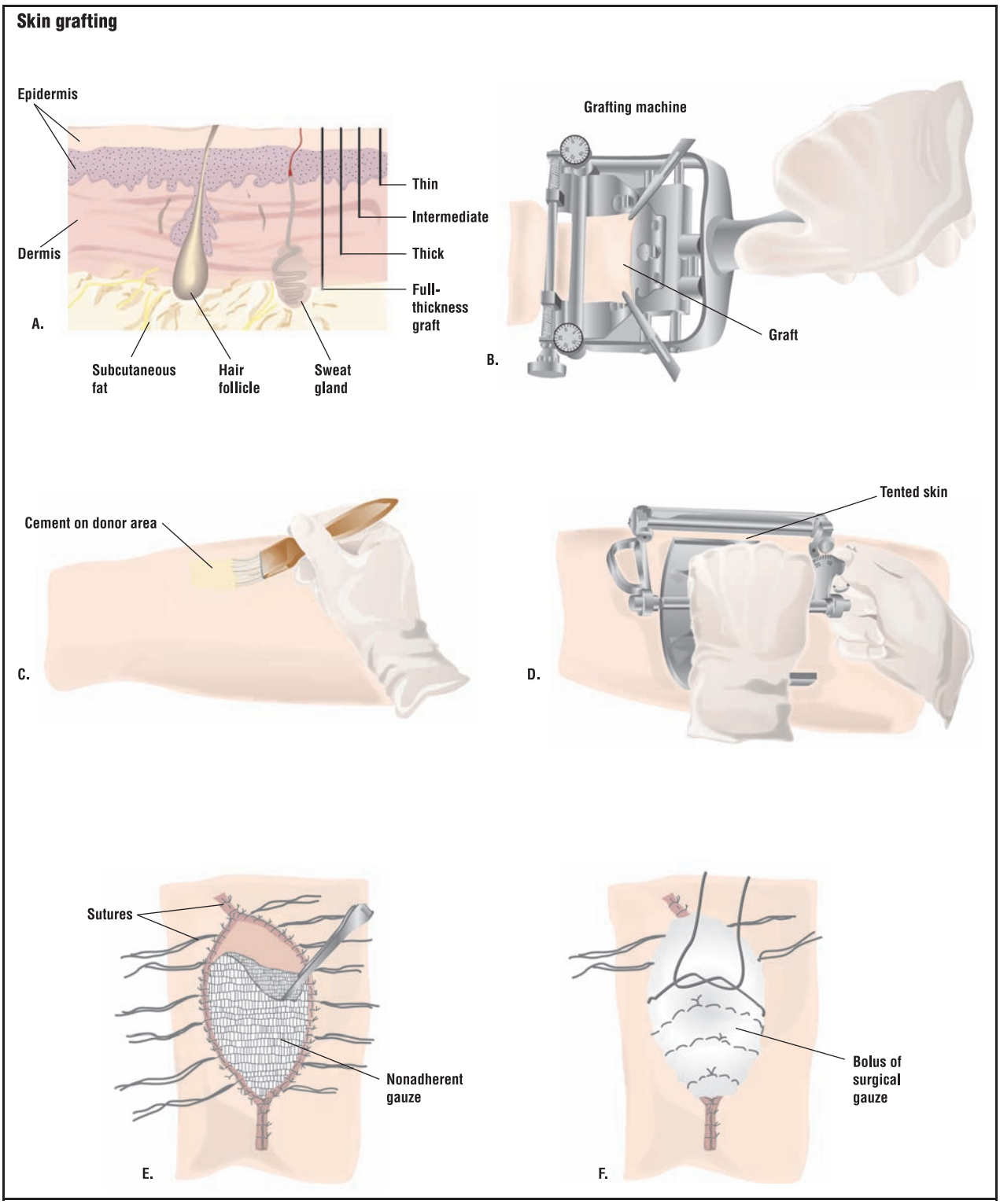

Skin grafts may be used in several thicknesses (A). To begin the procedure, a special cement is used on the donor skin area (C). The grafting machine is applied to the area, and sample taken (D). After the graft is stitched to the recipient area, it is covered with nonadherent gauze (E) and a layer of fluffy surgical gauze held in place with sutures (F). *(Illustration by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)*

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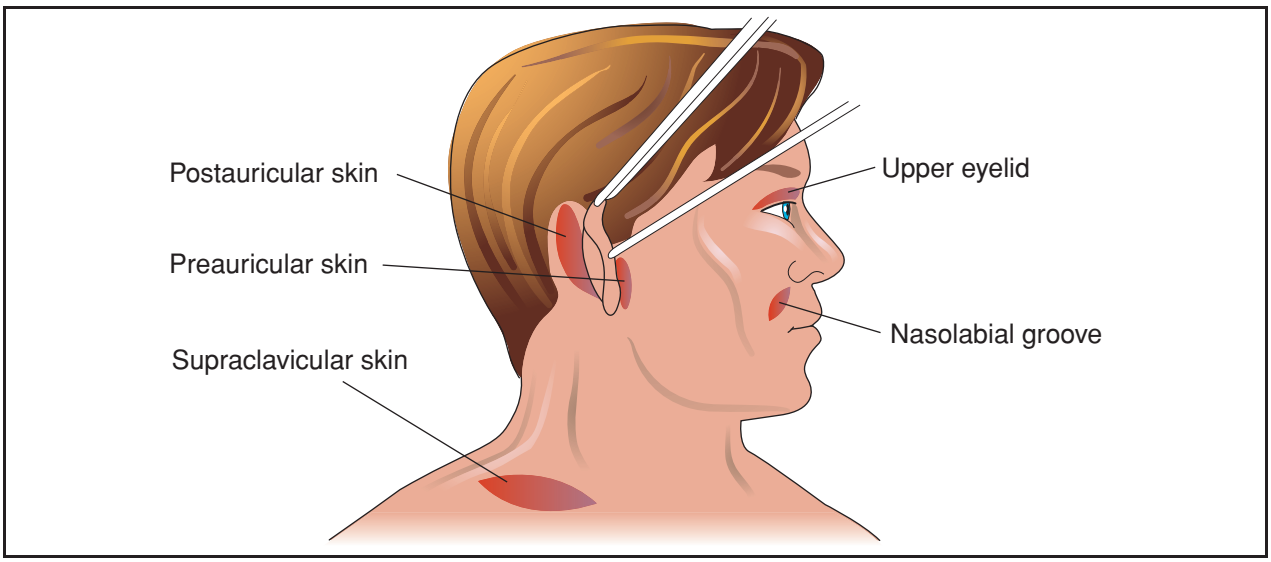

Skin grafting is a surgical procedure by which skin or a skin substitute is placed over a burn or non-healing wound to replace the damaged skin or provide a temporary wound covering. Skin for grafting can be obtained from another area of the patient's body, such as the face and neck, as shown in the illustration above. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Aftercare

Once a skin graft has been put in place, even after it has healed, it must be maintained carefully. Patients who have grafts on their legs should remain in bed for seven to 10 days with their legs elevated. For several months the patient should support the graft with an Ace bandage or Jobst stocking. Grafts in other areas of the body should be similarly supported after healing to decrease the amount of contracture.

Grafted skin does not contain sweat or oil glands, and should be lubricated daily for two to three months with a bland oil (e.g. mineral oil) to prevent drying and cracking.

Risks

The risks of skin grafting include those inherent in any surgical procedure that involves anesthesia. These include reactions to the medications, problems breathing, bleeding, and infection. In addition, the risks of an allograft procedure include transmission of **infectious disease**.

Normal results

A skin graft should provide significant improvement in the quality of the wound site, and may prevent the serious complications associated with burns or non-healing wounds.

KEY TERMS

Allograft—Tissue that is taken from one person's body and grafted to another person.

Autograft—Tissue that is taken from one part of a person's body and transplanted to a different part of the same person.

Collagen—A protein that provides structural support; the main component of connective tissue.

Dermis—The underlayer of skin, containing blood vessels, nerves, hair follicles, and oil and sweat glands.

Epidermis—The outer layer of skin, consisting of a layer of dead cells that perform a protective function and a second layer of dividing cells.

Fibroblasts—A type of cell found in connective tissue; produces collagen.

Keratinocytes—Cells found in the epidermis. The keratinocytes at the outer surface of the epidermis are dead and form a tough protective layer. The cells underneath divide to replenish the supply.

Xenograft—Tissue that is transplanted from one species to another (e.g. pigs to humans).

Abnormal results

Failure of a graft can result from poor blood flow, swelling, or infection.

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ORGANIZATIONS

American Burn Association, 625 N. Michigan Ave., Suite 2550, Chicago, IL, 60611, (312) 642-9260, (312) 642-9130, info@ameriburn.org, http://www.ameriburn.org.

American Diabetes Association, 1701 North Beauregard Street, Alexandria, VA, 22311, (800) 342-2383, Ask ADA@diabetes.org, http://www.diabetes.org/.

Lisa Christenson, PhD

Skin lesion removal

Definition

Skin lesion removal employs a variety of techniques from relatively simple biopsies, to more complex surgical excisions, to remove lesions that range from benign growths to **malignant melanoma**.

Purpose

Sometimes the purpose of skin lesion removal is to excise an unsightly mole or other cosmetically unattractive skin growth. Other times, physicians will remove a skin lesion to make certain it is not cancerous and, if it proves cancerous, to prevent its spread to other parts of the body.

Precautions

Most skin lesion removal procedures require few precautions. The area to be treated is cleaned before the procedure with alcohol or another antibacterial preparation, but generally it is not necessary to use a sterile operating room. Most procedures are performed on an outpatient basis using a local anesthetic. Some of the more complex procedures may require specialized equipment available only in an outpatient surgery center. Most of the procedures are not highly invasive and, frequently, can be well-tolerated by young and old patients, as well as those with other medical conditions.

Description

A variety of techniques are used to remove **skin lesions**. The particular technique selected will depend on such factors as the seriousness of the lesion, its location, and the patient's ability to tolerate the procedure. Some of the simpler techniques, such as a biopsy or cryosurgery, can be performed by a primary care physician. Some of the more complex techniques, such as excision with a scalpel, electrosurgery, or **laser surgery**, are typically performed by a dermatologic surgeon, plastic surgeon, or other surgical specialist. Often, the technique selected will depend on how familiar the physician is with the procedure and how comfortable he or she is with performing it.

Biopsy

In this procedure, the physician commonly injects a local anesthetic at the site of the skin lesion, then removes a sample of the lesion so that a definite diagnosis can be made. The sample is sent to a pathology laboratory, where it is examined under a microscope. Certain characteristic skin cells, and their arrangement in the skin, offer clues to the type of skin lesion, and whether it is cancerous or otherwise poses danger. Depending on the results of the microscopic examination, additional surgery may be scheduled.

A variety of methods are used to obtain a **skin biopsy**. The physician may use a scalpel to cut a piece or remove all of the lesion for examination. Lesions that are confined to the surface may be sampled with a shave biopsy, where the physician holds a scalpel blade parallel to the surface of the skin and slides the blade across the base of the lesion, removing a sample. Some physicians use a single-edge razor blade for this instead of a scalpel. A physician may also perform a punch biopsy, in which a small circular punch removes a plug of skin.

Excision

When excising a lesion, the physician attempts to remove it completely by using a scalpel to cut the shape of an ellipse around the lesion. Leaving an elliptical wound, rather than a circular wound, makes it easier to insert stitches. If a lesion is suspected to be cancerous, the physician will not cut directly around the lesion, but will attempt to also remove a healthy margin of tissue surrounding it. This is to ensure that no cancerous cells remain, which would allow the tumor to reappear. To prevent recurrence of basal and squamous cell skin cancers, experts recommend a margin of 0.08–0.16 in (2–4 mm) for malignant melanoma, the margin may be 1.2 in (3 cm) or more.

Destruction

Not all lesions need to be excised. A physician may simply seek to destroy the lesion using a number of destructive techniques. These techniques do not leave sufficient material to be examined by a pathologist, however, and are best used in cases where a visual diagnosis is certain.

- Cryosurgery. This technique employs an extremely cold liquid or instrument to freeze and destroy abnormal skin cells that require removal. Liquid

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nitrogen is the most commonly used cryogen. It is typically sprayed on the lesion in several freeze-thaw cycles to ensure adequate destruction of the lesion.

- Curettage. In this procedure, an instrument with a circular cutting loop at the end is drawn across the lesion, starting at the middle and moving outward. With successive strokes, the physician scrapes portions of the lesion away. Sometimes a physician will use the curet to reduce the size of the lesion before turning to another technique to finish removing it.
- Electrosurgery. This utilizes an alternating current to selectively destroy skin tissue. Depending on the type of current and device used, physicians may use electrosurgical equipment to dry up surface lesions (electrodessication), to burn off the lesion (electrocoagulation), or to cut the lesion (electrosection). One advantage of electrosurgery is that it minimizes bleeding.

Mohs' micrographic surgery

The real extent of some lesions may not be readily apparent to the eye, making it difficult for the surgeon to decide where to make incisions. If some **cancer** cells are left behind, for example, the cancer may reappear or spread. In a technique called Mohs' micrographic surgery, surgeons begin by removing a lesion and examining its margins under a microscope for evidence of cancer. If cancerous cells are found, the surgeon then removes another ring of tissue and examines the margins again. The process is repeated until the margins appear clear of cancerous cells. The technique is considered ideal for aggressive tumors in areas such as the nose or upper lip, where an excision with wide margins may be difficult to repair, and may leave a cosmetically poor appearance.

Lasers

Laser surgery is now applied to a variety of skin lesions, ranging from spider veins to more extensive blood vessel lesions called hemangiomas. Until recently, CO_2 lasers were among the more common laser devices used by physicians, primarily to destroy skin lesions. Other lasers, such as the Nd:YAG and flashlamp-pumped pulse dye laser have been developed to achieve more selective results when used to treat vascular lesions, such as hemangiomas, or pigmented lesions, such as café-au-lait spots.

Preparation

No extensive preparation is required for skin lesion removal. Most procedures can be performed on an outpatient basis with a local anesthetic. The lesion and surrounding area is cleaned with an antibacterial compound before the procedure. A sterile operating room is not required.

KEY TERMS

Curet—A surgical instrument with a circular cutting loop at one end. The curet is pulled over the skin lesion in repeated strokes to remove one portion of the lesion at a time.

Mohs' micrographic surgery—A surgical technique in which successive rings of skin tissue are removed and examined under a microscope to ensure that no cancer is left.

Shave biopsy—A method of removing a sample of skin lesion so it can be examined by a pathologist. A scalpel or razor blade is held parallel to the skin's surface and is used to slice the lesion at its base.

Aftercare

The amount of aftercare will vary, depending on the skin lesion removal technique. For biopsy, curettage, cryosurgery, and electrosurgery procedures, the patient is told to keep the wound clean and dry. Healing will take at least several weeks, and may take longer, depending on the size of the wound and other factors. Healing times will also vary with excisions and with Mohs' micrographic surgery, particularly if a skin graft or skin flap is needed to repair the resulting wound. Laser surgery may produce changes in skin coloration that often resolve in time. **Pain** is usually minimal following most outpatient procedures, so pain medicines are not routinely prescribed. Some areas of the body, such as the scalp and fingers, can be more painful than others and a pain medicine may be required.

Risks

All surgical procedures present risk of infection. Keeping the wound clean and dry can minimize the risk. **Antibiotics** are not routinely given to prevent infection in skin surgery, but some doctors believe they have a role. Other potential complications include:

- bleeding below the skin, which may create a hematoma and sometimes requires the wound to be reopened and drained,
- temporary or permanent nerve damage resulting from excision in an area with extensive and shallow nerve branches,
- wounds that may reopen after they have been stitched closed, increasing the risk of infection and scarring.

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Normal results

Depending on the complexity of the skin lesion removal procedure, patients can frequently resume their normal routine the day of surgery. Healing frequently will take place within weeks. Some excisions will require later reconstructive procedures to improve the appearance left by the original procedure.

Abnormal results

In addition to the complications outlined above, it is always possible that the skin lesion will reappear, requiring further surgery.

ORGANIZATIONS

American Academy of Dermatology, PO Box 4014, Schaumburg, IL, 60168-4014, (847) 240-1859, (866) 503-SKIN (7546), http://www.aad.org.

American Society for Dermatologic Surgery, 5550 Meadowbrook Dr., Suite 120, Rolling Meadows, IL, 60008, (847) 956-0900, (847) 956-0999, http://www.asds.net/.

American Society of Plastic Surgeons, 444 E. Algonquin Rd, Arlington Heights, IL, 60005, (847) 228-9900, http://www.plasticsurgery.org/.

Richard H. Camer

Skin lesions

Definition

A skin lesion is a superficial growth or patch of the skin that does not resemble the area surrounding it.

Description

Skin lesions can be grouped into two categories: primary and secondary. Primary skin lesions are variations in color or texture that may be present at birth, such as **moles** or **birthmarks**, or that may be acquired during a person's lifetime, such as those associated with infectious diseases (e.g. **warts**, **acne**, or **psoriasis**), allergic reactions (e.g. **hives** or **contact dermatitis**), or environmental agents (e.g. **sunburn**, pressure, or temperature extremes). Secondary skin lesions are those changes in the skin that result from primary skin lesions, either as a natural progression or as a result of a person manipulating (e.g. scratching or picking at) a primary lesion.

The major types of primary lesions are:

- Macule. A small, circular, flat spot less than $^2/_5$ in (1 cm) in diameter. The color of a macule is not the same as that of nearby skin. Macules come in a variety of shapes and are usually brown, white, or red. Examples of macules include freckles and flat moles. A macule more than $^2/_5$ in (1 cm) in diameter is called a patch.
- Vesicle. A raised lesion less than $^1/_5$ in (5 mm) across and filled with a clear fluid. Vesicles that are more than $^1/_5$ in (5 mm) across are called bullae or blisters. These lesions may may be the result of sunburns, insect bites, chemical irritation, or certain viral infections, such as herpes.
- Pustule. A raised lesion filled with pus. A pustule is usually the result of an infection, such as acne, impetigeo, or boils.
- Papule. A solid, raised lesion less than $^2/_5$ in (1 cm) across. A patch of closely grouped papules more than $^2/_5$ in (1 cm) across is called a plaque. Papules and plaques can be rough in texture and red, pink, or brown in color. Papules are associated with such conditions as warts, syphilis, psoriasis, seborrheic and actinic keratoses, lichen planus, and skin cancer.
- Nodule. A solid lesion that has distinct edges and that is usually more deeply rooted than a papule. Doctors often describe a nodule as "palpable," meaning that, when examined by touch, it can be felt as a hard mass distinct from the tissue surrounding it. A nodule more than 2 cm in diameter is called a tumor. Nodules are associated with, among other conditions, keratinous cysts, lipomas, fibromas, and some types of lymphomas.
- Wheal. A skin elevation caused by swelling that can be itchy and usually disappears soon after erupting. Wheals are generally associated with an allergic reaction, such as to a drug or an insect bite.
- Telangiectasia. Small, dilated blood vessels that appear close to the surface of the skin. Telangiectasia is often a symptom of such diseases as rosacea or scleroderma.

The major types of secondary skin lesions are:

- Ulcer. Lesion that involves loss of the upper portion of the skin (epidermis) and part of the lower portion (dermis). Ulcers can result from acute conditions such as bacterial infection or trauma, or from more chronic conditions, such as scleroderma or disorders involving peripheral veins and arteries. An ulcer that appears as a deep crack that extends to the dermis is called a fissure.
- Scale. A dry, horny build-up of dead skin cells that often flakes off the surface of the skin. Diseases that promote scale include fungal infections, psoriasis, and seborrheic dermatitis.
- Crust. A dried collection of blood, serum, or pus. Also called a scab, a crust is often part of the normal healing process of many infectious lesions.

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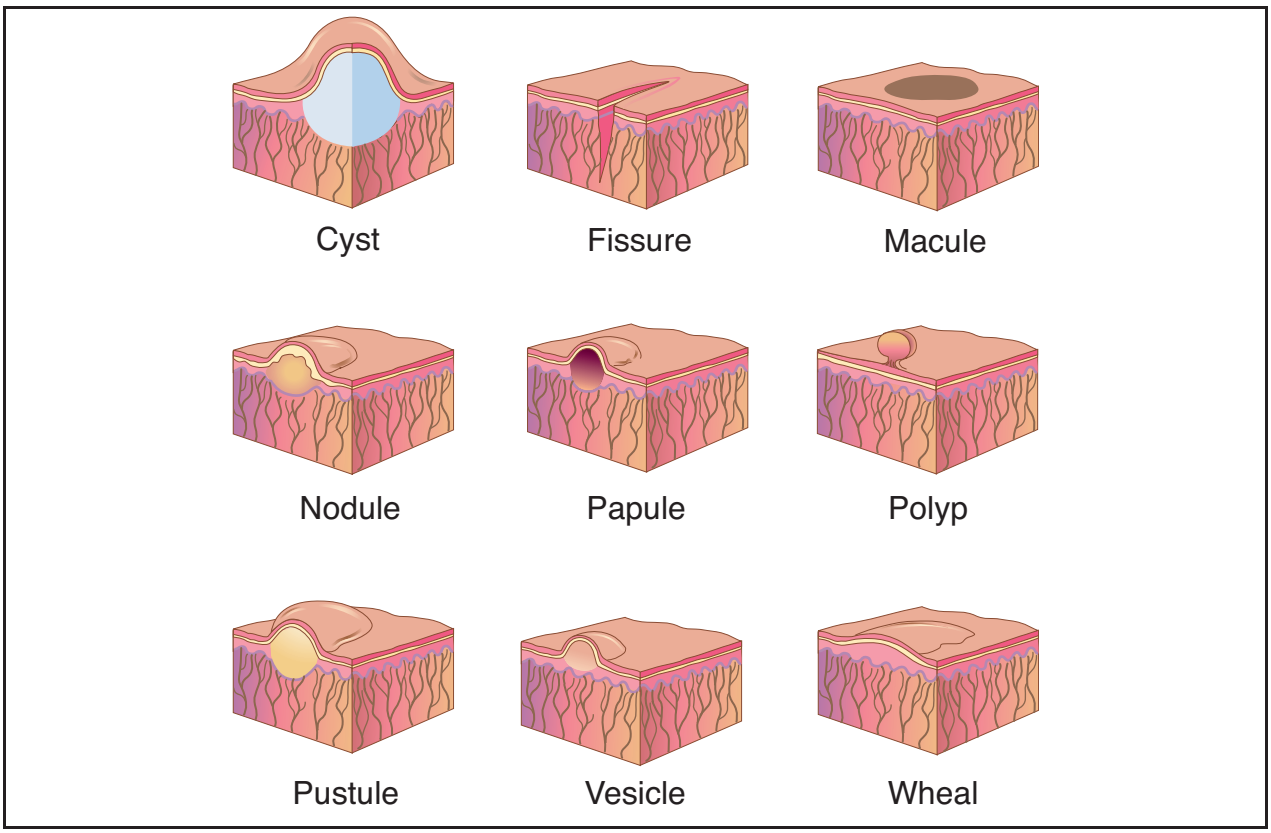

A skin lesion is an abnormal growth or an area of skin that does not resemble the skin surrounding it. The illustrations above feature some of the different types of skin lesions. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

- Erosion. Lesion that involves loss of the epidermis.
- Excoriation. A hollow, crusted area caused by scratching or picking at a primary lesion.
- Scar. Discolored, fibrous tissue that permanently replaces normal skin after destruction of the dermis. A very thick and raised scar is called a keloid.
- Lichenification. Rough, thick epidermis with exaggerated skin lines. This is often a characteristic of scratch dermatitis and atopic dermatitis.
- Atrophy. An area of skin that has become very thin and wrinkled. Normally seen in older individuals and people who are using very strong topical corticosteroid medication.

Causes and symptoms

Skin lesions can be caused by a wide variety of conditions and diseases. A tendency toward developing moles, freckles, or birthmarks may be inherited. Infection of the skin itself by bacteria, viruses, fungi, or parasites is the most common cause of skin lesions. Acne, **athlete's foot** (tinea pedis), warts, and **scabies** are examples of skin infections that cause lesions. Allergic reactions and sensitivity to outside environmental factors can also lead to the formation of skin lesions. Underlying conditions can also precipitate the appearance of skin lesions. For example, the decreased sensitivity and poor circulation that accompanies **diabetes mellitus** can contribute to the formation of extensive ulcers on extremities such as the feet. Infections of body's entire system can cause the sudden onset of skin lesions. For example, skin lesions are a hallmark symptom of such diseases as chicken pox, herpes, and small pox. Cancers affecting the skin, including **basal cell carcinoma**, squamous cell carcinoma, **malignant melanoma**, and **Kaposi's sarcoma**, are recognized by their lesions.

Diagnosis

Diagnosis of the underlying cause of skin lesions is usually based on patient history, characteristics of the lesion, and where and how it appears on the patient's body (e.g. pustules confined to the face, neck and upper back can indicate acne, while scales appearing on the scalp and face may indicate **seborrheic dermatitis**). To

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determine the cause of an infection, doctors may also take scrapings or swab samples from lesions for examination under a microscope or for use in bacterial, fungal, or viral cultures. In cases where a fungal infection is suspected, a doctor may examine a patient's skin under ultraviolet light using a filter device called a Woods light—under these conditions, certain species will taken on specific fluorescent colors. Dermatologists may also use contrast lighting and subdued lighting to detect variations in the skin. When involvement of the immune system is suspected, doctors may order a immunofluorescence test, which detects antibodies to specific antigens using a fluorescent chemical. In cases of contact **dermatitis**, a condition in which a allergic reaction to something irritates the skin, doctors may use patch tests in which samples of specific antigens are introduced into the skin via a scratch or a needle prick, to determine what substances are provoking the reaction.

The vast majority of skin lesions are noncancerous. However, doctors will determine whether or not a particular lesion or lesions are cancerous based on observation and the results of an excisional or punch biopsy, in which a tissue sample is excised for microscopic analysis. Since early detection is a key to successful treatment, individuals should examine their skin on a monthly basis for changes to existing moles, the presence of new moles, or a change in a certain area of skin. When examining moles, factors to look for include:

- Asymmetry. A normal mole is round, whereas a suspicious mole is uneven.
- Border. A normal mole has a clear-cut border with the surrounding skin, whereas the edges of a suspect mole may be irregular.
- Color. Normal moles are uniformly tan or brown but cancerous moles may appear as mixtures of red, white, blue, brown, purple, or black.
- Diameter. Normal moles are usually less than $^1/_5$ in (5 mm) in diameter, a skin lesion greater than this may be suspected as cancerous.

KEY TERMS

Corticosteroid—A type of steroid medication that helps relieve itching (puritis) and reduce inflammation.

Fibroma—A usually benign tumor consisting of fiborous tissue.

Lesion—A possibly abnormal change or difference in a tissue or structure, such as the skin.

Lipoma—A usually benign tumor of fatty tissue.

Patch test—Test in which different antigens (substances that cause an allergic reaction) are introduced into a patient's skin via a needle prick or scratch and then observed for evidence of an allergic reaction to one or more of them. Also known as a scratch test.

Woods light—Device that allows only ultraviolet light to pass through it.

Treatment

Treatment of skin lesions depends upon the underlying cause, what type of lesions they are, and the patient's overall health. If the cause of the lesions is an allergic reaction, removing the allergen from the patient's environment is the most effective treatment. Topical preparations can also be used to clean and protect irritated skin as well as to remove dead skin cells and scales. These may come in a variety of forms, including ointments, creams, lotions, and solutions. **Topical antibiotics**, fungicides, pediculicides (agents that kill lice), and scabicides (agents that kill the scabies parasite) can be applied to treat appropriate skin infections. Oral medications may be taken to address systemic infections or conditions. Deeply infected lesions may require minor surgery to lance and drain pus. Topical agents to sooth irritated skin and reduce inflammation may also be applied. **Corticosteroids** are particularly effective in reducing inflammation and **itching** (puritis). Oatmeal baths, baking soda mixtures, and calamine lotion are also recommended for the relief of these symptoms. A type of corticosteroid may be used to reduce the appearance of keloid **scars**. Absorbent powders may also be used to reduce moisture and prevent the spread of infection. In cases of ulcers that are slow to heal, pressure **dressings** may be used. At times, surgical removal of a lesion may be recommended—this is the usual course of therapy for skin **cancer**. Surgical removal usually involves a simple excision under local anesthetic but it may also be accomplished through freezing (**cryotherapy**) or **laser surgery**.

Prognosis

Skin lesions such as moles, freckles, and birthmarks are a normal part of skin and will not disappear unless deliberately removed by a surgical procedure. Lesions due to an allergic reaction often subside soon after the offending agent is removed. Healing of lesions due to infections or disorders depends upon the type of infection or disorder and the overall health of the individual. Prognosis for skin cancer primarily depends upon whether or not the lesion is localized and whether or not it has spread to other areas of the

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body, such as the lymph nodes. In cases where the lesion is localized and has not spread to other parts of the body, the cure rate is 95–100%.

Prevention

Not all skin lesions are preventable; moles and freckles, for example, are benign growths that are common and unavoidable. However others can be avoided or minimized by taking certain precautions. Skin lesions caused by an allergic reaction can be avoided by determining what the offending agent is and removing it from the home or workplace or, if this is impossible, developing strategies for safely handling it, such as with gloves and protective clothing. Keeping the skin, nails, and scalp clean and moisturized can help reduce or prevent the incidence of infectious skin diseases, as can not sharing personal care items such as combs and make-up with others. Skin lesions associated with **sexually transmitted diseases** can be prevented by the use of **condoms**. Scratching or picking at existing lesions should be avoided since this usually serves only to spread infection and may result in scarring. Individuals who have systemic conditions, such as diabetes mellitus or poor circulation, that could lead to serious skin lesions should inspect their bodies regularly for changes in their skin's condition. Regular visual inspection of the skin is also a key to preventing or minimizing the occurrence of skin cancer, as is the regular use of sun screens with an SPF of 15 or more.

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Bridget Travers

Skin pigmentation disorders

Definition

Skin pigmentation disorders are conditions that cause the skin to appear lighter or darker than normal, or blotchy and discolored.

Demographics

People of all races have skin pigmentation disorders. Some disorders, like **albinism** (which affects one out of every 17,000 people) are rare. Others, such as age spots, are very common.

Description

Skin pigmentation disorders occur because the body produces either too much or too little melanin, a pigment responsible for the color of hair, skin, and eyes. Melanin protects the body by absorbing ultraviolet light.

The term hypopigmentation refers to instances in which the body does not produces enough melanin. Albinism, for example, is an inherited condition that causes a lack of pigment. So people with albinism typically have light skin, white or pale yellow hair, and light blue or gray eyes. Another condition called **vitiligo**, is responsible for the development of smooth, depigmented white spots on the skin. Vitiligo affects nearly 2% of the population but it strikes people between 10 and 30 years old more often than other age groups, and is more evident in people with darker skin.

In **hyperpigmentation**, the body produces too much melanin, causing skin to become darker than usual. **Lichen simplex chronicus** is a skin disorder with severe **itching** that causes thick, dark patches of skin to develop. Lamellar **ichthyosis** (fish scale disease) is an inherited disease that also is characterized by darkened, scaly, dry patches of skin.

Hyperpigmentation also occurs in melasma, a dark mask-like discoloration that covers the cheeks and bridge of the nose. Melasma can occur during the end of **pregnancy**. People with the autoimmune disease systemic lupus also may develop a similar butterfly-shaped mask on their faces. In addition, many people have **moles**, freckles, age spots, and **birthmarks**, ranging from red or brown to bluish or black, covering various parts of their bodies.

Causes and symptoms

Scientists are still studying the reasons why skin pigmentation disorders occur. In some cases there are tangible causes, such as sun exposure, drug reactions or genetic inheritance. In other cases, etiology is not as clear.

Albinism is an inherited recessive trait. Albinism has many different forms but most people who have this condition have pale skin, hair, and eyes. Melanin is also responsible for eye color, and serves as a filter that prevents too much light from entering the eye. Since they lack melanin in their eyes, many people with

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KEY TERMS

Albinism—An inherited condition that causes a lack of pigment. People with albinism typically have light skin, white or pale yellow hair, and light blue or gray eyes

Hyperpigmentation—A skin condition that occurs when the body has too much melanin, or pigment.

Hypopigmentation—A skin condition that occurs when the body has too little melanin, or pigment.

Lamellar ichthyosis—Also called fish scale disease, this inherited condition is characterized by darkened, scaly, dry patches of skin.

Lichen simplex chronicus—A skin disorder accompanied by severe itching that causes thick, dark patches of skin to develop.

Melanin—A pigment that is responsible for the color of hair, skin and eyes. Melanin also protects the body by absorbing ultraviolet light.

Melanocytes—Cells that create melanin.

Melasma—A dark mask-like discoloration that covers the cheeks and bridge of the nose. Also called "the mask of pregnancy."

Vitiligo—A skin disorder that is characterized by smooth, depigmented white spots on the skin.

albinism also have **visual impairment**. With little skin pigmentation, they also **sunburn** easily and are more prone to skin **cancer**.

The hypopigmentation spots associated with vitiligo sometimes form in places where a person has been cut or injured. Research has shown that the light patches associated with vitiligo do not contain melanocytes, the skin cells that create melanin. Some scientists believe vitiligo may be caused by an autoimmune disorder. It also has been linked to other conditions such as **hyperthyroidism** (too much thyroid hormone) and **Addison's Disease**, which affects the adrenal gland.

Hyperpigmentation can be caused by many factors, from too much sunbathing to drug reactions or poor **nutrition**. **Wounds** and **scars** also can develop darker patches of skin. A psychological syndrome gives people with lichen simplex chronicus a compulsive need to scratch, which causes dark, leathery skin to form. This can lead to permanent scarring and infection if untreated. Scientists believe lamellar ichthyosis is caused by genetic factors.

The mask caused by melasma may be related to pregnancy hormones, and usually disappears after a woman gives birth. Birthmarks, moles, and **aging** spots usually are harmless. Some moles, however, can change in size, color, texture, or start bleeding, which could indicate possible skin cancer.

Diagnosis

Diagnostic tests vary for different types of skin pigmentation disorders. Physicians usually can diagnose albinism by looking carefully at a person's hair, skin, and eyes. They may order blood tests and eye exams as well. A visual exam also is enough to diagnose vitiligo.

For most hyperpigmentation disorders, doctors can make a diagnosis by looking at a person's appearance. To detect conditions such as lichen simplex chronicus or lamellar ichthyosis, or skin cancer, they may also do a biopsy to remove some of the affected skin for further study under a microscope. Some physicians also use a wood's lamp, or black light test, to diagnose skin conditions. Affected areas absorbs ultraviolet light and stands out with fluorescent colors in a darkened room.

Treatment

For albinism, healthcare providers advise people to cover exposed body parts, use sunscreen, and avoid excess sunlight to prevent skin cancer. People with albinism also must wear protective sunglasses and, in some cases, prescription corrective lenses. Surgery may be necessary to correct visual impairments.

To treat vitiligo, physicians may prescribe a combination of photo-sensitive medications like trimethylpsoralen and ultraviolet **light therapy** to darken the spots. If the person has depigmented patches covering more than 50% of the body, doctors also may be able to use skin bleaching agents like monobenzone to give the skin a lighter, more uniform appearance. Other options include cosmetic concealers and **skin grafting**.

Skin-lightening creams are available for hyperpigmentation disorders. Doctors also advise staying out of the sun. Counseling with a dietitian may help in cases caused by poor nutrition. For lichen simplex chronicus, doctors prescribe **antihistamines** and topical steroid creams to stop the itching. If a mole or

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birthmark appears suspicious, physicians often will surgically remove it to prevent skin cancer.

Prognosis

Most skin pigmentation disorders do not affect a person's health, only the outward appearance.

Prevention

In most cases, doctors will recommend using sunscreen and avoiding too much sun exposure.

Resources

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ORGANIZATIONS

American Academy of Dermatology (AAD), 930 E. Woodfield Rd., PO Box 4014, Schaumburg, IL, 60173-4014, (847) 330-0230, http://www.aad.org.

National Organization for Albinism and Hypopigmentation (NOAH), PO Box 959, East Hampstead, NH, 03826-0959, (800) 473-2310, http://www.albinism.org.

National Vitiligo Foundation, Inc. (NVFI), PO Box 23226, Cincinnati, OH, 45223, (513) 541-3903, http://nvfi.org.

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Skin resurfacing

Definition

Skin resurfacing employs a variety of techniques to change the surface texture and appearance of the skin. Common skin resurfacing techniques include chemical peels, dermabrasion, and laser resurfacing.

Purpose

Skin resurfacing procedures may be performed for cosmetic reasons, such as diminishing the appearance of wrinkles around the mouth or eyes. They may also be used as a medical treatment, such as removing large numbers of certain precancerous lesions called actinic keratoses. Physicians sometimes combine techniques, using dermabrasion or laser resurfacing on some areas of the face, while performing a chemical peel on other areas.

Precautions

As the popularity of skin resurfacing techniques has increased, many unqualified or inexperienced providers have entered the field. Patients should choose their provider with the same degree of care they take for any other medical procedure. Complications of skin resurfacing techniques can be serious, including severe infection and scarring.

Patient's with active herpes virus infections are not good candidates for resurfacing procedures. Persons who tend to scar easily may also experience poor results. Patients who have recently used the oral **acne** medication isotretinoin (Accutane) may be at higher risk of scarring following skin resurfacing.

Description

Chemical peel

Chemical peels employ a variety of caustic chemicals to selectively destroy several layers of skin. The peeling solutions are "painted on," area-by-area, to ensure that the entire face is treated. After the skin heals, discoloration, wrinkles, and other surface irregularities are often eliminated.

Chemical peels are divided into three types: superficial, medium-depth, and deep. The type of peel depends on the strength of the chemical used, and on how deeply it penetrates. Superficial peels are used for fine wrinkles, sun damage, acne, and **rosacea**. The medium-depth peel is used for more obvious wrinkles and sun damage as well as for precancerous lesions like actinic keratoses. Deep peels are used for the most severe wrinkling and sun damage.

Dermabrasion

Dermabrasion uses an abrasive tool to selectively remove layers of skin. Some physicians use a hand-held motorized tool with a small wire brush or diamond-impregnated grinding wheel at the end. Other physicians prefer to abrade the skin by hand with an abrasive pad or other instrument. Acne scarring is one of the

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prime uses for dermabrasion. It also can be used to treat wrinkling, remove surgical **scars**, and obliterate **tattoos**.

Laser resurfacing

Laser resurfacing is the most recently developed technique for skin resurfacing. Specially designed, pulsed CO_2 lasers can vaporize skin layer-by-layer, causing minimal damage to other skin tissue. Special scanning devices move the laser light across the skin in predetermined patterns, ensuring proper exposure. Wrinkling around the eyes, mouth, and cheeks are the primary uses for laser resurfacing. Smile lines or those associated with other facial muscles tend to reappear after laser resurfacing. Laser resurfacing appears to achieve its best results as a spot treatment; patients expecting complete elimination of their wrinkles will not be satisfied.

Preparation

Chemical peel

Preparation for the chemical peel begins several weeks before the actual procedure. To promote turnover of skin cells, patients use a mild glycolic acid lotion or cream in the morning, and the acne cream tretinoin in the evening. They also use hydroquinone cream, a bleaching product that helps prevent later discoloration. To prevent reappearance of a herpes simplex virus infection, antiviral medicine is started a few days before the procedure and continues until the skin has healed.

Patients arrive for the procedure wearing no makeup. The physician "degreases" the patient's face using alcohol or another cleanser. Some degree of **pain** accompanies all types of peels. For a superficial peel, use of a hand held fan to cool the face during the procedure is often sufficient. For medium-depth peels, the patient may take a sedative or **aspirin**. During the procedure, cold compresses and a hand-held fan can also reduce pain. Deep peels can be extremely painful. Some physicians prefer **general anesthesia** but local anesthetics combined with intravenous sedatives are frequently sufficient to control pain.

Dermabrasion

Dermabrasion does not require much preparation. It is usually performed under **local anesthesia**, although some physicians use intravenous **sedation** or general anesthesia. The physician begins by marking the areas to be treated and then chilling them with ice packs. In order to stiffen the skin, a spray refrigerant is applied to the area, which also helps control pain. Some physicians prefer to inject the area with a solution of saline and local anesthetic, which also leaves the skin's surface more solid. Since dermabrasion can cause quite a bit of bleeding, physicians and their assistants will wear gloves, gowns, and masks to protect themselves from possible blood-transmitted infection.

Laser resurfacing

Antiviral medications should be started several days before the procedure. Laser resurfacing is performed under local anesthesia. An oral sedative may also be taken. The patient's eyes must be shielded, and the area surrounding the face should be shielded with wet drapes or crumpled foil to catch stray beams of laser light. The physician will mark the areas to be treated before beginning the procedure.

Aftercare

Chemical peel

Within a day or so following a superficial peel, the skin will turn faint pink or brown. Over the next few days, dead skin will peel away. Patients will be instructed to wash their skin frequently with a mild cleanser and cool water, then apply an ointment to the skin to keep it moist. After a medium-depth peel, the skin turns deep red or brown and crusts may form. Care is similar to that following a superficial peel. Redness may persist for a week or more. Deep-peeled skin will turn brown and crusty. There may also be swelling and some oozing of fluid. Frequent washing and ointments are favored over **dressings**. The skin typically heals in about two weeks, but redness may persist.

Dermabrasion

Following the procedure, an ointment may be applied and the wound will be covered with a dressing and mask. Patients with a history of herpesvirus infections will begin taking an antiviral medication to prevent a recurrence. After 24 hours, the dressing is removed and ointment is reapplied to keep the wound moist. Patients are encouraged to wash their face with plain water and reapply ointment every few hours. This relieves **itching** and pain and helps remove oozing fluid and other matter. Patients may require a pain medication. A steroid medication may be taken during the first few days to reduce swelling. The skin will take a week or more to heal, but may remain very red.

Laser resurfacing

The skin should be kept moist following laser resurfacing. This promotes more rapid healing and reduces the risk of infection. Some physicians favor

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KEY TERMS

Actinic keratosis—A crusty, scaly skin lesion, caused by exposure to the sun, which can transform into skin cancer.

Herpesviruses—A family of viruses responsible for cold sores, chicken pox, and genital herpes.

Isotretinoin—A powerful vitamin A derivative used in the treatment of acne. It can promote scarring after skin resurfacing procedures.

application of ointments only to the skin; others prefer the use of dressings. In either case, care of the skin is similar to that given following a chemical peel. The face is washed with plain water to remove ooze and an ointment is reapplied. Healing will take approximately two weeks. Pain medications and a steroid to reduce swelling may also be taken.

Risks

All resurfacing procedures can lead to infection and scarring. It is also possible that skin coloration will be altered or that redness of the skin will be prolonged for many months. Some of the peeling agents used in deep chemical peels can affect the function of the heart.

Normal results

Depending on the resurfacing techniques selected, it is possible to improve the appearance of skin damaged by sun, age, or disease in many people. Skin resurfacing techniques address only the surface of the skin; procedures such as face-lift surgery or **blepharoplasty** may be needed to repair other age-related skin changes. All resurfacing procedures are accompanied by some pain, redness, and skin color changes. These may persist for several months following the procedure, but they usually resolve over time.

Abnormal results

As noted above, resurfacing procedures can reactivate herpesvirus infections or lead to new, sometimes serious infections. All resurfacing techniques intentionally create skin **wounds**, creating the possibility for scarring. Abnormal results such as these can be minimized with use of antiviral medications prior to the procedure and good wound care afterward. Selection of an experienced, reputable provider also is key.

ORGANIZATIONS

American Society for Dermatologic Surgery, 5550 Meadowbrook Dr., Suite 120, Rolling Meadows, IL, 60008, (847) 956-0900, (847) 956-0999, http://www.asds.net/.

American Society for Laser Medicine and Surgery, 2100 Stewart Ave., Suite 240, Wausau, WI, 54401, (715) 845-9283, (715) 848-2493, (877) 258-6028, information@aslms.org, http://www.aslms.org.

American Society of Plastic Surgeons, 444 E. Algonquin Rd, Arlington Heights, IL, 60005, (847) 228-9900, http://www.plasticsurgery.org/.

Richard H. Camer

Skin traction *see* **Traction; Immobilization**

Skull x rays

Definition

Skull x rays are performed to examine the nose, sinuses, and facial bones. These studies may also be referred to as sinus x rays. X-ray studies produce films, also known as radiographs, by aiming x rays at soft bones and tissues of the body. X-ray beams are similar to light waves, except their shorter wavelength allows them to penetrate dense substances, producing images and shadows on film.

Purpose

Doctors may order skull x rays to aid in the diagnosis of a variety of diseases or injuries.

Sinusitis

Sinus x rays may be ordered to confirm a diagnosis of **sinusitis**, or sinus infection.

Fractures

A skull x ray may detect bone **fractures** resulting from injury or disease. The skull x ray should clearly show the skull cap, jaw bones, and facial bones.

Tumors

Skull radiographs may indicate tumors in facial bones, tissues, or the sinuses. Tumors may be benign (not cancerous) or malignant (cancerous).

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A skull x ray. *(Photo Researchers, Inc.)*

Other

Birth defects (referred to as congenital anomalies) may be detected on a skull x ray by changes in bone structure. Abnormal tissues or glands resulting from various conditions or diseases may also be shown on a skull radiograph.

Precautions

As with any x-ray procedure, women who may be pregnant are advised against having a skull x ray if it is not absolutely necessary. However, a lead apron may be worn across the abdomen during the procedure to protect the fetus. Children are also more sensitive to x-ray exposure. Children of both sexes should wear a protective covering (a lead apron) in the genital/reproductive area. In general, skull x-ray exposure is minimal and x-ray equipment and procedures are monitored to ensure radiation safety.

Description

Skull or sinus x rays may be performed in a doctor's office that has x-ray equipment and a technologist available. The exam may also be performed in an outpatient radiology facility or a hospital radiology department.

In many instances, particularly for sinus views, the patient will sit upright in a chair, perhaps with the head held stable by a foam vise. A film cassette is located behind the patient. The x-ray tube is in front of the patient and may be moved to allow for different positions and views. A patient may also be asked to move his or her head at various angles and positions.

In some cases, technologists will ask the patient to lie on a table and will place the head and neck at various angles. In routine skull x rays, as many as five different views may be taken to allow a clear picture of various bones and tissues. The length of the test will vary depending on the number of views taken, but in general, it should last about 10 minutes. The technologist will usually ask a patient to wait while the films are being developed to ensure that they are clear before going to the radiologist.

Preparation

There is no preparation for the patient prior to arriving at the radiology facility. Patients will be asked to remove jewelry, dentures, or other metal objects that may produce artifacts on the film. The referring doctor or x-ray technologist can answer any questions regarding the procedure. Any woman who is, or may be, pregnant should tell the technologist.

Aftercare

There is no aftercare required following skull or sinus x-ray procedures.

Risks

There are no common side effects from skull or sinus x ray. The patient may feel some discomfort in the positioning of the head and neck, but will have no complications. Any x-ray procedure carries minimal radiation risk, and children and pregnant women should be protected from radiation exposure to the abdominal or genital areas.

Normal results

Normal results should indicate sinuses, bones, tissues, and other observed areas are of normal size, shape, and thickness for the patient's age and medical history. Results, whether normal or abnormal, will be provided to the referring doctor in a written report.

Abnormal results

Abnormal results may include:

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KEY TERMS

Radiograph—The actual picture or film produced by an x-ray study.

X ray—A form of electromagnetic radiation with shorter wavelengths than normal light. X rays can penetrate most structures.

Sinusitis

Air in sinuses will show up on a radiograph as black but fluid will be cloudy or white (opaque). This helps the radiologist to identify trapped fluids in the sinuses. In chronic sinusitis, the radiologist may also note thickening or hardening of the bony wall of an infected sinus.

Fractures

Radiologists may recognize even tiny facial bone fractures as a line of defect.

Tumors

Tumors may be visible if the bony sinus wall is distorted or destroyed. Abnormal findings may result in follow-up imaging studies.

Other

Skull x rays may also detect disorders that show up as changes in bone structure, such as Paget's disease of the bone or acromegaly (a disorder associated with excess growth hormones from the pituitary gland). Areas of calcification, or gathering of **calcium** deposits, may indicate a condition such as an infection of bone or bone marrow (**osteomyelitis**).

ORGANIZATIONS

Long Island Head Injury Association, 65 Austin Blvd., Commack, NY, (631) 543-2245, (631) 543-2261, http://www.lihia.org/.

National Cancer Institute (National Institutes of Health), NCI Office of Communications and Education, 6116 Executive Blvd. Suite 300, Bethesda, MD, 20892-8322, 800 4-CANCER (422-6237), cancergovstaff@mail.nih.gov, http://www.cancer.gov/.

Radiological Society of North America, 820 Jorie Boulevard, Oak Brook, IL, 60523-2251, (630) 571-2670, (630) 571-7837, (800) 381-6660, radiologyinfo.org.

Teresa Odle

SLE *see* **Systemic lupus erythematosus**

Sleep apnea

Definition

Sleep apnea is a condition in which breathing stops for more than ten seconds during sleep. Sleep apnea is a major, though often unrecognized, cause of daytime sleepiness. It can have serious negative effects on a person's quality of life and is thought to be considerably underdiagnosed in the United States.

Demographics

Approximately 6–7% of the U.S. population, or 18 million Americans, are thought to have sleep apnea but only 10 million have symptoms, and only 0.6 million have yet been diagnosed. In Americans aged 30–60 years, obstructive sleep apnea affects nearly one in four men and one in ten women; men are twice as likely as women to have sleep apnea. As sleep apnea seldom occurs in premenopausal females, it is suggested that hormones may play some role in the disorder.

Other predisposing factors include age, as nearly 20–60% of the elderly may be affected; overweight status or **obesity**; or use of alcohol or sedatives. Some studies have demonstrated that elderly African-Americans are more than twice as likely as elderly whites to suffer from sleep apnea. Some families appear to have increased incidence of sleep apnea.

Description

A sleeping person normally breathes continuouusly and uninterruptedly throughout the night. A person with sleep apnea, however, has frequent episodes (up to 400–500 per night) in which he or she stops breathing. This interruption of breathing is called "apnea." Breathing usually stops for about 30 seconds; then the person usually startles awake with a loud snort and begins to breathe again, gradually falling back to slep.

There are two forms of sleep apnea. In obstructive sleep apnea (OSA), breathing stops because tissue in the throat closes off the airway. In central sleep apnea, (CSA), the brain centers responsible for breathing fail to send messages to the breathing muscles. OSA is much more common than CSA. It is thought that about 1–10% of adults are affected by OSA; only about one tenth of that number have CSA. OSA can affect people of any age and of either sex, but it is most common in middle-aged, somewhat overweight men, especially those who use alcohol.

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Causes and symptoms

Obstructive sleep apnea

Obstructive sleep apnea occurs when part of the airway is closed off (usually at the back of the throat) while a person is trying to inhale during sleep. People whose airways are slightly narrower than average are more likely to be affected by OSA. Obesity, especially obesity in the neck, can increase the risk of developing OSA because the fat tissue tends to narrow the airway. In some people, the airway is blocked by enlarged tonsils, an enlarged tongue, jaw deformities, or growths in the neck that compress the airway. Blocked nasal passages may also play a part in some people.

When a person begins to inhale, the expansion of the lungs lowers the air pressure inside the airway. If the muscles that keep the airway open are not working hard enough, the airway narrows and may collapse, shutting off the supply of air to the lungs. OSA occurs during sleep because the neck muscles that keep the airway open are not as active then. Congestion in the nose can make collapse more likely, since the extra effort needed to inhale will lower the pressure in the airway even more. Drinking alcohol or taking tranquilizers in the evening worsens this situation because these cause the neck muscles to relax. (These drugs also lower the "respiratory drive" in the nervous system, reducing breathing rate and strength.)

People with OSA almost always snore heavily because the same narrowing of the airway that causes **snoring** can also cause OSA. Snoring may actually help cause OSA as well because the vibration of the throat tissues can cause them to swell. However, most people who snore do not go on to develop OSA.

Other risk factors for developing OSA include male sex; **pregnancy**; a family history of the disorder; and **smoking**. With regard to gender, it has been found that male sex hormones sometimes cause changes in the size or structure of the upper airway. The weight gain that accompanies pregnancy can affect a woman's breathing patterns during sleep, particularly during the third trimester. With regard to family history, OSA is known to run in families even though no gene or genes associated with the disorder have been identified. Smoking increases the risk of developing OSA because it causes inflammation, swelling, and narrowing of the upper airway.

Some patients being treated for **head and neck cancer** develop OSA as a result of physical changes in the muscles and other tissues of the neck and throat. Doctors recommend prompt treatment of the OSA to improve the patient's quality of life.

Central sleep apnea

In central sleep apnea, the airway remains open but the nerve signals controlling the respiratory muscles are not regulated properly. This can cause wide fluctuations in the level of carbon dioxide (CO_2) in the blood. Normal activity in the body produces CO_2, which is brought by the blood to the lungs for exhalation. When the blood level of CO_2 rises, brain centers respond by increasing the rate of respiration, clearing the CO_2. As blood levels fall again, respiration slows down. Normally, this interaction of CO_2 and breathing rate maintains the CO_2 level within very narrow limits. CSA can occur when the regulation system becomes insensitive to CO_2 levels, allowing wide fluctuations in both CO_2 levels and breathing rates. High CO_2 levels cause very rapid breathing (hyperventilation), which then lowers CO_2 so much that breathing becomes very slow or even stops. CSA occurs during sleep because when a person is awake, breathing is usually stimulated by other signals, including conscious awareness of breathing rate.

A combination of the two forms is also possible and is called mixed sleep apnea. Mixed sleep apnea episodes usually begin with a reduced central respiratory drive, followed by obstruction.

OSA and CSA cause similar symptoms. The most common symptoms are:

- daytime sleepiness
- morning headaches
- a feeling that sleep is not restful
- disorientation upon waking
- poor judgment
- personality changes

Sleepiness is caused not only by the frequent interruption of sleep but by the inability to enter long periods of deep sleep, during which the body performs numerous restorative functions. OSA is one of the leading causes of daytime sleepiness and is a major risk factor for motor vehicle accidents. Headaches and disorientation are caused by low oxygen levels during sleep from the lack of regular breathing.

Other symptoms of sleep apnea may include **sexual dysfunction**, loss of concentration, **memory loss**, intellectual impairment, and behavioral changes including **anxiety** and depression.

Sleep apnea is also associated with night sweats and nocturia, or increased frequency of urination at night. **Bedwetting** in children is also linked to sleep apnea.

Sleep apnea can also cause serious changes in the cardiovascular system. Daytime **hypertension** (high blood pressure) is common. An increase in

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KEY TERMS

Continuous positive airway pressure (CPAP)—A ventilation system that blows a gentle stream of air into the nose to keep the airway open.

Genioplasty—An operation performed to reshape the chin. Genioplasties are often done to treat OSA because the procedure changes the structure of the patient's upper airway.

Mandible—The medical term for the lower jaw. One type of oral appliance used to treat OSA pushes the mandible forward in order to ease breathing during sleep.

Nocturia—Excessive need to urinate at night. Nocturia is a symptom of OSA and often increases the patient's daytime sleepiness.

Polysomnography—A group of tests administered to analyze heart, blood, and breathing patterns during sleep.

Tracheotomy—A surgical procedure in which a small hole is cut into the trachea, or windpipe, below the level of the vocal cords.

Uvulopalatopharyngoplasty (UPPP)—An operation to remove excess tissue at the back of the throat to prevent it from closing off the airway during sleep.

the number of red blood cells (polycythemia) is possible, as is an enlarged left ventricle of the heart (**cor pulmonale**), and left ventricular failure. In some people, sleep apnea causes life-threatening changes in the rhythm of the heart, including heartbeat slowing (bradycardia), racing (tachycardia), and other types of "arrhythmias." Sudden **death** may occur from such **arrhythmias**. Patients with the **Pickwickian syndrome** (named after a Charles Dickens character) are obese and sleepy, with right **heart failure**, **pulmonary hypertension**, and chronic daytime low blood oxygen (hypoxemia) and increased blood CO_2 (hypercapnia).

Diagnosis

Excessive daytime sleepiness is the complaint that usually brings a person to see the doctor. A careful medical history will include questions about alcohol or tranquilizer use, snoring (often reported by the person's partner), and morning headaches or disorientation. A physical exam will include examination of the throat to look for narrowing or obstruction. Blood pressure is also measured. Measuring heart rate or blood levels of oxygen and CO_2 during the daytime will not usually be done since these are abnormal only at night in most patients.

In some cases the person's dentist may suggest the diagnosis of OSA on the basis of a dental checkup or evaluation of the patient for oral surgery.

Confirmation of the diagnosis usually requires making measurements while the person sleeps. These tests are called a **polysomnography** study and are conducted during an overnight stay in a specialized sleep laboratory. Important parts of the polysomnography study include measurements of:

- heart rate
- airflow at the mouth and nose
- respiratory effort
- sleep stage (light sleep, deep sleep, dream sleep, etc.)
- oxygen level in the blood, using a noninvasive probe (ear oximetry)

Simplified studies done overnight at home are also possible, and may be appropriate for people whose profile strongly suggests the presence of obstructive sleep apnea; that is, middle-aged, somewhat overweight men, who snore and have high blood pressure. The home-based study usually includes ear oximetry and cardiac measurements. If these measurements support the diagnosis of OSA, initial treatment is usually suggested without polysomnography. Home-based measurements are not used to rule out OSA, however, and if the measurements do not support the OSA diagnosis, polysomnography may be needed to define the problem further.

Treatment

Behavioral changes

Treatment of obstructive sleep apnea begins with reducing the use of alcohol or tranquilizers in the evening, if these have been contributing to the problem. Weight loss is also effective but if the weight returns, as it often does, so does the apnea. Changing sleeping position may be effective; snoring and sleep apnea are both most common when a person sleeps on his back. Turning to sleep on the side may be enough to clear up the symptoms. Raising the head of the bed may also help. Opening of the nasal passages can provide some relief. There are a variety of nasal devices such as clips, tapes, or holders which may help, though discomfort may limit their use. Nasal **decongestants** may be useful but should not be taken for sleep apnea without the consent of the treating physician.

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Oxygen and drug therapy

Supplemental nighttime oxygen can be useful for some people with either central and obstructive sleep apnea. Tricyclic **antidepressant drugs** such as protriptyline (Vivactil) may help by increasing the muscle tone of the upper airway muscles but their side effects may severely limit their usefulness.

Mechanical ventilation

For moderate to severe sleep apnea, the most successful treatment is nighttime use of a ventilator, called a CPAP machine. CPAP (continuous positive airway pressure) blows air into the airway continuously, preventing its collapse. CPAP requires the use of a nasal mask. The appropriate pressure setting for the CPAP machine is determined by polysomnography in the sleep lab. Its effects are dramatic; daytime sleepiness usually disappears within one to two days after treatment begins. CPAP is used to treat both obstructive and central sleep apnea.

CPAP is tolerated well by about two-thirds of patients who try it. Bilevel positive airway pressure (BiPAP), is an alternative form of ventilation. With BiPAP, the ventilator reduces the air pressure when the person exhales. This is more comfortable for some.

Surgery

Surgery can be used to correct obstructions in the airways. The most common surgery is called UPPP, for uvulopalatopharngyoplasty. This surgery removes tissue from the rear of the mouth and top of the throat. The tissues removed include parts of the uvula (the flap of tissue that hangs down at the back of the mouth), the soft palate, and the pharynx. Tonsils and adenoids are usually removed in this operation. This operation significantly improves sleep apnea in slightly more than half of all cases.

Reconstructive surgery is possible for those whose OSA is due to constriction of the airway by lower jaw deformities. Genioplasty, which is a procedure that plastic surgeons usually perform to reshape a patient's chin to improve his or her appearance, is now being done to reshape the upper airway in patients with OSA.

When other forms of treatment are not successful, obstructive sleep apnea may be treated by a tracheostomy. In this procedure, an opening is made into the trachea (windpipe) below the obstruction, and a tube inserted to maintain an air passage. A tracheostomy requires a great deal of care to prevent infection of the tracheostomy site. In addition, since air is no longer being filtered and moistened by the nasal passages before entering the lungs, the lower airways can become dry and susceptible to infection as well. Tracheostomy is usually reserved for those whose apnea has led to life-threatening heart arrhythmias, and who have not been treated successfully with other treatments.

Oral appliances

Another approach to treating OSA involves the use of oral appliances intended to improve breathing either by holding the tongue in place or by pushing the lower jaw forward during sleep to increase the air volume in the upper airway. The first type of oral appliance is known as a tongue retaining device or TRD. The second type is variously called an oral protrusive device (OPD) or mandibular advancement splint (MAS), because it holds the mandible, or lower jaw, forward during sleep. These oral devices appear to work best for patients with mild-to-moderate OSA, and in some cases can postpone or prevent the need for surgery. Their rate of patient compliance is about 50%; most patients who stop using oral appliances do so because their teeth are in poor condition. TRDs and OPDs can be fitted by dentists; however, most dentists work together with the patient's physician following a polysomnogram rather than prescribing the device by themselves.

Prognosis

The combination of behavioral changes, ventilation assistance, drug therapy, and surgery allow most people with sleep apnea to be treated successfully, although it may take some time to determine the most effective and least intrusive treatment. Polysomnography testing is usually required after beginning a treatment to determine how effective it has been.

Prevention

For people who snore frequently, weight control, avoidance of evening alcohol or tranquilizers, and adjustment of sleeping position may help reduce the risk of developing obstructive sleep apnea.

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American Academy of Otolaryngology, Head and Neck Surgery, Inc., One Prince Street, Alexandria, VA, 22314-3357, (703) 836-4444, http://www.entnet.org.

American Dental Association, 211 East Chicago Avenue, Chicago, IL, 60611, (312) 440-2500, http://www.ada.org.

American Sleep Apnea Association, 1424 K Street NW, Suite 302, Washington, DC, 20005, (202) 293-3650, (202) 293-3656, http://www.sleepapnea.org.

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Richard Robinson
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Sleep deprivation

Definition

Sleep deprivation is an inadequate amount of sleep for a given individual.

Demographics

Sleep deprivation has become so widespread in industrialized societies that daytime drowsiness may no longer seem abnormal. Between 1998 and 2005 the number of American adults who reported getting eight or more hours of sleep on weekday nights fell from 35% to 26%. Driver **fatigue** causes 100,000 accidents and 1,500 deaths annually in the United States.

Sleep deprivation is considered to be a widespread chronic health problem among American teenagers. A 2006 poll found that only 20% of teens got adequate sleep on school nights: by the end of high school they averaged fewer than seven hours and most teens reported feeling tired during the day.

Although sleep disturbances and disorders do not necessarily result in sleep deprivation, they can contribute to it:

- About half of all people over age 65 suffer frequent sleep disturbances.
- About 60 million Americans suffer from frequent or extended periods of insomnia resulting in sleep

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Recommended hours of sleep, by age group

Infants	
0–2 months	12–18 hours
2–12 months	14–15 hours
Toddlers/Children	
1–3 years	12–14 hours
3–5 years	11–13 hours
5–10 years	10–11 hours
Adolescents	
10–17 years	8.5–9.25 hours
Adults	
181	7–9 hours

SOURCE: National Sleep Foundation, "How Much Sleep Do We Really Need?" Available online at: http://www.sleepfoundation.org/article/how-sleep-works/how-much-sleep-do-we-really-need (accessed August 17, 2010).

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deprivation. The incidence of insomnia increases with age, affecting about 40% of women and 30% of men.

- An estimated 18 million Americans have sleep apnea, although it usually goes undiagnosed.
- Restless legs syndrome (RLS) is one of the most common sleep disorders that causes sleep deprivation, especially among older people. RLS is estimated to affect as many as 12 million Americans.
- Narcolepsy—which affects about 250,000 Americans—can cause nighttime insomnia, resulting in sleep deprivation.
- Most people with mental disorders—including depression and schizophrenia—have sleep disturbances that cause sleep deprivation.
- Many totally blind people have life-long sleeping problems, including insomnia and a type of permanent jetlag, which can result in sleep deprivation.

Description

Sleeping and wakefulness are controlled by neurotransmitters—chemical messengers in the brain—which act on different sets of nerve cells or neurons. The neurotransmitters serotonin and norepinephrine in the brainstem—the connection between the brain and the spinal cord—keep parts of the brain active during wakefulness and are switched off during sleep. Also during wakefulness an important chemical called adenosine builds up in the blood to the point where it eventually causes drowsiness and is broken down during sleep.

Humans normally cycle through five stages of sleep throughout the night, with one complete sleep cycle averaging 90–120 minutes:

- Stage 1 is drowsiness, drifting in and out of sleep, and being easily awakened.
- Stage 2 is light sleep, which accounts for about 50% of total sleeping time.
- Stage 3 is deep sleep.
- Stage 4 is slow-wave deep sleep.
- Stages 1, 3, and 4 together account for about 30% of sleeping time.
- Rapid eye movement (REM) sleep accounts for about 20% of total sleep time. During the first sleep cycles of the night, deep sleep is relatively long and REM sleep short. REM periods gradually increase in length as deep sleep shortens. Towards waking almost all sleep is stages 1, 2, and REM.

Sleep is essential for survival and sleep deprivation can eventually result in **death**. However scientists have only recently begun to understand the many functions of sleep:

- The brain is very active during sleep. During this period of low sensory input the brain consolidates recently acquired memories. Nerve-signaling patterns that are generated during the day are repeated during deep sleep. REM sleep is required for learning certain mental skills. Thus sleep appears to be necessary for encoding memories and learning.
- Sleep is required for proper nervous system functioning. Parts of the brain that are involved in emotions, decision-making, and social interactions are less active during sleep. These neurons may need sleep to repair and replenish themselves.
- Sleep may be necessary for growing new neurons.
- Sleep may be required for exercising neuronal functions that are less active during wakefulness.
- Many cells in the body produce more protein during deep and REM sleep. Thus sleep may be necessary for replenishing energy and repairing damage in cells throughout the body.
- Sleep is required for proper immune system function and cytokines—chemicals that fight infection—are produced during sleep.
- Growth hormones in children and young adults are released during deep sleep.

The amount of sleep required to prevent deprivation depends on a variety of factors, especially age and genetics:

- Infants need about 16 hours of sleep out of every 24 hours, with about 50% spent in REM.

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- Toddlers need about 14 hours of sleep, which gradually decreases with age to a requirement of slightly over nine hours in teenagers.
- Most adults need 7–8 hours of sleep each night, although individual requirements may vary from four to 12 hours per night.
- Researchers have identified a gene called DEC2 that turns off some genes involved in controlling circadian rhythms—the internal clock that regulates the sleep-wake cycle. People with certain mutations in the DEC2 gene require only about six hours of sleep per night.
- Women often need several extra hours of sleep during the first three months of pregnancy.
- Although older people tend to sleep more lightly and for shorter periods, they need about the same amount of total sleep as when they were younger.

For most people sleep deprivation accumulates as a "sleep debt," which must be made up. The ability to function relatively well—at least for short periods—under conditions of sleep deprivation appears to be genetically determined. Estimates suggest that 10–15% of people function adequately on little or no sleep, whereas another 10–15% cannot function at all without sleep. Most people cannot function at all after 48 hours without sleep; nor do humans appear to adapt to sleep deprivation. One study found that subjects who slept only 4–6 hours per night for 14 consecutive nights showed cognitive impairment equivalent to going without sleep for three consecutive days.

Although people may adjust to a sleep-depriving schedule, daily functioning and physical and mental health suffer:

- Sleep deprivation interferes with concentration, learning, and problem-solving.
- At least 6 hours of regular sleep are required for peak memory performance and sleep deprivation is directly linked to memory loss.
- Sleep deprivation interferes with work, school, and social interactions.
- Sleep deprivation can cause stress.
- Sleep deprivation slows reaction times. Sleep-deprived people perform at least as poorly on driving simulators and hand-eye coordination tasks as people who are intoxicated.
- Sleep deprivation easily disrupts the decision-making machinery of the brain, impairing judgment, increasing risky behaviors, and reducing sensitivity to loss.
- Sleep deprivation increases the risk of falls and accidents.
- Sleep deprivation can increase the risk for many health problems, including hypertension, cardiovascular disease, diabetes, obesity, and infections.
- Sleep deprivation can inhibit weight loss, even with proper exercise and diet.
- Sleep deprivation increases the effects of alcohol.
- Sleep deprivation can cause sleep paralysis—a rare but frightening condition in which a person temporarily loses the ability to speak or move while falling asleep or waking up.

Teenagers require an average of 9.25 hours of sleep per night for brain development, health, and optimal performance. Sleep-deprived teens are at risk for:

- impaired cognitive function and decision-making
- health problems
- poor grades and athletic performance
- emotional and behavioral problems
- depression
- substance abuse
- violence
- automobile accidents

Risk factors

Risk factors for sleep deprivation include:

- anxiety and stress
- careers with long or irregular working hours
- night or shift work
- work requiring long-distance travel
- multiple jobs
- combining full-time work and school
- being a family caregiver

Causes and symptoms

Sleep deprivation is most often caused by lifestyle choices or the requirements of work, school, or caregiving. Irregular sleep patterns that differ between weekdays and weekends can harm the quality of sleep. A new baby often results in sleep-deprived parents. Teenagers with hectic schedules of school, homework, athletics, after-school activities, jobs, and family and social obligations find themselves without enough hours for quality sleep. Furthermore, hormonal changes in adolescence set most teens' biological clocks on later schedules than those of children and adults. Teens may be wide awake—albeit exhausted—at bedtime but still have to wake up early for school.

Foods and drugs that change the balance of neurotransmitters in the brain can cause sleep deprivation:

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- Caffeinated drinks, such as coffee, and drugs, such as diet pills and decongestants, stimulate parts of the brain and can cause insomnia.
- Although alcohol induces and maintains light sleep, it deprives the brain of REM and deeper sleep.
- Many antidepressants suppress REM sleep.
- Heavy smokers often sleep lightly, are deprived of REM sleep, and wake up after three or four hours from nicotine withdrawal.

Changes in regions of the brain and in neurotransmitters can result in sleep deprivation. Sleeping problems in older people may be a normal part of **aging** or can be related to underlying medical conditions, medications, medical treatments, or sleep-disrupting hospital routines. **Anxiety** or chronic **pain** can cause sleep deprivation, which, in turn, can cause **anxiety disorders** or make it harder to cope with pain. Other conditions that can cause sleep deprivation include:

- menopause
- vision loss
- attention-deficit/hyperactivity disorder (AD/HD)
- head injury
- stroke
- cancer
- Alzheimer's disease

There are more than 70 known types of **sleep disorders**, which may or may not result in sleep deprivation. The most common include:

- insomnia, which can have various causes—including stress, jetlag, diet, or an underlying medical condition—and almost always affects next-day functioning
- sleep apnea—disrupted breathing during sleep—which causes frequent awakenings
- RLS—which is inherited or linked to conditions such as pregnancy, anemia, or diabetes—causes constant leg movement and insomnia
- periodic limb movement disorder (PLMD), which often accompanies RLS and causes repeated awakenings
- narcolepsy, which is characterized by brief attacks of daytime deep sleep and is usually caused by an inherited malfunction in the regulation of sleep-wake cycles

Symptoms of sleep deprivation include:

- difficulty awakening each morning
- daytime drowsiness
- microsleeps—very brief, often unnoticed—periods of sleep during waking hours
- falling asleep during school or work
- need for frequent naps
- routinely falling asleep within five minutes of lying down
- disrupted sleep
- parasomnias—uncontrollable actions during sleep, such as sleepwalking
- headaches
- poor school or work performance
- inability to concentrate
- inability to perform mathematical calculations
- impaired memory
- problems with decision-making
- clumsiness or impaired physical performance
- irritability or mood swings
- paranoia
- confusion
- hallucinations
- decreased consciousness

Although sleep deprivation can be an effective therapy for people with certain types of depression, it can cause depression in otherwise healthy people. Sleep deprivation can also trigger manic episodes of agitation and hyperactivity in people with **bipolar disorder** and seizures in patients with some types of **epilepsy**.

Diagnosis

Examination

Sleep deprivation is usually readily diagnosed from the symptoms accompanying the lack of sleep. Underlying medical problems resulting in sleep deprivation may require further diagnoses.

Procedures

Simple devices are available for detecting **sleep apnea**. Sleep apnea may be diagnosed at a specialized sleep center using **polysomnography** to record brain waves, heartbeat, and breathing for an entire night.

Treatment

Traditional

The usual treatment for sleep deprivation is sleep. Underlying conditions that result in sleep deprivation require more extensive treatments. For example, severe sleep apnea may require a mask—called a continuous positive airway pressure (CPAP) device—to

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KEY TERMS

Adenosine—A nucleoside that plays multiple physiological roles in energy transfer and molecular signaling, as a component of RNA, and as an inhibitory neurotransmitter that promotes sleep.

Apnea—The transient cessation of breathing.

Circadian rhythm—A 24-hour cycle of physiological or behavioral activities.

Cytokines—A class of proteins, including interferons and interleukins, that are released by cells as part of the immune response and as mediators of intercellular communication.

Insomnia—Prolonged or abnormal inability to obtain adequate sleep.

Melatonin—A hormone involved in regulation of circadian rhythms.

Narcolepsy—A condition characterized by brief attacks of deep sleep.

Neurotransmitters—Chemicals that transmit nerve impulses from one nerve cell to another.

REM—Rapid eye movement; a stage of the normal sleep cycle characterized by rapid eye movements, increased forebrain and midbrain activity, and dreaming.

Restless legs syndrome (RLS)—A neurological disorder characterized by aching, burning, or creeping sensations in the legs and an urge to move the legs, often resulting in insomnia.

keep the airways open during sleep. Surgery may be required to correct an airway obstruction.

Drugs

Caffeine and other stimulants cannot overcome the effects of severe sleep deprivation. However various products are available to treat sleep disturbances that can result in sleep deprivation:

- Over-the-counter sleep aids usually contain antihistamines. Although they are sometimes effective, they have side effects and tolerance can develop after just a few days of use.
- RLS and PLMD are often relieved with drugs that affect the neurotransmitter dopamine.
- Daily melatonin supplements can improve nighttime sleep in blind patients.

The U.S. Food and Drug Administration (FDA) has approved several sleep aids—called sedatives/hypnotics—for indefinite use. However most sleeping pills are usually prescribed only for short-term **insomnia**, because they:

- usually become ineffective after several weeks of nightly use
- can cause insomnia with long-term use
- may be habit-forming
- can mask an underlying cause of sleep deprivation
- can interact with alcohol and other medications
- can cause next-day grogginess
- can cause bizarre behaviors, such as sleep binge-eating or sleep driving
- can prevent people with sleep apnea from waking up to breathe

Alternative

Alternative treatments for insomnia and other sleep disturbances include:

- cognitive-behavioral therapy (CBT)
- hypnosis
- melatonin, a hormone derived from the neurotransmitter serotonin
- tryptophan, an amino acid precursor of serotonin

Herbal remedies for insomnia include:

- lemon balm
- chamomile
- valerian root
- kava kava
- passionflower
- lavender
- St. John's wort

Home remedies

Short-term sleep deprivation may require only a night or two of additional sleep. Longer-term sleep deprivation may require a sleep vacation—a few days devoted to sleeping as much as needed. Mild sleep apnea can be treated effectively by weight loss or by not sleeping on one's back.

Prognosis

Sleep deprivation is usually readily reversible with adequate sleep.

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Prevention

Sleep deprivation is preventable by getting as much sleep as an individual requires. Sleep deprivation caused by mild insomnia can often be prevented by:

- sleeping on a schedule—going to bed and rising at the same time every day, including weekends
- structuring daily activities
- exercising 20–30 minutes every day, especially 5–6 hours before sleep
- practicing stress management
- avoiding caffeine, nicotine, and alcohol
- relaxing before bed with activities such as reading or a warm bath that become routinely associated with sleep
- avoiding extreme temperatures that prevent falling or staying asleep
- avoiding lying awake in bed for more than 20 minutes since this can cause anxiety
- reading, watching television, listening to music, or performing an activity until drowsy
- sleeping until sunrise or waking with very bright lights to reset one's internal clock each day
- getting an hour of morning sun exposure

It is the responsibility of parents to ensure that their children and teens get adequate sleep. Some high schools have moved to a later start-time to address sleep deprivation in teenagers.

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ORGANIZATIONS

American Academy of Sleep Medicine, One Westbrook Corporate Center, Ste. 920, Westchester, IL, 60154, (708) 492-0930, (708) 492-0943, http://www.aasmnet.org.

National Institute of Neurological Disorders and Stroke (NINDS), NIH Neurological Institute, PO Box 5801, Bethesda, MD, 20824, (301) 496-5751, (800) 352-9424, http://www.ninds.nih.gov/index.htm.

National Sleep Foundation, 1522 K Street, NW, Suite 500, Washington, DC, 20005, (202) 347-3471, (202) 347-3472, nsf@sleepfoundation.org, http://www.sleepfoundation.org.

Margaret Alic, PhD

Sleep disorders

Definition

Sleep disorders are a group of syndromes characterized by disturbance in the patient's amount of sleep, quality or timing of sleep, or in behaviors or physiological conditions associated with sleep. There are about 81 different sleep disorders, according to the second edition of the *International Classification of Sleep Disorders*. To qualify for the diagnosis of sleep disorder, the condition must be a persistent problem, cause the patient significant emotional distress, and interfere with his or her social or occupational functioning.

Because sleep requirements vary from person to person, there is no specific amount of time spent sleeping that can be used as a cutoff to determine whether a person has a sleep disorder. Some healthy adults need

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A patient suffering from acute sleep apnea is hooked up to monitors in preparation for a night's sleep at a Stanford University sleep lab. *(Russell D. Curtis/Photo Researchers, Inc.)*

as much as 10 hours of sleep per night whereas others need as little as 5 hours.

Demographics

Sleep disorders are a common problem in the general population of North America. Researchers estimate that 20–40% of adults report difficulty sleeping at some point each year. About a third of all Americans will have a sleep disorder at some point in their lives. Twenty percent of adults say that they have problems with chronic **insomnia** and 17% consider their sleeping problem to be serious.

As far as is known, sleep disorders are equally common in all racial and ethnic groups in Canada and the United States.

Description

Normal sleep

Although sleep is a basic behavior in animals as well as humans, researchers still do not completely understand all of its functions in maintaining health. In the past 30 years, however, laboratory studies on human volunteers have yielded new information about the different types of sleep. Increasing interest in sleep disorders led to the recognition of sleep medicine as a distinct medical subspecialty with its own board certification procedures in 1978. Researchers have learned about the cyclical patterns of different types of sleep and their relationships to breathing, heart rate, brain waves, and other physical functions. These measurements are obtained by a technique called **polysomnography**.

There are five stages of normal human sleep. Four stages consist of non-rapid eye movement (NREM) sleep, with unique brain wave patterns and physical changes occurring. Dreaming occurs in the fifth stage, during rapid eye movement (REM) sleep.

- Stage 1 NREM sleep. This stage occurs while a person is falling asleep. It represents about 5% of a normal adult's sleep time.
- Stage 2 NREM sleep. In this stage, (the beginning of "true" sleep), the person's electroencephalogram

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(EEG) will show distinctive wave forms called sleep spindles and K complexes. About 50% of sleep time is stage 2 REM sleep.

- Stages 3 and 4 NREM sleep. Also called delta or slow wave sleep, these are the deepest levels of human sleep and represent 10–20% of sleep time. They usually occur during the first 30–50% of the sleeping period.
- REM sleep. REM sleep accounts for 20–25% of total sleep time. It usually begins about 90 minutes after the person falls asleep, an important measure called REM latency. It alternates with NREM sleep about every hour and a half throughout the night. REM periods increase in length over the course of the night.

Sleep cycles vary with a person's age. Children and adolescents have longer periods of stage 3 and stage 4 NREM sleep than do middle aged or elderly adults. Because of this difference, the doctor will need to take a patient's age into account when evaluating a sleep disorder. Total REM sleep also declines with age.

The average length of nighttime sleep varies among different age groups. Infants typically need about 16 hours of sleep each day, while adolescents need about 9 hours. Most adults sleep between 7 and 9 hours a night, although pregnant women may need as many as 10 or 11 hours of sleep. This population average appears to be constant throughout the world. In temperate climates, however, people often notice that sleep time varies with the seasons. It is not unusual for people in North America and Europe to sleep about 40 minutes longer per night during the winter.

Primary sleep disorders

Sleep disorders are classified based on what causes them. Primary sleep disorders are distinguished from those that are not caused by other mental disorders, prescription medications, **substance abuse**, or medical conditions. The two major categories of primary sleep disorders are the dyssomnias and the parasomnias.

DYSSOMNIAS. Dyssomnias are primary sleep disorders in which the patient suffers from changes in the amount, restfulness, and timing of sleep. The most important dyssomnia is primary insomnia, which is defined as difficulty in falling asleep or remaining asleep that lasts for at least one month. It is estimated that 35% of adults in the United States experience insomnia during any given year but the number of these adults who are experiencing true primary insomnia is unknown. Primary insomnia can be caused by a traumatic event related to sleep or bedtime and it is often associated with increased physical or psychological arousal at night. People who experience primary insomnia are often anxious about not being able to sleep. The person may then associate all sleep-related things (their bed, bedtime, etc.) with frustration, making the problem worse. The person then becomes more stressed about not sleeping. Primary insomnia usually begins when the person is a young adult or in middle age.

Hypersomnia is a condition marked by excessive sleepiness during normal waking hours. The patient has either lengthy episodes of daytime sleep or episodes of daytime sleep on a daily basis even though he or she is sleeping normally at night. In some cases, patients with primary hypersomnia have difficulty waking in the morning and may appear confused or angry. This condition is sometimes called sleep drunkenness and is more common in males. The number of people with primary hypersomnia is unknown, although 5–10% of patients in sleep disorder clinics have the disorder. Primary hypersomnia usually affects young adults between the ages of 15 and 30.

Nocturnal myoclonus and **restless legs syndrome** (RLS) can cause either insomnia or hypersomnia in adults. Patients with nocturnal myoclonus wake up because of cramps or twitches in the calves. These patients feel sleepy the next day. Nocturnal myoclonus is sometimes called periodic limb movement disorder (PLMD). RLS patients have a crawly or aching feeling in their calves that can be relieved by moving or rubbing the legs. RLS often prevents the patient from falling asleep until the early hours of the morning, when the condition is less intense.

Kleine-Levin syndrome is a recurrent form of hypersomnia that affects a person three or four times a year. Doctors do not know the cause of this syndrome. It is marked by two to three days of sleeping 18–20 hours per day, hypersexual behavior, compulsive eating, and irritability. Men are three times more likely than women to have the syndrome. Currently, there is no cure for this disorder.

Narcolepsy is a dyssomnia characterized by recurrent "sleep attacks" that the patient cannot fight. The sleep attacks are about 10–20 minutes long. The patient feels refreshed by the sleep, but typically feels sleepy again several hours later. Narcolepsy has three major symptoms in addition to sleep attacks: cataplexy, **hallucinations**, and sleep **paralysis**. Cataplexy is the sudden loss of muscle tone and stability ("drop attacks"). Hallucinations may occur just before falling asleep (hypnagogic) or right after waking up (hypnopompic) and are associated with an episode of REM sleep. Sleep paralysis occurs during the transition from being asleep to waking up. About 40% of patients with narcolepsy have or have had another mental disorder.

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Although narcolepsy is often regarded as an adult disorder, it has been reported in children as young as three years old. Almost 18% of patients with narcolepsy are 10 years old or younger. It is estimated that 0.02–0.16% of the general population suffer from narcolepsy. Men and women are equally affected.

Breathing-related sleep disorders are syndromes in which the patient's sleep is interrupted by problems with his or her breathing. There are three types of breathing-related sleep disorders:

- Obstructive sleep apnea syndrome. This is the most common form of breathing-related sleep disorder, marked by episodes of blockage in the upper airway during sleep. It is found primarily in obese people. Patients with this disorder typically alternate between periods of snoring or gasping (when their airway is partly open) and periods of silence (when their airway is blocked). Very loud snoring is a clue to this disorder.
- Central sleep apnea syndrome. This disorder is primarily found in elderly patients with heart or neurological conditions that affect their ability to breathe properly. It is not associated with airway blockage and may be related to brain disease.
- Central alveolar hypoventilation syndrome. This disorder is found most often in extremely obese people. The patient's airway is not blocked, but his or her blood oxygen level is too low.
- Mixed-type sleep apnea syndrome. This disorder combines symptoms of both obstructive and central sleep apnea.

Circadian rhythm sleep disorders are dyssomnias resulting from a discrepancy between the person's daily sleep/wake patterns and demands of social activities, shift work, or travel. The term *circadian* comes from a Latin word meaning daily. There are three circadian rhythm sleep disorders. Delayed sleep phase type is characterized by going to bed and arising later than most people. **Jet lag** type is caused by travel to a new time zone. Shift work type is caused by the schedule of a person's job. People who are ordinarily early risers appear to be more vulnerable to jet lag and shift work-related circadian rhythm disorders than people who are "night owls." There are some patients who do not fit the pattern of these three disorders and appear to be the opposite of the delayed sleep phase type. These patients have an advanced sleep phase pattern and cannot stay awake in the evening, but wake up on their own in the early morning.

PARASOMNIAS. Parasomnias are primary sleep disorders in which the patient's behavior is affected by specific sleep stages or transitions between sleeping and waking. They are sometimes described as disorders of physiological arousal during sleep.

Nightmare disorder is a parasomnia in which the patient is repeatedly awakened from sleep by frightening dreams and is fully alert on awakening. The actual rate of occurrence of nightmare disorder is unknown. Approximately 10–50% of children between three and five years old have nightmares. They occur during REM sleep, usually in the second half of the night. The child is usually able to remember the content of the nightmare and may be afraid to go back to sleep. More females than males have this disorder but it is not known whether the sex difference reflects a difference in occurrence or a difference in reporting. Nightmare disorder is most likely to occur in children or adults under severe or traumatic **stress**.

Sleep terror disorder is a parasomnia in which the patient awakens screaming or crying. The patient also has physical signs of arousal, like sweating, shaking, etc. It is sometimes referred to as pavor nocturnus. Unlike nightmares, sleep terrors typically occur in stage 3 or stage 4 NREM sleep during the first third of the night. The patient may be confused or disoriented for several minutes and cannot recall the content of the dream. He or she may fall asleep again and not remember the episode the next morning. Sleep terror disorder is most common in children 4 to 12 years old and is outgrown in adolescence. It affects about 3% of children. Fewer than 1% of adults have the disorder. In adults, it usually begins between the ages of 20 and 30. In children, more males than females have the disorder. In adults, men and women are equally affected.

Sleepwalking disorder, which is sometimes called somnambulism, occurs when the patient is capable of complex movements during sleep, including walking. Like sleep terror disorder, sleepwalking occurs during stage 3 and stage 4 NREM sleep during the first part of the night. If the patient is awakened during a sleepwalking episode, he or she may be disoriented and have no memory of the behavior. In addition to walking around, patients with sleepwalking disorder have been reported to eat, use the bathroom, unlock doors, or talk to others. It is estimated that 10–30% of children have at least one episode of sleepwalking. However, only 1–5% meet the criteria for sleepwalking disorder. The disorder is most common in children 8 to 12 years old. It is unusual for sleepwalking to occur for the first time in adults.

Unlike sleepwalking, REM sleep behavior disorder occurs later in the night and the patient can remember what they were dreaming. The physical activities of the patient are often violent.

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Sleep disorders related to other conditions

In addition to the primary sleep disorders, there are three categories of sleep disorders that are caused by or related to substance use or other physical or mental disorders.

SLEEP DISORDERS RELATED TO MENTAL DISORDERS. Many mental disorders, especially depression or one of the **anxiety disorders**, can cause sleep disturbances. Psychiatric disorders are the most common cause of chronic insomnia.

SLEEP DISORDERS DUE TO MEDICAL CONDITIONS. Some patients with chronic neurological conditions like **Parkinson's disease** or **Huntington's disease** may develop sleep disorders. Sleep disorders have also been associated with viral **encephalitis**, brain disease, and hypo- or **hyperthyroidism**.

SUBSTANCE-INDUCED SLEEP DISORDERS. The use of drugs, alcohol, and **caffeine** frequently produces disturbances in sleep patterns. Alcohol **abuse** is associated with insomnia. The person may initially feel sleepy after drinking but wakes up or sleeps fitfully during the second half of the night. Alcohol can also increase the severity of breathing-related sleep disorders. With amphetamines or **cocaine**, the patient typically suffers from insomnia during drug use and hypersomnia during drug withdrawal. Opioids usually make short-term users sleepy. However, long-term users develop tolerance and may suffer from insomnia.

In addition to alcohol and drugs that are abused, a variety of prescription medications can affect sleep patterns. These medications include **antihistamines**, **corticosteroids**, **asthma** medicines, and drugs that affect the central nervous system.

Sleep disorders in children and adolescents

Pediatricians estimate that 20–30% of children have difficulties with sleep that are serious enough to disturb their families. Although sleepwalking and night terror disorder occur more frequently in children than in adults, children can also suffer from narcolepsy and **sleep apnea** syndrome.

Risk factors

Risk factors for sleep disorders include:

- Sex. Primary insomnia is more common in women than in men, while obstructive sleep apnea is twice as common in men as in women.
- Age. Older adults are more likely to develop sleep disorders; the rate rises from 5% of adults between 30 and 50 to 30% in those over 50. One reason for the greater risk of sleep disorders in seniors is that they are more likely to have medical conditions that disturb sleep or to be taking medications that cause sleep disruption.
- Employment that requires frequent travel across time zones or frequent changes in work schedules.
- Environmental factors, including noise, high altitude, and abnormally hot or cold temperatures.
- Smoking. Heavy smokers often wake up after only a few hours of sleep due to nicotine withdrawal.
- High levels of emotional stress, whether job-related or associated with family or personal problems.
- Family history of sleep disorders. Sleepwalking is particularly likely to run in families.
- Having a disease or disorder that causes physical discomfort.
- Genetic factors. There is increasing evidence that obstructive sleep apnea, narcolepsy, and restless legs syndrome are associated with susceptibility genes for these disorders, although no specific genes have been identified as of 2009.

Causes and symptoms

The causes of sleep disorders have already been discussed with respect to the classification of these disorders.

The most important symptoms of sleep disorders are insomnia and sleepiness during waking hours. Insomnia is by far the more common of the two symptoms. It covers a number of different patterns of sleep disturbance. These patterns include inability to fall asleep at bedtime, repeated awakening during the night, and/or inability to go back to sleep once awakened.

Diagnosis

Diagnosis of sleep disorders usually requires a psychological history as well as a medical history. The patient's sex and age are useful starting points in assessing the problem. The doctor may also talk to other family members in order to obtain information about the patient's symptoms. The family's observations are particularly important to evaluate sleepwalking, kicking in bed, **snoring** loudly, or other behaviors that the patient cannot remember.

Examination

With the exception of sleep apnea syndromes, physical examinations are not usually revealing.

Tests

The doctor may order blood or urine tests to determine whether the patient's sleep disorder is associated

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with anemia, thyroid dysfunction, **alcoholism**, or opioid abuse. The patient's blood oxygen level may be tested during sleep in order to determine whether sleep apnea or other types of sleep-disordered breathing are involved. Imaging tests are not routinely done for sleep disorders but may be ordered in some cases to rule out brain tumors or other medical conditions.

Sleep logs

Many doctors ask patients to keep a sleep diary or sleep log for a minimum of one to two weeks in order to evaluate the severity and characteristics of the sleep disturbance. The patient records medications taken as well as the length of time spent in bed, the quality of the sleep, and similar information. Some sleep logs are designed to indicate circadian sleep patterns as well as simple duration or restfulness of sleep.

Psychological testing

The doctor may use **psychological tests** or inventories to evaluate insomnia because it is frequently associated with mood or affective disorders. The **Minnesota Multiphasic Personality Inventory** (MMPI), the Millon Clinical Multiaxial Inventory (MCMI), the Beck Depression Inventory, and the Zung Depression Scale are the tests most commonly used in evaluating this symptom.

Self-report tests

The Epworth Sleepiness Scale, a self-rating form recently developed in Australia, consists of eight questions used to assess daytime sleepiness. Scores range from 0–24, with scores higher than 16 indicating severe daytime sleepiness.

Laboratory sleep studies

If the doctor is considering breathing-related sleep disorders, myoclonus, or narcolepsy as possible diagnoses, he or she may ask the patient to be tested in a sleep laboratory or at home with portable instruments.

POLYSOMNOGRAPHY. Polysomnography can be used to help diagnose sleep disorders as well as conduct research into sleep. In some cases the patient is tested in a special sleep laboratory. The advantage of this testing is the availability and expertise of trained technologists but it is expensive. As of 2009, however, portable equipment is available for home recording of certain specific physiological functions.

MULTIPLE SLEEP LATENCY TEST (MSLT). The multiple sleep latency test (MSLT) is frequently used to measure the severity of the patient's daytime sleepiness. The test measures sleep latency (the speed with which the patient falls asleep) during a series of planned naps during the day. The test also measures the amount of REM sleep that occurs. Two or more episodes of REM sleep under these conditions indicates narcolepsy. This test can also be used to help diagnose primary hypersomnia.

REPEATED TEST OF SUSTAINED WAKEFULNESS (RTSW). The repeated test of sustained wakefulness (RTSW) is a test that measures sleep latency by challenging the patient's ability to stay awake. In the RTSW, the patient is placed in a quiet room with dim lighting and is asked to stay awake. As with the MSLT, the testing pattern is repeated at intervals during the day.

Treatment

Traditional

Treatment for a sleep disorder depends on what is causing the disorder. For example, if major depression is the cause of insomnia, then treatment of the depression with antidepressants should resolve the insomnia. In other cases, a change of environment or work schedule may help.

Drugs

Sedative or hypnotic medications are generally recommended only for insomnia related to a temporary stress (like surgery or grief) because of the potential for **addiction** or overdose. In general, these drugs are given for two weeks or less in order to reduce the risk of dependence. Trazodone, a sedating antidepressant, is often used for chronic insomnia that does not respond to other treatments. Sleep medications may also cause problems for elderly patients because of possible interactions with their other prescription medications. Among the safer hypnotic agents are lorazepam, temazepam, and zolpidem. Chloral hydrate is often preferred for short-term treatment in elderly patients because of its mildness. Short-term treatment is recommended because this drug may be habit forming.

Narcolepsy is treated with such stimulants as dextroamphetamine sulfate or methylphenidate. Nocturnal myoclonus has been successfully treated with clonazepam.

Children with sleep terror disorder or sleepwalking are usually treated with **benzodiazepines** because this type of medication suppresses stage 3 and stage 4 NREM sleep.

If the cause of insomnia is RLS, treatment includes massage, warm baths, and visualization techniques to distract from the discomfort. The only medication

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KEY TERMS

Apnea—The temporary absence of breathing. Sleep apnea consists of repeated episodes of temporary suspension of breathing during sleep.

Benzodiazepines—A class of sedative drugs used to treat sleep disorders.

Cataplexy—Sudden loss of muscle tone (often causing a person to fall), usually triggered by intense emotion. It is regarded as a diagnostic sign of narcolepsy.

Circadian rhythm—Any body rhythm that recurs in 24-hour cycles. The sleep-wake cycle is an example of a circadian rhythm.

Cognitive behavioral therapy (CBT)—A type of psychotherapy that helps patients identify and change problematic thoughts and behaviors.

Dyssomnia—A primary sleep disorder in which the patient suffers from changes in the quantity, quality, or timing of sleep.

Electroencephalogram (EEG)—The record obtained by a device that measures electrical impulses in the brain.

Hypersomnia—An abnormal increase of 25% or more in time spent sleeping. Patients usually have excessive daytime sleepiness.

Hypnotic—A medication that makes a person sleep.

Hypopnea—Shallow or excessively slow breathing usually caused by partial closure of the upper airway during sleep, leading to disruption of sleep.

Insomnia—Difficulty in falling asleep or remaining asleep.

Jet lag—A temporary disruption of the body's sleep-wake rhythm following high-speed air travel across several time zones. Jet lag is most severe in people who have crossed eight or more time zones in 24 hours.

Kleine-Levin syndrome—A disorder that occurs primarily in young males, three or four times a year. The syndrome is marked by episodes of hypersomnia, hypersexual behavior, and excessive eating.

Melatonin—A hormone produced by the pineal gland that is associated with sleep, and that may be useful in the treatment of some sleep disorders.

Narcolepsy—A lifelong sleep disorder marked by four symptoms: sudden brief sleep attacks,

approved by the U.S. Food and Drug Administration (FDA) for the treatment of RLS is ropinirole (Requip), although drugs used for the treatment of Parkinson's disease, benzodiazepines, and anticonvulsant medications also may be effective for this disorder.

Psychotherapy

Psychotherapy is recommended for patients with sleep disorders associated with depression or other mental disorders. In many cases the patient's scores on the Beck or Zung inventories will suggest the appropriate direction of treatment.

Cognitive-behavioral therapy (CBT) is a form of psychotherapy that is often recommended for insomnia as a way of breaking the cycle of **anxiety** about sleep and sleeplessness associated with insomnia. The patient is typically advised to limit the amount of time they spend in bed and to change certain habits that may contribute to the insomnia. For example, some patients are clock watchers who check their bedside clocks frequently to see how little sleep they are getting. They will be advised to put the clock under the bed or in some other location where they can't see it during the night.

Sleep education

"Sleep hygiene" or sleep education for sleep disorders often includes instructing the patient in methods to enhance sleep. Patients are advised to:

- wait until they are sleepy before going to bed
- avoid using the bedroom for work, reading, or watching television
- get up at the same time every morning no matter how much or how little they slept
- avoid smoking and avoid drinking liquids with caffeine
- get some physical exercise early in the day every day
- limit fluid intake after dinner; in particular, avoid alcohol because it frequently causes interrupted sleep
- learn to meditate or practice relaxation techniques
- avoid tossing and turning in bed; instead, the patient can get up and listen to relaxing music or read

Lifestyle changes

Patients with sleep apnea or hypopnea are encouraged to stop **smoking**, avoid alcohol or drugs of abuse,

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cataplexy, temporary paralysis, and hallucinations. The hallucinations are associated with falling asleep or the transition from sleeping to waking.

Nocturnal myoclonus—A disorder in which the patient is awakened repeatedly during the night by cramps or twitches in the calf muscles. Nocturnal myoclonus is sometimes called periodic limb movement disorder (PLMD).

Non-rapid eye movement (NREM) sleep—A type of sleep that differs from rapid eye movement (REM) sleep. The four stages of NREM sleep account for 75–80% of total sleeping time.

Parasomnia—A primary sleep disorder in which the person's physiology or behaviors are affected by sleep, the sleep stage, or the transition from sleeping to waking.

Pavor nocturnus—Another term for sleep terror disorder.

Polysomnography—Laboratory measurement of a patient's basic physiological processes during sleep. Polysomnography usually measures eye movement, brain waves, and muscular tension.

Primary sleep disorder—A sleep disorder that cannot be attributed to a medical condition, another mental disorder, or prescription medications or other substances.

Rapid eye movement (REM) sleep—A phase of sleep during which the person's eyes move rapidly beneath the lids. It accounts for 20–25% of sleep time. Dreaming occurs during REM sleep.

REM latency—After a person falls asleep, the amount of time it takes for the first onset of REM sleep.

Restless legs syndrome (RLS)—A disorder in which the patient experiences crawling, aching, or other disagreeable sensations in the calves that can be relieved only by movement. RLS is a frequent cause of difficulty falling asleep at night.

Sedative—A medication given to calm agitated patients; sometimes used as a synonym for hypnotic.

Sleep latency—The amount of time that it takes to fall asleep. Sleep latency is measured in minutes and is important in diagnosing depression.

Somnambulism—Another term for sleepwalking.

and lose weight in order to improve the stability of the upper airway.

In some cases, patients with sleep disorders related to jet lag or shift work may need to change employment or travel patterns. Patients may need to avoid rapid changes in shifts at work.

Children with nightmare disorder may benefit from limits on television or movies. Violent scenes or frightening science fiction stories appear to influence the frequency and intensity of children's nightmares.

Surgery

Although making a surgical opening into the windpipe (a tracheostomy) for sleep apnea or hypopnea in adults is a treatment of last resort, it is occasionally performed if the patient's disorder is life threatening and cannot be treated by other methods. In children and adolescents, surgical removal of the tonsils and adenoids is a fairly common and successful treatment for sleep apnea. Most sleep apnea patients are treated with continuous positive airway pressure (CPAP). Sometimes an oral prosthesis is used for mild sleep apnea.

Alternative

Some alternative approaches may be effective in treating insomnia caused by anxiety or emotional stress. **Meditation** practice, breathing exercises, and **yoga** can break the vicious cycle of sleeplessness, worry about inability to sleep, and further sleeplessness for some people. Yoga can also help some people to relax muscular tension in a direct fashion. The breathing exercises and meditation can keep some patients from obsessing about sleep.

Homeopathic practitioners recommend that people with chronic insomnia see a professional homeopath. They do, however, prescribe specific remedies for at-home treatment of temporary insomnia: *Nux vomica* for alcohol or substance-related insomnia, *Ignatia* for insomnia caused by grief, *Arsenicum* for insomnia caused by fear or anxiety, and *Passiflora* for insomnia related to mental stress.

Melatonin has also been used as an alternative treatment for sleep disorders. Melatonin is produced in the body by the pineal gland at the base of the brain. This substance is thought to be related to the body's circadian rhythms.

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Practitioners of Chinese medicine usually treat insomnia as a symptom of excess yang energy. Cinnabar is recommended for chronic nightmares. Either magnetic magnetite or "dragon bones" is recommended for insomnia associated with **hysteria** or fear. If the insomnia appears to be associated with excess yang energy arising from the liver, the practitioner will give the patient oyster shells. **Acupuncture** treatments can help bring about balance and facilitate sleep.

Dietary changes like eliminating stimulant foods (coffee, cola, chocolate) and late-night meals or snacks can be effective in treating some sleep disorders. Nutritional supplementation with magnesium, as well as botanical medicines that calm the nervous system, can also be helpful. Among the botanical remedies that may be effective for sleep disorders are valerian (*Valeriana officinalis*), passionflower (*Passiflora incarnata*), and skullcap (*Scutellaria lateriflora*).

Home remedies

Warm milk before bedtime is a classic home remedy for insomnia. It is thought that this treatment works for many people because milk contains tryptophan, an amino acid that increases the brain's production of melatonin.

Prognosis

The prognosis depends on the specific disorder. Children usually outgrow sleep disorders. Patients with Kleine-Levin syndrome usually get better around age 40. Narcolepsy, however, is a lifelong disorder, although cataplexy can be successfully controlled with medication, and many people find that their symptoms naturally decrease after age 60. The prognosis for sleep disorders related to other conditions depends on successful treatment of the substance abuse, medical condition, or other mental disorder. The prognosis for primary sleep disorders is affected by many things, including the patient's age, sex, occupation, personality characteristics, family circumstances, neighborhood environment, and similar factors.

About 85% of people with insomnia find relief with a combination of sleep hygiene and medication. Although there is no cure for sleep apnea, treatment can reduce the associated risks of high blood pressure and heart disease.

Insomnia and other sleep disorders are not fatal in and of themselves; however, chronic insomnia is associated with an increased risk of depression and **suicide**. In addition, insufficient sleep increases a person's risk of accidents on the road and in the workplace, with the possibility of serious injury or **death**. Driver **fatigue** is responsible for an estimated 100,000 motor vehicle accidents and 1500 deaths each year in the United States, according to the National Highway Traffic Safety Administration.

Prevention

Certain sleep disorders, such as insomnia, can sometimes be prevented by practicing good sleep hygiene. As mentioned, sleep hygiene involves going to bed at a regular time each night and avoiding stimulating activities, smoking, or heavy meals close to bedtime. Sleep apnea may be prevented in some cases by controlling body weight.

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ORGANIZATIONS

American Academy of Sleep Medicine (AASM), One Westbrook Corporate Center, Suite 920, Westchester, IL, 60154, (708) 492-0930, (708) 492-0943, http://www.aasmnet.org/.
American Psychiatric Association, 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209-3901, (703) 907-7300, apa@psych.org, http://www.psych.org/.
American Sleep Association (ASA), 110 West Ninth Street, Suite 826, Wilmington, DE, 19801, (940) 234-3357, http://www.sleepassociation.org/.
Anxiety Disorders Association of America (ADAA), 8730 Georgia Ave., Suite 600, Silver Spring, MD, 20910, (240) 485-1001, (240) 485-1035, information@adaa.org, http://www.adaa.org/.
National Institute of Neurological Disorders and Stroke (NINDS), P.O. Box 5801, Bethesda, MD, 20824, (800) 352-9424, (301) 496-5751, http://www.ninds.nih.gov/index.htm.
National Sleep Foundation (NSF), 1522 K Street, NW, Suite 500, Washington, DC, 20005, (202) 347-3471, (202) 347-3472, nsf@sleepfoundation.org, http://www.sleepfoundation.org/.

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Sleep study *see* **Polysomnography**
Sleeping drugs *see* **Anti-insomnia drugs**

Sleeping sickness

Definition

Sleeping sickness (also called trypanosomiasis) is an infection caused by *Trypanosoma* protozoa; it is passed to humans through the bite of the tsetse fly. If left untreated, the infection progresses to **death** within months or years.

Description

Protozoa are single-celled organisms considered to be the simplest life form in the animal kingdom. The protozoa responsible for sleeping sickness are a variety that bear numerous flagella (hair-like projections from the cell that help the cell to move). These protozoa exist only on the continent of Africa. The type of protozoa causing sleeping sickness in humans is referred to as the *Trypanasoma brucei* complex, which can be divided further into Rhodesian (Central and East African) and Gambian (Central and West African) subspecies.

The Rhodesian variety live within antelopes in savanna and woodland areas and they cause no problems with the antelope's health. The protozoa are then acquired by tsetse flies when they bite and suck the blood of an infected antelope or cow.

Within the tsetse fly, the protozoa cycle through several different life forms; ultimately they migrate to the salivary glands of the tsetse fly. Once the protozoa are harbored in the salivary glands, they are ready to be deposited into the bloodstream of the fly's next source of a blood meal.

Humans most likely to become infected by Rhodesian trypanosomes are people such as game wardens and visitors to game parks in East Africa, who may be bitten by a tsetse fly that has fed on game (antelope) carrying the protozoa. The Rhodesian variety of sleeping sickness causes a much more severe illness, with even greater likelihood of eventual death than the Gambian form.

The Gambian variety of *Trypanosoma* thrives in tropical rain forests throughout Central and West Africa; it does not infect game or cattle, and is primarily a threat to people dwelling in such areas, rarely infecting visitors.

Causes and symptoms

The first sign of infection with the trypanosome may be a sore appearing at the site of the tsetse fly bite about two to tree days after having been bitten. Redness, **pain**, and swelling occur but are often ignored by the patient.

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DAVID BRUCE (1855–1931)

David Bruce was born in Melbourne, Australia, on May 29,1855, to Scottish immigrants. Bruce's family moved back to Scotland when he was five years old. Bruce attended the University of Edinburgh where he studied natural history and medicine. Following his graduation, he accepted a position working with a doctor. In 1883, Bruce married Mary Elizabeth Steele who would help him with his work throughout his life.

In 1884, Bruce began to study the disease "Malta, Mediterranean" when he and Mary were stationed in Malta with the Army Medical Service. Using a microscope, Bruce discovered that the disease was caused by a "micrococcus" that grew in the individual's spleen. The organism responsible for this disease was ultimately isolated by Bernhard L. F. Bang. In 1905, Bruce led a scientific team that discovered that the soldiers who contracted the disease had ingested the milk of infected goats. The disease disappeared when the soldiers quit drinking goat's milk. Many physicians began calling the disease "brucellosis" in honor of Bruce's discoveries. Bruce also conducted research in Africa where he found that the tsetse fly could infect humans, as well as animals, with the "nagana" disease. Ultimately, his work would prove that sleeping sickness was caused by the tsetse fly.

In 1903, Bruce became the director of the Royal Society's Sleeping Sickness Commission and, in 1908, he was knighted. He served as commandant of the Royal Army Medical College after he and his wife returned to England. Bruce died on November 20, 1931.

Stage I illness

Two to three weeks later, Stage I disease develops as a result of the protozoa being carried through the blood and lymph circulation of the host. This systemic (meaning that symptoms affect the whole body) phase of the illness is characterized by a **fever** that rises quite high, then falls to normal, then respikes (rises rapidly). A rash with intense **itching** may be present, and **headache** and mental confusion may occur. The Gambian form, in particular, includes extreme swelling of lymph tissue, with enlargement of both the spleen and liver, and greatly swollen lymph nodes. "Winterbottom's sign" is classic of Gambian sleeping sickness, and consists of a visibly swollen area of lymph nodes located behind the ear and just above the base of the neck. During this stage, the heart may be affected by a severe inflammatory reaction, particularly when the infection is caused by the Rhodesian variety of trypanosomiasis.

Many of the symptoms of sleeping sickness are actually the result of attempts by the patient's immune system to get rid of the invading organism. The heightened activity of the cells of the immune system result in damage to the patient's own organs, anemia, and leaky blood vessels. These leaks in the blood vessels end up helping to further spread the protozoa throughout the afflicted person's body.

One reason for the intense reaction of the immune system to the presence of the trypanosomes is also the reason why the trypanosomes survive so well despite the efforts of the immune system to eradicate them. The protozoa causing sleeping sickness are able to rapidly change specific markers (unique proteins) on their outer coats. These kinds of markers usually serve to stimulate the host's immune system to produce immune cells that will specifically target the marker, allowing quick destruction of those cells bearing the markers. Trypanosomes, however, are able to express new markers at such a high rate of change that the host's immune system is constantly trying to catch up.

Stage II illness

Stage II sleeping sickness involves the nervous system. Gambian sleeping sickness, in particular, has a clearly delineated phase in which the predominant symptoms involve the brain. The patient's speech becomes slurred, mental processes slow, and the patient sits and stares for long periods of time, or sleeps. Other symptoms resemble Parkinson's disease, including imbalance when walking, slow and shuffling gait, trembling of the limbs, involuntary movements, muscle tightness, and increasing mental confusion. Untreated, these symptoms eventually lead to **coma** and then to death.

Diagnosis

Diagnosis of sleeping sickness can be made by microscopic examination of fluid from the original sore at the site of the tsetse fly bite. Trypanosomes will be present in the fluid for a short period of time following the bite. If the sore has already resolved, fluid can be obtained from swollen lymph nodes for examination. Other methods of trypanosome diagnosis involve culturing blood, lymph node fluid, bone marrow, or spinal fluid. These cultures are then injected into rats, which develop blood-borne protozoa infection that can be detected in blood smears within one to two weeks. However, this last method is effective only for the Rhodesian variety of sleeping sickness.

Treatment

Without treatment, sleeping sickness will lead to death. Unfortunately, however, those medications effective against the *Trypanosoma brucei* complex

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KEY TERMS

Immune system—That network of tissues and cells throughout the body that is responsible for ridding the body of any invaders, such as viruses, bacteria, protozoa, etc.

Protozoa—Single-celled organisms considered to be the simplest life form in the animal kingdom.

protozoa all have significant potential side effects for the patient. Suramin, eflornithine, pentamidine, and several drugs that contain arsenic (a chemical which in higher doses is highly poisonous to humans), are all effective anti-trypanosomal agents. Each of these drugs, however, requires careful monitoring to ensure that the drugs themselves do not cause serious complications such as fatal hypersensitivity (allergic) reaction, kidney or liver damage, or inflammation of the brain.

Prevention

Prevention of sleeping sickness requires avoiding contact with the tsetse fly. Insect repellents and clothing that covers the limbs to the wrists and ankles are advisable. Public health measures have included drug treatment of humans who are infected with one of the *Trypanosoma brucei* complex. There are currently no immunizations available to prevent the acquisition of sleeping sickness.

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ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

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Sleepwalking *see* **Sleep disorders**

Slipped disk *see* **Herniated disk**

Slit lamp examination *see* **Eye examination**

Small-for-gestational-age infant *see* **Intrauterine growth retardation**

Small bowel follow-through (SBFT) *see* **Upper GI exam**

Small cell lung cancer *see* **Lung cancer, small cell**

Small intestine biopsy

Definition

A biopsy is a diagnostic procedure in which tissue or cells are removed from a part of the body and specially prepared for examination under a microscope. When the tissue involved is part of the small intestine, the procedure is called a small-intestine (or small-bowel) biopsy.

Purpose

The small-bowel biopsy is used to diagnose and confirm disease of the intestinal mucosa (the lining of the small intestine). The test is most commonly done to test for tumors of the small bowel or malabsorption syndromes.

Precautions

Due to the slight risk of bleeding during or after this procedure, **aspirin**, aspirin-containing medications, **nonsteroidal anti-inflammatory drugs**, and anticoagulants and **antiplatelet drugs** should be withheld for at least five days before the test.

Description

The small intestine is approximately 21 ft (6.4 m). It has three sections: the duodenum (a short, curved segment fixed to the back wall of the abdomen), the jejunum, and the ileum (two larger, coiled, and mobile segments). Some digestion occurs in the stomach, but the small intestine is mainly responsible for digestion and absorption of foods.

Malabsorption syndromes occur when certain conditions result in impaired absorption of nutrients, **vitamins**, or **minerals** from the diet by the lining of the small intestine. For example, injury to the intestinal lining can interfere with absorption, as can infections, intestinal parasites, some drugs, blockage of the lymphatic vessels, poor blood supply to the intestine, or diseases like sprue.

Malabsorption is suspected when a patient not only loses weight but has **diarrhea** and nutritional deficiencies despite eating well (weight loss alone can have other causes). Laboratory tests like fecal fat, a measurement of fat in stool samples collected over 72 hours, are the most reliable tests for diagnosing fat malabsorption but abnormalities of the small intestine itself are diagnosed by small-intestine biopsy.

Several different methods are used to detect abnormalities of the small intestine. A tissue specimen can be obtained by using an endoscope (a flexible viewing tube) or by using a thin tube with a small cutting

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instrument at the end. This latter procedure is ordered when specimens larger than those provided by endoscopic biopsy are needed because it allows removal of tissue from areas beyond the reach of an endoscope.

Several similar types of capsules are used for tissue collection. In each, a mercury-weighted bag is attached to one end of the capsule, while a thin polyethylene tube about 5 ft (1.5 m) long is attached to the other end. Once the bag, capsule, and tube are in place in the small bowel, suction on the tube draws the tissue into the capsule and closes it, cutting off the piece of tissue within. This is an invasive procedure but it causes little **pain** and complications are rare.

A newer method of obtaining diagnostic information about the small intestine was approved by the Food and Drug Administration (FDA) in 2001. Known as the M2A Imaging System, the device was developed by a company in Atlanta, Georgia. The M2A system consists of an imaging capsule, a portable belt-pack image receiver and recorder, and a specially modified computer. The patient swallows the capsule, which is the size of a large pill. A miniature lens in the capsule transmits images through an antenna/transmitter to the belt-pack receiver, which the patient wears under ordinary clothing as he or she goes about daily activities. The belt-pack recording device is returned after seven or eight hours to the doctor, who then examines the images recorded as a digital video. The capsule itself is simply allowed to pass through the digestive tract.

Preparation requires only **fasting** the night before the M2A examination and taking nothing but clear liquids for two hours after swallowing the capsule. After four hours the patient can eat food without interfering with the test. As of the early 2000s, the M2A system is used to evaluate gastrointestinal bleeding from unknown causes, inflammatory bowel disease, some malabsorption syndromes, and to monitor surgical patients following small-bowel transplantation. The system has shown good results in detecting **Crohn's disease** undiagnosed by conventional methods.

Small-intestine biopsy procedure

After application of a topical anesthetic to the back of the patient's throat, the capsule and the tube are introduced, and the patient is asked to swallow as the tube is advanced. The patient is then placed on the right side and the instrument tip is advanced another 20 in (51 cm) or so. The tube's position is checked by fluoroscopy or by instilling air through the tube and listening with a stethoscope for air to enter the stomach.

The tube is advanced 2–4 in (5.1–10 cm)at a time to pass the capsule through the stomach outlet (pylorus).

KEY TERMS

Sprue—A disorder of impaired absorption of nutrients from the diet by the small intestine (malabsorption), resulting in malnutrition. Two forms of sprue exist: tropical sprue, which occurs mainly in tropical regions; and celiac sprue, which occurs more widely and is due to sensitivity to the wheat protein gluten.

Whipple's disease—A disorder of impaired absorption of nutrients by the small intestine. Symptoms include diarrhea, abdominal pain, progressive weight loss, joint pain, swollen lymph nodes, abnormal skin pigmentation, anemia, and fever. The precise cause is unknown but it is probably due to an unidentified bacterial infection.

Wireless capsule endoscopy—A newer method of examining the small bowel by means of a capsule swallowed by the patient. The capsule contains a miniaturized lens and an antenna that transmits information to a belt-pack recorder worn by the patient during the day.

When fluoroscopy confirms that the capsule has passed the pylorus, small samples of small intestine tissue are obtained by the instrument's cutting edge, after which the instrument and tube are withdrawn. The entire procedure may be completed in minutes.

Preparation

This procedure requires tissue specimens from the small intestine through means of a tube inserted into the stomach through the mouth. The patient is to withhold food and fluids for at least eight hours before the test.

Aftercare

The patient should not have anything to eat or drink until the topical anesthetic wears off (usually about one to two hours). If intravenous sedatives were administered during the procedure, the patient should not drive for the remainder of the day. Complications from this procedure are uncommon, but can occur. The patient is to note any abdominal pain or bleeding and report either immediately to the doctor.

Risks

Complications from this procedure are rare, but can include bleeding (hemorrhage), bacterial infection with **fever** and pain, and bowel puncture (perforation).

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The patient should immediately report any abdominal pain or bleeding to the physician in charge. Biopsy is contraindicated in uncooperative patients, those taking aspirin or anticoagulants, and in those with uncontrolled bleeding disorders.

Normal results

Normal results are no abnormalities seen on gross examination of the specimen(s) or under the microscope after tissue preparation.

Abnormal results

Small-intestine tissue exhibiting abnormalities may indicate Whipple's disease, a malabsorption disease; lymphoma, a group of cancers; and parasitic infections like **giardiasis**, strongyloidiasis, and coccidiosis. When biopsy indicates celiac sprue (a malabsorption disorder), infectious **gastroenteritis** (inflammation of the gastrointestinal tract), folate and B_{12} deficiency, or **malnutrition**, confirmation studies are needed for conclusive diagnosis.

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Smallpox

Definition

Smallpox is an infection caused by the variola virus, a member of the poxvirus family. Throughout history, smallpox has been a greatly feared disease because it was responsible for huge epidemics worldwide that resulted in large numbers of deaths. In 1980, the World Health Organization (WHO) announced that an extensive program of **vaccination** against the disease had resulted in the complete eradication of the virus with the exception of samples of stored virus in two laboratories.

Smallpox pustules on the arm of an Indian man. *(© C. James Webb/Phototake. — All rights reserved.)*

Description

Smallpox is strictly an infection of human beings. Animals and insects can neither be infected by smallpox, nor carry the virus in any form. Most infections are caused by contact with a person who has already developed the characteristic **skin lesions** (pox) of the disease, although a person who has a less severe infection (not symptomatic or diagnosable in the usual way) can unwittingly spread the virus.

Causes and symptoms

Smallpox is a relatively contagious disease, which accounts for its ability to cause massive epidemics. The variola virus is acquired from direct contact with individuals infected with the disease, from contaminated air droplets, and even from objects used by another

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smallpox victim (books, blankets, utensils, etc.). The respiratory tract is the usual entry point for the variola virus into a human being.

After the virus enters the body, there is a 12–14 day incubation period during which the virus multiplies, although no symptoms are recognizable. After the incubation period, symptoms appear abruptly and include **fever**, chills, and muscle aches. Two to three days later, a bumpy rash begins appearing first on the face and forearms. The rash progresses, ultimately reaching the chest, abdomen, and back. Seven to ten days after the rash appears, the patient is most infectious. The individual bumps (papules) fill with clear fluid and eventually become pus-filled over the course of 10–12 days. These pox eventually scab over, each leaving a permanently scarred pock or pit when the scab drops off.

Initially, the smallpox symptoms and rash appear similar to **chickenpox**. However, unlike chickenpox, smallpox lesions develop at the same rate so that they are all visible in the same stage. Another major difference is that smallpox occurs primarily on the face and entremities, whereas chickenpox tends to be concentrate on the face and trunk area.

Complications such as bacterial infection of the open skin lesions, **pneumonia**, or bone infections are the major causes of **death** from smallpox. A very severe and quickly fatal form called "sledgehammer smallpox," occurs in 5–10% of patients and results in massive, uncontrollable bleeding (hemorrhage) from the skin lesions, as well as from the mouth, nose, and other areas of the body. This form is very infectious and usually fatal five to seven days after onset.

Fear of smallpox comes from both the epidemic nature of the disease as well as from the fact that no therapies have ever been discovered to either treat the symptoms of smallpox, or shorten the course of the disease.

Diagnosis

In modern times, a diagnosis of smallpox is made using an electron microscope to identify virus in fluid from the papules, urine, or in the patient's blood prior to the appearance of the papular rash.

Treatment

No treatments have been developed to halt the progression of the disease. Treatment for smallpox is only supportive, meaning that it is aimed at keeping a patient as comfortable as possible. **Antibiotics** are sometimes administered to prevent secondary bacterial infections.

Prognosis

Approximately one in three patients die from smallpox, with the more severe, hemorrhagic form nearly 100% fatal. Patients who survive smallpox infection nearly always have multiple areas of scarring where each pock has been.

Prevention

From about the tenth century in China, India, and the Americas, it is noted that individuals who had even a mild case of smallpox could not be infected again. Fascinating accounts appear in writings from all over the world of ways in which people tried to prevent smallpox. Material from people mildly ill with smallpox (fluid or pus from the papules, scabs over the pox) was scratched into the skin of people who had never had the illness, in an attempt to produce a mild reaction and its accompanying protective effect. These efforts often resulted in full-fledged smallpox, and probably served only to help effectively spread the infection throughout a community. In fact, such crude smallpox "vaccinations" were against the law in Colonial America.

In 1798, Edward Jenner published a paper in which he discussed his important observation that milkmaids who contracted a mild infection of the hands (called cowpox, and caused by a relative of the variola virus) appeared to be immune to smallpox. Jenner created an immunization against smallpox using the pus found in the lesions of cowpox infection. Jenner's paper led to much work in the area of vaccinations and ultimately resulted in the creation of a very effective vaccination against smallpox that utilized the vaccinia virus, another close relative of variola. Indeed, the term vaccination is derived from *vacce*, Latin for cow and related to the cowpox link. Later, the term was applied to other vaccinations.

In 1967, WHO began its attempt to eradicate the smallpox virus worldwide. The methods used in the program were simple:

- Careful surveillance for all smallpox infections worldwide, to allow for quick diagnosis and immediate quarantine of patients.
- Immediate vaccination of all contacts diagnosed with infection, in order to interrupt the virus' usual pattern of infection.

The WHO's program was extremely successful, and the virus was declared eradicated worldwide in May 1980.

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KEY TERMS

Epidemic—A situation in which a particular infection is experienced by a very large percentage of the people in a given community within a given time frame.

Eradicate—To completely do away with something, eliminate it, end its existence.

Hemorrhage—Bleeding that is massive, uncontrollable, and often life-threatening.

Lesion—The tissue disruption or the loss of function caused by a particular disease process.

Papules—Firm bumps on the skin.

Pox—A pus-filled bump on the skin.

Vaccine—A preparation using a non-infectious element or relative of a particular virus or bacteria, and administered with the intention of halting the progress of an infection, or completely preventing it.

Future concerns

Today, two laboratories (the Centers for Disease Control and Prevention in Atlanta, Georgia, and the Russian State Centre for Research on Virology and Biotechnology in Koltsovo, Novosibirsk Region) officially retain samples of the smallpox virus. These samples, as well as stockpiles of the smallpox vaccine, are stored because some level of concern exists that another poxvirus could undergo genetic changes (mutate) and cause human infection. There is also the remote chance that smallpox virus could somehow escape from the laboratories where it is stored. For these reasons, surveillance continues of various animal groups that continue to be infected with viruses related to the variola virus, and large quantities of vaccine are stored in different countries around the world, so that response to any future threat by the smallpox virus could be prompt.

Of greatest concern is the potential use of smallpox as a biological weapon. Since 1980, when the WHO announced smallpox had been eradicated, essentially no one has been vaccinated against the disease. Those individuals vaccinated prior to 1980 are believed to be susceptible as well because immunity only lasts 15–20 years. These circumstances coupled with the nature of smallpox to spread quickly from person to person could lead to devastating consequences.

The United States and Russia are the only two countries to officially house remaining samples of the virus. However, it is believed that other countries, such as Iraq, may have obtained samples of the smallpox virus during the Cold War through their association with Russia. It is also possible that scientists with access to the virus may have sold their services and knowledge to other governments.

On June 22 and 23, 2001, four U.S. organizations (CSIS—Center for Strategic and International Studies, Johns Hopkins Center for Civilian Biodefense Studies, ANSER—Analytic Services Inc., and MIPT—Memorial Institute for the Prevention of Terrorism) presented a fictitious scenario of the United States' response to a deliberate introduction of smallpox titled *Dark Winter*. This exercise demonstrated that if such an event were to occur, the United States would be ill prepared on several fronts. The primary concern is an inadequate supply of vaccine, which is essential to preventing disease development in exposed persons. Between 1997 and 2001, two companies were contracted to produce additional smallpox vaccines for both military and civilian use. Through these contracts, an additional 40 million doses would be made available for civilian use by 2005. In the meantime, studies are underway to determine if the existing vaccines can be diluted in order to increase the number of doses available for immediate use. Results from a very small group of volunteers tested in 2000 found that at one-tenth strength, the existing smallpox vaccines are approximately 70% effective. In late 2001, a new study began evaluating the effectiveness of the vaccine at one-fifth strength.

In the event that smallpox is reintroduced into the current population, it will be imperative that doctors immediately recognize the symptoms and isolate the individual to prevent further spread of the disease. Prompt vaccination of any persons who had contact with the patient is also necessary to prevent additional cases of smallpox from developing. Controlling and containing spread of this disease is critical for prevention of a world-wide epidemic that would have a devastating impact on current populations.

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Rosalyn Carson-DeWitt, MD

Smelling disorders

Definition

Smelling disorders are disturbances of the olfactory sense, which is known as the sense of smell. These nasal dysfunctions range from the total loss of smell (**anosmia**) to dysosmia, a distorted sense of smell.

Description

An awareness of how the olfactory system works is helpful for understanding how smelling disorders affect the sense of smell. People detect odors because sensory receptors located in the nose carry smell sensations to the brain. The receptors, which are nerve cell endings, are found in the mucous membrane in the roof of the nose. This section of the nose called the olfactory area is located just below the brain's frontal lobes.

In the olfactory area are millions of tiny olfactory cells. Each cell contains about 12 cilia, tiny hairs that extend into a mucus layer. The mucus moistens the cilia. Mucus also catches odor molecules, while receptors in the cilia stimulate the molecules and send nerve impulses to the brain.

Olfactory nerve fibers carry the impulse to two olfactory bulbs located in the brain. Information is processed in the bulbs and then sent to the cerebral cortex. Once the transmission is inside the smell center of the brain, a person experiences the sense of smell.

A person with a normal sense of smell (normosmia) is able to distinguish 10,000 odors. The sense of smell stimulates salivary glands. As a result, smelling disorders often affect the sense of taste. The olfactory sense allows people to experience pleasurable odors like the scent of roses; smell is also thought to contribute to sexual attraction.

A smelling disorder that affects the sense of smell is generally not life-threatening. However, it can be dangerous. Without a sense of smell, a person might eat spoiled food. Lack of a sense of smell could pose a health risk if a person has little appetite and fails to eat enough. Furthermore, without a sense of smell, a person might not detect a gas leak or the smell of something burning. Loss of smell and the resulting loss of taste may lead to depression.

Types of smelling disorders

Smelling disorders differ in the way that the sense of smell is affected and how long a person has the disorder. For example, anosmia, the loss of the sense of smell, is often a temporary symptom of a cold or flu. However, a **head injury** could cause permanent anosmia. In addition, a head injury could produce dysosmia, the distorted sense of smell that could cause a person to hallucinate a foul odor.

Smelling disorders are categorized as:

- Anosmia, the loss of the sense of smell. It is the most common smelling disorder. This condition can be temporary or permanent.
- Dysosmia is a distorted sense of smell. A person senses non-existent unpleasant odors. It can be caused by medical and mental conditions.
- Hyperosmia is an increased sensitivity to smell. It can be a characteristic of someone with a neurotic or histrionic personality.
- Hyposmia is the diminished sense of smell. This is usually a temporary condition that a person may experience after a case of acute influenza. Sometimes this condition is referred to as partial anosmia.
- Presbyosmia refers to the lessening or loss of the olfactory sense that occurs when a person ages.

Smelling disorder demographics

Anosmia occurs in about 10% of head trauma injuries and head trauma is a leading cause of anosmia in young adults. In older adults, the disorder is generally caused by viral infection. **Aging** may also bring a loss of the sense of smell. In rare cases, anosmia is inherited. It is a symptom of male **hypogonadism** (Kallmann's syndrome).

Olfactory **hallucinations** known as dysosmia are generally associated with psychological conditions. In some cases, people may believe they are the source of foul odors.

Causes and symptoms

Anosmia is the most common type of smelling disorder. Loss of the olfactory sense is generally caused by nasal congestion or obstruction. Temporary partial anosmia often occurs when a person has a cold, the flu, or some types of **rhinitis**, especially hay **fever** (**allergic rhinitis**). During these conditions, nasal mucus membranes become inflamed. Other causes for anosmia are:

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- Nasal polyps and other disorders that prevent air from getting to the area in the nose where the smell receptors are found. Hay fever or an allergy may cause one or more polyps to show up.
- Viral upper respiratory infection.
- Atrophic rhinitis. This condition causes mucus membrane to waste away. The person may experience some level of permanent anosmia. One symptom of this condition is that a person expels a foul-smelling discharge.
- Hypertrophic rhinitis. Mucous membrane thickens, covering the olfactory nerve endings. If not treated, hypertrophic rhinitis can lead to permanent anosmia. This discharge could overpower other odors.
- Cigarettes. Smoking aggravates the nose's membrane and intensifys nasal polyp symptoms.
- A crooked nose or a deviated septum.
- When the olfactory bulbs, tracts, or central connections are destroyed. This can occur in situations such as head trauma, infections or nasal or sinus surgery.
- Head injury. If both olfactory nerves are torn during a head injury, permanent anosmia results.
- Medications such as antihistamines and decongestants, especially prolonged use of decongestants.
- Drugs like amphetamines, estrogen, naphazoline, phenothiazines, and resperine.
- The aging process may cause the sense to lessen. In most cases, there is no other obvious cause for the disorder.
- A tumor behind the nose or in the membranes surrounding the brain.
- Lead poisoning.
- Exposure to insecticides or other chemicals.
- Radiation therapy.
- Nervous disorders.
- Idiopathic loss, which means there is no diagnosable cause for the condition.

Anosmia symptoms

Most people with anosmia can distinguish salty, sweet, bitter, and sour tastes since the tongue senses these tastes. However, people with anosmia cannot sense other tastes. Since taste is largely based on the olfactory sense, people complain of losing the sense of taste (ageusia).

Dysosmia

Infected nasal sinuses and damage to the olfactory bulbs can cause dysosmia, the distorted sense of smell. Head trauma can cause this disorder. Poor **oral hygiene** can lead to dysosmia. In these cases, a person may also find that disagreeable odors are accompanied by the sensing of unpleasant tastes. In addition, brain-stem disease can cause smelling disorders. An epileptic seizure can include olfactory hallucinations.

Mental conditions such as depression and **schizophrenia** may be accompanied by dysosmia. In addition, when people who are person severely dependent on alcohol quit drinking, they may experience dysosmia.

Diagnosis

If a smelling disorder is a symptom of a mental condition such as schizophrenia, diagnosis should be part of treatment for that condition.

When the condition is caused by a medical condition such as **allergies** or a viral infection, a person may notice that the olfactory sense is impaired during that condition. If the smelling disorder continues after the person is well, an appointment should be made with a primarily health care provider.

Diagnosis of smelling disorders begins with a health assessment to determine the cause of the olfactory impairment. The patient's primary care doctor will ask if the patient has a cold, allergies, **sinusitis**, or an upper respiratory infection.

Treatment of a head injury or follow-up medical appointment should address smelling disorders. In all cases, discussion of the symptoms covers issues such as when the smelling disorder started, if this has been an ongoing problem, and whether the disorder is becoming more intense. The assessment will include questions about whether the patient can taste food and if the disorder affects all odors or specific smells. The patient will also be asked about medications taken.

Physical examinations

The **physical examination** will include a thorough inspection of the nose, nasopharynx, and the examination of the upper respiratory tract. The examination could include sinus transillumination, placement of a light on the face to help determine if sinuses are full. **Skull x rays** may be required to determine the presence of tumors in the nose or brain.

The patient may be referred to a neurologist; an ear, nose, and throat specialist; or to a center that specializes in treatment of smelling disorders.

Other diagnostic tests could be required. These include:

- A CT scan (computed tomography scans) of the head. Also known as a CAT scan, this process provides a more detailed image than the x ray.

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- Olfactory nerve testing.
- Nasal cytology, which involves the study of mucus under a microscope.
- Testing to determine the scope of smelling disorder. A basic smell test involves the patient trying to identify each one of a group of different odors. A variation of this is a scratch-and-sniff test. The patient may be asked to differentiate among concentrations of one odor. The alcohol sniff test that involves use of a material soaked in isopropyl alcohol. Patients close their eyes and the doctor moves around. Patients tell the doctor when they smell the alcohol.
- The patient may also take a taste test.

Medical costs

The costs for diagnosis and treatment vary because of the different types of smelling disorders, the range of causes for olfactory dysfunction, and the different types of treatment.

There are also differences in what health plans require in terms of patient co-pay. A health plan could cover treatments ranging from the initial appointment with a primary care provider to the surgery to remove brain tumors.

In addition, some health plans cover costs of treatment at specialized facilities like the Center for Smell and Taste Disorders at the University of Colorado Health Sciences Center in Denver. A series of tests including a taste-and-smell test cost $250 in May of 2001.

Treatment

Treating a condition that causes a smelling disorder can sometimes restore the olfactory sense. Treatments for smelling disorders are as varied as the olfactory dysfunctions. Treatment for smelling disorders ranges from lifestyle changes to surgery. Treatment of mental conditions could affect the smelling disorder. In some cases, the disorder can't be treated, and the person must adjust to the loss of the sense of smell. Anosmia associated with aging is not treatable.

Basic treatments for anosmia

The sense of smell should return after a condition like a cold or the flu ends. **Decongestants** such as Sudafed help reduce congestion related to colds, allergies, and sinus conditions. Manufacturer's dosage recommendations should be followed. If anosmia is related to excessive use of nasal decongestants, a person should discontinue use of those medications.

Saline sprays can be used to clean the interior of the nose.

If **smoking** causes anosmia, a person should quit smoking.

The sense of smell may return after treatment of allergic or bacterial rhinitis and sinusitis. An over-the-counter antihistamine such as Actifed may provide relief.

If allergies cause anosmia, adjustments should be made to avoid allergens. If dust causes allergies, care should be taken to clean areas such as the bedroom.

Antibiotics may be prescribed for infections.

Other medications prescribed for smelling disorders include **steroids** such as Prednisone. It should only be used for a short time since longterm use could lessen resistance to infection.

Surgical treatment

Removal of **nasal polyps** and benign tumors may cause the sense of smell to return. Polyp removal is an uncomplicated surgery. Generally, only a local anesthetic is needed.

Septoplasty straightens the nasal passage. It is generally an outpatient surgery, with local or **general anesthesia** required. **Rhinoplasty** straightens the structure of the nose. This surgery could be combined with septoplasty.

Endoscopic sinus surgery opens sinus drainage channels. This outpatient surgery is an option after a person sees no improvement after trying treatments such as medications.

Surgical treatment may not be effective in conditions that result in the destruction of the olfactory nerve or its central passages. However, regeneration of those tissues may cause the sense to return.

Enhancing taste

Without a sense of smell, most people can still taste salt and flavors that are sweet, sour, and bitter. People with anosmia could distinguish other tastes by adding spices such as pepper to food. These spices stimulate facial nerves that also sense flavors.

Alternative treatment

Alternative treatments for smelling disorder center around the theory that zinc supplements help improve the sense of smell. The supplement is said to be effective when the olfactory sense is impaired by conditions such as a head injury or an upper respiratory infection. A person should take 50 mg of zinc picolinate each day after eating. This procedure might be effective in the case of head injury. However, it may be several months

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KEY TERMS

Histrionic—A behavior characterized by an excitable nature and the constant desire for stimulation.

Nasopharynx—The passage that connects the nasal cavity to the top of the throat.

Neurotic—Behavior characterized by neurosis, mental functional orders with symptoms such as anxiety, depression, compulsions, and phobias.

Polyp—A benign growth in areas such as the nasal passage.

Rhinitis—The inflammation of the mucous membrane in the nose.

Septum—A sheet of cartilage and bone that separates the nostrils.

Sinusitis—Inflammation of the paranasal sinuses because of allergic reactions or viral, bacterial, or functional infections.

before results are seen. **Acupuncture** may also produce results.

If polyps cause a smelling disorder, a change in diet could be helpful. A person should avoid dairy products, take supplements such as garlic, and follow other recommendations from a health care practitioner. A daily dosage of 5,000–10,000 mg of vitamin C could cut back on the amount of polyps. **Vitamins** should not be taken all at once. A multi-vitamin and mineral complex could also help.

Prognosis

In cases where smelling disorders are treatable, the outcome is positive because the olfactory sense is restored. In those cases where the sense of smell is lost, the person must make adjustments to adapt to life without that sense. Those adjustments include using spices like pepper to stimulate tastebuds.

Since a person with anosmia can no longer smell food to determine whether it is safe to eat, care should be taken. The person who lives with other people can ask them if food smells fresh. People who live alone should discard food if there is a chance that it has spoiled. Other home safety measures include installing smoke alarms and gas detectors. Cooking on an electric stove is preferable to a gas stove.

Furthermore, people with smelling disorders can find support groups. These are often associated with smell and taste clinics. In addition, there are on-line bulletin board where people can share experiences. One site contains descriptions of how things smell. Those words provide a connection to a missing sense in the same way that sign language allows the hearing-impaired to understand the spoken word.

Prevention

Not all causes of smelling disorders can be prevented. However, people with a disorder should not smoke and should ask those around them not to smoke. Those with smelling disorders related to allergies should be taken to avoid allergens. Since head trauma injuries can lead to smelling disorders, people should wear protective helmets when bicycling or participating in sports like football.

Resources

BOOKS

DeVere, Ronald, and Marjorie Calvert. *Navigating Smell and Taste Disorders*. New York: Demos Health, 2011.

ORGANIZATIONS

American Academy of Otolaryngology—Head and Neck Surgery, 1650 Diagonal Road, Alexandria, VA, 22314-2857, (703) 836-4444, http://www.entnet.org.

The Smell and Taste Center, University of Pennsylvania, 5 Ravdin Pavilion 3400 Spruce Street, Philadelphia, PN, 19104-4283, (215) 662-6580, (215) 349-5266, Geraldine. Fischer@uphs.upenn.edu, http://www.med.upenn.edu.

Liz Swain

Smoke inhalation

Definition

Smoke inhalation is breathing in the harmful gases, vapors, and particulate matter contained in smoke.

Demographics

Smoke inhalation is estimated to be the cause of 60–80% of all fire-related deaths in the United States each year. People who are trapped in fires may suffer from smoke inhalation independent of receiving skin **burns**; however, the incidence of smoke inhalation increases with the percentage of total body surface area burned. Children under age 11 and adults over age 70 are most vulnerable to the effects of smoke inhalation. Children younger than 11 years and adults older than 70 are estimated to make up about 40% of all people who die

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from fire-related causes each year. Two to three times more people die of smoke inhalation than die of burns each year.

Description

Smoke inhalation typically occurs in victims or firefighters caught in structural fires. However, cigarette **smoking** also causes similar damage to the lungs on a much smaller scale over a longer period of time.

Causes and symptoms

Dangerous gasses and smoke are produced by both combustion (burning of material) and pyrolysis (the breakdown of material by heat in the absence of adequate amounts of oxygen to support combustion.

The harmful materials given off by combustion and pyrolysis injure the airways and lungs in three ways: heat damage, tissue irritation, and oxygen **starvation** of tissues (asphyxiation). Signs of heat damage are singed nasal hairs, burns around and inside the nose and mouth, and internal swelling of the throat.

Tissue irritation of the throat and lungs may appear as noisy breathing, coughing, hoarseness, black or gray spittle, and fluid in the lungs. Certain materials such as PVP pipe, wool, silk, nylon, and polyurethane give off poisonous gasses when they burn. When inhaled, these gasses can cause tissue irritation and chemical burns in the throat and lungs.

Asphyxiation is apparent from **shortness of breath** and blue-gray or cherry-red skin color. Carbon monoxide (CO), a colorless, odorless gas, is produced in large quantities in incomplete combustion or pyrolysis. The CO binds with hemoglobin molecules that normally carry oxygen to the body. Because hemoglobin bonded to CO cannot carry oxygen, oxygen starvation or asphyxiation occurs.

Diagnosis

In addition to looking for the signs of heat damage, tissue irritation, and asphyxiation, the physician will assess the patient's breathing by the respiratory rate (number of breaths per minute) and motion of the chest as the lungs inflate and deflate. The patient's circulation is also evaluated by the pulse rate (number of heartbeats per minute) and blood pressure. Blood tests will indicate the levels of oxygen and byproducts of poisonous gases. Chest x rays are too insensitive to show damage to delicate respiratory tissues, but can show fluid in the lungs (**pulmonary edema**).

The physician may perform a **bronchoscopy**, a visual examination in which the airways and lungs are seen through a fiber optic tube inserted down the patient's windpipe (trachea). Other **pulmonary function tests** may be performed to measure how efficiently the lungs are working.

Treatment

Treatment varies with the severity of the damage caused by smoke inhalation. The primary focus of treatment is to maintain an open airway and provide an adequate level of oxygen. If the airway is open and stable, the patient may be given high-flow humidified 100% oxygen by mask. If swelling of the airway tissues is closing off the airway, the patient may require the insertion of an endotracheal tube to artificially maintain an open airway.

Oxygen is often the only medication necessary. However, patients who have a **cough** with **wheezing** (bronchospasm), indicating that the bronchial airways are narrowed or blocked, may be given a bronchodilator to relax the muscles and increase ventilation. There are also antidotes for specific poisonous gases in the blood; dosage is dependent upon the level indicated by blood tests. **Antibiotics** are not given unless sputum and blood cultures confirm the presence of a bacterial infection.

In institutions where it is available, hyperbaric **oxygen therapy** may be used to treat smoke inhalation resulting in severe carbon monoxide or cyanide **poisoning**. This treatment requires a special chamber in which the patient receives pure oxygen at three times the normal atmospheric pressure, thus receiving more oxygen faster to overcome loss of consciousness, altered mental state, cardiovascular dysfunction, pulmonary **edema**, and severe neurological damage.

Alternative treatment

Following immediate treatment by conventional medicine, herbal medicines may help to maintain open airways and heal damaged mucous membranes. They can also help support the entire respiratory system. **Acupuncture** and homeopathic treatment can provide support to the whole person who has suffered a traumatic injury such as smoke inhalation.

Prognosis

Although the outcome depends of the severity of the smoke inhalation and the severity of any accompanying burns or other injuries, with prompt medical treatment, the prognosis for recovery is good. However, some patients may experience chronic pulmonary

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KEY TERMS

Asphyxiation—Oxygen starvation of tissues. Chemicals such as carbon monoxide prevent the blood from carrying sufficient oxygen to the brain and other organs. As a result, the person may lose consciousness, stop breathing, and die without artificial respiration (assisted breathing) and other means of elevating the blood oxygen level.

Hyperbaric oxygen therapy—Pure oxygen is administered to the patient in a special chamber at three times the normal atmospheric pressure. The patient gets more oxygen faster to overcome severe asphyxiation.

Pulmonary—Pertaining to the lungs.

Pulmonary edema—The filling of the lungs with fluid as the body's response to injury or infection.

problems following smoke inhalation, and those with **asthma** or other chronic respiratory conditions prior to smoke inhalation may find their original conditions have been aggravated by the inhalation injury.

Prevention

Smoke inhalation is best avoided by preventing structural fires. This includes inspection of wiring, safe use and storage of flammable liquids, and maintenance of clean, well-ventilated chimneys, wood stoves, and space heaters. Properly placed and working smoke detectors in combination with rapid evacuation plans will minimize a person's exposure to smoke in the event of a fire. When escaping a burning building, a person should move close to the floor where there is more cool, clear air to breathe because hot air rises, carrying gases and particulate matter upward. Finally, firefighters should wear proper protective gear.

Resources

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ORGANIZATIONS

American Association for Respiratory Care, 9425 N. MacArthur Boulevard, Suite 100, Irving, TX, 75063-4706, (972) 243-2272, www.aarc.org.

American Lung Association, 1301 Pennsylvania Ave., NW Suite 800, Washington, DC, 20004, (212) 315-8700, (800) LUNG-USA [(800) 548-8252], http://www. lungusa.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573; TTY: (240) 629-3255, (240) 629-3246, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi.nih.gov.

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Smoking-cessation drugs

Definition

Smoking cessation drugs are medicines that help people stop smoking cigarettes or using other forms of tobacco.

Purpose

The known major health risks associated with smoking have led to efforts to dramatically reduce the number of people who do smoke and to encourage individuals, particularly young people, to not begin smoking. These efforts include restricting access to tobacco products to minors, substantially raising the costs of tobacco products, and using taxes which smokers pay on tobacco products to fund community-based tobacco reduction and cessation education and intervention programs. In addition, more and more communities and states have adopted smoke-free laws and regulations.

Although most smokers state they would like to quit smoking, people who smoke cigarettes or use other forms of tobacco often have a difficult time when they try to stop smoking. The difficulty is partly psychological; individuals get in the habit of using tobacco at certain times of day or while they are doing certain things, such as having a cup of coffee or reading the newspaper. But the habit is also hard to break for physical reasons. Tobacco contains nicotine, a drug that is as addictive as **cocaine** or heroin. Of those who have ever tried even a single cigarette, about a third become nicotine-dependent. A person who is addicted to nicotine has withdrawal symptoms, such as irritability, **anxiety**, difficulty concentrating, and craving for tobacco when he or she stops using the product.

Some people can stop smoking through willpower alone but most do better if they have support from friends, family, a physician or pharmacist, or a formal stop-smoking program. Heavy tobacco users may find that smoking cessation products also help by easing their withdrawal symptoms. Most smoking cessation products contain nicotine but the nicotine is delivered

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Symptom	Cause	Duration	Relief
Craving for cigarette	Nicotine craving	Begins in first week and can linger for months	Distract yourself with other activities (e.g., exercise, hobbies, etc.)
Coughing, dry throat, nasal drip	Body ridding itself of mucus in lungs and airways	Several weeks	Drink plenty of fluids, use cough drops
Irritability, impatience	Nicotine craving	2–4 weeks	Exercise, practice relaxation techniques, avoid caffeine
Lack of concentration	Lack of nicotine stimulation	A few weeks	Reduce workload, avoid stress
Fatigue	Lack of nicotine stimulation	2–4 weeks	Practice relaxation techniques, nap
Insomnia	Nicotine craving temporarily reduces deep sleep	2–4 weeks	Avoid caffeine after 6 p.m.
Hunger	Cigarette cravings confused with hunger pangs	Up to several weeks	Drink water or low-calorie drinks, eat low-calorie snacks
Constipation, gas	Intestinal movement decreases with lack of nicotine	1–2 weeks	Drink plenty of fluids, add fiber to diet, exercise

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in small, steady doses spread out over many hours. In contrast, when a person inhales a cigarette, nicotine enters the lungs and then travels to the brain within seconds, delivering the "rush" that smokers crave. Another difference is that smoking cessation products do not contain the tar, carbon monoxide, and other toxins that make cigarettes so harmful to people's health.

Description

U.S. brand names

The brand names of nicotine replacement products which are sold either as over-the-counter (OTC) or non-prescription products or by prescription only in the United States are as follows:

- Nicotine patches: Habitrol (prescription), Nicoderm CQ (OTC), Nicotrol (OTC), ProStep (prescription)
- Nicotine Polacrilex Gums: Nicorette (OTC) and Nicorette DS (OTC)
- Nicotine Lozenges: Commit (OTC)
- Nicotine Inhaler: Nicotrol Inhaler (prescription)
- Nicotine Nasal Spray: Nicotrol NS (prescription)

Nicotine replacement products

Smoking cessation drugs that contain nicotine are also called nicotine substitution products or nicotine replacement therapy (NRT). Five forms are approved by the Food and Drug Administration (FDA) as of 2010—gum, skin patch, nasal spray, inhaler, and lozenges. Results of numerous research studies conducted in the United States and other countries have validated that nicotine replacement therapy (NRT) is an effective and safe approach when used as a first-line pharmacological treatment for tobacco reduction and/or cessation.

The nasal spray and inhaler are available only with a prescription, but gum, lozenges and some brands of the patch can be bought over-the-counter (without a prescription). People who buy the nonprescription products should check with a physician before starting to use them.

Other medications

Another type of smoking cessation drug, bupropion (Zyban), also reduces craving and withdrawal symptoms, although it is not a nicotine replacement product. Bupropion is an antidepressant medication that is thought to help people stop smoking by mimicking some of the effects of tobacco on brain tissue. Bupropion can be used together with nicotine replacement products. Several studies indicate that the combination helps more smokers quit than either method by itself. Bupropion is the only antidepressant currently approved by the FDA for use as a smoking cessation product.

Another non-nicotine product is the drug varenicline (Chantix). Varenicline is available only by prescription and is classified as a nicotinic receptor partial agonist. This drug works by targeting nicotine receptors in the brain. The drug attaches itself to the nicotine receptors and blocks nicotine from reaching the

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KEY TERMS

Acupuncture—A Chinese medical practice that treats illness or addictions by the insertion of very thin steel needles at specified points along the body's energy channels.

Bupropion—An antidepressant medication given to smokers for nicotine withdrawal symptoms. It is sold under the trade name Zyban.

Buspirone—An antianxiety medication that is also given for withdrawal symptoms. It is sold under the trade name BuSpar.

Nicotine—A colorless, oily chemical found in tobacco that makes people physically dependent on smoking. It is poisonous in large doses.

Withdrawal symptoms—A group of physical or mental symptoms that may occur when a person suddenly stops using a drug on which he or she has become dependent.

receptors. This action blocks the pleasurable sensation smokers derive from smoking.

Alternative approaches

Other approaches that have been used to help smokers quit include hypnosis and **acupuncture**. The evidence for the usefulness of hypnosis is largely anecdotal. It appears to be most helpful when used in combination with nicotine replacement products or bupropion. Although acupuncture has been used in Western countries since the 1970s to help people quit smoking, it does not appear to be particularly effective in this regard.

Recommended dosage

The recommended dosage of nicotine replacement products depends on the method of administration. Each form of this medicine comes with detailed instructions for its use. Following directions exactly is very important. For example, nicotine gum should not be chewed like regular chewing gum. It must be chewed very slowly until it has a slight taste or causes a slight **tingling** sensation in the mouth; then "parked" between the cheek and gum until the taste and tingling goes away; then chewed and parked in the same way for about 30 minutes. Nicotine patches and other products also must be used correctly to be effective. Some patches are meant to be worn only during the day and removed at night; others are worn 24 hours a day.

Smokers who are heavily dependent on nicotine may want to ask their doctors about using a combination of nicotine replacement products. Some study results indicate that combining the transdermal patch with either the gum or the nasal spray helps more smokers quit than any of the three products by itself. Authorities believe that the higher success rate is due to the different rates of speed at which these products deliver nicotine to the body. The nasal spray delivers nicotine very rapidly, and can be used to relieve intense cravings at times of the day when the smoker is accustomed to having a cigarette, while the patch delivers a smaller dosage of nicotine to the body at a steadier rate.

Precautions

Seeing a physician regularly while using smoking cessation drugs is important. The physician will check to make sure the medicine is working as it should and will watch for unwanted side effects.

Some side effects of smoking cessation drugs include:

- nausea
- vomiting
- severe pain in the stomach or abdomen
- severe diarrhea
- severe dizziness
- fainting
- convulsions (seizures)
- low blood pressure
- fast, weak, or irregular heartbeat
- hearing or vision problems
- severe breathing problems
- severe watering of the mouth or drooling
- cold sweat
- severe headache
- confusion
- severe weakness

Keep these drugs, including thrown-away patches and gum, out of the reach of children and pets. Even a small amount of nicotine can seriously harm a child or animal.

Nicotine in any form should not be used during **pregnancy**, as it may harm the fetus or cause **miscarriage**. Women who may become pregnant should use effective birth control while taking smoking cessation drugs. Women who become pregnant while taking this medicine should stop taking it immediately and check with their physicians.

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Nicotine passes into breast milk and may cause problems for nursing babies. Women who are **breastfeeding** and want to use smoking cessation drugs may need to stop breastfeeding during treatment.

Anyone who has had unusual reactions to nicotine in the past should let his or her physician know before using a smoking cessation drug. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances. People who have had a rash or irritation from adhesive **bandages** should check with a physician before using a nicotine patch.

Smoking cessation patches, gum, and other products may make certain medical problems worse. Before using a smoking cessation drug, people with any of these medical problems should make sure their physicians are aware of their conditions:

- heart or blood vessel disease
- high blood pressure
- diabetes
- overactive thyroid
- skin rash or irritation
- stomach ulcer
- pheochromocytoma (pcc) (a tumor of the adrenal medulla)
- dental problems or mouth sores
- sore throat
- jaw pain or temporomandibular joint disorder (TMJ)

There are also precautions to take with bupropion and buspirone. Bupropion should not be taken by patients with a history of seizures, high blood pressure, anorexia, or **bulimia nervosa**. People taking buspirone should be careful about driving or operating heavy machinery until they can tell whether the drug makes them drowsy as a side effect. Although buspirone does not interact with alcohol as intensely as most tranquilizers do, patients should still use alcohol cautiously if they are taking buspirone.

In 2009, the FDA directed the makers of the drugs varenicline (Chantix) and bupropion (Zyban) to include new warnings on the drug labels of their products related to the potential for the development of serious mental health side effects in individuals taking these drugs. Individuals with known psychiatric or mental health problems are at particularly high risk for the development of these mental health side effects, which include depression, agitation, and increased risk of **suicide**. Individuals without pre-existing mental health problems may also experience these serious side-effects

Side effects

Each type of smoking cessation product may cause minor side effects that usually go away as the body adjusts to the drug. These side effects usually do not need medical attention unless they continue or they interfere with normal activities. For example, nicotine gum may cause belching, jaw aches, or sore mouth or throat. Nicotine patches may cause redness, **itching**, or burning where the patch is applied. The nasal spray may irritate the nose and sinuses, while the inhaler may cause throat irritation or coughing.

If nicotine gum injures the mouth, teeth, or dental work, check with a dentist or physician as soon as possible. Other side effects are possible. Anyone who has unusual symptoms while using smoking cessation drugs should get in touch with his or her physician.

The side effects of bupropion include **dry mouth** and difficulty sleeping. The possible side effects of buspirone include headaches and drowsiness.

Bupropion and varenicline are associated with serious mental health side-effects including depression, agitation, thoughts of suicide, hostility, and attempted suicide. These side effects tend to occur shortly after the patient begins to take the medication and typically stop once the patient stops taking the drug. Patients experiencing these symptoms hould be closely monitored by a physician until the side-effects stop.

Interactions

People taking certain drugs may need to change their doses when they stop smoking. Anyone who uses a smoking cessation drug should let the physician know all other medicines he or she is taking and should ask whether the doses need to be changed. Examples of drugs that may be affected when a person stops smoking are:

- insulin
- airway opening drugs (bronchodilators) such as aminophylline (Somophyllin), oxtriphylline (Choledyl) and theophylline (Somophyllin-T)
- opioid (narcotic) pain relievers such as propoxyphene (Darvon)
- the beta blocker propranolol (Inderal)

Other drugs may also interact with smoking cessation drugs. Be sure to check with a physician or pharmacist before combining smoking cessation drugs with any other prescription or nonprescription (over-the-counter) medicine.

Bupropion should not be used by patients who are also taking monoamine oxidase inhibitor (MAOI) medications. These include such drugs as furazolidone,

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isocarboxazid, and phenelzine. Bupropion may also interact with phenytoin, carbamazepine, and levodopa. Buspirone also interacts with MAOIs, as well as with trazadone and haloperidol.

Resources

PERIODICALS

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ORGANIZATIONS

American Association for Respiratory Care (AARC), 9425 N. MacArthur Blvd., Suite 100, Irving, TX, 75063-4706, (972) 243-2272, http://www.aarc.org.

American Cancer Society (ACS), (800) ACS-2345, (404) 329-7530, http://www.cancer.org.

American Lung Association (ALA), 1301 Pennsylvania Ave. NW, Suite 800, Washington, DC, 20004, (202) 785-3355, (201) 452-1805, http://www.lungusa.org.

Office on Smoking and Health. Centers for Disease Control and Prevention (CDC-OSH), 4770 Buford Hwy, NE. MS K-50, Atlanta, GA, 30341-3717, (800) CDC-INFO (232-4636), http://www.cdc.gov/tobacco.

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Smoking

Definition

Smoking is the inhalation of the smoke of burning tobacco encased in cigarettes, pipes, and cigars. Casual smoking is the act of smoking only occasionally, usually in a social situation or to relieve **stress**. A smoking habit is a physical **addiction** to tobacco products. Many health experts now regard habitual smoking as a psychological addiction, too, and one with serious health consequences.

Description

The U.S. Food and Drug Administration has asserted that cigarettes and smokeless tobacco should be considered nicotine delivery devices. Nicotine, the active ingredient in tobacco, is inhaled into the lungs, where most of it stays. The rest passes into the bloodstream, reaching the brain in about 10 seconds and dispersing throughout the body in about 20 seconds.

Depending on the circumstances and the amount consumed, nicotine can act as either a stimulant or tranquilizer. This can explain why some people report that smoking gives them energy and stimulates their mental activity, while others note that smoking relieves **anxiety** and relaxes them. The initial "kick" results in

The wheals on the arm of this patient was caused by an allergic reaction to nicotine patches used to help subdue the urge to smoke. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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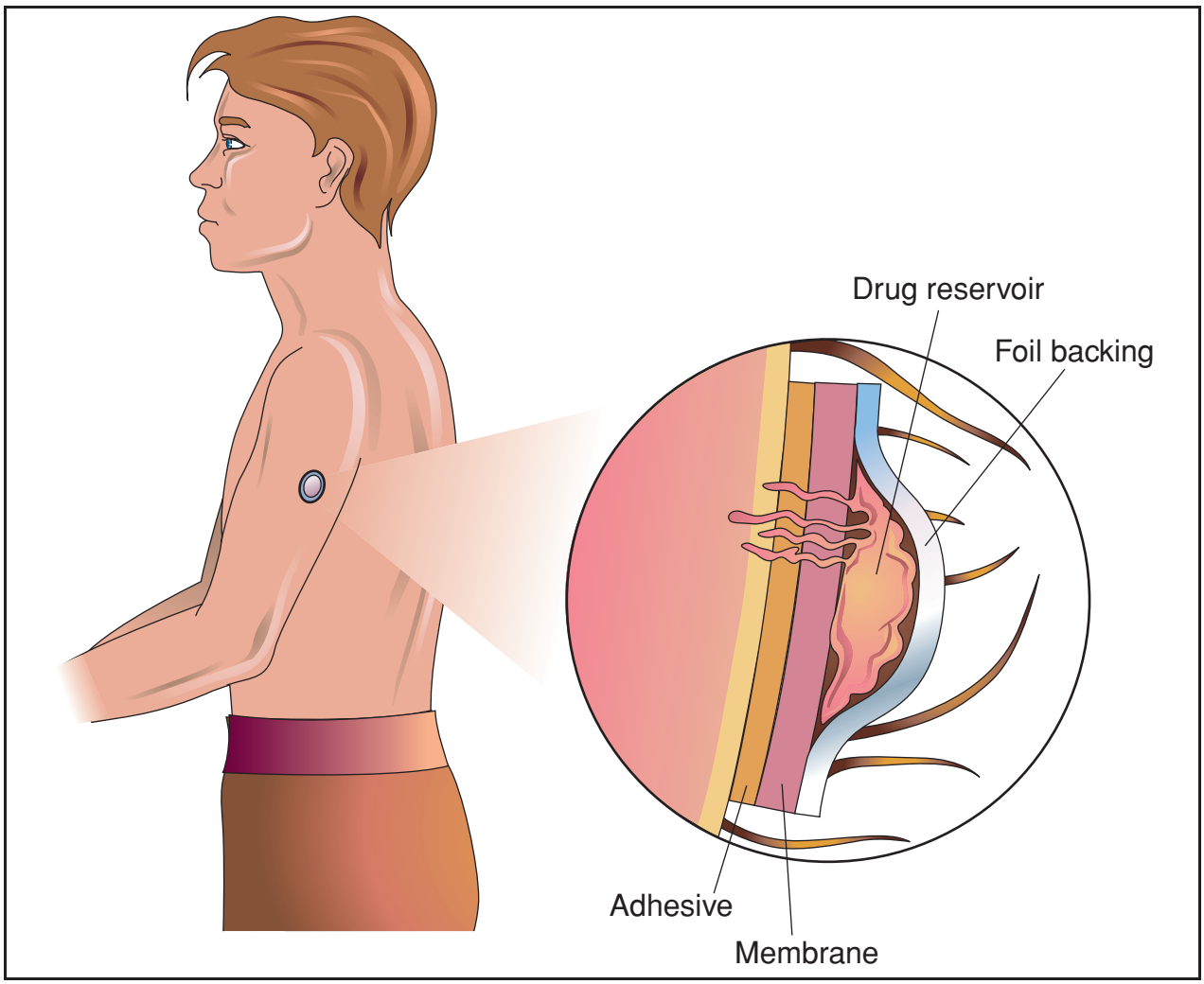

The nicotine patch is a type of transepidermal patch designed to deliver nicotine, the addictive substance contained in cigarettes, directly through the skin and into the blood stream. The patch contains a drug reservoir sandwiched between a nonpermeable back layer and a permeable adhesive layer that attaches to the skin. The drug leeches slowly out of the reservoir, releasing small amounts of the drug at a constant rate for up to 24 hours. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

part from the drug's stimulation of the adrenal glands and resulting release of epinephrine into the blood. Epinephrine causes several physiological changes—it temporarily narrows the arteries, raises the blood pressure, raises the levels of fat in the blood, and increases the heart rate and flow of blood from the heart. Some researchers think epinephrine contributes to smokers' increased risk of high blood pressure.

Nicotine, by itself, increases the risk of heart disease. However, when a person smokes, he or she is ingesting a lot more than nicotine. Smoke from a cigarette, pipe, or cigar is made up of many additional toxic chemicals, including tar and carbon monoxide. Tar is a sticky substance that forms into deposits in the lungs, causing lung **cancer** and respiratory distress. Carbon monoxide limits the amount of oxygen that the red blood cells can convey throughout your body. Also, it may damage the inner walls of the arteries, which allows fat to build up in them.

Besides tar, nicotine, and carbon monoxide, tobacco smoke contains 4,000 different chemicals. More than 200 of these chemicals are known be toxic. Nonsmokers who are exposed to tobacco smoke also take in these toxic chemicals. They inhale the smoke exhaled by the smoker as well as the more toxic *sidestream smoke*—the smoke from the end of the burning cigarette, cigar, or pipe.

Here's why sidestream smoke is more toxic than exhaled smoke: When a person smokes, the smoke he

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or she inhales and then breathes out leaves harmful deposits inside the body. But because lungs partially cleanse the smoke, exhaled smoke contains fewer poisonous chemicals. This is why exposure to tobacco smoke is dangerous even for a nonsmoker.

Causes and symptoms

No one starts smoking to become addicted to nicotine. It is not known how much nicotine may be consumed before the body becomes addicted. However, once smoking becomes a habit, the smoker faces a lifetime of health risks associated with one of the strongest addictions known to man.

About 70% of smokers in the United States would like to quit; in any given year, however, only about 3.6% of the country's 47 million smokers quit successfully. In 2008, the Centers for Disease Control and Prevention (CDC) reported that the prevalence of smoking in the United States fell in 2007 to 19.8%, almost a full percentage point decline from 20.8% in 2006.

Researchers conjecture that genetic factors contribute substantially to developing a smoking habit. Several twin studies have led to estimates of 46–84% heritability for smoking. It is thought that some genetic variations affect the speed of nicotine metabolism in the body and the activity level of nicotinic receptors in the brain.

Smoking risks

Smoking is recognized as the leading preventable cause of **death**, causing or contributing to the deaths of approximately 440,000 Americans each year. Anyone with a smoking habit has an increased chance of lung, cervical, and other types of cancer; respiratory diseases such as **emphysema**, **asthma**, and chronic **bronchitis**; and cardiovascular disease, such as **heart attack**, high blood pressure, **stroke**, and **atherosclerosis** (narrowing and hardening of the arteries). The risk of stroke is especially high in women who take birth control pills.

Smoking can damage fertility, making it harder to conceive, and it can interfere with the growth of the fetus during **pregnancy**. It accounts for an estimated 14% of premature births and 10% of infant deaths. There is some evidence that smoking may cause **impotence** in some men.

Because smoking affects so many of the body's systems, smokers often have vitamin deficiencies and suffer oxidative damage caused by free radicals. Free radicals are molecules that steal electrons from other molecules, turning the other molecules into free radicals and destabilizing the molecules in the body's cells.

Smoking is recognized as one of several factors that might be related to a higher risk of hip **fractures** in older adults.

Studies reveal that the more a person smokes, the more likely he is to sustain illnesses such as cancer, chronic bronchitis, and emphysema. But even smokers who indulge in the habit only occasionally are more prone to these diseases.

Some brands of cigarettes are advertised as "low tar" but no cigarette is truly safe. If a smoker switches to a low-tar cigarette, he or she is likely to inhale longer and more deeply to get the chemicals his body craves. A smoker has to quit the habit entirely in order to improve his health and decrease the chance of disease.

Though some people believe chewing tobacco is safer, it also carries health risks. People who chew tobacco have an increased risk of heart disease and mouth and throat cancer. Pipe and cigar smokers have increased health risks as well, even though these smokers generally do not inhale as deeply as cigarette smokers do. These groups haven't been studied as extensively as cigarette smokers but there is evidence that they may be at a slightly lower risk of cardiovascular problems but a higher risk of cancer and various types of circulatory conditions.

Recent research reveals that passive smokers, or those who unavoidably breathe in second-hand tobacco smoke, have an increased chance of many health problems such as lung cancer and asthma, and in children, **sudden infant death syndrome**.

Smokers' symptoms

Smokers are likely to exhibit a variety of symptoms that reveal the damage caused by smoking. A nagging morning **cough** may be one sign of a tobacco habit. Other symptoms include **shortness of breath**, **wheezing**, and frequent occurrences of respiratory illness, such as bronchitis. Smoking also increases **fatigue** and decreases the smoker's sense of smell and taste. Smokers are more likely to develop poor circulation, with cold hands and feet and premature wrinkles.

Sometimes the illnesses that result from smoking come on silently with little warning. For instance, **coronary artery disease** may exhibit few or no symptoms. At other times, there will be warning signs, such as bloody discharge from a woman's vagina, a sign of cancer of the cervix. Another warning sign is a hacking cough, worse than the usual smoker's cough, that brings up phlegm or blood—a sign of lung cancer.

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Withdrawal symptoms

A smoker who tries to quit may expect one or more of these withdrawal symptoms: **nausea**, **constipation** or **diarrhea**, drowsiness, loss of concentration, **insomnia**, **headache**, nausea, and irritability.

Diagnosis

It is not easy to quit smoking, which is why it may be wise for a smoker to turn to his physician for help. For the greatest success in quitting and to help with the withdrawal symptoms, the smoker should talk over a treatment plan with his doctor or alternative practitioner. He should have a general **physical examination** to gauge his general health and uncover any deficiencies. He should also have a thorough evaluation for some of the serious diseases that smoking can cause.

Treatment

Research shows that most smokers who want to quit benefit from the support of other people. It helps to quit with a friend or to join a group such as those organized by the American Cancer Society. These groups provide support and teach behavior modification methods that can help the smoker quit. The smoker's physician can often refer him to such groups.

Other alternatives to help with the withdrawal symptoms of kicking the habit include nicotine replacement therapy in the form of gum, patches, nasal sprays, and oral inhalers. These are available by prescription or over the counter. A physician can provide advice on how to use them. They slowly release a small amount of nicotine into the bloodstream, satisfying the smoker's physical craving. Over time, the amount of gum the smoker chews is decreased and the amount of time between applying the patches is increased. This helps wean the smoker from nicotine slowly, eventually beating his addiction to the drug. But there's one important caution: If the smoker lights up while taking a nicotine replacement, a nicotine overdose may cause serious health problems.

The prescription drug Zyban (bupropion hydrochloride) has shown some success in helping smokers quit. This drug contains no nicotine and was originally developed as an antidepressant. It isn't known exactly how bupropion works to suppress the desire for nicotine. A five-year study of bupropion reported that the drug has a very good record for safety and effectiveness in treating tobacco dependence. Its most common side effect is insomnia, which can also result from nicotine withdrawal.

Researchers are investigating two new types of drugs as possible treatments for tobacco dependence. The first is an alkaloid known as 18-methoxycoronaridine (18-MC), which selectively blocks the nicotinic receptors in brain tissue. Another approach involves developing drugs that inhibit the activity of cytochrome P450 2A6 (CYP2A6), which controls the metabolism of nicotine.

Expected results

Research on smoking shows that most smokers desire to quit. But smoking is so addictive that fewer than 20% of the people who try ever successfully kick the habit. Still, many people attempt to quit smoking over and over again, despite the difficulties—the cravings and withdrawal symptoms, such as irritability and restlessness.

For those who do quit, the benefits to health are well worth the effort. The good news is that once a smoker quits the health effects are immediate and dramatic. After the first day, oxygen and carbon monoxide levels in the blood return to normal. At two days, nerve endings begin to grow back and the senses of taste and smell revive. Within two weeks to three months, circulation and breathing improve. After one year of not smoking, the risk of heart disease is reduced by 50%. After 15 years of abstinence, the risks of health problems from smoking virtually vanish. A smoker who quits for good often feels a lot better too, with less fatigue and fewer respiratory illnesses.

Alternative treatment

There are a wide range of alternative treatments that can help a smoker quit the habit, including **hypnotherapy**, herbs, **acupuncture**, and **meditation**. For example, a controlled trial demonstrated that self-massage can help smokers crave less intensely, smoke fewer cigarettes, and in some cases completely give them up.

Hypnotherapy

Hypnotherapy helps the smoker achieve a trance-like state, during which the deepest levels of the mind are accessed. A session with a hypnotherapist may begin with a discussion of whether the smoker really wants to and truly has the motivation to stop smoking. The therapist will explain how hypnosis can reduce the stress-related symptoms that sometimes come with kicking the habit.

Often the therapist will discuss the dangers of smoking with the patient and begin to "reframe" the patient's thinking about smoking. Many smokers are convinced they can't quit and the therapist can help

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KEY TERMS

Antioxidant—Any substance that reduces the damage caused by oxidation, such as the harm caused by free radicals.

Chronic bronchitis—A smoking-related respiratory illness in which the membranes that line the bronchi, or the lung's air passages, narrow over time. Symptoms include a morning cough that brings up phlegm, breathlessness, and wheezing.

Cytochrome—A substance that contains iron and acts as a hydrogen carrier for the eventual release of energy in aerobic respiration.

Emphysema—An incurable, smoking-related disease, in which the air sacs at the end of the lung's bronchi become weak and inefficient. People with emphysema often first notice shortness of breath, repeated wheezing and coughing that brings up phlegm.

Epinephrine—A nervous system hormone stimulated by the nicotine in tobacco. It increases heart rate and may raise smokers' blood pressure.

Flavonoid—A food chemical that helps to limit oxidative damage to the body's cells, and protects against heart disease and cancer.

Free radical—An unstable molecule that causes oxidative damage by stealing electrons from surrounding molecules, thereby disrupting activity in the body's cells.

Nicotine—The addictive ingredient of tobacco, it acts on the nervous system and is both stimulating and calming.

Nicotine replacement therapy—A method of weaning a smoker away from both nicotine and the oral fixation that accompanies a smoking habit by giving the smoker smaller and smaller doses of nicotine in the form of a patch or gum.

Sidestream smoke—The smoke that is emitted from the burning end of a cigarette or cigar, or that comes from the end of a pipe. Along with exhaled smoke, it is a constituent of second-hand smoke.

persuade them that they can change this behavior. These suggestions are then repeated while the smoker is under hypnosis. The therapist may also suggest while the smoker is under hypnosis that his feelings of worry, anxiety, and irritability will decrease.

In a review of 17 studies of the effectiveness of hypnotherapy, the percentage of people treated by hypnosis who still were not smoking after six months ranged from 4–8%. In programs that included several hours of treatment, intense interpersonal interaction, individualized suggestions, and follow-up treatment, success rates were above 50%.

Aromatherapy

One study demonstrated that inhaling the vapor from black pepper extract can reduce symptoms associated with smoking withdrawal. Other essential oils can be used for relieving the anxiety a smoker often experiences while quitting.

Herbs

A variety of herbs can help smokers reduce their cravings for nicotine, calm their irritability, and even reverse the oxidative cellular damage done by smoking. Lobelia, sometimes called Indian tobacco, has historically been used as a substitute for tobacco. It contains a substance called lobeline, which decreases the craving for nicotine by bolstering the nervous system and calming the smoker. In high doses, lobelia can cause **vomiting** but the average dose—about 10 drops per day—should pose no problems.

Herbs that can help relax a smoker during withdrawal include wild oats and kava kava.

To reduce the oral fixation supplied by a nicotine habit, a smoker can chew on licorice root—the plant, not the candy. Licorice is good for the liver, which is a major player in the body's **detoxification** process. Licorice also acts as a tonic for the adrenal system, which helps reduce stress. And there's an added benefit: If a smoker tries to light up after chewing on licorice root, the cigarette tastes like burned cardboard.

Other botanicals that can help repair free-radical damage to the lungs and cardiovascular system are those high in flavonoids, such as hawthorn, gingko biloba, and bilberry, as well as **antioxidants** such as vitamin A, vitamin C, zinc, and selenium.

Acupuncture

This ancient Chinese method of healing is used commonly to help beat addictions, including smoking. The acupuncturist will use hair-thin needles to stimulate the body's *qi*, or healthy energy. Acupuncture is a sophisticated treatment system based on revitalizing qi, which supposedly flows through the body in defined pathways

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called meridians. During an addiction like smoking, qi isn't flowing smoothly or gets stuck, the theory goes.

Points in the ear and feet are stimulated to help the smoker overcome his addiction. Often the acupuncturist will recommend keeping the needles in for five to seven days to calm the smoker and keep him balanced.

Vitamins

Smoking seriously depletes vitamin C in the body and leaves it more susceptible to infections. Vitamin C can prevent or reduce free-radical damage by acting as an antioxidant in the lungs. Smokers need additional C, in higher dosage than nonsmokers. Fish in the diet supplies **Omega-3 fatty acids**, which are associated with a reduced risk of **chronic obstructive pulmonary disease** (emphysema or chronic bronchitis) in smokers. Omega-3 fats also provide cardiovascular benefits as well as an anti-depressive effect. Vitamin therapy doesn't reduce craving but it can help beat some of the damage created by smoking. Vitamin B_{12} and **folic acid** may help protect against smoking-induced cancer.

Prevention

How do you give up your cigarettes for good and never go back to them again?

Here are a few tips from the experts:

- Have a plan and set a definite quit date.
- Get rid of all the cigarettes and ashtrays at home or in your desk at work.
- Don't allow others to smoke in your house.
- Tell your friends and neighbors that you're quitting. Doing so helps make quitting a matter of pride.
- Chew sugarless gum or eat sugar-free hard candy to redirect the oral fixation that comes with smoking. This will prevent weight gain, too.
- Eat as much as you want but only low-calorie foods and drinks. Drink plenty of water. This may help with the feelings of tension and restlessness that quitting can bring. After eight weeks, you'll lose your craving for tobacco so it's safe then to return to your usual eating habits.
- Stay away from social situations that prompt you to smoke. Dine in the nonsmoking section of restaurants.
- Spend the money you save not smoking on an occasional treat for yourself.

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American Association of Oriental Medicine. 5530 Wisconsin Avenue, Suite 1210, Chevy Chase MD, 20815, (301) 941-1064, (888) 500-7999, http://www.aaom.org.

American Cancer Society. Contact the local organization or call (800) 227-2345, http://www.cancer.org.

American Lung Association. 1740 Broadway, New York NY, 10019, (800) 586-4872, (212) 315-8700, http://www.lungusa.org.

Herb Research Foundation. 1007 Pearl St., Suite 200, Boulder CO, 80302, (303) 449-2265, http://www.herbs.org.

National Heart, Lung, and Blood Institute (NHLBI). Building 31, Room 5A52, 31 Center Drive, MSC 2486,

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Bethesda MD, 20892, (301) 592-8573, http://www.nhlbi.nih.gov.
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Barbara Boughton

Snoring

Definition

Snoring is a sound generated during sleep by vibration of loose tissue in the upper airway.

Description

Snoring is one symptom of a group of disorders known as sleep disordered breathing. It occurs when the soft palate, uvula, tongue, tonsils, and/or muscles in the back of the throat rub against each other and generate a vibrating sound during sleep. 20% of all adults are chronic snorers and 45% of normal adults snore occasionally. As people grow older, their chance of snoring increases. Approximately half of all individuals over 60 snore regularly.

In some cases, snoring is a symptom of a more serious disorder called obstructed **sleep apnea** (OSA). OSA occurs when part of the airway is closed off (usually at the back of the throat) while a person is trying to inhale during sleep, and breathing stops for more than 10 seconds before resuming again. These breathless episodes can occur as many as several hundred times a night.

People with OSA almost always snore heavily because the same narrowing of the airway that causes snoring can also cause OSA. Snoring may actually attribute to OSA as well, because the vibration of the throat tissues which occurs in snoring can cause the tissue to swell.

Snoring is associated with physical problems as well as social **stress**. People who do not suffer from OSA may be diagnosed with socially unacceptable snoring (SUS), which refers to snoring that is loud enough to prevent the sleeper's bed partner or roommate from sleeping. SUS is a factor in the breakup of some marriages and other long-term relationships. Moreover, a study published in 2002 indicates that people who snore are at increased risk of developing type 2 diabetes. Snoring appears to be a risk factor that is independent of body weight or a family history of diabetes.

Causes and symptoms

There are several major causes of snoring, including:

- Excessively relaxed throat muscles. Alcohol, drugs, and sedatives can cause the throat muscles to become lax, and/or the tongue to pull back into the airway.
- Large uvula. The piece of tissue that hangs from the back of the throat is called the uvula. Individuals with a large or longer than average uvula can suffer from snoring when the uvula vibrates in the airway.
- Large tonsils and/or adenoids. The tonsils (tissue at the back of either side of the throat) can also vibrate if they are larger than normal, as can the adenoids.
- Excessive weight. Overweight people are more likely to snore. This is frequently caused by the extra throat and neck tissue they are carrying around.
- Nasal congestion. Colds and allergies can plug the nose, creating a vacuum in the throat that results in snoring as airflow increases.
- Cysts and tumors. Cysts and/or tumors of the throat can trigger snoring.
- Structural problems of the nose. A deviated septum or other nasal problems can also cause snoring.

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Diagnosis

A patient interview, and possibly an interview with the patient's spouse or anyone else in the household who has witnessed the snoring, is usually enough for a diagnosis of snoring. A medical history that includes questions about alcohol or tranquilizer use; past ear, nose, and throat problems; and the pattern and degree of snoring will be completed, and a physical exam will be performed to determine the cause of the problem. This will typically include examination of the throat to look for narrowing, obstruction, or malformations. If the snoring is suspected to be a symptom of a more serious disorder such as obstructive sleep apnea, the patient will require further testing. This testing is called a **polysomnography** study, and is conducted during an overnight stay in a specialized sleep laboratory. The polysomnography study include measurements of heart rate, airflow at the mouth and nose, respiratory effort, sleep stage (light sleep, deep sleep, dream sleep, etc.), and oxygen level in the blood.

In some cases the patient may be referred to a dentist or orthodontist for evaluation of the jaw structure and dentition.

In addition, the patient may be examined by sleep **endoscopy**. In this procedure, the patient is given a medication (midazolam) to induce sleep. His or her throat and nasal passages are then examined with a flexible laryngoscope. In many cases, sleep endoscopy reveals obstructions that are not apparent during a standard **physical examination** of the throat. Many patients are found to have obstructions at more than one level in their breathing passages.

Treatment

Several surgical procedures are available for treating chronic snoring. These include:

- Uvulopalathopharyngoplasty (UPPP), a surgical procedure which involves removing excess throat tissues (e.g., tonsils, parts of the soft palate) to expand the airway.
- Laser-assisted uvulopalatoplasty (LAUP) uses a surgical laser to remove part of the uvula and palate.
- Palatal stiffening is a minimally-invasive surgical technique where a laser or a cauterizer is used to produce scar tissue in the soft palate in order to stop the vibrations that produce snoring.
- Radiofrequency ablation is another technique which uses scarring to shrink the uvula and/or soft palate. A needle electrode is used to shrink and scar the mouth and throat tissues.

Alternative treatment

There are a number of remedies for snoring, but few are proven clinically effective. Popular treatments include:

- Mechanical devices. Many splints, braces, and other devices are available which reposition the nose, jaw, and/or mouth in order to clear the airways. Other devices are designed to wake an individual when snoring occurs. Patients should consult a dentist or orthodontist about these devices, as most require custom fitting. In addition, persons with certain types of gum disease or dental problems should not be fitted with oral appliances to stop snoring.
- Nasal strips. Nasal strips that attach like an adhesive bandage to the bridge of the nose are available at most drugstores and can help stop snoring in some individuals by opening the nasal passages.
- Continuous positive airway pressure (CPAP). Some chronic snorers find relief by sleeping with a nasal mask which provides air pressure to the throat.
- Decongestants. Snoring caused by nasal congestion may be successfully treated with decongestants. Some effective herbal remedies that clear the nasal passages include golden rod (*Solidago virgauria*) and golden seal (*Hydrastis canadensis*). Steam inhalation of essential oils of eucalyptus blue gum (*Eucalyptus globulus*) or peppermint (*Mentha x piperata*) can also relieve congestion.
- Weight loss. Snoring thought to be caused by excessive weight may be curtailed by a sensible weight loss and exercise program.
- Sleep position. Snoring usually worsens when an individual sleeps on his or her back, so sleeping on one's side may alleviate the problem. Those who have difficulty staying in a side sleeping position may find sleeping with pillows behind them helps them maintain the position longer. Other devices include a new vest designed to prevent the sleeper from lying on his or her back.
- Bed adjustments. For some people, raising the head of the bed solves their snoring problem. A slight incline can prevent the tongue from retracting into the back of the throat. Bricks, wooden blocks, or specially designed wedges can be used to elevate the head of the bed approximately 4–l6 in (10–41 cm).

Alternative treatments that have been reported to be effective for patients whose snoring is caused by colds or **allergies** include **acupuncture**, homeopathy, and **aromatherapy** treatments. Aromatherapy treatments for snoring typically make use of marjoram

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KEY TERMS

Ablation—The removal of abnormal tissue growths by surgery.

Cauterize—To seal tissue or blood vessels using a heat or electrical source.

Continuous positive airway pressure (CPAP)—A ventilation device that blows a gentle stream of air into the nose during sleep to keep the airway open.

Deviated septum—A hole or perforation in the septum, the wall that divides the two nasal cavities.

Endoscope—A slender optical instrument that allows a doctor to examine the inside of the throat or other hollow organ. Sleep endoscopy is a technique that allows the doctor to detect previously unsuspected obstructions in the patient's nose and throat.

Obstructive sleep apnea (OSA)—A potentially life-threatening condition characterized by episodes of breathing cessation during sleep alternating with snoring or disordered breathing. The low levels of oxygen in the blood of patients with OSA may eventually cause heart problems or stroke.

Polysomnography—A technique for diagnosing sleep disorders with the use of a machine that records the pulse, breathing rate and other variables while the patient sleeps.

Soft palate—The structure at the roof of the mouth that separates the mouth and the pharynx.

oil, which is thought to be particularly effective in clearing the nasal passages.

Prevention

Adults with a history of snoring may be able to prevent snoring episodes with the following measures:

- avoid alcohol and sedatives before bedtime
- remove allergens from the bedroom
- use a decongestant before bed
- sleep on the side, not the back

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American Academy of Otolaryngology—Head and Neck Surgery, 1650 Diagonal Road, Alexandria, VA, 22314-2857, (703) 836-4444, http://www.entnet.org.

American Academy of Sleep Medicine (AASM), 2510 N. Frontage Road, Darien, IL, 60561, (630) 737-9700, (630) 737-9790, inquiries@aasmnet.org, http://wwww.aasmnet.org.

American Dental Association, 211 E. Chicago Ave., Chicago, IL, 60611-2678, (312) 440-2500, http://www.ada.org.

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American Sleep Apnea Association, 6856 Eastern Avenue, NW, Suite 203, Washington, DC, 20012, (202) 293-3650, (202) 293-3656, http://www.sleepapnea.org/.
National Sleep Foundation, 1522 K St. NW, Suite 500, Washington, DC, 20005, (202) 347-3471, (202) 347-2472, http://www.sleepfoundation.org.

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Sodium

Definition

Sodium is a mineral that exists in the body as the ion Na+. Sodium is acquired through diet, mainly in the form of salt (sodium chloride, NaCl). Regulating the amount of Na+ in the body is absolutely critical to life and health.

Purpose

Sodium is possibly the most important mineral in the body. It plays a major role in controlling the distribution of fluids, maintaining blood pressure and blood volume, creating an electrical gradient that allows nerve transmission and muscle contraction to occur, maintaining the mechanisms that allow wastes to leave cells, and regulating the acidity (pH) of the blood. Many different organs working together, including the kidneys, endocrine glands, and brain, tightly control the level of Na+ in the body. Researchers estimate that between 20% and 40% of an adult's resting energy use goes toward regulating sodium. Sodium affects every cell in the body and a major failure of sodium regulatory mechanisms means **death**.

Sodium

Age	Adequate Intake (mg)
Children 0–6 mos.	120
Children 7–12 mos.	370
Children 1–3 yrs.	1,000
Children 4–8 yrs.	1,200
Children 9–13 yrs.	1,500
Adolescents 14–18 yrs.	1,500
Adults 19–50 yrs.	1,500
Adults 51–70 yrs.	1,300
Adults 71≥ yrs.	1,200
Pregnant women	1,500
Breastfeeding women	1,500

Food	Sodium (mg)
Table salt, 1 tsp.	2,300
Dill pickle, 1 large	1,731
Chicken noodle soup, canned, 1 cup	850–1,100
Ham, 3 oz.	1,000
Sauerkraut, ½ cup	780
Pretzels, 1 oz.	500
Turkey breast, deli, 1 oz.	335
Soy sauce, 1 tsp.	304
Potato chips, 1 oz.	165–185

mg = milligram

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Description

In the body, sodium exists as electrolyte. Electrolytes are ions that form when salts dissolve in water or fluids. These ions have an electric charge. Positively charged ions are called cations. Negatively charged ions are called anions. Electrolytes are not evenly distributed within the body and their uneven distribution allows many important metabolic reactions to occur. Sodium (Na+), potassium (K+), **calcium** (Ca 2+), magnesium (Mg 2+), chloride (Cl-), phosphate (HPO_4 2-), bicarbonate (HCO_3-), and sulfate (SO_4 2-) are important electrolytes in humans.

Na+ is ten times more concentrated in fluid outside cells (i.e. extracellular fluid and blood) than it is in fluid inside cells. This difference in concentration is maintained through the expenditure of cellular energy, and it is critical to many metabolic functions, including maintaining the proportion of water that exists inside and outside of cells. (See the entry on electrolytes for a more detailed explanation of how this occurs.) When Na+ is too high or too low, it is almost never because an individual has eaten too much or too little salt. Instead, it is because organs such as the kidneys or endocrine glands that regulate the conservation or removal of sodium from the body have broken down.

Sodium requirements

Researchers estimate that humans can remain healthy taking in only 500 mg of sodium daily. Salt is 40% sodium by weight and 500 mg is slightly less than the amount of sodium found in 1/4 teaspoon of salt. Humans almost never take in too little salt; their health problems result from too much salt in the diet.

The United States Institute of Medicine (IOM) of the National Academy of Sciences has developed values called Dietary Reference Intakes (DRIs) for many **vitamins** and **minerals**, including sodium. The DRIs consist of three sets of numbers. The Recommended Dietary Allowance (RDA) defines the average daily amount of the nutrient needed to meet the health needs of 97–98%

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of the population. The Adequate Intake (AI) is an estimate set when there is not enough information to determine an RDA. The Tolerable Upper Intake Level (UL) is the average maximum amount that can be taken daily without risking negative side effects. The DRIs are calculated for children, adult men, adult women, pregnant women, and **breastfeeding** women.

The IOM has not set RDAs for sodium, but instead it has set AI levels for all age groups based on observed and experimental information about the amount of sodium needed to replace what is lost by a moderately active individual each day. Sodium is lost in both urine and sweat. IAs for sodium are measured in milligrams (mg). UL levels have not been set. However, the IOM recommends that adults limit their sodium intake to less than 2,400 mg per day, and the American Heart Association recommends an adult daily intake of 1,500–2,300 mg.

The following list gives the recommended daily AL levels of sodium for each age group.

- children birth–6 months: AI 120 mg
- children 7–12 months: AI 370 mg
- children 1–3 years: AI 1,000 mg
- children 4–8 years: AI 1,200 mg
- children 9–13 years: AI 1,500 mg
- adolescents 14–18 years: IA 1,500 mg
- adults age 19–50: AI 1,500 mg
- adults ages50–70 1,300 mg
- adults 71 years or older: AI 1,200 mg
- pregnant women: IA 1,500 mg
- breastfeeding women: AI 1,500 mg

Sources of sodium

Many people think that the main source of salt in their diet is what they add to food when they are cooking or at the table while eating. In reality, more than three-quarters of the sodium in the average American's diet is added to food during processing. Another 12% is already naturally in the food. For example, 1 cup of low-fat milk contains 110 mg of sodium. About 6% of sodium in the diet is added as salt during cooking and another 5% from salting food while eating.

Although most sodium in diet comes from salt, other sources of sodium include preservatives and flavor enhancers added during processing. Sodium content is required to be listed on food labels of processed foods. Some common "hidden" sources of sodium include:

- baking soda
- baking powder
- disodium phosphate
- monosodium glutamate (MSG)
- sodium nitrate or sodium nitrite

Below are some common foods and their sodium content.

- table salt, 1 teaspoon:2,300 mg
- dill pickle, large: 1731 mg
- canned chicken noodle soup, 1 cup: 850–1,100 mg
- ham, 3 ounces: 1,000 mg
- sauerkraut, 1/2 cup: 780 mg
- pretzels, 1 ounce: 500 mg
- potato chips, 1 ounce: 165–185 mg
- soy sauce, 1 teaspoon: 304
- deli turkey breast, 1 ounce: 335 mg

Fresh fruits, vegetables, unsalted nuts, and rice, dried beans and peas are examples of foods that are low in sodium.

Sodium and health

Too high a concentration of sodium in the blood causes a condition called **hypernatremia**. Too much sodium in the diet almost never causes Hypernatremia. Causes include excessive water loss (e.g. severe **diarrhea**), restricted water intake, untreated diabetes (causes water loss), **kidney disease**, and hormonal imbalances. Symptoms include signs of **dehydration** such as extreme thirst, dark urine, sunken eyes, **fatigue**, irregular heart beat, muscle twitching, seizures, and **coma**.

Too low a concentration of sodium in the blood causes **hyponatremia**. Hyponatremia is not usually a problem in healthy individuals, although it has been known to occur in endurance athletes such as ultramarathoners. It is common in seriously ill individuals and can result from **vomiting** or diarrhea (extreme loss of sodium), severe **burns**, taking certain drugs that cause the kidney to selectively excrete sodium, extreme overconsumption of water (water intoxication, a problem among the elderly with **dementia**), hormonal imbalances, kidney failure, and liver damage. Symptoms include **nausea**, **vomiting**, **headache**, tissue swelling (**edema**), confusion, mental disorientation, **hallucinations**, muscle trembling, seizures, and coma.

Hypernatremia and hyponatremia are at the extreme ends of sodium imbalance. However, high dietary intake of salt can cause less visible health damage in the form of high blood pressure (**hypertension**). Hypertension silently damages the heart, blood vessels, and kidney and increases the risk of **stroke**, **heart attack**, and kidney damage. A low-salt diet significantly lowers blood pressure in 30–60% of people with high blood pressure and a quarter to half of people with normal

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blood pressure. Some individuals are more sensitive to sodium than others. Those people who are most likely to see a rise in blood pressure with increased sodium intake include people who are obese, have type 2 diabetes, are elderly, female, and African American.

The American Heart Association recommends reducing sodium in the diet to between 1,500 mg and 2,300 mg daily. Below are some suggestions for cutting down on salt.

- Eat more fresh fruits and vegetables.
- Look for processed foods that say "no salt added"
- Limit or eliminate salty snacks such as chips and pretzels.
- Restrict the amount processed meats such as hot dogs, pepperoni, and deli meats.
- Avoid high salt canned soups; choose heart-healthy lower salt soups instead.
- Use spices instead of salt to give foods flavor.

Precautions

People who are salt-sensitive may need to keep their salt intake at levels below the suggested daily amounts to control their blood pressure.

Interactions

Certain drugs cause large amounts of sodium to be excreted by the kidneys and removed from the body in urine. **Diuretics** ("water pills") are among the best known of these drugs. Other types of drugs that may cause low sodium levels, especially in ill individuals, include non-steroidal anti-inflammatory drugs (NSAIDs) such as Advil, Motrin, and Aleve, opiates such as codeine and morphine, selective serotonin-reuptake inhibitors (SSRIs) such as Prozac or Paxil, and **tricyclic antidepressants** such as Elavil and Tofranil.

Complications

Health concerns about sodium have been discussed above. Most problems related to high blood pressure are chronic, slow to develop disorders that do not cause serious complications until the second half of an individual's lifetime. Kidney failure, heart attack, and stroke are all complications of high blood pressure and potentially of high sodium intake.

Parental concerns

Salt is an acquired taste. Parents can help their children control their salt intake and discourage the development of a craving for salt by substituting low-salt foods for high-salt foods.

Resources

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ORGANIZATIONS

American Heart Association, 7272 Greenville Avenue, Dallas TX, 75231, (800) 242-8721, http://www.americanheart.org.

International Food Information Council, 1100 Connecticut Avenue, NW Suite 430, Washington, DC, 20036, (202) 296-6540, (202) 296-6547, http://ific.org.

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Sodium imbalance *see* **Hypernatremia; Hyponatremia**

Somatization disorder *see* **Somatoform disorders**

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Somatoform disorders

Definition

The somatoform disorders are a group of mental disturbances placed in a common category on the basis of their external symptoms. These disorders are characterized by physical complaints that appear to be medical in origin but that cannot be explained in terms of a physical disease, the results of **substance abuse**, or by another mental disorder. In order to meet the criteria for a somatoform disorder, the physical symptoms must be serious enough to interfere with the patient's employment or relationships, and must be symptoms that are not under the patient's voluntary control.

It is helpful to understand that the present classification of these disorders reflects recent historical changes in the practice of medicine and psychiatry. When psychiatry first became a separate branch of medicine at the end of the nineteenth century, the term *hysteria* was commonly used to describe mental disorders characterized by altered states of consciousness (for example, sleepwalking or trance states) or physical symptoms (for example, a "paralyzed" arm or leg with no neurologic cause) that could not be fully explained by a medical disease. The term *dissociation* was used for the psychological mechanism that allows the mind to split off uncomfortable feelings, memories, or ideas so that they are lost to conscious recall. Sigmund Freud and other pioneering psychoanalysts thought that the hysterical patient's symptoms resulted from dissociated thoughts or memories reemerging through bodily functions or trance states. Prior to the categorization all mental disorders that were considered to be forms of **hysteria** were grouped together on the basis of this theory about their cause. Since 1980, however, the somatoform disorders and the so-called **dissociative disorders** have been placed in separate categories on the basis of their chief symptoms. In general, the somatoform disorders are characterized by disturbances in the patient's physical sensations or ability to move the limbs or walk, while the dissociative disorders are marked by disturbances in the patient's sense of identity or memory.

Description

As a group, the somatoform disorders are difficult to recognize and treat because patients often have long histories of medical or surgical treatment with several different doctors. In addition, the physical symptoms are not under the patient's conscious control so that he or she is not intentionally trying to confuse the doctor or complicate the process of diagnosis. Somatoform disorders are, however, a significant problem for the health care system because patients with these disturbances overuse medical services and resources.

Somatization disorder (Briquet's syndrome)

Somatization disorder was formerly called Briquet's syndrome, after the French physician who first recognized it. The distinguishing characteristic of this disorder is a group or pattern of symptoms in several different organ systems of the patient's body that cannot be accounted for by medical illness. The criteria for this disorder require four symptoms of **pain**, two symptoms in the digestive tract, one symptom involving the sexual organs, and one symptom related to the nervous system. Somatization disorder usually begins before the age of 30. It is estimated that 0.2% of the United States population will develop this disorder in the course of their lives. Another researcher estimates that 1% of all women in the United States have symptoms of this disorder. The female-to-male ratio is estimated to range between 5:1 and 20:1.

Somatization disorder is considered to be a chronic disturbance that tends to persist throughout the patient's life. It is also likely to run in families. Some psychiatrists think that the high female-to-male ratio in this disorder reflects the cultural pressures on women in North American society and the social "permission" given to women to be physically weak or sickly.

Conversion disorder

Conversion disorder is a condition in which the patient's senses or ability to walk or move are impaired without a recognized medical or neurological disease or cause and in which psychological factors (such as **stress** or trauma) are judged to be temporarily related to onset or exacerbation. The disorder gets its name from the notion that the patient is converting a psychological conflict or problem into an inability to move specific parts of the body or to use the senses normally. An example of a conversion reaction would be a patient who loses his or her voice in a situation in which he or she is afraid to speak. The symptom simultaneously contains the **anxiety** and serves to get the patient out of the threatening situation. The resolution of the emotion that underlies the physical symptom is called the patient's *primary gain*, and the change in the patient's social, occupational, or family situation that results from the symptom is called a *secondary gain*. Doctors sometimes use these terms when they discuss the aftereffects of conversion disorder or of other somatoform disorders on the patient's emotional adjustment and lifestyle.

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The specific physical symptoms of conversion disorder may include a loss of balance or **paralysis** of an arm or leg; the inability to swallow or speak; the loss of touch or pain sensation; going blind or deaf; seeing double; or having **hallucinations**, seizures, or convulsions.

Unlike somatization disorder, conversion disorder may begin at any age, and it does not appear to run in families. It is estimated that as many as 34% of the population experiences conversion symptoms over a lifetime but that the disorder is more likely to occur among less educated or sophisticated people. Conversion disorder is not usually a chronic disturbance; 90% of patients recover within a month, and most do not have recurrences. The female-to-male ratio is between 2:1 and 5:1. Male patients are likely to develop conversion disorders in occupational settings or military service.

Pain disorder

Pain disorder is marked by the presence of severe pain as the focus of the patient's concern. This category of somatoform disorder covers a range of patients with a variety of ailments, including chronic headaches, back problems, arthritis, muscle aches and cramps, or pelvic pain. In some cases the patient's pain appears to be largely due to psychological factors, but in other cases the pain is derived from a medical condition as well as the patient's psychology.

Pain disorder is relatively common in the general population, partly because of the frequency of work-related injuries in the United States. This disorder appears to be more common in older adults, and the sex ratio is nearly equal, with a female-to-male ratio of 2:1.

Hypochondriasis

Hypochondriasis is a somatoform disorder marked by excessive fear of or preoccupation with having a serious illness that persists in spite of medical testing and reassurance. It was formerly called hypochondriacal neurosis.

Although hypochondriasis is usually considered a disorder of young adults, it is now increasingly recognized in children and adolescents. It may also develop in elderly people without previous histories of health-related fears. The disorder accounts for about 5% of psychiatric patients and is equally common in men and women. Hypochondriasis may persist over a number of years but usually occurs as a series of episodes rather than continuous treatment-seeking. The flare-ups of the disorder are often correlated with stressful events in the patient's life.

Body dysmorphic disorder

Body dysmorphic disorder is a new category of somatoform disorders. It is defined as a preoccupation with an imagined or exaggerated defect in appearance. Most cases involve features on the patient's face or head, but other body parts—especially those associated with sexual attractiveness, such as the breasts or genitals—may also be the focus of concern.

Body dysmorphic disorder is regarded as a chronic condition that usually begins in the patient's late teens and fluctuates over the course of time. It was initially considered to be a relatively unusual disorder but may be more common than was formerly thought. It appears to affect men and women with equal frequency. Patients with body dysmorphic disorder frequently have histories of seeking or obtaining **plastic surgery** or other procedures to repair or treat the supposed defect. Some may even meet the criteria for a delusional disorder of the somatic type.

Somatoform disorders in children and adolescents

The most common somatoform disorders in children and adolescents are conversion disorders, although body dysmorphic disorders are being reported more frequently. Conversion reactions in this age group usually reflect stress in the family or problems with school rather than long-term psychiatric disturbances. Some psychiatrists speculate that adolescents with conversion disorders frequently have overprotective or overinvolved parents with a subconscious need to see their child as sick; in many cases the son or daughter's symptoms become the center of family attention. The rise in body dysmorphic disorders in adolescents is thought to reflect the increased influence of media preoccupation with physical perfection.

Causes and symptoms

The causes of somatoform disorders include several different factors and they are categorized on the basis of symptom patterns.

Family stress

Family stress is believed to be one of the most common causes of somatoform disorders in children and adolescents. Conversion disorders in this age group may also be connected with physical or **sexual abuse** within the family of origin.

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Parental modeling

Somatization disorder and hypochondriasis may result in part from the patient's unconscious reflection or imitation of parental behaviors. This "copycat" behavior is particularly likely if the patient's parent derived considerable secondary gain from his or her symptoms.

Cultural influences

Cultural influences appear to affect the gender ratios and body locations of somatoform disorders as well as their frequency in a specific population. Some cultures (for example, Greek and Puerto Rican) report higher rates of somatization disorder among men than is the case for the United States. In addition, researchers found lower levels of somatization disorder among people with higher levels of education. People in Asia and Africa are more likely to report certain types of physical sensations (for example, burning hands or feet, or the feeling of ants crawling under the skin) than are Westerners.

Biological factors

Genetic or biological factors may also play a role. For example, people who suffer from somatization disorder may also differ in how they perceive and process pain.

Diagnosis

Accurate diagnosis of somatoform disorders is important to prevent unnecessary surgery, laboratory tests, or other treatments or procedures. Because somatoform disorders are associated with physical symptoms, patients are often diagnosed by primary care physicians as well as by psychiatrists. In many cases the diagnosis is made in a general medical clinic. Children and adolescents with somatoform disorders are most likely to be diagnosed by pediatricians. Diagnosis of somatoform disorders requires a thorough physical workup to exclude medical and neurological conditions, or to assess their severity in patients with pain disorder. A detailed examination is especially necessary when conversion disorder is a possible diagnosis because some neurological conditions—including **multiple sclerosis** and myasthenia gravis–have on occasion been misdiagnosed as conversion disorder. Some patients who receive a diagnosis of somatoform disorder ultimately go on to develop neurologic disorders.

In addition to ruling out medical causes for the patient's symptoms, a doctor who is evaluating a patient for a somatization disorder will consider the possibility of other psychiatric diagnoses or of overlapping psychiatric disorders. Somatoform disorders often coexist with **personality disorders** because of the chicken-and-egg relationship between physical illness and certain types of character structure or personality traits. At one time, the influence of Freud's theory of hysteria led doctors to assume that the patient's hidden emotional needs "cause" the illness. But in many instances, the patient's personality may have changed over time due to the stresses of adjusting to a chronic disease. This gradual transformation is particularly likely in patients with pain disorder. Patients with somatization disorder often develop panic attacks or **agoraphobia** together with their physical symptoms. In addition to anxiety or personality disorders, the doctor will usually consider major depression as a possible diagnosis when evaluating a patient with symptoms of a somatoform disorder. Pain disorders may be associated with depression and body dismorphic disorder may be associated with obsessive-compulsive disease.

Treatment

Relationship with primary care practitioner

Because patients with somatoform disorders often have lengthy medical histories, a long-term relationship with a trusted primary care practitioner (PCP) is a safeguard against unnecessary treatments as well as a comfort to the patient. Many PCPs prefer to schedule brief appointments on a regular basis with the patient and keep referrals to specialists to a minimum. This practice also allows them to monitor the patient for any new physical symptoms or diseases. However, some PCPs work with a psychiatric consultant.

Medications

Patients with somatoform disorders are sometimes given **antianxiety drugs** or **antidepressant drugs** if they have been diagnosed with a coexisting mood or anxiety disorder. In general, however, it is considered better practice to avoid prescribing medications for these patients since they are likely to become psychologically dependent on them. However, body dysmorphic disorder as been successfully treated with **selective serotonin reuptake inhibitors** (SSRI) antidepressants.

Psychotherapy

Patients with somatoform disorders are not considered good candidates for **psychoanalysis** and other forms of insight-oriented **psychotherapy**. They can benefit, however, from supportive approaches to treatment that are aimed at symptom reduction and stabilization of the patient's personality. Some patients with pain disorder benefit from **group therapy** or support

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KEY TERMS

Briquet's syndrome—Another name for somatization disorder.

Conversion disorder—A somatoform disorder characterized by the transformation of a psychological feeling or impulse into a physical symptom. Conversion disorder was previously called hysterical neurosis, conversion type.

Dissociation—A psychological mechanism in which the mind splits off certain aspects of a traumatic event from conscious awareness. Dissociation can affect the patient's memory, sense of reality, and sense of identity.

Hysteria—The earliest term for a psychoneurotic disturbance marked by emotional outbursts and/or disturbances of movement and sense perception. Some forms of hysteria are now classified as somatoform disorders and others are grouped with the dissociative disorders.

Hysterical neurosis—An older term for conversion disorder or dissociative disorder.

Primary gain—The immediate relief from guilt, anxiety, or other unpleasant feelings that a patient derives from a symptom.

Repression—A unconscious psychological mechanism in which painful or unacceptable ideas, memories, or feelings are removed from conscious awareness or recall.

Secondary gain—The social, occupational, or interpersonal advantages that a patient derives from symptoms. A patient's being relieved of his or her share of household chores by other family members would be an example of secondary gain.

Somatoform disorder—A category of psychiatric disorder characterized by physical complaints that appear to be medical in origin but that cannot be explained in terms of a physical disease, the results of substance abuse, or by another mental disorder.

groups, particularly if their social network has been limited by their pain symptoms. **Cognitive-behavioral therapy** is also used sometimes to treat pain disorder.

Family therapy is usually recommended for children or adolescents with somatoform disorders, particularly if the parents seem to be using the child as a focus to divert attention from other difficulties. Working with families of chronic pain patients also helps avoid reinforcing dependency within the family setting.

Hypnosis is a technique that is sometimes used as part of a general psychotherapeutic approach to conversion disorder because it may allow patients to recover memories or thoughts connected with the onset of the physical symptoms.

Alternative treatment

Patients with somatization disorder or pain disorder may be helped by a variety of alternative therapies including **acupuncture**, **hydrotherapy**, therapeutic massage, **meditation**, botanical medicine, and homeopathic treatment. Relief of symptoms, including pain, can occur on the physical level, as well as on the mental, emotional, and spiritual levels.

Prognosis

The prognosis for somatoform disorders depends, as a rule, on the patient's age and whether the disorder is chronic or episodic. In general, somatization disorder and body dysmorphic disorder rarely resolve completely. Hypochondriasis and pain disorder may resolve if there are significant improvements in the patient's overall health and life circumstances, and people with both disorders may go through periods when symptoms become less severe (remissions) or become worse (exacerbations). Conversion disorder tends to be rapidly resolved but may recur in about 25% of all cases.

Prevention

Generalizations regarding prevention of somatoform disorders are difficult because these syndromes affect different age groups, vary in their symptom patterns and persistence, and result from different problems of adjustment to the surrounding culture. In theory, allowing expression of emotional pain in children, rather than regarding it as "weak," might reduce the secondary gain of physical symptoms that draw the care or attention of parents.

Resources

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Somatotrophic hormone test *see* **Growth hormone tests**

Sore throat

Definition

Sore throat, also called pharyngitis, is a painful inflammation of the mucous membranes lining the pharynx. It is a symptom of many conditions, but most often is associated with colds or **influenza**. Sore throat may be caused by either viral or bacterial infections or environmental conditions. Most sore throats heal without complications but they should not be ignored because some develop into serious illnesses. A chronic sore throat with hoarseness is one of the seven warning signs of **cancer**.

Demographics

Almost everyone gets a sore throat at one time or another, although children in child care or grade school have them more often than adolescents and adults. Sore throats are most common during the winter months when upper respiratory infections (colds) are more frequent.

About 10% of children who go to the doctor each year have pharyngitis. 40% of the time that children are taken to the doctor with a sore throat, the sore throat is diagnosed as viral. An antibiotic cannot help to cure a virus; a virus has to be left to run its course.

In about 30% of the cases for which children are taken to the doctor, bacteria are found to be responsible for the sore throat. Many of these bacterial sore throats are cases of **strep throat**. Sore throats caused by bacteria can be successfully treated with **antibiotics**. In about 40% of these cases of pharyngitis, it is never clear what caused the sore throat. In these cases it is possible that the virus or bacteria was not identified or that other factors such as environment or postnasal drip may have been responsible.

Sore throat caused by a viral infection. *(© Scott Camazine/ Photo Researchers, Inc.)*

Description

Sore throats can be either acute or chronic. Acute sore throats are the more common. They appear suddenly and last from three to about seven days. A chronic sore throat lasts much longer and is a symptom of an unresolved underlying condition or disease, such as a sinus infection.

Causes and symptoms

Sore throats have many different causes and may or may not be accompanied by cold symptoms, **fever**, or swollen lymph glands. Proper treatment depends on understanding the cause of the sore throat.

Viral sore throat

Viruses cause 90–95% of all sore throats. Cold and flu viruses are the main culprits. These viruses cause an inflammation in the throat and occasionally the tonsils (**tonsillitis**). Cold symptoms almost always accompany

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a viral sore throat. These can include a runny nose, **cough**, congestion, hoarseness, **conjunctivitis**, and fever. The level of throat **pain** varies from uncomfortable to excruciating, when it is painful for the patient to eat, breathe, swallow, or speak.

Another group of viruses that cause sore throat are the adenoviruses. These may also cause infections of the lungs and ears. In addition to a sore throat, symptoms that accompany an adenovirus infection include cough, runny nose, white bumps on the tonsils and throat, mild **diarrhea**, **vomiting**, and a rash. The sore throat lasts about one week.

A third type of virus that can cause severe sore throat is the coxsackie virus. It can cause a disease called herpangina. Although anyone can get herpangina, it is most common in children up to age ten and is more prevalent in the summer or early autumn. Herpangina is sometimes called summer sore throat.

Three to six days after being exposed to the virus, an infected person develops a sudden sore throat that is accompanied by a substantial fever usually between 102–104°F (38.9–40°C). Tiny grayish-white blisters form on the throat and in the mouth. These fester and become small ulcers. Throat pain is often severe, interfering with swallowing. Children may become dehydrated if they are reluctant to eat or drink because of the pain. In addition, people with herpangina may vomit, have abdominal pain, and generally feel ill and miserable.

One other common cause of a viral sore throat is mononucleosis. Mononucleosis occurs when the **Epstein-Barr virus** infects one specific type of lymphocyte. The infection spreads to the lymphatic system, respiratory system, liver, spleen, and throat. Symptoms appear 30–50 days after exposure.

Mononucleosis, sometimes called the kissing disease, is extremely common. It is estimated that by the age of 35–40, 80–95% of Americans will have had mononucleosis. Often, symptoms are mild, especially in young children, and are diagnosed as a cold. Since symptoms are more severe in adolescents and adults, more cases are diagnosed as monomucleosis in this age group. One of the main symptoms of mononucleosis is a severe sore throat.

Although a runny nose and cough are much more likely to accompany a sore throat caused by a virus than one caused by a bacteria, there is no absolute way to tell what is causing the sore throat without a laboratory test. Viral sore throats are contagious and are passed directly from person to person by coughing and sneezing.

Bacterial sore throat

From 5–10% of sore throats are caused by bacteria. The most common bacterial sore throat results from an infection by group A *Streptococcus*. This type of infection is commonly called strep throat. Anyone can get strep throat but it is most common in school age children.

Pharyngeal **gonorrhea**, a sexually transmitted bacterial disease, causes a severe sore throat. Gonorrhea in the throat is transmitted by having oral sex with an infected person.

Noninfectious sore throat

Not all sore throats are caused by infection. Postnasal drip can irritate the throat and make it sore. It can be caused by hay fever and other **allergies** that irritate the sinuses. Environmental and other conditions, such as heavy **smoking** or breathing secondhand smoke, heavy alcohol consumption, breathing polluted air or chemical fumes, or swallowing substances that burn or scratch the throat can also cause pharyngitis. Dry air, like that in airplanes or from forced hot air furnaces, can make the throat sore. People who breathe through their mouths at night because of nasal congestion often get sore throats that improve as the day progresses. Sore throat caused by environmental conditions is not contagious.

Diagnosis

It is easy for people to tell if they have a sore throat but difficult to know what has caused it without laboratory tests. Most sore throats are minor and heal without any complications. A small number of bacterial sore throats do develop into serious diseases. Because of this, it is advisable to see a doctor if a sore throat lasts more than a few days or is accompanied by fever, **nausea**, or abdominal pain.

Diagnosis of a sore throat by a doctor begins with a **physical examination** of the throat and chest. The doctor will also look for signs of other illness, such as a sinus infection or **bronchitis**. Since both bacterial and viral sore throat are contagious and pass easily from person to person, the doctor will seek information about whether the patient has been around other people with flu, sore throat, colds, or strep throat. If it appears that the patient may have strep throat, the doctor will do laboratory tests.

If mononucleosis is suspected, the doctor may do a mono spot test to look for antibodies indicating the presence of the Epstein-Barr virus. The test in inexpensive, takes only a few minutes, and can be done in a physician's office. An inexpensive blood test can also determine the presence of antibodies to the mononucleosis virus.

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Treatment

Effective treatment varies depending on the cause of the sore throat. As frustrating as it may be to the patient, viral sore throat is best left to run its course without drug treatment. Antibiotics have no effect on a viral sore throat. They do not shorten the length of the illness nor do they lessen the symptoms.

Sore throat caused by a streptococci or another bacteria must be treated with antibiotics. Penicillin is the preferred medication. Oral penicillin must be taken for 10 days. Patients need to take the entire amount of antibiotic prescribed even after symptoms of the sore throat improve. Stopping the antibiotic early can lead to a return of the sore throat. Occasionally a single injection of long-acting penicillin G is given instead of 10 days of oral treatment. These medications generally cost under $15.

Because mononucleosis is caused by a virus, there is no specific drug treatment available. Rest, a healthy diet, plenty of fluids, limiting heavy **exercise** and competitive sports, and treatment of aches with **acetaminophen** (Datril, Tylenol, Panadol) or ibuprofen (Advil, Nuprin, Motrin, Medipren) will help the illness pass. Nearly 90% of mononucleosis infections are mild. The infected person does not normally get the disease again.

In the case of chronic sore throat, it is necessary to treat the underlying disease to heal the sore throat. If a sore throat caused by environmental factors, the aggravating stimulus should be eliminated from the sufferer's environment.

Home care for sore throat

Regardless of the cause of a sore throat, there are some home care steps that people can take to ease their discomfort. These include:

- taking acetaminophen or ibuprofen for pain; aspirin should not be given to children because of its association with increased risk for Reye's Syndrome, a serious disease
- gargling with warm double strength tea or warm salt water made by adding 1 tsp of salt to 8 oz (237 mL) of water
- drinking plenty of fluids, but avoiding acid juices like orange juice, which can irritate the throat (sucking on popsicles is a good way to get fluids into children)
- eating soft, nutritious foods like noodle soup and avoiding spicy foods
- refraining from smoking
- resting until the fever is gone, then resuming strenuous activities gradually
- a room humidifier may make sore throat sufferers more comfortable
- antiseptic lozenges and sprays may aggravate the sore throat rather than improve it

KEY TERMS

Antigen—A foreign protein to which the body reacts by making antibodies

Conjunctivitis—An inflammation of the membrane surrounding the eye; also known as pinkeye.

Lymphocyte—A type of white blood cell. Lymphocytes play an important role in fighting disease.

Pharynx—The pharynx is the part of the throat that lies between the mouth and the larynx or voice box.

Toxin—A poison. In the case of scarlet fever, the toxin is secreted as a byproduct of the growth of the streptococcus bacteria and causes a rash.

Alternative treatment

Alternative treatment focuses on easing the symptoms of sore throat using herbs and botanical medicines.

- Aromatherapists recommend inhaling the fragrances of essential oils of lavender (Lavandula officinalis), thyme (*Thymus vulgaris*), eucalyptus (*Eycalyptus globulus*), sage (*Salvia officinalis*), and sandalwood.
- Ayurvedic practitioners suggest gargling with a mixture of water, salt, and tumeric (*Curcuma longa*) powder or astringents such as alum, sumac, sage, and bayberry (*Myrica* spp.).
- Herbalists recommend taking osha root (*Ligusticum porteri*) internally for infection or drinking ginger (*Zingiber officinale*) or slippery elm (*Ulmus fulva*) tea for pain.
- Homeopaths may treat sore throats with superdilute solutions *Lachesis*, *Belladonna*, *Phytolacca*), yellow jasmine (*Gelsemium*), or mercury.
- Nutritional recommendations include zinc lozenges every two hours along with vitamin C with bioflavonoids, vitamin A, and beta-carotene supplements.

Prognosis

Sore throat caused by a viral infection generally clears up on its own within one week with no

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complications. The exception is mononucleosis. 90% of cases of mononucleosis clear up without medical intervention or complications, so long as **dehydration** does not occur. In young children the symptoms may last only a week but in adolescents the symptoms last longer. Adults over age 30 have the most severe and long lasting symptoms. Adults may take up to six months to recover. In all age groups **fatigue** and weakness may continue for up to six weeks after other symptoms disappear.

In rare cases of mononucleosis, breathing may be obstructed because of swollen tonsils, adenoids, and lymph glands. If this happens, the patient should immediately seek emergency medical care.

Patients with bacterial sore throat begin feeling better about 24 hours after starting antibiotics. Untreated strep throat has the potential to cause **scarlet fever**, kidney damage, or **rheumatic fever**. Scarlet fever causes a rash and can cause high fever and convulsions. Rheumatic fever causes inflammation of the heart and damage to the heart valves. Taking antibiotics within the first week of a strep infection will prevent these complications. People with strep throat remain contagious until after they have been taking antibiotics for 24 hours.

Prevention

There is no way to prevent a sore throat; however, the risk of getting one or passing one on to another person can be minimized by:

- washing hands well and frequently
- avoiding close contact with someone who has a sore throat
- not sharing food and eating utensils with anyone
- not smoking
- staying out of polluted air

Resources

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Tish Davidson, A.M.
Karl Finley

Sotalol *see* **Antiarrhythmic drugs**
Sound therapy *see* **Music therapy**

South American blastomycosis

Definition

South American **blastomycosis** is a potentially fatal, chronic fungus infection that occurs more often in men. The infection may affect different parts of the body, including the lungs or the skin, and may cause ulcers of the mouth, voicebox, and nose.

Description

South American blastomycosis occurs primarily in Brazil, although cases crop up in Mexico, Central America, or other parts of South America. It affects men between ages 20 and 50 about 10 times more often than women.

The disease is far more serious than its North American variant (North American blastomycosis), which is endemic to the eastern United States, southern Canada, and the midwest.

South American blastomycosis is known medically as paracoccidioidal granuloma, or paracoccidioidomycosis. The infection has a very long incubation period (at least five years).

Causes and symptoms

South American blastomycosis is caused by the yeast-like fungus *Paracoccidioides brasiliensis* that is acquired by breathing in the spores of the fungus, which is commonly found in old wood and soil. It may appear very similar to **tuberculosis**; in fact, both diseases may infect a patient at the same time.

Symptoms include ulcers in the mouth, larynx and nose, in addition to large, draining lymph nodes, **cough**, chest **pain**, swollen lymph glands, weight loss, and lesions on the skin, genitals, and intestines. There may also be lesions in the liver, spleen, intestines, and adrenal glands.

Diagnosis

A physician can diagnose the condition by microscopic examination of a smear prepared from a lesion or sputum (spit). Biopsy specimens may also reveal the infection. While blood tests are helpful, they cannot

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KEY TERMS

Amphotericin B—A drug used to treat fungal infections.

Sulfonamide drugs—A group of antibacterial drugs used to treat infections of the lungs and skin, among other things.

determine the difference between past and active infection.

Treatment

The primary goal of treatment is to control the infection. The best treatment has been amphotericin B. Sulfonamide drugs have been used and can stop the progress of the infection but they do not kill the fungus.

Scientists are studying new treatments for the fungal infection including ketoconazole, fluconazole, and itraconazole, which appear to be equally effective as amphotericin B, according to research.

Prognosis

The disease is chronic and often fatal. Because blastomycosis may be recurrent, patients should continue follow-up care for several years.

Prevention

There is no way to prevent the disease.

ORGANIZATIONS

National Institute of Allergies and Infectious Diseases, 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-6612, (301) 496-5717, (301) 402-3573, (866) 284-4107, ocpostoffice@niaid.nih.gov, http://www.niaid.nih.gov.

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923, (800) 999-6673, http://www.rarediseases.org.

Carol A. Turkington

Space medicine *see* **Aviation medicine**

Spanish flu *see* **Influenza**

Spastic colitis *see* **Irritable bowel syndrome**

Spastic colon *see* **Irritable bowel syndrome**

Speech disorders

Definition

According to the American Speech-Language-Hearing Association (ASHA), a language disorder is an impairment in comprehension use of the spoken, written, or other symbol system.

Description

Speech disorders affect the language and mechanics, the content of speech, or the function of language in communication. Because speech disorders affect a person's ability to communicate effectively, every aspect of the person's life can be affected, for example, the person's ability to make friends, and to communicate at school or at work.

Amyotrophic lateral sclerosis (ALS)

Amyotrophic lateral sclerosis (ALS), also known as Lou Gehrig's disease, is a neurological disease that attacks the nerve cells in the brain that control voluntary muscles. ALS causes motor neurons to die so that the brain and spinal cord are unable to send messages to the muscles telling them to move. Because the muscles are not functioning, they begin to atrophy. Muscles in the face and jaw can be affected, and thereby affecting a person's speech.

Aphasia

Aphasia results from damage to the language centers of the brain, which affects a person's ability to communicate through speaking, listening, and writing.

Persons with aphasia have trouble with expressive language, what is said, or receptive language, what is understood. Not only are speech and understanding speech affected, but also reading and writing is affected. The severity of aphasia varies from person to person, but in the most severe cases, a person may not be able to understand speech at all. Persons with mild aphasia may only become confused when speech becomes lengthy and complicated.

Developmental apraxia of speech

Developmental **apraxia** is a disorder that affects the nervous system and affects a person's ability to sequence and say sounds, syllables, and words. The brain does not send the correct messages to the mouth and jaw so that the person can say what he or she wants to say.

Children who are suffering from this disorder do not babble as an infant and first words are delayed.

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Older children may have more difficulty with longer phrases and may appear to be searching for words to express a thought. Listeners will likely have a difficult time understanding the child.

Laryngeal cancer

Laryngeal cancer is characterized by a malignant growth in the larynx, or the voice box, which sometimes requires removal of the larynx or part of it.

Cancer anywhere in the throat affects speech, swallowing, and chewing. Depending on the size of the growth, a person may have trouble moving the mouth and lips. Therefore, speech sounds and eating will be affected and a person will have trouble communicating.

Orofacial myofunctional disorders

Orofacial myofunctional disorder (OMD) causes the tongue to move forward in an exaggerated manner while a person is speaking or swallowing. The tongue also may protrude when resting in the mouth.

Because heredity contributes to the size and shape of a person's mouth, there may be genetic reasons for the disorder. **Allergies** also affect the mouth and face muscles, which make it difficult to breathe because of nasal congestion. Because a person may sleep with the tongue protruding, lip muscles weaken. Enlarged tonsils also can block airways, creating the same breathing problems. Additionally, thumb-sucking, nail-biting, and teeth-clenching and grinding also can contribute to the disorder.

Stuttering

Stuttering is a disorder of speech fluency that frequently interrupts the flow of speech.

Because children typically stumble and confuse their words as speech develops, stuttering is not immediately evident. It is usually when children become older and continue to stumble that stuttering becomes evident.

Causes and symptoms

Amyotrophic lateral sclerosis (ALS)

Initial symptoms include weakness in any part of the body, and appendages begin to tire easily. Occasionally the disease affects only one appendage rather than both at the same time. Persons with ALS may have trouble maintaining balance and may stumble or have difficulty with tasks that require manual dexterity, such as buttoning a shirt or tying a shoe.

Eventually, the diaphragm and chest wall become so weak that a person cannot breathe on his or her own and needs the help of a ventilator. Because of the lack of muscle strength, a person with ALS will experience difficulty speaking loudly and clearly until the person is unable to speak at all using the vocal cords. The person will have difficulty pronouncing words and have difficulty completing lengthy sentences.

Along with the difficulty in speaking also comes difficulty in chewing and swallowing. Food can be broken down and pureed to make it easier to chew and swallow. However, a person eventually will have difficulty chewing and swallowing foods that are broken down or pureed. When ability to eat is affected, proper **nutrition** and body weight also are affected, and medical professionals may decide that it is best to put in a feeding tube.

Aphasia

Stroke is the most common cause of aphasia, although other injuries, such as a **brain tumor** or gunshot wound, also can cause aphasia.

Developmental apraxia of speech

Developmental apraxia is a disorder that affects the nervous system and affects a person's ability to sequence and say sounds, syllables, and words. The brain does not send the correct messages to the mouth and jaw so that the person can say what he or she wants to say.

Children who are suffering from this disorder don't babble as an infant and first words are delayed. Older children may have more difficulty with longer phrases, and may appear to be searching for words to express a thought. Listeners will likely have a difficult time understanding the child.

There is no known cause for developmental apraxia of speech. Symptoms include weakness of the jaw, tongue, and lips, and delayed speech development. Persons with the disorder also may have trouble identifying an object in the mouth using the sense of touch, which is known as oral-sensory perception.

Laryngeal cancer

Any kind of **smoking** of cigarettes, cigars, or tobacco and alcohol **abuse** contribute to oral cancer, including smokeless tobacco. Persons with laryngeal cancer or another type of oral cancer may have a red or white patch or lump in the mouth. Symptoms also include difficulty chewing, swallowing, or chewing.

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Stuttering

There is no known cause for stuttering, although poor muscle coordination and the rate of language development are believed to contribute to it.

Stuttering is characterized by repetition of sounds, syllables, portions of a word, words, and complete phrases; stretching the sounds and syllables; hesitation between words; words spoken in spurts; tense muscles in the jaw and mouth; and a feeling of loss of control.

Diagnosis

Amyotrophic lateral sclerosis (ALS)

About 20,000 people in the United States have ALS at any given time with 5,000 new cases diagnosed every year. ALS is in the same family of disorders as **multiple sclerosis**, Parkinson's disease, and **muscular dystrophy**. Persons of all races and ethic groups are afflicted by the disease, although men are more likely to have it than women.

Aphasia

About 700,000 persons in the United States have strokes every year, and 1 million are estimated to have aphasia.

Developmental apraxia of speech

A child suspected to have apraxia should first have his or her hearing tested to determine if the child has any deafness. Muscle development in the face and jaw should be evaluated and speech exercises tested. Articulation of words should be tested as well as the person's expressive and receptive language skills.

Laryngeal cancer

It is likely that a dentist or physician will first detect signs of possible cancer. Oral cancer makes up about 2–5% of all cancers, and about 30,000 cases are diagnosed each year. Twice as many men than women are diagnosed with cancer typically between the ages of 50 and 70.

Orofacial myofunctional disorders

The diagnosis of orofacial myofunctional disorder affects speech sounds because of weak tongue tip muscles, although a person's speech may not be affected at all.

Stuttering

Stuttering is a problem that most likely will manifest itself during childhood rather than adulthood.

Treatment

Amyotrophic lateral sclerosis (ALS)

In addition to treatments such as a feeding tube, a person with ALS would likely enlist the help of a speech therapist to help him or her determine ways in which he or she can maintain vocal control. A person also may enlist the help of an occupational therapist, a medical professional trained to help persons who have trouble with activities of daily living such as dressing, bathing, and eating.

Aphasia

A speech-language pathologist can perform drills and exercises with a person that include practice in naming objects and following directions to try to improve skills. The person learns the best way to express himself of herself. **Group therapy** also is an option, which focuses on structured discussions.

Developmental apraxia of speech

Treatment should focus on the coordination of motor movements necessary during speech production, which includes controlling breathing. A speech-language pathologist teaches exercises to a person with apraxia that will strengthen the jaws, lips, and tongue to improve coordination during speech. The therapist uses tactile, auditory, and visual feedback to direct the brain to move the muscles used during speech.

Laryngeal cancer

Depending on when the cancer is first detected, and depending on the size of the cancer, the entire larynx may not need to be removed. Radiation, **chemotherapy**, or partial removal can be done in lieu of complete removal. In these cases, the voice may be preserved although the quality likely will be affected.

Orofacial myofunctional disorders

In cases where speech is affected, a speech pathologist should be consulted to help control breathing problems and work on speech articulation. The lip, palate, tongue, and facial muscles should be evaluated so that errors in speech can be detected. Therapy includes increasing awareness of the mouth and facial muscles, as well as the posture of the mouth and tongue. Muscle **exercise** can be done to increase strength and control.

Stuttering

A treatment plan by a speech therapist includes improving fluency and ease with which a person speaks. Strategies include reducing the rate of speech and using slower speech movements; articulating

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lightly; and starting air flow for speech before any other muscle movement.

Alternative treatment

Developmental apraxia of speech

Some persons with apraxia may decide to use alternative communication systems, such as a computer that transcribes and "speaks" what a person is directing it to say. These augmentative systems should only be used when a person is so severely impaired that effective speech or communication isn't possible.

Laryngeal cancer

In cases of a full **laryngectomy**, a hole is made in the neck and, rather than using the mouth and nose to talk and breath, the person must use the hole.

Once the larynx is removed, the person needs to develop a new speech system without a voice. A speech pathologist should follow one of three plans: esophageal speech, artificial larynx, or tracheoesophageal puncture (TEP).

- Esophageal speech. Without a larynx, a person is no longer able to exhale air from the lungs through the mouth to speak. Using esophageal speech, the person inhales and traps the air in the throat, causing the esophagus to vibrate and create sound.
- Artificial larynx. A mechanical instrument can be used that produces sound for some speech. These devices can be held against the neck or used by inserting a tube in the mouth.
- Tracheoesophageal puncture. This is a popular method in restoring speech production. During surgery, a hole is made between the trachea and esophagus and a valve is inserted into the hole. The person breathes air into the lungs and then covers the hole in the throat. During exhalation, the esophagus vibrates and creates speech.

Stuttering

A person suffering from stuttering may employ distraction strategies to help him or her stop stuttering. Typically, a person stuttering becomes frustrated and embarrassed; subsequently, encouraging the person to think of something or do something else may break the stuttering cycle.

Prognosis

Amyotrophic lateral sclerosis (ALS)

ALS patients often die of **respiratory failure** within three to five years of being diagnosed, although some persons have been known to survive as many as 10 years or longer.

Aphasia

Persons with aphasia can improve and eventually function in more typical public settings, and possibly return to school or work.

Developmental apraxia of speech

With proper treatment, apraxia can be brought under control and the person will be able to function normally as an adult.

Laryngeal cancer

Full removal of the larynx removes the risk of a cancer relapse, although other parts of the throat and mouth can be affected.

Orofacial myofunctional disorders

A person can learn to control this disorder with proper treatment and maintain normal speech and breathing patterns.

Stuttering

With proper **speech therapy**, stuttering can be controlled or eliminated.

Prevention

Laryngeal cancer

Persons should not engage in smoking or drug abuse to decrease the risk of oral cancer.

Orofacial myofunctional disorders

In cases where the cause is evident, such as allergies or enlarged tonsils, a person should first remedy that problem; perhaps have the tonsils removed and treat allergies with medication.

KEY TERMS

Neurons—Nerve cells in the brain, brain stem, and spinal cord that connect the nervous system and the muscles.

Resources

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Damico, Jack Samuel, Nicole Muller, and Martin J Ball. *The Handbook of Language and Speech Disorders*. Chichester, UK; Malden, MA: Wiley-Blackwell, 2010.

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ORGANIZATIONS

American Speech Language Hearing Association, 2200 Research Boulevard , Rockville, MD, 20850-3289, (301) 296-5700, (301) 296-8580, (800) 638-8255, actioncenter @asha.org, http://asha.org/.

Meghan Gourley

Speech disturbance *see* **Aphasia**

Speech therapy

Definition

Speech therapy is the diagnosis and treatment of a speech disorder, expressive or receptive language disorder, or certain **swallowing disorders** by a trained speech-language pathologist (SLP). SLPs commonly are called speech therapists.

Purpose

The purpose of speech therapy is to improve communication and/or the understanding of language and/or to remediate swallowing difficulties. In addition to oral communication, speech therapy may include sign language, picture communication, and the use of assistive devices to help augment speech or serve as an alternate form of communication (augmented and alternative communication [AAC]).

Demographics

According to the Bureau of Labor Statistics, in 2008 there were about 119,300 practicing SLPs in the United States, with the number expected to grow to about 141,400 by 2018. Of these, about 48% practice in schools, 9% are self-employed in private practice, and the remainder practice at hospitals, nursing homes, other health care facilities, or provide in-home health care services, usually through Medicare and Medicaid programs.

Description

Speech therapy addresses problems with speech production, language disorders, and swallowing. Problems with speech production include issues of articulation, speech rhythm, fluency, voice production, resonance, tone, and accent.

There are two basic categories of language disorders: expressive language disorders, which involves problems producing language and receptive language disorders, which involves problems understanding language. Individuals with expressive language disorders have difficulty in using language at the level expected for their age group. Often children with this type of disorder have lower than expected vocabularies, form sentences with a simpler structure than is expected, and have more difficulties expressing themselves in writing than other children their age. In some cases, (e.g. after a **stroke**) only one area will show a deficiency, such as an individual who has a good vocabulary but difficulty forming complex sentences. In other cases, all areas of language production are affected.

Individuals with receptive language disorders have difficulty understanding and processing language. This can affect comprehension of spoken or written language, or both. People who have difficulty understanding and following directions, responding to questions, or following a conversation may have a receptive language disorder. Individuals who can read words on the page but are unable to process the meaning of what they read have a receptive language disorder.

Speech therapy also addresses problems of swallowing that originate in the mouth and throat. Infants with **birth defects** of the mouth and individuals who have had a stroke or who have certain diseases such as **multiple sclerosis** are most likely to have swallowing problems.

Speech therapy is individualized. SLPs use a variety of techniques to overcome speech and language disorders based on the age of the client and the type of problem. Much work with children involves playing with them and using various toys and visual aids to encourage them to speak, along with modeling correct articulation and speech patterns. Therapy may be done one-on-one or with small groups of children. With older children and adults, the SLP may use a mirror to help the individual see how to move the muscles of their face to correctly form certain sounds. Exercises to strengthen certain facial muscles may be prescribed for people who have trouble swallowing. For individuals who have disabilities such as deafness or **cerebral palsy**, the SLP may teach the individual how to use assistive devices or alternate communication methods such as sign language.

Depending on the problems being addressed, the individual may have a speech therapy sessions as infrequently as once a week or as often as every day. There is no standard length of time an individual remains in speech therapy. Practice is the key to making progress with speech and language disorders. Parents and caregivers play an important role in the success of speech

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KEY TERMS

Articulation—The ability to pronounce a word correctly. A lisp is an example of an articulation problem.

Dysphagia—Difficult or painful swallowing.

Fluency—The ability to produce a flow of words and not get "stuck." Stuttering is an example of a fluency problem.

Stroke—Irreversible damage to the brain caused by insufficient blood flow to the brain as the result of a blocked artery. Damage can include loss of speech or vision, paralysis, cognitive impairment, and death.

therapy, as they usually are expected to both model good articulation and speech, to reinforce the lessons taught during therapy sessions, and to supervise practice of any home exercises the SLP prescribes.

Benefits

Speech therapy improves expressive communication and language understanding and can reduce or eliminate certain swallowing problems. Improved communication leads to reduced frustration and greater safety, both for language-impaired individuals and for those who live and work with them.

Precautions

As of 2009, 47 states in the United States had licensing requirements for SLPs. When choosing a speech therapist, families should make sure that the therapist is licensed. Not only is this a sensible precaution to assure appropriate therapy, but many government programs and private insurers will not pay for speech therapy performed by an unlicensed individual.

Many SLPs develop specialties, such as working with stroke victims, working with preschoolers, or working with autistic individuals, so it is important to find a speech therapist who has experience in the specific speech and language problem being treated. SLPs also should be willing to work closely with healthcare personnel and educators, as needed, to ensure maximum benefit from the therapy.

Preparation

No special preparation is needed to begin speech therapy. An evaluation of the speech-language-swallowing problem will be done at the first session.

Aftercare

Practice and repetition are key to the success of speech therapy. Individuals often are given speech, language and/or muscle exercises to perform regularly at home. Caregivers will need to supervise these exercises and reinforce what is accomplished at the therapy sessions.

Risks

No specific risks are associated with speech therapy.

Training and certification

Certification varies from country to country and in the United States, from state to state. All SLPs are required to have a college degree. In the United States, most states require a master's degree in speech-language pathology from an accredited college or university, passing a national examination offered through the Praxis Series of the Educational Testing Service, and a minimum of 300 hours of supervised clinical experience. Most states require the SLP to earn continuing education credits to maintain their license. The American Speech-Language-Hearing Association (ASHA) offers a voluntary Certificate of Clinical Competence (CCC), which imposes higher standards than the general standards mentioned above. Individuals who earn this certificate will indicate it by putting the letters CCC-SLP after their name. The ASHA also offers voluntary certification in certain speech-language therapy specialties. Certification and licensing requirements are quite similar in other countries in the English-speaking world.

Resources

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ORGANIZATIONS

American Speech-Language-Hearing Association (ASHA), 2200 Research Boulevard, Rockville, MD, 20850-3289, (301) 296-5700, TTY (301) 296-5650, (800) 638-8255, (301) 296-8580, actioncenter@asha.org, http://www.asha.org.
National Institute on Deafness and Other Communication Disorders, 31 Center Drive, MSC 2320, Bethesda, MD, 20892-2320, nidcdinfo@nidcd.nih.gov, http://www.nidcd.nih.gov.
Stuttering Foundation of America, 3100 Walnut Grove Road, Suite 603; P.O. Box 11749, Memphis, TN, 38111-0749, (901) 452-7343, (800) 992-9392, (901) 452-3931, info@stutteringhelp.org, http://www.stutteringhelp.org.

Tish Davidson, A.M.
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Sperm count *see* **Semen analysis**

Spina bifida

Definition

Spina bifida belongs to a group of disorders known as neural tube defects (NTDs). It is a serious birth abnormality characterized by the incomplete development of the brain, spinal cord, and/or meninges.

Demographics

According to the National Institute of Neurological Disorders and Stroke (NINDS), spina bifida is the most common neural tube defect (NTD) in the United States, affecting 1,500 to 2,000 of the more than 4 million babies born each year. The Center for Disease Control (CDC) reports that NTDs are more common among white women than black women and more common among Hispanic women than non-Hispanic women.

Spina bifida occurs worldwide but there has been a steady downward trend in occurrence rates over the past 50–70 years, particularly in regions of high prevalence. The highest prevalence rates, about one in 200 pregnancies, have been reported from certain northern

An infant with spina bifida. *(Biophoto Associates/Photo Researchers, Inc.)*

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provinces in China. Intermediate prevalence rates, about one in 1,000 pregnancies, have been found in Central and South America. The lowest prevalence rates, less than one in 2,000 pregnancies, have been found in the European countries.

Description

Spina bifida is also known by the name spinal dysraphism. Spina bifida may appear in the body midline anywhere from the neck to the buttocks. In its most severe form, termed spinal rachischisis, the entire spinal canal is open, exposing the spinal cord and nerves. More commonly, the abnormality appears as a localized mass on the back that is covered by skin or by the meninges, the three-layered membrane that surrounds the spinal cord. Spina bifida is usually readily apparent at birth because of the malformation of the back and **paralysis** below the level of the abnormality.

Various forms of spina bifida are known as meningomyelocele, myelomeningocele, spina bifida aperta, open spina bifida, myelodysplasia, spinal dysraphism, spinal rachischisis, myelocele, and meningocele. The term meningocele is used when the spine malformation contains only the protective covering (meninges) of the spinal cord. The other terms indicate involvement of the spinal cord and nerves in the malformation. A related term, spina bifida occulta, indicates that one or more of the bony bodies in the spine are incompletely hardened but that there is no abnormality of the spinal cord itself.

Risk factors

In the United States, 95% of neural tube defects (NTDs) occur in women with no family history of these conditions. The CDC outlines some of the risk factors associated with NTDs and by extension, with spina bifida. They include the occurrence of a previous NTD–affected **pregnancy**, or of maternal insulin–dependent diabetes as well as the use of certain anticonvulsant medications (such as Valproic acid/Depakene, and Carbamazapine/Tegretol). Medically diagnosed **obesity** is also considered a risk factor. The recurrence risk after the birth of an infant with isolated spina bifida is 3–5%. Recurrence may be for spina bifida or another type of spinal abnormality.

Causes and symptoms

Spina bifida occurs because the neural tube, around the area of the spine, fails to close during fetal development. Spina bifida may occur as an isolated abnormality or in the company of other malformations. As an isolated abnormality, spina bifida is caused by the combination of genetic factors and environmental influences that bring about malformation of the spine and spinal column. The specific genes and environmental influences that contribute to the many—factored causes of spina bifida are not precisely known. An insufficiency of **folic acid** is known to be one influential nutritional factor. Changes (mutations) in genes involving the metabolism of folic acid are believed to be significant genetic risk factors.

Spina bifida may arise because of chromosome abnormalities, single gene mutations, or specific environmental insults such as maternal **diabetes mellitus** or prenatal exposure to certain **anticonvulsant drugs**. The recurrence risk varies with each of these specific causes.

In most cases, spina bifida is obvious at birth because of malformation of the spine. The spine may be completely open, exposing the spinal cord and nerves. More commonly, the spine abnormality appears as a mass on the back covered by membrane (meninges) or skin. Spina bifida may occur anywhere from the base of the skull to the buttocks. About 75% of abnormalities occur in the lower back (lumbar) region. In rare instances, the spinal cord malformation may occur internally, sometimes with a connection to the gastrointestinal tract.

In spina bifida, many complications arise, dependent in part on the level and severity of the spine malformation. As a rule, the nerves below the level of the abnormality develop in a faulty manner and fail to function, resulting in paralysis and loss of sensation below the level of the spine malformation. Since most abnormalities occur in the lumbar region, the lower limbs are paralyzed and lack sensation. Furthermore, the bowel and bladder have inadequate nerve connections, causing an inability to control bowel and bladder function. Most infants also develop hydrocephaly, an accumulation of excess fluid in the four cavities of the brain. At least one of every seven cases develop findings of Chiari II malformation, a condition in which the lower part of the brain is crowded and may be forced into the upper part of the spinal cavity.

There are a number of mild variant forms of spina bifida, including multiple vertebral abnormalities, skin dimples, tufts of hair, and localized areas of skin deficiency over the spine. Two variants, lipomeningocele and lipomyelomeningocele, typically occur in the lower back area (lumbar or sacral) of the spine. In these conditions, a tumor of fatty tissue becomes isolated among the nerves below the spinal cord, which may result in tethering of the spinal cord and complications similar to those with open spina bifida.

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KEY TERMS

Anticonvulsant—Group of medications used in the treatment of epileptic seizures.

Chiari II anomaly—A structural abnormality of the lower portion of the brain (cerebellum and brain stem) associated with spina bifida. The lower structures of the brain are crowded and may be forced into the foramen magnum, the opening through which the brain and spinal cord are connected.

Fetus—The term used to describe a developing human infant from approximately the third month of pregnancy until delivery. The term embryo is used prior to the third month.

Folic acid—One of the B vitamins important for healthy growth of the fetus. It is essential to the normal development of a baby's spine, brain and skull, especially during the first four weeks of pregnancy.

Hydrocephalus—The excess accumulation of cerebrospinal fluid around the brain, often causing enlargement of the head.

Meninges—The protective covering around the brain and spinal cord.

Neural tube defect (NTD)—Defective neural tube, the narrow sheath that closes to form the brain and spinal cord of the embryo.

Diagnosis

Examination

Few disorders are to be confused with open spina bifida. The diagnosis is usually obvious based on the external findings at birth. Paralysis below the level of the abnormality and fluid on the brain (hydrocephaly) may contribute to the diagnosis. Other spine abnormalities such as congenital **scoliosis** and **kyphosis**, or soft tissue tumors overlying the spine, are not likely to have these accompanying findings. In cases in which there are no external findings, the diagnosis is more difficult and may not become evident until neurological abnormalities or hydrocephaly develop weeks, months, or years following birth.

Tests

Prenatal diagnosis may be made in most cases with ultrasound examination after 12–14 weeks of pregnancy. Ultrasounds cannot identify every structural problem in a developing baby, so some cases of spina bifida (especially mild forms) may be missed. However, it is a risk-free method to use that gives immediate results.

Prenatal blood screening is often offered to women between 15 and 21 weeks in a pregnancy. This screening measures the levels of various chemicals naturally found in a mother's blood, including alpha-fetoprotein (AFP). For this reason, the screening is often called AFP screening. AFP is a protein normally made by a developing fetus, so it is naturally present in maternal serum and called MS-AFP. When a fetus has spina bifida, the levels of MS-AFP may be higher than usual because it leaks out of the hole in the spine. If a woman's AFP screen comes back abnormal with a high MS-AFP value, she often is at a higher risk for having a baby with spina bifida. This may prompt her physician to offer her a detailed ultrasound, as well as other medical options that might give her more information about the baby.

Once spina bifida is seen outwardly, imaging scans like x-rays, ultrasound, **magnetic resonance imaging** (MRI), or computed tomography (CT) can be helpful to see the extent of it. It is also a good way to identify whether someone has associated neurological complications like **hydrocephalus**.

Some **genetic testing**, like chromosome studies, may identify a diagnosis or cause for the spina bifida. Abnormal genetic test results cannot be changed or reversed, but may provide answers about why the spina bifida occurred.

Procedures

One option to find spina bifida is a procedure called **amniocentesis**. Amniocentesis involves removing a small amount of fluid from around the baby, using a fine needle. This fluid naturally contains AFP, which may also be elevated if the baby has spina bifida. There is a small risk of **miscarriage**, about 1 in 200, with this procedure. As such, every women usually receives proper counseling through their doctor or a genetic counselor before having the test done.

Treatment

As of 2009, there is no known cure for spina bifida. Treatment primarily focuses on dealing with symptoms as they arise, since they vary so greatly from person to person.

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Traditional

Aggressive surgical and medical management have improved the survival and function of infants with spina bifida. Initial surgery may be carried out during the first days of life, providing protection against injury and infection. Subsequent surgery is often necessary to protect against excessive curvature of the spine, and in the presence of hydrocephaly, to place a mechanical shunt to decrease the pressure and amount of cerebrospinal fluid in the cavities of the brain. Because of weakness or paralysis below the level of the spine abnormality, most children will require **physical therapy**, bracing, and other orthopedic assistance to enable them to walk. A variety of approaches including periodic bladder catheterization, surgical diversion of urine, and **antibiotics** are used to protect urinary function.

Although most individuals with spina bifida have normal intellectual function, learning disabilities or mental impairment has occured. This may result, in part, from hydrocephaly and/or infections of the nervous system. Children so affected may benefit from early educational intervention, physical therapy, and **occupational therapy**. Counseling to improve self-image and lessen barriers to socialization becomes important in late childhood and adolescence.

Drugs

Medications are widely available to treat those who develop seizures and these may need periodic adjustments. Those who have problems with bowel or bladder control may also require medications.

Alternative

Open fetal surgery has been performed for spina bifida during the last half of pregnancy. After direct closure of the spine malformation, the fetus is returned to the womb. By preventing chronic intrauterine exposure to mechanical and chemical trauma, **prenatal surgery** improves neurological function and leads to fewer complications after birth. Fetal surgery is considered experimental, and results have been mixed.

Prognosis

Prognosis in spina bifida is extremely varied and unpredictable. Years ago with far less intervention and fewer treatments available, someone with severe spina bifida had a high chance to die from complications. Today, more than 80% of infants born with spina bifida survive with surgical and medical management. Although complications from paralysis, hydrocephaly, Chiari II malformation, and urinary tract deterioration threaten the well-being of the survivors, the outlook for normal intellectual function is good.

Prevention

Prevention of isolated spina bifida and other spinal abnormalities has become possible during recent decades. The major prevention is through the use of a B vitamin, folic acid, for several months prior to and following conception. The CDC and Prevention recommend the intake of 400 micrograms of synthetic folic acid every day for all women of childbearing years.

Resources

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ORGANIZATIONS

Disabled Sports USA, 451 Hungerford Drive, Suite 100, Rockville, MD, 20850, (301) 217-0960, (301) 217-0968, dsusa@dsusa.org, http://www.dsusa.org.
March of Dimes Foundation, 1275 Mamaroneck Avenue, White Plains, NY, 10605, (914) 428-7100, (888) MODIMES, (914) 428-8203, askus@marchofdimes.com, http://www.marchofdimes.com.
National Dissemination Center for Children with Disabilities (NICHCY), PO Box 1492, Washington, DC, 20013-1492, (800) 695-0285, (202) 884-8441, nichcy@aed.org, http://www.nichcy.org.
National Institute of Neurological Disorders and Stroke (NINDS), PO Box 5801, Bethesda, MD, 20824, (301) 496-5751, (800) 352-9424, http://www.ninds.nih.gov.
Spina Bifida Association of America, 4590 MacArthur Blvd. NW, Suite 250, Washington, DC, 20007-4266, (202) 944-3285, (800) 621-3141, (202) 944-3295, sbaa@sbaa.org, http://www.spinabifidaassociation.org.

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Spina bifida occulta *see* **Spina bifida**

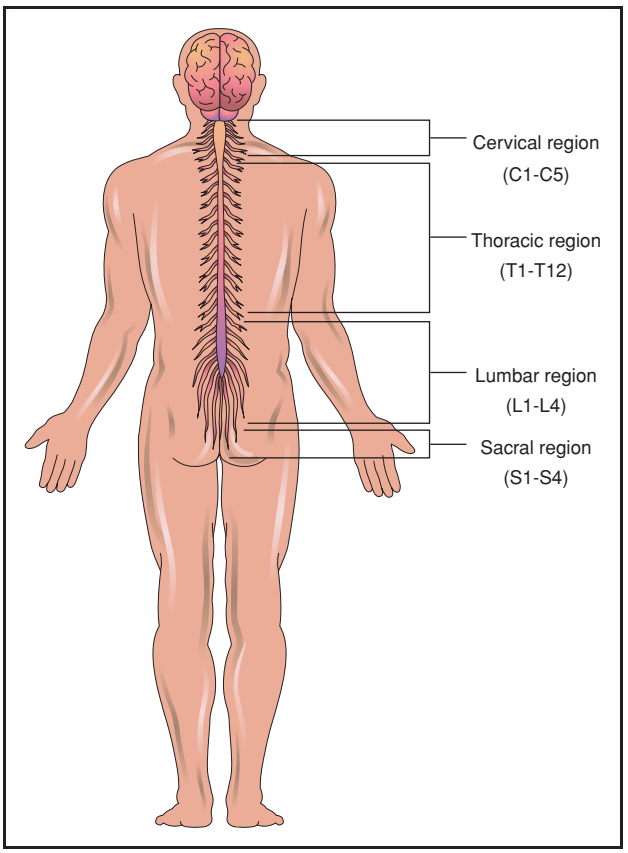
Spinal cord injury

Definition

Spinal cord injury is damage to the spinal cord that causes loss of sensation and motor control.

Description

Approximately 10,000 new spinal cord injuries (SCIs) occur each year in the United States. About 250,000 people are currently affected. Spinal cord injuries can happen to anyone at any time of life. The typical patient, however, is a man between the ages of 19 and 26, injured in a motor vehicle accident (about 50% of all SCIs), a fall (20%), an act of violence (15%), or a sporting accident (14%). Alcohol or other drug **abuse** plays an important role in a large percentage of all spinal cord injuries. Six percent of people who receive injuries to the lower spine die within a year and 40% of people who receive the more frequent higher injuries die within a year.



The extent of sensory and motor loss resulting from a spinal cord injury depends on the level of the injury because nerves at different levels control sensation and movement in different parts of the body. The distribution is as follows: C1–C4: head and neck; C3–C5: diaphragm; C5–T1: shoulders, arms, and hands; T2–T12: chest and abdomen (excluding internal organs); L1–L4: abdomen (excluding internal organs), buttocks, genitals, upper legs; L4–S3: legs; S2–S4: genitals, muscles of the perineum. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Short-term costs for hospitalization, equipment, and home modifications are approximately $140,000 for an SCI patient capable of independent living. Lifetime costs may exceed $1 million. Costs may be three to four times higher for the SCI patient who needs long-term institutional care. Overall costs to the American economy in direct payments and lost productivity are more than $10 billion per year.

Causes and symptoms

Causes

The spinal cord is about as big around as the index finger. It descends from the brain down the back through hollow channels of the backbone. The spinal cord is

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made of nerve cells (neurons). The nerve cells carry sensory data from the areas outside the spinal cord (periphery) to the brain and they carry motor commands from brain to periphery. Peripheral neurons are bundled together to make up the 31 pairs of peripheral nerve roots. The peripheral nerve roots enter and exit the spinal cord by passing through the spaces between the stacked vertebrae. Each pair of nerves is named for the vertebra from which it exits. These are known as:

- C1–8. These nerves enter from the eight cervical or neck vertebrae.
- T1–12. These nerves enter from the thoracic or chest vertebrae.
- L1–5. These nerves enter from the lumbar vertebrae of the lower back.
- S1–5. These nerves enter through the sacral or pelvic vertebrae.
- Coccygeal. These nerves enter through the coccyx or tailbone.

Peripheral nerves carry motor commands to the muscles and internal organs and they carry sensations from these areas and from the body's surface. (Sensory data from the head, including sight, sound, smell, and taste, do not pass through the spinal cord and are not affected by most SCIs.) Damage to the spinal cord interrupts these signals. The interruption damages motor functions that allow the muscles to move, sensory functions such as feeling heat and cold, and autonomic functions such as urination, sexual function, sweating, and blood pressure.

Spinal cord injuries most often occur where the spine is most flexible, in the regions of C5–C7 of the neck, and T10–L2 at the base of the rib cage. Several physically distinct types of damage are recognized. Sudden and violent jolts to nearby tissues can jar the cord. This jarring causes a temporary spinal **concussion**. Concussion symptoms usually disappear completely within several hours. A spinal contusion or bruise is bleeding within the spinal column. The pressure from the excess fluid may kill spinal cord neurons. Spinal compression is caused by some object, such as a tumor, pressing on the cord. Lacerations or tears cause direct damage to cord neurons. Lacerations can be caused by bone fragments or missiles such as bullets. Spinal transection describes the complete severing of the cord. Most spinal cord injuries involve two or more of these types of damage.

Symptoms

PARALYSIS AND LOSS OF SENSATION. The extent to which movement and sensation are damaged depends on the level of the spinal cord injury. Nerves leaving the spinal cord at different levels control sensation and movement in different parts of the body. The distribution is roughly as follows:

- C1–C4: head and neck.
- C3–C5: diaphragm (chest and breathing).
- C5–T1: shoulders, arms and hands.
- T2–T12: chest and abdomen (excluding internal organs).
- L1–L4: abdomen (excluding internal organs), buttocks, genitals, and upper legs.
- L4–S1: legs.
- S2–S4: genitals and muscles of the perineum.

Damage below T1, which lies at the base of the rib cage, causes **paralysis** and loss of sensation in the legs and trunk below the injury. Injury at this level usually does no damage to the arms and hands. Paralysis of the legs is called paraplegia. Damage above T1 involves the arms as well as the legs. Paralysis of all four limbs is called quadriplegia or tetraplegia. Cervical or neck injuries not only cause quadriplegia but also may cause difficulty in breathing. Damage in the lower part of the neck may leave enough diaphragm control to allow unassisted breathing. Patients with damage at C3 or above, just below the base of the skull, require mechanical assistance to breathe.

Symptoms also depend on the extent of spinal cord injury. A completely severed cord causes paralysis and loss of sensation below the wound. If the cord is only partially severed, some function will remain below the injury. Damage limited to the front portion of the cord causes paralysis and loss of sensations of **pain** and temperature. Other sensation may be preserved. Damage to the center of the cord may spare the legs but paralyze the arms. Damage to the right or left half causes loss of position sense, paralysis on the side of the injury, and loss of pain and temperature sensation on the opposite side.

DEEP VENOUS THROMBOSIS. Blood does not flow normally to a paralyzed limb that is inactive for long periods. The blood pools in the deep veins and forms clots, a condition known as **deep vein thrombosis**. A clot or thrombus can break free and lodge in smaller arteries in the brain, causing a **stroke**, or in the lungs, causing **pulmonary embolism**.

PRESSURE ULCERS. Inability to move also leads to pressure ulcers or bed sores. Pressure ulcers form where skin remains in contact with a bed or chair for a long time. The most common sites of pressure ulcers are the buttocks, hips, and heels.

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SPASTICITY AND CONTRACTURE. A paralyzed limb is incapable of active movement, but the muscle still has tone, a constant low level of contraction. Normal muscle tone requires communication between the muscle and the brain. Spinal cord injury prevents the brain from telling the muscle to relax. The result is prolonged muscle contraction or spasticity. Because the muscles that extend and those that bend a joint are not usually equal in strength, the involved joint is bent, often severely. This constant pressure causes deformity. As the muscle remains in the shortened position over several weeks or months, the tendons remodel and cause permanent muscle shortening or contracture. When muscles have permanently shortened, the inner surfaces of joints, such as armpits or palms, cannot be cleaned and the skin breaks down in that area.

HETEROTOPIC OSSIFICATION. Heterotopic ossification is an abnormal deposit of bone in muscles and tendons that may occur after injury. It is most common in the hips and knees. Initially heterotopic ossification causes localized swelling, warmth, redness, and stiffness of the muscle. It usually begins one to four months after the injury and is rare after one year.

AUTONOMIC DYSREFLEXIA. Body organs that regulate themselves, such as the heart, gastrointestinal tract, and glands, are controlled by groups of nerves called autonomic nerves. Autonomic nerves emerge from three different places: above the spinal column, in the lower back from vertebrae T1–L4, and from the lowest regions of the sacrum at the base of the spine. In general, these three groups of autonomic nerves operate in balance. Spinal cord injury can disrupt this balance, a condition called autonomic dysreflexia or autonomic hyperreflexia. Patients with injuries at T6 or above are at greatest risk.

In autonomic dysreflexia, irritation of the skin, bowel, or bladder causes a highly exaggerated response from autonomic nerves. This response is caused by the uncontrolled release of norepinephrine, a hormone similar to adrenaline. Uncontrolled release of norepinephrine causes a rapid rise in blood pressure and a slowing of the heart rate. These symptoms are accompanied by throbbing **headache**, **nausea**, **anxiety**, sweating, and goose bumps below the level of the injury. The elevated blood pressure can rapidly cause loss of consciousness, seizures, cerebral hemorrhage, and **death**. Autonomic dysreflexia is most often caused by an overfull bladder or bladder infection, impaction or hard impassable fecal mass in the bowel, or skin irritation from tight clothing, **sunburn**, or other irritant. Inability to sense these irritants before the autonomic reaction begins is a major cause of dysreflexia.

LOSS OF BLADDER AND BOWEL CONTROL. Bladder and bowel control require both motor nerves and the autonomic nervous system. Both of these systems may be damaged by SCI. When the autonomic nervous system triggers an urge to urinate or defecate, continence is maintained by contracting the anal or urethral sphincters. A sphincter is a ring of muscle that contracts to close off a passage or opening in the body. When the neural connections to these muscles are severed, conscious control is lost. In addition, loss of feeling may prevent sensations of fullness from reaching the brain. To compensate, the patient may help empty the bowel or bladder by using physical maneuvers that stimulate autonomic contractions before they would otherwise begin. However, the patient may not be able to relax the sphincters. If the sphincters cannot be relaxed, the patient will retain urine or feces.

Retention of urine may cause muscular changes in the bladder and urethral sphincter that make the problem worse. **Urinary tract infection** is common. Retention of feces can cause impaction. Symptoms of impaction include loss of appetite and nausea. Untreated impaction may cause perforation of the large intestine and rapid overwhelming infection.

SEXUAL DYSFUNCTION. Men who have sustained SCI may be unable to achieve an erection or ejaculate. Sperm formation may be abnormal too, which reduces fertility. Fertility and the ability to achieve orgasm are less impaired for women. Women may still be able to become pregnant and deliver vaginally with proper medical care.

Diagnosis

The location and extent of spinal cord injury is determined with **computed tomography scans** (CT scans), **magnetic resonance imaging** (MRI) scans, and x rays. X rays may be enhanced with an injected contrast dye.

Treatment

A person who may have a spinal cord injury should not be moved. Treatment of SCI begins with **immobilization**. This strategy prevents partial injuries of the cord from severing it completely. Use of splints to completely immobilize suspected SCI at the scene of the injury has helped reduce the severity of spinal cord injuries in the last two decades. Intravenous methylprednisone, a steroidal anti-inflammatory drug, is given during the first 24 hours to reduce inflammation and tissue destruction.

Rehabilitation after spinal cord injury seeks to prevent complications, promote recovery, and make the most of remaining function. Rehabilitation is a complex and long-term process. It requires a team of

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professionals, including a neurologist, physiatrist or rehabilitation specialist, physical therapist, and occupational therapist. Other specialists who may be needed include a respiratory therapist, vocational rehabilitation counselor, social worker, speech-language pathologist, nutritionist, special education teacher, recreation therapist, and clinical psychologist. Support groups provide a critical source of information, advice, and support for SCI patients.

As of early 2008, scientists were experimenting with stem cells to treat spinal cord injuries. Research in rats that used embryonic stem cells may lead to new therapies in humans. Embryonic stem cells have the potential to become any cell type in the body depending on what chemical signals they get when they mature. Researchers hope that by triggering embryonic stem cells to become nerve cell precursors and then transplanting these precursor cells into the injured area they can promote healing of the spinal cord. This research is still in its infancy and is controversial because of its use of stem cells from embryos, many of which are obtained from aborted fetuses.

Paralysis and loss of sensation

Some limited mobility and sensation may be recovered but the extent and speed of this recovery cannot be predicted. Experimental electrical stimulation has been shown to allow some control of muscle contraction in paraplegia. This experimental technique offers the possibility of unaided walking. Further development of current control systems will be needed before useful movement is possible outside the laboratory.

The physical therapist focuses on mobility, to maintain range of motion of affected limbs and reduce contracture and deformity. **Physical therapy** helps compensate for lost skills by using those muscles that are still functional. It also helps to increase any residual strength and control in affected muscles. A physical therapist suggests adaptive equipment such as braces, canes, or wheelchairs.

An occupational therapist works to restore ability to perform the activities of daily living, such as eating and grooming, with tools and new techniques. The occupational therapist also designs modifications of the home and workplace to match the individual impairment.

A pulmonologist or respiratory therapist promotes airway hygiene through instruction in assisted coughing techniques and postural drainage. The respiratory professional also prescribes and provides instruction in the use of ventilators, facial or nasal masks, and tracheostomy equipment where necessary.

Pressure ulcers

Pressure ulcers are prevented by turning in bed at least every two hours. The patient should be turned more frequently when redness begins to develop in sensitive areas. Special mattresses and chair cushions can distribute weight more evenly to reduce pressure. Electrical stimulation is sometimes used to promote muscle movement to prevent pressure ulcers.

Spasticity and contracture

Range of motion (ROM) exercises help to prevent contracture. Chemicals can be used to prevent **contractures** from becoming fixed when ROM **exercise** is inadequate. Phenol or alcohol can be injected onto the nerve or botulinum toxin directly into the muscle. Botulinum toxin is associated with fewer complications, but it is more expensive than phenol and alcohol. Contractures can be released by cutting the shortened tendon or transferring it surgically to a different site on the bone where its pull will not cause as much deformity. Such tendon transfers may also be used to increase strength in partially functional extremities.

Heterotopic ossification

Etidronate disodium (Didronel), a drug that regulates the body's use of **calcium**, is used to prevent heterotopic ossification. Treatment begins three weeks after the injury and continues for 12 weeks. Surgical removal of ossified tissue is possible.

Autonomic dysreflexia

Autonomic dysreflexia is prevented by bowel and bladder care and attention to potential irritants. It is treated by prompt removal of the irritant. Drugs to lower blood pressure are used when necessary. People with SCI should educate friends and family members about the symptoms and treatment of dysreflexia, because immediate attention is necessary.

Loss of bladder and bowel control

Normal bowel function is promoted through adequate fluid intake and a diet rich in fiber. Evacuation is stimulated by deliberately increasing the abdominal pressure, either voluntarily or by using an abdominal binder.

Bladder care involves continual or intermittent catheterization. The full bladder may be detected by feeling its bulge against the abdominal wall. Urinary

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KEY TERMS

Autonomic nervous system—The part of the nervous system that controls involuntary functions such as sweating and blood pressure.

Botulinum toxin—Any of a group of potent bacterial toxins or poisons produced by different strains of the bacterium *Clostridium botulinum*.

Computed tomography (CT)—An imaging technique in which cross-sectional x rays of the body are compiled to create a three-dimensional image of the body's internal structures.

Magnetic resonance imaging (MRI)—An imaging technique that uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

Motor—Of or pertaining to motion, the body apparatus involved in movement, or the brain functions that direct purposeful activity.

Motor nerve—Motor or efferent nerve cells carry impulses from the brain to muscle or organ tissue.

Peripheral nervous system—The part of the nervous system that is outside the brain and spinal cord. Sensory, motor, and autonomic nerves are included.

Postural drainage—The use of positioning to drain secretions from the bronchial tubes and lungs into the trachea or windpipe.

Range of motion (ROM)—The range of motion of a joint from full extension to full flexion (bending) measured in degrees like a circle.

Sensory nerves—Sensory or afferent nerves carry impulses of sensation from the periphery or outward parts of the body to the brain. Sensations include feelings, impressions, and awareness of the state of the body.

Voluntary—An action or thought undertaken or controlled by a person's free will or choice.

tract infection is a significant complication of catheterization and requires frequent monitoring.

Sexual dysfunction

Counseling can help in adjusting to changes in sexual function after spinal cord injury. Erection may be enhanced through the same means used to treat **erectile dysfunction** in the general population.

Prognosis

The prognosis of SCI depends on the location and extent of injury. Injuries of the neck above C4 with significant involvement of the diaphragm hold the gravest prognosis. Respiratory infection is one of the leading causes of death in long-term SCI. Overall, 85% of SCI patients who survive the first 24 hours are alive 10 years after their injuries. Recovery of function is impossible to predict. Partial recovery is more likely after an incomplete wound than after the spinal cord has been completely severed.

Prevention

Risk of spinal cord injury can be reduced through prevention of the accidents that lead to it. Chances of injury from automobile accidents, the major cause of SCIs, can be significantly reduced by driving at safe speeds, avoiding alcohol while driving, and using seat belts.

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National Spinal Cord Injury Association, 1 Church St., Suite 600, Rockville, MD, 20850, (866) 387-2196, (800) 962-9629, info@spinalcord.org, http://www.spinalcord.org.
Spinal Cord Injuries Australia, 1 Jennifer Street, Little Bay, Australia, NSW 2036, (800) 819-775, office@scia.org.au, http://www.scia.org.au.

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Spinal cord tumors

Definition

A spinal cord tumor is a benign or cancerous growth in the spinal cord, between the membranes covering the spinal cord, or in the spinal canal. A tumor in this location can compress the spinal cord or its nerve roots. As a result, even a noncancerous growth can be disabling unless properly treated.

Spinal cord tumors can be classified according to the origin of their location. Spinal cord tumors, which arise from inside the cord, are termed intramedullary tumors while tumors which originate outside of the cord are classified as extramedullary tumors.

Demographics

Spinal cord tumors are rare and account for about 15% of all tumors of the central nervous system. Primary spinal cord tumors (tumors originating in the spinal cord) are most likely to affect individuals between the ages of 30 and 50 years. Most spinal cord tumors are caused by metastatic lesions that originate from **cancer** elsewhere in the body. Up to 10% of patients diagnosed with cancer will be affected by metastasis of their primary cancer to the spinal cord.

Description

The spinal cord contains bundles of nerves that carry messages between the brain and the body. Because the spinal cord is rigidly encased in bone, any tumor that grows on or near it can compress the nerves, and interfere in this communication.

Newly formed tumors that begin within the spinal cord (primary spinal cord tumors) are unusual, especially among children and the elderly. The most common types of primary spinal cord tumors are classified as astrocytomas and ependymomas.

More typically, tumors originate elsewhere in the body and move through the bloodstream (metastasize) to the spinal cord. Cancers which tend to metastasize to the spinal cord include cancers of the breast, prostate, kidney, and lung as well as lymphoma, sarcoma, and **multiple myeloma**. Intramedullary metastases are very rare.

KEY TERMS

Computed tomography scans (CT scan)—The CT scan combines an x ray with a computer to create a detailed picture of the spinal cord. It may help to determine the type of tumor, locate swelling or bleeding, and check results of treatment.

Magnetic resonance imaging (MRI)—MRI is an imaging technique that uses a magnetic field to scan the body's tissues and structures. It gives a better picture of tumors located near bone than does a CT scan, without the risk of radiation, and can provide a three-dimensional image of the tumor.

Myelogram—A myelogram is an x-ray exam of the spinal cord, nerves, and other tissues within the spinal cord that are highlighted by injected contrast dye.

Causes and symptoms

The cause of primary spinal cord tumors is unknown.

Initially symptoms of a spinal cord tumor, whether primary or metastatic, may be vague and may include symptoms such as **pain** or stiffness. As the lesion grows however, the tumor places increasing pressure on the spinal cord resulting in symptoms including:

- back pain
- severe or burning pain in other parts of the body
- numbness or cold
- progressive loss of muscle strength or sensation in the legs
- loss of bladder or bowel control

A tumor in the top of the spinal column can cause pain radiating from the arms or neck; a tumor in the lower spine may cause leg or back pain. If there are several tumors in different areas of the spinal cord at the same time, it may cause symptoms in a variety of locations in the body.

Pain may not be associated with spinal cord tumors diagnosed in children. The most common symptom in children affected by intramedullary spinal cord tumors is often disturbance in gait.

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Diagnosis

Diagnosis of primary spinal cord tumors includes imaging studies such as MRI. There are no blood tests that can specifically detect tumors in the spinal cord.

Suspected spinal cord compression, by tumor, is a medical emergency. Prompt intervention may prevent **paralysis** and other neurologic complications.

If a **neurological exam** and review of symptoms suggest a spinal cord tumor, the doctor may order the following tests:

- MRI, the procedure of choice
- CT and nuclear medicine bone scans
- intrathecal contrast-enhanced myelography
- blood tests such as a complete blood test (CBC), erthyrocyte sedimentation rate (ESR), clotting studies, and metabolic profile including tests to determine calcium levels and liver function tests
- x rays of the spine

Lumbar puncture is often contraindicated when a spinal tumor is suspected.

Treatment

Primary spinal cord tumors are often slow-growing tumors, which are typically contained to an anatomic site. Therefore, when possible, surgical removal of the tumor is the treatment of choice. Because these tumors are slow-growing, **radiation therapy** and **chemotherapy** are not considered to be as effective on this tumor type. Some of the more aggressive tumor types may be treated using radiation therapy. Currently, chemotherapy is considered experimental therapy for the treatment of spinal cord tumors.

Treatment of a metastatic lesion to the spinal cord is initiated rapidly and is considered a medical emergency to prevent permanent neurologic damage. Treatment is typically initiated using **corticosteroids** such as dexamethasone (Decadron, Hexadrol). Corticosteroids have anti-inflammatory properties and may help to preserve neurologic function in spinal cord compression. Other treatments that may be used include radiation therapy to the site, chemotherapy, and surgical decompression.

Prognosis

The prognosis for patients diagnosed with primary spinal cord tumors is dependent upon several factors including tumor type, size of the tumor, location of the tumor, effect of the tumor on neurologic function prior to surgery, success of the surgery in removing most or all of the cancer, and age of the patient. Patients younger than age 60, with tumors affecting only one level of the spinal cord that are able to be totally removed generally, have the most favorable prognoses.

Patients with metastatic lesions to the spinal cord whose lesions are detected and treated promptly derive substantial benefit. However, the long-term prognosis is ultimately dependent upon the success of treating the primary tumor.

Prevention

At this time, since it is not known what causes most cases of primary spinal cord tumors, it is not possible to prevent this type of cancer.

Since metastatic spinal cord tumors are the result of a cancer that has first appeared elsewhere in the body, early detection and treatment of cancer in other organs may prevent the spread of the cancer to the spinal cord in some people. However, even though these primary cancers may be detected and treated promptly, it may not be possible to stop the spread of some of these cancers to the spinal cord.

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Spinal fluid analysis *see* **Cerebrospinal fluid (CSF) analysis**

Spinal fusion *see* **Disk removal**

Spinal instrumentation

Definition

Spinal instrumentation is a method of straightening and stabilizing the spine after spinal fusion, by surgically attaching hooks, rods, and wire to the spine in a way that redistributes the stresses on the bones and keeps them in proper alignment.

Purpose

Spinal instrumentation is used to treat instability and deformity of the spine. Instability occurs when the spine no longer maintains its normal shape during movement. Such instability results in nerve damage, spinal deformities, and disabling **pain**. Spinal deformities may be caused by:

- birth defects
- fractures
- marfan syndrome
- neurofibromatosis
- neuromuscular diseases
- severe injuries
- tumors

Curvature of the spine (**scoliosis**) is usually treated with spinal fusion and spinal instrumentation. Scoliosis is a disorder of unknown origin. It causes bending and twisting of the spine that eventually results in distortion of the chest and back. About 85% of cases occur in girls between the ages of 12 and 15, who are experiencing adolescent growth spurt.

Spinal instrumentation serves three purposes. It provides a stable, rigid column that encourages bones to fuse after spinal-fusion surgery. Second, it redirects the stresses over a wider area. Third, it restores the spine to its proper alignment.

Different types of spinal instrumentation are used to treat different spinal problems. Several common types of spinal instrumentation are explained below. Although the details of the insertion of rods, wires, and hooks varies, the purpose of all spinal instrumentation is the same—to correct and stabilize the backbone.

Harrington rod

The Harrington Rod is one of the oldest and most proven forms of spinal instrumentation. It is used to straighten and stabilize the spine when curvature is greater than 60 degrees. It is an appropriate treatment for scoliosis.

Advantages of the Harrington rod are its relative simplicity of installation, the low rate of complications, and a proven record of reducing curvature of the spine. The main disadvantage is that the patient must remain in a body cast for about six months, then wear a brace for another three to six months while the bone fusion solidifies.

Luque rod

Luque rods are custom contoured metal rods that are fixed to each segment (vertebra) in the affected part of the spine. The main advantage is that the patient may not need to wear a cast or brace after the procedure. The main disadvantage is that the risk of injury to the nerves and spinal cord is higher than with a some other forms of instrumentation. This is because wires must be threaded through each vertebra near the spinal column, increasing the risk of such damage. Luque rods are sometimes used to treat scoliosis.

Drummond instrumentation

Drummond instrumentation, also called Harri-Drummond instrumentation, uses a Harrington rod on the concave side of the spine and a Luque rod on the convex side. The advantage is that each vertebra segment is fixed, with the risk of nerve injury decreased over Luque rod instrumentation. The disadvantage is that, like Harrington rod instrumentation, the patient must wear a cast and a brace after surgery.

Cotrel-Dubousset instrumentation

Cotrel-Dubousset instrumentation uses hooks and rods in a cross-linked pattern to realign the spine and redistribute the biomechanical stress. The main advantage of Cotrel-Dubousset instrumentation is that because of the extensive cross-linking, the patient may have to wear a cast or brace after surgery. The disadvantage is the complexity of the operation and the number of hooks and cross-links that may fail.

Zeilke instrumentation

Zeilke instrumentation is similar to Cotrel-Dubousset instrumentation but is used to treat double curvature of the spine. It requires wearing a brace for many months after surgery.

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Other forms of instrumentation

The Kaneda device is used to treat fractured thoracic or lumbar vertebrae when it is suspected that bone fragments are present in the spinal canal. Variations on the basic forms of spinal instrumentation, such as Wisconsin instrumentation, are being refined as technology improves. A physician chooses the proper type of instrumentation based on the type of disorder, the age and health of the patient, and on the physician's experience.

Precautions

Since the hooks and rods of spinal instrumentation are anchored in the bones of the back, spinal instrumentation should not be performed on people with serious **osteoporosis**. To overcome this limitation, techniques are being explored that help anchor instrumentation in fragile bones.

KEY TERMS

Lumbar vertebrae—The vertebrae of the lower back below the level of the ribs.

Marfan syndrome—A rare hereditary defect that affects the connective tissue.

Neurofibromatosis—A rare hereditary disease that involves the growth of lesions that may affect the spinal cord.

Osteoporosis—A bone disorder, usually seen in the elderly, in which the boned become increasingly less dense and more brittle.

Spinal fusion—An operation in which the bones of the lower spine are permanently joined together using a bone graft obtained usually from the hip.

Thoracic vertebrae—The vertebrae in the chest region to which the ribs attach.

Description

Spinal instrumentation is performed by a neuro and/or orthopedic surgical team with special experience in spinal operations. The surgery is done in a hospital under **general anesthesia**. It is done at the same time as spinal fusion.

The surgeon strips the muscles away from the area to be fused. The surface of the bone is peeled away. A piece of bone is removed from the hip and placed alongside the area to be fused. The stripping of the bone helps the bone graft to fuse.

After the fusion site is prepared, the rods, hooks, and wires are inserted. There is some variation in how this is done based on the spinal instrumentation chosen. In general, Harrington rods are the simplest instrumentation to install, and Cotrel-Dubousset instrumentation is the most complex and risky. Once the rods are in place, the incision is closed.

Preparation

Spinal fusion with spinal instrumentation is a major surgery. The patient will undergo many tests to determine that nature and exact location of the back problem. These tests are likely to include x rays, **magnetic resonance imaging** (MRI), **computed tomography scans** (CT scans), and myleograms. In addition, the patient will undergo a battery of blood and urine tests, and possibly an electrocardiogram to provide the surgeon and anesthesiologist with information that will allow the operation to be performed safely. In Harrington rod instrumentation, the patient may be placed in **traction** or an upper body cast to stretch contracted muscles before surgery.

Aftercare

After surgery, the patient will be confined to bed and a catheter will be inserted so that the patient can urinate without getting up. Vital signs will be monitored and the patient's position will be changed frequently so that **bedsores** do not develop.

Recovery from spinal instrumentation can be a long, arduous process. Movement is severely limited for a period of time. In certain types of instrumentation, the patient is put in a cast to allow the realigned bones to stay in position until healing takes place. This can be as long as six to eight months. Many patients will need to wear a brace after the cast is removed.

During the recovery period, the patient is taught respiratory exercises to help maintain respiratory function during the time of limited mobility. Physical therapists assist the patient in learning self-care and in performing strengthening and range of motion exercises. Length of hospital stay depends on the age and health of the patient as well as the specific problem that was corrected. The patient can expect to remain under a physician's care for many months.

Risks

Spinal instrumentation carries a significant risk of nerve damage and **paralysis**. The skill of the surgeon can affect the outcome of the operation so patients

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should look for a hospital and surgical team that has a lot of experience doing spinal procedures.

After surgery there is a risk of infection or an inflammatory reaction due to the presence of the foreign material in the body. Serious infection of the membranes covering the spinal cord and brain can occur. In the long-term, the instrumentation may move or break, causing nerve damage and requiring a second surgery. Some bone grafts do not heal well, lengthening the time the patient must spend in a cast or brace, or necessitating additional surgery. Casting and wearing a brace may take an emotional toll, especially on young people. Patients who have had spinal instrumentation must avoid contact sports and, for the rest of their lives, eliminate situations that will abnormally put stress on their spines.

Normal results

Many young people with scoliosis heal with significantly improved alignment of the spine. Results of spinal instrumentation done for other conditions vary widely.

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National Scoliosis Foundation, 5 Cabot Place, Stoughton, Soughton, MA, 20724, (800) 673-6922, NSF@scoliosis.org, http://www.scoliosis.org.

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Spinal meningitis *see* **Meningitis**

Spinal stenosis

Definition

Spinal stenosis is any narrowing of the spinal canal that causes compression of the spinal nerve cord. Spinal stenosis causes **pain** and may cause loss of some body functions.

Description

Spinal stenosis is a progressive narrowing of the opening in the spinal canal. The spine is a long series of bones called vertebrae. Between each pair of vertebra is a fibrous intervertebral disk. Collectively, the vertebrae and disks are called the backbone. Each vertebra has a hole through it. These holes line up to form the spinal canal. A large bundle of nerves called the spinal cord runs through the spinal canal. This bundle of 31 nerves carries messages between the brain and the various parts of the body. At each vertebra, some smaller nerves branch out from these nerve roots to serve the muscles and tissue in the immediate area. When the spinal canal narrows, nerve roots in the spinal cord are squeezed. Pressure on the nerve roots causes chronic pain and loss of control over some functions because communication with the brain is interrupted. The lower back and legs are most affected by spinal stenosis. The nerve roots that supply the legs are near the bottom of the spinal cord. The pain gets worse after standing for a long time and after some forms of **exercise**. The posture required by these physical activities increases the **stress** on the nerve roots. Spinal stenosis usually affects people over 50 years of age. Women have the condition more frequently than men do.

Cervical spinal stenosis is a narrowing of the vertebrae of the neck (cervical vertebrae). The disease and its effects are similar to stenosis in the lower spine. A narrower opening in the cervical vertebrae can also put pressure on arteries entering the spinal column, cutting off the blood supply to the remainder of the spinal cord.

Causes and symptoms

Spinal stenosis causes pain in the buttocks, thigh, and calf and increasing weakness in the legs. The patient may also have difficulty controlling bladder and bowel functions. The pain of spinal stenosis seems more severe when the patient walks downhill. Spinal stenosis can be congenital, acquired, or a combination. Congenital spinal stenosis is a birth defect. Acquired spinal stenosis develops after birth. It is usually a consequence of tissue destruction (degeneration) caused by an **infectious disease** or a disease in which the immune system attacks the body's own cells (autoimmune disease). The two most common causes of spinal stenosis are birth defect and progressive degeneration of the tissue of the joints (**osteoarthritis**). Other causes include improper alignment of the vertebrae as in spondylolisthesis, destruction of bone tissue as in Paget's disease, or an overgrowth of bone tissue as in diffuse idiopathic skeletal hyperostosis. The spinal canal is usually more than 0.5 in (12 mm) in diameter. A smaller diameter indicates stenosis. The diameter of the cervical spine ranges is 0.6–1 in (15–12 mm). Any opening under 0.5 in (13 mm)in diameter is considered evidence of stenosis. Acquired spinal stenosis usually begins with degeneration of the intervertebral disks or the surfaces of the vertebrae or both. In trying to heal this degeneration, the body builds

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KEY TERMS

Computed tomography (CT) Scans—An imaging technique in which cross-sectional x rays of the body are compiled to create a three-dimensional image of the body's internal structures.

Congenital—Present before birth. The term is used to describe disorders that developed in the fetal stage.

Doppler scanning—A procedure in which ultrasound images are used to watch a moving structure such as the flow of blood or the beating of the heart.

Electromyography—A test that uses electrodes to record the electrical activity of muscle. The information gathered is used to find disorders of the nerves that serve the muscles.

Evoked potential—A test of nerve response that uses electrodes placed on the scalp to measure brain reaction to a stimulus such as a touch.

Magnetic resonance imaging (MRI)—An imaging technique that uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

Nerve conduction velocity test—A test that measures the time it takes a nerve impulse to travel a specific distance over the nerve after electronic stimulation.

Stenosis—The narrowing or constriction of a channel or opening.

up the spinal column. In the process, the spinal canal can become narrower.

Diagnosis

The physician must determine that the symptoms are caused by spinal stenosis. Conditions that can cause similar symptoms include a slipped (herniated) intervertebral disk, spinal tumors, and disorders of the blood flow (circulatory disorders). Spinal stenosis causes back and leg pain. The leg pain is usually worse when the patient is standing or walking. Some forms of spinal stenosis are less painful when the patient is riding an exercise bike because the forward tilt of the body changes the pressure in the spinal column. Doppler scanning can trace the flow of blood to determine whether the pain is caused by circulatory problems. X-ray images, **computed tomography scans** (CT scans), and **magnetic resonance imaging** (MRI) scans can reveal any narrowing of the spinal canal. **Electromyography**, nerve conduction velocity, or **evoked potential studies** can locate problems in the muscles indicating areas of spinal cord compression.

Treatment

Mild cases of spinal stenosis may be treated with rest, **nonsteroidal anti-inflammatory drugs** (such as **aspirin**), and **muscle relaxants**. Spinal stenosis can be a progressive disease, however, and the source of pressure may have to be surgically removed (surgical decompression) if the patient is losing control over bladder and bowel functions. The surgical procedure removes bone and other tissues that have entered the spinal canal or put pressure on the spinal cord. Two vertebrae may be fused, to eliminate improper alignment, such as that caused by spondylolisthesis. For surgery, patients lie on their sides or in a modified kneeling position. This position reduces bleeding and places the spine in proper alignment. Alignment is especially important if vertebrae are to be fused. Surgical decompression can eliminate leg pain and restore control of the legs, bladder, and bowels, but usually does not eliminate lower back pain. **Physical therapy** and massage can help reduce the symptoms of spinal stenosis. An exercise program should be developed to increase flexibility and mobility. A brace or corset may be worn to improve posture. Activities that place stress on the lower back muscles should be avoided.

Prognosis

Surgical decompression does not stop the degenerative processes that cause spinal stenosis and the condition can develop again. Nevertheless, most patients achieve good results with surgical decompression. The patient will probably continue to have lower back pain after the surgical procedure.

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Spinal tap *see* **Cerebrospinal fluid (CSF) analysis**

Spirometry

Definition

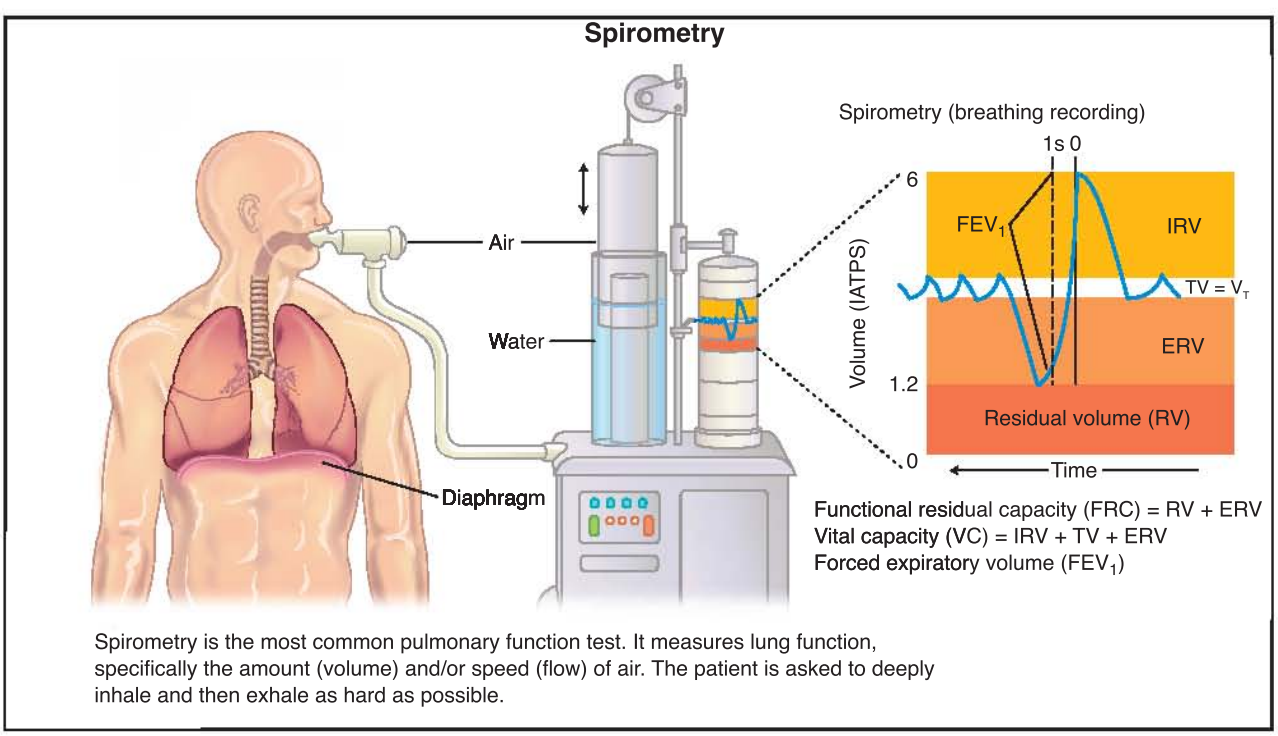
Spirometry is the measurement of air flow into and out of the lungs.

Description

Spirometry requires that the nose is pinched off as the patient breathes through a mouthpiece attached to the spirometer. The patient is instructed on how to breathe during the procedure. Three breathing maneuvers are practiced before recording the procedure, and the highest of three trials is used for evaluation of breathing. This procedure measures air flow by electronic or mechanical displacement principles and uses a microprocessor and recorder to calculate and plot air flow.

The test produces a recording of the patient's ventilation under conditions involving both normal and maximal effort. The recording, called a spirogram, shows the volume of air moved and the rate at which it travels into and out of the lungs. Spirometry measures several lung capacities. Accurate measurement is dependent upon the patient performing the appropriate maneuver properly. The most common measurements are:

- Vital capacity (VC). This is the amount of air (in liters) moved out of the lung during normal breathing. The patient is instructed to breathe in and out normally to attain full expiration. Vital capacity is usually about 80% of the total lung capacity. Because of the elastic nature of the lungs and surrounding thorax, a small volume of air will remain in the lungs after full exhalation. This volume is called the residual volume (RV).
- Forced vital capacity (FVC). After breathing out normally to full expiration, the patient is instructed to breathe in with a maximal effort and then exhale as forcefully and rapidly as possible. The FVC is the volume of air that is expelled into the spirometer following a maximum inhalation effort.
- Forced expiratory volume (FEV). At the start of the FVC maneuver, the spirometer measures the volume of air delivered through the mouthpiece at timed



Spirometry is the most common pulmonary function test. It measures lung function, specifically the amount (volume) and/or speed (flow) of air. The patient is asked to deeply inhale and then exhale as hard as possible.

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intervals of 0.5, 1.0, 2.0, and 3.0 seconds. The sum of these measurements normally constitutes about 97% of the FVC measurement. The most commonly used FEV measurement is FEV-1, which is the volume of air exhaled into the mouthpiece in one second. The FEV-1 should be at least 70% of the FVC.

- Forced expiratory flow 25–75% (FEF 25–75). This is a calculation of the average flow rate over the center portion of the forced expiratory volume recording. It is determined from the time in seconds at which 25% and 75% of the vital capacity is reached. The volume of air exhaled in liters per second between these two times is the FEF 25–75. This value reflects the status of the medium and small sized airways.
- Maximal voluntary ventilation (MVV). This maneuver involves the patient breathing as deeply and as rapidly as possible for 15 seconds. The average air flow (liters per second) indicates the strength and endurance of the respiratory muscles.

Normal values for FVC, FEV, FEF, and MVV are dependent on the patient's age, gender, and height.

KEY TERMS

Bronchodilator—A drug, usually self-administered by inhalation, that dilates the airways.

Forced expiratory volume (FEV)—The volume of air exhaled from the beginning of expiration to a set time (usually 0.5, 1, 2, and 3 seconds).

Forced vital capacity (FVC)—The volume of air that can be exhaled forceably after a maximal inspiration.

Hemoptysis—Spitting up of blood derived from the lungs or bronchial tubes as a result of pulmonary or bronchial hemorrhage.

Thrombosis—Formation or presence of a thrombus; clotting within a blood vessel that may cause infarction of tissues supplied by the vessel.

Thrombotic—Relating to, caused by, or characterized by thrombosis.

Vital capacity (VC)—The volume of air that can be exhaled following a full inspiration.

Purpose

Spirometry is the most commonly performed pulmonary function test (PFT). The test can be performed at the bedside, in a physician's office, or in a pulmonary laboratory. It is often the first test performed when a problem with lung function is suspected. Spirometry may also be suggested by an abnormal x ray, arterial **blood gas analysis**, or other diagnostic pulmonary test result. The National Lung Health Education Program recommends that regular spirometry tests be performed on persons over 45 years old who have a history of **smoking**. Spirometry tests are also recommended for persons with a family history of lung disease, chronic respiratory ailments, and advanced age.

Spirometry measures ventilation and the movement of air into and out of the lungs. The spirogram will identify two different types of abnormal ventilation patterns, obstructive and restrictive.

Common causes of an obstructive pattern are **cystic fibrosis**, **asthma**, **bronchiectasis**, **bronchitis**, and **emphysema**. These conditions may be collectively referred to by using the acronym CABBE. Chronic bronchitis, emphysema, and asthma result in dyspnea (difficulty breathing) and ventilation deficiency, a condition known as **chronic obstructive pulmonary disease** (COPD). COPD is the fourth leading cause of **death** among Americans.

Common causes of a restrictive pattern are **pneumonia**, heart disease, **pregnancy**, lung fibrosis, **pneumothorax** (collapsed lung), and **pleural effusion** (compression caused by chest fluid).

Obstructive and restrictive patterns can be identified on spirographs using both a "y" and "x" axis. Volume (liters) is plotted on the y-axis versus time (seconds) on the x-axis. A restrictive pattern is characterized by a normal shape showing reduced volumes for all parameters. The reduction in volumes indicates the severity of the disease. An obstructive pattern produces a spirogram with an abnormal shape. Inspiration volume is reduced. The volume of air expelled is normal but the air flow rate is slower, causing an elongated tail to the FVC.

A flow-volume loop spirogram is another way of displaying spirometry measurements. This requires the FVC maneuver followed by a forced inspiratory volume (FIV). Flow rate in liters per second is plotted on the y-axis and volume (liters) is plotted on the x-axis. The expiration phase is shown on top and the inspiration phase on the bottom. The flow-volume loop spirogram is helpful in diagnosing upper airway obstruction and differentiating some types of restrictive patterns.

Some conditions produce specific signs on the spirogram. Irregular inspirations with rapid frequency are caused by hyperventilation associated with **stress**. Diffuse fibrosis of the lung causes rapid breathing of reduced volume, which produces a repetitive pattern known as the penmanship sign. Serial reduction in the FVC peaks indicates air trapped inside the lung. A

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notch and reduced volume in the early segments of the FVC is consistent with airway collapse. A rise at the end of expiration is associated with airway resistance.

Spirometry is used to assess lung function over time and often to evaluate the efficacy of bronchodilator inhalers such as albuterol. It is important for the patient to refrain from using a bronchodilator prior to the evaluation. Spirometry is performed before and after inhaling the bronchodilator. In general, a 12% or greater improvement in both FVC and FEV-1, or an increase in FVC by 0.2 liters, is considered a significant improvement for an adult patient.

Precautions

The patient should inform the physician of any medications he or she is taking, or of any medical conditions that are present; these factors may affect the validity of the test. The patient's smoking habits and history should be thoroughly documented. The patient must be able to understand and respond to instructions for the breathing maneuvers. Therefore, the test may not be appropriate for very young, unresponsive, or physically impaired persons.

Spirometry is contraindicated in patients whose condition will be aggravated by forced breathing, including:

- hemoptysis (spitting up blood from the lungs or bronchial tubes)
- pneumothorax (free air or gas in the pleural cavity)
- recent heart attack
- unstable angina
- aneurysm (cranial, thoracic, or abdominal)
- thrombotic condition (such as clotting within a blood vessel)
- recent thoracic or abdominal surgery
- nausea or vomiting

The test should be terminated if the patient shows signs of significant head, chest, or abdominal **pain** while the procedure is in progress.

Spirometry is dependent upon the patient's full compliance with breathing instructions, especially his or her willingness to extend a maximal effort at forced breathing. Therefore, the patient's emotional state must be considered.

Preparation

The patient's age, gender, and race are recorded, and height and weight are measured before the procedure begins. The patient should not have eaten heavily within three hours of the test. He or she should be instructed to wear clothing that fits loosely over the chest and abdominal area. The respiratory therapist or other testing personnel should explain and demonstrate the breathing maneuvers to the patient. The patient should practice breathing into the mouthpiece until he or she is able to duplicate the maneuvers successfully on two consecutive attempts.

Aftercare

In most cases, special care is not required following spirometry. Occasionally, a patient may become lightheaded or dizzy. Such patients should be asked to rest or lie down, and should not be discharged until after the symptoms subside. In rare cases, the patient may experience pneumothorax, intracranial **hypertension**, chest pain, or uncontrolled coughing. In such cases, additional care directed by a physician may be required.

Normal results

The results of spirometry tests are compared to predicted values based on the patient's age, gender, and height. For example, a young adult in good health is expected to have the following FEV values:

- FEV-0.5—50–60% of FVC
- FEV-1—75–85% of FVC
- FEV-2—95% of FVC
- FEV-3—97% of FVC

In general, a normal result is 80–100% of the predicted value. Abnormal values are:

- mild lung dysfunction—60–79%
- moderate lung dysfunction—40–59%
- severe lung dysfunction—below 40%

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ORGANIZATIONS

National Lung Health Education Program (NLHEP), 1850 High Street, Denver, CO, 80218, http://www.nlhep.org.

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Spleen, enlarged *see* **Hypersplenism**
Spleen removal *see* **Splenectomy**

Splenectomy

Definition

Splenectomy is the surgical removal of the spleen, which is an organ that is part of the lymphatic system. The spleen is a dark-purple, bean-shaped organ located in the upper left side of the abdomen, just behind the bottom of the rib cage. In adults, the spleen is about 4.8 X 2.8 X 1.6 in (12 X 7 X 4 cm) in size and weighs about 4–5 oz (113–14 zg). Its functions include a role in the immune system; filtering foreign substances from the blood; removing worn-out blood cells from the blood; regulating blood flow to the liver; and sometimes storing blood cells. The storage of blood cells is called sequestration. In healthy adults, about 30% of blood platelets are sequestered in the spleen.

Purpose

Splenectomies are performed for a variety of different reasons and with different degrees of urgency. Most splenectomies are done after the patient has been diagnosed with **hypersplenism**. Hypersplenism is not a specific disease but a group of symptoms, or syndrome, that can be produced by a number of different disorders. It is characterized by enlargement of the spleen (splenomegaly), defects in the blood cells, and an abnormally high turnover of blood cells. It is almost always associated with splenomegaly caused by specific disorders such as **cirrhosis** of the liver or certain cancers. The decision to perform a splenectomy depends on the severity and prognosis of the disease that is causing the hypersplenism.

Splenectomy always necessary

There are two diseases for which splenectomy is the only treatment—primary cancers of the spleen and a blood disorder called hereditary spherocytosis (HS). In HS, the absence of a specific protein in the red blood cell membrane leads to the formation of relatively fragile cells that are easily damaged when they pass through the spleen. The cell destruction does not occur elsewhere in the body and ends when the spleen is removed. HS can appear at any age, even in newborns, although doctors prefer to put off removing the spleen until the child is five or six years old.

Splenectomy usually necessary

There are some disorders in which splenectomy is usually recommended. They include:

- Immune (idiopathic) thrombocytopenic purpura (ITP). ITP is a disease involving platelet destruction. Splenectomy has been regarded as the definitive treatment for this disease and is effective in about 70% of chronic ITP cases. More recently, however, the introduction of new drugs in the treatment of ITP has reopened the question as to whether splenectomy is always the best treatment option.
- Trauma. The spleen can be ruptured by blunt as well as penetrating injuries to the chest or abdomen. Car accidents are the most common cause of blunt traumatic injury to the spleen.
- Abscesses in the spleen. These are relatively uncommon but have a high mortality rate.
- Rupture of the splenic artery. Rupture sometimes occurs as a complication of pregnancy.
- Hereditary elliptocytosis. This is a relatively rare disorder. It is similar to HS in that it is characterized by red blood cells with defective membranes that are destroyed by the spleen.

Splenectomy sometimes necessary

In other disorders, the spleen may or may not be removed.

- Hodgkin's disease, a serious form of cancer that causes lymph nodes to enlarge. Splenectomy is often performed in order to find out how far the disease has progressed.
- Thrombotic thrombocytopenic purpura (TTP). TTP is a rare disorder marked by fever, kidney failure, and an abnormal decrease in the number of platelets. Splenectomy is one part of treatment for TTP.
- Autoimmune hemolytic disorders. These disorders may appear in patients of any age but are most common in patients over 50. The red blood cells are destroyed by antibodies produced by the patient's own body (autoantibodies).
- Myelofibrosis. Myelofibrosis is a disorder in which bone marrow is replaced by fibrous tissue. It produces

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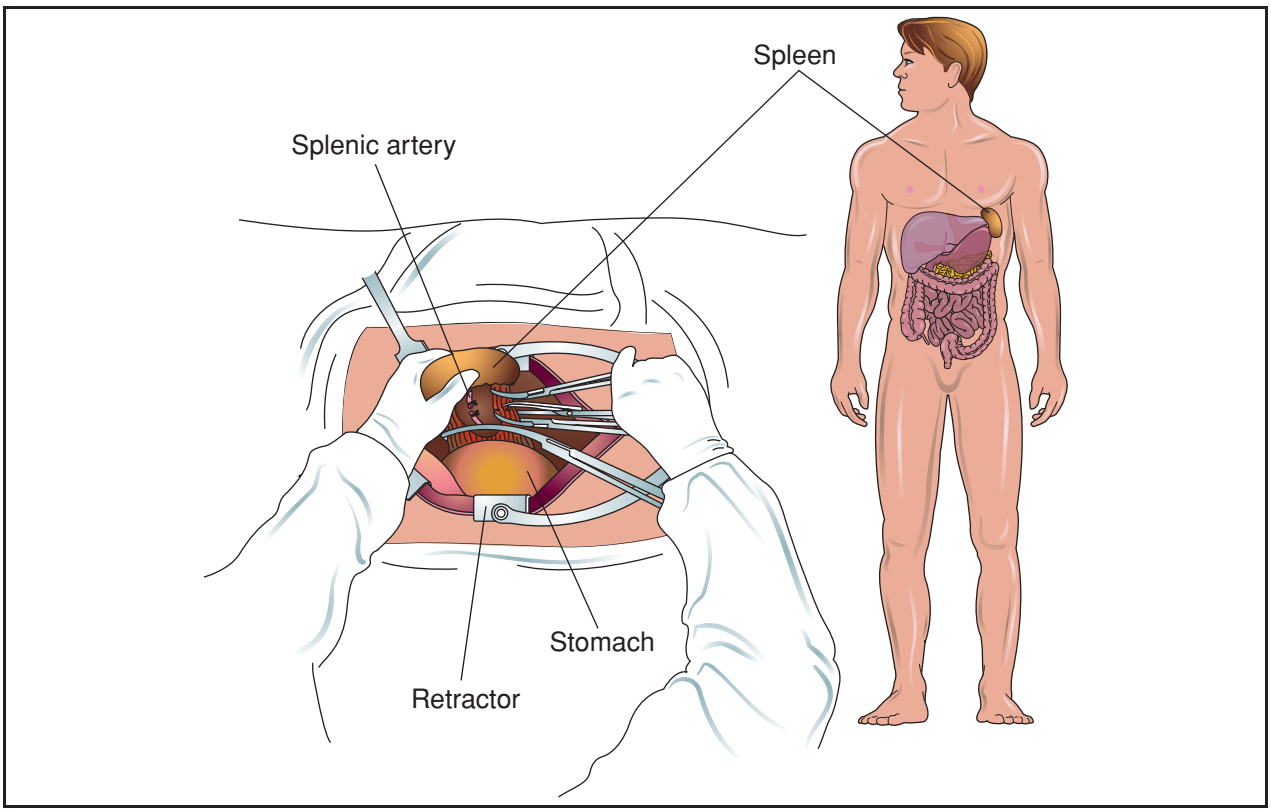

Splenectomy is the surgical removal of the spleen. This procedure is performed as a last result in most diseases involving the spleen. In some cases, however, splenectomy does not address the underlying causes of splenomegaly or other conditions affecting the spleen. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

severe and painful splenomegaly. Splenectomy does not cure myelofibrosis but may be performed to relieve pain caused by the swollen spleen.

- Thalassemia. Thalassemia is a hereditary form of anemia that is most common in people of Mediterranean origin. Splenectomy is sometimes performed if the patient's spleen has become painfully enlarged.

Precautions

Patients should be carefully assessed regarding the need for a splenectomy. Because of the spleen's role in protecting people against infection, it should not be removed unless necessary. The operation is relatively safe for young and middle-aged adults. Older adults, especially those with cardiac or pulmonary disease, are more vulnerable to post-surgical infections. Thromboembolism following splenectomy is another complication for this patient group, which has about 10% mortality following the surgery. Splenectomies are performed in children only when the benefits outweigh the risks.

The most important part of the assessment is the measurement of splenomegaly. The normal spleen cannot be felt when the doctor examines the patient's abdomen. A spleen that is large enough to be felt indicates splenomegaly. In some cases the doctor will hear a dull sound when he or she thumps (percusses) the patient's abdomen near the ribs on the left side. Imaging studies that can be used to demonstrate splenomegaly include ultrasound tests, technetium-99m sulfur colloid imaging, and CT scans. The rate of platelet or red blood cell destruction by the spleen can be measured by tagging blood cells with radioactive chromium or platelets with radioactive indium.

Description

Complete splenectomy

REMOVAL OF ENLARGED SPLEEN. Splenectomy is performed under general anesthesia. The most common technique is used to remove greatly enlarged spleens. After the surgeon makes a cut (incision) in the abdomen, the artery to the spleen is tied to prevent blood loss and reduce the spleen's size. It also helps

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prevent further sequestration of blood cells. The surgeon detaches the ligaments holding the spleen in place and removes it. In many cases, tissue samples will be sent to a laboratory for analysis.

REMOVAL OF RUPTURED SPLEEN. When the spleen has been ruptured by trauma, the surgeon approaches the organ from its underside and fastens the splenic artery.

In some cases, the doctor may prefer conservative (nonsurgical) management of a ruptured spleen, most often when the patient's blood pressure is stable and there are no signs of other abdominal injuries. In the case of multiple abdominal trauma, however, the spleen is usually removed.

Partial splenectomy

In some cases the surgeon removes only part of the spleen. This procedure is considered by some to be a useful compromise that reduces **pain** from an enlarged spleen while leaving the patient less vulnerable to infection. Long-term follow-up of the results of partial splenectomies has not yet been done.

Laparoscopic splenectomy

Laparoscopic splenectomy, or removal of the spleen through several small incisions, has been more frequently used in recent years. Laparoscopic surgery involves the use of surgical instruments, with the assistance of a tiny camera and video monitor. Laparoscopic procedures reduce the length of hospital stay, the level of post-operative pain, and the risk of infection. They also leave smaller **scars**. Laparoscopic splenectomy is not, however, the best option for many patients.

Laparoscopic splenectomy is gaining increased acceptance in the early 2000s as an alternative to open splenectomy for a wide variety of disorders, although splenomegaly still presents an obstacle to laparoscopic splenectomy; massive splenomegaly has been considered a contraindication. In patients with enlarged spleens, however, laparoscopic splenectomy is associated with less morbidity, decreased **transfusion** rates, and shorter hospital stays than when the open approach is used. Patients with enlarged spleens usually have more severe hematologic diseases related to greater morbidity; therefore, laparoscopic splenectomy has potential advantages.

The most frequent serious complication following laparoscopic splenectomy is damage to the pancreas. Application of a hydrogel sealant to the pancreas during surgery, however, appears to significantly reduce the risk of leakage from the pancreas.

Splenic embolization

Splenic embolization is an alternative to splenectomy that is used in some patients who are poor surgical risks. Embolization involves plugging or blocking the splenic artery to shrink the size of the spleen. The substances that are injected during this procedure include polyvinyl alcohol foam, polystyrene, and silicone. Embolization is a technique that needs further study and refinement.

Preparation

Preoperative preparation for nonemergency splenectomy includes:

- Correction of abnormalities of blood clotting and the number of red blood cells.
- Treatment of any infections.
- Control of immune reactions. Patients are usually given protective vaccinations about a month before surgery. The most common vaccines used are Pneumovax or Pnu-Imune 23 (against pneumococcal infections) and Menomune-A/C/Y/W-135 (against meningococcal infections).

Aftercare

Immediately following surgery, patients should follow the physician's instructions and take all medications intended to prevent infection. Blood transfusions may be indicated for some patients to replace defective blood cells. The most important part of aftercare, however, is long-term caution regarding vulnerability to infection. Patients should see their doctor at once if they have a **fever** or any other sign of infection, and avoid travel to areas where exposure to **malaria** or similar diseases is likely. Children with splenectomies may be kept on antibiotic therapy until they are 16 years old. All patients can be given a booster dose of pneumococcal vaccine 5 to 10 years after splenectomy.

Risks

The chief risk following splenectomy is overwhelming bacterial infection, or postsplenectomy **sepsis**. This vulnerability results from the body's decreased ability to clear bacteria from the blood, and lowered levels of a protein in blood plasma that helps to fight viruses (immunoglobulin M). The risk of dying from infection after splenectomy is highest in children, especially in the first two years after surgery. The risk of postsplenectomy sepsis can be reduced by vaccinations before the

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KEY TERMS

Embolization—An alternative to splenectomy that involves injecting silicone or similar substances into the splenic artery to shrink the size of the spleen.

Hereditary spherocytosis (HS)—A blood disorder in which the red blood cells are relatively fragile and are damaged or destroyed when they pass through the spleen. Splenectomy is the only treatment for HS.

Hypersplenism—A syndrome marked by enlargement of the spleen, defects in one or more types of blood cells, and a high turnover of blood cells.

Immune or idiopathic thrombocytopenic purpura (ITP)—A blood disease that results in destruction of platelets, which are blood cells involved in clotting.

Laparoscope—An instrument used to view the abdominal cavity through a small incision and perform surgery on a small area, such as the spleen.

Pneumovax—A vaccine that is given to splenectomy patients to protect them against bacterial infections. Other vaccines include Pnu-Imune and Menomune.

Sepsis—A generalized infection of the body, most often caused by bacteria.

Sequestration—A process in which the spleen withdraws some normal blood cells from circulation and holds them in case the body needs extra blood in an emergency. In hypersplenism, the spleen sequesters too many blood cells.

Splenomegaly—Abnormal enlargement of the spleen.

Thromboembolism—A clot in the blood that forms and blocks a blood vessel. It can lead to infarction, or death of the surrounding tissue due to lack of blood supply.

operation. Some doctors also recommend a two-year course of penicillin following splenectomy or long-term treatment with ampicillin.

Other risks following splenectomy include inflammation of the pancreas and collapse of the lungs. In some cases, splenectomy does not address the underlying causes of splenomegaly or other conditions. Excessive bleeding after the operation is an additional possible complication, particularly for ITP patients. Infection immediately following surgery may also occur.

Normal results

Results depend on the reason for the operation. In blood disorders, the splenectomy will remove the cause of the blood cell destruction. Normal results for patients with an enlarged spleen are relief of pain and of the complications of splenomegaly. It is not always possible, however, to predict which patients will respond well or to what degree.

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Non-emergency Surgery Hotline. (800) 638-6833.

ORGANIZATIONS

Leukemia Research Foundation, 3520 Lake Avenue, Suite #202, Wilmette, IL, 60091-1064, (847) 424-0600, (847) 424-0606, (888) 558-5385, info@LRFmail.org, http://www.leukemia-research.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

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Splenic trauma

Definition

Splenic trauma is physical injury to the spleen, the lymphatic organ located in the upper left side of the abdomen just under the rib cage. The spleen weighs between 75 and 150 grams (between 0.16 and 0.33 pounds) in adults.

Description

The spleen is an organ that produces white blood cells, filters the blood (10–15% of the total blood supply every minute), stores red blood cells and platelets, and destroys those that are **aging**. It is located near the stomach on the left side of the abdomen. A direct blow to the abdomen may bruise, tear or shatter the spleen. Trauma to the spleen can cause varying degrees of damage, the major problem associated with internal bleeding. Mild splenic subcapsular hematomas are injuries in which bleeding is limited to small areas on and immediately around the spleen. Splenic contusions refer to bruising and bleeding on and around larger areas of the spleen. Lacerations (tears) are the most common splenic trauma injuries. Tears tend to occur on the areas between the three main blood vessels of the spleen. Because of the abundant blood supply, splenic trauma may cause serious internal bleeding. Most injuries to the spleen in children heal spontaneously. Severe trauma can cause the spleen or its blood vessels to rupture or fragment.

Splenic trauma is more common in children than in adults. In general, children are prone to abdominal injuries due to accidents and falls and because their abdominal organs are less protected by bone, muscle and fat. Abdominal injuries including splenic trauma are the most common cause of preventable deaths in children.

Causes and symptoms

The most common cause of injury to the spleen is blunt abdominal trauma. Blunt trauma is often caused by a direct blow to the belly, car and motorcycle accidents, falls, sports mishaps, and fights. The spleen is the most commonly injured organ in blunt abdominal trauma; splenic injury occurs in nearly 25% of injuries of this type. Penetrating injuries such as those from stabbing, gunshot **wounds**, and accidental impaling also account for cases of splenic trauma, although far less frequently than blunt trauma.

In adults, ruptured spleens may have been preceded by conditions causing rapid splenic enlargement, such as infections, particularly those caused by the **Epstein-Barr virus** (EBV); **cancer**; immune system disorders; diseases of the spleen; or circulatory problems. In a very few cases the spleen may be injured by a spell of violent coughing. This type of rupture is known as an atraumatic rupture.

A spleen that has become enlarged and fragile from disease is sometimes ruptured by a doctor or medical student in the course of palpating (feeling) the patient's abdomen, or damaged by a surgeon in the course of an operation on other abdominal organs.

Damage to the spleen may cause localized or general abdominal **pain**, tenderness, and swelling. Fractured ribs may be present. Splenic trauma may cause mild or severe internal bleeding, leading to **shock** and for which symptoms include rapid heartbeat, **shortness of breath**, thirst, pale or clammy skin, weak pulse, low blood pressure, **dizziness**, **fainting**, sweating. **Vomiting** blood, blood in the stools or urine, deterioration of vital signs, and loss of consciousness are other symptoms.

Diagnosis

The goal of diagnosis of all abdominal traumas is to detect and treat life-threatening injuries as quickly as possible. The physician will determine the extent of organ damage and whether surgery will be necessary while providing appropriate emergency care. Initial diagnosis consists of detailing all circumstances of the injury from the patient and bystanders as well as the close **physical examination** of the patient and measurement of vital signs. Blood tests, **urinalysis**, stool samples and x rays of the chest and abdomen are usually performed. Plain x rays may show abdominal air pockets that indicate internal ruptures, but are rarely helpful because they do not show splenic and intra-abdominal damage.

Several other diagnostic tests may be used for the noninvasive and accurate assessment of splenic damage: **computed tomography scans** (CT), of **magnetic resonance imaging** (MRI), radionuclide scanning, and ultrasonography. Ultrasonography—particularly focused abdominal sonographic technique (FAST)—has now become a standard bedside technique in many hospitals to check for bleeding in the abdomen. Imaging tests allow doctors to determine the necessity and type of surgery required. The CT scan has been shown to be the most available and accurate test for abdominal trauma. MRI tests are accurate but costly and less available in some hospitals, while radionuclide scanning requires more time and patient stability. Peritoneal lavage is another diagnostic technique in which

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the abdominal cavity is entered and flushed to check for bleeding. When patients exhibit shock, infection, or prolonged internal bleeding, exploratory **laparoscopy** is used for emergency diagnosis.

Treatment

Not long ago nearly all cases of splenic trauma were treated by laparoscopy, opening the abdomen, and by **splenectomy**, the surgical removal of the spleen. This approach resulted from the difficulty in assessing the severity of the injury, the potential dangers of shock and **death**, and the beliefs that the spleen healed poorly and that it was not an important organ. Nowadays, improved techniques of diagnosis and monitoring (particularly the introduction of CT scans), as well as understanding that removal of the spleen creates future risk of a lowered capacity to fight infection, has modified treatment approaches. Research over the past two decades has shown that the spleen has high healing potential, and confirmed that children are more susceptible to infection after splenectomy (post splenectomy **sepsis**, PSS). PSS has a mortality rate of over 50% and standard procedure now avoids splenectomy as much as possible. Adult splenic trauma is treated by splenectomy more often than children's; for unknown reasons, the adult spleen more frequently spontaneously ruptures after injury. Adults are also less susceptible to PSS.

Nonoperative treatment

In nonoperative therapy, splenic trauma patients are monitored closely, often in intensive care units for several days. Fluid and blood levels are observed and maintained by intravenous fluid and possible blood transfusions. Follow-up scans may be used to observe the healing process.

Operative treatment

Splenic trauma patients require surgery when nonoperative treatment fails, when major or prolonged internal bleeding exists and for gunshot and many stab wounds. Whenever possible, surgeons try to preserve at least part of the spleen and try to repair its blood vessels.

Prognosis

The ample blood supply to the spleen can promote rapid healing. Studies have shown that intra-abdominal bleeding associated with splenic trauma stops without surgical intervention in up to two out of three cases in children. When trauma patients stabilize during nonoperative therapy, chances are high that surgery will be avoided and that spleen injuries will heal themselves. Splenic trauma patients undergoing diagnostic tests such as CT and MRI scans have improved chances of avoiding splenectomy and retaining whole or partial spleens.

KEY TERMS

Computed tomography (CT) scan—Computer-aided x-ray examination that allows cross-sectional views of organs and tissues.

Laparoscope—An optical or fiberoptic instrument that is inserted by incision in the abdominal wall and is used to view the interior of the peritoneal cavity.

Laparoscopy—Procedure using a laparoscope to view organs, obtain tissue samples and perform surgery.

Magnetic resonance imaging (MRI)—Imaging technique using magnets and radio waves to provide internal pictures of the body.

Radionuclide scanning—Diagnostic test in which a radioactive dye is injected into the bloodstream and photographed to display internal vessels, organs and tissues.

Ultrasonography—Imaging test using sound waves to view internal organs and tissues.

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American Association for the Surgery of Trauma. http://www.aast.org.

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ORGANIZATIONS

American Trauma Society, 8903 Presidential Pkwy Suite 512, Upper Marlboro, MD, 20227, (800) 556-7890.

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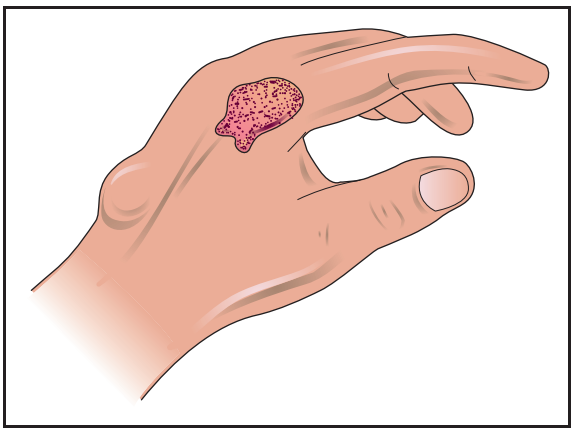
Split personality *see* **Multiple personality disorder**
Spontaneous abortion *see* **Miscarriage**
Sporothrix schenckii infection *see* **Sporotrichosis**



Sporotrichosis is a chronic infection caused by the microscopic fungus *Sporothrix schenckii*. It produces ulcers on the skin that are painless but do not heal, and nodules or knots in the lymph channels near the surface of the body. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Sporotrichosis

Definition

Sporotrichosis is a chronic infection caused by the microscopic fungus *Sporothrix schenckii*. The disease causes ulcers on the skin that are painless but do not heal, as well as nodules or knots in the lymph channels near the surface of the body. Infrequently, sporotrichosis affects the lungs, joints, or central nervous system and can cause serious illness.

Description

The fungus that causes sporotrichosis is found in spagnum moss, soil, and rotting vegetation. Anyone can get sporotrichosis but it is most common among nursery workers, farm laborers, and gardeners handling spagnum moss, roses, or barberry bushes. Cases have also been reported in workers whose jobs took them under houses into crawl spaces contaminated with the fungus. Children who played on baled hay have also gotten the disease. Sporotrichosis is sometimes called spagnum moss disease or alcoholic rose gardener's disease.

Causes and symptoms

The fungus causing sporotrichosis enters the body through scratches or cuts in the skin. Therefore, people who handle plants with sharp thorns or needles, like roses, barberry, or pines, are more likely to get sporotrichosis. Sporotrichosis is not passed directly from person to person, so it is not possible to catch sporotrichosis from another person who has it.

The first signs of sporotrichosis are painless pink, red, or purple bumps usually on the finger, hand, or arm where the fungus entered the body. These bumps may appear anywhere from one to 12 weeks after infection, but usually appear within three weeks. Unlike many other fungal infections sporotrichosis does not cause **fever** or any feelings of general ill health.

The reddish bumps eventually expand and fester, creating skin ulcers that do not heal. In addition, the infection often moves to nearby lymph nodes. Although most cases of sporotrichosis are limited to the skin and lymph channels, occasionally the joints, lungs, and central nervous system become infected. In rare cases, **death** may result.

People who have weakened immune systems, either from a disease such as acquired immune deficiency syndrome (**AIDS**) or leukemia, or as the result of medications they take (**corticosteroids**, **chemotherapy** drugs), are more likely to get sporotrichosis and are more at risk for the disease to spread to the internal organs. Alcoholics and people with **diabetes mellitus** or a pre-existing lung disease are also more likely to become infected. Although sporotrichosis is painless, it is important for people with symptoms to see a doctor and receive treatment.

Diagnosis

The preferred way to diagnose sporotrichosis is for a doctor to obtain a sample of fluid from a freshly opened sore and send it to a laboratory to be cultured. The procedure is fast and painless. It is possible to confirm the presence of advanced sporotrichosis through a blood test or a biopsy. Doctors may also take a blood sample to perform tests that rule out other fungal infections or diseases such as **tuberculosis** or bacterial **osteomyelitis**.

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Dermatologists and doctors who work with AIDS patients are more likely to have experience in diagnosing sporotrichosis. In at least one state, New York, the laboratory test to confirm this disease is provided free through the state health department. In other cases, diagnosis should be covered by health insurance at the same level as other diagnostic laboratory tests.

Treatment

When sporotrichosis is limited to the skin and lymph system, it is usually treated with a saturated solution of potassium iodine that the patient dilutes with water or juice and drinks several times a day. The iodine solution can only be prescribed by a physician. This treatment must be continued for many weeks. Skin ulcers should be treated like any open wound and covered with a clean bandage to prevent a secondary bacterial infection. The drug itraconazol (Sporanox), taken orally, is also available to treat sporotrichosis.

In serious cases of sporotrichosis, when the internal organs are infected, the preferred treatment is the drug amphotericin B. Amphotericin B is a strong anti-fungal drug with potentially severe toxic side effects. It is given intravenously so hospitalization is required for treatment. The patient may also receive other drugs to minimize the side effects of the amphotericin B.

Alternative treatment

Alternative treatment for fungal infections focuses on maintaining general good health and eating a diet low in dairy products, sugars, including honey and fruit juice, and foods, such as beer, that contain yeast. This is complemented by a diet high in raw food. Supplements of **vitamins** C, E, and A, B complex, and pantothenic acid may also be added to the diet, as may *Lactobacillus acidophilus*, bifidobacteria, and garlic capsules.

Fungicidal herbs such as myrrh (*Commiphora molmol*), tea tree oil (*Melaleuca* spp.), citrus seed extract, pau d'arco tea, and garlic (*Allium sativum*) may also be applied directly to the infected skin.

Prognosis

Most cases of sporotrichosis are confined to the skin and lymph system. With treatment, skin sores begin healing in one to two months but complete recovery often takes six months or more. People who have AIDS are also more likely to have the fungus spread throughout the body, causing a life-threatening infection. In people whose bones and joints are infected or who have pulmonary lesions, surgery may be necessary.

KEY TERMS

Acidophilus—The bacteria *Lactobacillus acidophilus,* usually found in yogurt.

Bacterial osteomyelitis—An infection of the bone or bone marrow that is caused by a bacterium.

Bifidobacteria—A group of bacteria normally present in the intestine. Commercial supplements are available.

Corticosteroids—A group of hormones produced naturally by the adrenal gland or manufactured synthetically. They are often used to treat inflammation. Examples include cortisone and prednisone.

Lymph channels—The vessels that transport lymph throughout the body. Lymph is a clear fluid that contains cells important in forming antibodies that fight infection.

Prevention

Since an opening in the skin is necessary for the sporotrichosis fungus to enter the body, the best way to prevent the disease is to avoid accidental scrapes and cuts on the hands and arms by wearing gloves and long sleeves while gardening. Washing hands and arms well after working with roses, barberry, spagnum moss, and other potential sources of the fungus may also provide some protection.

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Tish Davidson, A.M.

Sports injuries

Definition

Sports injuries result from acute trauma or repetitive **stress** associated with athletic activities. Sports injuries can affect bones or soft tissue (ligaments, muscles, tendons).

Professional dancers are increasingly recognized as performing athletes, and many of the treatments

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A soccer player grips his shin after being injured during a match. *(Manuel Queimadelos Alonso/Getty Images.)*

and preventive measures utilized in sports medicine are now applied to dance-related injuries.

It is also important to remember that many types of injuries that affect athletes may also occur in workers in certain occupations; for example, many people in the building trades develop **tennis elbow** or golfer's elbow. The principles of sports medicine can be applied in the treatment of most common musculoskeletal injuries.

Description

Adults are less likely to suffer sports injuries than children, whose vulnerability is heightened by immature reflexes, an inability to recognize and evaluate risks, and underdeveloped coordination.

In 2002, about 20.3 million Americans suffered a sports injury. Of those, 53% were minor enough to be self-treated or left untreated. However, about 10 million Americans annually receive medical attention for their sports-related injuries. That equates to almost 26 per 1,000 people. The highest rate is among children age five to 14 years old (59.3 per 1,000 people). As many as 20% of children who play sports get hurt, and about 25% of their injuries are classified as serious. Boys aged 12 to 17 are the highest risk group. More than 775,000 boys and girls under age 14 are treated in hospital emergency rooms for sports-related injuries.

Injury rates are highest for athletes who participate in contact sports, but the most serious injuries are associated with individual activities. Between one-half and two-thirds of childhood sports injuries occur during practice, or in the course of unorganized athletic activity.

Baseball and softball are the leading causes of sports-related facial trauma in the United States, with 68% of these injuries caused by contact with the ball rather than player-player collision or being hit by a swung bat.

Types of sports injuries

About 95% of sports injuries are minor soft tissue traumas.

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The most common sports injury is a bruise (contusion). It is caused when blood collects at the site of an injury and discolors the skin.

Sprains account for one-third of all sports injuries. A sprain is a partial or complete tear of a ligament, a strong band of tissue that connects bones to one another and stabilizes joints.

A strain is a partial or complete tear of:

- muscle (tissue composed of cells that enable the body to move)
- tendon (strong connective tissue that links muscles to bones)

Inflammation of a tendon (**tendinitis**) and inflammation of one of the fluid-filled sacs that allow tendons to move easily over bones (**bursitis**) usually result from minor stresses that repeatedly aggravate the same part of the body. These conditions often occur at the same time.

SKELETAL INJURIES. **Fractures** account for 5–6% of all sports injuries. The bones of the arms and legs are most apt to be broken. Sports activities rarely involve fractures of the spine or skull. The bones of the legs and feet are most susceptible to stress fractures, which occur when muscle strains or contractions make bones bend. Stress fractures are especially common in ballet dancers, long-distance runners, and in people whose bones are thin.

Shin splints are characterized by soreness and slight swelling of the front, inside, and back of the lower leg, and by sharp **pain** that develops while exercising and gradually intensifies. Shin splints are caused by overuse or by stress fractures that result from the repeated foot pounding associated with activities such as aerobics, long-distance running, basketball, and volleyball.

A compartment syndrome is a potentially debilitating condition in which the muscles of the lower leg grow too large to be contained within membranes that enclose them. This condition is characterized by **numbness and tingling**. Untreated compartment syndrome can result in long-term loss of function.

BRAIN INJURIES. Brain injury is the primary cause of fatal sports-related injuries. **Concussion**, which is also called mild traumatic brain injury or MTBI, can result from even minor blows to the head. A concussion can cause loss of consciousness and may affect:

- balance
- comprehension
- coordination
- hearing
- memory
- vision

Causes and symptoms

Common causes of sports injuries include:

- athletic equipment that malfunctions or is used incorrectly
- falls
- forceful high-speed collisions between players
- wear and tear on areas of the body that are continually subjected to stress

Symptoms include:

- instability or obvious dislocation of a joint
- pain
- swelling
- weakness

Diagnosis

Symptoms that persist, intensify, or reduce the athlete's ability to play without pain should be evaluated by an orthopedic surgeon. Prompt diagnosis often can prevent minor injuries from becoming major problems, or causing long-term damage.

An orthopedic surgeon should examine anyone:

- who is prevented from playing by severe pain associated with acute injury
- whose ability to play has declined due to chronic or long-term consequences of an injury
- whose injury has caused visible deformities in an arm or leg.

The physician will perform a **physical examination**, ask how the injury occurred, and what symptoms the patient has experienced. X rays and other imaging studies of bones and soft tissues may be ordered.

Anyone who has suffered a blow to the head should be examined immediately, and at five-minute intervals until normal comprehension has returned. The initial examination measures the athlete's:

- awareness
- concentration
- short-term memory

Subsequent evaluations of concussion assess:

- dizziness
- headache
- nausea
- visual disturbances

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Treatment

Treatment for minor soft tissue injuries generally consists of:

- compressing the injured area with an elastic bandage
- elevation
- ice
- rest.

Anti-inflammatories, taken by mouth or injected into the swelling, may be used to treat bursitis. Anti-inflammatory medications and exercises to correct muscle imbalances usually are used to treat tendinitis. If the athlete keeps stressing inflamed tendons, they may rupture, and casting or surgery is sometimes necessary to correct this condition.

Orthopedic surgery may be required to repair serious **sprains and strains**.

Controlling inflammation as well as restoring normal use and mobility are the goals of treatment for overuse injuries.

Athletes who have been injured are usually advised to limit their activities until their injuries are healed. The physician may suggest special exercises or behavior modifications for athletes who have had several injuries. Athletes who have been severely injured may be advised to stop playing altogether.

Prevention

Every child who plans to participate in organized athletic activity should have a pre-season sports physical. This special examination is performed by a pediatrician or family physician who:

- carefully evaluates the site of any previous injury
- may recommend special stretching and strengthening exercises to help growing athletes create and preserve proper muscle and joint interaction
- pays special attention to the cardiovascular and skeletal systems.

Telling the physician which sport the athlete plays will help that physician determine which parts of the body will be subjected to the most stress. The physician then will be able to suggest to the athlete steps to take to minimize the chance of getting hurt.

Other injury-reducing game plans include:

- being in shape
- knowing and obeying the rules that regulate the activity
- not playing when tired, ill, or in pain
- not using steroids, which can improve athletic performance but cause life-threatening problems
- taking good care of athletic equipment and using it properly
- wearing appropriate protective equipment

On a larger scale, sports injuries are becoming a public health concern in America. Prevention efforts include wearing protective devices (such as bicycle helmets and pads when skating or skateboarding), and educating both children and adults about safety. Other preventive efforts include changes in the rules of the game or sport to minimize injuries. For example, wearing goggles will be mandatory in women's lacrosse in order to reverse the rising rate of eye and other facial injuries in that sport. Research also continues on improving equipment. For example, thick rubber insoles can help prevent against repetitive injuries from running but scientists recently observed that they can add to injuries in sports such as soccer, where athletes need to make quick changes of direction. On the other hand, recent improvements in the design and construction of football helmets have been credited with a significant decline in the frequency and severity of head injuries among football players.

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ORGANIZATIONS

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Sports vision *see* **Vision training**
Spouse abuse *see* **Abuse**

Sprains and strains

Definition

Sprain refers to damage or tearing of ligaments or a joint capsule. Strain refers to damage or tearing of a muscle.

Description

When excessive force is applied to a joint, the ligaments that hold the bones together may be torn or damaged. This results in a sprain and its seriousness depends on how badly the ligaments are torn. Any joint can be sprained but the most frequently injured joints are the ankle, knee, and finger.

Strains are tears in the muscle. Sometimes called pulled muscles, they usually occur because of overexertion or improper lifting techniques. Sprains and strains are common. Anyone can have them.

Children under age eight are less likely to have sprains than are older people. Children's ligaments are tighter and their bones are more apt to break before a ligament tears. People who are active in sports suffer more strains and sprains than less active people. Repeated sprains in the same joint make the joint less stable and more prone to future sprains.

Causes and symptoms

There are three grades of sprains. Grade I sprains are mild injuries where there is no tearing of the ligament and no joint function is lost, although there may be tenderness and slight swelling.

Grade II sprains are caused by a partial tear in the ligament. These sprains are characterized by obvious swelling, extensive bruising, **pain**, difficulty bearing weight, and reduced function of the joint.

Grade III, or third degree, sprains are caused by complete tearing of the ligament where there is severe pain, loss of joint function, widespread swelling and bruising, and the inability to bear weight. These symptoms are similar to those of bone **fractures**.

Strains can range from mild muscle stiffness to great soreness. Strains result from overuse of muscles, improper use of the muscles, or as the result of injury in another part of the body when the body compensates for pain by altering the way it moves.

Diagnosis

Grade I sprains and mild strains are usually self-diagnosed. Grade II and III sprains are often seen by a physician, who takes x rays of the area to differentiate between a sprain and a fracture.

Treatment

Grade I sprains and mild strains can be treated at home. Basic **first aid** for sprains consists of RICE: Rest, Ice for 48 hours, Compression (wrapping in an elastic bandage), and Elevation of the sprain above the level of the heart. Over-the-counter pain medication such as **acetaminophen** (Tylenol) or ibuprofen (Motrin) can be taken for pain.

In addition to RICE, people with grade II and grade III sprains in the ankle or knee usually need to use crutches until the sprains have healed enough to bear weight. Sometimes, **physical therapy** or home exercises are needed to restore the strength and flexibility of the joint.

Grade III sprains are usually immobilized in a cast for several weeks to see if the sprain heals. Pain medication is prescribed. Surgery may be necessary to relieve pain and restore function. Athletic people under age 40 are the most likely candidates for surgery, especially with grade III knee sprains. For complete healing, physical therapy usually will follow surgery.

Alternative treatment

Alternative practitioners endorse RICE and conventional treatments. In addition, nutritional therapists recommend vitamin C and bioflavonoids to supplement a diet high in whole grains, fresh fruits, and vegetables. Anti-inflammatories, such as bromelain

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KEY TERMS

Ligament—Tough, fibrous connective tissue that holds bones together at joints.

(a proteolytic enzyme from pineapples) and tumeric (*Curcuma longa*), may also be helpful. The homeopathic remedy arnica (*Arnica montana*) may be used initially for a few days, followed by ruta (*Ruta graveolens*) for joint-related injuries or *Rhus toxicodendron* for muscle-related injuries. If surgery is needed, alternative practitioners can recommend pre- and post-surgical therapies that will enhance healing.

Prognosis

Moderate sprains heal within two to four weeks but it can take months to recover from severe ligament tears. Until recently, tearing the ligaments of the knee meant the end to an athlete's career. Improved surgical and rehabilitative techniques now offer the possibility of complete recovery. However, once a joint has been sprained, it will never be as strong as it was before.

Prevention

Sprains and strains can be prevented by warming-up before exercising, using proper lifting techniques, wearing properly fitting shoes, and taping or bracing the joint.

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Tish Davidson, A.M.

Sputum culture

Definition

Sputum is material coughed up from the lungs and expectorated (spit out) through the mouth. A sputum culture is done to find and identify the microorganism causing an infection of the lower respiratory tract such as **pneumonia** (an infection of the lung). If a microorganism is found, more testing is done to determine which **antibiotics** will be effective in treating the infection.

Purpose

A person with a **fever** and a continuing **cough** that produces pus-like material and/or blood may have an infection of the lower respiratory tract. Infections of the lungs and bronchial tubes are caused by several types of microorganisms, including bacteria, fungi (molds and yeast), and viruses. A **chest x ray** provides visual evidence of an infection; a culture can grow the microorganism causing the infection. The microorganism is grown in the laboratory so it can be identified and tested for its response to medications, such as antifungals and antibiotics.

Description

Based on the clinical condition of the patient, the physician determines what group of microorganism is likely to be causing the infection, and then orders one or more specific types of cultures: bacterial, viral, or fungal (for yeast and molds). For all culture types, the sputum must be collected into a sterile container. The sputum specimen must be collected carefully so that bacteria that normally live in the mouth and saliva do not contaminate the sputum and complicate the process of identifying the cause of the infectious agent. Once in the laboratory, each culture type is handled differently.

Bacterial culture

A portion of the sputum is smeared on a microscope slide for a Gram stain. Another portion is spread over the surface of several different types of culture plates, and placed in an incubator at body temperature for one to two days.

A Gram stain is done by staining the slide with purple and red stains, then examining it under a microscope. Gram staining checks that the specimen does not contain saliva or material from the mouth. If many epithelial (skin) cells and few white blood cells are seen, the specimen is not pure sputum and is not adequate for culture. Depending on laboratory policy, the specimen may be rejected and a new specimen requested. If many white blood cells and bacteria of one type are seen, this is an early confirmation of infection. The color of stain picked up by the bacteria (purple or red), their shape (such as round or rectangular), and their size provide valuable clues as to their identity and helps the physician predict what antibiotics might work best before the entire test is completed. Bacteria that stain purple are called gram-positive; those that stain red are called gram-negative.

During incubation, bacteria present in the sputum sample multiply and will appear on the plates as visible

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colonies. The bacteria are identified by the appearance of their colonies, by the results of biochemical tests, and through a Gram stain of part of a colony.

A sensitivity test, also called antibiotic susceptibility test, is also done. The bacteria are tested against different antibiotics to determine which will treat the infection by killing the bacteria.

The initial result of the Gram stain is available the same day or in less than an hour if requested by the physician. An early report, known as a preliminary report, is usually available after one day. This report will tell if any bacteria have been found yet, and if so, their Gram stain appearance—for example, a gram-negative rod, or a gram-positive cocci. The final report, usually available in one to three days, includes complete identification and an estimate of the quantity of the bacteria and a list of the antibiotics to which they are sensitive.

Fungal culture

To look for mold or yeast, a fungal culture is done. The sputum sample is spread on special culture plates that will encourage the growth of mold and yeast. Different biochemical tests and stains are used to identify molds and yeast. Cultures for fungi may take several weeks.

Viral culture

Viruses are a common cause of pneumonia. For a viral culture, sputum is mixed with commercially-prepared animal cells in a test tube. Characteristic changes to the cells caused by the growing virus help identify the virus. The time to complete a viral culture varies with the type of virus. It may take from several days to several weeks.

Special procedures

Tuberculosis is caused by a slow-growing bacteria called *Mycobacterium tuberculosis*. Because it does not easily grow using routine culture methods, special procedures are used to grow and identify this bacteria. When a sputum sample for tuberculosis first comes into the laboratory, a small portion of the sputum is smeared on a microscope slide and stained with a special stain, called an acid-fast stain. The stained sputum is examined under a microscope for tuberculosis organisms, which pick-up the stain, making them visible. This smear is a rapid screen for the organism and allows the physician to receive a preliminary report within 24 hours.

To culture for tuberculosis, portions of the sputum are spread on and placed into special culture plates and tubes of broth that promote the growth of the organism. Growth in broth is faster than growth on culture plates. Instruments are available that can detect growth in broth, speeding the process even further. Growth and identification may take two to four weeks.

Other microorganisms that cause various types of lower respiratory tract infections also require special culture procedures to grow and identify. *Mycoplasma pneumonia* causes a mild to moderate form of pneumonia, commonly called walking pneumonia; *Bordetella pertussis* causes **whooping cough**; *Legionella pneumophila*, Legionnaire's disease; *Chlamydia pneumoniae*, an atypical pneumonia; and *Chlamydia psittaci*, parrot fever.

Pneumocystis carinii causes pneumonia in people with weakened immune systems, such as people with **AIDS**. This organism does not grow in culture. Special stains are done on sputum when pneumonia caused by this organism is suspected. The diagnosis is based on the results of these stains, the patient's symptoms, and medical history.

Sputum culture is also called sputum culture and sensitivity.

It is possible that sputum cultures will eventually be replaced in the diagnosis of tuberculosis by newer molecular techniques. These advanced methods speed the diagnostic process as well as improve its accuracy. As of late 2002, four molecular techniques are increasingly used in laboratories around the world to diagnose TB. They include polymerase chain reaction to detect mycobacterial DNA in patient specimens; nucleic acid probes to identify mycobacteria in culture; restriction fragment length polymorphism analysis to compare different strains of TB for epidemiological studies; and genetic-based susceptibility testing to identify drug-resistant strains of mycobacteria.

Preparation

The specimen for culture should be collected before antibiotics are begun. Antibiotics in the person's system may prevent microorganisms present in the sputum from growing in culture.

The best time to collect a sputum sample is early in the morning, before having anything to eat or drink. The patient should first rinse his or her mouth with water to decrease mouth bacteria and dilute saliva. Through a deep cough, the patient must cough up sputum from within the chest. Taking deep breaths and lowering the head helps bring up the sputum. Sputum must not be held in the mouth but immediately spat into a sterile container. For tuberculosis, the

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KEY TERMS

Acid-fast stain—A special stain done to microscopically identify the bacteria that cause tuberculosis.

Culture—A laboratory test done to grow and identify microorganisms causing infection.

Gram stain—Microscopic examination of a portion of a bacterial colony or sample from an infection site after it has been stained by special stains. Certain bacteria pick up and retain the purple stain; these bacteria are called gram-positive. Other bacteria lose the purple stain and retain the red stain; these bacteria are called gram-negative. The color of the bacteria, in addition to their size and shape, provide clues as to the identity of the bacteria.

Normal flora—The mixture of bacteria normally found at specific body sites.

Pneumonia—An infection of the lungs.

Sputum—Material coughed up from the lower respiratory tract and expectorated through the mouth.

Sensitivity test—A test that determines which antibiotics will kill the bacteria that has been isolated from a culture.

physician may want the patient to collect sputum samples on three consecutive mornings.

If coughing up sputum is difficult, a health care worker can have the patient breathe in sterile saline produced by a nebulizer. This nebulized saline coats the respiratory tract, loosening the sputum, and making it easier to cough up. Sputum may also be collected by a physician during a **bronchoscopy** procedure. Bronchoscopy, however, is not regarded as a cost-effective way of obtaining a useful sample.

If tuberculosis is suspected, collection of sputum should be carried out in an **isolation** room, with all attending healthcare workers wearing masks.

In addition to special precautions in collecting sputum when tuberculosis is suspected, workers in hospital laboratories must take extra care to inactivate unstained smear preparations that may contain *M. tuberculosis*. The most effective deactivation technique is the use of a solution of 5% phenol in ethanol.

Normal results

Sputum from a healthy person would have no growth on culture. A mixture of microorganisms, however, normally found in a person's mouth and saliva often contaminate the culture. If these microorganisms grow in the culture, they may be reported as normal flora contamination.

Abnormal results

The presence of bacteria and white blood cells on the Gram stain and the isolation of a microorganism from culture, other than normal flora contamination, is evidence of a lower respiratory tract infection.

Microorganisms commonly isolated from sputum include: *Streptococcus pneumoniae*, *Haemophilus influenzae*, *Staphylococcus aureus*,*Legionella pneumophila*, *Mycoplasma pneumonia*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Bordetella pertussis*, and ***Escherichia coli***.

Resources

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ORGANIZATIONS

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National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

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Squamous cell carcinoma of the skin

Definition

A squamous cell carcinoma is a skin **cancer** that originates from squamous keratinocytes in the epidermis, the top layer of the skin. *Squamous* is a term that indicates a surface with a scaly nature.

Description

Squamous keratinocytes are flattened unpigmented skin cells in the middle of the epidermis. When they become cancerous, these cells invade the dermis (the layer of skin just below the epidermis) and spread out into the normal skin. They become visible as a small growth or area of change in the skin's appearance.

Most squamous cell carcinomas appear on areas that have been exposed to the sun: the head and neck, forearms, backs of the hands, upper part of the torso, and lower legs. Many develop in precancerous patches called actinic keratoses. Actinic keratoses are rough, scaly patches on the skin that usually start to show up in middle age. They are associated with a lifetime's exposure to the sun. Estimates of the chance that an actinic keratosis will turn into a squamous cell carcinoma vary from 0.24 to 20%.

Squamous cell carcinomas can also originate in old **scars** and **burns**, long-standing sores, and other areas of chronic skin irritation. These tumors tend to be more dangerous than those that arise in actinic keratoses.

Squamous cell carcinoma on the nose. *(Dr P. Marazzi/Photo Researchers, Inc.)*

The least dangerous type of squamous cell carcinoma is called Bowen's disease, intraepithelial squamous cell carcinoma, or squamous cell carcinoma *in situ*. Bowen's disease can show up anywhere on the skin but it is especially common on the head and neck. This cancer usually grows slowly but may evolve into a more serious, spreading form if it is not removed.

Other types of squamous cell carcinomas grow fairly quickly and can develop within a few months. These tumors may spread in the skin along the blood vessels, nerves, and muscles. They can also metastasize, or spread to other areas. On the average, 2–6% of squamous cell carcinomas metastasize but the rate varies with the tumor site. At least 95% of the tumors that originate in actinic keratoses remain in the skin; but up to 38% of the cancers from scars are metastatic. Metastasis is also more likely when the cancer originates on the ear, lip, or genitalia, is large or deep, or develops in someone with a severely suppressed immune system. Cancers that regrow after treatment, and tumors that spread along the nerves are particularly dangerous.

Demographics

Squamous cell carcinoma is the second most common type of skin cancer in North America. There are between 80,000 and 100,000 cases diagnosed each year in the United States.

Squamous cell carcinomas are more common in the older adult population rather than the young. Overall, the chance of developing one is about 7–11%. The likelihood increases with exposure to the sun, and is greatest for fair-skinned individuals who tan poorly. Living near the equator, where ultraviolet light is more intense, also increases the risk. A weakened immune system—for instance, from an organ transplant, or AIDS—can also increase the risk of developing a squamous cell carcinoma by a factor of 5 to 250.

Squamous cell carcinomas tend to be most dangerous in individuals with dark skin. The mortality rate for African-Americans with squamous cell carcinomas is 17–24%, much higher than the 2% **death** rate for white males with nonmelanoma skin cancer. One reason for this disparity is that the cancers that develop in dark skin are more likely to come from old scars and burns than from actinic keratoses.

Causes and symptoms

Squamous cell carcinoma is caused by genetic damage to a skin cell. A number of factors can increase the risk that this will happen, but the exact cause is rarely known.

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KEY TERMS

Actinic keratosis (plural actinic keratoses)—A rough, dry, scaly patch on the skin associated with sun exposure.

Albinism—A genetic disease characterized by the absence of the normal skin pigment, melanin.

Antioxidant—A substance that can neutralize free radicals. Free radicals are damaging molecules formed from oxygen. Antioxidant vitamins include vitamin E, C, and beta-carotene, a form of vitamin A.

Biopsy—A sample of an organ taken to look for abnormalities. Also, the technique used to take such samples.

Chronic—Long-standing.

Dermis—A layer of skin sandwiched between the epidermis and the fat under the skin. It contains the blood vessels, nerves, sweat glands, and hair follicles.

Epidermis—The thin layer of skin cells at the surface of the skin.

Fluorouracil—A cancer drug.

Interferon alpha—A chemical made naturally by the immune system and also manufactured as a drug.

Local anesthetic—A liquid used to numb a small area of the skin.

Lymph node—A small organ full of immune cells, found in clusters throughout the body. Lymph nodes are where reactions to infections usually begin.

Nonmelanoma skin cancer—A squamous cell carcinoma or basal cell carcinoma.

Nonsteroidal anti-inflammatory drugs (NSAIDS)—A class of drugs that suppresses inflammation. Includes a wide variety of drugs, including aspirin.

Papillomavirus—A member of a group of viruses associated with warts and cervical cancer.

Pathologist—A doctor who specializes in examining cells and other parts of the body for abnormalities.

Precancerous—Abnormal and with a high probability of turning into cancer, but not yet a cancer.

Oncologist—A doctor who specializes in the treatment of cancer.

Retinoids—A class of drugs related to vitamin A.

Selenium—A mineral needed in extremely small quantities by the body. Large amounts can be very toxic.

Xeroderma pigmentosum—A genetic disease characterized by the inability to repair damaged DNA. Individuals with this disease develop an excessive number of skin cancers.

Any of the following changes may be a warning sign that an actinic keratosis is developing into a squamous cell carcinoma:

- pain
- increased redness
- sores or bleeding
- hardening or thickening
- increased size

Most squamous cell carcinomas begin as a small red bump on the skin. More advanced squamous cell carcinomas have the following characteristics:

- a few millimeters to a few centimeters in diameter
- reddish-brown, flesh-colored, pink, or red
- bumpy or flat
- sharp, irregular edges in Bowen's disease; others may have no definite edge
- may be crusted or scaly
- may contain bleeding sores

Diagnosis

Squamous cell carcinomas are usually diagnosed with a **skin biopsy** taken in the doctor's office. This is generally a brief, simple procedure. After numbing the skin with an injection of local anesthetic, the doctor snips out the tumor or a piece of it. This skin sample is sent to a pathologist to be read. It can take up to a week for the biopsy results to come back. Squamous cell carcinomas are graded into categories of one through four. The grading is based on how deeply the tumor penetrates in the skin and how abnormal its cells are. Higher grades are more serious.

Treatment team

Primary care physicians remove some squamous cell carcinomas; other cancers, including larger or more complicated tumors, may be referred to a dermatologist. The services of a plastic surgeon are occasionally necessary. Metastatic tumors are often treated by an oncologist, surgeons, specially trained nurses, and specialists in radiation treatment.

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Clinical staging, treatments, and prognosis

Staging

In stage 0 (Bowen's disease), the cancer is very small and has not yet spread from the epidermis to the dermis.

In stage I, the cancer is less than 2 cm (0.8 inches) in diameter. No cancer cells can be found in lymph nodes or other internal organs.

In stage II, the cancer is more than 2 cm (0.8 inches) in diameter. No cancer cells can be found in lymph nodes or other internal organs.

In stage III, cancer cells have been found in nearby lymph nodes or in the bone, muscle, or cartilage beneath the skin.

A stage IV cancer can be any size. In this stage, cancer cells have been discovered in internal organs that are distant from the skin. Squamous cell carcinomas tend to spread to nearby lymph nodes, the liver, and the lungs.

Treatment

The treatment options for a squamous cell carcinoma depend on the size of the tumor, its location, and the likelihood that it will spread aggressively or metastasize. All of the treatments described below generally have cure rates of approximately 90 to 99% for small, localized cancers. The five-year cure rates are highest with Moh's surgery, also called Mohs micrographic surgery.

One option is conventional surgery. The doctor numbs the area with an injection of local anesthetic, then cuts out the tumor and a small margin of normal skin around it. The wound is closed with a few stitches. One advantage of conventional surgery is that the wound usually heals quickly. Another benefit is that the complete cancer can be sent to a pathologist for evaluation. If cancer cells are found in the skin around the tumor, additional treatments can be done.

Laser surgery may be an alternative. A disadvantage to laser surgery is that the **wounds** from some lasers heal more slowly than cuts from a scalpel. The advantage is that bleeding is minimal.

Another option is Moh's micrographic surgery. This technique is a variation of conventional surgery. In this procedure, the surgeon examines each piece of skin under the microscope as it is removed. If any cancer cells remain, another slice is taken from that area and checked. These steps are repeated until the edges of the wound are clear of tumor cells, then the wound is closed. The advantage to this technique is that all of the visible cancer cells are removed but as much normal skin as possible is spared. Mohs surgery is often used for larger or higher risk tumors and when cosmetic considerations are important. The main disadvantage is that it takes much longer than conventional surgery and requires a specially trained surgeon.

In cryosurgery, liquid nitrogen is used to freeze the tumor and destroy it. This treatment is another type of blind destruction; there is no skin sample to make sure the cancer cells have all been killed. Patients report swelling and **pain** after cryosurgery and a wound appears a few days later where the cells were destroyed. Healing takes about four to six weeks. When the site heals, it has usually lost its normal pigment. There is a risk of nerve damage with this technique. Cryosurgery is generally used only for small cancers in stage 0 and stage I.

In electro dessication and curettage, the physician scoops out the cancer cells with a spoon-shaped instrument called a curette. After most of the tumor is gone, the rest is destroyed with heat from an electrical current. The wound is left open to heal like an abrasion. It leaks fluid, crusts over, and heals during the next two to six weeks. This method is generally used only for the smallest squamous cell carcinomas (stage 0 and stage I). One disadvantage is that there is no skin sample to confirm that the tumor is completely gone. The electrical current used during this surgery can interfere with some **pacemakers**.

Some cases of Bowen's disease can be treated by applying a lotion containing 5-fluorouracil (fluorouracil or 5-FU) for several weeks. This treatment usually gives good cosmetic results. The side effects from 5-fluorouracil include **allergies** to the ingredients, infections, redness, peeling, and crusting, sensitivity to the sun, and changes in skin color. The main disadvantage to this treatment is that the drug cannot penetrate very far and cancer cells in the deeper parts of the tumor may not be destroyed.

Radiation therapy is sometimes used for squamous cell carcinomas, especially when the tumor is at a site where surgery would be difficult or remove a sizeable amount of tissue. This treatment is sometimes combined with surgery for cancers that have metastasized or are likely to. One disadvantage is that tumors returning after radiation tend to grow more quickly than the original cancer. In addition, x rays may promote new skin cancers. The cosmetic results are usually good. In some cases the skin may lose a little pigment, or develop spider veins. Some doctors reserve radiation treatment for those over 60. One drawback of radiation therapy for squamous cell carcinomas in or near the

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mouth is that the radiation may cause the tissues inside the mouth to break down.

Chemotherapy is often added to surgery or radiation for stage IV cancers. Retinoids and interferon are experimental treatments that may be helpful.

Prognosis

Because many squamous cell carcinomas are not staged, precise five-year survival rates for each stage are not available. In general, the prognosis is very good for small squamous cell carcinomas that originate in actinic keratoses. However, cancers that were not completely destroyed may regrow. Tumors can redevelop in the scar from the surgery, on the edges of the surgery site, or deep in the skin. Larger or higher-risk tumors, cancers that regrow after treatment, and tumors that have invaded local tissues or metastasized are more difficult to cure. Most metastases show up within the first two years after a skin tumor has been removed. The five-year survival rate for metastatic cancers is 34%.

Alternative and complementary therapies

Alternative treatments for squamous cell carcinoma usually attempt to prevent rather than treat this cancer. Options being tested include antioxidant **vitamins**, **minerals**, and green tea extracts.

Coping with cancer treatment

Most squamous cell carcinomas are removed with techniques that cause few, if any, lasting side effects. Patients who have cosmetic concerns may wish to discuss them with their doctors.

Clinical trials

The medical community considers the following treatments to be experimental.

Clinical trials are testing whether interferon alpha, injected into the tumor, can destroy some squamous cell carcinomas. An early report from a combination of interferon alpha and retinoids is promising.

Ongoing trials are also evaluating whether small squamous cell carcinomas can be cured with photodynamic laser therapy. In this technique, a dye activated by laser light destroys the cancer. This dye is spread onto the skin, injected, or drunk. During a waiting period, normal cells clear the dye, then a laser activates the remainder. This technique is only useful for cancers very near the surface of the skin. One side effect after treatment is a period of excessive sun-sensitivity.

Other clinical trials are testing whether retinoids spread onto the skin can prevent or treat squamous cell carcinoma.

Another new experimental approach to squamous cell carcinoma is **gene therapy**. Researchers in Texas reported in 2003 on a Phase III investigation that uses an adenovirus as a vector to carry an altered p53 gene into the cancerous squamous cells. The function of the p53 gene is to maintain the structure of the cell's DNA and to induce the cell to die if its DNA is damaged beyond repair. Phase I and phase II trials have indicated that this approach to treatment has lengthened the survival time in patients with recurrent squamous cell carcinoma.

Prevention

The most important risk factor for squamous cell carcinoma is exposure to the sun (or other source of ultraviolet light) combined with a lighter complexion and inability to tan. Other risk factors include:

- increasing age
- actinic keratoses
- a previous skin cancer
- exposure to arsenic or the chemicals in coal tars
- radiation treatments
- treatment with psoralen and ultraviolet light for psoriasis
- chronic skin damage such as burn scars and ulcers
- infection with some varieties of human papillomavirus
- genetic disorders such as xeroderma pigmentosum and albinism
- a weakened immune system

Most people will receive 80% of their lifetime exposure to the sun before they reach the age of 20. For this reason, prevention should start during childhood and adolescence. Some important steps to prevent squamous cell carcinoma, as well as other skin cancers include:

- Wear protective clothing and a wide-brimmed hat in the sun.
- Stay out of the sun from 10 a.m. to 4 p.m.
- Use a sunscreen that has a sun protection factor (SPF) of at least 15.
- Avoid suntanning booths.

Drugs related to vitamin A (including beta-carotene and retinoids), vitamin E, **nonsteroidal anti-inflammatory drugs** (NSAIDS), and selenium might be able to prevent some skin cancers, but their effectiveness is still in question.

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Special concerns

Because many squamous cell carcinomas are found on the face and neck, cosmetic concerns are a priority for many patients. If there is a risk of noticeable scarring or damage, a patient may wish to ask about alternative types of removal or inquire about the services of a plastic surgeon.

After treatment, it is important to return to the doctor periodically to check for regrowth or new skin cancers. Approximately a third to a half of all patients with nonmelanoma skin cancers find a new skin cancer within the next five years. Having a squamous cell carcinoma before the age of 60 may also increase the chance of developing other cancers in internal organs; however, this idea is still very controversial.

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ORGANIZATIONS

American Skin Association, 150 East 58th Street, 32nd Floor, New York, NY, 10155-0002, (212) 753-8260.

NIH/National Arthritis and Musculoskeletal and Skin Diseases Information Clearinghouse, One AMS Circle, Bethesda, MD, 20892-3675, (301) 495-4484, http://www. nih.gov/niams.

The NIAMS conducts and supports basic, clinical, and epidemiologic research and research training and disseminates information on diseases that include many forms of arthritis and diseases of the musculoskeletal system and the skin.

Skin Cancer Foundation, 245 Fifth Avenue, Suite 2402, New York, NY, 10016, (212) 725-5176.

Anna Rovid Spickler, D.V.M., Ph.D.
Rebecca J. Frey, PhD

Squint *see* **Strabismus**

SSPE *see* **Subacute sclerosing panencephalitis**

SSRIs *see* **Selective serotonin reuptake inhibitors**

SSSS *see* **Staphylococcal scalded skin syndrome**

St. Anthony's fire *see* **Erysipelas**

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St. John's wort

Definition

St. John's wort is a species of the Hypericum genus that is native around the world and was introduced in U.S. The plant has yellow flowers that have been used medicinally for over 2,000years.

Purpose

St. John's wort has been used to treat mental disorders and nerve **pain**, as a sedative and, as a salve, for **wounds**, **burns** and topical infections.

Today, it is sometimes used to treat mild depression, **anxiety**, and **sleep disorders**. Some clinical studies support its effectiveness, but two large and well designed ones do not.

St. John's wort flowers. *(Photo Researchers, Inc.)*

Preparations

The flowering tops are dried, ground and steeped as a tea to be drunk, placed in capsules to be taken by mouth in amounts of 500-1800mg per day, or combined with a salve for topical application.

Precautions

Though used as medicines, herbal products are regulated like dietary supplements in the United States. Thus, manufacturers are responsible only for their production processes. Imported herbals may not meet U.S. manufacturing standards. Approval of herbals is based on traditional use, not demonstrated safety and effectiveness. Before an herbal can be forcefully withdrawn from the market, the FDA must prove that it is unsafe.

Many herbal products vary from stated label potency.

St. John's wort should not be taken by pregnant women or nursing mothers.

St. John's wort may increase sensitivity to sunlight.

Interactions

St. John's wort may interact with, and increase the toxicity of, antidepressants like Prozac.

At higher doses, St. John's wort may reduce the effectiveness of cyclosporine, warfarin, birth control pills, HIV drugs, simvastatin, **digoxin**, and theophylline.

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James Waun, MD, R Ph

St. Vitus' dance *see* **Sydenham's chorea**

Stanford-Binet intelligence scales

Definition

The Stanford-Binet intelligence scale is a standardized test that assesses intelligence and cognitive abilities in children and adults aged two to 23.

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The Stanford-Binet intelligence scale. *(Photo Researchers, Inc.)*

KEY TERMS

Norms—Normative or mean score for a particular age group.

Representative sample—A random sample of people that adequately represents the test-taking population in age, gender, race, and socioeconomic standing.

Standard deviation—A measure of the distribution of scores around the average (mean). In a normal distribution, two standard deviations above and below the mean includes about 95% of all samples.

Standardization—The process of determining established norms and procedures for a test to act as a standard reference point for future test results. The Stanford-Binet test was standardized on a national representative sample of 5,000 subjects.

Purpose

The Stanford-Binet intelligence scale is used as a tool in school placement, in determining the presence of a learning disability or a developmental delay, and in tracking intellectual development. In addition, it is sometimes included in neuropsychological testing to assess the brain function of individuals with neurological impairments.

Precautions

Although the Stanford-Binet was developed for children as young as two, examiners should be cautious in using the test to screen very young children for developmental delays or disabilities. The test cannot be used to diagnose **mental retardation** in children aged three and under, and the scoring design may not detect developmental problems in preschool-age children.

Intelligence testing requires a clinically trained examiner. The Stanford-Binet intelligence scale should be administered and interpreted by a trained professional, preferably a psychologist.

Description

The Stanford-Binet intelligence scale is a direct descendent of the Binet-Simon scale, the first intelligence scale created in 1905 by psychologist Alfred Binet and Dr. Theophilus Simon. This revised edition, released in 1986, was designed with a larger, more diverse, representative sample to minimize the gender and racial inequities that had been criticized in earlier versions of the test.

The Stanford-Binet scale tests intelligence across four areas: verbal reasoning, quantitative reasoning, abstract/visual reasoning, and short-term memory. The areas are covered by 15 subtests, including vocabulary, comprehension, verbal absurdities, pattern analysis, matrices, paper folding and cutting, copying, quantitative, number series, equation building, memory for sentences, memory for digits, memory for objects, and bead memory.

All test subjects take an initial vocabulary test, which along with the subject's age, determines the number and level of subtests to be administered. Total testing time is 45–90 minutes, depending on the subject's age and the number of subtests given. Raw scores are based on the number of items answered and are converted into a standard age score corresponding to age group, similar to an IQ measure.

The 1997 Medicare reimbursement rate for psychological and neuropsychological testing, including intelligence testing, is $58.35 an hour. Billing time typically includes test administration, scoring and interpretation, and reporting. Many insurance plans cover all or a portion of diagnostic psychological testing.

Normal results

The Stanford-Binet is a standardized test, meaning that norms were established during the design phase of the test by administering the test to a large, representative sample of the test population. The test has a mean, or average, standard score of 100 and a standard deviation of 16 (subtests have a mean of 50 and a standard deviation of 8). The standard deviation indicates how far above or below the norm the

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subject's score is. For example, an eight-year-old is assessed with the Stanford-Binet scale and achieves a standard age score of 116. The mean score of 100 is the average level at which all eight-year-olds in the representative sample performed. This child's score would be one standard deviation above that norm.

While standard age scores provide a reference point for evaluation, they represent an average of a variety of skill areas. A trained psychologist will evaluate and interpret an individual's performance on the scale's subtests to discover strengths and weaknesses and offer recommendations based upon these findings.

ORGANIZATIONS

American Psychological Association (APA), 750 First St. NE, Washington, DC, 20002-4242, (202) 336-5500, (800) 374-2721, http://www.apa.org/.

Paula Anne Ford-Martin

Stapedectomy

Definition

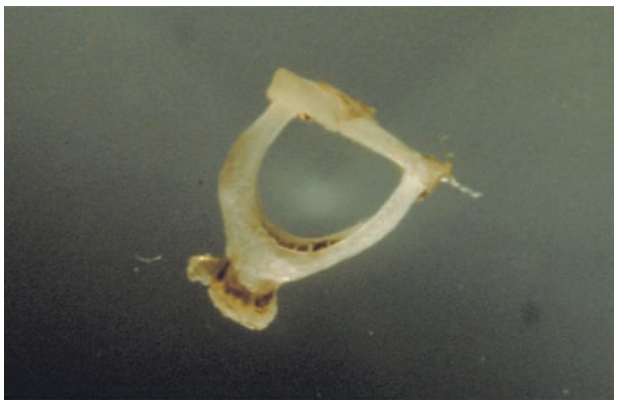
Stapedectomy is a surgical procedure in which the innermost bone (stapes) of the three bones (the stapes, the incus, and the malleus) of the middle ear is removed, and replaced with a small plastic tube of stainless-steel wire (a prosthesis) to improve the movement of sound to the inner ear.

Purpose

A stapedectomy is used to treat progressive **hearing loss** caused by **otosclerosis**, a condition in which spongy bone hardens around the base of the stapes. This condition fixes the stapes to the opening of the inner ear so that the stapes no longer vibrates properly; therefore, the transmission of sound to the inner ear is disrupted. Untreated otosclerosis eventually results in total deafness, usually in both ears.

Description

With the patient under local or **general anesthesia**, the surgeon opens the ear canal and folds the eardrum forward. Using an operating microscope, the surgeon is able to see the structures in detail, and evaluates the bones of hearing (ossicles) to confirm the diagnosis of otosclerosis.



A human stapes bone (located in middle ear) extracted during a stapedectomy. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Next, the surgeon separates the stapes from the incus; freed from the stapes, the incus and malleus bones can now move when pressed. A laser (or other tiny instrument) vaporizes the tendon and arch of the stapes bone, which is then removed from the middle ear.

The surgeon then opens the window that joins the middle ear to the inner ear and acts as the platform for the stapes bone. The surgeon directs the laser's beam at the window to make a tiny opening, and gently clips the prosthesis to the incus bone. A piece of tissue is taken from a small incision behind the ear lobe and used to help seal the hole in the window and around the prosthesis. The eardrum is then gently replaced and repaired, and held there by absorbable packing ointment or a gelatin sponge. The procedure usually takes about an hour and a half.

Good candidates for the surgery are those who have a fixed stapes from otosclerosis, and a conductive hearing loss at least 20 dB. Patients with a severe hearing loss might still benefit from a stapedectomy, if only to improve their hearing to the point where a hearing aid can be of help. The procedure can improve hearing in more than 90% of cases.

Preparation

Prior to admission to the hospital, the patient will be given a hearing test to measure the degree of deafness, and a full ear, nose, and throat exam.

Most surgeons prefer to use general anesthesia; in this case, an injection will be given to the patient before surgery.

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KEY TERMS

Cochlea—The hearing part of the inner ear. This snail-shaped structure contains fluid and thousands of microscopic hair cells tuned to various frequencies, in addition to the organ of Corti (the receptor for hearing).

Conductive hearing loss—A type of medically treatable hearing loss in which the inner ear is usually normal but there are specific problems in the middle or outer ears that prevent sound from getting to the inner ear in a normal way.

Incus—The middle of the three bones of the middle ear. It is also known as the "anvil."

Malleus—One of the three bones of the middle ear. It is also known as the "hammer."

Ossicles—The three small bones of the middle ear: the malleus (hammer), the incus (anvil) and the stapes (stirrup). These bones help carry sound from the eardrum to the inner ear.

Vertigo—A feeling of dizziness together with a sensation of movement and a feeling of rotating in space.

Aftercare

The patient is usually discharged the morning after surgery. **Antibiotics** are given up to five days after surgery to prevent infection; packing and sutures are removed about a week after surgery.

It is important that the patient not put pressure on the ear for a few days after surgery. Blowing one's nose, lifting heavy objects, swimming underwater, descending rapidly in high-rise elevators, or taking an airplane flight should be avoided.

Right after surgery, the ear is usually quite sensitive, so the patient should avoid loud noises until the ear retrains itself to hear sounds properly.

It is extremely important that the patient avoid getting the ear wet until it has completely healed. Water in the ear could cause an infection; most seriously, water could enter the middle ear and cause an infection within the inner ear, which could then lead to a complete hearing loss. When taking a shower, and washing the hair, the patient should plug the ear with a cotton ball or lamb's wool ball, soaked in Vaseline. The surgeon should give specific instructions about when and how this can be done.

Usually, the patient may return to work and normal activities about a week after leaving the hospital, although if the patient's job involves heavy lifting, three weeks of home rest is recommend. Three days after surgery, the patient may fly in a pressurized aircraft.

Risks

The most serious risk is an increased hearing loss, which occurs in about one percent of patients. Because of this risk, a stapedectomy is usually performed on only one ear at a time.

Less common complications include:

- temporary change in taste (due to nerve damage) or lack of taste
- perforated eardrum
- vertigo that may persist and require surgery
- damage to the chain of three small bones attached to the eardrum
- temporary facial nerve paralysis
- ringing in the ears

Severe **dizziness** or vertigo may be a signal that there has been an incomplete seal between the fluids of the middle and inner ear. If this is the case, the patient needs immediate bed rest, an exam by the ear surgeon, and (rarely) an operation to reopen the eardrum to check the prosthesis.

Normal results

Most patients are slightly dizzy for the first day or two after surgery and may have a slight **headache**. Hearing improves once the swelling subsides, the slight bleeding behind the ear drum dries up, and the packing is absorbed or removed, usually within two weeks. Hearing continues to get better over the next three months.

About 90% of patients will have a completely successful surgery, with markedly improved hearing. In 8% of cases, hearing improves, but not quite as patients usually expect. About half the patients who had ringing in the ears (**tinnitus**) before surgery will have significant relief within six weeks after the procedure.

ORGANIZATIONS

American Academy of Otolaryngology—Head and Neck Surgery, 1650 Diagonal Road, Alexandria, VA, 22314-2857, (703) 836-4444, http://www.entnet.org.

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Better Hearing Institute, 1444 I Street, NW, Suite 700, Washington, DC, 20005, (202) 449-1100, (800) 327-9355, mail@betterhearing.org, http://www.betterhearing.org/.http://www.betterhearing.org/.

Carol A. Turkington

Staphylococcal infections

Definition

Staphylococcal (staph) infections are communicable infections caused by a staphylococcal bacteria. They are generally characterized by the formation of abscesses. Staphlococcal infections are the leading cause of primary infections originating in hospitals (nosocomial infections) in the United States.

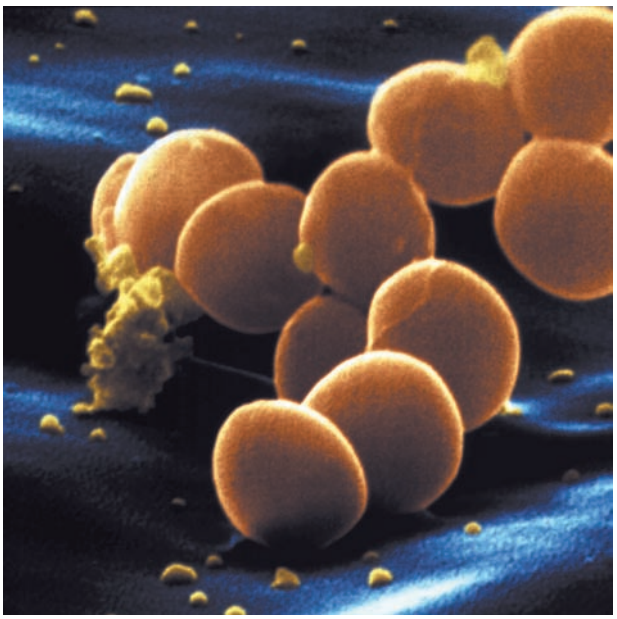
Description

Classified since the early twentieth century as among the deadliest of all disease-causing organisms, staph exists on the skin or inside the nostrils of 20–30% of healthy people. It is sometimes found in breast tissue, the mouth, and the genital, urinary, and upper respiratory tracts.

Although staph bacteria are usually harmless, when injury or a break in the skin enables the bacteria to invade the body and overcome the body's natural defenses, consequences can range from minor discomfort to **death**. Infection is most apt to occur in:

- newborns
- women who are breastfeeding

A close-up of a woman's finger and nail cuticle infected with *Staphylococcus aureus*. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*



A micrographic image of *Staphylococcus aureus*. *(Oliver Meckes/Photo Researchers, Inc.)*

- individuals whose immune systems have been undermined by radiation treatments, chemotherapy, HIV/AIDS, organ transplantation, or medication
- intravenous drug users
- those with surgical incisions, skin disorders, and serious illness like cancer, diabetes, and lung disease
- the elderly, particularly those who live in nursing homes or who are hospitalized.

Types of infections

Staph infections produce pus-filled pockets (abscesses) located just beneath the surface of the skin or deep within the body. Risk of infection is greatest among newborns, the very young, and the very old.

A localized staph infection is confined to a ring of dead and dying white blood cells and bacteria. The skin above it feels warm to the touch. Most of these abscesses eventually burst and pus that leaks onto the skin can cause new infections.

A small fraction of localized staph infections enter the bloodstream and spread through the body. In children, these systemic (affecting the whole body) or disseminated infections frequently affect the ends of the long bones of the arms or legs, causing a bone infection called **osteomyelitis**. When adults develop invasive staph infections, bacteria are most apt to cause abscesses of the brain, heart, kidneys, liver, lungs, or spleen.

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Staphylococcus aureus

Named for the golden color of the bacteria grown under laboratory conditions, *S. aureus* is a hardy organism that can survive in extreme temperatures or other inhospitable circumstances. About 70–90% of the population carry this strain of staph in the nostrils at some point in their life. Although present on the skin of only 5–20% of healthy people, as many as 40% carry the bacteria elsewhere, such as in the throat, vagina, or rectum. These people may carry the bacteria for varying periods of time (from hours to years) without developing symptoms or becoming ill.

S. aureus causes a variety of infections. **Boils** and inflammation of the skin surrounding a hair shaft (**folliculitis**) are the most common. Toxic shock (TSS) and scalded skin syndrome (SSSS) are among the most serious.

Methicillin-resistant Staphyloccus aureus. infections (MRSA)

S. aureus flourishes in hospitals, where it infects healthcare personnel and patients who have had surgery; who have acute **dermatitis**, insulin-dependent diabetes, or dialysis-dependent **kidney disease**; or who receive frequent allergy-desensitization injections. Staph bacteria can also contaminate bedclothes, catheters, and other objects.

Toxic shock

Toxic shock syndrome is a life-threatening infection characterized by severe **headache**, **sore throat**, **fever** as high as 105°F, and a sunburn-like rash that spreads from the face to the rest of the body. Symptoms appear suddenly; they also include **dehydration** and watery **diarrhea**.

Inadequate blood flow to peripheral parts of the body (shock) and loss of consciousness occur within the first 48 hours. Between the third and seventh day of illness, skin peels from the palms of the hands, soles of the feet, and other parts of the body. Kidney, liver, and muscle damage often occur.

SCALDED SKIN SYNDROME. Rare in adults and most common in newborns and other children under the age of five, scalded skin syndrome originates with a localized skin infection. A mild fever and/or an increase in the number of infection-fighting white blood cells may occur.

A bright red rash spreads from the face to other parts of the body and eventually forms scales. Large, soft blisters develop at the site of infection and elsewhere. When they burst, they expose inflamed skin that looks as if it had been burned.

MISCELLANEOUS INFECTIONS. *S. aureus* can also cause:

- arthritis
- bacteria in the bloodstream (bacteremia)
- pockets of infection and pus under the skin (carbuncles)
- tissue inflammation that spreads below the skin, causing pain and swelling (cellulitis)
- inflammation of the valves and walls of the heart (endocarditis)
- inflammation of tissue that enclosed and protects the spinal cord and brain (meningitis)
- inflammation of bone and bone marrow (osteomyelitis)
- pneumonia

Other strains of staph

S. EPIDERMIDIS. Capable of clinging to tubing (as in that used for intravenous feeding, etc.), prosthetic devices, and other non-living surfaces, *S. epidermidis* is the organism that most often contaminates devices that provide direct access to the bloodstream.

The primary cause of **bacteremia** in hospital patients, this strain of staph is most likely to infect **cancer** patients, whose immune systems have been compromised, and high-risk newborns receiving intravenous supplements.

S. epidermidis also accounts for two of every five cases of prosthetic valve **endocarditis**. Prosthetic valve endocarditis is endocarditis as a complication of the implantation of an artificial valve in the heart. Although contamination usually occurs during surgery, symptoms of infection may not become evident until a year after the operation. More than half of the patients who develop prosthetic valve endocarditis die.

STAPHYLOCOCCUS SAPROPHYTICUS. Existing within and around the tube-like structure that carries urine from the bladder (urethra) of about 5% of healthy males and females, *S. saprophyticus* is the second most common cause of unobstructed urinary tract infections (UTIs) in sexually active young women. This strain of staph is responsible for 10–20% of infections affecting healthy outpatients.

Causes and symptoms

Staph bacteria can spread through the air, but infection is almost always the result of direct contact with open sores or body fluids contaminated by these organisms.

Staph bacteria often enter the body through inflamed hair follicles or oil glands. Or they penetrate skin damaged by **burns**, cuts and scrapes, infection, insect **bites**, or **wounds**.

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Multiplying beneath the skin, bacteria infect and destroy tissue in the area where they entered the body. Staph infection of the blood (staphylococcal bacteremia) develops when bacteria from a local infection infiltrate the lymph glands and bloodstream. These infections, which can usually be traced to contaminated catheters or intravenous devices, usually cause persistent high fever. They may cause shock. They also can cause death within a short time.

Warning signs

Common symptoms of staph infection include:

- pain or swelling around a cut, or an area of skin that has been scraped
- boils or other skin abscesses
- blistering, peeling, or scaling of the skin; this is most common in infants and young children
- enlarged lymph nodes in the neck, armpits, or groin

A family physician should be notified whenever:

- Lymph nodes in the neck, armpits, or groin become swollen or tender.
- An area of skin that has been cut or scraped becomes painful or swollen, feels hot, or produces pus. These symptoms may mean the infection has spread to the bloodstream.
- A boil or carbuncle appears on any part of the face or spine. Staph infections affecting these areas can spread to the brain or spinal cord.
- A boil becomes very sore. Usually a sign that infection has spread, this condition may be accompanied by fever, chills, and red streaks radiating from the site of the original infection.
- Boils that develop repeatedly. This type of recurrent infection could be a symptom of diabetes.

Diagnosis

Blood tests that show unusually high concentrations of white blood cells can suggest staph infection, but diagnosis is based on laboratory analysis of material removed from pus-filled sores, and on analysis of normally uninfected body fluids, such as, blood and urine. Also, x rays can enable doctors to locate internal abscesses and estimate the severity of infection. Needle biopsy (removing tissue with a needle, then examining it under a microscope) may be used to assess bone involvement.

Treatment

Superficial staph infections can generally be cured by keeping the area clean, using soaps that leave a germ-killing film on the skin, and applying warm, moist compresses to the affected area for 20–30 minutes three or four times a day.

Severe or recurrent infections may require a 7 to 10 day course of treatment with penicillin or other oral **antibiotics**. The location of the infection and the identity of the causal bacteria determines which of several effective medications should be prescribed.

In case of a more serious infection, antibiotics may be administered intravenously for as long as six weeks. Intravenous antibiotics are also used to treat staph infections around the eyes or on other parts of the face.

Surgery may be required to drain or remove abscesses that form on internal organs, or on shunts or other devices implanted inside the body.

Alternative treatment

Alternative therapies for staph infection are meant to strengthen the immune system and prevent recurrences. Among the therapies believed to be helpful for the person with a staph infection are **yoga** (to stimulate the immune system and promote relaxation), **acupuncture** (to draw heat away from the infection), and herbal remedies. Herbs that may help the body overcome, or withstand, staph infection include:

- Garlic (*Allium sativum*). This herb is believed to have anitbacterial properties. Herbalists recommend consuming three garlic cloves or three garlic oil capsules a day, starting when symptoms of infection first appear.
- Cleavers (*Galium aparine*). This anti-inflammatory herb is believed to support the lymphatic system. It may be taken internally to help heal staph abscesses and reduce swelling of the lymph nodes. A cleavers compress can also be applied directly to a skin infection.
- Goldenseal (*Hydrastis canadensis*). Another herb believed to fight infection and reduce imflammation, goldenseal may be taken internally when symptoms of infection first appear. Skin infections can be treated by making a paste of water and powdered goldenseal root and applying it directly to the affected area. The preparation should be covered with a clean bandage and left in place overnight.
- Echinacea (*Echinacea* spp.). Taken internally, this herb is believed to have antibiotic properties and is also thought to strengthen the immune system.
- Thyme (*Thymus vulgaris*), lavender (*Lavandula officinalis*), or bergamot (*Citrus bergamot*) oils. These oils are believed to have antibacterial properties and may help to prevent the scarring that may result from skin infections. A few drops of these oils are added to water and then a compress soaked in the water is applied to the affected area.

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KEY TERMS

Abscess—A cavity containing pus surrounded by inflamed tissue.

Endocarditis—Inflammation of the lining of the heart, and/or the heart valves, caused by infection.

Nosocomial infections—Infections that were not present before the patient came to a hospital but were acquired by a patient while in the hospital.

- Tea tree oil (*Melaleuca* spp.). Another infection-fighting herb, this oil can be applied directly to a boil or other skin infection.

Prognosis

Most healthy people who develop staph infections recover fully within a short time. Others develop repeated infections. Some become seriously ill, requiring long-term therapy or emergency care. A small percentage die.

Prevention

Healthcare providers and patients should always wash their hands thoroughly with warm water and soap after treating a staph infection or touching an open wound or the pus it produces. Pus that oozes onto the skin from the site of an infection should be removed immediately. This affected area should then be cleansed with antiseptic or with antibacterial soap.

To prevent infection from spreading from one part of the body to another, it is important to shower rather than bathe during the healing process. Because staph infection is easily transmitted from one member of a household to others, towels, washcloths, and bed linens used by someone with a staph infection should not be used by anyone else. They should be changed daily and laundered separately in hot water with bleach until symptoms disappear.

Children should frequently be reminded not to share:

- brushes, combs, or hair accessories
- caps
- clothing
- sleeping bags
- sports equipment
- other personal items

A diet rich in green, yellow, and orange vegetables can bolster natural immunity. A doctor or nutritionist may recommend **vitamins** or mineral supplements to compensate for specific dietary deficiencies. Drinking 8 to 10 glasses of water a day can help flush disease-causing organisms from the body.

Because some strains of staph bacteria are known to contaminate artificial limbs, prosthetic devices implanted within the body, and tubes used to administer medication or drain fluids from the body, catheters and other devices should be removed on a regular basis, if possible, and examined for microscopic signs of staph. Symptoms may not become evident until many months after contamination has occurred so this practice should be followed even with patients who show no sign of infection.

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Staphylococcal scalded skin syndrome

Definition

Staphylococcal scalded skin syndrome (SSSS) is a disease caused by a type of bacteria in which large sheets of skin may peel away.

Description

SSSS primarily strikes children under the age of five, particularly infants. Clusters of SSSS cases (epidemics) can occur in newborn nurseries when staff in nurseries accidentally pass the causative bacteria between patients. It can also strike other age groups who have weakened immune systems. Such immunocompromised patients include those with **kidney**

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disease, people undergoing cancerchemotherapy, organ transplant patients, and individuals with acquired **immunodeficiency** syndrome (**AIDS**).

Causes and symptoms

SSSS is caused by a type of bacteria called *Staphylococcus aureus*. This bacteria produces a chemical called an epidermolytic toxin ("epiderm," deriving from the Greek words *epi,* meaning on, and *derma,* meaning skin, refers to the top layer of skin; "-lytic," deriving from the Greek word *lysis,* which literally denotes the act of undoing, means breaking or destroying; a toxin is a poison). While the bacteria itself is not spread throughout the body, it affects all of the skin by sending this toxin through the bloodstream.

SSSS begins with a small area of infection. In newborn babies, this may appear as a crusted area around the umbilicus, or in the diaper area. In children between the ages of one and six, a small, red, crusty bump appears near the nose or ear. The child may have no energy and may have a **fever**. The skin becomes sensitive and uncomfortable even before the rash is fully visible. The rash starts out as bright red patches around the original area of crusting. Blisters may appear and the skin may look wrinkled. When the blisters pop, they leave pitted areas. Even gently touching these red patches of skin may cause them to peel away in jagged sheets. The skin below is shiny, moist, and bright pink. Within a day or two, the top layer of skin all over the body is peeling off in large sheets.

The dangers of this illness include the chance that a different kind of bacteria will invade through the open areas in the skin and cause a serious systemic infection (**sepsis**). A lot of body fluid is lost as the skin peels away and the layer underneath dries. **Dehydration** is a danger at this point.

Diagnosis

Although good patient care includes taking specimens of blister fluid and smears from the nose or throat, no bacteria are usually demonstrated. SSSS is usually diagnosed on the basis of the typical progression of symptoms in a child of this age, prone to this disorder. A sample of skin (**skin biopsy**) should be taken, prepared, and examined under a microscope. If the patient's disease is truly SSSS, the biopsy will show a characteristic appearance. There will be no accumulation of those cells usually present in the case of a bacterial infection. Instead, there will be evidence of disruption of only the top layer of skin (epidermis).

KEY TERMS

Epidermis—The top layer of skin.

Epidermolytic—Damaging to the top layer of skin.

Sepsis—An overwhelming infection affecting all the systems of the body.

Treatment

Treatment involves careful attention to avoid the development of dehydration. A variety of lotions and creams are available to apply to areas where the epidermis has peeled away. This both soothes the sensitive areas and protects against drying and further moisture loss.

Prognosis

Most patients heal from SSSS within 10–14 days. Healing occurs without scarring in the majority of patients. **Death** may occur if severe dehydration or sepsis complicate the illness. About 3% of children die of these complications; about 50% of immunocompromised adults die of these complications.

Prevention

As always, good hygiene can prevent the passage of the causative bacteria between people. In the event of an outbreak in a newborn nursery, members of the staff should have nasal smears taken to identify an adult who may be unknowingly carrying the bacteria and passing it on to the babies.

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Staphylococccal food poisoning *see* **Food poisoning**

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Starvation

Definition

Starvation is the result of a severe or total lack of nutrients needed for the maintenance of life.

Description

Adequate **nutrition** has two components, necessary nutrients and energy in the form of calories. It is possible to ingest enough energy without a well-balanced selection of individual nutrients and produce diseases that are noticeably different from those resulting from an overall insufficiency of nutrients and energy. Although all foods are a source of energy for the human body, it is possible to consume a seemingly adequate amount of food without getting the required minimum of energy (calories). For example, marasmus is the result of a diet that is deficient mainly in energy. Children who get enough calories, but not enough protein have kwashiorkor. This is typical in cultures with a limited variety of foods that eat mostly a single staple carbohydrate like maize or rice. These conditions overlap and are associated with multiple vitamin and mineral deficits, most of which have specific names and set of problems associated with them.

- Marasmus produces a very skinny child with stunted growth.
- Children with kwashiorkor have body fat, an enlarged liver, and edema—swelling from excess water in the tissues. They also have growth retardation.
- Niacin deficiency produces pellagra characterized by diarrhea, skin rashes, brain dysfunction, tongue, mouth and vaginal irritation, and trouble swallowing.
- Thiamine (Vitamin B_1) deficiency causes beriberi, which can appear as heart failure and edema, a brain and nerve disease, or both.
- Riboflavin deficiency causes a sore mouth and throat, a skin rash, and anemia.
- Lack of vitamin C (ascorbic acid)—scurvy—causes hair damage, bleeding under the skin, in muscles and joints, gum disease, poor wound healing, and in severe cases convulsions, fever, loss of blood pressure, and death.
- Vitamin B_{12} is needed to keep the nervous system working properly. It and pyridoxine (vitamin B_6) are both necessary for blood formation.
- Vitamin A deficiency causes at first loss of night vision and eventually blindness from destruction of the cornea, a disease called keratomalacia.
- Vitamin K is necessary for blood clotting.
- Vitamin D regulates calcium balance. Without it, children get rickets and adults get osteomalacia.

Causes and symptoms

Starvation may result from a number of factors. They include:

- anorexia nervosa, which is an eating disorder characterized by extreme calorie restriction
- intentional fasting
- coma
- stroke
- inability to obtain food (famine; child abuse; aftermath of war or other disaster; being lost in wilderness or desert areas)
- severe gastrointestinal disease

Since the body will combat **malnutrition** by breaking down its own fat and eventually its own tissue, a whole host of symptoms can appear. The body's structure, as well as its functions, are affected. Starved adults may lose as much as 50% of their normal body weight.

Characteristic symptoms of starvation include:

- shrinkage of such vital organs as the heart, lungs, ovaries, or testes, and gradual loss of their functions
- chronic diarrhea
- anemia
- reduction in muscle mass and consequent weakness
- lowered body temperature combined with extreme sensitivity to cold
- decreased ability to digest food because of lack of digestive acid production
- irritability and difficulty with mental concentration
- immune deficiency
- swelling from fluid under the skin
- decreased sex drive

Complete starvation in adults leads to **death** within 8 to 12 weeks. In the final stages of starvation, adult humans experience a variety of neurological and psychiatric symptoms, including **hallucinations** and convulsions as well as severe muscle **pain** and disturbances in heart rhythm.

In children, chronic malnutrition is marked by growth retardation. Anemia is the first sign to appear in an adult. Swelling of the legs is next, due to a drop in the protein content of the blood. Loss of resistance to infection follows next, along with poor wound healing. There is also progressive weakness and difficulty swallowing, which may lead to inhaling food. At the same time, the signs of specific nutrient deficiencies may appear.

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KEY TERMS

Anemia—Not enough red blood cells in the blood.

Anorexia nervosa—Eating disorder marked by malnutrition and weight loss commonly occurring in young women.

Cornea—The clear part of the front of the eye that admits light.

Kwashiorkor—Severe malnutritution in children caused by mainly by a protein-poor diet, characterized by growth retardation.

Marasmus—Severe malnutritution in children caused by a diet lacking mainly in calories. Can also be caused by disease and parasitic infection.

Treatment

If the degree of malnutrition is severe, the intestines may not tolerate a fully balanced diet. They may, in fact, not be able to absorb adequate nutrition at all. Carefully prepared elemental **diets** or intravenous feeding must begin the treatment. A formula consisting of 42% dried skim milk, 32% edible oil, and 25% sucrose plus electrolyte, mineral, and vitamin supplements is recommended for the first phase of refeeding. The treatment back to health is long and first begins with liquids. Gradually, solid foods are introduced and a daily diet providing 5,000 calories or more is instituted.

Prognosis

People can recover from severe degrees of starvation to a normal stature and function. Children, however, may suffer from permanent **mental retardation** or growth defects if their deprivation was long and extreme.

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Stasis dermatitis *see* **Dermatitis**

Static encephalopathy *see* **Cerebral palsy**

STDs *see* **Sexually transmitted diseases**

Steatosis *see* **Fatty liver**

Steele-Richardson-Olszewski syndrome *see* **Progressive supranuclear palsy**

Stein-Leventhal syndrome *see* **Polycystic ovary syndrome**

Steinert's disease *see* **Myotonic dystrophy**

Stem cell therapy *see* **Bone marrow transplantation**

Stem cell transplantation

Definition

Stem cells are basic human cells that reproduce (replicate) easily, providing a continuous source of new, sometimes different types of cells. A stem cell transplant is a procedure that replaces unhealthy stem cells with healthy ones. Stem cells can be harvested from bone marrow, from peripheral blood and from umbilical cord blood.

Purpose

Physicians use stem cell transplants to treat many diseases that damage or destroy bone marrow, found in the soft fatty tissue inside the bones. Examples of these diseases are leukemia and **multiple myeloma**. Some patients develop bone marrow disorders because of aggressive **cancer** treatments or as result of diseases such as **aplastic anemia**, which causes abnormal blood cell production.

Recent advances in stem cell research have made it a treatment possibility for patients with certain types of lymphomas, genetic disorders, hereditary metabolic disorders and **autoimmune disorders** as well. Researchers are hoping eventually to harvest stem cells to treat diseases such as Parkinson's disease, type 1 diabetes,

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Alzheimer's disease, **liver disease**, arthritis, and spinal cord injuries.

Demographics

The number of stem cell transplants performed continues to increase. It is estimated that between 30,000 to 40,000 transplantations are performed on an annual basis worldwide and this number is increasing by up to 20% yearly.

Description

Stem cell transplants sometimes are called hematopoietic stem cell transplants, bone marrow transplants, or cord blood transplants. Nearly 100 years ago, physicians tried to give patients with leukemia and anemia bone marrow by mouth. These treatments were not successful, but led to experiments showing healthy bone marrow transfused into the blood stream could restore damaged bone marrow.

Today, two types of stem cell transplants are performed most often. When a patient's own stem cells are collected (harvested) then returned to the same patient's body, it is called an autologous transplant. Using stem cells from another person, or a donor, is called allogenic transplant. A third, less common type of transplant, is called a syngeneic transplant in which the donor is an identical twin. In many cases, donor cells come from a close relative, such as a brother or sister. However, the likelihood that a sibling will match the patient is only about 25%. Stem cells may need to come from a person not related to the recipient.

To find out if a patient can receive stem cells from a donor, physicians developed human leukocyte antigen (HLA) testing to match tissue types. The next challenge became finding donors. Throughout the 1980s and 1990s, private individuals, hospitals, foundations, and states worked to set up a nationwide registry of bone marrow donors. The National Marrow Donor Program (NMDP) now has the largest stem cell donor registry in the world. At present, there are more than three million donors registered through the NMDP. However, ethnic minorities represent only a small percentage of the donors to the NMDP making it often more difficult to provide a donor to a member of an ethnic minority requiring a stem cell transplant.

Stem cell transplants normally take place at specialized centers. Procurement of stem cells from the donor can be accomplished in several ways: from the bone marrow, the peripheral blood, and less commonly, from umbilical cord blood

Donor cells harvested directly from a donor's bone marrow is done in an operating room while the patient (the donor) is under regional or **general anesthesia**. Bone marrow normally is harvested from the top of the hip bone. The marrow usually is filtered, treated, and either transplanted immediately or frozen for later use.

Stem cells harvested from a donor's peripheral blood are collected during apheresis once a process called stem cell mobilization has occurred. Hematopoietic stem cells are typically found in low concentrations in the circulating peripheral blood. Stem cells can be mobilized to enter the peripheral blood by administering the hematopoietic growth factor, granulocyte colony-stimulating factor (G-CSF) (filgrastim or lenograstim) to the donor. After about four days, enough stem cells are available in the circulating peripheral blood to be harvested. During a three to four hour apheresis collection process more stem cells can typically be collected than during a bone marrow harvest without the need for general anesthesia and an operating room setting.

Bone marrow transplantation is considered superior to peripheral blood stem cell transplant (PBSCT) for most nonmalignant conditions. Peripheral blood stem cell transplant is considered superior to bone marrow transplant when rapid engraftment of stem cells is needed. PBSCT is also associated with early hospital discharges, decreased relapse rates, and decreased mortality rates. However, PBSCT is associated with increased incidence of graft versus host disease (GVHD), a post-transplant complication.

Stem cells are transfused through an intravenous (IV) catheter that physicians insert in the patient's neck or chest. The procedure is usually done in the patient's hospital room. This part of the transplant process is referred to as the "rescue process." The stem cells replace malignant or defective cells. Transplanted donor cells travel to the bone cavities and begin replacing old bone marrow.

Precautions

The transplant team will weigh many factors when determining if a patient is a candidate for stem cell transplantation, including overall health and function of many vital organ systems. Stem cell transplantation is an aggressive treatment and may not be recommended for some patients, including those with heart, kidney, or lung disorders. If the patient has an aggressive cancer that has spread throughout the body, he or she may not be considered a candidate for a stem cell transplant. It once was thought that stem cell transplants were not safe in patients over age 60, but research

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KEY TERMS

Catheter—A medical device shaped like a tube that physicians can insert into vessels, canals, or passageways to more easily inject or withdraw fluids.

Embryo—A developing human from the time of conception to the end of the eighth week after conception.

Engraftment—The process of transplanted stem cells reproducing new cells.

shows that some elderly patients can safely receive stem cells from donors.

Many ethical and legal factors are impacting the research and development into stem cell transplantation. Much debate surrounds scientific advances. For example, human embryos, fetal tissues and umbilical cords are sources of stem cells that may be transplanted or used for disease research. Some people have ethical problems with the use of embryos in fertility clinics for stem cell research or transplantation. Some link stem cell transplantation for disease with cloning and want to stop funding for stem cell research over fear of human cloning. A study released in 2005 stated that 63% of Americans back embryonic stem cell research and 70% support federal legislation to promote more research. Meanwhile, scientists continue to develop new and exciting possibilities for transplanting stem cells into the human body that may one day lead to new treatments for previously incurable diseases. Many do so with private funding.

Preparation

Standard preparation involves eliminating diseased and damaged cells. The exact process depends on the patient. In many cases when transplantation is done to treat cancer, the patient will receive **chemotherapy**, often in extremely high doses. Some also receive **radiation therapy**. Another goal of preparation is to suppress the immune system. This makes it less likely that the patient's body will reject the donated stem cells. This step is called the conditioning regimen and is considered a crucial element in stem cell transplantation. New advances have been made that allow some of the patient's diseased cells to remain and mix with the new cells. Immediately before transplantation, the treating physician and staff will give the patient special instructions and precautions, depending on his or her disease and exact procedure. Many serious side effects are associated with the preparative regimens including **nausea**, **vomiting**, hair loss (**alopecia**), **diarrhea**, skin **rashes**, mouth sores and ulcers, as well as lung, liver, and neurological toxicities. Another serious result of the conditioning regimen is **infertility**. Sperm banking may be an option for some men. Preservation of female fertility by banking of oocytes (eggs) has not been as successful.

Aftercare

Stem cells take up to three weeks or longer to begin producing new cells or bone marrow, a process called engraftment. Until engraftment is complete, patients may bleed easily and are at high risk for the development of life-threatening infections. To reduce the risk for infection patients are hospitalized in high-efficiency particulate air (HEPA) filtered rooms that are sealed using positive air pressure. All individuals entering the room should practice strict hand hygiene to minimize the potential for spread of infection. Patients may be required to stay in the hospital for at least one week following transplantation until blood cell counts reach a safe level. Patients who received autologous transplants can often be managed on an outpatient basis. Once home, patients usually must be closely monitored, be careful not to risk infection, may be anemic, and may be extremely fatigued. Most patients will receive prophylactic antibiotic and antifungal therapy for 75–100 days after the transplant and will be monitored very closely for the occurrence of graft-versus-host disease and other transplant-related side effects.

Risks

In addition to the risk of a life-threatening infection following a stem cell transplant, patients receiving stem cells from donors risk serious complications from graft-versus-host disease (GVHD). GVHD is caused when the donor's cells react against the patient's (recipient's) tissue. Sometimes, the patient's body simply rejects the new cells. Researchers continue to explore ways to lessen risks of complications following stem cell transplants.

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ORGANIZATIONS

International Myeloma Foundation (IMF), 12650 Riverside Dr., Suite 206, North Hollywood, CA, 91607–3421, (800) 452-CURE, http://www.myeloma.org.

National Marrow Donor Program (NMDP), 3001 Broadway St. NE, Suite 100, Minneapolis, MN, 55413–1753, (800) 627-7692, http://www.marrow.org.

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Stent *see* **Coronary stent**

Stereotactic surgery *see* **Gamma knife surgery**

Sterilization *see* **Tubal ligation; Vasectomy**

Steroids

Definition

Steroids constitute a large class of naturally occurring and synthetic chemicals including sterols, such as cholesterol, and various corticosteroid and sex hormones that have wide-ranging effects. There are five classes of steroid hormones:

- mineralocorticoids
- glucocorticoids
- estrogens
- progestins
- androgens

However, the term "steroid" commonly refers to anabolic-androgenic steroids (AASs), which are synthetic derivatives of the male sex hormone testosterone.

Purpose

Anabolic-androgenic steroids are growth inducers. They were first developed in Europe in the 1930s to treat malnourishment and to promote healing following surgery. They are most commonly prescribed for hormone-replacement therapy; however they are also prescribed for a wide variety of other conditions including:

- cachexia (weight loss and muscle wasting) from severe conditions such as HIV/AIDS, chronic obstructive pulmonary disease (COPD), liver or kidney failure, some cancers, infection, surgery, injury, or unexplained inability to maintain adequate weight
- various types of anemia
- certain types of breast cancer in women
- hereditary angioedema
- acute and chronic wounds
- malnutrition with weight loss
- severe burns
- short stature
- osteoporosis
- primary or secondary hypogonadism
- side effects of long-term corticosteroid use

In addition to their legitimate medical uses, AASs are widely abused for building muscle, increasing strength, losing fat and flab, enhancing athletic performance, and otherwise engaging in high-risk behavior. Their anabolic effects build muscle and their androgenic effects develop male sexual characteristics in both males and females. At medically prescribed dosages the growth effects of anabolic steroids are slow or unnoticeable. However at high abusive doses muscles increase rapidly in size and strength and AAS may increase energy and libido.

Competitive weightlifters began using AASs in the 1950s and their use gradually spread to other sports. Most major athletic competitions, including the Olympic Games, the Wimbledon tennis tournament, the Tour de France bicycle race, and major-league professional sports teams, now routinely screen athletes for steroid use. Some steroids are easily detectable with a urine screen since the products of steroid metabolism can be identified in the urine for six months or longer after the drugs are discontinued. However the technology for detecting steroids in blood or urine—and distinguishing the use of AASs from the products of

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normal metabolism or legitimate medications—is often one step behind the design of new steroid drugs.

Description

Steroids are chemicals containing a "steroid nucleus" consisting of four rings of 17 carbon atoms. They are fat-soluble compounds found in both plants and animals that function as hormones—chemical messengers. In humans steroids are produced from cholesterol in the endocrine glands, such as the adrenal cortex and the gonads (ovary and testis). Glands secrete the hormones directly into the bloodstream where they are transported to distant parts of the body and mediate various vital physiologic functions ranging from suppressing inflammation to regulating events during **pregnancy**.

Anabolic-androgenic steroids have three mechanisms of action:

- They help metabolize proteins.
- They speed up the synthesis of skeletal muscle tissue.
- They provide a "rush" that enables an athlete to train harder and longer by temporarily masking fatigue.

Common AASs preparations include:

- testosterone esters: testosterone propionate, cypionate, and enanthate
- testosterone derivatives: methyltestosterone (which is rarely used), methandrostenolone, and fluoxymesterone (which is rarely used clinically but is abused)
- nandrolone derivatives: nandrolone decanoate, ethylestrenol, and trenbolone
- dihydrotestosterone (DHT) derivatives: oxandrolone, stanozolol, and oxymetholone

AASs are taken orally as tablets or capsules, by injection into muscles, or through the skin via ointments or transdermal patches. They are sometimes combined with creatine, protein powders, and/or various antioxidant formulations. These are considered to be ergogenic aids—substances that enhance the body's production, use, or recovery of energy and provide athletes with a competitive advantage.

U.S. brand names

AASs that are prescribed for medical purposes in the United States include:

- Depo-Testosterone (testosterone cypionate) for low testosterone levels
- Android (methyltestosterone) for treating hot flashes in postmenopausal women
- Nandrolone decanoate, an injectable preparation available only as a generic and relatively safe at clinical doses for treating osteoporosis, but one of the most widely abused AASs
- Durabolin (nandrolone phenpropionate), a parenteral injection
- Oxandrin (oxandrolone), oral tablets prescribed for HIV/AIDS-related conditions, bone pain from osteoporosis, to prevent certain side effects of corticosteroids, and sometimes abused by female athletes
- Winstrol (stanozolol), oral tablets for treating hereditary angioedema
- Anadrol-50 (oxymetholone), oral tablets that are abused worldwide and are considered to be carcinogenic

In the past steroidal supplements such as androstenedione ("Andro") were commercially available in the United States. They were declared illegal in 2004 in an amendment to the Controlled Substances Act. The only remaining legal steroidal supplement in the United States is dehydroepiandrosterone (DHEA), which may or may not be converted to testosterone in the body.

Many athletes and other people obtain and use AASs illegally. Estimates of steroid **abuse** in the general adult population of the United States range from 0.5–5%. Although most anabolic steroid users are adult males, misuse is increasing among women and adolescents.

Street names for veterinary steroids that are abused include:

- Abolic
- Dianabol
- Equipoise
- Finajet/Finaject
- Parabolin
- Trenbolone
- Winstrol V

Street names for oral steroids that are abused include:

- Anadrol
- Anavar
- Maxibolin
- Methyltestosterone
- Parabolin
- Primbolin
- Primobolin
- Proviron
- Winstrol

Street names for abused injectable steroids include:

- Anatrofin
- Bolasterone
- Deca-Duabolin

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KEY TERMS

Anabolic—Causing muscle and bone growth and a shift from fat to muscle in the body.

Androgenic—Causing testosterone-like, masculinizing effects.

Angioedema—Patches of swelling of the skin, subcutaneous layers, mucus membranes, and sometimes internal organs.

Cachexia—Physical wasting and malnutrition, usually from chronic disease.

Cholesterol—A steroid alcohol in cells and body fluids that serves as a precursor for hormones and other steroids.

Corticosteroid—A steroid, such as cortisone, produced by the adrenal cortex.

Creatine—A nitrogen-containing substance found in muscle.

Estrogen—The primary female sex hormone.

Hormones—Chemical messengers that are carried by the bloodstream to various organs where they effect functioning, often by stimulatory action.

Sex hormones—Hormones that are responsible for sexual characteristics and reproductive functioning.

Steroids—A class of hormones and drugs that includes sex and stress hormones and anti-inflammatory medications, contraceptives, and growth-promoting substances.

Sterols—Steroid alcohols, such as cholesterol, that are widely distributed in the body.

Testosterone—The primary male sex hormone.

- Delatestryl
- Dep-testosterone
- Dihydrolone
- Durabolin
- Dymethzine
- Enoltestovis
- Methatriol
- Primbolin
- Primobolin
- Quinolone
- Sustanon 250
- Therobolin
- Trophobolene

"Designer" steroids include:

- THG (tetrahydrogestrinone)
- Madol (desoxymethyltestosterone)
- Genabol (norbolethone)
- Equipoise and others (boldenone undecylenate)

Canadian brand names

Canadian AASs include Deca-Durabolin (nandrolone decanoate) and Anapolon 50 (oxymetholone).

International brand names

There are many thousands of international brand names for AASs and in some countries they are available over the counter. Methandrostenolone (Dianabol, Danabol, DBOL, Reforvit-b) and ethylestrenol (Maxibolin) have been discontinued in the United States but are still manufactured internationally. Trenbolone, a veterinary drug in the United States, is a widely abused European prescription drug. Winstrol (stanozolol) is marketed internationally as well as in the United States, comes in both oral and injectable forms, and is widely abused.

Recommended dosage

Prescribed dosages of AASs depend on the specific drug and the condition being treated. Examples of dosages include:

- for malnutrition and cachexia from COPD: an initial 250-milligram (mg) injection of testosterone followed by 12 mg per day of stanozolol
- for renal-failure patients on hemodialysis: 100 mg per week of nandrolone
- for quadriplegic patients: 20 mg per day of oxandrolone
- for weight loss from alcoholic hepatitis: 80 mg per day of oxandrolone
- for decreasing the frequency and severity of angioedema attacks: 2 mg of stanozolol three times daily

Dosages used by AAS abusers are often 50–100 times higher than those for treating medical conditions. In one survey of 500 AAS users, more than half reported taking 1,000 mg or more every week. In addition 13% acknowledged using such unsafe injection practices such as sharing needles, reusing needles, or sharing multi-dose vials of steroids.

In addition to higher doses, AAS abusers may practice:

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- stacking: taking two or more AASs together, using more than one route of administration, or mixing AASs with other drugs such as stimulants or painkillers
- cycling: alternating periods of steroid use with periods of abstinence
- pyramiding: cycling of increasing doses over several weeks followed by decreasing doses Some users believe that cycling and pyramiding maximize the desirable effects of steroids while reducing the undesirable effects, although there is no scientific evidence to support this and cycling may build tolerance, requiring higher dosages.

Precautions

Although AASs are considered to be relatively safe at the usual prescribed dosages, at abusive dosages they can result in a wide range of serious health problems, including:

- abnormal lipid profiles
- early heart attacks
- strokes
- kidney failure
- severe liver problems including jaundice, tumors, and cancer
- depression
- severe psychiatric disturbances

Unsafe injection of AASs can result in HIV and **hepatitis B** and C infections. It also has been suggested that steroids may be gateway drugs for **narcotics** abuse and it is possible to become psychologically addicted to them.

Withdrawal from high doses of AASs may require:

- medication to relieve withdrawal symptoms
- antidepressants
- hormones to restore normal hormonal function

Pediatric

AASs should be used with extreme caution in children. They can cause early **puberty** and lead to premature cessation of bone growth, resulting in permanent short stature.

A 2008 survey found that 1.4% of eighth graders, 1.4% of tenth graders, and 2.2% of twelfth graders had used AASs. Some were athletes attempting to increase their strength and size; others were simply attempting to speed up their growth to keep pace with their peers. Many teenagers also are attracted by the psychological rush that comes with steroid abuse. Prevention programs often target school- or community-sponsored athletic teams, coaches, and team leaders. It has been recommended that educational prevention programs start with middle-school athletes.

Geriatric

Elderly patients can be more sensitive to the effects of AASs. They should not be used in elderly people with prostate problems, fluid buildup, or abnormal liver function.

Pregnant or breastfeeding

Pregnant women or women who are planning to become pregnant should never take AASs because they are known to cause **birth defects**. Although it is not known whether most AASs pass into breast milk, lactating women should avoid these drugs.

Other conditions and allergies

People with the following conditions should never take an AAS:

- high blood calcium levels (hypercalcemia)
- prostate cancer
- breast cancer in males
- breast cancer with high calcium levels in females
- severe kidney damage

The following conditions may be contraindications for AASs:

- heart or blood vessel disease
- previous heart attack
- high blood cholesterol
- bleeding or clotting problems
- diabetes, since AASs can affect blood sugar levels
- liver or kidney problems

Side effects

AASs usually have few side effects at medical dosages. However at the much higher doses used to improve body image or athletic performance, side effects can be serious and sometimes irreversible. Excessive use can cause harmful imbalances in hormones and body chemistry.

Common side effects of AASs include:

- excitability
- changes in sex drive
- swelling of the feet and ankles
- baldness
- breast swelling
- change in skin color

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- diarrhea
- nausea
- vomiting
- insomnia
- bladder irritation
- fertility problems
- testicular problems
- difficulty achieving an erection

Rare but more severe side effects of medically prescribed dosages of AASs include:

- severe allergic reactions
- acne, especially in women
- darkened urine
- deepening of the voice in women
- increased facial and body hair in women
- menstrual changes
- frequent painful erections
- behavioral or emotional changes
- jaundice

Side effects of AAS abuse can include:

- shrinking testicles, falling sperm counts, gynecomastia (swelling and enlargement of the breasts), increased urination, and enlarged prostate glands in males
- virilization in females, including hirsutism (growth of body and facial hair), male-pattern baldness, cessation of menstruation, decreased breast size, deepening of the voice, and abnormal enlargement of the clitoris
- an increase in "bad" cholesterol (LDL) and a decrease in "good" cholesterol (HDL)
- water retention leading to high blood pressure and stroke
- heart attacks
- liver and kidney tumors
- insomnia
- drastic mood swings ranging from mania to depression
- aggression, paranoia, irritability, delusions, hostility, psychosis

Pediatric

Side effects of AASs in young people can include:

- acne
- early puberty
- an initial growth spurt
- premature cessation of growth due to closure of growth plates

Other conditions and allergies

AAS preparations can contain various ingredients that may cause allergic reactions in some people.

Interactions

AASs may interact with:

- anticoagulants such as warfarin (Coumadin)
- carbamazepine
- insulin or oral diabetes medications
- corticosteroids
- eucaplyptus
- kava (*Piper methysticum*)

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National Institute on Drug Abuse (NIDA), 6001 Executive Boulevard, Room 5213, Bethesda, MD, 20892-9561, (301) 443-1124, information@nida.nih.gov, http://www.drugabuse.gov/NIDAHome.html.

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Stillbirth

Definition

A stillbirth is defined as the **death** of a fetus at any time after the twentieth week of **pregnancy**. Stillbirth is also referred to as intrauterine fetal death (IUFD).

Description

It is important to distinguish between a stillbirth and other words that describe the unintentional end of a pregnancy. A pregnancy that ends before the twentieth week is called a **miscarriage** rather than a stillbirth, even though the death of the fetus is a common cause of miscarriage. After the twentieth week, the unintended end of a pregnancy is called a stillbirth if the infant is dead at birth and premature delivery if it is born alive.

Factors that increase a mother's risk of stillbirth include: age over 35, **malnutrition**, inadequate prenatal care, **smoking**, and alcohol or drug **abuse**.

Causes and symptoms

Causes

A number of different disorders can cause stillbirth. They include:

- Pre-eclampsia and eclampsia. These are disorders of late pregnancy characterized by high blood pressure, fluid retention, and protein in the urine.
- Diabetes in the mother.
- Hemorrhage.
- Abnormalities in the fetus caused by infectious diseases, including syphilis, toxoplasmosis, German measles (rubella), and influenza.
- Severe birth defects, including spina bifida. Birth defects are responsible for about 20% of stillbirths.
- Postmaturity. Postmaturity is a condition in which the pregnancy has lasted 41 weeks or longer.
- Unknown causes. These account for about one-third of stillbirths.

KEY TERMS

Alpha-fetoprotein analysis—A blood test that can be done after the sixteenth week of pregnancy to evaluate the possibility of spina bifida and other birth defects in the fetus.

Electronic fetal nonstress test—A test in which electronic monitors attached to the mother's abdomen to detect contractions of the uterus as well as the baby's heartbeat and movements.

Miscarriage—The spontaneous end of a pregnancy before the twentieth week. The death of the fetus is a common cause of miscarriage.

Oxytocin—A drug that is given to induce labor in some cases of stillbirth.

Pre-eclampsia and eclampsia—Disorders of late pregnancy associated with high blood pressure, fluid retention, and protein in the urine. They can cause stillbirth.

Premature delivery—The birth of a live baby when a pregnancy ends spontaneously after the twentieth week.

Symptoms

In most cases the only symptom of stillbirth is that the mother notices that the baby has stopped moving. In some cases, the first sign of fetal death is **premature labor**. Premature labor is marked by a rush of fluid from the vagina, caused by the tearing of the membrane around the baby; and by abdominal cramps or contractions.

Diagnosis

When the mother notices that fetal movement has stopped, the doctor can use several techniques to evaluate whether the baby has died. The doctor can listen for the fetal heartbeat with a stethoscope, use Doppler ultrasound to detect the heartbeat, or give the mother an electronic fetal nonstress test. In this test, the mother lies on her back with electronic monitors attached to her abdomen. The monitors record the baby's heart rate, movements, and contractions of the uterus.

Treatment

Medical

In most cases of intrauterine death, the mother will go into labor within two weeks of the baby's death. If the mother does not go into labor, the doctor will bring

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on (induce) labor in order to prevent the risk of hemorrhage. Labor is usually induced by giving the mother a drug (oxytocin) that cause the uterus to contract.

Follow-up therapy

Emotional support from family and friends, self-help groups, and counseling by a mental health professional can help bereaved parents cope with their loss.

Prognosis

With the exception of women with diabetes, women who have a stillbirth have as good a chance of carrying a future pregnancy to term as women who are pregnant for the first time.

Prevention

The risk of stillbirth can be lowered to some extent by good prenatal care and the mother's avoidance of exposure to infectious diseases, smoking, alcohol abuse, or drug consumption. Tests before delivery (**antepartum testing**), such as ultrasound, the alpha-fetoprotein blood test, and the electronic fetal non-stress test, can be used to evaluate the health of the fetus before there is a stillbirth.

Resources

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ORGANIZATIONS

Compassionate Friends, P.O. Box 3696, Oak Brook, IL, 60522, (630) 990-0010, (630) 990-0246, (877) 969-0010, http://www.compassionatefriends.org.

GriefNet, GriefNet, Ann Arbor, MI, 48106-3272, cendra@griefnet.org, http://www.griefnet.org.

Hannah's Prayer, PO Box 15053, Long Beach, CA, 90815, (562) 335-4130, http://www.hannah.org.

M.E.N.D. (Mommies Enduring Neonatal Death), P.O. Box 1007 , Coppell, TX, 75019, (972) 506-9000, rebekah@mend.org, http://www.mend.org.

Pregnancy and Infant Loss Support (SHARE), 402 Jackson Street, St. Charles, MO, 63301, (636) 947-6164, (800) 821-6819.

Carol A. Turkington

Stings *see* **Bites and stings**

Stockholm syndrome

Definition

Stockholm syndrome refers to a group of psychological symptoms that occur in some persons in a captive or hostage situation. It has received considerable media publicity in recent years because it has been used to explain the behavior of such well-known kidnapping victims as Patty Hearst (1974) and Elizabeth Smart (2002). The term takes its name from a bank robbery in Stockholm, Sweden, in August 1973. The robber took four employees of the bank (three women and one man) into the vault with him and kept them hostage for 131 hours. After the employees were finally released, they appeared to have formed a paradoxical emotional bond with their captor; they told reporters that they saw the police as their enemy rather than the bank robber and that they had positive feelings toward the criminal. The syndrome was first named by Nils Bejerot (1921–1988), a medical professor who specialized in **addiction** research and served as a psychiatric consultant to the Swedish police during the standoff at the bank. Stockholm syndrome is also known as Survival Identification Syndrome.

Description

Stockholm syndrome is considered a complex reaction to a frightening situation and experts do not agree completely on all of its characteristic features or on the factors that make some people more susceptible than others to developing it. One reason for the disagreement is that it would be unethical to test theories about the syndrome by experimenting on human beings. The data for understanding the syndrome are derived from actual hostage situations since 1973 that differ considerably from one another in terms of location, number of people involved, and time frame. Another source of disagreement concerns the extent to which the syndrome can be used to explain other historical phenomena or more commonplace types of abusive relationships. Many researchers believe that Stockholm syndrome helps to explain certain behaviors of survivors of World War II concentration camps; members of religious cults; battered wives; incest survivors; and physically or emotionally abused children as well as persons taken hostage by criminals or terrorists.

Most experts, however, agree that Stockholm syndrome has three central characteristics:

- The hostages have negative feelings about the police or other authorities.
- The hostages have positive feelings toward their captor(s).

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- The captors develop positive feelings toward the hostages.

Causes & symptoms

Stockholm syndrome does not affect all hostages (or persons in comparable situations); in fact, a Federal Bureau of Investigation (FBI) study of over 1200 hostage-taking incidents found that 92% of the hostages did *not* develop Stockholm syndrome. FBI researchers then interviewed flight attendants who had been taken hostage during airplane hijackings, and concluded that three factors are necessary for the syndrome to develop:

- The crisis situation lasts for several days or longer.
- The hostage takers remain in contact with the hostages; that is, the hostages are not placed in a separate room.
- The hostage takers show some kindness toward the hostages or at least refrain from harming them. Hostages abused by captors typically feel anger toward them and do not usually develop the syndrome.

In addition, people who often feel helpless in other stressful life situations or are willing to do anything in order to survive seem to be more susceptible to developing Stockholm syndrome if they are taken hostage.

People with Stockholm syndrome report the same symptoms as those diagnosed with **post-traumatic stress disorder** (PTSD): **insomnia**, nightmares, general irritability, difficulty concentrating, being easily startled, feelings of unreality or confusion, inability to enjoy previously pleasurable experiences, increased distrust of others, and flashbacks.

Diagnosis

Stockholm syndrome is a descriptive term for a pattern of coping with a traumatic situation rather than a diagnostic category. Most psychiatrists would use the diagnostic criteria for **acute stress disorder** or posttraumatic stress disorder when evaluating a person with Stockholm syndrome.

Treatment

Treatment of Stockholm syndrome is the same as for PTSD, most commonly a combination of medications for short-term sleep disturbances and **psychotherapy** for the longer-term symptoms.

Prognosis

The prognosis for recovery from Stockholm syndrome is generally good, but the length of treatment needed depends on several variables. These include the nature of the hostage situation; the length of time the crisis lasted, and the individual patient's general coping style and previous experience(s) of trauma.

KEY TERMS

Coping—In psychology, a term that refers to a person's patterns of response to stress. Some patterns of coping may lower a person's risk of developing Stockholm syndrome in a hostage situation.

Flashback—The re-emergence of a traumatic memory as a vivid recollection of sounds, images, and sensations associated with the trauma. The person having the flashback typically feels as if they are reliving the event. Flashbacks were first described by doctors treating combat veterans of World War I (1914–1918).

Identification with an aggressor—In psychology, an unconscious process in which a person adopts the perspective or behavior patterns of a captor or abuser. Some researchers consider it a partial explanation of Stockholm syndrome.

Regression—In psychology, a return to earlier, usually childish or infantile, patterns of thought or behavior.

Syndrome—A set of symptoms that occur together.

Prevention

Prevention of Stockholm syndrome at the level of the larger society includes further development of crisis intervention skills on the part of law enforcement as well as strategies to prevent kidnapping or hostage-taking incidents in the first place. Prevention at the individual level is difficult as of the early 2000s because researchers have not been able to identify all the factors that may place some persons at greater risk than others; in addition, they disagree on the specific psychological mechanisms involved in Stockholm syndrome. Some regard the syndrome as a form of regression (return to childish patterns of thought or action) while others explain it in terms of emotional **paralysis** ("frozen fright") or identification with the aggressor.

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American Psychiatric Association (APA), 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209, (888) 357-7924, apa@psych.org, http://www.psych.org.

Federal Bureau of Investigation (FBI), 935 Pennsylvania Avenue, NW, Washington, DC, 20535-0001, (202) 324-3000, http://www.fbi.gov.

Rebecca Frey, PhD

Stomach acid determination *see* **Gastric acid determination**

An excised section of a human stomach showing a cancerous tumor (center, triangular shape). *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Stomach cancer

Definition

Stomach **cancer** (also known as gastric cancer) is a disease in which the cells forming the inner lining of the stomach become abnormal and start to divide uncontrollably, forming a mass called a tumor.

Description

The stomach is a J-shaped organ that lies in the left and central portion of the abdomen. The stomach produces many digestive juices and acids that mix with food and aid in the process of digestion. There are five regions of the stomach that doctors refer to when determining the origin of stomach cancer. These are:

- the cardia, area surrounding the cardiac sphincter which controls movement of food from the esophagus into the stomach,
- the fundus, upper expanded area adjacent to the cardiac region,
- the antrum, lower region of the stomach where it begins to narrow,
- the prepyloric, region just before or nearest the pylorus,
- and the pylorus, the terminal region where the stomach joins the small intestine

Cancer can develop in any of the five sections of the stomach. Symptoms and outcomes of the disease will vary depending on the location of the cancer.

Based on previous data from the National Cancer Institute and the United States Census, the American Cancer Society estimates that 21,700 Americans will be diagnosed with stomach cancer during 2001 and approximately 13,000 deaths will result from the disease. In most areas, men are affected by stomach cancer nearly twice as often as women. Most cases of stomach cancer are diagnosed between the ages of 50 and 70, but in families with a hereditary risk of stomach cancer, younger cases are more frequently seen.

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Stomach cancer is one of the leading causes of cancer deaths in several areas of the world, most notably Japan and other Asian countries. In Japan it appears almost ten times as frequently as in the United States. The number of new stomach cancer cases is decreasing in some areas, however, especially in developed countries. In the United States, incidence rates have dropped from 30 individuals per 100,000 in the 1930s, to only 8 in 100,000 individuals developing stomach cancer by the 1980s. The use of refrigerated foods and increased consumption of fresh fruits and vegetables, instead of preserved foods with high salt content, may be a reason for the decline.

Causes and symptoms

While the exact cause for stomach cancer has not been identified, several potential factors have lead to increased numbers of individuals developing the disease and therefore, significant risk has been associated. Diet, work environment, exposure to the bacterium *Helicobacter pylori*, and a history of stomach disorders, such as ulcers or polyps, are some of these believed causes.

Studies have shown that eating foods with high quantities of salt and nitrites increases the risk of stomach cancer. The diet in a specific region can have a great impact on its residents. Making changes to the types of foods consumed has been shown to decrease likelihood of disease, even for individuals from countries with higher risk. For example, Japanese people who move to the United States or Europe and change the types of foods they eat have a far lower chance of developing the disease than do Japanese people who remain in Japan and do not change their dietary habits. Eating recommended amounts of fruit and vegetables may lower a person's chances of developing this cancer.

A high risk for developing stomach cancers has been linked to certain industries as well. The best proven association is between stomach cancer and persons who work in coal mining and those who work processing timber, nickel, and rubber. An unusually large number of these workers have been diagnosed with this form of cancer.

Several studies have identified a bacterium (*Helicobacter pylori*) that causes stomach ulcers (inflammation in the inner lining of the stomach). Chronic (long-term) infection of the stomach with these bacteria may lead to a particular type of cancer (lymphomas or mucosa-associated lymphoid tissue [MALT]) in the stomach.

Another risk factor is the development of polyps, benign growths in the lining of the stomach. Although polyps are not cancerous, some may have the potential to turn cancerous. People in blood group A are also at elevated risk for this cancer for unknown reasons. Other speculative causes of stomach cancer include previous stomach surgery for ulcers or other conditions, or a form of anemia known as pernicious anemia.

Stomach cancer is a slow-growing cancer. It may be years before the tumor grows very large and produces distinct symptoms. In the early stages of the disease, the patient may only have mild discomfort, **indigestion**, **heartburn**, a bloated feeling after eating, and mild **nausea**. In the advanced stages, a patient will have loss of appetite and resultant weight loss, stomach pains, **vomiting**, difficulty in swallowing, and blood in the stool. Stomach cancer often spreads (metastasizes) to adjoining organs such as the esophagus, adjacent lymph nodes, liver, or colon.

Diagnosis

Unfortunately, many patients diagnosed with stomach cancer experience **pain** for two or three years before informing a doctor of their symptoms. When a doctor suspects stomach cancer from the symptoms described by the patient, a complete medical history will be taken to check for any risk factors. A thorough **physical examination** will be conducted to assess all the symptoms. Laboratory tests may be ordered to check for blood in the stool (**fecal occult blood test**) and anemia (low red blood cell count), which often accompany gastric cancer.

In some countries, such as Japan, it is appropriate for patients to be given routine screening examinations for stomach cancer, as the risk of developing cancer in that society is very high. Such screening might be useful for all high-risk populations. Due to the low prevalence of stomach cancer in the United States, routine screening is usually not recommended unless a family history of the disease exists.

Whether as a screening test or because a doctor suspects a patient may have symptoms of stomach cancer, **endoscopy** or barium x rays are used in diagnosing stomach cancer. For a barium x ray of the upper gastrointestinal tract, the patient is given a chalky, white solution of barium sulfate to drink. This solution coats the esophagus, the stomach, and the small intestine. Air may be pumped into the stomach after the barium solution in order to get a clearer picture. Multiple x rays are then taken. The barium coating helps to identify any abnormalities in the lining of the stomach.

In another more frequently used test, known as upper gastrointestinal endoscopy, a thin, flexible, lighted tube (endoscope) is passed down the patient's throat and into the stomach. The doctor can view the lining of the esophagus and the stomach through the

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tube. Sometimes, a small ultrasound probe is attached at the end of the endoscope. This probe sends high frequency sound waves that bounce off the stomach wall. A computer creates an image of the stomach wall by translating the pattern of echoes generated by the reflected sound waves. This procedure is known as an endoscopic ultrasound or EUS.

Endoscopy has several advantages, in that the physician is able to see any abnormalities directly. In addition, if any suspicious-looking patches are seen, biopsy forceps can be passed painlessly through the tube to collect some tissue for microscopic examination. This is known as a biopsy. EUS is beneficial because it can provide valuable information on depth of tumor invasion.

After stomach cancer has been diagnosed and before treatment starts, another type of x-ray scan is taken. Computed tomography (CT) is an imaging procedure that produces a three-dimensional picture of organs or structures inside the body. CT scans are used to obtain additional information in regard to how large the tumor is and what parts of the stomach it borders; whether the cancer has spread to the lymph nodes; and whether it has spread to distant parts of the body (metastasized), such as the liver, lung, or bone. A CT scan of the chest, abdomen, and pelvis is taken. If the tumor has gone through the wall of the stomach and extends to the liver, pancreas, or spleen, the CT will often show this. Although a CT scan is an effective way of evaluating whether cancer has spread to some of the lymph nodes, it is less effective than EUS in evaluating whether the nodes closest to the stomach are free of cancer. However, CT scans, like barium x rays, have the advantage of being less invasive than upper endoscopy.

Laparoscopy is another procedure used to stage some patients with stomach cancer. This involves a medical device similar to an endoscope. A laparoscopy is a minimally invasive surgery technique with one or a few small incisions, which can be performed on an outpatient basis, followed by rapid recovery. Patients who may receive **radiation therapy** or **chemotherapy** before surgery may undergo a laparoscopic procedure to determine the precise stage of cancer. The patient with bone pain or with certain laboratory results should be given a **bone scan**.

Benign gastric neoplasms are tumors of the stomach that cause no major harm. One of the most common is called a submucosal leiomyoma. If a leiomyoma starts to bleed, surgery should be performed to remove it. However, many leiomyomas require no treatment. Diagnosis of stomach cancers should be conducted carefully so that if the tumor does not require treatment the patient is not subjected to a surgical operation.

Treatment

More than 95% of stomach cancers are caused by adenocarcinomas, malignant cancers that originate in glandular tissues. The remaining 5% of stomach cancers include lymphomas and other types of cancers. It is important that gastric lymphomas be accurately diagnosed because these cancers have a much better prognosis than stomach adenocarcinomas. Approximately half of the people with gastric lymphomas survive five years after diagnosis. Treatment for gastric lymphoma involves surgery combined with chemotherapy and radiation therapy.

Staging of stomach cancer is based on how deep the growth has penetrated the stomach lining; to what extent (if any) it has invaded surrounding lymph nodes; and to what extent (if any) it has spread to distant parts of the body (metastasized). The more confined the cancer, the better the chance for a cure.

One important factor in the staging of adenocarcinoma of the stomach is whether or not the tumor has invaded the surrounding tissue and, if it has, how deep it has penetrated. If invasion is limited, prognosis is favorable. Disease tissue that is more localized improves the outcome of surgical procedures performed to remove the diseased area of the stomach. This is called a resection of the stomach.

Several distinct ways of classifying stomach cancer according to cell type have been proposed. The Lauren classification is encountered most frequently. According to this classification system, gastric adenocarcinomas are either called intestinal or diffuse. Intestinal cancers are much like a type of intestinal cancer called intestinal carcinoma. Intestinal tumors are more frequently found in males and in older patients. The prognosis for these tumors is better than that for diffuse tumors. Diffuse tumors are more likely to infiltrate, that is, to move into another organ of the body.

Because symptoms of stomach cancer are so mild, treatment often does not commence until the disease is well advanced. The three standard modes of treatment for stomach cancer include surgery, radiation therapy, and chemotherapy. While deciding on the patient's treatment plan, the doctor takes into account many factors. The location of the cancer and its stage are important considerations. In addition, the patient's age, general health status, and personal preferences are also taken into account.

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Surgery

In the early stages of stomach cancer, surgery may be used to remove the cancer. Surgical removal of adenocarcinoma is the only treatment capable of eliminating the disease. Laparoscopy is often used before surgery to investigate whether or not the tumor can be removed surgically. If the cancer is widespread and cannot be removed with surgery, an attempt will be made to remove blockage and control symptoms such as pain or bleeding. Depending on the location of the cancer, a portion of the stomach may be removed, a procedure called a partial **gastrectomy**. In a surgical procedure known as total gastrectomy, the entire stomach may be removed. However, doctors prefer to leave at least part of the stomach if possible. Patients who have been given a partial gastrectomy achieve a better quality of life than those having a total gastrectomy and typically lead normal lives. Even when the entire stomach is removed, the patients quickly adjust to a different eating schedule. This involves eating small quantities of food more frequently. High-protein foods are generally recommended.

Partial or total gastrectomy is often accompanied by other surgical procedures. Lymph nodes are frequently removed and nearby organs, or parts of these organs, may be removed if cancer has spread to them. Such organs may include the pancreas, colon, or spleen.

Preliminary studies suggest that patients who have tumors that cannot be removed by surgery at the start of therapy may become candidates for surgery later. Combinations of chemotherapy and radiation therapy are sometimes able to reduce disease for which surgery is not initially appropriate. Preliminary studies are being performed to determine if some of these patients can become candidates for surgical procedures after such therapies are applied.

Chemotherapy

Whether or not patients undergoing surgery for stomach cancer should receive chemotherapy is a controversial issue. Chemotherapy involves administering anti-cancer drugs either intravenously (through a vein in the arm) or orally (in the form of pills). This can either be used as the primary mode of treatment or after surgery to destroy any cancerous cells that may have migrated to distant sites. Most cancers of the gastrointestinal tract do not respond well to chemotherapy, however, adenocarcinoma of the stomach and advanced stages of cancer are exceptions.

Chemotherapy medicines such as doxorubicin, mitomycin C, and 5-fluorouracil, used alone, provide benefit to at least one in five patients. Combinations of agents may provide even more benefit, although it is not certain that this includes longer survival. For example, some doctors use what is called the FAM regimen, which combines 5-fluorouacil, doxorubicin, and mitomycin. Some doctors prefer using 5-fluorouracil alone to FAM since side effects are more moderate. Another combination some doctors are using involve high doses of the medications methotrexate, 5-fluorouracil, and doxorubicin. Other combinations that have shown benefit include the ELF regimen, a combination of leucovorin, 5-fluorouracil, and etoposide. The EAP regimen, a combination of etoposide, doxorubicin, and cisplatin is also used.

Although chemotherapy using a single medicine is sometimes used, the best response rates are often achieved with combinations of medicines. Therefore, in addition to studies exploring the effectiveness of new medicines there are other studies attempting to evaluate how to best combine existing forms of chemotherapy to bring the greatest degree of help to patients.

Radiation therapy

Radiation therapy is often used after surgery to destroy the cancer cells that may not have been completely removed during surgery. To treat stomach cancer, external beam radiation therapy is generally used. In this procedure, high-energy rays from a machine that is outside of the body are concentrated on the area of the tumor. In the advanced stages of gastric cancer, radiation therapy is used to ease symptoms such as pain and bleeding. However, studies of radiation treatment for stomach cancer have shown that the way it has been used it has been ineffective for many patients.

Researchers are actively assessing the role of chemotherapy and radiation therapy used before a surgical procedure is conducted. They are searching for ways to use both chemotherapy and radiation therapy so that they increase the length of survival of patients more effectively than current methods are able to do.

Prognosis

Overall, approximately 20% of patients with stomach cancer live at least five years following diagnosis. Patients diagnosed with stomach cancer in its early stages have a far better prognosis than those for whom it is in the later stages. In the early stages, the tumor is small, lymph nodes are unaffected, and the cancer has not migrated to the lungs or the liver. Unfortunately, only about 20% of patients with stomach cancer are diagnosed before the cancer had spread to the lymph nodes or formed a distant metastasis.

It is important to remember that statistics on prognosis may be misleading. Newer therapies are being

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KEY TERMS

Adenocarcinoma—Malignant cancers that originate in the tissues of glands or that form glandular structures.

Anemia—A condition in which iron levels in the blood are low.

Barium x ray (upper GI)—An x-ray test of the upper part of the gastrointestinal (GI) tract (including the esophagus, stomach, and a small portion of the small intestine) after the patient is given a white, chalky barium sulfate solution to drink. This substance coats the upper GI and the x rays reveal any abnormality in the lining of the stomach and the upper GI.

Biopsy—Removal of a tissue sample for examination under the microscope to check for cancer cells.

Chemotherapy—Treatment of cancer with synthetic drugs that destroy the tumor either by inhibiting the growth of the cancerous cells or by killing the cancer cells.

Endoscopic ultrasound (EUS)—A medical procedure in which sound waves are sent to the stomach wall by an ultrasound probe attached to the end of an endoscope. The pattern of echoes generated by the reflected sound waves are translated into an image of the stomach wall by a computer.

External radiation therapy—Radiation therapy that focuses high-energy rays from a machine on the area of the tumor.

Infiltrate—A tumor that moves into another organ of the body.

Polyp—An abnormal growth that develops on the inside of a hollow organ such as the colon, stomach, or nose.

Radiation therapy—Treatment using high-energy radiation from x-ray machines, cobalt, radium, or other sources.

Total gastrectomy—Surgical removal (excision) of the entire stomach.

Upper endoscopy—A medical procedure in which a thin, lighted, flexible tube (endoscope) is inserted down the patient's throat. Through this tube the doctor can view the lining of the esophagus, stomach, and the upper part of the small intestine.

developed rapidly and five-year survival has not yet been measured with these. Also, the largest group of people diagnosed with stomach cancer are between 60 and 70 years of age, suggesting that some of these patients die not from cancer but from other age-related diseases. As a result, some patients with stomach cancer may be expected to have longer survival than did patients just ten years ago.

Prevention

Avoiding many of the risk factors associated with stomach cancer may prevent its development. Excessive amounts of salted, smoked, and pickled foods should be avoided, as should foods high in nitrates. A diet that includes recommended amounts of fruits and vegetables is believed to lower the risk of several cancers, including stomach cancer. The American Cancer Society recommends eating at least five servings of fruits and vegetables daily and choosing six servings of food from other plant sources, such as grains, pasta, beans, cereals, and whole grain bread.

Abstaining from tobacco and excessive amounts of alcohol will reduce the risk for many cancers. In countries where stomach cancer is common, such as Japan, early detection is important for successful treatment.

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National Coalition for Cancer Survivorship, 1010 Wayne Ave., Suite 770, silver Spring, MD, 20910, (301) 650-9127, (301) 565-9670, (888) 650-9127, info@canceradvocacy.org, http://www.canceradvocacy.org.

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Stomach flu *see* **Gastroenteritis**

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Stomach flushing

Definition

Stomach flushing is the repeated introduction of fluids into the stomach through a nasogastric tube, and their subsequent withdrawal by **nasogastric suction**.

Purpose

Stomach flushing is performed to aid in controlling gastrointestinal bleeding or to cleanse the stomach of poisons.

Controlling stomach bleeding

Bleeding from the esophagus due to ruptured veins or bleeding from the stomach due to ulcers is a medical emergency. In an attempt to stop the bleeding, the stomach is flushed with large quantities of body-temperature saline solution or ice water. This procedure is called stomach flushing or gastric lavage.

Stomach flushing to control bleeding is not uniformly accepted, and some experts believe it is of little benefit and exposes the patient to unnecessary risks. It is usually done in conjunction with the administration of drugs to constrict the blood vessels.

Stomach flushing to remove poisons

At one time, stomach flushing was common practice to remove certain poisons. Recent thinking by the American Academy of Clinical Toxicology is that stomach flushing should not be used routinely with poisoned patients. It is useful only if the patient has swallowed a life-threatening quantity of poison, and when the flushing can be done within 60 minutes of having swallowed the poison.

Precautions

In **poisoning** cases, stomach flushing should not be used if the poison is a strong corrosive acid (hydrochloric acid, sulfuric acid), alkali (lye, ammonia), or a volatile hydrocarbon such as gasoline. Stomach flushing should also not be done on patients who are having convulsions. Patients who are losing or have lost consciousness must have their airways intubated before a nasogastric tube is inserted.

Description

Stomach flushing is performed in a hospital emergency room or intensive care unit by an emergency room physician or gastroenterologist. A nasogastric tube is inserted, and small amounts of saline or ice water are introduced into the stomach and withdrawn. The procedure is repeated until the withdrawn fluid is clear.

KEY TERMS

Electrolytes—Salts and minerals that ionize in body fluids. Common human electrolytes are sodium chloride, potassium, calcium, and sodium bicarbonate. Electrolytes control the fluid balance of the body and are important in muscle contraction, energy generation, and almost any major biochemical reaction in the body.

Saline—A salt water solution that mimics the concentration of electrolytes in the blood.

Preparation

Little preparation is necessary for this procedure other than educating the patient as to what will happen. The patient should remove dental appliances before the nasogastric tube is inserted.

Aftercare

After stomach flushing, the patient's vital signs will be monitored. Checks will be made for fluid and electrolyte imbalances. If necessary, additional treatment to prevent gastrointestinal bleeding or poisoning will be done.

Risks

In poisoning cases, stomach flushing delays the administration of **activated charcoal**, which may be more beneficial to treating the patient than flushing the stomach. In addition, stomach flushing may stimulate bleeding from the esophagus or stomach. The patient may inhale some of the stomach contents, causing aspiration, **pneumonia**, or infection in the lungs. Fluid and electrolyte imbalances are more likely to occur in older, sicker patients. Mechanical damage to the throat is more likely in patients who are uncooperative.

Normal results

Stomach flushing is usually tolerated by patients and is a temporary treatment, performed in conjunction with other therapies.

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PERIODICALS

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Tish Davidson, A.M.

Stomach removal *see* **Gastrectomy**
Stomach resection *see* **Gastrectomy**

Stomachache

Definition

A stomachache is **pain** in the abdomen, between the bottom of the ribcage and the crease of the groin. Stomachaches are common in children and can have many causes—physical, psychological, and emotional.

Demographics

All children have occasional stomachaches. Stomachaches account for many visits to doctors and emergency rooms, as well as many missed school days. Approximately one third of children have been seen by a physician for abdominal pain by the age of 15, but only a small proportion of these represent serious problems. Complaints of abdominal pain are more common in children under age 11 than in older children and teens.

Chronic or recurrent abdominal pain (RAP) affects as many as 15% of children, especially between the ages of 4 and 12. In addition, as many as 2% of all children may experience abdominal migraines. Females are more affected by these than males.

Description

Although parents may be frightened or frustrated by their child's stomachaches—especially when the cause is not obvious—abdominal pain that lasts less than three hours is rarely serious. There are different types of stomachaches:

- A localized stomachache is pain that is limited to one part of the abdomen.
- A generalized stomachache is pain involving at least half of the abdomen. It can occur with many different illnesses and conditions and usually resolves without medical treatment.
- A cramping-type stomachache is often relieved by passing gas or stool.
- Chronic abdominal pain or RAP, also called functional abdominal pain, is defined as occurring at least once a month for at least three months and is severe enough to interfere with a child's activities. "Functional" means that the pain is real, but is not caused by a disease or other medical condition. It may be related to diet, stress, psychological or emotional problems, or nervous system immaturity or increased sensitivity.
- Abdominal migraines are stomachaches or cramping, usually near the navel or midline, that typically occur in reaction to the same triggers that cause migraine headaches.

Risk factors

Risk factors for stomachaches depend on the underlying physical, psychological, or emotional causes. Depression and **anxiety disorders** are risk factors for RAP in children and adolescents. Recurrent stomachaches in preschoolers have been shown to correlate with maternal depression. Abdominal migraines usually occur in children with a family history of migraine.

Causes and symptoms

Stomachaches in children are rarely serious and often have no identifiable cause. Mild stomachaches are often caused by overeating, gas pains, or **indigestion**. Foods that are too spicy or greasy can give children stomachaches. Changes in eating habits or bowel movements are also common causes, particularly in children under age 12. Constipation—the inability to pass a stool—is one of the most common causes of lower abdominal cramping.

Toddlers do not necessarily distinguish between physical pain and physical or emotional needs. Thus, a stomachache in a young child can indicate **fatigue**, hunger, or the need for a bowel movement.

Strep throat, caused by the *Streptococcus pyogenes* bacterium, accounts for up to 10% of acute stomachaches in children. Other infections that can cause stomachaches include:

- gastroenteritis or stomach flu—a viral infection that causes stomach cramps, diarrhea, and/or vomiting
- food poisoning—often caused by bacteria from undercooked or spoiled food—that can also cause severe diarrhea and/or vomiting lasting less than 12 hours
- a cough
- an ear infection
- chicken pox
- urinary tract infection
- pneumonia
- parasitic infections

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Other physical causes of stomachaches in children include:

- swallowing air (aerophagia), which can result from anxiety or fear or from chewing gum or drinking carbonated beverages
- acid reflux or gastroesophageal reflux disease (GERD), in which stomach contents back up or reflux into the esophagus
- menstruation in girls
- lactose intolerance or difficulty digesting lactose—the sugar in milk products
- other food intolerances
- food allergies, such as a peanut allergy
- celiac disease—an inherited immune system response to gluten in flour
- latex allergy
- excessive caffeine
- irritable bowel syndrome
- inflammatory bowel disease
- poisoning from a plant, mushroom, drug, or chemical
- various medications, including drugs that have constipation as a side effect
- a swallowed foreign object
- injury to the abdomen

Pain that starts near the navel and progresses to severe pain in the lower right side of the abdomen can suggest **appendicitis**. Other symptoms of appendicitis include **fever**, loss of appetite, **vomiting**, and increasingly severe pain. Other rare but serious causes of stomachaches include:

- lead poisoning
- kidney infection
- a blocked intestine
- intussusception—slippage of a length of intestine into an adjacent portion, usually resulting in intestinal obstruction
- intestinal malrotation or twisting of a portion of the intestine

Stomachaches—especially RAP—in children aged three and older are very often stress-related. Stress- or anxiety-related causes of abdominal pain can include:

- separation anxiety, as when starting school
- social anxiety, such as attending a birthday party
- performance anxiety, such as a school exam
- over-excitement
- worry
- fear
- bullying
- abuse
- neglect
- depression
- anxiety disorders such as post-traumatic stress syndrome (PTSD)

Stomachaches can come on suddenly (acute) or persist for weeks or months (chronic). Stomachaches that last less than five minutes, even if they recur for many days, are unlikely to be serious. Stomach pain may be dull, sharp, or recurring cramps. The specific symptoms of a stomachache may suggest the cause:

- Indigestion or stomach flu can cause generalized abdominal pain.
- Pain and nausea or vomiting from a minor abdominal injury often subsides in just a few minutes.
- Stomachache, chest pain, and coughing are the most common symptoms of GERD in children.
- The closer the pain is to the navel, the more likely it is to be functional abdominal pain.
- When a stomachache is the only symptom, it is most often functional (the "Rule of Ones").
- A mild generalized pain or cramps that become more severe over a period of hours may suggest an intestinal blockage.
- Localized pain that occurs suddenly and worsens can indicate a serious problem, such as inflammation of an abdominal organ, appendicitis, gallbladder disease, or peptic ulcer disease.
- Severe sudden pain or pain that increases with coughing or movement is occasionally a symptom of a serious medical problem.
- Symptoms of abdominal migraines can include sudden severe pain across the midline that may last for an hour or up to three days, as well as nausea, vomiting, paleness, and an inability to eat.

Although an older child will complain of a stomachache and can point to the area of pain and describe its severity, children younger than five or six may not be able to describe their stomachache accurately. Young children may simply hold their belly or point to it. Babies may fuss and cry, draw their legs up toward their bellies, or refuse to eat.

A physician should be consulted if a child has severe sudden abdominal pain, new mild abdominal pain that becomes more severe over a period of hours or days, or chronic or frequent stomachaches that interfere with normal activities such as school, play, eating, or sleeping through the night. A stomachache accompanied by any of the following symptoms also requires medical consultation:

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KEY TERMS

Abdominal migraine—A variant form of a migraine headache; moderate to severe midline abdominal pain, usually occurring in children with a family history of migraine.

Appendicitis—Inflammation of the appendix—a narrow blind tube in the lower right abdomen.

Cognitive-behavioral therapy (CBT)—Treatment that identifies negative thoughts and behaviors and helps develop more positive approaches.

Constipation—The delayed or infrequent passage of dry, hard feces.

Functional pain—Pain that does not have a structural or organic cause.

Gastroenteritis—Stomach flu; inflammation of the lining of the stomach and intestines.

Gastroesophageal reflux disease (GERD)—Recurrent heartburn or acid indigestion caused by leakage of the stomach contents into the esophagus.

Recurrent abdominal pain (RAP)—Functional abdominal pain; stomachaches in children that recur at least once a month and that are not caused by an underlying medical condition.

- severe vomiting
- chronic severe diarrhea
- gastrointestinal bleeding
- unexplained fever
- persistent pain in the right side of the abdomen
- weight loss
- slow growth
- a family history of inflammatory bowel disease

A stomachache may be a medical emergency if the child:

- appears to be very ill
- becomes still or cannot stand or walk
- may have been poisoned by a plant, mushroom, medication, or chemical
- has had recent abdominal injury
- has a fever above 104°F (40°C) that is not reduced with fever medication
- is severely dehydrated
- is having difficulty breathing

Diagnosis

Examination

The healthcare provider will take a medical history and perform a **physical examination**, looking for signs of swelling and pressing on the child's belly to identify painful points. The physician will ask for information about the stomachache including:

- its intensity—mild, moderate, or severe
- whether the pain is crampy, a steady ache, sharp, or burning
- localization
- constancy
- duration
- recurrence
- foods, activities, or other factors that improve or worsen the pain
- any accompanying symptoms
- any other factors such as injury, recent travel, or drinking untreated water

Tests

Stomachaches do not usually require diagnostic tests. If appendicitis or another serious condition is suspected, then blood tests may be performed.

Procedures

Depending on the suspected cause of the stomachache, ultrasound imaging may be performed. X rays also may be taken.

Treatment

Traditional

Treatment of stomachaches depends on the suspected cause. They often do not require treatment. A special diet or specific eating instructions may be suggested. If **stress**, **anxiety**, or other psychological or emotional causes are suspected, the child may be referred to a psychologist or other mental health professional. Appendicitis requires an **appendectomy**, which is surgical removal of the appendix.

Drugs

Medications, especially **aspirin** and other **nonsteroidal anti-inflammatory drugs** (NSAIDs) such as ibuprofen and naproxen, can irritate the stomach lining and worsen stomachaches. If the stomachache is

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accompanied by a fever above 102°F (39°C), a child may be given an appropriate dose of **acetaminophen** (Tylenol). Children should not be given a laxative for stomach cramps.

Children with GERD may be treated with drugs called **proton pump inhibitors** that suppress stomach acid. In 2008 the U.S. Food and Drug Administration (FDA) approved esomeprazole (Nexium) for the short-term treatment of GERD in children aged 1 to 11.

Alternative

Peppermint tea, peppermint oil capsules, or ginger can help relieve mild stomachaches. Behavioral interventions have had the most success in reducing or eliminating RAP. These therapies include:

- cognitive-behavioral therapy (CBT)
- guided imagery
- distraction therapy
- relaxation techniques, including breathing and progressive muscle relaxation
- biofeedback
- self-hypnosis
- coping skills for children and parents

Home remedies

Stomachaches are most often treated at home. Mild stomachaches may be treated by:

- bed rest
- consuming plenty of clear fluids (water, broth, tea, or fruit juice diluted with water) to prevent dehydration
- taking frequent, small sips of fluids
- eating several small meals instead of two or three large meals
- eating mild foods, such as rice, dry toast, crackers, gelatin, or applesauce
- avoiding high-fat and spicy foods, most fruits, and caffeinated and carbonated drinks for at least 48 hours after symptoms have passed
- having a child sit on the toilet and try to pass a stool, which can relieve stomach pain due to constipation or diarrhea
- sitting in warm water to relax the anus and help release stool
- preparing for a child to vomit by having a pan ready, since young children may refer to nausea as a tummy ache

Dietary changes have not been shown to be effective in treating frequent stomachaches in children. However, increasing dietary fiber is a simple and inexpensive way to help some children.

Prognosis

Most mild stomachaches clear up within 30 minutes to 2 hours. Stomach cramps from **gastroenteritis** often precede each bout of **vomiting** and **diarrhea** and may last for several days. Stomachaches from **food poisoning** usually last less than 12 hours. With stomachaches that have serious causes, such as appendicitis, the pain continues to worsen and becomes constant.

Young children with RAP are more likely than other children to have behavioral problems and they are at greater risk for developing anxiety disorders as young adults. Children with abdominal migraines usually develop migraine headaches as they become older.

Prevention

Stomachaches in children are often preventable. Parents should ensure that their children:

- get plenty of sleep
- develop regular eating habits
- wash their hands before eating
- eat slowly
- avoid overeating
- avoid eating before bed
- have regular bowel movements and develop regular bowel habits
- eat fiber-rich foods that encourage regular bowel movements
- have only limited chewing gum and carbonated beverages to prevent swallowing air
- always correctly use car child-safety seats or seat belts to prevent abdominal injuries

Although children require less dietary fiber than adults, fiber may help prevent stomachaches in some children. The American Dietetic Association's formula for daily fiber intake, in grams, for children aged 3 to 18, is the child's age plus five grams. Fruits, vegetables, and whole grains are good sources of fiber. Dietary fiber should be increased gradually. Children should drink extra water or milk when increasing dietary fiber.

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ORGANIZATIONS

American Academy of Family Physicians, 11400 Tomahawk Creek Parkway, Leawood, KS, 66211-2680, (913) 906-6000, (800) 274-6000, (913) 906-6075, http://www.aafp.org.

American Academy of Pediatrics, 141 Northwest Point Blvd., Elk Grove Village, IL, 60007-1098, (874) 434-4000, (874) 434-8000, kidsdocs@aap.org, http://www.aap.org.

American Dietetic Association, 120 South Riverside Plaza, Suite 2000, Chicago, IL, 60606-6995, (800) 877-1600, http://www.eatright.org.

International Foundation for Functional Gastrointestinal Disorders, P.O. Box 170864, Milwaukee, WI, 53217-8076, (414) 964-1799, (888) 964-2001, (414) 964-7176, iffgd@iffgd.org, http://aboutkidsgi.org.

Margaret Alic, PhD

Stomatitis

Definition

Inflammation of the mucous lining of any of the structures in the mouth, which may involve the cheeks, gums, tongue, lips, and roof or floor of the mouth. The word "stomatitis" literally means inflammation of the mouth. The inflammation can be caused by conditions in the mouth itself, such as poor **oral hygiene**, poorly fitted dentures, or from mouth **burns** from hot food or drinks, or by conditions that affect the entire body, such as medications, allergic reactions, or infections.

This patient is afflicted with stomatitis, a common inflammatory disease of the mouth. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Description

Stomatitis is an inflammation of the lining of any of the soft-tissue structures of the mouth. Stomatitis is usually a painful condition, associated with redness, swelling, and occasional bleeding from the affected area. **Bad breath** (halitosis) may also accompany the condition. Stomatitis affects all age groups, from the infant to the elderly.

Causes and symptoms

A number of factors can cause stomatitis; it is a fairly common problem in the general adult population in North America. Poorly fitted oral appliances, cheek biting, or jagged teeth can persistently irritate the oral structures. Chronic mouth breathing due to plugged nasal airways can cause dryness of the mouth tissues, which in turn leads to irritation. Drinking beverages that are too hot can burn the mouth, leading to irritation and **pain**. Diseases, such as herpetic infections (the **common cold** sore), **gonorrhea**, **measles**, leukemia, **AIDS**, and lack of vitamin C can present with oral signs. Other systemic diseases associated with stomatitis include inflammatory bowel disease (IBD) and Behçet's syndrome, an inflammatory multisystem disorder of unknown cause.

Aphthous stomatitis, also known as recurrent aphthous ulcers (RAU) or **canker sores**, is a specific type of stomatitis that presents with shallow, painful ulcers that are usually located on the lips, cheeks, gums, or roof or

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floor of the mouth. These ulcers can range from pinpoint size to up to 1 in (2.5 cm) or more in diameter. Though the causes of canker sores are unknown, nutritional deficiencies, especially of vitamin B_{12}, folate, or iron is suspected. Generalized or contact stomatitis can result from excessive use of alcohol, spices, hot food, or tobacco products. Sensitivity to mouthwashes, toothpastes, and lipstick can irritate the lining of the mouth. Exposure to heavy metals, such as mercury, lead, or bismuth can cause stomatitis. Thrush, a fungal infection, is a type of stomatitis.

Diagnosis

Diagnosis of stomatitis can be difficult. A patient's history may disclose a dietary deficiency, a systemic disease, or contact with materials causing an allergic reaction. A **physical examination** is done to evaluate the oral lesions and other skin problems. Blood tests may be done to determine if any infection is present. Scrapings of the lining of the mouth may be sent to the laboratory for microscopic evaluation, or cultures of the mouth may be done to determine if an infectious agent may be the cause of the problem.

Treatment

The treatment of stomatitis is based on the problem causing it. Local cleansing and good oral hygiene are fundamental. Sharp-edged foods such as peanuts, tacos, and potato chips should be avoided. A soft-bristled toothbrush should be used, and the teeth and gums should be brushed carefully; the patient should avoid banging the toothbrush into the gums. Local factors, such as ill-fitting dental appliances or sharp teeth, can be corrected by a dentist. An infectious cause can usually be treated with medication. Systemic problems, such as AIDS, leukemia, and anemia are treated by the appropriate medical specialist. Minor mouth burns from hot beverages or hot foods will usually resolve on their own in a week or so. Chronic problems with aphthous stomatitis are treated by first correcting any vitamin B_{12}, iron, or folate deficiencies. If those therapies are unsuccessful, medication can be prescribed which can be applied to each aphthous ulcer with a cotton-tipped applicator. This therapy is successful with a limited number of patients. More recently, low-power treatment with a carbon dioxide laser has been found to relieve the discomfort of recurrent aphthae. Major outbreaks of aphthous stomatitis can be treated with tetracycline **antibiotics** or **corticosteroids**. Valacyclovir has been shown to be effective in treating stomatitis caused by herpesviruses.

KEY TERMS

Aphthous stomatitis—A specific type of stomatitis presenting with shallow, painful ulcers. Also known as *canker sores*.

Stomatitis—Inflammation of the lining of the mouth, gums, or tongue.

Thrush—A form of stomatitis caused by *Candida* fungi and characterized by cream-colored or bluish patches on the tongue, mouth, or pharynx.

Patients may also be given topical anesthetics (usually a 2% lidocaine gel) to relieve pain and a protective paste (Orabase) or a coating agent like Kaopectate to protect eroded areas from further irritation from dentures, braces, or teeth.

Alternative treatment

Alternate treatment of stomatitis mainly involves prevention of the problem. Patients with such dental appliances as dentures should visit their dentist on a regular basis. Patients with systemic diseases or chronic medical problems need to ask their health care provider what types of oral problems they can expect from their particular disease. These patients must also contact their medical clinic at the first sign of problems. Common sense needs to be exercised when consuming hot foods or drinks. Use of tobacco products should be discouraged. Alcohol should be used in moderation. Mouthwashes and toothpastes known to the patient to cause problems should be avoided.

Botanical medicine can assist in resolving stomatitis. One herb, calendula (*Calendula officinalis*), in tincture form (an alcohol-based herbal extract) and diluted for a mouth rinse, can be quite effective in treating aphthous stomatitis and other manifestations of stomatitis.

More recently, a group of researchers in Brazil have reported that an extract made from the leaves of *Trichilia glabra*, a plant found in South America, is effective in killing several viruses that cause stomatitis.

Prognosis

The prognosis for the resolution of stomatitis is based on the cause of the problem. Many local factors can be modified, treated, or avoided. Infectious causes of stomatitis can usually be managed with medication, or, if the problem is being caused by a certain drug, by changing the offending agent.

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Prevention

Stomatitis caused by local irritants can be prevented by good oral hygiene, regular dental checkups, and good dietary habits. Problems with stomatitis caused by systemic disease can be minimized by good oral hygiene and closely following the medical therapy prescribed by the patient's health care provider.

Resources

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Wohlschlaeger, A. "Prevention and Treatment of Mucositis: A Guide for Nurses." *Journal of Pediatric Oncology Nursing* 21 (September-October 2004): 281–287.

ORGANIZATIONS

American Dental Association, 211 E. Chicago Ave., Chicago, IL, 60611-2678, (312) 440-2500, http://www.ada.org.

American Medical Association, 515 N. State St., Chicago, IL, 60654, (800) 621-8335, http://www.ama-assn.org/.

Joseph Knight, PA
Rebecca J. Frey, PhD

Stone removal *see* **Gallstone removal**

Stool culture

Definition

Stool culture is a test to identify bacteria in patients with a suspected infection of the digestive tract. A sample of the patient's feces is placed in a special medium where bacteria is then grown. The bacteria that grow in the culture are identified using a microscope and biochemical tests.

Purpose

Stool culture is performed to identify bacteria or other organisms in persons with symptoms of gastrointestinal infection, most commonly **diarrhea**. Identification of the organism is necessary to determine the treatment of the patient's infection or to trace the cause of an outbreak or epidemic of certain types of diarrhea.

According to the Centers for Disease Control and Prevention (CDC), doctors are most likely to order a stool culture for patients with any of the following characteristics: **AIDS**, bloody stools, diarrhea lasting longer than three days, high **fever**, history of recent travel abroad, or severe **dehydration**.

Precautions

Stool culture is performed only if an infection of the digestive tract is suspected. The test has no harmful effects.

Description

Stool culture may also be called fecal culture. To obtain a specimen for culture, the patient is asked to collect a stool sample into a special sterile container. In some cases, the container may contain a transport solution. Specimens may need to be collected on three consecutive days. It is important to return the specimen to the doctor's office or the laboratory in the time specified by the physician or nurse. Laboratories do not accept stool specimens contaminated with water, urine, or other materials.

The culture test involves placing a sample of the stool on a special substance, called a medium, that provides nutrients for certain organisms to grow and reproduce. The medium is usually a thick gel-like substance. The culture is done in a test tube–or on a flat round culture plate–which is incubated at the proper temperature for growth of the bacteria. After a colony of bacteria grows in the medium, the type of bacteria is identified by observing the colony's growth, its physical characteristics, and its microscopic features. The bacteria may be dyed with special stains that make it easier to identify features specific to particular bacteria.

The length of time needed to perform a stool culture depends on the laboratory where it is done and the culture methods used. Stool culture usually takes 72 hours or longer to complete. Some organisms may take several weeks to grow in a culture.

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An antibiotic sensitivity test may be done after a specific bacterium is identified. This test shows which **antibiotics** will be most effective for treating the infection.

Although most intestinal infections are caused by bacteria, in some cases a fungal or viral culture may be necessary. The most common bacterial infections of the digestive tract are caused by *Shigella*, *Salmonella*, *Campylobacter*, and *Yersinia*. Patients taking certain antibiotics may be susceptible to infection with *Clostridium difficile*. In some cases, as with *Clostridium difficile*, the stool culture is used to detect the toxin (poison or harmful chemical) produced by the bacteria.

Patients with AIDS, or other immune system diseases, may also have gastrointestinal infections caused by such fungi as *Candida*, or viral organisms including cytomegalovirus.

Several intestinal parasites may cause gastrointestinal infection and diarrhea. Parasites are not cultured, but are identified microscopically in a test called "Stool Ova and Parasites."

Insurance coverage for stool culture may vary among different insurance plans. This common test usually is covered if ordered by a physician approved by the patient's insurance plan, and if it is done at an approved laboratory.

Alternative methods

Newer methods of testing stool samples for specific disease organisms include various forms of polymerase chain reaction (PCR) assays. One type that has been used to test for several different types of intestinal viruses at the same time is the RT-PCR, which stands for reverse transcriptase polymerase chain reaction. This assay measures changes in an organism's messenger RNA. RT-PCR assays have several advantages over standard stool cultures: they require only very small samples of material; they can be performed much more rapidly; and they can be used to test environmental water for virus contamination as well as human stool samples.

Preparation

The physician or other healthcare provider will ask the patient for a complete medical history and perform a **physical examination** to determine possible causes of the gastrointestinal problem. Information about the patient's diet, any medications taken, and recent travel may provide clues to the identity of possible infectious organisms.

KEY TERMS

Bismuth—A substance used in medicines to treat diarrhea, nausea, and indigestion.

Enteric—Pertaining to the intestine.

Enterotoxigenic—Refers to an organism that produces toxins in the gastrointestinal tract that cause such things as vomiting, diarrhea, and other symptoms of food poisoning.

Feces—Material excreted by the intestines.

Flora—Refers to normal bacteria found in a healthy person.

Gastrointestinal—Referring to the digestive tract; the stomach and intestines.

Psyllium hydrophilic mucilloid—A plant material contained in some laxatives.

Sterile—Free of microorganisms.

Toxin—A poison; usually refers to protein poisons produced by bacteria, animals, and some plants.

Stool culture normally does not require any special preparation. Patients do not need to change their diet before collecting the specimen. Intake of some substances can contaminate the stool specimen and should not be taken the day before collection. These substances include castor oil, bismuth, and laxative preparations containing psyllium hydrophilic mucilloid.

Normal results

Bacteria that are normally found in the intestines include *Pseudomonas* and ***Escherichia coli***. These enteric bacteria (bacteria of the gastrointestinal system) are considered normal flora and usually do not cause infection in the digestive tract.

Abnormal results

Bacteria that do not normally inhabit the digestive tract, and that are known to cause gastrointestinal infection include *Shigella*, *Salmonella*, *Campylobacter*, and *Yersinia*. *Clostridium difficile* produces a toxin that can cause severe diarrhea. Other bacteria that produce toxins are *Staphylococcus aureus*, *Bacillus cereus*, and enterotoxigenic (producing disease in the digestive system) *Escherichia coli*. Although *Escherichia coli* is a normal bacteria found in the intestines, the enterotoxigenic type of this bacteria can be acquired from eating contaminated meat, juice, or

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fruits. It produces a toxin that causes severe inflammation and bleeding of the colon.

Resources

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ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

Toni Rizzo
Rebecca J. Frey, PhD

Stool fat test

Definition

Stool fats, also known as fecal fats, or fecal lipids, are fats that are excreted in the feces. When secretions from the pancreas and liver are adequate, emulsified dietary fats are almost completely absorbed in the small intestine. When a malabsorption disorder or other cause disrupts this process, excretion of fat in the stool increases.

Purpose

This test evaluates digestion of fats by determining excessive excretion of lipids in patients exhibiting signs of malabsorption, such as weight loss, abdominal distention, and scaly skin.

Precautions

Drugs that may increase fecal fat levels include **enemas** and **laxatives**, especially mineral oil. Drugs that may decrease fecal fat include Metamucil and barium. Other substances that can affect test results include alcohol, potassium chloride, **calcium** carbonate, neomycin, kanamycin, and other broad-spectrum **antibiotics**.

Description

Excessive excretion of fecal fat is called steatorrhea, a condition that is suspected when the patient has large, "greasy," and foul-smelling stools. Both digestive and absorptive disorders can cause steatorrhea. Digestive disorders affect the production and release of the enzyme lipase from the pancreas, or bile from the liver, which are substances that aid digestion of fats; absorptive disorders disturb the absorptive and enzyme functions of the intestine. Any condition that causes malabsorption or maldigestion is also associated with increased fecal fat. As an example, children with **cystic fibrosis** have mucous plugs that block the pancreatic ducts. The absence or significant decrease of the pancreatic enzymes, amylase, lipase, trypsin, and chymotrypsin limits fat protein and carbohydrate digestion, resulting in steatorrhea due to fat malabsorption.

Both qualitative and quantitative tests are used to identify excessive fecal fat. The qualitative test involves staining a specimen of stool with a special dye, then examining it microscopically for evidence of malabsorption, such as undigested muscle fiber and various fats. The quantitative test involves drying and weighing a 72-hour stool specimen, then using an extraction technique to separate the fats, which are subsequently evaporated and weighed. This measurement of the total output of fecal fat per 24 hours in a three-day specimen is the most reliable test for steatorrhea.

Preparation

This test requires a 72-hour stool collection. The patient should abstain from alcohol during this time and maintain a high-fat diet (100 g/day) for three days before the test, and during the collection period. The patient should call the laboratory for instructions on how to collect the specimen.

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Normal results

Reference values vary from laboratory to laboratory but are generally found within the range of 5–7 g/24 hr.

It should be noted that children, especially infants, cannot ingest the 100 g/day of fat that is suggested for the test. Therefore, a fat retention coefficient is determined by measuring the difference between ingested fat and fecal fat, and expressing that difference as a percentage. The figure, called the fat retention coefficient, is 95% or greater in healthy children and adults. A low value is indicative of steatorrhea.

Abnormal results

Increased fecal fat levels are found in cystic fibrosis, malabsorption secondary to other conditions like Whipple's disease or **Crohn's disease**, maldigestion secondary to pancreatic or bile duct obstruction, and "short-gut" syndrome secondary to surgical resection, bypass, or congenital anomaly.

Resources

BOOKS

Pagana, Kathleen Deska, and Timothy J. Pagana. *Mosby's Manual of Diagnostic and Laboratory Tests*. 4th ed. St. Louis: Mosby, 2009.

Janis O. Flores

Stool O & P test

Definition

The stool O & P test is the stool ova and parasites test. In this test, a stool sample is examined for the presence of intestinal parasites and their eggs, which are called ova.

Purpose

The ova and parasites test is performed to look for and identify intestinal parasites and their eggs in persons with symptoms of gastrointestinal infection. Patients may have no symptoms, or experience **diarrhea**, blood in the stools, and other gastrointestinal distress. Identification of a particular parasite indicates the cause of the patient's disease and determines the medication needed to treat it.

Precautions

Stool O & P is performed if an infection of the digestive tract is suspected. The test has no harmful effects.

Description

Examination of the stool for ova and parasites is done to diagnose parasitic infection of the intestines. The test may be done in the doctor's office or a laboratory. The patient collects a stool sample in one or more sterile containers containing special chemical fixatives. The feces should be collected directly into the container. It must not be contaminated with urine, water, or other materials. Three specimens are often needed–collected every other day, or every third day. However, as many as six specimens may be needed to diagnose the amoeba *Entamoeba histolytica*. The specimen does not need to be refrigerated. It should be delivered to the doctor's office or laboratory within 12 hours.

In the laboratory, the stool sample is observed for signs of parasites and their eggs. Some parasites are large enough to be seen without a microscope. For others, microscope slides are prepared with fresh unstained stool, and with stool dyed with special stains. These preparations are observed with a microscope for the presence of parasites or their eggs.

An unstained stool examination for ova and parasites normally only takes a few minutes. If specimen staining and other preparation is done, the test may take longer. When the specimen is sent to a laboratory, the results may take eight to 24 hours to be reported.

The most common intestinal parasites in North America that cause infections are:

- roundworms: *Ascaris lumbricoides*
- hookworms: *Necator americanus*
- pinworms: *Enterobius follicularis*
- tapeworms: *Diphyllobothrium latum*, *Taenia saginata*, and *Taenia solium*
- protozoa: *Entamoeba histolytica* (an amoeba), and *Giardia lamblia* (a flagellate)

Numerous other parasites are found in other parts of the world. These may be contracted by travelers to other countries. Patients with acquired immune deficiency syndrome (**AIDS**) or other immune system disorders are commonly infected with the parasites in the *Microsporidia* family, *Cryptosporidium*, and *Isospora belli*.

Insurance coverage for stool ova and parasites may vary among different insurance plans. This test usually is covered if ordered by a physician approved by the

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KEY TERMS

Amoeba—A type of protozoa (one-celled animal) that can move or change its shape by extending projections of its cytoplasm.

Bismuth—A substance used in medicines to treat diarrhea, nausea, and indigestion.

Cryptosporidium—A type of parasitic protozoa.

Feces—Material excreted by the intestines.

Flagellate—A microorganism that uses flagella (hair-like projections) to move.

Gastrointestinal—Referring to the digestive tract; the stomach and intestines.

Isospora belli—A type of parasitic protozoa.

Microsporida—A type of parasitic protozoa.

Ova—Eggs.

Parasite—An organism that lives on or inside another living organism (host), causing damage to the host.

Pathogenic—Disease-causing.

Protozoa—One-celled eukaryotic organisms belonging to the kingdom Protista.

Sterile—Free of microorganisms.

patient's insurance plan, and if it is done at an approved laboratory.

Preparation

The physician, or other healthcare provider, will ask the patient for a complete medical history, and perform a **physical examination** to determine possible causes of the gastrointestinal symptoms. Information about the patient's diet, any medications taken, and recent travel may provide clues to the identity of possible infectious parasites.

Collecting a stool sample for ova and parasite detection normally does not require any special preparation. Patients do not need to change their diet before collecting the specimen. Patients should avoid taking any medications or treatments containing mineral oil, castor oil, or bismuth, magnesium or other antidiarrheal medicines, or **antibiotics** for 7 to 10 days before collecting the specimen.

Normal results

Normally, parasites and eggs should not be found in stools. Some parasites are not pathogenic, which means they do not cause disease. If these are found, no treatment is necessary.

Abnormal results

The presence of any pathogenic parasite indicates an intestinal parasitic infection. Depending on the parasite identified, other tests may need to be performed to determine if the parasite has invaded other parts of the body. Some parasites travel from the intestines to other parts of the body and may already have caused damage to other tissues by the time a diagnosis is made. For example, the roundworm, *Ascaris* penetrates the intestinal wall and can cause inflammation in the abdomen. It can also migrate to the lungs and cause **pneumonia**. This kind of injury can occur weeks before the roundworm eggs show up in the stool.

Other types of damage caused by intestinal parasites include anemia due to hemorrhage caused by hookworms, and anemia caused by depletion of vitamin B_{12} through the action of tapeworms.

When a parasite is identified, the patient can be treated with the appropriate medications to eliminate the parasite.

Resources

BOOKS

Daniels, Rick. *Delmar's Manual of Laboratory and Diagnostic Tests: Organized by Type of Test*. 2nd ed. Clifton Park, NY: Delmar Cengage Learning, 2010.

Toni Rizzo

Stool occult blood test *see* **Fecal occult blood test**

Stool ova and parasites test *see* **Stool O & P test**

Strabismus

Definition

Strabismus is a condition in which the eyes do not point in the same direction. It can also be referred to as a tropia or squint.

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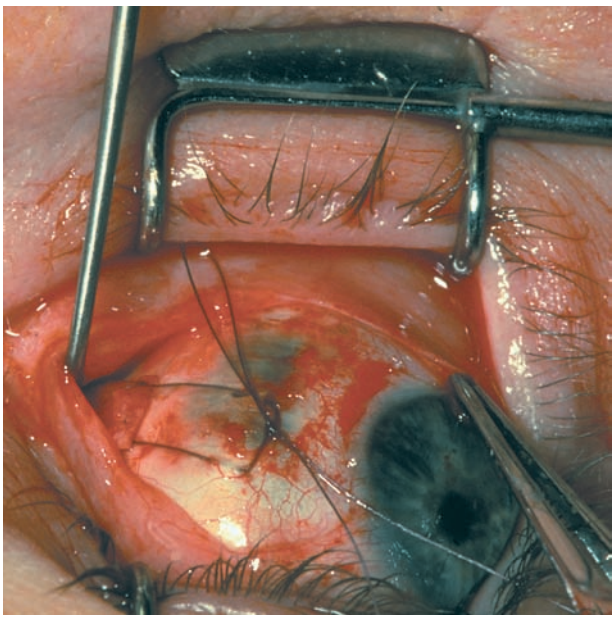

A close-up of ophthalmic surgery being performed to correct strabismus. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Description

Strabismus occurs in 2–5% of all children. About half are born with the condition, which causes one or both eyes to turn:

- inward (esotropia or "crossed eyes")
- outward (exotropia or "wall eyes")
- upward (hypertropia)
- downward (hypotropia)

Strabismus is equally common in boys and girls. It sometimes runs in families.

Types of strabismus

Esotropia is the most common type of strabismus in infants. Accommodative esotropia develops in children under age two who cross their eyes when focusing on objects nearby. This usually occurs in children who are moderately to highly farsighted (hyperopic).

Another common form of strabismus, exotropia, may only be noticeable when a child looks at far-away objects, daydreams, or is tired or sick.

Sometimes the eye turn is always in the same eye; however sometimes the turn alternates from one eye to the other'.

Most children with strabismus have comitant strabismus. No matter where they look, the degree of deviation does not change. In incomitant strabismus, the amount of misalignment depends upon which direction the eyes are pointed.

False strabismus (pseudostrabismus)

A child may appear to have a turned eye, however this appearance may actually be due to:

- extra skin that covers the inner corner of the eye
- a broad, flat nose
- eyes set unusually close together or far apart

This condition, false strabismus, usually disappears as the child's face grows. An eye doctor needs to determine whether the eyeturn is true or pseudostrabismus.

With normal vision, both eyes send the brain the same message. This binocular fixation (both eyes looking directly at the same object) is necessary to see three-dimensionally and to aid in depth perception. When an eye is misaligned, the brain receives two different images. Young children learn to ignore distorted messages from a misaligned eye, but adults with strabismus often develop double vision (diplopia).

A baby's eyes should be straight and parallel by three or four months of age. A child who develops strabismus after the age of eight or nine years is said to have adult-onset strabismus.

Causes and symptoms

Strabismus can be caused by a defect in muscles or the part of the brain that controls eye movement. It is especially common in children who have:

- brain tumors
- cerebral palsy
- Down syndrome
- hydrocephalus
- other disorders that affect the brain

Diseases that cause partial or total blindness can cause strabismus. So can extreme farsightedness, **cataracts**, eye injury, or having much better vision in one eye than the other.

In adults, strabismus is usually caused by:

- diabetes
- head trauma
- stroke
- brain tumor
- other diseases affecting nerves that control eye muscles

The most obvious symptom of strabismus is an eye that isn't always straight. The deviation can vary

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from day to day or during the day. People who have strabismus often squint in bright sunlight or tilt their heads to focus their eyes.

Diagnosis

Every baby's eyes should be examined by the age of six months. A baby whose eyes have not straightened by the age of four months should be examined to rule out serious disease.

A pediatrician, family doctor, ophthalmologist, or optometrist licensed to use diagnostic drugs uses drops that dilate the pupils and temporarily paralyze eye-focusing muscles to evaluate visual status and ocular health. Early diagnosis is important. Some eye turns may be a result of a tumor. Untreated strabismus can damage vision in the unused eye and possibly result in lazy eye (**amblyopia**).

Treatment

Preserving or restoring vision and improving appearance may involve one or more of the following:

- glasses to aid in focusing and straighten the eye(s)
- patching to force infants and young children to use and straighten the weaker eye
- eye drops or ointments as a substitute for patching or glasses, or to make glasses more effective
- surgery to tighten, relax, or reposition eye muscles
- medication injected into an overactive eye muscle to allow the opposite muscle to straighten the eye
- vision training (also called eye exercises)

Prognosis

Early consistent treatment usually improves vision and appearance. The most satisfactory results are achieved if the condition is corrected before the age of seven years old.

ORGANIZATIONS

American Academy of Ophthalmology (AAO), P. O. Box 7424, San Francisco, CA, 94120-7424, (415) 561-8500, (415) 561-8500, http://www.aao.org.

American Academy of Pediatric Ophthalmology and Strabismus (AAPOS), PO Box 193832, San Francisco, CA, 94119-3832, (415) 561-8505, (415) 561-8531, aapos@aao.org, http://www.aapos.org.

American Optometric Association, 243 North Lindbergh Blvd., St. Louis, MO, 63141, (314) 991-4100, (314) 991-4101, (800) 365-2219, http://www.aoa.org/.

Maureen Haggerty

Strawberry marks *see* **Birthmarks**
Strengthening exercises *see* **Exercise**
Strep culture *see* **Throat culture**
Strep test *see* **Streptococcal antibody tests**

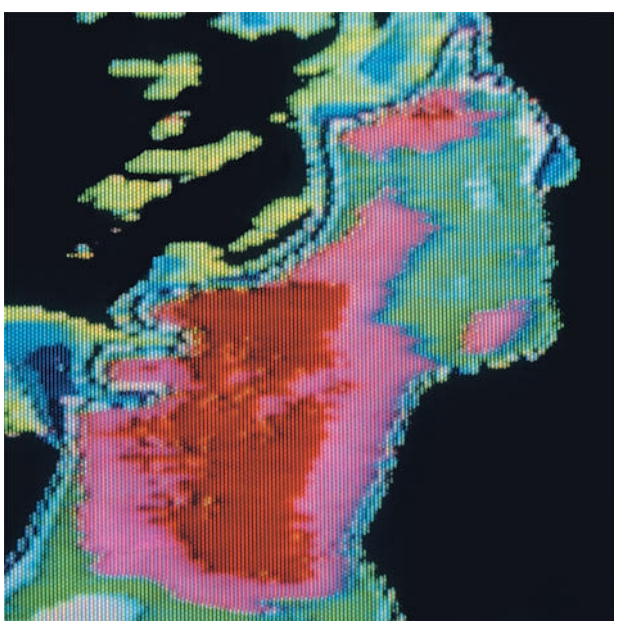
Strep throat

Definition

Streptococcal **sore throat**, or strep throat as it is more commonly called, is an infection of the mucous membranes lining the pharynx (throat). Sometimes the tonsils are also infected (**tonsillitis**). The disease is caused by group A *Streptococcus* bacteria. Untreated strep throat may develop into **rheumatic fever** or other serious conditions.

Description

Strep throat accounts for between 5–10% of all sore throats. Although anyone can get strep throat, it is most common in school-age children. People who smoke, who are fatigued, run down, or who live in damp, crowded conditions are also more likely to become infected. Children under age two and adults who are not around children are less likely to get the



A thermographic image showing a streptococcal sore throat, or strep throat. *(© Howard Sochurek/Corbis.)*

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disease; their sore throats are usually caused by viruses, not strep bacteria.

Strep throat occurs most frequently from November to April. The disease passes directly from person to person by coughing, sneezing, and close contact. Very occasionally the disease is passed through food, when a food handler infected with strep bacteria accidentally contaminates food by coughing or sneezing. Statistically, if someone in the household is infected, one out of every four other household members is likely to get strep throat within two to seven days.

Causes and symptoms

A person with strep throat suddenly develops a painful sore throat one to five days after being exposed to streptococcus bacteria. The **pain** is indistinguishable from sore throats caused by other types of bacteria or viruses.

The infected person usually feels tired and has a **fever**, sometimes accompanied by chills, **headache**, muscle aches, swollen lymph glands, and **nausea**. Young children may complain of abdominal pain. The tonsils look swollen and are bright red, with white or yellow patches of pus on them. Sometimes the roof of the mouth is red or has small red spots. Often a person with strep throat has **bad breath**.

Despite these common symptoms, strep throat can be deceptive. It is possible to have the disease and not show any of these symptoms. Many young children complain only of a headache and stomach ache, without the characteristic sore throat symptoms.

Occasionally, within a few days of developing the sore throat, an individual may develop a fine, rough, sunburn-like rash over the face and upper body and have a fever of 101–104°F (38.3–40°C). The tongue becomes bright red, with a flecked, strawberry-like appearance. When a rash develops, this form of strep throat is called **scarlet fever**. The rash is a reaction to toxins (poisons) released by streptococcus bacteria. Scarlet fever is no more dangerous than strep throat, and it is treated the same way. The rash disappears in about five days. One to three weeks later, patches of skin may peel off, as might occur with a **sunburn**, especially on the fingers and toes.

Untreated strep throat can cause rheumatic fever and rheumatic heart disease (damage to the heart caused by rheumatic fever). This is a serious illness, although it is uncommon in the United States. The most recent outbreak in the U. S. occurred in the mid-1980s. Worldwide, however, 90,000 people are estimated to die from rheumatic heart disease each year, with the highest rates occurring in developing countries. Rheumatic fever occurs most often in children between the ages of 5 and 15, and may have a genetic component since it seems to run in families. Although the strep throat that causes rheumatic fever is contagious, rheumatic fever itself is not.

Rheumatic fever begins one to six weeks after an untreated streptococcal infection. The joints, especially the wrists, elbows, knees, and ankles become red, sore, and swollen. The infected person develops a high fever, and possibly a rapid heartbeat when lying down, paleness, **shortness of breath**, and fluid retention. A red rash over the trunk may come and go for weeks or months. An acute attack of rheumatic fever lasts about three months.

Rheumatic fever can cause permanent damage to the heart and heart valves. It can be prevented by promptly treating **streptococcal infections** with **antibiotics**. It does not occur if all the streptococcus bacteria are killed within the first 10–12 days after infection.

In the 1990s, outbreaks of a virulent strain of group A *Streptococcus* were reported to cause a toxic-shock-like illness and a severe invasive infection called necrotizing fasciitis, which destroys skin and muscle tissue. Although these diseases are caused by group A *Streptococci*, they rarely begin with strep throat. Usually the streptococcus bacteria enter the body through a skin wound. These complications are rare. However, since the **death** rate in necrotizing fasciitis is 30–50%, it is wise to seek prompt treatment for any streptococcal infection.

Diagnosis

Diagnosis of a strep throat by a doctor begins with a **physical examination** of the throat and chest. The doctor will also look for signs of other illness, such as a sinus infection or **bronchitis**, and seek information about whether the patient has been around other people with strep throat. If it appears that the patient may have strep throat, the doctor will do laboratory tests.

There are two types of tests to determine if a person has strep throat. A rapid strep test can determine only the presence of streptococcal bacteria in material collected on a sterile swabb from the throat. It will not tell the doctor whether the sore throat is caused by another kind of bacteria or if it is caused by a virus. The results of a rapid strep test are available in about 20 minutes. The advantage of this test is the speed with which a diagnosis can be made.

The rapid strep test has a false negative rate of about 25%. In other words, in about one out of every four cases where no strep is detected by the rapid strep test, the patient actually does have strep throat.

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Because of this, when a rapid strep test is negative, the doctor often does a **throat culture**.

For a rapid strep test or a throat culture, a nurse will use a sterile swab to reach down into the throat and obtain a sample of material from the sore area. The procedure takes only a few seconds, but may cause gagging.

For a throat culture, a sample of swabbed material is cultured, or grown, in the laboratory on a medium that allows technicians to determine what kind of bacteria are present. Results take 24–48 hours. The test is very accurate and will show the presence of other kinds of bacteria besides *Streptococci*. It is important not to take any leftover antibiotics before visiting the doctor and having a throat culture. Even small amounts of antibiotics can suppress the bacteria and mask its presence in the throat culture, thus preventing the patient from getting proper treatment.

In the event that rheumatic fever is suspected, the doctor does a blood test. This test, called an antistreptolysin-O test, will tell the doctor whether the person has recently been infected with strep bacteria. This helps the doctor distinguish between rheumatic fever and **rheumatoid arthritis**.

Treatment

Strep throat is treated with antibiotics. Penicillin is the preferred medication. Oral penicillin must be taken for 10 days. Patients need to take the entire amount of antibiotic prescribed and not discontinue taking the medication when they feel better. Stopping the antibiotic early can lead to a return of the strep infection. Occasionally, a single injection of long-acting penicillin (Bicillin) is given instead of 10 days of oral treatment.

About 10% of the time, penicillin is not effective against the strep bacteria. When this happens a doctor may prescribe other antibiotics such as cefuroxime (Ceftin), cefixime (Suprax), cefpodoxime proxetil (Vantin), loracarbef (Lorabid), cefditoren (Spectracef), azithromycin (Zithromax), clindamycin (Cleocin), or a cephalosporin (Keflex, Durocef, Ceclor). Erythromycin (Eryzole, Pediazole, Ilosone), another inexpensive antibiotic, can be given to people who are allergic to penicillin. Scarlet fever is treated with the same antibiotics as strep throat.

Without treatment, the symptoms of strep throat begin subsiding in four or five days. However, because of the possibility of developing rheumatic fever, it is important to treat strep throat promptly with antibiotics. If rheumatic fever does occur, it is also treated with antibiotics. Anti-inflammatory drugs, such as **steroids**, are used to treat joint swelling. **Diuretics** are used to reduce water retention. Once the rheumatic fever becomes inactive, children may continue on low doses of antibiotics to prevent a reoccurrence. Necrotizing fasciitis is treated with hospitalization and intravenous antibiotics.

Home care for strep throat

There are home care steps that people can take to ease the discomfort of their strep symptoms.

- Take acetaminophen or ibuprofen for pain. Aspirin should not be given to children because of its association with an increase in Reye's Syndrome, a serious disease.
- Gargle with warm double strength tea or warm salt water, made by adding one teaspoon of salt to eight ounces of water, to relieve sore throat pain.
- Drink plenty of fluids, but avoid acidic juices like orange juice because they irritate the throat.
- Eat soft, nutritious foods like noodle soup. Avoid spicy foods.
- Avoid smoke and smoking.
- Rest until the fever is gone, then resume strenuous activities gradually.
- Use a room humidifier, as it may make sore throat sufferers more comfortable.
- Be aware that antiseptic lozenges and sprays may aggravate the sore throat rather than improve it.

Alternative treatment

Alternative treatment focuses on easing the symptoms of strep throat through herbs and botanical medicines. Some practitioners suggest using these treatments in addition to antibiotics, since they primarily address the comfort of the patient and not the underlying infection. Many practitioners recommend *Lactobacillus acidophilus* to offset the suppressive effects of antibiotics on the beneficial bacteria of the intestines.

Some suggested treatments include:

- Inhaling fragrances of the essential oils of lavender (*Lavandula officinalis*), thyme (*Thymus vulgaris*), eucalyptus (*Eucalyptus globulus*), sage (*Salvia officinalis*), and sandalwood (Aromatherapy).
- Gargling with a mixture of water, salt, and tumeric (*Curcuma longa*) powder or astringents, such as alum, sumac, sage, and bayberry (Ayurvedic medicine).
- Taking osha root (*Ligusticum porteri*) internally for infection or drinking tea made of sage, echinacea (*Echinacea* spp.) and cleavers (*Gallium aparine*) Osha root has an unpleasant taste many children will not accept (Botanical medicine).

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KEY TERMS

Lactobacillus acidophilus—A bacteria found in yogurt that changes the balance of the bacteria in the intestine in a beneficial way.

Prognosis

Patients with strep throat begin feeling better about 24 hours after starting antibiotics. Symptoms rarely last longer than five days. People remain contagious until after they have been taking antibiotics for 24 hours. Children should not return to school or childcare until they are no longer contagious. Food handlers should not work for the first 24 hours after antibiotic treatment because strep infections are occasionally passed through contaminated food. People who are not treated with antibiotics can continue to spread strep bacteria for several months.

About 10% of strep throat cases do not respond to penicillin. People who have even a mild sore throat after a 10 day treatment with antibiotic should return to their doctor. An explanation for this may be that the person is a carrier of strep but that something other than a strep bacterium is causing the sore throat.

Taking antibiotics within the first week of a strep infection will prevent rheumatic fever and other complications. If rheumatic fever does occur, the outcomes vary considerably. Some cases may be cured. In others there may be permanent damage to the heart and heart valves. In rare cases, rheumatic fever can be fatal.

Necrotizing fasciitis has a death rate of 30–50%. Patients who survive often suffer a great deal of tissue and muscle loss. Fortunately, this complication of a streptococcus infection is very rare.

Prevention

There is no way to prevent getting a strep throat. However, the risk of getting one or passing one on to another person can be minimized by:

- washing hands well and frequently, especially after nose blowing or sneezing and before food handling
- disposing of used tissues properly
- avoiding close contact with someone who has a strep throat
- not sharing food and eating utensils with anyone
- not smoking

Resources

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Tish Davidson, A.M.

Streptobacillary rat-bite fever *see* **Rat-bite fever**

Streptococcal antibody tests

Definition

Streptococcal infections are caused by a microorganism called *Streptococcus*. Three streptococcal antibody tests are available: the antistreptolysin O titer (ASO), the antideoxyribonuclease-B titer (anti-Dnase-B, or ADB), and the streptozyme test.

Purpose

The antistreptolysin O titer, or ASO, is ordered primarily to determine whether a previous group A *Streptococcus* infection has caused a poststreptococcal disease, such as **scarlet fever**, **rheumatic fever**, or a **kidney disease** called **glomerulonephritis**.

The anti-DNase-B (ADB) test is performed to determine a previous infection of a specific type of *Streptococcus*, group A beta-hemolytic *Streptococcus*. Identification of infections of this type are particularly important in suspected cases of acute rheumatic **fever** (ARF) or acute glomerulonephritis.

Streptozyme is a screening test used to detect antibodies to several streptococcal antigens. An antigen is a substance that can trigger an immune response, resulting in production of an antibody as part of the body's defense against infection and disease.

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Precautions

For the ASO test, increased levels of fats, called beta lipoproteins, in the blood can neutralize streptolysin O and cause a false-positive ASO titer. **Antibiotics**, which reduce the number of streptococci and thereby suppress ASO production, may decrease ASO levels. **Steroids**, which suppress the immune system, consequently may also suppress ASO production. Also Group A streptococcal infections of the skin may not produce an ASO response. Antibiotics also may decrease anti-DNase-B (ADB) levels.

Description

Streptococcal infections are caused by bacteria known as *Streptococcus*. There are several disease-causing strains of streptococci (groups A, B, C, D, and G), which are identified by their behavior, chemistry, and appearance. Each group causes specific types of infections and symptoms. These antibody tests are useful for group A streptococci. Group A streptococci are the most virulent species for humans and are the cause of **strep throat**, **tonsillitis**, wound and skin infections, blood infections (septicemia), scarlet fever, **pneumonia**, rheumatic fever, **Sydenham's chorea** (formerly called St. Vitus' dance), and glomerulonephritis.

Although symptoms may suggest a streptococcal infection, the diagnosis must be confirmed by tests. The best procedure, and one that is used for an acute infection, is to take a sample from the infected area for culture, a means of growing bacteria artificially in the laboratory. However, cultures are useless about two to three weeks after initial infection, so the ASO, anti-DNase-B, and streptozyme tests are used to determine if a streptococcal infection is present.

Antistreptolysin O titer (ASO)

The ASO titer is used to demonstrate the body's reaction to an infection caused by group A beta-hemolytic streptococci. Group A streptococci produce the enzyme streptolysin O, which can destroy (lyse) red blood cells. Because streptolysin O is antigenic (contains a protein foreign to the body), the body reacts by producing antistreptolysin O (ASO), which is a neutralizing antibody. ASO appears in the blood serum one week to one month after the onset of a strep infection. A high titer (high levels of ASO) is not specific for any type of poststreptococcal disease, but it does indicate if a streptococcal infection is or has been present.

Serial (several given in a row) ASO testing is often performed to determine the difference between an acute or convalescent blood sample. The diagnosis of a previous strep infection is confirmed when serial titers of ASO rise over a period of weeks, then fall slowly. ASO titers peak during the third week after the onset of acute symptoms of a streptococcal disease; at six months after onset, approximately 30% of patients exhibit abnormal titers.

Antideoxyribonuclease-B titer (anti-DNase B, or ADB)

Anti-DNase-B, or ADB, also detects antigens produced by group A strep, and is elevated in most patients with rheumatic fever and poststreptococcal glomerulonephritis. This test is often done concurrently with the ASO titer, and subsequent testing is usually performed to detect differences in the acute and convalescent blood samples. When ASO and ADB are performed concurrently, 95% of previous strep infections are detected. If both are repeatedly negative, the likelihood is that the patient's symptoms are not caused by a poststreptococcal disease.

When evaluating patients with acute rheumatic fever, the American Heart Association recommends the ASO titer rather than ADB. Even though the ADB is more sensitive than ASO, its results are too variable. It also should be noted that, while ASO is the recommended test, when ASO and ADB are done together, the combination is better than either ASO or ADB alone.

Streptozyme

The streptozyme test is often used as a screening test for antibodies to the streptococcal antigens NADase, DNase, streptokinase, streptolysin O, and hyaluronidase. This test is most useful in evaluating suspected poststreptococcal disease following *Streptococcus pyogenes* infection, such as rheumatic fever.

Streptozyme has certain advantages over ASO and ADB. It can detect several antibodies in a single assay, it is technically quick and easy, and it is unaffected by factors that can produce false-positives in the ASO test. The disadvantages are that, while it detects different antibodies, it does not determine which one has been detected, and it is not as sensitive in children as in adults. In fact, borderline antibody elevations, which could be significant in children, may not be detected at all. As with the ASO and ADB, a serially rising titer is more significant than a single determination.

Preparation

These tests are performed on blood specimens drawn from the patient's vein. The patient does not need to fast before these tests.

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KEY TERMS

Antibody—A protein manufactured by a type of white blood cells called lymphocytes, in response to the presence of an antigen, or foreign protein, in the body. Because bacteria, viruses, and other organisms commonly contain many antigens, antibodies are formed against these foreign proteins to neutralize or destroy the invaders.

Antigen—A substance that can trigger a defensive response in the body, resulting in production of an antibody as part of the body's defense against infection and disease. Many antigens are foreign proteins not found naturally in the body, and include bacteria, viruses, toxins, and tissues from another person used in organ transplantation.

Glomerulonephritis—An inflammation of the glomeruli, the filtering units of the kidney. Damage to these structures hampers removal of waste products, salt, and water from the bloodstream, which may cause serious complications. This disorder can be mild and cause no symptoms, or so severe enough to cause kidney failure.

Rheumatic fever—A disease that causes inflammation in various body tissues. Rare in most developed countries, but reported to be on the increase again in parts of the United States. Joint inflammation occurs, but more serious is the frequency with which the disease permanently damages the heart. The nervous system may also be affected, causing Sydenham's chorea.

Sydenham's chorea—A childhood disorder of the central nervous system. Once called St. Vitus' dance, the condition is characterized by involuntary, jerky movements that usually follow an attack of rheumatic fever. Rare in the United States today, but a common disorder in developing countries. Usually resolves in two to three months with no long-term adverse effects.

Risks

The risks associated with these tests are minimal but may include slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after the blood is drawn, or blood accumulating under the puncture site (hematoma).

Normal results

Antistreptolysin O titer:

- adult: 160 Todd units/mL
- child: 6 months to 2 years: 50 Todd units/mL; 2 to 4 years: 160 Todd units/mL; 5 to 12 years: 170–330 Todd units/mL
- newborn: similar to the mother's value

Antideoxyribonuclease-B titer:

- adult: 85 units
- child (preschool): 60 units
- child (school age): 170 units

Streptozyme: less than 100 streptozyme units.

Abnormal results

Antistreptolysin O titer: Increased levels are seen after the second week of an untreated infection in acute streptococcal infection, and are increased with acute rheumatic fever, acute glomerulonephritis (66% of patients will not have high ASO titers), and scarlet fever.

Antideoxyribonuclease-B titer: Increased titers are seen in cases of acute rheumatic fever and post-streptococcal glomerulonephritis.

Streptozyme: As this is a screening test for antibodies to streptococcal antigens, increased levels require more definitive tests to confirm diagnosis.

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Janis O. Flores

Streptococcal gangrene *see* **Gangrene**

Streptococcal infections

Definition

Streptococcal (strep) infections are communicable diseases that develop when bacteria of the genus *Streptococcus* invade parts of the body and overwhelm the

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The scarlet fever rash on this person's arm was caused by a streptococcal infection. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

body's immune system. Not every streptococcal infection causes detectable symptoms.

Description

Streptococcal bacteria produce symptoms that vary widely in location and severity—everything from skin infections to sore throats and **scarlet fever** to rare, but frequently fatal, necrotizing fasciitis and streptococcal toxic **shock**. Many people have some form of streptococcus bacteria in their body at some point in their life without necessarily showing any symptoms of infection. Nevertheless, a person who hosts bacteria without showing signs of infection is a carrier and can pass the infection on to others.

Types of infection

Primary strep infections invade healthy tissue. **Strep throat**, more formally called streptococcal pharyngitis, is the most common type of primary strep infection. It accounts for between 5–10% of all sore throats. and is especially common among school-aged children. Secondary strep infections invade tissue already weakened by injury or illness. Secondary strep infections frequently affect the bones, ears, eyes, joints, or intestines. Both primary and secondary strep infections can travel from affected tissues to lymph glands or enter the bloodstream and spread throughout the body (systemic infection). Many different strains of streptococcal bacteria have been identified since the 1930s. Types A, B, C, D, and G are the strains most likely to make people ill.

GROUP A *STREPTOCOCCUS*. All Group A strep (GAS) is the form of streptococcal bacteria most likely to be associated with serious illness. GAS is found worldwide. The incidence of respiratory strep A infections (strep throat, for example) is highest in cold climates and among young children. The incidence of GAS skin infections is highest in the tropics.

Two of the most severe invasive GAS infections are necrotizing fasciitis or flesh-eating bacteria disease, which causes the destruction of muscle tissue and fat, and **toxic shock syndrome**, a rapidly progressive disorder that causes shock and damages internal organs. In the mid-2000s, particularly virulent (strong and causing serious illness) strains of GAS bacteria appeared to be increasing. GAS is also the type of strep responsible for strep throat and scarlet **fever**. Strep throat is very common and is usually not serious. If untreated, however, strep throat can lead to **rheumatic fever**, which can permanently damage the heart and other organs.

GROUP B *STREPTOCOCCUS*. Group B strep (GBS) most often affects pregnant women, infants, the elderly, and chronically ill adults such as those with HIV/AIDS. Streptococcal infection occurs when bacteria contaminate cuts or open sores or otherwise penetrate the body's natural defenses. GBS exists in the reproductive tract of between 5 and 40% of all women. Most of these women are carriers who do not develop symptoms of infection. Nevertheless, they can transmit the bacterium to their newborns during **childbirth**. In the United States in 2006, two to three of every 1,000 live-born babies had a GBS infection. However, the number of babies dying of neonatal GBS infection has been declining steadily since the 1980s, most likely as the result of prevention programs initiated by the United States Centers for Disease Control (CDC).

About 75% of infected infants develop early-onset infection. Sometimes evident within a few hours of birth and always apparent within the first week of life, this condition causes inflammation of the membranes covering the brain and spinal cord (**meningitis**), **pneumonia**, blood infection (**sepsis**) and other problems.

Late-onset GBS develops between the ages of seven days and three months. It often causes meningitis. About half of all cases of this rare condition can be traced to mothers who are GBS carriers. The cause of the others is unknown.

Elderly individuals, especially those with other health problems, are also at higher risk of contracting a serious GBS infection that can spread to the entire body.

GROUP C *STREPTOCOCCUS*. Group C streptococcus (GCS) is a common source of infection in animals. It rarely causes human illness.

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GROUP D *STREPTOCOCCUS*. Group D streptococcus (GDS) is a common cause of wound infections in hospital patients. GDS is also associated with:

- abnormal growth of tissue in the gastrointestinal tract
- urinary tract infection (UTI)
- uterine infections in women who have just given birth

GROUP G *STREPTOCOCCUS*. Normally present on the skin, in the mouth and throat, and in the intestines and genital tract, Group G strep (GGS) is most likely to lead to infection in alcoholics and in people who have **cancer**, **diabetes mellitus**, **rheumatoid arthritis**, and other conditions that suppress immune-system activity.

GGS can cause a variety of serious infections, including:

- bacteria in the bloodstream (bacteremia)
- inflammation of the connective tissue structure surrounding a joint (bursitis)
- endocarditis (a condition that affects the lining of the heart chambers and the heart valves)
- meningitis
- inflammation of bone and bone marrow (osteomyelitis)
- inflammation of the lining of the abdomen (peritonitis)

Causes and symptoms

Streptococcal infection occurs when bacteria contaminate cuts or open sores or otherwise penetrate the body's natural defenses.

GAS

GAS is transmitted by direct contact with saliva, nasal discharge, or open **wounds** of someone who has the infection. Chronic illness, **kidney disease** treated by dialysis, and steroid use increase vulnerability to infection.

About one of five people with GAS infection develops a sore, inflamed throat (strep throat), and pus on the tonsils. The majority of those infected by GAS either have no symptoms or develop enlarged lymph nodes, fever, **headache**, **nausea**, **vomiting**, weakness, and a rapid heartbeat.

Necrotizing fasciitis, also called flesh-eating bacteria disease, can be caused by a virulent strain of GAS. In this rare disease (only 500 cases have been reported since 1883), tissues become gangrenous and rapidly decompose from the interior outward to the skin, resulting in muscle and skin loss. The **death** rate is as high as 75%. Toxic shock syndrome is characterized by severe headache, **sore throat**, fever as high as 105°F (40.6°C), **dehydration**, watery **diarrhea**, and a sunburn-like rash that spreads from the face to the rest of the body. Symptoms develop suddenly and can be fatal.

GBS

A pregnant woman who has GBS infection can develop infections of the bladder, blood, and urinary tract, and deliver a baby who is infected or stillborn. The risk of transmitting GBS infection during birth is highest in a woman whose labor begins before the 37th week of **pregnancy** or lasts more than 18 hours or who:

- becomes a GBS carrier during the final stages of pregnancy
- has a GBS urinary-tract infection
- has already given birth to a baby infected with GBS
- develops a fever during labor

Among men, and in women who are not pregnant, the average age of infection with GBS is 64. African Americans appear to be significantly more susceptible to infection by this strain of strep than any other racial group. The most common consequences of GBS infection are pneumonia and infections of blood, skin, and soft tissue.

Miscellaneous symptoms

Other symptoms associated with strep infection include:

- anemia
- elevated white blood cell counts
- inflammation of the epiglottis (epiglottitis)
- heart murmur
- high blood pressure
- infection of the heart muscle
- kidney inflammation (nephritis)
- swelling of the face and ankles

Diagnosis

Strep bacteria can be obtained by swabbing the back of the throat, vagina, rectum, or the infected area with a sterile cotton swab. There are two types of tests to determine if a person has a strep infection. A rapid strep test uses material collected on a sterile swab from the throat or other area where strep is suspected. This test can be done in a doctor's office and can determine only the presence of streptococcal bacteria. It is most often used to determine if a person has strep throat. The results of a rapid strep test are available in about 20 minutes. The advantage of this test is the speed with which a diagnosis can be made.

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The rapid strep test has a false negative rate of about 25%. In other words, in about one out of every four cases where no strep is detected by the rapid strep test, the patient actually does have a strep infection. Because of this, when a rapid strep test is negative, the doctor often does a culture test.

For a culture, a sample of swabbed material is grown in the laboratory on a medium that allows technicians to determine what kind of bacteria are present. Results take 24–48 hours. The test is very accurate and will show the presence of other kinds of bacteria besides *Streptococci*.

Treatment

Penicillin is often the antibiotic of choice to treat strep infections. Oral penicillin is usually taken for 10 days for infections such as strep throat and longer for systemic infections. Patients need to take the entire amount of antibiotic prescribed and not discontinue taking the medication when they feel better. Stopping the antibiotic early can lead to a return of the strep infection. Occasionally, a single injection of long-acting penicillin (Bicillin) is given instead of 10 days of oral treatment. It takes less than 24 hours for **antibiotics** to eliminate an infected person's ability to transmit strep bacteria.

About 10% of the time, penicillin is not effective against the strep bacteria. When this happens a doctor may prescribe other antibiotics such as cefuroxime (Ceftin), cefixime (Suprax), cefpodoxime proxetil (Vantin), loracarbef (Lorabid), cefditoren (Spectracef), azithromycin (Zithromax), clindamycin (Cleocin), or a cephalosporin (Keflex, Durocef, Ceclor). Erythromycin (Eryzole, Pediazole, Ilosone), another inexpensive antibiotic, can be given to people who are allergic to penicillin. Scarlet fever is treated with the same antibiotics as strep throat.

Without treatment, the symptoms of untreated strep throat begin subsiding in four or five days. However it is important to treat strep infections promptly with antibiotics because of the possibility of developing secondary disorders or infections. For example, rheumatic fever and rheumatic heart disease may develop from untreated strep throat.

Guidelines developed by the American Academy of Obstetrics and Gynecology (AAOG), the American Academy of Pediatrics (AAP), and the Centers for Disease Control and Prevention (CDC) recommend administering intravenous antibiotics to a woman at high risk of passing GBS infection on to her child, and offering the medication to any pregnant woman who wants it.

Initiating antibiotic therapy at least four hours before birth allows medication to become concentrated enough to protect the baby during its passage through the birth canal.

Newborns infected with GBS during or shortly after birth may die. Those who survive can require lengthy hospital stays and may develop vision or **hearing loss** and other permanent disabilities.

Alternative treatment

Conventional medicine is very successful in treating strep infections. However, several alternative therapies, including homeopathy and botanical medicine, may help relieve symptoms or support the person with a strep infection. For example, several herbs, including garlic (*Allium sativum*), **echinacea** (*Echinacea* spp.), and goldenseal (*Hydrastis canadensis*), are believed to strengthen the immune system, thus helping the body fight a current infection, as well as helping prevent future infections.

Prognosis

Most people who develop strep infections are treated with antibiotics and recover promptly without complications. Strep throat, for example, is almost never fatal. However, GAS is that results in systemic (involving the whole body) infection has a death rate of 25–40%. Streptococcal toxic shock and necrotizing fasciitis also have high death rates. GBS infection can be fatal in newborns and the elderly.

Prevention

Exposure to infected people should be avoided. However, the risk of getting one or passing one on to another person can be minimized by:

- washing hands well and frequently, especially after nose blowing or sneezing and before food handling
- disposing of used tissues properly
- avoiding close contact with someone who has a strep throat
- not sharing food and eating utensils with anyone
- not smoking

Resources

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Streptococcal sore throat *see* **Strep throat**

Streptococcal toxic shock syndrome *see* **Toxic shock syndrome**

Streptomycin *see* **Aminoglycosides**

Streptozyme test *see* **Streptococcal antibody tests**

Stress

Definition

Stress is defined as an organism's total response to environmental demands or pressures. When stress was first studied in the 1950s, the term was used to denote both the causes and the experienced effects of these pressures. More recently, however, the word stressor has been used for the stimulus that provokes a stress response.

Description

Stress in humans results from interactions between persons and their environment that are perceived as straining or exceeding their adaptive capacities and threatening their well being. The element of perception indicates that human stress responses reflect differences in personality as well as differences in physical strength or general health. One recurrent disagreement among researchers concerns the definition of stress in humans. Is it primarily an external response that can be measured by changes in glandular secretions, skin reactions, and other physical functions, or is it an internal interpretation of, or reaction to, a stressor; or is it both?

Stressful life events

Death of spouse, family member, or close friend
Divorce
Marital separation
Jail term/sentencing of close family member or friend
Personal injury or illness
Marriage
Loss of job due to termination
Retirement
Pregnancy
Change in financial state

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Risk factors

Risk factors for stress-related illnesses are a mix of personal, interpersonal, and social variables. These factors include lack or loss of control over one's physical environment and lack or loss of social support networks. People who are dependent on others (e.g. children or the elderly) or who are socially disadvantaged (because of race, gender, educational level, or similar factors) are at greater risk of developing stress-related illnesses. Other risk factors include feelings of helplessness, hopelessness, extreme fear or anger, and cynicism or distrust of others.

Recent research indicates that some vulnerability to stress is genetic. Scientists at the University of Wisconsin and King's College London discovered that people who inherited a short, or stress-sensitive, version of the serotonin transporter gene were almost three times as likely to experience depression following a stressful event as people with the long version of the gene. Further research is likely to identify other genes that affect susceptibility to stress.

Demographics

Nearly everyone experiences stress in their lives at some time. One study found that about 75% of those surveyed reported experiencing at least some stress in the previous two weeks. Occasional stress is an expected part of life for most people, and while often unpleasant, does not lead to long-term negative outcomes. In some cases however, severe or prolonged stress can lead to illness.

Causes and symptoms

Causes

The causes of stress can include any event or occurrence that a person considers a threat to his or

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her coping strategies or resources. Researchers generally agree that a certain degree of stress is a normal part of a living organism's response to the inevitable changes in its physical or social environment, and that positive, as well as negative, events can generate stress. Stress-related disease, however, results from excessive and prolonged demands on an individual's coping resources.

Stress can come from many different situations or events, and can affect different people in different ways. Things that cause stress in one individual may not cause a negative response in another individual. A specific upcoming event can cause significant stress, such as an upcoming job interview, presentation, or final exam. Even upcoming events that are considered positive or exciting can cause stress, such as a wedding or the birth of a baby. When an upcoming event is the source of stress, the individual may experience a constant, nagging worry about the event. He or she may visualize the event repeatedly, and may worry about things that could go wrong. It is often hard to stop thinking about the event. This type of stress can take a significant toll when it persists over long periods of time.

Stress also may be caused by things going on in the world. Events such as the terrorist attacks of September 11th, 2001 are believed to have increased stress in people not only in the United States, but also around the world. Events like terrorist attacks can lead to worry about the safety of family members and loved ones, worries about when another attack may happen, or concerns about many other things. These kind of worries, when they occur over a long period of time, can lead to stress and related negative outcomes.

A traumatic event, such as a car accident, earthquake, **rape**, or even witnessing a traumatic event, can cause severe stress. In these cases an individual may mentally relive the event repeatedly. This is a normal response to a traumatic event but if it persists for more than a short time or does not seem to be getting better, the individual may have **post-traumatic stress disorder** (PTSD), a serious psychiatric illness that occurs in individuals who have participated in or witnessed traumatic events. PTSD is particularly common as among warfighters who are constantly under stress while engaged in military campaigns.

Stress also can be caused, not just by a single event, but also by the presence of issues and problems that are upsetting or frustrating in day-to-day life. These can include worries about money, pressure at work, and problems with a relationship. Events such as divorce or the **death** of a loved one can also cause stress for many months or years.

Symptoms

The symptoms of stress can be either physical or psychological or both. Physical symptoms may include problems sleeping, **indigestion**, stomach pains, chest pains, **fatigue**, **headache**, back or neck **pain**, and many others. Psychological signs of stress include **anxiety**, frustration, irritability, and even depression. These symptoms may not be problematic if they occur for a short period of time but if they are ongoing an individual should consider seeing a doctor.

Stress-related physical illnesses, such as **irritable bowel syndrome**, heart attacks, arthritis, and chronic headaches, can result from long-term overstimulation of a part of the nervous system that regulates the heart rate, blood pressure, and digestive system. Stress-related emotional illness results from inadequate or inappropriate responses to major changes in one's life situation, such as marriage, completing one's education, becoming a parent, losing a job, or retirement. Psychiatrists sometimes use the term "adjustment disorder" to describe this type of illness. In the workplace, stress-related illness often takes the form of burnout—a loss of interest in or ability to perform one's job due to long-term high stress levels. For example, **palliative care** nurses are at high risk of burnout due to their inability to prevent their patients from dying or even to relieve their physical suffering in some circumstances.

Diagnosis

When the doctor suspects that a patient's illness is connected to stress, he or she will take a careful history that includes stressors in the patient's life (e.g. family or employment problems, other illnesses, recent major life changes). Many physicians will evaluate the patient's personality as well, in order to assess his or her coping resources and emotional response patterns. There are several personality inventories and **psychological tests** that doctors can use to help diagnose the amount of stress that the patient experiences and the coping strategies that he or she uses to deal with them. A variation on this is to identify what the patient perceives as threatening as well as stressful. Stress-related illness can be diagnosed by primary care doctors, as well as by those who specialize in psychiatry. The doctor will need to distinguish between **adjustment disorders** and anxiety or **mood disorders**, and between psychiatric disorders and physical illnesses (e.g., abnormal thyroid activity) that have psychological side effects.

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KEY TERMS

Adjustment disorder—A psychiatric disorder marked by inappropriate or inadequate responses to a change in life circumstances. Depression following retirement from work is an example of adjustment disorder.

Biofeedback—A technique in which patients learn to modify certain body functions, such as temperature or pulse rate, with the help of a monitoring machine.

Burnout—An emotional condition, marked by tiredness, loss of interest, or frustration, that interferes with job performance,. Burnout is usually regarded as the result of prolonged stress.

Stress hardiness—A personality characteristic that enables persons to stay healthy in stressful circumstances. It includes belief in one's ability to influence the situation; being committed to or fully engaged in one's activities; and having a positive view of change.

Stress management—A category of popularized programs and techniques intended to help people deal more effectively with stress.

Stressor—A stimulus, or event, that provokes a stress response in an organism. Stressors can be categorized as acute or chronic, and as external or internal to the organism.

Treatment

Recent advances in the understanding of the many complex connections between the human mind and body have produced a variety of mainstream approaches to stress-related illness. Present treatment regimens may include one or more of the following:

- Medications. These may include drugs to control blood pressure or other physical symptoms of stress, as well as drugs that affect the patient's mood (tranquilizers or antidepressants).
- Stress management programs. These may be either individual or group treatments, and usually involve analysis of the stressors in the patient's life. They often focus on job or workplace-related stress.
- Behavioral approaches. These strategies include relaxation techniques, breathing exercises, and physical exercise programs including walking.
- Massage. Therapeutic massage relieves stress by relaxing the large groups of muscles in the back, neck, arms, and legs.
- Cognitive therapy. These approaches teach patients to reframe or mentally reinterpret the stressors in their lives in order to modify the body's physical reactions.
- Meditation and associated spiritual or religious practices. Recent studies have found positive correlations between these practices and stress hardiness.

Alternative treatment

Treatment of stress is one area in which the boundaries between traditional and alternative therapies have changed in recent years, in part because some forms of physical **exercise** (**yoga**, **tai chi**, aikido) that were once associated with the counterculture have become widely accepted as useful parts of mainstream **stress reduction** programs. Other alternative therapies for stress that are occasionally recommended by mainstream medicine include **aromatherapy**, dance therapy, **biofeedback**, nutrition-based treatments (including dietary guidelines and **nutritional supplements**), **acupuncture**, homeopathy, and herbal medicine.

Prognosis

The prognosis for recovery from a stress-related illness is dependent on a wide variety of factors in a person's life, many of which are genetically determined (e.g. race, sex, illnesses that run in families) or beyond the individual's control (e.g. economic trends, cultural stereotypes and prejudices, death of a loved one). It is possible, however, for an individual to learn new responses to stress and, thus, change their experiences of it. A person's ability to remain healthy in stressful situations is sometimes referred to as stress hardiness. Stress-hardy people have a cluster of personality traits that strengthen their ability to cope. These traits include believing in the importance of what they are doing; believing that they have some power to influence their situation; and viewing life's changes as positive opportunities rather than as threats.

Prevention

Complete prevention of stress is neither possible nor desirable because stress is an important stimulus of human growth and creativity, as well as an inevitable part of life. In addition, specific strategies for stress prevention vary widely from person to person, depending on the nature and number of the stressors

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in an individual's life, and the amount of control he or she has over these factors. In general, however, a combination of attitudinal and behavioral changes works well for most patients. An important form of prevention may be parental modeling of healthy attitudes and behaviors within the family.

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ORGANIZATIONS

The American Institute of Stress, 124 Park Avenue, Yonkers, NY, 10703, (914) 963-1200, (914) 965-6267, Stress125@optonline.net, http://www.stress.org.

National Institute of Mental Health, 6001 Executive Boulevard, Room 8184, MSC 9663, Bethesda, MD, 20892-9663, (301) 443-4513, TTY (301) 443-8431, (866) 615-6464, TTY (866) 415-8051, (301) 443-4279, nimhinfo@nimh.gov, http://www.nih.nih.gov.

United States Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (404) 639-3534, (800)-CDC-INFO (800)-232-4636), TTY: (888) 232-6348, inquiry@cdc.gov, http://www.cdc.gov.

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Stress reduction

Definition

Stress is the body's normal response to anything that disturbs its natural physical, emotional, or mental balance. Stress reduction refers to various strategies that counteract this response and produce a sense of relaxation and tranquility.

Purpose

Although stress is a natural phenomenon of living, stress that is not controlled and that continues for a long period of time can seriously compromise health. For this reason, stress must be understood, managed, and appropriately reduced. Several very different strategies and therapies are available that can help with relaxation and stress management.

Precautions

Stress reduction can only present a problem if an individual attributes an actual, serious condition or disease to being simply a stress-related response and avoids consulting a physician.

People who have undergone a severe trauma (criminal assault, combat, natural disaster, car accident, etc.) may experience symptoms of **post-traumatic stress disorder** (PTSD) or **acute stress disorder** (ASD). These disorders are defined by their temporal connection to a traumatic event in the patient's life, and are characterized by a cluster of **anxiety** and dissociative symptoms. They interfere with the patient's normal level of functioning, and require some form of supportive therapy. People who experience a sense of detachment or unreality, emotional numbing, a general feeling of being dazed, **amnesia** for part of the traumatic event, or similar symptoms should consult a medical doctor in addition to using other approaches to stress reduction.

Description

Everyone encounters stress every day. Although most people think of stress as negative, it is neither good nor bad but is neutral or nonspecific. Stress may be internal (from within ourselves) or external (such as noise from the environment) and does not always result from something unpleasant. Stress can also be caused by events that are positive, like an upcoming wedding or the birth of a child. A certain amount of stress is actually essential to being sufficiently stimulated to meet the challenges of everyday life, but when stress is constant and acute, it can have dangerous consequences.

The specific and immediate cause of stress is called the stressor. A stressor can be something dramatic or terrible, such as a violent experience or the **death** of a loved one, or it can be a positive and rewarding event, like marriage or a promotion. The stressor can be internal, such as feelings of guilt or anger felt in a relationship, or it can be external, such as a natural disaster or the ordinary rigors and frustrations of commuting. It can also have a physical source, like simple **exercise** or hard work, or it can be strictly mental, like worry. Our bodies react the same way physiologically no matter what the source of the stress.

From a physical standpoint, the body reacts to stress in a standard and predictable manner. When

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stress occurs, the brain immediately receives nerve impulses. These impulses initiate an automatic sequence carried out by the body's sympathetic nervous system: it begins with stimulation of the brain's hypothalamus, which sends nerve impulses to both the adrenal and the pituitary glands. Also called the "fight or flight" response, this automatic physiological process is known to have evolved in humans and animals to enable them to cope with sudden, life-threatening emergencies. When faced with a major stressor, the body's biochemistry instantly hurtles into a ready mode that marshals all the possible resources necessary to either escape or do battle. Thus, the adrenal glands located on top of the kidneys provide an instant surge of adrenaline, quickening the heart rate and blood flow and providing every cell with extra oxygen. They also relea se cortisol or hydrocortisone, causing an increase in both amino acids (the building blocks of proteins) and blood sugar. These are required for tissue repair to take place. Finally, the pituitary gland at the base of the brain releases a variety of hormones, including endorphins, that act as natural painkillers and permit the body to do things it ordinarily could not do. Thus, very shortly after a stressor is recognized by the body, the heart and breathing rate spike, the pupils dilate to improve vision, perspiration increases, digestion slows, and the body is aroused, energized, and temporarily has an increased threshold for **pain**. This sequence of events allows individuals to do whatever is required to save themselves, whether it is to flee from a predator or engage in combat and fend off an attack.

While these automatic physiological responses served early humans well and were essential to survival of the species, today's men and women rarely must literally fight for their lives or dodge and elude a predator. Yet the body's automatic response to stress has remained largely unchanged in a radically changed world. Whether caveman or corporate executive, when the fight-or-flight response kicks in, a three-stage process begins. Stage one is the alarm stage in which the body releases hormones and prepares for extreme physical action. Resistance is stage two in which the body attempts to resist yet adapt to the stress and to repair any damage done. The final stage, exhaustion, occurs if the stress remains constant. It is especially dangerous since stage one's physical response may begin all over again. The persistence of stress and stage three's exhaustion is the point at which disease can occur. The body may then experience severe debilitating conditions like migraine, heart irregularities, and mental illness. Some bodily functions may even shut down altogether.

Although different individuals may have different levels of stress tolerance, chronic stress will eventually wear down even the strongest of people. Prolonged stress can cause biochemical imbalances that weaken the immune system and invite serious illness. Overall, stress that persists is known to interfere with digestion and, more seriously, alter brain chemistry, create hormonal imbalances, increase heart rate, raise blood pressure, and negatively affect both metabolic and immune function. It is also important to recognize that although stress itself is not a disease, it can worsen any number of already serious physical conditions. While long-term stress can seriously affect one's quality of life and lead to major, sometimes fatal, diseases, prolonged stress also results in the everyday miseries of **headache** and allergy, digestive disorders and **fatigue**, irritable bladder and **impotence**, **insomnia**, anxiety, depression, and chronic aches and pains. Researchers explo ring the connection between stress and susceptibility to colds exposed stressed individuals (who had experienced a death in the family, become divorced, or had recently moved) to cold viruses and then tested for antibodies a month later. Results indicated that severely stressed individuals were four times more likely to become infected.

Stress can cause or contribute to illness but reducing stress may have the opposite effect and may strengthen the body and even encourage healing. The most important step toward reducing the stress may be to understand the nature of stress and to learn how to gain some control over it. Being able to recognize that he or she is stressed is the first step in reducing stress. Of the many signs and symptoms that indicate the presence of stress, some are obvious and require only common sense to recognize. Short-term noticeable effects of stress include sweaty palms and other types of perspiration, dilated pupils, and difficulty in swallowing ("a lump in the throat"). Tightness in the chest is another stress signal as are stomach problems and some skin conditions. Stress that is the result of prolonged anxiety (a sense of apprehension) often results in feelings of panic or actual trembling, fatigue, insomnia, and **shortness of breath**, heart **palpitations** and dizziness, and irritability. Although none of these symptoms is pleasant, they are relatively minor compared to the silent but much more serious internal effects that can lead to serious health problems.

Fortunately, stress and the negative effects it creates can be reduced by a wide variety of therapeutic approaches. When successfully applied, many of these therapies and strategies can both reduce stress and begin reverse its damage. Before selecting a particular therapy, it is important to be able to distinguish unhealthy stress from stress that is not negative. Researchers have found that the most important variable among

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types of stress is an individual's sense of control over the situation. The least harmful stress scenario is one in which an individual feels that he or she has a sufficient degree of control or that the situation is highly predictable. Put simply, predictable pain is less stressful because individuals know when to relax (gaining relief from pain as well as protecting themselves from its damaging effects). But when individuals have no warning of pain, they are in a state of constant stress. An example from daily life might be the difference between the stress experienced during a move by parents, who are in control and making decisions, and a child who does not have a say in the matter. The former can pick and choose when to enter or engage a stressful situation or problem but the latter has no control nor any ability to predict when such a situation will arise and are constantly on alert or in a state of anxiety.

For those with little control over situations that make them anxious, there are two ways to deal with the stress. One is to remove or reduce the stressor, and the other is to increase resistance to it. Although there are many strategies to achieve each of these, all of them can be reduced to some variation of a single simple concept—relaxation. While there is no one single technique or therapy that will help everyone, the combination of lifestyle change, diet, exercise, and relaxation will allow nearly all types of individuals to better manage the stress in their lives. Although relaxation is at the core of most stress reduction methods, it is not something that everyone can fully achieve without assistance and guidance.

There are a number of relaxation therapies that enable an individual to achieve deep, beneficial relaxation. They can be grouped into the following general categories: mind-body therapies, body work and movement therapies, and herbal-based **diets** and natural regimens. Many of the specific techniques in these categories can be part of a self-help or self-care approach, although some require the help of an experienced practitioner.

Therapies that focus on a connection between the mind and body are based on the fact that thinking patterns and emotions can have physical effects on the body. These techniques encourage the individual to take control and learn techniques for coping with stressors rather than trying to eliminate them. Such therapies range from individual counseling and **meditation** or involvement with a support group to **guided imagery** and **biofeedback**. They all have the common goal of evoking the physiological relaxation response in which a person can achieve beneficial internal results such as lowering blood pressure and decreasing gastric acid secretion.

Body work and movement therapies include techniques ranging from dance therapy and massage to **reflexology** and **rolfing**. Body work is based partly on the therapeutic power of human touch and can also include manipulation, realignment, and posture correction. Movement therapies are a particular form of physical exercise, although they attempt to do much more than simply get a person into shape. Most usually emphasize the mind/body connection and strive to put people in better touch with both their bodies and their feelings. Body work and movement therapies can be as vigorous as deep tissue manipulation or as simple and minimal as the Alexander technique's light posture corrections.

Herbal remedies for stress are usually part of a larger system of natural, **holistic medicine**. Whether Chinese traditional medicine, its counterpart from India, or the homeopathy of the West, all these systems of natural medicine have a holistic focus and emphasize the need for inner balance. All demonstrate how the individual's physical, emotional, mental, and spiritual states are connected and use natural substances as part of the treatment for reducing stress. Such therapies range from the occasional purging (cleansing) of **Ayurvedic medicine** to the sleep-inducing properties of chamomile tea. They also can include the use of cayenne to relieve pain, fragrant essential oils from flowers to evoke a pleasing response and relieve tension, or aloe vera to soothe burned skin.

Some of the more common therapies and techniques available for reducing stress include:

- Acupuncture. Insertion of needles at certain spots under the skin for the purpose of attaining balance by either releasing blocked energy or draining off excess energy.
- Alexander technique. Improving the alignment of head, neck, and back to achieve efficient posture and movement.
- Aromatherapy. Massage with essential oils from flowers to affect mood and produce a sense of well-being.
- Art therapy. Creating something allows free expression and results in feelings of achievement and mood change.
- Autogenic training therapy. A form of deep meditation or self-hypnosis.
- Autosuggestion therapy. A form of verbal therapy involving repetition of a positive idea.
- Ayurvedic medicine. A complete system of daily living based on awareness of one's particular constitution.

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- Behavioral therapy. A variety of psychotherapies that are based on changing behavior through retraining.
- Bach flower therapy. Herbal remedies that are prepared from flowers acting energetically to soothe the mind and body.
- Bioenergetics. A practice that encourages sudden release of tensions by crying or kicking.
- Biofeedback. Monitoring rates of body functions and using data to influence and gain control over autonomic functions.
- Breathing for relaxation. Stylized breathing technique to control and lower body functions.
- Counseling. Work with a therapist trained in talking-based therapy.
- Dance movement therapy. Freedom of expression through movement.
- Feldenkrais method. Slow, light movements alter habits and reeducate neuromuscular system.
- Flotation therapy. Floating in a soundproof tank with no external stimulation.
- Guided imagery. Creating a mental picture of what is desired. Also called Creative imagery or Visualization.
- Herbal medicine. Uses substances derived from plants as treatment instead of synthetic drugs.
- Homeopathy. Uses minute doses of plant, animal, and mineral substances to stimulate the body's natural healing.
- Hydrotherapy. Use of water internally and externally for healing purposes.
- Hypnotherapy. Hypnosis in order to identify and release patterns that keep an individual from a personal balance point.
- Kinesiology. Uses muscle testing to correct imbalances in the body's "energy system." Also called Touch for Health.
- Massage. Use of touch and manipulation to soothe. Can also employ vigorous deep tissue manipulation.
- Meditation. Deep, relaxed, receptive, and focused concentration on a single object, sound, or word.
- Music therapy. Playing or listening to music to create an emotional reaction.
- Naturopathy. A complete health care system that uses a variety of natural healing therapies.
- Psychotherapy. A talking-based therapy with a mental health professional to get at the root of a conflict, modify behavior or change disruptive thought patterns.
- Reflexology. Manipulation of zones of the feet that relate to the major organs, glands, and areas of the body.
- Rolfing. Vigorous manipulation of the body's connective tissue to restore "balance."
- Shiatsu. Traditional Japanese finger pressure massage therapy.
- Sound therapy. Uses sound waves to slow the body's autonomic system.
- Tai chi chuan. System of slow, continuous exercises based on rhythm and equilibrium.
- Yoga. System of exercises that combines certain positions with deep breathing and meditation.

These and many other techniques, systems, and therapies are available to the person seeking to reduce and manage stress. Some methods are very simple and can be easily learned, while others are high-tech and often involve a practitioner. A search for common elements among most of these stress-reducing systems reveals several strategies that many people may be able to employ on their own. However, it is important to know and recognize the signals of stress. Further, it is easier to resist the negative effects of stress by eating properly and getting sufficient sleep and exercise.

Nearly all stress-reducing systems are geared to evoking some degree of beneficial mind/body relaxation and most include some version of the following:

- mental time out
- deep breathing
- meditation and singular focus
- gentle, repetitive exercise

The best stress reduction system is the one that works for the individual. Whether stress can be relieved by laughter, mellow music, repetition of a single word, self-massage, vigorous activity, or simply by doing everyday chores in a mindful state of heightened awareness, it is important that stress be recognized and managed every day. Studies have shown that regular relaxation eventually makes the body less responsive to its stress hormones and acts as a sort of natural tranquilizer. It is as if people can build their own defense against the stress response.

Many companies have introduced workplace stress management programs to improve their employees' health. These programs typically include instruction on emotional refocusing or restructuring, and have been shown to be beneficial in reducing the participants' blood pressure, heart rate, and other signs of emotional upset. In addition, stress management programs designed for persons in specific high-stress occupations (medicine, law enforcement, emergency response, etc.) have proved to be effective in reducing burnout and helping members of these professions cope with the specific stresses of their respective jobs.

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KEY TERMS

Adrenal gland—A pair of glands that rest on the top of each kidney that produce steroids, such as sex hormones and those concerned with metabolic functions.

Amino acid—Organic acids that are the main components of proteins and are synthesized by living cells.

Antibody—A type of protein produced in the blood in response to a foreign substance that destroys the intruding substance; it is responsible for immunity.

Burnout—An emotional condition marked by tiredness, loss of interest, or frustration that interferes with job performance. Burnout is usually regarded as the result of prolonged stress.

Chronic—Long-term or frequently recurring.

Debilitating—Weakening, or reducing the strength of.

Dilate—To enlarge, open wide, or distend.

Endorphins—A group of proteins with powerful pain-killing properties that originate naturally in the brain.

Holistic—That which pertains to the entire person, involving the body, mind, and spirit.

Hydrocortisone—A steroid hormone produced by the adrenal glands that provides resistance to stress.

Hypothalamus—A part of the brain that controls some of the body's automatic regulatory functions.

Immune function—The state in which the body recognizes foreign materials and is able to neutralize them before they can do any harm.

Impotence—The inability of the male to engage in sexual intercourse because of insufficient erection.

Insomnia—Inability to sleep under normal conditions.

Metabolic function—Those processes necessary for the maintenance of a living organism.

Neuromuscular—Relating to nerve and muscle or their interaction.

Physiological—Dealing with the functions and processes of the body.

Pituitary gland—A gland at the base of the brain responsible for growth, maturation, and reproduction.

Sympathetic nervous system—That part of the autonomic nervous system that affects contraction of muscles and blood vessels. Stimulation of this system by a stressor triggers the production of hormones that prepare the body for fight or flight

Therapeutic—Curative or healing.

An additional general strategy for handling stress in family life or the workplace is the cultivation of a group of character traits that has been termed "psychological hardiness." These traits include believing in the importance of what one is doing, believing that one has some power to influence the immediate situation, and viewing life's changes as positive opportunities rather than as threats. These qualities are sometimes referred to as the "3 Cs," which stand for commitment, control and challenge. Approaches to stress reduction that enhance these qualities are especially beneficial.

Newer trends in stress reduction

One trend in stress reduction in the 2000s is the development of stress management programs or stress reduction strategies tailored to specific categories of people, often defined by their occupation or by a chronic health condition. For example, journalists who cover traumatic events are increasingly recognized as susceptible to developing posttraumatic stress disorder. In July of 2007 a study presented at the annual meeting of the American Society for Clinical Oncology showed men taught stress management techniques before surgery for **prostate cancer** had improved outcomes after both 6 and 12 months.

Another new trend in stress reduction is the development of programs designed for communities as well as individuals. After the events of September 11, 2001, many mental health professionals recognized that acts of terrorism or mass violence affect large groups of people and that psychiatric interventions need to address stress as a group experience as well as an individual one.

Risks

All relaxation-based therapies to reduce stress are generally considered free of serious risk.

Normal results

Learning how to manage stress has the short-term benefits of giving people some sense of control in their lives, providing them with positive coping strategies,

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and making them more relaxed and healthier. The long-term benefits can be a stronger immune system, proper hormonal balance, and reduced susceptibility to disease.

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The American Institute of Stress, 124 Park Avenue, Yonkers, NY, 10703, (914) 963-1200, (914) 965-6267, Stress125@optonline.net, http://www.stress.org.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

National Child Traumatic Stress Network, University of California, Los Angeles. 11150 W. Olympic Blvd., Suite 650 , Los Angeles, CA, 90064 , (310) 235-2633, (310) 235-2612, http://www.nctsnet.org/nccts.

National Institute of Mental Health (NIMH), 6001 Executive Boulevard, Bethesda, MD, 20892, (301) 443-4513, (301) 443-4279, (866) 615-6464, nimhinfo@nih.gov, http://www.nimh.nih.gov.

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Stress test

Definition

A stress test is primarily used to identify **coronary artery disease**. It requires patients to **exercise** on a treadmill or exercise bicycle while their heart rate, blood pressure, electrocardiogram (ECG), and symptoms are monitored.

Purpose

The body requires more oxygen during exercise than when it is at rest. To deliver more oxygen during exercise, the heart has to pump more oxygen-rich blood. Because of the increased stress on the heart, exercise can reveal coronary problems that are not apparent when the body is at rest. This is why the stress test, though not perfect, remains the best initial, noninvasive, practical coronary test.

The stress test is particularly useful for detecting **ischemia** (inadequate supply of blood to the heart muscle) caused by blocked coronary arteries. Less commonly, it is used to determine safe levels of exercise in people with existing coronary artery disease.

Description

A technician affixes electrodes to the patient's chest, using adhesive patches with a special gel that conducts electrical impulses. Typically, electrodes are placed under each collarbone and each bottom rib, and six electrodes are placed across the chest in a rough outline of the heart. Wires from the electrodes are connected to an ECG, which records the electrical activity picked up by the electrodes.

The technician runs resting ECG tests while the patient is lying down, then standing up, and then breathing heavily for half a minute. These baseline tests can later be compared with the ECG tests performed while the patient is exercising. The patient's blood pressure is taken and the blood pressure cuff is left in place so that blood pressure can be measured periodically throughout the test.

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KEY TERMS

Angina—Chest pain from a poor blood supply to the heart muscle due to stenosis (narrowing) of the coronary arteries.

Cardiac arrhythmia—An irregular heart rate (frequency of heartbeats) or rhythm (the pattern of heartbeats).

Defibrillator—A device that delivers an electric shock to the heart muscle through the chest wall in order to restore a normal heart rate.

False negative—Test results showing no problem when one exists.

False positive—Test results showing a problem when one does not exist.

Hypertrophy—The overgrowth of muscle.

Ischemia—Dimished supply of oxygen-rich blood to an organ or area of the body.

The patient begins riding a stationary bicycle or walking on a treadmill. Gradually the intensity of the exercise is increased. For example, if the patient is walking on a treadmill, then the speed of the treadmill increases and the treadmill is tilted upward to simulate an incline. If the patient is on an exercise bicycle, then the resistance or "drag" is gradually increased. The patient continues exercising at increasing intensity until reaching the target heart rate (generally set at a minimum of 85% of the maximal predicted heart rate based on the patient's age) or experiences severe **fatigue**, **dizziness**, or chest **pain**. During the test, the patient's heart rate, ECG, and blood pressure are monitored.

Sometimes other tests, such as **echocardiography** or thallium scanning, are used in conjunction with the exercise stress test. For instance, studies suggest that women have a high rate of false negatives (results showing no problem when one exists) and false positives (results showing a problem when one does not exist) with the stress test. They may benefit from another test, such as exercise echocardiography. People who are unable to exercise may be injected with drugs, such as adenosine, which mimic the effects of exercise on the heart, and then given a thallium scan. The thallium scan or echocardiogram are particularly useful when the patient's resting ECG is abnormal. In such cases, interpretation of exercise-induced ECG abnormalities is difficult.

Preparation

Patients are usually instructed not to eat or smoke for several hours before the test. They should be advised to inform the physician about any medications they are taking, and to wear comfortable sneakers and exercise clothing.

Aftercare

After the test, the patient should rest until blood pressure and heart rate return to normal. If all goes well, and there are no signs of distress, the patient may return to his or her normal daily activities.

Risks

There is a very slight risk of myocardial infarction (a **heart attack**) from the exercise, as well as cardiac arrhythmia (irregular heart beats), **angina**, or cardiac arrest (about 1 in 100,000). The exercise stress test carries a very slight risk (1 in 100,000) of causing a heart attack. For this reason, exercise stress tests should be attended by health care professionals with immediate access to defibrillators and other emergency equipment.

Patients are cautioned to stop the test should they develop any of the following symptoms:

- unsteady gait
- confusion
- skin that is grayish or cold and clammy
- dizziness or fainting
- a drop in blood pressure
- angina (chest pain)
- cardiac arrhythmias (irregular heartbeat)

Normal results

A normal result of an exercise stress test shows normal electrocardiogram tracings and heart rate, blood pressure within the normal range, and no angina, unusual dizziness, or **shortness of breath**.

A number of abnormalities may appear on an exercise stress test. Examples of exercise-induced ECG abnormalities are ST segment depression or heart rhythm disturbances. These ECG abnormalities may indicate deprivation of blood to the heart muscle (ischemia) caused by narrowed or blocked coronary arteries. Stress test abnormalities generally require further diagnostic evaluation and therapy.

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Patient education

Patients must be well prepared for a stress test. They should not only know the purpose of the test but also signs and symptoms that indicate the test should be stopped. Physicians, nurses, and ECG technicians can ensure patient safety by encouraging them to immediately communicate discomfort at any time during the stress test.

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American Heart Association, National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, http://www.americanheart.org.

National Heart, Lung, and Blood Institute, Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, http://www.nhlbi.nih.gov.

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Stridor

Definition

Stridor is a term used to describe noisy breathing in general and to refer specifically to a high-pitched crowing sound associated with **croup**, respiratory infection, and airway obstruction.

Description

Stridor occurs when erratic air currents attempt to force their way through breathing passages narrowed by:

- illness
- infection
- the presence of foreign objects
- throat abnormalities

Stridor can usually be heard from a distance but is sometimes audible only during deep breathing. Someone who has stridor may crow and wheeze when:

- inhaling
- exhaling
- inhaling and exhaling

Most common in young children, whose naturally small airways are easily obstructed, stridor can be a symptom of a life-threatening respiratory emergency.

Causes and symptoms

During childhood, stridor is usually caused by infection of the cartilage flap (epiglottis) that covers the opening of the windpipe to prevent **choking** during swallowing. It can also be caused by a toy or other tiny object the child has tried to swallow.

Laryngomalacia is a common cause of a rapid, low-pitched form of stridor that may be heard when a baby inhales. This harmless condition does not require medical attention. It usually disappears by the time the child is 18 months old.

The most common causes of stridor in adults are:

- abscess or swelling of the upper airway
- paralysis or malfunction of the vocal cords
- tumor

Other common causes of stridor include:

- enlargement of the thyroid gland (goiter)
- swelling of the voice box (largyngeal edema)
- narrowing of the windpipe (tracheal stenosis)

When stridor is caused by a condition that slowly narrows the airway, crowing and **wheezing** may not develop until the obstruction has become severe.

Diagnosis

When stridor is present in a newborn, pediatricians and neonatologists look for evidence of:

- heart defects inherent at birth (congenital)
- neurological disorders
- general toxicity

If examinations do not reveal the reasons for the baby's noisy breathing, the air passages are assumed to be the cause of the problem.

Listening to an older child or adult breathe usually enables pediatricians, family physicians, and pulmonary specialists to estimate where an airway

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obstruction is located. The extent of the obstruction can be calculated by assessing the patient's:

- complexion
- chest movements
- breathing rate
- level of consciousness

X rays and direct examination of the voice box (larynx) and breathing passages indicate the exact location of the obstruction or inflammation. Flow-volume loops and pulse oximetry are diagnostic tools used to measure how much air flows through the breathing passages, and how much oxygen those passages contain.

Pulmonary function tests may also be performed.

Treatment

The cause of this condition determines the way it is treated.

Life-threatening emergencies may require:

- the insertion of a breathing tube through the mouth and nose (tracheal intubation)
- the insertion of a breathing tube directly into the windpipe (tracheostomy)

Resources

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Maureen Haggerty

Stroke

Definition

Stroke is a life-threatening condition that occurs when the blood supply to a part of the brain is suddenly cut off or when brain tissue is damaged by bleeding into the brain. There are two main types of stroke. Ischemic stroke occurs when a clot blocks an artery to the brain; this type accounts for about 80% of strokes. The other type, hemorrhagic stroke, occurs when a blood vessel in the brain bursts, allowing blood to spill out into brain tissue. The blood upsets the chemical balance that the nerve cells in the brain need to function.

Demographics

According to the Centers for Disease Control and Prevention (CDC), stroke is the third leading cause of **death** in the United States as of 2009, being responsible for about 160,000 deaths each year. About 795,000 Americans have strokes each year, 550,000 for the first time and 245,000 having a second or third stroke. Of these cases, approximately 625,000 are ischemic strokes. The total cost of stroke to the American economy per year as of 2009 is approximately $68.9 billion. By the year 2025, the annual number of strokes is expected to reach 1 million. As of 2009, more than 4.4 million people in the United States are stroke survivors. Worldwide, the World Health Organization estimates that 15 million people suffer a stroke each year, resulting in 5 million deaths and 5 million permanently disabled survivors.

About 50,000 Americans have a **transient ischemic attack** (TIA) in an average year; of this group, 35% will have a severe stroke at some point in the future.

Strokes can affect people in any age group; however, the risk increases sharply in people over 55 years of age. 75% percent of all strokes in Canada and the United States occur in people over 64. Men are 1.25 times more likely to have strokes than women; however, women are more likely to die of stroke because they are usually older when they have their first stroke.

Strokes in children are rare—about six cases per 100,000 children per year in North America. About a third of these cases are in newborns.

African Americans have an increased risk of stroke compared to other racial and ethnic groups in the United States and they are also more likely to suffer a stroke at younger ages. Hispanics are at lesser risk of stroke than African Americans but they also tend to have strokes at relatively young ages. African Americans between the ages of 45 and 55 die from stroke 4–5 times more often that Caucasians in the same age group.

Description

Stroke is usually a sudden occurrence. A stroke occurs when blood flow is interrupted to part of the brain. Without blood to supply oxygen and nutrients and to remove waste products, brain cells quickly begin to die. Depending on the region of the brain affected, a stroke may cause **paralysis**, speech impairment, loss of memory and reasoning ability, **coma**, or death. A stroke also is sometimes called a brain attack or a cerebrovascular accident (CVA).

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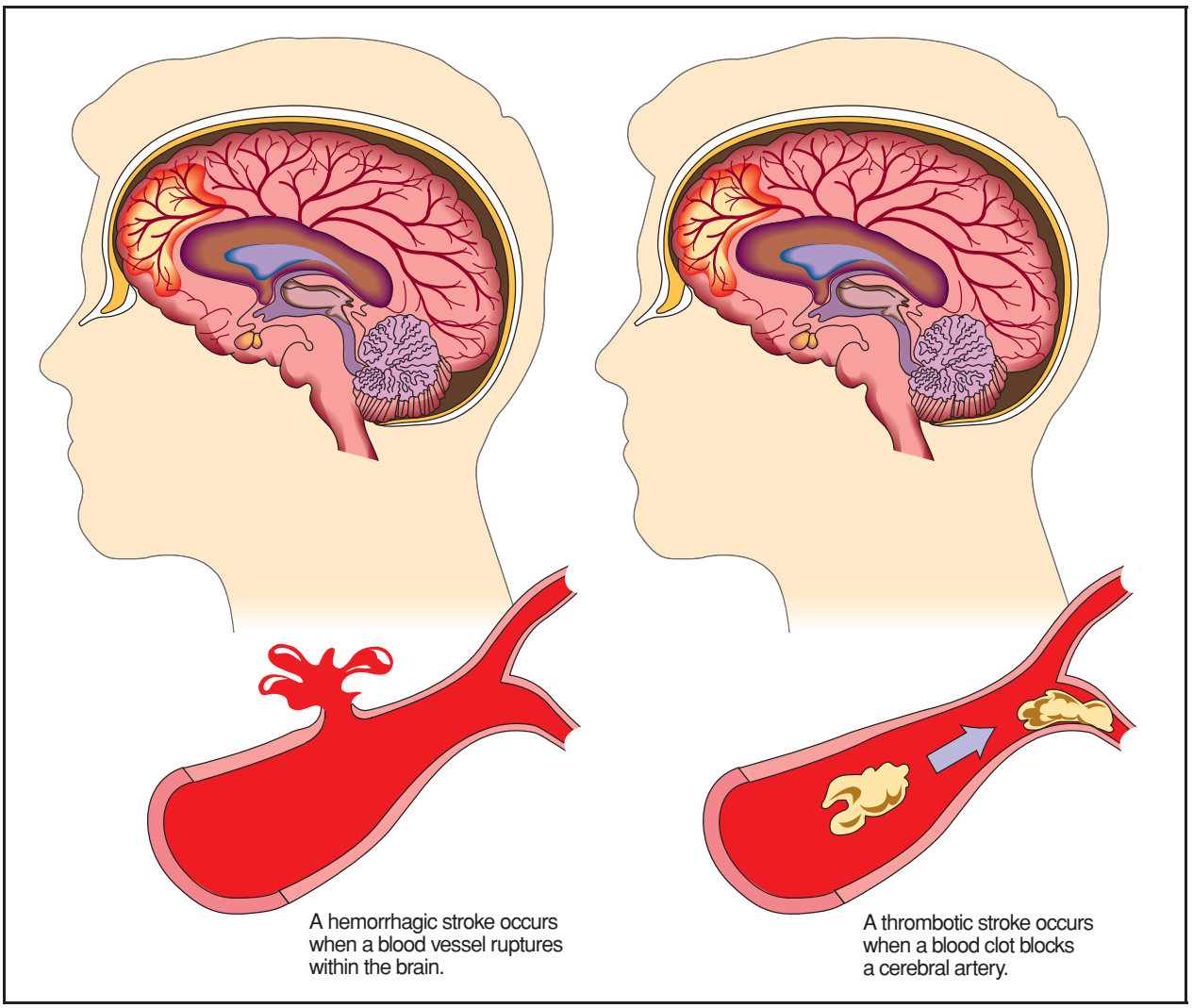

A hemorrhagic stroke (left) compared to a thrombotic stroke (right). *(Illustration by Hans & Cassady, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

Some people have a warning event called a transient ischemic attack (TIA) or mini-stroke. A TIA has the same symptoms as a full-blown stroke but goes away in a few minutes or hours, leaving no permanent effects. It is, however, an indication that the person is at risk of a major stroke and should see their doctor right away. A TIA offers the person an opportunity to take preventive action.

Stroke is a medical emergency requiring immediate treatment. Prompt treatment improves the chances of survival and increases the degree of recovery that may be expected. A person who may have suffered a stroke should be seen in a hospital emergency room without delay. Treatment to break up a blood clot, the major cause of stroke, must begin within three hours of the stroke to be effective. Improved medical treatment of all types of stroke has resulted in a dramatic decline in death rates in recent decades. In 1950, nine in ten stroke patients died, compared to slightly less than one in three in the twenty-first century. However, about two-thirds of stroke survivors will have disabilities ranging from moderate to severe.

Risk factors

Risk factors for stroke in adults include:

- Hypertension (high blood pressure). This is the most important single risk factor for stroke.
- High blood cholesterol levels.
- Age over 55.
- A family history of stroke, TIA, or heart attack.

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- Diabetes.
- Smoking. Smoking doubles a person's risk of ischemic stroke.
- Personal history of previous stroke or TIA.
- Obesity.
- Heavy use of cocaine.
- Irregular heart rhythm.
- Heavy drinking. Alcohol consumption raises a person's blood pressure.
- Use of birth control pills or hormone replacement therapy.

Risk factors for stroke in children include:

- Congenital (present at birth) malformations of blood vessels and other structures in the brain.
- Infections of the brain like encephalitis and meningitis.
- Head trauma.
- Blood disorders, particularly sickle cell disease.

Causes and symptoms

Causes

Stroke is caused by a loss of blood supply to the brain resulting either from a clot blocking an artery or from bleeding into or around the brain. Ischemic stroke can result from two types of clots. The first is an embolus, which is a free-floating clot produced in the heart or somewhere else in the body that travels to a blood vessel in the brain. The second type of clot is called a thrombus. It is formed within an artery in the head or neck and grows there until it is large enough to block the artery. **Atherosclerosis**, a disease of the blood vessels in which fatty deposits build up along the walls of the vessels, is a common cause of this type of clot.

ISCHEMIC STROKE. A cerebral **embolism** occurs when a blood clot from elsewhere in the circulatory system breaks free. If it becomes lodged in an artery supplying the brain, either in the brain or in the neck, it can cause a stroke. The most common cause of cerebral embolism is atrial fibrillation, a disorder of the heart beat. In atrial fibrillation, the upper chambers (atria) of the heart beat weakly and rapidly instead of slowly and steadily. Blood within the atria is not completely emptied. This stagnant blood may form clots within the atria, which can then break off and enter the circulation. Atrial fibrillation is a factor in about 15% of all strokes. The risk of a stroke from atrial fibrillation can be dramatically reduced with daily use of anticoagulant medication.

Cerebral thrombosis occurs when a blood clot, or thrombus, forms within the brain itself, blocking the flow of blood through the affected vessel. Clots most often form due to "hardening" (atherosclerosis) of brain arteries. Cerebral thrombosis occurs most often at night or early in the morning. Cerebral thrombosis is often preceded by a transient ischemic attack, or TIA, sometimes called a "mini-stroke." In a TIA, blood flow is temporarily interrupted, causing short-lived stroke-like symptoms. Recognizing the occurrence of a TIA, and seeking immediate treatment, is an important step in stroke prevention.

HEMORRHAGIC STROKE. Hemorrhagic stroke can occur when an aneurysm—a weak spot in the wall of an artery—suddenly bursts. High blood pressure is the most common cause of this type of hemorrhagic stroke. Hemorrhagic stroke can also occur when the walls of an artery become thin and brittle; they can then break and leak blood into the brain. Hemorrhagic stroke can take one of two forms: the blood can leak directly into brain tissue from an artery in the brain, or it can leak from an artery near the surface of the brain into the space between the skull and the membranes covering the brain.

The vessels most likely to break are those with preexisting defects such as an aneurysm. An aneurysm is a bulge or pouch in a blood vessel caused by weakening of the arterial wall. Brain aneurysms are surprisingly common; according to **autopsy** studies, about 6% of all Americans have them. Aneurysms rarely cause symptoms until they burst, however. Aneurysms are most likely to burst when blood pressure is highest, and controlling blood pressure is an important preventive strategy.

Intracerebral hemorrhage affects vessels within the brain itself, while **subarachnoid hemorrhage** affects arteries at the brain's surface, just below the protective arachnoid membrane. Intracerebral hemorrhages represent about 10% of all strokes, while subarachnoid hemorrhages account for about 7%.

In addition to depriving affected tissues of blood supply, the accumulation of fluid within the inflexible skull creates excess pressure on brain tissue, which can quickly lead to death. Nonetheless, recovery may be more complete for a person who survives hemorrhage than for one who survives a clot because the effects of blood deprivation usually are not as severe.

The death of brain cells triggers a chain reaction in which toxic chemicals created by cell death affect other nearby cells. This is one reason why prompt treatment can have such a dramatic effect on final recovery.

Symptoms

Stroke has five major signs or symptoms. The American Stroke Association has a quick symptom checklist called "Give Me 5" that can be used by a friend,

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KEY TERMS

Aneurysm—A pouchlike bulging of a blood vessel. Aneurysms can rupture, leading to stroke.

Atrial fibrillation—A disorder of the heart beat associated with a higher risk of stroke. In this disorder, the upper chambers (atria) of the heart do not completely empty when the heart beats, which can allow blood clots to form.

Cerebral embolism—A blockage of blood flow through a vessel in the brain by a blood clot that formed elsewhere in the body and traveled to the brain.

Cerebral thrombosis—A blockage of blood flow through a vessel in the brain by a blood clot that formed in the brain itself.

Comorbid—Referring to the presence of one or more diseases or disorders in addition to the patient's primary disorder.

Deficit—In medicine, the loss or impairment of a function or ability.

Dysphagia—The medical term for difficulty in swallowing.

Embolus—The medical term for a clot that forms in the heart and travels through the circulatory system to another part of the body.

Intracerebral hemorrhage—A cause of some strokes in which vessels within the brain begin bleeding.

Ischemia—Loss of blood supply to a tissue or organ resulting from the blockage of a blood vessel.

Platelets—Small irregularly shaped blood cells involved in the formation of blood clots.

Statins—A group of medications given to lower blood cholesterol levels that work by inhibiting an enzyme involved in cholesterol formation. Statins are also known as HMG-CoA reductase inhibitors.

Subarachnoid hemorrhage—A cause of some strokes in which arteries on the surface of the brain begin bleeding.

Thrombus—A blood clot that forms inside an intact blood vessel and remains there.

Tissue plasminogen activator (tPA)—A substance that is sometimes given to patients within three hours of a stroke to dissolve blood clots within the brain.

Transient ischemic attack (TIA)—A brief stroke lasting from a few minutes to 24 hours. TIAs are sometimes called mini-strokes.

relative, coworker, or caregiver as well as by a person who thinks they may be having a stroke:

- Walk: Is the person having trouble with balance or coordination?
- Talk: Is speech difficult or slurred? Is the person's face drooping?
- Reach: Is one side of the body weak or numb?
- See: Is vision partly or entirely lost?
- Feel: Does the person have a sudden severe headache with no obvious cause?

Other symptoms of stroke that some patients experience include drooling, uncontrollable eye movements, personality or mood changes, drowsiness, loss of memory, or loss of consciousness.

A person with stroke can have more than one of these symptoms at the same time. The important feature to keep in mind is that the symptoms of an embolic ischemic stroke come on suddenly, which helps in distinguishing stroke from other causes of **dizziness**, vision problems, or **headache**. The symptoms of a thrombotic stroke come on more gradually.

A child having a stroke may lose bladder control, have a seizure, or have **nausea and vomiting** as well as the symptoms associated with stroke in adults.

Diagnosis

The diagnosis of stroke includes taking the patient's history and obtaining an account of the patient's present symptoms. In younger patients, the doctor will ask about recent drug use, head trauma, use of **oral contraceptives**, or bleeding disorders. In middle-aged and older patients, the doctor will ask about such risk factors as **hypertension**, **diabetes mellitus**, tobacco use, high cholesterol, and a history of **coronary artery disease**, coronary artery bypass surgery, or atrial fibrillation.

An important part of the history-taking is finding out when the symptoms began and when the patient was last seen normal. Information from family, bystanders, or emergency personnel is often critical to prompt diagnosis and treatment, particularly when tissue plasminogen activator (tPA) therapy is an option. If the patient has awakened with the symptoms of stroke, then the

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time of onset is defined as the time the patient was last seen without symptoms.

Examination

The next step is a complete physical and neurological examination to rule out the possibility that the patient's symptoms are being caused by a **brain tumor**. The examination has several purposes: checking the patient's airway, breathing, and circulation; identifying any neurological deficits; identifying the potential cause(s) of the stroke; and identifying any comorbid conditions the patient may have. The neurologist may use the National Institutes of Health Stroke Scale (NIHSS), which is a checklist that allows the doctor to record the patient's level of consciousness; visual function; ability to move; ability to feel sensations; ability to move the facial muscles; and ability to talk.

Tests

Other tests used to diagnose stroke include:

- Blood tests. These can reveal the existence of blood disorders that increase a person's risk of stroke.
- Computed tomography (CT) scan. This type of imaging test is one of the first tests given to a patient suspected of having a stroke. It helps the doctor determine the cause of the stroke and the extent of brain injury.
- Magnetic resonance imaging (MRI). This imaging test is useful in pinpointing the location of small or deep brain injuries.
- Electroencephalogram (EEG). This test measures the brain's electrical activity.
- Blood flow tests. These are done to detect the location and size of any blockages in the blood vessels. One type of blood flow test uses ultrasound to produce an image of the arteries in the neck leading into the brain. Another type of blood flow test, called angiography, uses a special dye injected into blood vessels that will show up on an x ray.
- Echocardiography. This type of test uses ultrasound to produce an image of the heart. It can be useful in determining whether an embolus from the heart caused the patient's stroke.

Treatment

Traditional

Treatment of stroke depends on whether it is ischemic or hemorrhagic. Ischemic stroke is treated first with blood thinners, often **aspirin** or another drug known as warfarin. If the patient is seen by a specialized stroke team within 3 hours of the attack, he or she may be treated with a drug called tissue plasminogen activator or tPA, described more fully in the next section. It is critical, however, to be sure that the patient has an ischemic rather than a hemorrhagic stroke, as blood-thinning drugs can make a hemorrhagic stroke worse.

Ischemic stroke can also be treated by surgery. The two procedures most commonly used are **endarterectomy**, a procedure in which the surgeon removes the fatty deposits caused by atherosclerosis from the inside of one of the main arteries to the brain; and placing a tube made of metallic mesh called a stent inside the artery to prevent recurrent narrowing of the artery.

Hemorrhagic stroke is treated by removing pooled blood from the brain and repairing damaged blood vessels. To prevent another hemorrhagic stroke, the surgeon may use a procedure called aneurysm clipping. In this procedure, the surgeon clamps the weak spot in the artery away from the rest of the blood vessel, which reduces the chances that it will burst and bleed. Endovascular treatment may be used for aneurysms that are difficult to reach surgically. In this procedure, a catheter is guided from a larger artery up into the brain to reach the aneurysm. Small coils of wire are discharged into the aneurysm, which plug it and block off blood flow from the main artery.

Drugs

Emergency treatment of stroke from a blood clot is aimed at dissolving the clot. This "thrombolytic therapy" currently is performed most often with tissue plasminogen activator, or tPA. tPA must be administered within three hours of the stroke event. Therefore, patients who awaken with stroke symptoms are ineligible for tPA therapy, as the time of onset cannot be accurately determined. tPA therapy has been shown to improve recovery and decrease long-term disability in selected patients. tPA therapy carries a 6.4% risk of inducing a cerebral hemorrhage, however, and is not appropriate for patients with bleeding disorders, very high blood pressure, known aneurysms, any evidence of intracranial hemorrhage, or incidence of stroke, head trauma, or intracranial surgery within the past three months. Patients with clot-related (thrombotic or embolic) stroke who are ineligible for tPA treatment may be treated with heparin or other blood thinners, or with aspirin or other anti-clotting agents in some cases.

Emergency treatment of hemorrhagic stroke is aimed at controlling intracranial pressure. Intravenous

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urea or mannitol plus hyperventilation is the most common treatment. **Corticosteroids** also may be used. Patients with reversible bleeding disorders, such as those due to anticoagulant treatment, should have these bleeding disorders reversed, if possible.

Rehabilitation

Rehabilitation refers to a comprehensive program designed to regain function as much as possible and compensate for permanent losses. Approximately 10% of stroke survivors recover without any significant disability and able to function independently. Another 10% are so severely affected that they must remain institutionalized for severe disability. The remaining 80% can return home with appropriate therapy, training, support, and care services.

Rehabilitation is coordinated by a team of medical professionals and may include the services of a neurologist, a physician who specializes in rehabilitation medicine (physiatrist), a physical therapist, an occupational therapist, a speech-language pathologist, a nutritionist, a mental health professional, and a social worker. Rehabilitation services may be provided in an acute care hospital, rehabilitation hospital, long-term care facility, outpatient clinic, or at home.

The rehabilitation program is based on the patient's individual deficits and strengths. Strokes on the left side of the brain primarily affect the right half of the body, and vice versa. In addition, in left brain dominant people, who constitute a significant majority of the population left brain strokes usually lead to speech and language deficits, while right brain strokes may affect spatial perception. Patients with right brain strokes also may deny their illness, neglect the affected side of their body, and behave impulsively.

Rehabilitation may be complicated by cognitive losses, including diminished ability to understand and follow directions. Poor results are more likely in patients with significant or prolonged cognitive changes, sensory losses, language deficits, or incontinence.

PREVENTION OF COMPLICATIONS. Rehabilitation begins with prevention of stroke recurrence and other medical complications. The risk of stroke recurrence may be reduced with many of the same measures used to prevent stroke, including quitting **smoking** and controlling blood pressure.

One of the most common medical complications following stroke is deep venous thrombosis, in which a clot forms within a limb immobilized by paralysis. Clots that break free often become lodged in an artery feeding the lungs. This type of **pulmonary embolism** is a common cause of death in the weeks following a stroke. Resuming activity within a day or two after the stroke is an important preventive measure, along with use of elastic stockings on the lower limbs. Drugs that prevent clotting may be given, including intravenous heparin and oral warfarin.

Weakness and loss of coordination of the swallowing muscles may impair swallowing (dysphagia) and allow food to enter the lower airway. This may lead to aspiration **pneumonia**, another common cause of death shortly after a stroke. Dysphagia may be treated with retraining exercises and temporary use of pureed foods.

Depression occurs in 30–60% of stroke patients. Antidepressants and **psychotherapy** may be used in combination. Other medical complications include urinary tract infections, pressure ulcers, falls, and seizures.

TYPES OF REHABILITATIVE THERAPY. Brain tissue that dies in a stroke cannot regenerate. In some cases, the functions of that tissue may be performed by other brain regions after a training period. In other cases, compensatory actions may be developed to replace lost abilities.

Physical therapy is used to maintain and restore range of motion and strength in affected limbs, and to maximize mobility in walking, wheelchair use, and transferring (from wheelchair to toilet or from standing to sitting, for instance). The physical therapist advises on mobility aids such as wheelchairs, braces, and canes. In the recovery period, a stroke patient may develop muscle spasticity and **contractures**, or abnormal contractions. Contractures may be treated with a combination of stretching and splinting.

Occupational therapy improves such self-care skills as feeding, bathing, and dressing, and helps develop effective compensatory strategies and devices for activities of daily living. A speech-language pathologist focuses on communication and swallowing skills. When dysphagia is a problem, a nutritionist can advise alternative meals that provide adequate **nutrition**.

Mental health professionals may be involved in the treatment of depression or loss of thinking (cognitive) skills. A social worker may help coordinate services and ease the transition out of the hospital back into the home. Both social workers and mental health professionals may help counsel the patient and family during the difficult rehabilitation period. Caring for a person affected with stroke requires learning a new set of skills and adapting to new demands and limitations. Home caregivers may develop **stress**, **anxiety**, and depression. Caring for the caregiver is an important part of the overall stroke treatment program.

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Support groups can provide an important source of information, advice, and comfort for stroke patients and for caregivers. Joining a support group can be one of the most important steps in the rehabilitation process.

First aid

It is useful for friends, coworkers, or bystanders to know the basics of **first aid** for stroke victims. If someone appears to be having a stroke, the most important first step is to call for emergency help *at once*. Stroke is a medical emergency; the sooner the person is evaluated and treated, the better their chances of recovery. The drug presently considered most useful in treating stroke must be given within 3–4 hours of the attack to be effective.

Additional measures that can be taken to help the affected person while waiting for the emergency response team:

- If the person stops breathing, give them mouth-to-mouth resuscitation.
- If they are vomiting, tilt their head to one side to prevent them from swallowing the material.
- Do *not* give them anything to eat or drink.

Prognosis

The prognosis of stroke depends on the person's age, the type and location of the stroke, and the amount of time elapsed between diagnosis and treatment. In general, patients with ischemic stroke have a better prognosis than those with hemorrhagic stroke. In one study in the Boston area, 19% of patients with ischemic stroke died within the first 30 days of the attack compared to 35% with hemorrhagic stroke.

Stroke is fatal for about 27% of white males, 52% of black males, 23% of white females, and 40% of black females. Stroke survivors may be left with significant deficits. Emergency treatment and comprehensive rehabilitation can significantly improve both survival and recovery. One recent study found that treating stroke survivors with certain antidepressant medications, even if they were not depressed, could increase their chances of living longer. People who received the treatment were less likely to die from cardiovascular events than those who did not receive **antidepressant drugs**.

About 10% of stroke patients recover enough function to live independently without help; another 50% can remain at home with outside assistance. The remaining 40% require long-term care in a nursing home.

Stroke in children can be devastating. Between 20% and 35% of newborns who survive a stroke will go on to have a second stroke. More than 66% of older children who suffer strokes will have cognitive deficits, seizures, behavioral problems, changes in personality, or physical disabilities. Unlike adult survivors, children who survive strokes may develop **mental retardation**, **epilepsy**, or **cerebral palsy**.

Prevention

Many strokes are preventable with proper self-care. People cannot change some risk factors for stroke, such as race, age, sex, or family history, but they can control several other risk factors:

- They can quit smoking, drinking heavily, or using cocaine.
- They can keep their weight at a healthy level.
- They can exercise regularly, eat a healthy diet, and take medications for high blood pressure if they are diagnosed with it.
- They can take steps to lower their risk of diabetes or high blood cholesterol levels.
- They can lower the level of emotional stress in their life or learn to manage stress more effectively.
- They can get regular checkups for abnormal heart rhythms if they have been diagnosed with such problems.
- They can see their doctor at once if they have a TIA.

People with no previous history of stroke may be given certain drugs as preventive measures. These drugs include statins (drugs that lower blood cholesterol levels) and platelet antiaggregants (medications intended to prevent platelets in the blood from forming clumps that may lead to clots).

Damage from stroke may be significantly reduced through emergency treatment. Knowing the symptoms of stroke is as important as knowing those of a **heart attack**. Patients with stroke symptoms should seek emergency treatment without delay, which may mean dialing 911 rather than their family physician.

Treatment of atrial fibrillation may significantly reduce the risk of stroke. Preventive anticoagulant therapy may benefit those with untreated atrial fibrillation. Warfarin (Coumadin) has proven to be more effective than aspirin for patients at higher risk of stroke. Warfarin is, however, complicated to use because it interacts with a large number of other drugs and requires frequent monitoring by the patient's physician. A new drug called ximelagatran (Exanta) with fewer side effects was introduced in Europe but rejected by the U.S. Food and Drug Administration in 2004 because of

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indications of liver damage in 5–6% of subjects in clinical trials. The drug was withdrawn from the European market in 2006.

A recent innovation is the use of computer technology to allow stroke experts in one hospital to evaluate and diagnose a patient in another hospital that might not have a specialist available. Called TeleStroke, the network allows a patient to be evaluated for ischemic stroke within the three-hour time limit for the effective use of tPA. More recently, stroke specialists have proposed an updated version of TeleStroke called TeleStroke 2.0, which would be a Web-based system that could be accessed from any desktop or laptop computer, not just those connected to videoconferencing equipment.

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ORGANIZATIONS

American Academy of Neurology (AAN), 1080 Montreal Avenue, Saint Paul, MN, 55116, (651)-695-2717, (800) 879-1960, (651) 695-2791, http://www.aan.com/.

American Stroke Association (ASA), 7272 Greenville Avenue, Dallas, TX, 75231, (888) 4-STROKE, (214) 706-5231, strokeassociation@heart.org, http://www. strokeassociation.org/presenter.jhtml?identifier=1200037.

Brain Aneurysm Foundation (BAF), 269 Hanover Street, Building 3, Hanover, MA, 02339, (781) 826-5556, (888) 272-4602, office@bafound.org, http://www.bafound.org/.

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National Heart, Lung, and Blood Institute (NHLBI), Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301)-592-8573, (240)-629-3246, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi.nih.gov/.

National Institute of Neurological Disorders and Stroke (NINDS), P.O. Box 5801, Bethesda, MD, 20824, (800)-352-9424, (301)-496-5751, http://www.ninds.nih.gov/index.htm.

National Stroke Association (NSA), 9707 E. Easter Lane, Centennial, CO, 80112, (800)-STROKES, (303)-649-1328, info@stroke.org, http://www.stroke.org/site/PageNavigator/HOME.

Richard Robinson
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Strongyloidiasis *see* **Threadworm infection**
Structural integration *see* **Rolfing**
Stupor *see* **Coma**

Stuttering

Definition

There is no standard definition of stuttering (sometimes called stammering) but most attempt to define stuttering as blockages, discoordination, or fragmentations of the forward flow of speech (fluency). These stoppages, referred to as disfluencies, are often excessive and characterized by specific types of disfluency. These types of disfluencies include repetitions of sounds and syllables, prolongation of sounds, and blockages of airflow. Individuals who stutter are often aware of their stuttering and feel a loss of control when they are disfluent. Both children and adult stutterers expend an excessive amount of physical and mental energy when speaking. Older children and adults who stutter show myriad negative reactive behaviors, feelings, and attitudes. These behaviors, referred to as secondary behaviors, make the disorder more severe and difficult.

Demographics

Stuttering is a relatively low-prevalence disorder. According to the National Institute on Deafness and Other Communication Disorders (NIDCD), about 3 million people in the United States stutter as of 2010. Across all cultures, roughly 1% of people currently has a stuttering disorder. This figure differs from incidence, or number of individuals who have been diagnosed with stuttering at some point in their lives. Research suggests that roughly 5% of the population has been diagnosed with a stuttering disorder at some point across the life span. This difference suggests that a significant number of individuals who stutter develop through or outgrow the problem.

Stuttering is most common in children between the ages of two and five, the period when they are learning to speak. The majority of these children will eventually stop stuttering. In adults, approximately three times as many men stutter as women. The sex ratio seems to be lower in early childhood, with a similar number of girls and boys stuttering. The ratio of boys to girls appears to get larger as children become older. This phenomenon suggests that males are more likely to continue to stutter than females.

Description

Stuttering is a confusing and often misunderstood developmental speech and language disorder. Before discussing stuttering, it is important to understand the concepts of speech fluency and disfluency. Fluency is generally described as the forward flow of speech. For most speakers, fluent speech is easy and effortless. Fluent speech is free of any interruptions, blockages, or fragmentations. Disfluency is defined as a breakdown or blockage in the forward flow of speech, or fluency. For all speakers, some occurrence of disfluency is normal. For example, people may insert short sounds or words, referred to as interjections or fillers when speaking; examples of such are “um,” “like,” or “uh.” Also, speakers might repeat phrases, revise words or phrases, or sometimes repeat whole words for the purpose of clarification. For young children, disfluency is a part of the normal development of speech and language, especially during the preschool years (between the ages of two and five years).

The occurrence of disfluency is not the same as stuttering, though stuttered speech is characterized by an excessive amount of disfluency. The disfluencies produced by people who stutter will often be similar to those in the speech of individuals who do not stutter; however, certain types of disfluent behavior are likely to appear only in the speech of people who stutter. These disfluencies are sound and syllable repetitions (i.e. ca-ca-ca-cat), sound prolongations (“sssss–salad,” “ffffff-fish”), and complete blockages of airflow. These behaviors, often referred to as stuttering type disfluencies, distinguish stuttered speech from nonstuttered speech.

Unlike speakers who do not stutter, most people who stutter react negatively to their disfluencies. A person may develop a number of physical reactions, including tension of the muscles involved in speech (tongue, jaw, lips, or chest, for example) and tension

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in muscles not related to speech (such as shoulders, limbs, and forehead). In addition to these physiological reactions, people who stutter often have negative emotional reactions to the disorder. Among the emotions that people who stutter report are embarrassment, guilt, and frustration.

Finally, many people who stutter develop a number of negative attitudes and beliefs regarding themselves and speaking—because of their stuttering. These may be negative attitudes and beliefs in certain speaking situations, with people with whom they interact, and in their own abilities. These physiological, emotional, and attitudinal (cognitive) reactions to stuttering, described as secondary stuttering behaviors, are often very disruptive to the communication process and the person's life.

Stuttering behaviors can develop and vary throughout the life span. Sometimes, children will experience periods when stuttering appears to go away for a time, only to return in a more severe pattern. Many children, (estimates range between 50 and 80%) will develop normal fluency after periods of stuttering. For those who continue to stutter during late childhood, adolescence, and into adulthood, stuttering can become a chronic problem. Lifelong efforts will be needed to cope successfully with the behavior.

Due to the effect that stuttering has on communication, the person who stutters may experience certain difficulties in various parts of his or her life. These problems might be secondary to factors inside the person (symptoms of stuttering) and outside the person (society's attitudes toward stuttering and other barriers). For example, many people who stutter report difficulties in social settings. Children who stutter often experience teasing and other social penalties. Adolescents and adults also report a variety of social problems. Academic settings may be difficult for children who stutter because of the emphasis most schools place on verbal performance in the classroom.

There is some evidence that people who stutter confront barriers in employment, at least for jobs that require interacting with the public. These barriers may take the form of inability to do certain tasks easily (talking on the phone, for example), limitations in job choices, and discrimination in the hiring and promotion processes.

Risk factors

According to the Stuttering Foundation of America (SFA), the following are known risk factors for stuttering:

- Family history of stuttering.
- Sex. Boys are at greater risk of stuttering than girls.
- Age when stuttering begins. Children who begin to stutter before age three are more likely to outgrow it than those who begin to stutter later.
- Time elapsed since onset of stuttering. Children who have been stuttering longer than six months are less likely to outgrow the condition.

As far as is known as of 2010, race, ethnicity, or native language are not risk factors for stuttering. The rate of stuttering and sex ratio are thought to be similar throughout the world, although some researchers think that rates of stuttering are higher in Africa than elsewhere. What does seem to vary most widely from country to country is cultural attitudes toward stuttering.

Causes and symptoms

Although research has not identified a single cause of stuttering as of 2010, there appear to be several factors that are viewed as being important to the onset and development of stuttering. Therefore, stuttering is often described as multifactorial and having possibly multiple causes. First, there is a genetic predisposition to stutter, as evidenced by studies of families and twins. In 2010, researchers at NIDCD identified three specific genes—one on chromosome 12 and two on chromosome 16—that are linked to stuttering. The genes are known as GNPTAB, GNPTG, and NAGPA.

A second important factor in stuttering the onset of stuttering is the physiological makeup of people who stutter. Research suggests that the brains of people who stutter may function abnormally during speech production. These differences in functioning may lead to breakdowns in speech production and to the development of disfluent speech.

Third, there is some evidence that speech and language development is an important issue in understanding the development of stuttering. Studies have found some evidence that children show stuttering type behaviors may also have other difficulties with speech-language. Additionally, children with speech-language delays often show stuttering-type behaviors. Finally, environmental issues have a significant impact on the development of stuttering behaviors. An environment that is overly stressful or demanding may cause children to have difficulties developing fluent speech. Although the environment, in particular parental behaviors, does not cause stuttering, it is an important factor that might adversely affect a child who is operating at a reduced capacity for developing fluent speech.

There is no evidence that stuttering is secondary to a psychological disturbance. It is reasonable to assume

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that stuttering might have some effect on psychological adjustment and a person's ability to cope with speaking situations. People who stutter might experience a lower self-esteem, and some might report feeling depressed. These feelings and difficulties with coping are most likely the result and not the cause of stuttering. In addition, several research studies have reported that many people who stutter report high levels of **anxiety** and **stress** when they are talking and stuttering. These feelings, psychological states, and difficulties with coping are most likely the result and not the cause of stuttering.

Generally, children begin to stutter between the ages of two and five years. This type of stuttering is categorized as developmental stuttering. Another major category of stuttering is called neurogenic. Neurogenic stuttering results from brain damage, such as a **stroke**, a traumatic injury to the brain, or a degenerative neurological disease. In other cases, stuttering may be secondary to a psychological conversion disorder due to a psychologically traumatic event. When stuttering has abrupt onset secondary to a psychological trauma, it is described as psychogenic stuttering. As of 2010, psychogenic stuttering is considered the least common type.

As stated earlier, the primary symptoms of stuttering include excessive disfluency, both stuttering and normal types (core behaviors), as well as physical, emotional, and cognitive reactions to the problem. These behaviors vary in severity across people who stutter from very mild to very severe. Additionally, behaviors will vary considerably across different speaking situations. There are specific situations when people tend to experience more stuttering (such as talking on the phone or with an authority figure) or less stuttering (speaking with a pet or to themselves, for example). It is likely that this variability might even extend to people having periods (days and even weeks) when they can maintain normally fluent or nonstuttered speech.

Other symptoms that may be associated with stuttering in children include eye blinking, tremor in the lips or jaw, and tension or movement of the face or upper body.

Diagnosis

Examination

Speech-language pathologists (SLPs) are responsible for making the diagnosis and managing the treatment of adults and children who stutter. Preferably, a board-certified speech-language pathologist should be sought for direct intervention or consulting. Diagnosis of stuttering, or identifying children at risk for stuttering, is difficult because most children show excessive disfluencies in their speech. With children, diagnostic procedures include the collection and analysis of speech and disfluent behaviors in a variety of situations. In addition, the child's general speech-language abilities will be evaluated.

Finally, the speech-language pathologist will interview parents and teachers regarding the child's general developmental, speech-language development, and their perceptions of the child's stuttering behaviors. For adults and older children, diagnostic procedures will also include gathering and analyzing speech samples from a variety of settings. In addition, the speech-language pathologist will conduct a lengthy interview with the person about their stuttering and history of their stuttering problem. Finally, the person who stutters might be asked to report his or her attitudes and feelings related to stuttering, either while being interviewed or by completing a series of questionnaires.

Tests

In some cases, the child may be referred to an otolaryngologist (specialist in ear, nose, and throat disorders) or a neurologist to rule out the possibility that abnormalities in the structure of the child's tongue or mouth, or a brain disorder, are related to the stuttering.

Treatment

Traditional

GENERAL CONSIDERATIONS. Experts generally accept the view that conducting interventions with children and families early in childhood (preschool) is the most effective means of total recovery from stuttering. The chances for a person to recover fully from stuttering by obtaining near-normal fluency are

KEY TERMS

Developmental—Referring to a speech problem or other disorder that arises during a specific stage in human development.

Disfluency—Any difficulty in fluent speech, including stuttering.

Neurogenic—Referring to a disorder associated with damage to the central nervous system.

Psychogenic—Referring to a disorder associated with mental or emotional conflict. At one time most stuttering was considered psychogenic, but recent research indicates that psychogenic stuttering is the least common form.

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reduced as the person ages. This is the reason that early intervention is critical. For older children and adults for which stuttering has become a chronic disorder, the focus of therapy is on developing positive coping mechanisms for dealing with the problem. This therapy varies in success based on the individual.

TREATMENT OPTIONS FOR YOUNG CHILDREN. Treatment of young children generally follows one of two basic approaches. These approaches may also be combined into a single treatment program. The first type of approach, often referred to as indirect therapy, focuses on altering the environment to allow the child opportunities to develop fluent speech. With this approach, counseling parents regarding the alteration of behaviors that affect fluency is the focus. For example, parents may be taught to reduce the amount of household stress or in the level of speech-language demands being placed on the child. In addition, parents may be advised to change characteristics of their speech, such as their speech rate and turn-taking style; this is done to help their children develop more fluent speech.

The other basic approach in treatment with young children targets the development of fluent speech. This type of approach, often referred to as direct therapy, teaches children to use skills that will help them improve fluency, and they are sometimes given verbal rewards for producing fluent speech.

TREATMENT OPTIONS FOR OLDER CHILDREN AND ADULTS. Treatment approaches for older children and adults usually take one of two forms. These approaches target either helping the person to modify his or her stuttering or fluency. Approaches that focus on modifying stuttering usually teach individuals to reduce the severity of their stuttering behaviors by identifying and eliminating all of the secondary or reactive behaviors. Individuals also work to reduce the amount of emotional reaction toward stuttering.

Finally, the speech-language pathologist will help the individual to learn techniques that allow them to stutter in an easier manner. Therapy does not focus on helping the individual to speak fluently, although most individuals will attain higher levels of fluency if this approach is successful. The other groups of approaches focus on assisting adults and children who stutter to speak more fluently. This type of therapy, which focuses less on changing secondary and emotional reactions, helps the person to modify their speech movements in a specific manner that allows for fluent sounding speech. These procedures require the individual to focus on developing new speech patterns. This often requires a significant amount of practice and skill. The successful outcome of these approaches is nonstuttered, fluent sounding speech. Many therapists integrate stuttering modification and fluency shaping approaches into more complete treatment programs. In addition, psychological counseling may be used to supplement traditional **speech therapy**.

Drugs

There is no drug that has been approved by the Food and Drug Administration (FDA) just for the treatment of stuttering. Although various medications used to treat **epilepsy**, depression, and **anxiety disorders** have been tried as therapy for stuttering, all of these agents have problematic side effects, and none has been particularly successful in treating stuttering. There are, however, isolated case studies of successful treatment of neurogenic stuttering using **antipsychotic drugs**. As of 2010, NIDCD does not recommend the use of drugs to treat stuttering.

Another method of therapy for stuttering is the use of electronic devices to improve fluency. One type of device fits into the ear like a hearing aid and digitally replays the child's voice so that it sounds as if the child is speaking in unison with someone else. Another type of device, called delayed auditory feedback, forces the child to speak more slowly so that his or her voice will not sound distorted through the machine. NIDCD researchers maintain that the evidence about the success of these devices is mixed as of 2010: "Questions remain about how long such effects may last and whether people are able to easily use these devices in real-world situations."

Prognosis

The prognosis for developmental stuttering is generally good. About 65% of preschool children who stutter outgrow the condition and 74% recover by their early teens. In general, girls have a better prognosis than boys.

According to the American Speech-Language-Hearing Association (ASHA), no single factor can be used to estimate a given child's prognosis for full recovery from stuttering. Complete recovery from severe stuttering is most likely when children and their families receive treatment close to the time of onset. Thus, early identification and treatment of stuttering is critical. For older children and adults, stuttering becomes a chronic problem that requires a lifetime of formal and self–directed therapy. For individuals who show this more chronic form of the disorder, internal motivation for change and support from significant others is going to be an important part of recovery.

Friends, an association for young people who stutter, was founded in 1997 by John Ahlbach, an adult

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who stutters, and Lee Caggiano, a speech-language therapist who specializes in stuttering and is the mother of a son who stutters. Friends offers online support to young people who stutter, their parents, and speech-language professionals who work with them. The group also publishes books and a bi-monthly newsletter as well as holding an annual convention.

Prevention

With the exception of the small number of cases in which stuttering is caused by a traumatic brain injury, the condition is not preventable as of 2010.

Resources

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National Institute on Deafness and Other Communication Disorders (NIDCD). "Stuttering." (Accessed September 23, 2010) http://www.nidcd. nih.gov/health/voice/stutter.html.

ORGANIZATIONS

American Academy of Otolaryngology—Head and Neck Surgery, 1650 Diagonal Rd., Alexandria, VA, 22314-2857, (703) 836-4444, http://www.entnet.org/.

American Speech–Language–Hearing Association (ASHA), 2200 Research Blvd., Rockville, MD, 20850-3289, (301) 296-5700, http://www.asha.org/default.htm.

Friends: The National Association of Young People Who Stutter, [c/o Lee Caggiano] 38 South Oyster Bay Rd., Syosset, NY, 11791, (866) 866-8335, LCAGGIANO@aol.com, http://www.friendswhostutter.org/.

International Stuttering Association (ISA), [c/o Joseph Lukong Tardzenyuy, Secretary] PO Box 9598, Douala, Cameroon, admin@stutterisa.org, http://www.stutterisa.org/index.html.

National Institute on Deafness and Other Communication Disorders (NIDCD), 31 Center Dr., MSC 2320, Bethesda, MD, 20892-2320, (800) 241-1044, (301) 770–8977, nidcdinfo@nidcd.nih.gov, http://www.nidcd.nih.gov/index.asp.

Stuttering Foundation of America (SFA), 3100 Walnut Grove Rd., Suite 603, Memphis, TN, 38111-0749, (901) 452-7343, (800) 992-9392, (901) 452-3931, info@stutteringhelp.org, http://www.stutteringhelp.org/Default.aspx?tabid = 4.

Rodney Gabel, PhD
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Stye *see* **Eyelid disorders**

Subacute sclerosing panencephalitis

Definition

Subacute sclerosing panencephalitis is a rare, progressive brain disorder caused by an abnormal immune response to the **measles** virus.

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KEY TERMS

Measles encephalitis—A serious complication of measles occurring in about one out of every 1,000 cases, causing headache, drowsiness, and vomiting seven to ten days after the rash appears. Seizures and coma can follow, which may lead to retardation and death.

Description

This fatal condition is a complication of measles, and affects children and young adults before the age of 20. It usually occurs in boys more often than in girls but is extremely rare, appearing in only one out of a million cases of measles.

Causes and symptoms

Experts believe this condition is a form of measles **encephalitis** (swelling of the brain), caused by an improper response by the immune system to the measles virus.

The condition begins with behavioral changes, **memory loss**, irritability, and problems with school work. As the neurological damage increases, the child experiences seizures, involuntary movements, and further neurological deterioration. Eventually, the child starts suffering from progressive **dementia**. The optic nerve begins to shrink and weaken (atrophy) and subsequently the child becomes blind.

Diagnosis

Blood tests and spinal fluid reveal high levels of antibodies to measles virus, and there is a characteristically abnormal electroencephalogram (EEG), or brain wave test. Typically, there is a history of measles infection two to ten years before symptoms begin.

Treatment

There is no standard treatment and a number of **antiviral drugs** have been tested with little success. Treatment of symptoms, including the use of **anticonvulsant drugs**, can be helpful.

Prognosis

While there may be periodic remissions during the course of this disease, it is usually fatal (often from **pneumonia**) within one to three years after onset.

ORGANIZATIONS

National Institute of Allergies and Infectious Diseases, 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-6612, (301) 496-5717, (301) 402-3573, (866) 284-4107, ocpostoffice@niaid.nih.gov, http://www.niaid.nih.gov.

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923, (800) 999-6673, http://www.rarediseases.org.

Carol A. Turkington

Subacute spongiform encephalopathy *see* **Creutzfeldt-Jakob disease**

Subacute thyroiditis *see* **Thyroiditis**

Subarachnoid hemorrhage

Definition

A subarachnoid hemorrhage is an abnormal and very dangerous condition in which blood collects beneath the arachnoid mater, a membrane that covers the brain. This area, called the subarachnoid space, normally contains cerebrospinal fluid. The accumulation of blood in the subarachnoid space can lead to **stroke**, seizures, and other complications. Additionally, subarachnoid hemorrhages may cause permanent brain damage and a number of harmful biochemical events in the brain. A subarachnoid hemorrhage and the related problems are frequently fatal.

Description

Subarachnoid hemorrhages are classified into two general categories: traumatic and spontaneous. Traumatic refers to brain injury that might be sustained in an accident or a fall. Spontaneous subarachnoid hemorrhages occur with little or no warning and are frequently caused by ruptured aneurysms or blood vessel abnormalities in the brain.

Traumatic brain injury is a critical problem in the United States. According to annual figures compiled by the Brain Injury Association, approximately 373,000 people are hospitalized, more than 56,000 people die, and 99,000 survive with permanent disabilities due to traumatic brain injuries. The leading causes of injury are bicycle, motorcycle, and automobile accidents, with a significant minority due to accidental falls, and sports and recreation mishaps.

Exact statistics are not available on traumatic subarachnoid hemorrhages, but several large clinical studies have found an incidence of 23–39% in relation to

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severe **head injury**. Furthermore, subarachnoid hemorrhages have been described in the medical literature as the most common brain injury found during **autopsy** investigations of head trauma.

Spontaneous subarachnoid hemorrhages are often due to an aneurysm (a bulge or sac-like projection from a blood vessel) which bursts. **Arteriovenous malformations** (AVMs), which are abnormal interfaces between arteries and veins, may also rupture and release blood into the subarachnoid space. Both aneurysms and AVMs are associated with weak spots in the walls of blood vessels and account for approximately 60% of all spontaneous subarachnoid hemorrhages. The rest may be attributed to other causes, such as **cancer** or infection, or are of unknown origin.

In industrialized countries, it is estimated that there are 6.5–26.4 cases of spontaneous subarachnoid hemorrhage per 100,000 people annually. Certain factors raise the risk of suffering a hemorrhage. Aneurysms are acquired over a person's lifetime and are rarely a factor in subarachnoid hemorrhage before age 20. Conversely, AVMs are present at birth. In some cases, there may be a genetic predisposition for aneurysms or AVMs. Other factors that have been implicated, but not definitively linked to spontaneous subarachnoid hemorrhages, include **atherosclerosis**, cigarette use, extreme alcohol consumption, and the use of illegal drugs, such as **cocaine**. The exact role of high blood pressure is somewhat unclear, but since it does seem linked to the formation of aneurysms, it may be considered an indirect risk factor.

The immediate danger due to subarachnoid hemorrhage, whether traumatic or spontaneous, is **ischemia**. Ischemia refers to tissue damage caused by restricted or blocked blood flow. The areas of the brain that do not receive adequate blood and oxygen can suffer irreparable injury, leading to permanent brain damage or **death**. An individual who survives the initial hemorrhage is susceptible to a number of complications in the following hours, days, and weeks.

The most common complications are intracranial **hypertension**, vasospasm, and **hydrocephalus**. Intracranial hypertension, or high pressure within the brain, can lead to further bleeding from damaged blood vessels; a complication associated with a 70% fatality rate. Vasospasm, or blood vessel constriction, is a principal cause of secondary ischemia. The blood vessels in the brain constrict in reaction to chemicals released by blood breaking down within the subarachnoid space. As the blood vessels become narrower, blood flow in the brain becomes increasingly restricted. Approximately one third of spontaneous subarachnoid hemorrhages and 30–60% of traumatic bleeds are followed by vasospasm. Hydrocephalus, an accumulation of fluid in the chambers of the brain (ventricles) due to restricted circulation of cerebrospinal fluid, follows approximately 15% of subarachnoid hemorrhages. Because cerebrospinal fluid cannot drain properly, pressure accumulates on the brain, possibly prompting further ischemic complications.

Causes and symptoms

Whether through trauma or disease, subarachnoid hemorrhages are caused by blood being released by a damaged blood vessel and accumulating in the subarachnoid space. Symptoms associated with traumatic subarachnoid hemorrhage may or may not resemble those associated with spontaneous hemorrhage, as trauma can involve multiple injuries with overlapping symptoms.

Typically, a spontaneous subarachnoid hemorrhage is indicated by a sudden, severe **headache**. **Nausea**, **vomiting**, and **dizziness** frequently accompany the **pain**. Loss of consciousness occurs in about half the cases of spontaneous hemorrhage. A **coma**, usually brief, may occur. A stiff neck, **fever**, and aversion to light may appear following the hemorrhage. Neurologic symptoms may include partial **paralysis**, loss of vision, seizures, and speech difficulties.

Spontaneous subarachnoid hemorrhages may be preceded by warning signs prior to the initial bleed. Sentinel, or warning, headaches may be present in the days or weeks before an aneurysm or AVM ruptures. These headaches can be accompanied by dizziness, nausea, and **vomiting**, and possibly neurologic symptoms. Approximately 50% of AVMs are discovered before they bleed significantly; however, most aneurysms are not diagnosed before they rupture.

Diagnosis

To make a diagnosis, a health-care provider takes a detailed history of the symptoms and does a **physical examination**. The symptoms may mimic other disorders and diagnosis can be complicated, especially if the individual is unconscious. The sudden, severe headache can fuel suspicion of a subarachnoid hemorrhage or similar event, and a computed tomography scan (CT scan) or **magnetic resonance imaging** (MRI) scan is considered essential to a quick diagnosis. The MRI is less sensitive than the CT in detecting acute subarachnoid bleeding, but more sensitive in diagnosing AVM or aneurysm.

A CT scan reveals blood that has escaped into the subarachnoid space. For the best results, the scan should be done within 12 hours of the hemorrhage. If

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KEY TERMS

Aneurysm—A weak point in a blood vessel where the pressure of the blood causes the vessel wall to bulge outwards. An aneurysm may also appear as a sac-like projection from the blood vessel wall.

Arachnoid mater—One of three membranes that encase the brain and spinal cord. The arachnoid mater is the middle membrane.

Arteriovenous malformation—An abnormal tangle of arteries and veins in which the arteries feed directly into the veins without a normal intervening capillary bed.

Atherosclerosis—An abnormal condition in which lipids, or fats, form deposits on the inside walls of blood vessels.

Cerebral angiography—A medical test in which an x-ray visible dye is injected into blood vessels to allow them to be imaged on an x ray.

Cerebrospinal fluid—The clear, normally colorless fluid found within the subarachnoid space.

Computerized tomography (CT) scan—Cross-sectional x rays of the body compiled to create a three-dimensional image of the body's internal structures.

Hemorrhage—The escape of blood from blood vessels.

Hydrocephalus—Englargement of the chambers in the brain (ventricles) caused by an accumulation of cerebrospinal fluid.

Intracranial hypertension—Abnormally high pressure within the brain.

Ischemia—A condition in which blood flow is cut off or restricted from a particular area. The tissue becomes starved of oxygen and nutrients, resulting in tissue death.

Ischemic—Referring to ischemia.

Lumbar puncture—A diagnostic procedure in which a needle is inserted into the lower spine to withdraw a small amount of cerebrospinal fluid. This fluid is examined to assess trauma to the brain.

Subarachnoid—Referring to the space underneath the arachnoid mater.

Vasospasm—The constriction or narrowing of blood vessels. In cases of hemorrhage, the constriction is prompted by chemical signals from the escaped blood as it breaks down.

this is not possible, **lumbar puncture** and examination of the cerebrospinal fluid is advised. Lumbar puncture is also done in cases in which the CT scan doesn't reveal a hemorrhage, but there is a high suspicion that one has occurred. In subarachnoid hemorrhage, cerebrospinal fluid shows red blood cells and/or xanthochromia, a yellowish tinge caused by blood breakdown products. Xanthochromia first appears six to 12 hours after subarachnoid hemorrhage, making it advisable to delay lumbar puncture until at least 12 hours after the onset of symptoms for a more definite diagnosis.

Once a hemorrhage, AVM, or aneurysm has been diagnosed, further tests are done to pinpoint the damage. The CT scan may be useful in giving the general location, but cerebral **angiography** maps out the exact details. This procedure involves injecting a special dye into the blood stream. This dye makes blood vessels visible in x rays of the area.

Treatment

The initial course of treatment focuses on stabilizing the hemorrhage victim. Depending on the individual's condition, this may involve intubation and mechanical ventilation, supplemental oxygen, intravenous fluids, and close monitoring of vital signs. If the person suffers seizures, an anticonvulsant, such as phenytoin (Dilantin), is administered. Nimodipine, a **calcium** channel blocker, may be given to prevent vasospasm and its complications. Sedatives and medications for pain, nausea, and vomiting are administered as needed.

Once the individual is stabilized, cerebral angiography is done to locate the damaged blood vessel. This information and the individual's condition are considered before attempting surgical treatment. Surgery is necessary to remove the damaged area of the blood vessel and prevent a second hemorrhage. The specific neurosurgical procedures depend on the location and type of blood vessel damage. Typically, clip ligation is the preferred means of treating an aneurysm, and surgical excision, radiosurgery, or endovascular embolization are used to manage an AVM.

Prognosis

Individuals who are conscious and demonstrate few neurologic symptoms when they reach medical help have the best prognosis. However, the overall prospects for subarachnoid hemorrhage patients are generally not good. Of the individuals who suffer an aneurysmal

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hemorrhage, approximately 15% do not live long enough to get medical treatment. Another 20–40% will not survive the complications caused by the hemorrhage, and approximately 12% of the survivors will experience permanent neurologic disability. Neurologic disabilities may include partial paralysis, weakened or numbed areas of the body, cognitive or speech difficulties, and vision problems. Individuals whose subarachnoid hemorrhages occur as a result of AVMs have a slightly better prognosis, although the risk of death is approximately 10–15% for each hemorrhage.

Subarachnoid hemorrhage associated with traumatic brain injury has a poor prognosis. In clinical studies, 46–78% of head injury cases involving subarachnoid hemorrhage resulted in severe disability, vegetative survival, or death. Furthermore, it is possible that traumatic subarachnoid hemorrhages are accompanied by additional injuries, which would further diminish survival and recovery rates.

Prevention

Traumatic brain injury is the leading cause of subarachnoid hemorrhages, so it follows that efforts to prevent head injury would prevent these hemorrhages. Since accidents cannot always be prevented, measures to minimize potential damage are always advisable. Use of activity-appropriate protective gear, such as bicycle helmets, motorcycle helmets, and sports head gear, is strongly encouraged and promoted by medical associations, consumer organizations, advocacy groups, and health-care professionals. These same groups also advise using seat belts in automobiles.

Spontaneous subarachnoid hemorrhages are more difficult to prevent. Since there may be a genetic component to aneurysms and AVMs, close relatives to individuals with these conditions may consider being screened to assess their own status. Quitting **smoking** and keeping blood pressure within normal limits may also reduce the risk of suffering a spontaneous subarachnoid hemorrhage.

ORGANIZATIONS

Brain Injury Association of America, 1608 Spring Hill Road, Suite 110, Vienna, VA, 22182, (703) 761-0750, (703) 761-0755, http://www.biausa.org.

National Stroke Association, 9707 E Easter Lane Building B, Centennial, CO, 80112, (303) 649-1328, (800) 787-6537, Info@stroke.org, http://www.stroke.org.

Julia Barrett

Subdural empyema *see* **Central nervous system infections**

Subdural hematoma

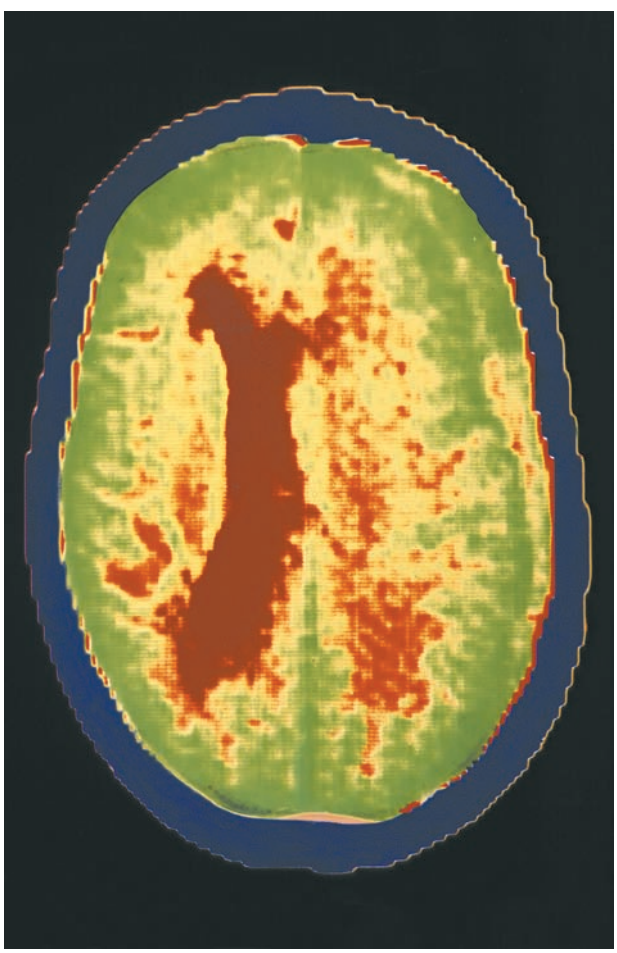
Definition

A subdural hematoma is a collection of blood in the space between the outer layer (dura) and middle layers of the covering of the brain (the meninges). It is most often caused by torn, bleeding veins on the inside of the dura as a result of a blow to the head.

Description

Subdural hematomas most often affect people who are prone to falling. Only a slight hit on the head or even a fall to the ground without hitting the head may be enough to tear veins in the brain, often without fracturing the skull. There may be no external evidence of the bruising on the brain's surface.

Small subdural hematomas may not be very serious, and the blood can be slowly absorbed over several



CT scan indicating subdural hematoma highlighted as a red mass on the center left of the brain. *(Photo Researchers, Inc.)*

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Subdural hematoma present on autopsied body. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

KEY TERMS

Corticosteroids—A group of drugs similar to natural corticosteroid hormones produced by the adrenal glands. The drugs have a wide variety of applications, including use for inflammatory disorders and swelling.

Diuretics—A group of drugs that helps remove excess water from the body by increasing the amount lost by urination.

Fontanelle—One of the two soft areas on a baby's scalp; a membrane-covered gap between the bones of the skull.

weeks. Larger hematomas, however, can gradually enlarge over several weeks, even though the bleeding has stopped. This enlargement can compress the brain itself, possibly leading to **death** if the blood is not drained.

The time between the injury and the appearance of symptoms can vary from less than 48 hours to several weeks, or more. Symptoms appearing in less than 48 hours are due to an acute subdural hematoma. This type of bleeding is often fatal, and results from tearing of the venous sinus. If more than two weeks have passed before symptoms appear, the condition is called a chronic subdural hematoma, resulting from tearing of the smaller vein. The young and the old are most likely to experience a chronic condition. This chronic form is less risky, as pressure of the veins against the skull lessens the bleeding. Prompt medical care can reduce the probability of permanent brain damage.

Causes and symptoms

A subdural hematoma is caused by an injury to the head that tears blood vessels. In childhood, hematomas are a common complication of falls. A subdural hematoma also may be an indication of **child abuse**, as evidenced by **shaken baby syndrome**.

Symptoms tend to fluctuate, and include:

- headache
- episodes of confusion and drowsiness
- one-sided weakness or paralysis
- lethargy
- enlarged or asymmetric pupils
- convulsions or loss of consciousness after head injury
- coma

A doctor should be contacted immediately if symptoms appear. Because these symptoms mimic the signs of a **stroke**, the patient should tell the doctor about any **head injury** within the previous few months.

In an infant, symptoms may include increased pressure within the skull, growing head size, bulging fontanelle (one of two soft spots on a infant's skull), **vomiting**, irritability, lethargy, and seizures. In cases of child abuse, there may be **fractures** of the skull or other bones.

Diagnosis

A chronic subdural hematoma can be difficult to diagnose but a slow loss of consciousness after a head injury is assumed to be a hematoma unless proven otherwise. The hematoma can be confirmed with **magnetic resonance imaging** (MRI), which is the preferred type of scan; a hematoma can be hard to detect on a computed tomography scan (CT scan), depending on how long after the hemorrhage the CT is done.

Treatment

Small hematomas that do not cause symptoms may not need to be treated. Otherwise, the hematoma should be surgically removed. Liquid blood can be drained from burr holes drilled into the skull. The surgeon may have to open a section of skull to remove a large hematoma or to tie off the bleeding vein.

Corticosteroids and **diuretics** can control brain swelling. After surgery, **anticonvulsant drugs** (such as phenytoin) may help control or prevent seizures, which can begin as late as two years after the head injury.

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Prognosis

If treatment is provided soon enough, recovery is usually complete. **Headache**, **amnesia**, attention problems, **anxiety**, and giddiness may continue for some time after surgery. Most symptoms in adults usually disappear within six months, with further improvement over several years. Children tend to recover much faster.

Prevention

Because a subdural hematoma usually follows a head injury, preventing head injury can prevent a hematoma.

ORGANIZATIONS

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Brain Injury Association of America, 1608 Spring Hill Road, Suite 110, Vienna, VA, 22182, (703) 761-0750, (703) 761-0755, http://www.biausa.org.

Head Injury Hotline, P.O. Box 84151, Seattle, WA, 98124, (206) 621-8558, http://www.headinjury.com.

Head Trauma Support Project, P.O. Box 215666, Sacramento, CA, 95821, (916) 568-6660.

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Subdural hemorrhage *see* **Subdural hematoma**

Subluxations *see* **Dislocations and subluxations**

Substance abuse and dependence

Definition

Substance abuse and dependence refer to any continued pathological use of a medication, non-medically indicated drug (called drugs of abuse), or toxin. They normally are distinguished as follows.

Substance abuse is any pattern of substance use that results in repeated adverse social consequences related to drug-taking—for example, interpersonal conflicts, failure to meet work, family, or school obligations, or legal problems. Substance dependence, commonly known as **addiction**, is characterized by the physiological and behavioral symptoms related to substance use. These symptoms include the need for increasing amounts of the substance to maintain desired effects, withdrawal if drug-taking ceases, and a great deal of time spent in activities related to substance use.

Substance abuse is more likely to be diagnosed among those who have just begun taking drugs and is often an early symptom of substance dependence. However, substance dependence can appear without substance abuse, and substance abuse can persist for extended periods of time without a transition to substance dependence.

Description

Substance abuse and dependence are disorders that affect all population groups although specific patterns of abuse and dependence vary with age, gender, culture, and socioeconomic status. According to data from the National Longitudinal Alcohol Epidemiologic Survey, 13.3% of a survey group of Americans exhibited symptoms of alcohol dependence during their lifetime, and 4.4% exhibited symptoms of alcohol dependence during the past 12 months. According to the United States Department of Health and Human Services' National Survey on Drug Use and Health, in 2005 9.1% of the population age 12 or older (about 22.2 million people) were classified as having substance abuse or dependence within the last year. About 7.7% (18.7 about million people) were classified as having alcohol abuse or dependence.

Although substance dependence can begin at any age, people aged 18 to 25 have been found to have higher substance abuse and dependency rates than other age groups. Individuals who first used drugs or alcohol at a young age are more likely to have drug abuse and dependence problems later in life than those who fist used drugs or alcohol at an older age. Gender proportions vary according to the class of drugs, but substance abuse and dependence is about twice as likely to occur in men than in women.

In addition to being an individual health disorder, substance abuse and dependence may be viewed as a public health problem with far-ranging health, economic, and social implications. Substance-related disorders are associated with teen **pregnancy** and the transmission of **sexually transmitted diseases** (STDs), as well as failure in school, unemployment, domestic violence, homelessness, and crimes such as **rape and sexual assault**, aggravated assault, robbery, burglary, and larceny. Many different estimates have been made for the economic cost of substance abuse and dependence, and most estimate it at tens or hundreds of billions of dollars.

The term substance, when discussed in the context of substance abuse and dependence, refers to

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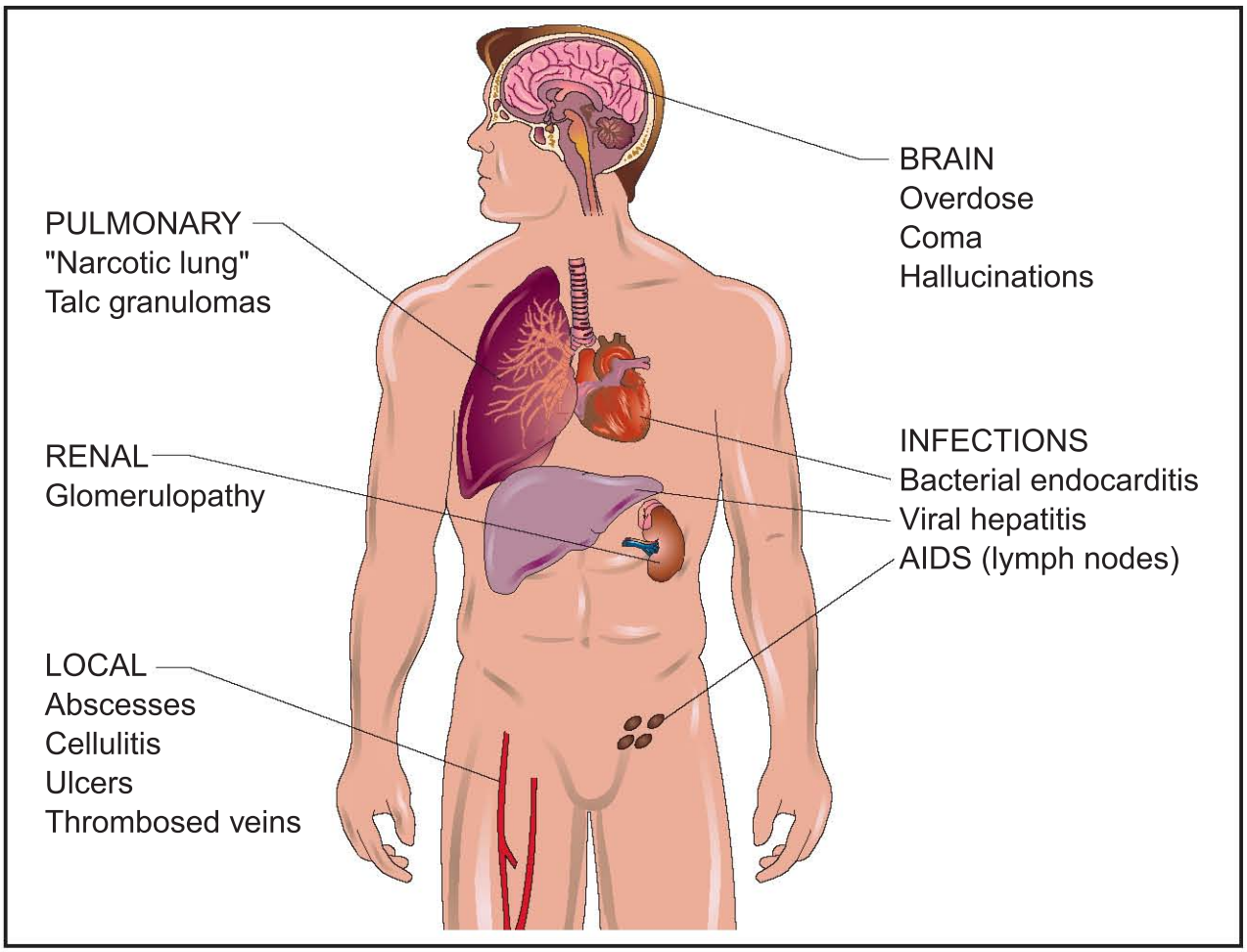

Substance abuse often causes a variety of medical abnormalities and conditions throughout the body, as shown in the illustration above. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

medications, drugs of abuse, and toxins. These substances have an intoxicating effect, desired by the user, which can have either stimulating (speeding up) or depressive/sedating (slowing down) effects on the body. Substance dependence and/or abuse can involve any of the following 10 classes of substances:

- alcohol
- amphetamines (including "crystal meth," some medications used in the treatment of attention deficit disorder [ADD], and amphetamine-like substances found in appetite suppressants)
- cannabis (including marijuana and hashish)
- cocaine (including "crack")
- hallucinogens (including LSD, mescaline, and MDMA ["ecstasy"])
- inhalants (including compounds found in gasoline, glue, and paint thinners)
- nicotine (including that found in cigarettes and smokeless tobacco)
- opioids (including morphine, heroin, codeine, methadone, oxycodone [Oxycontin (TM)])
- phencyclidine (including PCP, angel dust, ketamine)
- sedative, hypnotic, and anxiolytic (anti-anxiety) substances (including benzodiazepines such as valium, barbiturates, prescription sleeping medications, and most prescription anti-anxiety medications)

Caffeine has been identified as a substance in this context, but as yet there is insufficient evidence to establish whether caffeine-related symptoms fall under substance abuse and dependence.

Substances of abuse may thus be illicit drugs, readily available substances such as alcohol or glue, over-the-counter drugs, or prescription medications. In many cases, a prescription medication that becomes a substance of abuse may have been a legal, medically

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Percentage of population abusing illicit drugs or alcohol, by gender and age

Gender	Illicit drugs	Alcohol
Female	2.2	5.1
Male	3.4	9.7

Age	Illicit drugs	Alcohol
12–17	4.6	4.9
18–25	7.8	17.2
26 or older	1.7	6.0

SOURCE: Substance Abuse and Mental Health Services Administration (SAMHSA), Office of Applied Studies, *2008 National Survey on Drug Use and Health* (September 2009). Available online at: http://oas.samhsa.gov/NSDUHLatest.htm (accessed June 10, 2010).

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indicated prescription for the user, but the pattern of use diverges from the use prescribed by the physician.

Causes and symptoms

Causes

The causes of substance dependence are not well established, but three factors are believed to contribute to substance-related disorders: genetic factors, psychopathology, and social learning. In genetic epidemiological studies of **alcoholism**, the probability of identical twins both exhibiting alcohol dependence was significantly greater than with fraternal twins, thus suggesting a genetic component in alcoholism. It is unclear, however, whether the genetic factor is related to alcoholism directly, or whether it is linked to other psychiatric disorders that are known to be associated with substance abuse. For example, there is evidence that alcoholic males from families with **depressive disorders** tend to have more severe courses of substance dependence than alcoholic men from families without such family histories.

These and other findings suggest substance abuse may be a way to relieve the symptoms of a psychological disorder. In this model, unless the underlying pathology is treated, attempts to permanently stop substance dependence are ineffective. Psychopathologies that are associated with substance dependence include antisocial personality disorder, **bipolar disorder**, depression, **anxiety** disorder, and **schizophrenia**.

A third factor related to substance dependence is social environment. In this model, drug-taking is essentially a socially learned behavior. Local social norms determine the likelihood that a person is exposed to the substance and whether continued use is reinforced. For example, individuals may, by observing family or peer role models, learn that substance use is a normal way to relieve daily stresses. External penalties, such as legal or social sanctions, may reduce the likelihood of substance abuse.

At the level of neurobiology, it is believed that substances of abuse operate through similar pathways in the brain. The chemical changes induced by the stimulation of these pathways by initial use of the substance lead to the desire to continue substance use, and eventually to substance dependence.

Symptoms

The DSM-IV-TR identifies seven criteria (symptoms), at least three of which must be met during a given 12-month period, for the diagnosis of substance dependence:

- Tolerance, as defined either by the need for increasing amounts of the substance to obtain the desired effect or by experiencing less effect with extended use of the same amount of the substance.
- Withdrawal, as exhibited either by experiencing unpleasant mental, physiological, and emotional changes when drug-taking ceases or by using the substance as a way to relieve or prevent withdrawal symptoms.
- Longer duration of taking substance or use in greater quantities than was originally intended.
- Persistent desire or repeated unsuccessful efforts to stop or lessen substance use.
- A relatively large amount of time spent in securing and using the substance, or in recovering from the effects of the substance.
- Important work and social activities reduced because of substance use.
- Continued substance use despite negative physical and psychological effects of use.

Although not explicitly listed in the DSM-IV-TR criteria, "craving," or the overwhelming desire to use the substance regardless of countervailing forces, is a universally-reported symptom of substance dependence.

Symptoms of substance abuse, as specified by DSM-IV-TR, include one or more of the following occurring during a given 12-month period:

- Substance use resulting in a recurrent failure to fulfill work, school, or home obligations (such as work absences, substance-related school suspensions, or neglect of children).

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- Substance use in physically hazardous situations such as driving or operating machinery.
- Substance use resulting in legal problems such as drug-related arrests.
- Continued substance use despite negative social and relationship consequences of use.

In addition to the general symptoms, there are other physical signs and symptoms of substance abuse that are related to specific drug classes:

- Signs and symptoms of alcohol intoxication include such physical signs as slurred speech, lack of coordination, unsteady gait, memory impairment, and stupor, as well as behavior changes shortly after alcohol ingestion, including inappropriate aggressive behavior, mood volatility, and impaired functioning.
- Amphetamine users may exhibit rapid heartbeat, elevated or depressed blood pressure, dilated (enlarged) pupils, weight loss, excessively high energy levels, inability to sleep, confusion, and occasional paranoid psychotic behavior.
- Cannabis users may exhibit red eyes with dilated pupils, increased appetite, dry mouth, and rapid pulse. They may also be sluggish and slow to react.
- Cocaine users may exhibit rapid heart rate, elevated or depressed blood pressure, dilated pupils, and weight loss, in addition to wide variations in their energy level, severe mood disturbances, psychosis, and paranoia.
- Users of hallucinogens may exhibit anxiety or depression, paranoia, and unusual behavior in response to hallucinations (imagined sights, voices, sounds, or smells that appear real). Signs include dilated pupils, rapid heart rate, tremors, lack of coordination, and sweating. Flashbacks, or the re-experiencing of a hallucination long after stopping substance use, are also a symptom of hallucinogen use.
- Users of inhalants experience dizziness, spastic eye movements, lack of coordination, slurred speech, and slowed reflexes. Associated behaviors may include belligerence, tendency toward violence, apathy, and impaired judgment.
- Opioid drug users exhibit slurred speech, drowsiness, impaired memory, and constricted (small) pupils. They may appear slowed in their physical movements.
- Phencyclidine users exhibit spastic eye movements, rapid heartbeat, decreased sensitivity to pain, and lack of muscular coordination. They may show belligerence, predisposition to violence, impulsiveness, and agitation.
- Users of sedative, hypnotic, or anxiolytic drugs show slurred speech, unsteady gait, inattentiveness, and impaired memory. They may also display inappropriate behavior, mood volatility, and impaired functioning.

Other signs are related to the form in which the substance is used. For example, heroin, certain other opioid drugs, and certain forms of **cocaine** may be injected. A person using an injectable substance may have "track marks" (outwardly visible signs of the site of an injection, with possible redness and swelling of the vein in which the substance was injected). Furthermore, poor judgment brought on by substance use can result in the injections being made under dangerously unhygienic conditions. These unsanitary conditions and the use of shared needles are risk factors for major infections of the heart, as well as infection with HIV (the virus that causes **AIDS**), certain forms of hepatitis (a liver infection), and **tuberculosis**.

Cocaine is often taken as a powdery substance, which is "snorted" through the nose. This can result in frequent nosebleeds, sores in the nose, and even erosion (an eating away) of the nasal septum (the structure that separates the two nostrils).

Overdosing on a substance is a frequent complication of substance abuse. **Drug overdose** can be purposeful (with **suicide** as a goal), or due to carelessness, the unpredictable strength of substances purchased from street dealers, the mixing of more than one type of substance, or as a result of the increasing doses that a person must take to experience a similar level of effect. Substance overdose can be a life-threatening emergency, with the specific symptoms depending on the type of substance used. Substances with depressive effects may dangerously slow the breathing and heart rate, drop the body temperature, and result in general unresponsiveness. Substances with stimulatory effects may dangerously increase the heart rate and blood pressure, produce abnormal heart rhythms, increase body temperature, induce seizures, and cause erratic behavior.

Diagnosis

Tools used in the diagnosis of substance dependence include screening questionnaires and patient histories, **physical examination**, and laboratory tests. A simple and popular screening tool is the CAGE questionnaire. CAGE refers to the first letters of each word that forms the basis of each of the four questions of the screening exam:

- Have you ever tried to Cut down on your substance use?
- Have you ever been Annoyed by people trying to talk to you about your substance use?
- Do you ever feel Guilty about your substance use?

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- Do you ever need an Eye opener (use of the substance first thing in the morning) in order to start your day?

A "yes" answer to two or more of these questions is an indication that the individual should be referred for a more thorough work-up for substance dependency or abuse.

In addition to CAGE, other screening questionnaires are available. Some are designed for particular population groups such as pregnant women, and others are designed to more thoroughly assess the severity of substance dependence. These questionnaires, known by their acronyms, include AUDIT, HSS, HSQ, PRIME-MD, ACE, TWEAK, s-MAST, and SADD. There is some variability among questionnaires in terms of how accurately and comprehensively they can identify individuals as substance dependent.

Patient history, as taken through the direct interview, is important for identifying physical symptoms and psychiatric factors related to substance use. Family history of alcohol or other substance dependency is also useful for diagnosis.

A physical examination may reveal signs of substance abuse. These signs are specific to the substances used, and may include needle marks, tracks, or nasal erosion.

With the individual's permission, substance use can be detected through laboratory testing of his or her blood, urine, or hair. Laboratory testing, however, may be limited by the sensitivity and specificity of the testing method, and by the time elapsed since the person last used the drug.

One of the most difficult aspects of diagnosis involves overcoming the patient's denial. Denial is a psychological state during which a person is unable to acknowledge the (usually negative) circumstances of a situation. In this case, denial leads a person to underestimate the degree of his or her substance use and of the problems associated with the substance use.

Treatment

According to the American Psychiatric Association, there are three goals for the treatment of people with substance use disorders: (1) the patient abstains from or reduces the use and effects of the substance; (2) the patient reduces the frequency and severity of relapses; and (3) the patient develops the psychological and emotional skills necessary to restore and maintain personal, occupational, and social functioning.

In general, before treatment can begin, many treatment centers require that the patient undergo **detoxification**. Detoxification is the process of weaning the patient from his or her regular substance use. Detoxification can be accomplished "cold turkey," by complete and immediate cessation of all substance use, or by slowly decreasing (tapering) the dose the individual is taking, to minimize the side effects of withdrawal. Some substances must be tapered because "cold turkey" methods of detoxification are potentially life threatening. In some cases, medications may be used to combat the physical and psychological symptoms of withdrawal. For example, **methadone** is used to help patients adjust to the tapering off of heroin use.

Treatment itself consists of three parts: (1) assessment; (2) formulation of a treatment plan; (3) psychiatric management. The first step in treatment is a comprehensive medical and psychiatric evaluation of the patient. This evaluation includes:

- a history of the patient's past and current substance use, and its cognitive, psychological, physiological, and behavioral effects
- a medical and psychiatric history and examination
- a history of psychiatric treatments and outcomes
- a family and social history
- screening of blood, breath, or urine for substances
- other laboratory tests to determine the presence of other conditions commonly found with substance use disorders

After the assessment is made, a treatment plan is formulated. Treatment plans vary according to the needs of the specific patient and can change for the same patient as it is seen how he or she responds to different elements of treatment. Plans typically involve the following elements: (1) a strategy for the psychiatric management of the patient; (2) a strategy for reducing effects or use of substances, or for abstinence; (3) efforts to ensure compliance with the treatment program and to prevent relapse; (4) treatments for other conditions associated with substance use. Initial therapy and treatment setting (hospital, residential treatment, partial hospitalization, or outpatient) decisions are made as part of the treatment plan, but because substance use disorders are considered a chronic condition requiring long-term care, these plans can and do change through the course of treatment.

The third step, psychiatric management of the patient, is the implementation of the treatment plan. Psychiatric management of the patient includes establishing a trusting relationship between clinician and patient; monitoring the patient's progress; managing the patient's relapses and withdrawal; diagnosing and treating associated psychiatric disorders; and helping the patient adhere to the treatment plan through

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therapy and the development of skills and social interactions that reinforce a drug-free lifestyle.

As part of the treatment process, patients typically undergo psychosocial therapy and, in some cases, pharmacologic treatment. Psychosocial therapeutic modalities include **cognitive-behavioral therapy**, behavioral therapy, individual psychodynamic or interpersonal therapy, **group therapy**, **family therapy**, and self-help groups. Pharmacologic treatment may include medications that ease withdrawal symptoms, reduce cravings, interact negatively with substances of abuse to discourage drug-taking, or treat associated psychiatric disorders.

Alternative treatment

The efficacy of alternative treatments for substance use disorders remains for the most part ambiguous. Some studies suggest that **acupuncture** can be used to help treat cocaine addiction. However, a 2007 meta-analysis (summary analysis of studies) found that there was no reproducible scientific data indicating that acupuncture was helpful. A similar meta-analysis reported that acupuncture also had no statistically significant effect on **smoking** cessation.

There has been movement toward examining some touted treatments in more rigorous clinical trials. In particular, there has been some interest in *Pueraria lobata*, or kudzu, an herb that has reputedly been used in Chinese medicine to treat alcoholism. Preclinical trials of an herbal formula with kudzu have shown that increased consumption of the herbal formula is associated with decreased consumption of alcohol. Toxicity studies show few ill effects of the formula, and human trials are currently being undertaken to more fully evaluate the efficacy of this treatment.

The effectiveness of electroacupuncture (the practice of acupuncture accompanied by the application of low levels of electrical current at acupuncture points) in alleviating opiate withdrawal symptoms is also being examined. Preclinical trials suggest that electroacupuncture treatment given prior to the administration of naxolone seems to alleviate the withdrawal effects of naxolone.

Prognosis

Recovery from substance use is notoriously difficult, even with exceptional treatment resources. Although relapse rates are difficult to accurately obtain, the NIAAA cites evidence that 90% of alcohol dependent users experience at least one relapse within the 4 years after treatment. Relapse rates for heroin and nicotine users are believed to be similar. Certain pharmacological treatments, however, have been shown to reduce relapse rates.

Relapses are most likely to occur within the first 12 months of having discontinued substance use. Triggers for relapses can include any number of life stresses (problems on the job or in the marriage, loss of a relationship, **death** of a loved one, financial stresses), in addition to seemingly mundane exposure to a place, situation, or acquaintance associated with previous substance use.

The development of adaptive life skills and ongoing drug-free social support are believed to be two important factors in avoiding relapse. The effect of the support group Alcoholics Anonymous has been intensively studied, and many studies have found that long-term sobriety appears to be positively related to Alcoholics Anonymous attendance and involvement. Support for family members in addition to support for the individual in recovery is also important. Because substance dependence has a serious impact on family functioning, and because family members may inadvertently maintain behaviors that initially led to the substance dependence, ongoing therapy and support for family members should not be neglected.

KEY TERMS

Addiction—The state of being both physically and psychologically dependent on a substance.

Dependence—A state in which a person requires a steady concentration of a particular substance to avoid experiencing withdrawal symptoms.

Detoxification—A process whereby an addict is withdrawn from a substance.

Intoxication—The mental, physical, or emotional state produced by a substance.

Street drug—A substance purchased from a drug dealer; may be a legal substance, sold illicitly (without a prescription, and not for medical use), or it may be a substance that is illegal to possess.

Tolerance—A phenomenon whereby a drug user becomes physically accustomed to a particular dose of a substance, and requires increasing dosages in order to obtain the same effects.

Withdrawal—Those side effects experienced by a person who has become physically dependent on a substance, upon decreasing the substance's dosage or discontinuing its use.

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Prevention

Prevention is best aimed at teenagers and young adults aged 18–24 who are at very high risk for substance experimentation. Prevention programs should include an education component that outlines the risks and consequences of substance use and a training component that gives advice on how to resist peer pressure to use drugs.

Furthermore, prevention programs should work to identify and target children who are at relatively higher risk for substance abuse. This group includes victims of physical or **sexual abuse**, children of parents who have a history of substance abuse, and children with poor school performance and/or attention deficit disorder. These children may require more intensive intervention.

Resources

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ORGANIZATIONS

National Institute on Drug Abuse, 6001 Executive Blvd., Room 5213, Bethesda, MD, (301) 443-1124, information@nida.nih.gov, http://drugabuse.gov.

Genevieve Pham-Kanter
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Substance dependence *see* **Substance abuse and dependence**

Sucralfate *see* **Antiulcer drugs**

Sucrose intolerance *see* **Carbohydrate intolerance**

Sudden cardiac death

Definition

Sudden cardiac **death** (SCD) is an unexpected death due to heart problems, which occurs within one hour from the start of any cardiac-related symptoms. SCD is sometimes called cardiac arrest.

KEY TERMS

Defibrillator—A device which delivers a controlled electric shock to the heart to return it to normal beating rhythm.

Ventricular fibrillation—When the lower chamber of the heart quivers instead of pumping in an organized way.

Ventricular tachycardia—A rapid heartbeat, usually over 100 beats per minute.

Description

When the heart suddenly stops beating effectively and breathing ceases, a person is said to have experienced sudden cardiac death.

SCD is not the same as actual death. In actual death, the brain also dies. The important difference is that sudden cardiac death is potentially reversible. If it is reversed quickly enough, the brain will not die.

Sudden cardiac death is also not the same as a **heart attack**. A heart attack (myocardial infarction) is the result of a blockage in an artery which feeds the heart, so the heart becomes starved for oxygen. The part that has been starved is damaged beyond repair, but the heart can still beat effectively.

Causes and symptoms

Sudden cardiac death is usually caused by **ventricular fibrillation** (the lower chamber of the heart quivers instead of pumping in an organized rhythm). Ventricular fibrillation almost never returns to normal by itself, so the condition requires immediate intervention. **Ventricular tachycardia** can also lead to sudden cardiac death. The risk for SCD is higher for anyone with heart disease.

When the heart stops beating effectively and the brain is being deprived of oxygenated blood, a medical emergency exists.

Diagnosis

Diagnosis of sudden cardiac death is made when there is a sudden loss of consciousness, breathing stops, and there is no effective heart beat.

Treatment

When sudden cardiac death occurs, the first priority is to establish the flow of oxygenated blood to the brain.

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The next priority is to restore normal rhythm to the heart. Forcing air into the mouth will get oxygen into the lungs. Compressing the chest simulates a pumping heart and will get some blood flow to the lungs, brain, and coronary arteries. This method is called **cardiopulmonary resuscitation** (CPR). When trained help arrives, they will attempt to establish a normal heart beat by using a device called a defibrillator.

If sudden cardiac death occurs outside the hospital setting, cardiopulmonary resuscitation (CPR) must begin within four to six minutes and advanced **life support** measures must begin within eight minutes, to avoid brain death. CPR requires no special medical skills and training is available for the ordinary person nationwide.

Prognosis

Sudden cardiac death is reversible in most people if treatment is begun quickly. However, of the people who are resuscitated, 40% will have another SCD within two years if they do not receive appropriate treatment for the underlying cause of the episode.

Prevention

In order to prevent sudden cardiac death, underlying heart conditions must be addressed. Medications and implantable cardioverter-defibrillators may be used.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

Dorothy Elinor Stonely

Sudden infant death syndrome

Definition

Sudden infant **death** syndrome (SIDS) is the unexplained death without warning of an apparently healthy infant, usually during sleep. It is also known as crib death and cot death. According to the Centers for Disease Control and Prevention (CDC), a SIDS death is one that cannot be explained after a thorough investigation is conducted, including a complete **autopsy**, examination of the death scene, and review of the baby's clinical history. The American Academy of Pediatrics (AAP) issued a similar definition in its position paper on SIDS in 2005: SIDS is "the sudden death of an infant under 1 year of age, which remains unexplained after a thorough case investigation, including performance of a complete autopsy, examination of the death scene, and review of the clinical history."

Ten leading causes of infant death in the United States

Congenital malformations
Pre-term/low birth weight
Sudden infant death syndrome (SIDS)
Maternal complications
Accidents and unintentional injuries
Cord and placental complications
Bacterial sepsis of newborn
Respiratory distress
Diseases of the circulatory system
Neonatal hemorrhage

SOURCE: U.S. Department of Health and Human Services, National Center for Health Statistics, "Deaths: Final Data for 2007," *National Vital Statistics Reports* 58, no. 19 (May 2010). Available online at: http://www.cdc.gov/nchs/nvss.htm (accessed June 10, 2010).

Sudden infant death syndrome is the third leading cause of death among infants in the United States. *(Table by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)*

Demographics

According to the CDC, SIDS is the leading cause of death among American infants between the ages of 1 and 12 months, and is the third leading cause overall of infant mortality in the United States. SIDS is responsible for about 1 death per 2,000 live births as of the early 2000s; however, this figure is more than 50% lower than the figures for 1990, largely as a result of the "Back to Sleep" campaign. The CDC reports that as of 2010, more than 4500 infants die each year in the United States "of no obvious cause." About half these deaths are attributed to SIDS, with the remainder classified as Sudden Unexplained Infant Death or SUID.

Most SIDS deaths occur in babies between 2 and 4 months of age; only 1 percent occur in newborns. About 80% of all SIDS deaths involve infants younger than 5 months. Boys are more likely than girls to die of SIDS; 60–70% of SIDS cases involve boys. Most SIDS deaths in North America occur during the winter and early spring, which are the peak times for respiratory infections. A recent epidemic of a viral disease in the surrounding community is associated with an increased number of SIDS cases in that area.

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According to the National Institute for Child Health and Human Development (NICHD), African American babies are twice as likely as Caucasian babies to die from SIDS, and Native American and Alaska Native babies are three times as likely. The same high rates of SIDS cases that occur among Native Americans in the United States are found among First Nations tribes in Canada and aboriginal groups in Australia and New Zealand. The reason for these differences is not yet known as of 2010 but may be related to other risk factors listed below.

Description

In the typical SIDS case, the parents or caregivers put the baby to bed after feeding him or her. Checking on the baby shortly after bedtime indicates that everything is normal; however, the baby is later found dead, usually in the position in which he or she had been placed at bedtime or naptime.

In most cases of SIDS, the parents state that the child was apparently healthy; however, some parents of infants who died of SIDS report that their babies "were not themselves" in the hours before death. In a number of cases, the parents report that the baby had **diarrhea** and **vomiting** at some point in the two weeks prior to death. As of 2010, doctors do not know whether these digestive problems are related to SIDS in some way or are only coincidental.

Risk factors

Studies indicate that some mothers are at increased risk of having their child die of SIDS:

- Those who smoke during pregnancy and after childbirth.
- Those who abuse drugs or alcohol.
- Those who are underweight or suffer from malnutrition.
- Those who have children less than one year apart.
- Teenage mothers. The more children the mother has while still in her teens, the greater the risk of SIDS.
- Those who are obese.

Apart from sleeping position, some babies are at increased risk of SIDS:

- Babies who are born prematurely.
- Babies who weigh 4 pounds or less at birth.
- Babies who are not breastfed.
- Babies born during the fall or winter.
- Babies who had a sibling who died of SIDS.
- Babies who are part of a set of twins, triplets, or quadruplets.
- Babies who are exposed to tobacco smoke.
- Babies put to sleep in an overheated room.
- Babies whose parents practice co-sleeping (the baby shares the parents' bed at night).
- Babies who are overdressed for sleep or covered with too many blankets.

Causes and symptoms

The cause of SIDS is not yet known for certain, although at least 70 different theories have been proposed as of 2010. As of 2010 there are 20 clinical trials under way evaluating apnea, preterm birth, the use of pacifiers, sleeping position, and secondhand smoke in the home as risk factors for SIDS. It is likely that some cases of SIDS are the result of a combination of factors. Doctors have proposed several different theories for SIDS:

- Bacterial infections. A British study published in May 2008 reported that some cases of SIDS appear to result from previously undetected bacterial infections.
- Abnormalities in the part of the brain stem that controls breathing. A study published in the *Journal of the American Medical Association* in the fall of 2007 is one of the strongest pieces of evidence so far that innate differences in brain structure may put some babies at increased risk of SIDS.
- Smothering caused by sleeping on the stomach. This theory holds that babies put to sleep lying on the stomach may breathe in their own exhaled carbon dioxide because they do not have the same ability as older children to move their heads during sleep to get more oxygen.
- Episodes of apnea (sudden cessation of breathing). Babies sometimes stop breathing periodically for reasons that are still not completely understood.
- Abnormalities in heart rhythm. About 10% of babies who die of SIDS have been found to have sudden episodes of extremely rapid heartbeat.
- Triple-risk theory. This theory proposes to explain SIDS as the end result of three factors: a biological vulnerability (such as a weakened heart or abnormal brain stem), an environmental problem (such as sleeping on the stomach), and being too young to regulate breathing and other vital functions as effectively as older children.
- Genetic factors. There is evidence as of late 2009 that 5–10% of SIDS cases are associated with genetic mutations that affect potassium channels in the heart tissue. This abnormality increases the risk of irregular heart rhythms and sudden cardiac death. Some researchers also think that the relatively high

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KEY TERMS

Apnea—Temporary cessation of breathing. It may be intentional (holding one's breath) or involuntary, resulting from criminal assault (choking), a neurological disorder, an upper respiratory infection, or accidental trauma.

Autopsy—The examination of a body after death to determine the cause of death.

Brain stem—The lower part of the brain directly connected to the spinal cord. It controls breathing and other vital functions.

Co-sleeping—Allowing a baby to sleep in the same bed as its parents. It is also called bed sharing.

Congenital—Existing or present at the time of birth.

Crib death—Another name for SIDS. It is often called cot death in the United Kingdom, Australia, and New Zealand.

Infanticide—Intentional killing of a child within the first year of life.

Postmortem—Referring to the period following death.

rate of SIDS among African Americans compared to other racial groups may be related to a genetic predisposition to irregular heart rhythms. Research in this area is ongoing as of 2010.

Still other theories about the cause of death in SIDS include immune system disorders that cause changes in the baby's heart rate and breathing patterns during sleep, or a metabolic disorder that causes a buildup of fatty acids in the baby's system.

Theories that are no longer accepted include the notion that SIDS is caused by vaccinations, by dust mites or other insects in the crib mattress, or by toxic gases released by materials used in the manufacture of crib mattresses.

Diagnosis

The diagnosis of SIDS is primarily a diagnosis of exclusion. This means that it is given only after other possible causes of the baby's death have been ruled out. Known risk factors aid in the diagnosis. Unlike the pattern in other diseases, however, the diagnosis of SIDS can only be given postmortem. It is recommended that all infants who die in their sleep receive an autopsy to determine the cause. Autopsies indicate a definite explanation in about 20% of cases of sudden infant death. In addition, an autopsy can often put to rest any doubts the parents may have. Investigation of the location of the death is also useful in determining the child's sleeping position, bedding, room temperature, and similar factors.

The American Academy of Pediatrics (AAP) estimates that between 1% and 5% of cases of SIDS actually involve infanticide. As a result, the AAP has drawn up a list of criteria that must be met in order to distinguish a case of SIDS from child abuse:

- There has been a complete autopsy of the baby performed by a licensed medical examiner, and the autopsy findings are consistent with a diagnosis of SIDS.
- There is no evidence of head trauma or significant disease.
- There is no evidence of trauma to the baby's bones.
- Such other possible causes of death as pneumonia, metabolic disorders, dehydration, severe birth defects, massive infection, trauma to the abdomen, or carbon monoxide poisoning have been ruled out.
- There is no evidence that the baby was given alcohol, drugs, or other toxic substances.
- There is no evidence of foul play when the death scene is investigated.
- The baby's medical history does not indicate previous health problems.

Treatment

There is nothing that can be done to treat the infant when SIDS occurs. Treatment of the parents includes support and understanding; however, the doctor and other health professionals must at the same time conduct a thorough investigation into the circumstances surrounding the baby's death. There are some differences among the states as to the way in which the postmortem (after death) investigation is carried out, but all states require an investigation before the death can be defined as SIDS as of 2010. It is understandably difficult for parents to accept the need for an autopsy and an evaluation of the bed and room in which the baby died when they are grieving; unfortunately, ruling out the possibility of abuse or intentional suffocation of the child is a legal necessity.

Circumstances that concern doctors as well as law enforcement when a baby dies suddenly include:

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- The child was 7 months of age or older. SIDS is unusual in this age group.
- The pregnancy was unwanted.
- There have been previous unexplained infant deaths in the family.
- Family members have a history of arrests for violent or intoxicated behavior.

Prevention

The NICHD and CDC recommend the following precautions to reduce the risk of SIDS:

- Infants should always be placed on their backs to sleep when they are left alone; they should be placed on their stomachs *only* when they are awake and supervised by someone responsible.
- If the baby sleeps in a crib, the crib's mattress should be firm and fit snugly into the crib frame. Such other firm sleeping surfaces as bassinets or cradles are also fine.
- The baby should be dressed in a sleeper or pajama to keep it warm rather than being covered by a blanket.
- Parents who co-sleep with a baby should *never* smoke, drink alcohol, or use drugs when sleeping with the baby. It is better to have the baby sleep in a crib or bassinet next to the parents' bed rather than sharing the bed.
- Parents should *never* put a baby on a couch, waterbed, or pillow for a nap.
- Parents should *never* smoke in the same room as the baby or allow anyone else to do so.
- Caregivers should *never* place the baby to sleep or nap with any pillows, stuffed toys, bumper pads, comforters, quilts, or sheepskins.

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ORGANIZATIONS

American Academy of Pediatrics (AAP), 141 Northwest Point Boulevard, Elk Grove Village, IL, 60007, (847) 434-4000, (847) 434-8000, http://www.aap.org/.

American SIDS Institute, 509 Augusta Drive, Marietta, GA, 30067, (770) 426-8746, (800) 232-SIDS, (770) 4261369, http://sids.org/index.htm.

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Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

National Association of Medical Examiners (NAME), 430 Pryor Street SW, Atlanta, GA, 30312, (404) 730-4781, http://thename.org.

National Institute of Child Health and Human Development (NICHD)., Bldg 31, Room 2A32, MSC 2425, 31 Center Drive, Bethesda, MD, 20892, (800) 370-2943, (866) 760-5947, NICHDInformationResourceCenter@mail.nih.gov, http://www.nichd.nih.gov/.

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Sugar diabetes *see* **Diabetes mellitus**

Sugar intolerance *see* **Carbohydrate intolerance**

Suicide

Definition

Suicide is defined as the intentional taking of one's own life. In some European languages, for example German, the word for suicide translates into English as "self-murder." Until the end of the twentieth century approximately, suicide was considered a criminal act; legal terminology used the Latin phrase *felo-de-se*, which means "a crime against the self." Much of the social stigma that is still associated with suicide derives from its former connection with legal judgment as well as with religious condemnation.

In the social climate of 2009, however, suicidal behavior is most commonly regarded—and responded to—as a psychiatric or medical emergency. Law enforcement personnel may be involved in preventing an attempted suicide or taking suicidal individuals to a hospital emergency department but not in arresting these persons for breaking the law.

Demographics

In the United States, the rate of suicide has continued to rise since the 1950s. More people in the general population die from suicide than homicide in North America. There are almost 11 suicide deaths each year for every 100,000 people living in the United States, and for every suicide, there are between 8 and 25 attempts. There are over 30,000 suicides each year in the United States, or about 82 each day; and each day about 1,500 people attempt suicide.

The demographics of suicide in the United States vary considerably from state to state, with rates higher than the national average in the West and lower in the Midwest and Northeast. Some states, like Alaska, have suicide rates that are almost twice the national average; others, such as Massachusetts, have notably lower rates.

These variations from state to state result in part from differences in age and ethnic distributions and gender ratios among the states. In 2008, suicide was the eleventh leading cause of **death** in the United States, according to the National Institute of Mental Health (NIMH); it was the eighth leading cause of death among males and sixteenth leading cause of death among females. Males are four times more likely than females to succeed in their suicide attempts, but females report attempting suicide at some point in their lives three times as often as men. Among ethnic groups, suicide rates are highest among white males, followed closely by American Indian and Native Alaskan males. The increase in the overall suicide rate in the United States between 1999 and 2005 was due primarily to an increase in suicides among whites aged 40–64, with white middle-aged women experiencing the largest annual increases. As of 2009, the average age of people who completed suicide in the United States is 40 years.

In terms of age, the highest number of suicides are committed by people under age 40, but suicide rates (percentages in a given group) increase with age. People over age 65 have high suicide rates, with men outnumbering women who commit suicide nearly four to one. The ratio of attempted suicides to completed suicides among people over 65 is thought to be as low as 4:1. By contrast, according to the National Strategy for Suicide Prevention (NSSP), seniors are more likely than younger persons to use highly lethal means of suicide. According to a Canadian study published in 2008, seniors are most likely to use firearms to commit suicide, followed by hanging, self-poisoning, and leaping from heights.

The incidence of suicide and attempted suicide among seniors is widely perceived as a growing public health problem in the United States; as of 2009, older adults represent about 13% of the U.S. population but account for 20% of suicides. According to the NIMH, the highest suicide rate in the nation is for Caucasian men ages 85 and older: 65.3 deaths per 100,000 persons, about six times the national U.S. rate of 10.8 per 100,000.

The overall rate of suicide among young people has declined slowly since 1992, but it still remains the third leading cause of death in age groups spanning children 10 years old to young adults up to age 24. Suicidal behavior is rare in prepubertal children, probably because of their

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relative inability to plan and execute a suicide attempt. Children as young as 5, however, have succeeded in killing themselves by leaping out of windows or shooting themselves—as happened with one five-year-old who witnessed his mother kill herself with a gun and imitated her behavior several months later. Suicides among young people ages 15 to 24 show an extreme male bias, with the exception of Hispanics: Four times as many males as females aged 15 to 19 and six times as many males age 20 to 24 in the general population committed suicide in 2004. Over half the suicides in this group were firearm-related, and males in general are far more likely to use firearms. According to the NIMH, the rates of suicide for American youth in 2004 (the most recent data available) were as follows:

- Children between the ages of 10 and 14: 1.3 suicides per 100,000.
- Teenagers between the ages of 15 and 19: 8.2 per 100,000.
- Young adults between the ages of 20 and 24: 12.5 per 100,000.

Race or ethnicity is a factor in suicide rates among young people just as it is among older adults. Suicide rates among American Indian and Alaskan natives between 15 and 34 years are almost twice the national average for this age range. Young Hispanic females make significantly more suicide attempts than their male or non-Hispanic counterparts.

Suicide has become a major social and medical problem around the world, not just in North America. Worldwide suicide rates have increased by 60% since 1960. The World Health Organization (WHO) reported that over one million people worldwide died from suicide in the year 2005 (the most recent year for which data are available), more than were murdered or killed in war. That is a global mortality rate of 16:100,000—or one death by suicide every 40 seconds. According to WHO, more suicides occur in Asia than in any other region of the world—with China, Japan, and India accounting for 40% of the world's suicides. China is also the only country in the world where more women than men take their own lives, with female suicides representing 58% of the total. Rates among young people have risen even faster, to the point where they are now the age group at highest risk in 35% of the world's countries.

Description

Historical background

Attitudes toward suicide have varied throughout history. The ancient Greeks considered it an offense against the state, which was deprived of contributions by potentially useful citizens. The Romans, by comparison, thought that suicide could be a noble form of death, although they legislated against persons taking their own lives before an impending criminal conviction in order to insure their families' financial inheritance. Early Christianity, which downplayed the importance of life on earth, was not critical of suicide until the fourth century, when St. Augustine condemned it as a sin because it violated the sixth commandment ("Thou shalt not kill"). Eventually, the Roman Catholic Church excommunicated and even denied funeral rites to people who killed themselves. The medieval theologian St. Thomas Aquinas condemned suicide because it usurped God's power over life and death. In the *Divine Comedy*, the great writer Dante placed suicides in one of the lowest circles of Hell. The view of suicide as a sin prevailed in Western societies for hundreds of years, and many people are still influenced by it, either consciously or unconsciously. Suicide was a felony and attempted suicide a misdemeanor in England until 1961.

One of the greatest influences on twentieth-century notions about suicide has been the French sociologist Emile Durkheim's 1897 work *Le suicide*. Analyzing French statistics on suicide, Durkheim concluded that suicide is primarily a function of the strength or weakness of a person's ties to family, religion, and community. Persons with weak social ties and those for whom such ties have been disrupted (such as divorced or widowed people) are the most vulnerable to suicide. Durkheim also categorized suicide into four types. Altruistic suicide is actually approved by society, as in the case of a soldier who throws himself on a hand grenade to protect his comrades. In egoistic suicide, individuals kill themselves because they lack the social ties that could motivate them to go on living. Anomic suicide occurs following the loss of a spouse, child, job, or other significant connection to the community, and fatalistic suicides are committed by people driven to despair by dire external circumstances from which there appears to be no escape.

Twenty years after the publication of Durkheim's work, Sigmund Freud provided the first theory that addressed suicide in terms of one's inner mental and emotional state. In *Mourning and Melancholia* (1917), he proposed that suicide was the result of turning hostility toward a loved one back on oneself. In *Man against Himself* (1936), Karl Menninger extended Freud's contribution to the psychodynamic study of suicide, relating it to such other forms of self-destructive behavior as **alcoholism** or drug **abuse**. Some people still refer to such behavior as "slow-motion suicide."

Types of suicidal behavior

Some mental health professionals distinguish five levels of suicidal behavior: completed suicide; suicide

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attempts, which are potentially fatal; suicide gestures, which involve acting-out behavior that is not necessarily lethal; suicide gambles; and suicidal ideation, or thinking about suicide. An example of a suicide gesture would be cutting one's wrist just deeply enough to draw blood from the skin but not deeply enough to sever veins and arteries. The suicide gamble is a type of suicidal behavior in which the person takes the risk that he or she will be discovered in time and that the discoverer will save them. The poet Sylvia Plath's suicide in 1963 is considered an example of a suicide gamble. Plath gassed herself in the kitchen by turning on her oven without lighting it, but left a note on the door for her children's new nanny, had opened the windows in the children's bedroom to protect them, and had sealed the door to the kitchen with dish towels.

Suicidal ideation, or thinking about suicide, is even more common than suicide gestures or attempted suicide. Suicidal ideation spans a continuum from nonspecific thoughts such as "life is not worth living" to specific ideation. Community surveys indicate that between 12 and 25% of primary and high school children have some form of suicidal ideation, whereas 5 to 10% combine suicidal ideation with a plan or intent to make a suicide attempt. Not surprisingly, specific ideation is more closely associated with risk for attempted suicide, and frequently occurs in combination with other risk factors.

Risk factors

Some factors increase a person's risk of suicide:

- Male sex.
- Age over 75.
- A family history of suicide.
- A history of suicide attempts.
- Caucasian race.
- A history of abuse in childhood.
- Traumatic experiences after childhood.
- Recent stressful events, such as separation or divorce, job loss, or death of spouse.
- Chronic medical illness. Patients with AIDS have a rate of suicide 20 times that of the general population.
- Chronic, severe, or intractable pain.
- Loss of mobility or independence.
- Access to a firearm. Death by firearms now accounts for the majority of suicides in the United States.
- Alcohol or substance abuse. While mood-altering substances do not cause a person to kill himself or herself, they weaken impulse control.
- High blood cholesterol levels.
- Presence of a psychiatric illness. Over 90% of Americans who commit suicide have a mental illness. Major depression accounts for 60% of suicides, followed by schizophrenia, alcoholism, substance abuse, borderline personality disorder, Huntington's disease, and epilepsy. The lifetime mortality due to suicide in psychiatric patients is 15% for major depression; 20% for bipolar disorder; 18% for alcoholism; 10% for schizophrenia; and 5–10% for borderline and certain other personality disorders.

In children and adolescents, the most common triggers of suicidal behavior involve interpersonal conflict or loss, most frequently with parents or romantic attachment figures. Family discord, physical or **sexual abuse**, and an upcoming legal or disciplinary crisis are also commonly associated with completed and attempted suicide. The most serious suicide attempters leave suicide notes, show evidence of planning, and use an irreversible method. Most adolescent suicide attempts, though, are of relatively low intent and lethality, and only a minority actually want to die. Usually, children and adolescents who attempt suicide want to escape psychological **pain** or unbearable circumstances, gain attention, influence others, or communicate such strong feelings as rage or love.

Factors that lower the risk of suicide in adults include:

- A significant friendship network outside the workplace.
- Religious faith and practice, especially those that discourage suicide and value life.
- A stable marriage.
- A close-knit extended family.
- A strong interest in or commitment to a project or cause that brings people together: community service, environmental concerns, neighborhood associations, animal rescue groups, etc.

Causes and symptoms

Suicide is an act that represents the end result of a combination of factors in any individual. One model that has been used by clinicians to explain why people suffering under the same life stresses respond differently is known as the stress/diathesis model. Diathesis is a medical term for a predisposition that makes some people more vulnerable to thoughts of suicide. In addition to factors at the individual level, factors in the wider society have been identified as contributing to the rising rate of suicide in the United States:

- Stresses on the nuclear family, including more frequent divorce and economic hardship.

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KEY TERMS

Assisted suicide—A form of self-inflicted death in which individuals voluntarily bring about their own death with the help of another, usually a physician, relative, or friend. Assisted suicide is sometimes called physician-assisted death (PAD).

Cortisol—A hormone released by the cortex (outer portion) of the adrenal gland when a person is under stress. Cortisol levels are now considered a biological marker of suicide risk.

Dexamethasone test—A test that serves as a marker of suicide risk by reflecting signaling activity between the brain and the adrenal gland.

Diathesis—The medical term for predisposition. The stress/diathesis model is a diagram that is used to explain why some people are at greater risk of suicidal behavior than others.

Euthanasia—The act of putting individuals or animals to death painlessly or allowing them to die by withholding medical services, usually because of an incurable disease; also called mercy killing.

Frontal cortex—The part of the human brain associated with aggressiveness and impulse control. Abnormalities in the frontal cortex are associated with an increased risk of suicide.

Serotonin—A chemical that occurs in the blood and nervous tissue and functions to transmit signals across the gaps between neurons in the central nervous system. Abnormally low levels of serotonin are associated with depression and an increased risk of suicide.

Self-deliverance—Another term for assisted suicide, more commonly used in Great Britain than in the United States.

Suicide gesture—Attempted suicide characterized by a low-lethality method, low level of intent or planning, and little physical damage; sometimes called pseudocide.

Suicide magnet—A bridge, tall building, or geographic location that acquires a reputation for attracting people who want to commit suicide and attempt it.

- The loss of a set of moral values held in common by the entire society.
- The weakening of churches, synagogues, neighborhood associations, and other mid-range social groups outside the family. In the past, these institutions often provided a sense of belonging for people from troubled or emotionally distant families.
- Frequent geographical moves, which makes it hard for people to make and keep long-term friendships outside their immediate family.
- Sensationalized treatment of suicide in the mass media. A number of research studies have shown that there is a definite risk of "contagion" or copycat suicides from irresponsible reporting, particularly among impressionable adolescents. One group of researchers has estimated that as many as 6% of all suicides in the developed countries are copycat suicides.
- The development over the past century of medications that allow relatively painless suicide. For most of human history, the available means of suicide were uncertain, painful, or both.
- The easy availability of lethal methods of suicide, most notably firearms, and so-called suicide magnets such as bridges or tall buildings that do not have suicide barriers and are easy to reach even for teenagers too young to drive or seniors who have given up driving. The Golden Gate Bridge in San Francisco is the most notorious suicide magnet in the United States; others include the Aurora Bridge in Seattle, the Sunshine Skyway Bridge in Florida, and the Duke Ellington Bridge in Washington, D.C. Suicide magnets elsewhere in the world include the Aokigahara Forest at the base of Mount Fuji in Japan, and Beachy Head in the United Kingdom.

The role of the Internet in the rate of adolescent suicide has been debated. On the one hand, there are websites and chat rooms that foster preoccupation with suicide and offer detailed descriptions of suicide methods. There are even instances of adolescents recruiting other adolescents over the Internet to join them in a suicide pact, as happened in Japan in October 2004. Seven young people who had met via the Internet committed group suicide by inhaling carbon monoxide from a charcoal burner inside a locked van. Other websites attack psychiatry and mental health professionals, which may steer some vulnerable young people away from seeking help. On the other hand, there are many supportive websites for teens that offer resources (including peer counseling) and contact information for getting help if they are considering suicide.

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Diagnosis

The diagnosis of a suicide attempt is often made when the patient either goes to the emergency room of a hospital to seek help or is taken there by family members or first responders. In many cases the patient will have written a suicide note, talked about his or her intention, or begun to carry out a plan to kill themselves. If the patient is not conscious, the doctor will obtain as much information as possible from family members or first responders.

Treatment of attempted suicide

Suicide attempts can be broadly categorized along a continuum that ranges from planned attempts involving highly lethal methods that fail by good fortune to impulsive or poorly planned attempts using less lethal methods.

Adults

An adult suicide attempt of any kind, however, is treated as a psychiatric emergency by police or other rescue personnel. Treatment in a hospital emergency room includes a complete psychiatric evaluation, a **mental status examination**, and a detailed assessment of the circumstances surrounding the attempt. The physician will interview the person's relatives or anyone else who accompanied the patient in order to obtain as much information as possible. Some questions that the physician will ask include whether the patient had a detailed plan for suicide; whether he or she had the means of suicide at hand; what the patient hoped to gain by killing themselves (freedom from pain, reunion with a dead loved one, solution to financial problems, etc.); and whether the patient had any tendencies toward homicide. As a rule, suicide attempts requiring advance planning and the use of violent or highly lethal methods are regarded as the most serious. The patient will be kept under observation while decisions are made about the need for hospitalization.

People who have attempted suicide and who are considered a serious danger to themselves or to others can be legally hospitalized against their will. The doctor bases the decision on the severity of the patient's depression or agitation; the presence of other suicide risk factors, including a history of previous suicide attempts, **substance abuse**, recent stressful events, and symptoms of **psychosis**; and the availability of friends, relatives, or other social support. If the attempt is judged to be a nonlethal suicide gesture, and the patient has adequate support outside the hospital, then he or she may be released after the psychiatric assessment is completed.

Adolescent

The first step in the care of a suicidal teenager is to determine the degree of suicidal risk and the appropriate level of care. It is critical to obtain a no-suicide contract with the patient and family, in which the patient promises to refrain from self-destructive behavior and to notify the professional or caregiver if he or she does feel suicidal again. Treatment of the suicidal youngster should proceed on four levels: (1) removal of firearms and dangerous medications from the home; (2) treatment of the underlying psychiatric disorders; (3) remediation of social and problem-solving skills; (4) evaluation of the patient's home and school environment; and (5) family education about psychiatric problems and suicidal risk.

Another important aspect of aftercare is continuity of treatment; the growing complexity and specialization of the healthcare system means that suicidal children and adolescents are frequently shuffled from one clinic or facility to another. Lack of continuity of care places these young people at an increased risk of additional suicide attempts.

Ethical issues related to suicide

Several ethical issues related to suicide have emerged as public policy matters in the early twenty-first century. The most controversial of these are the notion of a "right to suicide" and the question of assisted suicide.

Right to suicide

The idea that suicide is a right among the elderly or those with terminal illnesses surfaced with the 1991 publication of Derek Humphry's *Final Exit*, a controversial book described by its author as a how-to manual for suicide and assisted suicide. Humphry is the founder of the Euthanasia Research and Guidance Organization (ERGO), known until 2003 as the Hemlock Society. Humphry maintains that people have a right to choose the time, place, and method of their death and that rational suicide is a legitimate and even reasonable choice.

People who are often overlooked in discussions of the right to commit suicide, however, are the relatives and friends who are bereaved by the suicide. It is estimated that each person who commits suicide leaves six survivors to deal with the aftermath. On the basis of this figure, there are at least 4.5 million survivors of suicide in the United States. In addition to the grief that ordinarily accompanies death, survivors of suicide often struggle with feelings of guilt and shame as well. Some people have blamed Humphry and his book for their loved one's decision to commit suicide.

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Assisted suicide

Questions pertaining to the legalization of assisted suicide for persons suffering from a terminal illness are connected in part to increases in the average lifespan. Physician-assisted suicide (also known as physician-assisted death or PAD) was legalized in the Netherlands in April 2001 and in the states of Oregon, Washington, and Montana. As of 2009 it was also legal in Belgium and is practiced openly in Switzerland. It is important to distinguish between physician-assisted suicide and euthanasia, or mercy killing. Assisted suicide, which is called "self-deliverance" in Britain, refers to individuals bringing about their own death with the help of another person. Because the other person is often a physician, the act is often called doctor-assisted suicide.

Euthanasia strictly speaking means that the physician or other person is the one who performs the last act that causes death. For example, if a physician injects a patient with a lethal dose of a pain-killing medication, the physician is performing euthanasia. If the physician leaves the patient with a loaded syringe and the patient injects himself or herself with it, the act is an assisted suicide. As of 2009, assisted suicide is illegal everywhere in the United States except Oregon, Washington, and Montana; and euthanasia is illegal in all fifty states. The *Merck Manual of Geriatrics* states: "Physicians can provide treatment intended to minimize [a patient's] physical and emotional suffering, even if a secondary result is the shortening of life, but they cannot specifically intend to hasten death."

Media treatment of suicide

In 1989, the Centers for Disease Control and Prevention (CDC) sponsored a national workshop to address the connection between sensationalized media treatments of suicide and the rising rate of suicide among American youth. The CDC and the American Association of Suicidology subsequently adopted a set of guidelines for media coverage of suicide intended to reduce the risk of copycat suicides.

The CDC guidelines point out that the following types of reporting may increase the risk of copycat suicides:

- Presenting oversimplified explanations of suicide, when in fact many factors usually contribute to it. One example concerns the suicide of the widow of a man who was killed in the collapse of the World Trade Center on September 11, 2001. Most newspapers that covered the story described her death as due solely to the act of terrorism, even though she had a history of depressive illness.
- Excessive, ongoing, or repetitive coverage of the suicide.
- Sensationalizing the suicide by inclusion of morbid details or dramatic photographs.
- Giving "how-to" descriptions of the method of suicide.
- Referring to suicide as an effective coping strategy or as a way to achieve temporary fame or other goals.
- Glorifying the act of suicide or the person who commits suicide.
- Focusing on the person's positive traits without mentioning his or her problems.

Traditional

People who survive a suicide attempt are usually treated with a combination of antidepressant medications and **psychotherapy**.

Drugs

In 2003 the Food and Drug Administration (FDA) approved the use of clozapine (Clozaril), an antipsychotic medication, for the treatment of patients with **schizophrenia** who have attempted suicide.

TREATMENT OF SUICIDE SURVIVORS. In addition to the grief that ordinarily accompanies death, survivors of a friend or relative's suicide often struggle with feelings of guilt and shame as well. In spite of a general liberalization of social attitudes since World War II, suicide is still stigmatized in many parts of Europe and the United States. Survivors often benefit from group or individual psychotherapy in order to work through such issues as wondering whether they could have prevented the suicide or whether they are at increased risk of committing suicide themselves. Increasing numbers of clergy as well as mental health professionals are taking advanced training in counseling survivors of suicide.

Prognosis

The prognosis for a person who has attempted suicide is generally favorable, although further research needs to be done. Many different studies have followed individuals who attempted suicide to determine how likely individuals who attempt suicide once are likely to die by suicide. These studies have generally found that the likelihood is less than 10%. Some have found the likelihood of eventual death by suicide to be 6% or lower. A doctor who studied 515 people who attempted suicide between 1937 and 1971 found that 94% were still alive at the time of his study or had died of natural causes. In general individuals who attempt suicide and rate highly on intent to commit suicide and hopelessness

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may be more likely to commit suicide at a later time. These findings may been taken to indicate that suicidal behavior is more likely to be a passing response to an acute crisis than a reflection of a permanent state of mind.

Prevention

One reason that suicide is such a tragedy is that most self-inflicted deaths are potentially preventable. Many suicidal people change their minds if they can be helped through their immediate crisis; Dr. Richard Seiden, a specialist in treating survivors of suicide attempts, puts the high-risk period at 90 days after the crisis. Some potential suicides change their minds during the actual attempt; for example, a number of people who survived jumping off the Golden Gate Bridge told interviewers afterward that they regretted their action even as they were falling and that they were grateful they survived.

Brain research is an important means of suicide prevention. Known biological markers for an increased risk of suicide can now be correlated with personality profiles linked to suicidal behavior under **stress** to help identify individuals at risk. One new clinical parameter that may be considered with personality profiles is the dexamethasone suppression test, which serves as an indicator of hyperactivity of a neuroendocrine hormonal pathway between the brain and the adrenal gland. Another clinical parameter that may be combined with psychological assessment is an assessment of serotonin function based on cholesterol levels, with high levels indicating an increased risk of suicide. In addition, brain imaging studies using **positron emission tomography (PET)** are being used to detect abnormal patterns of serotonin uptake in specific regions of the brain. Genetic studies are also yielding new information about inherited predispositions to suicide.

In the late 2000s research was ongoing to discover better methods of treating depression and other disorders that may influence a person's decision to commit suicide. In addition, primary care physicians are continually learning how to better identify and intervene when treating suicidal patients. An estimated 67% of all adults, and 80% of seniors who complete suicide, have seen a physician within a month of their death. Thus primary care physicians are in a good position to evaluate their patients for signs of depression. The good news is that depression in asults in any age group is highly treatable, particularly when antidepressant medications are combined with psychotherapy.

Warning signs of suicidal thinking have been identified:

- Reading a lot of books or articles on death and suicide
- Talking a lot about death or suicide or expressing feelings of hopelessness
- Stockpiling medications
- Refusing to take care of oneself
- Sudden interest in guns
- Giving away cherished possessions, writing long letters, or making other elaborate farewells
- Disrupted sleep patterns
- Hurriedly revising a will
- Increased intake of alcohol or prescription drugs

People who are concerned about a friend or relative at risk of self-harm should take the following steps:

- Become educated about warning signs and risk factors.
- Identify physicians and other healthcare professionals who know the person and can provide help; and keep their telephone numbers readily available.
- Talk openly with the person about his or her feelings. Although many people are afraid to ask whether someone is thinking about suicide for fear of angering them or giving them an idea, in many cases honest concern is welcomed by the individual.
- Call the local hospital emergency department or 911 if the person seems to be at immediate risk of suicide.

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ORGANIZATIONS

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American Association of Suicidology (AAS), 5221 Wisconsin Avenue, NW, Washington, DC, 20015, (202) 237-2280, (202) 237-2282, http://www.suicidology.org/web/guest/home.

American Foundation for Suicide Prevention (AFSP), 120 Wall Street, 22nd Floor, New York, NY, 10005, (212) 363-3500, (888) 333-AFSP, (212) 363-6237, inquiry@asfp. org, http://www.afsp.org/.

American Psychiatric Association, 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209-3901, (703) 907-7300, apa@psych.org, http://www.psych.org/.

National Institute of Mental Health (NIMH), 6001 Executive Boulevard, Room 8184, MSC 9663, Bethesda, MD, 20892-9663, (301) 443-4513, (866) 615-6464, (301) 443-4279, nimhinfo@nih.gov, http://www.nimh.nih.gov/index.shtml.

National Suicide Prevention Lifeline, (800) 273-TALK

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Sulfacetamide *see* **Antibiotics, ophthalmic**

Sulfamethoxazole and trimethoprim *see* **Sulfonamides**

Sulfinpyrazone *see* **Gout drugs**

Sulfisoxazole *see* **Sulfonamides**

Sulfonamides

Definition

Sulfonamides are medicines that prevent the growth of bacteria in the body.

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Purpose

Sulfonamides are used to treat many kinds of infections caused by bacteria and certain other microorganisms. Physicians may prescribe these drugs to treat urinary tract infections, ear infections, frequent or long-lasting **bronchitis**, bacterial **meningitis**, certain eye infections, *Pneumocystis carinii*pneumonia, **traveler's diarrhea**, and a number of other kinds of infections. These drugs will *not* work for colds, flu, and other infections caused by viruses.

Description

Sulfonamides, also called sulfa medicines, are available only with a physician's prescription. They are sold in tablet and liquid forms. Some commonly used sulfonamides are sulfisoxazole (Gantrisin) and the combination drug sulfamethoxazole and trimethoprim (Bactrim, Cotrim).

Recommended dosage

The recommended dosage depends on the type of sulfonamide, the strength of the medicine, and the medical problem for which it is being taken. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

Always take sulfonamides exactly as directed. To make sure the infection clears up completely, take the medicine for as long as it has been prescribed. Do not stop taking the drug just because symptoms begin to improve. Symptoms may return if the drug is stopped too soon.

Sulfonamides work best when they are at constant levels in the blood. To help keep levels constant, take the medicine in doses spaced evenly through the day and night. Do not miss any doses. For best results, take the medicine with a full glass of water and drink several more glasses of water every day. This will help prevent some of the medicine's side effects.

Precautions

Symptoms should begin to improve within a few days of beginning to take this medicine. If they do not, or if they get worse, check with the physician who prescribed the medicine.

Although such side effects are rare, some people have had severe and life-threatening reactions to sulfonamides. These include sudden, severe liver damage, serious blood problems, breakdown of the outer layer of the skin, and a condition called Stevens-Johnson syndrome, in which people get blisters around the mouth, eyes, or anus. Call a physician immediately if any of these signs of a dangerous reaction occur:

- skin rash or reddish or purplish spots on the skin
- other skin problems, such as blistering or peeling
- fever
- sore throat
- cough
- shortness of breath
- joint pain
- pale skin
- yellow skin or eyes

This medicine may cause **dizziness**. Anyone who takes sulfonamides should not drive, use machines or do anything else that might be dangerous until they have found out how the drugs affect them.

Sulfonamides may cause blood problems that can interfere with healing and lead to additional infections. Avoid injuries while taking this medicine. Be especially careful not to injure the mouth when brushing or flossing the teeth or using a toothpick. Do not have dental work done until the blood is back to normal.

This medicine may increase sensitivity to sunlight. Even brief exposure to sun can cause a severe **sunburn** or a rash. While being treated with this medicine, avoid being in direct sunlight, especially between 10 a.m. and 3 p.m.; wear a hat and tightly woven clothing that covers the arms and legs; use a sunscreen with a skin protection factor (SPF) of at least 15; protect the lips with a sun block lipstick; and do not use **tanning** beds, tanning booths, or sunlamps.

Babies under 2 months should not be given sulfonamides unless their physician has ordered the medicine.

Older people may be especially sensitive to the effects of sulfonamides, increasing the chance of unwanted side effects, such as severe skin problems and blood problems. Patients who are taking water pills (**diuretics**) at the same time as sulfonamides may also be more likely to have these problems.

Special conditions

People with certain medical conditions or who are taking certain other medicines can have problems if they take sulfonamides. Before taking these drugs, be sure to let the physician know about any of these conditions:

ALLERGIES Anyone who has had unusual reactions to sulfonamides, water pills (diuretics), diabetes medicines, or glaucoma medicine in the past should let his or her physician know before taking sulfonamides. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

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PREGNANCY In studies of laboratory animals, some sulfonamides cause **birth defects**. The drugs' effects on human fetuses have not been studied. However, pregnant women are advised not to use this medicine around the time of labor and delivery, because it can cause side effects in the baby. Women who are pregnant or who may become pregnant should check with their physicians about the safety of using sulfonamides during **pregnancy**.

BREASTFEEDING Sulfonamides pass into breast milk and may cause liver problems, anemia, and other problems in nursing babies whose mothers take the medicine. Because of those problems, women should not breastfeed when they are under treatment with this drug. Women who are **breastfeeding** and who need to take this medicine should check with their physicians to find out how long they need to stop breastfeeding.

OTHER MEDICAL CONDITIONS Before using sulfonamides, people with any of these medical problems should make sure their physicians are aware of their conditions:

- anemia or other blood problems
- kidney disease
- liver disease
- asthma or severe allergies
- alcohol abuse
- poor nutrition
- abnormal intestinal absorption
- porphyria
- folic acid deficiency
- deficiency of the enzyme glucose-6-phosphate dehydrogenase (G6PD)

USE OF CERTAIN MEDICINES Taking sulfonamides with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Side effects

The most common side effects are mild **diarrhea**, **nausea**, **vomiting**, dizziness, **headache**, loss of appetite, and tiredness. These problems usually go away as the body adjusts to the drug and do not require medical treatment.

More serious side effects are not common, but may occur. If any of the following side effects occur, check with a physician immediately:

- itching or skin rash
- reddish or purplish spots on the skin
- other skin problems, such as redness, blistering, peeling
- severe, watery or bloody diarrhea
- muscle or joint aches
- fever
- sore throat
- cough
- shortness of breath
- unusual tiredness or weakness
- unusual bleeding or bruising
- pale skin
- yellow eyes or skin
- swallowing problems

Other rare side effects may occur. Anyone who has unusual symptoms while taking sulfonamides should get in touch with his or her physician.

KEY TERMS

Anemia—A lack of hemoglobin–the compound in blood that carries oxygen from the lungs throughout the body and brings waste carbon dioxide from the cells to the lungs, where it is released.

Bronchitis—Inflammation of the air passages of the lungs.

Fetus—A developing baby inside the womb.

Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Meningitis—Inflammation of tissues that surround the brain and spinal cord.

***Pneumocystis carinii* pneumonia**—A lung infection that affects people with weakened immune systems, such as people with AIDS or people taking medicines that weaken the immune system.

Porphyria—A disorder in which porphyrins build up in the blood and urine.

Porphyrin—A type of pigment found in living things.

Urinary tract—The passage through which urine flows from the kidneys out of the body.

Interactions

Sulfonamides may interact with a large number of other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes sulfonamides should let the physician know all other medicines he or she is taking. Among the drugs that may interact with sulfonamides are:

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- acetaminophen (Tylenol)
- medicine for overactive thyroid
- male hormones (androgens)
- female hormones (estrogens)
- other medicines used to treat infections
- birth control pills
- medicines for diabetes such as glyburide (Micronase)
- anticoagulants such as warfarin (Coumadin)
- disulfiram (Antabuse), used to treat alcohol abuse
- amantadine (Symmetrel), used to treat flu and also Parkinson's disease
- water pills (diuretics) such as hydrochlorothiazide (HCTZ, HydroDIURIL)
- the anticancer drug methotrexate (Rheumatrex)
- antiseizure medicines such as valproice acid (Depakote, Depakene)

The list above does not include every drug that may interact with sulfonamides. Be sure to check with a physician or pharmacist before combining sulfonamides with any other prescription or nonprescription (over-the-counter) medicine.

Nancy Ross-Flanigan

Sumatriptan *see* **Antimigraine drugs**

Sunburn

Definition

Inflammation of the skin caused by overexposure to the sun.

Description

Sunburn is caused by exposure to the ultraviolet (UV) rays of the sun. There are two types of ultraviolet rays, UVA and UVB. UVA rays penetrate the skin more deeply and can cause melanoma in susceptible people. UVB rays, which do not penetrate as deeply, cause sunburn and wrinkling. Most UVB rays are absorbed by **sunscreens**, but only about half the UVA rays are absorbed.

Skin **cancer** from sun overexposure is a serious health problem in the United States, affecting more than a million Americans each year. One out of 87 will develop **malignant melanoma**, the most serious type of skin cancer, and 8,100 of them will die each year.

This person has a second-degree sunburn on the back of the neck. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Fair-skinned people are most susceptible to sunburn because their skin produces only small amounts of the protective pigment called melanin. People trying to get a tan too quickly in strong sunlight are also more vulnerable to sunburn. While they have a lower risk, even the darkest-skinned people can get skin cancer.

Repeated sun overexposure and burning can prematurely age the skin, causing yellowish, wrinkled skin. Overexposure can increase the risk of skin cancer, especially a serious burn in childhood.

Causes and symptoms

The ultraviolet rays in sunlight destroy cells in the outer layer of the skin, damaging tiny blood vessels underneath. When the skin is burned, the blood vessels dilate and leak fluid. Cells stop making protein. Their DNA is damaged by the ultraviolet rays. Repeated DNA damage can lead to cancer.

When the sun burns the skin, it triggers immune defenses, which identify the burned skin as foreign. At the same time, the sun transforms a substance on the skin which interferes with this immune response. While this substance keeps the immune system from attacking a person's own skin, it also means that any malignant cells in the skin will be able to grow freely.

Sunburn causes skin to turn red and blister. Several days later, the dead skin cells peel off. In severe cases, the burn may occur with sunstroke (**vomiting**, **fever** and collapse).

Diagnosis

Visual inspection and a history of exposure to the sun.

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KEY TERMS

Malignant melanoma—The most deadly of the three types of skin cancer.

Sunscreen—Products which block the damaging rays of the sun. Good sunscreens contain either para-aminobenzoic acid (PABA) or benzophenone, or both. Sunscreen protection factors range from 2–45.

Treatment

Aspirin can ease **pain** and inflammation. Tender skin should be protected against the sun until it has healed. In addition, apply:

- calamine lotion
- sunburn cream or spray
- cool tap water compress
- colloidal oatmeal (Aveeno) baths
- dusting powder to reduce chafing

People who are severely sunburned should see a doctor, who may prescribe corticosteroid cream to speed healing.

Alternative treatment

Over-the-counter preparations containing aloe (*Aloe barbadensis*) are an effective treatment for sunburn, easing pain and inflammation while also relieving dryness of the skin. A variety of topical herbal remedies applied as lotions, poultices, or compresses may also help relieve the effects of sunburn. Calendula (*Calendula officinalis*) is one of the most frequently recommended to reduce inflammation. Apple cider vinegar applied to the burn area also can help in relieving the pain of sunburns.

Prognosis

Moderately burned skin should heal within a week. While the skin will heal after sunburn, the risk of skin cancer increases with exposure and subsequent burns. Even one bad burn in childhood carries an increased risk of skin cancer.

Prevention

Everyone from age six months on should use a water-resistant sunscreen with a sun protective factor (SPF) of at least 15. Apply at least an ounce 15–30 minutes before going outside. It should be reapplied every two hours (more often after swimming). Babies should be kept completely out of the sun for the first six months of life, because their skin is thinner than older children. Sunscreens have not been approved for infants.

In addition, people should:

- limit sun exposure to 15 minutes the first day, even if the weather is hazy, slowly increasing exposure daily
- reapply sunscreen every two hours (more often if sweating or swimming)
- reapply waterproof sunscreen after swimming more than 80 minutes, after toweling off, or after perspiring heavily
- avoid the sun between 10 a.m. and 3 p.m.
- use waterproof sunscreen on legs and feet, since the sun can burn even through water
- wear an opaque shirt in water, because reflected rays are intensified

If using a sunscreen under SPF 15, simply applying more of the same SPF won't prolong allowed time in the sun. Instead, patients should use a higher SPF in order to lengthen exposure safely. A billed cap protects 70% of the face; a wide-brimmed hat is better. People at very high risk for skin cancer can wear clothing that blocks almost all UV rays, but most people can simply wear white cotton summer-weight clothing with a tight weave.

Resources

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American Academy of Dermatology (AAD), P. O. Box 4014, Schaumburg, IL, 60168-4014, (866) 503-7546, http://www.aad.org.

National Institute of Arthritis and Musculoskeletal and Skin Diseases, National Institutes of Health, 1 AMS Circle,

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Bethesda, MD, 20892, (877) 226-4267, http://www.niams.nih.gov.

American Burn Association, 625 N. Michigan Ave., Suite 2550, Chicago, IL, 60611, (800) 548-2876, http://www.ameriburn.org.

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Sunscreens

Definition

Sunscreens are products applied to the skin to protect against the harmful effects of the sun's ultraviolet (UV) rays.

Purpose

Everyone needs a little sunshine. About 15 minutes of exposure a day helps the body make vitamin D, which is important for healthy bones and teeth. But longer exposure may cause many problems, from wrinkles to skin **cancer**. One particularly deadly form of skin cancer, **malignant melanoma**, has been on the rise in recent decades, as **tanning** has become more popular. Over the same period, scientists have warned that the thin layer of ozone that protects life on Earth from the sun's ultraviolet radiation is being depleted. This allows more UV radiation to get through, adding to the risk of overexposure.

Sunscreens help protect against the sun's damaging effects. The sun gives off two kinds of ultraviolet radiation, called UVA and UVB. Ultraviolet B (UVB) rays are thought to cause most basal cell and squamous cell skin cancers. Ultraviolet A (UVA) rays penetrate the skin more deeply than UVB rays which may lead to more skin damage.

Some medical experts are concerned that sunscreens give people a false sense of security, allowing them to stay in the sun longer than they should. Although sunscreens protect the skin from burning, they may not protect against other kinds of damage. A number of studies suggest that people who use sunscreens may actually increase their risk of melanoma because they spend too much time in the sun. This does not mean that people should stop using sunscreens. It means that they should not rely on sunscreens *alone* for protection. According to the American Academy of Dermatology, sunscreens should be one part of sun protection, along with wide–brimmed hats and tightly–woven clothing that covers the arms and legs.

Sunscreens are also recommended for patients with **rosacea** or other skin disorders that are aggravated by exposure to sunlight.

Description

Many brands of sunscreens are available, containing a variety of ingredients. The active ingredients work by absorbing, reflecting, or scattering some or all of the sun's rays. Most sunscreen products contain combinations of ingredients.

Sunscreens are usually grouped into two major categories, namely chemical absorbers and physical blockers. Chemical absorbers absorb high-intensity UV rays while physical blockers reflect or scatter them. Chemical absorber compounds include avobenzone, padimate O, octyl methoxycinnamate, octisalate, and octocrylene. Physical blocker compounds include titanium dioxide and zinc oxide. The chief drawback of physical blockers is their tendency to leave a white film on the skin, causing many people to use less of the product than they should for full sun protection.

Sunscreen products are sold as lotions, creams, gels, oils, sprays, sticks, and lip balms, and can be bought without a physician's prescription.

The U.S. Food and Drug Administration (FDA) has required sunscreen products to carry a sun protection factor (SPF) rating on their labels since 1999. This number tells the consumer how well the sunscreen protects against burning. The higher the number, the longer a person can stay in the sun without burning. However, SPF ratings apply only to protection from UVB rays.

UVA rays damage the skin without burning. In the United States, the FDA has had no mandatory criteria related to labeling of the effectiveness of sunscreens in blocking UVA rays. However, new proposed labeling criteria which went into effect in October, 2010 requires companies to label their products' effectiveness in protecting against UVA rays by using a one to four star rating system. A product with a one star rating offers the lowest protection while a four star rating indicates the highest level of protection against UVA rays. Products that do not provide any protection against UVA rays would be labeled without a star and must state on the label "no UVA protection." The star rating is to be prominently displayed near the SPF rating on the product label.

Products that contain the ingredients zinc oxide, titanium dioxide, avobenzone, and mexoryl provide protection against UVA rays.

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KEY TERMS

Hair follicle—A tiny pit in the skin from which hair grows.

Melanoma—A rapidly spreading and deadly form of cancer that usually occurs on the skin.

Ozone—A gas found in the atmosphere. A layer of ozone about 15 mi (24 km) above Earth's surface helps protect living things from the damaging effects of the sun's ultraviolet rays.

Pus—Thick, whitish or yellowish fluid that forms in infected tissue.

Rosacea—A chronic skin disease characterized by persistent redness of the skin and periodic outbreaks of pustules, usually affecting the middle third of the face.

Ultraviolet rays—Invisible light rays with a wavelength shorter than that of visible light but longer than that of x rays.

Recommended dosage

One should be sure to read the instructions that come with a product. Some products need to be applied as long as one or two hours before sun exposure. Others should be applied 15–30 minutes before exposure, and reapplied frequently during exposure.

People should apply sunscreen liberally to all exposed parts of the skin, including hands, feet, nose, ears, neck, scalp (if the hair is thin or very short), and eyelids. Users should take care not to get sunscreen in the eyes, as it can cause irritation. People should also use a lip balm containing sunscreen to protect the lips, and reapply sunscreen liberally every one to two hours—more frequently when perspiring heavily or after swimming.

Precautions

Sunscreen alone will not provide full protection from the sun. When possible, one should wear a hat, long pants, long-sleeved shirts or blouses, and sunglasses. Adults should consider applying protective wear for children which is designed to cover the child from the neck to the knees with sun–protective factors. Try to stay out of the sun between 10 a.m. and 2 p.m. (11 a.m. to 3 p.m. Daylight Saving Time), when the sun's rays are strongest. The sun can damage the skin even on cloudy days, so get in the habit of using a sunscreen every day. Be especially careful at high elevations or in areas with surfaces that reflect the sun's rays, such as sand, water, concrete, or snow. Check online at www.epa.gov/sunwise/uvindex.html to determine the UV index in your area on any particular day.

Sunlamps, tanning beds, and tanning booths were once thought to be safer than the sun, because they give off mainly UVA rays. However, UVA rays are now known to cause serious skin damage and exposure to UVA rays does increase the risk of developing melanoma. Health experts strongly advise people not to use these tanning devices.

People with fair skin, blond, red or light–brown hair, and blue or light-colored eyes are at greatest risk for developing skin cancer. So are people with many large skin **moles**. These people should avoid exposure to the sun as much as possible. However, even dark-skinned people, including African Americans and Hispanic Americans, may suffer skin damage from the sun and should be careful about exposure.

Other groups of people who should minimize sun exposure are those who have had organ transplants or recent **plastic surgery**. Patients who have received organ transplants have a greatly increased risk of developing skin cancer, and the facial skin of people who have had face lifts or similar plastic surgery procedures sunburns more easily than intact skin.

Sunscreens should not be used on infants under six months of age because of the risk of side effects. Instead, children this young should be kept out of the sun. Children over six months should be protected with clothing and sunscreens of at least SPF 15, preferably lotions. Sunscreens containing alcohol should not be used on children because they may irritate the skin.

Older people who stay out of the sun and use sunscreens may not produce enough vitamin D in their bodies. They may need to increase the vitamin D in their **diets** by including foods such as fortified milk and salmon. A health care professional can help decide if this precaution is necessary.

Anyone who has had unusual reactions to any sunscreen ingredients in the past should check with a physician or pharmacist before using a sunscreen. The physician or pharmacist should also be told about any **allergies** to foods, dyes, preservatives, or other substances, especially the following:

- artificial sweeteners
- anesthetics such as benzocaine, procaine, or tetracaine
- diabetes medicine taken by mouth
- hair dyes
- sulfa medicines
- water pills
- cinnamon flavoring

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People with skin conditions or diseases should check with their physicians before using a sunscreen. This is especially true of people with conditions that get worse with exposure to light.

Side effects

The most common side effects are drying or tightening of the skin. This problem does not need medical attention unless it does not improve.

Other side effects are rare, but possible. If any of the following symptoms occur, check with a physician as soon as possible:

- acne
- burning, itching, or stinging of the skin
- redness or swelling of the skin
- rash, with or without blisters that ooze and become crusted
- pain in hairy parts of body
- pus in hair follicles

Interactions

Anyone who is using a prescription or nonprescription (over-the-counter) drug that is applied to the skin should check with a physician before using a sunscreen.

Resources

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ORGANIZATIONS

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Sunstroke *see* **Heat disorders**

Superficial phlebitis *see* **Thrombophlebitis**

Superior vena cava syndrome

Definition

The superior vena cava is the major vein in the chest that carries blood from the upper part of the body in to the heart. A restriction of the blood flow (occlusion) through this vein can cause superior vena cava syndrome (SVCS).

Description

Superior vena cava syndrome is a partial occlusion of the superior vena cava. This leads to a lower than normal blood flow through this major vein. SVCS is also called superior mediastinal syndrome and/or superior vena cava obstruction.

Causes and symptoms

More than 95% of all cases of SVCS are associated with cancers involving the upper chest. The cancers most commonly associated with SVCS are advanced lung cancers, which account for nearly 80% of all cases of SVCS, and lymphoma. Cancers that have spread (metastasized) to the chest, such as metastatic **breast cancer** to the chest and metastatic **testicular cancer** to the chest have also been shown to cause SVCS.

Other causes of SVCS include: the formation of a blood clot in the superior vena cava, enlargement of the thyroid gland, **tuberculosis**, and **sarcoidosis**.

The symptoms of SVCS include:

- change in voice
- confusion
- cough
- enlargement of the veins in the upper body, particularly those in the arms
- headache

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KEY TERMS

Metastasis—The spread of a cancer from one part of the body (where the cancer originated) to another part of the body.

Sarcoidosis—A disease of unknown origin in which there is chronic (recurrent) swelling in the lymph nodes and other tissues.

Superior vena cava—The major vein that carries blood from the upper body to the heart.

Thymoma—A tumor that originates in the thymus, a small gland just in front of the heart that produces hormones necessary for the development of certain components of the immune system.

- light-headedness
- shortness of breath
- swelling of the arms
- swelling of the face
- trouble swallowing

Diagnosis

SVCS should be considered in any **cancer** patient with swelling of the face and arms. This diagnosis can be confirmed by x ray, computerized tomography (CT) scan, or medical resonance imaging (MRI) of the chest that reveals a partial occlusion of the superior vena cava.

Treatment

Treatment of SVCS depends on the underlying cancer that is causing it. This treatment may include radiation, **chemotherapy**, or a combination of both. In some cases, surgical procedures may be performed to open (dilate) the vessel. These procedures are generally performed by a trained radiologist or vascular surgeon.

Alternative treatment

Since treatment of SVCS is aimed at treating the underlying disorder that is causing SVCS, alternative treatments must also focus on treating these underlying causes. Alternative treatments for cancer include **acupuncture**, **aromatherapy**, herbal remedies, **hydrotherapy**, hypnosis, and massage, among many others.

Prognosis

The prognosis depends on the underlying cause of SVCS. In cases of SVCS caused by lung cancers, the prognosis is generally rather poor since SVCS does not generally occur until the later stages of these diseases.

Prevention

SVCS may be prevented by early medical intervention to halt and/or reverse the cancer which, in a later stage, would have lead to SVCS.

Resources

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ORGANIZATIONS

Lung Cancer Alliance, 888 16th St, NW, Suite 140, Washington, DC, 20006, (202) 463-2080, (800) 298-2436, info@lunjgcan ceralliance.org, http://www.lungcanceralliance.org.

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Supportive cancer therapy *see* **Cancer therapy, supportive**

Surfactant

Definition

Surfactant is a complex naturally occurring substance made of six lipids (fats) and four proteins that is produced in the lungs. It can also be manufactured synthetically.

Purpose

Surfactant reduces the surface tension of fluid in the lungs and helps make the small air sacs in the lungs (alveoli) more stable. This keeps them from collapsing when an individual exhales. In preparation for breathing air, fetuses begin making surfactant while still in the womb. Babies that are born very prematurely often lack adequate surfactant and must receive surfactant replacement therapy immediately after birth in order to breathe.

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Precautions

Babies are considered premature if they are born before 37 weeks gestation. Fetuses begin to produce surfactant between weeks 24 and 28. By about 35 weeks, most babies have enough naturally produced surfactant to keep the alveoli from collapsing. Babies born before 35 weeks, especially those born very prematurely (before 30 weeks), are likely to need surfactant replacement therapy. Over half the babies born before 28 weeks gestation need this treatment, while about one-third born between 32 and 36 weeks need supplemental surfactant. Some very premature infants may also need to be placed on a mechanical ventilator.

Description

The lungs consist of spongy tissue filled with air spaces called alveoli. In the alveoli, oxygen is taken up by the blood and carbon dioxide, a waste product of cellular metabolism, is released and exhaled. For efficient oxygen-carbon dioxide exchange to occur, the surface area of the alveoli must be as large as possible. Under normal conditions, when a person exhales, the alveoli would collapse into each other and form larger air sacs with less surface area. Surfactant prevents this collapse by reducing the surface tension of the fluids that line the lungs and helping to equalize the pressures between large and small air spaces.

Surface tension is a measure of the attraction molecules of a fluid have for each other. The attractive force pulls fluids into a shape with the smallest surface area. This is why a drop of water on a flat surface is rounded rather than flat. If the surface tension is lowered, the attraction among molecules of the fluid is decreased and the surface area of the fluid increases. For example, if a drop of detergent is added to a drop of water, the detergent reduces the surface tension and the drop of water flattens out.

In the lungs, surfactant reduces the surface tension and helps to maximize the surface area available for gas exchange. Without adequate surfactant, a baby works much harder to breathe, becomes exhausted, and does not get enough oxygen. Babies that do not have enough surfactant to breathe normally at birth are said to have infant **respiratory distress syndrome** (RDS) or hyaline membrane disease (HMD).

Babies with RDS are given replacement surfactant as soon as possible within the first six hours after birth. Manufactured surfactant is a white powder that is mixed with sterile water. It is given through a breathing tube (endotracheal tube) that is inserted in the baby's lungs. Multiple doses are usually required.

KEY TERMS

Alveolus (plural alveoli)—The terminal air sacs of the lungs where gas exchange occurs.

Hyaline membrane—A thin layer of cells that line the lung.

Surface tension—The attraction of molecules in a fluid for each other.

Surfactant replacement therapy continues until the baby's lungs have matured enough to make surfactant on their own. Some very premature babies are also put on mechanical respirators to help them breathe. Surfactant replacement therapy has reduced deaths due to respiratory distress by 50% since the early 1990s. This therapy is expensive, but it is normally covered by insurance.

Preparation

The administration of surfactant is often a neonatal emergency. The only way to prevent the need for surfactant replacement therapy is to prevent a premature birth. Mothers who are at known high risk to deliver prematurely are given drugs called **corticosteroids** toward the end of the **pregnancy** that stimulate the lungs of the fetus to mature and begin producing surfactant sooner. This helps reduce the need for surfactant replacement therapy. Although babies of all races may be born prematurely, **prematurity** is more common if the mother is diabetic, is carrying multiple fetuses, or has delivered a previous premature baby. The decision to use surfactant replacement therapy is based on the condition of the baby, its blood oxygen level, and degree of respiratory distress.

Aftercare

Babies receiving surfactant therapy are normally cared for by a neonatologist, a pediatrician that specializes in newborn care. Premature newborns often have other health problems in addition to RDS. Aftercare varies depending on their other health risks.

Risks

Delivery of surfactant requires inserting a breathing tube into the baby's lungs. Complications of this therapy include air leaking into the area between the chest wall and the lungs and air leaking into the sac around the heart. Some infants also develop chronic lung disease.

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Normal results

Normally surfactant replacement therapy keeps the infant alive until the lungs start producing their own surfactant.

Abnormal results

Surfactant replacement therapy is very effective if begun within six hours after birth. When it fails, **death** may result.

Resources

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Tish Davidson, A.M.

Surgical debridement *see* **Debridement**

Swallowing disorders

Definition

Swallowing disorders include a number of diseases and conditions that cause difficulty in passing food or liquid from the mouth to the stomach.

Demographics

Each year, about 10 million people in the United States require medical evaluation for swallowing problems. Some experts say that about 10% of Americans develop symptoms of swallowing disorders in adulthood. Elderly people are the most likely to have problems with swallowing.

Description

Although swallowing is normally automatic and unconscious on the part of an individual, it is a complex process involving several phases and 29 muscles. Saliva helps soften food as it is chewed. The tongue helps move food to the back of the mouth, triggering a swallowing reflex that passes food through the pharynx. The epiglottis helps keep food from mistakenly going down the windpipe and directs it instead into the esophagus, which is the canal that carries food to the stomach. Swallowing disorders can occur at any phase in the swallowing process. The medical term for difficulty swallowing is dysphagia.

Causes and symptoms

Swallowing disorders often result from other conditions and diseases. For example, Parkinson's disease, **cerebral palsy**, **stroke**, **head injury**, and other central nervous system conditions can damage the muscles and nerves involved in swallowing. Some people are born with abnormalities in the swallowing structures, such as infants born with **cleft palate**.

Some cancers can lead to swallowing disorders. **Esophageal cancer** can cause narrowing and eventual blockage of the esophagus. Surgery and **radiation therapy** for **head and neck cancer** can restrict or weaken tongue motion, paralyze vocal cords, or cause muscle damage that affects swallowing. An inflamed esophagus, often resulting from **gastroesophageal reflux disease** (GERD), can cause painful or difficulty swallowing. Infections of the esophagus also can inflame it and cause it to narrow. Swallowing difficulty may result from **aging**, although researchers are not certain why.

The most common symptoms people report are **choking** and the feeling that food feels stuck in the throat. Other symptoms include needing to swallow many times to clear food from the mouth and throat, a "gurgly" wet sound to the voice after swallowing, having to clear the throat after eating, coughing, **pain** while swallowing, bringing food back up (regurgitation), food or acid backing up into the throat, unexpected weight loss, and not being able to swallow at all. Children also may gag during meals and may have excessive drooling or leaking of food or liquid from their mouths during meals. They may have difficulty breathing when eating or drinking, spit up frequently, and lag behind in weight gain. They also may have recurring **pneumonia** or respiratory infections.

Diagnosis

A physician should perform a full head and neck examination based on the patient's symptoms. Speech-language pathologists may aid in the diagnosis. Physicians also might order a swallowing test to study how the patient swallows. The patient will be asked to drink a

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liquid with a contrast agent called barium that will show up on x rays of the throat and upper chest. The exam might be imaged with a technique called video fluoroscopy, which will take motion camera images in addition to still images. For this exam, the patient may be asked to swallow liquid, paste, and solids. A speech pathologist may work with the radiologist to perform this exam.

If the physician thinks the problem originates in the lower esophagus or has concerns about an abnormality in the esophagus, an **endoscopy** may be ordered. This test involves passing a thin, flexible instrument called an endoscope down the throat. The lighted endoscope helps the physician view the esophagus. Other tests may be used, including ultrasound.

Treatment

Treatment will depend on the cause of the swallowing problem. Special exercises may help strengthen the muscles used for chewing and swallowing. Problems originating in the mouth may be treated with artificial saliva, improved hydration, or better dental care. Esophageal problems will be treated depending on the cause. Patients with GERD will receive medications and instructions on how to better manage the disease. Esophageal **cancer** is a life-threatening disease that will involve coordinating care with an oncologist. Many patients will receive help with their disorders from speech pathologists. Special liquid **diets** may be ordered for patients who continue to have trouble chewing or swallowing. In severe cases, the patient may need a feeding tube that bypasses the part of the swallowing system that does not work.

Alternative treatment

Some herbs that may help improve swallowing include oil of peppermint and licorice. Valerian may be used as a tea. Homeopathic physicians may suggest some remedies aimed at improving bloating, **indigestion**, or **cough**. Alternative care should be sought from licensed practitioners and coordinated with physician care.

Prognosis

In many cases, these disorders can be corrected. If not treated, swallowing disorders can lead to serious complications, including **dehydration** and **malnutrition**. There also is a risk of food entering the airway (aspiration) as a person attempts to swallow, which can lead to aspiration pneumonia as food particles enter the lungs.

KEY TERMS

Cleft palate—An opening or hole in the roof of the mouth that occurs at birth when the roof fails to fully develop in the infant.

Epiglottis—A thin layer of cartilage behind the tongue that helps block food from entering the windpipe.

Pharynx—The muscular cavity that leads from the mouth and nasal passages to the larynx and esophagus.

Prevention

Many causes of swallowing disorders cannot be prevented. Slowly and fully chewing food helps. People with GERD should manage it to lower the risk of developing swallowing difficulties.

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American Academy of Otolaryngology–Head and Neck Surgery, 1650 Diagonal Rd., Alexandria, VA, 22314–2857, (703) 836-4444, http://www.entnet.org.

American Speech–Language Association (ASHA), 2200 Research Blvd., Rockville, MD, 20850-3289, (800) 638-8255, http://www.asha.org.

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National Institute of Dental and Craniofacial Research (NIDCR), 45 Center Dr., Room 4AS19 MSC 6400, Bethesda, MD, 20892-6400, (301) 496-4261, http://www.nidr.nih.gov.
National Institute of Neurological Disorders and Stroke (NINDS), PO Box 5801, Bethesda, MD, 20824, (800) 352-9424, http://www.ninds.nih.gov/.
National Institutes of Health (NIH), 9000 Rockville Pike, Bethesda, MD, 20892, (301) 496-4000, http://www.nih.gov.
National Library of Medicine, 8600 Rockville Pike, Bethesda, MD, 20894, http://www.nlm.nih.gov.
National Stroke Association (NSA), 9707 E Easter Ln., Building B, Centennial, CO, 80112, (800) 787-6537, http://www.stroke.org.

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Swan-Ganz catheterization *see* **Pulmonary artery catheterization**
Sweating, excessive *see* **Hyperhidrosis**
Swimmer's ear *see* **Otitis externa**
Swimming pool conjunctivitis *see* **Inclusion conjunctivitis**
Swine flu *see* **H1N1 influenza**

Swollen glands

Definition

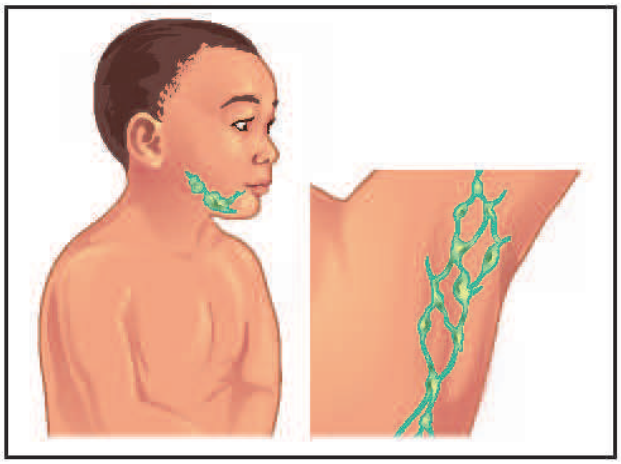
Swollen glands are enlarged lymph nodes. Lymph nodes are an integral part of the immune system and, although swollen glands can have many causes, they most often indicate that the body is fighting an infection. Swollen glands are also known as **lymphadenitis** or lymphadenopathy.

Demographics

Swollen glands are very common. They are one of the most frequent reasons for medical visits, especially by children. Swollen glands, especially in the neck region, are more common in children than in adults because children tend to have more viral infections than adults.

Description

Lymph glands or nodes are small, round or bean-shaped clusters of immune system cells called lymphocytes and macrophages. Lymphocytes are white blood cells that produce antibodies that recognize and bind to bacteria, viruses, and other foreign substances. Macrophages destroy these foreign invaders. There are about 600 lymph nodes located throughout the body, with the majority located in the head and neck region. Lymph glands occur in groups and filter the lymphatic fluid that drains from specific regions of the body, trapping and destroying bacteria, viruses, and other potentially harmful substances. They also help maintain the body's fluid balance.



Two common locations of swollen glands are in the neck and the armpit. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Lymph glands in children are normally about 0.4 in (1 cm) in diameter. They cannot be felt with the fingers unless they are swollen. The lymph glands that most often swell are those in the neck, under the jaw and chin, behind the ears, on the back of the head, and in the armpits and groin region. There are chains of lymph nodes on both sides of the front and back of the neck, as well as on each side of the neck. Swollen glands usually indicate that the numbers of lymphocytes in the glands have increased to produce more antibodies for fighting an infection.

Risk factors

Infection is the major risk factor for swollen glands. However, many other diseases and conditions can put a child at risk for swollen glands.

Causes and symptoms

There are numerous causes of swollen glands. An infection—especially a viral infection such as the common cold—is by far the most frequent cause. Infections that can cause swollen glands include:

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- viral infections, such as flu, mononucleosis (mono), chicken pox, measles, rubella, mumps, and cytomegalovirus (CMV)
- bacterial infections, such as strep throat caused by the *Streptococcus pyogenes* bacterium, Lyme disease spread by ticks, tuberculosis (TB), and cat scratch fever
- viral and bacterial sexually transmitted infections (STIs), including syphilis
- parasitic infections such as toxoplasmosis
- mouth sores
- gingivitis, an infection of the gums
- an infected (abscessed or impacted) tooth
- skin infections
- ear infections
- tonsillitis
- infections from cuts, wounds, or animal or insect bites or stings
- a boil or abscess from an infected hair follicle or sweat gland

Other causes of swollen glands include:

- various cancers, especially leukemia, Hodgkin's disease, non-Hodgkin's lymphoma, and breast cancer
- cancers that have spread (metastasized) to lymph nodes
- immune system disorders, such as lupus, rheumatoid arthritis, and HIV/AIDS
- side effects of vaccines, such as immunizations against malaria or typhoid
- side effects of certain medications, such as phenytoin (Dilantin)

The location and type of infection or other condition determine which glands swell. Infections or tumors in the head, mouth, or neck are particularly likely to cause swollen glands:

- A sore throat often causes glands in the neck to swell.
- A tooth, gum, or other mouth infection may cause swollen glands in the jaw or neck.
- Swollen glands at the base of the neck and above the collarbone are indicative of a chest infection or, rarely, a tumor in the chest.
- An infection on the arm may cause glands in the armpit to swell.
- An infected animal bite can cause swollen glands above the wound.

Swollen glands that are soft, tender, and move easily are usually signs of infection or inflammation. Serious infections can cause swollen glands to become very hard and tender. Sudden, painful swelling is usually caused by an injury or early-stage infection. Swollen glands that are caused by **cancer** or a tumor tend to develop gradually and painlessly and remain swollen. They usually do not have other signs of inflammation, such as redness or tenderness. Swelling of glands throughout the body can be caused by a systemic infection, such as mononucleosis or HIV/AIDS, or an immune disorder, such as lupus or **rheumatoid arthritis**.

Swollen glands may be two or three times their normal size and can be readily felt with the fingers. Sometimes the swelling can be seen through the skin. A child's lymph node is considered to be enlarged if it is more than 0.4 in (1 cm) in diameter. Other symptoms of swollen glands include:

- a lump
- tenderness or pain when a gland is pressed
- red, warm, swollen skin over a lymph node
- symptoms of an underlying infection, such as fever, runny nose, mouth sores, or a sore throat
- a swollen limb, which can indicate an enlarged lymph node that is causing a blockage in the lymph system, but is too deep inside the body to feel through the skin

A child with swollen glands should be seen by a pediatrician if:

- the swelling and tenderness last for more than five days
- glands throughout the body appear swollen
- glands enlarge rapidly
- skin over a swollen gland turns red or purple
- the child has a fever above 101°F (38.3°C)
- the child is tired or lethargic or has no appetite

Diagnosis

Examination

During an examination, the healthcare provider feels all of the palpable lymph nodes—those that can be felt through the skin. The lymph glands are examined for size, texture, tenderness, warmth, and firmness. The location of the swollen glands may help diagnose the underlying cause. The **physical examination** includes any other symptoms that are present. Sometimes it is possible to see signs of infection or injury near the swollen gland. The healthcare provider will take a medical history that includes any exposure to infectious agents, recent injuries, and medications.

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KEY TERMS

Antibody—A specific protein produced by the immune system in response to a specific foreign protein called an antigen.

Lymph nodes—Lymph glands; small, round or pea-shaped tissue masses that are distributed along the lymphatic vessels and contain lymphocytes that filter the lymphatic fluid.

Lymphatic system—Consists of lymphatic fluid and vessels, lymph nodes, lymphocytes, and the thymus, spleen, tonsils, and bone marrow. The part of the circulatory system that is responsible for immune responses, that scavenges fluids and proteins and returns them to the blood, and that removes debris and foreign substances.

Lymphocyte—A type of white blood cell that functions in the immune response, including antibody-producing B cells and T cells.

Macrophage—A type of immune system cell that engulfs and destroys antigens and presents them to other immune system cells.

Tests

Infections may require growing (culturing) a sample of a bodily fluid or secretion to identify the causative agent and to select an appropriate antibiotic in the case of a bacterial infection. Sometimes an infected lymph node is drained and cultured. A **tuberculosis** skin test or specific tests to diagnose mononucleosis may be required.

Blood tests to help diagnose the underlying cause of swollen glands may include:

- a complete blood count (CBC)
- a blood differential, which measures the percentages of each type of white blood cell
- liver function tests
- kidney function tests

Procedures

Procedures for diagnosing the underlying cause of swollen glands may include a:

- chest x ray
- liver-spleen scan
- computerized tomography (CT) scan of the affected area

Sometimes a **lymph node biopsy** is necessary for diagnosis, especially for diagnosis of a tumor or a fungal infection. A fine-needle aspiration (FNA), in which a thin, hollow needle is inserted into the node to remove or aspirate cells, may be performed in the physician's office or by a surgeon or radiologist. Ultrasound may be used to guide the needle. A surgical biopsy removes some or all of a lymph node through an incision and is performed under local or **general anesthesia**. The cells or tissue are sent to a laboratory for examination under a microscope.

Treatment

Traditional

Swollen glands most often return to normal on their own once the underlying infection is resolved. Likewise, swollen glands caused by a **vaccination** usually resolve on their own. Swelling caused by a medication may require changing the dose or type of drug. If the gland itself is infected, surgical drainage may be required. Swollen glands caused by an underlying condition such as cancer or an immune system disorder require treatment of the underlying disease.

Drugs

Swollen glands can be treated with over-the-counter **pain** relievers, such as **acetaminophen** (Tylenol) or a nonsteroidal anti-inflammatory drug (NSAID), such as ibuprofen (Advil, Motrin) or naproxen (Aleve). Children should not be given **aspirin** without consulting a physician, due to the unlikely but serious risk of developing **Reye's syndrome**. Swollen glands caused by a bacterial infection are usually treated with **antibiotics**.

Alternative

As with traditional treatments, alternative treatments for swollen glands depend on the cause. For example, many alternative practitioners recommend vitamin C and zinc or herbal remedies, such as *Echinacea* spp., for treating common colds.

Home remedies

A tender or painful swollen gland can be treated with warm, wet compresses. A washcloth wrung out with warm water should be applied for 20–30 minutes, three or four times per day. The heat and moisture can relieve discomfort, increase circulation to the area, localize the infection, and encourage healing. If possible, the gland should be exposed to the air. Swollen glands should not be rubbed, squeezed, scratched, or otherwise irritated. Bed rest also can be helpful for treating swollen glands.

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Prognosis

Swollen glands are rarely serious. Soreness in swollen glands usually disappears within a couple of days without treatment. Swollen glands often return to their normal size as soon as an infection, such as a cold, has resolved. However, it may be several weeks after an infection has cleared before the glands return to their normal size. When swollen glands result from a serious infection or other underlying condition, they may remain enlarged for a long period.

Prevention

Although there are no specific preventative measures for the less frequent causes of swollen glands, there are measures that can help prevent swollen glands caused by infection. Frequent and thorough hand washing, especially during cold and flu season, is one of the best ways to prevent infection. Proper cleaning of **wounds** and prompt treatment with antibiotics, if required, can prevent swollen glands. Measures for preventing skin infections include:

- keeping the skin clean with mild soap or cleanser and lukewarm water
- rinsing thoroughly and gently patting the skin dry after washing
- avoiding irritating skin products
- using water-based and oil-free or hypoallergenic skincare products that do not clog pores
- washing as soon as possible after sweating
- wearing soft, cotton clothing or moleskin under sports equipment to avoid irritation
- avoiding squeezing, scratching, draining, or puncturing swollen glands, so as not to inflame or irritate the glands or push infection deeper into the skin

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American Academy of Family Physicians, 11400 Tomahawk Creek Parkway, Leawood, KS, 66211-2680, (913) 906-6000, (800) 274-6000, (913) 906-6075, http://www.aafp.org.

American Academy of Pediatrics, 141 Northwest Point Blvd., Elk Grove Village, IL, 60007-1098, (874) 434-4000, (874) 434-8000, kidsdocs@aap.org, http://www.aap.org.

Margaret Alic, PhD

Sydenham's chorea

Definition

Sydenham's chorea is an acute but self-limited movement disorder that occurs most commonly in children between the ages of 5 and 15, and occasionally in pregnant women. It is closely associated with **rheumatic fever** following a throat infection. The disorder is named for Thomas Sydenham (1624–1689), an English doctor who first described it in 1686. Other names for Sydenham's chorea include simple chorea, chorea minor, acute chorea, rheumatic chorea, juvenile chorea, and St. Vitus' dance. The English word "chorea" itself comes from the Greek word *choreia*, which means "dance." The disorder takes its name from the rapid involuntary jerking or twitching movements of the patient's face, limbs, and upper body.

Description

Sydenham's chorea is a disorder that occurs in children and is associated with rheumatic **fever**. Rheumatic fever is an acute **infectious disease** caused by certain types of streptococci bacteria. It usually starts with **strep throat** or **tonsillitis**. These types of streptococci are able to cause disease throughout the body. The most serious damage caused by rheumatic fever is to the valves in the heart. At one time, rheumatic fever

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was the most common cause of damaged heart valves, and it still is in most developing countries around the world. Rheumatic fever and rheumatic heart disease are still present in the industrialized countries, but the incidence has dropped substantially.

Both acute rheumatic fever and Sydenham's chorea are relatively uncommon disorders in the United States. According to the Centers for Disease Control and Prevention (CDC), only 1–3% of people with streptococcal throat infections develop acute rheumatic fever (ARF); thus the incidence of ARF in the United States is thought to be about 0.5 per 100,000 patients between 5 and 17 years of age.

With regard to age, the incidence of Sydenham's chorea is higher in childhood and adolescence than in adult life. It occurs more frequently in females than in males; the gender ratio is thought to be about 2 F: 1 M. Since the peak incidence of rheumatic fever in North America occurs in late winter and spring, Sydenham's chorea is more likely to occur in the summer and early fall. There is no evidence that the disorder selectively affects specific racial or ethnic groups.

Rheumatic fever may appear in several different forms. Sydenham's chorea is one of five major criteria for the diagnosis of rheumatic fever. There are also four minor criteria and two types of laboratory tests associated with the disease. The "Jones criteria" define the diagnosis. They require laboratory evidence of a streptococcal infection plus two or more of the criteria. The laboratory evidence may be identification of streptococci from a **sore throat** or antibodies to streptococcus in the blood. The most common criteria are arthritis and heart disease, occurring in half to three-quarters of the patients. Sydenham's chorea, characteristic nodules under the skin, and a specific type of skin rash occur only 10% of the time.

About 20% of patients diagnosed with Sydenham's chorea experience a recurrence of the disorder, usually within two years of the first episode. Most women who develop Sydenham's during **pregnancy** have a history of acute rheumatic fever in childhood or of using birth control pills containing estrogen.

Causes and symptoms

Sydenham's is caused by certain types of streptococci called Group A beta-hemolytic streptococci or GAS bacteria. In general, streptococci are spherical-shaped anaerobic bacteria that occur in pairs or chains. GAS bacteria belong to a subcategory known as pyogenic streptococci, which means that the infections they cause produce pus. These particular germs seem to be able to create an immune response that attacks the body's own tissues along with the germs. Those tissues are joints, heart valves, skin, and brain.

The initial throat infection that leads to Sydenham's chorea is typically followed by a symptom-free period of 1–5 weeks. The patient then develops an acute case of rheumatic fever (ARF), an inflammatory disease that affects multiple organ systems and tissues of the body. In most patients, ARF is characterized by fever, arthritis in one or more joints, and carditis, or inflammation of the heart. In about 20% of patients, however, Sydenham's chorea is the only indication of ARF. Sydenham's is considered a delayed complication of rheumatic fever; it may begin as late as 12 months after the initial sore throat, and it may start only after the patient's temperature and other physical signs have returned to normal. The average time interval between the pharyngitis and the first symptoms of Sydenham's, however, is eight or nine weeks.

It is difficult to describe a "typical" case of Sydenham's chorea because the symptoms vary in speed of onset as well as severity. Most patients have an acute onset of the disorder, but in others, the onset is insidious, which means that the symptoms develop slowly and gradually. In some cases, the child's physical symptoms are present for 4–5 weeks before they become severe enough for the parents to consult a doctor. In other cases, emotional or psychiatric symptoms precede the clumsiness and involuntary muscular movements that characterize the disorder. The psychiatric symptoms that may develop in patients with Sydenham's chorea are one reason why it is sometimes categorized as a PANDAS disorder. PANDAS stands for Pediatric Autoimmune Neuropsychiatric Disorders Associated with Streptococcal Infections.

Behavioral or emotional disturbances that have been observed with Sydenham's include:

- frequent mood changes
- episodes of uncontrollable crying
- behavioral regression; that is, acting like much younger children
- mental confusion
- general irritability
- difficulty concentrating
- impulsive behavior

Some researchers think that children who have had Sydenham's are at increased risk of developing **obsessive-compulsive disorder** (OCD). OCD is characterized by obsessions, which are unwanted recurrent thoughts, images, or impulses, and by compulsions, which are repetitive rituals, mental acts, or behaviors. Obsessions in children often take the form of fears of intruders or

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KEY TERMS

Arthralgia—Joint pain.

Chorea—A term that is used to refer to rapid, jerky, involuntary movements of the limbs or face that characterize several different disorders of the nervous system, including chorea of pregnancy and Huntington's chorea as well as Sydenham's chorea.

Electrocardiogram—Mapping the electrical activity of the heart.

Insidious—Developing in a stealthy or gradual manner. Sydenham's chorea may have an insidious onset.

PANDAS disorders—A group of childhood disorders associated with such streptococcal infections as scarlet fever and "strep throat." The acronym stands for Pediatric Autoimmune Neuropsychiatric Disorders Associated with Streptococcal Infections. Sydenham's chorea is considered a PANDAS disorder.

Pharyngitis—Inflammation of the throat, accompanied by dryness and pain. Pharyngitis caused by a streptococcal infection is the usual trigger of Sydenham's chorea.

Rheumatic fever—Chiefly childhood disease marked by fever, inflammation, joint pain, and Syndenham's chorea. It is often recurrent and can lead to heart valve damage.

St. Vitus' dance—Another name for Sydenham's chorea. St. Vitus was a fourth-century martyr who became the patron saint of dancers and actors during the Middle Ages. He was also invoked for protection against nervous disorders, epilepsy, and the disease that bears his name.

Streptococcus (plural, streptococci)—A genus of spherical-shaped anaerobic bacteria occurring in pairs or chains. Sydenham's chorea is considered a complication of a streptococcal throat infection.

Tonsillitis—Inflammation of the tonsils, which are in the back of the throat.

harm coming to a family member. Compulsions may include such acts as counting silently, washing the hands over and over, insisting on keeping items in a specific order, checking repeatedly to make sure a door is locked, and similar behaviors.

Diagnosis

Because rheumatic fever is such a damaging disease, a complete evaluation should be done whenever it is suspected. This includes cultures for streptococci, blood tests, and usually an electrocardiogram (heartbeat mapping to detect abnormalities).

The diagnosis of Sydenham's is also based on the doctor's observation of the patient's involuntary movements. Unlike tics, the movements associated with chorea are not repetitive; and unlike the behavior of hyperactive children, the movements are not intentional. The recent onset of the movements rules out a diagnosis of **cerebral palsy**. If the doctor suspects Sydenham's, he or she may ask the patient to stick out the tongue and keep it in that position, or to squeeze the doctor's hand. Many patients with Sydenham's cannot hold their mouth open and keep the tongue out for more than a second or two. Another characteristic of Sydenham's is an inability to grip with a steady pressure; when the patient squeezes the doctor's hand, the strength of the grip will increase and decrease in an erratic fashion. This characteristic is sometimes called the "milking sign."

Treatment

Suspected streptococcal infections must be treated. All the other manifestations of rheumatic fever, including Sydenham's chorea and excluding heart valve damage, remit with the acute disease and do not require treatment. Sydenham's chorea generally lasts for several months.

Most patients with Sydenham's chorea recover after a period of bed rest and temporary limitation of normal activities. In most cases the symptoms disappear gradually rather than stopping abruptly.

Most doctors recommend ongoing treatment with penicillin to prevent a recurrence of rheumatic fever or Sydenham's chorea, although there is some disagreement as to whether this treatment should continue for 5 years after an acute attack or for the rest of the patient's life. The penicillin may be given orally or by injection. Patients who cannot take penicillin may be given erythromycin or sulfadiazine.

Prognosis

Syndenham's chorea usually clears up without complications when the rheumatic fever is treated. The heart valve damage associated with rheumatic fever may lead to heart trouble and require a surgical valve repair or replacement.

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In most cases of Sydenham's, the patient recovers completely, although a recurrence is possible. In a very few cases—about 1.5% of patients diagnosed with Sydenham's— there may be increasing muscle stiffness and loss of muscle tone resulting in disability. This condition is occasionally referred to as paralytic chorea

Prevention

All cases of strep throat in children should be treated with a full 10 days of **antibiotics** (penicillin or erythromycin). Treatment may best be delayed a day or two to allow the body to build up its own antibodies. In addition, for those who have had an episode of rheumatic fever or have damaged heart valves from any other cause, prophylactic antibiotics should be continued to prevent recurrence.

It is possible to eradicate dangerous GAS bacteria from a community by culturing everyone's throat and treating everyone who tests positive. This is worth doing wherever a case of rheumatic fever appears, but it is expensive and requires many resources.

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ORGANIZATIONS

American Academy of Child and Adolescent Psychiatry (AACAP), 3615 Wisconsin Ave. NW, Washington, DC, 20013-3007, (202) 966-7300, (202) 966-2891, communications@aacap.org, http://www.aacap.org/.

American Academy of Family Physicians (AAFP), 11400 Tomahawk Creek Parkway, Leawood, KS, 66211-2680, (913) 906-6000, (913) 906-6075, (800) 271-2237, http://www. aafp.org/.

National Institute of Neurological Disorders and Stroke (NINDS), NIH Neurological Institute, P. O. Box 5801, Bethesda, MD, 20824, (301) 496-5751, (800) 352-9424, http://www.ninds.nih.gov/.

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Sympathectomy

Definition

Sympathectomy is a surgical procedure that destroys nerves in the sympathetic nervous system. The procedure is done to increase blood flow and decrease long-term **pain** in certain diseases that cause narrowed blood vessels. It can also be used to decrease excessive sweating. This surgical procedure cuts or destroys the sympathetic ganglia, collections of nerve cell bodies in clusters along the thoracic or lumbar spinal cord.

Purpose

The autonomic nervous system that controls unwilled (involuntary) body functions, such as breathing, sweating, and blood pressure, are divided into the sympathetic and the parasympathetic nervous systems. The sympathetic nervous system speeds the heart rate, narrows (constricts) blood vessels, and raises blood pressure. Blood pressure is controlled by means of nerve cells that run through sheaths around the arteries. The sympathetic nervous system can be described as the "fight or flight" system because it allows us to respond to danger by fighting off an attacker or by running away. When danger threatens, the sympathetic nervous system increases heart and respiratory rate, increases blood flow to muscles, and decreases blood flow to other areas, such as skin, digestive tract, and limb veins. The net effect is an increase in blood pressure.

Sympathectomy is performed to relieve intermittent constricting of blood vessels (**ischemia**) when the fingers, toes, ears, or nose are exposed to cold (Raynaud's phenomenon). In Raynaud's phenomenon, the affected extremities turn white, then blue, and red as the blood

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supply is cut off. The color changes are accompanied by **numbness**, **tingling**, burning, and pain. Normal color and feeling are restored when heat is applied. The condition sometimes occurs without direct cause but it is more often caused by an underlying medical condition, such as **rheumatoid arthritis**. Sympathectomy is usually less effective when Raynaud's is caused by an underlying medical condition. Narrowed blood vessels in the legs that cause painful cramping (claudication) are also treated with sympathectomy.

Sympathectomy may be helpful in treating **reflex sympathetic dystrophy** (RSD), a condition that sometimes develops after injury. In RSD, the affected limb is painful (causalgia) and swollen. The color, temperature, and texture of the skin change. These symptoms are related to prolonged and excessive activity of the sympathetic nervous system.

Because sweating is controlled by the sympathetic nervous system, sympathectomy is also effective in treating excessive sweating (**hyperhidrosis**) of the palms, armpits, or face.

Precautions

To determine whether sympathectomy is needed, a reversible block of the affected nerve cell (**ganglion**) should be done. A reversible ganglion block interrupts nerve impulses by means of steroid and anesthetic injected into it. If the block has a positive effect on pain and blood flow in the affected area, the sympathectomy will probably be helpful. The surgical procedure should be performed only if conservative treatment has not worked. Conservative treatment includes avoiding exposure to **stress** and cold, **physical therapy**, and medications.

Sympathectomy is most likely to be effective in relieving the pain of reflex sympathetic dystrophy if it is done soon after the injury occurs. However, increased benefit from early surgery should be balanced against time needed to promote spontaneous recovery and response to conservative treatment.

Description

Sympathectomy was traditionally done as an inpatient surgical procedure under **general anesthesia**. An incision was made on the mid-back, exposing the ganglia to be cut. Recent techniques are less invasive and may be done under **local anesthesia** and as outpatient surgery. If only one arm or leg is affected, it may be treated with a percutaneous radiofrequency technique. In this technique, the surgeon locates the ganglia by a combination of x ray and electrical stimulation. The ganglia are destroyed by applying radio waves through electrodes on the skin.

Sympathectomy for hyperhidrosis can be done by making a small incision under the armpit and introducing air into the chest cavity. The surgeon inserts a fiber optic tube (endoscope) that projects an image of the operation on a video screen. The ganglia can then be cut with fine scissors attached to the endoscope. Laser beams can also be used to destroy the ganglia.

Preparation

As with any surgery, patients should discuss expected results and possible risks with their surgeons. They should tell their surgeons all medications they are taking and all their medical problems, and they should be in good general health. To improve general health, the patient may be asked to lose weight, give up **smoking** or alcohol, and get the proper sleep, diet, and **exercise**. Immediately before the surgery, patients will not be permitted to eat or drink, and the surgical site will be cleaned and scrubbed.

Aftercare

The surgeon will inform the patient about specific aftercare needed for the technique used. **Doppler ultrasonography**, a test using sound waves to measure blood flow, can help to determine whether sympathectomy has had a positive result.

Risks

Side effects of sympathectomy may include decreased blood pressure while standing, which may cause **fainting** spells. After sympathectomy in men, semen is sometimes ejaculated into the bladder, which may impair fertility. After a sympathectomy done by inserting an endoscope in the chest cavity, patients may experience chest pain with deep breathing. This problem usually disappears within two weeks. They may also experience **pneumothorax** (air in the chest cavity).

In 30% of cases, surgery for hyperhidrosis may cause increased sweating on the chest. In 2% of cases, this surgery causes increased sweating in other areas, including increased facial sweating while eating. Other complications occur less frequently. These complications include Horner's syndrome, a condition of the nervous system that causes the pupil of the eye to close, the eyelid to droop, and sweating to decrease on one side of the face. Other rare complications are nasal blockage and pain of the nerves supplying the skin between the ribs.

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KEY TERMS

Causalgia—A severe burning sensation sometimes accompanied by redness and inflammation of the skin. Causalgia is caused by injury to a nerve outside the spinal cord.

Claudication—Cramping or pain in a leg caused by poor blood circulation. This condition is frequently caused by hardening of the arteries (atherosclerosis). Intermittent claudication occurs only at certain times, usually after exercise, and is relieved by rest.

Fiberoptics—In medicine, fiberoptics uses glass or plastic fibers to transmit light through a specially designed tube. The tube is inserted into organs or body cavities where it transmits a magnified image of the internal body structures.

Hyperhidrosis—Excessive sweating. Hyperhidrosis can be caused by heat, overactive thyroid glands, strong emotion, menopause, or infection.

Parasympathetic nervous system—The division of the autonomic (involuntary or unwilled) nervous system that slows heart rate, increases digestive and gland activity, and relaxes the sphincter muscles that close off body organs.

Percutaneous—Performed through the skin, from the Latin *per*, meaning through and *cutis*, meaning skin.

Pneumothorax—A collection of air or gas in the chest cavity that causes a lung to collapse. Pneumothorax may be caused by an open chest wound that admits air.

Normal results

Some studies report that sympathectomy relieves causalgia in as many as 75% of cases. The studies also show that it relieves hyperhidrosis in more than 90% of cases. The less invasive procedures cause very little scarring. Most patients stay in the hospital for less than one day and return to work within the week.

Resources

OTHER

The American Institute for Hyperhidrosis Page. http://www.handsweat.com.

Laurie Barclay, MD

Syncope *see* **Fainting**
Syndactyly *see* **Polydactyly and syndactyly**
Synergistic gangrene *see* **Flesh-eating disease**
Synovial fluid analysis *see* **Joint fluid analysis**
Synovial membrane biopsy *see* **Joint biopsy**

Syphilis

Definition

Syphilis is a sexually transmitted disease (STD) caused by the spirochete bacterium *Treponema pallidum*. The infection is acquired through direct—usually sexual—contact with a syphilis sore. It also can be transmitted from a mother to her child either before or during birth. Untreated syphilis is a systemic, potentially fatal disease that can cause permanent damage to the heart and central nervous system.

Demographics

Syphilis has been a serious public health problem since at least the sixteenth century. Some estimates place the number of worldwide syphilis cases at about 50 million annually. However the incidence of syphilis varies greatly from one region to another and even within small geographical areas.

There were almost 41,000 new cases of syphilis reported in the United States in 2007. This included 11,466 cases of primary and secondary syphilis, 10,768 cases of early-latent syphilis, 18,256 cases of late-latent syphilis, and 430 cases of congenital syphilis in newborns. This is the highest number of new cases since 1997, but far less than the more than 135,000 new cases in 1990 and the more than 575,000 new cases reported in 1943. In 2007 the incidence of syphilis in the United States was 13.7 per 100,000 people, compared with 447 per 100,000 in 1943. These dramatic decreases are attributable to vastly improved treatment and prevention, as well as increased public awareness. The South accounts for almost half of all syphilis cases in the United States and only a small number of counties and urban areas account for the vast majority of cases.

In the United States syphilis primarily affects people aged 20–39. The highest numbers of cases are in women aged 20–24 and in men aged 35–39. Syphilis rates are highest among black Americans. In 2007 males

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This patient has secondary syphilis, evidenced by the appearance of lesions on the skin. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

accounted for six times the number of new syphilis cases as women. Men who have sex with men (MSM) account for more than 60% of cases. The increase in syphilis cases attributable to MSM increased from 4% in 2000 to 65% in 2007. Syphilis has been closely associated with HIV infection since the late 1980s. Syphilis makes it easier to transmit and acquire HIV. The incidence of syphilis is also high among crack **cocaine** users.

Description

Although the origin of syphilis remains controversial, evidence suggests that *Treponema* bacteria were brought to Europe from the New World with the return of Christopher Columbus's ships. Syphilis, which is also called lues from a Latin word meaning **plague**, was treated with mercury and other dangerous substances until World War I, when more effective treatments based on arsenic or bismuth were introduced. After World War II penicillin became available to cure syphilis and the incidence of the disease began to decline.

About 90% of syphilis cases are contracted through sexual contact, usually from people who are unaware that they have the disease. Syphilis is sometimes called the "great imposter," because its symptoms—when present at all—resemble those of various other diseases.

Syphilis is transmitted through direct contact with a syphilis sore, usually through vaginal, anal, or oral sex. Sores usually occur on the external genitals or in the vagina, anus, or rectum, but also can occur on the lips and in the mouth. The chances of contracting syphilis during unprotected sex with a person who has an early stage of the disease are 30–50%. The bacteria also can be transmitted by touching infected sores or using contaminated needles to inject drugs. Babies of infected mothers can be born with congenital syphilis. Transmission through a blood **transfusion** is very rare because the bacterium cannot survive for more than 24 hours in stored blood and blood products are screened for the bacteria. Syphilis cannot be spread through toilet seats, doorknobs, swimming pools, hot tubs, bathtubs, shared clothing, or eating utensils. *T. pallidum* is easily killed by heat and drying.

Syphilis has both acute and chronic phases that produce a wide variety of symptoms affecting most of the body's organ systems. The range of symptoms makes it easy to ignore early signs or to confuse it with less serious diseases. Syphilis that is acquired through sexual contact has four stages—primary, secondary, latent, and tertiary. The bacteria can be spread by sexual contact during the first three stages. Although latent syphilis has few external symptoms, the disease continues to progress. Patients with tertiary syphilis cannot infect others.

Syphilis can be transmitted from an infected mother to her fetus through the placenta at any time during **pregnancy** or through contact with syphilitic ulcers during the birth process. The chances of infection depend on the stage of the mother's disease. Almost all infants born to mothers with untreated primary or secondary syphilis will be infected. If a woman has untreated syphilis acquired within four years of a pregnancy, there is an 80% risk that the newborn will have congenital syphilis. However the infection rate drops to 40% if the mother's disease is in the early-latent stage and to 6–14% if she has late-latent syphilis.

Untreated syphilis can have devastating consequences:

- Syphilis appears to increase a man's risk of developing prostate cancer in later life.
- Cardiovascular syphilis occurs in 10–15% of patients with tertiary syphilis.
- About 8% of those with untreated syphilis develop neurosyphilis 5–35 years after the onset of the primary infection. This central nervous system disease has both physical and psychiatric consequences. It affects men more frequently than women and Caucasians more frequently than blacks.
- General paresis, also called dementia paralytica, results from neurosyphilis and is most common in patients over age 40.

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Risk factors

In the United States and Canada, populations at high risk for syphilis include:

- sexually abused children
- sexually active teenagers
- MSM
- women of childbearing age
- prisoners
- abusers of drugs or alcohol
- prostitutes of either sex and their customers
- those infected with another sexually transmitted infection (STI), including HIV/AIDS

Drug **abuse** can increase the risk of syphilis because of needle sharing and the exchange of sex for drugs. In addition, people abusing drugs or alcohol are more likely to engage in risky sexual practices.

Causes and symptoms

T. pallidum is a thin, spiral- or coil-shaped bacterium that enters the body through mucous membranes or breaks in the skin to cause primary syphilis. The first signs of infection often go unnoticed. After an incubation period of 10–90 days chancres may develop. These are small blister-like sores about 0.5 in (13 mm) in size. They resemble the ulcers of chlamydia infection, **genital herpes**, or skin tumors. Most chancres are on the genitals, but they also can develop on the breasts or lips or in the mouth. Rectal chancres are common in MSM. Chancres in a woman's vagina or on her cervix are easily overlooked. Chancres are not painful and disappear in three to six weeks without treatment. About 70% of patients with primary syphilis develop swollen lymph nodes near the chancre. The nodes may feel firm or rubbery but are not usually painful.

The disease continues to progress even in the complete absence of symptoms. Secondary syphilis begins between six weeks and six months after infection. Chancres may still be present but are usually healing. Secondary syphilis is a systemic infection marked by the eruption of skin **rashes** and ulcers in the mucous membranes. The skin rash may resemble other skin disorders such as drug reactions, **rubella**, **ringworm**, mononucleosis, or **pityriasis rosea**. Characteristics of a syphilis rash include:

- coppery color
- absence of pain or itching
- occurrence on the palms of the hands and soles of the feet

The skin eruptions may resolve in a few weeks or last as long as a year. Some patients develop condylomata lata—weepy, pinkish or grey patches of flattened skin on moist areas of the body. The skin rashes, mouth and genital ulcers, and condylomata lata are all highly contagious.

About 50% of patients with secondary syphilis develop swollen lymph nodes in the armpits, groin, and neck; about 10% develop inflammations of the eyes, kidney, liver, spleen, bones, joints, or the meninges—membranes covering the brain and spinal cord. Patients also may have flu-like symptoms, including low **fever**, chills, loss of appetite, **headache**, runny nose, **sore throat**, and aching joints.

The latent phase of syphilis is divided into early latency, occurring less than two years after infection, and late latency. During early latency patients are at risk for spontaneous recurrences of the ulcers and skin rashes of secondary syphilis. In late latency these recurrences are much less common. Late latency can either resolve spontaneously or continue for the remainder of the patient's life.

About 35–40% of untreated syphilis cases progress to the tertiary stage. Tertiary syphilis can be either benign late syphilis or cardiovascular and/or neurosyphilis.

Benign late syphilis begins three to ten years after infection and is characterized by the development of gummas. These are rubbery tumor-like growths that usually involve the skin or long bones, but also can develop in the eyes, mucous membranes, throat, liver, or stomach lining. Gummas have become uncommon since the introduction of **antibiotics** for treating syphilis. Benign late syphilis is usually rapid in onset and responds well to treatment.

Cardiovascular syphilis develops between 10 and 25 years after infection and often occurs along with neurosyphilis. It usually begins as an inflammation of the arteries leading from the heart and causes heart attacks, scarring of the aortic valves, congestive **heart failure**, or an **aortic aneurysm**.

There are four types of neurosyphilis:

- Asymptomatic neurosyphilis causes no central nervous system symptoms but can be detected in the spinal fluid.
- Meningovascular neurosyphilis is characterized by changes in the blood vessels of the brain or inflammation of the meninges. It causes headaches, irritability, and visual problems. If the spinal cord is involved, the patient may experience weakness of the shoulder and upper arm muscles.
- Tabes dorsalis is a progressive degeneration of the spinal cord and nerve roots, causing a loss of perception of body position and orientation in space and resulting

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KEY TERMS

Chancre—An open sore with a firm or hard base that is the initial skin ulcer of primary syphilis.

Condylomata lata—Highly infectious patches of weepy, pink or gray skin in moist areas of the body that occur during secondary syphilis.

Dark field—A microscopy technique in which light is directed at an oblique angle so that organisms appear bright against a dark background.

General paresis—An advanced form of neurosyphilis affecting personality and control of movement and possibly causing convulsions or partial paralysis.

Gumma—A rubbery swelling or tumor that heals slowly and leaves a scar and is a symptom of tertiary syphilis.

Jarisch-Herxheimer reaction—A temporary reaction to penicillin treatment for syphilis that includes fever, chills, and worsening of the skin rash or chancre.

Lues maligna—Areas of ulcerated and dying skin tissue that may occur with secondary syphilis, most frequently in HIV-positive patients.

Meninges—The membranes that cover the brain and spinal cord.

Miasm—In homeopathy, an inherited weakness or predisposition to disease. The syphilitic miasm is considered to be one of the most powerful.

Neurosyphilis—Syphilis of the central nervous system.

Nosode—A homeopathic remedy made from microbes, pus, or other disease material. Syphilinum is a nosode made from a diluted solution of killed *T. pallidum*.

Spirochete—A long, slender, coiled-shape bacterium, such as *T. pallidum* that causes syphilis.

Tabes dorsalis—A progressive deterioration of the spinal cord and spinal nerves that is associated with tertiary syphilis.

Treponema pallidum—The spirochete bacterium that causes syphilis.

in loss of muscle reflexes and difficulty walking. Patients may have shooting pains in the legs and periodic episodes of pain in the abdomen, throat, bladder, or rectum. Tabes dorsalis is sometimes called locomotor ataxia.

- General paresis affects the cortex of the brain, with slow, progressive memory loss, inability to concentrate, and loss of interest in self-care. Personality changes may include irresponsible behavior, depression, delusions of grandeur, or complete psychosis.

Syphilis sometimes mimics the symptoms of HIV/AIDS. Conversely HIV/AIDS appears to increase the severity of syphilis in patients suffering from both diseases and to speed the development or appearance of neurosyphilis. Patients with both syphilis and HIV/AIDS also are more likely to develop lues maligna, a skin condition that sometimes occurs in secondary syphilis and is characterized by areas of ulcerated and dying tissue.

Infants with early congenital syphilis have systemic symptoms that resemble those of secondary syphilis in adults. The central nervous system is affected in 40–60% of children with congenital syphilis. Symptoms include:

- skin rashes
- condylomata lata
- inflammation of the lungs
- persistent runny nose
- swollen lymph nodes
- jaundice
- enlargement of the spleen and liver
- anemia

Symptoms of late congenital syphilis develop after age two and include:

- facial deformities (saddle nose)
- Hutchinson's teeth (abnormal upper incisors)
- saber shins
- dislocated joints
- deafness
- mental retardation
- paralysis
- seizure disorders

Diagnosis

Examination

Diagnosis of syphilis is often delayed:

- The initial chancre may go unnoticed.
- There are wide variations in early symptoms.
- The incubation period varies greatly.

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- Patients often do not connect their symptoms with recent sexual contact.

The skin rash of secondary syphilis is sometimes the first symptom to be diagnosed. Women may be diagnosed in the course of a routine gynecological exam. While taking a medical history, the physician will ask about recent sexual contacts to determine whether the patient falls into a high-risk group. Symptoms such as skin rashes or swollen lymph nodes will be noted with respect to the timing of a patient's sexual contacts.

Tests

The definitive diagnosis of syphilis depends on laboratory test results. Various tests also are used as screens for syphilis and for follow-up monitoring after treatment. Because of the long-term risks of untreated syphilis, groups of people are routinely screened for the disease:

- marriage-license applicants
- pregnant women
- children born to infected mothers
- patients with HIV/AIDS
- sexual contacts or partners of patients diagnosed with syphilis

Nontreponemal antigen tests are used as screens for syphilis. They measure the presence of reagin, an antibody formed in reaction to *T. pallidum*. In the venereal disease research laboratory (VDRL) test, a sample of the patient's blood serum is mixed with cardiolipin and cholesterol. The formation of clumps indicates a positive reaction. The serum sample can be diluted to determine the concentration of reagin in the patient's blood. The rapid plasma reagin (RPR) test is a kit in which the serum is mixed with cardiolipin on a plastic-coated card that can be examined with the naked eye. Nontreponemal antigen tests require interpretation and sometimes further testing. They can yield both false-negative and false-positive results. False negatives can occur when patients are tested too soon after exposure to syphilis, since it takes about 14–21 days for antibodies to become detectable after infection. False-positive results can be caused by other diseases, including mononucleosis, **malaria**, **leprosy**, **rheumatoid arthritis**, and lupus. Whereas the overall rate of false positives is 0.8%, the rate of false positives in HIV/AIDS patients is about 4%.

Treponemal antibody tests are used to rule out false-positive results on nontreponemal screening tests. They are more expensive and complicated than nontreponemal tests, but are very specific and sensitive. They measure the presence of antibodies that are specific for *T. pallidum*. These tests include:

- the microhemagglutination-*T. pallidum* (MHA-TP) test, in which sheep red blood cells are coated with *T. pallidum* antigen; the cells clump if the patient's blood contains specific antibodies against the antigen
- the fluorescent treponemal antibody absorption (FTA-ABS) test, in which antibodies in the blood are used to coat *T. pallidum* on a slide and a fluorescein dye causes the coated spirochetes to fluoresce under ultraviolet (UV) light
- the INNO-LIA test—the most accurate antibody test—which uses recombinant and peptide antigens derived from *T. pallidum*

T. pallidum also can be identified in samples of tissue or lymphatic fluid. Slides of fresh samples are examined under microscopic dark-field illumination or slides of dried smears are stained with fluorescein and viewed under UV light.

A high **white blood cell count** and elevated protein levels in the cerebrospinal fluid (CSF) may suggest neurosyphilis. VDRL or FTA-ABS tests of the CSF are used to diagnose:

- neurosyphilis
- congenital syphilis
- syphilis in HIV/AIDS patients
- patients who are not responding to treatment with penicillin

Patients who test positive for syphilis are tested for HIV infection at the time of diagnosis. All sexual partners of a diagnosed patient must be tested for syphilis.

Treatment

Drugs

Syphilis is treated with antibiotics, either injected intramuscularly (benzathine penicillin G or ceftriaxone) or administered orally (doxycycline, minocycline, tetracycline, or azithromycin). In the vast majority of cases a single dose of penicillin is sufficient to cure primary and secondary syphilis. Penicillin is less effective in treating later stages and additional doses may be necessary. Neurosyphilis is treated with a combination of aqueous crystalline penicillin G, benzathine penicillin G, or doxycycline. The levels of penicillin in the patient's body must be kept sufficiently high over a period of days or weeks because *T. pallidum* has a relatively long reproduction time. Follow-up blood tests should be performed every three months to confirm that the patient is completely cured.

Pregnant women with syphilis are treated with tetracycline as early in pregnancy as possible. Infants with proven or suspected congenital syphilis are treated with

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either aqueous crystalline penicillin G or aqueous procaine penicillin G. Children who acquire syphilis after birth are treated with benzathine penicillin G.

Jarisch-Herxheimer reaction may occur during penicillin treatment for late-primary, secondary, or early-latent syphilis. The patient develops chills, fever, headache, and muscle pains within two to six hours after the penicillin injection and the chancre or rash temporarily worsens. The reaction lasts about one day and is thought to be an allergic reaction to the toxins that are released as massive numbers of spirochetes are destroyed.

Alternative

The historical link between homeopathy and syphilis is Hahnemann's theory of miasms, which labeled the syphilitic miasm as the second-oldest cause of constitutional weakness in humans. Homeopathic practitioners in the United States are banned from claiming that their treatments can cure syphilis. However because of the high incidence of syphilis in HIV/AIDS patients, some alternative practitioners claim that their homeopathic remedies for **AIDS** also are beneficial in treating syphilis. The most frequently suggested remedies are *Medorrhinum*, *Aurum*, *Mercurius vivus*, and *Syphilinum*. The use of *Mercurius vivus* reflects the historical use of mercury to treat syphilis. *Syphilinum* is in a class of homeopathic remedies called nosodes, which are made from disease material, such as bacteria, viruses, or pus. *Syphilinum* is made from a dilution of killed *T. pallidum*.

Certain outdated or discredited treatments for syphilis have resurfaced as alternative treatments for HIV/AIDS and **cancer**. Hyperthermia—inducing a fever to treat HIV/AIDS—originated as a treatment for syphilis, in which patients were infected with malaria in an attempt to kill *T. pallidum*. The Hoxsey treatment for cancer, which is no longer legally available in the United States, was developed in the 1920s by Harry Hoxsey and prescribed as a treatment for secondary and tertiary syphilis. The treatment consists of several chemical mixtures applied externally and a formula of nine herbs taken internally. The external formulation contains both arsenic and antimony, which were used to treat syphilis before the advent of antibiotics. The internal herbal formula includes *Phytolacca americana*, or pokeweed, which was used by Native Americans to treat syphilitic chancres, and *Stillingia sylvatica*, or queensroot, which was used in the past to treat syphilis. All of these components are potentially toxic and should not be used to treat syphilis.

Traditional Chinese medicine (TCM) and other alternative approaches emphasize the mental aspects of diseases such as syphilis. Alternative practitioners may recommend mind-body medicine, **guided imagery**, and affirmations as adjuncts to antibiotic treatment for syphilis.

Home remedies

Although antibiotics are essential for the treatment of syphilis, recovery can be aided by good dietary habits, adequate sleep, **exercise**, and stress-reduction techniques. Skin rashes and ulcers should be kept clean and dry. Patients must abstain from sexual contact until their disease has been cured. Other people should not be exposed to fluid or discharges from chancres, skin ulcers, rashes, or condylomata lata.

Prognosis

Antibiotics—especially penicillin—cure early-stage syphilis quickly and effectively. Treatment failures do occur, especially in HIV/AIDS patients treated with penicillin. Patients also can be re-infected. Patients should be followed up with blood tests at one, three, six, and 12 months after treatment or until the results are negative. CSF should be tested after one year. Patients with primary and secondary syphilis who remain symptom-free and have negative blood tests for two years after treatment are usually considered cured. Patients with recurrences during the latency period should be tested for re-infection.

In patients with untreated syphilis:

- About 30% undergo spontaneous remission.
- About 30% have lifelong latency.
- About 40% develop potentially fatal tertiary forms of syphilis.

Proper treatment for maternal syphilis during the second and third trimesters of pregnancy reduces the risk of congenital syphilis in the infant from 90% to less than 2%. However nearly 50% of untreated fetuses die shortly before or after birth. Those who survive may appear normal at birth but show signs of infection between three and eight weeks of age.

Prevention

Prevention of syphilis depends on a combination of personal and public health measures. Patients with syphilis do not acquire lasting immunity against the disease, so they can be easily re-infected. The only reliable methods for preventing transmission of syphilis are sexual abstinence or a monogamous relationship between uninfected partners. **Condoms** reduce the risk of transmission but protect only the covered parts of the genitals. The general public needs to be informed about the transmission and early symptoms of syphilis

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and public health facilities must provide for adequate testing and treatment.

U.S. law requires the reporting of all syphilis cases to public health agencies. Sexual contacts of patients diagnosed with syphilis are traced and tested for the disease. This includes all contacts in the past three months for cases of primary syphilis and in the past year for cases of secondary syphilis. Neither patients nor their contacts should have sexual contact until they have been tested and treated. Patients should be informed about the disease and counseled regarding sexual behavior, safe sexual practices, and the importance of completing antibiotic treatment. In addition:

- Sexually active adolescents should be routinely screened for syphilis.
- Pregnant women should be tested for syphilis at the time of their first prenatal visit and again shortly before delivery.
- Many obstetricians and gynecologists recommend the routine screening of non-pregnant women.
- Because of the rising incidence of syphilis worldwide, many public health physicians recommend routine screening of immigrants, refugees, and international adoptees.

In 2006 the Centers for Disease Control and Prevention (CDC) announced an update to its "National Plan to Eliminate Syphilis in the United States:"

- investing and enhancing public health services and interventions for syphilis treatment
- prioritizing and targeting interventions for high-risk populations, such as African Americans and MSM
- improving the accountability of prevention efforts

Resources

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ORGANIZATIONS

American Social Health Association, P.O. Box 13827, Research Triangle Park, NC, 27709, (919) 361-8400, (800) 227-8922, (919) 361-8425, info@ashastd.org, http://www.ashastd.org.

National Institute of Allergy and Infectious Diseases (NIAID), Office of Communications and Public Liaison, 6610 Rockledge Drive, Bethesda, MD, 20892-66123, (866) 284-4107, http://www3.niaid.nih.gov.

U.S. Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) CDC-INFO (232-4636), cdcinfo@cdc.gov, http://www.cdc.gov.

Rebecca J. Frey, PhD
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Systemic antifungal drugs *see* **Antifungal drugs, systemic**

Systemic lupus erythematosus

Definition

Lupus is an autoimmune disorder that may damage body tissues and lead to widespread, chronic inflammation and **pain** during periods of worsened symptoms called flares. Lupus can cause problems with multiple body systems and organs, including the joints, skin,

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A close-up view of a woman's face with a lesion caused by systemic lupus erythematosus (SLE). One characteristic of this autoimmune disease is a butterfly rash present across the cheeks and nose. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

kidneys, heart, lungs, and blood vessels. Although lupus cannot be cured, it is treatable with medications and other therapies.

Description

Lupus is an autoimmune disease. Normally, the white blood cells in the body's immune system protect a person from harmful substances called antigens. Antigens may include bacteria, viruses, foreign blood, **cancer** cells, and other toxins that could cause disease or infection. To defend the body against antigens, the body produces antibodies. In a person with a healthy immune system, the antibodies then destroy the antigens, keeping the person from getting sick.

In people with autoimmune diseases, however, the immune system cannot tell the difference between an antigen and healthy tissues. As a result, the body begins attacking its own healthy tissues. In people with lupus, the autoimmune response most often attacks the joints, skin, heart, lungs, kidneys, and blood and circulatory system.

There are several different types of lupus, including: systemic lupus erythematosus (SLE); **discoid lupus erythematosus** (DLE); and drug-induced lupus. The severity of lupus symptoms vary from person to person: in some people, the symptoms may be mild and involve only the joints and skin; in others, the disease may be severe and cause joint, kidney, lung, heart, and bone complications.

Systemic lupus usually involves multiple organs and body systems and is usually more severe than the DLE form of the disease. The majority, about 70% of all lupus cases involve this systemic form of the disease. People with SLE typically experience pain in the joints and muscles, **fatigue**, and skin **rashes**, which may come and go. These periods of more severe symptoms are called flares, whereas the milder periods of the disease are referred to as remission. People with SLE may experience kidney inflammation (**nephritis**), which can make it difficult for the body to remove toxins and other waste products. Lupus patients may be prone to develop **pneumonia** or inflammation of the chest cavity that makes it difficult to breathe. The disease may also contribute to central nervous system problems, including headaches, **dizziness**, seizures, behavior changes, and vision and memory difficulties. Having lupus also increases the risk of **atherosclerosis** (hardening of the arteries), **blood clots**, and deficiencies in red and white blood cells and platelets.

DLE, sometimes referred to as discoid or cutaneous lupus, primarily affects the skin and accounts for 10% of all lupus cases. People with this form of lupus typically develop a rash on the face, neck, and scalp but do not experience problems with the joints, kidneys, or heart. However, about 10% of people with DLE eventually develop SLE; doctors think that in these patients, the rash was an initial symptoms of systemic inflammation.

Drug-induced lupus may also develop after a person takes certain prescription medications. People with this type of lupus tend to have symptoms similar to those of SLE, but the symptoms of lupus typically fade within days, weeks, or months of discontinuing the medications. Medications that may induce lupus include hydralazine (a drug used to treat high blood pressure) and procainamide (a drug used to treat irregular heart rhythms). About 4% of people who take these medications develop drug-induced lupus.

Demographics

Lupus affects people of all ages and races, but it is most common in women. Ninety percent of the 1.4 million diagnoses of lupus in the United States are made in women. Lupus is also more prevalent among younger women between 15 and 44 and women of particular ethnic groups. Hispanic/Latino, African American, and American Indian women are more likely to develop lupus than white women, and their symptoms tend to be more severe.

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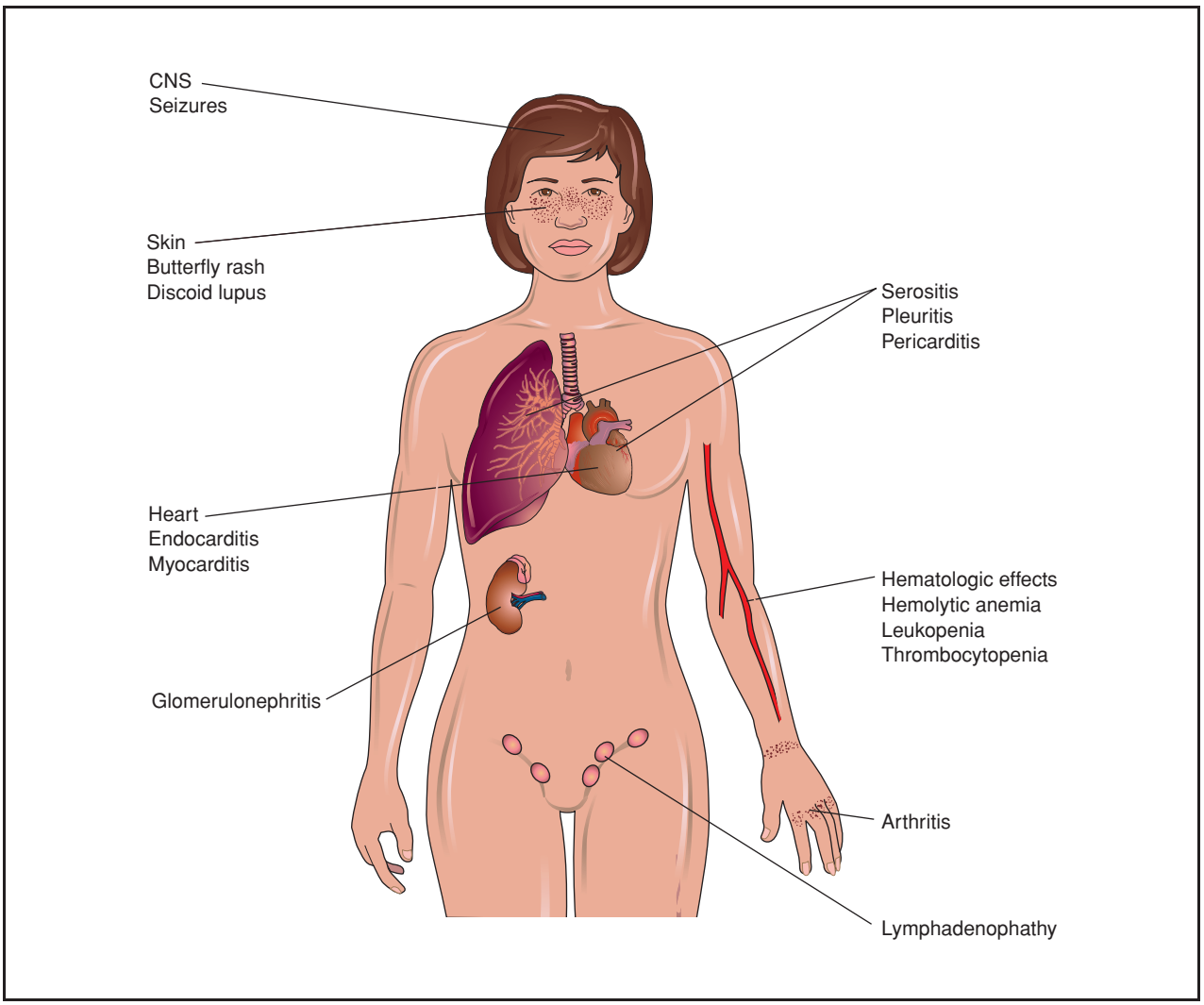

Systemic lupus erythematosus (SLE) is an autoimmune disease in which the individual's immune system attacks, injures, and destroys the body's own organs and tissues. Nearly every system of the body can be affected by SLE, as depicted in the illustration above. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

However, according to the Lupus Foundation of America, 15% of people with SLE develop it later in life—after age 55. Late onset lupus affects women eight times more than men, and is more prevalent in Caucasians, although it can occur in people of any race.

Drug-induced lupus is also more common in older adults because of the greater likelihood that they have other conditions (such as heart disease and high blood pressure) that require medication. When a person goes off the medication, the symptoms of drug-induced lupus eventually go away.

Causes and symptoms

The cause of SLE is unknown. Because the vast majority of patients are women, some research is being done to determine what (if any) link the disease has to female hormones. SLE may have a genetic basis, although more than one gene is believed to be involved in the development of the disease. Because lupus often runs in families, researchers think there is a genetic component to the disease. However, other factors, including environment, **stress**, the use of certain medications, and exposure to sunlight, may also influence lupus development and exacerbate flares.

Symptoms of lupus depend on the type a person has and can vary widely. Some common symptoms of lupus include:

- a signature red rash or color change in the skin across the nose and cheeks (this is also called a malar rash; often it is in the shape of a butterfly)

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- painful, swollen joints (arthritis) and glands
- fevers that can't be explained by illness
- pain in the chest when breathing
- extreme fatigue
- anemia (loss of red blood cells)
- hair loss
- sensitivity to the sun
- blood flow problems in the fingers when cold or stressed
- depression
- problems with memory or thinking clearly

For some people, mouth sores, seizures, **hallucinations**, and kidney problems signal lupus.

In people with late-onset lupus, symptoms tend to be milder and include arthritis, **pleurisy**, **pericarditis**, dry eyes and mouth, and muscle aches. In older adults, it may be harder to diagnose lupus because the symptoms mimic other diseases common in this age group, such as **rheumatoid arthritis**.

Lupus symptoms may come and go. These periods of worsened symptoms, called flares, may be triggered by spending time in the sun or during a time of emotional stress.

SLE has also been linked to a higher risk of developing **osteoporosis**, a disease that makes bones brittle and more likely to break. Osteoporosis may occur in lupus patients because the steroid medications often prescribed to reduce inflammation can lead to bone loss. Fatigue and pain in the joints and muscles also makes it more likely a person will remain inactive, which increases the likelihood of bone loss. Finally, lupus itself may contribute to weakened bones that are more likely to break.

According to the National Institute of Arthritis and Musculoskeletal and Skin Diseases, women with lupus may have more than five times the risk of a bone fracture from osteoporosis.

The severity of a patient's SLE varies over time. Patients may have periods with mild or no symptoms, followed by a flare. During a flare, symptoms increase in severity and new organ systems may become affected.

Many SLE patients have fevers, fatigue, muscle pain, weakness, decreased appetite, and weight loss. The spleen and lymph nodes are often swollen and enlarged. The development of other symptoms in SLE varies, depending on the organs affected.

- Joints. Joint pain and problems, including arthritis, are very common. About 90% of all SLE patients have these types of problems.
- Skin. A number of skin rashes may occur, including a red butterfly-shaped rash that spreads across the face. The "wings" of the butterfly appear across the cheekbones, and the "body" appears across the bridge of the nose. A discoid, or coin-shaped, rash causes red, scaly bumps on the cheeks, nose, scalp, ears, chest, back, and the tops of the arms and legs. The roof of the mouth may develop sore, irritated pits (ulcers). Hair loss is common. SLE patients tend to be very easily sunburned (photosensitive).
- Lungs. Inflammation of the tissues that cover the lungs and line the chest cavity causes pleuritis, with fluid accumulating in the lungs. The patient frequently experiences coughing and shortness of breath.
- Heart and circulatory system. Inflammation of the tissue surrounding the heart causes pericarditis; inflammation of the heart itself causes myocarditis. These heart problems may result in abnormal beats (arrhythmias), difficulty pumping the blood strongly enough (heart failure), or even sudden death. Blood clots often form in the blood vessels and may lead to complications.
- Nervous system. Headaches, seizures, changes in personality, and confused thinking (psychosis) may occur.
- Kidneys. The kidneys may suffer significant destruction, with serious life-threatening effects. They may become unable to adequately filter the blood, leading to kidney failure.
- Gastrointestinal system. Patients may experience nausea, vomiting, diarrhea, and abdominal pain. The lining of the abdomen may become inflamed (peritonitis).
- Eyes. The eyes may become red, sore, and dry. Inflammation of one of the nerves responsible for vision may cause vision problems, and blindness can result from inflammation of the blood vessels (vasculitis) that serve the retina.

Diagnosis

Obtaining a lupus diagnosis can be difficult for several reasons: the symptoms of lupus flare and disappear over long periods of time; the severity and type of lupus symptoms can vary widely from person to person; and finally, there is no one test that can diagnose the disease. Instead, doctors must rely on several diagnostic techniques to confirm a lupus diagnosis, including a detailed medical history, **physical examination**, blood and urine tests, and skin or kidney biopsies.

Many of the symptoms and laboratory test results of SLE patients are similar to those of patients with different diseases, including rheumatoid arthritis,

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multiple sclerosis, and various nervous system and blood disorders.

When conducting a medical history, doctors may ask patients a variety of questions, such as:

- Have you had stiff, tender, and swollen joints? Is this worse in the morning?
- Do you ever feel extremely tired for days or weeks, even when you're getting plenty of sleep at night?
- Have you ever felt pain in your chest when taking deep breaths?
- Does your skin break out when you're in the sun, but not from sunburn?
- Have you had a rash across your nose and cheeks? Is it in the shape of a butterfly?

In addition to taking a thorough medical history, doctors will also conduct a physical examination. A physician may listen to the heart (in some lupus patients, doctors can hear a sound called a heart friction rub) and conduct a **neurological exam**.

Laboratory tests are also an integral part of the lupus diagnosis process. One test, called the antinuclear antibody (ANA) test, is often checked when a doctor suspects a person has lupus. In this test, a person's blood is checked for autoantibodies that are often present in the blood of people with lupus. Testing positive for ANA does not automatically mean a person has lupus, but it can help doctors make a diagnosis when considered with a person's physical symptoms. Other tests doctors may use to confirm a lupus diagnosis include the anti-double strand DNA (dsDNA), anti-Smith antibodies (Sm), **erythrocyte sedimentation rate** (ESR), and **C-reactive protein** binding. SLE patients tend to have low numbers of red blood cells (anemia) and low numbers of certain types of white blood cells. The ESR, a measure of inflammation in the body, tends to be quite elevated. Also, samples of tissue (biopsies) from affected skin and kidneys may show characteristics of the disease.

A test called the lupus erythematosus cell preparation (or LE prep) test is also performed. This test involves obtaining a sample of the patient's blood. Cells from the blood are damaged in the laboratory in order to harvest their nuclei. These damaged cells are then put together with the patient's blood serum, the liquid part of blood separated from the blood cells. Antinuclear antibodies within the patient's serum will clump together with the damaged nuclear material. A material called Wright's stain will cause these clumps to turn blue. These stained clumps are then reacted with some of the patient's white blood cells, which will essentially eat the clumps. LE cells are the white blood cells that contain the blue clumps. This test will be positive in about 70–80% of all patients with SLE.

The American Rheumatism Association developed a list of symptoms used to diagnose SLE. Research supports the idea that people who have at least four of the eleven criteria (not necessarily simultaneously) are extremely likely to have SLE. The criteria are:

- butterfly rash
- discoid rash
- photosensitivity
- mouth ulcers
- arthritis
- inflammation of the lining of the lungs or the lining around the heart
- kidney damage, as noted by the presence of protein or other abnormal substances called casts in the urine
- seizures or psychosis
- the presence of certain types of anemia and low counts of particular white blood cells
- the presence of certain immune cells, anti-DNA antibodies, or a falsely positive test for syphilis
- the presence of antinuclear antibodies

If lupus is diagnosed, doctors may check a person's urine for signs of kidney problems, order chest x-rays for signs of inflammation in the lungs or heart, and have the patient's blood checked for problems with the white blood cells to see how far the disease has progressed.

Allopathic treatment

Several types of health care professionals may work together to treat an individual with lupus. Family doctors or internists, rheumatologists (specialists in rheumatic diseases), immunologists (specialists in immune system disorders), and other specialists may play a role in treating the lupus patient.

The treatment a person receives for lupus depends on the type of lupus and the extent and severity of the disease. Both over-the-counter and prescription medications may be recommended, such as:

- Nonsteroidal anti-inflammatory drugs (NSAIDS): These drugs, which include ibuprofen and naproxen, reduce inflammation and control pain, swelling, and fever. However, these medicines also may cause side effects such as nausea, heartburn, and diarrhea as well as liver, kidney, and neurological complications with prolonged use, so it is important that a person taking these drugs for lupus does so under the direction of a doctor.

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- Antimalarial drugs: Antimalarial drugs such as hydroxychloroquine treat the fatigue, joint pain, rashes, and lung inflammation caused by lupus and may prevent flares from occurring. Side effects include nausea and, in rare cases, vision problems.
- Corticosteroids: A variety of corticosteroid medications, including prednisone, hydrocortisone, methylprednisolone, and dexamethasone, can suppress the inflammation often associated with lupus. Lupus patients take these drugs in pill form, apply creams to the skin, or receive corticosteroid injections. Despite their effectiveness, corticosteroid drugs do have short-term side effects, such as increased appetite and weight gain. Long-term side effects may include high blood pressure, weakened bones, artery damage, diabetes, and cataracts.
- Immunosuppressive agents: These drugs, including azathioprine, cyclophosphamide and mycophenolate mofetil, block the production of immune cells and are typically used in lupus patients who experience kidney or central nervous system problems. A person taking immunosuppressive drugs may experience nausea and vomiting, as well as bladder problems, hair loss, decreased fertility, and an increased risk of infection.

Doctors may also use arthritis drugs to help control symptoms of lupus and reduce the risk of flares.

Other treatments for SLE try to help specific symptoms. Clotting disorders will require blood thinners. Psychotic disorders will require specific medications. Kidney failure may require the blood to be cleaned outside the body through a machine (dialysis) or even a **kidney transplantation**.

Alternative treatment

Medications for lupus are costly, and many have the potential for serious adverse side effects. As a result, some patients turn to other therapies to relieve lupus symptoms.

Massage and **acupuncture** are just a few of the alternative and complementary therapies that may be used by lupus patients. Doctors may encourage lupus patients to get regular, gentle **exercise** during remission to increase joint flexibility and muscle strength. Stress management is key for people with SLE and such techniques as **meditation**, **hypnotherapy**, and **yoga** may be helpful in promoting relaxation.

In addition, some patients have tried dietary supplements in an attempt to alleviate lupus symptoms. Supplementation with **omega-3 fatty acids** found in fish oils could hold promise for lupus patients. In one study of 60 people with SLE, daily doses of 3 grams of omega-3 fatty acids in the form of fish oil supplements over a 6-month period improved lupus symptoms. Not only did the supplements appear to relieve joint pain, but they also improved blood vessel function, researchers noted.

Other dietary suggestions include eating a whole foods diet with reduced amounts of red meat and dairy products in order to decrease pain and inflammation. **Food allergies** are believed either to contribute to SLE or to arise as a consequence of the digestive difficulties. Wheat, dairy products, and soy are the major offenders. An elimination/challenge diet can help identify the offending foods so that they can be avoided. Because alfalfa sprouts have been associated with the onset of flares in SLE, they should be avoided. Supplements that have been suggested to improve the health of SLE patients include **vitamins** B, C, and E, as well as selenium, zinc, magnesium, and a complete trace mineral supplement. Vitamin A is believed to help improve discoid skin rashes. Botanical medicine can help the entire body through immune modulation and **detoxification**, as well as assisting individual organs and systems. Homeopathy and flower essences can work deeply on the emotional level to help people with this difficult disease.

Nutrition/Dietetic concerns

There are no specific guidelines for people with lupus to follow, however, there are several nutritional considerations that may be impacted by a lupus diagnosis.

Lack of appetite and weight loss is common among people who have recently been diagnosed with lupus. Appetite and weight loss may be related to a person's symptoms of pain and fatigue, or they may be a side effect of common lupus medications. In addition, some people develop mouth sores when taking lupus medications, another factor that can make it difficult to eat. Older adults struggling with a lack of appetite should talk to their health care providers, who may recommend consulting with a registered dietitian who can suggest a diet that works best with the patient's needs and lifestyle.

Weight gain is also a common side effect of **corticosteroids**, drugs that are often used to treat the inflammation of lupus. If a person has gained weight after starting lupus medications, a registered dietitian (RD) can also help by devising a meal plan that incorporates nutritious foods that won't add excess weight. A RD can also help lupus patients work toward controlling high blood pressure and avoiding atherosclerosis. These cardiovascular

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KEY TERMS

Antinuclear antibody (ANA) test—A test often used to look for autoantibodies that react against components of the nucleus of the body's cells. Many people with lupus test positive for ANA.

Arthritis—A condition characterized by inflamed, swollen, painful joints.

Autoimmune disorder—A disorder in which the body's antibodies mistake the body's own tissues for foreign invaders. The immune system then attacks and causes damage to these tissues.

Chromosomes—Spaghetti-like structures located within the nucleus (or central portion) of each cell. Chromosomes contain genes, structures that direct the growth and functioning of all the cells and systems in the body. Chromosomes are responsible for passing on hereditary traits from parents to child.

Immune system—The system of specialized organs, lymph nodes, and blood cells throughout the body that work together to prevent foreign organisms (bacteria, viruses, fungi, etc.) from invading the body.

Nephritis—Inflammation of the kidneys.

Osteoporosis—A condition that makes bones less dense and more likely to fracture.

Pericarditis—Inflammation of the sac around the heart.

Pleurisy—Chest pain that occurs when a person takes a deep breath.

Psychosis—Extremely disordered thinking with a poor sense of reality; may include hallucinations (seeing, hearing, or smelling things that are not really there).

complications may be more common in lupus patients, but a combination of a low-fat diet and exercise may reduce the risk of these common complications.

Also, lupus patients taking corticosteroids may need to take vitamin D and **calcium** supplements to counteract the bone-damaging effects of the disease and reduce the risk of osteoporosis.

In general, if medication use or lupus symptoms are making it difficult to eat, patients should consult with a doctor or nurse, who can provide additional information.

Prognosis

The prognosis for patients with SLE varies, depending on the organ systems most affected and the severity of inflammation. Some patients have long periods of time with mild or no symptoms. About 90–95% of patients are still living after 2 years with the disease. About 82–90% of patients are still living after 5 years with the disease. After 10 years, 71–80% of patients are still alive, and 63–75% are still alive after 20 years. The most likely causes of **death** during the first 10 years include infections and kidney failure. During years 11–20 of the disease, the most likely cause of death involves the development of abnormal blood clots.

Because SLE frequently affects women of childbearing age, **pregnancy** is an important issue. For pregnant SLE patients, about 30% of the pregnancies end in **miscarriage**. About 25% of all babies born to mothers with SLE are premature. Most babies born to mothers with SLE are normal. However, a rare condition called neonatal lupus causes a baby of a mother with SLE to develop a skin rash, liver or blood problems, and a serious heart condition.

The Centers for Disease Control and Prevention estimate that more than 1,000 people die from lupus annually, and older adults, women, and blacks had the highest death rates among lupus patients. Following the doctor's instructions, taking medications exactly as they are prescribed, and getting help when symptoms flare can help lupus patients extend the quantity and quality of their lives.

Prevention

There are no known ways to avoid developing SLE. However, it is possible for a patient who has been diagnosed with SLE to prevent flares of the disease. Recommendations for improving general health to avoid flares include decreasing sun exposure, getting sufficient sleep, eating a healthy diet, decreasing stress, and exercising regularly. It is important for a patient to try to identify the early signs of a flare (like **fever**, increased fatigue, rash, **headache**). Some people believe that noticing and responding to these warning signs will allow a patient with SLE to prevent a flare, or at least to decrease its severity. In addition, getting regular health care and laboratory tests can help doctors note changes and make adjustments once a flare begins. Finally, because they are at risk for other complications from lupus, older adults should have their blood pressure

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and cholesterol checked regularly. An annual **influenza** vaccine may also be recommended, and patients should reduce exposure to the sun and always wear sunscreen.

Caregiver concerns

Caregivers can help by learning the signs of their loved ones' flares and encouraging communication with the doctor when lupus symptoms occur.

Caregivers should keep in mind that uncontrolled bleeding, trouble breathing, **fainting**, confusion, chest pain, or seizures in a lupus patient are signs of a serious problem. These symptoms indicate their loved one with lupus needs immediate medical help.

Resources

BOOKS

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Henderson, Shirley. "Living With Lupus: Although There Is No Cure, Many People are Making Lifestyle Adjustments to Fight the Disease and Improve Their Sense of Well-Being." *Ebony* (July 2007): 142(3).

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Walsh, Nancy. "Biologics Promising in Lupus, But More Research is Needed." *Family Practice News* (July 15, 2007): 35.

ORGANIZATIONS

Alliance for Lupus Research, 28 West 44th Street, Suite 501, New York, NY, 10036, (212) 218-2840, (800) 867-1743, info@lupusresearch.org, http://www.lupusresearch.org/home.html.

American College of Rheumatology, 1800 Century Place, Suite 250, Atlanta, GA, 30345, (404) 633-3777, http://www.rheumatology.org.

Lupus Canada, 590 Alden Road, Suite 211, Markham, Canada, ON, L3R 8N2, (905) 513-0004, (800) 661-1468 (Canada only), http://www.lupuscanada.org.

Lupus Foundation of America, 2000 L Street, N.W., Suite 710, Washington, DC, 20036, (202) 349-1155, (800) 558-0121, (202) 349-1156, http://www.lupus.org/newsite/index.html.

National Institute of Arthritis and Musculoskeletal and Skin Diseases, 1 AMS Circle, Bethesda, MD, 20892-3675, (301) 495-4484, (877) 226-4267, (301) 718-6366, NIAMSinfo@mail.nih.gov, http://www.niams.nih.gov..

S.L.E. Lupus Foundation, 330 Seventh Avenue, Suite 1701, New York, NY, 10001, (212) 685-4118, (212) 545-1843, Lupus@LupusNY.org, http://www.lupusny.org.

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T

T-cell count *see* **Lymphocyte typing**

T-PA *see* **Thrombolytic therapy**

Taeniasis *see* **Tapeworm diseases**

Tagged red blood cell scan *see* **GI bleeding studies**

Tai chi

Definition

T'ai chi is a Chinese **exercise** system that uses slow, smooth body movements to achieve a state of relaxation of both body and mind.

Purpose

As a system of physical exercise used to improve and maintain health, t'ai chi can be helpful in achieving a state of physical and mental relaxation while also strengthening the cardiovascular and immune systems.

Precautions

As a very slow and gentle form of moving, tai chi has virtually no side effects. However, if a person has any doubts about the conditions of his or her joints, vertebrae, or heart, a physician should be consulted.

Description

Developed originally in China as a self-defense strategy, or martial art, tai chi—the "supreme ultimate fist"—is practiced in modern times primarily as a gentle exercise technique. Described as "meditation in motion," tai chi consists of a standing person performing a series of postures or bodily movements in a slow and graceful manner, with each movement flowing without pause to the next. According to Chinese legend, the technique was created by a Taoist monk who was inspired as he watched a crane and a snake do battle. Impressed by the snake's ability to subtly and swiftly avoid the bird's thrusts, he devised a series of self-defense techniques that do not involve meeting the opponent's force with force, but rather stress evading the blow; causing the opponent's own momentum to work against him.

Tai chi is an ancient form of exercise, about 2,000 years old, that at one point had over 100 separate movements or postures. In current practice, there are two popular versions, of 18 and 37 movements respectively. The fact that in China 10 million people practice some type of t'ai chi daily suggests that it is the one of the most popular forms of exercise in the world. In the United States, t'ai chi is learned in classes in which students (or "players," as they are called in China) wear loose, comfortable clothing and either go barefoot or wear only socks or soft shoes on the feet. In China, t'ai chi is almost always practiced outdoors at dawn, and ideally near trees. Unlike other martial arts, t'ai chi is not competitive. Classes usually begin with a few minutes of standing **meditation** to calm the mind and gather energy. Following warm-up exercises, students are taught the basics of a particular form or posture. Learning forms is not easy, and it takes some time to master what looks like a simple position. Properly done postures are done in a relaxed, artful, and linked way, with the circular and rhythmic movements of one position flowing seamlessly into the next.

While strict attention to body position is critical, proper breathing is considered to be equally important. Just as movements are slow and continuous and without strain, breathing should be effortless yet deep. Finally, both mental and physical balance is considered essential to t'ai chi. The experienced practitioner of t'ai chi maintains perfect body balance throughout the exercise series. Altogether, the five essential qualities of t'ai chi are:

- Slowness. To develop awareness.
- Lightness. To make movements flow.

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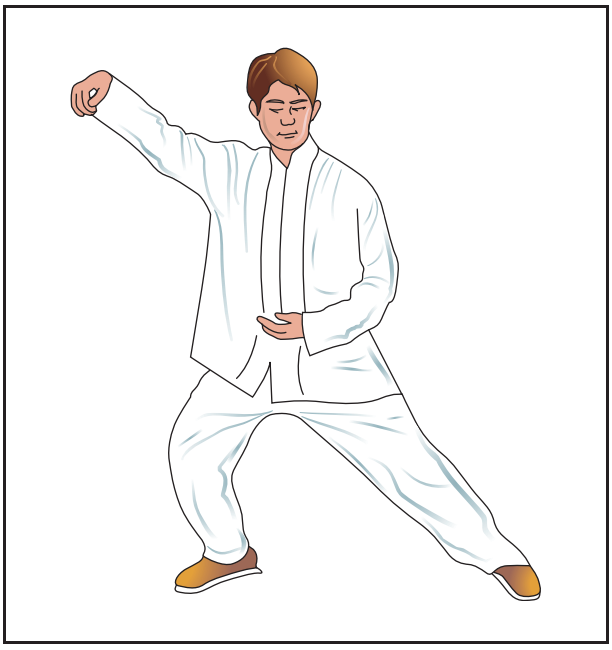

Tai chi is a Chinese exercise system which uses slow, smooth body movements to achieve a state of relaxation. The posture above is part of the single whip sequence of Tai chi motions. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

- Balance. To prevent body strain.
- Calmness. To maintain continuity.
- Clarity. To focus the mind.

T'ai chi has both physical and mental benefits. If done regularly, it improves muscle tone, flexibility, balance, and coordination. Many older people find that it boosts their energy, stamina, and agility, sharpens their reflexes, and gives an overall sense of well-being. The calming and meditative aspects of t'ai chi allow many to experience its ability to relieve stress. Some claim t'ai chi to be a healing therapy, and it is often used to support other treatments for chronic conditions; arthritis, fibromyalgia, and digestive disorders are just three examples. Like **yoga**, t'ai chi has several different styles to suit the individual. Also, it can eventually be done daily by oneself, and ultimately becomes a very personal endeavor. Most Westerners find it best to practice t'ai chi in the same place and at the same time of day; and those who enjoy it most are those who are not seeking major, dramatic breakthroughs, but rather who can take pleasure in small gains that accumulate over a long period of time.

Some research done in the United States focuses on the emotional and psychological benefits of t'ai chi. One recently discovered advantage of t'ai chi is its ability to hold people's interest longer than many other forms of exercise. One study in Oregon found that only 20% of people enrolled in a six-month t'ai chi program dropped out before the end, compared to an average of 55% for other forms of exercise. With regard to depression, a study of college students found that those who were taking t'ai chi classes had a lower rate of depression than students enrolled in other fitness programs.

KEY TERMS

Arthritis—Inflammation of the joints.

Cardiovascular—Relating to the heart and blood vessels.

Continuity—Uninterrupted and successive.

Fibromyalgia—A chronic disease syndrome characterized by fatigue, widespread muscular soreness, and pain at specific points on the body.

Meditation—An exercise of contemplation that induces a temporary feeling of relaxation.

Stamina—Staying power, endurance.

Yoga—A system of exercise aimed at promoting the control of the body and the mind.

Risks

T'ai chi is a safe exercise system for people of all ages and fitness levels. Done properly, without any overstretching, t'ai chi should not leave a person feeling tired or sore.

Normal results

Besides its overall fitness benefits and **stress reduction** aspects, regular t'ai chi sessions are said to be especially helpful for seniors, as they lower their blood pressure. T'ai chi claims to benefit arthritis sufferers, those recovering from an injury or rehabilitating their hearts, and also improves balance, and therefore, reduces the risk of falling, especially important for the elderly. T'ai chi can result in a significant improvement in the quality of life for anyone. But, because of the low stress level of the exercises it is a particularly attractive form of exercise to seniors.

In addition to studying the cardiovascular and range-of-motion benefits of t'ai chi, researchers are also investigating its positive effects on the immune system. A team of scientists in California reported in 2003 that t'ai chi boosts the resistance of older people to the **shingles** virus— a virus that is both more common and more severe in the elderly.

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American Tai Chi and Quigong Association, 2465 J-17 Centreville Road, No.150 , Herndon, VA, 20171, http://www.americantaichi.org.

Canadian Taijiquan Federation, P.O. Box 32055, London, CanadaOntario, N5V 5K4, http://www.canadiantaijiquanfederation.com.

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Tailbone injuries *see* **Coccyx injuries**

Talipes *see* **Clubfoot**

Tamoxifen *see* **Anticancer drugs**

Tamponade *see* **Cardiac tamponade**

Tanning

Definition

Tanning is the browning or darkening of skin from exposure to ultraviolet (UV) radiation, either from sunlight or from an artificial source.

A tanning bed. *(Pedro Miguel Sousa/Shutterstock.com.)*

Purpose

Many people consider tanning fashionable and pursue it for cosmetic purposes. Most Americans—including up to 80% of young people under age 25—believe that a tan improves their appearance. Tanning beds or "sunbeds" that darken the skin using UV–radiating lights have become increasingly popular throughout the developed world, especially among young women. Many people also believe that tanning prevents **sunburn**.

Everyone needs some exposure to sunlight to produce vitamin D3 or cholecalciferol, which is synthesized in the skin after exposure to ultraviolet B (UV–B) light and converted into the active form of vitamin D. Vitamin D is required for **calcium** absorption for strong, healthy bones, as well as for a variety of other bodily functions. Light–colored skin absorbs more UV–B than darker skin. It has been postulated that lighter–colored skin evolved as humans migrated to northern climates with less year–round sunlight, which required maximizing absorbance of UV–B for synthesizing vitamin D. However only 10 to 15 minutes of direct sunlight three times per week is adequate to meet the body's vitamin D requirement.

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Demographics

Most people get 50–80% of their lifetime sun exposure during childhood—before the age of 18. Teenage girls and young women account for much of the growth in the tanning–bed industry. However sun exposure, tanning, and especially sunburn, before the age of 15, are strongly associated with the development of melanoma and other forms of skin **cancer**. The incidence of skin cancer is reaching epidemic proportions in the United States, at a time when the incidence of many other types of cancer is leveling off or declining.

Skin cancers account for one–third of all cancers worldwide. Each year some 132,000 new cases of malignant melanoma—the deadliest form of skin cancer—and more than two million cases of other skin cancers are diagnosed around the world. More than 50,000 new cases of melanoma and more than one million new cases of other skin cancers are diagnosed each year in the United States. The incidence of melanoma is increasing faster than that of any other cancer. In the past, melanoma primarily affected people over age 50; however it has become the second most common cancer among 15–29–year–olds, especially females. Other types of skin cancer are also being diagnosed more often in younger patients, including teens. Whereas older patients generally develop skin cancer on their heads and necks, young people more often develop skin cancer on their torsos. The torso is the most common location for melanoma in young women. It is suspected that this is due to high–risk outdoor and indoor tanning.

Description

Tanned skin is often associated with healthy outdoor activities and vacations in sunny climes. Unfortunately tanning is also an indication of damaged skin. Two types of UV radiation from the sun reach the skin. UV–B affects the upper layers of skin or epidermis and is responsible for sunburn; however most UV–B rays from the sun are absorbed by the ozone layer surrounding the earth. Therefore the majority of ultraviolet exposure is to ultraviolet A (UV–A), which passes through window glass. Tanning beds generally use UV–A, although full–spectrum tanning lights include UV–B. UV–A radiation penetrates to the lower layers of the epidermis, where it triggers cells called melanocytes to produce a brown pigment called melanin, which is responsible for tanning. Darker–skinned people tan more deeply than light–skinned people because their melanocytes produce more melanin.

Although melanin can protect skin from burning because the pigment absorbs UV radiation, it does not protect against skin cancer and other problems. UV–A radiation can turn melanocytes cancerous, causing melanoma. UV–A also causes skin **aging** and wrinkling. UV–A can penetrate through the epidermis to the dermis, which contains blood vessels and nerves, and there UV–A can suppress the immune system, reducing its ability to protect against the development and spread of skin cancer. In addition to sunburn, UV–B rays can cause **cataracts** (clouding of the eye lens) and immune system damage, as well as contributing to skin cancer. Melanoma is thought to be associated with severe UV–B sunburns before the age of age 20. UV radiation damages DNA in skin cells and, although the cells can repair this damage, excessive UV exposure eventually causes the damage to outpace the repair system. Therefore both types of UV radiation, whether from the sun or from artificial sources such as tanning beds and sunlamps, are classified as known **carcinogens**.

The U.S. Food and Drug Administration (FDA) and the American Academy of Dermatology (AAD) classify skin into six types based on susceptibility to tanning and burning:

- I—extremely sun–sensitive—always burns easily and never tans
- II—very sun–sensitive—usually burns easily and tans only minimally
- III—sun–sensitive—sometimes burns and gradually tans to light brown
- IV—minimally sun–sensitive—burns minimally and always tans to moderate brown
- V—sun–insensitive—rarely burns and tans well
- VI—sun–insensitive—never burns and is deeply pigmented

Sunless tanning products, also called self–tanners, usually have dihydroxyacetone (DHA) as the active ingredient. DHA reacts with dead cells in the outermost layer of the skin to darken it. Although the color does not wash off, it fades as dead skin cells slough off, usually within a few days. These products are available as creams, gels, lotions, and sprays. Professional spray–on or airbrush tanning is also available. Although sunless tanning products are considered to be safe for applying to the skin, sunless tanning pills are unsafe. They usually contain the color additive canthaxanthin which, in large amounts, can turn the skin orange and cause **hives**, liver damage, and the formation of crystals in the retina of the eye.

Origins

Tanning has not always been considered desirable. In the past, tanning was often associated with outdoor manual labor and poverty. Then, in the 1920s, the designer Coco Chanel returned from a vacation on

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KEY TERMS

Dihydroxyacetone (DHA)—A chemical used for staining the skin to simulate a tan.

Melanin—Skin pigment that is responsible for tanning.

Melanocyte—An epidermal skin cell that produces melanin.

Melanoma—A rapidly spreading and deadly form of cancer that usually occurs on the skin.

Ozone—A type of oxygen gas that occurs in a layer about 15 miles (24 kilometers) above Earth's surface and that helps protect living organisms from the damaging effects of the sun's ultraviolet rays.

SPF—Sun protection factor; a number assigned to sunscreens that indicates the amount of UV–B radiation that is required to produce sunburn in the presence of the sunscreen, relative to the amount of UV–B radiation required to burn unprotected skin.

Sunblock—A skin preparation containing an active ingredient, such as titanium oxide, that prevents sunburn by physically blocking out ultraviolet radiation.

Sunscreen—A skin preparation containing an active ingredient, such as benzophenone, that prevents sunburn by chemically absorbing ultraviolet radiation.

Ultraviolet radiation; UV—Invisible light rays with wavelengths shorter than those of visible light, but longer than those of x rays.

Vitamin D—Any of several fat–soluble vitamins that are required for normal bone and teeth structure and various other physiological functions. Vitamin D is obtained from some foods and is produced in the body through the action of ultraviolet radiation.

the Riviera with a deep tan. Tanning suddenly became fashionable and a symbol of wealth and leisure.

Common problems

Tanning can put a child at risk for sunburn, short–term or long–term eye damage, premature skin aging, immune system suppression, and the eventual development of skin cancer. Sunburns, especially blistering sunburns during childhood or adolescence, increase the risk of developing melanoma. Some experts believe that melanoma on the legs and trunk may result from sun exposure during childhood, since these areas are less often exposed to sunlight during adulthood. Tanning booths can contribute to the development of melanoma anywhere on the body.

Experts now generally believe that all tanning damages the skin and that no degree of tanning can be considered safe. Along with the World Health Organization (WHO), the AAD supports a ban on indoor tanning by minors. The AAD also supports banning the manufacture and sale of indoor tanning equipment for non–medical purposes. Tanning salons are often unregulated and many fail to provide supervision or eye protection. In a National Cancer Institute–supported study published in 2009, female college students posed as fair–skinned, 15–year–olds who had never tanned. They telephoned more than 3,600 tanning facilities in all 50 states and inquired about their procedures. Fewer than 11% of the facilities followed the recommended schedule of no more than three sessions during the first week. Furthermore, 71% of the facilities promoted unlimited tanning packages and said that they would allow a teenager to tan every day during the first week.

Parental concerns

Parents should not promote tanning by their children and teens. It is particularly important to prevent sunburns in young children by limiting sun exposure and using sunscreen or sunblock. The AAD recommends that children with all skin types use water–resistant sunscreen with a sun protection factor (SPF) of at least 15 throughout the year, even on days when it is cool, windy, or cloudy. Sunscreen should be used even when very little time is spent outdoors, because up to 80% of sun exposure occurs during incidental day–to–day activities, rather than planned outside excursions. Unprotected skin can be damaged by as little as 15 minutes of sun exposure, although sunburn is sometimes not apparent until at least 12 hours later. Broad–spectrum sunscreen protects against both UV–A and UV–B rays. Titanium oxide is a sunblock that is appropriate for children with sensitive skin.

Babies have very thin, very sensitive skin and underdeveloped melanocytes. Therefore infants under six months should be kept in the shade, with their entire bodies covered. A minimal amount of sunscreen that is approved for babies under six months of age may be applied to the face and hands.

Sunscreen should be applied 15–30 minutes before going outdoors and reapplied every two hours and after swimming or sweating. Waterproof **sunscreens** may last

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up to 80 minutes in the water and some sunscreens are also sweat– and rub–proof. However studies have found that most people use only 25–50% of the recommended amount of sunscreen. One ounce (28 grams) is considered the proper amount for covering exposed portions of the body.

UV rays reflect off snow, sand, and water, increasing the likelihood of sunburn. Other concerns include certain medications—especially some **antibiotics** and **acne** medications—that can cause any type of skin to burn very easily. Some cosmetics also can increase sensitivity to UV radiation.

Children should:

- stay out of the sun between 10 a.m. and 4 p.m., when the sun is strongest, especially in the summer, at lower latitudes, and at high altitudes
- wear cool, lightweight, cotton clothing that covers the arms and legs
- wear sun-blocking shirts for swimming
- wear wide-brimmed hats that shade the face, scalp, ears, and neck
- wear sunglasses
- use a beach umbrella or pop-up tent for playing in the sun

Children and teens should never use tanning beds or sunlamps. Many states restrict the use of tanning beds by minors or require parental consent; however these restrictions are often ignored by tanning facilities. Sunscreen should be used in conjunction with sunless self-tanning products.

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ORGANIZATIONS

American Academy of Dermatology (AAD), PO Box 4014, Schaumburg, IL, 60168, (847) 240–1280, (866) 503–SKIN (7546), (847) 240–1859, http://www.aad.org.

American Academy of Pediatrics (AAP), 141 Northwest Point Blvd., Elk Grove Village, IL, 60007–1098, (874) 434–4000, (874) 434–8000, kidsdocs@aap.org, http://www.aap.org.

National Cancer Institute (NCI), NCI Public Inquiries Office, 6116 Executive Blvd., Room 3036A, Bethesda, MD, 20006, (800) 4–CANCER, http://www.cancer.gov.

U.S. Food and Drug Administration (FDA), 10903 New Hampshire Ave., Silver Spring, MD, 20993–0002, (888) INFO–FDA, http://www.fda.gov.

Margaret Alic, PhD

Tapeworm diseases

Definition

Tapeworms are a group of parasitic worms that live in the intestinal tracts of some animals. Several different species of tapeworms can infect humans.

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The head of an adult pork tapeworm. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

The head of an adult beef tapeworm. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Tapeworm disease or cestodiasis occurs most commonly after eating raw or undercooked meat or fish that contains the immature form of the tapeworm.

Description

Tapeworm infections pose a serious public health problem in many less developed countries due to poor sanitation conditions. The disease is most common where livestock, such as cattle and pigs, are raised in areas where human feces are not disposed of in a sanitary manner. Another common source of human tapeworms is certain species of freshwater fish. Tapeworm infections tend to occur more frequently in areas of the world where the people regularly eat raw or undercooked beef, pork, or fish. Persons of all ages and both sexes are susceptible to tapeworm infection, but children are generally not exposed until they are old enough to begin eating meat or fish.

Tapeworm infections in humans are less common in industrialized regions of the world, although German public health experts reported in 2003 that the rate of these infections is higher in Europe than the official statistics indicate. Travel to areas where tapeworm infections are more common and immigration of people from these areas serve as new sources of the parasite. Infected persons are often unaware of the presence of adult tapeworms in their intestinal tract, as they may have no obvious symptoms of infection. Some tapeworms can live in an infected person for over 10 years if diagnosis is not made and treatment is not administered.

In addition to the typical infection caused by eating undercooked meat or fish, people may also be directly infected by ingesting tapeworm eggs shed by the adult worm. This type of tapeworm infection can lead to a condition referred to as cysticercosis, in which the larvae continue to develop within tissues other than the intestinal tract. One of the most serious forms of this disease occurs when the tapeworm larvae infect the central nervous system, a disease referred to as neurocysticercosis. In contrast to a typical tapeworm infection, which may not be associated with symptoms, neurocysticercosis is a serious condition that may cause seizures and is potentially life-threatening.

Causes and symptoms

Several species of tapeworm can infect people. The two most common species are the pork tapeworm (*Taenia solium*) and the beef tapeworm (*Taenia saginata*). Improperly treated human sewage may be used to fertilize pastures or crops. Pigs or cattle become infected by grazing in contaminated pastures or drinking water contaminated with tapeworm eggs from human feces. The pea-sized larvae of these tapeworms are deposited in certain tissues of the body of infected pigs and cattle, including the muscles. The infection is then transmitted to people when raw or undercooked meat containing tapeworm larvae is consumed. The immature tapeworm develops into the adult form in the human intestine and may remain there for many years if not identified and treated.

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The *Taenia* tapeworms attach to the intestinal walls but cause only mild inflammation at the site of attachment. As a result, most tapeworm carriers show no symptoms (asymptomatic) and usually become aware of the infection only after noticing tapeworm segments in their feces. Segments of the beef tapeworm may spontaneously pass through the anus causing a noticeable sensation. Mild gastrointestinal symptoms, such as **nausea** or abdominal **pain**, can occur in infected individuals. In rare cases where the tapeworm segments migrate into the appendix, pancreas, or bile duct, there may be a sudden onset of severe abdominal discomfort.

Cysticercosis is a potentially serious complication of *Taenia solium* infection in which the larvae develop outside the intestinal tract. This type of infection is less common and occurs following accidental consumption of tapeworm eggs released from the adult worm. These eggs initially are localized in the anal area, but they may also contaminate the fingers or other parts of the body. Infection can occur in the person harboring the adult tapeworm or in other people with whom that individual comes in contact. The tapeworm larvae may develop in various tissues throughout the body. The most serious clinical problems occur when the larvae develop in the central nervous system (neurocysticercosis), potentially causing seizures and other neurological problems. An important aspect of this type of infection is that poor hygiene on the part of the individuals harboring an adult tapeworm can lead to an infection in an individual who may never consume meat. This is a particular problem if infected individuals are employed as food handlers.

Another important tapeworm that may infect people is the fish tapeworm (*Diphyllobothrium latum*). This is a frequent human intestinal parasite in many areas where raw freshwater fish is consumed. Human infection with the fish tapeworm is referred to as diphyllobothriasis. Feces from infected hosts or raw sewage contaminates a fresh water source. Tapeworm larvae are initially ingested by freshwater crustaceans and then are eaten by fish. Human infection occurs when a person consumes raw fish contaminated with the tapeworm larvae. Adult tapeworms then develop in the human intestinal tract.

Most infections with the fish tapeworm are not associated with symptoms. The tapeworm causes little damage to the lining of the intestine. Infected individuals may report **diarrhea**, **fatigue**, weakness, or sensation of hunger more commonly than uninfected individuals. One problem unique to this tapeworm is that it may compete with the host for absorption of vitamin B_{12} from the small intestine, causing the person to become deficient in this vitamin and leading to a condition called **pernicious anemia**.

Two smaller species of tapeworms may also infect people. The dwarf tapeworm (*Hymenolepis nana*) is a common infection throughout the world that can be passed from one person to another. Transmission is usually the result of inadvertent ingestion of tapeworm eggs from feces eliminated by infected individuals. As a result, infection with this tapeworm is encountered most frequently in children, the developmentally disabled, and psychiatric patient populations. Abdominal pain that is not localized to any particular area is the most common complaint. Patients may experience loose bowel movements or diarrhea with mucus, but bloody diarrhea is rare.

Another small tapeworm capable of infecting people is the rodent tapeworm (*Hymenolepis diminuta*). Rats, mice, and other rodents are the usual hosts for the adult tapeworm (definitive host), but humans can become infected following accidental consumption of insects containing tapeworm larvae. Meal worms or grain beetles that infest cereal, flour, or dried fruit are the most likely source of infection. Most human infections are not associated with symptoms, although some individuals report headaches, anorexia, nausea, and diarrhea.

Diagnosis

Identification of tapeworm segments or eggs in a stool sample is necessary for diagnosis of an adult tapeworm infection. In many cases, a tentative diagnosis may be made on the basis of a patient's description of short chains of tapeworm segments in their stool. Further evaluation is recommended to determine the actual species involved since infection with *Taenia solium* is potentially more serious due to the added risk of cysticercosis. Whenever possible, tapeworm segments should be carefully collected in water or salt solutions, using strict precautions to avoid contamination. Stool examination should be performed in a laboratory having experience in the diagnosis of intestinal parasites. It is recommended that at least three stool samples be collected on alternate days to increase the likelihood of being able to make an accurate diagnosis.

Although the general appearance of tapeworm segments from the two *Taenia* species is quite similar, trained laboratory personnel can detect distinct differences between the beef and pork tapeworms when samples are examined under a microscope. Tapeworm segments and eggs from the fish tapeworm and the dwarf tapeworm have characteristic appearances that allow accurate differentiation from the *Taenia* species of worms. Other diagnostic procedures may be necessary when cysticercosis is suspected. Blood samples from an infected individual are collected to look for the presence of

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KEY TERMS

Cestodiasis—Parasitic infection caused by the presence of adult tapeworms of the class Cestoda within the intestinal tract. Infection is caused by accidental consumption of tapeworm larvae.

Cysticercosis—Parasitic infection caused by the presence of immature tapeworm larvae (cysticerci) that have developed outside the intestinal tract. Infection is caused by accidental consumption of tapeworm eggs.

Diphyllobothriasis—Parasitic infection caused by the presence of tapeworms from the *Diphyllobothrium* genus, such as the fish tapeworm (*Diphyllobothrium latum*).

Hymenolepiasis—Parasitic infection caused by the presence of tapeworms from the *Hymenolepis* genus, such as the dwarf tapeworm (*Hymenolepis nana*) or the rodent tapeworm (*Hymenolepis diminuta*).

Neurocysticercosis—Parasitic infection caused by the presence of immature tapeworm larvae within the central nervous system.

Pernicious anemia—Type of anemia caused by a deficiency in vitamin B_{12}.

Taeniasis—Parasitic infection caused by the presence of tapeworms from the *Taenia* genus, such as the pork tapeworm (*Taenia solium*) or the beef tapeworm (*Taenia saginata*).

antibodies against the tapeworm larvae. In 2004, researchers isolated an antigen diagnostic for cysticercosis called GP50. In cases in which infection of the central nervous system is present, advanced imaging tests, such as **computed tomography scans** and **magnetic resonance imaging** (MRI), may be necessary to determine the exact location of the tapeworm larvae within the body.

Ultrasound imaging is also being used to diagnose tapeworm infections. Because of the recent rise in immigration and travel, clinicians in developed countries are seeing more patients with tapeworms. The World Health Organization (WHO) has developed standardized sets of ultrasound images to help doctors recognize the signs of a parasitic infection. In some cases, ultrasound allows the doctor to see the tapeworm directly.

Treatment

Effective treatment of tapeworm infections involves administering compounds that are toxic to the adult worm. Many of the early treatments were also somewhat toxic to the patient, so treatment was often quite an ordeal. Newer medications are much more easily tolerated and are highly effective in eliminating the parasite from the body. It is important, however, to completely eliminate the head and neck regions of the tapeworm, as the entire worm can regenerate from these parts.

One treatment that has been in use since the early 1960s is niclosamide (Niclocide). This drug is poorly absorbed from the digestive tract and rapidly kills tapeworms upon exposure. It has been shown to be effective against *Taenia* species and the fish tapeworm, but treatment of the dwarf tapeworm (*Hymenolepis nana*) may require a more prolonged treatment schedule. Side effects reported with niclosamide are infrequent and typically mild. When present, side effects may include nausea, abdominal discomfort, **vomiting**, diarrhea, light-headedness, and skin rash. This medication should be taken in the morning on an empty stomach. The tablets are chewed thoroughly and swallowed with water. For young children, the tablets may be pulverized and mixed with water. Patients are allowed to eat two hours after treatment. Recommended dosage is 2 grams for adults and about half this for children.

Another oral medication that has been shown to be 95% effective in the treatment of tapeworm infections associated with both *Taenia* and *Diphyllobothrium latum* species is praziquantel (Biltricide). Side effects reported for praziquantel are mild and appear to be short-lived. They include nausea, abdominal pain, **itching**, sore joints, and muscle pain.

It is recommended that follow-up stool samples be examined at one month and three months after treatment has been completed. Treatment can be considered successful if no eggs are present in several stool samples. It should be noted that the tapeworm medications do not kill the tapeworm eggs when they kill the adult worm, so the potential for infection with eggs still exists as the dead worm segments are passed. Proper personal hygiene in individuals receiving treatment will greatly reduce this potential.

Cases of neurocysticercosis, where larvae have developed in the central nervous system, may also be treated with praziquantel or albendazole. If the patient is treated promptly, damage to the central nervous system will be minimized.

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As of late 2003, researchers in developing countries were working on a vaccine for pigs to help control neurocysticercosis; however, the vaccine is not likely to be available for several years.

Prognosis

When confined to the intestinal tract, tapeworms cause minimal damage to their human host. Once the diagnosis of an intestinal tapeworm infection has been made, prognosis following treatment with niclosamide or praziquantel is good. The worms can be eliminated from the intestines with oral treatment, and there are usually no residual side effects. Serious problems from tapeworm infections occur when tapeworm eggs are consumed and the larvae localize in tissues outside the digestive tract (cysticercosis). Prompt diagnosis and treatment of this condition is necessary to prevent permanent damage to the central nervous system and other internal organs. In fact, cysticercosis is becoming increasingly recognized as an important cause of severe neurologic disease in the United States. Untreated cases of cysticercosis have the rare potential to be life-threatening; in some cases, **liver transplantation** has been necessary to save the patient's life.

Prevention

The best way to prevent infection with tapeworms is to eliminate the exposure of livestock to the tapeworm eggs by properly disposing of human feces. The next best strategy is to thoroughly cook or freeze all meat and fish before it is eaten to prevent consumption of live tapeworm larvae in infected samples. Larval cysts in pork and beef are killed by moderate temperatures of 150°F (65°C) or if frozen for at least 12 hours. Proper cooking of freshwater fish could also eliminate the possibility of human infection with the fish tapeworm. Freezing fresh fish for 24 hours will also kill the larval form.

People who raise sheep or horses should have these animals checked regularly by a veterinarian and dewormed if necessary.

The Centers for Disease Control and Prevention (CDC) recommends that people traveling abroad should wash their hands with soap and water before handling food; should wash and peel all raw vegetables and fruits before eating; and should drink only bottled or boiled water, or carbonated drinks in cans or bottles.

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ORGANIZATIONS

American Veterinary Medical Association (AVMA), 1931 North Meacham Road, Suite 100, Schaumburg, IL, 60173-4360, (847) 925-1329, (800) 248-2862, http://www.avma.org/.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

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Tardive dyskinesia

Definition

Tardive dyskinesia is a mostly irreversible neurological disorder of involuntary movements caused by long-term use of antipsychotic or neuroleptic drugs.

Description

Antipsychotic or neuroleptic drugs are powerful tranquilizers generally prescribed for serious psychiatric disorders, as well as neurological and gastrointestinal disorders. Some common antipsychotics are: chlorpromazine HCl (Thorazine), thioridazine HCl (Mellaril), haloperidol (Haldol), perphenazine (Trilafon), thiothixene (Navane), trifluoperazine HCl (Stelazine), and fluphenazine HCl (Permitil, Prolixin).

When these drugs are used long term, tardive dyskinesia (TD) can result. About 20 percent of people taking **antipsychotic drugs** for more then one year become

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KEY TERMS

Antipsychotics—Drugs used to treat psychotic conditions such as schizophrenia or psychosis. These medications are powerful tranquilizers that all have sedating and calming effects, but their major effect is to reduce psychotic thinking and behavior.

Neuroleptics—Any of a class of drugs used to treat psychotic conditions.

Psychosis—A condition where a person's ability to recognize reality and cope with everyday life is severely affected.

affected by TD. The prevalence of TD tends to be highest among elderly patients and among women.

Causes and symptoms

TD usually appears after years of antipsychotic drug use, and seems to be related to the total lifetime dose of medication. The symptoms include the following:

- tongue protrusion
- grimacing
- rapid eye blinking
- lip smacking, pursing, or puckering
- rapid movement of the arms or legs
- other involuntary movements of the head, face, neck and tongue muscles

Diagnosis

The diagnosis of TD is suspected upon observation of involuntary movements of the head, neck, face, and tongue in individuals who have a history of antipsychotic drug prescription.

Treatment

There is no standard treatment for TD. The primary approach is to discontinue or minimize the use of antipsychotic drugs while attempting to treat some of the symptoms. The treatment must be individualized to the patient, because discontinuation of the antipsychotic drug(s) may not be advisable, depending on the patient's condition. In some cases, substituting another drug for the antipsychotic drug may be beneficial.

Prognosis

Once TD appears in full–blown form, it can be permanent. With careful management, some symptoms may improve and even disappear with time. In less severe cases, some patients may recover from TD within three months of discontinuing the use of antipsychotic medication. Studies report that at least half of patients experience remission of major symptoms within 12 to 18 months following discontinuation of antipsychotic drugs. In some patients, however, decreasing the dose of the antipsychotic drug actually increases the symptoms of TD, while increasing the dose sometimes offers a temporary remission of the symptoms.

Prevention

TD can be prevented by early recognition and discontinuation of the antipsychotic medication if this is clinically possible. The use of antipsychotic drugs should in any case be kept to a minimum in all patients. Patients should be followed carefully to determine when the dose of the drug can be tapered off as the psychiatric condition improves. In all cases, the benefits of taking the antipsychotic medication should outweigh the risk of developing TD.

A study has shown that elderly institutionalized patients with **dementia** that were treated with risperidone had a low incidence of TD. Although further study is needed, this study shows that non-conventional neuroleptic drugs should be considered to avoid the risk of tardive dyskinesia, particularly in elderly patients.

Resources

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ORGANIZATIONS

National Institute of Mental Healt, 6001 Executive Boulevard, Room 8184, MSC 9663, Bethesda, MD, 20892-9663, (866) 615-6464, nimhinfo@nih.gov, http://www.nimh.nih.gov.

TG Center, 20 N. Orange Ave - Suite 1450, Orlando, FL, 32801, (800) 584-6601, information@tardivedyskinesia.com, http://www.tardivedyskinesia.com.

Kim A. Sharp, M.Ln.

Tarsorrhaphy

Definition

Tarsorrhaphy is a rare procedure in which the eyelids are partially sewn together to narrow the opening.

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KEY TERMS

Cornea—The clear part of the front of the eye through which vision occurs.

Enophthalmos—A condition in which the eye falls back into the socket and inhibits proper eyelid function.

Exophthalmos—A condition in which the eyes stick out of their sockets and inhibit proper eyelid function.

Palpebral fissure—Eyelid opening.

Sjögren's syndrome—A connective tissue disease that hinders the production of tears and other body fluids.

Purpose

The eye needs the a lid to protect it. It also needs tears and periodic blinking to cleanse it and keep it moist. There are many conditions that impair these functions and threaten the eye, specifically the cornea, with drying. Until they can be corrected, sewing the eyelids partially together helps protect the eye.

A partial list of the conditions that can require tarsorrhaphy includes:

- Paralysis or weakness of the eyelids so that they cannot close or blink adequately. Bell's palsy is a nerve condition that weakens the muscles of the face, including the eyelids. It is usually temporary. Myasthenia gravis also weakens facial muscles, but it is usually treatable. A stroke can also weaken eyelids so they do not close.
- Exophthalmos (the eyes sticking out of their sockets) occurs with Graves' disease of the thyroid and with tumors behind the eyes. If the eyes stick out too far, the lids cannot close over them.
- Enophthalmos is a condition in which the eye falls back into the socket so that the eyelid function is inadequate.
- Several eye and corneal diseases cause swelling of the cornea and require temporary added protection until the condition resolves.
- Sjögren's syndrome reduces tear flow to the point where it can endanger the cornea.
- Dendritic ulcers of the cornea caused by viruses may need to be covered with the eyelid while they heal.

Precautions

The use of eye drops and **contact lenses** to moisten and protect the eyes must be considered first before tarsorrhaphy is performed.

Description

Stitches are carefully placed at the corners of the eyelid opening (called the palpebral fissure) to narrow it. This allows the eye better lubrication and less exposure to the air. Eyeball motion can then help bathe the cornea in tears when it rolls up under the lid. The outpatient procedure is done under local anesthetic.

Preparation

Tarsorrhaphy is a minor procedure done under **local anesthesia**. Special preparation is not necessary.

Aftercare

Eye drops or ointment may still be needed to preserve the cornea or treat accompanying disease.

Risks

Tarsorrhaphy carries few risks. If complications occur, they are usually minor eyelid swelling and superficial infection.

Resources

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Brightbill, Frederick S., et al. *Corneal Surgery: Theory, Technique, & Tissue*. 4th ed. St. Louis: Mosby, 2009.

J. Ricker Polsdorfer, MD

Tattoos *see* **Piercing and tattoos**

Tay-Sachs disease

Definition

Tay-Sachs disease is a genetic disorder caused by a missing enzyme that results in the accumulation of a fatty substance in the nervous system. This results in disability and **death**.

Description

Gangliosides are fatty substances necessary for the proper development of the brain and nerve cells (nervous system). Under normal conditions, gangliosides are continuously broken down, so that an appropriate balance is maintained. In Tay-Sachs disease, the enzyme necessary for removing excess gangliosides is missing. This allows gangliosides to accumulate throughout the brain, and is responsible for the disability associated with the disease.

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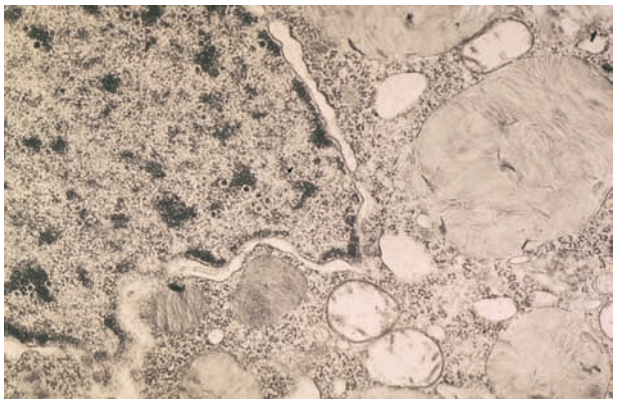

Section of brain tissue from patient with Tay-Sachs disease. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Tay-Sachs disease is particularly common among Jewish people of Eastern European and Russian (Ashkenazi) origin. About one out of every 3,600 babies born to Ashkenazi Jewish couples will have the disease. Tay-Sachs is also more common among certain French-Canadian and Cajun French families.

Causes and symptoms

Tay-Sachs is caused by a defective gene. Genes are located on chromosomes, and serve to direct specific development/processes within the body. The genetic defect in Tay-Sachs disease results in the lack of an enzyme called hexosaminidase A. Without this enzyme, gangliosides cannot be degraded. They build up within the brain, interfering with nerve functioning. Because Tay-Sachs is a recessive disorder, only people who receive two defective genes (one from the mother and one from the father) will actually have the disease. People who have only one defective gene and one normal gene are called carriers. They carry the defective gene and thus the possibility of passing the gene and/or the disease onto their offspring.

When a carrier and a non-carrier have children, none of their children will actually have Tay-Sachs. It is likely that 50% of their children will be carriers themselves. When two carriers have children, their children have a 25% chance of having normal genes, a 50% chance of being carriers of the defective gene, and a 25% chance of having two defective genes. The two defective genes cause the disease itself.

Classic Tay-Sachs disease strikes infants around the age of six months. Up until this age, the baby will appear to be developing normally. When Tay-Sachs begins to show itself, the baby will stop interacting with other people and develop a staring gaze. Normal levels of noise will startle the baby to an abnormal degree. By about one year of age, the baby will have very weak, floppy muscles, and may be completely blind. The head will be quite large. Patients also present with loss of peripheral (side) vision, inability to breath and swallow, and **paralysis** as the disorder progresses. Seizures become a problem between ages one and two, and the baby usually dies by about age four.

KEY TERMS

Ganglioside—A fatty (lipid) substance found within the brain and nerve cells.

A few variations from this classical progression of Tay-Sachs disease are possible:

- Juvenile hexosaminidase A deficiency. Symptoms appear between ages two and five; the disease progresses more slowly, with death by about 15 years.
- Chronic hexosaminidase A deficiency. Symptoms may begin around age five, or may not occur until age 20–30. The disease is milder. Speech becomes slurred. The individual may have difficulty walking due to weakness, muscle cramps, and decreased coordination of movements. Some individuals develop mental illness. Many have changes in intellect, hearing, or vision.

Diagnosis

Examination of the eyes of a child with Tay-Sachs disease will reveal a characteristic cherry-red spot at the back of the eye (in an area called the retina). Tests to determine the presence and quantity of hexosaminidase A can be performed on the blood, specially treated skin cells, or white blood cells. A carrier will have about half of the normal level of hexosaminidase A present, while a patient with the disease will have none.

Treatment

There is no treatment for Tay-Sachs disease.

Prognosis

Sadly, the prognosis for a child with classic Tay-Sachs disease is certain death. Because the chronic form of Tay-Sachs has been discovered recently, prognosis for this type of the disease is not completely known.

Prevention

Prevention involves identifying carriers of the disease and providing them with appropriate information concerning the chance of their offspring having Tay-Sachs

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disease. When the levels of hexosaminidase A are half the normal level, a person is a carrier of the defective gene. Blood tests of carriers reveals reduction of hexosaminidase A.

When a woman is already pregnant, tests can be performed on either the cells of the baby (aminocentesis) or the placenta (**chorionic villus sampling**) to determine whether the baby will have Tay-Sachs disease.

ORGANIZATIONS

Late Onset Tay-Sachs Foundation, 4924 Balboa blvd, #354, Encino, CA, 91316, (818) 205-9644, (818) 906-1914, http://www.lateonsettay-sachs.org/.

March of Dimes Birth Defects Foundation, 1275 Mamaroneck Ave., White Plains, NY, 10605, (914) 997-4488, http://www.modimes.org.

Laith Farid Gulli, M.D.

TB *see* **Tuberculosis**

TCM *see* **Traditional Chinese medicine**

TE fistula *see* **Tracheoesophageal fistula**

Technetium heart scan

Definition

The technetium heart scan is a noninvasive nuclear scan that uses a radioactive isotope called technetium to evaluate blood flow after a **heart attack**.

Purpose

The technetium heart scan is used to evaluate the heart after a heart attack. It can confirm that a patient had a heart attack when the symptoms and **pain** usually associated with a heart attack were not present; identify the size and location of the heart attack; and provide information useful in determining the patient's post-heart attack prognosis. The scan is most useful when the electrocardiogram and cardiac enzyme studies do not provide definitive results after heart surgery, for example, or when chest pain occurred more than 48 hours before the patient was examined. It is also used to evaluate the heart before and after heart surgery.

Precautions

Pregnant women and those who are **breastfeeding** should not be exposed to technetium.

Description

The technetium heart scan is a nuclear heart scan, which means that it involves the use of a radioactive isotope which targets the heart, and a radionuclide detector that traces the absorption of the radioactive isotope. The isotope is injected into a vein and absorbed by healthy tissue at a known rate during a certain time period. The radionuclide detector, in this case a gamma scintillation camera, picks up the gamma rays emitted by the isotope.

The technetium heart scan uses technetium Tc-99m stannous pyrophosphate (usually called technetium), a mildly radioactive isotope that binds to **calcium**. After a heart attack, tiny calcium deposits appear on diseased heart valves and damaged heart tissue. These deposits appear within 12 hours of the heart attack. They are generally seen two to three days after the heart attack and are usually gone within one to two weeks. In some patients, they can be seen for several months.

After the technetium is injected into a blood vessel in the arm, it accumulates in heart tissue that has been damaged, leaving "hot spots" that can be detected by the scintillation camera. The technetium heart scan provides better image quality than commonly used radioactive agents such as thallium, because it has a shorter half-life and can thus be given in larger doses.

During the test, the patient lies motionless on the test table. Electrocardiogram electrodes are placed on the patient's body for continuous monitoring during the test. The test table is rotated so that different views of the heart can be scanned. The camera, which looks like an x-ray machine and is suspended above the table, moves back and forth over the patient. It displays a series of images of technetium's movement through the heart and records them on a computer for later analysis.

The test is usually performed at least 12 hours after a suspected heart attack, but it can also be done during triage of a patient who goes to a hospital emergency room with chest pain but does not appear to have had a heart attack. Recent clinical studies demonstrate that technetium heart scans are very accurate in detecting heart attacks while the patient is experiencing chest pain. They are far more accurate than electrocardiogram findings.

The technetium heart scan is usually performed in a hospital's nuclear medicine department but it can be done at the patient's bedside during a heart attack if the equipment is available. The scan is done two to three hours after the technetium is injected. Scans are usually done with the patient in several positions, with each scan taking 10 minutes. The entire test takes about 30 minutes to an hour. The scan is usually repeated over several weeks to determine if any further damage has been done to the

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KEY TERMS

Electrocardiogram—A test in which electronic sensors called electrodes are placed on the body to record the heart's electrical activities.

Noninvasive—A procedure that does not penetrate the body.

Radioactive isotope—One of two or more atoms with the same number of protons but a different number of neutrons with a nuclear composition. In nuclear scanning, radioactive isotopes are used as a diagnostic agent.

Technetium—A radioactive isotope frequently used in radionuclide scanning of the heart and other organs. It is produced during nuclear fission reactions.

heart. The test is also called technetium 99m pyrophosphate scintigraphy, hot-spot myocardial imaging, infarct avid imaging, or myocardial infarction scan.

The technetium heart scan is not dangerous. The technetium is completely gone from the body within a few days of the test. The scan itself exposes the patient to about the same amount of radiation as a **chest x ray**. The patient can resume normal activities immediately after the test.

Preparation

Two to three hours before the scan, technetium is injected into a vein in the patient's forearm.

Normal results

If the technetium heart scan is normal, no technetium will show up in the heart.

Abnormal results

In an abnormal technetium heart scan, hot spots reveal damage to the heart. The larger the hot spots, the poorer the patient's prognosis.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

Texas Heart Institute. Heart Information Service, MC 3-116, PO Box 20345, Houston, TX, 77225, (832) 355-4011, (800) 292-2221, http://www.texasheart.org.

Lori De Milto

TEE *see* **Transesophageal echocardiography**

Teeth whitening

Definition

Teeth whitening is the process of using bleach or other materials to make teeth look whiter. The materials remove stains or other discoloration from the tooth surface.

Purpose

Teeth whitening is a cosmetic treatment done to improve the appearance of teeth. Teeth are whitened to remove the effects of coffee, cigarettes, and other substances that permanently stain or discolor teeth. Medications such as **antibiotics** like tetracycline may discolor teeth. Fluorosis, a condition caused by absorbing too much fluoride, could affect tooth color. Furthermore, **aging** also causes teeth to loose their bright color.

Precautions

Teeth whitening is not safe or effective for everyone, so a person should have a dental exam before starting treatment. The dentist can advise the patient about the most appropriate procedure. The oral health professional will also discuss the expected results of treatment. Patients may expect yellow or gray teeth to be replaced with a bright, white color. However, whitening may not work well on some stain colors.

The importance of a check-up

Whitening may not be recommended for people with gum disease, receding gums, or sensitive teeth. The dentist may advise against certain treatments if the enamel is worn. Enamel is the outer layer of the tooth. There is no enamel on an exposed tooth root, so the root cannot be whitened.

In addition, cavities must be filled before treatment begins. Otherwise, the patient could experience additional mouth sensitivity when treatment material comes into contact with decay or the tooth interior.

When whitening is not recommended

Women who are pregnant and nursing should avoid any whitening treatment except for toothpaste. Oral health care professionals advise that other treatments could contain levels of peroxide that are potentially dangerous to the child. Although no connections have been made between these treatments and harm to the child's health, mothers are urged to take preventive action and delay whitening treatment.

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Teenagers should not have their teeth bleached until they are between 14 and 16 years old. In a younger child, the nerve of the tooth called the pulp chamber has not fully developed. Whitening at this point could irritate the pulp and cause sensitivity.

People who are allergic to peroxide should not be treated with this whitening agent.

Cautions about tooth color

Treatments such as bleaching are most effective on yellowish stains, according to the American Dental Association (ADA). Teeth with brown stains may not bleach as well, and the treatment is even less effective on gray-stained teeth.

Furthermore, bleaching will not change the color of tooth-colored fillings, dentures, crowns, porcelain restorations, bonding, or other material used to restore or replace a tooth. If bleaching is done, the newly whitened teeth will stand out in contrast to fillings or other modifications.

Description

Teeth are whitened by the use of bleach or other material. The treatment may be done in the dental office, at home with guidance from a dentist, or at home with the use of over-the-counter products. Tools for self-treatment include bleaching trays, gels or strips that are applied to the teeth, and toothpaste.

Whitening treatments are cosmetic procedures, and are usually not covered by dental insurance.

Products used by oral health professionals such and those sold over the counter may have the ADA Seal of Acceptance. This endorsement indicates that products carrying the seal have met the American Dental Association's criteria for safety and effectiveness. Those standards are based on the patient following directions when the product is used.

The ADA evaluation program is voluntary. That means manufacturers are not required to submit products for review. As a result, the lack of a seal may not indicate that the product is unsafe. However, products on the Accepted list have the ADA endorsement, and the association may take positions on certain unevaluated procedures such as laser treatment.

Dental office treatment

The whitening treatment provided by dentists is known as chairside bleaching, in-office bleaching, or power bleaching. The dentist first protects the patient's gums and tissue by applying a protective gel or a rubber shield. The dentist than applies a whitening solution on the teeth.

The whitening solution contains hydrogen peroxide, which is a bleaching agent that could change the tooth color. The bleach is used to remove surface (extrinsic) and deeper (intrinsic) stains. Professionally applied whiteners, those solutions used by dentists, usually contain hydrogen peroxide. This bleaching agent comes in concentrations ranging from 15% to 35%. As of March of 2005, all solutions with the ADA Seal had a 35% concentration of hydrogen peroxide.

After the gel is applied, a light may be shined on the teeth to accelerate the whitening agent. Some agents are enhanced by lasers. However, no treatments requiring lasers were on the ADA list of accepted products as of March 2005. Although lasers may be safe, the association had not seen published, peer-reviewed data on the safety and effectiveness of laser whitening.

Chairside bleaching treatment may last from thirty minutes to an hour, according to the ADA. In addition, patients may need to return for additional treatments. The cost of treatment for the whole mouth can cost from $500 to $1,000. Factors affecting cost include the patient's location and the number of treatments needed. At the high end of the range is laser treatment, which could cost $1,000 or more.

Dentist-supervised treatment

Supervised treatment combines visits to the dentist with treatment at home. The procedure is also called tray bleaching or nightguard bleaching because the patient wears a tray on the teeth that protects the gums from the whitening solution.

For this treatment, the dentist takes an impression of the patient's teeth and makes a mouthpiece tray, or mouthguard, that will fit over the teeth. The dentist dispenses a whitening gel that the patient will place in the customized mouthguard.

The gel usually contains carbamide peroxide, which comes in concentrations of 10%, 16%, and 22%. Products with the ADA Seal have a 10% concentration. That amount is the equivalent of an approximately 3% concentration of hydrogen peroxide. The ADA endorsement applies only to home systems dispensed by dentists. The association's Seal reflects the importance of consulting with a dentist before undergoing treatment at home, according to the ADA.

The dentist will set up a schedule for wearing the mouthguard. Wearing times vary by product. A patient may wear the piece overnight for one to two weeks. For other systems, the patient wears the mouthguard for a

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set amount of time twice a day. This treatment usually lasts two weeks.

During supervised treatment, the dentist generally schedules appointments to monitor the patient's progress. In addition to checking the whitening process, the dentist may examine the fit of the mouthguard and look for signs of gum irritation.

Supervised home bleaching of the whole mouth costs from $300 to $600.

Over-the-counter (OTC) products

In-home treatments that can be purchased over-the-counter include products that use bleach in mouthguard trays as well as strips and gels. The bleaching agent is usually carbamide peroxide, which is not as strong as the hydrogen peroxide found in solutions that are used in chairside bleaching and supervised home treatment.

OTC treatments range in price from $20 to $150. Treatment lasts 14 days on average. Another treatment is the use of whitening toothpaste, a product that does not contain bleach.

TRAY TREATMENT. Mouthguard treatment kits can be bought in stores and over the Internet. The tray kits involve the use of a mouthguard and gel. While similar to dentist-supervised home treatment, the patient does not use a customized tray specifically for her or his mouth. Some kits have mouthguards that patients can mold to their teeth. However, the patient relies on the generic instructions provided by the manufacturer.

GELS AND WHITENING STRIPS. Gels are applied directly to the teeth. Whitening strips are thin, clear strips coated with a peroxide-based gel. The strips are applied to the teeth and worn for 30 minutes twice a day. Treatment time varies by product and generally lasts from five to 14 days.

WHITENING TOOTHPASTES. Whitening toothpastes do not contain bleach. Instead mild abrasives remove surface stains, but do not change tooth color. Products with the ADA Seal contain special chemicals or polishing agents that remove stains. A tube of whitening toothpaste costs about $5.

Preparation

The ADA advises people to consult with a dentist before beginning any teeth whitening treatment. The dentist can review the patient's oral health history and discuss the appropriate treatment. If necessary, the dentist will fill cavities.

KEY TERMS

Enamel—The hard, white, outer layer of the tooth.

Fluoride—A compound believed to combat cavities in teeth.

Peroxide—A bleaching agent that is a compound consisting of two atoms of oxygen connected by a single bond.

Aftercare

During supervised at-home treatment, the dentist may schedule appointments to check on the progress of whitening, side effects, and the tray fit.

After treatment is completed, people need to be aware that **smoking** will cause teeth to discolor. Beverages with **caffeine** should be consumed with a straw to reduce the effects of staining. Another preventive action is brushing the teeth after drinking or eating foods that cause stains.

Risks

Teeth-whitening may cause sensitivity to hot and cold food and beverages. This is a temporary side effect that usually ends when treatment is completed. Some patients also experience gum irritation if the tray does not fit properly.

Normal results

Dentists use a stronger bleaching agent than that found in commercial products, so in-office whitening treatment produces a more dramatic effect on teeth with yellow stains. Over-the-counter products with bleach provide some change in the tooth color, and whitening toothpaste works only on surface stains.

Bleaching does not leave teeth permanently white. Whitening can last from six months to a year. Sometimes teeth stay white even longer. However, smoking or consumption of food and beverages that stain can cause discoloration within one month.

Resources

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"Teeth Whitening: Is it for You?" Academy of General Dentistry. http://www.agd.org/media/2004/dec/whitening.asp.

"Tooth Whitening Systems." American Dental Hygienists' Association http://www.adha.org/oralhealth/whitening.htm.

"Tooth Whitening Treatments." American Dental Association http://www.ada.org/2754.aspx.

ORGANIZATIONS

Academy of General Dentistry, 211 East Chicago Avenue, Suite 900, Chicago, IL, 60611-1999, (312) 440-0559, (888) 243-3368, http://www.agd.org.

American Dental Association, 211 E. Chicago Ave., Chicago, IL, 60611-2678, (312) 440-2500, http://www.ada.org.

American Dental Hygienists' Association, 444 North Michigan Avenue, Suite 3400, Chicago, IL, 60611, (312) 440-8900, mail@adha.net, http://www.adha.org/.

Liz Swain

Teething

Definition

Teething is the emergence (eruption) through the gums of a baby's first or primary teeth.

Demographics

Every baby is different when it comes to teething. The timing of primary tooth eruption can vary by two or more years, but teething generally begins between four and eight months after birth. Some babies begin teething as early as three months and other do not begin until long past eight months. Rarely, children are born with one or two teeth—called natal teeth—or have neonatal teeth emerge during the first month of life. Dental development in girls generally proceeds ahead of that in boys, often by as much as 6%. However, most children have all of their 20 primary teeth by age three. It is extremely rare for children to not have primary teeth.

Description

The 20 primary or baby teeth are usually forming in the gums at birth. By 12–15 months of age, all of the primary teeth within the gums have formed crowns. Primary teeth usually erupt in pairs—one each on the right and left sides of the mouth. In general, the pairs alternate between the lower and upper jaws and proceed from front to back. From the age of six months on, children get four new teeth about every four months. The order of tooth eruption, as well as the timing, can vary.

An infant chews on a crib frame to relieve the pain that comes with teething. *(© M Son People/Alamy.)*

Primary teeth usually erupt in the following order:

- the two lower central incisors or front teeth at six to ten months of age
- the two upper central incisors four to eight weeks later, at eight to twelve months
- the two upper lateral or side incisors, on each side of the central incisors, at nine to 13 months
- the two lower lateral incisors about one month later, at ten to 16 months of age
- the two upper first molars, for grinding food, at 13 to 19 months
- the two lower first molars at 14 to 18 months
- the two upper canines or cuspids—the pointy eyeteeth between the lateral incisors and the first molars—at 16 to 22 months
- the two lower canines or cuspids at 17 to 23 months

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- the two lower second or lateral molars at 23 to 31 months
- the two upper second or lateral molars at 25 to 33 months

Most children have all 20 primary teeth by the age of two and a half to three years. These are known as the deciduous teeth because they eventually fall out and are replaced by the 32 permanent adult or secondary teeth, which begin to form within the jaw shortly before or at birth. The first permanent teeth—the six-year-molars or first permanent molars—erupt behind each of the four second baby molars, usually between the ages of five and six.

Children begin losing their primary teeth at about age six, after the permanent front teeth are almost completely formed beneath the gums. The pressure of the developing permanent teeth causes the roots of the primary teeth to dissolve. Without their anchor in the jaw, the baby teeth loosen and eventually fall out, usually beginning with the lower front teeth. The earlier the baby teeth come in, the earlier they will fall out. Most children have lost all of their baby teeth by age 13.

Risk factors

The age and rapidity at which babies undergo teething is determined primarily by hereditary factors. Various medical conditions, such as **Down syndrome**, can cause delays in teething.

Causes and symptoms

Teething is caused by the crowns of the developing primary teeth erupting through the gum tissue. For some children, teething is painless and passes almost unnoticed. For others, teething can cause considerable discomfort due to the pressure exerted on the periodontal membrane by the erupting tooth. The eruption of the large molars, in particular, can be painful. Periods of discomfort and irritability may be very brief or may last for weeks. In some cases, teething can be a significant source of **stress** for both parents and child. Teething does not interfere with **breastfeeding**.

Symptoms of teething usually begin three to five days before a tooth shows and disappear as soon as the tooth has broken through the skin of the gum. Symptoms of teething may include:

- tender, red, swollen gums at the site of the erupting tooth
- flushed cheeks
- congestion
- dribbling or drooling from the mouth
- rubbing of the gums

KEY TERMS

Canine; cuspid—Eyetooth; the conical, pointed tooth between the lateral incisor and the first primary molar or permanent premolar.

Crown—The part of the tooth above the gum.

Deciduous teeth—The primary, baby, or milk teeth that fall out and are replaced by permanent teeth.

Eruption—The emergence of a tooth through the gum.

Incisors—The eight front cutting teeth–four in the lower jaw and four in the upper jaw, located between the canines.

Molars—The teeth behind the primary canines or permanent premolars, with large crowns and broad chewing surfaces for grinding food.

- thumb sucking
- the desire to chew or bite down hard on various objects
- fussiness and irritability
- restlessness
- loss of appetite or refusal of food
- sleep disruptions
- excessive crying
- a slight fever from inflamed gums, no higher than 101°F (38.3°C)

Teething can sometimes cause earaches. It does not cause other childhood symptoms such as significant **fever**, **diarrhea**, or **vomiting**.

Diagnosis

Examination

Teething does not usually require medical consultation. However, if teething appears to cause prolonged or excessive irritability, severe **pain**, or pus, gum swelling, or excessive redness, a pediatrician or dentist should be consulted. It is usually recommended that children first visit a pediatric dentist within six months of their first tooth eruption or by one year of age. By the age of two children should be examined by a dentist at least twice per year.

Tests

There are no specific tests for teething.

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Procedures

If the eruption of the primary teeth appears to be preceding abnormally, the dentist may order x rays of the developing teeth inside the gums.

Treatment

Traditional

Traditional treatments for teething include massaging the baby's gums and using cold teething rings to relieve discomfort. Natal or neonatal teeth are often mobile and poorly formed. Although these are primary teeth, rather than extra teeth, they may have to be removed if they interfere with feeding, irritate the tongue or lips, or are likely to come loose and cause **choking**. Sometimes children develop an extra primary tooth. This can interfere with the eruption of the permanent tooth beneath and must be extracted.

Drugs

Acetaminophen (Infant Tylenol or others) can help relieve discomfort in teething babies and young children. Acetaminophen should only be administered after consultation with a pediatrician. It is very important to choose an over-the-counter (OTC) acetaminophen–containing product that is manufactured specifically for the child's age and to carefully follow all dosing instructions. Children should never be given **aspirin** because of the rare but serious risk of **Reye's syndrome**. Aspirin should never be held against a tooth; nor should alcohol be rubbed into a baby's gums.

OTC teething gels contain a topical anesthetic, such as benzocaine or lidocaine, that temporarily numbs the gums and relieves discomfort. Again, it is important to consult a pediatrician and to carefully follow the manufacturer's instructions. These gels can be harmful if used improperly, can cause reactions in some babies, and, if swallowed, can numb the throat and interfere with the gag reflex. Teething powders should never be used.

Alternative

Chamomile (*Matricaria recutita*, *Chamaemelum nobile*) is widely used as an herbal remedy for teething discomfort.

Home remedies

Teething symptoms are generally treated at home. Drool from a teething baby should be wiped away frequently to prevent **rashes** around the mouth and face and on the chest.

There are various types of teething aids that babies can chew on. In addition to relieving discomfort and massaging the gums, these may help speed tooth eruption. Frozen teething toys numb the gums and reduce swelling, but should not be left in the baby's mouth for more than one minute at a time. They should be removed from the freezer before becoming rock hard because they can bruise swollen gums. Teething aids must be large enough that they cannot fit completely in the mouth and be swallowed. They must be sturdy enough that they will not break into pieces. Rubber teething rings with liquid inside should be avoided because they can break and leak. Teething rings should never be tied around a baby's neck because of the risk of strangulation.

There are various other home remedies for teething:

- The baby's gums can be massaged with a clean finger or cool wet washcloth.
- The baby can chew on a wet washcloth that has been in the freezer for 30 minutes. It should be washed after each use.
- Older children can chew on ice, cold food such as an apple or frozen banana, or hard biscuits.
- The sore area should be kept clean but not brushed hard.
- The sore area may be rinsed often with saltwater (one teaspoon of salt per cup of warm water).

Prognosis

Most children teethe with a minimum of discomfort. The subsequent eruption of permanent teeth is generally pain-free.

Prevention

Daily dental care should begin even before the eruption of the first tooth. Although children lose their primary teeth, dental decay can hasten tooth loss. This can leave gaps before the permanent teeth emerge and cause the primary teeth to crowd in to fill the gaps, leading to crooked permanent teeth. Decay also can spread to the permanent teeth forming in the gums.

To help prevent decay and promote healthy gums prior to the eruption of primary teeth, an infant's mouth should be wiped with a damp cloth after breastfeeding and the baby's gums should be wiped at least once or twice daily with a clean, damp cloth or gauze.

Erupting teeth should be wiped with a damp cloth. All tooth surfaces and the gum line should be thoroughly cleaned using a soft, nylon-bristled, infant toothbrush. Once all of the primary teeth have erupted, the teeth should be brushed at least twice per day, especially after meals.

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Toothbrushes should be replaced every three months or when they become worn or frayed. Toothpaste should not be used until the child is able to spit it out, usually at about age three, and then only about a pea-sized amount should be used. Toothpaste should contain fluoride, but children should never be allowed to swallow fluoride toothpaste. Although children may start brushing their own teeth, the parent should remain the primary tooth brusher until the child is about five years of age. Flossing should begin once two teeth begin to touch.

In addition:

- Babies should never be allowed to comfort themselves or fall asleep with a bottle or sippy cup containing anything but water. Milk or juice can collect in the baby's mouth and cause plaque and tooth decay.
- Children should be given juice or flavored milk products only with meals.
- Pacifiers should never be sweetened with honey or other substances.
- Children should be offered fresh fruit and vegetable snacks rather than sugar.
- Parents should practice good oral hygiene and regular dental visits as examples to their children.

Resources

BOOKS

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ORGANIZATIONS

American Academy of Pediatric Dentistry, 211 East Chicago Avenue, Suite 1700, Chicago, IL, 60611-2637, (312) 337-2169, (312) 337-6329, http://www.aapd.org.

American Dental Association, 211 East Chicago Ave., Chicago, IL, 60611-2678, (312) 440-2500, http://www.ada.org.

Margaret Alic, PhD

Template bleeding time *see* **Bleeding time**

Temporal arteritis

Definition

The term temporal arteritis literally means "inflammation of the temporal arteries." As implied by the name, these blood vessels run along the temples after they branch off from the carotid artery in the neck. They provide the blood supply to portions of the scalp, jaw muscles, and salivary glands. Inflammation of these arteries, probably resulting from an abnormal immune reaction, disrupts this blood supply, resulting in a variety of symptoms. They can range from relatively minor jaw **pain** or **headache** to major symptoms, including temporary or permanent blindness.

Temporal arteritis is also called giant cell arteritis or cranial arteritis. It is a rheumatic disease that affects large– and medium–sized arteries throughout the body and can occur in a variety of patients. Although the temporal arteries are most commonly affected, other arteries throughout the body may be affected. The disease seems to target arteries containing elastic tissue. Veins are rarely affected. Temporal arteritis is a type of **vasculitis**.

Demographics

Temporal arteritis almost always occurs in people over 50, and it becomes more common as people age. About 20 out of 100,000 people over the age of 50 suffer from temporal arteritis. Women are affected twice as often as men. Some authorities say that temporal arteritis is more common in Caucasians (especially Scandinavians) than in people of other races. Close relatives of patients with temporal arteritis may be more likely than others to get the disease.

Description

Patients with temporal arteritis are diagnosed and overlap with a broader disorder called giant cell arteritis. This disorder can affect parts of the body in addition to the scalp, eyes, and jaw. Sometimes the disease can cause restricted circulation to both arms or both legs, producing pain in the affected limbs. With other blood

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vessels involved, patients with advanced forms of the disease may experience strokes or transient ischemic attacks (TIA). These result in brief episodes of pain caused by decreased blood flow. Even heart attacks are occasionally caused by giant cell arteritis.

Causes and symptoms

This disease is one of a group of diseases in which the linings of large– or medium–sized blood vessels become inflamed. The elastic layer of these vessels is attacked by "giant" cells and chemicals produced by the immune system. This reaction reduces blood flow through the blood vessels, and the limited blood supply causes the symptoms.

The disease usually begins with "flu–like" symptoms, including a mild **fever** (100–101°F; 37.8–38.3°C), general body discomfort, and a persistent, dull headache. The scalp may be tender to the touch over the affected blood vessels. Jaw muscles sometimes become painful when the patient chews.

As the disease progresses, more severe symptoms occur. These include blurred vision or temporary blindness that typically lasts ten minutes or less. Eventually, permanent loss of vision can occur. Transient ischemic attacks, strokes, and heart attacks may occur when the disease is far advanced.

KEY TERMS

Anemia—Lower than normal level of red blood cells, or of the oxygen–carrying chemical hemoglobin.

Biopsy—Removal and examination of a sample tissue from the body for diagnostic purposes.

Corticosteroids—A group of hormones, produced naturally by the adrenal gland and other organs. They are used to treat a wide variety of disorders, including many rheumatic disorders.

Erythrocyte sedimentation rate—The speed at which red blood cells sink in a tube of freshly drawn blood, which is a rough measure of clotting disorders or inflammation.

Prednisone—A corticosteroid often used to treat inflammation.

Rheumatic disease—A type of disease involving inflammation of muscles, joints, and other tissues.

Transient ischemic attack—A brief experience of stroke–like symptoms (for instance, numbness, paralysis, problems in speaking or understanding speech) that go away within hours, with no permanent damage. Also known as TIA.

Vasculitis—An inflammation of the blood vessels.

Diagnosis

Doctors from a number of specialties develop experience in diagnosing and treating temporal arteritis. These include internists, who treat a broad range of diseases; rheumatologists, who focus on rheumatic diseases; geriatricians, who treat older people; ophthalmologists, who treat eye and vision disorders; neurologists, who treat headaches and problems of the optic nerve; and vascular surgeons, who treat blood vessel problems.

The doctor will generally take a medical history first. The patient can help the doctor tremendously by reviewing all symptoms—both major and minor—from the last two or three months. If possible, the patient should ask family or close friends for help in recalling his or her ailments from recent months. Then the doctor will conduct a complete **physical examination**. Often, he or she will detect a tender, swollen artery on the scalp.

The doctor will order blood tests as well. A standard and inexpensive test called the **erythrocyte sedimentation rate** (ESR or "sed" rate) is particularly helpful. Results from this test, which measures inflammation in the body, will almost always be higher than normal. Tests of red blood cells may show mild anemia. Sometimes blood tests for liver function will also be abnormal.

The definitive diagnostic test is a temporal artery biopsy. A doctor will make one or more tiny incisions under **local anesthesia** to remove samples of the suspect artery. Under the microscope, a pathologist usually can identify the typical damage caused by temporal arteritis.

Treatment

The mainstay of treatment is a course of **corticosteroids** (steroid hormones that have an anti–inflammatory effect), usually prednisone. The initial prescription involves a fairly high dose of **steroids** (40–60 mg/day) which is gradually tapered down to a maintenance dose. Because of the high incidence of blindness in untreated cases, steroid therapy should be started immediately rather than waiting for biopsy results. Patients typically take this maintenance dose for periods of one to three years. Sometimes nonsteroidal anti–inflammatory drugs (NSAIDs) are prescribed for muscle aches or headaches, especially while steroid doses are being reduced.

Prognosis

The outlook for most patients with temporal arteritis is good, especially if the disorder is diagnosed early.

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Symptoms often diminish within a month once patients begin to take steroids. Although physicians do not talk about a "cure" for temporal arteritis, symptoms typically do not return after a full course of steroid treatment. Unfortunately, if the diagnosis is made late in the disease, lost vision may not return.

Prevention

There is no medically proven approach to prevention. The best way to prevent severe, permanent damage is to obtain expert medical advice if the patient or the family physician suspects this problem.

Resources

BOOKS

Porter, Robert S., et al., eds. *The Merck Manual Home Health Handbook: Third Home Edition*. Rahway, NJ: Merck Publishing Group, 2009.

ORGANIZATIONS

American College of Rheumatology (ACR), 2200 Lake Blvd. NE, Atlanta, GA, 30319, (404) 633–3777, http://www.rheumatology.org.

American Council for Headache Education (ACHE), 19 Mantua Rd., Mt. Royal, NJ, 08061, (609) 423–0043, (800) 255–2243, http://www.achenet.org.

National Headache Foundation (NHF), 820 N. Orleans, Suite 217, Chicago, IL, 60610, (888) 643–5552, http://www.headaches.org.

National Institutes of Health (NIH), 9000 Rockville Pike, Bethesda, MD, 20892, (301) 496-4000, http://www.nih.gov/index.html.

National Library of Medicine (NLM), 8600 Rockville Pike, Bethesda, MD, 20894, http://www.nlm.nih.gov.

National Stroke Association (NSA), 9707 E Easter Ln. Building B, Centennial, CO, 80112, (800) 787–6537, http://www.stroke.org.

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Temporomandibular joint disorders

Definition

Temporomandibular joint disorder (TMJ) is the name given to a group of symptoms that cause **pain** in the head, face, and jaw. The symptoms include headaches, soreness in the chewing muscles, and clicking or stiffness of the joints. They often have psychological as well as physical causes.

Demographics

The disorder has been observed in both male and female populations, and across all age groups. Several precipitating factors such as injury, jaw alignment, jaw structure, and ligament connectivity may predispose an individual to TMJ disorder.

Description

TMJ disorder, which is also sometimes called TMJ syndrome, results from pressure on the facial nerves due to muscle tension or abnormalities of the bones in the area of the hinge joint between the lower jaw and the temporal bone. This hinge joint is called the temporomandibular joint. There are two temporomandibular joints, one on each side of the skull just in front of the ear. The name of the joint comes from the two bones that make it up. The temporal bone is the name of the section of the skull bones where the jaw bone (the mandible) is connected. The jaw bone is held in place by a combination of ligaments, tendons, and muscles. The temporomandibular joint also contains a piece of cartilage called a disc, which keeps the temporal bone and the jaw bone from rubbing against each other. The jaw pivots at the joint area in front of the ear. The pivoting motion of the jaw is complicated because it can move downward and from side to side as well as forward. Anything that causes a change in shape or functioning of the temporomandibular joint will cause pain and other symptoms.

Causes and symptoms

Causes

TMJ syndrome has several possible physical causes:

- Muscle tension. Muscle tightness in the temporomandibular joint usually results from overuse of muscles. This overuse in turn is often associated with psychological stress and clenching or grinding of the teeth (bruxism).
- Injury. A direct blow to the jaw or the side of the head can result in bone fracture, soft tissue bruising, or a dislocation of the temporomandibular joint itself.
- Arthritis. Both osteoarthritis and rheumatoid arthritis can cause TMJ.
- Internal derangement. Internal derangement is a condition in which the cartilage disk lies in front of its proper position. In most cases of internal derangement, the disc moves in and out of its correct location, making a clicking or popping noise as it moves. In a few cases, the disc is permanently out of position, and the patient's range of motion in the jaw is limited.
- Hypermobility. Hypermobility is a condition in which the ligaments that hold the jaw in place are too loose and the jaw tends to slip out of its socket.

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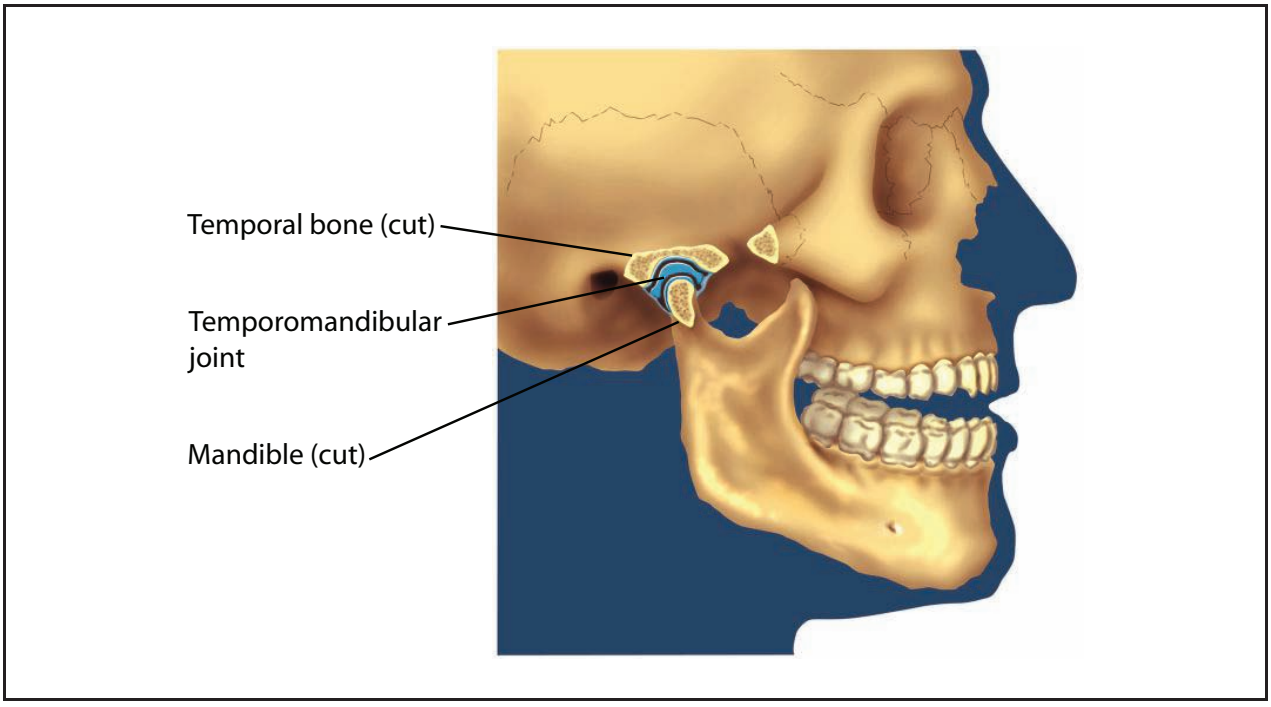

Side view of a temporomandibular joint. *(Illustration by Frank Forney. Reproduced by permission of Gale, a part of Cengage Learning.)*

- Birth abnormalities. These are the least frequent cause of TMJ but do occur in a minority of patients. In some cases, the top of the jawbone is too small; in others, the top of the jawbone outgrows the lower part.

Symptoms

The symptoms of TMJ depend in part on its cause. The most common symptoms are facial pain in front of the ears; headaches; sore jaw muscles; a clicking sound when chewing; a grating sensation when opening and closing the mouth; and temporary locking of the jaw. Some patients also report a sensation of buzzing or ringing in the ears. Usually, the temporomandibular joint itself is not painful. Most cases of TMJ are seen in women between 20–50 years of age.

Diagnosis

Dental examination and patient history

TMJ disorders are most frequently diagnosed by dentists. The dentist can often diagnose TMJ based on **physical examination** of the patient's face and jaw. The examination might include pressing on (palpating) the jaw muscles for soreness or asking the patient to open and close the jaw in order to check for misalignment of the teeth in the upper and lower jaw. This condition is called **malocclusion**. The dentist might also gently move the patient's jaw in order to check for loose ligaments.

Imaging studies

Imaging studies are not usually necessary to diagnose TMJ. In most cases, x rays and MRI scans of the temporomandibular joint will be normal. Consequently, these two tests are not commonly used to diagnose TMJ. If the dentist suspects that the patient has internal derangement of the disc, he or she can use a technique called **arthrography** to make the diagnosis. In an arthrogram, a special dye is injected into the joint, which is then x–rayed. Arthrography can be used to evaluate the movement of the jaw and the disc as well as size and shape, and to evaluate the effectiveness of treatment for TMJ.

Treatment

In many cases, the cause of pain in the TMJ area is temporary and disappears without treatment. About 80% of patients with TMJ will improve in six months without medications or physical treatments.

Medications

Patients with TMJ can be given **muscle relaxants** if their symptoms are related to muscle tension. Some patients may be given **aspirin** or nonsteroidal anti–

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KEY TERMS

Arthrography—An imaging technique that is sometimes used to evaluate TMJ associated with internal derangement.

Bruxism—Habitual clenching and grinding of the teeth, especially during sleep.

Electromyographic biofeedback—A method for relieving jaw tightness by monitoring the patient's attempts to relax the muscle while the patient watches a gauge. The patient gradually learns to control the degree of muscle relaxation.

Internal derangement—A condition in which the cartilage disc in the temporomandibular joint lies in front of its proper position.

Malocclusion—The misalignment of opposing teeth in the upper and lower jaws.

Mandible—The medical name for the lower jaw.

Osteoarthritis—A type of arthritis marked by chronic degeneration of the cartilage of the joints, leading to pain and sometimes loss of function.

Rheumatoid arthritis—A chronic autoimmune disorder marked by inflammation and deformity of the affected joints.

Temporal bones—The compound bones that form the left and right sides of the skull.

Transcutaneous electrical nerve stimulation—A method for relieving the muscle pain of TMJ by stimulating nerve endings that do not transmit pain. Authorities believe that this stimulation blocks impulses from nerve endings that do transmit pain.

inflammatory drugs (NSAIDs) for minor discomfort. If the TMJ is related to **rheumatoid arthritis**, it may be treated with **corticosteroids**, methotrexate (MTX, Rheumatrex) or gold **sodium** (Myochrysine).

Physical therapy and mechanical devices

Patients who have difficulty with **bruxism** are usually treated with splints. A plastic splint called a nightguard is given to the patient to place over the teeth before going to bed. Splints can also be used to treat some cases of internal derangement by holding the jaw forward and keeping the disc in place until the ligaments tighten. The splint is adjusted over a period of two to four months.

TMJ can also be treated with ultrasound, electromyographic **biofeedback**, stretching exercises, transcutaneous **electrical nerve stimulation**, **stress** management techniques, or friction massage.

Surgery

Surgery is ordinarily used only to treat TMJ caused by birth deformities or certain forms of internal derangement caused by misshapen discs.

Prognosis

The prognosis for recovery from TMJ is excellent for almost all patients. Most patients do not need any form of long–term treatment. Surgical procedures to treat TMJ are quite successful. In the case of patients with TMJ caused by arthritis or infectious diseases, the progression of the arthritis or the success of eliminating infectious agents determines whether TMJ can be eliminated.

Resources

BOOKS

Peterson, Cynthia. *The TMJ Healing Plan: Ten Steps to Relieving Headaches, Neck Pain and Jaw Disorders.* Alameda, CA: Hunter House, 2010.

ORGANIZATIONS

American Association of Oral & Maxillofacial Surgeons (AAOMS), 9700 W. Bryn Mawr Ave., Rosemont, IL, 60018, (847) 678–6200, http://www.aaoms.org.

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TEN *see* **Toxic epidermal necrolysis**

Tendinitis

Definition

Tendinitis is the inflammation of a tendon, a tough rope-like tissue that connects muscle to bone.

Description

Tendinitis usually occurs in individuals in middle or old age because it is often the result of overuse over a long period of time. Tendinitis does occur in younger patients as a result of acute overuse.

Tendons that commonly become inflamed include:

- tendons of the hand

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- tendons of the upper arm that effect the shoulder
- Achilles' tendon and the tendon that runs across the top of the foot

Causes and symptoms

Sudden stretching or repeated overuse injures the connection between the tendon and its bone or muscle. The injury is largely mechanical, but when it appears, the body tries to heal it by initiating inflammation. Inflammation increases the blood supply, bringing nutrients to the damaged tissues along with immunogenic agents to combat infection. The result is swelling, tenderness, **pain**, heat, and redness if the inflammation is close to the skin.

Diagnosis

Some tendon injuries are superficial and easy to identify. These include "tennis elbow" (extensor tendinitis) over the outside of the elbow, and Achilles' tendinitis just above the heel of the foot. There are several tendons in the shoulder that can be overused or stretched, and usually a shoulder will have more than one injury at a time. Tendinitis in the biceps, the infraspinatus, or the supraspinatus tendon may accompany a tear of the shoulder ligaments or an impingement of one bone or another. Careful pressure testing and movement of the parts is all that is necessary to identify the tendinitis.

Treatment

Rest, ice, compression, and elevation (RICE) will treat the acute condition. The best way to apply ice is in a bag with water. The water applies the cold directly to the skin. Chemical ice packs can get too cold and cause **frostbite**. Compression using an elastic wrap minimizes swelling and bleeding in an acute sprain. Splinting may help rest the limb. Pain and anti-inflammatory medications (**aspirin**, naproxen, ibuprofen) will help. Sometimes the inflammation lingers and requires additional treatment. Injections of cortisone-like medicine often relieve chronic tendinitis, but should be reserved for resistant cases since cortisone can occasionally cause problems of its own.

If tendinitis is persistent and unresponsive to nonsurgical treatment, a surgery to remove the afflicted portion of tendon can be performed. Surgery is also conducted to remove **calcium** buildup that comes with persistent tendinitis.

KEY TERMS

Biceps—The muscle in the front of the upper arm.

Infraspinatus—A muscle at the middle of the shoulder blade.

Supraspinatus—A muscle at the top of the shoulder blade.

Alternative treatment

An osteopathic soft-tissue treatment on the tendon may relieve pain and increase mobility. Increasing intake of antioxidant-rich foods and lowering intake of animal fats may help reduce the inflammation. **Acupuncture** has also been used to combat tendinitis. Hydrotherapies, such as whirlpool baths, help relax the surrounding muscles.

Prognosis

Generally, tendinitis will heal if the provoking activity is stopped.

Prevention

If given enough time, tendons will strengthen to meet the demands placed on them. They grow slowly because of their poor blood supply, so adequate time is required for good conditioning.

Resources

BOOKS

Fauci, Anthony S., et al., eds. *Harrison's Principles of Internal Medicine*. 17th ed. New York: McGraw–Hill Professional, 2008.

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Tennis elbow

Definition

Tennis elbow is an inflammation of several structures of the elbow. These include muscles, tendons, bursa, periosteum, and epicondyle (bony projections on the outside and inside of the elbow, where muscles of the forearm attach to the bone of the upper arm).

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Demographics

Tennis elbow is most common in adults ages 30 to 50, but the condition can affect anyone who repetitively stresses the wrists. Anyone who uses repetitive movements for at least two hours a day is at greater risk. People who smoke also have a higher risk of developing tennis elbow.

Description

The classic tennis elbow is caused by repeated forceful contractions of wrist muscles located on the outer forearm. The stress, created at a common muscle origin, causes microscopic tears leading to inflammation. This is a relatively small surface area located at the outer portion of the elbow (the lateral epicondyle). Medial tennis elbow, or medial epicondylitis, is caused by forceful, repetitive contractions from muscles located on the inside of the forearm. All of the forearm muscles are involved in tennis serves, when combined motions of the elbow and wrist are employed. This overuse injury is common between ages 20 and 40.

People at risk for tennis elbow are those in occupations that require strenuous or repetitive forearm movement. Such jobs include mechanics or carpentry. Sport activities that require individuals to twist the hand, wrist, and forearm, such as tennis, throwing a ball, bowling, golfing, and skiing, can cause tennis elbow. Individuals in poor physical condition who are exposed to repetitive wrist and forearm movements for long periods of time may be prone to tennis elbow. This condition is also called epicondylitis, lateral epicondylitis, medial epicondylitis, or golfer's elbow, where **pain** is present at the inside epicondyle.

Causes and symptoms

Tennis elbow pain originates from a partial tear of the tendon and the attached covering of the bone. It is caused by chronic stress on tissues attaching forearm muscles known as extensor muscles to the elbow area. Individuals experiencing tennis elbow may complain of pain and tenderness over either of the two epicondyles. This pain increases with gripping or rotation of the wrist and forearm. If the condition becomes long-standing and chronic, a decrease in grip strength can develop.

Diagnosis

Diagnosis of tennis elbow includes the individual observation and recall of symptoms, a thorough medical history, and **physical examination** by a physician. Diagnostic testing is usually not necessary unless there may be evidence of nerve involvement from underlying causes. X rays are usually always negative because the condition is primarily soft tissue in nature, in contrast to a disorder of the bones. However, **magnetic resonance imaging** (MRI) has been shown to be helpful in diagnosing cases of early tennis elbow because it can detect evidence of swelling and tissue tears in the common extensor muscle group.

Treatment

Conservative

Heat or ice is helpful in relieving tennis elbow pain. Once acute symptoms have subsided, **heat treatments** are used to increase blood circulation and promote healing. The physician may recommend **physical therapy** to apply diathermy or ultrasound to the inflamed site. These are two common modalities used to increase the temperature of the tissues in order to address both pain and inflammation. Occasionally, a tennis elbow splint or taping may be useful to help decrease stress on the elbow throughout daily activities. Exercises become very important to improve flexibility to all forearm muscles, and will aid in decreasing muscle and tendon tightness that has been creating excessive pull at the common attachment of the epicondyle.

The physician may also prescribe **nonsteroidal anti-inflammatory drugs** (NSAIDS) to reduce inflammation and pain. Injections of cortisone or anesthetics are often used if physical therapy is ineffective. Cortisone reduces inflammation, and anesthetics temporarily relieve pain. Physicians are cautious regarding an excessive number of injections as they have been found to weaken the tendon's integrity. In addition, a significant number of patients experience a temporary increase in pain following corticosteroid injections.

A newer method of treatment for tennis elbow is shock wave therapy, in which pulses of high-pressure sound are directed at the injured part of the tendon. The "shock" refers to the high pressure, which breaks down scar tissue and stimulates the regrowth of blood vessels in healthy tissue. Shock wave therapy sessions take about 20 minutes and the treatment has very few side effects; one group of German physicians found that temporary reddening of the skin or small **bruises** were the most commonly reported side effects. Initially reported to have a succes rate of 80%, newer studies have shown shock wave therapy to be less effective than previously thought.

Botulinum toxin, or Botox, is also being tried as a treatment for tennis elbow as of late 2003. Although further research needs to be done, Botox appears to relieve pain in chronic tennis elbow by relaxing muscles that have gone into spasm from prolonged inflammation.

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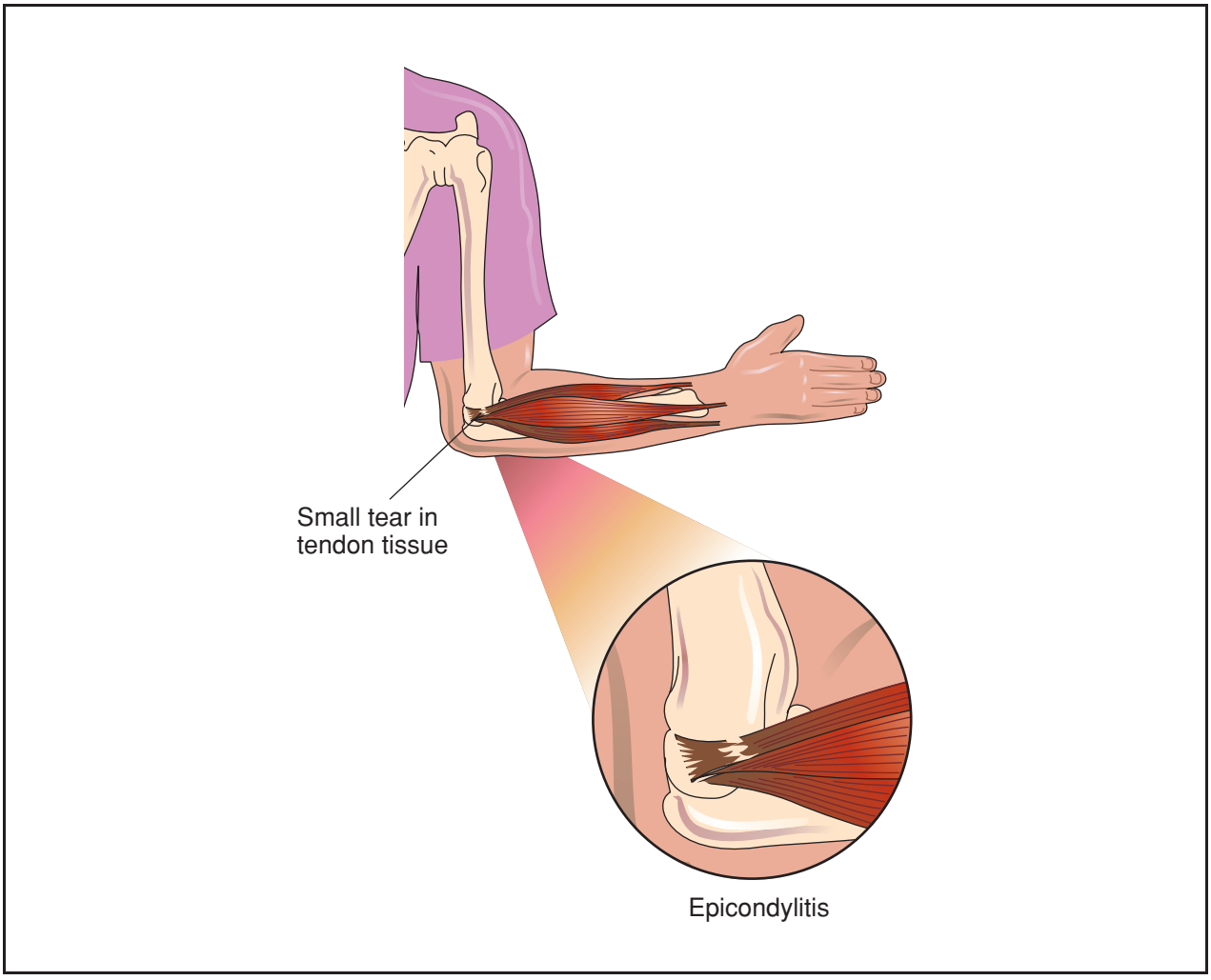

The classic tennis elbow is caused by repeated forceful contractions of wrist muscles located on the outer forearm. The stress created at a common muscle origin causes microscopic tears leading to inflammation. Persons who are most at risk of developing tennis elbow are those whose occupations require strenuous or repetitive forearm movement. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Surgery

If conservative methods of treatment fail, surgical release of the tendon at the epicondyle may be a necessary form of treatment. However, surgical intervention is relatively rare.

Alternative treatment

Massage therapy has been found to be beneficial if symptoms are mild. Massage techniques are based primarily on increasing circulation to promote efficient reduction of inflammation. Manipulation, **acupuncture**, and **acupressure** have been used as well. Contrast **hydrotherapy** (alternating hot and cold water or compresses, three minutes hot, 30 seconds cold, repeated three times, always ending with cold) applied to the elbow can help bring nutrient-rich blood to the joint and carry away waste products. Botanical medicine and homeopathy may also be effective therapies for tennis elbow. For example, cayenne (*Capsicum frutescens*) ointment or prickly ash (*Zanthoxylum americanum*) oil applied topically may help to increase blood flow to the affected area and speed healing.

Prognosis

Tennis elbow is usually curable; however, if symptoms become chronic, it is not uncommon for treatment to continue for three to six months.

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KEY TERMS

Epicondyle—A projection on the surface of a bone; often an area for muscle and tendon attachment.

Epicondylitis—A painful and sometimes disabling inflammation of the muscle and surrounding tissues of the elbow caused by repeated stress and strain on the forearm near the lateral epicondyle of the humerus (arm bone).

Extensor muscles—A group of muscles in the forearm that serve to lift or extend the wrist and hand. Tennis elbow results from overuse and inflammation of the tendons that attach these muscles to the outside of the elbow.

Periosteum—A fibrous vascular membrane that covers bones.

Shock wave therapy—A method of treating tennis elbow and other musculoskeletal injuries that involves directing bursts of high-pressure sound waves at the affected area.

Prevention

Until symptoms of pain and inflammation subside, activities requiring repetitive wrist and forearm motion should be avoided. Once pain decreases to the point that return to activity can begin, the playing of sports, such as tennis, for long periods should not occur until excellent condition returns. Many times, choosing a different size or type of tennis racquet may help. Frequent rest periods are important despite what the wrist and forearm activity may be. Compliance with a stretching and strengthening program is very important in helping prevent recurring symptoms and exacerbation.

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ORGANIZATIONS

American College of Occupational and Environmental Medicine (ACOEM), 1114 North Arlington Heights Road, Arlington Heights, IL, 60004, (847) 818-1800, (800) 227-2345, http://www.acoem.org.

American College of Sports Medicine, P.O. Box 1440, Indianapolis, IN, 46206-1440, (317) 637-9200, http://www.acsm.org.

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TENS *see* **Electrical nerve stimulation**

Tensilon test

Definition

Tensilon is the trade name for edrophonium chloride. The Tensilon test is an injection of edrophonium chloride used to diagnosis **myasthenia gravis** (MG).

Purpose

Tensilon blocks the action of an enzyme, acetylcholinesterase, an important part of the system regulating neuromuscular transmission. To stimulate a muscle, a nerve cell (neuron) releases the chemical acetylcholine. To prevent prolonged muscle response to a single nerve signal, acetylcholine is broken down by acetylcholinesterase after the muscle is stimulated.

In myasthenia gravis, there are too few receptors for acetylcholine on the muscle. The acetylcholine is broken down before it can fully stimulate this reduced number of receptors, and, as a result, the muscle is weak. By blocking the action of acetylcholinesterase, Tensilon prolongs the muscle stimulation, and temporarily improves strength. Increased strength following an injection of Tensilon strongly suggests a dignosis of MG. The Tensilon test is most effective when easily observed weakness is present, and is less useful for vague or fluctuating complaints.

Precautions

The Tensilon test may cause heart rhythm abnormalities, especially in those patients with preexisting conditions.

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KEY TERMS

Acetylcholine—A molecule released by neurons at the neuromuscular junction that causes muscle contraction.

Description

The Tensilon test involves the intravenous injection of a small amount of Tensilon. The needle is left in place. If no adverse reaction is observed within 30 seconds, an additional volume is injected. Results are apparent within one minute.

Preparation

Before the test, the patient must stop taking all drugs that can inhibit acetylcholinesterase. The referring physician can advise on specific drugs the patient is taking.

Aftercare

The effects of Tensilon subside quickly, and are completely gone after 30-60 minutes. No aftercare is needed.

Risks

Atrial fibrillation and bradycardia are possible in sensitive individuals. The administering physician must have appropriate resuscitative equipment available.

Normal results

In a patient without MG, the Tensilon test will not produce an obvious increase in a previously weak muscle. Some subjective feelings of increased strength are possible but not significant.

Abnormal results

An obvious increase in strength in weakened muscles strongly suggests the diagnosis of myasthenia gravis. The effect comes on very rapidly, and fades within minutes.

ORGANIZATIONS

Muscular Dystrophy Association, 3300 East Sunrise Drive, Tucson, AZ, 85718, (800) 572-1717, http://www.mdausa.org.

Myasthenia Gravis Foundation of America, 355 Lexington Avenue, 15th Floor, New York, NY, 10017, (212) 297-2156, (212) 370-9047, (800) 541-5454, http://www.myasthenia.org/.

Richard Robinson

Tension headache

Definition

This most common type of **headache** is caused by severe muscle contractions triggered by **stress** or exertion. Tension headaches are considered a type of primary headache, which means that they are not caused by another medical condition or disorder.

Other names for tension headaches include muscle contraction headache, ordinary headache, psychomyogenic headache, and stress headache.

Demographics

The American Council for Headache Education (ACHE) estimates that 95% of women and 90% of men in the United States and Canada have had at least one headache in the past twelve months.

In terms of age groups, chronic tension headaches have been reported in children younger than six years, but most people report that their tension headaches start in adolescence or the early twenties.

Description

While most American adults get a tension headache from time to time, women and people with more education are slightly more likely to suffer with them; the female: male ratio is reported to be 1.4: 1. People who are so anxious that they grind their teeth or hunch their shoulders may find that the physical strain in their body can be experienced as **pain** and tension in the muscles of the neck and scalp, producing almost constant pain.

Causes and symptoms

Tension headaches are caused by tightening in the muscles of the face, neck and scalp because of stress or poor posture. They can last for days or weeks and can cause pain of varying intensity. The tightening muscles cause more expansion and constriction of blood vessels, which can make head pain worse. Eyestrain caused by dealing with a large amount of paperwork or reading can cause a tension headache as well.

Many people report tension headache pain as a kind of steady ache (as opposed to a throb) that forms a tight band around the forehead, affecting both sides of the head. Tension headaches usually occur in the front of the head, although they also may appear at the top or the back of the skull.

Tension headaches often begin in late afternoon and can last for several hours. They can occur every day and

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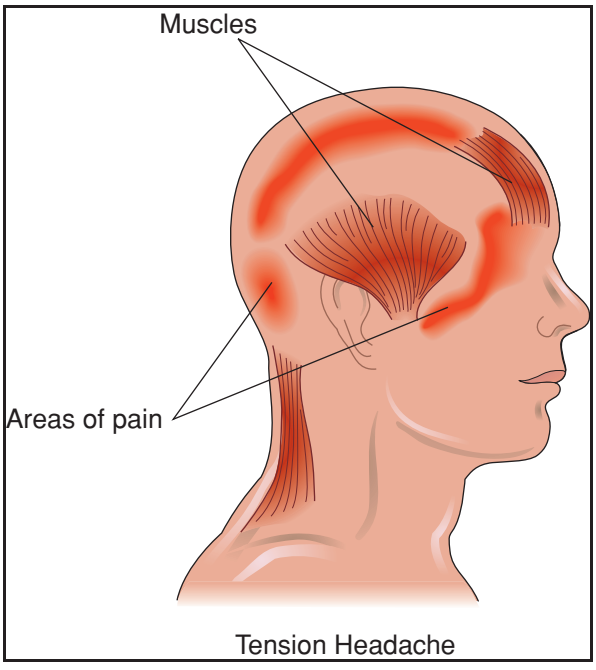

Tension headache is the most common type of headache caused by severe muscle contractions triggered by stress or exertion. Tension headaches usually occur in the front of the head, although they may also appear at the top or the back of the skull, as shown in the illustration above. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

last throughout most of the day, but most (82%) go away within a few hours. A tension headache that occurs on 15 or more days per month over a period of six months or longer is called a chronic tension headache. Unlike migraines, tension headaches do not cause **nausea and vomiting**, sensitivity to light, or any kind of aura before the headache begins.

It is possible for children as well as adults to have more than one type of headache. It is not unusual for patients with chronic tension headaches to suffer from migraine headaches as well.

Diagnosis

Diagnosis of tension headaches is made from a medical history, discussion of symptoms, and elimination of other types of headaches or underlying disorders.

Very few headaches are the sign of a serious underlying medical problem. However, sufferers should call a physician at once if they:

- have more than three headaches a week
- take painkillers almost every day
- need more than the recommended dose of painkiller
- have a stiff neck and/or fever in addition to headache
- are dizzy, unsteady, or have slurred speech, weakness, or numbness
- have confusion or drowsiness with the headache
- have headaches that began with a head injury
- have headaches triggered by bending, coughing or exertion
- have headaches that keep getting worse
- have severe vomiting with the headache
- have the first headache after age 50
- awaken with headache that gets better as the day goes on

Treatment

There are many different treatments for tension headaches, which respond well to both medication and massage. If these headaches become chronic, however, they are best treated by identifying the source of tension and stress and reducing or eliminating it.

Medication

Tension headaches usually respond very well to such over–the–counter **analgesics** as **aspirin**, ibuprofen, or **acetaminophen**. However, some of these drugs (especially those that contain **caffeine**) may trigger rebound headaches if discontinued after they are taken for more than a few days.

More severe tension headaches may require combination medications, including a mild sedative such as butalbital; these products should be used sparingly, though. Chronic tension headaches may respond to low–dose amitriptyline taken at night.

Massage

Massaging the tense muscle groups may help ease pain. Instead of directly massaging the temple, patients will get more relief from rubbing the neck and shoulders, because tension headaches can arise from tension in this area. In fact, relaxing the muscles of the neck can cut the intensity and duration of tension headaches at least in half.

To relax these muscles, the neck should be rotated from side to side as the shoulders shrug. Some people find that imagining a sense of warmth or heaviness in the neck muscles can help. Taking three very deep breaths at the first hint of tension can help prevent a headache.

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KEY TERMS

Analgesic—A medication that relieves pain without causing loss of consciousness. Over–the–counter analgesics include aspirin and NSAIDs.

Primary headache—A headache that is not caused by another disease or medical condition. Tension headaches are a subtype of primary headache.

Rebound headache—A type of primary headache caused by overuse of pain relievers. It is also known as analgesic abuse headache.

Other therapy

If tension headaches are a symptom of either depression or **anxiety**, the underlying problem should be treated with counseling, medication, or a combination of both.

Injections of botulinum toxin (Botox) have been reported to relieve tension headaches in some patients.

Alternative treatment

Eliminating the source of the tension as much as possible will help prevent tension headaches. **Acupuncture** may be helpful in treating some chronic tension headaches. Homeopathic remedies and botanical medicine can also help relieve tension headaches. Valerian (*Valeriana officinalis*), skullcap (*Scutellaria lateriflora*), and passionflower (*Passiflora incarnata*) are three herbal remedies that may be helpful. A tension headache can also be relieved by soaking the feet in hot water while an ice cold towel is wrapped around the neck.

Prognosis

Cutting down on stress and relying less on caffeine–containing medications can reduce the number of tension headaches for most people.

Prevention

Tension headaches can often be prevented by managing everyday stress and making some important lifestyle changes. Those who are prone to tension headaches should:

- take frequent "stress breaks"
- get regular exercise— even a brisk 15–minute walk can help prevent tension headaches
- get enough sleep
- release angry feelings

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ORGANIZATIONS

American Council for Headache Education (ACHE), 19 Mantua Rd., Mt. Royal, NJ, 08061, (609) 423–0043, (800) 255–2243, http://www.achenet.org.

American Headache Society (AHS), 19 Mantua Rd., Mount Royal, NJ, 08061, (856) 423–0258, (856)423–0082, http://www.achenet.org.

American Massage Therapy Association (AMTA), 500 Davis St., Suite 900, Evanston, IL, 60201–4695, (877)–905–2700, http://www.amtamassage.org.

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American Pain Foundation (APF), 201 North Charles St., Suite 710, Baltimore, MD, 21201–4111, (888) 615–PAIN, info@ painfoundation.org, http://www.painfoundation.org.
American Yoga Association (AYA), http://www.americanyogaassociation.org.
The Benson–Henry Institute for Mind Body Medicine. Massachusetts General Hospital, 151 Merrimac St., 4th Floor, Boston, MA, 02114, (617) 643–6090, http://www.massgeneral.org/bhi.
Center for Mindfulness in Medicine, Health Care and Society, The. Stress Reduction Clinic. University of Massachusetts Medical School, 55 Lake Ave., North, Worcester, MA, 01655, (508) 856–2656, (508) 856–1977, http://www.umassmed.edu/cfm.
Insight Meditation Society (IMS), 1230 Pleasant, St., Barre, MA, 01005, (978) 355–4378, (978) 355–6398, http://www.dharma.org.
National Headache Foundation (NHF), 820 N. Orleans, Suite 217, Chicago, IL, (888) 643–5552, http://www.headaches.org.
National Institute of Neurological Disorders and Stroke (NINDS), PO Box 5801, Bethesda, MD, 20284, (800) 352–9424, http://www.ninds.nih.gov.
National Institutes of Health (NIH), 9000 Rockville Pike, Bethesda, MD, 20892, (301) 496-4000, http://www.nih.gov/index.html.
National Library of Medicine (NLM), 8600 Rockville Pike, Bethesda, MD, 20894, http://www.nlm.nih.gov/medlineplus/medlineplus.html.

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Terazosin *see* **Alpha$_1$-adrenergic blockers**

Testicular cancer

Definition

Testicular **cancer** is a disease in which cancer cells are discovered in one or both testicles. The testicles, also known as testes or gonads, are located in a pouch beneath the penis called the scrotum.

Demographics

The American Cancer Society estimated that approximately 8,400 new cases of testicular cancer were diagnosed in American men in 2009. In addition, an estimated 380 men died of the disease in 2009. There is a 1 in 300 probability of developing testicular cancer. The disease is highly curable and the risk of dying from testicular cancer is very low. Only 1 in every 5,000 men diagnosed with testicular cancer die from their cancer. Although the incidence of testicular cancer is rising, having doubled since the 1970s, it is still rare. Scandinavian countries have the highest rate in the world. Germany and New Zealand also have high rates. The lowest incidences of testicular cancer are in Asia and Africa.

Description

The testicles make up one portion of the male reproductive system. Normally, they are each somewhat smaller than a golf ball in size and are contained within the scrotum. The testicles are a man's primary source of male hormones, particularly testosterone. They also produce sperm.

There are several types of cells contained in the testicles, and any of these may develop into one or more types of cancer. More than 95% of all testicular cancers begin in cells called germ cells. There are two main types of **germ cell tumors** in men: seminomas and nonseminomas. Seminomas make up about 40% of all testicular germ cell tumors. Nonseminomas make up a group of cancers, which include **choriocarcinoma**, yolk sac tumors, embryonal carcinoma, and teratoma. Clinically, nonseminomatous tumors are the more aggressive tumor type.

Although testicular cancer accounts for less than 2% of all cancers in men, it is the most commonly seen cancer in young men aged 15 to 35. It is also one of the most curable.

Risk factors

There is research showing that some men are more likely to develop testicular cancer than others. The risk for testicular cancer is much higher for boys born with one or both of their testicles located in the lower abdomen rather than in the scrotum. This condition is called cryptorchidism or undescended testicles. The lifetime risk of being diagnosed with testicular cancer is four times higher for boys with cryptorchidism than the risk in the general population. This risk factor remains even if surgery is done to place the testicle back into the scrotum.

Boys born with **Down syndrome** are also at higher risk of developing testicular cancer, although the reasons for this increased risk are not yet fully understood.

There are other risk factors as well. Men who have had abnormal development of their testicles are at increased risk, as are men with Klinefelter's syndrome (a disorder of the sex chromosomes). A family history of testicular cancer increases the possibility of getting the disease. Men infected with the human **immunodeficiency** virus (HIV), especially those with **AIDS**, have a higher incidence, as do infertile men. Certain testicular tumors appear more frequently among men who work in certain occupations, like miners, oil workers, and utility workers.

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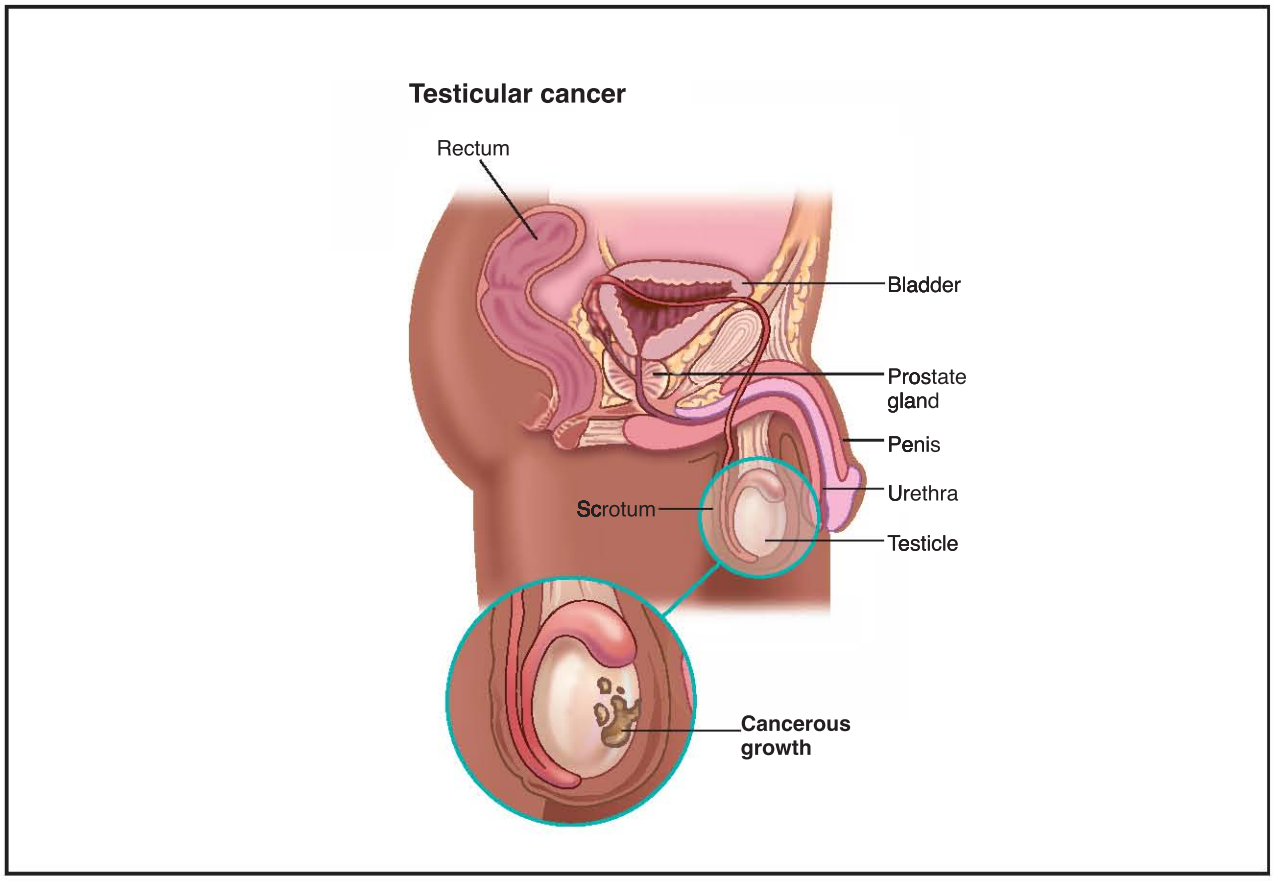

A cancerous growth on the testicle. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

There is no conclusive evidence that injuries to the testicles, or environmental exposure to various chemicals causes the disease.

Causes and symptoms

The exact causes of testicular cancer are unknown although a number of risk factors have been identified which, when present, seem to place some men at higher risk for the development of this type of cancer.

Testicular cancer usually shows no early symptoms with only 25% of men experiencing symptoms. It is suspected when a mass or lump is felt in the testes, although a testicular mass does not always indicate cancer and is usually painless.

Symptoms of testicular cancer include:

- a lump in either testicle (usually pea-sized, but may be as large as a marble or an egg)
- any enlargement or significant shrinking of a testicle
- a sensation of heaviness in the scrotum
- a dull ache in the groin or lower abdomen
- any sudden collection of fluid in the scrotum
- tenderness or enlargement of the breasts
- pain or discomfort in a testicle or in the scrotum

Other symptoms, such as **pain** in the lower back, **shortness of breath**, chest pain, **cough**, abdominal pain, and headaches, may be present if the cancer is advanced and has spread to the lymph nodes in the abdomen, the lungs and/or the brain.

Diagnosis

When a man exhibits symptoms that suggest a possibility of testicular cancer, several diagnostic steps will occur before a definitive diagnosis is made.

Examination

The physician conducts a personal and family medical history and a complete **physical examination** is performed. The doctor will examine the scrotum as well as the abdomen and other areas to check for additional masses.

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Tests

If a mass is found, an ultrasound of the testicles is performed. Through the use of sound waves, ultrasounds can help visualize internal organs and may be useful in telling the difference between fluid-filled cysts and solid masses.

Computed tomography (CT scan) as well as ultrasound may be used to diagnose malignant germ cell tumors in **undescended testes**. CT scans are also used to determine if the cancer has spread to other areas of the body outside of the testes.

A **chest x ray** may be done to see if the cancer has spread to the lungs and/or to the lymph nodes in the thoracic area. Other imaging tests which may be ordered include a **magnetic resonance imaging** (MRI) scan and/or a **positron emission tomography (PET)** scan.

Certain blood tests can be helpful in diagnosing some testicular tumors. **Tumor markers** are substances often found in higher-than-normal amounts in cancer patients. Some testicular cancers secrete high levels of certain proteins such as alpha-fetoprotein (AFP), human chorionic gonadotropin (HCG), and enzymes like lactate dehydrogenase (LDH). These markers may help find a tumor that is too small to be felt during a physical examination. In addition, these tests are also helpful in determining how much cancer is actually present, and in evaluating the response to treatment to make sure the tumor has not returned.

AFP is a tumor marker produced by nonseminomatous testicular tumors. Elevated HCG levels may be secreted by seminomas and nonseminoma tumors. Pure seminomas are not associated with elevated AFP levels. Some testicular tumors contain elements of both seminoma and nonseminoma tumors. In that case, the tumor is clinically managed as a nonseminoma.

Procedures

If a suspicious growth is found, a surgeon will need to remove the tumor and send it to the laboratory for testing. A pathologist examines the testicular tissue microscopically to determine whether cancer cells are present. If cancer cells are found, the pathologist sends back a report describing the type and extent of the cancer. In almost all cases, the surgeon removes the entire affected testicle through an incision in the groin, though not through the scrotum. This procedure is called radical inguinal orchiectomy.

Once testicular cancer is determined, further tests are necessary to find out if the cancer has metastasized (spread) to other parts of the body, and to ascertain the stage or extent of the disease. This information helps the doctor plan appropriate treatment. These tests may include abdominopelvic computed tomography (CT scan), bone scans, and chest x rays.

Treatment

Staging

One method the cancer treatment team uses to describe the scope of a patient's cancer is the use of a staging system. Testicular cancer is classified using the TNM system. However, in order to simplify and summarize this information, the TNM description can be grouped according to stages.

Stages of testicular cancer:

- Stage I. This stage refers to a cancer found only in the testicle, with no spread to the lymph nodes or to distant organs.
- Stage II. This indicates that the cancer has spread to the lymph nodes in the abdomen, but not to lymph nodes in other parts of the body.
- Stage III. In this stage, the cancer has spread beyond the lymph nodes in the abdomen, and/or the cancer is in parts of the body far away from the testicles, such as the lungs or the liver.
- Recurrent. Recurrent disease indicates that the cancer has come back after it has already been treated. Testicular cancer can come back in the same testicle (if it was not surgically removed) or in some other body part.

Treatment

The treatment decisions for testicular cancer are dependent on the stage and cell type of the disease, as well as the patient's age and overall health. The four kinds of treatment most commonly used are surgery, **radiation therapy**, **chemotherapy**, and bone marrow or **stem cell transplantation**.

Patients diagnosed with testicular cancer should be provided with information regarding fertility preservation options, including sperm banking, prior to the start of treatment.

Surgery is normally the first line of treatment for testicular cancer and involves the removal of the affected testicle. This procedure is known as a radical inguinal orchiectomy. Depending on the type and stage of the cancer, some lymph nodes may also be removed at the same time, or possibly in a second operation. This procedure is called a retroperitoneal lymph node dissection, and can be a major operation. Some patients will experience temporary complications after surgery, including infections and bowel obstruction. If both of the testicles are taken out, a man will have no ability to produce sperm cells and will become infertile (unable to father a

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child). Surgery removing the lymph nodes may cause some damage to nearby nerves, which may interfere with the ability to ejaculate. Men undergoing surgery for testicular cancer may wish to discuss nerve-sparing surgery with their doctor, as well as sperm banking.

Radiation therapy for testicular cancer is delivered from a machine and is known as external beam radiation. One potential problem with this type of radiation is that it can also destroy nearby healthy tissue as well as cancer cells. Other potential side effects include **nausea**, **diarrhea** and **fatigue**. A special device can be used to protect the unaffected testicle to preserve fertility. Seminomas are very sensitive to the effects of radiation therapy.

Chemotherapy refers to the use of drugs in treating cancer. Since the drugs enter the bloodstream and circulate throughout the body, chemotherapy is considered a systemic treatment. The drugs primarily used in the treatment of testicular cancer are cisplatin, vinblastine, bleomycin, carboplatin, cyclophosphamide, etoposide, ifosfamide, paclitaxel, mesna, gemcitabine, and oxaliplatin. These drugs are given in various combinations, since the use of two or more drugs is considered more effective than using only one drug.

Since chemotherapy agents can affect normal as well as cancerous cells, several side effects are possible. These side effects include:

- nausea and vomiting
- changes in appetite (anorexia)
- temporary hair loss (alopecia)
- mouth sores
- increased risk of infections
- bleeding or bruising
- fatigue
- diarrhea or constipation

Several drugs are available to assist in treating these side effects, most of which will disappear after the treatment is completed. However, some of the chemotherapy agents used during treatment of testicular cancer may cause long-term side effects. These include **hearing loss**, nerve damage, and possible kidney or lung damage. Another potentially serious long-term complication is an increased risk of leukemia. This is a rare side effect, however, as it occurs in less than 1% of testicular cancer patients who receive chemotherapy. Chemotherapy may also interfere with sperm production. This may be permanent for some, but many will regain their fertility within a few years.

Studies are ongoing to determine whether high doses of chemotherapy combined with stem-cell transplantation will prove effective in treating some patients with advanced testicular cancer. In this treatment, blood-forming cells called stem cells are taken from the patient (either from the bone marrow or filtered out of the patient's blood). These cells are kept frozen while high-dose chemotherapy is administered. After receiving the chemotherapy, the patient is given the stem cells through an infusion. This treatment enables the use of extra large doses of chemotherapy that might increase the cure rate for some testicular cancers.

Preferred treatment plans by stage of disease

Stage I: Stage I seminomas are normally treated with a radical inguinal orchiectomy followed by radiation treatment aimed at the lymph nodes. More than 95% of Stage I seminomas are cured through this method. Another treatment approach is treatment with a single dose of the chemotherapy drug, carboplatin, as an alternative to radiation therapy. Patients in this stage can experience relapse of the disease, however, as long five years or more after orchiectomy. Therefore, follow-up surveillance is strongly recommended. Current recommendations in 2009 regarding follow-up include a history and physical examination with measurement of tumor markers every three to four months in the first year, every six months in the second year and then annually after the second year. For those patients not undergoing radiation therapy, more intense follow-up is currently recommended. Stage I non-seminomas are also highly curable with surgery, followed by one of three options. These options include the performance of a retroperitoneal lymph node dissection, two cycles of chemotherapy, or careful observation for several years.

Stage II: Stage II seminomas and non-seminomas are cured in 90% to 95% of the cases. For the purposes of treatment, stage II testicular cancers are classified as either bulky or nonbulky. Nonbulky seminomas (no lymph nodes can be felt in the abdomen) are treated with an orchiectomy followed by radiation to the lymph nodes. Men with bulky seminomas have surgery, which is followed by a course of chemotherapy. Nonbulky Stage II non-seminomas are treated with surgery and lymph node removal, with possible chemotherapy. Men with bulky disease have surgery followed by chemotherapy.

Stage III: Stage III seminomas and non-seminomas are treated with surgery followed by chemotherapy. Those who are not cured may be eligible to participate in clinical trials of other chemotherapy agents. Virtually all patients with advanced seminoma, approximately 80% of patients, are cured after receiving chemotherapy receiving the drug cisplatin.

Recurrent: Treatment of recurrent testicular cancer is dependent upon the initial stage and the treatment given. This might include further surgery and chemotherapy. Many men whose disease comes back after

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chemotherapy are treated with high-dose chemotherapy followed by autologous stem cell transplantation.

Prognosis

The overall five-year survival rate for testicular cancer is 95%, making testicular cancer one of the most curable forms of cancer. According to the American Cancer Society, almost 200,000 American men have survived testicular cancer. When the cancer is detected before it has had the time to spread outside of the testicle the five-year survival rate is 99%. The survival rates for testicular cancers that have spread to the local lymph nodes and for those cancers that have spread beyond the lymph nodes in the immediate area are 96% and 71% respectively. The key is early diagnosis. Delay in diagnosis results in the patient's presentation in a more advanced stage of the disease at the time of diagnosis.

Prevention

The main risk factors associated with testicular cancer—cryptorchidism, family history of the disease, and being Caucasian—are unavoidable since they are present at birth. In addition, many men diagnosed with the disease have no known risk factors. Because of these reasons, it is not possible to prevent most incidences of testicular cancer.

Special concerns

For many men, testicles are symbolic of manhood, and the removal of one can lead to embarrassment, or fear about a partner's reaction. Indeed, after surgical removal, the affected side of the scrotum does look and feel empty. To correct this, a patient can have a testicular prosthesis implanted in his scrotum. This prosthesis looks and feels like a real testicle, and the surgical procedure usually leaves only a small scar.

See also Fertility issues; Sexuality.

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National Cancer Institute (National Institutes of Health), NCI Office of Communications and Education, 6116 Executive Blvd. Suite 300, Bethesda, MD, 20892-8322, (800) 4-CANCER (422-6237), cancergovstaff@mail.nih.gov, http://www.cancer.gov/.

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Testicular scan *see* **Scrotal nuclear medicine scan**

Testicular self-examination

Definition

A testicular self-examination (TSE) is the procedure by which a man checks the appearance and consistency of his testes.

Purpose

Most testicular cancers are first noticed by the man himself. Men should do a TSE every month to find out if the testes contain any suspicious lumps or other irregularities, which could be signs of **cancer** or infection.

Precautions

None.

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KEY TERMS

Epididymis—A tube in the back of the testes that transports sperm.

Scrotum—The pouch containing the testes.

Testes—Egg-shaped male gonads located in the scrotum. Testes is the plural form of testis, which is a testicle.

Vas deferens—A tube that is a continuation of the epididymis. This tube transports sperm from the testis to the prostatic urethra.

Description

A TSE should take place during a warm shower or bath, when the skin is warm, wet, and soapy. The man needs to step out of the tub so that he is in front of a mirror. The heat from the tub or shower will relax the scrotum (sac containing the testes) and the skin will be softer and thinner, making it easier to feel a lump. It is important that the exam be done very gently.

The man should stand facing his mirror and look for swelling on the scrotum. Using both hands, the scrotum should be gently lifted so that the area underneath can be checked.

The next step is examination by hand. The index and middle fingers should be placed under each testicle, with the thumbs on top. The testes should be examined one at a time. The man should roll each testicle between his fingers and thumbs. He should feel for lumps of any size (even as small as a pea) particularly on the front or side of each testicle. He should also look for soreness or irregularities. Next, the epididymis and vas deferens, located on the top and back of the testes, should be felt. This area feels like a cord, and should not be tender.

Normal results

It is normal for one testicle to be larger than the other is, and for them to hang at different levels; but the size should stay the same from one month to the next. The testes should be free from lumps, **pain**, irregularities and swelling.

Abnormal results

A TSE is considered abnormal if any swelling, tenderness, lumps, or irregularities are found. Hard, unmoving lumps are abnormal, even if they are painless. A lump could be a sign of an infection or a cancerous tumor. A change in testicle size from one month to the next is also abnormal. A feeling of heaviness in the scrotum is another abnormal sign. If any abnormality is found, a man is encouraged to check with his doctor as soon as possible because **testicular cancer** is highly curable if found early.

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Rhonda Cloos, R.N.

Testicular sonsgram *see* **Scrotal ultrasound**

Testicular surgery

Definition

Testicular surgery is any surgical operation on the testicles.

Purpose

Testicular surgery is used primarily to correct developmental defects, treat infection or trauma, and treat **cancer** of the testes.

Precautions

Testicular surgery, a group of surgical operations performed on the testicles, is considered major surgery. In all cases, except when the testes are being removed, care must be taken not to damage any of the nerves and blood vessels supplying the testes and associated organs.

Description

Testicular surgery is commonly performed for the following reasons: to reposition **undescended testes** (orchiopexy); to correct **testicular torsion**; to treat **testicular cancer**, which may involve removal of the testicles (castration) or the testes (orchiectomy); to

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treat traumatic injuries of the testicles; and to correct **intersex states**.

Undescended testes

Undescended testes are testes that have not dropped into the scrotum. During the fetal stage of development, the testes are not in the scrotum, but in the body. As male children age, the testes descend from the body to the scrotum for proper maturation and function. Undescended testes must be treated with surgery. There are two types of undescended testes, ectopic and cryptorchid. Ectopic testes are outside the normal route of descent. Cryptorchid testes are in the proper route of descent, but descent has been stopped before the testes reached the scrotum. The treatment for undescended testes is a surgical operation called orchiopexy, in which an incision allows the surgeon to reach the testes and pull them down into the scrotum. This operation is best done between the ages of one and two; otherwise, the testes are unlikely to mature normally. If the patient has one normal testis and one poorly developed testis, the undeveloped testis is usually removed.

Testicular torsion

Testicular torsion is a developmental defect in the tissues of the scrotum that allows the testes to rotate within the scrotum. This results in the blood vessels around other tubes in the scrotum to become wrapped around each other, resulting in blood supply to the testes bring cut off. Torsion disease is seen in young boys. **Pain**, **nausea**, and scrotal swelling are the main symptoms. When torsion is suspected, immediate surgery is recommended. An incision is made in the scrotum, and the blood vessels and other tissues are untangled. During surgery, the testes are examined to determine their condition. If they have received enough blood to remain viable, the testes are surgically attached to scrotal tissue to prevent twisting from recurring. If the testes do not regain a healthy pink color after the blood vessels have been untangled, then it is best to remove the testes. The lack of a pink color indicates that the testes have been without blood for too long a time period, and are dead tissue. Unless removed, they will turn necrotic and cause further harm to the body. Usually, testicular torsion occurs in only one testis. However, because the other testicle has similar anatomy, it too is subject to torsion. During surgery, the other testicle is attached to scrotal tissue to prevent torsion from occurring.

Cancer

Carcinoma of the testes is the medical term for cancer of the testicles. For males between ages 20–35, carcinoma of the testes is the second most common cancer. It accounts for 1–2% of all cancers in all males. There are many kinds of cancer that can affect the testes. A mass of tissue that is suspected to be cancer should be removed surgically. It is recommended that a biopsy not be performed, but that the physician proceed directly to surgery. Biopsies have not proven to be better at diagnosing cancer of the testicles than exploratory surgery. If the presence of cancer is confirmed during exploratory surgery, surgical excision of the cancer can be performed immediately.

The approach to the cancer during the operation depends on the location of the tissue mass. The two main approaches are through the scrotum and through the groin (inguinal region). The amount of tissue removed is variable and depends on the amount of cancerous tissue and the location. However, if a solid lesion is confirmed within a testis, a radical orchiectomy should be performed. A radical orchiectomy is a complete removal of one or both testes and associated lymphatic tissue. Other tumors allow partial removal of a testis. After surgery, the tumor is examined to determine the type of tumor for use as a guide in followup therapy.

Castration is the surgical removal of the testicles. Castration is performed as a cancer therapy, to reduce the amount of testosterone being produced, and as part of treatment for **prostate cancer**. In castration, an incision is made through one or both sides of the scrotum, depending on whether one or both testicles are being removed.

Trauma

Traumatic injuries to the testes may involve penetrating gunshot or knife **wounds**; explosions and other industrial accidents; and athletic injuries. Dislocation of the testes is a potential complication of blunt trauma to the abdomen, which commonly occurs in automobile or motorcycle accidents. A dislocated testis can usually be identified by either ultrasound or CT scans of the patient's pelvis.

Intersex states

Intersex states are a group of developmental diseases in which the patient has parts of both male and female genitalia. In testicular feminization syndrome, the patient appears to be a female and will have female genitalia but has internal testes. The internal testes are undescended. Genetic studies show that the person was to be a male. This form of intersex is also called male pseudohermaphroditism. There are a number of different causes of this condition. These patients produce the male hormone testosterone. Treatment consists of surgical removal of the internal testes, and the administration

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KEY TERMS

Biopsy—Removing tissue to test it for disease.

Lesion—An injury in the body tissue, such as a wound, sore, rash, or boil.

Orchiectomy—Surgical removal of one or both testes.

Orchiopexy—Surgical fixation of one or both testes.

Testes—The pair of male reproductive glands enclosed in the scrotum that produce the male sex hormone testosterone and the spermatozoa. The singular form is testis.

Testicles—The testes along with their enclosing structures.

of the hormone estrogen, which produces female characteristics. Failure to remove the testes is associated with a higher rate of cancer in these patients.

Preparation

About one hour before receiving **general anesthesia**, the patient will get a shot that dries up internal fluids and makes him sleepy. Presurgical counseling is often recommended for patients whose reproductive abilities will be compromised by their surgeries.

Aftercare

A patient who has had a testicle removed should visit his physician once a month for the first year and every other month for the second year, with periodic followups thereafter.

Risks

Testicular surgery, like any major surgery, can have postoperative complications. These complications include internal bleeding and wound infection, as well as adverse reactions to anesthesia. About 10–15% of patients develop fertility problems.

There is growing evidence that men who have had an orchiectomy followed by external beam **radiation therapy** have a significantly increased risk of dying from heart disease or a second cancer.

Normal results

Undescended testes are pulled down into their correct position and mature normally. In testicular torsion, the affected testis either regains its healthy pink color and is attached to the surrounding tissue with sutures, or it is removed along with any dead tissue surrounding it. (So long as only one testis is removed, sexual function and fertility will not be affected.) Successful surgery for cancer results in the removal of malignant tissue.

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ORGANIZATIONS

American Urological Association (AUA), 1000 Corporate Boulevard, Linthicum, MD, 21090, (410) 689-3700, (410) 689-3800, (866) 746-4282, aua@AUAnet.org, http://www.auanet.org.

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Testicular torsion

Definition

Testicular torsion is the twisting of a testis (testicle) on its connection, the spermatic cord. Testicular torsion is a medical emergency requiring immediate attention.

Demographics

About 70% of cases of testicular torsion occur prenatally while the infant is still in the uterus. Prenatal testicular torsion is associated with high birth weight. Of the remaining 30%, peak incidence is in boys ages 13–14, and most cases occur in males under age 25 years.

Description

The testes are suspended in the scrotum by the spermatic cord, a single bundle of tissues that also carries the blood supply to and from the testes. If a testicle rotates, the bundle kinks, and the blood supply is shut off. The resulting situation is an emergency because the testis will

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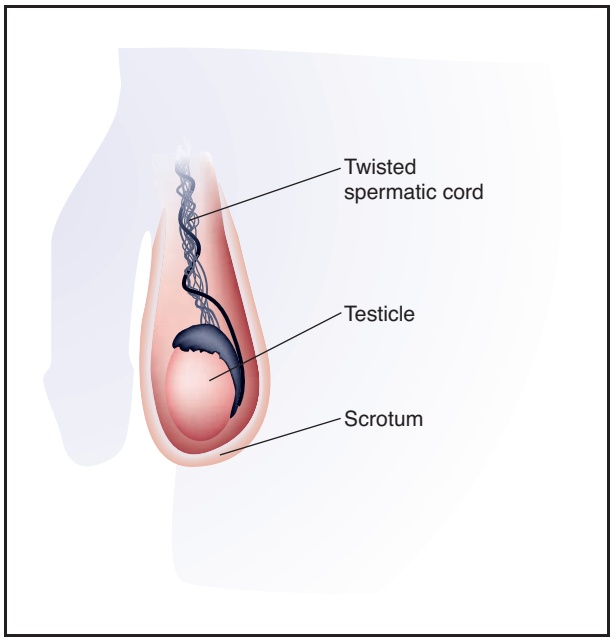

A rare condition, testicular t occurs when the spermatic cord is twisted and cuts off the blood supply to the testicle. *(Illustration by Argosy, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

die within hours if the blood supply is not restored. Testicular torsion is the most common cause for loss of a testicle.

Causes and symptoms

Some testes hang in such a way that they twist more easily than others. Nearly all torsions happen either prenatally or to adolescent males between the ages of 12 and 18 because their testes enlarge by a factor of five to six during **puberty**. A larger testis is more likely to twist. Torsion can also occur in a newborn.

Symptoms of testicular torsion are sudden severe **pain** in the scrotum, swelling, **nausea and vomiting**.

Diagnosis

Tests

Swift diagnosis is essential to save the testicle. The physician examines the scrotum and may order a **urinalysis** to look for white blood cells. A nuclear scan of the scrotum may be performed. In this procedure, a tiny amount of radioactive fluid is injected into the blood and detected as it flows through the scrotum and testicles. Torsion is indicated if the radioactive fluid does not flow through the sore testis. Ultrasound scan accompanied by a contrast agent can also be used to diagnose testicular torsion.

KEY TERMS

Orchiopexy—The surgical securing of the testis to prevent torsion.

Scrotum—The bag of skin below the penis that contains the testes.

Treatment

Surgery must be performed within 24 hours to ensure the health of the affected testis. During the procedure, the surgeon untwists the cord and secures the testis in place so that it cannot rotate again. The other testicle should also be secured to deter future testicular torsion. This procedure is called orchiopexy.

Prognosis

If the torsion is relieved within 6 hours of the onset of pain, testis will recover normal blood flow and function in more than 90% of cases. If surgery occurs between 6 and 12 hours after the pain begins, the testicle can be saved in between 20% and 50% of cases. If surgery is delayed 24 hours or more, there is little chance (0–10% that the testicle can be saved.

Prevention

Torsion of the unaffected testis is prevented by securing it during the surgery to correct the twisted testis.

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Testicular ultrasound *see* **Scrotal ultrasound**

Testicular x ray *see* **Scrotal nuclear medicine scan**

Testosterone test *see* **Sex hormones tests**

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Tetanus

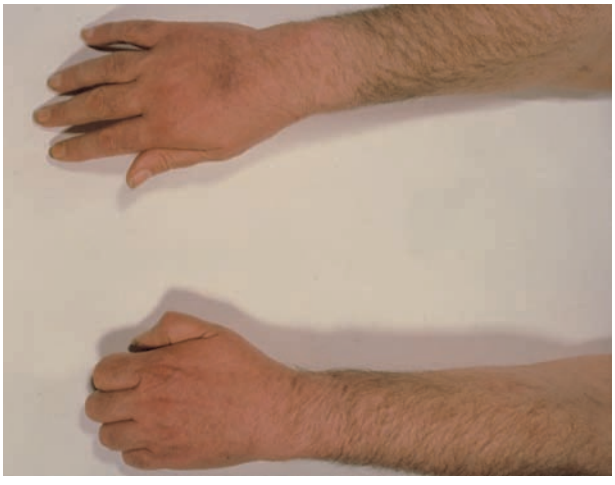
Definition

Tetanus is a rare but often fatal disease that affects the central nervous system by causing painful muscular contractions. It begins when tetanus bacteria enter the body, usually through a wound or cut exposed to contaminated soil. Tetanus is easily preventable through **vaccination**.

Description

Tetanus is rare in the United States, with nearly all cases occurring in adults who were not vaccinated as children. About 100 cases are reported each year; 63% of these occur in people over the age of 50. The number of tetanus cases in the United States has steadily decreased since the 1940s (500 to 600 cases per year); the number of reported cases has remained at approximately 50 to 100 cases per year since the mid-1970s. In 1999, however, the lowest number of annual cases to date was reported (33, or 0.02 per 100,000).

Tetanus causes convulsive **muscle spasms** and rigidity that can lead to respiratory **paralysis** and **death**. It is sometimes called "lockjaw" because one of the most common symptoms is a stiff jaw, unable to be opened. Sometimes, tetanus affects only the part of the body where the infection began, but in almost all of reported cases, it spreads to the entire body. The incubation period from the time of the injury until the first symptoms appear ranges from two to 50 days. Symptoms usually occur within five to 10 days. When symptoms occur early, the chance of death is increased. Tetanus is not contagious.



One characteristic of tetanus bacillus is the recurrent contracture of a muscle. Here, the patient's left hand is affected. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Causes and symptoms

Tetanus is caused by a bacterium called *Clostridium tetani*, whose spores (the dormant form) are found in soil, street dust, and animal (or even human) feces. Tetanus spores germinate in the body, producing a highly poisonous neurotoxin in the blood, spreading to the nervous system. The infection is usually transmitted through deep puncture **wounds** or cuts or scratches that are not cleaned well. Between 1997 and 1999, approximately 64% of tetanus cases in the United States were associated with such wounds as punctures, lacerations, or abrasions. Many people associate tetanus with rusty nails and other dirty objects, but any wound can be a source. Less common ways of getting tetanus are animal scratches and **bites**, surgical wounds, dental work, and **therapeutic abortion**. About 18% of cases reported between 1997 and 1999 were a result of intravenous drug use. Cases have also been reported in people with no known wound or medical condition.

The first symptom of tetanus is often a stiff or "locked" jaw that prevents the patient from opening his/her mouth or swallowing. This is also called trismus and results in a facial expression called a sardonic smile (or risus sardonicus). Stiffness of the neck and other muscles throughout the body and uncontrollable spasms often follow. Sometimes these convulsions are severe enough to cause broken bones. The bacterial toxin (*tetanospasmin*) affects the nerve endings, causing a continuous stimulation of muscles. Other symptoms include irritability, restlessness, loss of appetite, and drooling. People with tetanus that is localized experience **pain** and **tingling** only at the wound site and spasms in nearby muscles.

In the underdeveloped world, neonatal tetanus accounts for about one-half of tetanus deaths and is related to infection of the umbilical stump in a baby born of an unimmunized mother. The Centers for Disease Control and Prevention (CDC) estimate that over 270,000 deaths occur annually worldwide as a result of neonatal tetanus. In contrast, only two cases of neonatal tetanus in the United States were reported to the CDC between 1989 and 1999. Mothers who have been adequately immunized against tetanus protect their newborns by passing the antibody through the placenta.

Diagnosis

Tetanus is diagnosed by the clinical symptoms and a medical history that shows no tetanus immunization.

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Early diagnosis and treatment are crucial to recovery from tetanus.

Treatment

Tetanus is a life-threatening disease that requires immediate hospitalization, usually in an intensive care unit (ICU). Treatment can take several weeks and includes **antibiotics** to kill the bacteria and shots of antitoxin to neutralize the toxin. It also includes muscle-relaxing drugs to control muscle spasms or **barbiturates** for **sedation**. In severe cases, patients are placed on an artificial respirator. Recovery can take six weeks or more. After recovery, since the levels of circulating toxin are too low to stimulate natural antibody production, the patient must still be immunized against this disease to prevent reinfection.

Prognosis

Up to 30% of tetanus victims in the United States die. Early diagnosis and treatment improves the prognosis. Neonatal tetanus has a mortality rate of more than 90%.

Prevention

Pre-exposure vaccination

Tetanus is easily preventable through vaccination. All children should have a series of five doses of DTaP, a combined vaccine that offers protection against **diphtheria**, tetanus, and pertussis, before the age of seven, according to the Centers for Disease Control and Prevention's national immunization guidelines, the Advisory Committee on Immunization Practices, the Committee on Infectious Diseases of the American Academy of Pediatrics, and the American Academy of Family Physicians. Children will not be admitted to school without proof of this and other immunizations.

The DTaP (diptheria, tetanus, accellular pertussis) vaccine should be given at ages two months, four months, six months, 15 to 18 months, and four to six years. DTaP is the preferred vaccine for children up to the age of seven in the United States; it has fewer side effects than DTP and can be used to complete a vaccination schedule begun with DTP. DTaP was first approved by the Food and Drug Administration (FDA) in September 1996. In December 1996, it was approved for use in infants. Between the ages of 11 and 13, children should have a booster for diphtheria and tetanus, called Td.

Adults should have a Td booster every 10 years. Statistics from the Centers for Disease Control and Prevention (CDC) show that fewer than half of Americans 60 years of age and older have antibodies against tetanus. The CDC suggests adults may be revaccinated at mid-decade birthdays (for example, 45, 55). Adults who have never been vaccinated against tetanus should get a series of three injections of Td over six to 12 months and then follow the 10-year booster shot schedule.

Side effects of the tetanus vaccine are minor: soreness, redness, or swelling at the site of the injection that appear anytime from a few hours to two days after the vaccination and go away in a day or two. Rare but serious side effects that require immediate treatment by a doctor are serious allergic reactions or deep, aching pain and muscle wasting in the upper arms. These symptoms could start from two days to four weeks after the shot and could continue for months.

Post-exposure care

Keeping wounds and scratches clean is important in preventing infection. Since this organism grows only in the absence of oxygen, wounds must be adequately cleaned of dead tissue and foreign substances. Run cool water over the wound and wash it with a mild soap. Dry it with a clean cloth or sterile gauze. To help prevent infection, apply an antibiotic cream or ointment and cover the wound with a bandage. The longer a wound takes to heal, the greater the chance of infection. If the wound doesn't heal, or, it is red, warm, drains, or swells, consult a doctor.

Following a wound, to produce rapid levels of circulating antibody, a doctor may administer a specific antitoxin (human tetanus immune globulin, TIG) if the

KEY TERMS

Clostridium—A genus of deadly bacteria that are responsible for tetanus and other serious diseases, including botulism and gangrene from war wounds. Clostridia thrives without oxygen.

DTaP—Diphtheria and tetanus toxoids and accellular pertussis combination vaccine.

DTP— Diphtheria, tetanus, and whole-cell pertussis vaccine.

Td—Tetanus and diphtheria vaccine.

Toxin—A poisonous substance that flows through the body.

Wound—Any injury that breaks the skin, including cuts, scratches, and puncture wounds.

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individual does not have an adequate history of immunization. The antitoxin is given at the same sitting as a dose of vaccine but at separate sites. Some individuals will report a history of significant allergy to "tetanus shots." In most cases, this occurred in the remote past and was probably due to the previous use of antitoxin derived from horse serum.

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Lori De Milto

Tetracyclines

Definition

Tetracyclines are antibiotic medicines that kill bacteria and prevent their spread.

Purpose

Tetracyclines are called "broad-spectrum" **antibiotics**, meaning they can be used to treat a variety of infections, such as **gonorrhea**, **Rocky Mountain spotted fever**, **anthrax**, **Lyme disease**, and the bacterium (Helicobacter pylori) that causes peptic ulcers.

These drugs are used to treat infections in the lungs, urinary system, and skin (**acne**), and to prevent the spread of meningococcal **meningitis**.

Tetracyclines will *not* prevent or cure colds, flu, or other infections caused by viruses.

Description

Available only by prescription, tetracyclines come in capsule, tablet, liquid, and injectable forms.

Examples of tetracyclines include tetracycline (Sumycin), minocycline (Minocin and Dynacub) and doxycycline (Doryx, Vibramycin).

Recommended dosage

The dose of this class of drugs depends on the reason for its use. It is usually taken orally on an empty stomach one hour before or two hours after a meal, two to four times daily. Taking it with a full glass of water is recommended.

Precautions

Patients should take antibiotics as prescribed for as long as they are prescribed. They should not stop taking them if symptoms improve.

These medicines work best when taken on an empty stomach, with a full glass of water.

Tetracyclines should be taken at least one hour before, or two hours after, eating dairy products like milk, cheese, yogurt or ice cream.

These drugs reduce the effectiveness of some birth control pills. A secondary method of **contraception** should also be used when taking them.

Tetracyclines can produce false blood or urine sugar test results in diabetics.

Taking old, outdated tetracyclines may produce kidney damage.

Tetracyclines can permanently discolor growing and developing teeth and should not be given to pregnant women or children under the age of eight.

People taking these drugs are more vulnerable to **sunburn** and should avoid exposure to direct sunlight or prolonged use of **tanning** equipment.

Patients who take tetracyclines for prolonged periods of time should have periodic blood counts and their liver and kidney functions monitored.

Over-the-counter products, **vitamins** and food supplements that contain **minerals** such as **calcium**, magnesium, iron or zinc may reduce the effectiveness of tetracyclines.

ALLERGIES. Anyone who has had unusual reactions to tetracyclines should let his or her physician know before taking the drugs again.

PREGNANCY. Pregnant women should not take tetracyclines during the last half of **pregnancy** as they may interfere with the development of baby's bones and teeth and can cause baby's adult teeth to be permanently discolored. The medicine can also cause liver problems in pregnant women.

BREASTFEEDING. Tetracyclines pass into breast milk and can affect nursing baby's teeth and bones, may make them more sensitive to sunlight, and increase the risk of fungal infections such as thrush.

OTHER MEDICAL CONDITIONS. Before using tetracyclines, people with any of these medical problems should make sure their physicians are aware of their conditions:

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- liver disease
- kidney disease
- diabetes

Side effects

Most commonly, adverse effects from tetracyclines will be abdominal cramps and burning sensations, possibly with mild **diarrhea**.

Prolonged use of tetracyclines may produce chronic diarrhea from bacterial changes in the intestines.

These drugs may allow yeasts normally occurring in the body to produce infections in the mouth (thrush) and vagina (monilia).

These drugs may cause **dizziness**, **nausea**, blurred vision, headaches and **pain** behind the eyes that increases with coughing. These symptoms usually disappear after stopping the drugs.

Tetracyclines may affect the heart and produce **heart failure** in people who are hypersensitive to them.

These drugs may affect the skin, producing minor **rashes** and **itching** or even more serious skin conditions.

Interactions

Tetracyclines may increase the effectiveness of blood thinners, like warfarin (Coumadin). These drugs increase the effectiveness of **digoxin** (Lanoxin) and may reduce the effectiveness of all penicillin drugs.

Minerals that may interact with, and reduce the effectiveness of, tetracyclines include:

- Calcium, in antacids and dietary supplements
- Aluminum in antacids
- Iron in foods, multivitamins and mineral supplements
- Magnesium in antacids, laxatives and vitamin-mineral supplements
- Zinc in multivitamins and over the counter remedies

Resources

BOOKS

Chatu, Sukhdev. *The Hands–on Guide to Clinical Pharmacology*. 3rd ed. New York: Wiley/Blackwell, 2010.

Gallagher, Jason C., and Conan MacDougall. *Antibiotics, Simplified*. Sudbury, MA: Jones and Bartlett, 2009.

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Tetralogy of Fallot

Definition

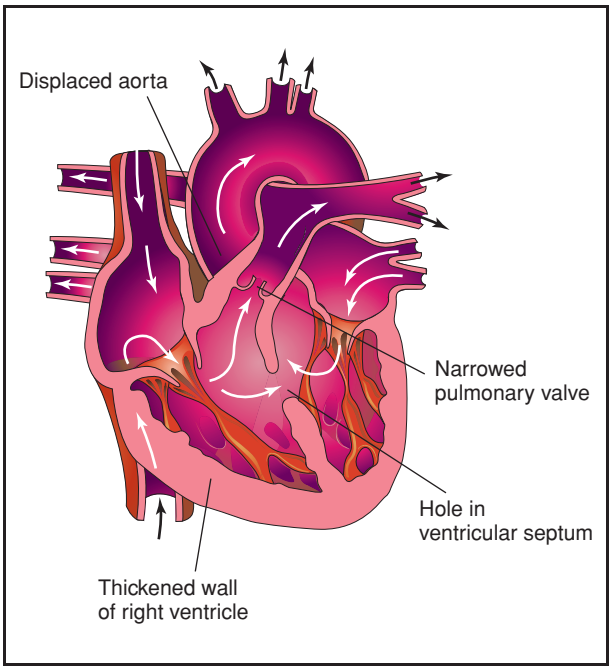
Tetralogy of Fallot is a common syndrome of congenital heart defects.

Description

The heart is two pumps in one. The ventricle on the left side pumps blood full of oxygen through the body; the ventricle on the right side pumps the same blood through the pulmonary artery to the lungs to take up oxygen. The left ventricle operates at pressures about four times as high as the right ventricle. Blood is supposed to flow through one side, then the other.

Tetralogy of Fallot is a condition that is characterized by several congenital heart defects occurring at once. They include:

- ventricular septal defect (Abnormal passageway between the right and left ventricles)
- displaced aorta



Tetralogy of Fallot is a common syndrome of congenital heart defects. This condition, present in utero, is caused by the narrowing of the pulmonary artery and a hole between the ventricles. When the baby is born and begins to breathe on its own, the baby turns cyanotic, or blue, due to the deoxygenated blood that bypasses the lungs because the narrowed pathway and the hole between the ventricles has remained open. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

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KEY TERMS

Aorta—Main arterial trunk that moves blood from the heart to the arteries, which transport the blood throughout the body.

Cyanosis—Blue-colored skin due to oxygen-deficient blood.

Endocarditis—Inflammation of the lining of the heart.

Infarct—Death of tissue due to shutting off the blood supply.

Septicemia—Blood poisoning.

Systemic circulation—Through the body, as opposed to "pulmonary"—through the lungs.

Ventricles—The muscular chambers of the heart that do the pumping.

- narrowed pulmonary valve
- thickened right ventricle wall

Each defect acts in combination with the others to create a malfunction of the heart. The problem starts very early in the uterus with a narrowed pulmonary valve and a hole between the ventricles. This is not particularly a problem for a fetus because hardly any blood flows through the lungs until birth. It is only after birth that the defects pose a problem. The blood that is supposed to start flowing through the lungs cannot easily get there because of the narrowed valve; however, the hole between the ventricles remains open. Because of the opening between ventricles, much of the blood that comes back to the heart needing oxygen is sent out without being properly oxygenated. In addition, the right heart has to pump at the same pressure as the left side. Several changes follow. First, the baby turns blue (cyanotic) because of the deoxygenated blood that bypasses the lungs. Deoxygenated blood is darker and appears blue through the skin. Second, the right side of the heart (ventricle) hypertrophies (gets more muscular) from the extra exercise demanded of it. Next, the low oxygen causes the blood to get thicker and clot more easily. Clots in the veins can now pass through the hole in the heart and directly enter the aorta, where they can do much more damage than in the lungs–such as causing infarcts in the brain. In addition, these anomalies make the lining of the heart more susceptible to infection–endocarditis– which can damage valves and lead to blood poisoning (septicemia).

Causes and symptoms

Tetralogy of Fallot is a congenital defect with unknown causes.

Babies with tetralogy of Fallot are blue at birth (**cyanosis**). Sometimes the blue color appears only when they cry. They also have detectable **heart murmurs**. Infants with mild forms can have surgery postponed until they are older. Infants with more severe symptoms often have attacks of worsened cyanosis. During attacks, they turn very blue, have **shortness of breath**, and can faint. This usually occurs during heightened activity, such as crying.

Diagnosis

A complete evaluation of the circulation is required, including testing the blood for its oxygen content; ultrasound; and x rays of the heart accompanied by a contrast agent to determine the amount of blood flowing in the wrong direction. A search for other **birth defects** is also necessary, because they tend to happen together.

Treatment

Correction of the defects is done through surgery. Surgery must be carefully timed with attention to the progression of the disease process, the size of the infant, and the size of the various defects. There are temporary surgical procedures that can prolong the time before corrective surgery while the baby grows larger and stronger.

During surgery, the pulmonary valve is widened, the **ventricular septal defect** is closed, and any interim corrections removed.

Prognosis

Surgical correction has a high rate of success, returning the child to near–normal health.

Resources

BOOKS

Fauci, Anthony S., et al., eds. *Harrison's Principles of Internal Medicine*. 17th ed. New York: McGraw–Hill Professional, 2008.

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Thalassemia

Definition

Thalassemia is a group of inherited disorders characterized by reduced or absent amounts of hemoglobin, the oxygen–carrying protein inside red blood cells. There are two basic groups of thalassemia disorders: alpha thalassemia and beta thalassemia. These

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conditions cause varying degrees of anemia, which can range from insignificant to life threatening.

Demographics

The thalassemias are among the most common genetic diseases worldwide. Both alpha and beta thalassemia have been described in individuals of almost every ancestry, but the conditions are more common among certain ethnic groups.

Beta thalassemia trait is seen most commonly in people with the following ancestry: Mediterranean (including North African, and particularly Italian and Greek), Middle Eastern, Indian, African, Chinese, and Southeast Asian (including Vietnamese, Laotian, Thai, Singaporean, Filipino, Cambodian, Malaysian, Burmese, and Indonesian). Alpha thalassemia trait is seen with increased frequency in the same ethnic groups. However, there are different types of alpha thalassemia traits within these populations. The frequency of hemoglobin H disease and alpha thalassemia major depends on the type of alpha thalassemia trait. The populations in which alpha thalassemia diseases are most common include Southeast Asians and Chinese (particularly Southern Chinese).

It is difficult to obtain accurate prevalence figures for various types of thalassemia within different populations. This difficulty arises because of testing limitations in determining exact genetic diagnoses, as well as the fact that many studies have focused on small, biased hospital populations. Internationally it is estimated that 15 million people have clinical symptoms of thalassemia. However, the number of people carrying the genetic mutation for the trait appears to be much higher. One study estimated that in India alone, 30 million people carried a genetic mutation for one of the thalassemias.

Determining prevalence figures for alpha thalassemia is even more difficult because of limitations in diagnostic testing. Two studies reflect prevalence figures that can be helpful counseling families and determining who to screen for beta thalassemia. Between the years of 1990 and 1996, the state of California screened more than 3.1 million infants born in the state for beta thalassemia. Approximately one in 114,000 infants had beta thalassemia major, with prevalence rates being highest among Asian Indians (about one in 4,000), Southeast Asians (about one in 10,000), and Middle Easterners (about one in 7,000). Another type of beta thalassemia disease, E/beta thalassemia, was represented in approximately one in 110,000 births, all of which occurred in families of Southeast Asian ancestry. Among Southeast Asians, the prevalence of E/beta thalassemia was approximately one in 2,600 births. This result is in keeping with the observation that hemoglobin E trait carrier rates are relatively high within the Southeast Asian population: 16% in a study of 768 immigrants to California, and up to 25% in some specific Southeast Asian populations such as Cambodians. While these California studies address some of the limitations of earlier population studies, the pattern observed in California is expected to be different in other areas of the United States and the world. For example, Italians are underrepresented in this population when compared to the population of the East Coast of the United States.

Description

All types of thalassemias are considered quantitative diseases of hemoglobin, because the quantity of hemoglobin produced is reduced or absent. Usual adult hemoglobin is made up of three components: alpha globin, beta globin, and heme. Thalassemias are classified according to the globin that is affected, hence the names *alpha* and *beta* thalassemia. Although both classes of thalassemia affect the same protein, the alpha and beta thalassemias are distinct diseases that affect the body in different ways.

Beta thalassemia

Beta thalassemia may be the best–known type of thalassemia and is also called Cooley's anemia. It is caused by a change in the gene for the beta globin component of hemoglobin. Beta thalassemia causes variable anemia that can range from moderate to severe, depending in part on the exact genetic change underlying the disease. Beta thalassemia can be classified based on clinical symptoms. Beta thalassemia major usually causes severe anemia that can occur within months after birth. If left untreated, severe anemia can result in insufficient growth and development, as well as other common physical complications that can lead to a dramatically decreased life expectancy. In developed countries, beta thalassemia usually is identified by screening in the newborn period before symptoms have developed. Children who are identified early can be started on ongoing blood **transfusion** therapy as needed. Although transfusion therapy prevents many of the complications of severe anemia, the body is unable to eliminate the excess iron contained in the transfused blood. Over time, the excess iron deposits in tissues and organs, resulting in damage and organ failure. Another medication must be administered to help the body eliminate the excess iron and prevent iron–overload complications. Beta thalassemia intermedia is a term used to describe the disease in individuals who have moderate anemia that requires blood transfusions only intermittently, if at all.

Alpha thalassemia

Alpha thalassemia is the result of changes in the genes for the alpha globin component of hemoglobin.

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There are two main types of alpha thalassemia disease: hemoglobin H disease and alpha thalassemia major. The two diseases are quite different from beta thalassemia as well as from one another. Individuals with hemoglobin H disease can experience events of hemolytic anemia—anemia caused by the rapid breakdown of red blood cells. These events are thought to be triggered by various environmental causes, such as infection and/or exposure to certain chemicals. Hemoglobin H disease is in most cases milder than beta thalassemia. It does not generally require transfusion therapy. Alpha thalassemia major is a very serious disease that results in severe anemia that begins even before birth. Most affected babies do not survive to be born, or they die shortly after birth.

Unaffected carriers of all types of thalassemia traits do not experience health problems. In fact, the thalassemia trait is protective against **malaria**, a disease caused by blood–borne parasites transmitted through mosquito **bites**. According to a widely accepted theory, most genetic changes (mutations) that cause thalassemia occurred multiple generations ago. Coincidentally, these mutations increased the likelihood that carriers would survive malaria infection. Survivors passed the mutation onto their offspring, and the trait became established throughout areas where malaria is common. As populations migrated, so did the thalassemia traits.

Causes

Genetics

Humans normally make several types of the oxygen–carrying protein hemoglobin. An individual's stage in development determines whether he or she makes primarily embryonic, fetal, or adult hemoglobins. All types of hemoglobin are made of three components: heme, alpha (or alpha–like) globin, and beta (or beta–like) globin. All types of thalassemia are caused by changes in either the alpha– or beta–globin gene. These changes cause the production of little or no globin. The thalassemias are, therefore, considered quantitative hemoglobin diseases. All types of thalassemias are recessively inherited, meaning that a genetic change must be inherited from both the mother and the father in order for the offspring to show symptoms of the disease. The severity of the disease is influenced by the exact thalassemia mutations inherited, as well as other genetic and environmental factors. There are rare exceptions, notably with beta thalassemia, where globin gene mutations exhibit a dominant pattern of inheritance in which only one gene needs to be altered in order to see disease symptoms.

BETA THALASSEMIA. Most individuals have two normal copies of the beta globin gene, which is located on chromosome 11 and makes the beta globin component of normal adult hemoglobin, hemoglobin A. There are approximately 100 genetic mutations that have been described that cause beta thalassemia, designated as either beta0 or beta+ mutations. No beta globin is produced with a beta0 mutation, and only a small fraction of the normal amount of beta globin is produced with a beta+ mutation.

When an individual has one normal beta globin gene and one with a beta thalassemia mutation, he or she is said to carry the beta thalassemia trait. Beta thalassemia trait, like other hemoglobin traits, is protective against malaria infection. Trait status is generally thought not to cause health problems, although some women with beta thalassemia trait may have an increased tendency toward anemia during **pregnancy**.

When two members of a couple carry the beta thalassemia trait, there is a 25% chance that each of their children will inherit beta thalassemia disease by inheriting two beta thalassemia mutations, one from each parent. The clinical severity of the beta thalassemia disease—whether an individual has beta thalassemia intermedia or beta thalassemia major—will depend largely on whether the mutations inherited are beta0 thalassemia or beta+ thalassemia mutations. Two beta0 mutations generally lead to beta thalassemia major, and two beta+ thalassemia mutations generally lead to beta thalassemia intermedia. Inheritance of one beta0 and one beta+ thalassemia mutation tends to be less predictable.

Although relatively uncommon, there are other thalassemia–like mutations that can affect the beta globin gene. Hemoglobin E is the result of a substitution of a single nucleotide. This change results in structurally altered hemoglobin that is produced in decreased amounts. Therefore, hemoglobin E is unique in that it is both a quantitative (i.e., thalassemia–like) and qualitative trait. When co–inherited with a beta thalassemia trait, it causes a disease that is almost indistinguishable from beta thalassemia disease. Large deletions around and including the beta globin gene can lead to delta/beta thalassemia or hereditary persistence of fetal hemoglobin (HPFH). Interestingly, delta/beta thalassemia trait behaves very similarly to beta thalassemia trait in its clinical manifestations. However, HPFH trait does not tend to cause hemoglobin disease when co–inherited with a second thalassemia or other beta globin mutation.

ALPHA THALASSEMIA. Most individuals have four normal copies of the alpha globin gene, two copies on each chromosome 16. These genes make the alpha globin component of normal adult hemoglobin, which is called hemoglobin A. Alpha globin is also a component of fetal hemoglobin and the other major adult hemoglobin

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called hemoglobin A2. Mutations of the alpha globin genes usually involve deletions of the gene, resulting in absent production of alpha globin. Since there are four genes (instead of the usual two) to consider when looking at alpha globin gene inheritance, several alpha globin types are possible.

Absence of one alpha globin gene leads to a condition known as silent alpha thalassemia trait. This condition causes no health problems and can be detected only by special **genetic testing**. Alpha thalassemia trait occurs when two alpha globin genes are missing. This change can occur in two ways. The genes may be deleted from the same chromosome, causing the 'cis' type of alpha thalassemia trait. Alternately, they may be deleted from different chromosomes, causing the 'trans' type of alpha thalassemia trait. In both instances, there are no associated health problems, although the trait status may be detected by more routine blood screening.

Hemoglobin H disease results from the deletion of three alpha globin genes, such that there is only one functioning gene. Typically, this changes occurs when one parent carries the silent alpha thalassemia trait, and the other parent carries the 'cis' type of the alpha thalassemia trait. In this situation, there is a 25% chance for hemoglobin H disease in each of such a couple's children.

Hemoglobin H disease–like symptoms also can be a part of a unique condition called alpha thalassemia **mental retardation** syndrome. Alpha thalassemia mental retardation syndrome can be caused by a deletion of a significant amount of chromosome 16, affecting the alpha globin genes. This condition is usually not inherited, but rather occurs sporadically in the affected individual. Affected individuals have mild hemoglobin H disease, mild–to–moderate mental retardation, and characteristic facial features. This syndrome can also occur as a sex–linked form in which a mutation is inherited in a particular gene on the X–chromosome. This gene influences alpha globin production, as well as various other developmental processes. Individuals affected with this form of the syndrome tend to have more severe mental retardation, delayed development, nearly absent speech, characteristic facial features, and genital–urinary abnormalities. The remaining discussion will focus only on aspects of hemoglobin H disease.

Alpha thalassemia major results from the deletion of all four alpha globin genes, such that there are no functioning alpha globin genes. This can occur when both parents carry the 'cis' type of the alpha thalassemia trait. In this situation, there is a 25% chance for alpha thalassemia major in each of such a couple's children.

Symptoms

Beta thalassemia

Beta thalassemia major is characterized by severe anemia that can begin months after birth. In the United States and other developed countries, beta thalassemia is identified and treated early and effectively. Therefore, the following discussion of symptoms applies primarily to affected individuals in the past and in some underdeveloped countries now. If untreated, beta thalassemia major can lead to severe lethargy, paleness, and delays in growth and development. The body attempts to compensate by producing more blood, which is made inside bone marrow. However, this process is ineffective without the needed genetic instructions to make enough functioning hemoglobin. Instead, obvious bone expansion and changes occur that cause characteristic facial and other changes in appearance, as well as increased risk of **fractures**. Severe anemia taxes other organs in the body, such as the heart, spleen, and liver, which must work harder than usual. This can lead to **heart failure**, as well as enlargement and other problems of the liver and spleen. When untreated, beta thalassemia major generally results in childhood **death**, usually due to heart failure.

In developed countries diagnosis usually is made early, often before symptoms have appeared. This allows for treatment with blood transfusion therapy, which can prevent most of the complications of the severe anemia caused by beta thalassemia major. Individuals with beta thalassemia intermedia have a more moderate anemia that may require treatment with transfusion intermittently only, such as when infections occur and **stress** the body. As a person with beta thalassemia intermedia gets older, however, the need for blood transfusions may increase to the point that they are required on a regular basis. When this occurs their disease becomes more similar to beta thalassemia major. Other genetic and environmental factors can influence the course of the disease as well. For example, co–inheritance of one or two alpha thalassemia mutations can tend to ameliorate some of the symptoms of beta thalassemia disease, which result in part from an imbalance in the amount of alpha– and beta–globin present in the red blood cells.

Hemoglobin H disease

Absence of three alpha globin genes causes an imbalance of alpha and beta globin proteins in the red blood cells. The excess beta globin proteins tend to come together to form hemoglobin H, which is unable to release oxygen to the tissues. In addition, hemoglobin H tends to precipitate out in the cells, causing damage to the red blood cell membrane. When affected individuals are exposed to certain drugs and chemicals known to

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make the membrane more fragile, the cells are thought to become vulnerable to break down in large numbers, a complication called **hemolytic anemia**. **Fever** and infection are also considered triggers of hemolytic anemia in hemoglobin H disease. This disease can result in **fatigue**, paleness, and a yellow discoloration of the skin and whites of eyes called **jaundice**. Usually, the anemia is mild enough not to require treatment. Severe anemia events may require blood transfusion, however, and are usually accompanied by such other symptoms as dark feces or urine and abdominal or back **pain**. These events are uncommon in hemoglobin H disease, although they occur more frequently in a more serious type of hemoglobin H disease called hemoglobin H/Constant Spring disease. Individuals effected with this type of hemoglobin H disease are also more likely to have enlargement of and other problems with the spleen.

Alpha thalassemia major

Because alpha globin is a necessary component of all major hemoglobins and some minor hemoglobins, absence of all functioning alpha globin genes leads to serious medical consequences that begin even before birth. Affected fetuses develop severe anemia as early as the first trimester of pregnancy. The placenta, heart, liver, spleen, and adrenal glands may all become enlarged. Fluid can begin collecting throughout the body as early as the start of the second trimester, causing damage to developing tissues and organs. Growth retardation is also common. Affected fetuses usually miscarry or die shortly after birth. In addition, women carrying affected fetuses are at increased risk of developing complications of pregnancy and delivery. Up to 80% of such women develop toxemia, a disturbance of metabolism that can potentially lead to convulsions and **coma**. Other maternal complications include premature delivery and increased rates of delivery by **cesarean section**, as well as hemorrhage after delivery.

Diagnosis

Diagnosis of thalassemia can occur under various circumstances and at various ages. Several states offer thalassemia screening as part of the usual battery of blood tests done for newborns. This allows for early identification and treatment. Thalassemia can be identified before birth through prenatal diagnosis. **Chorionic villus sampling** (CVS) can be offered as early as 10 weeks of pregnancy and involves removing a sample of the placenta made by the baby and testing the cells. CVS carries a risk of causing a **miscarriage** that is between 0.5%–1%. **Amniocentesis** is generally offered between 15 and 22 weeks of pregnancy, but can sometimes be offered earlier. Two to three tablespoons of the fluid surrounding the baby is removed. This fluid contains fetal cells that can be tested. The risk of miscarriage associated with amniocentesis ranges from 0.33–0.5%. Pregnant woman and couples may choose prenatal testing in order to prepare for the birth of a baby that may have thalassemia. Alternately, knowing the diagnosis during pregnancy allows for the option of pregnancy termination. Preimplantation genetic diagnosis (PGD) is a relatively new technique that involves in–vitro fertilization followed by genetic testing of one cell from each developing embryo. Only the embryos unaffected by genetic disease are transferred back into the uterus.

Thalassemia may be suspected if an individual shows signs that are suggestive of the disease. In all cases, however, laboratory diagnosis is essential to confirm the exact diagnosis and to allow for the provision of accurate **genetic counseling** about recurrence risks and testing options for parents and affected individuals. Screening is likewise recommended to determine trait status for individuals of high–risk ethnic groups.

Tests

The following tests are used to screen for thalassemia disease and/or trait:

- complete blood count
- hemoglobin electrophoresis with quantitative hemoglobin A2 and hemoglobin F
- free erythrocyte–protoporphyrin (or ferritin or other studies of serum iron levels)

A **complete blood count** (CBC) will identify low levels of hemoglobin, small red blood cells, and other red blood cell abnormalities that are characteristic of a thalassemia diagnosis. Since thalassemia trait can sometimes be difficult to distinguish from iron deficiency, tests to evaluate iron levels are important. A **hemoglobin electrophoresis** is a test that can help identify the types and quantities of hemoglobin made by an individual. This test uses an electric field applied across a slab of gel–like material. Hemoglobins migrate through this gel at various rates and to specific locations, depending on their size, shape, and electrical charge. Isoelectric focusing and high–performance liquid chromatography (HPLC) use similar principles to separate hemoglobins and can be used instead of or in various combinations with hemoglobin electrophoresis to determine the types and quantities of hemoglobin present. Hemoglobin electrophoresis results are usually within the normal range for all types of alpha thalassemia. However, hemoglobin A2 levels and sometimes hemoglobin F levels are elevated when beta thalassemia disease or trait is present. Hemoglobin electrophoresis can also detect structurally abnormal hemoglobins that may be co–inherited with a

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KEY TERMS

Anemia—A blood condition in which the level of hemoglobin or the number of red blood cells falls below normal values. Common symptoms include paleness, fatigue, and shortness of breath.

Bilirubin—A yellow pigment that is the result of hemoglobin breakdown. This pigment is metabolized in the liver and excreted from the body through the bile. Bloodstream levels are normally low; however, extensive red cell destruction leads to excessive bilirubin formation and jaundice.

Bone marrow—A spongy tissue located in the hollow centers of certain bones, such as the skull and hip bones. Bone marrow is the site of blood cell generation.

Desferoxamine—The primary drug used in iron chelation therapy. It aids in counteracting the life–threatening buildup of iron in the body associated with long–term blood transfusions.

Globin—One of the component protein molecules found in hemoglobin. Normal adult hemoglobin has a pair each of alpha–globin and beta–globin molecules.

Heme—The iron–containing molecule in hemoglobin that serves as the site for oxygen binding.

Hemoglobin—Protein–iron compound in the blood that carries oxygen to the cells and carries carbon dioxide away from the cells.

Hemoglobin A—Normal adult hemoglobin that contains a heme molecule, two alpha–globin molecules, and two beta–globin molecules.

Hemoglobin electrophoresis—A laboratory test that separates molecules based on their size, shape, or electrical charge.

Hydroxyurea—A drug that has been shown to induce production of fetal hemoglobin. Fetal hemoglobin has a pair of gamma–globin molecules in place of the typical beta–globins of adult hemoglobin. Higher–than–normal levels of fetal hemoglobin can ameliorate some of the symptoms of thalassemia.

Iron overload—A side effect of frequent blood transfusions in which the body accumulates abnormally high levels of iron. Iron deposits can form in organs, particularly the heart, and cause life–threatening damage.

Jaundice—Yellowing of the skin or eyes due to excess of bilirubin in the blood.

Mutation—A permanent change in the genetic material that may alter a trait or characteristic of an individual, or manifest as disease, and can be transmitted to offspring.

Placenta—The organ responsible for oxygen and nutrition exchange between a pregnant mother and her developing baby.

Red blood cell (RBC)—Hemoglobin–containing blood cells that transport oxygen from the lungs to tissues. In the tissues, red blood cells exchange their oxygen for carbon dioxide, which is brought back to the lungs to be exhaled.

thalassemia trait to cause thalassemia disease (i.e., hemoglobin E) or other types of hemoglobin disease (i.e., sickle hemoglobin). Sometimes DNA testing is needed in addition to the screening tests. Such testing can be performed to help confirm the diagnosis and establish the exact genetic type of thalassemia.

Treatment

Beta thalassemia

Individuals with beta thalassemia major receive regular blood transfusions, usually on a monthly basis. Transfusions help prevent severe anemia and allow for more normal growth and development. Transfusion therapy does have limitations, however. Individuals can develop reactions to certain proteins in the blood (a transfusion reaction). This can make locating appropriately matched donor blood more difficult. Although blood supplies in the United States are very safe, particularly relative to the past and to other areas of the world, there remains an increased risk of exposure to such blood–borne infections as hepatitis.

Additionally, the body is not able to get rid of excess iron that accompanies each transfusion. A medication called desferoxamine is administered, usually five nights per week over a period of several hours, using an automatic pump that can be used during sleep or taken anywhere the person goes. This medication is able to bind to the excess iron, which can then be eliminated through urine. If desferoxamine is not used regularly or is unavailable, iron overload can develop and cause tissue damage and organ damage and failure. The heart, liver, and endocrine organs are particularly vulnerable. Desferoxamine itself may rarely produce allergic or toxic side effects, including hearing damage. Signs of desferoxamine toxicity are screened for and generally develop in individuals who overuse the medication when body iron levels are sufficiently low. Overall, however,

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transfusion and desferoxamine therapy have increased the life expectancy of individuals with the most severe types of beta thalassemia major to the fourth or fifth decade. This can be expected to improve with time and increased developments in treatment, as well as for those with more mild forms of the disease.

New treatments offer additional options for some individuals with beta thalassemia major. Various medications can help increase production of red blood cells (i.e., erythropoeitin) or fetal hemoglobin (i.e., hydroxyurea and butyrate). Their effectiveness in ameliorating the severity of beta thalassemia is currently being investigated. The only effective cure for thalassemia is hematopoietic **stem cell transplantation** (HSCT). The blood–forming cells in the bone marrow are killed using **chemotherapy** drugs. Next, undifferentiated stem cells collected from appropriate newborn umbilical cord blood are injected into the individual with thalassemia. When the procedure is successful, these cells settle into the recipient's bone marrow and begin producing red blood cells with normal hemoglobin. When recipients and donors are carefully selected, as many as 90% of recipients are cured; however, not all individuals with thalassemia are good candidates for this procedure and there is always the risk of serious complications. Other possible treatments under investigation include **gene therapy** techniques aimed at increasing the amount of normal hemoglobin the body is able to make.

Hemoglobin H disease

Hemoglobin H disease is a relatively mild form of thalassemia that may go unrecognized. It is not generally considered a condition that will reduce one's life expectancy. Education is an important part of managing the health of an individual with hemoglobin H disease. It is important to be able to recognize the signs of severe anemia that require medical attention. It is also important to be aware of the medications, chemicals, and other exposures to avoid due to the theoretical risk they pose of causing a severe anemia event. When severe anemia occurs, it is treated with blood transfusion therapy. For individuals with hemoglobin H disease, this is rarely required. For those with the hemoglobin H/Constant Spring form of the disease, the need for transfusions may be intermittent or ongoing, perhaps on a monthly basis and requiring desferoxamine treatment. Individuals with this more severe form of the disease may also have an increased chance of requiring removal of an enlarged and/or overactive spleen.

Alpha thalassemia major

Because alpha thalassemia major is most often a condition that is fatal in the prenatal or newborn period, treatment has previously been focused on identifying affected pregnancies in order to provide appropriate management to reduce potential maternal complications. Pregnancy termination provides one form of management. Increased prenatal surveillance and early treatment of maternal complications is an approach that is appropriate for mothers who wish to continue their pregnancy with the knowledge that the baby will most likely not survive. Only a handful of infants with this condition have survived long term. Most of these infants received experimental treatment including transfusions before birth. For those infants that survive to delivery, there seems to be an increased risk of developmental problems and physical effects, particularly heart and genital malformations. Otherwise, their medical outlook is similar to a child with beta thalassemia major, with the important exception that ongoing, lifelong blood transfusions begin right at birth.

Prognosis

As discussed above, the prognosis for individuals with the most serious types of thalassemia has improved drastically in the last several years following recent medical advances in transfusion, chemotherapy, and transplantation therapy. Advances continue and promise to improve the life expectancy and quality of life further for affected individuals.

Prevention

Thalassemia is a genetic disorder present at birth. It cannot be prevented. Couples who suspect that they are carriers of a gene for thalassemia can have genetic counseling before trying to conceive a child and can have prenatal genetic testing to give them information about whether their child will have or be a carrier for thalassemia.

Resources

PERIODICALS

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Cooley's Anemia Foundation, Inc. website. http://www.thalassemia.org.

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Joint Center for Sickle Cell and Thalassemic Disorders website. http://cancer.mgh.harvard.edu/medOnc/sickle.htm.

ORGANIZATIONS

Children's Cancer and Blood Foundation, 333 East 38th St., Suite 830, New York, NY, 10016, (212) 297–4336, (212) 297–4340, info@childrenscbf.org, http://www.childrenscbf.org.

Cooley's Anemia Foundation, 330 Seventh Ave., #900, New York, NY, 10001, (800) 522–7222, (212) 279–5999, http://www.cooleysanemia.org.

March of Dimes Foundation, 1275 Mamaroneck Ave., White Plains, NY, 10605, (914) 997–4488, askus@marchofdimes.com, http://www.marchofdimes.com.

National Heart Lung and Blood Institute Health Information Center, PO Box 30105, Bethesda, MD, 20824–0105, (301) 592–8573; TTY: (240) 629–3255, (240) 629–3246, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi.nih.gov.

National Organization for Rare Diseases (NORD), PO Box 1968, Danbury, CT, 06813–1968, (203) 744–0100, (800) 999–NORD (6673), orphan@rarediseases.org, http://www.rarediseases.org.

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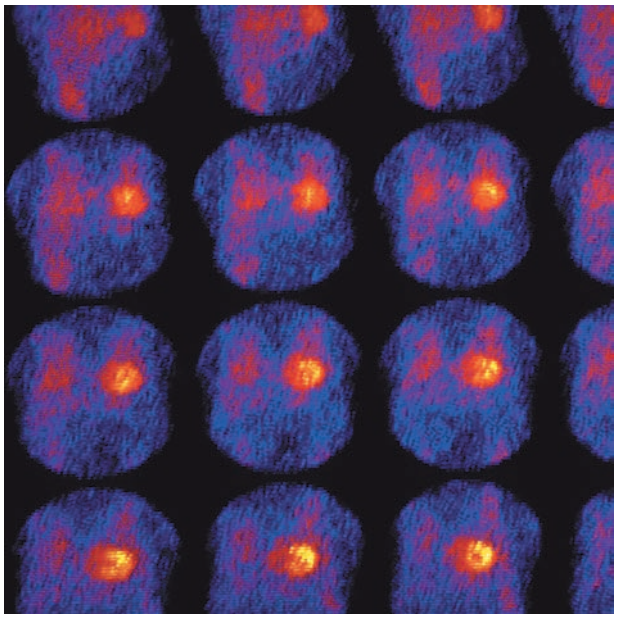
Thallium heart scan

Definition

A thallium heart scan is a test using a special camera and a small amount of radioactive substance injected into the bloodstream to make an image of the blood flow to the heart.

Purpose

A thallium heart scan is used to evaluate the blood supply to the heart muscle. It can identify areas of the heart that may have a poor blood supply as a result of damage from a previous **heart attack** or blocked coronary arteries. While exercise testing has long been a standard examination in the diagnosis of **coronary artery disease**, in some cases, the thallium scan may be more sensitive and more specific in the information it provides. In other words, the test may be better able to detect a problem and to differentiate one condition from another. A thallium heart scan may more accurately detect ischemic heart disease. This type of scan is most likely to be helpful in cases in which the exercise test is inconclusive, the patient cannot exercise adequately, or a quantitative evaluation of blood flow is required. In addition to evaluating coronary artery disease, thallium scanning can help to evaluate blood flow following treatment of clogged arteries with **coronary artery bypass graft surgery** or **angioplasty**.



A thallium scan showing many images of a human heart with cold spots. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Precautions

Radioisotopes such as thallium 201 should not be administered during **pregnancy** because they may be harmful to the fetus.

Description

The thallium scan is performed in conjunction with an exercise **stress test**. At the end of the stress test (once the patient has reached the highest level of exercise he or she can comfortably achieve), a small amount of the harmless radioisotope thallium 201 is injected into the patient's bloodstream through an intravenous (IV) line. The patient then lies down under a special camera called a gamma scintillation camera, which makes photographs from the gamma rays emitted by the thallium.

The thallium attaches itself to the red blood cells and is carried throughout the body in the bloodstream. It enters the heart muscle by way of the coronary arteries and collects in the cells of the heart muscle that come into contact with the blood. Since the thallium can reach only those areas of the heart with an adequate blood supply, no thallium will show up in

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poorly perfused areas of the heart (perfusion defects). These areas show up as "cold spots" on the thallium scan. The patient may then be given a second injection of thallium. Several hours later, the gamma scintillation camera takes more pictures in order to get an image of the heart when the patient is at rest.

Cold spots that appear at rest as well as during exercise often indicate areas where the heart tissue has been damaged (for example, as a result of a prior heart attack). Sometimes perfusion is adequate during rest but cold spots appear during exercise, when the heart has to work harder and has a greater demand for blood. This can indicate some blockage in the coronary arteries, producing a condition called **ischemia**. In ischemia, the heart temporarily does not get enough blood flow. People with perfusion defects, especially perfusion defects that appear only during exercise, have the greatest risk of such future cardiac events as heart attacks.

In recent years, there have been improvements in heart scanning. Many centers now use a single photon emission computed tomographic (SPECT) camera, which provides a clearer image. Some centers also use a type of radioactive chemical called sestamibi. Sestamibi is used along with a radioactive compound called technetium. While thallium may still be better for some uses, such as providing a better image of the heart muscle itself, sestamibi may produce clearer images in overweight patients and is more useful in assessing how well the heart pumps blood.

If the patient is unable to exercise because of another medical condition, such as arthritis, he or she may be given a drug to mimic the effects of exercise on the heart. Some of these drugs include dipyridamole (Persantine), which dilates the coronary arteries; and dobutamine, which increases blood flow through the heart muscle.

Preparation

Patients should not drink alcoholic or caffeinated beverages, smoke tobacco, or ingest other nicotine products for 24 hours before the test. These substances can affect test results. Patients should also not eat anything for at least three hours before the test. They may also be instructed to stop taking certain medications during the test that may interfere with test results.

Aftercare

In some cases, another set of scans may be needed, and the patient may be given special instructions regarding eating and test preparation. Otherwise, the patient is free to return to his or her normal daily activities.

KEY TERMS

Angioplasty—The reconstruction of damaged blood vessels.

Coronary bypass surgery—Surgery in which a section of blood vessel is used to bypass a blocked coronary artery and restore an adequate blood supply to the heart muscle.

Perfusion—The passage of fluid (such as blood) through a specific organ or area of the body (such as the heart).

Radioisotope—A radioactive form of a chemical element, which is used in medicine for therapeutic or diagnostic purposes.

Risks

Radioisotopes such as thallium 201 should not be administered during pregnancy because they may be harmful to the fetus.

Normal results

A normal thallium scan shows healthy blood flow through the coronary arteries and normal perfusion of the heart muscle, without cold spots, both at rest and during exercise.

Abnormal results

Cold spots on the scan, where no thallium shows up, indicate areas of the heart that are not getting an adequate supply of blood. Cold spots appearing both at rest and during exercise may indicate areas where the heart tissue has been damaged. However, "reversible" cold spots appearing only during exercise usually indicate some blockage of the coronary arteries.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

Robert Scott Dinsmoor

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Thematic apperception test

Definition

The thematic apperception test (TAT) is a projective personality test that was designed at Harvard in the 1930s by Christiana D. Morgan and Henry A. Murray. Along with the MMPI and the Rorschach, the TAT is one of the most widely used **psychological tests**. A projective test is one in which a person's patterns of thought, attitudes, observational capacity, and emotional responses are evaluated on the basis of responses to ambiguous test materials. The TAT consists of 31 pictures that depict a variety of social and interpersonal situations.The subject is asked to tell a story about each picture to the examiner. Of the 31 pictures, 10 are gender-specific while 21 others can be used with adults of either sex and with children. The TAT is distributed by Harcourt Brace Educational Measurement.

KEY TERMS

Apperception—The process of understanding through linkage with previous experience.

Human potential movement—A movement in psychotherapy that began in the 1960s and emphasized maximizing the potential of each participant through such techniques as group therapy and sensitivity training.

Projective test—A type of psychological test that assesses a person's thinking patterns, observational ability, feelings, and attitudes on the basis of responses to ambiguous test materials. It is not intended to diagnose psychiatric disorders.

Purpose

The original purpose of the TAT was to reveal the underlying dynamics of the subject's personality, such as internal conflicts, dominant drives and interests, motives, etc. The specific motives that the TAT assesses include the need for achievement, need for power, the need for intimacy, and problem-solving abilities. After World War II, however, the TAT was used by psychoanalysts and clinicians from other schools of thought to evaluate emotionally disturbed patients. Another shift took place in the 1970s, when the influence of the human potential movement led many psychologists to emphasize the usefulness of the TAT in assessment services—that is, using the test to help clients understand themselves better and stimulate their personal growth.

The TAT is widely used to research certain topics in psychology, such as dreams and fantasies, mate selection, the factors that motivate people's choice of occupations, and similar subjects. It is sometimes used in psychiatric evaluations to assess disordered thinking and in forensic examinations to evaluate crime suspects, even though it is not a diagnostic test. As mentioned earlier, the TAT can be used to help people understand their own personality in greater depth and build on that knowledge in making important life decisions. Lastly, it is sometimes used as a screener in psychological evaluations of candidates for high-stress occupations (law enforcement, the military, religious ministry, etc.).

Precautions

The TAT has been criticized for its lack of a standardized method of administration as well as the lack of standard norms for interpretation. Studies of the interactions between examiners and test subjects have found that the race, sex, and social class of both participants influence both the stories that are told and the way the stories are interpreted by the examiner. Attempts have been made to design sets of TAT cards for African American and for elderly test subjects, but the results have not been encouraging. In addition, the 31 standard pictures have been criticized for being too gloomy or depressing, and therefore limiting the range of personality characteristics that the test can assess.

Description

There is no standardized procedure or set of cards for administering the TAT, except that it is a one-on-one test. It cannot be administered to groups. In one common method of administration, the examiner shows the subject only 10 of the 31 cards at each of two sessions. The sessions are not timed, but average about an hour in length.

Preparation

There is no specific preparation necessary before taking the TAT, although most examiners prefer to schedule sessions (if there is more than one) over two days.

Risks

The chief risks involved in taking the TAT are a bad "fit" between the examiner and the test subject, and misuse of the results.

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Normal results

Since the TAT is used primarily for personality assessment rather than diagnosis of mental disorders, it does not yield a "score" in the usual sense.

Resources

BOOKS

Teglasi, Hedwig. *Essentials of TAT and Other Storytelling Assessments*, 2nd ed. New York: Wiley, 2010.

Rebecca J. Frey, PhD

Therapeutic abortion *see* **Abortion, therapeutic**

Therapeutic baths

Definition

Bathing the skin in a variety of preparations in order to remove crusts, scales, and old medications or to relieve inflammation and **itching** is called a therapeutic bath.

Purpose

Baths or soaks (balneotherapy) are an easy way to treat a variety of skin disorders involving large areas of the skin. They relieve general aches and pains and can ease dry or oily, inflamed or itchy skin. Hot baths are relaxing and stimulating; cool baths can reduce inflammation.

Therapeutic baths are useful for itchy skin, **hives**, **sunburn**, chafing, **poison ivy**, **poison oak**, **eczema**, skin irritation, and dry skin. They also may help to relieve emotional tension and **stress**. Brief therapeutic baths may be useful in preventing pressure ulcers and other skin problems in the elderly. Colloidal oatmeal baths are sometimes recommended to reduce the itch of chicken pox.

Many family care physicians recommend warm-water therapeutic baths as a way to relieve labor pains during **childbirth** without administering drugs.

Precautions

The temperature of the water should be comfortable. The bath should not last longer than 20–30 minutes because of the tendency of these soaks to soften and wear away the skin.

KEY TERMS

Eczema—An inflammation of the skin that usually itches and sometimes forms scales or blisters.

Emollient—A paste or compound having a soothing effect when applied to the skin.

A bath mat should be used, since medications may cause the floor of the tub to be slippery.

Eczema and other skin diseases can be treated with an ointment that contains a derivative of coal tar. Parts of the coal tar are volatile, so the bathroom should be well ventilated.

Description

The tub should be filled half–full with water at a comfortable temperature. The water should not be allowed to cool too much. If an emollient action is needed, the patient should apply a lubricating agent to the skin after the bath, since this increases hydration.

Different types of therapeutic baths are used for different conditions:

- colloidal oatmeal (oatmeal that has been ground into a fine powder, e.g., Aveeno) coats, soothes, stops itch and does not dry out the skin
- potassium permanganate—a dark purple salt—makes a good disinfectant
- bath oils are used as an emollient to ease itchy skin and eczema
- cornstarch is a soothing, drying bath for itchy skin
- sodium bicarbonate can be cooling for hot, dry skin conditions
- saline (salt) water baths are used to treat lesions scattered over the body

Preparation

Keep the room warm to minimize temperature fluctuations. This precaution is particularly important when bathing elderly patients.

Aftercare

After the bath, the skin should be blotted (not rubbed) carefully with a towel. The patient should wear loose, light clothing after the bath.

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Risks

A bath that is too hot can have negative consequences to the bathing individual including **burns**, skin irritation, and **dehydration**. It is key to ensure that the bath is warm but not hot. Bathing for more than 20–30 minutes can worsen some skin conditions. It is important to insure that the bathtub is cleaned thoroughly between uses, especially if the individual has any open cuts or lesions. This helps reduce the risk of infection.

Research and general acceptance

Therapeutic baths are generally considered a good way of helping to relieve the symptoms of various skin diseases and conditions. In many cases the therapeutic bath can reduce symptoms but does not treat the underlying problem. Therefore, it is important to see a doctor promptly for treatment of any underlying diseases or conditions causing the skin problems.

Training and certification

No special training or certification is generally required to take or give therapeutic baths. Some nursing and other programs may provide training in how best to assist elderly or disabled individuals in and out of the bathtub safely.

Resources

BOOKS

Chaitow, Leon, et al. *Naturopathic Physical Medicine: Theory and Practice for Manual Therapists and Naturopaths*. Edinburgh; New York: Churchill Livingstone/Elsevier, 2008.

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Hunter, S., et al. "Clinical Trial of a Prevention and Treatment Protocol for Skin Breakdown in Two Nursing Homes." *Journal of Wound, Ostomy, and Continence Nursing* 30 (September 2003): 250–258.

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Leeman, L., et al. "The Nature and Management of Labor Pain: Part I. Nonpharmacologic Pain Relief." *American Family Physician* 68 (September 15, 2003): 1109–1112.

ORGANIZATIONS

Canadian Association of Naturopathic Doctors, 20 Holly St., Ste. 200, Toronto, CanadaOntario, M4S 3B1, (416) 496-8633, (416) 496-8634, (800) 551-4381, http://www.cand.ca.

Alternative Medicine Foundation, PO Box 60016, Potomac, MD, 20859, (301) 340-1960, (301) 340-1936, http://www.amfoundation.org.

National Center for Complementary and Alternative Medicine Clearinghouse, PO Box 7923, Gaithersburg, MD, 20898, (301) 519-3153. TTY: (866) 464-3615, (888) 644-6226, (866) 464-3616, info@nccam.nih.gov, http://nccam.nih.gov.

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Therapeutic drug monitoring *see* **Drug therapy monitoring**

Therapeutic massage *see* **Massage**

Therapeutic touch

Definition

Therapeutic touch, or TT, is a noninvasive method of healing that was derived from an ancient laying–on of hands technique. In TT, the practitioner alters the patient's energy field through an energy transfer that moves from the hands of the practitioner to the patient.

Origins

Therapeutic touch was developed in 1972 by Dora Kunz, a psychic healer, and Dolores Krieger, PH.D., R.N, a nurse and professor of nursing at New York University. The year before, in 1971, when Krieger was working as a registered nurse in a hospital, she became very frustrated when one of her patients, a 30-year-old female, lay dying from a gallbladder condition. In desperation, she tried what she was learning from Kunz. Within one treatment, the patient's condition began to shift and she lived, surprising the other hospital staff. Krieger and Kunz met during the study of Oskar Estebany, a world–renowned healer. They had invited Estebany to form a study for three years, observing his work with patients. In this study, Estebany practiced laying–on of hands healing on various patients. Using her psychic and intuitive abilities, Kunz would observe and assist in the healing, while Krieger recorded the activities of the healing session and created profiles of the patients.

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DOLORES KRIEGER (1935–)

Dolores Krieger, a prominent professor of nursing at the New York University Division of Nursing, conceived of therapeutic touch as a healing technique in the early 1970s and introduced the therapy in 1972. Therapeutic touch rarely consists of physical contact with the patient. The practitioner focuses positive energy through the hands, which are held or waved two to three inches away from the patient, and directs it towards the patient's energy field. Krieger developed the technique along with a colleague, Dora Van Gelder Kunz, who is believed to be clairvoyant. They initially taught the system to graduate students at the nursing school, and it evolved from that basis. Since the introduction of therapeutic touch, Krieger traveled the world in teaching the technique before she retired as professor emerita at the university. An estimated 70,000 nurses were trained by Krieger and Kunz.

In 1981 Dr. Krieger published *Foundations for Holistic Health Nursing Practices*. She later published a manual, *The Therapeutic Touch: How to Use Your Hands to Help or to Heal,* in 1992.

Krieger became embroiled in controversy over the potential benefits of therapeutic touch technique between 1996-98, when nine-year-old schoolgirl Emily Rosa challenged the validity of the therapy with a simple experiment. She gathered 21 practitioners and through a covered box held her hand over one of the practitioner's own to test whether they could sense her energy field. Only 44% of the time were the practitioners able to determine which of their hands that Rosa's was hovering over. Although Rosa contacted Krieger in 1997, Krieger refused to meet with her, refused to participate in Rosa's experiment, and disputed the relevancy of an elementary school student's observations. Krieger holds both an R.N. and a Ph.D. degree and dismissed the validity of the experiment due to the student's and practitioners' lack of experience.

Krieger continues to promote her technique; her latest books include *Living the Therapeutic Touch*, published in 1999, and *Therapeutic Touch As Transpersonal Healing*, published in 2002.

As the study progressed, Kunz began teaching Krieger how to heal, based on her perceptions of Estebany's healing techniques. During her research of ancient healing methods, Krieger concluded that the energy transfer between the healer and the healee that takes place in a TT session is *prana*, an Eastern Indian concept representing energy, vitality, and vigor. Krieger then combined her research with Kunz's techniques to create TT.

TT was initially developed for persons in the health professions, but is currently taught worldwide to anyone who is interested in learning the technique. An estimated 100,000 people around the world have been trained in TT; 43,000 of those persons are health care professionals, many of whom use TT in conjunction with traditional medicine, as well as osteopathic, **chiropractic**, naturopathic, and homeopathic therapies. TT is taught in over 100 colleges, universities, and medical schools.

Benefits

The major effects of TT are relaxation, **pain** reduction, accelerated healing, and alleviation of psychosomatic symptoms. Studies have shown that TT has a beneficial effect on the blood as it has the ability to raise hemoglobin values. It also affects brain waves to induce a relaxed state. TT can induce the relaxation response often within five minutes.

Krieger has said that it is not individual illnesses that validate the effectiveness of TT, but rather, it is questioned which systems are most sensitive to TT. She and others have found that the most sensitive is the autonomic nervous system (ANS), which, for example, controls urination. The ANS is followed by dysfunctions of lymphatic and circulatory systems, and then finally musculoskeletal systems. In addition, the female endocrine system is more sensitive to TT than the corresponding male system. Thus, TT helps with **dysmenorrhea**, **amenorrhea**, problems with **contraception**, and the course of **pregnancy**.

TT is reported to have a positive effect on the immune system and thus accelerates the healing of **wounds**. Nurses use therapeutic touch in operating rooms to relax patients before surgery and in recovery rooms on postoperative patients to help speed the healing process. TT is used in the treatment of terminally ill patients, such as those with **cancer** and autoimmune deficiency syndrome (**AIDS**), to relieve **anxiety** and **stress**, create peace of mind, and reduce pain.

Many nurses use TT in the nursery. The conditions of many premature babies who received TT reportedly improved rapidly. TT has been used to calm colicky infants, assist women in **childbirth**, and increase milk let-down in breast-feeding mothers.

Other claims of TT include relief of acute pain, **nausea**, **diarrhea**, tension and migraine headaches, **fever**, and joint and tissue swelling. TT has been used to treat thyroid imbalances, ulcers, psychosomatic illnesses, **premenstrual syndrome**, **Alzheimer's disease**,

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stroke and **coma**, **multiple sclerosis**, **measles**, infections, **asthma**, and bone and muscle injuries.

Therapeutic touch is performed in many different locations, including healing centers, delivery rooms, hospitals, hospice settings, accident scenes, homes, and schools.

Description

Therapeutic touch treats the whole person: relaxes the mind, heals the body, and soothes the spirit. The principle behind it is that it does not stop at the skin. The human body extends an energy field, or aura, several inches to several feet from the body. When illness occurs, it creates a disturbance or blockage in the vital energy field. The TT practitioner uses her/his hands to sense the blockage or disturbance. In a series of gentle strokes, the healer removes the disturbance and rebalances the energy to restore health.

The TT session generally lasts about 20–30 minutes. Although the name is therapeutic touch, there is generally no touching of the physical body, only the energetic body or field. It is usually performed on fully clothed patients who are either lying down on a flat surface or sitting up in a chair.

Each session consists of five steps. Before the session begins, the practitioner enters a state of quiet **meditation** in which he/she becomes centered and grounded in order to establish intent for the healing session and to garner the compassion necessary to heal.

The second step involves the assessment of the person's vital energy field. During this step, the practitioner places the palms of his/her hands 2–3 in (5–8 cm) from the patient's body and sweeps them over the energy field in slow, gentle strokes beginning at the head and moving toward the feet. The practitioner might feel heat, coolness, heaviness, pressure, or a prickly or **tingling** sensation. These cues, as they are called, each signal a blockage or disturbance in the field.

To remove these blockages and restore balance to the body, the practitioner then performs a series of downward sweeping movements to clear away any energy congestion and smooth the energy field. This is known as the unruffling process and is generally performed from head to feet. To prevent any energy from clinging to him/her, the practitioner shakes his/her hands after each stroke.

During the next phase, the practitioner acts as a conduit to transfer energy to the patient. The energy used is not solely the energy of the practitioner. The practitioner relies on a universal source of energy so as not to deplete his/her own supply. In short, the healer acts as an energy support system until the patient's immune system is able to take over.

The practitioner then smoothes the field to balance the energy and create a symmetrical flow. When the session is over, it is recommended that the patient relax for 10–15 minutes in order for the energies to stabilize.

Side effects

The side effects reported occur when an excess of energy enters the body for an extended period of time creating restlessness, irritability, and hostility, or increasing anxiety and pain. **Burns** are sensitive to therapeutic touch, and it is recommended that TT be performed on burned tissue for short periods, generally two to three minutes at a time.

Research and general acceptance

Therapeutic touch is not generally accepted by Western medical professionals. Basic and anecdotal research has been performed on TT since its development in 1972, although little quantitative research has been carried out. It is based on a theory derived from formal research. It began as the basis of Dolores Krieger's postdoctoral research.

Dolores Krieger has performed extensive research on TT, including with pregnant women, and has noted that the following changes occur in a patient after short, consistent treatment: relaxation within the first five minutes of a session, a reduction of pain, and the acceleration of the healing process.

One study was created to determine the effect TT would have on wounds that resulted from a biopsy of the upper arm. Forty-four patients placed their injured arms through a hole in a door. Twenty-two of them received TT on their arms. The other half received no treatment. The wounds treated with TT healed more quickly than the wounds that received no treatment.

In 1998, a study was performed on 27 patients with **osteoarthritis** in at least one knee. For six weeks, the patients were treated with therapeutic touch, mock therapeutic touch, or standard care. According to *The Journal of Family Practice*, the journal that published the study, the results showed that the group who had received TT had "significantly decreased pain and improved function as compared with both the placebo and control groups."

Therapeutic touch can be combined with a number of different therapies, including **acupressure**, massage, mental imagery, **physical therapy**, and **yoga**. When combined with massage and physiotherapy, TT may reduce tension headaches, back pain, stress-related problems,

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circulatory problems, and **constipation**. **Shiatsu** and TT may help **sinusitis**, digestive disorders, **muscle cramps**, menstrual difficulties, and **insomnia**. Yoga and TT may be beneficial in the treatment of **bronchitis**, asthma, blood pressure, **fatigue**, and anxiety.

TT is practiced in over 70 countries worldwide: by Egyptians and Israelis during fighting in the Gaza Strip; in South Africa to reduce racial strife; and in Poland, Thailand, and the former Soviet Union.

Training and certification

Therapeutic touch is taught at over 100 universities and nursing and medical schools around the United States and Canada. Although it was developed primarily for nurses, anyone can learn TT.

State laws vary regarding the practice of TT. In general, laypersons are allowed to practice TT within their families. Therapeutic touch is considered an extension of health care skills, so most health care professionals are covered under the state medical practice act.

Many hospitals have established policies allowing nurses and staff to perform TT on patients at no extra charge. The American Nurse's Association often holds workshops on TT at national conventions. Therapeutic touch classes are often held for the general public through community education, healing clinics, and holistic schools.

Resources

OTHER

The Nurse Healers Professional Associates International (NH-PAI), the Official Organization of Therapeutic Touch. 3760 S. Highland Dr. Salt Lake City, UT 84106. (801) 273–3399. nhpai@therapeutic-touch.org. http://www.therapeutic-touch.org.

Jennifer Wurges

Thiabendazole *see* **Antihelminthic drugs**

Thiamine deficiency *see* **Beriberi**

Thoracentesis

Definition

Also known as pleural fluid analysis, thoracentesis is a procedure that removes fluid or air from the chest through a needle or tube.

Purpose

The lungs are lined on the outside with two thin layers of tissue called pleura. The space between these two layers is called the pleural space. Normally, there is only a small amount of lubricating fluid in this space. Liquid and/or air accumulates in this space between the lungs and the ribs from many conditions. The liquid is called a **pleural effusion**; the air is called a **pneumothorax**. Most pleural effusions are complications emanating from metastatic malignancy (movement of **cancer** cells from one part of the body to another). Most malignant pleural effusions are detected and controlled by thoracentesis. Thoracentesis is also performed as a diagnostic measure. In these cases, only small amounts of material need to be withdrawn.

Symptoms of a pleural effusion include breathing difficulty, chest **pain**, **fever**, weight loss, **cough**, and **edema**. Removal of air is often an emergency procedure to prevent suffocation from pressure on the lungs. Negative air pressure within the chest cavity allows normal respiration. The accumulation of air or fluid within the pleural space can eliminate these normal conditions and disrupt breathing and the movement of air within the chest cavity. Fluid removal is performed to reduce the pressure in the pleural space and to analyze the liquid. In addition, thoracentesis was traditionally used to remove blood from the chest cavity. This is rare now that the placement of a thoracostomy tube has proven to be a more effective and safer method.

Thoracentesis often provides immediate abatement of symptoms. However, fluid often begins to reaccumulate. A majority of patients will ultimately require additional therapy beyond a simple thoracentesis.

There are two types of liquid in the pleural space, one having more protein in it than the other. More watery liquids are called transudates; thicker fluids are called exudates. On the basis of this difference, the cause of the effusion can more easily be determined.

Transudates

Thin, watery fluid oozes into the chest either because back pressure from circulation squeezes it out or because the blood has lost some of its osmotic pressure.

- Heart failure creates back pressure in the veins as blood must wait to be pumped through the heart.
- A pulmonary embolism is a blood clot in the lung. It will create back pressure in the blood flow and also damage a part of the lung so that it leaks fluid.
- Cirrhosis is a sick, scarred liver that both fails to make enough protein for the blood and also restricts the flow of blood through it.

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- Nephrosis is a collection of kidney disorders that change the osmotic pressure of blood and allow liquid to seep into body cavities.
- Myxedema is a disease caused by too little thyroid hormone.

Exudates

Thicker, more viscous fluid is usually due to greater damage to tissues, allowing blood proteins as well as water to seep out.

- Pneumonia, caused by viruses and by bacteria, damages lung tissue and can open the way for exudates to enter the pleural space.
- Tuberculosis can infect the pleura as well as the lungs and cause them to leak liquid.
- Cancers of many types settle in the lungs or the pleura and leak liquids from their surface.
- Depending upon its size and the amount of damage it has done, a pulmonary embolism can also produce an exudate.
- Several drugs can damage the lung linings as an unexpected side effect. None of these drugs is commonly used.
- An esophagus perforated by cancer, trauma, or other conditions can spill liquids and even food into the chest. The irritation creates an exudate in the pleural space.
- Pancreatic disease can cause massive fluid in the abdomen, which can then find its way into the chest.
- Pericarditis is an inflammation of the sac that contains the heart. It can ooze fluid from both sides–into the heart's space and into the chest.
- Radiation to treat cancer or from accidents with radioactive materials can damage the pleura and lead to exudates.
- A wide variety of autoimmune diseases attacks the pleura. Among these are rheumatoid arthritis and systemic lupus erythematosus (SLE).
- Many other rare conditions can also lead to exudates.

Blood

Blood in the chest (hemothorax) is infrequently seen outside of two conditions:

- major trauma can sever blood vessels in the chest, causing them to bleed into the pleural space
- cancers can ooze blood as well as fluid; they do not usually bleed massively

Chyle

Occasionally, the liquid that comes out of the chest is neither transparent nor bloody, but milky. This is due to a tear of the large lymphatic channel–the thoracic duct carrying lymph fluid from the intestines to the heart. It is milky because it is transporting fats absorbed in the process of digestion. The major causes of chylothorax are:

- injury from major trauma, such as an automobile accident
- cancers eroding into the thoracic duct

Air

Air in the pleural space is called pneumothorax. Air can enter the pleural space either directly through a hole between the ribs or from a hole in the lungs. Holes in the lungs are sometimes spontaneous, sometimes traumatic, and sometimes the result of disease opening a communication to the air in the lung.

Precautions

Care must be taken not to puncture the lung when inserting the needle. Thoracentesis should never be performed by inserting the needle through an area with an infection. An alternative site needs to be found in these cases. Patients who are on **anticoagulant drugs** should be carefully considered for the procedure.

Description

The usual place to tap the chest is below the armpit (axilla). Under sterile conditions and **local anesthesia**, a needle, a through-the-needle-catheter, or an over-the-needle catheter may be used to perform the procedure. Overall, the catheter techniques may be safer. Fluid or air is withdrawn. Fluid is sent to the laboratory for analysis. If the air or fluid continue to accumulate, a tube is left in place and attached to a one-way system so that it can drain without sucking air into the chest.

Preparation

The location of the fluid is pinpointed through x ray or ultrasound. Ultrasound is a more accurate method when the effusion is small. A sedative may be administered in some cases but is generally not recommended. Oxygen should be given to the patient.

Aftercare

As long as the tube is in the chest, the patient must lie still. After it is removed, x rays will determine if the effusion or air is reaccumulating—though some

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KEY TERMS

Axilla—Armpit.

Catheter—A tube that is moved through the body for removing or injecting fluids into body cavities.

Hypovolemic shock—Shock caused by a lack of circulating blood.

Osmotic pressure—The pressure in a liquid exerted by chemicals dissolved in it. It forces a balancing of water in proportion to the amount of dissolved chemicals in two compartments separated by a semi-permeable membrane.

Pleura—Two thin layers lining the lungs on the outside.

researchers and clinicians believe chest x rays do not need to be performed after routine thoracentesis.

Risks

Reaccumulation of fluid or air is a possible complications, as are hypovolemic **shock** (shock caused by a lack of circulating blood) and infection. Patients are at increased risk for poor outcomes if they have a recent history of anticoagulant use, have very small effusions, have significant amounts of fluid, have poor health leading into this condition, have positive airway pressure, and have **adhesions** in the pleural space. A pneumothorax can sometimes be caused by the thoracentesis procedure. The use of ultrasound to guide the procedure can reduce the risk of pneumothorax.

Thoracentesis can also result in hemothorax, or bleeding within the thorax. In addition, such internal structures as the diaphragm, spleen, or liver, can be damaged by needle insertion. Repeat thoracenteses can increase the risk of developing hypoproteinemia (a decrease in the amount of protein in the blood).

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Mark A. Mitchell, M.D.

Thoracic aortic aneurysm *see* **Aortic aneurysm**

Thoracic empyema *see* **Empyema**

Thoracic outlet syndrome

Definition

Thoracic outlet syndromes are a group of disorders that cause **pain** and abnormal nerve sensations in the neck, shoulder, arm, and/or hand.

Description

The thoracic outlet is an area at the top of the rib cage, between the neck and the chest. Several anatomical structures pass through this area, including the esophagus, trachea, and nerves and blood vessels that lead to the arm and neck region. The area contains the first rib; collar bone (clavicle); the arteries beneath the collar bone (subclavian artery), which supply blood to the arms; a network of nerves leading to the arms (brachial plexus); and the top of the lungs.

Pain and other symptoms occur when the nerves or blood vessels in this area are compressed. The likelihood of blood vessels or nerves in the thoracic outlet being compressed increases with increased size of body tissues in this area or with decreased size of the thoracic outlet. The pain of thoracic outlet syndrome is sometimes confused with the pain of **angina** that indicates heart problems. The two conditions can be distinguished from each other because the pain of thoracic outlet syndrome does not appear or increase when walking, while the pain of angina does. Also, the pain of thoracic outlet syndrome usually increases if the affected arm is raised, which does not happen in cases of angina.

There are three types of thoracic outlet syndromes:

- True neurogenic thoracic outlet syndrome is caused by a compression of the nerves in the brachial plexus. Abnormal muscle or other tissue causes the problem.
- Arterial thoracic outlet syndrome is caused by compression of the major artery leading to the arm, usually by a rib.
- Disputed thoracic outlet syndrome describes patients who have chronic pain in the shoulders and arms and have no other disease or syndrome, but the underlying cause cannot be accurately determined.

Thoracic outlet syndrome is most common in women who are 35 to 55 years of age.

Causes and symptoms

Compression of blood vessels or nerves in the thoracic outlet causes pain and/or abnormal nerve sensations. Compression usually occurs at the location

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where the blood vessels and nerves pass out of the thoracic outlet into the arm.

There are several factors that contribute to a person developing thoracic outlet syndrome. Poor posture is a major cause and is easy to treat. A person's physical makeup also can cause thoracic outlet syndrome. For example, abnormalities of certain anatomical structures can put pressure on blood vessels or nerves. Typical abnormalities that can cause problems are malformed ribs and too narrow an opening between the collar bone and the first rib.

The main symptom is pain in the affected area. The patient can also develop weakness in the arm and hands, **tingling** nerve sensations, and a condition called Raynaud's syndrome. In Raynaud's syndrome, exposure to cold causes small arteries in the fingers to contract, cutting off blood flow. This causes the fingers to turn pale. In very severe cases of blood vessel compression, **gangrene** can result. Gangrene is the **death** of tissue caused by the blood supply being completely cut off.

In the case of arterial thoracic outlet syndrome, the artery beneath the collar bone leading to the arm is compressed, causing the artery to increase in size. **Blood clots** (thrombi) may form in the blood vessel. When blood vessels are compressed, the hands, arms, and shoulders do not receive proper blood supply. They can swell and turn blue from a lack of blood.

In the case of true neurogenic thoracic outlet syndrome, the nerves most affected are those of the network of nerves supplying the chest, shoulder, arm, forearm, and hand (brachial plexus). When a nerve is affected in thoracic outlet syndrome it produces a tingling sensation (paresthesia). It can also cause weakness in the hand and reduced sensation in the palm and fingers.

Diagnosis

There are no specific diagnostic tests for thoracic outlet syndromes. The diagnosis is made by ruling out other diseases and by observing the patient. Two nonspecific tests that can suggest the presence of thoracic outlet syndrome are the Adson test and the Allen test. In the Adson test, the patient takes a deep breath and tilts his or her head back and turns it to one side. The physician tests to see if the strength of the patient's pulse is reduced in the wrist on the arm on the opposite side of the head turn. In the Allen test, the arm in which the patient is experiencing symptoms is raised and rotated while the head is turned to the opposite side. The physician tests to see if the pulse strength at the wrist is reduced. If the strength of the pulse is reduced in either of these two tests it indicates compression of the subclavian artery.

KEY TERMS

Angina—A severe constricting pain in the chest, usually caused by a lack of oxygen to the heart.

Neurogenic—Caused by nerves; originating in the nerves.

Subclavian—Located beneath the collarbone (clavicle).

Occasionally, examination with a stethoscope may reveal abnormal sounds in affected blood vessels. X rays can reveal constrictions in blood vessels if a special dye is injected into the blood stream to make the blood vessels visible (**angiography**).

Certain tests are available to help with the diagnosis of nerve compression. These include the nerve conduction velocity test and somatosensory evoked potential test. In the nerve conduction velocity test, electrodes are placed at various locations on the skin along a nerve that is being tested. A mild electrical impulse is delivered through an electrode at one end of the nerve and the electrical activity is recorded by the other electrodes. The time it takes for the electrical impulse to travel down the nerve from the stimulating electrodes to the recording electrodes is used to calculate the nerve conduction velocity. This can be used to determine if any nerve damage exists.

In a somatosensory evoked potential test, electrodes are placed on the skin at the scalp, neck, shoulder, and wrist. A mild electrical impulse is delivered at the wrist, and a recording is made of the response by the brain and spinal cord. This test also can determine the presence of nerve damage.

Treatment

The main treatment for thoracic outlet syndrome is **physical therapy**. Exercises aimed at improving the posture of the affected person are also useful. In some cases, surgery can be performed to remove the cervical rib if this is causing the problem and physical therapy has failed to work. However, surgery is generally not used to treat thoracic outlet syndrome.

Prognosis

Treatment of true neurogenic and arterial thoracic outlet syndromes is usually successful. Treatment of disputed thoracic outlet syndrome is often unsuccessful. This may relate to the uncertainty of the underlying cause of the pain.

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Thoracic surgery

Definition

Thoracic surgery is the repair of organs located in the thorax, or chest. The thoracic cavity lies between the neck and the diaphragm, and contains the heart and lungs (cardiopulmonary system), the esophagus, trachea, pleura, mediastinum, chest wall, and diaphragm.

Purpose

Thoracic surgery repairs diseased or injured organs and tissues in the thoracic cavity. General thoracic surgery deals specifically with disorders of the lungs and esophagus. Cardiothoracic surgery also encompasses disorders of the heart and pericardium. Blunt chest trauma, reflux esophagitis, **esophageal cancer**, **lung transplantation**, lung **cancer**, and **emphysema** are just a few of the many clinical indications for thoracic surgery.

Precautions

Patients who have blood-clotting problems (coagulopathies), and who have had previous standard thoracic surgery may not be good candidates for video-assisted thoracic surgery (VATS). Because VATS requires the collapse of one lung, potential patients should have adequate respiratory function to maintain oxygenation during the procedure.

Description

Thoracic surgery is usually performed by a surgeon who specializes in either general thoracic surgery or cardiothoracic surgery. The patient is placed under **general anesthesia** and endotracheally intubated for the procedure. The procedure followed varies according to the purpose of the surgery. An incision that opens the chest (thoracotomy) is frequently performed to give the surgeon access to the thoracic cavity. Commonly, the incision is made beginning on the back under the shoulder blade and extends in a curved arc under the arm to the front of the chest. The muscles are cut, and the ribs are spread with a retractor. The surgeon may also choose to open the chest through an incision down the breastbone, or sternum (sternotomy). Once the repair, replacement, or removal of the organ being operated on is complete, a chest tube is inserted between the ribs to drain the wound and re-expand the lung.

Video-assisted thoracic surgery (VATS) is a minimally invasive surgical technique that uses a thoracic endoscope (thoracoscope) to allow the surgeon to view the chest cavity. A lung is collapsed and 3-4 small incisions, or access ports, are made to facilitate insertion of the thoracoscope and the surgical instruments. During the procedure, the surgeon views the inside of the pleural space on a video monitor. The thoracoscope may be extracted and inserted through a different incision site as needed. When the surgical procedure is complete, the surgeon expands the lung and inserts a chest tube in one of the incision sites. The remaining incisions are sealed with adhesive.

The thoracic surgeon may also use a mediastinoscope or a bronchoscope to explore the thoracic cavity. **Mediastinoscopy** allows visualization of the mediastinum, the cavity located between the lungs. The bronchoscope enables the surgeon to view the larynx, trachea, and bronchi. These instruments may be used in a separate diagnostic procedure prior to thoracic surgery, or during the surgery itself.

Preparation

Except in the case of emergency procedures, candidates for general thoracic surgery should undergo a complete medical history and thorough **physical examination** prior to surgery. Particular attention is given to the respiratory system. The patient's **smoking** history will be questioned. If the patient is an active smoker, encouragement is always given for the patient to quit smoking prior to the surgery to facilitate recovery and reduce chances of complications.

Diagnostic tests used to evaluate the patient preoperatively may include, but are not limited to, x rays, MRI, CT scans, **blood gas analysis**, **pulmonary function tests**, **electrocardiography**, **endoscopy**, pulmonary **angiography**, and **sputum culture**.

Candidates for thoracic surgery should be fully educated by their physician or surgeon on what their surgery will involve, the possible risks and complications, and requirements for postoperative care.

Patients are instructed not to eat 10 to 12 hours prior to a thoracic surgery procedure. A sedative may be provided to relax the patient prior to surgery. An intravenous line (IV) is inserted into the patient's arm or neck to administer fluids and/or medication.

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KEY TERMS

Blood gas analysis—A blood test that measures the level of oxygen, carbon dioxide, and pH in arterial blood. A blood gas analysis can help a physician assess how well the lungs are functioning.

Electrocardiography—A cardiac test that measures the electrical activity of the heart.

Embolism—A blood clot, air bubble, or clot of foreign material that blocks the flow of blood in an artery. When blood supply to a tissue or organ is blocked by an embolism, infarction, or death of the tissue that the artery feeds, occurs. Without immediate and appropriate treatment, an embolism can be fatal.

Emphysema—A lung disease characterized by shortness of breath and a chronic cough. Emphysema is caused by the progressive stretching and rupture of alveoli, the air sacs in the lung that oxygenate the blood.

Endoscopy—The examination of organs and body cavities using a long, tubular optical instrument called an endoscope.

Intubation—Insertion of an endotracheal tube down the throat to facilitate airflow to the lung(s) during thoracic surgery.

Pericardium—The sac around the heart.

Pleural space—The space between the pleural membranes that surround the lungs and the chest cavity.

Pulmonary angiography—An x-ray study of the lungs, performed by insertion of a catheter into a vein, through the heart, and into the pulmonary artery. Pulmonary angiography is performed to evaluate blood circulation to the lungs. It is also considered the most accurate diagnostic test for detecting a pulmonary embolism.

Sputum culture—A laboratory analysis of the fluid produced from the lungs during coughing. A sputum culture can confirm the presence of pathogens in the respiratory system, and help to diagnose certain respiratory infections, including bronchitis, tuberculosis, and pneumonia.

Aftercare

After surgery, the patient is taken to the recovery room, where vital signs are monitored; depending on the procedure performed, the breathing tube may be removed. The patient typically experiences moderate to severe **pain** following surgery. **Analgesics** or other pain medication are administered to keep the patient comfortable. Chest tubes are monitored closely for signs of fluid or air accumulation in the lungs that can lead to lung collapse. A urinary catheter will remain in the patient for 24 to 48 hours to drain urine from the bladder.

The hospital stay for thoracic surgery depends on the specific procedure performed. Patients who undergo a thoracotomy may be hospitalized a week or longer, while patients undergoing VATS typically have a shorter hospital stay of 2-3 days. During the recovery period, respiratory therapists and nurses work with the patient on deep breathing and coughing exercises to improve lung function.

Risks

Respiratory failure, hemorrhage, nerve injury, **heart attack**, **stroke**, **embolism**, and infection are all possible complications of general thoracic surgery. The chest tubes used for drainage after thoracic surgery may cause a build-up of fluid or the accumulation of air in the pleural space. Both of these conditions can lead to total lung collapse. Other specific complications may occur, depending on the procedure performed.

Normal results

Normal results of thoracic surgery are dependent on the type of procedure performed and the clinical purpose of the surgery.

ORGANIZATIONS

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Paula Anne Ford-Martin

Thoracoscopy

Definition

Thoracoscopy is the insertion of an endoscope, a narrow–diameter tube with a viewing mirror or camera attachment, through a very small incision (cut) in the chest wall.

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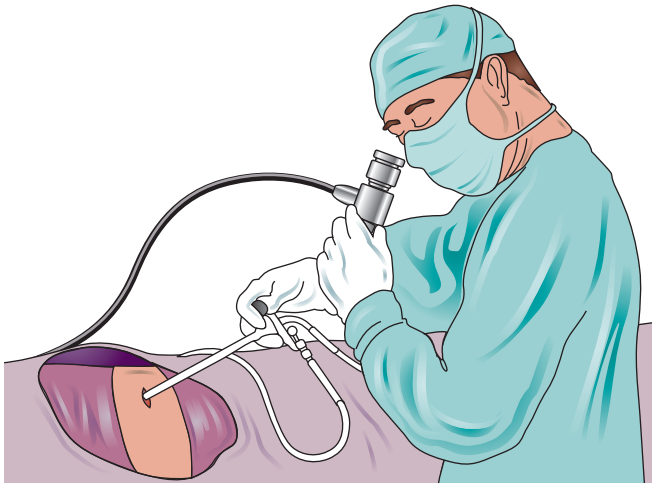

Thoracoscopy is a procedure in which a physician can view the chest cavity and the lungs by inserting an endoscope through the chest wall. Thoracoscopy is less evasive than surgical lung biopsy. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Purpose

Thoracoscopy makes it possible for a physician to examine the lungs or other structures in the chest cavity, without making a large incision. It is an alternative to thoracotomy (opening the chest cavity with a large incision). Many surgical procedures, especially taking tissue samples (biopsies), can also be accomplished with thoracoscopy. The procedure is done to:

- assess lung cancer
- take a biopsy for study
- determine the cause of fluid in the chest cavity
- introduce medications or other treatments directly into the lungs
- treat accumulated fluid, pus (empyema), or blood in the space around the lungs

For many patients, thoracoscopy replaces thoracotomy. It avoids many of the complications of open chest surgery and reduces **pain**, hospital stay, and recovery time.

Precautions

Because one lung is partially deflated during thoracoscopy, the procedure cannot be done on patients whose lung function is so poor that they do not receive enough oxygen with only one lung. Patients who have had previous surgery that involved the chest cavity, or who have blood clotting problems, are not good candidates for this procedure.

Thoracoscopy gives physicians a good but limited view of the organs, such as lungs, in the chest cavity. Endoscope technology is being refined every day, as is what physicians can accomplish by inserting scopes and instruments through several small incisions instead of making one large cut.

Description

Thoracoscopy is most commonly performed in a hospital, and **general anesthesia** is used. Some of the procedures are moving toward outpatient services and **local anesthesia**. More specific names are sometimes applied to the procedure, depending on what the target site of the effort is. For example, if a physician intends to examine the lungs, the procedure is often called pleuroscopy. The procedure takes two to four hours.

The surgeon makes two or three small incisions in the chest wall, often between the ribs. By making the incisions between the ribs, the surgeon minimizes damage to muscle and nerves and the ribs themselves. A tube is inserted in the trachea and connected to a ventilator, which is a mechanical device that assists the patient with inhaling and exhaling.

The most common reason for a thoracoscopy is to examine a lung that has a tumor or a metastatic growth of **cancer**. The lung to be examined is deflated to create

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KEY TERMS

Endoscope—Instrument designed to allow direct visual inspection of body cavities, a sort of microscope in a long access tube.

Thoracotomy—Open chest surgery.

Trachea—Tube of cartilage that carries air into and out of the lungs.

a space between the chest wall and the lung. The patient breathes with the other lung with the assistance of the ventilator.

A specialized endoscope, or narrow–diameter tube, with a video camera or mirrored attachment, is inserted through the chest wall. Instruments for taking necessary tissue samples are inserted through other small incisions. After tissue samples are taken, the lung is reinflated. All incisions except one are closed. The remaining open incision is used to insert a drainage tube. The tissue samples are sent to a laboratory for evaluation.

Preparation

Prior to thoracoscopy, the patient will have several routine tests, such as blood, urine and **chest x ray**. Older patients must have an electrocardiogram (a trace record of the heart activity) because the anesthesia and the lung deflation put a big load on the heart muscle. The patient should not eat or drink from midnight the night before the thoracoscopy. The anesthesia used can cause **vomiting**, and, because anesthesia also causes the loss of the gag reflex, a person who vomits is in danger of moving food into the lungs, which can cause serious complications and **death**.

Aftercare

After the procedure, a chest tube will remain in one of the incisions for several days to drain fluid and release residual air from the chest cavity. Hospital stays range from two to five days. Medications for pain are given as needed. After returning home, patients should do only light lifting for several weeks.

Risks

The main risks of thoracoscopy are those associated with the administration of general anesthesia. Sometimes excessive bleeding, or hemorrhage, occurs, necessitating a thoracotomy to stop it. Another risk comes when the drainage tube is removed, and the patient is vulnerable to lung collapse (**pneumothorax**).

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Tish Davidson, A.M.

Thoracotomy *see* **Lung surgery; Thoracic surgery**

Threadworm *see* **Enterobiasis**

Threadworm infection

Definition

Threadworm infection is an intestinal disease, which occasionally spreads to the skin, caused by a type of parasitic roundworm (helminth). In untreated patients, the disease has a high rate of reinfection caused by worms already present in the body. This type of disease recurrence is called autoinfection. Because of autoinfection, threadworms can remain inside humans for as long as 45 years after the initial infestation.

Description

Threadworm infection, which is also called strongyloidiasis, occurs in most countries of the world but is natural to (endemic in) tropical and subtropical climates. Strongyloidiasis is less common than other parasitic infections but may affect as much as 25% of the population in some developing countries. In the United States, threadworm infection is most likely to be found among immigrants; returning travelers or military personnel; people who live in parts of Appalachia and the southeastern states; and persons in homes for the retarded and similar institutions.

Human beings are universally susceptible to threadworm infection, although adults and older children are at greater risk of infection than younger children. The disease does not confer immunity. In addition to humans, threadworms can infect dogs, cats, horses, pigs, rats, and monkeys.

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Causes and symptoms

Threadworm infection is caused by *Strongyloides stercoralis*, a roundworm that lives in soil and can survive there for several generations. Mature threadworms may grow as long as 1–2 in. (2–5 cm). The larvae have two stages in their life cycle: a rod-shaped (rhabdoid) first stage, which is not infective; and a threadlike (filariform) stage, in which the larvae can penetrate intact human skin and internal tissues.

The infection is most commonly transmitted when a person comes into contact—usually by walking barefoot—with soil containing *S. stercoralis* larvae in their filariform stage. The threadlike larvae penetrate the skin, enter the lymphatic system, and are carried by the blood to the lungs. Once in the lungs, the larvae burst out of the capillaries into the patient's main respiratory system. They migrate upwards, usually without symptoms, to the patient's throat, where they are swallowed and carried down into the digestive tract. The filariform larvae settle in the small intestine. They mature into adults that deposit eggs that hatch, usually in the intestines, into noninfectious rhabdoid larvae. The rhabdoid larvae then migrate into the patient's large intestine and are excreted in the feces. The time from initial penetration of the skin to excretion is 17–28 days. The rhabdoid larvae metamorphose into the infective filariform stage in the soil.

Threadworms are unique among human parasites in having both free-living and parasitic forms. In the free-living life cycle, some rhabdoid larvae develop into adult worms that live in contaminated soil and produce eggs that hatch into new rhabdoid larvae. The adult worms may live as long as five years.

The signs and symptoms of threadworm infection vary according to the stage of the disease as the larvae migrate throughout the body. Patients who suffer from autoinfection may have chronic or intermittent symptoms for years after they are first infected.

Skin

The filariform larvae usually enter the body through the skin of the feet. There may be swelling, **itching**, and **hives** at the point of entry that may be confused with insect **bites**. Patients with chronic threadworm infection may also develop an itchy rash on their buttocks, thighs, or abdomen.

Digestive tract

Although some patients may notice only mild **diarrhea** and cramps, others may have **fever**, **nausea**, **vomiting**, general weakness, and blood or mucus in their stools. The **pain** may mimic a stomach ulcer.

Throat and lungs

When the larvae migrate to the lungs and air passages, the patient may have symptoms ranging from a simple dry **cough** to fever, difficulty breathing, and coughing up blood or pus.

Hyperinfection syndrome

Hyperinfection syndrome is a potentially fatal set of complications resulting from the spread of filariform larvae to the lungs and other organ systems. It can include inflammation of the heart tissue, stomach ulcers, perforation of the intestines, blood poisoning, **meningitis**, **shock**, and eventual **death**. Hyperinfection syndrome is most likely to occur in patients with immune disorders or **malnutrition**, or in those taking anti-inflammatory corticosteroid (anti-inflammatory) medications. It has been reported in only a few **AIDS** patients.

Autoinfection

Threadworm autoinfection in humans follows two patterns. In internal autoinfection, some rhabdoid larvae in the lower bowel develop into filariform larvae that enter the bloodstream from the intestines and migrate to the lungs. In external autoinfection, the skin around the patient's anus is infected by larvae in the feces.

Diagnosis

The doctor is likely to consider a diagnosis of threadworm infection when a patient has the symptoms described earlier and a history of travel or military service in areas where the disease is endemic. A definite diagnosis is made by finding rhabdoid or filariform larvae in the patient's body fluids. The larvae may be found in fresh stool specimens or in mucus coughed up when the infection has reached the lungs. Because the larvae cannot be detected in the stools of 25% of infected patients, the string test is often performed to confirm the diagnosis. In this test, the patient swallows a weighted string which is withdrawn after four hours. The digestive juices absorbed by the string are then examined for the presence of threadworm larvae.

Doctors can also use blood tests and diagnostic imaging to support the diagnosis. Between 85% and 95% of patients with threadworm infections will have a measurable level of antibodies in their blood, even though these antibodies do not prevent the disease from spreading. In addition, patients with severe infections often have unusually high levels of white cells in

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KEY TERMS

Antibody—A protein molecule produced by the immune system that is specific to a disease agent, such as threadworm larvae. The severity of a patient's infection can be measured from the level of antibody in the blood.

Autoinfection—An infection caused by a disease agent that is already present in the body.

Corticosteroid—A class of drugs based on hormones formed in the adrenal gland, used to reduce inflammation. They increase the likelihood of hyperinfection syndrome in patients with threadworm infection.

Endemic—Natural to or characteristic of a particular place, population, or climate. Threadworm infections are endemic in the tropics.

Filariform—Threadlike in appearance, like the infectious stage of the threadworm larva.

Helminth—A type of parasitic worm. Threadworms belong to a subcategory of helminths called nematodes, or roundworms.

Hyperinfection syndrome—A condition of massive infection in which threadworm larvae multiply rapidly and spread throughout the body. It is usually associated with damage to the immune system, the use of steroid medications, or malnutrition.

Rhabdoid—Rod- or wand-shaped, like the first stage of the threadworm larva.

String test—A test performed to diagnose threadworm infection. The patient is asked to swallow a weighted string that absorbs stomach juices, which can be analyzed for the presence of threadworm larvae.

their blood. X rays of the intestines or the chest often help in locating specific areas of inflamed or ulcerated tissue.

Treatment

Threadworm infections are treated with medications. The drugs most often given are ivermectin, thiabendazole (Mintezol), and albendazole. Ivermectin is generally preferred because it has fewer side effects than thiabendazole. These drugs, which are taken by mouth over a period of two to seven days, work by preventing the development of eggs and new larvae. Patients with severe infections should be given protein replacement, blood transfusions, and fluids to replace losses from nausea, **vomiting**, and diarrhea.

Patients who are taking **corticosteroids** should be carefully evaluated if they have symptoms of threadworm infection, because these medications encourage the development of hyperinfection syndrome.

Prognosis

The prognosis for complete recovery is good for most patients, except those with hyperinfection syndrome or severe protein loss.

Prevention

There is no effective immunization against threadworm infection. Prevention of the disease requires careful attention to personal and institutional hygiene in endemic areas, including handwashing after defecating and before handling food. Other precautions include wearing shoes when visiting countries with high rates of threadworm infection, and monitoring close contacts of patients for signs of infection.

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Rebecca J. Frey, PhD

Throat culture

Definition

A throat culture is a technique for identifying disease bacteria in material taken from the throat. Most throat cultures are done to rule out infections caused by beta-hemolytic streptococci, which cause **strep throat**. Hemolytic means that these streptococci destroy red blood cells.

Purpose

The primary purpose of a throat culture is identification of the specific organisms that cause strep throat. These organisms are Group A streptococci, specifically *Streptococcus pyogenes*. Since most sore throats are caused by viral infections rather than by *S. pyogenes*, a correct diagnosis is important to prevent unnecessary

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This nurse is taking a throat culture from a patient for laboratory analysis. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

KEY TERMS

Agar—A gel made from red algae that is used to culture certain disease agents in the laboratory.

Antibiotic—A drug given to stop the growth of bacteria. Antibiotics are ineffective against viruses.

Antigen—A substance that interacts with an antibody and causes an immune reaction.

Carrier—A person harboring an infectious disease who may be immune to it but who can give it to others.

Diphtheria—A serious disease caused by a bacterium, *Corynebacterium diphtheriae*.

Hemolytic—Able to dissolve red blood cells. The bacteria that cause strep throat are hemolytic organisms.

Streptococcus—A category (genus) of sphere-shaped bacteria that occur in pairs or chains.

Thrush—A disease occurring in the mouth or throat that is caused by a yeast, *Candida albicans*.

Whooping cough—An infectious disease of the respiratory tract caused by a bacterium, *Bordetella pertussis*.

use of **antibiotics** and to begin treatment of strep infections as soon as possible. Group A **streptococcal infections** are potentially life-threatening, often involving other parts of the body in addition to the throat. Besides causing **sore throat** (pharyngitis), streptococci can also cause **scarlet fever**, **rheumatic fever**, **kidney disease**, or abscesses around the tonsils.

Throat cultures can also be used to identify other disease organisms that are present in the patient's throat, and to identify people who are carriers of the organisms that cause **meningitis** and **whooping cough**.

Besides their use in diagnosis, throat cultures are sometimes used to test antibiotics for their effectiveness in treating different infections.

Precautions

Throat cultures should be taken before the patient is given any antibiotic medications. In addition, the patient's immunization history should be checked to evaluate the possibility that diseases other than strep are causing the sore throat. The care provider should wash the hands carefully after taking the specimen to prevent the spread of any infectious organisms.

Description

A throat culture test should be done on anyone who has symptoms of a strep throat. These symptoms include a sore throat that may be accompanied by a **fever**, body aches, and loss of appetite. Age is a consideration, in that strep throat is more common in children than in adults. The tonsils and the back of the throat often appear red, swollen, and streaked with pus. These symptoms usually appear one to three days after being exposed to group A strep. Because strep is highly contagious, family members and close contacts of patients diagnosed with strep throat should also have throat cultures performed if they show signs of the disease.

The specimen for throat culture is obtained by wiping the patient's throat with a cotton swab. The patient is asked to tilt the head back and open the mouth wide. With the tongue depressed and the patient saying "ah," the care provider wipes the back of the throat and the tonsils with a sterile swab. The swab is applied to any area that appears either very red or discharging pus. The swab is removed gently without touching the teeth, gums, or tongue. It is then placed in a sterile tube for immediate delivery to a laboratory. Obtaining the specimen takes less than 30 seconds. Laboratory results are usually available in two to three days. The swabbing procedure may cause gagging but is not painful. The doctor makes a note for the laboratory to indicate if any disease organisms other than strep are suspected, because some require special growth conditions in the laboratory.

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S. pyogenes is cultured on a growth medium called blood agar. Agar is a gel that is made from the cell walls of red algae. Blood agar is made from agar gel and sheep's blood. When the throat swab reaches the laboratory, it is wiped across a blood agar plate. The plate is allowed to incubate for 24–48 hours to allow the growth of bacteria. If the organism is a Group A hemolytic streptococcus, the area immediately around the bacterial colony will be cleared of red blood cells. Hemolytic streptococci dissolve (lyse) red blood cells, leaving a clear zone surrounding the colony.

Alternative procedures

So-called instant strep tests are now available to help diagnose strep throat. They can be used in the doctor's office and take about 10–30 minutes to perform. Instant tests detect an antigen associated with the streptococcus. These tests are relatively new and not available at all clinics. Their reliability has improved since they were first introduced. If an instant throat test is negative, however, a standard throat culture can be performed to verify the results.

Preparation

The patient does not need to avoid food or fluids before the test. Recent gargling or treatment with antibiotics, however, will affect the culture results. The laboratory should be notified if the patient has been recently taking antibiotic medications.

Aftercare

No specific aftercare is needed.

Risks

There is a minor risk for the health professional of exposure to the patient's illness.

Normal results

Normal results would include finding organisms that grow in healthy throat tissues. These organisms include non-hemolytic and alpha-hemolytic streptococci, some *Neisseria* species, staphylococci, **diphtheria** and hemophilus organisms, pneumococci, yeasts, and Gram-negative rods.

Abnormal results

In addition to *S. pyogenes*, other disease agents may be identified in the throat culture. Infectious agents that can be identified include *Candida albicans*, which can cause thrush; *Corynebacterium diphtheriae*, which can cause diphtheria; and *Bordetella pertussis*, which can cause whooping **cough**. In addition, the appearance of a normal organism in very high numbers may also be regarded as an abnormal result.

ORGANIZATIONS

American Medical Association, 515 N. State St., Chicago, IL, 60654, (800) 621-8335, http://www.ama-assn.org/.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

Cindy L. A. Jones, PhD

Thromboangiitis obliterans *see* **Buerger's disease**

Thrombocyte count *see* **Platelet count**

Thrombocytopenia

Definition

Thrombocytopenia is an abnormal drop in the number of blood cells involved in forming **blood clots**. These cells are called platelets.

Description

Thrombocytopenia is a blood disease characterized by an abnormally low number of platelets in the bloodstream. The normal amount of platelets is usually between 150,000 and 450,000 cells per microliter of blood. A microliter is an amount equal to one one-millionth of a liter (a liter is almost equal to a quart). Platelet numbers are counted by having a blood sample collected and placing a measured amount of blood in a machine called a cell counter. When the platelet number drops below 150,000 cells per microliter of blood, this person is said to be thrombocytopenic.

Causes and symptoms

Abnormal reductions in the number of platelets are caused when abnormalities occur in any of the following three processes: decreased platelet production by the bone marrow; increased trapping of platelets by the spleen; or a more rapid than normal destruction of platelets. Persons with this condition easily bruise and can have episodes of excess bleeding (a hemorrhage).

Platelets come from megakaryocytes, which are produced in the material located within the center cavity of the bones (bone marrow). When abnormalities develop in the marrow, the marrow cells can lose their ability to

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KEY TERMS

Gamma globulin—One of a group of proteins found in the blood that is involved in helping the body fight infections.

Stent—A man-made surgical device, usually tube-shaped, that is placed into a blood vessel to keep it from closing.

Transfusion—The transfer of blood from one person to another. Transfusions can be direct, in which blood is transferred from the donor to the recipient; or indirect, in which the blood is taken from the donor, stored in a container, and then given to the recipient.

produce platelets in correct amounts. The result is a lower than normal level of platelets in the blood. Drugs used in **cancer chemotherapy** can cause the marrow to malfunction in this way, as can the presence of tumor cells in the marrow itself.

Normally, the spleen holds about one-third of the body's platelets as part of this organ's function to recycle **aging** or damaged red blood cells (the cells that carry oxygen in the blood). When **liver disease** or cancer of the spleen is present, the spleen can enlarge, resulting in a greater number of platelets staying in the organ. This condition results in abnormally low numbers of platelets in the blood.

Platelets can break down in unusually high amounts in persons with abnormalities in their blood vessel walls; with blood clots; or with man-made replacement heart valves. Devices placed inside blood vessels to keep them from closing (stents) due to weakened walls or fat build-up can also cause platelets to break down. In addition, infections and other changes in the immune system can speed up the removal of platelets from the circulation.

Diagnosis

Thrombocytopenia is diagnosed by having a blood sample taken and counting the platelets present in the sample. However, accurately determining the medical reason for this conditions is complex.

Once a low **platelet count** is verified, a careful evaluation of the function of the bone marrow and spleen are necessary. Improper functioning of either or both of these organs can cause thrombocytopenia. In addition, the causes for the abnormal spleen or marrow function must be investigated since different cancers, blood disorders, or liver disease can be the true cause for the drop in platelets found in the blood.

Treatment

If low platelet counts are caused by an enlarged spleen, removal of the spleen can help raise the platelet level, since the spleen is no longer there to capture the platelets. However, proper treatment for what causes the enlarged spleen is necessary as well.

Low platelet counts can indicate more serious conditions. If a dysfunctional immune system is found to be the cause for this condition, drugs like **steroids** or **gamma globulin** can be used to help maintain platelet levels in certain cases.

If low platelet levels are due to an abnormally low level of platelet production, transfusions of platelets can be given as well.

Prognosis

Thrombocytopenia can result in fatal bleeding, but it also can indicate various other, more serious, cancers and disorders that affect the blood cells. This condition requires thorough medical evaluation.

Prevention

There is no known way to prevent hrombocytopenia.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

Dominic De Bellis, PhD

Thrombocytosis

Definition

Thrombocytosis is a blood disorder in which the body produces a surplus of platelets (thrombocytes).

Description

Thrombocytosis is an abnormally increased number of platelets in the blood. Platelets are blood cells that stick together, helping blood to clot. Thrombocytosis is a condition that may have many causes.

Throbocytosis is classified as one of two types. Secondary thrombocytosis can be traced to another cause, such as inflammation, severe bleeding, iron deficiency, or some cancers. Primary thrombocytosis (or essential thrombocythemia) is a single disease entity, with unique clinical characteristics.

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Causes and symptoms

The cause of essential thrombocytosis is unknown.

Secondary thrombocytosis may develop as a result of:

- acute hemorrhage or infection
- anemia
- arthritis and other chronic inflammations
- cancer
- exercise
- iron deficiency
- medication
- osteoporosis
- removal of the spleen (splenectomy)
- polycythemia vera (a disorder affecting other red blood cells, as well as platelets)
- stress
- surgery

Symptoms

Two of every three patients who have thrombocytosis do not have any symptoms of the disease at the time of diagnosis. Younger patients may remain symptom-free for years.

Enlargement of the spleen is detected in 60% of patients with thrombocytosis. The liver may also be enlarged. As many as half of all patients experience bleeding from the skin, gums, or nose; and 20–50% have some blockage of veins or arteries.

Other symptoms of thrombocytosis include:

- bloody stools
- bruising
- dizziness
- headache
- hemorrhage
- prolonged bleeding after having surgery or after having a tooth pulled
- redness or tingling of the hands and feet
- weakness. In rare instances, the lymph nodes become enlarged

The highest platelet counts usually produce the most severe symptoms. Younger patients (especially women) may not have symptoms, even though their platelet counts are very high.

Complications

Complications of thrombocytosis include **stroke**, **heart attack**, and formation of **blood clots** in the arms and legs.

A doctor should be notified whenever bleeding is unexplained or prolonged or the patient develops:

- chest or leg pain
- confusion
- numbness
- weakness

Diagnosis

The patient's symptoms suggest the presence of thrombocytosis. Blood tests confirm the diagnosis.

Bone marrow aspiration (removal of a tissue sample for microscopic examination) may also be performed.

Treatment

The key to treating secondary thrombocytosis is treating the underlying condition.

Any patient who has thrombocytosis should be encouraged not to smoke.

In young people who have no symptoms, this condition can remain stable for many years. These patients should be monitored by a physician, but may not require treatment.

Treatment for patients who do have symptoms focuses on controlling bleeding, preventing the formation of blood clots, and lowering platelet levels. Treatment for secondary thrombocytosis involves treating the condition or disease responsible for excess platelet production.

In 1997, the United States Food and Drug Administration (FDA) approved the use of anagrelide HCl (Agrylin) to reduce elevated platelet counts and decrease the risk of clot formation. Some patients have benefited from the use of hydroxyurea, an anti-cancer drug.

Low doses of **aspirin** may prevent clotting, but can cause serious hemorrhages.

If drug therapy does not bring platelet counts down to an acceptable level as rapidly as necessary, plateletpheresis may be performed. Usually combined with drug therapy and used primarily in medical emergencies, this procedure consists of:

- withdrawing blood from the patient's body
- removing platelets from the blood
- returning the platelet-depleted blood to the patient

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Prognosis

Many patients with thrombocytosis remain free of complications for long periods. However, some patients may die as a result of blood clots or uncontrolled bleeding.

Prevention

There is no known way to prevent thrombocytosis.

Resources

OTHER

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Maureen Haggerty

Thromboembolism *see* **Embolism**

Thrombolytic therapy

Definition

Thrombolytic therapy is the use of drugs that dissolve **blood clots**.

Purpose

When a blood clot forms in a blood vessel, it may cut off or severely reduce blood flow to parts of the body that are served by that blood vessel. This can cause serious damage to those parts of the body. If the clot forms in an artery that supplies blood to the heart, for example, it can cause a **heart attack**. A clot that cuts off blood to the brain can cause a **stroke**. Thrombolytic therapy is used to dissolve blood clots that could cause serious, and possibly life-threatening, damage if they are not removed. Research suggests that when used to treat stroke, thrombolytic therapy can prevent or reverse **paralysis** and other problems that otherwise might result.

Thrombolytic therapy also is used to dissolve blood clots that form in tubes put into people's bodies for medical treatments, such as dialysis or **chemotherapy**.

Description

Thrombolytic therapy uses drugs called thrombolytic agents, such as alteplase (Activase), anistreplase (Eminase), streptokinase (Streptase, Kabikinase), urokinase (Abbokinase), and tissue plasminogen activator (TPA) to dissolve clots. These drugs are given as injections, only under a physician's supervision.

Recommended dosage

The physician supervising thrombolytic therapy decides on the proper dose for each patient. He or she will take into account the type of drug, the purpose for which it is being used, and in some cases, the patient's weight.

Precautions

For thrombolytic therapy to be effective in treating stroke or heart attack, prompt medical attention is very important. The drugs must be given within a few hours of the beginning of a stroke or heart attack. However, this treatment is not right for every patient who has a heart attack or a stroke. Only a qualified medical professional can decide whether a thrombolytic agent should be used. To increase the chance of survival and reduce the risk of serious, permanent damage, anyone who has signs of a heart attack or stroke should get immediate medical help.

Thrombolytic therapy may cause bleeding. Usually this is not serious, but severe bleeding does occur in some people. This is especially likely in older people. To lower the risk of serious bleeding, people who are given this drug should move around as little as possible and should not try to get up on their own unless told to do so by a health care professional. Following all the instructions of the health care providers in charge is very important.

Thrombolytic therapy may be more likely to cause serious bleeding in people who have certain medical conditions or have recently had certain medical procedures. Before being given a thrombolytic agent, anyone with any of these problems or conditions should tell the physician in charge about it:

- blood disease or current or past bleeding problems in any part of the body
- heart or blood vessel disease
- stroke (recent or in the past)
- high blood pressure
- brain tumor or other brain disease
- stomach ulcer or colitis
- severe liver disease
- active tuberculosis
- recent falls, injuries, or blows to the body or head
- recent injections into a blood vessel
- recent surgery, including dental surgery
- tubes recently placed in the body for any reason

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KEY TERMS

Arteries—Blood vessels that carry blood away from the heart to the cells, tissues, and organs of the body.

Blood clot—A hard mass that forms when blood gels.

Chemotherapy—Treatment of an illness with chemical agents. The term is usually used to describe the treatment of cancer with drugs.

Dialysis—A process used in people whose kidneys are not working well. By way of a filtering machine, dialysis separates waste and other useless materials from the blood – a job the kidneys usually do.

Paralysis—Loss of the ability to move one or more parts of the body.

Stroke—A serious medical event in which blood flow to the brain is stopped. This may be because of a blood clot in an artery or because an artery has burst. Strokes may cause paralysis and changes in speech, memory, and behavior.

- recent delivery of a baby

In addition, anyone who has had a recent streptococcal (strep) infection should tell the physician in charge. Some thrombolytic agents may not work properly in people who have just had a strep infection, so the physician may want to use a different drug.

People who take certain medicines may be at greater risk for severe bleeding when they are given a thrombolytic agent.

Women who are pregnant should tell the physician in charge before being given a thrombolytic agent. There is a slight chance that a woman who is given thrombolytic therapy during the first five months of **pregnancy** will have a **miscarriage**. However, streptokinase and urokinase have both been used without problems in pregnant women.

After being treated with thrombolytic therapy, women who are **breastfeeding** should check with their physicians before starting to breastfeed again.

Side effects

Anyone who has **fever** or who notices bleeding or oozing from their gums, from cuts, or from the site where the thrombolytic agent was injected should immediately tell their health care provider.

People who are given thrombolytic therapy should also be alert to the signs of bleeding inside the body and should check with a physician immediately if any of the following symptoms occur:

- blood in the urine
- blood or black, tarry stools
- constipation
- coughing up blood
- vomiting blood or material that looks like coffee grounds
- nosebleeds
- unexpected or unusually heavy vaginal bleeding
- dizziness
- sudden, severe, or constant headaches
- pain or swelling in the abdomen or stomach
- back pain or backache
- severe or constant muscle pain or stiffness
- stiff, swollen, or painful joints

Other side effects of thrombolytic agents are possible. Anyone who has unusual symptoms during or after thrombolytic therapy should tell a health care professional.

Interactions

People who take certain medicines may be at greater risk for severe bleeding when they receive a thrombolytic agent. Anyone who is given a thrombolytic agent should tell the physician in charge about all other prescription or nonprescription (over-the-counter) medicines he or she is taking. Among the medicines that may increase the chance of bleeding are:

- aspirin and other medicines for pain and inflammation
- blood thinners (anticoagulants)
- antiseizure medicines, such as Depakote (divalproex) and Depakene (valproic acid)
- cephalosporins, such as cefamandole (Mandol), cefoperazone (Cefobid), and Cefotetan (Cefotan)

Also, anyone who has been treated with anistreplase or streptokinase within the past year should tell the physician in charge. These drugs may not work properly if they are given again, so the physician may want to use a different thrombolytic agent.

Resources

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Nancy Ross-Flanigan

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Thrombophlebitis

Definition

Thrombophlebitis is inflammation of a vein with blood clot formation inside the vein at the site of the inflammation. Thrombophlebitis also is known as phlebitis, phlebothrombosis, and venous thrombosis.

Demographics

Thrombophlebitis can occur in both deep veins and superficial veins, but most often occurs in superficial veins of the extremities (legs and arms). Most cases occur in the legs.

Description

There are two parts to thrombophlebitis, inflammation of a vein and blood clot formation. If the inflammation is minor, the disease usually is called venous thrombosis or phlebothrombosis. When thrombophlebitis occurs in a superficial vein, one that is near the surface of the skin and is visible to the eye, the disease is called superficial thrombophlebitis. Any form of injury to a blood vessel can result in thrombophlebitis. In the case of superficial thrombophlebitis, the blood clot usually attaches firmly to the wall of the affected vein. Since superficial blood veins do not have muscles that massage the veins, **blood clots** in superficial veins tend to remain where they form and seldom break loose. When thrombophlebitis occurs in a deep vein, a vein that runs deep within muscle tissue, it is called deep venous thrombosis. Deep venous thrombosis presents the threat of producing blood clots that will break loose to form emboli. These emboli can lodge in other tissues where they can block the blood supply, typically in the lungs. This condition results in tissue damage and can sometimes be serious or fatal, for example, **pulmonary embolism**.

Causes and symptoms

The main symptoms are tenderness and **pain** in the area of the affected vein. Redness and/or swelling also may be seen. In the case of deep venous thrombosis, there is more swelling than is caused by superficial thrombophlebitis, and the patient may experience muscle stiffness in the affected area. There are many causes of thrombophlebitis.

The main causes can be grouped into three categories: injury to blood veins, increased blood clotting, and blood stasis. When blood veins are damaged, collagen in the blood vein wall is exposed. Platelets respond to collagen by initiating the clotting process. Damage to a vein can occur as a consequence of indwelling catheters, trauma, infection, **Buerger's disease**, or the injection of irritating substances. Increased tendency of the blood to clot can be caused by malignant tumors, genetic disorders, and **oral contraceptives**, though newer generation birth control pills carry a lower risk for many women. Stasis, in which the blood clots due to decreased blood flow in an area, can happen following surgery, as a consequence of **varicose veins**, as a complication of postpartum states, and following prolonged bed rest. In the case of prolonged bed rest, blood clots form because of inactivity, which allows blood to move sluggishly and stagnate (collect) in blood veins. This condition can lead to blood clots. These clots (also called emboli) sometimes are released when the patient stands up and resumes activity. This can present a problem if the emboli lodge in vital organs. In the case of postpartum patients, a **fever** developing four to 10 days after delivery may indicate thrombophlebitis. A 2004 study revealed that postmenopausal women taking hormone therapy combining estrogen and progestin had more than a two–fold higher risk of venous thrombosis than non–hormone users.

KEY TERMS

Emboli, embolus—Emboli is the plural form of embolus. Embolus is any mass of air, blood clot, or foreign body that travels through the blood stream and is capable of lodging in smaller blood vessels where it can obstruct blood flow to that vessel.

Embolism—The obstruction of a blood vessel by a blot clot.

Phlebitis—Inflammation of a vein.

Thrombus—A blood clot that forms within a blood vessel or the heart.

Diagnosis

In superficial thrombophlebitis, the location of the clot sometimes can be seen by the unaided eye. Blood clots are hard and can usually be detected by a physician using palpation (touching or massage). Deep venous thrombosis requires specialized diagnostic procedures to detect the blood clot. Among the exams a physician may use are ultrasound and x ray, coupled with dye injection (venogram).

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Treatment

Superficial thrombophlebitis usually resolves without treatment. If treatment of superficial thrombophlebitis is given, it usually is limited to the application of heat or anti–inflammatory drugs, such as **aspirin** or ibuprofen, which also help to relieve the pain. It can take from several days to several weeks for the clot to resolve and the symptoms to completely disappear. A 2003 study showed that low intensity therapy with warfarin, a common blood thinner, prevented recurrent venous thromboembolism in study subjects. A newer anticoagulant called ximelagatran also has been shown as equally or more effective than warfarin in preventing **deep vein thrombosis**.

Deep venous thrombosis is a serious condition, treated with **anticoagulant drugs** and by keeping the affected limb elevated. The primary objective in treating deep venous thrombosis is prevention of a pulmonary **embolism**. The patient usually is hospitalized during initial treatment. The prescribed anticoagulant drugs limit the ability of blood clots to grow and new clots to form. Sometimes, a drug that dissolves blood clots is administered. These drugs must be used with caution because, as the clot dissolves, it may break loose from the site where it formed and become an embolus. Surgery may be used if the affected vein is likely to present a long–term threat of producing blood clots that will release emboli. When superficial thrombophlebitis occurs in the groin, where the superficial veins join the deep veins, the threat of emboli is present. In this case, blood clots formed in the superficial veins can extend into the much larger deep vein where they break off and are released into the blood stream. The affected veins are either removed or tied off to prevent the release of blood clots. Tying off superficial blood veins is an outpatient procedure that can be performed with **local anesthesia**. The patient is capable of immediately resuming normal activities.

Prognosis

Superficial thrombophlebitis seldom progresses to a serious medical complication, although non–lethal embolisms may be produced. Deep venous thrombosis may lead to embolism, especially pulmonary embolism. This is a serious consequence of deep venous thrombosis, and sometimes is fatal.

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ORGANIZATIONS

American Heart Association (AHA), 7272 Greenville Ave., Dallas, TX, 75231, (301) 223–2307, (800) 242–8721, http://www.americanheart.org.

Centers for Disease Control and Prevention (CDC). Division for Heart Disease and Stroke Prevention, 4770 Buford Hwy. NE, Atlanta, GA, 30341–3717, (770) 488–2424, http://www.cdc.gov/dhdsp/.

National Heart, Lung, and Blood Institute (NHLBI), PO Box 30105, Bethesda, MD, 20824–0105, (301) 592–8573, (204) 629–3246, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi.nih.gov.

Society of Interventional Radiology (SIR), 10201 Lee Hwy., Suite 500, Fairfax, VA, 22030, (703) 691–1805, http://www.sirweb.org.

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Thrush *see* **Candidiasis**

Thymol *see* **Antiseptics**

Thymoma

Definition

Thymomas are the most common tumor of the thymus.

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Description

The thymus is located in the upper chest just below the neck. It is a small organ that produces certain types of white blood cells before birth and during childhood. These white blood cells are called lymphocytes and are an important part of the body's immune system. Once released from the thymus, lymphocytes travel to lymph nodes where they help to fight infections. The thymus gland becomes smaller in adulthood and is gradually taken over by fat tissue.

Although rare, thymomas are the most common type of thymic **cancer**. They arise from thymic epithelial cells, which make up the covering of the thymus. Thymomas frequently contain lymphocytes, which are noncancerous. Thymomas are classified as either noninvasive (previously called "benign") or invasive (previously called "malignant"). Noninvasive thymomas are those in which the tumor is encapsulated and easy to remove. Invasive thymomas have spread to nearby structures (such as the lungs) and are difficult to remove. Approximately 30% to 40% of thymomas are of the invasive type.

Thymoma affects men and women equally. It is usually diagnosed between the ages of 40 and 60 years. Thymomas are uncommon in children.

Causes and symptoms

The cause of thymoma is unknown. Cancer is caused when the normal mechanisms that control cell growth become disturbed, causing the cells to continually grow without stopping. This is caused by damage to the DNA in the cell.

Approximately 40% of the patients diagnosed with thymoma have no symptoms. The symptoms in the remaining 60% of patients are caused by pressure from the enlarged thymus on the windpipe (trachea) or blood vessels, or by paraneoplastic syndromes. Paraneoplastic syndromes are collections of symptoms in cancer patients that cannot be explained by the tumor. Seventy-one percent of thymomas are associated with paraneoplastic syndromes. The most common syndromes related to thymoma are pure red cell aplasia (having abnormally low levels of red blood cells), **myasthenia gravis** (a muscular disorder), and hypogammaglobulinemia (having abnormally low levels of antibodies). These conditions are autoimmune diseases—those in which the body mounts an attack against certain normal cells of the body.

Symptoms of thymoma may include:

- shortness of breath
- swelling of the face
- coughing
- chest pain
- muscle weakness (especially in the eyes, neck, and chest, causing problems with vision, swallowing, and breathing)
- weakness
- dizziness
- shortness of breath
- fatigue

Diagnosis

The physician will conduct a complete physical exam. He or she may be able to feel a fullness in the lower neck region. Routine blood tests may be performed. Imaging studies are necessary because the symptoms of thymoma can be caused by many other diseases. Thymomas can be identified by **chest x ray**, **magnetic resonance imaging**, and computed tomography.

A biopsy may be performed, in which a small sample of the tumor is removed and examined under the microscope. However, because of the risk of "seeding" cancerous cells, biopsies are not routinely performed. There are a few different methods to biopsy a thymoma. For a **mediastinoscopy**, a wand-like lighted camera (endoscope) and special instruments are passed through a small cut in the lower neck. The surgeon can see the tumor on a monitor and can cut off small samples for microscopic analysis. Mediastinoscopy is performed under **general anesthesia**. Alternatively, a needle biopsy will be taken in which a long needle is passed through the skin and into the tumor. Fine needle biopsy uses a thin needle and larger-core needle biopsy uses a wider needle. Needle biopsies may be performed in conjunction with CT imaging.

Patients who are having difficulty breathing may have a **bronchoscopy** performed to examine the wind pipe. An endoscope, in this case a bronchoscope, is inserted through the mouth and into the windpipe. The physician will look for tumors and may perform biopsies.

Treatment

Clinical staging

There is more than one type of staging system for thymoma; but the Masaoka system, a surgical staging system developed in 1981, is used most often. Thymoma is categorized into four stages (I, II, III, and IV), which may be further subdivided (A and B) based on the spread of cancerous tissue. The Masaoka staging system is as follows:

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- Stage I. The thymoma lies completely within the thymus.
- Stage II. The thymoma has spread out of the thymus and invaded the outer layer of the lung (pleura) or nearby fatty tissue.
- Stage III. The thymoma has spread to other neighboring tissues of the upper chest, including the outer layer of the heart (pericardium), the lungs, or the heartôs main blood vessels.
- Stage IVA. The thymoma has spread throughout the pericardium and/or the pleura.
- Stage IVB. The thymoma has spread to organs in other parts of the body.

In 1999, the World Health Organization (WHO) adopted a new classification system for thymic tumors. This system is a histologic classification, which means that it is based on the microscopic features of the cells that make up the tumor. The WHO classification system ranks thymomas into types A, AB, B1, B2, B3, and C, by increasing severity.

The treatment for thymoma depends on the stage of cancer and the patients overall health. Because thymomas are so rare, there are no defined treatment plans. Treatment options include surgery, **radiation therapy**, and/or **chemotherapy**. Surgical removal of the tumor is the preferred treatment. Surgery is often the only treatment required for stage I tumors. Treatment of thymoma often relieves the symptoms caused by paraneoplastic syndromes.

A treatment that is intended to aid the primary treatment is called adjuvant therapy. For instance, chemotherapy may be used along with surgery to treat thymoma. Stages II, III, and IV thymomas are often treated with surgery and some form of adjuvant therapy.

Surgery

Thymoma may be treated by surgically removing (resecting) the tumor and some of the nearby healthy tissue. Removal of the entire thymus gland is called a thymectomy. Surgery on the thymus is usually performed through the chest wall by splitting open the breast bone (sternum), a procedure called a median sternotomy. When complete removal of the tumor is impossible, the surgeon will remove as much of the tumor as possible (debulking surgery, subtotal resection). In these cases, if the tumor has spread, surgery may include removal of such other tissues as the pleura, pericardium, blood vessels of the heart, lung, and nerves.

Radiation therapy

Radiation therapy uses high-energy radiation from x rays and gamma rays to kill the cancer cells. Radiation given from a machine that is outside the body is called external radiation therapy. Radiation therapy is often used as adjuvant therapy following surgery to reduce the chance of cancer recurrence. Radiation may be used to kill cancer cells in cases in which the tumor was only partially removed. It may be used before surgery to shrink a large tumor. Radiation therapy is not very effective when used alone, although it may be used alone when the patient is too sick to withstand surgery.

The skin in the treated area may become red and dry and may take as long as a year to return to normal. Radiation to the chest may damage the lung, causing **shortness of breath** and other breathing problems. Also, the tube that goes between the mouth and stomach (esophagus) may be irritated by radiation, causing swallowing difficulties. **Fatigue**, upset stomach, **diarrhea**, and **nausea** are also common complaints of patients having radiation therapy. Most side effects go away about two to three weeks after radiation therapy has ended.

Chemotherapy

Chemotherapy uses **anticancer drugs** to kill the cancer cells. The drugs are given by mouth (orally) or intravenously. They enter the bloodstream and can travel to all parts of the body. Chemotherapy may be given before surgery to shrink a tumor, which is called neoadjuvant therapy. Thymoma cells are very sensitive to anticancer drugs, especially cisplatin, doxorubicin, and ifosfamide. Generally, a combination of drugs is given because it is more effective than a single drug in treating cancer. **Corticosteroids** are also used to treat thymoma.

The side effects of chemotherapy are significant, and include stomach upset, **vomiting**, appetite loss, hair loss (**alopecia**), mouth sores, and fatigue. Women may experience vaginal sores, menstrual cycle changes, and **premature menopause**. There is also an increased chance of infections.

Alternative treatment

Although alternative and complementary therapies are used by many cancer patients, very few controlled studies on the effectiveness of such therapies exist. Mind-body techniques such as prayer, **biofeedback**, visualization, **meditation**, and **yoga**, have not shown any effect in reducing cancer; but they can reduce **stress** and lessen some of the side effects of cancer treatments. Gerson, macrobiotic, orthomolecular, and Cancell therapies are ineffective treatments for cancer.

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KEY TERMS

Adjuvant therapy—A treatment that is intended to aid the primary treatment. Adjuvant treatments for thymic cancer are radiation therapy and chemotherapy.

Invasive—A descriptive term for thymoma that has spread beyond the outer wall of the thymus.

Lymphocyte—A type of white blood cell that is found in the thymus.

Neoadjuvant therapy—Radiation therapy or chemotherapy used to shrink a tumor before surgical removal of the tumor.

Paraneoplastic syndrome—A set of symptoms that is associated with cancer but is not directly caused by the cancer.

Pleura—The outer covering of the lungs.

Clinical studies of hydrazine sulfate found that it had no effect on cancer and even worsened the health and well-being of the study subjects. One clinical study of the drug amygdalin (Laetrile) found that it had no effect on cancer. Laetrile can be toxic and has caused deaths. Shark cartilage has been studied as a cancer treatment and is presently being studied by the FDA in clinical trials. Although the results are mixed, clinical studies suggest that melatonin may increase the survival time and quality of life for cancer patients.

Selenium, in safe doses, may delay the progression of cancer. Laboratory and animal studies suggest that curcumin, the active ingredient of turmeric, has anticancer activity. Maitake mushrooms may boost the immune system, according to laboratory and animal studies. The results of laboratory studies suggest that mistletoe has anticancer properties; however, clinical studies have not been conducted.

Prognosis

The five-year survival rates for thymomas are 96% for stage I, 86% for stage II, 69% for stage III, and 50% for stage IV. Thorough (radical) surgery is associated with a longer survival rate. Almost 15% of thymoma patients develop a second cancer.

Thymomas rarely spread (metastasize) outside of the chest cavity. Metastasis is usually limited to the pleura. Invasive thymomas are prone to recurrence, even 10 to 15 years following surgery. The recurrence rates are drastically reduced and the five-year survival rates are drastically increased in patients who receive adjuvant radiation therapy.

Prevention

Because there are no known risk factors for the development of thymoma, there are no preventive measures. However, there may be an association between thymic cancer and exposure of the chest to radiation.

Resources

BOOKS

Markman, Maurie. *Atlas of Cancer*. 2nd ed. Philadelphia: Current Medicine, 2008.

Wood, William C., C. A. Staley, and John Elias Skandalakis. *Anatomic Basis of Tumor Surgery*. 2nd ed. Heidelberg; New York: Springer, 2010.

ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (800) 227-2345, http://www.cancer.org.

Cancer Research Institute (National Headquarters), One Exchange Plaza, 55 Broadway, Suite 1802, New York, NY, (212) 688-7515, (212) 832-9376, (800) 992-2623, http://www.cancerresearch.org/.

National Institutes of Health & National Cancer Institute, 6116 Executive Boulevard Suite 300, Bethesda, MD, 20892-8322, (800) 422-6237, cancergovstaff@mail.nih.gov, http://www.cancer.gov.

Belinda Rowland, Ph.D.

Thymus tumor *see* **Thymoma**

Thyroid biopsy

Definition

The thyroid biopsy is a procedure in which a sample of thyroid tissue is withdrawn for laboratory examination. The sample can be withdrawn through a needle or a surgical incision may be made to obtain a piece of thyroid tissue.

Purpose

The test is generally performed when a lump or a nodule is detected in the thyroid. The test may also be ordered if the thyroid gland is enlarged and the cause is not apparent. The biopsy is usually a test for **thyroid cancer**.

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Description

The thyroid is a butterfly–shaped gland located at the base of the neck. It produces thyroxine, a hormone that plays a very crucial role in regulating the metabolism of the body and controlling several vital functions, such as the heart beat, blood pressure, and body temperature. The thyroid also regulates childhood growth and development.

A thyroid biopsy is usually ordered when a painless lump or a nodule is detected, either by the patient or by a doctor during a routine **physical examination**. A biopsy is the only test that can accurately determine whether the lump is non–cancerous (benign) or cancerous (malignant). The biopsy can be performed in several ways.

The "fine needle aspiration" (FNA) can be done in the doctor's office. An anesthetic is not usually given. The patient will be asked to lie on his or her back. A pillow will be placed under the shoulders and the neck will be extended. The biopsy site will be cleansed with a sterile antiseptic solution. A thin needle will be inserted into the thyroid, and a sample of thyroid cells and some fluid will be collected. The needle will be quickly withdrawn. Pressure will be applied at the biopsy site to stop the bleeding and a bandage may be used to cover the area. The test takes three to five minutes.

For "large needle biopsy," a mild sedative may be given an hour before the procedure, to relax the patient. The patient will be asked to lie on his or her back, with the head tipped back and the neck extended. The biopsy site will be thoroughly cleansed and the physician will inject a local anesthetic. A small incision (about one inch) will be made in the skin. The biopsy needle will be inserted through the incision into the thyroid. A sample of tissue will be removed and the needle withdrawn. Pressure is applied at the biopsy site to stem the bleeding and a bandage applied. This test takes five to 10 minutes.

The "open incisional biopsy" is done in an operating room by a surgeon. The patient is given a general anesthetic. A sedative is given an hour before the procedure to relax the patient. An intravenous line is placed in the arm for infusion of fluids or drugs. An endotracheal tube is inserted through the mouth into the lungs for administering anesthetic gases. After the patient is anesthetized, a small incision is made in the neck. Either the whole thyroid or a part of it is removed. If only a portion is being removed, the surgeon may send a small piece of remaining tissue to the laboratory for immediate testing while the patient is still on the operating table. If the pathologist's report comes back stating that **cancer** is present in the remaining tissue, the entire thyroid is removed. The incision is closed with stitches. The whole procedure may take about an hour.

KEY TERMS

Biopsy—The surgical removal and microscopic examination of living tissue for diagnostic purposes.

Endotracheal tube—A hollow tube that is inserted into the windpipe (trachea), leading to the lungs.

Pathologist—A doctor who specializes in the diagnosis of disease by studying cells and tissues under a microscope.

Preparation

The doctor should be informed of any **allergies** to medications and provided a list of every medication the patient is taking. The doctor should be told if the patient is pregnant.

The patient will be asked to sign the necessary consent forms. If a needle biopsy is done, no special preparation is needed. If a large needle biopsy is being done, the doctor may order some tests to determine the clotting ability of the blood. In addition, the patient may be instructed not to eat or drink for at least four hours prior to the procedure to minimize the risk for **nausea and vomiting**. The patient will also be asked to urinate immediately before starting preparation for the procedure. If an open incisional biopsy is being done, a general anesthetic is required and the patient will be asked to refrain from eating or drinking anything eight to 12 hours before the test.

Aftercare

The needle used in fine needle aspiration is so thin, the whole procedure feels like a quick injection. There is no **pain** or tenderness at the site after the test. In large needle biopsy, a stinging needle prick may be felt when the local anesthetic is injected. The site may be sore for a few hours and tender for a day or two after the test.

In the open incisional biopsy, the patient will feel nothing during the procedure, because of the effects of the anesthetic and the sedative. However, the anesthetic may cause the patient to feel drowsy for several hours after the procedure. The anesthetic may also cause the patient to experience some **fatigue**, and general aches and pains for a day or two after the procedure. The endotracheal tube may make the throat feel mildly sore. Sutures may be necessary to close the incisional biopsy

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site. Some home care of the sutures may be required. Discharge instructions will typically be provided if suture care is required. If there is swelling at the biopsy site or if the patient develops a **fever**, the doctor should be notified immediately.

Risks

No risks are associated with fine needle aspiration. Large needle biopsy may cause bleeding into the thyroid gland. There is a small risk that the anesthetic used in open surgical biopsy may cause a life–threatening reaction.

A patient with a bleeding disorder should not have a biopsy unless the bleeding problem can be corrected by a **transfusion** of the cells that cause blood to clot (platelets).

Results

The normal appearance and architecture of the thyroid cells indicate that no cancer cells are present in the thyroid tissue.

Any abnormalities of the thyroid tissue cells may indicate cancer, benign tumors, or some other thyroid disease. If cancer is suspected, the pathologist may do some more testing to identify the extent of the cancer, so that it can be treated appropriately.

ORGANIZATIONS

American Thyroid Association, Inc. (ATA), 6066 Leesburg Pike, Suite 550, Falls Church, VA, 22041, (703) 998–8890, (703) 998–8893, http://thyroid.org.

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Thyroid cancer

Definition

Thyroid **cancer** is a disease in which the cells of the thyroid gland become abnormal, grow uncontrollably and form a mass of cells called a tumor.

Demographics

Diseases of the thyroid gland affect millions of Americans. The most common diseases of the thyroid are **hyperthyroidism** (Grave's disease) and **hypothyroidism**, an overactive or an underactive gland, respectively. Sometimes lumps or masses may develop in the thyroid. Although most (95%) of these lumps or nodules are non-cancerous (benign), all thyroid lumps should be taken seriously.

Thyroid cancer is one of the most treatable forms of cancer with the five year overall survival rate for all stages and all tumor types at 97%. The American Cancer Society estimates that in 2009, approximately 37,200 new cases of thyroid cancer were diagnosed in the United States and less than 2,000 individuals died from the disease.

Women are three times more likely to develop thyroid cancer than men. Unlike many cancers, thyroid cancers are most often diagnosed in younger people, with almost two-thirds of cases diagnosed in individuals between the ages of 20 and 55. Caucasians are affected more often than African Americans.

The incidence of thyroid cancer has increased slightly in recent years although this increase is thought to be primarily related to increased sophistication of detection capabilities. The **death** rate from thyroid cancer has remained stable for several years.

Description

The thyroid is a hormone-producing, butterfly-shaped gland located in the neck at the base of the throat. It has two lobes, the left and the right. The thyroid uses iodine, a mineral found in some foods, to make several of its hormones. **Thyroid hormones** regulate essential body processes such as heart rate, blood pressure, body temperature, metabolism, and affect the nervous system, muscles and other organs. These hormones play an important role in regulating childhood growth and development.

Types of thyroid cancer

Thyroid cancer is grouped into types based on how cells appear under a microscope. Differentiated thyroid cancers include papillary carcinoma (the most common type of thyroid tumor) and follicular carcinoma. Hurthle cell thyroid cancer is a subtype of follicular carcinoma. Other less commonly occurring types of thyroid cancers include medullary thyroid carcinomas, anaplastic thyroid cancers, and thyroid lymphomas. They grow at different rates and can spread to other parts of the body if left untreated. The two most common types of thyroid cancer are papillary carcinoma and follicular carcinoma.

PAPILLARY. The papillary type (60%–80% of all thyroid cancers) is a slow-growing cancer that develops in the hormone-producing cells containing iodine.

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Thyroid cancers

Cancer type	Characteristics	Prognosis
Papillary	60–80% of thyroid cancers Slow-growing cancer in hormone-producing cells	90% of patients will live for 15 years or longer after diagnosis
Follicular	30–50% of thyroid cancers Found in hormone-producing cells	90% of patients will live for 15 years or longer after diagnosis
Medullary	5–7% of thyroid cancers Found in calcitonin-producing cells Difficult to control as it often spreads to other parts of the body	80% of patients will live for at least 10 years after surgery
Anaplastic	2% of thyroid cancers Fastest growing Rapidly spreads to other parts of the body	3–17% of patients will survive for five years

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FOLLICULAR. The follicular type (30%–50% of thyroid cancers) also develops in the hormone-producing cells.

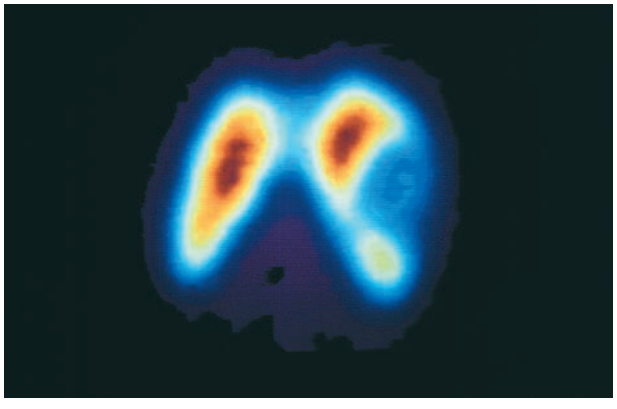
MEDULLARY. The medullary type (5%–7% of all thyroid cancers) develops in the parafollicular cells (known as the C cells) that produce calcitonin, a hormone that does not contain iodine.

ANAPLASTIC. The anaplastic type of thyroid cancer (2% of all thyroid cancers), is the fastest growing, most aggressive type.

Risk Factors

Risk factors associated with the development of thyroid cancer include:

- gender – thyroid cancers are diagnosed in women three times as often as in men
- age – most cases of thyroid cancer are diagnosed between the ages of 20 and 55 years



A gamma scan of the human thyroid gland revealing cancer. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

- diet – consumption of diets low in iodine have been linked to the development of papillary and follicular thyroid cancers
- radiation exposure – radiation exposure, particularly exposure in childhood, places individuals at higher risk for the development of thyroid cancer
- heredity – about 20% of cases of medullary thyroid cancer are related to an inherited genetic abnormality; Individuals with other inherited diseases such as Gardner syndrome, Cowden disease and familial adenomatous polyposis (FAP), appear to be at increased risk for the development of certain types of thyroid cancer.

Causes and symptoms

The exact cause of thyroid cancer is not known but as stated above, some risk factors have been identified. Radiation was used in the 1950s and 1960s to treat **acne** and to reduce swelling in infections of the tonsils, adenoids and lymph nodes. It has been proven that this exposure is a risk factor for thyroid cancer. In some areas of the world, **diets** are low in iodine. Papillary and follicular cancers occur more frequently in these areas. Iodine deficiency is not a large problem in the United States because iodine is added to table salt and other foods. Approximately 7% of thyroid cancers are caused by the alteration (mutation) of a gene called the RET oncogene, which can be inherited.

Symptoms of thyroid cancer are rare. Many thyroid tumors present as a painless lump in the neck. Some tumors are found during routine health-related checkups. The following are signs and symptoms of thyroid nodules.

- A lump or nodule that can be felt in the neck is the most frequent sign of thyroid cancer.

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- The lymph nodes in the neck may be swollen and the voice may become hoarse because the tumor presses on the nerves leading to the voice box.
- Some patients experience a tight or full feeling in the neck and have difficulty breathing or swallowing.

Diagnosis

Examination

A physician will carefully examine the neck and lymph nodes in the area if a thyroid tumor is suspected or if a patient complains of anterior neck **pain**, swelling, hoarseness or if a suspicious lump is present.

Tests

Physicians use several tests to confirm the suspicion of thyroid cancer, to identify the size and location of the lump and to determine whether the lump is noncancerous (benign) or cancerous (malignant).

A blood test called the thyroid stimulating hormone (TSH) test checks thyroid function.

The calcitonin test may be ordered to evaluate calcitonin levels in blood. Calcitonin is a hormone produced by the C cells (parafollicular cells) of the thyroid gland. The hormone is produced in excess when the parafollicular cells of the thyroid become cancerous. Results of this test are used to confirm the diagnosis of medullary thyroid. Another blood test, the carcinoembryonic antigen (CEA), test may be done if medullary thyroid cancer is suspected. CEA levels are usually high in patients with this type of thyroid cancer.

Computed tomography (CT) scan or ultrasonography (an ultrasound scan) are imaging tests used to produce a picture of the thyroid. A radiologist usually interprets the results of these tests within 24 hours. In ultrasonography, high-frequency sound waves are bounced off the thyroid. The pattern of echoes produced by these waves is converted into a computerized image on a television screen. This test can determine whether the lumps found in the thyroid are benign fluid-filled cysts or solid malignant tumors.

A nuclear medicine radioiodine scan is used to identify abnormal areas in the thyroid. For this test, the patient is given a very small amount of radioactive iodine that can either be swallowed or injected. Since the thyroid is the only gland in the body that absorbs iodine, the radioactive iodine accumulates there. An x-ray image is taken or an instrument called a scanner is used to identify areas in the thyroid that do not absorb iodine normally. These abnormal spots are called cold spots and further tests are performed to check whether the cold spots are benign or malignant tumors. If a significant amount of radioactive iodine is concentrated in the nodule, then it is termed "hot" and is usually benign. A radiologist interprets the results within a day.

An octreotide scan may be ordered to detect the spread of medullary thyroid cancer.

Other tests which may be ordered to assist in the diagnosis of thyroid cancer include **magnetic resonance imaging** (MRI) and **positron emission tomography (PET)** scans.

Procedures

The most accurate diagnostic tool for thyroid cancer is a biopsy. In this process, a sample of thyroid tissue is obtained and examined under a microscope by a pathologist. This usually takes a day. The tissue sample can be obtained either by drawing out a sample of tissue through a needle (such as a fine needle aspirate biopsy) or by surgical removal of the nodule (surgical biopsy). A needle biopsy takes a few minutes and can be done by a trained physician, usually a radiologist. The surgical biopsy is done by a surgeon under **general anesthesia** with the help of an anesthesiologist and takes a few hours. If thyroid cancer is diagnosed, further tests may be done to determine the stage of the disease and help doctors plan appropriate treatment.

Staging

The aggressiveness of each type of thyroid cancer is different. Cancer staging considers the size of the tumor, whether it has grown into surrounding lymph nodes and whether it has spread to distant parts of the body (metastasized). Age and general health status are also taken into account. The American Joint Commission on Cancer (AJCC) staging is summarized below for each thyroid cancer type.

PAPILLARY AND FOLLICULAR. In patients younger than 45 years:

- Stage I: Patients without evidence of cancer beyond the thyroid.
- Stage II: Patients with spread of cancer outside the thyroid gland to one or more distant sites.

In patients over 45:

- Stage I: Tumors are smaller than 2 cm (0.3 in).
- Stage II: Tumors are 2–4 cm (0.3–0.6 in) across but have not spread to adjacent lymph nodes or distant sites.
- Stage III: Tumors have spread locally to nearby lymph nodes or are larger than 4 cm (0.6 in) and have grown slightly outside of the thyroid but not into lymph nodes or distant sites.

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- Stage IV: Tumors have spread outside the thyroid area (distant metastases).

In the case of Stage IV cancer, the places to which thyroid cancer often metastasizes are the lungs and bone.

MEDULLARY. The stages of medullary thyroid carcinomas for individuals at any age are the same as for papillary or follicular thyroid cancer in people over age 45.

ANAPLASTIC. All cases of anaplastic thyroid cancer are considered Stage IV because this type of cancer is extremely aggressive.

Treatment

Papillary thyroid cancer can be treated successfully. Follicular thyroid cancer also has a good cure rate but may be difficult to control if the cancer invades blood vessels or spreads to nearby structures in the neck. Medullary thyroid cancers are more difficult to control because they often spread to other parts of the body. Anaplastic thyroid cancer is the fastest growing and tends to respond poorly to all treatments.

Like most cancers, cancer of the thyroid is best treated when it is found early by a primary physician. Treatment depends on the type of cancer and its stage. Several treatment modalities are used in the treatment of thyroid cancer including surgical removal of the tumor, external beam **radiation therapy**, thyroid hormone therapy, **chemotherapy** and radioactive hormone therapy. Using a combination of these therapies typically leads to optimal results.

Surgery

Surgical removal is the usual treatment if the cancer has not spread to distant parts of the body. It is the primary treatment for early stage papillary, follicular, and medullary thyroid cancers. The surgeon may remove the side or lobe of the thyroid where the cancer is found (**lobectomy**) or all of it (total **thyroidectomy**). If the adjoining lymph nodes are affected, they may also be removed during surgery.

Radiation/radioactive iodine therapy

For papillary and follicular thyroid cancers, radioactive iodine may be used in addition to surgery. In this treatment, the patient is asked to swallow a drink containing radioactive iodine. Because the thyroid cells take up iodine, the radioactive iodine collects in any thyroid tissue remaining in the body and kills the cancer cells. External beam radiation may be used if the radioactive iodine is unsuccessful.

For medullary cancers, radioactive iodine is not used. External beam radiation may be used as a palliative therapy. (A palliative therapy is one intended to make the patient more comfortable, not to cure the cancer.)

Hormone therapy

Removal of the thyroid gland causes levels of thyroid hormones to decrease. The pituitary gland then produces TSH, which normally stimulates the thyroid gland to make thyroid hormone. TSH stimulates thyroid cells to grow, and most likely promotes thyroid cancer growth. Hormone therapy uses hormones after surgery to stop this growth and the formation of new cancerous thyroid cells. To prevent cancerous growth, the natural hormones produced by the thyroid are taken in the form of a pill. This maintains normal hormone levels and inhibits the pituitary gland from making TSH. If the cancer has spread to other parts of the body and surgery is not possible, hormone treatment is aimed at killing or slowing the growth of cancer cells throughout the body.

Chemotherapy

For advanced thyroid cancers for which surgery was not an option or that have not responded well to other treatments, chemotherapy may be used. There is no standard chemotherapeutic regimen for advanced papillary, follicular, and anaplastic thyroid cancers. Clinical studies are ongoing for patients with these cancers. Anaplastic thyroid cancer may show an increased local response to the chemotherapeutic agent, doxorubicin, which is used as a radiation sensitizer in combination with hyperfractionated radiation therapy. Paclitaxel may provide some palliative benefit. Patients with anaplastic thyroid cancer may be eligible for ongoing clinical trials.

Prognosis

As of 2009, the ten year overall survival rates for individuals with thyroid cancer by type of cancer are:

- Papillary – 93%
- Follicular - 85%
- Medullary – 75%
- Anaplastic/undifferentiated carcinomas – 14%

Prevention

It is not possible to prevent this disease completely because most people with thyroid cancer have no known risk factor. The risk for radiation-related thyroid cancer can be reduced by avoiding radiation to the neck when possible. Inherited cases of medullary thyroid cancer can be prevented. If a family member has had this disease,

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other family members can be tested and treated early. Carriers of the RET mutation may want to consider a prophylactic thyroidectomy at an early age. The National Cancer Institute recommends that every one or two years, a doctor examine anyone who has received radiation to the head and neck during childhood. The neck and thyroid should be carefully examined for any lumps or enlargement of nearby lymph nodes. Ultrasound may be used to screen for the disease in people at risk for thyroid cancer.

ORGANIZATIONS

National Cancer Institute (National Institutes of Health), NCI Office of Communications and Education, 6116 Executive Blvd. Suite 300, Bethesda, MD, 20892-8322, (800) 4-CANCER (422-6237), cancergovstaff@mail.nih.gov, http://www.cancer.gov/.

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Thyroid drugs *see* **Thyroid hormones**

Thyroid function tests

Definition

Thyroid function tests are blood tests used to evaluate how effectively the thyroid gland is working. These tests include the thyroid-stimulating hormone test (TSH), the thyroxine test (T_4), the triiodothyronine test (T_3), the thyroxine-binding globulin test (TBG), the triiodothyronine resin uptake test (T_3RU), and the long-acting thyroid stimulator test (LATS).

Purpose

Thyroid function tests are used to:

- help diagnose an underactive thyroid (hypothyroidism) and an overactive thyroid (hyperthyroidism)
- evaluate thyroid gland activity
- monitor response to thyroid therapy

Precautions

Thyroid treatment must be stopped one month before blood is drawn for a thyroxine (T_4) test.

Steroids, propranolol (Inderal), cholestyramine (Questran), and other medications that may influence thyroid activity are usually stopped before a triiodothyronine (T_3) test.

Estrogens, anabolic steroids, phenytoin, and thyroid medications may be discontinued prior to a thyroxine-binding globulin (TBG) test. The laboratory analyzing the blood sample must be told if the patient cannot stop taking any of these medications. Some patients will be told to take these medications as usual so that the doctor can determine how they affect thyroxine-binding globulin.

Patients are asked not to take estrogens, androgens, phenytoin (Dilantin), salicylates, and thyroid medications before having a triiodothyronine resin uptake (T_3RU) test.

Prior to taking a long-acting thyroid stimulant (LATS) test, the patient will probably be told to stop taking all drugs that could affect test results.

Description

Most doctors consider the sensitive thyroid-stimulating hormone (TSH) test to be the most accurate measure of thyroid activity. By measuring the level of TSH, doctors can determine even small problems in thyroid activity. Because this test is sensitive, abnormalities in thyroid function can be determined before a patient complains of symptoms.

TSH "tells" the thyroid gland to secrete the hormones thyroxine (T_4) and triiodothyronine (T_3). Before TSH tests were used, standard blood tests measured levels of T_4 and T_3 to determine if the thyroid gland was working properly. The triiodothyrine (T_3) test measures the amount of this hormone in the blood. T_3 is normally present in very small amounts, but has a significant impact on metabolism. It is the active component of thyroid hormone.

The thyroxine-binding globulin (TBG) test measures blood levels of this substance, which is manufactured in the liver. TBG binds to T_3 and T_4, prevents the kidneys from flushing the hormones from the blood, and releases them when and where they are needed to regulate body functions.

The triiodothyronine resin uptake (T_3RU) test measures blood T_4 levels. Laboratory analysis of this test takes several days, and it is used less often than tests whose results are available more quickly.

The long-acting thyroid stimulator (LATS) test shows whether blood contains long-acting thyroid stimulator. Not normally present in blood, LATS causes the thyroid to produce and secrete abnormally high amounts of hormones.

It takes only minutes for a nurse or medical technician to collect the blood needed for these blood tests. A needle is inserted into a vein, usually in the forearm,

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and a small amount of blood is collected and sent to a laboratory for testing. The patient will usually feel minor discomfort from the "stick" of the needle.

Preparation

There is no need to make any changes in diet or activities. The patient may be asked to stop taking certain medications until after the test is performed.

Aftercare

Warm compresses can be used to relieve swelling or discomfort at the site of the puncture. With a doctor's approval, the patient may start taking medications stopped before the test.

Normal results

Not all laboratories measure or record thyroid hormone levels the same way. Each laboratory will provide a range of values that are considered normal for each test. Some acceptable ranges are listed below.

TSH

Normal TSH levels for adults are 0.5–5.0 mU/L.

T_4

Normal T_4 levels are:

- 10.1–2.0 ug/dL at birth
- 7.5–16.5 ug/dL at one to four months
- 5.5–14.5 ug/dL at four to 12 months
- 5.6–12.6 ug/dL at one to six years
- 4.9–11.7 ug/dL at 10 years
- 4–11 ug/dL at 10 years and older.

Levels of free T_4 (thyroxine not attached to TBG) are higher in teenagers than in adults.

Normal T_4 levels do not necessarily indicate normal thyroid function. T_4 levels can register within normal ranges in a patient who:

- is pregnant
- has recently had contrast x rays
- has nephrosis or cirrhosis

T_3

Normal T_3 levels are:

- 90–170 ng/dL at birth
- 115–190 ng/dL at six to12 years
- 110–230 ng/dL in adulthood

TBG

Normal TBG levels are:

- 1.5–3.4 mg/dL or 15–34 mg/L in adults
- 2.9–5.4 mg/dL or 29–54 mg/L in children.

T_3RU

Between 25% and 35% of T_3 should bind to or be absorbed by the resin added to the blood sample. The test indirectly measures the amount of thyroid binding globulin (TBG) and thyroid-binding prealbumin (TBPA) in the blood.

LATS

Long-acting thyroid stimulator is found in the blood of only 5% of healthy people.

Abnormal results

T_4

Elevated T_4 levels can be caused by:

- acute thyroiditis
- birth control pills
- clofibrate (Altromed-S)
- contrast x rays using iodine
- estrogen therapy
- heparin
- heroin
- hyperthyroidism
- pregnancy
- thyrotoxicosis
- toxic thyroid adenoma

Cirrhosis and severe non-thyroid disease can raise T_4 levels slightly.

Reduced T_4 levels can be caused by:

- anabolic steroids
- androgens
- antithyroid drugs
- cretinism
- hypothyroidism
- kidney failure
- lithium (Lithane, Lithonate)
- myxedema
- phenytoin
- propranolol

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KEY TERMS

Acidosis—A condition in which blood and tissues are unusually acidic.

Acromegaly—A disorder in which growth hormone (a chemical released from the pituitary gland in the brain) causes increased growth in bone and soft tissue. Patients have enlarged hands, feet, noses, and ears, as well as a variety of other disturbances throughout the body.

Acute intermittent porphyria—An inherited disease affecting the liver and bone marrow. The liver overproduces a specific acid and the disease is characterized by attacks of high blood pressure, abdominal colic, psychosis, and nervous system disorders.

Anabolic steroids—Protein-building compounds used to treat certain anemias and cancers, strengthen bones, and stimulate weight gain and growth. Anabolic steroids are sometimes used to illegally enhance athletic performance.

Cholestyramine (Questran)—A drug used to bind with bile acids and prevent their reabsorption and to stimulate fat absorption.

Cirrhosis—Progressive disease of the liver, associated with failure in liver cell functioning and blood flow in the liver. Tissue and cells are damaged, the liver becomes fibrous, and jaundice can result.

Clofibrate (Altromed-S)—Medication used to lower levels of blood cholesterol and triglycerides.

Cretinism—Severe hypothyroidism that is present at birth and characterized by severe mental retardation.

Graves' disease—The most common form of hyperthyroidism, characterized by bulging eyes, rapid heart rate, and other symptoms.

Heparin—An organic acid that occurs naturally in the body and prevents blood clots. Heparin is also made synthetically and can be given as a treatment when required.

Hepatitis—Inflammation of the liver.

Hyperthyroidism—Overactive thyroid gland; symptoms include irritability/nervousness, muscle weakness, tremors, irregular menstrual periods, weight loss, sleep problems, thyroid enlargement, heat sensitivity, and vision/eye problems. The most

T_3

Although T_3 levels usually rise and fall when T_4 levels do, T_3 toxicosis causes T_3 levels to rise while T_4 levels remain normal. T_3 toxicosis is a complication of:

- Graves' disease
- toxic adenoma
- toxic nodular goiter

T_3 levels normally rise when a woman is pregnant or using birth-control pills. Elevated T_3 levels can also occur in patients who use estrogen or **methadone** or who have:

- certain genetic disorders that do not involve thyroid malfunction
- hyperthyroidism
- thyroiditis
- T_3 thyrotoxicosis
- toxic adenoma

Low T_3 levels may be a symptom of:

- acute or chronic illness
- hypothyroidism
- kidney or liver disease
- starvation

Decreased T_3 levels can also be caused by using:

- anabolic steroids
- androgens
- phenytoin
- propranolol
- reserpine (Serpasil)
- salicylates in high doses

TBG

TBG levels, normally high during **pregnancy**, are also high in newborns. Elevated TBG levels can also be symptoms of:

- acute hepatitis
- acute intermittent porphyria
- hypothyroidism
- inherited thyroid hormone abnormality

TBG levels can also become high by using:

- anabolic steroids
- birth control pills
- anti-thyroid agents
- clofibrate
- estrogen therapy
- phenytoin

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common type of this disorder is called Graves' disease.

Hypoproteinemia—Abnormally low levels of protein in the blood.

Hypothyroidism—Underactive thyroid gland; symptoms include fatigue, difficulty swallowing, mood swings, hoarse voice, sensitivity to cold, forgetfulness, and dry/coarse skin and hair.

Lithium (Lithane, Lithromate)—Medication prescribed to treat manic (excited) phases of bipolar disorder.

Myxedema—Hypothyroidism, characterized by thick, puffy features, an enlarged tongue, and lack of emotion.

Nephrosis—Any degenerative disease of the kidney (not to be confused with nephritis, an inflammation of the kidney due to bacteria).

Nodular goiter—An enlargement of the thyroid (goiter) caused when groups of cells collect to form nodules.

Phenytoin (Dilantin)—Anti-convulsive medication used to treat seizure disorders.

Propranolol (Inderal)—Medication commonly prescribed to treat high blood pressure; is a beta-adrenergic blocker and can also be used to treat irregular heartbeat, heart attack, migraine, and tremors.

Reserpine (Serpasil)—A drug prescribed for high blood pressure.

Salicylates—Aspirin and certain other nonsteroidal anti-inflammatory drugs (NSAIDs).

Thiazides—A group of drugs used to increase urine output.

Thyroid gland—A butterfly-shaped gland in front and to the sides of the upper part of the windpipe; influences body processes like growth, development, reproduction, and metabolism.

Thyroiditis—Inflammation of the thyroid gland.

Thyrotoxicosis—A condition resulting from high levels of thyroid hormones in the blood.

Toxic thyroid adenoma—Self-contained concentrations of thyroid tissue that may produce excessive amounts of thyroid hormone.

- salicylates in high doses
- thiazides
- thyroid medications
- warfarin (Coumadin)

TBG levels can be raised or lowered by inherited **liver disease** whose cause is unknown.

Low TBG levels can be a symptom of:

- acromegaly
- acute hepatitis or other acute illness
- hyperthyroidism
- kidney disease
- malnutrition
- marked hypoproteinemia
- uncompensated acidosis

T_3RU

A high degree of resin uptake and high thyroxine levels indicate **hyperthyroidism**. A low degree of resin uptake, coupled with low thyroxine levels, is a symptom of **hypothyroidism**.

Thyroxine and triiodothyronine resin uptake that are not both high or low may be a symptom of a thyroxine-binding abnormality.

LATS

Long-acting thyroid stimulator, not usually found in blood, is present in the blood of 80% of patients with Graves' disease. It is a symptom of this disease whether or not symptoms of hyperthyroidism are detected.

ORGANIZATIONS

American Thyroid Association, Inc., 6066 Leesburg Pike, Suite 550, Falls Church, VA, 22041, (703) 998-8890, (703) 998-8893, (800) THYROID, thyroid@thyroid.org, http://www.thyroid.org.

Maureen Haggerty

Thyroid gland removal *see* **Thyroidectomy**

Thyroid hormones

Definition

Thyroid hormones are artificially made hormones that make up for a lack of natural hormones produced by the thyroid gland.

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Purpose

The thyroid gland, a butterfly-shaped structure in the lower part of the neck, normally produces a hormone called thyroxine. This hormone controls the rate of metabolism – all the physical and chemical processes that occur in cells to allow growth and maintain body functions. When the thyroid gland does not produce enough thyroxine, body processes slow down. People with underactive thyroid glands feel unusually tired and may gain weight even though they eat less. They may also have trouble staying warm and may have other symptoms, such as dry skin, dry hair, and a puffy face. By making up for the lack of natural thyroxine and bringing the rate of metabolism back to normal, artificially made thyroid hormone improves these symptoms.

Thyroid hormones also may be used to treat **goiter** (enlarged thyroid gland) and certain types of **thyroid cancer**.

Description

Thyroid hormones, also called thyroid drugs, are available only with a physician's prescription. They are sold in tablet form. A commonly used thyroid hormone is levothyroxine (Synthroid, Levoxyl, Levothroid).

Recommended dosage

For adults and teenagers, the usual starting dose of levothyroxine tablets is 0.0125 mg (12.5 micrograms) to 0.05 mg (50 micrograms) per day. The physician who prescribes the medicine may gradually increase the dose over time.

For children, the dose depends on body weight and must be determined by a physician.

Taking thyroid hormones exactly as directed is very important. The physician who prescribes the medicine will figure out exactly how much of the medicine a patient needs. Taking too much or too little can make the thyroid gland overactive or underactive.

This medicine should be taken at the same time every day.

Precautions

People who take thyroid hormones because their thyroid glands do not produce enough natural hormone may need to take the medicine for the rest of their lives. Seeing a physician regularly while taking this medicine is important. The physician will make sure that the medicine is working and that the dosage is correct.

In patients with certain kinds of heart disease, this medicine may cause chest pains and **shortness of breath** during **exercise**. People who have this problem should be careful not to exert themselves too much.

KEY TERMS

Adrenal glands—A pair of glands located next to the kidneys. The adrenal glands produce hormones that control many body functions.

Hormone—A chemical that is produced in one part of the body and then travels through the bloodstream to another part of the body where it has its effect.

Pituitary gland—A pea-sized gland at the base of the brain that produces many hormones that affect growth and body functions.

Anyone who is taking thyroid hormones should be sure to tell the health care professional in charge before having any surgical or dental procedures or receiving emergency treatment.

This medicine is safe to take during **pregnancy**, but the dosage may need to be changed. Women who are pregnant should check with their physicians to make sure they are taking the proper dosage.

Anyone who has had unusual reactions to thyroid hormones in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

Before using thyroid hormones, people with any of these medical problems should make sure their physicians are aware of their conditions:

- heart disease
- high blood pressure
- hardening of the arteries
- diabetes
- history of overactive thyroid
- underactive adrenal gland
- underactive pituitary gland

Side effects

This medicine usually does not cause side effects if the dosage is right. Certain symptoms may be signs that the dose needs to be changed. Check with a physician if any of these symptoms occur:

- headache
- fever
- diarrhea
- vomiting

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- changes in appetite
- weight loss
- changes in menstrual period
- tremors of the hands
- leg cramps
- increased sensitivity to heat
- sweating
- irritability
- nervousness
- sleep problems

Other side effects are possible. Anyone who has unusual symptoms while taking thyroid hormones should get in touch with his or her physician.

Interactions

Thyroid hormones may interact with other medicines. This may increase or decrease the effects of the thyroid medicine and may interfere with treatment. Anyone who takes thyroid hormones should not take any other prescription or nonprescription (over-the-counter) medicines without the approval of his or her physician. Among the drugs that may interact with thyroid hormones are:

- Medicine for colds, hay fever, and other allergies
- Medicine for asthma and other breathing problems
- Medicine for diabetes
- Blood thinners
- Amphetamines
- Diet pills (appetite suppressants)
- Cholesterol-lowering drugs such as cholestyramine (Questran) and colestipol (Colestid).

Resources

OTHER

Ogbru, Omudhome. "Levothyroxine Sodium, Synthroid, Levoxyl, Levothroid, Unithroid." MedicineNet.com. http://www.medicinenet.com/levothyroxine_sodium/article.htm (accessed December 2, 2010).

Nancy Ross-Flanigan

Thyroid nuclear medicine scan

Definition

A thyroid nuclear medicine scan is a diagnostic procedure to evaluate the thyroid gland, which is located in the front of the neck and controls the body's metabolism. A radioactive substance that concentrates in the thyroid is taken orally or injected into a vein (intravenously), or both. A special camera is used to take an image of the distribution of the radioactive substance in and around the thyroid gland. This is interpreted to evaluate thyroid function and to diagnose abnormalities.

Purpose

A thyroid scan may be ordered by a physician when the gland becomes abnormally large, especially if the enlargement is greater on one side, or when hard lumps (nodules) are felt. The scan can be helpful in determining whether the enlargement is caused by a diffuse increase in the total amount of thyroid tissue or by a nodule or nodules.

When other laboratory studies show an overactive thyroid (**hyperthyroidism**) or an underactive thyroid (**hypothyroidism**), a radioactive iodine uptake scan is often used to confirm the diagnosis. It is frequently done along with a thyroid scan.

Precautions

Women who are pregnant should not have this test.

Description

This test is performed in a radiology facility, either in an outpatient x ray center or a hospital department. Most often, the patient is given the radioactive substance in the form of a tasteless liquid or capsule. It may be injected into a vein (intravenously) in some instances. Images will be taken at a specified amount of time after this, depending on the radioisotope used. Most often, scanning is done 24 hours later, if the radioisotope is given orally. If it is given intravenously, the scan is performed approximately 20 minutes later.

For a thyroid scan, the patient is positioned lying down on his or her back, with the head tilted back. The radionuclide scanner, also called a gamma camera, is positioned above the thyroid area as it scans. This takes 30-60 minutes.

The uptake study may be done with the patient sitting upright in a chair or lying down. The procedure is otherwise the same as described for the thyroid scan. It takes approximately 15 minutes. There is no discomfort involved with either study.

A thyroid scan may also be referred to as a thyroid scintiscan. The name of the radioactive substance used may be incorporated and the study called a technetium thyroid scan or an iodine thyroid scan. The radioactive iodine uptake scan may be called by its initials, an RAIU test, or an iodine uptake test.

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KEY TERMS

Radioisotope—A radioactive or radiation-emitting form of an element.

Radionuclide—A substance that emits radiation as it disintegrates.

Preparation

Certain medications can interfere with iodine uptake. These include certain **cough** medicines, some **oral contraceptives**, and thyroid medications. The patient is usually instructed to stop taking these medicines for a period of time before the test. This period may range from several days up to three to four weeks, depending on the amount of time the medicine takes to clear from the body.

Other nuclear medicine scans and x-ray studies using contrast material performed within the past 60 days may affect this test. Therefore, patients should tell their doctors if they have had either of these types of studies before the thyroid scan is begun, to avoid inaccurate results.

Some institutions prefer that the patient have nothing to eat or drink after midnight on the day before the radioactive liquid or capsule is to be taken. A normal diet can usually be resumed two hours after the radioisotope is taken. Dentures, jewelry, and other metallic objects must be removed before the scanning is performed. No other physical preparation is needed.

The patient should understand that there is no danger of radiation exposure to themselves or others. Only very small amounts of radioisotope are used. The total amount of radiation absorbed is often less than the dose received from ordinary x rays. The scanner or camera does not emit any radiation, but detects and records it from the patient.

Aftercare

No **isolation** or special precautions are needed after a thyroid scan. The patient should check with his or her physician about restarting any medications that were stopped before the scan.

Risks

There are no risks with this procedure.

Normal results

A normal scan will show a thyroid of normal size, shape, and position. The amount of radionuclide uptake by the thyroid will be normal according to established laboratory figures. There will be no areas where radionuclide uptake is increased or decreased.

Abnormal results

An area of increased radionuclide uptake may be called a hot nodule or "hot spot." This means that a benign growth is overactive. Despite the name, hot nodules are unlikely to be caused by **cancer**.

An area of decreased radionuclide uptake may be called a cold nodule or "cold spot." This indicates that this area of the thyroid gland is underactive. A variety of conditions, including cysts, nonfunctioning benign growths, localized inflammation, or cancer may produce a cold spot.

A thyroid nuclear medicine scan is rarely sufficient to establish a clear diagnosis. Frequently, the information revealed will need to be combined with data from other studies to determine the problem.

Resources

BOOKS

Schiepers, Christiaan, ed. *Diagnostic Nuclear Medicine*. 2nd ed. Berlin: Springer, 2006.

Ellen S. Weber, MSN

Thyroid sonogram *see* **Thyroid ultrasound**

Thyroid storm *see* **Hyperthyroidism**

Thyroid ultrasound

Definition

Thyroid ultrasound is an imaging technique used for diagnosing suspected thyroid disease. It uses harmless, high-frequency sound waves to form an image. The sound waves are reflected by thyroid tissue to form a picture of internal structures. It is not invasive and involves no radiation.

Purpose

The thyroid gland is an organ located in front of the neck. It plays an important role in controlling the body's metabolism. Most thyroid ultrasounds are performed to evaluate a small lump (nodule) in the thyroid found during a **physical examination** or found by a radionuclide study (thyroid scan). The ultrasound can establish if the nodule is a cyst, which is an abnormal lump that contains fluid, or a solid mass. Cysts are almost always noncancerous

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(benign), although in some cases the fluid may be taken out for additional testing.

If there are several masses or nodules, this indicates the presence of enlargement of the thyroid gland (**goiter**). If there is only one mass, it may be cancerous and needs further evaluation. Specialized thyroid ultrasounds, such as color Doppler flow studies, can add valuable information. By showing an image of the blood circulation in the gland, this study can assess some ambiguous masses in greater detail, to further refine diagnosis. In some cases, a needle will be inserted to remove some tissue from the mass for evaluation in a laboratory (needle biopsy). Ultrasound is used during this procedure to help the physician guide the needle to the mass that needs to be evaluated.

Thyroid ultrasound can measure the size of the thyroid with great precision. Ultrasound studies may be done periodically to assess the response of the thyroid gland to medical therapy. An enlarged gland or a benign nodule should decrease in size when appropriate thyroid medication is taken.

Patients who have received therapeutic radiation to the head or neck may be monitored at regular intervals using thyroid ultrasound. The radiation puts these patients at higher risk for developing **thyroid cancer** or other abnormalities. In the early stages, these conditions may not cause symptoms or be apparent during a physical examination. They can, however, be detected by ultrasound.

Certain invasive medical procedures may be performed under ultrasound guidance. This is because ultrasound allows the physician to observe a needle as it enters body tissue below the skin. This is useful to direct the removal of fluid from a cyst (aspiration) or needle biopsy. Medications to treat recurrent cysts may be administered directly to the area using ultrasound guidance.

Precautions

Thyroid ultrasound is safe for people of all ages. It is the preferred procedure to evaluate suspected disease in pregnant women because no radiation is involved.

Description

The study may be done in an outpatient facility or in a hospital department. The patient lies on his or her back. A pillow or rolled towel is placed under the shoulders and upper back, allowing the head to tilt back (hyperextend). A gel that enhances sound transmission is spread over the thyroid area. The technologist then gently places a transducer, an instrument about the size of an electric shaver, against the skin. It is moved over the thyroid area. The images from reflected sound waves appear on a monitor screen. There is no discomfort involved with this study. The examination takes 15–30 minutes.

Preparation

Some facilities recommend limiting food and drink for one hour before the study to prevent discomfort. No other preparation is needed.

Aftercare

No special restrictions or procedures are needed after a thyroid ultrasound.

Risks

There are no risks with this procedure.

Normal results

A normal study would reveal a thyroid gland of normal size, shape, position, and uniform texture.

Abnormal results

A thyroid ultrasound may reveal cysts, solid masses that may or may not be cancerous, or an enlarged thyroid gland (goiter). In many cases, the ultrasound can establish a diagnosis. Sometimes the information revealed will need to be combined with data from other studies to determine the problem.

Resources

PERIODICALS

Rifat, Sami F., and Mack T. Ruffin. "Management of Thyroid Nodules." *American Family Physician* 50 (September 15, 1994): 785-791.

Ellen S. Weber, MSN

Thyroid x ray *see* **Thyroid nuclear medicine scan**

Thyroidectomy

Definition

Thyroidectomy is a surgical procedure in which all or part of the thyroid gland is removed. The thyroid gland is located in the forward part of the neck (anterior) just under the skin and in front of the Adam's apple.

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Purpose

All or part of the thyroid gland may be removed to correct a variety of abnormalities of the gland. If the patient has a **goiter** (an enlargement of the thyroid gland, causing a swelling in the front of the neck), it may cause difficulties with swallowing or breathing. **Hyperthyroidism** (over-functioning of the thyroid gland) produces hypermetabolism (abnormally increased use of oxygen, nutrients, and other materials). If medication cannot adequately treat this condition, or if the patient is a child or pregnant, the thyroid gland must be removed. Both cancerous tumors and noncancerous tumors (frequently called nodules) can occur and they must be removed, in addition to some or all of the thyroid gland.

Precautions

There are definite risks associated with the procedure. Therefore, the thyroid gland should be removed only if there is a pressing reason or medical condition that requires it.

Description

Thyroidectomy is an operative procedure done most commonly by a general surgeon, or occasionally by an otolaryngologist, in the operating room of a hospital. The operation begins when an anesthesiologist puts the patient to sleep. The anesthesiologist injects drugs into the patient's veins and then places an airway tube in the windpipe to ventilate (provide air for) the patient. The surgeon makes an incision in the front of the neck where a tight-fitting necklace would rest. He locates and takes care not to injure the parathyroid glands and the recurrent laryngeal nerves, while freeing the thyroid gland from these surrounding structures. The blood supply to the portion of the thyroid gland that is to be removed is clamped off. Then all or part of the gland is removed. If **cancer** is present, all, or almost all, of the gland is removed. If other diseases or a nodule is present, the surgeon may remove only part of the gland. The total amount of thyroid gland removed depends upon the thyroid disease being treated. A drain (a soft plastic tube that drains fluid out of the area) may be placed before the incision is closed. The incision is closed either with sutures (stitches) or metal clips. A dressing is placed over the incision and the drain, if one is used.

Patients generally stay in the hospital one to four days after completion of the operation.

Preparation

Before a thyroidectomy is performed, a variety of tests and studies are usually required to determine the nature of the thyroid disease. Laboratory analysis of blood determines the levels of active thyroid hormone circulating in the body. Sonograms and **computed tomography scans** (CT scans) help to determine the size of the thyroid gland and location of abnormalities. A **thyroid nuclear medicine scan** assesses the function of the gland. A needle biopsy of an abnormality or aspiration (removal by suction) of fluid from the thyroid gland may also be done to help determine the diagnosis.

If the diagnosis is hyperthyroidism, the patient may be asked to take antithyroid medication or iodides before the operation; or continued treatment with antithyroid drugs may be the treatment of choice. Otherwise, no other special procedure must be followed prior to the operation.

KEY TERMS

Endocrinologist—A physician who specializes in treating patients who have diseases of the thyroid, parathyroid, adrenal glands, and/or the pancreas.

Hyperthyroidism—Abnormal over-functioning of the thyroid glands. Patients are hypermetabolic, lose weight, are nervous, have muscular weakness and fatigue, sweat more, and have increased urination and bowel movements. This is also called thyrotoxicosis.

Hypothyroidism—Abnormal under-functioning of the thyroid gland. Patients are hypometabolic, gain weight, and are sluggish.

Recurrent laryngeal nerve—A nerve which lies very near the parathyroid glands and serves the larynx or voice box.

Aftercare

The incision requires little to no care after the dressing is removed. The area may be bathed gently with a mild soap. The sutures or the metal clips are removed three to seven days after the operation.

Risks

As with all operations, patients who are obese, smoke, or have poor **nutrition** are at greater risk for developing complications related to the general anesthetic itself.

Hoarseness or voice loss may develop if the recurrent laryngeal nerve was injured or destroyed during the operation. This is more apt to occur in patients who have large goiters or cancerous tumors.

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Hypoparathyroidism (under-functioning of the parathyroid glands) can occur if the parathyroid glands are injured or removed at the time of the thyroidectomy.

Hypothyroidism (under-functioning of the thyroid gland) can occur if all or nearly all of the thyroid gland is removed. This may be intentional when the diagnosis is cancer. If the patient's thyroid levels remain high, he or she may be required to take thyroid replacement for the rest of his or her life.

The neck and the area surrounding the thyroid gland have a rich supply of blood vessels. Bleeding in the area of the operation may occur and be difficult to control or stop. Rarely is a blood **transfusion** required, although a hematoma (collection of blood) may develop. If this occurs, it may be life-threatening. As the hematoma enlarges, it may obstruct the airway and cause the patient to stop breathing. If a hematoma does develop in the neck, it may require drainage to clear the airway.

Wound infections can occur. If they do, the incision is drained, and there are usually no serious consequences.

Normal results

Most patients are discharged from the hospital one to four days after the procedure. Most resume their normal activities two weeks after the operation. Patients who have cancer may require subsequent treatment by an oncologist or a endocrinologist.

Resources

OTHER

"Thyroid Gland Removal." *ThriveOnline*. http://thriveonline.oxygen.com.

Mary Jeanne Krob, MD, FACS

Thyroiditis

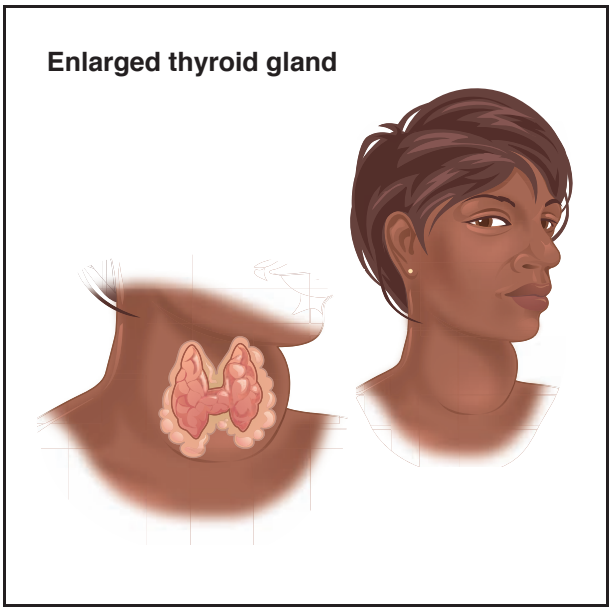
Definition

Thyroiditis is inflammation of the thyroid gland, a butterfly-shaped organ next to the windpipe.

Description

The thyroid is the largest gland in the neck. It produces, secretes, and stores thyroxine (T_4), a hormone that influences the metabolism of just about every body process.

When the thyroid gland is functioning properly, hormone release is carefully regulated. When bacteria or viruses invade and inflame the gland, T_4 surges into the bloodstream and raises hormone levels that then discourage the gland from creating more T_4. Eventually the hormone stores are exhausted, the thyroid loses its ability to manufacture T_4, and an underactive thyroid (**hypothyroidism**) results.



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The major cause of hypothyroidism, thyroiditis affects about 12 million people in the United States. This condition is more common in women than in men and usually develops between ages 30–50.

Hashimoto's disease

The most common type of thyroiditis is Hashimoto's disease, a painless disorder also known as:

- autoimmune thyroiditis
- chronic lymphocytic thyroiditis
- lymphadenoid goiter
- struma lymphomatosa

Hashimoto's disease can develop at any age, but is most common in middle-aged women. This immune system disorder runs in families, and affects about 5% of adults in the United States.

Hashimoto's disease slowly destroys thyroid tissue and robs the gland of its ability to change iodine into T_4. The condition progresses so gradually that many people who have it do not realize anything is wrong until the enlarged gland forms a **goiter**, a swelling seen and felt in the front of the neck. This may not happen

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until weeks or even years after an individual develops Hashimoto's.

Subacute thyroiditis

Much less common than Hashimoto's disease, subacute thyroiditis is a painful inflammation that develops suddenly in a patient who has had a viral infection, such as **mumps** or an upper respiratory illness. **Pain** radiates throughout the neck and patients feel ill and feverish. It may take as long as several months for normal thyroid function to resume.

Subacute thyroiditis is also called:

- DeQuervain's thyroiditis
- giant cell thyroiditis
- granulomatous thyroiditis
- subacute granulomatous thyroiditis

Silent thyroiditis

The least common of the three major types, silent thyroiditis is characterized by rigidity and slight enlargement of the thyroid gland. Postpartum thyroiditis, a form of silent thyroiditis, develops in 5–9% of all women who have recently given birth. Postpartum thyroiditis develops within a year of the baby's birth and disappears within six months.

Acute thyroiditis

Caused by acute infection, this rare disease is a medical emergency. A patient who has acute thyroiditis has a high **fever** and feels very ill. The neck is red, hot, and very tender.

Causes and symptoms

Hashimoto's disease

Hashimoto's disease develops when the immune system attacks the thyroid gland. It may be related to such hormone-related (endocrine system) disorders as:

- Addison's disease. This condition, caused by malfunction of the adrenal gland, is characterized by weakness, loss of weight and appetite, and increased sensitivity to cold.
- Diabetes mellitus. This metabolic disorder is caused by a lack of insulin production or by the body's inability to process insulin.
- Graves' disease. This disease is the most common form of hyperthyroidism.
- Vitiligo. This is a noncancerous skin disease characterized by unpigmented patches of skin.

Being female and having a family history of Hashimoto's thyroiditis increases the likelihood of developing the disease. Its symptoms include:

- constipation
- fatigue
- goiter or enlarged neck
- inability to tolerate cold temperatures
- weight gain, some patients' faces swell and their joints stiffen.

Subacute thyroiditis

Characterized by painful gland enlargement that is sometimes mistaken for a **sore throat** that may last for months, subacute thyroiditis often follows:

- influenza
- mumps
- upper respiratory infections
- viruses that produce cold symptoms and inflammation of the membrane that protects the brain (meningitis), inflammation of the sac that surrounds the heart (pericarditis), inflammation of the heart muscle (myocarditis), and other diseases

People who have subacute thyroiditis feel feverish, weak, and tired. The thyroid is sore to the touch. They may be nervous, sweat, and have trouble tolerating heat or swallowing. Symptoms of subacute thyroiditis also include:

- rapid heartbeat
- tremors
- weight loss.

Silent thyroiditis

The cause of silent thyroiditis is uncertain, but the condition is believed to be an immune-system disorder triggered by **childbirth**. Although silent thyroiditis is painless, the condition's other symptoms are similar to those of subacute thyroiditis. The thyroid gland enlarges only slightly, and the eyes do not bulge.

Diagnosis

Family physicians and endocrinologists usually base a diagnosis of thyroiditis on:

- blood levels of thyroid hormones, thyroid-stimulating hormone, and anti-thyroid antibodies
- personal and family medical history
- the appearance of a patient's thyroid gland

Thyroid antibodies present in 95% of patients with Hashimoto's thyroiditis make it possible to diagnose this disease without surgery or biopsy. A blood

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test that measures sedimentation rate, an indication of the extent of inflammation, is a useful tool for diagnosing subacute thyroiditis.

Treatment

Medical therapy for thyroiditis includes:

- antibiotics to fight infection
- high doses of aspirin to relieve inflammation
- hormones to suppress or replace thyroid function
- pain medications

Cortisone drugs are sometimes prescribed to reduce persistent inflammation. In rare instances, surgery can be used to drain infection or relieve pressure near the thyroid gland.

Hashimoto's disease

The goal of treatment for Hashimoto's disease is to prevent the thyroid gland from getting larger. Regular monitoring may be the only treatment indicated for patients whose gland is only slightly enlarged, and who show no signs of hormone deficiency. Levothyroxine (Synthroid) may be prescribed to correct hormone deficiency in a patient who has a large goiter.

Subacute thyroiditis

The goal of treatment for subacute thyroiditis is to relieve pain, reduce inflammation, and regulate **hyperthyroidism**. Bed rest and **beta blockers** (propranolol, naldolol) may be necessary until thyroid activity is controlled, and the patient may have to take:

- anti-inflammatory medication for several weeks
- high doses of aspirin
- other analgesics

If subacute thyroiditis continues for a long time, cortisone and thyroid hormone medication may be prescribed to relieve inflammation and allow the gland to rest. Glucocorticoids (prednisone) are prescribed for symptoms that do not respond to other treatment. The original problem often becomes more pronounced after these medications are discontinued.

Silent thyroiditis

Most patients who have silent thyroiditis don't need any treatment, but:

- bed rest and beta blockers are occasionally needed to regulate rapid heart beat
- inderal (propanolol) may be prescribed for brief periods of hyperthyroidism
- steroids may be prescribed for severe episodes of acute inflammation

Acute thyroiditis

Acute thyroiditis requires emergency treatment with **antibiotics** and surgery.

KEY TERMS

Addison's disease—A disease that results from a deficiency in adrenocortical hormones.

Diabetes mellitus—A disorder of the pancreas. This chronic disorder of carbohydrate metabolism results in hyperglycemia and glycosuria.

Goiter—An abnormal enlargement of the thryroid gland.

Graves' disease—Also called hyperthyroidism, this disease results from overactivity of the thyroid gland.

Subacute—An abnormal condition present in a person who appears to be clinically well.

Vitiligo—A benign skin disease that results in irregular patches of skin that are totally lacking in color.

Prognosis

Thyroiditis usually responds to treatment, and some patients recover normal thyroid function without treatment. Because permanent loss of thyroid function is a possibility and life-long thyroid replacement therapy may be necessary, regular medical monitoring should continue even after the patient has apparently recovered.

Hashimoto's disease

Some cases of Hashimoto's disease remain stable for years. Others slowly progress to hypothyroidism, which is treated with thyroid **hormone replacement therapy**.

Subacute thyroiditis

Most patients with subacute thyroiditis recover fully after no more than a few months. This condition occasionally recurs, but severe or long-term complications are rare.

Silent thyroiditis

Four of every five patients with silent thyroiditis recover completely within three months. The thyroid status of these patients should be evaluated within 12 months. Because silent thyroiditis recurs in 10% of

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patients within three years and may progress to hypothyroidism, medical monitoring should continue for three years after recovery appears complete.

Prevention

Flu shots or immunizations for **measles**, mumps, and **rubella** may help prevent conditions associated with subacute thyroiditis. There is no known way to prevent other forms of thyroiditis.

ORGANIZATIONS

American Thyroid Association, Inc., 6066 Leesburg Pike, Suite 550, Falls Church, VA, 22041, (703) 998-8890, (703) 998-8893, (800) THYROID, thyroid@thyroid.org, http://www.thyroid.org.

Maureen Haggerty

Thyrotoxicosis *see* **Hyperthyroidism**

Thyroxine-binding globulin test *see* **Thyroid function tests**

Thyroxine test *see* **Thyroid function tests**

TIA *see* **Transient ischemic attack**

Tic douloureux *see* **Trigeminal neuralgia**

Tick fever *see* **Relapsing fever**

Tilt table test

Definition

The tilt table test is a test in which a patient is positioned in a supine position and brought to a predetermined angle or angles from the horizontal position. Such positioning helps to determine the cause of any decrease in oxygen to the brain. Different types of drugs may also used in the testing process.

Purpose

The purpose of the tilt table test is to help determine appropriate therapy for individuals with **fainting** (syncope) and presyncope of unexplained origin.

Precautions

Precautions are few with the tilt table test. However, when any drug is used with this test, the appropriate precautions for that particular drug should be observed. For example, when isoproterenol or similiar drugs are used during the tilt table test, the taking of non-prescription drugs for **asthma**, **cough**, cold, or allergy; appetite suppressants; sleeping pills; or drugs containing **caffeine** should be made known to the physician prior to the test. Likewise, the physician should be informed of any **allergies** to any sympathomimetic drugs, including several of the diet pills on the market. The physician should be told of any serious heart-rhythm disorders.

KEY TERMS

Sympathomimetic—Denoting a drug that mimics the effects of stimulation of organs and structures by the sympathetic nervous system. The sympathetic nervous system pertains to the part of the nervous system originating in the thoracic and lumbar regions of the spinal cord. In general, it inhibits or opposes the physiological effects of another aspect of the nervous system, as in tending to reduce digestive secretions, speed up the heart, and contract the blood vessels.

Syncope—A loss of consciousness over a short period of time, caused by a temporary lack of oxygen in the brain.

Vertigo—The sensation of dizziness.

Description

Syncope is described as a pathological brief loss of consciousness caused by a temporary deficiency of oxygen in the brain. Previous studies have shown the effectiveness of tilt table testing in establishing the diagnosis of neurocardiogenic syncope, and in dictating therapy in patients with syncope of unknown origin. Despite its usefulness, small numbers of patients and brief followup reports have limited the majority of studies. Sensitivity-enhancing techniques, such as the administration of isoproterenol, are applied in specific cases to children and young adults to compensate for the otherwise low sensitivity (20-30%) observed in that population.

Preparation

In order for a patient to make informed decisions about any diagnostic test or procedure, there are important questions that need to be asked prior to the procedure. The information gained will be helpful for that patient in determining benefits, risks, and cost of the procedure, and alternatives. The patient should understand the purpose of the tilt table test, and the diagnosis that the physician is trying to confirm or rule out. If the tilt table test is positive, the patient should ask questions about the frequency of false-positive results for that

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particulare tilt table procedure, and should inquire about the next step in treatment.

Aftercare

After the procedure, the patient is asked to transfer from the supine position to a sitting position, and is observed for a short period of time. During this time and after several minutes in the sitting position, any symptoms of **dizziness** and vertigo are noted. When ready, the individual transfers from the sitting position to standing. After additional observation and taking of vital signs, the individual is allowed to go home.

Risks

Risks of the tilt table test are low, but do include significant changes in blood pressure while in the supine position, and any adverse reactions to any drugs administered during the tilt table test.

Normal results

Normal results of the tilt table test should help the physician in assessing what may or may not be the cause of the syncope.

Abnormal results

Abnormal results include any pathologic reactions to the position changes or sensitivity enhancing techniques, such as the administration of isoproterenol or other related drugs.

ORGANIZATIONS

American Medical Association, 515 N. State St., Chicago, IL, 60654, (800) 621-8335, http://www.ama-assn.org/.

Jeffrey P. Larson, RPT

Tinea cruris *see* **Ringworm**

Tinea pedis *see* **Athlete's foot**

Tingling *see* **Numbness and tingling**

Tinnitus

Definition

Tinnitus is hearing ringing, buzzing, or other sounds without an external cause. Patients may experience tinnitus in one or both ears or in the head.

Description

Tinnitus affects as many as 40 million adults in the United States. It is defined as either objective or subjective. In objective tinnitus, the doctor can hear the sounds, as well as the patient. Objective tinnitus is typically caused by tumors, turbulent blood flow through malformed vessels, or by rhythmic muscular spasms. Most cases of tinnitus are subjective, which means that only the patient can hear the sounds.

Causes and symptoms

Subjective tinnitus is frequently associated with **hearing loss**. About 90% of patients have sensorineural hearing loss; 5% suffer from conductive hearing loss; 5% have normal hearing. The causes of subjective tinnitus include:

- impacted ear wax
- ear infections
- hardening of the structures of the inner ear
- hearing loss related to age or excessive noise
- ototoxic medications, including aspirin, quinine, some diuretics, heavy metals, alcohol, and certain antibiotics
- Ménière's syndrome
- head trauma
- systemic diseases, including syphilis, hypertension, anemia, or hypothyroidism
- tumors of the ear

Diagnosis

Diagnosis of tinnitus includes a **physical examination** of the patient's head and neck. The doctor will use an otoscope to examine the ears for wax, infection, or structural changes. He or she will also use a stethoscope to listen to the blood vessels in the neck. Additional tests may include the following:

Tuning fork tests

The Rinne and Weber tests are commonly used to evaluate the type and severity of hearing loss. In the Weber test, the doctor holds a tuning fork against the patient's forehead or front teeth. If the hearing loss is sensorineural, the sound radiates to the ear with better hearing; if the hearing loss is conductive, the sound will be louder in the damaged ear. In the Rinne test, the tuning fork is placed alternately on the mastoid bone (behind the ear) and in front of the ear. In conductive hearing loss, bone conduction (BC) is greater than air conduction (AC). In sensorineural hearing loss, AC is greater than BC.

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KEY TERMS

Conductive hearing loss—Hearing loss caused by loss of function in the external or middle ear.

Meniere's syndrome—A disease of the inner ear, marked by recurrent episodes of loss of balance (vertigo) and roaring in the ears lasting several hours. Its cause is unknown.

Ototoxic—Damaging to the nerves controlling the senses of hearing and balance.

Sensorineural hearing loss—Hearing loss caused by damage to the nerves or parts of the inner ear governing the sense of hearing.

Diagnostic imaging

Magnetic resonance **angiography** or **venography** (MRA and MRV) can be used to evaluate malformations of the blood vessels. **Computed tomography scans** (CT scans) or **magnetic resonance imaging** scans (MRIs) can be used to locate tumors or abnormalities of the brain stem.

Blood tests

The doctor may order a **complete blood count** (CBC) with specific antibody tests to rule out **syphilis** or immune system disorders.

Treatment

Some cases of tinnitus can be treated by removal of the underlying cause. These include surgical treatment of impacted ear wax, tumors, head injuries, or malformed blood vessels; discontinuance of ototoxic medications; and antibiotic treatment of infections.

Subjective tinnitus, especially that associated with age-related hearing loss, can be treated with **hearing aids**, noise generators or other masking devices, **biofeedback**, antidepressant medications, or lifestyle modifications (elimination of **smoking**, coffee, and **aspirin**).

Alternative treatment

A variety of alternative therapies may be helpful in the treatment of tinnitus. Dietary adjustments, including the elimination of coffee and other stimulants, may be useful, since stimulants can make tinnitus worse. In addition, reducing the amount of fat and cholesterol in the diet can help improve blood circulation to the ears. Nutritional supplementation with vitamin C, vitamin E, B **vitamins**, **calcium**, magnesium, potassium, and essential fatty acids is also recommended. Gingko (*Gingko biloba*) is often suggested, since it is believed to enhance circulation to the brain. **Acupuncture** treatments may help decrease the level of tinnitus sounds the patient hears, and constitutional homeopathic treatment may also be effective.

Prognosis

The prognosis depends on the cause of the tinnitus and the patient's emotional response. Most patients with subjective tinnitus do not find it seriously disturbing, but about 5% have strong negative feelings. These patients are frequently helped by instruction in relaxation techniques.

Resources

BOOKS

McPhee, Stephen, and Maxine Papadakis. *Current Medical Diagnosis and Treatment, 2010*, 49th ed. New York: McGraw–Hill Medical, 2009.

Rebecca J. Frey, PhD

Tissue compatibility *see* **Tissue typing**

Tissue plasminogen activator *see* **Thrombolytic therapy**

Tissue typing

Definition

Tissue typing is a group of procedures that determines the type of histocompatibility antigens on a person's cells or tissues. This procedure is typically used prior to transplantation of tissues or organs.

Purpose

Tissue typing is done prior to transplantation to ensure as close a match as possible between the donor and the recipient. If the histocompatibility antigens do not match well, there is a much greater chance that the recipient will reject the donated tissue.

Histocompatibility antigens are molecules on the surface of all cells in the body. The specific types of histocompatibility antigens present on a person's cells determine their identity and distinguish each person. They are a "fingerprint."

Each person has a unique set of histocompatibility antigens. If the antigens on tissue or organs from a donor do not match that of the recipient, a rejection

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KEY TERMS

Antibody—A molecule produced by the body that is part of the immune response to attack antigens.

Antigen—A molecule that causes the body to produce an immunological response to attack the antigen.

Cornea—The transparent outer layer of the eye. It covers the iris and lens.

Lymphocyte—A class of white blood cells that are responsible for creating the immune response to antigens.

response can occur. The recipient's immune system will detect the difference between the two sets of antigen and start a rejection response to kill the donated tissue. Except in the case of identical twins, no two people are identical in terms of their histocompatibility antigen types. However, the closer two tissues come to matching, the more likely the recipient will accept the donated tissue or organ.

Human lymphocyte antigens (HLA) is the name given to the most commonly used histocompatibility antigens. The antigens can be grouped into two classes: class I antigens are found on almost all cells, and class II antigens are normally found only on B lymphocytes, macrophages, monocytes, dendritic cells, and endothelial cells.

Description

Generally, typing is performed on blood cells because they are an easy sample to obtain. Blood is withdrawn from a vein in the forearm, and the cells are separated. There are a number of different techniques used to identify the antigens on the cells. Typically, specific antibodies react with the cells. Each antibody preparation is specific for one histocompatibility antigen. If the antigen is present, the antibody will bind to it. Laboratory instruments are used to detect antibody binding to the cells. Class II antigens are determined by the mixed lymphocyte reaction (MLR) or by a polymerase chain reaction (PCR). In the mixed lymphocyte reaction, lymphocyte replication occurs if there is a mismatch, and is detected by a specific assay. The PCR test is a new DNA-based test that can detect the presence or absence of antigens by determining whether cells have the genes for the antigens.

One type of transplant does not require tissue typing. In the case of corneal transplants, tissue typing is not needed because cornea do not have their own blood supply. This greatly reduces the chance that immune cells will come in contact with the cornea and recognize it as foreign. For this reason, corneas can be transplant from any person, and there is little chance of rejection.

Normal results

Because each person has their own histocompatibility antigen "fingerprint," there is no true normal result. Each fingerprint is unique.

Resources

BOOKS

Berkow, Robert, et al., eds. *Merck Manual of Medical Information*. Whitehouse Station, NJ: Merck Research Laboratories, 2004.

John T. Lohr, PhD

TMJ *see* **Temporomandibular joint disorders**

Tobramycin *see* **Aminoglycosides; Antibiotics, ophthalmic**

Tocopherol deficiency *see* **Vitamin E deficiency**

Toenail removal *see* **Nail removal**

Tonsil removal *see* **Tonsillectomy and adenoidectomy**

Tonsillectomy and adenoidectomy

Definition

Tonsillectomy and adenoidectomy (T & A) are surgical procedures to remove the tonsils from the back of the mouth or adenoids from the back of the nasal cavity—both are part of the lymphatic system, which is responsible for fighting infection. These operations are often performed together and are usually done on children. T & As are the most common childhood operations.

Purpose

Tonsillectomy

Tonsils are removed (with or without the adenoids) when the child has any of the following conditions:

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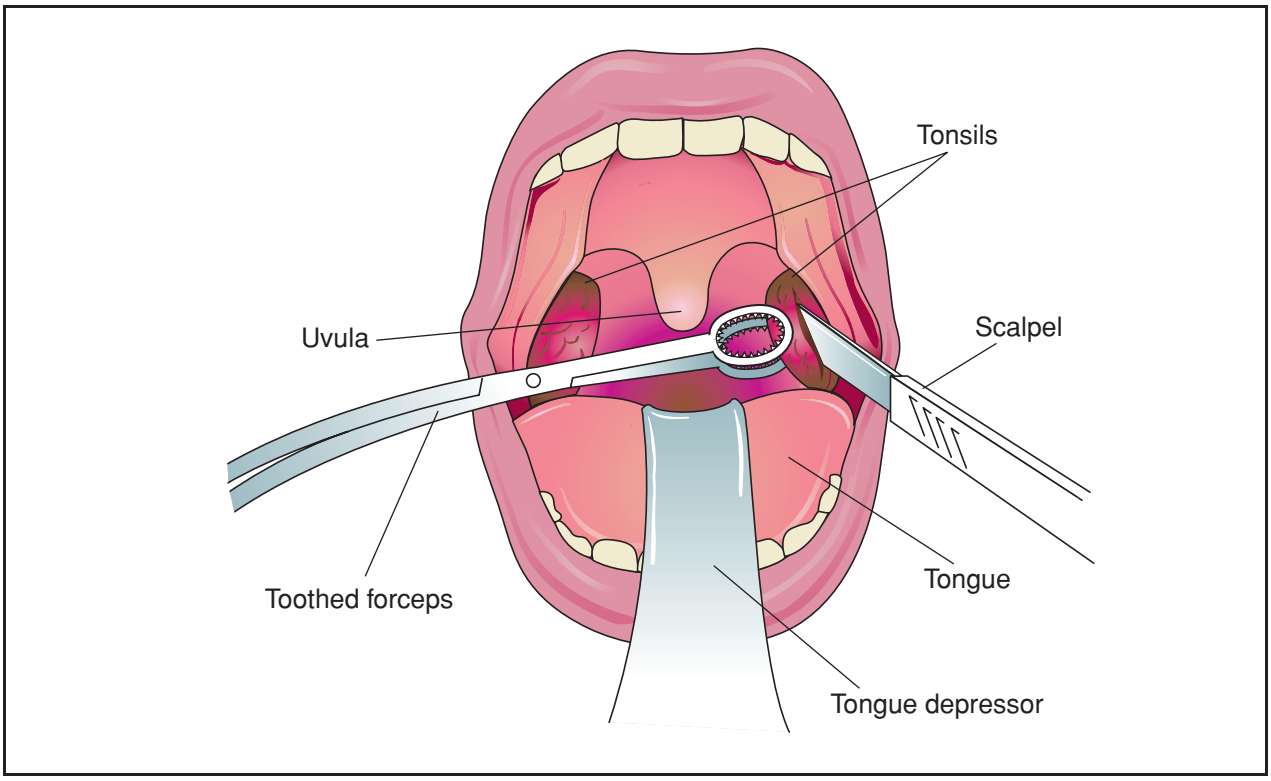

Tonsillectomy and adenoidectomy are surgical procedures performed to remove the tonsils or adenoids. The tonsils are removed in cases where they are a source of recurrent infection or have developed an abscess. Both operations are typically performed on children. The illustration above shows a tonsillectomy in progress. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

- obstruction
- sleep apnea. This is a condition in which the child snores loudly and stops breathing temporarily at intervals during sleep
- inability to swallow properly because of enlarged tonsils
- "hot potato" voice (breathy voice) and other speech abnormalities due to enlarged tonsils
- recurrent or persistent abscesses or throat infections

Doctors do not agree completely on the number of sore throats that make a tonsillectomy necessary. Most would agree that four cases of **strep throat** in any one year; six or more episodes of **tonsillitis** in one year; or five or more episodes of tonsillitis per year for two years indicate that the tonsils should be removed.

Adenoidectomy

Adenoids are removed (with or without the tonsils) when the child has any of the following conditions:

- alteration of facial growth because of enlarged adenoids
- upper airway obstruction
- development of an irregular bite (dental malocclusion)
- difficult speech or swallowing

Precautions

T & As are not performed as frequently today as they were in the past. One reason for a more conservative approach is that there is always some risk involved when a patient is put under **general anesthesia**.

In some cases, a T & A may need to be modified or postponed:

- children with cleft palates should not have the adenoids removed
- bleeding disorders; these must be brought under control before surgery
- acute tonsillitis; surgery should be postponed—usually for three to four weeks—until the infection is gone

Description

Tonsillectomies are hospital procedures. In adults, they may be performed under **local anesthesia**. Children are usually placed under general anesthesia. The doctor

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KEY TERMS

Abscess—A localized area of tissue destruction and pus formation.

Adenoids—Masses of lymphoid tissue that are found in the upper throat.

Sleep apnea—A condition marked by loud snoring during sleep and periodic episodes of suspended breathing.

Tonsils—Oval masses of lymphoid tissue on each side of the throat.

depresses the tongue in order to see the throat and removes the tonsils with a scooplike instrument. The adenoids are usually removed through the nose.

Aftercare

Patients are turned on the side after the operation to prevent the possibility of blood being drawn into the lungs. The patient's vital signs are checked. After the patient is fully awake, he or she can drink water and other nonirritating liquids.

Adult patients are usually warned to expect some bleeding after the operation and a very **sore throat**. **Antibiotics** are given to prevent infection. Medications to relieve **pain** may also be given. For at least the first 24 hours, the patient is fed soft or pureed foods and fluids. If the adenoids alone were removed, the patient may be allowed solid food the day after surgery.

Patients are usually sent home the next day, with instructions to call the doctor if there is bleeding, an earache, or a **fever** that lasts longer than three days. They are told to expect a white scab to form in the throat between five and 10 days after surgery.

Risks

About one in every fifteen thousand tonsillectomies ends in **death**, either from the anesthesia or from bleeding to death five to seven days after the operation. There is also a chance that children with previously normal speech will develop a nasal-sounding voice. In addition, children younger than five years may be badly emotionally upset by the hospital experience.

Normal results

Normal results include the correction of the condition for which the surgery was performed.

Resources

BOOKS

Hay, William W., et al. *Current Pediatric Diagnosis & Treatment*. 18th ed. New York: Lange Medical Books/McGraw–Hill, 2007.

Rebecca J. Frey, PhD

Tonsillitis

Definition

Tonsillitis, also known as tonsillar infection and sometimes as pharyngitis, is an inflammation of the tonsils at the back of the throat (the palatine tonsils) caused by infection by a virus or bacterium. The tonsils themselves are three pairs of clumps of lymphoid tissue; they are part of the lymphatic system and act as part of the immune system. Tonsillitis may be caused by either viruses (about 75 percent of cases) or bacteria (the remaining 25 percent).

Recurrent tonsillitis is defined as seven episodes of tonsillitis in one year; five episodes in two successive years; or three infections per year for three straight years.

Demographics

Tonsillitis is a common illness among children in the United States; nearly all have at least one episode of tonsillitis by the time they reach the teen years, although tonsillitis is rare in children younger than two. Recurrent tonsillitis is less common than single episodes, occurring in 11–13 percent of children.

An examination of this patient's mouth reveals acute tonsillitis. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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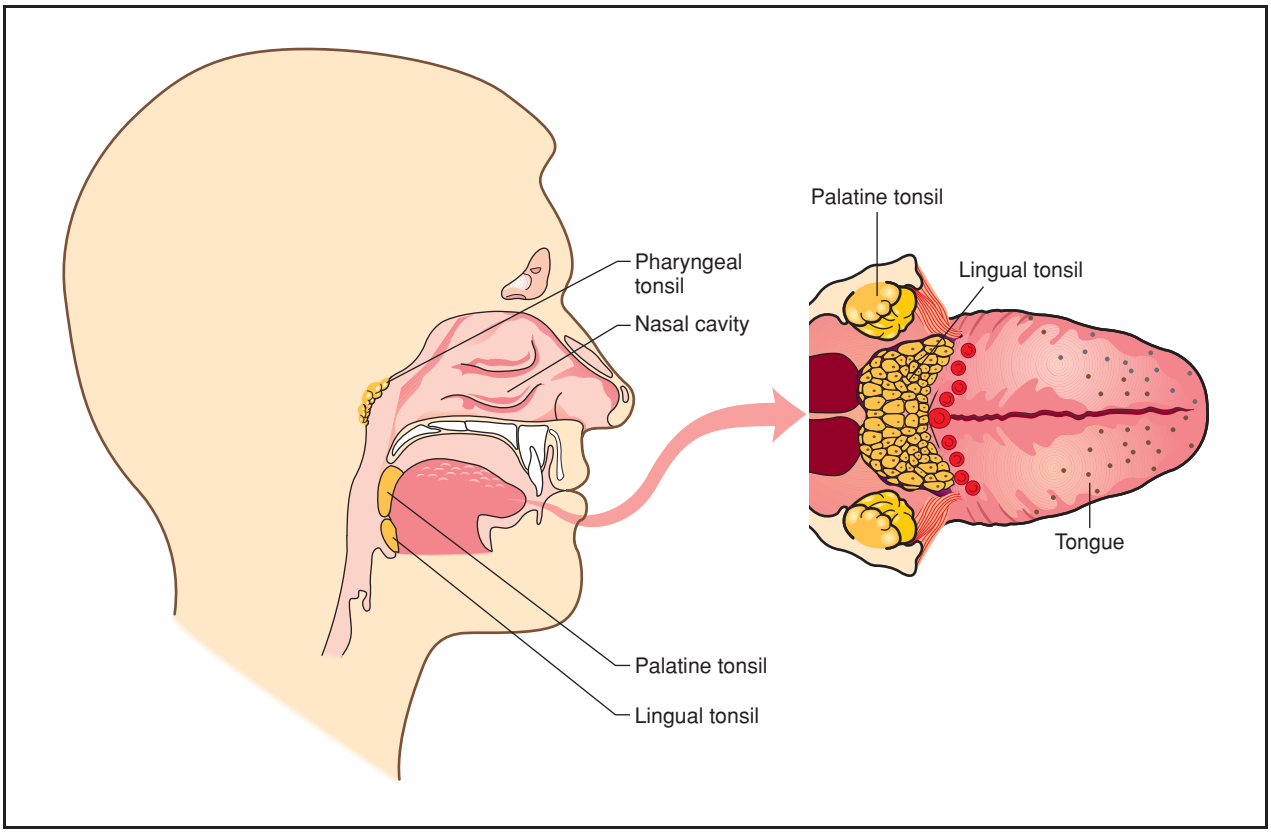

The palatine, lingual, and pharyngeal tonsils. *(Illustration by Hans & Cassady, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

Tonsillitis caused by bacteria is most common in children between the ages of five and 15, while children younger than five are more likely to have viral tonsillitis. As far as is known, tonsillitis affects boys and girls equally, and is equally common in all races and ethnic groups in the United States.

Description

The tonsils include three pairs of masses of lymphoid tissue located toward the back of the mouth and the upper part of the throat cavity: the palatine tonsils, which can be seen at the back of the throat and are the tonsils most often affected by tonsillitis; the lingual tonsils, located on the upper surface of the base of the tongue; and the adenoids, situated at the very back of the nasal cavity where the nose opens into the upper mouth. The tonsils function as part of the immune system to protect the body against infections of the throat and upper respiratory tract. These areas of tissue normally function to filter out disease organisms before they reach the lower throat; however, they can be overwhelmed by a virus or bacterium. At that point the tonsils become red and swollen, and may develop abscesses, which are pus–filled pockets or swellings. The swelling in turn causes painful or difficult swallowing, **sore throat**, and the other characteristic symptoms of tonsillitis.

Whether caused by viruses or bacteria, all forms of tonsillitis are contagious. Tonsillitis usually spreads from person to person by contact with discharges from the nose or throat of an infected child or adult. It is often spread by carriers—children or adults who are infected by a disease agent but do not have any of the symptoms of the disease. It is thought that between three and 11 percent of schoolchildren in Canada and the United States are carriers of the disease organisms that cause tonsillitis.

Risk factors

Risk factors for tonsillitis include:

- Age. Tonsillitis is most common in children from the preschool years to the mid–teenage years.
- Frequent exposure to germs in school or from living in overcrowded conditions.
- Malnutrition.

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KEY TERMS

Abscess—A pus–filled pocket or swelling within infected tissue.

Adenoids—The uppermost pair of tonsils, located at the very back of the nasal cavity where the nose joins the upper part of the mouth.

Carrier—A person or animal who is infected with an infectious disease agent but displays no symptoms of the disease.

Group A streptococcus—A sphere–shaped bacterium that grows in long chains and causes strep throat as well as scarlet fever and some forms of tonsillitis.

Lingual tonsils—A pair of small tonsils located on the upper side of the base of the tongue.

Palatine tonsils—The tonsils that can be seen at the back of the throat and are the tonsils most commonly affected by tonsillitis.

Tonsillectomy—Surgical removal of the tonsils.

- Weakened immune system or taking medications that suppress the immune response to infections.

Causes and symptoms

Causes

About three–quarters of all cases of tonsillitis are caused by viruses, with the remaining quarter caused by bacteria. The most common virus that causes tonsillitis is the Epstein–Barr virus (EBV), which also causes **infectious mononucleosis**. Viral tonsillitis can also be caused by the **measles** virus, herpes virus (the virus that causes **cold sores**), or adenoviruses (viruses that also cause stomach flu). The most common organisms responsible for bacterial tonsillitis are Group A streptococci, the bacteria that cause **strep throat** and **scarlet fever**. A new concern is the identification of methicillin–resistant *Staphylococcus aureus* (MRSA) as a cause of tonsillitis in the United States.

Symptoms

The symptoms of tonsillitis may include:

- Sore throat.
- Pain in the ears.
- Fever and chills.
- Red, swollen tonsils.
- White or yellow patches on the tonsils.
- Pain or difficulty in swallowing.
- Bad breath.
- "Hot potato" (muffled or weak) voice.
- Laryngitis.
- Swollen lymph nodes in the neck.
- Tiredness and overall sick feeling.
- Difficulty breathing or disturbed sleep, if the tonsils are extremely swollen.

Young children who cannot describe how they feel may become unusually fussy, drool because of difficulty swallowing, or refuse to eat.

Diagnosis

Diagnosis of tonsillitis can be made by a family doctor or by an otolaryngologist, a doctor who specializes in ear, nose, and throat disorders.

Examination

The diagnosis of tonsillitis is made from the visible symptoms and a **physical examination** of the patient. The doctor will examine the eyes, ears, nose, and throat, looking at the tonsils for signs of swelling, redness, or a discharge. In most cases the doctor can use a tongue depressor to examine the child's teeth and mouth from front to back, but a fiberoptic laryngoscope may be necessary if the child is in such distress that he or she cannot open the mouth wide enough to allow the use of a tongue depressor even when the doctor is as gentle as possible. A careful examination of the throat is necessary to rule out **diphtheria** and other conditions that may cause a sore throat. The doctor will also gently feel the lymph nodes in the neck for signs of tenderness or neck stiffness, and will check the condition of the child's skin and the tissues lining the mouth for evidence of **dehydration**.

Tests

Since most sore throats in children are caused by viruses rather than bacteria, the doctor may take a **throat culture** in order to test for the presence of streptococcal bacteria. A throat culture is performed by wiping a cotton swab across the tonsils and back of the throat, and sending the swab to a laboratory for culturing. *Streptococcus pyogenes*, the bacterium that causes strep throat, is the most common disease agent responsible for tonsillitis. Depending on what type of test is used for strep, the doctor may be able to determine within a few minutes if *S. pyogenes* is present. The quick tests for strep are not as reliable as a laboratory culture, which can take 24–48 hours. If the results of a quick test are positive, however, the doctor can prescribe **antibiotics** right away.

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If the quick test results are negative, the doctor can do a throat culture to verify the results and wait for the laboratory report before prescribing antibiotics.

A blood test may also be done to rule out a more serious infection or condition, and to check the patient's **white blood cell count** to see whether the body is responding to the infection. In some cases, the doctor may order blood tests for mononucleosis (the Monospot test), since about a third of patients with mononucleosis develop **streptococcal infections** of the tonsils.

Imaging studies are not useful in diagnosing acute tonsillitis; however, the doctor may order a CT scan to guide treatment of an **abscess** if one has developed.

Treatment

Traditional

To treat tonsillitis effectively, it is important for the doctor to know whether the tonsillitis is caused by strep throat bacteria or viruses because the treatments are different. If the child has viral tonsillitis, treatment consists largely of self–care at home: drinking plenty of warm fluids, taking nonaspirin **pain** relievers (Tylenol or Advil) to bring down the **fever**, and gargling with salt water to relieve the sore throat. It may take a week or so for the child to feel better. Antibiotics do not help in treating viral infections.

Drugs

If the doctor determines that the tonsillitis is caused by a bacterium, he or she will prescribe a course of antibiotics, most often penicillin taken by mouth, usually for 10 days. If the child has trouble swallowing, the antibiotic may be given by injection, or the doctor may also prescribe a steroid medication to bring down the throat swelling. The child should not return to school or day care for 24–48 hours after beginning antibiotic treatment, to prevent spreading the infection to others. In addition, it is important for the child to take the full course of antibiotics even though he or she may feel better in a day or two.

Surgery

The doctor may recommend **tonsillectomy** (surgical removal of the tonsils) for patients with recurrent tonsillitis. Tonsillectomy is one of the oldest surgical procedures known to Western medicine. It was first described around 50 AD by Celsus, a Roman doctor, who invented a hook for grasping tonsils. After hooking the infected tonsil with this device, Celsus removed the tissue with a sharp knife or scalpel. He then gave his patient a mixture of vinegar and herbs to stop the bleeding, cleanse the throat, and lower the risk of infection.

In the modern period, tonsillectomies are not performed nearly as often as they were in the 1950s and 1960s. The number of tonsillectomies performed each year in the United States has dropped from several million in the 1970s to approximately 600,000 in the early 2000s. Tonsillectomies are still recommended, however, to treat severe cases of recurrent tonsillitis accompanied by airway obstruction, and to reduce the risk of ear infections and other potential complications of tonsillitis.

As of 2010, surgeons in the United States generally remove tonsils with forceps and scissors after the patient has been put under **general anesthesia**. Several new techniques for tonsillectomy have been developed, however, that include the use of ultrasonic scalpels, lasers, and radiofrequency ablation. Radiofrequency ablation is a method that uses radiofrequency energy to shrink or destroy the tissue of the tonsils without the need for cutting.

Alternative

Strengthening the immune system is important whether tonsillitis is caused by bacteria or viruses. Naturopaths often recommend dietary supplements of vitamin C, bioflavonoids, and beta–carotenes—found naturally in fruits and vegetables—to ease inflammation and fight infection.

A variety of herbal remedies also may be helpful in treating tonsillitis. Calendula (*Calendula officinalis*) and cleavers (*Galium aparine*) target the lymphatic system, while **echinacea** (*Echinacea* spp.) and astragalus (*Astragalus membranaceus*) stimulate the immune system. Goldenseal (*Hydrastis canadensis*), myrrh (*Commiphora molmol*), and bitter orange act as antibacterials. *Lomatium dissectum* and *Ligusticum porteri* have an antiviral action.

Some of the homeopathic medicines that may be used to treat symptoms of tonsillitis include *Belladonna*, *Phytolacca*, *Mercurius*, *Lycopodium*, *Lachesis*, *Hepar sulphuris*, *Arsenicum*, or *Rhus toxicodendron*. As with any condition, the treatment and dosage should be appropriate for the particular symptoms and age of the patient. Alternative treatments should be used with care, as the benefits of many such treatments have not been confirmed by scientific research.

Prognosis

Most children and teenagers with tonsillitis recover without any long–term problems. In a few cases, however, the infection can spread from the tonsils to the deeper tissues of the neck or chest. If the tonsillitis is

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caused by streptococci, it can lead to such complications as inflammation of the kidney or **rheumatic fever**. For this reason, children with a severe sore throat and other symptoms of tonsillitis should see the doctor at once.

Tonsillectomy is the second most common operation performed on school–age children and is an extremely safe procedure. It is often done as an outpatient procedure with good results as of 2010; however, the child may need to recover at home for a week or two afterward. If fever persists for more than 48 hours, however, or is higher than 102°F (38.9°C), the patient should be seen by a doctor. Prolonged symptoms may indicate that the patient has other upper respiratory infections, most commonly in the ears or sinuses. An abscess behind the tonsil (a peritonsillar abscess or PTA) may also occur. In rare cases, a persistent sore throat may point to more serious conditions, such as rheumatic fever or **pneumonia**.

In rare cases, the tonsils may regrow after a tonsillectomy. If the child has another episode of tonsillitis, the regrowth can be removed surgically.

Prevention

People can lower their risk of tonsillitis by washing their hands frequently, avoiding sharing drinking glasses and food utensils, covering the nose and mouth when coughing or sneezing, and avoiding close contact with others who have upper respiratory infections. Children of school age should be taught the importance of washing their hands after using the bathroom, and particularly after coughing or sneezing.

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ORGANIZATIONS

American Academy of Family Physicians (AAFP), PO Box 11210, Shawnee Mission, KS, 66207, (913) 906-6000, (800) 274-2237, (913) 906-6075, contactcenter@aafp.org, http://www.aafp.org/online/en/home.html.

American Academy of Otolaryngology—Head and Neck Surgery (AAOHNS), 1650 Diagonal Rd., Alexandria, VA, 22314, (703) 836-4444, http://www.entnet.org/.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Rd., Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

National Institute of Allergy and Infectious Diseases (NIAID), 6610 Rockledge Dr., MSC 6612, Bethesda, MD, 20892-6612, (301) 496-5717, (866) 284-4107, (301) 402-3573, http://www3.niaid.nih.gov.

Altha Roberts Edgren
Rebecca J. Frey, PhD

Tooth decay

Definition

Tooth decay, which is also called dental cavities or dental caries, is the destruction of the outer surface (enamel) of a tooth. Decay results from the action of bacteria that live in plaque, which is a sticky, whitish

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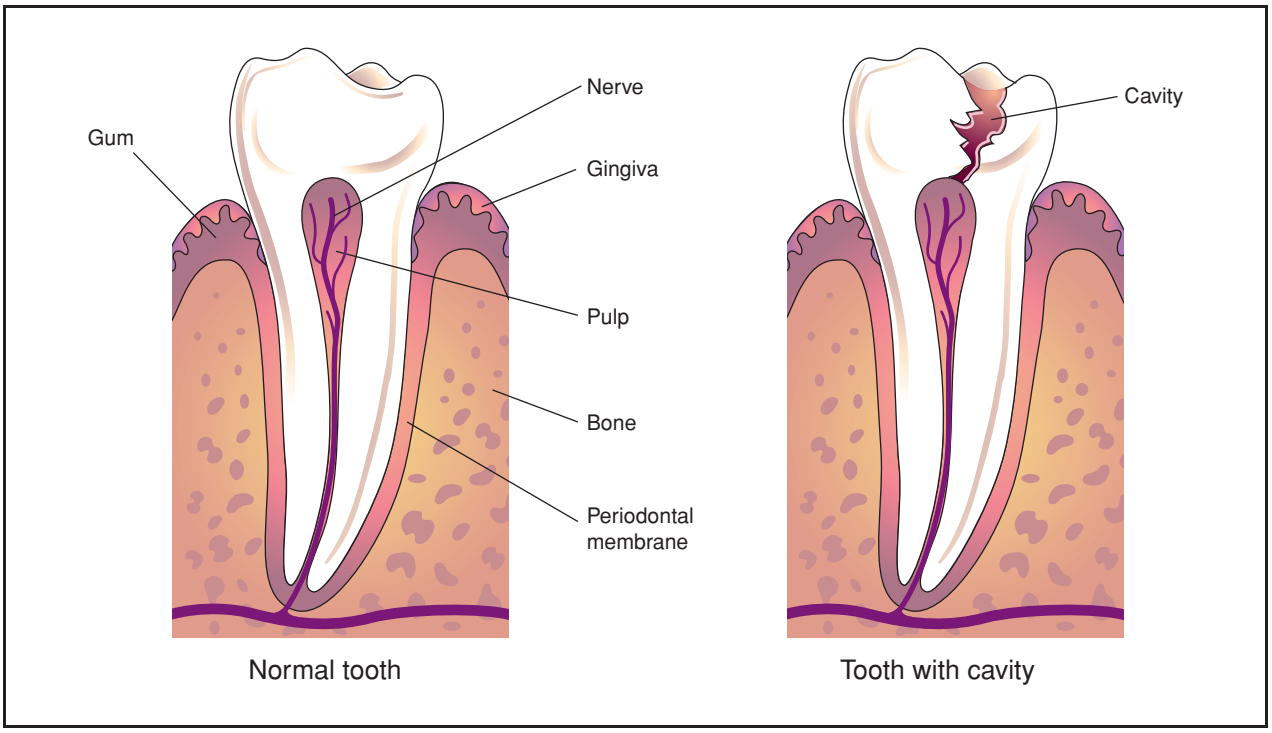

Tooth decay is the destruction of the outer surface, or enamel, of a tooth. It is caused by acid buildup from plaque bacteria, which dissolves the minerals in the enamel and creates cavities. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

film formed by a protein in saliva (mucin) and sugary substances in the mouth. The plaque bacteria sticking to tooth enamel use the sugar and starch from food particles in the mouth to produce acid.

Description

Tooth decay is a common health problem, second in prevalence only to the **common cold**. It has been estimated that 90% of people in the United States have at least one cavity, and that 75% of people had their first cavity by the age of five. Although anyone can have a problem with tooth decay, children and senior citizens are the two groups at highest risk. Other high-risk groups include people who eat a lot of starchy and sugary foods; people living in areas without a fluoridated water supply; and people who already have numerous dental restorations (fillings and crowns).

Baby bottle tooth decay

Baby bottle tooth decay is a dental problem that frequently develops in infants that are put to bed with a bottle containing a sweet liquid. Baby bottle tooth decay is also called nursing-bottle caries and bottle-mouth syndrome. Bottles containing such liquids as milk, formula, fruit juices, sweetened drink mixes, and sugar water continuously bathe an infant's mouth with sugar during naps or at night. The bacteria in the mouth use this sugar to produce acid that destroys the child's teeth. The upper front teeth are typically the ones most severely damaged; the lower front teeth receive some protection from the tongue. Pacifiers dipped in sugar, honey, corn syrup, or other sweetened liquid also contribute to bottle-mouth syndrome. The first signs of damage are chalky white spots or lines across the teeth. As decay progresses, the damage to the child's teeth becomes obvious.

Causes and symptoms

Tooth decay requires the simultaneous presence of three factors: plaque bacteria, sugar, and a vulnerable tooth surface. Although several microorganisms found in the mouth can cause tooth decay, the primary disease agent appears to be *Streptococcus mutans*. The sugars used by the bacteria are simple sugars such as glucose, sucrose, and lactose. They are converted primarily into lactic acid. When this acid builds up on an unprotected tooth surface, it dissolves the **minerals** in the enamel, creating holes and weak spots (cavities). As the decay

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spreads inward into the middle layer (the dentin), the tooth becomes more sensitive to temperature and touch. When the decay reaches the center of the tooth (the pulp), the resulting inflammation (pulpitis) produces a **toothache**.

Diagnosis

Tooth decay develops at varying rates. It may be found during a routine six-month dental checkup before the patient is even aware of a problem. In other cases, the patient may experience common early symptoms, such as sensitivity to hot and cold liquids or localized discomfort after eating very sweet foods. The dentist or dental hygienist may suspect tooth decay if a dark spot or a pit is seen during a visual examination. Front teeth may be inspected for decay by shining a light from behind the tooth. This method is called transillumination. Areas of decay, especially between the teeth, will appear as noticeable shadows when teeth are transilluminated. X rays may be taken to confirm the presence and extent of the decay. The dentist then makes the final clinical diagnosis by probing the enamel with a sharp instrument.

Tooth decay in pits and fissures may be differentiated from dark shadows in the crevices of the chewing surfaces by a dye that selectively stains parts of the tooth that have lost mineral content. A dentist can also use this dye to tell whether all tooth decay has been removed from a cavity before placing a filling.

Diagnosis in children

Damage caused by baby bottle tooth decay is often not diagnosed until the child has a severe problem, because parents seldom bring infants and toddlers in for dental check-ups. Dentists want to initially examine primary teeth between 12 and 24 months. Children still drinking from a bottle anytime after their first birthday are likely to have tooth decay.

Treatment

To treat most cases of tooth decay in adults, the dentist removes all decayed tooth structure, shapes the sides of the cavity, and fills the cavity with an appropriate material, such as silver amalgam or composite resin. The filling is put in to restore and protect the tooth. If decay has attacked the pulp, the dentist or a specialist called an endodontist may perform **root canal treatment** and cover the tooth with a crown.

In cases of baby bottle tooth decay, the dentist must assess the extent of the damage before deciding on the treatment method. If the problem is caught early, the teeth involved can be treated with fluoride, followed by changes in the infant's feeding habits and better **oral hygiene**. Primary teeth with obvious decay in the enamel that has not yet progressed to the pulp need to be protected with stainless steel crowns. Fillings are not usually an option in small children because of the small size of their teeth and the concern of recurrent decay. When the decay has advanced to the pulp, pulling the tooth is often the treatment of choice. Unfortunately, loss of primary teeth at this age may hinder the young child's ability to eat and speak. It may also have bad effects on the alignment and spacing of the permanent teeth when they come in.

Prognosis

With timely diagnosis and treatment, the progression of tooth decay can be stopped without extended **pain**. If the pulp of the tooth is infected, the infection may be treated with **antibiotics** prior to root canal treatment or extraction. The longer decay goes untreated, however, the more destructive it becomes and the longer and more intensive the necessary treatment will be. In addition, a patient with two or more areas of tooth decay is at increased risk of developing additional cavities in the future.

Prevention

It is easier and less expensive to prevent tooth decay than to treat it. The four major prevention strategies include: proper oral hygiene; fluoride; sealants; and attention to diet.

Oral hygiene

GENERAL CARE OF THE MOUTH. The best way to prevent tooth decay is to brush the teeth at least twice a day, preferably after every meal and snack, and floss daily. Cavities develop most easily in spaces that are hard to clean. These areas include surface grooves, spaces between teeth, and the area below the gum line. Effective brushing cleans each outer tooth surface, inner tooth surface, and the horizontal chewing surfaces of the back teeth, as well as the tongue. Flossing once a day also helps prevent gum disease by removing food particles and plaque at and below the gum line, as well as between teeth. Patients should visit their dentist every six months for oral examination and professional cleaning.

MOUTH CARE IN OLDER ADULTS. Older adults who have lost teeth or had them removed still need to maintain a clean mouth. Bridges and dentures must be kept clean to prevent gum disease. Dentures should be relined and adjusted by a dentist whenever necessary to maintain

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KEY TERMS

Amalgam—A mixture (alloy) of silver and several other metals, used by dentists to make fillings for cavities.

Caries—The medical term for tooth decay.

Cavity—A hole or weak spot in the tooth surface caused by decay.

Dentin—The middle layer of a tooth, which makes up most of the tooth's mass.

Enamel—The hard, outermost surface of a tooth.

Fluoride—A chemical compound containing fluorine that is used to treat water or applied directly to teeth to prevent decay.

Mucin—A protein in saliva that combines with sugars in the mouth to form plaque.

Plaque—A thin, sticky, colorless film that forms on teeth. Plaque is composed of mucin, sugars from food, and bacteria that live in the plaque.

Pulp—The soft, innermost layer of a tooth containing blood vessels and nerves.

Sealant—A thin plastic substance that is painted over teeth as an anti-cavity measure to seal out food particles and acids produced by bacteria.

Transillumination—A technique of checking for tooth decay by shining a light behind the patient's teeth. Decayed areas show up as spots or shadows.

proper fit. These adjustments help to keep the gums from becoming red, swollen, and tender.

MOUTH CARE IN CHILDREN. Parents can easily prevent baby bottle tooth decay by not allowing a child to fall asleep with a bottle containing sweetened liquids. Bottles should be filled only with plain, unsweetened water. The child should be introduced to drinking from a cup around six months of age and weaned from bottles by twelve months. If an infant seems to need oral comfort between feedings, a pacifier specially designed for the mouth may be used. Pacifiers, however, should never be dipped in honey, corn syrup, or other sweet liquids. After the eruption of the first tooth, parents should begin routinely wiping the infant's teeth and gums with a moist piece of gauze or a soft cloth, especially right before bedtime. Parents may begin brushing a child's teeth with a small, soft toothbrush at about two years of age, when most of the primary teeth have come in. They should apply only a very small amount (the size of a pea) of toothpaste containing fluoride. Too much fluoride may cause spotting (fluorosis) of the tooth enamel. As the child grows, he or she will learn to handle the toothbrush, but parents should control the application of toothpaste and do the followup brushing until the child is about seven years old.

Fluoride application

Fluoride is a natural substance that slows the destruction of enamel and helps to repair minor tooth decay damage by remineralizing tooth structure. Toothpaste, mouthwash, fluoridated public drinking water, and vitamin supplements are all possible sources of fluoride. Children living in areas without fluoridated water should receive 0.5 mg/day of fluoride (0.25 mg/day if using a toothpaste containing fluoride) from three to five years of age, and 1 mg/day from six to12 years.

While fluoride is important for protecting children's developing teeth, it is also of benefit to older adults with receding gums. It helps to protect their newly exposed tooth surfaces from decay. Older adults can be treated by a dentist with a fluoride solution that is painted onto selected portions of the teeth or poured into a fitted tray and held against all the teeth.

Sealants

Because fluoride is most beneficial on the smooth surfaces of teeth, sealants were developed to protect the irregular surfaces of teeth. A sealant is a thin plastic coating that is painted over the grooves of chewing surfaces to prevent food and plaque from being trapped there. Sealant treatment is painless because no part of the tooth is removed, although the tooth surface is etched with acid so that the plastic will adhere to the rough surface. Sealants are usually clear or tooth-colored, making them less noticeable than silver fillings. They cost less than fillings and can last up to 10 years, although they should be checked for wear at every dental visit. Children should get sealants on their first permanent "6-year" molars, which come in between the ages of five and seven, and on the second permanent "12-year" molars, which come in between the ages of 11 and 14. Sealants should be applied to the teeth shortly after they erupt, before decay can set in. Although sealants have been used in the United States for about 25 years, one survey by the National Institute of Dental Research reported that fewer than 8% of American children have them.

Diet

The risk of tooth decay can be lowered by choosing foods wisely and eating less often. Foods high in sugar and starch, especially when eaten between meals, increase the risk of cavities. The bacteria in

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the mouth use sugar and starch to produce the acid that destroys the enamel. The damage increases with more frequent eating and longer periods of eating. For better dental health, people should eat a variety of foods, limit the number of snacks, avoid sticky and overly sweetened foods, and brush often after eating.

Drinking water is also beneficial for rinsing food particles from the mouth. Children can be taught to "swish and swallow" if they are unable to brush after lunch at school. Similarly, saliva stimulated during eating makes it more difficult for food and bacteria to stick to tooth surfaces. Saliva also appears to have a buffering effect on the acid produced by the plaque bacteria and to act as a remineralizing agent. Older patients should be made aware that some prescription medications may decrease salivary flow. Less saliva tends to increase the activity of plaque bacteria and encourage further tooth decay. Chewing sugarless gum increases salivation and thus helps to lower the risk of tooth decay.

ORGANIZATIONS

American Dental Association, 211 E. Chicago Ave., Chicago, IL, 60611-2678, (312) 440-2500, http://www.ada.org.

American Dental Hygienists' Association, 444 North Michigan Avenue, Suite 3400, Chicago, IL, 60611, (312) 440-8900, mail@adha.net, http://www.adha.org/.

National Institute of Dental and Craniofacial Research, National Institutes of Health, Bethesda, MD, (301) 470-4098, (866) 232-4528, nidcrinfo@mail.nih.gov, http://www.nidcr.nih.gov.

Bethany Thivierge

Tooth extraction

Definition

Tooth extraction is the removal of a tooth from its socket in the bone.

Purpose

Extraction is performed for positional, structural, or economic reasons. Teeth are often removed because they are impacted. Teeth become impacted when they are prevented from growing into their normal position in the mouth by gum tissue, bone, or other teeth. Impaction is a common reason for the extraction of wisdom teeth. Extraction is the only known method that will prevent further problems. Teeth may also be extracted to make more room in the mouth prior to straightening the remaining teeth (orthodontic treatment), or because they are so badly positioned that straightening is impossible. Extraction may be used to remove teeth that are so badly decayed or broken that they cannot be restored. In addition, patients sometimes choose extraction as a less expensive alternative to filling or placing a crown on a severely decayed tooth.

A close-up view inside a person's mouth following the extraction of the lower right molar. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Precautions

In some situations, tooth extractions may need to be postponed temporarily. These situations include:

- Infection that has progressed from the tooth into the bone. Infections may make anesthesia difficult. They can be treated with antibiotics before the tooth is extracted.
- The patient's use of drugs that thin the blood (anticoagulants). These medications include warfarin (Coumadin) and aspirin. The patient should stop using these medications for three days prior to extraction.
- Patients who have had any of the following procedures in the previous six months: heart valve replacement, open heart surgery, prosthetic joint replacement, or placement of a medical shunt. These patients may be given antibiotics to reduce the risk of bacterial infection.

Description

Tooth extraction can be performed with **local anesthesia** if the tooth is exposed and appears to be easily removable in one piece. An instrument called an elevator is used to loosen (luxate) the tooth, widen the space in the

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KEY TERMS

Dry socket—A painful condition following tooth extraction in which a blood clot does not properly fill the empty socket. Dry socket leaves the underlying bone exposed to air and food.

Extraction site—The empty tooth socket following removal of the tooth.

Impacted tooth—A tooth that is growing against another tooth, bone, or soft tissue.

Luxate—To loosen or dislocate the tooth from the socket.

Nitrous oxide—A colorless, sweet-smelling gas used by dentists for mild anesthesia. It is sometimes called laughing gas because it makes some patients feel giddy or silly.

Oral surgeon—A dentist who specializes in surgical procedures of the mouth, including extractions.

Orthodontic treatment—The process of straightening teeth to correct their appearance and function.

bone, and break the tiny elastic fibers that attach the tooth to the bone. Once the tooth is dislocated from the bone, it can be lifted and removed with forceps.

If the extraction is likely to be difficult, the dentist may refer the patient to an oral surgeon. Oral surgeons are specialists who are trained to give nitrous oxide, an intravenous sedative, or a general anesthetic to relieve **pain**. Extracting an **impacted tooth** or a tooth with curved roots typically requires cutting through gum tissue to expose the tooth. It may also require removing portions of bone to free the tooth. Some teeth must be cut and removed in sections. The extraction site may or may not require one or more stitches to close the cut (incision).

Preparation

Before an extraction, the dentist will take the patient's medical history, noting **allergies** and prescription medications. A dental history is also taken, with particular attention to previous extractions and reactions to anesthetics. The dentist may then prescribe **antibiotics** or recommend stopping certain medications prior to the extraction. The tooth is x-rayed to determine its full shape and position, especially if it is impacted.

If the patient is going to have deep anesthesia, he or she should wear loose clothing with sleeves that are easily rolled up to allow for an intravenous line. The patient should not eat or drink anything for at least six hours before the procedure. Arrangements should be made for a friend or relative to drive the patient home after the surgery.

Aftercare

An important aspect of aftercare is encouraging a clot to form at the extraction site. The patient should put pressure on the area by biting gently on a roll or wad of gauze for several hours after surgery. Once the clot is formed, it should not be disturbed. The patient should not rinse, spit, drink with a straw, or smoke for at least 24 hours after the extraction and preferably longer. Vigorous **exercise** should not be done for the first three to five days.

For the first two days after the procedure, the patient should drink liquids without using a straw, and eat soft foods. Any chewing must be done on the side away from the extraction site. Hard or sticky foods should be avoided. The mouth may be gently cleaned with a toothbrush, but the extraction area should not be scrubbed.

Wrapped ice packs can be applied to reduce facial swelling. Swelling is a normal part of the healing process. It is most noticeable in the first 48–72 hours. As the swelling subsides, the patient may experience muscle stiffness. Moist heat and gentle exercise will restore jaw movement. The dentist may prescribe medications to relieve the postoperative pain.

Risks

Potential complications of tooth extraction include postoperative infection, temporary **numbness** from nerve irritation, jaw fracture, and jaw joint pain. An additional complication is called dry socket. When a blood clot does not properly form in the empty tooth socket, the bone beneath the socket is painfully exposed to air and food, and the extraction site heals more slowly.

Normal results

After an extraction, the wound usually closes in about two weeks. It takes three to six months for the bone and soft tissue to be restructured. Complications such as infection or dry socket may prolong the healing time.

ORGANIZATIONS

American Association of Oral & Maxillofacial Surgeons, 9700 West Bryn Mawr Avenue, Rosemont, IL, 60018-5701, (847) 678-6200, (847) 678-6286, (800) 822-6637, http://www.aaoms.org.

Bethany Thivierge

Tooth grinding *see* **Bruxism**

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Tooth replacements and restorations

Definition

A tooth restoration is any artificial substance or structure that replaces missing teeth or part of a tooth in order to protect the mouth's ability to eat, chew, and speak. Restorations include fillings, inlays, crowns, bridges, partial and complete dentures, and **dental implants**.

Purpose

Restorations have somewhat different purposes depending on their extensiveness. Fillings, inlays, and crowns are intended to repair damage to individual teeth. They replace tooth structure lost by decay or injury, protect the part of the tooth that remains, and restore the tooth's shape and function. Bridges, dentures, and implants are intended to protect the shape and function of the mouth as a whole.

Precautions

Some patients are allergic to the medications used for **local anesthesia** in dental restorations. In addition, many people in the general population are afraid of dental work. Most dentists in present-day practice can help patients with this specific fear.

Description

Fillings

Fillings are restorations that are done to repair damage caused by **tooth decay** (dental caries). Tooth decay occurs when microorganisms in the mouth convert sugar from food to acid, which attacks the tooth. The acid forms cavities that start in the hard outer surface of the tooth (the enamel) and may extend inward to the pulp, which contains the tooth's nerves and blood vessels. Left untreated, tooth decay may lead to inflammation and infection that may cause **toothache** and perhaps more serious complications.

To stop the decay process, the dentist removes the decayed portion of the tooth using a high-speed drill or an air abrasion system, shapes the cavity walls, and replaces the tooth structure with a filling of silver amalgam, composite resin, or gold. The filling is placed in the cavity as a liquid or soft solid. It sets within a few minutes and continues to harden over the next several hours. Silver amalgam is commonly used to fill cavities on the biting surfaces of the back teeth, because it is strong enough to withstand the tremendous pressures exerted by grinding and chewing. Composite resin is typically used to fill cavities in front teeth and any other teeth that are visible when the patient smiles, because its color can be matched to the tooth surface. Gold as a filling material is far less common, but is being increasingly used. Although it is more expensive and less easily applied, it does not trigger the sensitivity reactions that some patients have to silver amalgam.

Inlays

An inlay resembles a filling in that it fills the space remaining after the decayed portion of a tooth has been removed. The difference is that an inlay is shaped outside the patient's mouth and then cemented into place. After the decay is removed and the cavity walls are shaped, the dentist makes a wax pattern of the space. A mold is cast from the wax pattern. An inlay, usually of gold, is made from this mold and sealed into the tooth with dental cement.

Crowns

The crown of a tooth is the portion that is covered by enamel. A restorative crown replaces this outer part to protect the tooth. This protection becomes necessary when a tooth cracks or has its entire structure weakened by decay. As with a filling or inlay, the dentist first removes the decayed portion of the tooth. The tooth is then prepared for a crown. It may be tapered on the outside edges to a peg, reinforced with a cast metal core, or rebuilt with both a cast metal core and a post. A wax impression of the prepared tooth and the teeth next to it is made. The new crown is made to fit this mold. The crown may be made of gold or stainless steel alone, metal with a veneer of tooth-colored porcelain or resin, or of porcelain or resin alone. The finished crown is then placed over the prepared tooth, adjusted, and cemented into place.

Bridges

Bridges are a type of restoration that is done when one or more permanent teeth are lost or pulled. The resulting gap must be filled in to prevent the remaining teeth from shifting. If the other teeth shift, they will affect the patient's bite (occlusion), which sometimes produces **pain** in the jaw joint. As the teeth move and become crooked, they also become more difficult to keep clean. The risk of tooth decay and gum disease increases, increasing the likelihood that additional teeth will be lost. A bridge is inserted to prevent this risk. Bridges are nonremovable appliances of one or more artificial teeth (pontics) anchored by crowns on the adjacent teeth (abutment teeth). The abutment teeth carry the pressure when the patient chews food.

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Partial dentures

A partial denture is similar to a bridge in that it fills a gap left by missing teeth with artificial teeth on a metal frame. A partial denture is removable, however. It attaches to a crown on the abutment tooth with a metal clasp or precision attachment. A partial denture is primarily used at the end of a row of natural teeth, where there is only one abutment tooth. The pressure exerted by chewing is shared by this abutment and the soft tissues of the gum ridge beneath the appliance.

Complete dentures

Complete dentures may be worn when all of the top or bottom teeth have been lost. A complete denture consists of artificial teeth mounted in a plastic base molded to fit the remaining oral anatomy. It may or may not be held in place with a denture adhesive.

Implants

Dental implants are a means of securing crowns, bridges, and dentures in the mouth. A hard plastic or metal fixture is implanted through the soft tissue into the bone. Over time, the bone grows around this fixture, firmly anchoring it. The exposed end of this fixture is covered with a crown and may serve as a stable abutment for a bridge or denture.

Preparation

Before a restoration is placed in the mouth, the dentist removes all traces of decay and shapes the remaining tooth structure for the restoration. Fillings are the only restoration created within the tooth itself–the others are made up in a laboratory using a model of the tooth structure. Thus, a filling may be placed in a single dental visit, while the other restorations usually take several appointments. Temporary crowns and dentures are put in place after the tooth is shaped until the permanent restoration is delivered by the laboratory.

Aftercare

Fillings

Fillings need time to harden for several hours after being placed, so the patient should chew food on the opposite side of the mouth for the first day.

Dentures

A partial or complete denture may take several weeks of getting used to. Inserting and removing the denture will take practice. Speaking clearly may be difficult at first–the patient may find it helpful to read out loud for practice. Eating may also feel awkward.

KEY TERMS

Abutment tooth—A crowned tooth that stabilizes a bridge or partial denture.

Bridge—An appliance of one or more artificial teeth anchored by crowns on the adjacent teeth.

Complete denture—A full set of upper or lower teeth, mounted in a plastic base. Dentures are also called false teeth.

Crown—A protective shell that fits over the tooth.

Dental caries—A disease of the teeth in which microorganisms convert sugar in the mouth to acid that erodes the tooth.

Enamel—The hard outermost surface of a tooth.

Filling—Dental material that occupies the space remaining within a tooth after the decayed portion has been removed.

Implant—A fixture with one end implanted into the bone and the other end covered with a crown, often to serve as a stable abutment for a bridge or denture.

Inlay—A filling that is made outside of the tooth and then cemented into place.

Occlusion—The way upper and lower teeth fit together during biting and chewing.

Partial denture—A removable bridge that usually clasps onto only one abutment.

Pontic—An artificial tooth.

Pulp—The soft innermost layer of a tooth that contains its blood vessels and nerves.

The patient should begin by eating small pieces of soft foods. Very hard or sticky foods should be avoided.

Patients with dentures must work on good **oral hygiene**. Specialty brushes and floss threaders may be used to remove plaque and food from around crowns and bridges. Dentures should be removed and brushed daily with a specially designed brush and a denture cleaner or other mild soap.

The patient should see the dentist for an adjustment if there is any discomfort or irritation resulting from a restoration. Otherwise, the patient should see the dentist at least twice a year for an oral examination.

Risks

Restoration procedures typically require local anesthesia. Some people may have allergic reactions to the medication. A very small number of people are allergic to one or more of the metals used in a dental

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restoration. In most cases, the dentist can use another material.

Normal results

A well-made restoration should feel comfortable and last a relatively long time with proper care. Artificial dental restorations only approximate the original tooth, however. A complete denture will never feel as comfortable or work as well as natural teeth. It is better, therefore, to prevent the need for restorative dental work than to replace teeth. Restorations are expensive, may require many appointments, and still need careful cleaning and attention.

ORGANIZATIONS

Academy of General Dentistry, 211 East Chicago Avenue, Suite 900, Chicago, IL, 60611-1999, (312) 440-0559, (888) 243-3368, http://www.agd.org.

American Dental Association, 211 E. Chicago Ave., Chicago, IL, 60611-2678, (312) 440-2500, http://www.ada.org.

Bethany Thivierge

Toothache

Definition

A toothache is any **pain** or soreness within or around a tooth, indicating inflammation and possible infection.

Demographics

Serious toothaches and oral health problems are much less common today than ever before in history. The widespread availability of preventive dentistry and toothbrushes, toothpaste, and other oral care items has greatly improved oral health. However, most people experience some form of tooth pain at least once in their lives. Toothaches may occur more frequently in populations without regular access to dental care, such as low-income individuals. Toothaches also are more common in the elderly and individuals with certain diseases and conditions that make **tooth decay** more likely.

Description

A toothache may be either a sharp pain or a dull ache. The tooth may be sensitive to pressure, heat, cold, or sweets. In cases of severe pain, identifying the problem tooth can be difficult. Any patient with a toothache should see a dentist at once for diagnosis and treatment. Most toothaches get worse if not treated.

Causes and symptoms

Toothaches may result from many causes:

- tooth decay (dental caries)
- inflammation of the tooth pulp (pulpitis)
- abscess
- gum disease, including periodontitis
- loose or broken filling
- cracked or impacted tooth
- exposed tooth root
- food wedged between teeth or trapped below the gum line
- tooth nerve irritated by clenching or grinding of teeth (bruxism)
- pressure from congested sinuses
- traumatic injury

Diagnosis

Diagnosis includes identifying the location of the toothache, as well as the cause. The dentist begins by asking the patient specific questions about the toothache, including the types of foods that make the pain worse, whether the tooth is sensitive to temperature or biting, and whether the pain is worse at night. The dentist then examines the patient's mouth for signs of swelling, redness, and obvious tooth damage. The presence of pus indicates an **abscess** or gum disease. The dentist may flush the sore area with warm water to dislodge any food particles and to test for sensitivity to heat. The dentist may then dry the area with gauze to determine sensitivity to touch and pressure. The dentist may probe tooth crevices and the edges of fillings with a sharp instrument, looking for areas of tooth decay. Finally, the dentist may take x rays, looking for evidence of decay between teeth, a cracked or **impacted tooth**, or a disorder of the underlying bone.

Treatment

Emergency self-care

Toothaches should be professionally treated by a dentist. Some methods of self-treatment, however, may help manage the pain until professional care is available. Common home treatments include:

- rinsing with warm salt water
- using dental floss to remove any food particles

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KEY TERMS

Abscess—A hole in the tooth or gum tissue filled with pus as the result of infection.

Bruxism—Habitual clenching and grinding of the teeth because of stress. The behavior usually occurs during sleep.

Cavity—A hole or weak spot in the tooth surface caused by decay.

Dental caries—A disease of the teeth in which microorganisms convert sugar in the mouth to acid, which then erodes the tooth.

Enamel—The hard outermost surface of a tooth.

Endodontist—A dentist who specializes in diagnosing and treating diseases of the pulp and other inner parts of the tooth.

Impacted tooth—A tooth that is growing against another tooth, bone, or soft tissue.

Periodontitis—A gum disease that destroys the structures supporting the teeth, including bone.

Pulp—The soft innermost part of a tooth, containing blood vessels and nerves.

Pulpitis—Inflammation of the pulp of a tooth that involves the blood vessels and nerves.

- taking aspirin or acetaminophen (Tylenol) to relieve pain; the drug should be swallowed and never placed directly on the aching tooth or gum
- applying a cold compress against the outside of the cheek; heat should not be used as it can increase the likelihood that the infection will spread
- using clove oil (*Syzygium aromaticum*) to numb the gums; the oil may be rubbed directly on the sore area or used to soak a small piece of cotton and applied to the sore tooth

Traditional treatment

Treatment will depend on the underlying cause of the toothache. If the pain is due to tooth decay, the dentist will remove the decayed area and restore the tooth with a filling of silver amalgam or composite resin. Loose or broken fillings are removed, new decay cleaned out, and a new filling is placed. If the pulp of the tooth is damaged, root canal therapy may be required. During a root canal the dentist or a specialist called an endodontist removes the decayed pulp, fills the space left behind with a soothing paste, and covers the tooth with a crown to protect and seal it. If the damage cannot be treated by these methods, or if the tooth is impacted, the tooth must be extracted.

Alternative treatment

Toothaches caused by infection or tooth decay must be treated by a dentist. Several alternative therapies may be helpful for pain relief until dental treatment is available. Clove oil (*Syzygium aromaticum*) may be rubbed on sensitive gums to numb them or added to a small cotton pellet that is then placed into or over a hole in the tooth. The herb corydalis (*Corydalis yanhusuo*) may also help relieve toothache pain. Pain also may be reduced using **acupressure**, **acupuncture**, or **reiki**. Acupuncture should be done only by a licensed practitioner.

Prognosis

Prompt dental treatment provides a positive outcome for toothache. In the absence of active infection, fillings, root canal treatments, or extractions may be performed with minimal discomfort to the patient. When a toothache is left untreated, a severe infection may develop and spread to the sinuses or jawbone, and eventually cause blood poisoning.

Prevention

Maintaining proper **oral hygiene** is the key to preventing toothaches. The best way to prevent tooth decay is to brush at least twice a day, preferably after every meal and snack. Flossing once a day also helps prevent gum disease by removing food particles and bacteria at and below the gum line, as well as between teeth. Visiting the dentist at least every six months for oral examinations and professional cleaning can help prevent a variety of oral health problems that can lead to toothache.

Resources

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American Dental Association, 211 East Chicago Avenue, Chicago, IL, 60611-2678, (312) 440-2500, www.ada.org.

American Dental Education Association, 1400 K Street, Suite 1100, Washington, DC, 20005, (202) 289-7201, (202) 289-7204, www.adea.org.

American Dental Hygienists' Association, 444 North Michigan Avenue, Suite 3400, Chicago, IL, 60611, (312) 440-8900, mail@adha.net, www.adha.org.

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Topical anesthesia

Definition

Topical anesthesia is a condition of temporary **numbness** caused by applying a substance directly to a surface of the body. Loss of feeling occurs in the specific areas touched by the anesthetic substance.

Purpose

Topical anesthesia typically either relieves existing **pain** from a body surface or prevents pain during medical examinations or procedures. Body surfaces include both skin and mucous membranes, which are the moist linings of areas such as the inside of the mouth or nose. Occasionally, use of a topical anesthetic may help clarify whether a patient's pain comes from a body surface, which the substance is able to touch, or from deeper structures beyond the reach of the substance. A mucous membrane, an area of skin, or areas just beneath the skin's surface temporarily loses feeling during topical anesthesia.

Precautions

Topical anesthetic medications must be selected carefully and used in proper amounts in order to prevent harmful reactions. For instance, some topical drugs should be used only on intact skin to avoid rapid absorption into the body. Therefore, it is important to choose the right type and dosage of anesthetic for each specific purpose.

Description

Most drugs in the early 2000s used to cause topical anesthesia have at least some chemical similarity to **cocaine**, which was recognized as a topical anesthetic in the early 1900s. These drugs work by blocking nerve impulses that carry pain messages to the brain. Commonly used, twenty-first-century drugs include benzocaine, lidocaine, prilocaine, and tetracaine, These drugs come in several application forms, such as cream, jelly, ointment, solution, and spray, are available in varying strengths, and may be used alone or in combinations.

One common use for topical anesthetics is to relieve pain from problems such as sores in the mouth, skin scrapes, and **hemorrhoids**. A person typically applies a cream or jelly to the affected area. Numbness begins within a few minutes, and the anesthetic effect may last an hour or more. Repeated applications are often necessary.

The other broad category of use for topical anesthetics is to prevent pain from medical examinations or procedures on areas such as the eye, nose, throat, urethra, rectum, or skin. For example, even a single drop of anesthetic may allow examination of a painfully irritated eye or removal of a speck of dirt from the eye surface. Careful inspection of a nostril or insertion of a urinary drainage tube into the urethra may be difficult or impossible without the use of topical anesthetic spray or jelly beforehand.

Many uses of topical anesthetics involve application to the skin. Physicians and patients have long hoped for a way to numb an area of skin without having to use a needle to inject anesthetic. Original topical anesthetics were not effective in this way. A newer drug preparation called eutectic mixture of local anesthetics (EMLA, lidocaine 2.5%, and prilocaine 2.5%) can be used as a cream on intact skin. When applied for about 60 minutes, EMLA numbs the skin and penetrates as far as 5 mm below the surface. EMLA may help patients by decreasing the pain of needle pricks or simple skin procedures, such as repair of small lacerations. The main drawback to EMLA is that it takes so long for the anesthetic effect to begin, thus reducing its usefulness in settings such as the emergency rooms. Other drug combinations such as tetracaine, epinephrine (adrenaline), and cocaine (TAC), or lidocaine, epinephrine, and tetracaine (LET) have their own advantages and disadvantages.

The application of ice to a body area is a primitive method of producing topical anesthesia. Chemicals such as ethyl chloride can be sprayed onto intact skin to produce a momentary freezing and numbing effect.

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KEY TERMS

Anesthetic—Not having sensation; related to the loss of sensation; or, a substance that produces loss of sensation.

EMLA—Eutectic mixture of local anesthetics, a drug combination for use on intact skin.

LET—A topical anesthetic mixture containing lidocaine, epinephrine, and tetracaine.

Mucous membranes—Moist linings of body surfaces such as the inside of the mouth or nose.

Numbness—Loss of feeling or sensation.

TAC—A topical anesthetic mixture containing tetracaine, epinephrine (adrenaline), and cocaine.

Topical—For use directly on a body surface.

Covering the ointment with plastic wrap increases the absorption of the ointment through the skin. The use of plastic wrap, or other occlusive **dressings**, is the standard means of applying EMLA cream. Other techniques include using gentle heat or electric current to help the drugs penetrate intact skin.

Risks

Overall, topical anesthesia tends to be very safe. Minor problems might include discoloration of the skin at the application site or an uncomfortable feeling of numbness that lasts longer than expected. Repeated use of a topical anesthetic on a damaged eye surface may interfere with the normal healing process. Rarely, too much of the drug may be absorbed into the body in a short time and cause a reaction such as seizure or rapid heartbeat. **Death** related to topical anesthesia is extremely rare.

Normal results

Successful use of a topical anesthetic produces temporary loss of sensation in the area where it is applied.

Resources

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Kenneth J. Berniker, M.D.
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Topical antibiotics *see* **Antibiotics, topical**

Topical antifungal drugs *see* **Antifungal drugs, topical**

TORCH test

Definition

The TORCH test, which is sometimes called the TORCH panel, belongs to a category of blood tests called infectious-disease antibody titer tests. This type of blood test measures the presence of antibodies (protein molecules produced by the human immune system in response to a specific disease agent) and their level of concentration in the blood. The name of the test comes from the initial letters of the five disease categories. The TORCH test measures the levels of an infant's antibodies against five groups of chronic infections: *t*oxoplasmosis, *o*ther infections, *r*ubella, *c*ytomegalovirus (CMV), and *h*erpes simplex virus (HSV). The "other infections" usually include **syphilis**, **hepatitis B**, coxsackie virus, **Epstein-Barr virus**, varicella-zoster virus, and human parvovirus.

Since the TORCH test is a screening or first-level test, the pediatrician may order tests of other body fluids or tissues to confirm the diagnosis of a specific infection. In the case of **toxoplasmosis**, **rubella**, and syphilis, cerebrospinal fluid may be obtained from the infant through a spinal tap in order to confirm the diagnosis. In the case of CMV, the diagnosis is confirmed by culturing the virus in a sample of the infant's urine. In HSV infections, tissue culture is the best method to confirm the diagnosis.

Purpose

The five categories of organisms whose antibodies are measured by the TORCH test are grouped together because they can cause a cluster of symptomatic **birth defects** in newborns. This group of defects is sometimes called the TORCH syndrome. A newborn baby with these symptoms will be given a TORCH test to see if any of the five types of infection are involved.

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The symptoms of the TORCH syndrome include:

- Small size in proportion to length of the mother's pregnancy at time of delivery. Infants who are smaller than would be expected (below the tenth percentile) are referred to as small-for-gestational-age, or SGA.
- Enlarged liver and spleen
- Low level of platelets in the blood
- Skin rash. The type of skin rash associated with the TORCH syndrome is usually reddish-purple or brown and is caused by the leakage of blood from broken capillaries into the baby's skin.
- Involvement of the central nervous system. These defects can include encephalitis, calcium deposits in the brain tissue, and seizures.
- Jaundice. The yellowish discoloration of the skin and whites of the eyes due to liver disease.

In addition to these symptoms, each of the TORCH infections has its own characteristic symptom cluster in newborns:

Toxoplasmosis

Toxoplasmosis is caused by *Toxoplasma gondii*, a parasite that the mother can acquire from handling infected cats, drinking unpasteurized milk, or eating contaminated meat. The infection is carried to the infant through the mother's placenta, and can cause infections of the eyes or central nervous system. The organism can invade brain or muscle tissue and form tissue cysts. The later in **pregnancy** that the mother is infected, the higher the probability that the fetus will be infected. On the other hand, toxoplasmosis early in pregnancy is more likely to cause a **miscarriage** or serious birth defects. The incidence of toxoplasmosis in newborns is one in 1,000 live births.

Other (syphilis)

Syphilis is caused by a spirochete (spiral- or coil-shaped bacterium), *Treponema pallidum*. It is transmitted in the adult population by sexual intercourse. About 2-5% of children born to mothers diagnosed with syphilis will have the disease at birth. Syphilis was added to the TORCH panel because of a rapid increase in reported cases since 1990. It is also a potentially life-threatening infection for the fetus. Syphilis can cause early delivery, miscarriage, or **stillbirth**. The mortality rate in infants infected with syphilis is about 54%.

Rubella

Rubella is a virus that has a seasonal pattern, with epidemics most likely in the spring. Between 0.1-2% of newborns will be infected with rubella. The rate of fetal infection varies according to the timing of the mother's infection during pregnancy. Birth defects, however, are most likely (85%) in infants infected during the first eight weeks of pregnancy. Infants born with rubella may already show signs of heart disease, retarded growth, **hearing loss**, blood disorders, vision problems, or **pneumonia**. They may also develop problems later in childhood, including **autism**, hearing loss, brain syndromes, immune system disorders, or thyroid disease.

Cytomegalovirus (CMV)

Cytomegalovirus belongs to the herpesvirus group of infections. It can be transmitted through body secretions, as well as by sexual contact; some newborns acquire CMV through the mother's breast milk. In adults, it produces symptoms resembling those of mononucleosis. About 1–2.2% of newborns in the United States are infected with CMV. Of this group, 10% will have measurable symptoms. The mortality rate for these symptomatic newborns is 20–30%. Surviving infants with CMV may suffer from hearing problems (15%) or **mental retardation** (30%). Newborns that acquire CMV during the birth process or shortly after birth may develop pneumonia, hepatitis, or various blood disorders.

Herpes simplex virus (HSV)

Herpesvirus infections are among the most common viral infections in humans. They are spread by oral, as well as genital, contact. It is estimated that between 1 in 1,000 and 1 in 5,000 infants are born with HSV infections. About 80% of these infections are acquired during the birth process itself; the virus enters the infant through its eyes, skin, mouth, and upper respiratory tract. Of infants born with HSV infection, about 20% will have localized infections of the eyes, mouth, or skin. About 50% of infected infants will develop disease spread throughout the body (disseminated) within nine to 11 days after birth. Disseminated herpes infections attack the liver and adrenal glands, as well as other body organs. Without treatment, the mortality rate is 80%. Even with antiviral medication, the mortality rate is still 15–20%, with 40–55% of the survivors having long-term damage to the central nervous system. It is critical for the doctor to diagnose HSV infection in the newborn as soon as possible, for effective treatment.

Description

The TORCH panel requires a sample of the infant's blood. Samples from infants are usually obtained by the heelstick procedure when only a small quantity of blood is needed. The baby's foot is wrapped

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KEY TERMS

Antibody—A protein molecule produced by the immune system that is specific to a disease agent, such as CMV and the other organisms sought by the TORCH test. The antibody combines with the organism and disables it.

Perinatal—Referring to the period of time surrounding an infant's birth, from the last two months of pregnancy to the first 28 days of life. The TORCH panel tests for perinatal infections.

Small-for-gestational-age (SGA)—A term used to describe newborns who are below the 10th percentile in height or weight for their estimated gestational age. The gestational age is based upon the date of the mother's last menstrual period. SGA is one of the symptoms of TORCH syndrome.

Titer—The concentration of a substance in a given sample of blood or other tissue fluid.

in a warm cloth for five minutes, to make the blood flow more easily. The foot is then wiped with an alcohol swab and a lancet is used to stick the baby's heel on one side. It is important to avoid the center of the heel, in order to prevent an inflammation of the bone.

Preparation

No special preparation, other than sterile technique, is required.

Risks

The only complications associated with the TORCH test are those resulting from the heelstick technique itself. These risks include scarring, infection of the bone, **cellulitis** (inflammation of cellular tissue), small lumpy **calcium** deposits, and inaccurate test results.

Normal results

The normal result would be normal levels of immunoglobulin M (IgM) antibody in the infant's blood. IgM is one of five types of protein molecules found in blood that function as antibodies. IgM is a specific class of antibodies that seeks out virus particles. In contrast to adults, IgM is the most common type of immunoglobulin in newborn children. It is, therefore, the most useful indicator of the presence of a TORCH infection.

Abnormal results

The general abnormal, or positive, finding would be high levels of IgM antibody. The test can be refined further for antibodies specific to given disease agents. The TORCH screen, however, can produce both false-positive and false-negative findings. Doctors can measure IgM levels in the infant's cerebrospinal fluid, as well as in the blood, if they want to confirm the TORCH results.

Resources

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Rebecca J. Frey, PhD

Torticollis

Definition

Torticollis (cervical dystonia or spasmodic torticollis) is a type of movement disorder in which the muscles controlling the neck cause sustained twisting or frequent jerking.

Description

In torticollis, certain muscles controlling the neck undergo repetitive or sustained contraction, causing the neck to jerk or twist to the side. Cervical dystonia causes forward twisting, and is called antecollis. Backward twisting is known as retrocollis. The abnormal posture caused by torticollis is often debilitating, and is usually painful.

Torticollis most commonly begins between age 30–60, with females affected twice as often as males. According to the National Spasmodic Torticollis Association, torticollis affects 83,000 people in the United States. Dystonia tends to become more severe during the first months or years after onset, and may spread to other regions, especially the jaw, arm, or leg. Torticollis should not be confused with such other causes of abnormal neck posture as orthopedic or congenital problems.

Causes and symptoms

The nerve signals responsible for torticollis are thought to originate in the basal ganglia, a group of brain structures involved in movement control. The exact defect is unknown. Some cases of dystonia are

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due to the inheritance of a defective gene, whose function was unknown as of 2010. Other cases are correlated with neck or head trauma, such as from an automobile accident. Use of certain **antipsychotic drugs**, or neuroleptics, can induce dystonia.

There are three types of torticollis:

- tonic, in which the abnormal posture is sustained
- clonic, marked by jerky head movements.
- mixed, a combination of tonic and clonic movements

Symptoms usually begin gradually, and may be intermittent at first, worsening in times of **stress**. Symptoms usually progress over two to five years, and then remain steady. Symptoms may be relieved somewhat when lying down. Many people with torticollis can temporarily correct their head position by sensory tricks, as touching the chin or cheek on the side opposite the turning. The reason for the effectiveness of this "geste antagoniste," as it is called, is unknown.

Pain in the neck, back, or shoulder affects more than two-thirds of all people with torticollis. Pain may spread to the arm or hand.

Diagnosis

Diagnosis of torticollis is aided by an electrical study (**electromyography**) that can detect overactive muscles. Imaging studies, including x rays, may be done to rule out other causes of abnormal posture. A detailed medical history is needed to determine possible causes, including trauma.

Treatment

A variety of oral drugs are available to relax muscles, including baclofen. For a subgroup of patients, L-dopa provides effective relief. Denervation of the involved neck muscles may be performed with injection of alcohol or phenol on to the nerve.

Injection of botulinum toxin (BTX) is considered by many to be the treatment of choice. By preventing release of chemical messages from the nerve endings that stimulate the involved muscles, BTX partially paralyzes the muscles, therefore allowing more normal posture and range of motion. BTX treatment lasts several months, and may be repeated.

Physical therapy can help relieve secondary consequences of torticollis. Regular muscle stretching prevents contracture, or permanent muscle shortening. Pain and spasm may be temporarily lessened with application of heat or ice. Stress management techniques may help prevent worsening. An occupational therapist can suggest home or work modifications to reduce **fatigue** and improve function. Braces constructed to replace the patient's own sensory tricks may help reduce abnormal posture.

Alternative treatment

Biofeedback may be effective for some patients. Regular **massage therapy** can reduce additional pain in compensating areas of the body. Two energy-based therapies, **acupuncture** and **homeopathic medicine**, can work to rebalance the whole person, helping to correct the torticollis. Antispasmodic herbs may help to relax the muscles. In addition, herbs that can help balance the stimulus from the nervous system are often recommended.

Prognosis

Spontaneous remission is seen in up to 20% of patients, most often those patients with older onset and milder symptoms. Dystonia may spread to affect other regions of the body.

Prevention

There is no way known to prevent torticollis.

ORGANIZATIONS

National Spasmodic Torticollis Association, 9920 Talbert Avenue, Fountain Valley, CA, 92708, (800) 487-8385, NSTAmail@aol.com, http://www.torticollis.org.

Worldwide Education and Awareness for Movement Disorders, 204 W. 84th St., New York, NY, 10024, wemove@wemove.org, http://www.wemove.org.

Richard Robinson

Total parenteral nutrition

Definition

Total parenteral **nutrition** (TPN) is a way of supplying all the nutritional needs of the body by bypassing the digestive system and by administering nutrient solution directly into a vein. Other terms used synonymously with TPN include parenteral nutrition and hyperalimentation.

Purpose

TPN is used when individuals cannot or should not get their nutrition through eating. TPN is used when the intestines are obstructed, when the small intestine is not absorbing nutrients properly, or when a gastrointestinal **fistula** (abnormal connection) is

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present. It is also used when the bowels need to rest and should not have any food passing through them. Bowel rest may be necessary in **Crohn's disease**, **pancreatitis**, ulcerative **colitis**, and with prolonged bouts of **diarrhea** in young children. TPN is also used for individuals with severe **burns**, multiple **fractures**, and in malnourished individuals to prepare them for major surgery, **chemotherapy**, or radiation treatment. Individuals with **AIDS** or widespread infection (**sepsis**) and other medical conditions may also benefit from the administration of TPN.

KEY TERMS

Catheter—A hollow tube that is inserted into veins or other passages in the body to insert or remove fluid.

Electrolyte—An ion such as potassium, sodium, or chloride dissolved in fluid that helps to regulate metabolic activities of cells.

Fistula—An abnormal passage that connects one organ to another or that connects the organ to the outside of the body.

Description

TPN is normally given through a large central vein. A catheter is inserted into the vein in the chest area under **local anesthesia** and sterile conditions. Placement may be done in an operating room to decrease the chance of infection. Several different types of catheters are used based on the reason TPN is needed and the expected length of treatment. Catheters are made of silicone or similar materials. Once the catheter is in place, a **chest x ray** is done to make sure the placement is correct.

Normally TPN is administered in a hospital, but under certain conditions and with proper patient and caregiver education, it may also be used at home for long–term therapy. TPN solution is mixed daily under sterile conditions. Maintaining sterility is essential for preventing infection. For this reason, the outside tubing leading from the bag of solution to the catheter is changed daily, and special **dressings** covering the catheter are changed daily as well.

The contents of the TPN solution are determined based on the age, weight, height, and medical condition of the individual. All solutions contain sugar (dextrose) for energy and protein (amino acids). Fats (lipids) may also be added to the solution. Electrolytes such as potassium, **sodium**, **calcium**, magnesium, chloride, and phosphate are also included, as these are essential to the normal functioning of the body. Trace elements such as zinc, copper, manganese and chromium are also needed. **Vitamins** can be included in the TPN solution, and insulin, a hormone that helps the body use sugar, may need to be added. Adults need approximately two liters of TPN solution daily, although this amount varies with age, size, and health of the individual. Special solutions have been developed for individuals with reduced liver and kidney function. The solution is infused slowly at first to prevent fluid imbalances, then the rate is gradually increased. The infusion process takes several hours.

Successful TPN requires frequent, often daily, monitoring of the individual's weight, glucose (blood sugar) level, blood count, blood gases, fluid balance, urine output, waste products in the blood (plasma urea) and electrolytes. Liver and **kidney function tests** may also be performed. Contents of the solution are individualized based on the results of these tests.

Precautions

Individuals need to tell their doctor if they have any **allergies**, what medications they are taking, if they are diabetic, have had liver, kidney, heart, lung, or hormonal disorders, and if they are pregnant. All these factors can affect the type and amount of TPN required.

Preparation

Preparation to insert the catheter involves creating a sterile environment. Other special preparations are not normally necessary.

Aftercare

During the time the catheter is in place, patients and caregivers must be alert to any signs of infection such as redness, swelling, **fever**, drainage, or **pain**.

Risks

TPN requires close monitoring. Two types of complications can develop. Infection, air in the lung cavity (**pneumothorax**), and blood clot formation (thrombosis) all can develop as a result of inserting the catheter into a vein. Metabolic and fluid imbalances can occur if the contents of the nutritional fluid are not properly balanced and monitored. The most common metabolic imbalance is **hypoglycemia**, or low blood sugar, caused by abruptly discontinuing a solution high in sugar.

Most of the time, TPN is administered through an infusion pump so that delivery of the fluids can be precisely monitored and calculated.

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Results

Ideally TPN will provide all nutrients in the correct quantity to allow the body to function normally.

Resources

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Total protein test *see* **Protein components test**

Tourette syndrome

Definition

Tourette syndrome (TS) is an inherited disorder of the nervous system that typically appears in childhood. The main features of TS are repeated movements and vocalizations called tics. TS can also be associated with behavioral and developmental problems.

Demographics

Tourette syndrome is a relatively common disorder found in all populations and all ethnic groups. TS is three to four times more common in males than females. The exact incidence of Tourette syndrome is unknown but it is estimated to affect 1 to 10 in 1,000 children. According to the National Institute for Neurological Disorders and **Stroke** (NINDS), an estimated 200,000 Americans have the most severe form of TS, and as many as one in 100 have milder symptoms such as chronic motor or vocal tics. Early TS symptoms are almost always noticed first in childhood, with the average onset between the ages of 7 and 10 years.

Description

Tourette syndrome is a variable disorder with onset in childhood. Though symptoms can appear anywhere between the ages of 2 and 18, typical onset is around age 6 or 7. Tics, which may be motor or vocal, tend to wax and wane (increase and decrease) in severity over time. The first references in the literature to what might today be classified as TS largely describe individuals who were wrongly believed to be possessed by the devil. In 1885 Gilles de la Tourette, a French neurologist, provided the first formal description of this syndrome, which he described as an inherited neurological condition characterized by motor and vocal tics.

Although vocal and motor tics are the hallmark of Tourette syndrome, other symptoms such as the expression of socially inappropriate comments or behaviors, obsessive compulsive disorder, attention deficit disorder, self injuring behavior, depression, and **anxiety** also appear to be associated with Tourette syndrome. Symptoms usually intensify during teenage years and diminish in late adolescence or early adulthood. Patients may also develop co–occurring behavioral disorders, namely obsessive–compulsive disorder (OCD), **attention deficit hyperactivity disorder (ADHD)** or attention deficit disorder (ADD), poor impulse control, and/or **sleep disorders**. Though some children have learning disabilities, intelligence is not impaired. TS is not degenerative and life span is normal.

Risk factors

As of 2009, TS risk factors are unknown, and researchers are studying risk factors before and after birth that may contribute to this complex disorder. Some of the suggested factors include severe psychological trauma, recurrent daily stresses, extreme emotional excitement, PANDAS (pediatric autoimmune neuropsychiatric disorder with streptococcal infection), and drug **abuse**.

Causes and symptoms

A variety of genetic and environmental factors likely play a role in causing TS. Studies suggest that the tics in Tourette syndrome are caused by an increased amount of a neurotransmitter called dopamine. A neurotransmitter is a chemical found in the brain that helps to transmit information from one brain cell to another. Other studies suggest that the defect in Tourette syndrome involves another neurotransmitter called serotonin or involves other chemicals required for normal functioning of the brain.

Genetic factors are believed to play a major role in the development of TS. Several chromosomal regions have been identified as possible locations of genes that confer susceptibility to TS. Some family studies have indicated that TS may be inherited in an autosomal dominant manner, but other studies have shown that this is not the case. Mutations involving the SLITRK1

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gene have been identified in a small number of TS patients. This gene provides instructions for making a brain protein called SLITRK1. This protein probably plays a role in the development of nerve cells, including the growth of axons and dendrites that allow each nerve cell to communicate with nearby cells. It is unclear how mutations in the SLITRK1 gene can lead to this disorder. The inheritance pattern of Tourette syndrome remains unknown. Although the features of TS can cluster in families, many genetic and environmental factors are likely to be involved. Some researchers believe that Tourette syndrome has different causes in different individuals or is caused by changes in more than one gene. Further research is needed to establish the cause of Tourette syndrome.

Motor and vocal tics

The principal symptoms of Tourette syndrome include simple and complex motor and vocal tics. Simple motor tics are characterized by brief muscle contractions of one or more limited muscle groups. An eye twitch is an example of a simple motor tic. Complex motor tics tend to appear more complicated and purposeful than simple tics and involve coordinated contractions of several muscle groups. Some examples of complex motor tics include the act of hitting oneself and jumping. Copropraxia, the involuntary display of unacceptable/obscene gestures, and echopraxia, the imitation of the movement of another individual, are other examples of complex motor tics.

Vocal tics are actually manifestations of motor tics that involve the muscles required for vocalization. Simple vocal tics include **stuttering**, stammering, abnormal emphasis of part of a word or phrase, and inarticulate noises such as throat clearing, grunts, and high–pitched sounds. Complex vocal tics typically involve the involuntary expression of words. Perhaps the most striking example of this is coprolalia, the involuntary expression of obscene words or phrases, which occurs in fewer than one–third of people with Tourette syndrome. The involuntary echoing of the last word, phrase, sentence or sound vocalized by oneself (phalilalia) or of another person or sound in the environment (echolalia) are also classified as complex tics.

The type, frequency, and severity of tics exhibited varies tremendously between individuals with Tourette syndrome. Tourette syndrome has a variable age of onset and tics can start anytime between infancy and age 18. Initial symptoms usually occur before the early teens and the mean age of onset for both males and females is approximately seven years of age. Most individuals with symptoms initially experience simple muscle tics involving the eyes and the head. These symptoms can progress to tics involving the upper torso, neck, arms, hands, and occasionally the legs and feet. Complex motor tics are usually the latest onset muscle tics. Vocal tics usually have a later onset then motor tics. In some rare cases, people with Tourette syndrome suddenly present with multiple, severe, or bizarre symptoms.

Not only is there extreme variability in clinical symptoms between individuals with Tourette syndrome, but individuals commonly experience a variability in type, frequency, and severity of symptoms within the course of their lifetime. Adolescents with Tourette syndrome often experience unpredictable and variable symptoms, which may be related to fluctuating hormone levels and decreased compliance in taking medications. Adults often experience a decrease in symptoms or a complete end to symptoms.

A number of factors appear to affect the severity and frequency of tics. **Stress** appears to increase the frequency and severity of tics while concentration on another part of the body that is not taking part in a tic can result in the temporary alleviation of symptoms. Relaxation, following attempts to suppress the occurrence of tics, may result in an increased frequency of tics. An increased frequency and severity of tics can also result from exposure to drugs such as **steroids**, **cocaine**, amphetamines, and **caffeine**. Hormonal changes such as those that occur prior to the menstrual cycle can also increase the severity of symptoms.

Other associated symptoms

People with Tourette syndrome are more likely to exhibit non–obscene, socially inappropriate behaviors such as expressing insulting or socially unacceptable comments or socially unacceptable actions. It is not known whether these symptoms stem from a more general dysfunction of impulse control that might be part of Tourette syndrome.

Tourette syndrome appears to also be associated with attention deficit disorder (ADD). ADD is a disorder characterized by a short attention span and impulsivity and in some cases hyperactivity. Researchers have found that 21–90% of individuals with Tourette syndrome also exhibit symptoms of ADD, whereas 2–15% of the general population exhibit symptoms of ADD.

People with Tourette syndrome are also at higher risk for having symptoms of obsessive–compulsive disorder (OCD). OCD is a disorder characterized by persistent, intrusive, and senseless thoughts (obsessions) or compulsions to perform repetitive behaviors

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KEY TERMS

Attention deficit disorder (ADD)—Disorder characterized by a short attention span, impulsivity, and in some cases hyperactivity.

Autosomal dominant—A pattern of genetic inheritance where only one abnormal gene is needed to display the trait or disease.

Axon—The long extension of a nerve fiber that generally conducts impulses away from the body of the nerve cell.

Coprolalia—The involuntary expression of obscene words or phrases.

Copropraxia—The involuntary display of unacceptable/obscene gestures.

Decreased penetrance—Individuals who inherit a changed disease gene but do not develop symptoms.

Dendrites—Fibers of a brain cell that receive signals from other brain cells.

Dysphoria—Feelings of anxiety, restlessness, and dissatisfaction.

Echolalia—Involuntary echoing of the last word, phrase, or sentence spoken by someone else or sound in the environment.

Echopraxia—The imitation of the movement of another individual.

Neurotransmitter—Chemical in the brain that transmits information from one nerve cell to another.

Obsessive compulsive disorder (OCD)—Disorder characterized by persistent, intrusive, and senseless thoughts (obsessions) or compulsions to perform repetitive behaviors that interfere with normal functioning.

Phalilalia—Involuntary echoing of the last word, phrase, sentence, or sound vocalized by oneself.

Tic—Brief and intermittent involuntary movement or sound.

that interfere with normal functioning. A person with OCD, for example, may be obsessed with germs and may counteract this obsession with continual hand washing. Symptoms of OCD are present in 1.9–3% of the general population, whereas 28–50% of people with Tourette syndrome have symptoms of OCD.

Self–injurious behavior (SIB) is also seen more frequently in those with Tourette syndrome. Approximately 34–53% of individuals with Tourette syndrome exhibit some form of self–injuring behavior. The SIB is often related to OCD but can also occur in those with Tourette syndrome who do not have OCD.

Symptoms of anxiety and depression are also found more commonly in people with Tourette syndrome. It is not clear, however, whether these symptoms are symptoms of Tourette syndrome or occur as a result of having to deal with the symptoms of moderate to severe Tourette syndrome.

People with Tourette syndrome may also be at increased risk for having learning disabilities and **personality disorders** and may be more predisposed to behaviors such as aggression, antisocial behaviors, severe temper outbursts, and inappropriate sexual behavior. Further controlled studies need to be performed, however, to ascertain whether these behaviors are symptoms of Tourette syndrome.

Diagnosis

Examination

The TS diagnosis is made through observation and interview of the patient and discussions with other family members. The diagnosis of Tourette syndrome is complicated by a variety of factors. The extreme range of symptoms of this disorder makes it difficult to differentiate Tourette syndrome from other disorders with similar symptoms. Diagnosis is further complicated by the fact that some tics appear to be within the range of normal behavior. For example, an individual who only exhibits tics such as throat clearing and sniffing may be misdiagnosed with a medical problem such as **allergies**. In addition, bizarre and complex tics such as coprolalia may be mistaken for psychotic or "bad" behavior. Diagnosis is also confounded by individuals who attempt to control tics in public and in front of health care professionals and deny the existence of symptoms. Although there is disagreement over what criteria should be used to diagnosis Tourette syndrome, one aid in the diagnosis is the *Diagnostical and Statistical Manual of Mental Disorders* (*DSM–IV*). The *DSM–IV* outlines suggested diagnostic criteria for a variety of conditions including Tourette syndrome such as:

- Presence of both motor and vocal tics at some time during the course of the illness.

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- The occurrence of multiple tics nearly every day through a period of more than one year, without a remission of tics for a period of greater than three consecutive months.
- The symptoms cause distress or impairment in functioning.
- Age of onset of prior to 18 years of age.
- The symptoms are not due to medications or drugs and are not related to another medical condition.

Some physicians critique the *DSM–IV* criteria, citing that they do not include the full range of behaviors and symptoms seen in Tourette syndrome. Others criticize the criteria since they limit the diagnosis to those who experience a significant impairment, which may not be true for individuals with milder symptoms. For this reason many physicians use their clinical judgment as well as the *DSM–IV* criteria as a guide to diagnosing Tourette syndrome.

Tests

Patients may undergo blood tests, imaging studies such as **magnetic resonance imaging** (MRI), or an electroencephalogram (EEG) scan in order to rule out other possible explanations for the symptoms.

Treatment

There is no cure for Tourette syndrome, and treatment involves the control of symptoms through educational and psychological interventions and/or medications. The treatment and management of Tourette syndrome varies from patient to patient and is typically focused on the alleviation of the symptoms that are most bothersome to the patient or that cause the most interference with daily functioning.

Traditional

Psychological treatments such as counseling are not generally useful for the treatment of tics but can be beneficial in the treatment of associated symptoms such as obsessive–compulsive behavior and attention deficit disorder. Counseling may also help individuals to cope better with the symptoms of this disorder and to have more positive social interactions. Psychological interventions may also help people cope better with stressors that can normally be triggers for tics and negative behaviors. Relaxation therapies may, however, increase the occurrence of tics. Treatment is crucial in helping the affected child avoid depression, social isolation, and strained family relationships. The education of family members, teachers, and peers about Tourette syndrome can be helpful and may help to foster acceptance and prevent social isolation.

Drugs

Many people with mild symptoms of Tourette syndrome never require medications. Those with severe symptoms may require medications for all or part of their lifetime. No single or combination (more than one) drug therapy offers complete cessation of symptoms without adverse effects. The most effective treatment of tics associated with Tourette syndrome involves the use of drugs such as Haloperidol, Pimozide, Sulpiride, and Tiapride, which decrease the amount of dopamine in the body. Unfortunately, the incidence of side effects, even at low dosages, is quite high. The short–term side effects can include **sedation**, dysphoria, weight gain, movement abnormalities, depression, and poor school performance. Long–term side effects can include **phobias**, memory difficulties, and personality changes. These drugs are therefore better candidates for short–term rather than long–term therapy.

Tourette syndrome can also be treated with other drugs such as clonidine, clonazepam, and risperidone, but the efficacy of these treatments is unknown. In many cases, treatment of associated conditions such as ADD and OCD is often more of a concern than the tics themselves. Clonidine used in conjunction with stimulants such as Ritalin may be useful for treating people with Tourette syndrome who also have symptoms of ADD. Stimulants should be used with caution in individuals with Tourette syndrome since they can sometimes increase the frequency and severity of tics. OCD symptoms in those with Tourette syndrome are often treated with drugs such as Prozac, Luvox, Paxil, and Zoloft.

In many cases the treatment of Tourette syndrome with medications can be discontinued after adolescence. Trials should be performed through the gradual tapering off of medications and should always be done under a doctor's supervision.

Alternative

Clinical trials for the treatment of Tourette syndrome are currently sponsored by the National Institutes of Health (NIH) and other agencies. In 2009, NIH reported 22 ongoing or recently completed studies. Some examples include the following:

- A study to investigate how the sensitivity to touch and smell in patients with Tourette syndrome may differ from that of people without TS. (NCT00368433)
- The evaluation of whether deep brain stimulation is effective at reducing tic frequency and severity in adults with Tourette syndrome. (NCT00311909)

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- A study using magnetic resonance imaging (MRI) and magnetic resonance spectroscopy (MRS) of the brain to try to gain a better understanding of the disease process in Tourette's syndrome. (NCT00030953)

Clinical trial information is constantly updated by NIH and the most recent information on Tourette syndrome trials can be found at: http://clinicaltrials.gov/search/open/condition=%22Tourette+Syndrome%22

Prognosis

The prognosis for Tourette syndrome in individuals without associated psychological conditions is often quite good, and only approximately 10% of Tourette syndrome individuals experience severe tic symptoms. Approximately 30% of people with Tourette syndrome will experience a decrease in the frequency and severity of tics and another 30–40% will experience a complete end of symptoms by late adolescence. The other 30–40% will continue to exhibit moderate to severe symptoms in adulthood. There does not appear to be a definite correlation between the type, frequency, and severity of symptoms and the eventual prognosis. Patients with severe tics may experience social difficulties and may isolate themselves from others in fear of shocking and embarrassing them. People with Tourette syndrome who have other symptoms such as obsessive compulsive disorder, attention deficit disorder, and self–injurious behavior usually have a poorer prognosis.

Prevention

There is no known way to prevent Tourette syndrome.

Resources

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ORGANIZATIONS

National Institute of Neurological Disorders and Stroke (NINDS), PO Box 5801, Bethesda, MD, 20824, (301) 496-5751, (800) 352-9424, http://www.ninds.nih.gov.

Tourette Syndrome Association (TSA), 42-40 Bell Blvd., Suite 205, Bayside, NY, 11361-2820, (718) 224-2999, http://www.tsa-usa.org.

Tourette Syndrome Foundation of Canada, 5945 Airport Rd., Suite 195, MississaugaON, Canada, L4V 1R9, (905) 673-2255, (800) 361-3120, (905) 673-2638, http://www.tourette.ca.

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Toxic encephalopathy *see* **Delirium**

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Toxic epidermal necrolysis

Definition

Toxic epidermal necrolysis is a rare condition that causes large portions of the epidermis, the skin's outermost layer, to detach from the layers of skin below. A reaction to a medication is the primary cause.

Description

Toxic epidermal necrolysis (TEN) begins with **fever**, **cough**, and other nonspecific symptoms, and is soon followed by purplish, bloody-looking lesions on the skin and mucous membranes. These early lesions, typically found on the head, neck, and upper chest, soon merge and blister. Sheets of epidermis then begin to detach from the skin layers below. In time, the entire surface of the skin may be involved, with detachment of 100% of the epidermis.

Causes and symptoms

The main cause of TEN is a severe drug reaction. Some investigators believe there may be additional infectious causes. A severe reaction in transplant patients, called **graft-vs.-host disease**, can also produce TEN. One study reported more than 100 different drugs as causes of TEN. The drugs most commonly implicated, however, include antibacterial **sulfonamides** such as sulfadiazine, **antibiotics** such as aminopenicillins and **cephalosporins**, and anticonvulsants like phenytoin. TEN is extremely rare. Researchers estimate that there are 0.2 cases per million users of aminopenicillins and 4.5 cases per million users of sulfonamides.

Exactly what leads to detachment of the epidermis remains unclear. People with TEN seem to have difficulty metabolizing the offending drug. Some researchers suggest that certain substances that should be cleared from the body instead get deposited on the outer shell of the epidermis, causing an immune response that leads the body to "reject" the skin.

Diagnosis

Diagnosis is made primarily on the appearance and spread of the **skin lesions**, and on a history that includes introduction of a new medication within the previous one to three weeks. A biopsy of the early lesions will confirm the diagnosis. Physicians will consider other potential diseases that cause similar symptoms before reaching a diagnosis of TEN. One is **erythema multiforme**, a recurrent skin disorder that produces lesions similar in appearance to TEN. However, this disorder is not caused by a drug reaction and does not lead to sheet-like shedding of the skin. Another disease, Stevens-Johnson syndrome, is a drug-induced skin disease that some experts believe is really a milder form of TEN. **Staphylococcal scalded skin syndrome** (SSSS) also looks like TEN, but it is caused by a staphylococcal infection. Unlike TEN, which occurs rarely in children, SSSS primarily affects infants, young children, and adults with weakened immune systems.

KEY TERMS

Epidermis—The outermost layer of the skin.

Erythema multiforme—A recurrent skin disorder that produces lesions similar in appearance to TEN, but is not caused by a drug reaction and does not lead to sheet-like shedding of the skin.

Staphylococcal scalded skin syndrome—A disease caused by *Staphylococcus aureus,* in which large sheets of skin may peel away from the body. It most often affects infants, young children, and people with weakened immune systems.

Stevens-Johnson syndrome—A drug-induced skin disease that some experts believe is really a milder form of TEN.

Treatment

There is no specific treatment for TEN. Patients are typically treated in an intensive care unit or in a burn unit and receive treatment similar to that given to patients with major **burns**. With the loss of skin, severe **dehydration** is a major risk, so health care workers will attempt to replace fluids intravenously. Nutritional supplementation from a tube routed through the nose to the stomach may also be contemplated to promote the healing of the skin. Infection is a major risk, so some physicians "paint" the open lesions with topical **antiseptics**. Others use skin grafts taken from cadavers or cultured skin substitutes to cover large open areas until healing can occur. Some investigators believe system **corticosteroids** are useful in the treatment of TEN. But since these medications have also been implicated as a cause in some cases of TEN and are known to supress the immune system, their use should be considered carefully.

Prognosis

About 25-30% of patients with TEN die. Elderly patients, those with extensive skin lesions, and those with **AIDS** have the worst prognosis. Widespread

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systemic infection (**sepsis**) is the primary cause of **death**. Survivors, however, will be completely healed in three to four weeks.

Prevention

There is no prevention for TEN. No reliable test can indicate that a specific drug may cause TEN in a specific patient. Some researchers believe skin tests of potentially offending drugs may prove useful in the future.

ORGANIZATIONS

American Academy of Dermatology, PO Box 4014, Schaumburg, IL, 60168-4014, (847) 240-1859, (866) 503-SKIN (7546), http://www.aad.org.

Richard H. Camer

Toxic shock syndrome

Definition

Toxic shock syndrome (TSS) is an uncommon, but potentially fatal, illness that occurs when poisonous substances (toxins) produced by certain bacteria enter the bloodstream. TSS is a medical emergency and requires immediate medical attention.

Demographics

Although TSS is, in the public mind, most strongly associated with healthy women who used super-absorbent tampons during the 1980s and developed the syndrome, children and men also can develop TSS. At its height between 1980 and 1984, TSS affected 15,000 people in the United States annually. Once the cause of the syndrome was understood and the offending tampons were removed from the market, the rate dropped sharply. Although in 2010, TSS was uncommon (only 1–3 cases per 100,000 population), the rate is increasing, most likely due to an increase in strains of antibiotic-resistant bacteria that can cause the syndrome.

Description

TSS first came to the attention of the public in the late 1970s. Shortly after the introduction of super-absorbent tampons, young women across the United States experienced an epidemic of serious but unexplained symptoms. Thousands went to emergency rooms with high **fever**, **vomiting**, peeling skin, low blood pressure, **diarrhea**, and a rash resembling **sunburn**. The only thing they had in common was that they all were menstruating at the time they felt sick, and all were using tampons, especially super-absorbent products.

Despite the association of TSS and menstruating women, the disease can affect anyone of either sex or any age or race. The infection may occur in children, men, and non-menstruating women who are weakened from surgery, injury, or disease, and who cannot fight off a staphylococcal infection. New mothers also are at higher risk for TSS.

As of 2010, two kinds of toxic shock syndrome were recognized. Traditional toxic shock or TSS is caused by staphylococcus bacteria. Another form of toxic shock caused by streptococcal bacteria was recognized in 1987, It is referred to as Streptococcal toxic shock syndrome or (STSS). STSS is related to the strain of streptococcus nicknamed the "flesh-eating bacterium." It affects only one or two out of every 100,000 Americans. STSS almost never follows a simple **strep throat** infection. Sometimes STSS is referred to as toxic shock-like syndrome or TSLS.

Risk factors

People who are most likely to develop TSS are between the ages of 15 and 35. STSS is most likely to affect people between the ages of 20 and 50. Other risk factors include just having given birth, extended use of packing material to stop blood flow (e.g. tampons, packing to stop a nose bleed), the use of barrier contraceptives (e.g., diaphragm, vaginal sponge, especially if left in a long time) recent surgery, a recent staphylococcal or streptococcal infection and recent varicella (**chickenpox**) infection.

Causes and symptoms

TSS is caused by staphylococcal bacteria, most often a specific strain of *Staphylococcus aureus* found in the nose, mouth, and occasionally the vagina. The bacteria produce a characteristic toxin. In large enough quantities, the toxin enters the bloodstream and causes a potentially fatal infection.

These types of bacteria normally are present either on hands or in the vagina, and it takes an amount of bacteria only the size of a grain of sand to start an infection. Of the 15% of women who carry *Staphylococcus aureus*, only about 5% have the strain that produces the TSS toxin. STSS is caused by streptococcal bacteria, most often a specific strain of *Streptococcus pyogenes*.

TSS begins with 2–3 day period of mild symptoms, then symptoms escalate suddenly, with a high

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KEY TERMS

Electrocardiogram (ECG, EKG)—A test that records the electrical activity of the heart using small electrode patches attached to the skin on the chest.

Electrolyte—Salts and minerals that ionize in body fluids. The major human electrolytes are sodium (Na^+), potassium (K^+), calcium (Ca^{2+}), magnesium (Mg^{2+}), chloride (Cl^-), phosphate (HPO_4^{2-}), bicarbonate (HCO_3-), and sulfate (SO_4^{2-}). Electrolytes control the fluid balance of the body and are important in muscle contraction, energy generation, and almost all major biochemical reactions in the body.

Shock—A condition in which the amount of blood circulating in the body is inadequate to meet the body's needs. Shock can be caused by certain diseases, serious injury, or blood loss.

Staphylococcus—A genus of bacteria that is commonly found on human skin and mucous membranes.

Streptococcus—A genus of sphere-shaped bacteria that can cause a wide variety of infections.

Toxin—A poisonous protein that is produced by some bacteria. A toxin is less complex than a poison.

fever of 102°F (38.9°C) or above, **vomiting** and watery diarrhea, **headache**, and sunburn-like rash, together with a **sore throat** and body aches. Blood pressure may plummet a day or two after the first symptoms appear. When the blood pressure drops, an individual may become disoriented or go into shock. The kidneys may fail. After these developments, the skin on the hands and feet may peel. Symptoms of STSS are usually more serious and severe than those of TSS, although both variations of the syndrome can be fatal.

Diagnosis

No specific tests will diagnose TSS or STSS. A **complete blood count** (CBC) and blood cultures, blood electrolyte measurements, **urinalysis**, renal (Kidney) function and **liver function tests**, imaging studies, and an electrocardiogram (ECG) may be done to rule out other diseases and to indicate the direction of treatment.

Treatment

TSS and STSS are medical emergencies. Individuals who suspect that they have this syndrome should go to the emergency department immediately.

Individuals will be hospitalized usually in an intensive care unit (ICU), possibly for an extended period. All foreign packing material should be removed from the body as soon as possible. The first step in treatment is to stabilize the individual, which may involve giving oxygen, medications to increase blood pressure, or **kidney dialysis** if the kidney is failing and ventilator support if breathing is impaired. The second part of treatment involves the administration of intravenous (IV) **antibiotics** and sometimes surgery to eliminate the infection. The increasing prevalence of strains of antibiotic-resistant bacteria may make it necessary to use multiple antibiotics to control the infection. The final step of treatment involves, where possible, reversing any damage caused by the bacterial toxins. This may involve surgery to remove dead or damaged tissue.

Prognosis

Untreated TSS/STSS can be fatal. Even with treatment, about 5% of individuals with TSS die and up to 70% of individuals with STSS die. Individuals with diabetes, compromised immune systems, the very young, and the elderly are most likely to die. Rapid treatment increases the chance of survival. Survivors may experience long-term kidney damage, memory and concentration problems, lung damage, and nervous system abnormalities. The syndrome recurs within two months in 30–50% of individuals, although recurrence is generally less severe than the initial infection.

Prevention

Women who wear tampons should wash their hands before inserting the tampon and change tampons often (every 4–6 hours). **Wounds** should be kept clean and **dressings** changed regularly. Some of the more serious complications can be reduced or prevented by seeking emergency medical care as soon as TSS/STSS is suspected. This is not a condition that can be successfully treated with home care or alternative therapies.

Resources

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ORGANIZATIONS

Infectious Diseases Society of America (IDSA), 1300 Wilson Boulevard, Suite 300, Arlington, VA, 22209, 703 299-0200, 703 299-0204, info@idsociety.org, http://www.idsociety.org/.

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National Institute of Allergy and Infectious Diseases Office of Communications and Government Relations, 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-6612, 301 496-5717, 866 284-4107 or TDD: 800 877-8339 (for hearing impaired), 301 402-3573, http://www3.niaid.nih.gov.

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Toxocariasis *see* **Roundworm infections**

Toxoplasma gondii infection *see* **Toxoplasmosis**

Toxoplasmosis

Definition

Toxoplasmosis is an **infectious disease** caused by the one–celled protozoan parasite *Toxoplasma gondii*. Although most individuals do not experience any symptoms, the disease can be very serious, and even fatal, in individuals with weakened immune systems.

Demographics

There is no person–to–person transmission, except from an infected mother to her child in the womb. Approximately six out of 1,000 women contract toxoplasmosis during **pregnancy**. Nearly half of these maternal infections are passed on to the fetus. Known as congenital toxoplasmosis, this form of the disease is acquired at birth by approximately 3,300 infants in the United States every year. The risk of fetal infection is estimated to be between one in 1,000 to one in 10,000. In children born with toxoplasmosis, symptoms may be severe and quickly fatal, or may not appear until several months or even years after birth.

Description

Toxoplasmosis is caused by a one–celled protozoan parasite known as *Toxoplasma gondii*. Cats, the primary carriers of the organism, become infected by eating rodents and birds infected with the organism. Once ingested, the organism reproduces in the intestines of cats, producing millions of eggs known as oocysts, which are excreted in cat feces daily for approximately two weeks. In the United States, it is estimated that approximately 30% of cats have been infected by *T. gondii*. Oocysts are not capable of producing infection until approximately 24 hours after being excreted, but they remain infective in water or moist soil for approximately one year. When cattle, sheep, or other livestock forage through areas with contaminated cat feces, these animals become carriers of the disease. Fruits and vegetables can also become contaminated when irrigated with untreated water that has been contaminated with cat feces. In humans and other animals, the organisms produce thick–walled, dormant structures called cysts in the muscle and other tissues of the body.

Most humans contract toxoplasmosis by eating cyst–contaminated raw or undercooked meat, vegetables, or milk products. Humans can also become infected when they come into contact with *T. gondii* eggs while cleaning a cat's litter box, gardening, or playing in a sandbox, for instance. Once infected, an individual is immune to reinfection. The incubation period or period between infection and the start of the disease ranges from several days to months.

Anyone can be infected by *T. gondii*, but usually only those individuals with weakened immune systems (immunocompromised) develop symptoms of the disease. For them, toxoplasmosis can be severe, debilitating, and fatal. Immunocompromised individuals at risk include those with **AIDS**, **cancer**, or other chronic illnesses.

Causes and symptoms

Healthy individuals do not usually display symptoms. When symptoms do occur, they are usually mild, resembling **infectious mononucleosis**, and include the following:

- enlarged lymph nodes
- muscle pains
- intermittent fever
- general sick feeling

The distinction is made between acquired toxoplasmosis, in which an individual becomes infected, and neonatal congenital toxoplasmosis, in which a fetus is born with the infection because the mother became infected during pregnancy. If a fetus becomes infected early in pregnancy, the disease can cause the fetus to spontaneously abort or be stillborn. If full–term, the infant may die in infancy or suffer from central nervous system lesions. If the mother becomes infected in the last three months of pregnancy, however, the prognosis is good, and the baby may not even display any symptoms.

In adults, if infection continues for an extended period of time, chronic toxoplasmosis can cause an inflammation of the eyes called retinochoroiditis, which can lead to blindness, severe yellowing of the skin and whites of the eyes (**jaundice**), easy bruising, and convulsions.

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KEY TERMS

Cyst—The thick–walled dormant form of many organisms.

Immunocompromised—A state in which the immune system is suppressed or not functioning properly.

Oocyst—The egg form of the toxoplasmosis organism.

Protozoan—A single–celled, usually microscopic, organism.

Adults with weakened immune systems have a high risk of developing cerebral toxoplasmosis, including inflammation of the brain (**encephalitis**), one–sided weakness or **numbness**, mood and personality changes, vision disturbances, **muscle spasms**, and severe headaches. If untreated, cerebral toxoplasmosis can lead to **coma** and **death**. This form of encephalitis is the second most common AIDS–related nervous system infection that takes advantage of a person's weakened immune system (opportunistic infection).

Diagnosis

A diagnosis of toxoplasmosis is made based on clinical signs and supporting laboratory results, including visualization of the protozoa in body tissue or isolation in animals and blood tests. Laboratory tests for toxoplasmosis are designed to detect increased amounts of a protein or antibody produced in response to infection with the toxoplasmosis organism. Antibody levels can be elevated for years, however, without active disease.

Treatment

Most individuals who contract toxoplasmosis do not require treatment because their immune systems are able to control the disease. Symptoms are not usually present. Mild symptoms may be relieved by taking over–the–counter medications, such as **acetaminophen** (Tylenol) and ibuprofen (Motrin, Advil). **Sore throat** lozenges and rest may also ease the symptoms.

Although the treatment of women infected with toxoplasmosis during pregnancy is controversial, most physicians feel that treatment is justified. Transmission of toxoplasmosis from the mother to the fetus may be prevented if the mother takes the antibiotic spiramycin. Later in a pregnancy, if the fetus has contracted the disease, treatment with the antibiotic pyrimethamine (Daraprim, Fansidar) or **sulfonamides** may be effective. Babies born with toxoplasmosis who show symptoms of the disease may be treated with pyrimethamine, the sulfa drug sulfadiazine (Microsulfon), and folinic acid (an active form of **folic acid**).

AIDS patients who have not been infected may be given a drug called TMP/SMX (Bactrim or Septra) to prevent toxoplasmosis infection. To treat cases of toxoplasmosis in immunocompromised AIDS patients, a combination of pyrimethamine and a sulfa–based drug, either sulfadiazine or clindamycin (Cleocin), have been used together and can be effective in treating this disease. Other antibiotic combinations and dosing schedules are still being investigated. Physicians have reported success in alleviating symptoms by using trimethoprim–sulfamethoxazole (Proloprim or Trimpex) or dapsone (DDS) plus pyrimethamine. These drugs can produce side effects, such as allergic reaction, **itching**, **rashes**, and **nausea**, and patients must be monitored closely.

Prognosis

Prognosis is poor when congenital toxoplasmosis is acquired during the first three months of pregnancy. Afflicted children die in infancy or suffer damage to their central nervous systems that can result in physical and **mental retardation**. Infection later in pregnancy usually results in only mild symptoms, if any. The prognosis for acquired toxoplasmosis in adults with strong immune systems is excellent. The disease often disappears by itself after several weeks. However, the prognosis for immunodeficient patients is not as positive. These patients often relapse when treatment is stopped. The disease can be fatal to immunocompromised patients, especially AIDS patients, and particularly if not treated. As a result, immunocompromised patients are typically placed on anti–toxoplasmosis drugs for the rest of their lives.

Prevention

There are no drugs that can eliminate *T. gondii* cysts in animal or human tissues. Humans can reduce their risks of developing toxoplasmosis by practicing the following:

- freezing (to 10.4°F/–12°C) and cooking foods to an internal temperature of 152°F/67°C will kill the cyst
- practicing sanitary kitchen techniques, such as washing utensils and cutting boards that come into contact with raw meat
- keeping pregnant women and children away from household cats and cat litter
- disposing of cat feces daily, because the oocysts do not become infective until after 24 hours

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- helping cats to remain free of infection by feeding them dry, canned, or boiled food and by discouraging hunting and scavenging
- washing hands after outdoor activities involving soil contact and wearing gloves when gardening

Resources

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ORGANIZATIONS

American College of Obstetricians and Gynecologists (ACOG), 409 12th St. SW, PO Box 96920, Washington, DC, 20080–6920, (202) 863–2518, http://www.acog.org.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Rd., Atlanta, GA, 30333, (888) 232–3228, http://www.cdc.gov.

March of Dimes Birth Defects Foundation, 1275 Mamaroneck Ave., White Plains, NY, 10605, (914) 997–4488, http://www.marchofdimes.com.

Maury M. Breecher, Ph.D.
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Toxoplasmosis, Other, Rubella, Cytomegalovirus,Herpes simplex test *see* **TORCH test**

Trabeculectomy

Definition

Trabeculectomy is a surgical procedure that removes part of the trabeculum in the eye to relieve pressure caused by glaucoma.

Purpose

Glaucoma is a disease that injures the optic nerve, causing progressive loss of vision. Presently, glaucoma is a major cause of blindness in the United States If caught early, glaucoma-related blindness is easily prevented. However, since it does not produce symptoms until late in its cycle, periodic tests for the disease are necessary.

KEY TERMS

Cornea—Transparent film that covers the iris and pupil.

Iris—Colored part of the eye, which is suspended in aqueous humor and perforated by the pupil.

Sclera—White, outer coating of the eyeball.

Trabeculoplasty—Laser surgery that creates perforations in the trabeculum, to drain built up aqueous humor and relieve pressure.

Trabeculum—Tissue that is a drainage point for aqueous humor in the eye.

Glaucoma is usually associated with an increase in the pressure inside the eye. This increase occurs in front of the iris in a fluid called the aqueous humor. Aqueous humor is supposed to exit through tiny channels between the iris and the cornea, in an area called the trabeculum. When the trabeculum is blocked, pressure from the build up of aqueous humor either increases rapidly with considerable **pain** and redness, or, as in most cases, the pressure builds slowly with no symptoms until much of the vision is lost. Trabeculectomy is the last treatment employed for either type of glaucoma. It is used only after medications and laser trabeculoplasty (less invasive procedure that uses a laser to open the blocked trabeculum) have failed to alleviate the pressure.

Description

A trabeculectomy involves removing a tiny piece of the eyeball right at the place where the cornea connects to the sclera (the white part), and creating a flap to allow fluid to escape the anterior chamber without deflating the eye. Along with that tiny piece of cornea and sclera comes a piece of the iris. The whole area is called the trabeculum. Fluid can then flow out onto the surface of the eye and be absorbed by the conjunctiva, the transparent membrane that lines the sclera and the eyelids. Sometimes, an additional piece is taken out of the iris so that anterior chamber fluid can also flow backward into the vitreous part of the eye. This procedure is called an iridectomy.

Preparation

The procedure and its benefits and possible complications are fully explained. Antiglaucoma drugs are prescribed before surgery. Added pressure on the eye caused from coughing or sneezing should be avoided.

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Aftercare

Eye drops, and perhaps patching, will be needed until the eye is healed. The pressure inside the eye will still be monitored. Immediately following the procedure, the patient may experience blurred vision.

Risks

Infection and bleeding are risks of any surgery. Scarring can cause the drainage to stop. A third of patients with trabeculectomies will develop **cataracts**.

Resources

BOOKS

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J. Ricker Polsdorfer, MD

Tracheoesophageal fistula

Definition

Tracheoesophageal **fistula** (TEF) is commonly a birth defect, with the trachea connected to the esophagus. In most cases, the esophagus is discontinuous, causing immediate feeding difficulties. TEFs may develop in adult life, secondary to the invasion of **cancer** in the area. In addition, TEFs may be deliberately constructed with surgery to aid talking in a patient who has the larynx removed (a **laryngectomy**).

Description

The trachea, or windpipe, carries air to the lungs. The esophagus carries food to the stomach. Sometimes during development, these two tubes do not separate completely, but remain connected by a short passage. When this happens, air enters the gastrointestinal system, causing the bowels to distend, and mucus is breathed into the lungs causing aspiration **pneumonia** and breathing problems.

Most tracheoesophageal fistulas are diagnosed when a child is born. There are three types. In 85–90% of tracheoesophageal fistulas, the top part of the esophagus ends in a blind sac, and the lower part inserts into the trachea. In the second type, the upper part of the esophagus is connected directly to the trachea, while the lower part ends in a pouch. In a rare type of fistula called an H type, both the esophagus and trachea are complete, but they are connected. This is the most difficult type of tracheoesophageal fistula to diagnose, because both eating and breathing are possible.

KEY TERMS

Endoscopy—A procedure in which an instrument containing a camera and a light source is inserted into the gastrointestinal tract so that the physician can visually inspect the gastrointestinal system.

Gastrostomy tube—Stomach tube for feeding.

Laryngectomy—Surgical removal of the larynx to treat cancer.

Causes and symptoms

Tracheoesophageal fistulas arise as a developmental abnormality. At birth, the infant has difficulty swallowing. Eating produces severe coughing spells that interfere with breathing. Aspiration pneumonia can develop from fluid breathed into the lungs.

Small H type fistulas may go undiagnosed until later in life. Symptoms of an H type fistula include frequent pulmonary infections and bouts of abdominal bloating.

Diagnosis

Diagnosis that the esophagus is interrupted is confirmed by the inability to insert a **nasogastric suction** tube into the stomach. The exact type and location of the fistula can be determined using a radiopaque catheter, which allows pictures to be taken of the esophagus. X rays may show air in the bowels. **Endoscopy** often fails to located the fistula if it is small.

Treatment

Babies with all but H type fistulas are unlikely to survive without surgical separation and repair of the trachea and the esophagus. Surgery cannot always be performed immediately because of **prematurity**, the presence of other **birth defects**, or complications from aspiration pneumonia. It is usually done at a hospital that has special facilities for treating seriously ill newborns.

While awaiting surgery, the infant's condition is stabilized. Preoperative care concentrates on avoiding aspiration pneumonia and includes:

- elevating the head to avoid reflux and aspiration of the stomach contents
- using a suction catheter to continuously removed mucus and saliva that could be inhaled

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- when necessary, placement of a gastrostomy tube
- withholding feeding by mouth

When surgery is performed, the esophagus is reconnected to make it continuous and separate from the trachea. If the two ends of the esophagus are too far apart to be reattached, a piece of tissue from the large intestine is used to join the parts.

Prognosis

Infants who have tracheoesophageal fistula often have other birth defects that affect their recovery. Even when the esophagus is successfully separated and reattached, many infants have difficulty swallowing, because the contractility of the esophagus is impaired. Infants may also have problems with gastroesophageal reflux, in which the acidic contents of the stomach back up into the bottom of the esophagus and cause ulcers and scarring.

Prevention

Tracheoesophageal fistulas are not preventable birth defects.

Resources

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Beers, Mark H., Robert S. Porter, and Thomas V. Jones, eds. *The Merck Manual of Diagnosis and Therapy*. 18th ed. Whitehouse Station, NJ: Merck Research Laboratories, 2006.

Tish Davidson, A.M.

Tracheostomy *see* **Tracheotomy**

Tracheotomy

Definition

A tracheotomy is a surgical procedure that opens up the windpipe (trachea). It is performed in emergency situations, in the operating room, or at bedside of critically ill patients. The term tracheostomy is sometimes used interchangeably with tracheotomy. Strictly speaking, however, tracheostomy usually refers to the opening itself while a tracheotomy is the actual operation.

Purpose

A tracheotomy is performed if enough air is not getting to the lungs, if the person cannot breathe without help, or is having problems with mucus and other secretions getting into the windpipe because of difficulty swallowing. There are many reasons why air cannot get to the lungs. The windpipe may be blocked by a swelling; by a severe injury to the neck, nose, or mouth; by a large foreign object; by **paralysis** of the throat muscles; or by a tumor. The patient may be in a **coma**, or need a ventilator to pump air into the lungs for a long period of time.

Demographics

Emergency tracheotomies are performed as needed in any person requiring one.

Description

Emergency tracheotomy

There are two different procedures that are called tracheotomies. The first is done only in emergency situations and can be performed quite rapidly. The emergency room physician or surgeon makes a cut in a thin part of the voice box (larynx) called the cricothyroid membrane. A tube is inserted and connected to an oxygen bag. This emergency procedure is sometimes called a cricothyroidotomy.

Surgical tracheotomy

The second type of tracheotomy takes more time and is usually done in an operating room. The surgeon first makes a cut (incision) in the skin of the neck that lies over the trachea. This incision is in the lower part of the neck between the Adam's apple and top of the breastbone. The neck muscles are separated and the thyroid gland, which overlies the trachea, is usually cut down the middle. The surgeon identifies the rings of cartilage that make up the trachea and cuts into the tough walls. A metal or plastic tube, called a tracheotomy tube, is inserted through the opening. This tube acts like a windpipe and allows the person to breathe. Oxygen or a mechanical ventilator may be hooked up to the tube to bring oxygen to the lungs. A dressing is placed around the opening. Tape or stitches (sutures) are used to hold the tube in place.

After a nonemergency tracheotomy, the patient usually stays in the hospital for three to five days, unless there is a complicating condition. It takes about two weeks to recover fully from the surgery.

Diagnosis/Preparation

Emergency tracheotomy

In the emergency tracheotomy, there is no time to explain the procedure or the need for it to the patient. The patient is placed on his or her back with face

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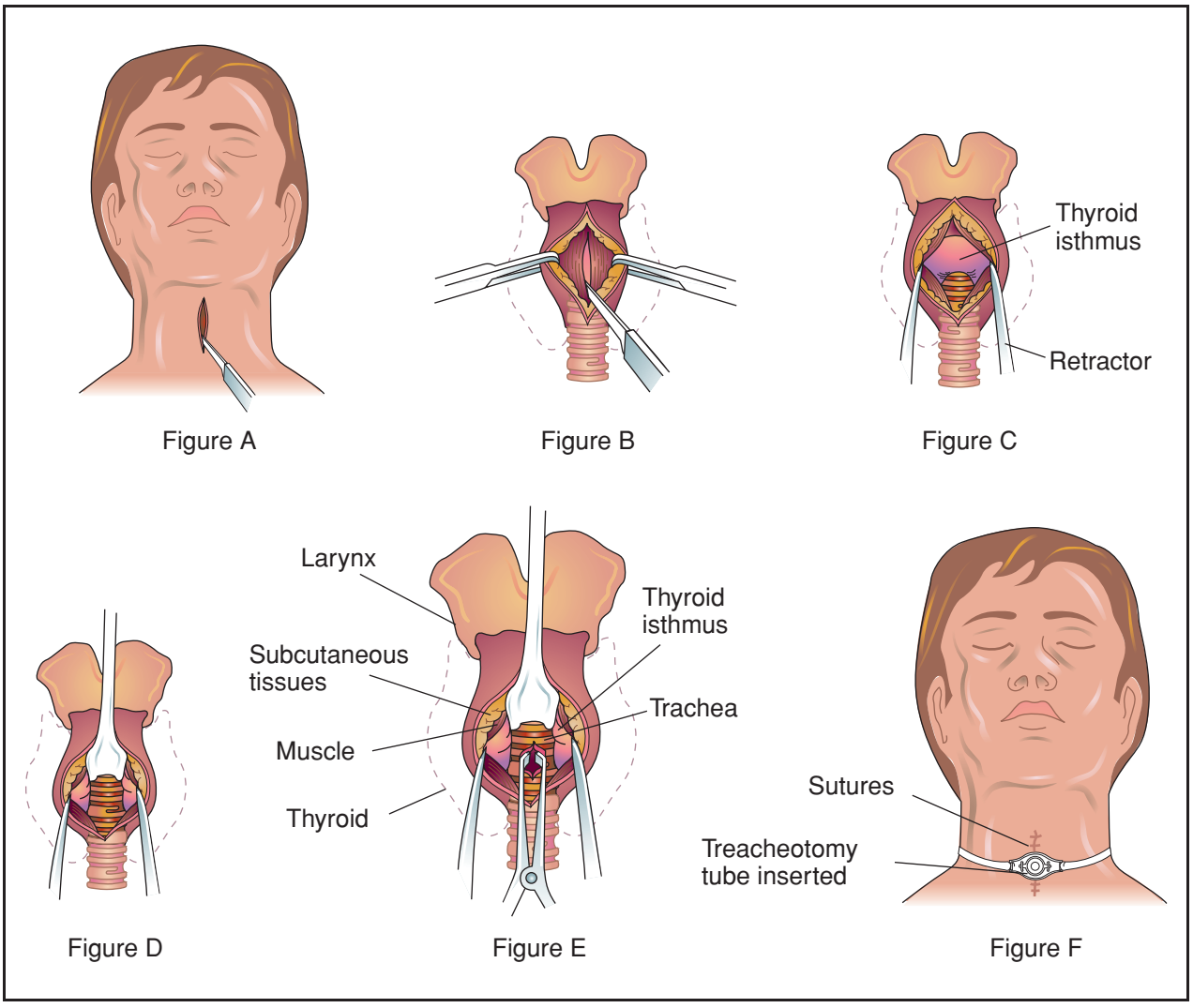

Tracheotomy is a surgical procedure in which an opening is made in the windpipe or trachea. As shown in the illustration above, the physician or surgeon will follow these steps in performing this procedure: Figure A: A vertical incision is made through the skin. Figure B: Another incision is made through the subcutaneous tissues and muscles of the neck. Figure C: The neck muscles are separated using retractors. Figure D: The thyroid isthmus is either cut or retracted. Figure E: The surgeon identifies the rings of cartilage that make up the trachea and cuts into the walls. Figure F: A metal or plastic tube is inserted into the opening and sutures are used to hold the tube in place. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

upward (supine), with a rolled-up towel between the shoulders. This positioning of the patient makes it easier for the doctor to feel and see the structures in the throat. A local anesthetic is injected across the cricothyroid membrane.

Nonemergency tracheotomy

In a nonemergency tracheotomy, there is time for the doctor to discuss the surgery with the patient, to explain what will happen and why it is needed. The patient is then put under **general anesthesia**. The neck area and chest are then disinfected and surgical drapes are placed over the area, setting up a sterile surgical field.

Aftercare

Postoperative care

A **chest x ray** is often taken, especially in children, to check whether the tube has become displaced or if complications have occurred. The doctor may prescribe **antibiotics** to reduce the risk of infection. If the patient can breathe without a ventilator, the room is

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KEY TERMS

Cartilage—A tough, fibrous connective tissue that forms various parts of the body, including the trachea and larynx.

Cricothyroidotomy—An emergency tracheotomy that consists of a cut through the cricothyroid membrane to open the patient's airway as fast as possible.

Larynx—A structure made of cartilage and muscle that connects the back of the throat with the trachea. The larynx contains the vocal cords.

Trachea—The tube that leads from the larynx or voice box to two major air passages that bring oxygen to each lung. The trachea is sometimes called the windpipe.

Ventilator—A machine that helps patients to breathe. It is sometimes called a respirator.

humidified; otherwise, if the tracheotomy tube is to remain in place, the air entering the tube from a ventilator is humidified. During the hospital stay, the patient and his or her family members will learn how to care for the tracheotomy tube, including suctioning and clearing it. Secretions are removed by passing a smaller tube (catheter) into the tracheotomy tube.

It takes most patients several days to adjust to breathing through the tracheotomy tube. At first, it will be hard even to make sounds. If the tube allows some air to escape and pass over the vocal cords, then the patient may be able to speak by holding a finger over the tube. Special tracheostomy tubes are also available that facilitate speech.

The tube will be removed if the tracheotomy is temporary. Then the wound will heal quickly and only a small scar may remain. If the tracheotomy is permanent, the hole stays open and, if it is no longer needed, it will be surgically closed.

Home care

After the patient is discharged, he or she will need help at home to manage the tracheotomy tube. Warm compresses can be used to relieve **pain** at the incision site. The patient is advised to keep the area dry. It is recommended that the patient wear a loose scarf over the opening when going outside. He or she should also avoid contact with water, food particles, and powdery substances that could enter the opening and cause serious breathing problems. The doctor may prescribe pain medication and antibiotics to minimize the risk of infections. If the tube is to be kept in place permanently, the patient can be referred to a speech therapist in order to learn to speak with the tube in place. The tracheotomy tube may be replaced four to 10 days after surgery.

Patients are encouraged to go about most of their normal activities once they leave the hospital. Vigorous activity is restricted for about six weeks. If the tracheotomy is permanent, further surgery may be needed to widen the opening, which narrows with time.

Risks

Immediate risks

There are several short-term risks associated with tracheotomies. Severe bleeding is one possible complication. The voice box or esophagus may be damaged during surgery. Air may become trapped in the surrounding tissues or the lung may collapse. The tracheotomy tube can be blocked by **blood clots**, mucus, or the pressure of the airway walls. Blockages can be prevented by suctioning, humidifying the air, and selecting the appropriate tracheotomy tube. Serious infections are rare.

Long-term risks

Over time, other complications may develop following a tracheotomy. The windpipe itself may become damaged for a number of reasons, including pressure from the tube, infectious bacteria that forms scar tissue, or friction from a tube that moves too much. Sometimes the opening does not close on its own after the tube is removed. This risk is higher in tracheotomies with tubes remaining in place for 16 weeks or longer. In these cases, the wound is surgically closed. Increased secretions may occur in patients with tracheostomies, which require more frequent suctioning.

High-risk groups

The risks associated with tracheotomies are higher in the following groups of patients:

- children, especially newborns and infants
- smokers
- alcoholics
- obese adults
- persons over 60
- persons with chronic diseases or respiratory infections
- persons taking muscle relaxants, sleeping medications, tranquilizers, or cortisone

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Normal results

Normal results include uncomplicated healing of the incision and successful maintenance of long-term tube placement.

Morbidity and mortality rates

The overall risk of **death** from a tracheotomy is less than 5%.

Alternatives

For most patients, there is no alternative to emergency tracheotomy. Some patients with pre-existing neuromuscular disease (such as ALS or **muscular dystrophy**) can be sucessfully managed with emergency noninvasive ventilation via a face mask, rather than with tracheotomy. Patients who receive nonemergency tracheotomy in preparation for mechanical ventilation may often be managed instead with noninvasive ventilation, with proper planning and education on the part of the patient, caregiver, and medical staff.

Resources

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Myers, Eugene N., and Jonas T. Johnson. *Tracheotomy: Airway Management, Communication, and Swallowing* 2nd ed. San Diego, CA: Plural, 2007.

ORGANIZATIONS

American College of Sports Medicine, P.O. Box 1440, Indianapolis, IN, 46206-1440, (317) 637-9200, (317) 634-7817, MSSR@Online, http://acsm.org.

American College of Surgeons, 633 North Saint Claire Street, Chicago, IL, 60611, (312) 202-5000, 800-621-4111, 312-202-5001, postmaster@facs.org, http://www.facs.org.

Jeanine Barone
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Trachoma

Definition

Trachoma, which is also called granular **conjunctivitis** or Egyptian ophthalmia, is a contagious, chronic inflammation of the mucous membranes of the eyes, caused by *Chlamydia trachomatis*. It is characterized by swelling of the eyelids, sensitivity to light, and eventual scarring of the conjunctivae and corneas of the eyes.

A close-up of a human eye with trachoma. Trachoma is caused by *Chlamydia trahomatis* and commonly results in blindness if left untreated. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Description

Trachoma is a major cause of blindness in the world. It is found in the Far East, as well as countries with desert climates. In the United States, it is most common among certain Native Americans and in parts of Appalachia. The infection is highly contagious in its early stages. Blindness results from recurrent untreated infections.

The conjunctiva is the clear mucous membrane that lines the inside of the eyelid and covers the white part (sclera) of the eye. Conjunctivitis is an inflammation of the conjunctiva.

Causes and symptoms

Trachoma is caused by *C. trachomatis*, a parasitic organism closely related to bacteria. It is transmitted by insects, by hand-to-eye contact, or by the sharing of infected handkerchiefs or towels. The incubation period is about a week.

The early symptoms of trachoma include the development of follicles (small sacs) on the conjunctivae of the upper eyelids, **pain**, swollen eyelids, a discharge, tearing, and sensitivity to light. If the infection is not treated, the follicles develop into large yellow or gray pimples, and small blood vessels develop inside the cornea. In most cases, both eyes are infected.

Repeated infections eventually lead to contraction and turning-in of the eyelids, scarring of the corneas and conjunctivae, eventual blockage of the tear ducts, and blindness.

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KEY TERMS

Conjunctivitis—Inflammation of the conjunctivae, which are the mucous membranes covering the white part of the eyeball (sclera) and lining the inside of the eyelids.

Cornea—The transparent front part of the eye that allows light to enter.

Ophthalmia—Inflammation of the eye. Usually severe and affecting the conjunctiva. Trachoma is sometimes called Egyptian ophthalmia.

Diagnosis

Diagnosis is based on a combination of the patient's history (especially living or traveling in areas with high rates of trachoma) and examination of the eyes. The doctor will look for the presence of follicles or scarring. He or she will take a small sample of cells from the patient's conjunctivae and examine them, following a procedure called Giemsa staining, to confirm the diagnosis.

Treatment

Treatment of early-stage trachoma consists of four to six weeks of antibiotic treatment with tetracycline, erythromycin, or **sulfonamides**. **Antibiotics** should be given without waiting for laboratory test results. Treatment may combine oral medication with antibiotic ointment applied directly to the eyes. A single-dose treatment with azithromycin is an alternative method. **Tetracyclines** should not be given to pregnant women or children below the age of seven years.

Patients with complications from untreated or repeated infections are treated surgically. Surgery can be used for **corneal transplantation** or to correct eyelid deformities.

Prognosis

The prognosis for full recovery is excellent if the patient is treated promptly. If the infection has progressed to the stage of follicle development, prevention of blindness depends on the severity of the follicles, the presence of additional bacterial infections, and the development of scarring.

Prevention

There are vaccines available that offer temporary protection against trachoma, but there is no permanent immunization. Prevention depends upon good hygiene and public health measures:

- Seek treatment immediately if a child shows signs of eye infection, and minimize his or her contact with other children.
- Teach children to wash hands carefully before touching their eyes.
- Protect children from flies or gnats that settle around the eyes.
- If someone has trachoma (or any eye infection), do not share towels, pillowcases, etc; wash items well.
- If medications are prescribed, follow the doctor's instructions carefully.

Resources

BOOKS

McPhee, Stephen, and Maxine Papadakis. *Current Medical Diagnosis and Treatment, 2010*, 49th ed. New York: McGraw-Hill Medical, 2009.

Rebecca J. Frey, PhD

Traction

Definition

Traction is the use of a pulling force to treat muscle and skeleton disorders.

Purpose

Traction is usually applied to the arms and legs, the neck, the backbone, or the pelvis. It is used to treat **fractures**, **dislocations**, and long-duration **muscle spasms**, and to prevent or correct deformities. Traction can either be short-term, as at an accident scene, or long-term, when it is used in a hospital setting.

Traction serves several purposes:

- it aligns the ends of a fracture by pulling the limb into a straight position
- it ends muscle spasm
- it relieves pain
- it takes the pressure off the bone ends by relaxing the muscle

There are two main types of traction: skin traction and skeletal traction. Within these types, many specialized forms of traction have been developed to address problems in particular parts of the body. The application of traction is an exacting technique that requires training

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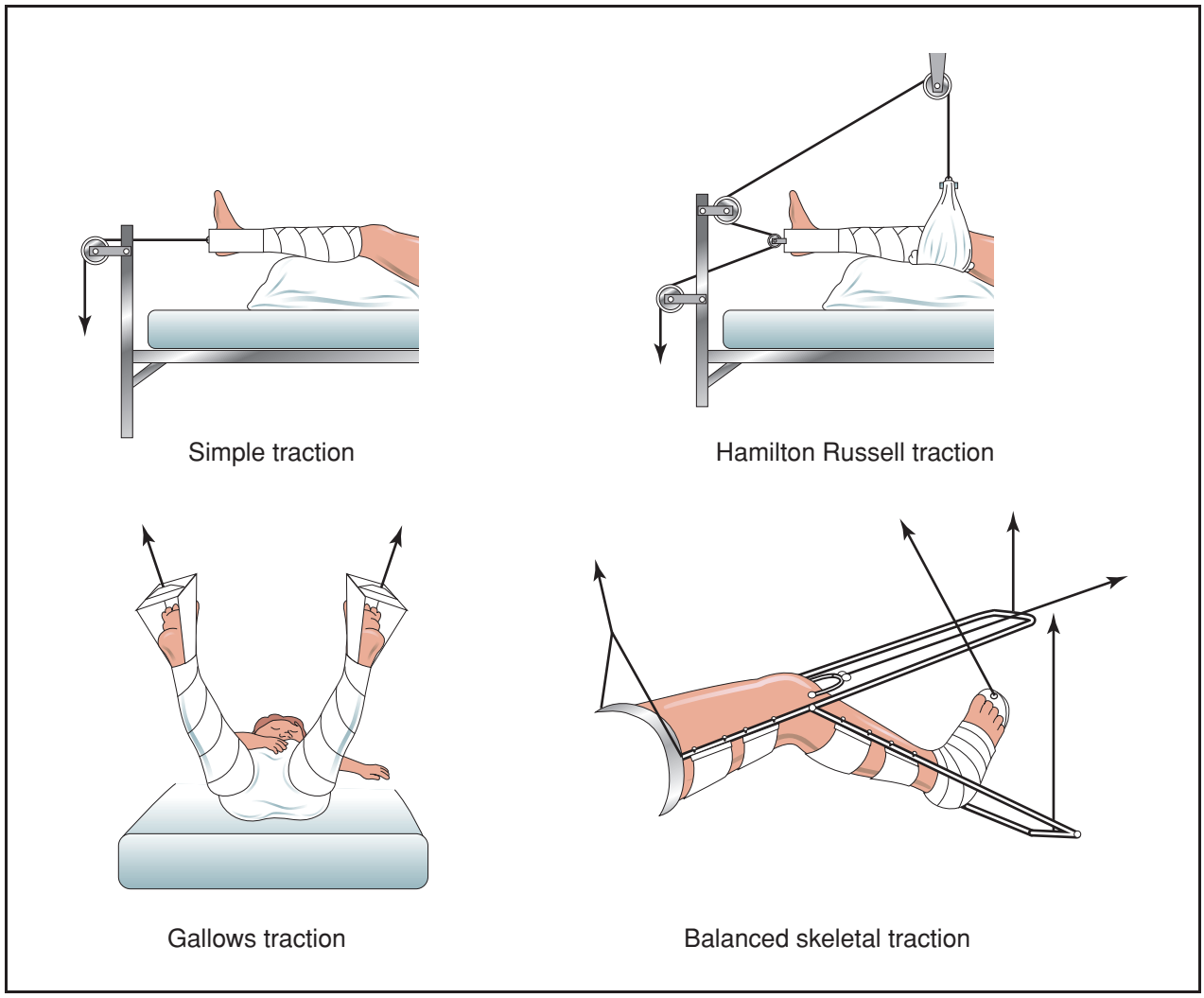

Traction refers to the use of a pulling force and special devices, such as a cast or splint, to treat muscle and skeletal disorders. It is used to treat fractures, dislocations, and long-duration muscle spasms, and to prevent or correct deformities. The illustration above features several commonly used forms of traction. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

and experience, since incorrectly applied traction can cause harm.

Positioning the extremity so that the angle of pull brings the ends of the fracture together is essential. Elaborate methods of weights, counterweights, and pulleys have been developed to provide the appropriate force while keeping the bones aligned and preventing muscle spasm. The patient's age, weight, and medical condition are all taken into account when deciding on the type and degree of traction.

Precautions

People who are suffering from skin disorders or who are allergic to tape should not undergo skin traction, because the application of traction will aggravate their condition. Likewise, circulatory disorders or **varicose veins** can be aggravated by skin traction. People with an inflammation of the bone (**osteomyelitis**) should not undergo skeletal traction.

Description

Skin traction

Skin traction uses five-to seven-pound weights attached to the skin to indirectly apply the necessary pulling force on the bone. If traction is temporary, or if only a light or discontinuous force is needed, then skin traction is the preferred treatment. Because the procedure is not invasive, it is usually performed in a hospital bed.

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Weights are attached either through adhesive or nonadhesive tape, or with straps, boots, or cuffs. Care must be taken to keep the straps or tape loose enough to prevent swelling and allow good circulation to the part of the limb beyond the spot where the traction is applied. The amount of weight that can be applied through skin traction is limited because excessive weight will irritate the skin and cause it to slough off.

Specialized forms of skin traction have been developed to address specific problems. Dunlop's traction is used on children with certain fractures of the upper arm, when the arm must be kept in a flexed position to prevent problems with the circulation and nerves around the elbow. Pelvic traction is applied to the lower spine, with a belt around the waist. Buck's skin traction is used to treat **knee injuries** other than fractures. The purpose of this traction is to stabilize the knee and reduce muscle spasm.

Skeletal traction

Skeletal traction is performed when more pulling force is needed than can be withstood by skin traction; or when the part of the body needing traction is positioned so that skin traction is impossible. Skeletal traction uses weights of 25-40 pounds.

Skeletal traction requires the placement of tongs, pins, or screws into the bone so that the weight is applied directly to the bone. This is an invasive procedure that is done in an operating room under general, regional, or **local anesthesia**.

Correct placement of the pins is essential to the success of the traction. The pin can be kept in place several months, and must be kept clean to prevent infection. Once the hardware is in place, pulleys and weights are attached to wires to provide the proper pull and alignment on the affected part.

Specialized forms of skeletal traction include cervical traction used for fractures of the neck vertebrae; overhead arm traction used for certain types of upper arm fractures; and tibia pin traction used for some fractures of the femur, hip, or pelvis.

Preparation

X rays are done prior to the application of both forms of traction, and may be repeated during treatment to assure that the affected parts are staying in alignment and healing properly. Since the insertion of the anchoring devices in skeletal traction is a surgical procedure, standard preoperative blood and urine testing are done, and the patient may meet with an anesthesiologist to discuss any health conditions that might affect the administration of anesthesia.

Aftercare

Aftercare for skin traction involves making sure the limb stays aligned, and caring for the skin so that it does not become sore and irritated. The patient should also be alert to any swelling or **tingling** in the limb that would suggest that the limb has been wrapped too tightly.

Aftercare for skeletal traction is more complex. The patient is likely to be immobile for an extended period. Deep breathing exercises are taught so that respiratory function is maintained during this time of little activity. Patients are also encouraged to do range-of-motion exercises with the unaffected parts of the body. The patient is taught how to use a trapeze (an overhead support bar) to shift on and off a bedpan, since it is not possible to get up to use the toilet. In serious injuries, traction may be continued for several months until healing is complete.

Risks

The main risks associated with skin traction are that the traction will be applied incorrectly and cause harm, or that the skin will become irritated. There are more risks associated with skeletal traction. Bone inflammation may occur in response to the introduction of foreign material into the body. Infection can occur at the pin sites. If caught early, infection can be treated with **antibiotics**, but if severe, it may require removal of the pin.

Both types of traction have complications associated with long periods of immobility. These include the development of bed sores, reduced respiratory function, urinary problems, and circulatory problems. Occasionally, fractures fail to heal. Being confined to traction for a long period can take a an emotional toll on the patient, also.

Normal results

When correctly applied, traction generally produces very good, if slow, results.

Resources

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Tish Davidson, A.M.

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Traditional Chinese medicine

Definition

Traditional Chinese medicine (TCM) is an ancient and still very vital holistic system of health and healing, based on the notion of harmony and balance, and employing the ideas of moderation and prevention.

Purpose

TCM is a complete system of health care with its own unique theories of anatomy, health, and treatment. It emphasizes diet and prevention and using **acupuncture**, herbal medicine, massage, and **exercise**; and focuses on stimulating the body's natural curative powers.

Precautions

In situations of severe trauma, TCM should not be substituted for contemporary modern trauma practice; it is most useful as an adjunct to the healing regimen. TCM is not the first line of treatment for bacterial infection or **cancer**, but may usefully complement contemporary medical treatment for those conditions.

Description

In theory and practice, traditional Chinese medicine is completely different from Western medicine, both in terms of considering how the human body works and how illness occurs and should be treated. As a part of a continuing system that has been in use for thousands of years, it is still employed to treat over one-quarter of the world's population. Since the earliest Chinese physicians were also philosophers, their ways of viewing the world and human beings role in it affected their medicine. In TCM, both philosophically and medically, moderation in all things is advocated, as is living in harmony with nature and striving for balance in all things. Prevention is also a key goal of Chinese medicine, and much emphasis is placed on educating the patient to live responsibly. The Chinese physician also is more of an advisor than an authority; he or she believes in treating every patient differently, based on the notion that one does not treat the disease or condition but rather the individual patient. Thus two people with the same complaint may be treated entirely differently, if their constitutions and life situations are dissimilar. Disease is also considered to be evidence of the failure of preventive health care and a falling out of balance or harmony.

There is some confusion in the West about the fundamental philosophical principles upon which traditional Chinese medicine is based – such as the concept of yin and yang, the notion of five elements (wood, fire, earth, metal and water), and the concept of *chi*–yet each can be explained in a way that is understandable to Westerners.

Yin and yang describe the interdependent relationship of opposing but complementary forces believed to be necessary for a healthy life. Basically, the goal is to maintain a balance of yin and yang in all things.

The five elements, or five phase theory, is also grounded in the notion of harmony and balance. The concept of *chi*, which means something like "life force" or "energy," is perhaps most different from Western ideas. TCM asserts that *chi* is an invisible energy force that flows freely in a healthy person, but is weakened or blocked when a person is ill. Specifically, the illness is a result of the blockage, rather than the blockage being the result of the illness.

Besides these philosophical concepts that differ considerably from infection-based principles of medicine and health, the methods employed by traditional Chinese medicine are also quite different. If allopathic Western practitioners could be described as interventionist and dependent on synthetic pharmaceuticals, TCM methods are mostly natural and noninvasive. For example, where Western physicians might employ surgery and **chemotherapy** or radiation for a cancer patient, a TCM physician might use acupuncture and dietary changes. TCM believes in "curing the root" of a disease and not merely in treating its symptoms.

Another major difference is how the patient is regarded. In Western medicine, patients with similar complaints or diseases, usually will receive virtually the same treatment. In TCM however, the physician treats the patient and not the condition, believing that identical diseases can have entirely different causes. In terms of the principles upon which it is based and the methods used, traditional Chinese medicine, therefore, is considered by many in the West to be a radically different system of health care.

To some in the Western world, this very strangeness is the reason why it might be attractive. To others, tired of what they perceive as their physician's perfunctory, analytical, and sometimes cold manner, TCM offers a more humane, patient-

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oriented approach that encourages a high degree of practitioner-patient interaction and is not overly dependent on technology.

For example, during a consultation with a TCM practitioner, the patient will receive a considerable amount of time and attention. During the important first visit, the practitioner will conduct four types of examinations, all extremely observational and all quite different from what patients usually experience.

First, the practitioner will ask many questions, going beyond the typical patient history to inquire about such particulars as eating and bowel habits or sleep patterns. Next, the physician looks at the patient, observing his or her complexion and eyes, while also examining the tongue very closely, believing that it is a barometer of the body's health and that different areas of the tongue can reflect the functioning of different body organs. After observing, they listen to the patient's voice or **cough** and then smell his or her breath, body odor, urine, and even bowel movements. Finally, the practitioner touches the patient, palpating his or her abdomen and feeling the wrist to take up to six different pulses. It is through these different pulses that the well-trained practitioner can diagnose any problem with the flow of the all-important *chi*. Altogether, this essentially observational examination will lead the physician to diagnose or decide the patient's problem. This diagnosis is very different from one in contemporary Western medicine. No blood or urine samples are tested in a laboratory. The key to this technique lies in the experience and skill of the practitioner.

After making a diagnosis, the physician will suggest a course of treatment from one or all of the available TCM methods. These fall into four main categories: herbal medicine, acupuncture, dietary therapy, and massage and exercise. A typical TCM prescription consists of a complex variety of many different herbal and mineral ingredients. Chinese herbal remedies are intended to assist the body's own systems so that eventually the patient can stop taking them and never becomes dependent on them. Herbal formulas are usually given as teas, which differ according to the patient.

Other common techniques used in a TCM prescription are as follows:

- Acupuncture is based on the notion that the body's vital energy force, *chi*, travels through known channels or "meridians." The acupuncturist inserts tiny, thin sterile needles at particular, selected points on the body to unblock or correct the flow of energy. These needles are hardly felt as they are inserted and are left in place for 15 to 20 minutes. Some patients report immediate improvement, others feel exhilarated, while some feel like sleeping. In some cases, patients say their condition worsens before it improves. No contemporary scientific explanation exists as to how or why acupuncture works.
- Moxibustion is a variation sometimes employed. Moxibustion is the slow burning on or over the body of special herbal "cones." These are placed on specific acupoints and provide penetrating, relaxing heat.
- Massage is often recommended, and a deep finger pressure technique known as acupressure is often used to promote the proper flow of *chi*.
- Diet is considered essential to good health, and what might be called "kitchen medicine" is just another aspect of herbalism. One example is a delicious DQ black bean soup that is traditionally eaten by women in China after childbirth and each menstrual cycle.
- Therapeutic exercises are sometimes prescribed as well. In both the exact and flowing movements of tai chi, and the breathing techniques of Qi Dong exercise is considered essential to relieving stress and promoting the smooth flow of *chi*.

As a system of total health care, TCM is prepared to deal with any physical or mental problem, condition, or disease. However, unlike Western medicine at its best, TCM is not able to render the kind of emergency crisis intervention that saves lives during physical traumas. Nonetheless, it works best at achieving its goal of practicing preventive medicine. It has proven effective in treating many types of aches and pains and in helping people with depression and **fatigue**, as well as circulation and digestive problems. Overall, its emphasis on good

KEY TERMS

Allopathic—Pertaining to conventional medical treatment of disease symptoms that uses substances or techniques to oppose or suppress the symptoms.

Anatomy—The science of the body structure of an organism and its parts.

Holistic—That which pertains to the entire person, including the mind, body, and spirit.

Palpate—To examine the body by touching or pressing with the fingers or the palm of the hand.

Pharmaceutical—Pertaining to drugs.

Therapeutic—Curative or healing.

Trauma—Injury or damage to the body.

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diet and exercise, as well as on individual responsibility and moderation in all things, suggest that it is grounded in fundamentally sound principles.

Risks

In the hands of a qualified practitioner, TCM is very safe. However, there is a small chance of not only getting an infection from acupuncture, but also that an existing infection could be spread to other parts of the body by increased blood flow and circulation.

Normal results

Traditional Chinese medicine seeks to harmonize and rebalance the entire human system rather than to treat just symptoms. Since proper internal balance is considered to be the key to human health, TCM strives to cure disease by restoring that balance and therefore allowing the body to repair itself. Its continuing medical goal is to detect and correct abnormalities before they cause permanent physical damage.

ORGANIZATIONS

American Academy of Medical Acupuncture, 1970 E. Grand Ave., Suite 330, El Segundo, CA, 90245, (310) 364-0193, administrator@medicalacupuncture.org, http://www.medicalacupuncture.org/.

American Association of Acupuncture & Oriental Medicine, PO Box 162340, Sacramento, CA, 95816, (866) 455-7999, http://www.aaaomonline.org.

Leonard C. Bruno, PhD

MILTON TRAGER (1909–1997)

Milton Trager was a medical doctor and a somatic educator, specializing in body learning. He was a contemporary of F. Matthias Alexander, Moshe Feldenkrais, and Ida Rolf.

As a young man in the 1920s, he occupied himself with gymnastics and boxing. Through his intensely physical pursuits, he arrived at his self-taught body learning theories. The techniques that he nurtured emphasized body control over strength, prowess, and endurance. For example, in striving to leap as high as possible, Trager focused his concentration on landing as softly as possible. He obtained a degree in physical medicine before serving in the military during World War II.

Upon his return, Trager funded his medical school education with his GI benefits. He established a private practice and spent the ensuing 50 years refining his body learning techniques and assisting afflicted individuals in the process. When Trager's father was stricken with sciatic pain, Trager learned to relieve the spasms by hand. In time he learned to alleviate the symptoms of polio victims and others who suffered from muscle spasms.

Trager established the Trager Institute in the 1970s to propagate the techniques that he had developed. By the year 2000, an estimated 2,000 students and practitioners had embraced the Trager Approach.

Trager lived with his wife, Emily, in Southern California at the time of his death in January 1997.

Trager psychophysical integration

Definition

Trager psychophysical integration therapy, also known as the Tragerwork system of physical integration, is a combination of hands-on tissue mobilization, relaxation, and movement reeducation called Mentastics. The underlying principle of psychophysical integration is that clients learn to be lighter, easier, and freer by experiencing lightness, ease, and freedom of movement in their bodies.

The Trager method is a psychologically grounded physical approach to muscle relaxation, which is induced when a practitioner and patient achieve a state of mind called hook-up. Hook-up is described as a connection to a state of grace or a powerful and nourishing life force. It is the opposite of strain or effort.

Purpose

Psychophysical integration therapy has been helpful in relieving muscle discomfort in patients afflicted with **polio**, **muscular dystrophy**, Parkinson's disease, **multiple sclerosis**, post-stroke trauma, and psychiatric disturbances. The therapy is useful in alleviating such chronic conditions as back and leg **pain**. Athletes may benefit from this system to increase resilience to injuries and to improve their mental attitudes. In addition, the Trager Institute maintains that Tragerwork helps clients achieve greater mental clarity through the release of "deep-seated physical and mental patterns."

Description

Origins

Psychophysical integration therapy began with Dr. Milton Trager (1908–1997), who earned a medical degree in midlife after working out his approach to

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KEY TERMS

Hook-up—A state of effortless connection with a life-enhancing force. Trager practitioners enter a state of hook-up before working with clients in order to focus on their needs. Trager himself described hook-up as a meditative process of "becoming one with the energy force that surrounds all living things."

Mentastics—The active phase of Trager therapy. Mentastics are a form of movement reeducation in which clients learn to reexperience movement as pleasurable and positive.

Tablework—The passive phase of Trager therapy, in which the practitioner uses gentle and noninvasive movements to allow the client to relax deeply and experience physical movement as free and effortless.

healing chronic pain. Trager was born with a spinal deformity and overcame it through practicing a variety of athletic exercises. At the time that he discovered his approach to bodywork, he was training to become a boxer. His therapy came to public attention when Esalen Institute in California, the famous center of the human potential movement, invited him to give a demonstration of his technique during the mid-1970s. Trager abandoned his private medical practice in 1977 to devote full energy to the development and further understanding of psychophysical integration. The Trager Institute, which continues his work, was founded in 1980.

The Trager method consists of two parts, a passive aspect referred to as tablework and an active aspect called Mentastics, which is a self-care **exercise** program. Although the benefits of the Trager approach are said to be cumulative, practitioners and clients appear to be free to set their own schedules for a series of sessions. There is no minimum number of sessions that clients must agree to take.

Tablework

The tablework is performed on a comfortable padded table. Sessions last about 60–90 minutes. The practitioner moves the client in ways that he or she naturally moves, in such a way that he or she experiences how it feels to move effortlessly and freely on one's own. The movements resemble general mobilization techniques, and incorporate some manual, cervical, and lumbar **traction**. The goal of tablework is to allow the client "slowly to give up muscular and mental control and sink into a very deep state of relaxation not unlike that experienced in hypnosis."

Mentastics

Mentastics are free-flowing dance-like movements intended to increase the client's self-awareness, as well as providing tools to help the client move through and control chronic pain. The client is encouraged to "let go," which means that he or she is asked to begin a movement, then release muscle tension and allow the weight of the body part involved to complete the motion. By experiencing movement as something pleasurable and positive rather than painful or negative, clients begin to loosen up, learn new movements more easily, and even begin inventing their own. In the early stages of treatment, clients are advised to do Mentastic movements at home for 10–15-minute sessions, three times per day.

Preparations

Prior to a session of tablework, the client dresses for comfort, "with a minimum of swimwear or briefs," according to the Trager Institute. The client is also covered with a drape. No oils or lotions are used.

The practitioner prepares for the session by clearing his or her mind of everything but the client, until he or she achieves a state of hook-up. This attitude of "relaxed meditative awareness" on the part of the practitioner is one of the unique features of Tragerwork. It is described as allowing the therapist "to connect deeply with the recipient in an unforced way and enables the practitioner to perceive the slightest responses from the [client's] body."

Precautions

Because of the unusual sensitivity and heightened awareness that is associated with the practitioner's touch, pain should never result from tablework sessions. It is important for clients to alert the practitioner to any pain associated with either the tablework or the Mentastics program.

Although the movements used in Trager tablework are gentle and noninvasive, clients who have had recent injuries or surgery should wait to heal before undertaking a course of Tragerwork.

Side effects

The Trager method should not produce physical side effects when employed by a qualified practitioner. It is possible that some clients may have emotional reactions associated with the release of physical patterns acquired as a response to trauma, but such reactions are unusual.

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Research and general acceptance

Tragerwork, like other forms of bodywork, has gained increasing acceptance as a form of treatment since the 1980s. In 2000 there were 1,200 certified psychophysical integration practitioners in 15 countries worldwide. The therapy has been reported as a commonly employed treatment for mainstream athletes. In addition, the National Institutes of Health lists psychophysical therapy as a mind-body form of complementary alternative medicine.

ORGANIZATIONS

Florida Institute of Psychophysical Integration: Quantum Balance, 5837 Mariner Drive, Tampa, FL, 33609-3411, (813) 186-2273, (813) 287-2870.

United States Trager Association, 13801 West Center Street, Suite C; PO Box 1009, Burton, OH, 44021, (404) 834-0308, (440) 834-0365, http://www.tragerus.org.

Gloria Cooksey

Tranquilizers *see* **Antianxiety drugs**

Trans fatty acids

Definition

Trans fatty acids are unsaturated fatty acids with at least one double bond in the *trans* configuration. Unsaturated fatty acids are derived metabolically from saturated fatty acids by the abstraction of pairs of hydrogen atoms from adjacent methylene groups. The removal of a pair of hydrogen atoms gives rise to a double bond. The remaining hydrogen atoms can either be on the same side of the fatty acid molecule, in which case the double bond has the *cis* geometrical configuration, or on opposite sides giving the *trans* configuration. *Trans* fatty acids occur naturally in a small amounts in a few foods, however, the majority are formed during the partial hydrogenation of vegetable oils. This process converts vegetable oils into semi-solid fats for use in margarines, commercial cooking, and manufacturing processes. There is strong evidence that the consumption of *trans* fatty acids from industrial sources increases the risk of coronary heart disease (CHD).

Purpose

Whereas the presence of a *cis* bond in a fatty acid molecule affects the linearity of the fatty acid chain, making it fold back on itself, a *trans* bond has minimal effect on the conformation of the chain, making its physical properties more closely resemble those of a saturated fatty acid. The molecules of a *trans* fatty acid are able to pack together more closely than those of a *cis* isomer and this is reflected in differences in melting points. The melting point of the saturated fatty acid stearic acid (chain length of 18 carbons) is 157°F (69.6°C), the melting point of oleic acid (chain length of 18 carbons with one *cis* bond) is 55.8°F (13.2°C), whereas the melting point of eladic acid, the *trans* isomer of oleic acid, is 111°F (44.0°C). For this reason, partially hydrogenated vegetable oils are used extensively by the food industry, as their high *trans* fatty acid content gives the oils a longer shelf life and an increased stability during deep-frying. Their semi-solidity can be customized to enhance the palatability of baked goods and sweets.

Description

Sources and consumption of trans fatty acids in the United States diet

The average consumption of industrially produced *trans* fatty acids in the United States is between 2 to 3% of total calories consumed. The major sources of *trans* fatty acids in the American diet are deep-fried foods, bakery products, packaged snack foods, margarines, and crackers. Naturally occurring *trans* fatty acids are found in meats and dairy products from cows, sheep, and other ruminant animals; they are produced in the forestomach of the animal where polyunsaturated fatty acids of plant origin, such as linoleic acid and linolenic acid, can undergo partial or complete hydrogenation by the action of symbiotic anaerobic bacteria present in the ruminant stomach. These naturally occurring *trans* fatty acids are consumed in much smaller amounts, approximately 0.5% of total energy intake.

Trans fatty acids from ruminant sources

The predominant *trans* isomer in ruminant animals is vaccenic acid, from which conjugated linolenic acid (CLA) can be formed. It is possible to change the *trans* fatty acid content of ruminant products by altering the animals' feed although levels of *trans* fatty acids in meat and milk are already relatively low, between 1 and 8% of total fat content. With respect to CLA, it is considered desirable to increase levels in foods rather than to decrease levels. This is due to the suggested health benefits of CLA in humans, such as reduced insulin sensitivity and improved immune function, although the evidence remains inconclusive.

There is no association between intake of *trans* fatty acids from ruminant sources and risk of CHD and in fact some studies have shown non-significant trends towards

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an inverse association. The absence of an positive association of *trans* fatty acids from ruminant sources compared with from industrial sources may be due to lower levels of intake (less than 0.5% of total energy intake), different biological effects of different isomers, or the presence of other factors in meat and diary products that outweigh any effects of the small amount of *trans* fatty acids they contain. Further research in these areas is needed although it would seem that *trans* fatty acids from ruminant sources do not pose a threat to public health.

Precautions

The physiological effects of trans fatty acids from industrial sources

The main effects of *trans* fatty acids are on serum lipid levels. Numerous controlled dietary trials have been conducted to evaluate the effect of isocaloric replacement of saturated or *cis* unsaturated fatty acids with *trans* fatty acids. The data from many of these studies has been used in a number of large meta-analyses, all of which strongly indicate that compared with saturated or *cis* unsaturated fatty acids, the consumption of *trans* fatty acids raises levels of low density lipoprotein (LDL) cholesterol, reduces levels of high density lipoprotein (HDL) cholesterol and increases the ratio of total cholesterol to HDL cholesterol, all of which are powerful risk factors from CHD.

There is substantial evidence to show that *trans* fatty acids also promote systemic inflammation. In a large trial of women, greater intake of *trans* fatty acids was associated with increased activity of the tumour necrosis factor (TFN) system, a biomarker used to measure inflammation. Among those with a higher body mass index (BMI), a greater intake of *trans* fatty acids was also associated with other inflammatory substances. The presence of inflammation is an independent risk factor for **atherosclerosis**, sudden **death** from cardiac causes, **diabetes mellitus**, and **heart failure**. Thus the inflammatory effects of *trans* fatty acids contribute further to overall CHD risk.

The risk to health of consuming *trans* fatty acids from industrial sources has been recognized and acknowledged by the United States government. The Food and Drug Administration (FDA) made it compulsory from 2006, for **nutrition** labels for all conventional foods and supplements to indicate the content of *trans* fatty acids. In addition, the Department of Agriculture has made a limited intake of *trans* fatty acids a key recommendation of the new food pyramid guidelines, following the recommendations of the Dietary Guidelines Advisory Committee that intake of *trans* fatty acids should be less than 1% of total energy. Furthermore, action is being taken at local levels; the New York City Department of Health and Mental Hygiene has asked 20,000 restaurants and 14,000 food suppliers to eliminate partially hydrogenated oils from kitchens and to provide foods free from industrially produced *trans* fatty acids. Although the elimination of these *trans* fatty acids may be challenging, experience in other countries, such as Denmark, indicates that these fats can largely be replaced by *cis* unsaturated fats without increasing the cost or availability of foods.

Health care providers should advise consumers about how to minimize the intake of *trans* fatty acids, consumers should be able to recognize and avoid products containing *trans* fatty acids and restaurants and food manufacturers should use alternative fats in food production and preparation. These measures should ensure a reduction in *trans* fatty acid consumption and result in substantial health benefits particularly a reduction in the incidence of CHD.

Complications

Trans fatty acid intake and risk of disease

***TRANS* FATTY ACID INTAKE AND CHD.** On a per calorie basis, *trans* fatty acids increase the risk of CHD more than any other macronutrient, conferring a substantially increased risk even at low levels of consumption (between 1 to 3% of total energy intake). Even a small rise in energy intake from *trans* fatty acids can cause a large increase risk. A meta-analysis of four prospective cohort studies that included data from 140,000 subjects showed a 23% increase in CHD incidence when energy intake from *trans* fatty acids increased by just 2%. So dramatic is the impact of *trans* fatty acids on CHD risk, another study showed that the positive association between levels of *trans* fatty acids in adipose tissue (a biomarker for dietary intake) and CHD risk was diminished after 1996, when *trans* fatty acids where eliminated from margarines sold in Australia and the population's consumption levels decreased.

The potential benefits of reducing of reducing consumption of *trans* fatty acids from industrial sources on the incidence of CHD in the United States has been calculated. On the basis of predicted changes in total and HDL cholesterol, CHD events could be reduced by between 3 and 6 percent. If the influence of *trans* fatty acids on other risk factors such as inflammatory effects is considered, CHD events could be reduced by 10–19% (equivalent to between 72,000 and 228,000 CHD events each year). This reduction could be even greater, if healthier *cis* unsaturated fatty acids, including **omega-3 fatty acids**, are used to replace *trans* fatty acids.

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***TRANS* FATTY ACID INTAKE AND DIABETES.** The association between risk of diabetes and *trans* fatty acid intake is less clear. Three prospective studies have investigated this relationship and in two of the studies, consumption of *trans* fatty acids was not significantly associated with increased risk of diabetes. However, in a study of nearly 85,000 female nurses a strong positive association was found. The nurses were followed for 16 years, information of dietary intake was periodically updated and self-reported diabetes was validated. The conclusions of no association in the first two studies may be explained by the relatively low intake in one cohort of male health professionals (average intake of 1.3% energy).

Parental concerns

Parents should eliminate all sources of *trans* fatty acids from industrial sources from their children's **diets** as these have no intrinsic health value above their energy value. Therefore their consumption is linked with considerable potential harm and no apparent benefit. As adverse effects are seen at even low levels of intake, between 1 and 3% of total energy (2–7g per day for a person consuming 2,000 calories), it seems complete or near complete avoidance of *trans* fatty acids should be advised in order to minimize health risks.

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ORGANIZATIONS

American Dietetic Association (ADA), 120 South Riverside Plaza, Suite 2000, Chicago, IL, 60606-6995, (800) 877-1600, http://www.eatright.org.

American Heart Association, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, http://www.americanheart.org.

Centre for Science in Public Interest, 1875 Connecticut Ave. N.W. Suite 300, Washington, DC, 20009, (202) 332-9110, http://www.cspinet.org.

Sarah E. Schenker, SRD, PhD, RPHNutr

Transcranial Doppler ultrasonography

Definition

Transcranial **Doppler ultrasonography** is a noninvasive method of analyzing blood flow in the brain.

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Purpose

The blood that flows through the brain distributes nutrients to the brain and removes wastes. This flow maintains the high rate of metabolism necessary for the brain to function. Restrictions in blood flow may occur from vessel narrowing (stenosis), clot formation (thrombosis), blockage (**embolism**), or blood vessel rupture (hemorrhage). Lack of sufficient blood flow (**ischemia**) threatens brain tissue and may cause a **stroke**.

The flow of blood through the arteries in the brain can be analyzed using transcranial Doppler ultrasonography (TCD). TCD is a form of ultrasound, in which high frequency sound waves bounce off or pass through body tissues. While most other types of ultrasonography create images of the tissue being studied, the results of TCD are audible sounds that the examiner listens to and records.

Doppler ultrasonography uses what is called the Doppler effect to measure the rate and direction of blood flow in the vessels. Just as a siren's pitch sounds higher when its source is moving toward you and lower as it moves away, so too will ultrasound waves change pitch, or frequency, as they bounce off the red blood cells moving in the blood. It is these pitch changes that produce the audible sounds during the exam.

Changes in frequency can be used to measure both the direction and the speed of blood flow. Faster blood flow causes a greater change in frequency. Combined with other tests, this information can be used to locate restrictions in the blood vessels in the brain, and to track changes in blood flow over time. In this way, TCD gives valuable information about the site of a stroke and the patient's progress after a stroke. TCD is also used to evaluate the contraction of blood vessels that can occur if a blood vessel ruptures.

Precautions

Ultrasonography procedures are safe, noninvasive, and painless. No special precautions are necessary.

Description

TCD is done with either one or two probes placed against the skin. The examiner spreads a clear gel on the areas of the head where the probe will be placed. Usually, the probes are placed on the temple, on the base of the skull at the back of the neck, and over the closed eyelid. In these places, there is the least amount of thick protective bone and the sound waves can penetrate the best. The examiner adjusts the probe position and orientation to direct the sound waves toward the blood vessels of interest. Finding the best approach may take some time. A compression test may be performed during the exam. In this test, the main artery in the neck (carotid artery) is briefly compressed, and changes in blood flow patterns are observed. A full TCD exam may last 30–45 minutes, and often longer in patients with disease.

Preparation

No special preparation is needed. The patient should remove **contact lenses**, and may wish to avoid the use of eye makeup, since the gel is likely to smear it.

Aftercare

The gel is washed off with soap and water. No other after care is needed.

Risks

TCD is noninvasive and has no risks. A compression test is occasionally, though very rarely, hazardous for a patient with narrowed arteries (**atherosclerosis**), since the increased pressure may dislodge a piece of the substance that causes the narrowing (plaque).

Normal results

TCD produces an audible sound that varies with the heartbeat. It also varies depending on the direction and rate of flow through the vessel being examined. Each of the vessels in the brain has a characteristic direction of flow, which can be detected by TCD. Flow rates are somewhat variable from person to person.

Abnormal results

Lack of flow indicates a vessel has been completely blocked (although absence of a signal may also be due to absorption of sound waves by bone). If blood flows in the wrong direction or alternates between normal and reverse flow, it may mean there is a blockage elsewhere. This happens because blood is rerouted due to abnormalities in pressure caused by the blockage.

If the speed of flow is increased, it may mean that blood is flowing through a restricted area that is just "upstream" from the probe. Intuitively, one might think that a restricted blood vessel would cause the speed of blood flow to slow down. However, the opposite is true. This is because the same amount of blood going through a narrower opening must go faster. Increased speed is also seen if a vessel is carrying rerouted blood.

Resources

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Richard Robinson

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Transesophageal echocardiography

Definition

Transesophageal **echocardiography** is a diagnostic test using an ultrasound device that is passed into the esophagus of the patient to create a clear image of the heart muscle and other parts of the heart. A tube with a device called a transducer is passed down into the patient's throat and into the esophagus (the food tube that connects the mouth to the stomach). The transducer directs ultrasound waves into the heart, and the reflected sound waves picked up by the transducer are translated into an image of the heart.

KEY TERMS

Endoscope—An instrument used to see and examine the inside of a body cavity or organ.

Gag reflex—A normal reflex consisting of elevation of the palate, retraction of the tongue, and contraction of the throat muscles.

Regurgitation—Backward flow of blood through a partly closed valve.

Transducer—A device that converts electrical signals into ultrasound waves and ultrasound waves back into electrical impulses.

Ultrasound—Sound waves at a frequency of 20,000 kHz, often used for diagnostic imaging.

Purpose

Since the esophagus is right next to the heart, transesophageal echocardiography provides a very clear picture of the heart. It can provide information on the size of the heart, its pumping strength, and the location and extent of any damage to its tissues. It can detect abnormal tissue growth around the heart valves. It is also good at detecting abnormalities in the pattern of blood flow, such as the backward flow of blood through partly closed heart valves, known as regurgitation or insufficiency. It is especially useful in cases in which conventional echocardiography (a test where the transducer is kept on the patient's chest) cannot offer a good image, such as when the patient is obese or has a thick chest wall. It is useful for monitoring heart function during cardiac surgery and detecting **blood clots** in the left atrium of the heart.

Precautions

Patients should avoid consuming alcohol for a day or so before the procedure, since alcohol may amplify the effects of the sedative used with the procedure.

Description

Echocardiography creates an image of the heart using ultra-high-frequency sound waves–sound waves that are much too high in frequency to be heard by the human ear. The technique is very similar to ultrasound scanning commonly used to visualize the fetus during **pregnancy**.

A transesophageal echocardiography examination generally lasts 30–60 minutes. The patient is given a mild sedative and the back of the throat is sprayed with a local anesthetic, in order to suppress the gag reflex. Next, a special viewing tube called an endoscope, containing a tiny transducer, is passed through the mouth and into the esophagus. It is carefully moved until it is positioned directly next to the heart. Essentially a modified microphone, the transducer directs ultrasound waves into the heart, some of which get reflected (or "echoed") back to the transducer. Different tissues and blood all reflect ultrasound waves differently. These sound waves can be translated into a meaningful image of the heart, which is displayed on a monitor or recorded on paper or tape. The transducer may be moved several times during the test to help doctors get a better view of the heart.

Preparation

The patient may be given a mild sedative before the procedure, and an anesthetic is sprayed into the back of the throat in order to suppress the gag reflex.

Aftercare

After the test, it is important to refrain from eating or drinking until the gag reflex has returned–otherwise, the patient may accidentally inhale some of the food or beverage. If a sedative has been given, patients should not drive or operate heavy machinery for at least 10-12 hours. They should avoid consuming alcohol for a day or so, since alcohol may amplify the effect of the sedative.

Risks

Transesophageal echocardiography may cause gagging and discomfort when the transducer is passed down into the throat. Patients may also experience **sore throat** for a few days after the test. In rare cases, the procedure may cause bleeding or perforation of the esophagus or an inflammatory condition known as infective **endocarditis**. The patient may have an adverse reaction to the sedative or local anesthetic.

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Normal results

A normal transesophageal echocardiogram shows a normal heart structure and the normal flow of blood through the heart chambers and heart valves.

Abnormal results

A transesophageal echocardiogram may show a number of abnormalities in the structure and function of the heart, such as thickening of the wall of the heart muscle (especially the left ventricle). Other abnormalities can include blood leaking backward through the heart valves (regurgitation), or blood clots in the left atrium of the heart.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

Robert Scott Dinsmoor

Transferrin test *see* **Iron tests**

Transfusion

Definition

Transfusion is the process of transferring whole blood or blood components from a donor to a recipient.

Purpose

Transfusions are given to restore lost blood, to improve clotting time, and to improve the ability of the blood to deliver oxygen to the body's tissues. About 32,000 pints of donated blood are transfused each day in the United States.

In the United States, blood collection is strictly regulated by the Food and Drug Administration (FDA), which has rules for the collection, processing, storage, and transportation of blood and blood products. In addition, the American Red Cross, the American Association of Blood Banks (AABB), and most states have specific rules for the collection and processing of blood. The main purpose of regulation is to ensure the quality of transfused blood and to prevent the transmission of infectious diseases through donated blood. Before blood and blood products are used, they are extensively tested for such infectious agents as hepatitis and human **immunodeficiency** virus (HIV).

Blood and its components

Either whole blood or its components can be used for transfusion. Most blood collected from donors is broken down (fractionated) into components that are used to treat specific problems or diseases. Treating patients with fractionated blood is the most efficient way to use the blood supply.

WHOLE BLOOD. Whole blood is used exactly as received from the donor. Blood components are parts of whole blood, such as red blood cells (RBCs), white blood cells (WBCs), plasma, platelets, clotting factors, and immunoglobulins. Whole blood is used only when needed or when fractionated components are not available, because too much whole blood can raise the recipient's blood pressure. Use of blood components is a more efficient way to use the blood supply, because blood that has been fractionated can be used to treat more than one person.

Whole blood is generally used when a person has lost a large amount of blood. Such blood loss can be caused by injury or surgical procedures. Whole blood is given to help restore the blood volume, which is essential for maintaining blood pressure. It is also given to ensure that the body's tissues are receiving enough oxygen. Whole blood is occasionally given when a required blood fraction is unavailable in isolated form.

RED BLOOD CELLS. Red blood cells (RBCs) carry oxygen throughout the body. They pick up oxygen as they pass through the lungs, and give up oxygen to the other tissues of the body as they are pumped through the arteries and veins. When patients do not have enough RBCs to properly oxygenate their bodies, they can be given a transfusion with RBCs obtained from donors. This type of transfusion will increase the amount of oxygen carried to the tissues of the body. RBCs are recovered from whole blood after donation. They are then typed, removed from the watery blood plasma to minimize their volume (packed), and stored. RBCs are given to people with anemia (including **thalassemia**), whose bone marrow does not make enough RBCs, or who have other conditions that decrease the number of RBCs in the blood. Occasionally, red blood cells from rare blood types are frozen. Once frozen, RBCs can survive for as long as 10 years. Packed RBCs are given in the same manner as whole blood.

WHITE BLOOD CELLS. White blood cells (WBCs) are another infection-fighting blood component. On rare occasions, white blood cells are given by transfusion to

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KEY TERMS

ABO blood groups—A system in which human blood is classified according to the A and B antigens found in red blood cells. Type A blood has the A antigen, type B has the B antigen, AB has both, and O has neither.

Antibody—A simple protein produced by the body to destroy bacteria, viruses, or other foreign bodies. The production of each antibody is triggered by a specific antigen.

Antigen—A substance that stimulates the immune system to manufacture antibodies (immunoglobulins). The function of antibodies is to fight off such intruder cells as bacteria or viruses. Antigens stimulate the blood to fight other blood cells that have the wrong antigens. If a person with blood type A is given a transfusion with blood type B, the A antigens will fight the foreign blood cells as though they were an infectious agent.

Apheresis—A procedure in which whole blood is withdrawn from a donor, a specific blood component is separated and collected, and the remainder is reinfused into the patient.

Autologous blood—The patient's own blood, drawn and set aside before surgery for use during surgery in case a transfusion is needed.

Fractionation—The process of separating the various components of whole blood.

Hemoglobin—The red pigment in red blood cells that transports oxygen.

Hemolysis—The destruction of red blood cells through disruption of the cell membrane, resulting in the release of hemoglobin. A hemolytic transfusion reaction is one that results in the destruction of red blood cells.

Immunoglobulin—An antibody.

Infusion—Introduction of a substance directly into a vein or tissue by gravity flow.

Injection—Forcing a fluid into the body by means of a needle and syringe.

Plasma—The liquid portion of blood, as distinguished from blood cells. Plasma constitutes about 55% of blood volume.

Platelets—Disk-shaped structures found in blood that play an active role in blood clotting. Platelets are also known as thrombocytes.

Rh (rhesus) factor—An antigen present in the red blood cells of 85% of humans. A person with Rh factor is Rh positive (Rh+); a person without it is Rh negative (Rh-). The Rh factor was first identified in the blood of a rhesus monkey.

Serum (plural, sera)—The clear fluid that separates from blood when the blood is allowed to clot completely. Blood serum can also be defined as blood plasma from which fibrinogen has been removed.

treat life-threatening infections. Such transfusions are given when the WBC count is very low or when the patient's WBCs are not functioning normally. Most of the time, however, **antibiotics** are used in these cases.

PLASMA. Plasma is the clear yellowish liquid portion of blood. It contains many useful proteins, especially clotting factors and immunoglobulins. After plasma or plasma factors are processed, they are usually frozen. Some plasma fractions are freeze-dried. These fractions include clotting factors I through XIII. Some people have an inherited disorder in which the body produces too little of the clotting factors VIII (**hemophilia** A) or IX (hemophilia B). Transfusions of these clotting factors help to stop bleeding in people with hemophilia. Frozen plasma must be thawed before it is used; freeze-dried plasma must be mixed with liquid (reconstituted). In both cases, these blood fractions are usually small in volume and can be injected with a syringe and needle.

PLATELETS. Platelets are small disk-shaped structures in the blood that are essential for clotting. People who do not have enough platelets (a condition called **thrombocytopenia**) have bleeding problems. People who have lymphoma or leukemia and people who are receiving **cancer** therapy do not make enough platelets. Platelets have a very short shelf life; they must be used within five days of **blood donation**. After a unit of blood has been donated and processed, the platelets in it are packed into bags. A platelet transfusion is given in the same manner as whole blood.

IMMUNOGLOBULINS. Immunoglobulins are the infection-fighting fractions in blood plasma. They are also known as **gamma globulin**, antibodies, and immune sera. Immunoglobulins are given to people who have difficulty fighting infections, especially people whose immune systems have been depressed by such diseases as **AIDS**. Immunoglobulins are also used to prevent **tetanus** after a cut has been contaminated; to treat animal **bites** when **rabies** is suspected; or to treat severe childhood diseases. Generally, the

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volume of immunoglobulins used is small, and it can be injected.

Demographics

In order to donate blood, an individual must be at least 17 years old, weigh at least 110 lb (50 kg), and be in generally good health. The average blood donor is a white, married, college-educated male between the ages of 30 and 50. Twenty-five percent of people receiving blood transfusions are over the age of 65, although the elderly constitute only 13% of the population. Fewer than 5% of Americans donate blood each year.

Description

Blood is collected from the donor by inserting a large needle into a vein in the arm, usually one of the larger veins near the inside of the elbow. A tourniquet is placed on the upper arm to increase the pressure in the arm veins, which makes the veins swell and become more accessible. Once the nurse or technician has identified a suitable vein, she or he sterilizes the area where the needle will be inserted by scrubbing the skin with a soap solution or an antiseptic that contains iodine. Sometimes both solutions are used. The donor lies on a bed or cot during the procedure, which usually takes between 10 and 20 minutes. Generally, an 18-gauge needle is used. This size of needle fits easily into the veins and yet is large enough to allow blood to flow easily. Human blood will sometimes clot in a smaller needle and stop flowing. The donor's blood is collected in a sterile plastic bag that holds one pint (450 mL). The bags contain an anticoagulant to prevent clotting and preservatives to keep the blood cells alive. A sample of the donator's blood is collected at the time of donation and tested for infectious diseases. The blood is not used until the test results confirm that it is safe. Properly handled and refrigerated, whole blood can last for 42 days.

The recipient of a transfusion is prepared in much the same way as the blood donor. The site for the needle insertion is carefully washed with a soap-based solution followed by an antiseptic containing iodine. The skin is then dried and the transfusion needle inserted into the vein. During the early stages of a transfusion, the recipient is monitored closely to detect any adverse reactions. If no signs of adverse reaction are evident, the patient is monitored occasionally for the duration of the transfusion period. Upon completion of the transfusion, a compress is placed over the needle insertion site to prevent extensive bleeding.

Blood typing

All donated blood is typed, which means that it is analyzed to determine which of several major and minor blood types (also called blood groups) it belongs to. Blood types are genetically determined. The major types are classified by the ABO system. This system groups blood with reference to two substances in the red blood cells called antigen A and antigen B. The four ABO blood types are A, B, AB, and O. Type A blood has the A antigen, type B has the B antigen, type AB has both, and type O has neither. These four types of blood are further classified by the Rh factor. The Rh, or rhesus factor, is also an antigen in the red blood cells. A person who has the Rh factor is Rh positive; a person who does not have the factor is Rh negative. If a person has red blood cells with both the B and the Rh antigens, that person is said to have a B positive (B+) blood type. Blood types determine which kinds of donated blood a patient can receive. Generally, patients are limited to receiving only blood of the exact same ABO and Rh type as their own. For example, a person with B+ blood can receive blood or blood cells only from another person with B+ blood. An exception is blood type O. Individuals with type O blood are called universal donors, because people of all blood types can accept their blood.

Blood can also be typed with reference to several other minor antigens, such as Kell, Kidd, Duffy, and Lewis. These minor antigens can become important when a patient has received many transfusions. These patients tend to build up an immune response to the minor blood groups that do not match their own. They may have an adverse reaction upon receiving a transfusion with a mismatched minor blood group. A third group of antigens that may cause a reaction are residues from the donor's plasma attached to the RBCs. To eliminate this problem, the RBCs are rinsed to remove plasma residues. These rinsed cells are called washed RBCs.

Other transfusion procedures

Autologous transfusion is a procedure in which patients donate blood for their own use. Patients who are to undergo surgical procedures requiring a blood transfusion may choose to donate several units of blood ahead of time. The blood is stored at the hospital for the patient's exclusive use. Autologous donation assures that the blood type is an exact match. It also assures that no infection will be transmitted through the blood transfusion. Autologous donation accounts for 5% of blood use in the United States each year.

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Directed donors are family or friends of the patient who needs a transfusion. Some people think that family and friends provide a safer source of blood than the general blood supply. Studies do not show that directed donor blood is any safer. Blood that is not used for the identified patient becomes part of the general blood supply.

Apheresis is a special procedure in which only certain specific components of a donor's blood are collected. The remaining blood fractions are returned to the donor. A special blood-processing instrument is used in apheresis. It fractionates the blood, saves the desired component, and pumps all the other components back into the donor. Because donors give only part of their blood, they can donate more frequently. For example, people can give almost 10 times as many platelets by apheresis as they could give by donating whole blood. The donation process takes about one to two hours.

Preparation

The first step in blood donation is the taking of the donor's medical history. Blood donors are questioned about their general health, their lifestyle, and any medical conditions that might disqualify them. These conditions include hepatitis, AIDS, cancer, heart disease, **asthma**, **malaria**, bleeding disorders, and high blood pressure. Screening prevents people from donating who might transmit diseases or whose medical condition would place them at risk if they donated blood. Some geographical areas or communities have a high rate of hepatitis or AIDS. Blood collection in most of these areas has been discontinued indefinitely.

The blood pressure, temperature, and pulse of donors are taken to ensure that they are physically able to donate blood. One pint (450 mL) of blood is usually withdrawn, although it is possible to donate smaller amounts. The average adult male has 10–12 pints of blood in his body; the average adult female has 8–9 pints in hers. Within hours after donating, most people's bodies have replaced the fluid lost with the donated blood, which brings their blood volume back to normal. Replacement of the blood cells and platelets, however, can take several weeks. Pregnant women and people with low blood pressure or anemia should not donate blood or should limit the amount of blood they give. Generally, people are allowed to donate blood only once every two months. This restriction ensures the health of the donor and discourages people from selling their blood. The former practice of paying donors for blood has essentially stopped. Donors who sell blood tend to be at high risk for the transmission of blood-borne diseases.

Aftercare

Recipients of blood transfusion are monitored during and after the transfusion for signs of an adverse reaction. Blood donors are generally given fluids and light refreshments to prevent such possible side effects as **dizziness** and **nausea**. They are also asked to remain in the donation area for 15–20 minutes after giving blood to make sure that they are not likely to faint when they leave.

Risks

Risks for donors

For donors, the process of giving blood is very safe. Only sterile equipment is used and there is no chance of catching an infection from the equipment. There is a slight chance of infection at the puncture site if the skin is not properly washed before the collection needle is inserted. Some donors feel lightheaded when they sit up or stand for the first time after donating. Occasionally, a donor will faint. Donors are encouraged to drink plenty of liquids to replace the fluid lost with the donated blood. It is important to maintain the fluid volume of the blood so that the blood pressure will remain stable. Strenuous **exercise** should be avoided for the rest of the day. It is normal to feel some soreness or to find a small bluish bruise at the site of the needle insertion. Most donors have very slight symptoms or no symptoms at all after giving blood.

Risks for recipients

A number of precautions must be taken for transfusion recipients. Donated blood must be matched with the recipient's blood type, as incompatible blood types can cause a serious adverse reaction (transfusion reaction). Blood is introduced slowly by gravity flow directly into the veins (intravenous infusion) so that medical personnel can observe the patient for signs of adverse reactions. People who have received many transfusions may develop an immune response to some factors in foreign blood cells. This immune reaction must be evaluated before the patient is given new blood.

Adverse reactions to mismatched blood (transfusion reaction) is a major risk of blood transfusion. Transfusion reaction occurs when antibodies in the recipient's blood react to foreign blood cells introduced by the transfusion. The antibodies bind to the foreign cells and destroy them. This destruction is called a hemolytic reaction. In addition, a transfusion reaction may also cause a hypersensitivity of the immune system that may in turn

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result in tissue damage within the patient's body. The patient may also have an allergic reaction to mismatched blood.

The first symptoms of transfusion reaction are a feeling of general discomfort and **anxiety**. Breathing difficulties, flushing, and a sense of pressure in the chest or back **pain** may also be present. Evidence of a hemolytic reaction can be seen in the urine, which will be colored from the hemoglobin leaking from the destroyed red blood cells. Severe hemolytic reactions are occasionally fatal. Reactions to mismatches of minor factors are milder. These symptoms include itchiness, dizziness, **fever**, **headache**, rash, and swelling. Sometimes the patient will experience breathing difficulties and **muscle spasms**. Most adverse reactions from mismatched blood are not life-threatening.

Infectious diseases can also be transmitted through donated blood and constitute another major risk of blood transfusion. The infectious diseases most often acquired from blood transfusion in the United States are hepatitis and HIV.

Patients who are given too much blood can develop high blood pressure, a concern for people who have heart disease. Very rarely, an air **embolism** is created when air is introduced into a patient's veins through the tubing used for intravenous infusion. The danger of embolism is greatest when infusion is begun or ended. Care must be taken to ensure that all air is bled out of the tubing before infusion begins, and that the infusion is stopped before air can enter the patient's blood system.

Normal results

Most individuals will feel only a slight sting from the needle used during the blood donation process, and will not experience any side effects after the procedure is over. Plasma is regenerated by the body within 24 hours, and red blood cells within a few weeks. Patients who receive a blood transfusion will usually experience mild or no side effects.

Morbidity and mortality rates

The risk of acquiring an **infectious disease** from a blood transfusion is very low. The risk of HIV transmission is one in 2,135,000 units of blood; **hepatitis B** virus (HBV), one in 205,000 units; and **hepatitis C** virus (HCV), one in 1,935,000 units. Bacterial contamination (a cause of infection) is identified in one in 500,000 for red blood cell units and one in 15,400 for apheresis platelet units. In about 1 in 600,000 to 800,000 transfusions a "fatal misidentification error" occurs; and in about 1 in 12,000 to 19,000 cases a non-fatal error occurs.

Alternatives

There are several alternatives to blood transfusion. These include:

- Volume expanders. Certain fluids (saline, Ringer's lactate solution, dextran, etc.) may be used to increase the patient's blood volume without adding additional blood cells.
- Blood substitutes. Much research is currently being done into compounds that can replace some or all of the functions of blood components. One such compound, called HBOC-201 or Hemopure, is hemoglobin derived from bovine (cow) blood. Hemopure shows promise as a substitute for red blood cell transfusion.
- Bloodless surgery. It may be possible to avoid excessive blood loss through careful planning prior to surgery. Specialized instruments can minimize the amount of blood lost during a procedure. It is also possible to collect some of the blood lost during surgery and reinfuse it into the patient at the end of the operation.

Resources

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ORGANIZATIONS

American Association of Blood Banks (AABB), 8101 Glenbrook Road, Bethesda, MD, 20814-2749, (301) 907-6977, http://www.aabb.org.

American Red Cross (ARC), National Headquarters, 431 Eighteenth Street, NW , Washington, DC, 20006, (202) 303-4498, http://www.redcross.org.

America's Blood Centers, 725 Fifteenth Street NW, Suite 700, Washington, DC, 20005, (202) 393-5725, http://www.americasblood.org.

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National Blood Data Resource Center (NBDRC), 8101 Glenbrook Road, Bethesda, MD, 20814-2749, (301) 215-6506, http://www.nbdrc.org .

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Transhepatic biliary catheterization

Definition

Transhepatic biliary catheterization is a surgical procedure during which a catheter is inserted into the bile duct to relieve an obstruction.

Purpose

Bile is a fluid made in the liver and stored in the gall bladder. The function of bile is to break down fats during digestion. When fatty foods move into the intestine, bile is released from the gall bladder, travels through the bile duct, and enters the first part of the small intestine (duodenum).

If the bile duct is blocked, the skin becomes yellowish (jaundiced), the abdomen is painful, and a **fever** develops. The bile duct can be blocked by **gallstones**, surgical injury, infection in the duct, or by tissue growth due to **cancer**. Transhepatic biliary catheterization is performed to relieve bile duct blockage. The most common reason for this procedure is to relieve obstruction from the overgrowth of cancer cells. Obstruction due to gallstones is usually cleared by other means.

Precautions

Transhepatic biliary catheterization is done when cancer has progressed to the point where all the malignant cells cannot be removed by surgery. Patients who need transhepatic biliary catheterization often suffer from additional complications of their cancer. Because of the likelihood of bleeding from the liver, this procedure should not be done on patients who have blood clotting abnormalities.

Description

Transhepatic biliary catheterization is performed by inserting a needle through the skin, into the abdomen, through the liver, and into the bile duct. A wire attached to the needle then guides the catheter into place. The procedure can take several hours. The patient is given medication for **pain**.

The catheter can either reestablish bile flow into the duodenum or reroute the bile so it drains into a bag outside the body. The choice depends on the extent and position of the obstruction.

Preparation

The standard preoperative blood tests are performed. The patient should not eat or drink the day of the procedure.

Aftercare

The patient must stay in bed after the procedure for at least six hours, to reduce the risk of bleeding. A nurse checks vital signs and looks for indications of complication such as pain, cramping, or leakage around the catheter. The catheter is flushed periodically to keep it open. Patient and caregiver education on how to keep the catheter clean and irrigated is an important part of aftercare.

Risks

The most common complication of transhepatic biliary catheterization is bleeding as a result of puncturing the liver. Infection may also result from this procedure. Sometimes the catheter itself becomes blocked and is ineffective.

Normal results

Transhepatic biliary catheterization is a treatment, not a cure. Successful treatment relieves the blocked bile duct, but does not change the underlying conditions that caused the blockage.

Resources

OTHER

"Extrahepatic Bile Duct Cancer." *National Cancer Institute Page*. http://www.nci.nih.gov.

ORGANIZATIONS

National Cancer Institute (National Institutes of Health), NCI Office of Communications and Education, 6116 Executive Blvd. Suite 300, Bethesda, MD, 20892-8322, (800) 4-CANCER (422-6237), cancergovstaff@mail.nih.gov, http://www.cancer.gov/.

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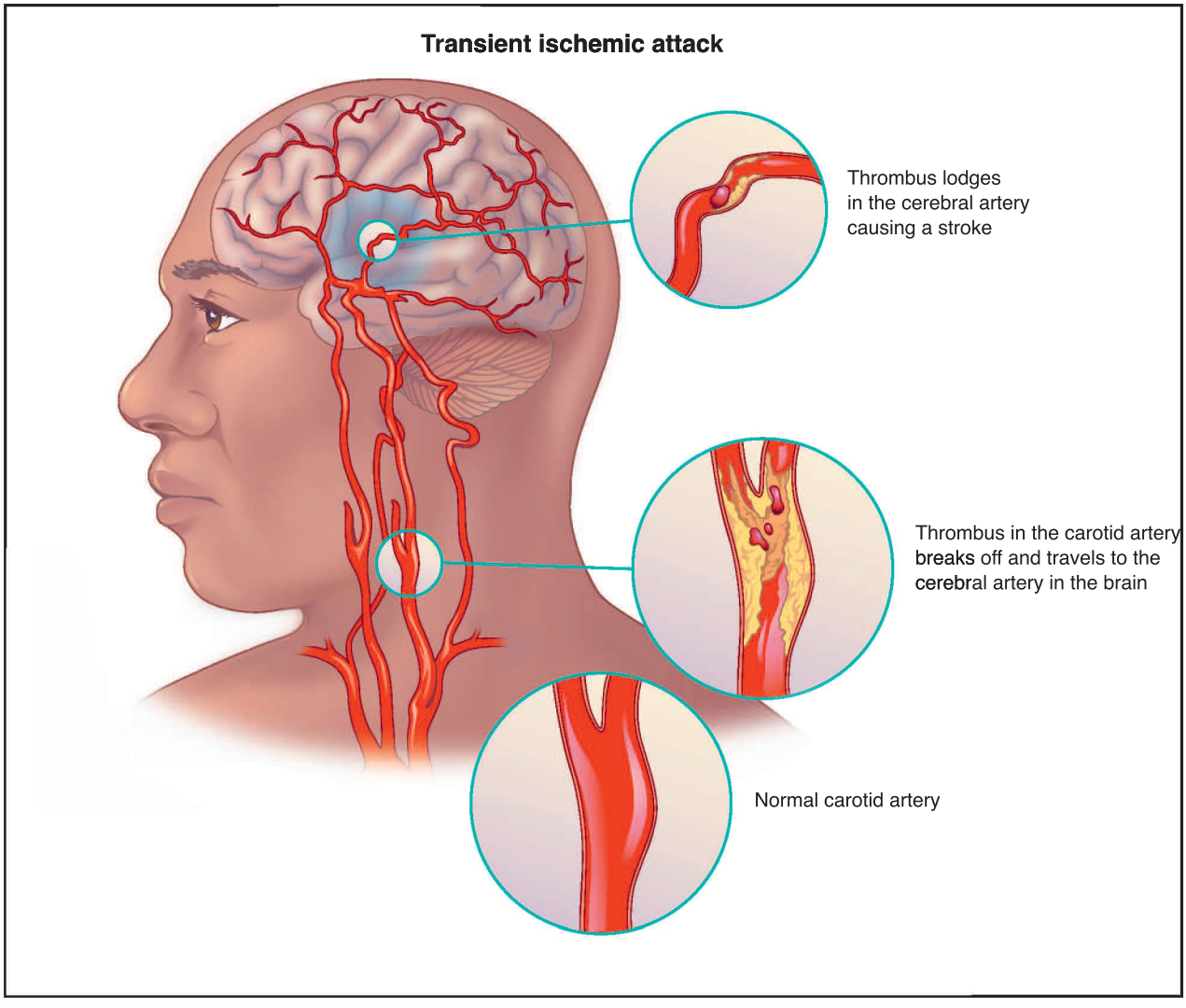
Transient ischemic attack

Definition

A transient ischemic attack, or TIA, is often described as a mini-stroke. Unlike a **stroke**, however, the symptoms can disappear within a few minutes. TIAs and strokes are both caused by a disruption of the blood flow to the brain. In TIAs and most strokes, this disruption is caused by a blood clot blocking one of the blood vessels leading to the brain. The blockage produces symptoms such as sudden weakness or **numbness** on one side of the body, sudden dimming or loss of vision, and difficulty speaking or understanding speech. If the symptoms are caused by a TIA, they last less than 24 hours and do not cause brain damage. Stroke-associated symptoms, on the other hand, do not go away and may cause brain damage or **death**. TIAs can serve as an early warning sign of stroke and require immediate medical attention.

Demographics

About 240,000 people in the United States are diagnosed with a TIA each year. However, this number may be low, since symptoms are transient and not everyone experiencing them will see a doctor. The risk of a TIA increases with age from about 2 per 10,000 people under age 35 to 1,500 people per 10,000 over age 85. Of people who have a TIA, roughly one-third will never have another, while the others will go on to have



In a transient ischemic attack (TIA), blood clots inhibit blood flow to the brain, causing symptoms similar to a stroke. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

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additional TIAs or a stroke. About 15% of people who have a stroke had a previous TIA.

Description

Strokes are the third leading cause of death in the United States and the leading cause of disability. Approximately 795,000 Americans have strokes annually; 20% die within one year. About 85% of these strokes are classified as ischemic. In ischemic stroke, a blood vessel leading to the brain becomes blocked and an area of the brain is deprived of oxygenated blood. (The other 15% of strokes are caused by bleeding from a blood vessel that has ruptured.) Without the blood supply, the cells in that area of the brain die. Since brain cells cannot grow back, the functions that are controlled by that brain area may be permanently lost.

Approximately 15% of strokes are preceded by one or more TIAs. However, an estimated one-third of all TIAs are followed by a stroke within five years. They are considered a medical emergency and prompt medical attention is very important.

Risk factors for strokes and TIAs are very similar. The risk of a TIA or stroke is higher among men, African Americans, people over age 65, and people with heart disease or diabetes. Smokers, people with high blood pressure, and people who are overweight also have a greater risk for TIAs and strokes.

Causes and symptoms

A TIA is caused by a temporary blockage of one of the arteries that leads into the brain. Small **blood clots**, called microemboli, are the immediate cause of the blockage. The blockage forms because of damage or disease within the circulatory system. Blood clots can form in blood vessels because of artery damage, vascular disease, and other cardiovascular problems. For example, **atherosclerosis** is strongly associated with TIAs. Atherosclerosis is the build-up of fatty deposits or plaque at certain areas in the circulatory system. Clotting cells in blood, called platelets, tend to stick to atherosclerotic plaques or other damaged sites within blood vessels. Occasionally, a clot may grow large enough to block a blood vessel, or a piece of a clot may break off and circulate to other areas of the body. If a clot does not dissolve quickly enough, it can lodge in a blood vessel and block it. In TIAs, the microemboli dissolve within a short time.

Blood flows into the brain through two main pathways: the carotid arteries and the vertebrobasilar arteries. The carotid arteries are located on the front of the neck; the vertebrobasilar arteries are at the base of the skull at the back of the head. The symptoms produced by a TIA are determined by the arteries affected.

If a vertebrobasilar artery is blocked, common symptoms include double vision and **dizziness**, **nausea and vomiting**, difficulty speaking, and problems understanding and using spoken words. There may also be numbness around the mouth and a **tingling** sensation in the limbs. Blockage of a carotid artery produces complete loss of vision, dimmed or foggy vision, and **paralysis** or weakness on one side of the body. These symptoms also may be accompanied by language problems and speech difficulty. With either type of blockage, the microemboli dissolve within hours and full function returns.

Diagnosis

Examination

The goal of diagnosis is to identify the precise cause of the TIA and to recommend treatment. Initial information that an individual can supply includes a medical history, what drugs are currently being taken and why, and a full description of the symptoms. Blood tests are ordered to screen blood counts—the numbers of specific blood cell types—and to measure glucose (sugar) and lipid (fats, including cholesterol) levels. Based on this information and a **physical examination** that includes blood pressure, pulse, and respiration measurements, one or more of the following imaging tests are ordered.

Tests

A computed tomography scan (CT scan) or a **magnetic resonance imaging** (MRI) scan usually is the first imaging test. CT or MRI can rule out other problems such as a tumor or **subdural hematoma** that can mimic the symptoms of a TIA. A CT scan also can uncover aneurysms and arteriovenous malformation, both of which are blood vessel abnormalities that can cause bleeding in the brain.

Another useful imaging test is carotid ultrasonography, a noninvasive procedure that allows examination of the interior of the carotid artery. This examination can detect carotid stenosis, a condition in which the artery is abnormally narrow because of atherosclerosis. Ultrasonography is very reliable in identifying stenosis, but it does not give enough information to accurately assess the degree of stenosis. Because treatment depends on the degree of stenosis, treatment decisions cannot be based on ultrasonography. Another type of ultrasonography, called **transcranial Doppler ultrasonography**, is used to detect stenosis of the blood vessels within the brain and in the vertebrobasilar arteries.

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KEY TERMS

Angioplasty—A medical procedure in which a catheter, or thin tube, is threaded through blood vessels. The catheter is used to place a balloon or stent (a small metal rod) at an area of stenosis and expand it mechanically.

Arteriography—A medical test in which an x-ray visible dye is injected into blood vessels. This dye allows the blood vessels to be imaged with x rays.

Atherosclerosis—A build-up of fatty tissue called plaque inside arteries that can impede or block blood flow.

Carotid artery—One of the major blood vessels leading to the brain; it runs up the front of the neck.

Echocardiography—A type of ultrasonography that is used to create an image of the heart and its functioning.

Endarterectomy—A surgical procedure in which diseased tissue and atherosclerotic plaque are removed from the inside of an artery.

Ischemia—A condition in which blood flow is cut off or restricted from a particular area. The surrounding tissue, starved of oxygen and nutrients, dies.

Microemboli—Small blot clots in the bloodstream.

Platelets—Tiny cells in the blood that help form blood clots.

Stenosis—The narrowing of an opening or passageway in the body. In arteries, stenosis is caused by a build-up of atherosclerotic plaque, disease, or other disorder.

Stroke—A condition in which blood flow to the brain has been blocked, thereby causing brain cells to die from lack of oxygen and nutrients; also called a "brain attack."

Ultrasonography—A medical test in which sound waves are directed against internal structures in the body. As sound waves bounce off the internal structure, they create an image on a video screen.

Vertebrobasilar arteries—Major blood vessels that lead to the brain. They are located at the base of the skull at the back of the head.

Procedures

If stenosis is identified, a further test called cerebral arteriography may be done. This test is not done if the individual is in poor health, because it may be too risky. Arteriography involves injecting a special dye into the blood vessels that makes them visible on x rays. This procedure also is used to find suspected problems with blood vessels in the brain. Because it is an invasive procedure, complications can arise. Typically, these complications are minor and temporary. In a very small percentage of people with cardiovascular disease, the procedure may cause serious complications, such as stroke.

Although TIAs affect the brain, the ultimate cause of the problem may be found in the heart. Heart disease or damage to the heart's blood vessels is assessed by **echocardiography**. Echocardiography is a type of ultrasonography and is a noninvasive procedure.

Treatment

Treatment is aimed at preventing further TIAs and especially at preventing a stroke. The particular therapy depends on the root cause of the TIA and is not begun until this cause is identified. If possible, drug therapy is the preferred method of treating TIAs. Surgical intervention may be required if an individual's situation is not likely to respond to medication or if medication has failed.

Drugs

Anticlotting drugs such as **aspirin** or cloplidgrel (Plavix) usually are given to reduce the chance of platelets forming clumps in the blood. These drugs are intended for long-term use. Anticoagulant (blood thinner) drugs such as warfarin (Coumadin) may be prescribed to keep blood from clotting. Other drugs may be prescribed to relax the smooth muscles of the arteries. Cholesterol-lowering drugs (statins) may be recommended, and conditions such as high blood pressure (**hypertension**) and **diabetes mellitus** that can worsen **vascular disease** will be treated.

Surgery

If carotid arteriography reveals at least a 70% blockage of the carotid artery, surgical treatment usually is recommended. The particular surgical method is called carotid **endarterectomy**. In endarterectomy, the artery is opened and the material clogging it is removed. Another procedure, called balloon **angioplasty**, has been suggested for treating carotid stenosis, but it is not as widely used. This procedure is performed by threading a thin tube through the blood vessel to the site that is clogged.

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A balloon or a stent (a slender rod) is then passed through the tube to mechanically widen the narrowed area. This procedure is successfully used in other blood vessels in the body, but there is some worry that using it close to the brain may be too dangerous. Surgical treatment of blockage of the vertebrobasilar arteries is not usually recommended.

Home remedies and lifestyle changes

Treatment of TIAs also focuses on underlying problems. High blood pressure, heart disease, and high levels of blood lipids all require medical intervention. Condition-specific medications often are prescribed and lifestyle changes are strongly encouraged. These may include:

- losing weight if necessary and maintaining a healthy weight
- stopping smoking
- avoiding alcohol or consuming alcohol in moderation
- exercising moderately but regularly (5 days a week)
- eating a diet low in animal fats and sweets and high in fresh fruits, vegetables, and fiber
- controlling high blood pressure through salt (sodium) restriction, exercise, and medications as necessary
- controlling diabetes through exercise, diet, and medication as necessary by monitoring blood glucose levels regularly

Prognosis

One-third of TIAs are followed by stroke in the next five years; in the other two-thirds, the TIAs may either continue or disappear on their own. However, because of the risk of stroke-related disability and death, all TIAs should be treated as emergency medical situations.

Medical treatment significantly decreases the risk of stroke for people who experience one or more TIAs. Anti-platelet therapy reduces risk as much as 31%. Carotid endarterectomy also substantially reduces stroke risk. The procedure itself carries some risk, but the complication rate is less than 5%. The risk of complication can be lowered by choosing to have the procedure done in a facility experienced with it and by a surgeon with a low complication rate.

Prevention

Treatment for TIAs is complemented by lifestyle changes. These practices also may prevent TIAs and strokes from ever occurring. Doctors and other healthcare providers universally recommend that individuals stop **smoking** and consume alcohol in moderation. Regular health checkups can detect high blood pressure, heart disease, and other underlying problems. Adhering to treatment for these problems can help minimize TIA and stroke risks. Finally, maintaining a healthy weight and engaging in regular **exercise** as able are strongly recommended.

Resources

OTHER

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Transient Ischemic Attack (TIA, Mini-Stroke). MedicineNet.com. March 4, 2008.

Wedro, Benjamin C. and Melissa C. Stoppler. Transient Ischemic Attack (TIA, Mini-Stroke). emedicinehealth.com. October 25, 2007. http://www.emedicinehealth.com/transient_ischemic_attack_mini-stroke/article_em.htm

ORGANIZATIONS

American Heart Association, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, http://www.americanheart.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573; TTY: (240) 629-3255, (240) 629-3246, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi.nih.gov.

National Institute of Neurological Disorders and Stroke (NINDS), P.O. Box 5801, Bethesda, MD, 20828, (301) 496-5751. TTY: (301) 468-5981, (800) 352-9424, http://www.ninds.nih.gov.

Society for Vascular Surgery, 633 N. St. Clair, 24th Floor, Chicago, IL, 60611, (312)334-2300, (800) 251-7188, (312) 334-2320, http://www.vascularweb.org.

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Transplant reaction screening test *see* **Cytomegalovirus antibody screening test**

Transplant surgery

Definition

Transplant surgery is the surgical removal of organs, tissue, or blood products from a donor and surgically placing or infusing them into a recipient. There are four categories of transplantation, classified by tissue origin: autograft (donor and recipient are the same person); isograft or syngeneic graft (donor and recipient are genetically identical, as in identical twins); allograft or homograft (donor and recipient are genetically unrelated but belong to the same species, i.e., both are human

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KEY TERMS

Antibody—A substance produced by the immune system in response to specific antigens, thereby helping the body fight infection and foreign substances. An antibody screen involves mixing the white blood cells of the donor with the serum of the recipient to determine if antibodies in the recipient react with the antigens of the donor.

Autologous blood—The patient's own blood, drawn and set aside for use during surgery in case a transfusion is needed.

Bone densitometry test—A test that quickly and accurately measures the density of bone.

Brain death—Irreversible cessation of brain function. Patients with brain death have no potential capacity for survival or for recovery of any brain function.

Cadaveric donor—An organ donor who has recently died of causes not affecting the organ intended for transplant.

Compatible donor—A person whose tissue and blood type are the same as the recipient's.

Confirmatory typing—Repeat tissue typing to confirm the compatibility of the donor and patient before transplant

Donor—A person who supplies organ(s), tissue or blood to another person for transplantation.

Harvesting—The process of removing tissues or organs from a donor and preserving them for transplantation.

Hemodilution—A technique in which the fluid content of the blood is increased without increasing the number of red blood cells.

Human leuckocyte antigen (HLA)—A group of protein molecules located on bone marrow cells that can provoke an immune response. A donor's and a recipient's HLA types should match as closely as possible to prevent the recipient's immune system from attacking the donor's marrow as a foreign material that does not belong in the body.

Immunosuppression—The use of medications to suppress the immune system to prevent organ rejection.

Organ procurement—The process of donor screening, and the evaluation, removal, preservation, and distribution of organs for transplantation.

Pulmonary function test—A test that measures the capacity and function of the lungs as well as the blood's ability to carry oxygen. During the test, the patient breathes into a device called a spirometer.

Rejection—An immune response that occurs when a transplanted organ is viewed as a foreign substance by the body. If left untreated, rejection can lead to organ failure and even death.

beings) and xenograft or heterograft (donor and recipient belong to different species, i.e., chimpanzee or rabbit tissues have been used in humans on an experimental basis).

Purpose

Transplant surgery is a treatment option for diseases or conditions that have not improved with other medical treatments and have led to organ failure or injury. Transplant surgery is generally reserved for people with end-stage disease who have no other options.

The decision to perform transplant surgery is based on the patient's age, general physical condition, specific diagnosis, and stage of the disease. Transplant surgery is not recommended for patients who have liver, lung, or kidney problems; poor leg circulation; **cancer**; or chronic infections.

Demographics

The former typical cut-off age for a transplant recipient ranged between 40 and 55 years; however, people aged 50–65 consitiute the fastest-growing age group added to the transplant waiting list. A person's general health is usually a more important factor. In addition, the percentage of transplant recipients over age 50 has increased since 1996. Expanded-criteria kidney donations are responsible for many of these later-life transplants. Kidneys in this category have been donated from people who in the past would not be considered optimum donors due to age or certain medical conditions. Studies have shown that older persons with kidney failure fare better with an expanded-criteria kidney transplant than by remaining on dialysis.

On average, 66 people receive transplants every day from either a living or deceased donor. Between January

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and October 2009, 23,846 transplants were performed in the United States; 18,404 organs came from deceased donors, while 5,442 came from living donors.

The national waiting list for most transplanted organs continues to grow every year, even though the number of recipients waiting for a heart transplant has leveled off in recent years, and the waiting list for heart-lung transplants has decreased over the past few years. As of January 2010, there were about 105,300 eligible recipients waiting for an organ transplant in the United States.

Description

Organ donors

Organ donors are classified as living donors or cadaveric (non-living) donors. All donors are carefully screened to make sure there is a suitable blood type match and to prevent any transmissible diseases or other complications.

LIVING DONORS. Living donors may be family members or biologically unrelated to the recipient. From 1992 to 2001, the number of biologically unrelated living donors increased tenfold. Living donors must be physically fit, in good general health, and have no existing disorders such as diabetes, high blood pressure, cancer, **kidney disease**, or heart disease. Of all the organs transplanted in 2008, about 22% came from living donors. Organs that can be donated from living donors include:

- Single kidneys. In 2009, about one third of all kidney transplants came from living donors. There is little risk in living with one kidney because the remaining kidney compensates for and performs the work of both.
- Liver. Living donors can donate segments of the liver because the organ can regenerate and regain full function.
- Lung. Living donors can donate lobes of the lung although lung tissue does not regenerate.
- Pancreas. Living donors can donate a portion of the pancreas even though the gland does not regenerate.
- Intestines. Living donors can donate a portion of their intestine.

Organs donated from living donors eliminate the need to place the recipient on the national waiting list. Transplant surgery can be scheduled at a mutually acceptable time rather than performed under emergency conditions. In addition, the recipient can begin taking immunosuppressant medications two days before the transplant surgery to prevent the risk of rejection. Living donor transplants are often more successful than cadaveric donor transplants because there is a better tissue match between the donor and recipient. The living donor's medical expenses are usually covered by the organ recipient's insurance company, but the amount of coverage may vary.

CADAVERIC OR DECEASED DONORS. Organs from cadaveric donors come from people who have recently died and have willed their organs before **death** by signing an organ donor card, or are brain-dead. The donor's family must give permission for **organ donation** at the time of death or diagnosis of brain death. Cadaveric donors may be young adults with traumatic head injuries, or older adults suffering from a **stroke**. The majority of deceased donors are older than the general population.

Transplant procedures

ORGAN HARVESTING. Harvesting refers to the process of removing cells or tissues from the donor and preserving them until they are transplanted. If the donor is deceased, the organ or tissues are harvested in a sterile operating room. They are packed carefully for transportation and delivered to the recipient via ambulance, helicopter, or airplane. Organs from deceased donors should be transplanted within a few hours of harvesting. After the recipient is notified that an organ has become available, he or she should not eat or drink anything.

When the organ is harvested from a living donor, the recipient's transplant surgery follows immediately after the donor's surgery. The recipient and the donor should not eat or drink anything after midnight the evening before the scheduled operation.

PREOPERATIVE PROCEDURES. After arriving at the hospital, the recipient will have a complete physical and such other tests as a **chest x ray**, blood tests, and an electrocardiogram (EKG) to evaluate his or her fitness for surgery. If the recipient has an infection or major medical problem, or if the donor organ is found to be unacceptable, the operation will be canceled.

The recipient will be prepared for surgery by having the incision site shaved and cleansed. An intravenous tube (IV) will be placed in the arm to deliver medications and fluids, and a sedative will be given to help the patient relax.

TRANSPLANT SURGERY. After the patient has been brought to the operating room, the anesthesiologist will administer a general anesthetic. A central venous catheter may be placed in a vein in the patient's arm or groin. A breathing tube will be placed in the patient's throat. The breathing tube is attached to a mechanical ventilator that expands the lungs during surgery.

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The patient will then be connected to a heart-lung bypass machine, also called a cardiopulmonary bypass pump, which takes over for the heart and lungs during the surgery. The heart-lung machine removes carbon dioxide from the blood and replaces it with oxygen. A tube is inserted into the patient's aorta to carry the oxygenated blood from the bypass machine back to the heart for circulation to the body. A nasogastric tube is placed to drain stomach secretions, and a urinary catheter is inserted to drain urine during the surgery.

The surgeon carefully removes the diseased organ and replaces it with the donor organ. The blood vessels of the donated organ are connected to the patient's blood vessels, allowing blood to flow through the new organ.

Diagnosis/Preparation

Pre-transplant evaluation

Several tests are performed before the transplant surgery to make sure that the patient is eligible to receive the organ and to identify and treat any problems ahead of time. The more common pre-transplant tests include:

- tissue typing
- blood tests
- chest x ray
- pulmonary function tests
- computed tomography (CT) scan
- heart function tests (electrocardiogram, echocardiogram, and cardiac catheterization)
- sigmoidoscopy
- bone densitometry test

The pre-transplant evaluation usually includes a dietary and social work assessment. In addition, the patient must undergo a complete dental examination to reduce the risk of infection from bacteria in the mouth.

Insurance considerations

Organ transplantation is an expensive procedure. Insurance companies and health maintenance organizations (HMOs) may not cover all costs. Many insurance companies require precertification letters of medical necessity. As soon as transplantation is discussed as a treatment option, the patient should contact his or her insurance provider as soon as possible to determine what costs will be covered. In the United States as of early 2008, a kidney transplant cost as much as $100,000, a liver transplant $250,000, and a heart transplant $860,000. There are, however, organizations that can assist with raising funds to cover the cost of transplantation, such as the National Foundation for Transplants and the National Transplant Assistance Fund and Catastrophic Injury Program.

Patient education and lifestyle changes

Before undergoing transplant surgery, the transplant team will ensure that the patient understands the potential benefits and risks of the procedure. In addition, a team of health care providers will review the patient's social history and psychological test results to ensure that he or she is able to comply with the regimen that is needed after transplant surgery. An organ transplant requires major lifestyle changes, including dietary adjustments, complex drug treatments, and frequent examinations. The patient must be committed to making these changes in order to become a candidate for transplant. Most transplant centers have extensive patient education programs.

Smoking cessation is an important consideration for patients who use tobacco. Many transplant programs require the patient to be a nonsmoker for a certain amount of time (usually six months) before he or she is eligible to participate in the pre-transplant screening evaluation. The patient must also be committed to avoid tobacco products after the transplant.

Informed consent

Patients are legally required to sign an informed consent form prior to transplant surgery. Informed consent signifies that the patient is a knowledgeable participant in making healthcare decisions. The doctor will discuss all of the following with the patient before he or she signs the form: the nature of the surgery; reasonable alternatives to the surgery; and the risks, benefits, and uncertainties of each option. Informed consent also requires the doctor to make sure that the patient understands the information that has been given.

Finding a donor

After the patient has completed the pre-transplant evaluation and has been approved for transplant surgery, the next step is locating a donor. Organs from cadaveric donors are located through a computerized national waiting list maintained by the United Network for Organ Sharing (UNOS) to assure equal access to and fair distribution of organs. When a deceased organ donor is identified, a transplant coordinator from an organ procurement organization enters the donor's data in the UNOS computer. The computer then generates a list of potential recipients. This list is called a match run. Factors affecting a potential organ

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recipient's ranking on the match run list include: tissue match, blood type, size of the organ, length of time on the waiting list, immune status, and the geographical distance between the recipient and donor. For some transplants, such as heart, liver, and intestinal segments, the degree of medical urgency is also taken into consideration.

The organ is offered to the transplant team of the first person on the ranked waiting list. The recipient must be healthy enough to undergo surgery, available, and willing to receive the organ transplant immediately. The matching process involves cross matching, performing an antibody screen and a host of other tests.

Donor searching can be a long and stressful process. A supportive network of friends and family is important to help the patient cope during this time. The healthcare provider or social worker can also put the patient in touch with support groups for transplant patients.

Contact and travel arrangements

The patient must be ready to go to the hospital as soon as possible after being notified that an organ is available. A suitcase should be kept packed at all times. Transportation arrangements should be made ahead of time. If the recipient lives more than a 90-minute drive from the transplant center, the transplant coordinator will help make transportation arrangements for the recipient and one friend or family member.

Because harvested organs cannot be preserved for more than a few hours, the transplant team must be able to contact the patient at all times. Some transplant programs offer a pager rental service, to be used only for receiving the call from the transplant center. The patient should clear travel plans with the transplant coordinator before taking any trips.

Blood donation and conservation

Some transplant centers allow patients to donate their own blood before surgery, which is known as autologous donation. Autologous blood is the safest blood for **transfusion**, since there is no risk of disease transmission. Preoperative donation is an option for patients receiving an organ from a living donor, since the surgery can be scheduled in advance. In autologous donation, the patient donates blood once a week for one to three weeks before surgery. The blood is separated and the blood components needed are reinfused during the operation.

In addition to preoperative donation, there are several techniques for minimizing the patient's blood loss during surgery:

- Intraoperative blood collection. The blood lost during surgery is processed, and the red blood cells are reinfused during or immediately after surgery.
- Immediate preoperative hemodilution. The patient donates blood immediately before surgery to decrease the loss of red blood cells during the operation. The patient is then given fluids to restore the volume of the blood.
- Postoperative blood collection. The blood lost from the incision following surgery is collected and reinfused after the surgical site has been closed.

Aftercare

Inpatient recovery

A transplant recipient can expect to spend three to four weeks in the hospital after surgery. Immediately following the operation, the patient is transferred to an intensive care unit (ICU) for close monitoring of his or her vital signs. When the patient's condition is stable, he or she is transferred to a hospital room, usually in a specialized transplant unit. The IV in the patient's arm, the urinary catheter, and a dressing over the incision remain in place for several days. A chest tube may be placed to drain excess fluids. Special stockings may be placed on the patient's legs to prevent **blood clots** in the deep veins of the legs. A breathing aid called an incentive spirometer is used to help keep the patient's lungs clear and active after surgery.

Medications to relieve **pain** will be given every three to four hours, or through a device known as a PCA (patient-controlled anesthesia). The PCA is a small pump that delivers a dose of medication into the IV when the patient pushes a button. The transplant recipient will also be given immunosuppressive medications to prevent the risk of organ rejection. These medications are typically taken by the recipient for the rest of his or her life.

A 2–4 week waiting period is necessary before the transplant team can evaluate the success of the procedure. Visitors are limited during this time to minimize the risk of infection. The patient will be given intravenous antibiotic, antiviral and antifungal medications, as well as blood and platelet transfusions to help fight off infection and prevent excessive bleeding. Blood tests are performed daily to monitor the patient's kidney and liver function, as well as his or her nutritional status. Other tests are performed as needed.

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Outpatient recovery

After leaving the hospital, the transplant recipient will be monitored through home or outpatient visits for as long as a year. Medication adjustments are often necessary, but barring complications, the recipient can return to normal activities about 6–8 months after the transplant.

Proper outpatient care includes:

- taking medications exactly as prescribed
- attending all scheduled follow-up visits
- contacting the transplant team at the first signs of infection or organ rejection
- having blood drawn regularly
- following dietary and exercise recommendations
- avoiding rough contact sports and heavy lifting
- taking precautions against infection
- avoiding pregnancy for at least a year

Risks

Short-term risks following an organ transplant include **pneumonia** and other infectious diseases; excessive bleeding; and liver disorders caused by blocked blood vessels. In addition, the new organ may be rejected, which means that the patient's immune system is attacking the new organ. Characteristic signs of rejection include **fever**, rash, **diarrhea**, liver problems, and a compromised immune system. Transplant recipients are given immunosuppressive medications to minimize the risk of rejection. In most cases, the patient will take these medications for the rest of his or her life.

Long-term risks include an elevated risk of cancer, particularly skin cancer. An estimated 6–8% of transplant patients develop cancer over their lifetime as compared to less than 1% in the general population.

There is a very small risk of infection from a transplanted organ, even though donors in the United States and Canada are carefully screened. In 2007, the Centers for Disease Control and Prevention (CDC) reported a case in which four organ recipients in the Chicago area developed **hepatitis C** and HIV infection from a high-risk donor. The diseases did not show up on screening tests because the donor contracted them about three weeks before his death, when there were not enough antibodies in his blood to be detected by present tests.

Normal results

In a successful organ transplant, the patient returns to a more nearly normal lifestyle with increased strength and stamina.

Morbidity and mortality rates

Mortality figures for transplant surgery include recipients who die before a match with a suitable donor can be found. About 17 patients die every day in the United States waiting for a transplant.

The Scientific Registry of Transplant Recipients gives the first-year survival rates for transplant surgery as follows:

- 97% of pancreas transplant recipients
- 95% of kidney transplant and kidney/pancreas recipients
- 90% of autologous bone marrow transplant patients
- 86% of liver transplant patients
- 85% of heart transplant patients
- 77% of lung transplant patients
- 70% of allogeneic bone marrow transplant patients

Three-year survival rates are:

- 91% for kidney transplant patients
- 87% for pancreas and kidney/pancreas transplant patients
- 80% for liver transplant patients
- 79% for heart transplant patients
- 59% for lung transplant patients

As of early 2010, about 190,000 Americans are living with a transplanted organ.

Alternatives

Clinical trials

Available alternatives to transplant surgery depend upon the individual patient's diagnosis and severity of illness. Some patients may be eligible to participate in clinical trials, which are research programs that evaluate a new medical treatment, drug or device. As of early 2010 the NIH has 208 studies of organ transplantation that are seeking new volunteers.

Complementary and alternative (CAM) therapies

Complementary therapies can be used along with standard treatments to help alleviate the patient's pain; strengthen muscles; and decrease depression, **anxiety**, and **stress**. Before trying a complementary treatment, however, patients should check with their doctors to make sure that it will not interfere with standard therapy or cause harm. Alternative approaches that have helped transplant recipients maintain a positive mental attitude both before and after surgery include **meditation**, **biofeedback**, and various relaxation techniques. **Massage**

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therapy, **music therapy**, **aromatherapy**, and **hydrotherapy** are other types of treatment that can offer patients some pleasant sensory experiences as well as relieve pain. **Acupuncture** has been shown in a number of NIH-sponsored studies to be effective in relieving **nausea** and **headache**, as well as chronic muscle and joint pain. Some insurance carriers cover the cost of acupuncture treatments.

Resources

BOOKS

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ORGANIZATIONS

American Society of Transplant Surgeons (ASTS), 2461 South Clark St., Suite 640, Arlington, VA, 22202, (703) 414-7870, http://www.asts.org.

Children's Organ Transplant Association, Inc., 2501 West COTA Drive, Bloomington, IN, 47403, (800) 366-2682, http://www.cota.org.

Coalition on Donation, 700 North 4th Street, Richmond, VA, 23219, (804)782-4920, http://www.organtransplants.org/donor/coalition/.

National Foundation for Transplants, 5350 Poplar Avenue, Suite 430, Memphis, TN, 38119, (901) 684-1697, http://www.transplants.org.

National Heart, Lung and Blood Institute (NHLBI) Information Center, P. O. Box 30105, Bethesda, MD, 20824-0105, (301) 251-2222, http://www.nhlbi.nih.gov.

National Transplant Assistance Fund and Catastrophic Injury Program, 150 N. Radnor Chester Road, Suite F-120, Radnor, PA, 19087, (800) 642-8399, http://www.transplantfund.org/.

Partnership for Organ Donation, Two Oliver Street, Boston, MA, 02109, (617) 482-5746, http://www.transweb.org/partnership/.

Transplant Foundation, Inc, 701 SW 27th Ave, Suite 705, Miami, FL, 33135, (305) 817-5645, http://www.transplantfoundation.org/.

Transplant Recipients International Organization (TRIO), 1000 16th Street, NW, Suite 602, Washington, DC, 20036-5705, (800) TRIO-386, http://www.transweb.org/people/recips/resources/support/bkuptrio_main.html.

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Transplantation *see* **Corneal transplantation; Hair transplantation; Heart transplantation; Kidney transplantation; Lung transplantation; Pancreas transplantation**

Transposition of the great arteries

Definition

Transposition of the great arteries is a birth defect causing a fatal condition in which there is a reversal, or switch, in the truncal connections of the two main (great) blood vessels to the heart, the aorta and pulmonary artery.

Demographics

In the United States, transposition of the great artery is one of the most common congenital heart defects It is more common in males than in females, race is not a factor, and it affects about 40 out of every 100,000 babies born. The mortality rate in untreated patients is approximately 30% in the first week, 50% in the first month, and 90% by the end of the first year.

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With improved diagnostic, medical, and surgical techniques, the overall short-term and midterm survival rate exceeds 90%.

Description

There are two great arteries, the pulmonary artery and the aorta. Normally, the pulmonary artery carries blood from the right ventricle to the lungs. The aorta carries blood from the left ventricle to the vessels of the rest of the body.

Normally, blood returning to the heart is depleted in oxygen. It goes first to the right atrium of the heart and then to the right ventricle where it is pumped to the lungs. While in the lungs, the blood picks up more oxygen. After the lungs, the blood flows to the left atrium, then the left ventricle, which pumps the blood out through the aorta to the rest of the body, thereby supplying the body with oxygenated blood.

Transposition of the great arteries results in oxygen-depleted blood going to the body. The reason is that the connection of the two great arteries is reversed. In this case, the aorta is connected to the right ventricle. Blood returning to the heart goes to the right atrium and ventricle, which is normal. Then, when the right ventricle pumps the blood out, it goes into the aorta for distribution throughout the body. At the same time, blood in the lungs goes to the left atrium, the left ventricle, but then back to the lungs. This happens because the pulmonary artery is connected to the left ventricle. The result is that highly-oxygenated blood keeps recycling through the lungs, while oxygen-depleted blood recycles through the body without going through the lungs to reoxygenate.

This condition develops during the fetal stage and must be treated promptly after birth if the newborn is to survive. The newborn can survive for a few days because the foramen ovale, a small hole in the septum that separates the two atria, is open, allowing some oxygenated blood to escape and mix into the blood that is being pumped throughout the body. However, the foramen ovale normally closes within a few days after birth.

Causes and symptoms

Transposition of the great arteries is a birth defect that occurs during fetal development. There is no identifiable disease or cause. The main symptom is blueness of the skin caused by a general lack of oxygen in the body's tissues. Other symptoms include, **shortness of breath**, poor feeding, and chubbing of the fingers or toes.

KEY TERMS

Aorta—The biggest artery in the body, receiving blood directly from the heart.

Artery—A blood vessel that carries blood away from the heart to the rest of the body.

Atrium—One of the two upper chambers of the heart.

Blood vessels—General term for arteries, veins, and capillaries that transport blood throughout the body.

Pulmonary artery—The blood vessel that delivers blood from the heart to the lungs.

Ventricle—A cavity, as in the brain or heart. The right ventricle of the heart drives blood from the heart into the pulmonary artery, which supplies blood to the lung.

Diagnosis

Diagnosis is made immediately after birth, when it is observed that the newborn is lacking oxygen. This is noted by the bluish color of the newborn, indicating **cyanosis**, a lack of oxygen. A definite diagnosis is made by x ray, **electrocardiography** (ECG), and **echocardiography**.

Treatment

The only treatment for this condition is prompt heart surgery shortly after birth. In surgery, the two great arteries are reconnected to their proper destination. This restores the normal blood flow pattern. The coronary arteries are also reconnected, so that they can supply blood to the heart itself. During the procedure at birth, the baby will receive prostaglandin through an IV (intravenous line). This medication helps the blood flow through the lungs and body. A procedure using **cardiac catheterization** may also be needed to create a large hole in the atrial septum to allow blood to mix. In many hospitals, a type of surgery called an arterial switch procedure can be used to permanently correct the problem within the first week of life. This surgery switches the great arteries back to the normal position along with the coronary arteries.

Prognosis

Improvement in symptoms, along with growth and development is seen after surgical correction of the

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defect. However, left untreated, this disease can be fatal within the first weeks of life.

Prevention

Because there is no identifiable cause, there is no way to prevent this condition. However, women who plan to become pregnant should be immunized against **rubella** if they are not already immune. Avoiding alcohol, eating healthy, and controlling diabetes both before and during **pregnancy** may also be helpful.

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John T. Lohr, PhD
Karl Finley

Transsexualism *see* **Gender identity disorder**

Transurethral bladder resection

Definition

Transurethral bladder resection is a surgical procedure, performed under **sedation** or anesthesia, with a lighted tube inserted through the urethra (the small tube-like structure that allows urine to empty from the bladder), into the bladder. It plays both a diagnostic and therapeutic role in the treatment of bladder cancers.

Purpose

Tranurethral resection is the initial form of treatment for bladder cancers. The procedure is performed to remove and examine bladder tissue and/or tumor. It may also serve to remove lesions and be the only treatment necessary for noninvasive tumors.

Description

For this procedure, a lighted tube (resectoscope) is inserted through the urethra, into the bladder. A clear solution is infused to maintain visibility, and the tumor or tissue to be examined is cut away using an electric current. Tumor and muscle fibers are biopsied (a sample is cut out and examined, usually under a microscope) in order to evaluate the depth of tissue involvement, while avoiding perforation of the bladder wall. Every attempt is made to remove all visible tumor tissue, along with a small border of healthy tissue. The resected tissue is examined under the microscope for diagnostic purposes. An indwelling catheter may be inserted to ensure adequate drainage of the bladder postoperatively. At this time, interstitial **radiation therapy** may be initiated if necessary.

Preparation

Preoperative x rays with dye studies are helpful as a guide in determining the character and extent of tumor involved. As with any surgical procedure, the patient is asked to sign a consent form after the procedure is thoroughly explained.

Aftercare

As with any surgical procedure, blood pressure and pulse will be monitored. Urine is expected to be blood-tinged in the early postoperative period. Continuous bladder irrigation (rinsing) may be used for approximately 24 hours after surgery. Most operative sites should be completely healed in three months. The patient is followed closely for possible recurrence with visual examination, using a special viewing device (cystoscope) at regular intervals as the physician deems necessary.

Abnormal results

Complications of the procedure may include bleeding, which may require bladder irrigation postoperatively, during which time the patient's activity is limited to bedrest. Perforation of the bladder is another risk, in which case the urinary catheter is left in place for four to five days postoperatively. The patient is started on antibiotic therapy preventively. If the bladder is lacerated, accompanied by spillage of urine into the abdomen, an abdominal incision may be required.

ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (800) 227-2345, http://www.cancer.org.

National Cancer Institute (National Institutes of Health), NCI Office of Communications and Education, 6116 Executive Blvd. Suite 300, Bethesda, MD, 20892-8322, (800) 4-CANCER (422-6237), cancergovstaff@mail.nih.gov, http://www.cancer.gov/.

Kathleen D. Wright, RN

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Transvaginal ultrasound

Definition

Transvaginal ultrasound is a imaging technique used to create a picture of the genital tract in women. The hand-held device that produces the ultrasound waves is inserted directly into the vagina, close to the pelvic structures, thus often producing a clearer and less distorted image than obtained through transabdominal ultrasound technology, where the probe is located externally on the skin of the abdomen.

Purpose

Transvaginal ultrasound can be used to evaluate problems or abnormalities of the female genital tract. It may provide more accurate information than transabdominal ultrasound for women who are obese, for women who are being evaluated or treated for **infertility**, or for women who have difficulty keeping a full bladder. However, it does provide a view of a smaller area than the transabdominal ultrasound. Types of conditions or abnormalities that can be examined include:

- the endometrium of women with infertility problems or who are experiencing abnormal bleeding
- sources of unexplained pain
- congenital malformations of the ovaries and uterus
- ovarian cysts and tumors
- pelvic infections, such as pelvic inflammatory disease
- bladder abnormalities
- a misplaced IUD (intrauterine device)
- other causes of infertility

Transvaginal ultrasound can also be used during **pregnancy**. Its capability of producing more complete images means that it is especially useful for identifying **ectopic pregnancy**, fetal heartbeat, and abnormalities of the uterus, placenta, and associated pelvic structures.

Transvaginal ultrasound is performed by an ultrasound technologist, who is supervised by a radiologist or a specialist such as an obstetrician.

Precautions

Studies have shown that ultrasound is not hazardous and has no harmful side effects.

Description

A ultrasound, or sonogram, is a procedure that utilizes reflected sound waves to produce a picture of organs and structures within the body. A transducer sends out high-pitched sounds, sounds that are above the range of human hearing, that are reflected back to the transducer. A computer is used to analyze the sound waves, transforming them into a picture (which is called a sonogram, echogram, or ultrasound scan) on a video monitor. These pictures can be saved as a permanent record of the test.

A transvaginal ultrasound is used for looking at organs and structures within the pelvic area that are solid and uniform, like the uterus, and ovaries, or for organs that are fluid-filled, like the bladder. Mineralized structures, like bones, or air-filled organs, such as the intestines, do not show up well on a sonogram and may disrupt the ultrasound beam so that deeper organs and structures cannot be seen clearly.

The transvaginal transducer that produces the ultrasound waves is shaped to fit within a woman's vagina. It is lubricated and covered with a sheath such as a condom. A woman should tell the health care provider if she is allergic to latex so that a latex-free cover can be applied to the transducer before it is inserted into the vagina.

Sometimes a woman may have both transvaginal and transabdominal ultrasound scans done to obtain a complete evaluation of the pelvic area.

Preparation

There is no special preparation required by a woman before a transvaginal ultrasound. She can continue to take medications prescribed by her health care provider, although she should not drink liquids for four hours before the test. A full bladder is not required for a transvaginal ultrasound, as is required for a transabdominal ultrasound. The test can be administered during any stage of the woman's menstrual cycle.

During the procedure, the woman lies on her back, with her hips slightly raised. The thin, lubricated tip of the transducer is inserted gently into the vagina. The transducer is moved and rotated to adjust the view of the pelvic structures displayed on the monitor. The woman must lie very still during the ultrasound scan. She may feel a mild discomfort from the pressure of the vaginal transducer. The procedure usually takes from 15 to 30 minutes.

Occasionally, **hysterosonography** is done on a nonpregnant woman to evaluate the inside of the uterus (endometrial cavity) and fallopian tubes by filling the uterus with fluid during a transvaginal ultrasound.

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KEY TERMS

Ectopic pregnancy—Pregnancy that develops outside the uterus, usually in one of the fallopian tubes.

Endometrium—The mucous membrane that makes up the inner layer of the uterine wall.

Gestational trophoblastic disease—A rare, aggressive, malignant, often metastatic (spreading to other organs) cancer in women of childbearing age in which cancer cells grow in the tissues that are formed in the uterus after conception.

Intrauterine device (IUD)—Contraceptive device consisting of a piece of bent plastic or metal that is inserted through the vagina into the uterus.

Transabdominal ultrasound—A small handheld instrument called a transducer is passed back and forth over the pelvic area to provide images of the abdomen.

Ovarian torsion—Twisting of the ovary due to the influence of another condition or disease, resulting in extreme lower abdominal pain.

Pelvic inflammatory disease (PID)—Inflammation of the female genital tract, especially of the fallopian tubes, caused by any of several microorganisms, chiefly chlamydia and gonococci, and characterized by severe abdominal pain, high fever, vaginal discharge, and in some cases destruction of tissue that can result in sterility.

Placental abruption—Premature separation of the placenta from the uterus.

Placenta previa—A low-lying placenta that covers part or all of the inner opening of the cervix. This can result in heavy bleeding during labor and delivery, which can be dangerous for mother and baby.

Aftercare

There is a slight risk of infection associated with a transvaginal ultrasound, especially if a biopsy was done in conjunction with the procedure. Therefore the patient should be aware of symptoms of an infection and seek care from a health care professional as necessary.

Risks

Since no ionizing radiation is associated with transvaginal ultrasound, there has been no documented adverse effects on patients or their fetuses with the use of the procedure.

Normal results

In a normal transvaginal ultrasound, the pelvic structures or organs or the fetus are found to have no abnormalities.

Abnormal results

Abnormal ultrasound results can be due to a variety of conditions and diseases. In non-pregnant women, these abnormal results may include:

- cancerous tumors or non-cancerous growths of the uterus, ovaries, vagina, or other pelvic structures
- ovarian torsion
- infections such as PID
- congenital malformations.

In pregnant women, the following abnormalities may be diagnosed through transvaginal ultrasound:

- ectopic pregnancies
- multiple pregnancies
- fetal death
- short cervix length, which may indicate the risk of preterm labor
- placental abnormalities such as placental previa and placental abruption
- tumors of pregnancy, including gestational trophoblastic disease.

A biopsy is needed to determine whether a tumor that is found during the transvaginal ultrasound scan is cancerous or non-cancerous.

Resources

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Hobbins, John C. *Obstetric Ultrasound: Artistry in Practice*. Malden, MA: Blackwell, 2008.

ORGANIZATIONS

American Institute of Ultrasound in Medicine, 14750 Sweitzer Lane, Suite 100, Laurel, MD, 20707-5906, (301) 498-4100, (301) 498-4450, http://www.aium.org.

Judith L. Sims

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Transverse myelitis

Definition

Transverse myelitis (TM) is an uncommon neurological syndrome caused by inflammation (a protective response which includes swelling, **pain**, heat, and redness) of the spinal cord, characterized by weakness, back pain, and bowel and bladder problems. It affects one to five persons per million.

Description

TM affects the entire thickness of the spinal cord, producing both sensory and movement problems. It is believed to be linked to the immune system, which may be prompted to attack the body's own spinal cord. Striking rapidly without warning, its effects can be devastating.

Causes and symptoms

Transverse myelitis has many different causes, often triggered by a variety of viral and bacterial infections (especially those associated with a rash such as **measles** or **chickenpox**). Once the infection subsides, the inflammation in the cord begins. About a third of patients experience a flu-like illness with **fever** about the time they develop symptoms of TM. Sometimes, there appears to be a direct invasion of, and injury to, the spinal cord by an infectious agent (such as herpes zoster or the **AIDS** virus).

TM can also accompany a variety of diseases that break down tissue that surrounds and insulates the nerves (demyelinating diseases), such as **multiple sclerosis** (MS).

Some toxic substances, such as carbon monoxide, lead, or arsenic, can cause a type of myelitis characterized by inflammation followed by hemorrhage or bleeding that destroys the entire circumference of the spinal cord. Other types of myelitis can be caused by poliovirus; herpes zoster; **rabies**, **smallpox** or **poliovaccination**; or parasitic and fungal infections.

Many experts believe that TM can occur without any apparent cause, probably as the result of an autoimmune process. This means that a person's immune system attacks the spinal cord, causing inflammation and tissue damage.

Regardless of the cause of the myelitis, onset of symptoms is sudden and rapid. Problems with movement and sensation appear within one or two days after inflammation begins. Symptoms include soft (flaccid) **paralysis** of the legs, with pain in the lower legs or back, followed by loss of feeling and sphincter (muscles which close an opening, as in the anus) control. The earliest symptom may be a girdle-like sensation around the trunk.

The extent of damage occuring will depend on how much of the spinal cord is affected, but TM rarely involves the arms. Severe spinal cord damage also can lead to **shock**.

KEY TERMS

Demyelinating disorders—A group of diseases characterized by the breakdown of myelin, the fatty sheath surrounding and insulating nerve fibers. This breakdown interferes with nerve function, and can result in paralysis. Multiple sclerosis is a demyelinating disorder.

Myelogram—An x-ray examination of the brain and spinal cord with the aid of a contrast dye, to look for tumors or spinal cord injury.

Diagnosis

A doctor will suspect transverse myelitis in any patient with a rapid onset of paralysis. Medical history, **physical examination**, brain and spinal cord scans, myelogram, spinal tap, and blood tests are used to rule out other neurological causes of symptoms, such as a tumor. If none of these tests suggest a cause for the symptoms, the patient is presumed to have transverse myelitis.

Treatment

There is no effective treatment for transverse myelitis, but any underlying infection must be treated. After this, the focus of care shifts from diagnosis and treatment to learning how to live with the effects of the syndrome. Patients are helped to cope psychologically with new limitations, and are given physical **rehabilitation**.

Physical adaptations include learning to cope with bowel and bladder control, sexuality, inability to control muscles (spasticity), mobility, pain, and activities of daily living (such as dressing).

As nerve impulses from the spinal cord are often scrambled and misinterpreted by the brain as pain, painkillers are given to ease discomfort. Antidepressants or anticonvulsants may also help.

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Prognosis

The prognosis depends on how much of the cord was damaged. Some people recover completely, while others have lasting problems and need help in learning how to cope with activities of daily living. People who develop spastic reflexes early in the course of the condition are more likely to recover than those who do not. If spinal cord tissue **death** (necrosis) occurs, the chance of a complete recovery is poor. Most recovery occurs within the first three months. A certain percentage of patients with TM will go on to develop multiple sclerosis.

ORGANIZATIONS

Transverse Myelitis Association, 1787 Sutter Parkway, Powell, OH, 43065-8806, (614) 766-1806, ssiegel@myelitis.org, http://www.myelitis.org.

Carol A. Turkington

Tranylcypromine *see* **Monoamine oxidase inhibitors**

This man's hand was surgically reattached following a traumatic amputation. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Traumatic amputations

Definition

Traumatic **amputation** is the accidental severing of some or all of a body part. A complete amputation totally detaches a limb or appendage from the rest of the body. In a partial amputation, some soft tissue remains attached to the site.

Description

Trauma is the second leading cause of amputation in the United States. About 30,000 traumatic amputations occur in this country every year. Four of every five traumatic amputation victims are male, and most of them are between the ages of 15–30.

Traumatic amputation most often affects limbs and appendages like the arms, ears, feet, fingers, hands, legs, and nose.

Causes and symptoms

Farm and factory workers have greater-than-average risks of suffering injuries that result in traumatic amputation. Automobile and motorcycle accidents and the use of lawnmowers, saws, and power tools are also common causes of traumatic amputation.

Blood loss may be massive or minimal, depending on the nature of the injury and the site of the amputation. Patients who lose little blood and have less severe injuries sometimes feel more **pain** than patients who bleed heavily and whose injuries are life-threatening.

Diagnosis

When the patient and the amputated part(s) reach the hospital, an Emergency Department physician will assess the probability that the severed tissue can be successfully reattached.

The Mangled Extremity Severity Score (MESS) assigns numerical values to such factors as body temperature, circulation, **numbness**, **paralysis**, tissue health, and the patient's age and general health. This is one of the diagnostic tools used to determine how successful reattachment surgery is apt to be. The total score is doubled if blood supply to the amputated part has been absent or diminished for more than six hours.

A general, emergency, or orthopedic surgeon makes the final determination about whether surgery should be performed. The surgeon also considers the patient's wishes and lifestyle. Additional concerns are how and to what extent the amputation will affect the patient's quality of life and ability to perform everyday activities.

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Treatment

First aid or emergency care given immediately after the amputation has a critical impact on both the physicians' ability to salvage and reattach the severed part(s) and the patient's ability to regain feeling and function.

Muscle tissue dies quickly, but a well-preserved part can be successfully reattached as much as 24 hours after the amputation occurs. Tissue that has not been preserved will not survive for more than six hours.

Initial response

The most important steps to take when a traumatic amputation occurs are:

- Contact the nearest emergency services provider, clearly describe what has happened, and follow any instructions given.
- Make sure the victim can breathe; administer CPR if necessary.
- Control bleeding, using direct pressure but minimizing or avoiding contact with blood and other body fluids.
- Patients should not be moved if back, head, leg, or neck injuries are suspected or if motion causes pain. If none are found by the EMT, lie the victim flat, with the feet raised 12 inches above the surface.
- Cover the victim with a coat or blanket to prevent shock.

The injured site should be cleansed with a sterile solution and wrapped in a clean towel or other thick material that will protect the wound from further injury. Tissue that is still attached to the body should not be forced back into place. If it cannot be gently replaced, it should be held in its normal position and supported until additional care is available.

Saving the patient's life is always more important than recovering the amputated part(s). Transporting the patient to a hospital or emergency center should never be delayed until missing pieces are located.

Preserving tissue

No amputated body part is too small to be salvaged. Debris or other contaminating material should be removed, but the tissue should not be allowed to get wet.

An amputated body part should be wrapped in **bandages**, towels, or other clean, protective material and sealed in a plastic bag. Placing the sealed bag in a cooler or in a container that is inside a second container filled with cold water or ice will help prevent tissue deterioration.

KEY TERMS

Phantom pain—Pain, tingling, itching, or numbness in the place where the amputated part used to be.

Prognosis

Possible complications of traumatic amputation include:

- excessive bleeding
- infection
- muscle shortening
- pulmonary embolism.

Improved medical and surgical care and **rehabilitation** have improved the long-term outlook for these patients.

Phantom pain

About 80% of all amputees over the age of four experience **tingling**, **itching**, numbness, or pain in the place where the amputated part used to be. Phantom sensations may begin immediately after the amputation, or they may develop months or years later. They often occur after an injury to the site of the amputation.

These intermittent feelings may:

- occur frequently or only once in a while
- be mild or intense
- last for a few minutes or several hours
- help patients adjust more readily to an artificial limb (prosthesis).

Prevention

The best way to prevent traumatic amputation is to observe common-sense precautions like using seat belts and obeying speed limits and other traffic regulations. It is important to take special precautions when using potentially dangerous equipment and make sure machinery is turned off and disconnected before attempting to service or repair it. Appropriate protective clothing should be worn at all times.

ORGANIZATIONS

American Amputation Foundation, Inc., PO Box 94227, North Little Rock, AR, 72190, (501) 835-9290, (501) 835-9292, info@americanamputee.org, http://www.americanamputee.org.

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Amputee Coalition of America, 900 East Hill Avenue, Suite 205, Knoxville, TN, 37915-2566, (865) 524-8772, (865) 525-7917, (888) 267-5669, http://www.amputee-coalition.org/.

Maureen Haggerty

Traveler's diarrhea

Definition

The occurrence of multiple loose bowel movements in someone traveling to an area outside their usual surroundings (usually from temperate industrialized regions to tropical areas), is known as Traveler's **diarrhea** (TD). The cause is almost always due to a bacterial or viral infection acquired through ingesting contaminated food or water.

Description

It is estimated that anywhere from 20–50% of the 12–20 million travelers going from temperate industrialized countries to the tropics will develop TD. Fortunately, most of these episodes are of short duration. Nevertheless, about 40% of those affected will need to rearrange their schedule, and 20% will be ill enough to remain in bed for some days.

The chance of winding up with TD is directly related to the area one is traveling to; only about 8% of individuals visiting an industrialized country are affected, whereas at least half of those traveling to non-industrialized regions become ill. It is also clearly related to the number of potentially contaminated foods or beverages consumed. Attention to recommended guidelines regarding food safety and sanitation can greatly decrease the risk of infection.

Causes and symptoms

Bacterial infections are the most common cause of the illness. Viruses and occasional parasites also can be the cause. As for the bacteria involved, toxin producing types of *E. coli* (called enterotoxigenic) account for approximately 40–60% of cases, with *Campylobacter* and *Shigella* each reported in at least 10% of cases. In some studies, *Campylobacter* has accounted for almost half of the attacks, especially during cooler seasons of the year. The cause can vary depending on several factors, including the season and country visited. More than one organism can be found in 15–30% of cases, while none is identified in up to 40% of cases worldwide.

Rotaviruses and a parvovirus called Norwalk agent also are responsible for TD. *Giardia* is probably the most common parasite identified, though amoebas (*Entamoeba histolytica*), *Cryptosporidium*, and *Cyclospora* are being found with increasing frequency. Amazingly, research released in 2003 found that those living in undeveloped countries with poor sanitation and high incidence of diarrheal disease also have the lowest incidence of colorectal **cancer**. It appears that an enterotoxin secreted from multiple bacteria leads to **colon cancer** resistance.

Younger age groups, particularly students, are at greatest risk, probably because of where and what they eat. Individuals over 55 years of age, persons staying with relatives, or business travelers are at lower risk. Foods with the highest chance of transmitting disease are uncooked vegetables, unpeeled fruits, meat, and seafood. Tap water and even ice can be dangerous unless one is sure of the source.

Symptoms usually start within a few days after arrival, but can be delayed for as long as two weeks. Illness lasts an average of 3 to 5 days, but is sometimes longer. Cramping abdominal **pain**, lack of appetite, and diarrhea are the main complaints. In approximately 10% of patients, diarrhea turns bloody. **Fever** develops in about half of them. The presence of bloody bowel movements and fever usually indicates a more severe form of illness and makes *Shigella* a more likely cause. Medications that decrease the motility or contractions of the intestine, such as loperamide (Imodium) or diphenoxylate (Lomotil), should not be used when fever or bleeding occur.

Complications

Diarrhea varies from a few loose stools per day to 10 or more. **Dehydration** and changes in the normal blood pH (acid-base balance) are the main dangers associated with TD. Signs of dehydration can be hard to notice, but increasing thirst, **dry mouth**, weakness or lightheadedness (particularly if worsening while standing), or a darkening/decrease in urination are suggestive. Severe dehydration and changes in the body's chemistry can lead to kidney failure and become life-threatening.

Another potential complication is "toxic megacolon," in which the colon gradually stretches and its wall thins to the point where it can tear. The presence of a hole in the intestine leads to **peritonitis** and is fatal unless quickly recognized and treated.

Other complications related to TD can involve the nervous system, skin, blood, or kidneys.

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Diagnosis

The occurrence of diarrhea in an individual while traveling is very suggestive of TD. Although there are other possible causes, these are less likely. In most instances, the specific organism responsible for the symptoms does not need to be identified, and the majority of patients need only rest and treatment to avoid potential complications.

When patients develop fever or bloody diarrhea, the illness is more serious and a specific diagnosis is needed. In those cases, or when symptoms last longer than expected, stool samples are obtained to identify the organism.

For this purpose, laboratories can either try to grow (culture) the organism, or identify it with high-powered microscopes (electron microscopy) or with the use of special tests or stains. These can show parasites such as *Giardia, Amoeba, Cryptosporidium* and others in freshly obtained stool specimens. New techniques that involve identification of DNA (the characteristic material that controls reproduction and is unique for all individuals) of the various organisms, also can be used in special circumstances.

Treatment

The best treatment of TD is prevention; however, once disease occurs, therapy is aimed at preventing or reducing dehydration, and using **antibiotics** when needed. Fortunately, severe dehydration is unusual in patients with TD, but any fluid losses should be treated early with either fruit juices and "clear fluids" such as tea or broth, or with the recommended Oral Rehydration Solutions (ORS) suggested by the World Health Organization (WHO). Persons traveling to known areas of infection should consult with their physician prior to departure and obtain appropriate instructions. For example, it may be advised to take along pre-prepared packets of ORS designed for easy mixing or commercial preparations such as Pedialyte, Ceralyte, Ricelyte, etc.

When nothing else is available, the following WHO recipe can be made up from household items and taken in small frequent sips;

- table salt: 1-3/4 teaspoon
- baking powder: 1 teaspoon
- orange juice: 1 cup
- water: 1 quart or liter

A debate has occurred in the medical community over the amount of salt (**sodium**) in the WHO preparations; some physicians feel that the content is too much for use by well-nourished persons in developed countries. Therefore these preparations should not be used for extended periods of time without consulting a physician.

Pepto-Bismol (bismuth subsalicylate preparation) is effective in both preventing and treating TD. For treatment once symptoms begin, the drug must be taken more frequently than when used for prevention. Bismuth subsalicylate preparation (1 oz of liquid or two 262.5-mg tablets every 30 minutes for eight doses) has been shown to decrease the number of bowel movements and shorten the length of illness. However, there is some concern about the large doses of bismuth in patients with **kidney disease**; therefore patients should check with physicians before starting this or any other therapy. Patients should be aware that bismuth can turn bowel movements black in color.

A new drug called rifamixin (Normix) for treating traveler's diarrhea was approved by the U.S. Food and Drug Administration (FDA) in 2010. Medications designed to decrease intestinal motility and contractions such as loperamide (Imodium), diphenoxylate (Lomotil), or others are safest when used by those without fever or bloody bowel movements. The presence of either of these symptoms indicates a more severe form of **colitis**.

Antibiotics are usually not prescribed, because most cases of TD rapidly improve with minimal treatment. For patients in whom symptoms are especially severe (4 or more stools per day or the onset of bloody diarrhea or fever), or those with compromised immune systems, antibiotics are indicated. Individuals with less severe attacks can be treated with either antimotility medications or bismuth subsalicylate.

Choice of an antibiotic should ideally be tailored to the most likely organism and then adjusted according to results of stool cultures. Trimethoprim-sulfamethoxazole (Bactrim) or ciprofloxacin (Cipro) are the antibiotics most often prescribed, but others are also used. The type and duration of treatment continues to be revised, and it is therefore extremely important that patients check with a physician prior to beginning treatment. In many instances, an antibiotic can be combined with an anti-motility agent to provide the quickest relief.

Prognosis

Up to 1% of patients with TD will become sick enough to require hospitalization, and 3% will continue to experience diarrhea for at least one month. The majority of patients rapidly recover with minimal therapy. Some will suffer symptoms for even longer. The small number who continue to suffer symptoms will need careful evaluation to rule out the many causes of chronic diarrhea (such as lactase deficiency, **irritable**

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KEY TERMS

Oral Rehydration Solution (ORS)—A liquid preparation developed by the World Health Organization that can decrease fluid loss in persons with diarrhea. Originally developed to be prepared with materials available in the home, commercial preparations have recently come into use.

bowel syndrome, parasites, etc.). It is unusual for diarrhea caused by bacteria to last over two weeks; therefore, more prolonged diarrhea indicates a non-bacterial cause.

Prevention

The best means of prevention is avoiding foods, beverages, and food handling practices that lead to infection with the organisms that cause TD. Drinking bottled water and using bottled water for brushing teeth, eating fruits that the traveler peels on his or her own, and eating well-cooked, hot foods can help prevent illness.

One effective means to prevent TD is liquid Pepto-Bismol; this bismuth-containing compound has been shown to be very effective in reducing the incidence of TD. Tablets are now available, which are easier to carry. Two tablets four times a day is recommended, but use should not go beyond three weeks.

Antibiotics can also prevent TD, but their use is controversial, unless it is absolutely necessary to avoid infection (such as someone on an important business trip or who has a weakened immune system). There is the tendency for bacteria to become resistant to these medications if used excessively; and these drugs have side effects that can be worse than the effects of TD. The benefits and risks of antibiotic treatment should be carefully weighed.

Resources

PERIODICALS

Jenkins, Susan. "Ah, the Irony: Colon Cancer Resistance Found in Traveler's Diarrhea." *The Scientist*. March 24, 2003: 27.

"Rifamixin for Traveler's Diarrhea." *R & D Directions*. January 2003: 60.

Seale, J. Paul. "Travel Risks: Update on Traveler's Diarrhea and Other Common Problems." *Consultant*. December 2002: 1778.

OTHER

Centers for Disease Control. http://www.cdc.gov.

David Kaminstein, MD
Teresa G. Odle

Tremors

Definition

Tremor is an unintentional (involuntary), rhythmical alternating movement that may affect the muscles of any part of the body. Tremor is caused by the rapid alternating contraction and relaxation of muscles and is a common symptom of diseases of the nervous system (neurologic disease).

Description

Occasional tremor is felt by almost everyone, usually as a result of fear or excitement. However, uncontrollable tremor or shaking is a common symptom of disorders that destroy nerve tissue, such as Parkinson's disease or **multiple sclerosis**. Tremor may also occur after **stroke** or **head injury**. Other tremors appear without any underlying illness.

Causes and symptoms

Tremor may be a symptom of an underlying disease, and it may be caused by drugs. It may also exist as the only symptom (essential tremor).

Underlying disease

Some types of tremor are signs of an underlying condition. About a million and a half Americans have Parkinson's disease, a disease that destroys nerve cells. Severe shaking is the most apparent symptom of Parkinson's disease. This coarse tremor features four to five muscle movements per second. The shaking is evident at rest but declines or disappears during movement.

Other disorders that cause tremor are multiple sclerosis, Wilson's disease, **mercury poisoning**, thyrotoxicosis, and **liver encephalopathy**.

A tremor that gets worse during body movement is called an "intention tremor." This type of tremor is a sign that something is amiss in the cerebellum, a region of the brain concerned chiefly with movement, balance and coordination.

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Essential tremor

Many people have what is called "essential tremor," in which the tremor is the only symptom. This type of shaking affects between three and four million Americans.

The cause of essential tremor is not known, although it is an inherited problem in more than half of all cases. The genetic condition has an autosomal dominant inheritance pattern, which means that any child of an affected parent will have a 50% chance of developing the condition.

Essential tremor most often appears when the hands are being used, whereas a person with Parkinson's disease will most often have a tremor while walking or while the hands are resting. People with essential tremor will usually have shaking head and hands, but the tremor may involve other parts of the body. The shaking often begins in the dominant hand and may spread to the other hand, interfering with eating and writing. Some people also develop a quavering voice.

Essential tremor affects men and women equally. The shaking often appears at about age 45, although the disorder may actually begin in adolescence or early adulthood. Essential tremor that begins very late in life is sometimes called "senile tremor."

Drugs and tremor

Several different classes of drugs can cause tremor as a side effect. These drugs include amphetamines, **antidepressant drugs**, **antipsychotic drugs**, **caffeine**, and lithium. Tremor also may be a sign of withdrawal from alcohol or street drugs.

Diagnosis

Close attention to where and how the tremor appears can help provide a correct diagnosis of the cause of the shaking. The source of the tremor can be diagnosed when the underlying condition is found. Diagnostic techniques that make images of the brain, such as computed tomography scan (CT scan) or **magnetic resonance imaging** (MRI), may help form a diagnosis of multiple sclerosis or other tremor caused by disorders of the central nervous system. Blood tests can rule out such metabolic causes as thyroid disease. A family history can help determine whether the tremor is inherited.

Treatment

Neither tremor nor most of its underlying causes can be cured. Most people with essential tremor respond to drug treatment, which may include propranolol, primidone, or a benzodiazepine. People with Parkinson's disease may respond to levodopa or other **antiparkinson drugs**.

Research has shown that about 70% of patients treated with botulinum toxin A (Botox) have some improvement in tremor of the head, hand, and voice. Botulinum is derived from the bacterium *Clostridium botulinum*. This bacterium causes **botulism**, a form of **food poisoning**. It is poisonous because it weakens muscles. A very weak solution of the toxin is used in cases of tremor and **paralysis** to force the muscles to relax. However, some patients experience unpleasant side effects with this drug and cannot tolerate effective doses. For other patients, the drug becomes less effective over time. About half of patients don't get any relief of tremor from medications.

Tremor control therapy

Tremor control therapy is a type of treatment using mild electrical pulses to stimulate the brain. These pulses block the brain signals that trigger tremor. In this technique, the surgeon implants an electrode into a large oval area of gray matter within the brain that acts as a relay center for nerve impulses and is involved in generating movement (thalamus). The electrode is attached to an insulated wire that runs through the brain and exits the skull where it is attached to an extension wire. The extension is connected to a generator similar to a heart pacemaker. The generator is implanted under the skin in the chest, and the extension is tunneled under the skin from the skull to the generator. The patient can control his or her tremor by turning the generator on with a hand-held magnet to deliver an electronic pulse to the brain.

Some patients experience complete relief with this technique, but for others it is of no benefit at all. About 5% of patients experience complications from the surgical procedure, including bleeding in the brain. The procedure causes some discomfort, because patients must be awake while the implant is placed. Batteries must be replaced by surgical procedure every three to five years.

Other surgical treatments

A patient with extremely disabling tremor may find relief with a surgical technique called thalamotomy, in which the surgeon destroys part of the thalamus. However, the procedure is complicated by **numbness**, balance problems, or speech problems in a significant number of cases.

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KEY TERMS

Computed tomography (CT) scan—An imaging technique in which cross-sectional x rays of the body are compiled to create a three-dimensional image of the body's internal structures.

Essential tremor—An uncontrollable (involuntary) shaking of the hands, head, and face. Also called familial tremor because it is sometimes inherited; it can begin in the teens or in middle age. The exact cause is not known.

Fetal tissue transplantation—A method of treating Parkinson's and other neurological diseases by grafting brain cells from human fetuses onto the affected area of the human brain. Human adults cannot grow new brain cells but developing fetuses can. Grafting fetal tissue stimulates the growth of new brain cells in affected adult brains.

Intention tremor—A rhythmic purposeless shaking of the muscles that begins with purposeful (voluntary) movement. This tremor does not affect muscles that are resting.

Liver encephalopathy—A condition in which the brain is affected by a buildup of toxic substances that would normally be removed by the liver. The condition occurs when the liver is too severely damaged to cleanse the blood effectively.

Multiple sclerosis—A degenerative nervous system disorder in which the protective covering of the nerves in the brain are damaged, leading to tremor and paralysis.

Magnetic resonance imaging (MRI)—An imaging technique that uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

Pallidotomy—A surgical procedure that destroys a small part of a tiny structure within the brain called the globus pallidus internus. This structure is part of the basal ganglia, a part of the brain involved in the control of willed (voluntary) movement of the muscles.

Parkinson's disease—A slowly progressive disease that destroys nerve cells. Parkinson's is characterized by shaking in resting muscles, a stooping posture, slurred speech, muscular stiffness, and weakness.

Thalamotomy—A surgical procedure that destroys part of a large oval area of gray matter within the brain that acts as a relay center for nerve impulses. The thalamus is an essential part of the nerve pathway that controls intentional movement. By destroying tissue at a particular spot on the thalamus, the surgeon can interrupt the nerve signals that cause tremor.

Thalamus—A large oval area of gray matter within the brain that relays nerve impulses from the basal ganglia to the cerebellum, both parts of the brain that control and regulate muscle movement.

Thyrotoxicosis—An excess of thyroid hormones in the blood, causing a variety of symptoms that include rapid heart beat, sweating, anxiety, and tremor.

Tremor control therapy—A method for controlling tremor by self-administered shocks to the part of the brain that controls intentional movement (thalamus). An electrode attached to an insulated lead wire is implanted in the brain; the battery power source is implanted under the skin of the chest, and an extension wire is tunneled under the skin to connect the battery to the lead. The patient turns on the power source to deliver the electrical impulse and interrupt the tremor.

Wilson's disease—An inborn defect of copper metabolism in which free copper may be deposited in a variety of areas of the body. Deposits in the brain can cause tremor and other symptoms of Parkinson's disease.

Pallidotomy is another type of surgical procedure sometimes used to decrease tremors from Parkinson's disease. In this technique, the surgeon destroys part of a small structure within the brain called the globus pallidus internus. The globus is part of the basal ganglia, another part of the brain that helps control movement. This surgical technique also carries the risk of disabling permanent side effects.

Fetal tissue transplantation (also called a nigral implant) is a controversial experimental method to treat Parkinson's disease symptoms. This method implants fetal brain tissue into the patient's brain to replace malfunctioning nerves. Unresolved issues include how to harvest the fetal tissue and the moral implications behind using such tissue, the danger of tissue rejection, and how much tissue may be required.

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Although initial studies using this technique looked promising, there has been difficulty in consistently reproducing positive results.

Small amounts of alcohol may temporarily (sometimes dramatically) ease the shaking. Some experts recommend a small amount of alcohol (especially before dinner). The possible benefits, of course, must be weighed against the risks of alcohol **abuse**.

Prognosis

Essential tremor and the tremor caused by neurologic disease (including Parkinson's disease) slowly get worse and can interfere with a person's daily life. While the condition is not life-threatening, it can severely disrupt a person's everyday experiences.

Prevention

Essential tremor and tremor caused by a disease of the central nervous system cannot be prevented. Avoiding use of stimulant drugs such as caffeine and amphetamines can prevent tremor that occurs as a side effect of drug use.

ORGANIZATIONS

American Academy of Neurology, 1080 Montreal Ave., St. Paul, MN, 55116, (651) 695-2717, (651) 695-2791, (800) 879-1960, memberservices@aan.com, http://www.aan.com/.

American Parkinson Disease Association Inc., 135 Parkinson Avenue, Staten Island, NY, 10305, (718) 981-8001, (718) 981-4399, (800) 223-2732, apda@apdaparkinson.org, http://www.apdaparkinson.org.

International Essential Tremor Foundation, P.O. Box 14005, Lenexa, KS, 66285-4005, (913) 341-3880, (913) 341-1196, (888) 387-3667, info@essentialtremor.org, http://www.essentialtremor.org.

National Parkinson Foundation., Inc., 1501 N.W. 9th Avenue/Bob Hope Road, Miami, FL, 33136-1494, (305) 243-6666, (305) 243-6073, (800) 473-4636, contact@parkinson.org, http://www.parkinson.org.

Carol A. Turkington

Trench fever

Definition

Trench **fever** is a bacterial infection that causes repeated cycles of high fever.

Description

The term trench fever refers to the crowded conditions in which troops fought in during World War I and World War II. Because the causative bacteria are passed among humans through contact with body lice, overcrowding, and conditions which interfere with good hygiene (including regular washing of clothing) soldiers were predispose to this disease. Currently, homeless people in the United States are sometimes diagnosed with this illness. The bacteria are sometimes passed through the bite of an infected tick. This can cause the illness in people who participate in outdoor activity and encounter ticks in that particular area.

Causes and symptoms

Two different bacteria can cause trench fever: *Bartonella quintana* and *Bartonella henselae*.*B. quintana* is carried by body lice; *B. henselae* is carried by ticks.

Infection with *B. quintana* occurs when an infected louse defecates while feeding on a human. When the person scratches, the feces (which are full of bacteria) are rubbed into the tiny wound. Infection with *B. henselae* occurs when an infected tick **bites** a human, passing the bacteria along through the tiny bite wound.

Symptoms of trench fever begin about 2 weeks to a month after exposure to the bacteria. Sudden fever, loss of energy, **dizziness**, **headache**, weight loss, skin rash, severe muscle and bone **pain** can occur. Pain is particularly severe in the shins, leading to the nickname "shin bone fever." The fever can reach 105°F (40.5°C) and stays high for five to six days at a time. The temperature then drops, and stays down for several days, usually recurring in five- to six-day cycles. An individual may experience as many as eight cycles of fever with the illness.

Diagnosis

Diagnosis is usually made on the basis of the patient's symptoms, and on knowledge of the conditions in which the patient lives. A blood sample can be drawn and bacteria in the sample are allowed to grow. Identification is made by looking at the number of bacteria that may be present on a glass slide seen under the lens of a microscope. However, this technique can take up to four weeks, because this type of bacterium grows very slowly. By this time, the practitioner has often decided to treat the patient anyway.

Treatment

Erythromycin and azithromycin are both used to treat trench fever. Four weeks of treatment are usually necessary. Inadequate treatment often results in a relapse. In fact, relapses have been reported to occur as long as 10 years after the first episode.

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Prognosis

Prognosis for patients with trench fever is excellent. Recovery may take a couple of months. Without treatment, there is always a risk of recurrence, even years after the original illness.

Prevention

Prevention involves good hygiene and decent living conditions. When this is impossible, insecticide dusting powders are available to apply to clothing. Avoidance of areas known to harbor ticks or the use of insect repellents is necessary to avoid the type of infection passed by ticks.

ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

Rosalyn Carson-DeWitt, MD

Treponema carateum infection *see* **Pinta**

Treponema pallidum infection *see* **Syphilis**

Tretinoin *see* **Antiacne drugs**

Trichinella spiralis infectio *see* **Trichinosis**

Trichiniasis *see* **Trichinosis**

Trichinosis

Definition

Trichinosis is a disease caused by a roundworm (nematode) called *Trichinella spiralis*. An individual worm of this species is called a trichina, from the Greek word meaning "hairlike." Trichinae can be readily avoided by proper handling and cooking of certain meats, particularly pork products.

Description

The life cycle of *T. spiralis* includes several different stages. The adult trichina lives in the intestinal lining of such meat-eating animals as swine, bears, walrus, and rodents. After mating, the male worm dies while the female goes on to produce the offspring.

Roundworms have a stage of development called the embryonic stage, which in many species occurs after birth. In trichinae, however, this embryonic stage occurs within the uterus of the female, so the offspring that are ultimately discharged into the host's intestinal lining are in the larval second stage of life. These larvae–about 1500 from each female worm–travel through the circulatory system to the heart, then through the blood vessels leading to striated muscle (the muscle of the skeletal system and the heart). Most larvae that cannot find suitable locations in striated muscle will die.

Those larvae that reach striated muscle will grow to a length of about one millimeter, coil themselves, and enclose themselves within a protective wall called a cyst. This process is referred to as encysting. The worms in the cysts can live for up to ten years in this form.

A pig that has been infected with *T. spiralis*, then, has thousands of cysts lying dormant within its muscles–the very muscles that humans look forward to consuming in the form of pork chops, ham, barbecued ribs, etc. When humans sit down to a delicious meal of undercooked, trichina-infected pig dinner, they are ingesting *T. spiralis* cysts. The cyst walls are broken down by the usual process of food digestion in the stomach, allowing the larvae to escape into the new host's intestines. There the larvae mature to become adult worms, capable of producing a new crop of larvae. When these new larvae hatch, they begin their migration throughout the human host's bloodstream to his or her muscles, where they live for a short while before encysting.

Causes and symptoms

Human hosts who eat meat infested with trichinae may experience symptoms in varying degrees. If the meat ingested has only a few cysts, then the human host's load of parasites (worm burden) is said to be relatively small, and symptoms will be moderate. In fact, many trichinosis infections are subclinical, which means that the symptoms are so mild that the infection remains undiagnosed. In a host with a greater worm burden, the initial symptoms will be caused by the presence of the adult worms in the intestine. These symptoms usually include **fever**, **diarrhea**, abdominal **pain**, and perhaps **vomiting**. The symptoms begin about one to two days after eating the contaminated meat, and may last for a week or so.

When the larvae begin their migration through the blood vessels, the host will begin to experience symptoms that affect the whole body (systemic symptoms), such as fever; swelling of the face and the area around the eyes; rash; bleeding into the nail beds, retina, and whites of the eyes; and **cough**. In very severe cases of trichinosis, inflammation of the heart muscle (**myocarditis**), lungs (pneumonitis), or brain (**encephalitis**) may occur. These symptoms can lead to the few deaths caused by trichinosis.

The larvae begin to burrow into the host's muscles and form cysts within two to three weeks of the initial

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infection. This encysting produces signs of muscle inflammation (**myositis**) including swelling of the affected muscle groups, pain, and weakness. The most frequently affected muscles are the muscles outside the eye (extraocular muscles) that control eye movements; the muscles of the jaw, neck, and upper arm (biceps muscle); the muscles of the lower back (lumbar region); and the diaphragm, which is the muscle that separates the abdominal and chest cavities and aids in breathing.

The symptoms of trichinosis are at their most severe at about three weeks after infection, and decrease very slowly in their severity. Recovery is extremely gradual, and symptoms may last for as long as three months. **Fatigue** and muscle pain (myalgia) may take several more months to subside.

Diagnosis

An initial diagnosis of trichinosis relies heavily on the presence of its classic symptoms–swelling around the eyes, muscle inflammation, fever, and high levels of a certain type of white blood cell (eosinophils)–coupled with the patient's history. If the patient reports having eaten undercooked meat from an animal known to be a potential carrier of trichinosis, the doctor may order a muscle biopsy to confirm the diagnosis. By the third or fourth week of infection, muscle biopsies usually indicate the presence of larvae. Stool tests rarely reveal adult worms, although larvae can sometimes be found in blood or duodenal washings after the second week of infection. The blood test that is the most specific for trichinosis is the bentonite flocculation (BF) test.

T. spiralis can infect a number of different animal species used for food. The most common food culprit in the United States has been pork sausage, while outbreaks in Europe have caused by wild boar and horse meat. Outbreaks of trichinosis in Asia and Africa have been traced to dog meat, and outbreaks in Northern Canada have resulted from consumption of walrus and bear meat.

Treatment

Supportive care

Treatment of trichinosis is primarily aimed at decreasing the severity of the symptoms. Symptomatic relief includes bed rest and medications to relieve fever and muscle pain. The medications most commonly given are **aspirin** and **nonsteroidal anti-inflammatory drugs** (NSAIDs). **Steroids** such as prednisone (Deltasone, Meticorten) are reserved for the most severe cases of muscle inflammation, or for complicated cases that include myocarditis.

KEY TERMS

Anthelminthic—A type of medication that is given to destroy or eliminate parasitic worms.

Cyst—In the life cycle of the round worm, a protective, walled-off capsule in which the larvae lie dormant.

Embryonic—In the life cycle of the round worm, a very early life stage occurring within the uterus of the female round worm.

Host—The animal within which a parasite lives, and from which the parasite receives its nutrition.

Inflammation—A reaction within the body to an invader (virus, bacteria, fungus, worm, etc.) or to tissue injury. The classic signs of inflammation include redness, heat, pain, and loss of function.

Larva—In the life cycle of the round worm, the second stage of life, sometimes considered the "adolescent" stage.

Nematode—A type of roundworm with a long, unsegmented body, usually parasitic on animals or plants.

Striated muscle—Also known as striped muscle; it includes muscles of the skeletal system and of the heart.

Trichina—An individual example of *Trichinella spiralis*.

Anthelminthic medications

In addition to medications for pain relief, trichinosis can be treated with drugs that are called anti-worm medications or anthelminthics. Two related anti-worm medications, mebendazole (Vermox) and thiabendazole (Mintezol), have been reported to be effective against intestinal larvae, but not against larvae encysted in the muscles. In particular, thiabendazole has worked best when given to patients who knew within 24 hours that they had eaten infested meat. Thiabendazole has, however, anti-inflammatory properties that can relieve some of the pain during the muscle stage of trichinosis.

Prognosis

The prognosis for recovery from trichinosis is generally good. Most people with the disease are unaware that they have even been infected. It is estimated that between 150,000 and 300,00 people in the United States become infected yearly, so that at any given time, 1.5 million people have *T. spiralis* infections. Most of these

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people have such light cases that trichinosis is never identified. Worm burden is measured in larvae per gram of muscle tissue; people with 10 or fewer larvae per gram of muscle tissue usually have no significant symptoms. When the number climbs to 100 larvae per gram of muscle tissue, the symptoms become noticeable. People with over 1000 larvae per gram of muscle tissue are usually extremely ill, and often die. The mortality rate of trichinosis is about 1%.

Prevention

Prevention of trichinosis is relatively simple. Swine should be fed only grain or cooked garbage because uncooked garbage may contain contaminated pork scraps. Meat from animals prone to trichinosis infection should be cooked or smoked thoroughly until it is no longer pink. Freezing meat at an adequately low temperature (5°F/–15°C for three weeks) can kill most encysted larvae, except for species which infect such arctic mammals as walrus or bear.

ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

Rosalyn Carson-DeWitt, MD

Trichomonas vaginalis infection *see* **Trichomoniasis**

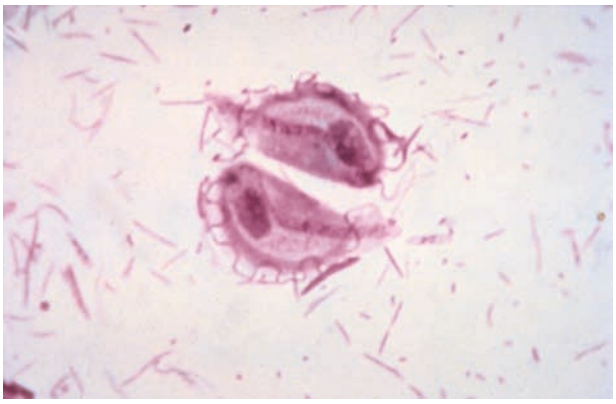
Trichomoniasis

Definition

Trichomoniasis refers to an infection of the genital and urinary tract. It is the most common sexually transmitted disease, affecting about 120 million women worldwide each year.

Description

Trichomoniasis is caused by a protozoan (the smallest, single-celled members of the animal kingdom). *Trichomonas vaginalis* is passed almost 100% of the time through sexual contact. Trichomoniasis is primarily an infection of women's vaginal and urinary tracts. A woman is most susceptible to infection just after having completed her menstrual period. Men may carry the organism unknowingly, since infection in men may cause mild or no symptoms.



A close-up image of *Trichomonas vaginalis*, the parasite that causes vaginitis in humans. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Causes and symptoms

Because trichomoniasis is a sexually transmitted disease, it occurs more often in individuals who have multiple sexual partners. The protozoan is passed to an individual by contact within the body fluids of an infected sexual partner. It often occurs simultaneously with other **sexually transmitted diseases**, especially **gonorrhea**.

In women, the symptoms of trichomoniasis include an unpleasant vaginal odor, and a heavy, frothy, yellow discharge from the vagina. The genital area (vulva) is often very itchy, and there is frequently **pain** with urination or with sexual intercourse. The labia (lips) of the vagina, the vagina itself, and the cervix (the narrowed, lowest segment of the uterus which extends into the upper part of the vagina) will be bright red and irritated.

In men, there are usually no symptoms at all. Occasionally, a man will notice a small amount of yellowish discharge from his penis, usually first thing in the morning. There may be some inflammation of the urethra, or **urethritis**, which produces mild discomfort while urinating.

The use of **antibiotics** is a contributing factor to recurrent trichomoniasis in some women because antibiotics affect the balance of bacteria in the vagina, allowing such organisms as *T. vaginalis* to multiply more rapidly.

Diagnosis

Diagnosis is easily made by taking a sample of the discharge from the women's vagina, or from the opening of the man's penis. The sample is put on a slide, and viewed under a microscope. The protozoa, which are able to move about, are easily viewed.

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KEY TERMS

Metronidazole—An anti-infective agent regarded as the best available drug for treating trichomoniasis. It is sold under the trade names Flagyl and MetroGel.

Protozoan—A one-celled organism belonging to the simplest phylum of the animal kingdom. Trichomoniasis is caused by a protozoan.

Urethritis—Inflammation of the urethra, which is the canal that carries urine from the bladder to the outside of the body.

Trichomoniasis tends to be underdiagnosed in men because of the relative mildness of symptoms in men and insufficiently sensitive diagnostic tests. The recent introduction of DNA amplification, however, indicates that the incidence of trichomoniasis in men is much higher than was previously thought.

Treatment

The usual treatment is a single large dose of metronidazole, or split doses over the course of a week. Sexual partners of an infected individual must all be treated, to prevent the infection being passed back and forth.

Women who are taking antibiotics for other illnesses should speak to their health care provider about the possibile effects of the medication(s) on the balance of organisms in their vagina.

As of late 2003, the number of cases of metronidazole-resistant trichomoniasis appears to be increasing rapidly. Some success has been reported with the broad-spectrum anti-parasitic drug nitazoxanide, but further research needs to be done. A group of researchers in Thailand is currently investigating the effectiveness of a group of drugs known as bisquaternary quinolinium salt compounds in treating trichomoniasis.

Alternative treatment

Cure of trichomoniasis may be difficult to achieve with alternative treatments. Some practitioners suggest eliminating sweets and carbohydrates from the diet and supplementing with **antioxidants**, including **vitamins** A, C, and E, and zinc. Naturopaths may recommend treatment with two douches (a wash used inside the vagina), alternating one in the morning and one at bedtime. One douche contains the herbs calendula (*Calendula officinalis*), goldenseal (*Hydrastis canadensis*), and **echinacea** (*Echinacea* spp.); the other douche contains plain yogurt. The herbal douche helps to kill the protozoa, while the yogurt reestablishes healthy flora in the vagina. Another herbal remedy that is sometimes used is tea tree oil. Acidifying the vagina by douching with boric acid or vinegar may also be useful.

Prognosis

Prognosis is excellent with appropriate treatment of the patient and all sexual partners. Without treatment, the infection can smolder on for a very long time, and can be passed to all sexual partners.

Prevention

All sexually transmitted diseases can be prevented by using adequate protection during sexual intercourse. Effective forms of protection include male and female **condoms**.

Resources

BOOKS

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Rosalyn Carson-DeWitt, MD
Rebecca J. Frey, PhD

Trichotillomania *see* **Alopecia**

Trichuriasis *see* **Roundworm infections**

Tricuspid incompetence *see* **Tricuspid valve insufficiency**

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Tricuspid regurgitation *see* **Tricuspid valve insufficiency**

Tricuspid stenosis *see* **Tricuspid valve stenosis**

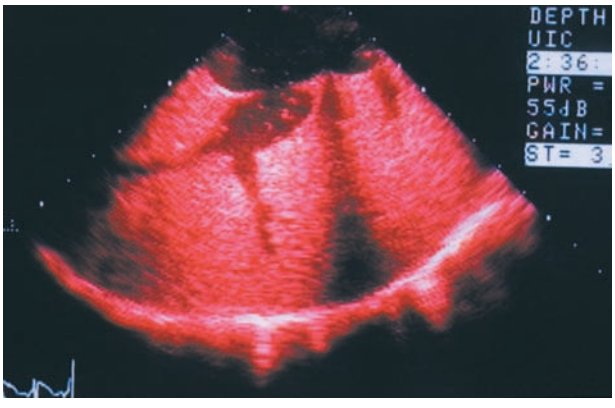
Tricuspid valve insufficiency

Definition

Tricuspid valve insufficiency occurs when a tricuspid valve does not close tightly enough to prevent leakage. This condition is also called tricuspid valve regurgitation and tricuspid incompetence.

Description

The tricuspid valve is located between the right atrium and the right ventricle of the heart. When the right ventricle contracts, it is supposed to pump blood forward into the lungs. If the tricuspid valve does not close tightly, some of that blood leaks back into the right atrium. When the atrium receives its usual quantity of blood from veins leading to the heart, plus the leaking blood, the pressure inside the atrium increases. This higher pressure creates resistance to the flow of blood in the veins that enter the atrium from the body. In addition, this increase in pressure causes the right atrium to enlarge over time. Congestion from fluid buildup occurs, particularly in the liver and legs.



This echocardiogram of the heart shows tricuspid valve insufficiency. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

KEY TERMS

Atrial fibrillation—A rapid, uncoordinated quivering of the upper chamber of the heart.

Atrium—The upper chamber of the heart.

Pulmonary valve—The valve at the opening from the right ventricle to the artery that leads to the lungs.

Causes and symptoms

If a person has serious lung disease or a narrowing of the pulmonary valve, the right ventricle must pump harder to force the blood through the pulmonary valve. In order to pump harder, the right ventricle enlarges and the valve opening stretches, causing the valve to leak.

Tricuspid valve insufficiency usually produces such vague symptoms, as general weakness and **fatigue**. As the conditions worsens, a person experiences **pain** in the upper right part of the abdomen, caused by a congested and enlarged liver. The legs may also swell (**edema**).

An enlarged right atrium can cause **atrial fibrillation** (the atria flutters, rather than pumping in a regular rhythm) and severe tricuspid regurgitation of blood, which can eventually lead to congestive **heart failure**.

Diagnosis

A leaky valve can be heard with a stethoscope; the sound is called a heart murmur. Additional support for diagnosing tricuspid valve insufficiency comes from a medical history, physical exam, and **chest x ray**. Further testing with **echocardiography**, to show an image of the leakage and its severity, is the most helpful diagnostic test for this condition.

Treatment

Tricuspid valve insufficiency itself usually does not require treatment, since a tiny leakage occurs in most normal people. In certain cases, however, if there is underlying pulmonary valve disease or lung disease, those conditions should be treated.

If irregular heart rhythms or heart failure are present, they are usually treated independently of the valve insufficiency.

Since a person with known tricuspid valve insufficiency is at risk for infections of the heart, **antibiotics**

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should be taken before and after oral or dental surgery, or urologic procedures.

Prognosis

Tricuspid valve insufficiency is not usually considered to be serious. If it is the result of other cardiopulmonary disease, the extent of those conditions effect the prognosis.

Prevention

In general, tricuspid valve insufficiency cannot be prevented.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

Dorothy Elinor Stonely

Tricuspid valve stenosis

Definition

Tricuspid valve stenosis is a narrowing or stiffening of the opening in the valve. This stenosis causes increased resistance to blood flow through the valve.

Description

The tricuspid valve is located between the right atrium and the right ventricle of the heart. It is the largest of the four valves in the heart. When the tricuspid valve is narrowed or stiffened, it decreases the amount of blood that can flow through it. This decrease raises the pressure in the right atrium and causes the atrium to enlarge. It also causes the right ventricle to shrink, and lowers the cardiac output.

Causes and symptoms

Tricuspid valve stenosis is most often the result of **rheumatic fever**. On rare occasions, it is caused by a tumor or disease of the connective tissue. The rarest cause is a birth defect.

A person with tricuspid valve stenosis may experience generalized weakness and **fatigue**. Many people have **palpitations** and can feel fluttering in their neck. Over time, there may be **pain** in the upper right abdomen, due to increased congestion and enlargement of the liver.

KEY TERMS

Rheumatic fever—An inflammatory illness that can follow strep throat, and could cause heart damage.

Diagnosis

The noise produced by blood trying to flow through a stenotic valve can be heard with a stethoscope, and is referred to as a murmur. An x ray of the chest will show the right atrium to be enlarged. Further support for this diagnosis is found on an echocardiogram of the heart, which will show an image of the stenotic valve and measure its severity.

Treatment

Tricuspid valve stenosis itself usually doesn't require treatment. However, if there is damage to other valves in the heart as well, then surgical repair or replacement must be considered.

Since a person with known tricuspid valve stenosis is at risk for infections of the heart, **antibiotics** should be taken before and after oral or dental surgery, or urologic procedures.

Prognosis

Mild tricuspid valve stenosis is not usually considered cause for surgery. The decision to repair or replace the tricuspid valve is often based on the health of the aortic and mitral valves, rather than on the severity of stenosis in the tricuspid valve.

Prevention

Rheumatic **fever**, the usual cause of tricuspid valve stenosis, has almost disappeared in North America and western Europe. Therefore, the number of people who acquired this condition in childhood will decline over time.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

Dorothy Elinor Stonely

Tricyclic antidepressants *see* **Antidepressants, tricyclic**

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Trigeminal neuralgia

Definition

Trigeminal **neuralgia** is a disorder of the trigeminal nerve (the fifth cranial nerve) that causes episodes of sharp, stabbing **pain** in the cheek, lips, gums, or chin on one side of the face.

Description

The trigeminal nerve, which is divided into three branches, is responsible for chewing, for producing saliva and tears, and for sending facial sensations to the brain. When this nerve breaks down for some reason, it can trigger brief but agonizing sizzles of pain on one side of the face.

This condition is unusual in those under age 50 and more often occurs after 70. Women are three times more likely to have the condition than are men. When trigeminal neuralgia does occur in younger people, it is often associated with **multiple sclerosis**.

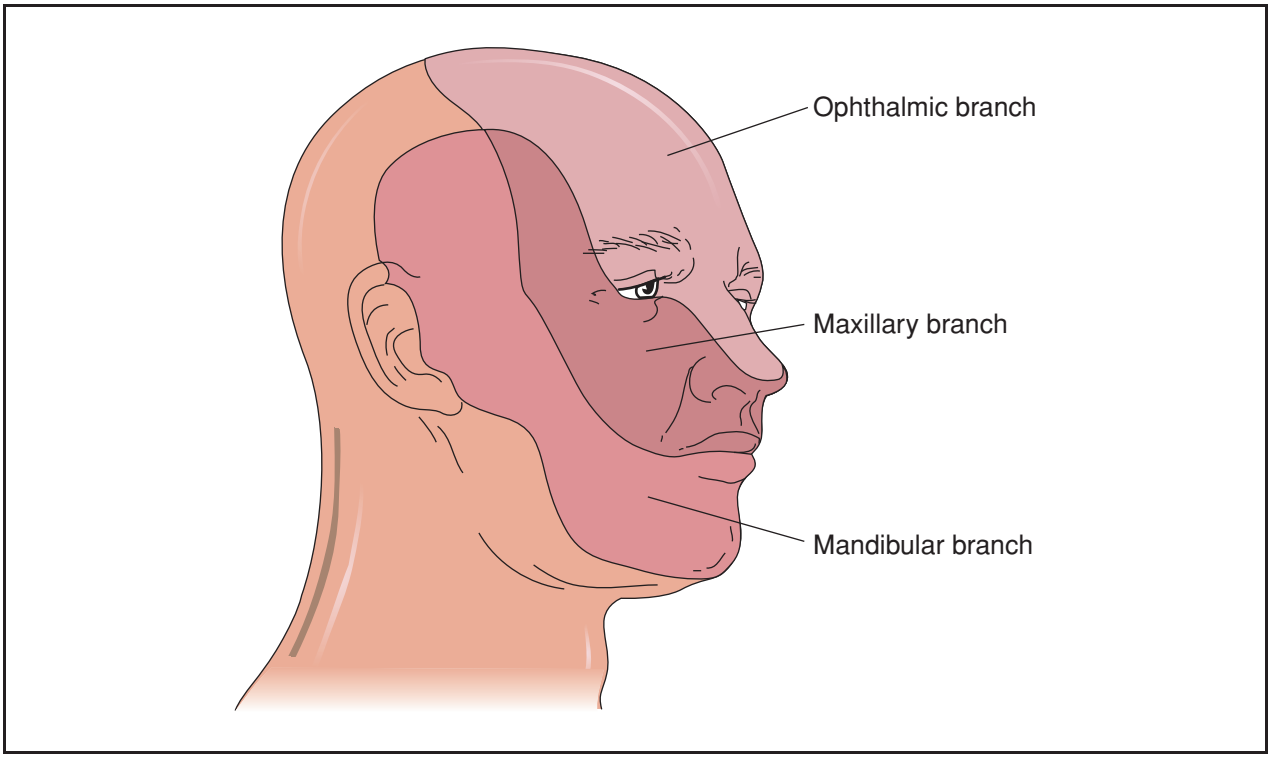
The pain, while brief, is so severe that the sufferer often can't do anything else while the attack lasts. People with this pain often wince or twitch, which is where trigeminal neuralgia gets its French nickname *tic douloureux*, meaning "painful twitch."

Causes and symptoms

The origin of trigeminal neuralgia is not certain, but scientists believe it may be caused by degeneration, pressure, or irritation of the trigeminal nerve. Some doctors believe the pain may be triggered by pressure from a nearby abnormally-formed artery lying too close to the nerve.

Any part of the three branches of the trigeminal nerve may be affected. Neuralgia of the first branch leads to pain around the eyes and over the forehead; the second branch causes pain in the upper lip, nose and cheek; the third branch causes pain on the side of the tongue and lower lip.

The first episodes are usually fairly mild and brief, and it may be minutes, hours, or weeks before the next attack. However, attacks tend to occur in clumps that may last for weeks at a time. As the sufferer ages, the episodes become more frequent and painful, until the person begins to live in constant fear of the next one.



Trigeminal neuralgia is a disorder of the trigeminal nerve (which is divided into three branches, as illustrated above) that causes episodes of sharp, stabbing pain in the cheek, lips, gums, or chin on one side of the face. The origin of this disorder is not certain, but scientists believe it may be caused by degeneration, pressure, or irritation of the trigeminal nerve. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

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KEY TERMS

Multiple sclerosis—A progressive disease of the central nervous system in which the coverings of nerves in the brain and spinal cord are destroyed.

The momentary bursts of pain usually begin from the same spot on the face each time. The pain can be triggered by touching the area, washing, shaving, eating, drinking, or even talking. Even a cool breeze across the face can set off an attack. Pain is more severe at the ends of the affected nerve, especially over the lip, chin, nostrils, or teeth.

Diagnosis

Diagnosis is usually made by eliminating other problems that could cause similar pain in teeth, jaw, head, or sinuses. Because patients with the condition tend to avoid trigger points, avoiding chewing, shaving, touching or washing their faces can be a clue to diagnosis of trigeminal neuralgia.

Treatment

It is not easy to treat trigeminal neuralgia. Pain can be suppressed by a range of medicines, including the anti-epilepsy medicines carbamazepine (Tegretol) or phenytoin (Dilantin). These drugs slow down the nerve signals at certain nerve terminals, which eases the pain. However, these drugs cause a wide range of side effects, including **nausea**, **dizziness**, drowsiness, liver problems, and skin **allergies**. Some people develop resistance to the drugs or they can't tolerate the high dosage needed to control the discomfort. If the medicines are stopped, the pain usually returns.

If drug treatment fails, surgical treatment to block pain signals from the nerve may be effective. Radiofrequency waves, gamma rays, or glycerol injections can deaden the nerve (and hence the pain). An operation that frees the nerve from whatever is compressing it (blood vessel or tumor) can permanently relieve pain, but this major neurosurgical procedure carries its own risks and complications. Alternatively, a new procedure seeks to place a cushioning sponge between the nerve and a pulsating artery wrapping around it to soothe the irritated nerve.

Prognosis

Although the pain is momentarily incapacitating, it's not life-threatening. As the person ages, the attacks can be expected to occur more and more frequently.

Prevention

While the condition itself can't be prevented, there are a number of things patients can do to avoid triggering attacks:

- wash with cotton pads and warm water over the face
- rinse the mouth with water after eating, if toothbrushing triggers pain
- eat and drink food and beverages at room temperature
- chew on the unaffected side
- eat soft foods, if eating is becoming a problem

ORGANIZATIONS

Americna Pain Society, 4700 W. Lake Ave., Glenview, IL, 60025, (847) 375-4715, (866) 574-2654, info@ampainsoc.org, http://www.ampainsoc.org.

National Institute of Neurological Disorders and Stroke (NINDS), NIH Neurological Institute, P. O. Box 5801, Bethesda, MD, 20824, (301) 496-5751, (800) 352-9424, http://www.ninds.nih.gov/.

Pain Connection, 12320 Parklawn Drive, Rockville, MD, 20852, (301) 231-0008, (301) 231-6668, http://www.painconnection.org.

Trigeminal Neuralgia Association, 925 NW 56th Terrace, Suite C, Gainesville, FL, 32605-6402, (800) 923-3608, http://www.fpa-support.org.

Carol A. Turkington

Trigger finger

Definition

Trigger finger is the popular name of stenosing tenosynovitis, a painful condition in which a finger or thumb locks when it is bent (flexed) or straightened (extended).

Description

Tendons are tough, fibrous cords that connect muscles to bones. Tendons must slide easily through their protective coverings (tendon sheaths). The finger and thumb bones have tendons that are responsible for bending and straightening the fingers. Problems start when a tendon sheath narrows (stenosis) and the outer covering of the tendon becomes inflamed (tenosynovitis). The tendon swells because of the constriction, sometimes forming a nodule, and is no longer able to move smoothly through its sheath. As a result, a finger may lock in an upward position as the person tries to straighten it. The condition usually happens in the ring and middle fingers and is more common in

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KEY TERMS

Microcirculation—The passage of blood in the smallest blood vessels of the body, such as the capillaries in the hand and fingers.

Myofascial—The fibrous tissue that encloses and separates layers of muscles.

Nodule—A swelling or knob that may form on a tendon and make it difficult to slide smoothly through its sheath.

Stenosis—Narrowing of a passageway or opening in the body. In trigger finger it is the tendon sheath that narrows.

Synovial tendon sheath—Where the tendons cross joints, they are sheathed in thin membranes known as synovium, which provide lubrication to decrease friction.

Tendon sheath—A membrane covering a tendon.

Tenosynovitis—Inflammation of a tendon and its enveloping sheath, usually resulting from overuse injury.

women, typically over age 30. In infants and small children, the condition generally occurs in the thumb.

Causes and symptoms

Trigger finger is often an overuse injury because of repetitive or frequent movement of the fingers. Trigger finger may happen because a person performs the same manipulation over and over on a job, from squeezing and gripping during a weekend of heavy pruning and gardening, or from such hobbies as playing a musical instrument or crocheting. Trigger finger may also result from trauma or accident. The symptoms of trigger finger are **pain** in the fingers and "popping" sensations. Sometimes the finger may lock down into the palm or lock out straight. Symptoms are usually worse in the morning and improve during the day.

Diagnosis

The diagnosis of trigger finger and thumb is obvious on **physical examination**. Often there is a click that can be felt as the nodule passes through the sheath. Most cases are uncomplicated although x rays are often taken to rule out other injuries or disease such as arthritis.

Treatment

Initial treatment for mild or infrequent symptoms of trigger finger include rest, avoiding or modifying those activities that caused the inflammation, and the use of a nonsteroidal anti-inflammatory drug (NSAID) such as ibuprofen. This may relieve the swelling and inflammation that resulted in the constriction of the sheath and the restriction of the tendon. Injection of a steroid medication (cortisone) into the tendon sheath is the next option to treat trigger finger. Depending on the severity, there may be one more injection a week later. Two-thirds of patients improve after one injection. Some physicians will splint the finger in extension after the injection.

In severe cases that do not respond to injections and the finger or thumb remains in a locked position, surgery may be required to relieve the symptoms. A local anesthetic is used for the surgical procedure performed on an outpatient basis. An incision is made by a surgeon in the palm of the hand at the base of the affected finger or thumb to relieve the constriction of the tendon. Recovery may take up to four weeks. Sometimes **physical therapy** of the hand is required after surgery to regain good use.

Alternative treatment

Treatment should begin when a person starts having difficulty moving the fingers. If started early, noninvasive measures have a good chance for success. Alternative treatments include **acupuncture** to facilitate healing and microcirculation, pulsed ultrasound, and myofascial release work for the affected area.

Prognosis

At least half of cases can be cured non-surgically. The key to successful treatment is early intervention. A mistake people make is trying to work through the pain. Diabetics have a higher incidence of the condition and are sometimes left with a disability.

Prevention

Taking frequent breaks from a repetitive activity will do much to prevent the condition. Depending on the intensity, that may mean a 10-minute break every hour from the repetitive activity. The break should be spent stretching the hands and arms and generally moving around.

ORGANIZATIONS

American Society for Surgery of the Hand, 6300 North River Road, Suite 600, Rosemont, IL, 60018, (847) 384-8300, (847) 384-1435, info@assh.org, http://www.hand-surg.org.

Ruthan Brodsky

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Triglycerides

Definition

Triglycerides are a form of fat, consisting of three molecules ("tri") of a fatty acid combined with one molecule of the alcohol glycerol. Triglycerides serve as the backbone of many types of lipids (fats). Triglycerides are produced by the liver as well as are ingested as part of the diet. Fats in foods are digested and changed to triglycerides.

Purpose

Triglycerides have several purposes in physiology. Triglycerides travel through the circulatory system and are either utilized immediately or are stored in adipose tissue, thereby serving as the most abundant form of stored energy in the body. Triglycerides can serve as this important storage medium because of their hydrophobicity, which allows them to be stored as droplets, without contact with water molecules. Often a typical human body may contain several months of fuel stored in the form of triglycerides. When physiological conditions dictate the need to use the triglycerides, hormones or a neurotransmitter signal their release. This release may be in response to **exercise**, **stress**, or **fasting**. An enzyme called lipase breaks down the triglyceride molecule into a glycerol molecule and three fatty acids before release from the adipose tissue. These breakdown products are transported within the circulatory system to the tissues that need them for energy.

In addition to serving as a source of energy, triglycerides carry the fat-soluble **vitamins** (including vitamin K, an important nutrient in normal blood coagulation). Triglycerides also provide thermal insulation and contribute to the structure of membranes by the formation of a lipid bilayer.

Triglyceride levels

Normal	Less than 150 mg/dL
Borderline-high	150–199 mg/dL
High	200–499 mg/dL
Very high	500 mg/dL or above

SOURCE: National Heart, Lung and Blood Institute, National Institutes of Health, U.S. Department of Health and Human Services

Healthy (normal) and unhealthy triglyceride levels. *(Table by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)*

Triglycerides combine with a blood protein to form chemicals referred to as high-density and low-density lipoproteins. These lipoproteins contain cholesterol, another substance related to fats.

Description

It is not yet clear whether high triglyceride levels act as a predictor of the risk for heart disease and heart attacks, especially in persons with normal levels of cholesterol. Some health care professionals feel that elevated triglycerides are a marker for other risk factors that do impact the risk of heart disease, that is, high levels of triglycerides are usually associated with low levels of high density lipoproteins, usually referred to as the "good" cholesterol.

However, there are some indications that high triglycerides may serve as a predictor for heart disease, especially in women. In a study involving postmenopausal women (aged 48 to 76 years old) conducted by a research group from the Center for Clinical and Basic Research in Ballerup, Denmark, it was found that women who had an enlarged waist and elevated levels of triglycerides had almost a five-fold increased risk of fatal cardiovascular events compared to women without those traits. The women at risk deposited fat centrally in their intra-abdominal compartment, rather than in their hips, thighs, and buttocks.

The mechanism of how triglycerides might affect heart health is not fully known, but it appears that elevated levels of triglycerides may allow increased blood clot formation and may slow the natural breakdown of clots after they have formed. However, high levels of triglycerides may mean an increased risk of diabetes, and very high levels of triglycerides may increase the risk of inflammation of the pancreas, resulting in **pancreatitis**.

Triglyceride levels are evaluated through blood testing.A fatty meal that is high in triglycerides will cause a short term increase in blood triglyceride levels. Therefore, before testing, a person should refrain from eating food for eight to ten hours before the test and not drink alcohol for 24 hours before the test. Some medications may interfere with test results, and the health care provider may request that the person cease taking the medications before testing. For example, **oral contraceptives**, estrogen, and cholestyramine (a drug used to treat high cholesterol levels) may increase blood triglyceride levels, while vitamin C (ascorbic acid), asparaginase (an enzyme used in the treatment of **cancer**), and various drugs to treat high levels of blood lipids may decrease blood triglyceride levels. Triglyceride levels can also be affected by the

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menstrual cycle, time of day, and recent exercise. A person should have two or three tests, one week apart, for the most accurate results.

The normal range of blood triglyceride levels depends on age and gender, with women naturally having higher levels, especially when pregnant. As people age and gain weight, triglyceride levels usually increase. According to the guidelines promulgated by the National Cholesterol Education Program, a division of the National Heart, Lung, and Blood Institute, a normal fasting level for adults is less than 150 milligrams per deciliter (mg/dL), with levels below 101 considered desirable. Levels of 150–199 mg/dL are considered borderline high, levels of 200–499 mg/dL are considered high, with levels greater than 500 mg/dL considered very high. Such high levels may indicate **liver disease** (**cirrhosis**), underactive thyroid activity, uncontrolled diabetes, pancreatitis, **kidney disease**, or a diet too low in protein and too high in carbohydrates.

Extremely low levels of triglycerides (less than 10 mg/dL) may indicate **malnutrition**, malabsorption, a diet too low in fat, or an overactive thyroid.

High triglyceride levels may be due to several causes, including:

- Lifestyle factors
- Weight gain
- Lack of exercise
- Smoking
- Skipping meals
- Eating large portions of food at one time
- Dietary factors
- Excessive intake of alcohol, saturated and trans fats, sugar, starch, and calories
- Medical conditions
- Medicines, including birth control pills, steroids, and diuretics
- Illnesses, including poorly controlled diabetes, insulin resistance (a precursor to diabetes), polycystic ovary syndrome (PCOS), hypothyroidism, kidney disease, and liver disease
- Age

Hereditary may also play a role in elevated levels of triglycerides. Familial hypertriglyceridemia is a common inherited disorder in which the level of triglycerides in a person's blood is higher than normal. This disorder is an autosomal dominant disorder, that is, if one parent has an abnormal gene and the other parent a normal gene, there is a 50% chance each child will inherit the abnormal gene and therefore the dominant trait. Some people with this condition also have high levels of very low density lipoprotein (VLDL), the "bad" cholesterol. **Obesity**, hyperglycemia (high blood glucose levels), and high levels of insulin are often associated with this condition and may result in even higher triglyceride levels.

Familial hypertriglyceridemia is not usually detected until **puberty** or early adulthood. Symptoms include a mild-to-moderate increase in blood triglyceride levels and premature **coronary artery disease**. Persons with this condition are also at increased risk for pancreatitis.

Familial hypertriglyceridemia occurs in about 1 in 500 individuals in the United States. Risk factors are a family history of hypertriglyceridemia or a family history of heart disease before the age of 50. If triglyceride levels cannot be not controlled by dietary and lifestyle changes, medication may be needed. Nicotinic acid and gemfibrozil have been shown to effectively reduce triglycerides in persons with familial hypertriglyceridemia. Screening family members for elevated levels of triglycerides may help to detect the disease early.

A nutritionist or dietitian may be consulted to help develop a dietary plan to help control triglyceride levels. In general, to lower or prevent high levels of triglycerides, a person should:

- Lose weight
- Get regular exercise
- Eat less sugar and sugar-containing foods
- Eat smaller meals and snacks throughout the day, rather than consuming two or three large meals
- Drink less alcohol (even small amounts of alcohol has been shown to elevate triglycerides)
- Limit fat in the diet to less than 35% of daily calories
- Avoid deep-fried foods
- Substitute monounsaturated and polyunsaturated fats, such as those found in canola or olive oils, for saturated fats
- Use a prescription medicine, as directed by the health care provider, to decrease the production of triglycerides by the liver
- Instead of eating meats high in saturated fats, consume fish high in omega-3 fatty acids, such as salmon, lake trout, herring, sardines, albacore tuna, or mackerel (about 10 to 15 grams of fish oil a day is recommended; 15 grams of fish oil can be obtained from an 8-ounce serving of fish)

Other good food choices include fruits (but not fruit juices, which are high in sugar), vegetables, whole grain breads and cereals, lean protein sources, such as lean meats, poultry without skin, eggs, egg substitute or egg white, cooked dried beans, lentils, peas, nuts, and low-fat soy products, fat-free or 1% milk products, nuts such as almonds, walnuts, and peanuts, avocados, and sugar-free products.

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One approach to successfully changing the diet to reduce blood triglyceride levels is to make changes in stages. For example, individuals could cut fat intake to 30% for one month (current American levels are approximately 40%) and then return to their health care provider to see if there has been an improvement in their triglyceride levels. If the level of decreases was not satisfactory, the individuals could further restrict their fat intake to 25% and again be evaluated after one month. If no improvement is noted, the fat intake should be lowered to 20% for two months. At this level of fat intake, it is likely that most calories are being obtained from complex carbohydrates, and a reduction in triglyceride levels should be seen.

Complications

Other risk factors for coronary heart disease can increase the hazards from high levels of triglycerides. Therefore a person with high levels should in addition to making dietary changes should also control high blood pressure and avoid cigarette **smoking**. Dietary management is important even when drugs are used to control triglyceride levels.

Parental concerns

If a child is suspected to have familial hypertriglyceridemia, the child should be tested for elevated levels of triglycerides. If the disorder is present, appropriate steps should be taken to help the child lower his or her triglyceride levels.

Resources

BOOKS

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Welson, Linda T., ed. *Triglycerides and Cholesterol Research* Hauppauge, NY: Nova Science Publishers, Inc., 2006

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, http://www.americanheart.org.

Judith L. Sims

Triglycerides test

Definition

Triglycerides test is a blood test to determine the amount of triglycerides, a form of fat, in the blood.

Purpose

The triglycerides test is one of the screening tests for excess lipids (fats) in the blood. It is usually part of an evaluation of risk factors for heart disease.

Description

Triglycerides are a form of fat that comes from foods. They can also be made and stored in the body and are used as an energy source. High levels of triglycerides in the blood can mean that there is too much fat in the diet. Hypertriglyceridemia (high levels of triglycerides) is associated with coronary heart disease, especially since elevated triglycerides levels are often associated with unhealthy low levels of hyper-density lipoproteins (the "good" cholesterol), which are necessary for good health.

Preparation

For triglycerides testing, blood is drawn from a vein in the arm. A vein at the inside of the elbow or on the back of the hand is usually selected. The area where the needle will be inserted is cleaned with antiseptic. A small needle is inserted through the skin and into the vein, allowing a small amount of blood to flow into a collection tube or syringe. Once the blood is collected, the needle is removed from the puncture site.

Before the blood test, the patient may be required to refrain from eating food from eight to 12 hours. Patients should not drink alcohol for 24 hours before the test. Some drugs may affect the test and the patient may be asked to cease taking certain medications before the test. **Oral contraceptives**, estrogen, and cholestyramine (a drug used to treat high cholesterol) can increase triglyceride levels. Ascorbic acid (vitamin C), asparaginase (an enzyme), and various drugs used to treat high blood lipids, can decrease blood triglyceride levels. These substances should not be taken prior to this test.

Aftercare

After the blood sample has been taken and the needle withdrawn from the puncture site, a cotton ball or gauze pad may be placed over the site and direct pressure applied to reduce bleeding. A piece of surgical tape or gauze adhesive bandage strip may be secured over the site to prevent further bleeding.

Risks

There is a very small risk that the puncture site may bleed excessively, a bruise or infection may develop at the site, or it may take several punctures to locate a vein. Some patients may feel faint or lightheaded when blood is drawn.

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Normal results

The normal range of triglycerides in the blood depends on the age and gender of the patient. Women naturally have higher levels of triglycerides than men. **Pregnancy** can also increase triglyceride levels. As people age and gain weight, triglyceride levels generally increase. For adults, a normal level is considered to be less than 200 mg/dL (milligrams per deciliter). Levels from 200–400 mg/dL are considered borderline high.

Abnormal results

Triglyceride levels ranging from 400-1000 mg/dL are considered high and levels greater than 1000 mg/dL are considered very high. High levels of triglycerides may indicate **liver disease** (**cirrhosis**), an underactive thyroid problem, uncontrolled diabetes, an infection of the pancreas (**pancreatitis**), **kidney disease**, or a diet too low in protein and too high in carbohydrates.

Extremely low triglycerides levels (less than 10 mg/dL) can also indicate a problem. Low levels may indicate **malnutrition** (not enough nutrients in the diet), malabsorption (inadequate absorption of nutrients in the intestinal tract), a diet too low in fat, or an overactive thyroid problem.

Resources

OTHER

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Altha Roberts Edgren

Triiodothyronine test *see* **Thyroid function tests**

Triple screen

Definition

Triple screen is a blood test offered to pregnant women during the 16th-18th week of **pregnancy** to help identify if the unborn baby is at risk for **birth defects**.

Purpose

Researchers have found that women carrying a fetus with **Down syndrome** tend to have three substances in their blood in a distinctive abnormal pattern. Both alpha-fetoprotein (AFP), a protein produced by the fetus, and unconjugated estriol (uE3), a hormone manufactured by both the fetus and the placenta, are lower than normal, while human chorionic gonadotropin (hCG), a hormone produced in the placenta, is higher. The level of each substance is then divided by the median concentration of that substance for the given week of pregnancy to generate a multiple of the median value (MOM). These values, along with other characteristics of the mother, such as her age, are analyzed by a computer program to indicate the probability that the fetus has Down syndrome. Down syndrome is a condition that includes **mental retardation**, skeletal abnormalities such as upslanted eyes and **cleft palate**, and organ abnormalities such as heart disease and intestinal obstruction.

Guidelines developed from this research help healthcare workers to determine whether the risk for any one pregnancy is clearly different from that for the general population of the same age. For example, the average 25-year-old woman has one chance in a 1,000 of bearing a Down syndrome baby. After her blood is analyzed for the three hormones, her risk can be refigured. It might be considerably lower—or higher—than average.

The triple screen was first aimed toward detecting fetuses at high risk for Down syndrome, an abnormality that comes about when, at fertilization, the embryo receives three copies of chromosome 21 instead of the usual two. For unknown reasons, extra amounts of genetic material are usually associated with severe developmental defects. Although Down syndrome is the most common such disorder, it is by no means the only one. Chromosomes 13 or 18 can also turn up as a triple set (or trisomy). An abnormal pattern of the three hormones sometimes signals one of these trisomies or another, more rare chromosomal disorder.

Precautions

It is important that the correct age of the unborn baby be determined by last menstrual period dating and recorded for the risk calculation. Errors in determining the age of the fetus lead to errors when interpreting the test results. Since an AFP test is only a screening tool, an abnormal test result is not necessarily indicative of a birth defect. Accurate dating of the fetus lowers the false-positive and false-negative rates associated with this screening test.

Description

Prior to 1964, when the association between low levels of AFP and an increased risk for Down syndrome was reported, risk assessment for chromosomal diseases was based upon maternal age. At age 35, the risk of carrying a Down syndrome pregnancy is approximately one in 270, and this was deemed sufficient to warrant **amniocentesis**, a more accurate but invasive test that

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KEY TERMS

Amniocentesis—A test performed to determine the health, sex, or genetic constitution of a fetus by taking a sample of amniotic fluid through a needle inserted into the womb of the mother.

Amniotic fluid—The fluid that surrounds a fetus while it is developing. It is the fluid that flows out in the "breaking of the water" before a baby is born.

Down syndrome—A genetic disorder characterized by a broad skull, blunt facial features, short stature, and learning difficulties. It is caused by the presence of an extra copy of chromosome 21.

Placenta—An organ that develops inside the uterus of pregnant women to supply food and oxygen to the fetus through the umbilical cord.

involves using a needle to draw out a sample of the embryonic fluid that surrounds the fetus. However, three of four Down syndrome pregnancies occur in women under 35 years old. When AFP testing was used along with maternal age, the rate of detection of Down syndrome increased to about 45%, but this level of sensitivity did not justify the screening of younger women because of the risk of **miscarriage**. The inclusion of uE3 and hCG testing has improved the detection rate to approximately 65-80% of cases for all age groups. The triple screen test costs $90-250 and is covered by most insurance plans.

Preparation

There is no specific physical preparation for this test. **Fasting** is not required.

Aftercare

After the blood sample is drawn, pressure should be applied to the puncture site until the bleeding stops to reduce bruising. A bandage or taped ball of cotton may be applied to the site. A warm pack may be applied to the site to relieve discomfort.

Risks

The complications associated with drawing blood are minimal, but may include bleeding from the puncture site, feeling faint or lightheaded after the blood is drawn, or blood accumulating under the puncture site (hematoma).

Normal results

Results are expressed as multiples of the median value used by the laboratory. Normal ranges expressed in concentration (for example, ng/mL) are dependent upon the age of the fetus, but MOMs are age-adjusted and do not change. These values are used to calculate risk. If the multiple of the median value is below 2.0 MOM or 2.5 MOM (depending on the laboratory), the fetus is considered to be at a lower risk for a genetic defect.

Abnormal results

If the multiple of the median value is above 2.0 MOM or 2.5 MOM (depending on the laboratory), the fetus is considered to be at a higher risk for a genetic defect. The MOM value for amniotic fluid is then used to calculate the exact probability the fetus is affected (1:100, for example). With respect to Down syndrome and trisomy 18, the MOM values are also used in the calculation of probability. The woman is considered to be "high risk" or "screen positive" for Down syndrome if the risk is greater than the standard risk for women who are 35 years old or older (one in 270). For trisomy 18, the cut-off is one in 150. In one study the triple marker screen test had a detection rate for Down syndrome of 67% and a false positive rate of 5%.

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ORGANIZATIONS

National Down Syndrome Society, 666 Broadway, 8th Floor, New York, NY, (800) 221-4602, info@ndss.org, http://www.ndss.org.

Ken R. Wells

Triplets *see* **Multiple pregnancy**

Trisomy 13 *see* **Patau's syndrome**

Trisomy 18 *see* **Edwards' syndrome**

Trisomy G syndrome *see* **Down syndrome**

Trobofloxacin *see* **Fluoroquinolones**

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Tropical spastic paraparesis

Definition

Tropical spastic paraparesis (TSP) is an incurable viral infection of the spinal cord that causes weakness in the legs. It is caused by the human T-cell lymphotropic virus-1 (HTLV-1) retrovirus.

Description

As the name implies, tropical spastic paraparesis usually occurs in tropical locales. Although isolated cases have been diagnosed in the southeastern United States and other places in the United States, TSP is most frequently found in:

- the Caribbean
- Japan
- the Seychelles Islands
- regions of South America
- western Africa

TSP usually affects adults between the ages of 30 and 40, and is far more common in women than in men.

The disease may remain undetected for years after infection is contracted. When the immune system's response to the virus causes nerve damage, the legs gradually lose strength and flexibility.

Causes and symptoms

TSP is caused by the HTLV-1 virus, which also causes leukemia. The virus can be spread through the placenta, and also through blood transfusions, **breast-feeding**, contaminated needles, and sexual contact.

Symptoms may begin years after infection. In response to the infection, the body's immune response may injure nerve tissue, causing symptoms that include bladder abnormalities, leg **pain**, loss of feeling in the feet, **tingling** sensations, and unpleasant sensations when the skin is touched.

As many as 20% of patients with TSP may also experience:

- deafness
- double vision
- the tendency to incorrectly estimate the amount of motion necessary to accomplish a specific task (dysmetria)
- exaggerated reflexes
- facial paralysis
- tremor.

KEY TERMS

Retrovirus—A family of RNA viruses containing a reverse transcriptase enzyme which allows the viruses' genetic information to become part of the genetic information of the host cell upon replication.

Virus—A microorganism, smaller than bacteria, which can replicate only within the a cell of a living plant or animal. The virus provides the genetic code and the host cell provides the energy and raw materials for replication.

Diagnosis

Infectious disease specialists use blood tests and **magnetic resonance imaging** (MRI) of the spinal cord to diagnose this condition.

Treatment

While the disease is incurable, significant improvement has been reported in the condition of TSP patients treated with **corticosteroids**. These drugs are believed to alleviate symptoms by suppressing the immune system's response to the virus that causes them.

Plasmapheresis, a dialysis-like procedure in which symptom-producing antibodies are removed from the blood, also provides temporary relief.

Prognosis

As noted, TSP cannot be cured.

Prevention

The United States Food and Drug Administration (FDA) has approved screening procedures developed to detect HTLV-1 in donated blood and blood products designated for **transfusion**. These procedures, which can also be used to diagnose patients with TSP, are designed to prevent the spread of the disease.

Resources

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Maureen Haggerty

Tropical sprue *see* **Malabsorption syndrome**

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Troponins test

Definition

Troponins are specific proteins found in heart muscle. Troponin testing is done to diagnose heart attacks (myocardial infarctions).

Purpose

When heart muscle is damaged, as in a myocardial infarction (MI), troponins leak out of cells and into the bloodstream. Increased troponin levels indicate myocardial infarction or injury in a person with chest **pain** or pressure. Some MIs are silent, manifesting few if any symptoms.

If infarction is ruled out in a person with continuing or recurring chest pain (unstable **angina**), an increased troponin level indicates the person has heart muscle **ischemia** (a decreased supply of oxygenated blood to the body), and is at an increased risk for a future serious heart event.

Description

Although troponins also exist in other muscles, those in the heart are unique, and are measured separately in laboratory tests. Troponins in the heart are called cardiac troponins. There are two main types of cardiac troponins; T and I. T is also referred to as cTnT, while I is also referred to as cTnI.

Both troponin T and I are cardiac markers used to diagnose myocardial infarctions. Cardiac markers are substances whose blood levels increase after a myocardial infarction. Others include CK (creatine kinase), myoglobin, and CK-MB (one of three CK isoenzymes).

Like all cardiac markers, troponins have a unique diagnostic window (the timeline during which the marker rises, peaks, and returns to normal). Troponin levels rise within four to six hours after the beginning of chest pain or heart damage, and stay elevated for at least one week. This long elevation allows detection of a myocardial infarction that occurred days earlier, but prevents detection of a second infarction if it occurred only days after the first.

Troponins I and T are considered superior cardiac markers for several reasons. The most significant is that cardiac troponins are the only markers specific for heart muscle. Other markers also increase following damage to other muscles. Troponin levels help predict the extent of heart muscle damage; higher levels are associated with increased damage, lower levels with less damage. Levels in a healthy person are negligible, so an increase is easily detected.

KEY TERMS

Angina—A temporary chest pain caused by the heart not receiving enough oxygen.

Cardiac marker—A substance in the blood whose level rises following a myocardial infarction.

Myocardial infarction—Commonly known as a heart attack, a myocardial infarction is an episode in which some of the heart's blood supply is severely cut off or restricted, causing the heart muscle to suffer and die from lack of oxygen.

The main difference between troponins I and T is that cardiac troponin I tests measure only cardiac troponin; tests for cardiac troponin T may cross-react with troponin found in other muscles and give positive or increased results in the absence of heart damage.

Two types of tests for troponins T and I are available: a traditional quantitative test that provides an actual measurement of troponin, and a newer qualitative test that simply reports the result as positive or negative. The quantitative test takes 45–90 minutes, and helps distinguish between myocardial infarction and unstable angina. The qualitative test takes 15 minutes and is used in emergency rooms in which rapid patient care decisions can be made based on the presence or absence of troponins.

Preparation

Troponins tests require 5 mL of blood. Collection of the sample takes only a few minutes.

Aftercare

Discomfort or bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Warm packs to the puncture site relieve discomfort.

Normal results

People without heart damage have troponin levels less than 0.5 ng/mL.

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Abnormal results

Levels greater than 2.0 ng/mL indicate a person has had a significant myocardial injury, such as an infarction, and is at an increased risk for future serious heart events. Levels between 0.5 and 2.0 ng/mL indicate a diagnosis of unstable angina, other heart disorders, or **chronic kidney failure**.

Resources

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Nancy J. Nordenson

Trypanosoma cruzi infection *see* **Chagas' disease**

TSS *see* **Toxic shock syndrome**

Tsutsugamushi fever *see* **Scrub typhus**

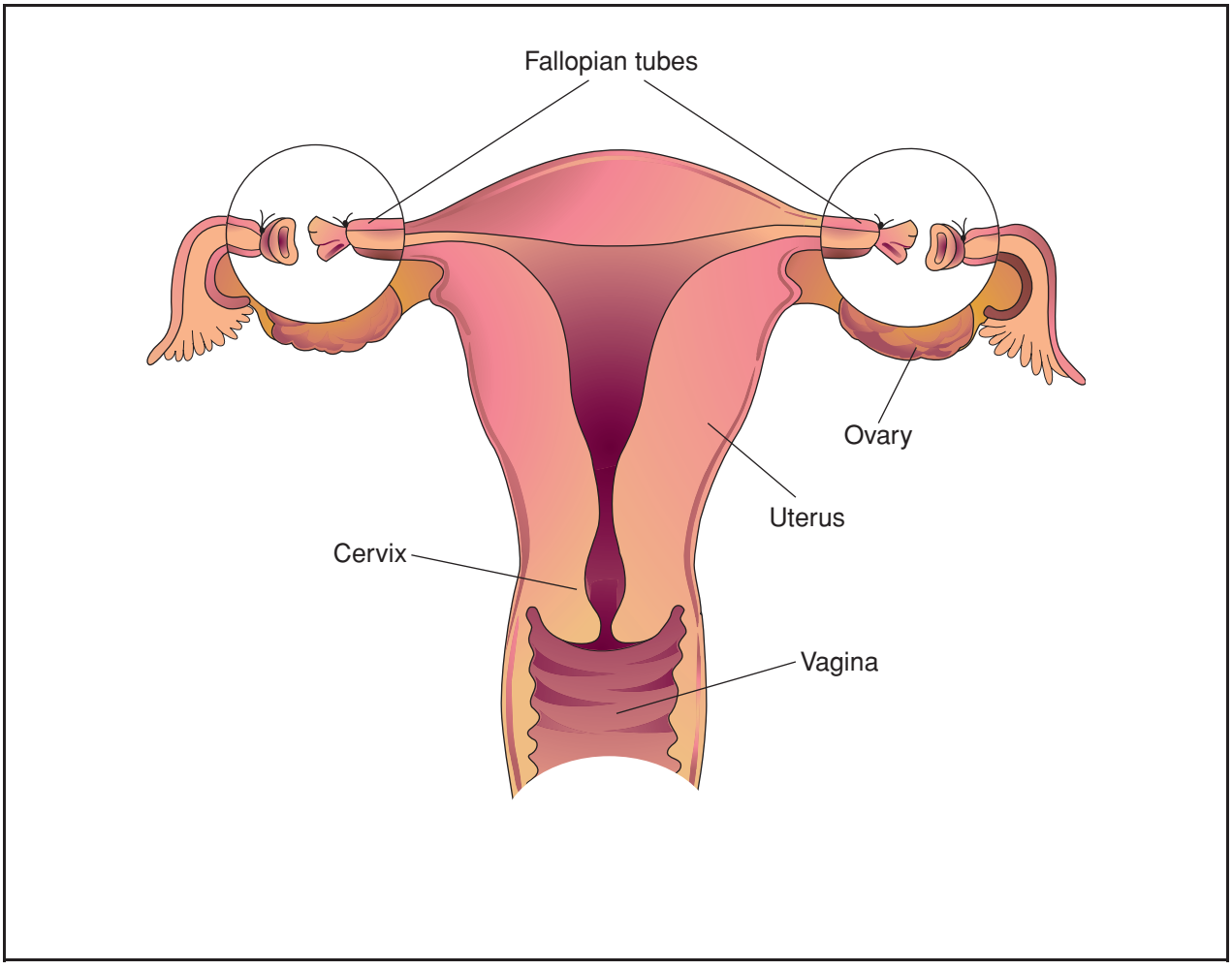
Tubal ligation

Definition

Tubal ligation is a permanent voluntary form of birth control (**contraception**) in which a woman's fallopian tubes are surgically cut, tied, or blocked off to prevent **pregnancy**.

Purpose

Tubal ligation is performed in women who want to prevent future pregnancies. It is frequently chosen



Tubal ligation is a permanent form of contraception in which a woman's Fallopian tubes are surgically cut, cauterized, tied, or blocked to prevent pregnancy. This procedure blocks the pathway sperm takes to fertilize an egg. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

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by women who do not want more children, but who are still sexually active and potentially fertile, and want to be free of the limitations of other types of birth control. Women who should not become pregnant for health concerns or other reasons may also choose this birth control method.

Demographics

Tubal ligation is one of the leading methods of contraception. This form of contraception is chosen by about 650,000–700,000 annually in the United States. The typical tubal ligation patient is over age 30, is married, and has had two or three children.

Description

Tubal ligation, or getting one's "tubes tied," refers to female sterilization, the surgery that ends a woman's ability to conceive. The operation is performed on the patient's fallopian tubes. These tubes, which are about 4 in (10 cm) long and 0.2 in (0.5 cm) in diameter, are found on the upper outer sides of the uterus. They open into the uterus through small channels. It is within the fallopian tube that fertilization, the joining of the egg and the sperm, takes place. During tubal ligation, the tubes are cut or blocked in order to close off the sperm's access to the egg.

Normally, tubal ligation takes about 20–30 minutes, and is performed under **general anesthesia**, spinal anesthesia, or **local anesthesia** with **sedation**. The surgery can be performed on either hospitalized patients within 24 hours after **childbirth** or on outpatients. The woman can usually leave the hospital the same day.

Tubal ligation should be postponed if the woman is unsure about her decision. While the procedure is sometimes reversible, it should be considered permanent and irreversible. As many as 10% of sterilized women regret having had the surgery, and about 1% seek treatment to restore their fertility.

The most common surgical approaches to tubal ligation include **laparoscopy** and mini-laparotomy. In a laparoscopic tubal ligation, a long, thin telescope-like surgical instrument called a laparoscope is inserted into the pelvis through a small cut about 0.5 in (1 cm) long near the navel. Carbon dioxide gas is pumped in to help move the abdominal wall to give the surgeon easier access to the tubes. Often, the surgical instruments are inserted through a second incision near the pubic hair line. An instrument may be placed through the vagina to hold the uterus in place.

In a mini-laparotomy, a 1–2 in (3–4 cm) incision is made just above the pubic bone or under the navel. A larger incision, or laparotomy, is rarely used today. Tubal ligation can also be performed at the time of a **cesarean section**.

KEY TERMS

Contraception—The prevention of the union of the male's sperm with the female's egg.

Ectopic pregnancy—The implantation of a fertilized egg in a fallopian tube instead of the uterus.

Electrocoagulation—The coagulation or destruction of tissue through the application of a high-frequency electrical current.

Female sterilization—The process of permanently ending a woman's ability to conceive by tying off or cutting apart the fallopian tubes.

Laparoscopy—Abdominal surgery performed through a laparoscope, which is a thin telescopic instrument inserted through an incision near the navel.

Laparotomy—A procedure in which the surgeon opens the abdominal cavity to inspect the patient's internal organs.

Vasectomy—Surgical sterilization of the male, done by removing a portion of the tube that carries sperm to the urethra.

The tubal ligation itself is performed in several ways, including:

- Electrocoagulation. A heated needle connected to an electrical device is used to cauterize or burn the tubes. Electrocoagulation is the most common method of tubal ligation.
- Falope ring. In this technique, an applicator is inserted through an incision above the bladder and a plastic ring is placed around a loop of the tube.
- Hulka clip. The surgeon places a plastic clip across a tube held in place by a steel spring.
- Silicone rubber bands. A band placed over a tube forms a mechanical block to sperm.

Tubal ligation costs between $2,000 and $2,500 when performed by a private physician, but is less expensive when performed at a family planning clinic. Most insurance plans cover treatment costs.

Diagnosis/Preparation

Preparation for tubal ligation includes patient education and counseling. Before surgery, it is important that the woman understand the permanent nature of

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tubal ligation as well as the risks of anesthesia and surgery. Her medical history is reviewed, and a **physical examination** and laboratory testing are performed. The patient is not allowed to eat or drink for several hours before surgery.

Aftercare

After surgery, the patient is monitored for several hours before she is allowed to go home. She is instructed on care of the surgical wound, and what signs to watch for, such as **fever**, **nausea**, **vomiting**, faintness, or **pain**. These signs could indicate that complications have occurred.

Risks

While major complications are uncommon after tubal ligation, there are risks with any surgical procedure. Possible side effects include infection and bleeding. After laparoscopy, the patient may experience pain in the shoulder area from the carbon dioxide used during surgery, but the technique is associated with less pain than mini-laparotomy, as well as a faster recovery period. Mini-laparotomy results in a higher incidence of pain, bleeding, bladder injury, and infection compared with laparoscopy. Patients normally feel better after three to four days of rest, and are able to resume sexual activity at that time.

The possibility for treatment failure is very low—about five women per 1,000 will become pregnant during the first year after sterilization. The failure rate increases over time, so that 10 years after the procedure, the failure rate is 18 women per 1,000. Failure can happen if the cut ends of the tubes grow back together; if the tube was not completely cut or blocked off; if a plastic clip or rubber band has loosened or come off; or if the woman was already pregnant at the time of surgery.

Normal results

After having her tubes tied, a woman does not need to use any form of birth control to avoid pregnancy. Tubal ligation is almost 100% effective for the prevention of conception.

Morbidity and mortality rates

About 1–4% of patients experience complications following tubal ligation. There is a low risk (less than 1%, or seven per 1,000 procedures) of a later **ectopic pregnancy**. Ectopic pregnancy is a condition in which the fertilized egg implants in a place other than the uterus, usually in one of the fallopian tubes. Ectopic pregnancies are more likely to happen in younger women, and in women whose tubes were closed off by electrocoagulation.

Rarely, **death** may occur as a complication of general anesthesia if a major blood vessel is cut. The mortality rate of tubal ligation is about 4-in-100,000 sterilizations.

Alternatives

There are numerous options available to women who wish to prevent pregnancy. **Oral contraceptives** are the second most common form of contraception—the first being female sterilization—and have a success rate of 95–99.5%. Other methods of preventing pregnancy include **vasectomy** (99.9% effective) for the male partner; the male condom (86–97% effective); the diaphragm or cervical cap (80–94% effective); the female condom (80–95% effective); and abstinence.

Resources

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ORGANIZATIONS

American College of Obstetricians and Gynecologists, 409 Twelfth Street SW, P.O. Box 96920, Washington, DC, 20090-6920, (202)638-5577, http://www.acog.org.

Planned Parenthood Federation of America, 810 Seventh Avenue, New York, NY, 10019, (800) 669-0156, http://www.plannedparenthood.org.

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Tube compression of the esophagus and stomach

Definition

Tube compression of the esophagus and stomach is an emergency procedure used to stop bleeding from the upper digestive tract.

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Purpose

Vomiting blood is both frightening and life-threatening. Among its causes are:

- bleeding from the nose and throat
- peptic ulcers
- stomach cancer
- esophageal cancer
- a tear in the esophagus caused by violent vomiting (Mallory-Weiss syndrome)
- breaking of blood vessels in the esophagus.

The most profuse bleeding comes from veins in the lower esophagus, just above the stomach, that have dilated to enormous dimensions as the result of **liver disease**. When the liver shrinks due to **cirrhosis** (scarring from chronic disease), its blood vessels shrink, forcing blood from the intestines to find alternate routes back to the heart. The blood usually flows through tiny veins in the esophagus located just beneath the passageway where food passes downward and vomitus passes upward. Major causes for this rearrangement are alcoholic liver disease, chronic hepatitis, and **cholangitis**. Called esophageal varices, the affected veins can be easily damaged and bleed voraciously.

Description

One emergency method of stopping bleeding from esophageal varices is to tamponade it with a balloon. The Sengstaken-Blakemore tube is a complex rubber device with two balloons and three channels—one channel for each balloon and one that goes all the way through. The Minnesota tube has four channels, an extra one that opens above the first balloon. The bottom balloon is round; the upper balloon is long and narrow. The tube is passed through the nose or mouth into the stomach, where the bottom balloon is inflated. Then the tube is pulled back until the bottom balloon comes up against the narrow valve at the top of the stomach, when it can go no further. At this point, the upper balloon is inflated, putting pressure on a length of esophagus where the bleeding veins are located. The tube is then fixed so it cannot be dislodged. The third channel in the tube is used to aspirate (suck out) stomach contents to see if the bleeding has stopped. The fourth channel aspirates from the esophagus.

These tubes are a temporary measure. They stabilize the patient until bleeding has stopped, blood transfusions are received, and permanent repair is imminent.

Since the lower balloon effectively separates the esophagus from the stomach, it is possible to determine more accurately where the bleeding is located when it is in place.

KEY TERMS

Cholangitis—Inflammation of the system of tubes that drains bile from the liver into the intestines.

Chronic hepatitis—Long lasting inflammation of the liver due to viruses or other causes.

Peptic ulcers—Wounds in the stomach and duodenum caused by stomach acid and the bacterium *Helicobacter pylori*.

Tamponade—To occlude by pressure.

This method of treating upper intestinal bleeding is being replaced by procedures that use a gastroscope, a flexible device that permits viewing and operating without surgery.

Preparation

The procedure is explained to the patient and family. A sedative may be given to prepare the patient for the procedure.

Aftercare

With the tube in place, the patient cannot eat and may have some difficulty breathing. The patient will be hospitalized until the tube can be removed.

Risks

Major complications frequently occur, and **death** results about 3% of the time. Problems include damage to the esophagus and stomach and interference with the airway. Should the tube remain in place too long, there is danger of the pressure eroding the esophagus or the nose.

Resources

BOOKS

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J. Ricker Polsdorfer, MD

Tube feedings

Definition

Nutrients, either a special liquid formula or pureed food, are delivered to a patient through a tube directly into the gastrointestinal tract, usually into the stomach or small intestine.

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Purpose

Tube feeding provides **nutrition** to patients who are unable or unwilling to eat food. Conditions where tube feeding is considered include **protein-energy malnutrition**, liver or kidney failure, **coma**, or in patients who cannot chew or swallow (dysphagia) due to **stroke**, **brain tumor**, or **head injury**. Patients who are receiving **radiation therapy** or **chemotherapy** treatments for **cancer** may also be candidates for tube feedings.

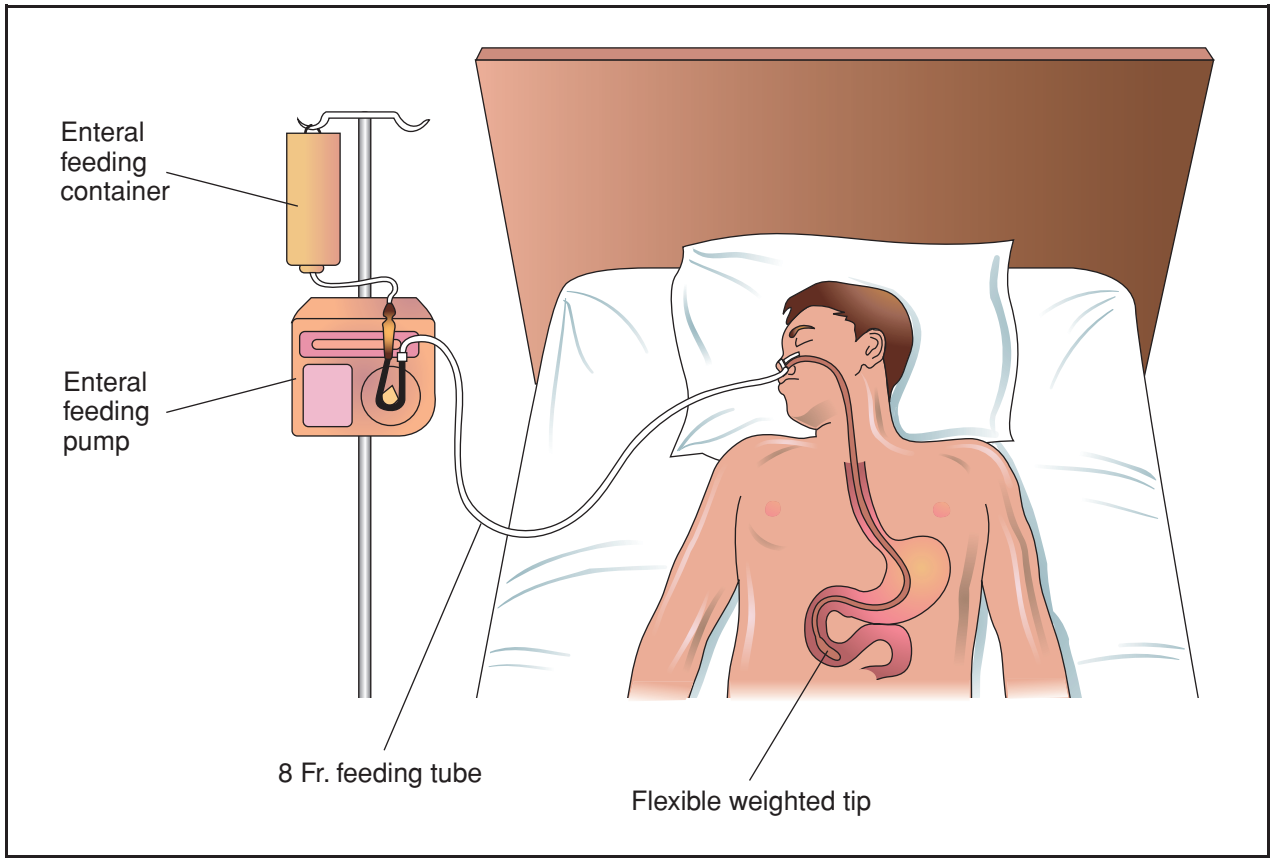
Precautions

Certain medications may interact with some formulas to inactivate the nutrients or change the way that the drug is absorbed.

Description

A flexible, narrow tube is inserted into some portion of the digestive tract and liquid formulas or liquefied foods are placed into the tube to meet the patient's nutritional needs. The feeding may be pumped into the tube or allowed to drip into the tube continuously or at scheduled feeding times.

A feeding tube can be inserted by a surgical or nonsurgical procedure in several positions along the gastrointestinal tract. The tube may be inserted into the nose and passed down the throat and through the esophagus. A nasogastric tube is inserted through the nose with the end of the tube reaching into the stomach. A nasoduodenal or nasojejunal tube is inserted through the nose and ends in either the duodenum or jejunum, both of which are portions of the small intestine. This type of tube placement is usually used for short-term feeding. Surgical placement of a feeding tube may be done if there will be a long-term need for feeding that bypasses the upper digestive tract. An esophagostomy creates an opening in the esophagus, a **gastrostomy** creates an



A feeding tube can be inserted by a surgical or nonsurgical procedure in several positions along the gastrointestinal tract to provide nutrition to patients who are unable or unwilling to eat food. The feeding may be pumped into the tube or allowed to drip into the tube continuously, or at scheduled feeding times. The illustration above features a nasojejunal tube which is inserted through the nose and ends in either the duodenum or jejunum. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

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KEY TERMS

Duodenum—The upper portion of the small intestine. It is approximately 10 in (25 cm) long and extends from the stomach to the jejunum.

Jejunum—The middle portion of the small intestine. It is approximately 8 ft (2.5 m) long and extends from the jejunum to the ileum.

opening into the stomach, and a jejunostomy creates an opening into the jejunum. The feeding tube is then inserted through the surgically created opening.

Tube feedings can be a mixture of regular foods that are blended with liquid to make a consistency that will pass through the tube. Nutritionally balanced liquid products are often more convenient to use and ensure a balance of proteins, fats, and carbohydrates along with **vitamins** and **minerals**. Specialized formulas are also available to meet almost any nutritional need. For example, patients with severe **burns**, protein-energy **malnutrition**, or slow wound healing may require formulas that are higher in protein. Patients with renal failure may require low-protein formulas with lower concentrations of minerals and vitamins.

Preparation

The reasons that tube feeding is necessary are discussed with the patient, as is the length of time that the feeding tube is expected to be in place. The specific procedure is also explained to the patient.

Aftercare

Patients with **ostomy** feeding tubes may have the tube positioned level with the surrounding skin. A cap or button can be placed over the opening so that it can be more comfortably concealed under clothing. The opening and surrounding tissue need to be cleaned and inspected regularly to prevent infection. For patients with a tube inserted through the nose, daily nasal hygiene is important and the mouth and lips should be kept moist. Good mouth care is necessary for any patient with a feeding tube.

Risks

Formula from the tube can back up in the esophagus and be breathed into the trachea and lungs, causing aspiration **pneumonia**. The placement of the tube should be checked frequently and the head of the bed elevated during and after feeding to prevent the solution from moving back up the digestive tract. Feeding tubes can also become clogged and should be flushed regularly with water. If the feeding formula is too concentrated or given too fast, the patient may experience **nausea**, **vomiting**, cramping, and bloating. The feeding may need to be diluted with liquid or the rate at which it is given decreased. **Diarrhea** or **constipation** can occur if the feeding is not the right composition or does not provide enough liquid. The tube itself can irritate the nasal passage, esophagus, or surrounding tissues.

Normal results

A patient may be able to return to a normal diet of solid foods after short-term supplementation with formula through a feeding tube. In cases where long-term nutritional therapy is required, all of the patient's nutritional needs will have to be provided by the formula. The balance of fluids, calories, proteins, fats, vitamins, and minerals may need to be adjusted periodically.

Abnormal results

If formula feedings are not tolerated by the patient or are inadequate to meet his or her nutritional needs, the patient may need to receive **nutrition through an intravenous line** (parenteral nutrition). This type of therapy involves delivery of sterile nutrient solutions directly into the bloodstream through a needle inserted into a vein.

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Altha Roberts Edgren

Tuberculin skin test

Definition

Tuberculosis (TB) is an airborne **infectious disease** caused by the bacterium *Mycobacterium tuberculosis*. Besides culturing in the laboratory, the two most common types of tests to screen for exposure to this disease are the Mantoux PPD tuberculin skin test, which is generally considered more reliable, and the older TB tine test, which is now rarely used. These tests are designed to help identify individuals who may have

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been infected by the tuberculosis bacterium. A diagnosis of active, infectious tuberculosis is never made solely based on the results of a TB skin test, but requires further testing, including a **sputum culture** and a chest x-ray.

Purpose

Because TB is spread through the air, especially in poorly ventilated areas, it is more commonly found among people living in crowded conditions, such as jails, nursing homes, and homeless shelters. Often, a TB skin test will be given as part of a **physical examination** when a person is hiring a new employee, particularly for those individuals seeking employment in the health care or food service professions.

People can be exposed to or infected with TB without showing any symptoms or necessarily developing the disease. Individuals with normally functioning immune systems generally prevent the spread of the bacteria by "walling off" or encysting the bacteria within the body. To be at risk for infection a person must have or had close contact with someone who has active tuberculosis (such as a friend or family member). Persons who are more at risk for developing the TB infection overtly include those with a weakened immune system (immunocompromised), either from a chronic disease, such as HIV infection; or as a result of a tissue or organ transplant or other medical treatment designed to suppress the immune system. In addition, persons who are heavy users of crack **cocaine** or alcohol are more susceptible to TB than those who do not abuse these substances. Symptoms of tuberculosis include a persistent **cough**, **fever**, weight loss, night sweats, **fatigue**, and loss of appetite.

Precautions

Although the test is generally considered safe, it is important to inform the person conducting the test if the patient may be pregnant, has had a positive TB test in the past, or has had tuberculosis in the past. People who have had a positive TB test in the past will probably always have a positive test and should not be tested again.

There are several situations when the TB test results might not be accurate. These include situations involving people who:

- have had vaccinations (such as those for measles, polio, rubella or mumps) within the last four weeks
- are taking steroids
- have severe malnutrition

Description

TB skin tests are usually given at a clinic, hospital, or doctor's office. Sometimes the tests are given at schools or workplaces and may be a pre-employment requirement. Many cities provide free TB skin tests and followup care. The Mantoux PPD tuberculin skin test involves injecting a very small amount of a substance called PPD tuberculin just under the top layer of the skin (intracutaneously). Tuberculin is a mixture of antigens obtained from the culture of *M. tuberculosis*. Antigens are foreign particles or proteins that stimulate the immune system to produce antibodies. Two different tuberculin preparations are available, Old Tuberculin (OT) and Purified Protein Derivative (PPD). The latter is the preferred testing substance. The test is usually given on the inside of the forearm about halfway between the wrist and the elbow, where a small bubble will form as the tuberculin is injected. The skin test takes just a minute to administer.

After 48–72 hours, the test site will be examined by a trained person for evidence of swelling. People who have been exposed to tuberculosis will develop an immune response, causing a slight swelling at the injection site. If there is a lump or swelling, the health care provider will use a ruler to measure the size of the reaction. Some public health physicians recommend using a 72-hour waiting period as a general practice on the grounds that a 48-hour waiting period yields a higher percentage of false negative test results.

The other method of TB skin test is called the multiple puncture test or tine test because the small test instrument has several small tines that lightly prick the skin. The small points of the instrument are either coated with dried tuberculin or are used to puncture through a film of liquid tuberculin. The test is read by measuring the size of the largest papule. Because it is not possible to precisely control the amount of tuberculin used in the tine test, a positive test should be verified using the Mantoux test. For this reason, the tine test is not as widely used as the Mantoux test and is considered to be less reliable; it is no longer recommended for general use.

Preparation

There is no special preparation needed before a TB skin test. A brief personal history will be taken to determine whether the person has had tuberculosis or a TB test before, has been in close contact with anyone with TB, or has any significant risk factors. Directly before the test, the skin on the arm at the injection site is usually cleaned with an alcohol swab and allowed to air dry.

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Aftercare

After having a TB skin test, it is extremely important to make sure that the patient keeps the appointment to have the test reaction read. The patient is instructed to keep the test site clean, uncovered, and to not scratch or rub the area. Should severe swelling, **itching**, or **pain** occur, or if the patient has trouble breathing, the clinic or health care provider should be contacted immediately.

Risks

The risk of an adverse reaction is very low. Occasionally, an individual who has been exposed to the TB bacteria will develop a large reaction in which the arm swells and is uncomfortable. This reaction should disappear in two weeks. A sore might develop where the injection was given, or a fever could occur, but these are extremely rare reactions.

It is possible that a person who has TB may receive a negative test result (called a "false negative") or a person who does not have TB may receive a positive test result (called a "false positive"). If there is some doubt, the test may be repeated or the person may be given a diagnostic test using a **chest x ray** and/or sputum sample culture test to determine whether the disease is present and/or active in the lungs.

Normal results

In people who have not been exposed to TB, there will be little or no swelling at the test site after 48–72 hours. This is a negative test result. Negative test results can be interpreted to mean that the person has not been infected with the tuberculosis bacteria or that the person has been infected recently and not enough time has elapsed for the body to react to the skin test. Persons become sensitive between two and ten weeks after the initial infection. As a result, if the person has been in contact with someone with tuberculosis, the test should be repeated in three months. Also, because it may take longer than 72 hours for an elderly individual to develop a reaction, it may be useful to repeat the TB skin test after one week to adequately screen these individuals. Immunocompromised persons may be unable to react sufficiently to the Mantoux test, and either a chest x ray or sputum sample may be required.

A newer test that appears to be preferable to the tuberculin skin test in evaluating patients who are HIV-positive is the enzyme-linked immunospot (ELISPOT) assay. A group of researchers in the United Kingdom found that the ELISPOT assay was more accurate than the PPD test in detecting active as well as latent tuberculosis in HIV-positive patients.

KEY TERMS

Antibody—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

Antigen—Any foreign particle or protein that causes an immune response.

Attenuated—Alive but weakened; an attenuated microorganism can no longer produce disease.

Cross-reaction—A positive reaction that occurs as a result of a person's exposure to other non-tuberculosis bacteria.

Immunocompromised—A state in which the immune system is suppressed or not functioning properly.

Induration—An abnormally hard spot or area on the skin. The tuberculin skin test produces an induration at the test site in persons who have been exposed to TB.

Intracutaneous—Into the skin, in this case directly under the top layer of skin.

Mantoux or PPD test—Other names for a tuberculin skin test. PPD stands for purified protein derivative.

Tuberculin—A mixture of antigens obtained from the cultured bacteria that cause tuberculosis, *Mycobacterium tuberculosis*.

Abnormal results

A reaction of 5 mm of induration (swelling) is considered positive for the following groups:

- household contacts of persons with active tuberculosis
- AIDS patients
- persons with old healed tuberculosis on chest x ray
- organ transplant recipients.
- persons receiving immunosuppressive medications

A reaction of 10 mm of induration is considered positive in individuals with one or more of the following risk factors which are either reasons to have a higher exposure to TB and/or a condition that increases the risk for progression to active TB:

- foreign-born immigrants from Asia, Africa, or Latin America
- injection drug users and persons who abuse alcohol
- residents and employees of such high-risk congregate settings as hospitals, homeless shelters, and jails
- medically under-served low income populations

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- TB laboratory personnel
- children younger than four years of age or infants, children or adolescents exposed to adults in high risk categories
- residents of long-term care facilities
- individuals with certain medical conditions that increase the risk of developing tuberculosis; these medical conditions include being 10% or more below ideal body weight, silicosis, chronic renal failure, diabetes mellitus, high dose corticosteroid or other immunosuppressive therapy, some blood disorders like leukemia and lymphomas, and other cancer

Finally, a reaction of 15 mm of induration or greater is considered positive in those with no risk factors and are therefore at the lowest risk of developing TB.

A TB skin conversion is defined as an increase of 10 mm or greater of induration within a two year period, regardless of age.

A positive reaction to tuberculin may be the result of a previous natural infection with *M. tuberculosis*, infection with a variety of non-tuberculosis mycobacteria (cross-reaction), or tuberculosis **vaccination** with a live, but weakened (attenuated) mycobacterial strain. TB vacination is not done in the United States. Cross-reactions are positive reactions that occur as a result of a person's exposure to other non-tuberculosis bacteria. These tend to be smaller than those caused by *M. tuberculosis*. There is no reliable way of distinguishing whether a positive TB skin test is due to a previous vaccination against tuberculosis. Generally, however, positive results are not due to vaccination exposure because reactions in vaccinated people tend to be less than 10 mm, and an individual's sensitivity to tuberculin steadily declines after vaccination. If the skin test is interpreted as positive, a chest x ray will be performed to determine whether the person has active tuberculosis or whether the body has sufficiently handled the infection.

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ORGANIZATIONS

American Lung Association, 1301 Pennsylvania Ave. NW, Suite 800, Washington, DC, 20001, (202) 758-3355, (202) 452-1805, (800) 548-8252, info@lungusa.org, http://www.lungusa.org/.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

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Tuberculosis

Definition

Tuberculosis (TB) is a chronic, potentially fatal contagious disease that most often affects the lungs but can affect other parts of the body. It is caused by a bacterium or tubercle bacillus *Mycobacterium tuberculosis*.

Description

Overview

Tuberculosis was the common disease called consumption until well into the twentieth century. In 1882 when the microbiologist Robert Koch discovered the tubercle bacillus that causes the disease, TB caused one of every seven deaths in Europe. The tubercle bacillus is transmitted when an infected person coughs or sneezes

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FLORENCE B. SEIBERT (1897–1991)

(The Library of Congress.)

Florence Barbara Seibert was born on October 6, 1897, in Easton, Pennsylvania, the second of three children. She was the daughter of George Peter Seibert, a rug manufacturer and merchant, and Barbara (Memmert) Seibert. At the age of three she contracted polio. Despite her resultant handicaps, she completed high school, with the help of her highly supportive parents, and entered Goucher College In Baltimore, where she studied chemistry and zoology. She graduated in 1918, then worked under the direction of one of her chemistry teachers, Jessie E. Minor, at the Chemistry Laboratory of the Hammersley Paper Mill in Garfield, New Jersey. She and her professor, having responded to the call for women to fill positions vacated by men fighting in World War I, coauthored scientific papers on the chemistry of cellulose and wood pulps.

A biochemist who received her Ph.D. from Yale University in 1923, Florence B. Seibert is best known for her research in the biochemistry of tuberculosis. She developed the protein substance used for the tuberculosis skin test. The substance was adopted as the standard in 1941 by the United States and a year later by the World Health Organization. In addition, in the early 1920s, Seibert discovered that the sudden fevers that sometimes occurred during intravenous injections were caused by bacteria in the distilled water that was used to make the protein solutions. She invented a distillation apparatus that prevented contamination. This research had great practical significance later when intravenous blood transfusions became widely used in surgery. Seibert authored or coauthored more than a hundred scientific papers. Her later research involved the study of bacteria associated with certain cancers. Her many honors include five honorary degrees, induction into the National Women's Hall of Fame in Seneca Falls, New York (1990), the Garvan Gold Medal of the American Chemical Society (1942), and the John Elliot Memorial Award of the American Association of Blood Banks (1962).

and another person breathes in the infected droplets. The disease is not spread through kissing or other physical contact.

Before **antibiotics** were discovered in the mid-1900s, the only means of controlling the spread of TB was to isolate patients in sanatoriums or hospitals limited to patients with TB. This practice continues today in some countries. The effect of this pattern of treatment was to separate the study of tuberculosis from mainstream medicine. Entire organizations were set up to study not only the disease as it affected individual patients, but also its impact on society. At the beginning of the twentieth century, more than 80% of the population in the United States was infected with TB before age 20, and tuberculosis was the single most common cause of **death**. By 1938 there were more than 700 specialized TB facilities in the United States.

Tuberculosis spread widely in Europe as the result of the industrial revolution in the late nineteenth century when many people moved to towns where they lived in crowded, unsanitary conditions. The disease became widespread somewhat later in the United States. In the early 1940s with the discovery of streptomycin, the first antibiotic effective against *M. tuberculosis*, the infection began for the first time to be contained. Although other more effective anti-tuberculosis drugs that continue to reduce the number of TB cases have been developed in the past half century, reports of active TB cases in the United States began to increase in the mid-1980s. This upsurge was in part a result of overcrowding and unsanitary conditions in the poor areas of large cities, prisons, and homeless shelters. Infected visitors and immigrants to the United States also contributed to the resurgence of TB. An additional factor was the **AIDS** epidemic. Individuals with HIV/AIDS are much more likely to develop tuberculosis because of their weakened immune systems than healthy individuals.

The number of reported TB cases in the United States peaked in 1993 and has since declined. However,

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new multi drug-resistant strains of TB (MDR TB) have become a major public health concern. In the mid 2000s, health officials worldwide joined to work at preventing a drug-resistant form of the disease from becoming widespread.

In 2005, the United States Centers for Disease Control and Prevention (CDC) reported a record low number of 14,097 cases of active TB in the United States, of which 55% occurred in foreign-born individuals. However, the rate of multi-drug resistant had increased 13.3% since 2000. The CDC estimated that in 2005 about 10 million people in the United States have latent (symptom-free) TB infections.

The World Health Organization (WHO) estimates that about one-third of the world's population is infected with *M. tuberculosis*. Of those infected, between 5% and 10% will develop active TB. In individuals who have HIV/AIDS infections, the rate is much higher. The greatest number of active TB infections per capita is found in sub-Saharan Africa where AIDS is epidemic. About one-third of infections occur in Southeast Asia. WHO estimates that TB caused about 1.6 million deaths in 2005. Although the rate per capita of active TB is declining worldwide, the absolute number of cases is increasing in many areas because of high population growth.

High-risk populations

THE ELDERLY. Tuberculosis is more common in elderly individuals. More than 60% of cases in the United States are diagnosed in people between the ages of 25–65. About one-quarter of TB cases newly diagnosed occur in people over age 65. Many elderly individuals developed TB after acquiring a latent TB infection years earlier. As they age, their immune systems can no longer control the disease, and they develop active TB symptoms. In addition, elderly people living in nursing homes and other group facilities are often in close contact with others who may be infected.

RACIAL AND ETHNIC GROUPS. Higher rates of TB are found in the non-white population in the United States, but health researchers believe that this likely is related to the socioeconomic status of these groups rather than to race-related biological factors. Individuals of lower socioeconomic status tend to live in more crowded conditions and have less access to health care than higher socioeconomic status individuals, conditions which encourage the infection with *M. tuberculosis*.

As of 2009, TB was a major health problem in the United States among certain immigrant groups that come from countries where TB infection is common. California, New York, Texas, Florida, all states with large immigrant populations, accounted for almost half of all active TB cases. The most common countries of origin for foreign-born persons in the United States with active TB were Mexico, the Philippines, Vietnam, India, and China.

LIFESTYLE FACTORS. The high risk of TB in AIDS patients extends to those infected by human **immunodeficiency** virus (HIV) who have not yet developed clinical signs of AIDS but whose immune systems are weakened by the virus. Other people who take drugs that suppress the immune system (e.g., transplant patients) are also at higher risk of becoming infected, as are people who have **silicosis**, a lung disease. Individuals who are alcoholics, intravenous drug abusers, and the homeless are also at increased risk of contracting tuberculosis.

Causes and symptoms

Transmission

Tuberculosis spreads by droplet infection. When a person infected with *M. tuberculosis* exhales, coughs, or sneezes, tiny droplets of fluid containing tubercle bacilli are released into the air. People in close physical contact with the infected person inhale this fine mist. Tuberculosis is not highly contagious compared to some other infectious diseases. As a rule, close, frequent, or prolonged contact is needed to spread the disease. Most people do not develop TB even when exposed to a person with active TB. Unlike many other infections, TB is not passed on by contact with a an infected individual's clothing, bed linens, dishes or cooking utensils. The disease is not spread through kissing or other physical contact. The most important exception is **pregnancy**. The fetus of an infected mother may contract TB by inhaling or swallowing the bacilli in the amniotic fluid.

Progression

Once a person inhales *M. tuberculosis*, one of four things can happen.

- The person's immune system can kill the bacteria; no TB infection results and the person is not contagious.
- The bacteria can become dormant and never grow; no TB symptoms are seen, and the person is not contagious.
- The bacteria can become dormant for a period, then begin to grow; TB symptoms appear a long time after infection. The person is not contagious during the dormant period, then becomes contagious when symptoms appear.
- The bacteria multiples immediately; active TB symptoms appear and the person is contagious.

At least nine of ten people who are infected with *M. tuberculosis* do not develop symptoms of TB, and

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their chest x-rays remain negative. These people have what is called a latent TB infection. They are not contagious; however, they do form a pool of infected individuals who may get sick later and then pass on TB to others. It is thought that more than 90% of cases of active tuberculosis come from this pool. In the United States, there are about 10 million people with latent TB infections. It is impossible to predict which individuals with latent TB infections will develop active TB. An estimated 5% of infected persons get sick within 12–24 months of being infected. Another 5% heal initially but, after years or decades, develop active tuberculosis either in the lungs or elsewhere in the body. On rare occasions, a previously infected person gets sick again after a later exposure to the tubercle bacillus.

Pulmonary tuberculosis

Pulmonary tuberculosis is TB that affects the lungs. Its initial symptoms are easily confused with those of other diseases. An infected person may at first feel vaguely unwell or develop a **cough** that could be blamed on **smoking** or a cold. A small amount of greenish or yellow sputum may be coughed up when the person gets up in the morning. In time, more sputum is produced that is streaked with blood. People who have pulmonary TB do not get a high **fever**, but they often have a low-grade one. The individual often loses interest in food and may lose weight. Chest **pain** is sometimes present. If the infection allows air to escape from the lungs into the chest cavity (**pneumothorax**) or if fluid collects in the pleural space (**pleural effusion**), the patient may have difficulty breathing. If a young adult develops a pleural effusion, the chance of tubercular infection being the cause is very high.

Before the development of effective TB drugs, many patients became chronically ill with increasingly severe lung symptoms. They lost a great deal of weight and developed a wasted appearance, hence the name consumption. This outcome is uncommon today where modern treatment methods are available.

Extrapulmonary tuberculosis

Although the lungs are the major site of damage caused by tuberculosis, other organs and tissues in the body may be affected. The usual progression is for the disease to spread from the lungs to locations outside the lungs (extrapulmonary sites). In occasional cases, however, the first sign of disease appears outside the lungs. The many tissues or organs that tuberculosis may affect include:

- bones. TB is particularly likely to attack the spine and the ends of the long bones. Children are especially prone to spinal tuberculosis. If not treated, the spinal segments (vertebrae) may collapse and cause paralysis in one or both legs.
- kidneys. Along with the bones, the kidneys are the commonest site of extrapulmonary TB. There may, however, be few symptoms even after part of a kidney is destroyed. TB may also spread to the bladder. In men, it may spread to the prostate gland and nearby structures.
- female reproductive organs. The ovaries in women may be infected and TB may spread from them to the peritoneum (the membrane lining the abdominal cavity).
- abdominal cavity. Tuberculosis peritonitis may cause pain ranging from the vague discomfort of stomach cramps to intense pain that may mimic the symptoms of appendicitis.
- joints. Tubercular infection of joints causes a form of arthritis that most often affects the hips and knees. The wrist, hand, and elbow joints also may become painful and inflamed.
- meninges. The meninges are tissues that cover the brain and the spinal cord. Infection of the meninges by the TB bacillus causes tuberculosis meningitis, a condition that is most common in young children but is especially dangerous in the elderly. Patients develop headaches, become drowsy, and eventually, comatose. Permanent brain damage is the rule unless prompt treatment is given. Some patients with tuberculosis meningitis develop a tumor-like brain mass called a tuberculoma that can cause stroke-like symptoms.
- skin, intestines, adrenal glands, and blood vessels. All these parts of the body can be infected by *M. tuberculosis*. Infection of the wall of the body's main artery (the aorta), can cause it to rupture with catastrophic results. Tuberculosis pericarditis occurs when the membrane surrounding the heart (the pericardium) is infected and fills up with fluid that interferes with the heart's ability to pump blood.
- miliary tuberculosis. Miliary TB is a life-threatening condition that occurs when large numbers of tubercle bacilli spread throughout the body. Huge numbers of tiny tubercular lesions develop that cause marked weakness and weight loss, severe anemia, and gradual wasting of the body.

Multi drug-resistant tuberculosis (MDR TB)

In the twenty-first century, there is increasing concern about strains of *M. tuberculosis* that are resistant to the TB drugs that have brought the disease under control in the past half century. MDR TB is TB that fails to

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respond to at least two drugs, isoniazid (INH) and rifampin (RIF), that are routinely used to treat TB. In the United States, MDR TB, although rare, is on the rise. The CDC has developed a special group of experts to work with physicians who have MDR TB patients. There is concern that drug-resistant TB could spread widely and cause a public health crisis. When alternate drug therapy fails to control MDR TB, **lung surgery** is the preferred treatment option.

Diseases similar to tuberculosis

There are many forms of mycobacteria other than *M. tuberculosis*, the tubercle bacillus. Some cause infections that may closely resemble tuberculosis, but they usually do so only when an infected person's immune system is defective. This occurs, for example, in some people who are HIV-positive. The most common mycobacteria that infect HIV/AIDS patients are a group known as *Mycobacterium avium* complex (MAC). People infected by MAC are not contagious, but they may develop a serious lung infection that is highly resistant to antibiotics. MAC infections typically start with the patient coughing up mucus. The infection progresses slowly, but eventually blood is brought up in the sputum, and the patient has trouble breathing. In HIV/AIDS patients, MAC disease can spread throughout the body, with anemia, **diarrhea**, and stomach pain as common symptoms. Often these patients die unless their immune system can be strengthened. Other mycobacteria grow in swimming pools and may cause skin infection. Some of them infect **wounds** and artificial body parts such as a **breast implants** or mechanical heart valves.

Diagnosis

The standard screening test for tuberculosis is the **tuberculin skin test**. This test detects the presence of infection, not of active TB. Tuberculin is an extract prepared from cultures of *M. tuberculosis*. It contains proteins belonging to the bacillus (antigens) to which an infected person has been sensitized. When tuberculin is injected into the skin of an infected person, the area around the injection becomes hard, swollen, and red within one to three days.

Skin tests use a substance called purified protein derivative (PPD) that has a standard chemical composition and is therefore is a good measure of the presence of tubercular infection. The PPD test is also called the Mantoux test. The Mantoux PPD skin test is not, however, 100% accurate; it can produce false positive as well as false negative results. In other words, some people who have a skin reaction are not infected (false positive) and some who do not react are in fact infected (false negative). The PPD test is, however, a highly useful screening test and is required in most states for children to enter school. In addition, anyone who has suspicious findings on a **chest x ray**, or any condition that makes TB more likely should have a PPD test, as should people who are in close contact with a TB patient, those who come from a country where TB is common, and all healthcare personnel as well as persons living or working in institutions such as prisons.

To verify the test results, the physician will do a chest x ray and obtain a sample of sputum or a tissue sample (biopsy) for culture. Three to five sputum samples should be taken early in the morning. Culturing *M. tuberculosis* is useful for diagnosis because the bacillus has certain distinctive characteristics. Unlike many other types of bacteria, mycobacteria can retain certain dyes even when exposed to acid. This acid-fast property is characteristic of the tubercle bacillus.

Body fluids other than sputum can be used for a TB culture. If TB has invaded the brain or spinal cord, culturing a sample of spinal fluid will make the diagnosis. If TB of the kidneys is suspected because of pus or blood in the urine, culture of the urine may reveal tubercular infection. Infection of the ovaries in women can be detected by inserting a tube having a light on its end (a laparoscope) into the area. Samples also may be taken from the liver or bone marrow to detect the tubercle bacillus.

For most people, a simple skin test is adequate to screen for TB. However, new advances in the diagnosis of TB use molecular techniques to speed the diagnostic process as well as improve its accuracy. As of 2007, molecular testing is being used more frequently in laboratories around the world. Molecular tests include a polymerase chain reaction to detect mycobacterial DNA in patient specimens; nucleic acid probes to identify mycobacteria in culture; restriction fragment length polymorphism analysis to compare different strains of TB for epidemiological studies; and genetic-based susceptibility testing to identify drug-resistant strains of mycobacteria.

Treatment

Supportive care

In the past, treatment of TB was primarily supportive. Patients were kept in **isolation**, encouraged to rest, and fed well. If these measures failed the lung was collapsed surgically so that it could "rest" and heal. Today surgical procedures still are used when necessary, but contemporary medicine relies on drug therapy as the mainstay of care. Given an effective combination of

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drugs, many patients with TB can be treated at home rather than in a sanatorium.

Drug therapy

Most patients with TB recover if given appropriate medication for a sufficient length of time. Three principles govern modern drug treatment of TB.

- Lowering the number of bacilli as quickly as possible. This minimizes the risk of transmitting the disease. When sputum cultures become negative, this has been achieved. Conversely, if the sputum remains positive after five to six months, treatment has failed.
- Preventing the development of drug resistance. For this reason, at least two different drugs and sometimes up to four are always given as initial treatment.
- Long-term treatment to prevent relapse.

Five drugs are most commonly used treat tuberculosis: isoniazid (INH, Laniazid, Nydrazid); rifampin (Rifadin, Rimactane); pyrazinamide (Tebrazid); streptomycin; and ethambutol (Myambutol). The Centers for Disease Control and Prevention (CDC) and the American Thoracic Society have developed standard regimens for treating TB in an effort to prevent the spread of drug resistant strains. For lung infections in non-immunocom promised people, the disease is usually treated with a regimen of rifampin and isoniazid (INH) for six months, supplemented in the first two months with pyrazinamide and sometimes ethambutol (or streptomycin in very young children). Because some strains of the disease are highly drug-resistant, cultures are grown from the patient's bacteria and tested with a variety of drugs to determine the most effective treatment, and alternate regimens may be determined to be more appropriate.

Except in cases of MDR TB, prolonged hospitalization is rarely necessary because most patients are no longer infectious after about two weeks of combination treatment. Follow-up involves monitoring of side effects and monthly sputum tests. Of the five medications, INH is the most frequently used drug for both treatment and prevention. Hospitalization, isolation, and infectious control measures are required for individuals with MDR TB, which is a very serious disease both for the individual and from a public health standpoint. Most states have laws that allow individuals with TB to be hospitalized against their will for non-compliance with treatment.

Surgery

Surgical treatment of TB may be used if drugs fail to control the disease. There are three surgical treatments for pulmonary TB: pneumothorax, in which air is introduced into the chest to collapse the lung; thoracoplasty, in which one or more ribs are removed; and removal of a diseased lung, in whole or in part. Removal is usually required in the case of MDR TB. Individuals can survive with one healthy lung. Extrapulmonary TB may result in the need for other surgeries.

KEY TERMS

Bacillus Calmette-Guérin (BCG)—A vaccine made from a weakened bacillus similar to the tubercle bacillus, which may help prevent serious pulmonary TB and its complications.

Mantoux test—Another name for the PPD test.

Miliary tuberculosis—The form of TB in which the bacillus spreads through all body tissues and organs, producing many thousands of tiny tubercular lesions. Miliary TB is often fatal unless promptly treated.

Mycobacteria—A group of bacteria that includes *Mycobacterium tuberculosis*, the bacterium that causes tuberculosis, and other forms that cause related illnesses.

Pneumothorax—Air inside the chest cavity, which may cause the lung to collapse. Pneumothorax is both a complication of pulmonary tuberculosis and a means of treatment designed to allow an infected lung to rest and heal.

Purified protein derivative (PPD)—An extract of tubercle bacilli that is injected into the skin to find out whether a person presently has or has ever had tuberculosis.

Sputum—Secretions produced in the lung and coughed up. A sign of illness, sputum is routinely used as a specimen for culturing the tubercle bacillus in the laboratory.

Tuberculoma—A tumor-like mass in the brain that sometimes develops as a complication of tuberculosis meningitis.

Prognosis

Most patients recover from TB if the disease is diagnosed early and given prompt treatment with appropriate medications on a long-term regimen. The relapse rate is less than 4%. The exception is for those with MDR TB. When TB is multi drug-resistant, the prognosis depends largely on the ability to surgically remove all infected tissue. The outcome of surgery depends on where and how widespread the infected area is. Miliary tuberculosis is still fatal in many cases but is rarely seen today in developed countries.

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Prevention

General measures

General measures such as avoidance of overcrowded and unsanitary conditions are one aspect of prevention. Hospital emergency rooms and similar locations can be treated with ultraviolet light, which has an antibacterial effect. Regular skin testing is required in some jobs and of most children when they enter school and often again if when enter college. Although screening does not prevent TB, it allows early treatment of those who are infected, reducing the likelihood that they will spread the disease.

Vaccination

Vaccination is a preventive measure against TB. A vaccine called BCG (Bacillus Calmette-Guérin, named after its French developers) is made from a weakened mycobacterium that infects cattle. Vaccination with BCG does not prevent infection by *M. tuberculosis,* but it does strengthen the immune system response and provide partial protection. BCG is used more widely in developing countries than in the United States. The effectiveness of vaccination is still being studied; it is not clear whether the vaccine's effectiveness depends on the population in which it is used or on variations in its formulation.

In 2007, the first new TB vaccine in 80 years was in clinical trials in South Africa. The new vaccine known as MVA85A, was developed at Oxford University, England, in response to increasing concern about the rise of MDR TB. This vaccine works with BCG vaccine to increase its effectiveness and produce a very strong immune system response. In 2007, clinical trials were focusing on whether the new vaccine actually prevents the disease. Makers of the vaccine predict that even if clinical trials are successful, the vaccine will not be available on the market until about 2015.

Prophylactic use of isoniazid

INH can be given for the prevention as well as the treatment of TB. INH is effective when given daily over a period of six to 12 months to people in high-risk categories. INH appears to be most beneficial to persons under the age of 25. Because INH carries the risk of side effects (liver inflammation, nerve damage, changes in mood and behavior) in about one-fifth of people taking the drug, it is important to give it only to persons at special risk. The increase in MDR TB is also causing some TB experts to re-evaluate preventative drug treatment.

High-risk groups for whom isoniazid prevention may be justified include:

- close contacts of TB patients, including health care workers
- newly infected patients whose skin test has turned positive in the past two years
- anyone who is HIV-positive with a positive PPD skin test; Isoniazid may be given even if the PPD results are negative if there is a risk of exposure to active tuberculosis
- intravenous drug users, even if they are negative for HIV
- persons with positive PPD results and evidence of old disease on the chest x-ray who have never been treated for TB
- patients who have an illness or are taking a drug that can suppress the immune system
- persons with positive PPD results who have had intestinal surgery; have diabetes or chronic kidney failure; have any type of cancer; or are more than 10% below their ideal body weight
- people from countries with high rates of TB who have positive PPD results
- people from low-income groups with positive skin test results
- persons with a positive PPD reaction who belong to high-risk ethnic groups (African Americans, Hispanics, Native Americans, Asians, and Pacific Islanders)
- householders who have lived with someone who has been diagnosed with an active TB infection.

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American Lung Association, 1301 Pennsylvania Ave. NW , Washington, DC, 20004, 202 785 3355 , 202 452 1805, http://www.lungusa.org.

American Thoracic Society, 61 Broadway, 6th Floor, New York, NY, 10006, (212) 315-8600, http://www.thoracic.org.

Division of Tuberculosis Elimination, Centers for Disease Control and Prevention, 1600 Clifton Road, NE. Mailstop E-10, Atlanta, GA, 30333, (888) 232-6348, (800) 232-4636, http://www.cdc.gov/tb/default.htm.

National Heart, Lung, and Blood Institute (NHLBI), P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, http://www.nhlbi.nih.gov.

World Health Organization, Communicable Diseases, 20 Avenue Appia, Switzerland, 1211 Geneva 27, +41(22) 791 4140, http://www.who.int/gtb.

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Tubo-ovarian abscesses *see* **Pelvic inflammatory disease**

Tularemia

Definition

Tularemia is an illness caused by a bacterium. It results in **fever**, rash, and greatly enlarged lymph nodes.

Description

Tularemia infects a variety of wild animals, including rabbits, deer, squirrels, muskrat, and beaver. Humans can acquire the bacterium directly from contact with the blood or body fluids of these animals, from the bite of a tick or fly which has previously fed on the blood of an infected animal, or from contaminated food or water.

Tularemia occurs most often in the summer months. It is most likely to infect people who come into contact with infected animals, including hunters, furriers, butchers, laboratory workers, game wardens, and veterinarians. In the United States, the vast majority of cases of tularemia occur in the southeastern and Rocky Mountain states.

Causes and symptoms

Five types of illness may occur, depending on where/how the bacteria enter the body:

- Ulceroglandular/glandular tularemia. Seventy-five to 85% of all cases are of this type. This type is contracted through the bite of an infected tick that has defecated bacteria-laden feces in the area of the bite wound. A tender red bump appears in the area of the original wound. Over a few weeks, the bump develops a punched-out center (ulcer). Nearby lymph nodes grow hugely swollen and very tender. The lymph nodes may drain a thick, pus-like material. Other symptoms include fever, chills, and weakness. In adults, the lymph nodes in the groin are most commonly affected; in children, the lymph nodes in the neck.
- Oculoglandular tularemia. This type accounts for only about 1% of all cases of tularemia. It occurs when a person's contaminated hand rubs his or her eye. The lining of the eyelids and the surface of the white of the eye (conjunctiva) becomes red and severely painful, with multiple small yellow bumps and pitted sores (ulcers). Lymph nodes around the ears, under the jaw, or in the neck may swell and become painful.
- Oropharyngeal and gastrointestinal tularemia. This type occurs when contaminated meat is undercooked and then eaten, or when water from a contaminated source is drunk. Poor hygiene after skinning and cleaning an animal obtained through hunting can also lead to

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KEY TERMS

Conjunctiva—The lining of the eyelids and the surface of the white part of the eye.

Shock—A state in which drastically low blood pressure prevents adequate blood flow to the tissues and organs throughout the body.

the bacteria entering through the mouth. Sores in the mouth and throat, as well as abdominal pain, nausea and vomiting, ulcers in the intestine, intestinal bleeding, and diarrhea may all occur.

- Pulmonary tularemia. This rare type of tularemia occurs when a person inhales a spray of infected fluid, or when the bacteria reach the lungs through the blood circulation. A severe pneumonia follows.
- Typhoidal tularemia. This type of tularemia is particularly hard to diagnose, because it occurs without the usual skin manifestations or swelling of lymph glands. Symptoms include continuously high fever, terrible headache, and confusion. The illness may result in a severely low blood pressure, with signs of poor blood flow to the major organs (shock).

Diagnosis

Samples from the **skin lesions** can be prepared with special stains, to allow identification of the causative bacteria under the microscope. Other tests are available to demonstrate the presence of antibodies (special immune cells that the body produces in response to the presence of specific foreign invaders) which would be increasing over time in an infection with tularemia.

Treatment

Streptomycin (given as a shot in a muscle) and gentamicin (given as either a shot in a muscle or through a needle in the vein) are both used to treat tularemia. Other types of **antibiotics** have been tested, but have often resulted in relatively high rates of relapse (20%).

Prognosis

With treatment, **death** rates from tularemia are under 1%. Without treatment, however, the death rate may reach 30%. The **pneumonia** and typhoidal types have the worst prognosis without treatment.

Prevention

Prevention involves avoiding areas known to harbor ticks and flies, or the appropriate use of insect repellents. Hunters should wear gloves when skinning animals or preparing meat. Others (butchers, game wardens, veterinarians) who work with animals or carcasses should always wear gloves. A vaccine exists, but is usually only given to people at very high risk due to their profession or hobby (veterinarians, laboratory workers, butchers, hunters, game wardens).

ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

Rosalyn Carson-DeWitt, MD

Tumor markers

Definition

Tumor markers are measurable biochemicals that are associated with a malignancy. They are either produced by tumor cells (tumor-derived) or by the body in response to tumor cells (tumor-associated). They are typically substances that are released into the circulation and thus measured in the blood. There are a few exceptions to this, such as tissue-bound receptors that must be measured in a biopsy from the solid tumor or proteins that are secreted into the urine.

Purpose

Though tumor markers are rarely specific enough to be used alone to diagnose **cancer**, they do have a number of clinical uses. They can be used to stage cancer, to indicate a prognosis, to monitor treatment, or in follow-up to watch for cancer recurrence. Changes in some tumor markers have been sensitive enough to be used as targets in clinical trials. When used for diagnosis, tumor markers are used in conjunction with other clinical parameters such as biopsy and radiological findings. Although there are a multitude of tumor markers, very few of them have found their way into clinical practice because of their lack of specificity. However, some of these non-specific markers have found a place in monitoring cancer treatment rather than in diagnosis.

Description

As tumor cells grow and multiply, some of their substances can increase and leak into the bloodstream or other fluids. Depending upon the tumor marker, it can be measured in blood, urine, stool or tissue. Some widely used tumor markers include: AFP, beta-HCG, CA 15-3, CA 19-9, CA 27-29, CA 125, CEA, and PSA. Some

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tumor markers are associated with many types of cancer; others, with as few as one. Some tumor markers are always elevated in specific cancers; most are less predictable. However, no tumor marker is specific for cancer and most are found in low levels in healthy persons, or can be associated with non-neoplastic diseases as well as cancer. Also, no tumor marker test is free of false negatives or false positives.

Once cancer is diagnosed, tumor marker levels sometimes help to determine the extent of cancer. Higher levels can indicate more advanced cancer and a worse prognosis in some cases. Patients and their physician may use this information to choose between more or less aggressive treatments.

Monitoring cancer treatment is the most common use of tumor markers. As cancer is reduced, levels often decrease. Stable or increasing levels often indicate that the cancer is not responding to treatment. The choice of tumor marker to use for monitoring is important. Only a marker elevated before treatment should be used to monitor a person during or after treatment. Timing of the tests is also important. Each tumor marker has a unique life span in the blood. To monitor a treatment's success, enough time must have passed for the initial marker to be cleared from the blood. Tests done too soon may be falsely elevated because the marker produced by the untreated cancer is still present.

Watching for cancer recurrence after treatment is another reason for tumor marker testing. Periodic testing can sometimes detect a recurrence often months earlier than could an ultrasound, x ray, or **physical examination**.

Tumor marker tests are performed in a lab using immunological techniques. A sample of blood or other tissue is mixed with a substance containing specific antibodies to each tumor marker. If that tumor marker is present, these very specific antibodies bind to the markers. Some type of label, often a radioactive substance, is then used to measure the amount of bound marker and antibody. From this measurement, the amount of tumor marker is calculated. The results are usually available within a few days.

Conclusions based on tumor marker tests are seldom based on one test result but on a series of test results, called serial measurements. A series of increasing or decreasing values is more significant than a single value.

Tumor marker testing is currently the object of much research and attention. Their use is directed by approval from the Food and Drug Administration (FDA) and guidelines established by organizations such as the American Society of Clinical Oncology and the American Cancer Society. Not all tumor receptor marker tests are widely available nor are they widely accepted.

Oncofetal antigens

There are two common oncofetal antigens, alpha-fetoprotein (AFP) and carcinoembryonic antigen (CEA). Carcinoembryonic antigen CA 72-4 is a more recently discovered oncofetal antigen just coming into usage. The oncofetal antigens are so named because they are normally produced during embryonic development and decrease soon after birth. Cancer cells tend to dedifferentiate, or revert to a more immature tissue and begin to produce fetal antigens again. Oncofetal antigens are very non-specific and expressed by a wide number of cancer types. However, they are used both to monitor a patient's progress and their response to treatment over time.

ALPHA-FETOPROTEIN (AFP). Elevated AFP typically indicates a primary liver tumor or a germ cell tumor of the ovary or testicle. AFP is a glycoprotein produced in high amounts by fetal tissue and is elevated during **pregnancy**. It is most widely used as a marker for hepatocellular carcinoma and **testicular cancer** but is also associated with **ovarian cancer**. Seventy percent of people with **liver cancer** have increased AFP levels. In China, where liver cancer rates are high, AFP is used as a screening test for that disease. AFP levels indicate the extent of cancer, and serial measurements are used to monitor treatment response. Non-cancerous liver conditions such as **cirrhosis** and hepatitis have moderately increased levels of AFP.

CARCINOEMBRYONIC ANTIGEN (CEA). CEA is a glycoprotein most often associated with colorectal cancer, and used to monitor patients with this type of cancer. Its most popular use is in early detection of relapse in individuals already treated for colorectal cancer. After surgery, serial measurements indicate the surgery's success and are used to detect early signs of recurrence. It has recently been found to be useful when measured during surgery for colorectal cancer to help determine prognosis and who will benefit from adjuvant treatment.

CEA is measured in the blood plasma. It is very nonspecific and can be increased in many types of cancer: gastrointestinal, colorectal, ovarian, bladder, cervical, stomach, kidney, lung, pancreatic, liver, prostate, thyroid, melanoma, lymphoma, and breast. People with noncancerous conditions, such as cirrhosis or peptic disease, or inflammatory intestinal conditions such as **colitis** or **diverticulitis**, may also have increased levels. CEA levels can be elevated in elderly patients and in those who smoke.

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CANCER ANTIGEN 72-4 (CA 72-4). The more recently identified carcinoembryonic protein is CA 72-4. Although it is slightly elevated with most carcinomas, it is mostly associated with gastric carcinoma (**stomach cancer**). CA 74-2 is finding a role in the management of patients with gastric carcinoma.

Cancer antigen 15-3 (CA 15-3)

CA 15-3 is produced by cells in the breast and increased levels can be associated with **breast cancer**. Rarely increased in women with early breast cancer, it may be used to detect recurrence of cancer in women following treatment or **mastectomy** and to monitor treatment for women with advanced breast cancer. However, adenocarcinomas of the ovary, lung, colon, and pancreas also express elevated CA 15-3 levels. Non-cancerous conditions sometimes associated with elevated CA 15-3 include benign breast or ovarian disease, **endometriosis**, **pelvic inflammatory disease**, and hepatitis. Pregnancy and **lactation** are also related to high CA 15-3 levels.

Cancer antigen 27-29 (CA 27-29)

CA 27-29, also called breast carcinoma-associated antigen, is used as a marker for breast cancer. Eighty percent of women with breast cancer have an increased CA 27-29 level. This marker may be used with other procedures and tumor marker levels such as CA 15-3 to check for recurrences of cancer in previously treated women. Serial measurements monitor treatment response and identify recurrence.

Levels of CA 27-29 may also be increased in cancers of the colon, stomach, kidney, lung, ovary, pancreas, uterus, and liver. Noncancerous conditions associated with elevated CA 27-29 include first trimester pregnancy, endometriosis, **ovarian cysts**, non-cancerous breast disease, **kidney disease**, and **liver disease**.

HER-2/neu

HER-2/neu is an oncogenic growth factor receptor also known as c-erbB-2. It is measured in the tissue from a biopsy either by immunological assays of the protein or polymerase chain reaction (PCR) to identify the DNA. The presence of HER-2/neu is generally associated with a poorer prognosis for breast cancer. It can also help to determine treatment options, since newer drugs can block this protein and decrease cancer growth. The most widely known of these drugs is trastuzumab (brand name Herceptin).

Estrogen receptor

Measurement of the estrogen receptor (ER) is used specifically to evaluate breast cancers. It gives an indication of prognosis and responsiveness to therapy. Tissue from a biopsy is used to measure the estrogen receptor. Most breast cancers in post-menopausal women are ER-positive, meaning that they require estrogen to grow. These ER positive breast cancers are less aggressive than ER negative breast cancers, which are found generally in pre-menopausal women.

Cancer antigen 125 (CA 125)

Although produced by a number of cell types, CA 125 is primarily produced by ovarian cancer cells. Eighty percent of women with ovarian cancer have increased CA 125 levels. Although the test is not sensitive or specific enough to be used for screening, it contributes to a diagnosis when combined with an ultrasound and pelvic examination. Blood levels of CA 125 are used primarily to monitor the treatment of ovarian cancer. A falling CA 125 level usually indicates that cancer is responding to the treatment. After diagnosis and treatment, serial measurements help detect remaining or recurrent cancer. A negative or normal result, however, does not guarantee the absence of cancer.

Women may have increased CA 125 levels during menstruation and pregnancy. Increased levels are also found in pelvic inflammatory disease, endometriosis, **pancreatitis**, and liver disease. Elevated levels are also associated with non-ovarian cancers including cancers of the uterus, cervix, pancreas, liver, colon, breast, lung, or digestive tract.

Prostate specific antigen (PSA)

Prostate specific antigen (PSA) levels, along with the **digital rectal examination**, are used to screen for **prostate cancer**. PSA is a protein produced by the prostate gland and can be overproduced in prostate cancer. It is perhaps the best tumor marker in use because of its tissue specificity, meaning that it is produced only by the prostate. Men over the age of 50 years are advised to consider annual screening for prostate cancer. Men at high risk for prostate cancer, such as African Americans or those with a family history of the disease, should begin screening at age 40. Once a diagnosis of prostate cancer is made, PSA levels can help determine the stage of the cancer, monitor the response to treatment, and watch for recurrence.

Measurements of PSA following **prostatectomy** are useful in determining the success of surgery. Any PSA level following surgery would indicate residual prostate tissue, possibly from metastasis. PSA levels can also be used to detect a recurrence of prostate cancer. PSA is also increased in benign prostatic

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hyperplasia (BPH), an **enlarged prostate** condition common in older men.

PSA can be found in the serum in two states, bound and free. Measuring both PSA levels can provide more specificity to the test and reduce unnecessary biopsies. The percentage of free PSA is greater in BPH than prostate cancer. If the total PSA level is higher than 4.0 nanogram/milliliter (ng/mL) and the free PSA level is less than 25%, a **prostate biopsy** is indicated.

PSA levels may increase after ejaculation. Men are recommended to abstain from sexual intercourse or masturbation for 48 hours before the test. PSA levels may also increase after prostate manipulation following the digital rectal exam.

Prostatic acid phosphatase (PAP) was originally found to be produced by the prostate and thought to be a marker for prostate cancer. It is now found to be elevated with testicular cancer, leukemia, non-Hodgkin's lymphoma and several noncancerous conditions.

Cancer antigen 19-9 (CA 19-9)

CA 19-9 has been identified in patients with digestive tract or intra-abdominal carcinomas such as colorectal cancer, pancreatic cancer, stomach cancer and **bile duct cancer**. In pancreatic cancer, higher levels are associated with more advanced disease. After diagnosis, levels help predict the success of surgery and monitor the course of the cancer. Not all people with pancreatic cancer have increased CA 19-9 levels. This antigen is related to the Lewis blood group and so only patients positive for the Lewis blood group antigen will test positive for CA 19-9. It is also increased in liver and gastrointestinal cancers and in noncancerous diseases, including pancreatitis, **gallstones** and **jaundice**.

Human chorionic gonadotropin (hCG)

Human chorionic gonadotropin is normally produced by the placenta during pregnancy. There are two protein subunits that make up HCG, beta and alpha. It is the beta subunit that is increased in women's serum during early pregnancy. It is also the beta subunit that is increased in some malignant tumors. Tumors that secrete beta-hCG are typically **germ cell tumors** such as teratocarcinomas. These are tumors found in the ovaries and testes that contain embryonal tissue. Rarely, these types of tumors are found in the pineal region of the brain where beta-hCG can serve as a marker. Levels of hCG rise with **choriocarcinoma** and with trophoblastic disease, a rare cancer that develops from an abnormally fertilized egg. Gestational trophoblastic tumors also secrete AFP and this test is often used in combination.

HCG is most often used to screen for cancer of the testis or ovary. Serial measurements monitor the progress and treatment of these cancers. This marker can be elevated in individuals who use **marijuana**.

Squamous cell carcinoma (SCC) Antigen

Squamous cell carcinoma (SCC) antigen was first identified in **cervical cancer**. It is a marker for squamous cell cancers, which can occur in the cervix, head and neck, lung, and skin. Levels of SCC can be used as an aid to stage the carcinoma and to determine the response to treatment.

Bence-Jones protein

Patients with plasmacytomas such as myeloma overproduce monoclonal immunoglobulins, also called M proteins. The Bence-Jones protein refers to the immunoglobulin light chain, a portion of these immunoglobulins. The Bence-Jones protein is secreted into the urine where it can be measured. It was the first tumor marker identified.

Neuron-specific enolase (NSE)

NSE is a protein found mainly in neurons and neuroendocrine cells. It is elevated in tumors derived from these tissues, including **neuroblastoma** and **small cell lung cancer**. It can give information about the extent of the disease, the patient's prognosis and the patient's response to treatment. NSE can also be elevated in medullary thyroid cancers, carcinoid tumors, pancreatic endocrine tumors, and melanoma.

Hormone assays

Tumors of the endocrine glands oversecrete their corresponding hormones. By measuring particular hormones, clues can be obtained regarding certain cancers. For instance, breast cancer cells may secrete prolactin and estrogen. Medullary carcinoma can secrete calcitonin. Pheochromocytomas secrete catecholamines. Tumors of the pituitary gland may secrete growth hormone or cortisol. Carcinoid tumors secrete serotonin. Some tumors of the pancreas secrete insulin. Serial measurements can also monitor treatment for these tumors.

Enzymes

Several serum enzymes can be measured to help detect metastases in cancer patients. Tumors that metastasize to the liver cause increases in serum alkaline phosphatase, gamma-glutamyltransferase, and transaminases. Although these are not necessarily tumor markers, they indicate liver damage that may be caused by metastatic cancer. Tumors that metastasize to the

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KEY TERMS

AFP (Alpha-fetoprotein)—A tumor marker associated with liver, testicular, and ovarian cancer.

Beta-HCG (Beta-human chorionic gonadotropin)—A tumor marker associated with testicular cancer and tumors, such as choriocarcinoma and molar pregnancies, that begin in placental cells called trophoblasts.

Biopsy—The process of taking a sample of tumor tissue through a needle.

CA 15-3 (Cancer antigen 15-3)—A tumor marker associated with breast cancer.

CA 19-9 (Cancer antigen 19-9)—A tumor marker associated with pancreatic cancer.

CA 27-29 (Breast carcinoma-associated antigen)—A tumor marker associated with breast cancer.

CA 125 (Cancer antigen 125)—A tumor marker associated with ovarian cancer.

CEA (Carcinoembryonic antigen)—A tumor marker associated with many cancers, especially liver, intestinal, and pancreatic.

Prognosis—The predicted outcome of a disease.

PSA (Prostate specific antigen)—A tumor marker associated with prostate cancer.

Sensitivity—A test's ability to detect all cases of a disease.

Serial measurements—A series of measurements looking for an increase or decrease over time.

Specificity—A test's ability to detect only the disease in question.

Tumor markers—Biochemicals produced by tumor cells or by the body in response to tumor cells. Their levels in the blood help evaluate people for certain kinds of cancer.

bone sometimes secrete elevated alkaline phosphatase. Lactate dehydrogenase is an enzyme found throughout the body. Because of this it cannot be used as a marker for cancer. It can, however, be used to monitor the treatment of some types of cancer including germ cell tumors, testicular cancer, Ewing's sarcoma, non-Hodgkins lymphoma and some types of leukemia.

Precautions

There is not a good consensus in the medical community about the value of most tumor markers. Because they lack specificity and accuracy, their use is limited. False positives can cause emotional distress and fear. It is not yet determined if there is a savings of life or money with testing. Currently, much controversy surrounds the issue of mass screening for cancer using tumor markers.

Preparation

Tumor marker tests usually require 5-10 mL of blood. A healthcare worker ties a tourniquet on the patient's upper arm, locates a vein in the inner elbow region, and inserts a needle into that vein. Vacuum action draws the blood through the needle into an attached tube. Collection of the sample takes a few minutes and results are available within a few days.

Some markers, such as those for **bladder cancer**, **multiple myeloma**, and plasmacytomas, are measured in the urine. Typically this requires a 24-hour urine sample, which means that the individual must collect all of his or her urine for 24 hours. This is usually about 1.5 quarts or more. These results are then available within a few days.

Other tumor markers require tissue samples for analysis. These include receptor analysis such as estrogen receptor and Her-2/neu. Tissue samples are obtained by biopsy. This is usually done by inserting a needle through the skin and into the tumor. The area is typically numbed prior to the procedure. These results are also available within two to three days.

Aftercare

Discomfort or bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Warm packs to the puncture site relieve discomfort. There is a rare chance of infection occurring especially after biopsy. Any sign of infections should be watched for such as **pain** and redness.

Normal results

- AFP: 99% of (nonpregnant) people have less than 15 ng/mL; 95% have less than 6 ng/mL. Serum AFP levels higher than 400 micrograms/L are associated with cancer or some other pathology.

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- Beta-HCG: in males, less than 2.5 IU/L; in females, less than 5.0 IU/L; in postmenopausal females, less than 9.0 IU/L.
- CA 15-3: less than 40 U/mL.
- CA 19-9: less than 40 U/mL.
- CA 27.29: less than or equal to 38 U/mL.
- CA 125: less than 35 U/L.
- CEA: less than or equal to 5 ng/mL.
- PSA: less than 4 ng/mL; PSA levels increase with age. Age-specific values range from 2.0 micrograms/L at age 40 to 7.2 micrograms/L at age 80. Typically, levels below 4.0 micrograms/L rule out prostate cancer.

Abnormal results

The meaning of an increased tumor marker level depends on the specific marker, the person's medical history, and why the test was done. Knowledge of the patient's history and additional tests and physical examinations are needed to correctly interpret tumor marker test results.

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ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (800) 227-2345, http://www.cancer.org.

American Society of Clinical Oncology, 2318 Mill Road, Suite 800, Alexandria, VA, 22314, (571) 483-1300, (888) 282-2552, membermail@asco.org, http://www.asco.org.

National Cancer Institute (National Institutes of Health), NCI Office of Communications and Education, 6116 Executive Blvd. Suite 300, Bethesda, MD, 20892-8322, (800) 4-CANCER (422-6237), cancergovstaff@mail.nih.gov, http://www.cancer.gov/.

Nancy J. Nordenson

Tumor removal

Definition

A tumor is an abnormal growth in the body that is caused by the uncontrolled division of cells. Benign tumors do not have the potential to spread to other parts of the body (a process called metastasis) and are curable by surgical removal. Malignant or cancerous tumors, however, may metastasize to other parts of the body and will ultimately result in **death** if not successfully treated by surgery and/or other methods.

Purpose

Surgical removal is one of four main ways that tumors are treated; the other treatment options include **chemotherapy**, **radiation therapy**, and biological therapy. There are a number of factors used to determine which methods will best treat a tumor. Because benign tumors do not have the potential to metastasize, they are often treated successfully with surgical removal alone. Malignant tumors, however, are most often treated with a combination of surgery and chemotherapy and/or radiation therapy (in about 55% of cases). In some instances, non-curative surgery may make other treatments more effective. Debulking a cancer—making it smaller by surgical removal of a large part of it—is thought to make radiation and chemotherapy more effective.

Surgery is often used to accurately assess the nature and extent of a **cancer**. Most cancers cannot be adequately identified without examining a sample of the abnormal tissue under a microscope. Such tissue samples are procured during a surgical procedure. Surgery may also be used to determine exactly how far a tumor has spread.

There are a few standard methods of comparing one cancer to another for the purposes of determining

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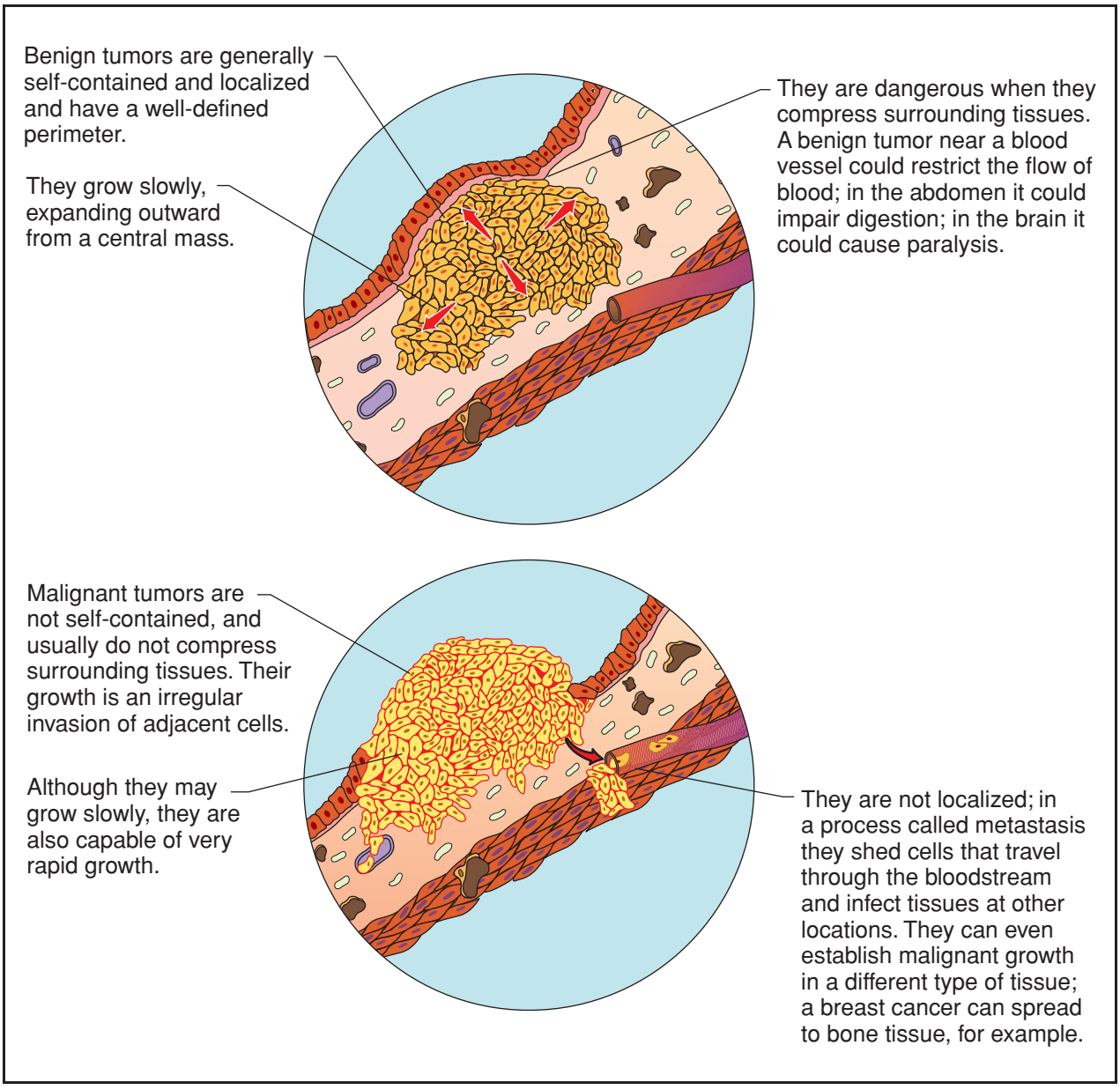

A comparison of benign (top of illustration) and malignant tumor characteristics. *(Illustration by Hans & Cassady, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

appropriate treatments and estimating outcomes. These methods are referred to as staging. The most commonly used method is the TNM system, including:

- "T" stands for tumor, and reflects the size of the tumor.
- "N" represents the spread of the cancer to lymph nodes, largely determined by those nodes removed at surgery that contain cancer cells. Since cancers spread mostly through the lymphatic system, this is a useful measure of a cancer's ability to disperse.
- "M" refers to metastasis, and indicates if metastases are present and how far they are from the original cancer.

Staging is particularly important with such lymphomas as Hodgkin's disease, which may appear in many places in the lymphatic system. Surgery is a useful tool for staging such cancers and can increase the chance of a successful cure, since radiation treatment is often curative if all the cancerous sites are located and irradiated.

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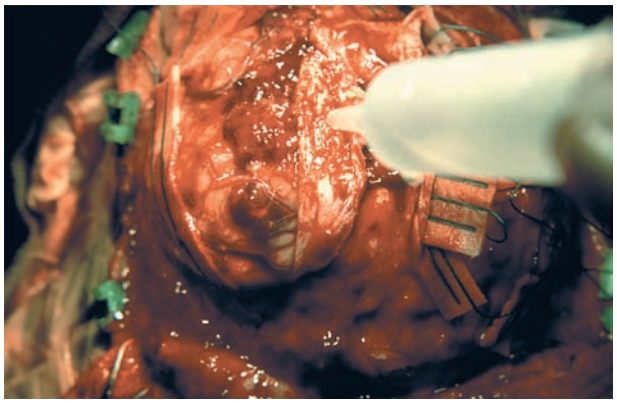

A tumor inside the brain is being removed. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

KEY TERMS

Aspiration—A technique for obtaining a piece of tissue for biopsy by using suction applied through a needle attached to a syringe.

Biopsy—The removal of living tissue from the body, done in order to establish a diagnosis.

Debulking—Surgical removal of a major portion of a tumor so that there is less of the cancer left for later treatment by chemotherapy or radiation.

Mammogram—A set of x rays taken of the front and side of the breast; used to diagnose various abnormalities of the breast.

Metastasis (plural, metastases)—A growth of cancer cells at a site in the body distant from the primary tumor.

Oncologist—A physician who specializes in the diagnosis and treatment of tumors.

Palliative—Offering relief of symptoms, but not a cure.

Pap test—The common term for the Papanicolaou test, a simple smear method of examining stained cells to detect cancer of the cervix.

Staging—The classification of cancerous tumors according to the extent of the tumor.

Demographics

The American Cancer Society estimates that approximately 1.45 million cases of cancer are diagnosed in the United States each year. Seventy-eight percent of cancers are diagnosed in men and women over the age of 55, although cancer may affect individuals of any age. Men develop cancer more often than women; one in two men will be diagnosed with cancer during his lifetime, compared to one in three women. Cancer affects individuals of all races and ethnicities, although incidence may differ among these groups by cancer type.

Description

Surgery may be used to remove tumors for diagnostic or therapeutic purposes.

Diagnostic tumor removal

A biopsy is a medical procedure that obtains a small piece of tissue for diagnostic testing. The sample is examined under a microscope by a doctor who specializes in the effects of disease on body tissues (a pathologist) to detect any abnormalities. A definitive diagnosis of cancer cannot be made unless a sample of the abnormal tissue is examined histologically (under a microscope).

There are four main biopsy techniques used to diagnose cancer, including:

- Aspiration biopsy. A needle is inserted into the tumor and a sample is withdrawn. This procedure may be performed under local anesthesia or with no anesthesia at all.
- Needle biopsy. A special cutting needle is inserted into the core of the tumor and a core sample is cut out. Local anesthesia is most often administered.
- Incisional biopsy. A portion of a large tumor is removed, usually under local anesthesia in an outpatient setting.
- Excisional biopsy. An entire cancerous lesion is removed along with surrounding normal tissue (called a clear margin). Local or general anesthesia may be used.

Therapeutic tumor removal

Once surgical removal has been decided, a surgical oncologist will remove the entire tumor, taking with it a large section of the surrounding normal tissue. The healthy tissue is removed to minimize the risk that abnormal tissue is left behind. Tumors may be removed by cutting with steel instruments, by the use of a laser beam, by radiofrequency ablation (the use of radiofrequency energy to destroy tissue), by cryoablation (the use of extreme cold to freeze and thus destroy the tumor), or by injecting alcohol into the tumor.

When surgical removal of a tumor is unacceptable as a sole treatment, a portion of the tumor is removed

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MOSES JUDAH FOLKMAN (1933–2008)

(AP Images.)

Moses Judah Folkman was born in Cleveland, Ohio, on February 24, 1933. He was one of three children born to Bessie and Jerome Folkman. Because Folkman's father, a rabbi, would take his children with him when he visited sick individuals in the hospital, his son Judah dreamed of becoming a surgeon. Young Folkman requested a microscope for his bar mitzvah present and upon receiving it, set up a laboratory in his parents basement.

Folkman entered Ohio State University as a pre-med student, graduating in 1953 after only three years of study. He then went on to Harvard Medical School, where he helped create one of the first pacemakers ever produced and he received his medical degree in 1957. Folkman completed his internship and residency at Massachusetts General Hospital in Boston. In 1960, he married Paula Prial and the couple moved to Bethesda, Maryland where Folkman worked as a lieutenant in the U.S. Navy at the National Naval Medical Center. It was here, with the help of his colleague, Fredrich Becker, that Folkman would make his initial discovery dealing with angiogenesis. Folkman found that a tumor would only grow if it had blood supplied to it. Additionally, the tumor would promote the growth of new blood vessels.

Folkman also held positions as a professor and surgeon for many years, including professor of Cell Biology at Harvard Medical School, but in 1981, he retired and became director of the Children's Hospital Surgical Research Laboratories in Boston. He died in 2008. Folkman's research opened new doorways that may allow scientists to ultimately find a cure for cancer.

to debulk the mass; this process is called cytoreduction. Cytoreductive surgery aids radiation and chemotherapy treatments by increasing the sensitivity of the tumor and decreasing the number of necessary treatment cycles.

Certain types of skin tumors can be removed by a technique called Mohs micrographic surgery, developed in the late 1930s by Dr. Frederick E. Mohs. The Mohs method involves four steps: surgical removal of the tumor; making a slide of the removed tissue and examining it for cancer cells (called mapping the tissue); interpreting the microscope slides and removing more tissue if necessary until no more cancer cells are found; and performing **reconstructive surgery** to cover the wound.

A newer technique for removing some tumors of the spinal cord involves the use of a suction tip rather than a scalpel. The newer technique appears to have a wider margin of safety when working around the delicate structures of the central nervous system.

In some instances, the purpose of tumor removal is not to cure the cancer, but to relieve the symptoms of a patient who cannot be cured. This approach is called palliative surgery. For example, a patient with advanced cancer may have a tumor causing significant **pain** or bleeding; in such a case, the tumor may be removed to ease the patient's pain or other symptoms even though a cure is not possible.

Seeding

The surgical removal of malignant tumors demands special considerations. There is a danger of spreading cancerous cells during the process of removing abnormal tissue (called seeding). Presuming that cancer cells can implant elsewhere in the body, the surgeon must minimize the dissemination of cells throughout the operating field or into the bloodstream.

Special techniques called block resection and no-touch are used. Block resection involves taking the entire specimen out as a single piece. The no-touch technique involves removing a specimen by handling only the normal tissue surrounding it; the cancer itself is never touched. These approaches prevent the spread of cancer cells into the general circulation. The surgeon takes great care to clamp off the blood supply first, preventing cells from leaving by that route later in the surgery.

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Diagnosis/Preparation

A tumor may first be palpated (felt) by the patient or by a healthcare professional during a **physical examination**. A tumor may be visible on the skin or protrude outward from the body. Still other tumors are not evident until their presence begins to cause such symptoms as weight loss, **fatigue**, or pain. In some instances, tumors are located during routine tests (e.g., a yearly mammogram or Pap smear).

Aftercare

Retesting and periodical examinations are necessary to ensure that a tumor has not returned or metastasized after total removal.

Risks

Each tumor removal surgery carries certain risks that are inherent to the procedure. There is always a risk of misdiagnosing a cancer if an inadequate sample was procured during biopsy, or if the tumor was not properly located. There is a chance of infection of the surgical site, excessive bleeding, or injury to adjacent tissues. The possibility of metastasis and seeding are risks that have to be considered in consultation with an oncologist.

Normal results

The results of a tumor removal procedure depend on the type of tumor and the purpose of the treatment. Most benign tumors can be removed successfully with no risk of the abnormal cells spreading to other parts of the body and little risk of the tumor returning. Malignant tumors are considered successfully removed if the entire tumor can be removed, if a clear margin of healthy tissue is removed with the tumor, and if there is no evidence of metastasis. The normal results of palliative tumor removal are a reduction in the patient's symptoms with no impact on length of survival.

Morbidity and mortality rates

The recurrence rates of benign and malignant tumors after removal depend on the type of tumor and its location. The rate of complications associated with tumor removal surgery differs by procedure, but is generally very low.

Alternatives

If a benign tumor shows no indication of harming nearby tissues and is not causing the patient any symptoms, surgery may not be required to remove it. Chemotherapy, radiation therapy, and biological therapy are treatments that may be used alone or in conjunction with surgery.

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American Cancer Society, 1599 Clifton Road NE, Atlanta, GA, 30329-4251, (800) 227-2345, http://www.cancer.org.

American College of Surgeons, 633 North Saint Claire Street, Chicago, IL, 60611, (312) 202-5000, 800-621-4111, 312-202-5001, postmaster@facs.org, http://www.facs.org.

National Cancer Institute, NCI Public Inquiries Office, 6116 Executive Boulevard, Bethesda, MD, 20892-8322, (800) 422-6237, http://www.cancer.gov.

Society of Surgical Oncology, 85 West Algonquin Road, Suite 550, Arlington Heights, IL, 60005, (847) 427-1400, http://www.surgonc.org.

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Turner syndrome

Definition

Turner syndrome is a chromosomal disorder affecting females wherein one of the two X-chromosomes is defective or completely absent.

Demographics

The prevalence of Turner syndrome is widely reported as being approximately one per 2,000 live female births, with little difference among racial or ethnic groups. About 15% of spontaneous abortions of female fetuses have this genetic abnormality. The incidence of Turner syndrome seems to be slightly higher in fetuses conceived by older women.

Description

Chromosomes are structures in the nucleus of every cell in the human body. Chromosomes contain the genetic information necessary to direct the growth and normal functioning of all cells and systems of the body. A normal individual has a total of 46 chromosomes in each cell, two of which are responsible for determining gender. Normally, females have two X-chromosomes (one from each parent) and males have one X and one Y-chromosome.

A low hairline at the back of the neck is one of several characteristics of Turner syndrome. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

In Turner syndrome, an error occurring very early in development results in an abnormal number and arrangement of chromosomes. Most commonly, an individual with Turner syndrome will be born with 45 chromosomes in each cell rather than 46. The missing chromosome is an X-chromosome. The affected person is always female.

About 1–2% of all female conceptions have a missing X-chromosome. Of these, the majority (99%) spontaneously abort, usually during the first trimester of **pregnancy**. With ultrasound being used more frequently, researchers have realized that some pregnancies with a missing X-chromosome that progress into the second trimester are associated with nuchal cysts, severe **lymphedema**, or hydrops fetalis. These pregnancies are associated with a high frequency of fetal **death**.

Causes and symptoms

Turner syndrome is a disorder associated with characteristic defects in the X-chromosome. The most common presentation is a female with a single X-chromosome and an absent X-chromosome. A Greek study from 1999 reported that the intact X-chromosome was as likely to come from the mother as from the father. This means that there is no parental pattern of responsibility for the missing or defective X-chromosome.

Another less common genetic pattern for Turner Syndrome (35%) is a mosaic. A Danish study reported that mosaicism has an effect on malformations that are associated with Turner syndrome. Researchers have found that XX/XO mosaic individual have a different growth pattern from children who are completely XO.

The exact location of the genes on the X-chromosome involved in Turner syndrome has not been determined as of 2010. Evidence exists that there is a locus for stature on the distal portion of the short arm of the X chromosome; there are loci for normal ovarian function on both the short and long arms; and there are loci contributing to fetal viability on the long arm of X.

Turner syndrome is characterized by retarded growth that leads to a small stature and frequent **infertility**. Individuals with Turner syndrome report an increased incidence of **fractures** in childhood and osteoporotic fractures in adulthood. The incidence of **diabetes mellitus** (both insulin dependent [type 1] and non-insulin dependent [type 2] varieties) has been reported increased in Turner syndrome. Ischemic heart disease, **stroke**, and **hypertension** are also more common.

Growth in children with Turner syndrome is characterized by a slight **intrauterine growth retardation**, relatively normal growth rates for the first several years

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KEY TERMS

Aortic dissection—A tear in the aorta (the main blood vessel carrying blood away from the heart) that allows blood to flow between layers of the aorta, eventually causing it to fail.

Chromosome—A microscopic thread-like structure found within each cell of the body that consists of a complex of proteins and DNA. Humans have 46 chromosomes arranged into 23 pairs. Changes in either the total number of chromosomes or their shape and size (structure) may lead to physical or mental abnormalities.

Diabetes mellitus—A disease in which insufficient insulin is made by the body to metabolize sugars.

Hydrops fetalis—Extreme edema of the fetus.

Mosaic—A term referring to a genetic situation in which an individual's cells do not have the exact same composition of chromosomes. In mosaic Turner syndrome, some cells are normal and have two X chromosomes (XX), while others are abnormal and have only one X chromosome (XO).

Nuchal cysts—Small cysts in the fetus's neck that present in 1% of pregnancies.

of life, a progressive deceleration of growth later in childhood, and the lack of a pubertal growth spurt.

Most individuals with Turner syndrome are not mentally retarded. They may have some learning disabilities, particularly with regard to spatial perception, visual-motor coordination, and mathematics. As a result, the nonverbal IQ in Turner syndrome tends to be lower than the verbal IQ.

Cardiovascular malformations are well-recognized congenital anomalies in Turner syndrome. Dilation and dissection of the aorta are reported in approximately half of women with Turner syndrome. heart valve abnormalities also are common. Because of the potential consequences of aortic dilation, some experts recommend screening all individuals with Turner syndrome.

Normal pubertal development and spontaneous menstrual periods do not occur in the majority of children with Turner syndrome. It is estimated that 3–8% of girls with a single X-chromosome and 12–21% of females with sex chromosome mosaicism may have normal pubertal development and spontaneous menstrual periods. A few pregnancies have been reported in women with Turner syndrome.

Diagnosis

Turner syndrome is diagnosed on the basis of genetic analysis of chromosomes. This can be done prior to birth or after birth.

Treatment

Traditional

Because it is so dangerous, experts suggest screening for **aortic dissection**, although the specific timing for this screening is controversial. **Plastic surgery** to correct webbing of the neck should be considered at an early age (before entering school) for girls with Turner syndrome.

Drugs

Most individuals with Turner syndrome require female hormone therapy to promote development of secondary sexual characteristics and menstruation. The time of beginning therapy varies with individuals. Experts recommend that therapy begin when a woman expresses concern about her onset of **puberty**.

All women receiving long-term, exogenous female hormone therapy require periodic gynecological examinations, because those with Turner syndrome have an increased risk of developing neoplasms such as gonadoblastoma and dysgerminoma, which arise from their rudimentary streak gonads.

Prognosis

Most women with Turner syndrome can live relatively normal lives. The prognosis for a person with Turner syndrome is dependent on other conditions that may be present. Care must be taken to regularly monitor the health problems that are associated with Turner syndrome. For example, heart or kidney defects, **hearing loss**, or the development of inflammatory bowel disease may significantly affect the quality of life. Without these types of conditions, however, their life expectancy is close to normal. Support will be necessary to help an adolescent girl cope with body image issues and to help some women accept the fact that they will never be able to have children.

Prevention

Turner syndrome is a genetic disorder that cannot be prevented. Prenatal testing may give parents information about whether their child has Turner syndrome and prepare them to make decisions about the child's future.

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Turner Syndrome Support Society(UK). http://www.tss.org.uk/.
University of Kansas Medical Center. http://www.kumc.edu/gec/support/turner.html.

ORGANIZATIONS

American Academy of Pediatrics (AAP), 141 Northwest Point Boulevard, Elk Grove Village, IL, 60007-1098, (847) 434-4000, (847) 424-8000, kidsdocs@aap.org, http://www.aap.org.
The Endocrine Society, 8401 Connecticut Ave., Suite 900, Chevy Chase, MD, 20815, (301) 641-0200, (301) 941-0259, (888) 363-6274, http://www.endo-society.org/.
The Human Growth Foundation, 997 Glen Cove Ave., Suite 5, Glen Head, NY, 11545, (516) 671-4055, (800) 451-6434, http://www.hgfound.org/.
Turner Syndrome Society of England, 13 Simpson Court, 11 South Ave, Clydebank Business Park, Clydebank, Scotland, G81 2NR, http://www.tss.org.uk.
Turner Syndrome Society of Canada, 323 Chapel Street, Ottawa, CanadaON, K1N 7Z2, (613) 321-2267, (613) 321-2268, (800) 465-6744, info@turnersyndrome.ca, http://www.turnersyndrome.ca.
National Newborn Status Screening and Genetics Resource Center, 1912 W. Anderson Lane, Suite 210, Austin, TX, 78757, (512) 454-6419, (512) 454-6509 , http://genes-r-us.uthscsa.edu.
National Society of Genetic Counselors, 401 N. Michigan Avenue, Chicago, IL, 60611, (312) 321-6834, (312) 673-6972, nsgc@nsgc.org, http://www.nsgc.org.
Turner Syndrome Society of the United States, 11250 West Rd. Suite G, Houston, TX, (832) 912-6006, (800) 365-9944, (832) 912-6446, tssusadmin1@gmail.com, http://www.turnersyndrome.org.

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Twins *see* **Multiple pregnancy**

2,3-diphosphoglycerate test

Definition

2,3-diphosphoglycerate (2,3-DPG) is a substance made in the red blood cells. It controls the movement of oxygen from red blood cells to body tissues. 2,3-DPG testing is done to help investigate both a deficiency in red blood cells (anemia) and an unexplained increase of red blood cells, called erythrocytosis.

Purpose

Hemoglobin, the protein in the blood that carries oxygen, uses 2,3-DPG to control how much oxygen is released once the blood gets out into the tissues. The more 2,3-DPG in the cell, the more oxygen is delivered to body tissues. Conversely, the less 2,3-DPG in the cell, the less oxygen is delivered.

Increasing the amount of 2,3-DPG is the body's primary way of responding to a lack of oxygen. Anemia, obstructive lung disease, **cystic fibrosis**, and **congenital heart disease** are all accompanied by increases in 2,3-DPG. When more oxygen is required because of increased metabolism, such as in **hyperthyroidism**, more 2,3-DPG is produced.

Decreased 2,3-DPG results from an inherited lack of the red blood cell enzymes 2,3-DPG mutase and 2,3-DPG phosphatase. These enzymes are needed to make 2,3-DPG. Without 2,3-DPG to control the movement of oxygen to its tissues, the body responds by making more red blood cells, a condition called erythrocytosis. The outside membrane of the cell is weakened, causing it to have an irregular shape and burst, or hemolyze, easily. This condition is called nonspherocytic **hemolytic anemia**.

2,3-DPG levels are important in large blood transfusions, because stored blood quickly loses 2,3-DPG and its ability to deliver oxygen. After **transfusion**, the red cells rebuild the 2,3-DPG, but it takes about 24 hours to regain a normal level of 2,3-DPG and hemoglobin function.

Description

In the laboratory, a person's serum is mixed with a substance that will react with 2,3-DPG. The end product of this reaction is measured; and from that measurement, the amount of 2,3-DPG in the person's serum is determined. Results are usually available the next day.

Preparation

This test requires drawing 5-10 mL of blood. The patient should not **exercise** before having the blood drawn. Exercise increases the body's need for oxygen and could cause a temporary increase in levels of 2,3-DPG.

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KEY TERMS

Anemia—A reduction in the number of erythrocytes or red blood cells. Erythrocytes are necessary to form hemoglobin for transporting oxygen.

Erythrocytosis—Increased production of red blood cells.

Hemoglobin—A protein within the red blood cell that carries oxygen.

Nonspherocytic hemolytic anemia—Anemia caused by variably shaped red blood cells that burst, or hemolyze, easily.

Aftercare

Discomfort or bruising may occur at the puncture site, or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops will reduce bruising. Warm packs to the puncture site will relieve discomfort.

Normal results

Normal results will vary based on the laboratory and testing methods used.

Abnormal results

Decreased levels of 2,3-DPG are found in cases of erythrocytosis and nonspherocytic hemolytic anemia caused by 2,3-DPG mutase and 2,3-DPG phosphatase deficiencies. Lower levels are also commonly found after large blood transfusions.

Increased levels of 2,3-DPG are found in conditions in which the body needs more oxygen, such as anemia, obstructive lung disease, cystic fibrosis, congenital heart disease, and hyperthyroidism. High altitudes and participating in exercise sessions before the test can also give false high values.

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Nancy J. Nordenson

2,3-DPG *see* **2,3-diphosphoglycerate test**

Tylenol *see* **Acetaminophen**

Tympanic membrane perforation *see* **Perforated eardrum**

Tympanometry *see* **Audiometry**

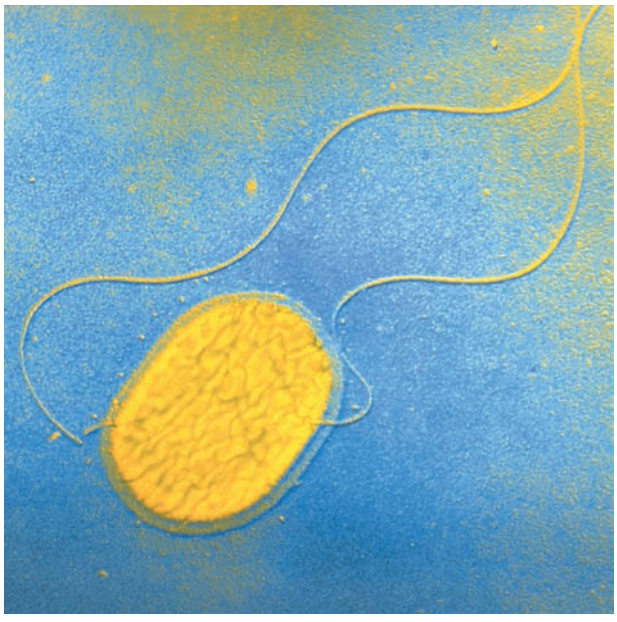
Typhoid fever

Definition

Typhoid **fever** is a severe infection caused by a bacterium, *Salmonella typhi*. *S. typhi* is in the same family of bacteria as the type spread by chicken and eggs, commonly known as salmonella **poisoning** or **food poisoning**. Unlike the bacteria that cause food poisoning, *S. typhi* bacteria do not have **vomiting** and **diarrhea** as the most prominent symptoms of their presence in humans. Instead, persistently high fever is the hallmark of *S. typhi* infection.

Demographics

Typhoid fever is rare in industrialized countries with good sewage treatment and clean water supplies. In the United States in 2006, there were 314 reported cases. Of these, about 80% occurred in individuals who had traveled outside the United States to areas where typhoid fever is common. Those areas include Asia, Africa, Latin America, the Caribbean, and



Transmission electron microscopy (TEM) scan of *Salmonella typhi*, the bacteria that causes typhoid fever in humans. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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MARY MALLON (1869–1938)

(© Bettman/Corbis.)

Mary Mallon was born in Cookstown, Ireland, on September 23, 1869, to Catherine Igo and John Mallon. As a teenager, Mallon left her parents and immigrated to New York to live with an aunt and uncle. Until 1906, when George A. Soper began to study an outbreak of typhoid fever in Long Island, little was known about Mallon.

Soper was called to identify possible causes of an eruption of typhoid fever at a summer house in Oyster Bay. After examining the food and water in a futile attempt to discover contaminants, Soper decided that the disease was probably transmitted by a human carrier. He soon learned that the cook had disappeared and tracked Mallon to her new place of employment, expecting her cooperation in dealing with the matter. Soper eventually turned the case over to the New York City Department of Health. When Mallon was ultimately caught, she refused treatment and was held for three years as a threat to the public. In 1910, a judge granted her release with the stipulation that she not seek employment as a cook, since the disease was transmitted through food. Mallon agreed but, in 1915, an outbreak of typhoid at a hospital was, once again, linked to her. When Soper investigated this incident he learned that employees had nicknamed one of the cooks "Typhoid Mary."

After Mallon was found, she was taken into custody, and spent the rest of her life at Riverside Hospital. Mallon died on November 11, 1938.

Oceania. Although typhoid fever can be found in all those areas, 80% of cases worldwide are found in Bangladesh, China, India, Indonesia, Laos, Nepal, Pakistan, and Vietnam. As of 2009, about 21.4 million people developed typhoid fever each year and 200,000 people died of the disease annually.

Description

Typhoid fever is passed from person to person through poor hygiene, such as incomplete or no hand washing after using the toilet. This allows *S. typhi* to enter the food and water supply. The bacteria are ingested and then passed into the stool and urine of infected patients. They may continue to be present in the stool of asymptomatic carriers—persons who have recovered from the symptoms of the disease but continue to carry the bacteria. This carrier state occurs in about 3% of all individuals who have recovered from typhoid fever. Persons who are carriers of the disease and who handle food can be the source of epidemic spread of typhoid. One such individual gave her name to the expression "Typhoid Mary," a name given to someone whom others avoid.

Causes and symptoms

S. typhi must be ingested to cause disease. Transmission often occurs when a person in the carrier state does not wash hands thoroughly (or not at all) after defecation and serves food to others. This pathway is sometimes called the fecal-oral route of disease transmission. In countries where open sewage is accessible to flies, the insects land on the sewage, pick up the bacteria, and then contaminate food to be eaten by humans. In countries with poor sewage treatment facilities, sewage can contaminate the water supply and typhoid fever can spread by drinking contaminated water.

After being swallowed, the *S. typhi* bacteria enter the digestive tract where they are taken in by cells called mononuclear phagocytes. These phagocytes are cells of the immune system, whose job it is to engulf and kill invading bacteria and viruses. In the case of *S. typhi*, however, the bacteria are able to survive ingestion by the phagocytes, and multiply within these cells. This period of time, during which the bacteria are multiplying within the phagocytes, is the 10- to 14-day incubation period of typhoid fever. When huge numbers of bacteria fill an individual phagocyte, they spill out of the cell and into the bloodstream, where their presence begins to cause symptoms.

The presence of increasingly large numbers of bacteria in the bloodstream (**bacteremia**) is responsible for an increasingly high fever, which lasts throughout the four to eight weeks of the disease in untreated

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KEY TERMS

Asymptomatic—A state in which a person experiences no symptoms of a disease.

Bacteremia—Bacteria in the blood.

Carrier—A person who has a particular disease agent present within his or her body, and can pass this agent on to others, but who displays no symptoms of infection.

Epidemic—A large number of cases of the same disease or infection all occurring within a short time period in a specific location.

Incubation period—The time between when an individual becomes infected with a disease-causing agent and when symptoms begin to appear.

Mononuclear phagocyte—A type of cell of the human immune system that ingests bacteria, viruses, and other foreign matter, thus removing potentially harmful substances from the bloodstream. These substances are usually then digested within the phagocyte.

Rose spots—A pinkish rash across the trunk or abdomen that is a classic sign of typhoid fever.

Sickle cell disease—An inherited disorder characterized by a genetic flaw in hemoglobin production. (Hemoglobin is the substance within red blood cells that enables them to transport oxygen.) The hemoglobin that is produced has a kink in its structure that forces the red blood cells to take on a sickle shape, inhibiting their circulation and causing pain. This disorder primarily affects people of African descent.

individuals. Other symptoms of typhoid fever include **constipation** (at first), **nausea**, extreme **fatigue**, **headache**, joint **pain**, and a rash across the abdomen known as rose spots.

The bacteria move from the bloodstream into certain tissues of the body, including the gallbladder and lymph tissue of the intestine (called Peyer's patches). The tissue's response to this invasion causes symptoms ranging from inflammation of the gallbladder (**cholecystitis**) to intestinal bleeding to actual perforation of the intestine. Perforation of the intestine refers to an actual hole occurring in the wall of the intestine, with leakage of intestinal contents into the abdominal cavity. This leakage causes severe irritation and inflammation of the lining of the abdominal cavity, which is called **peritonitis**. Peritonitis is a frequent cause of **death** from typhoid fever.

Other complications of typhoid fever include liver and spleen enlargement, sometimes so great that the spleen ruptures or bursts; anemia, or low red blood cell count due to blood loss from the intestinal bleeding; joint infections, which are especially common in patients with **sickle cell disease** and immune system disorders; **pneumonia** caused by a bacterial infection (usually *Streptococcus pneumoniae*), which is able to take hold due to the patient's weakened state; heart infections; and **meningitis** and infections of the brain, which cause mental confusion and even **coma**. It may take a patient several months to recover fully from untreated typhoid fever.

Diagnosis

In some cases, the doctor may suspect the diagnosis if the patient has already developed the characteristic rose spots, or if he or she has a history of recent travel in areas with poor sanitation. The diagnosis is confirmed by a **blood culture**. Samples of a patient's stool, urine, and bone marrow can also be used to grow *S. typhi* in a laboratory for identification under a microscope. Cultures are the most accurate method of diagnosis. Blood cultures usually become positive in the first week of illness in 80% of patients who have not taken **antibiotics**.

Treatment

Drugs

Antibiotics are the treatment of choice for typhoid fever. As of the late 2000s, commonly used drugs are ceftriaxone and cefoperazone. Ciprofloxacin is sometimes given as follow-up therapy. It should be noted, that antibiotic resistance is common in *S. typhi*. Forty-three percent of samples of *S. typhi* collected from patients in the United States were resistant to at least one antibiotic. The choice of antibiotic(s) used to treat typhoid fever is determined by the origin of the disease, sensitivity of cultures of the bacterium to specific antibiotics, and response to treatment.

Carriers of *S. typhi* must be treated even when they do not show any symptoms of the infection, because carriers are responsible for the majority of new cases of typhoid fever. Eliminating the carrier state is a fairly difficult task. It requires treatment with one or even two different medications over a period of four to six weeks. The antibiotics most commonly given are ampicillin (sometimes given together with probenecid) and amoxicillin. In the case of a carrier with **gallstones**, surgery

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may need to be performed to remove the gallbladder. This measure is necessary because typhoid bacteria are often housed in the gallbladder, where they may survive in spite of antibiotic treatment. In some patients, treatment with rifampin and trimethoprim-sulfamethoxazole is sufficient to eradicate the bacteria from the gallbladder without surgery.

Prognosis

The prognosis for recovery is good for most patients. In the era before effective antibiotics were discovered, about 12% of all typhoid fever patients died of the infection. Now, fewer than 1% of patients who receive prompt antibiotic treatment will die. The mortality rate is highest in the very young and very old, and in patients with **malnutrition**. The most ominous signs are changes in a patient's state of consciousness, including stupor or coma.

Prevention

Hygienic sewage disposal systems in a community, good water treatment facilities, and proper personal hygiene are the most important factors in preventing typhoid fever. Immunizations are available for travelers who expect to visit countries where *S. typhi* is a known public health problem. Some of these immunizations provide only short-term protection (for a few months), while others may be effective for several years. Efforts are being made to develop vaccines that provide a longer period of protection with fewer side effects from the vaccine itself. The most commonly reported side effects are flu-like **muscle cramps** and abdominal pain.

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ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (404) 639-3534, (800) CDC-INFO (800-232-4636). TTY: (888) 232-6348, inquiry@cdc.gov, http://www.cdc.gov.

National Institute of Allergy and Infectious Diseases Office of Communications and Government Relations, 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-6612, (301) 496-5717, (866) 284-4107 or TDD: (800)877-8339 (for hearing impaired), (301) 402-3573, http://www3.niaid.nih.gov.

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Typhus

Definition

Several different illnesses are called "typhus," all of them caused by one of the bacteria in the family Rickettsiae. Each illness occurs when the bacteria is passed to a human through contact with an infected insect.

Description

The four main types of typhus are:

- epidemic typhus
- Brill-Zinsser disease
- endemic or murine typhus
- scrub typhus

These diseases are all somewhat similar, although they vary in terms of severity. The specific type of *Rickettsia* that causes the disease also varies, as does the specific insect that can pass the bacteria along.

Epidemic typhus, which is sometimes called jail **fever** or louse-borne typhus, is caused by *Rickettsia prowazekii*, which is carried by body lice. When the lice feed on a human, they may simultaneously defecate. When the person scratches the bite, the feces (which carrys the bacteria) are scratched into the wound. Body lice are common in areas in which people live in overcrowded, dirty conditions, with few opportunities to wash themselves or their clothing. Because of this fact, this form of typhus occurs simultaneously in large numbers of individuals living within the same community; that is, in epidemics. This type of typhus

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occurs when cold weather, poverty, war, and other disasters result in close living conditions that encourage the maintenance of a population of lice living among humans. Some medical historians think that the Great **Plague** of Athens in 430 B.C. may have been epidemic typhus. Epidemic typhus is now found in the mountainous regions of Africa, South America, and Asia.

Brill-Zinsser disease is a reactivation of an earlier infection with epidemic typhus. It affects people years after they have completely recovered from epidemic typhus. When something causes a weakening of their immune system (like **aging**, surgery, illness), the bacteria can gain hold again, causing illness. This illness tends to be extremely mild.

Endemic typhus is carried by fleas. When a flea lands on a human, it may defecate as it feeds. When the person scratches the itchy spot where the flea was feeding, the bacteria-laden feces are scratched into the skin, thus causing infection. The causative bacteria is called *Rickettsia typhi*. Endemic typhus occurs most commonly in warm, coastal regions. In the United States, southern Texas and southern California have the largest number of cases.

Scrub typhus is caused by *Rickettsia tsutsugamushi*. This bacteria is carried by mites or chiggers. As the mites feed on humans, they deposit the bacteria. Scrub typhus occurs commonly in the southwest Pacific, southeast Asia, and Japan. It is a very common cause of illness in people living in or visiting these areas. It occurs more commonly during the wet season.

KEY TERMS

Antibody—Specialized cells of the immune system, which can recognize organisms that invade the body (such as bacteria, viruses, and fungi). The antibodies are then able to set off a complex chain of events designed to kill these foreign invaders.

Bioterrorism—The use of disease microorganisms to intimidate or terrorize a civilian population.

Endemic—Occurring naturally and consistently in a particular area.

Epidemic—A large cluster of cases all occurring at about the same time within a specific community or region.

Causes and symptoms

The four types of typhus cause similar types of illnesses, though varying in severity.

Epidemic typhus causes fever, **headache**, weakness, and muscle aches. It also causes a rash composed of both spots and bumps. The rash starts on the back, chest, and abdomen, then spreads to the arms and legs. The worst types of complications involve swelling in the heart muscle or brain (**encephalitis**). Without treatment, this type of typhus can be fatal.

Brill-Zinsser disease is quite mild, resulting in about a week-long fever, and a light rash similar to that of the original illness.

Endemic typhus causes about 12 days of high fever, with chills and headache. A light rash may occur.

Scrub typhus causes a wide variety of effects. The main symptoms include fever, headache, muscle aches and pains, **cough**, abdominal **pain**, **nausea and vomiting**, and **diarrhea**. Some patients experience only these symptoms. Some patients develop a rash, which can be flat or bumpy. The individual spots eventually develop crusty black scabs. Other patients go on to develop a more serious disease, in which encephalitis, **pneumonia**, and swelling of the liver and spleen (hepatosplenomegaly) occur.

Diagnosis

A number of tests exist that can determine the reactions of a patient's antibodies (immune cells in the blood) to the presence of certain viral and bacterial markers. When the antibodies react in a particular way, it suggests the presence of a rickettsial infection. Many tests require a fair amount of time for processing, so practitioners will frequently begin treatment without completing tests, simply on the basis of a patient's symptoms.

Treatment

The **antibiotics** tetracycline or chloramphenicol are used for treatment of each of the forms of typhus.

Prognosis

The prognosis depends on what types of complications an individual patient experiences. While children usually recover well from epidemic typhus, older adults may have as much as a 60% **death** rate without treatment. Brill-Zinsser, on the other hand, carries no threat of death. People usually recover uneventfully from endemic typhus, although the elderly, those with other medical problems, or people mistakenly treated with sulfa drugs may have a 1% death rate from the illness. Scrub typhus responds well to appropriate

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treatment, but untreated patients have a death rate of about 7%.

The relatively high death rate from untreated typhus is one reason why some researchers are concerned that its causative organisms might be used in the future as agents of bioterrorism.

Prevention

Prevention for each of these forms of typhus includes avoidance of the insects that carry the causative bacteria. Other preventive measures include good hygiene and the use of insect repellents.

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Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

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Tzanck preparation

Definition

Tzanck preparation is a rapid test done to diagnose infections caused by herpesviruses. Cells are examined under a microscope for signs of infection.

Purpose

Herpesviruses are responsible for several superficial infections. Varicella zoster virus causes **chickenpox** and **shingles**, herpes simplex type 1 causes the **common cold** sore or **fever** blister, and herpes simplex type 2 causes the sexually transmitted disease **genital herpes**. They are all characterized by blisters and ulcers.

KEY TERMS

Herpes—A family of viruses including herpes simplex types 1 and 2, and herpes zoster (also called varicella zoster). Herpes viruses cause several infections, all characterized by blisters and ulcers, including chickenpox, shingles, genital herpes, and cold sores or fever blisters.

Physicians usually can diagnose herpes infections simply by looking at the type of blisters and ulcers, and their distribution on the person's body. Sometimes laboratory evidence of herpes is needed to confirm the diagnosis. For example, herpes can be devastating to a newborn baby or a person with a weakened immune system. Treatment can begin once herpes is confirmed in a laboring mother's genital ulcers or in the skin blisters of an immunocompromised person. A lab tries to grow (culture) the virus that may be present in the blister. This lab test takes several days to complete, but the Tzanck preparation takes minutes.

Description

The Tzanck preparation is done by smearing cells taken from a fresh blister or ulcer onto a microscope slide. The cells are stained with a special stain, such as Wright's stain, and then examined under a microscope for characteristic changes caused by a herpesvirus. Herpes causes giant cells with multiple nuclei. The shape of each nucleus appears molded to fit together with those adjacent. The background of the cell looks like ground glass and contains small dark spots called inclusion bodies.

Tzanck preparation is also called a Tzanck smear, herpes stain for inclusion bodies, or inclusion bodies stain. Results are available the same or following day, often within minutes.

Preparation

A fresh blister is opened with a scalpel or sterile needle. The physician scrapes the base of the blister with the scalpel, gathers as much cellular material as possible, and gently spreads it on a microscope slide.

Normal results

A normal smear shows no evidence of a herpes infection. This test may also have false negatives. Studies have shown that the Tzanck preparation shows signs of

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infection in only 50–79% of people with a herpes infection. A negative Tzanck preparation may have to be confirmed by a herpes culture.

Abnormal results

A smear that shows evidence of herpes infection does not distinguish between the various infections caused by herpes virus. The physician uses the person's symptoms and other clinical findings to distinguish between these infections. In certain cases, the physician will follow a positive Tzanck smear with a culture for confirmation.

Resources

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Nancy J. Nordenson

Tzanck smear *see* **Tzanck preparation**

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U

Ulcer surgery

Definition

Ulcer surgery is a procedure used to cure peptic ulcer disease when medications have failed.

Purpose

Ulcer surgery is used to relieve a present peptic ulcer disease and to prevent recurrence of it.

Surgery is usually required if the ulcer is in one of the following states:

- perforated and overflowed into the abdomen
- scarred or swelled so much that the bowel is obstructed
- acute bleeding
- defied all other types of treatment

The need for ulcer surgery has diminished greatly over the past 20–30 years due to the discovery of two new classes of drugs and the presence of the causal germ *Helicobacter pylori* in the stomach. The drugs are the H2 blockers, such as cimetidine and ranitidine, and the **proton pump inhibitors**, such as omeprazole. These effectively arrest acid production. *H. pylori* can be eliminated from most patients with a combination of **antibiotics** and bismuth.

Precautions

There is a tumor of the pancreas that produces a hormone called gastrin. Gastrin causes ulcers by stimulating acid production. If this disease—Zollinger-Ellison syndrome—does not respond to medical treatment, either the tumor or the entire stomach must be removed.

Description

The two primary goals of ulcer surgery, elimination of the current problem and prevention of future problems bring with them a third problem—to perpetuate the normal function of the bowel. The vagus nerves relax the pylorus, allowing the stomach to empty. Cutting the vagus nerves, while reducing the stomach's acid production, also prevents stomach emptying. Therefore, the procedures described must guarantee stomach emptying along with their other goals.

Total gastrectomy

Removing the entire stomach is done only for resistant Zollinger-Ellison syndrome or extensive cancers.

Antrectomy

The lower half of the stomach makes most of the acid and gets all the peptic ulcers above the duodenum. Removing it leaves little place for ulcers to form and little acid to produce them.

Vagotomy

Cutting the vagus nerves can be done in three ways:

KEY TERMS

Gastrin—A type of hormone that produces gastric juice.

Hypoglycemia—An abnormal decrease in blood sugar level.

Jejunum—Section of the small intestine.

Laparoscope—A pencil-thin telescope that allows surgery to be done through half-inch incisions.

Pylorus—The opening from the stomach to the intestine.

Vagus nerve—Cranial nerves that supply the internal organs (viscera).

Zollinger-Ellison syndrome—A syndrome marked by peptic ulcers and gastrinomas in the pancreas.

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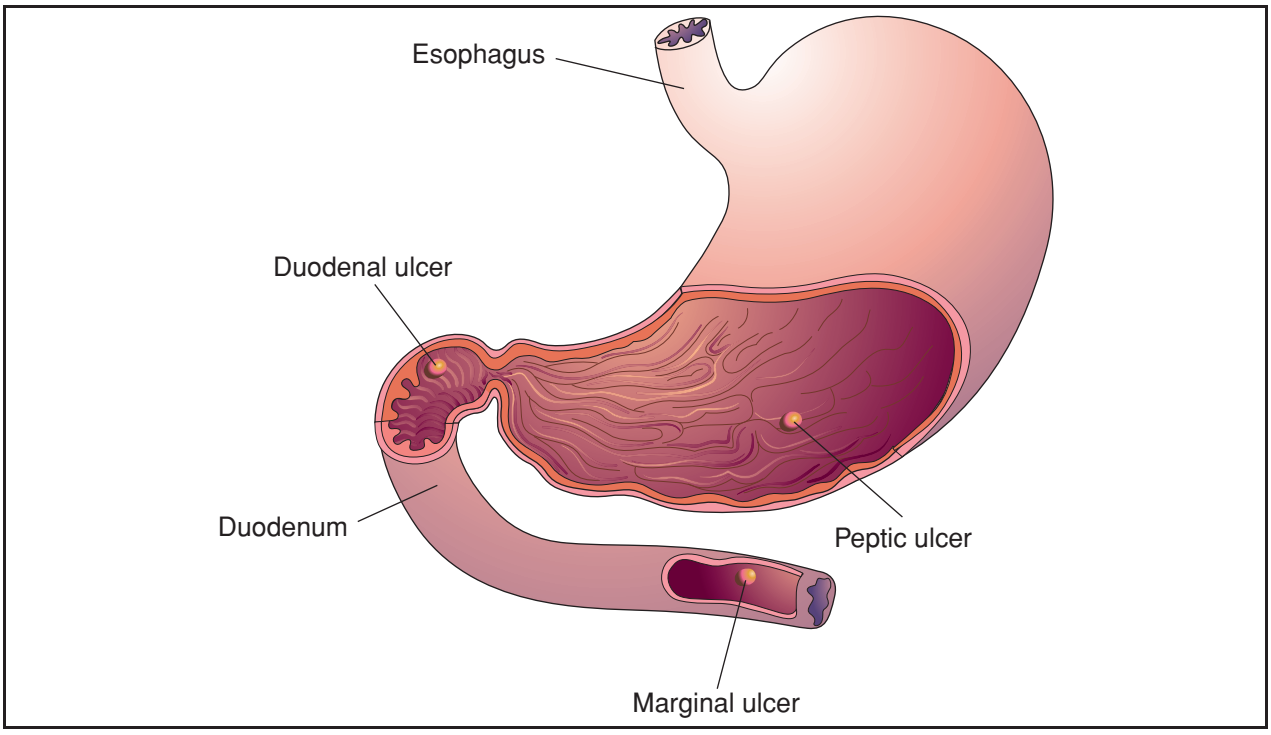

Common sites of ulcers in the human stomach. The need for ulcer surgery has diminished over the past 20-30 years due to the discovery that *Helicobacter pylori*, an infectious bacterium, plays a major role in causing ulcers. *H. pylori* can be eliminated from most patients with a combination of antibiotics and bismuth. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

- the main nerves can be cut completely as they enter the abdomen from the chest
- the branches that go to the stomach can be cut as they leave the main nerves
- the tiny branches that stimulate acid production can be cut on the surface of the stomach

Pyloroplasty

Opening up the valve at the outlet of the stomach guarantees that the stomach can empty, even without vagus nerve stimulation. **Pyloroplasty** is ordinarily done by cutting across the muscle that surrounds the outlet. It can also be done by passing a balloon down from the mouth and inflating it forcefully to stretch out the pylorus (opening from the stomach to the intestine).

Close perforation

For some patients all that can be done is to close the hole in the bowel and wait for the patient to recover before initiating corrective surgery.

Billroth I and II

After removing a piece of the stomach, the remainder must be reattached to the rest of the bowel. Simply joining the upper stomach back to the duodenum is called a Billroth I or gastroduodenostomy. It is sometimes better to attach the stomach with another piece of bowel (the jejunum), creating a "y" with the bile drainage and the duodenum forming the second branch of the "y." This part of the procedure is called a gastrojejunostomy. A gastroenterostomy is a more general term for connecting the stomach with any piece of bowel.

A selective **vagotomy** can be done alone. A complete vagotomy requires either a pyloroplasty or antrectomy. An antrectomy must be reconnected with either a Billroth I or a Billroth II.

Some of these procedures are now being done through a laparoscope.

Risks

All of these procedures carry risks, generally in proportion to their benefits. The more extensive surgeries, such as vagotomy and antrectomy with Billroth II reconnection, have the highest success rate and the highest complication rate.

Complications include:

- diarrhea after a meal

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- dumping syndrome occurring after a meal and characterized by sweating, abdominal pain, vomiting, lightheadedness, and diarrhea
- hypoglycemia after a meal
- alkaline reflux gastritis marked by abdominal pain, vomiting of bile, diminished appetite, and iron-deficiency anemia
- recurrence of an ulcer
- malabsorption of necessary nutrients, especially iron, in patients who have had all or part of their stomachs removed

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Ulcerative colitis *see* **Colitis**

Ulcers (digestive)

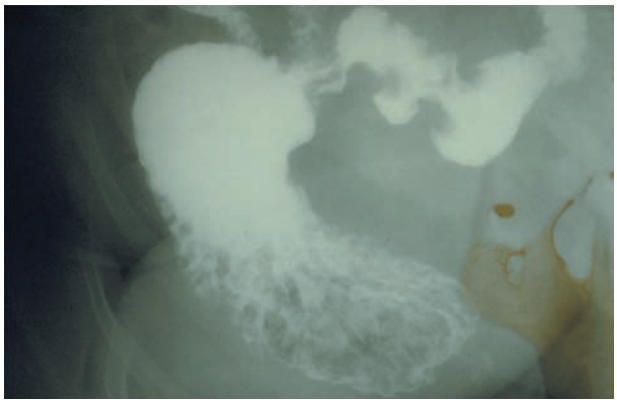
Definition

In general, an ulcer is any eroded area of skin or a mucous membrane marked by tissue disintegration. In common usage, however, ulcer usually is used to refer to disorders in the upper digestive tract.

Demographics

It is estimated that 2% of the adult population in the United States has active peptic ulcers, and that about 10% will develop ulcers at some point in their lives. There are about 500,000 new cases of peptic ulcer in the United States every year, with as many as 4 million recurrences. The male/female ratio for ulcers of the digestive tract is 3:1.

The most common forms of peptic ulcer are duodenal and gastric. About 80% of all ulcers in the digestive tract are duodenal ulcers. This type of ulcer may strike people in any age group but is most common in males between the ages of 20 and 45. The incidence of duodenal ulcers has dropped over the past 30 years. Gastric ulcers account for about 16% of peptic ulcers. They are most common in males between the ages of 55 and 70. The single most common cause of gastric ulcers is the use of **nonsteroidal anti-inflammatory drugs**, or NSAIDs. The widespread use of NSAIDs is thought to explain why the incidence of gastric ulcers in the United States is rising.



A barium x-ray image of a gastric ulcer. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Description

The terms ulcer, gastric ulcer, and peptic ulcer often are used loosely and interchangeably. Peptic ulcers can develop in the lower part of the esophagus, the stomach, the first part of the small intestine (the duodenum), and the second part of the small intestine (the jejunum).

Causes and symptoms

There are three major causes of peptic ulcers: infection, certain types of medication, and disorders that cause oversecretion of stomach juices.

Helicobacter pylori infection

Helicobacter pylori is a rod-shaped gram-negative bacterium that lives in the mucous tissues that line the digestive tract. Infection with *H. pylori* is the most common cause of duodenal ulcers. About 95% of patients with duodenal ulcers are infected with *H. pylori*, as opposed to only 70% of patients with gastric ulcers.

Nonsteroidal anti-inflammatory drugs (NSAIDS)

Nonsteroidal anti-inflammatory drugs, or NSAIDs, are painkillers that many people use for headaches, sore muscles, arthritis, menstrual cramps, and similar complaints. Many NSAIDs are available without prescriptions. Common NSAIDs include **aspirin**, ibuprofen (Advil, Motrin), flurbiprofen (Ansaid, Ocufen), ketoprofen (Orudis), and indomethacin (Indacin). Chronic NSAID users have 40 times the risk of developing a

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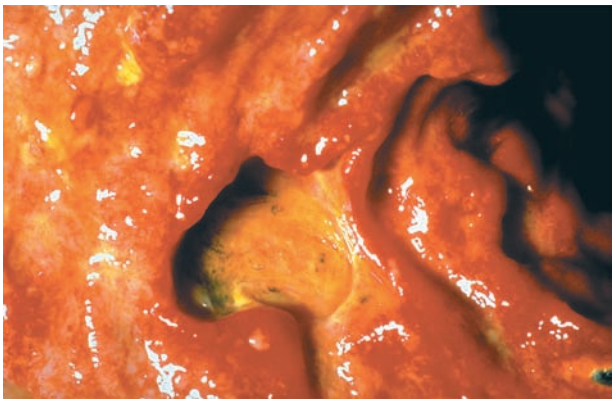

A clinical photograph of a large duodenal ulcer after surgical removal. The ulcer is the prominent triangular crater at center. *(Photo Researchers, Inc.)*

KEY TERMS

Duodenum—The first of the three segments of the small intestine. The duodenum connects the stomach and the jejunum. Most peptic ulcers are in the duodenum.

Helicobacter pylori—A gram-negative rod-shaped bacterium that lives in the tissues of the stomach and causes inflammation of the stomach lining.

Zollinger-Ellison syndrome—A disorder characterized by the presence of tumors (gastrinomas) that secrete a hormone (gastrin), which stimulates the production of digestive juices.

gastric ulcer as nonusers. Users also are three times more likely than nonusers to develop bleeding or fatal complications of ulcers. Aspirin is the NSAID that is most likely to cause ulcers.

Other syndromes and disorders

Fewer than 5% of peptic ulcers are due to Zollinger-Ellison syndrome, a disorder in which small tumors, called gastrinomas, secrete a hormone (gastrin) that stimulates the production of digestive juices. Because of this excess secretion, these disorders are sometimes called hypersecretory syndromes.

Risk factors

Smoking is an important risk factor that increases a patient's chance of developing an ulcer, decreases the body's response to therapy, and increases the chances of dying from ulcer complications. Blood type appears to be a predisposing factor for ulcer location; people with type A blood are more likely to have gastric ulcers, while those with type O are more likely to develop duodenal ulcers. The role of emotional **stress** in ulcer development is currently debated. Present research indicates that an individual's attitudes toward stress, rather than the amount of stress by itself, is a better predictor of vulnerability to peptic ulcers. Preferences for high-fat or spicy foods do not appear to be significant risk factors.

Gastric ulcers

The symptoms of gastric ulcers include feelings of **indigestion** and **heartburn**, weight loss, and repeated episodes of gastrointestinal bleeding. Ulcer **pain** often is described as gnawing, dull, aching, or resembling hunger pangs. The patient may be nauseated and have loss of appetite. About 30% of patients with gastric ulcers are awakened by pain at night. Many patients have periods of chronic ulcer pain alternating with symptom-free periods that last for several weeks or months. This characteristic is called periodicity.

Duodenal ulcers

The symptoms of duodenal ulcers include heartburn, stomach pain relieved by eating or **antacids**, weight gain, and a burning sensation at the back of the throat. The patient is most likely to feel discomfort two to four hours after meals, or after having citrus juice, coffee, or aspirin. About 50% of patients with duodenal ulcers awake during the night with pain, usually between midnight and 3 a.m. A regular pattern of ulcer pain associated with certain periods of day or night or a time interval after meals is called rhythmicity.

Not all digestive ulcers produce symptoms; as many as 20% of ulcer patients have so-called painless or silent ulcers. Silent ulcers occur most frequently in the elderly and in chronic NSAID users.

Diagnosis

Examination

The diagnosis of peptic ulcers should rarely be made on the basis of a **physical examination** alone. Many ulcer diagnoses based solely on physical exams actually are only **dyspepsia**, or upper adnominal pain and discomfort not caused by ulcers. The only significant finding may be mild soreness in the area over the stomach when the doctor presses (palpates) it. The doctor is more likely to suspect an ulcer if the patient has one or more of the following risk factors:

- male sex
- age over 45

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- recent weight loss, bleeding, recurrent vomiting, jaundice, back pain, or anemia
- history of using aspirin or other NSAIDs
- history of heavy smoking
- family history of ulcers or stomach cancer

Tests

Blood tests usually give normal results in ulcer patients without complications. They are useful, however, in evaluating anemia from a bleeding ulcer or a high white cell count from perforation or penetration. Serum gastrin levels can be used to screen for Zollinger-Ellison syndrome.

It is important to test for *H. pylori* because almost all ulcer patients who are not taking NSAIDs are infected. Noninvasive tests include blood tests for immune response and a breath test. In the breath test, the patient is given an oral dose of radiolabeled urea. If *H. pylori* is present, it will react with the urea and the patient will exhale radiolabeled carbon dioxide. Invasive tests for *H. pylori* include tissue biopsies and cultures performed from fluid obtained by **endoscopy**.

Procedures

An endoscopy is considered the best procedure for diagnosing digestive ulcers and for taking samples of stomach tissue for biopsies. An endoscope is a slender tube-shaped instrument that allows the doctor to view the tissues lining the stomach and duodenum. Duodenal ulcers are rarely malignant. If the ulcer is in the stomach, however, the doctor will take a tissue sample because 3–5% of gastric ulcers are malignant.

Radiological studies are sometimes used instead of endoscopy because they are less expensive, more comfortable for the patient, and are 85% accurate in detecting malignancies.

Treatment

Drugs

Most drugs that are currently given to treat ulcers work either by lowering the rate of stomach acid secretion or by protecting the mucous tissues that line the digestive tract.

Medications that lower the rate of stomach acid secretions fall into two major categories: **proton pump inhibitors**, which bind an enzyme that secretes stomach acid, and H_2 receptor antagonists, which work by reducing intracellular acid secretion. The proton pump inhibitors include omeprazole (Prilosec) and lansoprazole (Prevacid). The H_2 receptor antagonists include ranitidine (Zantac), cimetidine (Tagamet), famotidine (Pepcid), and nizatidine (Axid).

The drugs that are currently used to protect the stomach tissues are sucralfate (Carafate), which forms a paste-like substance that clings to the mucous tissues and prevents further damage from stomach acid, and bismuth preparations. A third type of protective drug includes misoprostol (Cytotec), which is often given to patients with ulcers caused by NSAIDs.

Surgery

Surgical treatment of ulcers is generally used only for complications and suspected malignancies. The most common surgical procedures used are vagotomies, in which the connections of the vagus nerve to the stomach are cut in order to reduce acid secretion, and antrectomies, which involve the removal of a part of the stomach (the antrum).

Eradication of Helicobacter pylori

Most doctors presently recommend treatment to eliminate *H. pylori* in order to prevent ulcer recurrences. Without such treatment, ulcers recur at the rate of 80% per year. A 2003 report showed that eradication *H. pylori* alone usually prevents recurring bleeding ulcers. The usual regimen used to eliminate the bacterium is a combination of tetracycline, bismuth subsalicylate (Pepto-Bismol), and metronidazole (Metizol, Flagyl).

Alternative

Alternative treatments can relieve symptoms and promote healing of ulcers. A primary goal of these treatments is to rebalance the stomach's hydrochloric acid output and to enhance the mucosal lining of the stomach.

Botanical medicine offers a variety of remedies that may be helpful in ulcer treatment. Deglycyrrhizinated licorice or DGL, in a chewable or powder form, can help heal the mucous membranes and increase mucous so that it mixes with saliva to protect the membranes. Raw cabbage juice, high in glutanic acid, is very effective in healing an ulcer (one quart per day in divided doses). Soothing herbs, such as plantain (*Plantago major*), marsh mallow (*Althaea officinalis*), and slippery elm (*Ulmus fulva*); astringent herbs, such as geranium (*Pelargonium odoratissimum*); and the antimicrobial herb goldenseal (*Hydrastis canadensis*) can all be effective. Nutritionists advise taking antioxidant nutrients, including **vitamins** A, C, and E, zinc, and selenium.

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Home remedies

Food allergies have been pointed to as a major cause of peptic (stomach) ulcers. An elimination/challenge diet can help identify the allergenic food(s) and continued elimination of these foods can assist in healing the ulcer. People with ulcers should not take aspirin. They also should stop smoking, since smoking irritates the mucosal lining of the stomach. Antacids should be avoided by anyone with an ulcer, because they can cause a rebound effect of increasing gastric acid secretion, as well as deplete vital nutrients necessary for healing. **Stress reduction** is also important for people with ulcers.

Prognosis

The prognosis for recovery from ulcers is good for most patients. Very few ulcers fail to respond to the medications that are currently used to treat them. Recurrences can be eliminated completely or cut to 5% by eradication of *H. pylori*. Most patients who develop complications recover without problems even when emergency surgery is necessary.

Complications

Between 10% and 20% of peptic ulcer patients develop complications at some time during the course of their illness. All of these are potentially serious conditions. Complications are not always preceded by diagnosis of or treatment for ulcers; as many as 60% of patients with complications have not had prior symptoms.

Bleeding is the most common complication of ulcers. It may result in anemia, **vomiting** blood (hematemesis), or the passage of bright red blood through the rectum (melena). About half of all cases of bleeding from the upper digestive tract are caused by ulcers. The mortality rate from ulcer hemorrhage is 6–10%.

About 5% of ulcer patients develop perforations, which are holes in the duodenal or gastric wall through which the stomach contents can leak out into the abdominal cavity. The incidence of perforation is rising because of the increased use of NSAIDs, particularly among the elderly. The signs of an ulcer perforation are severe pain, **fever**, and tenderness when the doctor touches the abdomen. Most cases of perforation require emergency surgery. The mortality rate is about 5%.

Ulcer penetration is a complication in which the ulcer erodes through the intestinal wall without digestive fluid leaking into the abdomen. Instead, the ulcer penetrates into an adjoining organ, such as the pancreas or liver. The signs of penetration are more severe pain without rhythmicity or periodicity and the spread of the pain to the lower back.

Obstruction of the stomach outlet occurs in about 2% of ulcer patients. It is caused by swelling or scar tissue formation that narrows the opening between the stomach and the duodenum (the pylorus). Over 90% of patients with obstruction have recurrent **vomiting** of partly digested or undigested food; 20% are seriously dehydrated. These patients usually feel full after eating only a little food and may lose weight.

Prevention

Strategies for the prevention of ulcers or their recurrence include the following:

- eradication of *H. pylori* in patients already diagnosed with ulcers
- giving misoprostol to patients who must take NSAIDs
- avoiding unnecessary use of aspirin and NSAIDs
- giving up smoking
- cutting down on alcohol, tea, coffee, and sodas containing caffeine

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American College of Gastroenterology, P.O. Box 342260, Bethesda, MD, 20827, (301) 263-9000, http://www.acg.gi.org.

American Gastroenterological Association, 4930 Del Ray Avenue, Bethesda, MD, 20814, (301) 654-2055, http://www.gastro.org.

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National Digestive Diseases Information Clearinghouse, 2 Information Way, Bethesda, MD, 20892-3570, (800) 891-5389, http://www.niddk.nih.gov/health/digest/nddic.htm.
National Institutes of Health (NIH), 9000 Rockville Pike, Bethesda, MD, 20892, (301) 496-4000, http://www.nih.gov.
U.S. National Library of Medicine, 8600 Rockville Pike, Bethesda, MD, 20894, http://www.nlm.nih.gov/medlineplus/medlineplus.html.

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Ultrasonic lithotripsy *see* **Lithotripsy**

Ultraviolet light treatment

Definition

Ultraviolet light treatment uses a particular band of the nonvisible light spectrum to treat **psoriasis** and a variety of other skin diseases. It can be used alone or in combination with other medications applied directly to the skin or taken internally.

Purpose

Ultraviolet (UV) light treatment is used primarily in cases of severe psoriasis that have not responded to other medications or in cases affecting large portions of the body. Patients will typically receive a series of 3–5 weekly treatments for a month or more to bring their psoriasis symptoms into check. They may also receive periodic maintenance treatments to prevent recurrence of their psoriasis. Other skin conditions treated with UV light treatments are **vitiligo**, a condition in which people lose pigmentation in large patches of their skin, and **atopic dermatitis**, an allergy-related skin condition that produces itchy, reddish, and scaly patches of skin.

Precautions

Exposure to UV radiation is known to prematurely age the skin over time and increase the risk of skin **cancer**. These potential effects should be weighed against the potential benefits of the treatment. A history will be taken regarding sun exposure and burning; medications, such as **diuretics**, that may increase UV sensitivity exposure; and any history of skin cancers. Sometimes, UV light treatments are given in combination with photosensitizing agents, which maximize UV's effects on the skin. Patients who receive these agents, called psoralens, must take care to avoid exposure to sunlight, which also contains UV radiation. Exposure to UV radiation can also cause **cataracts** and other eye damage, so the patient's eyes must be adequately shielded during the treatments.

Description

UV light treatment can employ one of two bands of the ultraviolet spectrum: ultraviolet A (UVA), and ultraviolet B (UVB). Patients receive full-body treatments in special light boxes; smaller areas of the skin are sometimes treated with hand-held devices.

UVB treatment

Psoriasis is the most common skin disease treated with UVB light treatment. Its mechanism of action remains unclear, but investigators speculate it may kill abnormal skin cells or alter immune system reactions in the skin. Most patients require 18–30 treatments before substantial improvement or complete clearing is seen. The intensity of the UV applied will vary depending on the patient's skin type. Fair-skinned patients will start with a relatively weaker dose; dark-skinned patients, a stronger dose. Physicians will first expose a small area of skin to UVB to determine the minimum erythema dose (MED), the minimum amount of UVB that produces redness 24 hours after exposure. Patients will be exposed for short times early in the treatment cycle, but these times will gradually increase over time.

The Goeckerman regimen, a treatment that combines UVB light with coal tar applied to the skin, is among the oldest and most frequently used treatments for patients with moderate to severe psoriasis. The coal tar is a photosensitizing agent and when it interacts with UVB, it appears to limit the abnormal turnover of skin cells characteristic of psoriasis. Although treatments with UVB and coal tar are highly effective, many patients dislike the smell. Some investigators believe that the use of petroleum jelly or other emollients is just as effective as the coal tar preparations.

In addition to their UVB treatments, many patients will receive such systemic agents as methotrexate, a drug used in severe case of psoriasis, and certain vitamin A derivatives called retinoids. A newer retinoid called bexarotene (Targretin), which was originally developed to treat **cutaneous T-cell lymphoma**, shows promise as a treatment for psoriasis in combination with UVB therapy.

Another new development in UV therapy is the use of a laser as the source of the UVB radiation. The type of laser that is used is known as a 308-nm excimer

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KEY TERMS

Erythema—The medical term for redness of the skin produced by congestion of the capillaries in the skin.

Goeckerman regimen—UVB light therapy combined with topical coal-tar preparations.

Minimum erythema dose—The minimum amount of UVB that produces redness 24 hours after exposure. It is the starting dose for UVB light treatments.

Minimum phototoxic dose—The dose of UVA that produces uniform redness 72 hours after ingesting a psoralen compound. It becomes the starting dose for PUVA treatment.

Psoralen—A family of photosensitizing chemicals that can be found in lemons, celery, and other plants. Chemically synthesized versions are used to augment the effects of UVA light treatments.

PUVA treatments—Treatments with the photosensitizers called psoralens and UVA.

Ultraviolet light—A portion of the light spectrum not visible to the eye. Two bands of the UV spectrum, UVA and UVB, are used to treat psoriasis and other skin diseases.

laser, which uses a specific mixture of gases to produce high-intensity, short pulses of UV light.

PUVA treatment

Psoralens are photosensitizing agents found in plants. They have been known since ancient Egypt but have only been available in a chemically synthesized form since the 1970s. Psoralens are taken systemically or can be applied directly to the skin. The psoralens allow a relatively lower dose of UVA to be used. When they are combined with exposure to UVA in PUVA, they are highly effective at clearing psoriasis. Like UVB light treatments, the reason remains unclear, though investigators speculate there may be similar effects on cell turnover and the skin's immune response.

Choosing the proper dose for PUVA is similar to the procedure followed with UVB. The physician can choose a dose based on the patient's skin type. Often, however, a small area of the patient's skin will be exposed to UVA after ingestion of a psoralen. The dose of UVA that produces uniform redness 72 hours later, called the minimum phototoxic dose (MPD), becomes the starting dose for treatment.

Some patients experience **nausea** and **itching** after ingesting the psoralen compound. For these patients "bath PUVA" may be a good option.

Preparation

No major preparation is required for UV light treatments. Areas of the skin that are especially sensitive to the effects of UV light, such as the groin, backside, or face, are shielded during the treatments. Areas not affected by psoriasis are also covered. Special goggles are worn to protect the eyes. Some physicians apply an emollient, such as petroleum jelly, to the skin or other topical agents, such as coal tar, to enhance the results. In PUVA treatments, the psoralen is usually taken one hour before the treatment.

Aftercare

No major aftercare is required following UV light treatments. Patients, however, must take great care to limit or eliminate other exposures to UV radiation, such as from sunlight or **tanning** beds, because of the increased risk of premature **aging** of the skin and the development of skin cancers. Patients should monitor their skin closely for any signs of precancerous or cancerous skin growths in the future.

Risks

People who receive UV light treatments are at higher risk of premature aging of the skin and of developing skin cancer. These risks should be balanced against the benefits of treatment. Patients must also take care to limit or eliminate their exposure to other sources of UV radiation, especially if they are taking a psoralen compound in addition to receiving the UV treatments.

Normal results

Psoriasis will normally show significant improvement to complete healing with three to five UVB treatments a week for about four to five weeks. PUVA treatments may require a bit longer to take effect, but because the overall dosage of UV is lower, they are thought by some investigators to be a safer alternative to UVB treatments.

Abnormal results

Modern light boxes carefully control the dosage of UV radiation and the exposure time. Overdose or

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overexposure is possible, however, and can lead to severe **burns**. It is important to choose a treatment provider who is experienced in the technique. It is also important to tell the physician about all medications being taken by the patient. Some medications, either alone or in combination with a psoralen, can provoke an extreme reaction to UV radiation. One medication that has been shown to be helpful in treating burns caused by overexposure to UV radiation is a gel containing a platelet-activating antagonist factor, or PAF, known as WEB 2086.

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ORGANIZATIONS

American Academy of Dermatology, PO Box 4014, Schaumburg, IL, 60168-4014, 847 240-1859, 866 503-SKIN (7546), http://www.aad.org.

National Psoriasis Foundation, 6600 SW 92nd Ave., Suite 300, Portland, OR, 97223-7195, 503 244-7404, 503 245-0626, getinfo@psoriasis.org, http://www.psoriasis.org.

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Umbilical cord blood banking

Definition

Umbilical cord blood banking is the practice of preserving for future use fetal blood that remains in the umbilical cord at the time of birth.

Purpose

During **pregnancy**, a developing fetus is attached to its mother's placenta by the umbilical cord. At birth, this cord is cut, and the placenta is expelled from the mother. Some fetal blood remains in the umbilical cord. Normally, this blood, along with the cord and the placenta, are simply disposed of. However, now there are ways to freeze the cord blood for future use.

Umbilical cord blood is special because it contains a lot of cells called hematopoietic stem cells. A stem cell is an unspecialized master cell that can develop into several different kinds of specialized cells. Hematopoietic stem cells normally develop into red blood cells that carry oxygen, white blood cells that fight infection, and platelets that help make blood clot. These hematopoietic stem cells are *not* the same as embryonic stem cells that are at the center political and ethical debate about their use in research. Their collection does not harm either the mother or the baby.

There are two other sources of hematopoietic stem cells—bone marrow and peripheral blood. Bone marrow is the spongy material inside bones that is the source for new blood cells produced throughout an individual's life. Peripheral blood is the blood that circulates through the body.

All cells have a protein profile that identifies them. When a foreign cell enters the body, immune system cells recognize the protein profile as foreign and attack the cell. The advantage of umbilical cord stem cells that they are more immature and have a less well developed protein profile than bone marrow or peripheral stem cells. As a result, they draw a weaker response from the body's immune system.

The protein profile of human cells is called the human leukocyte antigen (HLA) profile. Normally for transplanted cells such as bone marrow cells to be accepted, there must be a close to perfect match between the HLA profile of the donor and the recipient. Since there are over 10,000 HLA types, finding an exact match can be difficult. Because umbilical cord blood cells have a less well developed HLA profile, they do not have to match the recipient's HLA as closely to be accepted by the immune system of the transplant recipient.

Types of cord blood banks

There are two types of umbilical cord blood banks—private and public. Private blood cord banks can be for-profit or not-for-profit. They sell kits that can be used at any delivery to collect cord blood. They also charge a yearly fee to store the blood. The cord blood is available only to the child or members of the

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child's family from which it came. It is a perfect HLA match to child's blood. When a transplant is done using cells that came from the individual who needs the transplant, it is called an autologous transplant. Autologous transplants have a high rate of success.

Public cord banks do not charge a fee to collect or store cord blood. Parents of newborns donate the cord blood, and it is then available to anyone who needs it and is an appropriate match. This type of transplant where the recipient is not the same as the donor is called an allogeneic transplant. Much of the success of allogeneic transplants depends on finding a good HLA match. Because of funding considerations, there are a limited number of public cord blood banks. To donate to a public blood cord bank, the mother must give birth in a facility associated with a public blood cord bank.

How cord blood is used

The first successful umbilical cord **stem cell transplantation** occurred in 1988, when a newborn girl donated cord blood to cure her brother of Fanconi's anemia, a genetic defect. Many other blood diseases can now be treated successfully with cord stem cell transplants. These same diseases can be treated with bone marrow transplant if an appropriately matched donor can be found. In addition, research is ongoing in the hope that cord blood stem cells can be induced to differentiating into other types of cells, such as nerve cells, that can be used to treat other diseases.

Some diseases treated with blood stem cell transplant include:

- acute lymphatic leukemia
- acute myelogenous leukemia
- chronic myelogenous leukemia
- Hodgkin disease
- non-Hodgkin lymphoma
- neuroblastoma
- severe combined immune deficiency
- anapalstic anemia
- thalassemia
- sickle cell anemia
- Fanconi's anemia

In addition to being more readily accepted by the donor's body, cord blood offers other advantages over **bone marrow transplantation**. It is relatively quick and easy to thaw the cord blood and infuse it, while bone marrow harvesting is an invasive procedure with risks to the donor. In addition, cord blood is less likely to be contaminated with viruses that may create complications for the recipient.

Considerations in deciding to bank cord blood

Although the list of diseases treated with umbilical cord stem cells is impressive and growing, controversy exists about whether parents should pay private cord cell banks to preserve their newborn's blood. Private cord cell banks sell their services as a type of "insurance." In case the child develops a treatable disease, the child's own stem cells will be a perfect match. However, if the disease is caused by a genetic defect, (e.g., sickle cell and other **anemias**) the child's own stem cells will be useless, because they will contain the same genetic defect. In addition, the quantity of cord blood that can be collected is only enough to treat a child. Although research is being done to try to multiply cord cells in the laboratory in quantities great enough to treat an adult, results have not been successful. Therefore, if an adult develops a treatable disease, even if his own cord blood was banked, the quantity will be insufficient to produce a cure. Also, cord blood storage is a new enough technology that it is not clear how long the blood can remain frozen and still be effective.

In the most recent statement on cord blood banking released by the American Academy of Pediatrics, they concluded:

- There are no good estimates of how often a child will need a transplant of his own cells. Estimates range from 1 in 1,000 to 1 in 200,000
- Certain genetic disorders are not cured by autologous transplants
- Parents should be encouraged to donate their child's cord blood to free public cord blood banks for the widest possible use rather than paying private companies to store cord blood

The American College of Obstetricians and Gynecologists supports the position that parents should not be sold private blood cord banking without a realistic assessment of their need, nor should parents feel guilty if they are not eager or able to meet the annual expense associated with private storage. Although cord blood collection is safe, unless there is a family history of diseases for which hematopoietic stem cells are helpful, most pediatricians and obstetricians feel private cord blood storage is an unnecessary expense.

Precautions

Umbilical cord blood collection is usually not done in the case of multiple births.

Description

Cord blood collection is a simple procedure that takes between three and seven minutes. It is done

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KEY TERMS

Allogeneic—A transplant where the donated material comes from different (although often related) individual than the recipient

Autologous—A transplant where the material for the transplant comes from the individual who is also the recipient; thus, the transplant material is genetically identical to the donor's body.

Hematopoietic stem cell—A cell that can develop into any type of specialized blood cell.

immediately after the baby is delivered. Cord blood is drained into a standard blood bag and then processed and frozen at very low temperatures.

Preparation

Parents who wish to bank their child's cord blood must plan ahead. Private storage requires ordering a kit in advance and coordinating with the health care providers doing the delivery to make sure the cord blood is collected properly. Mothers must test negative for infectious diseases, such as HIV and hepatitis, before delivery. Donation to a public cord blood bank is not always possible because of their limited number and location.

Aftercare

No special aftercare is required for mother or child, but the cord blood must remain frozen at low temperatures.

Risks

The main risk associated with umbilical cord blood collection is the possibility that it will become contaminated with bacteria during collection.

Parents who are interested in private cord blood storage should research the company with which they contract, just as they would in making any business decision. They need to know the costs, whether the annual fee can increase, and what will happen to the blood if the company goes out of business.

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Leukemia and Lymphoma Society, 1311 Mamaroneck Avenue, Suite 310, White Plains, NY, 10605, 800 955-4572, http://www.leukemia-lymphoma.org.

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Umbilical hernia repair

Definition

An umbilical **hernia repair** is a surgical procedure performed to fix a weakness in the abdominal wall or to close an opening near the umbilicus (navel) that has allowed abdominal contents to protrude. The abdominal contents may or may not be contained within a membrane or sac. The medical name for a hernia repair is herniorrhaphy.

Purpose

Umbilical hernias are usually repaired either to relieve discomfort or to prevent complications. It is not always necessary to fix an umbilical hernia. If the person is not in **pain**, the hernia is often not repaired. Complications may develop if pressure inside the abdomen resulting from daily activity pushes the abdominal contents further through the opening. They may then become twisted or strangulated. Strangulation is a condition in which the circulation to a section of the intestine (or other part of the body) is cut off by compression or constriction; it can cause extreme pain. If the

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KEY TERMS

Abdominal distension—Swelling of the abdominal cavity, which creates painful pressure on the internal organs.

Hernia—The protrusion of a loop or piece of tissue through an incision or abnormal opening in other tissues.

Herniorraphy—The medical name for a hernia repair procedure.

Incarceration—The abnormal confinement of a section of the intestine or other body tissues. An umbilical hernia may lead to incarceration of part of the intestine.

Intra-abdominal pressure—Pressure that occurs within the abdominal cavity. Pressure in this area builds up with coughing, crying, and the pressure exerted when bearing down with a bowel movement.

Strangulation—A condition in which a vessel, section of the intestine, or other body part is compressed or constricted to the point that blood cannot circulate.

Umbilicus—The area where the umbilical cord was attached; also known as the navel or belly button.

strangulation persists, the tissue can die from lack of blood supply and lead to an infection.

Demographics

An umbilical hernia can occur in both men and women and can occur at any age, although it is often present at birth. Umbilical hernias are found in about 20% of newborns, especially in premature infants. Umbilical hernias are more common in male than in female infants; with regard to race, they are eight times more common in African Americans than in Caucasians or Hispanics. While umbilical hernia is not a genetically determined condition, it tends to run in families. In the adult population, umbilical hernias are more common in overweight persons with weak abdominal muscles and in women who are either pregnant or have borne many children. People with **liver disease** or fluid in the abdominal cavity are also at higher risk of developing an umbilical hernia.

Description

Repair of an abdominal hernia involves a cut, or incision, in the umbilical area. Most herniorrhaphies take about two hours to complete. After the patient has been given a sedative, the anesthesiologist will administer a local, spinal, or general anesthetic. The type of anesthesia used depends on the patient's age, general health, and complexity of the procedure. The incision is usually made underneath the belly button. The herniated tissues are isolated and pushed back inside the abdominal cavity. A hernia repair may be done using traditional open surgery or with a laparoscope. A laparoscopic procedure is performed through a few very small incisions. The hole in the abdominal wall may be closed with sutures, or by the use of a fine sterile surgical mesh. The mesh provides additional strength. Some surgeons may choose to use the mesh when repairing a larger hernia. A hernia repair done with a mesh insert is called a tension-free procedure because the surgeon does not have to put tension on the layer of muscle tissue in order to bring the edges of the hole together.

Diagnosis/Preparation

Diagnosis

In children, umbilical hernias are often diagnosed at birth, usually when the doctor feels a lump in the area around the belly button. The hernia may also be diagnosed if the child is crying from pain, because the crying will increase the pressure inside the abdomen and make the hernia more noticeable.

Umbilical hernias in adults occur more often in pregnant women and obese persons with weak stomach muscles. They may develop gradually without producing any discomfort, but the patient may see a bulge in the abdomen while bathing or getting dressed. Other patients consult their doctor because they have felt the tissues in the abdomen suddenly give way when they are having a bowel movement. In an office examination, the patient may be asked to lie down, lift the head, and **cough**. This action increases pressure inside the abdomen and causes the hernia to bulge outward.

A hernia that has become incarcerated or strangulated is a medical emergency. Its symptoms include:

- nausea
- vomiting
- abdominal swelling or distension
- pale complexion
- weakness or dizziness
- extreme pain

When a hernia is present at birth, some surgeons may opt for a "wait and see" approach, as umbilical hernias in children often close by themselves with time.

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If the hernia has not closed by the time the child is three or four years old, then surgery is usually considered. If the hernia is very large, surgery may be recommended.

Repair of an umbilical hernia in an adult is usually considered elective surgery. The patient's surgeon may recommend the procedure, however, on the grounds that hernias in adults do not close by themselves and tend to grow larger over time.

Preparation

Adults scheduled for a herniorraphy are given standard blood tests and a **urinalysis**. They should not eat breakfast on the morning of the procedure, and they should wear loose-fitting, comfortable clothing that they can easily pull on after the surgery without straining their abdomen.

Aftercare

Aftercare will depend in part on the invasiveness of the surgery, whether laparoscopic or open; the type of anesthesia; the patient's age; and his or her general medical condition. Immediately after the procedure, the person will be taken to the recovery area of the surgical center, where nurses will monitor the patient for signs of excessive bleeding, infection, uncontrolled pain, or **shock**. Hernia repairs are usually performed on an outpatient basis, which means that the patient can expect to go home within a few hours of the surgery. Adult patients, however, should arrange to have a friend or relative drive them home. If possible, someone should stay with them for the first night.

The nurses will provide the patient with instructions on incision care. The specific instructions will depend on the type of surgery and the way in which the incision was closed. Sometimes a see-through dressing is placed on the wound that the patient can remove about three days after the procedure. It may be necessary to keep the dressing dry until some healing has taken place. Very small incisions may be closed with Steri-strips rather than sutures.

Risks

There are surgical and anesthesia-related risks with all surgical procedures. The primary surgical risks include bleeding and infection. Anesthesia-related risks include reactions to the specific anesthetic agents that are used; interactions with over-the-counter and herbal preparations; and respiratory problems. The greatest risk associated with umbilical hernia is missing the diagnosis. Additional risks include the formation of scar tissue and recurrence of the hernia.

Normal results

Umbilical hernia repair is usually considered an uncomplicated procedure with a relatively short recovery period. A study reported in the December 2002 issue of the *American Journal of Surgery* found that patients who had laparoscopic surgery with the use of a surgical mesh had fewer complications and reoccurrences of a hernia than those with the traditional open surgery. However, laparoscopic surgery took somewhat longer to perform, possibly because the laparoscopic approach is often used for larger repairs.

Morbidity and mortality rates

In general, there are few complications with hernia repair in children. The most serious complication is surgical injury to the bladder or intestine; fortunately, this complication is very rare—about one in 1,000 patients. The recurrence rate is between 1% and 5%; recurrence is more likely in patients with very large hernias. The rate of infection is less than 1%. In the adult population, a November 2001 study reported in the *American Journal of Surgery* found a 5% mortality in elderly patients undergoing emergency hernia repairs.

Alternatives

There are no medical or surgical alternatives to an umbilical hernia repair other than watchful waiting. Since umbilical hernias present at birth often close on their own, intervention can often be delayed until the child is several years old. There is some risk that the hernia will enlarge, however, which increases the risk of incarceration or strangulation.

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ORGANIZATIONS

American Academy of Family Physicians, P.O. Box 11210, Shawnee Mission, KS, 66207, (913)906-6000, (800) 274-2237, (913) 906-6075, http://www.aafp.org.

American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, IL, 60007-1098, (847) 434-4000, http://www.aap.org.

Esther Csapo Rastegari, R.N., B.S.N., Ed.M.

Uncinariasis *see* **Hookworm disease**

Undernutrition

Definition

Undernutrition is the result of inadequate intake of calories, protein, or micronutrients. Although undernutrition and **malnutrition** often are used interchangeably, malnutrition is a more inclusive term that includes overnutrition.

Demographics

The United Nations Children's Fund (UNICEF) estimates that about 195 million children have stunted growth as a direct result of undernutrition. Of these, about 90% are in Africa and Asia. India has the largest absolute number of stunted children, while Afghanistan has the highest percentage of stunted children. Undernutrition is uncommon in the developed world, but the British Nutrition Foundation estimates that about two million people in the United Kingdom are undernourished. Undernutrition has the most severe impact on children under age five.

Undernutrition in children is much less common in the United States than in developing countries. Estimates suggest that only about 1% of all children in the United States experience undernutrition. The highest risk children in the United States are those living in homeless shelters, where an estimated 10% of children are undernourished. Estimates also suggest that one in every seven elderly individuals in the United States consume fewer than 1,000 calories per day and are undernourished.

Description

Undernutrition is a serious problem in developing countries, especially in children under age five years. Undernutrition can begin before a baby is born. Deficiencies in calories, protein, **minerals**, and/or **vitamins** often affect the fetus during **pregnancy** because the mother does not consume enough calories and micronutrients. This often results in the delivery of a low birthweight baby. According to the World Health Organization (WHO), low birthweight accounts for about 60% of deaths in newborns in developing countries or 3.3% of all child deaths.

Undernutrition frequently continues into early childhood. There is a strong relationship between undernutrition and failure to survive. Children may not directly starve to **death** from undernutrition, although some do die of disorders such as marasmus, which is a severe deficiency in calories and protein. Instead, undernourished children tend to have weak immune systems that leave them highly susceptible to common diseases such as **diarrhea**, **pneumonia**, **malaria**, and **measles**, all of which are common in the developing world. Often, undernourished children go through a downward cycle of repeated disease and recovery before they die; if they do survive, this cycle exacts a heavy toll on their development. Exact figures are difficult to obtain from developing countries, but estimates suggest that maternal and child undernutrition is the cause of 3–5 million deaths annually. Zinc and **vitamin A deficiency** are the most common micronutrient deficiencies, while iron and iodine deficiencies also contribute to undernutrition.

A critical window for development exists between birth and age two years. Even when children survive these critical years, the effects of undernutrition remain. Often these children are stunted (short stature) or wasted (seriously underweight). In addition to physical effects, undernutrition can restrict a child's mental development.

Undernutrition in the elderly is a greater problem in the United States than undernutrition in children. Declining appetite, limited funds, difficulty in preparing and eating food, and disease all contribute to undernutrition in the elderly. Elderly people living in nursing homes or hospitalized for prolonged periods are at high risk for undernutrition. Any age individuals who have had **gastric bypass** surgery may experience undernutrition unless they take prescribed vitamin and mineral supplements.

Risk factors

Risk factors for undernutrition include inadequate food supply (e.g., famine), inadequate variety of food (i.e., food does not contain all the required micronutrients), living in a war zone, poverty, low maternal

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KEY TERMS

Micronutrients—Minerals and vitamins needed in small quantities to maintain health (e.g., iodine).

Stunting—A height more than two standard deviations from the median height for the age in the reference population.

Wasting—Weight more than two standard deviations below that of the median weight for the reference population.

status, poor **breastfeeding** habits, and cultural attitudes (e.g., boy infants may be fed more than girl infants).

Homelessness is a major cause of undernutrition in the United States, as is **alcoholism**. Diseases such as depression or other mental illness can cause individuals to stop eating or to refuse to eat a variety of foods. Certain medications can also inhibit the uptake of nutrients from the digestive system, resulting in undernutrition. Certain diseases, such as some cancers and **AIDS,** can cause the body to increase the amount of calories used, resulting in severe wasting, called cachexia.

Causes and symptoms

The root cause of undernutrition is inadequate intake of calories, protein, and micronutrients. Secondary causes are the same as the risk factors previously described.

Symptoms of undernutrition in children include low birth weight, stunting, wasting, low energy level, slowed physical development, impaired mental development, and frequent serious illnesses. In the elderly, undernutrition can cause weight loss, thinning and drying of the skin, hair loss, constantly feeling cold, confused thinking, frequent falls, and frequent infections. These symptoms often go unrecognized and are attributed to a general decline due to **aging**.

Diagnosis

Examination

Diagnosis is most often made by examination and by comparing the height and weight of the individual to the median height and weight of the reference population. The physician will review drugs the individual is taking and ask questions about alcohol and food consumption.

Tests

A **complete blood count** (CBC) generally is done to assess the individual's general health and to look for signs of infections. Blood tests may be done to measure the amount of albumin in the blood. Albumin is a blood protein that decreases when there is an inadequate amount of protein in the diet. Additional tests may be done when a specific vitamin or **mineral deficiency** is suspected.

Treatment

The only treatment for undernutrition is to increase calories and protein and to replace the micronutrients missing from the diet. In healthcare settings, such as a nursing home or hospital, this can be done in consultation with a registered dietitian. Long-term success in reducing undernutrition generally requires overcoming the barriers that prevent the individual from getting enough calories and enough food variety. This may involve:

- treating any underlying disease or mental condition contributing to the undernutrition
- overcoming barriers to food preparation, for example by enrolling the individual in Meals on Wheels
- providing a wide range of nutritious food through meals for the homeless, the establishment of inner city farmers's markets, or providing transportation to local food banks
- using drugs to stimulate the appetite
- enrolling individuals in food support programs such as Women Infants and Children (WIC), the Supplementary Nutrition Program (SNAP, formerly food stamps), and the Federal School Lunch program in the United States

Individuals who cannot eat, for example those who cannot swallow because they have had a **stroke**, may be fed through a tube inserted into the nose and down the esophagus to the stomach. Individuals who do not absorb enough nutrients from the digestive tract may be fed intravenously (**total parenteral nutrition**). Both these feeding methods have drawbacks and potentially serious side effects.

Prognosis

Some early effects of undernutrition cannot be reversed. Consistent undernutrition before birth and during the first five years of life often leads to childhood death. In survivors, it has permanent physical and developmental effects. Even if the child later receives adequate nutrition, he or she may remain short of

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stature and have permanent cognitive deficits. Undernutrition during pregnancy can lead to **miscarriage**, premature delivery, a low birthweight baby, maternal susceptibility to disease, and maternal death. Undernutrition in the elderly results in more frequent and more severe illness and infection.

Prevention

The problem of preventing undernutrition is complex. Many international aid agencies work to prevent undernutrition, especially undernutrition in children. Their goal is to eventually help developing countries develop adequate food resources for the entire population. To do this, they must overcome food delivery, storage, and distribution problems; regional warfare; poverty; illiteracy; and cultural attitudes. UNICEF and WHO have made reducing child undernutrition one of their priorities for the twenty-first century.

Exclusive breastfeeding for at least six months with supplemental breast feeding until age two is recommended for all babies. This is especially important in developing countries where supplies of clean water and adequate infant food are limited. According to WHO, appropriately breastfed children in developing countries are six times more likely to survive to age five than those who are not breast fed.

In the United States, treating homelessness, alcoholism, and drug **abuse**, as well as educating individuals about food security programs that are available to them, are the most effective ways of preventing undernutrition.

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American Dietetic Association, 120 South Riverside Plaza, Suite 2000, Chicago, IL, 60606-6995, (800) 877-1600, http://www.eatright.org.

British Nutrition Foundation, High Holborn House, 52-54 High Holborn, London, United Kingdom, WC1V 6RQ, 020 7404 6504, 020 7404 6747, postbox@britishnutrition.org.uk, http://www.britishnutrition.org.uk.

World Health Organization, Avenue Appia 20, 1211 Geneva 27, Switzerland, +22 41 791 21 11, +22 41 791 31 11, info@who.int, http://www.who.int.

Tish Davidson, AM

Undescended testes

Definition

Also known as cryptorchidism, undescended testes is a congenital condition characterized by testicles that do not extend to the scrotum. This condition is the most common male sexual development abnormality.

Demographics

Thirty percent of premature boys have testes that have not yet made the full descent. Only 3–5% of full-term baby boys have undescended testes, and half of those complete the journey by the age of four months. Most cases, about 97% to 99%, of undescended testes naturally correct themselves during the first year of life. Spontaneous descent, however, does not seem to occur after age 9 months.

Description

In the fetus, the testes are in the abdomen. As development progresses they migrate downward through the groin and into the scrotum. This event takes place late in fetal development, during the eighth month of gestation. Undescended testes that are not corrected can lead to sterility, **testicular torsion** and an increased risk of **testicular cancer**.

Causes and symptoms

The cause of undescended testes is presently unknown. However, its symptoms are quite apparent. One or both of the testicles can be undescended,

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KEY TERMS

Cryptorchidism—Undescended testes.

Embryonic—Early stages of life in the womb.

Fetal—Refers to the fetus, also known in the first two months after conception as an embryo.

Orchiopexy—Surgical procedure that places the testicles in the scrotum.

therefore the testicles appear to be either missing or lopsided.

Undescended testicles are more likely to occur in boys of low birth weight, from twin pregnancies, and in small babies. Maternal estrogen exposure seems to play a role in cryptorchidism. Cryptorchidism is also associated with the following conditions:

- inguinal hernia
- hypospadias
- cerebral palsy
- mental retardation and Down syndrome
- Wilms tumor
- prune belly syndrome and Prader-Willi syndrome

Diagnosis

Examination

The newborn examination always includes checks for testes in the scrotum. It they are not found, a search will be conducted, but not necessarily right away. In most cases, the testes will drop into place later. If the testes are present at all, they can be anywhere within a couple of inches of the appropriate spot. In 5% of cases, one testis is completely absent. In 10%, the condition occurs on both sides.

The patient should be examined in a warm location and should be as relaxed as possible. The examination begins with a visual inspection prior to manual palpation. The patient may be placed in the frog-leg or catcher position to facilitate the examination. The preferred examination technique is to begin palpating at the level of the inguinal canal and to perform a milking motion down until the level of the scrotum. If the testicle cannot be located in the inguinal area, examination of the penis, femoral and perineal areas are conducted as occasionally the testicle may be found in those locations.

Tests

If the testes are unable to be palpated or if there is unilateral or bilateral undescended testes, chromosomal testing and measurement of multiple hormone levels may be indicated.

Procedures

Diagnostic **laparoscopy** may be implemented for localizing testis which can not be palpated. This procedure is often combined with definitive therapy such as laparoscopic or open orchiopexy.

Treatment

Once it is determined that the testes will not naturally descend, surgery becomes necessary. The procedure is called an orchiopexy and is relatively simple once the testes are located. The surgery is usually performed when the boy is between one and two years old. Early surgical intervention, prior to age one, seems to be of most benefit.

In Europe, hormonal therapy, utilizing human chorionic gonadotropin and/or leuteinizing releasing hormones, has been used for many years to treat cryptorchidism especially in patients who may not be candidates for surgical intervention.

Prognosis

Orchiopexy conducted prior to age two years has been shown to result in less damage to the testis and may also improve viability of sperm. Currently, orchiopexy prior to age 1 is recommended.

In men with undescended testes the risk for developing testicular **cancer** is 3–5% which is 4 to 7 times higher than when compared to the risk for men without this condition. Surgical intervention does not protect against the development of subsequent testicular cancer but it does place the testis in a more accessible anatomical position to facilitate routine self-evaluation and for clinical evaluation purposes.

Men with a history of bilateral undescended testicles tend to have a higher **infertility** rate when compared to men with unilateral cryptorchidism or with men in the general population. Men with bilateral undescended testicles have a 60% paternity rate while men with a unilateral undescended testicle have 90% paternity rate as compared to the paternity rate of 94% of men in the general population.

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J. Ricker Polsdorfer, MD
Melinda Granger Oberleitner, RN, DNS, APRN, CNS

Undulant fever *see* **Brucellosis**

Unipolar depression *see* **Depressive disorders**

Upper GI exam

Definition

An upper GI examination is a fluoroscopic examination (a type of x-ray imaging) of the upper gastrointestinal tract, including the esophagus, stomach, and upper small intestine (duodenum).

Purpose

An upper GI series is frequently requested when a patient experiences unexplained symptoms of abdominal **pain**, difficulty in swallowing (dysphagia), regurgitation, **diarrhea**, or weight loss. It is used to help diagnose disorders and diseases of, or related to, the upper gastrointestinal tract, including cases of **hiatal hernia**, diverticuli, ulcers, tumors, obstruction, enteritis, **gastroesophageal reflux disease**, **Crohn's disease**, and pulmonary aspiration.

Precautions

Because of the risks of radiation exposure to the fetus, pregnant women are advised to avoid this procedure. Patients with an obstruction or perforation in their bowel should not ingest barium (a radioactive substance used to show contrast in the images) for an upper GI, but may still be able to undergo the procedure if a water-soluble contrast medium is substituted for the barium.

Glucagon, a medication sometimes given prior to an upper GI procedure, may cause **nausea** and **dizziness**.

Description

An upper GI series takes place in a hospital or clinic setting and is performed by an x-ray technician and a radiologist. A radiologist typically is in attendance to oversee the procedure, and view and interpret the fluoroscopic pictures. Before the test begins, the patient is sometimes administered an injection of glucagon, a medication which slows stomach and bowel activity, to allow the radiologist to get a clearer picture of the gastrointestinal tract. In order to further improve the clarity of the upper GI pictures, the patient may be given a cup of baking soda crystals to swallow, which distend the stomach by producing gas.

Once these preparatory steps are complete, the patient stands against an upright x-ray table, and a fluoroscopic screen is placed in front of him. The patient will be asked to drink from a cup of flavored barium sulfate, a thick and chalky-tasting liquid that allows the radiologist to see the digestive tract, while the radiologist views the esophagus, stomach, and duodenum on the fluoroscopic screen. The patient will be asked to change positions frequently in order to coat the entire surface of the gastrointestinal tract with barium. The technician or radiologist may press on the patient's abdomen in order to spread the barium. The x ray table will also be moved several times throughout the procedure. The radiologist will ask the patient to hold his breath periodically while exposures are being taken. The entire procedure takes approximately 30 minutes.

In some cases, in addition to the standard upper GI series, a doctor may request a detailed intestine, or small bowel, radiography and fluoroscopy series; it is also called a small bowel follow-through (SBFT). Once the preliminary upper GI series is complete, the patient will be escorted to a waiting area while the barium travels down through the rest of the small intestinal path. Every 15–30 minutes, the patient will return to the x-ray suite for additional x rays, or films. Once the barium has completed its trip down the small bowel tract, the test is completed. This procedure can take anywhere from one to four hours.

Esophageal radiography, also called a barium esophagram or a barium swallow, is a study of the esophagus only, and is usually performed as part of the upper GI series. It is commonly used to diagnose the cause of difficulty in swallowing (dysphagia) and for detecting

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hiatal hernia. A barium sulfate liquid, and sometimes pieces of food covered in barium, are given to the patient to drink and eat while a radiologist examines the swallowing mechanism on a fluoroscopic screen. The test takes approximately 30 minutes.

Preparation

Patients must not eat, drink, or smoke for eight hours prior to undergoing an upper GI examination. Longer dietary restrictions may be required, depending on the type and diagnostic purpose of the test. Patients undergoing a small bowel follow-through exam may be asked to take **laxatives** the day prior to the test. Upper GI patients are typically required to wear a hospital gown, or similar attire, and to remove all jewelry, so the camera has an unobstructed view of the abdomen.

Aftercare

No special aftercare treatment or regimen is required for an upper GI series. The patient may eat and drink as soon as the test is completed. The barium sulfate may make the patient's stool white for several days, and patients are encouraged to drink plenty of fluids in order to eliminate it from their system.

Risks

Because the upper GI series is an x-ray procedure, it does involve minor exposure to ionizing radiation. Unless the patient is pregnant or multiple radiological or fluoroscopic studies are required, the small dose of radiation incurred during a single procedure poses little risk. However, multiple studies requiring fluoroscopic exposure that are conducted in a short time period have been known, on rare occasions, to cause skin **death** (necrosis) in some individuals. This risk can be minimized by careful monitoring and documentation of cumulative radiation doses administered to these patients.

Normal results

A normal upper GI series will show a healthy, functioning, and unobstructed digestive tract.

Abnormal results

Obstructions or inflammation, including ulcers of the esophagus, stomach, or small intestine, or irregularities in the swallowing mechanism are just a few of the possible abnormalities that may show up on an upper GI series.

Resources

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Paula Anne Ford-Martin

Urea clearance by the kidneys *see* **Kidney function tests**

Ureteral stenting

Definition

Ureteral stents are thin catheters threaded into segments of the ureter that carry urine, produced by the kidney, either down into the bladder internally, or to an external collection system. Insertion is most often done through the skin (percutaneously); however, in the presence of kidney or ureteral stones, stenting is ideally done during **cystoscopy**.

Purpose

Ureteral stenting may be placed on a long-term basis (months to years) in order to bypass ureteral obstruction. Short-term stenting (weeks to months) may be used as an adjunct to open surgical procedures of the urinary tract to provide a mold around which healing can occur, or to divert the urinary flow away from areas of leakage. Following balloon dilation or incision of ureteral strictures, placement of stents maintains the functionality of the ureters. Stents may also be used in the presence of **kidney stones** to manipulate or prevent stone migration prior to treatment or to make the ureters more easily identifiable during difficult surgical procedures. Ureteral stents may be used in those with active kidney infection or with markedly diseased, intolerant bladders (e.g., damage from **radiation therapy**, bladder invasion by adjacent neoplasm).

Preparation

The procedure should be thoroughly explained by a medical professional before it takes place. The patient will be asked to put on a hospital gown. If the procedure is performed with the aid of a cytoscope, the patient will assume a position that is typically used in a gynecological exam.

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KEY TERMS

Cystoscopy—Examination or treatment of the interior of the urinary bladder by looking through a special instrument with reflected light.

Stricture—An abnormal narrowing of a tube or passageway.

Ureter—The tube-like passageway in the body that carries urine from the kidney to the bladder.

Aftercare

Stents must be periodically replaced to prevent **fractures** within the catheter wall or buildup of encrustation. Stent replacement is recommended approximately every six months or more often in patients who form stones.

Normal results

Normally, a ureteral stent assures the patient of a free flow of urine. Postoperatively, urine flow will be monitored to ensure the stent has not been dislodged or obstructed.

Abnormal results

Serious complications of the procedure occur in approximately four percent of cases, with minor complications in another 10%. These may include:

- Bleeding. Usually minor and easily treated, occasionally requiring transfusion
- Catheter migration or dislodgement. May require readjustment with the fluoroscope in the Radiology Department
- Coiling of the stent within the ureter. May cause lower abdominal pain or flank pain on urination, urinary frequency, or blood in the urine
- Introduction or worsening of infection
- Penetration of adjacent organs (e.g., bowel, gallbladder, or lungs)

ORGANIZATIONS

National Kidney Foundation, 30 East 33rd Street, New York, NY, 10016, (212) 889-2210, (800) 622-9010, Fax (212) 689-9261, http://www.kidney.org.

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Ureterostomy *see* **Urinary diversion surgery**

Urethra defects *see* **Hypospadias and epispadias**

Urethritis

Definition

Urethritis is an inflammation of the urethra that is usually caused by an infection.

Description

The urethra is the canal that moves urine from the bladder to the outside of the body. When this canal becomes infected, inflammation occurs due to the accumulation of white blood cells in the area. When this occurs, it is called urethritis. Besides the urethra, the urinary tract consists of the bladder, ureters, and kidneys. Inflammation can move up the urethra, causing **cystitis** in the bladder, or **nephritis** in the kidneys. Collectively, these inflammations are called urinary tract infections or UTIs.

Urinary tract infections are much more common in women than in men, probably due to anatomy. Infections are especially more common in older women, due to bladder problems.

Causes and symptoms

Uncomplicated urethritis usually results from infection by the bacteria ***Escherichia coli***, commonly found in the bowel. Complicated urethritis can occur when other problems exist, such as **kidney stones**, malformations of the urinary tract, **spinal cord injury**, or a compromised immune system. People with diabetes tend to have more urinary tract infections, as well as hospitalized patients. Urinary tract infections can also be sexually transmitted. Some people seem to be susceptible to urinary tract infections, having them recurrently.

Frequently, a **urinary tract infection** has no symptoms. Common symptoms though, include **pain** and a burning sensation when urinating, frequent urination, or passing blood in the urine. Signs that the infection may be worsening include **fever** and chills, **nausea**, **vomiting**, and lower back pain.

Diagnosis

The diagnosis for a urinary tract infection is made by assessing the symptoms, feeling (palpating) the abdomen for tenderness, and a **urinalysis**. A urinalysis, or urine sample, is examined for both the presence of bacteria and white blood cells. After this, a **urine culture** to determine what bacteria is causing the infection may be done.

Treatment

Typical treatment for urinary tract infections is a course of **antibiotics**. In women who have recurrent

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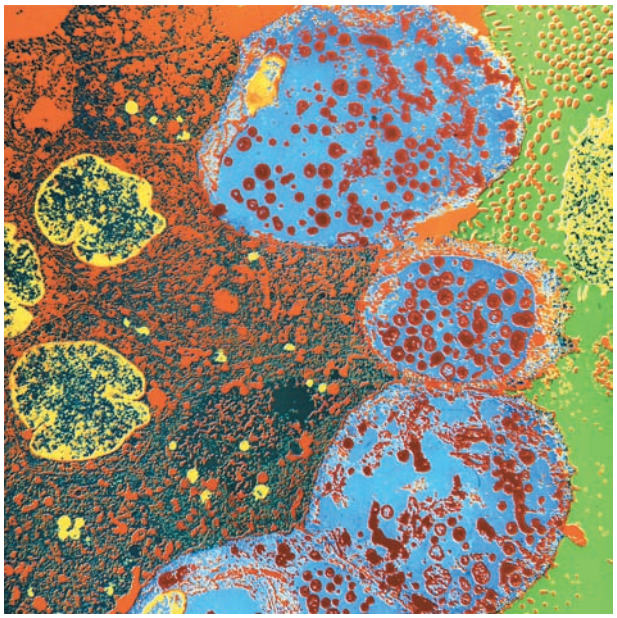

A false color transmission electron micrograph (TEM) scan of non-specific urethritis. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

urethritis, the diagnosis and treatment is often resolved over the phone. Additional drugs are sometimes given to relieve discomfort.

Alternative treatment

For those individuals who seem to be more susceptible to urinary tract infections, drinking lots of fluids at the first sign of an infection can ward it off by diluting the bacteria present and flushing the system. Adding a teaspoon of baking soda to a glass of water and drinking it can change the pH of the urine, causing it to burn less. Also, cranberry juice contains a compound that can prevent bacteria from sticking to and thus growing in the urinary tract. Antimicrobial herbs, such as uva ursi (*Arctostaphylos uva-ursi*) and pipsissewa (*Chimaphila umbellata*), may be helpful. Other herbs, such as marsh mallow (*Althaea officinalis*), slippery elm (*Ulmus fulva*), comfrey (*Symphytum officinale*), plantain (*Plantago major*), and cornsilk, can soothe the urinary tract. *Lactobacillus acidophilus* and *L. bifidus* supplementation reintroduces normal flora into the urinary tract. **Acupuncture** and homeopathy can also be effective therapies for urethritis.

Prognosis

Given the appropriate antibiotic, urinary tract infections usually go away quickly. If not treated soon enough, however, urethritis can move up the urinary tract, infecting the bladder and possibly the kidneys, resulting in kidney damage. If the infection moves into the blood, additional complications can arise. Those who have previously had a urinary tract infection are more susceptible to additional urinary tract infections. Because of this, patients need to be aware of the symptoms so that a physician can be notified if the infection becomes recurrent.

Prevention

There are some steps that can be taken to keep the urinary tract healthy and prevent infection:

- drink plenty of fluids
- do not hold urine once the urge to urinate has occurred
- after a bowel movement, wipe from front to rear to keep bowel bacteria at a distance
- wear cotton underwear
- rinse soap off well in the shower
- urinate after sexual intercourse
- for post-menopausal women, estrogen replacement therapy can help prevent urinary tract infection

ORGANIZATIONS

National Kidney and Urologic Diseases Information Clearinghouse, 3 Information Way, Bethesda, MD, 208923580, (800) 891–5390, TTY (866) 569–1162, FAX (703)7384929, nkudic@info.niddk.nih.gov, http://kidney.niddk.nih.gov

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Uric acid tests

Definition

Uric acid tests are tests that are done to measure the levels of uric acid in blood serum or in urine.

Purpose

Uric acid tests are used to evaluate the blood levels of uric acid for **gout** and to assess uric acid levels in the urine for kidney stone formation. The urine test is used most often to monitor patients already diagnosed with **kidney stones**, but it can also be used to detect disorders that affect the body's production of uric acid and to help measure the level of kidney functioning.

Uric acid is a waste product that results from the breakdown of purine, a nucleic acid. (Nucleic acids are

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KEY TERMS

Fanconi's syndrome—A rare disorder caused by vitamin D deficiency or exposure to heavy metals.

Gout—A metabolic disorder characterized by sudden recurring attacks of arthritis caused by deposits of crystals that build up in the joints due to abnormally high uric acid blood levels. In gout, uric acid may be overproduced, underexcreted, or both.

Hyperuricemia—Excessively high levels of uric acid in the blood, often producing gout.

Purine—A white crystalline substance that is one of the building blocks of DNA. Uric acid is produced when purine is broken down in the body.

Uric acid—A compound resulting from the body's breakdown of purine. It is normally present in human urine only in small amounts.

Uricosuria—Increased levels of uric acid in the urine.

Wilson's disease—A rare hereditary disease marked by the buildup of copper in the liver and brain, causing loss of kidney function.

the building blocks of DNA.) Uric acid is made in the liver and excreted by the kidneys. If the liver produces too much uric acid or the kidneys excrete too little, the patient will have too much uric acid in the blood. This condition is called hyperuricemia. Supersaturated uric acid in the urine (uricosuria) can crystallize to form kidney stones that may block the tubes that lead from the kidneys to the bladder (the ureters).

Precautions

Blood test

Patients scheduled for a blood test for uric acid should be checked for the following medications: loop **diuretics** (Diamox, Bumex, Edecrin, or Lasix); ethambutol (Myambutol); vincristine (Oncovin); pyrazinamide (Tebrazid); thiazide diuretics (Naturetin, Hydrex, Diuril, Esidrix, HydroDiuril, Aquatensen, Renese, Diurese); **aspirin** (low doses); **acetaminophen** (Tylenol); ascorbic acid (vitamin C preparations); levodopa (Larodopa); or phenacetin. These drugs can affect test results.

Certain foods that are high in purine may increase the patient's levels of uric acid. These include kidneys, liver, sweetbreads, sardines, anchovies, and meat extracts.

Urine test

Patients should be checked for the following medications before the urine test: diuretics, aspirin, pyrazinamide (Tebrazid), phenylbutazone, probenecid (Benemid), and allopurinol (Lopurin). If the patient needs to continue taking these medications, the laboratory should be notified.

The laboratory should also be notified if the patient has had recent x ray tests requiring contrast dyes. These chemicals increase uric acid levels in urine and decrease them in blood.

Description

The uric acid blood test is performed on a sample of the patient's blood, withdrawn from a vein into a vacuum tube. The procedure, which is called a venipuncture, takes about five minutes. The urine test requires the patient to collect all urine voided over a 24-hour period, with the exception of the very first specimen. The patient keeps the specimen container on ice or in the refrigerator during the collection period.

Preparation

The uric acid test requires either a blood or urine sample. For the blood sample, the patient should be **fasting** (nothing to eat or drink) for at least eight hours before the test. The urine test for uric acid requires a 24-hour urine collection. The urine test does *not* require the patient to fast or cut down on fluids. Some laboratories encourage patients to drink plenty of fluids during the collection period.

Risks

Risks for the blood test are minimal, but may include slight bleeding from the puncture site, a small bruise or swelling in the area, or **fainting** or feeling lightheaded.

Normal results

Blood test

Reference values for blood uric acid vary from laboratory to laboratory but are generally found within the following range: Male: 2.1–8.5 mg/dL; female: 2.0–6.6 mg/dL. Values may be slightly higher in the elderly.

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Urine test

Reference values for 24-hour urinary uric acid vary from laboratory to laboratory but are generally found within the following range: 250–750 mg/24 hours.

Abnormal results

The critical value for the blood test is a level of uric acid higher than 12 milligrams per deciliter (about 3.4 ounces).

Increased *production* of uric acid may result from eating foods that are high in purine. Increased uric acid levels due to overproduction may also be caused by gout, by a genetic disorder of purine metabolism, or by metastatic **cancer**, destruction of red blood cells, leukemia, or cancer **chemotherapy**.

Decreased *excretion* of uric acid is seen in chronic **kidney disease**, low thyroid, toxemia of **pregnancy**, and **alcoholism**. Patients with gout excrete less than half the uric acid in their blood as other persons. Only 10-15% of the total cases of hyperuricemia, however, are caused by gout.

Abnormally low uric acid levels may indicate that the patient is taking allopurinol or probenecid for treatment of gout; may be pregnant; or suffers from Wilson's disease or **Fanconi's syndrome**.

Resources

BOOKS

Pagana, Kathleen Deska, and Timothy J. Pagana. *Mosby's Manual of Diagnostic and Laboratory Tests*. 4th ed. St. Louis: Mosby, 2009.

Janis O. Flores

Urinalysis

Definition

Urinalysis is a diagnostic physical, chemical, and microscopic examination of a urine sample (specimen). Specimens can be obtained by normal emptying of the bladder (voiding) or by a hospital procedure called catheterization.

Purpose

Urinalyses are performed for several reasons:

- general evaluation of health
- diagnosis of metabolic or systemic diseases that affect kidney function
- diagnosis of endocrine disorders. Twenty-four hour urine studies are often ordered for these tests.
- diagnosis of diseases or disorders of the kidneys or urinary tract
- monitoring of patients with diabetes
- testing for pregnancy
- screening for drug abuse

Precautions

Voided specimens

Urinalysis should not be performed while a woman is menstruating or having a vaginal discharge. A woman who must have a urinalysis while she has a vaginal discharge or is having her period should insert a fresh tampon before beginning the test. She should also hold a piece of clean material over the entrance to her vagina to avoid contaminating the specimen.

Patients do not have to fast or change their food intake before a urine test. They should, however, avoid intense athletic training or heavy physical work before the test because it may result in small amounts of blood in the urine.

The following drugs can affect urinalysis results. The patient may be asked to stop taking them until after the test:

- nitrofurantoin (Macrodantin, Furadantin), prescribed for infections of the urinary tract and other bacterial infections
- phenazopyridine (Pyridium), used to relieve burning and pain caused by urinary tract infections
- rifampin (Rifadin), prescribed to treat tuberculosis, prevent the spread of meningitis, and treat other infections

Bladder catheterization

Bladder catheterization is sometimes used to collect urine samples from hospitalized patients. It should not, however, be used to collect specimens from males with acute inflammation of the prostate or from a patient of either sex with a fractured pelvis.

Description

Collecting a urine sample from emptying the bladder takes about two or three minutes. The sample can be collected at home as well as in a doctor's office. Urine specimens are usually collected early in the morning before breakfast. Urine collected eight hours after eating and at least six hours after the most recent

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urination is more likely to indicate abnormalities. Some people may be asked to void into a clean container before getting out of bed in the morning.

Specimen containers

The doctor or hospital will supply a sterile container for a specimen being collected for a colony count. A colony count is a test that detects bacteria in urine that has been cultured for 24–48 hours. It is used instead of a routine urinalysis when a patient's symptoms suggest a **urinary tract infection**. Nonsterile containers can be used for routine specimens that will not be tested immediately after being collected. An ordinary open-necked jar may be used after it and its lid have been soaked in very hot water for 15–20 minutes and then air-dried.

Laboratory procedures

STORAGE. Urine specimens should not remain unrefrigerated for longer than two hours. A urine specimen that cannot be delivered to a laboratory within two hours should be stored in a refrigerator. The reason for this precaution is that urine samples undergo chemical changes at room temperature. Blood cells begin to dissolve and the urine loses its acidity.

VISUAL EXAMINATION. A doctor, nurse, or laboratory technician will look at the specimen to see if the urine is red, cloudy, or looks unusual in any way. He or she will also note any unusual odor.

TESTING TECHNIQUES. Urine samples are tested with a variety of different instruments and techniques. Some tests use dipsticks, which are thin strips of plastic that change color in the presence of specific substances. Dipsticks can be used to measure the acidity of the urine (its pH) or the presence of blood, protein, sugar, or substances produced during the breakdown of fatty acids (ketones). A urinometer is used to compare the density of the urine specimen with the density of plain water. This measurement is called specific gravity.

The urine specimen is also examined under a microscope to determine whether it contains blood cells, crystals, or small pieces of fibrous material (casts).

Preparation

Voided specimens

Most urine specimens from adults or older children are collected by the patient's voiding into a suitable container. Soaps and disinfectants may contaminate urine specimens and should not be used. The doctor or laboratory may supply a special antiseptic solution that won't irritate the skin. The method for collection varies somewhat according to age and sex.

WOMEN AND GIRLS. Before collecting a urine sample, a woman or girl should use a clean cotton ball moistened with lukewarm water to cleanse the external genital area. Gently separating the folded skin (labia) on either side of her vagina, she should move the cotton ball from the front of the area to the back. After repeating this process several times, using a fresh piece of cotton each time, she should dry the area with a clean towel.

To prevent menstrual blood, vaginal discharge, or germs from the external genitalia from contaminating the specimen, a woman or girl should release some urine before she begins to collect her sample. A urine specimen obtained this way is called a midstream clean catch.

MEN AND BOYS. A man or boy should use a piece of clean cotton, moistened with antiseptic, to cleanse the head of his penis and the passage through which urine leaves his body (the urethral meatus). He should draw back his foreskin if he has not been circumcised. He should move the cotton in a circular motion away from the urinary opening, using a fresh piece of cotton each time. After repeating this process several times, he should use a fresh piece of cotton to remove the antiseptic. After the area has been thoroughly cleansed, he should begin urinating and collect a small sample in a container without interrupting the stream of urine.

INFANTS. A parent, nurse, or doctor should cleanse the child's genitals and as much of the surrounding area as will fit into the sterile urine-collection bag provided by the hospital. When the area has been thoroughly cleansed, the bag should be attached to the child's genital area and left in place until the child has urinated. It is important to remember not to touch the inside of the bag and to remove it as soon as a specimen has been obtained.

Bladder catheterization

Bladder catheterization is a hospital procedure used to collect uncontaminated urine when the patient cannot void. A catheter is a thin flexible tube that the doctor inserts through the urethra into the bladder to allow urine to flow out. To minimize the risk of infecting the patient's bladder with bacteria, many doctors use a so-called Robinson catheter, which is a plain rubber or latex tube that is removed as soon as the specimen is collected.

Suprapubic bladder aspiration is a technique that is sometimes used to collect urine from infants younger than six months. The doctor withdraws urine from the

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bladder into a syringe through a needle inserted through the skin over the bladder. This technique is used only when the child cannot void because of an abnormal urethra or if he or she has a urinary tract infection that has not responded to treatment.

Aftercare

The patient may return to normal activities after collecting the sample and may start taking medications that were discontinued before the test.

Risks

There are no risks associated with voided specimens. The risk of bladder infection from catheterization with a Robinson catheter is about 3%.

Normal results

Contents and appearance

Normal urine is a clear straw-colored liquid. It has a slight odor. It contains some crystals, a small number of cells from the tissues that line the bladder, and transparent (hyaline) casts. Normal urine does *not* contain sugars, yeast cells, protein, ketones, bacteria, or parasitic organisms.

The time of day a urine sample is collected can make a difference in the appearance of the specimen. Some foods and medicines, including red beets, asparagus, and penicillin, can affect the color or smell of urine. Although most color variations are harmless, they sometimes indicate the presence of serious disease. A doctor, nurse, or laboratory technician should be notified if the urine is red or cloudy or looks unusual in any way.

Acidity

The pH of normal urine is 4.5–8.0. Its specific gravity is 1.0005–1.035.

Abnormal results

Cloudiness

Urine may be cloudy (turbid) because it contains red or white blood cells, bacteria, fat, mucus, digestive fluid (chyle), or pus from a bladder or kidney infection.

Odor

Foul-smelling urine is a common symptom of urinary tract infection. A fruity odor is associated with **diabetes mellitus**, **starvation**, **dehydration**, or ketone formation. Other distinctive odors are present in the urine of patients with maple syrup urine disease or **phenylketonuria** (PKU).

Specific gravity

The specific gravity of urine can be affected by a range of diseases and disorders. Low specific gravity (below 1.005) is associated with **diabetes insipidus**, nephrogenic diabetes insipidus, acute tubular necrosis, and inflammation of the upper urinary tract (**pyelonephritis**). In fixed specific gravity, the specific gravity of the urine remains at 1.010 no matter how much fluid the person drinks. This condition occurs in patients who have chronic inflammation of the small blood vessels in the kidneys (**glomerulonephritis**) and serious kidney damage. High specific gravity (above 1.035) occurs in patients who are in **shock** or who suffer from **nephrotic syndrome**, dehydration, acute glomerulonephritis, congestive **heart failure**, or liver failure.

pH

A pH factor greater than 7 (more alkaline) may result from **Fanconi's syndrome**, urinary tract infections, or metabolic or **respiratory alkalosis**. A pH factor below 7 (more acid) may be due to **fever**, PKU, the secretion of homogentisic acid in the urine (alkaptonuria), or acidosis.

Blood and tissue cells

Red blood cells in the urine can be due to vigorous **exercise** or exposure to toxic chemicals. Bloody urine can also be a sign of bleeding in the genitourinary tract as a result of systemic bleeding disorders, various kidney diseases, bacterial infections, parasitic infections including **malaria**, obstructions in the urinary tract, **scurvy**, subacute bacterial **endocarditis**, traumatic injuries, and tumors.

A high number of white blood cells in the urine is usually a symptom of urinary tract infection. A large number of cells from tissue lining (epithelial cells) can indicate damage to the small tubes that carry material into and out of the kidneys.

Casts

Casts are small fibrous objects that are formed when protein and other materials settle in the kidney tubules and collecting ducts. Casts are dislodged by normal urine flow. A large number of them in a urine specimen is a sign of **kidney disease**.

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KEY TERMS

Acidosis—A condition of the blood in which bicarbonate levels are below normal.

Alkalosis—A condition of the blood and other body fluids in which bicarbonate levels are higher than normal.

Casts—Small fibrous objects formed from materials that collect in the kidney tubules and are washed out by normal urine flow.

Catheter—A thin flexible tube inserted through the urethra into the bladder to allow urine to flow out.

Clean catch specimen—A urine specimen that is collected from the middle of the urine stream after the first part of the flow has been voided.

Colony count—A measurement of the growth of bacteria in a urine sample that has been cultured for 24 to 48 hours.

Fanconi's syndrome—A rare disorder caused by vitamin D deficiency or exposure to heavy metals.

Ketones—Substances produced during the breakdown of fatty acids. They are produced in excessive amounts in diabetes and certain other abnormal conditions.

Nephrotic syndrome—A condition characterized by water retention, little or no protein in urine, and high blood cholesterol.

pH—A chemical symbol used to describe the acidity or alkalinity of a fluid, ranging from 0 (more acid) to 14 (more alkaline).

Urethra—The duct that carries urine from the bladder to the outside of the body.

Urinalysis (plural, urinalyses)—The diagnostic testing of a urine sample.

Voiding—Another word for emptying the bladder or urinating.

Crystals

There are several different chemicals in body fluids that can form crystals that appear in urine. Some of these appear in normal urine, such as **calcium** oxalate or uric acid crystals. A large number of calcium oxalate crystals, however, may be a sign of abnormally high levels of calcium in the blood (**hypercalcemia**). Other crystals, including tyrosine, leucine, and cholesterol, are abnormal. The presence of cystine crystals is a symptom of excessive urinary secretion of cystine (**cystinuria**). Cystine is an acid found in many proteins and normally reabsorbed by the kidney tubules.

Protein

Protein in the urine can be a symptom of **kidney stones**, inflammation of the kidneys, degenerative kidney disease, or multiple tumors.

Sugars

A high level of glucose and other sugars in the urine (glycosuria) is often a symptom of diabetes mellitus. Glycosuria can also be caused by advanced kidney disease, **Cushing's syndrome**, impaired tubular reabsorption, shock, a rare tumor of the adrenal gland (**pheochromocytoma**), or **cancer** of the pancreas.

Milk in the urine is normal if a woman is pregnant, has just given birth, or is **breastfeeding**. On the other hand, rare hereditary metabolic disorders are indicated when urine contains fruit sugar (fructose), milk sugar (galactose), or a simple sugar called pentose.

Ketones

The presence of abnormally high numbers of ketones in the urine (ketonuria) usually results from uncontrolled diabetes mellitus. Ketonuria can also be caused by prolonged **diarrhea** or **vomiting** that results in starvation.

Bilirubin

Bilirubin is an orange-yellow pigment found in bile, a fluid secreted by the liver. When it is found in urine, bilirubin may be a symptom of **liver disease** caused by the formation of fibrous tissue, medications that damage the liver, or obstructive **jaundice**.

Urobilinogen

Bacteria in the small intestine can convert bilirubin to urobilinogen, which is excreted in the feces, in bile, or in urine. An accumulation of urobilinogen in the urine may be a sign of severe infection, liver damage, or diseases that destroy red blood cells. Low levels of urobilinogen in the urine may be a result of antimicrobial therapy, inflammatory diseases, kidney disease, severe diarrhea, or blocked bile ducts.

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Other findings

The presence of bacteria, parasites, or yeast cells in the urine may be a symptom of urinary tract infection or contamination of the external genitalia. Other factors that may affect urinalysis results include failure to collect a specimen during the day's first voiding, frequent urination, large dietary intake of vitamin C, and urine with a pH value lower than 6.

ORGANIZATIONS

American Association of Kidney Patients, 3505 E. Frontage Road, Suite 315, Tampa, FL, 33607, 813 636-8122, 800 749-2257, info@aakp.org, http://www.aakp.org.

American Kidney Fund (AKF), 6110 Executive Boulevard, Suite 1010, Rockville, MD, 20852, 800 638-8299, http://www.kidneyfund.org.

Maureen Haggerty

Urinary anti-infectives

Definition

Urinary anti-infectives are medicines used to treat or prevent infections of the urinary tract—the passage through which urine flows from the kidneys out of the body.

Purpose

Normally, no bacteria or other disease-causing organisms live in the bladder. Likewise, the urethra—the tube-like structure that carries urine from the bladder out of the body—usually has either no bacteria or not enough to cause problems. But the bladder, urethra, and other parts of the urinary tract may become infected when disease-causing organisms invade from other body regions or from outside the body. Urinary anti-infectives are used to treat such infections or to prevent them in people who get them often.

Description

Commonly used urinary anti-infectives include methenamine (Urex, Hiprex, Mandelamine), nalidixic acid (NegGram) and nitrofurantoin (Macrobid, Furatoin, and other brands). These medicines are available only with a physician's prescription and come in capsule, tablet, granule, and liquid forms.

Recommended dosage

Methenamine

For adults and children 12 years and over, the usual dosage is 1 gram, taken either twice a day or four times a day, depending on the form in which the drug comes. For children aged 6–12 years, the dosage ranges from 500 mg taken 2–4 times a day to 1 gram taken twice a day, again depending on the form of the drug. For children under 6 years, a physician must determine the dose.

This medicine will not work properly unless the urine is acidic, with a pH of 5.5 or below. The physician who prescribes the medicine will explain how to test the urine's acidity. The physician also may suggest diet changes that will make the urine more acidic, such as eating more protein, drinking cranberry juice, eating plums and prunes, but avoiding most other fruits, and cutting down on milk and other dairy products. **Antacids** should be avoided.

Nalidixic acid

The recommended dosage for adults and children 12 years and older is 1 gram every 6 hours. If the medicine is taken for more than one or two weeks, the dosage may be decreased to 500 mg every 6 hours. A physician must determine the correct dosage for children 3 months to 12 years old. Children under 3 months should not take this medicine because it causes bone problems in young animals and could have the same effect in young children.

Nitrofurantoin

CAPSULES, TABLETS, OR LIQUID. The usual dose for adults and teenagers is 50–100 mg every six hours.

EXTENDED-RELEASE CAPSULES. For adults and children 12 years and older, the usual dosage is 100 mg every 12 hours for seven days.

For all forms of nitrofurantoin, a physician must determine the correct dose for children one month and older, based on the child's body weight. Children under one month should not take this medicine.

Precautions

Methenamine

People with certain medical conditions may have additional problems with this medicine: it may worsen liver or **kidney disease**.

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Nalidixic acid

This drug may produce **dizziness**, drowsiness or blurred vision. People should avoid driving or operating machinery until they have become accustomed to the effects of the drug.

Nalidixic acid may increase sensitivity to sunlight and **tanning** lights; even brief exposure may produce rash or **sunburn**. Even brief exposure to sun can cause a severe sunburn or a rash.

This drug may distort results from urine tests for sugar.

Laboratory studies have shown that nalidixic acid interferes with bone development in young animals and not recommended for use during **pregnancy**.

This medicine generally does not cause problems in nursing babies whose mothers take it. However, nursing babies with glucose-6-phosphate dehydrogenase (G6PD) deficiency (an inherited disorder that affects mainly black males) may have blood problems if their mothers take nalidixic acid.

People with a history of seizures or severe hardening of the arteries in the brain may be more likely to have side effects that affect the nervous system. People with glucose-6-phosphate dehydrogenase (G6PD) deficiency are more likely to have side effects that affect the blood. Also, people with **liver disease** or severe kidney disease have an increased chance of having any of the drug's possible side effects.

Nitrofurantoin

Pregnant women should not take this medicine within two weeks of their delivery date and should not use it during labor and delivery, as this could cause problems in the baby.

Women who are **breastfeeding** should check with their physicians before using this medicine. It passes into breast milk and could cause problems in nursing babies whose mothers take it. This is especially true of babies with glucose-6-phosphate dehydrogenase (G6PD) deficiency. The medicine also should not be given directly to babies up to one month of age, as they are particularly sensitive to its effects.

Older people may be more likely to have side effects when taking nitrofurantoin, because they are more sensitive to the drug's effects.

Taking nitrofurantoin may cause problems for people with certain medical conditions. Side effects may be greater, for example, in people with lung disease or nerve damage. In people with kidney disease, the medicine may not work as well as it should, but may cause more side effects. Those with glucose-6-phosphate dehydrogenase (G6PD) deficiency who take nitrofurantoin may develop anemia.

Diabetic patients should be aware that this medicine may cause false results on some urine sugar tests. They should check with a physician before making any changes in diet or diabetes medicine based on the results of a urine test.

General precautions for all urinary anti-infectives

Symptoms should improve within a few days of starting to take a urinary anti-infective. If they do not, or if they become worse, check with a physician. Patients who need to take this medicine for long periods should see their physicians regularly, so that the physician can check their progress.

Anyone who has had unusual reactions to urinary anti-infectives in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances. Patients taking nalidixic acid should tell their physicians if they have ever had reactions to medicines such as cinoxacin (Cinobac), ciprofloxacin (Cipro), enoxacin (Penetrex), norfloxacin (Noroxin), or ofloxacin (Floxin), all of which are also used to treat or prevent infections. Anyone taking nitrofurantoin should let the physician know if he or she has had an unusual reaction to medicines such as furazolidone (Furoxone) or nitrofurazone (Furacin).

Side effects

Methenamine

Nausea and vomiting are not common but may occur. These side effects do not need medical attention unless they are severe. One side effect that should be brought to a physician's attention immediately is a skin rash.

Nalidixic acid

Some side effects are fairly minor and are likely to go away as the body adjusts to the drug. These include dizziness, drowsiness, **headache**, **nausea** or **vomiting**, stomach **pain,** and **diarrhea**. Unless these problems continue or are bothersome, they do not need medical attention.

Other side effects, however, should have prompt medical attention. Anyone who has changes in vision, such as blurred vision, double vision, decreased vision, changes in color vision, halos around lights, or notices

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KEY TERMS

Altitude sickness—A set of symptoms that people who normally live at low altitudes may have when they travel to high altitudes. The symptoms include nosebleed, nausea, and shortness of breath.

Anemia—A lack of hemoglobin–the compound in blood that carries oxygen from the lungs throughout the body and brings waste carbon dioxide from the cells to the lungs, where it is released.

Bacteria—Tiny, one-celled forms of life that cause many diseases and infections.

Glaucoma—A condition in which pressure in the eye is abnormally high. If not treated, glaucoma may lead to blindness.

Glucose-6-phosphate dehydrogenase (G6PD) deficiency—An inherited disorder in which the body lacks an enzyme that normally protects red blood cells from toxic chemicals. When people with this condition take certain drugs, their red blood cells break down, causing anemia. This may also happen when they have a fever or an infection. The condition usually occurs in males. About 10% of black males have it, as do a small percentage of people from the Mediterranean region.

Granule—A small grain or pellet. Medicines that come in granule form usually are mixed with liquids or sprinkled on food before they are taken.

Organism—An individual of some type of life form, such as a plant or an animal.

pH—A measure of how acidic or alkaline something is. The pH scale ranges from 0 to 14. Values below 7 are acidic; values above 7 are alkaline.

Seizure—A sudden attack, spasm, or convulsion.

an excessive brightness of lights should check with a physician immediately.

Nitrofurantoin

This medicine may make the urine turn reddish-yellow to brown. This is nothing to worry about. Other possible side effects that do not need medical attention unless they are severe include pain in the stomach or abdomen, stomach upset, diarrhea, loss of appetite, and nausea or **vomiting**.

Anyone who has chest pain, breathing problems, **fever**, chills, or a **cough** while taking nitrofurantoin should check with a physician immediately.

General advice on side effects for all urinary anti-infectives

Other side effects are possible when taking any urinary anti-infective. Anyone who has unusual symptoms while taking this type of medicine should get in touch with his or her physician.

Interactions

Methenamine

Certain medicines may make methenamine less effective. These include thiazide **diuretics** (water pills) and medicines that make the urine less acid, such as antacids, bicarbonate of soda, and the drugs acetazolamide (Diamox), dichlorphenamide (Daranide), and methazolamide (Neptazane), which are used to treat glaucoma, **epilepsy**, **altitude sickness**, and other conditions.

Nalidixic acid

People who are taking blood thinners (anticoagulants) may be more likely to have bleeding problems if they take this medicine.

Nitrofurantoin

Nitrofurantoin may interact with many other medicines. For example, taking nitrofurantoin with certain drugs that include methyldopa (Aldomet), **sulfonamides** (sulfa drugs), vitamin K, and diabetes medicines taken by mouth may increase the chance of side effects that affect the blood. General side effects are more likely in people who take nitrofurantoin with the **gout drugs** probenecid (Benemid) or sulfinpyrazone (Anturane). The risk of side effects that involve the nervous system is higher in people who take nitrofurantoin with various drugs including lithium (Lithane), disulfiram (Antabuse), other anti-infectives, and the **cancer** drugs cisplatin (Platinol) and vincristine (Oncovin). Patients who have had a DPT (**diphtheria**, **tetanus**, and pertussis) vaccine within the last 30 days or who have one after taking nitrofurantoin are also more likely to have side effects that affect the nervous system. Because of the many possible interactions, anyone taking nitrofurantoin should be sure to check with a physician before combining it with any other medicine.

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General advice about interactions

Not every drug that may interact with a urinary anti-infective is listed here. Be sure to check with a physician or pharmacist before combining a urinary anti-infective with any other prescription or nonprescription (over-the-counter) medicine.

Resources

OTHER

Nickel, J. Curtis, MD. "How to Select the Right Drugs for UTIs." *The Clinical Advisor* (October 2005). http://www.clinicaladvisor.com (accessed December 3, 2010).

Nancy Ross-Flanigan

Urinary antiseptics *see* **Urinary anti-infectives**

Urinary catheterization

Definition

Urinary catheterization is the insertion of a catheter into a patient's bladder. The catheter is used as a conduit to drain urine from the bladder into an attached bag or container.

Purpose

Urinary catheterization is employed in hospital and nursing home settings to maintain urine output in patients who are undergoing surgery or who are confined to the bed and physically unable to use a bedpan. Critically ill patients who require strict monitoring of urinary output are also frequently catheterized.

Intermittent insertion of a urinary catheter is a treatment option for patients with certain types of **urinary incontinence**. Patients who are unable to completely empty the bladder during urination (urinary retention) or patients who have a bladder obstruction may also require intermittent urinary catheterization. Disabled individuals with neurological disorders that cause **paralysis** or a loss of sensation in the perineal area may also use regular intermittent catheter insertion to void their bladders.

Precautions

Because urinary catheterization carries a risk of causing **urinary tract infection** (UTI), precautions should be used to keep the catheter clean and free of bacteria. Patients requiring intermittent catheterization should be well trained in the technique by a qualified health care professional.

Description

Intermittent catheterization is performed a minimum of four times a day by the patient or a care giver. The genital area near the urethral opening is wiped with an antiseptic agent, such as iodine. A lubricant may be used to facilitate the entry of the catheter into the urethra, and a topical local anesthetic may be applied to numb the urethral opening during the procedure. One end of the catheter is placed in a container, and the other end is inserted into and guided up the urethra until urine flow begins. When urine flow stops, the catheter may be moved or rotated, or the patient may change positions to ensure that all urine has emptied from the bladder. The catheter is then withdrawn, cleaned, and sterilized for the next use. Recommended cleaning practices vary, from the use of soap and water to submersion in boiling water or a disinfectant solution. Some patients prefer to use a new catheter with each insertion.

Nonintermittent catheterization, which is initiated in a hospital or nursing home setting, uses the same basic technique for insertion of the urinary tract catheter. The catheter is inserted by a nurse or other health care professional and remains in the patient until bladder function can be maintained independently. When the catheter is removed, patients will experience a pulling sensation and may feel some minor discomfort. If the catheter is required for an extended period of time, a long-term, indwelling catheter, such as a Foley catheter, is used. To prevent infection, it should be regularly exchanged for a new catheter every three to six weeks.

Use of indwelling catheters should be restricted to patients whose incontinence is caused by urinary tract obstruction that can not be treated and for which alternative therapy is not feasible.

Preparation

If a patient wishes to perform intermittent catheterization himself, training in the technique by a qualified health care professional is required. Basic instruction in the anatomy, antiseptic techniques, catheter insertion, and proper catheter care should be provided. Patients learning chronic intermittent urinary catheterization may also benefit from an ultrasound examination to verify that they are completely emptying their bladder during the procedure.

Aftercare

Patients using intermittent catheterization as a treatment for incontinence will experience a period of

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KEY TERMS

Bladder obstruction—A blockage of the bladder caused by the presence of calculi (e.g., mineral deposits) or an anatomic abnormality.

Catheter—A long, thin, flexible tube.

Foley catheter—A two-channel catheter with a balloon on the bladder end of one channel. Once inflated, the balloon keeps the catheter securely in the bladder. The other channel of the catheter facilitates the flow of urine out of the bladder.

Local anesthetic—Medication applied topically to the skin or administered through an injection that deadens a specific part of the body and inhibits the sensation of pain.

Perineal area—The genital area between the vulva and anus in a woman and between the scrotum and anus in a man.

Ultrasound examination—A diagnostic test that uses sound waves to generate a picture of an organ or organ system.

Urinary incontinence—The inability to control one's urine flow.

adjustment as they try to establish a catheterization schedule that is adequate for their normal level of fluid intake.

Antibiotics may be prescribed as a preventive measure in long-term urinary catheterization patients who are at risk for urinary tract infection.

A patient with an indwelling catheter must be reassessed periodically to determine whether alternative treatment may be more effective in treating the problem.

Risks

Trauma to the urethra and/or bladder may result from incorrect insertion of the catheter. Repeated irritation to the urethra during catheter insertion may cause scarring and/or stricture, or narrowing, of the urethra. The catheter may introduce bacteria into the urethra and bladder, resulting in urinary tract infection. UTI can cause **fever** and inflammation of the bladder and urethra. Patients who practice intermittent catheterization can reduce their risks for UTI by using antiseptic techniques for insertion and catheter care.

Normal results

When used correctly, catheterization facilitates complete voiding of the bladder.

Resources

OTHER

"Urinary Catheters." MedLinePlus (updated September 3, 2010). http://www.nlm.nih.gov/medlineplus/

Paula Anne Ford-Martin

Urinary diversion surgery

Definition

A urinary diversion involves removal of the urinary bladder and adjacent tissues and organs and re-routing of the urinary stream. This may involve creation of an artificial opening in the abdomen called an **ostomy**.

Purpose

A urinary diversion is created as a means to treat **cancer** of the bladder, when conservative measures have been unsuccessful, or when there is recurrence of the disease invading the muscle wall. Congenital deformities or traumatic injury may also necessitate formation of a urinary diversion.

Description

Under **general anesthesia**, an incision is made in the abdomen. The ureters (tubes that carry urine away from the kidneys) are cut and tied. The bladder and surrounding tissues are cut free and removed. The ureters are then attached to a portion of the intestine. The most common types of urinary diversion are:

- Ileal conduit. Ureters are attached to a portion of the small intestine, the ileum, one end of which is brought through the abdominal wall as a conduit for the urine, creating a stoma
- Ureterosigmoidostomy. The ureters are attached to a portion of the large intestine, the sigmoid, which allows the urine to flow through the large intestine and out through the rectum
- Cutaneous ureterostomy. Bringing the detached ureters through the abdominal wall and attaching it to an opening in the skin

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Following creation of an artificial opening to drain the urine, ureteral stents (tubes that go through the stoma and up into the ureters) are often inserted and left in place to allow urine to drain freely from the kidneys, without risk of blockage from swelling due to surgery. The muscles are replaced and sewn together. A transparent pouch is applied to the abdomen to collect urine and attached to a bedside drainage bag. The incision is closed with sutures or clips ("staples"), which are usually removed about a week after surgery.

An alternative to a conventional urinary diversion is the continent urinary diversion. In this surgical procedure, a "false bladder" is constructed within the abdomen, using several lengths of small or large intestine. The ureters are sewn to this new reservoir for urine and nipple valves which are created at two sites: the abdominal wall for continence, and where the ureters are implanted, to prevent reflux of urine back to the kidneys. The patient is then taught to catheterize the reservoir to drain urine at regular intervals during the day. Although a continent diversion is not suitable for every patient who requires urinary diversion, it is an option to be considered.

Preparation

As with any surgical procedure, the patient will be required to sign a consent form after the procedure is explained thoroughly. Blood and urine studies, along with various x rays and an electrocardiogram (EKG), may be ordered as the doctor deems necessary. If creation of an ostomy is planned, the patient should visit an enterostomal therapist, who will mark an appropriate place on the abdomen for a stoma and offer preoperative education on ostomy management.

Eating or drinking is prohibited after midnight the night before the surgery. Oral anti-infectives, such as neomycin, erythromycin, or kanamycin sulfate, may be ordered to decrease bacteria in the intestine and help prevent postoperative infection. A nasogastric tube is inserted the day of surgery, or during surgery, to remove gastric secretions and prevent **nausea and vomiting**.

Aftercare

Postoperative care for a patient with a urinary diversion, as with those who have had any major surgery, involves monitoring of blood pressure, pulse, respirations, and temperature. Breathing tends to be shallow because of the effect of anesthesia, and the patient is reluctant to breathe deeply and experience **pain** that is caused by the abdominal incision. The patient is shown how to support the operative site during deep breathing and coughing and is given pain medication as necessary. Fluid intake and output are measured, and the operative site is observed for color and amount of wound drainage. The nasogastric tube will remain in place, attached to low intermittent suction, until bowel activity resumes. Fluids and electrolytes are infused intravenously until the patient's diet can gradually be resumed, beginning with liquids. The patient is usually able to move about in 8–24 hours after surgery and is discharged from the hospital in 5–10 days.

KEY TERMS

Ischemia— A compromise in blood supply to body tissues that causes tissue damage or death.

Ostomy—A surgically-created opening in the abdomen for elimination of waste products (urine or stool).

If an ostomy has been placed, the patient and close family members will be educated on how to care for it. Determination of appropriate pouching supplies and a schedule of how often to change the pouch should be established. Regular assessment and meticulous care of the skin surrounding the stoma is important to maintain an adequate surface on which to apply the pouch. The pouch should be connected to a bedside drainage bag at night to prevent large volumes of urine from collecting in the pouch. Otherwise, the weight of the pouch could cause disruption of the pouch seal and leakage of urine onto the surrounding skin. Often, an enterostomal therapist will visit the patient at home after discharge to help the new ostomy patient make the transition back to normal daily activities.

Risks

Potential complications of urinary diversion surgery include:

- excessive bleeding
- surgical wound infection
- thrombophlebitis (inflammation and blood clot to veins in the legs)
- pneumonia
- pulmonary embolism (blood clot or air bubble in the lungs' blood supply)

Normal results

Complete healing is expected without complications. The amount of time required for recovery from the surgery may vary depending of the patient's

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overall health status prior to surgery. The patient with a urinary diversion, without other medical complications, should be able to resume all daily activities once recovered from the surgery.

Abnormal results

The doctor should be made aware of any of the following problems after surgery:

- increased pain, swelling, redness, drainage, or bleeding in the surgical area
- headache, muscle aches, dizziness, or fever
- increased abdominal pain or swelling, constipation, nausea, or vomiting

Stomal complications to be monitored include:

- Stomal tissue death (necrosis). This occurs because of inadequate blood supply, which is usually visible 12 to 24 hours after surgery and may require additional surgery
- Stoma flush or below the abdomen surface (retraction). Caused by insufficient stomal length, this may be managed by use of special pouching supplies. Elective revision of the stoma is also an option
- Narrowing at the opening of the stoma (stenosis). Often associated with infection around the stoma or scarring, mild stenosis can be removed under local anesthesia. Severe stenosis may require surgery for stomal revision
- Parastomal hernia. The bowel causes a bulge in the abdominal wall next to the stoma. This is usually due to placement of the stoma where the abdominal wall is weak or an overly large opening in the abdominal wall. Use of an ostomy support belt and special pouching supplies may be adequate. If severe, the defect in the abdominal wall should be repaired and the stoma moved to another location

ORGANIZATIONS

United Ostomy Association, Inc. (UOA), PO Box 512, Northfield, MN, 55057-0512, 800 826-0826, info@ostomy.org, http://www.ostomy.org.

Kathleen D. Wright, RN

Urinary incontinence

Definition

Urinary incontinence is unintentional loss of urine that is sufficient enough in frequency and amount to cause physical and/or emotional distress in the person experiencing it.

Description

Approximately 13 million Americans suffer from urinary incontinence. Women are affected by the disorder more frequently than men; one in 10 women under age 65 suffers from urinary incontinence. A study published in late 2002 found that between 21% and 29% of adult women in the workforce reported at least one episode of urinary incontinence each month. Older Americans, too, are more prone to the condition. Twenty percent of Americans over age 65 are incontinent. In general, the condition is underrecognized and undertreated.

There are five major categories of urinary incontinence: overflow, stress, urge, functional, and reflex.

- Overflow incontinence. Overflow incontinence is caused by bladder dysfunction. Individuals with this type of incontinence have an obstruction to the bladder or urethra, or a bladder that doesn't contract properly. As a result, their bladders do not empty completely, and they have problems with frequent urine leakage.
- Stress incontinence. Stress incontinence occurs when an individual involuntarily loses urine after pressure is placed on the abdomen (i.e., during exercise, sexual activity, sneezing, coughing, laughing, or hugging).
- Urge incontinence. Urge incontinence occurs when an individual feels a sudden need to urinate, and cannot control the urge to do so. As a consequence, urine is involuntarily lost before the individual can get to the toilet.
- Functional incontinence. Individuals who have control over their own urination and have a fully functioning urinary tract, but cannot make it to the bathroom in time due to a physical or cognitive disability, are functionally incontinent. These individuals may suffer from arthritis, Parkinson's disease, multiple sclerosis, or Alzheimer's disease.
- Reflex incontinence. Individuals with reflex incontinence lose control of their bladder without warning. They typically suffer from neurological impairment.

In some cases, an individual may develop short-term or *acute incontinence*. Acute incontinence may occur as a symptom or by-product of illness, as a side effect of medication, or as a result of dietary intake. The condition is typically easily resolved once the cause is determined and addressed.

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Causes and symptoms

Urinary incontinence can be caused by a wide variety of physical conditions, including:

- Childbirth. Childbirth can weaken the pelvic muscles and cause the bladder to lose some support from surrounding muscles, resulting in stress incontinence.
- Dysfunction of the bladder and/or the urinary sphincter. In a continent individual, as the bladder contracts, the outlet that releases urine into the urethra (bladder sphincter) opens and urine exits the body. In individuals with overflow incontinence, bladder contractions and dilation of the sphincter do not occur at the same time.
- Enlarged prostate. In men, an enlarged prostate gland can obstruct the bladder, causing overflow incontinence.
- Hysterectomy or other gynecological surgery. Any surgery involving the urogenital tract runs the risk of damaging or weakening the pelvic muscles and causing incontinence.
- Menopause. The absence of estrogen in the postmenopausal woman can cause the bladder to drop, or prolapse.
- Neurological conditions. The nervous system sends signals to the bladder telling it when to start and stop emptying. When the nervous system is impaired, incontinence may result. Neurological conditions such as multiple sclerosis, stroke, spinal cord injuries, or a brain tumor may cause the bladder to contract involuntarily, expelling urine without warning or to cease contractions completely, causing urinary retention.
- Obesity. Individuals who are overweight have undue pressure placed on their bladder and surrounding muscles.
- Obstruction. A blockage at the bladder outlet may permit only small amounts of urine to pass, resulting in urine retention and subsequent overflow incontinence. Tumors, calculi, and scar tissue can all block the flow of urine. A urethral stricture, or narrow urethra caused by scarring or inflammation, may also result in urine retention.

Acute incontinence is a temporary condition caused by a number of factors, including:

- Bladder irritants. Substances in the urine that irritate the bladder may cause the bladder muscle to malfunction. The presence of a urinary tract infection and the ingestion of excess caffeine can act as irritants. Highly concentrated urine resulting from low fluid intake may also irritate the bladder.
- Constipation. Constipation can cause incontinence in some individuals. Stool that isn't passed presses against the bladder and urethra, triggering urine leakage.
- Illness or disease. Diabetes can greatly increase urine volume, making some individuals prone to incontinence. Other illnesses may temporarily impair the ability to recognize and control the urge to urinate or to reach the toilet in time to do so.
- Medications and alcohol. Medications that sedate, such as tranquilizers and sleeping pills, can interfere with the proper functioning of the urethral nerves and bladder. Both sedatives and alcohol can also impair an individual's ability to recognize the need to urinate and act on that need in a timely manner. Other medications, such as diuretics, muscle relaxants, and blood pressure medication, can also affect bladder function.
- Surgery. Men who undergo prostate surgery can suffer from temporary stress incontinence as a result of damage to the urethral outlet.

Diagnosis

Urinary incontinence may be diagnosed by a general practitioner, urologist, or gynecologist. If the patient is over age 65, a geriatrician may diagnose and treat the condition. A thorough medical history and **physical examination** is typically performed, along with specific diagnostic testing to determine the cause of the incontinence. Diagnostic testing may include x rays, ultrasound, urine tests, and a physical examination of the pelvis. It may also include a series of exams that measure bladder pressure and capacity and the urinary flow (urodynamic testing). The patient may also be asked to keep a diary to record urine output, frequency, and any episodes of incontinence over a period of several days or a week.

Treatment

There are numerous invasive and noninvasive treatment options for urinary incontinence:

- Behavior modification therapy. Behavior modification is a psychological approach to the treatment of urinary incontinence in which patients gradually increase the length of the time interval between voidings and "retrain" the bladder in other ways. It is reported to be highly effective in treating urge incontinence.
- Biofeedback. The use of sensors to monitor temperature and muscle contractions in the vagina to help

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KEY TERMS

Bladder neck—The place where the urethra and bladder join.

Bladder sphincter—The outlet that releases urine into the urethra.

Calculi (singular, calculus)—Mineral deposits that can form a blockage in the urinary system.

Occlusive—Closing off. One of the newest treatments for stress urinary incontinence in women is an external occlusive single-use cap that covers the urethral opening.

Perineal area—The genital area between the vulva and anus in a woman and between the scrotum and anus in a man.

Sacral nerves—The five pairs of nerves that arise from the lowermost segments of the spinal cord and control bladder, bowel, and pelvic functions. Stimulation of the sacral nerves by an implanted device is a newer treatment for urinary incontinence.

incontinent patients learn to control their pelvic muscles.

- Collagen injections. Collagen injected in the tissue surrounding the urethra can provide urethral support for women suffering from stress incontinence.
- External occlusive devices. A new single-use disposable urethral cap is available without a prescription as of late 2002 for women suffering from stress urinary incontinence. The cap is noninvasive and appears to be quite effective in managing incontinence.
- Inflatable urethral insert. Sold under the trade name Reliance, this disposable incontinence balloon for women is inserted into the urethra and inflated to prevent urine leakage.
- Intermittent urinary catheterization. The periodic insertion of a catheter into a patient's bladder to drain urine from the bladder into an attached bag or container.
- Medication. Estrogen hormone replacement therapy can help improve pelvic muscle tone in postmenopausal women. Other medications, including flurbiprofen, capsaicin, and botulinum toxin, are sometimes prescribed to relax the bladder muscles or to tighten the urethral sphincter. As of late 2002, newer medications for the treatment of urinary incontinence were undergoing clinical trials. One of these drugs, duloxetine, differs from present medications in targeting the central nervous system's control of the urge to urinate rather than the smooth muscle of the bladder itself.
- Pelvic toning exercises. Exercises to tone the pelvic muscle can help alleviate stress incontinence in both men and women. These exercises involve tightening the muscles of the pelvic floor and are also known as Kegel or PC muscle exercises.
- Perineal stimulation. Perineal stimulation is used to treat stress incontinence. The treatment uses a probe to deliver a painless electrical current to the perineal area muscles. The current tones the muscle by contracting it.
- Permanent catheterization. A permanent, or indwelling, catheter may be prescribed for chronic incontinence that doesn't respond to other treatments. A Foley catheter is usually used for urinary catheterization. One end is inserted through the urethra and into the bladder, and the external end is attached to a plastic reservoir bag that the patient may wear on the leg. A second alternative is a permanent catheter, called a suprapubic tube, surgically inserted into the bladder. The tube exits the body through the abdomen near the pubic bone, where it is attached to a drainage bag. As infection may result, this treatment should be reevaluated periodically, and the possibility of alternative treatment addressed.
- Sacral nerve stimulation (SNS). Also known as sacral neuromodulation, SNS is a procedure in which a surgeon implants a device that sends continuous stimulation to the sacral nerves that control the urinary sphincter. The FDA approved sacral nerve stimulation for the treatment of urinary urge incontinence in 1997 and for urinary frequency in 1999.
- Surgery. Bladder neck suspension surgery is used to correct female urinary stress incontinence. Surgical techniques such as the Marshall-Marchetti-Krantz and Burch procedures use sutures to raise and support the bladder neck and urethra. A sling procedure, which uses a strip of biocompatible material or the patient's own muscle or tissue as a supportive sling under the urethra and bladder neck, may also be used to treat stress incontinence. Bladder enlargement surgery may be recommended to treat incontinent men and women with unusually small bladders.
- Urinary sphincter implant. An artificial urinary sphincter may be used to treat incontinence in men and women with urinary sphincter impairment.

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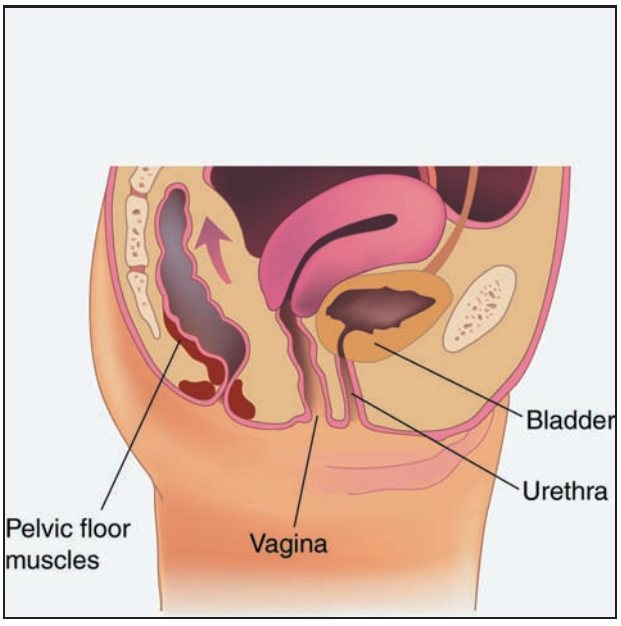

Strengthening the pelvic floor muscles by performing Kegel exercises helps to alleviate stress incontinence in women. Contract the pelvic floor muscles as if stopping an imaginary flow of urine. Hold for 10 seconds and repeat. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

- Vaginal inserts. Devices constructed of silicone or other pliable materials that can be inserted into a woman's vagina to support the urethra.

Prognosis

Left untreated, incontinence can cause physical and emotional upheaval. Individuals with long-term incontinence suffer from urinary tract infections, and skin **rashes** and sores. Incontinence can also affect their self-esteem and cause depression and social withdrawal. They frequently stop participating in physical activities they once enjoyed because of the risk of embarrassing "accidents." However, with the wide variety of treatment options for incontinence available today, the prognosis for incontinent patients is promising. If incontinence cannot be stopped, it can be improved in the majority of cases.

Prevention

Women who are pregnant or who have gone through **childbirth** can reduce their risk for stress incontinence by strengthening their perineal area muscles with Kegel exercises. Men who have undergone prostate surgery may also benefit from pelvic muscle exercises. Men and women should consult with their doctor before initiating any type of **exercise** program.

Resources

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ORGANIZATIONS

American Urological Association (AUA), 1000 Corporate Boulevard, Linthicum, MD, 21090, 410 689-3700, (410) 689-3800, (866) 746-4282, aua@AUAnet.org, http://www.auanet.org.

American Urological Association Foundation, 1000 Corporate Blvd., Linthicum, MD, 21090, (410) 689-3700, (410) 689-3800, (866) 746-4282, auafoundation@auafoundation.org, http://www.urologyhealth.org.

Center for Biologics Evaluation and Research (CBER), U.S. Food and Drug Administration (FDA), 10903 New Hampshire Ave, Silver Spring, MD, 20993-0002, (888) 463-6332, http://www.fda.gov/BiologicsBlood Vaccines.

National Association for Continence, P.O. Box 1019, Charleston, SC, 29402-1019, (843) 377-0900, (843) 377-0905, (800) 252-3337, memberservices@nafc.org, http://www.nafc.org.

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National Institute of Diabetes and Digestive and Kidney Diseases, NIDDK, NIH Bldg 31, Rm 9A06 31 Center Drive, MSC 2560, Bethesda, MD, 20892-2560, (301) 496.3583, http://www2.niddk.nih.gov/Footer.

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Rebecca J. Frey, PhD

Urinary tract infection

Definition

A urinary tract infection (UTI) is a bacterial infection in any part of the urinary tract—the urethra, bladder, ureters, or kidneys.

Demographics

UTIs are not uncommon in children. Approximately 1% of boys and 3% of girls develop a symptomatic UTI before the age of 11. During the first year of life, uncircumcised boys are two and half times as likely as girls to develop a UTI. However after the first year, girls are 20 times as likely as boys to develop UTIs. Girls are particularly susceptible to UTIs around the age of three as toilet training begins. The incidence of UTIs in both boys and girls decreases with age.

Description

The urinary tract produces and discharges urine from the body. It includes the kidneys, ureters, bladder, urethra, and, in males, the prostate. Urine, consisting of water and waste products, is produced by the kidneys and carried through the ureters to the bladder for storage. The urethra carries the urine from the bladder to the outside of the body. In males the urethra carries the urine through the prostate and out through the penis. The urethra in females is shorter and opens to the outside in front of the vaginal opening.

Urine is normally sterile, meaning that it is free from infectious organisms such as bacteria. The urinary tract has various mechanisms for protecting itself from infection:

- Urine has antibacterial properties.
- Urine is prevented from backing up in the ureters to the kidneys.
- The bladder secretes a protective coating that prevents bacteria from attaching to its lining.
- The flow of urine flushes bacteria from the body.

Infection can occur when bacteria attach to the opening of the urethra and enter the urinary tract. A UTI causes an inflammatory response in the lining of the urinary tract (the urothelium). Infections can affect the urethra (**urethritis**) and/or the bladder (**cystitis**). Untreated UTIs can reach the kidneys and cause a serious medical condition called **pyelonephritis**. However, in children most UTIs are restricted to the bladder.

Risk factors

A major risk factor for UTIs in girls is wiping from back to front (anus to urethral opening) after using the toilet. Other risk factors for UTIs in children include:

- previous UTIs
- infrequent or inadequate urination
- constipation in which a hard stool in the bowel presses against the urinary tract and impedes the flow of urine
- poor growth
- bubble baths
- tight–fitting clothing
- a family history of kidney disease
- birth defects in the urinary tract, especially vesicoureteral reflux—a defect in the valves between the ureters and the bladder that allows urine to back up into the ureters and kidneys
- a growth (mass) in the abdomen
- central nervous system disorders—such as myelomeningocele, spinal cord injury, or hydrocephalus—that make it difficult for children to completely empty their bladders

A susceptibility to UTIs often carries on into adulthood. In at least some cases, this susceptibility appears to be inherited.

Causes and symptoms

UTIs are caused by bacteria that enter the urinary tract. These bacteria are normally are found on the skin around the anus and sometimes around the vagina in girls or come from stool after a bowel movement. More than 95% of UTIs in children are caused by Enterobacteriaceae, a family of bacteria that includes ***Escherichia coli*** (*E. coli*), *Klebsiella* sp., *Proteus* sp., *Pseudomonas* sp., or *Enterococcus* sp.

Although some children are simply more susceptible to UTIs than others, the most common causes of bacteria entering a child's urinary tract are:

- girls wiping from back to front after using the toilet
- delayed urination
- failure to completely empty the bladder

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KEY TERMS

Bacteriuria—The presence of bacteria in the urine.

Bladder—The elastic, muscular pouch in which urine collects before being discharged from the body through the urethra.

Catheter—A hollow, flexible tube that is inserted into a body cavity, duct, or vessel for the passage of fluids or to distend a passageway.

Cystitis—Inflammation of the bladder.

Inflammatory response—The immune system's response to tissue injury caused by a physical, chemical, or biological substance.

Kidneys—The pair of bean–shaped organs, located below the ribs toward the middle of the back, which cleanse the blood, regulate acid concentration, and maintain water balance in the body through the formation of urine.

Prostate—The walnut–shaped gland that surrounds the urethra at the neck of the bladder in males and supplies fluid for semen.

Pyelonephritis—Bacterial infection of the kidney.

Sterile—Free from infectious organisms such as bacteria.

Ureters—The tubes that drain urine from the kidneys to the bladder.

Urethra—The tube that discharges urine from the bladder to the outside of the body. In males the urethra is located in the penis. In females the urethra is shorter than in the males and emerges above the vaginal opening.

Urethritis—Infection of the urethra.

Urinary tract—The organs that produce and discharge urine, including the kidneys, ureters, bladder, and urethra.

Urine—The fluid containing water and waste products that is produced by the kidneys, stored in the bladder, and removed from the body through the urethra.

Urothelium—The lining of the urinary tract, including the renal pelvis, ureters, bladder, and urethra.

Although young children with UTIs often have no symptoms, when symptoms are present they may include:

- fever, especially a recurring fever with no apparent cause
- poor appetite or refusal to eat
- fussiness or irritability
- diarrhea
- vomiting
- cloudy or foul–smelling urine
- blood in the urine

Symptoms of UTIs in older children may include:

- pain or burning during urination
- frequent urination
- bedwetting or daytime wetting
- dark or cloudy urine
- blood in the urine
- stomach or back pain

Additional symptoms of a bladder infection in children include:

- strong–smelling urine
- frequent or urgent need to urinate
- a general feeling of illness (malaise)
- pain or pressure in the lower back or lower pelvis

UTIs that spread to the kidneys can cause pyelonephritis. Symptoms of pyelonephritis include:

- fever
- flushed, red, or warm skin
- pain in the lower back or side
- severe belly pain
- nausea and vomiting
- shaking chills

Diagnosis

Examination

Clinical signs and symptoms are usually suggestive of a UTI. The child will be checked for **fever** and the physician will examine the child's abdomen and lower back for masses, bladder swelling, and unusual enlargement of the kidneys.

Tests

UTIs are diagnosed by **urinalysis**. A urine sample is collected by having the child urinate into a cup. If a child is still using diapers, the area around the urethra is

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cleansed with soap and warm water or a sterile wipe, and a collection bag is held in place over the urethral opening with adhesive strips. Sometimes urine is collected from infants and toddlers by inserting a catheter—a thin plastic tube—into the urethra to collect urine directly from the bladder. A suprapubic urine collection is performed by inserting a needle through the skin and muscles of the lower abdomen into the bladder.

The urine sample is examined under a microscope or tested with dipsticks for the presence of bacteria (bacteriuria), red blood cells, and white blood cells that indicate an immune system response to infection. The urine sample may be sent to a laboratory for culturing to determine the type of bacteria and the appropriate antibiotic for treatment. Additional blood tests may be performed to diagnose a kidney infection.

Procedures

Imaging procedures are sometimes performed to determine whether UTIs are caused by urinary reflux or another problem that is blocking urine flow. Imaging is also used to diagnose kidney damage. Although imaging may be performed while the child has a UTI, it is more often done after the infection has cleared up. Procedures include:

- ultrasound of the urinary tract
- a cystourethrogram—an x ray of the bladder and urethra, taken after injection of a contrast dye, to detect structural abnormalities
- a voiding cystourethrogram—an x ray taken while the child is urinating
- intravenous pyelogram for obtaining x-ray images of the bladder, kidneys, and ureters
- cystoscopy—in which a thin tube called a cystoscope, containing a light and a camera, is inserted through the urethra to examine the inside of the bladder and ureters and possibly remove a small amount of tissue for examination by a pathologist
- computed tomography (CT) scans to detect a kidney infection or cancer in the urinary tract

Treatment

Traditional

UTIs are treated immediately with **antibiotics** to protect the child's developing kidneys from infection. However urinary reflux or other structural problems may require surgery. Urinary reflux is sometimes treated by cutting one or both ureters away from the bladder and reattaching them at a different angle to prevent urine from backing up. Urinary reflux may also be treated by injecting a bulking agent around the ureter opening so that urine can flow into the bladder but is prevented from backing out.

Drugs

UTIs are usually treated immediately with oral antibiotics against the most common bacteria. Sometimes the type of antibiotic is changed after laboratory results have identified the specific bacterium. Most antibiotics are taken for 9 to 10 days, although some may require a two–week course of treatment. Young infants may require intravenous antibiotics that are administered in a hospital. Some children with recurrent UTIs are treated with antibiotics for as long as six months to two years. The most common antibiotics for treating UTIs in children include:

- amoxicillin (Amoxil, Trimox, Wymox) or amoxicillin/clavulanic acid (Augmentin)
- cephalosporins
- nitrofurantoin (Macrodantin, Furadantin)
- trimethoprim–sulfamethoxazole (TMP/SMZ; Bactrim, Septra, Cotrim)
- doxycycline, in children aged eight and older

Alternative

Although UTIs in children must be treated with antibiotics to prevent kidney damage, antimicrobial herbal therapies include:

- garlic (*Allium sativum*)
- goldenseal (*Hydrastis canadensis*)
- bearberry (*Arctostaphylos uva–ursi*)

Other alternative treatments for UTIs include:

- demulcents, such as corn silk and marsh mallow (*Althaea officinalis*), to soothe and coat the urinary tract
- homeopathic medicines based on the child's symptoms
- Chinese traditional medicine
- acupuncture

Alternative treatments should be used with care, as the benefits of many such treatments have not been confirmed by scientific research.

Home remedies

The most important home remedy for a UTI is drinking plenty of fluids, especially water. Other home treatments include:

- unsweetened cranberry juice, which has antibacterial activity
- ascorbic acid (vitamin C), which increases acidity of the urine

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- eliminating all sugar from the diet
- avoiding soft drinks with caffeine, citrus juices, spicy foods, coffee, and alcohol
- applying a heating pad to the lower abdomen
- soaking the pelvis in warm or hot water (a sitz bath) for 15–20 minutes

Prognosis

UTIs in children are usually readily cured with antibiotics and have an excellent prognosis, although they may require long–term treatment with low–dose antibiotics. A new antibiotic–resistant strain of *E. coli* is increasingly difficult to treat. Almost 26% of infants with symptomatic UTIs have a recurrence, usually within three months. About 40–60% of older girls with a UTI will also have a recurrence. However most children outgrow urinary reflux problems.

Repeated UTIs in children can damage their kidneys. Scarring of the kidneys is the fourth–leading cause of **kidney transplantation** in children. Long–term complications of repeated UTIs may include:

- pyelonephritis
- an abscess in a kidney
- high blood pressure
- kidney swelling (hydronephrosis)
- kidney insufficiency or failure

Prevention

Although some highly susceptible children may require long–term preventive antibiotic treatment, most UTIs in children can be prevented by good toilet hygiene:

- urinating regularly, whenever the child feels the urge, and never holding in urine
- emptying the bladder completely
- wiping from front to back, away from the urethra, especially after a bowel movement
- keeping the genital area clean

Other practices for preventing UTIs in children include:

- drinking plenty of fluids, especially water
- avoiding tight–fitting clothes that trap moisture and encourage bacterial growth
- wearing only cotton underwear that allows air in to dry out the genital area
- avoiding bubble bath and any other irritating products in the genital area
- taking showers rather than baths
- monitoring urination patterns in young children
- having older children notify their parents if urination becomes painful
- treating constipation
- drinking cranberry juice or taking vitamin C

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ORGANIZATIONS

American Academy of Family Physicians (AAFP), 11400 Tomahawk Creek Pkwy., Leawood, KS, 66211–2680, (913) 906–6000, (800) 274–6000, (913) 906–6075, http://www.aafp.org.

American Urological Association (AUA), 1000 Corporate Blvd., Linthicum, MD, 21090, (410) 689–3700, (866) RING–AUA (746–4282), (410) 689–3800, aua@AUAnet.org, http://www.auanet.org.

National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), Building 31, Room 9A06, 31 Center Dr., MSC 2560, Bethesda, MD, 20892–2560, (301) 496–3583, http://www2.niddk.nih.gov.

National Kidney and Urologic Diseases Information Clearinghouse (NKUDIC), 3 Information Way, Bethesda, MD, 20892–3580, (703) 738–4929, (800) 891–5390, (703)

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Margaret Alic, PhD

Urine concentration test *see* **Kidney function tests**

Urine culture

Definition

A urine culture is a diagnostic laboratory test performed to detect the presence of bacteria in the urine (bacteriuria).

Purpose

Culture of the urine is a method of diagnosis for **urinary tract infection** that determines the number of microorganisms present in a given quantity of urine.

Precautions

If delivery of the urine specimen to the laboratory within one hour of collection is not possible, it should be refrigerated. The health care provider should be informed of any **antibiotics** currently or recently taken.

Description

There are several different methods for collection of a urine sample. The most common is the midstream clean-catch technique. Hands should be washed before beginning. For females, the external genitalia (sex organs) are washed two or three times with a cleansing agent and rinsed with water. In males, the external head of the penis is similarly cleansed and rinsed. The patient is then instructed to begin to urinate, and the urine is collected midstream into a sterile container. In infants, a urinary collection bag (plastic bag with an adhesive seal on one end) is attached over the labia in girls or a boy's penis to collect the specimen.

Another method is the catheterized urine specimen in which a lubricated catheter (thin rubber tube) is inserted through the urethra (tube-like structure in which urine is expelled from the bladder) into the bladder. This avoids contamination from the urethra or external genitalia. If the patient already has a urinary catheter in place, a urine specimen may be collected by clamping the tubing below the collection port and using a sterile needle and syringe to obtain the urine sample; urine cannot be taken from the drainage bag, as it is not fresh and has had an opportunity to grow bacteria at room temperature. On rare occasions, the health care provider may collect a urine sample by inserting a needle directly into the bladder (suprapubic tap) and draining the urine; this method is used only when a sample is needed quickly.

KEY TERMS

Bacteriuria—The presence of bacteria in the urine.

Negative culture results showing no bacterial growth are available after 24 hours. Positive results require 24–72 hours to complete identification of the number and type of bacteria found.

Preparation

Drinking a glass of water 15–20 minutes before the test is helpful if there is no urge to urinate. There are no other special preparations or aftercare required for the test.

Risks

There are no risks associated with the culture test itself. If insertion of a urinary catheter (thin rubber tube) is required to obtain the urine, there is a slight risk of introducing infection from the catheter.

Normal results

No growth of bacteria is considered the normal result, and this indicates absence of infection.

Abnormal results

Abnormal results, or a positive test, where bacteria are found in the specimen, may indicate a urinary tract infection. Contamination of the specimen from hair, external genitalia, or the rectum may cause a false-positive result. Identification of the number and type of bacteria, with consideration of the method used in obtaining the specimen, is significant in diagnosis.

Escherichia coli causes approximately 80% of infections in patients without catheters, abnormalities of the urinary tract, or calculi (stones). Other bacteria that account for a smaller portion of uncomplicated infections include *Proteus klebsiella* and *Enterobacter*.

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ORGANIZATIONS

American Urological Association Foundation, 1000 Corporate Blvd., Linthicum, MD, 21090, (410) 689-3700, (410) 689-3800, (866) 746-4282, auafoundation@auafoundation.org, http://www.urologyhealth.org/.

Kathleen D. Wright, RN

Urine flow test

Definition

A urine flow test evaluates the speed of urination, or amount voided per second, and the total time of urination.

Purpose

A urine flow test is utilized to determine bladder function abnormalities, including a narrowed or obstructed urethra (the outflow passage from the bladder) and a weakened bladder muscle (detrusor).

Description

During a urine flow test, the patient urinates into a uroflowmeter, a funnel-shaped device that reads, measures, and computes the rate and amount of urine flow. The test takes approximately 10 minutes.

Preparation

The patient is prohibited from urinating at least two hours before the procedure.

Normal results

Average urine flow rates vary depending on age and gender.

Abnormal results

A urine flow test can indicate problems in bladder function, such as an obstruction, that will need further tests to diagnose.

Resources

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J. Ricker Polsdorfer, MD

Urography *see* **Intravenous urography**

KEY TERMS

Detrusor muscle—Bladder muscle.

Urethra—Passageway that carries urine from the bladder.

Urticaria *see* **Hives**

Uterine cancer *see* **Endometrial cancer**

Uterine fibroid embolization

Definition

Uterine fibroids are growths in the muscular tissue of the womb (uterus). Uterine fibroid embolization is non-surgical removal of the growths through the use of a tubular device called a catheter.

Purpose

It is estimated that between 20% and 40% of women over age 35 years have fibroids. These noncancerous tumors of the uterus, also called myomas, fibromyomas, or leiomyomas, can be as tiny as a pea or grow to as large as a cantaloupe. They grow along the muscular wall of the uterus and are made of both muscle and fiber-like tissue. Although they are not cancerous, they can cause uncomfortable symptoms in women, particularly **pain** and a feeling of pressure in the area between the hip bones (the lower pelvic area). Some women experience a feeling that they constantly need to urinate. Others may feel pressure in the bowel and experience bloating or **constipation**. Sometimes, fibroids cause heavy menstrual bleeding and lengthier menstrual periods.

In some cases, women need no treatment for fibroids, since the growths may cause no symptoms or may stop causing symptoms when a woman reaches **menopause**. However, when the fibroids cause heavy bleeding that can lead to anemia, pelvic pain, and create pressure on other organs, the physician and patient may discuss treatment options. A woman still planning to have children may need to have fibroids removed to ensure they do not interfere with the ability of a fertilized egg to implant on her uterine lining. In rare cases, fibroids cause such severe and sharp pelvic pain that emergency treatment is required.

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Although some medications may help ease the symptoms of fibroids or even slow their growth, they are not long-term solutions to the fibroid growths. Surgery also can remove the fibroids. **Myomectomy** is the most common surgery option still used to treat fibroids because it does not involve removing the uterus. In severe cases, women may have a **hysterectomy** and have their uterus removed.

The development of uterine fibroid embolization has offered women a non-surgical alternative to treating fibroids that are causing symptoms. It also is effective for treating multiple fibroids.

Precautions

Although uterine fibroid embolization has been shown in many studies to be effective, some physicians say it is a relatively new procedure that lacks long-term data on its effectiveness. Estimates show that at least 90% of women who have the procedure will have relief of symptoms and no return of fibroids. Some women have reportedly stopped having menstrual periods following the procedure. Since the long-term effects of uterine fibroid embolization on future pregnancies has not been studied extensively, patients still wanting to have children should discuss the latest research and fibroid treatment options with their physicians. Overall, however, the treatment is a safer and less invasive alternative than surgery.

Description

Uterine fibroid embolization usually is performed in a hospital, but sometimes in an outpatient imaging center. An interventional radiologist normally performs the procedure. Interventional radiologists are physicians who are specially trained to use x rays to see inside the body while guiding narrow tubes called catheters through blood vessels to diagnose or treat various diseases.

Uterine fibroid embolization also may be called uterine artery embolization. This is because the procedure injects tiny particles, called embolic agents, into the artery that supplies blood to the fibroid tumor, blocking off the tumor's blood supply. The radiologist reaches the uterine artery by first making a small nick (about one-quarter of an inch) in the patient's skin in the groin area. From this incision, the radiologist can inset the catheter into the femoral artery and then guide the catheter toward the area of the uterus. Patients do not feel the catheter as it moves along the artery and a nurse or anesthesiologist will provide drugs for pain relief at the insertion site. The nurse or a technologist also will insert a Foley catheter into the patient's bladder. This keeps the bladder emptied so that the radiologist can have a better picture of the uterus and the anatomy that surrounds the uterus during the procedure.

The radiologist can view the progress of the catheter using a moving x-ray technique called fluoroscopy. When the catheter reaches the artery supplying blood to the fibroid tumor, the radiologist injects the embolic agents, which are only about the size of grains of sand. When they gather together, they form a clot, and since no more blood can reach the fibroids, they eventually will shrink and disappear. If a woman has fibroids on both sides, the radiologist will guide the catheter around to repeat the procedure on the other side of the uterus. After removing the catheter, the medical team will clean the puncture area and cover it with a bandage. They also remove the Foley catheter. The entire procedure takes about one hour and should cost less than hysterectomy or other surgical treatments. Most insurance companies will pay for uterine fibroid embolization.

Preparation

When the embolization is scheduled, the hospital or facility should provide instructions regarding medications or food and drink to avoid prior to the procedure. Once a patient checks in, a nurse or technician may draw blood for routine tests and a nurse or radiologic technologist who specializes in vascular procedures will start an intravenous (IV) line through which the patient will receive **antibiotics** to prevent infection.

Aftercare

Although uterine fibroid embolization is an outpatient procedure, patients may stay in a recovery area for up to 23 hours. When patients are discharged, they will receive specific instructions about follow-up care and medication for relief of pain and swelling. Uterine fibroid embolization rarely requires stitches. Patients may be advised to use a stool softener while taking some of the aftercare medications to avoid constipation. They will be instructed to drink plenty of fluids for the first week following the procedure. Normally, the patient should avoid soaking in hot baths for the first three days and should not drive a car for about three days following uterine fibroid embolization.

Strenuous activity, such as climbing stairs, squatting, or lifting heavy objects should be avoided for about one week. Patients also should not stand in one position for long periods of time in the first week following the procedure. It is usually best to avoid heavy **exercise** routines, athletic activity and sexual

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KEY TERMS

Anemia—A condition in which the blood has a low number of red blood cells, low hemoglobin, or low total blood volume.

Artery—One of several tubular branches of muscular and elastic walled vessels that carry blood from the heart through the body.

Femoral artery—The chief artery of the thigh.

Groin—The fold that marks the meeting of the lower abdomen and the inner thigh.

relations for about up to month. Women also may be advised to avoid using tampons for menstrual periods for up to three months following uterine fibroid embolization, substituting sanitary pads.

Risks

Most patients experience moderate to severe pain and cramping for several hours after the procedure and some will have **nausea** and **fever**. There is a risk of infection from uterine fibroid embolization, but the risk is small and the infection usually can be controlled by antibiotics. A small percentage (about 1%) of women may experience an injury to the uterus or an infection that may lead to a later hysterectomy. There also is a small risk that a woman will stop having periods after uterine fibroid embolization. Overall, these risks are relatively low compared to surgical removal of fibroids.

Normal results

About 90% of women who have the procedure experience significant or complete relief of heavy bleeding, pain, and other symptoms. Patients usually will follow up with their gynecologist about two weeks following the procedure. Recurrence of fibroids is rare, though long-term studies of 10 years or more have shown that about 10% of patients may need additional treatment after 10 years. Additional studies continue on the procedure's long-term effectiveness.

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ORGANIZATIONS

National Uterine Fibroids Foundation, PO Box 9688, Colorado Springs, CO, 80932-0688, (719) 633-3454, (800) 874-7247, info@nuff.org, http://www.nuff.org.

Society of Interventional Radiology, 3975 Fair Ridge Drive, Suite 400 North, Fairfax, VA, 22033, (703) 691-1805, (703) 691-1855, (800) 488-7284, http://www.sirweb.org.

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Uterine fibroids

Definition

Uterine fibroids (also called leiomyomas or myomas) are benign growths of muscle inside the uterus. They are not cancerous, nor are they related to **cancer**. Fibroids can cause a wide variety of symptoms, including heavy menstrual bleeding and pressure on the pelvis.

Demographics

Uterine fibroids are extremely common. About 25% of women in their reproductive years have noticeable fibroids. There are probably many more women who have tiny fibroids that are undetected.

Fibroids develop between the ages of 30 and 50. They are never seen in women less than 20 years old. After **menopause**, if a woman does not take estrogen, fibroids shrink. It appears that African–American women are much more likely to develop uterine fibroids.

Description

Fibroids are divided into different types, depending on the location. Submucous fibroids are found in the uterine cavity; intramural fibroids grow on the wall of the uterus; and subserous fibroids are located on the outside of the uterus. Many fibroids are so large that they fit into more than one category. The symptoms caused by fibroids are often related to their location.

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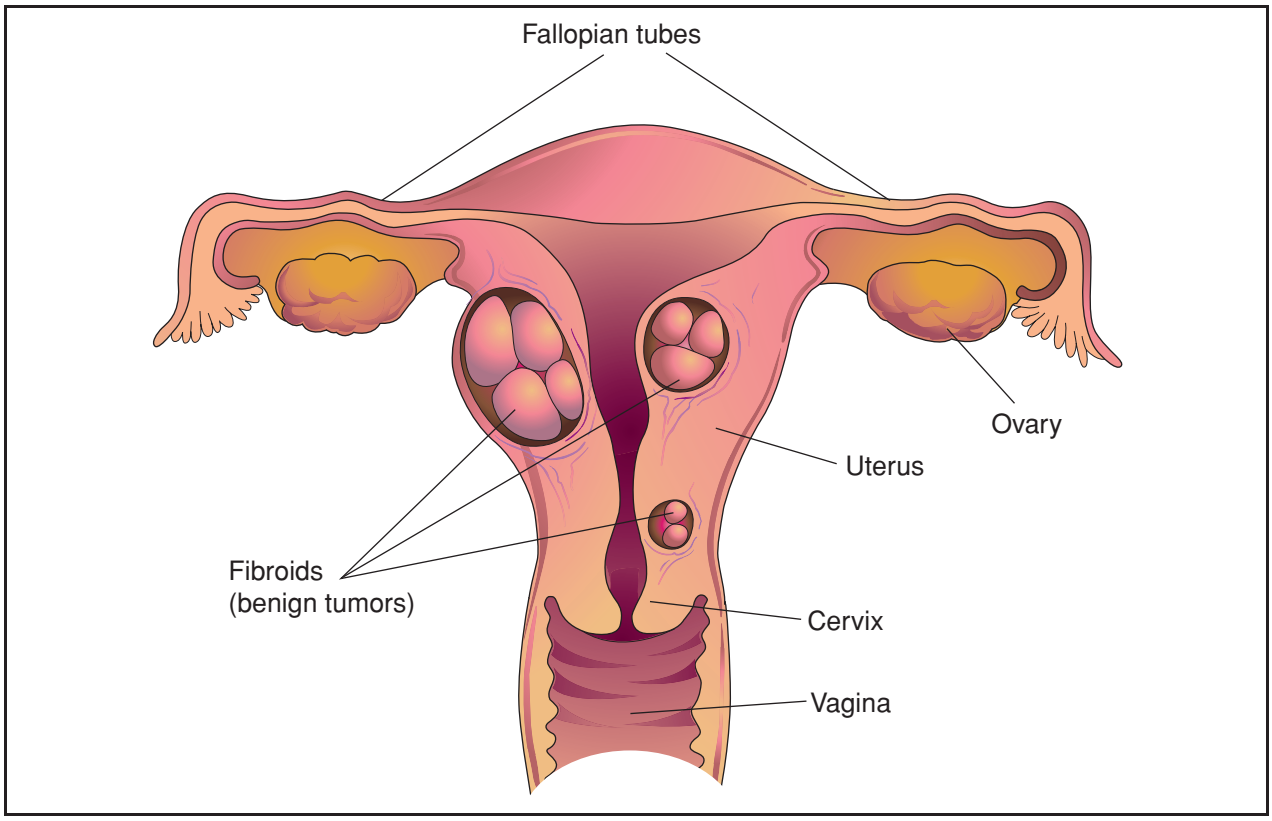

Uterine fibroids are benign growths of uterine muscle and are very common. They are divided into three types, depending on the location. Submucous fibroids are found in the uterine cavity; intramural fibroids grow on the wall of the uterus; and subserous fibroids are located outside of the uterus. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

Causes and symptoms

No one knows exactly what causes fibroids. However, the growth of fibroids appears to depend on the hormone estrogen. Fibroids often grow larger when estrogen levels are high, as in **pregnancy**. Medications that lower the estrogen level can cause fibroids to shrink.

The signs and symptoms of fibroids include:

- Heavy uterine bleeding. This is the most common symptom, occurring in 30% of women who have fibroids. The excess bleeding usually happens during the menstrual period. Flow may be heavier, and periods may last longer. Women who have submucous or intramural fibroids are most likely to have heavy uterine bleeding.
- Pelvic pressure and pain. Large fibroids that press on nearby structures such as the bladder and bowel can cause pressure and pain. Larger fibroids tend to cause worse symptoms.
- Infertility. This is a rare symptom of fibroids. It probably accounts for less than 3% of infertility cases. Fibroids can cause infertility by compressing the uterine cavity. Submucous fibroids can fill the uterine cavity and interfere with implantation of the fertilized egg.
- Miscarriage. This is also an unusual symptom of fibroids, probably accounting for only a tiny fraction of the miscarriages that occur.
- Pregnancy complications. Fibroids can greatly increase in size during pregnancy, because of increased levels of estrogen. They can cause pain and even lead to premature labor.

Diagnosis

A health care provider can usually feel fibroids during a routine pelvic examination. Ultrasound can be used to confirm the diagnosis, but this is not necessary.

Treatment

Not all fibroids cause symptoms. Even fibroids that do cause symptoms may not require treatment. In the majority of cases, symptoms are inconvenient and unpleasant, but do not result in health problems.

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KEY TERMS

Anemia—Low blood count.

GnRH antagonists—A group of medications that affect the reproductive hormones. These medications are used to treat fibroids, endometriosis, and infertility.

Hysterectomy—Removal of the uterus (with or without removal of the ovaries) by surgery. The surgery can be performed through an incision in the abdomen, or the uterus can be removed through the vagina.

Menopause—The end of the reproductive years, signaled by the end of menstrual periods. Also known as "the change."

Osteoporosis—A bone disorder in which the bones become increasingly less dense and more brittle.

Occasionally, fibroids lead to such heavy menstrual bleeding that the woman becomes severely anemic. In these cases, treatment of fibroids may be necessary. Very large fibroids are much harder to treat. Therefore, many doctors recommend treatment for moderately–sized fibroids, in the hopes of preventing them from growing into large fibroids that cause worse symptoms.

The following are possible treatment plans:

- Observation. This is the most common plan. Most women already have symptoms at the time their fibroids are discovered, but feel that they can tolerate their symptoms. Therefore, no active treatment is given, but the woman and her physician stay alert for signs that the condition might be getting worse.
- Hysterectomy. This involves surgical removal of the uterus, and it is the only real cure for fibroids. In fact, 25% of hysterectomies are performed because of symptomatic fibroids. By the time a woman has a hysterectomy for fibroids, she has usually endured several years of worsening symptoms because fibroids tend to grow over time. A gynecologist can remove a fibroid uterus during either an abdominal or a vaginal hysterectomy. The choice depends on the size of the fibroids and other factors such as previous births and previous surgeries.
- Myomectomy. In this surgical procedure only the fibroids are removed; the uterus is repaired and left in place. This is the surgical procedure many women choose if they are not finished with childbearing. At first glance, it seems that this treatment is a middle ground between observation and hysterectomy. However, myomectomy is actually a difficult surgical procedure, more difficult than a hysterectomy. Myomectomy often causes significant blood loss, and blood transfusions may be required. In addition, some fibroids are so large, or buried so deeply within the wall of the uterus, that it is not possible to save the uterus, and a hysterectomy must be done, even though it was not planned. There are exceptions to this, however. Sometimes, fibroids grow on a stalk (pedunculated fibroids), and these are easy to remove.
- Medical treatment. Since fibroids are dependent on estrogen for their growth, medical treatments that lower estrogen levels can cause fibroids to shrink. A group of medications known as GnRH antagonists can dramatically lower estrogen levels. Women who take these medications for three to six months find that their fibroids shrink in size by 50% or more. They usually experience dramatic relief of their symptoms of heavy bleeding and pelvic pain.

Unfortunately, GnRH antagonists cause unpleasant side effects in over 90% of women. The therapy is usually used for only three months, and should not be used for more than six months because the risk of developing brittle bones (**osteoporosis**) begins to increase. Once treatment is stopped, fibroids begin to grow back to their original size. Within six months, most of the old symptoms return. Therefore, GnRH agonists cannot be used as long–term solution. At the moment, treatment with GnRH antagonists is used mainly in preparation for surgery (**myomectomy** or **hysterectomy**). Shrinking the size of fibroids makes surgery much easier, and reducing heavy bleeding allows a woman to build up her blood count before surgery.

Fibroids can cause problems during pregnancy because they often grow in size. Large fibroids can cause **pain** and lead to **premature labor**. Fibroids cannot be removed during pregnancy because of the risk of injury to the uterus and hemorrhage. GnRH antagonists cannot be used during pregnancy. Treatment is limited to pain medication and medication to prevent premature labor, if necessary.

Prognosis

Many women who have fibroids have no symptoms or have only minor symptoms of heavy menstrual bleeding or pelvic pressure. However, fibroids tend to grow over time, and gradually cause more

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symptoms. Many women ultimately decide to have some form of treatment. Currently, hysterectomy is the most popular form of treatment.

Prevention

Uterine fibroids cannot be prevented.

Resources

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ORGANIZATIONS

American College of Obstetricians and Gynecologists (ACOG), 409 12th St. SW, PO Box 96920, Washington, DC, 20080–6920, (202) 863–2518, http://www.acog.org.

Association of Women's Health, Obstetric and Neonatal Nurses (AWHONN), 2000 L St. NW, Suite 740, Washington, DC, 20036, (202) 261–2400, (800) 673–8499, http://www.awhonn.org.

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Uterus x rays *see* **Hysterosalpingography**

Uveitis

Definition

Uveitis is an inflammation of the uveal tract, which lines the inside of the eye behind the cornea. Much of the uvea lies between the retina and the tough, outer sclera. The uveal tract has three parts: the iris, the ciliary body, and the choroid. Uveitis is categorized according to the part of the uveal tract that is affected. Anterior uveitis is an inflammation of the front part of the uveal tract; it includes inflammation of the iris (iritis) and inflammation of the iris and the ciliary body (iridocyclitis). Posterior uveitis is an inflammation of the part of the uveal tract behind the lens of the eye. It includes inflammation of the choroid (choroiditis) and inflammation of the choroid and retina (chorioretinitis). Uveitis that affects the entire uveal tract is called panuveitis or diffuse uveitis.

Description

The uveal tract is made up of the iris, ciliary body, and choroid. The iris is the colored part of the eye. The ciliary body is inside the eye and produces a fluid called aqueous humor. Ciliary muscles aid in accommodation, the process of changing the shape of the lens in the eye to see things at various distances. The choroid lines the back of the eye and has many blood vessels. It helps nourish part of the retina. The choroid lies between the retina and outermost sclera.

Uveitis may either persist for a long time (chronic) or have a short-term duration (acute). Anterior uveitis is classified as either granulomatous or nongranulomatous. The distinction is based on the disease agents that were considered responsible for the condition. At one time, it was thought that granulomatous uveitis was caused by **tuberculosis** bacilli whereas nongranulomatous uveitis was thought to be caused by streptococci. The distinction is still used even though the causes of uveitis are now understood differently.

In most cases, uveitis affects only one eye, although posterior uveitis sometimes involves both eyes. About 60% of cases develop within the eye itself, but 40% are associated with systemic diseases or disorders ranging from **toxoplasmosis** to **syphilis**. Many of these are diseases of childhood and adolescence. Uveitis does not appear to run in families or to be associated with lifestyle choices, occupational history, geographical location, or environmental factors.

Uveitis is a serious condition that may develop rapidly and cause lasting damage to the eye. Patients who think they may have chronic uveitis should seek evaluation and treatment by an ophthalmologist (a physician who specializes in diseases of the eye) as soon as possible. If the patient has a sudden loss of vision and the eye looks inflamed, the patient should go *immediately* to the doctor for emergency treatment.

Causes and symptoms

The causes of uveitis are not fully understood, but they can be a result of trauma, allergy, or a response to a systemic or ocular disease. Uveitis may be a type of immune-response mechanism. In people with

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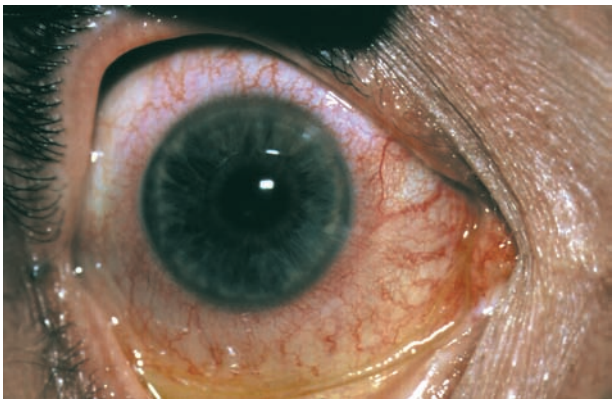

This person has acute iritis, or inflammation of the iris. Symptoms include pain in the eye or forehead and reddening of the margin of the iris. Treatment requires total rest of the eye (dark glasses and atropine drops which paralyze the muscles of accommodation), accompanied by application of corticosteroids. *(Photo Researchers, Inc.)*

impaired immune systems, uveitis may be due to an infection.

Chronic uveitis is often associated with systemic disorders (e.g., **Lyme disease**, **sarcoidosis**, or juvenile **rheumatoid arthritis**).

Anterior uveitis

The so-called classic symptoms of anterior uveitis—severe **pain**; redness, particularly around the edge of the iris; and extreme sensitivity to light (photophobia)—occur mostly in acute uveitis. In anterior uveitis, the doctor will see a so-called "flare and cell" pattern when looking into the watery fluid (aqueous humor) between the cornea and the lens of the patient's eye. The iris may adhere to the lens, thus increasing the intraocular pressure. There may be nodules on the iris. There may be tearing and the pupil may be constricted and nonreactive. In severe cases of anterior uveitis, there may be hypopyon (a small amount of pus or collection of white cells) visible when the doctor examines the eye.

GRANULOMATOUS UVEITIS. In granulomatous uveitis, there will be large yellowish-white cells visible on the back of the cornea and possibly some small nodules on the iris. Granulomatous uveitis is usually less acute than the nongranulomatous form; the eye is only mildly inflamed and the patient's vision is somewhat blurred.

Granulomatous uveitis can be produced by syphilis, toxoplasmosis, cytomegalovirus, sarcoidosis, tuberculosis, or Vogt-Koyonagi-Harada syndrome (VKH). VKH is marked by severe uveitis associated with hair loss, **hearing loss**, loss of pigment in the eyelashes and brows, and headaches. It occurs most commonly in Asians.

NONGRANULOMATOUS UVEITIS. In nongranulomatous uveitis, the cells visible on the cornea are smaller, and there are no masses on the iris. This type of anterior uveitis is, however, more painful. The eye is red and the patient experiences both photophobia and loss of vision.

Systemic diseases that can cause nongranulomatous uveitis include **ankylosing spondylitis**, **Reiter's syndrome**, **psoriasis**, ulcerative **colitis**, **Behcet's syndrome**, Lyme disease, and **Crohn's disease**. Children—especially girls—with anterior uveitis should be screened for juvenile rheumatoid arthritis (JRA).

Posterior uveitis

The symptoms of posterior uveitis are sometimes subtle. The patient may notice blurred or hazy vision, or floating black spots before the eyes. There may be pain and photophobia. The iris may attach to the lens in the eye, thus increasing intraocular pressure.

Posterior uveitis may be acute or chronic. It is more likely to involve both eyes. When the doctor examines the eye, cells may be seen in the vitreous humor, which is the normally transparent gel that fills the eyeball behind the lens. There will be yellowish or dark areas of inflammation on the choroid and the retina. The blood vessels in the retina develop a sheath or covering of inflammatory tissue. In severe cases, the vitreous humor is so cloudy that the doctor cannot see the retina at the back of the eye.

PARS PLANITIS. Pars planitis is an inflammation of the pars plana, which is a part of the ciliary body. Pars planitis usually occurs in older children or young adults, and can develop into posterior uveitis.

The diseases that cause granulomatous uveitis may also cause posterior uveitis.

Diagnosis

The eye doctor will examine the patient's eyes with a slit lamp in order to rule out **conjunctivitis** and certain types of glaucoma. The slit lamp is an instrument that combines a binocular microscope with a special light. The slit lamp can shine a narrow beam of very bright light into the eye and allow the doctor to examine the front part of the eye in detail. The slit-lamp exam is not painful, however if the patient is sensitive to light there will be discomfort.

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KEY TERMS

Choroid—The part of the uveal tract behind the ciliary body. The choroid underlies and nourishes the retina and absorbs scattered light.

Ciliary body—The part of the uveal tract between the iris and the choroid.

Cornea—The transparent front part of the eye that covers the iris and pupil.

Flare and cell—A pattern revealed by slit-lamp examination that indicates uveitis. Flare and cell resembles light filtered through smoke.

Hypopyon—A small amount of pus or collection of white cells that is visible in the front of the eye in severe cases of anterior uveitis.

Iris—The circular membrane that forms the colored portion of the eye and expands or contracts around the pupil.

Photophobia—Extreme sensitivity to light. Photophobia is a major symptom of acute uveitis.

Pupil—The opening in the center of the iris that allows light to pass through to the retina.

Retina—The innermost membrane at the back of the eyeball on which images are projected by the lens.

Slit lamp—An instrument that combines a binocular microscope with special lights. It allows an eye doctor to examine the front portion of the eye.

Uveal tract—The pigmented membrane that lines the back of the retina of the eye and extends forward to include the iris. The uveal tract is sometimes called the uvea and has three parts: the iris, the choroid, and the ciliary body.

Vitreous humor—The clear gel-like substance that fills the eyeball behind the lens.

The absence of a discharge from the eye and the absence of infectious organisms in a laboratory smear usually rule out conjunctivitis. In addition, the size of the pupil is often small in uveitis whereas it is normal in conjunctivitis. In acute glaucoma, the patient has severe pain, the cornea of the eye is cloudy, and the pressure level of the fluid inside the eye is abnormally high, whereas in uveitis the pain is moderate, the cornea is clear, and the fluid pressure is normal or possibly lower or slightly above normal. The doctor may also use the slit lamp and another lens to examine the back of the eye to get a good look at the retina and choroid. Other instruments, such as a hand-held ophthalmoscope or a binocular indirect ophthalmoscope, can be used to examine the back of the eye. There should be no discomfort with these tests except if the patient is sensitive to the bright light.

Laboratory testing

Laboratory testing is used to rule out conjunctivitis in some patients. The doctor wipes the inside of the patient's eyelid with a swab in order to obtain a sample for testing. Although blood tests are not necessary to diagnose uveitis by itself, they are used to diagnose the cause if the doctor suspects that toxoplasmosis or another systemic disease is responsible for the uveitis.

Treatment

Uveitis is generally treated by an ophthalmologist because therapy requires topical and oral medications; however, some optometrists (O.D.) are state licensed to use therapeutic medications. Other doctors may be involved in treating the underlying disease, if the patient has one, and in monitoring the patient's responses to medications.

Anterior uveitis is treated with corticosteroid drops; in severe cases, the patient may be given steroid injections in the area of the eye or oral **steroids**. Atropine sulfate drops may be given to dilate the patient's pupil. Posterior uveitis is treated with **systemic corticosteroids**. It is usually not necessary to dilate the pupil.

Prolonged steroid use may increase intraocular pressure, thereby increasing the risk of glaucoma. Steroid use has also been connected to cataract formation. Patients should be monitored closely and frequently.

Prognosis

The prognosis depends upon the location of the uveitis, on whether it is chronic or acute, and on the promptness of treatment. The prognosis for untreated uveitis is poor. Untreated anterior uveitis usually progresses to posterior uveitis, resulting in **cataracts**, scar tissue, and eventual glaucoma. If treated promptly, anterior uveitis usually clears up in several days or

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weeks, but is likely to recur. Posterior uveitis usually results in some permanent loss or blurring of vision.

Prevention

Patients with anterior uveitis should be warned about the possibility of recurrence and instructed about its symptoms, especially inflammation of the iris. They should be advised to seek treatment at once at the first signs of recurrence.

ORGANIZATIONS

American Academy of Ophthalmology (AAO), P. O. Box 7424, San Francisco, CA, 94120-7424, (415) 561-8500, (415) 561-8500, http://www.aao.org.

American Optometric Association, 243 North Lindbergh Blvd., St. Louis, MO, 63141, (314) 991-4100, (314) 991-4101, (800) 365-2219, http://www.aoa.org/.

Rebecca J. Frey, PhD

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V

Vaccination

Definition

Vaccination is the injection of a weakened or dead microbe in a person to stimulate the immune system against the microbe and prevent disease.

Purpose

The first vaccine was developed in 1796 by English physician Edward Jenner who took a few drops of the fluid seeping from a pustule of a cowpox-infected woman and injected it into a healthy young boy. Six weeks later, Jenner injected the boy with fluid from a **smallpox** pustule, and the boy did not develop dreaded smallpox, a devastating disease that killed over a million people each year in Europe. Survivors were often left with blindness, deep **scars**, and deformities. By the start of the twentieth century, vaccines for smallpox, **rabies**, **diphtheria**, **typhoid fever**, and **plague** had been developed. Vaccines are now available against more than 20 infectious diseases such as **influenza**, **pneumonia**, **whooping cough**, **rubella**, rabies, **meningitis**, and **hepatitis B**.

Vaccines are medicines that contain weakened or dead bacteria or viruses. When a person is given a vaccine, his or her immune system responds by producing proteins called antibodies. When the person is later exposed to live bacteria or viruses of the same kind that were in the vaccine, the antibodies destroy those organisms and prevent them from making the person sick. Vaccines usually stimulate the cellular immune system as well. In other words, the person becomes immune to the disease that the organisms normally cause. The process of building up immunity by being given a vaccine is called immunization.

Vaccines are used in several ways. Some, such as the rabies vaccine, normally are given only when a person is likely to have been exposed to the virus that causes the disease, for example, through a dog bite. Others are given to travelers planning to visit countries where certain diseases such as typhoid **fever** or **yellow fever** are common. Vaccines such as the influenza vaccine, or the "flu shot," are given mainly to specific groups of people who are at high risk of developing influenza or its complications. There are also vaccines that are given to almost everyone, such as the ones that prevent diphtheria, **tetanus**, **polio**, and **measles**.

Children routinely are given a series of vaccinations that begin at birth. Given according to a specific schedule, these vaccinations protect against hepatitis B, diphtheria, tetanus, whooping **cough**, measles, **mumps**, rubella (German measles), varicella (**chickenpox**), polio, pneumococcus and *Haemophilus influenzae* type b (Hib disease, a major cause of spinal meningitis) and, in some states, **hepatitis A**. This series of vaccinations is

An allergic reaction to a vaccination shot. *(© Lester V. Bergman/Corbis.)*

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recommended by the American Academy of Family Physicians, the American Academy of Pediatrics, and the Centers for Disease Control and Prevention (CDC). It is required in all states before children can enter school. All states will make exceptions for children who have medical conditions such as **cancer** that prevent them from having vaccinations, and some states also will make exceptions for children whose parents object for religious or other reasons.

Additional vaccines are available for preventing rotavirus infection (given to infants), **anthrax**, **cholera**, **Japanese encephalitis**, meningococcal meningitis, plague, **tuberculosis**, typhoid fever, **H1N1** (also known as swine flu), and yellow fever.

Description

Most vaccines are given as injections, but a few are given by mouth or as a nasal spray.

Some vaccines are combined in one injection, such as the measles-mumps-rubella (MMR) or diphtheria-tetanus-pertussis (DTaP) combinations.

Recommended dosage

The recommended dosage depends on the type of vaccine and may be different for different patients. Dosage is standardized for each specific type and usually varies based on age. The healthcare professional who gives the vaccine will determine the proper dose.

A vaccination health record helps parents and health care providers keep track of a child's vaccinations. The record should be started when the child has his or her first vaccination and should be updated with each additional vaccination. While most physicians follow the recommended vaccination schedule, parents should understand that some flexibility is allowed, for example if the child is sick at the time the vaccination is due. Slight departures will not prevent the child from developing immunity, as long as all the vaccinations are given at approximately the right times. The child's physician is the best person to decide when each vaccination should be given.

Anyone planning a trip to another country should check to find out what vaccinations are needed. Some vaccinations must be given as much as 12 weeks before the trip, so getting this information early is important. Many major hospitals and medical centers have travel clinics that can provide this information. The Traveler's Health Section of the Centers for Disease Control and Prevention also has information on vaccination requirements.

ALBERT BRUCE SABIN (1906–1993)

Albert Bruce Sabin was born on August 26, 1906, in Bialystok, Russia, to Jacob and Tillie Sabin. In order to escape extreme poverty, the Sabins immigrated to the United States and settled in Paterson, New Jersey. Following his graduation from high school in 1923, Sabin was able to attend dentistry school at New York University due to his uncle's generous offer for financing. However, after reading Paul deKruif's *Microbe Hunters* he became intrigued by virology and the idea of curing epidemic diseases. After two years of dentistry school, Sabin decided to switch to medicine, earning his M.D. in 1931. Sabin completed his residency and internship in the United States and then went to London to conduct research.

Sabin returned to the United States in 1935 to resume his research of polio at the Rockefeller Institute. In 1953, Jonas Salk announced that he had created a dead-virus polio vaccine that was safe, but soon after its administration many people died. Sabin, however, wanted to create a live-virus vaccine, which he felt would be safer. Sabin diluted three strains of the polio virus and tested these on himself, his family, and other volunteers. These live-virus vaccines (given orally) proved safe and effective and soon became the vaccinations of choice around the world. Sabin's published works include *Viruses and Cancer: A Public Lecture in Conversational Style* (1965), *Behavior of Chimpanzee-Avirulent Poliomyelitis Viruses in Experimentally Infected Human Volunteers* (1955), and *Recent Advances in Our Knowledge of Dengue and Sand Fly Fever* (1955). Sabin died of congestive heart failure on March 3, 1993.

Precautions

Vaccines are not always 100% effective, and there is no way to predict whether a vaccine will fail to provide adequate immunity in any particular person. To be most effective in preventing disease outbreaks, vaccination programs depend on whole communities participating. The more people who are vaccinated, the lower everyone's risk of being exposed to a disease. Even people who do not develop immunity through vaccination are safer when their friends, neighbors, children, and coworkers are immunized. In addition to vaccines, hand washing and proper hygiene are the most effective means for preventing the spread of infectious diseases.

Like most medical procedures, vaccination has risks as well as substantial benefits. Anyone who takes

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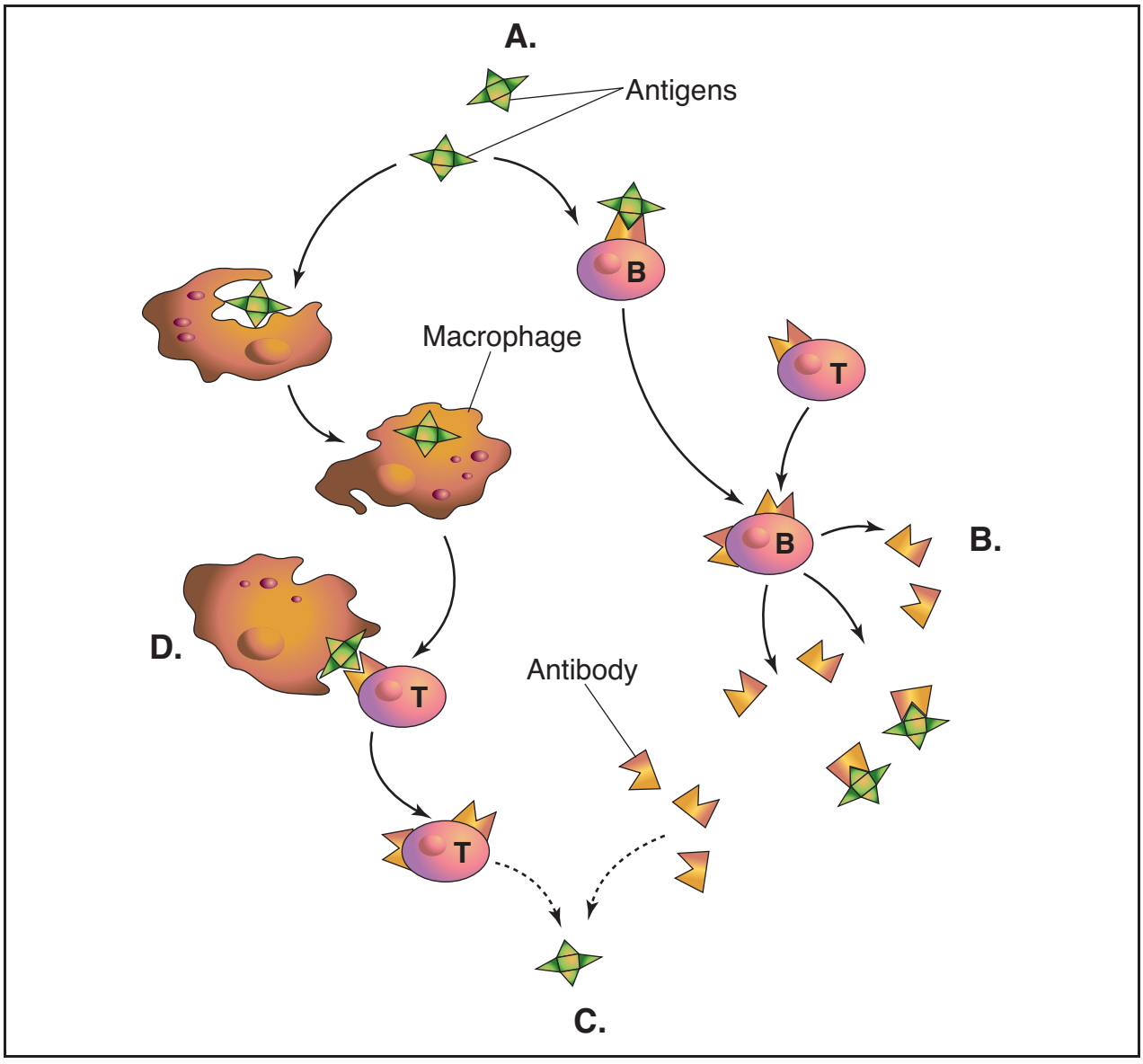

How vaccines work: A. Vaccines contain antigens (weakened or dead viruses, bacteria, and fungi that cause disease and infection). When introduced into the body, the antigens stimulate the immune system response by instructing B cells to produce antibodies, with assistance from T-cells. B. The antibodies are produced to fight the weakened or dead viruses in the vaccine. C. The antibodies "practice" on the weakened viruses, preparing the immune system to destroy real and stronger viruses in the future. D. When new antigens enter the body, white blood cells called macrophages engulf them, process the information contained in the antigens, and send it to the T-cells so that an immune system response can be mobilized. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

a vaccine should make sure he or she is fully informed about both the benefits and the risks. Any questions or concerns should be discussed with a physician or other health care provider. The Centers for Disease Control and Prevention (CDC) offers substantial information on immunizations and vaccinations.

Vaccines may cause problems for people with certain **allergies**. Patients who have allergies to:

- antibiotics neomycin or polymyxin B should not take rubella vaccine, measles vaccine, mumps vaccine, or the combined MMR vaccine
- baker's yeast should not take the hepatitis B vaccine
- antibiotics such as gentamicin sulfate, streptomycin sulfate or other aminoglycosides should check with their physicians before taking influenza vaccine, as some influenza vaccines contain small amounts of these drugs

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KEY TERMS

Anthrax—An infectious disease caused by a type of bacterium. The disease can be passed from animals to people and usually is fatal. Symptoms include sores on the skin.

Antibodies—Proteins that are normally produced by specialized white blood cells after stimulation by a foreign substance (antigen) and that act specifically against the antigen in an immune response.

Antigen—Any foreign substance, usually a protein, that stimulates the body's immune system to produce antibodies.

Bacteria—Tiny, single-celled forms of life that cause many diseases and infections.

Cholera—An infection of the small intestine caused by a type of bacterium. The disease is spread by drinking water or eating seafood or other foods that have been contaminated with the feces of infected people. It occurs in parts of Asia, Africa, Latin America, India, and the Middle East. Symptoms include watery diarrhea and exhaustion and is often fatal to young children and the elderly.

Cowpox—A mild disease in cows that is caused by a poxvirus.

Diphtheria—A serious, infectious disease that produces a toxin (poison) and an inflammation in the membrane lining of the throat, nose, trachea, and other tissues.

Encephalitis—Inflammation of the brain, usually caused by a virus. The inflammation may interfere with normal brain function and may cause seizures, sleepiness, confusion, personality changes, weakness in one or more parts of the body, and even coma.

Feces—The solid waste that is left after food is digested. Feces form in the intestines and pass out of the body through the anus. Also called stool.

Guillain-Barré syndrome (GBS)—A disease of the nerves with symptoms that include sudden numbness and weakness in the arms and legs, sometimes leading to paralysis. The disease is serious and requires medical treatment, but most people recover completely.

H1N1 (Swine Flu)—A disease that was originally found in pigs and can be passed from animal to human or human to human. Symptoms of H1N1 include fever, cough, chills, fatigue, headache, and body aches.

Immune system—The body's natural defenses against disease and infection.

Immunization—Administering a vaccine that stimulates the body to create antibodies to a specific disease (immunity) without causing symptoms of the disease.

Infectious disease—Any disease caused by invasion of a pathogen that subsequently grows and multiplies in the body.

- eggs should not take vaccines grown in the fluids of chick embryos including those for influenza, measles, and mumps

In general, anyone who has had an unusual reactions to a vaccine in the past should inform the physician before taking the same kind of vaccine again. The physician also should be told about any allergies to foods, medicines, preservatives, or other substances.

People with certain other medical conditions should be cautious about taking vaccines. Influenza vaccine, for example, may reactivate the rare Guillain-Barré syndrome (GBS) in people who have had it before. This vaccine also may worsen illnesses that involve the lungs, such as **bronchitis** or pneumonia. Vaccines that cause fever as a side effect may trigger seizures in people who have a history of seizures caused by fever.

Certain vaccines are not recommended for use during **pregnancy**, but some may be given to women at especially high risk of getting a specific disease such as polio. Vaccines also may be given to pregnant women to prevent medical problems in their babies. For example, vaccinating a pregnant woman with tetanus toxoid can prevent her baby from getting tetanus at birth.

Women should avoid becoming pregnant for three months after taking rubella vaccine, measles vaccine, mumps vaccine, or the combined MMR as these vaccines could cause problems in the unborn baby.

Women who are **breastfeeding** should check with their physicians before taking any vaccine.

Side effects

Most side effects from vaccines are minor and easily treated. The most common are **pain**, redness, and swelling

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Inflammation—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

Influenza—A disease caused by viruses that infect the respiratory tract.

Measles—An acute and highly contagious viral disease marked by distinct red spots followed by a rash that occurs primarily in children.

Meningitis—Inflammation of tissues that surround the brain and spinal cord.

Microbe—A microorganism, especially a bacterium, that causes disease.

Mumps—An acute and highly contagious viral illness that usually occurs in childhood.

Pathogen—A disease-causing microorganism.

Plague—A highly infectious disease that can be fatal if not treated promptly. The bacteria that cause plague mainly infect rats, mice, squirrels, and other wild rodents. The disease is passed to people through fleas. Infected people can then spread the disease to other people.

Rabies—A rare but serious disease caused by a virus carried in saliva. It is transmitted when an infected animal bites a person.

Rubella—A contagious viral disease that is milder than typical measles but is damaging to the fetus when it occurs early in pregnancy. Also called German measles.

Seizure—A sudden attack, spasm, or convulsion.

Smallpox—A highly contagious viral disease characterized by fever, weakness, and skin eruption with pustules that form scabs that slough off leaving scars.

Tuberculosis—An infectious disease that usually affects the lungs, but may also affect other parts of the body. Symptoms include fever, weight loss, and coughing up blood.

Typhoid fever—An infectious disease caused by a type of bacterium. People with this disease have a lingering fever and feel depressed and exhausted. Diarrhea and rose-colored spots on the chest and abdomen are other symptoms. The disease is spread through poor sanitation.

Virus—A tiny, disease-causing particle that can reproduce only in living cells.

Whooping cough—An infectious disease, also called pertussis, especially of children that is caused by a bacterium and is marked by a convulsive, spasmodic cough, sometimes followed by a shrill intake of breath.

Yellow fever—An infectious disease caused by a virus. The disease, which is spread by mosquitoes, is most common in Central and South America and Central Africa. Symptoms include high fever, jaundice (yellow eyes and skin) and dark-colored vomit, a sign of internal bleeding. Yellow fever can be fatal.

at the site of the injection. Some people may develop a fever or a rash. In rare cases, vaccines may cause severe allergic reactions, swelling of the brain, or seizures. Anyone who has an unusual reaction after receiving a vaccine should contact a physician immediately.

Interactions

Vaccines may interact with other medicines and medical treatments. When this happens, the effects of the vaccine or the other medicine may change or the risk of side effects may be greater. For example, **radiation therapy** and cancer drugs may reduce the effectiveness of many vaccines or may increase the chance of side effects. Anyone who takes a vaccine should let the physician know all other medicines he or she is taking and should ask whether the possible interactions could interfere with the effects of the vaccine or the other medicines.

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ORGANIZATIONS

American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, IL, 60007-1098, (847) 434-4000, (847) 434-8000, http://www.aap.org.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (404) 639-3534, (800) CDC-INFO (800-232-4636). TTY: (888) 232-6348, inquiry@cdc.gov, http://www.cdc.gov.

National Institute of Allergy and Infectious Diseases Office of Communications and Government Relations, 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-6612, (301) 496-5717, (866) 284-4107 or TDD (800) 877-8339 (for hearing impaired), (301) 402-3573, http://www3.niaid.nih.gov.

National Network for Immunization Information, 301 University Blvd., Galveston, TX, 77555-0351, (409) 772-0199, (409) 772-5208, http://www.immunizationinfo.org.

National Vaccine Program Office, 200 Independence Avenue, SW Room 715-H, Washington, DC, 20201, (202) 619-0257, (877) 696-6775, (409) 772-5208, http://www.hhs.gov/nvpo/.

World Health Organization, Avenue Appia 20, 1211 Geneva 27, Switzerland, +22 41 791 21 11, +22 41 791 31 11, info@who.int, http://www.who.int.

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Vaccines *see* **Vaccination**

Vaginal pain

Definition

Pain in the vaginal canal is usually associated with an underlying medical and/or psychological condition.

Demographics

Approximately 50–85% of the causes of vaginal pain are due to organic (medical) conditions. However, it is typical for the medical condition to be compounded by psychological issues such as depression, problems associated with sexual identity, or problems relating to personal female medical conditions (sometimes experienced by **breast cancer** and **hysterectomy** patients). The overall prevalence for vaginal pain experienced during sexual intercourse (**dyspareunia**), is 20% (15% of women and 57% of men).

Description

The vagina has three physiological functions: an outflow duct for menstrual discharge, to receive the penis during sexual intercourse, and as the birthing canal. Vaginal pain is experienced usually during vaginal manipulation or sexual intercourse. The primary entity concerns dyspareunia.

Causes and symptoms

Causes can be categorized as organic, due to a medical condition, and/or psychological difficulties. Medical conditions can include chronic diseases, minor ailments, breast **cancer**, and medications. Psychological cause can be related to physical or **sexual abuse**. **Pregnancy** and hormonal changes (decreased estrogen) have significant negative impact on sexual activity, desire, and satisfaction. Dyspareunia can be divided into three types of pain: superficial, vaginal, and deep. Superficial pain is associated with attempted penetration. This condition is usually caused by changes in anatomy, irritative condition, or **vaginismus**. Vaginal pain is associated with friction, indicating a problem with lubrication and/or arousal disorders. Deep pain is related to thrusting and is indicative of pelvic disease or an inability for **pelvic relaxation**.

Diagnosis

Diagnosis must be pursued with diligence and in a comprehensive manner. A careful history and **physical examination** is essential. Procedures that can be used include surgical investigation (**laparoscopy**) and treatment of the underlying cause(s).

Treatment

Treatment is directed at diagnosing the underlying condition, which can be medical and/or psychological cause(s). Treatment can include surgery, hormonal therapy (replacements), **psychotherapy**, and pain control protocols.

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KEY TERMS

Laparoscopic surgery—A surgical procedure to correct or diagnose an underlying disease.

Prognosis

Prognosis depends on the primary cause. If treatment is aggressively pursued and patient compliance is satisfactory, the overall outcome is favorable.

Prevention

There are no precise preventive measures since the condition can result from normal **aging** and/or progressively worsening psychological disease.

Resources

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ORGANIZATIONS

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Vaginal warts *see* **Genital warts**

Vaginismus

Definition

Vaginismus is a **sexual dysfunction** in which the muscles of the outer third of the vagina involuntarily contract or spasm during attempts at vaginal penetration, thereby closing the vagina.

Demographics

Sexual disorders are common among women, yet many cases go unreported and there is little accurate data regarding the incidence of specific problems. Vaginismus is believed to be uncommon. It is thought to occur most often in women of higher educational attainment and socioeconomic status.

Description

Vaginismus is a reflex response to pressing on the vagina. Women with vaginismus do not intentionally contract their vaginal muscles; rather the muscles of the outer vagina tighten automatically, often causing **pain**. Vaginismus can occur with any type of attempted vaginal penetration such as a penis, speculum, tampon, or other object. Sometimes it occurs with mere touching. Pushing harder increases the pain and most women with vaginismus cannot tolerate sexual intercourse. Vaginismus does not affect a woman's desire for sexual intercourse. Most women with vaginismus enjoy sexual activity that does not involve penetration and many have orgasms through clitoral stimulation.

There are different types of vaginismus:

- Lifelong vaginismus is the most common type and begins the first time vaginal penetration is attempted.
- Acquired vaginismus begins after a period of normal sexual functioning, often after a physical condition causes an episode of painful intercourse or after a woman has intercourse while emotionally distressed.
- General vaginismus occurs whenever vaginal penetration is attempted.
- Situational vaginismus occurs only in specific situations, such as with a certain sexual partner or during a gynecological examination.

Risk factors

Risk factors for vaginismus include physical conditions that cause painful intercourse, as well as sexual trauma or negative feelings about sex.

Causes and symptoms

There are many possible causes for vaginismus, but sometimes no cause can be determined. Vaginismus sometimes develops following painful intercourse caused by a physical condition. Such conditions include:

- infections of the vulva or vagina
- vulvodynia or vulvar vestibulitis, a stinging or burning around the opening to the vagina
- chronic pelvic pain from an underlying medical condition

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KEY TERMS

Cognitive behavioral therapy (CBT)—Psychotherapy that emphasizes the substitution of desirable patterns of thinking for undesirable patterns.

Coitus—Sexual intercourse.

Desensitization—The elimination of an emotional response, such as fear or anxiety, to specific stimuli.

Kegel exercises—Repetitive contractions to tone the pubococcygeal muscle of the pelvic floor for enhancing sexual response during intercourse or controlling incontinence.

Pelvic exam—A gynecological exam of the female reproductive organs.

Vulva—The external female genital organs, including the labia majora, labia minora, clitoris, and vestibule of the vagina.

Vulvar vestibulitis—A localized inflammation of the vestibule—the region immediately surrounding the opening of the vagina and the urethra.

Vulvodynia—A chronic burning, stinging, or irritation of the vulva.

- scars on the vagina from injury, childbirth, or surgery
- radiation therapy
- menopause or a medical treatment that affects female hormone levels
- irritation from douches, spermicides, or the latex in condoms

There are also various psychological causes of vaginismus. A common cause of vaginismus is the belief that sex is wrong, sinful, or "dirty"—often resulting from parental or religious teachings. In addition, a painful first sexual experience can cause the body to react as if all sexual intercourse will be painful. A traumatic childhood experience, such as sexual molestation, may cause lifelong vaginismus, while acquired vaginismus often results from **sexual assault** or **rape**. Women who feel threatened or powerless in a relationship may subconsciously tighten their vaginal muscles in defense or silent defiance. Another cause is fear of becoming pregnant.

According to the psychiatric handbook, the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Editon-Text Revision (DSM-IV-TR)*, a diagnosis of vaginismus requires that the response is due to psychological factors or a combination of psychological and medical factors, but not to medical factors alone.

The major symptom of vaginismus is the severe contraction of the outer vaginal muscles as the vagina is about to be penetrated. This may completely prevent penetration or make it difficult and painful. Women with vaginismus may be unable to consciously relax their vaginal muscles even when they truly desire to have sexual intercourse or allow penetration. Pelvic examinations may also be painful Some women cannot tolerate inserting a tampon or have never even tried.

Diagnosis

Examination

Diagnosing sexual disorders such as vaginismus is often very difficult, primarily due to discomfort or embarrassment about sexual discussions, even with a personal physician. Cultural norms and taboos often deter women from seeking help. Sometimes women are more comfortable consulting a physician if they are accompanied by a close friend or family member.

Involuntary spasm during a pelvic examination by a gynecologist or other women's healthcare specialist can confirm a diagnosis of vaginismus. The exam must be conducted as slowly and gently as possible. Physicians must explain what they are doing in detail. The woman may be offered a mirror and asked to guide the physician's hand or instruments into the vagina. Sometimes treatment for vaginismus must be initiated before a pelvic examination can be completed.

A complete physical exam and medical and sexual history are necessary to rule out other causes of painful sexual intercourse. The exam may reveal an infection, **scars**, or other abnormalities underlying the vaginismus. If physiological causes for the condition are ruled out, the patient may be referred to a psychiatrist, psychologist, or sex therapist.

According to the *DSM-IV-TR*, the first criteria for a diagnosis of vaginismus are that **muscle spasms** in the outer third of the vagina are involuntary and are recurring or persistent. The symptoms must cause physical and/or emotional distress or, in particular, problems with relationships. The symptoms must exist independently of another mental disorder that could account for them.

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Treatment

Traditional

As with most sexual disorders, there are many different treatments for vaginismus. Physical causes of vaginismus may require surgery or other treatment. Beyond that, treatment is aimed at reducing the **anxiety** and fear associated with penetration in order to weaken the reflexive tightening of vaginal muscles.

Desensitization techniques can, over time, enable a woman to relax her vaginal muscles and overcome the reflexive tightening of vaginismus. The woman begins by touching an area as close to her vaginal opening as possible without causing pain. Each day she touches a bit closer to the opening, becoming used to touching without pain. Once she can touch the tissues around the opening (the labia), she practices opening the vagina. Using a mirror to view her genitals, and bearing down, as if having a bowel movement, the opening is widened to make it more visible. Once she can touch the opening without pain, the woman inserts a finger past her hymen, pushing or bearing down to enlarge the opening. A small plastic dilator or cone is then inserted into the vagina, leaving it in place for 10–15 minutes. Once the vaginal muscles become used to the pressure, progressively larger inserts are used. Eventually, a dilator the size of a penis can be inserted comfortably. The woman's partner is then invited to insert the dilator. The couple then may attempt sexual intercourse. At first the woman may hold her partner's penis and insert it in her vagina. Some women are also more comfortable being on top during intercourse.

Desensitization procedures are somewhat controversial because they address the symptoms but not the cause of vaginismus. The exercises should be pursued under the direction of an experienced therapist or other healthcare provider. They should involve the sexual partner and gradually include intimate contact before culminating in sexual intercourse. Sometimes a male partner becomes overly cautious and reluctant to push and may lose his erection. In that case a phosphodiesterase inhibitor (sildenafil [Viagra], tadalafil [Cialis], or vardenafil [Levitra]) may be prescribed for the man.

Therapists also use **psychotherapy** or psychological techniques, couples or dual-sex therapy, **group therapy**, **hypnotherapy**, and/or behavioral therapies to treat vaginismus. Therapies should include information about sexual anatomy, physiology, the sexual response cycle, and common myths about sex. Treatment is usually extensive and multiple techniques are often used simultaneously.

Individual therapy often focuses on identifying and resolving underlying causes for vaginismus, such as childhood trauma or rape. When a woman has a trusting relationship with her therapist, insecurities or fears around sex resulting from factors such as parental attitudes or religious upbringing can often be revealed and successfully resolved.

Couples or dual-sex therapy is based on the concept that any sexual problems must be addressed by the couple, rather than the affected individual alone. The therapist will interact with the partners individually and as a couple. Addressing the couple's sexual history and any relationship problems may help to reveal and resolve the causes of vaginismus, especially when the disorder represents a nonverbal form of protest within a relationship. The couple is educated about the condition and taught various activities that may be helpful in overcoming the disorder.

Group therapy also can be effective for treating vaginismus. Couples or individuals who have the same or similar sexual disorders are brought together in a group. This setting can provide comfort and support for women or couples who are embarrassed or ashamed about their problem. Witnessing others discussing sex and sexual problems in an open and honest forum can encourage patients to become more open and honest themselves. Group therapy also exerts a certain amount of positive pressure and encouragement to open up and express oneself and to follow through with "homework," which may include masturbation or certain kinds of foreplay.

Hypnotherapy is effective for some patients with vaginismus. Hypnotherapy tends to focus on overcoming the condition itself, rather than resolving any underlying causes or conflicts. It often entails a number of sessions during which the patient and therapist define the goals of hypnotherapy. When the actual hypnosis occurs, suggestions are aimed at resolving underlying fears or concerns and alleviating symptoms. For example, the patient may be told that she can have intercourse without pain and that she will be able to overcome her muscle spasms. Problems that are causing the vaginismus may be explored under hypnosis and attempts made to reverse underlying feelings or fears.

Cognitive behavioral therapy (CBT) assumes that vaginismus is a learned behavior that can be unlearned. Behavioral therapy usually involves desensitization. Patients are exposed to situations that create a mild sense of psychological discomfort or anxiety. Once this mild anxiety is overcome, they are exposed to sexual situations that they find successively more threatening, until eventually coitus is achieved without difficulty.

Drugs

Infections underlying vaginismus can be treated with medications. A recent study found that injections

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with botulinum neurotoxin type A was often effective in treating vaginismus in women with vulvar vestibulitis syndrome.

Alternative

Biofeedback may help teach a woman to control her vaginal muscles.

Home remedies

Specific exercises, including pelvic floor muscle contractions and relaxation called Kegel exercises, may help women control muscle contractions during sex.

Prognosis

Vaginismus is one of the most treatable sexual disorders, with a success rate of at least 63%. Because the causes of vaginismus vary, different treatments are successful with different women. In general a treatment plan that combines two or more therapeutic techniques supervised by a specialist in **sex therapy** has the greatest likelihood of success. Untreated vaginismus can lead to unsatisfying sexual relationships, tension, and emotional distress between partners.

Prevention

There are no known preventions for vaginismus; however, maintaining open and honest communication within a sexual relationship may help prevent the disorder. Seeking prompt treatment if vaginismus does occur can minimize problems.

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Vaginitis *see* **Vulvovaginitis**

Vagotomy

Definition

Vagotomy is the surgical cutting of the vagus nerve to reduce acid secretion in the stomach.

Purpose

The vagus nerve splits into branches that go to different parts of the stomach. Stimulation from these branches causes the stomach to produce acid. Too much stomach acid leads to ulcers that may eventually bleed and create an emergency situation.

Vagotomy is performed when acid production in the stomach can not be reduced by other means. It is used when ulcers in the stomach and duodenum do not respond to medication and changes in diet. It is an appropriate surgery when there are ulcer complications, such as obstruction of digestive flow, bleeding, or perforation. The frequency with which elective vagotomy is performed has decreased since the 1990s as drugs have become increasingly effective in treating ulcers. However, the number of vagotomies performed in emergency situations has remained about the same.

Vagotomy is often performed in conjunction with other gastrointestinal surgery, such as partial removal of the stomach (antrectomy or subtotal **gastrectomy**). There are several types of vagotomies. Truncal

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vagotomy severs the trunk of the vagus nerve as it enters the abdomen. Parietal cell or proximal gastric vagotomy leaves the trunk intact, but severs the branches that go to different parts of the stomach.

Precautions

Patients who receive vagotomies are most often seen in emergency situations where bleeding and perforated ulcers make it necessary to act immediately. As with any major surgery, people who use alcohol excessively, smoke, are obese, and are very young or very old are at higher risks for complications.

Description

Vagotomy is performed under **general anesthesia** by a surgeon in a hospital. The surgeon makes an incision in the abdomen and locates the vagus nerve. Either the trunk or the branches leading to the stomach are cut. Then the abdominal muscles are sewn back together, and the skin is closed with sutures.

Often, other gastrointestinal surgery is performed at the same time as the vagotomy. Part of the stomach may be removed, for instance. Vagotomy causes a decrease in peristalsis and a change in the emptying patterns of the stomach. To ease this, a **pyloroplasty** is often performed. This procedure widens the outlet from the stomach to the small intestine.

Preparation

A gastroscopy and x rays of the gastrointestinal system are performed as diagnostic procedures to determine the position and condition of the ulcer. Standard preoperative blood and urine tests are done. The patient should discuss with the anesthesiologist any medications or conditions that might affect the administration of anesthesia.

Aftercare

Patients who have had a vagotomy stay in the hospital for about seven days. For the first three or four days, nasogastric suctioning is required. A tube is inserted through the nose and into the stomach. The stomach contents are then suctioned out. Patients eat a clear liquid diet until the gastrointestinal tract is functioning again. When patients return to a regular diet, spicy and acidic food should be avoided.

It takes about six weeks to fully recover from the surgery. The sutures that close the skin can be removed in 7–10 days. Patients are encouraged to move around soon after the operation to prevent the formation of deep vein **blood clots**. **Pain** medication, stool softeners, and **antibiotics** may be prescribed following the operation.

KEY TERMS

Duodenum—The section of the small intestine immediately after the stomach.

Peristalsis—The rhythmic contractions that move material through the bowel.

Risks

As with all surgery, excessive bleeding and infection are possible complications. In addition, the emptying patterns of the stomach are changed. This can lead to dumping syndrome and **diarrhea**. Dumping syndrome is a condition where shortly after eating, the patient experiences **palpitations**, sweating, **nausea**, cramps, **vomiting**, and diarrhea.

Normal results

Normal recovery is expected for most patients. In about 10% of those who have vagotomy without stomach removal, ulcers recur. Between 2% and 3% of patients who have some portion of their stomach removed also have recurrent ulcers.

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Tish Davidson, A.M.

Valacyclovir *see* **Antiviral drugs**

Valley fever *see* **Coccidioidomycosis**

Valsalva maneuver

Definition

The Valsalva maneuver is performed by attempting to forcibly exhale while keeping the mouth and nose closed. It is used as a diagnostic tool to evaluate the condition of the heart and is sometimes done as a treatment to correct abnormal heart rhythms or relieve chest **pain**.

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Purpose

The Valsalva maneuver is used with patients who have suspected heart abnormalities, often in conjunction with **echocardiography**. The maneuver is based on the fact that when a patient forcibly exhales against a closed nose and mouth while bearing down, as if having a bowel movement, specific changes occur in blood pressure and the rate and volume of blood returning to the heart.

Comparing the changes in a diseased heart to those expected in a normal heart gives clues to the type and location of heart damage. In addition, when a doctor listens to the chest with a stethoscope during the Valsalva maneuver, characteristic heart sounds are heard. Variations in these sounds can indicate the type of abnormality present in the heart. A 2004 study found that blood pressure response to the Valsalva maneuver could predict mortality in elderly patients with congestive **heart failure**. This could prove to be a new noninvasive way to help determine how long elderly patients with congestive heart failure are expected to live.

The Valsalva maneuver also corrects some rapid heartbeats originating in the atria. When the maneuver is done correctly, blood pressure rises. This forces the heart to respond by correcting its rhythm and beating more slowly. On rare occasions, the Valsalva maneuver can be used to diminish chest pain in patients with mild coronary disease.

Unrelated to any evaluation of the heart, the Valsalva maneuver also is taught to patients with **multiple sclerosis** who are unable to fully empty the bladder (flaccid bladder). It sometimes is used in sexual therapy to help men avoid **premature ejaculation**.

Precautions

The Valsalva maneuver should not be performed by patients who have severe **coronary artery disease**, have experienced recent **heart attack**, or have a moderate to severe reduction in blood volume.

Description

When performed formally, the patient is asked to blow against an aneroid pressure measuring device (manometer) and maintain a pressure of 40 millimeters of mercury (mm Hg) for 30 seconds. Less formally, the patient may be asked to bear down, as if having a bowel movement. During this 30 second period, a recording is made of the changes in blood pressure and murmurs of the heart.

KEY TERMS

Atria—The heart has four chambers. The right and left atria are at the top of the heart and receive returning blood from the veins. The right and left ventricles are at the bottom of the heart and act as the body's main pumps.

Echocardiography—An ultrasound test that shows the size, shape, and movement of the heart.

Preparation

The patient may be connected to a heart monitor and echocardiograph or the physician may simply use a stethoscope to monitor the heart. Sometimes an indwelling needle is inserted for accurate pressure measurements, depending on whether the procedure is being done for corrective or diagnostic purposes.

Aftercare

When this procedure is done to regulate irregular heart rhythms, the patient usually remains on a heart monitor to evaluate heartbeat.

Risks

The patient may feel dizzy or faint during the procedure, but serious consequences are rare. There is a risk that the Valsalva maneuver can cause **blood clots** to detach, bleeding, and abnormal rhythms originating in the ventricle. It can also cause cardiac arrest. Consequently, the procedure is usually performed in a setting where emergency equipment is accessible.

Normal results

There are four characteristic changes or phases in a normal heart's response to the Valsalva maneuver. An abnormality in any of these phases indicates a cardiovascular abnormality.

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Valvular heart disease

Definition

Valvular heart disease refers to several disorders and diseases of the heart valves, which are the tissue flaps that regulate the flow of blood through the chambers of the heart.

Description

The human heart consists of four chambers—two upper chambers (the atria) and two lower chambers (the ventricles)—that are responsible for pumping blood. The heart valves are like one-way doors, which open and close with each beat of the heart, controlling the blood flow from one chamber to the next. Each of these valves is made up of a few thin folds of tissue. When functioning correctly, they keep blood from flowing backward into a chamber when closed.

The four valves function in the following manner:

- The mitral valve is located between the left atrium and the left ventricle. It is the only valve with two flaps, or cusps.
- The tricuspid valve is located on the right side of the heart, between the right atrium and right ventricle. It is made up of three cusps, each a different size.
- The aortic valve is located on the left side of the heart and opens to allow blood to leave the heart from the left ventricle into the aorta, which is the main artery of the body. It closes to prevent blood from flowing back into the left ventricle.
- The pulmonary valve is situated on the right side of the heart, between the right ventricle and pulmonary artery. It allows blood to exit the heart and enter the lungs via the pulmonary artery. It closes to prevent blood from flowing back into the right ventricle.

Patients with valvular heart disease have a malfunction of one or more of these valves. There are several types of valvular heart diseases with distinct symptoms and treatments. These are:

- mitral valve prolapse (displacement)
- mitral valve insufficiency (regurgitation)
- mitral valve stenosis (narrowing)
- aortic valve insufficiency
- aortic valve stenosis
- tricuspid valve insufficiency
- tricuspid valve stenosis
- pulmonic stenosis
- pulmonic insufficiency

Certain types of heart disease can lead to one of the specific conditions listed above. These include **rheumatic fever** and infective inflammation of the heart (**endocarditis**). Multivalvular heart disease refers to a condition involving more than one of the heart valves.

Causes and symptoms

Problems with heart valves may occur as a result of infection, degeneration, or congenital abnormality. The most common infections are rheumatic **fever** and infective endocarditis.

Rheumatic fever

Rheumatic fever is a condition that results from the body's immune response to certain types of streptococcal bacteria. It occurs rarely. When it occurs, it is most often in children who have had **strep throat** that was not completely treated. The symptoms of rheumatic fever include heart inflammation, uncontrolled movement of face and limbs, arthritis that moves from joint to joint, **shortness of breath**, weakness, and either lumps under the skin or raised red patches on the skin. The most common valvular heart diseases to result from rheumatic fever are mitral stenosis, tricuspid stenosis, aortic insufficiency, aortic stenosis, multivalvular involvement, and less commonly, pulmonic stenosis. Chronic rheumatic heart disease can result from one occurrence or from repeated attacks. It is not as common as it once was in the United States, but still occurs frequently in developing countries.

Infective endocarditis

Infective endocarditis is an infection and inflammation of the inner layer, or membrane, of heart tissue (endocardium). Most people with a healthy, normal heart are not at significant risk for contracting infective endocarditis. However, people who have had rheumatic fever, with its resulting scarring, or a congenital cause of heart malformation, may contract this disease when certain bacteria enter the bloodstream and become lodged in the heart. In particular, dental surgery or any surgery involving the mouth, bladder, prostate, or female pelvic organs increases risk for this infection. The disease also may occur in drug addicts who inject their veins using unsterilized needles, even if they have normal heart valves. Symptoms of infective endocarditis include fever, a new or changing heart murmur, and abnormal loss of appetite or **fatigue**.

The use of appetite suppressants

In 1997 the manufacturers of fen-phen, the abbreviation for a combination of the two weight-loss drugs

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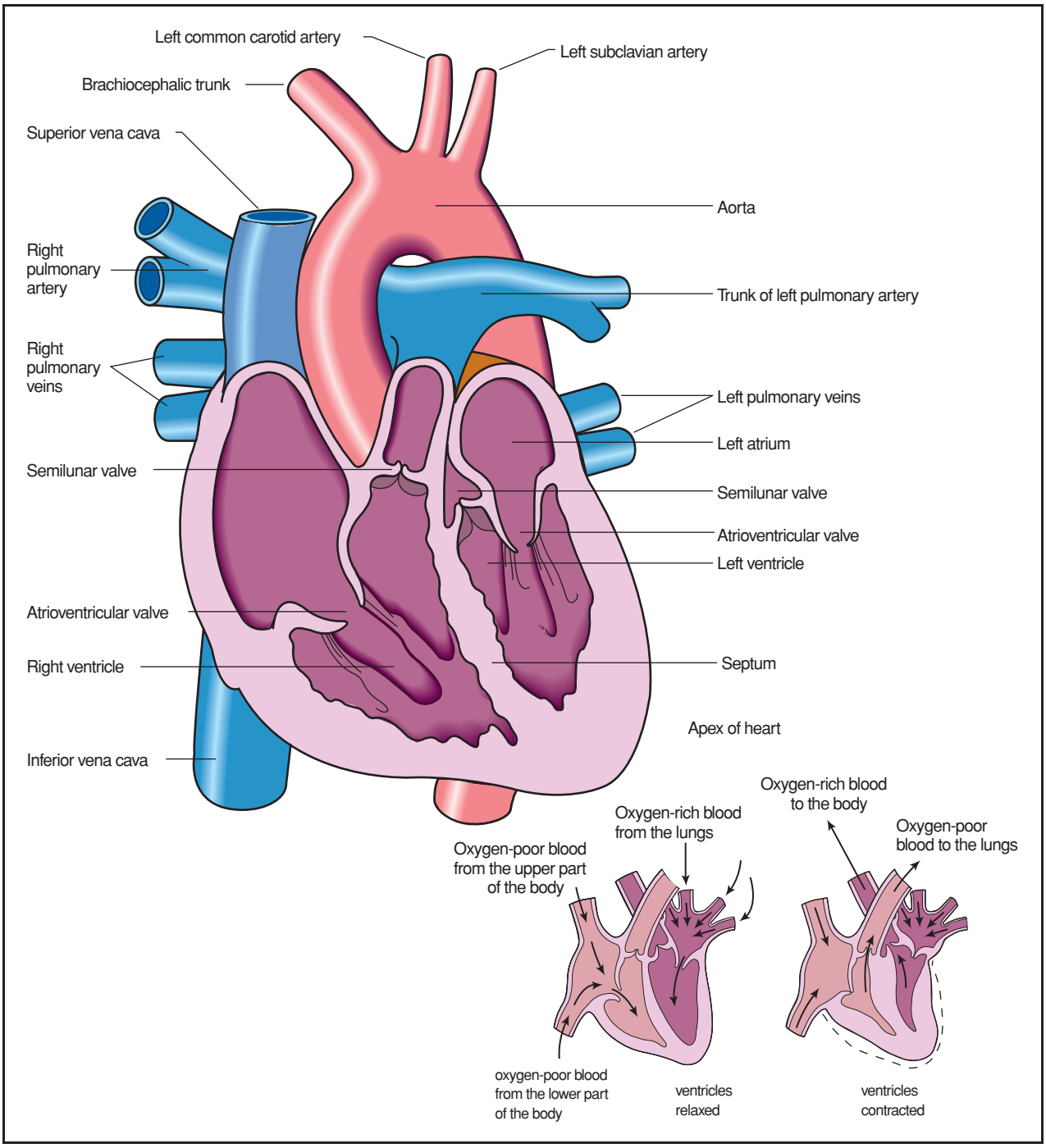

Anatomy of the human heart. The illustration at the bottom right shows how the right and left ventricles contract and relax when blood is pumped through the heart. *(Illustration by Hans & Cassady, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

fenfluramine and phentermine, withdrew the supplements from the market. Preliminary research showed that they caused heart valve problems in some patients. Physicians were concerned that this drug combination could affect the heart valves because the drugs alter the metabolism of serotonin in the body. Serotonin is a natural substance found in the brain and intestines that can affect blood vessels. Until the issue could be studied more, physicians recommended that patients taper off the drugs, finally stopping them

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altogether. Eventually, the company reached a $3.75 billion settlement of most lawsuits by former users of the diet drugs.

Other valvular heart disease

The mitral and aortic valves may also be affected by deposits of **calcium** in the heart that occurs with **aging**. This can lead to thickening and leakage of heart valves. Heart attacks also can damage the mitral valve structures. Additionally, certain connective tissue disorders can adversely affect the heart valves, for example, Marfan's syndrome and myxomatous degeneration.

Diagnosis

Specific types of valvular heart disease are diagnosed using **electrocardiography** (EKG), **echocardiography**, certain x-ray studies, and/or **cardiac catheterization**. An EKG provides a record of electrical changes in the heart muscle during the heartbeat. Echocardiography uses sound waves to make images of the heart. These images can show if there are any abnormalities of the heart valves. Cardiac catheterization is a procedure in which a small tube (called a catheter) is inserted into an artery and passed into the heart. It is used to measure pressure in the heart and the amount of blood pumped by the heart.

Rheumatic fever

Rheumatic fever may be suspected when a recent throat infection has occurred and other major or minor symptoms appear, such as joint ache, abnormal EKG, or a blood test indicating heart inflammation. **Heart murmurs** may be detected from routine examination.

Infective endocarditis

A diagnosis of infective endocarditis can be obtained through patient history, EKG, ultrasound, or cardiac catheterization. Patients who have developed the disease rapidly may report fever, fatigue, night sweats, chills, and joint inflammation. Those whose disease has developed more slowly will show signs of rapid heart rate, an enlarged spleen, various skin colors or spots, and heart murmur. The physician may order blood tests to determine what is causing the infection.

Appetite suppressants

People with a history of using appetite suppressants may be sent for EKGs or further testing if any of the symptoms of valvular heart disease, such as swelling, considerable fatigue, or shortness of breath occur.

Treatment

The treatment of specific valvular heart diseases will vary, depending on the valve involved and the extent of damage or malfunction. Some patients will not require treatment and many will be treated with medication. Sometimes, patients need surgery. If multivalvular disease is suspected or involved, different valves may be evaluated during surgery on one of the affected valves. Women with heart valve disease who want to become pregnant should receive a thorough check-up and see a cardiologist regularly throughout their **pregnancy**.

Rheumatic fever

Patients with rheumatic fever will be treated with **antibiotics** to eliminate streptococcal organisms that may still remain in the heart. Patients may receive antibiotics to prevent further infection, and inflammation may be treated with **aspirin** or cortisone-like drugs.

Infective endocarditis

Physicians will use the appropriate antibiotic or some combination of antibiotics to treat infective endocarditis, depending on the type of bacterium that caused the disease. Severe cases of this disease may be corrected by valve replacement surgery.

Appetite suppressants

The role of appetite suppressants (fen-phen) in valvular heart disease has been under study. Many of the people who suffered complications of the diet drugs experienced regurgitation. However, some 2001 studies found that these valve problems often did not worsen or even improved after a period of time after the patients stopped taking fen-phen.

Prognosis

The prognosis for patients with valvular heart disease varies depending on the underlying cause, age and health of the patient, and the degree of valvular damage or involvement.

Rheumatic fever

Patients with rheumatic heart disease face a lifetime of caution over contact with the same bacterium that caused the disease. Since it can cause inflammation of one or more organs or joints, complications

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KEY TERMS

Congenital—Used to describe a condition or defect present at birth.

Stenosis—An abnormal valve condition which is characterized by tightening or narrowing of the opening.

Streptococcal (*Streptococcus*)—*Streptococcus* is a bacterium that causes infection in people. Its most commonly known strain causes the infection strep throat.

Throat culture—A test for strep throat that involves swabbing the back of the throat and sending the swab to a laboratory, which will determine whether bacteria is present.

can occur. The inflammation of the heart may subside without side effects. Permanent scarring of one or more heart valves is a possibility and may require surgery to repair or replace damaged valves. In severe cases, rheumatic fever can lead to **death** from **heart failure**.

Infective endocarditis

The prognosis for patients with infective endocarditis depends on the underlying heart disease and resulting complications. If the disease further damages heart valves, symptoms may occur for years after initial treatment. Sometimes, endocarditis can result in heart or renal failure. If untreated, it can be fatal.

Appetite suppressants

Since it is believed that different valves may be affected, treatment for those taking these drugs most likely follows a similar course as that for the specific valvular disease.

Prevention

Certain measures can be taken to prevent some valvular disease. However, once valvular heart disease that results from congenital abnormality occurs, it may not be prevented. Steps can be taken to prevent further complications.

Rheumatic fever

The best prevention for rheumatic fever is prompt and thorough treatment of any suspected streptococcal infection, particularly strep throat in children. A physician should check any **sore throat** with fever that persists for more than 24 hours. The physician will probably order a **throat culture**. Completion of the antibiotic treatment even after symptoms diminish is important to be certain the infection is eliminated.

Infective endocarditis

Anyone who was born with a defective heart valve, those with artificial (prosthetic) valves, or those who have had a valve scarred by rheumatic fever, should use prescribed antibiotics by mouth before and after a dental procedure. These patients also may need to receive injected antibiotics prior to procedures involving the bladder, prostate, and pelvic organs.

Appetite suppressants

The drug associated with valvular heart disease, fen-phen, was removed from the market, so as long as people avoid obtaining this appetite suppression combination, they can prevent its negative effects.

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ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

Teresa G. Odle

Valvuloplasty *see* **Heart valve repair**

Varicella *see* **Chickenpox**

Varicocele removal *see* **Testicular surgery**

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Varicose veins

Definition

Varicose veins are dilated, tortuous, elongated superficial veins that are usually seen in the legs.

Description

Varicose veins, also called varicosities, are seen most often in the legs, although they can be found in other parts of the body. Most often, they appear as lumpy, winding vessels just below the surface of the skin. There are three types of veins, superficial veins that are just beneath the surface of the skin, deep veins that are large blood vessels found deep inside muscles, and perforator veins that connect the superficial veins to the deep veins. The superficial veins are the blood vessels most often affected by varicose veins and are the veins seen by eye when the varicose condition has developed.

The inside wall of veins has valves that open and close in response to the blood flow. When the left ventricle of the heart pushes blood out into the aorta, it produces the high pressure pulse of the heartbeat and pushes blood throughout the body. Between heartbeats, there is a period of low blood pressure. During the low pressure period, blood in the veins is affected by gravity and wants to flow downward. The valves in the veins prevent this from happening.

Varicose veins on a man's leg. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Varicose veins start when one or more valves fail to close. The blood pressure in that section of vein increases, causing additional valves to fail. This allows blood to pool and stretch the veins, further weakening the walls of the veins. The walls of the affected veins lose their elasticity in response to increased blood pressure. As the vessels weaken, more and more valves are unable to close properly. The veins become larger and wider over time and begin to appear as lumpy, winding chains underneath the skin. Varicose veins can develop in the deep veins also. Varicose veins in the superficial veins are called primary varicosities, while varicose veins in the deep veins are called secondary varicosities.

Causes and symptoms

The predisposing causes of varicose veins are multiple, and lifestyle and hormonal factors play a role. Some families seem to have a higher incidence of varicose veins, indicating that there may be a genetic component to this disease. Varicose veins are progressive; as one section of the veins weakens, it causes increased pressure on adjacent sections of veins. These sections often develop varicosities. Varicose veins can appear following **pregnancy**, **thrombophlebitis**, congenital blood vessel weakness, or **obesity**, but is not limited to these conditions. **Edema** of the surrounding tissue, ankles, and calves, is not usually a complication of primary (superficial) varicose veins and, when seen, usually indicates that the deep veins may have varicosities or clots.

Varicose veins are a common problem; approximately 15% of the adult population in the United States have varicose veins. Women have a much higher incidence of this disease than men. The symptoms can include aching, **pain**, itchiness, or burning sensations, especially when standing. In some cases, with chronically bad veins, there may be a brownish discoloration of the skin or ulcers (open sores) near the ankles. A condition that is frequently associated with varicose veins is spider-burst veins. Spider-burst veins are very small veins that are enlarged. They may be caused by back-pressure from varicose veins, but can be caused by other factors. They are frequently associated with pregnancy and there may be hormonal factors associated with their development. They are primarily of cosmetic concern and do not present any medical concerns.

Diagnosis

Varicose veins can usually be seen. In cases where varicose veins are suspected, but can not be seen, a physician may frequently detect them by palpation (pressing with the fingers). X rays or ultrasound tests

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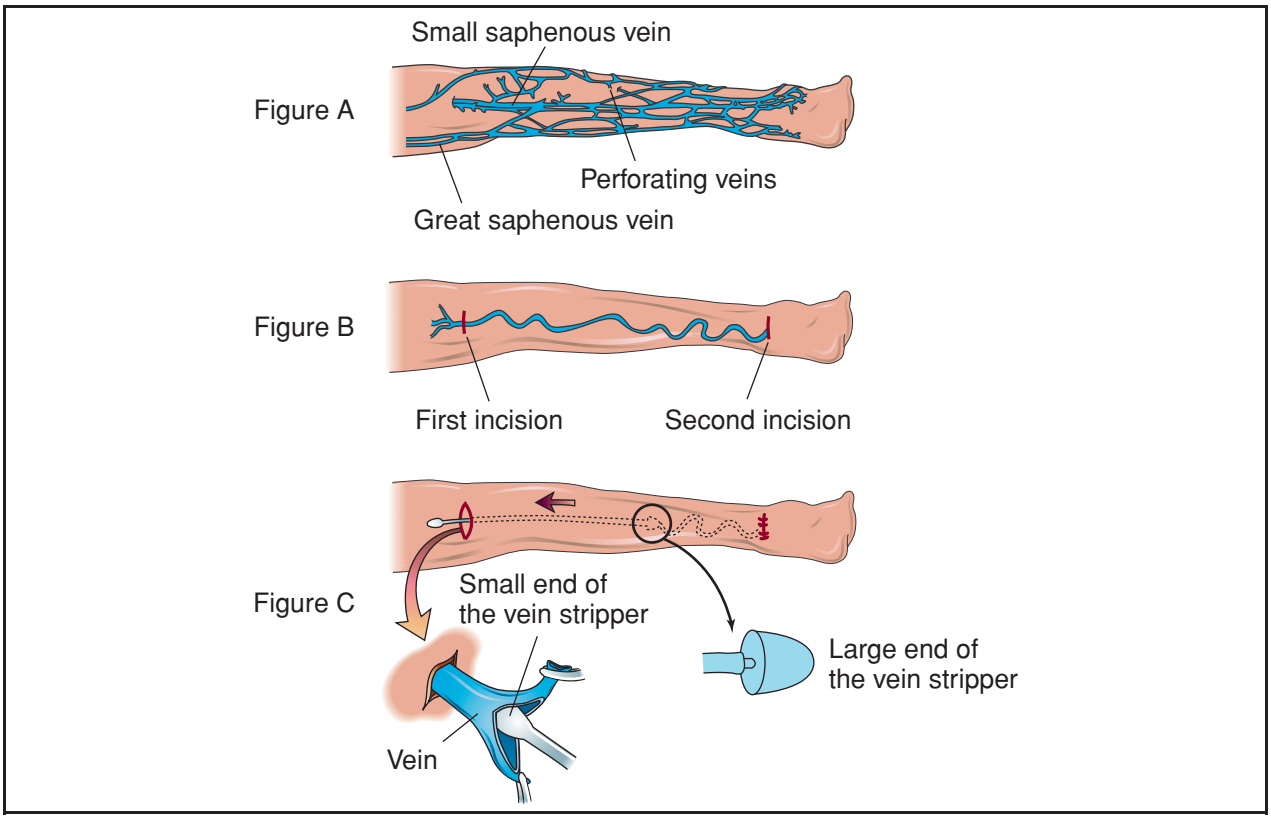

Varicose veins may be surgically removed from the body when they are causing pain and when hemorrhaging or recurrent thrombosis appear. Surgery involves making an incision through the skin at both ends of the section of vein being removed (figure B). A flexible wire is inserted through one end and extended to the other. The wire is then withdrawn, pulling the vein out with it (figure C). *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

can detect varicose veins in the deep and perforator veins and rule out **blood clots** in the deep veins.

Treatment

There is no cure for varicose veins. Treatment falls into two classes; relief of symptoms and removal of the affected veins. Symptom relief includes such measures as wearing support stockings, which compress the veins and hold them in place. This keeps the veins from stretching and limits pain. Other measures are sitting down, using a footstool when sitting, avoiding standing for long periods of time, and raising the legs whenever possible. These measures work by reducing the blood pressure in leg veins. Prolonged standing allows the blood to collect under high pressure in the varicose veins. **Exercise**, such as walking, biking, and swimming, is beneficial. When the legs are active, the leg muscles help pump the blood in the veins. This limits the amount of blood that collects in the varicose veins and reduces some of the symptoms. These measures reduce symptoms, but do not stop the disease.

Surgery is used to remove varicose veins from the body. It is recommended for varicose veins that are causing pain or are very unsightly and when hemorrhaging or recurrent thrombosis appear. Surgery involves making an incision through the skin at both ends of the section of vein being removed. A flexible wire is inserted through one end and extended to the other. The wire is then withdrawn, pulling the vein out with it. This is called "stripping" and is the most common method to remove superficial varicose veins. As long as the deeper veins are still functioning properly, a person can live without some of the superficial veins. Because of this, stripped varicose veins are not replaced.

Injection therapy is an alternate therapy used to seal varicose veins. This prevents blood from entering the sealed sections of the vein. The veins remain in the body, but no longer carry blood. This procedure can be performed on an outpatient basis and does not require anesthesia. It is frequently used if people develop more varicose veins after surgery to remove the larger varicose veins and to seal spider-burst veins

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KEY TERMS

Congenital—Existing at or before birth; a condition that developed while the fetus was in utero or as a consequence of the birth process.

Edema—Swelling caused by a collection of fluid in a tissue or body cavity.

Hemorrhage—Bleeding from blood vessels.

Palpation—The process of examining a patient by touch.

for people concerned about cosmetic appearance. Injection therapy is also called sclerotherapy. At one time, a method of injection therapy was used that did not have a good success rate. Veins did not seal properly and blood clots formed. Modern injection therapy is improved and has a much higher success rate.

Prognosis

Untreated varicose veins become increasingly large and more obvious with time. Surgical stripping of varicose veins is successful for most patients. Most do not develop new, large varicose veins following surgery. Surgery does not decrease a person's tendency to develop varicose veins. Varicose veins may develop in other locations after stripping.

Resources

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John T. Lohr, PhD

Variola *see* **Smallpox**

Vascular disease

Definition

Vascular disease is a general term for disease that occurs in the arteries and veins. There are many specific types of vascular disease.

Demographics

Vascular disease is common, especially in people over age 50. The exact number of people with vascular disease is difficult to estimate, as many vascular diseases show no symptoms until they reach an advanced stage. Estimates suggest that about 37% of Americans (over 80 million individuals) have cardiovascular disease (disease of either the heart or vascular system) and about 795,000 Americans have strokes each year. Vascular disease is more common in men than in women and appears in men at an earlier age. Researchers believe that the female hormone estrogen provides a protective effect until women reach the age of **menopause** at about age 50.

Internationally, vascular disease is highest in regions where people eat a Western diet high in animal fats and calories and low in fiber (e.g., Northern Europe). In cultures in Africa where the diet is low in animal products, low in calories, and high in whole grains, the prevalence of vascular disease is low.

Description

The vascular system is composed of arteries and veins. Arteries carry oxygen-rich blood away from the heart, while veins return oxygen-depleted blood to the heart. Vascular disease can occur in either arteries or veins, although vascular disease in arteries is more common.

Arteriosclerosis and **atherosclerosis** are the most common causes of vascular disease. Arteriosclerosis is commonly called "hardening of the arteries." The large and medium-sized arteries of the body have elastic, muscular walls. Whenever the heart contracts and pushes blood into the arteries, the walls of the artery expand slightly to accommodate the increased pressure of the blood. However, over many years, too much pressure can cause the artery walls to thicken and harden, losing their elasticity. This loss of elasticity is called arteriosclerosis.

Atherosclerosis is the build-up of plaque on the inside of the artery walls. Arterial plaque (different from dental plaque that builds up on teeth) is made up of fats, cholesterol, **calcium**, and bits of dead cells. Plaque can restrict the flow of blood. If blood flow is restricted, the heart must work harder (exert more pressure) to push blood through the artery and blood pressure rises. Plaque also can break off, causing damage to the artery wall. A blood clot may form where this happens. Bits of plaque and **blood clots** that form an **embolism** and travel through the vascular system with the potential to block a smaller artery and restrict or shut off the blood supply flowing through that artery. If blood supply to the heart is shut off, the individual has a **heart attack**. If blood supply is shut off in the internal carotid artery going to the brain or in any of the small vessels in the brain, the individual

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has a **stroke**. If the brain blockage is brief and resolves on its own with minimal damage, the incident is called a **transient ischemic attack** (TIA). Blood vessels in other parts of the body also may be blocked, with blockage most common in the blood vessels in the legs. Arteriosclerosis and atherosclerosis most often occur together, and these words commonly are used interchangeably to indicate the presence of vascular disease.

Arteriosclerosis and atherosclerosis can lead to the following types of vascular disease. For greater detail, consult the entries for each specific disease.

- Hypertension (high blood pressure) because the heart must use more force to pump blood through inflexible arteries and past obstructions in the arteries.
- Coronary artery disease (CAD) when the coronary arteries supplying the heart are narrowed.
- Cerebrovascular disease, carotid artery disease, or stroke, when a blood vessel to the brain is narrowed or blocked.
- Peripheral artery disease (PAD) also called peripheral vascular disease (PDV), when blood vessels in other parts of the body, usually the legs, are narrowed or blocked. This is most common in people with diabetes.
- Renovascular disease when arteries to the kidney are narrowed.
- Peripheral aneurysms, which often occur in the abdomen or behind the knee. Aneurysms are weak spots in the wall of an artery that bulge out and can burst. They may form where plaque breaks off the artery wall.

Other types of vascular disease that are not directly related to atherosclerosis or arteriosclerosis include:

- Deep vein thrombosis develops from prolonged periods of inactivity that reduce circulation and allow blood to pool and clots to form in the interior (deep) veins of the legs.
- Pulmonary embolism occurs when a blood clot breaks off and travels to the artery supplying the lungs. Pulmonary embolisms that completely block the artery to the lung are fatal.
- Chronic venous insufficiency occurs when a blood clot prevents enough blood from flowing back to the heart.
- Thoracic outlet syndrome (TOS) can be caused by compression of a vein or artery going to the arm. Venous compression often is caused by repetitive, energetic use of the arm (e.g., baseball pitcher) and artery compression often occurs in individuals who were born with a small extra rib. Nerves can also be compressed in TOS.
- Certain disorders, such as thrombocythemia or polycythemia vera, cause blood to clot too easily, increasing the risk of embolism formation.

Risk factors

Although there are a number of different vascular diseases, most have risk factors in common. An increased risk of developing vascular disease occurs in individuals who:

- are obese
- smoke tobacco
- have high blood pressure
- have high cholesterol and triglyceride levels
- get little exercise
- eat a diet high in saturated fats and low in fiber
- have either type 1 or type 2 diabetes, especially if poorly controlled
- have a family history of heart or vascular disease
- experience prolonged immobility, such as during a hospital stay after surgery

Causes and symptoms

Poor diet resulting in high levels of cholesterol and fats in the blood, lack of **exercise**, **aging**, uncontrolled **hypertension**, and uncontrolled diabetes lead to the development of atherosclerosis and arteriosclerosis. These, in turn, cause other vascular diseases. Some vascular problems are have a hereditary component (e.g., TOS, blood clotting diseases).

Atherosclerosis and arteriosclerosis develop gradually with no symptoms until the artery is so rigid and narrow that not enough blood can flow through it to meet the needs of the tissue it supplies. At this point, **pain** is the most common symptom. Clogged coronary arteries can cause chest pain (**angina**) and complete blockage causes a heart attack (myocardial infarction). Clogged arteries supplying the brain can lead to diminished mental function. Complete blockage of the blood supply can result in sudden **numbness** and weakness in the face, arm, or leg. Speech and coordination may be affected. If these events are brief and there is no lasting damage, the individual is said to have had a transient ischemic attack or TIA, or "warning stroke." If damage is permanent, the individual is said to have had a stroke or cerebrovascular accident (CVA). **Peripheral vascular disease** usually results in pain. If blockage occurs in the legs, the individual will have pain when walking and possible swelling. Sores on the legs and feet will be slow to heal. Blockage of

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KEY TERMS

Aneurysm—An abnormal bulge of an artery that can rupture leading to hemorrhage.

Angiogram—An x-ray (radiographic) study of the blood vessels. An angiogram uses a radiopaque substance, or contrast medium, to make the blood vessels visible under x ray.

Angioplasty—A technique used for treating blocked coronary arteries by inserting a catheter with a tiny balloon at the tip into the artery and then inflating it.

Arteriosclerosis—A chronic condition characterized by thickening and hardening of the arteries and the build-up of plaque on the arterial walls. Arteriosclerosis can slow or impair blood circulation.

Atherosclerosis—A chronic condition characterized by of plaque formed by on the arterial walls. Atherosclerosis can slow or impair blood circulation.

Balloon angioplasty—A surgical procedure is done to reopen a partially blocked artery so that blood can flow through it again at a normal rate. A tiny tube (catheter) is threaded through blood vessels to the point of the blockage. The catheter contains a balloon that is then expanded to stretch and open the artery.

Carotid artery—An artery located in the neck. There are two on each side of the neck. The internal carotid artery carries blood to the brain while the external carotid artery carries blood to skin and muscles of the face.

Cholesterol—A waxy substance made by the liver and also acquired through diet. High levels in the blood may increase the risk of cardiovascular disease.

Coronary arteries—These are the first arteries to branch off the aorta (the large artery leaving the heart). The coronary arteries surround the heart like a crown, coming out of the aorta, arching down over the top of the heart, dividing into two branches, and taking oxygen-rich blood to the heart muscle. Blockage of these arteries can cause insufficient blood flow to the heart or a heart attack.

Coronary artery disease (CAD)—Also called atherosclerosis, it is a build-up of fatty matter and debris in the coronary artery wall that causes narrowing of the artery.

Electrocardiogram (ECG, EKG)—A test that records the electrical activity of the heart using small electrode patches attached to the skin on the chest.

Embolism—A blood clot, air bubble, or clot of foreign material that travels and blocks the flow of blood in an artery. When blood supply to a tissue or organ is blocked by an embolism, infarction (death of the tissue the artery feeds) occurs. Without immediate and appropriate treatment, an embolism can be fatal.

Stent—A device made of expandable, metal mesh that is placed (by using a balloon catheter) at the site of a narrowing artery; the stent stays in place to keep the artery open.

Stress test—A test that involves an electrocardiogram during rest and exercise to determine how the heart responds to stress.

Stroke—Irreversible damage to the brain caused by insufficient blood flow to the brain as the result of a blocked artery. Damage can include loss of speech or vision, paralysis, cognitive impairment, and death.

Triglycerides—A type of fat found in the blood. High levels of triglycerides can increase the risk of coronary artery disease.

Type 1 diabetes—A chronic immune system disorder in which the pancreas does not produce sufficient amounts of insulin, a hormone that enables cells to use glucose for energy. Also called juvenile diabetes, it must be treated with insulin injections.

Type 2 diabetes—Formerly called adult-onset diabetes. In this form of diabetes, the pancreas either does not make enough insulin or cells become insulin resistant and do not use insulin efficiently.

Ultrasound—A technique that uses high-frequency sound waves to create a visual image (a sonogram) of soft tissues.

the arteries leading to the penis can cause **erectile dysfunction**.

Diagnosis

Diagnosis of vascular disease may occur during a routine **physical examination** or after the individual complains of symptoms.

Examination

Diagnosis begins with a complete physical examination and medical history. The doctor may notice abnormally high blood pressure or a week pulse below the area of a blockage in an artery. By listening to the arteries in the neck, the doctor may be able to hear an abnormal whooshing sounds (bruits). These

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sounds are caused by blood flowing around a blockage. The doctor also will look for signs of poor wound healing in the arms, legs, and feet, especially if the patient has diabetes.

Tests

Blood tests are done as part of a routine physical. Cholesterol, triglyceride, and blood sugar (blood glucose) levels will be checked. A urine test will look for protein in the urine which indicated a problem with kidney function.

If blockage of an artery is suspected, a series of non-invasive tests can be performed to located the blockage and estimate its size. These include:

- Doppler ultrasound. This is the standard diagnostic test for blood clots in the vascular system. An ultrasound wand applied over the area of the suspected blockage uses high-frequency sound waves to measure the speed at which the blood moves through the artery. Movement at an abnormal speed indicates a blockage.
- Ankle-brachial index. This is a test to determine if there is a narrowing of arteries in the legs or feet. First, blood pressure is taken in the normal way in the arm. Next, blood pressure is taken in the ankle. In a healthy person, the systolic pressure (the top number in a blood pressure reading) in both places will be approximately equal. If systolic pressure is lower in the ankle reading, this suggests the individual has PAD in the leg.
- Electrocardiogram (ECG). In this test, electrodes are placed on the chest to measure the electrical activity of the heart. If an ECG is done while walking on a treadmill, it is called a stress test. The results of this test can be used to help determine the health of the arteries supplying blood to the heart.

Procedures

When an artery blockage has been found, the doctor may perform an angiogram to determine its exact size and location. A special dye is injected into the arteries that make them visible on x ray images. From this, the doctor can pinpoint the location and size of the blockage(s). This test often is done before surgery to help guide the surgical procedure.

Treatment

Mild to moderate vascular disease usually is treated with a combination of lifestyle changes and drug therapy. If this fails, or if vascular disease is severe, surgery may be required.

Home remedies and lifestyle changes

An important first-line treatment for mild to moderate vascular disease involves lifestyle changes. These can be very effective. They include:

- losing weight if necessary and maintaining a healthy weight
- stopping smoking
- avoiding alcohol or consuming alcohol in moderation
- exercising moderately but regularly (five days a week)
- eating a diet low in animal fats and sweets and high in fresh fruits, vegetables, and fiber
- controlling high blood pressure through salt (sodium) restriction, exercise, and medications as necessary
- controlling diabetes through exercise, diet, and medication as necessary by monitoring blood glucose levels regularly

Drugs

When lifestyle changes are not enough to control vascular disease, drug therapy may be added to the program. These drugs normally will be taken long term and should not be stopped without consulting a doctor. Drugs may include:

- cholesterol-lowering drugs such as simvastin (Zocor) or atorvastatin (Lipitor)
- anti-platelet drugs such as aspirin or cloplidgrel (Plavix) to reduce the chance of platelets forming clumps in the blood
- anticoagulant drugs such as warfarin (Coumadin)to keep blood from clotting
- drugs to lower blood pressure (antihypertensive drugs)

Surgery

When drugs and lifestyle changes are not adequate or if blood vessel blockage is severe, surgical procedures may be used to open the blood vessel. These include:

- Balloon angioplasty. In this procedure, a thin wire with a deflated balloon at the tip is moved through an artery until it reaches the blockage. The balloon is then inflated so that the obstructing plaque is pressed against the artery wall and the vessel is made wider. Often a short mesh tube called a stent is placed at the site of the blockage to keep the blood vessel open.
- Endartectomy or atherectomy. These are surgical procedures to ream out blood vessels. This is sometimes called "Rotorooter surgery." Endartectomy is often performed on the carotid artery.

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- Bypass surgery. A section of blocked vessel is surgically removed and replaced with blood vessel taken from elsewhere in the body.
- Thrombolytic therapy. This uses a drug that breaks up blood clots. The drug is surgically delivered to the spot in the artery where the clot exists.

Prognosis

The progression of vascular disease often is silent and gradual until a dramatic event such as a stroke or heart attack occurs. When recognized early, vascular disease is highly treatable through lifestyle changes and drug therapy. When recognized late, surgery may be required. If unrecognized, vascular disease can be fatal. Cardiovascular disease accounts for about 35% of all deaths in the United States.

Prevention

Prevention is the same as the lifestyle changes listed under home remedies—healthy diet, exercise, avoiding **smoking**, maintaining a healthy weight and controlling blood pressure and diabetes. Prevention needs to begin at as early an age as possible because vascular disease normally shows no symptoms until it is advanced. However, making these changes, even after vascular disease has developed can reverse or slow its progression.

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ORGANIZATIONS

American College of Cardiology, Heart House, 2400 N Street, NW, Washington, DC, 20037, (202) 375-6000, (800) 253-4636 x8603, (202) 375-7000, resource@acc.org, http://www.acc.org.

American Heart Association, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, http://www.americanheart.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573; TTY (240) 629-3255, (240) 629-3246, nhlbiinfo@nhlbi.nih.gov, http://www.nhlbi.nih.gov.

National Institute of Neurological Disorders and Stroke (NINDS), P.O. Box 5801, Bethesda, MD, 20828, (301) 496-5751, TTY (301) 468-5981, (800) 352-9424, http://www.ninds.nih.gov.

Society for Vascular Surgery, 633 N. St. Clair, 24th Floor, Chicago, IL, 60611, (312) 334-2300, (800) 251-7188, (312) 334-2320, http://www.vascularweb.org.

Tish Davidson, A.M.

Vascular headache *see* **Migraine headache**

Vascular surgery

Definition

Vascular surgery is the treatment of surgery on diagnosed patients with diseases of the arterial, venous, and lymphatic systems (excluding the intracranial and coronary arteries).

Purpose

Vascular surgery is indicated when a patient has **vascular disease** that cannot be treated by less invasive, non-surgical treatments. The purpose of vascular surgery is to treat vascular diseases, which are diseases of the arteries and veins. Arterial disease is a condition in which **blood clots**, arteriosclerosis, and other vascular conditions occur in the arteries. Venous disease involves problems that occur in the veins. Some vascular conditions occur only in arteries, others occur only in the veins, and some affect both veins and arteries.

Demographics

As people age, vascular diseases are very common. Since they rarely cause symptoms in the early stages, many people do not realize that they suffer from these diseases. A large percentage of the 10 million people in the United States who may have **peripheral vascular disease** (PVD) are males. In the majority of cases, the blockage is caused by one or more blood clots that travel to the lungs from another part of the body. Factors that increase the chances of vascular disease include:

- increasing age (which results in a loss of elasticity in the veins and their valves)
- a family history of heart or vascular disease
- illness or injury
- pregnancy
- prolonged periods of inactivity sitting, standing, or bed rest
- smoking

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KEY TERMS

Ankle-brachial index (ABI) test—A means of checking the blood pressure in the arms and ankles using a regular blood pressure cuff and a special ultrasound stethoscope (Doppler). The pressure in the ankle is compared to the pressure in the arm.

Aorta—A large, elastic artery beginning at the upper part of the left ventricle of the heart that becomes the main trunk of the arterial system.

Aortic aneurysms—Occurs when an area in the aorta (the main artery of the heart) is weakened and bulges like a balloon.

Arteriogram—A test to check the blood pressure at several points in the leg by using a blood pressure cuff and a Doppler. The patient is then asked to walk on a treadmill, after which the ankle pressure is taken again to determine if the pressure decreased after walking.

Abdominal aortic aneurysm—Occurs when an area in the aorta (the main artery of the heart) is weakened and bulges like a balloon. The abdominal section of the aorta supplies blood to the lower body.

Aneurysm—A weakening of the artery wall due to atherosclerosis, causing a bulge that can rupture, and lead to thrombosis or embolism.

Angiography or angiogram—An x-ray exam of the arteries and veins (blood vessels) to diagnose blockages and other blood vessel problems.

Atherosclerosis—A form of arteriosclerosis affecting the innermost area of the artery; a series of calcified deposits that can close down the vessel.

Arteriogram—An x-ray picture of an artery achieved by injecting an opaque dye with a needle or tube into the affected artery.

Artery—A blood vessel conveying blood in a direction away from the heart.

Bruit—A roaring sound created by a partially blocked artery.

Capillary—Smallest extremity of the arterial vessel, where oxygen and nutrients are released from the blood into the cells, and cellular waste is collected.

Carotid artery—Major artery leading to the brain, blockages of which can cause temporary or permanent strokes.

Carotid artery disease—A condition in which the arteries in the neck that supply blood to the brain become clogged, causing the danger of a stroke.

Carotid endarterectomy—A surgical technique for removing intra-arterial obstructions of the internal carotid artery.

Cerebral aneurysm—The dilation, bulging, or ballooning out of part of the wall of a vein or artery in the brain.

Cholesterol—An abundant fatty substance in animal tissues. High levels in the diet are a factor in the cause of atherosclerosis.

Claudication—Attacks of lameness or pain chiefly in the calf muscles, brought on by walking because of a lack of oxygen reaching the muscle.

Computed tomography (CT) scan—A special type of x ray that can produce detailed pictures of structures inside the body.

Collaterals—Alternate pathways for arterial blood.

- obesity
- hypertension, diabetes, high cholesterol, or other conditions that affect the health of the cardiovascular system
- lack of exercise

Description

Vascular surgery involves techniques relating to endovascular surgeries, including balloon **angioplasty** and/or stenting, aortic and peripheral vascular endovascular stent/graft placement, thrombolysis, and other adjuncts for vascular reconstruction.

The vascular system is the network of blood vessels that circulate blood to and from the heart and lungs. The circulatory system (made up of the heart, arteries, veins, capillaries, and the circulating blood) provides nourishment to the body's cells and removes their waste. The arteries carry oxygenated blood from the heart to the cells. The veins return the blood from the cells back to the lungs for reoxygenation and recirculation by the heart. The aorta is the largest artery leaving the heart; it then subdivides into smaller arteries going to every part of the body. The arteries, as they narrow, are connected to smaller vessels called capillaries. In these capillaries, oxygen and nutrients are released from the blood into the cells, and cellular wastes are

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Coronary—Of or relating to the heart.

Embolism—Obstruction or closure of a vessel by a transported clot of foreign matter.

Endovascular grafting—A procedure that involves the insertion of a delivery catheter through a groin artery into the abdominal aorta under fluoroscopic guidance.

Intracranial—Existing or occurring within the cranium; affecting or involving intracranial structures.

Lower extremity amputation—To cut a limb from the body.

Lymphangiography—Injection of dye into lymphatic vessels followed by x rays of the area. It is a difficult procedure, as it requires surgical isolation of the lymph vessels to be injected.

Lymphoscintigraphy—A technique in which a radioactive substance that concentrates in the lymphatic vessels is injected into the affected tissue and mapped using a gamma camera, which images the location of the radioactive tracer.

Magnetic resonance imaging (MRI)—A noninvasive diagnostic technique that produces computerized images of internal body tissues and is based on nuclear magnetic resonance of atoms within the body induced by the application of radio waves.

Plethysmography—A test in which a patient sits inside a booth called a plethysmograph and breathes through a mouthpiece, while pressure and air flow measurements are collected to measure the total lung volume.

Pulmonary embolism—A blocked artery in the lung.

Renal artery aneurysm—An aneurysm relating to, involving, or located in the region of the kidneys.

Thoracic aortic aneurysm—Occurs when an area in the thoracic section of the aorta (the chest) is weakened and bulges like a balloon. The thoracic section supplies blood to the upper body.

Thrombolysis—A treatment that opens up blood flow and may prevent permanent damage to the blood vessels.

Thrombosis—The formation or presence of a blood clot within a blood vessel.

Thrombus—A blood clot that may form in a blood vessel or in one of the cavities of the heart.

Ulcer—A lesion or rough spot formed on the surface of an artery.

Ultrasound scan—The scan produces images of arteries on a screen and is used to evaluate the blood flow, locate blockages, and measure the size of the artery.

Varicose veins —Twisted, enlarged veins near the surface of the skin, which develop most commonly in the legs and ankles.

Vascular—Relating to the blood vessels.

Vasculogenic erectile dysfunction—The inability to attain or sustain an erection satisfactory for coitus, due to atherosclerotic disease of penile arteries, inadequate impedance of venous outflow (venous leaks), or a combination of both.

Venous stasis disease—A condition in which there is pooling of blood in the lower leg veins that may cause swelling and tissue damage, and lead to painful sores or ulcers.

collected for the return trip. The capillaries then connect to veins, which return the blood back to the heart.

The aorta stems from the heart, arches upward, and then continues down through the chest (thorax) and the abdomen. The iliac arteries, which branch out from the aorta, provide blood to the pelvis and legs. The thoracic section of the aorta supplies blood to the upper body, as it continues through the chest. The abdominal section of the aorta, which supplies blood to the lower body, continues through the abdomen.

Vascular diseases are usually caused by conditions that clog or weaken blood vessels, or damage valves that control the flow of blood in and out of the veins, thus robbing them of vital blood nutrients and oxygen. A few common diseases affecting the arteries are peripheral vascular disease (PVD), carotid artery disease, and aortic aneurysms.

Surgery is used to treat specific diseased arteries, such as **atherosclerosis**, to help prevent strokes or heart attacks, improve or relieve **angina** or **hypertension**, remove aneurysms, improve claudication, and save legs that would otherwise have to be amputated. The choices involve repairing the artery, bypassing it, or replacing it.

As people age, atherosclerosis, commonly called hardening of the arteries, occurs with the constant passage of blood through the arteries. It can take on a

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number of forms, of which atherosclerosis (hardening of the innermost portion) is the most common. This occurs when fatty material containing cholesterol or **calcium** (plaque) is deposited on the innermost layer of the artery. This causes a narrowing of the inside diameter of the blood vessel. Eventually, the artery becomes so narrow that a blood clot (thrombus) forms, and blocks blood flow to an entire portion of the body. This condition is called PVD, or peripheral arterial disease. In another form of atherosclerosis, a rough area or ulcer forms in the diseased interior of the artery. Blood clots then tend to develop on this ulcer, break off, and travel further along, forming a blockage where the arteries get narrower. A blockage resulting from a clot formed elsewhere in the body is called an **embolism**.

People who have few areas affected by PVD may be treated with angioplasty by opening up the blood vessel with a balloon placed on the end of a catheter. A stent is often used with angioplasty to help keep the artery open. The type of surgery used to treat PVD is based upon the size and location of the damaged artery. The surgery techniques used for severe PVD include:

- Bypass surgery is preferred for people who have many areas of blockage or a long, continuous blockage.
- Aortobifemoral bypass is used for PVD affecting the major abdominal artery (aorta) and the large arteries that branch off of it.
- In a technique called thromboendarterectomy, the inner diseased layers of the artery are removed, leaving the relatively normal outer coats of the artery.
- Resection involves a technique to remove a diseased artery following an aneurysm; a bypass is created with a synthetic graft.
- In a bypass graft, a vein graft from another part of the body or a graft made from artificial material is used to create a detour around a blocked artery.
- Tibioperoneal bypass is used for PVD affecting the arteries in the lower leg or foot.
- Femoropopliteal (fem-pop) bypass surgery is used for PVD affecting the arteries above and below the knee.
- Embolectomy is a technique in which an embolic clot on the wall of the artery is removed, using an inflatable balloon catheter.
- Thrombectomy is a technique in which a balloon catheter is inserted into the affected artery beyond a blood clot. The balloon is then inflated and pulled back, bringing the clot with it.

An aneurysm occurs when weakened blood vessels bulge like balloons as blood flows through them. Once they have grown to a certain size, there is a risk of rupture and life-threatening bleeding. There are two types of aortic aneurysms: abdominal **aortic aneurysm** (AAA) and thoracic aortic aneurysm. This classification is based on where the aneurysm occurs along the aorta. Aneurysms are more common in the abdominal section of the aorta than the thoracic section.

Most blood clots originate in the legs, but they can also form in the veins of arms, the right side of the heart, or even at the tip of a catheter placed in a vein. Venous disease conditions that usually occur in the veins of the legs include:

- varicose veins
- phlebitis
- venous stasis disease
- deep vein thrombosis (DVT)
- claudication
- blood clots

Carotid artery disease is a condition in which the arteries in the neck that supply blood to the brain become clogged; this condition can cause a **stroke**.

Lymphatic obstruction involves blockage of the lymph vessels, which drain fluid from tissues throughout the body and allow immune cells to travel where they are needed. Some of the causes of lymphatic obstruction (also known as swelling of the lymph passages), include infections such as chronic **cellulitis**, or parasitic infections such as **filariasis**, trauma, tumors, certain surgeries including **mastectomy**, and **radiation therapy**. There are rare forms of congenital **lymphedema** that probably result from abnormalities in the development of the lymphatic vessels. Most patients with lymphedema will not need surgery, as the symptoms are usually managed by other techniques. Surgical therapy for lymphedema includes removal of tissue containing abnormal lymphatics and, less commonly, transplant of tissue from areas with normal lymphatic tissues to areas with abnormal lymphatic drainage. In rare cases, bypass of abnormal lymphatic tissue is attempted, sometimes using vein grafts.

Other examples of vascular surgery include:

- cerebral aneurysm
- acute arterial and graft occlusion
- carotid endarterectomy
- endovascular grafting
- vasculogenic erectile dysfunction
- renal artery aneurysm
- surgery on varicose veins
- lower extremity amputation

Diagnosis/Preparation

In order for a patient to be diagnosed with a vascular disease, he or she must be clinically evaluated

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by a vascular surgeon, which includes a history and **physical examination**. A vascular surgeon also treats vascular disorders by non-operative means, including drug therapy and risk factor management.

The symptoms produced by atherosclerosis, thrombosis, embolisms, or aneurysms depend on the particular artery affected. These conditions can sometimes cause **pain**, but often there are no symptoms at all.

A physician has many ways of feeling, hearing, measuring, and even seeing arterial blockages. Many arteries in the body can be felt or palpated. A doctor can feel for a pulse in an area he or she believes afflicted. Usually, the more advanced the arteriosclerosis, the less pulse in a given area.

As the artery becomes blocked, it can cause a noise very much like water roaring over rocky rapids. The physician can listen to this noise (bruit) directly, or can use special amplification systems to hear the noise.

There are other tests that can be done to determine if arterial blood flow is normal, including:

- ankle-brachial index (ABI) test
- arteriogram
- segmental pressure test
- ultrasound scan
- magnetic resonance imaging (MRI)
- computed tomography (CT) scan
- angiography
- lymphangiography
- lymphoscintigraphy
- plethysmography
- duplex ultrasound scanning

There may be no symptoms of vascular disease caused by blood clots until the clot grows large enough to block the flow of blood through the vein. Symptoms that may come on suddenly include:

- pain
- sudden swelling in the affected limb
- reddish blue discoloration
- enlargement of the superficial veins
- skin that is warm to the touch

The physician will probably do an evaluation of all organ systems, including the heart, lungs, circulatory system, kidneys, and the gastrointestinal system. The decision whether to have surgery or not is based on the outcome of these evaluations.

For high-risk patients undergoing vascular surgery, research has shown that taking oral beta-blockers one to two weeks before surgery and continuing for at least two weeks after the operation can significantly reduce the chance of dying or having a **heart attack**. Scientists suspect that the drug improves oxygen balance in the wall of the heart and stabilizes plaques in the arteries.

Aftercare

The length of time in intensive care and hospitalization will vary with each surgery, as will the recovery time, depending on numerous factors. Because surgery for an abdominal aortic aneurysm (AAA) is more serious, the patient can expect to be in intensive care for 24 hours, and in the hospital for 5–10 days, providing the patient was healthy and had a smooth operative and postoperative course. The hospital stay will likely increase if there are complications. It may take as long as six months to fully recover from surgery for an AAA.

Living a heart-healthy lifestyle is the best way of preventing and controlling vascular disease: quit **smoking**; eat nutritious foods low in fat; **exercise**; maintain a healthy weight; and control risk factors such as high blood pressure, high cholesterol, diabetes, hypertension, and other factors that contribute to vascular disease.

Medications that may be used to treat PVD include:

- aspirin and other antiplatelet medications to treat leg pain
- statins to lower cholesterol levels
- medications to control high blood pressure
- medications to control diabetes
- anticoagulants (these are rarely, but not generally, used to treat PVD unless the person is at an increased risk for forming blood clots)

Risks

All surgeries carry some risks. There is a risk of infection whenever incisions are required. Operations in the chest or those that involve major blood vessels carry a higher risk of complications. Patients that have high blood pressure, chronic lung or **kidney disease**, or other illnesses are at greater risk of complications during and after surgery. Other risks of vascular surgery include:

- bleeding
- failed or blocked grafts

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- heart attack or stroke
- smoking
- leg swelling if a leg vein is used
- people over 65 years are at greater risk for brain impairment after major surgery
- the more damaged the circulatory system is before surgery, the higher susceptibility to mental decline after vascular surgery
- impotence

The patient should discuss risks with the surgeon after careful review of the patient's medical history and a physical examination.

Normal results

The success rate for vascular surgery varies depending on a number of factors that may influence the decision on whether to have surgery or not, as well as the results.

The chance that an aneurysm will rupture generally increases with the size of the aneurysm; AAAs smaller than 1.6 in (4 cm) in diameter have up to a 2% risk of rupture, while ones larger than 2 in (5 cm) in diameter have a 22% risk of rupture within two years.

Arterial bypass surgery and peripheral bypass surgery have very good success rates. Most of those who undergo AAA surgery recover well, except in the case of a rupture. Most patients who have a ruptured aortic aneurysm die due to excessive, rapid blood loss.

Surgical therapy for lymphedema has met with limited success and requires significant experience and technical expertise.

Morbidity and mortality rates

Peripheral vascular disease affects 10 million people in the United States, including 5% of those over 50. Only a quarter of PVD sufferers are receiving treatment. More than two million people in the United States develop DVT each year. More than 650,000 Americans experience a **pulmonary embolism** every year. Of those, approximately 200,000 people die from the condition.

Alternatives

There a few alternatives to treating vascular disease, although extensive research has not been done. **Acupuncture** is used to aid in hypertension and **chelation therapy** is thought to stabilize the effects of vascular disease. The focus should be on maintaining a proper diet and being aware of a family history of vascular disease so as to catch it as early as possible.

Resources

BOOKS

Khatri, V. P., and J. A. Asensio. *Operative Surgery Manual*, 1st ed. Philadelphia: Saunders, 2003.

Libby, P., et al. *Braunwald's Heart Disease*, 8th ed. Philadelphia: Saunders, 2007.

Mason, R. J., et al. *Murray & Nadel's Textbook of Respiratory Medicine*, 4th ed. Philadelphia: Saunders, 2007.

Townsend, C. M., et al. *Sabiston Textbook of Surgery*, 17th ed. Philadelphia: Saunders, 2004.

PERIODICALS

Abir, Farshad, Iannis Kakisis, and Bauer Sumpio. "Do Vascular Surgery Patients Need a Cardiology Work-up? A Review of Preoperative Cardiac Clearance Guidelines in Vascular Surgery." *European Journal of Vascular and Endovascular Surgery* 25 no. 2 (2003): 110–117.

Moore, Wesley S., M.D., et al. "Guidelines for Hospital Privileges in Vascular Surgery: An Update by an Ad Hoc Committee of the American Association for Vascular Surgery and the Society for Vascular Surgery." *Journal of Vascular Surgery* 36 no. 6 (2002): 1276–1282.

ORGANIZATIONS

American Board of Vascular Surgery (ABVS), 900 Cummings Center, #221-U, Beverly, MA, 01915, http://abvs.org.

National Heart, Lung and Blood Institute, 6701 Rockledge Drive, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, nhlbiinfo@rover.nhlbi.nih.gov, http://www.nhlhi.nih.gov.

National Institutes of Health (NIH), Department of Health and Human Services, 9000 Rockville Pike, Bethesda, MD, 20892, http://www.nih.gov.

Society of Interventional Radiology, 10201 Lee Highway, Suite 500, Fairfax, VA, 22030, (800) 488-7284, info@ sirweb.org, http://www.sirweb.org/index.shtml.

Society for Vascular Surgery, 900 Cummings Center, #221-U, Beverly, MA, 01915, http://www.vascularweb.org.

U.S. Department of Health and Human Services, 200 Independence Avenue, S.W., Washington, DC, 20201, (877) 696-6775, http://www.hhs.gov.

Valley Baptist Heart and Vascular Institute, 2101 Pease Street, P.O. Drawer 2588, Harlingen, TX, 78550, (956) 389-4848.

Crystal H. Kaczkowski, MSc
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Vasculitis

Definition

Vasculitis refers to a varied group of disorders which all share a common underlying problem of inflammation of a blood vessel or blood vessels. The inflammation may affect any size blood vessel, anywhere in the body. It may affect either arteries and/or veins. The inflammation may be focal, meaning that it affects a single location within a vessel, or it may be widespread, with areas of inflammation scattered throughout a particular organ or tissue, or even affecting more than one organ system in the body.

Description

Inflammation is a process which occurs when the immune system of the body responds to either an injury or a foreign invader (virus, bacteria, or fungi). The immune system response involves sending a variety of cells and chemicals to the area in question. Inflammation causes blood vessels in the area to leak, causing swelling. The inflamed area becomes red, hot to the touch, and tender.

Antibodies are immune cells which recognize and bind to specific markers (called antigens) on other cells (including bacteria and viruses). These antibody-antigen complexes can then stimulate the immune system to send a variety of other cells and chemicals involved in inflammation to their specific location.

Some researchers believe that the damaging process of vasculitis is kicked off by such antibody-antigen complexes. These complexes are deposited along the walls of the blood vessels. The resulting inflow of immune cells and chemicals causes inflammation within the blood vessels.

The type of disease caused by vasculitis varies depending on a number of factors:

- the organ system or tissue in which the vasculitis occurs
- the specific type of inflammatory response provoked
- whether the affected vessels are veins (which bring blood to the heart) or arteries (which carry blood and oxygen from the heart to the organs and tissues)
- the degree to which blood flow within the affected vessel is reduced

This person's legs are afflicted with leukocytoblastic vasculitis, a condition in which a blood or lymph vessel becomes inflamed. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Causes and symptoms

Some types of vasculitis appear to be due to a type of allergic response to a specific substance (for example, a drug). Other types of vasculitis have no identifiable initiating event. Furthermore, researchers have not been able to consistently identify antibody-antigen complexes in all of the types of diseases caused by vasculitis. The types of antigens responsible for the initial immune response have often gone unidentified as well. Furthermore, not all people with such complexes deposited along the blood vessels go on to develop vasculitis. Some researchers believe that, in addition to the presence of immune complexes, an individual must have some other characteristics which make him or her susceptible to vasculitis. Many questions have yet to be answered to totally explain the development these diseases.

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Symptoms

Symptoms of vasculitis depend on the severity of the inflammation and the organ system or systems affected. Some types of vasculitis are so mild that the only symptoms noted are small reddish-purple dots (called petechiae) on the skin due to tiny amounts of blood seeping out of leaky blood vessels. In more widespread types of vasculitis, the patient may have general symptoms of illness, including **fever**, achy muscles and joints, decreased appetite, weight loss, and loss of energy. The organ systems affected by vasculitis may include:

- The skin. Rashes, bumps under the skin, petechiae, larger reddish-purple circles (purpura), or bruising (ecchymoses) may appear. Areas of skin totally deprived of blood flow, and therefore of oxygen, may die, resulting in blackened areas of gangrene.
- The joints. In addition to joint pain, the joints themselves may become inflamed, resulting in arthritis.
- Brain and nervous system. Inflammation of the blood vessels in the brain can cause headaches, changes in personality, confusion, and seizures. If an area of the brain becomes totally deprived of oxygen, a stroke occurs. A stroke means that an area of brain tissue is either severely injured or completely dead from lack of oxygen. This may leave the individual with a permanent disability. If the vessels that lead to the eyes are affected, vision may become seriously disturbed. Nerves in the arms and legs may result in painful tingling sensations, loss of feeling, and weakness.
- Gastrointestinal system. Patients may have significant abdominal pain, vomiting, and diarrhea. If blood flow is completely cut off to an area of intestine, that part of the intestine will die off. The liver may be affected.
- Heart. This is an extremely serious type of vasculitis. The arteries of the heart (coronary arteries) may develop weakened areas, called aneurysms. The heart muscle itself may become inflamed and enlarged. With oxygen deprivation of the heart muscle, the individual may suffer a heart attack.
- Lungs. The patient may experience shortness of breath with chest pain, and may cough up blood. There may be wheezing.
- Kidney. Changes in the arteries of the kidney may result in high blood pressure. The kidneys may become increasingly unable to appropriately filter the blood, and kidney failure may occur.

Specific diseases

Multiple types of disease are associated with vasculitis. Many autoimmune diseases have vasculitis as one of their complications. These include **systemic lupus erythematosus**, **rheumatoid arthritis**, **scleroderma**, and **polymyositis**. Other types of diseases which have vasculitis as their major manifestations include:

- Polyarteritis nodosa. This is an extremely serious, systemic (affecting systems throughout the body) form of vasculitis. Small and medium arteries are involved, and the inflammation is so severe that the walls of the arteries may be destroyed. Any organ system, or multiple organ systems, may be affected. The most serious effects include kidney failure, complications involving the heart, gastrointestinal problems, and high blood pressure.
- Kawasaki's disease is an acute disease which primarily strikes young children. Fever and skin manifestations occur in all patients. While most patients recover completely, a few patients suffer from vasculitis in the heart. This is frequently fatal.
- Henoch-Schonlein purpura. While this frequently occurs in children, adults may also be affected. This disease tends to affect the skin, joints, gastrointestinal tract, and kidneys.
- Serum sickness occurs when an individual reacts to a component of a drug, for example penicillin. Symptoms of this are often confined to the skin, although fevers, joint pain, and swelling of lymph nodes may also occur.
- Temporal arteritis (also called giant cell arteritis) tends to involve arteries which branch off the major artery that leads to the head, called the carotid. An artery which feeds tissues in the area of the temple (the temporal artery) is often affected. Severe headaches are the most classic symptom. Other symptoms include fatigue, loss of appetite and then weight, fever, heavy sweating, joint pain, and pain in the muscles of the neck, shoulders, and back. If the vasculitis includes arteries which supply the eye, serious visual disturbance or even blindness may result.
- Takayasu's arteritis affects the aorta (the very large main artery that exits the heart and receives all of the blood to be delivered throughout the body), and arteries which branch off of the aorta. Initial symptoms include fatigue, fever, sweating at night, joint pain, and loss of appetite and weight. Every organ may be affected by this disease. A common sign of

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KEY TERMS

Aneurysm—A weakened area in the wall of a blood vessel which causes an outpouching or bulge. Aneurysms may be fatal if these weak areas burst, resulting in uncontrollable bleeding.

Antibody—Specialized cells of the immune system which can recognize organisms that invade the body (such as bacteria, viruses, and fungi). The antibodies are then able to set off a complex chain of events designed to kill these foreign invaders.

Antigen—A special, identifying marker on the outside of cells.

Autoimmune disorder—A disorder in which the body's antibodies mistake the body's own tissues for foreign invaders. The immune system therefore attacks and causes damage to these tissues.

Immune system—The system of specialized organs, lymph nodes, and blood cells throughout the body which work together to prevent foreign invaders (bacteria, viruses, fungi, etc.) from taking hold and growing.

Inflammation—The body's response to tissue damage. Includes hotness, swelling, redness, and pain in the affected part.

Petechia—A tiny, purplish-red spot on the skin. Caused by the leakage of a bit of blood out of a vessel and under the skin.

Purpura—A large, purplish-red circle on the skin. Caused by the leakage of blood out of a vessel and under the skin.

this disease is the inability to feel the pulse in any of the usual locations (the pulse is the regular, rhythmic sensation one can feel with a finger over an artery, for example in the wrist, which represents the beating of the heart and the regular flow of blood).

- Wegener's granulomatosis: This disease exerts its most serious effects on the respiratory tract. The vasculitis produced by this disease includes the formation of fibrous, scarring nodules called granulomas. Symptoms include nose bleeds, ear infections, cough, shortness of breath, and chest pain. There may be bleeding in the lungs, and a patient may cough up blood. The kidneys, eyes, and skin are also frequently involved.

Diagnosis

Diagnosis of any type of vasculitis involves demonstrating the presence of a strong inflammatory process. Tests which reveal inflammation throughout the body include **erythrocyte sedimentation rate**, blood tests which may reveal anemia and increased white blood cells, and tests to demonstrate the presence of immune complexes and/or antibodies circulating in the blood. An x-ray procedure, called **angiography**, involves injecting dye into a major artery, and then taking x-ray pictures to examine the blood vessels, in order to demonstrate the presence of inflammation of the vessel walls. Tissue samples (biopsies) may be taken from affected organs to demonstrate inflammation.

Treatment

Even though there are many different types of vasculitis, with many different symptoms based on the organ system affected, treatments are essentially the same. They all involve trying to decrease the activity of the immune system. Steroid medications (like prednisone) are usually the first types of drugs used. **Steroids** work by interfering with the chemicals involved in the inflammatory process. More potent drugs for severe cases of vasculitis have more serious side effects. These include drugs like cyclophosphamide. Cyclophosphamide works by actually killing cells of the patient's immune system.

Prognosis

The prognosis for vasculitis is quite variable. Some mild forms of vasculitis, such as those brought on by reactions to medications, may resolve totally on their own and not even require treatment. **Temporal arteritis**, **serum sickness**, Henoch-Schonlein purpura, and Kawasaki's disease usually have excellent prognoses, although when Kawasaki's affects the heart, there is a high **death** rate. Other types of vasculitis were always fatal, prior to the availability of prednisone and cyclophosphamide, and continue to have high rates of fatal complications. These include polyarteritis nodosa and **Wegener's granulomatosis**.

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Prevention

Because so little is known about what causes a particular individual to develop vasculitis, there are no known ways to prevent it.

ORGANIZATIONS

Lupus Foundation of America, 2000 L Street, N.W., Suite 710, Washington, DC, 20036, (202) 349-1155, (202) 349-1156, (800) 558-0121, http://www.lupus.org.

Vasculitis Foundation, PO Box 28660, Kansas City, MO, 64188, (800) 277-9474, http://www.vasculitisfoundation.org/wegenersgranulomatosis.

Rosalyn Carson-DeWitt, MD

Vasectomy

Definition

A vasectomy is a surgical procedure performed on males in which the vas deferens (tubes that carry sperm from the testicles to the seminal vesicles) are cut, tied, cauterized (burned or seared) or otherwise interrupted. The semen no longer contains sperm after the tubes are cut, so conception cannot occur. The testicles continue to produce sperm, but they die and are absorbed by the body.

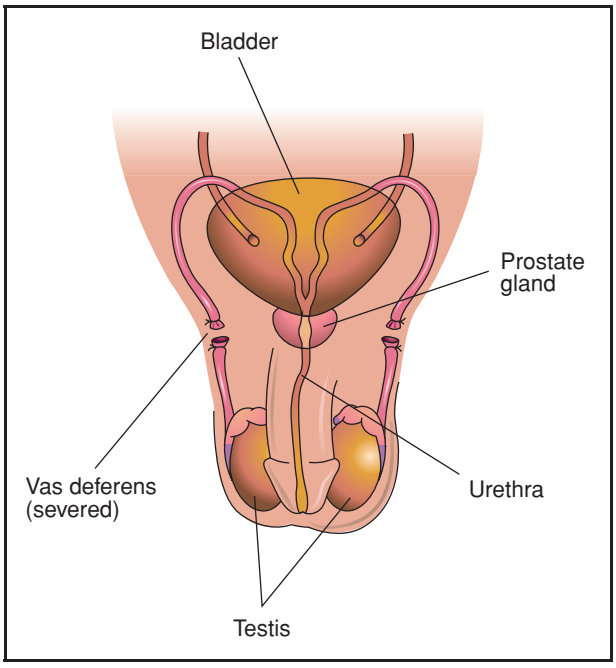
Purpose

The purpose of this operation is to provide reliable **contraception**. Research indicates that the level of effectiveness is 99.6%. Vasectomy is the most reliable method of contraception.

Description

Vasectomies are often performed in the doctor's office using a **local anesthesia**. The patient's scrotum area will be shaved and cleaned with an antiseptic solution to reduce the chance of infection. A small incision is made into the scrotum (the sac containing the testicles that produce the sperm). Each of the vas deferens (one from each testicle) is tied in two places with nonabsorbable (permanent) sutures and the tube is severed between the ties. The ends may be cauterized (burned or seared) to decrease the chance that they will leak or grow back together.

Sterility does not occur immediately after the procedure is finished. Men must use other methods of contraception until two consecutive semen analyses confirm that there are no sperm present in the semen.



Vasectomy is a surgical procedure performed on males in which the vas deferens (tubes that conduct sperm from the testicles to the penis) are cut, tied, cauterized, or otherwise interrupted. Although the testicles still produce sperm, the sperm die and are absorbed by the body. Men who have had vasectomies may continue to ejaculate the same amount of semen as before the procedure. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

This will take four to six weeks or 15–20 ejaculations to clear all of the sperm from the tubes.

"No scalpel" vasectomies are gaining popularity. Instead of an incision, a small puncture is made into the scrotum. The vas deferens are cut and sealed in a manner similar to that described above. No stitches are necessary and the patient has less **pain**. Other advantages include less damage to the tissues, less bleeding, less risk of infection, and less discomfort after the procedure.

In some, cases vasectomies may be reversed. However, this procedure should be considered permanent as there is no guarantee of successful reversal.

Preparation

No special physical preparation is required. The physician will first assess the patient's general health in order to identify any potential problems that could occur. The doctor will then explain possible risks and side effects. The patient is asked to sign a consent form which indicates that he understands the information he has received, and gives the doctor permission to perform the operation.

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KEY TERMS

Ejaculation—The act of expelling the sperm through the penis during orgasm.

Epididymitis—Inflammation of the small tube that rests on top of the testicle and is part of the system that carries sperm from the testicle to the penis. The condition can be successfully treated with antibiotics if necessary.

Scrotum—The sac which contains the testicles.

Sperm granuloma—A collection of fluid that leaks from an improperly sealed or tied vas deferens. They usually disappear on their own, but can be drained if necessary.

Testicles—The two egg-shaped organs found in the scrotum that produce sperm.

Tubal ligation—A surgical procedure in which the fallopian tubes are tied in two places and cut between. This prevents eggs from moving from the ovary to the uterus.

Aftercare

Following the surgery, ice packs are often applied to scrotum to decrease pain and swelling. A dressing (or athletic supporter) which supports the scrotum can also reduce pain. Mild over-the-counter pain medication such as **aspirin** or **acetaminophen** (Tylenol) should be able to control any discomfort. Activities may be restricted for one or two days and sexual intercourse for three to four days.

Risks

There are very few risks associated with vasectomy other than infection, bruising, **epididymitis** (inflammation of the tube that carries the sperm from the testicle to the penis), and sperm granulomas (collection of fluid that leaks from a poorly sealed or tied vas deferens). These are easily treated if they do occur. Patients do not experience difficulty achieving an erection, maintaining an erection, or ejaculating. There is no decrease in the production of the male hormone (testosterone), and sex drive and ability are not altered. Vasectomy is safer and less expensive than **tubal ligation** (sterilization of a female by cutting the fallopian tube to prevent conception).

Normal results

Normally, vasectomies are 99% successful in preventing conception. As such, it is one of the most effective methods available to consumers.

ORGANIZATIONS

Planned Parenthood Federation of America, 434 West 33rd St., New York, NY, 10001, (212) 541-7800, (212) 245-1845, (800) 230-7526, http://www.plannedparenthood.org.

Donald G. Barstow, RN

Vasodilators

Definition

Vasodilators are medicines that act directly on muscles in blood vessel walls to make blood vessels widen (dilate).

Purpose

Vasodilators are used to treat high blood pressure (**hypertension**). By widening the arteries, these drugs allow blood to flow through more easily, reducing blood pressure. Controlling high blood pressure is important because the condition puts a burden on the heart and the arteries, which can lead to permanent damage over time. If untreated, high blood pressure increases the risk of **heart attack**, **heart failure**, **stroke**, or kidney failure. Vasodilators usually are prescribed with other types of blood pressure drugs and rarely are used alone.

Description

Examples of vasodilators are hydralazine (Apresoline) and **minoxidil** (Loniten). The vasodilator hydralazine also may be used to control high blood pressure in pregnant women or to bring down extremely high blood pressure in emergency situations. In the forms used for treating high blood pressure (tablets or injections), these drugs are available only with a physician's prescription. A liquid form of minoxidil, used to promote hair growth in people with certain kinds of baldness and is applied directly to the scalp, and is sold without a prescription.

Recommended dosage

The recommended dosage depends on the type of vasodilator. The physician who prescribed the drug or the pharmacist who filled the prescription can

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recommend the correct dosage. This medicine should only be used as directed.

Physicians usually prescribe vasodilators along with other blood pressure medicines. Taking each drug at the correct time is extremely important. Health care providers can offer suggestions on how to remember when to take each drug.

Precautions

Seeing a physician regularly while taking a vasodilator is important, especially during the first few months. The physician will check to make sure the medicine is working as it should and will watch for unwanted side effects. People who have high blood pressure often feel fine. However, even when they feel well, patients should keep seeing their physicians and taking their medicine.

Vasodilators will not cure high blood pressure, but will help control the condition. To avoid the serious health problems that high blood pressure can cause, patients may have to take medicine for the rest of their lives. Furthermore, medicine alone may not be enough. People with high blood pressure also may need to avoid certain foods and keep their weight under control. The health care professional who is treating the condition can offer advice on what measures may be necessary.

Some people feel dizzy or have headaches while using this medicine. These problems are especially likely to occur in older people, who are more sensitive than younger people to the medicine's effects. Anyone who takes these drugs should not drive, use machines, or do anything else that might be dangerous until they know how the drugs affect them.

Special conditions

People who have certain medical conditions or who are taking certain other medicines may have problems if they take vasodilators. In the past, patients with severe aortic stenosis could not use vasodilators because they could cause blood pressure to drop too low and result in severe complications. However, in 2003, a report announced that the vasodilator nitroprusside was safe in these patients and rapidly improved their cardiac function. Before a patient takes vasodilators, he or she should be sure to let the physician know about any of these conditions:

ALLERGIES. Anyone who has had an unusual reaction to a vasodilator in the past should let his or her physician know before taking this type of drug again. The physician also should be told about any **allergies** to foods, dyes, preservatives, or other substances.

PREGNANCY. Several problems—from excess hair growth to blood abnormalities—have been reported in babies whose mothers take certain vasodilators during **pregnancy**. In studies of laboratory animals, hydralazine caused **birth defects** in mice and rabbits, but not in rats. The effects of taking vasodilators during pregnancy have not been specifically studied in humans. Women who are pregnant or who may become pregnant should check with their physicians before using this medicine. Women who become pregnant while taking a vasodilator should tell their physicians right away.

BREASTFEEDING. Women who are **breastfeeding** their babies or who plan to breastfeed should check with their physicians before using this medicine.

OTHER MEDICAL CONDITIONS. Using a vasodilator to lower blood pressure may worsen the problems that result from heart disease, blood vessel disease, or a recent heart attack or stroke. This medicine also may make **angina** (chest **pain**) worse. Vasodilators may make pheochromocytomas (tumors of the adrenal medulla), more active. Before using a vasodilator, people with any of these medical problems should make sure their physicians are aware of their conditions.

People with **kidney disease** also should check with their physicians before using a vasodilator. Side effects may be greater in these people because their kidneys are slow to clear the medicine from the body.

USE OF CERTAIN MEDICINES. Taking vasodilators with certain other drugs may affect the way the drugs work or may increase the chance of side effects. Any other prescription or nonprescription (over-the-counter) medicine should not be taken along with a vasodilator unless it has been discussed with the physician who prescribed the vasodilator.

Side effects

Some side effects of vasodilators go away as the body adjusts to the drug and do not need medical attention unless they continue or interfere with normal activities. These include:

- headache
- nausea or vomiting
- diarrhea
- loss of appetite

In addition, minoxidil may cause a temporary increase in hair growth, especially on the face, arms, and back. Patients who are bothered by this should check with their physicians.

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KEY TERMS

Adrenal gland—One of a pair of organs located next to the kidneys. The adrenal glands produce hormones that control many body functions.

Adrenal medulla—The inner part of the adrenal gland. The adrenal medulla produces the hormones epinephrine (adrenaline), which stimulates the heart, tightens blood vessels, and relaxes some smooth muscles, and norepinephrine, which has similar effects.

Arteries—Blood vessels that carry blood away from the heart to the cells, tissues, and organs of the body.

Other side effects of vasodilators should have medical attention. Rapid or irregular heartbeat are reasons to check with a physician immediately. If any of the following problems occur, a physician should be consulted as soon as possible:

- chest pain
- muscle pain
- joint pain
- pain, numbness, tingling, or weakness in the hands or feet
- swollen feet or lower legs
- swollen lymph nodes
- bloating
- fever and sore throat
- general discomfort or feeling of illness
- weakness
- blisters on skin; skin rash or itching; flushing or redness of the skin

Additional side effects are possible. Anyone who has unusual symptoms while taking a vasodilator should get in touch with his or her physician.

Interactions

Vasodilators may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the chance of side effects may be greater. In addition, many prescription and nonprescription (over-the-counter) drugs may affect blood pressure. *No other medication should be taken without the approval of the physician who prescribed the vasodilator*. In particular, avoiding over-the-counter medicines for appetite control, colds, **cough**, sinus problems, **asthma**, hay fever, and other allergies, should be avoided as these may increase blood pressure. At the other extreme, dangerously low blood pressure may result when drugs such as the blood pressure medicine guanethidine (Ismelin) or nitrates, used to treat chest pain, are combined with vasodilators.

Resources

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Nancy Ross-Flanigan
Teresa G. Odle

Vasodilatory *see* **Shock**

Vasopressin test *see* **Antidiuretic hormone (ADH) test**

Vasovagal faint *see* **Fainting**

Vegetarianism

Definition

Vegetarianism is the voluntary abstinence from eating meat. Vegetarians refrain from eating meat for various reasons, including religious, health, and ethical ones. Lacto-ovo vegetarians supplement their diet with dairy (lactose) products and eggs (ovo). Vegans (pronounced vee-guns) do not eat any animal-derived products at all.

Purpose

Vegetarianism is recommended as a dietary therapy for a variety of conditions, including heart disease, high cholesterol, type 2 diabetes, and **stroke**. Vegetarianism is a major dietary therapy in the alternative treatment of **cancer**. Other conditions treated with a dietary therapy of vegetarianism include **obesity**, **osteoporosis**, arthritis, **allergies**, **asthma**, environmental illness, **hypertension**, **gout**, **gallstones**, **hemorrhoids**, **kidney stones**, ulcers, **colitis**, **premenstrual syndrome**, **anxiety**, and depression. Vegetarians often report higher energy levels, better digestion, and mental clarity. Vegetarianism is an economical and easily implemented preventive practice as well.

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DR. JOHN HARVEY KELLOGG (1852–1943)

(AP Images.)

John Harvey Kellogg is known as the father of modern breakfast cereal. He was born in Tyrone Township, Michigan, on February 26, 1852, into a Seventh Day Adventist family. At age 12, he became an apprentice at the Review and Herald Press, a publishing company run by the church. He attended school in Battle Creek, Michigan.

He attended Bellevue Hospital Medical College in New York where he received his medical degree in 1875. In 1876, at the age of 24, Kellogg became an abdominal surgeon and superintendent of the Western Health Reform Institute, which he renamed the Battle Creek Sanitarium. There, he began applying his theories about natural living to his medical practice. As a vegetarian, he first advocated a diet high in whole grains, fruits, nuts, and legumes. He later included all types of vegetables in the diet. His controversial health regimen included morning calisthenics, open-air sleeping, cleansing enemas, chewing food hundreds of times before swallowing, and drinking plenty of water.

In the 1890s, Kellogg established a laboratory at the sanitarium to develop more nutritious foods. His brother, Will Keith Kellogg, joined in his research. In 1895 they developed a breakfast cereal of wheat flakes called Granose. The cereal quickly grew in popularity and was soon sold by mail order. This was followed by rice flakes and corn flakes. The brothers established the Sanitas Food Company. However, philosophical differences led them to split into two companies. Will founded the W. K. Kellogg Company, which retained the rights to the cereal products. John set up the Battle Creek Food Company, which produced coffee substitutes and soymilk. John Kellogg also edited *Good Health Magazine*, which promoted vegetarianism, for 60 years. In 1904, he published a book, *The Miracle of Life*. He continued to promote his version of healthy living and radical techniques until his death in 1943.

Description

The term vegetarian was coined in 1847 by the founders of the Vegetarian Society of Great Britain, but vegetarianism has been around as long as people have created **diets**. Some of the world's oldest cultures advocate a vegetarian diet for health and religious purposes. In India, millions of Hindus are vegetarians because of their religious beliefs. One of the ancient mythological works of Hinduism, the *Mahabharata*, states that, "Those who desire to possess good memory, beauty, long life with perfect health, and physical, moral and spiritual strength, should abstain from animal foods." The **yoga** system of living and health is vegetarian, because its dietary practices are based on the belief that healthy food contains *prana*. Prana is the universal life energy, which yoga experts believe is abundant in fresh fruits, grains, nuts and vegetables, but absent in meat because meat has been killed. Yogis also believe that spiritual health is influenced by the practice of *ahimsa*, or not harming living beings. The principle of *ahimsa* (non-violence) appears in the Upanishads (Vedic literature) from c. 600–300 B.C. Taking of animal life or human life under any circumstances is sinful and results in rebirth as a lower organism. It became a fundamental element of Jainism, another religion of India. Some Buddhists in Japan and China are also vegetarian because of spiritual beliefs. In the Christian tradition, the Trappist Monks of the Catholic Church are vegetarian, and some vegetarians argue that there is evidence that Jesus and his early followers were vegetarian. Other traditional cultures, such as those in the Middle East and the Mediterranean regions, have evolved diets that frequently consist of vegetarian foods. The **Mediterranean diet**, which a Harvard study declared to be one of the world's healthiest, is primarily, although not strictly, vegetarian.

The list of famous vegetarians forms an illustrious group. The ancient Greek philosophers, including Socrates, Plato, and Pythagoras, advocated vegetarianism.

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In modern times, the word to describe someone who likes to feast on food and wine is "epicure," but it is little known that Epicurus, the ancient philosopher, was himself a diligent vegetarian. Other famous vegetarians include Leonardo da Vinci, Sir Isaac Newton, Leo Tolstoy, Ralph Waldo Emerson, and Henry Thoreau. The twentieth century's celebrated vegetarians include Gandhi, the physician Albert Schweitzer, writer George Bernard Shaw, musician Paul McCartney, and champion triathlete Dave Scott. Albert Einstein, although not a strict vegetarian himself, stated that a vegetarian diet would be an evolutionary step for the human race.

Vegetarianism in the United States received a lot of interest during the last half of the nineteenth century and the beginning of the twentieth century, during periods of experimentation with diets and health practices. Vegetarianism has also been a religious practice for some Americans, including the Seventh-day Adventists, whose lacto-ovo vegetarian diets have been studied for their health benefits. Vegetarianism has been steadily gaining acceptance as an alternative to the meat-and-potatoes bias of the traditional U.S. diet. In 2009, Vegetarian Resource Group performed a poll that showed that 3% of the adult U.S. population identified themselves as vegetarians.

Several factors contribute to the interest in vegetarianism in the United States. Outbreaks of **food poisoning** from meat products, as well as increased concern over the additives in meat such as hormones and **antibiotics**, have led some people and professionals to question meat's safety. There is also an increased awareness of the questionable treatment of farm animals in factory farming. However, the growing health consciousness of Americans is probably the major reason for the surge in interest in vegetarianism. **Nutrition** experts have built up convincing evidence that there are major problems with the conventional U.S. diet, which is centered around meat products that are high in cholesterol and saturated fat and low in fiber. Heart disease, cancer, and diabetes, which cause 68% of all deaths in the United States, are all believed to be influenced by this diet. Nutritionists have repeatedly shown in studies that a healthy diet consists of plenty of fresh vegetables and fruits, complex carbohydrates, such as whole grains, and foods that are high in fiber and low in cholesterol and saturated fat. Vegetarianism, a diet that fulfills all these criteria, has become part of many healthy lifestyles. In alternative medicine, vegetarianism is a cornerstone dietary therapy, used in **Ayurvedic medicine**, **detoxification** treatments, macrobiotics, the Ornish diet for heart disease, and in therapies for many chronic conditions.

Preparations

Some people, particularly those with severe or chronic conditions such as heart disease or cancer, may be advised by a health practitioner to become vegetarian suddenly. For most people, nutritionists recommend that a vegetarian diet be adopted gradually to allow people's bodies and lifestyles time to adjust to new eating habits and food intake.

Some nutritionists have designed transition diets to help people become vegetarian in stages. Many Americans eat meat products at nearly every meal, and the first stage of a transition diet is to substitute just a few meals a week with wholly vegetarian foods. Then particular meat products can be slowly reduced and eliminated from the diet and replaced with vegetarian foods. Red meat can be reduced and then eliminated, followed by pork, poultry, and fish. For those wishing to become pure vegetarians or vegans, the final step would be to substitute eggs and dairy products with other nutrient-rich foods. Individuals should be willing to experiment with transition diets, and should have patience when learning how combine vegetarianism with social activities such as dining out.

The transition to vegetarianism can be smoother for those who make informed choices with dietary practices. Sound nutritional guidelines include decreasing the intake of fat, increasing fiber, and emphasizing fresh fruits, vegetables, legumes, and whole grains in the diet while avoiding processed foods and sugar. Everyone can improve their health by becoming familiar with recommended dietary and nutritional practices, such as reading labels and understanding basic nutritional concepts such as daily requirements for calories, protein, fat, and nutrients. Would-be vegetarians can experiment with meat substitutes, foods that are high in protein and essential nutrients. Thanks to the growing interest in vegetarianism, many meat substitutes are now readily available. Tofu and tempeh are products made from soybeans that are high in protein, **calcium**, and other nutrients. There are "veggie-burgers" that can be grilled like hamburgers, and vegetarian substitutes for turkey and sausage with surprisingly authentic textures and taste. There are many vegetarian cookbooks on the market as well.

A set of guidelines for North American vegetarian diets, updated for 2004, is available from the American Dietetic Association and the Dietitians of Canada. The new guidelines are intended to promote variety within vegetarian diets and to meet the needs of different stages in the life cycle as well as incorporate the most recent findings of medical research.

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One remaining drawback to the widespread practice of vegetarianism is the unpleasant taste or smell of many vegetables. A number of phytonutrients have a bitter, astringent, or acrid taste that they impart to products made from vegetables that contain them. Some experts think that people tend to reject such strong-smelling or bitter-tasting vegetables as turnips, cabbage, brussels sprouts, or broccoli because humans have been programmed in the course of evolution to associate bitter taste with poisonous plants. It is increasingly recognized that the major barrier to dietary change for the sake of health is taste. One recommendation for improving the taste appeal of vegetarian diets is more frequent use of spices. In addition to pleasing the human palate, spices derived from plants have been shown to have chemoprotective effects, boosting the immune system, reducing inflammation, and fighting harmful bacteria and viruses.

Precautions

In general, a well-planned vegetarian diet is healthful and safe; in the summer of 2003, a position paper endorsed by the American Dietetic Association and the Dietitians of Canada referred to vegetarian diets as "healthful, nutritionally adequate, and [able to] provide health benefits in the prevention and treatment of certain diseases." However, vegetarians, and particularly vegans who eat no animal products, need to be aware of particular nutrients that may be lacking in non-animal diets. These are amino acids, vitamin B_{12}, vitamin D, calcium, iron, zinc, and essential fatty acids. Furthermore, pregnant women, growing children, and those with health conditions have higher requirements for these nutrients.

Vegetarians should be aware of getting *complete protein* in their diets. A complete protein contains all of the essential amino acids, which are the building blocks for protein essential to the diet because the body cannot make them. Meat and dairy products generally contain complete proteins, but most vegetarian foods such as grains and legumes contain incomplete proteins, lacking one or more of the essential amino acids. However, vegetarians can easily overcome this by combining particular foods in order to create complete proteins. For instance, beans are high in the amino acid lysine but low in tryptophan and methionine, but rice is low in lysine and high in tryptophan and methionine. Thus, combining rice and beans makes a complete protein. In general, combining legumes such as soy, lentils, beans, and peas with grains like rice, wheat, or oats forms complete proteins. Eating dairy products or nuts with grains also makes proteins complete. Oatmeal with milk on it is complete, as is peanut butter on whole wheat bread. Proteins do not necessarily need to be combined in the same meal, but generally within four hours.

Getting enough vitamin B_{12} may be an issue for some vegetarians, particularly vegans, because meat and dairy products are the main sources. Vitamin supplements that contain vitamin B_{12} are recommended. Spirulina, a nutritional supplement made from algae, is also a vegetarian source, as are fortified soy products and nutritional yeast.

Vitamin D can be obtained by **vitamins**, fortified foods, and sunshine. Calcium can be obtained in enriched tofu, seeds, nuts, legumes, dairy products, and dark green vegetables including broccoli, kale, spinach, and collard greens. Iron is found in raisins, figs, legumes, tofu, whole grains (particularly whole wheat), potatoes, and dark green leafy vegetables. Iron is absorbed more efficiently by the body when iron-containing foods are eaten with foods that contain vitamin C, such as fruits, tomatoes, and green vegetables. Zinc is abundant in nuts, pumpkin seeds, legumes, whole grains, and tofu. For vegetarians who do not eat fish, getting enough omega-3 essential fatty acids may be an issue, and supplements such as flaxseed oil should be considered, as well as eating walnuts and canola oil.

Vegetarians do not necessarily have healthier diets. Some studies have shown that some vegetarians consume large amounts of cholesterol and saturated fat. Eggs and dairy products contain cholesterol and saturated fat, while nuts, oils, and avocados are vegetable sources of saturated fat. To reap the full benefits of a vegetarian diet, vegetarians should be conscious of cholesterol and saturated fat intake. Vegetarians may also consider buying organic foods, which are grown without the use of synthetic chemicals, as another health precaution.

Research and general acceptance

A vegetarian diet has many well-documented health benefits. It has been shown that vegetarians have a higher life expectancy, as much as several years, than those who eat a meat-centered diet. The U.S. Food and Drug Administration (FDA) has stated that data has shown vegetarians to have a strong or significant probability against contracting obesity, heart disease, lung cancer, **colon cancer**, **alcoholism**, hypertension, diabetes, gallstones, gout, kidney stones, and ulcers. However, the FDA also points out that vegetarians tend to have healthy lifestyle habits, so other factors may contribute to their increased health besides diet alone.

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KEY TERMS

Cholesterol—A steroid fat found in animal foods that is also produced in the body from saturated fat for several important functions. Excess cholesterol intake is linked to many diseases.

Complex carbohydrates—Complex carbohydrates are broken down by the body into simple sugars for energy, are found in grains, fruits and vegetables. They are generally recommended in the diet over refined sugar and honey, because they are a more steady source of energy and often contain fiber and nutrients as well.

Legume—Group of plant foods including beans, peas, and lentils, which are high in protein, fiber, and other nutrients.

Organic food—Food grown without the use of synthetic pesticides and fertilizers.

Saturated fat—Fat that is usually solid at room temperature, found mainly in meat and dairy products but also in vegetable sources such as some nuts, seeds, and avocados.

Tempeh—A fermented cake of soybeans and other grains; it is a staple food in Indonesia.

Tofu—A soft cheeselike food made from curdled soybean milk.

Unsaturated fat—Fat found in plant foods that is typically liquid (oil) at room temperature. They can be monounsaturated or polyunsaturated, depending on the chemical structure. Unsaturated fats are the most recommended dietary fats.

A vegetarian diet, as prescribed by Dr. Dean Ornish, has been shown to improve heart disease and reverse the effects of **atherosclerosis**, or hardening of the arteries. It should be noted that Dr. Ornish's diet was used in conjunction with **exercise**, **stress reduction**, and other holistic methods. The Ornish diet is lacto-ovo vegetarian, because it allows the use of egg whites and non-fat dairy products.

Vegetarians have a resource of statistics in their favor when it comes to presenting persuasive arguments in favor of their eating habits. Vegetarians claim that a vegetarian diet is a major step in improving the health of citizens and the environment. Americans eat over 200 lbs (91 kg) of meat per person per year. The incidence of heart disease, cancer diabetes, and other diseases has increased along with a dramatic increase in meat consumption during the past century. Many statistics show significantly smaller risks for vegetarians contracting certain conditions. The risks of women getting **breast cancer** and men contracting prostrate cancer are nearly four times as high for frequent meat eaters as for those who eat meat sparingly or not at all. For heart attacks, American men have a 50% risk of having one, but the risk drops down to 15% for lacto-ovo vegetarians and to only 4% for vegans. For cancer, studies of populations around the world have implied that plant-based diets have lower associated risks for certain types of cancer.

Vegetarians claim other reasons for adopting a meat-free diet. One major concern is the amount of pesticides and synthetic additives such as hormones that show up in meat products. Chemicals tend to accumulate in the tissue of animals that are higher in the food chain, a process called *bioaccumulation*. Vegetarians, by not eating meat, can avoid the exposure to these accumulated toxins, many of which are known to influence the development of cancer. One study showed that DDT, a cancer-causing pesticide, was present in significant levels in mother's milk for 99% of American women, but only 8% of vegetarian women had significant levels of the pesticide. Women who eat meat had 35 times higher levels of particular pesticides than vegetarian women. The synthetic hormones and antibiotics added to U.S. cattle has led some European countries to ban U.S. beef altogether. The widespread use of antibiotics in livestock has made many infectious agents more resistant to them, making some diseases harder to treat.

Vegetarians resort to ethical and environmental arguments as well when supporting their food choices. Much of U.S. agriculture is dedicated to producing meat, which is an expensive and resource-depleting practice. It has been estimated that 1.3 billion people could be fed with the grain that the United States uses to feed livestock, and **starvation** is a major problem in world health. Producing meat places a heavy burden on natural resources, as compared to growing grain and vegetables. One acre of land can grow approximately 40,000 lbs (18,000 kg) of potatoes or 250 lbs (113 kg) of beef, and it takes 50,000 gal (200,000 l) of water to produce 1 lb (0.45 kg) of California beef but only 25 gal (100 l) of water to produce 1 lb (0.45 kg) of

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wheat. Half of all water used in the United States is for livestock production. Vegetarians argue that the consumption of beef in the United States may also be contributing to global warming, by the large amounts of fossil fuels used in its production. The South American rainforest is being cleared to support U.S. beef consumption, as the United States yearly imports 300 million lbs (136 million kg) of meat from Central and South America. The production of meat has been estimated as causing up to 85% of the loss of topsoil of U.S. farmlands. A German researcher in the field of nutrition ecology has summarized the environmental benefits of vegetarian diets, saying, "Research shows that vegetarian diets are well suited to protect the environment, to reduce pollution, and to minimize global climate changes."

Despite the favorable statistics, vegetarianism does have its opponents. The meat industry in the United States is a powerful organization that has spent millions of dollars over decades advertising the benefits of eating meat. Vegetarians point out that life-long eating habits are difficult to change for many people, despite research showing that vegetarian diets can provide the same nutrients as meat-centered diets.

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Vegetarian Nutrition and Health Letter. 1707 Nichol Hall, Loma Linda, CA 92350. (888) 558-8703.

Vegetarian Times. 4 High Ridge Park, Stamford, CT 06905. (877) 321-1796.

ORGANIZATIONS

American Dietetic Association, 120 S. Riverside Plaza, Suite 2000, Chicago, IL, 60606-6995, (312) 899-0040, (800) 877-1600, http://www.eatright.org/.

Dietitians of Canada., 480 University Ave., Suite 604, Toronto, Canada, M5G 1V2, (416) 596-0857, centralinfo@dietitians.ca, http://www.dietitians.ca.

North American Vegetarian Society, PO Box 72, Dolgeville, NY, 13329, (518) 568-7970, http://www.navs-online.org/

Douglas Dupler, MA
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Vegetative state

Definition

A coma-like state characterized by open eyes and the appearance of wakefulness is defined as vegetative.

Description

The vegetative state is a chronic or long-term condition. This condition differs from a persistent vegetative state (PVS, a state of **coma** that lacks both awareness and wakefulness) since patients have awakened from coma, but still have not regained awareness. In the vegetative state patients can open their eyelids occasionally and demonstrate sleep-wake cycles. They also completely lack cognitive function. The vegetative state is also called coma vigil.

Causes and symptoms

The vegetative state can be caused by:

- cardiac arrest
- prolonged and profound hypoglycemia (an abnormal and severe decrease in blood sugar)

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- carbon monoxide poisoning
- head injury
- brain hemorrhage
- compression of the brainstem
- tumors
- bilateral hemispheric demyelination (a loss of nerve cells)
- injury of the brain following infections (meningitis or encephalitis)
- neurodegenerative diseases
- anencephaly (an abnormality of the brain and skull)
- diffuse nerve cell injury

Patients in a vegetative state apparently have functioning of a special area in the brain called the reticular activating system (RAS) responsible for sleep-wake cycles. The connections that integrate more complex abilities such as awareness are interrupted. Patients in the vegetative state can open and close eyes spontaneously. They may appear to track or follow objects with their eyes. Patients may chew and swallow food placed in the mouth. The vegetative patient does not respond to sound, hunger, or **pain**. Patients cannot obey verbal commands and lack local motor responses. Additionally, these patients cannot talk in comprehendible terms and they may become noisy, restless, and hypermobile. These patients are in a state of arousal but completely lack awareness.

Diagnosis

Diagnosis of vegetative state depends on the primary cause of brain dysfunction. A comprehensive history and neurological examination, neuroimaging studies, and chemical analysis of the blood are essential. Additionally, special tests such as cerebrospinal fluid (CSF, the fluid that bathes and nourishes the brain and spinal cord) analysis and **electroencephalography** (EEG analyzes the electrical activity within the brain) may be indicated to establish a diagnosis.

Treatment

Treatment is directed to presenting symptoms and patient needs. Patients require constant monitoring and assistance with feeding, hydration hygiene, assisted movement (to help prevent ulcers and **blood clots** in the legs), and elimination of waste products.

Alternative treatment

There is no known alternative treatment for vegetative patients.

KEY TERMS

Cognitive—The ability (or lack of) to think, learn, and memorize.

Hypermobility—Increased movement of joints.

Prognosis

The prognosis is generally poor and the condition can persist chronically.

Prevention

There is no known prevention since this state can occur as a result of unavoidable situations such as an accident, tumor, and bleeding or genetic abnormality.

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Laith Farid Gulli, M.D.

Velopharyngeal insufficiency

Definition

Velopharyngeal insufficiency is the improper closing of the velopharyngeal sphincter (soft palate muscle) during speech characterized by an acute nasal quality of the voice.

Description

At the back of the mouth is a circle of structures that include the tonsils, the tongue, and the palate. During speech, this apparatus must close off the nose for proper articulation of the explosive consonants "p," "b," "g," "t," and "d." If it does not close, there is a snort sound produced through the nose. Improper function of this structure also produces a nasal tone to the voice.

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KEY TERMS

Adenoids—Lymph glands just above the tonsils and the palate.

Cleft palate—Congenital defect marked by a split in the roof of the mouth.

Nasopharyngoscopy—A diagnostic procedure that examines the nasal passageways and pharynx with an instrument outfitted with an optical system.

Pharynx—A canal located between the mouth cavity and the esophagus.

Tonsillectomy—Surgical removal of the tonsils.

Tonsils—Lymph glands in the throat, just behind the back teeth.

Causes and symptoms

There are three main causes for this defect:

- Cleft palate is a congenital condition, producing a defect in the palate that allows air to escape upward during speech.
- If tonsil and adenoid surgery is done improperly, velopharyngeal insufficiency may result. The occurrence rate is approximately one in every 2,000–3,000 tonsillectomies.
- Nerve or muscle disease may paralyze the muscles that operate the velopharyngeal sphincter.

The primary symptom is the speech impediment. Some people develop a change in their speaking pattern or a series of facial grimaces to try to overcome the difficulty. If the condition is acute, regurgitation through the nose may occur.

Diagnosis

Examination of the velopharyngeal sphincter through ultrasound scans, fiber-optic nasopharyngoscopy, and videofluoroscopy will reveal the extent of velopharyngeal insufficiency. Speech and velopharyngeal sphincter movement are compared to make the diagnosis.

Treatment

Velopharyngeal insufficiency is treated with a combination of surgery and **speech therapy**. There are several surgical procedures that can be performed to correct the physical malfunction. They include:

- Pharyngeal flap procedure that moves the skin flap from the pharynx to the soft palate.
- Palatal push-back that separates the hard and soft palate in order to lengthen the soft palate.
- Pharyngoplasty that lengthens the soft palate by turning the pharyngeal skin flaps.
- Augmentation pharyngoplasty that inserts an implant into the pharyngeal wall to enlarge it, thus narrowing the velopharyngeal opening.
- Velopharyngeal sphincter reconstruction.

Prognosis

The combination of surgery to correct the insufficiency and speech therapy to retrain the voice successfully alleviate velopharyngeal insufficiency.

Resources

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J. Ricker Polsdorfer, MD

Vena cava filter

Definition

A vena cava filter is a device inserted into a major vein to prevent a blood clot from entering the lungs.

Purpose

The purpose of a vena cava filter is to prevent a blood clot from potentially traveling to the lungs. A thrombus clot traveling to the lungs is called a **pulmonary embolism** (PE). A thrombus in the deep venous system (the part of the circulation that brings blood back to the heart) represents a disorder of normal hemostasis (the normal clotting of blood).

Insertion of a vena cava filter is indicated for patients who:

- cannot receive medications that can dissolve the clot (anticoagulation therapy)
- have a thrombus in a deeply situated vein
- experiance complication of anticoagulation therapy such as bleeding

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- experiance failure of anticoagulation therapy to prevent pulmonary embolism
- have an embolus in the lungs (pulmonary embolectomy) removed
- have a recurrent embolism while receiving adequate medications
- have significant bleeding complications during anticoagulation

Precautions

There are no significant precautions concerning insertion of a vena cava filter. The devices are usually effective and short-term complications are unusual.

Description

Vena cava filters are usually inserted in to prevent PE caused by a thrombosis in a deep vein (DVT). Approximately 60% of patients who die in a hospital have evidence of PE during **autopsy**. The incidence (number of new cases) of DVT is highest for patients undergoing surgical repair of a fractured hip. However, DVT is common in both surgical and medical patients. DVT is found in 29–33% of patients in medical intensive care units (MICU) and in 27–40% of patients with a **heart attack** (myocardial infarction). Vena cava filters are placed to prevent thrombi from entering the lungs. There is currently a new type of filter called the Kim-Ray-Greenfield filter.

Preparation

Insertion of a vena cava filter is an invasive procedure. The patient is prepared for this procedure using standard surgical protocols. The VCF is commonly implanted in the jugular vein in the neck or the femoral vein in the groin. The procedure is generally well tolerated.

Aftercare

This depends on the patient's health status and recommendations for continued care.

Risks

Many patients have died from PE even with a vena cava implantation. Use of a VCF is primarily indicated if there are contraindications for anticoagulation therapy. VCF can increase a patient's susceptibility for developing recurrent DVT.

Normal results

The patient progresses well and prevention of large emboli that can cause a PE is successful.

KEY TERMS

Embolus—An embolus (or emboli the plural form) is a blood clot that has detached from its site of origin and travels to the lungs (pulmonary artery), where it can rupture the artery, causing death.

Pulmonary embolism—A traveling thrombus that has lodged in the pulmonary artery.

Thrombus—A thrombus (or thrombi the plural form) is a blood clot that can form in a deeply situated vein.

Abnormal results

The desired effect is not accomplished and the patient develops a PE resulting in **death**.

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American Society of Angiology, 708 Glen Cove Ave., Glen Head, NY, 11545, (516) 671-1975, (516) 759-5524, anngailius@amsocang.org, http://amsocang.org.

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Venereal diseases *see* **Sexually transmitted diseases**

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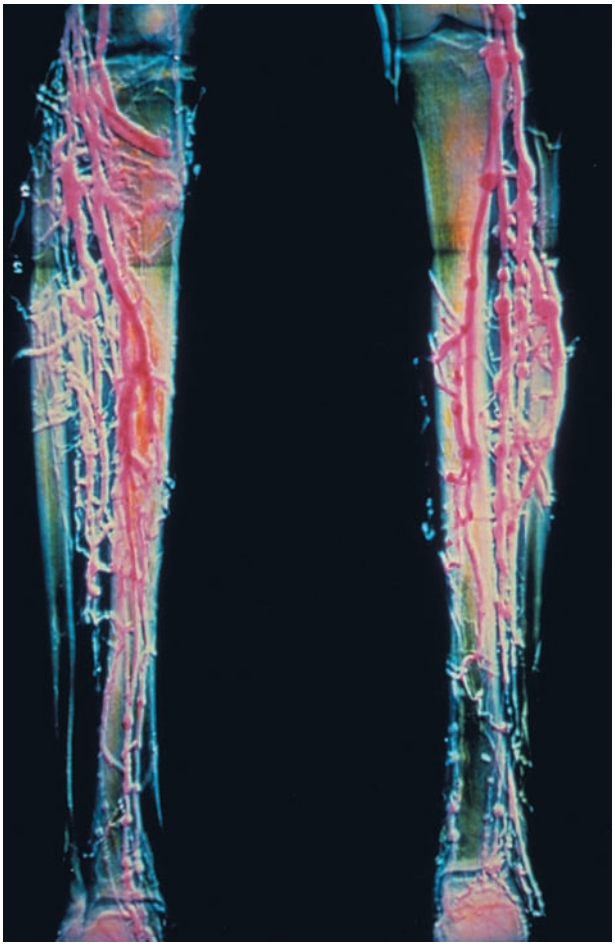
Venography

Definition

Venography is an x-ray test that provides an image of the leg veins after a contrast dye is injected into a vein in the patient's foot.

Purpose

Venography is primarily performed to diagnose **deep vein thrombosis** (a condition that can lead to **pulmonary embolism**). It is the standard procedure used to detect this type of disorder. Venography also can be used to distinguish **blood clots** from obstructions in the veins, to evaluate congenital vein problems, to see how the deep leg vein valves are working, and to identify a vein for arterial bypass grafting.



A venographic image of a patient's legs with varicose veins. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

Precautions

Venography usually is not performed in patients with kidney (renal) problems.

Description

Venography (also called phlebography, ascending contrast phlebography, or contrast venography) is an invasive diagnostic test that provides a constant image of leg veins on a fluoroscope screen. Venography identifies the location, extent, and degree of attachment of the blood clots and enables the condition of the deep leg veins to be assessed. It is especially useful when there is a strong suspicion of deep vein thrombosis but non-invasive tests have failed to identify the disease.

Venography is the most accurate test for detecting deep vein thrombosis. It is nearly 100% sensitive and specific in making this diagnosis (pulmonary **embolism** is diagnosed in other ways). Accuracy is crucial since deep vein thrombosis can lead to pulmonary embolism, a condition that can be fatal.

Venography is not used often, however, because it is painful, expensive, exposes the patient to a fairly high dose of radiation, and can cause complications. In about 5% of cases, there are technical problems in conducting the test. In addition, the test is less accurate in diagnosing problems below the knee. Venography takes between 30–45 minutes and can be done in a physician's office, outpatient center, or a hospital.

In 2003, a report said that computed tomography (CT) scanning could be used to diagnose pulmonary embolism and deep veinous thrombosis in one examination. By combining CT **angiography** and CT venography, researchers could look for both conditions in one procedure with high-speed CT scanners. The procedure was quick and delivered a reduced radiation dose. However, it has not become accepted as a replacement for traditional venography and is only preferred if the patient is clinically stable and requires immediate diagnosis and treatment.

During the procedure, the patient lies on a tilting x-ray table. The area where the catheter will be inserted will be shaved, if necessary, and cleaned. Sometimes a local anesthetic is injected to numb the skin at the site of the insertion. A small incision may be required to make a point for insertion. The catheter is inserted and the contrast solution (or dye) is slowly injected. Injection of the dye causes a warm, flushing feeling in the leg that may spread through the body. The contrast solution also may cause slight **nausea**. About 18% of patients experience discomfort from the contrast solution.

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KEY TERMS

Contrast solution—A liquid dye injected into the body that allows veins to be seen by x rays. Without the dye, the veins could not be seen on x rays.

Deep vein thrombosis—The development or presence of a blood clot in a vein deep within the leg. Deep vein thrombosis can lead to pulmonary embolism.

Invasive—A diagnostic test that invades healthy tissue; in the case of venography, through an incision in a healthy vein.

Pulmonary embolism—An obstruction of a blood vessel in the lungs, usually due to a blood clot, that blocks a pulmonary artery. Pulmonary embolism can be very serious and in some cases is fatal.

In order to fill the deep venous system with dye, a tight band (or tourniquet) may be tied around the ankle of the foot the dye is injected into or the lower extremities may be tilted. The patient is asked to keep the leg still. The doctor also observes the movement of the solution through the vein with a fluoroscope. At the same time, a series of x rays are taken. When the test is finished, fluid is injected to clear the dye from the veins, the catheter is removed, and a bandage is applied over the site of the injection.

Preparation

Fasting or drinking only clear liquids is necessary for four hours before the test. However, sometimes the test is done in an emergency even if the patient has eaten. The contrast solution contains iodine, to which some people are allergic. Patients who have **allergies** or hay fever, or have had a bad reaction to a contrast solution, should tell the doctor. A sedative, such as diazepam (Valium), may be prescribed to help the patient relax.

Aftercare

Patients should drink large amounts of fluids to flush the remaining contrast solution from their bodies. The area around the incision will be sore for a few days. If there is swelling, redness, **pain**, or fever, the doctor should be notified. Pain medication may be needed. In most cases, the patient can resume normal activities the next day.

Risks

Venography also can cause complications such as phlebitis, tissue damage, and the formation of deep vein thrombosis in a healthy leg. A rare side effect in up to 8% of cases is a severe allergic reaction to the dye. This usually happens within 30 minutes after injection of the dye and requires medical attention.

Normal results

Normal venography results show proper blood flow through the leg veins.

Abnormal results

Abnormal venography results show well-defined filling defects in veins. Findings include:

- blood clots
- consistent filling defects
- an abrupt end of a test dye column
- major deep veins that are unfilled
- dye flow that is diverted

These results confirm a diagnosis of deep vein thrombosis.

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Lori De Milto
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Venous access

Definition

Venous access introduces a needle or catheter into a vein. The venous access can then be used to withdraw blood, administer fluids or blood products, infuse parenteral **nutrition**, and/or administer medications.

Purpose

Venous access is necessary for fluid administration, medication administration, and obtaining blood

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for chemical analysis. Sites for access include veins located in the peripheral arms or legs, scalp, neck, and bone. Large central veins such as the subclavian vein may also be used to initiate venous access.

Venous access in children may pose special problems since finding appropriate veins and **immobilization** during the procedure may be difficult but essential. For complicated procedures **sedation** may be indicated. Venous access can be performed during emergency situations, and can be performed for outpatients, inpatients, and those who require long term administration of blood products or medication such as **chemotherapy**.

KEY TERMS

Cannula—Insertion of a tube.

Catheterization—The process of inserting a tubular instrument into a body cavity to permit passage of fluid.

Phlebitis— Inflammation of a vein.

Pneumothorax—The presence of air in the cavity that surrounds the lungs.

Description

For peripheral venipuncture the common site is usually a vein in the arm (the anticubital fossa located on the opposite side of the elbow) or on the flat bony area of the hand (dorsum of the hand). Scalp veins are accessible in infants under one year of age. The selected vein should be long and straight for needle accommodation. It should be identified by straightness, lack of pulsation (characteristic of an artery), and filling with blood from above (arteries fill from below). Internal jugular catheterization is performed in the neck using special bone and muscle landmarks. The external jugular vein can be cannulized by immobilizing, tilting and rotating the head. The subclavian approach is a complicated procedure and emergency access can be performed if attempts to access a vein in other areas have failed. Intraosseous venous access is usually accomplished through a leg bone. Catheters and subcutaneously implanted ports placed in the front of the chest (anterior chest wall) and other anatomic locations can accomplish long-term venous access as can peripherally inserted central catheters (PICC lines).

Precautions

There are no major precautions for access during emergency procedures. The main concern during an emergency is to secure a portal of entry to infuse potentially life-saving medications and fluids. For all methods of access the main precautionary measures include attention to accurate procedures. Proper procedures are necessary to minimize the possibility of infection, **embolism**, phlebitis, or destruction of neighboring tissue.

Preparation

For peripheral vein access in the arm, a tourniquet is applied a few inches over the puncture site. The skin over the puncture site is cleansed with an alcohol pad or similar cleansing product. The needle is inserted and either blood is drawn and the needle is removed or a catheter is inserted to place an intravenous line. Internal jugular vein catheterization is accomplished by extending the patient's head over the edge of a bed, table or cart and rotating the head away from the intended puncture site. Immobilizing the head and extending it 15–20 degrees over the edge of a bed or cart and rotating away from the puncture site can cannulize the external jugular vein. The subclavian vein access is a complicated procedure and may require sedation and special positioning (Trendelenburg). A towel should be place in the back of the area. The skin should be cleansed and the puncture site anesthetized. For the femoral approach the leg is externally rotated. The artery should be felt and along with specific anatomical landmarks the vein can be localized. The skin should be cleaned and anesthetized. During venous cutdown a large vein near the anklebone is careful dissected away from underlying tissues. The area must be properly cleaned and anesthetized prior to making an incision. A catheter is inserted and secured in place with sutures.

Aftercare

For simple procedures such as peripheral venous access, applying simple pressure (to stop bleeding) once the catheter is removed and then a bandage may be sufficient. Aftercare of more complicated venous access procedures varies depending on the type of device placed and the location of the device.

Risks

For access into a peripheral vein, care must be taken not to puncture both sides of the vein. After removal of the needle or catheter, pressure should be applied over the puncture site to prevent unwanted bleeding. Access utilizing a scalp vein should be performed with care by experienced clinicians only to avoid hematoma formation (localized blood clot),

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accidental puncture of an artery, or infection. Access into the internal jugular vein in the neck can cause laceration of an artery or nerve. This procedure can also cause hematoma (blood clot) formation, damage to local nerves within the area, **pneumothorax**, or misplaced catheterization. Venous access into the external jugular vein can cause hematoma or placement of a venous access device outside the thorax. Subclavian vein access can cause air to enter a vein (resulting in an air embolus) or pneumothorax. Cannulation of the femoral vein in the groin area can cause infection or **thrombophlebitis**. Intraosseous venous access, commonly performed in a leg bone, can cause hematomas, infection, or damage to bone marrow. This procedure should not be performed if the attempts in one leg are unsuccessful, the skin over the legs is diseased (from a burn or infection), or there is a broken leg bone or bone disease. Venous cutdown can cause infection, loss of the catheter in the vein, phlebitis, or nerve damage.

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Venous insufficiency

Definition

Venous insufficiency is described as abnormal blood flow through veins that can cause local damage, damage to affected legs, or **death**.

Description

Syndromes related to venous insufficiency are caused by valve incompetence. Venous insufficiency is a chronic (long term) condition. The number of new and existing cases is dependent on age and gender. Some patients may have a positive family history. Usually older persons and females are more commonly affected. Deep situated and superficial veins can be affected. **Cancer** obstructing veins in the pelvis area can cause superficial venous insufficiency. Deep venous insufficiency is commonly caused by **thrombophlebitis**, causing obstruction of valves that regulate blood flow in veins. Small veins that have been occluded by a thrombosis may re-canalize (opening up new channels to re-direct blood flow). These re-canalized veins are inadequate and cannot correct the impairment of flow. However, larger veins may still remain occluded. When a thrombosis occurs the valves that regulate venous blood flow become thickened and incompetent, rendering them incapable of regulating back flow of blood. This valvular incompetence will cause an increase in the presence within veins (venous **hypertension**). Venous hypertension is responsible for most of the symptoms associated with venous disease. Superficial veins can become dilated causing **varicose veins** (veins that bulge and seem tortuous). Leg ulcers can be severe and are responsible for 100,000 cases of disability in the United States alone.

Causes and symptoms

The symptoms of chronic venous insufficiency can be subjective and objective. Subjective symptoms include throbbing, cramping, burning sensations, and leg **fatigue**. Patients can also develop chronic leg ulcers that may not heal. Varicose veins in the legs can bleed (since veins are delicate structures with thin walls) and cause death. Patients often develop fluid retention (**edema**) in the affected limb. Skin changes can occur and affected areas can become thin, shiny, discolored (blue-purple), and atrophic. The skin usually becomes thick and tough.

Diagnosis

There are several techniques used to diagnose venous disease. Electrical impedance plethysmography (IPG) provides a functional evaluation for outflow obstruction ultrasound (a machine that transmits sound waves) studies can visualize the venous system in certain areas. Another technique called duplex scanning can measure velocity within a vein.

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KEY TERMS

Atrophic—A wasting of cells and tissues.

Thrombophlebitis—Venous inflammation with formation of a thrombus.

Thrombus—A clot in the cardiovascular system (the system that circulates blood throughout the body).

Treatment

Periodic elevation of legs and bed rest can help with leg swelling. Patients are advised to avoid prolonged periods of standing or sitting. Wearing compression stockings can also reduce swelling of the leg. Mild skin infections can be treated with compresses, **steroids**, and, if infection is present, with **antibiotics**. Ulcerations can be treated with compresses, possible surgery, special ointments, and a semi-rigid boot that helps improve blood flow. Varicose veins can be treated with elastic stockings. About 15–20% of patients require surgery, but only after careful evaluation and specialized testing confirms a beneficial value.

Prognosis

The prognosis is variable and depends on the progression of disease, extent of damage, and the presence of other diseases, which may affect the cardiovascular system.

Prevention

Persons who have a strong family history, evidence of disease, and/or those who stand on their legs many hours daily should discuss the option of elastic stocking with their primary clinician.

Resources

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Ventricular aneurysm

Definition

Ventricular aneurysm is a complication of a **heart attack** (myocardial infarction). It is a ballooning of a section of a blood vessel in the heart that first appears several days or weeks after an acute myocardial infarction.

Description

A myocardial infarction occurs when a section of the heart wall is deprived of blood and dies (undergoes necrosis, or tissue **death**, and scarring). The heart wall is mainly muscle. It has two ventricles, the right and left ventricles, which pump blood to and from the lungs, and to the body. When part of the heart muscle dies, pumping power from that part of the wall is lost. After a myocardial infarction, the part of the heart wall that did not die must continue pumping blood and compensate for the dead muscle.

Ventricular aneurysm is one of the complications that follow a myocardial infarction.

An aneurysm is the outward swelling, or ballooning, of a blood vessel at a weak spot in the wall of the blood vessel. In the case of ventricular aneurysm, the aneurysm occurs in the wall of the heart at the spot where the myocardial infarction occurred. A scar usually forms in the area of the dead muscle tissue, and may eventually calcify. Ventricular aneurysms generally do not rupture. The left ventricle is involved in most cases of ventricular aneurysm.

Causes and symptoms

The principle symptom of a ventricular aneurysm is cardiac insufficiency, a condition in which not enough blood is being pumped to the body. Ventricular aneurysm is usually found after a large infarction in the muscle wall of a ventricle. Ventricular aneurysm is seldom seen immediately after a myocardial infarction. It takes several days or weeks to several months to develop. Frequently, recurrent ventricular irregular heartbeats (**arrhythmias**) and low cardiac output result from the presence of a ventricular aneurysm. **Blood clots** (thrombi) may form on the inside wall of the aneurysm and produce systemic blood clots that get stuck in a blood vessel (embolisms), which could lead to **stroke** or an ischemic leg (a usually painful condition in which lack of blood circulation leads to reduced function).

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KEY TERMS

Arrhythmia—A disturbance in the beating pattern of the heart.

Myocardial infarction—Commonly known as a heart attack, a myocardial infarction occurs when a part of the heart muscle is deprived of blood and dies.

Diagnosis

A number of signs may indicate ventricular aneurysm, including an abnormal precordial impulse in the heartbeat, persistent elevation of the S-T segment of an electrocardiogram, and a characteristic bulge seen on the heart when x rayed. The bulge is typically seen when the heart contracts, driving blood to the aorta, in the systolic phase of the heartbeat. Echolocation (**echocardiography** or ultrasound) can confirm the presence of an aneurysm. **Cardiac catheterization** may be performed to determine the extent of the aneurysm and the status of the coronary arteries. Stethoscopic examination reveals abnormal heart sounds, especially those associated with a backflow of blood from the left ventricle to the left atrium in systole or contraction beat (mitral regurgitation). This heart murmur is caused by the heart muscles no longer being able to properly operate the mitral valve.

Treatment

Most cases of ventricular aneurysm are treated by close medical follow-up and limiting patient activity. Surgical removal of the aneurysm is an option when persistent left ventricular failure or arrhythmia occurs, and the aneurysm is large. **Vasodilators**, **diuretics**, and **digoxin** are used to treat **heart failure**. **Anticoagulant drugs** are used to prevent the formation of blood clots. **Antiarrhythmic drugs** are used to treat heart arrhythmias.

Prognosis

Ventricular aneurysm occurs more frequently than is commonly thought. Based on postmortem examination, ventricular aneurysm occurs in as many as 15% of myocardial infarction cases. Patients with a large ventricular aneurysm in the left ventricle have a reduced survival rate. Many patients have mild symptoms which are not life-threatening. The survival rate is dependent on the function of the left ventricle.

Resources

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John T. Lohr, PhD

Ventricular assist device

Definition

A ventricular assist device (VAD) is a mechanical pump used for temporary blood circulation support. It decreases the workload of the heart while maintaining adequate flow and blood pressure.

Purpose

A VAD is a temporary life-sustaining device. VADs can replace the left ventricle (LVAD), the right ventricle (RVAD), or both ventricles (BIVAD). They are used when the heart muscle is damaged and needs to rest in order to heal or when blood flow from the heart is inadequate. VADs can also be used as a bridge in patients awaiting **heart transplantation** or in patients who have rejected a transplanted heart.

Examples of patients who might be candidates for a VAD are those who:

- have suffered a massive heart attack
- cannot be weaned from heart-lung bypass after treatment with intravenous fluids, medications, and insertion of a balloon pump in the aorta
- have an infection in the heart wall that does not respond to conventional treatment
- are awaiting a heart transplant and are unresponsive to drug therapy and intravenous fluids
- are undergoing high-risk procedures to clear the blockages in a coronary artery

Although one in five people suffer left side ventricular failure, only a minority are candidates for VADs. To be considered for a VAD, patients must meet specific criteria concerning blood flow, blood pressure, and general health.

Precautions

Poor candidates for a VAD include those with:

- irreversible renal failure
- severe disease of the vascular system of the brain
- cancer that has spread (metastasized)

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- severe liver disease
- blood clotting disorders
- severe lung disease
- infections that do not respond to antibiotics
- extreme youth or age

Description

There are four types of VADs, each appropriate for a different condition. Surgery to install a VAD is performed under **general anesthesia** in a hospital operating room. An incision is made in the chest, then catheters are inserted into the heart and the correct artery. The surgeon sutures the catheters in place, then attaches tubing to connect the catheters to the pump. The pump stays outside the body. Once it is turned on, blood flows out of the diseased ventricle and into the pump, then is returned to the correct blood vessel leaving the heart.

Preparation

Before the operation the patient meets with an anesthesiologist to determine any special conditions that will affect the administration of anesthesia. Standard preoperative blood and urine studies are performed, and the heart is monitored both before and during the operation with an electrocardiograph.

Aftercare

The patient is monitored in intensive care, with follow-up blood, urine, and neurological studies. Blood thinning medications are given to prevent blood clotting.

Except for those patients awaiting a heart transplant, patients are slowly and gradually weaned from the VAD. Even when patients no longer need the VAD, they will require supportive drug therapy and/or a balloon pump inserted in the aorta.

Risks

VAD insertion carries risks of severe complications. Bleeding from surgery is common and occurs in as many as 30–50% of patients. Other complications include the development of **blood clots**, partial **paralysis** of the diaphragm, **respiratory failure**, kidney failure, failure of the VAD, damage to the coronary blood vessels, **stroke**, and infection.

Sometimes when the left ventricle is supported, the right ventricle begins to need assistance. If VADs are inserted in both ventricles, the heart may become so dependent on their support that they cannot be removed.

KEY TERMS

Coronary blood vessels—The arteries and veins that supply blood to the heart muscle.

Diaphragm—The muscle that separates the chest cavity from the abdominal cavity.

Ventricle—The heart has four chambers. The right and left ventricles are at the bottom of the heart and act as the body's main pumps.

Normal results

Because conditions for which VADs are used vary widely and because of the high risks associated with VAD insertion, the outcome of surgery cannot be predicted.

Resources

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Ventricular ectopic beats

Definition

A ventricular ectopic beat (VEB) is an extra heartbeat originating in the lower chamber of the heart. This beat, also called a premature ventricular contraction (PVC), occurs before the beat triggered by the heart's normal function.

Description

Ventricular ectopic beats are common and do not indicate a problem in people without heart disease. However, if a person has aortic stenosis, **heart failure**, or a previous **heart attack**, VEBs may be followed by **ventricular tachycardia** and fibrillation, which can lead to sudden **death**.

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KEY TERMS

Angioplasty—A surgical procedure which dilates a narrowed or blocked part of an artery.

Aortic stenosis—A stiffening of the artery which carries blood from the heart to the body.

Beta-blockers—A class of medication used to block the cellular response to chemicals normally present in the body.

Coronary artery—The vessel which brings blood to the muscle of the heart.

Fibrillation—Rapid, uncoordinated quivering of the heart.

Heart failure—A term used when the heart is unable to pump enough blood to supply the needs of the body.

Causes and symptoms

Although the origin of a VEB is well documented, the exact cause or causes are not well understood. Some physicians believe the beat is caused by a trigger of specific origin, while other physicians believe the beat is random. Occasional ventricular ectopic beats occur in healthy people. If there is no evidence of heart disease, there is little or no danger to the individual.

A single ventricular ectopic beat has very little effect on the pumping ability of the heart and usually does not cause any symptoms. If a symptom is felt, it is the feeling of a strong or skipped beat, often described as a thump, kick, or flip-flop. Sometimes, the sensation is referred to as a fullness in the neck.

Diagnosis

Ventricular ectopic beats are easily seen on an electrocardiogram.

Treatment

If a person is otherwise healthy, the only treatment needed is to decrease **stress** and limit the use of alcohol and **caffeine**. Cold medicines, available without prescription, sometimes contain drugs (e.g., **decongestants**) that stimulate the heart and should be used with caution.

If symptoms are uncomfortable, or the pattern of VEBs indicates a problem, the physician may prescribe drug therapy. Beta-blockers are quite safe and are usually tried first.

A person who has a history of heart attack or heart disease, and is experiencing frequent or complex VEBs, is at greater risk of sudden death. Drug therapy with beta-blockers will be recommended. In addition, **angioplasty** or coronary artery bypass surgery may relieve any underlying coronary artery blockage and reduce the danger of sudden death.

Treatment with **antiarrhythmic drugs** can suppress VEBs, but they can also increase the risk of a fatal abnormal rhythm. Often, extensive electrophysiologic testing and risk evaluation will be done before this method of treatment is prescribed.

Prognosis

In healthy people, VEBs are inconsequential. If a person with heart disease is able to find an effective means of controlling ventricular ectopic beats, the outlook is good.

Prevention

Occasional ventricular ectopic beats in healthy people do not need to be prevented. People with a history of heart disease can usually control VEBs with medication.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

Dorothy Elinor Stonely

Ventricular failure *see* **Heart failure**

Ventricular fibrillation

Definition

Ventricular fibrillation is a very rapid, uncoordinated, ineffective series of contractions throughout the lower chambers of the heart. Unless stopped, these chaotic impulses are fatal.

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KEY TERMS

Atrial fibrillation—A condition in which the upper chambers of the heart quiver instead of contracting effectively.

Cardiopulmonary resuscitation (CPR)—Using rescue breathing and chest compressions to help a person whose breathing and heartbeat have stopped.

Cardioversion—An electrical shock delivered to the heart to restore a normal rhythm.

Electrocardiogram—A visual representation of the heart beat.

Heart failure—A term used when the heart is unable to pump enough blood to supply the needs of the body.

Hypoxia—Insufficient oxygen in the cells of the body.

Ischemic—Insufficient blood reaching the tissues.

Description

When the ventricles begin to quiver and do not employ coordinated contractions, the heart is said to be fibrillating. In this condition the ventricles cannot pump blood from the heart. Ventricular fibrillation (V-fib) is the worst kind of abnormal heart rhythm, and is a form of cardiac arrest. It involves the pumping of the lower chambers of the heart, while **atrial fibrillation** involves the upper chambers.

Causes and symptoms

Ventricular fibrillation often is associated with acute ischemic events (**ischemia** involves the deprivation of oxygenated blood to an area of tissue), and with chronic ischemic heart disease. It is frequently seen immediately following a **heart attack**. It also may develop during hypoxia, atrial fibrillation, or improper grounding of electrical devices. An extremely low level of potassium in the blood also can cause ventricular fibrillation.

The first, and usually the only, symptom of V-fib is sudden unconsciousness.

Diagnosis

When an individual suddenly collapses, the possibility of ventricular fibrillation should be considered immediately. A quick assessment usually shows no pulse or heartbeat. The diagnosis of ventricular fibrillation is confirmed with an electrocardiogram.

Treatment

Basic **life support** with standard **cardiopulmonary resuscitation** (CPR) must be started within a few minutes, followed as soon as possible with **cardioversion**. Cardioversion is an electric shock delivered to the heart to stop the fibrillating. Early **defibrillation** is the key to survival. If left untreated, irreversible brain damage, due to lack of oxygen to the brain, occurs after about five minutes. After the heart resumes its normal rhythm, medications are given to help maintain the rhythm.

Research continues into methods to deliver defibrillation as soon as possible to those experiencing ventricular fibrillation. One of the studies addressed in 2003 researched various clinical trials that implanted defibrillators into patients to prevent **sudden cardiac death**. The devices worked in many instances but more proof of their success was needed for widespread use.

Prognosis

Early and effective CPR may provide the time necessary for medical personnel to arrive with a defibrillator. If a defibrillator is able to promptly restore a normal rhythm, up to 25% of victims are able to leave the hospital without evidence of brain damage.

If ventricular fibrillation occurs in the hospital in conjunction with a heart attack, defibrillation has a 95% success rate. If shock and **heart failure** are present at the time, even with immediate defibrillation, only about 30% of those stricken are successfully restored to a normal heart rate.

Prevention

A healthy lifestyle to reduce the risk of heart diseases which lead to ventricular fibrillation is the best prevention. For people who have experienced an episode of V-fib, an internal cardioverter-defibrillator may prevent further episodes.

Resources

PERIODICALS

Ezekowitz, Justin A., et al. "Implantable Cardioverter Defibrillators in Primary and Secondary Prevention: A Systematic Review of Randomized, Controlled Trials." *Annals of Internal Medicine* January 2002: 445.

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ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

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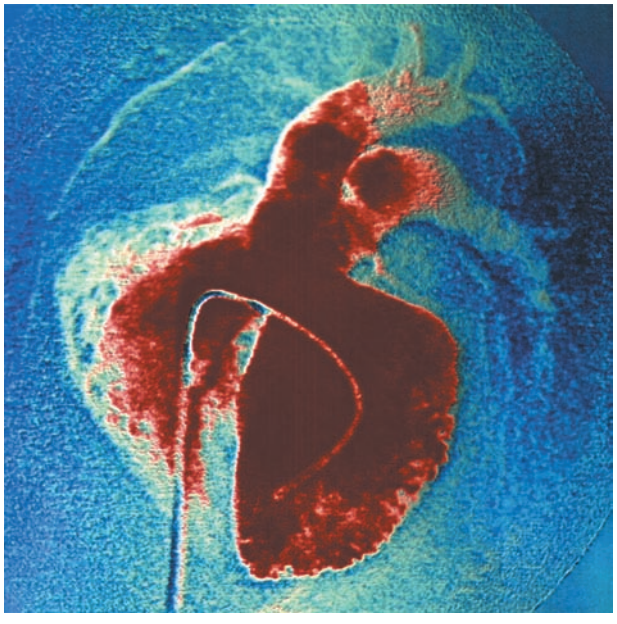
Ventricular septal defect

Definition

A ventricular septal defect is a hole in the wall of the heart (septum) that separates the left lower chamber (left ventricle) from the right lower chamber (right ventricle). The hole allows blood to flow from the left ventricle to the right ventricle instead of entering the aorta for distribution throughout the body. Ventricular septal defect is one of a group of heart problems found in newborn babies that are collectively called **congenital heart disease**.



An angiogram of a ventricular septal defect. This is a hole in the ventricular septum causing blood to flow from the left ventricle (right of image) to the right ventricle and to the lungs. The bent catheter at the center, which is used to take the angiogram, passes through the hole between the ventricles. *(Simon Fraser/SPL/Photo Researchers, Inc.)*

Description

The heart has four chambers. The two lower chambers are called ventricles and are responsible for pumping blood. The right ventricle pumps blood to the lungs and the left ventricle pumps blood throughout the body. If there is a hole in the septum that separates the two ventricles, blood from the left ventricle can enter the right ventricle. This blood recycles through the lungs before returning to the left ventricle. This results in less oxygenated blood reaching the body. If the hole is sufficiently large, the lack of oxygen being delivered to the body can cause severe problems, including **heart failure** and breathlessness. Approximately 0.7% of all babies have a congenital heart defect. Of these, 20% have a ventricular septal defect.

Causes and symptoms

Congenital heart defects are errors in the development of the heart structure. They occur early in the life of the embryo. There is no known cause of congenital heart defects. They can be associated with several diseases, such as German **measles** (rubella)and **Down syndrome**. Genetics does not seem to play a role in ventricular septal defect. People with a heart defect do not have an increased chance of passing it on to their children.

Symptoms result from a reduced amount of oxygen going to the body. Symptoms are proportional to the size of the defect. They may appear at any time in the life of the child. In cases where the hole in the septum is very small, few or no symptoms may appear and the child may develop normally. In cases where the ventricular septal defect is large, the newborn will shows signs of heavy breathing, sweating, and feeding difficulties. Children with this defect tire easily. Ventricular septal defect can also result in stunted growth resulting from insufficient oxygen being delivered to the growing body. Children with ventricular septal defect tend to suffer more frequent colds and **pneumonia**, and have a higher rate of inflammation and infection of the heart (**endocarditis**).

Diagnosis

The condition is first suspected based on observation of the child. The physician will listen to the heart with a stethoscope (auscultation) to detect a heart murmur. X rays, electrocardiogram (ECG), and **echocardiography** can all be used to evaluate ventricular septal defect.

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KEY TERMS

Echocardiogram—An image of the heart produced by an instrument that uses sound waves to create image the heart.

Electrocardiogram—A graph of the heart's beating action.

Endocarditis—An inflammation of the interior lining of the heart that is frequently caused by infectious agents.

Treatment

Most small holes close without treatment. Often, as the child grows, the hole closes or becomes smaller. If the hole is large or fails to close, the child is usually treated with drugs. Holes that persist and are causing problems in development are corrected by open heart surgery. Usually, surgery is performed after one year of age, but before the child enters school. This allows time for a trial of drug therapy, which could potentially eliminate the need for surgery. The operation is generally safe.

Prognosis

Children with small septal defects tend to develop normally and without any effect on their ability to participate in physical activities. Surgery allows children with larger defects to live nearly normal lives.

Resources

BOOKS

Fuster, Valentin, et al. *Hurst's the Heart*. 12th ed. New York: McGraw-Hill Professional, 2007.

John T. Lohr, PhD

Ventricular shunt

Definition

Ventricular shunt is a surgical procedure in which a tube is placed in one of the fluid-filled chambers inside the brain (ventricles). The fluid around the brain and the spinal column is called the cerebrospinal fluid. When infection or disease causes an excess of this cerebrospinal fluid in the ventricles, the shunt is placed to drain it and thereby relieve excess pressure.

Purpose

Ventricular shunt relieves **hydrocephalus**, a condition in which the ventricles are enlarged. In hydrocephalus, pressure from the cerebrospinal fluid usually increases. It may be caused by tumor of the brain or of the membranes covering the brain (meninges), infection of or bleeding into the cerebrospinal fluid, or inborn malformations of the brain. Symptoms of hydrocephalus may include **headache**, personality disturbances and loss of intellectual abilities (**dementia**), problems in walking, irritability, **vomiting**, abnormal eye movements, or a low level of consciousness.

Normal pressure hydrocephalus is associated with progressive dementia, problems in walking, and loss of bladder control (**urinary incontinence**). Even though the cerebrospinal fluid is not thought to be under increased pressure in this condition, it may also be treated by ventricular shunting.

Precautions

As with any surgical procedure, the surgeon must know about any medications or health problems that may increase the patient's risk. Because infections are both common and serious complications, **antibiotics** are often given before and after surgery.

Description

The ventricular shunt tube is placed to drain fluid from the ventricular system in the brain to the cavity of the abdomen or to the large vein in the neck (jugular vein). Therefore, surgical procedures must be done both in the brain and at the drainage site. The tubing contains valves to insure that fluid can only flow out of the brain and not back into it. The valve can be set at a desired pressure to allow cerebrospinal fluid to escape whenever the pressure level is exceeded.

A small reservoir may be attached to the tubing and placed under the scalp. This reservoir allows samples of cerebrospinal fluid to be removed with a syringe to check the pressure. Fluid from the reservoir can also be examined for bacteria, **cancer** cells, blood, or protein, depending on the cause of hydrocephalus. The reservoir may also be used to inject antibiotics for cerebrospinal fluid infection or **chemotherapy** medication for meningeal tumors.

Preparation

The diagnosis of hydrocephalus should be confirmed by diagnostic techniques that make images of the brain, such as computed tomography scan (CT scan) or **magnetic resonance imaging** (MRI), before

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KEY TERMS

Cerebrospinal fluid—Fluid bathing the brain and spinal cord.

Computed tomography (CT) scan—An imaging technique in which cross-sectional x rays of the body are compiled to create a three-dimensional image of the body's internal structures.

Dementia—Progressive loss of mental abilities.

Magnetic resonance imaging (MRI)—An imaging technique that uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

the shunting procedure is performed. These techniques will also show any associated brain abnormalities. Cerebrospinal fluid should be examined if infection or tumor of the meninges is suspected. Patients with dementia or **mental retardation** should undergo neuropsychological testing to establish a baseline psychological profile before the shunting procedure.

Patients with normal pressure hydrocephalus may experience a temporary improvement in walking and mental abilities upon removal of a moderate amount of cerebrospinal fluid. This improvement may be an indication that shunting will improve their condition. However, patients who do not improve after temporary cerebrospinal fluid drainage may still benefit from ventricular shunt. When a case is in doubt, continuous monitoring of cerebrospinal fluid pressure (which in itself requires a surgical procedure) may indicate whether shunting is likely to be helpful.

Aftercare

To avoid infections at the shunt site, the area should be kept clean. Cerebrospinal fluid should be checked periodically by the doctor to be sure there is no infection or bleeding into the shunt. Cerebrospinal fluid pressure should be checked to be sure the shunt is operating properly. The eyes should be examined regularly because shunt failure may damage the nerve to the eyes (optic nerve). If not treated promptly, damage to the optic nerve causes irreversible loss of vision. Patients or caregivers should understand the life-threatening nature of shunt problems. All symptoms and signs of potential shunt failure or infection must be taken seriously.

Risks

Complications of shunting occur in 30% of cases, but only 5% are serious. Serious and long-term complications are bleeding under the outermost covering of the brain (**subdural hematoma**), infection, **stroke**, and shunt failure. Infection at the shunt site may cause a loss of intelligence. When shunts drain to the abdomen (ventriculoperitoneal shunts), fluid may accumulate in the abdomen or abdominal organs may be injured. If cerebrospinal fluid pressure is lowered too much, patients may have severe headaches, often with **nausea and vomiting**, whenever they sit up or stand.

Normal results

Of patients with normal pressure hydrocephalus who are treated with shunting, 25–80% experience long-term improvement. Normal pressure hydrocephalus is more likely to improve when it is caused by infection of or bleeding into the cerebrospinal fluid than when it occurs without an underlying cause. Walking difficulties and bladder control are more likely to improve than dementia is.

After shunting, the ventricles get smaller within three or four days. This shrinkage occurs even when hydrocephalus has been present for a year or more. Clinically detectable signs of improvement occur within a few weeks. The cause of hydrocephalus, duration of hydrocephalus before shunting, and associated brain abnormalities affect the outcome.

ORGANIZATIONS

American Academy of Neurology, 1080 Montreal Ave., St. Paul, MN, 55116, (651) 695-2717, (651) 695-2791, (800) 879-1960, memberservices@aan.com, http://www.aan.com/.

Laurie Barclay, MD

Ventricular tachycardia

Definition

Ventricular tachycardia (V-tach) is a rapid heart beat that originates in one of the lower chambers (the ventricles) of the heart. To be classified as tachycardia, the heart rate is usually at least 100 beats per minute.

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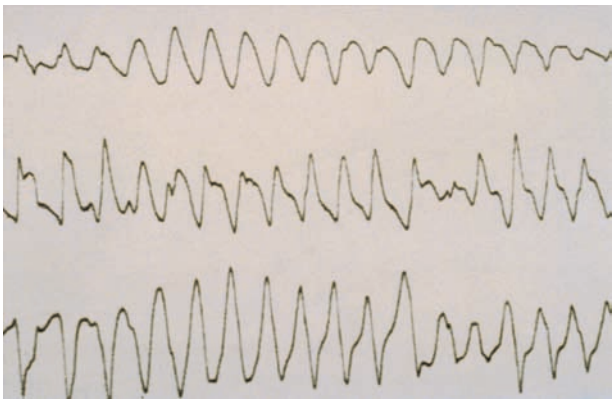

An electrocardiographic image indicating a rapid heart beat. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

KEY TERMS

Atrial—Having to do with the upper chambers of the heart.

Cardiomyopathy—A disease of the heart muscle.

Cardioversion—A electrical shock delivered to the heart to restore a normal rhythm.

Coronary artery—The artery that supplies blood to the heart muscle itself.

Electrocardiogram—A visual representation of the heart beat.

Fibrillation—Rapid, uncoordinated, quivering of the heart.

Palpitations—Uncomfortable feeling of the heart beat in the chest.

Valvular—Having to do with the valves inside the heart.

Description

A rapid heart rate can originate in either the left or right ventricle. Ventricular tachycardia which lasts more than 30 seconds is referred to as sustained ventricular tachycardia. A period of three to five rapid beats is called a salvo, and six beats or more lasting less than 30 seconds is called nonsustained ventricular tachycardia. Rapid ventricular rhythms are more serious than rapid atrial rhythms because they make the heart extremely inefficient. They also tend to cause more severe symptoms, and have a much greater tendency to result in **death**.

Although generally considered to be among the life-threatening abnormal rhythms, harmless forms of sustained V-tach do exist. These occur in people without any structural heart disease.

Causes and symptoms

Most ventricular tachycardias are associated with serious heart disease such as coronary artery blockage, **cardiomyopathy**, or **valvular heart disease**. V-tach is often triggered by an extra beat originating in either the right or left ventricle. It also occurs frequently in connection with a **heart attack**. V-tach commonly occurs within 24 hours of the start of the attack. It must be treated quickly to prevent fibrillation. After 48–72 hours of the heart attack, the risk of ventricular tachycardia is small. However, people who have suffered severe damage to the larger anterior wall of the heart have a second danger period, because V-tach often occurs during convalescence from this type of heart attack.

Sustained ventricular tachycardia prevents the ventricles from filling adequately so the heart can not pump normally. This results in loss of blood pressure, and can lead to a loss of consciousness and to **heart failure**.

The individual with V-tach almost always experiences palpitation, though some episodes cause no symptoms at all.

Diagnosis

Diagnosis is easily made with an electrocardiogram.

Treatment

Any episode of ventricular tachycardia that causes symptoms needs to be treated. An episode that lasts more than 30 seconds, even without symptoms, also needs to be treated. Drug therapy can be given intravenously to suppress episodes of V-tach. If blood pressure falls below normal, a person will need electric **cardioversion** ("shock") immediately.

Prognosis

With appropriate drug or surgical treatment, ventricular tachycardia can be controlled in most people.

Prevention

A person susceptible to sustained ventricular tachycardia often has a small abnormal area in the ventricles that is the source of the trigger event. This area can sometimes be surgically removed. If surgery is not an option, and drug therapy is not effective, a

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device called an automatic cardioverter-defibrillator may be implanted.

ORGANIZATIONS

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Dorothy Elinor Stonely

Verrucae *see* **Warts**

Vertigo *see* **Dizziness**

Vesicle *see* **Skin lesions**

Vesicoureteral reflux

Definition

Vesicoureteral reflux (VUR) refers to a condition in which urine flows from the bladder, back up the ureter, and into the kidneys.

Demographics

VUR is most often diagnosed in children. No large studies have been done to determine the incidence of VUR. Small studies suggest that the condition occurs in less than 1% of healthy children, although some experts believe this is an underestimate. The condition is 10 times more common in white children than in African-American children and is especially common (for unknown reasons) in children with red hair.

Description

The normal flow of urine begins in the collecting system of each kidney. Urine then flows out of each kidney and into a tube called the ureter. Each ureter leads into the bladder where the urine collects until it is passed out of the body. Normally, urine should flow only in this direction. In vesicoureteral reflux, however, urine that has already collected in the bladder is able to flow backwards from the bladder, up the ureter, and back into the collecting system of the kidney. VUR may be present in either one or both ureters.

Vesicoureteral reflux causes damage to the kidneys in two ways. The kidney is not designed to withstand very much pressure. When VUR is present, backpressure of the urine on the kidney is significant. This can damage the kidney. In addition, the kidney usually is sterile, meaning that no bacteria are normally present within it. In VUR, bacteria that enter through the urinary tract may be carried back up the ureter with the urine. These bacteria can enter the kidney, causing severe infection.

Causes and symptoms

Most cases of VUR are due to a defect in the way the ureter is implanted into the bladder. The angle may be wrong, or the valve that should allow urine only one-way entrance into the bladder may be weak. Structural defects of the urinary system also may cause VUR. These include a situation in which two ureters leave a kidney, instead of the usual one (duplicated ureters), and in which the ureter is greatly enlarged at the end leading into the bladder (ureterocele).

VUR alone does not usually cause symptoms. Symptoms develop when an infection has set in. The usual symptoms of infection include frequent need to urinate, **pain** or burning with urination, and blood or pus in the urine. Occasionally, VUR is suspected when a child has a difficult time becoming toilet trained. In these cases, the bladder may become irritable and spasm because it is never totally empty of urine. When the kidneys have been damaged, high blood pressure may develop.

Diagnosis

VUR is most often diagnosed in infancy or childhood because of frequent urinary tract infections (UTIs).

Tests

VUR is diagnosed by taking a series of x-ray pictures (called a voiding cystourethrogram). These are taken after putting a small tube (catheter) into the bladder. The bladder is then filled with a dye solution that lights up on the x-ray picture. Pictures are taken immediately, followed by x rays taken while the patient is urinating. This will allow reflux to be demonstrated, and will reveal whether the level of reflux increases when pressure increases during urination. Reflux is then graded based on the height and effects of the VUR:

- Grade I. VUR enters just the portion of the ureter closest to the bladder. The ureter appears normal in size.
- Grade II. VUR enters the entire ureter and goes up into the collecting system of the kidney. The ureter and the collecting system appear normal in size and structure.
- Grade III. VUR enters the entire ureter and kidney collecting system. Either the ureter or the collecting system are abnormal in size or shape.

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KEY TERMS

Bladder—The muscular sac which receives urine from the kidneys, stores it, and ultimately works to remove it from the body during urination.

Electrolyte—Salts and minerals that ionize in body fluids. The major human electrolytes are sodium (Na+), potassium (K+), calcium (Ca 2+), magnesium (Mg2+), chloride (Cl-), phosphate (HPO4 2-), bicarbonate (HCO3-), and sulfate (SO4 2-). Electrolytes control the fluid balance of the body and are important in muscle contraction, energy generation, and almost all major biochemical reactions in the body.

Reflux—A condition in which flow is backwards from normal.

Ureter—A muscular tube leading from the kidney to the bladder, down which the urine flows.

- Grade IV. Similar to Grade III, but the ureter is greatly enlarged.
- Grade V. Similar to Grade IV, but the ureter is also abnormally twisted/curved, and the collecting system is greatly enlarged, with absence of the usual structural details.

Other tests that may be performed include a **urinalysis**, kidney and bladder ultrasound, intravenous pyelogram, or a nuclear scan of the kidney and bladder.

Treatment

Treatment depends on the grade of reflux that is diagnosed.

Drugs and monitoring

In grades I and II, the usual treatment involves long-term use of a small daily dose of **antibiotics** to prevent the development of infections. The urine is tested regularly to make sure that no infection occurs. The kidneys are evaluated regularly to make sure that they are growing normally and that no new scarring has occurred. Grade III VUR can be treated with antibiotics and careful monitoring. New infections, scarring, or stunting of kidney growth may result in a need for surgery. Grades IV and V are extremely likely to require surgery.

Surgery

Surgery for VUR consists of re-implanting the ureters into the bladder at a more normal angle. This usually improves the functioning of the valve leading into the bladder. When structural defects of the urinary system are present, surgery will almost always be required to repair these defects.

Prognosis

Prognosis is dependent on the grade of VUR. About 80% of children with grades I and II VUR simply grow out of the problem. As they grow, the ureter lengthens, changing its angle of entry into the bladder. About 50% of children with grade III VUR will require surgery. Nearly all children with grades IV and grade V VUR will require surgery. In these cases, it is usually best to perform surgery at a relatively young age in order to avoid damage and scarring to the kidneys.

Prevention

While there is no known method of preventing VUR, it is important to note that a high number of the siblings of children with VUR will also have VUR. Many of these siblings (about 36%) will have no symptoms, but will be discovered through routine examinations prompted by their brother's or sister's problems. It is important to identify these children, so that antibiotic treatment can be used to prevent the development of infection and kidney damage.

ORGANIZATIONS

American Urological Association Foundation, 1000 Corporate Blvd., Linthicum, MD, 21090, (410) 689-3700, (410) 689-3800, (866) 746-4282, auafoundation@auafoundation.org, http://www.urologyhealth.org/.

American Foundation for Urologic Disease, 1000 Corporate Boulevard, Linthicum, MD, 21010, (410) 689-3990, (800) 828-7866, http://www.urologyhealth.org.

National Kidney and Urologic Disease Information Clearinghouse, 3 Information Way, Bethesda, MD, 20892-3580, (800) 891-5390 TTY (866) 569-1162, (703) 738-4929, nkudic@info.kidney.niddk.nih.gov, http://kidney.niddk.nih.gov.

Rosalyn Carson-DeWitt, MD
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Vestibulitis *see* **Labyrinthitis**

Viagra *see* **Sildenafil citrate**

Vibrio cholera infection *see* **Cholera**

Vibrio parahemolyticus infection *see* **Vibriosis**

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Vibriosis

Definition

Vibriosis is a disease caused by an infection with bacteria of the *Vibrio* genus, most commonly *Vibrio parahemolyticus* or *Vibrio vulnificus*. *Vibrio* bacteria cause **diarrhea**, skin infections, and/or blood infections. The diarrhea-causing *Vibrio parahemolyticus* is a relatively harmless infection, but *Vibrio vulnificus* infection, although rare, can lead to blood poisoning and **death** in many cases.

Description

Vibriosis is a general term referring to an infection by any member of the large group of *Vibrio* bacteria. The bacteria that causes **cholera** is in this group. Alternate names include non-cholera *Vibrio* infection, *Vibrio parahemolyticus* infection, and *Vibrio vulnificus* infection.

Vibrio parahemolyticus and *Vibrio vulnificus* are found in salt water. Infection with either of these two bacteria primarily occurs through eating contaminated raw seafood. Raw oysters are the usual source, although other seafood can carry the bacteria.

Vibrio parahemolyticus causes severe diarrhea. *Vibrio vulnificus* may cause diarrhea, but in persons with an underlying disease it may cause severe blood infections (septicemia or blood poisoning). Contact of a wound with seawater or contaminated seafood can lead to a *Vibrio vulnificus* skin infection.

Vibriosis is not very common in the United States. Most cases occur in coastal states between June and October. Between 1988 and 1991, there were only 21 reported cases of *Vibrio parahemolyticus* infection in the United States. Between 1988 and 1995, there were over 300 reports of *Vibrio vulnificus* infection in the United States.

Causes and symptoms

Vibriosis is caused by eating seafood contaminated with *Vibrio parahemolyticus* or *Vibrio vulnificus*. These bacteria damage the inner wall of the intestine, which causes diarrhea and related symptoms. *Vibrio vulnificus* can get through the intestinal wall and into the bloodstream.

Persons at risk for severe, often fatal vibriosis include those with **liver disease** (**cirrhosis**), excess iron (**hemochromatosis**), **thalassemia** (a blood disorder), **AIDS**, diabetes, or those who are immunosuppressed.

Symptoms of intestinal infection occur within two days of eating contaminated seafood. Symptoms last for 2 to 10 days and include watery diarrhea, abdominal cramps, **nausea**, **vomiting**, **headache**, and possibly **fever**. Symptoms of a blood infection develop one to two days after eating contaminated seafood, and include fever, chills, low blood pressure, and large fluid-filled blisters on the arms or legs. Similar blisters can also be produced by a *Vibrio vulnificus* skin infection.

Diagnosis

Vibriosis can be diagnosed and treated by an **infectious disease** specialist. It is diagnosed when *Vibrio* bacteria are grown from samples of stool, blood, or blister fluid. The symptoms and a recent history of eating raw seafood are very important clues for diagnosis.

Treatment

To counteract the fluid loss resulting from diarrhea, the patient will receive fluids either by mouth or intravenously. **Antibiotics** are not helpful in treating *Vibrio parahemolyticus* diarrhea.

However, *Vibrio vulnificus* infections are treated with antibiotics such as tetracycline (Sumycin, Achromycin V), or doxycycline (Monodox) plus ceftazidime (Ceftaz, Fortraz, Tazicef). One out of five patients with vibriosis requires hospitalization.

Prognosis

Most healthy persons completely recover from diarrhea caused by *Vibrio* bacteria. *Vibrio vulnificus* blood infection affects persons with underlying illness and is fatal in half of those cases. *Vibrio vulnificus* wound infections are fatal in one quarter of the cases.

Prevention

Contamination with *Vibrio* bacteria does not change the look, smell, or taste of the seafood. Vibriosis can be prevented by avoiding raw or undercooked shellfish, keeping raw shellfish and its juices away from cooked foods, and avoiding contact of wounded skin with seawater or raw seafood.

Resources

OTHER

Center for Food Safety and Applied Nutrition. http://www.fda.gov/AboutFDA/CentersOffices/CFSAN/default.htm

Belinda Rowland, PhD

Viral diarrhea *see* **Rotavirus infections**
Viral meningitis *see* **Meningitis**
Visceral l *see* **Roundworm infections**

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Vision training

Definition

Vision training, also known as vision therapy or orthoptics, consists of a variety of programs to enhance visual performance. It includes treatments for focusing, binocularity, and eye movement problems. Vision training is generally provided by an optometrist (O.D.).

Purpose

While visual acuity refers to how clearly each eye can see, vision training addresses how well the two eyes work together as a team. When looking at an object, the eyes must focus on the object (e.g., focusing for near or far objects). This involves the lens system of the eyes. The eyes must also work as a team and point at the same object so that the person does not see double. Aiming precisely at the same object will aid in depth perception (stereopsis) and seeing objects in three-dimensions (3D).

Although crossed eyes (**strabismus**) is an obvious condition, many defects in the coordination of eye movement are far less apparent. Even so, they can cause problems in reading, driving vehicles, and other complex tasks that require the integrated function of eyes and body. It is the goal of vision therapy to improve these subtle interactions using carefully devised exercises and devices.

The discipline, called "behavioral optometry," involves a careful evaluation of visual function, concentrating on complex skills such as rapid reading, distance perception, peripheral field awareness, accommodative facility, and the coordinated movement of each eye in relationship to the other. From that assessment the doctor goes on to design a course of exercises to correct the problems discovered. Like any other type of training, success requires practice and persistence until habits and reflexes can be retrained.

There are a number of different techniques and instruments used in vision therapy; the field is evolving rapidly in many directions. Some computerized exercises are being developed that promise better patient motivation. A device called the Dynavision apparatus has produced positive results in retraining **stroke** victims to operate motor vehicles. In addition, traditional forms of vision therapy have increased reading efficiency in an older age group (62–75 years).

Because the goal of vision training is to improve visual efficiency and visual processing, people having problems reading should consider a vision training evaluation. Children rubbing their eyes while reading, avoiding reading, or getting headaches while reading should be evaluated. Problems with sustaining focusing (accommodative insufficiency) or problems keeping words single (convergence or divergence problems) may be present. A full eye-health evaluation and vision training workup may reveal a problem. Vision training is also appropriate for people learning how to coordinate the eyes after surgery for strabismus. Vision training can also be used in lazy eye (**amblyopia**) and includes patching the eye and doing various exercises.

Dyslexia is a problem with following the flow of words when reading. Often the order of letters or words is reversed. It is a complex problem involving the way the brain processes the stream of information coming in from the eyes. While vision therapy is not a treatment for dyslexia or learning disabilities, there may be an underlying visual processing problem that may be present. Vision therapy can be part of a multidisciplinary approach to treating learning disabilities.

Sports vision deals with visual performance in sport-related activities. Protective eyewear is also a large consideration when participating in sports. Basketball, baseball, racquetball, and swimming (and other sports as well) can all cause injury to the eyes. Batting helmets with face shields, protective goggles with polycarbonate lenses, or something as simple as ultraviolet (UV) coatings on glasses to protect the eyes from the sun in outdoor sports such as golf can protect the eyes. Hitting a baseball or throwing a basketball into a hoop requires accurate fixation. Golfers need to see clearly and judge distance. Bifocals may need to be adjusted to allow for putting, driving, and reading the score card. While many of these issues (e.g., UV coatings) can be addressed at a regular eye exam, sports vision may be able to help with more specific, individual problems.

Precautions

Behavioral optometry is a relatively new field of study. Results are mixed. Newer techniques, more refined evaluation methods, and newer pieces of apparatus are continuously being appraised. More study results are needed to define the scope and benefits of this discipline.

Description

Vision therapy is individually tailored to the subject and the discovered problems. It can be a lengthy process with many variations that requires repetition

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KEY TERMS

Accommodation—The focusing of the lens of the eye.

Binocular—Both eyes accurately pointing to the same object.

Stereopsis—The visual perception of depth, or the ability to see three-dimensionally. For this to occur, the person must be binocular.

until eye muscles, coordination, reflexes, habits, and the way the brain handles visual input are all retrained. Each program will be individualized. The patient should be aware of the time involved for treatment. Treatment can be from several weeks to several months depending upon the condition. Some insurance plans may cover vision training.

Preparation

If vision therapy is recommended, the optometrist will discuss thoroughly what is expected and necessary for success. The patient must be prepared to perform some eye exercises at home.

Aftercare

Even after the treatment is successful, it may be necessary to continue the exercises to maintain the benefits. It may be necessary to repeat treatment in the future.

Risks

No risk is involved. The treatment is safe.

Normal results

A carefully and individually tailored program of vision therapy should result in a gradual improvement in whatever complex visual function is being addressed. This progress ought to be measurable by using the same tests that were used to diagnose it. If the patient had symptoms, such as headaches or double vision while reading, it should be alleviated.

Abnormal results

Because the treatment is safe, the only abnormal result is failure. At the start of treatment, the optometrist should provide a reasonable estimate of what improvement to expect and how long it will take. Should this prove incorrect, either the treatment needs to be modified or the problem deemed untreatable by that method.

ORGANIZATIONS

American Optometric Association, 243 North Lindbergh Blvd., St. Louis, MO, 63141, (314) 991-4100, (314) 991-4101, (800) 365-2219, http://www.aoa.org/.

Prevent Blindness America, 211 West Wacker Drive, Suite 1700, Chicago, IL, 60606, (800) 331-2020, http://www.preventblindness.org.

J. Ricker Polsdorfer, MD

Visual evoked potential study *see* **Evoked potential studies**

Visual impairment

Definition

Total blindness is the inability to tell light from dark, or the total inability to see. Visual impairment or low vision is a severe reduction in vision that cannot be corrected with standard glasses or **contact lenses** and reduces a person's ability to function at certain or all tasks. Legal blindness (which is actually a severe visual impairment) refers to a best-corrected central vision of 20/200 or worse in the better eye or a visual acuity of better than 20/200 but with a visual field no greater than 20° (e.g., side vision that is so reduced that it appears as if the person is looking through a tunnel).

Description

Vision is normally measured using a Snellen chart. A Snellen chart has letters of different sizes that are read, one eye at a time, from a distance of 20 ft. People with normal vision are able to read the 20 ft line at 20 ft–20/20 vision, or the 40 ft line at 40 ft, the 100 ft line at 100 ft, and so forth. If at 20 ft the smallest readable letter is larger, vision is designated as the distance from the chart over the size of the smallest letter that can be read.

Eye care professionals measure vision in many ways. Clarity (sharpness) of vision indicates how well a person's central visual status is. The diopter is the unit of measure for refractive errors such as nearsightedness, farsightedness, and **astigmatism** and indicates the strength of corrective lenses needed. People do not just see straight ahead; the entire area of vision is called the visual field. Some people have good vision (e.g., see clearly) but have areas of reduced or no vision (blind

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spots) in parts of their visual field. Others have good vision in the center but poor vision around the edges (peripheral visual field). People with very poor vision may be able only to count fingers at a given distance from their eyes. This distance becomes the measure of their ability to see.

The World Health Organization (WHO) defines impaired vision in five categories:

- Low vision 1 is a best corrected visual acuity of 20/70.
- Low vision 2 starts at 20/200.
- Blindness 3 is below 20/400.
- Blindness 4 is worse than 5/300
- Blindness 5 is no light perception at all.
- A visual field between 5° and 10° (compared with a normal visual field of about 120°) goes into category 3; less than 5° into category 4, even if the tiny spot of central vision is perfect.

Color blindness is the reduced ability to perceive certain colors, usually red and green. It is a hereditary defect and affects very few tasks. Contrast sensitivity describes the ability to distinguish one object from another. A person with reduced contrast sensitivity may have problems seeing things in the fog because of the decrease in contrast between the object and the fog.

According to the WHO there are over 40 million people worldwide whose vision is category 3 or worse, 80% of whom live in developing countries. Half of the blind population in the United States is over 65 years of age.

Causes and symptoms

The leading causes of blindness include:

- macular degeneration
- glaucoma
- cataracts
- diabetes mellitus

Other possible causes include infections, injury, or **nutrition**.

Infections

Most infectious eye diseases have been eliminated in the industrialized nations by sanitation, medication, and public health measures. Viral infections are the main exception to this statement. Some infections that may lead to visual impairment include:

- Herpes simplex keratitis. A viral infection of the cornea. Repeated occurrences may lead to corneal scarring.
- Trachoma. This disease is responsible for six to nine million cases of blindness around the world, of the third of a billion who have the disease. Trachoma is caused by an incomplete bacterium, *Chlamydia trachomatis*, that is easily treated with standard antibiotics. It is transmitted directly from eye to eye, mostly by flies. The chlamydia gradually destroy the cornea.
- Leprosy (Hansen's disease). This is another bacterial disease that has a high affinity for the eyes. It, too, can be effectively treated with medicines.
- River blindness. Much of the tropics of the Eastern Hemisphere are infested with *Onchocerca volvulus*, a worm that causes "river blindness." This worm is transmitted by fly bites and can be treated with a drug called ivermectin. Nevertheless, 28 million people have the disease, and 40% of them are blind from it.

Other causes

Exposure of a pregnant woman to certain diseases (e.g., **rubella** or **toxoplasmosis**) can cause congenital eye problems. Injuries to the eyes can result in blindness. Very little blindness is due to disease in the brain or the optic nerves. **Multiple sclerosis** and similar nervous system diseases, brain tumors, diseases of the eye sockets, and head injuries are rare causes of blindness.

Nutrition

Vitamin A deficiency is a widespread cause of corneal degeneration in children in developing nations. As many as five million children develop xerophthalmia from this deficiency each year. Five percent end up blind.

Diagnosis

A low vision exam is slightly different from a general exam. While a case history, visual status, and eye health evaluation are common to both exams, some things do differ. Eye charts other than a Snellen eye chart will be used. Testing distance will vary. A trial frame worn by the patient is usually used instead of the instrument containing the lenses the patient sits behind (phoropter). Because the low vision exam is slightly more goal oriented than a general exam, for example, what specifically is the patient having trouble with (reading, seeing street signs, etc.) different optical and nonoptical aids will generally be tried. Eye health is the last thing to be checked so that the lights necessary to examine the eyes will not interfere with the rest of the testing.

Treatment

There are many options for patients with visual impairment. There are optical and nonoptical aids. Optical aids include:

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- Telescopes. May be used to read street signs.
- Hand magnifiers. May be used to read labels on things at the store.
- Stand magnifiers. May be used to read.
- Prisms. May be used to move the image onto a healthy part of the retina in some eye diseases.
- Closed circuit television (CCTV). For large magnification (e.g., for reading).

Nonoptical aids can include large print books and magazines, check-writing guides, large print dials on the telephone, and more.

For those who are blind, there are enormous resources available to improve the quality of life. For the legally blind, financial assistance for help may be possible. Braille and audio books are increasingly available. Guide dogs provide well-trained eyes and independence. Orientation and mobility training is available. There are special schools for blind children and access to disability support through Social Security and private institutions.

Prognosis

The prognosis generally relates to the severity of the impairment and the ability of the aids to correct it. A good low vision exam is important to be aware of the latest low vision aids.

Prevention

Regular eye exams are important to detect silent eye problems (e.g., glaucoma). Left untreated, glaucoma can result in blindness.

Corneal infections can be treated with effective **antibiotics**. When a cornea has become opaque beyond recovery it must be transplanted. Good hygiene (e.g., washing hands frequently) to prevent infection, proper use of contact lenses, and not sharing makeup are just some ways to guard against corneal infections.

Cataracts should be removed when they interfere with a person's quality of life.

Primary prevention addresses the causes before they ever begin. Fly control can be accomplished by simple sanitation methods. Public health measures can reduce the incidence of many infectious diseases. Vitamin A supplementation (when appropriate) will eliminate xerophthalmia completely. It is possible that protecting the eyes against ultraviolet (UV) light will reduce the incidence of cataracts, **macular degeneration**, and some other eye diseases. UV coatings can be placed on regular glasses, sunglasses, and ski goggles. Patients should ask their eye care professional about UV coatings. Protective goggles should also be worn in certain situations (e.g., certain jobs, sports, even mowing the lawn).

Secondary prevention addresses treating established diseases before they cause irreversible eye damage. Having general physical checkups can also detect systemic diseases such as diabetes or high blood pressure. Control of diabetes is very important in preserving sight.

KEY TERMS

Cornea—The clear dome-shaped structure that is part of the front of the eye. It lies in front of the colored part of the eye (iris).

Diabetic retinopathy—Retinal disease caused by the damage diabetes does to small blood vessels.

Phoropter—The instrument used to measure refractive status of the eyes. It contains many lenses which are then changed in front of the eyes while the patient is looking at an eye chart. This is when the doctor usually asks, "Which is better, one or two?"

Xerophthalmia—A drying of the cornea and conjunctiva.

ORGANIZATIONS

American Academy of Ophthalmology (AAO), P. O. Box 7424, San Francisco, CA, 94120-7424, (415) 561-8500, (415) 561-8500, http://www.aao.org.

American Foundation for the Blind, 2 Penn Plaza, Suite 1102, New York, NY, 10121, (212) 502-7600, (888) 545-8381, (800) AFB-LIND (232-5463), http://www.afb.org/.

Center for Sight and Hearing, P.O. Box 5944, Rockford, IL, 61107, (815) 332-6800, (815) 332-6810, http://www.rockfordcenter.org.

Children's Eye Foundation, 1631 Lancaster Drive, Ste 200, Grapevine, TX, 76051, (817) 310-2641, info@childrenseyefoundation.org, http://www.childrenseyefoundation.org.

Guide Dogs for the Blind, National Office, P.O. Box 151200, San Rafael, CA, 94915-1200, (800) 295-4050, http://ww.guidedogs.com.

International Eye Foundation, 10801 Connecticut Avenue, Kensington, MD, 20895, (240) 290-0263, (240) 290-0263, ief@iefusa.org, http://www.iefusa.org/.

Lighthouse International, 111 East 59th Street, New York, NY, 10022, (212) 821-9200, (212) 821-9707, (800) 829-0500, info@lighthouse.org, http://www.lighthouse.org.

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National Eye Institute, 31 Center Drive MSC 2510, Bethesda, MD, (301) 496-5248, http://www.nei.nih.gov/.

National Federation of the Blind, 200 East Wells Street, Baltimore, MD, 21230, (410) 659-9314, (410) 685-5653, http://www.nfb.org.

Prevent Blindness America, 211 West Wacker Drive, Suite 1700, Chicago, IL, 60606, (800) 331-2020, http://www.preventblindness.org.

Research to Prevent Blindness, 645 Madison Ave., Floor 21, New York, NY, 10022-1010, (212) 752-4333, (800) 621-0026, inforequest@rpbusa.org, http://www.rpbusa.org.

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Visualization *see* **Guided imagery**

Vitamin A deficiency

Definition

Vitamin A deficiency exists when the chronic failure to eat sufficient amounts of vitamin A or beta-carotene results in levels of blood-serum vitamin A that are below a defined range. Beta-carotene is a form of pre-vitamin A, which is readily converted to vitamin A in the body. Night blindness is the first symptom of vitamin A deficiency. Prolonged and severe vitamin A deficiency can produce total and irreversible blindness.

Description

Vitamin A (called retinol in mammals) is a fat-soluble vitamin. The recommended dietary allowance (RDA) for vitamin A is 1.0 mg/day for an adult man and 0.8 mg/day for an adult woman. Since beta-carotene is converted to vitamin A in the body, the body's requirement for vitamin A can be supplied entirely by beta-carotene. Six mg of beta-carotene are considered to be the equivalent of 1 mg of vitamin A. The best sources of vitamin A are eggs, milk, butter, liver, and fish, such as herring, sardines, and tuna. Beef is a poor source of vitamin A. Plants do not contain vitamin A, but they do contain beta-carotene and other carotenoids. The best sources of beta-carotene are dark-green, orange, and yellow vegetables; spinach, carrots, oranges, and sweet potatoes are excellent examples. Cereals are poor sources of beta-carotene.

Vitamin A is used for two functions in the body. Used in the eye, it is a component of the eye's light-sensitive parts, containing rods and cones, that allow night-vision or seeing in dim-light circumstances. Vitamin A (retinol) occurs in the rods. Another form of Vitamin A, retinoic acid, is used in the body for regulating the development of various tissues, such as the cells of the skin, and the lining of the lungs and intestines. Vitamin A is important during embryological development, since without vitamin A, the fertilized egg cannot develop into a fetus.

Causes and symptoms

Vitamin A deficiency occurs with the chronic consumption of **diets** that are deficient in both vitamin A and beta-carotene. When vitamin A deficiency exists in the developed world, it tends to happen in alcoholics or in people with diseases that affect the intestine's ability to absorb fat. Examples of such diseases are **celiac disease** (chronic nutritional disorder), **cystic fibrosis**, and **cholestasis** (bile-flow failure or interference). Vitamin A deficiency occurred in infants during the early 1900s in Denmark. The deficiency resulted when milk fat was made into butter for export, leaving the by-product (skimmed milk) for infant feeding. Vitamin A deficiency has taken place in infants in impoverished populations in India, where the only foods fed to the infants were low in beta-carotene. Vitamin A deficiency is also common in areas like Southeast Asia, where polished rice, which lacks the vitamin, is a major part of the diet.

The earliest symptom of vitamin A deficiency is night blindness. Prolonged deficiency results in drying of the conjunctiva (the mucous membrane that lines the inner surface of the eyelids and extends over the forepart of the eyeball). With continued vitamin A deficiency, the drying extends to the cornea (xerophthalamia). The cornea eventually shrivels up and becomes ulcerated (keratinomalacia). Superficial, foamy gray triangular spots may appear in the white of the eye (Bitot's spots). Finally, inflammation and infection occur in the interior of the eye, resulting in total and irreversible blindness.

Diagnosis

Vitamin A status is measured by tests for retinol. Blood-serum retinol concentrations of 30–60 mg/dL are considered in the normal range. Levels that fall below this range indicate vitamin A deficiency. Night blindness is measured by a technique called electroretinography. Xerophthalamia, keratinomalacia, and Bitot's spots are diagnosed visually by trained medical personnel.

Treatment

Vitamin A deficiency can be prevented or treated by taking vitamin supplements or by getting injections of the vitamin. The specific doses given are oral retinyl palmitate (110 mg), retinyl acetate (66 mg), or injected retinyl palmitate (55 mg) administered on each of two

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KEY TERMS

Bitot's spots—Bitot's spots are superficial, foamy gray, triangular spots on the white of the eyeball.

Carotenoids—Carotenoids are yellow to deep-red pigments.

Conjunctiva—The conjunctiva is a clear layer of cells that covers the eye and directly contacts the atmosphere. The conjunctiva is about 5 cells thick.

Cornea—The cornea is a clear layer of cells that covers the eye, just under the conjunctiva. The cornea is about 50 cells thick.

Fat-soluble vitamin—Fat-soluble vitamins can be dissolved in oil or in melted fat. Water-soluble vitamins can be dissolved in water or juice.

Keratomalacia—Keratomalacia is ulceration of the cornea.

Recommended Dietary Allowance (RDA)—The Recommended Dietary Allowances are quantities of nutrients in the diet that are required to maintain good health in people. RDAs are established by the Food and Nutrition Board of the National Academy of Sciences, and may be revised every few years. A separate RDA value exists for each nutrient. The RDA values refer to the amount of nutrient expected to maintain good health in people. The actual amounts of each nutrient required to maintain good health in specific individuals differ from person to person.

Xerophthalmia—Xerophthalmia is a dry, thickened, lusterless condition of the eyeball resulting from vitamin A deficiency.

successive days, and once a few weeks later if symptoms are not relieved.

Prognosis

The prognosis for correcting night blindness is excellent. Xerophthalamia can be corrected with vitamin A therapy. Ulcerations, tissue **death**, and total blindness, caused by severe vitamin A deficiency, cannot be treated with vitamin A.

Prevention

Vitamin A deficiency can be prevented by including foods rich in vitamin A or beta-carotene as a regular component of the diet; liver, meat, eggs, milk, and dairy products are examples. Foods rich in beta-carotene include red peppers, carrots, pumpkins, as well as those just mentioned. Margarine is rich in beta-carotene, because this chemical is used as a coloring agent in margarine production. In Africa, Indonesia, and the Philippines, vitamin A deficiency is prevented by public health programs that supply children with injections of the vitamin.

Resources

BOOKS

Brody, Tom. *Nutritional Biochemistry*. 2nd ed. San Diego: Academic Press, 2008.

Tom Brody, PhD

Vitamin B_1 *see* **Beriberi**

Vitamin B_2 deficiency *see* **Riboflavin deficiency**

Vitamin B_6 deficiency

Definition

Vitamin B_6 is used by the body as a catalyst in reactions that involve amino acids. Vitamin B_6 deficiency is rare, since most foods eaten contain the vitamin.

Description

Vitamin B_6 is a water-soluble vitamin. The recommended dietary allowance (RDA) for vitamin B_6 is 2.0 mg/day for the adult man and 1.6 mg/day for the adult woman. Vitamin B_6 in the diet generally occurs as a form called pyridoxal phosphate. In this form, it cannot be absorbed by the body. During the process of digestion, the phosphate group is removed, and pyridoxal is produced. However, the body readily absorbs pyridoxal, and converts it back to the active form of the vitamin (pyridoxal phosphate).

Poultry, fish, liver, and eggs are good sources of vitamin B_6, consisting of about 3–4 mg vitamin/kg food; meat and milk contain lesser amounts of the vitamin. The vitamin also occurs, at about half this level, in a variety of plant foods, including beans, broccoli, cabbage, and peas. Vitamin B_6 tends to be destroyed with prolonged cooking, with storage, or with exposure to light.

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KEY TERMS

Amino acid—Amino acids are small molecules that are used as building blocks for all proteins. Some amino acids are also used in the body for the manufacture of hormones. There are about 20 nutritionally important amino acids, including glutamic acid, glycine, methionine, lysine, tryptophan, serine, and glycine.

Fat-soluble vitamins—Fat-soluble vitamins can be dissolved in oil or in melted fat.

Recommended Dietary Allowance (RDA)—The Recommended Dietary Allowances (RDAs) are quantities of nutrients in the diet that are required to maintain good health in people. RDAs are established by the Food and Nutrition Board of the National Academy of Sciences, and may be revised every few years. A separate RDA value exists for each nutrient. The RDA values refer to the amount of nutrient expected to maintain good health in people. The actual amounts of each nutrient required to maintain good health in specific individuals differ from person to person.

Water-soluble vitamins—Water-soluble vitamins can be dissolved in water or juice.

As mentioned, vitamin B_6 takes various forms. One of these forms, called pyridoxine, is relatively stable. For this reason, pyridoxine is the form of vitamin B_6 that is used in vitamin supplements, or when foods are fortified. Apples and other fruits are poor sources of the vitamin, containing only 0.2–0.6 mg vitamin/kg food.

Vitamin B_6, used mainly in the body for the processing of amino acids, performs this task along with certain enzymes. The enzyme that participates in this type of complex is aminotransferase. Several types of aminotransferase exist. With vitamin B_6 deficiency, while aminotransferase continues to occur in the various organs of the body, there is an abnormally low level of the active vitamin B_6/aminotransferase complex present. Thus, this vitamin deficiency results in the impairment of a variety of activities in the body. With supplement correction of the vitamin B_6 deficiency, the aminotransferase then readily forms the active complex, and normal metabolism is restored.

Vitamin B_6 converts certain amino acids (glutamic acid, aspartic acid, glycine) to energy. This allows the body to process all dietary protein, even when the dietary protein is in excess of the body's needs. Vitamin B_6 also allows the body to synthesize certain amino acids. For example, if the diet is deficient or low in certain amino acids, such as glycine or serine, vitamin B_6 enables the body to make them from sugar. Vitamin B_6 is used also for the synthesis of certain hormones, such as adrenaline.

Causes and symptoms

Vitamin B_6 deficiency occurs rarely. When it does, it is usually associated with poor absorption of nutrients in the gastrointestinal tract (as in **alcoholism**, or with chronic **diarrhea**), the taking of certain drugs (as isoniazid, hydrolazine, penicillamine) that inactivate the vitamin, with genetic disorders that inhibit metabolism of the vitamin, or in cases of **starvation**.

The symptoms of vitamin B_6 deficiency in adults are only vaguely defined. These include nervousness, irritability, **insomnia**, muscle weakness, and difficulty in walking. Vitamin B_6 deficiency may produce fissures and cracking at the corners of the mouth. The deficiency occurred in infants fed early versions of commercial canned infant formula, when the vitamin had been inadvertently omitted from the formula. This error resulted in infants failing to grow, in irritability, and in seizures.

Diagnosis

Vitamin B_6 status is measured by the transaminase stimulation test. This test requires extraction of red blood cells, and placement of the cells in two test tubes. Special chemicals (reagents) are added to both test tubes to allow for measurement of aminotransferase. This enzyme requires pyridoxal phosphate. A known quantity of pure pyridoxal phosphate is added to one of the test tubes. The activity level of the enzyme is measured, and compared, in both test tubes. If the added pyridoxal phosphate did not stimulate activity, the patient is considered not to be deficient in vitamin B_6. Neither is the patient considered deficient if only slight stimulation occurred. But if a stimulation of four-fold or more occurred, a vitamin B_6 deficiency is present.

Treatment

Vitamin B_6 deficiency can be prevented or treated with consumption of the recommended dietary allowance, as supplied by food or by vitamin supplements.

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Prognosis

The prognosis for correcting vitamin B_6 deficiency is excellent.

Prevention

Vitamin B_6 deficiency is not a major concern for most people. The deficiency can be prevented with consumption of a mixed diet that includes poultry, fish, eggs, meat, vegetables, and grains.

Resources

BOOKS

Brody, Tom. *Nutritional Biochemistry*. 2nd ed. San Diego: Academic Press, 2008.

Tom Brody, PhD

Vitamin B_{12} deficiency anemia *see* **Pernicious anemia**

Vitamin C deficiency *see* **Scurvy**

Vitamin D

Age	Adequate intake		Tolerable Upper Intake Level	
Children 0–12 mos.	200 IU	5 mcg	1,000 IU	25 mcg
Children 1–18 yrs.	200 IU	5 mcg	2,000 IU	50 mcg
Adults 19–50 yrs.	200 IU	5 mcg	2,000 IU	50 mcg
Adults 51–70 yrs.	400 IU	10 mcg	2,000 IU	50 mcg
Adults 71≥ yrs.	600 IU	15 mcg	2,000 IU	50 mcg
Pregnant women	200 IU	5 mcg	2,000 IU	50 mcg
Breastfeeding women	200 IU	5 mcg	2,000 IU	50 mcg

Food	Vitamin D (IU)
Cod liver oil, 1 tbsp.	1,360
Salmon, cooked, 3.5 oz.	360
Mackerel, cooked, 3.5 oz.	345
Tuna, canned in oil, 3 oz.	200
Milk, fortified, 1 cup	100
Orange juice, fortified, 1 cup	100
Cereal, fortified, 1 serving	40
Egg, 1 whole	20

IU = International Unit
mcg = microgram

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Vitamin D deficiency

Definition

Vitamin D deficiency exists when the concentration of 25-hydroxy-vitamin D (25-OH-D) in the blood serum occurs at 12 ng/mL (nanograms/milliliter), or less. The normal concentration 25-hydroxy-vitamin D in the blood serum is 25–50 ng/mL. When vitamin D deficiency continues for many months in growing children, the disease commonly referred to as **rickets** will occur. A prolonged deficiency of the vitamin in adults results in osteomalacia. Both diseases involve defects in bones.

Demographics

One group of researchers at Oxford University estimated in 2010 that over three billion people in the world have vitamin D levels lower than are necessary to influence optimum health, and that one billion people have a deficiency of vitamin D. The Oxford group also linked vitamin D deficiency to increased susceptibility to some autoimmune diseases including **multiple sclerosis** (MS), Type-1 diabetes, and **rheumatoid arthritis**, as well as certain cancers. Severe vitamin D deficiency is less common in the United States and other industrialized countries because of the wide availability of vitamin D-fortified infant formulas and milks. However, in northern latitudes where there is less sunshine, vitamin D deficiencies are more common. Vitamin D deficiency is also slightly more common in inner city areas, because environmental factors such as smog can block the necessary ultraviolet (UV) component of sunlight. Children with darkly pigmented skin are more likely to be vitamin D deficient than light skinned children. Children who are exclusively breast-fed without vitamin D supplementation, particularly if they are not exposed to sunlight, are at higher risk of vitamin D deficiency.

Description

Vitamin D is a fat-soluble vitamin, meaning it dissolves in fat. While some vitamin D is supplied by the diet, most of it is made in the body. To make vitamin D, cholesterol, a sterol that is widely distributed in animal tissues and occurs in the yolk of eggs, as well as in various oils and fats, is necessary. Once cholesterol is available in the body, a slight alteration in the cholesterol molecule occurs, with one change that takes place in the skin. This alteration requires the energy of sunlight (or ultraviolet light). Vitamin D deficiency, as well as rickets and osteomalacia, tends to occur in persons who do not get enough sunlight and who fail to eat foods that are rich in vitamin D.

Once consumed, or made in the body, vitamin D is further altered to produce a hormone called 1,25-dihydroxy-vitamin D (1,25-diOH-D). The conversion of vitamin D to 1,25-diOH-D does not occur in the

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skin, but in the liver and kidney. First, vitamin D is converted to 25-OH-D in the liver; it then enters the bloodstream, where it is taken–up by the kidneys. At this point, it is converted to 1,25-diOH-D. Therefore, the manufacture of 1,25-diOH-D requires the participation of various organs of the body—the liver, kidney, and skin.

The purpose of 1,25-diOH-D in the body is to keep the concentration of **calcium** at a constant level in the bloodstream. The maintenance of calcium at a constant level is absolutely required for human life to exist, since dissolved calcium is required for nerves and muscles to work. One of the ways in which 1,25-diOH-D accomplishes this mission is by stimulating the absorption of dietary calcium by the intestines.

The sequence of events that can lead to vitamin D deficiency, then to bone disease, is as follows: a lack of vitamin D in the body creates an inability to manufacture 1,25-diOH-D, which results in decreased absorption of dietary calcium and increased loss of calcium in the feces. When this happens, the bones are affected. Vitamin D deficiency results in a lack of bone mineralization (calcification) in growing persons, or in an increased demineralization (decalcification) of bone in adults.

Causes and symptoms

Vitamin D deficiency can be caused by conditions that result in little exposure to sunlight. These conditions include: living in northern countries; having dark skin; being elderly or an infant, and having little chance to go outside; and covering one's face and body, such as for religious reasons. Many Arab women cover the entire body with black cloth, and wear a veil and black gloves when they go outside. These women may acquire vitamin D deficiency, even though they live in a sunny climate.

Most foods contain little or no vitamin D. As a result, sunshine is often a deciding factor in whether vitamin D deficiency occurs. Although fortified milk and fortified infant formula contain high levels of vitamin D, human breast milk is rather low in the vitamin. The term fortified means that **vitamins** are added to the food by the manufacturer.

To say that a food is high or low in vitamin D means how much of that food needs to be eaten in order to prevent vitamin deficiency and maintain good health. An exact meaning can be provided by comparing the Recommended Dietary Allowance of vitamin D with the amount of vitamin D supplied by a particular food per day. The Recommended Dietary Allowance, also referred to as RDA, is a recommendation based on data derived from different population groups and ages. The RDA for vitamin D for adults is 200 International Units (IU) per day, and can be supplied by eating approximately about three pounds (1.5 kg) of beef, five pounds (2.0 kg) of corn oil, or 200 pounds (100 kg) of cabbage. Few people, however, would want to eat three pounds of beef in one day, and no human being is capable of eating 200 pounds of cabbage in a day; therefore, these foods are poor sources of vitamin D. However, saltwater fish such as salmon, herring, and sardines are rich in vitamin D, supplied from the oils produced by these fish. The RDA can also be supplied by eating roughly two ounces (50 g) of salmon or less than a tenth of an ounce (2 g) of cod liver oil. Since fortified milk contains 400 IU per quart, half a quart of milk provides the RDA. For comparison, human breast milk contains only 4–60 IU per quart.

No harm is likely to result from vitamin D deficiency that occurs for only a few days a year. If the deficiency occurs for a period of many months or years, however, rickets or osteomalacia may develop. The symptoms of rickets include bowed legs and bowed arms. The bowed appearance is due to the softening of bones, and their bending if the bones are weight bearing. Bone growth occurs through the creation of new cartilage, a soft substance at the ends of bones. When the mineral calcium phosphate is deposited onto the cartilage, a hard structure is created. In vitamin D deficiency, though, calcium is not available to create hardened bone, and the result is soft bone. Other symptoms of rickets include particular bony bumps on the ribs called rachitic rosary (beadlike prominences at the junction of the ribs with their cartilages) and knock-knees. Seizures may also occasionally occur in a child with rickets, because of reduced levels of dissolved calcium in the bloodstream.

Although osteomalacia is rare in the United States, symptoms of this disease include reduced bone strength, an increase in bone **fractures**, and sometimes bone **pain**, muscle weakness, and a waddling walk.

Diagnosis

Vitamin D deficiency is diagnosed by measuring the level of 25-hydroxy-vitamin in blood serum. The normal level or concentration of this form of the vitamin ranges from 25–50 ng/mL. Deficiency occurs when this level decreases to about 12 ng/mL or less. As mentioned previously, 25-OH-D is not the active form of the vitamin. It must be converted to 1,25-diOH-D in order to cause responses in various organs of the body. However, the levels of vitamin D, or of 1,25-dihydroxy-vitamin D in the blood, do not give a reliable picture of whether a person is deficient in the

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KEY TERMS

25-hydroxy-vitamin—The form of vitamin D that is measured in order to assess vitamin D deficiency.

Cholesterol—A fat-soluble steroid alcohol (sterol) found in animal fats and oils, and in egg yolks. The human body needs cholesterol to produce vitamin D.

Fat–soluble vitamin—A vitamin that dissolves easily in fat or oil, but not in water. The fat–soluble vitamins are vitamins D, E, A, and K.

International unit (IU)—A measurement of biological activity in which one IU is equal to one mg (milligram).

Osteomalacia—Osteomalacia is a bone disease that occurs in adults and is caused by a prolonged period of vitamin D deficiency.

Rachitic rosary—Beadlike bumps present at the junction of the ribs with their cartilages; often seen in children with rickets.

Recommended Dietary Allowance (RDA)—The amount of nutrients, including vitamins, that should be supplied by foods on a daily basis to maintain normal health. Recommendations are based on data obtained from different population groups and ages.

Rickets—A bone disease that occurs in infants and growing children and is caused by a prolonged period of vitamin D deficiency.

vitamin. For this reason, they are not measured when testing for vitamin D deficiency.

Rickets is diagnosed by x–ray examination of leg bones. A distinct pattern of irregularities, abnormalities, and a coarse appearance can be clearly seen with rickets. Osteomalacia is also diagnosed with x–ray examination. Measurements of blood plasma 25-OH-D, blood plasma calcium, and blood plasma parathyroid hormone must also be obtained for the diagnosis of these diseases. Parathyroid hormone and 1,25-diOH-D work together in the body to regulate the levels of calcium in the blood.

Treatment

Rickets heals promptly with 4,000 IU of oral vitamin D per day administered for approximately one month. During this treatment, the doctor should monitor the levels of 25-OH-D in plasma to make certain they are raised to a normal value. Bone abnormalities (visible by x ray) generally disappear gradually over a period of three to nine months. Parents are instructed to take their infants outdoors for approximately 20 minutes per day with their faces exposed. Children should also be encouraged to play outside. Foods that are good sources of vitamin D include cod liver oil, egg yolks, butter, and oily fish. Some foods, including milk and breakfast cereals, are also fortified with synthetic vitamin D.

Osteomalacia is treated by injesting 2,500 IU per day of vitamin D for about three months. Measurements of 25-OH-D, calcium, and parathyroid hormone should be obtained after the treatment period to make sure the therapy did, in fact, result in normal blood values. In post-menopausal women with bone loss, or persons with parathyroid disease, vitamin D deficiency is often treated with therapeutic supplements of 50,000 IU taken once or more per week for a select short period of time, usually about eight weeks.

Care must be taken in treating vitamin D deficiency, since high doses of vitamin D are toxic and can result in the permanent deposit of **minerals** in the heart, lungs, and kidneys. Symptoms of toxicity are **nausea**, **vomiting**, pain in joints, and decreased appetite. In adults, vitamin D toxicity can occur with ingesting 50,000 IU or more per day. In infants, toxicity occurs with 1,000 IU per day. The continued intake of toxic doses results in **death**.

Rickets and osteomalacia are almost always treated with oral supplements of vitamin D, with the recommendation to acquire daily exposure to direct sunlight. An alternative to sunlight is the use of an ultraviolet (UV) lamp. When using UV lamps, the eyes must be covered to protect them against damage. Many types of sunglasses allow UV light to pass through, so only those that are opaque to UV light should be used. Attempts to acquire sunlight through glass windows fail to help the body make vitamin D. The reasons is that UV light does not pass through window glass.

Rickets may also occur with calcium deficiency, even when a child is regularly exposed to sunshine. This type of rickets has been found in various parts of Africa. The bone deformities are similar to, or are the same as, those that occur in typical rickets; however,

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calcium deficiency rickets is treated by increasing the amount of calcium in the diet. No amount of vitamin D can cure the rickets of a child with a diet that is extremely low in calcium. For this reason, specialists recommend that calcium be given in conjunction with vitamin D supplementation.

Prognosis

The prognoses for correcting vitamin D deficiency, rickets, and osteomalacia are excellent. Vitamin D treatment results in the return of bone mineralization to a normal rate, the correction of low plasma calcium levels, the prevention of seizures, and a recovery from bone pain. On the other hand, deformities such as bowed legs and the rachitic rosary persist throughout adult life.

Prevention

Food fortification has almost completely eliminated rickets in the United States. Vitamin D deficiency can be prevented by acquiring the RDA through drinking fortified milk and eating fortified cereals. For those who cannot drink milk, supplements of pills might be considered. In some older people, a 400 IU supplement may not be enough to result in the normal absorption of calcium; therefore, daily doses of 10,000 IU per day may be needed. For infants who are fed only breast milk (and rarely exposed to sunshine), a daily supplement of 200–300 IU is often recommended.

Rickets continues to be a problem in Africans and Asian Indians who migrate to Canada or Great Britain, especially where these immigrants do not drink fortified milk. Prevention of rickets in these populations is attempted through educational programs sponsored by the government.

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Vitamin E deficiency

Definition

Vitamin E deficiency is a very rare problem that results in damage to nerves. When vitamin E deficiency does occur, it strikes people with diseases that prevent the absorption of dietary fats and fat-soluble nutrients. Since vitamin E is a fat-soluble vitamin, it has some of the properties of fat.

Description

The recommended dietary allowance (RDA) for vitamin E is 10 mg/day for an adult man, 10 mg/day for an adult woman, and 3 mg/day for an infant. Vitamin E occurs in foods in a variety of related forms. The most potent and useful form of vitamin E is called alpha-tocopherol. The best sources of vitamin E are vegetable oils, such as corn oil, soy oil, and peanut oil. Animal fats, such as butter and lard, contain lower levels of the vitamin. Corn oil contains about 16 mg of alpha-tocopherol per 100 g oil. Wheat-germ oil contains 120 mg alpha-tocopherol per 100 g oil. Fish, eggs, and beef contain relatively low levels of the vitamin, with about 1 mg per 100 g food.

Vitamin E seems to have only one function in the body: the prevention of the natural and continual process of deterioration of all body tissues. This deterioration is provoked by a number of causes; one of these is toxic oxygen. During the body's metabolism of atmospheric oxygen, toxic oxygen is produced continuously in the body by the formation of by-products. These toxic by-products include hydrogen peroxide, superoxide, and hypochlorite.

Hypochlorite is a natural product, produced by cells of the immune system. It is also the active component of bleach. Once formed, toxic oxygen can damage

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KEY TERMS

Fat-soluble vitamin—Fat-soluble vitamins can be dissolved in oil or in melted fat.

Recommended dietary allowance (RDA)—The quantity of a given nutrient in the diet that is required to maintain good health in people. RDAs are established by the Food and Nutrition Board of the National Academy of Sciences and may be revised every few years. A separate RDA value exists for each nutrient. The RDA values refer to the amount of nutrient expected to maintain good health in people. The actual amounts of each nutrient required to maintain good health in specific individuals differ from person to person.

Toxic oxygen—Oxygen is required for life, as it is needed for energy production. When oxygen is used by the body, most of it is converted to water. However, a small fraction of the oxygen breathed is converted to toxic oxygen. The body uses several different processes for preventing and repairing toxic-oxygen damage. One of these processes involves vitamin E.

Water-soluble vitamins—Water-soluble vitamins can be dissolved in water or juice.

various parts of the body, such as the membranes which form the boundaries of every cell. Vitamin E serves the body in protecting membranes from toxic oxygen damage. In contrast, vitamin C serves to protect the aqueous, or watery, regions of the cell from toxic oxygen damage. The membranes that are most sensitive to toxic oxygen damage are the membranes of nerves; therefore, the main symptom of vitamin E deficiency is damage to the nervous system.

Causes and symptoms

As mentioned, when vitamin E deficiency occurs, it strikes people with diseases that prevent the absorption of dietary fats and fat-soluble nutrients. These diseases include **cystic fibrosis**, **pancreatitis**, and **cholestasis** (bile-flow obstruction). Bile salts, produced in the liver, are required for the absorption of fats. Cholestasis causes a decrease in the formation of bile salts and the consequent failure of the body to absorb dietary fats. For this reason, this disease may result in vitamin E deficiency. Premature infants may be at risk for vitamin E deficiency because they may be born with low tissue levels of the vitamin, and because they have a poorly developed capacity for absorbing dietary fats. Infants suffering from fat-malabsorption diseases can develop symptoms of vitamin E deficiency by age two. In adults, the onset of a fat-malabsorption disease can provoke vitamin E deficiency after a longer period, as an example, 10 years.

Patients with colorectal **cancer** caused by the so-called Ki-ras mutation have also been shown to absorb less vitamin E from their diet than either normal control subjects or cancer patients without the mutation. The relationship between genetic mutations and dietary factors requires more intensive study.

Vitamin E deficiency in humans results in ataxia (poor muscle coordination with shaky movements), decreased sensation to vibration, lack of reflexes, and **paralysis** of eye muscles. One particularly severe symptom of vitamin E deficiency is the inability to walk.

Another symptom of early vitamin E deficiency in children with cystic fibrosis is a decline in cognitive function, which results in difficulty with reading and falling behind in other intellectual skills during the elementary school years. Researchers have urged the introduction of neonatal screening in order to offset the potential effects of early vitamin E deficiency.

More recently, the suggestion has been made that vitamin E deficiency may be involved in the development of partial open-angle glaucoma (POAG), an eye disorder whose causes are not fully understood as of the early 2000s. The possibility that POAG is a vitamin-deficiency disorder, however, needs further research.

Diagnosis

Vitamin E status is measured by assessment of the content of alpha-tocopherol in the blood plasma, using a method called high-pressure liquid chromatography. Blood plasma levels of alpha-tocopherol that are 5.0 mg/l, or above, indicate normal vitamin E status; levels below 5.0 mg/l indicate vitamin E deficiency.

Treatment

Vitamin E deficiency that occurs with cholestatic **liver disease** or other malabsorption syndromes can be treated with weekly injections of 100 mg alpha-tocopherol that may continue for six months. Vitamin E deficiency in premature infants may require treatment for only a few weeks.

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Prognosis

The prognosis for correcting the neurological symptoms of vitamin E deficiency is fair to excellent.

Prevention

The prevention of vitamin E deficiency should not be a concern for most people, since the vitamin is found in a wide variety of foods. Attention has been given to the theory that vitamin E serves to protect against cancer and **atherosclerosis**. The evidence that normal levels of vitamin E protect against atherosclerosis is fairly convincing. However, there is little or no proof that vitamin E intake, above and beyond the recommended daily allowance (RDA), can prevent cancer or atherosclerosis.

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Vitamin K deficiency

Definition

Vitamin K deficiency exists when chronic failure to eat sufficient amounts of vitamin K results in a tendency for spontaneous bleeding or in prolonged and excessive bleeding with trauma or injury. Vitamin K deficiency occurs also in newborn infants, as well as in people treated with certain **antibiotics**. The protein in the body most affected by vitamin K deficiency is a blood-clotting protein called prothrombin.

Description

Vitamin K is a fat-soluble vitamin. The recommended dietary allowance (RDA) for vitamin K is 80 mg/day for an adult man, 65 mg/day for an adult woman, and 5 mg/day for a newborn infant. The vitamin K present in plant foods is called phylloquinone; while the form of the vitamin present in animal foods is called menaquinone. Both of these **vitamins** are absorbed from the diet and converted to an active form called dihydrovitamin K.

Spinach, lettuce, broccoli, brussels sprouts, and cabbage are good sources of vitamin K, containing about 8 mg vitamin K/kg food. Cow milk is also a good source of the vitamin.

A portion of the body's vitamin K is supplied by bacteria living in the intestine rather than by dietary sources.

Vitamin K plays an important role in blood clotting. Without the vitamin, even a small cut would cause continuous bleeding in the body, and **death**. Blood clotting is a process that begins automatically when any injury produces a tear in a blood vessel. The process of blood clotting involves a collection of molecules, which circulate continuously through the bloodstream. When an injury occurs, these molecules rapidly assemble and form the blood clot. The clotting factors are proteins, and include proteins called Factor II, Factor VII, Factor IX, and Factor X. Factor II is also called prothrombin. These proteins require vitamin K for their synthesis in the body. The blood-clotting process also requires a dozen other proteins that do not need vitamin K for their synthesis.

Causes and symptoms

Newborns are especially prone to vitamin K deficiency. A nursing-mother's milk is low in the vitamin; breast milk can supply only about 20% of the infant's requirement. Infants are born with low levels of vitamin K in their body; they do not have any vitamin K-producing bacteria in their intestines. Their digestive tracts are sterile. As a result, a form of vitamin K deficiency, called hemorrhagic disease of the newborn, may develop. This disease involves spontaneous bleeding beneath the skin or elsewhere in the infant's body, and occurs in about 1% of all infants. In rare cases, it causes death due to spontaneous bleeding in the brain.

Vitamin K deficiency in adults is rare. When it occurs, it is found in people with diseases that prevent the absorption of fat. These diseases include **cystic fibrosis**, **celiac disease**, and **cholestasis**. Vitamin K deficiency can exist in adults treated with antibiotics

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KEY TERMS

Fat-soluble vitamin—Fat-soluble vitamins can be dissolved in oil or in melted fat.

Hemorrhage—Bleeding that continues for an abnormally long period of time.

Phylloquinone—An alternate name for vitamin K_1.

Prothrombin—Prothrombin is a blood-clotting protein. Injury to a blood vessel produces a signal which triggers the conversion of prothrombin to thrombin. Thrombin is a protein which plays a central role in provoking the assembly of other proteins to form the blood clot.

Recommended Dietary Allowance (RDA)—The Recommended Dietary Allowances (RDAs) are quantities of nutrients in the diet that are required to maintain good health in people. RDAs are established by the Food and Nutrition Board of the National Academy of Sciences and may be revised every few years. A separate RDA value exists for each nutrient. The RDA values refer to the amount of nutrient expected to maintain good health in people. The actual amounts of each nutrient required to maintain good health in specific individuals differ from person to person.

Water-soluble vitamins—Water-soluble vitamins can be dissolved in water or juice.

that kill the bacteria that normally live in the digestive tract. As mentioned, the intestine-bacteria supply part of our daily requirement of vitamin K. Vitamin K deficiency can result in bleeding gums, and in skin that is easily bruised.

Others who may benefit from supplemental vitamin K include those taking medications that interact with it or deplete the supply. It also appears to have some effectiveness in preventing **osteoporosis**, but some studies done involved patients using a high dietary intake of the vitamin rather than supplements. In 2003, however, a group of Japanese researchers reported that supplemental doses of vitamin K_2 given together with vitamin D_3 appeared to reduce bone turnover and sustain bone density in postmenopausal women with mild osteoporosis.

Chronically low levels of vitamin K are correlated with higher risk of hip fracture in older men and women. A study done in 2003 reported that the current recommended dietary intake for vitamin K in adults may not be adequate for older women.

Diagnosis

Vitamin K status is measured by the **prothrombin time** test. The normal prothrombin time is about 13 seconds. With vitamin K deficiency, the prothrombin time can be several minutes. The test involves taking a sample of blood, placing it in a machine called a fibrometer, and measuring the time it takes for blood-clot formation. Blood-clotting problems can also be caused by a rare genetic disease called **hemophilia**. Hemophilia is not related to vitamin K deficiency. Once vitamin K deficiency is suspected, further tests must be used to distinguish it from possible hemophilia. Where a bleeding disorder can be corrected by vitamin K treatment, the diagnosis of vitamin K deficiency is proven to be correct.

Treatment

Vitamin K deficiency in newborn infants is treated and prevented with a single injection of phylloquinone (5 mg). Adults with vitamin K deficiency are treated with daily oral doses of 10 mg phylloquinone for one week.

Prognosis

The prognosis for correcting vitamin K deficiency, and associated blood-clotting problems, is excellent.

Prevention

Aside from newborns and young infants, vitamin K deficiency is not a concern for the general population. Vitamin K deficiency can be prevented by assuring that the diet contains such foods as spinach, cabbage, brussels sprouts, and eggs. Soybean oil, canola oil, and olive oil are good sources of the vitamin, while corn oil and peanut oil are very poor sources. Elderly people, especially those living alone, should be checked for adequate intake of the vitamin.

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American Academy of Pediatrics (AAP), 141 Northwest Point Boulevard, Elk Grove Village, IL, 60007-1098, (847) 434-4000, (847) 424-8000, kidsdocs@aap.org, http://www.aap.org.
American Society for Clinical Nutrition, 9650 Rockville Pike, Bethesda, MD, 20814, (301) 634-7050, (301) 634-7892, http://www.nutrition.org/.

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Vitamin poisoning *see* **Vitamin toxicity**

Vitamin tests

Definition

Vitamin tests measure the levels of certain **vitamins** in an individual's blood. They are generally used to aid in the diagnosis of vitamin deficiencies or in detecting toxic amounts of a vitamin in a patient's system.

Purpose

Vitamins are components of food that are needed for growth, reproduction, and maintaining good health. The vitamins include vitamin D, vitamin E, vitamin A, and vitamin K, which are the fat-soluble vitamins, and folate, vitamin B_{12}, biotin, vitamin B_6, niacin, thiamin, riboflavin, pantothenic acid, and ascorbic acid, which are the water-soluble vitamins. Vitamins are required in the diet in only tiny amounts, in contrast to the energy components of the diet, such as sugars, starches, and fats. However, not receiving sufficient quantities of a certain vitamin can be devastating, resulting in vitamin deficiency diseases such as **scurvy**, **pellagra**, or **rickets**. Conversely, consuming too much of a certain vitamin can be toxic to a person's system. Vitamin tests are used to assess the level of certain vitamins in an individual's blood so that doctors can more accurately diagnose vitamin deficiency diseases or vitamin overdoses and devise effective therapy. The vitamins that are most commonly measured by doctors are folate, vitamin B_{12}, vitamin K, vitamin D, and vitamin A.

Description

Most of the vitamin tests are conducted by acquiring a sample of blood, and then preparing plasma or serum from the blood sample. Each vitamin occurs at extremely small concentrations when compared to levels of most other molecules in the blood. Blood contains a great number of chemicals and molecules, and many of these tend to interfere with the vitamin tests. For this reason, a procedure that separates the vitamin from contaminating substances is usually performed immediately prior to conducting the actual test. Most laboratories use high pressure liquid chromatography (HPLC), also called high performance liquid chromatography, as this purification step. In HPLC, the sample is pumped at high pressure through a tube lined with an absorbent material, to which the different molecules cling at different rates. Following separation or purification by HPLC, the vitamin is detected by a color reaction or fluorescence reaction. In these reactions, the amount of color or fluorescence that is formed is proportional to the amount of vitamin in the sample, allowing the analyst to calculate the amount of vitamin present in the original sample. In the case of some vitamins, the purified vitamin is reacted with a special chemical (reagent) prior to detection.

Levels of some vitamins may be measured indirectly by a biological test that mimics the actual function of the vitamin in the body. Riboflavin status is often measured by a test in which the rate by which a certain enzyme converts one molecule into another indicates how much Vitamin B_2 is present in a person's blood. Vitamin K is often measured by a test that times how long it takes for a spontaneous blood clot to form in a prepared sample. Vitamin E status is often measured by placing the red blood cells in a test tube, adding hydrogen peroxide, and assessing the resulting breakdown of the red blood cells. When a **vitamin E deficiency** exists, the red blood cells have a greater tendency to break.

Preparation

Most vitamin tests require no preparation; however, some may require that the patient fast for at least eight hours before giving a blood sample, or stop using some medications.

Normal results

The values that are considered to be normal for each vitamin can vary slightly. This variability can arise from different testing machines or from different

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types of chemistry that are used in conducting the vitamin assays. In interpreting data on plasma vitamin levels, it should also be noted that different normal ranges may exist for different age groups and genders. For example, the normal range for plasma vitamin B_6 is 7–52 nanograms per milliliter (ng/mL) for males and 2–26 ng/mL for females.

The normal ranges for levels of certain vitamins are as follows. Please note that, by convention, the units referring to the levels of each of the vitamins may differ from each other. The units picogram/milliliter (pg/mL), nanogram/milliliter (ng/mL), and micrograms per deciliter (micrograms/dL) refer to the weight of vitamin in the specified volume. The units nanomoles/liter (nmol/L) and micromoles/liter (M/L) refer to the concentration of vitamin in the specified volume.

- folate (folic acid): 3.1–18.0 ng/mL
- vitamin B_{12}: 200–1100 pg/mL
- thiamin: 9–44 nmol/L
- riboflavin: 6.2–39 nmol/L
- vitamin B_6: 7–52 ng/mL
- vitamin C (asorbic acid): 28–84 M/L
- vitamin A: 28–94 micrograms/dL
- vitamin D (25-hydroxy-vitamin D): 25–50 ng/mL
- vitamin K: 80–1160 pg/mL

Abnormal results

In all cases, abnormal results fall below or above the normal concentration range. However, values that are considered to be borderline or severely abnormal can differ according to the discretion of the medical laboratory or physician.

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Vitamin toxicity

Definition

Vitamin toxicity is a condition in which a person develops symptoms as side effects from taking massive doses of **vitamins**. Vitamins vary in the amounts that are required to cause toxicity and in the specific symptoms that result. Vitamin toxicity, which is also called hypervitaminosis or vitamin **poisoning**, is becoming more common in developed countries because of the popularity of vitamin supplements. Many people treat themselves for minor illnesses with large doses (megadoses) of vitamins.

Description

Overview

Vitamins are organic molecules in food that are needed in small amounts for growth, reproduction, and the maintenance of good health. Some vitamins can be dissolved in oil or melted fat. These fat-soluble vitamins include vitamin D, vitamin E, vitamin A (retinol), and vitamin K. Other vitamins can be dissolved in water. These water-soluble vitamins include folate (**folic acid**), vitamin B_{12}, biotin, vitamin B_6, niacin, thiamin, riboflavin, pantothenic acid, and vitamin C (ascorbic acid). Taking too much of any vitamin can produce a toxic effect. Vitamin A and vitamin D are the most likely to produce hypervitaminosis in large doses, while riboflavin, pantothenic acid, biotin, and vitamin C appear to be the least likely to cause problems.

Vitamins in medical treatment

Vitamin supplements are used for the treatment of various diseases or for reducing the risk of certain diseases. For example, moderate supplements of folic acid appear to reduce the risk for certain **birth defects** (neural tube defects) and possibly reduce the risk of **cancer**. Therapy for diseases brings with it the risk for irreversible vitamin toxicity only in the case of vitamin D. This vitamin is toxic at levels which are only moderately greater than the recommended dietary allowance (RDA). Niacin is commonly used as a drug for the treatment of heart disease. Niacin is far less toxic than vitamin D. Vitamin toxicity is not a risk with medically supervised therapy using any of the other vitamins.

Vitamin megadoses

With the exception of folic acid supplements, the practice of taking vitamin supplements by healthy individuals has little or no relation to good health. Most adults in the United States can obtain enough vitamins by eating a well-balanced diet. It has, however, become increasingly common for people to take vitamins at levels far greater than the RDA. These high levels are sometimes called vitamin megadoses. Megadoses are harmless for most vitamins. But in the cases of a few of the vitamins—specifically vitamin D, vitamin A, and vitamin B_6—megadoses can be harmful or fatal. Researchers have also started to look more closely at

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megadoses of vitamin C and of vitamin E, since indirect evidence suggests that these two vitamins may reduce the risks of cancer, heart disease, and **aging**. It is not yet clear whether megadoses of either of these vitamins have any influence on health. Some experts think that megadoses of vitamin C may protect people from cancer. On the other hand, other researchers have gathered indirect evidence that vitamin C megadoses may cause cancer.

Causes and symptoms

Fat-soluble vitamins

VITAMIN D. Vitamin D and vitamin A are the most toxic of the fat-soluble vitamins. The symptoms of vitamin D toxicity are **nausea**, **vomiting**, **pain** in the joints, and loss of appetite. The patient may experience **constipation** alternating with **diarrhea**, or have **tingling** sensations in the mouth. The toxic dose of vitamin D depends on its frequency. In infants, a single dose of 15 mg or greater may be toxic, but it is also the case that daily doses of 1.0 mg over a prolonged period may be toxic. In adults, a daily dose of 1.0–2.0 mg of vitamin D is toxic when consumed for a prolonged period. A single dose of about 50 mg or greater is toxic for adults. The immediate effect of an overdose of vitamin D is abdominal cramps, **nausea and vomiting**. Toxic doses of vitamin D taken over a prolonged period of time result in irreversible deposits of **calcium** crystals in the soft tissues of the body that may damage the heart, lungs, and kidneys.

VITAMIN A. Vitamin A toxicity can occur with long-term consumption of 20 mg of retinol or more per day. The symptoms of vitamin A overdosing include accumulation of water in the brain (**hydrocephalus**), **vomiting**, tiredness, constipation, bone pain, and severe headaches. The skin may acquire a rough and dry appearance, with hair loss and brittle nails. Vitamin A toxicity is a special issue during **pregnancy**. Expectant mothers who take 10 mg vitamin A or more on a daily basis may have an infant with birth defects. These birth defects include abnormalities of the face, nervous system, heart, and thymus gland. It is possible to take in toxic levels of vitamin A by eating large quantities of certain foods. For example, about 30 grams of beef liver, 500 grams of eggs, or 2,500 grams of mackerel would supply 10 mg of retinol. The livers of polar bears and other arctic animals may contain especially high levels of vitamin A.

VITAMIN E. Megadoses of vitamin E may produce headaches, tiredness, double vision, and diarrhea in humans. Studies with animals fed large doses of vitamin E have revealed that this vitamin may interfere with the absorption of other fat-soluble vitamins. The term absorption means the transfer of the vitamin from the gut into the bloodstream. Thus, large doses of vitamin E consumed over many weeks or months might result in deficiencies of vitamin D, vitamin A, and vitamin K.

VITAMIN K. Prolonged consumption of megadoses of vitamin K (menadione) results in anemia, which is a reduced level of red blood cells in the bloodstream. When large doses of menadione are given to infants, they result in the deposit of pigments in the brain, nerve damage, the destruction of red blood cells (hemolysis), and **death**. A daily injection of 10 mg of menadione into an infant for three days can kill the child. This tragic fact was discovered during the early days of vitamin research, when newborn infants were injected with menadione to prevent a disease known as hemorrhagic disease of the newborn. Today a different form of vitamin K is used to protect infants against this disease.

Water-soluble vitamins

FOLATE. Folate occurs in various forms in food. There are over a dozen related forms of folate. The folate in oral vitamin supplements occurs in only one form, however—folic acid. Large doses of folic acid (20 grams/day) can result in eventual kidney damage. Folate is considered, however, to be relatively nontoxic, except in cases where folate supplementation can lead to **pernicious anemia**.

VITAMIN B_{12}. Vitamin B_{12} is important in the treatment of pernicious anemia. Pernicious anemia is more common among middle-aged and older adults; it is usually detected in patients between the ages of 40 and 80. The disease affects about 0.1% of all persons in the general population in the United States, and about 3% of the elderly population. Pernicious anemia is treated with large doses of vitamin B_{12}. Typically, 0.1 mg of the vitamin is injected each week until the symptoms of pernicious anemia disappear. The patient then takes oral doses of vitamin B_{12} for the rest of his or her life. Although vitamin B_{12} toxicity is not an issue for patients being treated for pernicious anemia, treatment of these patients with folic acid may cause problems. Specifically, pernicious anemia is often first detected because the patient feels weak or tired. If the anemia is not treated, the patient may suffer irreversible nerve damage. The problem with folic acid supplements is that the folic acid treatment prevents the anemia from developing, but allows the eventual nerve damage to occur.

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KEY TERMS

Absorption—The transfer of a vitamin from the digestive tract to the bloodstream.

Ascorbic acid—Another name for vitamin C.

Hypercalcemia—Hypercalcemia is a condition marked by abnormally high levels of calcium in the blood. It is an issue during vitamin D toxicity.

Hypervitaminosis—Another name for vitamin toxicity.

Megadose—A very large dose of a vitamin, taken by some people as a form of self-medication.

Menadione—A synthetic form of vitamin K. It is sometimes called vitamin K_3.

Recommended Dietary Allowance (RDA)—The recommended dietary allowances (RDAs) are the quantities of nutrients in the diet that are needed for good health. RDAs are established by the Food and Nutrition Board of the National Academy of Sciences and may be revised every few years.

Retinol—Another name for vitamin A.

VITAMIN B_6. Vitamin B_6 is clearly toxic at doses about 1,000 times the RDA. Daily doses of 2–5 grams of one specific form of this vitamin can produce difficulty in walking and tingling sensations in the legs and soles of the feet. Continued megadoses of vitamin B_6 result in further unsteadiness, difficulty in handling small objects, and **numbness** in the hands. When the high doses are stopped, recovery begins after two months. Complete recovery may take two to three years.

VITAMIN C. The RDA for vitamin C in adults is 60 mg per day. Large doses of vitamin C are considered to be toxic in persons with a family history of or tendency to form **kidney stones** or gallbladder stones. Kidney and gallbladder stones usually consist of calcium oxalate. Oxalate occurs in high concentrations in foods such as cocoa, chocolate, rhubarb, and spinach. A fraction of the vitamin C in the body is normally broken down in the body to produce oxalate. A daily supplement of 3.0 grams of vitamin C has been found to double the level of oxalate that passes through the kidneys and is excreted into the urine.

NIACIN. The RDA for niacin is 15–19 mg per day in adults. Niacin comes in two forms, nicotinic acid and nicotinamide. Either form can satisfy the adult requirement for this vitamin. Nicotinic acid, however, is toxic at levels of 100 times the RDA. It can cause flushing of the skin, nausea, diarrhea, and liver damage. Flushing is an increase in blood passing through the veins in the skin, due to the dilation of arteries passing through deeper parts of the face or other parts of the body. In spite of the side effects, however, large doses of nicotinic acid are often used to lower blood cholesterol in order to prevent heart disease. Nicotinic acid results in a lowering of LDL-cholesterol ("bad cholesterol"), an increase in HDL-cholesterol ("good cholesterol"), and a decrease in plasma **triglycerides**. Treatment involves daily doses of 1.5–4.0 grams of nicotinic acid per day. Flushing of the skin occurs as a side effect when nicotinic acid therapy is started, but may disappear with continued therapy.

Diagnosis

The diagnosis of vitamin toxicity is usually made on the basis of the patient's dietary or medical history. Questioning the patient about the use of vitamin supplements may shed light on some of his or her physical symptoms. With some vitamins, the doctor can confirm the diagnosis by ordering blood or urine tests for specific vitamins. When large amounts of water-soluble vitamins are consumed, a large fraction of the vitamin is absorbed into the bloodstream and promptly excreted into the urine. Fat-soluble vitamins are more likely to be absorbed into the bloodstream and deposited in the fat and other tissues. In the cases of both water-soluble and fat-soluble vitamins, any vitamin not absorbed by the intestines is excreted in the feces. Megadoses of many of the vitamins produce diarrhea because the non-absorbed nutrient draws water out of the body and into the gut, resulting in the loss of this water from the body.

Treatment

In all cases, treatment of vitamin toxicity requires discontinuing vitamin supplements. Vitamin D toxicity needs additional action to reduce the calcium levels in the bloodstream because it can cause abnormally high levels of plasma calcium (**hypercalcemia**). Severe hypercalcemia is a medical emergency and may be treated by infusing a solution of 0.9% **sodium** chloride into the patient's bloodstream. The infusion consists of two to three liters of salt water given over a period of one to two days.

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Prognosis

The prognosis for reversing vitamin toxicity is excellent for most patients. Side effects usually go away as soon as overdoses are stopped. The exceptions are severe vitamin D toxicity, severe vitamin A toxicity, and severe vitamin B_6 toxicity. Too much vitamin D leads to deposits of calcium salts in the soft tissue of the body, which cannot be reversed. Birth defects due to vitamin A toxicity cannot be reversed. Damage to the nervous system caused by megadoses of vitamin B_6 can be reversed, but complete reversal may require a recovery period of over a year.

Prevention

Vitamin toxicity can be prevented by minimizing the use of vitamin supplements. If vitamin D supplements are being used on a doctor's orders, vitamin toxicity can be prevented by monitoring the levels of plasma calcium. The development of hypercalcemia with vitamin D treatment indicates that the patient is at risk for vitamin D toxicity.

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American Dietetic Association, 120 S. Riverside Plaza, Suite 2000, Chicago, IL, 60606-6995, (312) 899-0040, (800) 877-1600, http://www.eatright.org/.

Dietitians of Canada, 480 University Ave., Suite 604, Toronto, Ontario, M5G 1V2, Canada, (416) 596-0857, centralinfo@ dietitians.ca, http://www.dietitians.ca.

National Institutes of Health, Office of Dietary Supplements, 6100 Executive Blvd., Room 3B01, MSC 7517, Bethesda, MD, 20892-7517, (301) 435-2920, (301) 480-1845, ods@nih.gov, http://ods.od.nih.gov.

Tom Brody, PhD
Ken R. Wells

Vitamins

Definition

Vitamins are organic components in food that are needed in very small amounts for growth and for maintaining good health. The vitamins include vitamin D, vitamin E, vitamin A, and vitamin K, or the fat-soluble vitamins, and folate (**folic acid**), vitamin B_{12}, biotin, vitamin B_6, niacin, thiamin, riboflavin, pantothenic acid, and vitamin C (ascorbic acid), or the water-soluble vitamins. Vitamins are required in the diet in only tiny amounts, in contrast to the energy components of the diet. The energy components of the diet are sugars, starches, fats, and oils, and these occur in relatively large amounts in the diet.

Most of the vitamins are closely associated with a corresponding vitamin deficiency disease. **Vitamin D deficiency** leads to diseases of the bones, such as **osteoporosis** and **rickets**. **Vitamin E deficiency** occurs only rarely, and causes nerve damage. **Vitamin A deficiency** is common throughout the poorer parts of the world, and causes night blindness. Severe vitamin A deficiency can result in xerophthalamia, a disease which, if left untreated, results in total blindness. **Vitamin K deficiency** results in spontaneous bleeding. Mild or moderate folate deficiency is common throughout the world, and can result from the failure to eat green, leafy vegetables or fruits and fruit juices. Folate deficiency causes megaloblastic anemia, which is characterized by the presence of large abnormal cells called megaloblasts in the circulating blood. The symptoms of megaloblastic anemia are tiredness and weakness. Vitamin B_{12} deficiency occurs with the failure to consume meat, milk or other dairy products. Vitamin B_{12} deficiency causes megaloblastic anemia and, if severe enough, can result in irreversible nerve damage. Niacin deficiency results in **pellagra**. Pellagra involves skin **rashes** and scabs, **diarrhea**, and mental depression.

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Essential vitamins

Vitamin	Benefits
Vitamin A (beta carotene)	Promotes growth and repair of body tissues; reduces susceptibility to infections; aids in bone and teeth formation; maintains smooth skin
Vitamin B_1 (thiamin)	Promotes growth and muscle tone; aids in the proper functioning of the muscles, heart, and nervous system; assists in digestion of carbohydrates
Vitamin B_2 (riboflavin)	Maintains good vision and healthy skin, hair, and nails; assists in formation of antibodies and red blood cells; aids in carbohydrate, fat, and protein metabolism
Vitamin B_3 (niacin)	Reduces cholesterol levels in the blood; maintains healthy skin, tongue, and digestive system; improves blood circulation; increases energy
Vitamin B_5 (pantothenic acid)	Fortifies white blood cells; supports the body's resistance to stress; builds cells
Vitamin B_6 (pyridoxine)	Aids in the synthesis and breakdown of amino acids and the metabolism of fats and carbohydrates; supports the central nervous system; maintains healthy skin
Vitamin B_7 (biotin)	Aids in the metabolism of proteins and fats; promotes healthy skin
Vitamin B_{12} (cobalamin)	Promotes growth in children; prevents anemia by regenerating red blood cells; aids in the metabolism of carbohydrates, fats, and proteins; maintains healthy nervous system
Folic acid (folate; considered a B-complex vitamin)	Promotes the growth and reproduction of body cells; aids in the formation of red blood cells and bone marrow
Vitamin C (ascorbic acid)	One of the major antioxidants; essential for healthy teeth, gums, and bones; helps to heal wounds, fractures, and scar tissue; builds resistance to infections; assists in the prevention and treatment of the common cold; prevents scurvy
Vitamin D	Improves the absorption of calcium and phosphorous (essential in the formation of healthy bones and teeth); maintains nervous system
Vitamin E	A major antioxidant; supplies oxygen to blood; provides nourishment to cells; prevents blood clots; slows cellular aging
Vitamin K	Prevents internal bleeding; reduces heavy menstrual flow

(Table by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)

Thiamin deficiency results in **beriberi**, a disease that can cause atrophy, weakness of the legs, nerve damage, and **heart failure**. Vitamin C deficiency results in **scurvy**, a disease that involves bleeding. Specific diseases uniquely associated with deficiencies in vitamin B_6, riboflavin, or pantothenic acid have not been found in humans, although persons who have been starving or consuming poor **diets** for several months might be expected to be deficient in most of the nutrients, including vitamin B_6, riboflavin, and pantothenic acid.

Some vitamins serve only one function in the body, while other vitamins serve a variety of unrelated functions. Therefore, some vitamin deficiencies tend to result in one type of defect, while other deficiencies result in a variety of problems.

Purpose

People are treated with vitamins for three reasons. The primary reason is to relieve a vitamin deficiency, when one has been detected. Chemical tests suitable for the detection of all vitamin deficiencies are available. The diagnosis of vitamin deficiency often is aided by visual tests, such as the examination of blood cells with a microscope, the x-ray examination of bones, or a visual examination of the eyes or skin.

A second reason for vitamin treatment is to prevent the development of an expected deficiency. Here, vitamins are administered even with no test for possible deficiency. One example is vitamin K treatment of newborn infants to prevent bleeding. Food supplementation is another form of vitamin treatment. The vitamin D added to foods serves the purpose of preventing the deficiency from occurring in persons who may not be exposed much to sunlight and who fail to consume foods that are fortified with vitamin D, such as milk. Niacin supplementation prevents pellagra, a disease that occurs in people who rely heavily on corn as the main source of food, and who do not eat much meat or milk. In general, the U.S. food supply is fortified with niacin.

A third reason for vitamin treatment is to reduce the risk for diseases that may occur even when vitamin deficiency cannot be detected by chemical tests. One example is folate deficiency. The risk for cardiovascular disease can be slightly reduced for a large fraction of the population by folic acid supplements. In addition, the risk for certain **birth defects** can be sharply reduced if certain pregnant women use folic acid supplements.

Vitamin treatment is important during specific diseases where the body's normal processing of a vitamin is impaired. In these cases, high doses of the needed vitamin can force the body to process or utilize it in the normal manner. One example is **pernicious anemia**, a disease that tends to occur in middle age or old age and impairs the absorption of vitamin B_{12}. Surveys have revealed that about 0.1% of the general population, and 2–3% of the elderly, may have the disease. If left untreated, pernicious anemia leads to nervous system damage. The disease can easily be treated with large oral daily doses of vitamin B_{12} (hydroxocobalamin) or with monthly injections of the vitamin.

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KEY TERMS

Genetic disease—A genetic disease is a disease that is passed from one generation to the next, but does not necessarily appear in each generation. An example of genetic disease is Down syndrome.

Plasma—Blood consists of red and white cells, as well as other components, that float in a liquid. This liquid is called plasma.

Recommended dietary allowance (RDA)—The Recommended Dietary Allowances (RDAs) are quantities of nutrients of the diet that are required to maintain human health. RDAs are established by the Food and Nutrition Board of the National Academy of Sciences and may be revised every few years. A separate RDA value exists for each nutrient. The RDA values refer to the amount of nutrient expected to maintain health in the greatest number of people.

Serum—Serum is blood plasma with the blood clotting proteins removed. Serum is prepared by removing blood from the subject, allowing the blood naturally to form a blood clot and then using a centrifuge to remove the red blood cells and the blood clot. The blood clot takes the form of an indistinct clump.

Vitamin status—Vitamin status refers to the state of vitamin sufficiency or deficiency of any person. For example, a test may reveal that a patient's folate status is sufficient, borderline, or severely inadequate.

Vitamin supplements are widely available as over-the-counter products. Whether they work to prevent or curtail certain illnesses, particularly in people with a balanced diet, is a matter of debate and ongoing research. For example, vitamin C is not proven to prevent the **common cold**. Nevertheless millions of people take it for that reason. A physician or pharmacist can provide more information on the appropriate use of multivitamin supplements. Likewise, although vitamin supplements have been touted as a prevention for **cancer**, a 2004 report by the U.S. Preventive Services Task Force concluded that the evidence is inadequate to recommend supplementation of vitamins A, C, or E, multivitamins with folic acid, or antioxidant combinations to decrease the risk of cancer.

Precautions

Vitamin A and vitamin D can be toxic in high doses. Side effects range from **dizziness** to kidney failure. A physician or pharmacist can help with the correct use of a multivitamin supplement that contains these vitamins.

Description

Vitamin treatment usually is done in three ways: by replacing a poor diet with one that supplies the recommended dietary allowance, by consuming oral supplements, or by injections. Injections are useful for people with diseases that prevent absorption of fat-soluble vitamins. Oral vitamin supplements are especially useful for people who otherwise cannot or will not consume food that is a good vitamin source, such as meat, milk, or other dairy products. For example, a vegetarian who will not consume meat may be encouraged to consume oral supplements of vitamin B_{12}.

Treatment of genetic diseases that impair the absorption or utilization of specific vitamins may require megadoses of the vitamin throughout one's lifetime. Megadose means a level of about 10–1,000 times greater than the recommended daily allowance (RDA). Pernicious anemia, homocystinuria, and biotinidase deficiency are three examples of genetic diseases that are treated with megadoses of vitamins.

Preparation

The diagnosis of a vitamin deficiency usually involves a blood test. An overnight fast usually is recommended as preparation prior to withdrawal of the blood test so that vitamin-fortified foods do not affect the test results.

Aftercare

Response to vitamin treatment can be monitored by chemical tests, by an examination of red blood cells or white blood cells, or by physiological tests, depending on the exact vitamin deficiency.

Risks

Few risks are associated with supervised vitamin treatment. Risks depend on the vitamin and the reason why it was prescribed. Ask a physician or pharmacist about how and when to take vitamin supplements, particularly those that have not been prescribed by a physician. There are health risks associated with

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taking megadoses of some vitamins, including folic acid (a B vitamin), vitamin A, and vitamin D.

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American Dietetic Association, 120 S. Riverside Plaza, Suite 2000, Chicago, IL, 60606-6995, (312) 899-0040, (800) 877-1600, http://www.eatright.org/.

Dietitians of Canada, 480 University Ave., Suite 604, Toronto, Ontario, M5G 1V2, Canada (416) 596-0857, centralinfo@ dietitians.ca, http://www.dietitians.ca.

National Institutes of Health, office of Dietary Supplements, 6100 Executive Blvd., Room 3B01, MSC 7517, Bethesda, MD, 20892-7517, (301) 435-2920, (301) 480-1845, ods@nih.gov, http://ods.od.nih.gov.

Tom Brody, PhD
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Vitiligo

Definition

Vitiligo is a condition in which a loss of cells that give color to the skin (melanocytes) results in smooth, white patches in the midst of normally pigmented skin.

Description

Vitiligo is a common, often inherited disorder characterized by areas of well-defined, milky white skin. People with vitiligo may have eye abnormalities and also have a higher incidence of thyroid disease, **diabetes mellitus**, and **pernicious anemia**. Vitiligo affects about 1-2% of the world's population. It is more easily observed in sun-exposed areas of the body and in darker skin types, but it affects any area of the body and all races. Vitiligo seems to affect men and women equally, although women more frequently seek treatment for the disorder.

Vitiligo may appear as one or two well-defined white patches or it may appear over large portions of the body. Typical sites for generalized vitiligo are areas surrounding body openings, bony areas, fingers, and toes. It can begin at any age but about 50% of the time it starts before the age of 20.

Causes and symptoms

Vitiligo is a disorder with complex causes. People with vitiligo seem to inherit a genetic predisposition for the disorder, and the appearance of disorder can be brought on by a variety of precipitating causes. Many people report that their vitiligo first appeared

Loss of pigmentation is one characteristic of vitiligo, as seen on this woman's hand. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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KEY TERMS

Autoimmune disease—A condition in which something triggers the immune system to react against and attack the body's own tissues.

Autologous transplantation—A procedure wherein the person donates blood or tissue to themselves.

Iris—The colored part of the eye.

Pernicious anemia—A disease in which red blood cells are abnormally formed due to the body's inability to absorb vitamin B_{12}.

Retina—The innermost layer of the eye, it contains the rods and cones, specialized light-sensitive cells.

following a traumatic or stressful event, such as an accident, job loss, **death** of a family member, severe **sunburn**, or serious illness. There are at least three theories about the underlying mechanism of vitiligo. One theory says nerve endings in the skin release a chemical that is toxic to the melanocytes. A second theory states that the melanocytes simply self-destruct. The third explanation is that vitiligo is a type of autoimmune disease in which the immune system targets the body's own cells and tissues.

The primary symptom of vitiligo is the loss of skin color. Hair growing from the affected skin areas also lacks color. In addition, people with vitiligo may have pigment abnormalities of the retina or iris of the eyes. A minority of patients also may have inflammation of the retina or iris, but vision is not usually impaired.

Diagnosis

The diagnosis of vitiligo is usually made by observation. Progressive, white areas found at typical sites point to a diagnosis of vitiligo. If the diagnosis is not certain, the doctor will test for other conditions which can mimic vitiligo, such as chemical leukoderma or **systemic lupus erythematosus**. If the tests rule out other conditions, vitiligo is confirmed.

Treatment

Vitiligo cannot be cured, but it can be managed. Cosmetics can be used to improve the appearance of the white areas not covered by clothing. **Sunscreens** prevent burning of the affected areas and prevent the normal skin around the patches from becoming darker. Skin creams and oral medications are available for severe cases, but they have side effects that may make them undesirable. Autologous transplantation of skin is an option for those who are severely affected. Bleaching or depigmentation of the normal skin is another option.

In addition to treating the skin, attention should be paid to the psychological well-being of the individual. Extreme cases of vitiligo can be unattractive and may affect a person's outlook and social interactions.

Prognosis

The condition is usually gradually progressive. Sometimes the patches grow rapidly over a short period, and then the condition remains stable for many years.

Prevention

No measures are currently known to prevent vitiligo.

ORGANIZATIONS

National Vitiligo Foundation, P.O. Box 23226, Cincinnati, OH, 45223, (513) 541-3903, info@nvfi.org, http://www.nvfi.org.

Vitiligo Support International, P.O. Box 4008, Valley Village, CA, 91617-0008, (818) 752-9002, http://www.vitiligosupport.org.

Dorothy Elinor Stonely

Vitrectomy

Definition

Vitrectomy is the surgical removal of the vitreous (transparent gel that fills the eye from the iris to the retina).

Purpose

The bulk of the contents of the eyeball is a clear jelly-like substance that is susceptible to several afflictions that impair vision by damaging its transparency.

- Infections
- Injuries

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KEY TERMS

Computed tomography (CT scan)—Computerized method of creating images of internal organs using x rays.

Diabetic retinopathy—Disease that damages the blood vessels in the back of the eye caused by diabetes mellitus.

Endophthalmitis—Inflammation of the eyeball.

Iatrogenic—Inadvertently caused by medical treatment.

Magnetic resonance imaging (MRI)—Computerized method of creating images of internal organs using magnetic fields.

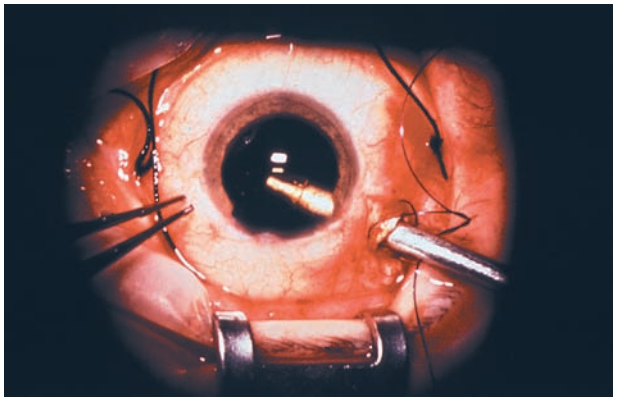
Saline—A salt solution equivalent to that in the body—0.9% salt in water.

- Bleeding, particularly from diabetic retinopathy
- Blood vessels growing into the vitreous, again due to diabetes

The retina is the light-sensitive membrane that receives images and transmits them to the brain. It covers the inside of the back of the eye. On occasion the retina will fall into the vitreous, a condition called **retinal detachment**. This may be due to disease in the vitreous that pulls the retina inward, small tears in the retina that allow liquid to seep behind it and push it forward, or injury to the eye that simply breaks the retina loose. It may be necessary to remove the vitreous in order to replace the retina and restore vision.

Description

Using instruments suited for microscopic surgery, the ophthalmologist (eye surgeon) penetrates the eyeball, aspirates the vitreous, and replaces it with saline. The saline replaces the vitreous at a constant pressure in order to keep the eye from collapsing. Once the saline is in place, both eyes are patched. The procedure takes two to three hours to complete.



Vitrectomy is a surgical procedure in which the vitreous, the transparent gel that fills the eye from the iris to the retina, is removed. During this procedure, the surgeon penetrates the eyeball with a tiny instrument (shown above), which liquefies the vitreous and suctions it out of the eye. *(Photo Researchers, Inc.)*

Preparation

Because this is a major operation on the eye, the surgeon will perform a very extensive evaluation of both eyes. After looking inside with a variety of lenses, a CT, MRI, or ultrasound study may be needed. Immediately prior to the vitrectomy, the pupils will be dilated.

Aftercare

Eye drops and **antibiotics** are administered, and eye rest is advised until healing is completed.

Risks

Risks associated with vitrectomy are retinal detachment, bleeding, iatrogenic (medically caused) **cataracts**, and endophthalmitis (inflammation of the eyeball).

Normal results

Vision is restored to useful levels in two-thirds of patients.

Resources

BOOKS

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J. Ricker Polsdorfer, MD

Vivax malaria *see* **Malaria**

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Vocal cord nodules and polyps

Definition

Vocal cord nodules and polyps are noncancerous growths on the vocal cords that affect the voice.

Description

The vocal cords, located in the voice box in the middle of the neck, are two tough, fibrous bands that vibrate to produce sound. They are covered with a layer of tissue that is similar to skin. With use, this layer thickens. With heavy use, the thickening may localize, producing a nodule. Unlike skin, heavy usage over a short time may also produce polyps. A polyp is a soft, smooth lump containing mostly blood and blood vessels. A nodule is similar to a polyp, but tends to be firmer.

Causes and symptoms

Chronic infections caused by **allergies** and inhalation of irritants, such as cigarette smoke, may produce these lesions, but extensive use of the voice is the most common cause of vocal nodules and polyps. Nodules and polyps are more common in male children, female adolescents, and female adults. This may be due in part to the faster speed at which the cords vibrate to produce higher-pitched voices.

Voice alterations are most apparent in singers, who may notice the higher registers are the first to change. Hoarseness causes others to seek medical attention.

Diagnosis

The head and neck surgeon (otorhinolaryngologist) must see the vocal cords to diagnose these lesions. It is also important to confirm that there are not other problems instead of or in addition to these benign lumps. Other causes of hoarseness include throat cancers, **vocal cord paralysis**, and simple **laryngitis**. The cords can usually be seen using a mirror placed at the back of the tongue. More elaborate scopes, including a videostroboscope, allow better views while the cords are producing sounds.

A biopsy of a nodule or polyp will ensure they are not cancerous.

Treatment

Nodules usually only require voice therapy; less than 5% of nodules require surgery. Small polyps can be treated with voice therapy, but typically they are surgically removed.

KEY TERMS

Laryngitis—Inflammation of the larynx (voice box).

Lesion—A wound or injury.

Otorhinolaryngologist—A physician specializing in ear, nose, and throat diseases. Also known as otolaryngologist.

Prognosis

Continued overuse of the voice will cause these lesions to regrow.

Prevention

Careful use of the voice will prevent most vocal cord nodules and polyps. Avoiding inhaled irritants may also prevent nodules and polyps from forming.

Resources

BOOKS

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Vocal cord paralysis

Definition

Vocal cord **paralysis** is the inability to move the vocal cords and the resulting loss of vocal cord function.

Description

The vocal cords are a pair of tough, fibrous bands that lie across the air column in the middle of the voice box. They assist three functions: breathing, swallowing, and speaking. When vocal cords vibrate, they produce sound, allowing us to speak. Vocal cords temporarily stop breathing to aid coughing and for expelling **foreign objects**. During swallowing, the vocal cords shut the airway so that food is not inhaled. When vocal cords are paralyzed, all three functions are affected.

The relaxed position of the vocal cords is halfway open. There is one set of muscles that closes them all the way and one set that opens them. Each set of muscles is controlled by a different nerve. Each nerve comes from a different direction—one from above and

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KEY TERMS

Computed tomography (CT scan)—Computerized use of x rays to create images of internal organs.

Laryngoscope—A diagnostic instrument that is used to examine the interior of the larynx.

Magnetic resonance imaging (MRI)—Computerized use of magnetic fields and radio-frequency signals to create images of internal organs.

Recurrent laryngeal nerve—One of two offshoots of the vagus nerve that connect to the larynx. It is located below the larynx.

Stridor—A raspy sound that occurs during respiration when the airways are blocked.

Tracheostomy—Surgical opening in the neck to the trachea to aid respiration.

Voice box—The larynx.

one from below (the recurrent laryngeal nerve). Vocal cords can either be partially paralyzed on one side or completely paralyzed on both sides.

Causes and symptoms

Vocal cord paralysis can result from injury, tumors, or surgery in the neck and upper chest. Brain tumors and **stroke** can also affect the nerves. Infectious diseases that damage nerves—like **whooping cough**, **tetanus** and polio—can also cause vocal cord paralysis. Vocal cord paralysis can also appear as a congenital defect. If congenital, the most frequent cause is a brain defect, which can often be effectively treated.

The most dangerous form of vocal cord paralysis is one that affects the opening function, controlled by the recurrent laryngeal nerve. If both vocal cords are paralyzed, breathing stops or becomes very labored. Fortunately, injury during trauma or surgery often involves only one side, but the congenital causes can damage both sides.

Vocal cord paralysis produces several symptoms.

- The voice is always affected; at best it is breathy and weak. At worst, it is not there at all. In infants, the cry can be weak. Older children will suppress laughing and coughing because it is hard to do.
- Swallowing may be hindered so that food ends up in the airway, causing violent coughing and often leading to pneumonia.
- Breathing is obstructed on aspiration, producing a condition known as stridor. Closing the airway while breathing in produces creaking noises in the throat and changes the shape of the chest. The breast bone is drawn inward, much more visibly in the flexible chest of a small child.

Diagnosis

The voice box must be observed during breathing to characterize the problem. A viewing instrument called a laryngoscope, either flexible or rigid, is passed through the nose or throat until the cords becomes visible. The motion of each cord can then be seen, and other problems in the area identified.

X rays, CT, or MRI scans of the skull may be done if a brain disorder is suspected.

Treatment

An adequate airway is immediately necessary, usually secured with an endotracheal tube in the windpipe. If a cure cannot be achieved, a permanent breathing hole (tracheostomy) is cut in the neck. Brain problems that are relieved within 24 hours usually allow the cords to regain their function. Care must be taken to assure that swallowing takes place normally.

Alternative treatment

Vocal cord paralysis can be addressed with constitutional homeopathy. This will work with the whole person, not just the symptoms, to help bring about healing. Botanical medicine and deep tissue massage to the area can also bring some resolution, although it may not be long term.

Resources

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J. Ricker Polsdorfer, MD

Vocal cord polyps *see* **Vocal cord nodules and polyps**

Voiding cystourethrography *see* **Retrograde urethrography**

Volvulus *see* **Intestinal obstructions**

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Vomiting

Definition

Vomiting is the forceful emptying or throwing up of a large portion of the stomach contents through the mouth. It can include the complete inability to hold fluids or food in the stomach. Vomiting is often accompanied or preceded by abdominal discomfort and **nausea**. **Nausea and vomiting** are also called emesis.

Demographics

Vomiting is very common, especially in the early years of life. Contagious rotaviruses are one of the most common causes of vomiting in infants and young children. Fortunately, rotavirus infection has become less prevalent in the United States since the introduction of a vaccine.

Although vomiting can stem from a variety of causes at any stage of life, **cyclic vomiting syndrome** (CVS) most often affects children. As many as one in 50 children may experience CVS, which most often begins between the ages of three and seven years. It was once thought to primarily affect girls, but CVS is now believed to be equally common in boys.

Description

Vomiting is a reflex reaction in which the abdominal muscles and diaphragm vigorously contract while the stomach is relaxed. The vomiting center in the brain triggers this reaction when it is stimulated by factors such as:

- nerve signals from the stomach and intestine that indicate irritation or swelling of the gastrointestinal tract
- chemicals in the blood, including various drugs
- psychological stimuli, such as particular sights or smells
- signals from the middle ear, as with motion sickness

Spitting up by infants, especially during the first year of life, is not considered vomiting. Spitting up is the occasional movement of small amounts of breast milk or formula from the stomach, through the esophagus, and out of the mouth, often accompanied by a burp.

Risk factors

Various medical conditions can cause vomiting. Most vomiting in children is not due to any particular risk factors. Children with CVS often have a family history of migraine and may themselves develop migraine headaches as they get older.

Causes and symptoms

Vomiting in children after the first few months of life is most often caused by **gastroenteritis** or **gastritis**. This is usually a viral infection of the gastrointestinal tract, often caused by a rotavirus. It also can be caused by **noroviruses**, enteroviruses, or adenoviruses, or bacteria or parasites. Sometimes called stomach flu, gastroenteritis usually starts with vomiting, followed by **diarrhea** within 12–24 hours. Other symptoms may include nausea, **fever**, and abdominal **pain**. Gastroenteritis is usually contagious.

Other causes of vomiting include:

- infections other than gastroenteritis, including infections of the respiratory system, urinary tract, middle ear (otitis), or membranes surrounding the brain and spinal cord (meningitis)
- a problem with infant formula
- foods that are hard to digest, such as excess sugar
- food poisoning from bacteria in undercooked meat or fish or from improperly refrigerated foods, such as *Staphylococcus* toxin in egg salad or *Bacillus cereus* toxin in rice dishes
- motion sickness
- migraine headaches
- medications, including cancer chemotherapy
- morning sickness during pregnancy

There are several serious causes of vomiting in infants:

- Pyloric stenosis is a thickening of the muscle at the end of the stomach that prevents food from entering the intestines. It causes persistent forceful vomiting of large amounts of fluid or formula within about 15–30 minutes after feeding. It is most common in infants between the ages of two weeks and four months.
- Spitting up that gradually increases during the first few weeks to months of life may indicate gastroesophageal reflux disease (GERD). GERD occurs when the muscles at the lower end of the esophagus are overly relaxed, enabling the stomach contents to back up.
- Intussusception is an intestinal obstruction in which a portion of the bowel slides into an adjacent portion. It is most common between 5 and 10 months of age and is indicated by vomiting all liquids, red-colored diarrhea, and uncontrollable crying while pulling the knees to the chest.

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KEY TERMS

Appendicitis—Inflammation of the appendix—a narrow blind tube in the lower right abdomen.

Cyclic vomiting syndrome (CVS)—Episodes of severe nausea, gagging, and vomiting in children that last for hours or a day or two, repeat at regular intervals, and have no known cause.

Dehydration—Abnormal depletion of bodily fluids.

Diarrhea—Abnormally frequent bowel movements with fluid stools.

Gastroenteritis—Also called gastritis or stomach flu; inflammation of the lining of the stomach and intestines.

Gastroesophageal reflux disease; GERD—Recurrent heartburn or acid indigestion caused by leakage of the stomach contents into the esophagus.

Motion sickness—Also called kinetosis; nausea and possibly vomiting induced by motion, such as travel by car, boat, or plane.

Nausea—Stomach distress characterized by a distaste for food and the urge to vomit.

Oral rehydration solution (ORS)—Oral electrolyte maintenance solution; a balanced salt solution, containing some sugar, that replaces fluid and salts lost through vomiting and diarrhea.

Rotavirus—Any virus of the genus *Rotavirus,* some of which cause gastroenteritis.

- Appendicitis may be suggested by vomiting that persists for more than 24 hours without diarrhea.

CVS is characterized by episodes of severe nausea, gagging, and vomiting that have no known cause and last for hours or one or two days. Vomiting may occur as often as 12 times in an hour. Episodes generally begin at about the same time of day—usually late at night or upon waking in the morning. Each episode has similar symptoms and intensity levels and lasts for about the same length of time. Episodes of CVS in children are often triggered by excitement or **stress**. Children have about 12 episodes per year.

At the start of an illness that causes vomiting, especially **food poisoning**, it is common for children to vomit everything in their stomachs for three or four hours, followed by mild or moderate vomiting. Excessive vomiting, especially in combination with diarrhea, can cause dehydration—the excessive loss of body fluids. Although **dehydration** can occur at any age, young children can become dehydrated very quickly. In general, a child's risk for dehydration is:

- mild, if vomiting one to three times per day
- moderate, if vomiting 4–10 times per day
- severe, if a baby vomits continuously for 6–12 hours or a child aged two or older for 12–24 hours, especially if vomiting is accompanied by watery stool

Signs and symptoms of dehydration include:

- thirst—indicated by infant crying, irritability, and eagerly drinking
- dry mouth
- infrequent urination—less than six wet diapers per day or eight hours or more without urinating
- dark urine
- irritability
- poor appetite
- weight loss
- lack of tears when crying
- sunken soft spots on top of the head in babies under 18 months of age
- loss of springiness or elasticity of the skin
- sleepiness
- inability to drink adequate fluid

Diagnosis

Examination

Medical consultation and a **physical examination** are required if a child is vomiting and:

- may have been poisoned
- cannot retain any clear liquids
- is less than six months old
- is older than six months and has a fever above 101.4°F (38.5°C)
- has been vomiting for more than eight hours or is vomiting with increasing force
- has blood in the stool
- has blood or bile (greenish liquid) in the vomit
- has a headache and stiff neck
- is lethargic, listless, or unusually sleepy
- has severe abdominal pain or abdominal pain for more than two hours
- is very irritable
- is having convulsions
- has signs or symptoms of dehydration

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Tests

Blood and/or urine tests may be performed. If a bacterial infection is suspected, a stool sample may be cultured to identify the bacteria and its susceptibility to **antibiotics**.

Procedures

If the physician suspects that the vomiting is a symptom of a serious problem in the gastrointestinal tract, x rays or other imaging procedures may be performed.

Treatment

Traditional

Vomiting is most often caused by a virus and resolves without treatment. Severe diarrhea may require the administration of intravenous (IV) fluids in a hospital. Serious underlying causes of vomiting, such as **pyloric stenosis** or **appendicitis**, may require surgery.

Drugs

Oral rehydration solution (ORS) may be required to replace fluids and nutrients lost through vomiting and diarrhea. ORS is safe for babies and older children and is readily available in grocery stores and pharmacies. It comes in various forms, including liquid, a powder to be mixed with water, and frozen popsicles. Brands include Pedialyte, Ricelyte, Rehydralyte, and the World Health Organization's Oral Rehydration Solution (WHO-ORS).

Over-the-counter and prescription remedies should not be used to treat vomiting unless specifically prescribed by a physician:

- Antiemetic drugs, such as bismuth subsalicylate (Kaopectate, Pepto-Bismol), can help relieve nausea and vomiting, but should not be given to children aged 12 or younger, or to children under 18 who may have the flu or chicken pox, because of the risk of Reye's syndrome.
- Antibiotics may be prescribed for a bacterial infection that is causing vomiting.
- Antihistamines can help prevent nausea and vomiting from motion sickness, especially if they are taken before the problem develops. They are believed to dampen the perception of motion by the middle ear and/or block nerve signals to the vomiting center in the brain. Motion sickness drugs include dimenhydrinate (Dramamine) and meclizine hydrochloride (Dramamine Less Drowsy).

Alternative

Ginger (*Zingiber officinale*) is used in Asian medicine to treat stomachaches, nausea, and diarrhea. Studies indicate that short-term use of ginger can safely treat nausea and vomiting from morning sickness and may possibly be effective for nausea from **motion sickness**, **chemotherapy**, or surgery. Ginger is available in various forms, including fresh or dried root, tablets, capsules, liquid extracts or tinctures, and teas. Ginger extract is included in many digestive, anti-nausea, cold, and flu supplements sold in the United States.

Home remedies

The correct balance of salts (electrolytes) is very important for infants. Breast milk contains the proper fluids and electrolytes. Infants who are exclusively breastfed and vomit their entire feeding more than once should be breastfed for a total of 5–10 minutes every two hours, returning to normal **breastfeeding** after vomiting has ceased for eight hours. Babies who are not exclusively breastfed should be treated with ORS—unflavored for infants under six months. Older babies can be given flavored ORS, or it can be flavored with 0.5 tsp (3 mL) of non-acidic juice. Frozen ORS pops also can be given to older babies. ORS can be made by mixing 8 tsp (48 mL) of sugar and 1 tsp (6 mL) of salt in a quart (4 cups, 0.9 L) of water. Adding a cup of orange juice to the mix or feeding the child a banana will supply needed potassium.

Vomiting infants and young children should be kept lying on their stomachs or sides as much as possible to reduce the risk of inhaling vomit into the upper airways or lungs.

Vomiting infants under one year:

- should not be given plain water unless the physician has specified an amount
- should be offered 2–3 tablespoons or up to 0.5 oz (15 mL) of ORS every 15–20 minutes with a spoon or oral syringe
- should be given an increasing amount of ORS once the solution is kept down for more than two hours, slowly increasing it over a day to the amount that is normally taken in one feeding, such as 4 oz (120 mL)
- should not be given more solution at one time than they would normally be fed, so as not to cause more vomiting
- should be reintroduced to formula slowly after at least eight hours without vomiting, beginning with frequent feedings of 0.5–1 oz (15–30 mL) for a young

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infant and 1–2 oz (30–60 mL) for an infant over six months
- can be slowly returned to their normal baby cereal or soft, bland foods such as bananas, crackers, or other mild baby food
- should be slowly returned to normal feedings after not vomiting for 24 hours

Vomiting children over one year of age should be given small amounts (2 teaspoons to 2 tablespoons, up to 1 oz or 30 mL) of clear fluids every 15 minutes. Appropriate fluids include ice chips, water, ORS, or frozen ORS pops. They should not be given milk or milk products. If the child vomits again, 2 tsp (5 mL) of fluid should be given. Small amounts every few minutes may stay down better than larger amounts. Children can also be given clear soups or sodas or juice mixed with water. They should not be given dark sodas, which are usually high in sugar and can irritate the stomach. After six to eight hours without vomiting, mild, bland foods can be slowly reintroduced. Appropriate foods include saltine crackers, bread, toast, broths, mild soups, mashed potatoes, or rice. The child should not be forced to eat. After 24 hours without vomiting, a normal diet can be gradually resumed. Milk products should not be given for two to three days.

GERD can usually be controlled by:
- not overfeeding
- feeding smaller amounts more frequently
- burping frequently
- thickening milk with small amounts of baby cereal, as directed by the pediatrician
- placing the infant in a safe, quiet, upright position for at least 30 minutes after feeding

Prognosis

Children usually recover from vomiting quickly without treatment. Most children with CVS outgrow it as teenagers, although they are at increased risk for migraines as adults.

Prevention

Measures to help prevent vomiting include:
- thorough, frequent hand washing, especially before cooking and eating, after handling raw meat, and after using the toilet, to help prevent infection and food poisoning
- a healthy diet
- avoiding close contact with someone with gastroenteritis
- vaccination against rotavirus

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ORGANIZATIONS

American Academy of Family Physicians, 11400 Tomahawk Creek Parkway, Leawood, KS, 66211-2680, (913) 906-6000, (800) 274-6000, (913) 906-6075, http://www.aafp.org.

American Academy of Pediatrics, 141 Northwest Point Blvd., Elk Grove Village, IL, 60007-1098, (874) 434-4000, (874) 434-8000, kidsdocs@aap.org, http://www.aap.org.

Margaret Alic, PhD

Von Gierke's disease *see* **Glycogen storage diseases**

Von Recklinghausen disease *see* **Neurofibromatosis**

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Von Willebrand disease

Definition

Von Willebrand disease is caused by a deficiency or an abnormality in a protein called von Willebrand factor and is characterized by prolonged bleeding.

Description

The Finnish physician Erik von Willebrand was the first to describe von Willebrand disease (VWD). In 1926 Dr. von Willebrand noticed that many male and female members of a large family from the Aland Islands had increased bruising (bleeding into the skin) and prolonged episodes of bleeding. The severity of the bleeding varied between family members, ranged from mild to severe, and typically involved the mouth, nose, genital and urinary tracts, and occasionally the intestinal tract. Excessive bleeding during the menstrual period (menorrhagia) was also experienced by some of the women in this family. What differentiated this bleeding disorder from classical **hemophilia** was that it appeared not to be associated with muscle and joint bleeding and affected people of either sex rather than just men. Dr. von Willebrand named this disorder *hereditary pseudohemophilia*.

Pseudohemophilia, or von Willebrand disease (VWD) as it is now called, occurs when the body does not produce enough of a protein called von Willebrand factor(vWF) or produces abnormal vWF. vWF is involved in the process of blood clotting (coagulation). Blood clotting is necessary to heal an injury to a blood vessel. When a blood vessel is injured, vWF enables blood cells called platelets to bind to the injured area and form a temporary plug to seal the hole and stop the bleeding. vWF is secreted by platelets and by the cells that line the inner wall of the blood vessels (endothelial cells). The platelets release other chemicals, called factors, in response to a blood vessel injury that are involved in forming a strong permanent clot. vWF binds to and stabilizes factor VIII, one of the factors involved in forming the permanent clot.

A deficiency or abnormality in vWF can interfere with the formation of the temporary platelet plug and also affect the normal survival of factor VIII, which can indirectly interfere with the production of the permanent clot. Individuals with VWD, therefore, have difficulty in forming **blood clots** and as a result they may bleed for longer periods of time. In most cases the bleeding is due to an obvious injury, although it can sometimes occur spontaneously.

VWD is classified into three basic types: type 1, type 2, and type 3. The definitions of each type are based on the amount and type of vWF that is produced. Type 1 is the most common and mildest form and results when the body produces slightly decreased amounts of typically normal vWF. Type 2 can be classified into four subtypes (IIA,IIB,IIM, and IIN) and results when the body produces an abnormal type of vWF. Type 3 is the rarest and most severe form and results when the body does not produce any detectable amount of vWF.

Approximately 1 out of 100 people are affected with VWD, making it the most common inherited bleeding disorder (hemophilia). VWD affects people of all ethnic backgrounds. Approximately 70–80% of people with VWD have type 1 and close to 20–30% have type 2. Type 3 is very rare and occurs in fewer than 1% of people with VWD.

Causes and symptoms

The genetics of VWD are complex and involve a gene that produces vWF and is found on the short arm of chromosome 12. Since humans inherit two of each type of chromosome, they inherit two vWF genes. There are different types of changes (mutations) in the vWF gene that can affect the production of vWF. Some types of changes can cause the vWF gene to produce decreased amounts of normal vWF, while other changes can cause the gene to produce abnormal vWF. Most of the gene changes are significant enough that a change in only one vWF gene is sufficient to cause VWD. Some gene mutations cause VWD only if both genes are changed, which often leads to more severe symptoms.

Type 1 VWD is called an autosomal dominant condition since it is caused by a change in only one vWF gene. Since type 1 VWD results in only a slight decrease in the amount of vWF produced, the symptoms are often mild and even non-existent in some patients. Most cases of Type 2 VWD are autosomal dominant since they are caused by a change in only one vWF gene that results in the production of an abnormal protein. An autosomal dominant form of VWD can be inherited from either parent or can occur spontaneously in the embryo that is formed when the egg and sperm cells come together during fertilization.

Some cases of type 2 VWD and all cases of type 3 VWD are autosomal recessive since they are caused by

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changes in both vWF genes. A person with an autosomal recessive form of VWD has inherited a changed gene from his or her mother and a changed gene from his or her father. Parents who have a child with an autosomal recessive form of VWD are called carriers, since they each possess one changed vWF gene and one unchanged vWF gene. Many carriers for the autosomal recessive forms of type 2 VWD and type 3 VWD do not have any symptoms, although some people with type 3 VWD are born to parents who have type 1 VWD and may have symptoms. Each child born to parents who are both carriers for VWD has a 25% chance of having VWD, a 50% chance of being a carrier, and a 25% chance of being neither a carrier nor affected with VWD disease. A person with an autosomal dominant form of VWD has a 50% chance of passing the changed gene on to his or her children who may or may not have symptoms.

VWD is usually a relatively mild disorder characterized by easy bruising, recurrent nosebleeds, heavy menstrual periods, and extended bleeding after surgeries and invasive dental work. There is a great deal of variability in the severity of symptoms, which can range from clinically insignificant to life-threatening. Even people within the same family who are affected with the same type of VWD may exhibit different symptoms. An individual with VWD may exhibit a range of symptoms over the course of his or her lifetime and may experience an improvement in symptoms with age. The severity of the disease is partially related to the amount and type of vWF that the body produces, but is also influenced by other genetic and non-genetic factors.

Type 1

Type 1, the mildest form of VWD, is usually associated with easy bruising, recurrent nosebleeds, heavy menstrual periods, and prolonged bleeding after surgeries and invasive work. Many people with type 1 VWD do not have any noticeable symptoms or only have prolonged bleeding after surgery or significant trauma. The amount of vWF produced by the body increases during **pregnancy**, so prolonged bleeding during delivery is uncommon in people with type 1 VWD.

Type 2

People with type 2 VWD usually have symptoms from early childhood and symptoms may even be present at birth. They usually experience prolonged bleeding from cuts, easy bruising, nose bleeds, skin hematomas, and prolonged bleeding from the gums following teeth extraction and minor trauma. More than 50% of women with type 2 VWD experience heavy periods that may require a blood **transfusion**. Gastrointestinal bleeding is rare but can be life-threatening. Some women with type 2 VWD exhibit prolonged bleeding during delivery.

Type 3

Type 3 VWD can be quite severe and is associated with bruising and bleeding from the mouth and nose, as well as intestinal, genital, and urinary tracts. Type 3 is also associated with spontaneous bleeding into the muscles and joints, which can result in joint deformities. Some women with type 3 VWD experience prolonged bleeding during delivery.

Diagnosis

Diagnostic testing

Many people with VWD have mild symptoms or symptoms that can be confused with other bleeding disorders, making it difficult to diagnose VWD on the basis of clinical symptoms. VWD should be suspected in any person with a normal number of platelets in their blood and bleeding from such mucous membranes as the nose, gums, and gastrointestinal tract. Testing for an individual with suspected VWD often includes the measurement of:

- how long it takes for the bleeding to stop after a tiny cut is made in the skin (the bleeding time)
- the amount of vWF (vWF antigen measurement)
- the activity of vWF (ristocetin co-factor activity)
- the amount of factor VIII (factor VIII antigen measurement)
- activity of factor VIII

Many doctors routinely screen women with menorrhagia for VWD, as heavy menstrual bleeding is the most common symptom of the disorder in females.

People with type 1 VWD usually have an increased **bleeding time** but they may have an intermittently normal bleeding time. They also have a decreased amount of vWF, and decreased vWF activity and usually have slightly decreased factor VIII levels and activity. People with type 2 VWD have a prolonged bleeding time, decreased activity of vWF and may have decreased amounts of vWF and factor VIII, and may have decreased factor VIII activity. Type 3 individuals have undetectable amounts of vWF, negligible vWF activity, factor VIII levels of less than 5–10%, and significantly reduced factor VIII activity. The activity of vWF is reduced for all types of VWD, making it the

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most sensitive means of identifying all three types of VWD. Patients with borderline results should be tested two to three times over a three month period.

Once a patient is diagnosed with VWD, further testing such as vWF multimer analysis and ristocetin-induced platelet aggregation (RIPA) may need to be performed to determine the subtype. Multimer analysis evaluates the structure of the vWF, and RIPA measures how much ristocetin is required to cause the clumping of platelets in a blood sample. The vWF multimer analysis is able to differentiate people with a structurally normal vWF (type 1) from people with a structurally abnormal vWF (type 2) and is often able to identify the subtype of patients with type 2 VWD. People with type 1 VWD usually have normal to decreased RIPA concentrations. Depending on the subtype, patients with type 2 VWD either have increased or decreased RIPA. RIPA is usually absent and the multimer analysis shows undetectable vWF in people with type 3 VWD.

In some cases DNA testing can be a valuable adjunct to biochemical testing. The detection of gene alteration(s) can confirm a diagnosis and can determine the type and subtype of VWD. It can also help to facilitate prenatal testing and testing of other family members. Unfortunately, many people with VWD possess DNA changes that are not detectable through DNA testing. A person who has a mother, father, or sibling diagnosed with VWD should undergo biochemical testing for VWD. If the relative with VWD possesses a detectable gene change, then DNA testing should also be considered.

Prenatal testing

If one parent has been diagnosed with an autosomal dominant form of VWD or both parents are carriers for an autosomal recessive form of VWD, then prenatal testing can be considered. If the parent with an autosomal dominant form of VWD possesses a detectable gene change or both parents who are carriers for an autosomal recessive form of VWD possess detectable mutations, then DNA testing of their fetus would be available. DNA testing can be performed through **amniocentesis** or **chorionic villus sampling**. If the DNA change in the parent(s) is unknown then prenatal testing can sometimes be performed through biochemical testing of blood obtained from the fetal umbilical cord, which is less accurate and is associated with a higher risk of pregnancy loss.

Treatment

VWD is most commonly treated by replacement of vWF through the administration of blood products that contain vWF or through treatment with desmopressin (DDAVP, 1-deamino-8-D-arginine vasopressin). DDAVP functions by increasing the amount of factor VIII and vWF in the bloodstream. Treatment with blood products or DDAVP may be started in response to uncontrollable bleeding or may be administered prior to procedures such as surgeries or dental work. The type of treatment chosen depends on the type of VWD and a patient's response to a preliminary treatment trial.

Treatment with desmopressin

DDAVP is the most common treatment for people with type 1 VWD. About 80% of people with type 1 VWD respond to DDAVP therapy. Treatment with DDAVP can also be used to treat some people with type 2 VWD. Patients with Type 2B VWD should not be treated with this medication since DDAVP can induce dangerous platelet clumping. Type 3 VWD should not be treated with DDAVP since this medication does not increase the level of vWF in type 3 patients. DDAVP should only be used in people who have been shown to be responsive through a pre-treatment trial transfusion with this medication.

DDAVP can be administered intravenously or through a nasal inhaler. DDAVP has relatively few side effects although some people may experience facial flushing, **tingling** sensations, and headaches after treatment with this medication. Often treatment with this medication is only required prior to invasive surgeries or dental procedures.

Treatment with blood products

Patients who are unable to tolerate or are unresponsive to drug-based treatments are treated with concentrated factor VIII obtained from blood products. Not all factor VIII concentrates can be used since some do not contain enough vWF. The concentrate is treated to kill most viruses, although caution should be used since not all types of viruses are destroyed. If the factor VIII concentrates are unable to manage a severe bleeding episode, then blood products called cryoprecipitates, which contain concentrated amounts of vWF, or platelet concentrates should be considered. Caution should be used when treating with these blood products since they are not treated to kill viruses.

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KEY TERMS

Amniocentesis—A procedure performed at 16-18 weeks of pregnancy in which a needle is inserted through a woman's abdomen into her uterus to draw out a small sample of the amniotic fluid from around the baby. Either the fluid itself or cells from the fluid can be used for a variety of tests to obtain information about genetic disorders and other medical conditions in the fetus.

Autosomal dominant—A pattern of genetic inheritance where only one abnormal gene is needed to display the trait or disease.

Autosomal recessive—A pattern of genetic inheritance where two abnormal genes are needed to display the trait or disease.

Biochemical testing—Measuring the amount or activity of a particular enzyme or protein in a sample of blood or urine or other tissue from the body.

Carrier—A person who possesses a gene for an abnormal trait without showing signs of the disorder. The person may pass the abnormal gene on to offspring.

Chorionic villus sampling (CVS)—A procedure used for prenatal diagnosis at 10–12 weeks gestation. Under ultrasound guidance a needle is inserted either through the mother's vagina or abdominal wall and a sample of cells is collected from around the early embryo. These cells are then tested for chromosome abnormalities or other genetic diseases.

Chromosome—A microscopic thread-like structure found within each cell of the body and consists of a complex of proteins and DNA. Humans have 46 chromosomes arranged into 23 pairs. Changes in either the total number of chromosomes or their shape and size (structure) may lead to physical or mental abnormalities.

Deoxyribonucleic acid (DNA)—The genetic material in cells that holds the inherited instructions for growth, development, and cellular functioning.

Desmopressin (DDAVP)—A drug used in the treatment of von Willebrand's disease.

Diagnostic testing—Testing performed to determine if someone is affected with a particular disease.

DNA testing—Analysis of DNA (the genetic component of cells) in order to determine changes in genes that may indicate a specific disorder.

Endothelial cells—The cells lining the inner walls of the blood vessels.

Factor VIII—A protein involved in blood clotting that requires vWF for stability and long-term survival in the bloodstream.

Gene—A building block of inheritance, which contains the instructions for the production of a particular protein, and is made up of a molecular sequence found on a section of DNA. Each gene is found on a precise location on a chromosome.

Menorrhagia—Excessively heavy menstrual flow with cycles of normal length. It is also called hypermenorrhea.

Mutation—A permanent change in the genetic material that may alter a trait or characteristic of an individual, or manifest as disease, and can be transmitted to offspring.

Platelets—Small disc-shaped structures that circulate in the blood stream and participate in blood clotting.

Prenatal testing—Testing for a disease, such as a genetic condition, in an unborn baby.

Protein—Important building blocks of the body, composed of amino acids, involved in the formation of body structures and controlling the basic functions of the human body.

Skin hematoma—Blood from a broken blood vessel that has accumulated under the skin.

von Willebrand factor (vWF)—A protein found in the blood that is involved in the process of blood clotting.

Other treatments and precautions

Medications called fibrinolytic inhibitors can be helpful in the control of intestinal, mouth, and nose bleeding. Estrogens such as those found in **oral contraceptives** increase the synthesis of vWF and can sometimes be used in the long-term treatment of women with mild to moderate VWD. Estrogens are also sometimes used prior to surgery in women with type 1 VWD. Some topical agents are available to treat nose and mouth bleeds.

Endometrial ablation, or the removal of the lining of the uterus by means of electrocautery or other thermal methods, is sometimes recommended as a treatment for menorrhagia associated with VWD.

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This procedure appears to be successful in lowering the amount of bleeding that these women experience during their menstrual periods.

Patients with VWD should avoid taking **aspirin**, ibuprofen, or other NSAIDs, which can increase their susceptibility to bleeding. They should also inform their dentist of their diagnosis, as many routine dental procedures can cause bleeding from the gums. People with severe forms of VWD should avoid activities that increase their risk of injury such as contact sports.

Patients with type 3 VWD living in the United States may wish to contact one of the 146 federally funded Hemophilia Treatment Centers (HTCs) for advice about prophylactic treatment and general follow-up.

Prognosis

The prognosis for VWD disease is generally fairly good and most individuals have a normal lifespan. The prognosis can depend, however, on accurate diagnosis and appropriate medical treatment.

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ORGANIZATIONS

American Society of Hematology, 2021 L St. NW, Suite 900, Washington, DC, 20036, (202) 776-0544, (202) 776-0545, http://www.hematology.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

National Hemophilia Foundation, 116 West 32nd St., 11th Floor, New York, NY, 10001, (212) 328-3700, (212) 328-3777, http://www.hemophilia.org.

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VSD *see* **Ventricular septal defect**

Vulvar cancer

Definition

Vulvar **cancer** refers to an abnormal, cancerous growth in the external female genitalia.

Description

Vulvar cancer is a rare disease that occurs mainly in elderly women. The vulva refers to the external female genitalia, which includes the labia, the opening of the vagina, the clitoris, and the space between the vagina and anus (perineum). There are two pairs of labia (a Latin term meaning lips). The labia meet to protect the openings of the vagina and the tube that connects to the bladder (urethra). The outer, most prominent folds of skin are called labia majora, and the smaller, inner skin folds are called labia minora. Vulvar cancer can affect any part of the female genitalia, but usually affects the labia.

Approximately 70% of vulvar cancers involve the labia (usually the labia majora), 15–20% involve the clitoris, and 15–20% involve the perineum. For approximately 5% of the cases, the cancer is present at more than one location. For approximately 10% of the cases, so much of the vulva is affected by cancer that the original location cannot be determined. Vulvar cancer can spread to nearby structures including the anus, vagina, and urethra.

Most vulvar cancers are squamous cell carcinomas. Squamous cells are the main cell type of the skin. Squamous cell carcinoma often begins at the edges of the labia majora or labia minora or the area around the vagina. This type of cancer is usually slow-growing

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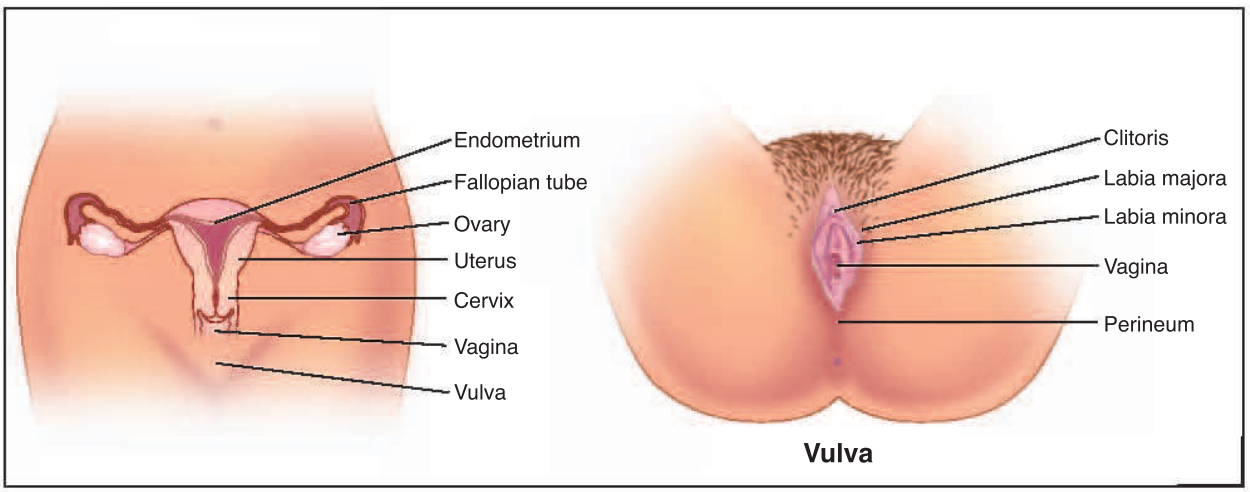

Illustration showing the female reproductive anatomy (left) and the anatomy of the vulva (right). *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

and may begin with a precancerous condition referred to as vulvar intraepithelial neoplasia (VIN), or dysplasia. This means that precancerous cells are present in the surface layer of skin.

Other, less common types of vulvar cancer are melanoma, **basal cell carcinoma**, adenocarcinomas, Paget's disease of the vulva, and tumors of the connective tissue under the skin. Melanoma, a cancer that develops from the cells that produce the pigment that determines the skin's color, can occur anywhere on the skin, including the vulva. Melanoma is the second most common type of vulvar cancer, and accounts for 5–10% of the cases. Half of all vulvar melanomas involve the labia majora. Basal cell carcinoma, which is the most common type of cancer that occurs on parts of the skin exposed to the sun, very rarely occurs on the vulva. Adenocarcinomas develop from glands, including the glands at the opening of the vagina (Bartholin's glands) that produce a mucus-like lubricating fluid.

Vulvar cancer is most common in women over 50 years of age. The median age at diagnosis is 65–70 years old. Additional risk factors for vulvar cancer include having multiple sexual partners, **cervical cancer**, and the presence of chronic vaginal and vulvar inflammations. This type of cancer is often associated with **sexually transmitted diseases**.

Vulvar cancer is most common in women who are between the ages of 65 and 75 years. In the United States there are approximately 3,000 new cases of vulvar cancer diagnosed each year. Vulvar cancer accounts for only 1% of all cancers in women. Approximately 5% of all gynecologic cancers occur on the vulva. For unknown reasons, the incidence of vulvar cancer seems to be rising.

Causes and symptoms

Cancer is caused when the normal mechanisms that control cell growth become disturbed, causing the cells to continually grow without stopping. This is usually the result of damage to the DNA in the cell. Although the cause of vulvar cancer is unknown, studies have identified several risk factors for vulvar cancer. These include:

- Vulvar intraepithelial neoplasia (VIN). This abnormal growth of the surface cells of the vulva can sometimes progress to cancer.
- Infection with human papillomavirus (HPV). This virus is sexually transmitted and can cause genital warts. Although HPV DNA can be detected in most cases of vulvar intraepithelial neoplasia, it is detected in fewer than half of all cases of vulvar cancer. Therefore, the link between HPV infection and vulvar cancer is unclear. It is theorized that two classes of vulvar cancer exist: one that is associated with HPV infection and one that is not.
- Herpes simplex virus 2 (HSV2). This sexually transmitted virus is also associated with increased risk for vulvar cancer.
- Cigarette smoking. Smoking in combination with infection by HPV or HSV2 was found to be a particularly strong risk factor for vulvar cancer.
- Infection with human immunodeficiency virus (HIV). This virus, which causes AIDS, decreases

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the body's immune ability, leaving it vulnerable to a variety of diseases, including vulvar cancer.

- Chronic vulvar inflammation. Long term irritation and inflammation of the vulva and vagina, which may be caused by poor hygiene, can increase the risk of vulvar cancer.
- Abnormal Pap smears. Women who have had abnormal Pap smears are at an increased risk of developing vulvar cancer.
- Chronic immunosuppression. Women who have had long-term suppression of their immune system caused by disease (such as certain cancers) or medication (such as those taken after organ transplantation) have an increased risk of developing vulvar cancer.

The hallmark symptom of vulvar cancer is **itching** (pruritus), which is experienced by 90% of the women afflicted by this cancer. The cancerous lesion is readily visible. Unfortunately, because of embarrassment or denial, it is not uncommon for women to delay medical assessment of vulvar abnormalities. Any abnormalities should be reported to a gynecologist.

If squamous cell vulvar cancer is present, it may appear as a raised red, pink, or white bump (nodule). It is often accompanied by **pain**, bleeding, vaginal discharge, and painful urination. **Malignant melanoma** of the vulva usually appears as a pigmented, ulcerated growth. Other types of vulvar cancer may appear as a distinct mass of tissue, sore and scaly areas, or cauliflower-like growths that look like **warts**.

Diagnosis

A gynecological examination will be used to observe the suspected area. During this examination, the physician may use a special magnifying instrument called a colposcope to view the area better. Additionally, the area may be treated with a dilute solution of acetic acid, which causes some abnormal areas to turn white, making them easier to see. During this examination, if any area is suspected of being abnormal, a tissue sample (biopsy) will be taken. The biopsy can be performed in the doctor's office with the use of local anesthetic. A wedge-shaped piece of tissue, which contains the suspect lesion with some surrounding normal skin and the underlying skin layers and connective tissue, will be removed. Small lesions will be removed in their entirety (excisional biopsy). The diagnosis of cancer depends on a microscopic analysis of this tissue by a pathologist.

The diagnosis for vulvar cancer will determine how advanced the cancer is and how much it has spread. This is determined by the size of the tumor and how deep it has invaded the surrounding tissue and organs, such as the lymph nodes. It will also be determined if the cancer has metastasized, or spread to other organs. Tests used to determine the extent of the cancer include x ray and computed tomography scan (CT scan). Endoscopic examination of the bladder (**cystoscopy**) and/or rectum (proctoscopy) may be performed if it is suspected that the cancer has spread to these organs.

Treatment

Clinical staging

The International Federation of Gynecology and Obstetrics (FIGO) has adopted a surgical staging system for vulvar cancer. The stage of cancer is determined after surgery. The previous clinical staging system for vulvar cancer is no longer used. Vulvar cancer is categorized into five stages (0, I, II, III, and IV) which may be further subdivided (A and B) based on the depth or spread of cancerous tissue. The FIGO stages for vulvar cancer are:

- Stage 0. Vulvar intraepithelial neoplasia.
- Stage I. Cancer is confined to the vulva and perineum. The lesion is less than 2 cm (about 0.8 in) in size.
- Stage II. Cancer is confined to the vulva and perineum. The lesion is larger than 2 cm (larger than 0.8 in) in size.
- Stage III. Cancer has spread to the vagina, urethra, anus, and/or the lymph nodes in the groin (inguinofemoral).
- Stage IV. Cancer has spread to the bladder, bowel, pelvic bone, pelvic lymph nodes, and/or other parts of the body.

Treatments

Treatment for vulvar cancer will depend on its stage and the patient's general state of health. Surgery is the mainstay of treatment for most cases of vulvar cancer.

SURGERY. The primary treatment for stage I and stage II vulvar cancer is surgery to remove the cancerous lesion and possibly the inguinofemoral lymph nodes. Removal of the lesion may be done by laser, to burn off a minimal amount of tissue, or by scalpel (local excision), to remove more of the tissue. The choice will depend on the severity of the cancer. If a large area of the vulva is removed, it is called a vulvectomy. Radical vulvectomy removes the entire vulva. A vulvectomy may require skin grafts from other areas of the body to cover the wound and make an artificial vulva. Because of the significant morbidity and the

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psychosexual consequences of radical vulvectomy, there is a trend toward minimizing the extent of cancer excision. The specific inguinofemoral lymph node that would receive lymph fluid from the cancerous lesion, known as the sentinel node, may be exposed for examination (lymph node dissection) or removed (lymphadenectomy), especially in cases in which the cancerous lesion has invaded to a depth of more than 1 mm. Surgery may also be followed by **chemotherapy** and/or **radiation therapy** to kill additional cancer cells.

Surgical treatment of stage III and stage IV vulvar cancer is much more complex. Extensive surgery would be necessary to completely remove the cancerous tissue. Surgery would involve excision of pelvic organs (pelvic exenteration), radical vulvectomy, and lymphadenectomy. Because this extensive surgery comes with a substantial risk of complications, it may be possible to treat advanced vulvar cancer with minimal surgery by using radiation therapy and/or chemotherapy as additional treatment (adjuvant therapy).

An intraoperative technique that is used to identify the sentinel node in **breast cancer** and melanoma is being applied to vulvar cancer. This technique, called lymphoscintigraphy, is performed during surgical treatment of vulvar cancer and allows the surgeon to immediately identify the sentinel node. A radioactive compound (technetium 99m sulfur colloid) is injected into the cancerous lesion approximately two hours prior to surgery. This injection causes little discomfort, so **local anesthesia** is not required. During surgery, a radioactivity detector is used to locate the sentinel node and any other nodes to which cancer has spread. Although in the experimental stage, vulvar lymphoscintigraphy shows promise in reducing morbidity and hospital length of stay.

The most common complication of vulvectomy is the development of a tumor-like collection of clear liquid (wound seroma). Other surgical complications include **urinary tract infection**, wound infection, temporary nerve injury, fluid accumulation (**edema**) in the legs, **urinary incontinence**, falling or sinking of the genitals (genital prolapse), and **blood clots** (thrombus).

RADIATION THERAPY. Radiation therapy uses high-energy radiation from x rays and gamma rays to kill the cancer cells. The skin in the treated area may become red and dry and may take as long as a year to return to normal. **Fatigue**, upset stomach, **diarrhea**, and **nausea** are also common complaints of women having radiation therapy. Radiation therapy in the pelvic area may cause the vagina to become narrow as scar tissue forms. This phenomenon, known as vaginal stenosis, makes intercourse painful.

CHEMOTHERAPY. Chemotherapy uses **anticancer drugs** to kill the cancer cells. The drugs are given by mouth (orally) or intravenously. They enter the bloodstream and can travel to all parts of the body to kill cancer cells. Generally, a combination of drugs is given because it is more effective than a single drug in treating cancer. The side effects of chemotherapy are significant and include stomach upset, **vomiting**, appetite loss, hair loss, mouth or vaginal sores, fatigue, menstrual cycle changes, and **premature menopause**. There is also an increased chance of infections.

Alternative treatment

Although alternative and complementary therapies are used by many cancer patients, very few controlled studies on the effectiveness of such therapies exist. Mind-body techniques such as prayer, **biofeedback**, visualization, **meditation**, and **yoga** have not shown any effect in reducing cancer but can reduce **stress** and lessen some of the side effects of cancer treatments. Clinical studies of hydrazine sulfate found that it had no effect on cancer and even worsened the health and well-being of the study subjects. One clinical study of the drug amygdalin (Laetrile) found that it had no effect on cancer. Laetrile can be toxic and has caused **death**. Shark cartilage, although highly touted as an effective cancer treatment, is an improbable therapy that has not been the subject of clinical study.

The American Cancer Society has found that the "metabolic diets" pose serious risk to the patient. The effectiveness of the macrobiotic, Gerson, and Kelley **diets** and the Manner metabolic therapy has not been scientifically proven. The FDA was unable to substantiate the anticancer claims made about the popular Cancell treatment.

There is no evidence for the effectiveness of most over-the-counter herbal cancer remedies. However, some herbals have shown an anticancer effect. As shown in clinical studies, Polysaccharide krestin, from the mushroom *Coriolus versicolor*, has significant effectiveness against cancer. In a small study, the green alga *Chlorella pyrenoidosa* has been shown to have anticancer activity. In a few small studies, evening primrose oil has shown some benefit in the treatment of cancer.

Prognosis

Factors that are correlated with disease outcome include the diameter and depth of the cancerous lesion, involvement of local lymph nodes, cell type, HPV status, and age of the patient. Vulvar cancers

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KEY TERMS

Adjuvant therapy—A treatment that is intended to aid primary treatment. Adjuvant treatments for vulvar cancer are radiation therapy and chemotherapy.

Biopsy—Removal of a small piece of tissue for microscopic examination. This is done under local anesthesia and removed by either using a scalpel or a punch, which removes a small cylindrical portion of tissue.

Colposcope—An instrument used for examination of the vagina and cervix. Part of the instrument includes a magnifying lens for better visualization.

Metastasis—The movement of cancer cells from one area of the body to another. This occurs through the blood vessels or the lymph vessels.

Pelvic exenteration—Surgical removal of the organs of the true pelvis which includes the uterus, vagina, and cervix.

Sentinel lymph node—The first lymph node to receive lymph fluid from a tumor. If the sentinel node is cancer-free, then it is likely that the cancerous cells have not metastasized.

that are HPV positive have a better prognosis than those that are HPV negative. The five-year survival rate is 98% for stage I vulvar cancer and 87% for stage II vulvar cancer. The survival rate drops steadily as the number of affected lymph nodes increases. The survival rate is 75% for patients with one or two, 36% for those with three or four, and 24% for those with five or six involved lymph nodes. The previous statistics were obtained from studies of patients who received surgical treatment only and cannot be used to determine survival rates when adjuvant therapy is employed.

Vulvar cancer can spread locally to encompass the anus, vagina, and urethra. Because of the anatomy of the vulva, it is not uncommon for the cancer to spread to the local lymph nodes. Advanced stages of vulvar cancer can affect the pelvic bone. The lungs are the most common site for vulvar cancer metastasis. Metastasis through the blood (hematogenous spread) is uncommon.

Prevention

The risk of vulvar cancer can be decreased by avoiding risk factors, most of which involve lifestyle choices. Specifically, to reduce the risk of vulvar cancer, women should not smoke and should refrain from engaging in unsafe sexual behavior. Good hygiene of the genital area to prevent infection and inflammation may also reduce the risk of vulvar cancer.

Because vulvar cancer is highly curable in its early stages, women should consult a physician as soon as a vulvar abnormality is detected. Regular gynecological examinations are necessary to detect precancerous conditions that can be treated before the cancer becomes invasive. Because some vulvar cancer is a type of skin cancer, the American Cancer Society also recommends self-examination of the vulva using a mirror. If **moles** are present in the genital area, women should employ the ABCD rule:

- Asymmetry. A cancerous mole may have two halves of unequal size.
- Border irregularity. A cancerous mole may have ragged or notched edges.
- Color. A cancerous mole may have variations in color.
- Diameter. A cancerous mole may have a diameter wider than 6 mm (1/4 in).

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Quackwatch. "Questionable Cancer Therapies." July 3, 2001. http://www.quackwatch.com.

ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (800) 227-2345, http://www.cancer.org.

Cancer Research Institute (National Headquarters), One Exchange Plaza, 55 Broadway, Suite 1802, New York, NY, (212) 688-7515, (212) 832-9376, (800) 992-2623, http://www.cancerresearch.org/.

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Gynecologic Cancer Foundation, 230 W. Monroe, Suite 2528, Chicago, IL, 60606, (312) 578-1439, (312) 578-9769, info@thegcf.org, http://www.wcn.org/.

National Institutes of Health & National Cancer Institute, 6116 Executive Boulevard Suite 300, Bethesda, MD, 20892-8322, (800) 422-6237, cancergovstaff@mail.nih.gov, http://www.cancer.gov.

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Vulvitis *see* **Vulvovaginitis**

Vulvodynia

Definition

Vulvodynia is chronic **pain** of the vulva—the external or visible portion of the female genitalia—in the absence of vulvar or vaginal infection or skin disease. Vulvodynia is not a well-defined condition and its cause is usually unknown.

Demographics

Vulvodynia can affect any female of any age, although the onset of symptoms appears to be highest among women aged 18–25 and lowest in women over age 35. It has been estimated that at least 18% of women suffer from vulvodynia at some point in their lives. Approximately one-half of these women seek treatment. It has been estimated that about 15% of women visiting private gynecologists and about 1% of those visiting genitourinary medical clinics suffer from localized vulvodynia. Generalized vulvodynia appears to be more common in postmenopausal women and in younger women who have had back injuries.

Description

In 2003 the International Society for the Study of Vulvovaginal Disease (ISSVD) adopted a new classification system for vulvodynia: generalized vulvodynia is pain that extends beyond the vulva to other parts of the genitalia and pelvis; localized vulvodynia is pain that is restricted to the vestibule of the vulva—the region immediately surrounding the opening of the vagina and urethra. Both types of vulvodynia are further classified as:

- provoked—sexual, nonsexual, or both—depending whether the pain occurs with sex and/or with other activities
- unprovoked—pain that is constant or occurs unpredictably and is not related to specific activities
- mixed—both provoked and unprovoked

Provoked vulvodynia is pain that occurs during or after pressure is applied to the vulva. Examples of activities or factors that can provoke vulvodynia include:

- touching the vestibule
- intercourse or other sexual activity
- tampon insertion
- a gynecological exam
- urination
- sitting for a long period
- bicycle or horseback riding
- jogging or other exercise
- tight-fitting underwear or pants

Older terms for vulvodynia continue to be used. Older terms for generalized vulvodynia include dysesthetic vulvodynia and generalized vulvar dysesthesia. Older terms for localized vulvodynia include vulvar or vulval vestibulitis syndrome (VVS) and provoked vestibulodynia. Another older classification system distinguishes between organic vulvodynia, in which a cause can be identified, and essential vulvodynia, in which a cause cannot be identified. A distinction may also be made between sexually provoked primary and secondary vulvodynia, depending on whether pain occurred with a woman's first vaginal penetration or developed after a period of pain-free vaginal penetration, respectively.

As with other types of chronic pain, vulvodynia can have a significant impact on the quality of life. It may interfere with daily activities including sitting, walking, physical **exercise**, and social interactions. Sexual intercourse may be painful or impossible. Vulvodynia can lead to exhaustion and depression. In extreme cases a woman may become bedridden.

Risk factors

One study indicated that women who experienced pain when first using a tampon were seven to eight times more likely to have vulvodynia at some point in their lives. Between 10% and 25% of women with interstitial cystitis—a bladder condition that causes frequent urination with burning—also have symptoms of vulvodynia. Other possible risk factors include:

- infection of or trauma to the genitalia
- laser treatments or surgery on the external genitalia
- diabetes
- precancerous or cancerous conditions of the cervix
- a history of sexual abuse

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Causes and symptoms

Although the causes of vulvodynia are unknown, there are many suggested causes, including:

- abnormalities of embryonic development
- hypersensitivity to infection
- recurrent infections
- inflammation
- rashes
- allergies or chemical irritation
- overuse of topical medications
- irritation from high oxalate levels in the urine
- genetic or inherited susceptibility to pain, chronic vestibular inflammation, or infection
- immune system factors or autoimmune responses
- injury to or irritation of vulvar or pelvic nerves or an increased nerve fiber density
- hormonal changes, including those that occur with menstrual cycles, menopause, or use of birth control pills
- pelvic floor muscle weakness or spasm

Contact or allergic **dermatitis** or chemical irritation resulting in vulvodynia can be caused by:

- soap
- shampoo
- perfume
- laundry detergent
- fabric softener
- scented or dyed toilet paper
- scented menstrual pads or tampons
- feminine hygiene products such as vulvar wipes, deodorants, or douches
- sexual lubricants
- spermicides
- some medications, particularly topical steroids
- synthetic underwear
- excessive vaginal discharge
- urine or feces

Symptoms of vulvodynia vary greatly in both type and severity. The condition usually begins suddenly and may last for months or years. The most common symptom is a painful burning sensation in the genitalia. Sometimes painful sexual intercourse is the first symptom. The pain may be intermittent or constant and localized or generalized throughout the pelvic region. Other common sensations of vulvodynia include:

- irritation
- tenderness
- stinging
- rawness or dryness
- intense itching
- soreness
- aching
- stretching of the skin in the vestibule
- throbbing
- swelling
- sharp, knife-like pain

Generalized vulvodynia is characterized by pain throughout the genitalia—not just in the vestibule—or in different areas at different times. Areas commonly affected include the:

- vestibule
- hymen
- introitus—the membranes surrounding the vaginal opening
- small or minor vestibular glands around the vaginal opening
- vulvovaginal (Batholin's) glands located on each side of the vaginal opening
- paraurethral (Skene's) glands located on each side of the urethral opening
- labia minora or inner labia
- labia majora or outer labia

Some women also experience pain in the clitoris, the perineum, the mons pubis, the anus, the inner thighs, and the lower back.

Diagnosis

Examination

A diagnosis of vulvodynia is made on the basis of pain or burning that lasts for more than three months with no apparent infection or **skin lesions**. Sometimes the vulvar tissue is inflamed, but often it appears completely normal. Other conditions that can cause chronic vulvar pain may coexist with vulvodynia and many women are misdiagnosed for years or told that they have a chronic yeast infection or a psychological disorder. It is not uncommon for women to visit at least five doctors before vulvodynia is diagnosed.

Diagnosis includes:

- a medical history
- questions about symptoms, sexual activity, diet, feminine hygiene, and medications
- an examination of the vulva and vagina for signs of infection or a skin disorder
- a pelvic examination
- use of a magnifying glass to look for abnormalities

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KEY TERMS

Autoimmune response—A response in which the immune system's antibodies or T cells attack the body's own proteins, cells, or tissues.

Colposcopy—The use of a special microscope—a colposcope—to view the genitalia.

Contact dermatitis—Irritant dermatitis; direct skin contact with a substance that causes inflammation in some people.

Hymen—A membrane that partially or completely covers the vaginal opening.

Interstitial cystitis—Chronic inflammation of the bladder; sometimes associated with vulvodynia.

Labia majora—Major lips; mounds of tissue forming the lateral boundaries of the vulva.

Labia minora—Minor lips; narrow folds of tissue between the labia major, on either side of the urethral and vaginal openings.

Mons pubis—The fatty tissue over the area where the pubic bones meet.

Oxalate—A salt of oxalic acid produced during metabolism and excreted in the urine.

Perineum—The area between the external genitalia and the anus.

Vestibule—Vestibule of the vulva or vagina; the space between the labia minora containing the openings of the vagina and urethra.

Vestibulectomy—Surgical removal of the vestibule and hymen.

Vulva—The external female genitalia including the mons pubis, labia majora and minora, clitoris, vestibule, glands, and the vaginal opening.

Tests

- a "touch test" with a cotton–tipped applicator to reveal painful areas or points
- culturing of vaginal secretions to test for yeast and bacteria
- blood tests for levels of the sex hormones estrogen, progesterone, and testosterone

Procedures

A colposcopy—an examination with a special magnifying lens—may be performed to look for inflamed surface blood vessels. A tissue biopsy—the removal of a small piece of tissue for microscopic examination— may be performed, particularly if skin lesions are present.

Treatment

Traditional

There is no cure for vulvodynia. Because vulvodynia has multiple causes and symptoms vary greatly, no single treatment is appropriate for all women. Although usually treated with medications, techniques such as neurostimulation are also used. Vestibulectomy—surgical removal of the vestibule and hymen—is sometimes used as a last resort. Laser treatments to destroy the irritated tissue have not proved successful and may worsen the condition.

Drugs

Symptoms of vulvodynia may be treated with:

- creams or oral medications for yeast infections
- topical anesthetics, such as viscous or liquid five percent lidocaine ointment (Xylocaine) for temporary relief
- cortisone creams
- corticosteroid ointments, such as triamcinolone or desoximetasone
- hormone creams, such as topical estrogen or testosterone
- antihistamines, such as Atarax or Vistaril
- oral pain-blocking medications, such as tricyclic antidepressants, serotonin-norepinephrine reuptake inhibitors, or anticonvulsants
- topical compounded formulations of antidepressants or anticonvulsants
- opioid painkillers
- interferon—an antiviral drug—injected into the vulva, particularly in women who also have human papillomavirus
- a nerve block—the injection or spinal pump infusion of an anesthetic, sometimes combined with an anti-inflammatory
- trigger-point injections of a steroid or bupivacaine

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Alternative

Alternative treatments for vulvodynia include:

- pelvic floor therapy—physical and exercise therapy to strengthen and relax the pelvic-floor muscles
- biofeedback with sensitive detectors designed for use on the vulva
- acupuncture
- cognitive behavioral therapy
- hypnotherapy

Home remedies

Gentle vulvar hygiene is extremely important for treating vulvodynia:

- cleaning the vulva with water only
- bathing with mild soap
- eliminating any potentially irritating products, such as douches, vaginal wipes, deodorants, bubble bath, or deodorant-containing pads or tampons
- douching with baking soda to relieve inflammation
- wearing all-cotton underwear
- avoiding tight-fitting underwear, pantyhose, and underwear at night
- applying cool gel packs to the vulvar area to reduce pain and itching
- taking cool or lukewarm sitz baths to relieve irritation and burning
- applying a compress of Aveeno—a powdered oatmeal bath treatment—to the vulva three to four times per day
- using lubrication for sexual intercourse
- aerobic exercising that does not put pressure directly on the vulva

Vulvodynia that might be caused by acidic, irritating oxalate crystals in the urine may be helped by following a low-carbohydrate, low-oxalate diet for three months to a year:

- eliminating all foods with more than 10 mg of oxalate per serving
- limiting moderate (2–10 mg per serving) oxalate-containing foods to three servings per week
- drinking 12–14 cups of water per day
- taking calcium citrate supplements without vitamin D approximately 45 minutes before eating to decrease oxalate in the urine

Prognosis

Vulvodynia sometimes disappears spontaneously and often improves over time without treatment. Although treatment—especially **corticosteroids** or the tricyclic antidepressant amitriptyline—often results in partial or complete relief of symptoms, this may take weeks, months, or even years, and some women are never completely symptom free. Vestibulectomy has the highest success rate of any treatment.

Prevention

There are numerous measures for potentially preventing or relieving symptoms of vulvodynia. These include:

- using soft, white or unbleached, unscented toilet tissue
- using 100%-cotton unscented menstrual pads and tampons
- avoiding soap and shampoo in the vulvar region
- avoiding bubble bath, feminine hygiene products, perfumed creams and soaps, petroleum jelly, and bath oils
- washing the vulva frequently with cool or lukewarm water
- drying the perineum with a hair dryer on the cool setting
- urinating before the bladder is full
- rinsing the vulva with water from a squeeze bottle after urination
- using a bidet
- eating fiber from whole grains, fruits, vegetables, and psyllium products to prevent constipation
- drinking eight glasses of water daily
- sitting on a foam rubber donut and standing periodically when sitting for long periods
- using relaxation techniques

Clothing and laundry suggestions include:

- wearing all-white cotton underwear, washing new underwear before use, and not wearing underwear at night
- wearing loose-fitting skirts and pants
- avoiding pantyhose and jeans
- wearing wicking underwear for exercise
- promptly removing wet bathing suits and exercise clothing
- washing clothes in a dermatologically approved detergent or baking soda soap
- double rinsing underwear and other clothing that contacts the vulva
- avoiding fabric softener and dryer sheets

Advice on physical activity includes:

- avoiding activities that put direct pressure on the vulva, such as bicycle and horseback riding

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- limiting intense exercise that applies friction to the vulva
- applying a frozen gel pack wrapped in a towel after exercising to relieve symptoms
- performing stretching and relaxation exercises such as yoga
- avoiding hot tubs and highly-chlorinated swimming pools

Suggestions for sexual activities include:

- applying a topical anesthetic, such as 5% lidocaine gel, to the vestibule 10–15 minutes before intercourse
- applying pure almond oil, vegetable oil, or a water–soluble, glycerin-containing lubricant
- avoiding lubricants containing preservatives or other chemicals
- avoiding contraceptive creams, spermicides, and devices that may irritate the vulva
- applying ice or a frozen blue gel pack after intercourse to prevent burning
- urinating and rinsing the vulva with cool water after intercourse

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American College of Obstetricians and Gynecologists (ACOG), PO Box 96920, Washington, DC, 20090-6920, (202) 638-5577, (800) 673-8444, resources@acog.org, http://www.acog.org.

International Society for the Study of Vulvovaginal Disease (SSVD), 8814 Peppergrass Ln., Waxhaw, NC, 28173, (704) 814-9493, (704) 814-9571, Executive.Director@issvd.org, http://www.issvd.org.

National Vulvodynia Association (NVA), PO Box 4491, Silver Spring, MD, 20914-4491, (301) 299-0775, (301) 299-3999, http://www.nva.org.

VP (Vulvar Pain) Foundation, PO Drawer 177, Graham, NC, 27253, (336) 226-0704, (336) 226-8518, http://www.vulvarpainfoundation.org.

Margaret Alic, PhD

Vulvovaginitis

Definition

Inflammation of the vagina and vulva most often caused by a bacterial, fungal, or parasitic infection.

Description

Vulvovaginitis, vulvitis, and vaginitis are general terms that refer to the inflammation of the vagina and/or vulva (the external genital organs of a woman). These conditions can be caused by bacterial, fungal, or parasitic infections. Also, vulvovaginitis can be caused by low estrogen levels (called "atrophic vaginitis") or any type of allergic or irritation response from things such as spermicidal products, **condoms**, soaps, and bubble bath.

In general, vulvovaginitis causes vaginal discharge, irritation, and **itching**. One of the most common reasons why women visit their doctor is because of a change in vaginal discharge. It is completely normal for a woman to have a vaginal discharge, the amount and consistency of which varies during the course of the menstrual cycle. Each of the three most common types of vulvovaginitis will be described separately.

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Bacterial vaginosis

Bacterial vaginosis is the most common cause of vaginitis during the childbearing years. Forty percent to 50% of vaginitis cases are caused by bacterial vaginosis. The occurrence of bacterial vaginosis is difficult to determine but studies have proposed that 10–41% of women have had it at least once. The occurrence of bacterial vaginosis in the United States is highest among African-American women and women who have had multiple sexual partners and lowest among Asian women and women with no history of sexual contact with men. Bacterial vaginosis is not considered a sexually transmitted disease although it can be acquired by sexual intercourse.

Bacterial vaginosis is not caused by a particular organism but is a change in the balance of normal vaginal bacteria. Ninety percent of the bacteria found in a healthy vagina belong to the *Lactobacillus* family. For unknown reasons, there is a shift in the bacterial population that results in overgrowth of other bacteria. Patients suffering from bacterial vaginosis have very high numbers of such bacteria as *Gardnerella vaginalis*, *Mycoplasmahominis*, *Bacteroides* species, and *Mobiluncus* species. These bacteria can be found at numbers 100 to 1000 times greater than found in the healthy vagina. In contrast, *Lactobacillus* bacteria are in very low numbers or completely absent from the vagina of women with bacterial vaginosis.

Candida vulvovaginitis

Candida vulvovaginitis also has been called "vulvovaginal candidiasis," "candidal vaginitis," "monilial infection," or "vaginal yeast infection." Twenty to 25% of the vaginitis cases are *Candida* vulvovaginitis. It has been estimated that about 75% of all women get a vaginal yeast infection at least once. In 80–90% of the cases, *Candida* vulvovaginitis is caused by an overgrowth of the yeast *Candida albicans*. The remaining cases are caused by other species of *Candida*. It is not known what causes the yeast overgrowth. However, **antibiotics** can inadvertently kill normal bacteria in the vagina and cause an overgrowth of *Candida*.

Candida vulvovaginitis is not considered a sexually transmitted disease because *Candida* species are commonly found in the healthy vagina. It is a rare disease in girls before **puberty** and celibate women. Vaginal yeast infections tend to occur more frequently in women who are pregnant, diabetic and not controlling their disease, taking birth control pills, or taking antibiotics. The **stress** of military deployment has also been found to be a factor in triggering vaginal yeast infections. Some women have four or more attacks per year, a condition called "recurrent vaginal candidiasis."

Trichomoniasis

Trichomoniasis, which is sometimes called "trich," accounts for 15–20% of the cases of vaginitis. It is estimated that two million to three million U.S. women get trichomoniasis each year, and as many as 120 million women worldwide. Unlike the other two causes of vulvovaginitis, trichomoniasis is a sexually transmitted disease. This means that the disease is passed from person to person only by sexual contact. Trichomoniasis occurs in both men and women and is caused by infection with the single-celled parasite *Trichomonas vaginalis*. Infection with *Trichomonas vaginalis* is frequently associated with other **sexually transmitted diseases** and assists the spread of the **AIDS** virus.

Causes and symptoms

Vulvovaginitis is most often caused by a bacterial, fungal, or parasitic infection as described above. Other microorganisms may cause vulvovaginitis, or it may be caused by allergic reaction, irritation, injury, low estrogen levels, and certain diseases. Risk factors for bacterial vaginosis include using an intrauterine device (**IUD**), non-white race, prior **pregnancy**, first sexual activity at an early age, having multiple sexual partners, and having a history of sexually transmitted diseases. Persons at an increased risk for *Candida* vulvovaginitis include those who have had previous candida infections, frequent sexual intercourse, use birth control pills, have AIDS, are pregnant, are taking antibiotics or **corticosteroids**, are diabetic, use douches, use perfumed feminine hygiene sprays, wear tight clothing, or use vaginal sponges or an IUD.

The typical symptoms of vulvovaginitis are: vaginal discharge, itching, and irritation. Women may have few or no symptoms, while others may have pronounced symptoms. The main symptom of bacterial vaginosis is a fishy-smelling, thin, milky-white or gray vaginal discharge but itching and burning may also be present. The fishy smell is stronger after sexual intercourse. The symptoms of candida vulvovaginitis are itching, soreness, painful sexual intercourse, and a thick, curdy, white (like cottage cheese) vaginal discharge. Trichomoniasis symptoms are: painful urination, painful sexual intercourse, and a yellow-green to gray, foul smelling, sometimes frothy, vaginal discharge.

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Diagnosis

Vulvovaginitis can be diagnosed and treated by a nurse practitioner or physician. Most insurance companies cover the costs of diagnosis and treatment. To diagnose vulvovaginitis, the doctor will examine the vagina (using a speculum to keep the vagina open) and take a sample of the vaginal discharge for tests and microscopic analysis. Laboratory culture results should be available in two to three days but the microscopic examination of the vaginal discharge may be immediately performed in the doctor's office. Diagnosis may be difficult because there are many different causes of vulvovaginitis. Women who think that they have vulvovaginitis should always visit their doctor to get an accurate diagnosis. Many women assume that they have a yeast infection and take over-the-counter medicines without first consulting their doctors.

There are four signs that indicate that a woman has bacterial vaginosis. These signs (known as Amsel's criteria) are: a thin, milky white discharge that clings to the walls of the vagina, presence of a fishy odor, a vaginal pH greater than 4.5, and the presence of clue cells in the vagina. Clue cells are vaginal cells that are covered with small bacteria. A diagnosis of candida vulvovaginitis is made after finding a normal vaginal pH (4 to 4.5) and the presence of many yeast cells in the sample of vaginal discharge or growth of yeast on laboratory media. In the spring of 2004, the U.S. Food and Drug Administration (FDA) cleared a new quick test to diagnose trichnomonas infection. The test provides results in 10 minutes. The company that manufactures the test also has a rapid result test to bacterial vaginosis. A trichomoniasis diagnosis is made when the parasites are found in the vaginal discharge either by microscopic examination or in laboratory cultures.

Trichomoniasis tends to be underdiagnosed in men because of the relative mildness of symptoms in men and insufficiently sensitive diagnostic tests. The recent introduction of DNA amplification, however, indicates that the incidence of trichomoniasis in men is much higher than was previously thought.

Treatment

Both bacterial vaginosis and trichomoniasis require prescription medication for treatment. Candida vulvovaginitis may be treated with either prescription or over-the-counter medicines. It is not advisable to take over-the-counter vaginal yeast infection medicines if one does not have a yeast infection. An Institute of Epidemiological Research survey of 390 gynecologists found that 44% of the women who were diagnosed with bacterial vaginosis had first treated themselves with over-the-counter yeast infection medications.

Bacterial vaginosis should be treated daily for one week with the antibiotics metronidazole (Flagyl, Protostat) or clindamycin (Cleocin) either as pills taken orally or in a gel or cream form put into the vagina. Trichomoniasis is treated with either a large, single dose of metronidazole or with a smaller dose taken twice daily for one week. Male sexual partners of women with trichomoniasis also must be treated.

Candida vulvovaginitis is most often treated by the application of medicated gels, creams, or suppositories applied directly to the vagina. The antifungal drugs used to treat candida vulvovaginitis include oral fluconazole (Diflucan), butoconazole (Femstat), clotrimazole (Gyne-lotrimin, Mycelex), miconazole (Monistat), and ticonazole (Vagistat). Most require only one or a few days of therapy to be effective. Women who have recurrent *Candida* infections may receive treatment for several weeks and then some form of a long-term preventive treatment.

Alternative treatment

One of the primary focuses of alternative treatment for vaginal conditions including vulvovaginitis is rebalancing the normal vaginal flora. To assist with this rebalancing, *Lactobacillus acidophilus* and *L. bifidus* are recommended, either taken internally or introduced directly into the vagina. Garlic (*Allium sativum*), both taken internally and inserted into the vagina (a peeled whole clove wrapped in gauze), may be helpful due to its antibacterial and antifungal actions. A variety of other herbs can be used as douches or in suppository form to help treat acute flare-ups of vaginal symptoms. For example a douche made by steeping 1–2 tsp. of calendula (*Calendula officinalis*) in boiling water (let the water cool before using) may help reduce inflammation. A boric acid douche can help to acidify the vaginal pH so that unwanted bacteria cannot survive and multiply. For atrophic vaginitis, especially in menopausal women, topical application of progesterone cream can help with symptoms caused by thinning of the tissue lining the vagina.

Dietary modification and nutritional supplementation may also be helpful in the treatment of vulvovaginitis. Antioxidant **vitamins**, including A, C, and E, as well as B complex vitamins, and vitamin D, are recommended. Foods to avoid include cheese, alcohol, chocolate, soy sauce, sugar, vinegar, fruits, and any fermented foods. Wearing cotton underwear, loose fitting clothes, and avoiding panty hose can help keep the vagina cool and dry, thus helping to prevent

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KEY TERMS

Parasite—An animal or plant that can only survive by living inside or upon another animal or plant.

Vulva—The external genital organs of a woman, including the outer and inner lips, clitoris, and opening of the vagina.

some forms of vulvovaginitis. Cases of chronic vulvovaginitis should be addressed on systemic level by an alternative practitioner.

Prognosis

Vulvovaginitis is a disease with minor symptoms and most women respond well to medications. It is believed that certain vaginal infections, if left untreated, can lead to more serious conditions, such as **pelvic inflammatory disease**, endometritis, postsurgical infections, and spread of the AIDS virus.

Prevention

Vaginal infections may be prevented by following these suggestions:

- Over-the-counter yeast infection treatments should not be taken unless the woman had been diagnosed with candidiasis before and recognizes the symptoms.
- Douching should be avoided because it may disturb the balance of organisms in the vagina and may spread them higher into the reproductive system.
- Thoroughly dry oneself after bathing and remove a wet bathing suit promptly.
- Avoid wearing tight clothing and wear cotton underwear.
- Clean diaphragms, cervical caps, and spermicide applicators after use. Use condoms to avoid sexually transmitted disease.
- After a bowel movement, wipe from front to back to avoid spreading intestinal bacteria to the vagina.

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American College of Obstetricians and Gynecologists, PO Box 96920, Washington, DC, 20090-6920, (202) 638-5577, http://www.acog.org.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

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W

Waldenströ disease *see* **Waldenström's macroglobulinemia**

Waldenström's macroglobulinemia

Definition

Waldenstrom's macroglobulinemia is a rare, chronic **cancer** of the immune system that is characterized by hyperviscosity, or thickening, of the blood.

Description

Waldenstrom's (Waldenstrom, Waldenstroem's) macroglobulinemia (WM) is a lymphoma, or cancer of the lymphatic system. It was first identified in 1944, by the Swedish physician Jan Gosta Waldenstrom, in patients who had a thickening of the serum, or liquid part, of the blood. Their blood serum contained a great deal of a very large molecule called a globulin. Thus, the disorder is called macroglobulinemia.

Lymphomas are cancers that originate in tissues of the lymphatic system. All lymphomas other than Hodgkin's disease, including WM, are known collectively as non-Hodgkin's lymphomas. There are 13 major types of non-Hodgkin's lymphomas and others that are very rare. Other names that are sometimes used for WM include lymphoplasmacytic lymphoma, lymphoplasmacytic leukemia, macroglobulinemia of Waldenstrom, primary macroglobulinemia, Waldenstrom's syndrome, Waldenstrom's purpura, and hyperglobulinemic purpura. Purpura refers to purple spots on the skin, resulting from the frequent bleeding and bruising that can be a symptom of WM.

WM is classified as a low-grade or indolent form of lymphoma because it is a slow-growing cancer that produces fewer symptoms than other types of lymphomas. WM most often affects males over the age of 65. Frequently, this disease produces no symptoms and does not require treatment. It has not been studied as extensively as other types of lymphoma.

The lymphatic system

The lymphatic system is part of the body's immune system for fighting disease and part of the blood-producing system. It includes the lymph vessels and nodes, spleen, bone marrow, and thymus. The narrow lymphatic vessels carry lymphatic fluid from throughout the body. The lymph nodes are small, pea-shaped organs that filter the lymphatic fluid and trap foreign substances, including viruses, bacteria, and cancer cells. The spleen, in the upper left abdomen, removes old cells and debris from the blood. The bone marrow, the spongy tissue inside the bones, produces new blood cells.

B lymphocytes or B cells are white blood cells that recognize disease-causing organisms. They circulate throughout the body in the blood and lymphatic fluid. Each B lymphocyte recognizes a specific foreign substance, or antigen. When it encounters its specific antigen, the B cell begins to divide and multiply, producing large numbers of identical (monoclonal), mature plasma cells. These plasma cells produce large amounts of antibody that are specific for the antigen. Antibodies are large proteins called immunoglobulins (Igs) that bind to and remove the specific antigen.

A type of Ig, called IgM, is part of the early immune response. The IgM molecules form clusters in the bloodstream. When these IgM clusters encounter their specific antigen, usually a bacterium, they cover it so that it can be destroyed by other immune system cells.

Plasma cell neoplasm

WM is a type of plasma cell neoplasm or B-cell lymphoma. These are lymphomas in which certain

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plasma cells become abnormal, or cancerous, and begin to grow uncontrollably. In WM, the cancerous plasma cells overproduce large amounts of identical (monoclonal) IgM antibody. This IgM also is called M protein, for monoclonal or myeloma protein.

Macroglobulinemia refers to the accumulation of the M protein in the serum of the blood. This large amount of M protein can cause the blood to thicken, causing hyperviscosity. The malignant plasma cells of some WM patients also produce and secrete partial immunoglobulins called light chains, or Bence-Jones proteins. The malignant plasma cells can invade various tissues, including the bone marrow, lymph nodes, and spleen, causing these tissues to swell.

WM accounts for about 1-2% of non-Hodgkin's lymphomas. It is estimated that it may affect about five out of every 100,000 people. It usually affects people over the age of 50 and most often develops after age 65. It is more common in men than in women. In the United States, WM is more common among Caucasians than among African Americans. The disease can run in families.

Causes and symptoms

The cause of WM is not known.

Many individuals with WM have no symptoms of the disease. This is known as asymptomatic macroglobulinemia. When symptoms of WM are present, they may vary greatly from one individual to the next.

Hyperviscosity syndrome

At least 50% of individuals with WM have hyperviscosity syndrome, an increased viscosity or thickening of the blood caused by the accumulation of IgM in the serum. Hyperviscosity can cause a slowing in the circulation through small blood vessels. This condition can lead to a variety of symptoms:

- fatigue
- weakness
- rash
- bruising
- nose bleeds
- gastrointestinal bleeding
- weight loss
- night sweats
- increased and recurrent infections
- poor blood circulation in the extremities

Poor blood circulation, or Raynaud's phenomenon, can affect any part of the body, but particularly the fingers, toes, nose, and ears.

Cold weather can cause additional circulatory problems by further thickening the blood and slowing down circulation. In some cases, the excess blood protein may precipitate out of the blood in the cold, creating particles that can block small blood vessels. This is called cryoglobulinemia. The extremities may turn white, or a patchy red and white. The hands, feet, fingers, toes, ears, and nose may feel cold, numb, or painful.

Hyperviscosity may affect the brain and nervous system, leading to additional symptoms. These symptoms include:

- peripheral neuropathy, caused by changes in the nerves, leading to pain or numbness in the extremities
- dizziness
- headaches
- vision problems or loss of vision
- Mental confusion
- poor coordination
- temporary paralysis
- mental changes

Hyperviscosity can clog the tubules that form the filtering system of the kidneys, leading to kidney damage or kidney failure. Existing heart conditions can be aggravated by WM. In extreme cases, WM may result in **heart failure**. Late-stage WM also may lead to mental changes that can progress to **coma**.

Anemia

The accumulation of IgM in the blood causes an increase in the volume of the blood plasma. This effectively dilutes out the red blood cells and other blood components. The lowered concentration of red blood cells can lead to anemia and cause serious **fatigue**. Likewise, a deficiency in platelets (**thrombocytopenia**), which cause the blood to clot, can result in easy bleeding and bruising. As the cancer progresses, there may be abnormal bleeding from the gums, nose, mouth, and intestinal tract. There may be bluish discoloration of the skin. In the later stages of the disease, leukopenia, a deficiency in white blood cells, also can develop.

Organ involvement

In 5-10% of WM cases, the IgM may be deposited in tissues. Thus, some individuals with WM have enlargement of the lymph nodes, the spleen, and/or the liver.

If Bence-Jones proteins are produced by the malignant plasma cells, they may be deposited in the

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kidneys. There they can plug up the tiny tubules that form the filtering system of the kidneys. This can lead to kidney damage and kidney failure.

Diagnosis

Since many individuals with WM have no symptoms, the initial diagnosis may result from blood tests that are performed for some other purpose. Blood cell counts may reveal low red blood cell and platelet levels. A **physical examination** may indicate enlargement of the lymph nodes, spleen, and/or liver. A retinal **eye examination** with an ophthalmoscope may show retinal veins that are enlarged or bleeding.

Blood and urine tests

Serum **protein electrophoresis** is used to measure proteins in the blood. In this laboratory procedure, serum proteins are separated in an electrical field, based on the size and electrical charge of the proteins. Serum **immunoelectrophoresis** uses a second antibody that reacts with IgM. A spike in the Ig fraction indicates a large amount of identical or monoclonal IgM in individuals with WM.

Normal serum contains 0.7-1.6 gm per deciliter (g/dL) of Ig, with no monoclonal Ig present. At serum IgM concentrations of 3-5 g/dL, symptoms of hyperviscosity often are present. However some individuals remain asymptomatic with IgM levels as high as 9 g/dL.

Urinalysis may indicate protein in the urine. A urine Bence-Jones protein test may indicate the presence of these small, partial Igs.

Bone marrow

Abnormal blood tests usually are followed by a **bone marrow biopsy**. In this procedure, a needle is inserted into a bone and a small amount of marrow is removed. Microscopic examination of the marrow may reveal elevated levels of lymphocytes and plasma cells. However, less than 5% of patients with WM have lytic bone lesions, caused by cancerous plasma cells in the bone marrow that are destroying healthy cells. Bone lesions can be detected with x rays.

Treatment

Clinical staging, to define how far a cancer has spread through the body, is the common method for choosing a cancer treatment. However, there is no generally-accepted staging system for WM.

There also is no generally-accepted course of treatment for WM. Treatment may not be necessary for asymptomatic macroglobulinemia. However, if IgM serum levels are very high, treatment may be initiated even in the absence of symptoms. If symptoms are present, treatment is directed at relieving symptoms and retarding the disease's development. Of major concern is the prevention or alleviation of blood hyperviscosity. Therefore, the initial treatment depends on the viscosity of the blood at diagnosis.

Hyperviscosity

Plasmapheresis, or plasma exchange **transfusion**, is a procedure for thinning the blood. In this treatment, blood is removed and passed through a cell separator that removes the plasma, containing the IgM, from the red and white blood cells and platelets. The blood cells are transfused back into the patient, along with a plasma substitute or donated plasma. Plasmapheresis relieves many of the acute symptoms of WM. Individuals with WM may be given fluid to counter the effects of hyperviscous blood.

Low blood cell counts

Treatments for low blood cell levels include:

- the drug Procrit to treat anemia
- transfusions with packed red blood cells to treat anemia in later stages of the disease
- antibiotics to treat infections caused by a deficiency in white blood cells
- transfusions with blood platelets

Chemotherapy

Chemotherapy, the use of anti-cancer drugs, helps to slow the abnormal development of plasma cells, but does not cure WM. It can reduce the amount of IgM in the bone marrow. In particular, chemotherapy is used to treat severe hyperviscosity and anemia that are caused by WM.

Chlorambucil (Leukeran), possibly in combination with prednisone, is the typical chemotherapy choice for WM. This treatment is effective in 57% of cases. These drugs are taken by mouth. Prednisone is a corticosteroid that affects many body systems. It has anti-cancer and anti-inflammatory effects and is an immune system suppressant. Other drug combinations that are used to treat WM include cyclophosphamide (Cytoxan), vincristine, and prednisone, with or without doxorubicin. Fludaribine, 2-chlorodeoxyadenosine, and **corticosteroids** also may be used.

side effects of chemotherapy may include:

- mouth sores
- nausea and indigestion
- hair loss

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KEY TERMS

Anemia—Any condition in which the red blood cell count is below normal.

Antibody—Immunoglobulin produced by immune system cells that recognizes and binds to a specific foreign substance (antigen).

Antigen—Foreign substance that is recognized by a specific antibody.

Autosomal dominant—Genetic trait that is expressed when present on only one of a pair of non-sex-linked chromosomes.

B cell (B lymphocyte)—Type of white blood cell that produces antibodies.

Bence-Jones protein—Light chain of an immunoglobulin that may be overproduced in Waldenstrom's macroglobulinemia; it is excreted in the urine.

Biopsy—Removal of a small sample of tissue for examination under a microscope; used in the diagnosis of cancer.

Cryoglobulinemia—Condition in which protein in the blood forms particles in the cold, blocking blood vessels and leading to pain and numbness of the extremities.

Hyperviscosity—Thick, viscous blood, caused by the accumulation of large proteins, such as immunoglobulins, in the serum.

Immunoelectrophoresis—Use of an electrical field to separate proteins in a mixture (such as blood or urine), on the basis of the size and electrical charge of the proteins; followed by the detection of an antigen (such as IgM), using a specific antibody.

Immunoglobulin (Ig)—Antibody such as IgM; large protein produced by B cells that recognizes and binds to a specific antigen.

Interferon alpha—Potent immune-defense protein; used as an anti-cancer drug.

Lymphatic system—The vessels, lymph nodes, and organs, including the bone marrow, spleen, and thymus, that produce and carry white blood cells to fight disease.

Lymphoma—Cancer that originates in lymphatic tissue.

M protein—Monoclonal or myeloma protein; IgM that is overproduced in Waldenstrom's macroglobulinemia and accumulates in the blood and urine.

Monoclonal—Identical cells or proteins; cells (clones) derived from a single, genetically-distinct cell, or proteins produced by these cells.

Plasma cell—Type of white blood cell that produces antibodies; derived from an antigen-specific B cell.

Plasmapheresis—Plasma exchange transfusion; the separation of serum from blood cells to treat hyperviscosity of the blood.

Platelet—Cell that is involved in blood clotting.

Stem cell—Undifferentiated cell that retains the ability to develop into any one of numerous cell types.

- increased appetite
- nervousness
- insomnia

These side effects disappear after the chemotherapy is discontinued.

The long-term management of WM usually is accomplished through a combination of plasmapheresis and chemotherapy.

Alternative and complementary therapies

Biological therapy or immunotherapy, with the potent, immune system protein interferon alpha, is used to relieve the symptoms of WM. Interferon alpha works by boosting the body's immune response. Interferon can cause flu-like symptoms, such as **fever**, chills, and fatigue. It also can cause digestive problems and may affect blood pressure.

The drug rituximab, an antibody that is active against antibody-producing cells, is effective in about 30% of individuals with WM. Rituximab is a monoclonal antibody produced in the laboratory. Monoclonal antibody treatment may cause a an allergic reaction in some people.

Prognosis

There is no cure for WM. In general, patients go into partial or complete remission following initial treatments. However the disease is not cured and follow-up treatment may be necessary.

The prognosis for this cancer depends on an individual's age, general health, and genetic (hereditary) makeup. Males, individuals over age 60, and those

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with severe anemia have the lowest survival rates. The Revised European American Lymphoma (REAL) classification system gives WM a good prognosis following treatment, with an average 5-year survival rate of 50-70%. However, many people with WM live much longer, some without developing any symptoms of the disease. About 16-23% of individuals with WM die of unrelated causes.

Prevention

There is no known prevention for WM.

Resources

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ORGANIZATIONS

International Waldenstrom's & Macroglobulinemia Foundation, 3932D Swift Road, Sarasota, FL, 34231, (941) 927-4963, (941) 927-4467, info@iwmf.com, http://www.iwmf.com/.

Leukemia and Lymphoma Society, 1311 Mamaroneck Avenue, Suite 310, White Plains, NY, 10605, (800) 955-4572, http://www.leukemia-lymphoma.org.

Lymphoma Research Foundation, 115 Broadway, Suite 1301, New York, NY, 10006, (212) 349-2910, (212) 349-2886, (800) 235-6848, helpline@lymphoma.org, http://www.lymphoma.org.

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Walleye *see* **Strabismus**

Warts

Definition

Warts are small, benign growths caused by a viral infection of the skin or mucous membrane. The virus infects the surface layer. The viruses that cause warts are members of the **human papilloma virus** (HPV) family. Warts are not cancerous but some strains of HPV, usually not associated with warts, have been linked with **cancer** formation. Warts are contagious from person to person and from one area of the body to another on the same person.

Demographics

Warts are particularly common among children, young adults, and women. They affect about 7–10 percent of the U. S. population. The incidence of **genital warts** in the United States is around one million cases annually. It is estimated that approximately one in 272 have genital warts, which is roughly 0.37% of the population.

Description

Particularly common among children, young adults, and women, warts are a problem for 7-10% of the population. There are close to 60 types of HPV that cause warts, each preferring a specific skin location. For instance, some types of HPV cause warts to grow on the skin, others cause them to grow inside the mouth, while still others cause them to grow on the genital and rectal areas. However, most can be active anywhere on the body. The virus enters through the skin and produces new warts after an incubation period of one to eight months. Warts are usually

Warts on finger. *(CMSP/Getty Images.)*

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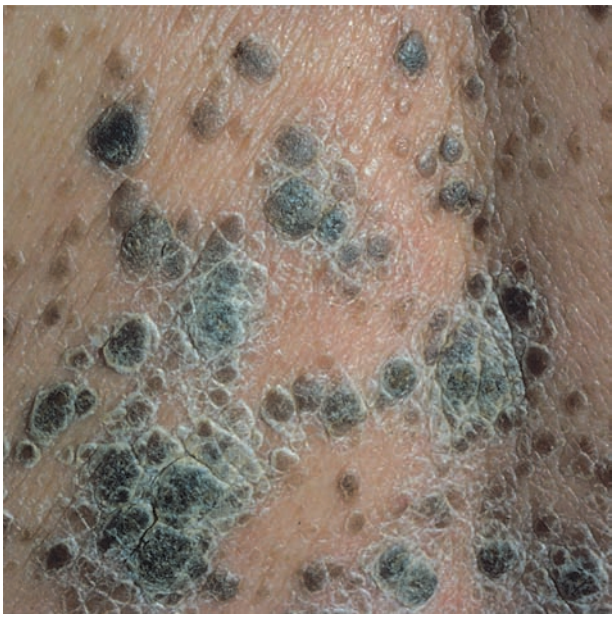

Seborrhoeic warts appearing on a patient's back. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

skin-colored and feel rough to the touch, but they also can be dark, flat, and smooth.

Warts are passed from person to person, directly and indirectly. Some people are continually susceptible to warts, while others are more resistant to HPV and seldom get them. The virus takes hold more readily when the skin has been damaged in some way, which may explain why children who bite their nails tend to have warts located on their fingers. People who take a medication to suppress their immune system or are on long-term steroid use are also prone to a wart virus infection. This same is true for patients with **AIDS**.

Causes and symptoms

The more common types of warts include:

- common hand warts
- foot warts
- flat warts
- genital warts

Hand warts

Common hand warts grow around the nails, on the fingers, and on the backs of hands. They appear more frequently where skin is broken, such as in areas where fingernails are bitten or hangnails picked.

Foot warts

Foot warts are called plantar warts because the word plantar is the medical term for the sole of the foot, the area where the wart usually appears as a single lesion or as a cluster. Plantar warts, however, do not stick up above the surface like common warts. The ball of the foot, the heel and the plantar part of the toes are the most likely locations for the warts because the skin in those areas is subject to the most weight, pressure, and irritation, making a small break or crack more likely.

Plantar warts are familiar to all ages groups, appearing frequently in children between the ages of 12 and 16. Adolescents often come into contact with a wart virus in a locker room, swimming pool area, or by walking barefooted on dirty surfaces. The blood vessels feeding them are the black dots that are visible on the wart. If left untreated, these warts can grow to an inch or more in circumference and spread into clusters of several warts. They are known to be very painful at times, the **pain** usually compared to the feeling of a permanent stone in the shoe, particularly if the wart is on a pressure point of the foot. People with **diabetes mellitus** are prone to complications from plantar warts related to the development of sores or ulceration and the poor healing potential associated with diabetes.

Flat warts

Flat warts tend to grow in great numbers and are smaller and smoother than other warts. They can erupt anywhere, appearing more frequently on the legs of women, the faces of children, and on the areas of the face that are shaved by young adult males.

Genital warts

Genital warts, also called condyloma acuminata or venereal warts, are one of the most common causes of sexually transmitted disease (STD) in this country. According to the *Journal of the American Medical Association's* STD Information Center, they are contracted by sexual contact with an infected person who carries HPV and are more contagious than other warts. It is estimated that two-thirds of the people who have sexual contact with a partner with genital warts will develop the disease within three months of contact. As a result, about one million new cases of genital warts are diagnosed in the United States each year.

Genital warts tend to be small flat bumps or they may be thin and tall. They are usually soft and not scaly like other warts. In women, genital warts appear

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on the genitalia, within the vagina, on the cervix, and around the anus or within the rectum. In men, genital warts usually appear on the tip of the penis but may also be found on the scrotum or around the anus. Genital warts can also develop in the mouth of a person who has had oral sexual contact with an infected person.

Diagnosis

Patients who notice warts in their genital area should see a doctor. The doctor may be able to diagnose the warts with a simple examination. If the warts are small, the doctor may put a vinegar-like liquid on the skin, which makes the warts turn white and easier to see, and then use a magnifying glass to look for them.

Treatment

Home/self treatment

Many of the nonprescription wart remedies available at drug stores will remove simple warts from hands and fingers. These medications may be lotions, ointments, or plasters and work by chemically removing the skin that was affected by the wart virus. The chemicals are strong, however, and should be used with care since they can remove healthy as well as infected skin. These solutions should be avoided by diabetics and those with cardiovascular or other circulatory disorders whose skin may be insensitive and not appreciate irritation.

Flat warts are best treated with topical retinoides (retinoic acid) or a gel containing salicylic acid. The acid doesn't actually kill the wart virus, but waterlogs the skin so that the surface layer, with the virus, peels off. These products can take up to three months of treatment depending on the size and depth of the wart. Patches are also good to use. Rather than applying drops, a small pad is placed on the wart and left for 48 hours and then replaced with a new one. The patch usually contains a higher concentration of salicylic acid and may irritate the surrounding skin. If this occurs, patients should switch to a gel or stop medication for a period. To help the healing process for flat facial warts, men should shave with an electric shaver or temporarily grow a beard. Women with flat warts on areas that are shaved should use other methods to remove hair, such as depilatory cream or wax.

Professional treatment

Physicians should be consulted if there are no signs of progress after a month of self treatment. Doctors have many ways of removing warts, including using stronger topically applied chemicals than those available in drugstores. Some of these solutions include podofilox, topical podophyllum, and trichloracetic acid (TCA). Some burning and discomfort for one or more days following treatment can be expected. Although these chemicals are effective, they may not destroy all warts completely. A second method of removal is freezing or cryosurgery on the wart using liquid nitrogen. **Cryotherapy** is relatively inexpensive, does not require anesthesia, and usually does not result in scarring. Although temporarily uncomfortable, it provides an effective and safe way to deliver freezing temperatures to a particular area on the skin, and healing is usually quick. Physicians may also choose to burn the wart with liquid nitrogen or numb the skin and then scrape off the wart. Another removal process is electrocautery (electric burning), destroying the wart by burning it with an electric needle. **Laser surgery** is also becoming a more common option for removing warts.

Genital warts are the most difficult to treat. They can be removed, but the viral infection itself cannot be cured. Often, because the warts are so small, more than one treatment may be needed. The virus continues to live in the deeper skin, which is why warts often return after they have been removed. Strong chemicals may be applied as well as surgical excision with or without electrocautery. This therapy requires a small operative procedure and a local anesthetic. Laser therapy, although more expensive, is often used for treating venereal warts that are more extensive. The use of lasers which vaporize the lesion can theoretically transmit the HPV. It is not at all clear, however, if this occurs.

There is no one recommended method for eliminating plantar warts. If detected early, cryotherapy is usually enough. However, they can be very resilient, requiring treatment over several months. Treatment ranges from the conservative approach of applying chemical solutions to the more aggressive option of surgery. Patients with diabetes or **vascular disease** are usually treated with the more conservative methods.

Alternative treatment

There are a variety of alternative approaches to the treatment of warts. The suggestions described below apply to common warts and plantar warts, not to genital or cervical warts. Since genital and cervial warts are transmitted sexually, they should be treated by a physician.

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KEY TERMS

Condyloma acuminata—Another term for genital warts.

Cryotherapy—Freezing with liquid nitrogen for removal.

Endometritis—Inflammation of the endometrium or mucous membrane of the uterus.

Epidermis—The outer layer of human skin.

Human papilloma virus (HPV)—A family of viruses that causes hand warts, foot warts, flat warts, and genital warts.

Retinoic acid—Vitamin A_1 acid, which is used topically to treat acne.

Salicylic acid—An agent prescribed in the treatment of hyperkeratotic skin conditions and fungal infections.

For the treatment of common or plantar warts, alternative practitioners may recommend these remedies:

- Apply a paste made of vitamin C powder to the wart for one to two weeks.
- Place a crushed or sliced garlic clove over the wart for seven consecutive nights while sleeping.
- Soak the wart in water, put cross-hatches over it with a sterile needle, and apply drops of thuja (*Thuja occidentalis*) tincture onto the wart. Repeat the cross-hatching and tincture application until the wart is saturated with the tincture. Repeat several times each day for one to two weeks. (A tincture is an herbal extract made with alcohol.)
- Tape a piece of banana peel, latex side down, over the wart and leave it on overnight. Repeat nightly for one to two weeks.

Because warts are caused by a virus, general immune system support can be effective in helping to keep warts from coming back after treatment or to keep them from multiplying or growing. Eating a well balanced diet high in sources of **vitamins** A, C, and E can help strengthen the immune system. Avoiding **stress**, which is believed to compromise the immune system, is also helpful.

Prognosis

Even though genital warts may be removed, the virus itself continues to live. The HPV can cause tissue changes in the cervix of women with cervical infection. The general recommendation for women who have a history of genital warts is to see their doctors every six months for Pap smears to monitor any changes that may occur.

For plantar warts, the treatment goal is to destroy the wart and its virus without causing much damage to healthy skin. It is not unusual for treatment to cause pain until the foot heals because of the weight put on the foot.

Prevention

Genital warts can be prevented by using **condoms** and avoiding unprotected sex. Barrier protection will not, however, prevent the spread of wart-causing HPV to uncovered areas such as the pubis and upper thighs. Plantar warts can be prevented by wearing shoes, changing shoes daily, keeping feet clean and dry, and not ignoring skin growths and changes in the skin.

Resources

BOOKS

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ORGANIZATIONS

American Academy of Dermatology, 930 N. Meacham Road, P.O. Box 4014, Schaumburg, IL, 60168-4014, (847) 330-0230, (847) 330-0050, http://www.aad.org.

American Academy of Family Physicians, 8880 Ward Parkway, Kansas City, MO, 64114, (816) 333-9700, http://www.aafp.org.

American Podiatric Medical Association, 9312 Old Georgetown Road, Bethesda, MD, 20814-1698, (301) 571-9200, http://www.apma.org.

Dermatology College of Medicine, The University of Iowa, 200 Hawkins Dr., Iowa City, IO, 52242, (319) 356-2274, http://tray.dermatology.uiowa.edu.

Ruthan Brodsky
Karl Finley

Water pills *see* **Diuretics**

Water therapy *see* **Hydrotherapy**

Waterhouse-Friderichsen syndrome *see* **Meningococcemia**

Weber test *see* **Hearing tests with a tuning fork**

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Wechsler intelligence test

Definition

The Wechsler Intelligence Scales are a series of standardized tests used to evaluate cognitive abilities and intellectual abilities in children and adults.

Purpose

The Wechsler Intelligence Scales for Children (regular, revised, and third edition) and Wechsler Preschool and Primary Scale of Intelligence are used as tools in school placement, in determining the presence of a learning disability or a developmental delay, in identifying giftedness, and in tracking intellectual development.

The Wechsler Adult Intelligence Scales (regular and revised) are used to determine vocational ability, to assess adult intellectual ability in the classroom, and to determine organic deficits. Both adult and children's Wechsler scales are often included in neuropsychological testing to assess the brain function of individuals with neurological impairments.

Precautions

Intelligence testing requires a clinically trained examiner. The Wechsler scales should be administered, scored, and interpreted by a trained professional, preferably a psychologist or psychiatrist.

Description

All of the Wechsler scales are divided into six verbal and five performance subtests. The complete test takes 60-90 minutes to administer. Verbal and Performance IQs are scored based on the results of the testing, and then a composite Full Scale IQ score is computed. Although earlier editions of some of the Wechsler Scales are still available, the latest revisions are:

Wechsler Adult Intelligence Scale-Revised (WAIS-R)

The WAIS-R, the 1981 revision of the original Wechsler Adult Intelligence Scale, is designed for adults, ages 16-74. The 11 subtests of the WAIS-R include information, digit span, vocabulary, arithmetic, comprehension, similarities, picture completion, picture arrangement, block design, object assembly, and digit symbol. An example of questions on the subtest of similarities might be: "Describe how the following pair of words are alike or the same—hamburger and pizza." A correct response would be "Both are things to eat."

Wechsler Intelligence Scale for Children, Third Edition (WISC-III)

The WISC-III subtests includes many of the same categories of subtests as the WAIS-R. In addition, there are two optional performance subtests: symbol search and mazes.

Wechsler Preschool and Primary Scale of Intelligence (WPPSI)

The WPPSI is designed for children age 4-6½ years. The test is divided into six verbal and five performance subtests. The 11 subtests are presented in the following order: information, animal house and animal house retest, vocabulary, picture completion, arithmetic, mazes, geometric design, similarities, block design, comprehension, and sentences.

The 1997 Medicare reimbursement rate for psychological and neuropsychological testing, including intelligence testing, is $58.35 an hour. Billing time typically includes test administration, scoring and interpretation, and reporting. Many insurance plans cover all or a portion of diagnostic psychological testing.

Normal results

The Wechsler Intelligence Scales are standardized tests, meaning that as part of the test design, they were administered to a large representative sample of the target population, and norms were

KEY TERMS

Norms—Normative or mean score for a particular age group.

Representative sample—A random sample of people that adequately represents the test-taking population in age, gender, race, and socioeconomic standing.

Standard deviation—A measure of the distribution of scores around the average (mean). In a normal distribution, two standard deviations above and below the mean includes about 95% of all samples.

Standardization—The process of determining established norms and procedures for a test to act as a standard reference point for future test results.

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determined from the results. The scales have a mean, or average, standard score of 100 and a standard deviation of 15. The standard deviation indicates how far above or below the norm the subject's score is. For example, a 10-year-old is assessed with the WISC-III scale and achieves a full-scale IQ score of 85. The mean score of 100 is the average level at which all 10-year-olds in the representative sample performed. This child's score would be one standard deviation below that norm.

While the full-scale IQ scores provide a reference point for evaluation, they are only an average of a variety of skill areas. A trained psychologist will evaluate and interpret an individual's performance on the scale's subtests to discover their strengths and weaknesses and offer recommendations based upon these findings.

ORGANIZATIONS

American Psychological Association (APA), 750 First St. NE, Washington, DC, 20002-4242, (202) 336-5500, (800) 374-2721, http://www.apa.org/.

Catholic University of America, 620 Michigan Ave., N.E., Washington, DC, 20064, (202) 319-5000, http://www.cua.edu.

Paula Anne Ford-Martin

Wegener's granulomatosis

Definition

Wegener's granulomatosis is a very rare disease that affects many different organs and systems of the body. It mainly attacks the respiratory system (sinuses, nose, windpipe, and the lungs) and the kidneys. One of the main features of the disease is an inflammation of the blood vessels (**vasculitis**). The inflammation narrows the blood vessels and reduces the blood flow to the affected organs. This destroys tissues and damages vital organs.

Description

Wegener's granulomatosis (WG) is not a contagious disease, and there is no evidence to suggest that it is hereditary either. It is a very rare disease, affecting only 1 in every 30,000-50,000 people. About 500 new cases are diagnosed each year. The disease can occur at any age, however, it mostly affects individuals in their 30s and 40s. It affects males and females equally. Ninety-seven percent of all patients are Caucasian, 2% are black, and 1% are of another race.

Causes and symptoms

No viral, bacterial, or other causative agent has yet been identified for WG. It is thought to be an autoimmune disease, meaning that the body's immune system attacks itself—that is, the body's own tissues.

Whenever there is an infection in the body, proteins called antibodies, which are capable of attacking the infectious agent, are formed in the blood. In WG, the antibodies that are formed are directed against the white blood cells of the immune system. They are therefore called "auto-antibodies" (antibodies against one's own body cells). These auto-antibodies bind to the blood cells and forms clumps known as immune complexes. The complexes accumulate in the tissues and the blood vessels, leading to a tumor-like (granulomatous) inflammation of the blood vessels. This slows down the blood flow to the different organs and tissues, causing damage and resulting in the many symptoms of WG.

The symptoms of WG, and the severity of the symptoms, vary from patient to patient. One of the most common features is a chronic runny nose and other cold-like symptoms that do not respond to standard treatment. The cold symptoms gradually worsen and could lead to **sinusitis** (inflammation of the sinuses), middle ear infection (**otitis media**), **cough**, coughing of blood, and inflammation of the lung (pleuritis and **pneumonia**). Other symptoms include **fever**, **fatigue**, loss of appetite, weight loss, joint **pain**, night sweats, change in urine color, and weakness.

Kidney (renal) disease is the most serious development of WG. Patients who do not have renal disease are said to have "Limited Wegener's."

Diagnosis

Early diagnosis is critical for the most effective treatment of the disease. However, there are no specific laboratory tests for WG. Blood tests are used to rule out other causes of the symptoms and to determine which organs are affected. The blood tests often show anemia (low red cell count) and high white blood cell counts. If the kidneys are involved, red blood cells are seen in the urine when viewed under a microscope. Also, blood tests aimed at measuring kidney function may show abnormalities.

Chest x rays are used to determine if the lungs are involved. **Computed tomography scans** (CT scans) of

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sinuses and lungs, and **kidney biopsy**, are also important tools used in diagnosing WG.

A specific type of antibody called anti-neutrophil cytoplasmic antibody (ANCA) is seen in the blood of about 90% of the patients with WG. The ANCA is a group of antibodies directed against the individual's own white blood cells (namely, the neutrophils). These anti-neutrophil cytoplasmic antibodies are also found in other inflammatory conditions and diseases (such as HIV infection). Although the ANCA test is useful, it cannot be used by itself to make a diagnosis of WG. However, the amount of ANCA in the blood can be measured and correlates well with the progression of the disease. When there is a relapse or a flare-up, the ANCA levels go up. Levels decrease when the disease is controlled by appropriate treatment.

Since there are no definitive laboratory tests for WG, and the initial symptoms of the disease are not very specific, it takes 5-15 months, on average, to make a diagnosis of WG.

Treatment

Cyclophosphamide (Cytoxan) which is an anti-cancer drug, and **corticosteroids**, such as prednisone, are used to treat WG. These are powerful drugs that suppress the immune system. However, they are also very toxic and can have serious side effects. The patient has to be watched carefully by the doctors, and the dosage of the drugs has to be adjusted, if needed.

Since the patient's immune system is suppressed while on these drugs, he or she is at an increased risk for contracting infections. Vaccinations for flu and pneumonia are recommended.

Prognosis

In the past, approximately 80% of the patients with untreated WG died within a year of contracting the disease and 90% died within two years. Today, however, the prognosis has been dramatically improved. With appropriate treatment, patients can survive for much longer periods and lead relatively normal lives.

Approximately 50% of the patients with WG will have a relapse of the disease. This generally happens within two years of stopping the medication, but can occur at any point either during treatment or after stopping treatment. Therefore, it is extremely important that patients continue to see their doctors regularly even after stopping the medications.

KEY TERMS

Auto-antibodies—An antibody that is produced in, and reacts with, an antigen in the same person or animal.

Autoimmune disease—Any disease which causes tissue injury due to an immunological reaction of antibodies against the patient's own tissues.

Granulomatous—Resembling a tumor made of granular material.

Immune complexes—Clusters or aggregates of antigen and antibody bound together.

Vasculitis—Inflammation of the walls of the blood vessels.

Prevention

At present, there are no preventive measures known for Wegener's granulomatosis.

ORGANIZATIONS

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923, (800) 999-6673, http://www.rarediseases.org.

Vasculitis Foundation, PO Box 28660, Kansas City, MO, 64188, (800) 277-9474, http://www.vasculitisfoundation. org/wegenersgranulomatosis.

Lata Cherath, PhD

Weight loss drugs

Definition

Weight loss drugs are medications that may help an obese person lose weight in combination with a low-calorie diet and physical activity.

Purpose

More than 60% of adults in the United States are overweight or obese. Since the 1980s the number of overweight people has increased steadily and the number of obese people has almost doubled. Excess weight and physical inactivity account for more than 300,000 premature deaths in the United States each year, second only to smoking-related deaths.

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Risks from obesity

Overweight and obese people are at higher risk for developing the following problems:

- sleep apnea (interrupted breathing while asleep)
- osteoarthritis (wearing away of the joints)
- high blood pressure
- heart disease
- stroke
- diabetes
- gallbladder disease
- gout (joint pain caused by excess uric acid)
- many common types of cancer

Body mass index (BMI)

An overweight person has an excess of body weight but not necessarily an excess of body fat. **Obesity** refers to an excessively high proportion of body fat. The BMI is used to determine whether a person is overweight or obese. It defines body weight relative to height and, for most adults, correlates with total body fat.

BMI charts are widely available; however, an approximate BMI can be calculated by the following steps:

- multiplying body weight in pounds by 703
- dividing the result by height in inches
- dividing the result by height in inches again

With the exception of very muscular people, BMI is a measure of health:

- 18.5–24.9: healthy
- 25–29.9: overweight
- 30 or above: obese

Generally the higher the BMI the higher the risk of health problems; however, excess abdominal fat is a separate health risk. Men with waists of more than 40 in (102 cm) and women with waists of more than 35 in (89 cm) are at greater risk for health problems.

Prescription weight loss drugs are approved for use only by people with BMIs of 30 or above or those with BMIs of 27 and above who have other risk factors, including the following:

- high blood pressure
- type 2 diabetes
- dyslipidemia (abnormal amounts of fat in the blood)
- sleep apnea

Even short-term weight loss in some obese people has been found to reduce the following:

- blood pressure
- blood cholesterol
- triglycerides (fats)
- insulin resistance (the inability to utilize blood sugar)

Overweight or obese patients who have not lost an average of 1 lb. (0.5 kg) per week after at least six months on a balanced low-calorie diet, including increased **exercise** and behavior therapy, may be considered candidates for weight loss drugs.

Description

Weight loss medications are prescribed only as a component of a weight loss program that includes a healthy low-calorie diet and regular physical activity. On average, people on prescription weight loss drugs lose about 5–10% of their original weight. They may lose in the range of 4.4–22 lbs. (2–10 kg) above what they might have lost following a diet and exercise program alone. Patients who lose weight initially on a drug tend to continue to respond. However, those who fail to lose 4 lbs. (2 kg) within the first month on a weight loss medication may be less likely to respond to that particular drug even at an increased dosage. Most over-the-counter weight loss drugs have been found to be ineffective, unsafe, or both. However, in 2007 the U.S. Food and Drug Administration (FDA) approved the drug Alli, a reduced-strength version of the prescription drug Xenical (orlistat), for over-the-counter sale. It is meant to be used in conjunction with a low-fat, low-calorie diet and a regular exercise program. A one-month supply of the drug costs about $60. It can help people lose 50% more weight than by dieting alone, according to its manufacturer, GlaxoSmithKline.

Most weight loss occurs within the first six months of drug use, after which the weight levels off or increases. The majority of patients regain the lost weight after discontinuing the medication. Thus short-term use of weight loss drugs may not be beneficial. However, long-term use of weight loss drugs may help maintain the lower weight. Since obesity is a chronic disorder, treatment must be continued for years or for life. However, as of 2007, sibutramine (Meridia) and orlistat (Xenical) were the only prescription weight loss drugs approved by the FDA for use for more than 12 weeks. Adipex-P (phentermine) and Tenuate (diethylpropion) are FDA-approved for short-term use.

Appetite suppressants (anorexiants)

Most FDA-approved weight loss drugs suppress the appetite by affecting one or more neurotransmitters

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in the brain that control appetite and mood. Various appetite suppressants increase the secretion of dopamine, norepinephrine, or serotonin or inhibit the reuptake of these neurotransmitters into the nerve cell. Some drugs affect more than one neurotransmitter. These drugs may cause a person to feel less hungry or more satiated.

SIBUTRAMINE. Sibutramine was approved by the FDA in 1997 for long-term use. It reduces appetite by inhibiting the reuptake of norepinephrine, dopamine, and serotonin. One study found that patients taking sibutramine lost an average of 7–10 lbs. (3—5 kg) more over one year than those on a low-calorie diet alone.

AMPHETAMINES OR SYMPATHIMIMETIC DRUGS. Some amphetamines are FDA-approved for very short-term weight loss. Although most of these drugs do not cause weight loss over more than a few months, phentermine continues to be one of the two most commonly prescribed weight loss medications—along with subitramine—in the United States.

Some amphetamine-type weight loss drugs, including **methamphetamine** (Desoxyn), were approved by the FDA in the mid-1990s based on very little data. Other FDA-approved weight loss drugs for short-term use include:

- benzphetamine (Didrex)
- diethylpropion (Tenuate, Tenuate Dospan, Tepanil Ten-Tab), approved in 1959
- mazindol (Mazanor, Sanorex)
- phendimetrazine (Adipost, Bontril PDM, Bontril Slow-Release, Melfiat, Obezine, Phendiet, Phendiet-105, PT 105, Plegine, Prelu-2, X-Trozine), approved in 1982
- phentermine (Adipex-P, Fastin, Ionamin, Obenix, Oby-trim, Phentercot, Phentride, Pro-Fast, Teramine, Zantryl), approved in 1959

Lipase inhibitors

In 1999 the FDA approved orlistat (the first of a new class of anti-obesity drugs called lipase inhibitors) for long-term use. Orlistat inhibits the pancreatic enzyme lipase that breaks down dietary fat, which in turn decreases the body's absorption of dietary fat by as much as 30%. The undigested fat is excreted in the stool.

Orlistat is prescribed for overweight or obese patients who also have high cholesterol, diabetes, high blood pressure, or heart disease

Off-label use

Physicians sometimes prescribe drugs for weight loss that are not FDA-approved for that purpose—so-called off-label use. The use of weight loss medications—other than sibutramine and orlistat—for more than a 12 weeks is also considered off-label use.

Off-label weight loss drugs include:

- antidepressants, such as bupropion
- the anticonvulsant drugs topiramate and zonisamide
- the diabetes medications metformin, exenatide, and pramlintide

Antidepressants may result in moderate weight loss for up to six months after which the weight usually is regained. Metformin appears to reduce hunger and food intake and may promote small weight loss in the obese and those with type 2 diabetes.

Drugs withdrawn from the market

Although effective for long-term weight loss, fenfluramine (Pondimin and others), dexfenfluramine (Redux), and a fenfluramine/phentermine combination (fen/phen) were withdrawn from the market in 1997 after it was found that they caused potentially fatal complications.

In February of 2004 the FDA prohibited the sale of dietary supplements containing ephedrine alkaloids, including ephedra, Ma huang, Sida cordifolia, and pinellia, because of potential complications. These supplements were aggressively marketed for weight control, as well as for energy and sports performance. Although they may affect modest short-term weight loss, these drugs raise blood pressure, stress the circulatory system, and have been linked to **heart attack** and **stroke**.

Phenylpropanol amine, a drug mainly used to treat colds and **allergies**, was also taken off the market because young women who were taking it for weight loss had a higher rate of stroke due to bleeding in the brain.

Recommended dosage

Dosages of appetite suppressants vary with the individual and a full dose may be more than necessary for some people. A low dose of subitramine often is prescribed for at least the first four weeks. Once-a-day appetite suppressors should be taken 10–14 hours before bedtime. When taking more than one dose per day, the last dose should be 4–6 hours before bedtime. Long-acting capsules or tablets should be swallowed

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whole, rather then chewed or cut up. Missed doses should be skipped.

The average doses of appetite suppressants are:

- sibutramin: a 10-mg capsule once a day, usually in the morning; a maximum of 15 mg per day
- benzphetamine: 25 to 50-mg tablets once a day in mid-morning or mid-afternoon
- diethylpropion: 25-mg tablets, three times per day, one hour before meals; 75-mg extended-release tablet, once a day in mid-morning
- mazindol: 1-mg tablet once a day, taken with food
- phendimetrazine: 17.5–35-mg tablets, two to three times per day, one hour before meals; 105-mg extended-release capsules, 30 to 60 minutes before the morning meal
- phentermine: 15–37.5-mg capsule or tablet, once a day, before breakfast or one to two hours after or smaller doses 30 minutes before meals; 15–30-mg oral resin capsule, once-per-day, before breakfast

The usual dose of prescription orlistat is a 120-mg capsule taken three times a day, up to one hour after each main meal that contains fat. The meal should contain no more than 30% calories from fat. Orlistat should not be taken if a meal is missed, the meal does not contain fat, or it is more than one hour past the meal. The usual dose of Alli, a reduced-strength form of orlistat, is 75 mg.

Precautions

With the exception of orlistat, all prescription weight loss medications are controlled substances. Very few studies have evaluated for their safety or effectiveness for periods of more than six months to two years. The use of any combination of weight loss drugs is not recommended. The risks of using appetite-suppressing drugs during **pregnancy** are unknown. Orlistat is approved for use in those aged 12 and above. No other weight loss drug is approved for use in children under age 16.

After beginning a weight loss drug, patients should return for follow-ups in two to four weeks, monthly for three months, and then every three months for the first year to monitor weight, blood pressure, pulse, and side effects, and have laboratory testing.

Appetite suppressants

Appetite suppressants should not be taken within 14 days of taking a monoamine oxidase (MAO) inhibitor; extremely high blood pressure and seizures may develop suddenly. Taking subitramine along with a drug that has MAO-inhibitor activity can cause a life-threatening condition called serotonin syndrome.

Sibutramine should not be used by people with the following problems:

- poorly-controlled high blood pressure
- irregular heartbeat (arrhythmia)
- a history of stroke
- heart disease
- congestive heart failure

Most appetite suppressants can be habit-forming. In late 2004 Meridia was singled out by critics as a drug that is only minimally effective and has been associated with several deaths.

Amphetamine-type weight loss drugs should not be use by anyone with the following problems:

- high blood pressure
- heart disease
- an overactive thyroid gland
- glaucoma

Amphetamine-type weight loss drugs can test positive on urine screenings for amphetamines. These drugs have a high potential for **abuse** and **addiction**.

Orlistat

Orlistat may decrease the absorption of fat-soluble **vitamins** and beta-carotene. Therefore, a daily multivitamin supplement, including vitamins A, E, K and beta-carotene, should be taken at least two hours before or after orlistat or at bedtime. Foods containing more than 30% fat should be avoided while a person is using orlistat. Gallbladder problems may become worse with orlistat.

Other precautions

Various conditions may affect the choice of a weight loss drug, including the following:

- pregnancy or breastfeeding
- a history of drug or alcohol abuse or dependence
- a history of eating disorders
- a history of depression or manic-depressive disorder
- a family history of mental illness
- the use of MAO inhibitors or other antidepressants
- migraine headaches requiring medication
- glaucoma
- diabetes mellitus
- epilepsy
- thyroid disease
- kidney problems

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- gallstones
- liver disease
- problems absorbing food (malabsorption syndrome)
- high blood pressure
- heart disease, a heart condition such as arrhythmia, blood vessel disease
- future surgery that will require general anesthesia

Some dietary supplements are marketed as weight loss products. They are not reviewed by the FDA and are not necessarily safe. They may interact with other drugs and may be dangerous for people with certain medical conditions. Herbal medications have unpredictable amounts of active ingredients and unpredictable and potentially harmful side effects.

Side effects

Many overweight people are generally healthy, and the side effects of weight loss drugs may far outweigh the benefits. Side effects may be reduced by starting at the lowest effective dose, although any drug can cause an allergic reaction in any individual.

Appetite suppressants

Side effects of sibutramine and other appetite suppressants may include:

- increased blood pressure
- dry mouth
- headache
- abdominal cramps or pain
- constipation
- nausea or vomiting
- drowsiness
- insomnia
- irritability
- anxiety
- dizziness, lightheadedness, confusion
- poor coordination

Dry mouth can be relieved with sugarless candy or gum, ice, or a saliva substitute. However, dry mouth lasting more than two weeks can increase the risk of serious dental disease.

Less common side effects of appetite suppressants include:

- fast or irregular heart beat
- skin rash or hives
- fever
- sore throat
- sweating
- uncontrollable trembling or shaking
- diarrhea
- unusual bruising or bleeding
- depression

Although sibutramine side effects usually are mild and may improve with continued use, additional side effects may include:

- increased thirst
- changes in sense of taste
- heartburn
- stuffy or runny nose
- skin burning, itching, prickling, or tingling
- back pain
- painful menstruation
- weakness
- swelling in various parts of the body

Fast heart rate can be a symptom of sibutramine overdose. Other rare serious complications from subitramine include:

- chest pain
- difficulty speaking, swallowing, or breathing
- muscle stiffness
- uncoordinated or abnormal movement
- fainting
- rapid mood shifts
- enlarged pupils, eye pain, vision changes
- confusion
- seizures

Other side effects of amphetamines can include:

- a false sense of well-being
- an unpleasant taste
- decreased alertness
- restlessness
- uncontrollable activity or excitement
- hallucinations
- increased need to urinate
- difficult or painful urination
- numbness, particularly on one side of the face or body
- blurred vision
- changes in libido or decreased sexual function

Higher dosages, more frequent doses, or longer-term use of amphetamines can lead to physical dependence or overdose, with symptoms that include:

- skin disease
- severe insomnia

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KEY TERMS

Amphetamines—Sympathomimetic amines; sometimes called speed; synthetic chemicals that stimulate the central nervous system.

Body mass index (BMI)—The correlation of body weight with height; usually correlates with total body fat.

Dopamine—A neurotransmitter and precursor of norepinephrine; found in high concentrations in the brain.

Ephedrine—A sympathomimetic amine from plants of the genus *Ephedra* or chemically synthesized; an asthma medication that previously was used in weight loss drugs.

Lipase—A fat-splitting enzyme found in pancreatic juice, blood, and many tissues.

Neurotransmitter—A substance that helps transmit impulses between two nerve cells or a nerve and muscle.

Norepinephrine—A hormone that constricts blood vessels.

Orlistat—A drug that inhibits lipase.

Phentermine—An amphetamine prescribed for appetite suppression.

Serotonin—5-Hydroxytryptamine; a chemical in various parts of the body that stimulates smooth muscle contraction, constricts blood vessels, and inhibits stomach secretions.

Sibutramine—An appetite-suppressing drug that may increase the activity of norepinephrine and serotonin in the brain.

- excessive excitability or irritability
- panic
- violent urges
- personality changes
- severe mental illness
- high or low blood pressure
- seizures
- coma

Symptoms of withdrawal may be lessened or prevented by gradually reducing the dosage.

Orlistat

Orlistat side effects usually are mild and can improve with continued use. They may include the following:

- intestinal discomfort or cramping
- flatulence
- frequent, urgent need to defecate
- inability to control bowel movements and leakage
- oily diarrhea
- flu- or cold-like symptoms
- irregular menstrual periods

Less common side effects of orlistat include:

- rectal pain
- back pain
- tooth or gum problems
- chest tightness
- wheezing
- anxiety

Orlistat side effects requiring immediate medical attention include:

- itching, rash, or hives
- fever
- frequent, difficult, or painful urination
- bloody or cloudy urine
- swelling of body parts
- chest pain
- difficulty breathing
- earache or hearing changes

Orlistat side effects can be worsened by eating meals with at least 30% of total calories from fat. Side effects usually disappear within two to three days after discontinuing the drug.

Interactions

Appetite-suppressants can interact negatively with numerous other drugs, including the following:

- other appetite suppressants and amphetamines
- caffeine
- cold and allergy medicines
- asthma medications
- selective serotonin reuptake inhibitors (Saris)
- tricycles antidepressants
- medications used during surgical, dental, or emergency procedures
- cocaine and other street drugs

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In addition to the above, subitramine is known to interact with numerous other drugs, including the following:

- pain relievers and muscle relaxants
- sulfa antibiotics
- antifungal medications
- sedatives, sleeping pills, tranquilizers
- high-blood-pressure medications
- migraine-headache medications
- medications for nausea, anxiety, mental illness, seizures
- blood thinners, such as warfarin (Coumadin)
- chemotherapies

Orlistat may interact with the following:

- other weight loss medications
- diabetes medications, including insulin
- blood thinners
- herbal products
- cyclosporine

Resources

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ORGANIZATIONS

American Council for Fitness and Nutrition, 1350 I Street, Suite 300, Washington, DC, 20005, http://www.acfn.org/.

American Dietetic Association, 120 S. Riverside Plaza, Suite 2000, Chicago, IL, 60606-6995, (312) 899-0040, (800) 877- 1600, http://www.eatright.org/.

Dietitians of Canada, 480 University Ave., Suite 604, Toronto, Ontario, M5G 1V2, Canada, (416) 596-0857, centralinfo @dietitians.ca, http://www.dietitians.ca.

The Obesity Society, 8630 Fenton St., Suite 814, Silver Spring, MD, 20910, (301) 563-6526, (301) 563-6595, http://www.obesity.org/.

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Weil's disease *see* **Leptospirosis**

Wermer's syndrome *see* **Multiple endocrine neoplasia syndromes**

Wernicke-Korsakoff disease *see* **Alcohol-related neurologic disease**

West Nile virus

Definition

West Nile virus is a mosquito-borne virus that causes viral illnesses of varying seriousness, ranging from no symptoms or mild flu-like symptoms to **encephalitis** or **meningitis**.

Description

The primary hosts of West Nile virus (WNV) are birds, in which the virus numbers multiply before being transmitted by mosquitoes to the next victim. Over 140 species of birds can be infected with WNV. Besides birds, the virus can infect other vertebrates, including humans. WNV is a flavivirus that belongs to the **Japanese encephalitis** serocomplex, which includes St. Louis encephalitis, Murray Valley encephalitis, and Kunjin virus. Infections occur generally between late summer and early fall in temperate areas, and throughout the year in southern climates. Although typical manifestation of WNV is asymptomatical, the virus can cross the blood-brain barrier and cause severe illness and **paralysis**.

WNV was originally isolated in a feverish woman living in the West Nile District of Uganda during 1937. The virus was ecologically characterized in Egypt during the 1950s and later linked to severe human meningoencephalitis in elderly patients during a 1957 outbreak in Israel. Since 1937, subsequent outbreaks of WNV have been reported in Africa, Asia, Australia, Oceania, Western Europe, and the Middle East.

In the summer of 1999, WNV was first reported in the New York City area and then spread rapidly across the entire continent. It is still unknown how the WNV reached the United States, but it is suspected that the transport of infected birds or the international

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West Nile virus neuroinvasive and nonneuroinvasive disease cases and deaths, by year—United States,* 1999–2008

Year	Neuroinvasive			Nonneuroinvasive			Total		
	No. of cases	Deaths		No. of cases	Deaths		No. of cases	Deaths	
		No.	(%)		No.	(%)		No.	(%)
1999	59	7	(12)	3	0	(0)	62	7	(11)
2000	19	2	(11)	2	0	(0)	21	2	(10)
2001	64	10	(16)	2	0	(0)	66	10	(15)
2002	2,946	278	(9)	1,210	9	(<1)	4,156	287	(7)
2003	2,866	232	(8)	6,996	32	(<1)	9,862	264	(3)
2004	1,148	94	(8)	1,391	6	(<1)	2,539	100	(4)
2005	1,309	104	(8)	1,691	15	(<1)	3,000	119	(4)
2006	1,495	162	(11)	2,774	15	(<1)	4,269	177	(4)
2007	1,227	117	(10)	2,403	7	(<1)	3,630	124	(3)
2008	689	41	(6)	667	3	(<1)	1,356	44	(4)
Total	**11,822**	**1,045**	**(9)**	**17,139**	**86**	**(<1)**	**28,961**	**1,134**	**(4)**

*No cases were reported from Alaska, Hawaii, Maine, or any U.S. territories.

SOURCE: Centers for Disease Control and Prevention, "Surveillance for Human West Nile Virus Disease—United States, 1999–2008" *MMWR Surveillance Summaries* 59, no. SS—5 (April 2, 2010): 1–17.

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travel of infected humans may have been to blame. After its arrival in the New Work area, the virus spread rapidly across the United States, as well as north into Canada and south into Mexico. In 2002, a severe outbreak of WNV in the United States killed 284 people and caused 2,944 cases of severe brain damage. As of January 2005 the Center for Disease Control (CDC) has recorded avian or animal WNV infections in every state except Alaska, Hawaii, and Washington.

Life Cycle and Transmission

Like most flaviviruses, the WNV is maintained in a natural host-vector-host cycle, where the primary vector is the mosquito. The zoonotic cycle begins with a reservoir host, which is most commonly of avian origin. When a mosquito feeds on the infected bird, the virus is passed to the insect along with the blood meal. The virus then multiplies rapidly within the mosquito's body and salivary glands over the next few days. When the insect feeds on another animal or human, the virus can be transmitted through the bite and cause serious illness.

Most mosquitoes can become infected with the WNV. However, female mosquitoes of the *Culex pipiens* species are of particular concern, as they live in suburban and urban areas, can survive through the winter, prefer to feed on birds, and frequently bite humans. The *Culex pipiens*, also known as the house mosquito, is also the most common vector for WNV transmission. *Culex restuan*, *Culex quinquefasciatus*, *Aedes Albopictus*, and *Aedes Vexans* are also common carriers of the WNV.

Common food sources for mosquitoes, birds represent the primary WNV reservoir species. A continent-wide study published in 2007 suggests that WNV has severely affected bird populations associated with human habitats in North America, showing that WNV is indeed the main factor behind the observed large-scale declines in bird populations. For instance, in 2005, crow populations declined regionally by up to 45% from 1998 levels, although they had increased steadily for two decades. Crow declines have been positively correlated with the intensity of human WNV epidemics within each region studied. Similar correlations between human infections and impacts on bird species were strongest for house wrens and eastern bluebirds. The virus has also been identified in more than 250 bird species in the United States, including blue jays, ravens, magpies, sparrows, and starlings. Many in the scientific community believe that the rapid spread of WNV in North America may be due in part to the migratory nature of birds. Infected birds carry the virus with them as they travel in summer and winter, thus acting as reservoirs in their new nesting sites.

Most vertebrates, such as alligators, bats, chipmunks, skunks, squirrels, and rabbits, can also be infected with WNV. Horses, in particular, are commonly infected with WNV. Like humans, the majority of horses suffer either no or mild symptoms, but severe illness and **death** can and does occur. There are relatively few cases of dogs and cats becoming infected

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with WNV. Animals of all species exhibiting **fever**, weakness, poor coordination, spasms, seizures, and/or personality changes may be infected with WNV.

There is no evidence of WNV transmission from person–to–person through touch, kissing, or other contact. However, there is evidence of WNV transplacental (mother-to-child) transmission, as well as viral transmission through **breastfeeding**. As such, pregnant mothers should be aware of the presence of WNV in their area and take appropriate precautions. The transmission of WNV has also been evidenced in blood–transfusions and organ transplants although the current blood supply is now tested for the presence of the WNV. People that are immunocompromised (from disease or **chemotherapy**, for example) and people aged 50 and older represent the highest risk group for serious WNV infection.

Demographics

In the United States, the CDC monitors and records human WNV infections. In 2007, 3,404 cases were reported, including 98 fatalities in every state except Alaska, Hawaii, New Hampshire, Vermont, Washington, and West Virginia. In 2007, 14 cases were reported in eastern Canada, 1,976 cases were reported in central Canada, and 336 cases were reported in western Canada. Experts believe that WNV is now firmly established in the Western Hemisphere.

Among those with severe illness due to West Nile virus, fatality rates range from 3% to 15% and are highest among the elderly. Less than 1% of people who become infected with West Nile virus will develop severe illness as most people who get infected do not develop any disease at all.

Causes and symptoms

The exact mechanism of WNV–caused illnesses remains unclear. However, it is suspected that the virus enters the host's blood stream and multiples. It can then develop to the point where it crosses the blood-brain barrier, which separates the blood from the central nervous system. When this occurs, the virus can infect the brain, spinal cord, and other vital systems, creating a potentially deadly inflammatory response.

The incubation period for WNV after infection typical ranges between 3 to 14 days. Eighty percent of infected persons will exhibit no clinically apparent symptoms whatsoever. Roughly 20% of infected persons will exhibit a series of mild flu-like symptoms, also known as West Nile Fever. These mild symptoms can persist for 3 to 6 days, possibly weeks, and include:

- eye pain
- fever
- headache
- loss of appetite
- lymphadenopathy (abnormal enlargement of the lymph nodes)
- malaise (nonspecific bodily discomfort)
- myalgia (nonspecific muscular pain/tenderness)
- nausea
- rash (on the neck, torso, and limbs)
- vomiting

In rare cases, approximately 1 in 150 cases (0.7%), WNV can cross the blood-brain barrier and develop into a severe neuroinvasive disease. Immunocompromised and elderly (>50 years of age) patients are at an increased risk for developing more severe syndromes; a 20-fold increase in incidence among older patients. Symptoms indicating the possible presence of severe West Nile–related syndromes include:

- severe headache
- high fever
- acute muscle weakness
- neck stiffness
- convulsions and tremors
- disorientation and stupor
- paralysis
- coma

People exposed to WNV infection, especially the immunocompromised and elderly, should contact their health provider immediately if they develop a severe **headache** accompanied by high fever.

Typically, severe WNV syndromes manifest as one of three syndromes: West Nile encephalitis (inflammation of the brain); West Nile meningitis (inflammation of the meninges of the brain and spinal cord); or West Nile meningoencephalitis (inflammation of both the brain and the meninges). These three syndromes can cause severe brain damage and even death. Severe WNV disease carries a mortality rate ranging between 3% and 15%, with elderly patients suffering the highest mortality rate. The majority of these deaths are a result of complication attributable to West Nile meningoencephalitis. Additionally, severe WNV disease can cause acute vision loss due to inflammatory disorders of the eye, such as chorioretinitis, **optic neuritis**, retinal **vasculitis**, **uveitis**, and vitritis. Less frequently, the patient can exhibit acute

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flaccid paralysis, similar to poliomyelitis (**polio**) or Guillain-Barré syndrome, caused by inflammation of the spinal cord and/or damage to the peripheral nerves. In some severe cases, this acute flaccid paralysis can disrupt muscles that control breathing and result in **respiratory failure**.

Diagnosis

A proper diagnosis of WNV infection depends heavily upon clinical presentation, laboratory testing, and patient history. Patients with a known susceptibility to WNV (the elderly and immunocompromised) that exhibit symptoms during the late spring to early fall, or at any time in warmer climates, should be tested for WNV and other arboviral infections. Additionally, health providers should remain constantly aware of the local presence of WNV activity, such as reports of recent animal and/or human cases. Similarities of symptomology between and serological cross-reactivity of WNV and other flaviviruses, may lead to confusion and an incorrect diagnosis. Health providers must use thorough laboratory testing to differentiate WNV antibodies from those of other arboviruses.

Symptomatic WNV infection can be classified as either non–neuroinvasive or neuroinvasive, with each being identified according to certain criteria.

Non–neuroinvasive

The majority of WNV infections are asymptomatic. In approximately 20% of WNV cases, clinically recognizable symptoms can manifest. However, to be clinically classified as non-neuroinvasive West Nile disease, the following must be true:

- no neuroinvasive symptomology
- presence of fever without other recognizable cause
- four–fold or greater increase in serum antibody titer
- virus isolated from and or deomonstrated in blood, tissue, cerebrospinal fluid (CSF), or other bodily fluid
- virus–specific immunoglobulin M (IgM antibodies demonstrated in CSF through antibody-capture methods

Neuroinvasive

In rare cases (0.7%) of West Nile disease, the virus crosses the blood-brain barrier and manifests in severe and life-threatening symptomology. Clinical confirmation of neuroinvasive of neuroinvasive disease requires the presence of a fever and at least one of the following:

- acutely altered mental status, such as disorientation, stupor, or coma
- acute central or peripheral neurological difficulties, such as paralysis, nerve palsy, sensory deficits, and abnormal muscle function
- an increased white blood cell concentration in the CSF coupled with symptoms of meningitis, such as severe headache and neck pain

Treatment

Currently, there are no treatment modalities for WNV infection. Instead, supportive care is utilized to treat the varying symptoms and syndromes associated with the various West Nile diseases. Although milder symptoms can be treated at home, severe symptoms can require hospitalization. Treatment of severe symptoms may require the use of intravenous infusions, airway and respiratory management and support, and use of preventive measures against secondary infection.

Clinical trials

Many clinical trials for the study and treatment of WNV are currently sponsored by the National Institutes of Health (NIH) and other agencies. In 2007, NIH reported 12 ongoing or recently completed studies, including five in the recruitment stage.

A few examples include:

- The safety of Omr–IgG–am for the treatment of WNV infection. (NCT00069316)
- The examination of how WNV affects the human body. (NCT00069303)
- The study of WNV outcomes and of the effects of the disease on individuals, specifically on their nervous systems. (NCT00138463)
- The evaluation of the safety of an experimental vaccine for preventing WNV. (NCT00300417)

Clinical trial information is constantly updated by NIH. The most recent information on WNV trials can be found at http://clinicaltrials.gov/ct2/results?term=west+nile+virus.

Prognosis

The majority of WNV infections will manifest asymptomatically. West Nile fever offers an excellent prognosis associated with quick recovery and no adverse side-effects. The majority of symptoms will resolve within a few days or weeks of manifestation.

However, the prognosis is not a positive for patients suffering the more severe syndromes attributable to WNV infection. Symptoms of West Nile encephalitis, West Nile meningitis, and West Nile

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KEY TERMS

Flavivirus—An arbovirus that can cause potentially serious diseases, such as dengue, yellow fever, Japanese encaphilitis, and West Nile fever.

Guillain-Barré—A disorder in which the body's immune system attacks part of the peripheral nervous system. Weakness, tingling, and abnormal sensations in the arms and upper body can progress until the muscles become totally disabled and the patient is effectively paralyzed.

Meninges—A series of membranous layers of connective tissue that protect the central nervous system (brain and spinal cord). Damage or infection to the meninges, such as in meningitis, can cause serious neurological damage and even death.

Zoonotic diseases—Diseases caused by infectious agents that can be transmitted between (or are shared by) animals and humans. This can include transmission through the bite of an insect, such as a mosquito.

meningoencephalitis can last for several weeks, as well as cause severe and permanent neurological damage. Inflammation can interfere with the brain and central nervous system and result in death, especially among the elderly population. Patients with West Nile poliomyelitis may suffer prolonged muscle weakness and loss of motor control. Long-term **rehabilitation** is typically required and a full recovery is not assured. If the poliomyelitis affects muscles used for breathing, death from respiratory failure may result.

Prevention

Although there is a vaccine used for horses and exotic birds in zoos, there is no WNV vaccine for humans at the current time. Several pharmaceutical companies, however, have WNV vaccines in development.

Prevention techniques of WNV typically coincide with avoidance measures against mosquito **bites**, the primary source of the virus. These include the use of insect repellant (with 5% to 20% DEET) on exposed body parts, wearing loose-fitting clothes over the limbs and torso while outdoors, using mosquito coils and/or citronella candles outdoors, and limiting outdoor activities during peak biting periods and/or in areas with high mosquito density. While camping outdoors, knockdown spray or bed netting with pyrethrum is suggested. Mosquito eradication programs have been instituted in most major cities. Public health authorities can utilize United States Environmental Protection Agency-approved "adulticidies" in areas suspected of the presence of WNV.

The *Culex pipiens* mosquito is the primary vector of WNV transmission and is also commonly live and feed in urban areas. Special precautions should be taken to reduce exposure to these potentially infected insects. Screen doors and enclosed porches can help keep mosquitoes from coming into the house. It should be noted that studies have shown that mosquito control devices such as "bug zappers" and CO2-baited traps do not significantly reduce the risk of being bitten.

Removing potential mosquito breeding areas from near the home and from the neighborhood can further reduce the risk of bites. Any container which can collect half an inch of standing water can become a potential breeding site in as little as five days. Old tires, empty plant pots, and empty trashcans should be removed, while water sources like ponds or birdbaths should be cleaned regularly. Standing water on any property should be drained, such as from clogged eaves. Swimming pools and hot tubs should be properly covered and chlorinated to prevent mosquitoes breeding in them.

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National Institute of Allergies and Infectious Diseases, 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-6612, (301) 496-5717, (301) 402-3573, (866) 284-4107, ocpostoffice@niaid.nih.gov, http://www.niaid.nih.gov.

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Western equine encephalitis *see* **Arbovirus encephalitis**

Western herbalism *see* **Herbalism, western**

Wheezing

Definition

Wheezing is a high-pitched whistling sound associated with labored breathing.

Description

Wheezing occurs when a child or adult tries to breathe deeply through air passages that are narrowed or filled with mucus as a result of:

- allergy
- infection
- illness
- irritation

Wheezing is most common when exhaling. It is sometimes accompanied by a mild sensation of tightness in the chest. **Anxiety** about not being able to breathe easily can cause muscle tension that makes matters worse.

Causes and symptoms

Wheezing is the symptom most associated with **asthma**. It can be caused by:

- exposure to allergens (food, pollen, and other substances that cause a person to have an allergic reaction)
- fumes
- ice-cold drinks or very cold air
- medication
- strenuous exercise
- weather changes
- foreign objects trapped in the airway
- cystic fibrosis and other genetic disorders
- respiratory illnesses, such as pneumonia, bronchitis, congestive heart failure, and emphysema

Diagnosis

A family physician, allergist, or pulmonary specialist takes a medical history that includes questions about **allergies** or unexplained symptoms that may be the result of allergic reactions. If the pattern of the patient's symptoms suggests the presence of allergy, skin and blood tests are performed to identify the precise nature of the problem.

A pulmonary function test may be ordered to measure the amount of air moving through the patient's breathing passages. X rays are sometimes

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indicated for patients whose wheezing seems to be caused by chronic **bronchitis** or **emphysema**.

In 2004, researchers in Japan discovered a new method for diagnosing asthma in infants by testing for certain antibodies in their sputum (mucus that spits up from the bronchi).

Treatment

Mild wheezing may be relieved by drinking plenty of juice, water, weak tea, and broth. Ice-cold drinks should be avoided.

A vaporizer can help clear air passages. A steam tent, created by lowering the face toward a sink filled with hot water, placing a towel over the head and sink, and inhaling the steam, can do likewise.

Bronchodilators (medications that help widen narrowed airways) may be prescribed for patients whose wheezing is the result of asthma. Newer asthma medications taken daily can help prevent asthma attacks, as can avoiding asthma and allergy triggers.

Antibiotics are generally used to cure acute bronchitis and other respiratory infections. **Expectorants** (cough-producing medications) or certain bronchodilators are prescribed to remove excess mucus from the breathing passages.

If wheezing is caused by an allergic reaction, **antihistamines** will probably be prescribed to neutralize body chemicals that react to the allergen.

Medical emergencies

Breathing problems can be life-threatening. Immediate medical attention is required whenever an individual:

- turns blue or gray and stops breathing
- becomes extremely short of breath, and is unable to speak
- coughs up bubbly-pink or white phlegm
- seems to be suffocating
- develops a fever of 101°F (38.3°C) or higher
- wheezes most of the time and coughs up gray or greenish phlegm

Alternative treatment

Certain **yoga** positions (Bridge, Cobra, Pigeon, and Sphinx) may relieve wheezing by improving breathing control and reducing **stress**. Patients whose wheezing is related to asthma, chronic bronchitis, emphysema, or a severe allergic reaction may benefit from these techniques, but must continue to have their condition monitored by a conventional physician.

Prognosis

Mild wheezing caused by infection or acute illness usually disappears when the underlying cause is eliminated.

Some doctors believe that childhood respiratory infections may activate parts of the immune system that prevent asthma from developing.

Prevention

Stopping **smoking** can eliminate wheezing. So can reducing or preventing exposure to other substances that cause the problem.

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Whiplash

Definition

Whiplash is a sudden, moderate-to-severe strain affecting the bones, discs, muscles, nerves, or tendons of the neck.

Description

The neck is composed of seven small bones. Known as the cervical spine, these bones:

- support the head
- help maintain an unobstructed enclosure for the spinal cord
- influence the shape and structure of the spine
- affect posture and balance

About 1,000,000 whiplash injuries occur in the United States every year. Most are the result of motor vehicle accidents or collisions involving contact sports. When unexpected force jerks the head back,

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then forward, the bones of the neck snap out of position, and irritated nerves can interfere with flow of blood and transmission of nerve impulses. Pinched nerves can damage or destroy the function of body parts whose actions they govern.

Risk factors

Osteoarthritis of the spine increases the risk of whiplash injury. So do poor driving habits, driving in bad weather, or driving when tired, tense, or under the influence of alcohol or other drugs.

Causes and symptoms

Tension shortens and tightens muscles. **Fatigue** relaxes them. Either condition increases the likelihood that whiplash will occur and the probability that the injury will be severe.

Sometimes symptoms of whiplash appear right away. Sometimes they do not develop until hours, days, or weeks after the injury occurs. Symptoms of whiplash include:

- pain or stiffness in the neck, jaw, shoulders, or arms
- dizziness
- headache
- loss of feeling in an arm or hand
- nausea and vomiting

Depression and vision problems are rare symptoms of this condition.

Diagnosis

Whiplash is difficult to diagnose because x rays and other imaging studies do not always reveal changes in bone structure. Organs affected by nerve damage or reduced blood supply may generate symptoms not clearly related to whiplash.

Diagnosis is based on observation of the patient's symptoms, medical history, **physical examination**, and neurological studies to determine whether the spine has been injured.

Treatment

Medication, **physical therapy**, and supportive measures are used to treat whiplash. Chiropractors gently realign the spine to relax pinched nerves or improve blood flow. A patient whose symptoms are severe may wear a soft, padded collar (Thomas collar or cervical collar) until the **pain** diminishes.

When pressure on the root of the nerve causes loss of strength or sensation in a hand or arm, a cervical **traction** apparatus may be recommended.

Self-care

Inflammation and cramping can be alleviated by wrapping ice or an ice pack in a thin towel and applying it to the injured area for 10-20 minutes every hour. After the first 24 hours, painful **muscle spasms** can be prevented by alternating cold packs with **heat treatments**. Letting a warm shower run on the neck and shoulders for 10-20 minutes twice a day is recommended. Between showers, warm towels or a heat lamp should be used to warm and soothe the neck for 10-15 minutes several times a day.

Improving posture is important, and gentle massage can be beneficial. Sleeping without a pillow promotes healing, and a cervical collar or small rolled towel pinned under the chin can provide support and prevent muscle fatigue.

Alcohol should be avoided. A chiropractor, primary care physician, or orthopedic specialist should be notified whenever a painful neck injury occurs. Another situation requiring attention is if the face or arm weaken or become painful or numb following a neck injury.

Prognosis

With treatment, whiplash can usually be cured in one week to three months after injury occurs. If nerve roots are damaged, **numbness** and weakness may last until recovery is complete.

Prevention

Chiropractors can recommend diet and **exercise** techniques to reduce **stress** and tension. Careful, defensive driving, wearing seatbelts, and using padded automobile headrests can lessen the likelihood of whiplash.

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Maureen Haggerty

Whipple's disease *see* Malabsorption syndrome

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KEY TERMS

Band—Immature neutrophil.

Basophil—White blood cell that increases in response to parasitic infections and allergic reactions.

Differential—Blood test that determines the percentage of each type of white blood cell in a person's blood.

Eosinophil—White blood cell that increases in response to parasitic infections and allergic reactions.

Leukocytosis—A white count increased to over 10,000/µL.

Leukopenia—A white count decreased to less than 4,000/µL.

Lymphocyte—White blood cell that fights viral and some bacterial infections by direct attack or the production of antibodies.

Monocyte—White blood cell that increases during a variety of conditions including severe infections. It removes debris and microorganisms by phagocytosis.

Neutrophil—White blood cell that increases in response to bacterial infection. It removes and kills bacteria through phagocytosis.

Phagocytosis—A process by which a white blood cell envelopes and digests debris and microorganisms to remove them from the blood.

White blood cell count and differential

Definition

The white blood cell count and differential determine the number of white blood cells and the percentage of each type of white blood cell in a person's blood. These tests are included in general health examinations and help investigate a variety of illnesses, including infection, allergy, and leukemia.

Purpose

The white blood cell count provides a clue to the presence of illness. White cells protect the body by fighting infection and attacking foreign material. When extra white cells are needed, the bone marrow increases production.

There are five types of white cells, each with different functions: neutrophils, lymphocytes, monocytes, eosinophils, and basophils. The differential reveals if these cells are present in a normal distribution or if one cell type is increased or decreased. This information helps diagnose specific types of illness.

Conditions or medications that weaken the immune system, such as **AIDS** or **chemotherapy**, cause a decrease in white cells. The white cell count detects dangerously low numbers of white cells.

Recovery from illness can be monitored by the white cell count. Counts continuing to rise or fall to abnormal levels indicate a worsening condition; counts returning to normal indicate improvement.

Description

Neutrophils increase in response to bacterial infection. They destroy bacteria by enveloping and digesting them, a process called phagocytosis. When many neutrophils are needed, they are released from the bone marrow as immature cells, called bands or stab cells.

Lymphocytes fight viral infections and some bacterial infections. Certain lymphocytes directly attack invading microorganisms; others produce antibodies that attack and destroy microorganisms and other foreign material. Large lymphocytes, called atypical lymphocytes, are seen during **infectious mononucleosis** and other illnesses.

Monocytes increase during severe infections, and other conditions. They remove debris and microorganisms by phagocytosis. Eosinophils and basophils increase in response to allergic reactions and parasitic infection.

White cell counts are usually done on an automated instrument. A sample of blood is mixed with a chemical to burst the red blood cells. The remaining white cells are counted by the instrument.

The differential is done by spreading a drop of blood on a microscope slide. The slide is stained with a special stain and examined under a microscope. One hundred white cells are counted and identified as either neutrophils, bands, lymphocytes, monocytes, eosinophils or basophils. Any atypical or immature cells also are counted. Cells are identified by the shape and appearance of the nucleus, the color of cytoplasm (the background of the cell), and the

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presence and color of granules. The percentage of each cell type is reported. At the same time, red cells and platelets are examined for abnormalities in appearance. Some instruments perform an automated differential.

Both the white blood cell count (also called white count or leukocyte count) and the differential (also called diff) are covered by insurance. Results are available the same day.

Preparation

This test requires 7 mL of blood. A healthcare worker ties a tourniquet on the person's upper arm, locates a vein in the inner elbow region, and inserts a needle into that vein. Vacuum action draws the blood through the needle into an attached tube. Collection of the sample takes only a few minutes.

Aftercare

Discomfort or bruising may occur at the puncture site. Pressure to the puncture site until the bleeding stops reduces bruising; warm packs relieve discomfort. The person may feel dizzy or faint.

Normal results

Total white cell count 5,000-10,000 uL. Neutrophils 50-60%. Lymphocytes 20-40%. Monocytes 2-6%. Eosinophils 1-4%. Basophils 0.5-1%. Bands 0-3%.

Abnormal results

The white cell count and differential are interpreted according to a person's clinical condition and medical history. **Leukocytosis** (a white count increased to over 10,000/uL) is seen in bacterial infections, inflammation, leukemia, trauma, and **stress**. Leukopenia (a white count decreased to less than 4,000/μL) is seen in some viral infections or severe bacterial infections and in conditions that affect the bone marrow, such as dietary deficiencies, chemotherapy, **radiation therapy**, and autoimmune diseases.

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Whooping cough

Definition

Whooping **cough**, also known as pertussis, is a highly contagious disease that causes classic spasms (paroxysms) of uncontrollable coughing, followed by a sharp, high-pitched intake of air that creates the characteristic "whoop" of the disease's name.

Demographics

The number of cases of whooping cough in the United States has periodically increased with a peak every 2-5 years since the 1980s. Cases occur equally in males and females. Whites make up the large majority at over 85% of cases diagnosed. People under the age of 20 years make up over 75% of cases, most of these being reported in children under the age of one or between the ages of 10 and 19. Because the whooping cough **vaccination** does not provide lifelong immunity and immunity is no longer evident after 12 years, people must be revaccinated in order to be protected.

Description

Whooping cough is caused by a bacteria called *Bordatella pertussis*. *B. pertussis* causes its most severe symptoms by attaching itself to cells in the respiratory tract that have cilia. Cilia are small, hair-like projections that beat continuously, and serve to constantly sweep the respiratory tract clean of such debris as mucus, bacteria, viruses, and dead cells. When *B. pertussis* interferes with this normal janitorial function, mucus and cellular debris accumulate and cause constant irritation to the respiratory tract, triggering coughing and increasing further mucus production.

Whooping cough is a disease that exists throughout the world. While people of any age can contract whooping cough, children under the age of two are at the highest risk for both the disease and for serious complications and **death**. Apparently, exposure to *B. pertussis* bacteria earlier in life gives a person some immunity against infection with it later on. Subsequent infections resemble the **common cold**.

Causes and symptoms

Whooping cough has four somewhat overlapping stages: incubation, catarrhal stage, paroxysmal stage, and convalescent stage.

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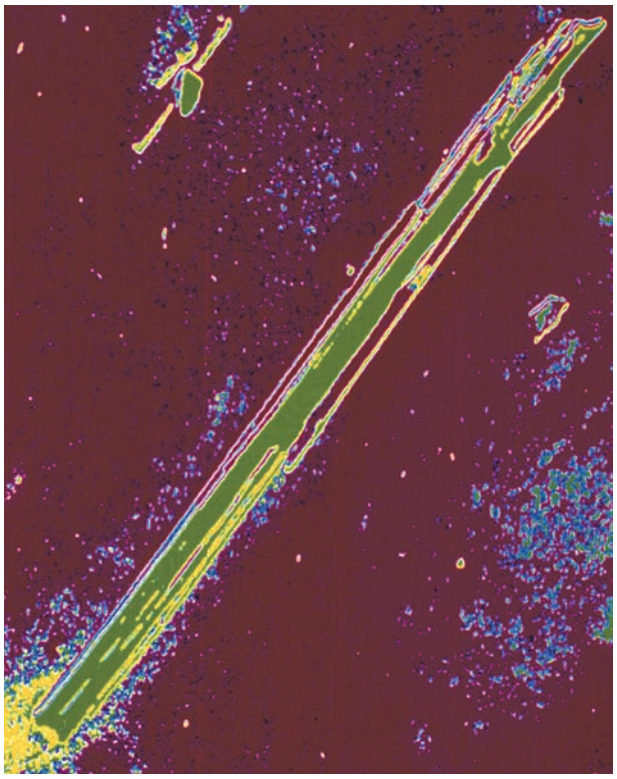

A magnified image of a pertussis toxin crystal that causes whooping cough. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

An individual usually acquires *B. pertussis* by inhaling droplets infected with the bacteria coughed into the air by someone with the infection. Incubation is the symptomless period of 7-14 days after breathing in the *B. pertussis* bacteria, and during which the bacteria multiply and penetrate the lining tissues of the entire respiratory tract.

The catarrhal stage is often mistaken for an exceedingly heavy cold. The patient has teary eyes, sneezing, **fatigue**, poor appetite, and an extremely runny nose (rhinorrhea). This stage lasts about 10–14 days.

The paroxysmal stage, lasting two to four weeks, begins with the development of the characteristic whooping cough. Spasms of uncontrollable coughing, the "whooping" sound of the sharp inspiration of air, and **vomiting** are all hallmarks of this stage. The whoop is believed to occur due to inflammation and mucous, which narrow the breathing tubes, causing the patient to struggle to get air into his or her lungs; the effort results in intense exhaustion. The paroxysms (spasms) can be induced by activity, feeding, crying, or even overhearing someone else cough.

The mucus produced during the paroxysmal stage is thicker and more difficult to clear than the more watery mucus of the catarrhal stage, and the patient becomes increasingly exhausted attempting to clear the respiratory tract through coughing. Severely ill children may have great difficulty maintaining the normal level of oxygen in their system and may appear somewhat blue (cyanotic) after a paroxysm of coughing, due to the low oxygen content of their blood. Such children may experience swelling and degeneration of the brain (encephalopathy), which is believed to be caused both by lack of oxygen to the brain during paroxysms and also by bleeding into the brain caused by increased pressure during coughing. Seizures may result from decreased oxygen to the brain. Some children have such greatly increased abdominal pressure during coughing that hernias result (hernias are the abnormal protrusion of a loop of intestine through a weak area of muscle). Another complicating factor during this phase is the development of **pneumonia** from infection with another bacterial agent; the bacteria takes hold due to the patient's already-weakened condition.

If the patient survives the paroxysmal stage, recovery occurs gradually during the convalescent stage, usually taking about three to four weeks. However, spasms of coughing may continue to occur over a period of months, especially when a patient contracts a cold, or other respiratory infection.

Diagnosis

Examination

Diagnosis based just on the patient's symptoms is not particularly accurate, as the catarrhal stage may appear to be a heavy cold, a case of **influenza**, or a simple **bronchitis**. Other viruses and **tuberculosis** infections can cause symptoms similar to those found during the paroxysmal stage. The presence of a pertussis-like cough along with an increase of certain specific white blood cells (lymphocytes) is suggestive of whooping cough. However, cough can occur from other pertussis-like viruses.

Tests

The most accurate method of diagnosis is to culture (grow on a laboratory plate) the organisms obtained from swabbing mucus out of the nasopharynx (the breathing tube continuous with the nose). *B. pertussis* can then be identified by examining the culture under a microscope.

Treatment

Drugs

Treatment with the antibiotic erythromycin is helpful only at very early stages of whooping cough,

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KEY TERMS

***Bordatella pertussis*—**A bacteria that causes whooping cough by attaching itself to cells in the respiratory tract.

Cilia—Tiny, hair-like projections from a cell. In the respiratory tract, cilia beat constantly in order to move mucus and debris up and out of the respiratory tree, in order to protect the lung from infection or irritation by foreign bodies.

Encephalopathy—Swelling and degeneration of the brain.

Lymphocytes—A type of white blood cell.

Nasopharynx—The breathing tube continuous with the nose.

Rhinorrhea—A name for the common cold.

during incubation and early in the catarrhal stage. After the cilia and the cells bearing those cilia are damaged, the process cannot be reversed. Such a patient will experience the full progression of whooping cough symptoms; symptoms only improve when the old, damaged lining cells of the respiratory tract are replaced over time with new, healthy, cilia-bearing cells. However, treatment with erythromycin is still recommended to decrease the likelihood of *B. pertussis* spreading. In fact, all members of the household where a patient with whooping cough lives should be treated with erythromycin to prevent the spread of *B. pertussis* throughout the community.

Home remedies

The only other treatment is supportive and involves careful monitoring of fluids to prevent **dehydration**; rest in a quiet, dark room to decrease paroxysms; and suctioning of mucus. Patients should be hospitalized if at risk for complication, such as infants from birth to six months of age.

Prognosis

Just under 1% of all cases of whooping cough cause death. Children who die of whooping cough usually have one or more of the following three conditions present:

- severe pneumonia, perhaps with accompanying encephalopathy
- extreme weight loss, weakness, and metabolic abnormalities due to persistent vomiting during paroxysms of coughing
- other pre-existing conditions, so that the patient is already in a relatively weak, vulnerable state (such conditions may include low birth weight babies, poor nutrition, infection with the measles virus, presence of other respiratory or gastrointestinal infections or diseases)

Prevention

The mainstay of prevention lies in programs similar to the mass immunization program in the United States, which begins immunization inoculations when infants are two months old. The pertussis vaccine, most often given as one immunization together with **diphtheria** and **tetanus** (DTP or DTaP), has greatly reduced the incidence of whooping cough.

There has been some concern about serious neurologic side effects from the vaccine itself. This concern led huge numbers of parents in England, Japan, and Sweden to avoid immunizing their children, which in turn has led to major epidemics of disease in those countries. However, several carefully constructed research studies have disproved the idea that the pertussis vaccine is the cause of neurologic damage. Furthermore, a newer formulation of the pertussis vaccine is available. Unlike the old whole cell pertussis vaccine, which is composed of the entire bacterial cell that has been deactivated (and therefore unable to cause infection), the newer acellular pertussis vaccine does not use a whole cell of the bacteria. Instead, it is made up of between two and five chemical components of the *B. pertussis* bacteria. The acellular pertussis vaccine appears to greatly reduce the risk of unpleasant reactions to the vaccine, including high **fever** and discomfort following vaccination.

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ORGANIZATIONS

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American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, IL, 60007-1098, (847) 434-4000, (847) 434-8000, http://www.aap.org.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (404) 639-3534, (800) CDC-INFO (800-232-4636). TTY: (888) 232-6348, inquiry@cdc.gov, http://www.cdc.gov.

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Wilderness medicine

Definition

Wilderness medicine encompasses the prevention, diagnosis, and treatment of injuries and medical conditions that may occur during activities in remote territories.

Purpose

Activities that may require wilderness medicine include backpacking, cross-country skiing, mountaineering, white water rafting, scuba diving, and exploration in undeveloped regions such as deserts or jungles. Wilderness medicine has evolved to deal with situations in which definitive medical care is hours or days away, and in which patients may require quick or extended attention. Wilderness medicine utilizes **first aid** techniques, but requires additional skills that take into account demanding environments, uncommon threats to health, hazardous or lengthy travel to medical facilities, and difficulties in obtaining food, water, and shelter.

Wilderness medicine uses techniques to assess and treat a variety of conditions and injuries, including:

- wounds and burns
- external and internal bleeding
- cardiac arrest
- head injuries
- spinal cord injuries
- fractures and dislocations
- altitude sickness
- problems from cold and heat
- allergic and anaphylactic reactions
- lightning strikes
- near drowning
- insect reptile, and animal bites
- poisoning
- emergency child birth

Precautions

In wilderness situations caregivers should follow the maxim of *first, do no harm*. Uninjured members of groups should not attempt rescues that place themselves in danger. People administering first aid or wilderness medicine should remain calm and organized at all times. Only those with experience should administer medications and medical procedures. Injured people should not be moved until they are fully evaluated or unless environmental conditions are threatening and require immediate shelter.

People with certain medical conditions should avoid travel in the wilderness, which can make existing conditions worse. These conditions include metastatic **cancer**, peptic ulcers, **coronary artery disease**, **chronic obstructive pulmonary disease**, clotting or bleeding disorders, high-altitude sickness, chronic **rheumatoid arthritis**, chronic severe back **pain**, and chronic knee and hip joint disease.

Description

The first stage of wilderness medicine begins with an assessment of the injury or condition. Primary assessment is used to quickly determine if a patient is in a life-threatening situation and to provide immediate emergency care. Secondary assessment is the thorough evaluation of a patient after life-threatening circumstances are relieved.

Primary assessment

A rule of thumb for the first steps of primary assessment, recommended by the Wilderness Medicine Institute, is the ABCDE procedure. It stands for Airway, Breathing, Circulation, Disability, and Exposure assessment. First, a patient's airway should be checked by close observation of whether or not air can move in and out and any obstructions to

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breathing should be alleviated. In unconscious people the tongue can often fall to the back of the throat and block breathing, so the head should be tilted back and the lower jaw raised to alleviate the obstruction. If neck or spinal cord injuries are suspected, the head must be handled with extreme care to avoid further injury to the delicate spinal cord. In these cases, the lower jaw can be pulled forward to open the airway. If the neck is severely out of alignment due to an injury or fall, it may be gently realigned to free the airway.

After the airway is cleared and breathing is ensured, a patient's circulation is checked by noting the pulse of the carotid artery, on the neck, the pulse of the femoral artery in the front groin, and by listening to the heartbeat. If pulse is lacking, **cardiopulmonary resuscitation** (CPR) may be required, which requires chest compression and mouth-to-mouth breathing. Circulation checks include surveying a patient for bleeding. If severe bleeding is present, it should be stopped by direct pressure to the injured area and by elevating the wound level to the heart, if possible.

Disability assessment means checking for damage to the spinal cord, particularly in the cervical region of the neck. Assessment of exposure determines if environmental conditions, such as heat or cold, are immediate threats to a patient's life, which may require actions such as seeking shelter or covering the patient with protective clothing.

Secondary assessment

During this stage, a thorough **physical examination** of the patient is made from head to toe to determine the extent of injuries or problems. Caretakers performing the assessment should write detailed notes in order to inform physicians or emergency workers later. Patients are thoroughly interviewed to determine the scope of problems and any previous medical issues that might be related. Patients should be spoken to calmly to determine their mental states and how well they respond to stimuli. Vital signs such as heart rate and respiration rate should be noted and monitored. The skin should be carefully observed for injuries, **boils**, **rashes**, and discoloration. Red or flushed skin may indicate **fever** or heat-related conditions, while pale or blotchy skin can point to **shock** or **hypothermia**. A bluish tint to the skin may mean a lack of oxygen. **Contact lenses** should be removed from patients in cold conditions, as they can freeze to the eyes. During secondary assessment the patient should be closely monitored over time until improvement is noted or further treatment decisions are made.

KEY TERMS

Anaphylactic shock—Severe allergic reaction characterized by airway constriction, tissue swelling, and lowered blood pressure.

Cardiac arrest—Heart failure or heart attack.

Dislocation—Displacement of bones at a joint.

Envenomation—Exposure to venom by bites or stings from insects, reptiles, and fish.

Wilderness—Large backcountry areas lacking roads, communication and other modern infrastructure.

At all times in wilderness injuries, shock must be watched for and immediately treated.

Shock

In wilderness situations shock should be suspected after traumatic injuries, significant loss of blood due to internal or external bleeding, extreme loss of fluids from **vomiting** or **diarrhea**, heart attacks, and spinal cord injuries. Shock is easiest to alleviate when it is treated early; when not treated properly, it can progress to unconsciousness and **death**. When the likelihood of shock occurs, patients should be continually monitored and supported.

Symptoms of shock begin with **anxiety** and restlessness, with increased heart rates and labored, shallow breathing. Shock victims tend to sweat profusely with cool and clammy skin. Thirst and **nausea** are also symptoms.

Shock is treated in the wilderness by maintaining an open airway for the patient to breathe, by treating any injuries such as bleeding **wounds**, by reducing pain if possible, and by replenishing fluids. Patients should be kept calm and warm, and their feet should be elevated if possible to increase blood flow to the organs. If shock symptoms progress, plans should be quickly made to get help or evacuate the patient.

Evacuation

Evacuation of a patient may be a crucial decision in the wilderness, depending upon the severity of an injury or condition, the difficulty of moving the patient, the time considerations involved, and the availability of outside help. In general, if a patient with severe symptoms is not improving despite care then evacuation becomes necessary. The Wilderness

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Medical Society lists symptoms that require postponing travel or evacuating patients:

- progressive deterioration with symptoms of dizziness, fainting, abnormally slow (bradycardia) or fast (tachycardia) heart rate, labored breathing, poor mental status, progressive weakness, constant vomiting or diarrhea, intolerance of oral fluids, or recurrent loss of consciousness due to head injuries
- debilitating pain
- inability to sustain pace due to medical problems
- passage of blood by mouth or rectum
- symptoms of serious high-altitude illness
- infections that get worse despite treatment
- chest pain that is not musculoskeletal in origin
- psychological status threatening the individual or group

If a patient cannot be moved without risk of further injury, then other members of a party, preferably two or more, should be sent to get outside help. When requesting outside assistance, the safety of incoming rescuers and time constraints should be weighed. Requests for outside help should be made in writing, and include an assessment of the patient and situation as well as a detailed location of the incident. In some regions, helicopter evacuation may be an option, and should be used if an injury is life-threatening.

During evacuation patients must be handled with extreme care, as well as insulated from heat, cold, and further injuries. Larger wilderness expeditions may have special devices available for transporting injured members, while smaller parties may have to improvise transporting devices by using backpacks, ropes, and other available materials.

Wounds and burns

In wilderness situations wound management strives to stop bleeding, prevent infection, and speed healing. Bleeding from wounds should be controlled by direct pressure. Wounds and **burns** should be cleaned gently and thoroughly, treated with antibiotic ointment, and covered with **bandages** to avoid infections. Wounds that have high risks of infections, such as large cuts, open **fractures**, and animal **bites**, should be watched closely.

External and internal bleeding

External bleeding should be stopped by direct pressure, such as firmly applying a clean bandage or compress to an open wound. Secondary pressure may be applied to pressure points, such as the large arteries in the upper arm or groin, to slow bleeding. Tourniquets are recommended only in life-threatening situations, as they can cause complications and infections. Symptoms of internal bleeding include **dizziness**, **fainting**, rapid heartbeat, weak pulse, **shortness of breath**, thirst, loss of color, **vomiting** blood, blood in the feces or urine, and severe pain or swelling in the abdomen. If internal bleeding is suspected, medical help should be sought immediately. With all cases of significant blood loss, shock must be carefully considered.

Cardiac arrest

Cardiac arrest in the wilderness may require CPR, although CPR is less effective in remote regions that lack access to the **life support** technology that ambulances quickly supply. CPR should be administered to patients who have suffered near drowning, hypothermia, lightning strikes, and drug overdoses. CPR generally should not be administered in the wilderness if it endangers the rescuers, if the time of the cardiac arrest is unknown, if the patient appears to be dead or rigor mortis has set in, or if cardiac arrest was caused by severe trauma or lethal injuries.

Head injuries

Head injuries that do not cause loss of consciousness in the victim are rarely dangerous. Short-term loss of consciousness following head injuries is known as **concussion**, and these patients should be closely monitored for 24 hours, including waking them every three hours during sleep to check for mental alertness. For head injuries that cause prolonged unconsciousness, the airway and cervical spine must be protected. Severe brain injury is indicated by relapses into unconsciousness, bad headaches, bleeding from the ears, clear fluid draining from the nose, vomiting, persistent disorientation, personality changes, seizures, irregular heartbeat and breathing, and unequal or unreactive pupils. Severe head injuries must be treated by seeking immediate medical help or evacuation.

Spinal cord injuries

If spinal cord injuries are suspected, patients must be immobilized. Some expeditions or rescue teams may carry special splints or vests in their medical kits. If no such equipment is available, *spineboards* may be fashioned from available materials, such as backpacks, poles, or ice axes, to prevent unnecessary movement of the injured backbone.

Fractures and dislocations

Wilderness care for fractures recommends **immobilization** by using splints and slings. If manufactured

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splints and slings are not available in the medicine kit, they can be improvised by using natural materials, ski poles, ice axes, clothing, or parts of backpacks. In the case of **dislocations**, standard wilderness procedure is to splint, tape, and stabilize the injury in the current position. However, if circulation or nerve function is impaired, or if the injured person is in extreme pain, relocation may be necessary by realigning the injured area. Relocation is most effective if it is done immediately following the injury, before stiffness or **muscle spasms** set in.

Altitude sickness

Symptoms of **altitude sickness** include **headache**, nausea, **fatigue**, vomiting, and bluish skin. Ataxia, or loss of muscular control and balance indicates more severe altitude sickness. Altitude sickness can occur at altitudes above 8,000 feet. The best prevention of the condition is allowing plenty of time for acclimatization at high altitudes, drinking plenty of fluids, and eating a diet rich in carbohydrates. **Aspirin** or **acetaminophen** may be taken, while the drug acetazolamide (Diamox) can relieve symptoms of mild acute mountain sickness (AMS). Other related conditions, which can cause death, are high altitude cerebral **edema** (HACE), which causes fluid accumulation on the brain, and high altitude **pulmonary edema** (HAPE), which causes fluid in the lungs. The main treatment for acute mountain sickness is to rapidly descend to lower altitudes. In some cases oxygen may be available to ease symptoms.

Problems from cold and heat

Frostbite is localized tissue damage from exposure to cold and is remedied by the slow warming of exposed parts, preferably in heated water. Hypothermia is the condition resulting from lowered body core temperature and is a common affliction in wilderness medicine. Mild hypothermia occurs when the body's core temperature (measured rectally) falls from normal to 95°F (35°C) Fahrenheit. Moderate hypothermia gives temperatures between 90-95°F (32.2-35°C), while severe hypothermia occurs when a body's core temperature falls below 90°F (32.2°C). Symptoms include severe shivering, confusion, apathy, drowsiness, slurred speech, and impaired reflexes and progresses to the point of unconsciousness.

Even cases of the mildest hypothermia must be cared for closely. Patients in whom hypothermia is suspected should be immediately warmed by gently removing wet clothing and providing dry clothing, blankets, and shelter. They should be monitored for body temperature changes. Severe hypothermia cannot be remedied in the wilderness; victims must be immediately and gently evacuated. Warming severe hypothermia victims too quickly is dangerous. Cardiopulmonary resuscitation (CPR) may be initiated on victims of severe hypothermia who have cardiac arrest. In cases of near drowning, hypothermia must always be suspected.

Illness from heat includes heat exhaustion and the more severe heat **stroke**. Symptoms include confusion, rapid weak pulse, cramps, dizziness, nausea, diarrhea, headache, and high measured temperatures. Sweating may or may not occur, and the skin may be clammy and blotched. The principle treatment for heat illness in the wilderness is immediate cooling of the patient, by providing shade, fanning, sponging, and immersion in cold water. Heat exhaustion will correct itself with enough rest and water. Heat stroke is life threatening and requires immediate cooling and rehydration with fluids, preferably intravenous ones. Prevention of heat illness includes proper conditioning, protective clothing, and avoiding **dehydration**.

Insect, reptile, and animal bites

Wilderness medicine must deal with an array of **bites and stings**, from bears, snakes, reptiles, spiders, scorpions, bees, fish, and ticks. Prevention includes knowledge of the threats in the region being explored, as well as packing appropriate supplies such as bee sting kits for anaphylactic shock and snakebite kits for venomous attacks. The goal of treatment is to stop bleeding, prevent infection, and alleviate envenomation, or exposure to poison. The Sawyer Extractor is a suction tool used to remove snake venom, while the Epipen and Ana-kit are available by prescription for anaphylactic shock due to **stings** and severe allergic reactions.

Preparation

Knowledge and sound planning can be the difference between success and disaster in the backcountry. Members of extended wilderness outings should undergo thorough examinations by their physicians and dentists prior to undertaking expeditions. People going on wilderness outings should begin in a state of sound physical fitness by undertaking appropriate conditioning programs, as well as becoming acclimatized to special conditions such as altitude or extreme temperatures. Those with medications should be aware of potential side effects and complications, and inform other members of their group. At least two, and preferably all, members of wilderness expeditions should be familiar with first aid, wilderness medicine and rescue procedures. All members of wilderness outings should

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carry appropriate clothing, equipment, food, water, and first aid supplies. Trip itineraries should be recorded with park rangers or other official services. Means of communication with rescue facilities should be considered in advance in case emergencies arise.

Carrying adequate medical supplies is a crucial preparation for wilderness outings. These supplies will vary depending on the length of the trip and the region. Medical kits should contain basic first aid supplies, such as bandages, **dressings**, pain relievers, water purification tablets, sunscreen, **antiseptics**, and ointments. Additional medical supplies include **antibiotics**, medications for gastrointestinal problems, **antihistamines,** and emergency kits for **asthma** or allergic reactions, snake and insect bite kits, splints, and basic surgical supplies. Extended expeditions or those facing extreme conditions might include intravenous fluids, oxygen bottles for altitude problems, rescue gear and evacuation equipment, and specific medications for regional diseases and infections, such as **malaria**.

Immunizations are a very important preparation for those entering wilderness areas, particularly in Third World countries. Immunizations should be planned as far in advance as possible, as some take several weeks to become effective and others cannot be given together. Some immunizations that may be required, depending on the region, include **tetanus**, poliovirus, **measles**, **mumps**, **rubella**, **cholera**, **yellow fever**, meningococcus, hepatitis, bubonic **plague**, **typhoid fever,** and **rabies**. See Resources at the end of this article for sources of specific immunization information.

Several organizations provide training and certification for various levels of wilderness medicine. The most basic levels of preparation are first aid and first responder certifications, followed by outdoor emergency care (OEC) training. More rigorous training provides the wilderness first responder (WFR), the wilderness emergency medical technician (WEMC), or the wilderness prehospital emergency care (WPHEC) certifications. The most advanced level of wilderness medical certification is search and rescue (SAR) emergency care, which provides expertise in a sophisticated array of rescue techniques and equipment.

Resources

BOOKS

Auerbach, Paul, MD. *Medicine for the Outdoors: The Essential Guide to First Aid and Medical Emergencies*. 5th ed. New York: The Lyons Press, 2009.

ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

International Association for Medical Assistance to Travelers (IAMAT), 1623 Military Road, #279, Niagara Falls, NY, 14304-1745, (716) 754-4883, http://www.iamat.org/index.cfm.

Wilderness Medical Society, 2150 S. 1300 Suite 500, Salt Lake City, UT, 84106, (801) 990-2988, wms@wms.org, http://www.wms.org.

Douglas Dupler, MA

Wilms' tumor

Definition

Wilms' tumor is a cancerous tumor of the kidney that usually occurs in young children. This tumor type is named for the German surgeon Max Wilms (1867–1918) and is also known as a nephroblastoma.

Demographics

Wilms' tumor occurs almost exclusively in young children. The average patient is about three years old, although cases have been reported in infants younger than six months and in adults in their early twenties. It is uncommon for this type of **cancer** to be diagnosed after age six years. Incidence of Wilms' tumor is slightly higher among African Americans and females. In the United States, about 500 new cases are diagnosed annually—the incidence rate has been stable for many years. Wilms' accounts for about 5% of all cancers diagnosed in children in the United States, and it is the most common type of renal cancer in children.

Description

When an unborn baby is developing, the kidneys are formed from primitive cells. Over time, these cells become more specialized. The cells mature and organize into normal kidney structure. Sometimes, clumps of these cells remain in their original, primitive form. If these cells begin to multiply after birth, they may ultimately form a large mass of abnormal cells. This is known as a Wilms' tumor.

Wilms' tumor is a type of malignant tumor, which means that it is made up of cells that are significantly immature and abnormal. These cells are also capable of invading nearby structures within the kidney and

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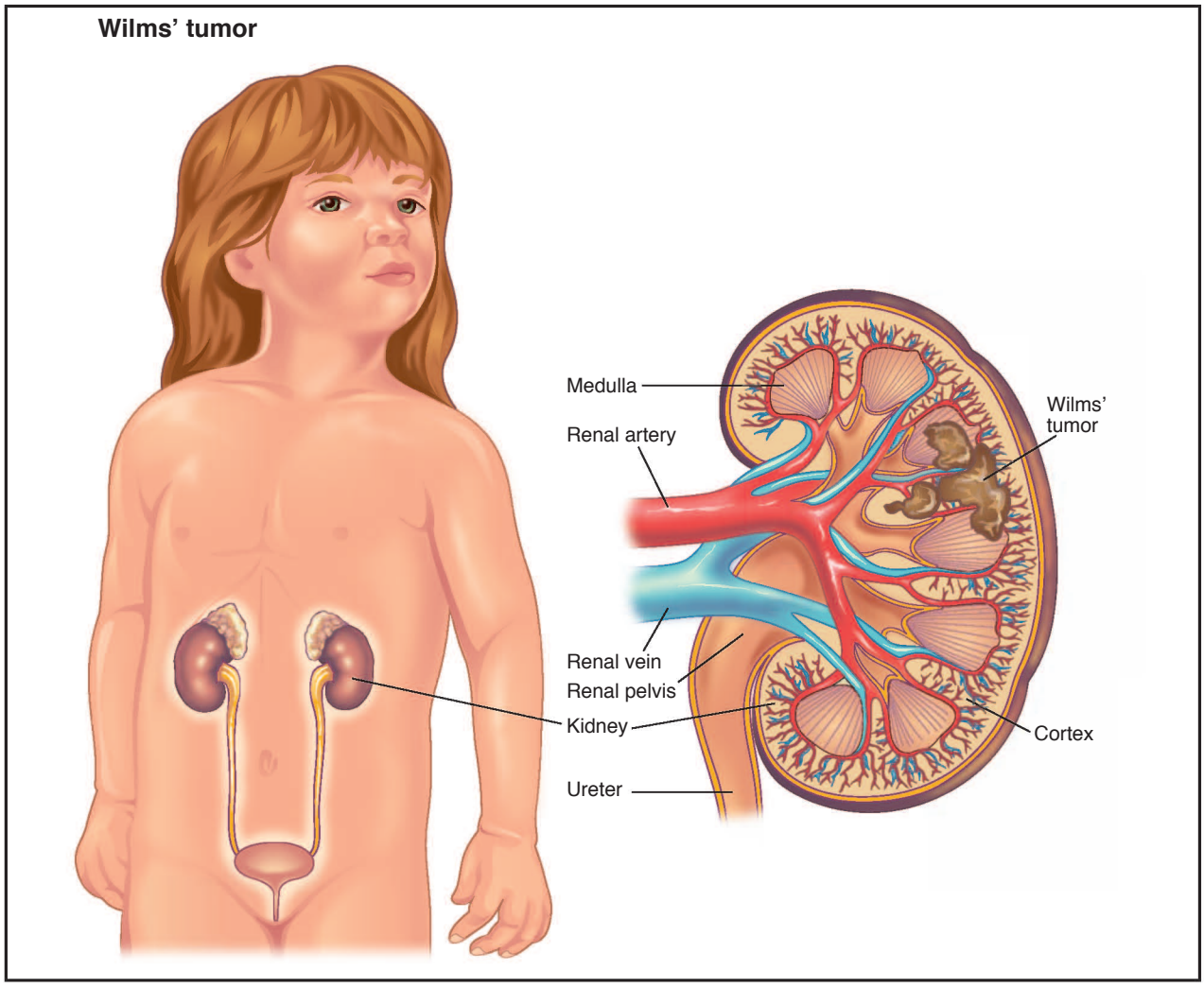

Wilms' tumor. *((Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

traveling out of the kidney into other structures. Malignant cells can even travel through the body to invade other organ systems, most commonly the lungs and brain. These features of Wilms' tumor make it a type of cancer that, without treatment, eventually causes **death**. However, advances in medicine during the last 20 years have made Wilms' tumor a very treatable form of cancer.

There are three types or variants of Wilms' tumors: those cases that develop sporadically; tumors that develop as part of genetic syndromes; and those that are familial or hereditary in nature. Most Wilms' tumors develop independent of genetic syndromes or family history although familial Wilms' tumor can be very common in some families.

Wilms' tumors may be found in patients with other types of **birth defects**. These defects include:

- absence of the colored part (the iris) of the eye (aniridia)
- enlargement of one arm, one leg, or half of the face (hemihypertrophy)
- certain birth defects of the urinary system or genitals
- certain genetic syndromes (WAGR syndrome, Denys–Drash syndrome, and Beckwith–Wiedemann syndrome)

Causes and symptoms

The cause of Wilms' tumor is not completely understood. Because 15% of all patients with this type of tumor have other heritable defects, it seems clear that at least some cases of Wilms' tumor are due to an inherited alteration. A genetic defect known as WT1, the Wilms' tumor suppressor gene, has been identified in some patients on chromosome 11p13. It

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appears that the tendency to develop a Wilms' tumor can run in families. In fact, about 1.5% of all children with a Wilms' tumor have family members who have also had a Wilms' tumor. The genetic mechanisms associated with the disease are unusually complex. Researchers believe that the tumor develops because the defective WT1 gene fails to stop its growth.

Some patients with Wilms' tumor experience abdominal **pain**, **nausea**, **vomiting**, high blood pressure, or blood in the urine. However, the parents of many children with this type of tumor are the first to notice a firm, rounded mass in their child's abdomen. This discovery is often made while bathing or dressing the child and frequently occurs before any other symptoms appear. Rarely, a Wilms' tumor is diagnosed after there has been bleeding into the tumor, resulting in sudden swelling of the abdomen and a low red blood cell count (anemia).

About 4-5% of Wilms' tumor cases involve both kidneys during the initial evaluation. The tumor appears on either side equally. When pathologists look at these tumor cells under the microscope, they see great diversity in the types of cells. Some types of cells are associated with a more favorable outcome in the patient than others. In about 15% of cases, physicians find some degree of cancer spread (metastasis). The most common sites in the body where metastasis occurs are the liver and lungs.

Researchers have found evidence that certain types of lesions occur before the development of the Wilms' tumor. These lesions usually appear in the form of stromal, tubule, or blastemal cells.

KEY TERMS

Biopsy—A procedure in which a small sample of tissue is removed, prepared, and examined with a microscope to determine the characteristics of the tissue's cells.

Blastemal—An immature material from which cells and tissues develop.

Cancer—A process in which abnormal cells within the body begin to grow out of control, acquire the ability to invade nearby structures, and travel through the bloodstream and invade distant structures.

Malignant—Refers to cancer or cancer cells.

Sarcoma—A type of cancer that originates from connective tissue such as bone or muscle.

Stromal—A type of tissue that is associated with the support of an organ.

Tubule—Tissues and cells associated with the structures that connect the renal pelvis to the glomeruli.

Diagnosis

Children with Wilms' tumor generally first present to physicians with a swollen abdomen or with an obvious abdominal mass. The physician may also find that the child has **fever**, bloody urine, or abdominal pain. The physician will order a variety of tests before imaging is performed. These tests mostly involve blood analysis in the form of a **white blood cell count**, **complete blood count**, coagulation profile, **platelet count**, and serum **calcium** evaluation. Liver and kidney function testing will also be performed, as well as a **urinalysis**. Other tests which may be ordered include testing for chromosome analysis and gene mapping.

Initial diagnosis of Wilms' tumor is made by looking at the tumor using various imaging techniques. Ultrasound, **computed tomography scans** (CT scans), and **magnetic resonance imaging** (MRI) are helpful in diagnosing Wilms' tumor. Final diagnosis, however, depends on obtaining a tissue sample from the mass (biopsy) and examining it under a microscope in order to verify that it has the characteristics of a Wilms' tumor. This biopsy is usually done during surgery to remove or decrease the size of the tumor. Other studies (chest x rays, CT scan of the lungs, bone scans) may also be done in order to see if the tumor has spread to other locations.

Treatment

In the United States, treatment for Wilms' tumor almost always begins with surgery to remove or decrease the size of the kidney tumor. Except in patients who have tumors in both kidneys, this surgery usually requires complete removal of the affected kidney. During surgery, the surrounding lymph nodes, the area around the kidneys, and the entire abdomen will also be examined. While the tumor can spread to these surrounding areas, it is less likely to do so as compared to other types of cancer. In cases where the tumor affects both kidneys, surgeons try to preserve the kidney with the smaller tumor by removing only a portion of the kidney, if possible. Additional biopsies of these areas may be done to see if the cancer has spread. The next treatment steps depend on whether and where the cancer has spread. Samples of the tumor

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are also examined under a microscope to determine particular characteristics of the cells making up the tumor.

Information about the tumor cell type and the spread of the tumor is used to decide the best kind of treatment for a particular patient. Treatment is usually a combination of surgery, medications used to kill cancer cells (**chemotherapy**), and x rays or other high–energy rays used to kill cancer cells (**radiation therapy**). These therapies are called adjuvant therapies, and this type of combination therapy has been shown to substantially improve outcome in patients with Wilms' tumor. It has long been known that Wilms' tumors respond to radiation therapy. Likewise, some types of chemotherapy have been found to be effective in treating Wilms' tumor. The most effective drugs include dactinomycin, doxorubicin, and vincristine. Cyclophosphamide can be added to the treatment regimen if the tumor is comprised of an unfavorable tumor type or if the cancer is in an advanced stage. The chemotherapy drugs cyclophosphamide, ifosfamide, cisplatin, carboplatin, and etoposide can be used to treat patients once they have relapsed following initial treatment. Chemotherapy may be administered preoperatively to some patients, specifically for patients with tumor in both kidneys and to treat large tumors that are considered to be inoperable initially.

The National Wilms' Tumor Study Group (NWTSG) has developed a staging system to describe Wilms' tumors. All of the stages assume that surgical removal of the tumor has occurred. Stage I involves "favorable" Wilms' tumor cells and is usually treated successfully with combination chemotherapy involving dactinomycin and vincristine for 18 weeks and without abdominal radiation therapy. Stage II tumors involving a favorable histology (cell characteristics) are usually treated with the same therapy as Stage I with the addition of the chemotherapy drug doxorubicin and are treated for 24 weeks. Stage III tumors with favorable histology are usually treated with combination chemotherapy consisting of doxorubicin, dactinomycin, and vincristine for 24 weeks, along with radiation therapy to the abdomen. Stage IV disease with a favorable histology is generally treated with combination chemotherapy with dactinomycin, doxorubicin, and vincristine. These patients usually receive abdominal radiation therapy and lung radiation therapy if the tumor has spread to the lungs. Patients in Stage IV with a favorable histology will also receive prophylactic administration of the antibiotic drug sulfamethoxazole and trimethoprim (Bactrim) to prevent infection with Pneumocystis carinii.

In the case of Stage II through IV tumors with unfavorable, or anaplastic, cells, then the previously mentioned combination chemotherapy is used along with the drug cyclophosphamide for 24 months. These patients also receive lung radiation therapy if the tumor has spread to the lungs as well as radiation to the abdomen. Another type of tumor cell can be present in Stages I through IV. This cell type is called clear cell sarcoma of the kidney. If this type of cell is present, then patients receive combination therapy with vincristine, doxorubicin, and dactinomycin. All of these patients receive abdominal radiation therapy and lung radiation therapy if the tumor has spread to the lungs.

Prognosis

The prognosis for patients with Wilms' tumor is quite good compared to the prognosis for most types of cancer. The overall survival rate has risen to approximately 90% during the past three decades. Patients who have the best prognosis are usually those who have a small-sized tumor, a favorable cell type, are young (especially under two years old), and have an early stage of cancer that has not spread. Modern treatments have been especially effective in the treatment of this cancer.

Genetic factors can be used to help determine the prognosis in some children diagnosed with Wilms' tumor. Children with genetic changes on chromosomes 1p and 16q, about 5% of children diagnosed with favorable-histology Wilms' tumor, appear to be at greater risk for relapse after initial treatment and are at greater risk of dying than children without these chromosomal changes.

Prevention

There are no known ways to prevent a Wilms' tumor, although it is important that children with birth defects associated with Wilms' tumor be carefully monitored. Some clinicians recommend screening using ultrasounds of the kidneys once or twice per year.

Resources

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Chu, A., et al. "Wilms' Tumor: A Systematic Review of Risk Factors and Meta-Analysis." *Paediatric and Perinatal Epidemiology* 24(5) (September 2010): 449–69.

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"Wilms Tumor." American Cancer Society, (July 9, 2010) http://www.cancer.org/Cancer/WilmsTumor/DetailedGuide/index (accessed September 16, 2010).

"Wilms Tumor and Other Childhood Kidney Tumors Treatment (PDQ)." National Cancer Institute (June 25, 2010) http://www.cancer.gov/cancertopics/pdq/treat ment/Wilms/patient (accessed September 16, 2010).

ORGANIZATIONS

American Cancer Society (ACS), (800) 227-2345, http://www.cancer.org.

March of Dimes Birth Defects Foundation, National Office, 1275 Mamaroneck Ave., White Plains, NY, 10605, (914) 997-4488, http://www.modimes.org.

National Cancer Institute (NCI), Bldg. 31, Rm. 10A31, 31 Center Dr., MSC 2580, Bethesda, MD, 20892-2580, (800) 422-6237, http://www.cancer.gov.

National Wilms Tumor Study Group (NWTSG), Fred Hutchinson Cancer Research Center, 1100 Fairview Ave., North, PO Box 19024, Seattle, WA, 98109-1024, (800) 553-4878, (206) 667-6623, http://www.nwtsg.org.

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Wilson disease

Definition

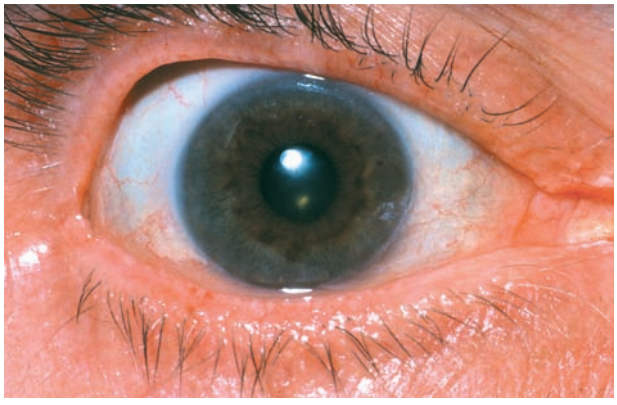
Wilson disease, or WD, is a rare inherited disorder that causes excess copper to accumulate in the body. It is also known as hepatolenticular degeneration. Steadily increasing amounts of copper circulating in the blood are deposited primarily in the brain, liver, kidneys, and the cornea of the eyes. WD is fatal if it is not recognized and treated. It is named for a U.S. neurologist, Samuel A. K. Wilson, who first described it in 1912.

Description

Under normal conditions, copper that finds its way into the body through the diet is processed within the liver. This processed form of copper is then passed into the gallbladder, along with the other components of bile (a fluid produced by the liver, which enters the small intestine in order to help in digestive processes). When the gallbladder empties its contents into the first part of the small intestine (duodenum), the copper in the bile enters and passes through the intestine with the waste products of digestion. In healthy individuals, copper is then passed out of the body in stool.

In Wilson disease, copper does not pass from the liver into the bile, but rather begins to accumulate within the liver. As copper levels rise in the liver, the damaged organ begins to allow copper to flow into the bloodstream, where it circulates. Copper is then deposited throughout the body, building up primarily in the kidneys, the brain and nervous system, and the eyes. Wilson disease, then, is a disorder of copper **poisoning** occurring from birth.

Wilson disease affects approximately 1 in 30,000 to 1 in 100,000 individuals and can affect people from many different populations. Approximately one in 90 individuals are carriers of the gene for Wilson disease.



Copper deposits are visible as a ring around the iris in patients with Wilson disease. *(Photo Researchers, Inc.)*

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Causes and symptoms

Wilson disease is inherited in an autosomal recessive manner. Autosomal recessive refers to the pattern of inheritance where each parent carries a gene for the disease on one of his or her chromosome pairs. When each parent passes on the chromosome with the gene for Wilson disease, the child will be affected with the disease. Both males and females can be affected with Wilson disease. If an individual is a carrier of the Wilson disease gene they do not have any symptoms of this disease. In order to be affected, an individual must inherit two copies of the gene, one from each parent. Many cases of Wilson disease may not be inherited but occur as a spontaneous mutation in the gene.

The gene for Wilson disease is located on chromosome number 13. The name of the gene is called ATP7B and is thought to be involved in transporting copper. More than 200 different mutations of this gene have been identified, making diagnosis by **genetic testing** difficult.

Symptoms typically present between the ages of 3 and 60, with age 17 considered to be the average age a diagnosis is made. About half of all patients experience their first symptoms in the liver. The illness causes swelling and tenderness of the liver, sometimes with **fever**, mimicking more common disorders, such as viral hepatitis and **infectious mononucleosis**. Abnormal levels of circulating liver enzymes reveal that the liver is being seriously damaged. This form of damage is referred to as fatty degeneration. Without medical intervention, the liver damage will progress to actual **cirrhosis**. An often-fatal manifestation of **liver disease** is called fulminant hepatitis. This extremely severe inflammation of the liver (hepatitis) results in **jaundice**, fluid leaking into the abdomen, low protein circulating in the blood, abnormalities of the blood clotting system, swelling of the brain, and anemia due to the abnormal destruction of red blood cells.

Neurological symptoms are the first to occur in half of all patients due to copper accumulation in the brain and nervous system. The average age of onset for neurological symptoms is 21. These symptoms include **tremors** of the hands, uncontrollable movements of the limbs, stiffness, drooling, difficulty swallowing, difficulty talking, and **headache**. There is no change in patient's intelligence.

About one-third of all patients with Wilson disease have a variety of psychiatric symptoms as the first signs of the disease. These symptoms include inability to cope, depression, irritability, increased anger, and inappropriate behavior. Often times patients have trouble completing tasks at work or in school.

Other symptoms that can affect patients with Wilson disease, and may occur before or after a diagnosis has been made, include joint disorders, symptoms of arthritis, and skeletal problems such as **osteoporosis**. Patients have occasionally been affected with **kidney stones**, abnormal handling of glucose in their body, and women have menstrual cycle irregularities including stopping their regular cycle temporarily.

Diagnosis

The diagnosis of Wilson disease can be performed relatively easily through several different tests; however, because Wilson disease is so rare, diagnosis is often unfortunately delayed. The tests used to diagnose Wilson disease can be performed on patients who have and who have not already shown symptoms of the disease. It is extremely important to make a diagnosis as soon as possible since liver damage can occur before there are any signs of the disease.

An easy way to diagnose Wilson disease is to measure the amount of a glycoprotein found in the blood called ceruloplasmin. Low levels of ceruloplasmin can diagnose the disease in about 80% of affected patients. This procedure is not as effective for women taking birth control pills, pregnant women, or infants younger than six months of age.

A second test involving an **eye examination** to detect a characteristic ring of copper deposited in a membrane of the cornea (referred to as Kayser-Fleischer rings) is very easy to perform and is very useful in diagnosing patients who have already exhibited symptoms. This test is not as effective in persons without symptoms. This diagnostic test cannot be used by itself to make a diagnosis because some patients with liver disease but not Wilson disease will test positive.

A third test for diagnosing Wilson disease involves measuring the amount of copper in the liver. This can be accomplished by sampling a portion of the liver, called a biopsy. This is one of the most effective ways in which to diagnose Wilson disease, but the procedure itself is more difficult to perform than the others.

Other tests are also useful, for example measuring the amount of copper passed into the urine daily (high in Wilson disease). Another lab test measures the ability of a patient's ceruloplasmin to bind with a form of copper (decreased in Wilson disease). Finally, as discussed under genetic profile, some patients can be diagnosed through a DNA test to determine whether or not they carry two genes for Wilson disease. This

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KEY TERMS

Anemia—A blood condition in which the level of hemoglobin or the number of red blood cells falls below normal values. Common symptoms include paleness, fatigue, and shortness of breath.

Bile—A substance produced by the liver, and concentrated and stored in the gallbladder. Bile contains a number of different substances, including bile salts, cholesterol, and bilirubin.

Biopsy—The surgical removal and microscopic examination of living tissue for diagnostic purposes.

Cell—The smallest living units of the body which group together to form tissues and help the body perform specific functions.

Ceruloplasmin—A protein circulating in the bloodstream that binds with copper and transports it.

Chelation therapy—A method of removing copper or other heavy metals from the body by giving medications that bind to the metal and allow it to be excreted.

Chromosome—A microscopic thread-like structure found within each cell of the body and consists of a complex of proteins and DNA. Humans have 46 chromosomes arranged into 23 pairs. Changes in either the total number of chromosomes or their shape and size (structure) may lead to physical or mental abnormalities.

Cirrhosis—A chronic degenerative disease of the liver, in which normal cells are replaced by fibrous tissue. Cirrhosis is a major risk factor for the later development of liver cancer.

Deoxyribonucleic acid (DNA)—The genetic material in cells that holds the inherited instructions for growth, development, and cellular functioning.

Gallbladder—A small, pear-shaped organ in the upper right hand corner of the abdomen. It is connected by a series of ducts (tube-like channels) to the liver pancreas, and duodenum (first part of the small intestine). The gallbladder receives bile from the liver and concentrates and stores it. After a meal, bile is squeezed out of the gallbladder into the intestine, where it aids in digestion of food.

Gene—A building block of inheritance, which contains the instructions for the production of a particular protein, and is made up of a molecular sequence found on a section of DNA. Each gene is found on a precise location on a chromosome.

Glucose—One of the two simple sugars, together with galactose, that makes up the protein, lactose, found in milk. Glucose is the form of sugar that is usable by the body to generate energy.

Hepatitis—A viral disease characterized by inflammation of the liver cells (hepatocytes). People infected with hepatitis B or hepatitis C virus are at an increased risk for developing liver cancer.

Jaundice—Yellowing of the skin or eyes due to excess of bilirubin in the blood.

Toxic—Poisoinous.

test does not always prove to be useful in certain patients and is of most use when used to test the brothers and sisters of affected patients.

Molecular genetic testing is not particularly valuable in diagnosing WD because of the large number of possible gene mutations.

Treatment

Treatment involves life-long administration of either D-penicillamine (Cuprimine, Depen) or trientine hydrochloride (Syprine). Both of these drugs remove copper deposits throughout the body by binding to the copper which then leaves the body in the urine. This type of treatment is called **chelation therapy**. Zinc acetate (Galzin) and a low copper diet are other ways in which to treat Wilson disease.

Penicillamine has a number of serious side effects:

- joint pain
- neurological problems
- systemic lupus erythematosus
- decreased production of all blood elements
- interference with clotting
- allergic reactions

Careful monitoring is necessary. When patients have side effects from penicillamine, the dose can sometimes be lowered to an effective level that causes fewer difficulties. Alternatively, steroid medications may be required to reduce certain sensitivity reactions. Trientine has fewer potential side effects, but must still be carefully monitored.

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Treatment with zinc acetate is also an effective way to remove excess copper from the body. Zinc is a metal that works to block copper absorption and bind copper in the intestinal cells until it is all released into the stool approximately one week later. The benefit of treatment with zinc is there are no toxic side effects however the zinc is a slower acting agent than the other drugs. It takes four to eight months for the zinc to be effective in reducing the overall amount of copper in the body.

Finally, patients with Wilson disease are encouraged to follow a diet low in copper, with an average copper intake of 1.0 mg per day. Foods to be avoided for the high levels of copper include liver and shellfish. Patients are also instructed to monitor their drinking water for excess levels of copper and drink distilled water instead.

Patients may be given a liver transplant in the event of liver failure as a complication of WD. **Liver transplantation** has been reported to have a relatively favorable outcome, in some cases decreasing the patient's neurologic symptoms.

Prognosis

Without treatment, Wilson disease is always fatal. With treatment, symptoms may continue to worsen for the first six to eight weeks. After this time, definite improvement should begin to be seen. However, it may take several years (two to five) of treatment to reach maximal benefit to the brain and liver. Even then, many patients are not returned to their original level of functioning. Patients with Wilson disease need to maintain some sort of anticopper treatment for the rest of their lives in order to prevent copper levels from rising in the body. Interruptions in treatment can result in a relapse of the disease which is not reversible, and can ultimately lead to **death**.

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Wilson's Disease Association. http://www.wilsonsdisease.org.

ORGANIZATIONS

American Liver Foundation, 75 Maiden Lane, Suite 603, New York, NY, 10038, (212) 668-1000, (212) 483-8179, http://www.liverfoundation.org/.

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923, (800) 999-6673, http://www.rarediseases.org.

Wilson Disease Association, 5572 N. Diversey Blvd, Milwaukee, WI, 53217, (414) 961-0533, (866) 961-0533, info@wilsonsdisease.org, http://www.wilsonsdisease.org.

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Wiskott-Aldrich syndrome

Definition

Wiskott-Aldrich syndrome (WAS) is a rare inherited disorder **immunodeficiency** disorder marked by a low level of blood platelets (**thrombocytopenia**), **eczema**, recurrent infections, and a high risk of leukemia or lymph node tumors.

Demographics

WAS syndrome is rare. It affects about 1 in every 250,000 male children and occurs worldwide. Children are born with the genetic defect that causes this syndrome and usually do not live beyond childhood.

Description

WAS is named for the two physicians who first reported the disorder. In 1937, Dr. A. Wiskott, a physician working in Munich, Germany, described two affected boys of German ancestry who had repeated infections, a skin rash, and poor blood-clotting ability. Nearly 20 years later, Dr. R. A. Aldrich reported similar symptoms in members of a U.S. family of Dutch ancestry.

WAS is inherited as a rare X-linked genetic disorder and therefore affects only males. The gene responsible

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for WAS, officially called the Wiskott-Aldrich syndrome (eczema-thrombocytopenia) gene or WAS gene, is located on the short arm of the X chromosome. Since males have only one X chromosome, they have only one copy of the genes on this chromosome. If their copy of the WAS gene is abnormal, they will have WAS. In contrast, females have two X chromosomes. They can have a normal copy of the WAS gene on one chromosome, even if they have an abnormal WAS gene on the other. Because the defective gene that causes WAS is rare and usually causes **death** in childhood, it is highly unlikely that a female will have two defective copies of the gene. The single normal copy of the WAS gene on one X chromosome is sufficient to prevent females from having WAS. However, women who have one abnormal copy of the WAS gene are designated as carriers. While they will not have WAS, they have a 50% chance of passing the gene to each of their sons who will have WAS. Carrier females also have a 50% risk of passing the defective copy of the gene to their daughters who also become carriers.

Researchers identified the gene for WAS in 1994 and pinpointed its location on the short arm of the X chromosome. As of 2010, over 250 different mutations have been found in the gene among WAS patients. The fact that there are many mutations may explain some of the variability of symptoms among boys with WAS. However, even within the same family, affected individuals with the identical WAS gene mutation may have different degrees of severity of the disease. The mild form, called X–linked thrombocytopenia, is also caused by mutations in this same gene.

Causes and symptoms

The syndrome is caused by a defect (mutation) in a specific gene called the WAS gene that normally codes for the protein named Wiskott-Aldrich Syndrome Protein (WASP). This vital protein is a component of cells that are important in the body's defense against infection (lymphocytes). The same protein also functions in cells that help prevent bleeding (platelets). A less severe form of the disease, X–linked thrombocytopenia, affects mainly platelets.

Increased susceptibility to infections, eczema, and excessive bleeding are hallmarks of WAS, although symptoms can vary significantly from one patient to another. The immune system of patients with WAS produces too few B and T cells. B cells are cells in the body that make antibodies. There are many types of T cells. Both B and T cells are needed to defend the body against infection. Because both types of cells are affected, WAS patients are subject to repeated infections from bacteria, fungi, and viruses. Ear infections, **meningitis**, and **pneumonia** are common in boys with WAS.

WAS patients also have thrombocytopenia, a decreased number of platelets. Platelets are specialized blood cells that help to form **blood clots** and prevent uncontrolled bleeding. The platelets also may be smaller than normal. Some of the earliest symptoms of the syndrome are hemorrhage from **circumcision**, bloody **diarrhea**, and a tendency to bruise very easily.

Anemia and an enlarged spleen (splenomegaly) are seen in some patients. About 10% of patients develop malignancies (cancers), usually leukemia or tumors in the lymph nodes (non–Hodgkin's lymphoma).

Diagnosis

The diagnosis of WAS is usually suspected in male infants who have excessive bleeding, eczema, and frequent bacterial or viral infections. Special blood tests can then be ordered to confirm WAS. The blood of Wiskott-Aldrich patients will show a low **platelet count** and a weak immune (antibody) response. It is also possible to confirm the diagnosis by obtaining a small sample of the patient's blood and analyzing the DNA for a mutation in the WAS gene. Knowledge of the exact mutation combined with information about how much WAS protein the defective gene can produce may help predict how severe a form of the disease an individual will have.

Carrier Testing

If the specific WAS gene mutation is identified in an affected child, that child's mother can then be tested to confirm that she carries the gene. Other members of the mother's family may also want to consider testing to find out if they carry the same gene mutation. The first step in studying other family members is for a geneticist or genetic counselor to obtain a detailed family history and construct a pedigree (family tree) to determine which family members should be offered testing.

Prenatal Diagnosis

In families where one child has been born with WAS, prenatal testing should be offered in subsequent pregnancies. There is a 50% chance with each

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KEY TERMS

Amniocentesis—A procedure performed at 16–18 weeks of pregnancy in which a needle is inserted through a woman's abdomen into her uterus to draw out a small sample of the amniotic fluid from around the baby. Either the fluid itself or cells from the fluid can be used for a variety of tests to obtain information about genetic disorders and other medical conditions in the fetus.

Anemia—A blood condition in which the level of hemoglobin or the number of red blood cells falls below normal values. Common symptoms include paleness, fatigue, and shortness of breath.

B cells (B lymphocytes)—a type of white blood cell that produces antibodies.

Chorionic villus biopsy—A procedure used for prenatal diagnosis at 10–12 weeks gestation. Under ultrasound guidance a needle is inserted either through the mother's vagina or abdominal wall and a sample of cells is collected from around the early embryo. These cells are then tested for chromosome abnormalities or other genetic diseases.

Eczema—Inflammation of the skin with redness and other variable signs such as crusts, watery discharge, and itching.

Gene—A building block of inheritance which contains the instructions for the production of a particular protein and is made up of a molecular sequence found on a section of DNA. Each gene is found on a precise location on a chromosome.

Immune system—The mechanism that protects the body from foreign substances, foreign cells, and pathogens. The thymus, spleen, lymph nodes, white blood cells, including the B cells and T cells, and antibodies are involved in the immune response, which aims to destroy these foreign bodies.

Mutation—A permanent change in the genetic material that may alter a trait or characteristic of an individual, or manifest as disease, and can be transmitted to offspring.

Platelets—Small disc–shaped structures that circulate in the blood stream and participate in blood clotting.

Prenatal diagnosis—The determination of whether a fetus possesses a disease or disorder while it is still in the womb.

Syndrome—A group of signs and symptoms that collectively characterize a disease or disorder.

T cells (T lymphocytes)—White blood cells that originate in the thymus gland. T cells regulate the immune system's response to infections, including HIV. CD4 lymphocytes are a subset of T lymphocytes.

Thrombocytopenia—A persistent decrease in the number of blood platelets usually associated with hemorrhaging.

X–linked—Located on the X chromosome, one of the sex chromosomes. X–linked genes follow a characteristic pattern of inheritance from one generation to the next.

subsequent **pregnancy** that the mother, who is a carrier, will transmit the abnormal copy of the gene to her baby. The key is to first identify the particular WAS gene mutation in the child with WAS. Then, early in a pregnancy, cells can be obtained from the developing fetus by **chorionic villus sampling** or **amniocentesis**, and checked for the same mutation. Women who carry the abnormal WAS gene and are considering prenatal diagnosis should discuss the risks and benefits of this type of testing with a geneticist or genetic counselor.

Treatment

Standard treatments for individuals with WAS include **antibiotics** for infections and platelet transfusions to limit bleeding. Immune globulin is given to strengthen the individual's immune system. Eczema can be treated with corticosteroid creams applied directly to the skin. The spleen is sometimes removed to reduce the risk of bleeding. In individuals with WAS, however, removal of the spleen also increases the risk of infection unless antibiotics are given to prevent infections.

About 50% of individuals with WAS are helped by treatment with transfer factor, which is a substance derived from the T cells of a healthy person. Transfer factor is given to improve both blood clotting and immune functions. **Bone marrow transplantation** has been successful in a number of cases. It has been most successful in boys under five years of age where the donor is a sibling whose tissue type closely matches that of the individual with WAS. Bone marrow

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transplantation can cure this condition but a highly matched donor must be found, transplantation should occur before age five, and the procedure carries substantial risks. Investigation into treatment with **gene therapy** is ongoing as of 2010.

Prognosis

Prognosis for males diagnosed with Wiskott-Aldrich syndrome who do not undergo successful bone marrow transplantation is poor. The average individual lives about six years; those who survive into adolescence often develop **cancer**. Death usually occurs from severe bleeding or overwhelming infection in the first few years of life.

Prevention

Wiskott-Aldrich syndrome is a genetic defect present at birth and cannot be prevented.

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NORD-National Organnization for Rare Disorders, inc. http://www.rarediseases.org.

ORGANIZATIONS

Immune Deficiency Foundation, 40 West Chesapeake Avenue, Suite 308, Towson, MD, 21204, (800) 296-4433, http://www.primaryimmune.org/.

National Newborn Status Screening and Genetics Resource Center, 1912 W. Anderson Lane, Suite 210, Austin, TX, 78757, (512) 454-6419, (512) 454-6509 , http://genes-r-us.uthscsa.edu.

National Organization for Rare Diseases (NORD), PO Box 1968, Danbury, CT, 06813-1968, (203) 744-0100, (800) 999-NORD (6673), orphan@rarediseases.org, http://www.rarediseases.org.

National Society of Genetic Counselors, 401 N. Michigan Ave., Chicago, IL, 60611, (312) 321-6834, (312) 673-6972, nsgc@nsgc.org, http://www.nsgc.org.

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Withdrawal syndromes

Definition

Withdrawal syndrome occurs in drug and alcohol addicted individuals who discontinue or reduce the use of their drug of choice. This process of eliminating drugs and alcohol from the body is known as **detoxification**. **Anxiety**, **insomnia**, **nausea**, perspiration, body aches, and **tremors** are just a few of the physical and psychological symptoms of drug and alcohol withdrawal that may occur during detoxification.

Description

Drugs and alcohol affect mood by altering brain chemistry, specifically the production of neurotransmitters. Neurotransmitters are chemicals in the central nervous system that enable nerve impulses to travel through the central nervous system and regulate thought processes, behavior, and emotion. Drugs that temporarily elevate neurotransmitter levels are called stimulants. Drugs that decrease neurotransmitter levels and depress the central nervous system are called depressants; they include opiates and sedative-hypnotic drugs such as alcohol and **barbiturates**. (There are exceptions: benzodiazepine elevates the level of an inhibitory neurotransmitter, GABA, therefore it serves as a tranquilizer.)

When drug or alcohol consumption becomes chronic, the body adjusts to the constant presence of the substance by changing its normal production of neurotransmitters. If drug and alcohol use suddenly stops, the body and central nervous system react to the absence of the substance with an array of symptoms known collectively as withdrawal syndrome.

Causes and symptoms

Acute withdrawal syndrome begins within hours of abstinence and includes a full range of physical and psychological symptoms. More long-term, or subacute, withdrawal symptoms, such as intense drug craving, may occur weeks or months after detoxification has taken place.

Alcohol withdrawal

Alcohol withdrawal syndrome occurs in alcohol-dependent individuals who suddenly stop or dramatically reduce their alcohol intake. The onset of the syndrome is likely to occur within a week, but usually occurs within 24 hours of the individual's last drink and is triggered when the central nervous system attempts to adjust to the sudden absence of ethyl

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alcohol in the body. Symptoms may include extreme anxiety, disorientation, **hallucinations**, **sleep disorders**, hand tremors, nausea, sweating, seizures, and racing pulse. **Delirium** tremens (DTs) are an extreme example of withdrawal. In the worst cases, untreated alcohol withdrawal syndrome can result in **death**. As many as two million Americans may experience symptoms of alcohol withdrawal conditions each year.

Barbiturate withdrawal

Barbiturates are prescribed as anticonvulsants, sedatives, and general anesthetics. They can also mimic some of the characteristics of alcohol intoxication (including euphoria, elation, and uninhibited behavior), which make them candidates for **abuse**. Commonly abused barbiturates include amobarbital (Amytal), pentobarbital (Nembutal), and secobarbital (Seconal). These drugs depress the respiratory and nervous system functions. Because abusers rapidly build up a tolerance to the effects of the drug, fatal overdose or **coma** can easily occur. Symptoms of withdrawal syndrome appear 12-20 hours after the last dose; they include anxiety, irritability, elevated heart and respiration rate, muscle **pain**, nausea, tremors, hallucinations, confusion, and seizures. Death is a possibility if the condition is left untreated. Because barbiturates decrease REM (rapid eye movement) sleep, during which dreaming takes place, withdrawal often results in sleep disruptions such as nightmares, insomnia, or vivid dreaming.

Opiate withdrawal

Opiates are powerfully addictive analgesic drugs that deaden nerve pathways related to pain. Abusers of propoxyphene (Darvon), meperidine (Demerol), percocet (Oxycodone), heroin, morphine, and other powerfully addictive opiates quickly build up a tolerance to the drugs and need progressively larger doses to achieve the desired effect. Stopping or reducing the intake of the drug can cause severe withdrawal symptoms, which begin six to eight hours after the last dosage. Symptoms are flu-like and include gastrointestinal distress, anxiety, nausea, insomnia, muscle pain, fevers, sweating, and runny nose and eyes.

Stimulant withdrawal

Use of stimulants, such as **cocaine**, crack, amphetamines, and methamphetamines, cause an increase in neurotransmitters in the central nervous system and produce feelings of alertness and increased energy. This initial "rush" is followed by a longer period of neurotransmitter loss, characterized by depression, lethargy, and a craving for more stimulants sometimes called a rebound effect. When a stimulant-dependent individual abstains from stimulant use, withdrawal symptoms, including depression, **fatigue**, insomnia, and loss of appetite, reflect this drop in neurotransmitter levels. Withdrawal typically takes one to two weeks.

Diagnosis

A detailed history of the patient's drug or alcohol use taken before detoxification can be helpful in predicting the severity of withdrawal symptoms. Standardized clinical tests, such as the Clinical Institute Withdrawal Assessment for Alcohol, revised, (CIWA-Ar), are used to evaluate the severity of withdrawal symptoms throughout the detoxification procedure.

Treatment

Pharmacologic and medical management is often recommended for withdrawal syndrome. The physical condition of the patient is closely monitored throughout the detoxification procedure.

Alcohol withdrawal

Alcohol withdrawal syndrome can be treated at home or in a hospital or treatment setting. Inpatient treatment is recommended for patients who are at risk for serious withdrawal symptoms or re-intoxication if treated as an outpatient. Withdrawal symptoms are minimized through the administration of cross-tolerant sedatives. Long-acting **benzodiazepines**, such as diazepam (Valium), chlordiazepoxide (Librium), and lorazepam (Ativan), are the pharmacologic treatments of choice in managing the symptoms of alcohol withdrawal. Drug dosage is adjusted to offset the discomfort of withdrawal, without causing a euphoric effect, and is then gradually decreased as withdrawal symptoms lessen.

Barbiturate withdrawal

Because the risk for seizures and other severe complications is high, barbiturate withdrawal should be monitored in a hospital setting. Patients are given low doses of phenobarbital at a regular interval until mild intoxication is achieved. The dosage amount and frequency is then gradually decreased until withdrawal is complete.

Opiate withdrawal

Two basic treatment approaches are used for managing opiate withdrawal. The first involves treating the symptoms of the withdrawal with appropriate

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KEY TERMS

Analgesics—Pain killing drugs that depress respiratory function. Opiates are analgesics.

Antagonist—A substance that tends to nullify the action of another.

Benzodiazepines—Sedatives used to treat anxiety, epilepsy, and alcohol withdrawal syndrome. Diazepam (Valium), alprazolam (Xanax), and chlordiazepoxide (Librium) are all benzodiazepines.

Cross-tolerant—A drug that has the same pharmacological effect as another is considered cross-tolerant. Cross-tolerant drugs are often used in treating withdrawal syndromes.

Detoxification—The process of physically eliminating drugs and/or alcohol from the system of a substance-dependent individual.

Dysphoria—A depressed and anxious mood state.

Neurotransmitters—Chemicals in the brain that affect the nervous system and alter thinking patterns.

Opiates—Analgesic, pain killing drugs, such as heroin and morphine that depress the central nervous system.

medication. Clondine, an antihypertensive drug, is commonly prescribed to reduce muscle pain and cramping. Other symptom-specific drugs are administered on an as-needed basis.

The second treatment option is to replace the patient's drug of choice with **methadone**, a long-acting, cross-tolerant opiate that does not normally produce a "high." Doses of methadone are administered every four to six hours. The patient's reaction is closely observed, and dosages are slowly decreased until withdrawal symptoms have disappeared, then dosages are discontinued. Methadone withdrawal can be completed within three weeks. It is important to note that methadone withdrawal treatment differs from a methadone maintenance program, in which patients who are unwilling to give up opiates are prescribed methadone as a legal, long-term substitute for their drug of choice.

Rapid opiate detoxification (ROD) is an emerging treatment option for opiate withdrawal. The ROD method is reported to be faster and to cause less physical discomfort than traditional forms of opiate detoxification. The treatment is typically performed in a hospital or private clinic setting. Naltrexone, an opiate antagonist that blocks opiate receptors and reverses the effects of opiates, is administered to trigger the withdrawal response. Clonidine is given simultaneously to ease the symptoms of withdrawal. The patient is anesthetized throughout the three to four hour procedure, and withdrawal occurs while the patient sleeps. Vital signs are monitored closely and a ventilator may be employed.

In early 2004, a new single injection method for opiate **addiction** was being tested. It consisted of a slow-release form of buprenorphine and prevented symptoms for an entire month.

Stimulant withdrawal

Because of the depression and dysphoria (feeling of a psychological low) related to stimulant withdrawal, psychological and/or medical management is critical. Treatment may include a regimen of drugs that increase neurotransmitter production.

Prognosis

A closely observed, medically managed detoxification typically results in a safe and tolerable withdrawal experience for the patient. Detoxification is only a short-term solution for obtaining abstinence. An addiction treatment and long-term recovery program is necessary to achieve long-term sobriety. Without such a treatment program, the likelihood of recurrence of abuse, and, therefore, the recurrence of withdrawal syndrome, is high.

Prevention

After detoxification, alcohol and drug dependent individuals are encouraged to maintain their abstinence through participation in **substance abuse** treatment or a 12-step recovery program.

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Alcoholics Anonymous, World Services, P.O. Box 459, New York, NY, 10163, (212) 870-3400, http://www.aa.org.

National Clearinghouse for Alcohol and Drug Information, P.O. Box 2345, Rockville, MD, 20847-2345, (877) 726-4727, http://store.samhsa.gov/.

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National Council on Alcoholism and Drug Dependence, Inc., 244 East 58th Street, 4th Floor , New York, NY, 10022, (212) 269-7797, (212) 269-7510, 800 NCA-CALL, national@ncadd.org, http://www.ncadd.org.
National Institute on Alcohol Abuse and Alcoholism (NIAAA), 5635 Fishers Lane, MSC 9304, Bethesda, MD, 20892-9304, (301) 443-3860, http://www.niaaa.nih.gov/.

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Wolff-Parkinson-White syndrome

Definition

Wolff-Parkinson-White syndrome is an abnormality in the electrical functioning of the heart which may cause rapid heart rates. The abnormality affects the electrical signal between the atria and ventricles.

Description

Blood is circulated through the heart and body by a muscular pump and valve system involving the atria and ventricles. The right atrium receives oxygen-lacking blood returning to the heart from the body. The blood is passed from the right atrium into the right ventricle, which contracts and sends blood out to the pulmonary artery. The pulmonary artery sends the blood into the lungs, where carbon dioxide is removed, and fresh oxygen is added. The left atrium receives blood with oxygen from the lungs and passes this arterial blood to the left ventricle, where it is emptied into the aorta, the main artery of the heart.

These functions are directed by electrical signals within the heart. In patients afflicted with Wolff-Parkinson-White syndrome, an abnormal pathway exists that causes additional electrical signals to pass between the atria and ventricles, possibly causing rapid heart rate.

Causes and symptoms

Congenital heart disease may contribute to this and other **arrhythmias**. Ebstein's anomaly, a congenital heart defect that involves displacement of the tricuspid valve, located on the right side of the heart, is one known cause of Wolff-Parkinson-White syndrome. This anomaly allows blood to flow via the small hole to the other side of the heart. Often, there is no known cause for Wolff-Parkinson-White syndrome. Many people with the syndrome have no symptoms. On the other hand, some people experience temporary rapid heartbeat due to certain drugs, **smoking**, and **anxiety**.

Diagnosis

Electrocardiography (ECG) is used to diagnose Wolff-Parkinson-White syndrome, and other cardiac arrhythmias. A trained physician, normally a cardiologist, can recognize patterns of electrical conduction. With this syndrome, the extra pathway will show a pattern different from those of normal conduction. If no irregular patterns show on the ECG, the patient may be sent home with a 24-hour heart monitor, called a Holter monitor, which will help detect intermittent occurrences. Other studies, such as the cardiac electrophysiologic study (EPS), may be ordered to pinpoint the location of the accessory pathway and to determine a course of treatment.

Treatment

Various drugs may be used to treat Wolff-Parkinson-White syndrome, as well as other cardiac arrhythmias. The purpose of these drugs is to slow the electrical signals and excitation of heart muscles. As some of these drugs may have side effects, including the rare production of new or more frequent arrhythmias, the patient should be carefully observed. Ablative therapies may be accomplished with radiofrequency or cardiac catheters to cut through the tissue which is causing the abnormal electrical signals.

At one time, only open heart surgery was used, but the procedure can be done now with **local anesthesia** in a special cardiac laboratory. In some cases, surgery may still be recommended to treat Wolff-Parkinson-White syndrome.Young people with this syndrome may be treated more successfully with surgery, rather than enduring a lifetime of drug treatments, or the possible threat of **sudden cardiac death**.

Alternative treatment

A provider may teach patients methods to help control heart rate. Relaxation techniques, **acupuncture**, botanical medicine, and homeopathy can all be helpful supportive therapies.

Prognosis

Most patients with this syndrome can lead normal lives, even with episodes of tachycardia. In many cases, the syndrome is secondary to the underlying congenital heart defect. However, Wolff-Parkinson-White syndrome can cause sudden cardiac arrest in certain instances.

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KEY TERMS

Ablative—Used to describe a procedure involving removal of a tissue or body part, or destruction of its funtion.

Arrhythmia—Irregular heart beat.

Electrocardiograph (ECG)—A test of a patient's heartbeat that involves placing leads, or detectors, on the patient's chest to record electrical impulses in the heart. The test will produce a strip, or picture record of the heart's electrical function.

Tachycardia—Rapid heart rate, defined as more than 100 beats per minute.

Prevention

If the syndrome is not due to congenital heart disease, the patient may try avoiding behaviors which lead to arrhythmia, such as elimination of **caffeine**, alcohol, **cocaine**, and smoking.

ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, http://www. nhlbi.nih.gov.

Teresa Odle

Women's health

Definition

Women's health is concerned with how disease and health issues affect women and with diseases and conditions that affect women at higher rates. It promotes the inclusion of gender perspectives in a broad spectrum of health issues.

Description

Generally speaking, both women and men share the same health problems. However, several conditions and diseases affect women differently, either because they experience different symptoms or because the disease may be more common in women, such as **osteoarthritis obesity,** and depression. Other conditions, such as **menopause** and **pregnancy**, are unique to women. Another factor in women's health is consideration of the health consequences of discrimination against women that exist in nearly all cultures.

The average life expectancy has almost doubled for women (79 years for women and 73 years for men), when compared with averages at the beginning of the twentieth century. Because of the gender gap in lifespan, women represent approximately two-thirds of the population older than 65 and three-fourths of the population aged 85 years and older. The reasons for this variance are primarily due to physiological differences among men and women.

During different phases of a woman's life cycle, there are complex interactions between sex hormones, physiological changes, and emotional issues. Physiological changes occur as early as embryonic development when hormones program structural differences between male and female brains. During reproductive years, sex hormones profoundly influence reproduction and development, which creates a spectrum of gender-specific health issues. With advancing age and onset of menopause, women's risk factors for disease is generally similar to men's. Although the same disease may affect women and men equally, biological mechanisms and psychosocial differences can influence the clinical course of a disease differently in women. The number of women working has doubled within the past 50 years. The effect of work **stress**, new environmental exposures and multiple roles is expected to have health and social impact. For example, women are often more stressed than men at work, due to the high demands of having to combine work and family responsibilities.

The leading causes of **death** among women are cardiovascular disease, **cancer**, cerebrovascular disease, chronic lung disease, pneumonia/influenza, and diabetes.

Malignant cancers are the most common cause of premature death among women. **Breast cancer** is the second leading cause of death in women and the most commonly diagnosed cancer. Lung cancer, secondary to cigarette **smoking** is the leading cause of cancer death among women.

Cerebrovascular disease accounts for approximately 6% of all deaths in women and it is the third leading cause of mortality. The least common form of **stroke** in the general population, **subarachnoid hemorrhage**, is more common in women.

The prevalence of cigarette smoking has increased greatly in women and this is correlated with pulmonary

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Statistics on women's health

Characteristic	Percentage of U.S. women	Age
In fair or poor health	14%	18+
Without health insurance	15%	<65
Currently smoke	18%	18+
Engage in regular physical activity	30%	18+
Have hypertension	33%	20+
Are obese	35%	20+
Had a mammogram in the past 2 years	68%	40+
Had a Pap smear in the past 3 years	75%	18+

SOURCE: Centers for Disease Control and Prevention, FastStats.

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disease. Death rates for pulmonary disease including cancer and infectious causes of death are expected to rise for women.

Diabetes, a leading cause of death in women is more prevalent among Hispanic, African-American, and Native American women. Past age 45, diabetes affects about one in six women.

Women are more vulnerable to psychological disorders, such as depression, a serious affective disorder whereby the prevailing emotional mood interferes with quality of life and normal functioning. **Postpartum depression** is specific to women and is diagnosed when a new mother develops a major depressive episode within one month after giving birth. Other psychological disorders include **eating disorders**, such as **anorexia nervosa** and bulimia, which are much more prevalent in teenage girls and young women than in boys and young men.

Other health issues affecting women include:

- Osteoporosis, or loss of the quantity of bone, common in postmenopausal women.
- Alcohol abuse, which can have adverse affects on fertility and in the developing fetus (fetal alcohol syndrome). Women frequently do not seek treatment because of fear of consequences (i.e., loss of child custody).
- Acquired immunodeficiency syndrome (AIDS), which represents the highest percent increase in the death rates of women.
- Violence is a major issue and a leading cause of death, primarily from a perpetrator who is or was a partner.

Demographics

A number of diseases affect women at a disproportionately high rate and the prevalence of some diseases is also increasing in women. For example, by the end of 2005, according to the World Health Organization (WHO), 17.5 million women worldwide were infected with HIV. According to the Centers for Disease Control and Prevention (CDC), between 2000 and 2004, the estimated number of **AIDS** cases in the United States increased 10% among women compared to 7% in males. In 2004, women accounted for 27% of the 44,615 newly reported AIDS cases among adults and adolescents. HIV affects African-American and Hispanic women to a higher degree. Even though they represent less than 25% of all women in the United States, they account for more than 79% of AIDS cases in women. Worldwide, more than 90% of all adolescent and adult HIV infections have resulted from heterosexual intercourse. Women are particularly vulnerable to heterosexual HIV transmission as a result of substantial mucosal exposure to seminal fluids. This increases the risk of HIV transmission when coupled with the high prevalence of non-consensual sex, sex without condom use, and the high-risk behaviors of their partners.

Heart disease also ranks high in women's health issues. It is responsible for more deaths in women than all forms of cancer combined. Heart disease is the most significant health concern for women in the United States, causing nearly 350,000 deaths each year.

The third leading cause of cancer death for women in the United States is colorectal cancer. Colorectal cancer is often mistakenly thought of as a man's disease, but equal numbers of men and women die of colorectal cancer each year.

Nearly 160,000 people in the United States die of stroke each year, and almost two-thirds of them are women. Stroke not only ranks as women's third killer, but is also one of the leading causes of women's disability in the United States.

Chronic lung conditions, including **bronchitis** and **emphysema**, kill approximately 65,000 women in the United States each year. The main cause is smoking, strongly associated with lung cancer.

More women than men have **Alzheimer's disease**. Some 45,000 women die with Alzheimer's disease each year, more than twice the number of men. One reason more women may be affected is that women generally live longer, and the risk of Alzheimer's increases with age.

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Autoimmune diseases, which include **systemic lupus erythematosus** (SLE), **rheumatoid arthritis**, and **multiple sclerosis**, represent another health issue for women. Although many autoimmune diseases are rare, collectively these chronic diseases afflict 5–8% of the U.S. population and affect women at much higher rates. For example, 90% of the nearly two million Americans diagnosed with (or suspected of having) SLE are women.

Chronic fatigue syndrome (CFS) is another disorder that is diagnosed two to four times more often in women than in men.

An estimated 15 million new cases of **sexually transmitted diseases** (STD) occur in the United States each year. Some STDs such as **syphilis** have declined in women, while others (e.g., **genital herpes**, **gonorrhea**, chlamydia) continue to spread through the population, posing a significant health problem for women. This is because symptoms in women are minor or nonspecific, especially in the early stages. The result is that STDs in women sometimes are not diagnosed until late in the disease. STDs that occur during pregnancy can affect the fetus or newborn. About one-quarter to one-half of women infected with an STD during pregnancy give birth to either premature or low-birthweight infants. In about one-third to two-thirds of these pregnancies, the infection is passed to the infant, possibly causing permanent disabilities.

Psychological and affective disorders are more prevalent in women. Major depression and dysthymia affect twice as many women as men. This two-to-one ratio exists regardless of racial and ethnic background or economic status. The same ratio has been reported in ten other countries all over the world. Men and women have about the same rate of **bipolar disorder**, although its course in women typically has more depressive and fewer manic episodes. A greater number of women have the rapid cycling form of bipolar disorder, which may be more resistant to standard treatments. As for postpartum depression, it is estimated that 10–15% of women experience it after giving birth. As for eating disorders, the American Anorexia/Bulimia Association reports that more than 1,000 women and girls die of anorexia each year and more than 90% of people with anorexia are adolescent and young women.

Causes and symptoms

Cardiovascular disease can be caused by blockage of a blood vessel, high blood pressure, or a secondary complication to another disease. There may be an abnormal heart rhythm or cell death. Patients may complain of a broad spectrum of symptoms that may include **pain**, chest discomfort, high blood pressure, or strain during physical exertion.

When attempting to define the cause and symptoms of cancer, it is important to assess the type of cancer and location. Additionally, whether the tumor is localized (benign) or has spread to other areas (malignant) is vital for treatment planning and overall prognosis. In cases of breast cancer there may be a lump discovered during self-examination or **mammography** (special breast x rays).

Cerebrovascular disease may cause **tremors** (shaking), loss of balance and coordination, or functional and sensation loss in some parts of the body. Patients may have sudden transient strokes that could result in temporary loss of consciousness and **amnesia** of the incident. Patients may also develop chronic neurological states that causing **memory loss** and behavioral changes (Alzheimer's disease).

Patients with pulmonary (lung) cancer may develop **shortness of breath**, **fatigue**, weight loss, worsening **cough**, and coughing up bright red blood with sputum. Lung infections such as **pneumonia** may present with high **fever**, weakness, difficulty breathing, and abnormal breath sounds heard with a stethoscope during **physical examination**.

Diabetes is a syndrome with disordered metabolism and high blood sugar due to an abnormality in the chemical that regulates sugar levels. It is characterized by an increased thirst, urination, and chronic skin infections.

Osteoporosis may cause the bones to be brittle and weak. It is usually not detected until bones start to break.

An alcohol abuser will continue to drink despite negative repercussions. The person may not seek treatment to evade legal and/or child custody problems. The patient may hide alcohol, or confine drinking to specific times. The disease progresses to where there may be permanent liver damage, memory blackouts, and **malnutrition**.

Depression is characterized by a combination of symptoms that interfere with the ability to work, sleep, study, eat, and enjoy once-pleasurable activities.

Patients with AIDS may not have symptoms for years. When active disease occurs, patients typically develop recurrent infections that are the usual cause of death.

Domestic violence is usually associated with a perpetrator who is in a relationship with the affected

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person. **Abuse** can be manifested by physical violence and/or homicide.

Diagnosis

Diagnosis can be accomplished with a history, physical examination, and specialized tests or procedures.

Tests

For cardiovascular disease, an electrocardiogram can determine the activity of the heart. Additional tests may include **echocardiography** (ultrasonic waves that generate an image), stress testing, and studies that require placing a catheter with a probe to examine the damage to heart tissue. Special tests may inject dyes to enhance visualization.

Cancer may be detected using specialized test called **tumor markers** and imaging studies such as MRI and CAT scans. Cerebrovascular disease can be detected with a complete neurological examination and specialized imaging technology. Diabetes is usually detected by a careful history, presence of risk factors (obesity), and blood analysis of glucose levels. Osteoporosis can be evaluated with specialized bone densitometry.

Alcohol abuse can be established by a bio-psychosocial assessment and standardized tests that screen for this disorder. Psychological evaluation (such as the **Minnesota Multiphasic Personality Inventory**, MMPI) can usually detect depression or eating disorders. AIDS can be established by a careful history, belonging to high-risk groups and Western blot analysis (examination of blood to detect the protein of human **immunodeficiency** virus). Violence can be established by physical signs of beating, such as cuts and **bruises**.

Treatment

Treatment depends on the extent of disease and the present health status of the patient. In some cases, treatment may stopped or it may altogether be refused.

Treatment for cardiovascular disease may include surgical intervention and/or conservative medical treatment with medications. Diet, **exercise**, and weight reduction are important parameters for treatment planning. Appropriate referrals, counseling, and follow-up are usually indicated. Treatment for cancer may include a combination of surgery, **chemotherapy**, or **radiation therapy**. These treatment modalities may be given singly or in combination different times during disease progression. Cerebrovascular disease can be treated surgically and/or with medications that thin the blood. Symptomatic care may be indicated in addition to close monitoring if the patient develops disability and/or cognitive impairment.

Diabetes can be treated by dietary modifications and medications, which treat abnormal levels of blood glucose (sugar). Osteoporosis can be treated with estrogen replacement therapy and regular vitamin/mineral intake. Alcohol abuse may require long-term therapy, inpatient treatment and medications. Community-centered support group meetings are also recommended as a form of treatment maintenance.

To date there is no treatment for AIDS, other than medications that offer symptomatic relief. Alcohol abuse, psychological disorders, and violence require therapy, possible medication, and community centered support group meetings.

Alternative

There are numerous studies that support intake of co-enzyme Q10 for cardiovascular health. Studies have shown that beta-carotene and vitamin E and C have no effect for cancer. Some studies indicate positive results for reproductive health using **acupuncture**. Certain herbs may be beneficial during menopause. According to most medical literature, further research using scientific method is vital for general acceptance.

Clinical trials

Many clinical trials for the study and treatment of women's health are currently sponsored by the National Institutes of Health (NIH) and other agencies. Clinical trial information is constantly updated by NIH.

Prognosis

The prognosis depends on the extent of disease and the physical and emotional status of the patient. Prognosis is also related to tolerance of treatment, adverse drug effects, complication during or after surgery, disease resurgence, and patient compliance with treatment recommendations.

Prevention

One of the most reliable measures of prevention is education and training. The Council on Graduate Medical Education and several institutes of the NIH have provided funding for numerous centers to research women's health issues. On a more individual level, preventive and personal habits are vital for good

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KEY TERMS

Alzheimer's disease—A progressive neurologic disease of the brain that leads to the irreversible loss of neurons and dementia.

Anorexia nervosa—Starving oneself to reduce body weight below the minimum level required to maintain health.

Antidepressant—A drug used to treat depression.

Bulimia—Eating excessively large amounts of food followed by vomiting or other forms of purging and stomach emptying.

Cardiovascular disease—A structural or functional abnormality of the heart, or of the blood vessels supplying the heart, that impairs its normal function.

Cerebrovascular disease—Disorders affecting the blood vessels that supply the brain that may result in a stroke.

Chlamydia—Small pathogens associated with pneumonia, abortion, diarrhea, conjunctivitis, arthritis, and encephalitis.

Dysthymia—Type of affective disorder or mood disorder that often resembles a less severe, yet more chronic form of major.

Electrocardiogram—An instrument that monitors heart rate and rhythm.

Emphysema—A chronic, irreversible disease of the lungs.

Estrogen—A hormone secreted by the ovaries that affects many aspects of the female body, including a woman's menstrual cycle and normal sexual and reproductive development.

Estrogen replacement therapy—Use of the female hormone estrogen to replace that which the body no longer produces naturally after medical or surgical menopause.

Genital herpes—A sexually-transmitted disease caused by the herpes simplex virus.

Gonorrhea—A sexually-transmitted infection caused by the bacterium *Neisseria gonorrhoea*.

Menopause—The time of life when a woman's menstrual periods stop. A woman is in menopause when she has not had a period for 12 months in a row.

Osteoporosis—A decrease in bone density.

Postmenopausal—A term referring to the time period following menopause.

Stroke—The sudden death of some brain cells due to a lack of oxygen when the blood flow to the brain is impaired by blockage or rupture of an artery to the brain.

Syphilis—A sexually-transmitted disease caused by the bacterium *Treponema pallidum*.

health. Most physicians believe that a baseline physical examination is a reliable comparative tool. Women should receive counseling for special health issues such as smoking, exercise, diet, primary disease prevention, safe sexual practices, alcohol abuse, psychological disorders, and violence. Knowledge of family history is important since many diseases have a strong propensity among first-degree relatives. Blood pressure should normally be measured every other year. Screening tests for breast, cervical, and colorectal cancer is recommended. Pap smears taken during routine pelvic examinations can screen for disease processes in the reproductive tract. Serum cholesterol monitoring and reduction are advised. Patients may require postmenopausal estrogen replacement therapy and vitamin/mineral supplements.

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ORGANIZATIONS

American College of Obstetricians and Gynecologists (ACOG), 409 12th St. SW, PO Box 96920, Washington, DC, 20090-6920, (202) 638-5577, http://www.acog.org.

American College of Obstetricians and Gynecologists, PO Box 96920, Washington, DC, 20090-6920, (202) 638-5577, http://www.acog.org.

American Dietetic Association, 120 South Riverside Plaza, Suite 2000, Chicago, IL, 60605, (800) 877-1600, http://www.eatright.org.

American Menopause Foundation, Inc., Empire State Bldg., 350 Fifth Ave., Ste. 2822, New York, NY, 10118, (212) 714-2398, http://www.americanmenopause.org.

Food and Drug Administration, Office of Women's Health, 10903 New Hampshire Avenue WO32-2333, Silver Spring, MD, 20993, (301) 796-9440, (301) 847-8604, http://www.fda.gov/ForConsumers/byAudience/ForWomen.

Office of Research on Women's Health, 6707 Democracy Blvd. Suite 400, Bethesda, MD, 20892-5484, (301) 402-1770, (301) 402-1798, ODORWH-research@mail.nih.gov, http://orwh.od.nih.gov.

National Eating Disorders Association, 603 Stewart St., No. 803, Seattle, WA, 98101, (206) 382-3587, http://www.nationaleatingdisorders.org.

National Institutes of Health, Office of Research on Women's Health, 6707 Democracy Blvd., Suite 400, Bethesda, MD, 20892-5484, (301) 402-1770, http://orwh.od.nih.gov.

National Women's Health Information Center, 200 Independence Ave. SW, Room 712E, Washington, DC, 20201, (888) 220-5446, http://womenshealth.gov.

National Women's Health Network, 514 10th Street NW, Suite 400, Washington, DC, 20004, (202) 628-7814, http://www.nwhn.org.

USDA National Agricultural Library, Food and Nutrition Information Center, 10301 Baltimore Ave., Beltsville, MD, 20705-2351, http://www.nutrition.gov.

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Wound culture

Definition

A wound culture is a laboratory test in which microorganisms from a wound are grown in a special growth medium. It is done to find and identify the microorganism causing an infection in a wound or an **abscess**. If a microorganism is found, more testing is done to determine how to treat the infection.

Purpose

Wounds are injuries to body tissues caused by disease processes or events such as **burns**, punctures, and human or animal **bites**. Wounds or abscesses also occur within body tissues as a result of surgery or dental procedures. Wounds become infected when microorganisms from the outside environment, or from within the person's body, enter the open wound and multiply. A wound that is red, painful, swollen, and draining pus is probably infected. A **fever** following surgery indicates an infection at the site of surgery.

To enable healing and prevent the spread of infection to other body tissues, the infecting microorganisms must be killed. A wound culture discovers which type of microorganism is causing the infection and the best antibiotic with which to kill it. This is important as physicians have become less inclined to prescribe **antibiotics** until certain they are needed because of antibiotic resistance that has developed due to overuse of the drugs.

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KEY TERMS

Aerobe—Bacteria that require oxygen to live.

Anaerobe—Bacteria that live only where there is no oxygen.

Normal flora—The mixture of bacteria normally found at specific body sites.

Description

A sample of material, such as pus or a portion of tissue, is taken from the wound, placed in a sterile container, and sent to the laboratory. In the laboratory, this material is spread over the surface of several different types of culture plates and placed in an incubator at body temperature for one to two days.

A Gram stain is done by staining the slide with purple and red stains, then examining it under a microscope. If many white blood cells and bacteria are seen, it is an early confirmation of infection. The color of stain retained by the bacteria (purple or red), their shape (such as round or rectangular), and their size provides valuable clues as to their identity, and helps the physician predict which antibiotics might work best even before the entire test is completed. Bacteria that stain purple are called gram-positive; those that stain red are called gram-negative.

Bacteria can be grouped into two categories: aerobes and anaerobes. Aerobes are bacteria that need oxygen to live; anaerobes live only where there is no oxygen. Deep wounds, closed-off from oxygen, are an ideal environment for an anaerobic infection to develop. Foul-smelling odor, gas, or **gangrene** at the infection site are signs of an infection caused by an anaerobic bacteria. Routine cultures typically only look for aerobic bacteria. If the physician tells the laboratory to include a culture for anaerobes, a portion of the wound sample will be put on culture plates, or in a tube of culture broth, and incubated in a special chamber without oxygen.

Bacteria present in the wound sample will multiply and appear as visible colonies on the plates, or as cloudiness in the tube of broth. They are identified by the appearance of their colonies, the results of biochemical tests, and information from Gram staining part of the bacterial colony.

A sensitivity test, also called an antibiotic susceptibility test, is also done. The bacteria are tested against different antibiotics to determine which will treat the infection by killing the bacteria.

If the physician thinks the wound may be infected with a mold or yeast, a fungal culture is also done. The wound sample is spread on special culture plates that are treated to encourage the growth of mold and yeast. Different biochemical tests and stains are used to identify molds and yeast.

Other more unusual microorganisms, such as *Mycobacterium leprae*, may be the cause of a wound infection. The physician must notify the laboratory to culture specifically for these more unusual microorganisms.

The initial Gram stain result is available the same day, or in less than an hour if requested by the physician. An early report, known as a preliminary report, is usually available after one day. This report will tell if any microorganisms have yet been found, and, if so, their Gram stain appearance. For example, they may have the appearance of a gram-negative rod, or a gram-positive cocci (spherical shape). The final report, usually available in one to three days, includes complete identification, an estimate of the quantity of the microorganisms, plus a list of the antibiotics to which they are sensitive. Cultures for fungi and anaerobic bacteria may take two to three weeks.

Wound culture is also called soft tissue culture, abscess culture, or wound culture and sensitivity.

Preparation

A piece of the infected tissue is the best specimen. If this is not possible, the next best specimen is pus from the wound. Because many microorganisms normally live on skin and mucous membrane, the specimen must not be allowed to touch the area surrounding the wound.

The physician first cleans the surface of the wound using alcohol. Using a syringe, the physician suctions out (aspirates) as much pus as possible from the wound. Next, this is sent to the laboratory in a sterile container. If it is impossible to aspirate the pus, pus from within the wound can be collected on a swab.

The physician may choose to start the person on an antibiotic before the culture and sensitivity tests are completed. However, the specimen for culture should be collected before antibiotics are begun. Antibiotics in the person's system may prevent microorganisms present in the wound from growing in culture, and thus not be identifiable.

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Normal results

A normal culture may be contaminated by a mixture of microorganisms normally found on a person's skin (normal flora).

It is not uncommon for the microorganism causing a wound infection to not grow in culture. This is particularly true if the specimen was collected with a swab rather than an aspirate or tissue biopsy.

Abnormal results

Streptococcus Group A, ***Escherichia coli***, *Proteus*, *Klebsiella*, *Pseudomonas*, *Enterobacter*, Enterococci, *Staphylococcus aureus*, *Bacterioides*, and *Clostridium*, are common causes of wound infections. More than one microorganism may be the cause of the infection.

Resources

PERIODICALS

"Does Increased Use of Antibiotics Result in Increased Antibiotics Resistance?" *Clinical Infectious Diseases* July 1, 2004: 18–20.

ORGANIZATIONS

Wound Healing Society, 341 N. Maitland Ave., Suite 130, Maitland, FL, 32751, (407) 647-8839, info@wound-heal. org, http://www.woundheal.org.

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Wound flushing

Definition

Wound flushing is a method of cleaning a wound by applying pressurized water or antiseptic solutions to the tissues. It is also called irrigation.

Purpose

Wound flushing is used to help flush debris from a wound, lessening the risk of infection or treating an infection that already exists. If the wound is flushed with an antiseptic, it is more likely to heal correctly; flushing the wound can help prevent the surface from healing over a possibly infected area underneath.

Wound flushing is routinely performed by dentists or oral surgeons following tooth extractions, mouth trauma, or gum surgery, to prevent bacteria from the mouth entering the bloodstream as well as to cleanse the tooth socket.

KEY TERMS

Antiseptic—Chemicals applied to the skin to destroy bacteria and prevent infection.

Irrigation—The medical name for wound flushing.

Description

Wound flushing is usually done in a hospital or oral surgery center, although if it is performed at home, there is less chance of infection because of the higher risk of bacterial contamination in the hospital environment. Wound flushing is especially helpful in treating people with **bites**, lacerations, or crush injuries, which often become infected due to the presence of dead tissue and foreign debris, such as splinters or dirt. In a non-surgical situation, the procedure is usually performed by a nurse. An acute injury, such as a crushing wound or knife cut, the wound is flushed right before the injury is stitched closed. For people with chronic **wounds**, such as bed sores or abscesses, the wound may be flushed periodically to treat or prevent infection. During an operation, a surgeon uses an antibacterial solution to flush the surgical site just before stitching the wound closed. After surgery, the wounds may be flushed to treat or prevent infection.

Preparation

The nurse or doctor may inject the site with a local anesthetic before flushing the wound.

Aftercare

After the wound is flushed, the health care provider cleans the area around the wound to guard against infection. Packing to absorb excess fluids may be placed into the wound, followed by a sterile bandage.

Risks

Complications rarely occur, especially if the solution used to flush the wound is chosen carefully so as to avoid skin irritation; occasionally, however, serious infections are reported. In addition, damage to skin or internal organs has been reported from the use of hydrogen peroxide to flush wounds or irrigate the abdominal cavity after surgery.

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Patients should call the doctor immediately if there is any sign of infection, such as **fever**, pus, or swelling.

Normal results

The wound will heal correctly, from the inside out, without infection.

Resources

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Carol A. Turkington
Rebecca J. Frey, PhD

Wounds

Definition

A wound occurs when the integrity of any tissue is compromised (e.g. skin breaks, muscle tears, **burns**, or bone **fractures**). A wound may be caused by an act, such as a gunshot, fall, or surgical procedure; by an **infectious disease**; or by an underlying condition.

Demographics

Wounds are very common. Nearly everyone has had a wound of one type or another. Minor wounds are especially common in childhood because children engage in so much play and activity. Annually, about 3.6 million Americans acquire some type of open wound requiring treatment by a healthcare provider, and an additional four million Americans are affected by a chronic wound.

Description

Types and causes of wounds are wide ranging, and health care professionals have several different ways of classifying them. They may be chronic, such as the skin ulcers caused by **diabetes mellitus**, or acute, such as a gunshot wound or animal bite. Wounds may also be referred to as open, in which the skin has been compromised and underlying tissues are exposed, or closed, in which the skin has not been compromised, but trauma to underlying structures has occurred (e.g. a bruised rib or cerebral contusion). Emergency personnel and first-aid workers generally place acute wounds in one of eight categories:

- Abrasions. Also called scrapes, they occur when the skin is rubbed away by friction against another rough surface (e.g. rope burns and skinned knees).
- Avulsions. These occur when an entire structure or part of it is forcibly pulled away, such as the loss of a permanent tooth or an ear lobe. Explosions, gunshots, and animal bites may cause avulsions.
- Contusions. Also called bruises, these are the result of a forceful trauma that injures an internal structure without breaking the skin. Blows to the chest, abdomen, or head with a blunt instrument (e.g., a football or a fist) can cause contusions.
- Crush wounds. Occur when a heavy object falls onto a person, splitting the skin and shattering or tearing underlying structures.
- Cuts. These are slicing wounds made with a sharp instrument, leaving even edges. They may be as minimal as a paper cut or as significant as a surgical incision.
- Lacerations. Also called tears, these are separating wounds that produce ragged edges. They are produced by a tremendous force against the body, either from an internal source as in childbirth, or from an external source like a punch.
- Missile wounds. Also called velocity wounds, they are caused by an object entering the body at a high speed, typically a bullet.

A close-up of a hard-contact gunshot wound with accompanying burn marks on the left and right sides of the wound. *(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

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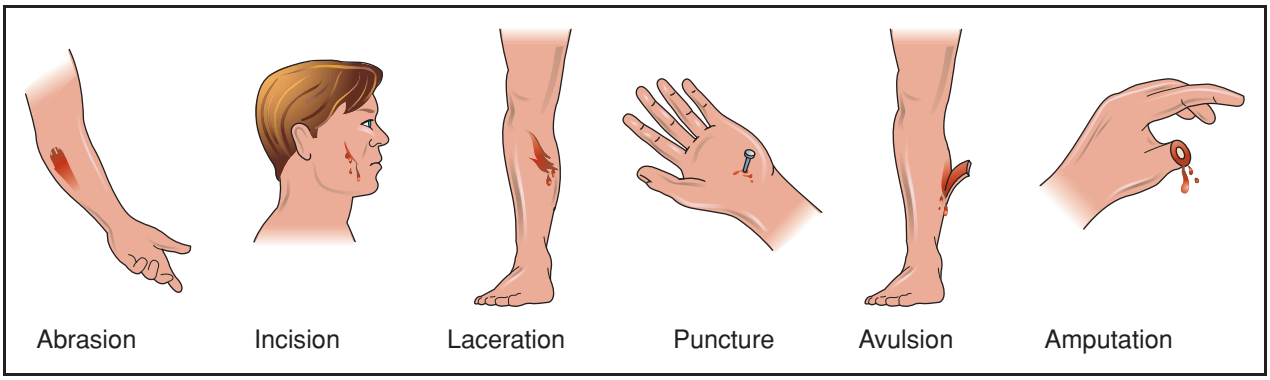

Examples of open wounds. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

- Punctures. These are deep, narrow wounds produced by sharp objects such as nails, knives, and broken glass.

Causes and symptoms

Acute wounds have a wide range of causes. Often they are the unintentional results of motor vehicle accidents, falls, mishandling of sharp objects, or sports-related injury. Wounds may also be an intentional result of violence involving assault with weapons, including fists, knives, or guns.

The general symptoms of a wound are localized **pain** and bleeding. Specific symptoms include:

- An abrasion usually appears as lines of scraped skin with tiny spots of bleeding.
- An avulsion has heavy, rapid bleeding and a noticeable absence of tissue.
- A contusion may appear as a bruise beneath the skin or may appear only on imaging tests. An internal wound may also generate symptoms such as weakness, perspiration, and pain.
- A crush wound may have irregular margins like a laceration; however, the wound will be deeper and trauma to muscle and bone may be apparent.
- A cut may have little or profuse bleeding depending on its depth and length; its even edges readily line up.
- A laceration may have little or profuse bleeding. The tissue damage is generally greater and the wound's ragged edges do not readily line up.
- A missile entry wound may be accompanied by an exit wound, and bleeding may be profuse, depending on the nature of the injury.
- A puncture wound will be greater in depth than in its length, therefore there is usually little bleeding around the outside of the wound and more bleeding inside, causing discoloration.

Diagnosis

A diagnosis is made by visual examination and may be confirmed by a report of the causal events. Medical personnel will also assess the extent of the wound and the effect it has had on the patient's well-being (e.g., profound blood loss, damage to the nervous system or skeletal system).

Treatment

Treatment of wounds involves stopping any bleeding, then cleaning and dressing the wound to prevent infection. Additional medical attention may be required if the effects of the wound have compromised the body's ability to function effectively.

Stopping the bleeding

Most bleeding may be stopped by direct pressure. Direct pressure is applied by placing a clean cloth or dressing over the wound and pressing the palm of the hand over the entire area. This limits local bleeding without disrupting a significant portion of the circulation. The cloth absorbs blood and allows clot formation. The clot should not be disturbed, so if blood soaks through the cloth, another cloth should be placed directly on top rather than replacing the original cloth.

If the wound is on an arm or leg that does not appear to have a broken bone, the wound should be elevated to a height above the person's heart while direct pressure is applied. Elevating the wound allows gravity to slow down the flow of blood to that area.

If severe bleeding cannot be stopped by direct pressure or with elevation, the next step is to apply pressure to the major artery supplying blood to the area of the wound. In the arm, pressure would be applied to the brachial artery by pressing the inside

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KEY TERMS

Abrasion—Also called a scrape. The rubbing away of the skin surface by friction against another rough surface.

Avulsion—The forcible separation of a piece of tissue from an entire structure.

Butterfly bandage—A narrow strip of adhesive with wider flaring ends (shaped like butterfly wings) used to hold the edges of a wound together while it heals.

Cut—Separation of skin or other tissue made by a sharp edge, producing regular edges.

Laceration—Also called a tear. Separation of skin or other tissue by a tremendous force, producing irregular edges.

Plasma—The straw-colored fluid component of blood, without blood cells.

Puncture—An injury caused by a sharp, narrow object deeply penetrating the skin.

Tourniquet—A device used to control bleeding, consisting of a constricting band applied tightly around a limb above the wound. It should only be used if the bleeding in life-threatening and can not be controlled by other means.

Traumatic shock—A condition of depressed body functions as a reaction to injury with loss of body fluids or lack of oxygen. Signs of traumatic shock include weak and rapid pulse; shallow and rapid breathing; and pale, cool, clammy skin.

Whole blood—Blood that contains red blood cells, white blood cells, and platelets in plasma.

of the upper arm against the bone. In the leg, pressure would be applied to the femoral artery by pressing on the inner crease of the groin against the pelvic bone.

If the bleeding from an arm or leg is so extreme as to be life-threatening and if it cannot be stopped by any other means, a tourniquet may be required. However, in the process of limiting further blood loss, the tourniquet also drastically deprives the limb tissues of oxygen. As a result, the patient may live but the limb may die.

In 2004, a new solution to stopping bleeding was introduced. Called QuikClot, the U.S. Food and Drug Administration (FDA) approved substance is made up of synthetically made material called zeolite, which occurs naturally in volcanic rock. When used properly, it can be poured into a wound that will not stop bleeding and will slow blood loss. The trauma pack costs about 50 cents and has shown particular promise in the battlefield and in wilderness situations.

Dressing the wound

Once bleeding has been stopped, cleaning and dressing the wound is important for preventing infection. Although flowing blood flushes debris from the wound, running water should also be used to rinse away dirt. Embedded particles such as wood slivers and glass splinters, if not too deep, may be removed with a needle or pair of tweezers that has been sterilized in rubbing alcohol or in the heat of a flame. Once the wound has been cleared of foreign material and washed, it should be gently blotted dry, with care not to disturb the blood clot. An antibiotic ointment may be applied. The wound should then be covered with a clean dressing and bandaged to hold the dressing in place.

Getting medical assistance

A person who has become impaled on a fixed object, such as a fence post or a stake in the ground, should be moved only by emergency medical personnel. **Foreign objects** embedded in the eye should be removed only by a doctor. Larger penetrating objects, such as a fishhook or an arrow, should be removed only by a doctor to prevent further damage as the object exits the body.

Additional medical attention is necessary in several instances. Wounds that penetrate the muscle beneath the skin should be cleaned and treated by a doctor. Such a wound may require sutures (stitches) to keep it closed during healing. Some deep wounds that do not extend to the underlying muscle may only require butterfly **bandages** to keep them closed during healing. Wounds to the face and neck, even small ones, should always be examined and treated by a doctor to preserve sensory function and minimize scarring. Deep wounds to the hands and wrists should be examined for nerve and tendon damage. Puncture wounds may require a **tetanus** shot to prevent serious infection. Animal **bites** should always be examined and the possibility of **rabies** infection determined.

Infection

Wounds that develop signs of infection should also be brought to a doctor's attention. Signs of infection are swelling, redness, tenderness, throbbing pain, localized warmth, **fever**, swollen lymph glands, the presence of pus either in the wound or draining from it, and red streaks spreading away from the wound.

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Emergency treatment

With even as little as one quart of blood lost, a person may lose consciousness and go into traumatic **shock**. Because this is a life-threatening situation, emergency medical assistance should be called immediately. If the person stops breathing, artificial respiration (also called mouth-to-mouth resuscitation or rescue breathing) should be administered. In the absence of a pulse, **cardiopulmonary resuscitation** (CPR) must be performed. Once the person is breathing unassisted, the bleeding may be attended to.

In cases of severe blood loss, medical treatment may include the intravenous replacement of body fluids. This may be infusion with saline or plasma, or a **transfusion** of whole blood.

Chronic wound treatment

Treating a chronic wound involves encouraging an environment in the wound bed that promotes healing, supporting overall health and **nutrition**, and managing chronic conditions (such as diabetes) that contribute to chronic wounds. **Debridement** of dead tissue from the wound, either by surgery or with the use of enzymatic debriding medication, helps create a wound bed that enables new tissue granulation. Occlusive moist **dressings** encourage autolytic debridement, which is the body's own sloughing and breaking down of dead cells. Negative pressure dressings, silver-containing antimocrobial medication, hyperbaric **oxygen therapy**, **physical therapy**, and **nutritional supplements** are also available to treat chronic wounds. Chronic wounds are often chronically painful, so **pain management** is important to enable the affected person to participate fully in their care and maintain their usual activities.

In some cases, clinicians have resorted to a Civil War-era treatment that does not sound appealing, but works well enough to receive FDA approval. Maggots can be placed on wounds that refuse to heal with high–tech medical methods. The maggots are dropped into the wound and covered with special mesh to keep them in place. They are removed in two to three days.

Alternative treatment

In addition to the conventional treatments described above, there are alternative therapies that may help support the injured person. Homeopathy can be very effective in acute wound situations. *Ledum* (*Ledum palustre*) is recommended for puncture wounds (taken internally). Calendula (*Calendula officinalis*) is the primary homeopathic remedy for wounds. An antiseptic, it is used topically as a succus (juice), tea, or salve. Another naturally occurring antiseptic is tea tree oil (*Melaleuca* spp.), which can be mixed with water for cleaning wounds. Aloe (*Aloe barbadensis*) can be applied topically to soothe skin during healing. When wounds affect the nerves, especially in the arms and legs, St. John's wort (*Hypericum perforatum*) can be helpful when taken internally or applied topically. **Acupuncture** can help support the healing process by restoring the energy flow in the meridians that have been affected by the wound. Alternative treatments should be used with care, as the benefits of many such treatments have not been confirmed by scientific research.

Prognosis

Without the complications of infection or excess blood loss, most wounds heal well with time. Depending on the depth and size of the wound, it may or may not leave a visible scar.

Generally, wounds heal in a series of progressive steps. During the inflammatory phase, which begins with the injury, blood vessels narrow and clot formation begins. Substances are also released that initiate the healing process and macrophages begin to clear the wound of debris. The next phase is one of proliferation, during which a network of collagen and new capillaries begin to form the basis of the healing wound bed. The wound appears dark pink or purple due to the presence of many new capillaries that supply blood to the healing tissue. During the phase of epithelialization, new skin cells begin to form, eventually creating a new barrier between the wound bed and outside elements. This process usually begins within about 48 hours of injury. The collagen and new skin cells become more organized during the remodeling phase, which ends in the closure of the wound with skin that is about 75% as strong as the original skin. When excess collagen is formed in a wound bed that penetrates the dermis, a scar is formed. When wound healing is severely delayed or remains in a particular phase, it becomes a chronic wound.

Prevention

Most actions that result in wounds are preventable. Injuries from motor vehicle accidents may be reduced by wearing seat belts and placing children in size-appropriate car seats in the back seat. Sharp, jagged, or pointed objects or machinery parts should be used according to the manufacturer's instructions and only for their intended purpose. Firearms and

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explosives should be used only by adults with explicit training; they should also be kept locked and away from children. Persons engaging in sports, games, and recreational activities should wear all proper protective equipment and follow safety rules.

Chronic wounds are best avoided by preventing the diseases that cause them. Diabetes and **peripheral vascular disease** are the major causes of chronic wounds among ambulatory people. Maintaining a healthy diet, weight, and lifestyle that includes **exercise** are helpful in preventing either of these conditions. Maintaining control of blood glucose levels, along with care of the feet and toes is important for persons with diabetes in preventing wounds that can become chronic. In non-ambulatory persons, pressure reliving devices in wheelchairs or beds, frequent changes in position, and sometimes **diets** fortified with protein, **vitamins** A and C, and the mineral zinc can help prevent chronic ulcerating wounds.

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"Nutrition Guidelines to Improve Wound Healing." *Cleveland Clinic*. http://my.clevelandclinic.org/healthy_living/nutrition/hic_nutrition_guidelines_to_improve_wound_healing.aspx (accessed September 16, 2010).

ORGANIZATIONS

American Red Cross (ARC), 2025 E. St., NW, Washington, DC, 20006, (202) 303-5000, (800) 733-2767, http://www.redcross.org/.

Association for the Advancement of Wound Care (AAWC), 83 General Warren Blvd. Suite 100, Malvern, PA, 19355, (610) 560-0484, (800) 237-7285, (610) 560–0502, sdonato@aawconline.org, http://www.aawconline.org/.

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Wryneck *see* **Torticollis**

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X

X-linked agammaglobulinemia

Definition

X-linked agammaglobulinemia (XLA), or Bruton's agammaglobulinemia, is present at birth (congenital) and is characterized by low or completely absent levels of immunoglobulins in the bloodstream. Immunoglobulins are protein molecules in blood serum that function like antibodies. Without them, the body lacks a fully functioning immune system. Persons with XLA are vulnerable to repeated, potentially fatal bacterial infections.

Description

XLA occurs in one in 50,000 to one in 100,000 newborns. Almost all persons with the disorder are males. Although persons with XLA carry the genes to produce immunoglobulins, a genetic defect on the X chromosome prevents their formation. This defect is not associated with the immunoglobulins themselves, but rather with the B cells in the bloodstream that ordinarily secrete the immunoglobulins.

B cells are a type of white blood cell. They are the sole producers of immunoglobulins in the body. B cells are produced in the bone marrow and carried to the spleen, lymph nodes, and other organs as they mature. The maturation process depends on an enzyme called Bruton's agammaglobulinemia tyrosine kinase (Btk). If Btk is missing or defective, the B cells cannot mature and cannot produce immunoglobulins.

The gene for Btk is on the X chromosome. Certain changes (mutations) in this gene result in defective Btk. Since the gene is carried on the X chromosome, XLA individuals are almost always male. Females have two X chromosomes, which means they have two copies of the Btk gene, one of which is normal. Males have only one X chromosome.

Causes and symptoms

XLA is caused by a defect in the gene that codes for Btk. This defect leads to blocked maturation of B cells, the cells that produce immunoglobulins. Because other portions of the immune system are functional, people with XLA can fight off some types of infection, such as fungal and most viral infections. Immunoglobulins, however, are vital to combat bacterial infections. Infants with XLA usually do not show symptoms during the first six months of life because immunoglobulins from their mothers are circulating in their bloodstreams. As the mother's supply decreases, the baby becomes increasingly vulnerable to bacterial infections.

Common symptoms of immunoglobulin deficiency appear after the infant is six months old. They include frequent ear and sinus infections, **pneumonia**, and **gastroenteritis**. Certain viruses, such as hepatitis and **polio**, can also pose a threat. Children with XLA grow slowly, have small tonsils and lymph nodes, and may develop chronic skin infections. Approximately 20% of these children develop arthritis, possibly as a result of joint infections.

Diagnosis

Frequent bacterial infections, a lack of mature B cells, and low-to-nonexistent levels of immunoglobulins point to a diagnosis of XLA. A sample of the infant's blood serum can be analyzed for the presence of immunoglobulins by a technique called **immunoelectrophoresis**. To make a definitive diagnosis, the child's X chromosome is analyzed for defects in the Btk gene. Similar analysis can be used for prenatal diagnosis or to detect carriers of the defective gene.

Treatment

Treatment of XLA consists of regular intravenous doses of commercially prepared **gamma globulin** (sold under the trade names Gamimune or Gammagard) to ward off infections. **Antibiotics** are used to treat

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KEY TERMS

Antibody—A molecule that is produced by the immune system in response to a protein, called an antigen, that is not recognized as belonging in the body.

B cell—A type of lymphocyte, or white blood cell, that is a key component of the body's immune system. Mature B cells produce immunoglobulins.

Bruton's agammaglobulinemia tyrosine kinase (Btk)—An enzyme vital for the maturation of B cells.

Carrier—A person who has a genetic defect but does not develop any symptoms or signs of the defect. The carrier's offspring may inherit the defect and develop the associated disorder.

Enzyme—A protein molecule that prompts rapid biochemical reactions.

Immunoglobulin—A protein molecule formed by mature B cells in response to foreign proteins in the body. There are five types of immunoglobulins, but the major one is gamma globulin, or immunoglobulin G.

Mutation—A change in a gene that alters the function or other characteristics of the gene's product.

X chromosome—One of the two sex chromosomes (the other is Y) that determine a person's gender. Normal males have both an X and a Y chromosome, and normal females have two X chromosomes.

infections as they occur. Children with XLA must be treated promptly for even minor cuts and scrapes and taught to avoid crowds and people with active infections.

Prognosis

Prior to the era of gamma globulin and antibiotic treatment, approximately 90% of XLA individuals died before age 8. Early diagnosis and current therapy allows most individuals with XLA to reach adulthood and lead relatively normal lives. Infants who develop polio or persistent viral infections, however, have a poorer prognosis.

Prevention

Parents of a child with XLA should consider **genetic counseling** if they are planning to have more children.

ORGANIZATIONS

Immune Deficiency Foundation, 40 West Chesapeake Avenue, Suite 308, Towson, MD, 21204, (800) 296-4433, http://www.primaryimmune.org/.

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923, (800) 999-6673, http://www.rarediseases.org.

Julia Barrett

X rays of the orbit

Definition

Orbital x rays are studies of the area and structures containing the eye. The orbit is the circle of thin bones that houses and protects the eye, even extending behind the eye and nearly wrapping around it. The orbit includes the eyebrow, the bridge of the nose and the cheekbone. X rays are a form of radiation (like light) that can penetrate body tissues.

Purpose

Orbital x ray, or orbital radiography, is often used to detect problems resulting from injury or trauma to the eye. The exam may also detect changes to the structure of the eye, which may indicate various diseases. An ophthalmologist may also order an orbital x ray if there is concern that foreign bodies may be present in the eye that cannot be detected with an instrument called an ophthalmoscope.

Precautions

Pregnant women and women who could possibly be pregnant should only receive orbital x rays when absolutely necessary. If the patient is in severe **pain** due to injury or trauma, a painkiller may be given to help ease discomfort during positioning of the head throughout the exam. No other precautions are necessary for orbital x rays.

Description

Each orbit is composed of a floor, a roof, a medial (in the center plane) and lateral (sides of the plane) walls. The orbital x ray involves several different views in order for the physician to clearly see various parts of the eye without obstruction. In orbital x rays, images of the unaffected eye may also be taken to compare its shapes and structures to those of the affected eye. Views may include side view (lateral), back to front (posteroanterior), base view, views from both sides, and an image from the center to one outside edge (half-axial projection). Projections of the optical canal will also be included. For all of these views, the patient may be seated upright or asked to lie on a table in the x ray room.

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The orbital x ray procedure should take about 15 minutes to complete. Following the procedure, the patient will usually be asked to wait until the films are developed to ensure they are high enough quality and that repeat x rays are not necessary. A physician may perform the x ray exam in his or her office, or refer the patient to an outpatient radiology facility or hospital radiology department. In the case of emergency, the exam may be performed in the emergency room or a nearby radiology area of the hospital.

Preparation

There are no special dietary preparations needed prior to an orbital x ray. As with any radiography procedure, the patient should remove any jewelry or metal objects, which may interfere with a clear image.

Aftercare

No aftercare is required following this diagnostic test.

Risks

Radiation exposure is low for this procedure and all certified radiology facilities follow strict personnel and equipment guidelines for radiation protection. Women of child bearing age and children should be offered protective shielding (lead aprons) to cover the genital and/or abdominal areas.

Normal results

Normal findings will show the bones of the orbit intact, and will show similarity between the orbit that is being studied and the unaffected orbit.

Abnormal results

Positive findings from an orbital x ray may show that there has been injury to the eye. Certains signs may indicate some disease that is affecting the orbital structures. Tiny **fractures** in the orbital bones can usually be detected on the radiograph. The floor bone, the medial wall and the ethmoid bone, which is a spongy bone that forms the upper part of the nasal cavity, are the most likely to break. In a blowout fracture (one involving the orbital floor), radiographic findings may include disruption to the orbital floor, an opaque look to the sinuses on the same side as the affected orbit (due to hemorrhage), or signs of sinus problems from the orbital root's interference. These indications can be seen in most typical orbital x ray views.

Since the physician examines both orbits side by side, indications of differences in size and shape of the various structures in the orbit may be apparent. The orbit may be enlarged, indicating irritation from an injury or foreign body. A number of growing tumors within the eye or brain area may also cause orbital enlargement. Destruction of the walls of the orbit may indicate a nearby infection or malignancy. Changes in density of the tiny orbit bones may also be a sign of bone disease or **cancer** spread to bone.

Children's orbits are more likely to be enlarged by a fast growing lesion, since their orbital bones have not fully developed.

KEY TERMS

Blowout fracture—A fracture or break in the orbit that is caused by sudden and violent impact to the area.

Malignancy—A tumor that is cancerous and growing.

Medial wall—The middle bone, or wall, of the eye's orbit. It is generally thicker than the roof and floor walls.

Ophthalmologist—A physician who specializes in the workings, structures, and care of the eyes.

Ophthalmoscope—An instrument routinely used by ophthalmologists to examine the interior of the eye. It consists of a small light, a mirror, and lenses of differing powers that magnify.

Radiography—Examination of any part of the body through the use of x rays. The process produces an image of shadows and contrasts on film.

X ray—A form of electromagnetic radiation with shorter wavelengths than normal light. X rays can penetrate most structures.

Resources

OTHER

Scheie Eye Institute. University of Pennsylvania Health System. http://www.uphs.upenn.edu/ophthalmology/.

ORGANIZATIONS

American Academy of Ophthalmology (AAO), P. O. Box 7424, San Francisco, CA, 94120-7424, (415) 561-8500, (415) 561-8500, http://www.aao.org.

National Eye Institute, 31 Center Drive MSC 2510, Bethesda, MD, (301) 496-5248, http://www.nei.nih.gov/.

Teresa Odle,

Xerophthalmia *see* **Vitamin A deficiency**

Xerostomia *see* **Dry mouth**

XLA *see* **X-linked agammaglobulinemia**

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Y

Yaws

Definition

Yaws is a chronic illness that first affects the skin and then affects the bones.

Description

Yaws tends to strike children, particularly between the ages of two and five. It is common in areas where poverty and overcrowding interfere with good hygiene practices. The most common locations are in rural areas throughout Africa, Southeast Asia, and in locations bordering the equator in the Americas.

Causes and symptoms

Yaws is caused by a spiral-shaped bacterium (spirochete) called *Treponema pertenue*. This bacterium belongs to the same family as the bacterium that causes **syphilis**.

Yaws is passed among people by direct skin contact. It requires some kind of a scratched or insect bitten area in order for the bacteria to actually settle in and cause infection. An injured spot on the leg is the most common part of the body through which the bacteria enter. Young children, who are constantly bumping themselves in play, who wear little clothing, who do not wash their hands often, and who may frequently put their hands in their mouths, are particularly susceptible.

The first symptom of yaws occurs three to four weeks after acquiring the bacteria. The area where the bacteria originally entered the skin becomes a noticeable bump (papule). The papule grows larger and develops a punched-out center (ulcer), covered with a yellow crust. Lymph nodes in the area may become swollen and tender. This first papule may take as long as six months to heal. Secondary soft, gummy growths then appear on the face, arms and legs, and buttocks. These soft, tumor-like masses may grow on the soles of the feet, causing the patient to walk in an odd and characteristic fashion on the sides of his or her feet (nicknamed "crab yaws"). More destructive tumors may then disrupt the bones of the face, the jaw, and the lower leg. Ulcers around the nose and on the face may be very mutilating.

Diagnosis

Samples taken from the first papules may be examined using a technique called dark-field microscopy. This often allows the spirochetes to be identified. They may also be identified in fluid withdrawn from swollen lymph nodes. Various tests can also be run on blood samples to determine if an individual is producing antibodies (special immune cells) which are specifically made in response to the presence of these spirochetes.

Treatment

A single penicillin injection in a muscle is sufficient to completely end the disease.

Prognosis

Without treatment, yaws is a terribly disfiguring, chronic illness. With appropriate treatment, the progression of the disease can be completely halted.

Prevention

For a time, the World Health Organization (WHO) was working to totally eradicate yaws, just as **smallpox** was successfully eradicated. This has not occurred, however. WHO continues to work to identify and respond to outbreaks quickly, in an effort to at least slow the spread of yaws.

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KEY TERMS

Papule—A raised bump on the skin.

Ulcer—A punched-out, irritated pit on the skin.

ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, 800 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov.

Rosalyn Carson-DeWitt, MD

Yellow fever

Definition

Yellow **fever**, also known as sylvatic fever and viral hemorrhagic fever or VHF, is a severe **infectious disease** caused by a type of virus called a flavivirus. This flavivirus can cause outbreaks of epidemic proportions throughout Africa and tropical America.

Demographics

Yellow fever is found most commonly in men between the ages of 15 and 45 years who work outdoors and live in fever-endemic areas. Race has not been shown to be a factor in contraction or transmission. Between 1970 and 2002, only nine cases of yellow fever were reported in travelers from the United States and Europe. All cases were found in unimmunized travelers who had visited South America or Africa. Seven of the cases were fatal.

Description

The first written evidence of a yellow fever epidemic occurred in the Yucatan in 1648. Since that time, much has been learned about the interesting transmission patterns of this devastating illness. It is thought that the disease originated in Africa and spread to the Americas in the seventeenth and eighteenth centuries through trading ships. The flavivirus that causes yellow fever was first identified in 1928 and the first vaccine against the disease was produced at the Rockefeller Institute in New York in 1937.

In order to understand how yellow fever is passed, several terms need to be defined. The word "host" refers to an animal that can be infected with a particular disease. The term "vector" refers to an organism that can carry a particular disease-causing agent (such as a virus or bacteria) without actually developing the disease. The vector can then pass the virus or bacterium on to a new host.

Many of the common illnesses in the United States (including the **common cold**, many viral causes of **diarrhea**, and **influenza** or "flu") are spread by direct passage of the causative virus between human beings. Yellow fever, however, cannot be passed directly from one infected human to another. Instead, the virus responsible for yellow fever requires an intermediate vector, a mosquito, which carries the virus from one host to another.

The hosts of yellow fever include both humans and monkeys. The cycle of yellow fever transmission occurs as follows: an infected monkey is bitten by a tree-hole breeding mosquito. This mosquito acquires the virus and can pass the virus on to any number of other monkeys that it may bite. This form of yellow fever is known as sylvatic yellow fever, and usually affects humans only incidentally. When a human is bitten by an infected mosquito, the human may acquire the virus. In the case of South American yellow fever, the infected human may return to the city, where an urban mosquito (*Aedes aegypti*) serves as a viral vector, spreading the infection rapidly by biting humans. This form of the disease is known as urban yellow fever or epidemic yellow fever.

Yellow fever epidemics also may occur after flooding caused by earthquakes and other natural disasters. They result from a combination of new habitats available for the vectors of the disease and changes in human behavior (spending more time outdoors and neglecting sanitation precautions).

Cases of yellow fever are uncommon in the United States and Canada as of 2010. The last reported case of a U.S. citizen dying of yellow fever concerned a man who contracted yellow fever after visiting Venezuela in 1999. The man had not been vaccinated against yellow fever. The last epidemic in the United States occurred in New Orleans in 1905.

Causes and symptoms

Once a mosquito has passed the yellow fever virus to a human, the chance of disease developing is about 5%–20%. Infection may be fought off by the host's immune system or may be so mild that it is never identified.

In human hosts who develop the disease yellow fever, there are five distinct stages through which the

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WILBUR AUGUSTUS SAWYER (1879–1951)

Wilbur Augustus Sawyer was born in Appleton, Wisconsin, on August 7, 1879, to Minnie Edmea (Birge) and Wesley Caleb Sawyer. The Sawyers moved to Oshkosh, Wisconsin and finally to Stockton, California in 1888. Sawyer spent two years at the University of California and then entered Harvard College where he earned his A.B. degree in 1902. In 1906, Sawyer graduated from Harvard Medical School and began a private practice, which lasted until he started his internship at Massachusetts General Hospital. Sawyer returned to California in 1908 in order to obtain a position at the University of California as a medical examiner. He then worked with California State Board of Health from 1910 until 1918. In 1911, Sawyer married Margaret Henderson. The couple had three children.

Sawyer's first publication (1913) dealt with his research of poliomyelitis. His discovery, in 1915, that examination of the individual's stool could lead to detection of the disease was later regarded as very significant. In 1918 and 1919, Sawyer worked to control venereal disease while employed by the Army Medical Corps. In 1926 and 1927, while director of the West African Yellow Fever Commission, Sawyer succeeded in isolating the yellow fever virus. He would ultimately return to the United States, where he and Wray Lloyd would devise an immunization against yellow fever (1931).

In 1944, Sawyer became director of health for the United Nations Relief and Rehabilitation Administration, a position he held for three years. He retired to Berkeley, California, where he died on November 12, 1951. The company he built with his brother still thrives today.

infection evolves. These have been termed the periods of incubation, invasion, remission, intoxication, and convalescence.

Yellow fever's incubation period (the amount of time between the introduction of the virus into the host and the development of symptoms) is three to six days. During this time, there are generally no symptoms identifiable to the host.

The period of invasion lasts two to five days, and begins with an abrupt onset of symptoms, including fever and chills, intense **headache** and lower backache, muscle aches, **nausea**, and extreme exhaustion. The patient's tongue shows a characteristic white, furry coating in the center, surrounded by a swollen, reddened margin. While most other infections that cause a high fever also cause an increased heart rate, yellow fever results in an unusual finding, called Faget's sign. This is the simultaneous occurrence of a high fever with a slowed heart rate. Throughout the period of invasion, there are still live viruses circulating in the patient's bloodstream. Therefore, a mosquito can bite the ill patient, acquire the virus, and continue passing it on to others.

The next phase is the period of remission. The fever falls, and symptoms decrease in severity for several hours to several days. In some patients, this signals the end of the disease; in other patients, this proves only to be the calm before the storm.

The period of intoxication represents the most severe and potentially fatal phase of the illness. During this time, lasting three to nine days, a type of degeneration of the internal organs (specifically the kidneys, liver, and heart) occurs. This fatty degeneration results in what is considered the classic triad of yellow fever symptoms: **jaundice**, black vomit, and the dumping of protein into the urine. Jaundice causes the whites of the patient's eyes and the patient's skin to take on a distinctive yellow color. This is due to liver damage, and the accumulation of a substance called bilirubin, which is normally processed by a healthy liver. The liver damage also results in a tendency toward bleeding; the patient's vomit appears black due to the presence of blood. Protein, which is normally kept out of the urine by healthy, intact kidneys, appears in the urine due to disruption of the kidney's healthy functioning.

Patients who survive the period of intoxication enter into a relatively short period of convalescence. They recover with no long-term effects related to the yellow fever infection. Infection with the yellow fever virus results in lifelong immunity against repeated infection with the virus.

The course of yellow fever is complicated in some patients by secondary bacterial infections.

Diagnosis

Examination

A diagnosis of yellow fever may be suspected during a physical exam when the classic triad of symptoms are present. These include:

- a sudden onset of fever, chills, intense headaches and lower backaches, muscle aches, nausea, and exhaustion
- Faget's sign—simultaneous occurance of a high fever and increased heart rate
- a white furry coating in the center of the tongue surround by a swollen, red margin

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KEY TERMS

Antibody—A protein normally produced by the immune system to fight infection or rid the body of foreign material. The material that stimulates the production of antibodies is called an antigen. Specific antibodies are produced in response to each different antigen and can only inactivate that particular antigen.

Antigen—Any foreign substance, usually a protein, that stimulates the body's immune system to produce antibodies.

Bilirubin—A reddish-yellow bile pigment made by the liver.

Dialysis—The cleansing of the blood through use of a special machine that filters the blood. Dialysis is done when the kidneys are unable to filter blood properly.

Epidemic—A situation in which a particular disease spreads rapidly through a population of people in a relatively short period of time.

Faget's sign—The simultaneous occurrence of a high fever with a slowed heart rate.

Flavivirus—The virus that causes yellow fever.

Hemorrhage—Abnormal and obsessive bleeding.

Host—The organism (such as a monkey or human) in which another organism (such as a virus or bacteria) is living.

Jaundice—The yellowing of the skin and whites of the eyes caused by an increased level of bilirubin in the blood.

Sylvatic—Pertaining to or living in the woods or forested areas. The form of yellow fever transmitted by mosquitoes to rainforest monkeys is called sylvatic yellow fever.

Vector—A carrier organism (such as a fly or mosquito) that serves to deliver a virus (or other agent of infection) to a host.

Tests

Diagnosis of yellow fever depends on the examination of blood by various techniques in order to demonstrate either yellow fever viral antigens (the part of the virus that stimulates the patient's immune system to respond) or specific antibodies (specific cells produced by the patient's immune system that are directed against the yellow fever virus). The most rapid method of diagnosis as of 2010 was capture enzyme immunoassay.

Procedures

Typically, the only procedure required for diagnosis is a blood draw so that the blood can be evaluated for signs of yellow fever.

Treatment

Traditional

As of 2010, the only treatments for yellow fever are given to relieve its symptoms. Fevers and **pain** should be relieved with **acetaminophen**, not **aspirin** or ibuprofen, both of which could increase the already-present risk of bleeding. **Dehydration** (due to fluid loss both from fever and bleeding) needs to be carefully avoided. This can be accomplished by increasing fluids. The risk of bleeding into the stomach can be decreased through the administration of **antacids** and other medications. Hemorrhage (heavy bleeding) may require blood transfusions. Kidney failure may require dialysis (a process that allows the work of the kidneys in clearing the blood of potentially toxic substances to be taken over by a machine, outside of the body).

Drugs

There are no antiviral treatments available as of 2010 to combat the yellow fever virus. Nonclinical research has led to limited results.

Researchers have found that ribavirin (Virazole, Rebetol), a drug that is given by mouth to treat **hepatitis C**, is successful in reducing mortality from yellow fever in hamsters, but only if given within 120 hours of infection. Another drug, Interferon-alpha has also been found to reduce mortality in monkeys with yellow fever but only when administered within 24 hours of infection.

Alternative

Prognosis

Five to ten percent of all diagnosed cases of yellow fever are fatal. Jaundice occurring during a yellow fever infection is an extremely grave predictor; 20-50% of these patients die of the infection. **Death** may occur due to massive bleeding (hemorrhage), often following a lapse into a comatose (unconscious) state.

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Prevention

A very safe and very effective yellow fever vaccine exists. The Arilvax vaccine is made from a live attenuated (weakened) form of the yellow fever virus, strain 17D. In the United States, the vaccine is given only at Yellow Fever **Vaccination** Centers authorized by the United States Public Health Service. About 95% of vaccine recipients acquire long-term immunity to the yellow fever virus. Careful measures to decrease mosquito populations in both urban areas and jungle areas where humans are working, along with programs to vaccinate all people living in such areas, are necessary to avoid massive yellow fever outbreaks.

Individuals planning to travel to countries where yellow fever is endemic may obtain up-to-date information on yellow fever vaccination from the Centers for Disease Control and Prevention.

Resources

BOOKS

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Busowski, Mary T., Mark R. Wallace, and Janelle L. Robertson. "Yellow Fever." eMedicine. April 17, 2009. http://emedicine.medscape.com/article/232244-overview (accessed June 6, 2010).

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"Yellow Fever." World Health Organization. Fact Sheet No. 100. December 2009. http://www.who.int/mediacentre/factsheets/fs100/en/ (accessed June 6, 2010).

"Yellow Fever Fact Sheet." Centers for Disease Control and Prevention. June 11, 2007. http://www.cdc.gov/ncidod/dvbid/yellowfever/YF_FactSheet.html (accessed June 6, 2010).

ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (404) 639-3534, (800) CDC-INFO (800-232-4636). TTY: (888) 232-6348, inquiry@cdc.gov, http://www.cdc.gov.

National Institute of Allergy and Infectious Diseases Office of Communications and Government Relations, 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-6612, (301) 496-5717, (866) 284-4107 or TDD: (800)877-8339 (for hearing impaired), (301) 402-3573, http://www3.niaid.nih.gov.

World Health Organization, Avenue Appia 20, 1211 Geneva 27, Switzerland, +22 41 791 21 11, +22 41 791 31 11, info@who.int, http://www.who.int.

Yellow Fever Travel Clinic, 1925 1st Ave S., Minneapolis, MN, 55403, (612) 871-4354, (612) 872-4343, http://yellowfevertravelclinic.org.

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Yersinia enterocolitica infection *see* **Yersinosis**

Yersinia pestis see **Plague**

Yersinia pseudotuberculosis infection *see* **Yersinosis**

Yersinosis

Definition

Yersinosis refers to infection by a genus of bacteria known as *Yersinia*. The two sub-types that are responsible for yersinosis are *Yersinia enterocolitica* and *Yersinia pseudotuberculosis*. The diseases produced by these organisms are called "zoonoses," because the bacteria is passed to humans from animal sources.

The name *Yersinia* comes from Dr. Alexandre Yersin, who was the first person to grow a much more deadly type of *Yersinia* known as *Yersinia pestis*, the bacteria responsible for what is now known as bubonic **plague**. This article, however, will deal with the more common forms of *Yersinia*, namely *Y. enterocolitica* and *Y. pseudotuberculosis*.

Description

Yersinia are classified as gram-negative bacteria (bacteria that do not accept the color of a stain in a Gram stain test, which indicates the general chemical nature of the cell wall of the bacteria); they have a variety of appearances, and are therefore called pleomorphic. They belong to Enterobacteriacae, the large group of organisms that inhabit the intestinal tract. There are many different subtypes of *Yersinia*.

They are found worldwide and have been isolated from soil, fresh water, contaminated foods, and many wild and domestic animals. For reasons not entirely clear, disease caused by these organisms occurs more

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frequently in areas of northern Europe, especially Scandinavia. Infection, particularly in children ages one through four years, is quite common, though often these infections produce few symptoms. Studies have shown that infection with these bacteria is almost as common as that with *Shigella* or *Campylobacter*.

Causes and symptoms

Animals are the most important sources of bacterial infection for humans. Whether from pets or undercooked meat (especially pork), these bacteria almost always enter the human body through the mouth (oral transmission). An incubation period of one to eleven days passes before signs of disease develop. Rare cases have been transmitted by way of contaminated blood transfusions.

Yersinia produces several different types of disease. The most common form is a short-lived inflammation of the intestine known as enterocolitis. Most often the very end of the small intestine is involved, an area known as the terminal ileum. The result is **gastroenteritis**, with cramping abdominal **pain**, **fever**, and **diarrhea**. Diarrhea generally continues for two weeks or so, but can go on for many months. Up to 40% of patients also experience **nausea and vomiting**, and in one-third, inflammation of the intestine leads to bleeding.

In other patients, the same area of the intestine is involved, but instead of causing diarrhea, a syndrome resembling **appendicitis** occurs. In this syndrome, the lymph nodes surrounding the intestine are especially involved; this has lead to the term mesenteric adenitis. Although this syndrome resolves without serious consequences, it is often difficult to differentiate from appendicitis, and leads to surgery in some instances. Ultrasound exam may be able to demonstrate a normal appendix and avoid surgery. Why some patients develop symptoms of gastroenteritis, and others only inflammation, pain, and fever, is unknown.

In some patients, *Yersinia* produces infection of areas other than the intestinal tract. These include:

- Inflammation of the throat (pharyngitis) and tonsillitis; this can be quite severe and even lead to death, particularly in adults.
- Septicemia, or infection of the blood stream, with spreading of infection to other organs such as bone, meninges, kidneys, and others. Individuals with decreased immunity due to liver disease, diabetes, cancer, and other diseases are at increased risk for this complication.

KEY TERMS

Mesenteric adenitis—Inflammation of the lymph nodes that serve the small intestine, with symptoms similar to appendicitis.

Septicemia—Systemic disease associated with the presence of microorganisms or their toxins in the blood; blood poisoning.

Different parts of the body may be affected (such as joints, eyes, and urinary system) by changes in the immune system caused by *Yersinia* infection. Arthritis, which is especially frequent in Scandinavia, occurs in up to 10% of *Yersinia* infections. About one week after typical intestinal symptoms, swelling and pain in multiple joints occurs. The knees and ankles are most often involved and become inflamed over a period of two weeks. In two-thirds of those affected, symptoms gradually resolve over one to three months without need for treatment. Rarely does chronic joint disease develop.

Inflammation of the heart muscle, called **myocarditis**, sometimes occurs together with the arthritis. In about 15%–20% of patients, the skin develops a red, raised area, usually located on the shins, called **erythema nodosum**. This appears within a few weeks of the intestinal symptoms and disappears over a month or so.

Diagnosis

Identifying *Yersinia* as the cause of all or any of these symptoms is not an easy task. It is possible to grow the organism from stool cultures, but this is difficult to do unless special methods are used.

A change in antibody levels can also be used to determine the presence of infection. To be accurate, levels must be initially examined early in the illness. Therefore, it is most important for the possible diagnosis and examination to be thought of early.

Treatment

Since most of the symptoms caused by *Yersinia* are self limiting, specific antibiotic treatment is generally not needed. Patients with **dehydration** from gastroenteritis are given supportive therapy, including treatment aimed at replacing fluids.

Antibiotics are indicated, however, for those patients who develop more severe infections, such as invasion of the bloodstream (septicemia), or who develop infections at specific sites, such as bone. A

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variety of antibiotics have been used, but it is not clear which produces the best results.

No specific treatment is indicated for the joint, ocular, skin, or urinary symptoms that result from infection. As stated, these are not due to direct invasion by the bacteria, but are related to changes in immune reactions produced by the infection. However, treatment of those experiencing severe arthritic symptoms with NSAIDS (**nonsteroidal anti-inflammatory drugs**) or steroid injection at inflamed joints is used in selected cases.

Prognosis

As noted, most of the time, *Yersinia* infection has an excellent outlook. However, when these bacteria invade the bloodstream or produce disease beyond the gastrointestinal tract, the outlook is less positive. This may be because more severe infections occur in those with decreased immunity. The **death** rate from septicemia has been reported to be as high as 50%.

Prevention

Safe food handling procedures and food-preparation practices are by far the best means of avoiding infection. Undercooked food, especially pork or other animal products, should not be eaten.

Resources

OTHER

"Bad Bug Book." *U.S. Food and Drug Administration*. http://www.fda.gov/(accessed December 2, 2010).

David Kaminstein, MD

Yoga positions

Name	Description
Boat	Sitting on floor with knees bent, extend legs out at a 45-degree angle to the floor so that body forms a "V" shape. Arms should be parallel to the ground.
Bridge	Lying on back with knees bent and feet flat on floor, raise pelvis off floor and arch back, keeping shoulders pressed to the ground.
Camel	While kneeling, arch back and bend head back toward feet. Hold heels with hands and exhale while in movement.
Cat-cow	On hands and knees, arch back and inhale, looking at ceiling. On exhale, round back and drop head down.
Child	Kneeling with arms to the side, roll torso to floor and rest forehead on the ground.
Cobra	Stretched out on floor with stomach down, align elbows beneath shoulders and raise torso up. Arms should straighten with hands flat on floor.
Corpse	Lie on back with feet and arms outstretched. Breathe deeply.
Downward Dog	From hands and knees, form an inverted "V" by straightening legs and pressing hands and heels to floor. Exhale while in movement.
Locust	Lying on stomach with hands at sides, squeeze buttocks and lift legs up off the ground. Simultaneously lift head, chest, and arms.
Mountain	Standing with feet together, inhale while raising arms straight above the head and clasp hands together. Exhale while lowering arms.
Spinal twist	Sitting with right foot crossed over left leg, grasp right leg with left arm and twist to the right. Repeat on other side.
Tree	While standing, place one foot on the inside of the opposite thigh. Place hands in prayer position in front of chest, and then extend toward ceiling.
Triangle	Standing with legs slightly wider than hip width, turn one foot out and reach for that foot, extending opposite arm toward ceiling.
Warrior I	Raise arms over head with palms together and lunge forward with one foot, keeping thigh parallel to the ground.
Warrior II	From Warrior I, rotate back foot so that it is perpendicular with front heel and extend arms straight out to sides. Look out over front hand.

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Yoga

Definition

The term *yoga* comes from a Sanskrit word which means yoke or union. Traditionally, yoga is a method joining the individual self with the Divine, Universal Spirit, or Cosmic Consciousness. Physical and mental exercises are designed to help achieve this goal, also called self-transcendence or enlightenment. On the physical level, yoga postures, called *asanas*, are designed to tone, strengthen, and align the body. These postures are performed to make the spine supple and healthy and to promote blood flow to all the organs, glands, and tissues, keeping all the bodily systems healthy. On the mental level, yoga uses breathing techniques (*pranayama*) and **meditation** (*dyana*) to quiet, clarify, and discipline the mind. However, experts are quick to point out that yoga is not a religion, but a way of living with health and peace of mind as its aims.

Purpose

Yoga has been used to alleviate problems associated with high blood pressure, high cholesterol,

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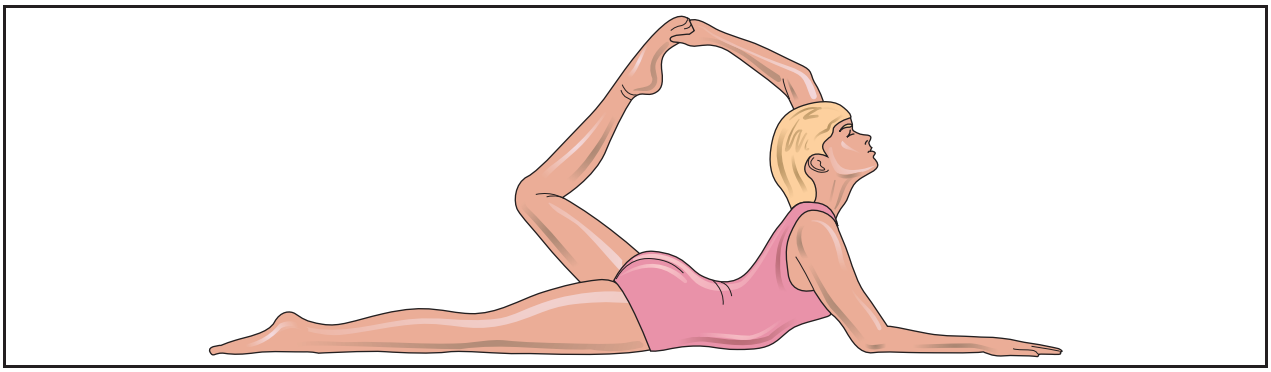

Yoga is a system that benefits the body, mind, and spirit by teaching self-control through a series of postures and exercises as well as through breathing, relaxation, and meditation techniques. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

migraine headaches, **asthma**, shallow breathing, backaches, **constipation**, diabetes, **menopause**, **multiple sclerosis**, **varicose veins**, **carpal tunnel syndrome**, and many chronic illnesses. It also has been studied and approved for its ability to promote relaxation and reduce **stress**.

As of late 2002, yoga is increasingly recommended for **dysmenorrhea**, **premenstrual syndrome**, and other disorders in premenopausal women in Europe as well as in the United States.

Yoga can also provide the same benefits as any well-designed **exercise** program, increasing general health and stamina, reducing stress, and improving those conditions brought about by sedentary lifestyles. Yoga has the added advantage of being a low-impact activity that uses only gravity as resistance, which makes it an excellent **physical therapy** routine; certain yoga postures can be safely used to strengthen and balance all parts of the body. A study published in late 2002 summarized recent findings about the benefits of yoga for the cardiovascular and musculoskeletal systems. The review noted that yoga is still viewed as a "trendy" form of exercise rather than one with documented medical benefits.

Meditation has been much studied and approved for its benefits in reducing stress-related conditions. The landmark book *The Relaxation Response*, by Harvard cardiologist Herbert Benson, showed that meditation and breathing techniques for relaxation could have the opposite effect of stress, reducing blood pressure and other indicators. Since then, much research has reiterated the benefits of meditation for **stress reduction** and general health. Currently, the American Medical Association recommends meditation techniques as a first step before medication for borderline **hypertension** cases. Some 2002 studies indicate that yogic meditation by itself is effective in lowering serum cholesterol as well as blood pressure.

Modern psychological studies have shown that even slight facial expressions can cause changes in the involuntary nervous system; yoga utilizes the mind/body connection. That is, yoga practice contains the central ideas that physical posture and alignment can influence a person's mood and self-esteem, and also that the mind can be used to shape and heal the body. Yoga practitioners claim that the strengthening of mind/body awareness can bring eventual improvements in all facets of a person's life.

Description

Origins

Yoga originated in ancient India and is one of the longest surviving philosophical systems in the world. Some scholars have estimated that yoga is as old as 5,000 years; artifacts detailing yoga postures have been found in India from over 3000 B.C. Yoga masters (*yogis*) claim that it is a highly developed science of healthy living that has been tested and perfected for all these years. Yoga was first brought to the United States in the late 1800s when Swami Vivekananda, an Indian teacher and yogi, presented a lecture on meditation in Chicago. Yoga slowly began gaining followers, and flourished during the 1960s when there was a surge of interest in Eastern philosophy. There has since been a vast exchange of yoga knowledge in the United States, with many students going to India to study and many Indian experts coming here to teach, resulting in the establishment of a wide variety schools. Today, yoga is thriving, and it has become easy to find teachers and practitioners throughout the United States. A recent Roper poll, commissioned

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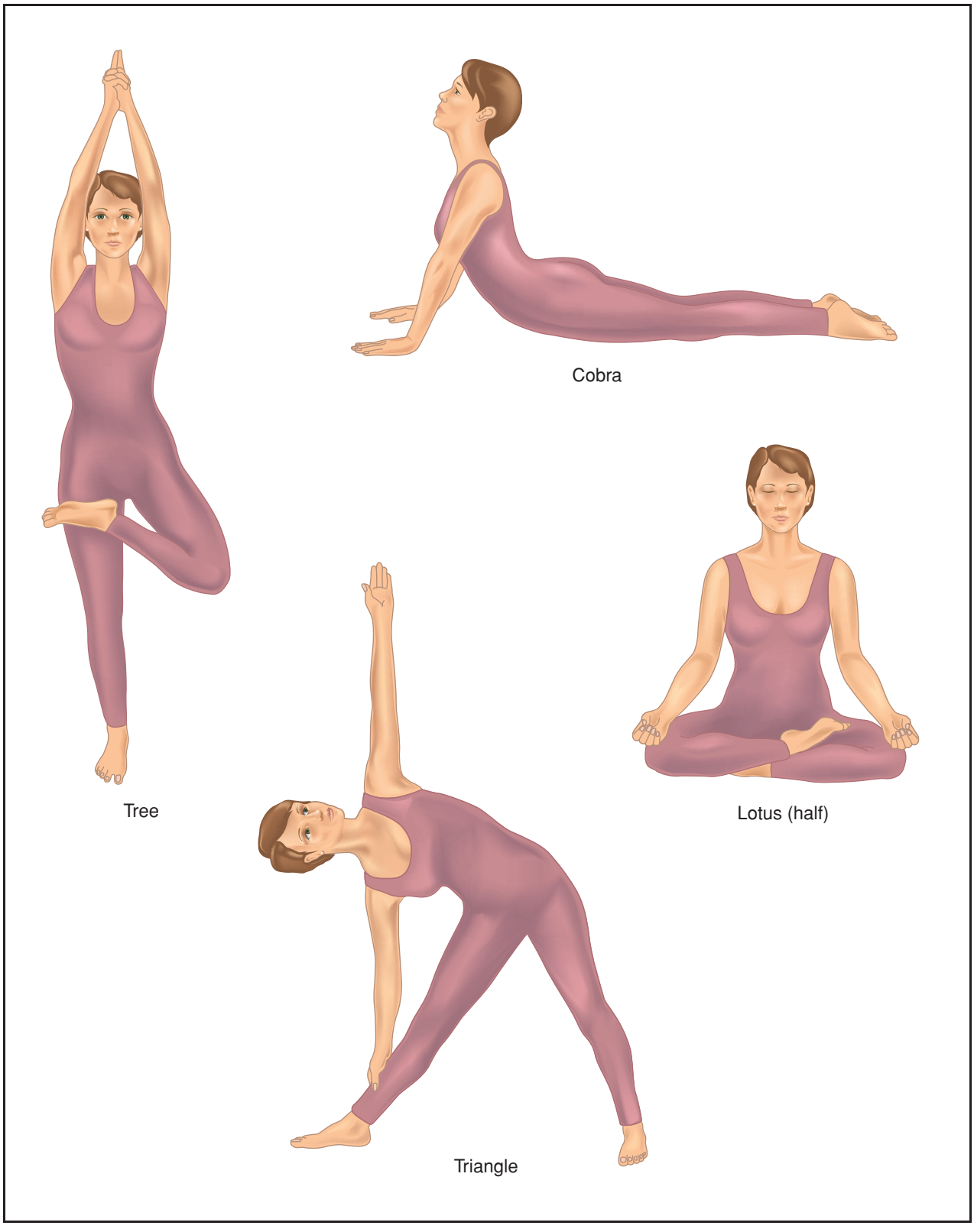

Demonstrations of the tree, triangle, cobra, and lotus poses. The tree and triangle are good for balance and coordination. Cobra stretches the pelvic and strengthens the back. Lotus is a meditative pose. *(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

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PATANJALI (SECOND CENTURY B.C.)

There is little historical information available on Patanjali, who is credited with developing yoga, one of the six systems of Hindu philosophy. Several scholars suggest several persons may have developed yoga under the pseudonym of Patanjali. In any case, Patanjali existed around 150 B.C. in India. He developed yoga based on a loose set of doctrines and practices from the Upanishads, themselves a set of mystical writings. The Upanishads are part of the Aranyakas, philosophical concepts that are part of the Veda, the most ancient body of literature of Hinduism. Patanjali gave these combined philosophical and esoteric writings a common foundation in his *Yoga Sutra*, a set of 196 concise aphorisms (wise sayings) that form the principles of yoga. He also drew upon Samkhya, the oldest classic system of Hindu philosophy. Patanjali's yoga accepted Samkhya metaphysics and the concept of a supreme soul. He established an eight-stage discipline of self-control and meditation. The individual sutras (verses) lay out the entire tradition of meditation. They also describe the moral and physical disciplines needed for the soul to attain absolute freedom from the body and self.

by *Yoga Journal*, found that 11 million Americans do yoga at least occasionally and 6 million perform it regularly. Yoga stretches are used by physical therapists and professional sports teams, and the benefits of yoga are being touted by movie stars and *Fortune* 500 executives. Many prestigious schools of medicine have studied and introduced yoga techniques as proven therapies for illness and stress. Some medical schools, like UCLA, even offer yoga classes as part of their physician training program.

Classical yoga is separated into eight limbs, each a part of the complete system for mental, physical and spiritual well-being. Four of the limbs deal with mental and physical exercises designed to bring the mind in tune with the body. The other four deal with different stages of meditation. There are six major types of yoga, all with the same goals of health and harmony but with varying techniques: hatha, raja, karma, bhakti, jnana, and tantra yoga. **Hatha yoga** is the most commonly practiced branch of yoga in the United States, and it is a highly developed system of nearly 200 physical postures, movements and breathing techniques designed to tune the body to its optimal health. The yoga philosophy believes the breath to be the most important facet of health, as the breath is the largest source of *prana*, or life force, and hatha yoga utilizes *pranayama*, which literally means the science or control of breathing. Hatha yoga was originally developed as a system to make the body strong and healthy enough to enable mental awareness and spiritual enlightenment.

There are several different schools of hatha yoga in the United States; the two most prevalent ones are Iyengar and ashtanga yoga. Iyengar yoga was founded by B.K.S. Iyengar, who is widely considered as one of the great living innovators of yoga. Iyengar yoga puts strict emphasis on form and alignment, and uses traditional hatha yoga techniques in new manners and sequences. Iyengar yoga can be good for physical therapy because it allows the use of props like straps and blocks to make it easier for some people to get into the yoga postures. Ashtanga yoga can be a more vigorous routine, using a flowing and dance-like sequence of hatha postures to generate body heat, which purifies the body through sweating and deep breathing.

The other types of yoga show some of the remaining ideas which permeate yoga. Raja yoga strives to bring about mental clarity and discipline through meditation, simplicity, and non-attachment to worldly things and desires. Karma yoga emphasizes charity, service to others, non-aggression, and non-harming as means to awareness and peace. Bhakti yoga is the path of devotion and love of God, or Universal Spirit. Jnana yoga is the practice and development of knowledge and wisdom. Finally, tantra yoga is the path of self-awareness through religious rituals, including awareness of sexuality as sacred and vital.

A typical hatha yoga routine consists of a sequence of physical poses, or asanas, and the sequence is designed to work all parts of the body, with particular emphasis on making the spine supple and healthy and increasing circulation. Hatha yoga asanas utilize three basic movements: forward bends, backward bends, and twisting motions. Each asana is named for a common thing it resembles, like the sun salutation, cobra, locust, plough, bow, eagle, tree, and the head to knee pose, to name a few. Each pose has steps for entering and exiting it, and each posture requires proper form and alignment. A pose is held for some time, depending on its level of difficulty and one's strength and stamina, and the practitioner is also usually aware of when to inhale and exhale at certain points in each posture, as breathing properly is another fundamental aspect of yoga. Breathing should be deep and through the nose. Mental concentration in each position is also very important, which improves awareness, poise and posture. During a yoga routine there is often a position in which to perform meditation, if deep relaxation is one of the goals of the sequence.

Yoga routines can take anywhere from 20 minutes to two or more hours, with one hour being a good time

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investment to perform a sequence of postures and a meditation. Some yoga routines, depending on the teacher and school, can be as strenuous as the most difficult workout, and some routines merely stretch and align the body while the breath and heart rate are kept slow and steady. Yoga achieves its best results when it is practiced as a daily discipline, and yoga can be a life-long exercise routine, offering deeper and more challenging positions as a practitioner becomes more adept. The basic positions can increase a person's strength, flexibility, and sense of well-being almost immediately, but it can take years to perfect and deepen them, which is an appealing and stimulating aspect of yoga for many.

Yoga is usually best learned from a yoga teacher or physical therapist, but yoga is simple enough that one can learn the basics from good books on the subject, which are plentiful. Yoga classes are generally inexpensive, averaging around 10 dollars per class, and students can learn basic postures in just a few classes. Many YMCAs, colleges, and community health organizations offer beginning yoga classes as well, often for nominal fees. If yoga is part of a physical therapy program, its cost can be reimbursed by insurance.

Preparations

Yoga can be performed by those of any age and condition, although not all poses should be attempted by everyone. Yoga is also a very accessible form of exercise; all that is needed is a flat floor surface large enough to stretch out on, a mat or towel, and enough overhead space to fully raise the arms. It is a good activity for those who can't go to gyms, who don't like other forms of exercise, or have very busy schedules. Yoga should be done on an empty stomach, and teachers recommend waiting three or more hours after meals. Loose and comfortable clothing should be worn.

Precautions

People with injuries, medical conditions, or spinal problems should consult a doctor before beginning yoga. Those with medical conditions should find a yoga teacher who is familiar with their type of problem and who is willing to give them individual attention. Pregnant women can benefit from yoga, but should always be guided by an experienced teacher. Certain yoga positions should not be performed with a **fever** or during menstruation.

Beginners should exercise care and concentration when performing yoga postures and not try to stretch too much too quickly as injury could result. Some advanced yoga postures, like the headstand and full lotus position, can be difficult and require strength, flexibility, and gradual preparation, so beginners should get the help of a teacher before attempting them.

Yoga is not a competive sport; it does not matter how a person does in comparison with others, but how aware and disciplined one becomes with one's own body and limitations. Proper form and alignment should always be maintained during a stretch or posture, and the stretch or posture should be stopped when there is **pain**, **dizziness**, or **fatigue**. The mental component of yoga is just as important as the physical postures. Concentration and awareness of breath should not be neglected. Yoga should be done with an open, gentle, and non-critical mind; when one stretches into a yoga position, it can be thought of accepting and working on one's limits. Impatience, self-criticism, and comparing oneself to others will not help in this process of self-knowledge. While performing the yoga of breathing (pranayama) and meditation (dyana), it is best to have an experienced teacher, as these powerful techniques can cause dizziness and discomfort when done improperly.

KEY TERMS

Asana—A position or stance in yoga.

Dyana—The yoga term for meditation.

Hatha yoga—Form of yoga using postures, breathing methods and meditation.

Meditation—Technique of concentration for relaxing the mind and body.

Pranayama—Yoga breathing techniques.

Yogi (female, yogini)—A trained practitioner of yoga.

Side effects

Some people have reported injuries by performing yoga postures without proper form or concentration, or by attempting difficult positions without working up to them gradually or having appropriate supervision. Beginners sometimes report muscle soreness and fatigue after performing yoga, but these side effects diminish with practice.

Research and general acceptance

Although yoga originated in a culture very different from that of the modern United States, it has been

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accepted and its practice has spread relatively quickly. Many yogis are amazed at how rapidly yoga's popularity has spread in the United States and Canada, considering the legend that it was passed down secretly by handfuls of adherents for many centuries.

There can still be found some resistance to yoga, for active and busy Americans sometimes find it hard to believe that an exercise program that requires them to slow down, concentrate, and breathe deeply can be more effective than lifting weights or running. However, ongoing research in top medical schools is showing yoga's effectiveness for overall health and for specific problems, making it an increasingly acceptable health practice.

The growing acceptability of yoga as an alternative therapy for certain disorders or conditions is reflected in the fact that the National Center for Complementary and Alternative Medicine (NCCAM) is conducting a series of clinical trials of yoga. As of December 2010, NCCAM has four clinical trials in progress, evaluating yoga as a treatment for **menopause**, **post-traumatic stress disorder**, and arthritis.

Resources

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ORGANIZATIONS

International Association of Yoga Therapists (IAYT), P.O. Box 12890, Prescott, AZ, 86304, 928 541-0004, http://www.iayt.org/.

National Center for Complementary and Alternative Medicine (NCCAM), P.O. Box 7923, Gaitherburg, MD, 20898, 866 464-3616, 888 644-6226, info@nccam.nih.gov, http://nccam.nih.gov/.

Yoga Alliance, 1701 Clarendon Boulevard, Suite 110, Arlington, VA, 22209, 571 482-3336, 888 921-9642, http://www.yogaalliance.org/.

Yoga Science Foundation, 10336 Loch Lomond Road No. 221, Middletown, CA, 95461, http://www.yrec.org.

Douglas Dupler, MA
Rebecca J. Frey, PhD

"Yuppie flu" *see* **Chronic fatigue syndrome**

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Z

Zellweger syndrome

Definition

Zellweger syndrome (ZS) is the most severe of three very rare, inherited, related metabolic disorders known collectively as the Zellweger spectrum. ZS affects all of the major organs of the body, especially the brain, liver, and kidneys. It is almost always fatal within the first year of life.

Demographics

The worldwide incidence of Zellweger syndrome is estimated to be about one in 100,000 births. The incidence of Zellweger spectrum is estimated at about one in 50,000.

Description

Zellweger syndrome and the other two disorders that constitute Zellweger spectrum—neonatal **adrenoleukodystrophy** (NALD) and infantile Refsum disease (IRD)—are peroxisome biogenesis disorders (PBDs). PBDs are inherited defects or mutations in genes that are involved in the formation of peroxisomes. Peroxisomes are small sac–like compartments or organelles in all human cells. Peroxisomes are surrounded by a membrane and contain enzymes that break down or oxidize many different substances, especially fatty acids and certain toxins. For example, when large amounts of alcohol are consumed, 5 to 25 percent of the ethanol is oxidized and detoxified in peroxisomes. Peroxisomes also are important for the synthesis of some key compounds in the body, including hormones and fats (lipids) that are required by the nervous system and for digestion. Peroxisomes are especially important in the brain, liver, and kidneys. In peroxisome biogenesis disorders, defective genes prevent peroxisomes from forming correctly, resulting in an absence of peroxisomes or malformed peroxisomes that cannot perform their functions adequately.

Peroxisomes are essential for the formation and maintenance of myelin. Myelin is the substance that covers and protects nerves and promotes the efficient transmission of nerve impulses. The parts of the brain and spinal cord that contain myelin are called the white matter and include the cerebral cortex of the brain. Therefore peroxisome biogenesis disorders interfere with brain development. The destruction of the myelin (demyelination) causes the loss of white matter or leukodystrophy. Therefore, PBDs are members of a larger group of inherited disorders known as leukodystrophies. Leukodystrophies also affect the metabolism of some substances.

The brain abnormalities of Zellweger syndrome are caused by disruption of neuroblast migration in the fetus during about the third month of gestation. Neuroblasts are cells that develop into nerve cells, called neurons. This defect leads to small thick convolutions in the cerebral tissue of the brain and distinguishes Zellweger syndrome from other brain abnormalities.

After birth, defects in these same genes that cause the brain abnormalities of Zellweger syndrome also cause the reduction in or elimination of peroxisomes. The absence of peroxisomes in the liver and kidney cells of babies with Zellweger syndrome was first demonstrated in 1985 by the American pathologist S. L. Goldfischer. This absence of peroxisomes is now considered to be the hallmark of Zellweger syndrome. Babies with Zellweger syndrome also have far fewer peroxisomes in their brain cells. The fibroblasts of the skin appear to have ghost–like peroxisomes because the organelles lack certain proteins. Development of the heart, cartilage, and muscle also are affected in Zellwinger syndrome.

Risk factors

Newborns are at risk for Zellweger syndrome if each parent carries an abnormal copy of a gene responsible for the disorder. Zellweger syndrome is inherited as an autosomal recessive trait. “Autosomal” means that the genes that are responsible for ZS are not located on the X or Y sex chromosomes and therefore affect males and

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KEY TERMS

Amniocentesis—The insertion of a needle through the mother's abdomen into the uterus at 16–18 weeks of gestation to withdraw a small sample of the amniotic fluid surrounding the fetus to test for genetic disorders and other medical conditions.

Autosomal—Located on a chromosome other than the X or Y sex chromosomes.

Fibroblast—A connective–tissue cell.

Leukodystrophy—Any of several inherited diseases characterized by the degeneration of myelin in the brain, spinal cord, and peripheral nerves.

Myelin—Soft white material composed of lipids (fats) and protein that forms a thick sheath around nerve cells.

Neuroblast—An embryonic nerve cell that differentiates into a neuron.

Peroxins—Proteins that are responsible for forming the peroxisomal membrane and transporting other proteins into the peroxisome; these proteins are encoded by various PEX genes.

Peroxisome—A cellular organelle or microbody that contains various enzymes that are responsible for the production of cellular components and the breakdown of toxic waste products.

Peroxisome biogenesis disorder; PBD—An inherited disorder, such as Zellweger syndrome and other Zellweger spectrum disorders, that disrupt the formation and functioning of peroxisomes.

Plasmalogen—Any of a group of phospholipids; plasmalogen synthesis is disrupted in ZS.

Recessive—A gene or trait whose effects are apparent only in the absence of a corresponding dominant gene or trait.

Zellweger spectrum—Three peroxisome biogenesis disorders—Zellwinger syndrome, neonatal adrenoleukodystrophy, and infantile Refsum disease—which can be caused by different mutations in the same genes and which differ only in the severity of the resulting condition.

females with equal frequency. "Recessive" means that Zellweger syndrome only occurs in individuals with two defective gene copies, one inherited from each parent. Although the parents each carry one copy of the mutated gene, they typically have no signs and symptoms of the condition. However each of their offspring has a 25% chance of having Zellwinger syndrome and a 50% chance of inheriting one abnormal gene, thereby becoming a ZS "carrier."

Causes and symptoms

Zellweger syndrome is caused by mutations or defects in any one of several genes that encode proteins called peroxins that are essential for the formation (biogenesis) and normal functioning of peroxisomes. Peroxins produce the peroxisome membrane and import enzymes into the organelle. Mutations in at least 12 different genes can result in Zellweger spectrum. These genes are located on different chromosomes and encode distinct peroxin proteins. Defects in the peroxin–1 protein encoded by the PEX1 gene account for about 70% of Zellweger spectrum disorders. Zellweger syndrome is caused by severe defects in PEX1 or other PEX genes that result in peroxisomes that are essentially nonfunctional.

The symptoms of Zellweger syndrome are apparent at birth. They include distinct facial, developmental, and ocular (eye) features, some of which are due to high levels of iron and copper in the blood and tissues. These signs and symptoms include:

- a flattened face
- high forehead
- broad nasal bridge
- up–slanted eyes
- skin folds—called epicanthal folds—between the upper and lower eyelids along the nasal border
- underdeveloped eyebrow ridges
- deformed ear lobes
- neurological abnormalities, such as mental retardation and seizures
- an enlarged liver
- severe weakness and lack of muscle tone—sometimes to the degree that the infant is unable to move, suck, or swallow
- ocular abnormalities that can affect vision, including glaucoma and retinal degeneration
- hearing impairment
- cysts on the kidneys
- sometimes jaundice or gastrointestinal bleeding

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Diagnosis

Examination

Although the distinctive shape of the head and facial features are diagnostic for Zellweger spectrum, in some cases it can be difficult to distinguish between Zellweger syndrome and the other related conditions of the spectrum.

Tests

Zellweger syndrome is usually diagnosed through biochemical tests of the blood, urine, and fibroblasts. The most commonly used test is a measurement of very–long–chain fatty acids (VLCFA), which accumulate to high levels in the blood plasma with ZS. Blood levels of other fatty acids, pipecolic acid, and bile acid intermediates are also typically elevated. Plasmalogen levels are diminished.

A medical geneticist may confirm the diagnosis through detection of DNA mutations in one of the 12 different PEX genes located on chromosomes 1, 2, 6, 7, 8, 11, 12, 17, and 22. A PEX1 gene mutation is the most common cause of Zellweger syndrome. Genetic studies are accomplished with a small blood sample.

Procedures

Fatty acid levels and plasmalogen synthesis can be detected before birth using amniocentesis—the withdrawal through the mother's abdomen of fetal cells in the amniotic fluid.

Various procedures may be used to detect life–threatening problems in other organs and tissues, including the liver, heart, and kidneys. X rays can detect skeletal abnormalities, including a large space between the bones of the skull and characteristic bone spots called chondrodysplasia punctata.

Treatment

Traditional

There is neither a cure for Zellweger syndrome nor a standard course of treatment. Since most of the neurological and metabolic abnormalities are caused during fetal development, treatments after birth are severely limited. The goal is to lessen symptoms and support the involved organs. In addition to physicians and nurses, physical, occupational, respiratory, and speech therapists provide supportive strategies and devices to maintain posture, independent breathing, eating, speech, and other developmentally appropriate activities for as long as is practical. It is important to protect against infection in order to delay the development of complications. Support services are available for family members.

Drugs

Infants may be treated with vitamin K to prevent abnormal bleeding. Some patients have improved with experimental therapies using docosahexaenoic acid (DHA), an omega–3 essential fatty acid that is deficient with Zellweger syndrome. The administration of bile acids, such as cholic acid or chenodeoxycholic acid, is being tested for improvement of liver function.

Prognosis

Most infants with Zellweger syndrome do not survive past their first six months and rarely live more than one year after diagnosis. **Death** is usually due to respiratory distress, liver failure, severe feeding difficulties, heart defects, and/or gastrointestinal bleeding.

Prevention

Because Zellweger syndrome is usually fatal within the first year of life, **genetic counseling** and prenatal diagnosis are usually a high priority for parents who are at risk of conceiving an afflicted child, particularly couples who have had a previous child with Zellweger syndrome. Prospective parents with family histories of Zellweger syndrome or spectrum may be able to undergo genetic screening to determine the likelihood of their conceiving an afflicted child.

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ORGANIZATIONS

National Institute of Neurological Disorders and Stroke (NINDS), NIH Neurological Institute, PO Box 5801, Bethesda, MD, 20824, (301) 496–5751, (800) 352–9424, http://www.ninds.nih.gov/index.htm.

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United Leukodystrophy Foundation (ULF), 2304 Highland Dr., Sycamore, IL, 60178, (800) 728–5483, (815) 895–2432, office@ulf.org

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Zenker's diverticulum *see* **Esophageal pouches**
Zidovudine *see* **Antiretroviral drugs**
Zinc deficiency *see* **Mineral deficiency**
Zinc excess *see* **Mineral toxicity**
Zolpidem *see* **Anti-insomnia drugs**

Zoonosis

Definition

Zoonosis, also called *zoonotic disease*, refers to diseases that can be passed from animals, whether wild or domesticated, to humans.

Description

Although many diseases are species specific, meaning that they can only occur in one animal species, many other diseases can be spread between different animal species. These are infectious diseases, caused by bacteria, viruses, or other disease causing organisms that can live as well in humans as in other animals.

There are different methods of transmission for different diseases. In some cases, zoonotic diseases are transferred by direct contact with infected animals, much as being near an infected human can cause the spread of an **infectious disease**. Other diseases are spread by drinking water that contains the eggs of parasites. The eggs enter the water supply from the feces of infected animals. Still others are spread by eating the flesh of infected animals. Tapeworms are spread this way. Other diseases are spread by insect vectors. An insect, such as a flea or tick, feeds on an infected animal, then feeds on a human. In the process, the insect transfers the infecting organism.

The Centers for Disease Control (CDC) in Atlanta have said that most emerging diseases around the world are zoonotic. The director of the CDC has said that 11 of the last 12 emerging infections in the world with serious health consequences has probably arisen from animal sources. Wild animal trade occurs across countries and many people take in wild animals as domestic pets. However, pet shops and food markets are not properly testing for diseases and parasites that can cause harm to humans and other animals.

Some zoonotic diseases are well known, such as rats (**plague**) and deer ticks (**Lyme disease**). Others are not as well known. For example, elephants may develop **tuberculosis** and spread it to humans.

Causes and symptoms

The following is a partial list of animals and the diseases that they may carry. Not all animal carriers are listed, nor are all the diseases that the various species may carry.

- Bats are important rabies carriers and also carry several other viral diseases that can affect humans.
- Cats may carry the causative organisms for plague, anthrax, cowpox, tapeworm, and many bacterial infections.
- Dogs may carry plague, tapeworm, rabies, Rocky Mountain Spotted Fever, and Lyme disease.
- Horses may carry anthrax, rabies, and *Salmonella* infections.
- Cattle may carry the organisms that cause anthrax, European tick-borne encephalitis, rabies, tapeworm, *Salmonella* infections, and many bacterial and viral diseases.
- Pigs are best known for carrying tapeworm, but may also carry a large number of other infections including anthrax, influenza, and rabies.
- Sheep and goats may carry rabies, European tick-borne encephalitis, *Salmonella* infections, and many bacterial and viral diseases.
- Rabbits may carry plague and Q-Fever.
- Birds may carry *Campylobacteriosis*, *Chlamydia psittaci*, *Pasteurella multocida*, *Histoplasma capsulatum*, *Salmonellosis*, and others.

Zoonotic diseases may be spread in different ways. Tapeworms can often spread to humans when people eat the infected meat of cattle and swine. Other diseases are transferred by insect vectors, often blood-feeding insects that carry the cause of the disease from one animal to another.

Diagnosis

Diagnosis of the disease is made in the usual manner, by identifying the infecting organism. Each disease has established symptoms and tests. Identifying the carrier may be easy or may be more difficult when the cause is a fairly common infection. For example, tapeworms are usually species specific. Cattle, pigs, and fish all carry

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KEY TERMS

Anthrax—A disease of warm blooded animals, particularly cattle and sheep, transmissible to humans. The disease causes severe skin and lung damage.

Bovine spongiform encephalopathy—Also known as Mad Cow disease, a progressive, fatal disease of the nervous system of domestic animals that is transmitted by eating infected food.

Lyme disease—An acute disease which is usually marked by skin rash, fever, fatigue, and chills. Left untreated, it may cause heart and nervous system damage.

Q-Fever—A disease that is marked by high fever, chills, and muscle pain. It is seen in North America, Europe, and parts of Africa. It may be spread by drinking raw milk or by tick bites.

Zoonotic—A disease which can be spread from animals to humans.

different species of tapeworms, although all can be transmitted to humans who eat undercooked meat containing live tapeworm eggs. Once the tapeworm has been identified, it is easy to tell which species the tapeworm came from.

Other zoonotic infections may be harder to identify. Sometimes the infection is fairly common among both humans and animals, and it is impossible to tell. Snakes may carry the bacteria ***Escherichia coli*** and *Proteus vulgaris*, but since these bacteria are already common among humans, it would be difficult to trace infections back to snakes.

Because of increased trade between nations and changes in animal habitats, there are often new zoonotic diseases. These may be found in animals transported from one nation to another, bringing with them new diseases. In some cases, changes in the environment lead to changes in the migratory habits of animal species, bringing new infections.

Treatment

Treatment is the established treatment for the specific infection.

Prevention

Prevention of zoonotic infections may take different forms, depending on the nature of the carrier and the infection.

Some zoonotic infections can be avoided by immunizing the animals that carry the disease. Pets and other domestic animals should have **rabies** vaccinations, and wild animals are immunized with an oral vaccine that is encased in a suitable bait. In some places, the bait is dropped by airplane over the range of the potential rabies carrier. When the animals eat the bait, they also ingest the oral vaccine, thereby protecting them from rabies and reducing the risk of spread of the disease. This method has been used to protect foxes, coyotes, and other wild animals.

Many zoonotic diseases that are passed by eating the meat of infected animals can be prevented by proper cooking of the infected meat. Tapeworm infestations can be prevented by cooking, and *Salmonella* infections from chickens and eggs can be prevented by being sure that both the meat and the eggs are fully cooked.

For other zoonotic diseases, programs are in place to eliminate the host, or the vector, that spreads the disease. Plague is prevented by elimination of the rats—a common source of the infection—and of fleas that carry the disease from rats to humans. Efforts around the world to control bovine spongiform **encephalitis**, better known as Mad Cow disease, have focused on the destruction of infected cattle to prevent spread of the disease. Regulations on the makeup of the cattle feed to ensure safety and prevent the disease have helped curb its spread.

Other means of prevention simply rely on care. People living in areas where Lyme disease is common are warned to take precautions against the bite of the deer tick, which transfers the disease. These precautions include not walking in tall grass, not walking bare legged, and wearing light-colored clothing so that the presence of the dark ticks can be readily seen.

Resources

PERIODICALS

"Zoonotic Diseases." *Medical Laboratory Observer*, March 2004: 12.

ORGANIZATIONS

American Association of Zoo Keepers (AAZK), 3601 SW 29th St., Topeka, KS, 66614-2054, (785) 273-9149, http://aazk.org.

National Animal Disease Center Zoonotic Research Unit, 300 Dayton Ave., PO Box 70, Ames, IA, 50010.

Samuel D. Uretsky, PharmD
Teresa G. Odle

Zoonotic infections *see* **Zoonosis**

Zygomycosis *see* **Mucormycosis**

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ORGANIZATIONS

The following is an alphabetical compilation of organizations listed in the *Resources* section of the main body entries. Although the list is comprehensive, it is by no means exhaustive. It is a starting point for gathering further information. Many of the organizations listed provide information for multiple disorders and have links to additional related websites. E-mail addresses and web addresses listed were provided by the associations; Gale, Cengage Learning is not responsible for the accuracy of the addresses or the contents of the web sites.

5p-Society
7108 Katella Ave. no. 502
Stanton, CA 90680
Phone: (562) 804-4506
Fax: (562) 920-5240
Toll free: (888) 970-0777
E-mail: director@fivepminus.org
Web site: http://www.fivepminus.org/

A

Academy of General Dentistry
211 East Chicago Avenue, Suite 900
Chicago, IL 60611-1999
Fax: (312) 440-0559
Toll free: (888) 243-3368
Web site: http://www.agd.org

Academy for Guided Imagery
30765 Pacific Coast Highway, Suite 359
Malibu, CA 90265
Fax: (800) 727-2070
Toll free: (800) 726-2070
E-mail: info@acadgi.com
Web site: http://www.academyfor guidedimagery.com/

Acid Maltase Deficiency Association
PO Box 700248
San Antonio, TX 78270-0248
Phone: (210) 494-6144
E-mail: tianrama@aol. com
Web site: http://www.amda-pompe.org

Acoustic Neuroma Association of Canada
6192 Main Street
Ottawa
Canada ON, K1S 1C2
Toll free: (800) 561-2622
E-mail: info@anac.ca
Web site: http://www.anac.ca

Action Against Allergy (AAA)
PO Box 278
Middlesex
England TW1 4QQ
Phone: 44 (020) 8892-0711
Fax: 44 (020) 8892-4950
E-mail: AAA@actionagainstallergy.reeserve.co.uk
Web site: http://actionagainstallergy.co.uk

Acupressure Institute
1533 Shattuck Avenue
Berkeley, CA 94709
Phone: (510) 845-1059
Toll free: (800) 442-2232
E-mail: unfo@acupressureinstitute.com
Web site: http://www.acupressure institute.com

Adult Congenital Heart Disease Association
6757 Greene St., Suite 335
Philadelphia, PA 19119-3508
Phone: (215) 849-1260
Fax: (215) 849-1261
Toll free: (888) 921-ACHA
E-mail: Info@achaheart.org
Web site: http://www.achaheart.org

Aerospace Medical Association
320 South Henry Street
Alexandria, VA 22314-3579
Phone: (703) 739-2240
Fax: (703) 739-9652
E-mail: inquiries@asma.org
Web site: http://www.asma.org

Albinism World Alliance
PO Box 959
East Hampstead, NH 03826-0959
Phone: (603) 887-2310
Toll free: (800) 473-2310
Web site: http://www.albinism.org

Alcoholics Anonymous, World Services
PO Box 459
New York, NY 10163
Phone: (212) 870-3400
Web site: http://www.aa.org

Alexander Graham Bell Association for the Deaf and Hard of Hearing
3417 Volta Place NW
Washington, DC 20007
Phone: (202) 337-5220
Fax: (202) 337-8314
E-mail: info@agbell.org
Web site: http://www.agbell.org

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1692 Massachusetts Ave., 3rd Floor
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Toll free: (888) 668-8996
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Toll free: (800) 878-4403
Web site: http://www.aanma.org

Alliance for the Prudent Use of Antibiotics (APUA)
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Alternative Medicine Foundation
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Alzheimer's Association
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Web site: http://www.anesthetist.org

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Web site: http://www.audiology.org/

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American Association of Colleges of Osteopathic Medicine
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American Association for Marriage and Family Therapy
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Web site: http://www.cancer.org

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Web site: http://www.facs.org

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American Council for Headache Education (ACHE)
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American Heart Association National Center
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Chevy Chase, MD 20815
Phone: (301) 656-3920
Fax: (301) 656-3815
E-mail: email@asam.org
Web site: http://www.asam.org

American Society of Anesthesiologists
520 N. Northwest Highway
Park Ridge, IL 60068-2573
Phone: (847) 825-5586
Fax: (847) 825-1692
Web site: http://www.asahq.org

American Society of Angiology
708 Glen Cove Ave.
Glen Head, NY 11545
Phone: (516) 671-1975
Fax: (516) 759-5524
E-mail: anngailius@amsocang.org
Web site: http://amsocang.org

American Society of Cataract and Refractive Surgery
4000 Legato Road, Suite 700
Fairfax, VA 22033
Phone: (703) 591-2220
Fax: (703) 591-0614
Web site: http://www.ascrs.org

American Society of Clinical Hypnosis
140 N. Bloomingdale Rd
Bloomingdale, IL 60108
Phone: (630) 980-4740
Fax: (630) 351-8490
E-mail: info@asch.net
Web site: http://www.asch.net/

American Society for Clinical Nutrition
9650 Rockville Pike
Bethesda, MD 20814
Phone: (301) 634-7050
Fax: (301) 634-7892
Web site: http://www.nutrition.org/

American Society of Clinical Oncology
2318 Mill Road, Suite 800
Alexandria, VA 22314
Phone: (571) 483-1300
Toll free: (888) 282-2552
E-mail: membermail@asco.org
Web site: http://www.asco.org

American Society for Clinical Pathologists
33 West Monroe Street, Suite 1600
Chicago, IL 60603
Phone: (312) 541-4999
Fax: (312) 541-4998
Toll free: (800) 267-2727, option 2
E-mail: info@ascp.org
Web site: http://www.ascp.org/

American Society of Colon and Rectal Surgeons
85 W. Algonquin Road, Suite 550
Arlington Heights, IL 60005
Phone: (847) 290-9184
Fax: (847) 290-9203
E-mail: ascrs@fascrs.org
Web site: http://www.fascrs.org/

American Society for Dermatologic Surgery
5550 Meadowbrook Dr., Suite 120
Rolling Meadows, IL 60008
Phone: (847) 956-0900
Fax: (847) 956-0999
Web site: http://www.asds.net/

American Society for Gastrointestinal Endoscopy
1520 Kensington Road, Suite 202
Oak Brook, IL 60523
Phone: (630) 573-0600
Fax: (630) 573-0691
Toll free: (866) 353-2743
E-mail: info@asge.org
Web site: http://www.asge.org/

American Society of Health-System Pharmacists (ASHP)
7272 Wisconsin Avenue
Bethesda, MD 20814
Phone: (301) 657-3000
Toll free: (866) 279-0681
Web site: http://www.ashp.org

American Society of Hematology
2021 L St. NW, Suite 900
Washington, DC 20036
Phone: (202) 776-0544
Fax: (202) 776-0545
Web site: http://www.hematology.org

American Society of Human Genetics
9650 Rockville Pike
Bethesda, MD 20814-3998
Phone: (301) 634-7300
Fax: (301) 634-7079
Web site: http://www.ashg.org/

American Society of Hypertension
148 Madison Avenue, Fifth Floor
New York, NY 10016
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Fax: (212) 696-0711
E-mail: ash@ash-us.org
Web site: http://www.ash-us. org/

American Society for Laser Medicine and Surgery
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Wausau, WI 54401

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Web site: http://www.aslms.org

American Society of Microbiology
1752 N Street NW
Washington, DC 20036-2904
Phone: (202) 737-3600
Web site: http://www.asm.org/

American Society of Nephrology
1725 I Street, NW, Suite 510
Washington, DC 20006
Phone: (202) 659-0599
Fax: (202) 659-0709
Web site: http://www.asn-online.org

American Society of Nuclear Cardiology
4550 Montgomery Ave., Suite 780 North
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E-mail: info@asnc.org
Web site: http://www.asnc.org

American Society of Ophthalmic Plastic and Reconstructive Surgery
5841 Cedar Lake Road, Suite 204
Minneapolis, MN 55416
Phone: (952) 646-2038
Fax: (952) 545-6073
Web site: http://www.asoprs.org

American Society of Parasitologists
PO Box 1897
Lawrence, KS 66044
Fax: (785) 843-6153
Toll free: (800) 627-0326
Web site: http://asp.unl.edu/

American Society of Plastic Surgeons
444 E. Algonquin Rd
Arlington Heights, IL 60005
Phone: (847) 228-9900
Web site: http://www.plasticsurgery.org/

American Society of Radiologic Technologists
15000 Central Ave., SE
Albuquerque, NM 87123-3909
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Fax: (505) 298-5063
Toll free: (800) 444-2778
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Web site: https://www.asrt.org/

American Society for Reproductive Medicine
1209 Montgomery Highway
Birmingham, AL 35216-2809
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E-mail: asrm@asrm.org
Web site: http://www.asrm.org

American Society for Surgery of the Hand
6300 North River Road, Suite 600
Rosemont, IL 60018
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Fax: (847) 384-1435
E-mail: info@assh.org
Web site: http://www.hand-surg.org

American Society of Transplantation
15000 commerce Parkway, Suite C
Mt. Laurel, NJ 08054
Phone: (856) 439-9986
Fax: (856) 439-9982
E-mail: info@a-s-t.org
Web site: http://www.a-s-t.org/

American Speech Language Hearing Association
2200 Research Boulevard
Rockville, MD 20850-3289
Phone: (301) 296-5700
Fax: (301) 296-8580
Toll free: (800) 638-8255
E-mail: actioncenter@asha.org
Web site: http://asha.org/

American Tai Chi and Qigong Association
2465 J-17 Centreville Road, No.150
Herndon, VA 20171
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Web site: http://www.thoracic.org

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Web site: http://www.thyroid.org

American Tinnitus Association
PO Box 5
Portland, OR 97207-0005
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Fax: (503) 248-0024
Toll free: (800) 634-8978
E-mail: tinnitus@ata.org
Web site: http://www.ata.org/

American Trauma Society
8903 Presidential Pkwy Suite 512
Upper Marlboro, MD 20227
Toll free: (800) 556-7890

American Urological Association (AUA)
1000 Corporate Boulevard
Linthicum, MD 21090
Phone: (410) 689-3700
Fax: (410) 689-3800
Toll free: (866) 746-4282
E-mail: aua@AUAnet.org
Web site: http://www.auanet.org

American Veterinary Medical Association (AVMA)
1931 North Meacham Road, Suite 100
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Fax: (847) 925-1329
Toll free: (800) 248-2862
Web site: http://www.avma.org/

Amputee Coalition of America
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Knoxville, TN 37915-2566
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Toll free: (888) 267-5669
Web site: http://www.amputee-coalition.org/

Anxiety Disorders Association of America
8730 Georgia Ave. Suite 600
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Fax: (140) 485-1035
Web site: http://www.adaa.org

Arthritis Foundation
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Atlanta, GA 30357-0669
Phone: (404) 872-7100
Web site: http://www.arthritis.org

Arthritis National Research Foundation
200 Oceangate, Suite 830
Long Beach, CA 90802
Fax: (562) 983-1410
Toll free: (800) 588-2873
Web site: http://www.curearthritis.org

Association for the Advancement of Gestalt Therapy
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New York, NY 10022
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Web site: http://www.aagt.org

Association for Applied Psychophysiology and Biofeedback
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Association of Birth Defect Children
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Association for Neuro-Metabolic Disorders
5223 Brookfield Lane
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Association of Reproductive Health Professionals
1901 L Street, NW, Suite 300
Washington, DC 20036
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Web site: http://arhp.org

Association for Spina Bifida and Hydrocephalus
42 Park Rd
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UK PE1 2UQ
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Web site: http://www.asbah.org

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Web site: http://www.aafa.org/

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Web site: http://www.audiologyawareness.com

Austin Wound and Lymphedema Center
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Web site: http://www.behcets.org

Benson-Henry Institute for Mind-Body Medicine
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E-mail: mindbody@partners.org
Web site: http://www.massgeneral.org

Beryllium Support Group
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Broomfield, CO 80038-2021
Phone: (303) 412-7065
Web site: http://www.chronicberylliumdisease.com/tools/tl_support.htm

Better Hearing Institute
1444 I Street, NW, Suite 700
Washington, DC 20005
Phone: (202) 449-1100
Toll free: (800) 327-9355
E-mail: mail@betterhearing.org
Web site: http://www.betterhearing.org/

Biofeedback Certification Institute of America
10200 W. 44th Avenue
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Fax: (303) 422-8894
Toll free: (866) 908-8713
E-mail: info@bcia.org
Web site: http://www.bcia.org/

Brain Aneurysm Foundation
66 Canal St
Boston, MA 02114
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Web site: http://www.bafound.org

Brain Injury Association of America
1608 Spring Hill Road, Suite 110
Vienna, VA 22182
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Fax: (703) 761-0755
Web site: http://www.biausa.org

Breast Cancer Network of Strength
135 S. LaSalle St., Suite 2000
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Fax: (312) 294-8597
Toll free: (800) 221-2141
Web site: http://www.networkofstrength.org

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Canadian Association of Naturopathic Doctors
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Toll free: (800) 551-4381
Web site: http://www.cand.ca

Canadian Cancer Society
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Web site: http://www.cancer.ca

Canadian Diabetes Association
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Web site: http://www.diabetes.ca

Canadian Institute of Stress/Hans Selye Foundation
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E-mail: info@stresscanada.org
Web site: http://www.stresscanada.org

Canadian Pain Society
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Fax: (905)404-3727
Web site: http://www.canadianpainsociety.ca

Canadian Paraplegic Association
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Web site: http://www.canparaplegic.org

Canadian Retinoblastoma Society
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Canada Ontario, M5M 2M9
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E-mail: info@rbsociety.ca
Web site: http://www.rbsociety.ca

Canadian Society for Mucopolysaccharide and Related Diseases
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Toll free: (800) 667-1846
E-mail: info@mpssociety.ca
Web site: http://www.mpssociety.ca

Canadian Taijiquan Federation
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Cancer Group Institute
17620 9th Ave. NE
Miami Beach, FL 33162
Phone: (305) 493-1980
Web site: http://www.cancergroup.com

Cancer Hope Network
2 North Road - Suite A
Chester, NJ 07930
Phone: (908) 879-4039
Fax: (908) 879-6518
Toll free: (800) 552-4366
Web site: http://www.cancerhopenetwork.org

Cancer Prevention Coalition
University of Illinois at Chicago, School of Public Health, MC 922, 2121 West Taylor Street
Chicago, IL 60612
Phone: (312) 996-2297
Fax: (312) 413-9898
Web site: http://www.preventcancer.com/

Cancer Research Institute (National Headquarters)
One Exchange Plaza, 55 Broadway, Suite 1802
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Toll free: (800) 992-2623
Web site: http://www.cancerresearch.org/

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Toll free: (800) 813-4673
E-mail: info@cancercare.org
Web site: http://www.cancercare.org

Carcinoid Cancer Foundation
333 Mamaroneck Avenue #492
New York, NY 10605
Toll free: (888) 722-3132
Web site: http://www.carcinoid.org/

Cardiac Arrhythmia Research and Education Foundation (C.A.R.E.)
427 Fulton Street; PO Box 69
Seymour, WI 54165
Phone: (920) 833-7000
Fax: (920) 833-7005
Toll free: (800) 404-9500
E-mail: care@careforhearts.org
Web site: http://www.longqt.com/

Center for Biologics Evaluation and Research (CBER), U. S. Food and Drug Administration (FDA)
10903 New Hampshire Ave
Silver Spring, MD 20993-0002
Toll free: (888) 463-6332
Web site: http://www.fda.gov/BiologicsBloodVaccines

Center for Cell and Gene Therapy, Baylor College of Medicine
One Baylor Plaza
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Toll free: (888) 550-9288
E-mail: gradappboss@bcm.edu
Web site: http://www.bcm.edu/genetherapy/

Center for Fertility and In Vitro Fertilization Loma Linda University
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Web site: http://www.holisticurology.columbia.edu

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Center for Sight and Hearing
PO Box 5944
Rockford, IL 61107
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Fax: (815) 332-6810
Web site: http://www.rockfordcenter.org

Centers for Disease Control and Prevention (CDC)
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Toll free: (800) 232-4636
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Web site: http://www.cdc.gov

CFIDS Association of America
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Web site: http://www.cfids.org

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Fax: (610) 499-9267
Toll free: (800) 606-2682
E-mail: info@charcot-marie-tooth.org
Web site: http://www.charcot-marie-tooth.org

CHASER (Congenital Heart Anomalies Support, Education, and Resources)
2112 North Wilkins Road E820
Swanton, OH 43558
Phone: (419) 825-5575
Fax: (419) 825-2880
E-mail: CHASER@compuserve.com
Web site: http://www.csun.edu

Childhelp National Child Abuse Hotline
15757 N. 78th St., Suite B.
Scottsdale, AZ 85260
Phone: (480) 922-8212
Fax: (480) 922-7061
Toll free: (800) 422-4453
Web site: http://www.childhelp.org

Childhood Asthma Research and Education (CARE) Network. National Heart, Lung, and Blood Institute
6701 Rockledge Drive, MSC 7952
Bethesda, MD 20892-7952
Phone: (301) 435-0202
Fax: (301) 480-3557
E-mail: taggartv@nhlbi.nih.gov
Web site: http://www.asthma-carenet.org

Childhood Lead Poisoning Prevention Branch, Centers for Disease Control and Prevention
1600 Clifton Road
Atlanta, GA 30333
Toll free: (800) 232-4636
E-mail: cdcinfo@cdc.gov
Web site: http://www.cdc.gov/nceh/lead/

Children's Brittle Bone Foundation
7701 95th St
Pleasant Prairie, WI 53158
Phone: (773) 263-2223
Fax: (262) 947-0724
E-mail: bonelink@oif.org
Web site: http://www.cbbf.org

Children's Cancer and Blood Foundation
333 East 38th St., Room 830
New York, NY 10016
Phone: (212) 297.4336
Fax: (212) 297-4340
Web site: http://www.childrenscbf.org

Children's Cardiomyopathy Foundation
PO Box 547
Tenafly, NJ 07670
Fax: (201) 227-7016
Toll free: (866) 808-2873
E-mail: info@childrenscardiomyopathy.org
Web site: http://www.childrens cardiomyopathy.org

Children's Eye Foundation
1631 Lancaster Drive, Ste 200
Grapevine, TX 7605
Phone: (817) 310-2641
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Web site: http://www.childrenseye foundation.org

Children's Foundation
95 Pine Street, 16th Floor
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Children's Gaucher Research Fund
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Web site: http://www.childrens gaucher.org

Children's Organ Transplant Association, Inc.
2501 COTA Drive
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Children's Orthopedics of Atlanta
5445 Meridian Mark Road Suite 250
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Phone: (404) 255-1933
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Web site: http://www.childrens ortho.com

Children's PKU Network (CPN)
3790 Via De La Valle, Ste 120
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Fax: (310) 559-2554
E-mail: cawso@ca.org
Web site: http://www.ca.org/

Cochlear Implant Club International
5335 Wisconsin Ave. NW, Suite 440
Washington, DC 20015-2052
Phone: (202) 895-2781

College of American Pathologists
325 Waukegan Road
Northfield, IL 60093-2750
Phone: (847) 832-7000
Fax: (847) 832-8000
Toll free: (800) 323-4040
Web site: http://www.cap.org

Coma/Traumatic Brain Injury Recovery Association
8300 Republic Airport Suite 106
Farmingdale, NY 11735
Phone: (631) 756-1826
Web site: http://www.comarecovery.org

Compassionate Friends
PO Box 3696
Oak Brook, IL 60522
Phone: (630) 990-0010
Fax: (630) 990-0246
Toll free: (877) 969-0010
Web site: http://www.compassionatefriends.org

Congenital Heart Information Network (C.H.I.N.)
101 N. Washington Ave., Suite 1A
Margate City, NJ 08402-1195
Phone: (609) 882-1572
Fax: (609) 822-1574
E-mail: mb@tchin.org
Web site: http://tchin.org/

Congenital Nevus Support Group
PO Box 305
West Salem, OH 44287
Phone: (419) 853-4525
E-mail: info@nevusnetwork.org
Web site: http://www.nevusnetwork.org/

Consumer Product Safety Commission
4330 East West Highway
Bethesda, MD 20814
Phone: (301) 504-7923
Fax: (301) 504-0124
Toll free: (800) 638-2772
Web site: http://www.cpsc.gov/

Cooley's Anemia Foundation
330 Seventh Avenue, #900
New York, NY 10001
Fax: (212) 279-5999
Toll free: (800) 522-7222
E-mail: eileen.s@cooleysanemia.org
Web site: http://www.thalassemia.org

Council for Homeopathic Certification
PMB 187, 16915 SE 272nd St., Suite 100
Covington, WA 98042
Fax: (815) 366-7622
Toll free: (866) 242-3399
Web site: http://www.homeopathicdirectory.com

Cri du Chat Syndrome Support Group
PO Box 3408
Norwich
England NR3 3WE
Phone: 44 0 (845) 094-2725
E-mail: admin@criduchat.org.uk
Web site: http://www.criduchat.org.uk

Crohn's & Colitis Foundation of America
386 Park Avenue South17th Floor
New York, NY 10016
Toll free: (800) 932-2423
E-mail: info@ccfa.org
Web site: http://www.ccfa.org

Cystic Fibrosis Foundation
6931 Arlington Road, 2nd floor
Bethesda, MD 20814
Phone: (301) 951-4422
Fax: (301) 951-6378
Toll free: (800) 344-4823
E-mail: info@cff.org
Web site: http://www.cff.org

Cystinuria Support Network
21001 NE 36th St.
Redmond, WA 98053
Phone: (425) 868-2996
E-mail: sue@cystinuria.com
Web site: http://www.cystinuria.com

D

DanceSafe
536 45th Ave.
Oakland, CA 94609
Web site: http://www.dancesafe.org

Deafness Research Foundation
641 Lexington Avenue, Fl 15
New York, NY 10022-4503
Phone: (212) 328-9480
Fax: (212) 328-9484
Toll free: (888) 435-6104
Web site: http://www.drf.org

Depression and Bipolar Support Alliance (DBSA)
730 N. Franklin Street, Suite 501
Chicago, IL 60654-7225
Fax: (312) 642-7243
Toll free: (800) 826-3632
Web site: http://www.dbsalliance.org/

Dietitians of Canada
480 University Ave., Suite 604
Toronto
Canada M5G 1V2
Phone: (416) 596-0857
E-mail: centralinfo@dietitians.ca
Web site: http://www.dietitians.ca

Digestive Disease National Coalition
507 Capitol Court NE, Suite 200
Washington, DC 20002
Phone: (202) 544-7497
Fax: (202) 546-7105
E-mail: ddnc@hmcw.org
Web site: http://www.ddnc.org

Divers Alert Network
6 West Colony Place
Durham, NC 27705
Phone: (919) 684-2948
Fax: (919) 490-6630
Toll free: (800) 446-2671
Web site: http://www.diversalertnetwork.org

Division of Aging and Seniors, Health Canada
Pubic Health Agency of Canada
1908A1
Ottawa
Canada Ontario, K1A 0K9
Phone: (613) 952-7606
Fax: (613) 957-9938
Toll free: (800) 267-1245
E-mail: seniors-aines@phac-aspc.gc.ca
Web site: http://www.phac-aspc.gc.ca/seniors-aines

Dougy Center for Grieving Children and Families
PO Box 86852
Portland, OR 97286
Phone: (503) 775-5683
Fax: (503) 777-3097
Toll free: (866) 775-5683
Web site: http://www.dougy.org

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E

EAR Foundation of Arizona
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Phoenix, AZ 85008
Phone: (602) 685-1050
Fax: (602) 239-5117
E-mail: melissa@earfoundationaz.com
Web site: http://www.earfoundationaz.com

Easter Seals Disability Services
233 South Wacker Drive, Suite 2400
Chicago, IL 60606
Phone: (312) 726-6200
Fax: (312) 726-1494
Toll free: (800) 221-6827
Web site: http://www.easterseals.com

Ehlers-Danlos National Foundation
1760 Old Meadow Road, Suite 500
McLean, VA 22102
Phone: (703) 506-2892
Web site: http://www.ednf.org/

Ehlers-Danlos Support Group - UK
PO Box 337
Aldershot
UK Surrey GU12 6WZ
Phone: 01252 690940
Web site: http://www.ehlers-danlos.org/

The Endocrine Society
8401 Connecticut Ave., Suite 900
Chevy Chase, MD 20815
Phone: (301) 641-0200
Fax: (301) 941-0259
Toll free: (888) 363-6274
Web site: http://www.endo-society.org/

Epilepsy Foundation of America
8301 Professional Place
Landover, MD 20785-7223
Fax: (301) 577-2684
Toll free: (800) 332-1000
E-mail: info@efa.org
Web site: http://www.efa.org

Epilepsy Information Service
Medical Center Boulevard
Winston-Salem, NC 27157
Toll free: (800) 642-0500
E-mail: pgibson@wfubmc.edu
Web site: http://www.wfubmc.edu/Neurosciences/Comprehensive-Epilepsy-Center/Epilepsy-Information-Service.htm

ERIC Clearinghouse on Assessment and Evaluation
1131 Shriver Laboratory (Bldg 075),
University of Maryland
College Park, MD 20742
Toll free: (800) 464-3742
E-mail: feedback3@ericae.net
Web site: http://www.ericae.net

European Dermato-Epidemiology Network
Department of Dermatology
University Medical Centre
Groningen
The Netherlands 9700 RB
Phone: 0031 50 3612520
Fax: 0031 50 3619247
E-mail: p.j.coenraads@med.umcg.nl
Web site: http://eden.dermis.net

EyeCare America: The Foundation of the American Academy of Ophthalmology
P. O. Box 429098
San Francisco, CA 94142-9098
Fax: (415) 561-8567
Toll free: (877) 887-6327
Web site: http://www.eyecareamerica.org

F

Feminist Women's Health Center
106 East E Street
Yakima, WA 98901
Toll free: (800) 572-4223
Web site: http://www.fwhc.org

Fetal Treatment Center, University of California at San Francisco Children's Hospital
505 Parnassus Ave.
San Francisco, CA 94143
Toll free: (888) 689-8273
E-mail: referral.center@ucsfmedctr.org
Web site: https://www.ucsfbeni offchildrens.org

Florida Institute of Psychophysical Integration: Quantum Balance
5837 Mariner Drive
Tampa, FL 33609-3411
Phone: (813) 186-2273
Fax: (813) 287-2870

Flower Essence Society
PO Box 459
Nevada City, NV 95959
Phone: (530) 265-9163
Fax: (530) 265-0584
Toll free: (800) 736-9222
E-mail: info@flowersociety.org
Web site: http://www.flowersociety.org/

Focus Adolescent Services
P. O. Box 4514
Salisbury, MD 21803
Phone: (410) 341-4216
Web site: http://www.focusas.com

Food Allergy & Anaphylaxis Network
11781 Lee Jackson Hwy., Suite 160
Fairfax, VA 22033-3309
Fax: (703) 691-2713
Toll free: (800) 929-4040
Web site: http://www.foodallergy.org

Foundation Fighting Blindness
7168 Columbia Gateway Drive,
Suite 100
Columbia, MD 21046
Toll free: (800) 683-5555
E-mail: info@FightBlindness.org
Web site: http://www.blindness.org

Foundation for Ichthyosis and Related Skin Types (FIRST)
2616 North Broad Street
Colmar, PA 18915
Phone: (215) 997-9400
Fax: (215) 997-9403
Toll free: (800) 545-3286
E-mail: info@firstskinfoundation.org
Web site: http://www.firstskin foundation.org/

Foundation for Osteoporosis Research & Education
1814 Franklin Street, Suite 620
Oakland, CA 94612
Phone: (510) 832-2663
Fax: (510) 208-7174
Toll free: (888) 266-3015
E-mail: info@fore.org
Web site: http://www.fore.org

G

Gay and Lesbian Medical Association
459 Fulton Street, Suite 107
San Francisco, CA 94102
Phone: (415) 255-4547
Fax: (415) 255-4784
E-mail: info@glma.org
Web site: http://www.glma.org

Gender Dysphoria Organization
E-mail: lynn@genderdysphoria.org
Web site: http://www.gender dysphoria.org

Genetic Alliance, Inc.
4301 Connecticut Ave. NW,
Suite 404
Washington, DC 20008-2369
Phone: (202) 966-5557
Fax: (202) 966-8553
E-mail: info@geneticalliance.org
Web site: http://www.genetic alliance.org

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Genetic and Rare Diseases Information Center
PO Box 8126
Gaithersburg, MD 20898-8126
Phone: (301) 251-4925
Fax: (301) 251-4911
Toll free: (888) 205-2311
Web site: https://rarediseases.info.nih.gov/GARD

GriefNet
GriefNet
Ann Arbor, MI 48106-3272
E-mail: cendra@griefnet.org
Web site: http://www.griefnet.org

Guide Dogs for the Blind, National Office
PO Box 151200
San Rafael, CA 94915-1200
Toll free: (800) 295-4050
Web site: http://www.guidedogs.com

Gynecologic Cancer Foundation
230 W. Monroe, Suite 2528
Chicago, IL 60606
Phone: (312) 578-1439
Fax: (312) 578-9769
E-mail: info@thegcf.org
Web site: http://www.wcn.org/

H

Hairy Cell Leukemia Research Foundation
790 Estate Drive, Suite 180
Deerfield, IL 60015
Toll free: (866) 376-0046
E-mail: hairycellpatientservices@hotmail.com
Web site: http://www.hairycellleukemia.org/

Head Injury Hotline
PO Box 84151
Seattle, WA 98124
Phone: (206) 621-8558
Web site: http://www.headinjury.com

Head Trauma Support Project
PO Box 215666
Sacramento, CA 95821
Phone: (916) 568-6660

Health Services and Resources Administration, Division of Organ Transplantation
5600 Fishers Lane
Rockville, MD 20857
Toll free: (888) 275-4772
E-mail: ask@hrsa.gov
Web site: http://organdonor.gov

Hearing Industries Association
1444 I Street, NW, Suite 700
Washington, DC 20005
Phone: (202) 449-1090
Fax: (202) 216-9646
E-mail: mspangler@bostrom.com
Web site: http://www.hearing.org

Hearing Loss Association of America
7910 Woodmont Ave., Suite 1200
Bethesda, MD 20814
Phone: (301) 657-2248
Web site: http://www.hearingloss.org

Heart Association of Australia
Level 3, 80 William Street
Sydney
Australia NSW 2011
Phone: (02) 029219 2444
E-mail: reception.sydney@heartfoundation.org.au
Web site: http://www.heartfoundation.org.au

Heart Failure Society of America, Inc.
Court International - Suite 240 S,
2550 University Avenue West
St. Paul, MN 55114
Phone: (651) 642-1633
Fax: (651) 642-1502
Web site: http://www.hfsa.org

Heart and Stroke Foundation of Canada
222 Queen Street, Suite 1402
Ottawa
Canada ON, K1P 5V9
Phone: (613) 569-4361
Fax: (613) 569-3278
Web site: http://www.heartandstroke.com

Hemochromatosis Foundation
PO Box 675
Taylor, SC 29687
Fax: (864) 292-1878
Toll free: (888) 565-4766
E-mail: patientservices@irondisorders.org
Web site: http://www.hemochromatosis.org

Hemochromatosis Information Center
PO Box 675
Taylors, SC 29687
Phone: (864) 292-1175
Fax: (864) 292-1878
Toll free: (888) 565-4766
E-mail: patientservices@irondisorders.org
Web site: http://www.hemochromatosis.org/

Hermansky-Pudlak Syndrome Network, Inc.
One South Road
Oyster Bay, NY 11771-1905
Phone: (516) 922-4022
Toll free: (800) 780-9477
Web site: http://www.hpsnetwork.org

Histiocytosis Association of America
332 North Broadway
Pittman, NJ 08071
Fax: (856) 589-6614
Toll free: (800) 548-2758
E-mail: Association@histio.org
Web site: http://www.histio.org

Homeopathic Medical Council of Canada
31 Adelaide Street East, Box 605
Toronto
Canada Ontario, M5C 2J8
Phone: (416) 788-4622
E-mail: Ontario@HMCC.ca
Web site: http://www.hmcc.ca

Hospice Education Institute
3 Unity Square; PO Box 98
Machiasport, ME 04655-0098
Phone: (207) 255-8800
Fax: (207) 255-8008
Toll free: (800) 331-1620
E-mail: info@hospiceworld.org
Web site: http://www.hospiceworld.org/

Hospice Foundation of America
1710 Rhode Island Ave., NW,
Suite 400
Washington, DC 20036
Phone: (202) 457-5811
Fax: (202) 457-5815
Toll free: (800) 854-3402
E-mail: hfaoffice@hospicefoundation.org
Web site: http://www.hospicefoundation.org

Human Growth Foundation
997 Glen Cove Ave., Suite 5
Glen Head, NY 11545
Fax: (516) 671-4055
Toll free: (800) 451-6434
Web site: http://www.hgfound.org/

Hydrocephalus Foundation, Inc. (HyFI)
910 Rear Broadway
Saugus, MA 01906
Phone: (781) 942-1161
E-mail: HyFII@netscape.net
Web site: http://www.hydrocephalus.org/

Hygeia Foundation
264 Amity Road Suite 211
Woodbridge, CT 06525
Toll free: (800) 893-9198
E-mail: info@hygeiafoundation.org
Web site: http://www.hygeiafoundation.org

Hypertrophic Cardiomyopathy Association
328 Green Pond Rd., PO Box 306
Hibernia, NJ 07842

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Phone: (973) 983-7429
Fax: (973) 983-7870
E-mail: support@4hcma.org
Web site: http://www.4hcm.org/

Hypnotherapy Society
PO Box 131
Arundel
UK BN18 8BR
Phone: 44 0 870 Phone: 850-3387
E-mail: secretary@hypnotherapy society.com
Web site: http://www.hypnotherapy society.com

I

IgA Nephropathy Support Network
89 Ashfield Road
Shelburne Falls, MA 01370
Phone: (413) 625-9339
Web site: http:// www.igansupport.org

Immune Deficiency Foundation
40 West Chesapeake Avenue, Suite 308
Towson, MD 21204
Toll free: (800) 296-4433
Web site: http:// www.primaryimmune.org/

Infectious Diseases Society of America (IDSA)
1300 Wilson Blvd., Suite 300
Arlington, VA 22209
Phone: (703) 299-0200
Fax: (703) 299-0204
Web site: http://www.idsociety.org/

Insight Meditation Society
1230 Pleasant St.
Barre, MA 01005
Phone: (973) 355-4378
E-mail: rc@dharma.org
Web site: http://www.dharma.org/

Institute for Families with Blind Children
4650 Sunset Blvd, Mail Stop 111
Los Angeles, CA 90027
Phone: (323) 361-4649
Fax: (323) 665-7869
E-mail: info@instituteforfamilies.org
Web site: http://www.institutefor families.org

Interactive Guide to Learning Disabilities for Parents, Teachers, and Children
2775 S. Quincy St.
Arlington, VA 22206
Fax: (703) 998-2060
Web site: http://www.ldonline.org

The International Association of Laryngectomees (IAL)
925B Peachtree Street - NE Suite 316
Atlanta, GA 30309
Toll free: (866) 425-3678
Web site: http://www.theial.com/ial/

International Association for Medical Assistance to Travelers (IAMAT)
1623 Military Road, #279
Niagara Falls, NY 14304-1745
Phone: (716) 754-4883
Web site: http://www.iamat.org/ index.cfm

International Association of Reiki Professionals
E-mail: info@iarp.org
Web site: http://www.iarpreiki.org/

International Association of Yoga Therapists (IAYT)
PO Box 12890
Prescott, AZ 86304
Phone: (928) 541-0004
Web site: http://www.iayt.org/

International Bureau for Epilepsy
100 Priory Hall, Stillorgan, Blackrock
Dublin, Ireland
Phone: 353 1 210-8850
Fax: 353 1 210-8450
E-mail: ibedublin@eircom.net
Web site: http://www.ibe-epilepsy.org

International Center for Reiki Training
21421 Hilltop Street, Unit #28
Southfield, MI 48033
Phone: (248) 948-8112
Fax: (248) 948-9534
Toll free: (800) 332-8112
E-mail: center@reiki.org
Web site: http://www.reiki.org/

International Child Amputee Network (I-CAN)
PO Box 514
Abilene, TX 79604-0514
E-mail: job525@att.net
Web site: http://www.child-amputee.net/

International College of Applied Kinesiology
17A Lenox Pointe NE
Atlanta, GA 30324
Phone: (404) 634-0201
Web site: http://www.icak.com/

International Council for Medical and Clinical Therapists
7361 McWhorter Place, Suite 300
Annandale, VA 22003-5649
Phone: (703) 658-2014
Web site: http://www.seec-icmct.com/ icmct.htm

International Council for the Control of Iodine Deficiency Disorders
PO Box 51030, 375 des Epinettes
Ottawa
Canada Ontario, K1E 3E
Web site: http://www.iccidd.org/

International Essential Tremor Foundation
PO Box 14005
Lenexa, KS 66285-4005
Phone: (913) 341-3880
Fax: (913) 341-1196
Toll free: (888) 387-3667
E-mail: info@essentialtremor.org
Web site: http://www.essentialtremor.org

International Eye Foundation
10801 Connecticut Avenue
Kensington, MD 20895
Phone: (240) 290-0263
Fax: (240) 290-0263
E-mail: ief@iefusa.org
Web site: http://www.iefusa.org/

International Foundation for Functional Gastrointestinal Disorders
PO Box 17864
Milwaukee, WI 53217-8076
Phone: (414) 964-1799
Fax: (414) 964-7176
Toll free: (888) 964-2001
E-mail: iffd@iffgd.org
Web site: http://www.iffgd.org/

International Institute of Reflexology
PO Box 12642
St. Petersburg, FL 33733-2642
Phone: (727) 343-4811
Fax: (727) 381-2807
E-mail: info@reflexology-usa.net
Web site: http://www.reflexology-usa.net/

International Medical and Dental Hypnotherapy Association
8852 SR 3001
Laceyville, PA 18623
Phone: (570) 869-1021
Fax: (570) 869-1249
Toll free: (800) 553-6886
E-mail: info@imdha.com
Web site: http://www.imdha.com/

International NLP Trainers Association
1201 Delta Glen Court
Vienna, VA 22182
E-mail: wyatt.woodsmall@inlpta.org
Web site: http://www.inlpta.org

International OCD Foundation
1PO Box 961029
Boston, MA 02196
Phone: (617) 973-5801
Fax: (617) 973-5803
E-mail: info@ocfoundation.org
Web site: http://www.ocfoundation.org

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International Paruresis Association
PO Box 65111
Baltimore, MD 21209
Phone: (410) 367-1253
Fax: (410) 367-1254
Toll free: (800) 247-3864
Web site: http://www.paruresis.org/

International Prader-Willi Syndrome Organization
c/o Baschirotto Institute for Rare Diseases (BIRD), Via Bartolomeo Bizio, 1
1-36023 Costozza (VI)
Italy
Web site: http://www.ipwso.org/

International School of Shiatsu
10 South Clinton Street
Doylestown, PA 18901
Phone: (215) 340-9918
Fax: (215) 340-9181
Web site: http://www.shiatsubo.com

International Waldenstrom's & Macroglobulinemia Foundation
3932D Swift Road
Sarasota, FL 34231
Phone: (941) 927-4963
Fax: (941) 927-4467
E-mail: info@iwmf.com
Web site: http://www.iwmf.com/

Intersex Society of North America
979 Golf Course Drive #282
Rohnert Park , CA 94928
Fax: (801) 348-5350
Web site: http://www.isna.org/

Iron Disorders Institute
PO Box 675
Taylors, SC 29687
Phone: (864) 292-1175
Fax: (864) 292-1878
Toll free: (888) 565-IRON (4766)
Web site: http://www.irondisorders.org

Iron Overload Diseases Association, Inc.
West Palm Beach, FL 33405
Phone: (561) 586-8246
E-mail: iod@ironoverload.org
Web site: http://www.ironoverload.org/

J

Juvenile Diabetes Research Foundation International
26 Broadway, 14th Floor
New York, NY 10004
Fax: (212) 785-9595
Toll free: (800) 533-2873
E-mail: info@jdrf.org
Web site: http://www.jdf.org

K

Kids With Heart, National Association for Children's Heart Disorders, Inc.
PO Box 12504
Green Bay, WI 54307-2504
Phone: (920) 498-0058
Toll free: (800) 538-5390
E-mail: michelle@kidswithheart.org
Web site: http://www.kidswithheart.org/

Komen Foundation
5005 LBJ Freeway, Suite 250
Dallas, TX 75244
Toll free: (877) GO KOMEN
Web site: http://www.komen.org/

KS&A, Klinefelter Syndrome
PO Box 461047
Aurora, CO 80046-1047
Phone: (303) 400-9040
Toll free: (888) 999-9428
E-mail: info@genetic.org
Web site: http://www.genetic.org

L

Late Onset Tay-Sachs Foundation
4924 Balboa blvd, #354
Encino, CA 91316
Phone: (818) 205-9644
Fax: (818) 906-1914
Web site: http://www.lateonsettay-sachs.org/

Learning Disabilities Association of America
4156 Library Road
Pittsburg, PA 15234-1349
Phone: (412) 341-1515
Fax: (412) 344-0224
Web site: http://www.ldanatl.org/

Lesch-Nyhan Disease International Study Group
Web site: http://www.lesch-nyhan.org/

Leukemia and Lymphoma Society
1311 Mamaroneck Avenue, Suite 310
White Plains, NY 10605
Toll free: (800) 955-4572
Web site: http://www.leukemia-lymphoma.org

Leukemia Research Foundation
3520 Lake Avenue, Suite #202
Wilmette, IL 60091-1064
Phone: (847) 424-0600
Fax: (847) 424-0606
Toll free: (888) 558-5385
E-mail: info@LRFmail.org
Web site: http://www.leukemia-research.org

Lighthouse International
111 East 59th Street
New York, NY 10022-120
Phone: (212) 821-9200
Fax: (212) 821-9707
Toll free: (800) 829-0500
E-mail: info@lighthouse.org
Web site: http://www.lighthouse.org

Little People of America, Inc.
250 El Camino Real, Suite 201
Tustin, CA 92780
Phone: (714) 368-3689
Fax: (714) 368-3367
Toll free: (888) LPA-2001 (572-2001)
Web site: http://www.lpaonline.org

Long Island Head Injury Association
65 Austin Blvd.
Commack, NY 11725
Phone: (631) 543-2245
Fax: (631) 543-2261
Web site: http://www.lihia.org/

Lung Cancer Alliance
888 16th St, NW, Suite 140
Washington, DC 20006
Phone: (202) 463-2080
Toll free: (800) 298-2436
E-mail: info@lunjgcanceralliance.org
Web site: http://www.lungcanceralliance.org

Lupus Foundation of America
2000 L Street, NW, Suite 710
Washington, DC 20036
Phone: (202) 349-1155
Fax: (202) 349-1156
Toll free: (800) 558-0121
Web site: http://www.lupus.org

Lymphoma Research Foundation
8800 Venice Boulevard, Suite 207
Los Angeles, CA 90034
Phone: (212) 349-2910
Fax: (212) 349-2886
Toll free: (800) 235-6848
E-mail: Helpline@lymphoma.org
Web site: http://www.lymphoma.org

M

Management of Myelomeningocele Study (MOMS)
the GWU Biostatistics Center, 6110 Executive Blvd., Suite 750
Rockville, MD 20852
Fax: (866) 458-4621
Toll free: (866) 275-6667
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Web site: http://www.spinabifidamoms.com/english/index.html

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March of Dimes Birth Defects Foundation
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White Plains, NY 10605
Phone: (914) 997-4488
Web site: http://www.modimes.org

Massachusetts College of Emergency Physicians
860 Winter Street
Waltham, MA 02451
Phone: (781) 890-4407
Fax: (781) 890-4109
Web site: http://www.macep.org

Massachusetts General Hospital, Functional and Stereotactic Neurosurgery Cingulotomy Unit
55 Fruit St., Gray 502
Boston, MA 02114
Phone: (617) 724-6590
Fax: (617) 724-0339
Web site: http://neurosurgery.mgh.harvard.edu/functional

Mental Health America
2000 N. Beauregard Street, 6th Floor
Alexandria, VA 22311
Phone: (703) 684-7722
Fax: (703) 684-5968
Toll free: (800) 969-6642
E-mail: infoctr@mentalhealthamerica.net
Web site: http://www.mentalhealthamerica.net

Midwest Heart Specialists
1901 S. Meyers Road, Suite 350
Oak Brook Terrace, IL 60181
Phone: (630) 932-2165
Fax: (630) 268-9609
Web site: http://www.midwestheart.com

Milne Institute Inc.
PO Box 220
Big Sur, CA 93920
Phone: (831) 667-2323
Fax: (831) 667-2525
E-mail: infomilne@aol.com
Web site: http://www.milneinstitute.com/contact

Mine Safety and Health Administration
4015 Wilson Blvd
Arlington, VA 22203
Toll free: (877) 778-6055
E-mail: MSHAhelpdesk@dol.gov
Web site: http://www.msha.gov

Mommies Enduring Neonatal Death (M.E.N.D.)
PO Box 1007
Coppell, TX 75019
Phone: (972) 506-9000
E-mail: rebekah@mend.org
Web site: http://www.mend.org

Multidisciplinary Association for Psychedelic Studies
309 Cedar Street No. 2323
Santa Cruz, CA 95060
Phone: (831) 429-6362
Fax: (831) 429-6370
Web site: http://www.maps.org

Multiple Myeloma Research Foundation
383 Main Avenue 5th Floor
Norwalk, CT 06851
Phone: (203) 229-0464
Fax: (203) 229-0572
E-mail: info@themmrf.org
Web site: http://www.themmrf.org

Muscular Dystrophy Association
3300 East Sunrise Drive
Tucson, AZ 85718
Toll free: (800) 572-1717
Web site: http://www.mdausa.org

Myasthenia Gravis Foundation of America
355 Lexington Avenue, 15th Floor
New York, NY 10017
Phone: (212) 297-2156
Fax: (212) 370-9047
Toll free: (800) 541-5454
Web site: http://www.myasthenia.org/

The Myositis Association
1737 King Street, Suite 600
Alexandria, VA 22314
Toll free: (800) 821-7356
E-mail: TMA@ myositis.org
Web site: http://www.myositis.org

Myositis Support Group
PO Box 1793
Athens, TX 75751
Web site: http://www.myositis supportgroup.org

N

Nar-Anon Family Group Headquarters
22527 Crenshaw Blvd., Suite 200B
Torrance, CA 90505
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Toll free: (800) 477-6291
E-mail: naranonwso@nar-anon.org
Web site: http://www.nar-anon.org/Nar-Anon

National Adrenal Diseases Foundation
505 Northern Boulevard, Suite 200
Great Neck, NY 11021
Phone: (516) 487-4992
Web site: http://www.nadf.us

National AIDS Hotline, CDC
1600 Clifton Road
Atlanta, GA 30333
Toll free: (800) 232-4636
E-mail: cdcinfo@cdc.gov
Web site: http://www.cdc.gov/hiv

National AIDS Treatment Advocacy Project
580 Broadway, Ste. 1010
New York, NY 10012
Phone: (212) 219-0106
Fax: (212) 219-8473
Toll free: (866) 26-NATAP
E-mail: info@natap.org
Web site: http://www.natap.org

National Air Disaster Alliance/ Foundation (NADA)
2020 Pennsylvania Avenue NW #315
Washington, DC 20006-1846
Fax: (336) 643-1394
Toll free: 888 444-NADA (6232)
Web site: http://www.planesafe.org

National Alliance for Medication Assisted Recovery
435 Second Avenue
New York, NY 10010
E-mail: nama.info@methadone.org
Web site: http://www.methadone.org

National Alliance for the Mentally Ill (NAMI)
3803 N. Fairfax Dr., Ste. 100
Arlington, VA 22203
Phone: (703) 524-7600
Fax: (703) 524-9094
Toll free: (800) 950-6264
Web site: http://www.nami.org

National Animal Disease Center Zoonotic Research Unit
300 Dayton Ave. PO Box 70
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National Aphasia Association
350 Seventh Avenue, Suite 902
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Toll free: (800) 922-4622
E-mail: responsecenter@aphasia.org
Web site: http://www.aphasia.org

National Association for Continence
PO Box 1019
Charleston, SC 29402-1019
Phone: (843) 377-0900
Fax: (843) 377-0905
Toll free: (800) 252-3337
E-mail: memberservices@nafc.org
Web site: http://www.nafc.org

National Association of the Deaf
8630 Fenton St, #820
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Phone: (301) 587-1788
Fax: (301) 587-1791
Web site: http://www.nad.org

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National Association of Holistic Aromatherapy
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Phone: (828) 898-6161
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E-mail: info@naha.org
Web site: http://www.naha.org

National Association for Premenstrual Syndrome
41 Old Road East Peckham
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England TN12 5AP 44
Phone: 08 815-7311
Web site: http://www.pms.org.uk

National Association for Pseudoxanthoma Elasticum
8760 Manchester Road
St. Louis, MO 63144-2724
Phone: (314) 962-0100
E-mail: napestlouis@sbcglobal.net
Web site: http://www.pxenape.org

National Association for the Relief of Paget's Disease
323 Manchester Road, Walkden, Worsley
Manchester
England M28 3HH
Phone: 44 (161) 799-4646
E-mail: director@paget.org.uk
Web site: http://www.paget.org.uk

National Bladder and Bowel Foundation
SATRA Innovation Park
Rockingham Road
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Phone: 44 015 365-3255
Fax: 44 015 365-3240
E-mail: info@bladderandbowel foundation.org
Web site: http://www.bladderand bowelfoundation.org

National Breast Cancer Coalition
1101 17th Street, NW, Suite 1300
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Phone: (202) 296-7477
Fax: (202) 265-6854
Toll free: (800) 622-2838
Web site: www.stopbreastcancer.org

National Cancer Institute (National Institutes of Health)
NCI Office of Communications and Education, 6116 Executive Blvd. Suite 300
Bethesda, MD 20892-8322
Toll free: (800) 4-CANCER (422-6237)
E-mail: cancergovstaff@mail.nih.gov
Web site: http://www.cancer.gov/

National Cancer Institute, Office of Cancer Complementary and Alternative Medicine
6116 Executive Blvd., Suite 609, MSC 8339
Bethesda, MD 20892
Phone: (301) 435-7980
Fax: (301) 480-0075
E-mail: ncioccam1-r@mail.nih.gov
Web site: http://www.cancer.gov/cam/

National Center for Complementary and Alternative Medicine (NCCAM)
PO Box 7923
Gaitherburg, MD 20898
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E-mail: info@nccam.nih.gov
Web site: http://nccam.nih.gov/

National Center for Drug Free Sport Inc.
2735 Madison Avenue
Kansas City, MO 64108
Phone: (816) 474-8644
Fax: (816) 501-9287
E-mail: info@drugfreesport.com
Web site: http://www.drugfreesport.com

National Center on Elder Abuse
c/o Center for Community Research and Services, University of Delaware, 297 Graham Hall
Newark, DE 19716
Phone: (302) 831-3525
Fax: (302) 831-4225
Toll free: (800) 677-1116
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Web site: http://www.ncea.aoa.gov

National Center for Environmental Health
1600 Clifton Road
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Web site: http://www.cdc.gov/nceh

National Center for Learning Disabilities
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Toll free: (888) 575-7373
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National Center for Preparedness, Detection, and Control of Infectious Diseases
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Web site: http://www.nhlbi.nih.gov/about/ncsdr

National Certification Board for Therapeutic Massage and Bodywork
1901 South Meyers Road, Suite 240
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Web site: http://www.ncbtmb.org

National CFIDS Foundation
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Web site: http://www.ncf-net.org/contact

National Child Traumatic Stress Network
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Los Angeles, CA 90064
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Fax: (310) 235-2612
Web site: http://www.nctsnet.org/nccts

National Cholesterol Education Program, National Heart, Lung, and Blood Information Center
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Phone: (301) 592-8573
Fax: (240) 629-3246
E-mail: nhlbiinfo@nhlbi.nih.gov
Web site: http://www.nhlbi.nih.gov/about/ncep

National Chronic Fatigue Syndrome and Fibromyalgia Association
PO Box 18426
Kansas City, MO 64133
Phone: (816) 737-1343
Web site: http://www.ncfsfa.org

National Clearinghouse for Alcohol and Drug Information
PO Box 2345
Rockville, MD 20847-2345
Toll free: (877) 726-4727
Web site: http://store.samhsa.gov/

National Coalition Against Domestic Violence
1120 Lincoln Street, Suite 1603
Denver, CO 80203

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Phone: (303) 839-1852
Fax: (303) 831-9251
Web site: http://ww.ncadv.org/

National Coalition for Cancer Survivorship
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silver Spring, MD 20910
Phone: (301) 650-9127
Fax: (301) 565-9670
Toll free: (888) 650-9127
E-mail: info@canceradvocacy.org
Web site: http://www.cancer advocacy.org

National Council on Alcoholism and Drug Dependence, Inc.
244 East 58th Street, 4th Floor
New York, NY 10022
Phone: (212) 269-7797
Fax: (212) 269-7510
Toll free: (800) NCA-CALL
E-mail: national@ncadd.org
Web site: http://www.ncadd.org

National Diabetes Education Program
One Diabetes Way
Bethesda, MD 20814-9692
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Toll free: (888) 693-6337
Web site: http://www.ndep.nih.gov/

National Diabetes Information Clearinghouse (NDIC)
1 Information Way
Bethesda, MD 20892-3560
Fax: (703) 738-4929
Toll free: (800) 860-8747
E-mail: ndic@info.niddk.nih.gov
Web site: http://diabetes.niddk. nih.gov/

National Domestic Violence Hotline
P. O. box 161810
Austin, TX 78716
Phone: (512) 794-1133
Toll free: (800) 799-SAFE (7233)
Web site: http://www.thehotline.org

National Down Syndrome Society
666 Broadway, 8th Floor
New York, NY 10012
Toll free: (800) 221-4602
E-mail: info@ndss.org
Web site: http://www.ndss.org

National Endocrine and Metabolic Diseases Information Service
6 Information Way
Bethesda, MD 20892-3569
Fax: (703) 738-4929
Toll free: (888) 828-0904
E-mail: endoandmeta@info.niddk. nih.gov
Web site: http://endocrine.niddk. nih.gov

National Eye Institute
31 Center Drive MSC 2510
Bethesda, MD 20892-2510
Phone: (301) 496-5248
Web site: http://www.nei.nih.gov/

National Federation of the Blind
200 East Wells Street
Baltimore, MD 21230
Phone: (410) 659-9314
Fax: (410) 685-5653
Web site: http://www.nfb.org

National Fragile X Foundation
Phone: (925) 938-9300
Fax: (925) 938-9315
Toll free: (800) 688-8765
Web site: http://www.fragilex.org

National Gaucher Foundation
2227 Idlewood Road, Suite 6
Tucker, GA 30084
Fax: (770) 934-2911
Toll free: (800) 504-3189
E-mail: ngf@gaucherdisease.org
Web site: http://www.gaucherdisease.org/

National Headache Foundation
820 N. Orleans, Suite 217
Chicago, IL 60610
Phone: (312) 274-2650
Toll free: (888) NHF-5552
E-mail: info@headaches.org
Web site: http://www.headaches.org

National Healthy Mothers, Healthy Babies Coalition
2000 N. Beauregard Street, 6th Floor
Alexandria, VA 22311
Phone: (703) 837-4792
Fax: (703) 684-5968
E-mail: info@hmhb.org
Web site: http://www.hmhb.org/

National Heart, Lung, and Blood Institute Health Information Center
PO Box 30105
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Fax: (240) 629-3246
Web site: http://www.nhlbi.nih.gov

National Hemophilia Foundation
116 West 32nd St., 11th Floor
New York, NY 10001
Phone: (212) 328-3700
Fax: (212) 328-3777
Web site: http://www.hemophilia.org

National Hospice and Palliative Care Organization
700 Diagonal Road, Suite 625
Alexandria, VA 22314
Phone: (703) 837-1500
Fax: (703) 837-1233
Web site: http://www.nhpco.org

National Human Genome Research Institute
National Institutes of Health Building 31, Room 4B09 31 Center Drive, MSC 2152, 9000 Rockville Pike
Bethesda, MD 20892-2152
Phone: (301) 402-0911
Fax: (301) 402-2218
Web site: http://www.genome.gov

National Information Centre for Inherited Metabolic Diseases
The Quadrangle, Crewe Hall, Weston Rd.
Cheshire
England CW1-6UR
Phone: 44 0(845) 241-2172
Toll free: (800) 652-3181
E-mail: fam.svcs@climb.org.uk
Web site: http://www.climb.org.uk

National Institute on Aging
Building 31, Room 5C27, 31 Center Dr. Bethesda, MD 20892
Phone: (301) 496-1752
Fax: (301) 496-1072
Web site: http://www.nia.nih.gov/

National Institute on Alcohol Abuse and Alcoholism (NIAAA)
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Bethesda, MD 20892-9304
Phone: (301) 443-3860
Web site: http://www.niaaa.nih.gov/

National Institute of Allergies and Infectious Diseases
6610 Rockledge Drive, MSC 6612
Bethesda, MD 20892-6612
Phone: (301) 496-5717
Fax: (301) 402-3573
Toll free: (866) 284-4107
E-mail: ocpostoffice@niaid.nih.gov
Web site: http://www.niaid.nih.gov

National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS)
1 AMS Circle
Bethesda, MD 20892-3675
Phone: (301) 495-4484
Fax: (301) 718-6366
Toll free: (877) 226-4267
E-mail: NIAMSinfo@mail.nih.gov
Web site: http://www.niams.nih.gov/

National Institute of Ayurvedic Medicine
584 Milltown Road
Brewster, NY 10509
Phone: (845) 278-8700
Fax: (845) 278-8215
E-mail: ayurveda@niam.com

National Institute of Child Health and Human Development
Bldg 31, Room 2A32, MSC 2425, 31 Center Drive
Bethesda, MD 20892-2425
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Toll free: (800) 370-2943
Web site: http://www.nichd.nih.gov/

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National Institute on Deafness and Other Communication Disorders
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Toll free: (800) 241-1044
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Web site: http://www.nidcd.nih.gov

National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK)
Bldg 31, Rm 9A06 31 Center Drive, MSC 2560
Bethesda, MD 20892-2560
Phone: (301) 496-3583
Web site: http://www2.niddk.nih.gov

National Institute on Drug Abuse
6001 Executive Blvd., Room 5213
Bethesda, MD 20892-9561
Phone: (301) 443-1124
E-mail: information@nida.nih.gov
Web site: http://drugabuse.gov

National Institute of General Medical Sciences
45 Center Drive, MSC 6200
Bethesda, MD 20892-6200
Phone: (301) 496-7301
Web site: http://www.nigms.nih.gov

National Institute of Mental Health (NIMH)
6001 Executive Boulevard, Room 8184, MSC 9663
Bethesda MD20892-9663
Toll free: (866) 615-6464
E-mail: nimhinfo@nih.gov
Web site: http://www.nimh.nih.gov

National Institute of Neurological Disorders and Stroke (NINDS)
NIH Neurological Institute,
P. O. Box 5801
Bethesda, MD 20824
Phone: (301) 496-5751
Toll free: (800) 352-9424
Web site: http://www.ninds.nih.gov/

National Institute for Occupational Safety and Health
1600 Clifton Road
Atlanta, GA 30333
Toll free: (800) 232-4636
E-mail: cdcinfo@cdc.gov
Web site: http://www.cdc.gov/niosh

National Institutes of Health
9000 Rockville Place
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Web site: http://www.nih.gov

National Kidney Cancer Association
PO Box 96503
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Toll free: (800) 850-9132
E-mail: kidney. cancer@hotmail.com
Web site: http://www.kidneycancer.org

National Lead Information Center
422 S. Clinton Ave.
Rochester, NY 14620
Fax: (585) 232-3111
Toll free: (800) 424-5323
Web site: http://www.epa.gov/lead

National Lymphedema Network
116 New Montgomery Street, Suite 235
San Francisco, CA 94105
Phone: (415) 908-3681
Fax: (415) 908-3813
Toll free: (800) 541-3259
E-mail: nln@lymphnet.org
Web site: http://www.lymphnet.org

National Marrow Donor Program
3001 Broadway Street Northeast, Suite 100
Minneapolis, MN 55413-1753
Toll free: (800) 627-7692
E-mail: patientinfo@nmdp.org
Web site: https://www.marrow-donor.org

National MPS (Mucopolysaccharidoses) Society
PO Box 14686
Durham, NC 27709-4686
Phone: (877) 677-1001
Fax: (919) 806-2055
E-mail: info@mpssociety.org
Web site: http://www.mpssociety.org

National Necrotizing Fasciitis Foundation
2731 Porter SW
Grand Rapids, MI 49509
E-mail: nnfffeb@aol.com
Web site: http://www.nnff.org

National Network for Immunization Information
301 University Blvd
Galveston, TX 77555-0350
Phone: (409) 772-0199
Fax: (409) 772-5208
E-mail: nnii@i4ph.org
Web site: http://www.immunization info.org

National Organization for Albinism and Hypopigmentation (NOAH)
PO Box 959
East Hampstead, NH 03826-0959
Phone: (603) 887-2310
Fax: (800) 648-2310
Toll free: (800) 473-2310
Web site: http://www.albinism.org/

National Organization for Rare Disorders
PO Box 8923
New Fairfield, CT 06812-8923
Toll free: (800) 999-6673
Web site: http://www.rarediseases.org

National Osteoporosis Foundation (NOF)
1150 17th Street NW, Suite 850
Washington, DC 20036-4603
Phone: (202) 223-2226
Fax: (202) 223-2237
Toll free: (800) 231-4222
Web site: http://www.nof.org

National Parkinson Foundation, Inc.
1501 NW 9th Avenue/Bob Hope Road
Miami, FL 33136-1494
Phone: (305) 243-6666
Fax: (305) 243-6073
Toll free: (800) 473-4636
E-mail: contact@ parkinson.org
Web site: http://www.parkinson.org

National Pressure Ulcer Advisory Panel
1025 Thomas Jefferson St. NW, Suite 500 East
Washington, DC 20007
Phone: (202) 521-6789
Fax: (202) 833-3636
E-mail: npuap@npuap.org
Web site: http://www.npuap.org

National Prevention Information Network
PO Box 6003
Rockville, MD 20849-6003
Fax: (888) 282-7681
Toll free: (800) 458-5231
E-mail: info@cdcnpin.org
Web site: http://www.cdcnpin.org

National Prostate Cancer Coalition
1154 Fifteenth Street NW
Washington, DC 20005
Phone: (202) 463-9455
Fax: (202) 463-9456
Toll free: (888) 245-9455
E-mail: info@fightprostatecancer.org
Web site: http://www.zerocancer.org

National Psoriasis Foundation
6600 SW 92nd Ave., Suite 300
Portland, OR 97223-7195
Phone: (503) 244-7404
Fax: (503) 245-0626
E-mail: getinfo@psoriasis.org
Web site: http://www.psoriasis.org

National Qigong Association
PO Box 270065
St. Paul, MN 55127
Fax: (888) 359-9526
Toll free: (888) 815-1893
Web site: http://nqa.org/

National Rehabilitation Association
633 S. Washington St.
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National Rehabilitation Information Center
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Web site: http://www.naric.com

National Respiratory Distress Syndrome Foundation
PO Box 723
Montgomeryville, PA 18936
Phone: (215) 822-3585
Web site: http://membrane.com/philanet/rds/

National Rosacea Society
198 James St/
Barrington, IL 60010
Toll free: (888) 662-5874
E-mail: rosaceas@aol.com
Web site: http://www.rosacea.org

National Safety Council
1121 Spring Lake Dr.
Itasca, IL 60143-3201
Phone: (630) 285-1121
Fax: (630) 285-1315
Toll free: (800) 621-7615
E-mail: customerservice@nsc.org
Web site: http://www.nsc.org

National Scoliosis Foundation
5 Cabot Place, Stoughton
Soughton, MA 20724
Toll free: (800) 673-6922
E-mail: NSF@scoliosis.org
Web site: http://www.scoliosis.org

National Sleep Foundation
1522 K St. NW, Suite 500
Washington, DC 20005
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Fax: (202) 347-2472
Web site: http://www.sleepfoundation.org

National Society for Phenylketonuria
PO Box 26642
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Web site: http://www.nspku.org/

National Space Biomedical Research Institute
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Web site: http://www.nsbri.org

National Spasmodic Torticollis Association
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Fountain Valley, CA 92708
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Web site: http://www.torticollis.org

National Spinal Cord Injury Association
1 Church St., Suite 600
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Web site: http://www.spinalcord.org

National Stroke Association
9707 E Easter Lane Building B
Centennial, CO 80112
Fax: (303) 649-1328
Toll free: (800) 787-6537
E-mail: Info@stroke.org
Web site: http://www.stroke.org

National Uterine Fibroids Foundation
PO Box 9688
Colorado Springs, CO 80932-0688
Phone: (719) 633-3454
Toll free: (800) 874-7247
E-mail: info@nuff.org
Web site: http://www.nuff.org

National Vaccine Program Office. U.S. Department of Health & Human Services
Room 715-H 200 Independence Avenue, SW
Washington, DC 20201
Phone: (202) 690-5566
E-mail: nvpo@hhs.gov
Web site: http://www.hhs.gov/nvpo

National Vitiligo Foundation
PO Box 23226
Cincinnati, OH 45223
Phone: (513) 541-3903
E-mail: info@nvfi.org
Web site: http://www.nvfi.org

NCI Office of Communications and Education6116 Executive Blvd. Suite 300
Bethesda, MD 20892-8322
Toll free: (800) 4-CANCER (422-6237)
E-mail: cancergovstaff@mail.nih.gov
Web site: http://www.cancer.gov/aboutnci/cis

Nemours Foundation
10140 Centurion Parkway
Jacksonville, FL 32256
Phone: (904) 697-4100
Fax: (904) 697-4220
Web site: http://www.nemours.org

Neurofibromatosis, Inc. 8855 Annapolis Rd., #110, Lanham
PO Box 66884
Chicago, IL 60666
Toll free: (800) 942-6825
Web site: http://www.nfinc.org

Neuropathy Association, Inc
60 East 42nd Street, Suite 942
New York, NY 10165
Phone: (212) 692-0662
Fax: (212) 692-0668
E-mail: info@neuropathy.org
Web site: http://www.neuropathy.org

New York University Department of Ophthalmology
462 First Avenue, NBV 5N 18
New York, NY 10016
Phone: (212) 263-6434
Fax: (212) 263-8749
Web site: http://www.med.nyu.edu

North American Vegetarian Society
PO Box 72
Dolgeville, NY 13329
Phone: (518) 568-7970
Web site: http://www.navs-online.org

O

Obesity Society
8630 Fenton St., Suite 814
Silver Spring, MD 20910
Phone: (301) 563-6526
Fax: (301) 563-6595
Web site: http://www.obesity.org/

Obsessive-Compulsive Anonymous
PO Box 215
New Hyde Park, NY 11040
Phone: (516) 739-0662
Web site: http://obsessivecompulsiveanonymous.org

Office of Dietary Supplements, National Institutes of Health
6100 Executive Blvd., Room 3B01, MSC 7517
Bethesda, MD 20892-7517
Phone: (301) 435-2920
Fax: (301) 480-1845
E-mail: ods@nih.gov
Web site: http://ods.od.nih.gov

Office of Population Research, Princeton University
Wallace Hall
Princeton, NJ 08544
Phone: (609) 258-4870
Fax: (609) 258-1039
Web site: http://opr.princeton.edu

Office of Research on Women's Health
6707 Democracy Blvd. Suite 400
Bethesda, MD 20892-5484
Phone: (301) 402-1770
Fax: (301) 402-1798
E-mail: ODORWH-research@mail.nih.gov
Web site: http://orwh.od.nih.gov

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Office of the Special Assistant for Gulf War Illnesses
Force Health Protection & Readiness Policy & Programs Four Skyline Place, 5113 Leesburg Pike, Suite 901
Falls Church, VA 22041
Toll free: (800) 497-6261
Web site: http://www.gulflink.osd.mil

Oncolink, University of Pennsylvania Cancer Center
3400 Spruce Street 2 Donner
Philadelphia, PA 19104
Phone: (215) 349-8895
Fax: (215) 349-5445
E-mail: hampshire@uphs.upenn.edu
Web site: http://oncolink.org

Optician Association of America
678 Parkside Drive
Palatine, IL 60067
Phone: (847) 202-1411
Web site: http://www.eyewebmasters.com

Osteoporosis and Related Bone Diseases—National Resource Center
2 AMS Circle
Bethesda, MD 20892-3676
Phone: (202) 223-0344
Fax: (202) 293-2356
E-mail: NIAMSBoneInfo@mail.nih.gov
Web site: http://www.niams.nih.gov/Health_Info/bone/default.asp

P

Pain Connection
12320 Parklawn Drive
Rockville, MD 20852
Phone: (301) 231-0008
Fax: (301)231-6668
Web site: http://www.painconnection.org

Parents of Galactosemic Children
PO Box 2401
Mandeville, LA 70470-2401
Toll free: (866) 9007421
Web site: http://www.galactosemia.org

PATH
PO Box 900922
Seattle, WA 98109
Phone: (206) 285-3500
Fax: (206) 285-6619
E-mail: info@path.org
Web site: http://www.path.org

Pediatric/Adolescent Gastroesophageal Reflux Association
PO Box 7728
Silver Spring, MD 20907
Phone: (301) 601-9541
E-mail: gergroup@aol.com
Web site: http://www.reflux.org

Periodic Paralysis Association
155 West 68th St., Suite 17
New York, NY 10023
Phone: (407) 339-9499
Web site: http://www.periodicparalysis.org

Pilates Method Alliance
PO Box 370906
Miami, FL 33137-0906
Fax: (305) 573-4461
Toll free: (866) 573-4945
E-mail: info@pilatesmethodalliance.org
Web site: http://www.pilatesmethodalliance.org

Pituitary Network Association
PO Box 1958
Thousand Oaks, CA 91358
Phone: (805) 499-9973
Fax: (805) 480-0633
E-mail: info@pituitary.org
Web site: http://www.pituitary.org

Planned Parenthood Federation of America, Inc.
434 West 33rd St.
New York, NY 10001
Phone: (212) 541-7800
Fax: (212) 245-1845
Toll free: (800) 230-7526
Web site: http://search.plannedparenthood.org

Polio Survivors Association
12720 Lareina Ave.
Downey, CA 90242
Phone: (562) 862-4508
E-mail: info@polioassociation.org
Web site: http://polioassociation.org

Polycystic Ovarian Syndrome Association
PO Box 3403
Englewood, CO 80155-3403
E-mail: info@pcosupport.org
Web site: http://www.pcosupport.org

Post-Polio Health International (PHI)
4207 Lindell Blvd., Suite 110
St. Louis, MO 63108-2930
Phone: (314) 534-0475
Fax: (314) 534-5070
E-mail: info@post-polio.org
Web site: http://www.post-polio.org/

Prader-Willi Foundation
PO Box 222
Baldwinsville, NY 13027
Phone: (716) 276-2211
Toll free: (800) 442-1655
E-mail: alliance@prader-willi.org
Web site: http://www.prader-willi.org

Pregnancy and Infant Loss Support (SHARE)
402 Jackson Street
St. Charles, MO 63301
Phone: (636) 947-6164
Toll free: (800) 821-6819

Prevent Blindness America
211 West Wacker Drive, Suite 1700
Chicago, IL 60606
Toll free: (800) 331-2020
Web site: http://www.preventblindness.org

Prevent Child Abuse America
228 South Wabash Avenue 10th Floor
Chicago, IL 60604
Phone: (312) 663-3520
Fax: (312) 939-8962
E-mail: mailbox@preventchildabuse.org
Web site: http://www.preventchildabuse.org

Progeria Research Foundation
PO Box 3453
Peabody, MA 01961-3453
Phone: (978) 535-2594
Fax: (978) 535-5849
E-mail: info@progeriaresearch.org
Web site: http://www.progeriaresearch.org

Pulmonary Fibrosis Association
811 W Evergreen Avenue Suite 303
Chicago, IL 60642-2642
Toll free: (888) 733-6741
E-mail: info@pulmonaryfibrosis.org
Web site: http://www.pulmonaryfibrosis.org

Pulmonary Hypertension Association
801 Roeder Road, Ste. 1000
Silver Spring, MD 20910
Phone: (301) 565-3004
Fax: (301) 565-3994
Web site: http://www.phassociation.org

Q

Qigong Institute
617 Hawthorne Avenue
Los Altos, CA 94024
Web site: http://www.qigongsinstitute.or

R

Radiological Society of North America
820 Jorie Boulevard
Oak Brook, IL 60523-2251
Phone: (630) 571-2670
Fax: (630) 571-7837
Toll free: (800) 381-6660
Web site: radiologyinfo.org

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Rape, Abuse, and Incest National Network (RAINN)
2000 L Street NW, Suite 406
Washington, DC 20036
Phone: (202) 544-1034
Fax: (202) 544-3556
Toll free: (800) 656-HOPE (4673)
Web site: http://www.rainn.org/get-help/national-sexual-assault-online-hotline

Reflexology Association of America
PO Box 714
Chepachet, RI 02814
Phone: (980) 234-0159
Fax: (401) 568-6449
E-mail: InfoRAA@reflexology-usa.org
Web site: http://www.reflexology-usa.org

Rehabilitation International
25 East 21st Street, 4th floor
New York, NY 10010
Phone: (212) 420-1500
Fax: (212) 505-0871
E-mail: ri@riglobal.org
Web site: http://www.riglobal.org

Research to Prevent Blindness
645 Madison Ave., Floor 21
New York, NY 10022-1010
Fax: (212) 752-4333
Toll free: (800) 621-0026
E-mail: inforequest@rpbusa.org
Web site: http://www.rpbusa.org

Retinoblastoma International
18030 Brookhurst Street, Box 408
Fountain Valley, CA 92708
E-mail: info@retinoblastoma.net
Web site: http://www.retinoblastoma.net

Rocky Mountain Institute of Yoga and Ayurveda
PO Box 1091
Boulder, CO 80306
Phone: (303) 443-6923
E-mail: info@rmiya.org
Web site: http://www.rmiya.org

Rolf Institute of Structural Integration
5055 Chaparral Ct. Suite 103
Boulder, CO 80301
Phone: (303) 449-5903
Fax: (303) 449-5978
Toll free: (800) 530-8875
Web site: http://www.rolf.org

S

SDS/MSA Support Group
8311 Brier Creek Parkway, Suite 105-434
Raleigh, NC 27617
Toll free: (866) 737-5999
E-mail: vjames@shy-drager.org
Web site: http://www.shy-drager.org

Second Wind Lung Transplant Association
3440 Halliday Ave.
St. Louis, MO 63118-1102
Toll free: (888) 855-9463
Web site: http://www.2ndwind.org

Self Help for Hard of Hearing People, Inc.
7910 Woodmont Ave., Suite 1200
Bethesda, MD 20814
Phone: (301) 657-2248
Web site: http://www.shhh.org

Sexuality Information and Education Council of the U.S.
90 John St. Suite 402
New York, NY 10038
Phone: (212) 819-9770
Fax: (212) 819-9776
E-mail: pmalone@siecus.org
Web site: http://www.siecus.org

Shriners Hospitals for Children
2900 Rocky Point Drive
Tampa, FL 33607
Phone: (813) 281-0300
Web site: http://www.shrinershq.org/Hospitals/Main

Shyness Research Institute
4201 Grant Line Rd.
New Albany, IN 47150
Phone: (812) 941-2295
Fax: (812) 941-2591
E-mail: bcarducc@ius.edu
Web site: http://homepages.ius.edu

Sickle Cell Disease Association of America, Inc.
231 East Baltimore Street, STE 800
Baltimore, MD 21202
Phone: (800) 421-8453
Toll free: (800) 421-8453
E-mail: scdaa@sicklecelldisease.org
Web site: http://sicklecelldisease.org

Simon Foundation for Continence
Post Office Box 815
Wilmette, IL 60091
Toll free: (800) 2237-4666
Web site: http://www.simonfoundation.org

Skin Cancer Foundation
149 Madison Avenue Suite 901
New York, NY 10016
Phone: (212) 725-5176
Web site: http://www.skincancer.org

Smell and Taste Center, University of Pennsylvania
5 Ravdin Pavilion 3400 Spruce Street
Philadelphia, PA 19104-4283
Phone: (215) 662-6580
Fax: (215) 349-5266
E-mail: Geraldine.Fischer@uphs.upenn.edu
Web site: http://www.med.upenn.edu

Society for Clinical and Experimental Hypnosis
728 Old McLean Village Drive
McLean, VA 22101

Society of Interventional Radiology
3975 Fair Ridge Drive, Suite 400 North
Fairfax, VA 22033
Phone: (703) 691-1805
Fax: (703) 691-1855
Toll free: (800) 488-7284
Web site: http://www.sirweb.org

Society for Light Treatment and Biological Rhythms
PO Box 591687, 174 Cook St
San Francisco, CA 94159-1687
Web site: http://www.sltbr.org

Society for Mucopolysaccharide Diseases
MPS House, Repton Place, White Lion Road, Amersham
Buckinghamshire
UK HP7 9LP
Phone: 44 0 (845) 389-9901
E-mail: mps@mpssociety.co.uk
Web site: http://www.mpssociety.co.uk

Society of Neuro-Lingustic Programming
7065 Bella Vista Road
Vernon
Canada BC, V1H 1X3
Phone: (250) 545-6448
E-mail: access@nlpmind.com
Web site: http://www.nlpmind.com/contact

Society of Nuclear Medicine (SNM)
1850 Samuel Morse Dr.
Reston, VA 20190
Phone: (703) 708-9000
Fax: (703) 708-9015
Web site: http://www.snm.org

Society for Progressive Supranuclear Palsy, Inc.
Suite #5065 Johns Hopkins Outpatient Center, 601 N. Caroline St.
Baltimore, MD 21287
Toll free: (800) 457-4777
Web site: http://www.psp.org

Society for Thermal Medicine
PO Box 1897
Lawrence, KS 66044-1897
Fax: (785) 843-1274
Toll free: (800) 627-0326
E-mail: stm@ allenpress.com
Web site: http://www.thermaltherapy.org

Society for Vascular Surgery
633 North Saint Clair Street, 22nd Floor

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Chicago, IL 60611
Phone: (312) 334-2300
Fax: (312) 334-2320
Toll free: (800) 258-7188
E-mail: vascular@vascularsociety.org
Web site: http://www.vascularweb.org

Society for Women's Health Research
1025 Connecticut Ave., NWSuite 701
Washington, DC 20036
Phone: (202) 223-8224
Fax: (202) 833-3472
E-mail: info@swhr.org
Web site: http://www.womenshealthresearch.org

Spinal Cord Injuries Australia
1 Jennifer Street
Little Bay
Australia NSW 2036
Toll free: (800) 819-775
E-mail: office@scia.org.au
Web site: http://www.scia.org.au

SPOHNC, Support for People with Oral and Head and Neck Cancer
PO Box 53
Locust Valley, NY 11560-0053
Fax: (516) 671-8794
Toll free: (800) 377-0928
E-mail: info@spohnc.org
Web site: http://www.spohnc.org

Spondylitis Association of America
PO Box 5872
Sherman Oaks, CA 91413
Phone: (818) 892-1616
Fax: (818) 892-1611
Web site: http://www.spondylitis.org

Starkey Hearing Foundation
6700 Washington Ave South
Eden Prairie, MN 55344
Toll free: (866) 354-3254
Web site: http://www.starkeyhearingfoundation.org

Substance Abuse Treatment Referral Hotline
PO Box 2345
Rockville, MD 20847-2345
Toll free: (800) 662-HELP (4357)
Web site: http://www.samhsa.gov

Sudden Arrhythmia Death Syndromes Foundation
508 E. South Temple, Suite #20
Salt Lake City, UT 84102
Toll free: (800) 786-7723
Web site: http://www.sads.org

Support Organization for Trisomy 18, 13, and Related Disorders (SOFT)
2982 South Union Street
Rochester, NY 14624
Phone: (585) 594-4621
Toll free: (800) 716-7638
E-mail: barbsoft@rochester.rr.com
Web site: http://www.trisomy.org

Support Organization for Trisomy in Australia (SOFT Australia)
198 Oak Road
Kirrawee
Australia NSW 2232
Phone: 02 Phone: 9521-6031
E-mail: SOFTAus@optushome.com.au
Web site: http://www.members.optushome.com.au/softaus

T

Texas Heart Institute, Heart Information Service
MC 3-116, PO Box 20345
Houston, TX 77225
Phone: (832) 355-4011
Toll free: (800) 292-2221
Web site: http://www.texasheart.org

Thyroid, Head, and Neck Cancer Foundation
10 Union Square East, Suite 5B
New York, NY 10003
Phone: (212) 844-6832
Fax: (212) 844-8465
E-mail: info@thancfoundation.org
Web site: http://www.thancfoundation.org

Traditional Chinese Medicine Association and Alumni, Inc. (TCMAA)
108-A East 38th Street
New York, NY 10016
Phone: (212) 889-4802
Fax: (643) 309-7633
E-mail: peng8@verizon.net
Web site: http://www.tcmaa.org/

Tragedy Assistance Program for Survivors, Inc. (TAPS)
National Headquarters, 1777 F Street NW, Suite 600
Washington, DC 20006
Phone: (202) 588-TAPS (8277)
Fax: (202) 509-8282
Toll free: (800) 959-TAPS (8277)
E-mail: info@taps.org
Web site: Http://ww.taps.org

Trans-Hyperboreau Institute of Science
PO Box 2344
Sausalito, CA 94966
Phone: (415) 331-0230
Fax: (415) 331-0231
Toll free: (800) 485-8095.

Transverse Myelitis Association
1787 Sutter Parkway
Powell, OH 43065-8806
Phone: (614) 766-1806
E-mail: ssiegel@myelitis.org
Web site: http://www.myelitis.org

Trigeminal Neuralgia Association
925 NW 56th Terrace, Suite C
Gainesville, FL 32605-6402
Toll free: (800) 923-3608
Web site: http://www.fpa-support.org

Turner Syndrome Society of England
13 Simpson Court, 11 South Ave,
Clydebank Business Park
Clydebank
Scotland G81 2NR
Phone: 0141 952-8006
Web site: http://www.tss. org.uk

U

Undersea and Hyperbaric Medical Society
21 West Colony Place, Suite 280
Durham, NC 27705
Phone: (919) 490-5140
Fax: (919) 490-5149
Toll free: (877) 533-UHMS (8467)
E-mail: uhms@uhms.org
Web site: http://www.uhms.org

United Network for Organ Sharing (UNOS)
700 N. 4th Street; PO Box 2484
Richmond, VA 23218
Phone: (804) 782-4800
Fax: (804) 782-4817
Toll free: (888) 894-6361
Web site: http://www.unos.org

United Ostomy Association, Inc. (UOA)
PO Box 512
Northfield, MN 55057-0512
Toll free: (800) 826-0826
E-mail: info@ostomy.org
Web site: http://www.ostomy.org

United States Drug Enforcement Administration
Dr Mailstop: AXS, 2401 Jefferson Davis Highway
Alexandria, VA 22301
Phone: (202) 307-1000
Web site: http://www.dea.gov

United States Food and Drug Administration (FDA)
10903 New Hampshire Ave.
Silver Spring, MD 02993-0002
Toll free: (888) 463-6332
Web site: http://www.fda.gov

United States Food and Drug Administration, Office of Women's Health
10903 New Hampshire Avenue
WO32-2333
Silver Spring, MD 20993
Phone: (301) 796-9440
Fax: (301) 847-8604
Web site: http://www.fda.gov/ForConsumers/byAudience/ForWomen

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United States National Library of Medicine
8600 Rockville Pike
Bethesda, MD 0894, 20894
Toll free: (888) 346-3656
Web site: http://www.nlm.nih.gov

United States Pilates Association
1500 East Broward Blvd. Suite 250
Ft. Lauderdale, FL 33301
Toll free: (888) 484-8772
E-mail: info@unitedstatespilatesassociation.com
Web site: http://www.unitedstatespilatesassociation.com

United States Renal Data System (USRDS)
914 South 8th Street, Suite S-206
Minneapolis, MN 55404
Phone: (612) 347-7776
Toll free: (888) 997-7737
E-mail: usrds@usrds.org
Web site: http://www.usrds.org/

United States Trager Association
13801 West Center Street, Suite C; PO Box 1009
Burton, OH 44021
Phone: (404) 834-0308
Fax: (440) 834-0365
Web site: http://www.tragerus.org

University of California, Los Angeles Harbor-UCLA Medical Center Research and Education Institute
1124 W Carson St., B-4
South Torrance, CA 90502

University of Washington PKU Clinic
CHDD, Box 357920, University of Washington
Seattle, WA 98195
Phone: (206) 685-3015
Web site: http://depts.washington.edu/pku/contact.html

Upledger Institute
11211 Prosperity Farms Rd., Suite D-325
Palm Beach Gardens, FL 33410
Phone: (561) 622-4334
Fax: (561) 622-4771
Toll free: (800) 233-5880
E-mail: upledger@upledger.com
Web site: http://www.upledger.com/

V

Vascular Birthmarks Foundation
PO Box 106
Latham, NY 12110
Toll free: (877) VBF-4646
E-mail: hvbf@aol.com
Web site: http://www.birthmark.org

Vasculitis Foundation
PO Box 28660
Kansas City, MO 64188
Toll free: (800) 277-9474
Web site: http://www.vasculitisfoundation.org/wegenersgranulomatosis

Velo-Cardio-Facial Syndrome Educational Foundation, Inc.
PO Box 874
Milltown, NJ 08850
Phone: (214) 360-4740
E-mail: info@vcfsef.org
Web site: http://www.vcfsef.org/

Vestibular Disorders Association (VEDA)
PO Box 4467
Portland, OR 97208-4467
Fax: (503) 229-8064
Toll free: (800) 837-8428
Web site: http://www.vestibular.og

Veterans Administration, Persian Gulf Medical Information Helpline
400 South 18th Street
St. Louis, MO 63103-2271
Web site: http://www.publichealth.va.gov/exposures/gulfwar

Vitiligo Support International
PO Box 4008
Valley Village, CA 91617-0008
Phone: (818) 752-9002
Web site: http://www.vitiligosupport.org

The Voice Center at Eastern Virginia Medical School
PO Box 1980
Norfolk, VA 23501-1980
Phone: (757) 446-7360
Web site: http://www.evms.edu/evms

W

Weight-control Information Network
1 WIN Way
Bethesda, MD 20892-3665
Fax: (202) 828-1028
Toll free: (877) 946-4627
E-mail: win@info.niddk.nih.gov
Web site: http://win.niddk.nih.gov

Wilderness Medical Society
2150 S. 1300 Suite 500
Salt Lake City, UT 84106
Phone: (801) 990-2988
E-mail: wms@wms.org
Web site: http://www.wms.org

Wilson Disease Association
5572 N. Diversey Blvd
Milwaukee, WI 53217
Phone: (414) 961-0533
Toll free: (866) 961-0533
E-mail: info@wilsonsdisease.org
Web site: http://www.wilsonsdisease.org

World Health Organization (WHO)
Avenue Appia 20 1211
Geneva
Switzerland 27
Phone: 41 22 791-2111
E-mail: info@who.int
Web site: http://www.who.int

World Hypnosis Organization, Inc
2521 W. Montrose Avenue
Chicago, IL 60618
Phone: (773) 267-6677
E-mail: copal@anet-chi.com
Web site: http://www.worldhypnosis.org

Worldwide Education and Awareness for Movement Disorders
204 W. 84th St.
New York, NY 10024
E-mail: wemove@wemove.org
Web site: http://www.wemove.org

Wound Care Institute
1100 NE 163rd Street, Suite #101
North Miami Beach, FL 33162
E-mail: FishmanTamara@hotmail.com
Web site: http://www.woundcare.org

Wound Healing Society
341 N. Maitland Ave., Suite 130
Maitland, FL 32751
Phone: (407) 647-8839
E-mail: info@woundheal.org
Web site: http://www.woundheal.org

Wound Ostomy and Continence Nurses Society
15000 Commerce Parkway, Suite C
Mt. Laurel, NJ 08054
Toll free: (888) 224-9626
Web site: http://www.wocn.org

Wright State University, Division of Aerospace Medicine
3640 Col. Glenn Highway
Dayton, OH 45435
Phone: (937) 7751400
Fax: (937) 775-1403
E-mail: betty.somers@wright.edu
Web site: http://www.med.wright.edu/asm

Y

Yoga Alliance
1701 Clarendon Boulevard, Suite 110
Arlington, VA 22209
Fax: (571) 482-3336
Toll free: (888) 921-9642
Web site: http://www.yogaalliance.org/

Yoga Science Foundation
10336 Loch Lomond Road No. 221
Middletown, CA 95461
Web site: http://www.yrec.org

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GLOSSARY

The following is an alphabetical compilation of terms and definitions listed in the *Key Terms* section of the main body entries. Although the list is comprehensive, it is by no means exhaustive.

25–HYDROXY–VITAMIN D. The form of vitamin D that is measured in order to assess vitamin D deficiency.

A

AADC INHIBITORS. Drugs that block the amino acid decarboxylase; one type of enzyme that breaks down dopamine. Also called DC inhibitors, they include carbidopa and benserazide.

ABDOMINAL AORTIC ANEURYSM. Occurs when an area in the aorta (the main artery of the heart) is weakened and bulges like a balloon. The abdominal section of the aorta supplies blood to the lower body.

ABDOMINAL DISTENSION. Swelling of the abdominal cavity, which creates painful pressure on the internal organs.

ABDOMINAL MIGRAINE. A variant form of a migraine headache; moderate to severe midline abdominal pain, usually occurring in children with a family history of migraine.

ABLATION. The removal of abnormal tissue growths by surgery.

ABLATIVE. Used to describe a procedure involving removal of a tissue or body part, or destruction of its funtion.

ABO ANTIGEN. Protein molecules located on the surfaces of red blood cells that determine a person's blood type: A, B, or O.

ABO BLOOD GROUPS. A system in which human blood is classified according to the A and B antigens found in red blood cells. Type A blood has the A antigen, type B has the B antigen, AB has both, and O has neither.

ABO BLOOD TYPE. Blood type based on the presence or absence of the A and B antigens on the red blood cells.

ABORTIVE. Referring to treatment that relieves symptoms of a disorder.

ABRASION. An area of the body whose surface has been worn away by some abnormal process.

ABROVIRUS VIRUSES. Also known as arthropod-borne viruses, these viruses are maintained in nature through biological transmission between vertebrate hosts and blood-feeding arthropods. Infection occurs when an infected arthropod, such as a mosquito, feeds off a vertebrate, such as a human.

ABSCESS. A collection of pus buried deep in the tissues or in a body cavity.

ABSORPTION. The transfer of a vitamin from the digestive tract to the bloodstream.

ABSORPTION SPECTROMETRY. A scientific procedure to determine chemical makeup of samples.

ABSTINENCE. Refraining from the use of alcoholic beverages.

ABUTMENT TOOTH. A crowned tooth that stabilizes a bridge or partial denture.

ACALCULOUS CHOLECYSTITIS. Inflammation of the gallbladder that occurs without the presence of gallstones.

ACAMPROSATE. An anti–craving medication used in Europe to reduce the craving for alcohol. It is presently undergoing tests for approval in the United States.

ACANTHOSIS NIGRICANS. A dark brownish or blackish discoloration of the skin related to overweight and high levels of insulin in the blood. Acanthosis nigricans is most likely to develop in the groin or armpits, or around the back of the neck.

ACCESS. The point where a needle or catheter is inserted for dialysis.

ACCESS SITE. The vein tapped for vascular access in hemodialysis treatments. For patients with temporary

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treatment needs, access to the bloodstream is gained by inserting a catheter into the subclavian vein near the patient's collarbone. Patients in long-term dialysis require stronger, more durable access sites, called fistulas or grafts, that are surgically created.

ACCESSORY ORGAN. A lump of tissue adjacent to an organ that is similar to it, but which serves no important purpose, if functional at all. While not necessarily harmful, such organs can cause problems if they grow too large or become cancerous. In any case, their presence points to an underlying abnormality in the parent organ.

ACCOMMODATION. The ability of the eye to change its focus from near to distant objects.

ACETABULUM. The large cup-shaped cavity at the junction of pelvis and femur or thigh bone.

ACETAMINOPHEN. A drug for relieving pain and fever. Tylenol is the most common example.

ACETYLCHOLINE. A neurotransmitter with effects that are generally opposite those of dopamine and norepinephrine. Acetylcholine dilates blood vessels, lowers blood pressure, and slows heartbeat.

ACETYLCHOLINESTERASE. An enzyme that breaks down acetylcholine.

ACHALASIA. Failure of the lower end of the esophagus (or another tubular valve) to open, resulting in obstruction, either partial or complete.

ACHLORHYDRIA. An abnormal condition in which hydrochloric acid is absent from the secretions of the gastric glands in the stomach.

ACHROMATOPSIA. The inability to distinguish any colors.

ACID. Common street name for LSD.

ACID INDIGESTION. Stomach discomfort that results from too much acid in the stomach.

ACID-BASE BALANCE. A balance of acidity and alkalinity of fluids in the body that keeps the pH level of blood around 7.35–7.45.

ACID-FAST STAIN. A special stain done to microscopically identify the bacteria that cause tuberculosis.

ACIDOPHILUS. The bacteria *Lactobacillus acidophilus* usually found in yogurt.

ACIDOSIS. A disturbance of the balance of acid to base in the body causing an accumulation of acid or loss of alkali (base). There are two types of acidosis: metabolic and respiratory. One of the most common causes of metabolic acidosis is an overdose of aspirin. Respiratory acidosis is caused by impaired breathing caused by conditions such as severe chronic bronchitis, bronchial asthma, or airway obstruction.

ACINAR CELL CARCINOMA. A malignant tumor arising from the acinar cells of the pancreas.

ACNE. A chronic inflammation of the sebaceous glands that manifests as blackheads, whiteheads, and/or pustules on the face or trunk.

ACOUSTIC NEUROMA. A benign tumor that grows on the nerve leading from the inner ear to the brain. As the tumor grows, it exerts pressure on the inner ear and causes severe vertigo.

ACQUIRED IMMUNE DEFICIENCY SYNDROME (AIDS). HIV infection that has led to certain opportunistic infections, cancers, or a CD4+ T-lymphocyte (helper cell) blood cell count lower than 200/mL.

ACROCYANOSIS. A slight cyanosis, or blueness of the hands and feet of the neonate is considered normal. This impaired ability to fully oxygenate the extremities is due to an immature circulatory system which is still in flux.

ACROMEGALY. A rare disease resulting from excessive growth hormone caused by a benign tumor. If such a tumor develops within the first 10 years of life, the result is gigantism (in which growth is accelerated) and not acromegaly. Symptoms include coarsening of the facial features, enlargement of the hands, feet, ears, and nose, jutting of the jaw, and a long face.

ACTH. Adrenocorticotropic hormone, a hormone normally produced by the pituitary gland, sometimes taken as a treatment for arthritis and other disorders.

ACTINIC KERATOSIS (PLURAL, KERATOSES). A type of precancerous skin growth with a scaly or bumpy surface caused by overexposure to the sun.

ACTIVATED PARTIAL THROMBOPLASTIN TIME. Partial thromboplastin time test that uses activators to shorten the clotting time, making it more useful for heparin monitoring.

ACTIVE IMMUNIZATION. Treatment that provides immunity by challenging an individual's own immune system to produce antibody against a particular organism, in this case the rabies virus.

ACTIVE TREATMENT STAGE. The period during which orthodontic appliances or braces are used.

ACTIVITIES OF DAILY LIVING (ADL). The skills and practices that determine how well individuals function

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in their daily lives and relate to and participate in their environment.

ACUPOINT. A pressure point stimulated in acupressure.

ACUPRESSURE. A form of acupuncture in which certain points of the body are pressed with the fingers and hands to release energy blocks.

ACUPUNCTURE. A treatment technique associated with traditional Chinese medicine, in which thin needles are inserted into specific points located along energy channels in the human body known as meridians.

ACUTE. Having a sudden onset and lasting a short time.

ACUTE INTERMITTENT PORPHYRIA. An inherited disease affecting the liver and bone marrow. The liver overproduces a specific acid and the disease is characterized by attacks of high blood pressure, abdominal colic, psychosis, and nervous system disorders.

ACUTE LYMPHOBLASTIC LEUKEMIA (ALL). A type of leukemia, also called acute lymphocytic leukemia, primarily in children, affecting lymphocytes.

ACUTE OTITIS MEDIA. Inflammation of the middle ear with signs of infection lasting less than three months.

ACUTE PAIN. Pain in response to injury or another stimulus that resolves when the injury heals or the stimulus is removed.

ACUTE PHASE REACTANT. A substance in the blood that increases as a response to an acute condition such as infection, injury, tissue destruction, some cancers, burns, surgery, or trauma.

ACUTE PRESCRIBING. Homeopathic treatment for self-limiting illnesses with abrupt onset.

ACUTE RENAL (KIDNEY) FAILURE. Abrupt loss of kidney function.

ACUTE RESPIRATORY DISTRESS SYNDROME. A serious reaction to various forms of injuries to the lung, which is characterized by inflammation of the lung, leading to impaired gas exchange and release of inflammatory mediators causing inflammation and low blood oxygen and frequently resulting in multiple organ failure. This condition is life threatening and often lethal, usually requiring mechanical ventilation and admission to an intensive care unit.

ACUTE RETROVIRAL SYNDROME (ARS). A syndrome that develops in about 30% of HIV patients within a few weeks of infection. ARS is characterized by nausea, vomiting, fever, headache, general tiredness, and muscle cramps.

ACYCLOVIR. An antiviral drug used for combating chickenpox and other herpes viruses.

ADDICTION. The state of being both physically and psychologically dependent on a substance or activity.

ADDICTIVE PERSONALITY. The concept that addiction is the result of pre-existing character defects.

ADDISON'S DISEASE. A disease characterized by a deficiency in adrenocortical hormones due to destruction of the adrenal gland.

ADENOCARCINOMA. Malignant cancers that originate in the tissues of glands or that form glandular structures.

ADENOCARCINOMA. Type of cancer beginning in glandular epithelium.

ADENOIDS. Common name for the pharyngeal tonsils, which are lymph masses in the wall of the air passageway (pharynx) just behind the nose.

ADENOMA. A type of noncancerous (benign) tumor that often involves the overgrowth of certain cells of the type normally found within glands.

ADENOMYOSIS. Uterine thickening caused when endometrial tissue, which normally lines the uterus, extends outward into the fibrous and muscular tissue of the uterus.

ADENOSINE. A nucleoside that plays multiple physiological roles in energy transfer and molecular signaling, as a component of RNA, and as an inhibitory neurotransmitter that promotes sleep.

ADENOSINE DEAMINASE (ADA). An enzyme that is lacking in a specific type of SCID. Children with an ADA deficiency have low levels of both B and T cells.

ADENOVIRUS. A virus that affects the upper respiratory tract.

ADHD. Attention deficit hyperactivity disorder; a disorder characterized by a persistent pattern of inattention and/or hyperactivity.

ADHESION. The joining or sticking together of parts of an organ that are not normally joined together.

ADIPOSE TISSUE. Fat tissue.

ADJUNCTIVE. Refers to a form of treatment that is not strictly necessary to a therapy regimen but is helpful. Music therapy is an example of an adjunctive form of treatment.

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ADJUSTMENT. A specific type of manipulation of the spine designed to return it to proper structural and functional form.

ADJUSTMENT DISORDER. A disorder defined by the development of significant emotional or behavioral symptoms in response to a stressful event or series of events within the normal range of human experience.

ADJUVANT. A substance added to a vaccine to increase the immune system's response to the vaccine contents.

ADJUVANT CHEMOTHERAPY. Treatment of the tumor with drugs after surgery to kill as many of the remaining cancer cells as possible.

ADJUVANT THERAPY. Treatment involving radiation, chemotherapy (drug treatment), hormone therapy, biotherapeutics, or a combination of any of these given after the primary treatment in order to rid the body of residual microscopic cancer.

ADRENAL CORTEX. The outer tissue of the adrenal gland. It produces a group of chemically related hormones called corticosteroids that control mineral and water balance in the body and include aldosterone and cortisol.

ADRENAL GLAND. An endocrine gland located above each kidney. The inner part of each gland secretes epinephrine (adrenaline) and the outer part secretes steroid hormones.

ADRENAL MEDULLA. The inner part of the adrenal gland. The adrenal medulla produces the hormones epinephrine (adrenaline), which stimulates the heart, tightens blood vessels, and relaxes some smooth muscles; and norepinephrine, which has similar effects.

ADRENALS. Glands on top of the kidneys that produce four different types of hormones.

ADRENERGIC. Refers to neurons (nerve cells) that use catecholamines as neurotransmitters at a synapse.

ADRENERGIC RECEPTOR. There are three families of adrenergic receptors, alpha$_1$, alpha$_2$ and beta, and each family contains three distinct subtypes. Each of the nine subtypes are coded by separate genes, and display specific drug specificities and regulatory properties.

ADRENOCORTICOTROPIC HORMONE (ACTH). A pituitary hormone that stimulates the cortex of the adrenal glands to produce adrenal cortical hormones.

ADRENOCORTICOTROPIN (CORTICOTROPHIN). A hormone that acts on cells of the adrenal cortex, causing them to produce male sex hormones and hormones that control water and mineral balance in the body.

ADSORPTION. A process that occurs when molecules of a liquid or gas cling to the surface of a solid.

ADVANCED BREAST BIOPSY INSTRUMENT (ABBI). Uses a rotating circular knife and thin heated electrical wire to remove a large cylinder of abnormal breast tissue.

AEROBIC BACTERIA. Bacteria that require oxygen in order to grow and survive.

AEROBIC EXERCISE. Any exercise that increases the body's oxygen consumption and improves the functioning of the cardiovascular and respiratory systems.

AEROSOLS. Sprays that contain propellants and solvents, including many household products.

AFFECT. An observed emotional expression or response.

AFFECTIVE DISORDER. An emotional disorder involving abnormal highs and/or lows in mood.

AFFECTIVE FLATTENING. A loss or lack of emotional expressiveness. It is sometimes called blunted or restricted affect.

AFFERENT. Refers to peripheral nerves that transmit signals to the spinal cord and the brain. These nerves carry out sensory function.

AFLATOXINS. A group of naturally occurring toxins produced by fungi of the genus *Aspergillus*.

AFP (ALPHA-FETOPROTEIN). A tumor marker associated with liver, testicular, and ovarian cancer.

AFRICAN ENDEMIC KAPOSI'S SARCOMA. A form of KS that affects men and boys and that can appear like classic KS or in a more lethal form.

AGAMMAGLOBULINEMIA. The lack of gamma globulins in the blood. Antibodies are the main gamma globulins of interest, so this term means a lack of antibodies.

AGAR. A gel made from red algae that is used to culture certain disease agents in the laboratory.

AGAVE NECTAR. A sweetener produced commercially in Mexico from the leaves of the agave, a succulent plant with thick fleshy leaves.

AGE-RELATED MACULAR DEGENERATION (ARMD). Degeneration of the macula (the central part of the retina where the rods and cones are most dense) that leads to loss of central vision in people over 60 years of age.

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AGGLUTININ. An antibody that causes particulate antigens such as bacteria or other cells to clump together.

AGGRAVATED SEXUAL ABUSE. When an individual is forced to submit to sexual acts by use of physical force; threats of death, injury, or kidnapping; or substances that render that individual unconscious or impaired.

AGGREGATION. The blood cell clumping process that is measured in the platelet aggregation test.

AGITATION. Excessive restlessness or emotional disturbance that is often associated with anxiety or psychosis; common in middle-stage AD.

AGNOSIA. The inability to recognize familiar people, places, and objects.

AGONIST. A chemical that is added to the blood sample in the platelet aggregation test to stimulate the clumping process.

AGORAPHOBIA. An intense fear of being trapped in a crowded, open, or public space where it may be hard to escape, combined with the dread of having a panic attack.

AGRANULOCYTOSIS. An acute condition marked by severe depression of the bone marrow, which produces white blood cells, and by prostration, chills, swollen neck, and sore throat sometimes with local ulceration. Aalso called agranulocytic angina or granulocytopenia.

AIDS. Acquired immune deficiency syndrome. A disease caused by infection with the human immunodeficiency virus (HIV). In people with this disease, the immune system breaks down, increasing vulnerability to other infections and some types of cancer.

AIDS DEMENTIA COMPLEX. A type of brain dysfunction caused by HIV infection that causes difficulty thinking, confusion, and loss of muscular coordination.

AIDS–RELATED KAPOSI'S SARCOMA. A form of KS that emerged as one of the first illnesses associated with AIDS patients. Tumors usually appear on the upper body, the soft palate and gum areas, and, as the disease advances, in the lymph nodes, stomach, intestines, and lungs.

AKATHISIA. Agitated or restless movement, usually affecting the legs and accompanied by a sense of discomfort. It is a common side effect of neuroleptic medications.

ALBINISM. A genetic disease characterized by the absence of the normal skin pigment, melanin.

ALBINO. A person or animal lacking normal coloring in the eyes, hair, and skin due to a hereditary inability to produce the skin pigment melanin. The condition itself is called albinism.

ALBUMIN. A blood protein that is made in the liver and helps to regulate water movement in the body.

ALCOHOL USE DISORDERS INVENTORY TEST (AUDIT). A test for alcohol use developed by the World Health Organization (WHO). Its ten questions address three specific areas of drinking over a 12–month period: the amount and frequency of drinking, dependence upon alcohol, and problems that have been encountered due to drinking alcohol.

ALDOLASE. An enzyme, found primarily in the muscle, that helps convert sugar into energy.

ALDOLASE B. Also called fructose 1-phosphate aldolase, this chemical is produced in the liver, kidneys, and brain. It is needed for the breakdown of fructose, a sugar found in fruits, vegetables, honey, and other sweeteners.

ALDOSTERONE. A hormone produced in the cortex of the adrenal gland that increases the reabsorption of sodium and water and the release of potassium in the kidneys.

ALDOSTERONISM. A condition defined by high serum levels of aldosterone, a hormone secreted by the adrenal gland that is responsible for increasing sodium reabsorption in the kidneys.

ALEXANDER TECHNIQUE. A technique developed by Frederick Alexander that focuses on the variations in body posture, muscles, and breathing. Defects in these functions can lead to stress, nervous tension or possible loss of function.

ALGAE. Plants that have one cell.

ALKALINE. A solution is considered alkaline if it contains fewer hydrogen atoms than pure water.

ALKALINE PHOSPHATASE. An enzyme found throughout the body, primarily in liver, bone, placenta, and intestine.

ALKALOID. A bitter organic base, such as caffeine or morphine, that contains nitrogen and usually oxygen, often occurs in plant seeds, and usually has physiological activity.

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ALKALOSIS. A condition of the blood and other body fluids in which bicarbonate levels are higher than normal.

ALKYLATING AGENT. A chemical that alters the composition of the genetic material of rapidly dividing cells, such as cancer cells, causing selective cell death; used as a chemotherapeutic agent to treat B-CLL.

ALLERGEN. A foreign substance, such as mites in house dust or animal dander which, when inhaled, causes the airways to narrow and produces symptoms of asthma.

ALLERGENIC. Acting as an allergen or inducing an allergic response.

ALLERGIC REACTION. An immune system reaction to a substance in the environment; symptoms include rash, inflammation, sneezing, itchy watery eyes, and runny nose.

ALLERGIC RHINITIS. Inflammation of the mucous membranes of the nose and eyes in response to an allergen. Hay fever is seasonal allergic rhinitis.

ALLERGY. Altered body reaction, usually hypersensitivity, as a response to exposure to a specific substance.

ALLEVIATE. To make something easier to be endured.

ALLOGENEIC. Referring to bone marrow transplants between two different, genetically dissimilar people.

ALLOGRAFT. Tissue that is taken from one person's body and grafted to another person.

ALLOPATHIC. Pertaining to conventional medical treatment of disease symptoms that uses substances or techniques to oppose or suppress the symptoms.

ALLOPATHY. Conventional medical treatment of disease symptoms that uses substances or techniques to oppose or suppress the symptoms.

ALLOPURINOL. A drug that corrects hyperuricemia by inhibiting urate production.

ALOE VERA. An extract from the plant *Aloe barbadensis* that is used in skin creams and for treating burns.

ALOPECIA. The medical term for baldness.

ALPHA BLOCKERS. Medications that bind alpha adrenergic receptors and decrease the workload of the heart and lower blood pressure. They are commonly used to treat hypertension, peripheral vascular disease, and hyperplasia.

ALPHA-2 AGONIST. A class of drugs that bind to and stimulate alpha-2 adrenergic receptors, causing responses similar to those of adrenaline and noradrenaline, by inhibiting aqueous humor production.

ALPHA-FETOPROTEIN. A substance produced by a fetus' liver that can be found in the amniotic fluid and in the mother's blood. Abnormally high levels of this substance suggests there may be defects in the fetal neural tube, a structure that will include the brain and spinal cord when completely developed. Abnormally low levels suggest the possibility of Down' syndrome.

ALPHA-FETOPROTEIN TEST. A blood test that can be done after the sixteenth week of pregnancy to evaluate the possibility of spina bifida and other birth defects in the fetus.

ALPHA-INTERFERON. A natural body substance that now can be made in large quantities and is an effective treatment for some types of viral inflammatory disease, including hepatitis C.

ALPHA-THALASSEMIA. An inherited disorder that interferes with the normal production of hemoglobin.

ALPROSTADIL. A smooth muscle relaxant sometimes injected into the penis or applied to the urethral opening to treat impotence.

ALTER. An alternate or secondary personality in a patient with Dissociative Identity Disorder (DID).

ALTERNATING CURRENT (AC). An electric current in which the flow of the electric charge periodically reverses direction. AC is the form in which electricity is usually delivered to homes. The usual household wall outlet (120 volts) provides a current with 120 reversals of the direction of flow occurring each second and is termed 60-cycle alternating current.

ALTERNATIVE THERAPY. A therapy is generally called alternative when it is used instead of conventional treatments.

ALTITUDE SICKNESS. A set of symptoms that people who normally live at low altitudes may have when they travel to high altitudes. The symptoms include nosebleed, nausea, and shortness of breath.

ALVARADO SCORE. A ten-point scoring system used by doctors to evaluate the likelihood that a patient has acute appendicitis.

ALVEOLI (SINGULAR, ALVEOLUS). Small spherical sacs at the ends of the bronchioles in the lungs in which blood gases are exchanged.

ALYKYLATING DRUG. A drug that kills cells by directly damaging DNA.

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ALZHEIMER'S DISEASE. A progressive, neurodegenerative disease characterized by loss of function and death of nerve cells in several areas of the brain, leading to loss of mental functions such as memory and learning.

AMALGAM. A mixture of metals, primarily mercury used to make large, durable fillings. Also called silver fillings.

AMBIENT. Surrounding.

AMBLYOPIA. Decreased visual acuity, usually in one eye, in the absence of any structural abnormality in the eye; often called lazy eye.

AMBULATION. Moving from place to place.

AMBULATORY MONITORING. ECG recording over a prolonged period during which the patient can move around.

AMEBIASIS. An infection caused by an ameba, which is a type of protozoan.

AMEBOMA. A mass of tissue that can develop on the wall of the colon in response to amebic infection.

AMENORRHEA. Abnormal cessation of menstruation.

AMINO ACID. An organic compound composed of both an amino group and an acidic carboxyl group; amino acids are the basic building blocks of proteins.

AMINOACIDURIA. The abnormal presence of amino acids in the urine.

AMNESIA. A general medical term for loss of memory that is not due to ordinary forgetfulness. Amnesia can be caused by head injuries, brain disease, or epilepsy as well as by dissociation.

AMNESIC. Relating to amnesia, the loss of memory.

AMNIOCENTESIS. A procedure in which a needle is inserted through a pregnant woman's abdomen and into her uterus to withdraw a small sample of amniotic fluid. The amniotic fluid can be examined for sign of disease or other problems afflicting the fetus.

AMNIOTIC BAND. An abnormal condition of fetal development in which fibrous bands of tissue develop out of the amniotic sac. The bands encircle and constrict parts of the baby's body, interfering with normal development and sometimes causing congenital amputation.

AMNIOTIC FLUID. Fluid within the uterine sac in which the fetus lives until born.

AMNIOTIC MEMBRANE. The thin tissue that creates the walls of the amniotic sac.

AMNIOTIC SAC. The membranous sac that surrounds the embryo and fills with watery fluid as pregnancy advances.

AMOEBA. A type of protozoa (one-celled animal) that can move or change its shape by extending projections of its cytoplasm.

AMPERAGE. A measurement of the amount of electric charge passing a given point per unit time. One ampere represents about 6.241×10^{18} electrons passing a given point in a wire in one second of time.

AMPHETAMINES. Sympathomimetic amines; sometimes called speed; synthetic chemicals that stimulate the central nervous system.

AMPHOTERICIN B (FENGIZONE). An antifungal medication, prescribed for topical or systemic use in treating fungal infections.

AMPLIFICATION. A process by which something is made larger. In clotting, only a very few chemicals are released by the initial injury; they result in a cascade of chemical reactions which produces increasingly larger quantities of different chemicals, resulting in an appropriately sized, strong fibrin clot.

AMPULLA OF VATER. The widened portion of the duct through which bile and pancreatic juices enter the intestine. Ampulla is a Latin word for a bottle with a narrow neck that opens into a wide body.

AMPUTATION. Surgical removal of a limb.

AMYGDALA. An almond-shaped brain structure of the limbic system that is activated in stressful situations and triggers fear.

AMYLASE. A digestive enzyme that breaks down starch.

AMYLOID PLAQUE. A waxy, translucent substance composed of complex protein fibers and polysaccharides that forms in body tissues in some degenerative diseases, such as Alzheimer s disease.

AMYLOIDOSIS. Accumulation of amyloid deposits in various organs and tissues in the body such that normal functioning of an organ is compromised.

AMYLOPHAGIA. The compulsive eating of purified starch, typically cornstarch or laundry starch.

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ANABOLIC. Causing muscle and bone growth and a shift from fat to muscle in the body.

ANABOLIC STEROID. Drugs derived from the male sex hormones that increase the rate of tissue growth. They are best known for increasing the rate of muscle development.

ANAEROBIC BACTERIA. Bacteria that can grow and reproduce in an oxygen-free environment.

ANAGRELIDE. An orphan drug that is approved for treating Polycythemia vera patients on an investigational basis. Anagrelide works by controlling the level of platelets in the blood.

ANAL FISSURE. An ulcer on the margin of the anus.

ANAL SPHINCTER MUSCLES. Muscles that control the opening and closing of the anus.

ANALGESIA. A state of insensitivity to pain even though the person remains fully conscious.

ANALGESIC. A medication that relieves pain without causing loss of consciousness. Over–the–counter analgesics include aspirin and NSAIDs.

ANALOGUE. A drug that is similar to the drug from which it is derived.

ANALYSAND. A person undergoing psychoanalysis.

ANAPHYLAXIS. Also called anaphylactic shock; a severe allergic reaction characterized by airway constriction, tissue swelling, and lowered blood pressure.

ANASTOMOSIS. Surgical re-connection of the ends of the bowel after removal of a portion of the bowel.

ANATOMIC. Related to the physical structure of an organ or organism.

ANATOMY. The science of the body structure of an organism and its parts.

ANDROGENIC. Causing testosterone-like, masculinizing effects.

ANDROGENS. A class of chemical compounds (hormones) that stimulates the development of male secondary sexual characteristics.

ANDROSTENEDIONE. Also called ''andro,'' this hormone occurs naturally during the making of testosterone and estrogen.

ANEMIA. A blood condition in which the level of hemoglobin or the number of red blood cells falls below normal values. Common symptoms include paleness, fatigue, and shortness of breath.

ANEMIA OF CHRONIC DISEASE (ACD). Blood disorder that results from a medical condition that affects the production and lifespan of red blood cells.

ANENCEPHALY. Congenital absence of the brain. Occurs during the first month of embryonic development.

ANESTHESIA. A condition created by drugs that produces a numb feeling. General anesthesia produces unconsciousness whereas a local anesthesia produces numbness around the site where the drug was introduced.

ANESTHESIOLOGIST. A physician who has special training and expertise in the delivery of anesthetics.

ANESTHETIC. A drug that causes loss of sensation. It is used to lessen the pain of surgery and medical procedures.

ANEUPLOID. An abnormal number of chromosomes in a cell.

ANEURYSM. A pouchlike bulging of a blood vessel. Aneurysms can rupture, leading to stroke.

ANGINA. A condition in which lack of blood to the heart causes severe chest pain.

ANGINA PECTORIS. A feeling of tightness, heaviness, or pain in the chest, caused by a lack of oxygen in the muscular wall of the heart.

ANGIOEDEMA. An allergic skin disease characterized by patches of confined swelling involving the skin the layers beneath the skin, the mucous membranes, and sometimes the viscera—called also angioneurotic edema, giant urticaria, Quincke's disease, or Quincke's edema.

ANGIOGENESIS. The formation of new blood vessels, for example, as a result of a tumor.

ANGIOGRAM. An x-ray (radiographic) study of the blood vessels. An angiogram uses a radiopaque substance, or contrast medium, to make the blood vessels visible under x ray.

ANGIOGRAPHY. A mapping of the brain's blood vessels, using x-ray imaging.

ANGIOID STREAKS. Gray, orange, or red wavy branching lines in Bruch's membrane.

ANGIOMA. A tumor (such as a hemangioma or lymphangioma) that mainly consists of blood vessels or lymphatic vessels.

ANGIOMATOUS MALFORMATIONS. Tumors in blood vessels.

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ANGIOPLASTY. A medical procedure in which a catheter, or thin tube, is threaded through blood vessels. The catheter is used to place a balloon or stent (a small metal rod) at an area of stenosis and expand it mechanically.

ANGIOSPASM. Spasmodic contraction of a blood vessel with increase in blood pressure.

ANGIOTENSIN-CONVERTING ENZYME (ACE) INHIBITOR. A drug that lowers blood pressure by interfering with the breakdown of a protein-like substance involved in blood pressure regulation.

ANION. An ion carrying a negative charge owing to a surplus of electrons. Anions in the body include bicarbonate, chloride, phosphate, sulfate, certain organic acids, and certain protein compounds.

ANISOMETROPIA. An eye condition in which there is an inequality of vision between the two eyes. There may be unequal amounts of nearsightedness, farsightedness, or astigmatism, so that one eye will be in focus while the other is not.

ANKLE-BRACHIAL INDEX (ABI) TEST. A means of checking the blood pressure in the arms and ankles using a regular blood pressure cuff and a special ultrasound stethoscope (Doppler). The pressure in the ankle is compared to the pressure in the arm.

ANKYLOSING. When bones of a joint are fused, stiff, or rigid.

ANKYLOSING SPONDYLITIS. A type of arthritis that causes gradual loss of flexibility in the spinal column. It occurs most commonly in males between 16 and 35.

ANODE. The positive electrode to which an electromagnetic current flows.

ANOGENITORECTAL SYNDROME. Another name for third-stage LGV.

ANOMIC APHASIA. A condition characterized by either partial or total loss of the ability to recall the names of persons or things as a result of a stroke, head injury, brain tumor, or infection.

ANOREXIA NERVOSA. A disorder of the mind and body in which people starve themselves in a desire to be thin, despite being of normal or below normal body weight for their size and age.

ANORGASMIA. A sexual dysfunction characterized by the inability to achieve orgasm.

ANOVULATION. The absence of ovulation.

ANOVULATORY BLEEDING. Bleeding without release of an egg from an ovary.

ANOXEMIA. An extreme lack of oxygen in the blood.

ANOXIA. An absence of oxygen.

ANTACIDS. Substances that counteract or neutralize acidity. They act promptly and have short durations of actions.

ANTAGONIST. A substance that tends to nullify the action of another.

ANTEPARTUM. This refers to the time period of the woman's pregnancy from conception and onset of labor.

ANTHELMINTHIC (ALSO SPELLED ANTHELMINTIC). A type of drug or herbal preparation given to destroy parasitic worms or expel them from the body.

ANTHRAX. An infectious disease caused by a type of bacterium. The disease can be passed from animals to people and usually is fatal. Symptoms include sores on the skin.

ANTHROPOLOGY. The study of the origins, biological characteristics, beliefs, and social customs of human beings.

ANTIANDROGEN. A substance that blocks the action of androgens, the hormones responsible for male characteristics. Used to treat prostate cancers that require male hormones for growth.

ANTIBIOTIC. A drug used to treat infections caused by bacteria and other microorganisms.

ANTIBIOTIC RESISTANCE. The ability of infectious agents to change their biochemistry in such a way as to make an antibiotic no longer effective.

ANTIBODY. A blood protein produced in response to a specific foreign substance including bacteria, viruses, and parasites; the antibody destroys the organism, providing protection against disease.

ANTI-CHOLINERGIC DRUG. A medication that blocks or subdues the action of the neurotransmitter acetylcholine.

ANTICOAGULANT. A chemical or medication that prevents blood from clotting.

ANTICONVULSANTS. A class of drugs given to control seizures.

ANTIDEPRESSANT. A medication used to relieve the symptoms of clinical depression.

ANTIDIURETIC HORMONE (ADH); VASOPRESSIN. A polypeptide hormone that is secreted by the pituitary gland along with oxytocin, or is chemically

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synthesized, and which suppresses water loss and increases blood pressure.

ANTIDOTE. A remedy to counteract unwanted effects from medications or poisons.

ANTIEMETIC. A drug that helps stop nausea and vomiting.

ANTIFUNGAL. A medicine used to treat infections caused by a fungus.

ANTIGEN. A foreign protein or particle that causes the body to produce specific antibodies that bind to it.

ANTIGEN PRESENTING CELL. A cell of the immune system that ingests antigens and exposes them to cells of the immune system in a way that activates the cells to seek out and destroy any other cells displaying that antigen.

ANTIHISTAMINE. A drug that inhibits the actions of histamine. Histamine causes dilatation of capillaries, contraction of smooth muscle, and stimulation of gastric acid secretion.

ANTI-INFLAMMATORY DRUGS. A class of drugs that lower inflammation and that includes NSAIDs and corticosteroids.

ANTIMETABOLITE. A drug that interferes with a cell's growth or ability to multiply.

ANTIMICROBIAL AGENT. A substance that kills microorganisms such as bacteria or mold, or stops them from growing and causing disease.

ANTI-MOTILITY MEDICATIONS. Medications such as loperamide (Imodium), dephenoxylate (Lomotil), or medications containing Codeine or narcotics that decrease the ability of the intestine to contract. This can worsen the condition of a patient with dysentery or colitis.

ANTIMYOCARDIAL ANTIBODY. An autoantibody that attacks a person's own heart muscle, or myocardium.

ANTINEOPLASTICS. Agents that inhibit or prevent the development, maturation, and proliferation of malignant cells.

ANTINUCLEAR ANTIBODIES. Autoantibodies that attack substances found in the center, or nucleus, of all cells.

ANTINUCLEAR ANTIBODY (ANA) TEST. A test often used to look for autoantibodies that react against components of the nucleus of the body's cells. Many people with lupus test positive for ANA.

ANTIOXIDANT. A molecule that prevents oxidation. In the body, antioxidants attach to other molecules called free radicals and prevent the free radicals from causing damage to cell walls, DNA, and other parts of the cell.

ANTIPLATELET DRUG. Drug that inhibits platelets from aggregating to form a plug. They are used to prevent clotting and alter the natural course of atherosclerosis.

ANTIPSYCHOTICS. Drugs used to treat psychotic conditions such as schizophrenia or psychosis. These medications are powerful tranquilizers that all have sedating and calming effects, but their major effect is to reduce psychotic thinking and behavior.

ANTIPYRETIC. A drug that lowers fever, like aspirin or acetaminophen.

ANTISEPTIC. Chemicals applied to the skin to destroy bacteria and prevent infection.

ANTISOCIAL PERSONALITY. A personality characterized by attitudes and behaviors at odds with society's customs and moral standards, including illegal acts.

ANTITHROMBIC. Preventing clot formation.

ANTITOXIN. A substance that inactivates a poison (e.g., toxin) and protects the body from being injured by it.

ANTITUSSIVES. Drugs used to suppress coughing.

ANTIVIRAL. Refers to a drug that can destroy viruses and help treat illnesses caused by them.

ANTRECTOMY. A surgical procedure for ulcer disease in which the antrum, a portion of the stomach, is removed.

ANUS. The canal at the end of the large intestine through which waste is excreted to the outside of the body.

ANXIETY. An abnormal and overwhelming sense of apprehension and fear often marked by physiological signs (as sweating, tension, and increased pulse), by doubt concerning the reality and nature of the threat, and by self-doubt about one's capacity to cope with it.

ANXIETY DISORDER. The experience of prolonged, excessive worry about circumstances in one's life that is severe enough to disrupt daily life.

ANXIOLYTIC. A type of medication that helps to relieve anxiety.

AORTA. The largest artery in the body, arising from the left ventricle (lower chamber) of the heart and extending down into the abdomen.

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AORTIC ANEURYSMS. Occurs when an area in the aorta (the main artery of the heart) is weakened and bulges like a balloon.

AORTIC DISSECTION. A tear in the aorta (the main blood vessel carrying away from the heart) that allows blood to flow between layers of the aorta, eventually causing it to fail.

AORTIC STENOSIS. A stiffening of the artery which carries blood from the heart to the body.

AORTIC VALVE. The valve between the heart's left ventricle and ascending aorta that prevents regurgitation of blood back into the left ventricle.

APANA. Life sustaining energy centered in the larger intestine; the fifth of the five airs of Ayurvedic philosophy; the life force governing expulsion activity.

APHAKIA. Absence of the lens of the eye.

APHASIA. The loss of the ability to speak, or to understand written or spoken language. A person who cannot speak or understand language is said to be aphasic.

APHERESIS. A procedure in which whole blood is withdrawn from a donor, a specific blood component is separated and collected, and the remainder is reinfused into the patient.

APHTHOUS STOMATITIS. A specific type of stomatitis presenting with shallow, painful ulcers. Also known as *canker sores*.

APICAL. Rounded end of the root of a tooth that is embedded in hard tissue (bone); toward the apex of the root.

APICOECTOMY. Also called root resectioning. The root tip of a tooth is accessed in the bone and a small amount is shaved away. The diseased tissue is removed and a filling is placed to reseal the canal.

APLASTIC. Exhibiting incomplete or faulty development.

APLASTIC ANEMIA. A disorder in which the body produces inadequate amounts of red blood cells and hemoglobin due to underdeveloped or missing bone marrow.

APNEA. A cessation of breathing.

APOLIPOPROTEIN E (APOE). A protein that transports cholesterol throughout the body. One form of this protein, APOE e4, is associated with a 60% risk of late-onset AD.

APOPTOSIS. Cell death.

APOXIA. Altitude sickness.

APPENDECTOMY. Surgical removal of the appendix.

APPENDICITIS. Condition characterized by the rapid inflammation of the appendix, a part of the intestine.

APPENDIX (PLURAL, APPENDICES). The finger-shaped pouch attached to the cecum, the beginning of the large intestine.

APPERCEPTION. The process of understanding through linkage with previous experience.

APPETITE SUPPRESSANT. A drug that reduces appetite.

APRAXIA. Impairment of the ability to make purposeful movements, but not paralysis or loss of sensation.

AQUEOUS HUMOR. A transparent liquid, contained within the eye, that is composed of water, sugars, vitamins, proteins, and other nutrients.

ARACHNODACTYLY. A condition characterized by abnormally long and slender fingers and toes.

ARACHNOID MATER. One of three membranes that encase the brain and spinal cord. The arachnoid mater is the middle membrane.

ARC FLASH. A type of electrical explosion resulting from electrical breakdown of the gases in air, which normally does not conduct electricity. Arc flashes can occur where there is sufficient voltage in an electrical system and a path to the ground or to lower voltage.

AREOLA. The area of pigmented skin surrounding the human nipple in both males and females. It is roughly circular in shape.

ARGON. A colorless, odorless gas.

AROMATHERAPY. The therapeutic use of plant-derived, aromatic essential oils to promote physical and psychological well-being.

ARREST. A sudden stopping of the function of a body organ, such as no breathing (respiratory arrest) or no beating of the heart (cardiac arrest).

ARRHYTHMIA. A variation in the normal rhythm of the heart beat. Atrial fibrillation and flutter are two types of arrhythmia.

ARTEMINISININS. A family of antimalarial products derived from an ancient Chinese herbal remedy. Two of the most popular varieties are artemether and artesunate, used mainly in southeast Asia in combination with mefloquine.

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ARTERIAL BLOOD GASES TEST. A test to analyze blood for oxygen, carbon dioxide, and bicarbonate content, as well as blood pH (acidity level). Used to test the effectiveness of respiration.

ARTERIAL EMBOLISM. A blood clot arising from another location that blocks an artery.

ARTERIES. Blood vessels that carry blood away from the heart to the cells, tissues, and organs of the body.

ARTERIOGRAM. A diagnostic test that involves viewing the arteries and/or attached organs by injecting a contrast medium or dye, into the artery and taking an x ray.

ARTERIOGRAPHY. A medical test in which an x-ray visible dye is injected into blood vessels. This dye allows the blood vessels to be imaged with x rays.

ARTERIOLES. Small blood vessels that carry arterial (oxygenated) blood.

ARTERIOSCLEROSIS. A chronic condition characterized by thickening and hardening of the arteries and the build-up of plaque on the arterial walls. Arteriosclerosis can slow or impair blood circulation.

ARTERIOVENOUS MALFORMATION. An abnormal tangle of arteries and veins in which the arteries feed directly into the veins without a normal intervening capillary bed.

ARTERITIS. Inflammation of an artery.

ARTERY. A blood vessel that carries blood away from the heart to peripheral tissues.

ARTHEROSCLEROTIC PLAQUE. A deposit of fatty and calcium substances that accumulate in the lining of the artery wall, restricting blood flow.

ARTHRALGIA. Sharp, severe pain, extending along a nerve or group of nerves, experienced in a joint and/or joints.

ARTHRITIS. A condition characterized by inflamed, swollen, painful joints.

ARTHROCENTESIS. A procedure in which the doctor inserts a needle into the patient's joint to withdraw fluid for diagnostic testing or to drain infected fluid from the joint.

ARTHROCHALASIA. Excessive loosness of the joints.

ARTHROGRAPHY. An imaging technique used to evaluate joints. Dye is injected into a joint and then x rays are taken; areas where the dye leaks out may indicate an injury.

ARTHROPLASTY. The surgical reconstruction or replacement of a joint.

ARTHROPODS. A phylum name referring to certain insects (including mosquitoes and ticks) and spiders.

ARTHROSCLEROSIS. A condition where fatty deposits cause the arteries to narrow.

ARTHROSCOPE. An instrument for the visual examination of the interior of a joint.

ARTHROSCOPIC KNEE SURGERY. Surgery performed to examine or repair tissues inside the knee joint through a special scope (arthroscope).

ARTHROSCOPY. Examination of a joint with an arthroscope or joint surgery using an arthroscope.

ARTICULAR BONES. Two or more bones connected to each other via a joint.

ARTICULAR CAPSULE. An envelope of tissue that surrounds a free moving joint, composed of an external layer of white fibrous tissue and an external synovial membrane that secretes a lubricant into the joint.

ARTICULATION. The ability to pronounce a word correctly. A lisp is an example of an articulation problem.

ASANA. A position or stance in yoga.

ASBESTOS. A silicate (containing silica) mineral that occurs in a variety of forms; it is characterized by a fibrous structure and resistance to fire.

ASCITES. Abnormal accumulation of fluid in the abdomen, making the abdomen appear distended.

ASCORBIC ACID. Another term for vitamin C, a nutrient found in fresh fruits and vegetables. Good sources of vitamin C in the diet are citrus fruits like oranges, lemons, limes, and grapefruits, berries, tomatoes, green peppers, cabbage, broccoli, and spinach.

ASEPTIC. Sterile; containing no microorganisms, especially no bacteria.

ASEPTIC MENINGITIS. A term that is sometimes used for meningitis that is not caused by bacteria.

ASHERMAN'S SYNDROME. The cessation of menstruation and/or infertility caused by intrauterine adhesions.

ASPERGER SYNDROME. Characterized by autistic-type behavior but no problems with language and no clinically significant cognitive delay.

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ASPERGILLOMA. A ball or mass made of *Aspergillus* fungi that can form in the lungs of patients with suppressed immune systems.

ASPERGILLOSIS. A lung infection caused by the mold *Aspergillus fumigatus*.

ASPHYXIA. Lack of oxygen.

ASPHYXIATION. Oxygen starvation of tissues.

ASPIRATION. A procedure in which pus or other fluid is removed from a body cavity through a hollow needle connected to a syringe.

ASPIRATOR. A medical instrument that uses suction to withdraw fluids from the lungs, digestive tract, or other parts of the body for laboratory testing.

ASPIRIN. A derivative of salicylic acid used to relieve pain and fever.

ASSAY. An analysis of the chemical composition or strength of a substance.

ASSISTED SUICIDE. A form of self-inflicted death in which individuals voluntarily bring about their own death with the help of another, usually a physician, relative, or friend. Assisted suicide is sometimes called physician-assisted death (PAD).

ASTHENIA. Muscle weakness.

ASTHMA. A lung condition, usually of allergic origin, in which the airways become narrow due to smooth muscle contraction, causing wheezing, coughing, and shortness of breath.

ASTIGMATISM. A condition in which one or both eyes cannot filter light properly and images appear blurred and indistinct.

ASYMMETRIC. Not occurring equally on both sides of the body.

ASYMPTOMATIC. Persons who carry a disease and are usually capable of transmitting the disease but who do not exhibit symptoms of the disease are said to be asymptomatic.

ATAXIA. A deficiency of muscular coordination, especially when voluntary movements are attempted, such as grasping or walking.

ATHERECTOMY. A non-surgical technique for treating diseased arteries with a rotating device that cuts or shaves away obstructing material inside the artery.

ATHEROSCLEROSIS. A disorder in which plaques of cholesterol, lipids, and other debris build up on the inner walls of arteries, narrowing them.

ATHEROSCLEROTIC DISEASE. The progressive narrowing and hardening of the arteries over time.

ATHEROSCLEROTIC PLAQUE. A deposit of fat and other substances that accumulate in the lining of the artery wall.

ATHETOSIS. A condition marked by slow, writhing, involuntary muscle movements.

ATHLETE'S FOOT. A fungal infection between the toes, officially known as tinea pedis.

ATMOSPHERE. A measurement of pressure. One atmosphere equals the pressure of air at sea level (14.7 pounds per square inch [psi]).

ATOPIC DERMATITIS. An intensely itchy inflammation often found on the face of people prone to allergies. In infants and early childhood, it is called infantile eczema.

ATOPY. Genetic predisposition toward the development of allergies.

ATRESIA. A congenital defect in which the blood pumped through the body has too little oxygen. In tricuspid atresia, the baby lacks a triscupid valve. In pulmonary atresia, a pulmonary valve is missing.

ATRIA (SINGULAR, ATRIUM). The right and left upper chambers of the heart.

ATRIAL. Having to do with the upper chambers of the heart.

ATRIAL FIBRILLATION. A condition in which the upper chamber of the heart quivers instead of pumping in an organized way.

ATRIAL FLUTTER. A rapid pulsation of the upper chamber of the heart that interferes with normal function.

ATRIOVENTRICULAR NODE (AV NODE). Highly specialized area of the heart muscle which transmits electrical impulses.

ATRIUM (PLURAL ATRIA). The right or left upper chamber of the heart.

ATROPHY. A progressive wasting and loss of function of any part of the body.

ATROPINE. A poisonous alkaloid obtained from belladonna or related plants, used medically to dilate the pupils of the eyes and to stop spasms.

ATTENTION DEFICIT/HYPERACTIVITY DISORDER (ADD). A persistent pattern of inattention, hyperactivity and/or impulsiveness; the pattern is more frequent and severe than is typically observed in people at a similar level of development.

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ATTENUATED. Alive but weakened; an attenuated microorganism can no longer produce disease.

ATTUNEMENT. Life energy teaching given by Reiki master to a student.

ATYPICAL ADENOMATOUS HYPERPLASIA. The overgrowth of the endometrium. This precancerous condition is estimated to progress to cancer in one third of the cases.

AUDIOGRAM. A chart or graph of the results of a hearing test conducted with audiographic equipment. The chart reflects the softest (lowest volume) sounds that can be heard at various frequencies or pitches.

AUDIOLOGIST. A person with a degree and/or certification in the areas of identification and measurement of hearing impairments and rehabilitation of those with hearing problems.

AUDITORY. Relating to the sense of the organs of hearing.

AURA. A group of visual or other sensations that precedes the onset of a migraine attack.

AURICLE. The external structure of the ear.

AURICULAR ACUPUNCTURE. Acupuncture using only points found on the ears.

AUSCULTATION. The process of listening to sounds that are produced in the body. Direct auscultation uses the ear alone, such as when listening to the grating of a moving joint. Indirect auscultation involves the use of a stethoscope to amplify the sounds from within the body, like a heartbeat.

AUTISM. A severe developmental disorder that usually begins before three years of age and affects a child's social as well as intellectual development. Some researchers theorized that immunization with the MMR vaccine was a risk factor for autism.

AUTISTIC PSYCHOPATHY. Hans Asperger's original name for Asperger syndrome. It is still used occasionally as a synonym for the disorder.

AUTOANTIBODY. An antibody produced by the body in reaction to any of its own cells or cell products.

AUTOGENIC TRAINING. A form of self-hypnosis developed in Germany that appears to be beneficial to migraine sufferers.

AUTOGRAFT. Tissue that is taken from one part of a person's body and transplanted to a different part of the same person.

AUTOHEMOTHERAPY. A form of ozone therapy in which a small quantity of the patient's blood is withdrawn, treated with a mixture of ozone and oxygen, and reinfused into the patient.

AUTOIMMUNE. Pertaining to an immune response by the body against one of its own tissues or types of cells.

AUTOIMMUNE DISORDER. A disorder in which the body's antibodies mistake the body's own tissues for foreign invaders. The immune system then attacks and causes damage to these tissues.

AUTOIMMUNE RESPONSE. A condition in which a person's immune system fails to recognize its own cells as being "self" and attacks its own body.

AUTOINFECTION. An infection caused by a disease agent that is already present in the body.

AUTOLOGOUS. A transplant where the material for the transplant comes from the individual who is also the recipient; thus, the transplant material is genetically identical to the donor's body.

AUTOLOGOUS BLOOD. The patient's own blood, drawn and set aside before surgery for use during surgery in case a transfusion is needed.

AUTOLOGOUS TRANSPLANTATION. A procedure wherein the person donates blood or tissue to themselves.

AUTOMATED EXTERNAL DEFIBRILLATOR (AED). A portable electronic device that automatically diagnoses potentially life-threatening cardiac arrhythmias (ventricular fibrillation and ventricular tachycardia) and is able to treat them through defibrillation.

AUTOMATIC THOUGHTS. Thoughts that automatically come to mind when a particular situation occurs. Cognitive-behavioral therapy seeks to challenge automatic thoughts.

AUTOMATISMS. Movements during a seizure that are semi–purposeful but involuntary.

AUTONOMIC. Refers to peripheral nerves that carry signals from the brain and that control involuntary actions in the body, such as the beating of the heart.

AUTONOMIC NERVOUS SYSTEM (ANS). The part of the nervous system that supplies nerve endings in the blood vessels, heart, intestines, glands, and smooth muscles, and governs their involuntary functioning. The autonomic nervous system is responsible for the biochemical changes involved in experiences of anxiety.

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AUTOPSY. The examination of a body after death to determine the cause of death.

AUTOSOMAL. Relating to any chromosome besides the X and Y sex chromosomes. Human cells contain 22 pairs of autosomes and one pair of sex chromosomes.

AUTOSOMAL CHROMOSOME. One of the non-X or non-Y chromosomes.

AUTOSOMAL DISEASE. A disease caused by a gene mutation located on a chromosome other than a sex chromosome.

AUTOSOMAL DOMINANCE. A pattern of heredity in which a trait is inherited without respect to sex and from either parent. The hereditary diseases associated with intestinal polyps are all autosomal dominant.

AUTOSOMAL DOMINANT INHERITANCE. A pattern of inheritance in which a trait will be expressed if the gene is inherited from either parent.

AUTOSOMAL DOMINANT OR AUTOSOMAL RECESSIVE. Refers to the inheritance pattern of a gene on a chromosome other than X or Y. Genes are inherited in pairs—one gene from each parent. However, the inheritance may not be equal, and one gene may overshadow the other in determining the final form of the encoded characteristic. The gene that overshadows the other is called the dominant gene; the overshadowed gene is the recessive one.

AUTOSOMAL GENE. A gene found on one of the 22 autosomal chromosome pairs; i.e., not on a sex (X or Y) chromosome.

AUTOSOMAL RECESSIVE INHERITANCE. A pattern of genetic inheritance where two abnormal genes are needed to display the trait or disease.

AUTOSOME. A chromosome not involved in sex determination.

AVIAN CHLAMYDIOSIS. An illness in pet birds and poultry caused by *Chlamydia psittaci*. It is also known as parrot fever in birds.

AVULSION. The forcible separation of a piece of tissue from an entire structure.

AVULSION FRACTURE. A fracture caused by the tearing away of a fragment of bone where a strong ligament or tendon attachment forcibly pulls the fragment away from the bone tissue.

AXIAL. A straight line passing through a spherical body between its two poles and about which the body may revolve.

AXILLA. Armpit.

AXILLARY. Located in or near the armpit.

AXILLARY LYMPH NODE. Lymph nodes under the arm.

AXIS. A line that passes through the center of the body or body part.

AXON. A long, threadlike projection that is part of a nerve cell.

AYURVEDA MEDICINE. Ayurveda is a system of wholistic medicine from India that aims to bring the individual into harmony with nature. It provides guidance regarding food and lifestyle, so that healthy people can stay healthy and people with health challenges can improve their health.

AZOTEMIA. The presence of excess nitrogenous wastes in the blood.

B

B CELL. A type of lymphocyte or white blood cell that is derived from precursor cells in the bone marrow.

B LYMPHOCYTE. A type of lymphocyte that circulates in the blood and lymph and produces antibodies when it encounters specific antigens. B lymphocytes are also called B cells.

B VITAMINS. This family of vitamins consists of thiamine (B_1), riboflavin (B_2), niacin (B_3), pantothenic acid (B_5), pyridoxine (B_6), biotin, folic acid (B_9), and cobalamin (B_{12}). They are interdependent and involved in converting glucose to energy.

BABESIOSIS. A disease caused by protozoa of the genus *Babesia* characterized by a malaria-like fever, anemia, vomiting, muscle pain, and enlargement of the spleen. Babesiosis, like Lyme disease, is carried by a tick.

BABINSKI REFLEX. A reflex movement by the big toe when the sole is tickled: an upward response is normal in infancy, but indicates central nervous system damage in older children and adults.

BACILLUS. A rod-shaped bacterium, such as the diphtheria bacterium.

BACILLUS CALMETTE-GUÉRIN (BCG). A vaccine made from a weakened bacillus similar to the tubercle bacillus, which may help prevent serious pulmonary TB and its complications.

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BACTEREMIA. An infection caused by bacteria in the blood.

BACTERIA. Single–celled microorganisms that can be seen only through a microscope. Many bacteria cause disease.

BACTERIAL OSTEOMYELITIS. An infection of the bone or bone marrow that is caused by a bacterium.

BACTERIAL VAGINITIS. This is the term for inflammation of the vagina due to a bacterial infection.

BACTERICIDAL. An agent that destroys bacteria (e.g., *Staphylococci aureus, Streptococci pneumoniae, Escherichia coli, Salmonella enteritidis*).

BACTERIURIA. The presence of bacteria in the urine.

BALANITIS XEROTICA OBLITERANS (BXO). A chronic, progressive, hardening skin inflammation of the penis.

BALLOON ANGIOPLASTY. A surgical procedure in which a balloon catheter is used to flatten plaque against an artery wall.

BAND. Immature neutrophil (a type of white blood cell).

BARBITURATES. A group of medicines that slow breathing and lower the body temperature and blood pressure. They can be habit forming and are now used chiefly for anesthesia.

BARIATRICS. The branch of medicine that deals with the prevention and treatment of obesity and related disorders.

BARIUM. A chemical used in certain radiological studies to enhance visualization of anatomical structures.

BARIUM ENEMA. An X-ray test of the bowel performed after giving the patient an enema of a white chalky substance (barium) that outlines the colon and the rectum.

BARIUM SULFATE. A barium compound used during a barium enema to block the passage of x rays during the exam.

BARIUM SWALLOW. Barium is used to coat the throat in order to take x-ray pictures of the tissues lining the throat.

BARIUM X RAY (UPPER GI). An x-ray test of the upper part of the gastrointestinal (GI) tract (including the esophagus, stomach, and a small portion of the small intestine) after the patient is given a white, chalky barium sulfate solution to drink. This substance coats the upper GI and the x rays reveal any abnormality in the lining of the stomach and the upper GI.

BAROTRAUMA. Ear pain caused by unequal air pressure on the inside and outside of the ear drum. Barotrauma, which is also called pressure–related ear pain or barotitis media, is the most common reason for myringotomies in adults.

BARRETT'S ESOPHAGUS. A precancerous condition of the esophagus that may develop as a complication of gastroesophageal reflux disease (GERD).

BARTHOLIN'S GLANDS. These glands are embedded in the vestibule of the vagina and function to maintain moisture.

BASAL CELL CANCER. The most common form of skin cancer; it usually appears as one or several nodules having a central depression. It rarely spreads (metastisizes), but is locally invasive.

BASAL GANGLIA. Brain structure at the base of the cerebral hemispheres, involved in controlling movement.

BASELINE. A return to an original state.

BASOPHIL. White blood cell that increases in response to parasitic infections and allergic reactions.

BECKER MUSCULAR DYSTROPHY (BMD). A type of muscular dystrophy that affects older boys and men, and usually follows a milder course than Duchenne muscular dystrophy.

BEHAVIOR MODIFICATION. Therapy aimed at changing behavior by substituting problem behaviors with more useful activities.

BEHAVIORAL THERAPY. Form of psychotherapy used to treat depression, anxiety disorders, phobias, and other forms of psychopathology.

BELL'S PALSY. Facial paralysis or weakness with a sudden onset, caused by swelling or inflammation of the seventh cranial nerve, which controls the facial muscles. Disseminated Lyme disease sometimes causes Bell's palsy.

BENCE-JONES PROTEIN. Light chain of an immunoglobulin that is overproduced in multiple myeloma and is excreted in the urine.

BENIGN. Mild, nonmalignant. Recovery is favorable with treatment.

BENIGN PROSTATE HYPERPLASIA (BPH). A noncancerous swelling of the prostate.

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BENIGN TUMOR. An abnormal proliferation of cells that does not spread to other parts of the body.

BENZENE. A colorless volatile flammable toxic liquid hydrocarbon used as a solvent and as a motor fuel.

BENZODIAZEPINES. A class of drugs that have a hypnotic and sedative action, used mainly as tranquilizers to control symptoms of anxiety.

BERYLLIUM. A steel-grey, metallic mineral used in the aerospace and nuclear industries and in a variety of manufacturing processes.

BETA 2-MICROGLOBULIN. Protein produced by B-cells; high concentrations in the blood are indicative of multiple myeloma.

BETA BLOCKER. An anti-hypertensive (blood pressure-lowering) drug that limits the activity of epinephrine, a hormone that increases blood pressure.

BETA RADIATION. Streams of electrons emitted by beta emitters like carbon-14 and radium.

BETA-AGONIST. Beta2-agonist; beta-adrenergic agonist; a bronchodilator medication—inhaled or oral—that relaxes the muscles surrounding the airways to relieve asthma symptoms.

BETA-AMYLOID PLAQUES. Senile plaques; structures in the brain, composed of dead or dying nerve cells and cell debris surrounding deposits of beta-amyloid protein, that are diagnostic of AD. Beta-amyloid forms when amyloid precursor protein (APP) is not broken down properly.

BETA-BLOCKERS. A class of medication used to block the cellular response to chemicals normally present in the body.

BETA-HCG (BETA-HUMAN CHORIONIC GONADOTROPIN). A tumor marker associated with testicular cancer and tumors, such as choriocarcinoma and molar pregnancies, that begin in placental cells called trophoblasts.

BETA$_2$-MICROGLOBULIN. A protein found on the surface of many cells, particularly white blood cells.

BIBLIOTHERAPY. The use of books (usually self-help or problem-solving works) to improve one's understanding of personal problems and/or to heal painful feelings.

BICEPS. The muscle in the front of the upper arm.

BICUSPID. Premolar; the two-cupped tooth between the first molar and the cuspid.

BIFIDOBACTERIA. A group of bacteria normally present in the intestine.

BILATERAL. Located on or affecting both sides of the body.

BILE. A liquid secreted by the liver and passed through ducts to the small intestine where it aids in the digestion and absorption of fats.

BILE ACID. A detergent that is made in the liver and excreted into the intestine to aid in the absorption of fats.

BILE DUCTS. Tubes that carry bile, a thick yellowish-green fluid that is made by the liver, stored in the gallbladder, and helps the body digest fats.

BILIARY. Relating to the system that produces and transports bile.

BILIARY ATRESIA. The underdevelopment or absence of bile ducts.

BILIARY SYSTEM. The gall bladder and the system of tubes that carries bile from the liver into the intestine.

BILIRUBIN. A red–yellow pigment in the bile and blood; excessive accumulation of bilirubin results in jaundice.

BINGE DRINKING. Consumption of five or more alcoholic drinks in a row on a single occasion.

BINGE-EATING DISORDER. A condition characterized by uncontrolled eating.

BINOCULAR FIXATION. Both eyes pointed to and looking at the same object.

BINOCULAR VISION. Using both eyes at the same time to see an image.

BIOCHEMICAL TESTING. Measuring the amount or activity of a particular enzyme or protein in a sample of blood or urine or other tissue from the body.

BIOENERGETICS. A system of therapy that combines breathing and body exercises, psychological therapy, and the free expression of emotions to release blocked physical and psychic energy.

BIOFEEDBACK. A technique in which a person is taught to consciously control the body's response to a stimulus.

BIOFIELD HEALING. A general term for a group of alternative therapies based on the belief that the human body is surrounded by an energy field (or aura) that reflects the condition of the person's body and spirit. Rebalancing or repairing the energy field is thought to bring about healing in mind and body. Reiki, therapeutic touch, polarity balancing, Shen

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therapy, and certain forms of color therapy are considered forms of biofield healing.

BIOLOGICAL CLOCK. A synonym for the body's circadian rhythm, the natural biological variations that occur over the course of a day.

BIOLOGICAL PSYCHIATRY. An approach to psychiatry that aims to understand mental disorders in terms of the biological and biochemical functions of the central nervous system.

BIOLOGICAL TISSUE VALVE. A replacement heart valve that is harvested from the patient (autograft), a human cadaver (homograft or allograft), or other animal, such as a pig (heterograft).

BIOLOGICS. A class of drugs produced by means of biological processes involving recombinant DNA technology.

BIOMARKER. A biochemical substance that can be detected in blood samples and indicates the presence of a cancerous tumor.

BIOPSY. A diagnostic procedure in which a small sample of tissue is obtained and examined under the microscope to determine they type and stage of a disease.

BIOSYNTHESIS. The manufacture of materials in a biological system.

BIOTERRORISM. The intentional use of disease-causing microbes or other biologic agents to intimidate or terrorize a civilian population for political or military reasons.

BIOTIN. A B complex vitamin, found naturally in yeast, liver, and egg yolks.

BIOTYPE. A variant strain of a bacterial species with distinctive physiological characteristics.

BIPOLAR DISORDER. A mood disorder marked by alternating episodes of extremely low mood (depression) and exuberant highs (mania). Also known as manic–depressive disorder.

BISMUTH. A substance used in medicines to treat diarrhea, nausea, and indigestion.

BISPHOSPHONATE. A class of drugs used to treat Paget's disease. These drugs bind to the minerals in bone tissue and lessen the amount of bone loss associated with Paget's disease.

BITOT'S SPOTS. Bitot's spots are superficial, foamy gray, triangular spots on the white of the eyeball.

BLACKHEAD. A plug of fatty cells capped with a blackened mass.

BLADDER. A balloon-like organ located in the lower abdomen that stores urine.

BLADDER NECK. The place where the urethra and bladder join.

BLADDER OBSTRUCTION. A blockage of the bladder caused by the presence of calculi (e.g., mineral deposits) or an anatomic abnormality.

BLADDER SPHINCTER. The outlet that releases urine into the urethra.

BLADDER TRAINING. A behavioral modification program used to treat stress incontinence. Bladder training involves putting the patient on a toilet schedule, and gradually increasing the time interval between urination.

BLASTEMAL. An immature material from which cells and tissues develop.

BLASTOCYST. A cluster of cells representing multiple cell divisions that have occurred in the Fallopian tube after successful fertilization of an ovum by a sperm. This is the developmental form which must leave the Fallopian tube, enter the uterus, and implant itself in the uterus to achieve actual pregnancy.

BLEACHING. Technique used to brighten stained teeth.

BLEEDING DISORDER. Problems in the clotting mechanism of the blood.

BLENDED FAMILY. A family formed by the remarriage of a divorced or widowed parent. It includes the new husband and wife, plus some or all of their children from previous marriages.

BLEPHARITITS. An inflammation of the eyelid.

BLEPHAROPLASTY. Surgical reshaping of the eyelid.

BLOOD BANK. A laboratory that specializes in blood typing, antibody identification, and transfusion services.

BLOOD CLOT. A dense mat formed by certain components of the blood stream to prevent blood loss.

BLOOD CULTURE. A procedure where blood is collected from a vein and is placed in a small bottle that contains a special liquid; the liquid will make any organisms that are present in the blood sample grow. These organisms can then be grown and identified in the laboratory so that the proper antibiotic can be given to the patient.

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BLOOD GAS ANALYSIS. A blood test that measures the level of oxygen, carbon dioxide, and pH in arterial blood. A blood gas analysis can help a physician assess how well the lungs are functioning.

BLOOD GLUCOSE. The main sugar that the body makes from the food in the diet.

BLOOD PERFUSION. A physiological term that refers to the process of nutritive delivery of arterial blood to a capillary bed in the biological tissue.

BLOOD SUGAR. The concentration of glucose in the blood.

BLOOD TYPE. Blood categories based on the presence or absence of certain antigens on the red blood cells.

BLOOD UREA NITROGEN (BUN). A waste product that is formed in the liver and collects in the bloodstream; patients with kidney failure have high BUN levels.

BLOOD VESSELS. General term for arteries, veins, and capillaries that transport blood throughout the body.

BLOOD-BRAIN BARRIER. A specialized, semi-permeable layer of cells around the blood vessels in the brain that controls which substances can leave the circulatory system and enter the brain.

BLOWOUT FRACTURE. A fracture or break in the orbit that is caused by sudden and violent impact to the area.

BODY DYSMORPHIC DISORDER. A psychiatric disorder marked by preoccupation with an imagined physical defect.

BODY IMAGE. A term that refers to a person's inner picture of his or her outward appearance. It has two components: perceptions of the appearance of one's body, and emotional responses to those perceptions.

BODY MASS INDEX (BMI). A measure of body fat: the ratio of body weight in kilograms to the square of body height in meters.

BODY PLETHYSMOGRAPHY. A very sensitive test given to measure damage to the lungs that might be missed by routine pulmonary function tests. The patient sits within a so-called airtight body box while various devices measure both the air pressure in the patient's alveoli and the airflow through the respiratory system.

BODYWORK. A term that covers a variety of therapies that include massage, realignment of the body, and similar techniques to treat deeply ingrained stresses and traumas carried in the tissues of the body.

BOIL. A collection of pus localized deep in the skin.

BONDING. Rebuilding, reshaping, and covering tooth defects using tooth-colored materials.

BONE DENSITOMETRY TEST. A test that quickly and accurately measures the density of bone.

BONE MARROW. A spongy tissue located in the hollow centers of certain bones, such as the skull and hip bones. Bone marrow is the site of blood cell generation.

BONE MARROW ASPIRATION AND BIOPSY. A procedure in which a needle is inserted into the large bones of the hip or spine and a small piece of marrow is removed for microscopic examination.

BONE MARROW BIOPSY. A procedure in which cellular material is removed from the pelvis or breastbone and examined under a microscope to look for the presence of abnormal blood cells characteristic of specific forms of leukemia and lymphoma.

BONE MARROW SUPPRESSION. A decrease in cells responsible for providing immunity, carrying oxygen, and those responsible for normal blood clotting.

BONE MARROW TRANSPLANT. A procedure in which a quantity of bone marrow is extracted through a needle from a donor, and then passed into a patient to replace the patient's diseased or absent bone marrow.

BONE SCAN. An x-ray study in which patients are given an intravenous injection of a small amount of a radioactive material that travels in the blood. When it reaches the bones, it can be detected by x ray to make a picture of their internal structure.

BONE SPUR. Also called an osteophyte, it is an outgrowth or ridge that forms on a bone.

BORDATELLA PERTUSSIS. A bacteria that causes whooping cough by attaching itself to cells in the respiratory tract.

BORDERLINE PERSONALITY DISORDER (BPD). A pattern of behavior characterized by impulsive acts, intense but chaotic relationships with others, identity problems, and emotional instability.

BOTULINUM TOXIN (BOTULIN). A neurotoxin made by *Clostridium botulinum*; causes paralysis in high doses, but is used medically in small, localized doses to treat disorders associated with involuntary muscle contraction and spasms, in addition to strabismus.

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BOUGIE. A mercury-filled dilator in the shape of a cylinder or tapered cylinder. Bougies come in a range of different sizes.

BOUGIENAGE. The procedure of dilating tubal organs, like the esophagus, with a bougie or bougies.

BOVINE SPONGIFORM ENCEPHALOPATHY. A progressive, fatal disease of the nervous system of domestic animals. It is transmitted by eating infected food. Also known as Mad Cow disease.

BOWEL. The part of the intestines that is connected to the anus.

BOWEL LUMEN. The space within the intestine.

BOWEL OBSTRUCTION. Anything that prevents waste from moving normally to the anal opening.

BOWMAN'S CAPSULE. The structure surrounding the glomerulus.

BPH. Benign prostatic hyperplasia, a noncancerous disorder that causes the prostate to enlarge.

BRACES. An orthodontic appliance consisting or brackets cemented to the surface of each tooth and wires of stainless steel or nickel titanium alloy. Braces are used to treat malocclusion by changing the position of the teeth.

BRACHYTHERAPY. A type of radiation treatment for cancer in which the source of the radiation is applied directly to the surface of the body.

BRADYKINESIA. Extremely slow movement.

BRAIN DEATH. Irreversible cessation of brain function. Patients with brain death have no potential capacity for survival or for recovery of any brain function.

BRAIN STEM. The lower part of the brain directly connected to the spinal cord. It controls breathing and other vital functions.

BRAXTON HICKS' CONTRACTIONS. Short, fairly painless uterine contractions during pregnancy that may be mistaken for labor pains. They allow the uterus to grow and help circulate blood through the uterine blood vessels.

BRCA1 OR BRCA2 GENETIC MUTATION. A genetic mutation that predisposes otherwise healthy women to breast cancer.

BREAST BIOPSY. A procedure where suspicious tissue is removed and examined by a pathologist for cancer or other disease. The breast tissue may be obtained by open surgery, or through a needle.

BREECH BIRTH. Birth of a baby bottom-first, instead of the usual head first delivery. This can add to labor and delivery problems because the baby's bottom doesn't mold a passage through the birth canal as well as does the head.

BREECH POSITION. When a child is oriented feet first in the mother's uterus just before delivery.

BRIDGE. An appliance of one or more artificial teeth anchored by crowns on the adjacent teeth.

BRIEF PSYCHOTIC DISORDER. An acute, short-term episode of psychosis lasting no longer than one month. This disorder may occur in response to a stressful event.

BRIQUET'S SYNDROME. Another name for somatization disorder.

BROCA'S APHASIA. A condition characterized by either partial or total loss of the ability to express oneself, either through speech or writing. Hearing comprehension is not affected. This condition may result from a stroke, head injury, brain tumor, or infection.

BRONCHIAL. Relating to the air passages to and from the lungs including the bronchi and the bronchioles.

BRONCHIAL LAVAGE. A procedure that involves repeatedly washing the inside of the bronchial tubes of the lung.

BRONCHIAL TUBES. The major airways to the lungs and their main branches.

BRONCHIECTASIS. A disorder of the bronchial tubes marked by abnormal stretching, enlargement, or destruction of the walls. Bronchiectasis is usually caused by recurrent inflammation of the airway and is a diagnostic criterion of ABPA.

BRONCHIOLE. A very small thin-walled air passage in the lungs that branches off from a bronchus.

BRONCHITIS. Inflammation of the air passages of the lungs.

BRONCHOALVEOLAR LAVAGE. A way of obtaining a sample of fluid from the airways by inserting a flexible tube through the windpipe. Used to diagnose the type of lung disease.

BRONCHODILATOR. A drug that relaxes bronchial muscles resulting in expansion of the bronchial air passages.

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BRONCHOPLEURAL FISTULA. An abnormal connection between an air passage and the membrane that covers the lungs.

BRONCHOSCOPE. An illuminated instrument that is inserted into the airway to inspect and retrieve objects from the bronchial tubes.

BRONCHOSCOPY. A medical test that enables a physician to examine the breathing passages and lungs by inserting a hollow, lighted tube into the nostril (or mouth). Sometimes cells are collected by washing the lungs with a small amount of fluid.

BRONCHUS (PLURAL, BRONCHI). One of the two major divisions of the airway that lead into the right and left lungs.

BRUCH'S MEMBRANE. A membrane in the eye between the choroid membrane and the retina.

BRUIT. A roaring sound created by a partially blocked artery.

BRUTON'S AGAMMAGLOBULINEMIA TYROSINE KINASE (BTK). An enzyme vital for the maturation of B cells.

BRUXISM. Habitual clenching and grinding of the teeth because of stress. The behavior usually occurs during sleep.

BUBOES. Smooth, oval, reddened, and very painful swellings in the armpits, groin, or neck that occur as a result of infection with the plague.

BUCK'S FASCIA. The deep connective tissue of the penis.

BUERGER'S DISEASE. An episodic disease that causes inflammation and blockage of the veins and arteries of the limbs. It tends to be present almost exclusively on men under age 40 who smoke, and may require amputation of the hand or foot.

BUFFY COAT. The thin layer of concentrated white blood cells that forms when a tube of blood is spun in a centrifuge.

BULBAR MUSCLES. Muscles that control chewing, swallowing, and speaking.

BULIMIA NERVOSA. An eating disorder characterized by binging and purging (self-induced vomiting) behaviors.

BUPROPION. An antidepressant medication given to smokers for nicotine withdrawal symptoms. It is sold under the trade name Zyban.

BURNOUT. An emotional condition marked by tiredness, loss of interest, or frustration that interferes with job performance. Burnout is usually regarded as the result of prolonged stress.

BURSAE. A closed sac lined with a synovial membrane and filled with fluid, usually found in areas subject to friction, such as where a tendon passes over a bone.

BURSITIS. Inflammation of a bursa, a fluid-filled cavity or sac. In the body, bursae are located at places where friction might otherwise develop.

BUSPIRONE. An antianxiety medication that is also given for withdrawal symptoms. It is sold under the trade name BuSpar.

BUTTERFLY BANDAGE. A narrow strip of adhesive with wider flaring ends (shaped like butterfly wings) used to hold the edges of a wound together while it heals.

BUTTON BATTERIES. Tiny, round batteries containing mercuric chloride that power items such as watches, hearing aids, calculators, cameras, and penlights.

BYPASS SURGERY. A surgical procedure that grafts blood vessels onto arteries to reroute the blood flow around blockages in the arteries (arteriosclerosis).

C

CA 125 (CANCER ANTIGEN 125). A tumor marker associated with ovarian cancer.

CA 15-3 (CANCER ANTIGEN 15-3). A tumor marker associated with breast cancer.

CA 19-9 (CANCER ANTIGEN 19-9). A tumor marker associated with pancreatic cancer.

CA 27-29 (BREAST CARCINOMA-ASSOCIATED ANTIGEN). A tumor marker associated with breast cancer.

CACHEXIA. Severe malnutrition involving muscle wasting and organ damage.

CADAVER. The human body after death.

CADAVER KIDNEY. A kidney from a brain-dead organ donor used for purposes of kidney transplantation.

CADAVER ORGAN. A pancreas, kidney, or other organ from a brain-dead organ donor.

CADAVERIC DONOR. An organ donor who has recently died of causes not affecting the organ intended for transplant.

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CADUCEUS. The ancient and universal symbol of medicine consisting of the winged staff of Mercury and two intertwining serpents.

CAFFEINISM. A group of symptoms caused by excess caffeine.

CAGE. A four–question assessment for the presence of alcoholism in both adults and children.

CALCANEOUS. The heel bone.

CALCIFICATION. Hardening or stiffening due to calcium accumulation.

CALCIFIED. Hardened by calcium deposits.

CALCITONIN. A naturally occurring hormone made by the thyroid gland that can be used as a drug to treat Paget's disease.

CALCIUM. A mineral that helps build bone.

CALCIUM CHANNEL BLOCKER. A drug that blocks the entry of calcium into the muscle cells of small blood vessels (arterioles) and keeps them from narrowing.

CALCULI (SINGULAR, CALCULUS). Mineral deposits that can form a blockage in the urinary system.

CALCULUS. A hardened yellow or brown mineral deposit from unremoved plaque; also called tartar.

CALICIVIRUS. A member of the *Caliciviridae* family of viruses that includes noroviruses.

CALLUS. Thickened skin due to chronic rubbing or irritation.

CALORIC TESTING. Flushing warm and cold water into the ear stimulates the labyrinth and causes vertigo and nystagmus if all the nerve pathways are intact.

CALORIE. A unit of heat measurement used in nutrition to measure the energy value of foods. A calorie is the amount of heat energy needed to raise the temperature of 1 kilogram of water 1°C.

CALORIE REDUCTION. A decrease in the number of calories that a person consumes.

CANALICULI. Also known as lacrimal ducts, these tube-like structures carry the tears from the eyes to the lacrimal sac.

CANCER. A disease caused by uncontrolled growth of the body's cells.

CANCER STAGING. A surgical procedure to remove a lymph node and examine the cells for cancer. It determines the extent of the cancer and how far it has spread.

CANCER VACCINES. A treatment that uses the patient's immune system to attack cancer cells.

CANDIDIASIS. A common fungal infection caused by yeast that thrives in moist, warm areas of the body.

CANINE; CUSPID. Eyetooth; the conical, pointed tooth between the lateral incisor and the first primary molar or permanent premolar.

CANKER SORE. A blister-like sore on the inside of the mouth that can be painful but is not serious.

CANNABINOIDS. The chemical compounds that are the active principles in marijuana.

CANNULA. A tube inserted into a cavity to serve as a channel for the transport of fluid.

CAPILLARY. Smallest extremity of the arterial vessel, where oxygen and nutrients are released from the blood into the cells, and cellular waste is collected.

CAPILLARY BED. A dense network of tiny blood vessels that enables blood to fill a tissue or organ.

CAPSAICIN. An alkaloid found in hot peppers that is used in an inhalation test to identify patients with MCS.

CAPSID. The outer protein coat of a virus.

CAPSULAR CONTRACTURE. Thick scar tissue around a breast implant, which may tighten and cause discomfort and/or firmness.

CARBOHYDRATE. Sugars, starches, celluloses, and gums that are a major source of calories from foods.

CARBON DIOXIDE. A heavy, colorless gas that dissolves in water.

CARBON MONOXIDE. A colorless, odorless, highly poisonous gas.

CARBON MONOXIDE DIFFUSING TEST. Also called the transfer factor test, this test measures the ability of the patient's lungs to transfer blood gases.

CARBONIC ANHYDRASE INHIBITOR. A class of diuretic drugs that inhibit the enzyme carbonic anhydrase, an enzyme involved in producing bicarbonate, which is required for aqueous humor production by the ciliary tissues in the eye.

CARBOXYHEMOGLOBIN (COHB). Hemoglobin that is bound to carbon monoxide instead of oxygen.

CARBUNCLE. A large, deep skin abscess formed by a group or cluster of boils.

CARCINOGEN. An agent that is known to cause cancer.

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CARCINOID SYNDROME. The pattern of symptoms (often including asthma and diarrhea) associated with carcinoid tumors of the digestive tract or lungs.

CARCINOMA IN SITU. Cancer that is confined to the cells in which it originated and has not spread to other tissues.

CARDIAC ANGIOGRAPHY. A procedure used to visualize blood vessels of the heart. A catheter is used to inject a dye into the vessels; the vessels can then be seen by x ray.

CARDIAC ARREST. A condition in which the heart stops functioning. Fibrillation can lead to cardiac arrest if not corrected quickly.

CARDIAC ARRHYTHMIA. An irregular heart rate (frequency of heartbeats) or rhythm (the pattern of heartbeats).

CARDIAC CATHETER. Long, thin, flexible tube that is threaded into the heart through a blood vessel.

CARDIAC CATHETERIZATION. A diagnostic procedure (using a catheter inserted through a vein and threaded through the circulatory system to the heart) which does a comprehensive examination of how the heart and its blood vessels function.

CARDIAC DYSRHYTHMIAS. Abnormal heart rate, rhythm, or sequence of rhythms.

CARDIAC MARKER. A substance in the blood that rises following a heart attack.

CARDIAC REHABILITATION. A structured program of education and activity offered by hospitals and other organizations.

CARDIAC SHUNT. A defect in the wall of the heart that allows blood from different chambers to mix.

CARDIAC TAMPONADE. Compression and restriction of the heart that occurs when the pericardium fills with blood or fluid. This increase in pressure outside the heart interferes with heart function and can result in shock and/or death.

CARDIOGENIC. Originating with the heart.

CARDIOLOGIST. A doctor who specializes in diagnosing and treating disorders of the heart.

CARDIOMEGALY. An enlarged heart.

CARDIOMYOPATHY. A disease of the heart muscle.

CARDIOPULMONARY. Relating to the heart and lungs.

CARDIOPULMONARY BYPASS MACHINE. A mechanical instrument that takes over the circulation of the body while heart surgery is taking place.

CARDIOPULMONARY DISEASE. Illness of the heart and lungs.

CARDIOPULMONARY RESUSCITATION (CPR). Using rescue breathing and chest compressions to help a person whose breathing and heartbeat have stopped.

CARDIOVASCULAR. Relating to the heart and blood vessels.

CARDIOVASCULAR DISEASE. A structural or functional abnormality of the heart, or of the blood vessels supplying the heart, that impairs its normal function.

CARDIOVERSION. A electrical shock delivered to the heart to restore a normal rhythm.

CARDIOVERTER. A device to apply electric shock to the chest to convert an abnormal heartbeat into a normal heartbeat.

CARIES. The medical term for tooth decay.

CARNASSIALS. The last upper premolar teeth in the mouths of cats and other carnivores, adapted to shear or puncture food. Carnassial teeth often cause puncture wounds when a cat bites a human.

CAROTENOIDS. Carotenoids are yellow to deep-red pigments.

CAROTID ARTERY. An artery located in the neck. There are two on each side of the neck. The internal carotid artery carries blood to the brain while the external carotid artery carries blood to skin and muscles of the face.

CAROTID ARTERY DISEASE. A condition in which the arteries in the neck that supply blood to the brain become clogged, causing the danger of a stroke.

CAROTID ENDARTERECTOMY. A surgical technique for removing intra-arterial obstructions of the internal carotid artery.

CARPAL TUNNEL. A passageway in the wrist, created by the bones and ligaments of the wrist, through which the median nerve passes.

CARPAL TUNNEL SYNDROME. A condition caused by compression of the median nerve in the carpal tunnel of the hand, characterized by pain.

CARRIER. A person who bears or carries a disease agent in or on their body and can transmit the disease to others, but is immune to the disease or has no symptoms of it.

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CARRIER OIL. An oil used to dilute essential oils for use in massage and other skin care applications.

CARRIER STATE. The continued presence of an organism (bacteria, virus, or parasite) in the body that does not cause symptoms, but is able to be transmitted and infect other persons.

CARTILAGE. A flexible, fibrous type of connective tissue which serves as a base on which bone is built.

CASE MANAGER. A health-care professional who can provide assistance with a patient's needs beyond the hospital.

CASEIN HYDROLYSATE. A preparation made from the milk protein casein, which is hydrolyzed to break it down into its constituent amino acids. Amino acids are the building blocks of proteins.

CASTS. Small fibrous objects formed from materials that collect in the kidney tubules and are washed out by normal urine flow.

CATABOLIC. A metabolic process in which energy is released through the breakdown of complex molecules into simpler ones.

CATABOLISM. A process of metabolism that breaks down complex substances into simple ones.

CATALYST. A substance that changes the rate of a chemical reaction, but is not physically changed by the process.

CATAPLEXY. Sudden loss of muscle tone (often causing a person to fall), usually triggered by intense emotion. It is regarded as a diagnostic sign of narcolepsy.

CATARACT. A condition in which the lens of the eye turns cloudy and interferes with vision.

CATATONIA. Psychomotor disturbance characterized by muscular rigidity, excitement or stupor.

CATATONIC BEHAVIOR. Behavior characterized by muscular tightness or rigidity and lack of response to the environment. In some patients rigidity alternates with excited or hyperactive behavior.

CATECHOLAMINES. Family of neurotransmitters containing dopamine, norepinephrine and epinephrine, produced and secreted by cells of the adrenal medulla and the brain.

CATHARSIS. Therapeutic discharge of emotional tension by recalling past events.

CATHARTIC COLON. A poorly functioning colon, resulting from the chronic abuse of stimulant cathartics.

CATHETER. A hollow flexible tube that is inserted into a body cavity, duct, or vessel for the passage of fluids.

CATHETERIZATION. Inserting a tube into the bladder so that a patient can urinate without leaving the bed.

CATHODE. The negative electrode from which an electromagnetic current flows.

CATION. An ion carrying a positive charge due to a loss of electrons. Cations in the body include sodium, potassium, magnesium, and calcium ions.

CAT-SCRATCH DISEASE. An infectious disease caused by bacteria transmitted by the common cat flea that causes a self-limiting, mild infection in healthy people.

CAUDA EQUINA. The collection of spinal nerve roots that lie inside the spinal column below the end of the spinal cord. The name comes from the Latin for "horse's tail."

CAUDA EQUINA SYNDROME (CES). A group of symptoms characterized by numbness or pain in the legs and/or loss of bladder and bowel control, caused by compression and paralysis of the nerve roots in the cauda equina. CES is a medical emergency.

CAUSALGIA. A severe burning sensation sometimes accompanied by redness and inflammation of the skin. Causalgia is caused by injury to a nerve outside the spinal cord.

CAUTERIZE. To damage with heat or cold so that tissues shrink. It is an effective way to stop bleeding.

CAUTERY. The use of heat, electricity, or chemicals to destroy tissue.

CAVITY. A hole or weak spot in the tooth surface caused by decay.

CD4. A type of protein molecule in human blood that is present on the surface of 65% of human T cells. CD4 is a receptor for the HIV virus.

CD4 COUNT. A measure of the strength of the immune system.

CEA (CARCINOEMBRYONIC ANTIGEN). A tumor marker associated with many cancers, especially liver, intestinal, and pancreatic.

CECUM. The beginning of the large intestine and the place where the appendix attaches to the intestinal tract.

CELIAC DISEASE. A disease, occurring in both children and adults, which is caused by a sensitivity to

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gluten, a protein found in grains. It results in chronic inflammation and shrinkage of the lining of the small intestine.

CELL. The smallest living units of the body which group together to form tissues and help the body perform specific functions.

CELLULITE. Dimpled skin that is caused by uneven fat deposits beneath the surface.

CELLULITIS. Inflammation of tissue due to infection.

CENTRAL LINE. A tube placed by needle into a large, central vein of the body.

CENTRAL NERVOUS SYSTEM (CNS). Part of the nervous system consisting of the brain, cranial nerves and spinal cord.

CENTRAL NERVOUS SYSTEM (CNS) DEPRESSANT. Any drug that tends to reduce the activity of the central nervous system. The major drug categories included in this classification are: alcohol, anesthetics, anti-anxiety medications, antihistamines, antipsychotics, hypnotics, narcotics, sedatives, and tranquilizers.

CENTRAL PRECOCIOUS PUBERTY (CPP). Precocious puberty resulting from the early maturation of the HPG axis.

CENTRAL RETINAL ARTERY. A branch of the ophthalmic artery that supplies blood to the retina and branches to form the arterioles of the retina.

CENTRAL RETINAL VEIN. Central blood vessel and its branches that drains the retina.

CENTROMERE. The centromere is the constricted region of a chromosome. It performs certain functions during cell division.

CEPHALOPELVIC DISPROPORTION (CPD). The condition in which the baby's head is too large to fit through the mother's pelvis.

CERCARIA (PLURAL, CERCARIAE). An intermediate-stage of the fluke larva, released into water by infected snails.

CEREBELLAR. Involving the part of the brain (cerebellum), which controls walking, balance, and coordination.

CEREBRAL. Pertaining to the brain.

CEREBRAL ANEURYSM. The dilation, bulging, or ballooning out of part of the wall of a vein or artery in the brain.

CEREBRAL ANGIOGRAPHY. A medical test in which an x-ray visible dye is injected into blood vessels to allow them to be imaged on an x ray.

CEREBRAL CORTEX. Brain region responsible for reasoning, mood, and perception.

CEREBRAL EDEMA. Movement of water into brain cells causing the cells to swell, which disrupts normal functioning of the cells.

CEREBRAL EMBOLISM. A blockage of blood flow through a vessel in the brain by a blood clot that formed elsewhere in the body and traveled to the brain.

CEREBRAL PALSY. Brain damage before, during, or just after birth that results in lack of muscle coordination and problems with speech.

CEREBRAL THROMBOSIS. A blockage of blood flow through a vessel in the brain by a blood clot that formed in the brain itself.

CEREBROSIDES. Fatty carbohydrates that occur in the brain and nervous system.

CEREBROSPINAL FLUID (CSF). The clear fluid that surrounds the spinal cord and brain and acts as a shock absorber.

CEREBROSPINAL FLUID ANALYSIS. An analysis that is important in diagnosing diseases of the central nervous system. The fluid within the spine will indicate the presence of viruses, bacteria, and blood. Infections such as encephalitis will be indicated by an increase of cell count and total protein in the fluid.

CEREBROVASCULAR DISEASE. Disorders affecting the blood vessels that supply the brain that may result in a stroke.

CERULOPLASMIN. A protein circulating in the bloodstream that binds with copper and transports it.

CERUMEN. The medical term for earwax.

CERVICAL. Relating to the top part of the spine that is composed of the seven vertebrae of the neck and the disks that separate them.

CERVICAL CANCER. Cancer of the entrance to the womb (uterus). The cervix is the lower, narrow part of the uterus (womb).

CERVICAL CANCER SCREENING. Use of the Papanicolaou (Pap) smear test to detect cervical cancer in the early curable stage.

CERVICAL CERCLAGE. A procedure in which the cervix is sewn closed; used in cases when the cervix

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starts to dilate too early in a pregnancy to allow the birth of a healthy baby.

CERVICAL DYSPLASIA. Dysplasia is the abnormal growth of the epithelial cells. This is what a Pap smear will detect in the cervix.

CERVICAL INTRA-EPITHELIAL NEOPLASIA (CIN). A precancerous condition in which a group of cells grow abnormally on the cervix but do not extend into the deeper layers of this tissue.

CERVICAL POLYPS. Growths originating from the surface of the cervix or endocervical canal. These small, fragile growths hang from a stalk and protrude through the cervical opening (the os).

CERVICITIS. Cervicitis is an inflammation of the cervix or neck of the uterus.

CERVIX. A small cylindrical organ about an inch or so long and less than an inch around that makes up the lower part and neck of the uterus. The cervix separates the body and cavity of the uterus from the vagina.

CESAREAN SECTION; C-SECTION. A surgical procedure in which an incision is made in a woman's abdomen to deliver the infant from the uterus.

CESTODIASIS. Parasitic infection caused by the presence of adult tapeworms of the class Cestoda within the intestinal tract. Infection is caused by accidental consumption of tapeworm larvae.

CFTR. Cystic fibrosis transmembrane conductance regulator. The protein responsible for regulating chloride movement across cells in some tissues. When a person has two defective copies of the CFTR gene, cystic fibrosis is the result.

CGG OR CGG SEQUENCE. Shorthand for the DNA sequence: cytosine-guanine-guanine. Cytosine and guanine are two of the four molecules, otherwise called nucleic acids, that make up DNA.

CHAGAS DISEASE. A parasitic disease that causes mild early swelling at the site of the infection, then becomes asymptomatic for many years, but later may cause serious heart and digestive system problems. Parasites causing this disease are most common in rural Central and South America.

CHAKRA. One of seven major energy centers in the body, as defined by Hindu and yoga philosophy.

CHANCRE. An open sore with a firm or hard base that is the initial skin ulcer of primary syphilis.

CHARACTER DISORDER. Another name for personality disorder.

CHELATE. A chemical that binds to heavy metals in the blood, thereby helping the body to excrete them in urine.

CHELATION. The process by which a molecule encircles and binds to a metal and removes it from tissue.

CHELATION THERAPY. A method of removing copper or other heavy metals from the body by giving medications that bind to the metal and allow it to be excreted.

CHELATORS. Various compounds that bind to metals such as mercury.

CHEMOPREVENTIVE. Description of a drug given in order to prevent the development of a specific disease.

CHEMOTHERAPY. A cancer treatment that uses synthetic drugs to destroy the tumor either by inhibiting the growth of the cancerous cells or by killing the cancer cells.

CHEST X RAY. A diagnostic procedure in which a very small amount of radiation is used to produce an image of the structures of the chest (heart, lungs, and bones) on film.

CHI. Basic life energy.

CHIARI II ANOMALY. A structural abnormality of the lower portion of the brain (cerebellum and brain stem) associated with spina bifida. The lower structures of the brain are crowded and may be forced into the foramen magnum, the opening through which the brain and spinal cord are connected.

CHILD DEVELOPMENT. The process of physical, intellectual, emotional, and social growth that occurs from infancy through adolescence.

CHILDREN'S HOSPICE. A holistic philosophy that addresses the physical, emotional, social, and spiritual needs of children with life-threatening illnesses, as well as the needs of their families.

CHIROPRACTIC. A method of treatment based on the interactions of the spine and the nervous system. Chiropractors adjust or manipulate segments of the patient's spinal column in order to relieve pain.

CHLAMYDIA. One of the most common sexually transmitted diseases in the United States. It can cause discharge, inflammation and burning during urination. About half of the cases of nongonococcal urethritis are due to chlamydia.

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CHLAMYDIA PSITTACI. An organism related to bacteria that infects some types of birds and can be transmitted to humans to cause parrot fever.

CHLOASMA. A skin discoloration common during pregnancy, also known as the "mask of pregnancy" or melasma, in which blotches of pale brown skin appear on the face. It is usually caused by hormonal changes.

CHLOROQUINE. An antimalarial drug that was first used in the 1940s, until the first evidence of quinine resistance appeared in the 1960s. It is now ineffective against falciparum malaria almost everywhere. However, because it is inexpensive, it is still the antimalarial drug most widely used in Africa. Native individuals with partial immunity may have better results with chloroquine than a traveler with no previous exposure.

CHOLANGIOGRAPHY. Radiographic examination of the bile ducts after injection with a special dye.

CHOLANGITIS. Infection or inflammation of the bile ducts; often causes abdominal pain, fever, and jaundice.

CHOLECYSTECTOMY. Surgical removal of the gallbladder.

CHOLECYSTITIS. Infection and inflammation of the gallbladder, causing severe pain and rigidity in the upper right abdomen.

CHOLECYSTOTOMY. An operation during which the gallbladder is opened, gallstones are removed, and excess bile is drained. The gallbladder is not removed.

CHOLEDOCHOLITHIASIS. The presence of gallstones within the common bile duct.

CHOLELITHIASIS. Also known as gallstones, these hard masses are formed in the gallbladder or passages, and can cause severe upper right abdominal pain radiating to the right shoulder, as a result of blocked bile flow.

CHOLELITHOTOMY. Surgical incision into the gallbladder to remove stones.

CHOLERA. A severe bacterial infection of the small intestine characterized by profuse diarrhea and eventual dehydration. Cholera is still a frequent cause of death among children in developing countries.

CHOLESCINTIGRAPHY. Another term for a gallbladder nuclear medicine scan.

CHOLESTATIS. Stoppage or suppression of the flow of bile.

CHOLESTEATOMA. A cystic mass of cells in the middle ear, occurring as a congential defect or as a serious complication of a disease or traumtic condition of the ear.

CHOLESTEROL. A fat–soluble steroid alcohol (sterol) found in animal fats and oils, and in egg yolks. The human body needs cholesterol to produce vitamin D.

CHOLESTYRAMINE (QUESTRAN). A drug used to bind with bile acids and prevent their reabsorption and to stimulate fat absorption.

CHOLINERGIC DRUG. A medication that mimics or enhances the action of the neurotransmitter acetylcholine.

CHOLINERGIC NERVES. Nerves that are stimulated by acetylcholine.

CHOLINESTERASE INHIBITORS. Drugs that may slow the progression of AD by inhibiting the enzymes that break down acetylcholine.

CHOREA. A term that is used to refer to rapid, jerky, involuntary movements of the limbs or face that characterize several different disorders of the nervous system, including chorea of pregnancy and Huntington's chorea as well as Sydenham's chorea.

CHORION. The outer embryonic membrane of the developing fetus that gives rise to the placenta. Inside the chorion is the amniotic sac or sacs, inside of which are the fetuses.

CHORIONIC VILLI. Microscopic, finger-like projections that emerge from the outer sac which surrounds the developing baby. Chorionic villi are of fetal origin and eventually form the placenta.

CHORIONIC VILLUS SAMPLING (CVS). A procedure used for prenatal diagnosis at 10–12 weeks gestation. Under ultrasound guidance a needle is inserted either through the mother's vagina or abdominal wall and a sample of cells is collected from around the early embryo. These cells are then tested for chromosome abnormalities or other genetic diseases.

CHOROID. The part of the uveal tract behind the ciliary body. The choroid underlies and nourishes the retina and absorbs scattered light.

CHROMATOGRAPHY. A family of laboratory techniques that separate mixtures of chemicals into their individual components.

CHROMOSOME. A microscopic thread–like structure found within each cell of the body consisting of a

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complex of proteins and DNA. Humans have 46 chromosomes arranged into 23 pairs.

CHRONIC. A disease or condition that progresses slowly but persists or reoccurs over time.

CHRONIC BRONCHITIS. A smoking-related respiratory illness in which the membranes that line the bronchi, or the lung's air passages, narrow over time. Symptoms include a morning cough that brings up phlegm, breathlessness, and wheezing.

CHRONIC HEPATITIS. Long lasting inflammation of the liver due to viruses or other causes.

CHRONIC KIDNEY FAILURE. End-stage renal disease (ESRD); chronic kidney failure is diagnosed as ESRD when kidney function falls to 5–10% of capacity.

CHRONIC LYMPHOCYTIC LEUKEMIA. A cancer of the blood cells characterized by large numbers of cancerous, mature white blood cells and enlarged lymph nodes.

CHRONIC MYELOGENOUS LEUKEMIA (CML). Also called chronic myelocytic leukemia, a malignant disorder that involves abnormal accumulation of white cells in the marrow and bloodstream.

CHRONIC OBSTRUCTIVE LUNG DISEASE. A common form of lung disease in which breathing, and therefore gas exchange, is labored and increasingly difficult.

CHRONIC OBSTRUCTIVE PULMONARY DISEASE (COPD). A term used to describe chronic lung diseases, like chronic bronchitis, emphysema, and asthma.

CHRONIC OTITIS MEDIA. Inflammation of the middle ear with signs of infection lasting three months or longer.

CHRONIC PAIN. Pain that lasts beyond the term of an injury or painful stimulus.

CHRONIC RENAL (KIDNEY) FAILURE. Progressive loss of kidney function over several years that can result in permanent kidney failure requiring dialysis.

CHYMOPAPAIN. An enzyme from the milky white fluid of the papaya, used for medical purposes in chemonucleolysis.

CILIA (SINGULAR, CILIUM). Tiny hair-like projections from a cell. Within the respiratory tract, the cilia act to move mucus along, in an effort to continually flush out and clean the respiratory tract.

CILIARY BODY. A structure in the eye that contains muscles that will affect the focusing of the lens.

CILIARY MUSCLES. The small muscles that permit the lens to change its shape in order to focus on near or distant objects.

CILIATED. Covered with short, hair-like protrusions, like *B. coli* and certain other protozoa. The cilia or hairs help the organism to move.

CIRCADIAN RHYTHM. Any body rhythm that recurs in 24-hour cycles. The sleep-wake cycle is an example of a circadian rhythm.

CIRCULATION. The passage of blood and delivery of oxygen through the veins and arteries of the body.

CIRCUMCISION. A procedure, usually with religious or cultural significance, in which the prepuce—the skin covering the tip of the male penis or the female clitoris, is cut away.

CIRRHOSIS. A chronic degenerative disease of the liver, in which normal cells are replaced by fibrous tissue. Cirrhosis is a major risk factor for the later development of liver cancer.

CITALOPRAM HYDROBROMIDE. An SSRI that is highly specific for serotonin reuptake.

CLASSIC INCISION. In a cesarean section, an incision made vertically along the uterus.

CLASSIC KAPOSI'S SARCOMA. A form of KS that usually affects older men of Mediterranean or eastern European backgrounds and produces tumors on the lower legs.

CLASSICAL CONDITIONING. The memory system that links perceptual information to the proper motor response. For example, Ivan Pavlov conditioned a dog to salivate when a bell was rung.

CLAUDICATION. Cramping or pain in a leg caused by poor blood circulation. This condition is frequently caused by hardening of the arteries (atherosclerosis). Intermittent claudication occurs only at certain times, usually after exercise, and is relieved by rest.

CLEAN CATCH SPECIMEN. A urine specimen that is collected from the middle of the urine stream after the first part of the flow has been voided.

CLEFT PALATE. Congenital defect marked by a split in the roof of the mouth.

CLINDAMYCIN. An antibiotic that can be used instead of penicillin.

CLINICAL AROMATHERAPY. Aromatherapy is the therapeutic use of plant-derived, aromatic essential oils to promote physical and psychological well-being. It is sometimes used in combination with

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massage and other therapeutic techniques as part of a holistic treatment approach.

CLINICAL NUTRITION. The use of diet and nutritional supplements as a way to enhance health prevent disease.

CLINICAL TRIALS. Highly regulated and carefully controlled patient studies, where either new drugs to treat cancer or novel methods of treatment are investigated.

CLITORIDECTOMY. A procedure in which the clitoris and possibly some of the surrounding labial tissue at the opening of the vagina is removed.

CLITORIS. The small erectile organ at the front of the female vulva that is the site of female sexual pleasure.

CLOFIBRATE (ALTROMED-S). Medication used to lower levels of blood cholesterol and triglycerides.

CLONIC. Referring to clonus, rapid contractions and relaxations of a muscle.

CLOSED-HEAD INJURY. An injury to the head in which the skull is not broken or penetrated.

CLOSTRIDIUM. A genus of deadly bacteria that are responsible for tetanus and other serious diseases, including botulism and gangrene from war wounds. Clostridia thrives without oxygen.

CLOT. A soft, semi-solid mass that forms when blood gels.

CLOTTING FACTOR. Also known as coagulation factors. Proteins in the plasma that serve to activate various parts of the blood clotting process by being transformed from inactive to active form.

CLUBBING. Rounding of the ends and swelling of fingers found in people with lung disease.

CNS DEPRESSANT. Anything that depresses, or slows, the sympathetic impulses of the central nervous system (i.e., respiratory rate, heart rate).

COAGULATING FACTORS. Components within the blood that help form clots.

COAGULATION. The entire process of blood clotting.

COAGULATION CASCADE. The sequence of biochemical activities, involving clotting factors, that stop bleeding by forming a clot.

COAGULATION FACTORS. Specific coagulation proteins in the blood required for clotting. Coagulation proteins are designated with roman numerals I through XIII.

COAGULOPATHY. A disorder in which blood is either too slow or too quick to coagulate (clot).

COARCTATION. The medical term for a constriction or narrowing.

COARCTATION OF THE AORTA. A congenital defect in which severe narrowing or constriction of the aorta obstructs the flow of blood.

COBB ANGLE. A measure of the curvature of scoliosis, determined by measurements made on x rays.

COCCYDYNIA. Also called coccygodynia. Pain in or around the coccyx.

COCCYX. The last bone of the spinal column, consisting of three to five fused vertebrae that connect with the sacrum, a part of the pelvis.

COCHLEA. The hearing part of the inner ear. This snail-shaped structure contains fluid and thousands of microscopic hair cells tuned to various frequencies, in addition to the organ of Corti (the receptor for hearing).

COENZYME. A substance needed by enzymes to produce many of the reactions in energy and protein metabolism in the body.

COENZYME Q_{10}. A substance used by cells in the human body to produce energy for cell maintenance and growth. It is being studied as a possible preventive for migraine headaches.

COGNITION. The mental activities associated with thinking, learning, and memory.

COGNITIVE BEHAVIORAL THERAPY. A psychotherapeutic approach that aims at altering cognitions—including thoughts, beliefs, and images—as a way of altering behavior.

COGNITIVE PROCESSES. Thought processes (i.e., reasoning, perception, judgment, memory).

COGNITIVE RESTRUCTURING. The process of replacing maladaptive thought patterns with constructive thoughts and beliefs.

COGNITIVE-BEHAVIORAL THERAPY (CBT). A psychotherapeutic approach that emphasizes correcting distorted thinking patterns and changing one's behaviors accordingly.

COINFECTION. Invasion of the body by two viruses at about the same time.

COITUS. Sexual intercourse.

COLCHICINE. A compound that blocks the assembly of microtubules–protein fibers necessary for cell

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division and some kinds of cell movements, including neutrophil migration. Side effects may include diarrhea, abdominal bloating, and gas.

COLD AGGLUTININS. Antibodies that cause clumping of red blood cells when the blood temperature falls below normal body temperature (98.6°F/37°C).

COLD SORE. A small blister on the lips or face, caused by a virus. Also called a fever blister.

COLECTOMY. Surgical removal of the large bowel.

COLITIS. An inflammation of the large intestine that occurs in some cases of balantidiasis. It is marked by cramping pain and the passing of bloody mucus.

COLLAGEN. A protein that provides structural support; the main component of connective tissue.

COLLAGEN-VASCULAR DISEASE. Various diseases inflaming and destroying connective tissue.

COLLATERAL VESSEL. A side branch or network of side branches of a large blood vessel.

COLLATERALS. Alternate pathways for arterial blood.

COLON. The major part of the large intestine; a digestive system organ.

COLONIZATION. The presence of bacteria on a body surface (like on the skin, mouth, intestines or airway) without causing disease in the person.

COLONOSCOPE. A thin, flexible, hollow, lighted tube that is inserted through the anus and rectum to the colon to enable the physician to view the entire lining of the colon.

COLONOSCOPY. A diagnostic endoscopic procedure that uses a long flexible tube called a colonoscope to examine the inner lining of the entire colon; may be used for colorectal cancer screening or for a more thorough examination of the colon.

COLONY COUNT. A measurement of the growth of bacteria in a urine sample that has been cultured for 24 to 48 hours.

COLORECTAL CANCER. Cancer of the large intestine, or colon, including the rectum.

COLOSTOMY. A surgical procedure in which an opening is made in the wall of the abdomen to allow a part of the large intestine (the colon) to empty outside the body.

COLPOSCOPE. An instrument used for examination of the vagina and cervix. Part of the instrument includes a magnifying lens for better visualization.

COLPOSCOPY. Diagnostic procedure using a hollow, lighted tube (colposcope) to look inside the cervix and uterus.

COLUMELLA. The strip of skin running from the tip of the nose to the upper lip, which separates the nostrils.

COMA. A state of prolonged unconsciousness in which a person cannot respond to spoken commands or mildly painful physical stimuli.

COMEDO, COMEDONE. A hard plug composed of sebum and dead skin cells.

COMEDOLYTIC. A drug that breaks up comedones and opens clogged pores.

COMMINUTED FRACTURE. A fracture where there are several breaks in a bone creating numerous fragments.

COMMON BILE DUCT. The branching passage through which bile—a necessary digestive enzyme—travels from the liver and gallbladder into the small intestine. Digestive enzymes from the pancreas also enter the intestines through the common bile duct.

COMMON COLD. A mild illness caused by a upper respiratory viruses. Usual symptoms include nasal congestion, coughing, sneezing, throat irritation, and a low-grade fever.

COMMON PATHWAY. The pathway that results from the merging of the extrinsic and intrinsic pathways. The common pathway includes the final steps before a clot is formed.

COMMUNITY-ACQUIRED. Refers to an infectious disease that is passed among individuals who have close contact with one another.

COMORBID. Referring to the presence of one or more diseases or disorders in addition to the patient's primary disorder.

COMPARTMENT SYNDROME. Compartment syndrome is a condition in which a muscle swells but is constricted by the connective tissue around it, which cuts off blood supply to the muscle.

COMPATIBLE DONOR. A person whose tissue and blood type are the same as the recipient's.

COMPLEMENT. One of several proteins in the blood that acts with other proteins to assist in killing bacteria.

COMPLEMENTARY THERAPY. A therapy is called complementary when it is used in addition to conventional cancer treatments.

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COMPLETE BLOOD COUNT (CBC). A blood test to check the numbers of red blood cells, white blood cells, and platelets in the blood.

COMPLETE DENTURE. A full set of upper or lower teeth, mounted in a plastic base. Dentures are also called false teeth.

COMPLEX CARBOHYDRATES. Complex carbohydrates are broken down by the body into simple sugars for energy, are found in grains, fruits and vegetables. They are generally recommended in the diet over refined sugar and honey, because they are a more steady source of energy and often contain fiber and nutrients as well.

COMPLIANCE. A term used to describe how well a patient's behavior follows medical advice.

COMPLICATED GRIEF. An abnormal response to bereavement that includes unrelieved yearning for the dead person, the complete loss of previous positive beliefs or worldviews, and a general inability to function.

COMPOSITE FILLING. A resin material that is tooth colored and is used to fill a tooth once decay has been removed. It is used most often in front teeth, but may be used in any tooth for aesthetic reasons.

COMPOUND FRACTURE. A fracture in which the broken end or ends of the bone have torn through the skin. Compound fractures are also known as open fractures.

COMPOUND HETEROZYGOTES. Individuals who have one gene in a pair with one mutation and the other gene in the pair has a different mutation.

COMPRESSED AIR. Air that is held under pressure in a tank to be breathed by underwater divers. A tank of compressed air is part of a diver's scuba (self-contained underwater breathing apparatus) gear.

COMPRESSION. An increase in pressure from the surrounding water that occurs with increasing diving depth.

COMPULSION. A repetitive or ritualistic behavior that a person performs to reduce anxiety. Compulsions often develop as a way of controlling or undoing obsessive thoughts.

COMPULSIVE GAMBLING DISORDER. An impulse control disorder in which an individual cannot resist gambling despite repeated losses.

COMPUTED TOMOGRAPHY (CT OR CAT) SCAN. An imaging technique in which cross-sectional x rays of the body are compiled to create a three-dimensional image of the body's internal structures.

COMT INHIBITORS. Drugs that block catechol-o-methyl transferase, an enzyme that breaks down dopamine. COMT inhibitors include entacapone and tolcapone.

CONCENTRATION. Refers to the amount of solute present in a solution, compared to the total amount of solvent.

CONCEPTION. The union of egg and sperm to form a fetus.

CONDITIONING. Process of preparing a patient to receive marrow donation, often through the use of chemotherapy and radiation therapy.

CONDOM. A thin sheath worn over the penis during sexual intercourse to prevent pregnancy or the transmission of STDs. There are also female condoms.

CONDUCT DISORDER. A behavioral and emotional disorder of childhood and adolescence. Children with a conduct disorder act inappropriately, infringe on the rights of others, and violate societal norms.

CONDUCTION APHASIA. A condition characterized by the inability to repeat words, sentences, or phrases as a result of a stroke, head injury, brain tumor, or infection.

CONDUCTIVE HEARING LOSS. A type of medically treatable hearing loss in which the inner ear is usually normal, but there are specific problems in the middle or outer ears that prevent sound from getting to the inner ear in a normal way.

CONDYLOMATA ACUMINATA (SINGULAR, CONDYLOMA ACUMINATUM). The medical term for infectious warts on the genitals caused by HPV.

CONDYLOMATA LATA. Highly infectious patches of wart-like pink or gray skin legions in moist areas of the body that occur during secondary syphilis.

CONES. Receptor cells that allow the perception of colors.

CONFABULATION. An attempt to fill in memory gaps by fabricating information or details.

CONFIRMATORY TYPING. Repeat tissue typing to confirm the compatibility of the donor and patient before transplant.

CONGENITAL. A condition present at birth.

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CONGENITAL CYSTIC ADENOMATOID MALFORMATION (CCAM). A condition in which one or more lobes of the fetal lungs develop into fluid-filled sacs called cysts.

CONGENITAL DIAPHRAGMATIC HERNIA (CDH). A condition in which the fetal diaphragm—the muscle dividing the chest and abdominal cavity—does not close completely.

CONGENITAL HEART DEFECTS. Abnormal formation of structures of the heart or of its major blood vessels present at birth.

CONGESTIVE CARDIOMYOPATHY. Also called dilated cardiomyopathy; cardiomyopathy in which the walls of the heart chambers stretch, enlarging the heart ventricles so they can hold a greater volume of blood than normal.

CONGESTIVE HEART FAILURE. A condition in which the heart cannot pump enough blood to supply the body's tissues with sufficient oxygen and nutrients; back up of blood in vessels and the lungs causes buildup of fluid (congestion) in the tissues.

CONIZATION. Cone biopsy; removal of a cone–shaped section of tissue from the cervix for diagnosis or treatment.

CONJUCTIVA. The mucous membrane that covers the white part of the eyes and lines the eyelids.

CONN'S SYNDROME. A disorder caused by excessive aldosterone secretion by a benign tumor of one of the adrenal glands. This results in malfunction of the body's salt and water balance and subsequently causes hypertension. Symptoms include thirst, muscle weakness, and excessive urination.

CONNECTIVE TISSUE. A group of tissues responsible for support throughout the body, including cartilage, bone, fat, tissue underlying skin, and tissues that support organs, blood vessels, and nerves throughout the body.

CONSANGUNITY. Related from a common ancestor; blood relative.

CONSOLIDATION. A condition in which lung tissue becomes firm and solid rather than elastic and air-filled because it has accumulated fluids and tissue debris.

CONSTIPATION. The delayed or infrequent passage of dry, hard feces.

CONTACT DERMATITIS. Irritant dermatitis; direct skin contact with a substance that causes inflammation in some people.

CONTAMINATION. The process by which an object or body part becomes exposed to an infectious agent such as a virus.

CONTINENCE. The ability to control one's bladder and bowel functions.

CONTINUITY. Uninterrupted and successive.

CONTINUOUS POSITIVE AIRWAY PRESSURE (CPAP). A ventilation device that blows a gentle stream of air into the nose during sleep to keep the airway open.

CONTRACEPTION. The use of a device, sexual practice, or chemical intended to prevent conception; birth control.

CONTRACTION. A tightening of the uterus during pregnancy. Contractions may or may not be painful and may or may not indicate labor.

CONTRACTURE. A tightening of muscles that prevents normal movement of the associated limb or other body part.

CONTRAST AGENT. A chemical or other substance placed in the body to show structures that would not otherwise be visible on x ray or other imaging studies.

CONTRAST HYDROTHERAPY. A series of hot and cold water applications. A hot compress (as hot as an individual can tolerate) is applied for three minutes followed by an ice cold compress for 30 seconds. These applications are repeated three times each and ending with the cold compress.

CONTRAST MEDIUM. A substance that is swallowed or injected into the body to create clearer images in radiographic studies of internal structures.

CONTRAST SOLUTION. A liquid dye injected into the body that allows veins to be seen by x rays. Without the dye, the veins could not be seen on x rays.

CONVENTIONAL THERAPY. Treatments that are widely accepted and practiced by the mainstream medical community.

CONVERSION DISORDER. A somatoform disorder characterized by the transformation of a psychological feeling or impulse into a physical symptom. Conversion disorder was previously called hysterical neurosis, conversion type.

CONVULSION. Involuntary contractions of body muscles that accompany a seizure episode.

COOLEY'S ANEMIA. Another name for the most severe form of beta-thalassemia. It is named for Thomas Benton Cooley (1871–1945), an American pediatrician who first described it in the children of Italian immigrants.

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COPING. In psychology, a term that refers to a person's patterns of response to stress.

COPROLALIA. The involuntary expression of obscene words or phrases.

COPROPRAXIA. The involuntary display of unacceptable/obscene gestures.

COR PULMONALE. Enlargement and structural change of the right ventricle of the heart as a result of emphysema or other respiratory disorder.

CORDOCENTESIS. A procedure for delivering a blood transfusion to a fetus. It involves a fine needle being threaded through a pregnant woman's abdomen and into the umbilical cord with the aid of ultrasound imaging.

CORNEA. A transparent structure of the eye over the iris and pupil; light must pass through the cornea to make vision possible.

CORNEAL ABRASION. A scratch on the surface of the eyeball.

CORONARY. Of or relating to the heart.

CORONARY ARTERIES. The arteries that provide blood to the heart. The coronary arteries surround the heart like a crown, coming out of the aorta, arching down over the top of the heart, and dividing into two branches.

CORONARY ARTERY BYPASS. Surgical procedure to reroute blood around a blocked coronary artery.

CORONARY ARTERY DISEASE (CAD). Also called atherosclerosis, it is a build-up of fatty matter and debris in the coronary artery wall that causes narrowing of the artery.

CORONARY BLOOD VESSELS. The arteries and veins that supply blood to the heart muscle.

CORONARY BYPASS SURGERY. Surgery in which a section of blood vessel is used to bypass a blocked coronary artery and restore an adequate blood supply to the heart muscle.

CORONARY OCCLUSIVE ARTERY DISEASE. Blockage of the arteries that supply blood to the heart; frequently a precursor to a heart attack.

CORONAVIRUS. One of a family of RNA-containing viruses known to cause severe respiratory illnesses. In March 2003, a previously unknown coronavirus was identified as the causative agent of severe acute respiratory syndrome, or SARS.

CORPORA CAVERNOSA. The pair of columns of erectile tissue on either side of the penis that, together with the corpus spongiosum, produce an erection when filled with blood.

CORPUS CAVERNOSUM (PLURAL, CORPORA CAVERNOSA). One of two rods of spongy tissue in the penis that become engorged with blood in order to produce an erection.

CORPUS LUTEUM. A small, yellow structure that forms in the ovary after an egg has been released.

CORTEX. The thin convoluted surface of the brain comprised primarilyof cell bodies of neurons.

CORTICAL. Regarding the cortex, or the outer layer of the brain, as distinguished from the inner portion.

CORTICOSTEROID. A class of drugs based on hormones formed in the adrenal gland, used to reduce inflammation. They increase the likelihood of hyperinfection syndrome in patients with threadworm infection.

CORTISOL. A hormone produced by the adrenal cortex. It is partially responsible for regulating blood sugar levels.

CORTISONE. Glucocorticoid produced by the adrenal cortex in response to stress. Cortisone is a steroid and has anti-inflammatory and immunosuppressive properties.

COUGH SUPPRESSANT. Medicine that stops or prevents coughing.

COUGHING. Coughing helps break up secretions in the lungs so that the mucus can be suctioned out or expectorated. Patients sit upright and inhale deeply through the nose. They then exhale in short puffs or coughs. Coughing is repeated several times per day.

COUNTERTRANSFERENCE. The analyst s emotional reaction to or entanglement with the analysand.

COWPOX. A mild disease in cows that is caused by a poxvirus.

COX-2 INHIBITORS. A class of newer NSAIDs that are less likely to cause side effects in the digestive tract. COX-2 inhibitors work by inhibiting the production of cyclooxygenase-2, an enzyme involved in inflammation.

COXSACKIEVIRUS B. A type of virus in the group Enterovirus that causes an infection similar to polio, but without paralysis.

CRABS. An informal term for pubic lice.

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CRANIAL NERVES. The set of twelve nerves found on each side of the head and neck that control the sensory and muscle functions of a number of organs such as the eyes, nose, tongue face and throat.

CRANIOCAUDAL. Head to tail, x-ray beam directly overhead the part being examined.

CRANIOPHARYNGIOMA. A tumor near the pituitary gland in the craniopharyngeal canal that often results in intracranial pressure.

CRANIOSYNOSTOSIS. A premature closure of one or more of the joints (fissures) between the bones of the skull, which causes an abnormally shaped skull.

CRANIOTOME. A type of surgical drill used to operate on the skull. It has a self-controlled system that stops the drill when the bone is penetrated.

CRANIOTOMY. Procedure to remove a lesion in the brain through an opening in the skull.

C-REACTIVE PROTEIN (CRP). A protein present in blood serum in various abnormal states, like inflammation.

CREATININE. The metabolized by-product of creatine, an organic acid that assists the body in producing muscle contractions. Creatinine is found in the bloodstream and in muscle tissue. It is removed from the blood by the kidneys and excreted in the urine.

CREEPING ERUPTION. Itchy irregular, wandering red lines on the foot made by burrowing larvae of the hookworm family and some roundworms.

CREPITUS. A crackling or crunching sound heard when the ends of a fractured piece of bone rub against each other.

CRETINISM. Severe hypothyroidism that is present at birth and characterized by severe mental retardation.

CREUTZFELD-JAKOB DISEASE. A rare, often fatal disease of the brain, characterized by gradual dementia and loss of muscle control that occurs most often in middle age and is caused by a slow virus.

CRIB DEATH. Another name for SIDS. It is often called cot death in the United Kingdom, Australia, and New Zealand.

CRIBRIFORM PLATE. The horizontal bone plate perforated with several holes for the passage of olfactory nerve filaments from the nasal cavity.

CRICOTHYROIDOTOMY. An emergency tracheotomy that consists of a cut through the cricothyroid membrane to open the patient's airway as fast as possible.

CRIGLER-NAJJAR SYNDROME. A moderate to severe form of hereditary jaundice.

CROHN'S DISEASE. A chronic inflammatory disease of unknown cause, involving any part of the gastrointestinal tract from mouth to anus, but commonly involving the large intestine, with scarring and thickening of the bowel wall. Crohn's disease frequently leads to intestinal obstruction and has a high rate of recurrence after treatment.

CROSSBITE. The condition in which the upper teeth bite inside the lower teeth.

CROSS-DRESSING. Dressing in clothing that is stereotypical of the opposite sex.

CROSSMATCH. A laboratory test done to confirm that blood from a donor and blood from the recipient are compatible.

CROSS-REACTION. A reaction that occurs in blood testing when a disease agent reacts to the specific antibody for another disease agent. Cross-reactions are common in blood tests for fluke infections because the different species are closely related.

CROSS-TOLERANT. A drug that has the same pharmacological effect as another is considered cross-tolerant. Cross-tolerant drugs are often used in treating withdrawal syndromes.

CROWN. The upper part of the tooth, covered by enamel; dental restoration that is a protective shell fitting over a tooth.

CRYOABLATION. A technique for removing cancerous tissue by killing it with extreme cold.

CRYOGEN. A substance with a very low boiling point, such as liquid nitrogen, used in cryotherapy treatment.

CRYOGLOBULIN. An abnormal blood protein associated with several diseases. It is characterized by its tendency to clump in cold temperatures.

CRYOGLOBULINEMIA. Condition in which protein in the blood forms particles in the cold, blocking blood vessels and leading to pain and numbness of the extremities.

CRYOSURGERY. Freezing and destroying abnormal cells.

CRYOTHERAPY. Cancer treatment in which the tumor is destroyed by exposure to intense cold.

CRYPTORCHIDISM. Undescended testes.

CRYPTOSPORIDIUM. A type of parasitic protozoa.

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CT SCAN (COMPUTED TOMOGRAPHY SCAN). Cross-sectional x rays of the body are compiled to create a three-dimensional image of the body's internal structures.

CULTURE. A laboratory procedure in which a sample from a wound, the blood or other body fluid is taken from an infected person. The sample is placed in conditions under which bacteria can grow. If bacteria grow, identification tests are done to determine the bacteria species causing the infection.

CURETTAGE. The removal of tissue or growths by scraping with a curette.

CURETTE. A surgical instrument with a circular cutting loop at one end. The curette is pulled over the skin lesion in repeated strokes to remove one portion of the lesion at a time.

CUSHING'S SYNDROME. A group of conditions caused by increased production of cortisol hormones or by the administration of glucocorticoid hormones (cortisone-like hormones).

CUT. Separation of skin or other tissue made by a sharp edge, producing regular edges.

CUTANEOUS. Pertaining to the skin.

CYANOSIS. A bluish tinge to the skin that can occur when the blood oxygen level drops too low.

CYANOTIC. Marked by bluish discoloration of the skin due to a lack of oxygen in the blood. It is one of the types of congenital heart disease.

CYCLIC VOMITING SYNDROME (CVS). Episodes of severe nausea, gagging, and vomiting in children that last for hours or a day or two, repeat at regular intervals, and have no known cause.

CYCLICAL NEUTROPENIA. A rare genetic blood disorder in which the patient's neutrophil level drops below 500/mm^3 for six to eight days every three weeks.

CYCLOTHYMIA. A milder form of bipolar disorder characterized by alternating hypomania and less severe depressive episodes.

CYST. A protective sac that includes either fluid or the cell of an organism. The cyst enables many organisms to survive in the environment for long periods of time without need for food or water.

CYSTECTOMY. Surgical removal of a cyst.

CYSTIC FIBROSIS. A genetic disease that causes multiple digestive, excretion, and respiratory complications. Among the effects, the pancreas fails to provide secretions needed for the digestion of food.

CYSTICERCOSIS. Parasitic infection caused by the presence of immature tapeworm larvae (cysticerci) that have developed outside the intestinal tract. Infection is caused by accidental consumption of tapeworm eggs.

CYSTINOSIS. A genetic disorder characterized by a buildup of an amino acid called cystine in the body. It leads to abnormal amounts of carbohydrates and amino acids in the urine, excessive urination, and low blood levels of potassium and phosphates.

CYSTITIS. Inflammation of the bladder, usually caused by bacterial infection.

CYSTOCELE. Bulging of the bladder into the vagina.

CYSTOMETRY. A test of bladder function in which pressure and volume of fluid in the bladder are measured during filling, storage, and voiding.

CYSTOSCOPE. Endoscope especially designed for urological use to examine the bladder, lower urinary tract, and prostate gland.

CYSTOSCOPY. A diagnostic procedure that uses a cystoscope to look inside the bladder and to collect samples of urine and tissue.

CYSTOURETHROCELE. Bulging of the bladder neck into the vagina.

CYTOCHROME. A substance that contains iron and acts as a hydrogen carrier for the eventual release of energy in aerobic respiration.

CYTOKINE. A protein associated with inflammation that, at high levels, may be toxic to nerve cells in the developing brain.

CYTOMEGALOVIRUS (CMV). A common human virus causing mild or no symptoms in healthy people, but permanent damage or death to an infected fetus, a transplant patient, or a person with HIV.

CYTOTOXIC DRUGS. Drugs that function by destroying cells.

D

DACRON. A synthetic polyester fiber used to surgically repair damaged sections of heart muscle and blood vessel walls.

DACRYOCYSTOGRAPHY. An x ray of the tear duct after injection of a dye that is used to help locate a blockage in the duct.

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DACRYOCYSTORHINOSTOMY. A surgical procedure to drain the tear sac into the nasal passage.

DACRYOSTENOSIS. Obstruction or narrowing of the nasolacrimal duct. May be present at birth.

DARK FIELD. A microscopy technique in which light is directed at an oblique angle so that organisms appear bright against a dark background.

DAWN SIMULATION. A form of light therapy in which the patient is exposed while asleep to gradually brightening white light over a period of an hour and a half.

DEBILITATING. Weakening, or reducing the strength of.

DEBRIDEMENT. Surgical procedure in which dead or dying tissue is removed.

DEBULKING. Surgical removal of a major portion of a tumor so that there is less of the cancer left for later treatment by chemotherapy or radiation.

DECELERATION. A decrease in the fetal heart rate that can indicate inadequate blood flow through the placenta.

DECIBEL. A unit of measure for expressing the loudness of a sound. Normal speech is typically spoken in the range of about 20-50 decibels.

DECIDUOUS TEETH. The primary, baby, or milk teeth that fall out and are replaced by permanent teeth.

DECISION TREE. A decision support model used in medical and psychiatric diagnosis that consists of a tree-like chart or diagram including various symptoms, tentative diagnoses, diagnostic decisions, and their possible consequences.

DECOMPRESSION SICKNESS. A condition found in divers in which gas bubbles of nitrogen form in tissues and blood vessels as a result of decreasing surrounding pressure, such as in ascent from a dive. It may be a painful condition, especially as nitrogen bubbles invade the joints; persons stricken may walk stooped over in pain, in a bent stance that led to it being called "the bends."

DECONGESTANT. Medicines that shrink blood vessels and consequently mucus membranes. Pseudoephedrine, phenylephrine, and phenylpropanolamine are the most common.

DECORTICATION. Surgical removal of the fibrous peel that covers the lungs in third-stage empyema.

DECREASED PENETRANCE. Individuals who inherit a changed disease gene but do not develop symptoms.

DECUBITUS ULCERS. A pressure sore resulting from ulceration of the skin occurring in persons confined to bed for long periods of time.

DEEP BITE. A closed bite; a deep or excessive overbite in which the lower incisors bite too closely to or into the gum tissue or palate behind the upper teeth.

DEEP BREATHING. Helps expand the lungs and forces better distribution of the air into all sections of the lung. The patient either sits in a chair or sits upright in bed and inhales, pushing the abdomen out to force maximum amounts of air into the lung. The abdomen is then contracted, and the patient exhales.

DEEP VEIN THROMBOSIS. A blood clot in the calf's deep vein. This frequently leads to pulmonary embolism if untreated.

DEFECATE. To pass feces (stool) out of the rectum through the anus.

DEFERVESCENCE. Return to normal body temperature after high fever.

DEFIBRILLATION. An electronic process that helps re-establish a normal heart rhythm.

DEFICIENCY. A shortage of something necessary for health.

DEFICIT. In medicine, the loss or impairment of a function or ability.

DEGAS. To release and vent gases. New building materials often give off gases and odors and the air should be well circulated to remove them.

DEGENERATION. Gradual, progressive loss of nerve cells.

DEGENERATIVE. Degenerative disorders involve progressive impairment of both the structure and function of part of the body.

DEGENERATIVE ARTHRITIS, OR OSTEOARTHRITIS. A noninflammatory type of arthritis, usually occurring in older people, characterized by degeneration of cartilage, enlargement of the margins of the bones, and changes in the membranes in the joints.

DEHYDRATION. A condition in which the body lacks the normal level of fluids, potentially impairing normal body functions.

DELAYED HYPERSENSITIVITY REACTIONS. Allergic reactions mediated by T cells that occur hours to days after exposure to the antigen.

DELETION. The absence of genetic material that is normally found in a chromosome. Often, the genetic

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material is missing due to an error in replication of an egg or sperm cell.

DELIRIUM. A disturbance of consciousness marked by confusion, difficulty paying attention, delusions, hallucinations, or restlessness. It can be distinguished from dementia by its relatively sudden onset and variation in the severity of the symptoms.

DELIRIUM TREMENS. A complication that may accompany alcohol withdrawal. The symptoms include body shaking (tremulousness), insomnia, agitation, confusion, hearing voices or seeing images that are not really there (hallucinations), seizures, rapid heart beat, profuse sweating, high blood pressure, and fever.

DELUSION. A false belief that is resistant to reason or contrary to fact. Common delusions include delusions of persecution, delusions about one s importance (sometimes called delusions of grandeur), or delusions of being controlled by others.

DELUSIONAL DISORDER. Individuals with delusional disorder suffer from long-term, complex delusions that fall into one of six categories: persecutory, grandiose, jealousy, erotomanic, somatic, or mixed.

DEMENTIA. A decline in a person's level of intellectual functioning. Dementia includes memory loss as well as difficulties with language, simple calculations, planning or decision-making, and motor (muscular movement) skills.

DEMYELINATING DISORDERS. A group of diseases characterized by the breakdown of myelin, the fatty sheath surrounding and insulating nerve fibers. This breakdown interferes with nerve function, and can result in paralysis. Multiple sclerosis is a demyelinating disorder.

DEMYELINATION. Disruption or destruction of the myelin sheath, leaving a bare nerve. Results in a slowing or stopping of impulses traveling along that nerve.

DENDRITES. Fibers of a brain cell that receive signals from other brain cells.

DENDRITIC CELL. A special type of antigen-presenting cell that is effective in stimulating T cells.

DENTAL CARIES. A disease of the teeth in which microorganisms convert sugar in the mouth to acid that erodes the tooth.

DENTAL LASER. A device that generates a low-powered beam of light that is used in place of a dentist's drill to cut away decay from a tooth or remove gum tissue.

DENTIN. The middle layer of a tooth, which makes up most of the tooth's mass.

DEOXYRIBONUCLEIC ACID (DNA). The genetic material in cells that holds the inherited instructions for growth, development, and cellular functioning.

DEPENDENCE. A state in which a person requires a steady concentration of a particular substance to avoid experiencing withdrawal symptoms.

DEPERSONALIZATION. A dissociative symptom in which the patient feels that his or her body is unreal, is changing, or is dissolving.

DEPOLARIZATION. A change in a cell's membrane potential, making its electrical charge more positive or less negative. Defibrillation essentially depolarizes a portion of the heart muscle, allowing the heart's natural pacemaker to reestablish normal heart rhythm.

DEPOT DOSAGE. A form of medication that can be stored in the patient's body tissues for several days or weeks, thus minimizing the risk of the patient forgetting daily doses. Haloperidol and fluphenazine can be given in depot form.

DEPRESSION. A mental condition in which a person feels extremely sad and loses interest in life. A person with depression may also have sleep problems and loss of appetite and may have trouble concentrating and carrying out everyday activities. Severe depression may instigate a suicide attempt.

DEPRIVATION. A condition of having too little of something.

DEPRIVATIONAL DWARFISM. A condition where emotional disturbances are associated with growth failure and abnormalities of pituitary function.

DEREALIZATION. A dissociative symptom in which the external environment is perceived as unreal.

DERMABRASION. A technique for removing the upper layers of skin with planing wheels powered by compressed air.

DERMATITIS. A skin condition characterized by a red, itchy rash. It may occur when the skin comes in contact with something to which it is sensitive.

DERMATITIS HERPETIFORMIS. A chronic very itchy skin disease with groups of red lesions that leave spots behind when they heal. It is sometimes associated with cancer of an internal organ.

DERMATOLOGIST. A doctor who specializes in diagnosing and treating diseases of the skin.

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DERMATOLOGY. The branch of medicine that studies and treats disorders of the skin.

DERMATOPHYTE. The medical name for three genera of fungi that cause ringworm in humans and domestic pets. The name is derived from two Greek words that mean "skin" and "plant."

DERMATOSIS. A noninflammatory skin disorder.

DERMATOSPARAXIS. Skin fragility caused by abnormal collagen.

DERMIS. The basal layer of skin; it contains blood and lymphatic vessels, nerves, glands, and hair follicles.

DERMOID. A skin-like benign growth that may appear on the ovary and resemble a cyst.

DESENSITIZATION. The elimination of an emotional response, such as fear or anxiety, to specific stimuli.; or, a technique of pain reduction in which the painful area is stimulated with whatever is causing the pain.

DESFEROXAMINE. The primary drug used in iron chelation therapy. It aids in counteracting the life–threatening buildup of iron in the body associated with long–term blood transfusions.

DESICCATION. Tissue death.

DESMOPRESSIN (DDAVP). A drug used in the treatment of von Willebrand's disease.

DESQUAMATION. Shedding of the cells lining the insides of the air sacs. A feature of desquamative interstitial pneumonitis.

DETOXIFICATION. A process of altering the chemical structure of a compound to make it less toxic.

DETRUSOR MUSCLE. Bladder muscle.

DEVELOPMENTAL. Referring to a speech problem or other disorder that arises during a specific stage in human development.

DEVELOPMENTAL DAMAGE. A term that some therapists prefer to personality disorder, on the grounds that it is more respectful of the patient's capacity for growth and change.

DEVELOPMENTAL DELAY. The failure to meet certain developmental milestones, such as sitting, walking, and talking, at the average age. Developmental delay may indicate a problem in development of the central nervous system.

DEVIATED SEPTUM. A hole or perforation in the septum, the wall that divides the two nasal cavities.

DEXA BONE DENSITY SCAN. A bone density scan that uses a rotating x-ray beam to measure the strength of an individual's bones and his or her fracture risk.

DEXAMETHASONE TEST. A test that serves as a marker of suicide risk by reflecting signaling activity between the brain and the adrenal gland.

DIABETES. A disease characterized by an inability to process sugars in the diet, due to a decrease in or total absence of insulin production. May require injections of insulin before meals to aid in the metabolism of sugars.

DIABETES INSIPIDUS. A metabolic disorder in which the pituitary gland produces inadequate amounts of antidiuretic hormone (ADH) or the kidneys are unable to respond adequately to ADH. Primary symptoms are excessive urination and constant thirst.

DIABETES MELLITUS. A disease in which insufficient insulin is made by the body to metabolize sugars.

DIABETIC COMA. Reduced level of consciousness that requires immediate medical attention.

DIABETIC KETOACIDOSIS. A condition caused by low insulin levels where the amount of sugar and ketones in the blood is high.

DIABETIC PERIPHERAL NEUROPATHY. A condition in which the sensitivity of nerves to pain, temperature, and pressure is dulled, particularly in the legs and feet.

DIABETIC RETINOPATHY. A condition in which the tiny blood vessels to the retina, the tissues that sense light at the back of the eye, are damaged, leading to blurred vision, sudden blindness, or black spots, lines, or flashing lights in the field of vision.

DIAGNOSTIC TESTING. Testing performed to determine if someone is affected with a particular disease.

DIAGNOSTIC WINDOW. A cardiac marker's timeline for rising, peaking, and returning to normal after a heart attack.

DIALECTICAL BEHAVIOR THERAPY. A type of cognitive-behavioral therapy designed specifically to treat borderline personality disorder.

DIALYSATE. A chemical bath used in dialysis to draw fluids and toxins out of the bloodstream and supply electrolytes and other chemicals to the bloodstream.

DIALYSIS. A blood filtration therapy that replaces the function of the kidneys, filtering fluids, and waste

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products out of the bloodstream. There are two types of dialysis treatment: hemodialysis, which uses an artificial kidney, or dialyzer, as a blood filter; and peritoneal dialysis, which uses the patient's abdominal cavity (peritoneum) as a blood filter.

DIALYZER. An artificial kidney usually composed of hollow fiber which is used in hemodialysis to eliminate waste products from the blood and remove excess fluids from the bloodstream.

DIAPHRAGM. A sheet of muscle tissue that divides the chest cavity from the abdominal cavity; or a dome-shaped device used to cover the back of a woman's vagina during intercourse in order to prevent pregnancy.

DIAPHRAGM BREATHING. Method of deep breathing using the entire lungs.

DIARRHEA. Abnormally frequent bowel movements with fluid stools.

DIASTOLE. Period between contractions of the heart.

DIASTOLIC. The phase of blood circulation in which the heart's pumping chambers (ventricles) are being filled with blood. During this phase, the ventricles are at their most relaxed, and the pressure against the walls of the arteries is at its lowest.

DIATHERMY. Also called electrocautery, this is a procedure that heats and destroys abnormal cells.

DIATHESIS. The medical term for predisposition. The stress/diathesis model is a diagram that is used to explain why some people are at greater risk of suicidal behavior than others.

DIAZEPAM. One of the most commonly used sedative-hypnotic medications.

DIENCEPHALON. A part of the brain that binds the mesencephalon to the cerebral hemispheres. Considered by some as part of the brain stem.

DIETARY SUPPLEMENT. A product, such as a vitamin, mineral, herb, amino acid, or enzyme, intended to be consumed in addition to an individual's diet with the expectation that it will improve health.

DIETHYLSTILBESTROL (DES). A synthetic form of estrogen that was widely prescribed to women from 1940 to 1970 to prevent complications during pregnancy, and linked to several serious birth defects and disorders of the reproductive system in daughters of women who took DES.

DIETITIAN. A health care professional who specializes in individual or group nutritional planning, public education in nutrition, or research in food science. To be licensed as a registered dietitian (RD) in the United States, a person must complete a bachelor's degree in a nutrition-related field and pass a state licensing examination. Dietitians are also called nutritionists.

DIFFERENTIAL. A blood cell count in which the percentages of cell types are calculated as well as the total number of cells.

DIFFERENTIAL DIAGNOSIS. Comparing and contrasting the signs, symptoms, and laboratory findings of two or more diseases to determine which is causing the patient's condition.

DIFFERENTIATION. The ability to retain one's identity within a family system while maintaining emotional connections with the other members.

DIFFUSION TENSOR IMAGING (DTI). A refinement of magnetic resonance imaging that allows the doctor to measure the flow of water and track the pathways of white matter in the brain. DTI is able to detect abnormalities in the brain that do not show up on standard MRI scans.

DIGESTION. The mechanical, chemical, and enzymatic process in which food is converted into the materials suitable for use by the body.

DIGESTIVE ENZYMES. Molecules that catalyze the breakdown of large molecules (usually food) into smaller molecules.

DIGESTIVE TRACT. The stomach, intestines, and other parts of the body through which food passes.

DIGIT. A finger or a toe.

DIGITAL RECTAL EXAMINATION. A routine screening test that is used to detect any lumps in the prostate gland or any hardening or other abnormality of the prostate tissue. The doctor inserts a gloved and lubricated finger (digit) into the patient's rectum, which lies just behind the prostate.

DIGITALIS. A drug that helps the heart muscle to have stronger pumping action.

DIHYDROXYACETONE (DHA). A chemical used for staining the skin to simulate a tan.

DILATE. To enlarge, open wide, or distend.

DILATED CARDIOMYOPATHY. Also called congestive cardiomyopathy; cardiomyopathy in which the walls of the heart chambers stretch, enlarging the

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heart ventricles so they can hold a greater volume of blood than normal.

DILATATION AND CURETTAGE (D & C). A procedure in which the doctor opens the cervix and uses a special instrument to scrape tissue from the inside of the uterus.

DILUTE. A solution that has comparatively more fluid in it, relative to the quantity of solute.

DIMERCAPROL (BAL). A chemical agent used to remove excess lead from the body.

DIOPTER (D). A unit of measure for describing refractive power.

DIPHTHERIA–TETANUS–PERTUSSIS (DTP). The standard preparation used to immunize children against diphtheria, tetanus, and whooping cough. A so–called "acellular pertussis" vaccine (aP) is usually used since its release in the mid–1990s in a combined vaccine known as DTaP.

DIPHTHERIA. A serious, infectious disease that produces a toxin (poison) and an inflammation in the membrane lining of the throat, nose, trachea, and other tissues.

DIPHYLLOBOTHRIASIS. Parasitic infection caused by the presence of tapeworms from the *Diphyllobothrium* genus, such as the fish tapeworm (*Diphyllobothrium latum*).

DIPLEGIA. Paralysis affecting like parts on both sides the body, such as both arms or both legs.

DIPLOPIA. The medical term for seeing double.

DIRECT CURRENT (DC). An electric current in which the electric charge moves in only one direction. It is the type of current produced by batteries and solar cells.

DIRECTION. Bringing about the free balance of the head on the spine and the resulting release of the erector muscles of the back and legs which establish improved coordination.

DISACCHARIDE. Any sugar formed when two monosaccharides are joined together and a molecule of water is removed.

DISCHARGE PLANNER. A health-care professional who helps patients arrange for health and home care needs after they go home from the hospital.

DISEASE MODIFYING ANTI-RHEUMATIC DRUGS (DMARDS). A class of antirheumatic drugs, including chloroquine, methotrexate, cyclosporine, and gold compounds, that influence the disease process itself and do not only treat its symptoms.

DISENFRANCHISED GRIEF. Grief that cannot be openly expressed because the death or other loss cannot be publicly acknowledged.

DISEQUILIBRIUM. Difficulty with equilibrium that can mean a deficiency in balance and/or orientation.

DISFLUENCY. Any difficulty in fluent speech, including stuttering.

DISINFECTED. Decreased the number of microorganisms on or in an object.

DISK. A ringlike structure that fits between the vertebrae in the spine to protect the bones, nerves, and blood vessels. The outer layer is a tough, fibrous tissue, and the inner core is composed of more elastic tissue.

DISKECTOMY. The surgical removal of a portion of an intervertebral disk.

DISLOCATION. Displacement of bones at a joint.

DISPERSANT. Chemicals that break up spilled oil into small particles that can be further scattered and broken down by water and wind, thus sparing oil damage to marine and coastal environments.

DISPLACEMENT. A psychological process in which feelings originating from one source are expressed outwardly in terms of concern or preoccupation with an issue or problem that the individual considers more acceptable.

DISSECTION. A cut or divide.

DISSEMINATED INTRAVASCULAR COAGULATION (DIC). A condition in which spontaneous bleeding and clot formation occur throughout the circulatory system. DIC can be caused by transfusion reactions and a number of serious illnesses.

DISSOCIATION. A psychological mechanism in which the mind splits off certain aspects of a traumatic event from conscious awareness. Dissociation can affect the patient's memory, sense of reality, and sense of identity.

DISSOCIATIVE DISORDERS. A group of mental disorders in which dissociation is a prominent symptom. Patients with dissociative disorders have a high rate of self-mutilation.

DISSOCIATIVE IDENTITY DISORDER (DID). Term that replaced Multiple Personality Disorder (MPD). A condition in which two or more distinctive identities or personality states alternate in controlling a person's consciousness and behavior.

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DISTAL MUSCULAR DYSTROPHY (DD). A form of muscular dystrophy that usually begins in middle age or later, causing weakness in the muscles of the feet and hands.

DISTAL PHALANX. The outermost bone of any finger or toe.

DISTAL TUBULE. The portion of the kidney tubule that lies furthest away from the point at which fluid from the blood enters the tubule.

DISULFIRAM. A medication that has been used since the late 1940s as part of a treatment plan for alcohol abuse. Disulfiram, which is sold under the trade name Antabuse, produces changes in the body's metabolism of alcohol that cause headaches, vomiting, and other unpleasant symptoms if the patient drinks even small amounts of alcohol.

DIURETIC. A drug designed to encourage excretion of urine in people who accumulate excess fluid such as individuals with high blood pressure or heart conditions.

DIURETIC AGENT. A drug which increases urine output.

DIVERTICULA. Abnormal pouches of tissue that bulge off the main part of the digestive system.

DIVERTICULITIS. A condition of the diverticulum of the intestinal tract, especially in the colon, where inflammation may cause distended sacs extending from the colon and pain.

DIVERTICULOSIS. A condition in which the colon (large intestine) develops a number of outpouchings or sacs.

DIVERTICULUM. A pouch extending from a hollow organ.

DNA (DEOXYRIBONUCLEIC ACID). The hereditary material that makes up genes; influences the development and functioning of the body.

DNA PROBE. An agent that binds directly to a predefined sequence of nucleic acids.

DNA TESTING. Analysis of DNA (the genetic component of cells) in order to determine changes in genes that may indicate a specific disorder.

DOMINANT INHERITANCE. A pattern of inheritance in which a trait or disease is conferred by one gene or allele. A parent with a disorder caused by a dominant allele has a 50% chance of passing the trait for disease to their offspring.

DOMINANT TRAIT. A genetic trait in which one copy of the gene is sufficient to yield an outward display of the trait; dominant genes mask the presence of recessive genes; dominant traits can be inherited from a single parent.

DONEPEZIL HYDROCHLORIDE (ARICEPT). A drug that increases the levels of acetylcholine in the brain.

DONOR. A person who supplies organ(s), tissue or blood to another person for transplantation.

DONOVAN BODIES. Rod-shaped oval organisms found in tissue samples from patients with granuloma inguinale. Donovan bodies appear deep purple when stained with Wright's stain.

DOPA. The common name for a natural chemical (3, 4-dihydroxyphenylalanine) made by the body during the process of making melanin.

DOPAMINE. A neurochemical made in the brain that is involved in many brain activities, including movement and emotion.

DOPAMINE RECEPTOR ANTAGONISTS (DAS). The older class of antipsychotic medications, also called neuroleptics. These primarily block the site on nerve cells that normally receive the brain chemical dopamine.

DOPPLER EFFECT. The principle that the sound of an object moving toward you has a higher pitch than the sound when it is moving away from you.

DOPPLER SCANNING. A procedure in which ultrasound images are used to watch a moving structure such as the flow of blood or the beating of the heart.

DOPPLER ULTRASOUND. An imaging technique that can detect moving fluids.

DORSAL. Referring to a position closer to the back than to the stomach. The laminae in the spinal column are located on the dorsal side of each vertebra.

DORSAL RHIZOTOMY. A surgical procedure that cuts nerve roots to reduce spasticity in affected muscles.

DORSAL ROOT ENTRY ZONE (DREZ). A type of nerve surgery for postherpetic neuralgia that is occasionally used when the patient can get no other pain relief. The surgery destroys the area where damaged nerves join the central nervous system, thereby interfering with inappropriate pain messages from nerves to the brain.

DOSHA. One of three constitutional types, either vata, pitta, or kapha, found in Ayurvedic medicine.

DOWN SYNDROME. A chromosomal disorder caused by an extra copy or a rearrangement of chromosome 21. Children with Down syndrome have

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varying degrees of mental retardation and may have heart defects.

DRUG INTERACTION. A chemical or physiological reaction that can occur when two different drugs are taken together.

DRUSEN. Clumps of pigment that accumulate under the retina when wastes build up faster than they can be removed. Drusen are a sign of dry age-related macular degeneration.

DRY SOCKET. A painful condition following tooth extraction in which a blood clot does not properly fill the empty socket, leaving the bone underneath exposed to air and food.

DUBOWITZ EXAM. A standardized test that scores responses to 33 specific neurological stimuli to estimate an infant's neural development and, hence, gestational age.

DUCHENNE MUSCULAR DYSTROPHY (DMD). The most severe form of muscular dystrophy, DMD usually affects young boys and causes progressive muscle weakness, usually beginning in the legs.

DUCT. A tube through which various substances can pass. These substances can travel through ducts to another organ or into the bloodstream.

DUCTAL ADENOCARCINOMA. A malignant tumor arising from the duct cells within a gland.

DUCTAL CARCINOMA. A type of cancer that accounts for as much as 80% of breast cancers. These tumors feel bigger than they look on ultrasound or mammogram.

DUCTUS. The blood vessel that joins the pulmonary artery and the aorta. When the ductus does not close at birth, it causes a type of congenital heart disease called patent ductus arteriosus.

DUCTUS ARTERIOSUS. The temporary channel or blood vessel between the aorta and pulmonary artery in the fetus.

DUODENAL. Pertaining to the first part of the small intestine.

DUODENAL ATRESIA. Closure or blockage of the duodenum, the upper section of the small intestine.

DUPUYTREN'S CONTRACTURE. Shortening and thickening of connective tissue in the palm causing the fingers to pull in.

DURA. A tough fibrous membrane that covers and protects the spinal cord.

DURA MATER. One of the membranes that sheathes the spinal cord and brain; the outermost layer.

DWARFISM. A congenital disease of bone growth that results in short stature and weak bones.

DYANA. The yoga term for meditation.

DYSBIOSIS. The condition that results when the natural flora of the gut are thrown out of balance, such as when antibiotics are taken.

DYSENTERY. A type of diarrhea caused by infection and characterized by mucus and blood in the stools.

DYSKINESIA. Impaired ability to make voluntary movements.

DYSLEXIA. An inability to read, write, or spell words in spite of the ability to see and recognize letters. Dyslexia is an autosomal dominant disorder thst occurs more frequently in males.

DYSMENORRHEA. Painful menstruation.

DYSPAREUNIA. Difficult or painful sexual intercourse.

DYSPEPSIA. A vague feeling of being too full and having heartburn, bloating, and nausea. Usually felt after eating.

DYSPHAGIA. Difficult or painful swallowing.

DYSPHORIA. A depressed and anxious mood state.

DYSPLASTIC NEVUS SYNDROME. A familial syndrome characterized by the presence of multiple atypical appearing moles, often at a young age.

DYSPNEA. A difficulty in breathing or shortness of breath, typically associated with some form of heart or lung disease. Also known as air hunger.

DYSSOMNIA. A primary sleep disorder in which the patient suffers from changes in the quantity, quality, or timing of sleep.

DYSTHYMIA. Type of affective disorder or mood disorder that often resembles a less severe, yet more chronic form of major.

DYSTOCIA. Failure to progress in labor, either because the cervix will not dilate (expand) further or (after full dilation) the head does not descend through the mother's pelvis.

DYSTROPHIN. A protein that helps muscle tissue repair itself. Both Duchenne muscular dystrophy and Becker muscular dystrophy are caused by flaws in the gene that instructs the body how to make this protein.

DYSURIA. Painful or difficult urination.

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E

EAR CANDLING. An alternative method for removing impacted cerumen with a lighted hollow cone of paraffin or beeswax. It does not work, and is not considered an acceptable treatment for any ear problem or disorder.

EAR SPECULUM. A cone- or funnel-shaped attachment for an otoscope which is inserted into the ear canal to examine the eardrum.

EARDRUM. A paper-thin covering stretching across the ear canal that separates the middle and outer ears.

EATING DISORDER. A condition characterized by an abnormal attitude towards food, altered appetite control, and unhealthy eating habits that affect health and the ability to function normally.

EBOLA. The disease caused by the newly described and very deadly Ebola virus found in Africa.

ECCHYMOSIS (PLURAL, ECCHYMOSES). The medical term for a bruise. Ecchymoses may develop around the eyes following a nasal fracture.

ECG OR EKG. A record of the waves that relate to the electrical impulses produced at each beat of the heart.

ECHOCARDIOGRAM. A non-invasive imaging procedure used to create a picture of the heart's movement, valves, and chambers.

ECHOCARDIOGRAPH. A record of the internal structures of the heart obtained from beams of ultrasonic waves directed through the wall of the chest.

ECHOCARDIOGRAPHY. A diagnostic instrument that assesses the structure of the heart using sound waves.

ECHOLALIA. Involuntary echoing of the last word, phrase, or sentence spoken by someone else.

ECHOPRAXIA. The imitation of the movement of another individual.

ECTOPIA LENTIS. Dislocation of the lens of the eye. It is one of the most important single indicators in diagnosing Marfan syndrome.

ECTOPIC BEAT. Abnormal heart beat arising elsewhere than from the sinoatrial node.

ECTOPIC PARATHYROID TISSUE. A condition where the thyroid tissue is located in an abnormal place.

ECTOPIC PREGNANCY. A pregnancy in which the fertilized egg has implanted outside the uterus, most often in the Fallopian tubes, although in some cases the pregnancy implants in the ovary or in the abdomen.

ECZEMA. A disease in which the skin becomes dry, red, itchy, and thickened.

EDEMA. A condition where tissues contain excessive fluid.

EDETATE CALCIUM DISODIUM (EDTA CALCIUM). A chemical agent used to remove excess lead from the body.

EDTA. A colorless compound used to keep blood samples from clotting before tests are run. Its chemical name is ethylenediaminetetraacetic acid.

EFFACEMENT. The thinning out of the cervix that normally occurs along with dilation shortly before delivery.

EFFERENT. Refers to peripheral nerves that carry signals away from the brain and spinal cord. These nerves carry out motor and autonomic functions.

EFFERENT NERVES. Nerves that convey impulses away from the central nervous system to the periphery.

EFFUSION. A collection of fluid which has leaked out into some body cavity or tissue.

EGO–SYNTONIC. Consistent with one's sense of self, as opposed to ego–alien or dystonic (foreign to one's sense of self). Ego–syntonic traits typify patients with personality disorders.

EHLERS-DANLOS SYNDROME. A rare inheritable disease of the connective tissue marked by very elastic skin, very loose joints, and very fragile body tissue.

EIGHTH CRANIAL NERVE DISEASE. A disorder affecting the eighth cranial nerve, characterized by a loss of hearing and/or balance.

EJACULATION. The act of expelling the sperm through the penis during orgasm.

EJACULATORY INCOMPETENCE. The inability to ejaculate within the vagina.

EJECTION FRACTION. A measure of the portion of blood that is pumped out of a filled ventricle.

EKG. A tracing of the electrical activity of the heart.

ELASTIC FIBER. Fibrous, stretchable connective tissue made primarily from proteins, elastin, collagen, and fibrillin.

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ELECTOLYTES. Salts, such as sodium and chloride.

ELECTROCARDIOGRAPHY (ECG). A test of a patient's heartbeat that involves placing leads, or detectors, on the patient's chest to record electrical impulses in the heart. The test will produce a strip, or picture record of the heart's electrical function.

ELECTROCOAGULATION. The coagulation or destruction of tissue through the application of a high-frequency electrical current.

ELECTROCONVULSIVE THERAPY (ECT). Therapy for mood disorders that involves passing electrical current through the brain in order to create a brief convulsion.

ELECTRODES. Tiny wires in adhesive pads that are applied to the body for ECG measurement.

ELECTRODESICCATION. To make dry, dull, or lifeless with the use of electrical current.

ELECTROENCEPHALOGRAPHY (EEG). The recording of the tiny electrical impulses produced by the brain's activity. By measuring characteristic wave patterns, the EEG can help diagnose certain conditions of the brain.

ELECTROLYTE. An ion such as potassium, sodium, or chloride dissolved in fluid that helps to regulate metabolic activities of cells; or A substance that conducts electric current within the body and is essential for sustaining life.

ELECTROMYOGRAPHIC BIOFEEDBACK. A method for relieving jaw tightness by monitoring the patient's attempts to relax the muscle while the patient watches a gauge. The patient gradually learns to control the degree of muscle relaxation.

ELECTROMYOGRAPHY (EMG). A test that uses electrodes to record the electrical activity of muscle. The information gathered is used to diagnose neuromuscular disorders.

ELECTRON. An elementary particle carrying a negative charge. Electrons may exist either independently or as components of an atom outside its nucleus.

ELECTRONIC FETAL NONSTRESS TEST. A test in which electronic monitors attached to the mother's abdomen to detect contractions of the uterus as well as the baby's heartbeat and movements.

ELECTRONYSTAGMOGRAPHY. A method for measuring the electricity generated by eye movements. Electrodes are placed on the skin around the eye and the individual is subjected to a variety of stimuli so that the quality of eye movements can be assessed.

ELECTROPHORESIS. A method of separating complex protein molecules suspended in a gel by running an electric current through the gel.

ELECTROPHYSIOLOGICAL STUDY. A test that monitors the electrical activity of the heart in order to diagnose arrhythmia. An electrophysiological study measures electrical signals through a cardiac catheter that is inserted into an artery in the leg and guided up into the atrium and ventricle of the heart.

ELECTROPHYSIOLOGY. Study of how electrical signals in the body relate to physiologic function.

ELECTROSURGICAL DEVICE. A medical device that uses electrical current to cauterize or coagulate tissue during surgical procedures, often used in conjunction with laparoscopy, colonoscopy, or sigmoidoscopy.

ELECTROTHERAPY. The treatment of body tissues by passing electrical currents through them, stimulating the nerves and muscles.

ELEMENTAL MERCURY; HG. Metallic mercury; quicksilver; a heavy, silvery, poisonous metallic element that is a liquid at room temperature but vaporizes readily.

ELEPHANTIASIS. A condition characterized by the gross enlargement of limbs and/or the genitalia that is also accompanied by a hardening and stretching of the overlying skin. Often a result of an obstruction in the lymphatic system caused by infection with a filarial worm.

ELISA. Enzyme-linked immunosorbent assay; a screening test that uses antibodies to detect infections such as gonorrhea and HIV.

ELIXIR. Liquid that contains alcohol, water, and a therapeutic agent.

EMBOLISM. The blocking of the flow of blood in an artery by an embolus. When an embolism blocks the blood supply to a tissue or organ, the tissue the artery feeds dies (infarction). Without immediate and appropriate treatment, an embolism can be fatal.

EMBOLIZATION. A technique for stopping bleeding by introducing a substance into larger blood vessels that blocks or closes them.

EMBOLUS (PLURAL, EMBOLI). A gas or air bubble, bit of tissue, blood clot, or foreign object that circulates in the bloodstream until it lodges in a vessel. A large embolus can narrow or block the vessel, which leads to decreased blood flow in the organ supplied by that vessel.

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EMBRYO. A developing human from the time of conception to the end of the eighth week after conception.

EMBRYONIC. Early stages of life in the womb.

EMERGENCY CONTRACEPTIVE PILLS; ECPS. Medication containing synthetic hormones for preventing pregnancy after unprotected vaginal intercourse.

EMESIS. The medical term for vomiting.

EMETIC. A medication or substance given to induce vomiting.

EMLA. Eutectic mixture of local anesthetics, a drug combination for use on intact skin.

EMMENAGOGUE. A medication or herbal preparation given to bring on a woman's menstrual period.

EMOLLIENT. A paste or compound having a soothing effect when applied to the skin.

EMOTIONAL CONDITIONING. The memory system that links perceptual information to an emotional response. For example, spotting a friend in a crowd causes a person to feel happy.

EMPHYSEMA. A chronic disease characterized by loss of elasticity and abnormal accumulation of air in lung tissue.

EMPIRICAL TREATMENT. Medical treatment that is given on the basis of the doctor's observations and experience.

EMPYEMA. An accumulation of pus in the lung cavity, usually as a result of infection.

ENAMEL. The hard outer surface of a tooth.

ENCEPHALITIS. A rare viral infection that causes inflammation in the membranes lining the brain.

ENCEPHALOCELES. Protrusion of the brain through a defect in the skull.

ENCEPHALOPATHY. A dysfunction of the brain. Hepatic encephalopathy is brain dysfunction that occurs because the liver isn't removing harmful substances from the blood.

ENCOPRESIS. Abnormalities relating to bowel movements that can occur as a result of stress or fear.

ENCYSTED. Enclosed in a cyst or capsule. Flukes spend part of their life cycle as encysted larvae.

END-STAGE HEART FAILURE. Severe heart disease that does not respond adequately to medical or surgical treatment.

END-STAGE LUNG DISEASE. The final stages of lung disease, when the lung can no longer keep the blood supplied with oxygen. End-stage lungs in pulmonary fibrosis have large air spaces separated by bands of inflammation and scarring.

END-STAGE RENAL DISEASE (ESRD). Total kidney failure; chronic kidney failure is diagnosed as ESRD when kidney function falls to 5-10% of capacity.

ENDARTERECTOMY. A surgical procedure in which diseased tissue and atherosclerotic plaque are removed from the inside of an artery.

ENDARTERITIS. Chronic inflammation of the inner layer of arteries.

ENDEMIC. A condition that is always present in a given population, such as human lice infestation.

ENDEMIC AREA. A geographical area where a particular disease is prevalent.

ENDEMIC DISEASE. An infectious disease that occurs frequently in a specific geographical locale. The disease often occurs in cycles. Influenza is an example of an endemic disease.

ENDOCARDITIS. A dangerous infection of the heart valves caused by certain bacteria.

ENDOCARDIUM. The inner wall of the heart muscle, which also covers the heart valves.

ENDOCERVICAL CURETTAGE. Biopsy performed with a curette to scrape the mucous membrane of the cervical canal.

ENDOCRINE. A system of organs that produces chemicals that go into the bloodstream to reach other organs whose functioning they affect.

ENDOCRINE GLAND. A ductless gland, such as the pituitary, thyroid, or adrenal gland, that secretes its products directly into the blood or lymph.

ENDOCRINE SYSTEM. A system of ductless glands that secrete hormones that regulate a variety of body processes, including growth and sexual maturation. A doctor who specializes in diseases and disorders of these glands is called an endocrinologist.

ENDOCRINOLOGIST. A doctor who specializes in diagnosing and treating disorders of the endocrine glands and the hormones they secrete.

ENDODONTIC. Pertaining to the inside structures of the tooth, including the dental pulp and tooth root, and the periapical tissue surrounding the root.

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ENDODONTIST. A dentist who specializes in diagnosing and treating diseases of the pulp and other inner parts of the tooth.

ENDOMETRIAL BIOPSY. A procedure in which a sample of the endometrium is removed and examined under a microscope.

ENDOMETRIAL CANCER. Cancer of the inner mucous membrane of the uterus.

ENDOMETRIAL IMPLANTS. Growths of endometrial tissue that attach to organs, primarily in the pelvic cavity.

ENDOMETRIAL POLYPS. A growth in the lining of the uterus (endometrium) that may cause bleeding and can develop into cancer.

ENDOMETRIOMA. A type of cyst formed when endometrial tissue grows within the ovary.

ENDOMETRIOSIS. A benign condition that occurs when cells from the lining of the uterus begin growing outside the uterus.

ENDOMETRITIS. Inflammation of the endometrium or mucous membrane of the uterus.

ENDOMETRIUM. The layer lining the inner cavity of the uterus; this layer changes daily throughout the menstrual cycle.

ENDOMYOCARDIAL BIOPSY. Removal of a small sample of heart tissue to check it for signs of damage caused by organ rejection.

ENDOPHTHALMITIS. Inflammation of the eyeball.

ENDORPHINS. A class of peptides in the brain that are produced during exercise and bind to opiate receptors, resulting in pleasant feelings and pain relief.

ENDOSCOPE. A medical instrument that can be passed into an area of the body (e.g., the bladder or intestine) to allow examination of that area. The endoscope usually has a fiber-optic camera, which allows a greatly magnified image to be shown on a television screen viewed by the operator.

ENDOSCOPIC RETROGRADE CHOLANGIOPANCREATOGRAPHY. A diagnostic procedure for mapping the pancreatic and common bile ducts. A flexible tube with a light transmitter (fiberoptics) is placed in the duct. A contrast dye is instilled directly into the duct and a series of x-ray images are taken.

ENDOSCOPIC TUBE. A tube that is inserted into a hollow organ permitting a physician to see the inside it.

ENDOSCOPIC ULTRASONOGRAPHY (EUS). Diagnostic imaging technique in which an ultrasound probe is inserted down a patient's throat to determine if a tumor is present.

ENDOSCOPY. A diagnostic procedure in which a tube is inserted through the mouth, into the esophagus and stomach. It is used to visualize various digestive disorders, including hiatal hernias.

ENDOSTEAL IMPLANTS. Dental implants that are placed within the bone.

ENDOTHELIAL CELLS. The cells lining the inner walls of the blood vessels.

ENDOTHELIAL. Referring to the endothelium, the layer of cells that lines body cavities and vessels.

ENDOTRACHEAL TUBE. A hollow tube that is inserted into the windpipe (trachea), leading to the lungs.

ENDOVASCULAR GRAFTING. A procedure that involves the insertion of a delivery catheter through a groin artery into the abdominal aorta under fluoroscopic guidance.

ENEMA. Insertion of a tube into the rectum to infuse fluid into the bowel and encourage a bowel movement. Ordinary enemas contain tap water, mixtures of soap and water, glycerine and water, or other materials.

ENGRAFTMENT. The process of transplanted stem cells reproducing new cells.

ENKEPHALINES. Peptide produced by the body that have analgesic properties.

ENOPHTHALMOS. A condition in which the eye falls back into the socket and inhibits proper eyelid function.

ENTERAL NUTRITION. Liquid nutrition provided through tubes that enter the gastrointestinal tract, usually through the mouth or nose.

ENTERIC. Pertaining to the intestine.

ENTERIC FEVER. A term that is sometimes used for either typhoid or paratyphoid fever.

ENTEROCELE. Bulging of the intestine into the upper part of the vagina.

ENTEROSTOMAL THERAPIST (ET). A specialized counselor, usually a registered nurse, who provides ostomy patients with education and counseling before the operation. After surgery, the ET helps the patient learn to take care of the stoma and appliance, and offers long-term emotional support.

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ENTEROTOXIGENIC. Refers to an organism that produces toxins in the gastrointestinal tract that cause such things as vomiting, diarrhea, and other symptoms of food poisoning.

ENTEROTOXIN. A type of harmful protein released by bacteria and other disease agents that affects the tissues lining the intestines.

ENTEROVIRUS. Any of a group of viruses that primarily affect the gastrointestinal tract.

ENTRAINMENT. The patterning of body processes and movements to the rhythm of music.

ENUCLEATION. Surgical removal of the eyeball.

ENVENOMATION. Exposure to venom by bites or stings from insects, reptiles, and fish.

ENZYMATIC REPLACEMENT THERAPY. A treatment method used to replace missing enzymes. It is possible to synthesize enzymes and then inject them intravenously into patients.

ENZYME. A biological catalyst that increases the rate of a chemical reaction without being used up in the reaction.

ENZYME ACTIVITY. A measure of the ability of an enzyme to catalyze a specific reaction.

ENZYME-LINKED IMMUNOSORBENT ASSAY (ELISA). A diagnostic blood test used to screen patients for AIDS or other viruses. The patient's blood is mixed with antigen attached to a plastic tube or bead surface. A sample of the patient's blood serum is added, and excess proteins are removed. A second antibody coupled to an enzyme is added, followed by a chemical that will cause a color reaction that can be measured by a special instrument.

EOSINOPHIL. A type of white blood cell containing granules that can be stained by eosin (a chemical that produces a red stain).

EOSINOPHILIA. An abnormal increase in the number of a specific type of white blood cell. Eosinophilia is a characteristic of all types of roundworm infections.

EPHEDRINE. A sympathomimetic amine from plants of the genus *Ephedra* or chemically synthesized; an asthma medication that previously was used in weight loss drugs.

EPI-LASIK. A surgical procedure that uses a blunt, plastic oscillating blade called an epithelial separator to cut a flap in the cornea.

EPICONDYLE. A projection on the surface of a bone; often an area for muscle and tendon attachment.

EPICONDYLITIS. A painful and sometimes disabling inflammation of the muscle and surrounding tissues of the elbow caused by repeated stress and strain on the forearm near the lateral epicondyle of the humerus (arm bone).

EPIDEMIC. A large number of cases of the same disease or infection all occurring within a short time period in a specific location.

EPIDEMIC PAROTITIS. The medical name for mumps.

EPIDEMIOLOGY. The branch of medicine that deals with the transmission of infectious diseases in large populations and with detection of the sources and causes of epidemics.

EPIDERMAL. Referring to the thin outermost layer of the skin, itself made up of several layers, that covers and protects the underlying dermis (skin).

EPIDERMOLYTIC. Damaging to the top layer of skin.

EPIDIDYMO-ORCHITIS. Inflammation of both the testes and a part of the spermatic duct system.

EPIDURAL ANESTHESIA. A method of pain relief for surgery in which local anesthetic is injected into the epidural space in the middle and lower back.

EPIDURAL SPACE. The space surrounding the spinal fluid sac.

EPIGLOTTIS. A leaf-like piece of cartilage extending upwards from the larynx, which can close like a lid over the trachea to prevent the airway from receiving any food or liquid being swallowed.

EPIKERATOPHAKIA. A procedure in which the donor cornea is attached directly onto the host cornea.

EPILEPSY. A brain disorder with symptoms that include seizures.

EPILEPTOLOGIST. A physician who specializes in the treatment of epilepsy.

EPINEPHRINE. A hormone produced by the adrenal medulla. It is important in the response to stress and partially regulates heart rate and metabolism. It is also called adrenaline.

EPISIOTOMY. Incision of the perineum, the area between the vulva and the anus, to assist delivery and avoid severe tearing of the perineum.

EPISTAXIS. The medical term for a nosebleed.

EPITHELIAL. Referring to the epithelium, the layer of cells forming the epidermis of the skin and the surface layer of mucous membranes.

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EPITHELIAL CELLS. Cells that form a thin surface coating on the outside of a body structure.

EPITHELIUM. Cells composing the lining of an organ.

EPITOPE. A portion of a protein or other molecule that is the specific target of an immune response.

EPSTEIN-BARR VIRUS (EBV). A virus in the herpes family that causes mononucleosis.

EQUATOR. Imaginary line encircling the eyeball and dividing the eye into a front and back half.

ERADICATE. To completely do away with something, eliminate it, end its existence.

ERECTILE DYSFUNCTION (ED). The consistent inability to achieve or maintain a penile erection.

ERGONOMICS. The study of the relationship between people and their working environment.

ERGOTAMINE. A drug used to prevent or treat migraine headaches.

ERUPTION. The process of a tooth breaking through the gum tissue to grow into place in the mouth.

ERYTHEMA. The medical term for redness of the skin produced by congestion of the capillaries in the skin.

ERYTHEMA MIGRANS (EM). A red skin rash that is one of the first signs of Lyme disease in about 75% of patients.

ERYTHEMA MULTIFORME. A type of hypersensitivity (allergic) reaction that occurs in response to medications, infections, or illness.

ERYTHROBLASTOPENIA. A deficiency in the cells that create red blood cells. This condition may be severe and life-threatening, but there is a transient form, seen in young children, which resolves spontaneously and does not recur.

ERYTHROBLASTOSIS FETALIS. A disorder of newborn infants marked by a high level of immature red blood cells (erythroblasts).

ERYTHROCYTE SEDIMENTATION RATE (ESR). The rate at which red blood cells settle out in a tube of unclotted blood, expressed in millimeters per hour; elevated sedimentation rates indicate the presence of inflammation.

ERYTHROCYTE. The name for red blood cells or red blood corpuscles. These components of the blood are responsible for carrying oxygen to tissues and removing carbon dioxide from tissues.

ERYTHROCYTOSIS. Increased production of red blood cells.

ERYTHRODERMA. An abnormal reddening of the entire skin surface.

ERYTHROGENIC TOXIN. A toxin or agent produced by the scarlet fever-causing bacteria that causes the skin to turn red.

ERYTHROMYCIN. An antibiotic that can be used instead of penicillin.

ERYTHROPOIESIS. The process through which new red blood cells are created; it begins in the bone marrow.

ERYTHROPOIETIC. Referring to the creation of new red blood cells.

ERYTHROPOIETIN. A hormone produced by the kidneys that stimulates the production of red blood cells by bone marrow.

ESCHAR. A hardened black crust of dead tissue that may form over a wound.

ESCHERICHIA COLI. A type of enterobacterium that is responsible for most cases of severe bacterial diarrhea in the United States.

ESCITALOPRAM OXALATE. An SSRI that is very similar to citalopram hydrobromide.

ESOPHAGEAL ATRESIA. Blockage or closure of the esophagus, the tube leading from the mouth to the stomach.

ESOPHAGEAL MANOMETRY. A test in which a thin tube is passed into the esophagus to measure the degree of pressure exerted by the muscles of the esophageal wall.

ESOPHAGEAL SPHINCTER. A circular band of muscle that closes the last few centimeters of the esophagus and prevents the backward flow of stomach contents.

ESOPHAGEAL VARIX. An enlarged vein of the esophagus. (Plural: esophageal varices.)

ESOPHAGITIS. Inflammation of the esophagus.

ESOPHAGOGASTRODUODENOSCOPY (EGD). A test that involves visually examining the lining of the esophagus, stomach, and upper duodenum with a flexible fiber-optic endoscope.

ESOPHAGOMYOTOMY. A surgical incision through the muscular tissue of the esophagus.

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ESOPHAGOSCOPY (ALSO ESOPHAGOENDOSCOPY). Examination of the inside of the esophagus using a flexible tube that transmits video images.

ESOPHAGUS. The muscular tube that leads from the back of the throat to the entrance of the stomach.

ESSENCE. The constituent of a plant that determines its characteristics.

ESSENTIAL FATTY ACIDS. Sources of fat in the diet, including omega-3 and omega-6 fatty acids.

ESSENTIAL OIL. A volatile oil extracted from the leaves, fruit, flowers, roots, or other components of a plant and used in aromatherapy, perfumes, and foods and beverages.

ESSENTIAL TREMOR. An uncontrollable (involuntary) shaking of the hands, head, and face. Also called familial tremor because it is sometimes inherited, it can begin in the teens or in middle age. The exact cause is not known.

ESTRODIOL. The most physiologically active form of estrogen.

ESTROGEN REPLACEMENT THERAPY (ERT). A treatment in which estrogen is used therapeutically during menopause to alleviate certain symptoms such as hot flashes. ERT has also been shown to reduce the risk of osteoporosis and heart disease in women.

ESTROGEN. A female hormone produced by the ovaries that stimulates the growth of the lining of the uterus.

ETHANOL. The chemical name for beverage alcohol. It is also sometimes called ethyl alcohol or grain alcohol to distinguish it from isopropyl or rubbing alcohol.

ETHINYL ESTRADIOL. A semi-synthetic derivative of estradiol—an estrogen or female sex hormone—used in birth control pills and combined ECPs.

EUPHORIA. An exaggerated state of psychological and physical well-being.

EUSTACIAN TUBE. A tube connecting the middle ear with the back of the nose, allowing air pressure to equalize within the ear whenever it opens, such as with yawning.

EUSTRESS. A term that is sometimes used to refer to positive stress.

EUTHANASIA. The act of putting individuals or animals to death painlessly or allowing them to die by withholding medical services, usually because of an incurable disease; also called mercy killing.

EUTHYROID. Having the right amount of thyroxin stimulation.

EVENT RECORDER. A small machine, worn by a patient usually for several days or weeks, that is activated by the patient to record his or her EKG when a symptom is detected.

EVIDENCE-BASED MEDICINE. Recommendations that are based on an evaluation of randomized, controlled trials; non-randomized trials; other experiments; descriptive studies; and reports of expert committees.

EVISERATED. Removal of eye contents.

EVOKED POTENTIAL. A test of nerve response that uses electrodes placed on the scalp to measure brain reaction to a stimulus such as a touch.

EVULSION. The forceful, and usually accidental, removal of a tooth from its socket in the bone.

EX UTERO INTRAPARTUM TREATMENT (EXIT). A cesarean section in which the infant is removed from the uterus but the umbilical cord is not cut until after surgery for a congenital defect that blocks an air passage.

EXANTHEM (PLURAL, EXANTHEMS OR EXANTHEMATA). A skin eruption regarded as a characteristic sign of such diseases as measles, German measles, and scarlet fever.

EXCIMER LASER. An instrument that is used to vaporize tissue with a cold, coherent beam of light with a single wavelength in the ultraviolet range.

EXCISIONAL BIOPSY. Removal of an entire lymph node; often the most suspicious-looking node is removed for testing.

EXHIBITIONISM. Obtaining sexual arousal by exposing genitals to an unsuspecting stranger.

EXOCRINE. A system of organs that produces chemicals that go through a duct (or tube) to reach other organs whose functioning they affect.

EXOPHTHALMOS. A condition in which the eyes stick out of their sockets and inhibit proper eyelid function.

EXOTOXIN. A poisonous secretion produced by bacilli which is carried in the bloodstream to other parts of the body.

EXPECTORANT. Drug used to thin mucus.

EXPLICIT MEMORY. Conscious recall of facts and events that is classified into episodic memory (involves time and place) and semantic memory (does not involve time and place).

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EXSTROPHY. Being turned inside out combined with being outside the body.

EXTENDED FAMILY FIELD. A person's family of origin plus grandparents, in-laws, and other relatives.

EXTENSIVE SUPPORT. Ongoing daily support required to assist an individual in a specific adaptive area, such as daily help with preparing meals.

EXTENSOR MUSCLES. A group of muscles in the forearm that serve to lift or extend the wrist and hand. Tennis elbow results from overuse and inflammation of the tendons that attach these muscles to the outside of the elbow.

EXTERNAL RADIATION THERAPY. Radiation therapy that focuses high-energy rays from a machine on the area of the tumor.

EXTRACORPOREAL. Outside of, or unrelated to, the body.

EXTRACORPOREAL CIRCUIT (ECC). The path the hemodialysis patient's blood takes outside of the body. It typically consists of plastic tubing, a hemodialysis machine, and a dialyzer.

EXTRACTION. The surgical removal of a tooth from its socket in a bone.

EXTRACTION SITE. The empty tooth socket following removal of the tooth.

EXTRAGONADAL. Occurring outside of the gonads or outside of the reproductive organs.

EXTRAOCULAR MUSCLES. The muscles (lateral rectus, medial rectus, inferior rectus, superior rectus, superior oblique, and inferior oblique) that move the eyeball.

EXTRAOCULAR RETINOBLASTOMA. Cancer that has spread from the eye to other parts of the body.

EXTRAPYRAMIDAL SYMPTOMS (EPS). A group of side effects associated with antipsychotic medications. EPS include parkinsonism, akathisia, dystonia, and tardive dyskinesia.

EXTRINSIC PATHWAY. One of three pathways in the coagulation cascade.

EXTUBATION. Removal of a breathing tube.

EXUDATE. Cells, protein, fluid, or other material that passes through blood vessel walls and accumulates in the surrounding tissue.

F

FACE MASK. The simplest way of delivering a high level of oxygen to patients with ARDS or other low-oxygen conditions.

FACELIFT. Plastic surgery performed to remove sagging skin and wrinkles from an individual's face.

FACIOSCAPULOHUMERAL MUSCULAR DYSTROPHY (FSH). This form of muscular dystrophy, also known as Landouzy–Dejerine condition, begins in late childhood to early adulthood and affects both men and women, causing weakness in the muscles of the face, shoulders, and upper arms.

FACTITIOUS DISEASES. Conditions in which symptoms are deliberately manufactured by patients in order to gain attention and sympathy; also known as factitious disorders.

FACTOR VIII. A protein involved in blood clotting that requires von Willebrand factor for stability and long-term survival in the bloodstream.

FACTOR. Any of several substances necessary to produce a result or activity in the body. The term is used when the chemical nature of the substance is unknown. In endocrinology, when the chemical nature is known, factors are renamed hormones.

FAGET'S SIGN. The simultaneous occurrence of a high fever with a slowed heart rate.

FALLOPIAN TUBES. Part of the internal female anatomy that carries eggs from the ovaries to the uterus.

FALSE NEGATIVE. Test results showing no problem when one exists.

FAMCICLOVIR. An oral antiviral drug that blocks the replication of the varicella zoster virus.

FAMILIAL POLYPOSIS. An inherited condition in which lumps of tissue (polyps) form inside the colon. Familial polyposis may develop into cancer.

FAMILY SYSTEMS THEORY. An approach to treatment that emphasizes the interdependency of family members rather than focusing on individuals in isolation from the family. This theory underlies the most influential forms of contemporary family therapy.

FANCONI'S ANEMIA. An inherited form of aplastic anemia.

FANCONI'S SYNDROME. A kidney disorder in which glucose, amino acids, uric acid, phosphate,

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and bicarbonate are passed into the urine instead of being reabsorbed into the blood.

FARMER'S LUNG. An allergic reaction to moldy hay, most often seen in farmers, that results in lung disease.

FASCIA. The sheet of connective tissue that covers the body under the skin and envelops the muscles and various organs.

FASCIA, DEEP. A fibrous layer of tissue that envelopes muscles.

FASCIA, SUPERFICIAL. A fibrous layer of tissue that lies between the deepest layer of skin and the subcutaneous fat.

FASCICULATIONS. Involuntary twitching of patient's muscles.

FAT. Molecules composed of fatty acids and glycerol; the slowest utilized source of energy, but the most energy-efficient form of food. Each gram of fat supplies about nine calories, more than twice that supplied by the same amount of protein or carbohydrate.

FAT-SOLUBLE VITAMIN. A vitamin that dissolves easily in fat or oil, but not in water. The fat-soluble vitamins are vitamins D, E, A, and K.

FATIGUE. Loss of energy; tiredness.

FATTY LIVER. An abnormal amount of fat tissue in the liver caused by alcohol abuse.

FEBRILE SEIZURE. Convulsions brought on by fever.

FECAL IMPACTION. Obstruction of the rectum by a large mass of feces (stool).

FECES. Bodily waste material that normally passes through the anus.

FELDENKRAIS METHOD. A therapy based on creating a good self image by correction and improvements of body movements.

FELTY'S SYNDROME. An autoimmune disorder in which neutropenia is associated with rheumatoid arthritis and an enlarged spleen.

FEMALE ATHLETE TRIAD. A combination of disorders frequently found in female athletes that includes disordered eating, osteoporosis, and oligo- or amenorrhea. The triad was first officially named in 1993.

FEMALE STERILIZATION. The process of permanently ending a woman's ability to conceive by tying off or cutting apart the fallopian tubes.

FEMORAL ARTERY. An artery located in the groin area that is the most frequently accessed site for arterial puncture in angiography.

FEMUR. The thighbone.

FERRITIN. A protein found in the liver, spleen, and bone marrow that stores iron.

FERTILIZATION. The joining of the sperm and the egg; conception.

FETAL. Refers to the fetus, also known in the first two months after conception as an embryo.

FETAL ALCOHOL SYNDROME. A cluster of birth defects that includes abnormal facial features and mental retardation, caused by the mother's consumption of alcoholic beverages during pregnancy.

FETAL TISSUE TRANSPLANTATION. A method of treating Parkinson's and other neurological diseases by grafting brain cells from human fetuses onto the affected area of the human brain. Human adults cannot grow new brain cells but developing fetuses can. Grafting fetal tissue stimulates the growth of new brain cells in affected adult brains.

FETISHISM. Obtaining sexual arousal using or thinking about an inanimate object or part of the body.

FETOSCOPE. A fiber-optic instrument for viewing the fetus inside the uterus.

FETUS. A baby developing in the uterus from the third month to birth.

FIBER. Also known as roughage or bulk. Insoluble fiber moves through the digestive system almost undigested and gives bulk to stools. Soluble fiber dissolves in water and helps keep stools soft.

FIBEROPTICS. In medicine, fiberoptics uses glass or plastic fibers to transmit light through a specially designed tube. The tube is inserted into organs or body cavities where it transmits a magnified image of the internal body structures.

FIBRILLATION. Rapid, uncoordinated contractions of the upper or the lower chambers of the heart.

FIBRILLIN. A protein that is an important part of the structure of the body's connective tissue. In Marfan's syndrome, the gene responsible for fibrillin has mutated, causing the body to produce a defective protein.

FIBRIN. The protein formed as the end product of the blood clotting process when fibrinogen interacts with thrombin.

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FIBRIN SPLIT PRODUCTS (FSP). Pieces of the protein fibrin released from a dissolving clot.

FIBRINOGEN. A type of blood protein called a globulin that interacts with thrombin to form fibrin.

FIBRINOLYSIS. The clot dissolving portion of the coagulation process.

FIBROADENOMA. A benign breast growth made up of fibrous tissue.

FIBROBLAST. A connective-tissue cell.

FIBROID TUMOR. A noncancerous tumor formed of fibrous tissue.

FIBROIDS. Benign (noncancerous) growths that arise from the smooth muscle layer and connective tissue of the uterus. They sometimes cause secondary dysmenorrhea.

FIBROMA. A usually benign tumor consisting of fiborous tissue.

FIBROMUSCULAR DYSPLASIA. A disorder that causes unexplained narrowing of arteries and high blood pressure.

FIBROMYALGIA. A chronic disease syndrome characterized by fatigue, widespread muscular soreness, and pain at specific points on the body.

FIBROSIS. A condition characterized by the presence of scar tissue, or reticulin and collagen proliferation in tissues to the extent that it replaces normal tissues.

FIBROUS CONNECTIVE TISSUE. Dense tissue found in various parts of the body containing very few living cells.

FIFTH DISEASE. Erythema infectiosum; a common respiratory infection among children caused by parvovirus B19 that usually is not serious but can cause fetal complications.

FILARIAL. Threadlike. The word "filament" is formed from the same root word.

FILARIASIS. A tropical disease caused by worms that live in lymph channels.

FILARIFORM. Threadlike in appearance, like the infectious stage of the threadworm larva.

FILLING. Dental material that occupies the space remaining within a tooth after the decayed portion has been removed.

FILTRATE. The medical term for the water and small molecules filtered in the nephron of the kidney.

FINE NEEDLE ASPIRATION BIOPSY. A procedure using a thin needle to remove fluid and cells from a lump in the breast.

FINGER STICK. A technique for collecting a very small amount of blood from the fingertip area.

FIRST–RANK SYMPTOMS. A set of symptoms designated by Kurt Schneider in 1959 as the most important diagnostic indicators of schizophrenia. These symptoms include delusions, hallucinations, thought insertion or removal, and thought broadcasting. First–rank symptoms are sometimes referred to as Schneiderian symptoms.

FISSURE. Any cleft or groove, normal or otherwise, especially a deep fold in the anus.

FISTULA. A passageway formed by a disease or injury that drains fluid from an infected area to the outside or to other parts of the body.

FLACCID. Flabby, limp, weak.

FLACCID PARALYSIS. Paralysis characterized by limp, unresponsive muscles.

FLAGELLATE. A microorganism that uses flagella (hair-like projections) to move.

FLAGELLUM. A tail–like projection extending from the cell walls of certain bacteria. Its name is the Latin word for "whip."

FLAP. A section of tissue moved from one area of the body to another.

FLARE AND CELL. A pattern revealed by slit-lamp examination that indicates uveitis. Flare and cell resembles light filtered through smoke.

FLASHBACK. A temporary reliving of a traumatic event.

FLATULENCE. Excess gas in the digestive tract.

FLATUS. Gas or air in the digestive tract.

FLAVIVIRUS. An arbovirus that can cause potentially serious diseases, such as dengue, yellow fever, Japanese encaphilitis, and West Nile fever.

FLAVONOID. A food chemical that helps to limit oxidative damage to the body's cells, and protects against heart disease and cancer.

FLOATERS. Translucent specks that float across the visual field, due to small objects floating in the vitreous humor.

FLORA. Living inhabitants of a region or area.

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FLUENCY. The ability to produce a flow of words and not get "stuck," as in stuttering.

FLUKE. A parasitic flatworm that has external suckers. Flukes are sometimes called trematodes.

FLUORESCEIN. A fluorescent chemical used to examine the cornea.

FLUORESCEIN DYE. An orange dye used to illuminate the blood vessels of the retina in fluorescein angiography.

FLUORESCENCE IN SITU HYBRIDIZATION (FISH). A technique used to detect small deletions or rearrangements in chromosomes.

FLUORESCENT ANTIBODY TEST (FA TEST). A test in which a fluorescent dye is linked to an antibody for diagnostic purposes.

FLUORIDE. A chemical compound containing fluorine that is used to treat water or applied directly to teeth to prevent decay.

FLUOROQUINOLONES. A relatively new group of antibiotics that have had good success in treating infections with many gram-negative bacteria, such as *Shigella*; they should not be used in children under 17 years of age, because of possible effect on bone or cartilage growth.

FLUOROSCOPE. A device used in some radiology procedures that provides immediate images and motion on a screen much like those seen at airport baggage security stations.

FLUOROURACIL. A cell-killing (cytotoxic) medication that can be applied in cream form to treat cancer of the penis.

FLUOXETINE. The first SSRI; marketed as Sarafem for treating PMDD.

FLUVOXAMINE. An SSRI that is used to treat obsessive-compulsive disorder as well as other conditions.

FMR-1 GENE. A gene found on the X chromosome. Its exact purpose is unknown, but it is suspected that the gene plays a role in brain development.

FOLEY CATHETER. A tube that drains urine from the bladder.

FOLIC ACID. One of the B vitamins important for healthy growth of the fetus. It is essential to the normal development of a baby's spine, brain and skull, especially during the first four weeks of pregnancy.

FOLLICLE. The small sac at the base of a hair shaft. The follicle lies below the skin surface.

FOLLICLE STIMULATING HORMONE (FSH). A female hormone that regulates ovulation and menstruation.

FOLLICULAR. Relating to one of the round cells in the ovary that contain an ovum.

FOMITE. An inanimate object that can transmit infectious organisms.

FONTANEL. One of the membranous intervals between the uncompleted angles of the parietal and neighboring bones of a fetal or young skull; so called because it exhibits a rhythmical pulsation.

FOOD IRRADIATION METHODS. A process using radiant energy to kill microorganisms in food, to extend the amount of time in which food can be sold and eaten safely.

FOOD-BORNE ILLNESS. A disease that is transmitted by eating or handling contaminated food.

FOOTLING BREECH. A position of the fetus while in the uterus where the feet of the fetus are nearest the cervix and will be the first part of the fetus to exit the uterus, with the head of the fetus being the last part to exit the uterus.

FORAMEN (PLURAL, FORAMINA). The medical term for a natural opening or passage. The foramina of the spinal column are openings between the vertebrae for the spinal nerves to branch off from the spinal cord.

FORAMEN MAGNUM. The opening at the base of the skull, through which the spinal cord and the brainstem pass.

FORCED EXPIRATORY VOLUME (FEV). The volume of air exhaled from the beginning of expiration to a set time (usually 0.5, 1, 2, and 3 seconds).

FORCED VITAL CAPACITY (FVC). The volume of air that can be exhaled forceably after a maximal inspiration.

FOREMILK. Thin watery milk found at the beginning of breast feeding.

FORENSIC. Pertaining to or used during legal proceedings.

FORESKIN. A covering fold of skin over the tip of the penis.

FOVEA. A small area of the retina responsible for acute vision.

FRACTIONATION. A laboratory test or process in which blood or another fluid is broken down into its components. Fractionation can be used to assess the proportions of the different types of cholesterol in a

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blood sample. In radiation therapy, it is used to divide a dose of radiation into smaller treatment doses.

FRACTURE. A break in a bone.

FRAGILE X SYNDROME. A genetic condition related to the X chromosome that affects mental, physical, and sensory development.

FREE FLAP. A section of tissue detached from its blood supply, moved to another part of the body, and reattached by microsurgery to a new blood supply.

FREE RADICAL. An unstable molecule that causes oxidative damage by stealing electrons from surrounding molecules, thereby disrupting activity in the body's cells.

FREQUENCY. Sound, whether traveling through air or the human body, produces vibrations—molecules bouncing into each other—as the shock wave travels along. The frequency of a sound is the number of vibrations per second. Within the audible range, frequency means pitch—the higher the frequency, the higher a sound's pitch.

FRONTAL CORTEX. The part of the human brain associated with aggressiveness and impulse control. Abnormalities in the frontal cortex are associated with an increased risk of suicide.

FRONTAL LOBE. The largest, most forward-facing part of each side or hemisphere of the brain.

FROTTEURISM. Obtaining sexual arousal and gratification by rubbing one's genitals against others in public places.

FROZEN SHOULDER. A shoulder that becomes scarred and cannot move.

FRUCTOSE. A monosaccharide sugar found in many fruits.

FUCHS' DYSTROPHY. A hereditary disease of the inner layer of the cornea. Treatment requires penetrating keratoplasty. The lens of the eye may also be affected and require surgical replacement at the same time as the cornea.

FUGUE. A dissociative experience during which a person travels away from home, has amnesia for their past, and may be confused about their identity but otherwise appear normal.

FULMINANT. Occurring or flaring up suddenly and with great severity. A potentially fatal complication of amebic dysentery is an inflammation of the colon known as fulminant colitis.

FULMINATING COLITIS. A potentially fatal complication of amebic dysentery marked by sudden and severe inflammation of the intestinal lining, severe bleeding or hemorrhaging, and massive shedding of dead tissue.

FUNCTIONAL CYST. A benign cyst that forms on the ovary and resolves on its own without treatment.

FUNCTIONAL PAIN. Pain that does not have a structural or organic cause.

FUNCTIONAL RESIDUAL CAPACITY (FRC). The volume of air left in the lungs at the end of passive expiration (breathing out). It can be measured by body plethysmography.

FUNDOPLICATION. A surgical procedure that increases pressure on the LES by stretching and wrapping the upper part of the stomach around the sphincter.

FUNDUS. The inside of an organ. In the eye, refers to the back area that can be seen with the ophthalmoscope.

FUNGI. A kingdom of saprophytic and parasitic spore–producing organisms that include mushrooms and yeast.

FUNGUS. A member of a group of simple organisms that are related to yeast and molds.

FUNNEL BREAST. A condition where there is a hollow depression in the lower part of the chest.

FURUNCULOSIS. A condition in which the patient suffers from recurrent episodes of boils.

G

GADOLINIUM. A very rare metallic element useful for its sensitivity to electromagnetic resonance, among other things. Traces of it can be injected into the body to enhance the MRI pictures.

GAG REFLEX. A normal reflex consisting of elevation of the palate, retraction of the tongue, and contraction of the throat muscles.

GALACTORRHEA. Excessive or spontaneous flow of milk.

GALACTOSE. One of two simple sugars, the other being glucose, that make up the protein lactose found in milk. Galactose can be toxic in high levels.

GALACTOSEMIA. A rare genetic disorder where an infant cannot metabolize the sugar in breast milk, and therefore cannot breastfeed

GALLBLADDER. A small, pear-shaped organ in the upper right-hand corner of the abdomen. It is

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connected by a series of ducts (tube-like channels) to the liver, pancreas, and duodenum (first part of the small intestine). The gallbladder receives bile from the liver and concentrates and stores it. After a meal, bile is squeezed out of the gallbladder into the intestine, where it aids in digestion of food.

GALLIUM. A form of radionuclide that is used to help locate tumors and inflammation (specifically referred to as GA67 citrate).

GALLOP RHYTHM. An abnormal heart rhythm in which the doctor can hear three (sometimes four) sounds instead of the usual two, resembling the rhythm of a horse's gallop.

GALLSTONE ILEUS. Obstruction of the large intestine caused by a gallstone that has blocked the intestinal opening.

GAMETE. An egg (ovum) from the female or a mature sperm from the male.

GAMETE INTRAFALLOPIAN TUBE TRANSFER (GIFT). A reproductive procedure in which eggs are taken from a woman's ovaries, mixed with sperm, and then deposited into the woman's fallopian tube.

GAMMA CAMERA. A device inside the SPECT machine that forms images of the gamma rays emitted by the radionuclides used in tracers in nuclear medicine.

GAMMA GLOBULIN. One of a group of proteins found in the blood that is involved in helping the body fight infections.

GAMMA KNIFE. High-dose radiation treatment for intracranial tumors.

GAMMA RAYS. Short wavelength, high energy electromagnetic radiation emitted by radioactive substances.

GANGLION. A mass of nerve tissue outside of the central nervous system.

GANGLIONEUROMA. A ganglioneuroma is a tumor composed of mature nerve cells.

GANGLIOSIDE. A fatty (lipid) substance found within the brain and nerve cells.

GANGRENE. Death of tissue due to loss of blood supply followed by bacterial invasion and putrefaction.

GANSER'S SYNDROME. An unusual factitious disorder characterized by dissociative symptoms and absurd answers to direct questions.

GANTRY. A name for the couch or table used in a CT scan. The patient lies on the gantry while it slides into the x-ray scanner portion.

GAS EMBOLISM. The presence of gas bubbles in the bloodstream that obstruct circulation. Also called air embolism.

GAS EXCHANGE. The process by which oxygen is extracted from inhaled air into the bloodstream, and, at the same time, carbon dioxide is eliminated from the blood and exhaled.

GASTRIC. Relating to the stomach.

GASTRIC LAVAGE. Also called a stomach pump. For this procedure, a flexible tube is inserted through the nose, down the throat, and into the stomach and the contents of the stomach are suctioned out. The inside of the stomach is rinsed with a saline (salt water) solution.

GASTRIC (OR PEPTIC) ULCER. An ulcer (sore) of the stomach, duodenum or other part of the gastrointestinal system. Though the causes are not fully understood, they include excessive secretion of gastric acid, stress, heredity, and the use of certain drugs, especially acetylsalicylic acid and nonsteroidal anti-inflammatory-drugs.

GASTRIN. A hormone secreted in the stomach that is involved in the production of gastric acid. Overproduction of gastric acid contributes to peptic ulcer formation.

GASTRINOMA. Tumor that arises from the gastrin-producing cells in the pancreas.

GASTROENTERITIS. An inflammation of the lining of the stomach and intestines, usually caused by a viral or bacterial infection.

GASTROENTEROLOGIST. A doctor who specializes in diagnosing and treating diseases of the digestive system.

GASTROESOPHAGEAL REFLUX DISEASE (GERD). A condition in which gastric juice from the stomach backs up into the bottom of the esophagus and causes irritation, inflammation, or erosion of the cells lining the esophagus.

GASTROINTESTINAL. Pertaining to the stomach and intestines.

GASTROINTESTINAL TRACT. A group of organs and related structures that includes the esophagus, stomach, liver, gallbladder, pancreas, small intestine, large intestine, rectum, and anus.

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GASTROJEJUNOSTOMY. A surgical procedure in which the stomach is surgically connected to the jejunum (middle portion of the small intestine).

GASTROPLASTY. A surgical procedure used to reduce digestive capacity by shortening the small intestine or shrinking the side of the stomach.

GASTROSCOPY. Looking into the stomach with a flexible viewing instrument called a gastroscope.

GASTROSTOMY. Surgical creation of an artificial opening into the stomach through the abdominal wall to allow tube feeding.

GASTROSTOMY TUBE. Stomach tube for feeding.

GAUCHER'S DISEASE. A rare genetic disease caused by a deficiency of enzymes needed for the processing of fatty acids.

GELASTIC SEIZURES. Seizures manifesting with brief involuntary laughter.

GENDER IDENTITY DISORDER (GID). A condition in which a person strongly identifies with the opposite gender and feels uncomfortable with his or her biological sex. It occurs more often in males than in females.

GENDER REASSIGNMENT SURGERY. The surgical alteration and reconstruction of a person's sex organs to resemble those of the other sex as closely as possible. It is sometimes called gender reassignment surgery.

GENE. The basic unit of genetic material carried in a particular place on a chromosome. Genes are passed on from parents to child during conception and determine how traits such as blood type are inherited and expressed.

GENE THERAPY. A method of treating a disorder by replacing damaged or abnormal genes with normal ones.

GENERAL ANESTHESIA. Deep sleep induced by a combination of medicines that allows surgery to be performed.

GENERAL PARESIS. An advanced form of neurosyphilis affecting personality and control of movement and possibly causing convulsions or partial paralysis.

GENERAL SURGEON. A physician who has special training and expertise in performing a variety of operations.

GENETIC CLUSTER. A group of viral strains with very similar, yet distinct, nucleic acid sequences.

GENETIC DISEASE. A disease that is (partly or completely) the result of the abnormal function or expression of a gene; the inheritance and expression of a genetic mutation.

GENIOPLASTY. An operation performed to reshape the chin. Genioplasties are often done to treat OSA because the procedure changes the structure of the patient's upper airway.

GENITAL. Sexual organ.

GENITAL HERPES. A sexually-transmitted disease caused by the herpes simplex virus.

GENOGRAM. A family tree diagram that represents the names, birth order, sex, and relationships of the members of a family. Therapists use genograms to detect recurrent patterns in the family history and to help the members understand their problem(s).

GENOGROUP. Related viruses within a genus; may be further subdivided into genetic clusters.

GENOME. The genetic makeup of a cell, composed of DNA.

GENOTYPE. The genetic makeup of a cell or organism.

GENU VALGUM. Deformity in which the legs are curved inward so that the knees are close together, nearly or actually knocking as a person walks with ankles widely apart of each other.

GENUINE URINARY STRESS INCONTINENCE (USI). Stress incontinence due to hypermobility of the urethra.

GEOPHAGIA. The compulsive eating of earthy substances, including sand, soil, and clay.

GERM. A disease-causing microorganism.

GERM CELL. One of the cells that ordinarily develops into eggs or sperm (also sperm and eggs).

GERMINOMA. A tumor of germ cells (ovum and sperm cells that participate in production of the developing embryo).

GESTALT THERAPY. A humanistic therapy technique that focuses on gaining an awareness of emotions and behaviors in the present rather than in the past.

GESTATION. The period from conception to birth, during which the developing fetus is carried in the uterus.

GESTATIONAL AGE. The estimated age of a fetus expressed in weeks, calculated from the first day of the last normal menstrual period.

GESTATIONAL TROPHOBLASTIC DISEASE. A rare, aggressive, malignant, often metastatic (spreading to other organs) cancer in women of childbearing age in

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which cancer cells grow in the tissues that are formed in the uterus after conception.

GHRELIN. A peptide hormone secreted primarily by the stomach that has been implicated in the control of food intake and fat storage.

GIANT CELL ARTERITIS. Also called temporal arteritis. A condition which causes the inflammation of temporal arteries. It can cause blindness when the inflammation effects the ophthalmic artery.

GIARDIA LAMBLIA. A type of protozoa with a whip-like tail that infects the human intestinal tract, causing giardiasis. The protozoa will not spread to other parts of the body.

GIARDIASIS. A condition in which the intestines are infected with *Giardia lamblia*, a type of protozoan.

GIGANTISM. Excessive growth, especially in height, resulting from overproduction during childhood or adolescence of growth hormone by a pituitary tumor. Untreated, the tumor eventually destroys the pituitary gland, resulting in death during early adulthood. If the tumor develops after growth has stopped, the result is acromegaly, not gigantism.

GILBERT'S SYNDROME. A mild hereditary form of jaundice.

GILLBERG'S CRITERIA. A six–item checklist for Asperger syndrome developed by Christopher Gillberg, a Swedish researcher. It is widely used as a diagnostic tool.

GINGIVITIS. Inflammation of the gums, seen as painless bleeding during brushing and flossing.

GINKGO. An herb from *Ginkgo biloba*, a shade tree native to China with fan-shaped leaves and fleshy seeds with edible kernels.

GLAND. A collection of cells that releases certain chemicals, or hormones, that are important to the functioning of other organs or body systems.

GLANS. The head of the penis.

GLAUCOMA. A condition in which pressure in the eye is abnormally high, damaging the optic nerve. If not treated, glaucoma may lead to blindness.

GLEASON GRADING SYSTEM. A method of predicting the tendency of a tumor in the prostate to metastasize based on how similar the tumor is to normal prostate tissue.

GLOBAL APHASIA. A condition characterized by either partial or total loss of the ability to communicate verbally or using written words as a result of widespread injury to the language areas of the brain. This condition may be caused by a stroke, head injury, brain tumor, or infection.

GLOBIN. Protein component of hemoglobin. Normal adult hemoglobin has a pair each of alpha-globin and beta-globin molecules that each contain a heme group.

GLOBULINS. A group of proteins in blood plasma whose levels can be measured by electrophoresis in order to diagnose or monitor a variety of serious illnesses.

GLOMERULAR KIDNEY DISEASE. Disease of the kidney that affects the glomeruli, the part of the kidney that filters certain substances out of the blood.

GLOMERULI (SINGULAR, GLOMERULUS). Groups of tiny blood vessels with very thin walls that function as filters in the kidney.

GLOMERULONEPHRITIS. An inflammation of the filtering units of the kidney (glomeruli). The condition impairs the kidney's ability to filter waste products, salt, and water from the bloodstream, leading to serious complications such as renal failure.

GLOSSOPHARYNGEAL NEURALGIA. Sharp recurrent pain deep in the throat that extends to the area around the tonsils and possibly the ear. It is triggered by swallowing or chewing.

GLOTTIS. The opening between the vocal cords at the upper part of the larynx.

GLUCOCEREBROSIDE. A cerebroside that contains glucose in the molecule.

GLUCOCORTICOID THERAPY. Treatment using corticoids that are anti-inflammatory and immunosuppressive.

GLUCOCORTICOIDS. A class of steroid hormones synthesized by the adrenal cortex that are involved in fat, protein, and carbohydrate metabolism and that have anti-inflammatory and immunosuppressive actions; also known as glucocorticosteroids.

GLUCOSE. A simple sugar produced when carbohydrates are broken down in the small intestine. It is the primary source of energy for the body.

GLUCOSE-6-PHOSPHATE DEHYDROGENASE (G6PD) DEFICIENCY. An inherited disorder in which the body lacks an enzyme that normally protects red blood cells from toxic chemicals. When people with this condition take certain drugs, or sometimes when they have a fever or an infection, their red blood cells break down, causing anemia.

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GLUTATHIONE. A molecule that acts as a co-enzyme in cellular oxidation-reduction reactions.

GLUTEN. A protein found in wheat, rye, barley, and oats.

GLUTEN ENTEROPATHY. A hereditary malabsorption disorder caused by sensitivity to gluten, a protein found in wheat, rye, barley, and oats. Also called nontropical sprue or Celiac disease.

GLYCEMIC INDEX (GI). A ranking from 1–100 that measures how much carbohydrate-containing foods raise blood sugar levels within two hours after being eaten. Foods with a glycemic index of 50 or lower are considered "good" because they are digested at a slower rate.

GLYCOGEN. A macromolecule composed mainly of glucose that serves as the storage form of glucose that is not immediately needed by the body.

GLYCOGENOLYSIS. The process of tearing-down a glycogen molecule to free up glucose.

GLYCOGENOSIS. An alternate term for glycogen storage disease. The plural form is glycogenoses.

GLYCOLYSIS. The pathway in which a cell breaks down glucose into energy.

GLYCOSYLATED HEMOGLOBIN. A test that measures the amount of hemoglobin bound to glucose. It is a measure of how much glucose has been in the blood during the past two to four months.

GNRH ANTAGONISTS. A group of medications that affect the reproductive hormones. These medications are used to treat fibroids, endometriosis, and infertility.

GOECKERMAN REGIMEN. UVB light therapy combined with topical coal-tar preparations.

GOITER. An abnormal enlargement of the thryroid gland.

GONADOTROPINS. Protein hormones secreted by the pituitary gland that affect and stimulate the ovaries or testes; used in treating infertility.

GONADS. Glands that make sex hormones and reproductive cells—testes in the male, ovaries in the female.

GONIOMETER. An instrument for measuring angles of a joint.

GONIOSCOPE. An instrument used to inspect the eye. It consists of a magnifier and a lens equipped with mirrors and is placed on the patient's cornea.

GONOCOCCUS (PLURAL, GONOCOCCI). The bacterium *Neisseria gonorrheae* that causes gonorrhea, a sexually transmitted infection of the genitals and urinary tract. Gonococci may occasionally affect the eye, causing blindness if not treated.

GONORRHEA. A sexually transmitted disease that affects the genital mucous membranes of men and women.

GONZALEZ REGIMEN. An alternative therapy for pancreatic cancer that includes a special diet, nutritional supplements, pancreatic enzymes, and coffee enemas.

GOUT. A type of arthritis in which uric acid, a waste product that normally passes out of the body in urine, collects in the joints and the kidneys, resulting in swollen, painful joints and possibly kidney stones.

GRAFT. A transplanted organ or other tissue.

GRAFT VERSUS HOST DISEASE. A life-threatening complication of bone marrow transplants in which the donated marrow causes an immune reaction against the recipient's body.

GRAINS. Flecks of hardened material such as bacteria or fungi spores.

GRAM STAIN. A staining procedure used to visualize and classify bacteria. The Gram stain procedure allows the identification of purple (Gram positive) organisms and red (Gram negative) organisms.

GRANULATION TISSUE. A kind of tissue formed during wound healing, with a rough or irregular surface and a rich supply of blood capillaries.

GRANULE. A small grain or pellet. Medicines that come in granule form usually are mixed with liquids or sprinkled on food before they are taken.

GRANULOCYTE. Any of several types of white blood cells that have granules in their cell substance. Neutrophils are the most common type of granulocyte.

GRANULOCYTE/MACROPHAGE COLONY STIMULATING FACTOR (GM–CSF). Also known as sargramostim, a substance produced by cells of the immune system that stimulates an attack upon foreign cells. Used to treat prostate cancers as a genetically engineered component of a vaccine that stimulates the body to attack prostate tissue.

GRANULOCYTOPENIA. A condition characterized by a deficiency of white blood cells.

GRANULOMA. A nodule or mass of chronically inflamed tissue.

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GRANULOMATOUS. Resembling a tumor made of granular material.

GRANULOMATOUS DISEASE. Characterized by growth of tiny blood vessels and connective tissue.

GRANULOMATOUS MYOCARDITIS. Also called giant cell myocarditis, this noninfectious inflammation of the heart causes large areas of tissue death in the heart muscle, ventricular enlargement, and clots inside the heart chambers.

GRAVEL. The debris which is formed from a fragmented kidney stone.

GRAVES' DISEASE. An autoimmune disorder of the thyroid gland, in which the gland swells to twice its normal size and secretes too much thyroid hormone.

GRAY MATTER. The portion of the brain that contains neurons, as opposed to white matter, which contains nerve tracts.

GROIN. The region of the body that lies between the abdomen and the thighs.

GROUP A STREPTOCOCCUS. A sphere–shaped bacterium that grows in long chains and causes strep throat as well as scarlet fever and some forms of tonsillitis.

GROUP B STREPTOCOCCAL (GBS) DISEASE. A common bacterial infection that is potentially life-threatening if transmitted to a fetus during early pregnancy or birth.

GROUP THERAPY. Group interaction designed to provide support, correction through feedback, constructive criticism, and a forum for consultation and reference.

GROWTH FACTOR. A naturally occuring compound in the body that promotes cellular growth and survival.

GROWTH HORMONE. A hormone that eventually stimulates growth; also called somatotropin.

GROWTH PLATE. The place in long bones where growth occurs during childhood.

GUAIAC. A compound derived from the wood resin of guaiacum trees. Guaiac reacts with blood in the stool to produce a blue-colored reaction when peroxide is added to the sample.

GUIDE WIRE. A wire that is inserted into an artery to guide a catheter to a certain location in the body.

GUIDED IMAGERY. The use of relaxation and mental visualization to improve mood and/or physical well-being.

GUILLAIN-BARRÉ SYNDROME. A disorder in which the body's immune system attacks part of the peripheral nervous system, destroying the myelin sheath that surrounds the nerves. The syndrome usually occurs after a respiratory infection and results in progressive but reversible paralysis or weakness of multiple muscles, starting in the lower extremities and often ascending to the muscles involved in respiration.

GUMMA. A rubbery swelling or tumor that heals slowly and leaves a scar and is a symptom of tertiary syphilis.

GUTTA PERCHA. An inert, latex-like substance used for filling root canals.

GYNECOLOGIST. A physician with specialized training in diseases and conditions of the female reproductive system.

GYNECOMASTIA. Excessive growth of breast tissue in males.

H

H1N1 (SWINE FLU). A virus that was originally found in pigs, symptoms of H1N1 influenza include fever, cough, chills, fatigue, headache, and body aches.

H2 BLOCKERS. Also known as H_2 antagonists, a type of drug that relieves indigestion by reducing the production of stomach acid.

HAIR CELLS. Sensory receptors in the inner ear that transform sound vibrations into messages that travel to the brain.

HAIR FOLLICLE. A tube-like indentation in the skin from which a single hair grows.

HAIRBULB. The root of a strand of hair from which the color develops.

HALF-LIFE. The time required for half of the atoms in a radioactive substance to disintegrate.

HALITOSIS. The medical term for bad breath.

HALLUCINATION. A false or distorted sensory experience that appears to be real to the person experiencing it.

HALLUCINOGEN. A drug that distorts sensory perceptions and disturbs emotion, judgment, and memory.

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HALLUCINOGEN PERSISTING PERCEPTION DISORDER (HPPD). The recurrence of LSD effects after the drug experience has ended.

HANTAVIRUS. A group of arboviruses that cause hemorrhagic fever (characterized by sudden onset, fever, aching and bleeding in the internal organs).

HAPTOGLOBIN. A protein in blood plasma that binds hemoglobin.

HARVESTING. The process of removing tissues or organs from a donor and preserving them for transplantation.

HASHIMOTO'S DISEASE. An autoimmune disorder that is the most common cause of primary hypothyroidism. It was the first disease to be recognized as an autoimmune disorder. It is named for a Japanese doctor, Hakaru Hashimoto, who first described it in 1912.

HATHA YOGA. Form of yoga using postures, breathing methods and meditation.

HDL CHOLESTEROL. High-density lipoprotein cholesterol; a component of cholesterol that helps protect against heart disease. HDL is nicknamed "good" cholesterol.

HEART ATTACK. A cardiac emergency that occurs when a clot blocks blood flow in one or more of the heart's arteries. Oxygen supply to the heart muscle is cut off, resulting in the death of heart tissue in the affected area.

HEART BLOCK. A problem with electrical conduction in the heart muscle that may lead to irregular heart beat and require a pacemaker for treatment.

HEART CATHETERIZATION. A heart catheterization is used to view the heart's chamber and valves. A tube (catheter) is inserted into an artery, usually in the groin. A dye is then put into the artery through the tube. The dye makes its way to the heart to create an image of the heart on x-ray film. The image is photographed and stored for further examination.

HEART FAILURE. A term used when the heart is unable to pump enough blood to supply the needs of the body.

HEART MURMUR. Sound during the heartbeat caused by a heart valve that does not close properly.

HEART VALVES. Valves that regulate blood flow into and out of the heart chambers.

HEARTBURN. A burning sensation in the chest that can extend to the neck, throat, and face, caused by the movement of stomach acid flowing backwards (refluxing) into the esophagus.

HEAT STROKE. A severe condition caused by prolonged exposure to high heat. Heat stroke impedes the body's ability to cool itself and can lead to collapse and coma.

HEAVY METAL. One of 23 chemical elements that has a specific gravity (a measure of density) at least five times that of water.

HEIMLICH MANEUVER. The application of sudden upward pressure on the upper abdomen to force an obstructing object from the trachea of a choking victim.

HELICOBACTER PYLORI. A gram-negative rod-shaped bacterium that lives in the tissues of the stomach and causes inflammation of the stomach lining.

HELMINTHS. Parasitic worms, such as tapeworms or liver flukes, that can live in the human body.

HEMAGGLUTINATION. The clumping or clustering of red blood cells caused by certain viruses, antibodies, or other substances.

HEMARTHROSIS. A condition of blood within a joint.

HEMATIN. A drug administered intravenously to halt an acute porphyria attack. It causes heme biosynthesis to decrease, preventing the further accumulation of heme precursors.

HEMATOCRIT. The proportion of whole blood in the body, by volume, that is composed of red blood cells.

HEMATOCRIT (HCT) LEVEL. A measure of red blood cells.

HEMATOLOGIST. A physician who specializes in diseases of the blood and blood-forming organs.

HEMATOLOGY. The medical specialty that deals with the blood and the organs that form blood.

HEMATOMA. An accumulation of blood, often clotted, in a body tissue or organ, usually caused by a break or tear in a blood vessel.

HEMATOPOIETIC CELLS. Those cells that are lodged within the bone marrow and are responsible for producing the cells that circulate in the blood (red blood cells, white blood cells, and platelets).

HEMATOPOIETIC STEM CELL. A cell that can develop into any type of specialized blood cell.

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HEMATOPOIETIC SYSTEM. The system in the body responsible for the production of blood cells.

HEMATOPORPHYRIN. A dark reddish-purple pigment found in blood. A purified form of hematoporphyrin is used to make porfimer sodium.

HEMATURIA. Blood in the urine.

HEME. The iron-containing molecule in hemoglobin that serves as the site for oxygen binding.

HEMIPLEGIA. Paralysis of one side of the body.

HEMISPHERE. One of the two halves or sides—the left and the right—of the brain.

HEMIVERTEBRA. Condition in which one side of a vertebra fails to form normally before birth.

HEMOCHROMATOSIS. A disorder of iron metabolism characterized by excessive absorption of iron from food.

HEMOCYTOMETER. An instrument used to count platelets or other blood cells.

HEMODIALYSIS. The removal of waste products from the blood stream in patients with kidney failure. Blood is removed from a vein, passed through a dialysis machine, and then put back into a vein.

HEMODILUTION. A technique in which the fluid content of the blood is increased without increasing the number of red blood cells.

HEMOGLOBIN. A protein-iron compound in red blood cells that functions primarily in carrying oxygen from the lungs to the tissues of the body.

HEMOGLOBIN A. Normal adult hemoglobin that contains four heme molecules, two alpha-globin molecules, and two beta-globin molecules.

HEMOGLOBIN C DISEASE. A disease of abnormal hemoglobin, occurring in 2–3% of African Americans. Only those who have two genes for the disease develop anemia, which varies in severity. Symptoms include episodes of abdominal and joint pain, an enlarged spleen and mild jaundice.

HEMOGLOBIN ELECTROPHORESIS. A laboratory test that separates molecules based on their size, shape, or electrical charge.

HEMOGLOBIN H DISEASE. A thalassemia-like syndrome causing moderate anemia and red blood cell abnormalities.

HEMOLYSIS. The destruction or breakdown of red blood cells, resulting in the release of hemoglobin.

HEMOLYTIC. Able to break down or dissolve red blood cells.

HEMOLYTIC ANEMIA. A type of anemia marked by the premature breakdown of red blood cells.

HEMOLYTIC BACTERIA. Bacteria that are able to burst red blood cells.

HEMOLYTIC-UREMIC SYNDROME (HUS). A potentially fatal complication of *E. coli* infections characterized by kidney failure and destruction of red blood cells.

HEMOPHILIA. An inherited bleeding disorder caused by a deficiency of factor VIII, one of a series of blood proteins essential for blood clotting.

HEMOPTYSIS. The coughing up of large amounts of blood or of blood-containing sputum.

HEMORRHAGE. Abnormal and excessive bleeding.

HEMORRHAGIC. A condition resulting in massive, difficult-to-control bleeding.

HEMORRHOID. An area around the anus comprised of enlarged veins and swollen tissue, causing itching and pain.

HEMOSIDEROSIS. An overload of iron in the body resulting from repeated blood transfusions. Hemosiderosis occurs most often in patients with thalassemia.

HEMOTHORAX. Blood in the pleural cavity.

HENNA. Mehndi; a reddish-brown dye from the leaves of the henna plant; used for hair dye and temporary tattoos.

HEPARIN. A blood component that controls the amount of clotting. It can be used as a drug to reduce blood clot formation.

HEPARIN CHALLENGE TEST. A medical test to evaluate how readily the blood clots.

HEPATIC. Referring to the liver.

HEPATIC ARTERY. The blood vessel supplying arterial blood to the liver.

HEPATITIS. Inflammation of the liver caused by a virus, chemical, or drug.

HEPATITIS B. A disease that causes inflammation of the liver and serious liver damage.

HEPATOBILIARY SCAN. Another term for a gallbladder nuclear medicine scan.

HEPATOCELLULAR. Of or pertaining to liver cells.

HEPATOCYTE. A liver cell.

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HEPATOMEGALY. General swelling of the liver.

HEPATOTOXIN. A substance that is toxic to the liver.

HEREDITARY. Something that is inherited or passed down from parents to offspring. In biology and medicine, the word pertains to inherited genetic characteristics.

HEREDITARY ANGIOEDEMA. A complement deficiency characterized by lymphatic vessel blockages that cause temporary swelling (edema) of areas of the skin, mucous membranes, and, sometimes, internal organs.

HEREDITARY ATAXIA. One of a group of hereditary degenerative diseases of the spinal cord or cerebellum. These diseases cause tremor, spasm, and wasting of muscle.

HEREDITARY SPHEROCYTOSIS (HS). A blood disorder in which the red blood cells are relatively fragile and are damaged or destroyed when they pass through the spleen. Splenectomy is the only treatment for HS.

HERMANSKY-PUDLAK SYNDROME (HPS). A rare type of albinism characterized by a problem with blood clotting and a buildup of waxy material in lungs and intestines.

HERNIA. A rupture in the wall of a body cavity, through which an organ may protrude.

HERNIATED DISK. A protrusion in a disk located in the spinal column.

HERNIORRHAPHY. Surgical repair of a hernia.

HERPES SIMPLEX VIRUS (HSV). A virus that causes sores on or in the mouth (cold sores, HSV type 1) or on the genitals (genital herpes, HSV type 2).

HERPES VIRUSES. A family of viruses including herpes simplex types 1 and 2, and herpes zoster (also called varicella zoster). Herpes viruses cause several infections, all characterized by blisters and ulcers, including chicken pox, shingles, genital herpes, and cold sores or fever blisters.

HERPES ZOSTER VIRUS. Acute inflammatory virus that attacks the nerve cells on the root of each spinal nerve with skin eruptions along a sensory nerve ending.

HETEROZYGOTE. An individual who has one gene in a pair that has a mutation while the other gene in the pair is unaffected.

HETEROZYGOUS. Two different genes controlling a specified inherited trait.

HIATAL HERNIA. A condition where part of the stomach protrudes through the diaphragm into the chest cavity; also called hiatus hernia.

HIB DISEASE. An infection caused by *Haemophilus influenza* type b (Hib). This disease mainly affects children under the age of five. In that age group, it is the leading cause of bacterial meningitis, pneumonia, joint and bone infections, and throat inflammations.

HIGH SPOT. An area of a tooth or restoration that feels abnormal or uncomfortable because it hits its opposing tooth before other teeth meet.

HIGH-DENSITY LIPOPROTEIN (HDL). A type of lipoprotein that protects against coronary artery disease by removing cholesterol deposits from arteries or preventing their formation.

HIGH-FUNCTIONING AUTISM (HFA). A subcategory of autistic disorder consisting of children diagnosed with IQs of 70 or higher.

HIGHLY ACTIVE ANTIRETROVIRAL THERAPY (HAART). An individualized combination of three or more antiretroviral drugs used to treat patients with HIV infection. It is sometimes called a drug cocktail.

HIGH-RISK HPV TYPE. A member of the HPV family of viruses that is associated with the development of cervical cancer and precancerous growths.

HIPPOCAMPUS. A part of the brain's limbic system that is involved in memory formation and learning.

HIRSCHSPRUNG DISEASE. Hirschsprung disease is a congenital abnormality (birth defect) of the bowel in which there is absence of the ganglia (nerves) in the wall of the bowel.

HIRSUTISM. Excessive hair growth on the face and body.

HISTAMINE. A chemical found naturally in the body that produces inflammation and increases blood flow; the uncomfortable symptoms of an allergy attack or an allergic reaction are generally caused by the release of histamine.

HISTOCOMPATIBILITY. The relationship between tissues that characterizes how well a patient and donor are matched in a transplant or graft.

HISTOCOMPATIBILITY ANTIGENS. Histocompatibility determinants; proteins scattered throughout body tissues that are unique for almost every individual.

HISTOLOGY. The study of the structure, composition, and function of tissues of organs.

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HISTOPATHOLOGY. The study of diseased tissues at a minute (microscopic) level.

HISTRIONIC. A behavior characterized by an excitable nature and the constant desire for stimulation.

HIVES. A raised, itchy area of skin that is usually a sign of an allergic reaction.

HLA-B27. An antigen or protein marker on cells that may indicate ankylosing spondylitis.

HODGKIN DISEASE. Cancer of the lymphatic system, characterized by lymph node enlargement.

HOLISTIC. In medicine, a practice that focuses on treating the patient as a whole (rather than just treating the disease); addresses the physical, social, emotional, and spiritual needs of a patient.

HOLTER MONITOR. A portable device used to record heart rhythms over a period of at least 24 hours.

HOME MODIFICATION. The altering of the physical environment of the home to remove hazards and provide a more functional environment; examples include the installation of grab bars and no-slip foot mats in the bathroom to prevent falls.

HOME PARENTERAL NUTRITION (HPN). Long-term parenteral nutrition, given through a central venous catheter and administered in the patient's home.

HOMEOPATHY. The use of diluted remedies that would otherwise produce symptoms similar to those they are curing. They are prescribed according to the axiom that "like cures like."

HOMEOSTASIS. The regulation of body processes to maintain an internal balance.

HOMOCYSTEINE. An amino acid normally found in small amounts in the blood.

HOMOZYGOTE. An individual who has both genes in a pair with the same mutation.

HOMOZYGOUS. A condition in which both genes in a pair have the same mutation.

HOOKWORM. Parasitic intestinal infestation caused by any of several parasitic nematode worms of the family Ancylostomatidae. These worms have strong buccal hooks that attach to the host's intestinal lining.

HORMONE. A chemical messenger produced by the body that is involved in regulating specific bodily functions such as growth, development, reproduction, metabolism, and mood.

HORMONE REPLACEMENT THERAPY (HRT). Short-term replacement of the hormones (estrogen and progesterone) that a woman's body no longer produces after menopause; may lower the risk of osteoporosis in postmenopausal women.

HORMONE THERAPY. Manipulation of hormone levels in the body for a medical purpose, such as to inhibit menstruation (contraception); in cancer treatment, focuses on inhibiting the production of certain hormones instead of using cell-killing drugs.

HOSPICE. A facility or program that provides for the physical and emotional needs of the terminally ill in a caring environment.

HOST. An organism that is infected by a virus, bacterium, or parasite.

HOT FLASH. A wave of heat that is one of the most common perimenopausal symptoms, triggered by the hypothalamus' response to estrogen withdrawal.

"HOT TUB" FOLLICULITIS. A skin infection caused by *P. aeruginosa* that often follows bathing in a hot tub or public swimming pool.

HUMAN CHORIONIC GONADOTROPIN (HCG). A hormone produced by the placenta during pregnancy.

HUMAN HERPESVIRUS 8. Also called Kaposi's sarcoma–associated herpesvirus (KSHV), this virus is thought to be a cause for Kaposi's sarcoma.

HUMAN IMMUNODEFICIENCY VIRUS (HIV). The virus that causes acquired immune deficiency syndrome (AIDS).

HUMAN LEUCKOCYTE ANTIGEN (HLA). A group of protein molecules located on bone marrow cells that can provoke an immune response. A donor's and a recipient's HLA types should match as closely as possible to prevent the recipient's immune system from attacking the donor's marrow as a foreign material that does not belong in the body.

HUMAN PAPILLOMAVIRUS (HPV). A group of viruses that cause abnormal cell growth (warts or papillomas) on the hands, feet, or genitals; some types can cause cervical cancer.

HUMAN POTENTIAL MOVEMENT. A movement in psychotherapy that began in the 1960s and emphasized maximizing the potential of each participant through such techniques as group therapy and sensitivity training.

HUMANIZATION. Fusing the constant and variable framework region of one or more human immunoglobulins with the binding region of an animal immunoglobulin, done to reduce human reaction against the fusion antibody.

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HUMERUS. The bone of the upper arm.

HUMORAL. Pertaining to or derived from a body fluid. The humoral part of the immune system includes antibodies and immunoglobulins in blood serum.

HUNTINGTON'S DISEASE. A hereditary disease that typically appears in midlife, characterized by progressive dementia and loss of control over voluntary movements. It is sometimes called Huntington's chorea.

HYALINE MEMBRANE. A fibrous layer that settles in the lungs and prevents oxygen from escaping to the bloodstream, resulting in increased carbon dioxide levels.

HYDATIDIFORM MOLE. Also called a molar pregnancy. A mass of abnormal, partially developed tissues inside the uterus (womb). Moles develop during a pregnancy that begins with an abnormal fertilization. The mass may or may not be cancerous.

HYDRATION. Taking in water or fluid to replace loss of fluid.

HYDROCELE. An accumulation of fluid in the membrane that surrounds the testis.

HYDROCEPHALUS. Abnormal accumulation of cerebrospinal fluid within the skull, causing expansion of the skull and brain.

HYDROCORTISONE. A steroid hormone produced by the adrenal glands that provides resistance to stress.

HYDROGEN. The simplest, most common element known in the universe. It is composed of a single electron (negatively charged particle) circling a nucleus consisting of a single proton (positively charged particle).

HYDROGEN PEROXIDE. A colorless, unstable compound of hydrogen and oxygen (H_2O_2). An aqueous solution of hydrogen peroxide is used as an antiseptic and bleaching agent.

HYDROPS FETALIS. A condition in which a fetus or newborn baby retains fluids, causing swollen arms and legs and impaired breathing.

HYDROTHERAPY. The use of water (hot, cold, steam, or ice) to relieve discomfort and promote physical well-being; also known as water therapy.

HYDROXYAPATITE. A calcium phosphate complex that is the primary mineral component of bone.

HYDROXYUREA. A drug that has been shown to induce production of fetal hemoglobin.

HYMEN. A membrane that partially or completely covers the vaginal opening.

HYMENOLEPIASIS. Parasitic infection caused by the presence of tapeworms from the *Hymenolepis* genus, such as the dwarf tapeworm (*Hymenolepis nana*) or the rodent tapeworm (*Hymenolepis diminuta*).

HYPERALIMENTATION. A method of re-feeding anorectics by infusing liquid nutrients and electrolytes directly into central veins through a catheter.

HYPERANDROGENISM. Excessive secretion of androgens (male sex hormones).

HYPERAROUSAL. A state of increased emotional tension and anxiety, often including jitteriness and being easily startled.

HYPERBARIC CHAMBER. A sealed compartment in which patients are exposed to controlled pressures of up to three times normal atmospheric pressure.

HYPERBARIC OXYGEN THERAPY (HBOT). A form of oxygen therapy in which the patient breathes pure oxygen in a pressurized chamber. Hyperbaric treatment may be used to regulate blood gases, reduce gas bubbles, and provide higher levels of oxygen more quickly.

HYPERBARIC OXYGENATION. Administration of oxygen in a compression chamber at an ambient pressure greater than one atmosphere, in order to increase the amount of oxygen in organs and tissues.

HYPERBILIRUBINEMIA . An excess of bilirubin in the blood.

HYPERCALCEMIA. Abnormally high levels of calcium in the blood.

HYPERCHOLESTEROLEMIA. The presence of excessively high levels of cholesterol in the blood.

HYPEREMESIS. Severe vomiting during pregnancy. Hyperemesis appears to increase a woman's risk of postpartum depression.

HYPEREXTENSIBILITY. The ability to extend a joint beyond the normal range.

HYPERGLYCEMIA. Too much glucose or sugar in the blood.

HYPERHIDROSIS. Excessive sweating. Hyperhidrosis can be caused by heat, overactive thyroid glands, strong emotion, menopause, or infection.

HYPERINFECTION SYNDROME. A condition of massive infection in which threadworm larvae multiply rapidly and spread throughout the body. It is usually associated with damage to the immune system, the use of steroid medications, or malnutrition.

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HYPERINSULINEMIA. High blood insulin levels.

HYPERKALEMIA. An abnormally high level of potassium in the blood.

HYPERKETONEMIA. Condition characterized by an overproduction of ketones by the body.

HYPERLACTATION. Another term for galactorrhea.

HYPERLIPIDEMIA. Abnormally high levels of lipids in the blood.

HYPERMAGNESEMIA. An abnormally high concentration of magnesium in the blood.

HYPERMOBILITY. Unusual flexibility of the joints, allowing them to be bent or moved beyond their normal range of motion.

HYPEROSMOTIC. Hypertonic, containing a higher concentration of salts or other dissolved materials than normal tissues.

HYPEROSMOTIC DRUGS. Refers to a class of drugs for glaucoma that increase the osmotic pressure in the blood, which then pulls water from the eye into the blood.

HYPERPARATHYROIDISM. Over-functioning of the parathyroid glands. Symptoms include generalized aches and pains, depression, and abdominal pain.

HYPERPIGMENTATION. A skin condition that occurs when the body has too much melanin, or pigment.

HYPERPLASIA. An overgrowth of normal cells within an organ or tissue.

HYPERPLASTIC OBESITY. Excessive weight gain in childhood, characterized by an increase in the number of fat cells.

HYPERSECRETORY. Excessive production of a bodily secretion.

HYPERSENSITIVITY. An excessive response by the body to a foreign substance.

HYPERSOMNIA. An abnormal increase in time spent sleeping, usually accompanied by excessive daytime sleepiness.

HYPERSPLENISM. A syndrome marked by enlargement of the spleen, defects in one or more types of blood cells, and a high turnover of blood cells.

HYPERTENSION. High blood pressure.

HYPERTENSIVE HEART DISEASE. High blood pressure resulting in a disease of the heart.

HYPERTHERMIA THERAPY. A type of treatment in which body tissue is exposed to high temperatures to damage and kill cancer cells or to make cancer cells more sensitive to the effects of radiation and certain anticancer drugs.

HYPERTHYROID. Having too much thyroxin stimulation.

HYPERTHYROIDISM. A condition in which the thyroid gland in the throat is overactive and produces too much thyroid hormone.

HYPERTONIA. Having excessive muscular tone.

HYPERTROPHIC. Enlarged.

HYPERTROPHIC OBESITY. Excessive weight gain in adulthood, characterized by expansion of pre-existing fat cells.

HYPERTROPHY. The overgrowth of body tissue.

HYPERURICEMIA. Excessively high levels of uric acid in the blood.

HYPERVENTILATION. Rapid, deep breathing, possibly exceeding 40 breaths/minute. The most common cause is anxiety.

HYPERVIGILANCE. A condition of abnormally intense watchfulness or wariness. Hypervigilance is one of the most common symptoms of PTSD.

HYPERVISCOSITY. Thick, viscous blood, caused by the accumulation of large proteins, such as immunoglobulins, in the serum.

HYPERVITAMINOSIS. Another name for vitamin toxicity.

HYPNOGOGIC HALLUCINATION. A hallucination, such as the sensation of falling, that occurs at the onset of sleep.

HYPNOPOMPIC HALLUCINATION. A hallucination that occurs as a person is waking from sleep.

HYPNOSIS. An induced trance state, often characterized by extreme relaxation and suggestibility.

HYPNOTIC. A medication that causes sleep.

HYPNOTIC AGENT. A drug capable of inducing a hypnotic state.

HYPNOTIC STATE. A state of heightened awareness that can be used to modulate the perception of pain.

HYPOCALCEMIA. Low blood calcium.

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HYPOCHROMIC. A descriptive term applied to a red blood cell with a decreased concentration of hemoglobin.

HYPOGLYCEMIA. Too little glucose or sugar in the blood.

HYPOGONADISM. Functional incompetence of the male gonads, with impaired production of hormones and germ cells.

HYPOKALEMIA. An abnormally low level of potassium in the blood.

HYPOMAGNESEMIA. An abnormally low concentration of magnesium in the blood.

HYPOMANIA. A less severe form of elevated mood state that is a characteristic of bipolar type II disorder.

HYPONATREMIA. A deficiency of sodium in the blood.

HYPOPARATHYROIDISM. Insufficient production of parathyroid hormone, caused by under-functioning of the parathyroid glands.

HYPOPIGMENTATION. A skin condition that occurs when the body has too little melanin, or pigment.

HYPOPITUITARISM. Underactivity of the pituitary gland.

HYPOPLASIA. Incomplete development of a body tissue or structure.

HYPOPLASTIC. Incomplete or underdevelopment of a tissue or organ. Hypoplastic left heart syndrome is the most serious type of congenital heart disease.

HYPOPLASTIC ANEMIA. Anemia caused by defective function of the blood-forming organs (such as bone marrow).

HYPOPNEA. Shallow or excessively slow breathing usually caused by partial closure of the upper airway during sleep, leading to disruption of sleep.

HYPOPROTEINEMIA. Abnormally low levels of protein in the blood.

HYPOPYON. A small amount of pus or collection of white cells that is visible in the front of the eye in severe cases of anterior uveitis.

HYPOSPADIAS. A congenital deformity of the penis where the urinary tract opening is not at the tip of the glans.

HYPOTENSION. Low blood pressure.

HYPOTHALAMIC-PITUITARY-GONADAL (HPG) AXIS. A term used by doctors to refer to the combined effects of the hypothalamus, the pituitary gland, and the gonads.

HYPOTHALAMUS. A structure within the brain responsible for a large number of normal functions throughout the body, including regulating sleep, body temperature, hunger, and sexual development. The hypothalamus also regulates the functions of the pituitary gland by directing the pituitary to stop or start production of its hormones.

HYPOTHERMIA. Low body temperature.

HYPOTHYROID. Having too little thyroxin stimulation.

HYPOTHYROIDISM. A disorder in which the thyroid gland produces too little thyroid hormone, causing a decreased rate of metabolism.

HYPOTONIA. Reduced or diminished muscle tone.

HYPOVENTILATION. Reduced ventilation in the lungs' air sacs resulting in above normal carbon dioxide pressure.

HYPOVOLEMIC SHOCK. Shock caused by a lack of circulating blood.

HYPOXEMIA. An abnormally low amount of oxygen in the blood, the major consequence of respiratory failure, when the lungs no longer are able to perform their chief function of gas exchange.

HYPOXIA. The medical term for deprivation of an adequate oxygen supply, either to specific tissues or to the entire organism.

HYSTERECTOMY. Removal of the uterus (with or without removal of the ovaries) by surgery. The surgery can be performed through an incision in the abdomen, or the uterus can be removed through the vagina.

HYSTERIA. The earliest term for a psychoneurotic disturbance marked by emotional outbursts and/or disturbances of movement and sense perception. Some forms of hysteria are now classified as somatoform disorders and others are grouped with the dissociative disorders.

HYSTERICAL NEUROSIS. An older term for conversion disorder or dissociative disorder.

HYSTEROSALPINGOGRAPHY; HSG. X raying of the uterus and fallopian tubes following the injection of a contrast dye.

HYSTEROSCOPY. A procedure in which an endoscope is inserted through the cervix to view the cervix and uterus.

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I

I&D. Incision and drainage of a wound.

IATROGENIC. Inadvertently caused by medical treatment.

IATROGENIC KAPOSI'S SARCOMA. A form of Kaposi's sarcoma that develops in transplant patients who take immunosuppressive drugs to prevent rejection of their organ transplant.

ICHTHYOSIS. A group of congenital disorders of keratinization characterized by dryness and scaling of the skin.

ICSI. Stands for intracytoplasmic sperm injection. This process is used to inject a single sperm into each egg before the fertilized eggs are put back into the woman's body. The procedure may be used if the male has a low sperm count.

ICTAL EEG. Used to measure brain activity during a seizure. May be useful in learning more about patients who aren't responding to conventional treatments.

ICTERUS. Jaundice.

IDEAL WEIGHT. Weight corresponding to the lowest death rate for individuals of a specific height, gender, and age.

IDENTIFICATION WITH AN AGGRESSOR. In psychology, an unconscious process in which a person adopts the perspective or behavior patterns of a captor or abuser. Some researchers consider it a partial explanation of Stockholm syndrome.

IDENTIFIED PATIENT (IP). The family member in whom the family's symptom has emerged or is most obvious.

IDIOPATHIC. Refers to a disease that arises from an obscure or unknown cause.

IDIOPATHIC CARDIOMYOPATHY. Cardiomyopathy without a known cause.

IDIOSYNCRASY. A defect in that particular pathway resulting in an abnormality.

ILEUM. The lowest part of the small intestine, located beyond the duodenum and jejunum, just before the large intestine (the colon).

ILEUS. Obstruction of the intestines caused by the absence of peristalsis.

ILIAC ARTERY. Large blood vessel in the pelvis that leads into the leg.

ILIZAROV FRAME. A device invented by a Russian physician for correcting deformities of the legs and feet, consisting of rings to be attached to the bone and rods extending between the rings that stretch the affected limb.

ILLUSION. A false visual perception of an object that others perceive correctly.

IMIQUIMOD. A drug, approved by the FDA to treat warts, that may destroy basal cell carcinomas by stimulating the immune system. Also known by its trade name Aldara.

IMMEDIATE HYPERSENSITIVITY REACTIONS. Allergic reactions that are mediated by mast cells and occur within minutes of allergen contact.

IMMUNE COMPLEXES. Clusters or aggregates of antigen and antibody bound together.

IMMUNE FUNCTION. The body's defense system against bacteria, viruses and fungi, and any malfunction of the organism.

IMMUNE GLOBULIN. Serum containing antibodies against a specific infection.

IMMUNE OR IDIOPATHIC THROMBOCYTOPENIC PURPURA (ITP). A blood disease that results in destruction of platelets, which are blood cells involved in clotting.

IMMUNE RESPONSE. The protective reaction by the immune system against foreign antigens (substances that the body perceives as potentially dangerous). The immune system combats disease by neutralizing or destroying antigens.

IMMUNE SUPPRESSANT DRUG. Any drug that dampens immune responses and decreases inflammation.

IMMUNE SUPPRESSING. Anything that reduces the activity of the immune system.

IMMUNE SYSTEM. The system of specialized organs, lymph nodes, and blood cells throughout the body, which work together to prevent foreign invaders (bacteria, viruses, fungi, etc.) from taking hold and growing.

IMMUNIZATION. Administering a vaccine that stimulates the body to create antibodies to a specific disease (immunity) without causing symptoms of the disease.

IMMUNOCOMPETENCE. An individual's ability to fight off infection.

IMMUNOCOMPROMISED. Refers to conditions in which the immune system is not functioning properly and cannot adequately protect the body from infection.

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IMMUNODEFICIENCY. A disorder in which the immune system is ineffective or disabled due either to acquired or inherited disease.

IMMUNOELECTROPHORESIS. Use of an electrical field to separate proteins in a mixture (such as blood or urine), on the basis of the size and electrical charge of the proteins; followed by the detection of an antigen (such as IgM), using a specific antibody.

IMMUNOFLUORESCENT ASSAY (IFA). A blood test sometimes used to confirm ELISA results instead of using the Western blotting. In an IFA test, HIV antigen is mixed with a fluorescent compound and then with a sample of the patient's blood. If HIV antibody is present, the mixture will fluoresce when examined under ultraviolet light.

IMMUNOGLOBULIN (IG). A substance made by B cells that neutralizes specific disease-causing substances and organisms. Also called "antibody." Immunoglobulins are divided into five classes: IgA, IgD, IgE, IgG, and IgM.

IMMUNOGLOBULIN E (IGE). A type of protein in blood plasma that acts as an antibody to activate allergic reactions. About 50% of patients with allergic disorders have increased IgE levels in their blood serum.

IMMUNOGLOBULIN G (IGG). A group of antibodies against certain viral infections that circulate in the bloodstream. One type of IgG is specific against the mumps paramyxovirus.

IMMUNORESISTANCE. The presence of circulating antibodies.

IMMUNOSUPPRESSANT. Any agent that decreases the response of the immune response of an individual.

IMMUNOSUPPRESSED. A state in which the immune system is suppressed by medications during the treatment of other disorders, such as cancer, or following an organ transplantation.

IMMUNOSUPPRESSION. The use of medications to suppress the immune system to prevent organ rejection.

IMMUNOSUPPRESSIVE CYTOTOXIC DRUGS. A class of drugs that function by destroying cells and suppressing the immune response.

IMMUNOSUPPRESSIVE DRUG. Medication used to suppress the immune system.

IMMUNOTHERAPY. A form of treatment that uses biologic agents to enhance or stimulate normal immune function.

IMPACTED TOOTH. A tooth that is growing against another tooth, bone, or soft tissue.

IMPACTION. A condition in which earwax has become tightly packed in the outer ear to the point that the external ear canal is blocked.

IMPERFORATE ANUS. A congenital malformation (a birth defect) in which the rectum is a blind alley (a cul-de-sac) and there is no anus.

IMPLANT. A fixture with one end implanted into the bone and the other end covered with a crown, often to serve as a stable abutment for a bridge or denture.

IMPLANTABLE CARDIOVERTER-DEFIBRILLATOR. A device placed in the body to deliver an electrical shock to the heart in response to a serious abnormal rhythm.

IMPLANTATION. The process in which the fertilized egg embeds itself in the wall of the uterus.

IMPOTENCE. The inability to achieve and sustain an erection suitable for intercourse.

IMPRESSION. An imprint of the upper or lower teeth made in a pliable material that sets. When this material has hardened, it may be filled with plaster, plastic, or artificial stone to make an exact model of the teeth.

IMPRINTING. Process that silences a gene or group of genes. The genes are silenced depending on if they are inherited through the egg or the sperm.

IN VITRO. A biological reaction occurring in a laboratory apparatus.

IN VIVO. Occurring in a living organism.

INBORN ERROR OF METABOLISM. A rare enzyme deficiency; children with inborn errors of metabolism do not have certain enzymes that the body requires to maintain organ functions. Inborn errors of metabolism can cause brain damage and mental retardation if left untreated. Phenylketonuria is an inborn error of metabolism.

INCARCERATED HERNIA. A hernia that cannot be reduced, or pushed back into place inside the abdominal wall.

INCARCERATION. The abnormal confinement of a section of the intestine or other body tissues. An umbilical hernia may lead to incarceration of part of the intestine.

INCENTIVE SPIROMETER. A breathing device that provides feedback on performance to encourage deep breathing.

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INCEST. Sexual intercourse between people who are too closely related to legally marry.

INCISIONAL BIOPSY. Removal of a part of a lymph node for diagnostic purposes.

INCISORS. The eight front cutting teeth–four in the lower jaw and four in the upper jaw, located between the canines.

INCONTINENCE. Loss of ability to control urination or to control bowel movements (fecal incontinence).

INCREASED INTRACRANIAL PRESSURE. Increased overall pressure inside the skull.

INCUBATION. The time period between exposure to an infectious agent, such as a virus or bacteria, and the appearance of symptoms of illness.

INCUBATION PERIOD. The time it takes for symptoms to develop after initial exposure to a disease-causing organism.

INCUS. The middle of the three bones of the middle ear. It is also known as the "anvil."

INDEX OF REFRACTION. A constant number for any material for any given color of light that is an indicator of the degree of the bending of the light caused by that material.

INDIA INK TEST. A diagnostic test used to detect the cryptococcal organism *C. neoformans*. A dye, called India ink, is added to a sample of CSF fluid, and if the fungi is present, they will become visible as the dye binds to the capsule surrounding the fungus.

INDIGESTION. A feeling of discomfort or illness that results from the inability to properly digest food.

INDIUM. A silvery metallic element with some nonmetallic chemical properties used to label white blood cells prior to scanning.

INDOLENT LYMPHOMA (ALSO CALLED LOW-GRADE). Cancerous growths of lymphoid tissue that progress slowly to more aggressive forms of cancer.

INDURATION. An abnormally hard spot or area on the skin. The tuberculin skin test produces an induration at the test site in persons who have been exposed to TB.

INFANTICIDE. Intentional killing of a child within the first year of life.

INFANTILE SPASMS. Clusters of rapid jerks followed by stiffening or jackknife movements. Usually starts in the first year of life and stops by age 4.

INFARCT. Death of tissue due to shutting off the blood supply.

INFARCTION. An area of dead tissue caused by obstruction of the blood supply to that tissue.

INFECTIOUS DISEASE. Any disease caused by invasion of a pathogen that subsequently grows and multiplies in the body.

INFECTIOUS DISEASE TEAM. A team of physicians who help control the hospital environment to protect patients against harmful sources of infection.

INFERIOR VENA CAVA. The biggest vein in the body, returning blood to the heart from the lower half of the body.

INFERTILITY. The inability of a man and woman to conceive a child after 12 months of unprotected sexual intercourse.

INFESTATION. A condition in which a parasite develops and multiplies on the body of its host rather than inside the body.

INFIBULATION. A procedure that closes the labia majora to prevent sexual intercourse, leaving only a small opening for the passage of urine and menstrual blood.

INFILTRATES. Cells or body fluids that have passed into a tissue or body cavity.

INFILTRATING LOBULAR CARCINOMA. A type of cancer that accounts for 8% to 10% of breast cancers. In breasts that are especially dense, ultrasound can be useful in identifying these masses.

INFILTRATIVE. A process whereby inflammatory or other types of disease spread throughout an organ such as the lungs.

INFLAMED BOWEL. Irritation of the intestinal tract.

INFLAMMATION. The body's reaction to invasion by foreign matter, particularly infection. The result is swelling and redness from an increase in water and blood, and pain from the chemical activity of the reaction.

INFLAMMATORY BOWEL DISEASES. Ulcerative colitis or Crohn's disease: chronic conditions characterized by periods of diarrhea, bloating, abdominal cramps, and pain, sometimes accompanied by weight loss and malnutrition because of the inability to absorb nutrients.

INFLAMMATORY RESPONSE. The immune system's response to tissue injury caused by a physical, chemical, or biological substance.

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INFLUENZA. A virus that affects the respiratory system, causing fever, congestion, muscle aches, and headaches.

INFORMED CONSENT. An educational process between health-care providers and patients intended to instruct the patient about the nature and purpose of the procedure or treatment, the risks and benefits of the procedure, and alternatives, including the option of not proceeding with the test or treatment.

INFRASPINATUS. A muscle at the middle of the shoulder blade.

INFUSION. Introduction of a substance directly into a vein or tissue by gravity flow.

INGUINAL HERNIA. An opening, weakness, or bulge in the lining of the abdominal wall in the groin area, with protrusion of the large intestine.

INHALANT. Medicine that is breathed into the lungs.

INHALATION CHALLENGE TEST. A test given to diagnose asthma by asking the patient to breathe cold air, methacholine, histamine, or another airway irritant and measuring the decline (if any) in the forced expiratory volume (FEV1).

INHERITANCE PATTERN. Refers to dominant or recessive inheritance.

INHIBITION. Restraint of or interference with a biological process, such as the clumping of blood cells.

INJECTION. Forcing a fluid into the body by means of a needle and syringe.

INLAY. A filling that is made outside of the tooth and the cemented into place.

INNER EAR. The interior section of the ear, where sound vibrations and information about balance are translated into nerve impulses.

INNOCENT. The medical term for a harmless heart murmur.

INORGANIC MERCURY. Inorganic compounds such as mercuric oxide (HgO) and mercuric chloride ($HgCl_2$).

INOTROPIC DRUGS. Medications used to stimulate the heart beat.

INPATIENT SURGERY. Surgery that requires an overnight stay of one or more days in the hospital.

INSECTICIDE. A pesticide that kills insects.

INSIDIOUS. Progressing gradually and inconspicuously, but with serious effects.

INSIGHT-ORIENTED THERAPY. An approach to psychotherapy based on helping the client understand the existence of previously unconscious conflicts and the origin of maladaptive behavior in order to change it. Psychoanalysis is one form of insight-oriented therapy.

INSOMNIA. Prolonged or abnormal inability to obtain adequate sleep.

INSPECTION. The visual examination of the body using the eyes and a lighted instrument if needed. The sense of smell may also be used.

INSUFFLATION. Inflation of the abdominal cavity using carbon dioxide; performed prior to laparoscopy to give the surgeon space to maneuver surgical equipment.

INSULIN. A hormone secreted by the pancreas in response to high blood sugar levels that induces hypoglycemia. Insulin regulates the body's use of glucose and the levels of glucose in the blood by acting to open the cells so that they can intake glucose.

INSULIN RESISTANCE. An inability to respond to insulin, a hormone produced by the pancreas that helps the body to use glucose.

INSULINOMA. Tumor that arises from the insulin-producing cells in the pancreas.

INTEGUMENT. The medical name for the skin.

INTENTION TREMOR. A rhythmic purposeless shaking of the muscles that begins with purposeful (voluntary) movement. This tremor does not affect muscles that are resting.

INTERCEPTIVE ORTHODONTICS. Preventative orthodontics; early, simpler orthodontic treatment.

INTERDENTAL. Between the teeth.

INTERFERON. Potent immune–defense protein produced by viral–infected cells. Manufactured interferon is used as an anticancer and antiviral drug.

INTERFERON ALPHA. Potent immune-defense protein; used as an anti-cancer drug.

INTERMITTENT CLAUDICATION. Leg pain and weakness caused by walking.

INTERMITTENT EXPLOSIVE DISORDER. A personality disorder in which an individual is prone to intermittent explosive episodes of aggression during which he or she causes bodily harm or destroys property.

INTERNAL DERANGEMENT. A condition in which the cartilage disc in the temporomandibular joint lies in front of its proper position.

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INTERNATIONAL UNIT (IU). A measurement of biological activity in which one IU is equal to one mg (milligram).

INTERPERSONAL THERAPY. An approach that includes psychoeducation about the sick role, and emphasis on the present and improving interpersonal dynamics and relationships. Interpersonal therapy is effective in treating adjustment disorders related to physical illness.

INTERSTITIAL. Refers to the connective tissue that supports the "working parts" of an organ, in the case of the lungs the air sacs.

INTERSTITIAL CYSTITIS. A chronic inflammatory condition of the bladder involving symptoms of bladder pain, frequent urination, and burning during urination.

INTERSTITIAL FLUID. The fluid between cells in tissues. Referred to as the liquid substance of the body.

INTERSTITIAL LUNG DISEASE. About 180 diseases fall into this category of breathing disorders. Injury or foreign substances in the lungs (such as asbestos fibers) as well as infections, cancers, or inherited disorders may cause the diseases. They can lead to breathing or heart failure.

INTERSTITIAL SPACES. Spaces within body tissues that are outside the blood vessels. Also known as interstitial compartments.

INTERVERTEBRAL DISK. Cylindrical elastic-like gel pads that separate and join each pair of vertebrae in the spine.

INTESTINE. Also called the bowels and divided into large and small intestine, they extend from the stomach to the anus, where waste products exit the body. The small intestine is about 20 ft (6.1m) long and the large intestine, about 5 ft (1.5m) long.

INTOXICATION. The mental, physical, or emotional state produced by a substance.

INTRA-ABDOMINAL PRESSURE. Pressure that occurs within the abdominal cavity. Pressure in this area builds up with coughing, crying, and the pressure exerted when bearing down with a bowel movement.

INTRACELLULAR PARASITE. An organism which can only feed and live within the cell of a different animal.

INTRACEREBRAL HEMORRHAGE. A cause of some strokes in which vessels within the brain begin bleeding.

INTRACRANIAL. Existing or occurring within the cranium; affecting or involving intracranial structures.

INTRACRANIAL HYPERTENSION. Abnormally high blood pressure within the skull.

INTRACUTANEOUS. Into the skin, in this case directly under the top layer of skin.

INTRAMUSCULARLY. A medication given by needle into a muscle.

INTRAOCULAR. Literally, within the eye.

INTRAOCULAR LENS. Lens made of silicone or plastic placed within the eye; can be corrective.

INTRAOCULAR LENS (IOL) IMPLANT. A small, plastic device (IOL) that is usually implanted in the lens capsule of the eye to correct vision after the lens of the eye is removed; used in cataract surgery.

INTRAOCULAR RETINOBLASTOMA. Cancer that is limited to the eye and has not spread to other parts of the body.

INTRATHECAL. Administration of chemotherapy drugs injected into the cerebrospinal fluids which surround the brain and spinal cord.

INTRATHECAL THERAPY. Injecting chemotherapy directly into the CSF using lumbar puncture.

INTRAUTERINE. Situated or occuring in the uterus.

INTRAUTERINE DEVICE (IUD). Contraceptive device consisting of a piece of bent plastic or metal that is inserted through the vagina into the uterus.

INTRAVENOUS. Into a vein; a needle is inserted into a vein in the back of the hand, inside the elbow, or some other location on the body. Fluids, nutrients, and drugs can be injected.

INTRAVENOUS PYELOGRAM (IVP). A procedure in which a dye is injected into a vein in the arm. The dye travels through the body and concentrates in the urine to be discharged. It outlines the kidneys, ureters, and the urinary bladder. An x-ray image is then made and any abnormalities of the urinary tract are revealed.

INTRAVENTRICULAR HEMORRHAGE (IVH). A condition in which blood vessels within the brain burst and bleed into the hollow chambers (ventricles) normally reserved for cerebrospinal fluid and into the tissue surrounding them.

INTRINSIC FACTOR. A substance produced by the parietal cells of the stomach. In order to be absorbed by the intestine, vitamin B_{12} must form a complex with intrinsic factor.

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INTRINSIC PATHWAY. One of three pathways in the coagulation cascade.

INTRINSIC SPHINCTER DEFICIENCY (ISD). A factor in severe stress incontinence due to the inadequacy of the sphincter muscles to keep the bladder closed.

INTUBATION. The insertion of a tube into the patient's airway to protect the airway from collapsing. Intubation is sometimes done as an emergency procedure for patients with epiglottitis.

INTUSSUSCEPTION. The slipping or telescoping of one part of the intestine into the section next to it.

INVASIVE. A diagnostic test that invades healthy tissue; in the case of venography, through an incision in a healthy vein.

INVASIVE SURGERY. A form of surgery that involves making an incision in the patient's body and inserting instruments or other medical devices into it.

ION. An atom or molecule that has an electric charge. In the body ions are collectively referred to as electrolytes.

IONIZING RADIATION. Radiation that can damage living tissue by disrupting and destroying individual cells at the molecular level. All types of nuclear radiation–x rays, gamma rays and beta rays–are potentially ionizing. Sound waves physically vibrate the material through which they pass, but do not ionize it.

IQ. Intelligence quotient; a measure of intellectual functioning determined by performance on standardized intelligence tests.

IRIDO CORNEAL ENDOTHELIAL SYNDROME; ICE. A type of glaucoma in which cells from the back of the cornea spread over the surface of the iris and tissue that drains the eye, forming adhesions that bind the iris to the cornea.

IRIS (PLURAL, IRIDES). The circular pigmented membrane behind the cornea of the eye that gives the eye its color. The iris surrounds a central opening called the pupil.

IRON OVERLOAD. A side effect of frequent blood transfusions in which the body accumulates abnormally high levels of iron. Iron deposits can form in organs, particularly the heart, and cause life–threatening damage.

IRON POISONING. A potentially fatal condition caused by swallowing large amounts of iron dietary supplements.

IRRIGATION. In medicine, the practice of washing out or flushing a wound or body opening with a stream of water or another liquid.

IRRITABLE BOWEL DISEASE. An intestinal disorder often accompanied by abdominal pain and diarrhea.

ISCHEMIA. A condition in which blood flow is cut off or restricted from a particular area. The tissue becomes starved of oxygen and nutrients, resulting in tissue death.

ISCHEMIC. An inadequate supply of blood to a part of the body, caused by partial or total blockage of an artery.

ISCHEMIC HEART DISEASE. Insufficient blood supply to the heart muscle (myocardium).

ISLETS OF LANGERHANS. Special structures in the pancreas responsible for insulin secretion among other functions. They are named for Paul Langerhans, the German researcher who first identified them in 1869.

ISOENZYME. One of a group of enzymes that catalyze the same reaction but are differentiated by variations in physical properties.

ISOMETRIC EXERCISES. Exercises which strengthen through muscle resistance.

ISOSPORA BELLI. A type of parasitic protozoa.

ISOTOPE. Any of two or more species of atoms of a chemical element with the same atomic number and nearly identical chemical behavior but with differing atomic mass and physical properties.

ISOTRETINOIN. A drug for severe acne that decreases sebum production and dries up pimples.

ISOZYME. One of a group of enzymes that perform the same function, but are different from one another in their structure or the way in which they move.

J

JARISCH-HERXHEIMER REACTION. A temporary reaction to penicillin treatment for syphilis that includes fever, chills, and worsening of the skin rash or chancre.

JAUNDICE. A condition that results in a yellow tint to the skin, eyes and body fluids. Bile retention in the liver, gallbladder and pancreas is the immediate cause, but the underlying cause could be as simple as obstruction of the common bile duct by a gallstone or as serious as pancreatic cancer.

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JEJUNOSTOMY. Surgical creation of an opening to the middle portion of the small intestine (jejunum), through the abdominal wall.

JEJUNUM. The middle portion of the small intestine. It is approximately 8 ft (2.5 m) long and extends from the jejunum to the ileum.

JET LAG. A temporary disruption of the body's sleep-wake rhythm following high-speed air travel across several time zones. Jet lag is most severe in people who have crossed eight or more time zones in 24 hours.

JOINT. The point of connection between two bones that allows motion.

JOINT CONTRACTURES. Stiffness of the joints that prevents full extension.

JOINT DISLOCATION. The displacement of a bone.

K

KALLMANN SYNDROME. A rare genetic disorder in which the hypothalamus does not produce enough gonadotropin–releasing hormone, leading to underfunctioning of the testes in males and the ovaries in females.

KAPOSI'S SARCOMA. A cancer of the connective tissue that produces painless purplish red (in people with light skin) or brown (in people with dark skin) blotches on the skin. It is a major diagnostic marker of AIDS.

KARYOTYPE. A standard arrangement of photographic or computer–generated images of chromosome pairs from a cell in ascending numerical order, from largest to smallest.

KARYOTYPING. A laboratory procedure in which chromosomes are separated from cells, stained, and arranged so that their structure can be studied under the microscope.

KEGEL EXERCISES. Repetitive contractions to tone the pubococcygeal muscle of the pelvic floor for enhancing sexual response during intercourse or controlling incontinence.

KELOID. An unusual or abnormal growth of scar tissue, as in the third stage of granuloma inguinale.

KERATIN. A tough, nonwater-soluble protein found in the nails, hair, and the outermost layer of skin. Human hair is made up largely of keratin.

KERATINOCYTES. Cells found in the epidermis. The keratinocytes at the outer surface of the epidermis are dead and form a tough protective layer. The cells underneath divide to replenish the supply.

KERATOCONJUNCTIVITIS. Inflammation of the conjunctiva and cornea of the eye.

KERATOCONUS. An eye condition in which the cornea bulges outward, interfering with normal vision. Usually both eyes are affected.

KERATODERMA BLENNORRHAGICA. The medical name for the patches of scaly skin that occur on the arms, legs, and trunk of RS patients.

KERATOLYTIC. An agent that dissolves or breaks down the outer layer of skin (keratins).

KERATOMALACIA. Keratomalacia is ulceration of the cornea.

KERION. A raised boggy or swollen patch of reddened skin that develops as a complication of ringworm.

KERNICTERUS. A serious condition in which bilirubin deposits in the brain leading to permanent neurological damage and potentially death.

KETOACIDOSIS. A condition due to starvation or uncontrolled Type I diabetes. Ketones are acid compounds that form in the blood when the body breaks down fats and proteins. Symptoms include abdominal pain, vomiting, rapid breathing, extreme tiredness, and drowsiness.

KETOGENIC DIET. A diet that supplies an abnormally high amount of fat, and small amounts of carbohydrates and protein.

KETONES. Poisonous acidic chemicals produced by the body when fat instead of glucose is burned for energy. Breakdown of fat occurs when not enough insulin is present to channel glucose into body cells.

KETOSIS. An abnormal increase in ketones in the body, usually found in people with uncontrolled diabetes mellitus.

KIDNEY. Either of two organs in the lumbar region that filter the blood, excreting the end products of the body's metabolism in the form of urine and regulating the concentrations of hydrogen, sodium, potassium, phosphate and other ions in the body.

KIDNEY DIALYSIS. A process during which blood is filtered through a dialysis machine to remove waste products that would normally be removed by the kidneys. The filtered blood is then circulated back into the patient. This process also is called renal dialysis.

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KIDNEY DISEASE. Any disorder that impairs the kidney's ability to remove waste and toxins from the body.

KIDNEY FAILURE. The inability of the kidney to excrete toxic substances from the body.

KIDNEY STONE. A hard mass that forms in the urinary tract and can cause pain, bleeding, obstruction, or infection. Stones are primarily made up of calcium.

KIESSELBACH'S PLEXUS. An area on the anterior part of the nasal septum that has a rich supply of blood vessels and is a common site of nosebleeds. It is named for Wilhelm Kiesselbach, a nineteenth-century German otolaryngologist.

KINESIOLOGY. The study of the anatomy and physiology of body movement.

KLEINE-LEVIN SYNDROME. A disorder that occurs primarily in young males, with episodes three or four times a year. The syndrome is marked by bouts of hypersomnia, hypersexual behavior, and excessive eating.

KLEPTOMANIA. An impulse control disorder characterized by the overwhelming urge to steal.

KLINEFELTER SYNDROME. A condition caused by extra X chromosome(s) in a male, which results in small testes and infertility together with increased height, decreased facial hair, and sometimes breast enlargement.

KOCK POUCH. A type of ileostomy in which the surgeon forms an artificial rectum from a section of the ileum. A Kock pouch is sometimes called a continent ileostomy because it is drained with a tube.

KOH. The chemical formula for potassium hydroxide, which is used to perform the KOH test. The test is also called a potassium hydroxide preparation.

KOPLIK'S SPOTS. Tiny spots occurring inside the mouth, especially on the inside of the cheek. These spots consist of minuscule white dots (like grains of salt or sand) set onto a reddened bump. Unique to measles.

KOSHER. Conforming to Jewish dietary laws.

KWASHIORKOR. Severe malnutrition in children primarily caused by a protein-poor diet, characterized by growth retardation.

KYPHOSCOLIOSIS. Abnormal front-to-back and side-to-side curvature of the spine.

KYPHOSIS. An abnormal outward curvature of the spine, with a hump at the upper back.

L

LABIA. The fatty folds of the vulva.

LABIA MAJORA. Major lips; mounds of tissue forming the lateral boundaries of the vulva.

LABIA MINORA. Minor lips; narrow folds of tissue between the labia major, on either side of the urethral and vaginal openings.

LABOR. The process during which the uterus contracts and the cervix opens to allow the passage of a baby into the vagina.

LABYRINTH. The bony cavity of the inner ear.

LACERATION. Also called a tear. Separation of skin or other tissue by a tremendous force, producing irregular edges.

LACRIMAL DUCT. A short canal leading from a small orifice at the medial angle of each eyelid to the lacrimal sac.

LACRIMAL GLAND. An almond-shaped gland that secretes tears.

LACRIMAL SAC. The dilated upper end of the nasolacrimal duct in which the lacrimal ducts empty.

LACTASE. The enzyme needed to break down lactose, the sugar found in milk.

LACTASE ENZYME. The enzyme produced by cells lining the small intestine that allows the body to break down lactose.

LACTATION. Secretion of milk from the breasts; the act of breastfeeding.

LACTIC ACIDOSIS. A serious condition caused by the build up of lactic acid in the blood, causing it to become excessively acidic. Lactic acid is a by-product of glucose metabolism.

LACTOBACILLUS ACIDOPHILUS. A bacteria found in yogurt that changes the balance of the bacteria in the intestine in a beneficial way.

LACTOSE. A sugar found in milk that provides energy.

LACTOSE INTOLERANCE. An inability to properly digest milk and dairy products.

LAMELLAR ICHTHYOSIS. Also called fish scale disease, this inherited condition is characterized by darkened, scaly, dry patches of skin.

LAMINAE (SINGULAR, LAMINA). The broad plates of bone on the upper surface of the vertebrae that fuse

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together at the midline to form a bony covering over the spinal canal.

LAMINARIA. A medical product made from a certain type of seaweed that is physically placed near the cervix to cause it to dilate.

LAMINECTOMY. An operation in which the surgeon cuts through the covering of a vertebra to reach a herniated disk in order to remove it.

LAMINOTOMY. A less invasive alternative to a laminectomy in which a hole is drilled through the lamina.

LANUGO. A soft, downy body hair that develops on the chest and arms of anorexic women.

LAPAROSCOPE. A pencil-thin telescope that allows surgery to be done through half-inch incisions.

LAPAROSCOPIC. A minimally invasive surgical or diagnostic procedure that uses a flexible endoscope (laparoscope) to view and operate on structures in the abdomen.

LAPAROSCOPIC CHOLECYSTECTOMY. Removal of the gallbladder using a laparoscope, a fiberoptical instrument inserted through the abdomen.

LAPAROSCOPIC PROCEDURES. Surgical procedures performed using a laparoscope—a pencil-thin instrument that has its own lighting system and miniature video camera. To perform surgeries, only small incisions are needed to insert the instruments and the miniature camera.

LAPAROSCOPIC SURGERY. A minimally invasive surgery in which a camera and surgical instruments are inserted through a small incision.

LAPAROSCOPY. Procedure using a laparoscope to view organs, obtain tissue samples, and perform surgery.

LAPAROTOMY. Surgical incision into the abdomen to locate, repair, and/or remove injured or diseased tissues.

LARGE CORE NEEDLE BIOPSY. A procedure using a thicker needle to remove a core of tissue, about the size of a grain of rice, from the breast.

LARVA. The immature, early form of an organism that at birth or hatching is not like its parent and has to undergo metamorphosis before assuming adult features.

LARYNGECTOMY. Surgical removal of the larynx to treat cancer.

LARYNGITIS. Inflammation of the larynx (voice box).

LARYNGOSCOPE. A diagnostic instrument that is used to examine the interior of the larynx.

LARYNGOSCOPY. A medical procedure that uses flexible, lighted, narrow tubes inserted through the mouth or nose to examine the larynx and other areas deep inside the neck.

LARYNGOSPASM. Spasm of the larynx.

LARYNX. Also known as the voice box, the larynx is composed of cartilage that contains the apparatus for voice production. This includes the vocal cords and the muscles and ligaments that move the cords.

LASER. A device that concentrates electromagnetic radiation into a narrow beam and treats tissue quickly without heating surrounding areas.

LASER CYCLOPHOTOCOAGULATION. A procedure used for severe glaucoma in patients who have not responded well to previous treatments. The laser partially destroys the tissues that make the fluid of the eye.

LASER PERIPHERAL IRIDOTOMY. This procedure makes a drainage hole in the iris allowing the fluid to drain from the eye.

LASER TRABECULOPLASTY. In this procedure, the laser attempts to open the normal drainage channels of the eye so fluid can drain more effectively.

LASER-ASSISTED IN-SITU KERATOMILEUSIS (LASIK). A surgical procedure that uses a cutting tool and a laser to modify the cornea and correct moderate to high levels of myopia.

LATCH-ON. The process whereby the baby opens the mouth widely and first exerts negative pressure on the mother's nipple and then positive pressure. Good latch-on will result in adequate transfer of milk into the baby's mouth and prevent sore nipples from occurring.

LATE DECELERATION. Transient slowing of the fetal heart (brachycardia), which reaches its height more than 30 seconds after the peak of the uterine contraction and may indicate the fetus is not receiving enough oxygen (hypoxia).

LATENCY. The period of inactivity between the time a stimulus is provided and the time a response occurs.

LATENT VIRUS. An inactive virus that is in a dormant state within a cell.

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LATEX. A rubber material that gloves and condoms are made from.

LAVAGE. The washing out of a hollow body organ—for example, the stomach—using a flow of water.

LAW OF SIMILARS. The basic principle of homeopathic medicine that governs the selection of a specific remedy. It holds that a substance of natural origin that produces certain symptoms in a healthy person will cure those same symptoms in a sick person.

LAXATIVE. Material that encourages a bowel movement.

LDL CHOLESTEROL. Low-density lipoprotein cholesterol is the primary cholesterol molecule. High levels of LDL increase the risk of coronary heart disease. LDL is nicknamed "bad cholesterol."

LEAD. Name given the electrode when it is attached to the skin.

LEARNING DISORDER. An impairment of the cognitive processes of understanding and using spoken and written language that results in difficulties with one or more academic skill sets (e.g., reading, writing, mathematics).

LEEP. Loop Electrosurgical Excision Procedure.

LEFT ANTERIOR DESCENDING CORONARY ARTERY (LAD). One of the branches of the heart's left main coronary artery that supplies blood to the left ventricle.

LEFT VENTRICLE. The large chamber on the lower left side of the heart. The left ventricle sends blood to the aorta and the rest of the body.

LEGIONELLOSIS. A disease caused by infection with a *Legionella* bacterium.

LEGUME. Group of plant foods including beans, peas, and lentils, which are high in protein, fiber, and other nutrients.

LEISHMAN-DONOVAN BODY. A body of a (trypanosomatid) protozoa at a particular and characteristic stage in its life cycle; the infectious (trypanosomatid) protozoa can cause leishmaniasis.

LENS. The transparent, elastic, curved structure behind the iris (colored part of the eye) that helps focus light on the retina.

LENTICONUS. A rare, usually congenital condition in which the surface of the lens of the eye is conical.

LEPTIN. A peptide hormone produced by fat cells that acts on the hypothalamus to suppress appetite and burn stored fat.

LESION. Any visible, local abnormality of the tissues of the skin, such as a wound, sore, rash, or boil.

LET. A topical anesthetic mixture containing lidocaine, epinephrine, and tetracaine.

LETHARGY. The state of being sluggish.

LEUKEMIA. A cancer of blood cells characterized by the abnormal increase in the number of white blood cells in the tissues. There are many types of leukemias and they are classified according to the type of white blood cell involved.

LEUKEMIA STAINS. Special stains added to smears of blood or bone marrow, performed to diagnose and classify leukemia.

LEUKOCORIA. A pupil reflex that is white instead of red or that has white spots.

LEUKOCYTE. A white blood cell. Leukocytes protect the body against infection and fight infection when it occurs; they are bigger than red blood cells.

LEUKOCYTE ADHESION DEFICIENCY SYNDROME. A complement deficiency syndrome characterized by recurrent infections of the skin, mucous membranes, and gastrointestinal tract and the absence of pus formation. This disorder is sometimes apparent at birth when separation of the umbilical cord takes longer than normal.

LEUKOCYTE ALKALINE PHOSPHATASE (LAP) TEST. A blood test that measures the level of enzyme activity in a type of white blood cell called neutrophils.

LEUKOCYTOSIS. An increased level of white cells in the blood. Leukocytosis is a common reaction to infections.

LEUKODYSTROPHY. Any of several inherited diseases characterized by the degeneration of myelin in the brain, spinal cord, and peripheral nerves.

LEUKOPENIA. A white blood cell count decreased to less than 4,000/μL.

LEUKOTRIENES. A class of small molecules produced by cells in response to allergen exposure; they contribute to allergy and asthma symptoms.

LEVODOPA (L–DOPA). A substance used in the treatment of Parkinson's disease. Levodopa can cross the blood-brain barrier that protects the brain. Once in the brain, it is converted to dopamine and thus can replace the dopamine lost in Parkinson's disease.

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LEVONORGESTREL. A synthetic progestin used in emergency contraceptive pills.

LEWY BODIES. Areas of injury found on damaged nerve cells in certain parts of the brain associated with dementia.

LEYDIG CELLS. Cells that make up the endocrine tissue of the testis and produce testosterone. They are named for Franz von Leydig (1821–1908), the German professor of anatomy who first identified them.

LICHEN PLANUS. A noncancerous, chronic, itchy skin disease that causes small, flat, purple plaques on the wrists, forearms, and ankles.

LICHEN SIMPLEX CHRONICUS. A skin disorder accompanied by severe itching that causes thick, dark patches of skin to develop.

LIGAMENT. A type of connective tissue that connects bones or cartilage and provides support and strength to joints.

LIGAMENTA FLAVA (SINGULAR, LIGAMENTUM FLAVUM). A series of bands of tissue that are attached to the vertebrae in the spinal column. They help to hold the spine straight and to close the spaces between the laminar arches. The Latin name means "yellow band(s)."

LIMB-GIRDLE MUSCULAR DYSTROPHY. An autosomal recessive form of muscular dystrophy that appears anywhere from late childhood to middle age and is characterized by progressive muscular weakness beginning either in the shoulder or pelvic girdle; the disease usually progresses slowly with cardiopulmonary complications in the later stages.

LIMBIC SYSTEM. A group of structures in the brain that includes the hypothalamus, amygdala, and hippocampus. The limbic system plays an important part in regulation of human moods and emotions. Many psychiatric disorders are related to malfunctioning of the limbic system.

LIMITED SCLERODERMA. A subtype of systemic scleroderma with limited skin involvement. It is sometimes called the CREST form of scleroderma, after the initials of its five major symptoms.

LIMITED SUPPORT. A predetermined period of assistance required to deal with a specific event, such as training for a new job.

LINDANE. An organic chloride, neurotoxic insecticide that kills lice.

LINGUAL TONSILS. A pair of small tonsils located on the upper side of the base of the tongue.

LINOLEIC ACID. An unsaturated omega-6 fatty acid found in many plant oils that humans need in their diet. Plant oils rich in linoleic acid are beneficial to the skin when used in massage.

LIPASE. A fat-splitting enzyme found in pancreatic juice, blood, and many tissues.

LIPIDS. A group of fats and fat-like substances that are not soluble in water, are stored in the body, and serve as a source of fuel for the body.

LIPODYSTROPHY. The medical term for redistribution of body fat in response to highly active antiretroviral therapy, insulin injections in diabetics, or rare hereditary disorders.

LIPOMA. A usually benign tumor of fatty tissue.

LIPOPROTEIN. A complex molecule that consists of a protein membrane surrounding a core of lipids. Lipoproteins carry cholesterol and other lipids from the digestive tract to the liver and other body tissues. There are five major types of lipoproteins.

LIPOSHAVING. Involves removing fat that lies closer to the surface of the skin by using a needle-like instrument that contains a sharp-edged shaving device.

LIPOSUCTION. A cosmetic surgery technique for removing unwanted fat cells from the abdomen, hips, thighs, or male breast while doing as little damage as possible to nearby connective tissue and blood vessels.

LISTERIOSIS. A food-borne bacterial infection caused by *Listeria monocytogenes* to which pregnant women are particularly susceptible.

LITHIUM (LITHANE, LITHROMATE). Medication prescribed to treat manic (excited) phases of bipolar disorder.

LITHOTRIPSY. A nonsurgical technique for removing gallstones by breaking them apart with high-frequency sound waves.

LIVER. A solid organ located on the right in the upper abdomen. It plays a major role in metabolism, digestion, detoxification, and elimination of substances from the body.

LIVER BIOPSY. A surgical procedure where a small piece of the liver is cut out for examination. A needle or narrow tube may be inserted either directly through the skin and muscle or through a small incision and passed into the liver for collection of a sample of liver tissue.

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LIVER ENCEPHALOPATHY. A condition in which the brain is affected by a buildup of toxic substances that would normally be removed by the liver. The condition occurs when the liver is too severely damaged to cleanse the blood effectively.

LIVER FUNCTION TESTS. Tests used to evaluate liver metabolism, storage, filtration, and excretion. The tests include alkaline phosphatase, alanine aminotransferase, and aspartate aminotransferase.

LIVING WILL. A legal document detailing a person's wishes during the end of life, to be carried out by designated decision makers.

LOBAR. Relating to a lobe.

LOBAR HEMORRHAGE. Bleeding into one of the lobes of the brain.

LOBULES. A small lobe or subdivision of a lobe (often on a gland) that may be seen on the surface of the gland by bumps or bulges.

LOCAL ANESTHETIC. Medication applied topically to the skin or administered through an injection that deadens a specific part of the body and inhibits the sensation of pain.

LOCALIZED. Confined to a small area.

LOCALIZED SCLERODERMA. Thickening of the skin from overproduction of collagen.

LOCUS CERULEUS. Area in the brain stem that processes sensory signals from all areas of the body.

LODESTONE. A variety of magnetite that possesses magnetic polarity.

LOEFFLER'S MEDIUM. A special substance used to grow diphtheria bacilli to confirm a diagnosis.

LOEFFLER'S SYNDROME. The respiratory phase of ascariasis, marked by inflammation of the lungs and eosinophilia.

LONG-STRETCH BANDAGES. Specialized bandages, similar to an Ace bandage, that have 100% to 200% stretch.

LOOP ELECTROSURGICAL EXCISION (LEEP). A procedure that can help diagnose and treat cervical abnormalities using a thin wire loop that emits a low-voltage high-frequency radio wave that can excise tissue.

LOW TRANSVERSE INCISION. Incision made horizontally across the lower end of the uterus.

LOW-DENSITY LIPOPROTEIN (LDL). A type of lipoprotein that consists of about 50% cholesterol and is associated with an increased risk of coronary artery disease.

LOWER ESOPHAGEAL SPHINCTER (LES). A muscular ring at the base of the esophagus that keeps stomach contents from entering back into the esophagus.

LOWER EXTREMITY AMPUTATION. To cut a limb from the lower body.

LOW-STRETCH BANDAGE. Specialized bandages with 30% to 90% stretch that are used to obtain the correct compression during the treatment of lymphedema; also known as short-stretch bandages.

LUES MALIGNA. Areas of ulcerated and dying skin tissue that may occur with secondary syphilis, most frequently in HIV-positive patients.

LUGOL'S SOLUTION. A strong iodine solution.

LUMBAR. Pertaining to the part of the back between the chest and the pelvis.

LUMBAR PUNCTURE. Also called a spinal tap, a procedure in which a thin needle is used to withdraw a sample of cerebrospinal fluid for diagnostic purposes from the area surrounding the spine.

LUMBAR SPINE. The segment of the human spine above the pelvis that is involved in low back pain. There are five vertebrae, or bones, in the lumbar spine.

LUMBAR VERTEBRAE. The vertebrae of the lower back below the level of the ribs.

LUMBOSACRAL. Referring to the lower part of the backbone or spine.

LUMEN. The cavity or channel inside a blood vessel or tube-shaped organ.

LUMPECTOMY. A surgical procedure in which only the cancerous tumor in the breast is removed, together with a rim of normal tissue.

LUNG FUNCTION TESTS. Tests of how much air the lungs can move in and out, and how quickly and efficiently this can be done. Lung function tests are usually done by breathing into a device that measures air flow.

LUNG NODULE. See pulmonary nodule.

LUPUS (SYSTEMIC LUPUS ERYTHEMATOSUS OR SLE). A chronic inflammatory autoimmune disorder that may affect many organ systems including the skin, joints, and internal organs.

LUTEINIZING HORMONE. A hormone secreted by the pituitary gland that regulates the menstrual cycle

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and triggers ovulation in females. In males, it stimulates the testes to produce testosterone.

LUTEINIZING HORMONE RELEASING HORMONE (LHRH) AGONIST. A substance that blocks the action of LHRH, a hormone that stimulates the production of testosterone (a male hormone) in men. Used to treat prostate cancers that require testosterone for growth.

LUTROPIN. Another term for luteinizing hormone, this hormone stimulates the development and release of the egg from the ovary.

LUX. The International System unit for measuring illumination, equal to one lumen per square meter.

LUXATE. To loosen or dislocate the tooth from the socket.

LYME DISEASE. An acute recurrent inflammatory disease involving one or a few joints, believed to be transmitted by a tick-borne virus. The condition was originally described in the community of Lyme, Connecticut, but has also been reported in other parts of the United States and other countries. Knees and other large joints are most commonly affected, with symptoms including local inflammation and swelling.

LYMPH. A clear fluid that contains cells important in forming antibodies that fight infection; also known as lymphatic fluid.

LYMPH NODE DISSECTION. Surgical removal of a group of lymph nodes.

LYMPH NODES. Oval-shaped organs the size of peas that are located throughout the body and contain clusters of cells called lymphocytes. They filter out and destroy bacteria, foreign particles, and cancerous cells from the blood.

LYMPHANGIOGRAPHY. Injection of dye into lymphatic vessels followed by x rays of the area. It is a difficult procedure, as it requires surgical isolation of the lymph vessels to be injected.

LYMPHANGITIS. Inflammation of the lymphatic vessels. It often occurs together with lymphadenitis.

LYMPHATIC SYSTEM. Also referred to as the lymph system, a network of vessels, nodes, and organs responsible for filtering and transporting fluid and nutrients to the bloodstream; serves as an important part of the immune system.

LYMPHATIC VESSELS. Vessels that carry lymph from the tissues to the bloodstream; also referred to as lymph channels or lymphatics.

LYMPHEDEMA. The unnatural accumulation of lymph in the tissues of the body, which results in swelling in that area.

LYMPHOCYTES. Type of white blood cells that are part of the immune system. The lymphocytes are composed of three main cell lines: B lymphocytes, T lymphocytes, and natural killer (NK) cells.

LYMPHOCYTOSIS. A condition in which the number of lymphocytes increases above normal levels.

LYMPHOID. Tissues relating to the lymphatic system.

LYMPHOID TISSUE. Sites within the body that produce cells of the immune system, including lymph nodes, bone marrow, and the thymus.

LYMPHOMA. A blood cancer in which lymphocytes, a variety of white blood cells, grow at an unusually rapid rate.

LYMPHOPENIA. A condition in which the number of lymphocytes falls below normal levels.

LYMPHOSCINTIGRAPHY. A technique in which a radioactive substance that concentrates in the lymphatic vessels is injected into the affected tissue and mapped using a gamma camera, which images the location of the radioactive tracer.

LYSOSOME. Membrane-enclosed compartment in cells, containing many hydrolytic enzymes, where large molecules and cellular components are broken down.

LYSSAVIRUS. A genus of viruses that includes the rabies virus and related viruses that infect insects as well as mammals.

LYSYL OXIDASE. An enzyme required for the cross-linking of elastin and collagen molecules to form properly functioning connective tissue.

M

M PROTEIN. Monoclonal or myeloma protein; abnormal antibody found in large amounts in the blood and urine of individuals with multiple myeloma.

MACROBIOTIC DIET. A diet based primarily on whole grains, vegetables, and beans, avoiding refined or processed foods.

MACROCYTIC. A descriptive term applied to a larger-than-normal red blood cell.

MACROMASTIA. Excessive size of the breasts.

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MACROPHAGE. A cell of the immune system that engulfs and digests foreign invaders such as bacteria and viruses in an attempt to stop them from causing disease within the body.

MACULA. The sensitive center of the retina that is responsible for detailed central vision.

MACULAR DEGENERATION. A condition usually associated with age in which the area of the retina called the macula is impaired due to hardening of the arteries (arteriosclerosis). This condition interferes with vision.

MACULE. A flat, discolored area on the skin.

MACULOPAPULAR RASH. A rash characterized by raised, spotted lesions.

MAGNETIC FIELD. The three-dimensional area surrounding a magnet, in which its force is active.

MAGNETIC RESONANCE ANGIOGRAPHY. A noninvasive diagnostic technique that uses radio waves to map the internal anatomy of the blood vessels.

MAGNETIC RESONANCE IMAGING (MRI). An imaging technique that uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

MAJOR DEPRESSIVE DISORDER. A mood disorder characterized by profound feelings of sadness or despair.

MAJOR TRANQUILIZERS. The family of drugs that includes the psychotropic or neuroleptic drugs, sometimes used to help autistic people. They carry significant risk of side effects, including Parkinsonism and movement disorders, and should be prescribed with caution.

MALABSORPTION. Poor absorption of materials in the digestive system.

MALABSORPTION SYNDROME. A condition characterized by indigestion, bloating, diarrhea, loss of appetite, and weakness, caused by poor absorption of nutrients from food.

MALADAPTIVE. Unsuitable or counterproductive; for example, maladaptive behavior is behavior that is inappropriate to a given situation.

MALARIA. Disease caused by the presence of sporozoan parasites of the genus *Plasmodium* in the red blood cells, transmitted by the bite of anopheline mosquitoes, and characterized by severe and recurring attacks of chills and fever.

MALATHION. An organic phosphate, neurotoxic insecticide that kills lice.

MALIGNANCY. A locally invasive and destructive growth.

MALIGNANT. The term literally means growing worse and resisting treatment. It is used as a synonym for cancerous and connotes a harmful condition that generally is life threatening.

MALIGNANT HYPERTHERMIA. A type of reaction (probably with a genetic origin) that can occur during general anesthesia and in which the patient experiences a high fever, muscle rigidity, and irregular heart rate and blood pressure.

MALIGNANT MELANOMA. A potentially fatal form of skin cancer that develops from melanocytes, which are skin cells containing melanin.

MALIGNANT MESOTHELIOMA. A cancer of the pleura (the membrane lining the chest cavity and covering the lungs) that typically is related to asbestos exposure.

MALIGNANT TUMOR. An abnormal proliferation of cells that can spread to other sites.

MALINGERING. Pretending to be sick in order to be relieved of an unwanted duty or obtain some other obvious benefit.

MALLEUS. One of the three bones of the middle ear; also known as the "hammer."

MALOCCLUSION. The misalignment of opposing teeth in the upper and lower jaws.

MAMMARY ARTERY. A chest wall artery that descends from the aorta and is commonly used for bypass grafts.

MAMMARY HYPERPLASIA. Increased size of the breast.

MAMMOGRAM. A set of x rays taken of the front and side of the breast; used to diagnose various abnormalities of the breast.

MAMMOGRAPHY. X-ray imaging of the breast that can often detect lesions in the tissue too small or too deep to be felt.

MAMMOPLASTY. Surgery performed to change the size or shape of breasts.

MAMMOTOME. A method for removing breast biopsies using suction to draw tissue into an opening in the side of a cylinder inserted into the breast tissue.

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A rotating knife then cuts tissue samples from the rest of the breast; also known as a vacuum-assisted biopsy.

MANDALA. A design, usually circular, that appears in religion and art. In Buddhism and Hinduism, the mandala has religious ritual purposes and serves as a yantra (a geometric emblem or instrument of contemplation).

MANDIBLE. The lower jaw, a U–shaped bone attached to the skull at the temporomandibular joints.

MANIA. A mood disorder in which a person experiences prolonged elation or irritability characterized by overactivity that can lead to exhaustion and medical emergencies.

MANOMETER. A device used to measure fluid pressure.

MANOMETRY. Measurement of pressure.

MANTOUX TEST. A tuberculin skin test; also called the PPD (purified protein derivative) test.

MANTRA. A sacred word or formula repeated over and over to concentrate the mind.

MAO-B INHIBITORS. Inhibitors of the enzyme monoamine oxidase B. MAO-B helps break down dopamine; inhibiting it prolongs the action of dopamine in the brain.

MARASMUS. Severe malnutrition in children caused by a diet lacking in calories as well as protein. Marasmus may also be caused by disease and parasitic infection.

MARFAN SYNDROME. An inheritable disorder that affects the skeleton, joints, and blood vessels. Major indicators are excessively long arms and legs, lax joints, and vascular defects.

MARSUPIALIZATION. Cutting out a wedge of the cyst wall and putting in stitches so the cyst cannot reoccur.

MARTIAL ARTS. Group of diverse activities originating from ancient Asian fighting techniques.

MASOCHISM. Sexual arousal by having pain and/or humiliation inflicted upon oneself.

MAST CELLS. A type of immune system cell that is found in the lining of the nasal passages and eyelids, displays a type of antibody called immunoglobulin type E (IgE) on its cell surface, and participates in the allergic response by releasing histamine from intracellular granules.

MASTECTOMY, MODIFIED RADICAL. Total mastectomy with axillary lymph node dissection, but with preservation of the pectoral muscles.

MASTECTOMY, RADICAL. Removal of the breast, pectoral muscles, axillary lymph nodes, and associated skin and subcutaneous tissue.

MASTECTOMY, SIMPLE. Removal of only the breast tissue, nipple and a small portion of the overlying skin.

MASTOID BONE. The prominent bone behind the ear that projects from the temporal bone of the skull.

MASTOID PROCESS. The protrusions of bone behind the ears at the base of the skull.

MASTOIDITIS. An inflammation of the bone behind the ear (the mastoid bone) caused by an infection spreading from the middle ear to the cavity in the mastoid bone.

MASTOPEXY. Surgical procedure to lift up a breast. May be used on opposite breast to achieve symmetrical appearance with a reconstructed breast.

MATCH. How similar the HLA typing, out of a possible six antigens, is between a donor and a recipient.

MATERNAL. From one's mother.

MATERNAL BLOOD SCREENING. Maternal blood screening is normally done early in pregnancy to test for a variety of conditions. Abnormal amounts of certain proteins in a pregnant woman's blood raise the probability of fetal defects. Amniocentesis is recommended if such a probability occurs.

MATERNAL SERUM ANALYTE SCREENING. A medical procedure in which a pregnant woman's blood is drawn and analyzed for the levels of certain hormones and proteins. These levels can indicate whether there may be an abnormality in the unborn child. This test is not a definitive indicator of a problem and is followed by more specific testing such as amniocentesis or chorionic villus sampling.

MATERNAL UNIPARENTAL DISOMY. Chromosome abnormality in which both chromosomes in a pair are inherited from one's mother.

MATRIX. The tissue at the base of the nail, from which the nail grows.

MATURATION. The process by which stem cells transform from immature cells without a specific function into a particular type of blood cell with defined functions.

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MAXILLA. The bone of the upper jaw, which serves as a foundation of the face and supports the orbits.

MCCUNE-ALBRIGHT SYNDROME (MCAS). A genetic syndrome characterized in girls by the development of ovarian cysts and puberty before the age of 8, together with abnormalities of bone structure and skin pigmentation.

MCH–1. Major histocompatibility complex proteins that protect cells from invasion.

MEAN CORPUSCULAR HEMOGLOBIN (MCH). A measurement of the average weight of hemoglobin in a red blood cell.

MEAN CORPUSCULAR HEMOGLOBIN CONCENTRATION (MCHC). The measurement of the average concentration of hemoglobin in a red blood cell.

MEAN CORPUSCULAR VOLUME (MCV). A measure of the average volume of a red blood cell.

MEASLES. An acute and highly contagious viral disease marked by distinct red spots followed by a rash that occurs primarily in children.

MEASLES ENCEPHALITIS. A serious complication of measles occurring in about one out of every 1,000 cases, causing headache, drowsiness, and vomiting seven to ten days after the rash appears. Seizures and coma can follow, which may lead to retardation and death.

MECHANICAL VALVE. An artificial device used to replace the patient's heart valve. They include three types: ball valve, disk valve, and bileaflet valve.

MECONIUM. A greenish fecal material that forms the first bowel movement of an infant.

MECONIUM ASPIRATION SYNDROME. Breathing in of meconium by a fetus or newborn, which can block air passages and interfere with lung expansion.

MEDIA. Substance that contains all the nutrients necessary for bacteria to grow in a culture.

MEDIAL WALL. The middle bone, or wall, of the eye's orbit. It is generally thicker than the roof and floor walls.

MEDIAN NERVE. A nerve that runs through the wrist and into the hand. It provides sensation and some movement to the hand, the thumb, the index finger, the middle finger, and half of the ring finger.

MEDIASTINOSCOPY. A procedure that allows the physician to see the organs in the mediastinal space using a thin, lighted, hollow tube (a mediastinoscope).

MEDIASTINUM. The area between the lungs, bounded by the spine, breastbone, and diaphragm.

MEDITATION. Technique of concentration for relaxing the mind and body.

MEDULLA OBLONGATA. The lowest section of the brainstem, located next to the spinal cord. The medulla is the site of important cardiac and respiratory regulatory centers.

MEDULLARY THYROID CANCER (MTC). A slow-growing tumor associated with multiple endocrine neoplasia.

MEFLOQUINE. An antimalarial drug that was developed by the United States Army in the early 1980s. Today, malaria resistance to this drug has become a problem in some parts of Asia (especially Thailand and Cambodia).

MEGACOLON. Abnormally large colon associated with some chronic intestine disorders.

MEGADOSE. A very large dose of a vitamin, taken by some people as a form of self-medication.

MEGAKARYOCYTE. A large bone marrow cell that is responsible for the production of platelets, which are active in blood clotting.

MEGALOBLAST. A large erythroblast (a red marrow cell that synthesizes hemoglobin).

MEIBOMIAN GLAND. Oil-producing glands in the eyelids that open near the eyelid margins.

MELANIN. A pigment that is responsible for the color of hair, skin, and eyes. Melanin also protects the body by absorbing ultraviolet light.

MELANOCYTE. An epidermal skin cell that produces melanin.

MELANOMA. A rapidly spreading and deadly form of cancer that usually occurs on the skin.

MELASMA. A dark mask-like discoloration that covers the cheeks and bridge of the nose. Also called "the mask of pregnancy."

MELATONIN. A hormone produced by the pineal gland that is associated with sleep, and that may be useful in the treatment of some sleep disorders.

MEMBRANE OXYGENATOR. The artificial lung that adds oxygen and removes carbon dioxide.

MENADIONE. A synthetic form of vitamin K. It is sometimes called vitamin K_3.

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MENARCHE. The first menstrual period in a human female, considered the central event of puberty in girls.

MENDELIAN INHERITANCE. An inheritance pattern for autosomal gene pairs. The genetic trait displayed results from one parent's gene dominating over the gene inherited from the other parent.

MENGHINI NEEDLE. A special needle used to obtain a sample of liver tissue.

MÉNIÈRE'S DISEASE. An abnormality of the inner ear that causes dizziness, ringing in the ears, and hearing loss.

MENINGES (SINGULAR, MENINX). The membranes that cover the brain and spinal cord.

MENINGITIS. An infection or inflammation of the membranes or tissues that cover the brain and spinal cord, caused by bacteria or a virus.

MENOPAUSE. The end of a woman's menstrual periods when a woman no longer can conceive a child.

MENORRHAGIA. Excessively heavy menstrual flow with cycles of normal length. It is also called hypermenorrhea.

MENTAL RETARDATION. Significant impairment in intellectual function and adaptation in society. Usually associated an intelligence quotient (IQ) below 70.

MEQ/L. Abbreviation for milliequivalents per liter. Some medical test results are reported in mEq/L.

MERCURIC CHLORIDE; MERCURY(II) CHLORIDE; $HGCL_2$. A poisonous crystalline form of inorganic mercury that is used as a disinfectant and fungicide.

MERIDIAN. In traditional Chinese medicine, the channels that run beneath the skin through which the body's energy flows.

MESENTERIC ADENITIS. Inflammation of the lymph nodes that serve the small intestine. Has symptoms similar to appendicitis.

MESOSALPINX. A ligament connected to the fallopian tube.

MESOTHELIUM. A membrane/sac that protects the body's major internal organs and allows them freedom of movement (for example, lung contractions). The mesothelium is comprised of several regions, including the abdominal cavity (peritoneum), the chest cavity (pleura), and pericardium (heart).

METABOLIC. Refers to the chemical reactions in living things.

METABOLIC ACTIVITY. The sum of the chemical processes in the body that are necessary to maintain life.

METABOLIC BONE DISEASE. Weakening of bones due to a deficiency of certain minerals, especially calcium.

METABOLIC EQUIVALENT OF TASK (MET). The energy cost of a physical activity, measured as a multiple of the resting metabolic rate, which is defined as 3.5 milliliters of oxygen consumed per kilogram (kg) of body weight per minute, equivalent to 1 kilocalorie per kg per hour.

METABOLIC FUNCTION. Those processes necessary for the maintenance of a living organism.

METABOLIC PATHWAY. A sequence of chemical reactions that lead from some precursor to a product, where the product of each step in the series is the starting material for the next step.

METABOLIC SYNDROME. A group of risk factors for heart disease, diabetes, and stroke. It includes abdominal obesity, high blood pressure, high blood glucose levels, and low levels of high-density lipoprotein (HDL) cholesterol. The metabolic syndrome is sometimes called the insulin resistance syndrome.

METABOLISM. All the physical and chemical changes that occur in cells to allow growth and maintain body functions. These include processes that break down substances to yield energy and processes that build up other substances necessary for life.

METABOLITES. Substances produced by metabolism or by a metabolic process.

METACERCARIA (PLURAL, METACERCARIAE). The encysted stage of a fluke larva that produces infection in human beings.

METASTASIS (PLURAL, METASTASES). A tumor growth or deposit that has spread via lymph or blood to an area of the body remote from the primary tumor.

METASTASIZE. Spread of cells from the original site of the cancer to other parts of the body where secondary tumors are formed.

METASTATIC. The term used to describe a secondary cancer, or one that has spread from one area of the body to another.

METASTATIC CANCER. A cancer that has spread to an organ or tissue from a primary cancer located elsewhere in the body.

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METHAMPHETAMINE (METH, METHADRINE, "SPEED"). A highly addictive medication that is widely abused as a stimulant.

METHEMOGLOBIN. A compound formed from hemoglobin by oxidation.

METHOTREXATE. A drug that interferes with cell growth and is used to treat rheumatoid arthritis as well as various types of cancer. Side effects may include mouth sores, digestive upsets, skin rashes, and hair loss.

METHYLATION TESTING. DNA testing that detects if a gene is active or imprinted.

METHYLENE BLUE. A dye that is used to stain the blood cells for the reticulocyte count.

METHYLMERCURY. Any of various toxic compounds containing the organic grouping CH_3Hg. These compounds occur as industrial byproducts and pesticide residues, accumulate in fish and other organisms—especially those high on the food chain, and are rapidly absorbed through the human intestine to cause neurological disorders such as Minamata disease.

METRONIDAZOLE. An anti-infective agent regarded as the best available drug for treating trichomoniasis. It is sold under the trade names Flagyl and MetroGel.

MIASM. In homeopathy, an inherited weakness or predisposition to disease.

MICROANGIOPATHIC. Pertaining to disorders of the small blood vessels.

MICROBE. A microorganism, especially a bacterium, that causes disease.

MICROCALCIFICATIONS. Tiny flecks that are too small to be felt. They are important markers of cancer that show up on ultrasound and mammogram.

MICROCEPHALY. An abnormally small head.

MICROCIRCULATION. The passage of blood in the smallest blood vessels of the body, such as the capillaries in the hand and fingers.

MICROCYTIC. A descriptive term applied to a smaller than normal red blood cell.

MICROEMBOLI. Small blot clots in the bloodstream.

MICROFILARIAE. The larvae and infective form of filarial worms.

MICROFLORA. The bacterial population in the intestine.

MICROKERATOME. A precision surgical instrument that can slice an extremely thin layer of tissue from the surface of the cornea.

MICRONUTRIENTS. Essential dietary elements that are needed only in very small quantities. Micronutrients are also known as trace elements. They include copper, zinc, selenium, iodine, magnesium, iron, cobalt, and chromium.

MICROORGANISMS. Microscopic organisms, such as bacteria, viruses, algae, and fungi.

MICROSPORIDA. A type of parasitic protozoa.

MICROSURGERY. Surgery on small body structures or cells performed with the aid of a microscope and other specialized instruments.

MICROTUBULES. Slender, elongated anatomical channels in worms.

MIDDLE EAR. The cavity or space between the eardrum and the inner ear. It includes the eardrum, the three little bones (hammer, anvil, and stirrup) that transmit sound to the inner ear, and the Eustachian tube, which connects the inner ear to the nasopharynx (the back of the nose).

MIGRAINE HEADACHE. An intense throbbing pain that occurs on one or both sides of the head. The headache is usually accompanied by other symptoms, such as nausea, vomiting, and aversion to light.

MIGRAINE NEURALGIA. A variant of migraine pain, also called cluster headache, in which severe attacks of pain affect the eye and forehead on one side of the face.

MILD COGNITIVE IMPAIRMENT (MCI). A transitional phase of memory loss in older people that precedes dementia or Alzheimer's disease.

MILIARY TUBERCULOSIS. The form of TB in which the bacillus spreads through all body tissues and organs, producing many thousands of tiny tubercular lesions. Miliary TB is often fatal unless promptly treated.

MILK-ALKALI SYNDROME. Elevated blood calcium levels and alkalosis caused by excessive intake of milk and alkalis. Usually occurs in the treatment of peptic ulcer.

MINERAL. An inorganic substance found in the earth that is necessary in small quantities for the body to maintain health. Examples: zinc, copper, iron.

MINERALIZATION. The process by which the body uses minerals to build bone structure.

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MINIGRAFT OR MICROGRAFT. Transplantation of a small number of hair follicles, as few as one to three hairs, into a transplant site.

MINIMUM ERYTHEMA DOSE. The minimum amount of ultraviolet B (UVB) light that produces redness 24 hours after exposure. It is the starting dose for UVB light treatments.

MINIMUM PHOTOTOXIC DOSE. The dose of ultraviolet A (UVA) light that produces uniform redness 72 hours after ingesting a psoralen compound. It becomes the starting dose for PUVA (psoralen + UVA) treatment.

MIOTIC. A drug that causes pupils to contract.

MIRACIDIUM (PLURAL, MIRACIDIA). The free-swimming larval form in the life cycle of the liver fluke.

MISCARRIAGE. The spontaneous end of a pregnancy before the twentieth week. The death of the fetus is a common cause of miscarriage.

MISPROSTOL. A drug used in combination with mifepristone to cause uterine contractions that expel the contents of the uterus.

MITE. An insect parasite belonging to the order Acarina.

MITOCHONDRIA. Spherical or rod-shaped parts of the cell. Mitochondria contain genetic material (DNA and RNA) and are responsible for converting food to energy.

MITRAL STENOSIS. Narrowing or constricting of the mitral valve, which separates the left atrium from the left ventricle.

MITRAL VALVE. The heart valve that prevents blood from flowing backwards from the left ventricle into the left atrium. Also known as bicuspid valve.

MITRAL VALVE LEAFLETS. The mitral valve is made up of two valve leaflets (the anteromedial leaflet and the posterolateral leaflet) and a ring around the valve, known as the mitral valve annulus. The orientation of the two leaflets resembles a bishop's miter, which is where the valve received its name.

MITRAL VALVE PROLAPSE. A heart defect in which one of the valves of the heart (which normally controls blood flow) becomes floppy. Mitral valve prolapse may be detected as a heart murmur but there are usually no symptoms.

MIXED MANIA. A mental state in which symptoms of both depression and mania occur simultaneously.

MOBILIZATION. Making movable; restoring the power of motion in a joint; movement that increases joint mobility.

MODALITIES. The factors and circumstances that cause a patient's symptoms to improve or worsen.

MOHS' MICROGRAPHIC SURGERY. A surgical technique in which successive rings of skin tissue are removed and examined under a microscope to ensure that no cancer is left.

MOLARS. The teeth behind the primary canines or permanent premolars, with large crowns and broad chewing surfaces for grinding food.

MOLLUSCUM CONTAGIOSUM. A disease of the skin and mucuous membranes, caused by a poxvirus and found all over the world.

MONOAMINE OXIDASE INHIBITOR (MAOI). An older class of antidepressants.

MONOCHORIONIC TWINS. Twins that share a single placenta.

MONOCLONAL. Identical cells or proteins; cells (clones) derived from a single, genetically distinct cell, or proteins produced by these cells.

MONOCLONAL ANTIBODY. A protein substance that is produced in the laboratory by a single population of cells; used in cancer immunotherapy treatment.

MONOCLONAL GAMMOPATHY OF UNDETERMINED SIGNIFICANCE (MGUS). Common condition in which M-protein is present, but there are no tumors or other symptoms of disease.

MONOCYTE. White blood cell that increases during a variety of conditions including severe infections. It removes debris and microorganisms by the cellular process phagocytosis.

MONONUCLEAR PHAGOCYTE. A type of cell of the human immune system that ingests bacteria, viruses, and other foreign matter, thus removing potentially harmful substances from the bloodstream. These substances are usually then digested within the phagocyte.

MONONUCLEOSIS. An infection that causes swelling of lymph nodes, spleen, and liver, usually accompanied by extremely sore throat, fever, headache, and intense long-lasting fatigue.

MONOSACCHARIDE. The simplest form of sugar. Monosaccharides combine to form disaccharides and such complex carbohydrates as starch and cellulose.

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MONOUNSATURATED FAT. Fats that contain one double or triple bond per molecule; examples include canola oil and olive oil.

MONS PUBIS. The fatty tissue over the area where the pubic bones meet.

MONSEL'S SOLUTION. A solution used to stop bleeding.

MONTELUKAST (SINGULAIR). An inhibitor that prevents leukotrienes from binding to cell receptors; taken over time, montelukast can reduce or prevent symptoms of asthma and allergies.

MOOD DISORDER. A group of mental disorders involving a disturbance of mood, along with either a full or partial excessively happy (manic) or extremely sad (depressive) syndrome not caused by any other physical or mental disorder. Mood refers to a prolonged emotion.

MORBIDITY. Morbidity refers to an illness or disease condition. In statistics it refers to the rate at which a disease occurs.

MORBIDLY OBESE. Definition of a person who is 100 lb (45 kg) or more than 50% overweight and has a body mass index above 40.

MORO REFLEX. A reflex startle reaction in infants: the arms and legs move away from the body and to the side and are then drawn together.

MORPHEA. The most common form of localized scleroderma.

MORPHINE. Morphine is the naturally occurring opioid in the opium poppy, *Papaver somniferum*. It is a powerful narcotic analgesic, and its primary clinical use is in the management of moderately severe to severe pain. After heroin, morphine has the greatest potential for addiction of all narcotic analgesics.

MORPHOLOGY. Literally, the study of form. In medicine, morphology refers to the size, shape, and structure rather than the function of a given organ.

MORTALITY. Mortality means death. In statistics it refers to the rate at which death occurs in a population for a particular disease condition.

MOSAIC. A term referring to a genetic situation in which an individual's cells do not have the exact same composition of chromosomes—for example, in Down syndrome, some of the individual's cells may have a normal 46 chromosomes, while other cells have an abnormal 47 chromosomes.

MOSAICISM. A genetic condition resulting from a mutation, crossing over, or nondisjunction of chromosomes during cell division, causing a variation in the number of chromosomes in the cells.

MOTHER TINCTURE. The first stage in the preparation of a homeopathic remedy, made by soaking a plant, animal, or mineral product in a solution of alcohol.

MOTILITY. The movement or capacity for movement of an organism or body organ.

MOTION SICKNESS. Also called kinetosis; nausea and possibly vomiting induced by motion, such as travel by car, boat, or plane.

MOTOR. Of or pertaining to motion, the body apparatus involved in movement, or the brain functions that direct purposeful activity.

MOTOR NERVE. Motor or efferent nerve cells carry impulses from the brain to muscle or organ tissue.

MOTOR NEURON. Nerve cells within the central nervous system that carry nerve impulses controlling muscle movement.

MOTOR SKILL LEARNING. Memory system associated with physical movement and activity. For example, learning to swim is initially difficult, but once an efficient stroke is learned, it requires little conscious effort.

MOTOR SKILLS. Controlled movement of muscle groups. Fine motor skills involve tasks that require dexterity of small muscles, such as buttoning a shirt. Tasks such as walking or throwing a ball involve the use of gross motor skills.

MOTOR UNIT ACTION POTENTIALS. Spikes of electrical activity recorded during an EMG that reflect the number of motor units (motor neurons and the muscle fibers they transmit signals to) activated when the patient voluntarily contracts a muscle.

MOURNING. The public expression of bereavement; it may include funerals and other rituals, special clothing, and symbolic gestures.

MOUSSE OIL. Crude oil that has emulsified or weathered, mixed with dispersants, water, and marine material to form a spongy, light brown, mousse-like material.

MOXIBUSTION. An acupuncture technique that burns the herb moxa or mugwort.

MUCIN. A protein in saliva that combines with sugars in the mouth to form plaque.

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MUCINOUS (COLLOID) CARCINOMA. A type of cancer that accounts for 1% to 2% of breast cancers. Resembles medullary carcinoma in ultrasound and mammogram, but usually affects older women.

MUCOCILIARY ESCALATOR. The coordinated action of tiny projections on the surfaces of cells lining the respiratory tract, which moves mucus up and out of the lungs.

MUCOCUTANEOUS LYMPH NODE SYNDROME (MLNS). Another name for Kawasaki syndrome. The name comes from the key symptoms of the disease, which involve the mucous membranes of the mouth and throat, the skin, and the lymph nodes.

MUCOLYTIC. An agent that dissolves or destroys mucin, the chief component of mucus.

MUCOPOLYSACCHARIDE. A complex molecule made of smaller sugar molecules strung together to form a chain. Found in mucous secretions and intercellular spaces.

MUCOSA. The mucous membrane, or the thin layer that lines body cavities and passages.

MUCOSAL. Refers to tissues that produce mucus, such as the digestive, genital, and urinary tracts.

MUCOUS MEMBRANES. The moist coverings that line the mouth, nose, intestines, and other internal organs.

MUCUS. Thick fluid produced by the moist membranes that line many body cavities and structures.

MULTIDRUG–RESISTANT ORGANISMS (MDROS). Bacteria that are resistant to one or more classes of antimicrobial agents and usually are resistant to all but one or two commercially available antimicrobial agents.

MULTI-FETAL PREGNANCY. A pregnancy of two or more fetuses.

MULTIFOCAL. Having many focal points; occuring at multiple sites.

MULTI-INFARCT DEMENTIA. Dementia caused by damage to brain tissue resulting from a series of blood clots or clogs in the blood vessels. It is also called vascular dementia.

MULTINODULAR GOITER. A condition in which benign lumps of tissue (nodules) form within the thyroid gland and cause it to secrete too much thyroid hormone. It is also called Plummer's disease.

MULTIPLE CHEMICAL SENSITIVITY. A condition characterized by severe and crippling allergic reactions to commonly used substances, particularly chemicals. Also called environmental illness.

MULTIPLE ENDOCRINE NEOPLASIA. Abnormal tissue growth on one or more of the endocrine (hormone-secreting) glands.

MULTIPLE ENDOCRINE NEOPLASIA TYPE 1 (MEN-1). An inherited condition marked by multiple malignancies of the pituitary gland, parathyroid gland, and islet cells of the pancreas. About half of MEN-1 patients with pancreatic islet cell tumors will have gastrinomas, gastrin-producing tumors that lead to ulcer disease.

MULTIPLE MYELOMA. Cancer of the plasma cells.

MULTIPLE PERSONALITY DISORDER (MPD). An older term for dissociative identity disorder (DID).

MULTIPLE SCLEROSIS. A degenerative nervous system disorder in which the protective covering of the nerves in the brain are damaged, leading to tremor and paralysis.

MULTITASKING. Performing multiple duties or taking on multiple responsibilities and roles simultaneously.

MUMPS. An acute and highly contagious viral illness that usually occurs in childhood.

MUNCHAUSEN BY PROXY. A factitious diagnosis in children produced by a parent or other caregiver.

MUNCHAUSEN SYNDROME. A factitious self-diagnosis in which the patient's symptoms are dramatized and exaggerated.

MURMUR. An abnormal heart sound that can reflect a valve dysfunction.

MUSCLE DYSMORPHIA. A subtype of body dysmorphic disorder, described as excessive preoccupation with muscularity and body building to the point of interference with social, educational, or occupational functioning.

MUSCLE TONE. Also termed tonus; the normal state of balanced tension in the tissues of the body, especially the muscles.

MUSCULAR DYSTROPHY. A group of inherited diseases characterized by progressive wasting of the muscles.

MUTATE. Undergo a spontaneous change in the makeup of genes or chromosomes.

MUTATION. A permanent change in the genetic material that may alter a trait or characteristic of an individual, or manifest as disease, and can be transmitted to offspring.

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MUTISM. The inability or refusal to speak.

MYALGIA. Muscular pain or tenderness, typically of a diffuse and/or nonspecific nature.

MYALGIC ENCEPHALOMYELITIS. An older name for chronic fatigue syndrome; encephalomyelitis refers to inflammation of the brain and spinal cord.

MYASTHENIA GRAVIS. A muscle weakness that occurs because the body makes antibodies to the natural chemical that facilitates transmission of impulses between the nerve and the muscle.

MYCOBACTERIA. A group of bacteria that includes *Mycobacterium tuberculosis*, the bacterium that causes tuberculosis, and other forms that cause related illnesses.

MYCOPLASMA. A type of free-living microorganism that has no cell wall. Mycoplasmas cause some varieties of pneumonia and urinary tract infections that stimulate the body to produce cold agglutinins.

MYCOPLASMA PNEUMONIA. An incomplete bacterium that infects the lung.

MYCOSIS FUNGOIDES. The most common type of cutaneous T-cell lymphoma. This low-grade lymphoma primarily affects the skin. Generally, it has a slow course and often remains confined to the skin. In about 10% of cases, it can progress to the lymph nodes and internal organs.

MYDRIATIC. Causing dilation or widening of the pupil of the eye.

MYELIN. A protective cover that surrounds nerve cells and helps to increase the speed by which information travels along the nerve; also referred to as myelin sheath.

MYELODYSPLASIA. Also called myelodysplastic syndrome, it is a condition in which the bone marrow does not function normally and can affect the various types of blood cells produced in the bone marrow. Often referred to as a preleukemia and may progress and become acute leukemia.

MYELOFIBROSIS. An anemic condition in which bone marrow cells are abnormal or defective and become fibrotic.

MYELOGRAM. A special type of x-ray study of the spinal cord, made after a contrast medium has been injected into the space surrounding the cord.

MYELOGRAPHY. An imaging procedure involving the injection of a radioactive dye into the fluid surrounding the spine. A myelography can be used to detect herniated disks, nerve root damage, and other problems affecting the cervical spine.

MYELOMA. A tumor of plasma cells that originates in bone marrow and usually spreads to more than one bone.

MYELOMENINGOCELES (MMC). A protrusion in the vertebral column containing spinal cord and meninges.

MYELOPATHY. A disorder in which the tissue of the spinal cord is diseased or damaged.

MYELOPROLIFERATIVE DISORDER. A disorder in which the bone marrow produces too many cells too rapidly.

MYELOSUPPRESSIVE THERAPY. Any form of treatment that is aimed at slowing down the rate of blood cell production.

MYOCARDIAL INFARCTION. Commonly known as a heart attack, a myocardial infarction is an episode in which some of the heart's blood supply is severely cut off or restricted, causing the heart muscle to suffer and die from lack of oxygen.

MYOCARDITIS. Inflammation of the heart tissue.

MYOCARDIUM. The medical term for the specialized involuntary muscle tissue found in the walls of the heart.

MYOCLONIC. A rapid, involuntary muscle contraction, particularly near the eye.

MYOCLONUS. Involuntary contractions of a muscle or group of muscles.

MYOFASCIAL. The fibrous tissue that encloses and separates layers of muscles.

MYOGLOBIN. A protein that holds oxygen in heart and skeletal muscle. It rises after damage to either of these muscle types.

MYOGLOBINURIA. Reddish urine caused by excretion of myoglobin, a breakdown product of muscle.

MYOMA. Benign (noncancerous) tumors of the uterus.

MYONECROSIS. The destruction or death of muscle tissue.

MYOPATHY. A disorder that causes weakening of muscles.

MYOPIA. A vision problem in which distant objects appear blurry. Myopia results when the cornea is too steep or the eye is too long and the light doesn't focus properly on the retina. People who are myopic or

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nearsighted can usually see near objects clearly, but not far objects.

MYOTONIC DYSTROPHY. A form of muscular dystrophy, also known as Steinert's condition, characterized by delay in the ability to relax muscles after forceful contraction, wasting of muscles, and other abnormalities.

MYRINGOTOMY. Surgical cutting of the eardrum to allow fluid to escape from the middle ear.

MYXEDEMA. Hypothyroidism, characterized by thick, puffy features; an enlarged tongue; and lack of emotion.

N

NAIL BED. The layer of tissue underneath the nail.

NALTREXONE. A medication originally developed to treat addiction to heroin or morphine that is also used to treat alcoholism. It works by reducing the craving for alcohol rather than by producing vomiting or other unpleasant reactions.

NANOMETER. A measurement of length equal to 10^{-9} meters, or one billionth of a meter. It is used as a unit of measurement for light waves.

NARCOLEPSY. A lifelong sleep disorder marked by four symptoms: sudden brief sleep attacks, cataplexy, temporary paralysis, and hallucinations. The hallucinations are associated with falling asleep or the transition from sleeping to waking.

NARCOTIC. A drug derived from opium or compounds similar to opium. Such drugs are potent pain relievers and can affect mood and behavior. Long-term use of narcotics can lead to dependence and tolerance.

NASAL POLYPS. Drop-shaped overgrowths of the nasal membranes.

NASAL SCRAPING. Pathological material obtained for clinical study by scratching the inner surface of the nose with a clinical instrument.

NASAL SEPTUM. The membrane that separates the nostrils.

NASOGASTRIC TUBE. A tube placed through the nose into the stomach.

NASOLACRIMAL DUCT. A channel that transmits tears from the lacrimal sac to the nose.

NASOPHARYNGEAL. Referring to the passage connecting the nasal cavity behind the nose to the top of the throat behind the soft palate.

NASOPHARYNGOSCOPY. A diagnostic procedure that examines the nasal passageways and pharynx with an instrument outfitted with an optical system.

NASOPHARYNX. The passage that connects the nasal cavity to the top of the throat.

NATURAL KILLER (NK) CELL. A lymphocyte that acts as a primary immune defense against infection.

NATUROPATHIC PHYSICIANS. Physicians specializing in the treatment of disease using a variety of natural methods and plant-based medicines.

NAUSEA. Stomach distress characterized by a distaste for food and the urge to vomit.

NEARSIGHTEDNESS. A condition in which one or both eyes cannot focus normally, causing objects at a distance to appear blurred and indistinct. Also called myopia.

NEBULIZER. A device that turns liquid forms of medicine into a fine spray that can be inhaled.

NECROSIS. The death of cells, a portion of tissue, or a portion of an organ due to permanent damage of some sort, such as a lack of oxygen supply to the tissues.

NECROTIZING ENTEROCOLITIS (NEC). A condition in which part of the intestines are destroyed as a result of bacterial infection.

NECROTIZING FASCIITIS. A destructive infection which follows severe cellulitis and involves the deep skin and underlying tissues.

NECROTIZING PNEUMONIA. Pneumonia that causes the death of lung tissue. It often precedes the development of lung abscess.

NEEDLE BIOPSY. The procedure of using a large hollow needle to obtain a sample of intact tissue.

NEGATIVE SYMPTOMS. Symptoms of schizophrenia characterized by the absence or elimination of certain behaviors. DSM–IV specifies three negative symptoms: affective flattening, poverty of speech, and loss of will or initiative.

NEGATIVISM. Behavior characterized by resistance, opposition, and refusal to cooperate with requests, even the most reasonable ones.

NEISSERIA GONORRHOEAE. The bacterium that causes gonorrhea.

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NEMATODE. A type of roundworm with a long, unsegmented body, usually parasitic on animals or plants.

NEOADJUVANT THERAPY. Radiation therapy or chemotherapy used to shrink a tumor before surgical removal of the tumor.

NEONATAL. Referring to the period shortly after birth.

NEONATAL JAUNDICE. A disorder in newborns where the liver is too premature to conjugate bilirubin, which builds up in the blood.

NEONATE. A term referring to the newborn infant, from birth until one month of age.

NEONATOLOGIST. A physician who specializes in problems of newborn infants.

NEOPLASIA. Abnormal growth of cells, which may lead to a neoplasm, or tumor.

NEOPLASM. An uncontrolled growth of new tissue (a tumor).

NEOVASCULARIZATION. Abnormal or excessive formation of blood vessels as in some retinal disorders.

NEPHRECTOMY. A medical procedure in which the kidney is surgically removed.

NEPHRITIS. Inflammation of the kidneys.

NEPHROLOGIST. A doctor who specializes in the diseases and disorders of the kidneys.

NEPHRON. The basic structural unit of the kidney, responsible for regulating the concentration of water and soluble chemicals in the blood by filtering the blood, reabsorbing the compounds needed by the body, and excreting the rest in the urine. Each kidney in humans contains between 800,000 and one million nephrons.

NEPHROSCOPE. An instrument made of a light source in a tube. The tube is inserted into the kidney through an incision in the back and used to locate kidney stones. The stones are broken up with high frequency sound waves and removed by suction through the scope.

NEPHROSIS. Any degenerative disease of the kidney (not to be confused with nephritis, an inflammation of the kidney due to bacteria).

NEPHROTIC SYNDROME. A condition characterized by water retention, little or no protein in urine, and high blood cholesterol.

NEPHROTOXIC. Toxic, or damaging, to the kidney.

NEPHROTOXIN. Substance that is poisonous to the kidneys.

NERVE BIOPSY. A medical test in which a small portion of a damaged nerve is surgically removed and examined under a microscope.

NERVE CONDUCTION. The speed and strength of a signal being transmitted by nerve cells.

NERVE CONDUCTION TESTING; NERVE CONDUCTION VELOCITY TEST. Procedure that measures the speed at which impulses move through the nerves after electrical stimulation.

NERVE GROWTH FACTOR. A protein resembling insulin that affects growth and maintenance of nerve cells.

NERVOUS SYSTEM. The complete network of the body's nerves, sense organs, and brain.

NERVOUS TIC. A repetitive, involuntary action, such as the twitching of a muscle or repeated blinking.

NEUCHAL TRANSLUCENCY. A pocket of fluid at the back of an embryo's neck visible via ultrasound that, when thickened, may indicate the infant will be born with a congenital heart defect.

NEURAL TUBE DEFECTS (NTDS). A group of birth defects that affect the brain and spinal cord.

NEURALGIA. Pain extending along one or more nerves.

NEURALLY MEDIATED HYPOTENSION. A rapid fall in blood pressure that causes dizziness, blurred vision, and fainting, often followed by prolonged fatigue.

NEURASTHENIA. A term coined in the late nineteenth century to refer to a condition of chronic mental and physical weakness and fatigue.

NEURITIS. An inflammation of the nerves.

NEUROBLAST. An embryonic nerve cell that differentiates into a neuron.

NEUROBLAST CELLS. Cells produced by the fetus that mature into nerve cells and adrenal medulla cells.

NEUROBLASTOMA. Neuroblastoma is a tumor of the adrenal glands or sympathetic nervous system. Neuroblastomas can range from being relatively harmless to highly malignant.

NEUROCYSTICERCOSIS. Parasitic infection caused by the presence of immature tapeworm larvae within the central nervous system.

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NEURODEGENERATIVE. Relating to degeneration of nerve tissues.

NEURODEGENERATIVE DISEASE. A disease in which the nervous system progressively and irreversibly deteriorates.

NEURODERMATITIS. An itchy skin disease (also called lichen simplex chronicus) found in nervous, anxious people.

NEUROFIBRILLARY TANGLES. Accumulations of twisted protein fragments inside nerve cells in the brain that are diagnostic of Alzheimer's disease.

NEUROFIBROMA. A soft tumor usually located on a nerve.

NEUROFIBROMATOSIS. A rare hereditary disease that involves the growth of lesions that may affect the spinal cord.

NEUROFIBROMATOSIS TYPE 2 (NF2). A hereditary condition associated with an increased risk of bilateral acoustic neuromas, other nerve cell tumors, and cataracts.

NEUROGENIC. Caused by nerves; originating in the nerves.

NEUROLEPTICS. Antipsychotic drugs, including major tranquilizers, used in the treatment of psychoses like schizophrenia.

NEUROLOGIC. Pertaining to the nervous system.

NEUROLOGICAL CONDITIONS. A condition that has its origin in some part of the patient's nervous system.

NEUROLOGICAL SYSTEM. The tissue that initiates and transmits nerve impulses, including the brain, spinal cord, and nerves.

NEUROLOGIST. A doctor who specializes in disorders of the brain and central nervous system.

NEUROMUSCULAR. Relating to nerves and muscles or their interaction.

NEUROMUSCULAR JUNCTION. The site at which nerve impulses are transmitted to muscles.

NEURON. A unique type of cell found in the brain and body that is specialized to process and transmit information.

NEUROPATHY. A condition affecting the nerves supplying the arms and legs. Typically, the feet and hands are involved first. If sensory nerves are involved, numbness, tingling, and pain are prominent, and if motor nerves are involved, the patient experiences weakness.

NEUROPROTECTIVE. Conveying some form of protection to the nervous system from injury.

NEUROPSYCHOLOGICAL TEST. A test or assessment given to diagnose or evaluate a brain disorder, disease, or injury.

NEUROPSYCHOLOGIST. A clinical psychologist who specializes in assessing psychological status caused by a brain disorder.

NEUROSYPHILIS. Syphilis of the central nervous system.

NEUROTIC. Behavior characterized by neurosis, mental functional orders with symptoms such as anxiety, depression, compulsions, and phobias.

NEUROTOXIN. A substance that damages, destroys, or impairs the functioning of nerve tissue.

NEUROTRANSMISSION. When a neurotransmitter, or chemical agent released by a particular brain cell, travels across the synapse to act on the target cell to either inhibit or excite it.

NEUROTRANSMITTER. One of a group of chemicals secreted by a nerve cell (neuron) to carry a chemical message to another nerve cell, often as a way of transmitting a nerve impulse. Examples of neurotransmitters include acetylcholine, dopamine, serotonin, and norepinephrine.

NEUTROPHIL. The primary type of white blood cell involved in inflammation. Neutrophils are a type of granulocyte, also known as a polymorphonuclear leukocyte.

NEVUS (PLURAL, NEVI). The medical term for any anomaly of the skin that is present at birth, including moles and birthmarks.

NIACINAMIDE. A form of niacin that is usually used as a dietary supplement for people with insufficient niacin.

NICOTINE. A colorless, oily chemical found in tobacco that makes people physically dependent on smoking. It is poisonous in large doses.

NICOTINE REPLACEMENT THERAPY. A method of weaning a smoker away from the habit by giving the smoker smaller and smaller doses of nicotine over time.

NIGHT GUARD. A removable, custom-fitted plastic appliance that fits between the upper and lower teeth to prevent them from grinding against each other.

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NIMODIPINE (NIMOTOP). A calcium-channel blocker; a drug that relaxes arterial smooth muscle by slowing the movement of calcium across cell walls.

NIT. The egg sac laid by adult female lice.

NITROGEN NARCOSIS. Also called "rapture of the deep," the condition is caused by increased nitrogen pressure at depth and is characterized by symptoms similar to alcohol intoxication.

NITROPRUSSIDE. A compound that is used in laboratory tests to identify large amounts of cystine in urine samples.

NITROUS OXIDE. A colorless, sweet-smelling gas used by dentists for mild anesthesia. It is sometimes called laughing gas because it makes some patients feel giddy or silly.

NOCICEPTOR. A nerve cell that is capable of sensing pain and transmitting a pain signal.

NOCTURIA. Excessive need to urinate at night.

NOCTURNAL ENURESIS. The medical term for bedwetting.

NOCTURNAL MYOCLONUS. A disorder in which the patient is awakened repeatedly during the night by cramps or twitches in the calf muscles. Nocturnal myoclonus is sometimes called periodic limb movement disorder (PLMD).

NODULAR GOITER. An enlargement of the thyroid (goiter) caused when groups of cells collect to form nodules.

NODULES. A small mass of tissue in the form of a protuberance or a knot that is solid and can be detected by touch.

NONDISJUNCTION. Non-separation of a chromosome pair, during either meiosis or mitosis.

NON-HODGKIN'S LYMPHOMA. Cancer that originates in the lymphatic system and typically spreads throughout the body.

NONINVASIVE. A procedure that does not penetrate the body.

NON-IONIZING RADIATION. Rays of energy that move in long, slow wave patterns and do not penetrate cells.

NONMELANOMA SKIN CANCER. A squamous cell carcinoma or basal cell carcinoma.

NON-MYELOABLATIVE ALLOGENEIC BONE MARROW TRANSPLANT. Also called "mini" bone marrow transplants, this type of transplant involves receiving low-doses of chemotherapy and radiation therapy, followed by the infusion of a donor's bone marrow or peripheral stem cells. The goal is to suppress the patient's own bone marrow to allow the donor's cells to engraft.

NON-NUCLEOSIDE REVERSE TRANSCRIPTASE INHIBITORS. A class of antiretroviral drugs that work by inhibiting the reverse transcriptase enzyme necessary for HIV replication.

NONOXYNOL-9. The chemical name of the organic compound most commonly used in contraceptive creams, foams, and jellies. It was also used in the manufacture of spermicide-treated condoms until 2005, but the use of such condoms is now discouraged.

NONPALPABLE. Cannot be felt by hand.

NONPHARMACOLOGICAL. Referring to therapy that does not involve drugs.

NONPROLIFERATIVE RETINOPATHY. Retinopathy without the growth of new blood vessels.

NON-RAPID EYE MOVEMENT (NREM) SLEEP. A type of sleep that differs from rapid eye movement (REM) sleep. The four stages of NREM sleep account for 75%–80% of total sleeping time.

NONSPHEROCYTIC. Not sphere-shaped.

NONSPHEROCYTIC HEMOLYTIC ANEMIA. Anemia caused by variably shaped red blood cells that burst, or hemolyze, easily.

NONSTEROIDAL. Not containing steroids or cortisone.

NONSTEROIDAL ANTI-INFLAMMATORY DRUGS (NSAIDS). A class of drugs that is used to relieve pain and symptoms of inflammation, such as ibuprofen and aspirin.

NON-STRESS TEST. A record of the fetal heart rate in the absence of contractions (stress).

NONVERBAL LEARNING DISABILITY (NLD). A learning disability syndrome identified in 1989 that may overlap with some of the symptoms of Asperger syndrome.

NOREPINEPHRINE. A hormone released by nerve cells and the adrenal medulla that causes constriction of blood vessels. Norepinephrine also functions as a neurotransmitter.

NORMAL FLORA. The mixture of bacteria normally found at specific body sites.

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NORMAL WEIGHT. A BMI of between 18.5 and 24.9.

NORMOCHROMIC. A descriptive term applied to a red blood cell with a normal concentration of hemoglobin.

NORMOCYTIC. A descriptive term applied to a red blood cell of normal size.

NORMS. Normative or mean score for a particular age group.

NOSOCOMIAL. Contracted in a hospital; nosocomial infections are infections acquired by a patient while in the hospital.

NOSODE. A homeopathic remedy made from microbes, pus, or other disease material.

NOTCHING. A deformity of the surface of the ribs that is often associated with coarctation of the aorta.

NPO. A term that means "nothing by mouth." NPO refers to the time after which a patient is not allowed to eat or drink prior to a procedure or treatment.

NUCHAL CORD. The term used when the umbilical cord is looped around the fetus's neck in utero.

NUCHAL CYSTS. Small cysts in the fetus's neck that present in 1% of pregnancies.

NUCLEAR FAMILY. The basic family unit, consisting of father, mother, and their biological children.

NUCLEAR MEDICINE. A branch of medicine that makes use of radioisotopes (also called radionuclides) to evaluate the rate of radioactive decay in diagnosing and treating various diseases.

NUCLEAR SCANNING. Use of injected radioactive elements to analyze blood flow.

NUCLEIC ACID AMPLIFICATION TEST (NAAT). A screening test for gonorrhea that detects bacterial DNA in a urine sample or cervical swab.

NUCLEIC ACIDS. The cellular molecules DNA and RNA that act as coded instructions for the production of proteins and are copied for transmission of inherited traits.

NUCLEOSIDE ANALOGUES. The first group of effective antiretroviral medications. They work by interfering with the AIDS virus's synthesis of DNA.

NUCLEOTIDE. Any of a group of organic molecules that link together to form the building blocks of DNA or RNA.

NUCLEUS PULPOSUS (NP). An elastic, pulpy mass in the center of each vertebral disk.

NULLIPARITY. The condition of being nulliparous, or not bearing offspring.

NUMBNESS. Loss of feeling or sensation.

NUTRIENT. A food substance that provides energy or is necessary for growth and repair. Examples of nutrients are vitamins, minerals, carbohydrates, fats, and proteins.

NYMPH. The immature louse that hatches from the nit.

NYSTAGMUS. An involuntary back-and-forth movement of the eyes that is often found in albinism.

O

OBESITY. Excessive weight due to accumulation of fat, usually defined as a body mass index (BMI) of 30 or above or body weight greater than 30% above normal on standard height-weight tables.

OBSESSION. A repetitive or persistent thought, idea, or impulse that is perceived as inappropriate and distressing.

OBSESSIVE-COMPULSIVE DISORDER. An anxiety disorder in which people cannot prevent themselves from dwelling on unwanted thoughts, acting on urges, or performing repetitious rituals, such as washing their hands or checking to make sure they turned off the lights.

OBSTRUCTION. A blockage that prevents movement.

OBSTRUCTIVE SLEEP APNEA (OSA). A potentially life-threatening condition characterized by episodes of breathing cessation during sleep alternating with snoring or disordered breathing. The low levels of oxygen in the blood of patients with OSA may eventually cause heart problems or stroke.

OCCIPITAL NEURALGIA. Pain on one side of the back of the head caused by entrapment or pinching of an occipital nerve.

OCCLUSION. The way upper and lower teeth fit together during biting and chewing.

OCCLUSION THERAPY. A type of treatment for amblyopia in which the good eye is patched for a period of time. This forces the weaker eye to be used.

OCCLUSIVE. Closing off; blocking.

OCCULT. Not visible or easily detected.

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OCCULT BLOOD. Presence of blood that cannot be seen with the naked eye.

OCHRONOSIS. People with this rare hereditary condition tend to develop arthritis in adulthood.

OCULAR FUNDUS. The part of the eye opposite the pupil.

OCULAR LARVA MIGRANS (OLM). A syndrome associated with toxocariasis, in which the eye is invaded by migrating larvae.

OCULAR MELANOMA. A malignant tumor that arises within the structures of the eye. It is the most common eye tumor in adults.

OCULAR NEOVASCULARIZATION. Abnormal or excessive formation of blood vessels in the eye.

OCULOPHARYNGEAL MUSCULAR DYSTROPHY (OPMD). Form of muscular dystrophy affecting adults of both sexes, and causing weakness in the eye muscles and throat.

ODYNOPHAGIA. Pain felt when swallowing.

OFF-LABEL USE. The use of a prescription medication to treat conditions outside the indications approved by the U.S. Food and Drug Administration (FDA). It is legal for physicians to administer drugs for off-label uses, but it is not legal for pharmaceutical companies to advertise drugs for off-label uses.

OINTMENT. A thick substance that contains medicine and is meant to be spread on the skin, or if an ophthalmic ointment, in the eye.

OMEGA-3 FATTY ACIDS. A class of fatty acids that lowers the level of cholesterol in the blood. Omega-3 fatty acids are also essential for the growth and development of the brain and nerve tissue.

OMPHALOCELE. A congenital hernia in which a small portion of the fetal abdominal contents, covered by a membrane sac, protrudes into the base of the umbilical cord.

ONCHOCERCIASIS. Parasitic infestation caused by filamentous worms of the genus Onchocerca, especially *Onchocerca volvulus*, that is found in tropical America and is transmitted by several types of blackflies.

ONCOGENE. A gene that causes normal cell growth, but if mutated or expressed at high levels, encourages normal cells to change into cancerous cells.

ONCOLOGIST. A doctor who specializes in the treatment of cancer.

ONYCHOLYSIS. The separation of a nail from its underlying bed. Onycholysis is a common symptom of candidal infections of the nail or of exposure to harsh chemicals and detergents.

OOCYST. The egg form of the toxoplasmosis organism.

OOPHORECTOMY. Surgical removal of the ovaries; often performed laparoscopically.

OPACITY. An opaque spot in a normally transparent structure, such as the lens of the eye.

OPEN BITE. A malocclusion in which some teeth do not meet the opposing teeth.

OPHTHALMIA. Inflammation of the eye, usually severe and affecting the conjunctiva.

OPHTHALMIA NEONATORUM. The medical term for conjunctivitis in newborns.

OPHTHALMIC. Pertaining to the eye.

OPHTHALMIC ARTERY. The artery supplying the eye and adjacent structures with blood.

OPHTHALMOLOGIST. A physician specializing in the medical and surgical treatment of eye disorders.

OPHTHALMOLOGY. The branch of medicine that deals with the diagnosis and treatment of eye disorders.

OPHTHALMOSCOPE. An instrument routinely used by ophthalmologists to examine the interior of the eye. It consists of a small light, a mirror, and lenses of differing powers that magnify.

OPIATE. A drug containing or derived from opium—such as codeine, morphine, and heroin—that alleviates pain and induces sleep.

OPIATE BLOCKERS. A type of drug that blocks the effects of natural opiates in the system. This makes some people, including some people with autism, appear more responsive to their environment.

OPIOID. Any morphine-like synthetic narcotic that produces the same effects as drugs derived from the opium poppy (opiates), such as pain relief, sedation, constipation, and respiratory depression.

OPIOID RECEPTORS. Receptors located in the brain and various organs that bind opiates or opioid substances.

OPPORTUNISTIC INFECTION. An infection that is normally mild in a healthy individual, but that takes advantage of an ill person's weakened immune system to move into the body, grow, spread, and cause serious illness.

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OPPOSITIONAL DEFIANT DISORDER. A childhood behavioral disorder characterized by an ongoing pattern of disobedient, hostile, and defiant behavior toward authority figures that goes beyond the bounds of normal childhood conduct.

OPTIC ATROPHY. Degeneration of the optic nerve.

OPTIC DISK. The small area in the retina where the optic nerve enters the eye that is not sensitive to light. Also called the blind spot.

OPTIC NERVE. The nerve that carries visual messages from the retina to the brain.

OPTIC NEURITIS. Inflammation of the optic nerve that connects to the retina of the eye. This variable condition can present with any of the following symptoms: blurred vision, loss of visual acuity, loss of some or all color vision, complete or partial blindness, and pain behind the eye.

OPTOKINETIC. A reflex that causes a person's eyes to move when his or her field of vision moves.

OPTOMETRIST. A medical professional who examines and tests the eyes for disease and treats visual disorders by prescribing corrective lenses and/or vision therapy. In many states, optometrists are licensed to use diagnostic and therapeutic drugs to treat certain ocular diseases.

ORAL AND MAXILLOFACIAL SURGEON. A dentist who is trained to perform surgery to correct injuries, defects, or conditions of the mouth, teeth, jaws, and face.

ORAL REHYDRATION SOLUTION (ORS). A liquid preparation developed by the World Health Organization that can decrease fluid loss in persons with diarrhea. Originally developed to be prepared with materials available in the home, commercial preparations are also available.

ORAL SURGEON. A dentist who specializes in surgical procedures of the mouth, including extractions.

ORBIT. The eye socket, which contains the eyeball, muscles, nerves, and blood vessels that serve the eye.

ORCHIECTOMY. Surgical removal of the testes as a way of treating prostate cancer by eliminating the production of testosterone.

ORCHIOPEXY. The surgical securing of the testis to prevent torsion.

ORCHITIS. Inflammation or swelling of the scrotal sac containing the testicles.

ORGAN PROCUREMENT. The process of donor screening and the evaluation, removal, preservation, and distribution of organs for transplantation.

ORGANELLE. Specialized structure within a cell, which is separated from the rest of the cell by a membrane composed of lipids and proteins, where chemical and metabolic functions take place.

ORGANIC BRAIN DISORDER. An organic brain disorder refers to impaired brain function due to damage or deterioration of brain tissue.

ORGANIC FOOD. Food grown without the use of synthetic pesticides and fertilizers.

ORGANIC ILLNESS. A physically, biologically based illness.

ORGANIC MERCURY. Poisonous compounds containing mercury and carbon, such as methylmercury, ethylmercury, and phenylmercury.

ORGANISM. A single, independent life form, such as a bacterium, a plant, or an animal.

ORGASM. The climax of sexual excitement, usually characterized by vaginal contractions by the female and ejaculation of semen by the male.

ORGASMIC DISORDER. The impairment of the ability to reach sexual climax.

ORLISTAT. A drug that inhibits lipase.

OROPHARYNX. The part of the airway into which the mouth leads.

ORPHAN DRUG. A drug that is known to be useful in treatment but lacks sufficient funding for further research and development.

ORTHODONTHIC TREATMENT. The process of straightening teeth to correct their appearance and function.

ORTHOGNATHIC SURGERY. Surgery to alter the relationships of the teeth and/or supporting bones, usually in conjunction with orthodontic treatment.

ORTHOKERATOLOGY. A method of reshaping the cornea using a contact lens. It is not considered a permanent method to reduce myopia.

ORTHOPEDICS. A medical specialty concerned with treating diseases, injuries, and malformations of the bones and supporting structures, such as tendons, ligaments, joints, and muscles.

ORTHOPEDIST. A doctor specializing in treatment of the skeletal system and its associated muscles and joints.

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ORTHOPNEA. Difficulty in breathing that occurs while the patient is lying down.

ORTHOPOXVIRUS. The genus of viruses that includes monkeypox, smallpox, cowpox, and camelpox.

ORTHOSIS. An external device, such as a splint or a brace, that prevents or assists movement.

ORTHOSTATIC HYPOTENSION. A drop in blood pressure that causes faintness or dizziness and occurs when one rises to a standing position. Also known as postural hypotension.

ORTHOTIC. A device or brace to control, correct, or compensate for a bone deformity.

ORTHOTIST. A health care professional who is skilled in making and fitting orthopedic appliances.

OSLER'S NODES. Small, raised, reddish, tender areas associated with endocarditis, commonly found inside the fingers or toes.

OSMOLALITY. A measurement of urine concentration that depends on the number of particles dissolved in it. Values are expressed as milliosmols per kilogram (mOsm/kg) of water.

OSMOTHERAPY. Intravenous injection or oral administration of an agent that induces dehydration. The goal of dehydration is to reduce accumulated fluid in the brain.

OSMOTIC PRESSURE. Pressure that occurs when two solutions of differing concentrations are separated by a semipermeable membrane, such as a cellular wall, and the lower concentration solute is drawn across the membrane into the higher concentration solute (osmosis).

OSSICLES. The three small bones of the middle ear: the malleus (hammer), the incus (anvil) and the stapes (stirrup). These bones help carry sound from the eardrum to the inner ear.

OSTEOARTHRITIS. A type of arthritis marked by chronic degeneration of the cartilage of the joints, leading to pain and sometimes loss of function.

OSTEOBLASTS. Bone cells that build new bone tissue.

OSTEOCLASTS. Bone cells that break down and remove bone tissue.

OSTEOCONDUCTION. Provision of a scaffold for the growth of new bone.

OSTEOCYTES. Bone cells that maintain bone tissue.

OSTEOGENESIS. Growth of new bone.

OSTEOGENESIS IMPERFECTA. A genetic disorder involving defective development of connective tissues, characterized by brittle and fragile bones that are easily fractured by the slightest trauma.

OSTEOINDUCTION. Acceleration of new bone formation by chemical means.

OSTEOLYTIC LESION. Soft spot or hole in bone caused by cancer cells.

OSTEOMALACIA. A softening of bones caused by lack of vitamin D and/or calcium in the diet.

OSTEOMYELITIS. An inflammation of bone or bone marrow, often caused by bacterial infections. Chronic melioidosis may cause osteomyelitis.

OSTEOPATHY. A system of medical practice that believes that the human body can make its own remedies to heal infection. It originally used manipulative techniques but also added surgical, hygienic, and medicinal methods when needed.

OSTEOPENIA. Reduction in bone mass, usually caused by a lowered rate of formation of new bone that is insufficient to keep up with the rate of bone destruction. Osteopenia often occurs together with amenorrhea and eating disorders in female athletes. It can lead to premature osteoporosis if left untreated.

OSTEOPHYTE. Also referred to as bone spur, it is an outgrowth or ridge that forms on a bone.

OSTEOPOROSIS. The excessive loss of calcium from the bones, causing the bones to become fragile and break easily. Postmenopausal women are especially vulnerable to this condition because estrogen, a hormone that protects bones against calcium loss, decreases drastically after menopause.

OSTOMY. A surgically created opening in the abdomen for elimination of waste products (urine or stool).

OTIC. Pertaining to the ear.

OTITIS. An infection of the ear.

OTITIS MEDIA. Infection of the middle ear.

OTOLARYNGOLOGIST. A doctor who specializes in diagnosing and treating disorders of the ears, nose, and throat; also called an otorhinolaryngologist.

OTOLOGIC. Relating to the study, diagnosis, and treatment of diseases of the ear and related structures.

OTOSCLEROSIS. A disease that scars and limits the motion of the small conducting bones in the middle ear.

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OTOSCOPE. A handheld instrument with a tiny light and a funnel-shaped attachment called an ear speculum, which is used to examine the ear canal and eardrum.

OTOTOXIC. Damaging to the nerves controlling the senses of hearing and balance.

OUTPATIENT SURGERY. Also called same-day or ambulatory surgery. The patient arrives for surgery and returns home on the same day.

OVA. Eggs.

OVAL WINDOW. A tiny opening at the entrance to the inner ear.

OVARIAN CYST. A benign or malignant growth on an ovary. An ovarian cyst can disappear without treatment or become extremely painful and have to be surgically removed.

OVARIAN FOLLICLES. Structures found within the ovary that produce eggs.

OVARIAN TORSION. Twisting of the ovary due to the influence of another condition or disease, resulting in extreme lower abdominal pain.

OVARY. One of the two almond-shaped glands in the female reproductive system responsible for producing eggs and the hormones estrogen and progesterone.

OVERBITE. Protrusion of the upper teeth over the lower teeth.

OVERWEIGHT. A BMI between 25.0 and 30.0.

OVULATION. The phase of the female monthly cycle when a developed egg is released from the ovary into the fallopian tube for possible fertilization.

OVUM (PLURAL, OVA). The reproductive cell of the female, which contains genetic information and participates in the act of fertilization. Also popularly called the egg.

OXALATE. A salt of oxalic acid produced during metabolism and excreted in the urine.

OXIDATION. Interaction in which one molecule removes an electron from another molecule to stabilize itself.

OXYGEN FREE RADICALS. Reactive molecules containing oxygen that can cause cell damage.

OXYGENATED BLOOD. Blood carrying oxygen through the body.

OXYTOCIN. A hormone secreted in the brains of mammals that acts as a neurotransmitter in the brain and also functions in sexual arousal, maternal behavior, and emotional bonding in humans. Synthetic oxytocin is used to induce or support labor in difficult childbirths.

OZONE. A form of oxygen with three atoms in its molecule (O_3), produced by an electric spark or ultraviolet light passing through air or oxygen. Ozone is used therapeutically as a disinfectant and oxidative agent.

P

PACEMAKER. An electrical device that has electrodes attached to the heart to stimulate the heart to beat normally. Pacemakers can be internal (placed under the skin) or external, with the electrodes placed on the skin or threaded through a tube placed into the heart.

PAGET'S DISEASE. A disease, whose cause is unknown, that is generally found in older people. Symptoms include bone pain, bowed legs, curved spine, and broken bones. Another name for this disease is osteitis deformans.

PAGOPHAGIA. The compulsive eating of ice.

PAIN DISORDER. A psychiatric disorder in which pain in one or more parts of the body is caused or made worse by psychological factors. The lower back is one of the most common sites for pain related to this disorder.

PALATINE TONSILS. The tonsils that can be seen at the back of the throat and are the tonsils most commonly affected by tonsillitis.

PALLIATIVE. Referring to any type of treatment that is given to relieve the symptoms of a disease rather than to cure it.

PALLIDOTOMY. A surgical procedure that destroys a small part of a tiny structure within the brain called the globus pallidus internus. This structure is part of the basal ganglia, a part of the brain involved in the control of willed (voluntary) movement of the muscles.

PALLOR. Extreme paleness in the color of the skin.

PALPATE. To examine the body by touching or pressing with the fingers or the palm of the hand.

PALPATION. The examination of the body using the sense of touch. There are two types: light and deep.

PALPEBRAL FISSURE. Eyelid opening.

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PALPITATION. Rapid, forceful, throbbing, or fluttering heartbeat.

PALSY. Uncontrolable tremors.

PANCARDITIS. Inflammation of the lining of the heart, the sac around the heart, and the muscle of the heart.

PANCHAKARMA. Intensive Ayurvedic cleansing and detoxification program.

PANCREAS. An elongated gland situated across the back of the abdomen behind the stomach. It secretes both digestive enzymes and hormones. Pancreatic hormones regulate the level of sugar in the blood.

PANCREATECTOMY. Partial or total surgical removal of the pancreas.

PANCREATIC INSUFFICIENCY. Reduction or absence of pancreatic secretions into the digestive system due to scarring and blockage of the pancreatic duct.

PANCREATICODUODENECTOMY. Removal of all or part of the pancreas along with the duodenum. Also known as ''Whipple's procedure'' or ''Whipple's operation.''

PANCREATITIS. Inflammation of the pancreas, either acute (sudden and episodic) or chronic, usually caused by excessive alcohol intake or gallbladder disease.

PANDAS DISORDERS. A group of childhood disorders associated with such streptococcal infections as scarlet fever and strep throat. The acronym stands for Pediatric Autoimmune Neuropsychiatric Disorders Associated with Streptococcal Infections.

PANDEMIC. The occurrence of a disease that in a short time infects a large percentage of the population over a wide geographical area.

PANHYPOPITUITARISM. Generalized decrease of all of the anterior pituitary hormones.

PANIC ATTACK. A time-limited period of intense fear accompanied by physical and cognitive symptoms. Panic attacks may be unexpected or triggered by specific internal or external cues.

PANIC DISORDER. A disorder in which people have sudden and intense attacks of anxiety in certain situations. Symptoms such as shortness of breath, sweating, dizziness, chest pain, and extreme fear often accompany the attacks.

PANNICULITIS. Inflammation of fatty tissue.

PANNUS. Overgrowth of connective tissue on the articular surface of a joint.

PANTETHEINE. A growth factor substance essential in humans, and a constituent of coenzyme A.

PAP TEST. The common term for the Papanicolaou test, a simple smear method of removing cervical cells to screen for abnormalities that indicate cancer or a precancerous condition.

PAPAVERINE. A smooth muscle relaxant sometimes injected into the penis as a treatment for impotence.

PAPILLARY CARCINOMA. A type of breast cancer that primarily occurs in older women. On ultrasound, this type of tumor may look like a solid or complex mass, or it may show up as solid tissue protruding into a cyst.

PAPILLOMA. A benign growth on the skin or mucous membrane. Viruses that cause these growths are called human papillomaviruses (HPVs).

PAPILLOMAVIRUS. A member of a group of viruses associated with warts and cervical cancer.

PAPULE. A small hard elevation of the skin.

PARACENTESIS. A procedure in which fluid is drained from a body cavity by means of a catheter placed through an incision in the skin.

PARALYSIS. Loss of the ability to move one or more parts of the body.

PARAMYXOVIRUS. A genus of viruses that includes the causative agent of mumps.

PARANEOPLASTIC SYNDROME. A set of symptoms that is associated with cancer but is not directly caused by the cancer.

PARANOIA. An unfounded or exaggerated distrust of others, sometimes reaching delusional proportions.

PARAPHILIA. Recurring strong sexual arousal to fantasies, objects, situations, or individuals that are not considered normal in the individual's culture.

PARAPHIMOSIS. The entrapment of a retracted foreskin behind the coronal sulcus, a groove that separates the shaft and head of the penis.

PARAPROTEIN. M-protein; abnormal immunoglobulin produced in multiple myeloma.

PARASITE. An organism that lives and feeds in or on another organism (the host) and does nothing to benefit the host.

PARASITIC. Of or relating to a parasite.

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PARASOMNIA. A primary sleep disorder in which the person's physiology or behaviors are affected by sleep, the sleep stage, or the transition from sleeping to waking.

PARASYMPATHETIC NERVOUS SYSTEM. The division of the autonomic (involuntary or unwilled) nervous system that slows heart rate, increases digestive and gland activity, and relaxes the sphincter muscles that close off body organs.

PARASYMPATHOMIMETIC. An agent whose effects mimic those resulting from stimulation of the parasympathetic nerves.

PARENTERAL. Administered inside the body but outside the digestive tract.

PARENTERAL NUTRITION. Liquid nutrition provided through tubes that are placed in the veins.

PARESTHESIA. A prickly, tingling, or burning sensation on the skin.

PARIETAL CELLS. Cells of the gastric glands in the stomach lining that secrete hydrochloric acid.

PARKINSON'S DISEASE. A neurological disorder caused by deficiency of dopamine, a neurotransmitter, which is a chemical that assists in transmitting messages between the nerves within the brain. It is characterized by muscle tremor or palsy and rigid movements.

PARKINSONISM. A group of conditions that all have these typical symptoms in common: tremor, rigidity, slow movement, and poor balance and coordination.

PARONYCHIA. Inflammation of the folds of skin that surround a nail.

PAROTID GLAND. The salivary gland that lies below and in front of each ear.

PAROTITIS. Inflammation and swelling of the salivary glands.

PAROXETINE HYDROCHLORIDE. An SSRI that is used to treat mental depression, OCD, anxiety, and various other disorders.

PAROXYSM. A sudden attack of symptoms.

PAROXYSMAL NOCTURNAL DYSPNEA (PND). A form of dyspnea characterized by the patient's waking from sleep unable to breathe.

PAROXYSMAL NOCTURNAL HEMOGLOBINURIA (PNH). A rare complement disorder characterized by episodes of red blood cell destruction (hemolysis) and blood in the urine (hemoglobinuria) that is worse at night.

PARTIAL DENTURE. A removable bridge that usually clasps onto only one abutment.

PARTIAL PARENTERAL NUTRITION (PPN). Partial nutrition obtained by the injection of a solution containing some essential nutrients into a vein; intended to temporarily supplement the diet when a patient cannot tolerate consuming enough food to meet daily nutritional requirements.

PARTIAL PRESSURE. The pressure exerted by one of the gases in a mixture of gases. The partial pressure of the gas is proportional to its concentration in the mixture. The total pressure of the gas mixture is the sum of the partial pressures of the gases in it (Dalton's Law) and as the total pressure increases, each partial pressure increases proportionally.

PARTIAL SEIZURE. A seizure that starts in one particular part of the brain. The abnormal electrical activity may remain confined to that area, or may spread to the entire brain. Also called a focal seizure.

PARTIAL THROMBOPLASTIN TIME. A test that checks the clotting factors of the intrinsic pathway.

PASSIVE IMMUNITY. Immunity produced by providing a person with antibodies from another source than self. Infants are born with passive immunity acquired from their mothers.

PASSIVE IMMUNIZATION. Treatment that provides immunity through the transfer of antibodies obtained from an immune individual.

PASTEURELLOSIS. A bacterial infection caused by *Pasteurella multocida*. Pasteurellosis is characterized by inflammation around the wound site and may be accompanied by bacteria in the bloodstream and infection in tissues and organs.

PASTEURIZATION. A process during which milk is heated up and maintained at a particular temperature long enough to kill bacteria.

PASTIA'S LINES. Red lines in the folds of the skin, especially in the armpit and groin, that are characteristic of scarlet fever.

PATCH TEST. Test in which different antigens (substances that cause an allergic reaction) are introduced into a patient's skin via a needle prick or scratch and then observed for evidence of an allergic reaction to one or more of them. Also known as a scratch test.

PATELLA. The kneecap.

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PATENCY. Being widely open. A blood vessel that has been widened or reopened is said to be patent.

PATENT DUCTUS ARTERIOSUS. A congenital defect in which the temporary blood vessel connecting the left pulmonary artery to the aorta in the fetus doesn't close in the newborn.

PATERNAL. From one's father.

PATHOGEN. Any biological agent that causes illness or disease in its host. A pathogen may be a virus, bacterium, fungus, or prion.

PATHOGENIC. Disease-causing.

PATHOLOGIC. Characterized by disease or the structural and functional changes due to disease. Pathologic heart murmurs may indicate a heart defect.

PATHOLOGIST. A doctor who specializes in the diagnosis of disease by studying cells and tissues under a microscope.

PATHOLOGY. The branch of medicine that looks at the abnormal changes in cells and tissues that signal disease.

PATIENT YEARS. In clinical trials, the number of patients multiplied by the number of years that they were followed in a study divided by the number of study events that occurred.

PAUCIARTICULAR JUVENILE RA. Rheumatoid arthritis (RA) found in children that affects less than four joints.

PAVOR NOCTURNUS. Another term for sleep terror disorder.

PCI. A type of radiotherapy that is used to prevent tumors from growing in the brain.

PEAK FLOW. A measurement of the maximum speed of a patient's expiration (breathing out). It is also known as the peak expiratory flow rate or PEFR. Peak flow is measured by a small handheld device called a peak flow meter.

PECTUS CARINATUM. An abnormality of the chest in which the sternum (breastbone) is pushed outward. It is sometimes called "pigeon breast."

PECTUS EXCAVATUM. An abnormality of the chest in which the sternum (breastbone) sinks inward; sometimes called "funnel chest."

PEDICLE FLAP. A section of tissue, with its blood supply intact, that is maneuvered to another part of the body; also called an attached flap.

PEDICULICIDE. Any substance that kills lice.

PEDICULOSIS (PLURAL, PEDICULOSES). A lice infestation.

PEDOPHILE. A person who sexually abuses children.

PEDOPHILIA. A sexual perversion in which children are the preferred sexual object.

PEG-ADA. An orphan drug that is useful in treating severe combined immunodeficiency related to adenosine deaminase deficiency.

PELLEGRA. A condition caused by a dietary deficiency of one of the B vitamins, called niacin.

PELVIC EXAM. A gynecological exam of the female reproductive organs.

PELVIC EXENTERATION. Extensive surgery to remove the uterus, ovaries, pelvic lymph nodes, part or all of the vagina, and the bladder, rectum, and/or part of the colon.

PELVIC INFLAMMATORY DISEASE (PID). Inflammation of the female genital tract, especially of the fallopian tubes, caused by any of several microorganisms, chiefly chlamydia and gonococci, and characterized by severe abdominal pain, high fever, vaginal discharge, and in some cases destruction of tissue that can result in sterility.

PELVIC ORGANS. The organs inside of the body that are located within the confines of the pelvis. This includes the bladder and rectum in both sexes and the uterus, ovaries, and fallopian tubes in females.

PEMPHIGUS. An autoimmune disorder in which the immune system produces antibodies against specific proteins in the skin and mucous membrane. These antibodies produce a reaction that leads to a separation of skin cells.

PENICILLAMINE (CUPRIMINE, DEPEN). A drug used to treat medical problems (such as excess copper in the body and rheumatoid arthritis) and to prevent kidney stones. It is also sometimes prescribed to remove excess lead from the body.

PENICILLIN. An antibiotic that is used to treat bacterial infections.

PENTAMIDINE ISETHIONATE. An antibiotic used to treat and prevent pneumocystis pneumonia.

PEPTIC. Induced by or associated with the action of digestive secretions.

PEPTIC ULCER. A wound in the bowel that can be caused by stomach acid or a bacterium called *Helicobacter pylori*.

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PEPTIC ULCER DISEASE (PUD). A stomach disorder marked by corrosion of the stomach lining due to the acid in the digestive juices.

PERCUSSION. An assessment method in which the surface of the body is struck with the fingertips to obtain sounds that can be heard or vibrations that can be felt. It can determine the position, size, and consistency of an internal organ. It is done over the chest to determine the presence of normal air content in the lungs, and over the abdomen to evaluate air in the loops of the intestine.

PERCUTANEOUS. Performed through the skin, from the Latin *per*, meaning through, and *cutis*, meaning skin.

PERCUTANEOUS BIOPSY. A biopsy in which a needle is inserted and a tissue sample removed through the skin.

PERCUTANEOUS TRANSHEPATIC CHOLANGIOGRAPHY. An x-ray examination of the bile ducts. A needle is passed through the skin (percutaneous) across or over the liver (transhepatic) and directly into a bile duct to inject a contrast dye. The dye enhances the x-ray image mapping the system of bile ducts (cholangiography).

PERENNIAL. Present at all seasons of the year.

PERFECT USE. A measurement of the effectiveness of a contraceptive based only on those who use the method correctly and use it every time they have intercourse. It is also called the method effectiveness rate.

PERFORATION. A hole.

PERFUSION. Blood flow through an organ or tissue.

PERFUSION LUNG SCAN. A scan that shows the pattern of blood flow in the lungs.

PERICARDIAL EFFUSION. An accumulation of excess fluid in the pericardial sac that surrounds the heart.

PERICARDIOCENTESIS. A procedure used to drain fluid out of the sac surrounding the heart. This is done by inserting a needle through the chest and into the sac.

PERICARDITIS. Inflammation of the pericardium, the membrane surrounding the heart.

PERICARDIUM. The pericardium is the thin, sac-like membrane that surrounds the heart. It has two layers: the serous pericardium and the fibrous pericardium.

PERICORONITIS. A gum condition in which irritation and inflammation are produced by the crown of an incompletely erupted tooth.

PERINATAL. Refers to the period shortly before and after birth, generally from around the 20th week of pregnancy to one to four weeks after birth.

PERINATAL INFECTION. A maternal infection that is transmitted to the fetus after membrane rupture or during labor or delivery.

PERINATOLOGIST. A specialist in the branch of obstetrics that deals with high-risk pregnant women.

PERINEUM. The area between the thighs that lies behind the genital organs and in front of the anus; also known as the perineal area.

PERIODIC LIMB MOVEMENTS IN SLEEP (PLMS). Random movements of the arms or legs that occur at regular intervals of time during sleep.

PERIODONTAL. Pertaining to the gums.

PERIODONTITIS. A gum disease that destroys the structures supporting the teeth, including bone.

PERIOSTEUM. A fibrous vascular membrane that covers bones.

PERIPHERAL NERVES. Nerves throughout the body that carry information to and from the spinal cord.

PERIPHERAL NERVOUS SYSTEM (PNS). One of the two major divisions of the nervous system. PNS nerves link the central nervous system with sensory organs, muscles, blood vessels, and glands.

PERIPHERAL NEUROPATHY. A disease affecting the portion of the nervous system outside the brain and spinal chord. One or more nerves can be involved, causing sensory loss, muscle weakness and shrinkage, and decreased reflexes.

PERIPHERAL PRECOCIOUS PUBERTY. Precocious puberty resulting from the presence of sex steroids independent of the activation of the HPG axis. It is also called precocious pseudopuberty.

PERIPHERAL STEM CELL TRANSPLANT. The process of transplanting peripheral stem cells instead of using bone marrow. The stem cells in the circulating blood that are similar to those in the bone marrow are given to the patient after treatment to help the bone marrow recover and continue producing healthy blood cells. A peripheral stem cell transplant may also be used to supplement a bone marrow transplant.

PERIPHERAL STEM CELLS. Stem cells that are taken directly from the circulating blood and used for transplantation. Stem cells are more concentrated in the bone marrow, but they can also be extracted from the bloodstream.

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PERIPHERAL VASCULAR DISEASE. A disease affecting blood vessels, especially in the arms, legs, hands, and feet.

PERIPHERAL VISION. The ability to see objects that are not located directly in front of the eye. Peripheral vision allows people to see objects located on the side or edge of their field of vision.

PERISTALSIS. The waves of muscular contraction in the intestines that push the food along during the process of digestion.

PERITONEAL FLUID. Fluid from the abdominal cavity.

PERITONEUM. The transparent membrane lining the abdominal cavity that holds organs, such as the intestines, in place.

PERITONITIS. Inflammation of the peritoneum, the membrane surrounding the abdominal contents.

PERMEABLE. Capable of allowing substances to pass through.

PERMETHRIN. A synthetic pyrethroid for killing lice.

PERNICIOUS ANEMIA. One of the main types of anemia, caused by inadequate absorption of vitamin B_{12}. Symptoms include tingling in the hands, legs, and feet; spastic movements; weight loss; confusion; depression; and decreased intellectual function.

PEROXIDE. A bleaching agent that is a compound consisting of two atoms of oxygen connected by a single bond.

PEROXINS. Proteins that are responsible for forming the peroxisomal membrane and transporting other proteins into the peroxisome; these proteins are encoded by various PEX genes.

PEROXISOME. A cellular organelle or microbody that contains various enzymes that are responsible for the production of cellular components and the breakdown of toxic waste products.

PEROXISOME BIOGENESIS DISORDER (PBD). An inherited disorder that disrupts the formation and functioning of peroxisomes.

PERPETRATOR. The legal term for a person who commits a crime.

PERSECUTORY DELUSION. A fixed, false, and inflexible belief that others are engaging in a plot or plan to harm an individual.

PERSEVERATION. Continuous involuntary repetition of speech or behavior.

PERSONALITY. The organized pattern of behaviors and attitudes that makes a human being distinctive. Personality is formed by the ongoing interaction of temperament, character, and environment.

PERVASIVE DEVELOPMENTAL DISORDER (PDD). The term used by the American Psychiatric Association for individuals who meet some but not all of the criteria for autism.

PESSARY. A device inserted into the vagina to support sagging organs.

PETECHIAE. Small pinpoint hemorrhages in skin or mucous membranes caused by the rupture of capillaries.

PETROLEUM JELLY OR OINTMENT. Petrolatum, a gelatinous substance obtained from oil that is used as a protective dressing.

PEYRONIE'S DISEASE. A disease resulting from scarring of the corpus cavernosa, causing painful erections.

PH. A measure of the acidity of a fluid. On a scale of 1 to 14, a pH of 7 is neutral. Higher pH readings are alkaline and lower pH readings are acidic.

PHACOEMULSIFICATION. Surgical procedure to remove a cataract using sound waves to disintegrate the lens, which is then removed by suction.

PHAGOCYTIC CELLS. A cell that ingests microorganisms and foreign particles.

PHAGOCYTOSIS. A process by which a white blood cell envelopes and digests debris and microorganisms to remove them from the blood.

PHALANX. A bone of the fingers or toes.

PHALILALIA. Involuntary echoing of the last word, phrase, sentence, or sound vocalized by oneself.

PHANTOM LIMB. The perception that a limb is present (and throbbing with pain) after it has been amputated.

PHANTOM PAIN. Pain, tingling, itching, or numbness in the place where an amputated limb used to be.

PHARMACEUTICAL. Pertaining to drugs.

PHARMACO-DYNAMICS. The study of the relationships and interactions of herbs.

PHARMACOLOGICAL. Referring to therapy that relies on drugs.

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PHARYNGITIS. Inflammation of the throat, accompanied by dryness and pain.

PHARYNX. The muscular cavity that leads from the mouth and nasal passages to the larynx and esophagus.

PHASE CONTRAST MICROSCOPE. A light microscope in which light is focused on the sample at an angle to produce a clearer image.

PHENOTHIAZINE-DERIVATIVE DRUGS. A large family of drugs derived from phenothiazine, a compound that in itself is too poisonous for human consumption. Phenothiazine derivatives include tranquilizers, medications that prevent vomiting, antihistamines, and drugs used to enhance the effectiveness of anesthesia.

PHENTERMINE. An amphetamine prescribed for appetite suppression.

PHENYLALANINE. An essential amino acid that must be obtained from food since the human body cannot manufacture it.

PHENYLKETONURIA (PKU). An enzyme deficiency present at birth that disrupts metabolism and causes brain damage. This rare inherited defect may be linked to the development of autism.

PHENYTOIN (DILANTIN). Anti-convulsive medication used to treat seizure disorders.

PHEOCHROMOCYTOMA. A tumor of specialized cells of the adrenal gland.

PHILADELPHIA CHROMOSOME. An abnormal chromosome that is found in patients with chronic myelogenous leukemia.

PHIMOSIS. A tightening of the foreskin that may close the opening of the penis.

PHLEBITIS. Inflammation of a vein.

PHLEBOTOMIST. Health care professional trained to obtain samples of blood.

PHLEBOTOMY. Drawing blood from a vein for diagnosis or treatment. Phlebotomy is sometimes used in the treatment of hemoglobinopathies to lower the iron concentration of the blood.

PHLEGM. Thick mucus produced in the air passages.

PHOBIA. A fear of a specific situation, object, or type of object. Phobias are often considered illogical or irrational, as the situation or object does not pose any significant danger for the individual experiencing the phobia.

PHONICS. A system to teach reading by teaching the speech sounds associated with single letters, letter combinations, and syllables.

PHOROPTER. The instrument used to measure refractive status of the eyes. It contains many lenses that are changed in front of the eyes while the patient is looking at an eye chart. The patient is asked to choose which lens produces a clearer image.

PHOSPHODIESTERASE–5 (PDE5) INHIBITORS. The drugs Viagra, Levitra, and Cialis, which are used to treat erectile dysfunction.

PHOTOCOAGULATION. Cancer treatment in which the tumor is destroyed by an intense beam of laser light.

PHOTODYNAMIC THERAPY (PDT). A treatment for tumors in which a light-sensitive dye is injected into the blood (or skin) to be taken up selectively by the tumors. Light of a specific wavelength is then applied to the affected area to kill the tumors.

PHOTON. A light particle.

PHOTOPHOBIA. An extreme sensitivity to light.

PHOTOPIGMENT. Pigment that is most sensitive to a particular wavelength of light.

PHOTORECEPTORS. Specialized nerve cells (rods and cones) in the retina that are responsible for vision.

PHOTOREFRACTIVE KERATECTOMY (PRK). A type of refractive eye surgery using a laser to change the shape of the cornea.

PHOTOSENSITIVITY. An abnormally heightened reaction to light.

PHOTOSENSITIZER. A chemical compound that can be excited (activated) by light of a specific wavelength.

PHOTOTHERAPY. Also called light therapy, the patient is exposed to a bright light to compensate for reduced exposure to sunlight.

PHOTOTOXIC. Causes a harmful skin reaction when exposed to sunlight.

PHYLLOQUINONE. An alternate name for vitamin K_1.

PHYSIATRIST. A physician who specializes in physical medicine.

PHYSICAL ACTIVITY. Any activity that involves moving the body and burning calories.

PHYSICAL FITNESS. A combination of muscle strength, cardiovascular health, and flexibility that is usually attributed to regular exercise and good nutrition.

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PHYSICAL MANIPULATION. The use of deep massage, spinal alignment, and joint manipulation to stimulate tissues.

PHYSIOLOGIC. Refers to physiology, particularly normal, healthy, physical functioning.

PHYSIOLOGICAL. Dealing with the functions and processes of the body.

PHYTO- (AS IN PHYTOCHEMICAL, PHYTOMEDICINAL, AND PHYTOTHERAPY). Meaning, or pertaining to, a plant or plants.

PHYTOESTROGENS. Compounds found in plants that can mimic the effects of estrogen in the body.

PIA MATER. The innermost layer of the meninges.

PICA. A medical disorder characterized by cravings for dirt, ice cubes, paper, starch, clay, or other non-nutritive items. It is often a sign of iron deficiency or hemolytic anemia.

PICK'S DISEASE. A rare type of primary dementia that affects the frontal lobes of the brain. It is characterized by a progressive loss of social skills, language, and memory, leading to personality changes and sometimes loss of moral judgment.

PIGEON BREAST (ALSO KNOWN AS PECTUS CARINATUM). A chest shape with a central projection resembling the keel of a boat.

PILONIDAL CYST. A special kind of abscess that occurs in the cleft between the buttocks. Forms frequently in adolescence after long trips that involve sitting.

PINWORM. Enterobius vermicularis, a nematode worm of the family Oxyuridae that causes parasitic infestation of the intestines and cecum. Pinworm is endemic in both temperate and tropical regions and common especially in school age children.

PIPERONYL BUTOXIDE. A liquid organic compound that enhances the activity of insecticides.

PIRIFORMIS. A muscle in the pelvic girdle that is closely associated with the sciatic nerve.

PITTING EDEMA. A swelling in the tissue under the skin, resulting from fluid accumulation, that is measured by the depth of indentation made by finger pressure over a boney prominence.

PITUITARY GLAND. A gland located at the base of the brain and controlled by the hypothalamus. It controls most endocrine functions and is responsible for things such as kidney function, lactation, and growth and development.

PLACEBO. A pill or liquid given during the study of a drug or dietary supplement that contains no medication or active ingredient. Usually study participants do not know if they are receiving a pill containing the drug or an identical-appearing placebo.

PLACENTA. The organ that provides oxygen and nutrition from the mother to the fetus during pregnancy. The placenta is attached to the wall of the uterus and leads to the fetus via the umbilical cord.

PLACENTA PREVIA. A low-lying placenta that covers part or all of the inner opening of the cervix. This can result in heavy bleeding during labor and delivery, which can be dangerous for the mother and baby.

PLACENTAL ABRUPTION. Separation of the placenta from the uterine wall before the baby is born, cutting off blood flow to the baby.

PLAGUE. A highly infectious disease that can be fatal if not treated promptly. The bacteria that cause plague mainly infect rats, mice, squirrels, and other wild rodents. The disease is passed to people through fleas. Infected people can then spread the disease to other people.

PLANTAR FASCIA. A tough fibrous band of tissue surrounding the muscles of the sole of the foot. Also called plantar aponeurosis.

PLAQUE. A compound made up of fat, cholesterol, calcium, and other substances found in the blood. It can stick to the walls of arteries, partially or totally blocking blood flow.

PLAQUE (DENTAL). A sticky film of saliva, food particles, and bacteria that attaches to the tooth surface and causes decay.

PLASMA. Clear, yellow- or straw-colored fluid that is the liquid component of blood and lymphatic fluid.

PLASMA CELL. Type of white blood cell that produces antibodies; derived from an antigen-specific B cell.

PLASMALOGEN. Any of a group of phospholipids; plasmalogen synthesis is disrupted in ZS.

PLASMAPHERESIS. Plasma exchange transfusion; the separation of serum from blood cells to treat hyperviscosity of the blood.

PLATELET. A small, disk-shaped body in the blood that has an important role in blood clotting: they form the initial plug at the rupture site of a blood vessel.

PLATELET AGGREGATION. The clumping together of blood cells, possibly forming a clot.

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PLATYPNEA. Dyspnea that occurs when the patient is sitting up.

PLETHYSMOGRAPHY. A test in which a patient sits inside a booth called a plethysmograph and breathes through a mouthpiece, while pressure and air flow measurements are collected to measure the total lung volume.

PLEURA OR PLEURAE. A delicate membrane that encloses the lungs. The pleura is divided into two areas separated by fluid–the visceral pleura, which covers the lungs, and the parietal pleura, which lines the chest wall and covers the diaphragm.

PLEURAL. Pleural refers to the pleura or membrane that enfolds the lungs.

PLEURAL CAVITY. The space surrounding the lungs, including the membranes covering the lungs and lining the inside of the chest wall.

PLEURAL EFFUSION. An abnormal accumulation of fluid in the pleura, a fibrous membrane that lines the inside of the chest cavity and protects the lungs. This accumulation can cause shortness of breath, cough, and chest pain.

PLEURAL SPACE. The small space between the two layers of the membrane that covers the lungs and lines the inner surface of the chest.

PLEURISY. Chest pain that occurs when a person takes a deep breath.

PLEURITIS. Inflammation of the pleura, the membrane surrounding the lungs.

PNEUMOCOCCAL. Infection by the bacterium *Streptococcus pneumoniae*) that causes acute pneumonia.

PNEUMOCONIOSIS (PLURAL, PNEUMOCONIOSES). Any chronic lung disease caused by inhaling particles of silica or similar substances that lead to loss of lung function.

***PNEUMOCYSTIS CARINII* PNEUMONIA (PCP).** A severe lung infection caused by a parasitic protozoan. The disease mainly affects people with weakened immune systems, such as people with AIDS.

PNEUMOCYSTOSIS. Another name for active PCP infection.

PNEUMONIA. A disease in which the lungs become inflamed. Pneumonia may be caused by bacteria, viruses, or other organisms, or by physical or chemical irritants.

PNEUMONITIS (ASPIRATION). Inflammation of the lung caused by inhaling a liquid, usually carbon based.

PNEUMOTHORAX. Presence of gas or air in the hollow space around the lungs.

PNEUMOVAX. A vaccine that is given to splenectomy patients to protect them against bacterial infections. Other vaccines include Pnu-Imune and Menomune.

PODIATRIST. A physician who specializes in the medical care and treatment of the human foot.

PODIATRY. A medical specialty concerned with treating diseases, injuries, and malformations of the feet.

PODOPHYLLUM RESIN. A medication derived from the May apple or mandrake and used to treat genital warts.

POINT OF VIEW. In a person with dyslexia, this term is used to describe the angle from which their mind's eye views an object. This point of view may be unanchored and moving about, as if several different people were telling what they see all at the same time.

POLYARTHRITIS. A nonspecific term for arthritis involving two or more joints, typically associated with auto-immune forms of arthritis. Symptoms usually include pain, inflammation, and/or swelling in multiple joints.

POLYARTICULAR JUVENILE RA. Rheumatoid arthritis found in children that affects more than four joints.

POLYCARBONATE. A very strong type of plastic often used in safety glasses, sport glasses, and children's eyeglasses. Polycarbonate lenses have approximately 50 times the impact resistance of glass lenses.

POLYCYSTIC KIDNEY DISEASE. A hereditary kidney disease that causes fluid- or blood-filled pouches of tissue called cysts to form on the tubules of the kidneys. These cysts impair normal kidney function.

POLYCYSTIC OVARIAN SYNDROME (PCOS). A condition in which the eggs are not released from the ovaries and instead form multiple cysts.

POLYCYSTIC OVARY DISEASE. A condition in which a woman has little or no menstruation, is infertile, has excessive body hair, and is obese. The ovaries may contain several cysts.

POLYCYTHEMIA VERA. A condition characterized by an unusually large number of red blood cells in the blood due to increased production by the bone marrow. Symptoms include headaches, blurred vision, high blood pressure, dizziness, and night sweats.

POLYDIPSIA. Excessive thirst.

POLYGENIC. A trait or disorder that is determined by several different genes. Most human characteristics,

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including height, weight, and general body build, are polygenic. Schizophrenia and late-onset AD are considered polygenic disorders.

POLYMER. A substance formed by joining smaller molecules. For example, plastic, acrylic, cellulose acetate, cellulose propionate, nylon, etc.

POLYMERASE CHAIN REACTION (PCR). A test performed to evaluate false-negative results to the ELISA and Western blot tests. Numerous copies of a gene are made by separating the two strands of DNA containing the gene segment, marking its location, using DNA polymerase to make a copy, and then continuously replicating the copies. The amplification of gene sequences that are associated with HIV allows for detection of the virus by this method.

POLYMYOSITIS. An inflammation of many muscles.

POLYP. A lump of tissue protruding from the lining of an organ, such as the nose, bladder, or intestine. Polyps can sometimes block the passages in which they are found.

POLYPOSIS. The medical term for the development of multiple polyps on a body part.

POLYSOMNOGRAPHY. A technique for diagnosing sleep disorders with the use of a machine that records the pulse, breathing rate, and other variables while the patient sleeps.

POLYUNSATURATED FAT. Fats that contain two or more double or triple bonds per molecule; examples include fish, safflower, sunflower, corn, and soybean oils.

POLYURIA. Excessive secretion of urine.

PONTIC. An artificial tooth.

PORNOGRAPHY. Sexually explicit pictures, writings, or other material produced for the purpose of sexual arousal.

PORPHYRIA. A disorder in which porphyrins build up in the blood and urine.

PORPHYRIN. A type of pigment found in living things, such as chlorophyll, which makes plants green, or hemoglobin, which makes blood red.

PORTABLE CHEST X RAY. An x ray procedure taken by equipment that can be brought to the patient. The resulting radiographs may not be as high in quality as stationary x-ray radiographs.

PORTAL. An entrance or a means of entrance.

PORTAL HYPERTENSION. A condition caused by cirrhosis of the liver. It is characterized by impaired or reversed blood flow from the portal vein to the liver, an enlarged spleen, and dilated veins in the esophagus and stomach.

PORTAL VEIN. The blood vessel carrying venous blood from the abdominal organs to the liver.

PORTAL VEIN THROMBOSIS. The development of a blood clot in the vein that brings blood into the liver. Untreated portal vein thrombosis causes portal hypertension.

POSITIVE SYMPTOMS. Symptoms of schizophrenia that are characterized by the production or presence of behaviors that are grossly abnormal or excessive, including hallucinations and thought–process disorder. DSM–IV subdivides positive symptoms into psychotic and disorganized.

POSITRON. One of the small particles that make up an atom. A positron has the same mass and amount of charge as an electron, but the positron has a positive charge.

POSITRON EMISSION TOMOGRAPHY (PET) SCAN. An imaging system that creates a picture showing the location of tumor cells in the body. A substance called radionuclide dye is injected into a vein, and the PET scanner rotates around the body to create the picture.

POSTEXPOSURE PROPHYLAXIS (PEP). Any treatment given after exposure to a disease to try to prevent the disease from occurring.

POST-HERPETIC NEURALGIA (PHN). Long-lasting nerve pain caused by herpes zoster.

POSTMENOPAUSAL. A term referring to the time period following menopause.

POSTMORTEM. Referring to the period following death.

POSTPARTUM. Referring to the time period following childbirth.

POST-TRAUMATIC STRESS DISORDER (PTSD). A psychological reaction that continues long after a highly stressful event and is characterized by depression, anxiety, flashbacks, and nightmares.

POSTURAL DRAINAGE. Techniques to help expel excess mucus by specific poistions of the body (that decrease the effects of gravity) combined with manual percussion and vibration over various parts of the lung.

POSTURAL HYPOTENSION (ORTHOSTATIC HYPOTENSION). A sudden drop in blood pressure when rising from a sitting or lying down position.

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POTASSIUM. A mineral found in whole grains, meat, legumes, and some fruits and vegetables, which is important for many body processes, including proper functioning of the nerves and muscles.

POTENTIZATION. The process of increasing the power of homeopathic preparations by successive dilutions and succussions of a mother tincture.

POTENTIZE. The process of transferring the healing energy of a plant into spring water.

POVERTY OF SPEECH. A negative symptom of schizophrenia, characterized by brief and empty replies to questions. It should not be confused with shyness or reluctance to talk.

POX. A pus-filled bump on the skin.

PRADER-WILLI SYNDROME. An uncommon genetic disorder that causes a constant feeling of hunger.

PRAKRITI. An individual's unique dosha pattern.

PRANA. Life sustaining energy centered in the human brain; the first of the five airs of Ayurvedic philosophy; the life force governing inspiration and the conscious intellect.

PRANAYAMA. Yoga method of breathing.

PRECANCEROUS. Abnormal and with a high probability of turning into cancer, but not yet a cancer.

PRECIPITIN. An antibody in blood that combines with an antigen to form a solid that separates from the rest of the blood.

PRECOCIOUS. Developing at an unusually early age.

PRECONCEPTIONAL. This refers to the time period before pregnancy, i.e., conception, occurs.

PREDNISONE. A corticosteroid often used to treat inflammation.

PREECLAMPSIA AND ECLAMPSIA. Disorders of late pregnancy associated with high blood pressure, fluid retention, and protein in the urine. They can cause stillbirth.

PREGNANCY CATEGORY. A system of classifying drugs according to their established risks for use during pregnancy. Category A: Controlled human studies have demonstrated no fetal risk. Category B: Animal studies indicate no fetal risk, but no human studies, or adverse effects in animals, but not in well-controlled human studies. Category C: No adequate human or animal studies, or adverse fetal effects in animal studies, but no available human data. Category D: Evidence of fetal risk, but benefits outweigh risks. Category X: Evidence of fetal risk. Risks outweigh any benefits.

PREMALIGNANT SKIN LESION. An abnormal change in the skin that has a good chance of turning into skin cancer but is not yet cancerous.

PREMATURE ATRIAL BEAT. A beat that occurs before it would normally be expected.

PREMATURE DELIVERY. The birth of a live baby when a pregnancy ends spontaneously after the twentieth week.

PREMATURE EJACULATION. Rapid ejaculation before the person wishes it, usually in less than one to two minutes after beginning intercourse.

PREMENSTRUAL DYSPHORIC DISORDER (PMDD). Premenstrual syndrome (PMS); symptoms including back and abdominal pain, nervousness and irritability, headache, and breast tenderness that occur the week before menstruation.

PREMENSTRUAL SYNDROME. (PMS) A set of symptoms that occur in some women 2–14 days before they begin menstruating each month. Symptoms include headache, fatigue, irritability, depression, abdominal bloating, and breast tenderness.

PREMUTATION. A change in a gene that precedes a mutation; this change does not alter the function of the gene.

PRENATAL DIAGNOSIS. The determination of whether a fetus possesses a disease or disorder while it is still in the womb.

PRENATAL INFECTION. A maternal infection that is transmitted to the fetus through the placenta.

PRENATAL TESTING. Testing for a disease such as a genetic condition in an unborn baby.

PREPUCE. The fold of tissue covering the clitoris in females and the tip of the penis in males.

PRESBYOPIA. A condition affecting people over the age of 40 where the system of accommodation that allows focusing of near objects fails to work because of age-related hardening of the lens of the eye.

PRESENILE DEMENTIA. The original name for Alzheimer's disease.

PRESENILIN (PSEN). Presenilin 1 and presenilin 2 are proteins that are involved in processing amyloid precursor protein (APP). Mutations in the genes encoding these proteins can cause early-onset AD.

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PRESENTATION. The part of the fetus's body that enters into the birth canal first.

PRESSURE POINTS. Specific locations on the feet and hands that correspond to nerve endings that connect to the organs and glands of the human body via the spinal cord.

PRESSURE ULCER. Also known as a decubitus ulcer, pressure ulcers are open wounds that form whenever prolonged pressure is applied to skin covering bony outcrops of the body. Patients who are bedridden are at risk of developing pressure ulcers. Pressure ulcers are commonly known as bedsores.

PRETERM LABOR. Labor before the thirty-seventh week of pregnancy.

PREVALENCE. The percentage of a population that is affected by a specific disease at a given time.

PRIAPISM. A prolonged erection lasting more than four hours.

PRIMARY ENERGY PATTERN. A spiral motion that radiates from the umbilicus; the energy pattern associated with a child in the womb.

PRIMARY GAIN. The immediate relief from guilt, anxiety, or other unpleasant feelings that a patient derives from a symptom.

PRIMARY HEADACHE. A headache that is not caused by another disease or medical condition. Tension headaches are a subtype of primary headache.

PRIMARY PERSONALITY. The core personality of an dissociative identity disorder patient. In women, the primary personality is often timid and passive, and may be diagnosed as depressed.

PRIMARY PROGRESSIVE. A pattern of symptoms of multiple sclerosis in which the disorder progresses without remission, or with occasional plateaus or slight improvements.

PRIMARY SCLEROSING CHOLANGITIS. A chronic disease in which the immune system fails to recognize the cells that compose the bile ducts as part of the same body, and attempts to destroy them. It is frequently associated with another inflammatory disease of the digestive tract, ulcerative colitis.

PRIMARY SLEEP DISORDER. A sleep disorder that cannot be attributed to a medical condition, another mental disorder, or prescription medications or other substances.

PRIMING MEMORY. The memory system that joins perceptual and conceptual representations.

PROBENECID. A drug that corrects hyperuricemia by increasing the urinary excretion of urate.

PROBIOTICS. Food supplements containing live bacteria or other microbes intended to improve or restore the normal balance of microorganisms in the digestive tract.

PROCAINE PENICILLIN. An injectable form of penicillin that contains an anesthetic to reduce the pain of the injection.

PROCESS ADDICTION. Addiction to certain mood-altering behaviors, such as eating, gambling, sexual activity, overwork, and shopping.

PROCESSUS VAGINALIS. A pouch of the peritoneum (lining of the abdominal cavity) that is carried into the scrotum with the descent of the testicles to become the tunica vaginalis.

PROCTITIS. Inflammation of the anus and rectum.

PROCTOSCOPE. An instrument consisting of a thin tube with a light source, used to examine the inside of the rectum.

PROCTOSCOPY. A procedure in which a thin tube containing a camera and a light is inserted into the rectum so the doctor can visually inspect it.

PRODROME. Symptom(s) experienced prior to the onset of a disease. For example, visual disturbances may precede and signal the onset of a migraine headache.

PROGESTERONE. A female hormone that acts on the inner lining of the uterus and prepares it for implantation of the fertilized egg.

PROGESTIN. A synthetic or natural drug that acts on the uterine lining.

PROGNOSIS. The predicted outcome of a disease.

PROGRESSIVE. A term that refers to a disease that gets worse over time.

PROGRESSIVE SUPRANUCLEAR PALSY. A rare disease that gradually destroys nerve cells in the parts of the brain that control eye movements, breathing, and muscle coordination, which causes palsy, or paralysis.

PROHORMONES. A physiologically inactive precursor of a hormone.

PROJECTIVE TEST. A type of psychological test that assesses a person's thinking patterns, observational ability, feelings, and attitudes on the basis of responses to ambiguous test materials. It is not intended to diagnose psychiatric disorders.

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PROKINETIC. A drug that works to speed up the emptying of the stomach and the motility of the intestines.

PROLACTIN. A hormone that helps the breast prepare for milk production during pregnancy.

PROLACTINOMA. A benign (noncancerous) tumor of the pituitary gland that secretes the hormone prolactin.

PROLAPSED UMBILICAL CORD. Occurs when the cord falls into the birth canal, and may even hang out of the mother's vagina. This can cause compression of the cord and lead to decreased oxygen and blood flow to the fetus.

PROLAPSED UTERUS. A uterus that has slipped out of place, sometimes protruding down through the vagina.

PROLIFERATIVE RETINOPATHY. Retinopathy with the growth of new blood vessels (neovascularization).

PRONATION. The lowering or descending of the inner edge of the foot by turning the entire foot outwards.

PROPENSITY. A greater risk for developing a disease.

PROPHYLACTIC. Referring to medications or other treatments given to prevent disease.

PROPHYLAXIS. Preventive. Antibiotic prophylaxis is the use of antibiotics to prevent a possible infection.

PROPIONIBACTERIUM ACNES. Skin bacteria that infect sebaceous follicles, causing acne.

PROPRANOLOL (INDERAL). Medication commonly prescribed to treat high blood pressure; is a beta-adrenergic blocker and can also be used to treat irregular heartbeat, heart attack, migraine, and tremors.

PROPRIOCEPTIVE. Pertaining to proprioception, or the awareness of posture, movement, and changes in equilibrium and the knowledge of position, weight, and resistance of objects as they relate to the body.

PROSTAGLANDIN. A group of molecules that exert local effects on a variety of processes including fluid balance, blood flow, and gastrointestinal function.

PROSTAGLANDIN ANALOGUE. A class of drugs that are similar in structure and function to prostaglandin.

PROSTATE. A donut-shaped gland below the bladder in men that contributes to the production of semen.

PROSTATE GLAND. The gland surrounding the male urethra just below the base of the bladder. It secretes a fluid that constitutes a major portion of the semen.

PROSTATE–SPECIFIC ANTIGEN (PSA). A protein made by the cells of the prostate that is increased by both BPH and prostate cancer.

PROSTHESIS. A synthetic replacement for a missing part of the body such as a knee or a hip.

PROSTHETIC TOOTH. The final tooth that is held in place by the dental implant anchor.

PROSTHETICS. Mechanical devices that replace missing body parts.

PROSTHETIST. A health care professional who is skilled in making and fitting artificial parts (prosthetics) for the human body.

PROTEASE INHIBITORS. The second major category of drug used to treat AIDS that works by suppressing the replication of the HIV virus.

PROTEIN. A substance produced by a gene that is involved in creating the traits of the human body, such as hair and eye color, or is involved in controlling the basic functions of the human body, such as control of the cell cycle.

PROTEINURIA. The presence of protein in the urine exceeding normal levels.

PROTHROMBIN. A type of protein called a glycoprotein that is converted to thrombin during the clotting process.

PROTHROMBIN TIME. A blood test that determines how quickly a person's blood will clot.

PROTOPORPHYRIN. A precursor molecule to the porphyrin molecule.

PROTOPORPHYRIN IX. Protoporphyrin IX is a protein. The measurement of this protein is useful for the assessment of iron status. Hemoglobin consists of a complex of a protein plus heme. Heme consists of iron plus protoporphyrin IX. Normally, during the course of red blood cell formation, protoporphyrin IX acquires iron, to generate heme, and the heme becomes incorporated into hemoglobin. However, in iron deficiency, protophoryrin IX builds up.

PROTOZOA. (Plural form of protozoan) Single-celled organisms (not bacteria) of which about 30 kinds cause disease in humans.

PROXIMAL TUBULE. The portion of the kidney tubule that lies closest to the point at which fluid from the blood enters the tubule.

PRURICEPTORS. Nerve endings specialized to perceive itching sensations.

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PRURITUS. The medical term for itching.

PRUSSIAN BLUE. The common name of potassium ferric hexacyanoferrate, a compound approved in the United States for treatment of thallium poisoning. Prussian blue gets its name from the fact that it was first used by artists in 1704 as a dark blue pigment for oil paints. It has also been used in laundry bluing and fabric printing.

PSEUDODEMENTIA. Depression with symptoms resembling those of dementia. The term "dementia of depression" is now preferred.

PSEUDOGYNECOMASTIA. Enlargement of the male breast caused solely by fat accumulation. It is also called lipomastia.

PSEUDOPHAKIC BULLOUS KERATOPATHY. Painful swelling of the cornea occasionally occurring after surgery to implant an artificial lens in place of a lens affected by cataract.

PSEUDOXANTHOMA ELASTICUM. A hereditary disorder of the connective, or elastic, tissue marked by premature aging and breakdown of the skin and degeneration of the arteries that leads to hemorrhages.

PSORALEN. A family of photosensitizing chemicals that can be found in lemons, celery, and other plants. Chemically synthesized versions are used to augment the effects of UVA light treatments.

PSORIASIS. A common recurring skin disease that is marked by dry, scaly, and silvery patches of skin that appear in a variety of sizes and locations on the body.

PSORIATIC ARTHRITIS MUTILANS. A severe form of psoriatic arthritis that destroys the joints of the fingers and toes and causes the bones to fuse, leaving patients with gnarled and club-like hands and feet.

PSYCHIATRIST. A medical doctor who has completed specialized training in the diagnosis and treatment of mental illness.

PSYCHOACTIVE. Substance that effects emotional and psychological perception in the brain.

PSYCHOACTIVE DRUGS. Any drug that affects the mind or behavior. There are five main classes of psychoactive drugs: opiates and opioids (e.g. heroin and methadone); stimulants (e.g. cocaine, nicotine), depressants (e.g. tranquilizers, antipsychotics, alcohol), hallucinogens (e.g. LSD), and marijuana and hashish.

PSYCHODYNAMIC PSYCHOTHERAPY. A less intensive form of insight-oriented therapy than psychoanalysis that typically involves greater interaction between therapist and patient than classical psychoanalysis.

PSYCHODYNAMIC THERAPY. A therapeutic approach that assumes dysfunctional or unwanted behavior is caused by unconscious, internal conflicts and focuses on gaining insight into these motivations.

PSYCHOGENIC. Referring to a disorder associated with mental or emotional conflict. At one time most stuttering was considered psychogenic, but recent research indicates that psychogenic stuttering is the least common form.

PSYCHOLOGICAL. Pertaining to the mind, its mental processes, and its emotional makeup.

PSYCHOLOGICAL TESTS. Written, verbal, or visual tasks that assess psychological functioning, intelligence, and/or personality traits.

PSYCHOLOGIST. A mental health professional who treats mental and behavioral disorders by support and insight to encourage healthy behavior patterns and personality growth. Psychologists also study the brain, behavior, emotions, and learning.

PSYCHOMOTOR AGITATION. Disturbed physical and mental processes (e.g., fidgeting, wringing of hands, racing thoughts); a symptom of major depressive disorder.

PSYCHOMOTOR RETARDATION. Slowed physical and mental processes (e.g., slowed thinking, walking, and talking); a symptom of major depressive disorder.

PSYCHOPATHOLOGY. A mental disorder or illness, such as schizophrenia, personality disorder, or major depressive disorder.

PSYCHOSIS. A serious mental disorder characterized by defective or lost contact with reality often with hallucinations or delusions.

PSYCHOSOCIAL. A term referring to the mind's ability to, consciously or unconsciously, adjust and relate the body to its social environment.

PSYCHOSOMATIC. Referring to physical symptoms that are caused or significantly influenced by emotional factors. Some doctors regard couvade syndrome as a psychosomatic condition.

PSYCHOSURGERY. Brain surgery performed to alleviate chronic psychological conditions such as obsessive-compulsive disorder (OCD), depression, and bipolar disorder.

PSYCHOTHERAPY. The treatment of mental and behavioral disorders by support and insight to encourage healthy behavior patterns and personality growth.

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PSYCHOTIC DISORDER. A mental disorder characterized by delusions, hallucinations, or other symptoms of lack of contact with reality. The schizophrenias are psychotic disorders.

PSYLLIUM HYDROPHILIC MUCILLOID. A plant material contained in some laxatives.

PUBERTY. Point in development when the gonads begin to function and secondary sexual characteristics begin to appear.

PUBIS. The anterior portion of the pelvis located in the anterior abdomen.

PULMONARY. Referring to the lungs and respiratory system.

PULMONARY ANGIOGRAPHY. An x-ray study of the lungs, performed by insertion of a catheter into a vein, through the heart, and into the pulmonary artery. Pulmonary angiography is performed to evaluate blood circulation to the lungs. It is also considered the most accurate diagnostic test for detecting a pulmonary embolism.

PULMONARY ARTERY. The blood vessel that delivers blood from the heart to the lungs.

PULMONARY EDEMA. A problem caused when fluid backs up into the veins of the lungs. Increased pressure in these veins forces fluid out of the vein and into the air spaces (alveoli). This interferes with the exchange of oxygen and carbon dioxide in the alveoli.

PULMONARY EMBOLISM. An obstruction of a blood vessel in the lungs, usually caused by a blood clot that blocks a coronary artery. Pulmonary embolism can be very serious and, in some cases, fatal.

PULMONARY FIBROSIS. A scarring process that is the end result of many forms of long-lasting lung disease.

PULMONARY FUNCTION TEST. A test that measures the capacity and function of the lungs as well as the blood's ability to carry oxygen. During the test, the patient breathes into a device called a spirometer.

PULMONARY HYPERTENSION. High blood pressure in the veins and arteries of the lungs.

PULMONARY NODULE. A lesion surrounded by normal lung tissue. Nodules may be caused by bacteria, fungi, or a tumor (benign or cancerous).

PULMONARY REHABILITATION. A program to treat COPD, which generally includes education and counseling, exercise, nutritional guidance, techniques to improve breathing, and emotional support.

PULMONARY VALVE. The heart valve that is positioned between the right ventricle and the opening into the pulmonary artery.

PULMONIC VALVE. A fold in the pulmonary artery that directs blood to the lungs. It may be transferred to replace a severely diseased aortic valve during heart valve replacement surgery for aortic stenosis.

PULP. The soft innermost layer of a tooth that contains its blood vessels and nerves.

PULP CHAMBER. The area within the tooth occupied by dental pulp.

PULPITIS. Inflammation of the pulp of a tooth that involves the blood vessels and nerves.

PULSE OXIMETRY. The noninvasive monitoring or determination of oxygen-hemoglobin saturation of the blood.

PUNCH BIOPSY. A method of obtaining skin samples under local anesthesia using a surgical skin punch.

PUNCTUM. Tiny opening at the inner corners of the upper and lower lids. The area for the beginning of tear drainage.

PUNCTURE. An injury caused by a sharp, narrow object deeply penetrating the skin.

PUPIL. The opening in the center of the iris that allows light to pass through to the retina.

PURGING. The use of vomiting, diuretics, or laxatives to clear the stomach and intestines after a binge.

PURIFIED PROTEIN DERIVATIVE (PPD). An extract of tubercle bacilli that is injected into the skin to find out whether a person presently has or has ever had tuberculosis.

PURINE. A white crystalline substance that is one of the building blocks of DNA. Uric acid is produced when purine is broken down in the body.

PURKINJE'S CELLS. Large branching cells of the nervous system.

PURPURA. A skin discoloration of purplish or brownish red spots caused by bleeding from broken capillaries.

PURULENT. Consisting of or containing pus.

PUS. A generally viscous, yellowish–white fluid formed in infected tissue, consisting of white blood cells, cellular debris, and dead tissue.

PUSTULE. A small elevation of the skin containing pus or cloudy tissue fluid.

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PUVA. A type of phototherapy that combines the oral or topical photosensitizing chemical psoralen with long-wave ultraviolet light A (UVA).

PYELONEPHRITIS. Bacterial inflammation of the upper urinary tract.

PYLORUS. The ring of muscle that controls the passage of material from the stomach into the small intestine.

PYODERMA. A pus-containing skin infection, such as impetigo, caused by *Staphylococcus* or group A *Streptococcus* bacteria.

PYOGENIC. Capable of generating pus. *Streptococcus*, *Staphocococcus*, and bowel bacteria are the primary pyogenic organisms.

PYOGENIC ARTHRITIS. Another name for infectious arthritis. Pyogenic means that pus is formed during the disease process.

PYRETHRIN, PYRETHROID. Naturally-occurring insecticide extracted from chrysanthemum flowers. It paralyzes lice so that they cannot feed.

PYREXIA. A medical term denoting fevers.

PYRIDOSTIGMINE BROMIDE (MESTINON). An anticholinesterase drug used in treating myasthenia gravis.

PYROGEN. A chemical circulating in the blood that causes a rise in body temperature.

PYROMANIA. An impulse control disorder in which one sets fires.

Q

Q-FEVER. A disease that is marked by high fever, chills and muscle pain. It is seen in North America, Europe, and parts of Africa. It may be spread by drinking raw milk, or by tick bites.

QI. Basic life energy, according to traditional Chinese medicine.

QRS. A pattern seen in an electrocardiogram that indicates the pulses in a heart beat and their duration. Variations from a normal QRS pattern indicate heart disease.

QUADRANTECTOMY. Removal of a quadrant, or about a quarter of the breast.

QUADRICEPS, HIP FLEXORS, HAMSTRINGS. Major muscles in the thigh area that affect knee mechanics.

QUADRIPLEGIA. Paralysis of all four limbs.

QUADRIVALENT VACCINE. A vaccine that protects against four pathogens.

QUANTIFIABLE. Can be expressed as a number. The results of quantifiable psychological tests can be translated into numerical values, or scores.

QUININE. One of the first treatments for malaria, quinine is a natural product made from the bark of the Cinchona tree. It was popular until being superseded by the development of chloroquine in the 1940s. In the wake of widespread chloroquine resistance, however, it has become popular again. Quinine, or its close relative quinidine, can be given intravenously to treat severe *Falciparum* malaria.

QV. Quantum vacuum, a theory coined by physicists, which defines the interactions of energy that combine to form reality.

R

RABIES. A rare but serious disease caused by a virus carried in saliva. It is transmitted when an infected animal bites a person.

RACHITIC ROSARY. Beadlike bumps present at the junction of the ribs with their cartilages; often seen in children with rickets.

RADIAL ARTERY. An artery located in the arm and used for bypass grafts.

RADIAL KERATOTOMY (RK). A surgical procedure involving the use of a diamond–tipped blade to make several spoke–like slits in the peripheral (non–viewing) portion of the cornea to improve the focus of the eye and correct myopia by flattening the cornea.

RADIATION THERAPY. Use of radioisotopes to kill tumor cells. Applied externally through a beam of x rays, intraoperatively (during surgery), or deposited internally by implanting radioactive seeds in tumor tissue.

RADICAL PROSTATECTOMY. Surgical removal of the entire prostate, a common method of treating prostate cancer.

RADICAL RESECTION. Surgical resection that takes the blood supply and lymph system supplying the organ along with the organ.

RADICULAR. Pain that is caused by the root of a nerve.

RADICULOPATHY. Sometimes referred to as a pinched nerve, it refers to compression of the nerve

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root–the part of a nerve between vertebrae. This compression causes pain to be perceived in areas to which the nerve leads.

RADIO WAVES. Electromagnetic energy of the frequency range corresponding to that used in radio communications, usually 10,000 cycles per second to 300 billion cycles per second. Radio waves are the same as visible light, x rays, and all other types of electromagnetic radiation, but are of a higher frequency.

RADIOACTIVE ISOTOPE. One of two or more atoms with the same number of protons but a different number of neutrons with a nuclear composition. In nuclear scanning, radioactive isotopes are used as a diagnostic agent.

RADIOCONTRAST AGENTS. Dyes administered to a patient for the purposes of a radiologic study.

RADIOFREQUENCY ABLATION (RFA). A procedure in which radiofrequency waves are used to destroy blood vessels and tissues.

RADIOGRAPH. The actual picture or film produced by an x-ray study.

RADIOGRAPHICALLY DENSE. An abundance of glandular tissue that results in diminished anatomic detail on the mammogram.

RADIOGRAPHY. Examination of any part of the body through the use of x rays. The process produces an image of shadows and contrasts on film.

RADIOISOTOPE. An unstable form of an element that gives off radiation to become stable.

RADIOLOGIST. A medical doctor specially trained in radiology (x ray) interpretation and its use in the diagnosis of diseases and injuries.

RADIONUCLIDE. A substance that emits radiation that can be detected by a scanner as the substance disintegrates.

RADIONUCLIDE BONE SCAN. A test that tells if cancer has spread to the bones.

RADIONUCLIDE SCANNING. Diagnostic test in which a radioactive dye is injected into the bloodstream and photographed to display internal vessels, organs and tissues.

RADIOPHARMACEUTICAL. A radioactive pharmaceutical or chemical (usually radioactive iodine or cobalt) used for diagnostic or therapeutic purposes.

RADIOSURGERY. A precise delivery of a large dose of radiation to a targeted area within the brain.

RADIOTHERAPY. The use of ionizing radiation, either as x rays or radioactive isotopes, to treat disease.

RANGE OF MOTION (ROM). The range of motion of a joint from full extension to full flexion (bending) measured in degrees like a circle.

RAPID CYCLING. Four or more manic, hypomanic, mixed, or depressive episodes within a 12-month period.

RAPID EYE MOVEMENT (REM) SLEEP. A phase of sleep during which the person's eyes move rapidly beneath the lids. It accounts for 20–25% of sleep time. Dreaming occurs during REM sleep.

RASH. A spotted, pink or red skin eruption that may be accompanied by itching and is caused by disease, contact with an allergen, food ingestion, or drug reaction.

RAYNAUD PHENOMENON/RAYNAUD DISEASE. A condition in which blood flow to the body's tissues is reduced by a malfunction of the nerves that regulate the constriction of blood vessels. When attacks of Raynaud's occur in the absence of other medical conditions, it is called Raynaud disease. When attacks occur as part of a disease (as in scleroderma), it is called Raynaud phenomenon.

REACTIVE ARTHRITIS. Another name for Reiter's syndrome.

REACTIVE STRESS TEST. A positive sign of fetal well being. The FHR rises at least 20 beats per minute above the baseline heart rate for at least 20 seconds, occurring at least twice in a 20-minute period.

REBOUND HEADACHE. A type of primary headache caused by overuse of pain relievers. It is also known as analgesic abuse headache.

RECEPTOR. A molecular structure in a cell or on the surface of a cell that allows binding of a specific substance that causes a specific physiologic response.

RECESSIVE GENE. A type of gene that is not expressed as a trait unless inherited by both parents.

RECESSIVE INHERITANCE. A pattern of inheritance where both parents carry the gene responsible for a trait or disease (although they seldom show symptoms). Their offspring will have a 25% chance of having the trait or disease. Recessive inheritance is also responsible for disorders such as hemophilia, where the mother carries the affected gene on the X chromosome and passes it to her son.

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RECESSIVE TRAIT. An inherited trait or characteristic that is outwardly obvious only when two copies of the gene for that trait are present.

RECIPIENT. A person who receives an organ transplant.

RECOMBINANT PROTEIN. A manipulated or modified form of a protein which results in the ability to produce the modified protein on a large scale.

RECOMMENDED DIETARY ALLOWANCE (RDA). Guidelines for the amounts of vitamins and minerals necessary for proper health and nutrition established by the National Academy of Sciences in 1989.

RECOMPRESSION. Restoring the elevated pressure of the diving environment to treat decompression sickness and gas embolism by decreasing bubble size.

RECTAL PROLAPSE. Protrusion of the rectal mucous membrane through the anus.

RECTOCELE. Bulging of the rectum into the vaginal wall.

RECTUM. The last few inches of the large intestine that store waste until it is eliminated from the body through the anus.

RECURRENT ABDOMINAL PAIN (RAP). Functional abdominal pain; stomachaches in children that recur at least once a month and that are not caused by an underlying medical condition.

RECURRENT CORNEAL EROSION (RCE). Repeated erosion of the cornea. May be a result of inadequate healing of a previous abrasion.

RECURRENT LARYNGEAL NERVE. One of two offshoots of the vagus nerve that connect to the larynx. It is located below the larynx.

RECURRENT ULCER. Peptic ulcers that flare up after healing. They may be caused a helicobacter pylori bacterial infection and are treated with a combination of antibiotics and gastric acid reducing medications, like proton pump inhibitors.

RED BLOOD CELL (RBC). Cell that contains hemoglobin (the molecule that transports oxygen) and help remove wastes from tissues throughout the body.

RED BLOOD CELL INDICES. Measurements that describe the size and hemoglobin content of red blood cells.

RED CELL DISTRIBUTION WIDTH (RDW). A measure of the variation in size of red blood cells.

REDUCIBLE HERNIA. A hernia that can be gently pushed back into place or that disappears when the person lies down.

REED-STERNBERG CELLS. Cancerous cells that, when present in the body, are indicative of Hodgkin's lymphoma.

REFERRED PAIN. The presence of pain in an area other than where it originates.

REFLEX. An involuntary response to a particular stimulus.

REFLEX SEIZURE. Seizure brought on by specific sensory stimuli.

REFLEXOLOGY. Belief that reflex areas in the feet correspond to every part of the body, including organs and glands, and that stimulating the correct reflex area can affect the body part.

REFLUX. An abnormal backward or return flow of a fluid.

REFLUX ESOPHAGITIS. Inflammation of the lower esophagus caused by the backflow of stomach contents.

REFRACTION. The bending of light rays as they pass from one medium through another. Used to describe the action of the cornea and lens on light rays as they enter they eye. Also used to describe the determination and measurement of the eye's focusing system by an optometrist or ophthalmologist.

REFRACTIVE ERROR. The inability of the eye to properly focus light due to an irregularly shaped cornea, resulting in blurry vision, nearsightedness, farsightedness, or astigmatism.

REFRACTIVE SURGERY. A surgical procedure that corrects visual defects by permanently changing the shape of the cornea.

REGRESSION. A return to earlier, particularly infantile, patterns of thought and behavior.

REGURGITATION. Flow of material back up the esophagus and into the throat or lungs.

REHYDRATION. The restoration of water or fluid to a body that has become dehydrated.

REITER'S SYNDROME. A group of symptoms that includes arthritis, inflammation of the urethra, and conjunctivitis, and develops as a late complication of infection with *Shigella flexneri*. The syndrome was first described by a German doctor named Hans Reiter in 1918.

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REJECTION. An immune response that occurs when a transplanted organ is viewed as a foreign substance by the body. If left untreated, rejection can lead to organ failure and even death.

RELAPSE. A recurrence of symptoms after a period of improvement or recovery.

RELAPSING-REMITTING. A pattern of symptoms of multiple sclerosis in which symptomatic attacks occur that last 24 hours or more, followed by complete or almost complete improvement.

RELAXATION RESPONSE. The human body's response to relaxation techniques, during which metabolism and stress levels decrease and immune response increases.

RELAXATION TECHNIQUE. A technique used to relieve stress. Exercise, biofeedback, hypnosis, and meditation are all effective relaxation tools. Relaxation techniques are used in cognitive-behavioral therapy to teach patients new ways of coping with stressful situations.

REM LATENCY. After a person falls asleep, the amount of time it takes for the first onset of REM (rapid eye movement) sleep.

REMEDY ANTIDOTE. Certain foods, beverages, prescription medications, aromatic compounds, and other environmental elements that counteract the efficacy of homeopathic remedies.

REMISSION. A disappearance of a disease as a result of treatment. Complete remission means that all disease is gone. Partial remission means that the disease is significantly improved by treatment, but residual traces of the disease are still present.

REMODELING. The ongoing process of bone formation and breakdown that results in healthy bone development.

RENAL. Relating to the kidneys, from the Latin word *renes*.

RENAL AGENESIS. Failure of the fetal kidneys to form. Oligohydramnios usually associated with absence of both kidneys.

RENAL ARTERY ANEURYSM. An aneurysm relating to, involving, or located in the region of the kidneys.

RENAL ARTERY STENOSIS. Narrowing or constriction of the artery that supplies the kidney with blood.

RENAL CELL CARCINOMA. Cancer of the kidney.

RENAL DISEASE. Kidney disease.

RENAL FAILURE. Disorder characterized by the kidney's inability to filter wastes from the blood. It may be acute (occuring suddenly and usually reversable) or chronic (developing slowly over time as a result of permanent damage).

RENAL ULTRASOUND. A painless and non-invasive procedure in which sound waves are bounced off the kidneys. These sound waves produce a pattern of echoes that are then used by the computer to create pictures of areas inside the kidney (sonograms).

RENIN. An enzyme produced in the kidneys that controls the activation of the hormone angiotensin, which stimulates the adrenal glands to produce aldosterone.

REPERFUSION THERAPY. Restoration of blood flow to an organ or tissue; following a heart attack, quickly opening blocked arteries to reperfuse the heart muscles to minimize damage.

REPETITIVE STRESS INJURY; REPETITIVE STRAIN INJURY (RSI). Any of various musculoskeletal disorders—such as tendonitis or carpal tunnel syndrome—that are caused by cumulative damage to muscles, tendons, ligaments, nerves, or joints from highly repetitive movements, such as of the hand, wrist, arm, or shoulder.

REPRESENTATIVE SAMPLE. A random sample of people that adequately represents the test-taking population in age, gender, race, and socioeconomic standing.

REPRESSION. A unconscious psychological mechanism in which painful or unacceptable ideas, memories, or feelings are removed from conscious awareness or recall.

REPRODUCTIVE ORGANS. The group of organs (including the testes, ovaries, and uterus) whose purpose is to produce a new individual and continue the species.

RESECT; RESECTION. To remove surgically.

RESECTABLE CANCER. A tumor that can be surgically removed.

RESERPINE (SERPASIL). A drug prescribed for high blood pressure.

RESERVOIR. A population in which a virus is maintained without causing serious illness to the infected individuals.

RESIDUE. Traces that remain after most of the rest of the material is gone.

RESORBED. Absorbed by the body because of lack of function. This happens to the jawbone after tooth loss.

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RESPIRATION. Respiration is the process by which nutrients (specifically sugar, or glucose) and oxygen are taken in to a cell; chemical reactions take place; energy is produce and stored; and carbon dioxide and wastes are given off.

RESPIRATORY. Referring to breathing in and breathing out, and the function of the lungs.

RESPIRATORY DISTRESS. A condition in which patients with lung disease are not able to get enough oxygen.

RESPIRATORY DISTRESS SYNDROME (RDS). Condition in which a premature infant with immature lungs does not develop surfactant, a protective film that helps air sacs in the lungs to stay open. RDS is the most common problem seen in premature infants.

RESPIRATORY TRACT. The air passages from the nose to the air sacs of the lungs, including the pharynx, larynx, trachea, and bronchi.

RESPITE CARE. Temporary care of a patient to provide parents or other caregivers with a period of physical, mental, and emotional rest.

RESTENOSIS. The narrowing of a blood vessel after it has been opened, usually by balloon angioplasty.

RESTLESS LEGS SYNDROME (RLS). A neurological disorder characterized by aching, burning, or creeping sensations in the legs and an urge to move the legs, often resulting in insomnia.

RESUSCITATION. Reviving an unconscious person or restoring breathing.

RETAINER. An orthodontic appliance that is worn to stabilize teeth in a new position.

RETENTION TREATMENT STAGE. The passive treatment period following orthodontic treatment, when retainers may be used to stabilize the teeth.

RETICULOCYTE. An early, immature form of a red blood cell. Over time, the reticulocyte develops to become a mature, oxygen-carrying red blood cell.

RETINA. The inner, light-sensitive layer of the eye containing rods and cones; transforms the image it receives into electrical messages sent to the brain via the optic nerve.

RETINAL DETACHMENT. A serious vision disorder in which the light-detecting layer of cells inside the eye (retina) is separated from its normal support tissue and no longer functions properly.

RETINAL HEMORRHAGE. Bleeding in the back of the eye.

RETINOBLASTOMA. A hereditary malignant tumor of the retina that develops during childhood.

RETINOIC ACID. Vitamin A_1 acid which is used topically to treat acne.

RETINOID. A synthetic vitamin A derivative used in the treatment of a variety of skin disorders.

RETINOL. Another name for vitamin A.

RETINOPATHY OF PREMATURITY. A condition in which the blood vessels in a premature infant's eyes do not develop normally, and can, in some cases, result in blindness.

RETINOSCOPE. An instrument for determining the state of refraction of the eye by illuminating the retina with a mirror.

RETRACTOR. An instrument used during surgery to hold an incision open and pull back underlying layers of tissue.

RETROGRADE EJACULATION. A condition in which the semen spurts backward into the bladder.

RETROGRADE MENSTRUATION. Menstrual flow that travels into the body cavity rather than being expelled through the uterus.

RETROGRADE PYELOGRAM. A pyelography or x-ray technique in which a dye is injected into the kidneys through the ureters.

RETROPUBIC URETHROPEXY. A generic term for the Burch procedure and its variants that treat mild stress incontinence by stabilizing the urethra with retropubic surgery.

RETROVIRUS. A family of RNA viruses containing a reverse transcriptase enzyme, which allows the viruses' genetic information to become part of the genetic information of the host cell upon replication.

REVERSE TRANSCRIPTION-POLYMERASE CHAIN REACTION; RT-PCR. A method of polymerase-chain-reaction amplification of nucleic acid sequences that uses RNA as the template for transcribing the corresponding DNA using reverse transcriptase.

REYE'S SYNDROME. A life-threatening disease that affects the liver and the brain and sometimes occurs after a viral infection, such as flu or chickenpox. Children or teenagers who are given aspirin for flu or chickenpox are at increased risk of developing Reye's syndrome.

RH (RHESUS) FACTOR. An antigen present in the red blood cells of 85% of humans. A person with Rh factor is Rh positive (Rh+); a person without it is

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Rh negative (Rh-). The Rh factor was first identified in the blood of a rhesus monkey.

RH BLOOD INCOMPATIBILITY. A blood type problem between mother (who is Rh negative) and baby (who is Rh positive), making the immune system of the mother attack her unborn baby. During delivery of the first pregnancy, the mother's immune system becomes sensitive to the Rh positive blood of the baby. The mother's system may then attack later pregnancies and cause severe illness or death to those babies.

RH BLOOD TYPE. Blood type based on the presence or absence of the D antigen on the red blood cells.

RH DISEASE. The Rh factor is a genetically determined antigen on red blood cells that produce immune responses. If an Rh-negative woman is pregnant with an Rh-positive fetus, her body will produce antibodies against the fetus's blood, causing Rh disease.

RH NEGATIVE. Lacking the Rh factor, genetically determined antigens in red blood cells that produce immune responses.

RH SENSITIZATION. A woman with a negative blood type (Rh negative) who has produced antibodies against her fetus with a positive blood type (Rh positive). The mother's body considered the fetal blood cells a foreign object and mounted an immune attack on it. Rh immune globulin (RhoGAM) is a vaccine that must be given to a woman after an abortion, miscarriage, or prenatal tests in order to prevent sensitization to Rh disease.

RHABDOID. Rod- or wand-shaped, like the first stage of the threadworm larva.

RHABDOVIRUS. A type of virus named for its rod- or bullet-like shape. The rabies virus belongs to a family of viruses called Rhabdoviridae.

RHEUMATIC DISEASE. A type of disease involving inflammation of muscles, joints, and other tissues.

RHEUMATIC FEVER. A disease that causes inflammation in various body tissues. Rare in most developed countries, but reported to be on the increase in parts of the United States. Joint inflammation occurs, but more serious is the frequency with which the disease permanently damages the heart. The nervous system may also be affected, causing Sydenham's chorea.

RHEUMATIC HEART DISEASE. A condition caused by a streptococcus infection which can result in permanent heart damage.

RHEUMATOID ARTHRITIS. A joint disease of unknown origins that may begin at an early age, causing deformity and loss of function in the joints.

RHEUMATOID FACTOR (RF). An antibody present in the blood serum of many individuals affected by rheumatoid arthritis.

RHEUMATOLOGIST. Physician specializing in the diagnosis and treatment of arthritis and related conditions.

RHEUMATOLOGY. The branch of medicine that specializes in the diagnosis and treatment of disorders affecting the muscles and joints.

RHINITIS. An inflammation of the mucous membranes that line the nasal passages.

RHINOPHYMA. Long-term swelling and overgrowth in skin tissue of the nose that leaves it with a knobby bulb-like look.

RHINOPLASTY. Plastic surgery of the nose to repair or change the shape of the nose.

RHINORRHEA. A name for the common cold.

RHINOVIRUS. A virus that infects the upper respiratory system and causes the common cold.

RHYTHM METHOD. The oldest method of contraception, in which partners periodically refrain from having sex during ovulation. This method has a high failure rate.

RHYTIDECTOMY. It literally means "wrinkle excision." It is another term for face lift surgery.

RIBAVIRIN. A drug that is used to combat viral infections.

RICKETS. A condition caused by the dietary deficiency of vitamin D, calcium, and usually phosphorus, seen primarily in infancy and childhood, and characterized by abnormal bone formation.

RICKETTSIA. A rod-shaped infectious microorganism that can reproduce only inside a living cell. Scrub typhus is a rickettsial disease.

RIGHT-HEART CARDIAC CATHERIZATION. A medical procedure during which a physician threads a catheter into the right side of the heart to measure the blood pressure in the right side of the heart and the pulmonary artery. The right heart's pumping ability can also be evaluated.

RINGWORM. A fungal infection of the skin, usually known as tinea corporis.

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RINNE TEST. A hearing test using a vibrating tuning fork which is held near the ear and held at the back of the skull.

ROD. Photoreceptor that is highly sensitive to low levels of light and transmits images in shades of gray.

ROLFING. Based on the belief that proper alignment of various parts of the body is necessary for physical and mental health, rolfing uses deep tissue massage and movement exercises in an attempt to bring the body into correct alignment.

ROOT CANAL. The space within a tooth that runs from the pulp chamber to the tip of the root.

ROOT CANAL TREATMENT. The process of removing diseased or damaged pulp from a tooth, then filling and sealing the pulp chamber and root canals.

RORSCHACH TEST. A well–known projective test that requires the patient to describe what he or she sees in each of 10 inkblots. It is named for the Swiss psychiatrist who invented it.

ROSACEA. A chronic skin disease characterized by persistent redness of the skin and periodic outbreaks of pustules, usually affecting the middle third of the face.

ROSE SPOTS. Small slightly raised reddish pimples that are a distinguishing feature of typhoid or paratyphoid infection.

ROTABLATION. A nonsurgical technique for treating diseased arteries in which a special catheter with a diamond-coated tip is guided to the point of narrowing in the artery. The catheter tip spins at high speed and grinds away the blockage or plaque on the artery walls.

ROTAVIRUS. Any virus of the genus *Rotavirus,* some of which cause gastroenteritis.

ROULEAUX. The stacking up of red blood cells, caused by extra or abnormal proteins in the blood that decrease the normal distance red cells maintain between each other.

ROUNDWORM. Any round-bodied unsegmented worm as distinguished from a flatworm. Also called a nematode, they look similar to the common earthworm.

RUBELLA. A contagious viral disease that is milder than typical measles but is damaging to the fetus when it occurs early in pregnancy. Also called German measles.

RUPTURE. A tear or break in body tissue of an organ.

RUSSELL'S SIGN. Scraped or raw areas on the patient's knuckles, caused by self-induced vomiting.

S

SACCULAR ANEURYSM. A type of aneurysm that resembles a small sack of blood attached to the outer surface of a blood vessel by a thin neck.

SACRAL NERVES. The five pairs of nerves that arise from the lowermost segments of the spinal cord and control bladder, bowel, and pelvic functions. Stimulation of the sacral nerves by an implanted device is a newer treatment for urinary incontinence.

SACROCOCCYGEAL TERATOMA (SCT). A tumor occurring at the base of the fetus's tailbone.

SACRUM. Posterior bony wall of the pelvis.

SADISM. Sexual arousal through inflicting pain on another person.

SALICYLATES. A group of drugs that includes aspirin and related compounds. Salicylates are used to relieve pain, reduce inflammation, and lower fever.

SALICYLIC ACID. An agent prescribed in the treatment of hyperkeratotic skin conditions and fungal infections.

SALINE. A salt solution in water. Normal saline has the same salt concentration as the body, 0.9%.

SALIVARY DUCT. Tube through which saliva is carried from the salivary gland to the mouth.

SALIVARY GLAND. Three pairs of glands that secrete into the mouth and aid digestion.

SALMONELLOSIS. Food poisoning; an infection by bacteria of the genus *Salmonella* that usually causes severe diarrhea and may be transmitted to the fetus.

SALPINGITIS. Inflammation of the fallopian tube.

SALVAGE THERAPY. Treatment measures taken late in the course of a disease after other therapies have failed. It is also known as rescue therapy.

SAMANA. Life sustaining energy of the smaller intestine; the fourth of the five airs of Ayurvedic philosophy; the life force governing side-to-side motion.

SAPHENOUS VEIN. A long vein in the thigh or calf commonly used for bypass grafts.

SARCOIDOSIS. A chronic disease that causes formation of abnormal areas containing inflammatory cells, called granulomas, in any organ or tissue; in

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the heart, large areas of the heart muscle can be involved, causing cardiomyopathy.

SARCOMA. A type of cancer that originates from connective tissue such as bone or muscle.

SARGRAMOSTIM. A medication made from yeast that stimulates WBC production. It is sold under the trade names Leukine and Prokine.

SATURATED FAT. Found mainly in meat and dairy products but also in vegetable sources such as some nuts, seeds, and avocados.

SCABIES. A contagious parasitic skin disease characterized by intense itching.

SCHEMAS. Fundamental core beliefs or assumptions that are part of the perceptual filter people use to view the world. Cognitive-behavioral therapy seeks to change maladaptive schemas.

SCHEUERMANN'S DISEASE. Juvenile kyphosis due to damaged bone in the spinal vertebrae.

SCHIZOAFFECTIVE DISORDER. Schizophrenic symptoms occurring concurrently with a major depressive and/or manic episode.

SCHIZOPHRENIA. A severe mental illness in which a person has difficulty distinguishing what is real from what is not real. It is often characterized by hallucinations, delusions, and withdrawal from people and social activities.

SCHIZOPHRENIFORM DISORDER. A short-term variation of schizophrenia that has a total duration of one to six months.

SCHWANNOMA. A tumor derived from the cells of the myelin sheath that surrounds many nerve cells.

SCIATICA. Pain that radiates along the sciatic nerve, extending from the buttock down the leg to the foot.

SCINTIGRAM. A nuclear angiogram; a scintigram involves injection of a radioactive substance into the patient's circulatory system. As the substance travels through the body, a special scanning camera takes pictures.

SCINTILLATION OR GAMMA CAMERA. A camera, somewhat like an x-ray machine, used to photograph internal organs after the patient has been injected with a radioactive material.

SCLERA. The tough, fibrous, white outer protective covering that surrounds the eye.

SCLERODERMA. A disease that first affects the skin and later affects certain internal organs. The first symptoms are the hardening, thickening, and shrinking of the skin.

SCLEROSANT. An irritating solution that stops bleeding by hardening the blood or vein it is injected into.

SCLEROSIS. Hardening.

SCOLIOMETER. A tool for measuring trunk asymmetry; it includes a bubble level and angle measure.

SCOLIOSIS. An abnormal, side-to-side curvature of the spine.

SCOTOMA. An area of lost or depressed vision within the visual field surrounded by an area of normal vision. Survivors of retinoblastoma frequently develop scotomas.

SCREENING. Process through which carriers of a trait may be identified within a population.

SCROTUM. The pouch of skin containing the testes, epididymis, and portions of the spermatic cords.

SCURVY. A nutritional disorder resulting from a deficiency of vitamin C that causes skin bruising and hemorrhages.

SEALANT. A thin plastic substance that is painted over teeth as an anti-cavity measure to seal out food particles and acids produced by bacteria.

SEALED RADIOACTIVE SOURCES. A radioactive source which is contained or sealed within a ribbon, wire, needle, balloon, tube or catheter.

SEASONAL AFFECTIVE DISORDER (SAD). A mood disorder characterized by depression during the winter months.

SEBACEOUS FOLLICLES. Structures in the skin that contain oil-producing glands and hair follicles and which give rise acne.

SEBACEOUS GLANDS. Tiny structures in the skin that produce oil (sebum). If they become plugged, sebum collects inside and forms a nurturing place for germs to grow.

SEBUM. An oily or waxy substance secreted by certain glands in the skin that protects hair and skin against fungi and some bacteria.

SECONDARY GAIN. The social, occupational, or interpersonal advantages that a patient derives from symptoms. A patient's being relieved of his or her

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share of household chores by other family members would be an example of secondary gain.

SECONDARY INFECTION. An infection by a microbe that occurs because the body is weakened by a primary infection caused by a different kind of microbe; also called an opportunistic infection.

SECONDARY POLYCYTHEMIA. Secondary polycythemia occurs when the excess of red blood cells is caused by a condition other than polycythemia vera. For example, when low levels of oxygen in the blood stimulate the bone marrow to produce more red blood cells, as in chronic lung disease.

SECONDARY PROGRESSIVE. A pattern of symptoms of multiple sclerosis in which there are relapses and remissions, followed by more steady progression of symptoms.

SECRETION. A substance, such as saliva or mucus, that is produced and given off by a cell or a gland.

SEDATIVE. Medicine that has a calming effect and may be used to treat nervousness or restlessness.

SEDENTARY. Inactivity and lack of exercise; a lifestyle that is a major risk factor for becoming overweight or obese and developing chronic diseases.

SEIZURE. A sudden attack, spasm, or convulsion.

SELECTIVE REDUCTION. Typically referred to in cases of multifetal pregnancy, when one or more fetuses are aborted to preserve the viability of the remaining fetuses and decrease health risks to the mother.

SELECTIVE SEROTONIN REUPTAKE INHIBITORS (SSRIS). A class of antidepressants that work by blocking the reabsorption of serotonin in brain cells, raising the level of the chemical in the brain. SSRIs include Prozac, Zoloft, Luvex, and Paxil.

SELENIUM. A mineral needed in extremely small quantities by the body. Large amounts can be very toxic.

SELF-DELIVERANCE. Another term for assisted suicide, more commonly used in Great Britain than in the United States.

SELF-LIMITED. A disease that runs its course without the need for professional medical treatment.

SEMEN. The thick whitish liquid released from the penis during sexual intercourse. It contains sperm and other secretions.

SEMICIRCULAR CANALS. Structures of the inner ear that help in maintaining balance.

SENESCENCE. Aging.

SENSITIVITY TEST. A test that determines which antibiotics will kill the bacteria that has been isolated from a culture.

SENSORINEURAL HEARING LOSS. Hearing loss caused by damage to the nerves or parts of the inner ear governing the sense of hearing.

SENSORY AWARENESS. Bringing attention to the sensations of tension and/or release in the muscles.

SENSORY DEPRIVATION. A situation where an individual finds himself in an environment without sensory cues. Also, (used here) the act of shutting one's senses off to outside sensory stimuli to achieve hallucinatory experiences and/or to observe the psychological results.

SENSORY INTEGRATION DYSFUNCTION. A neurological disorder in which a person has trouble processing and integrating all the information relayed to the brain by the various senses. Some researchers think that it is a possible cause of selective mutism.

SENSORY NERVES. Nerves that convey impulses from sense organs to the higher parts of the nervous system, including the brain.

SENTINEL LYMPH NODE. The first lymph node to receive lymph fluid from a tumor. If the sentinel node is cancer free, then it is likely that the cancerous cells have not metastasized.

SENTINEL NODE BIOPSY. A newer procedure performed in order to determine whether breast cancer has spread to auxiliary (underarm) lymph nodes.

SEPSIS. An overwhelming infection with effects throughout the body.

SEPTAL. Relating to the ventricular septum, the thin muscle wall dividing the right and left sides of the heart.

SEPTAL DEFECTS. These are holes in the septum, the muscle wall separating the right and left sides of the heart. Atrial septal defects are openings between the two upper heart chambers and ventricular septal defects are openings between the two lower heart chambers.

SEPTAL HEMATOMA. A mass of extravasated blood that is confined within the nasal septum.

SEPTIC. Referring to the presence of infection.

SEPTIC ARTHRITIS. Another name for infectious arthritis.

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SEPTIC SHOCK. A life-threatening drop in blood pressure caused by bacterial infection.

SEPTICEMIA. The medical term for blood poisoning, in which bacteria have invaded the bloodstream and circulates throughout the body.

SEPTUM (NASAL). The dividing partition in the nose that separates the two nostrils. It is composed of bone and cartilage.

SEPTUM (VENTRICULAR). That portion of the heart wall that divides the right and left ventricles.

SEQUESTRATION. A process in which the spleen withdraws some normal blood cells from circulation and holds them in case the body needs extra blood in an emergency.

SERIAL CASTING. A series of casts designed to gradually move a limb into a more functional position.

SERIAL MEASUREMENTS. A series of measurements looking for an increase or decrease over time.

SERIAL MONITORING. Monitoring of results of several blood tests over time to detect a pattern of increasing, decreasing, or unchanging values in the blood.

SERIAL X RAYS. A number of x rays performed at set times in the disease progression or treatment intervals. The radiographs will be compared to one another to track changes.

SEROCONVERSION. The development of detectable specific antibodies in a patient's blood serum as a result of infection or immunization.

SEROLOGICAL TESTS. Tests of immune function that are performed using the clear yellow liquid part of blood.

SEROLOGY. The analysis of the contents and properties of blood serum.

SEROSITIS. Inflammation of a serosal membrane. Polyserositis refers to the inflammation of two or more serosal membranes.

SEROTONIN. 5-Hydroxytryptamine; a substance that occurs throughout the body with numerous effects including neurotransmission in the brain. Inadequate amounts of serotonin are implicated in some forms of depression, obsessive-compulsive disorder, and anxiety disorders.

SEROTONIN DOPAMINE ANTAGONIST (SDA). The newer second-generation antipsychotic drugs, also called atypical antipsychotics. SDAs include clozapine (Clozaril), risperidone (Risperdal), and olanzapine (Zyprexa).

SEROTONIN SYNDROME. A group of symptoms caused by severely elevated serotonin levels in the body.

SEROTYPE. Microorganisms differing in the type of surface antigens.

SERTRALINE. An SSRI that is used to treat mental depression and a variety of other disorders.

SERUM (PLURAL, SERA). The clear fluid that separates from blood when the blood is allowed to clot completely. Blood serum can also be defined as blood plasma from which fibrinogen has been removed.

SERUM GASTRIN TEST. A laboratory test that is performed on a blood sample to determine that level of the hormone gastrin. High levels of gastrin indicate the presence a duodenal ulcer or a gastrinoma.

SERUM REAGENTS. Serum is fluid, or the fluid portion of the blood retained after removal of the blood cells and fibrin clot. Reagents are substances added to the serum to produce a chemical reaction.

SEX HORMONES. Hormones that are responsible for sexual characteristics and reproductive functioning.

SEX-LINKED. Refers to genes or traits carried on one of the sex chromosomes, usually the X.

SEX-LINKED GENETIC DISORDER. A disease or disorder caused by a gene mutation located on the X (female) or Y (male) chromosome.

SEXUAL ABUSE. When an individual is forced to engage in sexual activity by use of threats or other fear tactics, or instances in which an individual is physically unable to refuse.

SEXUAL ANHEDONIA. The inability to experience sexual pleasure.

SEXUAL AROUSAL DISORDER. The inhibition of the general arousal aspect of sexual response.

SEXUAL ASSAULT NURSE EXAMINER (SANE). A registered nurse who is trained to collect and document evidence from a sexual assault victim, evaluate and treat for STDs and pregnancy, and refer victims to follow-up medical care and counseling.

SEXUALLY TRANSMITTED DISEASE (STD). A disease that is passed from one person to another through sexual intercourse or other intimate sexual contact; also referred to as a sexually transmitted infection (STI).

SÉZARY SYNDROME. A leukemic phase of CTCL that develops in some patients, characterized by the appearance of malignant T cells in the peripheral blood and

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sometimes in the lymph nodes. The syndrome is named for Alfred Sézary (1880-1956), a French dermatologist.

SHARED PSYCHOTIC DISORDER. Also known as folie à deux; shared psychotic disorder is an uncommon disorder in which the same delusion is shared by two or more individuals.

SHAVE BIOPSY. A method of removing a sample of skin lesion so it can be examined by a pathologist. A scalpel or razor blade is held parallel to the skin's surface and is used to slice the lesion at its base.

SHEEP BLOOD AGAR PLATE. A petri dish filled with a nutrient gel containing red blood cells that is used to detect the presence of streptococcal bacteria in a throat culture. Streptococcal bacteria will lyse or break the red blood cells, leaving a clear spot around the bacterial colony.

SHIATSU. Japanese form of acupressure massage.

SHINGLES. A disease caused by an infection with the Herpes zoster virus, the same virus that causes chickenpox. Symptoms of shingles include pain and blisters along one nerve, usually on the face, chest, stomach, or back.

SHOCK. An abnormal condition resulting from low blood volume due to hemorrhage or dehydration. Signs of shock include rapid pulse and breathing, and cool, moist, pale skin.

SHOCK WAVE THERAPY. A method of treating tennis elbow and other musculoskeletal injuries that involves directing bursts of high-pressure sound waves at the affected area.

SHORT BOWEL SYNDROME. A condition in which the bowel is not as long as normal, either because of surgery or because of a congenital defect. Because the bowel has less surface area to absorb nutrients, it can result in malabsorption syndrome.

SHUNT. A passageway (or an artificially created passageway) that diverts blood flow from one main route to another.

SIALOGOGUE. A medication given to increase the flow of saliva.

SIBUTRAMINE. An appetite-suppressing drug that may increase the activity of norepinephrine and serotonin in the brain.

SICK BUILDING SYNDROME. An illness related to MCS in which a person develops symptoms in response to chronic exposure to airborne environmental chemicals found in a tightly sealed building.

SICKLE CELL. A red blood cell that has assumed an elongated shape due to the presence of hemoglobin S.

SICKLE CELL DISEASE. An inherited disorder characterized by a genetic flaw in hemoglobin production. (Hemoglobin is the substance within red blood cells that enables them to transport oxygen.) The hemoglobin that is produced has a kink in its structure that forces the red blood cells to take on a sickle shape, inhibiting their circulation and causing pain. This disorder primarily affects people of African descent.

SIDEROBLASTIC ANEMIA. Disorder in which the body has adequate iron but is unable to incorporate it into hemoglobin.

SIDEROPHILIN. Another name for transferrin.

SIGMOID COLON. The final portion of the large intestine that empties into the rectum.

SIGMOIDOSCOPY. A process of passing a long, hollow tubular instrument through the anus in order to permit inspection, diagnosis, treatment, and imaging, especially of the sigmoid colon.

SILENT REFLUX. An acid reflux problem that does not have marked symptoms but can cause chronic, recurrent respiratory symptoms much like asthma.

SILICOSIS. A progressive disease that results in impairment of lung function and is caused by inhalation of dust containing silica.

SINGLET OXYGEN. A highly reactive form of the oxygen molecule (O_2) formed during PDT that helps to destroy cancer cells by attacking their cell membranes.

SINGLETON. A fetus that develops alone in the uterus.

SINOATRIAL NODE (SAN). The heart's natural pacemaker, a group of cells located in the wall of the right atrium (upper chamber) of the heart near the entry of the superior vena cava, a major vein that carries deoxygenated blood from the upper part of the body to the heart.

SINUS TRACT. A narrow, elongated channel in the body that allows the escape of fluid.

SINUSES. Cavities or hollow areas.

SINUSITIS. Inflammation of the paranasal sinuses because of allergic reactions or viral, bacterial, or functional infections.

SITZ BATH. A hydrotherapy treatment for soaking the pelvic or genital areas.

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SJÖGREN'S SYNDROME. A connective tissue disease that hinders the production of tears and other body fluids.

SKELETAL MUSCLES. Muscles that move the skeleton. All of the muscles under voluntary control are skeletal muscles.

SKENE'S GLANDS. These are the glands of the female urethra.

SKIN APPENDAGES. Structures related to the integument such as hair follicles and sweat glands.

SKIN CONTRACTURE. A permanent tightening of the skin that prevents normal movement of the associated body part and that can cause permanent deformity.

SKIN GRAFTING. A technique in which a piece of healthy skin from the patient's body (or a donor's) is used to cover another part of the patient's body that has lost its skin.

SKIN HEMATOMA. Blood from a broken blood vessel that has accumulated under the skin.

SKIN TAG. A small outgrowth of skin tissue that may be smooth or irregular, flesh-colored and benign.

SLEEP APNEA. A condition marked by loud snoring during sleep and periodic episodes of suspended breathing.

SLEEP DISORDER. Any condition that interferes with sleep.

SLEEP LATENCY. The amount of time that it takes to fall asleep. Sleep latency is measured in minutes and is important in diagnosing depression.

SLEEP PARALYSIS. An abnormal episode of sleep in which the patient cannot move for a few minutes, usually occurring on falling asleep or waking up. Often found in patients with narcolepsy.

SLIT LAMP. An instrument that combines a binocular microscope with special lights. It allows an eye doctor to examine the front portion of the eye.

SMALL BOWEL OBSTRUCTION; SBO. An obstruction of the small intestine that prevents the free passage of material; sometimes caused by postoperative adhesions.

SMALL INTESTINE. Consists of three sections: duodenum (nearest the stomach), jejunum, and ileum (nearest the colon or large intestine). Different nutrients are absorbed in different sections of the small intestine.

SMALL-FOR-GESTATIONAL-AGE (SGA). A term used to describe newborns who are below the 10th percentile in height or weight for their estimated gestational age.

SMALLPOX. A highly contagious viral disease characterized by fever, weakness, and skin eruption with pustules that form scabs that slough off leaving scars.

SMEAR. A specimen prepared for microscopic study by spreading the material across a slide and treating it with a specific stain.

SMEAR LAYER. A layer of organic and inorganic material produced on teeth by dental instrumentation that may also contain bacteria and their by-products.

SMOOTH MUSCLES. Muscles that surround the linings of the digestive system, airways, and circulatory system.

SOCIAL PHOBIA. Fear of being judged or ridiculed by others; fear of being embarrassed in public.

SOCIALIZATION. Process by which new members are integrated into a social group.

SOFT PALATE. The structure at the roof of the mouth that separates the mouth and the pharynx.

SOLUTE. Solid substances that are dissolved in liquid in order to make a solution.

SOLUTION-FOCUSED THERAPY. A type of therapy that involves concrete goals and an emphasis on future direction rather than past experiences.

SOMATIC CELLS. All the cells of the body with the exception of the egg and sperm cells.

SOMATIZATION DISORDER. A chronic condition in which psychological stresses are converted into physical symptoms.

SOMATOFORM DISORDER. A category of psychiatric disorder characterized by physical complaints that appear to be medical in origin but that cannot be explained in terms of a physical disease, the results of substance abuse, or by another mental disorder.

SOMNAMBULISM. Another term for sleepwalking.

SONOGRAM. The picture formed by the pattern of echoes from an ultra sound.

SORE. An open wound, bruise, or lesion on the skin.

SPACE MAINTAINER. An orthodontic appliance that is worn to prevent adjacent teeth from moving into the space left by an unerupted or prematurely lost tooth.

SPASM. Sudden, involuntary tightening or tensing of a muscle or a group of muscles.

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SPASTIC. A condition in which the muscles are rigid, posture may be abnormal, and fine motor control is impaired.

SPASTICITY. Increased muscle tone, or stiffness, which leads to uncontrolled, awkward movements.

SPECIFICITY. A test's ability to detect only the disease in question.

SPECULUM. An instrument for enlarging the opening of any canal or cavity in order to facilitate inspection of its interior.

SPENT PHASE. A late development in polycythaemia vera leading to failure of the bone marrow and severe anemia.

SPERM. The reproductive cell of the male, which contains genetic information and participates in the act of fertilization of an ovum.

SPERM GRANULOMA. A collection of fluid that leaks from an improperly sealed or tied vas deferens. They usually disappear on their own, but can be drained if necessary.

SPERMATOGENESIS. The process by which sperm develop to become mature sperm, capable of fertilizing an ovum.

SPERMICIDE. A substance that kills sperm.

SPF. Sun protection factor; a number assigned to sunscreens that indicates the amount of UV-B radiation that is required to produce sunburn in the presence of the sunscreen, relative to the amount of UV-B radiation required to burn unprotected skin.

SPHINCTER. A circular band of muscle that surrounds an opening or passage in the body and narrows or closes the opening by contracting.

SPIKE WAVE DISCHARGE. Characteristic abnormal wave pattern in the electroencephalogram that is a hallmark of an area that has the potential of generating a seizure.

SPINA BIFIDA. Myelomeningocele; a congenital defect in which the fetal backbone and spinal canal do not close completely, allowing the spinal cord and its surrounding membranes to protrude.

SPINAL CANAL. The cavity or hollow space within the spine that contains cerebrospinal fluid.

SPINAL CORD. Elongated nerve bundles that lie in the vertebral canal and from which the spinal nerves emerge.

SPINAL FUSION. An operation in which the bones of the lower spine are permanently joined together using a bone graft obtained usually from the hip.

SPINAL STENOSIS. Narrowing of the canals in the vertebrae or around the nerve roots, causing pressure on the spinal cord and nerves.

SPINE. A term for the backbone that includes the vertebrae, disks, and spinal cord as a whole.

SPIRAL CT. Also referred to as helical CT, this method allows for continuous 360-degree x-ray image capture.

SPIROCHETE. A long, slender, coiled-shape bacterium, such as *T. pallidum* that causes syphilis.

SPIROMETER. A device used to measure the volume and rate at which air is inhaled and exhaled by the patient's lungs.

SPIROMETRY. A test using an instrument called a spirometer that shows how difficult it is for an asthmatic individual to breathe. It is used to determine the severity of asthma and to see how well it is responding to treatment.

SPLEEN. An organ located at the left side of the stomach that acts as a reservoir for blood cells and produces lymphocytes and other products involved in fighting infection.

SPLENECTOMY. Surgical removal of the spleen.

SPLENOMEGALY. Abnormal enlargement of the spleen.

SPLINT. A thin piece of rigid material that is sometimes used during nasal surgery to hold certain structures in place until healing is underway.

SPONDYLITIS. An inflammation of the spine.

SPONDYLOSIS. Arthritis of the spine.

SPONTANEOUS PNEUMOTHORAX. Air in the chest cavity that occurs because of disease or other naturally occurring cause. Air and blood together in this space is called a pneumohemothorax.

SPORADIC. Occurring at random or by chance, and not as a result of a genetically determined, or inherited, trait.

SPORE. A dormant form assumed by some bacteria, such as anthrax, that enable the bacterium to survive high temperatures, dryness, and lack of nourishment for long periods of time. Under proper conditions, the spore may revert to the actively multiplying form of the bacteria.

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SPRUE. A disorder of impaired absorption of nutrients from the diet by the small intestine (malabsorption), resulting in malnutrition. Two forms of sprue exist: tropical sprue, which occurs mainly in tropical regions; and celiac sprue, which occurs more widely and is due to sensitivity to the wheat protein gluten.

SPUR. Any projection from a bone.

SPUTUM. The mixture of mucus, irritants, and other substances expelled from the lungs by coughing.

SPUTUM CULTURE. A laboratory analysis of the fluid produced from the lungs during coughing. A sputum culture can confirm the presence of pathogens in the respiratory system, and help to diagnose certain respiratory infections, including bronchitis, tuberculosis, and pneumonia.

SPUTUM CYTOLOGY. A lab test in which a microscope is used to check for cancer cells in the sputum.

SQUAMOUS CELL CARCINOMA. A form of skin cancer that usually originates in sun-damaged areas or pre-existing lesions; at first local and superficial, it may later spread to other areas of the body.

SQUAMOUS CELLS. Thin, flat cells of the surfaces of the skin and cervix and linings of various organs.

SQUAMOUS EPITHELIAL CELLS. Thin, flat cells found in layers or sheets covering surfaces such as skin and the linings of blood vessels and esophagus.

SQUAMOUS INTRAEPITHELIAL LESION (SIL). A term used to categorize the severity of abnormal changes arising in the squamous, or outermost, layer of the cervix.

STAGING. The classification of cancerous tumors according to the extent and spread of the tumor.

STAMINA. Staying power, endurance.

STANDARD DEVIATION. A measure of the distribution of scores around the average (mean). In a normal distribution, two standard deviations above and below the mean includes about 95% of all samples.

STANDARDIZATION. The process of determining established norms and procedures for a test to act as a standard reference point for future test results.

STAPHYLOCOCCAL INFECTION. An infection caused by any of several pathogenic species of *Staphylococcus*, commonly characterized by the formation of abscesses of the skin or other organs.

STAPHYLOCOCCAL SCALDED SKIN SYNDROME. A disease caused by *Staphylococcus aureus,* in which large sheets of skin may peel away from the body. It most often affects infants, young children, and people with weakened immune systems.

STAPHYLOCOCCUS. A genus of bacteria that is commonly found on human skin and mucous membranes.

STATIC ENCEPHALOPATHY. A disease of the brain that does not get better or worse.

STATINS. A group of medications given to lower blood cholesterol levels that work by inhibiting an enzyme involved in cholesterol formation. Statins are also known as HMG-CoA reductase inhibitors.

STATUS MIGRAINOSUS. The medical term for an acute migraine headache that lasts 72 hours or longer.

STEAM DISTILLATION. A process of extracting essential oils from plant products through a heating and evaporation process.

STEATORRHEA. An excessive amount of fat in the stool.

STEM CELL. Undifferentiated cell that retains the ability to develop into any one of numerous cell types.

STENOSIS (PLURAL, STENOSES). The narrowing or constriction of an opening or passageway in the body.

STENT. A device made of expandable, metal mesh that is placed (by using a balloon catheter) at the site of a narrowing artery; the stent stays in place to keep the artery open.

STEREOPSIS. The visual perception of depth, or the ability to see three-dimensionally. For this to occur, the person must be binocular.

STEREOTACTIC. Characterized by precise positioning in space. When applied to radiosurgery, stereotactic refers to a system of three-dimensional coordinates for locating the target site.

STEREOTACTIC BIOPSY. A biopsy taken by precisely locating areas of abnormal growth through the use of delicate instruments.

STEREOTACTIC BRAIN NEEDLE BIOPSY. In this procedure a computer uses information from a CT or MRI to create a three-dimensional map of the operation site to better guide the needle to perform the biopsy.

STEREOTACTIC TECHNIQUE. A technique used by neurosurgeons to pinpoint locations within the brain. It employs computer imaging to create an external frame of reference.

STERILE. Free of microorganisms.

STERILITY. Inability to conceive a child.

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STERNUM. The breastbone. The sternum is located over the heart, is the point of attachment for ribs at the front of the body, and provides protection to the heart beneath it.

STEROIDS. A class of hormones and drugs that includes sex and stress hormones and anti-inflammatory medications, contraceptives, and growth-promoting substances.

STEROLS. Steroid alcohols, such as cholesterol, that are widely distributed in the body.

STETHOSCOPE. A medical instrument for listening to a patient's heart and lungs.

STEVENS-JOHNSON SYNDROME. A severe inflammatory skin eruption that occurs as a result of an allergic reaction or respiratory infection.

STIMULANTS. A class of psychoactive drugs that improve alertness and concentration. They may be used to treat attention disorders but have a high potential for abuse.

STIMULUS. A factor capable of eliciting a response in a nerve.

STOCKINETTE. A soft elastic material used for bandages and clothing for infants.

STOMA. A surgical opening made in the abdominal wall to allow waste products to pass directly to the outside.

STOMATITIS. Inflammation of the lining of the mouth, gums, or tongue.

STONES. Also known as calculi, stones result from an excessive build-up of mineral crystals in the kidney. Symptoms of stones include intense pain in the lower back or abdomen, urinary tract infection, fever, burning sensation on urination, and/or blood in the urine.

STOOL. The solid waste that is left after food is digested. Stool forms in the intestines and passes out of the body through the anus.

STRABISMUS. A disorder where the two eyes do not point in the same direction.

STRANGULATED HERNIA. A hernia that is so tightly incarcerated outside the abdominal wall that the intestine is blocked and the blood supply to that part of the intestine is cut off.

STRANGULATED OBSTRUCTION. An obstruction in which a loop of the intestine has its blood supply cut off.

STRANGULATION. A condition in which a vessel, section of the intestine, or other body part is compressed or constricted to the point that blood cannot circulate.

STRAWBERRY TONGUE. A sign of scarlet fever in which the tongue appears to have a red coating with large raised bumps.

STREET DRUG. A substance purchased from a drug dealer; may be a legal substance, sold without a prescription and not for medical use, or it may be a substance that is illegal to possess.

STREP THROAT. An infection of the throat caused by bacteria of the *Streptococcus* family, which causes tonsillitis.

STREPTOCOCCAL INFECTION. An infection caused by a pathogenic bacteria of one of several species of the genus *Streptococcus* or their toxins. Almost any organ in the body may be involved.

STREPTOCOCCUS (PLURAL, STREPTOCOCCI). A genus of spherical-shaped anaerobic bacteria occurring in pairs or chains.

STRESS FRACTURE. A crack in a bone (usually the result of overuse).

STRESS INCONTINENCE. Leakage of urine upon movements that put pressure on the abdominal muscles such as coughing, sneezing, laughing, or exercise. One of four types of incontinence.

STRESS MANAGEMENT. A set of techniques and programs intended to help people deal more effectively with stress in their lives by analyzing the specific stressors and taking positive actions to minimize their effects.

STRESS TEST. A test that involves an electrocardiogram during rest and exercise to determine how the heart responds to stress.

STRESSOR. A stimulus or event that provokes a stress response in an organism. Stressors can be categorized as acute or chronic, and as external or internal to the organism.

STRIATED MUSCLE. Also known as striped muscle; it includes muscles of the skeletal system and of the heart.

STRICTURE. An abnormal narrowing of a tube or passageway.

STRIDOR. A harsh or crowing breath sound caused by partial blockage of the patient's upper airway.

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STRING TEST. A test performed to diagnose threadworm infection. The patient is asked to swallow a weighted string that absorbs stomach juices, which can be analyzed for the presence of threadworm larvae.

STROKE. Irreversible damage to the brain caused by insufficient blood flow to the brain as the result of a blocked artery. Damage can include loss of speech or vision, paralysis, cognitive impairment, and death.

STROMA. A term used to describe the supportive tissue surrounding a particular structure, such as an organ.

STRUCTURAL INTEGRATION. The term used to describe the method and philosophy of life associated with Rolfing. Its fundamental concept is the vertical line.

STUNTING. A height more than two standard deviations from the median height for the age in the reference population.

STYPTIC. Any remedy with an astringent and hemostatic (stopping bleeding) quality.

SUBACUTE. An abnormal condition present in a person who appears to be clinically well.

SUBARACHNOID. Referring to the space underneath the arachnoid mater.

SUBARACHNOID HEMORRHAGE. A cause of some strokes in which arteries on the surface of the brain begin bleeding.

SUBARACHNOID SPACE. A space between membranes that covers and protects the brain.

SUBCLAVIAN. Located beneath the collarbone (clavicle).

SUBCORTICAL APHASIA. A condition characterized by either partial or total loss of the ability to communicate verbally or using written words as a result of damage to non language-dominated areas of the brain. This condition may be caused by a stroke, head injury, brain tumor, or infection.

SUBCUTANEOUS. Referring to the area beneath the skin.

SUBCUTANEOUS EMPHYSEMA. A pathologic accumulation of air underneath the skin resulting from improper insufflation technique.

SUBDURAL HEMATOMA. A collection of blood or a clot trapped under the dura mater, the outermost membrane surrounding the brain and spinal cord, often causing neurological damage due to pressure on the brain.

SUBLUXATION. Misalignment between vertebrae that structurally and functionally impairs nerve function.

SUBSTANTIA NIGRA. One of the movement control centers of the brain.

SUBTHRESHOLD. A term used in psychiatry to describe a condition that has significant clinical features but does not meet the full criteria of major disorders. Adjustment disorders are considered subthreshold disorders.

SUCCIMER (CHEMET). A drug used to remove excess lead from the body.

SUCCUSSION. The act of shaking diluted homeopathic remedies as part of the process of potentization.

SUCROSE. The scientific name for table sugar. Sucrose is a disaccharide derived from glucose and fructose.

SUGARS. Those carbohydrates having the general composition of one part carbon, two parts hydrogen, and one part oxygen.

SUICIDE GESTURE. Attempted suicide characterized by a low-lethality method, low level of intent or planning, and little physical damage; sometimes called pseudocide.

SUICIDE MAGNET. A bridge, tall building, or geographic location that acquires a reputation for attracting people who want to commit suicide and attempt it.

SULFADOXONE/PYRIMETHAMINE (FANSIDAR). An antimalarial drug developed in the 1960s. It is the first drug tried in some parts of the world where chloroquine resistance is widespread. It has been associated with severe allergic reactions due to its sulfa component.

SULFINPYRAZONE. A drug that corrects hyperuricemia by increasing the urinary excretion of urate.

SULFITE. A type of preservative that causes allergic reactions in some people.

SULFONAMIDE DRUGS. A group of antibacterial drugs used to treat infections of the lungs and skin, among other things.

SUNBLOCK. A skin preparation containing an active ingredient, such as titanium oxide, that prevents sunburn by physically blocking out ultraviolet radiation.

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SUNSCREEN. Products that block the damaging rays of the sun. Good sunscreens contain either para-aminobenzoic acid (PABA) or benzophenone, or both. Sunscreen protection factors range from 2–45.

SUNSETTING. Confusion or agitation in the evening.

SUPERINFECTION. Infection by a second virus after a previous infection by a different virus has become well established.

SUPERIOR MESENTERIC ARTERY SYNDROME. A condition in which a person vomits after meals due to blockage of the blood supply to the intestine.

SUPERIOR VENA CAVA. The major vein that carries blood from the upper body to the heart.

SUPERIOR VENA CAVA (SVC) SYNDROME. A condition seen in lung cancer patients where the tumor presses against a large blood vessel and causes various symptoms.

SUPPORT GROUP. A group whose primary purpose is the provision of empathy and emotional support for its members. Support groups are less formal and less goal-directed than group therapy.

SUPPORTIVE THERAPY. An approach to psychotherapy that seeks to encourage the patient or offer emotional support to him or her, as distinct from insight-oriented or educational approaches to treatment.

SUPPOSITORY. A solid medication that slowly dissolves after being inserted into the rectum or other body cavity.

SUPPURATE. To produce or discharge pus.

SUPRAGLOTTITIS. Another term for epiglottitis.

SUPRASPINATUS. A muscle at the top of the shoulder blade.

SUPRAVENTRICULAR. A term for an event that occurs in the upper chambers (atria) of the heart.

SUPRAVENTRICULAR TACHYCARDIA. A fast heart beat that originates above the ventricles.

SURFACE TENSION. The attraction of molecules in a fluid for each other.

SURFACTANT. A substance secreted by the alveoli in the lungs that reduces the surface tension of lung fluids, allowing gas exchange and helping maintain the elasticity of lung tissue.

SWEAT GLANDS. Tiny glands scattered throughout the skin that produce sweat.

SWIMMER'S ITCH. An allergic skin inflammation caused by a sensitivity to flatworms that die under the skin, causing an itchy rash.

SYDENHAM'S CHOREA. A childhood disorder of the central nervous system. Once called St. Vitus' dance, the condition is characterized by involuntary, jerky movements that usually follow an attack of rheumatic fever. Rare in the United States today, but a common disorder in developing countries. Usually resolves in two to three months with no long-term adverse effects.

SYLVATIC. Pertaining to or living in the woods or forested areas. The form of yellow fever transmitted by mosquitoes to rainforest monkeys is called sylvatic yellow fever.

SYMPATHETIC NERVE. A nerve of the autonomic nervous system that regulates involuntary and automatic reactions, especially to stress.

SYMPATHETIC NERVOUS SYSTEM. A division of the autonomic nervous sytem, the portion of the nervous system that controls involuntary bodily functions such as heart rate.

SYMPATHOMIMETIC. Denoting a drug that mimics the effects of stimulation of organs and structures by the sympathetic nervous system. The sympathetic nervous system pertains to the part of the nervous system originating in the thoracic and lumbar regions of the spinal cord.

SYMPTOMATIC. Refers to treatment that addresses the symptoms of an illness, but not its underlying cause.

SYNAPSE. A connection between nerve cells, by which nervous excitation is transferred from one cell to the other.

SYNCOPE. A loss of consciousness over a short period of time, caused by a temporary lack of oxygen in the brain.

SYNDACTYLY. A fusion of two or more toes or fingers.

SYNDROME. A collection of abnormalities that occur often enough to suggest they have a common cause.

SYNDROME OF INAPPROPRIATE SECRETION OF ANTIDIURETIC HORMONE (SIADH). A potentially fatal condition of excessive secretion of ADH, leading to concentrated urine and blood sodium deficiency.

SYNDROME X. A term that was sometimes used for metabolic syndrome when the syndrome was first identified in the 1960s.

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SYNERGISTIC. The combined action of two or more processes is greater than the sum of each acting separately.

SYNGENEIC. Referring to a bone marrow transplant from one identical twin to the other.

SYNOVIAL FLUID (SF). A fluid secreted by tissues surrounding the joints that lubricates the joints.

SYNOVIAL JOINT. A joint that allows for bone movement.

SYNOVIAL MEMBRANE. A layer of connective tissue that lines the cavities of joints.

SYNOVIAL TENDON SHEATH. Where the tendons cross joints, they are sheathed in thin membranes known as synovium, which provide lubrication to decrease friction.

SYNOVITIS. Inflammation of the synovium, a membrane found inside joints.

SYNOVIUM. A fibrous envelope that produces a fluid to help to reduce friction and wear in a joint.

SYPHILIS. A sexually transmitted disease caused by a bacteria. There is also a second form that is not sexually transmitted but passed on by direct contact with the patient or through use of shared food dishes and utensils.

SYSTEMIC. A term used to describe a medicine that has effects throughout the body as opposed to topical drugs that work on the skin. Most medicines that are taken by mouth or by injection are systemic drugs.

SYSTEMIC CIRCULATION. Through the body, as opposed to pulmonary circulation (through the lungs).

SYSTEMIC DISEASE. A disease that affects the entire body instead of a specific organ.

SYSTEMIC LUPUS ERYTHEMATOSUS (SLE). A chronic, inflammatory, autoimmune disorder in which the individual's immune system attacks, injures, and destroys the body's own organs and tissues. It may affect many organ systems including the skin, joints, lungs, heart, and kidneys.

SYSTEMIC SCLEROSIS. A rare disorder that causes thickening and scarring of multiple organ systems.

SYSTOLE. The phase of blood circulation in which the heart's pumping chambers (ventricles) are actively pumping blood. The ventricles are squeezing (contracting) forcefully, and the pressure against the walls of the arteries is at its highest.

SYSTOLIC. Relating to or occuring during systole (e.g., systolic blood pressure).

T

T CELLS (T LYMPHOCYTES). White blood cells that originate in the thymus gland. T cells regulate the immune system's response to infections, including HIV. CD4 lymphocytes are a subset of T lymphocytes.

TABES DORSALIS. A progressive deterioration of the spinal cord and spinal nerves that is associated with tertiary syphilis.

TABLEWORK. The passive phase of Trager therapy, in which the practitioner uses gentle and noninvasive movements to allow the client to relax deeply and experience physical movement as free and effortless.

TAC. A topical anesthetic mixture containing tetracaine, epinephrine (adrenaline), and cocaine.

TACHYCARDIA. Rapid heart rate, defined as more than 100 beats per minute.

TAENIASIS. Parasitic infection caused by the presence of tapeworms from the *Taenia* genus, such as the pork tapeworm (*Taenia solium*) or the beef tapeworm (*Taenia saginata*).

TALK THERAPY. A general term for any form of psychotherapy based on conversational interaction between a trained therapist and a client. It includes psychodynamic therapy, humanistic therapy, and the various behavioral therapies as well as psychoanalysis.

TAMPONADE. To occlude by pressure.

TANNER STAGES. A set of scales to measure sexual development during puberty, named for James Tanner (1920–2010), the British pediatrician who devised it.

TAPERING. Gradually reducing the intake of an addictive substance (such as nicotine) as part of a cessation effort.

TAPEWORM. An intestinal parasite that attaches to the intestine or travels to other organs such as the liver and lungs.

TARDIVE DYSKINESIA. Involuntary movements of the face and/or body which are a side effect of the long-term use of some older antipsychotic (neuroleptic) drugs. Tardive dyskinesia affects 15-20% of patients on long-term neuroleptic treatment.

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TARGET HEART RATE. The heart rate, in beats per minute (bpm), that should be maintained during cardiovascular exercise by an individual of a given age.

TARTAR. A hardened yellow or brown mineral deposit from unremoved plaque; also called calculus.

TASER. Also called a conducted electrical weapon or CEW, a taser is an electroshock device used by some police departments in various countries to subdue armed or otherwise dangerous suspects without having to use lethal force. Tasers work by interfering with the brain's capacity to control voluntary muscles. The name *taser* is an acronym for *Thomas A. Swift's Electric Rifle*, an adventure novel about a fictional weapon published in 1911.

TAU PROTEIN. A protein involved in maintaining the internal structure of nerve cells. Tau protein is damaged in AD and forms neurofibrillary tangles.

TAURINE. An amino acid that is important in the development of brain tissue. Taurine is a key component of bile which is needed to digest fats.

TAY-SACHS DISEASE. An inherited disease prevalent among the Ashkenazi Jewish population of the United States. Infants with the disease are unable to process a certain type of fat that accumulates in nerve and brain cells, causing mental and physical retardation, and death by age four.

TD. Tetanus and diphtheria vaccine.

TEAR. A drop of the clear, salty fluid secreted by the lachrimal gland.

TECHNETIUM. A radioactive isotope frequently used in radionuclide scanning of the heart and other organs. It is produced during nuclear fission reactions.

TELANGIECTASIAS. Very small arteriovenous malformations, or connections between the arteries and veins. The result is small red spots on the skin known as "spider veins."

TELEMEDICINE. The use of communications or information technology to deliver clinical care or diagnosis. The medical information may be conveyed by telephone, Internet connections, or other electronic networks.

TEMPEH. A fermented cake of soybeans and other grains; it is a staple food in Indonesia.

TEMPERAMENT. A person's natural or genetically determined disposition.

TEMPORAL ARTERITIS. Also known as giant cell arteritis. Inflammation of the large arteries located in the temples which is marked by the presence of giant cells and symptoms of headache and facial pain.

TEMPORAL BONES. The compound bones that form the left and right sides of the skull.

TEMPORAL LOBE. The part of each side or hemisphere of the brain that is on the side of the head, nearest the ears.

TEMPOROMANDIBULAR JOINT (TMJ). One of a pair of joints that attaches the mandible of the jaw to the temporal bone of the skull. It is a combination of a hinge and a gliding joint.

TEMPOROMANDIBULAR JOINT SYNDROME (TMJ SYNDROME). An incorrect alignment of the lower jaw to the skull that causes the bite to be off line. It causes pain, chronic headaches, nausea, and other symptoms.

TENDINITIS. Inflammation of a tendon, which is a tough band of tissue that connects muscle to bone.

TENDON. A strong connective tissue that connects muscle to bone.

TENDON REFLEX. A reflex action, such as a knee jerk, in which a light blow to the tendon causes the muscle to contract.

TENDON SHEATH. A membrane covering a tendon.

TENESMUS. Straining to urinate or defecate without being able to do so. Tenesmus is a characteristic feature of bacillary dysentery.

TENOSYNOVITIS. Inflammation of a tendon and its enveloping sheath, usually resulting from overuse injury.

TENOTOMY. A surgical procedure that cuts the tendon of a contracted muscle to allow lengthening.

TENS. The abbreviation for transcutaneous electrical nerve stimulation, a technique used to control chronic pain. Electrodes placed over the painful area deliver a mild electrical impulse to nearby nerve pathways.

TENSILON TEST. A test for diagnosing myasthenia gravis. Tensilon is injected into a vein and, if the person has MG, their muscle strength will improve for about five minutes.

TENSION-TYPE HEADACHE. A dull pain that seems to exert pressure on the head; the most common form of headache.

TERATOGEN. Any drug, chemical, maternal disease, or exposure that can cause physical or functional defects in an exposed embryo or fetus.

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TESTES. The pair of male reproductive glands enclosed in the scrotum that produce the male sex hormone testosterone and the spermatozoa. The singular form is testis.

TESTICULAR CANCER. A cancer that originates in the testes.

TESTOSTERONE. Male hormone produced by the testes and (in small amounts) in the ovaries. Testosterone is responsible for some masculine secondary sex characteristics such as growth of body hair and deepening voice.

TETANUS. An acute infectious disease caused by a toxin produced by the bacterium *Clostridium tetani* and usually introduced into the body through a wound.

TETANUS TOXOID. Tetanus toxoid is a vaccine used to prevent tetanus (also known as lockjaw).

TETANY. A disorder of the nervous system characterized by muscle cramps, spasms of the arms and legs, and numbness of the extremities.

TETRALOGY OF FALLOT. A cyanotic defect in which the blood pumped through the body has too little oxygen. Tetralogy of Fallot includes four defects: a large hole between the ventricles, narrowing at or beneath the pulmonary valve, an overly muscular right ventricle, and an aorta over the large hole.

THALAMOTOMY. A surgical procedure that destroys part of a large oval area of gray matter within the brain that acts as a relay center for nerve impulses. The thalamus is an essential part of the nerve pathway that controls intentional movement. By destroying tissue at a particular spot on the thalamus, the surgeon can interrupt the nerve signals that cause tremor.

THALAMUS. A large oval area of gray matter within the brain that relays nerve impulses from the basal ganglia to the cerebellum, both parts of the brain that control and regulate muscle movement.

THALASSEMIA. A group of inherited disorders that affects hemoglobin production. Because hemoglobin production is impaired, a person with this disorder may suffer mild to severe anemia. Certain types of thalassemia can be fatal.

THANATOLOGY. The medical, psychological, or legal study of death and dying.

THELARCHE. The onset of breast development in girls. It is usually first noticed as a firm but tender lump directly under the center of the nipple.

THERAPEUTIC. Curative or healing.

THIAMINE. A B vitamin essential for the body to process carbohydrates and fats.

THIAMINE PYROPHOSPHATE (TPP). The coenzyme containing thiamine that is essential in converting glucose to energy.

THIAZIDE DIURETIC. A particular class of medication that encourages urine production.

THIAZIDES. A group of drugs used to increase urine output.

THIMEROSAL. A crystalline organic mercury compound used as an antifungal and antibacterial agent and present in very small amounts in some vaccines.

THORACENTESIS. A procedure in which fluid is withdrawn from the pleural cavity through a needle inserted between the ribs. The fluid may be withdrawn either for diagnostic tests or to drain the cavity.

THORACIC. Pertaining to the area bounded by the rib cage.

THORACIC AORTIC ANEURYSM. Occurs when an area in the thoracic section of the aorta (the chest) is weakened and bulges like a balloon. The thoracic section supplies blood to the upper body.

THORACIC VERTEBRAE. The vertebrae in the chest region to which the ribs attach.

THORACOSCOPY. Examination of the contents of the chest through a thin, lighted tube passed through a small incision.

THORACOTOMY. Open chest surgery.

THORAX. The chest area, which runs between the abdomen and neck and is encased in the ribs.

THREADWORM. Any long, thin nematode worm.

THROAT CULTURE. A test for strep throat that involves swabbing the back of the throat and sending the swab to a laboratory, which will determine whether bacteria is present.

THROMBIN. An enzyme in blood plasma that helps to convert fibrinogen to fibrin during the last stage of the clotting process.

THROMBIN INHIBITOR. Thrombin inhibitors are one type of anticoagulant medication, used to help prevent formation of harmful blood clots in the body by blocking the activity of thrombin.

THROMBOCYTE. Another name for platelet.

THROMBOCYTOPENIA. An abnormal decline in the number of platelets in the blood.

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THROMBOCYTOSIS. A vascular condition characterized by high blood platelet counts.

THROMBOEMBOLISM. A clot in the blood that forms and blocks a blood vessel. It can lead to infarction, or death of the surrounding tissue due to lack of blood supply.

THROMBOLYSIS. A treatment that opens up blood flow and may prevent permanent damage to the blood vessels.

THROMBOLYTICS. Drugs that dissolve blood clots. Thrombolytics are used to treat embolisms.

THROMBOPHLEBITIS. Inflammation of a vein, associated with the formation of a blood clot.

THROMBOPLASTIN. A protein in blood that converts prothrombin to thrombin.

THROMBOSIS. Formation of a clot in the blood that either blocks, or partially blocks a blood vessel. The thrombus may lead to infarction, or death of tissue, due to a blocked blood supply.

THROMBOTIC. Relating to, caused by, or characterized by thrombosis.

THROMBUS. A blood clot that may form in a blood vessel or in one of the cavities of the heart.

THRUSH. A disease of the mouth, caused by *Candida albicans* and characterized by a whitish growth and ulcers. It can be diagnosed with the KOH test.

THYMOMA. A tumor that originates in the thymus, a small gland just in front of the heart that produces hormones necessary for the development of certain components of the immune system.

THYMUS. A gland located behind the sternum that coordinates the development of the immune system.

THYROID. A butterfly-shaped gland in front and to the sides of the upper part of the windpipe; influences body processes like growth, development, reproduction, and metabolism.

THYROID STORM. A rare but potentially life-threatening complication of hyperthyroidism, characterized by fever over 104°F, irregular heart rhythm, vomiting, diarrhea, dehydration, coma, and death.

THYROIDECTOMY. Surgical removal of the thyroid gland.

THYROIDITIS. Inflammation of the thyroid gland. It can be caused by a viral infection, a malfunction of the immune system, or certain medications.

THYROID-STIMULATING HORMONE (TSH). A hormone produced by the pituitary gland that stimulates the thyroid gland to produce the hormones that regulate metabolism. Also called thyrotropin.

THYROTOXICOSIS. An excess of thyroid hormones in the blood, causing a variety of symptoms that include rapid heart beat, sweating, anxiety, and tremor.

THYROXINE (T_4). The thyroid hormone that regulates many essential body processes.

TIBIA. One of the two bones of the lower leg.

TIC. Brief and intermittent involuntary movement or sound.

TICK-BORNE DISEASE. A disease that is spread to animals by the bite of an infected tick.

TILT TABLE; TILTBOARD. An apparatus for rotating a person from horizontal to an oblique or vertical position.

TINEA. A superficial infection of the skin, hair, or nails, caused by a fungus and commonly known as ringworm.

TINNITUS. A sensation of noise or ringing in the ears. Tinnitus may be a symptom of cerumen impaction.

TISSUE FACTOR. A glycoprotein involved in blood coagulation.

TISSUE PLASMINOGEN ACTIVATOR (TPA). A substance that is sometimes given to patients within three hours of a stroke to dissolve blood clots within the brain.

TITER. The concentration of a substance in a given sample of blood or other tissue fluid.

TITRATE. To analyze the best end point (for dose) for a medication.

TNM SYSTEM. A commonly used staging system that examines the main tumor (T), the lymph nodes (N), and metastases (M).

TOCOLYTIC. A medication that inhibits uterine contractions.

TOFU. A soft cheeselike food made from curdled soybean milk.

TOLERANCE. The requirement for higher doses of a substance or more frequent engagement in an activity to achieve the same effect.

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TOMOGRAPHY. A technique of using ultrasound, gamma rays, or x rays to produce a focused image of the structures across a specific depth within the body, while blurring details at other depths.

TONIFICATION. Acupuncture technique for strengthening the body.

TONOMETER. An instrument that measures intraocular pressure (IOP).

TONOMETRY. The measurement of pressure.

TONSILLECTOMY. Surgical removal of the tonsils.

TONSILLITIS. Inflammation of the tonsils, which are in the back of the throat.

TONSILS. Oval masses of lymphoid tissue on each side of the throat.

TOPHUS (PLURAL, TOPHI). A chalky deposit of a uric acid compound found in gout. Tophi occur most frequently around joints and in the external ear.

TOPICAL. Referring to a medication or other preparation applied to the skin or the outside of the body.

TOPICAL CORTICOSTEROIDS. Cortisone and related drugs used on the skin and in the eye, usually for allergic conditions.

TORSION. The action of twisting.

TORTUOUS ARTERIES. Arteries with many bends and twists.

TOTAL GASTRECTOMY. Surgical removal (excision) of the entire stomach.

TOTAL LUNG CAPACITY. The volume of air in the lungs at the end of a deep breath. The normal value in adults is between 4 and 6 quarts.

TOTAL PARENTERAL NUTRITION (TPN). Intravenous administration of a solution containing all of the nutrients required by the body, such as protein, fat, calories, vitamins, and minerals. TPN provides a complete and balanced source of nutrients for patients who cannot consume a normal diet.

TOTAL-SKIN ELECTRON BEAM THERAPY. A method of radiation therapy used to treat CTCL that involves bombarding the entire body surface with high-energy electrons.

TOURETTE SYNDROME. An abnormal condition that causes uncontrollable facial grimaces and tics as well as arm and shoulder movements. Tourette syndrome is perhaps best known for uncontrollable vocal tics that include grunts, shouts, and use of obscene language (coprolalia).

TOURNIQUET. Any device that is used to compress a blood vessel to stop bleeding or to collect a blood sample. Phlebotomists usually use an elastic band as a tourniquet.

TOXEMIA. Poisoning of the blood.

TOXIC. Poisonous.

TOXIC MEGACOLON. Acute enlargement or dilation of the large intestine.

TOXIC OXYGEN. Oxygen is required for life, as it is needed for energy production. When oxygen is used by the body, most of it is converted to water. However, a small fraction of the oxygen breathed is converted to toxic oxygen. The body uses several different processes for preventing and repairing toxic-oxygen damage. One of these processes involves vitamin E.

TOXIC SHOCK SYNDROME. An uncommon, but potentially fatal, disease that has been associated with the use of diaphragms and vaginal tampons. The symptoms include high fever, vomiting, and diarrhea.

TOXIC THYROID ADENOMA. Self-contained concentrations of thyroid tissue that may produce excessive amounts of thyroid hormone.

TOXICOLOGY. The branch of medicine that deals with the effects, detection, and treatment of poisons.

TOXIN. A substance that has poisonous effects on the body.

TOXOID. A preparation made from inactivated exotoxin, used in immunization.

TRABECULAR MESHWORK. A sponge-like tissue located near the cornea and iris that functions to drain the aqueous humor from the eye into the blood.

TRABECULOPLASTY. Laser surgery that creates perforations in the trabeculum, to drain built up aqueous humor and relieve pressure.

TRABECULUM. Tissue that is a drainage point for aqueous humor in the eye.

TRACE ELEMENTS. A group of elements that are present in the human body in very small amounts but are nonetheless important to good health. They include chromium, copper, cobalt, iodine, iron, selenium, and zinc. Trace elements are also called micronutrients.

TRACER. A substance containing a radioisotope, injected into the body and followed in order to obtain information about various metabolic processes in the body.

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TRACHEA. The tube that leads from the larynx or voice box to two major air passages that bring oxygen to each lung. The trachea is sometimes called the windpipe.

TRACHEOBRONCHIAL. Pertaining both to the tracheal and bronchial tubes or to their junction.

TRACHEOSTOMY. A procedure in which a small opening is made in the neck and into the trachea. A breathing tube is then placed through this opening.

TRACHEOSTOMY TUBE. A tube that is inserted into an incision in the trachea (tracheostomy) to relieve upper airway obstruction.

TRACHEOTOMY. The surgical creation of an opening in the trachea that functions as an alternative airway so that the patient may breathe.

TRACTION. The process of placing a bone, limb, or group of muscles under tension by applying weights and pulleys. The goal is to realign or immobilize the part or to relieve pressure on that particular area to promote healing and restore function.

TRANQUILIZER (MINOR). A drug that has a calming effect and is used to treat anxiety and emotional tension.

TRANS FAT. Fat that is produced by hydrogenation during food processing; trans fats increase bad cholesterol and decrease good cholesterol.

TRANSABDOMINAL ULTRASOUND. A small handheld instrument called a transducer is passed back and forth over the pelvic area to provide images of the abdomen.

TRANSCENDENTAL MEDITATION (TM). A meditation technique based on Hindu practices that involves the repetition of a mantra.

TRANSCORTICAL APHASIA. A condition characterized by either partial or total loss of the ability to communicate verbally or using written words that does not affect an individual's ability to repeat words, phrases, and sentences.

TRANSCRANIAL MAGNETIC STIMULATION. A procedure used to treat patients with depression.

TRANSCUTANEOUS ELECTRICAL NERVE STIMULATION (TENS). A treatment in which a mild electrical current is passed through electrodes on the skin to stimulate nerves and block pain signals.

TRANSDUCER. A device that converts electrical signals into ultrasound waves and ultrasound waves back into electrical impulses.

TRANSESOPHAGEAL ECHOCARDIOGRAPHY. A diagnostic test using an ultrasound device, passed into the esophagus of the patient, to create a clear image of the heart muscle.

TRANSFERENCE. The redirection of feelings and thoughts from early childhood experiences toward a person in the present, usually the analyst.

TRANSFERRIN. A protein in blood plasma that carries iron derived from food intake to the liver, spleen, and bone marrow.

TRANSFUSION. The therapeutic introduction of blood or a blood component into a patient's bloodstream.

TRANSGENIC ANIMAL. Animals that have had genes from other species inserted into their genetic code.

TRANSIENT ISCHEMIC ATTACK (TIA). A brief stroke lasting from a few minutes to 24 hours. TIAs are sometimes called mini-strokes.

TRANSILLUMINATION. A technique by which a strong light is shone through body tissues to examine an organ or structure.

TRANSLOCATION. The transfer of one part of a chromosome to another chromosome during cell division.

TRANSPLANTATION. The removal of tissue from one part of the body for implantation to another part of the body; or the removal of tissue or an organ from one individual and its implantation in another individual by surgery.

TRANSPOSITION OF THE GREAT ARTERIES. A cyanotic defect in which the blood pumped through the body has too little oxygen. The pulmonary artery and the aorta are reversed.

TRANSSEXUAL. A person with gender identity disorder who has an overwhelming desire to change anatomic sex; one who seeks hormonal or surgical treatment to change sex.

TRANSTRACHEAL BIOPSY. A transtracheal biopsy is the removal of a small piece of tissue from across the trachea or windpipe for examination under a microscope.

TRANSUDATE. The type of pleural effusion seen with heart failure or other disorders of the circulation. It features clear fluid containing few cells and little protein.

TRANSUDATION. The passage of fluid, as through blood vessels into the vagina.

TRANSURETHRAL RESECTION OF THE PROSTATE (TURP). Surgical removal of a portion of the prostate through the urethra, a method of treating the symptoms of an enlarged prostate, whether from BPH or cancer.

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TRANSVERSE PRESENTATION. A position in which the fetus lies sideways against the birth canal, with a shoulder or arm possibly entering the canal.

TRANSVESTITISM. Sexual arousal from dressing in the clothes of the opposite sex.

TRAUMA. A disastrous or life-threatening event that can cause severe emotional distress, including dissociative symptoms and disorders.

TRAUMATIC GRIEF. Grief resulting from the loss of a loved one in a traumatic situation (natural or transportation disaster, act of terrorism or mass murder, etc.).

TRAUMATIC SHOCK. A condition of depressed body functions as a reaction to injury with loss of body fluids or lack of oxygen. Signs of traumatic shock include weak and rapid pulse, shallow and rapid breathing, and pale, cool, clammy skin.

TRAVELER'S DIARRHEA. An illness due to infection from a bacteria or parasite that occurs in persons traveling to areas where there is a high frequency of the illness. The disease is usually spread by contaminated food or water.

TREMATODE. Parasitic flatworms or another name for fluke, taken from a Greek word that means having holes.

TREMOR. Shakiness or trembling.

TREMOR CONTROL THERAPY. A method for controlling tremor by self-administered shocks to the part of the brain that controls intentional movement (thalamus). An electrode attached to an insulated lead wire is implanted in the brain; the battery power source is implanted under the skin of the chest, and an extension wire is tunneled under the skin to connect the battery to the lead. The patient turns on the power source to deliver the electrical impulse and interrupt the tremor.

TREPHINE. A small surgical instrument that is rotated to cut a circular incision.

TREPONEMA PALLIDUM. The spirochete bacterium that causes syphilis.

TRETINOIN. A naturally occurring retinoid, derived from vitamin A, that treats acne by increasing the turnover (death and replacement) of skin cells.

TRIANGLING. A process in which two family members lower the tension level between them by drawing in a third member.

TRICHIASIS. A disease of the eye, in which the eyelashes, being turned in upon the eyeball, produce constant irritation by the motion of the lids.

TRICHINA. An individual example of *Trichinella spiralis*.

TRICHINOSIS. A roundworm infection, usually contracted by eating raw or undercooked meat. Trichinosis is rare in the United States but a common infection in some parts of the world.

TRICHOTILLOMANIA. An impulse or compulsion to pull out one's own hair.

TRICUSPID VALVE. A fold in between the right atrium and the right ventricle of the heart that directs blood that needs oxygen to the lungs.

TRIDOSHA. The combination of three basic principles of energy, or biological humor, that comprise life, according to Ayurvedic philosophy.

TRIGEMINAL NEURALGIA. Brief episodes of severe shooting pain on one side of the face caused by inflammation of the root of the trigeminal nerve. Also referred to as tic douloureux.

TRIGLYCERIDE. A substance formed in the body from fat in the diet. Triglycerides are the main fatty materials in the blood. Together with protein, they make up high- and low-density lipoproteins (HDLs and LDLs). Triglyceride levels are important in the diagnosis and treatment of many diseases including high blood pressure, diabetes, and heart disease.

TRIIODOTHYRONINE (T_3). A thyroid hormone similar to thyroxine but more powerful. Preparations of triiodothyronine are used in treating hypothyroidism.

TRIMESTER. The first third or 13 weeks of pregnancy.

TRIMETHOPRIM-SULFAMETHOXAZOLE (TMP-SMX). An antibiotic used to treat and prevent PCP.

TRINUCLEOTIDE REPEAT EXPANSION. A sequence of three nucleotides that is repeated too many times in a section of a gene.

TRIPLOIDY. The condition where an individual has three entire sets of chromosomes instead of the usual two.

TRISOMY. An abnormal condition where three copies of one chromosome are present in the cells of an individual's body instead of two, the normal number.

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TRITURATION. The process of diluting a nonsoluble substance for homeopathic use by grinding it to a fine powder and mixing it with lactose powder.

TROCAR. A small sharp instrument used to puncture the abdomen at the beginning of the laparoscopic procedure.

TROPHOBLAST. The tissues that surround an embryo and attach it to the uterus.

TROPHOZOITE. The active feeding stage of a protozoal parasite, as distinct from its encysted stage.

TRYPTOPHAN. An essential amino acid that has to consumed in the diet because it cannot be manufactured by the body. Tryptophan is converted by the body to niacin, one of the B vitamins.

TUBAL LIGATION. A surgical procedure in which the fallopian tubes are tied in two places and cut between. This prevents eggs from moving from the ovary to the uterus.

TUBAL PREGNANCY. Pregnancy in one of the fallopian tubes.

TUBE ENTEROSTOMY. An enterostomy performed to allow the insertion of a feeding tube into the jejunum or stomach.

TUBERCULIN. A mixture of antigens obtained from the cultured bacteria that cause tuberculosis, *Mycobacterium tuberculosis*.

TUBERCULOMA. A tumor-like mass in the brain that sometimes develops as a complication of tuberculosis meningitis.

TUBERCULOSIS. An infectious disease that usually affects the lungs, but may also affect other parts of the body. Symptoms include fever, weight loss, and coughing up blood.

TUBEROUS SCLEROSIS. A genetic disease that causes skin problems, seizures, and mental retardation. Autism occurs more often in individuals with tuberous sclerosis.

TUBULAR CARCINOMA. A type of cancer that accounts for approximately 1% to 2% of breast cancers. Can appear small on ultrasound or mammogram.

TUBULAR KIDNEY DISEASE. Disease of the kidney that affect the tubules, the part of the kidney that allows certain substances to be reabsorbed back into the blood.

TUBULE. A very small tube-shaped structure in the nephron of the kidney that removes certain ions and molecules from the blood and deposits them into the fluid within the tubule.

TUMOR. An abnormal growth resulting from a cell that lost its normal growth control restraints and started multiplying uncontrollably.

TUMOR LYSIS SYNDROME. A side effect of some immunotherapies, like monoclonal antibodies, that lyse the tumor cells, due to the toxicity of flooding the bloodstream with such a quantity of cellular contents.

TUMOR MARKERS. Biochemicals produced by tumor cells or by the body in response to tumor cells. Their levels in the blood help evaluate people for certain kinds of cancer.

TUMOR-SUPPRESSOR GENE. Gene involved in controlling normal cell growth and preventing cancer.

TUNICA ALBUGINEA. The sheath of elastic tissue enclosing the corpora cavernosa.

TUNICA VAGINALIS. A sac-like membrane covering the outer surface of the testis.

TURBIDIMETRY. A technique of measurement that analyzes the amount of sediment in a liquid.

TURBIDITY. The cloudiness or lack of transparency of a solution.

TURBINADO SUGAR. A type of sugar made from sugar cane extract. It resembles light brown sugar in color but is paler and has larger crystals. It is called demerara sugar in the United Kingdom.

TURBINATE. Ridge-shaped cartilage or soft bony tissue inside the nose.

TURNER'S SYNDROME. A disorder in women caused by an inherited chromosomal defect. This disorder inhibits sexual development and causes infertility. A symptom is absence of menstruation.

TWILIGHT ANESTHESIA. An intravenous mixture of sedatives and other medications that decreases patients' awareness of the procedure being performed.

TWIN REVERSED ARTERIAL PERFUSION (TRAP) SEQUENCE. A condition in which one fetus lacks a heart and the other fetus pumps the blood for both.

TWIN-TO-TWIN TRANSFUSION SYNDROME (TTTS). A condition in monochorionic twins in which there is a connection between the two circulatory systems so that the donor twin pumps the blood to the recipient twin without a return of blood to the donor.

TYMPANIC MEMBRANE. The eardrum. A thin disc of tissue that separates the outer ear from the middle ear.

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TYMPANOSTOMY TUBE. Ear tube. A small tube made of metal or plastic that is inserted during myringotomy to ventilate the middle ear.

TYPE 1 DIABETES. A chronic immune system disorder in which the pancreas does not produce sufficient amounts of insulin, a hormone that enables cells to use glucose for energy. Also called juvenile diabetes, it must be treated with insulin injections.

TYPE 2 DIABETES. Sometimes called adult-onset diabetes, this disease prevents the body from properly using glucose (sugar), but can often be controlled with diet and exercise.

TYPHOID FEVER. An infectious disease caused by a type of bacterium. People with this disease have a lingering fever and feel depressed and exhausted. Diarrhea and rose-colored spots on the chest and abdomen are other symptoms. The disease is spread through poor sanitation.

TYPICAL USE. A measurement of the effectiveness of a contraceptive that counts all users, including those who use the method incorrectly or only occasionally.

TYROSINASE. An enzyme in a pigment cell which helps change tyrosine to DOPA during the process of making melanin.

TYROSINE. A protein building block found in a wide variety of foods that is used by the body to make melanin.

TZANCK PREPARATION. A procedure in which skin cells from a blister are stained and examined under the microscope.

U

UDANA. Life sustaining energy of the diaphragm, the third of the five airs of Ayurvedic philosophy, the life force governing upward motion.

ULCER. An open sore on the skin, resulting from tissue destruction, that is usually accompanied by redness, pain, or infection.

ULCERATED. Damaged so that the surface tissue is lost and/or necrotic (dead).

ULCERATION. A pitted area or break in the continuity of a surface, such as the skin or mucous membrane.

ULCERATIVE COLITIS. A disease of the colon characterized by inflammation of the mucous lining, ulcerated areas of tissue, and bloody diarrhea.

ULTRASONOGRAM. A procedure in which high-frequency sound waves that cannot be heard by human ears are bounced off internal organs and tissues. These sound waves produce a pattern of echoes that are then used by the computer to create sonograms or pictures of areas inside the body.

ULTRASONOGRAPHER. The person who performs the radiologic technique of ultrasound in which deep structures of the body are visualized.

ULTRASONOGRAPHY. Imaging test using sound waves to view internal organs and tissues.

ULTRASOUND. An imaging technique that uses sound waves to generate a picture of an internal structure in the body.

ULTRASOUND SCAN. The scan produces images of arteries on a screen and is used to evaluate the blood flow, locate blockages, and measure the size of the artery.

ULTRASOUND WAVES. High frequency sound waves.

ULTRAVIOLET (UV) LIGHT. A portion of the light spectrum not visible to the eye. It is damaging to living material, especially eyes and DNA.

ULTRAVIOLET RADIATION (UV). Invisible light rays that may be responsible for sunburns, skin cancers, and cataract formation.

UMBILICAL. Referring to the opening in the abdominal wall where the blood vessels from the placenta enter.

UMBILICAL CORD. The blood vessels that allow the developing baby to receive nutrition and oxygen from its mother; the blood vessels also eliminate the baby's waste products. One end of the umbilical cord is attached to the placenta and the other end is attached to the baby's belly button (umbilicus).

UMBILICAL CORD BLOOD TRANSPLANT. A procedure in which the blood from a newborn's umbilical cord, which is rich in stem cells, is used as the donor source for bone marrow transplants.

UMBILICUS. The area where the umbilical cord was attached; also known as the navel or belly button.

UNIFOCAL. Only one tumor present in one eye.

UNILATERAL. Located on or affecting only one side of the body.

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UNIPARENTAL DISOMY. Chromosome abnormality in which both chromosomes in a pair are inherited from the same parent.

UNRESECTABLE CANCER. A tumor that cannot be completely removed by surgery.

UNSATURATED FAT. Fat found in plant foods that is typically liquid (oil) at room temperature. They can be monounsaturated or polyunsaturated, depending on the chemical structure. Unsaturated fats are the most recommended dietary fats.

UPPER ENDOSCOPY. A medical procedure in which a thin, lighted, flexible tube (endoscope) is inserted down the patient's throat. Through this tube the doctor can view the lining of the esophagus, stomach, and the upper part of the small intestine.

URATE CRYSTALS. Crystals formed by high levels of uric acid in the blood.

UREA. A compound containing nitrogen that occurs in the urine and other body fluids as a result of protein metabolism.

UREMIA. The presence of excessive amounts of urea and other waste products in the blood.

UREMIC POISONING. Accumulation of waste products in the body.

URETER. The tube-like passageway in the body that carries urine from the kidney to the bladder.

URETERAL STENT. A surgical device implanted in patients with damaged ureters that holds the ureter open so that urine can flow freely from the kidneys to the bladder.

URETEROVESICAL JUNCTION. The joining of the ureter to the bladder.

URETEROVESICAL VALVE. A sphincter (an opening controlled by a circular muscle), located where the ureter enters the bladder, that keeps urine from flowing backward toward the kidney.

URETHRA. The tube that carries urine from the bladder to outside the body. In females, the urethral opening is between the vagina and clitoris; in males, the urethra travels through the penis, opening at the tip.

URETHRA HYPERMOBILITY. Main factor in stress urinary incontinence, with severity based upon how far the urethra has descended into the pelvic floor through herniation or cystocele.

URETHRAL MEATUS. This is the external opening of the urethra.

URETHRAL STRICTURE. A narrowing of the urethra (urine tube).

URETHRITIS. Inflammation of the urethra.

URETOSCOPE. A tube-shaped device inserted into the body through the urinary system that allows objects to be both seen and grasped for removal.

URIC ACID. A compound resulting from the body's breakdown of purine. It is normally present in human urine only in small amounts.

URICOSURIA. Increased levels of uric acid in the urine.

URINALYSIS (PLURAL, URINALYSES). The diagnostic testing of a urine sample.

URINARY INCONTINENCE. The inability to control one's urine flow.

URINARY RETENTION. The result of progressive obstruction of the urethra by an enlarging prostate, causing urine to remain in the bladder even after urination.

URINARY TRACT. The passage through which urine flows from the kidneys out of the body.

URINE. The fluid containing water and waste products that is produced by the kidneys, stored in the bladder, and removed from the body through the urethra.

URINE DIPSTICK TEST. A test using a small, chemically treated strip that is dipped into a urine sample; when testing for protein, an area on the strip changes color depending on the amount of protein (if any) in the urine.

UROGENITAL. Both the urinary system and the sexual organs, which form together in the developing embryo.

UROGYNECOLOGIST. A physician that specializes in female medical conditions concerning the urinary and reproductive systems.

UROLOGIST. A physician who specializes in problems of the urinary system.

URORADIOLOGIST. A radiologist that specializes in diagnostic imaging of the urinary tract and kidneys.

UROSTOMY. A surgical opening (a stoma) created to divert urine to the outside of the body for collection once the bladder has been removed.

UROTHELIUM. The lining of the urinary tract, including the renal pelvis, ureters, bladder, and urethra.

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UTERINE FIBROID. A noncancerous tumor of the uterus that can range from the size of a pea to the size of a grapefruit. Small fibroids require no treatment, but those causing serious symptoms may need to be removed.

UTERINE PROLAPSE. Bulging of the uterus into the vagina.

UTERUS. The hollow, muscular female organ that supports the development and nourishment of the unborn baby during pregnancy.

UVEA. The middle of the three coats of tissue surrounding the eye, comprising the choroid, iris, and ciliary body. The uvea is pigmented and well supplied with blood vessels.

UVEAL TRACT. The pigmented membrane that lines the back of the retina of the eye and extends forward to include the iris. The uveal tract is sometimes called the uvea and has three parts: the iris, the choroid, and the ciliary body.

UVEITIS. Inflammation of the area of the eye around the pupil.

UVULOPALATOPHARYNGOPLASTY (UPPP). An operation to remove excess tissue at the back of the throat to prevent it from closing off the airway during sleep.

V

VACCINATION. Injection of a killed or weakened microbe in order to stimulate the immune system against the microbe, thereby preventing disease. Vaccinations, or immunizations, work by stimulating the immune system, the natural disease-fighting system of the body. The healthy immune system is able to recognize invading bacteria and viruses and produce substances (antibodies) to destroy or disable them. Vaccinations prepare the immune system to ward off a disease. To immunize against viral diseases, the virus used in the vaccine has been weakened or killed.

VACCINE. A preparation using a non-infectious element or relative of a particular virus or bacteria, administered with the intention of halting the progress of an infection or completely preventing it.

VAGINA. The birth canal; the passage from the cervix of the uterus to the opening leading outside of a woman's body.

VAGINAL DISCHARGE. Discharge of secretions from the cervical glands of the vagina; normally clear or white.

VAGINAL PROLAPSE. Bulging of the top of the vagina into the lower vagina or outside the opening of the vagina.

VAGINAL STENOSIS. Narrowing of the vagina due to a buildup of scar tissue.

VAGINAL YEAST INFECTION. An overgrowth of fungus in the vaginal area.

VAGINISMUS. A painful spasmodic vaginal contraction.

VAGINITIS. Inflammation of the vagina.

VAGOTOMY. Cutting of the vagus nerve. If the vagus nerves are cut as they enter the stomach (truncal vagotomy), gastric secretions are decreased, as is intestinal motility (movement) and stomach emptying. In a selective vagotomy, only those branches of the vagus nerve are cut that stimulate the secretory cells.

VAGUS NERVE. Cranial nerves that supply the internal organs (viscera).

VALACYCLOVIR. An oral antiviral drug that blocks the replication of the varicella zoster virus.

VALSALVA MANEUVER. Pilots grunt and tighten their abdominal muscles to prevent black outs during high-performance flying.

VALVE. Tissue in the passageways between the heart's upper and lower chambers that controls passage of blood and prevents regurgitation.

VALVULAR. Having to do with the valves inside the heart.

VALVULAR HEART DISEASE. A disease of any one of the four valves that controls blood flow into, through, and out of the heart.

VAPORIZE. To dissolve solid material or convert it into smoke or gas.

VARIABLE DECELERATION. Fetal bradycardia below 100 beats per minute denoting compression of the umbilical cord at the height of a uterine contraction.

VARICELLA. Chickenpox; a disease caused by the *Varicella zoster* virus—human herpes virus 3—that can cause severe birth defects if transmitted to the fetus during the first 20 weeks of pregnancy and newborn complications if it is transmitted perinatally.

VARICELLA–ZOSTER IMMUNE GLOBULIN (VZIG). A substance that can reduce the severity of chickenpox symptoms.

VARICES. Swollen or enlarged veins.

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VARICOCELE. An abnormal enlargement of the veins which drain the testicles.

VARICOSE VEINS . Twisted, enlarged veins near the surface of the skin, which develop most commonly in the legs and ankles.

VARIEGATION. Patchy variation in color.

VAS DEFERENS. The duct that stores sperm and carries it from the epididymis to the ejaculatory duct.

VASCULAR. Pertaining to blood vessels.

VASCULITIS. An inflammation of the blood vessels.

VASCULOGENIC ERECTILE DYSFUNCTION. The inability to attain or sustain an erection satisfactory for coitus, due to atherosclerotic disease of penile arteries, inadequate impedance of venous outflow (venous leaks), or a combination of both.

VASECTOMY. Surgical sterilization of the male, done by removing a portion of the tube that carries sperm to the urethra.

VASOCONSTRICTION. Constriction of a blood vessel.

VASODILATATION. The increase in the internal diameter of a blood vessel that results from relaxation of smooth muscle within the wall of the vessel thus causing an increase in blood flow.

VASODILATOR. A class of drugs that widen the blood vessels, that in turn decreases resistance to blood flow and lowers blood pressure.

VASOPRESSORS. Medications that constrict the blood vessels.

VASOSPASM. Narrowing of a blood vessel caused by a spasm of the smooth muscle of the vessel wall.

VASOVAGAL REACTION. Regarding the action of stimuli from the vagus nerve on blood vessels.

VATA. One of the three main constitutional types found under Ayurvedic principles. Keeping one's particular constitution in balance is considered important in maintaining health.

VBAC. Vaginal birth after cesarean.

VECTOR. An animal carrier that transfers an infectious organism from one host to another.

VEGETATION. An abnormal growth of tissue around a valve, composed of blood platelets, bacteria, and a protein involved in clotting.

VEIN. A blood vessel that returns oxygen-depleted blood from various parts of the body to the heart.

VENA CAVA. The large vein that drains directly into the heart after gathering incoming blood from the entire body.

VENEREAL DISEASE. Another term for sexually transmitted disease.

VENESECTION. Another name for phlebotomy.

VENOARTERIAL (V-A) BYPASS. The type of ECMO that provides both heart and lung support, using two tubes (one in the jugular vein and one in the carotid artery).

VENOM. A poisonous substance secreted by an animal, usually delivered through a bite or a sting.

VENOUS STASIS DISEASE. A condition in which there is pooling of blood in the lower leg veins that may cause swelling and tissue damage, and lead to painful sores or ulcers.

VENOVENOUS (V-V) BYPASS. The type of ECMO that provides lung support only, using a tube inserted into the jugular vein.

VENTILATOR. A mechanical device that can take over the work of breathing for a patient whose lungs are injured.

VENTRICLES. The two chambers of the heart that are involved in pumping blood. The right ventricle pumps blood into the lungs to receive oxygen. The left ventricle pumps blood into the circulation of the body to deliver oxygen to all of the body's organs and tissues.

VENTRICULAR FIBRILLATION. A condition in which the lower chamber of the heart quivers instead of pumping in an organized way.

VENTRICULAR SEPTAL DEFECT (VSD). A defect or opening in the ventricular septum, the wall of tissue that separates the two lower chambers of the heart.

VENTRICULAR TACHYCARDIA. A rapid heartbeat, usually more than 100 beats per minute.

VERMILION BORDER. The line between the lip and the skin.

VERTEBRA (PLURAL, VERTEBRAE). One of the bones of the spinal column. There are 33 vertebrae in the human spine.

VERTEBRAL COLUMN. The vertebral column, also called the spinal column or spine, consists of a series of vertebrae connected by ligaments. It provides a supporting axis for the body and protects the spinal cord. The vertebral column consists of seven cervical vertebrae in the neck, followed by 12 thoracic vertebrae that

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connect to the ribs, five lumbar vertebrae in the lower back, the sacrum, and the coccyx.

VERTEBROBASILAR ARTERIES. Major blood vessels that lead to the brain. They are located at the base of the skull at the back of the head.

VERTIGO. The sensation of moving around in space, or objects moving around a person. It is a disturbance of equilibrium.

VESICLE. A bump on the skin filled with fluid.

VESTIBULAR SYSTEM. The brain and parts of the inner ear that work together to detect movement and position.

VESTIBULECTOMY. Surgical removal of the vestibule and hymen.

VESTIBULOCOCHLEAR NERVE (EIGHTH CRANIAL NERVE). Nerve that transmits information, about hearing and balance from the ear to the brain.

VIAGRA. Trade name of an orally administered drug for erectile failure first cleared for marketing in the United States in March 1998. Its generic name is sildenafil citrate.

VIBRATION. A procedure to help break up lung secretions, performed as the patient breathes deeply. When done manually, the person performing the vibration places his or her hands against the patient's chest and creates vibrations by quickly contracting and relaxing arm and shoulder muscles while the patient exhales. The procedure is repeated several times each day for about five exhalations.

VIBROACOUSTIC STIMULATION. In the biophysical profile, use of an artificial larynx to produce a loud noise to "awaken" the fetus.

VIDEO-ASSISTED THORACIC SURGERY (VATS). A technique used to aid in the placement of chest tubes or when performing decortications when treating advanced empyema.

VIDEOSCOPE. A surgical camera.

VILLI. Tiny, finger–like projections that enable the small intestine to absorb nutrients from food.

VIRAL LOAD. A measure of the severity of a viral infection, calculated by estimating the number of copies of the virus in a milliliter of blood.

VIRAL LOAD TEST. A new blood test for monitoring the speed of HIV replication in AIDS patients. The viral load test is based on PCR techniques and supplements the CD4+ cell count tests.

VIRTUAL COLONOSCOPY. Two new techniques that provide views of the colon to screen for colon polyps and cancer. The images are produced by computerized manipulations rather than direct observation through the colonoscope; one technique uses the X-ray images from a CT scan, and the other uses magnetic images from an MRI scan.

VIRUS. A tiny, disease-causing structure that can reproduce only in living cells and causes a variety of infectious diseases.

VISCERA. Any of the body's organs located in the chest or abdomen.

VISCERAL LARVA MIGRANS (VLM). Another name for toxocariasis. The name is derived from the life cycle of the organism.

VISUAL ACUITY. Sharpness or clearness of vision.

VISUAL ACUITY TEST. An eye examination that determines sharpness of vision, typically performed by identifying objects and/or letters on an eye chart.

VISUALIZATION. The process of making an internal organ visible. A radiopaque subtance is introduced into the body, then an x-ray picture of the desired organ is taken.

VISUAL-MOTOR SKILLS. Hand-eye coordination; in the Bender-Gestalt test, visual-motor skills are measured by the subject's ability to accurately perceive and then reproduce figures.

VISUAL-PERCEPTUAL SKILLS. The capacity of the mind and the eye to "see" something as it objectively exists.

VITAL CAPACITY (VC). The largest amount of air expelled after one's deepest inhalation.

VITAL SIGNS. Basic indicators of body function, usually meaning heartbeats per minute, breaths per minute, blood pressure, body temperature, and weight.

VITAMIN. An essential nutrient the body needs in small amounts to remain healthy but that the body cannot manufacture for itself and must acquire through diet.

VITAMIN D. Any of several fat-soluble vitamins that are required for normal bone and teeth structure and various other physiological functions. Vitamin D is obtained from some foods and is produced in the body through the action of ultraviolet radiation.

VITAMIN STATUS. Vitamin status refers to the state of vitamin sufficiency or deficiency of any person. For example, a test may reveal that a patient's folate status is sufficient, borderline, or severely inadequate.

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VITILIGO. A chronic skin disorder that causes loss of pigmentation (color) from patches of skin, most often on the face, hands, and wrists.

VITREOUS. The transparent gel that fills the back part of the eyeball, behind the lens; also referred to as the vitreous body.

VITREOUS HUMOR. The clear gel-like substance that fills the eyeball behind the lens.

VITREOUS SEEDING. When small pieces of tumor have broken off and are floating around the vitreous.

VOICE BOX. The larynx.

VOIDING. Another word for emptying the bladder or urinating.

VOLATILE. Something that vaporizes or evaporates quickly when exposed to air.

VOLATILE ORGANIC COMPOUNDS. VOCs, a large class of carbon-based chemicals that release gases into the air as they evaporate at room temperature. Found both in natural sources such as living trees, decomposing vegetation, and crude oil, and in manmade sources such as solvents, adhesives, and gasoline, VOCs help form ozone at ground levels and are major air contaminants.

VOLATILE SOLVENTS. Liquids that vaporize at room temperature, including a variety of industrial and household products and art and office-supply solvents.

VOLTAGE. The force necessary to drive an electric current between two specified points. A large voltage exerts a greater force, which moves more electrons through a wire at a given rate of time.

VOLUNTARY. An action or thought undertaken or controlled by a person's free will or choice.

VOLUNTARY MUSCLE. A muscle under conscious control, such as arm and leg muscles.

VOLVULUS. A twisting of the intestine that causes an obstruction.

VON WILLEBRAND FACTOR (VWF). A protein found in the blood that is involved in the process of blood clotting.

VON WILLEBRAND'S DISEASE. An inherited lifelong bleeding disorder caused by an abnormal gene, similar to hemophilia. The gene defect results in a decreased blood concentration of a substance called von Willebrand's factor (vWF).

VOYEURISM. Sexual stimulation by visual means, usually by observing an unsuspecting individual.

VULVA. The external female genitalia including the mons pubis, labia majora and minora, clitoris, vestibule, glands, and the vaginal opening.

VULVAR VESTIBULITIS. A localized inflammation of the vestibule—the region immediately surrounding the opening of the vagina and the urethra.

VULVODYNIA. A chronic burning, stinging, or irritation of the vulva.

VYANA. Life sustaining energy of the heart and lungs; the second of the five airs of Ayurvedic philosophy; the life force governing circular motion.

W

WARFARIN. A drug that reduces the ability of the blood to clot.

WART. A raised growth on the surface of the skin or other organ.

WARTHIN'S TUMOR. A benign tumor of the parotid gland.

WASTING SYNDROME. A combination of weight loss and change in composition of body tissues that occurs in patients with HIV infection. Typically, the patient's body loses lean muscle tissue and replaces it with fat as well as losing weight overall.

WATER BRASH. The flow of saliva and stomach acid back up the esophagus and into the throat or lungs.

WATER HOMEOSTASIS. A condition of adequate fluid level in the body in which fluid loss and fluid intake are equally matched and sodium levels are within normal range.

WATER INTOXICATION. A potentially life-threatening condition caused by drinking too much water, which leads to hyponatremia and may result in seizures, coma, and death.

WATER-SOLUBLE VITAMINS. Vitamins that are not stored in the body and are easily excreted. They must, therefore, be consumed regularly as foods or supplements to maintain health.

WBC DIFFERENTIAL. A white blood cell count in which the technician classifies the different white blood cells by type as well as calculating the number of each type. A WBC differential is necessary to calculate the absolute CD4+ lymphocyte count.

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WEBER TEST. A hearing test using a vibrating tuning fork which is held at various points along the midline of the skull and face.

WEGENER'S GRANULOMATOSIS. A disease usually affecting males that causes the infiltration of inflammatory cells and tissue death in the lungs, kidneys, blood vessels, heart, and other tissues.

WERNICKE-KORSAKOFF SYNDROME. A combination of symptoms, including eye-movement problems, tremors, and confusion, that is caused by a lack of the B vitamin thiamine and may be seen in alcoholics.

WERNICKE'S APHASIA. A condition characterized by either partial or total loss of the ability to understand what is being said or read. The individual maintains the ability to speak, but speech may contain unnecessary or made-up words.

WESTERN BLOT. A procedure that uses electrical current passed through a gel containing a sample of tissue extract in order to break down the proteins in the sample and detect the presence of antibodies for a specific disease. The Western blot method is used in HIV testing to confirm the results of an initial screening test.

WHEEZE. A whistling sound made by the flow of high-velocity air through narrowed airways. Wheezing is a symptom of several respiratory diseases including byssinosis and asthma.

WHIPPLE PROCEDURE. Surgical removal of the head of the pancreas, part of the small intestine, and some surrounding tissue.

WHIPPLE'S DISEASE. A disorder of impaired absorption of nutrients by the small intestine. Symptoms include diarrhea, abdominal pain, progressive weight loss, joint pain, swollen lymph nodes, abnormal skin pigmentation, anemia, and fever. The precise cause is unknown, but it is probably due to an unidentified bacterial infection.

WHIPWORM. A nematode worm of the family Trichuridae with a body that is thick at one end and very long and slender at the other end.

WHITE BLOOD CELL (LEUKOCYTE; WBC). A blood cell that is responsible for fighting infection.

WHOLE BLOOD. Blood that contains red blood cells, white blood cells, and platelets in plasma.

WHOOPING COUGH. An infectious disease, also called pertussis, especially of children that is caused by a bacterium and is marked by a convulsive, spasmodic cough, sometimes followed by a shrill intake of breath.

WILDCRAFTING. Gathering of herbs or other natural materials.

WILDERNESS. Large backcountry areas lacking roads, communication and other modern infrastructure.

WILSON'S DISEASE. A genetic disorder in which copper accumulates in the body, leading to liver disease and a variety of neurological and psychiatric symptoms.

WINDOW OPERATION. Cutting out a large oval-shaped piece of the cyst wall and putting in stitches to create a window so the cyst cannot reoccur.

WINDOW PERIOD. The period of time between a person's getting infected with HIV and the point at which antibodies against the virus can be detected in a blood sample.

WIRELESS CAPSULE ENDOSCOPY. A newer method of examining the small bowel by means of a capsule swallowed by the patient. The capsule contains a miniaturized lens and an antenna that transmits information to a belt-pack recorder worn by the patient during the day.

WISDOM TOOTH. One of the four last teeth on the top and bottom rows of teeth. Also called a third molar.

WITHDRAWAL. Physical symptoms and psychological discomforts experienced after a person suddenly stops using a drug on which he or she has become dependent.

"WHEAL AND FLARE" REACTION. A rapid response to a skin allergy test characterized by the development of a red, itching spot in the area where the allergen was injected.

WOLFF-PARKINSON-WHITE SYNDROME. An abnormal, rapid heart rhythm, due to an extra pathway for the electrical impulses to travel from the atria to the ventricles.

WOOD'S LAMP. A special lamp that uses ultraviolet light to detect certain types of skin infections and infestations. It was invented in 1903 by a physicist named Robert Wood.

WORD CATHETER. A small rubber catheter with an inflatable balloon tip that is inserted into a stab incision in the cyst, after the contents of the cyst have been drained.

WORD SALAD. Speech that is so disorganized that it makes no linguistic or grammatical sense.

WORKING MEMORY. The memory system that relates to the task at hand and coordinates recall of memories necessary to complete it.

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WOUND. Any injury that breaks the skin, including cuts, scratches, and puncture wounds.

WRIGHT'S STAIN. A chemical used to stain tissue samples for laboratory analysis.

X

X CHROMOSOME. One of the two types of sex chromosomes; females have two X chromosomes, while males have one X chromosome and one Y chromosome.

X RAY. A form of electromagnetic radiation with shorter wavelengths than normal light. X rays can penetrate most structures.

XANTHOMAS. Fatty yellow patches or nodules on the skin or internal tissues.

XENOGRAFT. Tissue that is transplanted from one species to another (e.g., pigs to humans).

XENOTRANSPLANT. Transplantation of animal cells or tissues into a human.

XERODERMA PIGMENTOSUM. A genetic disease characterized by the inability to repair damaged DNA. Individuals with this disease develop an excessive number of skin cancers.

XEROPHTHALMIA. A drying of the cornea and conjunctiva.

XEROSTOMIA. The medical term for dry mouth.

X-LINKED. Refers to a gene carried on the X chromosome, one of the two sex chromosomes.

X-LINKED DOMINANT INHERITANCE. The inheritance of a trait by the presence of a single gene on the X chromosome in a male or female, passed from an affected female who has the gene on one of her X chromosomes.

X-LINKED GENE. A gene carried on the X chromosome, one of the two sex chromosomes.

X-LINKED HYPOPHOSPHATEMIA,. A type of rickets caused by genetic factors which prevent the kidneys from retaining phosphate.

X-LINKED RECESSIVE INHERITANCE. The inheritance of a trait by the presence of a single gene on the X chromosome in a male, passed from a female who has the gene on one of her X chromosomes, and who is referred to as an unaffected carrier.

Y

YELLOW FEVER. An infectious disease caused by a virus. The disease, which is spread by mosquitoes, is most common in Central and South America and Central Africa. Symptoms include high fever, jaundice (yellow eyes and skin) and dark-colored vomit, a sign of internal bleeding. Yellow fever can be fatal.

YIN/YANG. Complimentary universal characteristics used to describe aspects of the natural world.

YOGA. A system of exercise aimed at promoting the control of the body and the mind.

YOGI (FEMALE, YOGINI). A trained practitioner of yoga.

YOLK SAC. A sac made of membranous tissue which is attached to the embryo and which provides nutrition to the embryo.

YUZPE REGIMEN. A form of emergency contraception in which two oral contraceptive pills that contain both of the hormones estrogen and progestin are taken to prevent pregnancy.

Z

ZAFIRLUKAST (ACCOLATE). An inhibitor that prevents leukotrienes from binding to cell receptors; taken over time, zafirlukast can help reduce or prevent asthma symptoms.

ZELLWEGER SPECTRUM. Three peroxisome biogenesis disorders—Zellwinger syndrome, neonatal adrenoleukodystrophy, and infantile Refsum disease—which can be caused by different mutations in the same genes and which differ only in the severity of the resulting condition.

ZEN. A form of meditation that emphasizes direct experience.

ZIFT. Stands for zygote intrafallopian tube transfer. In in vitro fertilization, the eggs are fertilized in a laboratory dish and then placed in the woman's fallopian tube.

ZILEUTON (ZYFLO). A medication that interferes with the biosynthetic pathway that produces leukotrienes; used to help prevent asthma attacks.

ZOLLINGER-ELLIZON SYNDROME. Severe peptic ulceration from excessive stomach acid production stimulated by one or more tumors that produce a powerful acid secretion.

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ZONE THERAPY. Also called zone analgesia, a method of relieving pain by applying pressure to specific points on the body. It was developed in the early twentieth century by Dr. William Fitzgerald.

ZOONOSIS (PLURAL, ZOONOSES). Any disease of animals that can be transmitted to humans under natural conditions. Lyme disease, rabies, psittacosis (parrot fever), cat-scratch fever, and monkeypox are examples of zoonoses.

ZOONOTIC DISEASES. Diseases caused by infectious agents that can be transmitted between (or are shared by) animals and humans. This can include transmission through the bite of an insect, such as a mosquito.

ZYGOMYCOSIS. Another term for mucormycosis. The fungi that cause mucormycosis belong to a group called Zygomycetes.

ZYGOTE. A fertilized egg.

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